

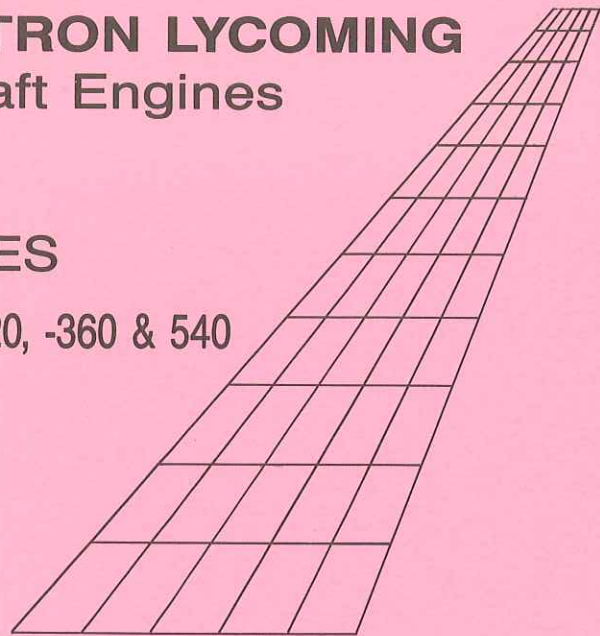
OPERATOR'S MANUAL

TEXTRON LYCOMING
Aircraft Engines

SERIES

AEIO-320, -360 & 540

60297-21



TEXTRON Lycoming

Textron Lycoming/Subsidiary of Textron Inc.
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Williamsport, PA 17701 U.S.A.
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LYCOMING WILLIAMSPORT DIVISION

OPERATOR'S MANUAL

REVISION

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NOTE

This manual contains all revisions from December 1974 through May, 1983.

OPERATOR'S MANUAL

AE10-320,-360 and 540
SERIES
AIRCRAFT ENGINES

1st Edition

Oct 1974

Approved by F.A.A.

Part No. 60297-21

WILLIAMSPORT, PENNSYLVANIA

Printed in U.S.A.

LYCOMING OPERATOR'S MANUAL

ATTENTION OWNERS, OPERATORS AND MAINTENANCE PERSONNEL

This manual contains a description of the engines, their specifications, and detailed information on how to operate and maintain them. 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. Modification procedures to install the inverted oil system are included. Repair procedures to install the inverted oil system are included. 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.

INSTALLATION WARNING

The modification procedures described herein for installing the inverted oil system to the engine is applicable only to the AEIO series engines set forth in this manual and not to any other Avco Lycoming engines. Also, do not attempt to start or run any of these engines until the inverted oil system is installed as described in Section 3 of this manual; consequent oil starvation and serious engine damage will result.

NOTE

Operational aspects, performance data, and specifications for the AEIO-360-H series engines are the same as shown herein for the AEIO-360-B series engines.

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

NEW AND REMANUFACTURED
RECIPROCATING AIRCRAFT ENGINE

WHAT TEXTRON LYCOMING PROMISES YOU

Textron Lycoming Williamsport Plant warrants each new and remanufactured reciprocating engine sold by it to be free from defects in material and workmanship appearing within one (1) year 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, 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 cost for labor in connection with the repair or replacement as provided in Textron Lycoming's then current Removal and Installation Labor Allowance Guidebook.

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 two (2) years from the date of first operation, whichever occurs first, Textron Lycoming will reimburse you for a pro rata portion 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 proration period extends to major parts of the engine, which are limited to crankcase, crankshaft, camshaft, cylinders, connecting rods, pistons, sump, accessory housing and gears. The proration policy does not extend to labor or to accessories, including but not limited to magnetos, carburetors or fuel injectors, fuel pumps, starters, alternators and turbochargers and their controllers.

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

YOUR OBLIGATIONS

The engine must have received normal use and service. You must apply for warranty 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 October 1, 1988 Revision G''

*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

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 one (1) year 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. 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 original warranty period.

YOUR OBLIGATIONS

The engine in which the replacement part is installed must have received normal use and service. You must apply for warranty 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 subject 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

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Effective October 1, 1988 Revision G''

*Textron Lycoming Williamsport Plant
Williamsport, Pennsylvania*

TEXTRON Lycoming

Williamsport Plant

TEXTRON LYCOMING WILLIAMSPORT PLANT

WARRANTY

OVERHAULED
RECIPROCATING AIRCRAFT ENGINE

WHAT TEXTRON LYCOMING PROMISES YOU

Textron Lycoming Williamsport Plant warrants each overhauled reciprocating engine sold by it to be free from defects in material and workmanship appearing within one (1) year 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, 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 cost 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 so repaired or replaced will be entitled to warranty for the remainder of the original warranty period.

YOUR OBLIGATIONS

The engine must have received normal use and service. You must apply for warranty 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 subject 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.

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Effective October 1, 1988 Revision G"

*Textron Lycoming Williamsport Plant
Williamsport, Pennsylvania*

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LYCOMING OPERATOR'S MANUAL

AEROBATIC SERIES

SECTION 1

SECTION 1

DESCRIPTION

The AEIO-320, -360 and -540 series are four and six cylinder, direct drive, horizontally opposed, air cooled engines. Although similar to the Avco Lycoming IO-320, -360 and -540 engines, the AEIO aerobic series differ in respect to the sump and the inverted oil system; see Operators Manual No. 60297-16 for description and operating instructions for IO-320 engines, 60297-12 for IO-360 engines, and 60297-10 for IO-540 engines.

In referring to the location of the various engine components, the parts are described in their relationship to the engine as installed in the airframe. Thus, the power take-off end is considered the front and the accessory drive end the rear. The sump section is considered the bottom and the opposite side of the engine where the shroud tubes are located the top. Reference to the left and right side is made with the observer facing the rear of the engine. The cylinders are numbered from front to rear, odd numbers on the right, even numbers on the left. The direction of rotation for accessory drives is determined with the observer facing the drive pad. The direction of rotation of the crankshaft, viewed from the rear, is clockwise.

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

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

LYCOMING OPERATOR'S MANUAL

SECTION 1

AEROBATIC SERIES

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

Crankshaft - The crankshaft is made from a chrome nickel molybdenum steel forging. All bearing journal surfaces are nitride hardened.

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

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

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

Oil Sump - Besides the usual oil drain plug and injector mounting pad the sump is further modified by having a plug installed in the oil suction screen hole. (See paragraph on Lubrication System for explanation.) On the opposite side of the sump from the oil drain plug a fitting is provided for oil return. The conventional intake riser and intake pipe connectors are also incorporated in the sump.

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

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SECTION 1

Induction System - Avco Lycoming AEIO-320, -360 and -540 series engines are equipped with Bendix RSA fuel injection systems. This system is based on the principle of measuring air flow and using the air flow signal in a regulator to convert the force of the air to a corresponding fuel force. This fuel force (fuel pressure differential) applies across the fuel metering section (jet system) makes fuel flow proportional to air flow. A manual mixture control and idle cut-off are provided. Particularly good distribution of the fuel-air mixture is obtained through the center zone induction system, which is integral with the oil sump and is submerged in oil and aids in cooling the oil in the sump. From the riser, distribution to each cylinder is by individual intake pipes. Fuel vaporization takes place at the intake ports.

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

The oil pressure screen is provided to filter from the oil any solid particles that may have passed through the suction screen in the sump. After being filtered in the pressure screen chamber, the oil is fed through a drilled passage to the oil relief valve, located in the upper right side of the crankcase in front of the accessory housing.

LYCOMING OPERATOR'S MANUAL

SECTION 1

AEROBATIC SERIES

This relief valve regulates the engine oil pressure by allowing excessive oil to return to the sump, while the balance of the pressure oil is fed to the main oil gallery in the right half of the crankcase. During its travel through this main gallery, the oil is distributed by means of separate drilled passages to the main bearings of the crankshaft. Separate passages from the rear main bearings supply pressure oil to both crankshaft idler gears. Angular holes are drilled through the main bearings to the rod journals. Oil from the main oil gallery also flows to the cam and valve gear passages, and is then conducted through branch passages to the hydraulic tappets and camshaft bearings. Oil enters the tappets through indexing holes and travels out through the hollow push rods to the valve mechanism, lubricating the valve rocker bearings and valve stems. Residual oil from the bearings, accessory drives and the rocker boxes is returned by gravity to the sump. From the sump, oil is conducted to the oil valve (which is part of the inverted oil system) and from thence to the oil suction screen in the sump.

The lubrication system of these engines differs from conventional models in that the hole in the front of the oil suction screen housing is plugged, preventing passage of the oil from the sump to the screen housing. Instead, oil from the sump is supplied to the screen housing by way of the oil valve which is connected by a hose to the rear of the oil screen housing. The breather port, in the top of the engine is connected to the oil separator which permits entrapped oil to return to the sump. For mechanical details of the inverted oil system see Section 3.

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Revised January, 1978

LYCOMING OPERATOR'S MANUAL

AEROBATIC SERIES

SECTION 2

SECTION 2

SPECIFICATIONS

| | AEIO-540 Series | AEIO-360 Series | AEIO-320 Series |
|---|--------------------|--------------------|--------------------|
| FAA Type Certificate | 1E4 | 1E10 | 1E12 |
| Rated horsepower | *260 | **200 | ***150 |
| Rated speed, RPM | *2700 | 2700 | 2700 |
| Bore, inches | 5.125 | 5.125 | 5.125 |
| Stroke, inches | 4.375 | 4.375 | 3.875 |
| Displacement, cubic inches | 540 | 361.0 | 319.8 |
| Compression ratio | 8.5:1 | **8.7:1 | ***7.0:1 |
| Firing order | 1-4-5-2-3-6 | 1-3-2-4 | 1-3-2-4 |
| Spark occurs, degrees BTC | 25° | 25° | 25° |
| Valve rocker clearance (hydraulic tappets collapsed) | .028-.080 | .028-.080 | .028-.080 |
| Propeller drive ratio | 1:1 | 1:1 | 1:1 |
| Propeller drive rotation (viewed from rear) | Clockwise | Clockwise | Clockwise |

* - AEIO-540-C series are rated at 250 @ 2575 RPM.

** - AEIO-360-B, -H series engines are rated at 180 HP and have 8.5:1 compression ratio.

*** - AEIO-320-D1B series engines are rated at 160 HP and have 8.5:1 compression ratio.

AEIO-540-L Series

| | |
|---|-------------|
| FAA Type Certificate | 1E4 |
| Rated horsepower | 300 |
| Rated speed, RPM | 2700 |
| Bore, inches | 5.125 |
| Stroke, inches | 4.375 |
| Displacement, cubic inches | 541.5 |
| Compression ratio | 8.7:1 |
| Firing Order | 1-4-5-2-3-6 |
| Spark occurs, degrees BTC | 20° |
| Valve rocker clearance (hydraulic tappets collapsed) | .028-.080 |
| Propeller drive ratio | 1:1 |
| Propeller drive rotation (viewed from rear) | Clockwise |

LYCOMING OPERATOR'S MANUAL

SECTION 2

AEROBATIC SERIES

| *Accessory Drive | Drive Ratio | | **Direction of Rotation |
|------------------------------|-----------------|-----------------|-------------------------|
| | AEIO-540 Series | AEIO-360 Series | |
| Starter | 16.556:1 | 16.556:1 | Counter-Clockwise |
| Generator | 1.910:1 | 1.910:1 | Clockwise |
| Generator (Optional) | 2.500:1 | 2.500:1 | Clockwise |
| Alternator | 3.250:1 | 3.250:1 | Clockwise |
| Tachometer | 0.500:1 | 0.500:1 | Clockwise |
| Magneto | 1.500:1 | 1.000:1 | Clockwise |
| Vacuum Pump | 1.300:1 | 1.300:1 | Counter-Clockwise |
| Prop. Gov. AN20010 | | | |
| Mounted on Accy. Hsg. | 0.947:1 | 0.866:1 | Clockwise |
| Mounted on Crankcase | 0.859:1 | 0.895:1 | Clockwise |
| Fuel Pump AN20003 | 1.000:1 | 1.000:1 | Counter-Clockwise |
| Fuel Pump - Plunger operated | 0.500:1 | 0.500:1 | |
| Dual Drives | | | |
| Vac. - Hyd. Pump | 1.300:1 | 1.300:1 | Counter-Clockwise |
| Vac. Pump - Prop. Gov. | 1.300:1 | 1.300:1 | Counter-Clockwise |

| *Accessory Drive | Drive Ratio | | **Direction of Rotation |
|------------------------------|-----------------|--|-------------------------|
| | AEIO-320 Series | | |
| Starter | 13.556:1 | | Counter-Clockwise |
| Starter | 16.556:1 | | Counter-Clockwise |
| Generator | 1.910:1 | | Clockwise |
| Generator (Optional) | 2.500:1 | | Clockwise |
| Alternator | 3.250:1 | | Clockwise |
| Tachometer | 0.500:1 | | Clockwise |
| Magneto | 1.000:1 | | Clockwise |
| Vacuum Pump | 1.300:1 | | Counter-Clockwise |
| Prop. Gov. AN20010 | | | |
| Mounted on Accy. Hsg. | 0.866:1 | | Clockwise |
| Mounted on Crankcase | 0.895:1 | | Clockwise |
| Fuel Pump AN20003 | 1.000:1 | | Counter-Clockwise |
| Fuel Pump - Plunger operated | 0.500:1 | | |
| Dual Drives | | | |
| Vac. - Hyd. Pump | 1.300:1 | | Counter-Clockwise |
| Vac. Pump - Prop. Gov. | 1.300:1 | | Counter-Clockwise |

* - When applicable.

** - Viewed facing drive pad.

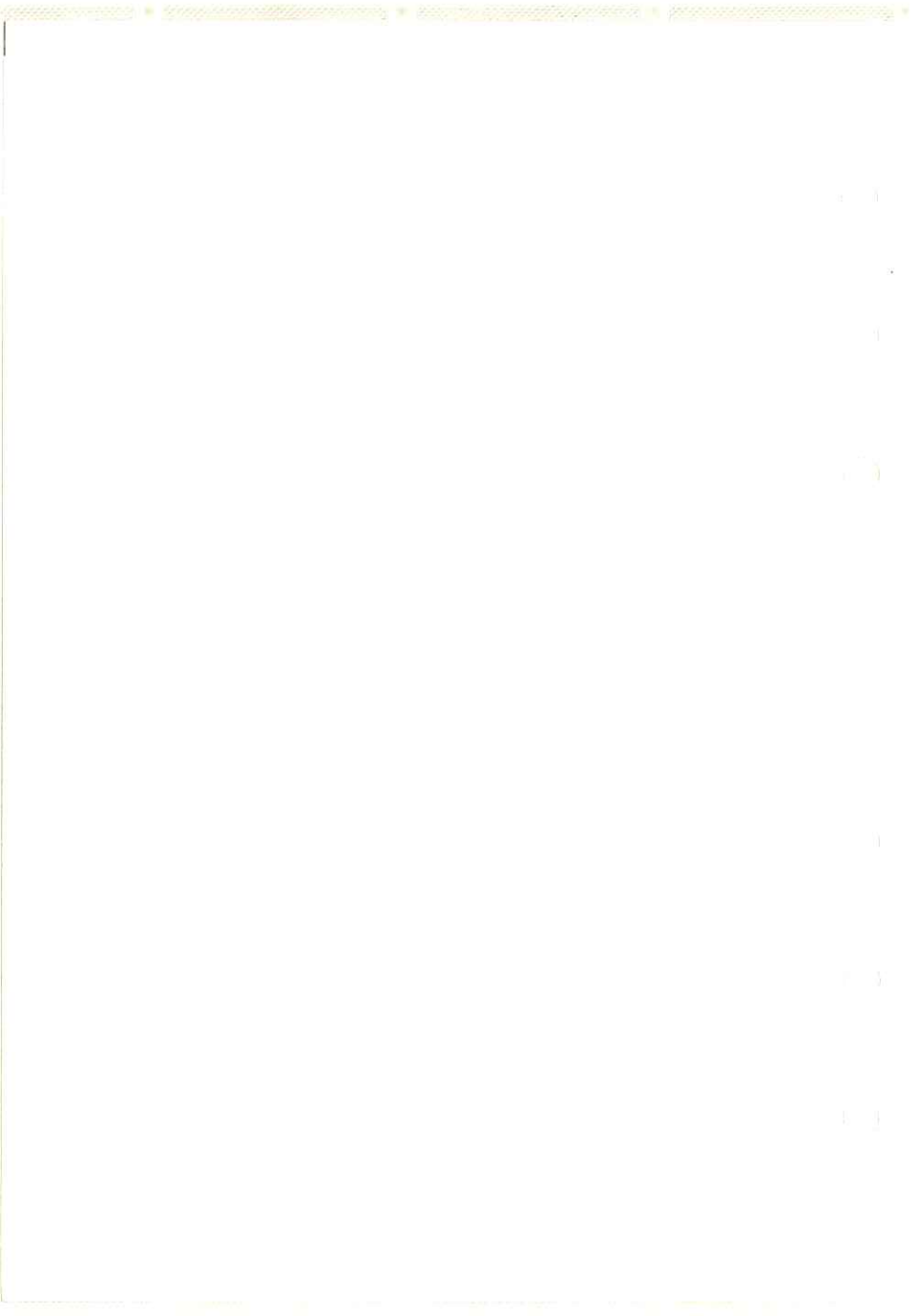
LYCOMING OPERATOR'S MANUAL

AEROBATIC SERIES

SECTION 2

Standard Dry Weight

| | |
|-----------------------|----------|
| AEIO-320 Series | 306 lbs. |
| AEIO-360 Series | 331 lbs. |
| AEIO-540-D | 402 lbs. |
| AEIO-540-N | 428 lbs. |
| AEIO-540-L | 476 lbs. |



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INVERTED OIL SYSTEM INSTALLATION WITH PARTS LIST

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SECTION 3

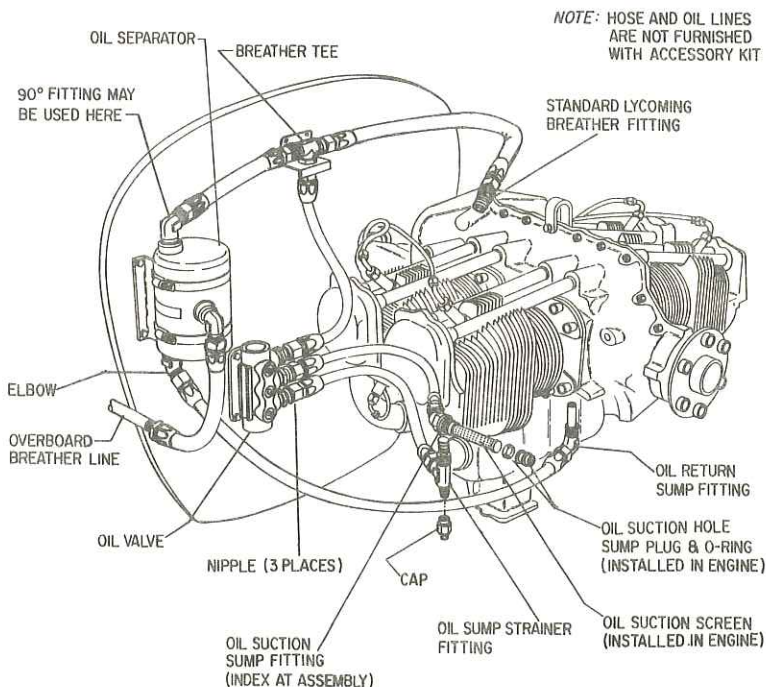


Figure 3-1. Typical Inverted Oil System Component Identification

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SECTION 3

INVERTED OIL SYSTEM INSTALLATION WITH PARTS LIST

3-1 - INTRODUCTION

This manual provides complete information for installation, operation, and maintenance of the inverted oil system.

Careful planning is required before proceeding with installation. Because of the great variety of engine configurations and mounting arrangements, installation details will necessarily vary. To ensure proper operation with a particular aircraft, it is important to understand how the system functions, and then to proceed with installation planning and actual installation based on system principles as described herein.

3-2 - DESCRIPTION

The inverted oil system, shown in Figure 3-1 is supplied as a kit-form accessory for Avco Lycoming AEIO-320, -360 and -540 engines which permits normal engine lubrication, with minimal oil loss, during inverted flight. The system functions in all negative-g flight conditions, and is particularly suited to high performance aircraft used for unlimited-class aerobatic competition involving extensive inverted flight and frequent negative-g maneuvers.

The inverted oil system kit, as shown in Figure 3-1, consists of the oil valve, oil separator, sump fitting, breather tee, oil sump strainer fitting, and oil return sump fitting. The oil suction screen, oil suction sump fitting and sump plug are installed in the engine and are not included with the accessory kit. Hose, oil lines, and standard fittings required to install the kit are not included.

3-3 - APPLICATION

The inverted oil system covered in this manual is intended for installation in all AEIO-320, -360 and -540 engines. Connection to the engine is through the sump screen access port, breather port, and sump drain ports.

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3-4 - PRINCIPLES OF OPERATION

Inverted Oil System, Normal Flight - Refer to Figure 3-2. During normal flight, the weighted ball valve at the top of the oil separator is open, allowing blowby gasses from the engine crankcase to be vented from the breather port, through the breather tee, to the top of the oil separator, and out through the overboard breather line. The top ball valve of the oil valve is closed, and the bottom ball valve is open, allowing oil to flow from the sump out through the strainer fitting, to the oil valve, back through the sump fitting to the oil pump and out to engine lubrication points.

Inverted Oil System, Inverted Flight - Refer to Figure 3-2. When the aircraft is inverted, engine oil falls to the top of the crankcase. The weighted ball valve in the oil separator closes, preventing overboard loss of oil through the top of the oil separator. Blow-by gasses from the engine crankcase are vented from the sump to the bottom of the oil separator and out through the overboard breather line. The top ball valve of the oil valve is open, and the bottom ball valve is closed, allowing oil to flow out from the breather port, through the breather tee, to the oil valve, through the sump fitting and the sump screen, to the oil pump and out to engine lubrication points.

Any oil in lines which fails to return to the sump during the transition between normal and inverted flight drains into the oil separator. This oil then returns to the sump from the bottom of the oil separator during periods of normal flight.

3-5 - INSTALLATION

The location of each component, the routing of each hose, and the final selection and location of fitting must be planned carefully before commencing installation of the inverted oil system. Proper performance can be assured by following several general rules:

- a. The oil separator must be mounted as high as possible, and as far as possible toward the side of the engine opposite the oil return port on the sump. The bottom of the oil separator must be at least two inches above the top of the sump, and the centerline of the oil separator must be located at least 10 inches from the sump centerline on the side opposite the oil return port. The height requirement ensures rapid emptying of the oil separator following the transition from inverted to normal flight. The side location requirement prevents loss of oil during some types of maneuvers such as knife-edge flight; if the oil separator and oil return port were located on the same side, oil could then run out of the oil return port, filling the oil separator, with consequent loss through the overboard breather line.

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3-5 - INSTALLATION (CONT.)

- b. Oil valve must be located such that its center port is horizontally aligned with the sump screen access port. See figures 8-3, 8-4, 8-5 and 8-6. The oil valve itself is equipped with alternate ports to permit hose fittings to be attached either along its front or side (unused ports are blocked with plugs supplied).
- c. To maximize oil flow rates, avoid 90° fittings in oil lines. Exceptions: fittings in bottom of sump must normally be 90° because of clearance conditions; fittings at top and side ports on the oil separator are non-critical and may be the 90° type.
- d. To ensure rapid return of oil to the sump from the oil separator, the fitting at the bottom of the oil separator must be either straight, or 45° maximum. If a 90° fitting is used at this point, excessive oil losses may result. See figure 3-1.
- e. All hose lengths should be as short as possible.
- f. Aircraft equipped with constant-speed propellers require evaluation before modification for aerobatic flight. During periods of zero oil pressure, some propeller types decrease pitch, while other types increase pitch. Momentary interruption of engine oil pressure during aerobatic flight, which normally occurs during certain maneuvers, may produce decreased pitch and cause engine overspeed if the propeller is of the decreasing-pitch type. For safe engine operation during aerobatic flight, therefore, the propeller should be of the increasing-pitch type.
- g. All hoses should be routed and clamped in positions which provide smooth, sweeping curves. Sharp bends should be avoided to prevent collapse of hose walls and restrictions to oil flow.
- h. The hose from the bottom of the oil separator must extend in a continuous downward slope to the bottom of the sump. An elevated section in this hose run may result in excessive oil loss.
- i. A breather fitting is provided to permit connection of hose to the crankcase breather port at the top rear of the crankcase. See figures 8-3, 8-4, 8-5 and 8-6.

3-5 - INSTALLATION (CONT.)

j. The engine and engine compartment should be inspected for obstructions which may affect installation of the oil system. For engines equipped with accessories or parts which prevent normal installation, modifications will be required. Before proceeding with nonstandard modifications, be sure the modification plan is compatible with the operating principles of the system and that care is taken to ensure the mechanical integrity of the engine and airframe.

Dimensions for each component of the inverted oil system are shown in figure 8-3.

3-6 - INSTALLATION PROCEDURE

When planning has been completed, proceed as follows for installation:

- a. Remove drain plugs from sump and thoroughly drain all engine oil. See Section 8 for instructions on depreservation.
- b. Loosen the setscrew in the side of the sump fitting and swivel the rear portion of the fitting to the required final angle. Considerable force may be required to swivel the fitting due to the friction of the internal o-ring seals and the clamping action against the sump screen. A hose fitting may be temporarily installed on the sump fitting to increase leverage. Tighten the setscrew to lock the angle.
- c. Securely mount the oil valve in position on the engine mount or firewall. Verify that the center port is horizontally aligned with the sump fitting. See figures 8-3, 8-4, 8-5 or 8-6.
- d. Securely mount the oil separator in position on the engine mount or firewall. When mounting oil separator on a tubular engine mount using cushioned clamps, it may be necessary to drill additional holes in the oil separator mounting bracket.

CAUTION

Verify that the bottom of the oil separator is as high as possible and at least 2 inches above the top of the sump and as far as possible to the side opposite the oil return port. (Centerline of oil separator to be at least 10 inches from engine sump centerline.) See figures 8-3, 8-4, 8-5 or 8-6.

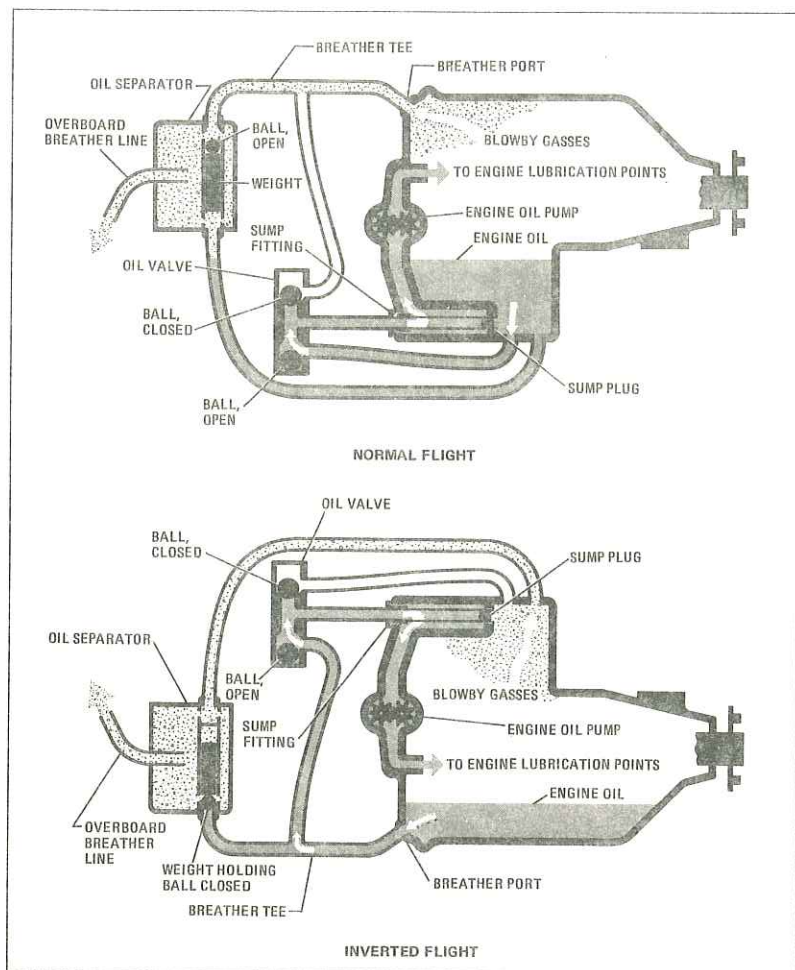


Figure 3-2. Schematic Section thru AEIO Engine Showing Oil Circulation During Normal and Inverted Flight

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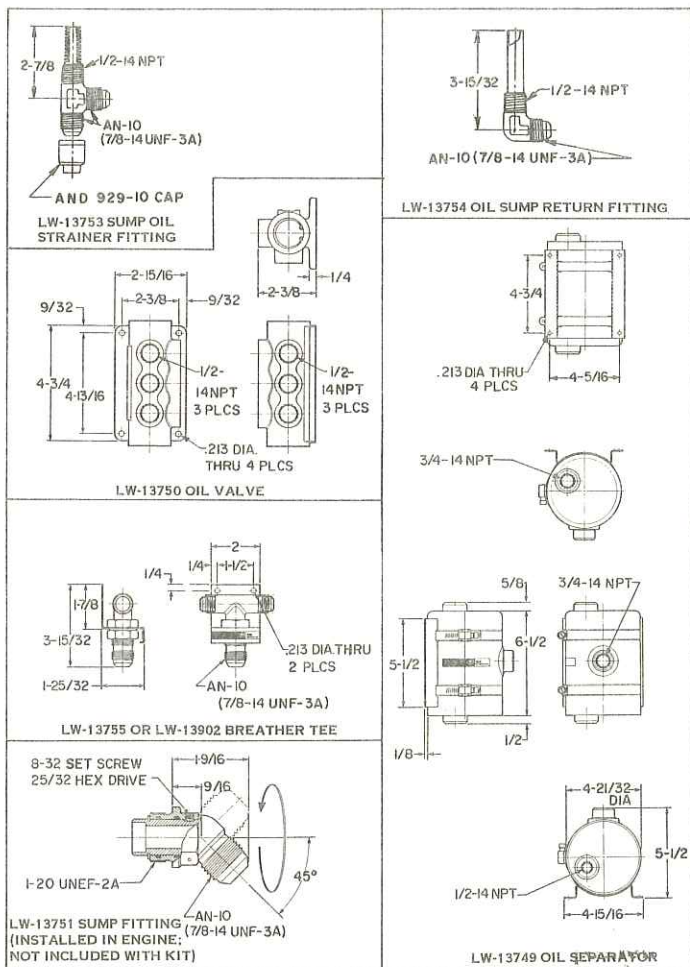


Figure 3-3. Dimensions of Inverted Oil System Components

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3-6 - INSTALLATION PROCEDURE (CONT.)

e. Securely mount the breather tee in position on the engine mount or firewall.

f. Install required fittings in all engine and component ports. Use anti-seizing lubricating thread compound. Normal fitting locations for typical installations are shown in figure 3-1.

NOTE

The breather hose must be of proper size to maintain not less than zero and not more than 5 inches water pressure in the crankcase.

g. Measure, cut and install Aeroquip 601 for breather hose. See figures 8-3, 8-4, 8-5 or 8-6.

NOTE

Three hose lengths are required: crankcase breather to breather tee, breather tee to upper port of oil separator, and side port on oil separator to overboard breather line.

Use care during installation to ensure large-radius curves without sharp bends or kinks. Observe hose marking stripes during installation to avoid helical twists.

h. Measure and cut hose for remaining oil lines. Typical hose layout is shown in Figure 3-1. To determine exact cutting length for hose using Aeroquip 816-10D hose fittings, allow exactly 1 inch for each hose fitting.

NOTE

Four hose lengths are required: central sump oil outlet to lower oil valve port, sump fitting to center oil valve port, bottom of breather tee to upper oil valve port, and lower oil separator port to sump oil return port.

For steel-braided hose, such as Aeroquip 601 hose, use abrasive cutting wheel to ensure clean, professional quality cuts. Hold the hose squarely across the cutting wheel, and slowly press the hose into the cutting wheel.

i. Thoroughly clean each hose length and attach hose fittings. For Aeroquip 601 hose, attach Aeroquip 816-10D hose fittings as follows:

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3-6 - INSTALLATION PROCEDURE (CONT.)

- (1) Unscrew the hose end sections of the fitting (red anodized).
 - (2) Insert hose in socket with twisting, pushing motion until hose is in line with back of socket threads.
 - (3) Mark hose position at rear of socket using grease pencil or tape.
 - (4) Without getting oil in cutting spur of nipple, lubricate inside of hose and nipple threads using SAE 30 oil.
 - (5) Insert nipple and engage socket threads.
 - (6) Making sure hose is not pushed out of socket, tighten the assembly. The final allowable gap between nut faces is .031 inch.
 - (7) Verify that hose has remained in correct original position by checking mark on hose.
- j. When all hose fittings are attached, thoroughly clean each hose section and install as required. Be sure hose routing is as smooth as possible, free from sharp bends, and free from helical twisting. Securely tighten all fittings.
- k. Inspect all work for accuracy and mechanical integrity.

3-7 - GROUND OPERATING CHECK AND ADJUSTMENT

- a. Add required quantity of engine oil.

NOTE

For severe aerobatic flight conditions, the importance of oil quality cannot be over emphasized. See Section 4, item 8 for correct grades of lubrication oil.

- b. Start engine. Oil pressure should rise to approximately normal readings after 10 to 15 seconds.

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3-7. GROUND OPERATING CHECK AND ADJUSTMENT (CONT.)

CAUTION

If oil pressure fails to rise after 30 seconds, shut off engine. Refer to paragraph 7-1 for trouble-shooting procedures.

- c. While idling, inspect oil lines and fittings for leaks. If noted, take corrective action.
- d. Allow engine to warm up.

3-8. FLIGHT TEST

CAUTION

Ground checks (paragraph 3-7) verify correct operation of parts of the oil system which function during normal flight attitudes only. The initial flight for inverted oil circulation should be limited to about 15 minutes, to guard against possible excessive oil loss from system leaks. See Section 4 for starting and operating instructions before flying aircraft.

- a. Fly aircraft at safe aerobatic altitude and roll to inverted flight attitude. Oil pressure will drop while oil lines purge, but should rise to normal in about 5 seconds. If oil pressure does not rise to normal within 15 seconds, roll immediately to normal flight attitude.

CAUTION

Do not fly for more than ten seconds in the following attitudes:

1. Vertical flight, steep dive.
2. Inverted flight, steep dive.
3. Zero G periods.
4. Wing-down or knife-edge flights.

In these modes the oil system will not scavenge and engine damage can occur. Normally oil pressure will "flicker" from 10 to 30 psi when transitioning from upright to inverted flight; however, return immediately to normal attitude anytime oil pressure drops 20 psi below normal.

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3-8 - FLIGHT TEST (CONT.)

b. Failure of oil pressure during initial inverted flight is typically caused by the difficulty of getting oil flow started in dry hoses and passages. Try to start system circulation with a short series of steep dives and climbs, then roll to inverted flight attitude. If oil pressure again fails to rise within 15 seconds, return to normal flight. Inverted flight trials may be repeated a few times. If inverted oil pressure still fails to rise, land aircraft and troubleshoot system (paragraph 3-10).

c. When normal oil pressure is initially developed during inverted flight, try a short sequence of alternating inverted and normal flight attitudes. The slight flicker in oil pressure during the transition between normal and inverted flight is normal and occurs as the balls in the oil valve switch oil circulation paths.

NOTE

Because of the longer oil pick-up flow path, oil pressure inverted may be 5 to 10 pounds less than oil pressure during normal flight.

d. Land aircraft and thoroughly inspect all hoses, fittings, and components for evidence of oil leakage. Take corrective action, if required.

e. For any engine which is either new or recently overhauled, fly in the inverted attitude for a sufficient period of time so that oil circulation will flush metal chips or other contaminating debris through the system. Short periods of normal flight should be alternated with longer periods of inverted flight to operate the ball valves during flushing. Flushing reduces the possibility of foreign material blocking one of the ball valves in the Christen 801 System. Valve blockage will cause failure of oil pressure during inverted flight.

3-9 - DETERMINATION OF NORMAL OIL LEVEL

a. Starting with engine at normal oil capacity (8 quarts for four cylinder models; 12 quarts for six cylinder models) fly an aerobatic sequence of about 5 or 10 minutes.

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3-9 - DETERMINATION OF NORMAL OIL LEVEL (CONT.)

- b. Land and check oil level. As much as 1 quart of oil loss may be observed.
- c. Fly another aerobatic sequence similar to that used in Step 1. Land and check oil level again.
- d. Continue this procedure until oil losses per flight are abruptly reduced. Typically, this level is between 6 and 7 quarts.
- e. This establishes the normal operating level. When oil is added beyond this normal operating level, the excess oil can be expected to be thrown off fairly quickly. However, at the normal operating level, a series of five or six 10-minute severe, unlimited-class aerobatic sequences can be flown per quart of oil loss.

3-10 - TROUBLESHOOTING AND REPAIR

NOTE

A troubleshooting chart for the engine will be found in Section 7.

If oil system malfunctions are noted, inspect the system, keeping in mind its basic principles of operation. Possible problems and causes which may occur are tabulated below.

a. Normal Flight OK, No Oil Pressure when Inverted

- (1) Faulty seal at sump plug. Inspect sump plug o-ring for damage. Be sure sump plug is properly seated.
- (2) Accumulated engine oil sludge or foreign material in oil valve presents free operation of balls. Disassemble and clean thoroughly.
- (3) Collapsed breather hose. Reroute or replace hose.
- (4) Obstruction in breather hose or breather tee. Disassemble and clean thoroughly.

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3-10 - TROUBLESHOOTING AND REPAIR (CONT.)

- (5) Sludge or foreign material in oil separator causing faulty valve sealing. Disassemble and clean thoroughly.
- (6) Operation in cold weather with insufficient warm-up or excessive oil viscosity. See paragraph 4, Section 4.
- (7) Damaged and leaking valve seats in oil valve. Test valve and reseal balls as described in paragraph 3-11, a.
- (8) Damaged and leaking valve seats in oil separator. Reseat ball as described in paragraph 3-11, a.
- (9) Sluggish pressure indication resulting from restrictor-type fitting on oil pressure gauge port. See paragraph 3-7.

b. Low Oil Pressure in Normal Flight

- (1) Sump screen clogged. Disconnect hose at sump fitting, remove sump fitting, extract sump screen, and clean thoroughly.
- (2) Obstruction in oil valve. Disassemble and clean thoroughly.
- (3) Defective oil pump; defective pressure gauge. Test and repair as required.
- (4) Oil pressure not checked and adjusted after system installation. Adjust as described in Section 6, item 3.
- (5) Damaged seats in oil valve; reseal balls. See paragraph 3-11, a.

c. Excessive Oil Loss

- (1) Oil separator mounted too low. Reposition oil separator and extend hose lengths as required.
- (2) Oil return hose between bottom of oil separator and sump not routed in smooth, continuously downward direction. Reroute hose as required.

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3-10 - TROUBLESHOOTING AND REPAIR (CONT.)

- (3) Restrictive fitting installed at bottom of oil separator. Replace restrictive fitting with straight or 45° fitting.
- (4) Performance of unusual aerobic maneuver series in rapid succession without enough time in normal flight for oil to drain from oil separator. See paragraph 3-7.
- (5) Oil level maintained above normal aerobic oil level.
- (6) Oil separator not mounted as far as possible to the side opposite the oil return port in the sump. Reposition as required.
- (7) Restriction in breather hose causing crankcase pressure which forces oil overboard through oil return line and oil separator. Clean or replace.

3-11 - MAINTENANCE

The inverted oil system normally requires no maintenance. During major overhauls or when repairs require sump removal, inspect sump for excessive deposits of sludge, varnish, or foreign material. If sump is dirty, remove and thoroughly clean all hoses and components; then use compressed air blast for drying and cleanout before reassembly.

a. Reseating Valve Balls -

Marginal operation of valves may result from nicks in the valve seats which cause leakage when the valve should be closed. Such nicks can be caused by mishandling or by small chips of metal being caught between the ball and the seat as the valve operates during initial run-in of a new or newly overhauled engine. Valves may be tested for suspected leakage as follows:

- (1) Verify that unused ports are plugged.
- (2) Hold the valve so that its axis is vertical and cover the lower port using a finger.
- (3) Suck on the center port to produce partial vacuum, then place the tongue over the center port to retain vacuum; ball valve seating should be sufficient to retain the partial vacuum for 2 to 3 seconds.

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3-11 - MAINTENANCE (CONT.)

- (4) Invert the valve and repeat steps 2 and 3 above.

To reseat the valve if seat nicks and leakage are found, proceed as follows:

- (1) Disassemble the valve and remove the ball; remove an end retaining ring, then strike the oil valve sharply against a padded bench top to drive the end cap out of the valve body.
- (2) Thoroughly clean all oil passages, including ball and valve seat.
- (3) Place the ball in position on its seat; place a brass, aluminum, or other soft metal rod against the ball and tap the rod with a single, sharp hammer blow to reshape the valve seat to the ball.
- (4) Inspect the o-ring and replace if damaged. Coat the o-ring with light oil or grease and reassemble the valve. The end cap should snap into the valve body. Be sure the retaining ring is fully seated in its groove.
- (5) Recheck the valve for leakage before installation. Perform all ground and flight tests.

3-12 - CLEANING INVERTED OIL SYSTEM

The inverted oil system must be flushed with a suitable petroleum solvent, such as varsol, every 300 (three hundred) hours of engine operation or when there is evidence of the loss of oil through the breather after normal flight.

3-13 - REPLACEABLE PARTS LIST

The following illustrations and parts lists identify all inverted oil system parts which can be ordered for repair through all Avco Lycoming distributors. With all parts orders, be sure to include part number and description of parts. If part number is not known, include complete description, location, and part application with inquiry.

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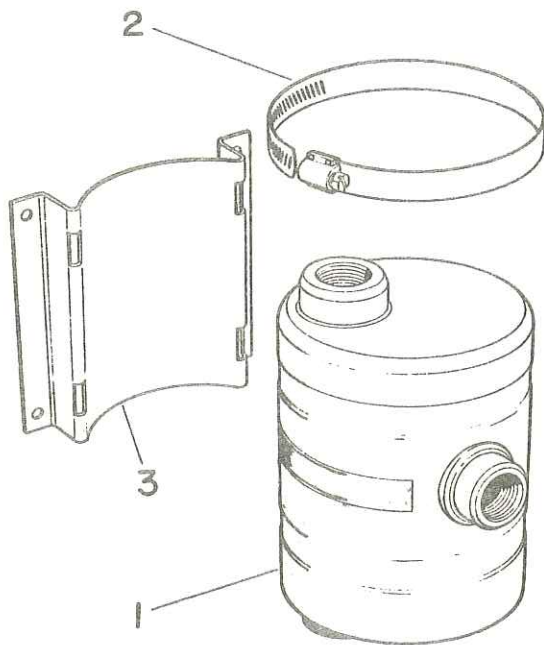
70484 Oil Suction Screen (This part is installed in the engine oil sump; it is not included with kit)

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LW-13749 Oil Separator (Normally installed on firewall or engine mount. Requires two AN842-12D or -16D hose elbows and one MS20823-10D elbow to mate with appropriate hoses and -10 size (5/8 in.) hose fitting.)



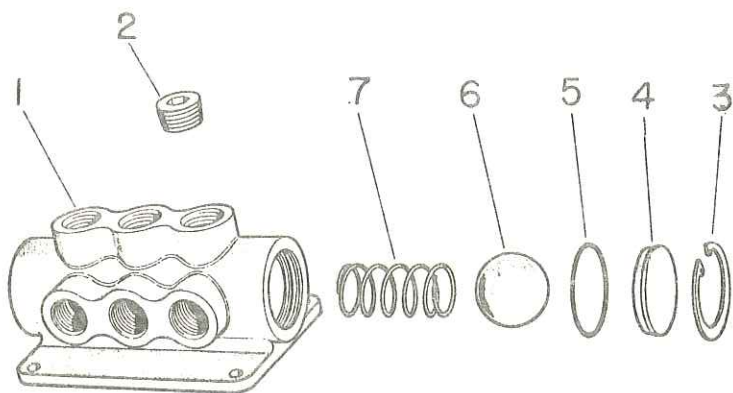
| Index No. | Description | Part No. | Quantity |
|-----------|-------------------|-----------|----------|
| 1 | Can assembly | 30009-501 | 1 |
| 2 | Clamp, worm drive | 50003-072 | 2 |
| 3 | Bracket | 30008-001 | 1 |

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LW-13750 Oil Valve (Normally installed on firewall or engine mount. Requires three AN816-10D nipples for hose connection.



| Index No. | Description | Part No. | Quantity |
|-----------|---------------------------|-----------|----------|
| 1 | Valve body assembly | 30051-501 | 1 |
| 2 | Plug, hex drive | 50039-005 | 3 |
| 3 | Retaining ring, internal | 50024-026 | 2 |
| 4 | Body plug | 30003-001 | 2 |
| 5 | O-ring | 50004-027 | 2 |
| 6 | Ball, corrosion resistant | 30078-001 | 2 |
| 7 | Spring, compression | 50015-854 | 1 |

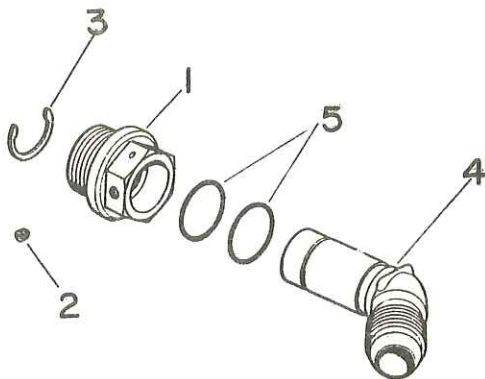
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LW-13751

Sump Fitting, Oil Suction (45°adjustable: swivels 360° with leakproof o-ring seals and clamping screw) This part is installed in the engine; it is not included with the kit. It must be adjusted to the required angle at time oil line is connected to it.



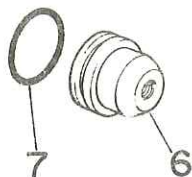
| Index No. | Description | Part No. | Quantity |
|-----------|--------------------------|-----------|----------|
| 1 | Sump bushing | 30043-001 | 1 |
| 2 | Setscrew, cup point | 50016-065 | 1 |
| 3 | Retaining ring, external | 50020-016 | 1 |
| 4 | Sump elbow | 30048-001 | 1 |
| 5 | O-ring | 50004-018 | 2 |

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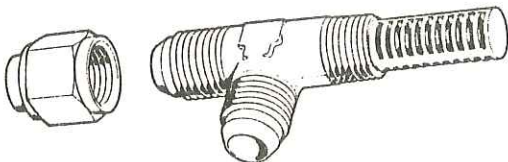
AEROBATIC SERIES

LW-13752 Oil Suction Hole Sump Plug (Includes o-ring seal)
 Installed in front end of sump screen to block oil flow passage to screen. This part is installed in engine; it is not included with kit.



| Index No. | Description | Part No. | Quantity |
|-------------|----------------------|-----------|----------|
| 6 | Sump plug | 30002-001 | 1 |
| 7 | O-ring | 50004-111 | 1 |
| (Not shown) | Gasket, sump fitting | 50042-016 | 1 |

LW-13753 Oil Strainer Sump Fitting (Installed in sump drain port) Supplied with AN929-10 cap for use on unused fitting port. Mates directly with -10 size (5/8 in.) hose fitting



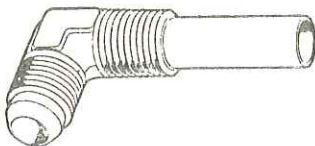
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LW-13754 Oil Return Sump Fitting

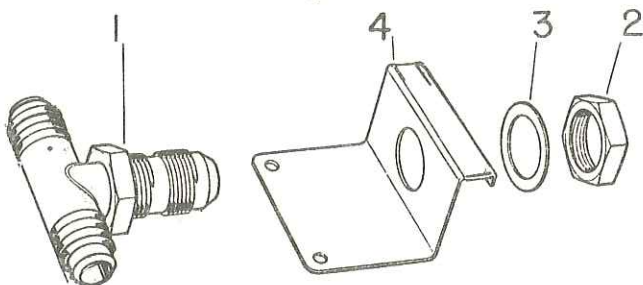
Normally installed in forward engine sump drain port. Mates directly with -10 size (5/8 in.) hose fitting.



LW-13755 Breather Tee — -320, -360 Series

LW-13902 Breather Tee — -540 Series

(Normally installed on firewall or on engine mount) Mates directly with -10 (5/8 in.) or -12 (3/4 in.) hose fitting.



| Index No. | Description | Part No. | Quantity |
|-----------|---------------------------|-----------|----------|
| 1 | Tee assembly | 30080-501 | 1 |
| 2 | Nut, flared tube bulkhead | 50031-010 | 1 |
| 3 | Gasket | 50041-010 | 1 |
| 4 | Bracket assembly | 30073-501 | 1 |

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SECTION 4

SECTION 4

OPERATING INSTRUCTIONS

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

NOTE

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

New engines have been carefully run-in 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 on straight mineral oil for a minimum of 50 hours or until oil consumption has stabilized. After this period, a change to an approved additive oil may be made, if so desired. See Avco Lycoming Service Instruction No. 1014 for specific lubricating oil instructions.

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

The minimum fuel octane rating is listed in the flight chart, Part 9 of this section. Under no circumstances should fuel of a lower octane rating or automotive fuel (regardless of octane rating) be used.

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2. PRESTARTING ITEMS OF MAINTENANCE. Before starting the aircraft engine for first flight of the day, there are several items of maintenance inspection that should be performed. These are described in Section 5 under Daily Pre-Flight Inspection. They must be observed before the engine is started.

CAUTION

Do not start any AEIO series engines that does not have the inverted oil system installed; to do so will cause engine damage because of oil starvation.

3. STARTING PROCEDURES

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

a. Cold Engines.

- (1) Perform pre-flight inspection.
- (2) Set alternate air control in "off" position.
- (3) Set propeller governor control in "Full RPM" position (where applicable).
- (4) Turn fuel valve "On".
- (5) Open throttle approximately 1/4 travel.
- (6) Turn boost pump "On".
- (7) Move mixture control to "Full Rich" until a slight but steady fuel flow is noted (approximately 3 to 5 seconds) and return mixture control to "Idle Cut-Off".
- (8) Set magneto selector switch (Consult airframe manufacturer's handbook for correct position).
- (9) Engage starter.

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- (10) When engine fires move the magneto switch to "Both".
- (11) Move mixture control slowly and smoothly to "Full Rich".
- (12) Check oil pressure gage. If minimum oil pressure is not indicated within thirty seconds, stop engine and determine trouble.

b. Hot Engines. Because of the fact that the fuel percolates and the system must be cleared of vapor, it is recommended that the same procedure be used as outlined for cold engine start.

4. COLD WEATHER STARTING - In very cold weather it is important to use the proper viscosity engine oil and to run the engine sufficiently long to bring the engine oil to the normal operating temperature. Cold oil will not circulate well in cold lines and other engine parts, so the flow of oil from an engine sump through the external hoses, valve and fittings of the inverted oil system will be severely impeded until the oil, the engine, and all external system parts are warmed up. Once the engine oil itself is warm, the aircraft should be flown inverted for an extended period to allow the oil to warm up the oil separator and associated external lines. When all system components are warm, the system function and oil pressure should be normal. It may be necessary in some very cold areas to modify or partially bypass the engine oil cooling system to keep the oil at normal operating temperature.

5. GROUND RUNNING AND WARM-UP.

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

NOTE

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

- a. Head the aircraft into the wind.
- b. Leave mixture in "Full Rich".
- c. Operate only with the propeller in minimum blade angle setting.
- d. Warm-up at approximately 1000-1200 RPM. Avoid prolonged idling and do not exceed 2200 RPM on the ground.

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

f. In these aerobic engines, the oil flow path from the engine sump to the engine oil pump is much longer than it is on an engine without an inverted flight oil system. As a result, there is a greater resistance to the flow of oil to the pump, and a so-called "pressure drop" effect occurs. This condition varies with the viscosity of the engine oil, the arrangement of hoses and fittings in the system, and the size of the engine. Since oil viscosity varies with temperature, oil pressure change with increasing engine oil temperature will be different in these engines than it is in a non-aerobic engine. When a conventional engine is cold, oil pressure is normally high and it falls to the recommended operating range as the engine warms up. In these aerobic engines, cold and highly viscous oil lowers oil pressure due to the pressure drop effect, and the pressure rises to the recommended operating range as the engine warms up. In some cases, there is a balance between the pressure drop effect and the change of oil viscosity with temperature, and no oil pressure change occurs as oil temperature changes. This depends on the particular engine characteristics and the oil system arrangement.

6. GROUND CHECK.

a. Warm-up as directed above.

b. Check both oil pressure and oil temperature.

c. Leave mixture in "Full Rich".

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

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

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(1) (*Controllable Pitch Propeller*) With propeller in minimum pitch angle, set the engine to produce 50 - 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 a maximum of 2000/2100 RPM.

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

f. Do not operate on a single magneto for too long a period, a few seconds is usually sufficient to check drop-off and will minimize plug fouling.

7. OPERATION IN FLIGHT.

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

b. *Oil Pressure Indication* - It is normal for oil pressure to "flicker" momentarily from 10 to 30 psi when transitioning from upright to inverted flight. This "flicker" should last about a second, and oil pressure in the inverted flight attitude should be the same as in the upright flight attitude. (Some engines have a restricted orifice fitting at the oil pressure port to prevent major loss of oil in the event of an oil pressure line failure. This restrictor dampens the oil pressure gauge reaction to oil pressure change, and causes the gauge to lag actual pressure substantially.) The normal "flicker" of oil pressure when transitioning from upright to inverted flight and vice versa may become a prolonged pressure change indication lasting up to four or five seconds in engines with the restricted orifice fitting. It should be remembered that this is an oil pressure gauge phenomenon and not an indication that the oil system is not functioning properly. A slow rather than "flicker-like" change of pressure when no restrictor is present does indicate an oil system problem, and the system should be thoroughly checked when this occurs.

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c. Momentary Loss of Oil Pressure -

(1) Oil pressure may be interrupted momentarily in certain aircraft attitudes or during certain combinations of maneuvers. These attitudes and maneuver combinations are generally of the type which can only be maintained for short periods of time, so there is no serious effect on engine performance. The effect is normal and should not be construed as a system malfunction.

(2) The main cause of momentary loss of oil pressure is that in certain attitudes, the oil in the sump (or at the top of the crankcase during inverted flight) is placed so that it cannot be drawn into the oil pickup line (or breather line, for inverted flight). For example, during a vertical or steep inverted dive the engine oil will fall to the front or top-front of the engine so that neither the breather line nor the oil feed line at the sump has an available supply of oil.

(3) A secondary cause of oil pressure loss is that conditions may occur which result in uncertain closure of the ball valves in the oil valve. For example, if an abrupt entry into knife-edge flight is made from a zero-g condition, it is possible for both balls in the oil valve to be jarred from their proper positions, with a resultant interruption in oil flow in the oil pickup line.

(4) Oil pressure is usually maintained by the existing oil in the oil feed line for a short period of time after the oil supply is interrupted in some aerobatic attitudes. These effects vary depending on the engine type, quantity of oil in the engine, and the design of the particular installation.

CAUTION

Do not fly for more than ten seconds in the following attitudes:

- 1. Vertical flight, steep dive.*
- 2. Inverted flight, steep dive.*
- 3. Zero G periods.*
- 4. Wing-down or knife-edge flights.*

In these modes the oil system will not scavenge and engine damage can occur. Normally oil pressure will "flicker" from 10 to 30 psi when transitioning from upright to inverted flight; however, return immediately to normal attitude anytime oil pressure drops 20 psi below normal.

d. Oil Loss from Unusual Maneuvers -

(1) If the system is functioning properly, only very small losses from normal oil level will occur.

(2) Certain uncommon aerobic maneuvers, if performed for an extended period of time or in rapid repetitive sequences, may result in abnormal oil losses. For example, if an aircraft performs a lengthy series of vertical roll-type maneuvers in rapid succession, from inverted flight entry and with inverted recovery, oil which accumulates in the oil separator has no opportunity to return to the engine sump. As a result, the oil eventually flows overboard through the breather line. Such a series of maneuvers would be performed rarely, and then only in unusual competition practice and not in competition sequence. The oil loss problem in such practice can be eliminated simply by bringing the aircraft to the normal upright attitude occasionally to allow oil accumulated in the oil separator to return to the engine sump.

e. 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 Lycoming aircraft power-plants, utilize the instructions in this publication any time the fuel/air mixture is adjusted during flight.

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

GENERAL RULES

Never exceed the maximum red line cylinder head temperature limit.

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

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GENERAL RULES (CONT.)

Maintain mixture control in "Full Rich" position for rated take-off, climb and maximum cruise powers (above approximately 75%). However, during take-off from high elevation airport or during climb, roughness or loss of power may result from over-richness. In such a case adjust mixture control only enough to obtain smooth operation - not for economy. Observe instruments for temperature rise.

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

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

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

a. LEANING WITH EXHAUST GAS TEMPERATURE GAGE.

(1) Maximum Power Cruise (approximately 75% power) - Never lean beyond 150°F. on rich side of peak EGT unless aircraft operator's manual shows otherwise. Monitor cylinder head temperatures.

(2) Best Economy Cruise (approximately 75% power and below) - Operate at peak EGT.

b. LEANING WITH FLOWMETER.

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

c. LEANING WITH MANUAL MIXTURE CONTROL (Economy Cruise, 75% power or less) without flowmeter or EGT gage).

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

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

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

As shown in Figure 4-1, if engine speed and throttle setting are kept constant at normal cruise conditions, the effect of leaning on engine power and engine temperatures will be as shown. Power drops rapidly when the engine is leaned beyond peak exhaust gas temperature; also, best power is attained on the rich side of peak exhaust gas temperature.

**DELETE PARAGRAPH 8.
(USE OF INTAKE AIR HEAT CONTROL)**

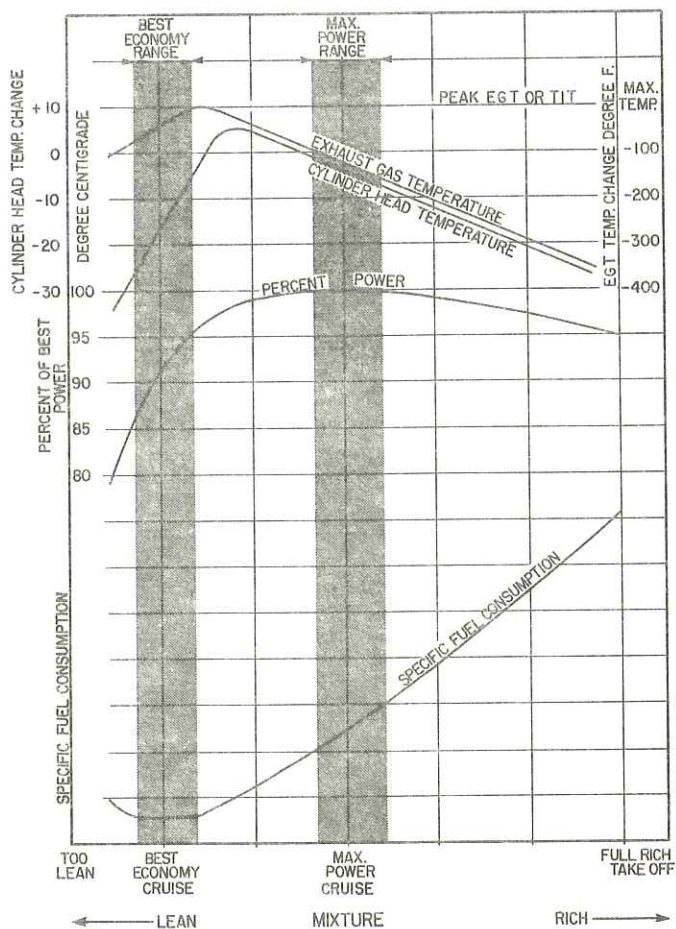


Figure 4-1. Representative Effect of Leaning on Cylinder Head Temperature, EGT (Exhaust Gas Temperature), Engine Power and Specific Fuel Consumption at Constant Engine RPM and Manifold Pressure

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9. ENGINE FLIGHT CHART

a. Fuel

AEIO-320
 AEIO-320-D
 AEIO-360-A
 AEIO-360-B
 AEIO-540
 AEIO-540-L

Aviation Grade Fuel
 80/87 octane min.
 91/96 or 100/130 octane min.
 100/130 octane min.
 91/96 or 100/130 octane min.
 91/96 or 100/130 octane min.
 100/100LL octane min.

NOTE

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

| Fuel Pressure | Max. (psi) | Min. (psi) | Min. Idle |
|---------------------------------|------------|------------|-----------|
| AEIO-320, -360 | | | |
| Inlet to fuel pump | 35 | -2 | |
| Inlet to fuel injector (-320) | 45 | 12 | |
| Inlet to fuel injector (-360) | 45 | 14 | |
| AEIO-540-C, -D, -N Series | | | |
| Inlet to fuel pump | 35 | -2 | |
| Inlet to fuel injector | 45 | 14 | 12 |
| AEIO-540-L1B5D Series | | | |
| Inlet to fuel pump | 40 | -2 | |
| Inlet to fuel injector | 40 | 18 | 12 |
| | | | Gal./Hr. |
| b. Fuel Consumption | | | |
| AEIO-320 Series | | | |
| Normal Rated (2700 RPM, 150 HP) | | | 13.8/15.2 |
| 75% Rated (2450 RPM, 110 HP) | | | 10.0 |
| 65% Rated (2350 RPM, 97 HP) | | | 8.8 |
| AEIO-320-D Series | | | |
| Normal Rated (2700 RPM, 160 HP) | | | 13.8 |
| 75% Rated (2450 RPM, 120 HP) | | | 10.0 |
| 65% Rated (2350 RPM, 104 HP) | | | 8.8 |
| AEIO-360-A Series | | | |
| Normal Rated (2700 RPM, 200 HP) | | | 16.1 |
| 75% Rated (2450 RPM, 150 HP) | | | 12.3 |
| 65% Rated (2350 RPM, 130 HP) | | | 9.5 |
| AEIO-360-B, -H Series | | | |
| Normal Rated (2700 RPM, 180 HP) | | | 14.5 |
| 75% Rated (2450 RPM, 135 HP) | | | 11.0 |
| 65% Rated (2350 RPM, 117 HP) | | | 8.5 |
| AEIO-540-C Series | | | |
| Normal Rated (2575 RPM, 250 HP) | | | 20.5 |
| 75% Rated (2350 RPM, 190 HP) | | | 16.5 |
| 65% Rated (2200 RPM, 150 HP) | | | 12.5 |

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| | |
|---------------------------------------|----------|
| AEIO-540-D, -N Series | Gal./Hr. |
| Normal Rated (2700 RPM, 260 HP) | 21.6 |
| 75% Rated (2450 RPM, 195 HP) | 19.0 |
| 65% Rated (2350 RPM, 155 HP) | 14.0 |
| AEIO-540-L Series | |
| Normal Rated (2700 RPM, 300 HP) | 24.0 |
| 75% Rated (2450 RPM, 225 HP) | 18.0 |
| 65% Rated (2350 RPM, 180 HP) | 12.8 |

c. Lubricating Oil -

ALL MODELS

*Recommended Grade Oil

| | MIL-L-6082 Grades | MIL-L-22851 Ashless Dispersant Grades |
|------------------------------------|----------------------|---|
| Average Ambient Air | | |
| All Temperature | ----- | SAE 15W50 or 20W50 |
| Above 80°F. (26.67°C.) | SAE 60 | SAE 60 |
| Above 60°F. (15.55°C.) | SAE 50 | SAE 40 or SAE 50 |
| 30° (-1.11°C.) to 90°F. (32.22°C.) | SAE 40 | SAE 40 |
| 0° (-17.77°C.) to 70°F. (21.11°C.) | SAE 30 | SAE 40 or SAE 30 |
| Below 10°F. (-12.22°C.) | SAE 20 | SAE 30 |

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

| Average Ambient Air | Desired | Maximum |
|------------------------------------|----------------|-----------------|
| Above 80°F. (26.67°C.) | 180°F. (82°C.) | 245°F. (118°C.) |
| Above 60°F. (15.55°C.) | 180°F. (82°C.) | 245°F. (118°C.) |
| 30° (-1.11°C.) to 90°F. (32.22°C.) | 180°F. (82°C.) | 245°F. (118°C.) |
| 0° (-17.77°C.) to 70°F. (21.11°C.) | 170°F. (77°C.) | 225°F. (107°C.) |
| Below 10°F. (-12.22°C.) | 160°F. (71°C.) | 210°F. (99°C.) |

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

d. Oil Sump Quantities -

| | Max. Sump Capacity | Min. Safe Qty. in Sump | Max. Angle Degrees Nose Up | Nose Down |
|-------------------|-----------------------|---------------------------|-------------------------------|-----------|
| AEIO-320 | 8 qts. | 4 | 30° | 20° |
| AEIO-360 (180 HP) | 8 qts. | 4 | 30° | 25° |
| AEIO-360 (200 HP) | 8 qts. | 4 | 30° | 20°** |
| AEIO-540 | 12 qts. | 6 | 30° | 18° |
| AEIO-540-L1B5D | 16 qts. | 8*** | 37° | 20° |

** - This 20° angle applies when the fitting with the 3-1/2 inch extension is installed. With the present fitting, the maximum nose down angle is 8°.

*** - Minimum safe quantity of oil in sump for 37° nose up and 25° nose down is 9 qts.

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| e. Oil Pressure | Maximum | Minimum** | Idling |
|-------------------|---------|-----------|--------|
| Normal Operating | 90 | 60 | 25 |
| Start and Warm-Up | 100 | 55 | 25 |

** - See Section 6, Item 3 for oil pressure relief valve adjustment.

f. Oil Consumption -

| | Max. (Qt./Hr.) Oil Cons. |
|---------------------------------------|-----------------------------|
| AEIO-320 Series | |
| Normal Rated (2700 RPM, 150 HP) | .067 |
| 75% Rated (2450 RPM, 110 HP) | .037 |
| 65% Rated (2350 RPM, 97 HP) | .033 |
| AEIO-320-D Series | |
| Normal Rated (2700 RPM, 160 HP) | .072 |
| 75% Rated (2450 RPM, 120 HP) | .040 |
| 65% Rated (2350 RPM, 104 HP) | .035 |
| AEIO-360-A Series | |
| Normal Rated (2700 RPM, 200 HP) | .089 |
| 75% Rated (2450 RPM, 150 HP) | .050 |
| 65% Rated (2350 RPM, 130 HP) | .044 |
| AEIO-360-B, -H Series | |
| Normal Rated (2700 RPM, 180 HP) | .080 |
| 75% Rated (2450 RPM, 135 HP) | .045 |
| 65% Rated (2350 RPM, 117 HP) | .039 |
| AEIO-540-C Series | |
| Normal Rated (2575 RPM, 250 HP) | .111 |
| 75% Rated (2350 RPM, 190 HP) | .085 |
| 60% Rated (2200 RPM, 150 HP) | .050 |
| AEIO-540-D, -N Series | |
| Normal Rated (2700 RPM, 260 HP) | .116 |
| 75% Rated (2450 RPM, 195 HP) | .087 |
| 60% Rated (2350 RPM, 155 HP) | .052 |
| AEIO-540-L1B5D Series | |
| Normal Rated (2700 RPM, 300 HP) | .134 |
| 75% Rated (2450 RPM, 225 HP) | .075 |
| 60% Rated (2350 RPM, 180 HP) | .060 |

g. Cylinder Head Temperature -

Max. permissible 500°F. (260°C.)

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NOTE

*Cylinder head temperature taken at bayonet location. For maximum service life of the engine maintain cylinder head temperatures between 150°F. (66°C.) and *400°F. (204°C.) during continuous operation.*

* - For AEIO-540 series engines, maximum cylinder head temperature of 435°F. (224°C.) is permissible for continuous operation.

10. ENGINE SHUT-DOWN.

- a. Set propeller at minimum blade angle (where applicable).
- b. Idle until there is a decided decrease in cylinder head temperature.
- c. Move mixture control to "Idle Cut-Off".
- d. When engine stops, turn ignition switch off.

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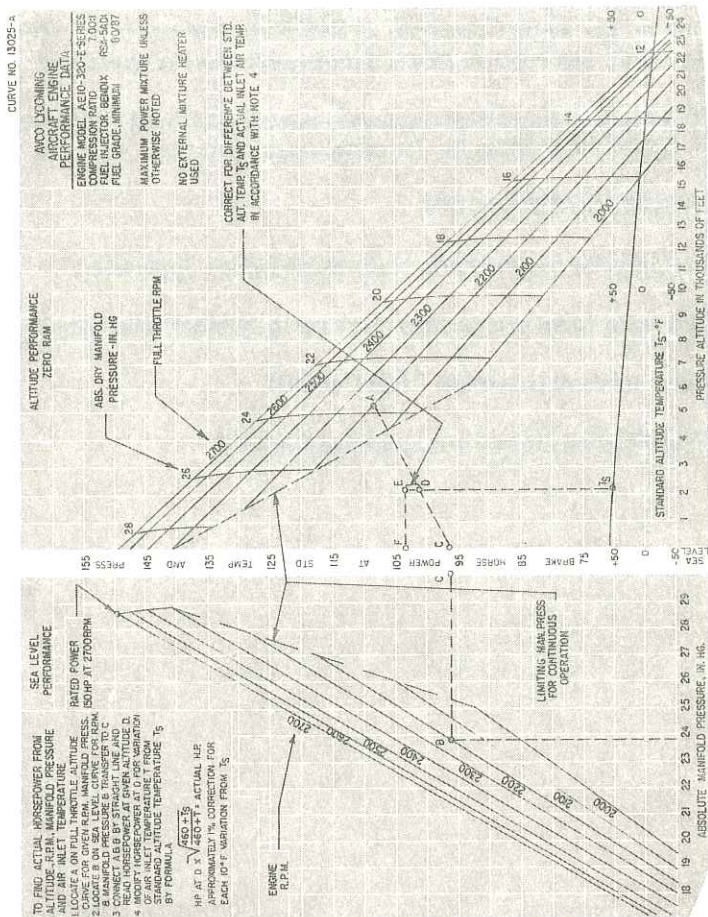


Figure 4-2. Sea Level and Altitude Performance - AEO-320-E Series

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CURVE NO. 12780-A

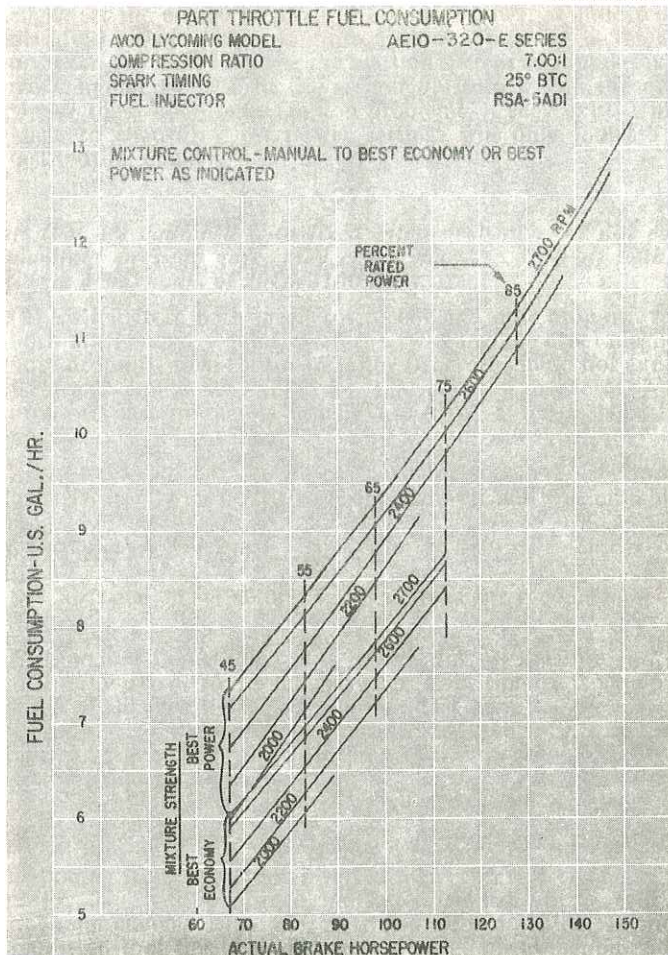


Figure 4-3. Part Throttle Fuel Consumption
 AEIO-320-E Series

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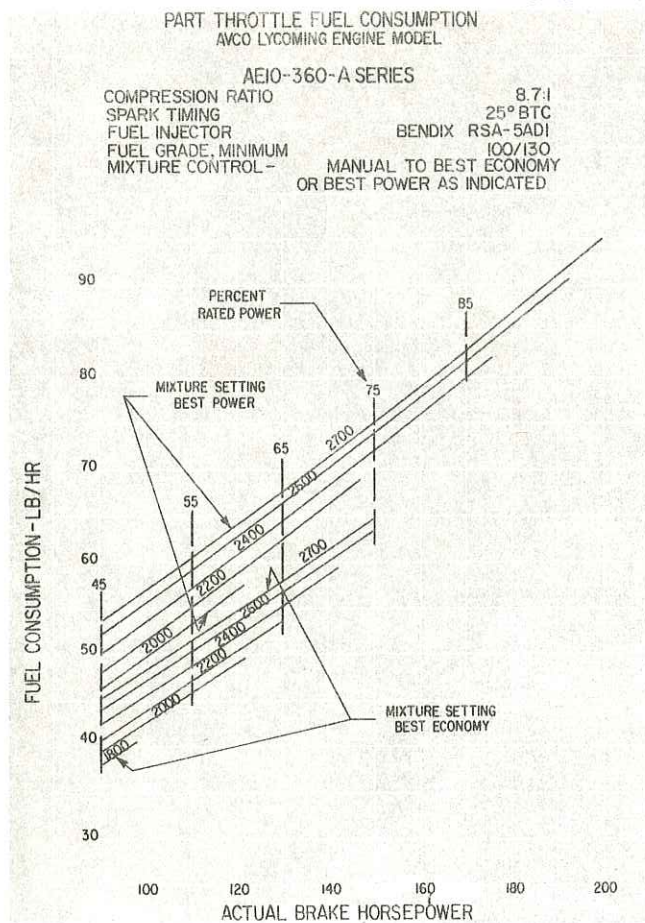


Figure 4.5. Part Throttle Fuel Consumption - AEIO-360-A Series

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CURVE NO 12849A

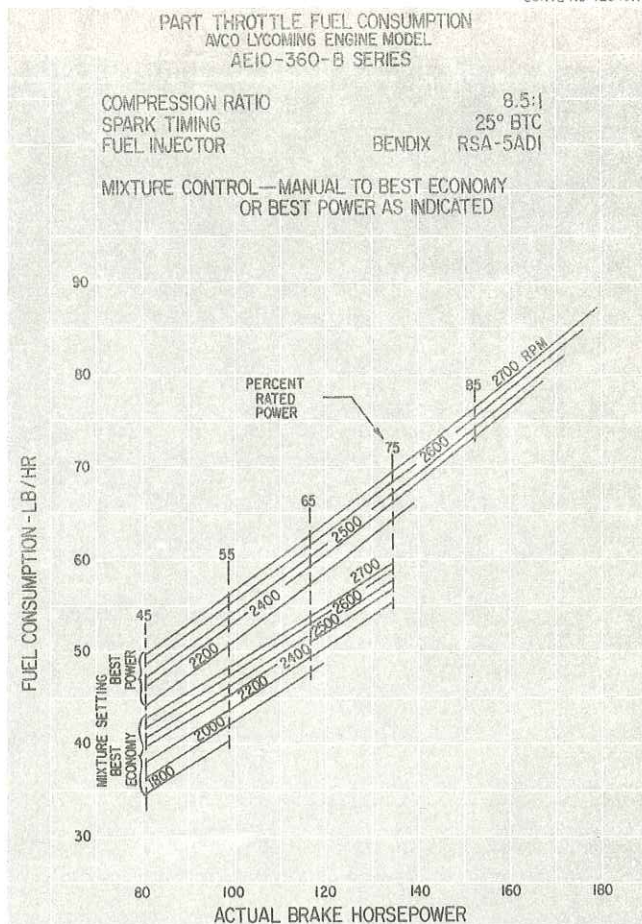


Figure 4-7. Part Throttle Fuel Consumption - AEIO-360-B, -H Series

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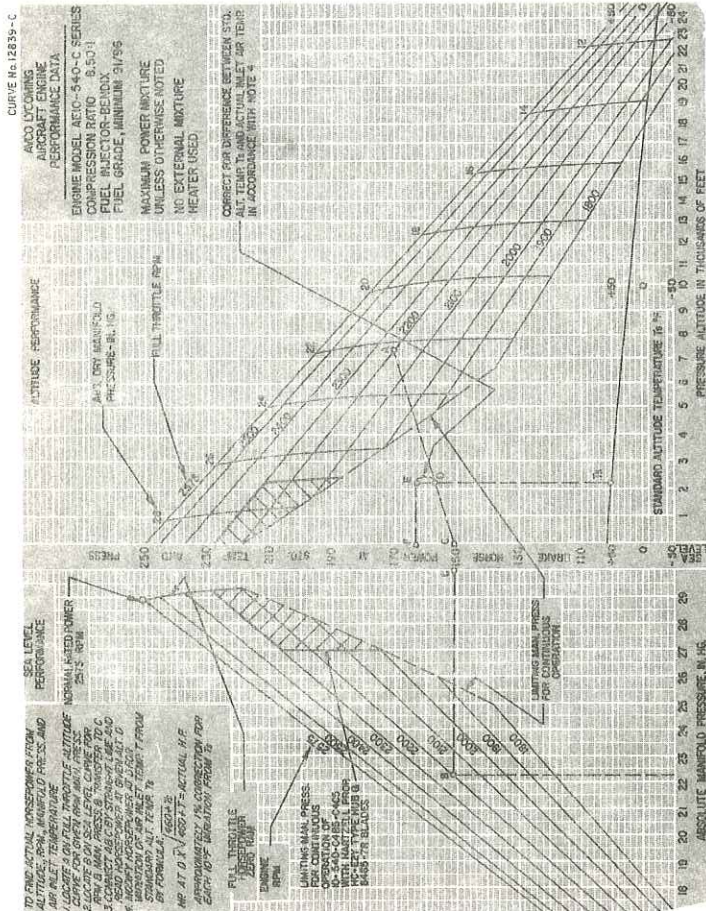


Figure 4-8. Sea Level and Altitude Performance Curve - AEIO-540-C

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CURVE NO. 12957

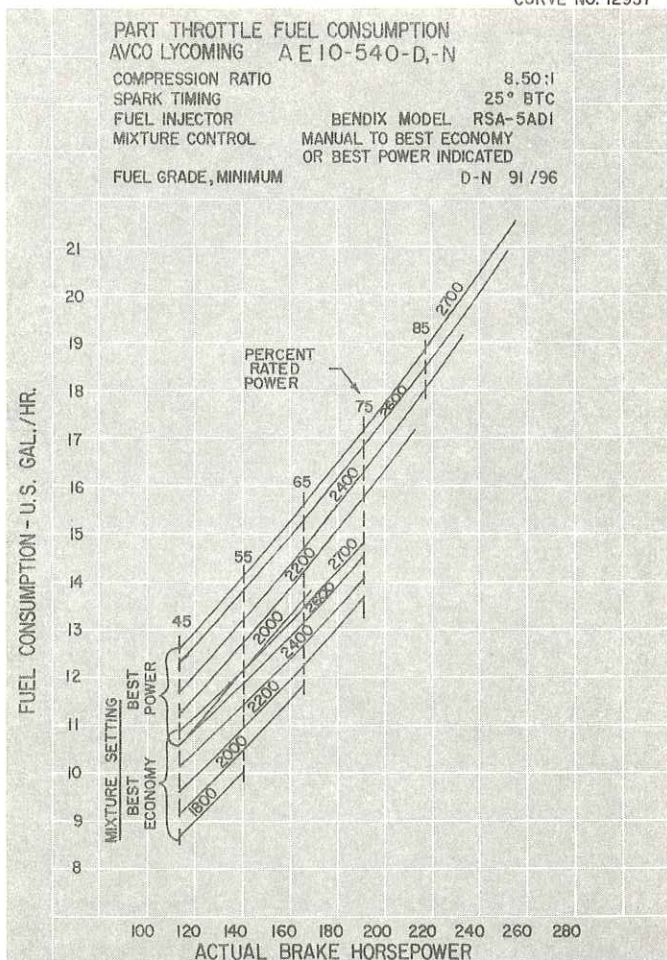


Figure 4-11. Part Throttle Fuel Consumption Curve - AE10-540-D,-N

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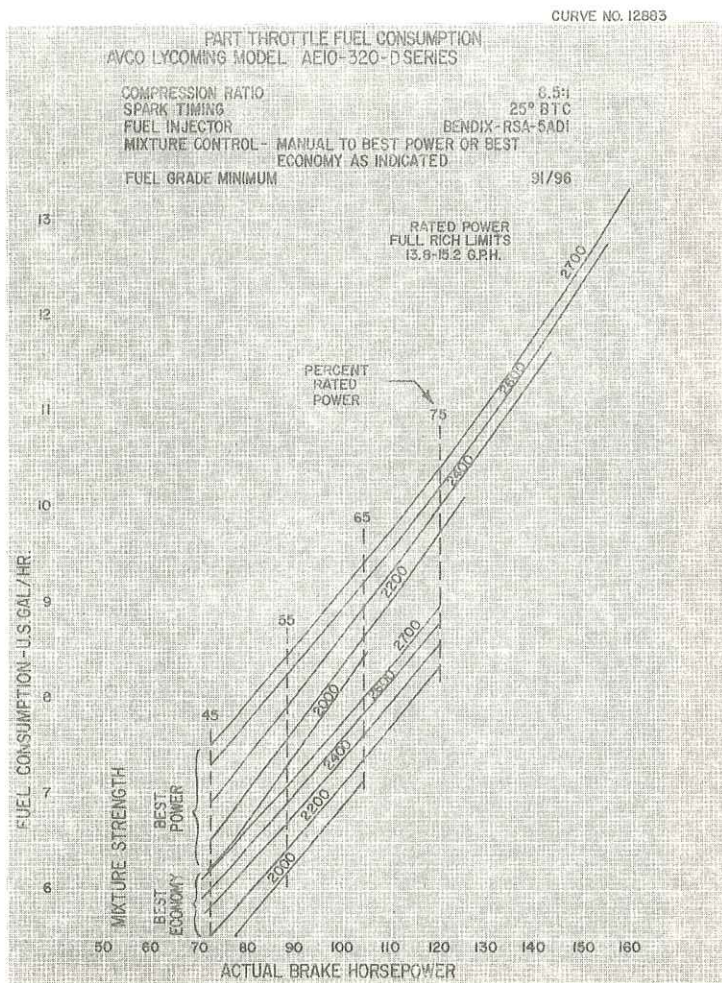


Figure 4-12. Part Throttle Fuel Consumption - AEIO-320-D

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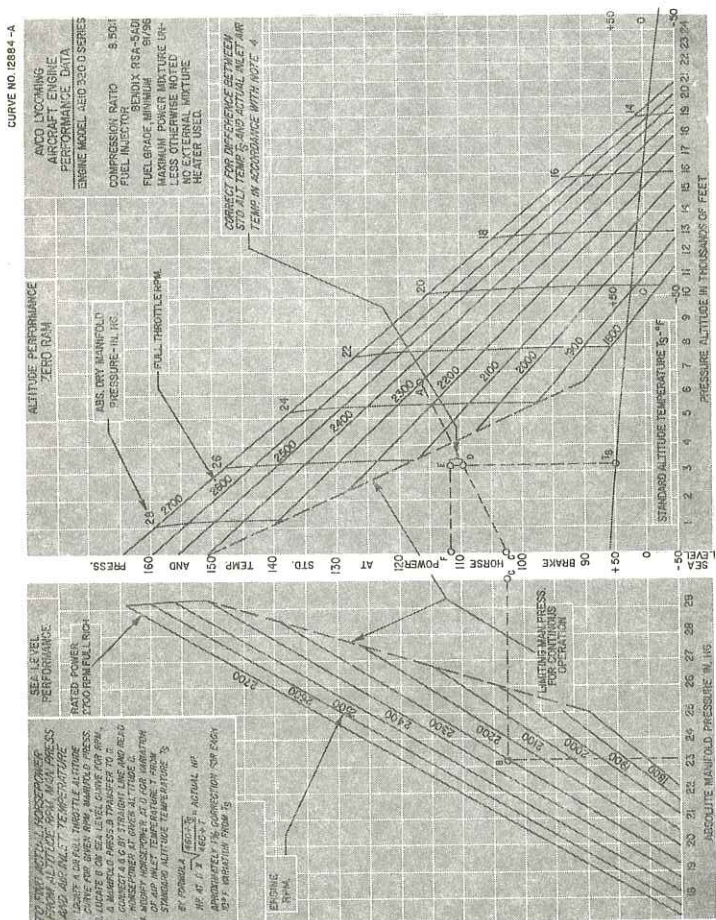


Figure 4-13. Sea Level and Altitude Performance Curve - AEIO-320-D

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CURVE NO. 13012

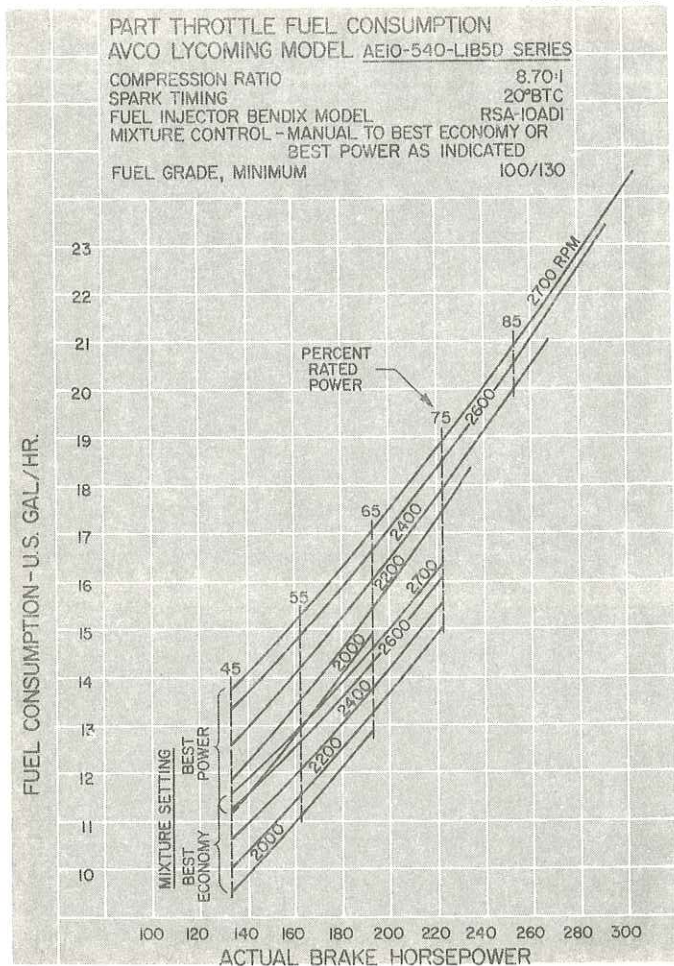


Figure 4-14. Part Throttle Fuel Consumption
 AEIO-540-L1B5D

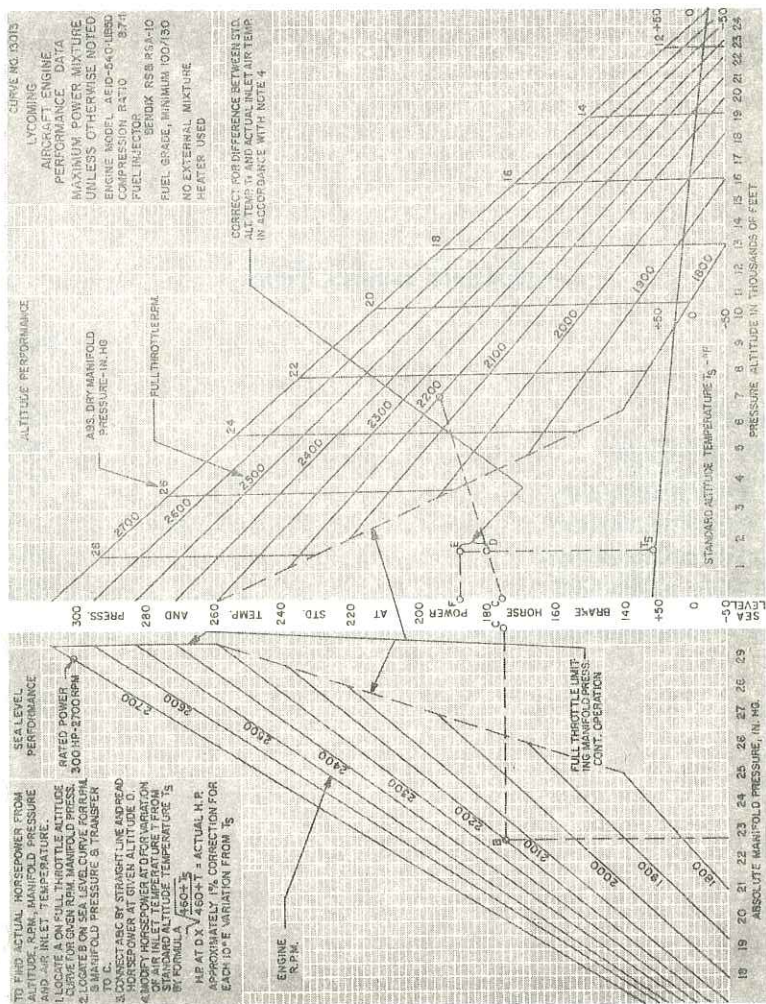


Figure 4-15. Sea Level and Altitude Performance Curve
AE10-540-L1B5D

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| Non-Scheduled Inspection | .5-5 |

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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 additional instructions.

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

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

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 -

- (1) If fouling of spark plugs has been apparent, rotate bottom plugs to upper position.

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

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

b. Fuel and Induction System - Remove and clean the fuel inlet strainers. Check the mixture control and throttle linkage for travel, freedom of movement, security of the clamps and lubricate if necessary. Check the air intake ducts for leaks, security, filter damage; evidence of dust or other solid material in the ducts is indicative of inadequate filter care or damaged filter. Check vent lines for evidence of fuel or oil seepage; if present, fuel pump may require replacement.

c. Lubrication System -

(1) Remove oil suction and oil pressure screens and check carefully for presence of metal particles that are indicative of internal engine damage. This step is not feasible unless oil is being changed and should be omitted on installations employing an external full flow oil filter.

WARNING

When the oil suction screen is removed, extreme care must be taken to see that the sump plug, located in the extreme end of the scavenger oil chamber, is not dislodged from its location. See figure 3-2. If this plug is not secure in its correct location, lubrication failure will occur with severe damage to the engine.

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

NOTE

Intervals between oil changes can be increased as much as 100% on engines equipped with full flow oil filters - provided the element is replaced each 50 hours of operation.

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

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

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

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

Heavy discoloration and appearance of seepage at cylinder head and barrel attachment area is usually due to emission of thread lubricant used during assembly of the barrel at the factory, or by slight gas leakage which stops after the cylinder has been in service for awhile. This condition is neither harmful or detrimental to engine performance and operation. If it can be proven that 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 -

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

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

b. Lubrication System - Drain and renew lubrication oil.

c. Magnetos - Check breaker points for pitting and minimum gap. Check for excessive oil in the breaker compartment, if found, wipe dry with a clean lint free cloth. The felt located at the breaker points should be lubricated in accordance with the magneto manufacturer's instructions. Check magneto to engine timing. Timing procedure is described in Section 6, par. 1. b. of this manual.

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d. Engine Accessories - Engine mounted accessories such as pumps, temperature and pressure sensing units, and inverted oil system should be checked for secure mounting, tight connections.

e. Cylinders - Check cylinders visually for cracked or broken fins.

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

g. Fuel Injector Nozzles and Fuel Lines - Check fuel injector nozzles for looseness. Tighten to 60 inch pounds torque. Check fuel lines for fuel stains which are indicative of fuel leaks. Repair or replacement must be accomplished before the aircraft resumes operation.

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

Valve Inspection - Remove rocker box covers and check for freedom of valve rockers when valves are closed. Look for evidence of abnormal wear or broken parts in the area of the valve tips, valve keeper, springs and spring seats. If any indications are found, the cylinder and all of its components should be removed (including the piston and connecting rod assembly) and inspected for further damage. Replace any parts that do not conform with limits shown in the latest edition of Table of Limits Publication No. SSP2070.

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 the latest edition of Service Letter No. L114 for subscription information. Maintenance facilities should have an up-to-date file of these publications available at all times.

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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 -

(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 until the advance timing mark on the front face of the starter ring gear is in alignment with the small hole located at the two o'clock position on the front face of the starter housing. (Ring gear may be marked at 20° and 25°. Consult specifications for correct timing mark for your installation.) At this point, the engine is ready for assembly of the magnetos.

(2) *Bendix magnetos* - Remove the inspection plugs from both magnetos and turn the drive shaft in direction of normal rotation until (-20 and -200 series) the first painted chamfered tooth on the distributor gear is aligned in the center of the inspection window (-1200 series) the applicable timing mark on the distributor gear is approximately aligned with the mark on the distributor block. See figure 6-2. Being sure the gear does not move from this position, install gaskets and magnetos on the engine. Note that an adapter is used with all magnetos. Secure with (clamps on -1200 series) washers and nuts; tighten only finger tight.

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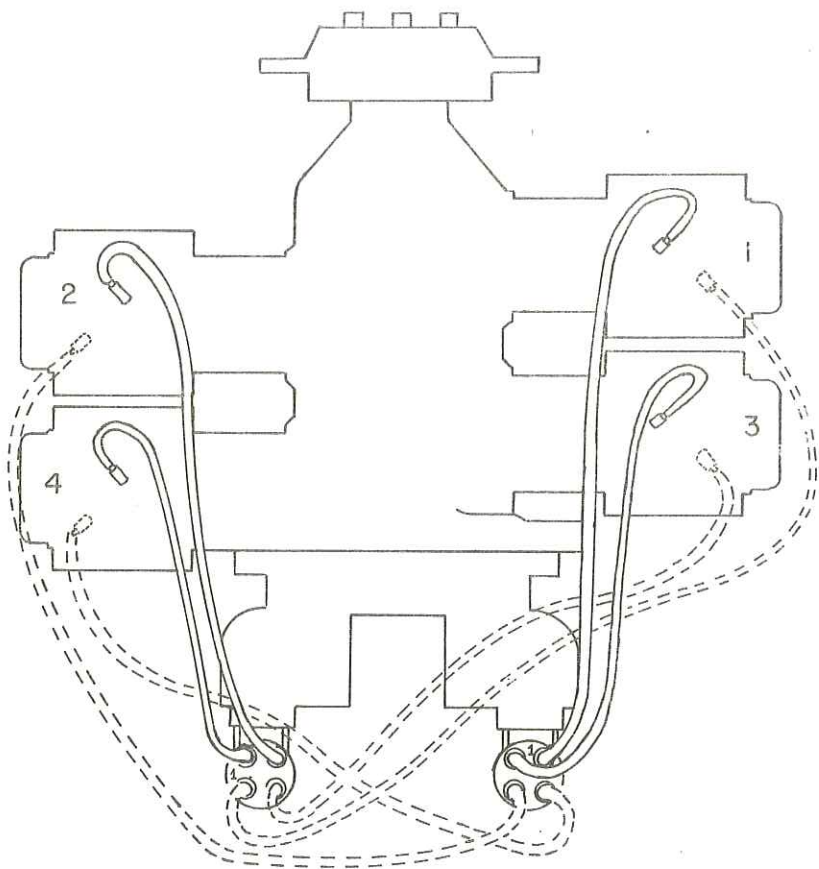
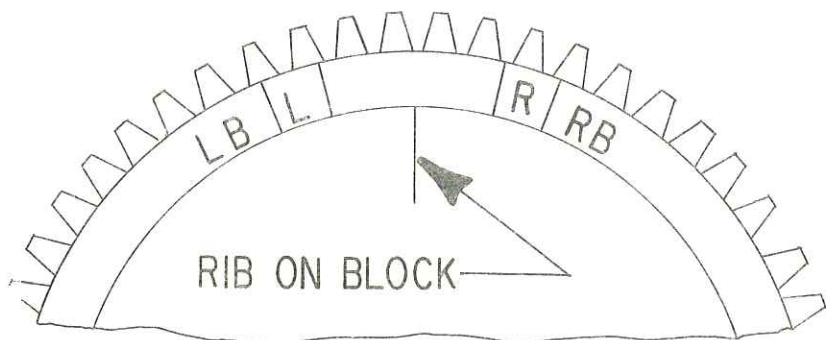


Figure 6-1. Ignition Wiring Diagram

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Timing Marks - 6 cyl. 1200 Series

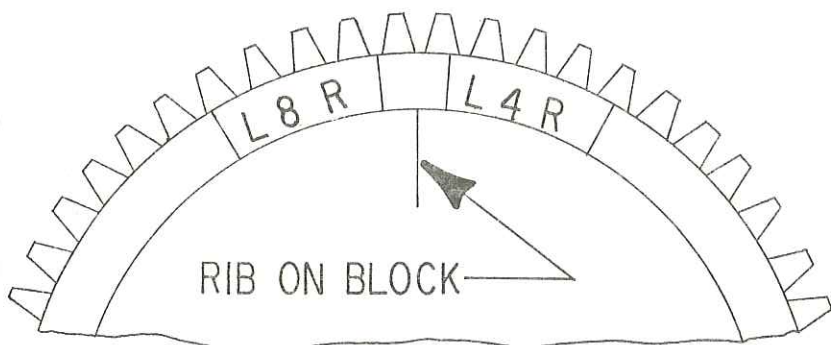


Figure 6-2. Timing Marks - 4 cyl. 1200 Series

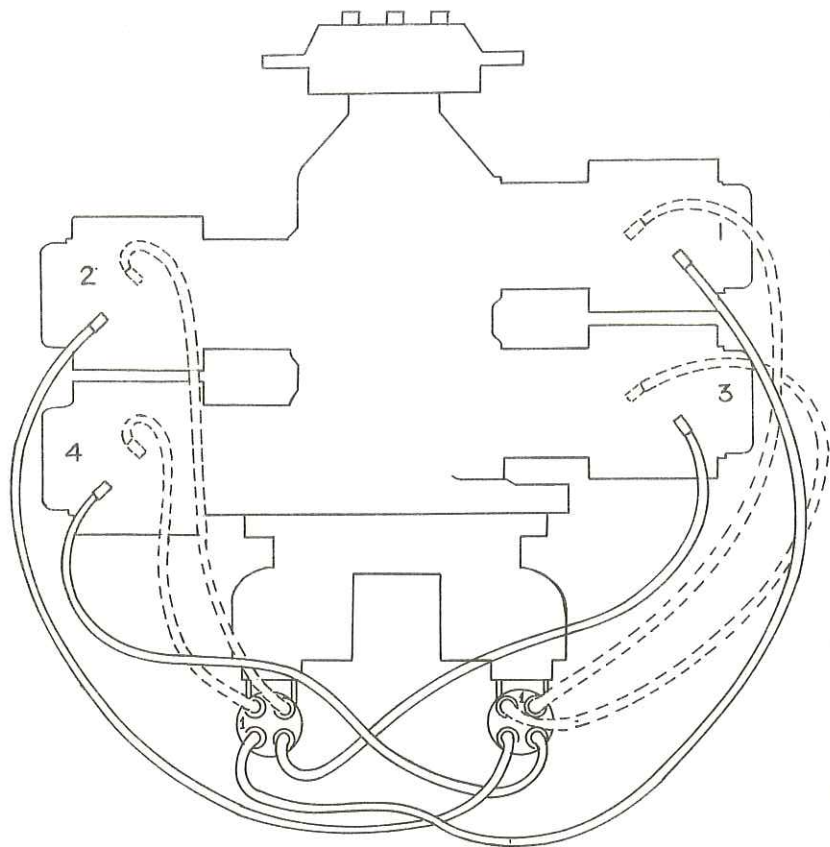


Figure 6-3. Ignition Wiring Diagram

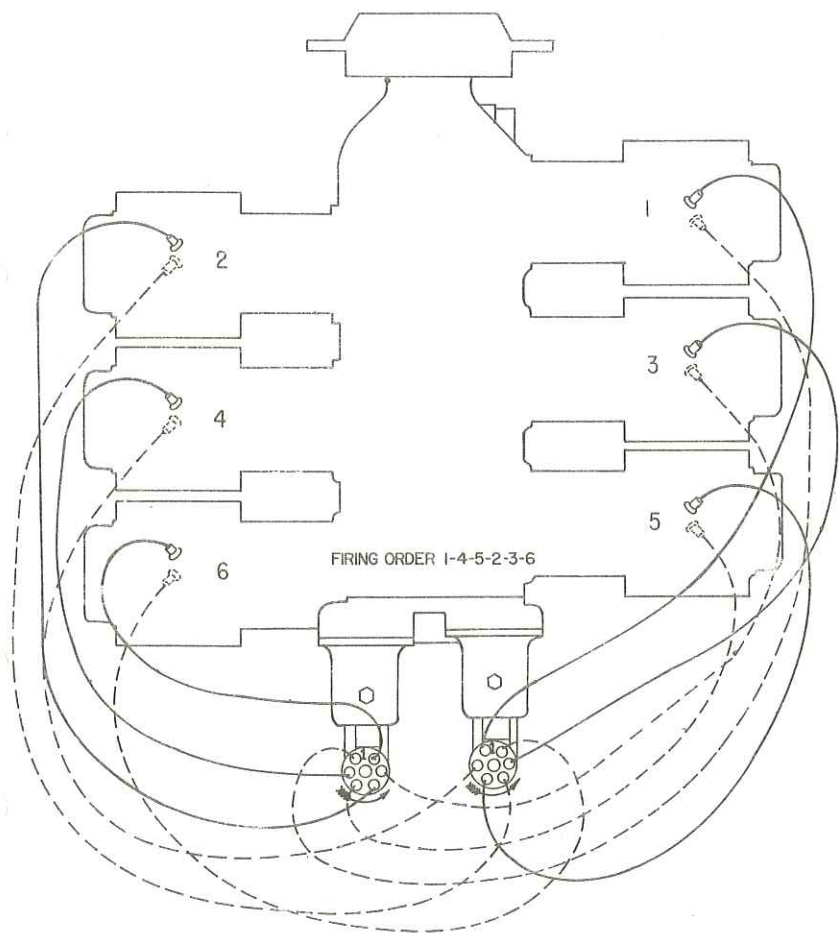


Figure 6-4. Ignition Wiring Diagram

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(3) Using a battery powered timing light, attach the positive lead to a suitable terminal connected to the switch 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.

(4) 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.

(5) *Slick Magnetos* - Remove the bottom vent plugs and "spark out" the magnetos. This is accomplished in the following manner.

(*Impulse Coupling Magneto*) Hold the T1 or B1 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 B1 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.

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

WARNING

Do not attach harness spark plug ends to the spark plugs until all magneto-to-engine timing procedures and magneto-to-switch connections are entirely completed.

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(7) 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.

(8) 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.

(9) After both magnetos have been timed to the engine, check, as described below, to ascertain that both magnetos are set to fire together.

(10) 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.

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

2. FUEL SYSTEM.

a. Repair of Fuel Leaks - In the event a line or fitting in the fuel system is replaced, only a fuel soluble lubricant, such as clean engine oil or Loctite Hydraulic Sealant may be used. Do not use any other form of thread compound.

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

c. Fuel Grades and Limitations - See recommended fuel grades on page 4-11.

In the event that the specified fuel is not available at some locations, it is permissible to use higher octane fuel. Fuel of a lower octane than specified is not to be used. Under no circumstances should automotive fuel be used (regardless of octane rating).

NOTE

It is recommended that personnel be familiar with 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 adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

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

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

3. LUBRICATION SYSTEM.

a. Oil Grades and Limitations - Service the engine in accordance with the recommended grade oil as specified in Section 4, item 9.

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

NOTE

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

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

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. CYLINDERS. 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, baffle and any clips that might interfere with the removal of the cylinder.
- (3) Disconnect ignition cables and remove spark plugs.

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(4) Remove rocker box cover and rotate crankshaft until piston is approximately at top center of the compression stroke. This approximate position may be located by observing top of piston through the spark plug hole and also watching the valve action.

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

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

NOTE

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

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

b. Removal of 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 valves 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 the 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 - 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:

(1) Remove the hydraulic tappet push rod socket by inserting the forefinger into the concave end of the socket and withdrawing. 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.

(2) To remove the hydraulic tappet plunger assembly, use the special Avco Lycoming service tool. In the event that the tool is not available, the hydraulic tappet plunger assembly may be removed by a hook in the end of a short piece of lockwire, inserting the 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 Hydraulic Tappet Plunger Assemblies - To assemble the unit, unseat the ball by inserting a thin clean bronze wire through the oil inlet hole. With the ball off its seat, insert the plunger and twist clockwise so that the spring catches.

f. 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 spring and outer valve spring over the valve stem and guide. Place the upper valve spring seat on top of the springs.

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NOTE

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

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.

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 that corresponds with both valves closed.

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

(2) Assemble piston with rings so that the cylinder number stamped on the piston pin boss is toward the front of the engine. The piston pin should be a handpush 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 quantity 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 rubber oil seal ring around the cylinder skirt. Coat piston and 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 at the bottom of the engine. Push the cylinder all of the way on, catching the ring compressor as it is pushed off.

NOTE

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

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

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NOTE

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

- (a) Tighten 1/2 inch hold-down nuts to 300 inch lbs. (25 foot lbs.) torque, in clockwise sequence.
- (b) Using the same sequence, tighten the 1/2 inch cylinder base nuts, to 600 in. lbs. (50 foot lbs.) torque.
- (c) Tighten the 3/8 inch hold-down nuts to 300 inch lbs. (25 foot lbs.) torque. Sequence of tightening is optional.
- (d) As a final check, hold the torque wrench on each nut for about five seconds. If the nut does not turn, it may be presumed to be tightened to correct torque.

CAUTION

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

- (5) Install a new shroud tube oil seal on the crankcase end of each shroud tube and fit a new annular ring in the groove provided in the rocker box end of each shroud tube. Install each shroud tube through rocker box and seat the end firmly in the crankcase. Place a spacer, two springs, a lock plate and nut over the stud provided in the rocker box and secure both shroud tubes in place. Bend the tang of the lock plate to prevent the nut and spring from loosening.
- (6) 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. Before installing exhaust valve rocker, place rotator cap over end of exhaust valve stem.
- (7) Be sure that the piston is at top center of 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, the valve clearance should be between .028 and .080 inch. If 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 longer push rod will decrease the valve clearance.

(8) Install intercylinder baffles, rocker box covers, intake pipes, rocker box drain tubes and exhaust manifold.

5. GENERATOR OR ALTERNATOR 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 or alternator drive belt tension.

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SECTION 7

TROUBLE—SHOOTING

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

NOTE

Specific recommendations for trouble-shooting the inverted oil system will be found in Section 3, paragraph 3-10.

1. TROUBLE-SHOOTING—ENGINE.

| TROUBLE | PROBABLE CAUSE | REMEDY |
|----------------------------|-------------------------|--|
| Failure of Engine to Start | Lack of fuel | Check fuel system for leaks. Fill fuel tanks. Clean dirty lines, strainers or fuel valves. |
| | Defective spark plugs | Clean and adjust or replace spark plugs. |
| | Defective ignition wire | Check with electric tester, and replace any defective wires. |
| | Defective battery | Replace with charged battery. |

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| TROUBLE | PROBABLE CAUSE | REMEDY |
|------------------------------------|---------------------------------------|--|
| Failure of Engine to Start (Cont.) | Improper operation of magneto breaker | Clean points. Check internal timing of magnetos. |
| | Lack of sufficient fuel flow | Disconnect fuel line and check fuel flow. |
| | Water in fuel injector | Drain fuel injector and fuel lines. |
| Failure of Engine to Idle Properly | Internal failure | Check oil screens for metal particles. If found, complete overhaul of the engine may be indicated. |
| | Incorrect idle mixture | Adjust mixture. |
| | Leak in induction system | Tighten all connections in the induction system. Replace any parts that are defective. |
| | Incorrect idle adjustment | Adjust throttle stop to obtain correct idle. |
| | Uneven cylinder compression | Check condition of piston rings and valve seats. |
| | Faulty ignition system | Check entire ignition system. |
| | Insufficient fuel pressure | Adjust fuel pressure. |
| | Leak in air bleed nozzle balance line | Check connection and replace if necessary. |
| | Plugged fuel injector nozzle | Clean or replace nozzle. |
| Flow divider fitting plugged. | Clean fitting. | |

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| TROUBLE | PROBABLE CAUSE | REMEDY |
|----------------------------------|---|--|
| Low Power and Uneven Running | Mixture too rich indicated by sluggish operation, red exhaust flame at night. Extreme cases indicated by black smoke from exhaust | Readjustment of fuel injector by authorized personnel is indicated. |
| | Mixture too lean; indicated by overheating or backfiring | Check fuel lines for dirt or other restrictions. Readjustment of fuel injector by authorized personnel is indicated. |
| | Leaks in induction system | Tighten all connections. Replace defective parts. |
| | Defective spark plugs | Clean and gap or replace spark plugs. |
| | Improper fuel | Fill tanks with fuel of recommended grade. |
| | Magneto breaker points not working properly | Clean points. Check internal timing of magnetos. |
| | Defective ignition wire | Check wire with electric tester. Replace defective wire. |
| | Defective spark plug terminal connectors | Replace connectors on spark plug wire. |
| | Plugged fuel injector nozzle | Clean or replace nozzle. |
| | Failure of Engine to Develop Full Power | Leak in induction system |
| Throttle lever out of adjustment | | Adjust throttle lever. |

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| TROUBLE | PROBABLE CAUSE | REMEDY |
|---|---------------------------------------|---|
| Failure of Engine to Develop Full Power (Cont.) | Improper fuel flow | Check strainer, gage and flow at the fuel inlet. |
| | Plugged fuel injector nozzle | Clean or replace nozzle. |
| | Restriction in air scoop | Examine air scoop and remove restrictions. |
| | Improper fuel | Drain and refill tank with recommended fuel. |
| Rough Engine | Faulty ignition | Tighten all connections. Check system with tester. Check ignition timing. |
| | Cracked engine mount | Replace or repair mount. |
| | Defective mounting bushings | Install new mounting bushings. |
| | Uneven compression | Check compression. |
| Low Oil Pressure | Plugged fuel injector nozzle | Clean or replace nozzle. |
| | Insufficient oil | Fill to proper level with recommended oil. |
| | Air lock or dirt in relief valve | Remove and clean oil pressure relief valve. |
| | Leak in suction line or pressure line | Check gasket between accessory housing and crankcase. |
| | High oil temperature | See "High Oil Temperature" in "Trouble" column. |

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| TROUBLE | PROBABLE CAUSE | REMEDY |
|---------------------------|--|--|
| Low Oil Pressure (Cont.) | Defective pressure gage | Replace. |
| | Stoppage in 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 to proper level with specified oil. |
| | Incorrect grade of oil | Replace with oil conforming to specifications. |
| | Clogged oil lines or strainers | Remove and clean oil strainers. |
| | Excessive blow-by | Usually caused by worn or stuck rings. |
| | Failing or failed bearing | Examine sump for metal particles. If found, overhaul of engine is indicated. |
| | Defective temperature gage | Replace gage. |
| Excessive Oil Consumption | Incorrect grade of oil | Fill tank with oil conforming to specifications. |
| | Failing or failed bearings | Check sump for metal particles. |
| | Worn piston rings | Install new rings. |
| | Incorrect installation of piston rings | Install new rings. |

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AEROBATIC SERIES

| TROUBLE | PROBABLE CAUSE | REMEDY |
|---------------------------------------|---|--|
| Excessive Oil Consumption (Cont.) | Failure of rings to seat (new nitrided cylinders) | Use mineral base oil. Climb to cruise altitude at full power and operate at 75% cruise power setting until oil consumption stabilizes. |
| High Fuel Flow Indicated on Fuel Gage | Plugged fuel injector nozzle | Clean or replace nozzle. |

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INSTALLATION AND STORAGE

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| Preparation of Engine for Installation | .8-1 |
| General | .8-2 |
| Inspection of Engine Mounts | .8-2 |
| Attaching Engine to Mounts | .8-2 |
| Oil and Fuel Line Connections | .8-2 |
| Propeller Installation | .8-2 |
| Preparation of Fuel Injectors for Installation | .8-2 |
| Preparation of Engine for Storage | .8-2 |

SECTION 8

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

CAUTION

Do not rotate the crankshaft of an engine containing preservative oil before removing the spark plugs, because if the cylinders contain any appreciable amount of the mixture, the resulting action, known as hydraulic, 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 fuel injector should also be removed and cleaned in a hydrocarbon solvent. The operator should also note if any valves are sticking. If they are, this condition can be eliminated by coating the valve stem generously with a mixture of gasoline and lubricating oil.

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

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

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

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

2. PREPARATION OF FUEL INJECTORS FOR INSTALLATION.

Fuel injectors that have been prepared for storage should undergo the following procedures before being placed in service. Remove and clean the fuel inlet strainer assembly and reinstall. Inject clean fuel into the fuel inlet connection with the fuel outlets uncapped until clean fuel flows from the outlets. Do not exceed 15 psi inlet pressure.

3. PREPARATION OF ENGINE FOR STORAGE.

Engines installed in aircraft that is inactive should be prepared for corrosion prevention as described in Service Letter No. L180.

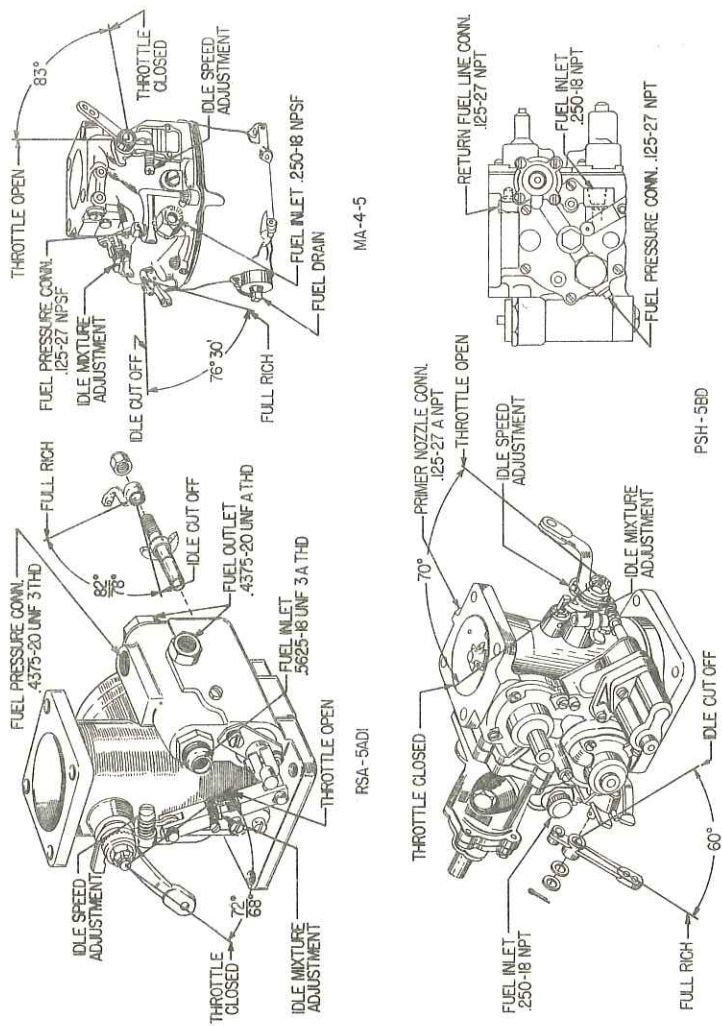


Figure 8-1. Fuel Metering Systems

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AEROBATIC SERIES

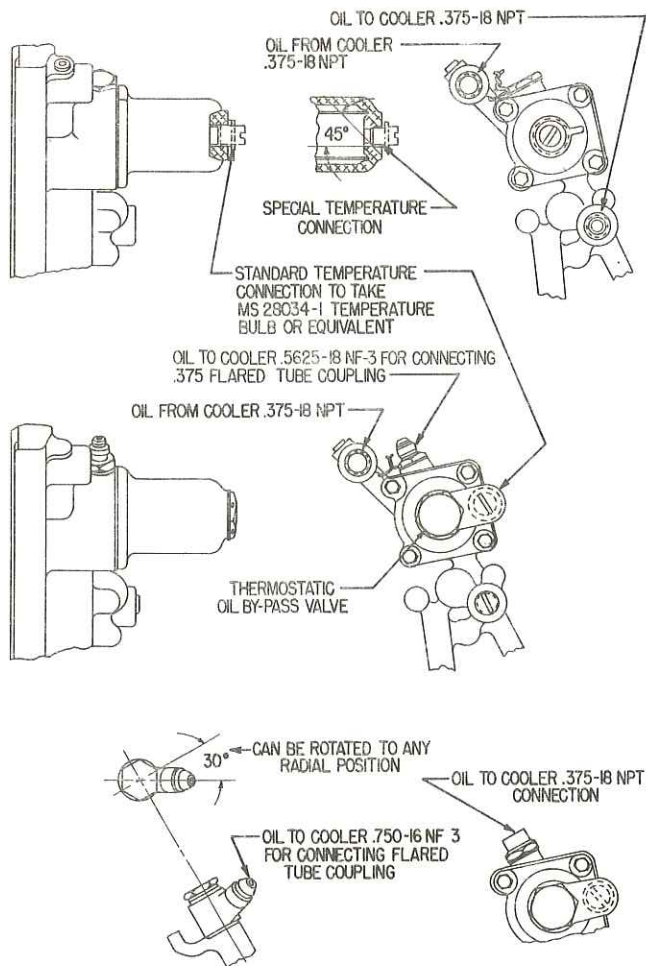


Figure 8-2. Optional Connections to Oil Cooler

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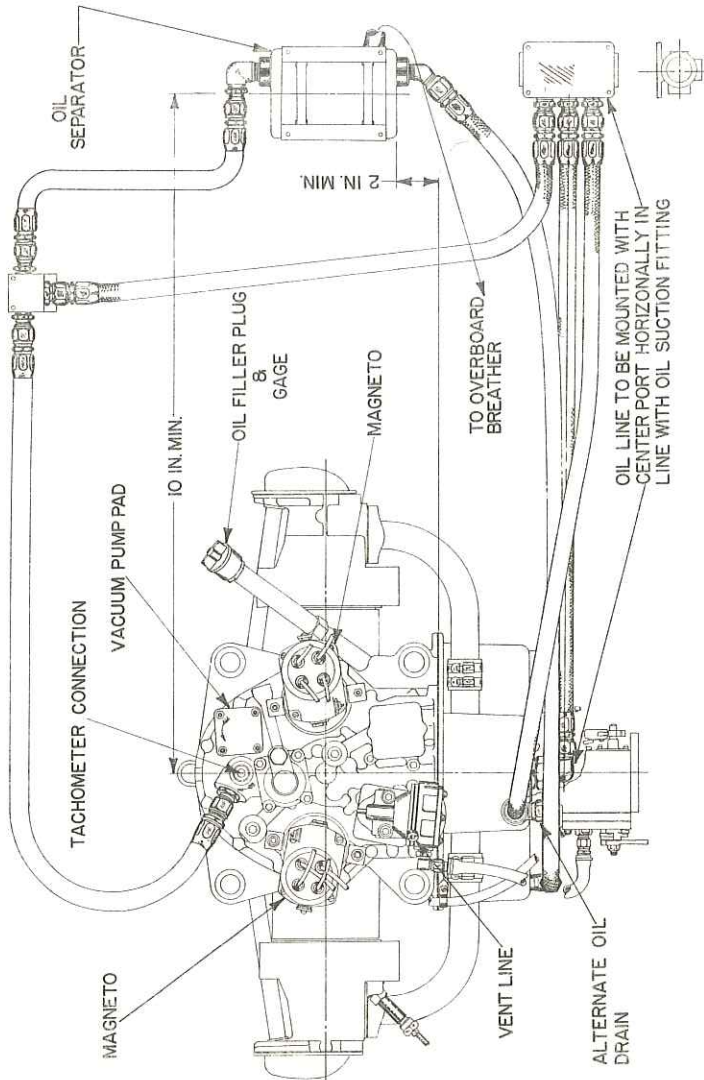


Figure 8-3. Rear View - AEIO-320 Series

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AEROBATIC SERIES

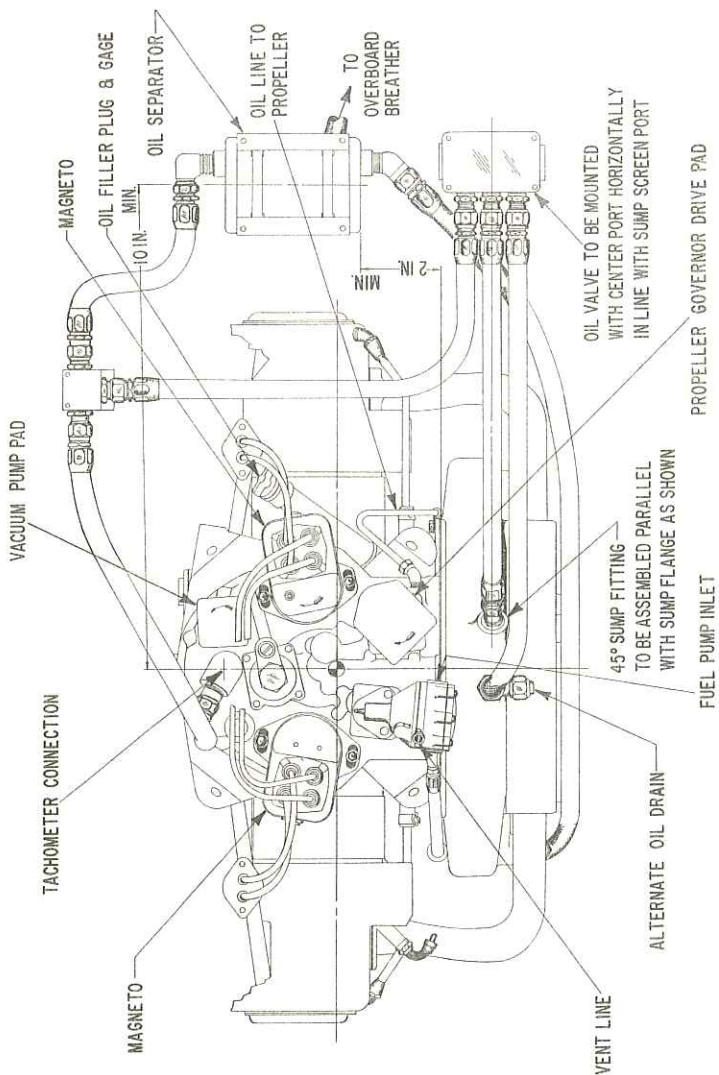


Figure 8-4. Rear View - AEIO-360 Special

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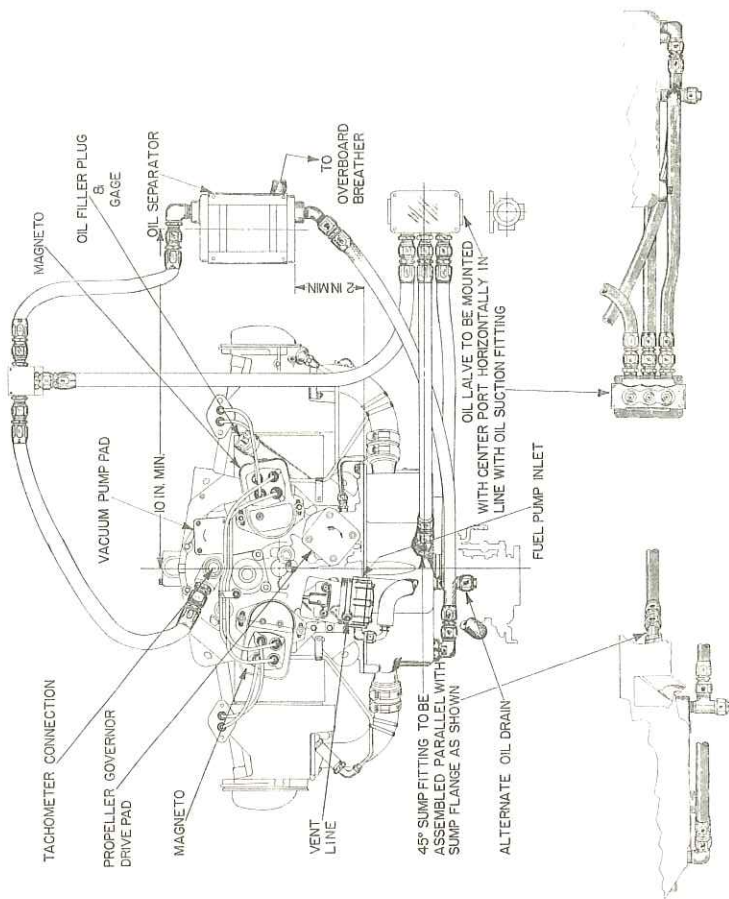


Figure 8-5. Rear View - AEIO-360-B

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AEROBATIC SERIES

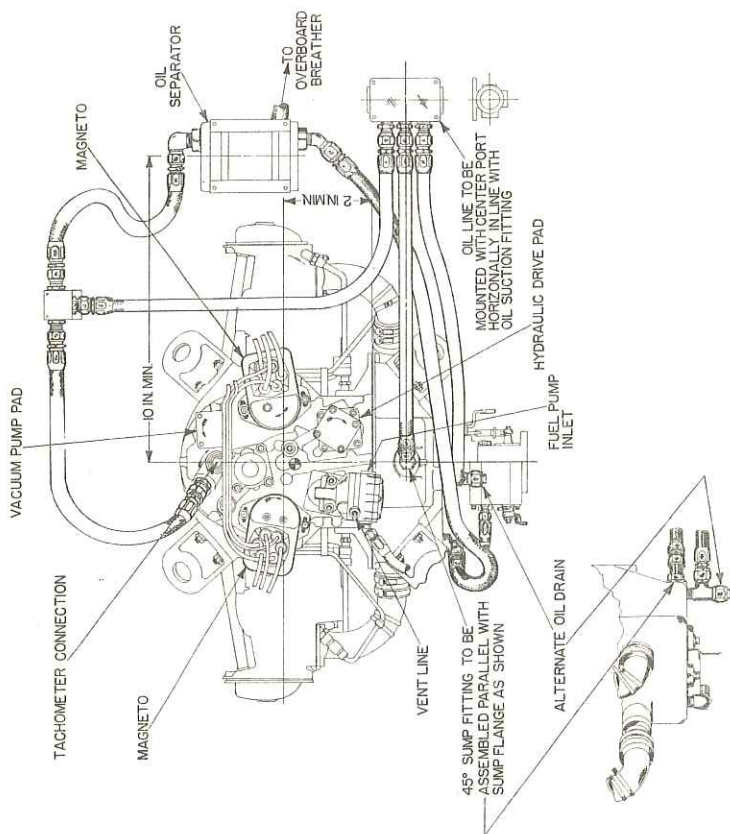


Figure 8-6. Rear View - AEIO-540-C, -D

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| Ground Run After Top Overhaul | 9-2 |
| Flight Test After Top Overhaul | 9-3 |
| Full Throttle HP at Altitude | 9-4 |
| Table of Speed Equivalents | 9-4 |
| Centigrade-Fahrenheit Conversion Table | 9-5 |
| Inch - Fractions Conversion | 9-6 |

SECTION 9

TABLES

FOR TIGHTENING TORQUE RECOMMENDATIONS AND INFORMATION CONCERNING TOLERANCES AND DIMENSIONS THAT MUST BE MAINTAINED IN AVCO LYCOMING AIRCRAFT ENGINES, CONSULT LATEST EDITION OF TABLE OF LIMITS NO. SSP2070.

SECTION 9

AEROBATIC SERIES

FIXED WING ONLY

GROUND RUN AFTER TOP OVERHAUL
OR CYLINDER CHANGE WITH NEW RINGS
(DO NOT USE AFTER MAJOR OVERHAUL)

Type Aircraft _____
Registration No. _____
Aircraft No. _____
Owner _____
Engine Model _____ S/N _____
Date _____
Run-Up By _____

1. Avoid dusty location and loose stones.
2. Head aircraft into wind.
3. All cowlings 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.

GROUND RUN

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

Mag. Check

Power Check

Idle Check

Adjustment Required

After Completion of Ground Run

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

**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

| | MAP | | Temperature | | Pressure | | Temperature | | Fuel Flow | | | | | |
|--------------|-----|--------|-------------|--------|----------|--------|-------------|---------|-----------|---------|---------|-----|------|-------|
| | RPM | L. oil | R. oil | L. cyl | R. cyl | L. oil | R. oil | L. fuel | R. fuel | L. carb | R. carb | Air | Left | Right |
| Time (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 barrels for scoring.

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SECTION 9

AEROBATIC SERIES

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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SECTION 9

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.

| <u>C</u> | <u>F-C</u> | <u>F</u> | <u>C</u> | <u>F-C</u> | <u>F</u> |
|----------|------------|----------|----------|------------|----------|
| -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 |

LYCOMING OPERATOR'S MANUAL

SECTION 9

AEROBATIC SERIES

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 | 21.437 |
| 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 |