O-200-D
X

CONTINENTAL® AIRCRAFT ENGINE

MAINTENANCE AND OVERHAUL MANUAL

Technical Portions Accepted by the Federal Aviation Administration

Publication M-2

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Supersedure Notice

This manual revises O-200-D & X series maintenance and overhaul instructions contained in Publication Part No. M-2 dated 15 October 2009. Previous editions of M-2 are obsolete upon release of this manual. Instructions in this manual are for O-200-D and subsequent engine models only and shall not be used for O-200-A, B or C series engines.

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Service Document and Technical References

Technical information in the service documents listed below relevant to the engine models covered by this engine manual have been incorporated in this manual. The full content of active Continental Motors service documents are available on the Continental Motors web site. Refer to Section 1-3, “Contact Information” for Continental Motors web site details.

Service Document	Subject	Affected Chapter
M64-18, Turbocharger Field Conversion	Engine Modification	N/A
M72-17R1, Maximum Weight Difference Allowance Between Connecting Rods and Pistons in the Same Engine	Engine Assembly and Overhaul	10, 15, 17
M73-13, Reaming and Bushing Rocker Shaft Bosses	Cylinder Repair and Overhaul	10, 15, 17
M75-6R1, Conversion of Engines From One Model to Another	Engine Configuration	N/A
M76-4, Installation Of Propeller Shaft Or Nose Oil Seals	Oil Seal Replacement	10, 15, 17
M76-5R1, Remote Mounted Oil Coolers	Engine Installation and Oil Servicing	4 & 5
M76-8, Intake Valve Change	Engine Maintenance and Overhaul	N/A
M76-15, Fuel Pumps	Fuel Pump and Camshaft Replacement	N/A
M77-19, Intake and Exhaust Rocker Arm Identification and Application	Engine Assembly	N/A
M81-8R1, Fuel Pump Screen Restriction	Fuel Pump Inspection and Parts Replacement	N/A
M81-25, Exhaust Flange to Cylinder Installation Procedures	Engine Installation	5
M86-9, Crankcase Modification	Engine Overhaul	N/A
M87-15, Alternator Ground Strap	Alternator Replacement	N/A
M88-9, Lightning Strikes	Unscheduled Maintenance	7
M88-10, Contaminated Fuels	Unscheduled Maintenance	7
M89-7R1, Engine Operation after Cylinder Replacement and/or Major Overhaul	Engine Operation-break-in	5, 7 & 18
M89-9, Excessive Crankcase Pressure	Unscheduled Maintenance	6 & 8
M89-18, EGT Recommendations	EGT Leaning	N/A
M90-9, New TCM Magneto and Harness Applications	Magneto and Ignition Harness Replacement	10 & 17
M90-13, Exhaust Valve Stem Corrosion/Erosion	Inspection & Overhaul	7, 10 & 15
M90-17, Crankcase Inspection Criteria	Inspection	10 & 15
M91-4, Piston Identification and Piston Ring Application Bulletin	Piston Replacement	10 & 17
M91-9, Cam and Lifter Lubrication during Rebuild	Overhaul	10 & 16
M92-5, Precision Airmotive Corporation Mandatory Service Bulletin #MSA-1 Rev. 1 and MSA-2 Rev. 1	Carburetor Parts Replacement	10 & 16
M92-8, Application of 4-1/6" Diameter Cylinder Assemblies	Cylinder Replacement	10, 13, 15 & 16

Service Document	Subject	Affected Chapter
M93-8, Rocker Arm to Rotocoil Clearance	Rocker Arm Clearance	10 & 15
M93-10, TCM Ignition Systems Service Bulletin 639	Inspection	7, 10 & 15
SIL93-11A, New Service Document Format	Service Documents	1
MSB93-12, Valve Retainer Key Installation Inspection	Inspection	10, 15 & 16
SIL93-14, CFC Compliance	N/A	N/A
SIL93-15, General Practices for Installation of Lock Wire, Tab Washers, and Cotter Pins	Standard Practices	Appendix C
CSB94-1, TCM Ignition CSB641	Magneto Coil	10 & 15
SIL94-5, Mobil AV-1 Oil	Authorized Lubricants	3
MSB94-8C, Magneto to Engine Timing	Service	5, 6, 10 & 17
SID94-12, Precision Airmotive Corp. Service Bulletin MSA-7	Carburetor Venturi Replacement	6, 10 & 15
SB95-2, Inspection and Maintenance of Engine Control Cables and Linkage	Inspection	6
SB95-3B, Alternator/Generator Drive Couplings	Inspection	6, 10 & 15
CSB95-4, Intake Valve Guide Seal Inspection	N/A	10 & 15
SIL95-5, Hose and Tubing Installation	Hose and tubing installation	Appendix C
CSB96-1, Starter Gear and Clutch Assembly, P/N 653575	Starter Replacement	6, 10 & 15
SID96-6, TCM Ignition SB653	Engine Operation-Hot magneto Test	6 & 7
SB96-7C, Torque Limits	fastener torque	Appendix B
MSB96-10, Requirements for Ultrasonic Inspection	Crankshaft Removal & Replacement	15
SB96-11B, Propeller Strikes and Hydraulic Lock	Scheduled Inspection	6
SB96-12, Continued Airworthiness for TCM Cylinders	Scheduled Inspection	6 & 10
SIL97-1, Airworthiness Limitations	Airworthiness Limitations	4
SID97-2B, TCM Cylinder Warranties	N/A	N/A
SID97-4C, Cylinder Bore and Piston Fit Specifications	Overhaul & Service Limits	10 & Appendix D
SB97-6A, Mandatory Replacement Parts	Engine Inspection & Assembly	Throughout
CSB97-10A, Piston Pin Plug Wear	Service Limits	10
SIL97-14, Replacement Cylinder Assembly	Cylinder Replacement	7, 10, 15, 16, 17 & App. D
SB97-15, TCM Ignition Service Bulletin SB660	N/A	6
CSB98-1B, Intake and Exhaust Valve Inspection	Service Limits	10 & 15, 16, 17 & App. D
SIL98-9A, Time Between Overhaul Periods	Engine Specifications, Scheduled Maintenance	2 & 6

Service Document	Subject	Affected Chapter
SIL99-1, Engine Preservation for Active and Stored Aircraft	Engine preservation and returning an engine to service after storage	9
SIL99-2C, Current Listing of Sealants, Lubricants and Adhesives Authorized by TCM	Materials	Throughout
SB99-8, Engine Fuel Injection System Preservation	Fuel Injection system storage	5
SB00-3A, Crankshaft, Counterweight and Connecting Rod Repair Information	Repair Specifications	10
SB00-4A, Australian AVGAS Contamination	Inspection and Operation	6
SIL00-7A, Oil Gauge Rod Application	Oil Servicing	6
SIL00-9A, Engine Data Plates	N/A	N/A
SB00-10, Fuel Pump Seal	Fuel Pump Installation	10 & 17
SIL00-11B, Release of new Cylinder Induction Port Drain Connector	Cylinder Assembly	10 & 17
SB00-12, Service Publications for Rolls Royce Manufactured Engines	Publication Responsibility	N/A
SIL02-6A, Production Release of Optional Intake And Exhaust Valves	Valve Replacement	N/A
CSB02-8, TCM Ignition Systems CSB664	N/A	6, 10 & 15
SIL03-1, Cold Weather Operation – Engine Preheating	Preheating procedures	7
SIL03-2B, Currently Active Approved Spark Plug Application	Spark plugs	2 & 6
SIL03-3, Differential Pressure Test and Borescope Inspection	Inspection Criteria	6
SIL04-2, Cylinder Barrel Ultrasonic Inspection	N/A	10, 15
CSB04-5A, TCM Ignition Systems CSB665A	Magneto Service	10
SB04-10, Piston Pin Marking	Overhaul Repairs	10 & 15
SB04-11, Valve Guide Application, Installation and Reaming	Valve Guide Repairs	10 & 15
SIL04-12, TCM Authorized Engine Adjustments, Component Replacement and Repositioning	Engine Specification	2, 5, 10 & 17
SID05-1, Design, Operation and Maintenance of TCM Camshafts and Hydraulic Lifters	Inspection Criteria	15 & Appendix D
SB05-2, Overspeed Limitations	Unscheduled Maintenance	6 & 7
SIL05-3, Engine Specification Numbers	Engine Specification	2
SB05-9, Slick Service Bulletin SB1-88B	Magneto Inspection	6 & 15
SB07-1, Connecting Rod Piston Pin Bushing Inspection	Inspection	15
SB07-8, Recommended Minimum RPM & Manifold Pressure Cruise Operations Limits	Engine Operation	7
SB08-3, Throttle & Mixture Control Arms	N/A	N/A
SB08-6, Precision Airmotive, LLC Mandatory Carburetor Service Bulletin MSA-13	Carburetor Inspection	6 & 10

Service Document	Subject	Affected Chapter
SB08-7, Precision Airmotive, LLC Mandatory Carburetor Service Bulletin MSA-14	Carburetor Inspection	6 & 10
SB08-8, Slick Service Bulletin SB2-08	Magneto Inspection	6, 15
SB08-9A, Slick Service Bulletin SB3-08A	Magneto Inspection	6, 15
SB08-13, Induction System Hose and Clamp Installation	Induction System Inspection & Assembly	6, 10 & 17
SIL640, Service Document Format	Service Documents	Preface & 1
SB643B, Maintenance Intervals for TCM Bendix Magnetos	Inspection & Operation	6, 7, 10, 15, 16 & 17
SB653, Hot Magneto Test	Inspection & Operation	6, 7

Service Documents Released After Publication

Continental Motors strives to provide clear, concise, and accurate information and instructions based on best known engineering data at the time of publication. Ongoing process improvements may change a specification or procedure after a manual is released. Service documents, defined in Chapter 1, expedite customer notification and serve as the prevailing instruction over conflicting information until the new information is incorporated in the manual text. As service documents are received, note the service document number, release date, title, and applicable section affected by the service document in the blank cells below and insert a copy of the service document behind the last page of this section. Make pen & ink corrections, where appropriate, to the original text in the manual with a citation to the service document; i.e. *see SB9X-1*. For paragraphs or entire sections, draw an "X" through the affected information in the manual and reference the service document containing the correction.

Service Bulletins Release After This Manual

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PREFACE

Continental Motors, Inc. provides Instructions for Continued Airworthiness based on the design, testing, and certification of engines and parts for which Continental Motors is the holder of the Type Certificate (TC) or Parts Manufacture Approval (PMA) issued by the Federal Aviation Administration (FAA). Instructions in Continental Motors manuals, which include maintenance, repair limits, overhaul, and installation, are applicable only to engines and parts supplied by Continental Motors.

O-200-D and subsequent model engines are developed and certified in compliance with Federal Aviation Regulation (FAR) §33. The Airworthiness Limitation Section (Chapter 4) of this manual is approved by the FAA, with the balance of the Instructions for Continued Airworthiness (ICAs) contained in this manual designated as “acceptable” by the FAA. Pursuant to FAR §43.13, each person performing maintenance, alteration, or preventive maintenance on the engine or accessories must use methods, techniques, and practices prescribed in the ICAs.

Except for FAR part 43.3 authorized owner preventive maintenance, Continental Motors ICAs are written for exclusive use by FAA (or equivalent authority) licensed mechanics or FAA (or equivalent authority) certified repair station employees working under the supervision of an FAA licensed mechanic. Information and instructions contained in this manual anticipate the user possesses and applies the knowledge, training, and experience commensurate with the requirements to meet the prerequisite FAA license and certification requirements. No other use is authorized.

Installation of aftermarket parts on a Continental Motors engine constitutes a deviation from type-design criteria. Continental Motors has not participated in design, test, or certification of any aftermarket parts. Continental Motors does not provide product manufacturing specifications to aftermarket parts manufacturers and accepts no liability for the suitability, durability, longevity, or safety of such parts installed on Continental Motors engines. Installation of aftermarket parts on a Continental Motors engine must be performed using Instructions for Continued Airworthiness prepared by the manufacturer and accepted by the FAA for the subject installation. Continental Motors ICAs must not be used for such parts.

Service documents may contain general information or information specific to a group of engines or be in effect for a limited time frame. Service Documents may also contain advance changes to the ICAs. It is the responsibility of the organization/person maintaining or operating the engine to verify that current and complete information, including Service Documents, FAA Airworthiness Directives (ADs), and publications are used.

To facilitate the use of current data, Continental Motors provides information the Continental Motors web site. The information available includes a listing of the latest manual versions, service documents, FAA ADs, and other information applicable to the ICAs.

Manuals published since 2003 are available on the Continental Motors web site to Fixed Base Operators (FBOs) who subscribe to Continental Motors Internet Services. Information available to engine owners is also available to FBOs. Printed manuals and service subscriptions are also available. Printed manuals and service subscriptions are also available. Refer to “Publication Access” in Section 1-2.3.

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Chapter 1. Introduction

1-1. Scope and Purpose of This Manual

This manual provides maintenance and overhaul instructions for O-200-D, and subsequent engine models in the O-200 class of lightweight aircraft engines, manufactured by Continental Motors. Instructions in this manual are specific to the O-200-D and subsequent engine models. For information pertaining to other Continental Motors engine series, including the O-200-A, B & C engine models, aircraft engine accessories, or the airplane, refer to the appropriate manual. Chapters are arranged in sequential order to remove and install, service, operate, maintain and overhaul the engine.

Chapter 2 contains detailed engine model descriptions and specifications. Special tools and consumables such as lubricants, sealants and adhesives are listed in Chapter 3. Airworthiness limitations are in Chapter 4. Chapter 5 provides instructions for installing the engine in an airframe with engine installation drawings. Chapter 6 contains inspection and service intervals and instructions. Chapter 7 provides supplemental information also found in the Installation and Operation Manual approved by the FAA under Part 33.5 on which the Airplane Flight Manual (AFM) and Pilot Operating Handbook (POH) are based. Chapter 8 contains engine troubleshooting instructions. Engine preservation and storage instructions are in Chapter 9. Non-overhaul engine part removal and installation instructions are in Chapter 10. Chapter 11-18 contain engine overhaul instructions. Appendix A contains a glossary of common terms and acronyms used throughout the manual; Appendix B provides torque specifications, and Appendix C contains standard maintenance practices. Appendix D contains engine overhaul dimensional fits and limits.

1-1.1. Advisories

This manual utilizes three types of advisories; defined as follows:

WARNING

A warning emphasizes information which, if disregarded, could result in severe injury to personnel or equipment failure.

CAUTION: Emphasizes certain information or instructions, which if disregarded, may result in damage to the engine or accessories.

NOTE: Provides special interest information, which may facilitate performance of a procedure or operation of equipment.

Warnings and cautions precede the steps to which they apply; notes are placed in the manner which provides the greatest clarity. Warnings, cautions, and notes do not impose undue restrictions. Failure to heed advisories will likely result in the undesirable or unsafe conditions the advisory was intended to prevent. Advisories are inserted to ensure maximum safety, efficiency, and performance. Abuse, misuse, or neglect of equipment can cause eventual engine malfunction or failure.

1-1.2. Using this Manual

This manual, the accessory manuals listed in Table 1-1, and certain service bulletins that are incorporated into the ICAs as revisions, constitute the Instructions for Continued Airworthiness (ICAs) prepared by Continental Motors and accepted by the FAA. We prepared this manual in a user-friendly format suited equally for electronic viewing or printing. Illustrations in this manual are for reference only, depicting the most prominent configuration in the engine series when only minor differences exist. When significant variations exist between engine models, separate instructions are prepared for each model. Consult the illustrated parts breakdown on the Continental Motors web site for your specific engine model and each subsystem.

Continental Motors provides Instructions for Continued Airworthiness based on the design, testing, and certification of engines and parts for which Continental Motors is the holder of the Type Certificate (TC) or Parts Manufacture Approval (PMA) issued by the Federal Aviation Administration (FAA).

WARNING

Continental Motors Instructions for Continued Airworthiness are applicable *only* to Continental Motors engines conforming to the approved, type certified engine model configuration. Continental Motors ICAs *must not* be used for aftermarket parts.

Exploded assembly illustrations accompany instructions throughout the manual. Parts in illustrations (Figure 1-1) are identified with numerical callouts (indexes). Corresponding parts listings follow the illustrations for reference. The first time instructions refer to an illustration, the figure number is identified in parentheses, followed by the callout. In subsequent parts references, only the callout will be specified unless the referenced illustration changes.

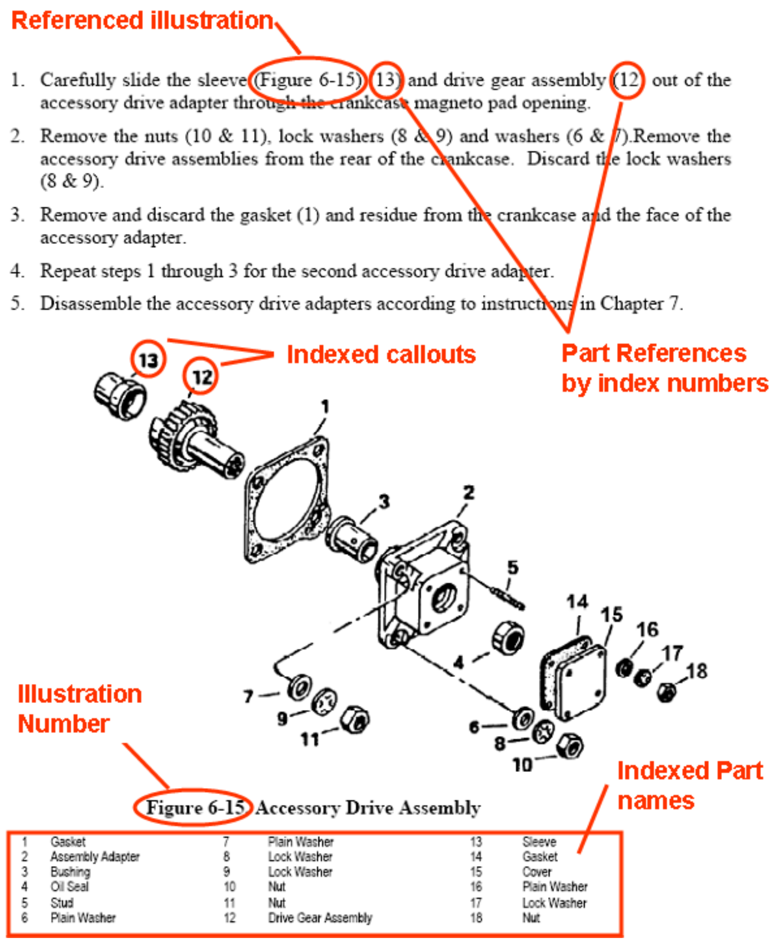


Figure 1-1. Figure and Index Reference

1-1.3. Compliance

The owner/operator is responsible for ensuring the engine is maintained in an airworthy condition, including compliance with FAA Airworthiness Directives and certain service bulletins that are incorporated into the ICAs as revisions. Engine service life is calculated based on compliance with the aircraft and engine manufacturer’s required instructions, inspections, and maintenance schedule. Failure to comply may void the engine warranty.

WARNING

Prior to authorizing engine installation or maintenance, the owner must ensure the mechanic meets the Federal Aviation Administration (or equivalent authority) regulatory requirements.

Except for FAR part 43.3 authorized owner preventive maintenance, Continental Motors ICAs are written for exclusive use by FAA (or equivalent authority) licensed mechanics or FAA (or equivalent authority) certified repair station employees working under the supervision of an FAA licensed mechanic. Information and instructions contained in this manual anticipate the user possesses and applies the knowledge, training, and experience commensurate with the prerequisite FAA license and certification requirements. No other use is authorized.

WARNING

Failure to comply with ICAs may result in injury or subsequent engine failure. Pursuant to Federal Aviation Regulation (FAR) §43.13, each person performing maintenance, alteration or preventive maintenance on an engine or accessory must use methods, techniques and practices set forth in the Instructions for Continued Airworthiness or other methods, techniques, and practices acceptable to the Administrator.

This manual shall be used in conjunction with FAA Advisory Circular 43.13-1B "Acceptable Methods, Techniques, and Practices," service documents, related publications and accessory manufacturer's instructions. Pursuant to Federal Aviation Regulation (FAR) §43.13, each person performing maintenance, alteration, or preventive maintenance on the engine or accessories must use methods, techniques, and practices prescribed in the ICAs or other methods, techniques, and practices acceptable to the Administrator.

1-1.4. Order of Precedence

Continental Motors engine operating instructions are generated prior to and independently of the aircraft operating instructions. Continental Motors operating instructions are developed using factory controlled parameters that are not necessarily the same as those specifications required to satisfy a specific aircraft/engine installation.

WARNING

The aircraft operator must use the airframe manufacturer's operating instructions found in the Airplane Flight Manual/ Pilot's Operating Handbook (AFM/POH) while operating the aircraft unless the AFM/POH directs otherwise.

Refer to the AFM/POH published by the airframe manufacturer for operating instructions and specifications relative to your aircraft.

WARNING

New or updated Instructions for Continued Airworthiness may be contained in service documents. Service documents applicable to the engine or accessories within the scope of this manual must be consulted and complied with prior to performing installation, maintenance, or overhaul function.

New information contained in service documents may override the instructions contained in this manual. Prior to commencing engine maintenance, consult the Continental Motors web site to verify the current status of the ICAs relating to the intended procedure.

1-2. Publications

1-2.1. Service Documents

Continental Motors may issue Service Documents ranging from mandatory (Category 1) to informational (Category 6). Definitions of the categories are listed below:

NOTE: Upon FAA approval, Continental Motors publishes service documents for immediate availability on our web site. The service document cover page indicates the engine models affected by the service document. Service documents may alter or replace manufacturer's ICAs. Insert a copy of applicable Service Documents in affected manuals until the service document instructions are incorporated in the manual, or the service document is cancelled or superseded.

Category 1: Mandatory Service Bulletin (MSB)

Used to identify and correct a known or suspected safety hazard which has been incorporated in whole or in part into an Airworthiness Directive (AD) issued by the FAA or have been issued at the direction of the FAA by the manufacturer requiring compliance with an already-issued AD (or an equivalent issued by another country's airworthiness authority). May contain updates to Instructions for Continued Airworthiness (ICAs) to address a safety issue.

Category 2: Critical Service Bulletin (CSB)

This category identifies a condition that threatens continued safe operation of an aircraft, persons or property on the ground unless some specific action (inspection, repair, replacement, etc.) is taken by the owner or operator. Documents in this category are candidates for incorporation into an FAA Airworthiness Directive. May contain updates to ICAs to address a safety issue.

Category 3: Service Bulletin (SB)

Information which the product manufacturer believes may improve the inherent safety of an aircraft or aircraft component; this category includes the most recent updates to ICAs.

Category 4: Service Information Directive (SID)

The manufacturer directs the owner/operator/mechanic in the use of a product to enhance safety, maintenance or economy. May contain updates to ICAs in the form of maintenance procedures or specifications.

Category 5: Service Information Letter (SIL)

This category includes all information (not included in categories 1 through 4) that may be useful to the owner/operator/technician. May contain updates to ICAs for optional component installations, which are not covered in the Applicable Operator, Maintenance, or Overhaul Manuals.

Category 6: Special Service Instruction (SSI)

This category is used to address an issue limited to specific model and/or serial number engines. Continental Motors will distribute SSI notification directly to the affected engine's owners. SSIs will not be included in the general service document set but will be made available through our Customer Service Department to owners of the affected engines only. An SSI may update the applicable engine's Instructions for Continued Airworthiness.

1-2.2. Related Publications

The table below lists related publications, source, and accessibility relevant to O-200 Series engine maintenance & overhaul.

WARNING

Use only the latest revision of all publications. Using superseded information may jeopardize engine airworthiness.

Table 1-1. Related Publications

Publication	Supplied With Engine	Available download at web site[1]	Printed Manual Available for Purchase
Installation and Operation Manual (OI-2)	Yes	Yes[2]	Yes
S-20/S-200 Magneto Service Manual (X42002)	Yes	Yes	Yes
Plane Power R14-50 Alternator AIrcraft Manual Supplement (11-0001)	Yes	No	No
Plane Power Alternator Brush Replacement Instructions (SI-09-01PP)	Yes	No	No
Service Documents	No	Yes	Yes
Parts Catalog	No	Yes	No

1. Our web site (continentalmotors.aero) provides 24-hour access to engine technical data. If you are an internet service subscriber, you can access our web site to confirm and review the latest revision of this manual. If you have not subscribed to internet service and are using printed manuals, contact a service representative using the “Contact Information” in Section 1-3 to confirm you have the latest revision of the manual.
2. The Installation and Operation Manual is provided to the airframe manufacturer as part of the engine interface control document to aid in development of the Airplane Flight Manual/Pilot’s Operating Handbook with detailed installation instructions and dimensional limits.

1-2.3. Publication Access

Contact an authorized Continental Motors distributor to discuss service subscription options and pricing or visit the Continental Motors web site (See Section 1-3). Printed technical publications may be ordered through authorized distributors or via the Internet at http://continentalmotors.aero.

1-2.4. Publication Changes

The instructions in this manual represent the best and most complete information available at the time of publication. Product or process improvements may trigger changes to existing product design specifications or procedures contained in publications. As new technical information becomes available, Continental Motors will make the information available to the customer.

WARNING

New information may be contained in Continental Motors service documents. Service documents applicable to engines and accessories within the scope of this manual must be complied with as defined in these documents. This manual and other related publications noted herein constitute the ICAs prepared by Continental Motors and accepted by the FAA.

Continental Motors releases publication changes in the form of either change pages or complete publication revisions, depending upon the extent of change. Service Documents may supplement or replace technical information contained in one publication or an entire series of publications. Such Service Documents represent a change to the published ICA until the individual publications incorporate the latest technical information.

1-2.4.1. Update/Change Distribution

Document updates are available on our web site upon notification of FAA document approval. Printed publication subscribers receive printed changes and revisions as they are released.

Document revisions are released if the update changes more than 50% of the contents of a publication. Revisions replace the previous version of a publication from cover to cover. Minor corrections are released as change pages to the original publication, identified with a change number and effective change date in the page footer. Information on the page that changed from the previous edition is identified by a vertical, six-point black line (Figure 1-2), referred to as a “change bar” in the outside margin of the page. A change page replaces only the previous edition of the affected page.

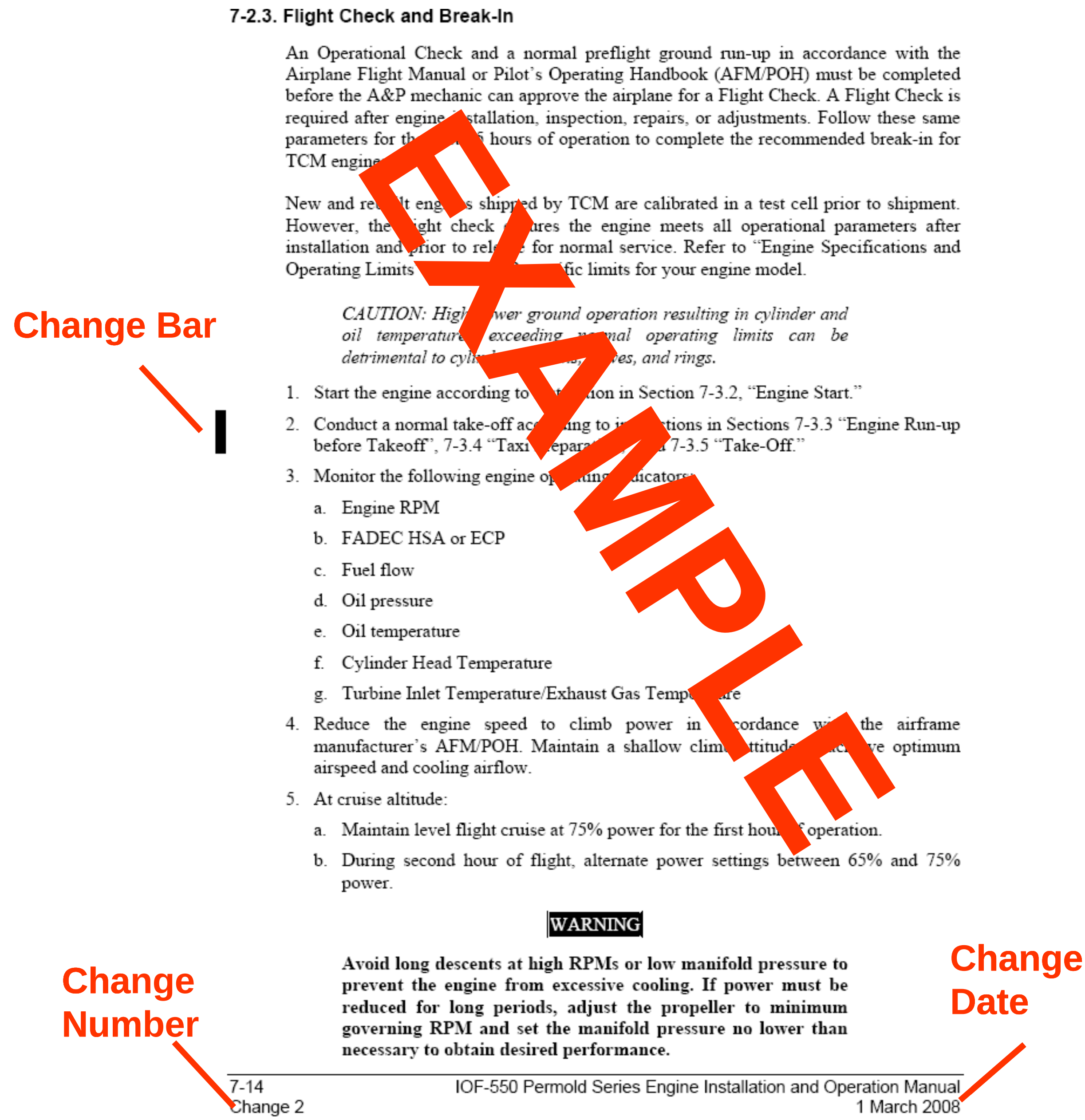
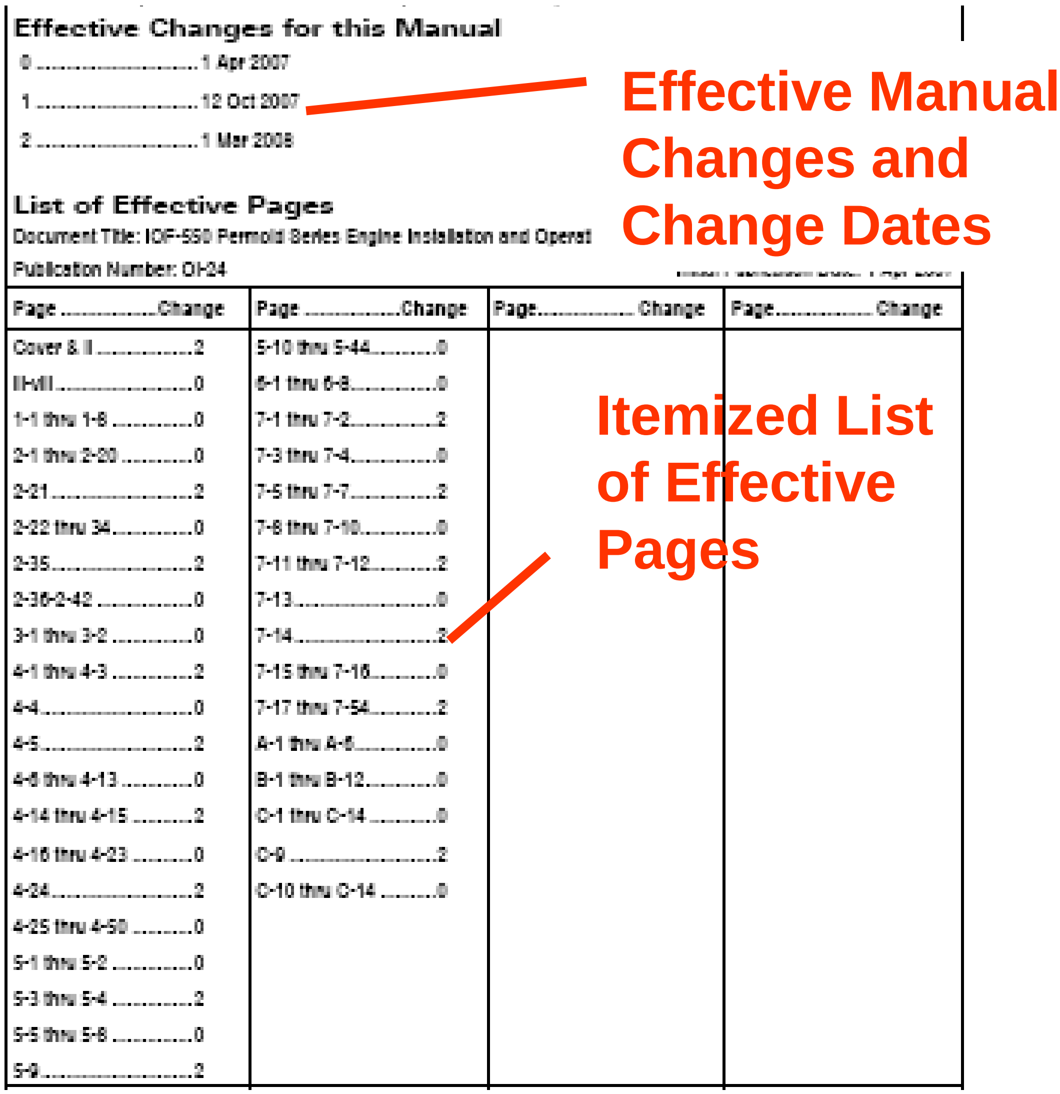


Figure 1-2. Change Page Identification

Page A of the manual contains the original publication date and an itemized list of changes issued for the technical manual (Figure 1-3). If change pages are issued for the manual, the change will be identified, with an effective date under the heading "Effective Changes for This Manual." The list of effective pages, itemizes the pages in each section, by change number. Original pages are designated by a 0 in the List of Effective Pages "Change" column.



Effective Changes for this Manual

0 .... 1 Apr 2007
1 .... 12 Oct 2007
2 .... 1 Mar 2008

List of Effective Pages

Document Title: IOF-550 Permold Series Engine Installation and Operat

Publication Number: OI-24

Page ....Change	Page ....Change	Page..............Change	Page..............Change
Cover & II 2	5-10 thru 5-44.........0		
III-VIII 0	6-1 thru 6-8.............0		
1-1 thru 1-8 0	7-1 thru 7-2.............2		
2-1 thru 2-20 0	7-3 thru 7-4.............0		
2-21........................2	7-5 thru 7-7.............2		
2-22 thru 34.............0	7-8 thru 7-10...........0		
2-35........................2	7-11 thru 7-12.........2		
2-36-2-42 0	7-13........................0		
3-1 thru 3-2 0	7-14........................2		
4-1 thru 4-3 2	7-15 thru 7-16.........0		
4-4..........................0	7-17 thru 7-54.........2		
4-5..........................2	A-1 thru A-6.............0		
4-6 thru 4-13 0	B-1 thru B-12...........0		
4-14 thru 4-15 2	C-1 thru C-14 0		
4-16 thru 4-23 0	C-9 2		
4-24........................2	C-10 thru C-14 0		
4-25 thru 4-50 0			
5-1 thru 5-2 0			
5-3 thru 5-4 2			
5-5 thru 5-8 0			
5-9..........................2			

Figure 1-3. List of Effective Pages

1-2.4.2. Suggestions and Corrections

Continental Motors solicits and encourages user comments regarding suggested changes to this manual. Direct recommended changes or questions to the attention of "Publications" at the address listed in Section 1-3 or send comments via email to CM.techpubs@continentalmotors.aero.

Notify our Customer Service Department immediately, using our toll-free number, if you discover incorrect information which adversely affects safety.

1-3. Contact Information

Continental Motors is available to answer technical questions and encourages suggestions regarding products, parts, or service. If customers have an inquiry or require technical assistance, they should contact their local Continental Motors distributor or field representative. To contact a factory representative, refer to the contact information below:

Continental Motors, Inc.
P. O. Box 90
Mobile, AL 36601

Customer Service Department:
Toll free within the Continental United States: 1-888-826-5465
International: 1-251-438-8299

Internet: http://continentalmotors.aero.

Chapter 2. Engine Description

2-1. General Engine Description

O-200-D and X model engines are four-cylinder, four-stroke reciprocating aircraft engines, designed for fixed pitch, ground adjustable, or electric constant speed propellers. Cylinder displacement of 200 cubic inches is achieved with a 4.06 inch bore and a 3.88 inch stroke. O-200 series engines are equipped with carburetors and an updraft induction system.

The engines are designed with a wet sump, positive displacement oil pump installed in the accessory case. When properly maintained, under normal operating conditions, the desired oil pressure is maintained by a pressure relief valve located in the accessory case. Engine cranking is accomplished by a geared starter mounted on the accessory case.

A gear driven alternator may be installed at the aft end of the accessory case. The engine is equipped with two gear-driven magnetos. The downdraft exhaust system is supplied by the airframe manufacturer.

O-200 series engines have six bolt propeller flanges.

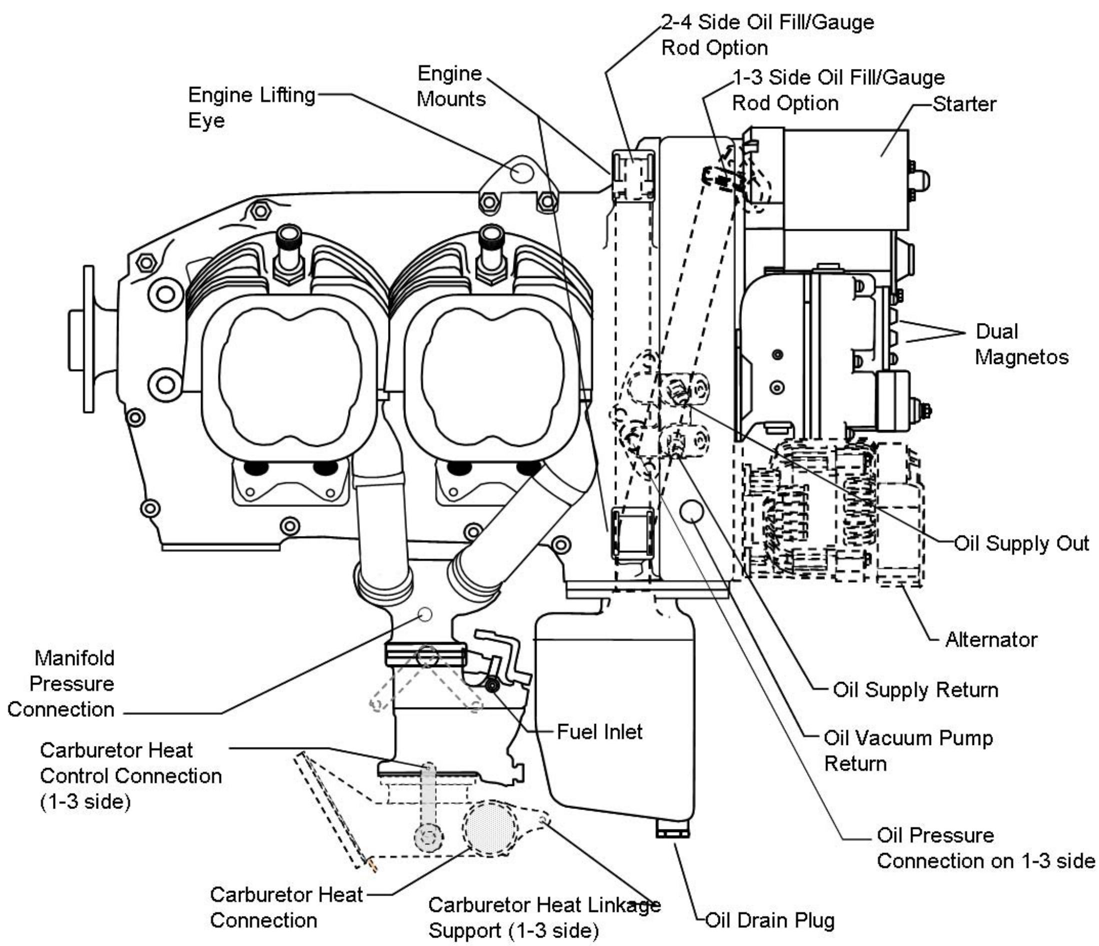


Figure 2-1. Engine Features

2-1.1. Engine Model Number Definition

The description of each alphanumeric character in the engine model number is given below for the example engine model number O-200-D1B (Figure 2-2).

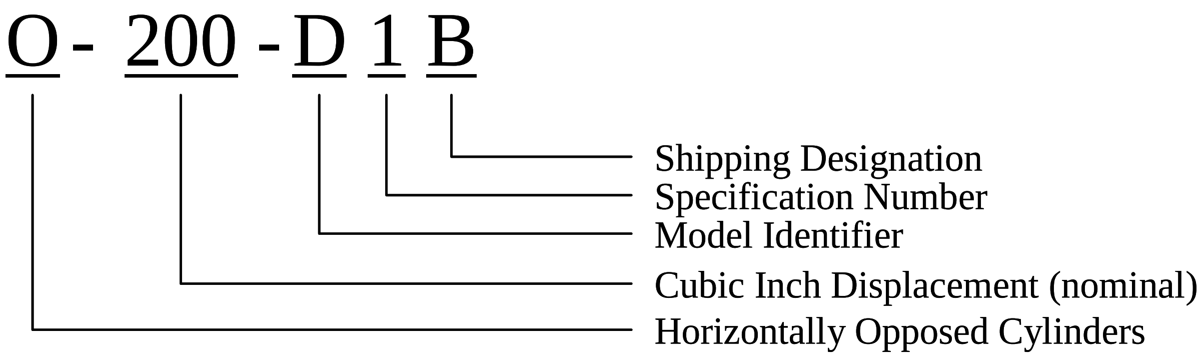


Figure 2-2. Engine Model Definition

2-1.2. Cylinder Number Designations

Refer to Figure 2-3:

- "The front of the engine is the end closest to the propeller and the rear of the engine is the accessory end.
- "Viewed from the rear of the engine, the left-side cylinders are designated by even numbers 2-4, with Cylinder 2 being closest to the rear.
- "The right side cylinders have odd number sequential designation 1-3, with Cylinder 1 being closest to the rear.
- "Firing order of the engine is 1-3-2-4.

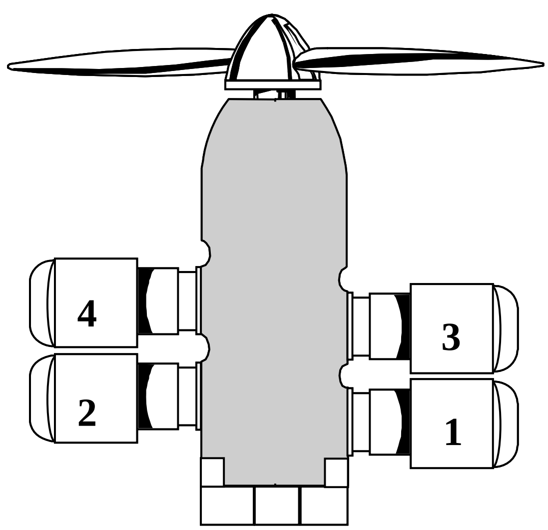


Figure 2-3. Cylinder Number Designation

2-2. Detailed Engine Description

2-2.1. Crankcase

Two aluminum alloy castings are joined along the vertical center plane to form the crankcase. The individual castings (with studs and inserts) are referred to as the "left crankcase" and "right crankcase." The crankcase provides a tight enclosure, sufficiently rigid to support the crankshaft, camshaft and bearings, with oil galleries for lubrication.

Upper and lower flanges are attached by fourteen hex head screws, washers, and plain nuts, two of which attach the engine lifting eye to the upper flanges. Each casting has two machined cylinder mount pads. Cylinder openings in pads on the two sides of the case are offset to align with the connecting rod journal for each piston. Cylinder pads and case webs are stiffened by integral ribs cast in the crankcase. A counterbore around the crankshaft opening in the front of the case receives the crankshaft oil seal. A groove at each end of the front main bearing boss accommodates thrusts washers.

Seats for precision steel-backed crankshaft main bearing inserts are line bored through web bosses, camshaft bearings are bored directly in the case metal. Bearings are divided equally by the parting surface, camshaft bearings being directly below the main bearings.

Crankcase halves are retained by through studs installed in the bosses above and below the front and rear main bearings, two through bolts installed in lieu of two through studs at the center bearing bosses and one through stud below the rear camshaft bearing. In addition to the through studs or through bolts, cylinder mount pads have short studs to secure the cylinder to the crankcase.

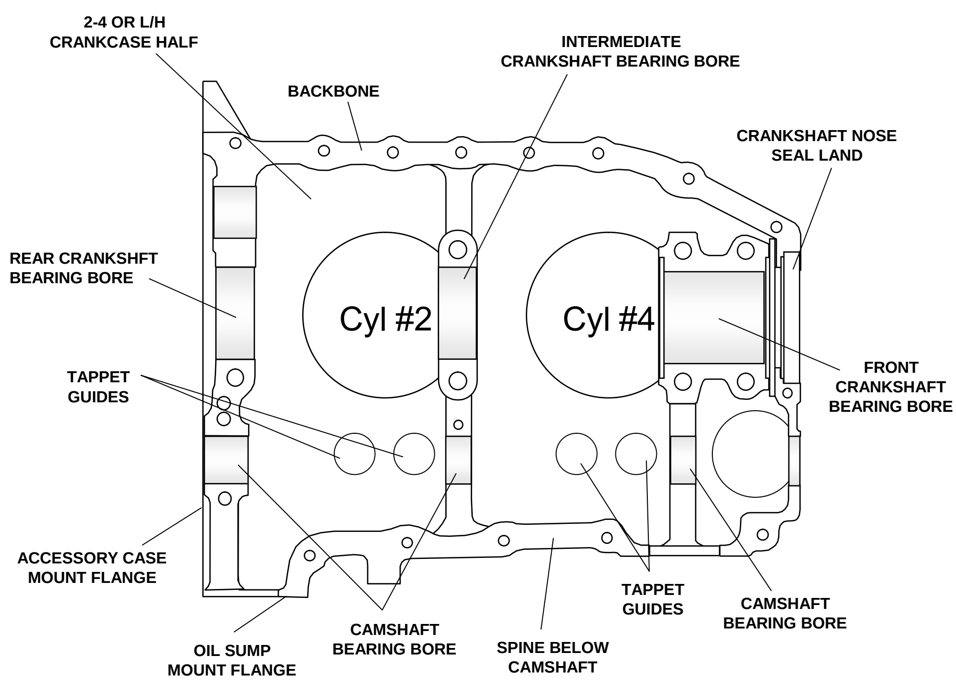


Figure 2-4. Crankcase Features

An enlargement of each casting's lower parting flange at the front end forms half of a boss which is machined and studded to make a mount pad for a vacuum pump. A semicircular flange at the rear of the crankcase bottom surface is machined flat and studded to form the front half of the oil sump mount pad.

Two studs driven into bosses at the lower parting flanges are used to attach the intake manifold. The crankcase breather elbow is screwed into a tapped boss forward of No. 3 cylinder. An upper and a lower arm at the rear of each case casting affords an engine mounting point. The arm bosses of the crankcases are bored through and counterbored for mount bushing assemblies. The flange surrounding the rear end of the crankcase is machined flat and studded to attach the accessory case. The studded fuel pump mount pad on the 1-3 side of the crankcase is a legacy feature which is no longer used. The pad is supplied with a cover.

2-2.2. Engine Drive Train

The engine drive train consists of the crankshaft, camshaft and drive gears.

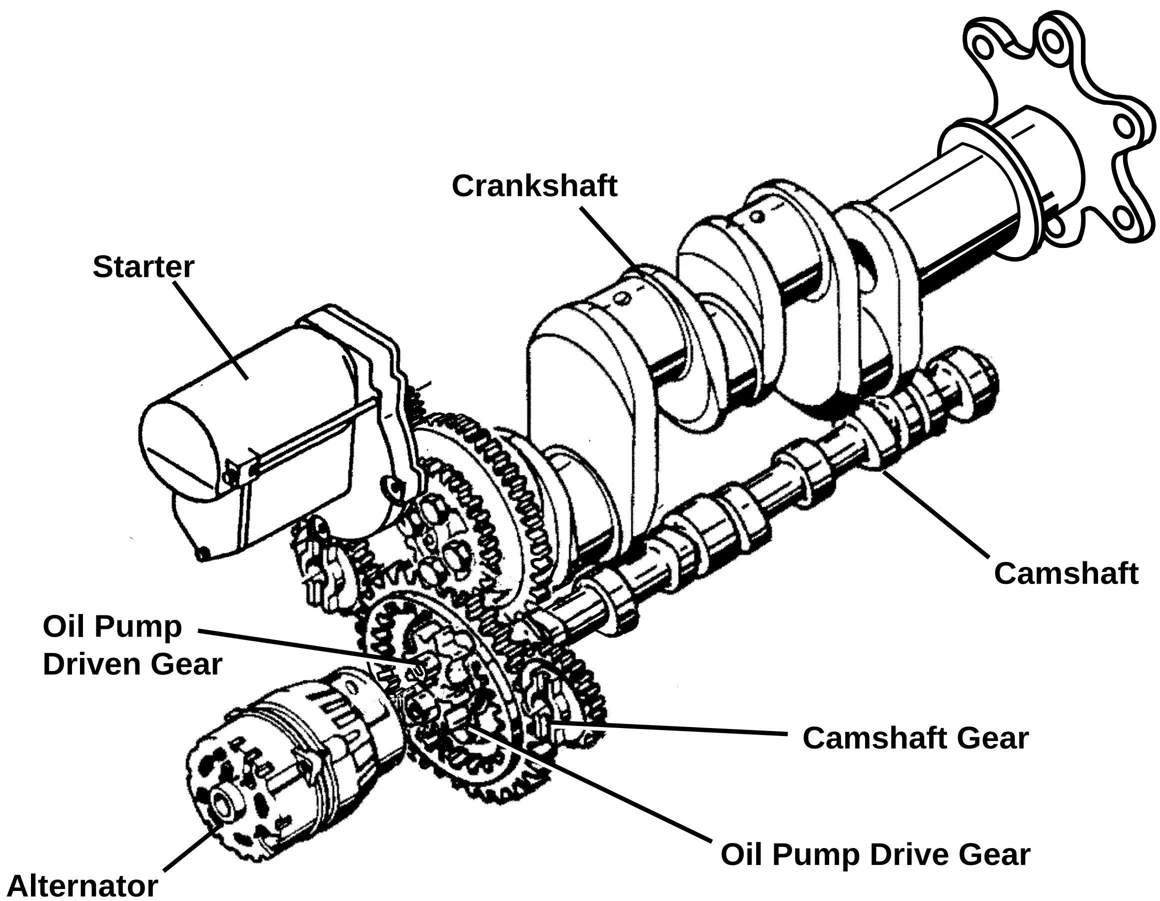


Figure 2-5. Engine Drive Train

2-2.2.1. Crankshaft

The crankshaft is an aircraft quality steel forging with three machined, main journals supported by precision-bearing inserts in each of the three bearing saddles machined in the crankcase. Four machined rod journals provide attachment of the connecting rod assemblies. The crankshaft gear is indexed on the crankshaft by a dowel and secured by machined bolts. A split neoprene oil seal over the crankshaft flange is seated between the crankcase castings in the front shaft exit area, and is sealed to the crankshaft by a helical spring inside the seal's cavity.

Crankshafts are center bored for weight reduction. The front bore runs out at the front crank cheek and the rear end bore at the rear crunched. Oil holes are drilled through solid cheeks from the center journal to crankpins.

The crankshafts have a unique propeller flange with six through holes equally spaced around a four inch pitch circle diameter. The propeller is clamped between the steel hub flange and a loose steel flange in front by six bolts and nuts. The flange type crankshaft has a propeller mount flange forged on the front end with six tapped holes in the flange. Six bolts, screwed into the propeller flange, clamp the propeller between a loose front flange and the propeller flange. The loose front flange and the six bolts are not supplied as part of the engine.

The crankshaft gear is piloted on the small rear flange of the crankshaft and aligned by the crankshaft dowel, retained by four screws. The space between two adjacent punch marked gear teeth points to the camshaft when No. 1 crankpin is at TDC. A cluster gear is driven by the starter pinion

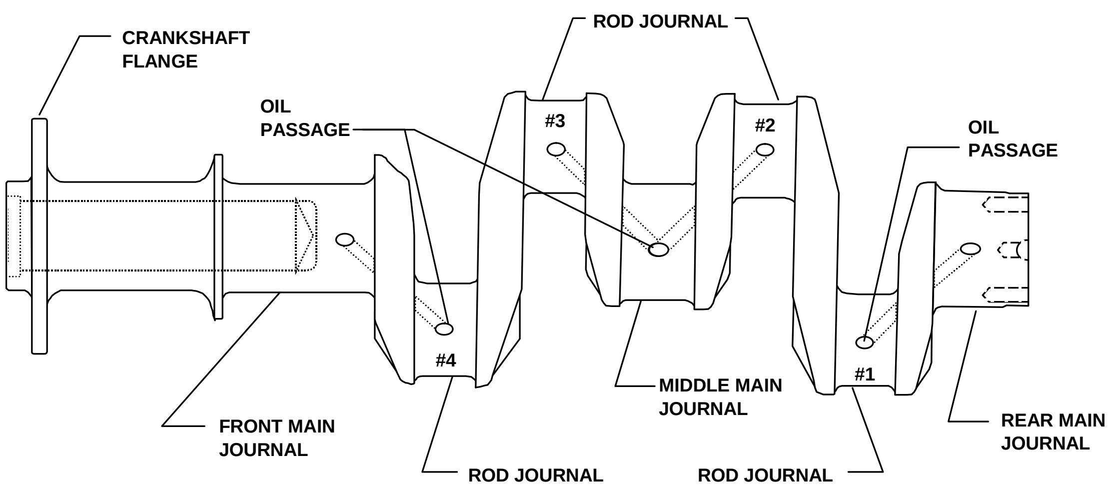


Figure 2-6. Crankshaft

2-2.2.2. Connecting Rods

The connecting rods halves are machined from a single forging of aircraft quality steel and cut into two pieces, splitting the center of the larger opening of the connecting rod assembly. The resulting pieces, called the rod and cap are fitted with a two piece bearing and attach to the crankpin or rod journal with special bolts and nuts.

The portion of the rod between the rod and the crankpin and piston pin ends is called the "I" beam. A split steel-backed bronze bushing is pressed into the piston pin end and machined for a precision pin-to-bushing fit. Weight variations between opposing crankshaft positions is limited to ½ ounce (14.175 grams).

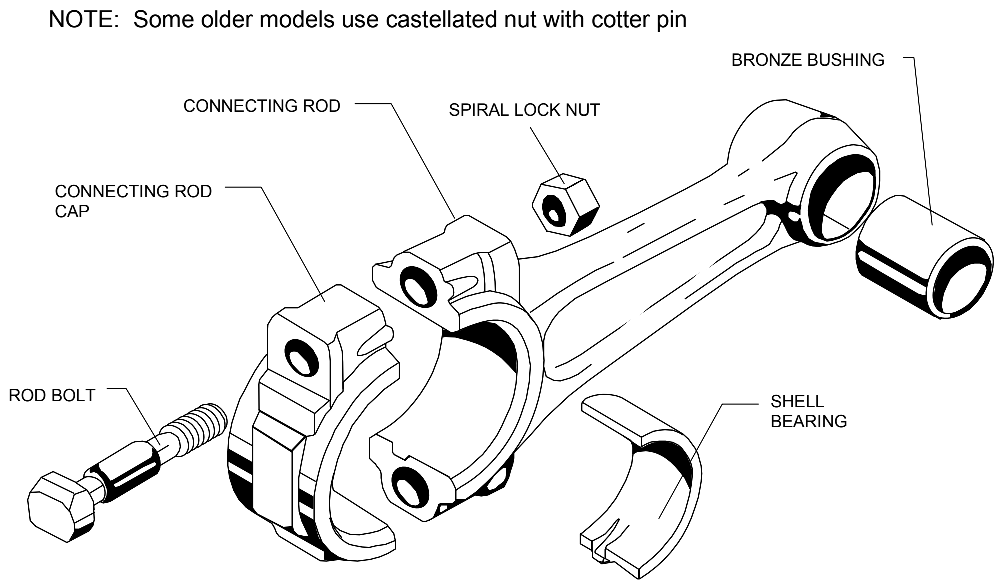


Figure 2-7. Connecting Rod

2-2.2.3. Camshaft

The camshaft forging is machined on three main journals, six cam lobes and the gear mount flange at the rear of the camshaft. The lobes and journals are ground and hardened. Camshaft main journals are supported in the crankcase by machined bearing saddles. Hydraulic tappets move inward and outward in their bores, following the eccentric shape of the cam lobes. Four unequally spaced bolts secure the gear to the camshaft and ensure proper positioning, locating the gears' timing mark in relation to the cam lobes. The camshaft gear has internal teeth to drive the alternator. A front-mounted bevel gear drives the accessory drive bevel gear. The camshaft is hollow to reduce total engine weight.

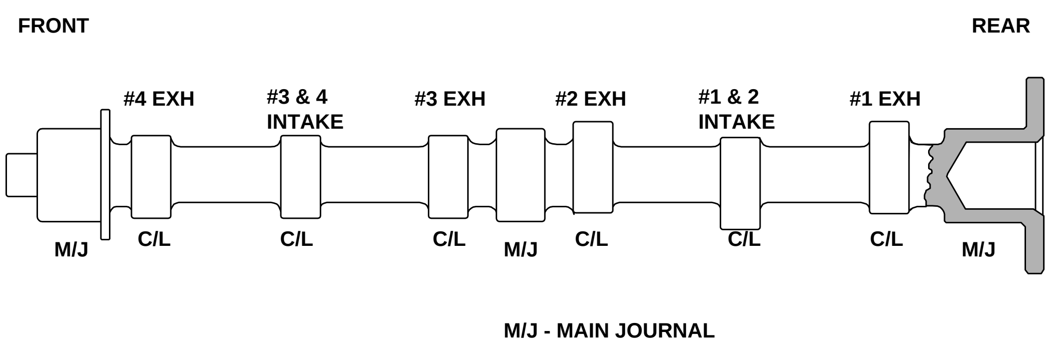


Figure 2-8. Camshaft

2-2.3. Accessory Case

The accessory case aluminum alloy casting is attached to the rear of the engine crankcase, aligned with crankcase dowels. The accessory case is secured to the crankcase by crankcase studs and various attaching hardware. Accessory mount pads on the rear surface are machined in one plane parallel to the machined parting flange which surrounds the front side of the casting. Mounting pads for the magnetos, alternator cover, starter, tachometer drive, oil filter adapter, oil pressure relief valve and an oil suction screen boss are provided. The accessory case casting has two holes above and three studs to attach the starter. The oil filter adapter housing, adjacent to the alternator mounting pad fastens to a accessory case and accepts a screw on type disposable oil filter.

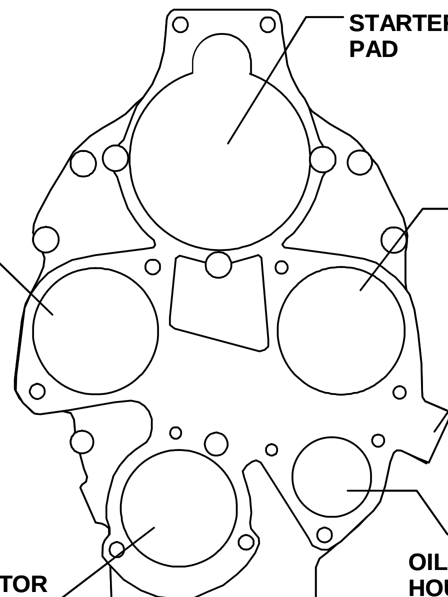


Figure 2-9. Accessory Case Features

The oil pump housing is machined into the internal portion of the accessory case. A machined, threaded boss is located on the lower right side of the accessory case for installation of a non-adjustable oil pressure relief valve. Oil pump gear chambers are machined in the interior of the accessory case. The oil pump drive gear shaft hole is machined in-line with the camshaft and the driven gear shaft hole is directly above it.

A semicircular opening at the accessory case bottom is a machined threaded hole to accommodate installation of the oil suction tube. Passages cast into the accessory case allow oil to flow from the oil suction tube to the oil pump gears, pressure relief valve, and main oil gallery.

2-2.4. Cylinders

The engine has four, horizontally-opposed, air cooled cylinders, two on the left side and two on the right side of the engine. Aviation fuel and air are drawn into a cylinder during the intake stroke, compressed by the piston during the compression stroke and then ignited by a high intensity spark from each spark plug (two per cylinder). As the mixture is ignited, the expanding gases force the piston to move inward toward the crankshaft during the power stroke.

The rocker box cast in the outer end of the head has a surrounding flange which is machined flat. The pressed steel rocker cover is sealed to the flange by a gasket and retained by four fillister head screws. Three bosses cast in the rocker box are bored in a horizontal line at right angles to the cylinder axis to form rocker shaft supports. Valve ports in the head open downward into two flanges, each provided with two studs. Bronze guides for intake and exhaust valves are pressed into holes bored from the bottom of the rocker box into the valve chambers in line with the valve seats. Stellite valve seat inserts are shrunk into counterbores in the combustion chamber surface.

A 1/8 inch pipe tapped hole through the upper wall of the intake valve chamber of earlier production cylinders is intended for an optional primer jet, which may be installed by the owner. The hole is normally sealed by a countersunk hex head pipe plug. An external base flange below the cylinder barrel fins is mounted flat and drilled for the six crankcase studs to which the assembly is attached by flanged hex nuts. From the base flange, the cylinder skirt extends inward through the crankcase wall opening, as a pilot. A rubber packing ring, placed around the cylinder skirt and against the flange, is compressed in a chamfer around the pad opening and prevents oil leakage. Cylinder cooling fins are tapered toward the base for weight reduction.

Pushrod tubes are comprised of a pushrod to crankcase adapter and pushrod tubes fitted with O-rings at the crankcase adapter and cylinder head; springs fitted to a flange on the outside of the pushrod tube apply constant downward pressure on the lower O-ring to prevent leaks.

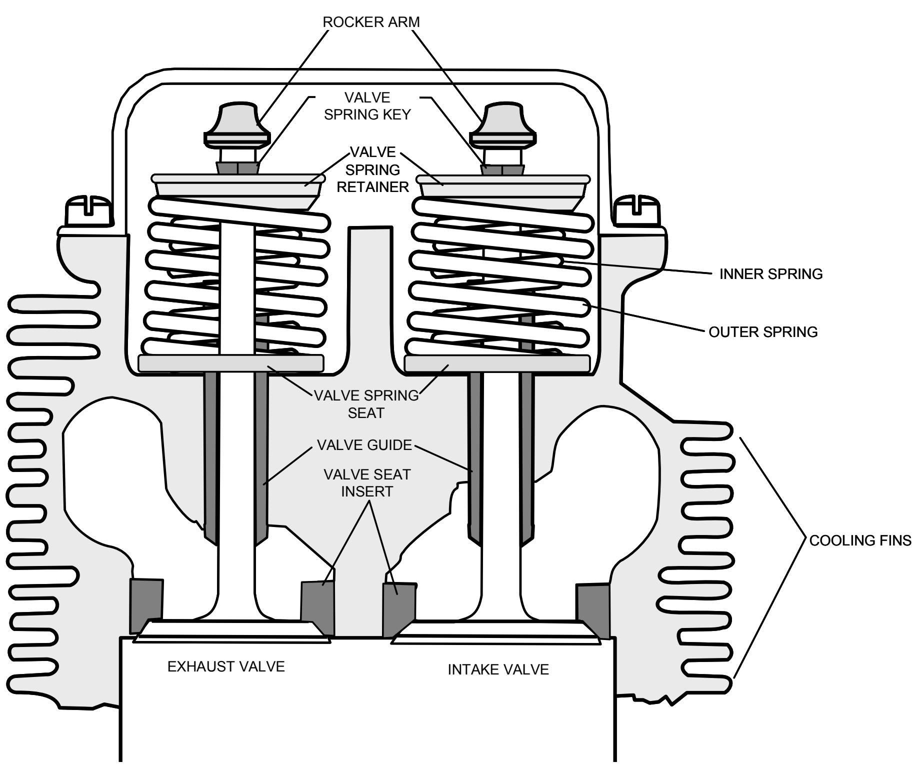


Figure 2-10. Cylinder Features

2-2.4.1. Pistons

Pistons are aluminum alloy castings. The skirts are solid with cylindrical relief cuts at the bottom. Weight differences are limited to ten grams between opposing cylinders bays. Piston pins are full floating with permanently pressed-in aluminum end plugs.

The lightweight piston has two ring grooves above the piston pin and one oil scraper ring below the piston pin. The upper ring is a semi-keystone design, the second compression ring is rectangular shaped.

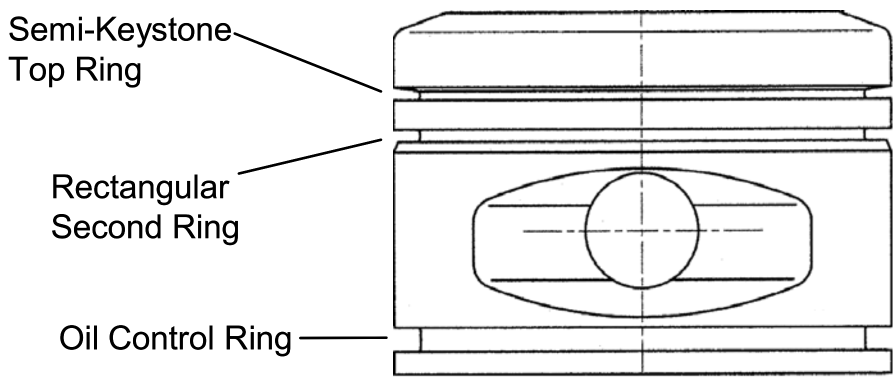


Figure 2-11. Piston Features

2-2.4.2. Hydraulic Valve Tappets

The hydraulic valve tappet (lifter) performs two functions. First, it provides an interface between the camshaft lobe and the remaining valve train. Hydraulic valve lifters ride on the eccentric cam lobes opening and closing the intake and exhaust valves mechanically via push rod tubes and rocker arms, allowing conversion of the cam lobe profile into a linear movement for intake and exhaust valves actuation. The hydraulic mechanism inside the lifter maintains zero clearance between the valve and actuating components.

The interface between a cam lobe and lifter is intended to wear to some degree as the engine operates. This is similar to the piston ring / cylinder wall interface that must seat together for proper operation and wear over time.

2-2.5. Lubrication System

The engine lubrication system delivers lubricating oil throughout the engine to various bearings, bushings, and engine components. The wet sump lubrication system consists of an internal engine-driven oil pump, a fixed, non-adjustable pressure relief valve, an oil sump and oil sensing ports. An optional oil cooler adapter is available to connect a remote mounted oil cooler.

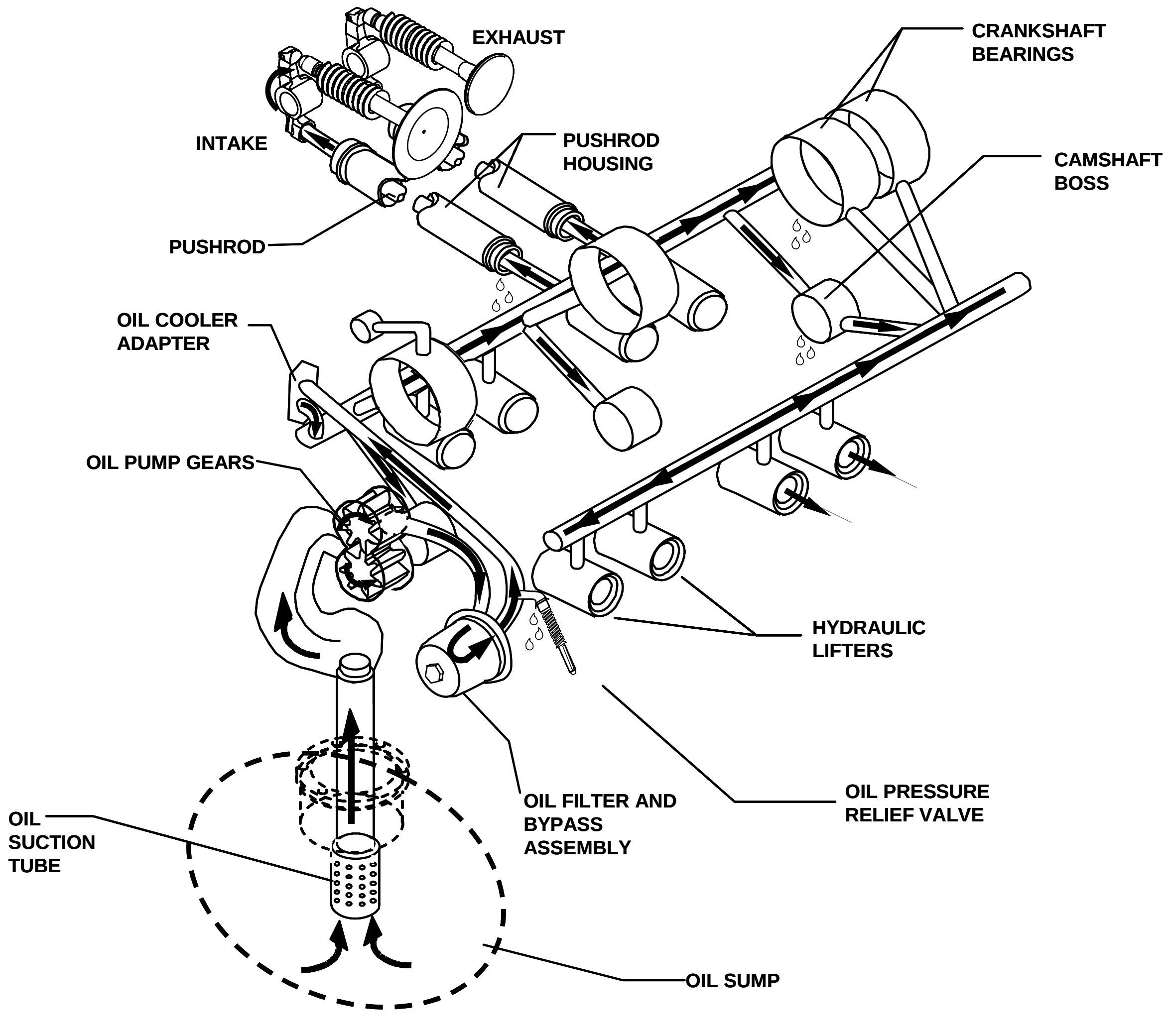


Figure 2-12. Lubrication Schematic

2-2.5.1. Oil Pump

The engine-driven, gear type oil pump (Figure 2-13) is a positive displacement pump that consists of two meshed steel gears that revolve inside the oil pump cavity machined in the accessory case. The camshaft drives the oil pump drive gear, which drives the oil pump driven gear. The oil pump driven gear is supported by a shaft pressed into the accessory case and the oil pump cover plate. The oil pump drive gear shaft is supported by bushings pressed into the accessory case.

The oil pump housing and oil pump gear chambers are machined in the interior of the accessory case. The oil pump drive gear shaft bore is machined in-line with the camshaft; the driven gear shaft rests in the bore directly above the drive shaft.

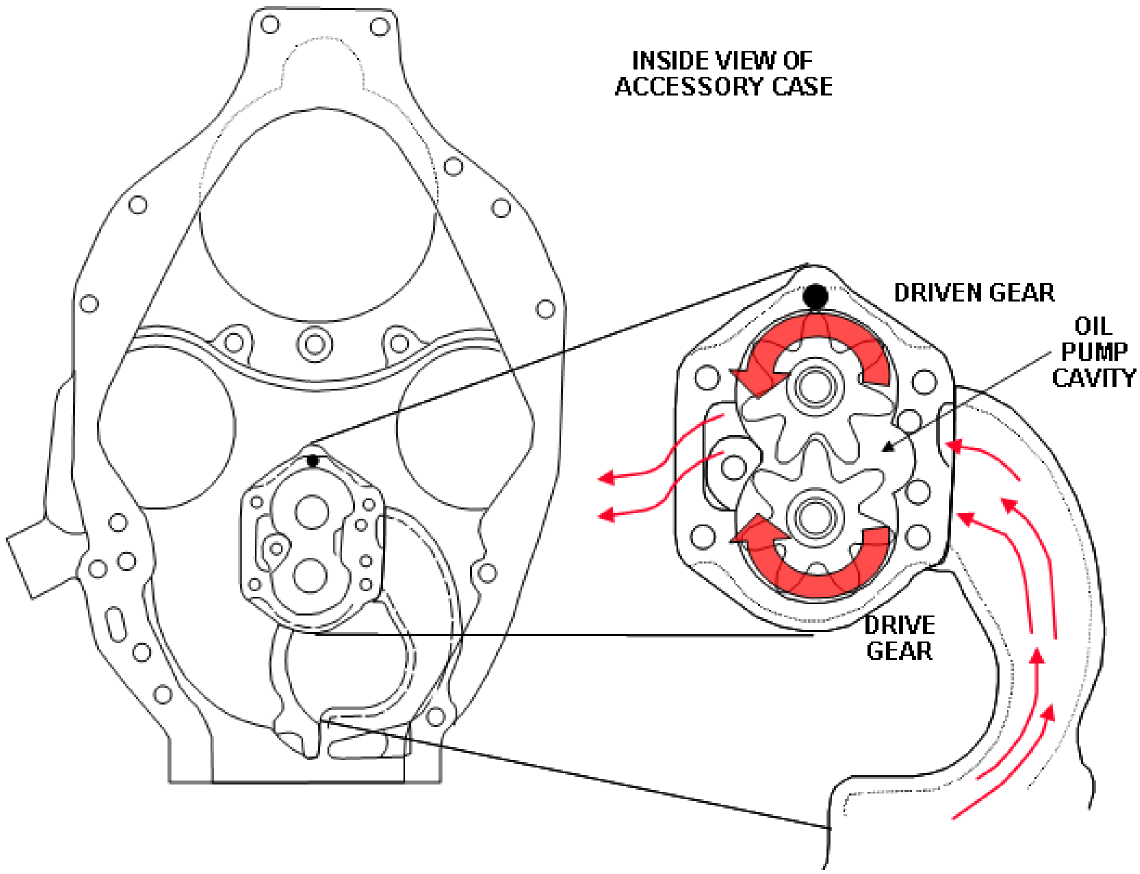


Figure 2-13. Oil Pump

2-2.5.2. Oil Sump

The oil sump assembly is fabricated from a milled aluminum upper body welded to the shaped sheet metal lower sump section. The upper section features a rib-reinforced crankcase mounting flange and a boss for the pressed oil gauge rod and extension tube assembly. The lower oil sump body is fitted with a threaded drain plug boss with safety wire provisions. The oil gauge rod is marked in quarts to the full mark and features a locking lever with compression seal.

2-2.5.3. Oil Pressure Relief Valve

A machined, threaded boss is located on the lower right side of the accessory case for installation of a non-adjustable oil pressure relief valve. Its passages are connected to the oil pump outlet passage. This valve opens when the oil pump pressure exceeds the specified operating limit and directs oil back to the oil sump.

2-2.5.4. Oil Cooler Adapter

The standard engine configuration feature a cover over the oil gallery flange to route the oil from crankcase oil cooler pad back to the oil gallery. Optional oil cooler adapters are available with a footprint illustrated in Figure 2-14. The adapter, or cover is attached to the lower 2-4 side of the crankcase to allow connection of the engine oil supply to a remote mounted oil cooler.

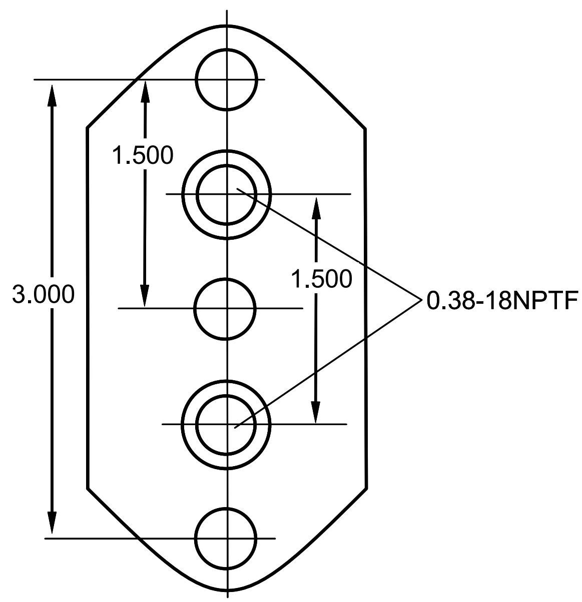


Figure 2-14. Oil Cooler Adapter Footprint

2-2.6. Ignition System

Two magnetos, installed on the aft side of the accessory case use magneto drive adapters to interface with the crankshaft gear. O-200 Series engines are fitted with either Unison (Slick, now Champion) or Continental Motors (Bendix) magnetos, designed to provide ignition for four cylinder aircraft engines. The Continental Motors magneto model number identifies the key features of each magneto model, as shown in Figure 2-15. The magnetos generate and distribute high voltage ignition pulses through high tension leads to the spark plugs. Radio shielded harnesses are available for most ignition system configurations.

To obtain the retard spark necessary for starting, magnetos may be equipped with a starting vibrator for a shower of sparks type ignition or employ impulse couplings within the magneto. Impulse couplings rotate the magneto between impulse trips faster than engine cranking speed, thus generating a better spark for starting the engine and automatically retard the spark during engine cranking. After engine start, impulse couplings function as normal magneto drive couplings.

The ignition system magnetos employ impulse couplings to provide timing advance during engine starting. With the single (left) impulse coupling configuration, the right magneto must be grounded during engine start. Separate removal instructions are provided for both the Slick and Continental Motors magnetos.

Magneto wiring harness delivers spark to cylinders as illustrated in Figure 2-16. The left magneto fires the 1-3 lower and 2-4 upper spark plugs; the right magneto fires the 1-3 upper and 2-4 lower spark plugs.

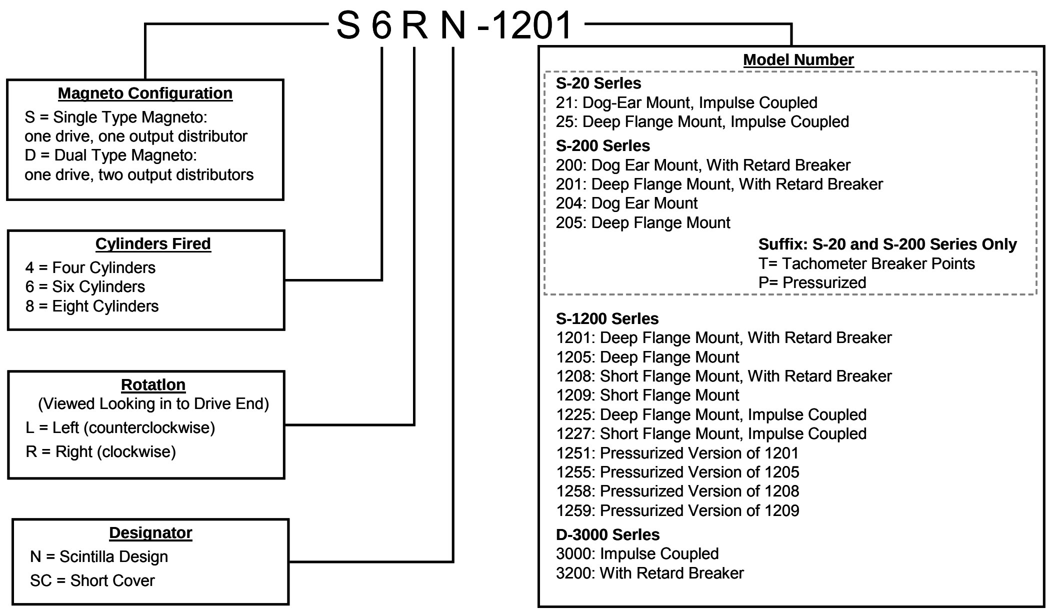


Figure 2-15. Continental Motors Magneto Part Number Structure

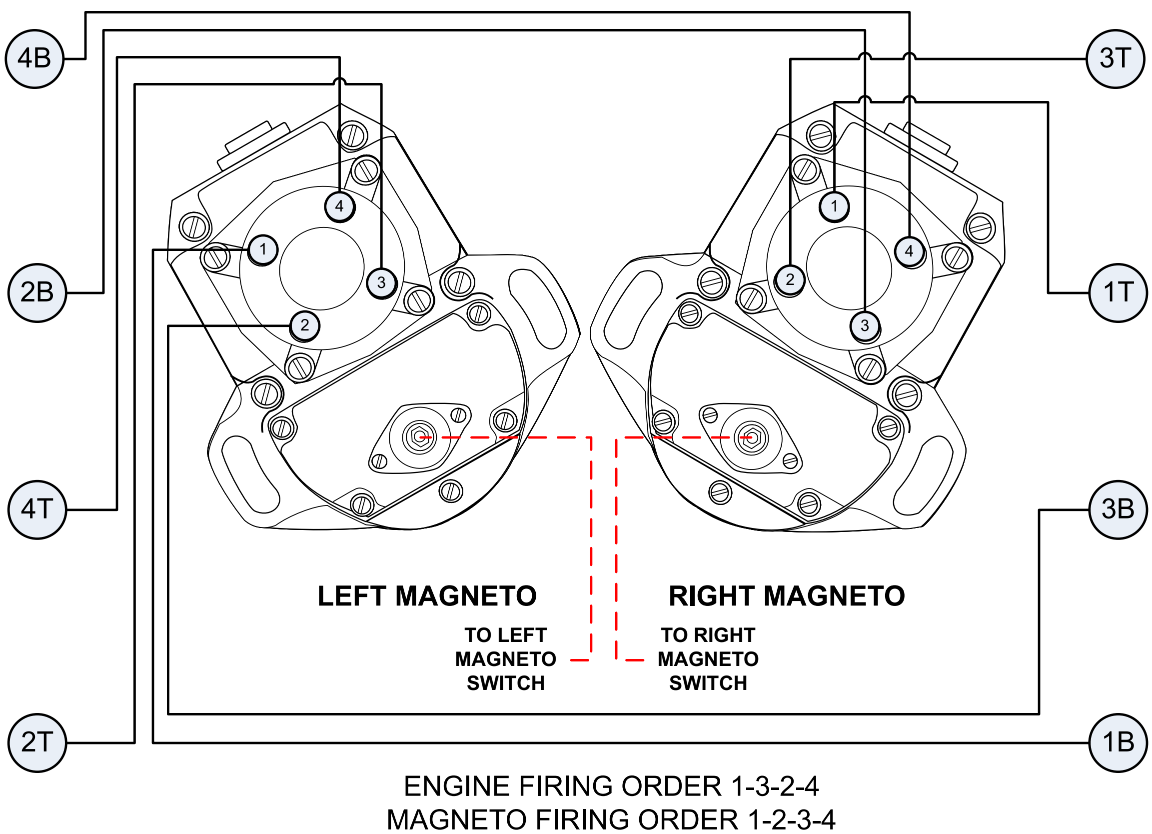


Figure 2-16. Ignition Harness Distribution

2-2.7. Starter Assembly

The engine series employs a lightweight electric starter motor mounted on the rear of the accessory case. Starter engagement is controlled by the airframe wiring harness and ignition switch contactor.

2-2.8. Alternator

The engine accessory case incorporates a boss on the rear of the engine for mounting a 12 volt, 50 or 60 amp, direct drive alternator. The alternator generates electrical current for recharging aircraft batteries and powering aircraft electrical systems. For a description of the aircraft electrical and charging system, see the applicable Airframe Manufacturer's Instructions. For a detailed description of Continental Motors alternators, refer to Continental Motors Alternator Service Instructions.

2-2.9. Engine Cooling

The engine cylinders are cooled by transferring heat from the cylinder barrel and cylinder head cooling fins to the surrounding airflow. The airframe engine cowling, baffles, and baffle seals direct cooling air (which is ram air-induced by the aircraft's forward speed) evenly around the cylinders. This airflow is regulated by the size of the cooling air inlets and outlets. Increasing or decreasing outlet size with the use of cowl flaps changes airflow and is used as an aid in controlling engine operating temperatures. Inter-cylinder baffles are provided as standard equipment.

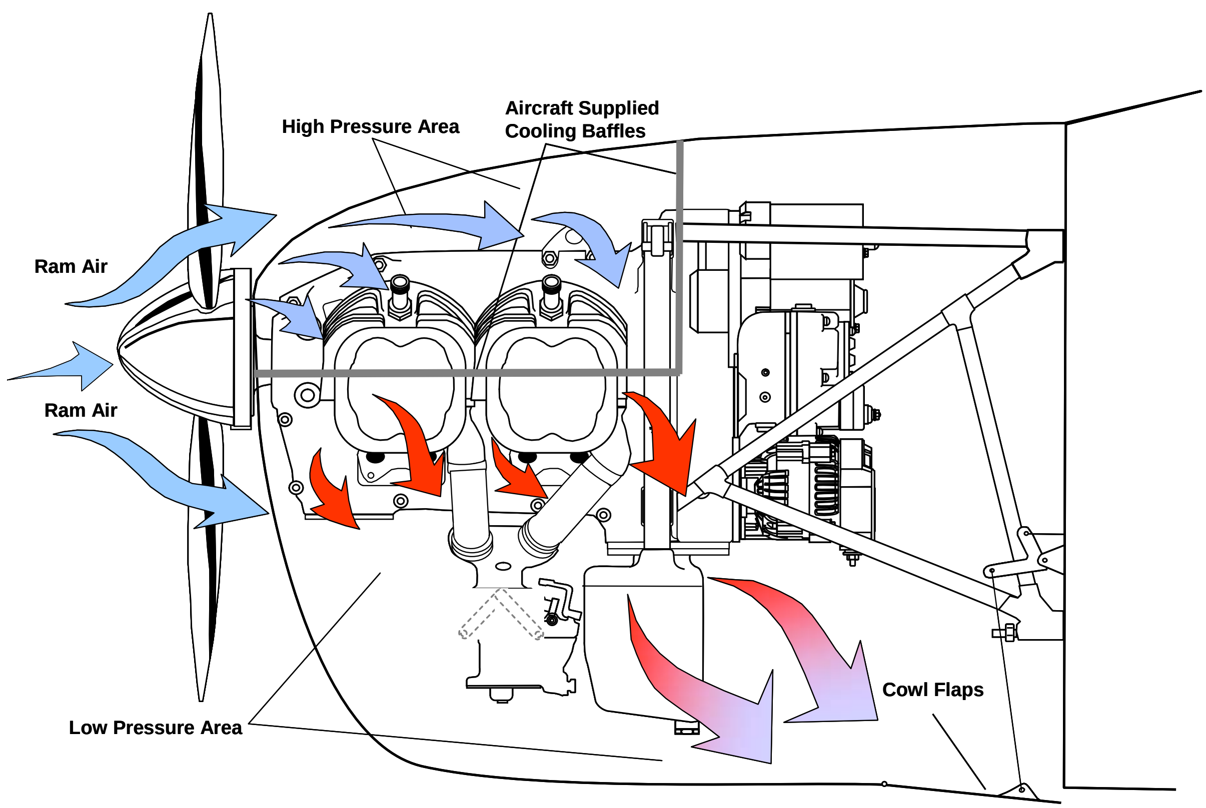


Figure 2-17. Engine Cooling

2-2.10. Fuel System

The primary element of the fuel system is the carburetor. The engine model and specification determines the installed carburetor configuration. Fuel is supplied to the carburetor by gravity feed.

2-2.11. Induction System

The intake manifold is attached to two studs on the lower crankcase flange. The carburetor is attached to the bottom of the intake manifold with a gasket and four fasteners. Air passage through the manifold divides into four outlets, to which cylinder intake tubes are connected by rubber hoses and clamps. The air intake housing attaches to the bottom of the carburetor flange. The front end of the air intake flares upward to match the outline of the air filter. A hot air supply tube and a fuel drain tube are incorporated in the air intake housing.

2-3. Engine Specifications

Table 2-1. O-200-D Specifications

General		
Model	O-200-D	
FAA Type Certificate	E252	
Installation Drawing Number	657316	
Compression Ratio	8.5:1	
Number of Cylinders	4	
Firing Order	1-3-2-4	
Recommended Time Between Overhaul (TBO)	2000 accumulated hours or 12 years	
Bore	4.06 in.	103.12 mm
Stroke	3.88 in.	98.55 mm
Piston Displacement	201 cubic inches	3.29 L
Crankshaft Speed & Brake Horsepower		
Rated Maximum Continuous Operation[1]	100 BHP -0/+5% @ 2750 RPM	
Crankshaft Speed (Maximum rated)	2750 rpm	
Engine Idle Speed, Minimum	675-925; application dependent	
Rated Manifold Pressure	29.5 in. Hg Full Throttle (Sea Level)	
Maximum Recommended Cruise	75 bhp @ 2500 rpm	
Fuel System Specifications		
Fuel Minimum Grade[2]	100-LL	
Fuel Grade- People's Republic of China[3]	RH 100/130	
Fuel System Pressure and Flow	Refer to Figure 2-19	
Fuel Consumption		
Power Level	BHP (kW)	lbs./hr (max)
Rated Power, 100%	100 (74.5)	See Figure 2-19
Cruise, 75%	75 (55.9)	See Figure 2-19
Cruise, 65%	65 (48.4)	See Figure 2-19
Ignition		
Spark Plugs to be used	FAA Approved Radio Shielded	
Ignition Timing	24°± 1° BTC	
Spark Plug Gap	Spark plug manufacturer's specified gap.	
Cylinder Head Temperature		
Maximum Cruise Operational Temperature[4]	420°F	215°C
Maximum Allowable Operational Temperature[4]	525°F	273°C
Minimum Takeoff Temperature[4]	240°F	116°C
Exhaust		
Exhaust System back pressure, maximum, measured 1.5 inches from port flange, in Hg (kPa)		2.0 (6.75)
EGT Thermocouple Probe, minimum distance from port, in. (mm)		2.0/2.50 (50.8/63.5)

Table 2-1. O-200-D Specifications

Oil		
Oil Pressure - Normal Operation @ 75° to 240°F (24° to116°C)	30 to 60 psig	
Maximum Allowable Oil Pressure[4] (cold oil)	100 psig	
Minimum Oil Pressure @ Idle (600 RPM)[4]	10 psig at or below 200°F	
Maximum Allowable Oil Temperature[4]	240°F	116°C
Minimum Take-off Oil Temperature[4]	75°F	24°C
Cruise Flight Oil Temperature	170° to 220° F	77° to 104° C
Oil Sump Capacity	5.0 quarts	4.73L
Usable Oil - 16° Nose Up	4.5 quarts	4.25L
Usable Oil - 10° Nose Down	4.0 quarts	3.78L
Oil Grade, Specification	See Section 3-2.1	
Brake Specific Oil Consumption		
Maximum BSOC = 0.006 lb. X (engine rated power) X (% power at which measured/100) X (duration of test in hours) 1 quart = 1.875 pounds		
Engine Physical Specifications		
Weight, dry (basic engine), lb. (kg) +/- 2.5% Basic engine, minus starter, alternator, magnetos, ignition harness, spark plugs, filters, air box and engine mount isolators.	168.53 (76.44)	
Overall Dimensions, inches (mm) Height Width Length	 26.25 31.56 26.22	 (666.75) (801.60) (666.00)
Center of Gravity, inches (mm) Forward of rear accessory case Below crankshaft centerline Beside crankshaft centerline toward 1-3 side	 14.55 0.96 0.06	 (369.60) (24.40) (1.50)

1. Performance is based on sea level, standard day, zero water vapor pressure conditions at the throttle inlet and exhaust exit with no engine accessory load. Standard day conditions are 29.92 in. Hg and 59°F. Horsepower will vary approximately 1% for each 10°F (5.6° C) change in compressor inlet air temperature. Correction must also be made for the effect of exhaust back pressure and accessory drive losses. Contact Continental Motors engineering for correction factors for specific applications.
2. This engine is certified for operation with 100-LL Blue aviation fuel. If the minimum fuel grade is not available, use the next higher available grade. Never use a lower grade fuel.
3. Engine Operation with this fuel is limited to 9840 ft (2999 m) at maximum continuous power and speed and 19680 ft (5998 m) at maximum continuous power and speed.
4. Measured using spark plug ring thermocouples.

Table 2-2. O-200-X Specifications

General		
Model	O-200-X	
FAA Type Certificate	E252	
Installation Drawing Number	657988	
Compression Ratio	8.5:1	
Number of Cylinders	4	
Firing Order	1-3-2-4	
Recommended Time Between Overhaul (TBO)	2000 accumulated hours or 12 years	
Bore	4.06 in.	103.12 mm
Stroke	3.88 in.	98.55 mm
Piston Displacement	201 cubic inches	3.29 L
Crankshaft Speed & Brake Horsepower		
Rated Maximum Continuous Operation[1]	100 BHP -0/+5% @ 2750 RPM	
Crankshaft Speed (Maximum rated)	2750 rpm	
Engine Idle Speed, Minimum	675-925; application dependent	
Rated Manifold Pressure	29.5 in. Hg Full Throttle (Sea Level)	
Maximum Recommended Cruise	75 bhp @ 2500 rpm	
Fuel System Specifications		
Fuel Minimum Grade[2]	100-LL	
Fuel Grade- People's Republic of China[3]	RH 100/130	
Fuel System Pressure and Flow	Refer to Figure 2-19	
Fuel Consumption		
Power Level	BHP (kW)	lbs./hr (max)
Rated Power, 100%	100 (74.5)	See Figure 2-19
Cruise, 75%	75 (55.9)	See Figure 2-19
Cruise, 65%	65 (48.4)	See Figure 2-19
Ignition		
Spark Plugs to be used	FAA Approved Radio Shielded	
Ignition Timing	24°± 1° BTC	
Spark Plug Gap	Spark plug manufacturer's specified gap.	
Cylinder Head Temperature		
Maximum Cruise Operational Temperature[4]	420°F	215°C
Maximum Allowable Operational Temperature[4]	525°F	273°C
Minimum Takeoff Temperature[4]	240°F	116°C
Exhaust		
Exhaust System back pressure, maximum, measured 1.5 inches from port flange, in Hg (kPa)		2.0 (6.75)
EGT Thermocouple Probe, minimum distance from port, in. (mm)		2.0/2.50 (50.8/63.5)

Table 2-2. O-200-X Specifications

Oil		
Oil Pressure - Normal Operation @ 75° to 240°F (24° to116°C)	30 to 60 psig	
Maximum Allowable Oil Pressure[4] (cold oil)	100 psig	
Minimum Oil Pressure @ Idle (600 RPM)[4]	10 psig at or below 200°F	
Maximum Allowable Oil Temperature[4]	240°F	116°C
Minimum Take-off Oil Temperature[4]	75°F	24°C
Cruise Flight Oil Temperature	170° to 220° F	77° to 104° C
Oil Sump Capacity	5.0 quarts	4.73L
Usable Oil - 16° Nose Up	4.5 quarts	4.25L
Usable Oil - 10° Nose Down	4.0 quarts	3.78L
Oil Grade, Specification	See Section 3-2.1	
Brake Specific Oil Consumption		
Maximum BSOC = 0.006 lb. X (engine rated power) X (% power at which measured/100) X (duration of test in hours) 1 quart = 1.875 pounds		
Engine Physical Specifications		
Weight, dry (basic engine), lb. (kg) +/- 2.5% Basic engine, minus starter, alternator, magnetos, ignition harness, spark plugs, filters, air box and engine mount isolators.	168.53 (76.44)	
Overall Dimensions, inches (mm) Height Width Length	 26.25 31.56 26.22	 (666.75) (801.60) (666.00)
Center of Gravity, inches (mm) Forward of rear accessory case Below crankshaft centerline Beside crankshaft centerline toward 1-3 side	 14.55 0.96 0.06	 (369.60) (24.40) (1.50)

1. Performance is based on sea level, standard day, zero water vapor pressure conditions at the throttle inlet and exhaust exit with no engine accessory load. Standard day conditions are 29.92 in. Hg and 59°F. Horsepower will vary approximately 1% for each 10°F (5.6° C) change in compressor inlet air temperature. Correction must also be made for the effect of exhaust back pressure and accessory drive losses. Contact Continental Motors engineering for correction factors for specific applications.
2. This engine is certified for operation with 100-LL Blue aviation fuel. If the minimum fuel grade is not available, use the next higher available grade. Never use a lower grade fuel.
3. Engine Operation with this fuel is limited to 9840 ft (2999 m) at maximum continuous power and speed and 19680 ft (5998 m) at maximum continuous power and speed.
4. Measured using spark plug ring thermocouples.

2-3.1. Accessory Drive Ratios

Accessory drive ratios are the same for all of the O-200 engines, except as noted.

Table 2-3. Accessory Drive Ratios

Accessory	Direction of Rotation[1]	Drive Ratio to Crankcase	Maximum Torque (in. lbs.)		Maximum Overhang Moment, (in lbs.)
			Cont.	Static	
Starter Motor	CW	35.7:1	--	--	--
Alternator (gear driven)	CCW	2.035:1	60	600	100
Vacuum Pump[2]	CCW	1.5:1	100	800	25

1. CW=Clockwise Rotation CCW=Counterclockwise rotation; viewed facing the drive; OPT= Optional
2. Drive is an AND20000 pad modified for speed only

2-3.2. Performance Data

WARNING

The performance charts included in this manual indicate uninstalled engine performance under controlled conditions and will vary from installed performance. The charts are neither intended nor suitable for installed performance specifications or flight planning. Consult the Airplane Flight Manual or Pilot's Operating Handbook for installed aircraft performance specification.

2-3.2.1. O-200-D & X Performance Charts

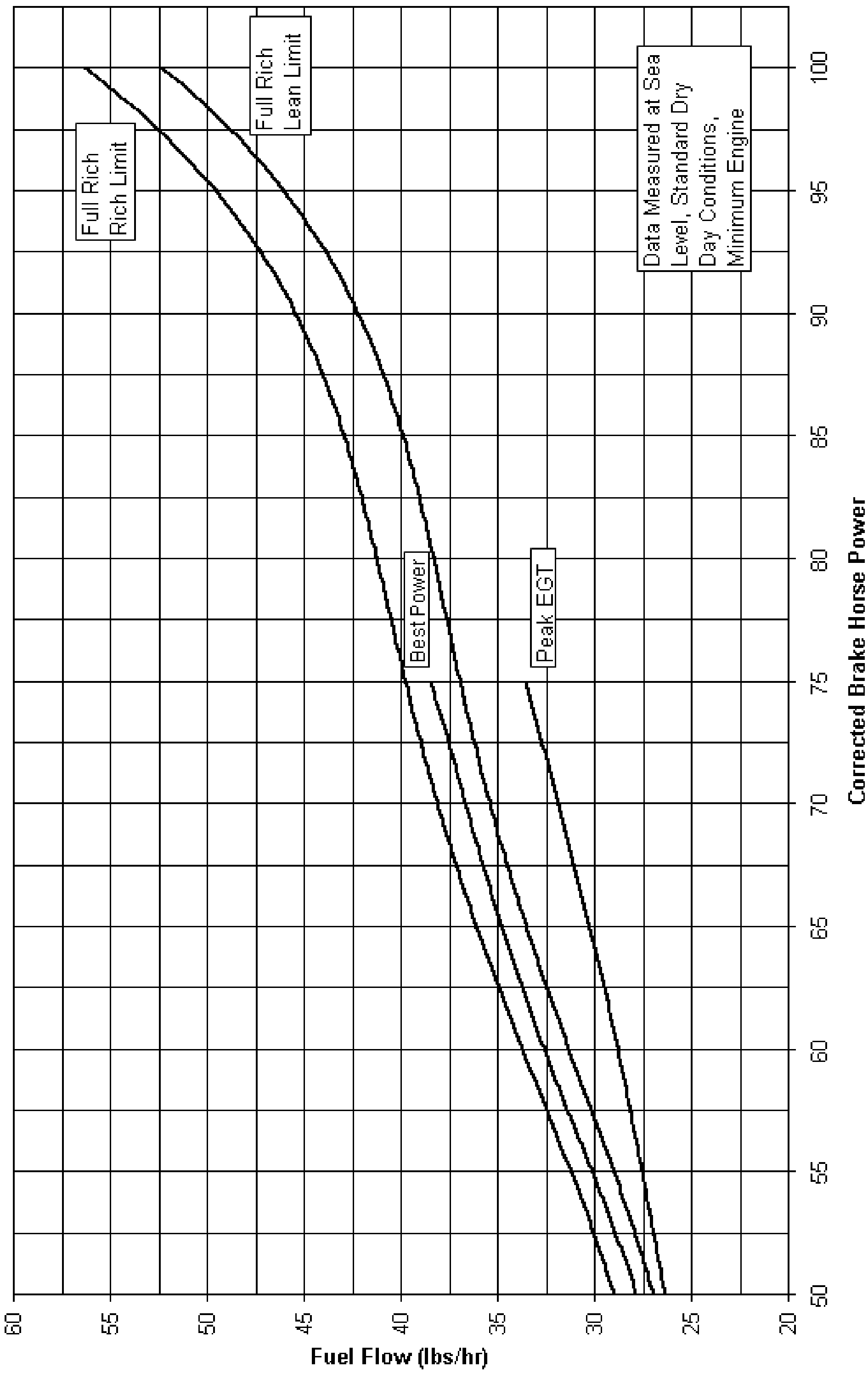


Figure 2-18. Fuel Flow vs. Brake Horsepower

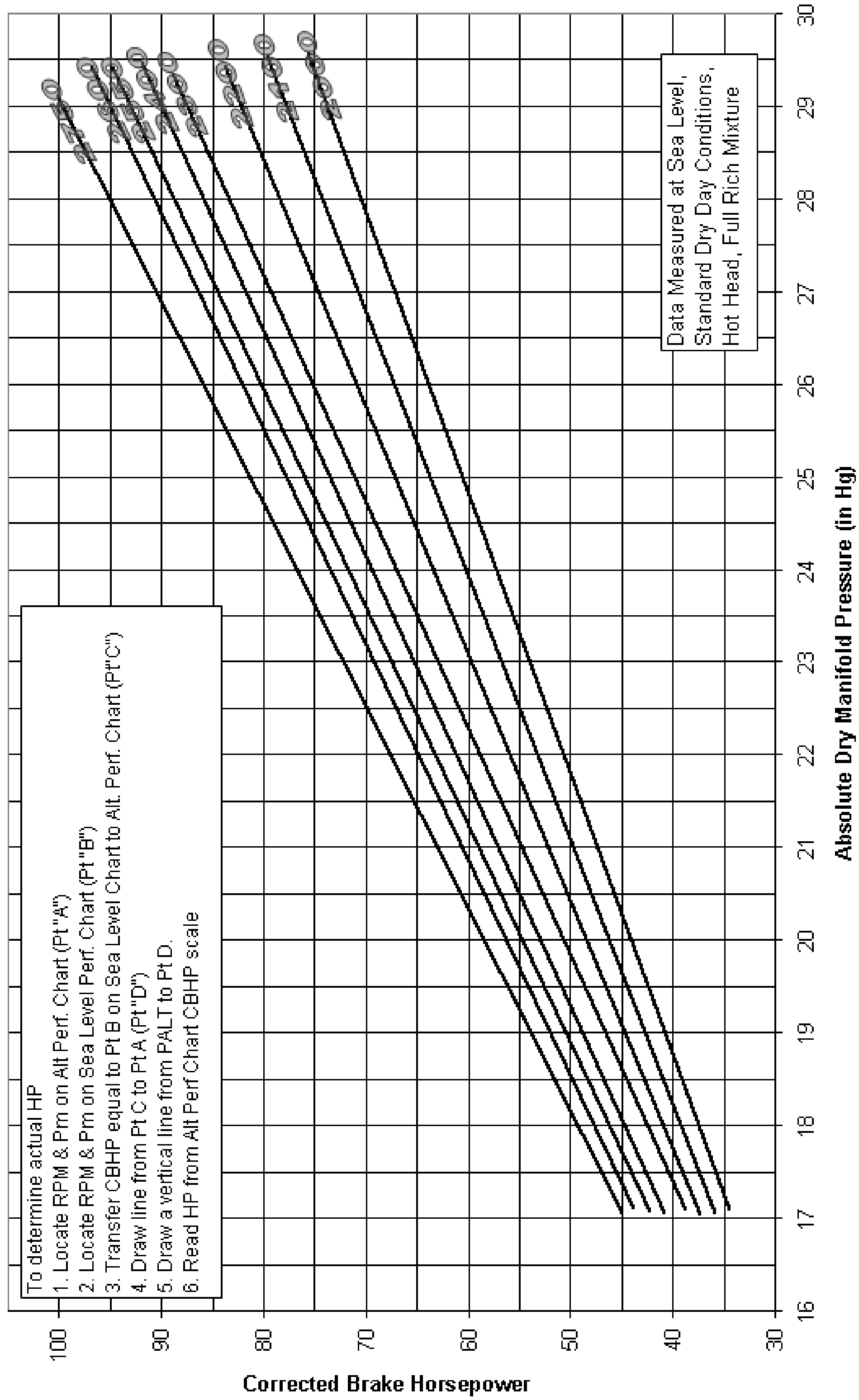


Figure 2-19. Sea Level Performance

Chapter 3. Special Tools and Supplies

3-1. Special Tools

NOTE: All tools in the Special Tool List are for reference only, not for the purpose of promoting a particular vendor or requiring the customer to purchase from the indicated sources. The providers listed are potential sources for the items based on information available at the time of printing. Customers are free to obtain equivalent items from alternate sources.

Special tool provider contact information is listed in Table 3-2.

Table 3-1. Special Tools List

Special Tool	Use or Reference	Suggested Providers	Part Number
Maintenance			
Alternator Analyzer Voltage Regulator Tester	Alternator Voltage Regulator Check	Eastern Technology Corporation	647
Alternator/Regulator/ Battery Tester	Check Battery	Eastern Technology Corporation	E100
Bearing Puller	Component Maintenance	Burroughs***	8039C
Borescope	Cylinder Borescope Inspection	Q.A. Technologies	AUTOSCOPE™ Lenox Instrument Company
Differential Pressure Tester	Cylinder Differential Pressure Test	Eastern Technology Corporation	Model E2M, Model E2A
Digital Multimeter	Troubleshooting	Commercial, off the shelf	---
High Tension Lead Test Kit	Ignition Harness Troubleshooting	Eastern Technology Corporation	E5
Master Orifice Tool	Cylinder Differential Pressure Test	Eastern Technology Corporation	Model E2M
Oil Filter Can Cutter	Cut Oil Filter Can	Champion Aerospace	CT-923
Oil Filter Torque Wrench	Oil Filter Installation	Champion Aerospace	CT-921
Oil Seal Installation Tool	Oil Seal Installation	Fabricate according to Figure 3-5	Local Manufacture
Portable Digital EGT/ CHT Tester	Verify EGT/CHT Accuracy	Alcor, Inc.	ALCAL 2000
Protractor/Timing Indicator Disc and TDC Locator	Engine Timing	Eastern Technology Corporation	E25
Pulley puller	Remove Generator/Alternator Sheave	Burroughs***	61-5
Timing Light	Magneto to Engine Timing	Eastern Technology Corporation	E50
Voltage & Circuit Tester	Check Voltage/Circuits	Eastern Technology Corporation	Model 29

Table 3-1. Special Tools List

Special Tool	Use or Reference	Suggested Providers	Part Number
Overhaul			
Bearing Puller	Component Maintenance	Burroughs***	8093C
Boring Bars	Cylinder Repair	Burroughs***	8116-1B through -15B
Carbide Tipped Reamer	Valve Guide Reaming	Kent-Moore***	2847-2CP 2847-1CP
Common Drive Handle	Cylinder Repair	Burroughs***	8122A
Common Parts Kit	Valve Seat Replacement	Burroughs***	8116
Connecting Rod Boring & Alignment Fixture	Connecting Rod Piston Bushing Replacement	Burroughs***	8111A
Connecting Rod Bushing Removal/ Installation Set	Connecting Rod Piston Bushing Replacement	Burroughs***	8098
Connecting Rod Bushing Installation and Removal Tool Adapter Kit	Connecting Rod Piston Pin Bushing Replacement	Burroughs***	8042C
Connecting Rod Bushing Reamer	Connecting Rod Bushing Bore Honing	Kent-Moore***	5008
Crankcase Splitter	Separate The Crankcase	Kent-Moore***	L423
Crankcase Through Bolt Remover	Crankcase Disassembly	Burroughs***	8114-8
Crankshaft Nose Oil Seal Installer Tool	Connecting Rod And Bearing Installation Crankshaft Nose Oil Seal Installation	Kent-Moore***	5209
Cylinder Base Nut Wrenches	Cylinder Maintenance	Kent-Moore***	5203, 5204, & 8158A, 3882, & 3882-2
		Burroughs***	8079
Cylinder Heating Stand	Cylinder Maintenance	Burroughs***	8156
Cylinder Holding Fixture	Valve Seat Replacement Valve Guide Replacement Valve Seat Machining	Burroughs***	5221B
Cylinder Holding Fixture Adapters	Valve Seat Replacement Valve Guide Replacement Valve Seat Machining	Burroughs***	5221-13A 5221-15A 5221-16A
Cylinder Hone	Engine Cylinder Bore Honing	Snap On Tools	CFL10
Dial Indicator	Gear Backlash Measurement	Commercial, off the shelf	---
Exhaust Valve Seat Grinding Stone (Roughening)	Valve Seat Machining	Aircraft Tool Supply	K491 & 91
Exhaust Valve Seat Grinding Stone (Finishing)	Intake Or Exhaust Valve Seat Machining	Aircraft Tool Supply	K421 & K21
Expanding Guide Bodies	Valve Guide Replacement	Burroughs***	8116-1 through -16

Table 3-1. Special Tools List

Special Tool	Use or Reference	Suggested Providers	Part Number
Floating Holder	Valve Guide Replacement	Burroughs***	3170
Generator Drive Holder	Secure The Generator Drive	Burroughs***	4973
Helical Coil Extracting Tool	Helical Coil Insert Replacement	Emhart Fastening Teknologies	---
Helical Coil Installation Tool	Helical Coil Insert Replacement	Emhart Fastening Teknologies	---
Helical Coil Expanding Tool No. 520-2	Helical Coil Insert Replacement	Emhart Fastening Teknologies	520-2
High Speed Steel Reamer	Reaming Valve Guides	Kent-Moore***	2847-1HP 2847-2HP
Holding Fixture Adapter	Valve Seat Replacement Valve Guide Replacement Intake or Exhaust Valve Seat Machining	Burroughs***	5221-15A
Hommel Tester T500 & Software T1000	Cylinder Bore Honing	Hommel America	191800
Intake Valve Seat Grinding Stone (Roughening)	Valve Seat Machining	Aircraft Tool Supply	KK498 & K28
Intake Valve Seat Grinding Stone (Finishing)	Valve Seat Machining	Aircraft Tool Supply	K428 & K98
O-ring Installation Tool	Crankcase Hardware Installation	Fabricate according to Figure 3-4	---
Oil Pressure Relief Spot Facer	Oil Pressure Relief Valve Seat Refacing	Kent-Moore***	8048
Oil Seal Tool	Crankcase And Accessory Drive Adapter Oil Seal Installation	Fabricate according to Figure 3-5	MT500260
Piston Ring Compressor	Engine Cylinder Installation	Kent-Moore***	3601
Piston Ring Removers	Piston Ring Removal	Kent-Moore***	8121
Polishing Tool	Drive Train Inspection	Burroughs***	8087A
Plug Gauge	Cylinder Intake Valve Guide Inspection	Kent-Moore***	2848-1
Pushrod Spring Compressor Tool	Pushrod Installation	Kent-Moore	68-3
Reamers	Valve Guide Reaming	Burroughs***	8116-1R through -15R
Reamer, Adjustable Blade	Magneto Drive Adapters Bushing And Oil Seal Installation		Size range 25132-27132
Rocker Arm Bushing Remover/Installer	Rocker Arm Bushings (Single-Bushing Type) Replacement	Kent-Moore***	8118
Rocker Arm Bushing Reamer	Ream Rocker Arm Bushing	Kent-Moore***	7232
Rosan Stud Remover	Remove Step-Type Rosan Studs	McMaster-Carr Supply Company	---

Table 3-1. Special Tools List

Special Tool	Use or Reference	Suggested Providers	Part Number
Rosan® Stud Remover (Rosan® is a registered trademark of Fairchild Aerospace Fastener Division)	Remove Rosan Studs	McMaster-Carr Supply Company	2769A13
Rosan® Lock Ring Installer	Rosan Studs Installation	Kent-Moore***	8074
Spark Plug Insert Remover	Spark Plug Helicoil Insert Removal	Burroughs***	4919
Spark Plug Insert Replacer	Spark Plug Helicoil Insert Installation	Burroughs***	4918
Spark Plug Tap (18 mm)	Repair Damaged Spark Plug Threads/Boss	Burroughs***	445
Test Club	Post-Overhaul Testing	Hartzell Propeller, Inc.	
Valve Guide Boss Reamers	Valve Guide Reaming	Kent-Moore***	4943-1 HS through -5HS
Valve Guide Floating Holder	Valve Guide Replacement	Burroughs***	3170
Valve Guide Remover	Valve Guide Replacement	Kent-Moore***	4981
Valve Guide Seal Installation Tool	Valve Guide Seal Installation	Fabricate according to Figure 3-3	Local manufacture
Valve Seat Grinder Set “Sioux Brand”	Machining Intake Or Exhaust Valve Seat	Aircraft Tool Supply	1675
Valve Seat Grinder Pilot 0.437 diameter	Machining Intake Or Exhaust Valve Seat	Aircraft Tool Supply	AEX 437
Valve Seat (Straight Side) Insert Cutters	Valve Seat Repair	Kent-Moore***	5224 & 5225
Valve Seat (Step Side) Insert Cutters	Valve Seat Repair	Kent-Moore***	8135, 8136, & 8138
Valve Seat Insert Remover & Replacer	Valve Seat Replacement	Burroughs***	8086
Valve Spring Compressor Tool	Engine Cylinder Assembly	Kent-Moore***	3602
Overhaul Inspection			
Contour Probe	Magnetic Particle Inspection	Parker Research Corporation	DA-200
Dial Bore Gauges	Cylinder Bore Inner Diameter Dimensional Inspection	MAHR Federal	545-116
Plug Gauge	Cylinder Intake Valve Guide Inspection	Kent-Moore***	2848-1
Ultrasonic Test Instrument, Portable	Crankshaft Ultrasonic Inspection	Krautkramer-Branson	Krautkramer-Branson P/N: USK 7D OR7S USL 42 USL 48 USN 50 USN 52

Table 3-1. Special Tools List

Special Tool	Use or Reference	Suggested Providers	Part Number
Ultrasonic Test Instrument Calibration Block	Crankshaft Ultrasonic Inspection (Equipment Calibration)	Krautkramer-Branson	DSC Block or Rompas Block (steel)
Coaxial Cable - Grade 74 RG174/U 50 ohm Microdot to BNC (6’)	Crankshaft Ultrasonic Inspection (For Connecting The Transducer To The Ultrasonic Equipment)	Krautkramer-Branson	Krautkramer-Branson P/N 118140012
Coaxial Cable MMD to BNC (6’)	Cylinder Barrel Ultrasonic Inspection	Krautkramer-Branson	Krautkramer-Branson P/N C-047
Filter (microhenry BNC to BNC)	Cylinder Barrel Ultrasonic Inspection	Krautkramer-Branson	Krautkramer-Branson P/N 281-678-200
Fixture 60° Axial	Cylinder Barrel Ultrasonic Inspection	Krautkramer-Branson	Krautkramer-Branson P/N 291-678-000
Flaw Detector	Cylinder Barrel Ultrasonic Inspection	Krautkramer-Branson	Krautkramer-Branson P/N USL-42 or equivalent
Transducer 5.0 MHz, 0.125 diameter	Cylinder Barrel Ultrasonic Inspection	Krautkramer-Branson	Krautkramer-Branson P/N SMSWS 113-214-585
Transducer, Miniature (Gamma Series 5 MHz)	Crankshaft Ultrasonic Inspection (Provide Piezoelectric Effect)	Krautkramer-Branson	Krautkramer-Branson P/N MSWS 224-580
Crankshaft Main Bearing 2.2375 – 2.2485 inches (5.6833 – 5.7112 cm) and	Crankshaft Ultrasonic Inspection	Continental Motors	654478-1
Miniature Wedge (45° shear wave)	Crankshaft Ultrasonic Inspection	Continental Motors	654484
Crankshaft Main Bearing 2.3630 – 2.3750 inches (6.0020 – 6.0325 cm) and	Crankshaft Ultrasonic Inspection	Continental Motors	654483-1
Miniature Wedge (45° shear wave)	Crankshaft Ultrasonic Inspection	Continental Motors	654578
Crankshaft Main Bearing 2.6140 – 2.6250 inches (6.6396 – 6.6675 cm) and	Crankshaft Ultrasonic Inspection	Continental Motors	654485-1
Miniature Wedge (45° shear wave)	Crankshaft Ultrasonic Inspection	Continental Motors	654484
Micrometers (series 3 point contact inside micrometers)	Counterweight Hanger Blade Bushing Replacement	Starrett	No. 78

Table 3-1. Special Tools List

Special Tool	Use or Reference	Suggested Providers	Part Number
Runout Block Set	Drive Train Dimensional Inspection	Burroughs***	8117a
*or equivalent **Providers can be subject to change or discontinue manufacturing tools *** The rights to manufacture Burroughs and Kent-Moore tools has been acquired by Kell-Strom Tool Company.			

3-1.1. Vendor Contact Information

Table 3-2. Tool, Accessory and Supply Vendors

Supplier	Address	Phone	FAX	Web Address
Aircraft Tool Supply	P.O. Box 370 1000 Old U.S. 23 Oscoda, MI 48750	800-248-0638 517-739-1447	517-739-1448	aircraft-tool.com
Alcor	300 Breesport San Antonio, TX 78216	800-343-7233 210-349-6491	210-308-8536	alcorav.com
Approved Aircraft Accessories	29300 Goddard Road Romulus, MI 48174	800-521-1046 734-946-9000	734-946-5547	approvedaircraft.net
A. W. Chesterton Company	225 Fallon Road Stoneham, MA 02180-9101	800-835-4135 781-438-7000	781-438-8971	chesterton.com
Burroughs	See Kell-Strom Tools			
Champion Aerospace, Inc.	1230 Old Norris Road Liberty, SC 29067	864-843-5333	864-843-5402	championaerospace.c om
CRC Industries/ Chemical Products	885 Louis Drive Warminister, PA 18974	800-272-4620 800-556-5074	800-272-4560 215-674-2196	crcindustries.com
Davis Inotek Instruments	4701 Mount Hope Drive Baltimore, MD 21215	800-358-5525	888-818-3981	inotek.com
Dow Corning Corporation	P.O. Box 997 South Saginaw Road Midand, MI 48686	517-496-6000 800-248-2481		dowcorning.com
Eastern Electronics	See Eastern Technology Corporation			
Eastern Technology Corporation	42 Nelson St. East Hartford CT 06108	860-528-9821	860-289-7639	easterntech.com
Emhart Fastening Teknologies	Industrial Division 50 Shelton Technology Center P.O. Box 859 Shelton, CT 06484	203-924-9341	203-925-3109	emhart.com/products
Federal Mogul	Southfield, MI	248-354-7700		federal-mogul.com
Hartzell Propeller Inc.	One Propeller Place Piqua, OH 45356	937-778-4200	937-778-4271	hartzellprop.com
Hommel America	30 Peter Court New Britain, CT 06051	860-827-8500	860-223-2979	hommelamerica.com
Kell Strom Tool Company	214 Church Street Wethersfield, CT 06109	800-851-6851 860-529-6851	860-257-9694	kell-strom.com

Table 3-2. Tool, Accessory and Supply Vendors

Supplier	Address	Phone	FAX	Web Address
Kelly Aerospace	Power Systems 2900 Selma Hwy Montgomery, AL 36108	877-359-5355	334-386-5410	kellyaerospace.com
Kent-Moore	See Kell-Strom Tools			
Krautkramer-Branson	50 Industrial Park Road Lewistown, Pennsylvania 17044	717-242-0327 334-438-3411		metrologyworld.com/ storefronts/ krautkramer.html
Loctite	1001 Trout Brook Crossing Rocky Hill, CT 06067-3910	860-571-5100 800-243-4874	860-571-5465	loctite.com
Lubriplate	129 Lockwood St. Newark, NJ	973-589-9150 800-733-4755	973-589-4432	lubriplate.com
MAHR Federal	2828-L I-85 South Charlottle, NC 28208	704-398-2298		deterco.com/products/ MahrFederal/ mahr.htm
McMaster-Carr Supply Company	P.O. Box 4355 Chicago, IL 60680-4355	630-833-0300	630-834-9427	mcmaster.com
Merit Abrasives	201 W. Mansville Dr. Compton, CA 90224	800-421-1936 310-639-4242	800-472-3094	meritabr.com
Miller-Stephenson Chemical Company	6348 Oakton St. Morton Grove, IL 60053	847-966-2022 800-992-2424	847-966-8468	miller-stephenson.com
Q.A. Technologies	P.O. Box 61085 Savannah, GA 31420	912-330-0500	912-330-0104	qatek.com
Parker Research Corporation	P.O. Box 1406 Dunedin, FL 34697	800-525-3935	727-797-3941	parkreascorp.com
Shell Oil Company	P.O. Box 4320 Houston, TX 77210	713-241-4819	713-241-6511	shell-lubricants.com
Snap On (Tools)		877-740-1900	877-740-1880	snapon.com
L.S. Starrett Company		800-541-8887 978-249-3551	978-249-8495	starrett.com
Tanair (Tanis Aircraft Services)	P.O. Box 117 Glenwood, MN 56334	800-443-2136 In Minnesota: 800-862-2443	800-443-2136	tanair.com
Turco Henkel Aerospace	Aerospace - Structural Adhesives P. O. Box 312 Bay Point, CA 94565-0031	925-458-8000	925-458-8030	aerospace.henkel.com/
Unison Industries (Slick)	Unison Industries ATTN: Subscription Dept. 7575 Baymeadows Way Jacksonville, FL 32256	904-739-4201	904-739-4006	unisonindustries.com/ news/ service_documents.html
U.S. Industrial Tool & Supply	15101 Cleat St. Plymouth, MI 48170	888-4USTOOL 734-455-3388 800-521-4800	734-455-3256	ustool.com
*Unless otherwise indicated, type *http://www.* and the internet address				

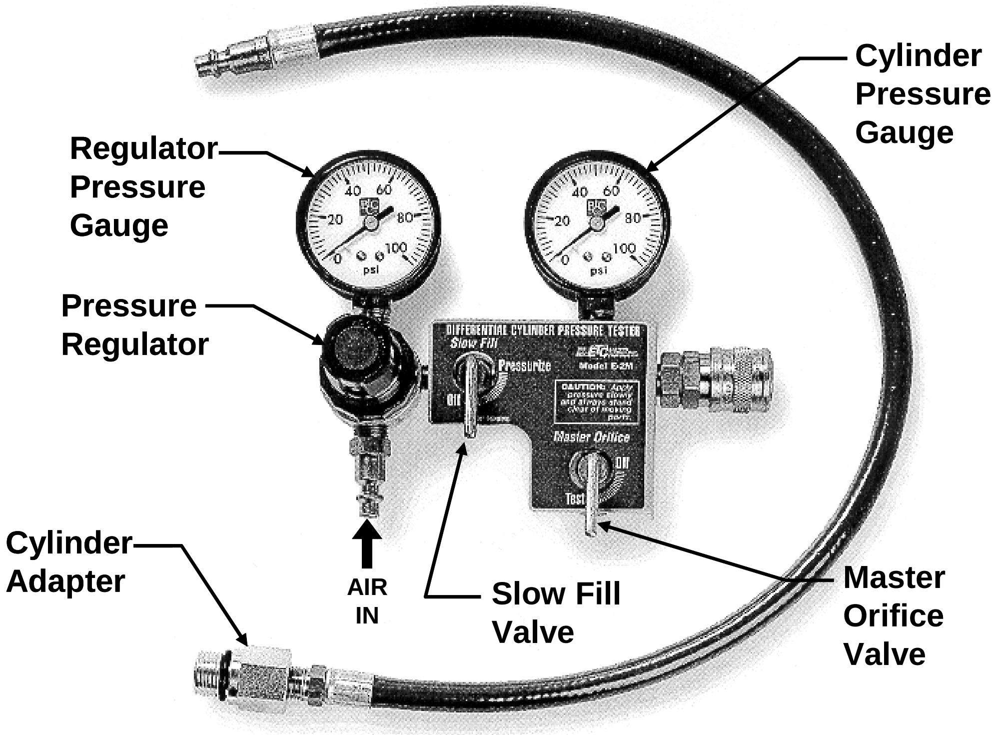


Figure 3-1. Model E2M Differential Pressure Tester (built in Master Orifice Tool)

NOTE: The Model E2A Differential Pressure Tester may only be used with a Master Orifice Tool, which is no longer produced, nor available. If no Master Orifice Tool is available, the Model E2M must be used to perform the Cylinder Differential Pressure Test.

The Master Orifice Tool restrictor orifice dimensions for these engines must be 0.040 inch orifice diameter, 0.250 inch long with 60° approach angle. The airflow rate should be 120 ±5 cubic feet per hour at 30 psi differential pressure.

Figure 3-2. Borescope (Autoscope®)

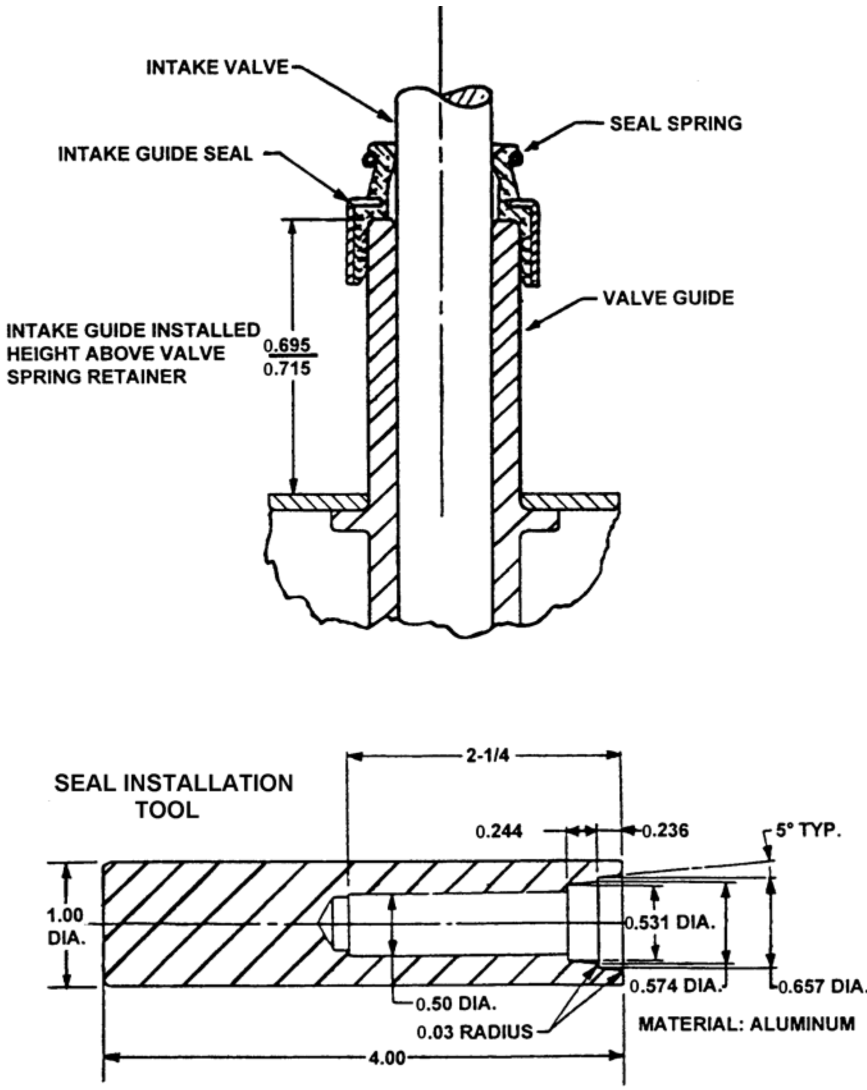
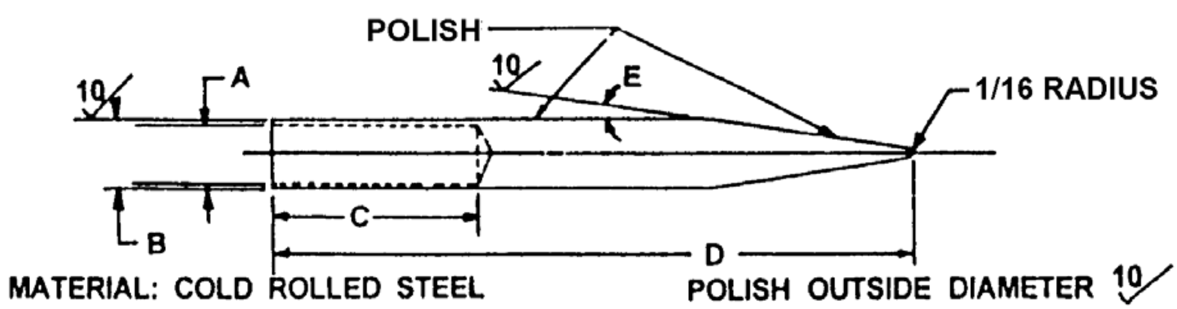


Figure 3-3. Valve Guide Seal Installation Tool



3/8 BOLTS	3/8" Dia.	7/16" Dia.	1-3/8"	4°	8°Degrees
7/16 BOLTS	7/16" Dia.	1/2" Dia.	1-3/8"	4°	8°Degrees
1/2 BOLTS	1/2" Dia.	9/16" Dia.	1-3/8"	4°	8°Degrees
SIZE	A	B	C	D	E

Figure 3-4. O-Ring Installation Tool

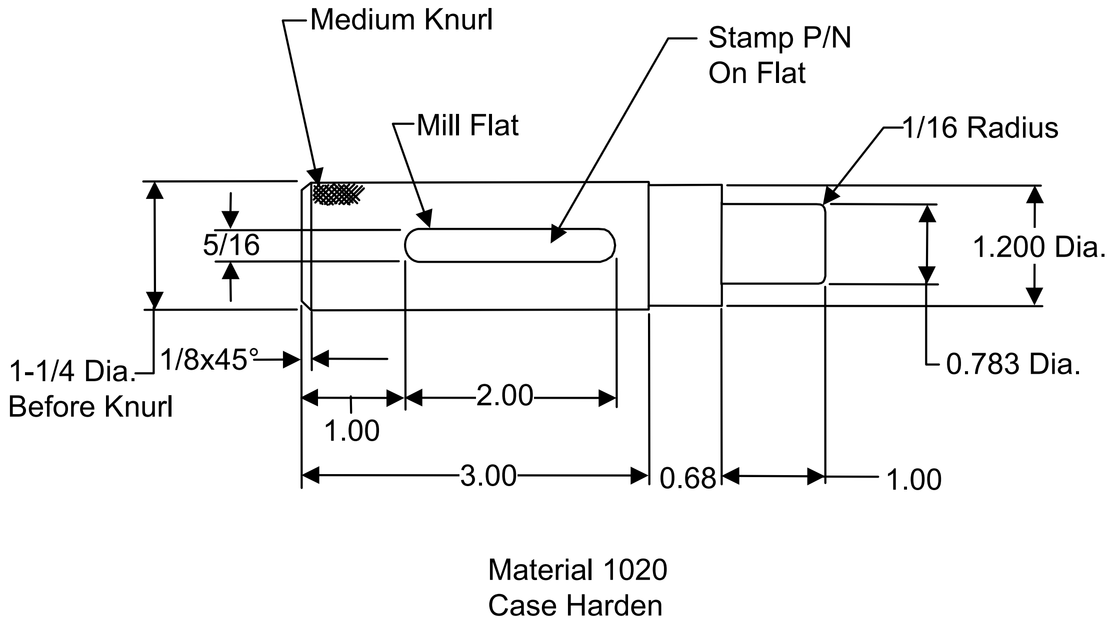


Figure 3-5. Oil Seal Tool

Figure 3-6. Helical Coil Extraction Tool

Figure 3-7. Helical Coil Insertion Tool

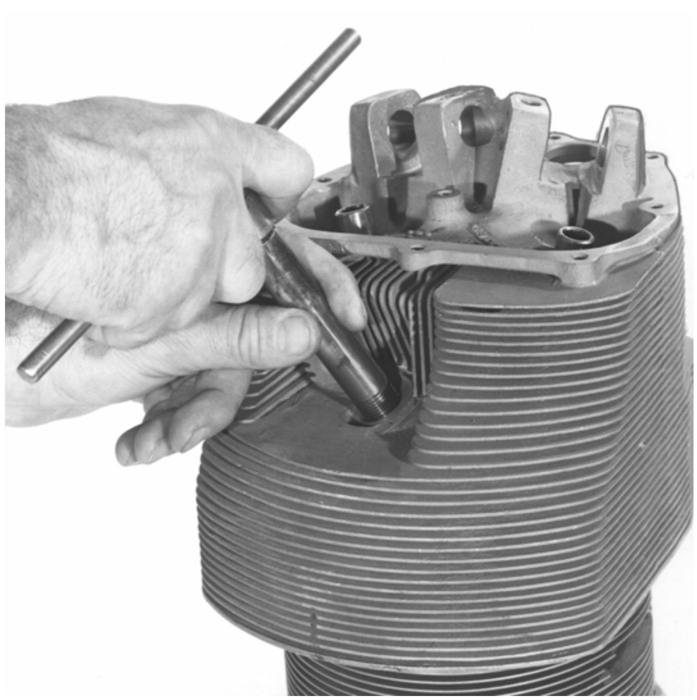


Figure 3-8. Helical Coil Expanding Tool

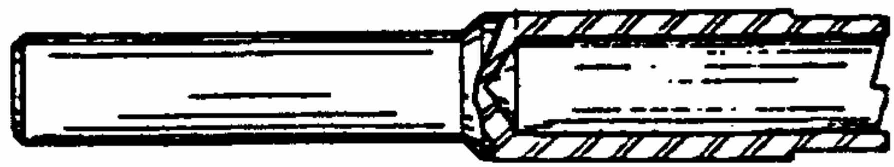


Figure 3-9. Rosan® Stud Removal Tool

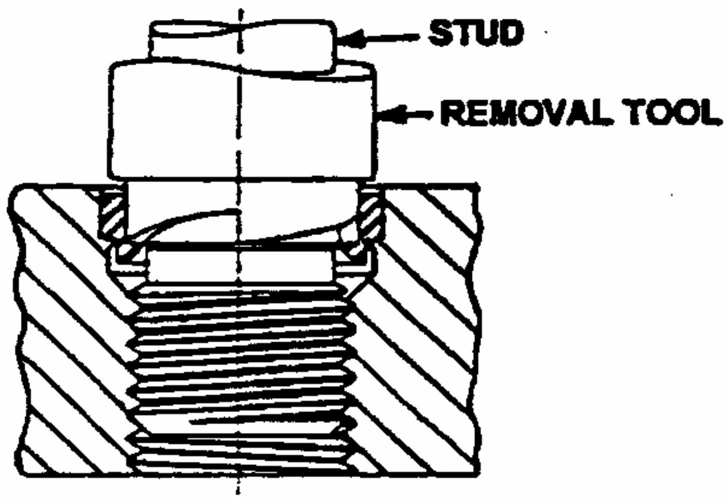


Figure 3-10. Rosan Stud Removal Tool Installed on Stud

3-1.2. Mechanic's Tools

The tools listed below are required to perform overhaul procedures on the engines.

Open end wrenches – ¼-inch through 1-	1/4-inch Slide hammer
Deep socket wrenches: •¼-inch drive •5/32 through ½-inch drive •3/8-inch through 1-1/2-inch drive •7/16-inch through 1-1/4-inch	Ratchets: •¼-inch drive •3/8-inch drive •½-inch drive
Deep well sockets: •½-inch drive •7/16-inch drive through 1-inch	Heat Gun (variable intensity/ equipped with a small tip)
Calibrated torque wrenches: •0 to 1000 in-lbs •0 to 500 in-lbs •0 to 100 ft-lbs	•Drill, 0.266 (H) Pneumatic drill •00.339 Drill High speed borer •Drill bit No. 17 bit (0.1730)
Micrometers	Ball peen hammer
Allen wrenches - assortment	Pullers
Slotted screwdrivers – assortment	Blind Bearing Remover
Phillips screwdrivers – Nos. 1 and 2	Vernier calipers
Safety wire pliers	Leather or soft plastic mallet
Common pliers	Small hole gauges, thickness gauges
Diagonal cutter pliers	Feeler gauges (leaf-type)
Needle nose pliers	C-clamps
Duck bill pliers	Brass wire brush
Snap ring pliers (with 90-degree bend)	Stiff-bristled, non-wire scrub brush
Inspection light/flashlight	Dry blaster cleaning tool
2-inch Merit wheel	Air impact tool
T-handle Drive Magnifying glass (10X power)	Tool maker's square Inertia puller
Mirror	Profilometer
Utility Knife or Razor Knife	Chamfer Tool
Scissors	Morse adapter
Crimp Tool	Heavy duty drill press
Wire ties	Arbor press (and 8-inch arbors)
Ring expander	Vertical mill
Shield vise	Engine hoist
Fiber drift, brass drift, pin or punch	Engine stand
Magnet	Transport dolly
Stud Extractor Tool	Aircraft tie downs and stop blocks
Ezy Out	V-blocks

3-2. Lubricants, Sealants and Adhesives

3-2.1. Engine Oil Specifications

Lubricating oils qualified for use in Continental Motors engines are required to meet SAE (Society of Automotive Engineers) specifications. SAE J-1899 is the specification for aircraft piston engine ashless-dispersant oil. SAE J-1966 is the specification for aircraft piston engine non-dispersant mineral oil. See Chapter 2 for engine oil sump capacities.

NOTE: MIL-L-6082E, dated 1 November 1995 and MIL-L-22851D, dated 1 November 1995 have been superseded by SAE specifications SAE J-1966 and SAE J-1899, respectively.

QPL-J-1899: Qualified Products List is available from:

SAE Headquarters
400 Commonwealth Drive
Warrendale, PA 15096-001

The Naval Air Systems Command maintains QPL-J-1899 and QPL-J-1966.

Naval Air Systems Command
Air 4.4.5
Jefferson Davis Highway
Arlington, VA 2243-5120

3-2.2. Recommended Oil Grade:

Above 40°F ambient air, sea level- SAE 50 or Multi Viscosity

Below 40°F ambient air, sea level - SAE 30 or Multi Viscosity

Table 3-3. Break-in Oil

Type	Equivalent	Application
SAE J-1966 Aviation	Non-dispersant mineral oil for piston aircraft engines	First 25 hours of engine operation or until oil consumption stabilizes
MIL-C-6529 Type II Corrosion preventive mineral oil	Fly-away oil	

NOTE: NOTE: Mineral oil conforming to MIL-C-6529 Type II contains a corrosion preventive additive and must not be used for more than 25 hours or six months, whichever occurs first. If oil consumption has not stabilized in this time, drain and replenish the oil and replace the oil filter.

Table 3-4. Preservative Oil

Type	Equivalent	Application
MIL-P46002A	NOX-RUST 1101	Temporary or Indefinite Storage
MIL-P46002A	Motorstor Engine Protectant	Temporary or Indefinite Storage

3-2.3. Recommended Ashless Dispersant Aviation Engine Oils

NOTE: Continental Motors makes no endorsement of the listed products. The alphabetical listing is provided only for the convenience of Continental Motors customers. If the aviation oil you use or wish to use is not listed, contact the Naval Air Systems Command.

Table 3-5. Qualified SAE J-1899 Ashless Dispersant Engine Oil

Supplier	Brand
Air BP Lubricants	Castrol Aviator AD Oil
Air BP Lubricants	Castrol Aviator A Oil
Chevron USA	Chevron Aero Oil
Continental Oil	Conoco Aero S
Delta Petroleum Company	Delta Avoil Oil
Exxon Company, USA	Exxon Elite
Exxon Company, USA	Exxon Aviation Oil EE
Gulf Oil Company	Gulfpride Aviation AD
Mobil Oil Company	Mobil Aero Oil
NYCO SA	Turbonycoil 3570
Pennzoil Company	Pennzoil Aircraft Engine Oil
Phillips Petroleum Company	Phillips 66 Aviation Oil, Type A 100 AD, 120 AD
Phillips Petroleum Company	X/C Aviation Multi viscosity Oil M20W50 SAE 20W-50, SAE 25W-60
Quaker State Oil & Refining Co.	Quaker State AD Aviation Oil
Red Ram Limited (Canada)	Red Ram X/C Aviation Oil 20W-50
Shell Aviation	Aeroshell Oil, (Mineral) 65, 80, 100, 2F Anti Corrosion Formula
Shell Aviation	Aeroshell Multi-grade Oil AD, 15W - 50
Shell Aviation	Aeroshell Oil W65, W80, W100
Shell Aviation	Aeroshell Oil W80 Plus, W100 Plus Anti Corrosion Formula
Sinclair Oil Company	Sinclair Avoil
Texaco Inc.	Texaco Aircraft Engine Oil-Premium AD
Total France	Total Aero DM 15W - 50
Union Oil Company of California	Union Aircraft Engine Oil HD

3-2.4. Oil Change Intervals

Refer to the engine maintenance manual and/or the aircraft manufacturers or Supplemental Type Certificate (STC) holders AFM/POH for fuel specifications, specified oil change intervals and inspection procedures.

Oil change intervals published in this manual are minimum requirements. Continental Motors believes more frequent oil and filter changes enhance engine service life. Continental Motors recommends engine oil be drained and replenished every 25 hours of operation or 4 months for engines that incorporate an oil screen. Engines with the small full flow oil filters should have the oil changed every 50 hours or 6 months.

3-2.5. Additives

There are many fuel and oil additives and/or concentrates on the market today which were formulated primarily for automotive and industrial engine applications. From time to time, we receive inquiries regarding use of these products in our aircraft engines. Most of these additives and concentrates, while they may be highly beneficial to automotive and industrial operation, are not compatible with air-cooled, light aircraft engines in their operating environments. With the exception of the use of isopropyl alcohol and ethylene glycol monomethyl ether compound described in the following paragraph, we do not recommend the use of additives or concentrates in any of our aircraft engines. In fact, the use of such additives may void the engine warranty. Use only recommended fuels and lubricants.

WARNING

Mixing of the DEGMME compound with fuel concentration in excess of the recommended (0.15 percent volume maximum) could have a harmful effect on engine components. Use only the manufacturer's recommended blending equipment and procedures to achieve proper proportioning.

Under certain ambient conditions of temperature and humidity, sufficient quantities of water may exist in the fuel to create restrictive ice formation in the fuel supply. To alleviate this occurrence, it is permitted to add no more than three percent Isopropyl Alcohol to the fuel supply. Also, Diethylene Glycol Monomethyl Ether (DEGMME) conforming to military specification MIL-DTL-85470B, if approved by the aircraft manufacturer, may be added for this purpose. The DEGMME compound must be carefully mixed with the fuel in concentrations not to exceed 0.15 percent by volume.

Table 3-6. Lubricants

Type	Application	Remarks
Part No. 646943 (Loctite 76732 Anti-Seize Lubricant)	Exhaust studs	Apply to nut end before torque
	Mechanical tachometer drive housing threads not through to an oil source.	At engine assembly
	Vernatherm plug	
	All 0.3125 and larger studs unless otherwise noted	
	Throttle body air reference fittings	where applicable
Part No. 654468 (Shell #5 MIL-G-3545-C Grease)	Fuel pump o-rings	During assembly
	Fuel pressure regulator spring seat	
	Mixture shaft bushings	
Part No. 654561 (Shell Alvania # 2)	Light coat at contact point between nut seat and ignition lead ferrule	All Models
Part No. 656817 (Molyshield Grease)	Needle bearings and ball bearings	All Models during engine assembly
	Valve stems	
	Accessory drive splines and couplings	where applicable
	Oil seal lips only	All Models
	Magneto rubber drive bushings	
	Oil pumps (pressure & scavenge)	Coat gear cavity during pump assembly

Table 3-6. Lubricants

Type	Application	Remarks
Chesterton #995 Release agent or WD-40	Induction system hoses and flex duct connections, fuel pump aneroid seal	All Models
Dow Corning® No. 4	Rubber oil seal of spin-on oil filter	where applicable
	Magneto adapter gaskets -(both sides)	
Dow Corning® G-N Paste	Camshaft lobes and tappet faces	During engine assembly
Lubriplate 930 AA	O.D. of valve guides	During valve guide installation
SAE J-1966 Grade 50 Non-compounded Break-in Aviation Oil	Crankshaft bearings Connecting rod bearings	All Models
	Camshaft bearings	
	Tachometer gears & adapters	
	Accessory spur gear teeth	
	Starter cone, bushing & nut	
	Valve guide seals	Apply to sealing surface
	Pistons, piston pins & piston rings	All Models
	Thrust washers	All Models
	Oil filter adapter seals	
	O-rings	
	Cylinder studs and through bolts, crankcase studs, connecting rod bolts and nuts; and engine accessory studs unless otherwise specified	lubricate bolt thread and nut seat before tightening nuts
	Carburetor fuel connections (male threads only)	
Spark Plug Manufacturer's recommended spark plug thread lubricant such as CHAMPION® Spark Plug Thread Lubricant No. 2612	Spark plugs	All Models

Table 3-7. Sealants

Type	Application	Remarks
Part No. 642188 (CRC Copper Coat 401504 Gasket Sealant)	Accessory case to crankcase gasket (crankcase side only)	C-90, O-200, O-300, 360 & IO-240
	Oil Drain Back Tubes	C-90, O-200, O-300
	Intake manifold gasket	All Models
	All press type plugs (Hubbard etc)	All Models
	In parting line area of 3-way joints	Sump to crankcase or sump to crankcase to accessory case
	2 bolt suction tube gasket - both sides	where applicable
Part No. 646942-Gasket Maker (Loctite 515™ Gasket Eliminator® Flange Sealant)	Crankcase parting face	where applicable
	Engine nose seal between crankcase and sump gasket oil pump covers	
	Between oil sump and sump gasket	Non-beaded gaskets
	642910 oil seal, O.D. of all uncoated oil seals, except fuel pump adapter seal	applicable models

Table 3-7. Sealants

Type	Application	Remarks
Part No. 653692 (Loctite LocQuic Primer 7649)	Crankshaft nose oil seal area	All models
Part No. 654663 (Loctite 30516) used with Part No. 641543 Silk Thread	Crankcase parting face	Apply according to assembly instructions
	Starter adapter to accessory case	
	Accessory drive adapter	
Loctite 592 Teflon PS/T Pipe Sealant	Use on all pipe threads except as noted	where applicable
	All pressure relief valve housing threads	
	All threaded fasteners installed in a through hole to an oil source	Apply before installing threaded fastener
Miller-Stephenson MS-122AD	Ignition harness terminals at magneto block end	All models

Table 3-8. Adhesives

Type	Application	Remarks
Part No. 646940 (Loctite 222 Sealant or optional Loctite Hydraulic Sealant 569)	Through stud holes on accessory end of crankcase	apply when installing studs
	Studs 0.25 diameter and smaller	All models
Part No. 646941 (Loctite 271 High Strength Adhesive Sealant) used with Part No. 653693 (Loctite 7471 Primer)	Cylinder deck studs	breakaway torque minimum 100 in-lbs. after two hours
	Crankcase nose seal retainer bolts	All models
	Squirt nozzle	All models
	Mechanical tachometer drive studs to an oil source	where applicable
	Intake Manifold Mount Studs	C-75, C-85, C-90 & O-200
Part No. 654470 (3M Brand EC 1252 White Spot Seal Putty)	Air throttle & fuel metering assembly Magneto flanges Cylinder deck stud nuts & through bolts Fuel pump, manifold valve, throttle and control fittings	All models
Part No. 654562 (Loctite 609 Adhesive / Sealant)	Fuel pump adapter seal	
	Fuel pump shaft seal	O-200, IO-240, O-300
	Starter clutch assembly bearing O.D.	
Part No. 655700	Cylinder baffle isolators Rubber vibration isolators Chafing pads	

Table 3-9. Miscellaneous

Type	Application	Remarks
Part No. 626531-1 Enamel - Gold (1qt) Part No. 626531-2 Enamel - Gold (1 gal)	High temperature paint for cosmetic and corrosion protection	
Part No. 535011 Safety wire -.032 in dia. Steel, Corrosion Resistant	Where safety wire is required	
"ACCELAGOLD" Turco® Products	Corrosion protection interior and exterior aluminum parts	

Chapter 4. Airworthiness Limitations

The Airworthiness Limitations Section is FAA approved and specifies maintenance required under §§ 43.16 and 91.403 of the Federal Aviation Regulations unless an alternative program has been FAA approved.

Federal Aviation Regulations §§ 43.16 and 91.403 require owner/operator compliance with all maintenance limitations in this section concerning mandatory replacement times, inspection intervals, and other related procedures that are specific to this engine. Any such limitations listed below are part of the design limits of the engine, which was type certified based upon required owner/operator compliance with the limitations.

4-1. Mandatory Replacement Times

Subject to additional information contained in FAA Airworthiness Directives issued after the date of certification, the engines covered in this manual do not contain any components having mandatory replacement times required by type certification.

4-2. Mandatory Inspection Intervals

Subject to additional information contained in FAA Airworthiness Directives issued after the date of certification, the engines covered in this manual do not require specific intervals of inspection pursuant to type certification.

4-3. Other Related Procedures

Subject to additional information contained in Airworthiness Directives issued after the date of certification, there are no other related procedures required pursuant to the type certification for the engines covered in this manual.

4-4. Distribution of Changes to Airworthiness Limitations

Changes to this Airworthiness Limitations Section constitute changes to the type design of the engines covered in this manual and require FAA approval pursuant to Federal Aviation Regulations. Changes which result in new or more restrictive limits, will be published in FAA Airworthiness Directives.

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Chapter 5. Engine Removal & Installation

5-1. Engine Removal

WARNING

Turn the ignition switch off, verify continuity between the magneto capacitor and aircraft ground, and disconnect engine electrical power prior to commencing any engine maintenance. If the magnetos are not properly grounded, turning the propeller could cause an uncommanded engine start. Do not stand or place equipment within the arc of the propeller.

1. Turn off the Ignition Switch and Master Power Switch according to the airframe manufacturer's instructions. Open the circuit breakers powering the switches according to the airframe manufacturer's instructions. Turn the fuel selector valve to the OFF position and disconnect engine electrical power according to the airframe manufacturer's instructions.
2. Remove engine compartment cowling and airframe accessories that could obstruct engine removal according to the airframe manufacturer's instructions.
3. Disconnect the aircraft battery according to the airframe manufacturer's instructions.
4. Disconnect the power cable from the starter according to the airframe manufacturer's instructions.
5. Remove the propeller, spinner and back-plate according to the airframe manufacturer's instructions.
6. Remove the baffling required to avoid contact with the engine nacelle during removal according to the airframe manufacturer's instructions.
7. Remove the oil sump drain plug and gasket; drain the oil according to the "Engine Oil Servicing" instructions in Section 6-3.7.
8. Temporarily install the oil sump drain plug and gasket to prevent contamination during transit. The gaskets will be replaced when the oil is serviced.
9. Disconnect and tag the ignition circuit p-leads from the magnetos according to the airframe manufacturer's instructions.
10. Disconnect and tag the engine wiring bundles and other connections from the following components in accordance with the airframe manufacturer's instructions.
    a. Pneumatic pump
    b. Oil temperature sensor connection
    c. Exhaust gas temperature sensor connection
    d. Cylinder head temperature sensor connection
    e. Oil temperature sensor connection
    f. Alternator

g. Manifold pressure gauge line

h. Airframe fuel supply hoses

i. Throttle and mixture control cables

j. Airframe accessories and instrument connections

11. Disconnect the Ignition Harness (according to “Ignition System Removal and Disassembly” in Section 12-2).

12. Remove all wiring bundle attaching clamps and hardware according to the airframe manufacturer's instructions. Route wiring bundles clear of engine.

13. Disconnect any remaining airframe hoses and lines that may interfere with engine removal according to the airframe manufacturer's instructions.

CAUTION: Do not use tape and/or plugs inside open lines or fittings.

14. Properly cap off disconnected fluid lines and connections to prevent fuel spillage and debris from entering the engine.

15. Ensure all wires, lines, hoses and attachments between the engine and airframe are disconnected.

16. Disconnect and remove the exhaust system from the airframe according to the airframe manufacturer's instructions.

17. Remove the engine mount isolators and fastening hardware according to the airframe manufacturer's instructions.

18. Attach the engine hoist to the engine lifting eyes. (For the location of the lifting eyes, refer to the Installation Drawings in Section 5-4).

CAUTION: Do not allow the chains to become entangled in the engine or its hardware. Ensure the area is clear when lifting the engine. Do not allow the front, rear, sides or bottom of the engine to bump or strike any obstructions to prevent damage to the engine or its components.

19. Relieve the engine weight from the engine mounts with the hoist and carefully lift the engine out of the airframe according to the airframe manufacturer's instructions.

20. Place the engine on an engine stand, transport dolly or engine shipping container base.

21. Use a tank sprayer filled with stoddard solvent and soft bristle brush to preclean the engine, followed by a wash with a mild soap and water solution. Rinse thoroughly with clean water to minimize contamination before bringing the engine in the shop area for disassembly.

5-2. Engine Installation

5-2.1. Common Tools and Consumable Supplies Required

1. Hoist
2. Oil conforming to SAE J-1966 (break-in oil, non-dispersant mineral oil) MIL-C-6529 Type II (Fly-away oil)
3. Ashless dispersant oil conforming to SAE J-1899
4. MIL-P-46002, Grade 1 oil
5. 100-LL Blue aviation fuel
6. Spark plugs and copper gaskets
7. Safety Wire (.032")
8. Cable ties
9. Bladder-type pressure pot (at least 1 gallon capacity)
10. Type 1 flammable fuel container
11. MS-122AD Spray (procured from Miller-Stephenson)
12. Spark Plug Manufacturer's recommended spark plug thread lubricant
13. Other supplies required by the airframe manufacturer

5-2.2. Engine Receipt and Handling

When the engine arrives, inspect the crating for damage. If the engine crating appears damaged, notify the freight shipping company for resolution. If the crating appears intact, proceed to Section 5-2.2.1.

5-2.2.1. Uncrating the Engine

1. Remove the lag screws attaching the wooden cover to the base.
2. Lift the wooden cover and remove it.
3. Open the plastic bag wrapped around the engine.
4. Inspect the engine according to the "Acceptance Inspection" criteria in Section 5-2.2.3.

   NOTE: The engine is preserved for long term storage at the factory; if it is not immediately installed after acceptance, refer to the "Engine Preservation and Storage" in Chapter 9 for ongoing corrosion protection instructions. Environmental conditions (humidity), seasonal changes, and engine usage influence susceptibility to corrosion. In areas of high humidity, corrosion can occur within two days of uncrating the engine. The owner/operator is responsible for recognizing the risk of corrosion and taking the appropriate precautions.

5. If the engine will be stored for any length of time, refer to the "Engine Preservation and Storage" instructions in Chapter 9.

5-2.2.2. Crating an Engine for Shipping

1. Lower the engine onto the container base.
2. Attach the engine using shock mounts and bolts.
3. Cover the engine with a plastic bag.
4. Install and attach the container cover to the base.

5-2.2.3. Acceptance Inspection

CAUTION: If hidden engine damage or corrosion is discovered, contact Continental Motors (see "Contact Information" in Section 1-3). Do not install or place a damaged/corroded engine in storage.

1. Verify the engine serial number and model number on the engine nameplate are the same as specified in the engine logbook and the packing slip.
2. Inspect the engine for signs of damage or corrosion.
   a. If the engine exhibits no sign of damage or corrosion, proceed with installation. If the engine is to be installed within 30 days of unpacking, proceed with the instructions in Section 5-3.2, "Prepare the Engine for Installation."
   b. If damage or corrosion is discovered, contact the supplier of the engine for disposition. Do not install a damaged or corroded engine or place it in storage.

5-2.3. Engine Transport

Refer to the "Engine Installation Drawings" in Section 5-4 for the engine lifting eye locations.

CAUTION: Do not allow chains to become entangled on the engine or its hardware. Be sure the area is clear when lifting the engine. Do not allow the front, rear, sides or bottom of the engine to strike any obstructions as the extreme weight may damage the engine or its components.

1. Attach a hoist to the engine lifting eyes located at the top of the crankcase backbone.
2. Take up slack on the hoist prior to loosening the engine mount bolts; remove the bolts from the shipping shock mounts.
3. Lift the engine and install it on a transportation stand or dolly.

5-3. Installation Procedures

5-3.1. Prepare the Airframe for Engine Installation

1. The airframe fuel filter must be installed, clean, and in working order.

WARNING

Purge the aircraft fuel tanks and lines to remove contamination prior to connecting the fuel supply to the engine. Failure to purge contamination may cause erratic engine operation.

CAUTION: Follow the airframe manufacturer's scheduled interval for airframe mounted fuel and oil hose replacement. Hoses become brittle with age; Continental Motors recommends hose replacement coincident with engine overhaul to avoid immediate contamination or failure at a later date.

2. Replace all aircraft flexible oil and fuel hoses according to the aircraft manufacturer's instructions prior to engine installation.
3. Clean the aircraft fuel strainer and allow at least one quart of fuel to flow through the strainer and fuel supply line into a Type 1 fuel container through a paper filter.
4. Inspect the paper filter for contamination; if the fuel supply is free of contamination, proceed with engine installation. If contaminants are found in the fuel supply, isolate and correct the source of contamination prior to connecting the aircraft fuel supply to the engine.

5-3.2. Prepare the Engine for Installation

Remove packing material, tags, and the preservative fluid from the oil sump of new, rebuilt, overhauled or stored engines prior to installation.

NOTE: If the engine won't be installed immediately, refer to the "Engine Preservation and Storage" instructions in Chapter 9.

1. Remove the shipping plugs or dehydrator plugs from the spark plug holes.
2. Remove the AN-4060 protectors from the ignition leads.
3. Place a basin under the engine to catch the cylinder preservation oil.

NOTE: A small amount of preservative oil remaining in the cylinder bore is acceptable; it will burn off during the first engine start.

4. Turn the crankshaft through at least two complete revolutions to remove the cylinder preservation oil from the cylinders.
5. Catch the cylinder preservation oil draining out of the lower spark plug holes.

NOTE: If corrosion or abnormal conditions are discovered during the borescope inspection, contact the supplier (If the engine was obtained from Continental Motors, refer to *"Contact Information" in Section 1-3*) for disposition instructions.

6. Inspect the cylinder bores with a borescope for rust and contamination.

7. Remove the oil sump drain plug and drain the remaining cylinder preservation oil from the oil sump. Drain plug locations are depicted in the "Engine Installation Drawings" in Section 5-4.
8. Install the oil sump drain plug with a new crush washer; torque the drain plug according to Appendix B specifications; safety wire the drain plug according to instructions in Appendix C.

    NOTE: Approved accessories such as hydraulic pumps, vacuum pumps, etc. may be installed in the accessory drive pads located forward of the oil sump. Remove the accessory drive covers and install new gaskets. Install accessories in accordance with the airframe manufacturer's instructions.

9. Install all airframe manufacturer-required components according to the airframe manufacturer's instructions, including the following:
    a. Cooling baffles
    b. Hoses and fittings
    c. Brackets
    d. Ground straps
    e. Hydraulic or vacuum pumps
    f. Exhaust system
    g. Other airframe manufacturer required item(s)
10. Install the engine in the sequence indicated in Section 5-3.3.

5-3.3. Installation Sequence

CAUTION: Do not allow chains to become entangled on the engine or its hardware. Be sure the area is clear when lifting the engine. Do not allow the front, rear, sides, or bottom of the engine to strike any obstructions, as the extreme weight may damage the engine or its components.

1. Install the engine in the airframe mounts according to the airframe manufacturer's instructions. Refer to the "Engine Installation Drawings" in Section 5-4 for engine dimensions, clearances, and connections.
2. Connect the aircraft fuel supply to the carburetor according to airframe manufacturer's instructions.
3. Connect the starter and alternator wiring according to airframe manufacturer's instructions.
4. Install the exhaust system according to the airframe manufacturer's instructions.

WARNING

Oil pressure is applied to the face of the accessory drive pads. If gasket or accessory covers are not properly installed and torqued to Appendix B specifications, oil leakage will occur.

5. Connect the remote oil cooler (if equipped) hoses to the engine oil cooler adapter according to the airframe manufacturer's instructions.
6. Service the engine to the specified oil sump capacity according to instruction in “Engine Oil Servicing” instructions in Section 6-3.7.

WARNING

Do not install the ignition harness “B” nuts on the spark plugs until the propeller installation and the ignition system operational checkout is complete. Failure to comply can result in bodily injury when the propeller is rotated during installation.

7. Verify the Ignition Switch is OFF according to the airframe manufacturer's instructions.
8. Install the propeller according to the airframe and propeller manufacturer's instructions.
9. Perform the “Engine Pre-oiling” procedure according to Section 5-3.3.1.
10. If the magnetos were loosened or rotated during engine installation, adjust magneto to engine timing according to the “Magneto Timing” instructions in Section 6-3.8.1.
11. Install any remaining aircraft accessories according to the airframe manufacturer's instructions.
12. Purge the aircraft fuel lines, connect the fuel lines to the carburetor, and leak check the installed fuel lines according to the instructions in Section 5-3.3.2.

WARNING

Do not operate the engine until all hardware, spark plugs, gaskets, and seals are in place and torqued and the oil sump is properly filled to the specified capacity with oil.

13. Inspect the engine for any debris, discrepancies, or damage. Correct any discrepancies.
14. Perform an “Installation Inspection” according to instructions in Section 5-3.4.
15. Perform the “Engine Operational Check” according to instructions in Section 6-3.6.

5-3.3.1. Engine Pre-oiling

CAUTION: If the engine oil cooler adapter is connected to an airframe mounted oil cooler, the oil cooler and hoses will contain trapped air that oil servicing will not evacuate from the engine lubrication system. Failure to purge the air from the oil cooler and hoses prior to engine start will damage the engine.

1. Install and torque the spark plugs according to the “Spark Plug Maintenance” instructions in Section 6-3.8.2. Connect the ignition lead wires according to “Ignition Harness Maintenance” instructions in Section 6-3.8.3.

2. Verify lubrication lines, fittings, hoses, screens, and filters are in place prior to pre-oiling.
3. Obtain a clean, one gallon capacity bladder-type pressure pot with 50 psi output pressure (not to exceed 60 psi).
4. Connect the pre-oiler supply hose to the engine oil pressure output (fitting). It may be necessary to disconnect the airframe oil pressure sensor fitting according to the airframe manufacturer's instructions.
5. Remove the rocker covers (temporarily installed in Chapter 17).
6. Open the pre-oiler valve and monitor the engine cylinder rocker areas for oil flow. Depending upon oil temperature, it may take up to 20 minutes to see an indication of oil flow.
7. Close the pre-oiler valve upon verification of oil flow at the rocker arms.
8. Install the rocker covers with new gaskets according to the “Rocker Arm Installation” instructions in Section 17-4.2. Torque the rocker cover fasteners to Appendix B specifications.
9. Disconnect the pre-oiler supply hose and cap; connect the airframe oil pressure sensor to the engine oil pressure output according to the airframe manufacturer's instructions.

WARNING

Do not operate the engine unless the oil is properly serviced.

10. Check the oil level in the sump using the oil gauge rod (dip stick). Verify the engine oil is at the proper level according to instructions in Section 6-3.7.1.

5-3.3.2. Fuel Purge and Leak Check

1. Connect a length of the appropriate size hose to the aircraft fuel supply using an AN union fitting and secure the end of the hose in a properly grounded Type 1 flammable fluid container.

   CAUTION: Ensure the ignition switch is in the OFF position and clear the rotational arc of the propeller before proceeding.

2. Position the fuel selector valve to the ON position.
3. Allow a minimum of one quart (0.94 liter) of fuel to flow through a paper filter until the fuel is free of contaminants.
4. Position the fuel selector valve to the OFF position.
5. Remove the hose and union installed in step 1 from the aircraft fuel supply.
6. Lubricate the male fitting threads with Grade 50 aviation engine oil and connect the aircraft fuel supply to the carburetor inlet fitting; torque the fuel hose “B” nut to Appendix B specifications.
7. Turn the aircraft fuel selector valve to the ON position.
8. Place the mixture control in FULL RICH and the throttle ¼ OPEN.

9. Visually inspect all fuel lines, hoses and fitting for evidence of fuel leakage.
10. Place the mixture control to IDLE CUT-OFF and CLOSE the THROTTLE.
11. Turn the aircraft fuel selector valve to the OFF position.
12. Correct any discrepancies noted.
13. Dispose of the fuel/oil mixture in accordance with Federal and State Hazardous Material Regulations.

5-3.4. Installation Inspection

Perform a "Visual Inspection" according to the instructions in Section 6-3.5 and correct any discrepancies before attempting engine start.

5-3.5. Preflight and Run-up

Perform an Engine Operational Check after completing the engine installation and before performing the flight check according to the Airplane Flight Manual (AFM) or Pilot Operating Handbook (POH). Perform a flight check before releasing the engine for normal service to ensure the installed engine meets the manufacturer's performance and operational specifications.

WARNING

The fuel system must be adjusted after installation in the airframe according to the "Engine Operational Check" instructions in Section 6-3.6 to ensure proper operation. Correct all discrepancies prior to release for flight.

O-200 engines are neither designed, nor approved, for continuous negative or zero "G" operation. Engine Mount loads shall not exceed FAR 23 utility category load factors.

CAUTION: Adhere to the Operating Limits in Section 2-3 during all modes of engine operation, including the Flight Check and Break-In period.

NOTE: Perform a flight check according to instructions in Section 7-2.3 before releasing the engine for normal operations. New and rebuilt engines, and engine with one or more new cylinders or pistons, require a 25-hour break-in. After installation, avoid prolonged ground operation at high power.

1. Perform an "Engine Operational Check" according to instructions in Section 6-3.6.
2. Re-torque the exhaust flange nuts to Appendix B specifications after initial engine run-up, prior to first flight.
3. Perform a "Flight Check" according to instructions in Section 7-2.3.2.

5-4. Engine Installation Drawings

Installation drawings are provided to help the airframe manufacturer determine appropriate fittings and fasteners for airframe interconnect requirements. Pay particular attention to the engine models depicted when referencing drawings for engine installation requirements.

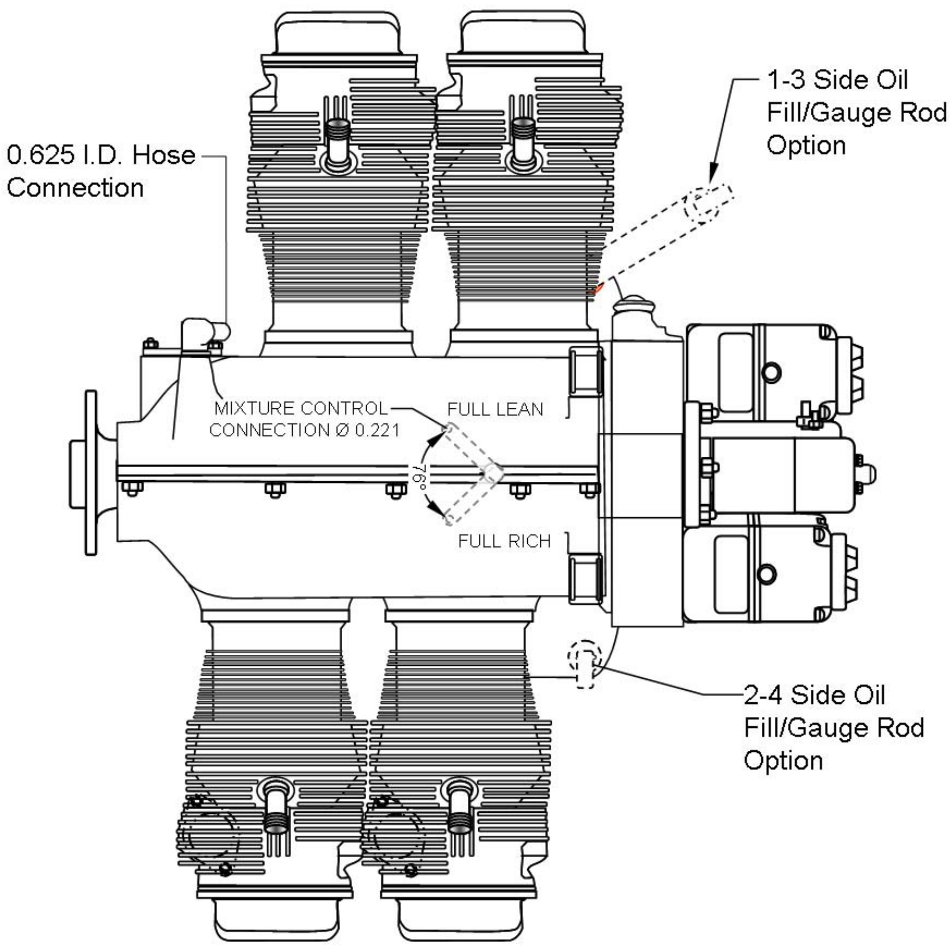


Figure 5-1. O-200-D & X Top View

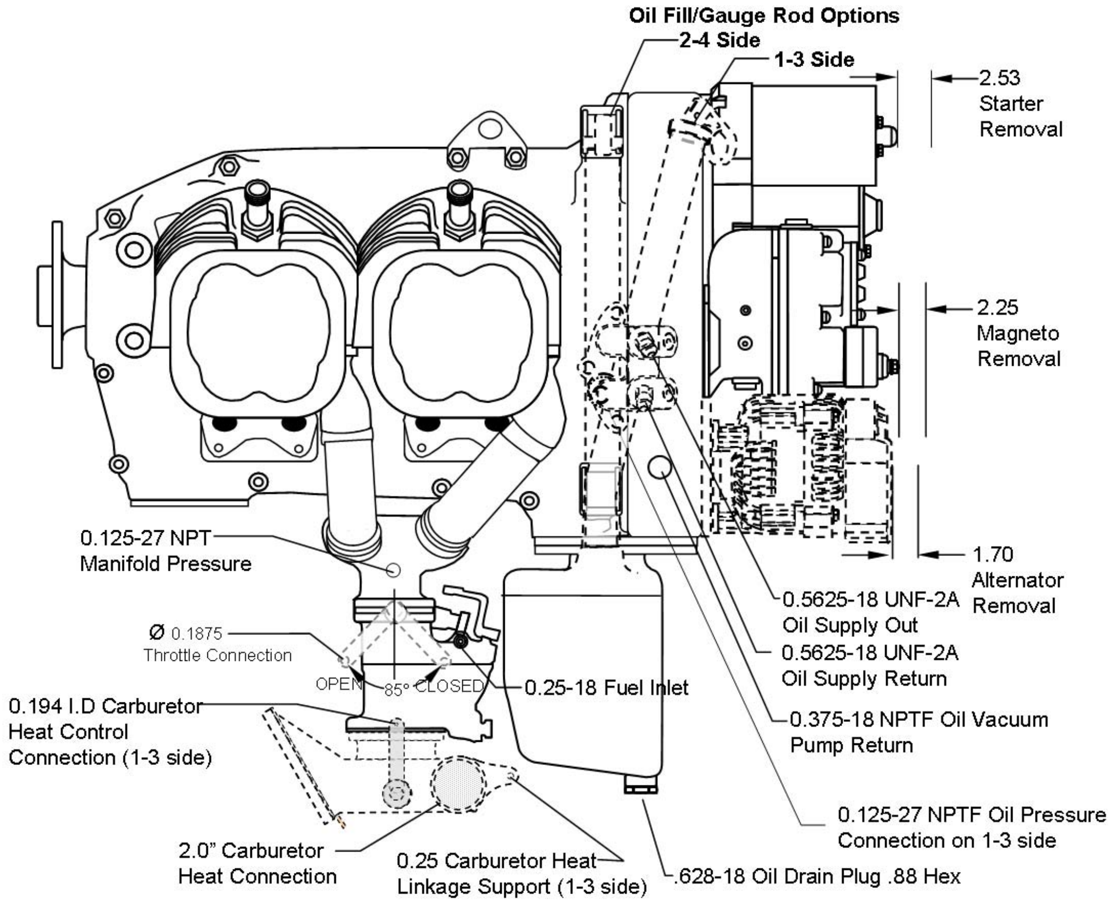


Figure 5-2. O-200-D & X Side View

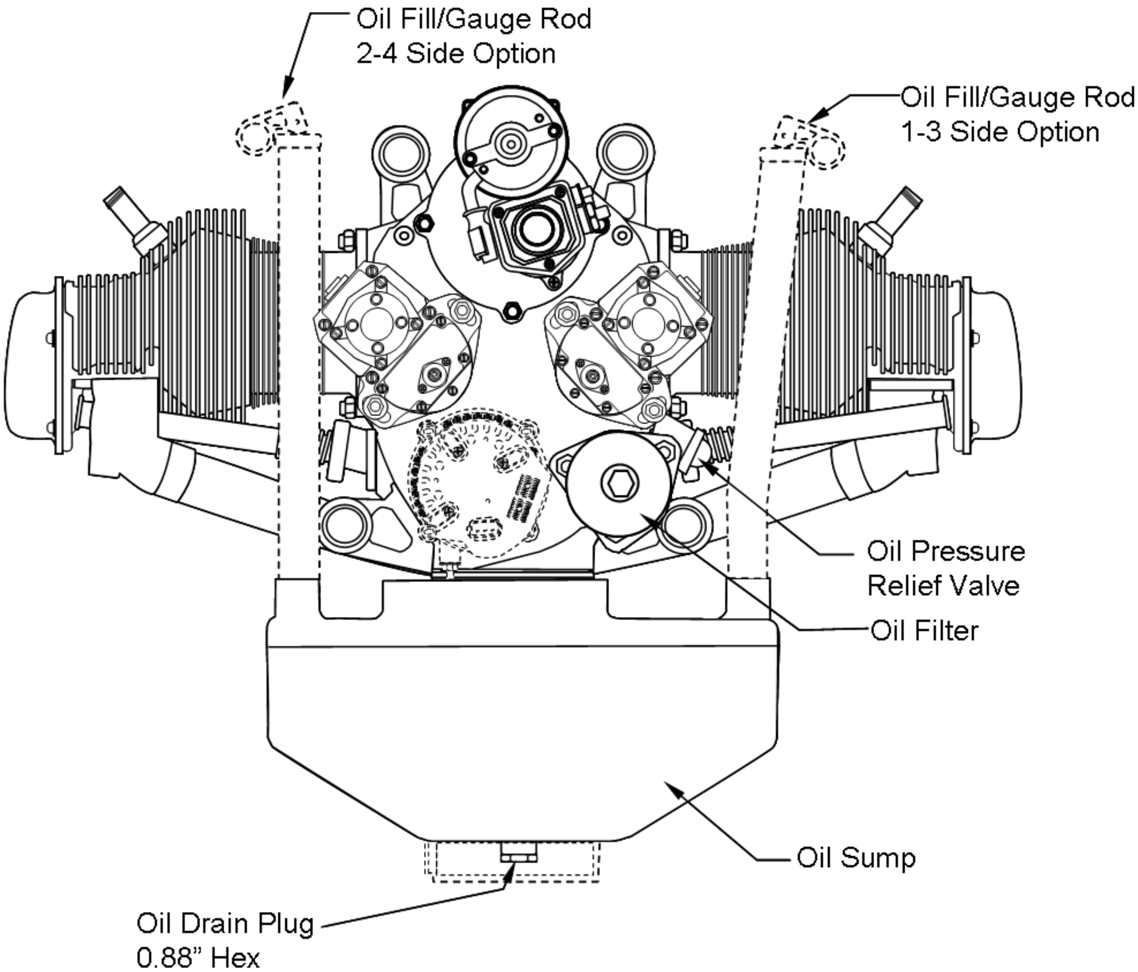


Figure 5-3. O-200-D & X Rear View

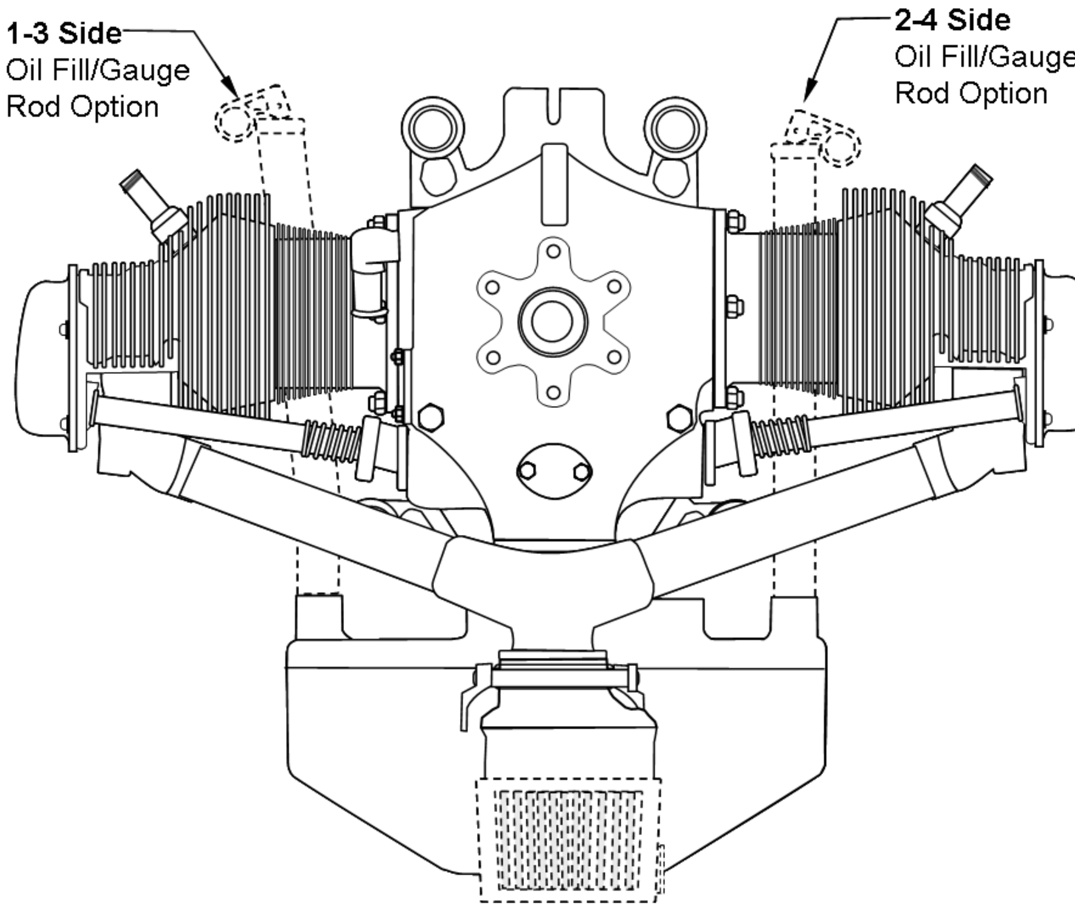


Figure 5-4. O-200-D & X Rear View

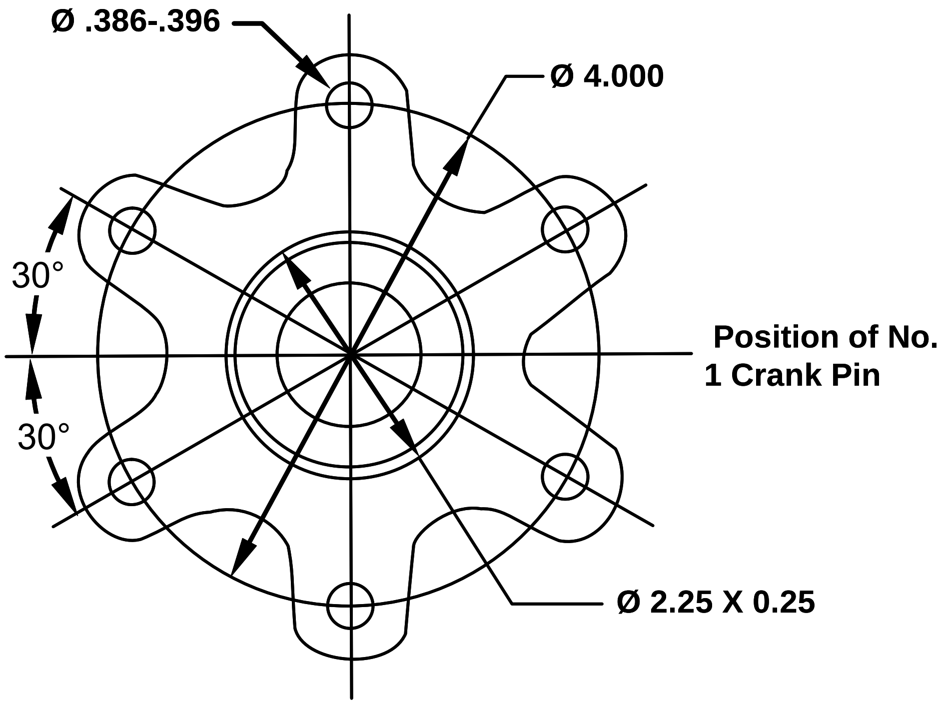


Figure 5-5. Propeller Flange

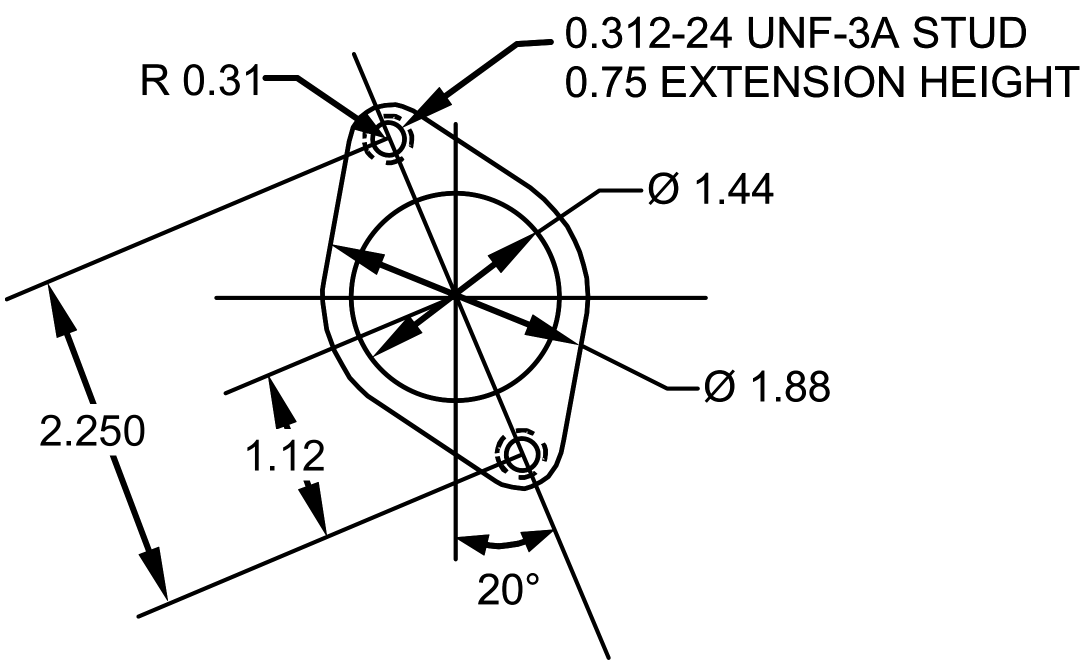


Figure 5-6. Exhaust Flange Dimensions

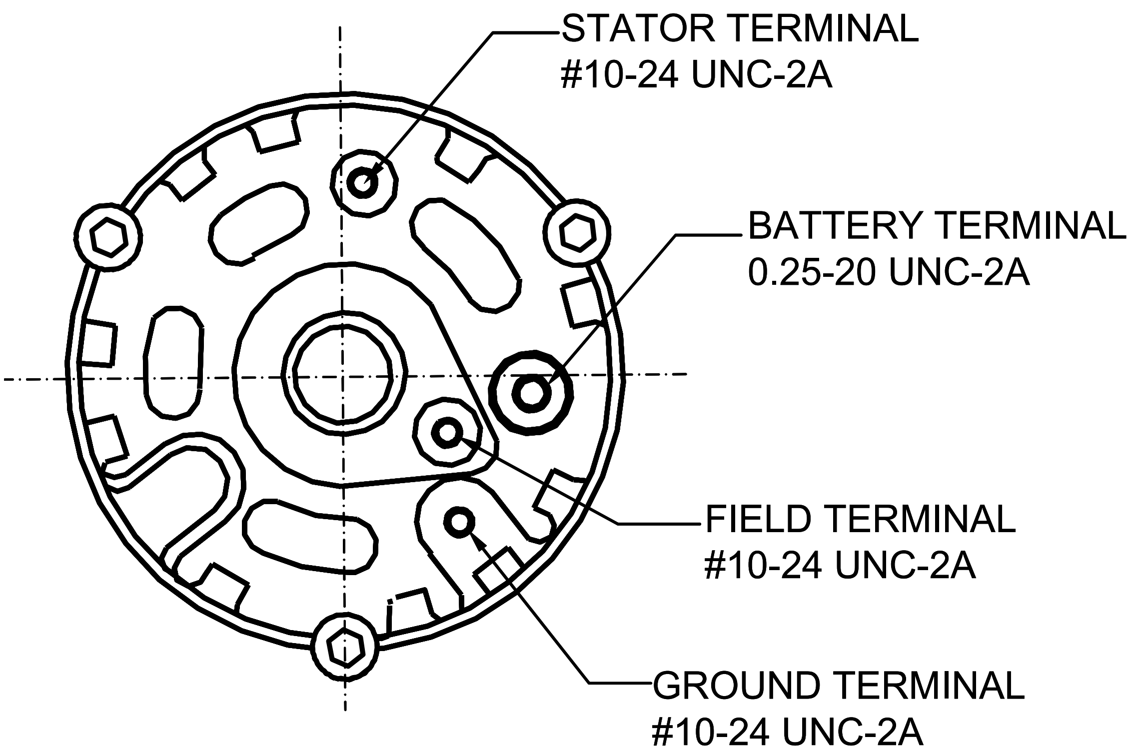


Figure 5-7. 60 Amp Alternator Detail

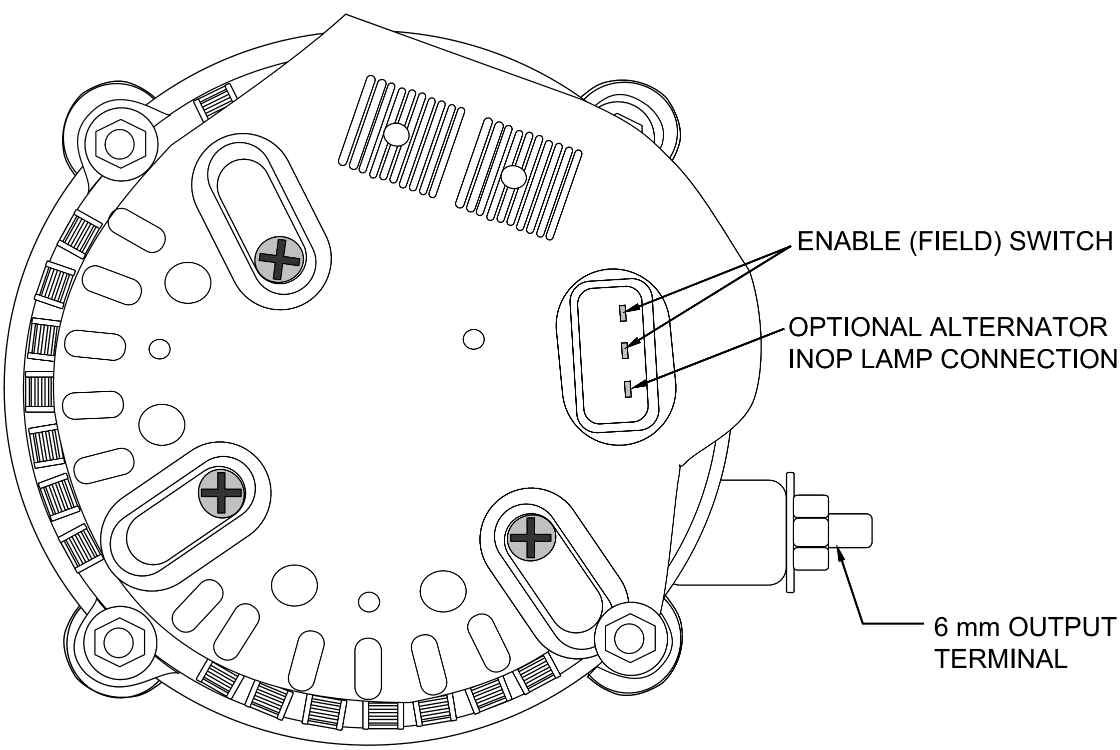
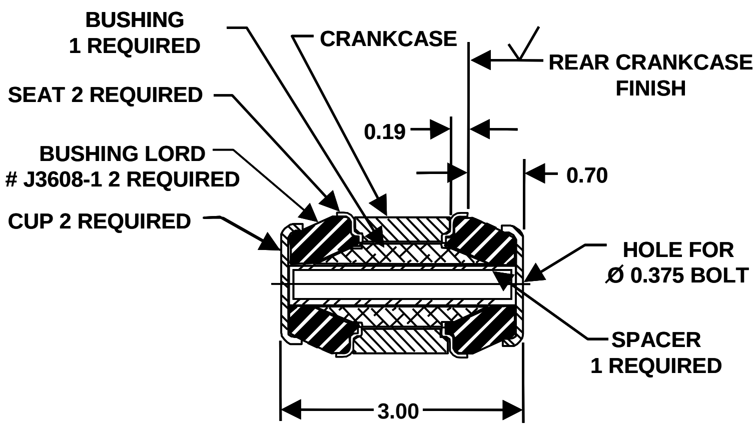
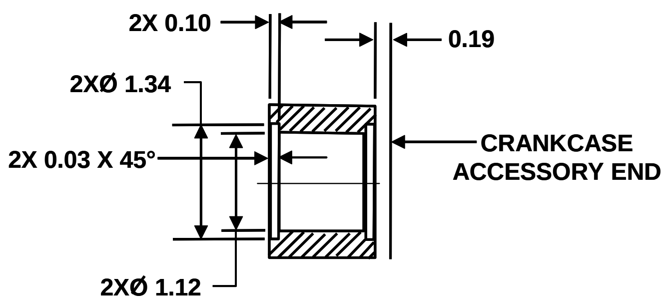


Figure 5-8. 50 Amp Alternator Detail



ENGINE MOUNT ASSEMBLY

4 ASSEMBLIES REQUIRED
BUSHINGS ARE SUPPLIED
WITH ENGINE



ENGINE MOUNT LEG

Figure 5-9. Engine Mounts

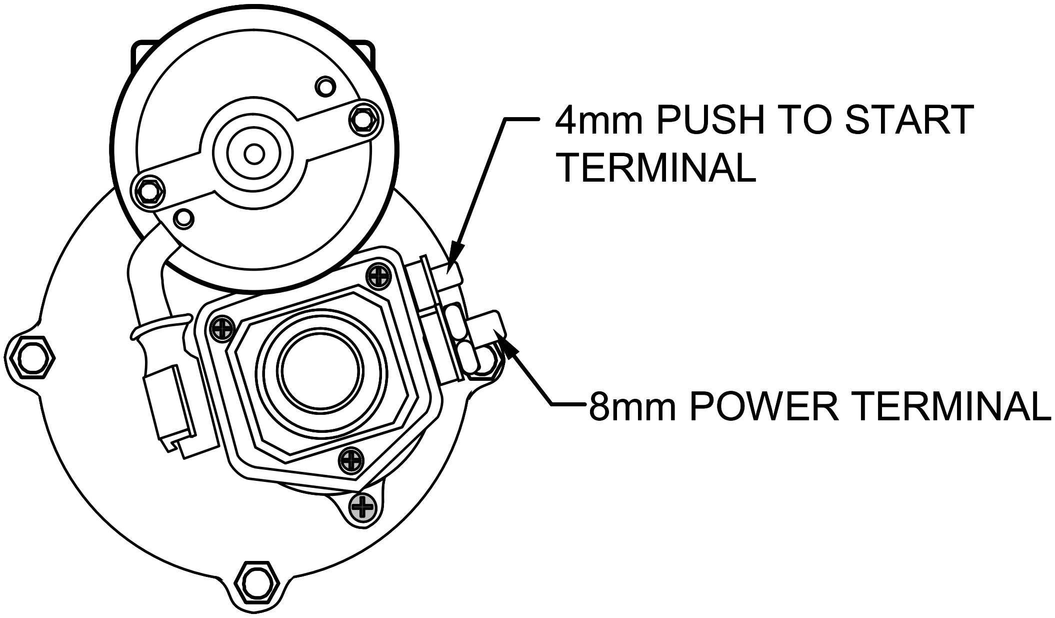


Figure 5-10. Starter Connection Details

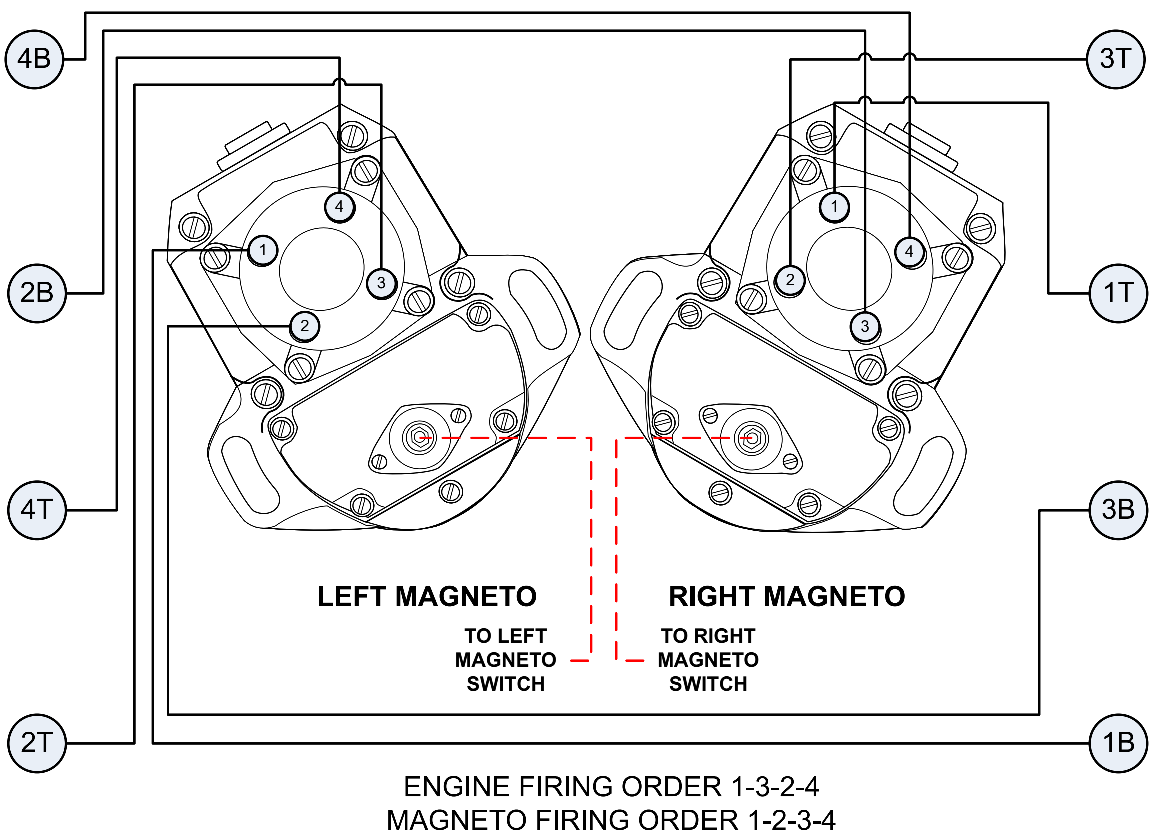
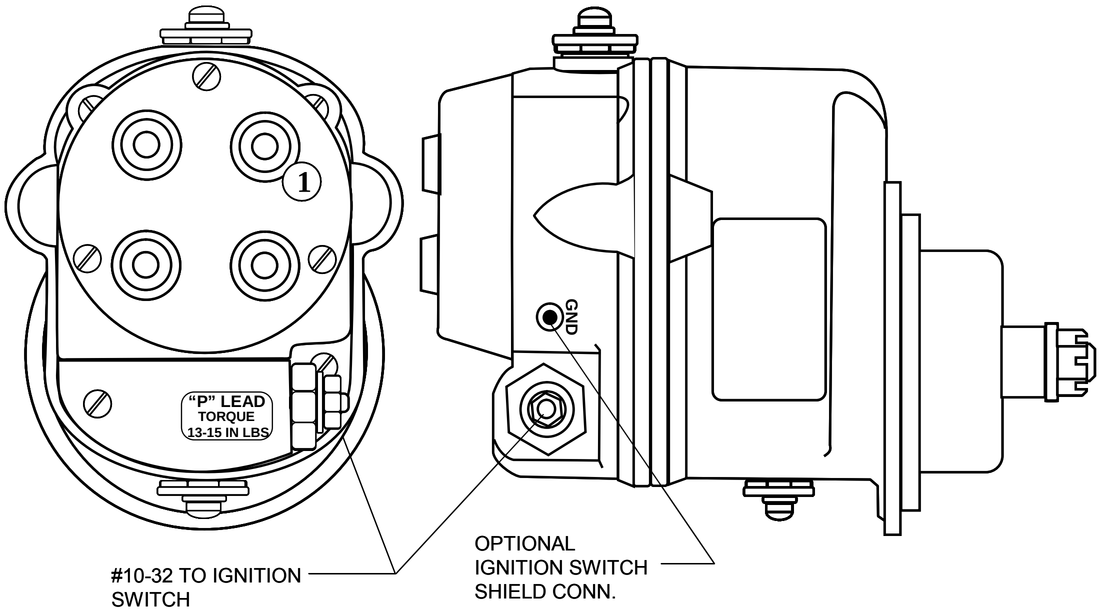
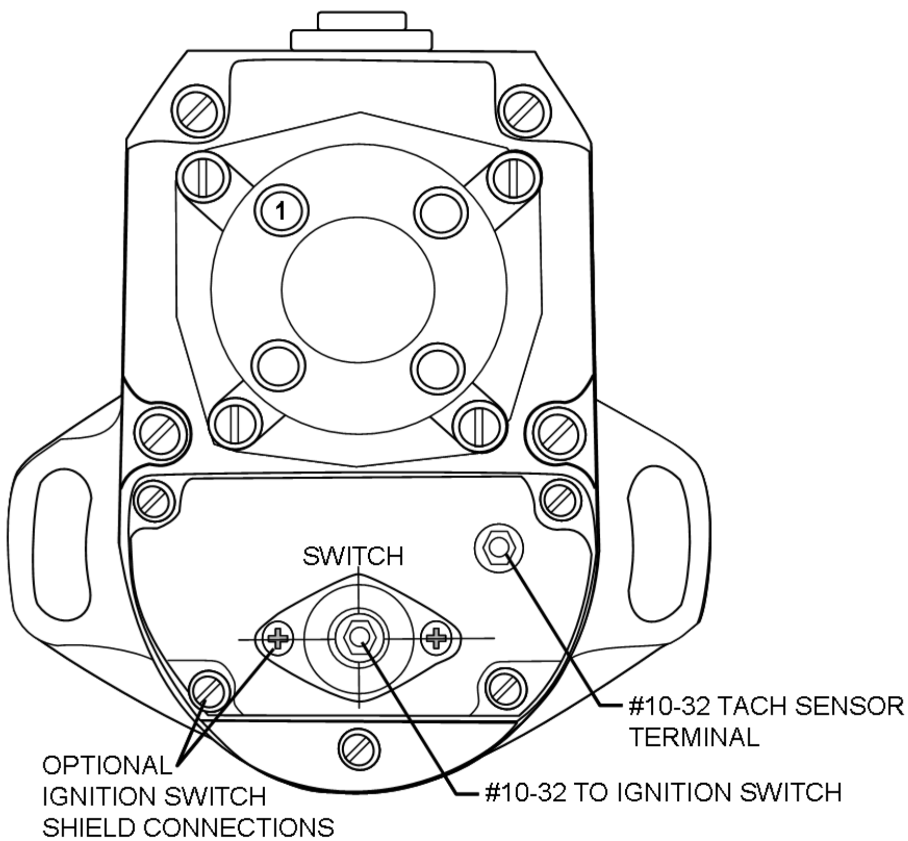


Figure 5-11. Ignition Distribution

Slick Magneto





CONTINENTAL MAGNETO

Figure 5-12. Airframe Ignition Switch Connections to Magneto

Chapter 6. Engine Inspection and Service

6-1. Inspection Program Introduction

Inspections described in this chapter apply only to the Continental Motors engines covered by this manual. Perform the engine inspections according to the instructions provided. Perform aircraft inspections according to the aircraft manufacturer's instructions. Refer to the following sections:

- Section 6-2, "Inspection and Maintenance Schedule"
- Section 6-3, "Scheduled Inspections"
- Section 6-5, "Inspection Checklists"

Some inspections are at predetermined intervals (scheduled) while others are based on circumstance (unscheduled). Engine servicing is performed at scheduled intervals. The first part of this chapter is devoted to scheduled maintenance intervals and associated procedures; unscheduled maintenance instructions follow the scheduled maintenance instructions.

NOTE: Discrepancies discovered by the person conducting the scheduled or unscheduled inspections, even if the discrepancy is not an itemized inspection item, should be corrected upon discovery. Fuel and oil system contamination affects engine performance and service life. If oil or fuel system contamination is discovered, do not limit the correction to the symptom; isolate and correct the source of the contamination, including any residual material left in the engine by the source of the contamination.

6-2. Inspection and Maintenance Schedule

Unless another FAA-approved Inspection Program is established, the Engine Inspection and Maintenance Schedule shows the inspections for the subject engines covered by this manual in their original type design. The inspections described in this chapter apply to the engine and not to the aircraft. Refer to the Airframe Manufacturer's manual for airframe inspection requirements.

The inspections are progressive; commencing from the date the engine is placed in service. The inspection intervals are tracked by Engine Log entries and designated by hours of operation or calendar time, whichever occurs first.

The inspection techniques must be executed consistently for reliability.

6-3. Scheduled Inspections

Scheduled inspections are performed at predetermined intervals to verify the system and subsystem integrity; Scheduled inspections and maintenance are intended to enhance serviceability by discovering minor discrepancies and correcting them before the condition degrades. Scheduled inspections are based on calendar days or operating hours or a combination of both. Scheduled maintenance and service tasks are included in the inspections for convenience.

Table 6-1. Engine Inspection and Maintenance Schedule

NOTE: If operating hours and a calendar period are specified, perform the inspection coincident with the earliest occurrence.			
Interval			
Cumulative Operating Hours	Calendar	Task	Reference
25	6 months	Initial operation inspection after placing a new, rebuilt, or overhauled engine in service, including cylinder replacement. Repeat this inspection after each 25 hours of operation until oil consumption stabilizes.	Section 6-3.1
50	4 months	50-hour engine inspection	Section 6-3.2
50	6 months	Oil and Filter Change (w/replacable filter cartridge)	Section 6-3.7
100	Annual	100-hour engine inspection	Section 6-3.3
500	4 years	Continental Motors magneto inspection	Section 6-3.3
500	---	500-hour inspection	Section 6-3.4
NOTE: At engine TBO, engine accessories, including the alternator, magnetos and fuel system must be replaced with new, serviceable, or overhauled components. No overhaul is permitted on the starter; it must be replaced with a new unit.			
2000	12 years	O-200-D & X Recommended Time Between Overhaul (TBO)	Section 2-3

6-3.1. 25-Hour Initial Operation Inspection

Frequency

- Twenty-five (25) hours or six months (whichever occurs first) after:
  - Installation of a new, rebuilt or overhauled engine
  - Replacement of one or more engine cylinder and/or piston rings
- After every 25 hours of engine operation until oil consumption stabilizes

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

Procedure

WARNING

Correct all fuel or oil leaks. Flammable petroleum products may ignite if exposed to an ignition source.

1. Perform a visual inspection according to instructions in Section 6-3.5; correct any discrepancies.
2. Perform a normal "Engine Start" according to instructions in Section 7-3.2 and "Ground Run-up" according to instructions in Section 7-3.3. When the engine reaches normal operating temperatures, check the following:
   a. Idle RPM .... 700 RPM
   b. Idle/Cutoff Mixture Rise .... 25-50 RPM
   c. Acceleration .... Smooth from IDLE to Wide Open
   If acceleration is rough or the Idle RPM or Idle/Cutoff Mixture Rise is outside the parameters specified in Section 2-3, perform an "Engine Operational Check" according to Section 6-3.6 and adjust the fuel system accordingly.
3. Determine oil consumption by reviewing engine log book service record. Calculate the brake specific oil consumption (BSOC) using the formula in Section 2-3. If oil consumption exceeds the maximum limit, consumption is excessive, proceed to step 3a. If consumption is acceptable, proceed to step 4.
   a. If oil consumption is excessive, troubleshoot according to the "Troubleshooting" instructions in Chapter 8.
   b. Perform a "Cylinder Borescope Inspection" according to the instructions in Section 6-3.9.3.
   c. Service the engine with mineral oil conforming to SAE J-1966 rather than the ashless dispersant oil specified in step 5. Repeat this inspection after 25 hours of operation.

4. Establish and oil analysis profile by collecting an oil sample according to the instructions in Section 6-3.7.4, “Oil Sample Collection” and Section 6-3.7.5, “Oil Trend Monitoring and Spectrographic Oil Analysis.”
5. Change the oil and filter according to instructions in Section 6-3.7.2, “Oil Change.” Fill the oil sump to the proper capacity for the engine model (Section 2-3) with fresh, ashless dispersant aviation engine oil conforming to SAE J-1899 (Section 3-2.1).
6. Remove and inspect the induction air filter. Clean or replace the filter media if necessary. Verify the induction air filter is installed properly; tighten any loose fastening hardware. With the induction air filter installed, verify the induction air filter retainer is properly installed and the attaching hardware is secure in accordance with the aircraft manufacturer's instructions.

6-3.2. 50-Hour Engine Inspection

Frequency

- 25 hours after the 25 hour Initial Operation Inspection
- After every 50 hours of engine operation

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

Procedure

WARNING

Correct all fuel or oil leaks. Flammable petroleum products may ignite if exposed to an ignition source.

1. Perform a “Visual Inspection” according to instructions in Section 6-3.5; correct any discrepancies.
2. Perform a normal “Engine Start” according to instructions in Section 7-3.2 and “Ground Run-up” according to instructions in Section 7-3.3. When the engine reaches normal operating temperatures, check the following:
   a. Idle RPM.. 700 RPM
   b. Idle/Cutoff Mixture Rise............................ 25-50 RPM
   c. Acceleration .... Smooth from IDLE to Wide Open
   If acceleration is rough or the Idle RPM or Idle/Cutoff Mixture Rise are outside the normal operating parameters specified in the “Engine Specifications”in Section 2-3, perform an “Engine Operational Check” according to instructions in Section 6-3.6.

3. Collect an engine oil sample according to the instructions in Section 6-3.7.4, “Oil Sample Collection” and submit it for analysis according to Section 6-3.7.5, “Oil Trend Monitoring and Spectrographic Oil Analysis.”
4. Change the engine oil and filter according to the Section 6-3.7.2, “Oil Change.” Fill the oil sump to the proper capacity for the engine model (Section 2-3) with fresh, ashless dispersant aviation engine oil conforming to SAE J-1899 (Section 3-2.1).
5. Perform an “Induction System Inspection” according to Section 6-3.12.

6-3.3. 100-Hour (Annual) Engine Inspection

Frequency

The 100-Hour Inspection is accomplished under two circumstances:

- After every 100 hours of accumulated engine operation
- Annually, if the engine did not accumulate 100 hours of operation during the calendar year since the last 100-Hour Engine Inspection.

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

Procedure

WARNING

Correct all fuel or oil leaks. Flammable petroleum products may ignite if exposed to an ignition source.

1. Perform a “Visual Inspection” according to instructions in Section 6-3.5; correct any discrepancies.
2. Perform an “Engine Operational Check” according to instructions in Section 6-3.6.
3. Collect an engine oil sample according to the instructions in Section 6-3.7.4, “Oil Sample Collection” and submit it for analysis according to Section 6-3.7.5, “Oil Trend Monitoring and Spectrographic Oil Analysis.”
4. Perform the “Cylinder Inspections” according to instructions in Section 6-3.9. The cylinder inspections consist of multiple inspections and checks including Cylinder Power Stroke Area, Differential Pressure, Borescope, Baffle, Cowling, and Cylinder Mounting Deck Inspections.
5. Perform a “Crankcase Inspection” according to Section 6-3.10.
6. Perform an “Engine Mount Inspection” according to Section 6-3.11.
7. Perform an “Induction System Inspection” according to Section 6-3.12.
8. Perform an “Ignition System Inspection” according to Section 6-3.13.

9. Perform an "Engine Gauge Inspection" according to Section 6-3.14.
10. Perform a "Fuel System Inspection" according to Section 6-3.15.
11. Inspect the exhaust system according to the airframe manufacturer's instructions.
12. Change the engine oil and filter according to the Section 6-3.7.2, "Oil Change." Fill the oil sump to the proper capacity for the engine model (Section 2-3) with fresh, ashless dispersant aviation engine oil conforming to SAE J-1899 (Section 3-2.1).
13. Inspect installed accessories for mounting security, condition, and proper operation according to the aircraft maintenance manual or accessory manufacturer's instructions.
14. Perform an "Engine Operational Check" according to instructions in Section 6-3.6.

6-3.4. 500-Hour Engine Inspection

Frequency

- After each 500 hours of accumulated engine operation

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

Procedure

1. Complete the "100-Hour (Annual) Engine Inspection" requirements in Section Section 6-3.3.
2. Replace aftermarket magnetos with new, rebuilt, or serviceable units. Perform a 500-Hour Magneto Inspection on Continental Motors magnetos according to the Continental Motors Magneto Service Manual (See Section 1-2.2, "Related Publications").
3. Replace paper type induction air filters according to the airframe manufacturer's instructions, regardless of condition.
4. Perform an "Alternator Inspection" according to the instructions in Section 6-3.17. Inspect and test the alternator for proper operation according to the inspection criteria in the alternator manufacturer's maintenance manual.
5. For any other optional engine accessories, refer to the accessory manufacturer's maintenance instructions for inspection criteria.

6-3.5. Visual Inspection

Frequency

- Begin any service interval with a visual inspection

Procedure

1. Verify the engine nacelle is clean and free of fuel leaks, oil leaks, dirt and debris.
2. Inspect all fuel and oil lines for signs of chafing.
3. Inspect the oil cooler (if installed) and oil filter (or screen) for signs of leaks and physical discrepancies.
4. Check the following on the engine for cracks, dents, pitting or physical damage:
   a. External cylinder barrels
   b. Cylinder barrel fins
   c. Areas between and adjacent to the cylinder barrel fins.
   d. External surfaces of the cylinder head, including areas around
      1) Cylinder head fins
      2) Top and bottom spark plug bosses
      3) Crankcase external surfaces
      4) Accessories
      5) Support structures adjacent to accessories

   NOTE: If cylinder discrepancies are discovered during the visual inspection, perform the “Cylinder Inspections” in Section 6-3.9.
5. Check the security of the engine wiring harnesses, including spark plug leads. Inspect the ignition leads for signs of thermal breakdown, chafing, deterioration and proper routing.
6. Replace broken or damaged cushion clamps and stressed or broken wire ties.
7. Check magnetos for external damage, cracks and mounting security. Ensure the ignition plate is securely fastened to the magneto and the ignition wires are properly routed.

   NOTE: For items 8 - 11, inspect for obvious signs of physical damage, wear or deterioration, loose or missing hardware, leaks or foreign material that may hinder normal operation. Correct any discrepancies.
8. Inspect the physical integrity of the fuel system.
9. Inspect the physical integrity of the induction system airbox, ducts, seals and gaskets.
10. Inspect the physical integrity of the lubrication system.
11. Repair any observable damage or deficiency before the aircraft is returned to service. Refer to Chapter 10, Non-Overhaul Repair and Replacement Procedures.

6-3.6. Engine Operational Check

An engine operational check must be performed after any of the following:

- Engine Installation
- Carburetor Replacement, Maintenance or Troubleshooting
- Post-Overhaul
- Return from storage
- After each 100-Hour/Annual, and 500-Hour Inspection

Perform the “Maintenance Preflight Inspection” in Section 6-3.6.1 and gather the required test equipment indicated in Section 6-3.6.2 prior to performing the Engine Operational Check.

WARNING

Flight is prohibited until the engine successfully completes the operational check and a flight check. If, during an operational check or engine warm-up, abnormal operation is observed or leaks occur, do not take-off. Determine the cause of the problem and take corrective action.

Perform the tasks listed in Table 6-2 on a newly installed, repaired or overhauled engine before the releasing the engine for normal flight operations.

Table 6-2. Engine Operation Prerequisites

Sequence	Requirement	Section Reference
1	Prepare the engine for operation	Maintenance Preflight Inspection
2	Check Engine Operation	Engine Operational Check
3	Complete the Engine Operational Checklist	Operational Checklist
4	Perform Flight Check	“Flight Check” in Section 7-2.3[1]

1. and according to the AFM/POH

6-3.6.1. Maintenance Preflight Inspection

Perform the preflight inspection prior to engine operation following engine installation, inspection, troubleshooting, maintenance, or overhaul work to determine if the aircraft and engine are in an airworthy condition.

WARNING

Operation of a malfunctioning engine can result in additional damage to the engine, possible bodily injury or death.

Procedure

1. Turn the Master Power Switch and the Ignition Switch to the OFF position.

WARNING

Ensure the propeller arc is clear of personnel and obstructions before starting the engine.

2. Remove engine cowling according to the airframe manufacturer’s instructions.

WARNING

The engine is certified for operation with 100-LL (Blue) aviation fuel. If the minimum grade required is not available, use the next higher grade. Use of lower octane rated fuel or jet fuel will result in damage to, or destruction of, an engine the first time high power is applied. If the aircraft is inadvertently serviced with the wrong grade of fuel, or jet fuel, drain the fuel system completely and service the fuel tanks according to the aircraft manufacturer's instructions and perform a "Contaminated Fuel System Inspection" inspection according to instructions in Section 6-4.5.

3. If the engine is newly installed or being returned to service after long-term storage, pre-oil the engine according to the instructions in Section 5-3.3.1.
4. Check the engine oil level. Service the oil sump as required with the oil grade specified in Section 3-2.1.
5. Service the aircraft fuel system according to the airframe manufacturer's instructions with the aviation fuel specified in Section 2-3. If the minimum grade required is not available, use the next higher grade available. Never use a lower grade fuel.
6. Verify the accuracy of the tachometer, manifold pressure gauge and fuel flow gauges prior to making any adjustments. Replace faulty gauges.
7. Verify the fuel system components are properly configured (part numbers conform to type design and parts are installed properly).
8. Remove, clean inspect and reinstall the aircraft fuel screens in accordance with airframe manufacturer's instructions.
9. Inspect the airframe induction air filter and alternate air system for condition, operation and cleanliness, in accordance with airframe manufacturer's instructions.
10. Inspect the engine control rod ends for wear, proper installation and security in accordance with airframe manufacturer's instructions.
11. Inspect the throttle and control assembly link rods (where used) for correct installation, security and wear at attach points in accordance with airframe manufacturer's instructions.
12. Lubricate engine control rod ends and fuel system moving parts using the approved lubricants listed in Section 3-2 and the airframe manufacturer's instructions.
13. Visually inspect the engine and nacelle for debris, loose, missing or broken lines, hoses, fittings, clamps and connections. Inspect for restrictions to cooling airflow; remove any debris.
14. Inspect hoses and wire bundles for chafing, loose connections, leaks, and stains.
15. Inspect the exhaust and induction systems for proper installation, security and leaks.
16. Verify the engine crankcase breather is secure, with no breather airflow restrictions.

17. Visually inspect the engine, propeller hub area, and nacelle for evidence of fuel and engine oil leaks. Correct any discrepancies.
18. Visually inspect the engine and nacelle for debris, loose, missing, or broken lines, hoses, fittings, clamps, or connections. Inspect for restrictions to cooling airflow. Remove any debris.
19. Verify all baffles and baffle seals are installed, correctly positioned, and serviceable.
20. Correct all discrepancies prior to engine operation.
21. If the engine has been exposed to temperatures below 20ºF (-7 C) for more than two hours, preheat the engine according to “Engine Preheating” instructions in Section Section 7-4.1.1. If the engine has been exposed to an ambient temperature between 20º to 40ºF (-7º to 4º C), refer to the “Cold Weather Starting Without Preheating” instructions in Section 7-4.1.1.3.

6-3.6.2. Required Test Equipment

- Portable Tachometer
- Digital EGT/CHT Tester to verify engine gauge and sensor accuracy

NOTE: Carburetor adjustments are interactive. Follow the adjustment procedure from beginning to end whenever carburetor adjustments are performed.

6-3.6.3. Carburetor Adjustment

1. Place the Mixture Control in the Full Rich position.

CAUTION: Do not over-tighten the idle mixture adjustment screw. Excessive force will damage the needle valve seat and prohibit satisfactory idle mixture adjustment.

2. Turn the idle mixture adjustment screw (Figure 6-1) clockwise until it touches the seat, then one turn counterclockwise for the initial mixture adjustment.
3. Perform a normal “Engine Start” according to instructions in Section 7-3.2 and “Ground Run-up” according to Section 7-3.3 to allow the engine to warm to normal operating temperatures.

WARNING

Maintain a safe distance from the propeller when making carburetor adjustments. Contact with a moving propeller may cause permanent injury or death!

4. Turn the idle adjustment (throttle stop) screw (Figure 6-1) for 700 RPM engine speed.
5. Turn the idle mixture adjustment screw (Figure 6-1) slowly counterclockwise until the engine begins to run rough from the rich mixture, noting the idle mixture adjustment screw position. Turn the idle mixture adjustment screw slowly clockwise until the engine begins to starve from the lean mixture, noting the idle mixture adjustment screw position. These settings are the carburetor rich and lean extremes of operation. Turn the idle mixture adjustment screw counterclockwise again to the

rich extreme, then clockwise 1/8th turn. Set the idle speed to 700 RPM with the idle adjustment screw.

6. Secure the engine cowling and relocate personnel and equipment remaining outside of the cabin fifty feet to the side of the aircraft.

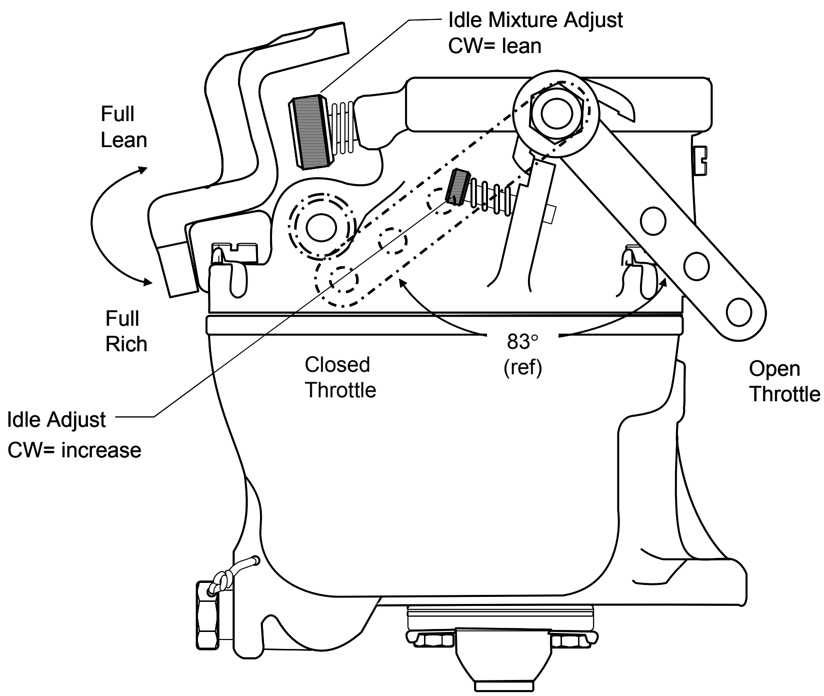


Figure 6-1. Carburetor Controls and Adjustments

7. Gradually advance the throttle to rated RPM. Engine acceleration from idle to wide open throttle should be smooth. If acceleration is sluggish, lean the mixture slightly by turning the idle mixture adjustment screw clockwise in 1/16 turn increments.
8. Smoothly retard the Mixture Control toward IDLE/CUTOFF; observe the engine RPM gauge for a RPM mixture rise of 25-50 RPM. Return the cabin Mixture Control to FULL RICH. If RPM mixture rise is less than 25 RPM, turn the idle mixture adjustment counterclockwise for a richer mixture. If RPM mixture rise is greater than 50 RPM, turn the idle mixture adjustment clockwise for a leaner mixture.
9. Repeat the carburetor idle mixture, mixture RPM rise and idle RPM adjustments until the engine idles smoothly at 700 RPM and accelerates smoothly to wide open throttle.
10. Upon completion of mixture adjustments, set the idle adjust screw to the desired IDLE RPM setting between 675 and 925 RPM.
11. If no further checks are required, record the engine adjustments on a copy of the "Engine Operational Checklist" and proceed to the "Engine Shutdown" instructions in Section 6-3.6.5.

6-3.6.4. Magneto Drop Check

WARNING

Absence of RPM drop during magneto check may be an indication of a faulty ignition circuit (Hot Magneto). Should the propeller be turned by hand (as in during preflight), the engine could inadvertently start and cause personal injury or death. Flight is prohibited until the condition is corrected.

CAUTION: When operating on single ignition, some RPM drop and slight engine roughness as each magneto is switched off should be noted. Excessive (greater than 150 RPM) RPM drop may indicate a faulty magneto or fouled spark plugs.

NOTE: If the engine runs roughly after single magneto operation, increase engine speed to 2200 RPM in the BOTH position and lean the mixture control until the RPM peaks for ten seconds before returning to the full rich position to clear the spark plugs and smooth operation before returning to single magneto operation.

Procedure

1. Start the engine according to the “Engine Start” instructions in Section 7-3.2.
   RESULT: No defects noted. Allow the engine oil to warm to normal (75°F (24°C)) operating temperature.

   CAUTION: Avoid prolonged single magneto operation to preclude spark plug fouling.

2. Throttle.. 1700 RPM
3. Magneto Switch .... R
   RESULT: RPM drop does not exceed 150 RPM; record Left Magneto channel drop result. Maximum allowable RPM drop spread between magneto channels is 75 RPM.
4. Magneto Switch .... BOTH
5. Magneto Switch L
   RESULT: RPM drop does not exceed 150 RPM; record Right Magneto channel drop result. Maximum allowable RPM spread between magneto channels is 75 RPM.
6. Magneto Switch .... BOTH
7. Throttle.. Reduce to IDLE
8. If no further checks are required, proceed to “Engine Shutdown” on page 13.

6-3.6.5. Engine Shutdown

Procedure

1. Perform a normal engine shutdown according to the "Engine Shutdown" instructions in Section 7-3.4.
   a. Throttle.. IDLE
   b. Mixture.. IDLE/CUTOFF
   c. Fuel Selector Valve .... OFF
   d. Ignition Switch... OFF
   e. Master Power Switch .... ON
   f. Remove installed test equipment
2. Perform a visual inspection of the engine and engine compartment, look for indications of fuel or oil leaks. If the engine exhibits malfunctions or fails to meet operating specifications, refer to the "Troubleshooting" instructions in Chapter 8 to correct the discrepancy.
3. Install the engine cowling according to the airframe manufacturer's instructions.

6-3.7. Engine Oil Servicing

The engine lubrication system provides either pressure or splash oil to areas of the engine subject to frictional loading. A certain amount of oil consumption is normal if the plane is flown on a regular basis. However, if oil consumption exceeds the Brake Specific Oil Consumption rate in Section 2-3 or there is an abrupt change in the rate of oil consumption, determine the cause and correct it before further flight.

WARNING

Do not fly the aircraft if oil consumption is abnormal or is suspect; investigate for oil leakage. If no oil leakage is noted, perform the "Cylinder Inspections" in Section 6-3.9.

6-3.7.1. Check and Replenish Engine Oil Level

Maintain the oil sump capacity at the specified level. To check the oil level or add oil, perform the following procedure:

WARNING

Check the oil level before each flight and maintain the engine oil at the specified level. Engine operation with less than the specified capacity will cause engine malfunction or failure.

Petroleum based aviation engine oil is flammable. Follow fire hazard precautions. Store oil in a well-ventilated area away from heat or ignition sources.

1. Unlock and withdraw the oil gauge rod (dipstick) from the fill tube (See Figure 6-2 for engine oil servicing points).
2. Wipe the oil from the oil gauge rod with a clean, lint-free cloth. Avoid getting any lint or debris in the oil sump.
3. Insert the cleaned oil gauge rod back into the oil sump and withdraw the rod again.
4. Verify the oil on the rod touches, but does not pass the oil fill line on the rod.

   NOTE: Oil sump capacities may differ by engine model. Refer to the "Engine Specifications" in Section 2-3.

   CAUTION: When adding oil, completely remove the protective seal from the oil container to prevent the seal from falling into the oil fill port. Prevent any debris from falling into the oil fill port.
5. If more oil is required, add a sufficient quantity of oil meeting the specifications in Section 3-2.1 to reach the fill line on the oil gauge rod.

   NOTE: If oil is spilled on the engine or nacelle during servicing, clean the spilled oil immediately and dispose of oily rags and absorbent materials according to local environmental regulations.
6. Install and lock the oil gauge rod in the fill tube and secure the oil gauge rod by folding the locking lever to the closed position indicated in Figure 6-2 after servicing the engine oil.

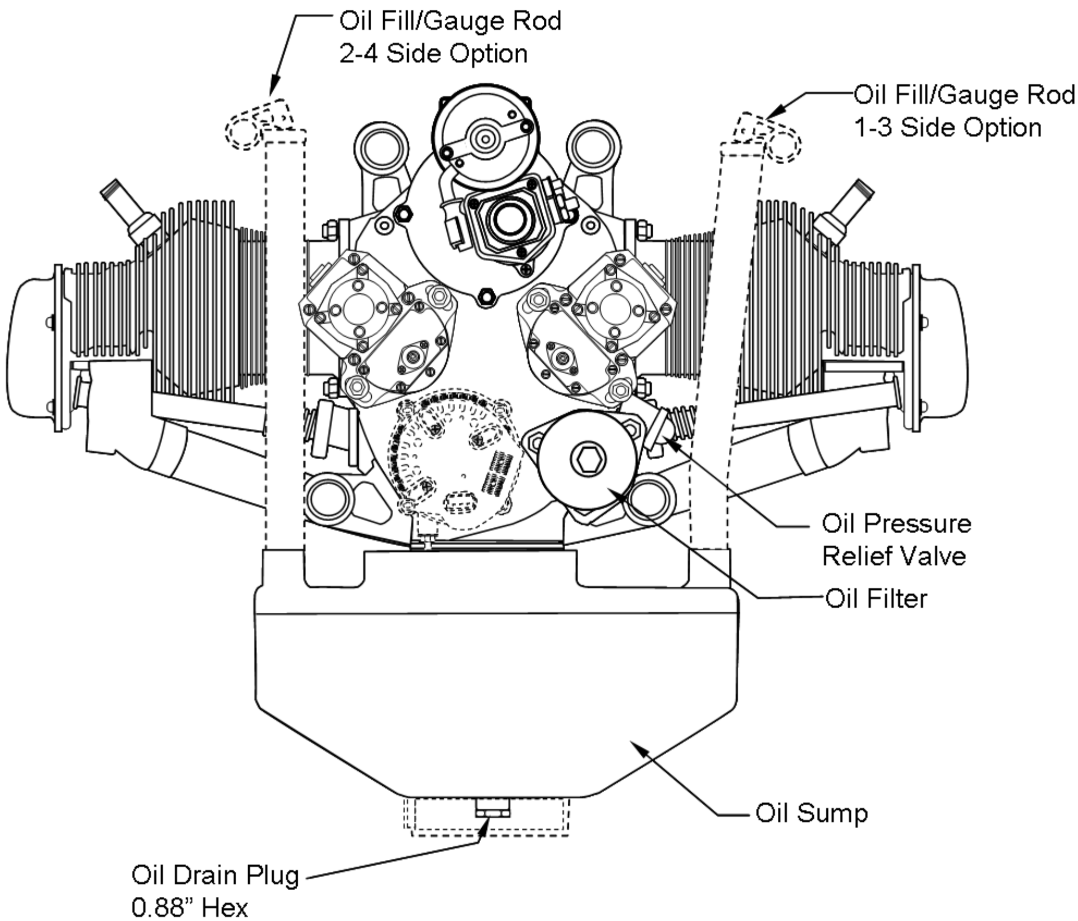


Figure 6-2. O-200-D & X Oil Servicing Points

6-3.7.2. Oil Change

CAUTION: Dispose of used engine oil according to local environmental standards.

Perform an oil change within 30 minutes of engine shutdown (to obtain a useful oil sample) according to the oil changes interval specified in Section 6-2.

NOTE: More frequent oil changes are recommended under extreme usage (flight training, shuttle service, or crop dusting) or adverse (desert or arctic climates) weather conditions.

1. Place a catch basin, approved for collecting oil, beneath the oil sump. Remove the oil sump drain plug (Figure 6-2) and drain the oil into the catch basin.

NOTE: Continental Motors recommends customers submit a sample of the oil drained during each oil change, or if engine trouble is suspected, for spectrographic oil analysis. The first three samples establish the oil analysis trend baseline.

The amount of wear material present in new, rebuilt, or overhauled engines is typically greater during the engine break in period, tapering off during subsequent oil changes. If the amount of wear material does not decrease during subsequent oil changes, note the wear material characteristics (refer to Section 6-3.7.5, “Oil Trend Monitoring and Spectrographic Oil Analysis”) and troubleshoot the engine according to instructions in Chapter 8.

2. Collect an oil sample according to the “Oil Sample Collection” instructions in Section 6-3.7.4. Inspect the oil sump drain plug for evidence of wear material. Metal fragments on the drain plug may indicate excessive wear or part disintegration. Evidence of bronze in the oil sump suggests piston pin bushing loss. Remove the cylinders and inspect the piston pin bushings for proper installation according to instructions in Chapter 10.

3. Remove the oil filter. Cut the oil filter open using an appropriate Oil Filter Can Cutter (Champion Part No. CT-923 (Table 3-1, “Special Tools List”)). Inspect the oil filter for metal debris trapped within the filter to assess the engine condition. If debris is found, wash the filter media in a clean glass container to ascertain content. Use a magnet to check for steel particulate. New, rebuilt, or overhauled engines typically exhibit more wear material on the first and second oil filter change, which is normal. Wear material volume should taper off during subsequent oil changes. If the same quantity of wear material is noted on subsequent oil changes, note the characteristics of the wear material (Section 6-3.7.5, “Oil Trend Monitoring and Spectrographic Oil Analysis”).

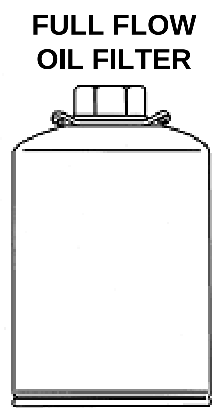


Figure 6-3. Disposable Oil Filter

4. Apply a thin coating of Dow Corning DC-4 compound to the oil filter gasket to prevent gasket material sticking to the mating surface. Install the new oil filter; torque the filter to Appendix B specifications and safety wire the filter according to instructions in Section C-4.

5. Install the oil drain plug with a new crush gasket; torque the drain plug to Appendix B specifications and safety wire the drain plug according to instructions in Section C-4.

6. Add fresh oil and check the oil level according to instructions in Section 6-3.7.1.

7. Check for oil leaks according to instructions in Section 6-3.7.3.

6-3.7.3. Check for Oil Leaks

WARNING

Keep the engine compartment, nacelle, and fuselage adjacent to the nacelle clean to enable detection of oil leaks.

Procedure

1. Perform a normal "Engine Start" according to instructions in Section 7-3.2 and "Ground Run-up" according to Section 7-3.3 to allow the engine to warm to normal operating temperatures. Document engine oil pressure and temperature.
2. Shut down the engine according to the "Engine Shutdown" instructions in Section 7-3.4.
3. Check the engine nacelle, engine compartment, and adjacent area for oil leaks. If leaks are found, determine the source and correct the cause of the leak(s).
4. Check the oil level in the sump according to Section 6-3.7.1, "Check and Replenish Engine Oil Level."

6-3.7.4. Oil Sample Collection

Oil samples may be collected during the oil change procedure, before new oil is added or between oil changes. The oil sample must be taken after the engine has been operated within normal (Section 2-3, "Engine Specifications") operating limits, including normal cruise and maximum power settings for at least 30 minutes.

NOTE: Collect oil samples within 30 minutes of engine shutdown.

Procedure

1. Clean any dirt or debris from around the oil sump drain plug.
2. Use the following sample collection devices:
   a. Sampling tube and/or funnel
   b. Sample vial

   NOTE: Oil sampling equipment must be clean and free of debris, foreign material, or residue to ensure sample integrity and accurate chemical analysis.
3. Collect one to two ounces (30 to 60 ml) of oil from one of the following sample collection locations consistently:
   a. Midstream of the oil drain flow after 1/3 of the oil has drained from the oil sump
   b. From the oil fill port, at least two to three inches above the bottom of the oil sump.

   NOTE: Never take an oil sample from the bottom of the oil sump or the oil filter canister.
4. Fill the oil sample tube or vial 3/4 full and tighten the cap.
5. Label the oil sample vial with the date the sample was taken, the serial number of engine it was taken from, and the submitter's name and company.

Submit the oil sample to the same laboratory for analysis (unless otherwise directed). The following laboratories provide thorough, detailed oil analysis and reporting:

Aviation Oil Analysis
3319 Earll Drive
Phoenix, AZ 85038

Aviation Laboratories
910 Maria Street
Kenner, LA 70062

6-3.7.5. Oil Trend Monitoring and Spectrographic Oil Analysis

Spectrographic oil analysis identifies concentration, in parts per million (PPM), of wear material in an oil sample (see Section 6-3.7.4) collected during an oil change. Analysis begins with the first oil change sample, and continues with successive oil changes. The first samples establish a baseline. Subsequent samples, taken over time establish trends. These trends help determine if wear material is deviating from the baseline. (Establishment of the baseline and ensuing wear trends assume analysis is done by the same laboratory using the same method of analysis.)

Spectrographic oil analysis results will vary for reasons exclusive of engine condition. Chemical composition of engine oils vary by manufacturer. For consistent, meaningful analysis, service the engine with the appropriate grade of aviation engine oil from the same manufacturer, collect engine oil samples at regular intervals and submit the samples to the same laboratory for analysis.

6-3.8. Ignition System Maintenance

6-3.8.1. Magneto Timing

Equipment Required

- Eastern Technology Corp. Model E-25 Timing Indicator (or equivalent)
- Top Dead Center Locator
- Eastern Technology Corp. Model E50 timing light (or equivalent)

6-3.8.1.1. Crankshaft Top Dead Center Alignment

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts. Do not stand or place equipment within the arc of the propeller. Attach a “Hot Magneto-Do Not Turn” sign to the propeller.

CAUTION: Incorrect timing, in addition to a rough running engine, can lead to detonation, pre-ignition, possible internal engine damage, or engine failure.

Gravity affects the timing indicator pendulum position. Prior to checking or adjusting engine timing, level the aircraft (engine).

1. Place the fuel selector valve in the OFF position.

2. Turn the ignition switch to the OFF position. Disconnect the aircraft battery according to the airframe manufacturer's instructions.
3. Remove the upper spark plugs from each cylinder.
4. Find the No.1 cylinder compression stroke by placing a finger over the spark plug hole and rotating the crankshaft in the direction of normal rotation. When the cylinder is on the compression stroke, the valves will be closed and pressure will build as the piston moves to the top of the cylinder. Pressure buildup in the cylinder can be felt at your fingertip.
5. When the crankshaft is positioned to place the No. 1 cylinder on the compression stroke, install the top dead center (TDC) locator (Figure 6-4) in the No. 1 cylinder spark plug hole.

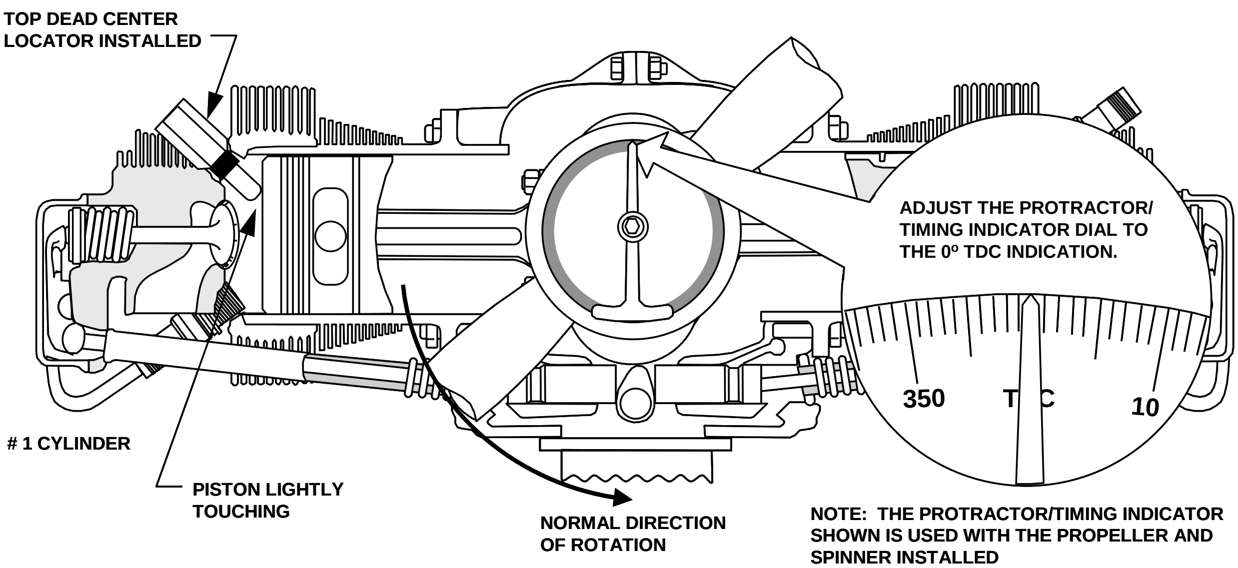


Figure 6-4. Installed Timing Disk and TDC Locator

NOTE: Ensure the timing disk is securely fastened to the propeller to prevent movement during engine timing.

6. Securely install the timing disk indicator on the crankshaft flange, propeller spinner or propeller hub using the supplied elastic bands.
7. Turn propeller slowly in the direction of normal rotation until the piston lightly touches the top dead center locator.
8. Rotate the timing disc until the Top Dead Center (TDC) mark on the timing disk aligns with the weighted pendulum pointer.

9. Slowly rotate the crankshaft opposite of the direction of normal rotation until the piston lightly touches the top dead center locator (Figure 6-5).

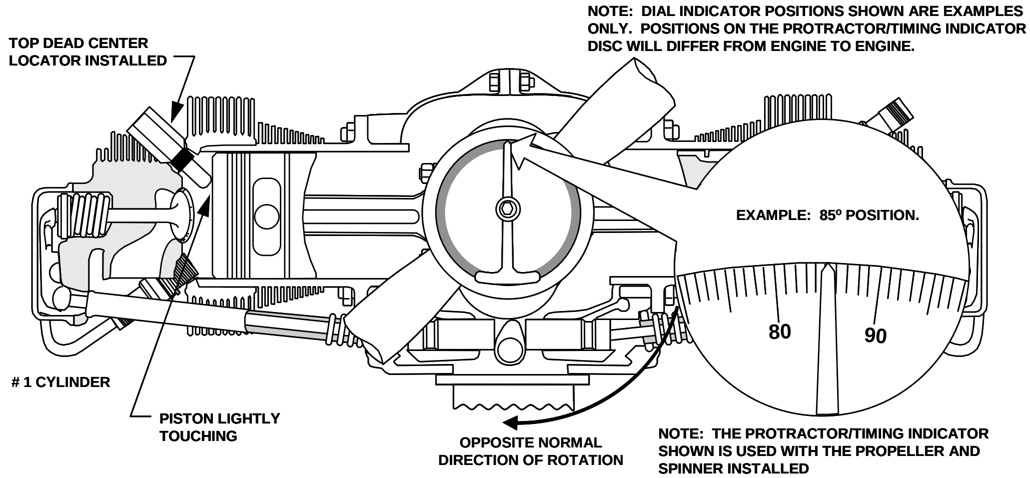


Figure 6-5. No. 1 Cylinder Positioned at Top of Intake Stroke

10. Determine the difference between TDC and the current pointer indication (Figure 6-5) and divide by two; turn the timing disk to align the pointer with the resulting number (Figure 6-6), without turning the timing indicator base.

11. Rotate the crankshaft in the direction of normal rotation on the compression stroke until the pointer aligns with the 0° mark. On magnetos equipped with impulse couplings, continue turning the crankshaft in the direction of normal rotation until each impulse coupling trips. Couplings may trip a few degrees on either side of TDC. If one or both couplings trip after TDC, rotate the crankshaft opposite of the direction of normal rotation a few degrees before TDC, then back in the direction of normal rotation toward TDC. The crankshaft is now positioned at top dead center (TDC) of the No. 1 cylinder compression stroke.

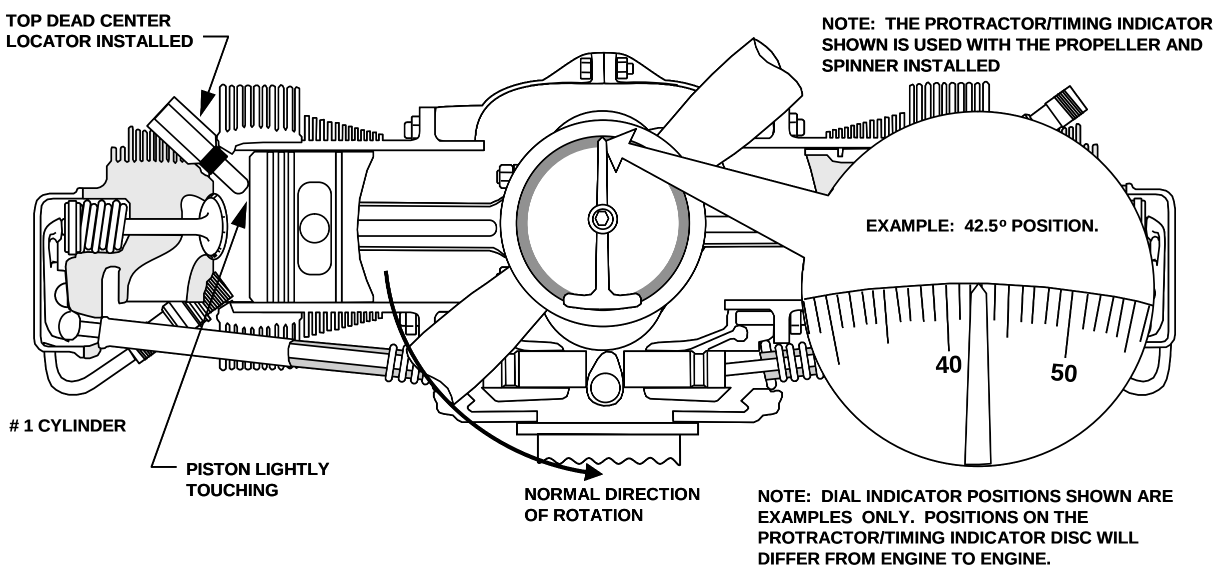


Figure 6-6. Crankshaft Positioned at TDC for No. 1 Cylinder

12. Remove the Top Dead Center locator from the No.1 cylinder (Figure 6-7).

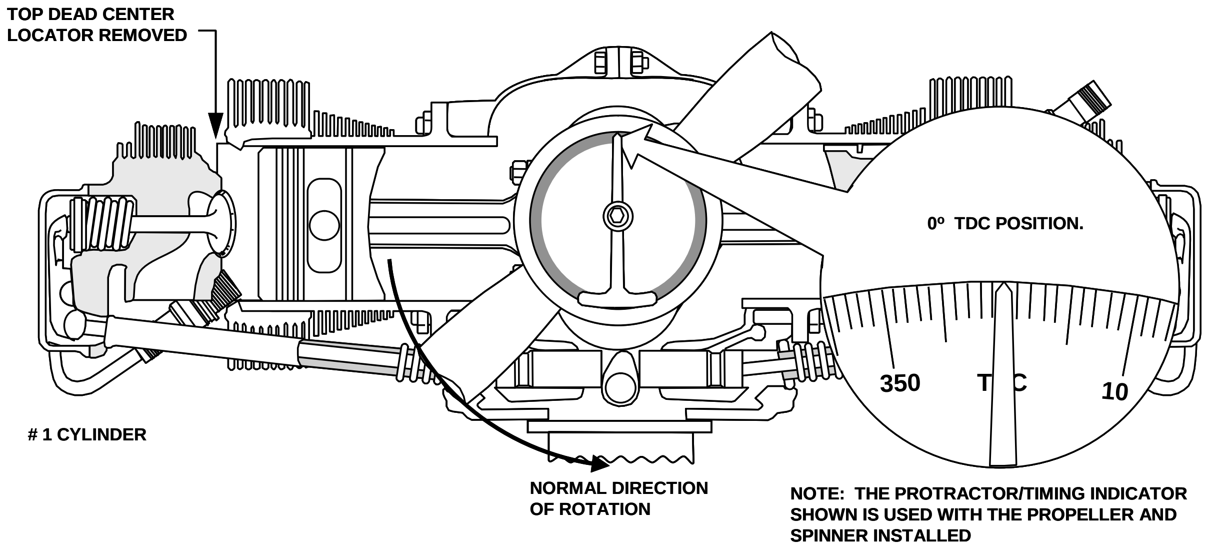


Figure 6-7. Cylinder No. 1 at Top of Compression Stroke

13. Turn the crankshaft in the opposite of the direction of normal rotation past the specified magneto timing specification to remove gear backlash. Turn the crankshaft in the direction of normal rotation until the pointer aligns with the engine timing specification (Section 2-3) on the timing disk (Figure 6-8). The engine is now prepared for magneto removal, installation or magneto to engine timing.

6-3.8.1.2. Magneto to Engine Timing

Procedure

1. Complete Section 6-3.8.1.1, "Crankshaft Top Dead Center Alignment."

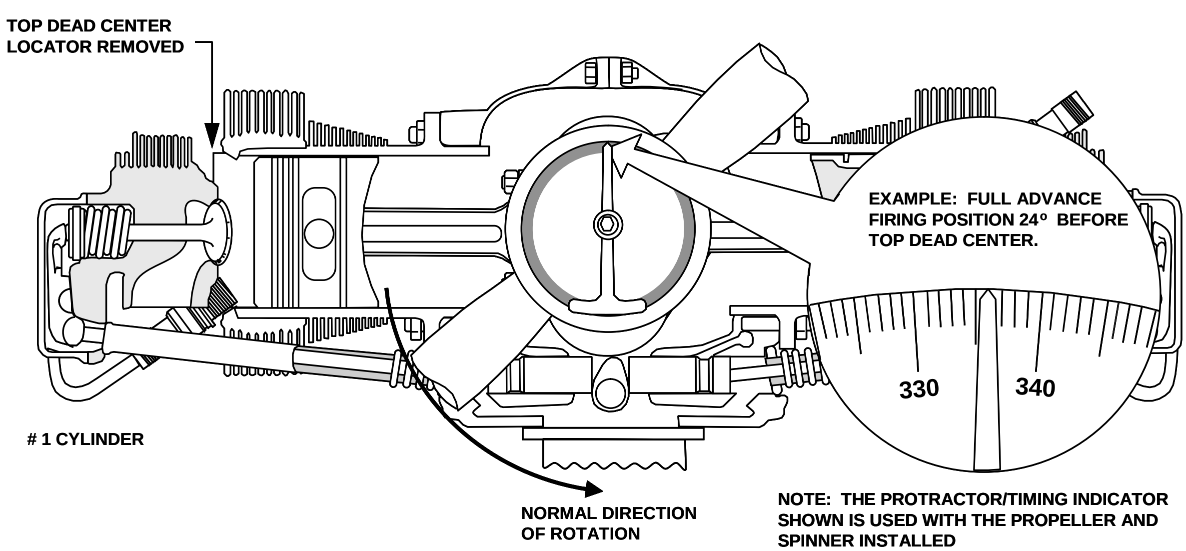


Figure 6-8. Crankshaft Positioned at No. 1 Cylinder Full Advance Timing Position

NOTE: Be familiar with the test equipment function prior to use. Some timing lights indicate proper ignition timing by illuminating a lamp; other models illuminate a lamp until the magneto cam lobe opens the circuit and turns the lamp off while other timing indicators use an audible signal to indicate timing status.

2. Disconnect the P-leads from the magnetos. Connect a timing light right lead to the right magneto ground terminal and the left lead to the left magneto ground terminal. Connect the timing light ground lead to a suitable ground on the engine such as an unpainted bolt or stud.

   NOTE: Engines equipped with impulse coupling magnetos must be turned clockwise past the impulse coupling trip point prior to centering the pointer at engine timing mark.

3. With the crankshaft in the correct timing position, turn the crankshaft a few degrees in the opposite direction of normal rotation before the point of ignition to clear valve backlash. Turn the crankshaft in the direction of normal rotation toward the point of ignition and observe the timing light as the needle approaches the proper engine timing setting. As the pointer aligns with the correct ignition timing, the timing light should indicate proper timing. Lightly tap the end of the pointer with a finger to verify the pointer position.
4. If the timing light fails to illuminate, loosen the nuts securing the magneto to the mounting flange and rotate the magneto to the left or right in the mount until the lamp illuminates. If magneto timing adjustment is not possible, replace the suspect magneto.
5. Remove the protractor and timing disk from the propeller flange, spinner or propeller hub. Reconnect the ground switch leads to the magneto.
6. Inspect the spark plugs according to Section 6-3.8.2.
7. Inspect the ignition harness according to Section 6-3.8.3.
8. Connect the aircraft battery according to the aircraft manufacturer’s instructions.

6-3.8.2. Spark Plug Maintenance

1. Remove the ignition harness leads from all spark plugs.
2. Remove the upper and lower spark plug from each cylinder. Mark each plug's installed location during removal.
3. Inspect plug condition in comparison to Figure 6-9 for serviceability. Discard spark plugs that fail to meet the “normal electrode condition” characteristics.
4. Remove and discard the copper gaskets from all reusable spark plugs.
5. If a new spark plug is required, select one from the list in Table 6-3, or the most current version of SIL03-2.

Table 6-3. O-200 Approved Spark Plug List

Applicability	Manufacturer Part No.	Part Number	Barrel Size	Electrode Gap
CHAMPION				
D & X	REM40E	627643	5/8”-24	.016”-.021”
D & X	REM437BY	655707	5/8”-24	.016”-.021”
AUTOLITE by UNISON				
D & X	UREM437BY	656082	5/8”-24	.016”-.021”
D & X	UREM40E	655899	5/8”-24	.016”-.021”

6. Clean the spark plugs (new or re-used) according to the cleaning instructions in Section 14-1. Set the spark plug gap to the spark plug manufacturer's data recommended setting for the spark plug part number.
7. Install new copper gaskets on all (new and reusable) spark plugs.

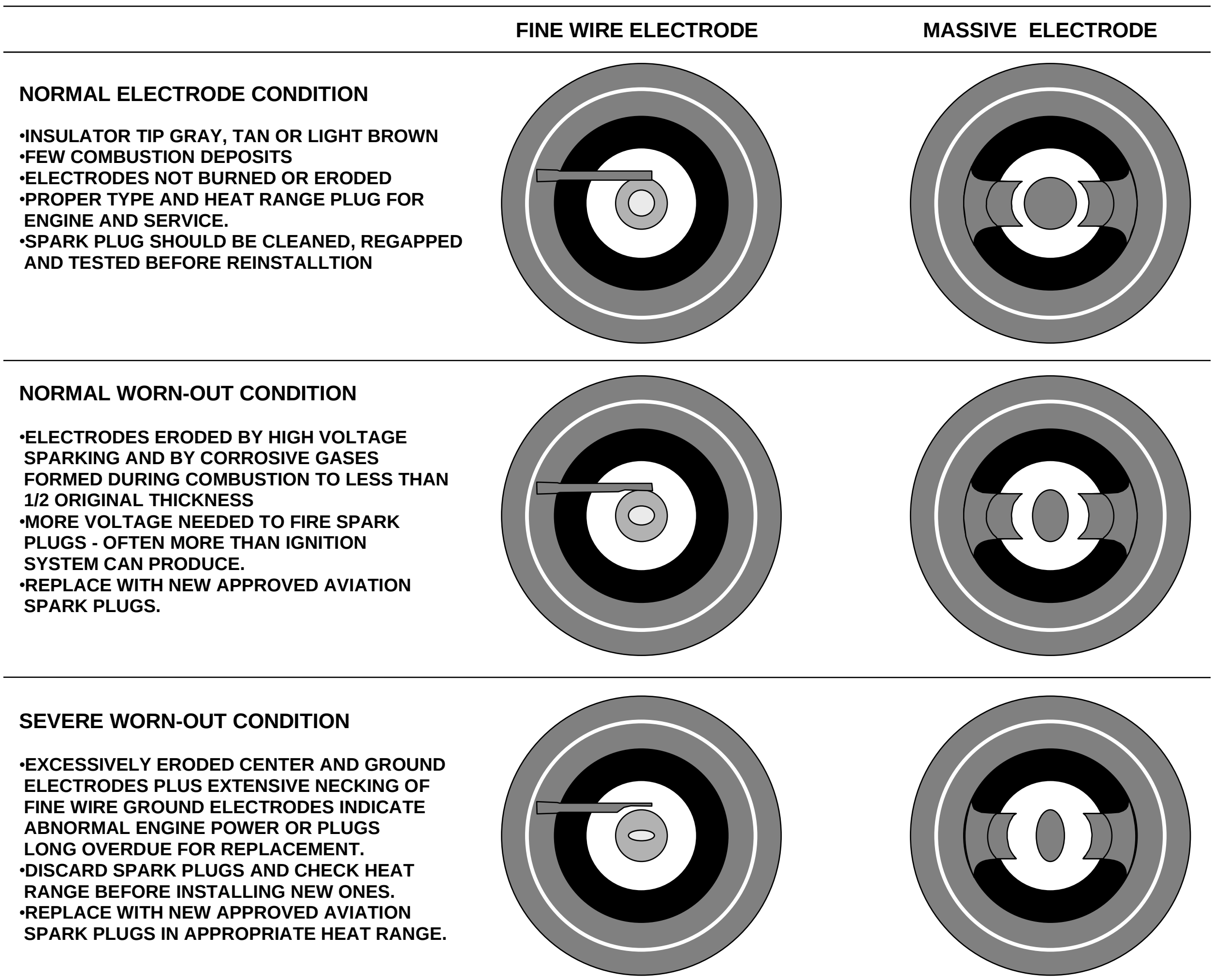
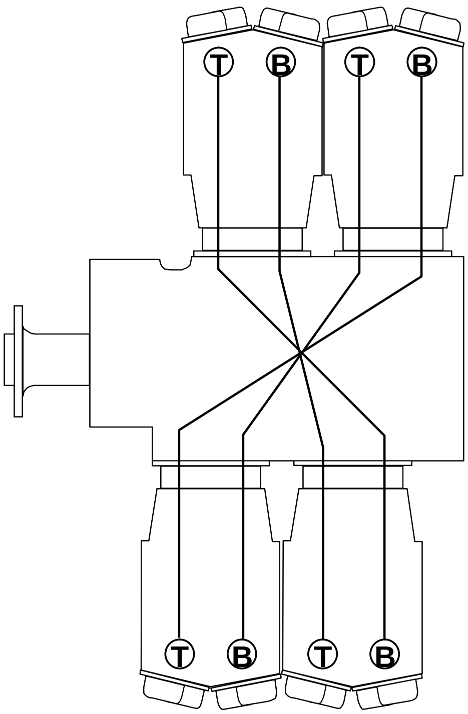


Figure 6-9. Spark Plug Inspection Criteria

8. Refer to the spark plug rotation chart (Figure 6-10); mark serviceable spark plugs with the respective “TO” cylinder number. For all remaining locations, replace with a new spark plug.



Reduce wear of spark plug electrodes due to constant polarity, either negative or positive, by reversing bottom (B) spark plugs with top (T) spark plugs per chart.

CYL NO.		CYL NO.
1---T	TO	4---B
1---B	TO	4---T
2---T	TO	3---B
2---B	TO	3---T
3---T	TO	2---B
3---B	TO	2---T
4---T	TO	1---B
4---B	TO	1---T

Figure 6-10. Spark Plug Rotation Chart

9. Sparingly apply the spark plug manufacturer’s recommended thread lubricant to all except the first row of threads on the spark plug.
10. Thread each spark plug by hand into the engine cylinder head within one to two threads of the gasket. If the spark plug cannot be easily turned, clean the cylinder or spark plug threads.
11. Torque the spark plugs to Appendix B specifications using a currently calibrated torque wrench and six-point deep well socket.

6-3.8.3. Ignition Harness Maintenance

NOTE: Cable outlet plates are keyed to attach to the magneto in only one position. No. 1 position marked on the magneto cover aligns with the firing position for cylinder number 1.

1. Inspect the spark plug leads for chafing, heat damage, wear, and cracking. Replace damaged cables, if repair kits are available or replace the harness.
2. Clean and spray the mating surfaces with MS-122AD spray before installing harness on magneto.

3. Install and tighten three (Slick) or four (Continental Motors) screws around the cable outlet plate alternately to seat the cover squarely on magneto. Torque the screws to Appendix B specifications.
4. Refer to the airframe manufacturer's instructions for specific ignition harness routing through baffling and cushion clamp placement. Observe the following when installing the harness on an engine:
   a. Support leads with the necessary clamps and cable ties to prevent whipping or chafing action. Inter-cylinder baffles are fitted with nut plates to secure ignition harness clamps.
   b. Refer to the airframe manufacturer’s instructions for routing the ignition through baffling and cushion clamp placement; ensure the ignition harness is not routed in close proximity to the exhaust system.
   c. To prevent the sleeves from sticking and minimize twisting of the ferrule, coat the insulating sleeves (see Figure 6-11) with MS-122AD spray.

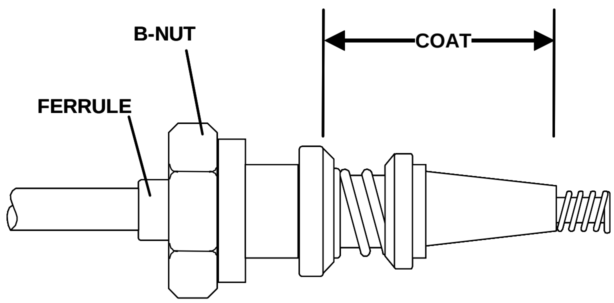


Figure 6-11. Lubricate Ignition Wire with MS-122AD

   d. Apply a light coat of Shell Alvania No. 2 lubricant to the contact point between the nut seat and ferrule on each ignition lead.
   e. Route the ignition leads to the cylinder number and position found on the labels on the loose end of the cable. If the labels are missing or unclear, refer to the ignition harness routing illustrations (Figure 6-13). Secure the ignition leads to the rocker covers using the ignition lead cushion clamps and rocker cover screws.
5. If the ignition harness includes elbow clamps, install the elbow clamps (Figure 6-12) on the harnesses at the ferrule to prevent harness strain; secure clamp with screw and lock washer.

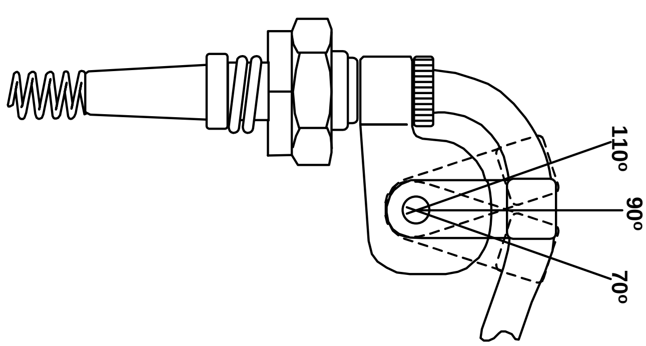


Figure 6-12. Ignition Wire Strain Relief

6. Wipe the spark plug lead connector clean using a lint-free cloth moistened with MEK, acetone, wood alcohol, or naphtha.

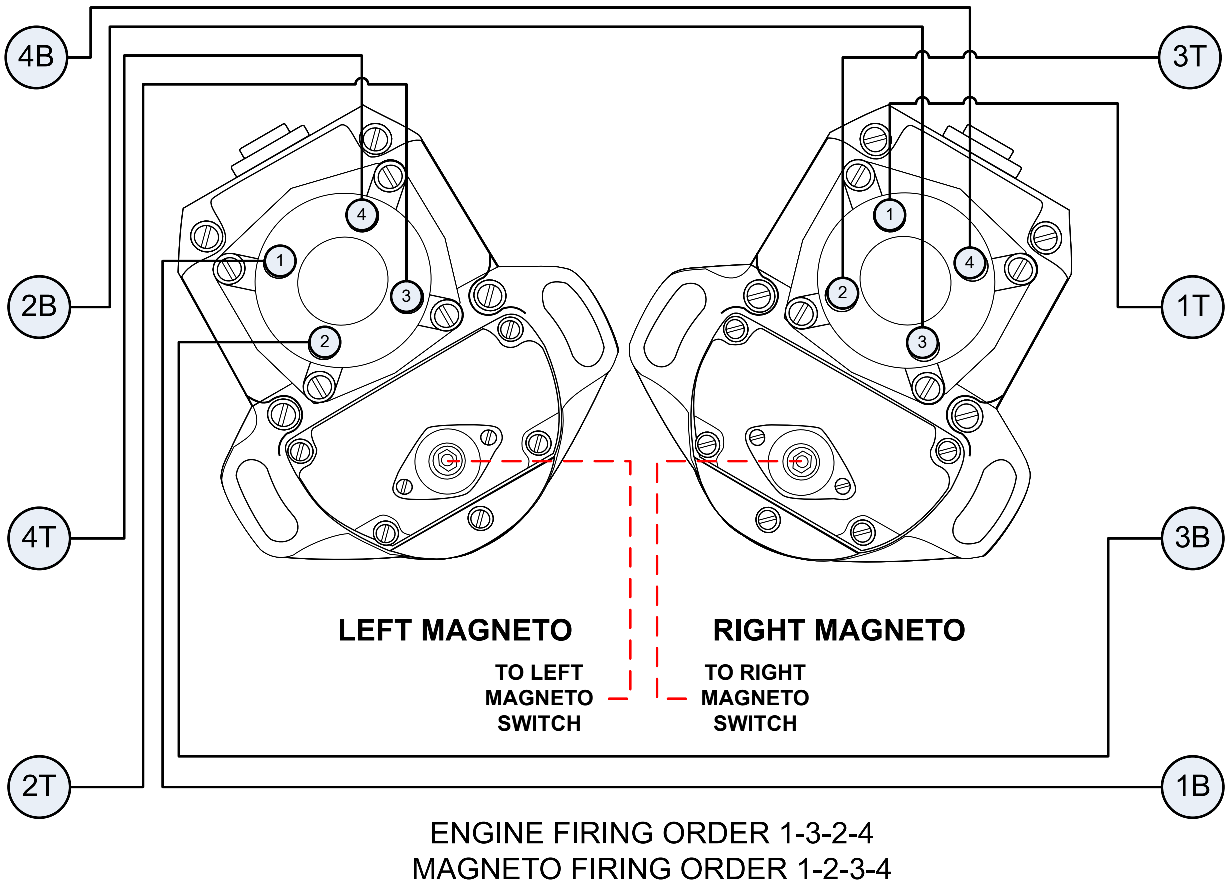


Figure 6-13. Ignition Distribution

7. Verify the inside of the spark plug barrel is clean and dry.

CAUTION: Hold ferrules while torquing or loosening spark plug coupling nuts to protect against twisting the ignition cable.

8. Insert the spring-end of the lead into the spark plug barrel. While holding the lead wire B-nut, firmly push the rubber insulator into the spark plug.

9. Push the ferrule against the spark plug and turn the B-nut clockwise. Continue turning the B-nut until it seats and is finger-tight. While holding the spark plug lead ferrule stationary, torque the B-nut to Appendix B specifications.

10. If all maintenance is complete, perform an “Engine Operational Check” according to the instructions in Section 6-3.6.

6-3.9. Cylinder Inspections

A complete cylinder inspection entails the tasks described in the respective sections Table 6-4 below. Performing all of the tasks in Table 6-4 ensures items that can affect cylinder operation have been inspected and verified for proper operation. Use a copy of the "Cylinder Inspection Checklist" on page 6-77 to record inspection progress and findings.

Table 6-4. Cylinder Inspection Tasks and References

Task[1]	Section Reference
Cylinder visual inspection	Section 6-3.9.1
Check cylinder differential pressure	Section 6-3.9.2
Inspect engine cylinders with borescope	Section 6-3.9.3
Inspect cylinder to crankcase mounting deck	Section 6-3.9.4
Inspect baffles	Section 6-3.9.5
Inspect cowling	Section 6-3.9.6

1. All tasks in this table must be performed for a complete cylinder inspection.

6-3.9.1. Cylinder Visual Inspections

Procedure

1. Remove the engine compartment cowling according to the airframe manufacturer's instructions and perform steps 2 & 3 without cleaning the engine.
2. Inspect the cylinder barrel power stroke areas (Figure 6-14) with an inspection mirror and light for cracks, sharp indentations, chafing, damage or pitting. Repair discrepancies according to instructions in Chapter 15. The power stroke areas include the:
    - Twelve o'clock area on the first six fins below the head on the 1-3 side of the engine as mounted on the crankcase.
    - Six o'clock area on the first six fins below the head on the 2-4 side of the engine as mounted on the crankcase.
3. Inspect the external surfaces of the cylinder head including the fins, intake and exhaust ports, top and bottom spark plug bosses and fuel nozzle bosses for cracks, exhaust flange leakage or any signs of oil, fuel, or soot leakage indicating the cylinder or the head-to-barrel junction structural integrity has been breached.

    NOTE: If discrepancies are noted during the visual inspection, perform a "Differential Pressure Test" according to instructions in Section 6-3.9.2 and a "Cylinder Borescope Inspection" according to instructions in Section 6-3.9.3.

4. Thoroughly clean the exterior of the engine according to instructions in Chapter 14 and repeat steps 2 & 3.

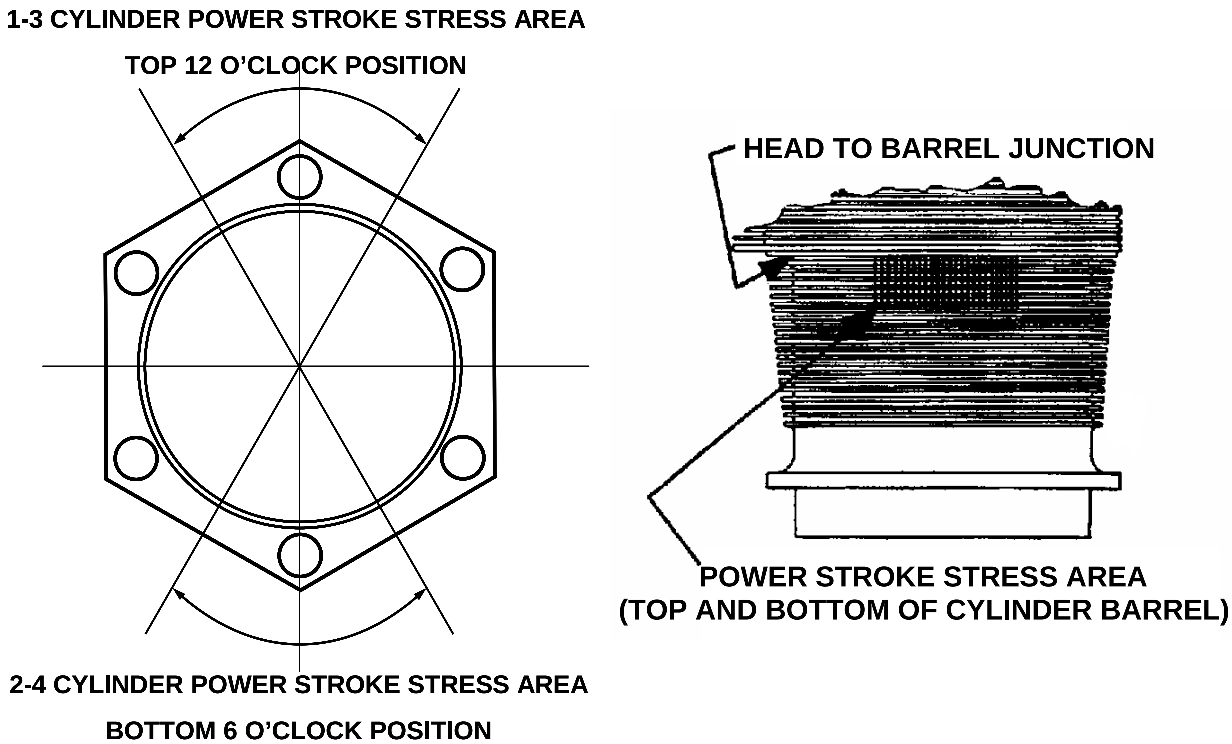


Figure 6-14. Cylinder Power Stroke Areas

6-3.9.2. Differential Pressure Test

Purpose

The Cylinder Differential Pressure Test is a nondestructive method of determining the internal condition of cylinders and cylinder components. As with any test or inspection, the Cylinder Differential Pressure Test has certain limitations that may necessitate its use in conjunction with other non-invasive inspections. The Cylinder Differential Pressure Test identifies leaks and the source of leaks, with the engine under static conditions (not running), using a regulated 80 psi pressure source. Marginal or unsatisfactory results of the Cylinder Differential Pressure Test or Cylinder Borescope inspections may indicate the need to perform additional inspections.

NOTE: The static leak check does not relate directly to cylinder pressures developed during actual engine operations.

Monitor and record engine oil consumption, the appearance or color of the engine oil and any visual indications of high crankcase pressure (combustion blow-by) such as an oily, wet area on the aircraft belly or lower wing surface.

Monitor and record the engine's oil consumption, the appearance or color of the engine oil and any visual indications of high crankcase pressure (combustion blow-by) such as an oily, wet area on the aircraft belly or lower wing surface.

NOTE: Prior to performing the cylinder differential pressure test, determine the baseline master orifice calibrated pressure reading according to instructions in Section 6-3.9.2.1.

Excess cylinder wall or piston ring wear, broken piston rings and burned valves exhibit additional symptoms that include, but are not limited to the following:

- Excessive cylinder barrel wear and/or piston ring wear:
  - Elevated crankcase pressure; see "Excessive Crankcase Pressure" in Chapter 8.
  - Sudden increased oil consumption (based on trend monitoring)
  - Oil discolored within first 10 hours after an oil change
- Broken piston rings:
  - Scored, grooved cylinder wall, evident via a borescope inspection
  - Abnormal debris in oil filter or oil screen
- Burned valves:
  - Extremely low cylinder differential pressure test results
  - Usually evident during borescope inspection.

Many variables affect Differential Pressure Test results, such as:

- Abnormal amounts of oil in the cylinder
- Engine temperature and cylinder temperature uniformity
- Test equipment accuracy
- Capacity and quality of the compressed air source
- Techniques used by the technician when performing the test

Frequency

Perform the differential pressure test:

- During 100-hour or Annual inspections
- If excessive oil consumption or blow-by is suspected
- If the cylinder exhibits signs of accelerated wear

Test Equipment

- Dry, oil-free compressed air source capable of providing a minimum line pressure of 125 P.S.I. with a minimum flow capability of 15 Cubic Feet per Minute (CFM).

  NOTE: Master Orifice Tool (Part No. 646953A) is no longer available. Without the Master Orifice Tool, the Model E2A Differential Pressure Tester is not a valid test equipment option; the Model E2M Differential Pressure Tester must be used. If the facility performing the repairs is in possession of both a Model E2A Differential Pressure Tester and the Master Orifice Tool, the shop may continue to use them as alternatives to the Model E2M Differential Pressure Tester. Instructions in this manual apply only to the Model E2M Differential Pressure Tester

- Cylinder Differential Pressure Tester:
  - Eastern Technology Corporation Model E2M (Figure 6-15) This Differential Pressure Tester incorporates a 0.040 inch Master Orifice Tool

WARNING

Differential Pressure Test equipment must be calibrated annually. Failure to properly maintain and calibrate the Differential Pressure Test equipment may result in misleading or erroneous Differential Pressure Test readings.

Perform the “Differential Pressure Tester Setup” instructions in Section 6-3.9.2.1 to calibrate the test equipment prior to conducting the Cylinder Differential Pressure Test. Perform the Cylinder Differential Pressure Test as soon as possible after the aircraft has returned from flight. If the aircraft cannot be flown prior to performing the Cylinder Differential Pressure Test, operate it on the ground, with the cowling installed until a minimum of 300 to 350°F (149 to 177°C) is observed on the aircraft cylinder head temperature (CHT) gauge.

WARNING

Turn the Ignition Switch and fuel supply OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts. Take necessary precautions to prevent accidental rotation of the propeller while performing this test. Differential pressure tests are best performed with two people, one to adjust the pressure regulator and one to hold the aircraft propeller.

The “Master Orifice” is a calibration standard that must be used prior to performing the Cylinder Differential Pressure Test. The Master Orifice establishes the acceptable cylinder pressure leakage limit for the test equipment being used and the atmospheric conditions at the time of the test. Record the acceptable cylinder pressure leakage limit, along with the individual cylinder readings in the engine logbook and on a copy of “Cylinder Inspection Checklist” on page 6-77.

6-3.9.2.1. Differential Pressure Tester E2M Setup

Perform this procedure to prepare the Model E2M Differential Pressure Tester (Figure 6-15) for use and establish the acceptable cylinder pressure leakage limit.

Procedure

1. Turn the Differential Pressure Tester pressure regulator valve OFF.
2. Position the Master Orifice Valve to the OFF position; handle is horizontal and directly over the OFF label.
3. Position the Slow Fill Valve (next to the pressure regulator) to the OFF position; handle is vertical, pointing down.
4. With the Slow Fill Valve in the OFF position, connect the air source to the Differential Pressure Tester male quick disconnect.
5. Adjust the pressure regulator for indicated 80 psi.
6. Set the Master Orifice Valve to the TEST position; handle is vertical, pointing down.

7. Turn the Slow Fill Valve to the PRESSURIZE position.
8. If necessary, adjust the pressure regulator to maintain an 80 psi indication on the regulator pressure gauge.
9. Record the cylinder pressure gauge indication on the Cylinder Inspection Checklist. This is the Acceptable Cylinder Pressure Leakage Limit.
10. Turn the Slow Fill Valve to the OFF position; handle is vertical, pointing down.
11. Turn the Master Orifice Valve to the OFF position; handle is horizontal, directly over the OFF label.
12. The Differential Pressure Tester is ready for use; proceed to Section 6-3.9.2.3, "Cylinder Differential Pressure Test."

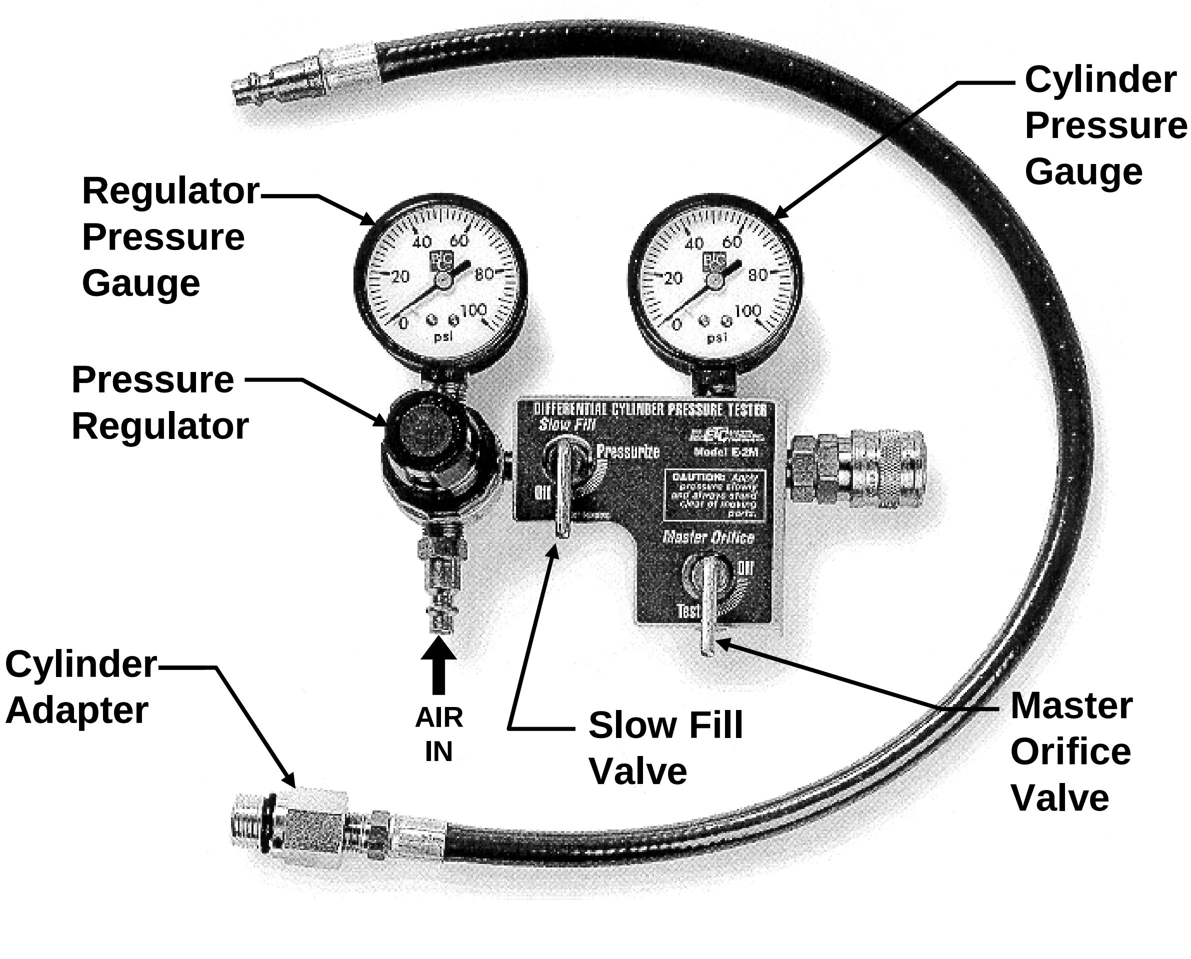


Figure 6-15. Model E2M Differential Pressure Tester

6-3.9.2.2. Differential Pressure Tester Reliability Check

Keep the Differential Pressure Tester clean and check it periodically for accuracy:

1. Apply a line pressure of 100 to 120 psi; close the Slow Fill Valve.
2. Adjust the pressure regulator to 80 psi. The pressure in both gauges should stabilize with no leakage.

6-3.9.2.3. Cylinder Differential Pressure Test

Have an assistant hold the propeller when applying air pressure to the cylinder to prevent propeller rotation.

WARNING

Turn the Ignition Switch and fuel supply OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts. Do not stand or place equipment within the arc of the propeller.

Procedure

1. Perform the test as soon as possible after engine shut down to ensure the piston rings, cylinder walls, and other engine parts are well lubricated and at operating clearance.
2. Remove the most accessible spark plug from each cylinder. Identify the cylinder number and position of the removed spark plugs. Examine the spark plugs to aid in diagnosing engine and cylinder conditions. Refer to the spark plug manufacturer's technical data.
3. Turn the crankshaft by hand in the direction of rotation until the piston in the cylinder under test is positioned just before its compression stroke.
4. Install the cylinder adapter in the spark plug hole and connect the Differential Pressure Tester to the cylinder adapter (Figure 6-16).

   NOTE: The Slow Fill Valve should be in the CLOSED position.

   WARNING

   Exercise care when opening the cylinder pressure valve, air pressure entering the cylinder may cause the crankshaft to rotate if the piston is not at top dead center.

5. Have an assistant secure the propeller to prevent rotation and slowly turn the Slow Fill Valve in the direction of the PRESSURIZE position to pressurize the cylinder to 20 psi.
6. Continue turning the propeller in the normal direction of rotation, against the pressure until the piston reaches top dead center (TDC) indicated by a sudden decrease in the force required to turn the crankshaft. If the crankshaft is rotated too far, back up at least one-half revolution and start over again to eliminate the effect of valve train backlash and to keep the piston rings seated.

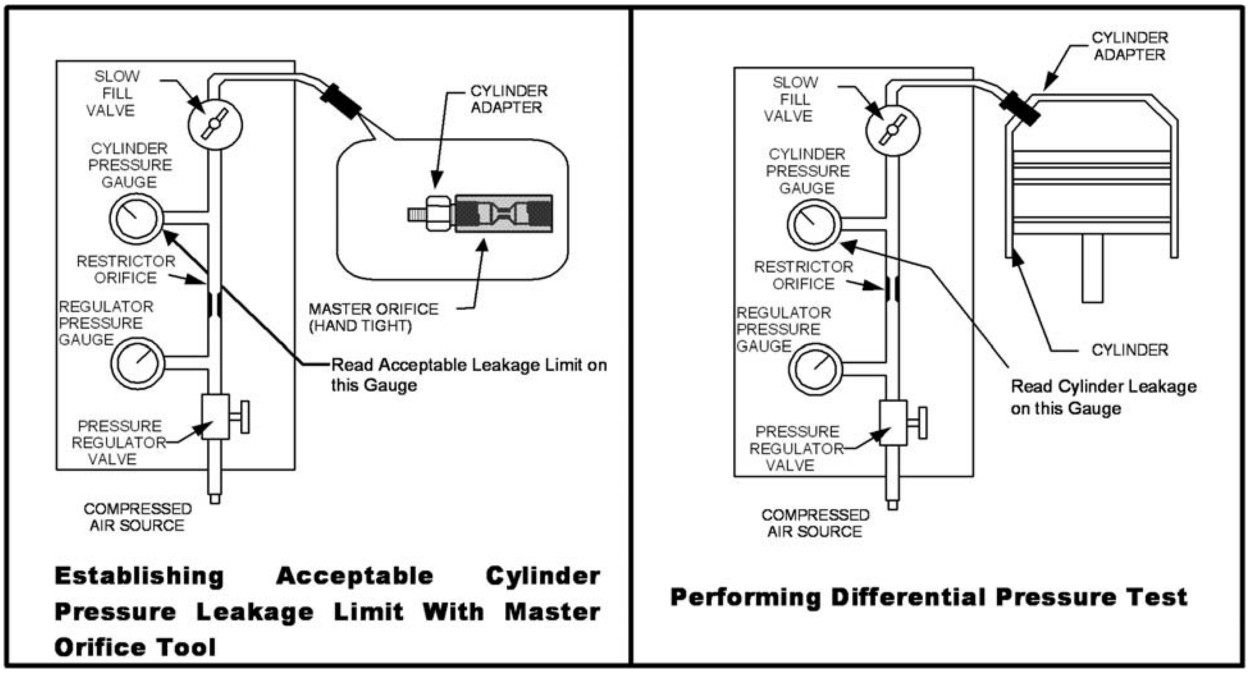


Figure 6-16. Differential Pressure Test Equipment Usage

WARNING

The probability of air pressure in the cylinders turning the propeller during this procedure will be highest when the air pressure in the cylinder is raised to 80 psi in step 7. Stand outside the propeller arc with balanced footing while holding the propeller firmly to avoid injury.

7. With the piston at top dead center, open the Slow Fill Valve completely. Observe the regulator pressure gauge and adjust the pressure regulator, if necessary, for an 80 psi indication.

8. To ensure the piston rings are seated and the piston is square in the cylinder bore, move the propeller slightly back and forth with a rocking motion, while applying the regulated pressure of 80 psi, to obtain the highest indicated pressure reading on the cylinder pressure gauge. Adjust the pressure regulator, as necessary, to maintain a regulated pressure indication of 80 psi.

9. Record cylinder pressure gauge indication. The difference between indicated cylinder pressure and indicated regulator pressure is the amount of cylinder leakage. Record cylinder pressure indication as: $^{\text{(pressure reading)}}/_{\text{80 psi}}$.

   NOTE: Repeat steps 3 through 9 on each engine cylinder. Record Cylinder Differential Pressure Test results for each cylinder on the Cylinder Inspection Checklist.

10. Compare the recorded test results with Table 6-5 to determine what action, if any, is recommended.

11. Turn the Slow Fill Valve to the OFF position. Disconnect the test equipment from the cylinder and proceed to the “Cylinder Borescope Inspection” in Section 6-3.9.3.

Table 6-5. Differential Pressure Test Results

Air Discharge Source	Pressure Test Value	Symptoms and Observations	Recommended Action
Air discharge at oil filler/ crankcase breathe.	Cylinder Differential Pressure Test reading above the acceptable cylinder pressure leakage limit.	Normal borescope indications. Oil consumption stable, no excessive oil discharge out engine breather	Continue engine in service. Repeat Differential Pressure Test at next 100-hour/ annual inspection.
	Cylinder Differential Pressure Test reading below the acceptable cylinder pressure leakage limit.	Normal borescope indications. Oil consumption stable, no excessive oil discharge out engine breather.	Fly aircraft at Cruise Power setting[1] and repeat Cylinder Differential Pressure Test.
	Cylinder Differential Pressure Test reading below the acceptable cylinder pressure leakage limit after re-test.	Not applicable	Remove cylinder for repair.
	Cylinder Differential Pressure Test reading above or below the acceptable cylinder pressure leakage limit	Oil consumption abnormal[2], with oil discharge out engine breather. Borescope inspection reveals heavy carbon deposits in combustion chamber and on piston crown with excessive oil puddling in cylinder barrel.	Remove cylinder for repair.
Air escaping at spark plug spot face	Cylinder Differential Pressure Test readings not applicable	Dye check of area reveals cracks.	Remove cylinder for replacement.
Little to no air discharge at oil filler/crankcase breather.	Cylinder Differential Pressure Test reading abnormally high	Oil consumption abnormal[2], with oil discharge out engine breather. Borescope inspection reveals heavy carbon deposits in combustion chamber and on piston crown with excessive oil puddling in cylinder barrel.	Remove cylinder for repair.

Table 6-5. Differential Pressure Test Results

Air Discharge Source	Pressure Test Value	Symptoms and Observations	Recommended Action
Air discharge into induction system	Cylinder Differential Pressure Test reading above the acceptable cylinder pressure leakage limit.	Normal cylinder borescope inspection results.	Continue engine in service.
	Cylinder Differential Pressure Test reading below the acceptable cylinder pressure leakage limit.	Normal cylinder borescope inspection results.	Fly aircraft at cruise power setting[1] and repeat Cylinder Differential Pressure Test.
	Cylinder Differential Pressure Test reading below the acceptable cylinder pressure leakage limit after re-check.	Not Applicable	Remove cylinder for repair.
Air discharge into exhaust system	Cylinder Differential Pressure Test reading above the acceptable cylinder pressure leakage limit.	Normal cylinder borescope inspection results.	Continue engine in service.
	Cylinder Differential Pressure Test reading below the acceptable cylinder pressure leakage limit.	Normal cylinder borescope inspection results.	Fly aircraft at cruise power setting[1] and repeat Cylinder Differential Pressure Test.
	Cylinder Differential Pressure Test reading below the acceptable cylinder pressure leakage limit after re-check.	Not Applicable	Remove cylinder for repair.
Air discharge at cylinder head to barrel juncture or between barrel fins	Cylinder Differential Pressure Test readings above the acceptable cylinder pressure leakage limit.	First cylinder head fin above cylinder barrel wet with oil or baked on oil residue. See the latest revision of Service Bulletin SB96-12 for additional tests to be performed.	Remove cylinder for replacement.

1. Fly the aircraft at cruise power setting between 65 and 75 percent power according to the Aircraft Flight manual/Pilots Operating Handbook (AFM/POH) for a duration that will allow engine oil and temperatures to stabilize, or at least 45 minutes. Repeat the differential pressure test on the suspect cylinder.
2. A sudden increase in oil consumption from the established, normal trend.

6-3.9.3. Cylinder Borescope Inspection

Regular engine operation provides an oil coating for the cylinder and minimizes rust formation. New cylinders are particularly sensitive to rust formation if the engine is infrequently used or not properly preserved during storage.

NOTE: Ground operation of the engine is an unacceptable substitute for in-flight engine operation. Ground operation does not provide adequate cylinder cooling and introduces water and acids into the lubrication system.

Purpose

The cylinder borescope inspection provides a non-destructive method of visually examining the internal cylinder components and must be used in conjunction with the "Differential Pressure Test" to assess the condition of the valve, piston top, deposits, and the hone pattern on the cylinder barrel and identify abnormal wear patterns which can contribute to low differential pressure readings or increased oil consumption.

The cylinder wall hone pattern consists of engineered surface "scratches" which aid in ring seating by allowing the ring and wall surface to wear uniformly and provides a reservoir of oil for lubrication during ring travel. The cylinder walls and rings are designed to wear over the life of the engine, particularly in the power stroke area. The visible hone pattern in the upper portion of the bore may disappear during normal operation; and is not cause for cylinder replacement.

Required Equipment

- Mechanics tools
- Borescope

Frequency

- During 100-hour/Annual inspection
- If oil consumption is excessive
- After an engine overspeed incident
- Whenever an anomaly is suspected

WARNING

Turn the Ignition Switch and fuel supply OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts. Do not stand or place equipment within the arc of the propeller.

Take preventive measures to avoid burns when performing a Cylinder Borescope Inspection on a hot engine.

Procedure

1. Remove the engine cowling as necessary to gain access to the top spark plugs.
2. Remove the upper spark plug from each cylinder.

3. Position the piston at bottom dead center on the power stroke. The exhaust valve will be open with the piston in this position.
4. Insert the borescope probe through the upper spark plug hole and inspect the internal surfaces of each cylinder, including the exhaust valve and exhaust valve seat. Use
5. Position the piston at bottom dead center at the end of the intake stroke.
6. Insert the borescope through the upper spark plug hole and inspect the intake valve and valve seat. Use Table 6-6 and Figure 6-17 through Figure 6-20 to interpret inspection findings.

Table 6-6. Borescope Inspection Objectives and Corrective Actions

Inspection Item	Objective	If Abnormality Noted
Combustion Chamber	Inspect: •Valve seat inserts for erosion, burning •Spark plug heli-coils for protrusion into combustion chamber •Heavy carbon deposits/presence of excessive oil	Remove cylinder for repair
Exhaust Valve Face	Inspect for signs of leakage or damage indicated by: •Localized discoloration on the valve face circumference (Figure 6-18) •Minute cracks •Erosion (missing material)	Repair or replace cylinder
Intake Valve Face	Inspect for signs of leakage or damage indicated by: •Localized discoloration on the valve face circumference •Erosion (missing material)	Repair or replace cylinder
Cylinder Bore	Inspect exposed surface of bore for: •Heavy scoring/piston rub (Figure 6-21) •Piston pin rub (wide band pattern in horizontal plane at 3 o'clock and/or 9 o'clock position)	Repair or replace cylinder
	Corrosion (Figure 6-20)[1] Excessive oil in cylinder/heavy deposits of carbon in combustion chamber	Remove cylinder for repair
	Upper portion of cylinder bore has no visible hone pattern (Figure 6-22) and (Figure 6-23)	Normal indication for in service cylinders
Piston Head	Inspect for: •Piston crown for erosion, missing material •Visible damage from foreign debris	Remove cylinder for repair

1. Remove cylinder for repair or replacement. Perform complete inspection of connecting rod bushing for correct installation and finishing.

Figure 6-17. Normal Combustion Chamber

Exhaust valve has reddish deposit in center with dark outer edge. Intake valve has light brown combustion deposits. Combustion chamber has light brown deposits.

Figure 6-18. Burned Exhaust Valve

Note the edge of valve face has lost all combustion residue with striations moving toward center of valve.

Figure 6-19. Phosphate-Coated Cylinder w/ Revised Hone Pattern

Phosphate coating provides increased corrosion protection during initial hours of engine operation.

Figure 6-20. Phosphated Cylinder Bore

Phosphate coating in valleys of the cylinder bore hone pattern. Light corrosion at top of cylinder bore, above piston ring travel limit in this area is normal.

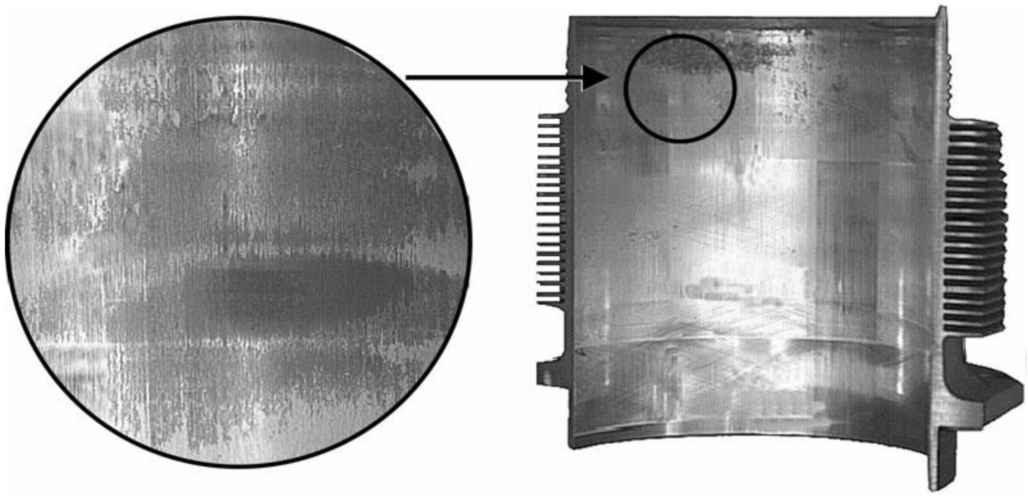


Figure 6-21. Cylinder Barrel Scoring and Piston Rub

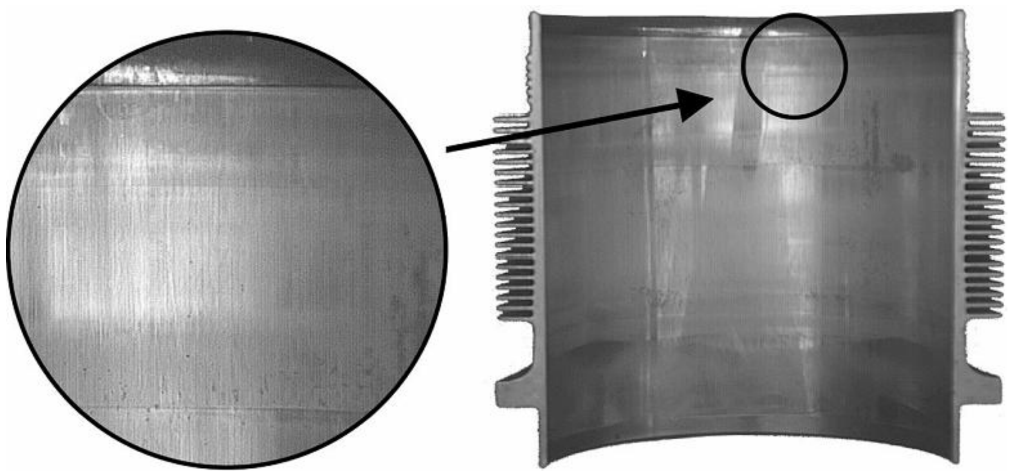


Figure 6-22. Typical Wear in Upper Ring Travel

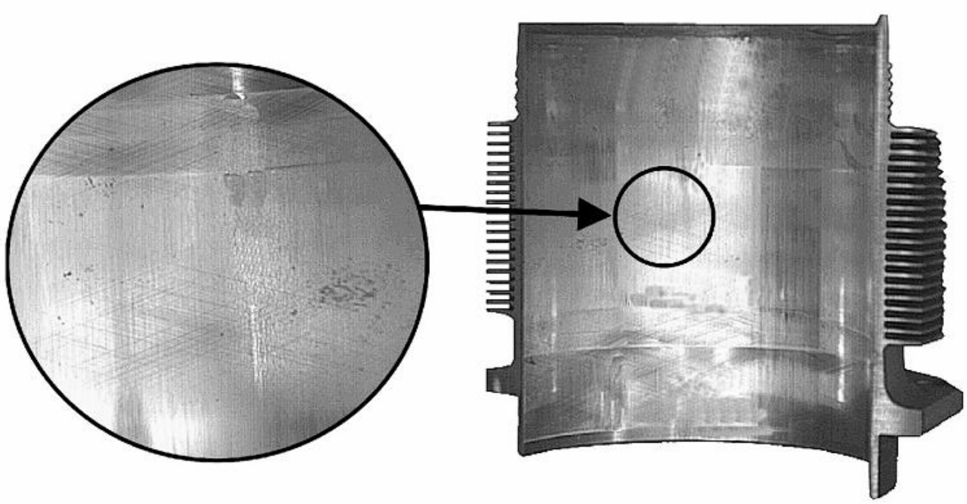


Figure 6-23. Typical Cylinder Wear

6-3.9.4. Cylinder to Crankcase Mounting Deck Inspection

Purpose

Proper cylinder torque requires a solid mounting surface. Foreign materials, such as grease or unauthorized sealants applied to the mounting base or flange will not allow proper fastener preload. Proper torque procedures are critical to engine operation.

Frequency

- During 100-hour/Annual inspection

WARNING

Do not apply any form of sealant to the crankcase cylinder deck, chamfer, cylinder mounting flange, O-ring, or fastener threads. The use of RTV silicone or other sealant on mating threads or between mating surfaces during engine assembly will cause a loss of cylinder deck stud or through-bolt torque. Subsequent loss of main bearing crush or fretting of the crankcase parting surfaces can lead to cylinder separation, main bearing movement, or oil starvation and catastrophic engine failure.

Procedure

Inspect the cylinder-to-crankcase mounting deck for evidence of silicone RTV sealant on the cylinder deck flange. If silicone RTV sealant or any other unauthorized sealant or adhesive is discovered, the engine must be completely disassembled, cleaned, inspected and assembled according to the overhaul instructions in Chapter 12-18 of this manual

1. Remove the engine from the aircraft according to instructions in Section 5-1.
2. Disassemble the engine according to the instructions in Chapters 12 and 13.
3. Clean the engine components according to the instructions in Chapter 14.
4. Inspect the engine components according to the instructions in Chapter 15.
5. Reassemble the engine according to instructions in Chapters 16 and 17.
6. Perform the “Post-overhaul Testing” according to instructions in Chapter 18.
7. Install the overhauled engine according to instructions in Section 5-2.

6-3.9.5. Baffle Inspection

Purpose

To prevent cylinder deterioration and verify baffles are properly fitted and installed. This inspection performed in concert with the cylinder inspection.

The heat transfer in piston engines requires efficient and reliable operation of cooling baffles to prevent rapid deterioration of the cylinders and other engine components. Verify the baffles are installed, intact, and positioned properly.

Frequency

- During 100-hour/Annual inspection or whenever the cowling is removed

Procedure

1. Check the following for deterioration, wear, correct position, and proper contact with the cowl. Figure 6-24 through Figure 6-27 show improperly positioned baffle seals.
2. Repair or replace worn or distorted baffles in accordance with the airframe manufacturer or Supplemental Type Certificate (STC) holder's information.
3. Check and adjust inter-cylinder baffles to ensure a tight fit.
4. Inspect for holes and cracks that would allow cooling airflow to be wasted. Seal any cracks or holes by applying a non-corrosive silicone adhesive/sealant. Consult the aircraft manufacturer for application instructions. Baffle conditions shown in Figure 6-28 shows air gaps that lead to inadequate cooling airflow. Figure 6-29 and Figure 6-30 show evidence of cooling air loss at the baffle seals.
5. Check the integrity of all cooling ducts, heater ducts, etc. and repair as necessary.

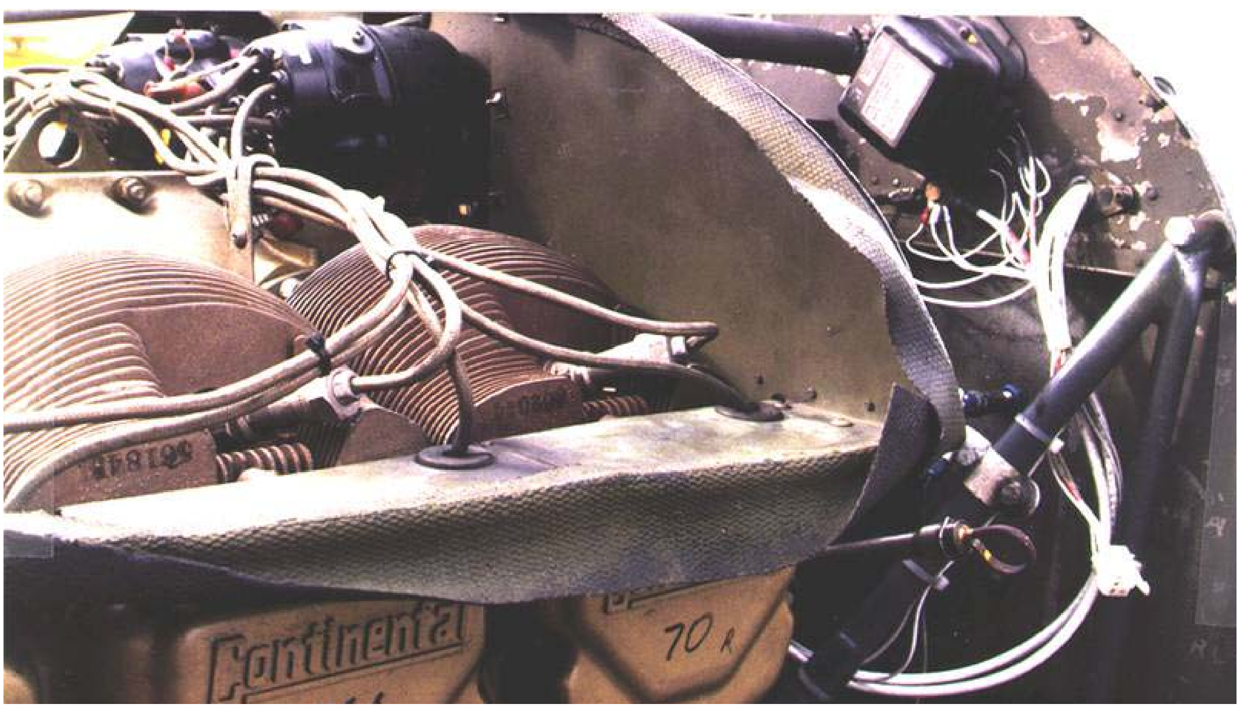


Figure 6-24. Improperly Positioned Baffle Seals

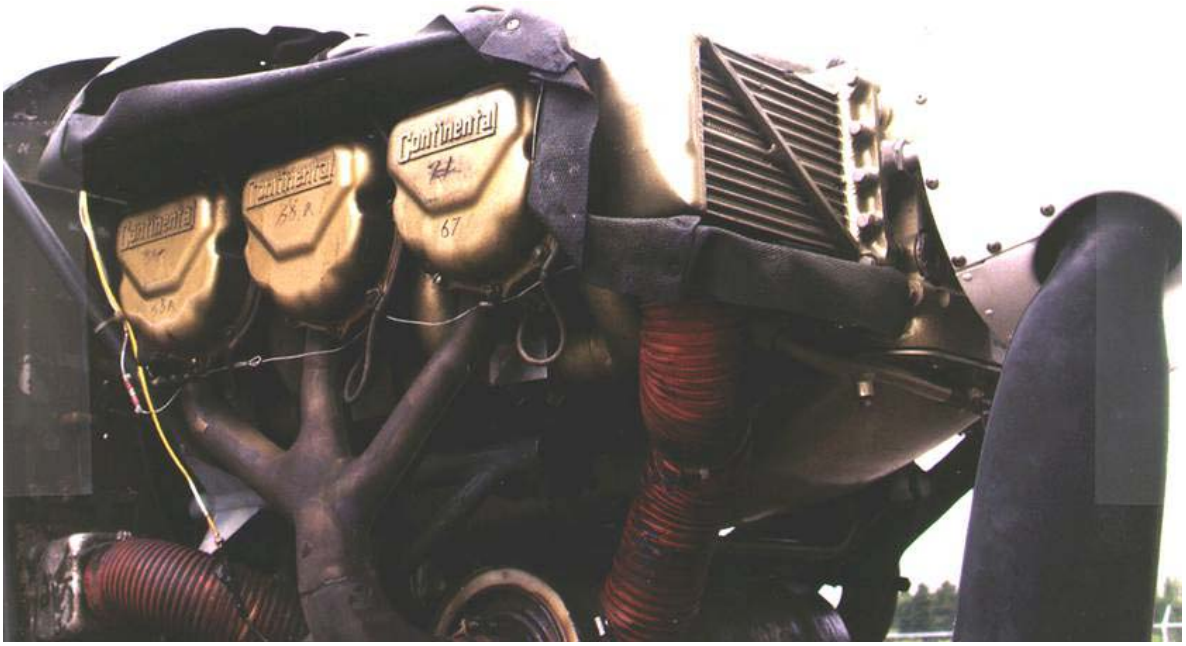


Figure 6-25. Improperly Positioned Baffle Seals

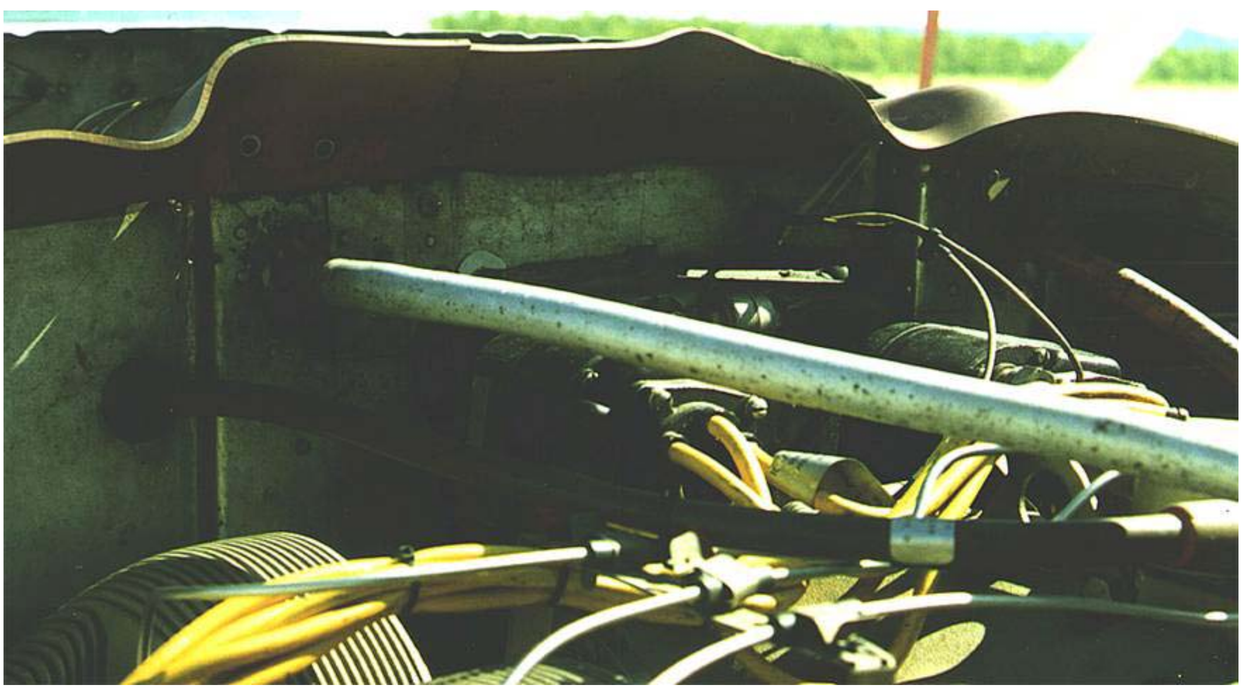


Figure 6-26. Improperly Positioned Aft and Side Peripheral Baffle Seals

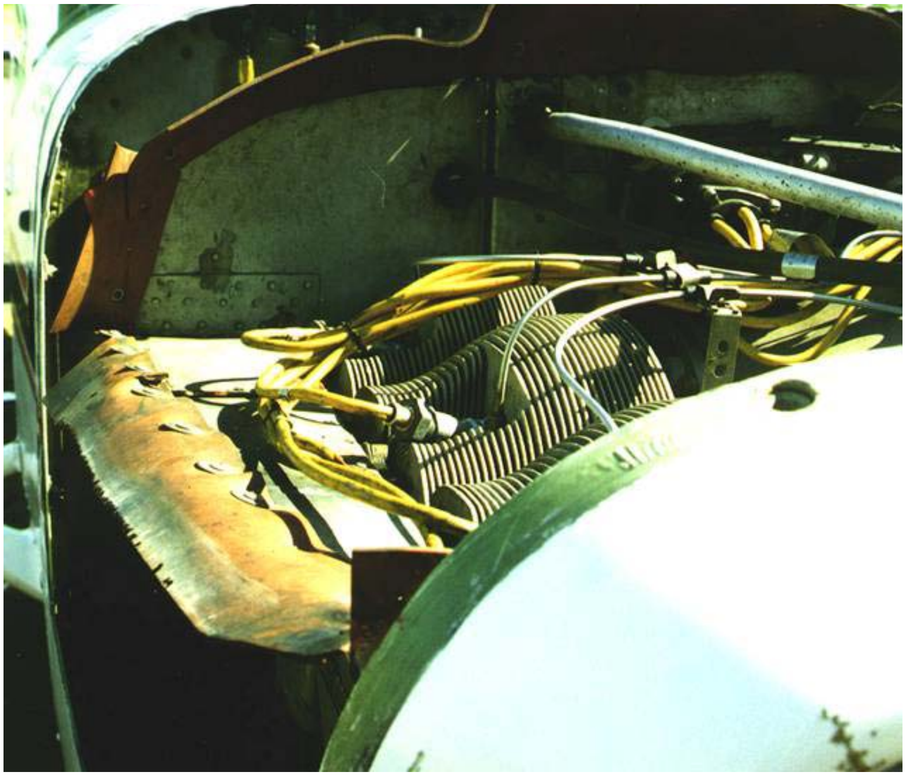


Figure 6-27. Improperly Positioned Aft and Side Peripheral Baffle Seals

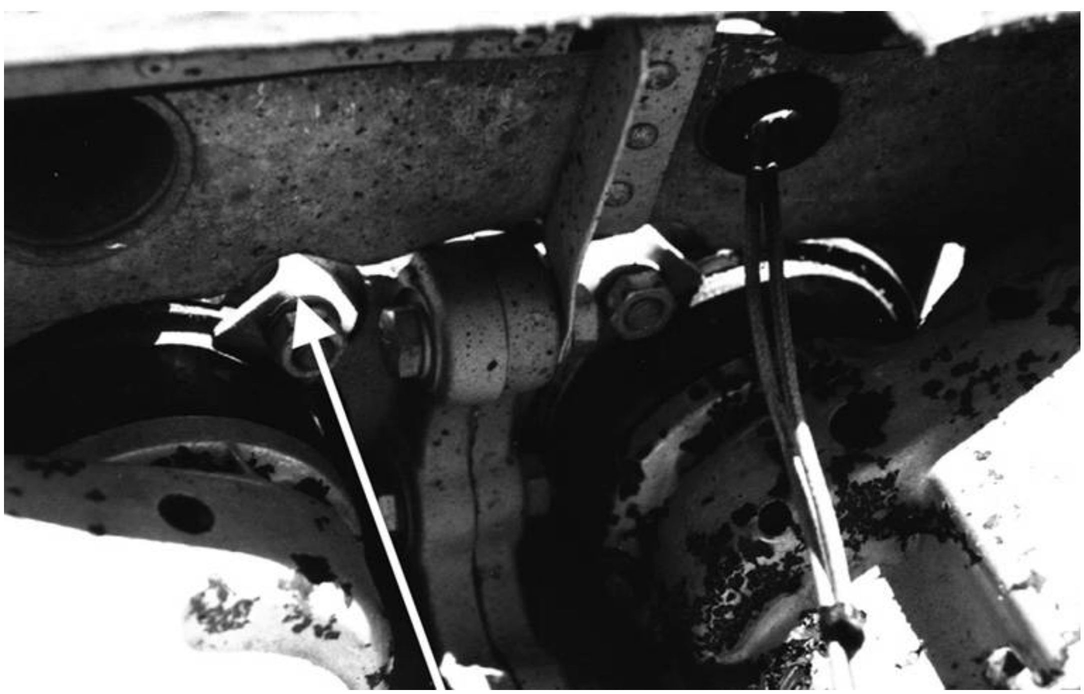


Figure 6-28. Aft and Side Baffles with Air Gaps

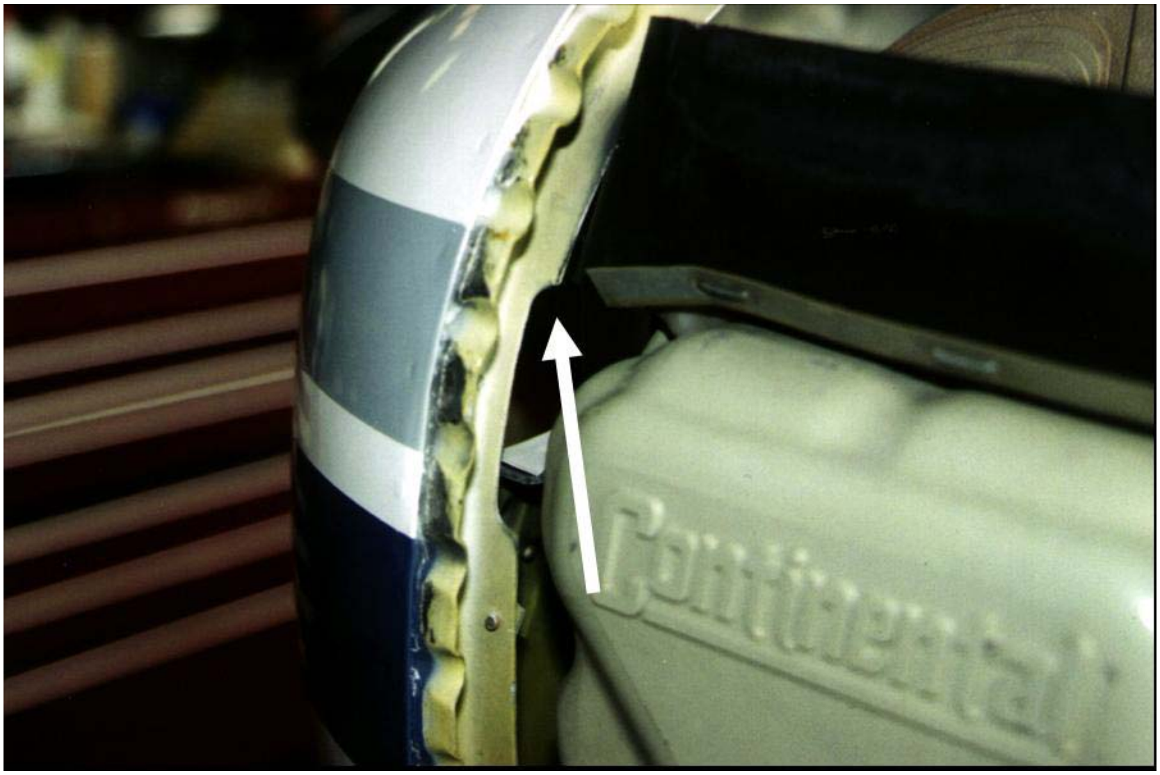


Figure 6-29. Cooling Loss Due to Gaps in Baffle Seals

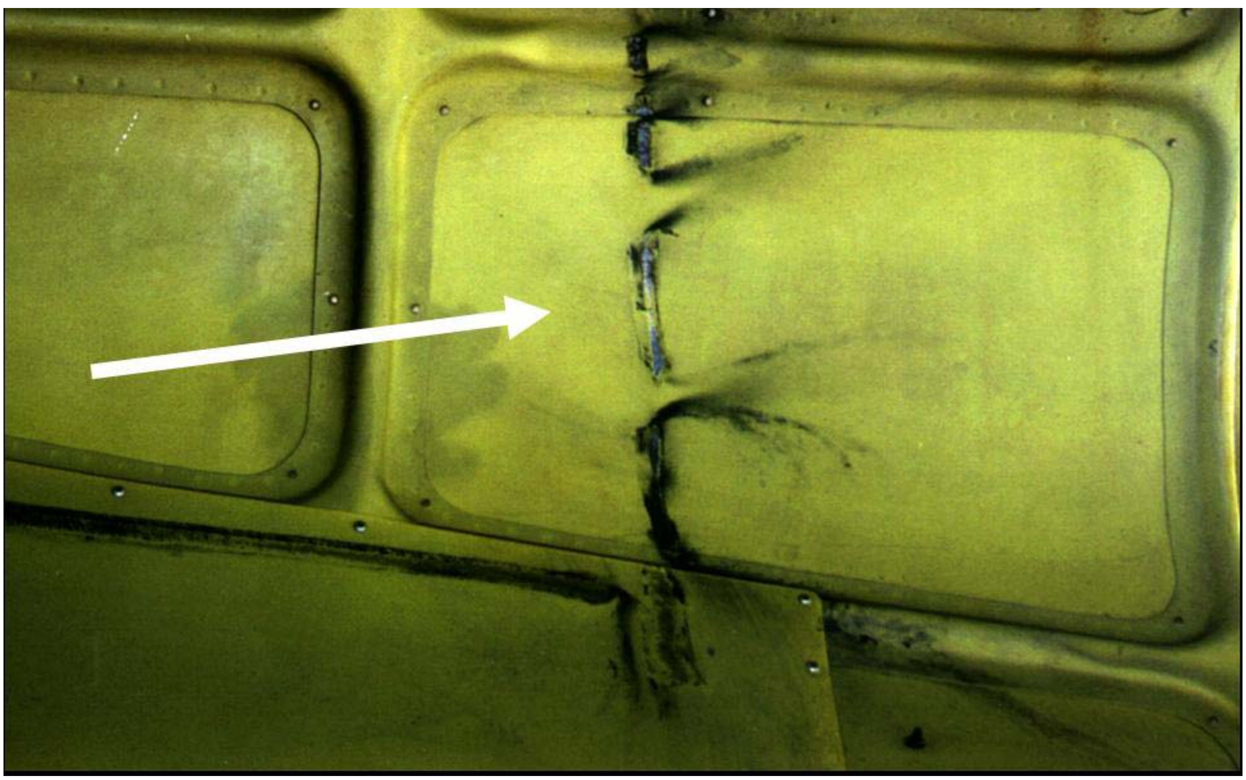


Figure 6-30. Cooling Loss Due to Gaps in Baffle Seals

6-3.9.6. Cowling Inspection

Purpose

Check cowl openings for restrictions and proper operation of the cowl flap. Cowl flap operation is an integral function of engine cooling control.

Frequency

- During 100-hour/Annual inspection

Procedure

1. Verify add-on accessories and their associated hardware do not restrict cowl inlet, cowl outlet, and air flow through the cooling fins.
2. Verify the cowl flap rigging and operation meet the appropriate aircraft maintenance manual specifications.
3. Check for cracks and other obvious physical defects.

6-3.10. Crankcase Inspection

Purpose

To verify the crankcase is free of oil leaks, cracks, and physical damage.

Frequency

- During 100-hour/Annual inspection

Procedure

WARNING

If neglected, crankcase cracks may progress to the point of causing major oil leakage or engine structural failure.

1. Inspect the exterior of the crankcase halves for cracks. Carefully inspect the entire external surface of the crankcase using an inspection light and mirror.

   NOTE: All crankcase cracks require attention, regardless of size or location. Do not ignore crankcase cracks.

   a. Cylinder deck (white/non-shaded in Figure 6-31 = critical areas) cracks, regardless of size require **immediate crankcase replacement**.

   b. Repair cracks two inch (5.08 cm) or longer in the shaded (non-critical) locations of Figure 6-31 according to instructions in Section 15-7.7. Replace the crankcase if satisfactory repair is not possible.

   c. Cracks shorter than two inches in the shaded locations of Figure 6-31 may remain in service. Scribe the extremities of cracks smaller than two inches in the non-critical areas for further growth progression monitoring. Cracks with seeping oil must be repaired or replaced immediately. At 25-hour inspection intervals, inspect the progression of any previously identified crack located in the shaded locations of Figure 6-31 that is less than two inches in length. If a crack in the non-critical area of Figure 6-31 progresses to two inches or more in length, repair or replace the crankcase. Inspect the scribed cracks at the next 50 hour engine inspection for progression. If no progression is noted, repeat the progression inspection at each 100-hour inspection interval until the crack is repaired or the crankcase is replaced. Repair or replace the crankcase if the cracks in the non-critical area progress to two inches or beyond in the shaded locations.

2. Investigate oil leaks as possible crack indications. If oil leaks are the result of damaged or improperly sealed gaskets, replace questionable gaskets according to the overhaul instructions.

3. Inspect the crankcase breather for cracks or dents. Inspect tube ends for scoring or eccentricity that may prohibit a proper seal. Discard and replace unserviceable components.

4. Inspect engine mount brackets for cracks, dents and wear. Inspect hardware for distorted, stripped threads and damaged wrench flats. Discard and replace unserviceable components.

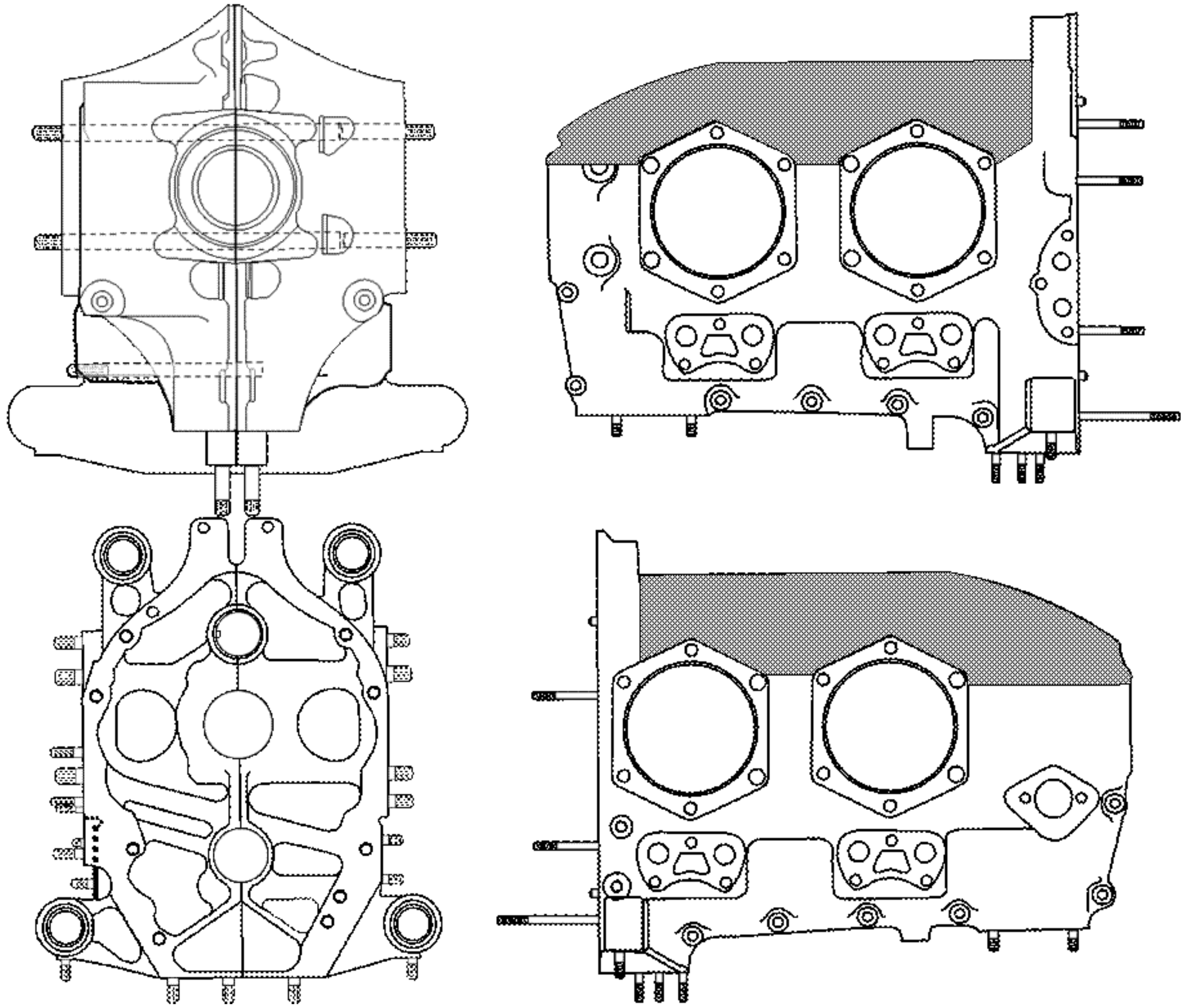


Figure 6-31. Crankcase Critical (white) and Non-critical (Shaded) Area

5. Inspect the crankcase backbone seam for signs of oil leaks. Oil leakage in this area may be caused by under-torqued through bolts. Retorque the crankcase fasteners according to the instructions in Section 17-3.1, “Cylinder and Crankcase Torque.”

WARNING

The use of sealants or lubricants other than those specified by instructions in this manual on mating threads and between mating surfaces can cause incorrect torque application and subsequent engine damage or failure.

6. Inspect the cylinder deck for signs of RTV Sealant used on the cylinder deck flange. If RTV Sealant is found, refer to Section 6-3.9.4, “Cylinder to Crankcase Mounting Deck Inspection” for corrective action.

6-3.11. Engine Mount Inspection

Frequency

- During 100-hour/Annual inspection

Procedure

1. Inspect engine mounts and mount isolators for visible evidence of cracks. If cracks are suspected, perform nondestructive inspection using dye penetrant or eddy current methods to determine engine mount condition.

WARNING

Do not allow a cracked engine mount to remain in service. Replace upon discovery.

2. Inspect engine mount isolators for signs of deterioration, proper assembly and security.
3. Replace damaged or deteriorated engine mounts or engine mount isolators.

6-3.12. Induction System Inspection

Purpose

Check the integrity of the air filter, seals, and airbox to prevent particulates from entering the engine that can abrade cylinder walls and ring faces thereby damaging the engine.

Frequency

- During 100-hour/Annual inspection

Procedure

1. Remove and inspect the induction air filter for cleanliness, normal operation and the absence of gaps or leaks in the filtering element. Verify the air filter seal prevents airflow except through the filter. Inspect or replace as necessary in accordance with the airframe manufacturer/STC holder's information.
2. Verify the integrity of the airbox; look for alternate air circuits which can bypass the filtering system. Any holes or bypass circuits found behind the filtering element should be repaired as required in accordance with the airframe manufacturer/STC holder's information.
3. Verify the operation of the alternate air door and the integrity of the seal in the closed position. Verify the door operating mechanism closes securely. Replace or repair, as necessary, according to the airframe manufacturer/STC holder's instructions.
4. If oil analyses are done on engine oil samples, check the silicone content of the most recent oil analysis and the overall silicone trend to further assess the possibility of Induction System leaks or pilot operational issues such as extensive use of carburetor heat or alternate air during ground operation.
5. Inspect the induction tube and hose connections to verify proper installation. Induction tubes incorporate a “bead” (Figure 6-32) which provides an anchor point for the induction tube clamps and enhances the seal between the induction tube and hose. Remove, inspect and install induction system according to instructions in

Section 17-14 if induction tubes, hoses or clamps are improperly installed or inspection identifies parts as unserviceable.

a. Visually inspect the induction system clamps for proper fit and positioning. Clamps should be positioned squarely over the joint between the induction tubes and hose (Figure 6-32), inboard of the induction tube bead; no part of the end of the induction tube should be visible with the hose and clamp properly installed. Loosen the clamps, reposition, and torque to Appendix B specifications, if necessary. If the clamp will not tighten or remain torqued to Appendix B specifications, the clamp is unserviceable - replace the clamp.

b. Perform a visual inspection on the induction hoses for proper fit and positioning. Hoses should be flexible; splits, tears, or cracks are unserviceable conditions. Replace cracked, split, or torn induction hoses. Hoses should not exhibit "twists" from misalignment, which can cause stress cracks. Hoses must be positioned over the induction tubes to secure the induction tube beads within the clamped portion of the hose.

c. Perform a visual inspection on the induction tubes. Replace tubes exhibiting deep scratches, dents, cracks, or eroded sealing beads.

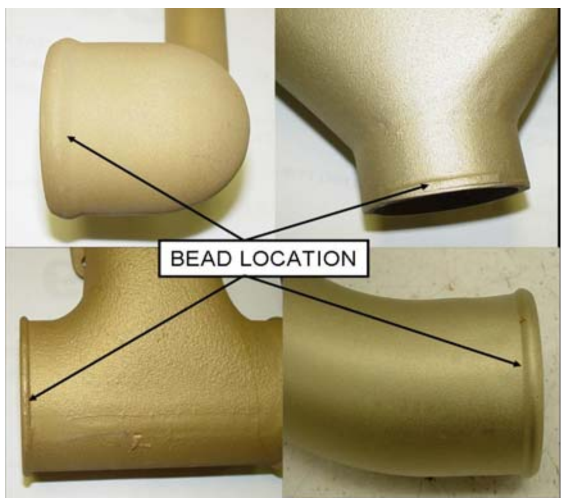


Figure 6-32. Induction Tube Bead Location

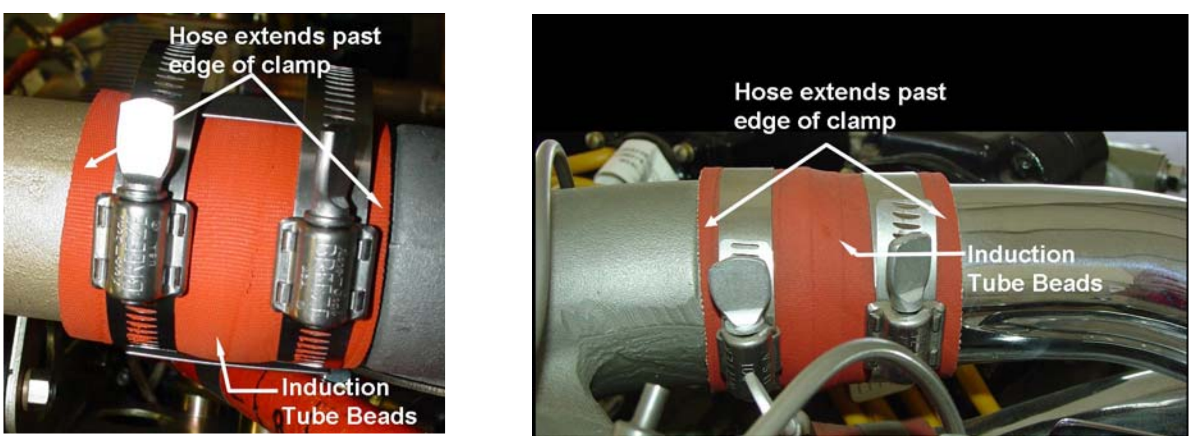


Figure 6-33. Properly Installed Induction Tube, Hose and Clamps

6-3.13. Ignition System Inspection

Purpose

Verify the following:

- Magneto housing is free of damage
- Magneto (Continental Motors units only) breaker points are serviceable
- Magneto to engine timing is set properly
- Ignition leads are intact and secure
- Spark plugs are clean, operating properly, and correctly gapped

Frequency

- During 100-hour/Annual inspection

Procedure

WARNING

Turn the Ignition Switch and fuel supply OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts. Do not stand or place equipment within the arc of the propeller.

1. Ignition Switch..OFF
2. Disconnect the spark plug leads from the upper and lower spark plugs and ground the leads to the engine.
3. Verify continuity between the magneto capacitors and aircraft ground.
4. Visually inspect the ignition leads for chafing, deterioration and insulation breakdown. Replace worn or frayed ignition wires.
5. For engines equipped with impulse coupled magnetos, perform an “Impulse Coupling Functional Check” according to the instructions in Section 6-3.13.1.
6. Remove the spark plugs from each cylinder. Clean and inspect the spark plugs according to instructions in Section 6-3.8.2. Rotate spark plugs from original locations during installation.

WARNING

Failure to maintain the magneto, spark plugs and ignition leads can cause engine damage or failure due to misfire.

7. Perform a “Crankshaft Top Dead Center Alignment” according to instructions in Section 6-3.8.1.1 to position the crankshaft for magneto replacement.
8. Remove the magnetos from the engine according to instructions in Section 10-5
9. Perform a “Gear Tooth Inspection” on the magneto drive gears and camshaft gear according to the instruction in Section 15-3.1. If the gear teeth are chipped, broken, or otherwise damaged, disassemble the engine, remove the camshaft gear according to instructions in Section 13-6, replace the camshaft gear according to instructions in

Section 16-8 and perform a “Foreign Object Contamination Inspection” according to instructions in Section 6-4.6.

CAUTION: Verify the magneto ventilation port is open. If the vent is clogged, nitrogen gases accumulating in the magneto will cause rapid degradation of the magneto internal components, leading to imminent magneto failure.

10. Visually inspect the external surfaces of the magneto for evidence of wear or corrosion. Replace aftermarket magnetos exhibiting unusual wear or corrosion. Correct Continental Motors magneto discrepancies according to instructions in the Magneto Service Manual. Remove the magneto ventilation plug and clean the opening with a small segment of clean 0.020” safety wire. Install the ventilation plug and torque to Appendix B specifications.

    NOTE: Continental Motors magnetos with riveted impulse couplings require 100 hour inspections. Refer to the magneto service manual for details.

11. Perform a 100-Hour inspection on Continental Motors magnetos according to instructions in the Magneto Service Manual (X42002).
12. Note the magneto drop test results recorded during the “Engine Operational Check” in Section 6-3.6. If magneto drop or spread during run-up was not within published limits, inspect, troubleshoot, repair and adjust as required to correct discrepancy.
13. Install the magneto in the accessory case in the approximate orientation from where it was removed according to instructions in Section 10-5.
14. Check magneto to engine timing according to the “Magneto to Engine Timing” instructions in Section 6-3.8.1.2. If magneto timing cannot be adjusted:
    a. Remove the magneto according to the instructions in Section 10-5, “Magneto Replacement.”
    b. Replace non-Continental Motors magnetos according to the instructions in Section 10-5, “Magneto Replacement.” Troubleshoot and repair Continental Motors magnetos according to instructions in the Magneto Service Manual.
15. For engines equipped with a shower of sparks ignition system, perform a “Starting Vibrator Functional Check” according to instructions in Section 6-3.13.2 after verification of magneto to engine timing.

6-3.13.1. Impulse Coupling Functional Check

WARNING

Turn the Ignition Switch OFF and disconnect engine electrical power before commencing maintenance or inspections. Confirm continuity between the magneto capacitor and aircraft ground to prevent accidental engine start during maintenance. Do not stand or place equipment within the arc of the propeller.

Procedure

1. Mixture Control .... IDLE/CUTOFF
2. Throttle.. CLOSED
3. Fuel Selector Valve .... OFF
4. Master Power Switch....................................... ON

   NOTE: The left magneto features an impulse coupling; the right magneto must be grounded during engine start.

5. Crank the engine several revolutions using the Start switch (if separate from the Ignition switch) or Ignition switch (if start function is controlled by the Ignition switch).
   RESULT: Impulse coupling operation is audible and can be felt through the magneto housing. The “clicking” sound from the impulse couplings should be consistent while the engine is cranked. If no “clicking” is heard, or the clicking is intermittent, remove and service the magnetos according to the manufacturer's instructions.
6. Disconnect the aircraft battery according to the airframe manufacturer's instructions.
7. Turn and hold the Ignition Switch in the START position and verify continuity between the right magneto P-lead and ground. If continuity is not present, repair the circuit before proceeding.
8. Disconnect the P-leads from each magneto. Verify continuity between both magneto P-leads and aircraft ground with a multimeter. If either circuit is faulty, repair the circuit before proceeding.
9. Reconnect the magneto P-leads and place the Ignition Switch in the OFF position.

6-3.13.2. Starting Vibrator Functional Check

1. Disconnect aircraft electrical power from the starter according to the airframe manufacturer's instructions.
2. Remove the lower spark plug lead from the No. 1 cylinder. Position the tip of the spark plug lead 3/16" from engine ground.
3. Master Switch .... ON

   CAUTION: The starting vibrator duty cycle is 16.6% or 20/120 seconds; do not engage the starting vibrator for longer than 20 seconds in a two minute period. Exceeding the duty cycle will overheat the circuit and may damage the starting vibrator.

4. Ignition Switch... START (maximum 20 seconds)
   RESULT: A strong blue spark emits from the spark plug lead at a few degrees before top dead center on the No. cylinder compression stroke. If no spark is observed before the maximum advanced position, inspect the left magneto main and retard contact point timing circuit according to the appropriate manufacturer's Magneto Service Manual.
5. Reconnect the spark plug lead to the No. 1 cylinder lower spark plug.
6. Reconnect aircraft electrical power to the starter according to the airframe manufacturer's instructions.

6-3.14. Engine Gauge Inspection

CAUTION: Inaccurate aircraft engine related gauges can cause operation outside of engine certification and specification limits and can lead to decreased cylinder life. Aircraft gauge calibration errors can be particularly harmful for high horsepower engines. Gauges may require re-marking for modified (STC) engines. Significant aircraft engine gauge inaccuracies can lead to engine

Purpose

Verify proper gauge operation and ensure reliable condition feedback to the pilot.

Frequency

- During 100-hour/Annual inspection

Procedure

Verify the following indicators are working properly according to the instructions in the Aircraft Maintenance Manual. Repair or replace faulty components.

- Tachometer
- Manifold pressure gauge
- Fuel flow gauge
- Oil pressure gauge
- Oil temperature gauge
- Cylinder head temperature gauge
- Exhaust gas temperature gauge

NOTE: Verify the accuracy of the EGT indicating system. The aircraft manufacturer may require EGT reporting be operational for all categories of flight. Consult the Aircraft Maintenance Manual for interval and operational requirements. In many cases, EGT calibration is a 100-hour inspection requirement.

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6-3.15. Fuel System Inspection

Purpose

Engine operation and cooling are directly related to the correct fuel-air ratio. Improper fuel settings can affect engine performance in terms of both power and throttle response.

Purpose

- Clean the fuel filters (if equipped)
- Check the fuel supply to the carburetor for leaks

Frequency

- During 100-hour/Annual inspection

Procedure

1. Remove, inspect, clean and reinstall the gascolator or fuel filter bowl according to the airframe manufacturer's instructions.
2. Remove, clean and reinstall the carburetor fuel screen.
   a. Place the fuel selector valve in the OFF position.
   b. Remove the plug (Figure 6-35) from the female fitting on the left aft side of the carburetor bowl to reveal the fuel screen.
   c. Remove the safety wire and drain plug (Figure 6-34) from the middle of the aft end of the carburetor; discard the safety wire.
   d. Install suitable male fittings and length of hose in the fittings and torque to Appendix B specifications.
   e. Remove, clean, and reinstall the carburetor fuel screen according to the “Cleaning” instructions in Section 14-1.
   f. Route the drain hoses from the carburetor to a suitable waste fuel container.
   g. Turn the fuel selector valve to the ON position.
   h. Position the throttle to the WIDE OPEN position
   i. Flush approximately one quart of fuel (or until the fuel runs clear into the filter paper) through the carburetor into a paper filter into the waste fuel container.
   j. Position the throttle to the CLOSED position.
   k. Turn the fuel selector valve to the OFF position.
   l. Remove the fittings and hoses from the carburetor drain plugs. Apply a small amount of anti-seize lubricant to the first two male threads of the plugs and install the plugs in the carburetor bowl. Torque the plugs to Appendix B specifications.
3. Inspect fuel lines between the airframe fuel supply and the carburetor for chafing, wear, or damage. Replace worn, chafed or damaged fuel lines with new fuel lines.
4. Visually inspect all fuel lines for signs of leaks with positive pressure from the fuel supply by turning the fuel selector valve to the ON position.

5. At the completion of the leak check, turn the fuel selector valve to the OFF position.

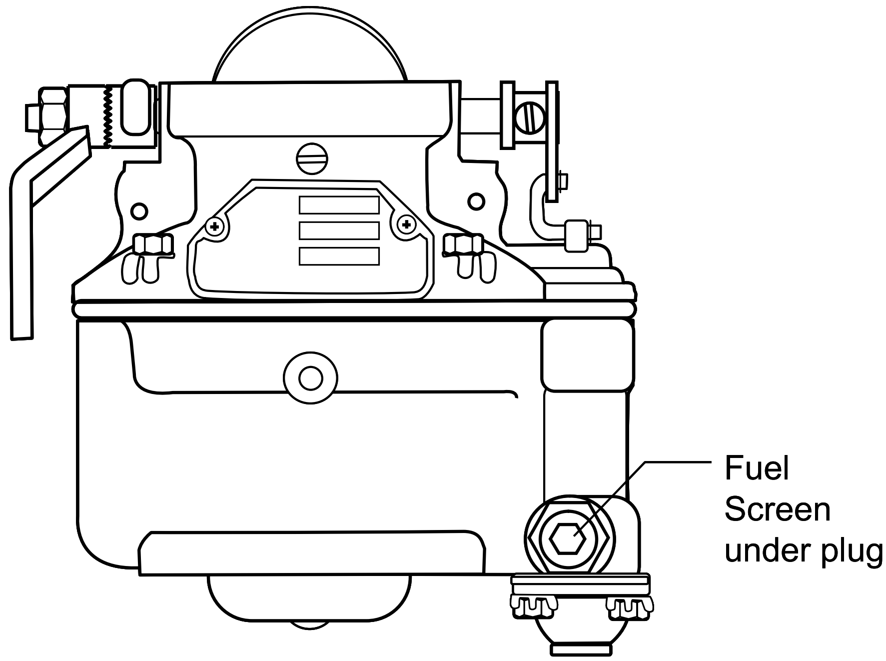

Figure 6-34. Carburetor Aft View

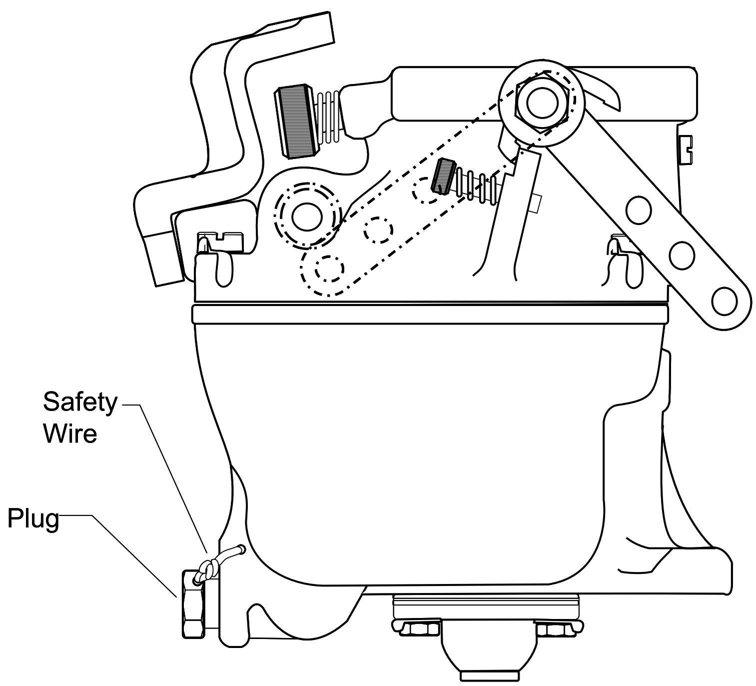

Figure 6-35. Carburetor Side View

6-3.16. Engine Control Linkage Inspection

Purpose

To ensure proper operation and to prevent accelerated wear, inspect the engine control linkage rods for excessive play, which may restrict control travel or damage control levers or cables.

Frequency

- During 100-hour/Annual inspection

Procedure

1. Inspect the pivot points of levers and linkages for debris, old grease, and oil.
2. Replace worn or corroded linkage and attaching hardware according to the airframe manufacturer's instructions.
3. Clean pivot point areas thoroughly according to instructions in Chapter 14. After cleaning, dry each area using compressed air.
4. Unless otherwise specified by the airframe manufacturer's instructions, apply LPS 2, LOCTITE Maintain^{TM} Lubricant, or equivalent to each pivot point (Figure 6-36) including the throttle shaft bushings.
5. Consult the airframe manufacturer's and/or their most current published instructions concerning aircraft engine control cable attach point inspection, cleaning, repair, installation, and lubrication.
6. Cycle the throttle and mixture controls through full range of motion.
   a. Verify each control has full range of travel and the required safeties are in place.
   b. Ensure levers and linkages do not bind and control movement is unrestricted by parts or components in close proximity.

A- Lubricate according to instructions in this manual.

B- Lubricate according to airframe manufacturer's instructions.

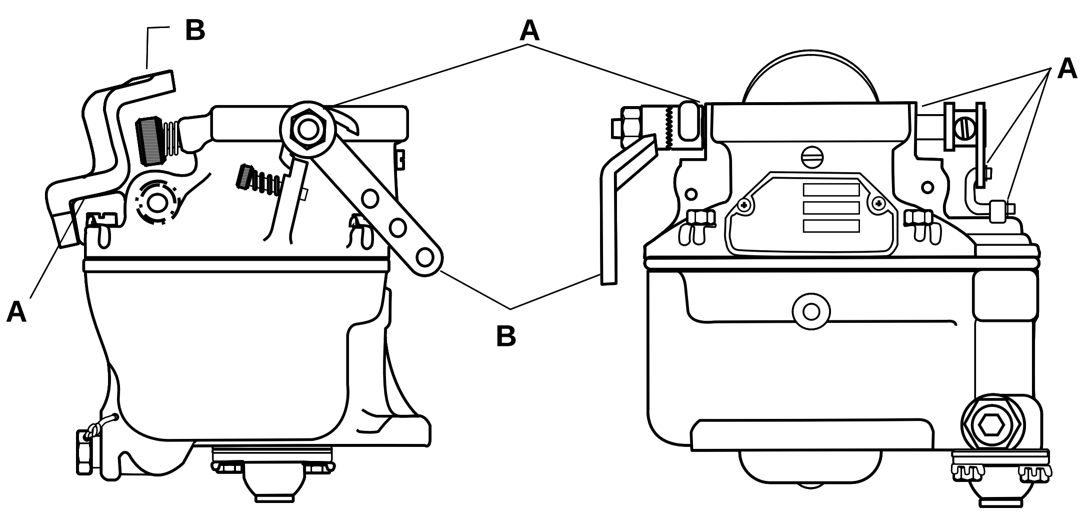

Figure 6-36. Throttle and Mixture Control Lubrication

6-3.17. Alternator Inspection

Frequency

- During 500-hour inspection

Procedure

1. Remove engine cowling and airframe components necessary to gain access to the alternator.
2. Remove the alternator according to instructions in Section 10-4.1 Perform the “Alternator Drive Hub Inspection” in Section 6-3.17.1 on all gear driven alternators.
3. Perform accessory manufacturer’s 500-Hour Alternator inspection.
   a. Inspect the Plane Power alternator brushes according to the manufacturer’s instructions (Section 1-2.2, “Related Publications”); correct any discrepancies discovered during the inspection.
   b. Replace non-Plane Power alternators with a new or rebuilt alternator or an alternator overhauled according to approved FAA procedures.
4. Install the serviceable alternator according to Section 10-4.2, “Alternator Installation” after successfully completing the alternator manufacturer's service and inspection requirements.
5. Perform the instructions in the normal “Engine Start” (Section 7-3.2) and “Ground Run-up” (Section 7-3.3) to verify alternator operation.
6. Install airframe components and cowling according to the airframe manufacturer's instructions.

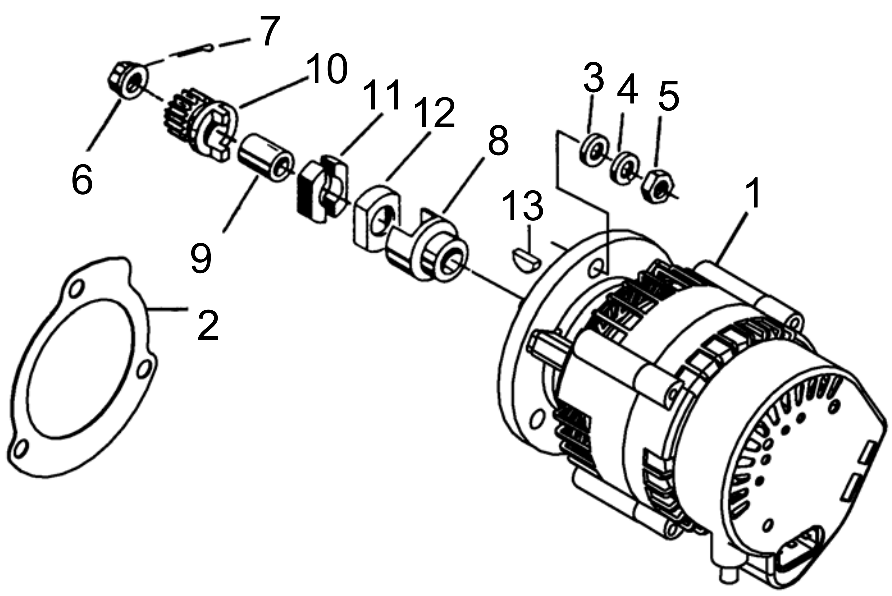

Figure 6-37. Alternator and Drive Coupling

1	Alternator	5	Nut	9	Sleeve	13	Woodruff Key
2	Gasket	6	Slotted Nut	10	Gear		
3	Washer	7	Cotter Pin	11	Bushing		
4	Lock Washer	8	Alternator Coupling Hub	12	Retainer		

6-3.17.1. Alternator Drive Hub Inspection

NOTE: This procedure only applies to the direct drive alternator. The alternator drive hub is designed to slip when abnormal torque is required to rotate the alternator shaft.

Procedure

1. Remove the upper spark plugs according to instructions in Section 6-3.8.2.
2. Perform a "Gear Tooth Inspection" according to instructions in Section 15-3.1 on the alternator drive hub gear and the crankshaft gear.
   a. Rotate the crankshaft 360° in order to inspect the circumference of the crankshaft gear.
   b. Inspect the drive hub gear teeth for damage or missing material. If damage to the drive hub clutch is suspect, or damage is obvious, perform a "Foreign Object Contamination Inspection" according to instructions in Section 6-4.6.

   NOTE: If the alternator drive hub exhibits damage or missing material, perform a "Foreign Object Contamination Inspection" according to the instructions in Section 6-4.6. Remove the foreign material from the crankcase and perform a visual inspection to determine if surrounding components were damaged as a result of the component failure.
3. Inspect the alternator drive coupling assembly for shearing or tearing; pay particular attention to the condition of the bushings (Figure 6-37) (12). Replace worn or damaged parts observed according to instructions in Section 10-4.1.2, "Alternator Drive Hub Installation."
4. Inspect the exterior of the alternator for evidence of oil leakage; Consult the alternator service instructions for oil seal replacement instructions. If the oil seal cannot be replaced, replace the alternator according to instructions in Section 10-4.
5. Install the serviceable drive hub on the alternator according to instructions in Section 10-4.1.2, "Alternator Drive Hub Installation."
6. Install the upper spark plugs according to instructions in Section 6-3.8.2.

6-4. Unscheduled Maintenance

6-4.1. Propeller Strike

A propeller strike is any incident (whether or not the engine is operating) in which the propeller contact a foreign object that 1) results in the necessity to repair the propeller blade(s) (other than minor blade dressing) or 2)results in loss of engine RPM at the time of contact. Propeller strikes can cause engine and component damage even if the propeller continues to rotate. This damage can result in catastrophic engine failure.

WARNING

Do not attempt to dress a propeller blade without consulting the propeller manufacturer's instructions. Stresses imposed on the propeller are more concentrated in areas that are nicked and cut. They may act as stress risers. Stress risers weaken the blade and can eventually cause the blade to fracture.

In cases where a small foreign object such as a small stone, strikes the propeller during operation, inspect and repair the propeller according to the propeller manufacturer's instructions. If foreign object damage requires removal of the propeller for repair(s) perform the “Propeller Strike Inspection” in Section 6-4.1.1.

6-4.1.1. Propeller Strike Inspection

Procedure

1. Remove the propeller - inspect according to propeller manufacturer's instructions.
2. Disassemble the engine according to instructions in Chapter 12 and Chapter 13.
3. Thoroughly clean the crankshaft according to instruction in Chapter 14; all surfaces, especially those forward of the front main bearing, must be free of paint, sludge, or any substance that may mask cracks.
4. Perform a “Magnetic Particle Inspection” on the crankshaft, connecting rods, gears and remaining steel internal engine parts according to instructions in Section 15-5.
5. Clean the crankcase thoroughly according to instruction in Chapter 14; all surfaces must be free of paint, sludge, or any substance that may mask reliable inspection.
6. Perform a “Fluorescent Penetrant Inspection” on the crankcase according to instructions in Section 15-4, paying particular attention to the forward crankcase bearing support and adjacent structure.
7. Inspect the remainder of the engine according to the instructions in Chapter 15.
8. Perform the aircraft inspections required by the airframe manufacturer.
9. Inspect all engine accessories according to the manufacturer's instructions.
10. Regardless of condition, replace all counterweight pins, bushings, end plates and snap rings. Replace all connecting rod nuts and bolts, regardless of condition.
11. Assemble the engine according to instructions in Chapter 16 and Chapter 17, replacing items identified in the Section C-2.3, “100% Parts Replacement Requirements” and Section C-2.4, “Mandatory Overhaul Replacement Parts.”

6-4.2. Hydraulic Lock Inspection

Hydraulic lock occurs when fluid accumulates in the induction system or the cylinder assembly. The fluid restricts piston travel during the compression stroke. Engine damage occurs when the other cylinders fire, forcing the piston in the fluid filled cylinder through the compression stroke. Engine damage from hydraulic lock can be extensive due to the high stresses generated, which can adversely affect connecting rods, pistons, cylinder assemblies, piston pins, the crankcase, and crankshaft. Hydraulic lock may occur because of any of the following:

- Improper maintenance of the cylinder fuel drain lines
- Improper starting procedures
- Failure to properly remove preservative oil from an engine returned from storage

WARNING

Do not operate the engine if hydraulic lock is suspected.

1. Remove the engine from the aircraft according to instructions in Section 5-1.
2. Disassemble the engine and remove all cylinders and connecting rods according to instructions in Chapter 12 and Chapter 13.
3. Perform a “Connecting Rod Magnetic Particle Inspection” according to the instructions in Section 15-5.1 and “Connecting Rod Dimensional Inspection” according to Section 15-6.2.1. If all connecting rods pass the inspection criteria, proceed to step 5, otherwise continue with the step 4.

   NOTE: Destroy the stressed parts to prevent future installation.

4. If any connecting rod fails the inspection criteria, disassemble the engine completely according to Chapter 12 and Chapter 13. Clean the crankcase, cylinders and pistons according to instructions in Chapter 14. Perform Magnetic Particle, Fluorescent Penetrant and Ultrasonic Inspections, as appropriate, on the crankshaft, crankcase and cylinder parts. Perform the dimensional inspections for the crankcase and crankshaft according to Chapter 15 instructions. Replace any part which fails the inspection criteria and destroy the faulty part(s).
5. Reassemble the engine according to Chapter 16 and Chapter 17 and perform the “Post-Overhaul Test and Adjustments” according to instructions in Chapter 18.

6-4.3. Engine Overspeed Inspections

Operating an engine beyond its capacity can damage the engine and result in subsequent engine failure. Engine overspeed severity is divided into three categories in Table 6-7:

Table 6-7. Overspeed Categories

Category	Engine Speed
CAT I	Rated Full power RPM to 3000 RPM
CAT II	3000-3300 RPM
CAT III	Over 3300 RPM

NOTE: Rated RPM limits for aircraft equipped with digital RPM measuring equipment may be adjusted to include a +2% deviation for normal operations. Any operation beyond the rated RPM limit plus the 2% deviation must follow the inspection criteria.

6-4.3.1. Category I Overspeed Inspection

If the duration of the overspeed event is less than ten seconds, no action is required. If the overspeed event persists longer than 10 seconds, land the plane and perform the following inspection:

Procedure

1. Drain oil and inspect for debris. Remove the oil filter and inspect the filter element for debris.
2. Remove the rocker covers and inspect the following for damage or debris:
   a. Valves
   b. Springs
   c. Rocker arms
   d. Tappets
   e. Spring retainers
   f. Pushrods
3. Inspect components using the service limits in Chapter 10; repair and assemble the engine components according to instructions Chapter 15 through Chapter 18.
4. Check accessory drives for excessive backlash.
5. Service the engine with new oil and oil filter according to instructions in Section 6-3.7.2.
6. If no discrepancies are noted, repeat step 1 after five hours of accumulated flight.

6-4.3.2. Category II Overspeed Inspection

If the overspeed event duration is less than ten seconds, no action is required. If the overspeed event lasts longer than 10 seconds, land the plane and perform the following inspection:

Procedure

1. Complete Category I inspection and service requirements.
2. Remove all cylinder assemblies, including pistons and rods.
3. Remove all counterweights.
4. Replace all connecting rod nuts and bolts. Inspect remaining components using service limit tolerances in Chapter 10 and assemble the engine according to instructions in Chapter 16 and Chapter 17.

6-4.3.3. Category III Overspeed Inspection

Overspeed conditions in this category are considered extreme. Category III overspeed cases must be evaluated based on factors at the time of the incident. A Customer Service representative (see “Contact Information”in Section 1-3) will assist in determining required actions to return the engine to an airworthy service condition.

Procedure

1. Remove the engine and clearly identify the reason for removal:

   “Removed for excessive overspeed”

2. Perform a complete engine overhaul. Replace the following without regard to overhaul inspection limits:
   a. connecting rods
   b. connecting rod bolts and nuts
   c. all valve train components

6-4.4. Lightning Strike Inspection

Procedure

1. Remove the engine according to instructions in Section 5-1.
2. Disassemble the engine according to instructions in Chapter 12 and Chapter 13.
3. Inspect the engine for arcing and heat damage to the crankshaft rod journals, main journals, camshaft lobes, bearings, gear teeth, and all other hardened surfaces. Perform a “Magnetic Particle Inspection” according to instructions in Section 15-5 and degauss all steel parts of the engine during the inspection.
4. Perform dimensional inspections on the remaining parts according to Chapter 15 using to the Service Limits in Chapter 10. Replace all non-conforming parts.
5. Reassemble the engine according to instructions in Chapter 15 through Chapter 18.

6-4.5. Contaminated Fuel System Inspection

Engines described in this manual are certified for operation with 100-LL Blue aviation fuels. If the fuel tanks are filled with an improper grade of fuel the engine is not operated with the improper grade of fuel, purge the fuel tanks according to the aircraft maintenance manual instructions. If the engine is operated with an incorrect grade of aviation fuel or jet fuel:

Procedure

1. Do not fly the aircraft.
2. Drain and purge the aircraft fuel system according to the aircraft manufacturer's instructions.
3. Disassemble, clean, and inspect the engine according to instructions in Chapter 12 through Chapter 14. Replace any cylinder, piston, piston pin, connecting rod or crankshaft exhibiting signs of detonation.
4. Reassemble and test the engine according to instructions in Chapter 15 through Chapter 18.

6-4.6. Foreign Object Contamination Inspection

Foreign Object Damage (FOD) occurs when material that wasn't included in the original design contacts (internally or externally) and contaminates the engine. FOD can increase friction, prohibit normal distance of travel, block oil passages, accelerate wear on contact surfaces or cause immediate catastrophic failure of components or the entire engine. FOD may be caused by external elements (i.e. sand, grit or metal shavings) or debris from fractured internal components such as an improperly torqued fasteners.

WARNING

Exercise strict housekeeping standards when performing aircraft and engine maintenance. Inventory tools before and after performing maintenance. When replacing engine parts, remove all remnants (safety wire, gasket material, o-rings, fragmented parts, etc.) of the removed part from the engine before installing the new part.

Procedure

1. Drain the engine oil and remove the oil sump from the crankcase.
2. Conduct a thorough inspection of the oil sump, crankcase, crankshaft, camshaft, cylinder walls and pistons for the presence of, or damage caused by foreign objects.
   a. If damage is discovered or any portion of the foreign material is not accounted for: disassemble, clean, inspect, repair and assemble the engine according to instructions in Chapter 12 through Chapter 18 using the service limits in Chapter 10.

CAUTION: Continental Motors recommends engine disassembly and thorough inspection of the entire engine before assembly and return to service following a foreign object contamination event. Minimum inspection requirements are provided in step b if the *owner/operator determines no foreign material remains in the engine and elects to not perform a complete inspection. Continental Motors assumes no responsibility for engine operation or airworthiness after a contamination event.*

b. If 100% of the foreign material is retrieved from the oil sump and no further material is discovered, clean the sump according to instructions in Chapter 14; install the oil sump, service the engine oil and return the engine to service. Perform the next three oil changes at ten hour intervals to confirm lack of foreign material in the oil.

3. Correct discrepancies discovered during the inspection. Do not return the engine to service until the contamination is eliminated and appropriate repairs are made to correct any discrepancies discovered during the inspection.

6-5. Inspection Checklists

Inspection checklists are included as a convenient record of inspection progress and findings. Using a copy of the form ensures a blank form will be available for the next scheduled inspection. When an inspection is due, make a copy of the inspection checklist to record inspection progress and findings while following the steps in the inspection procedures. The checklists are not designed to replace the procedures; only augment them. File the completed checklists in the aircraft logbook.

Table 6-8. Engine Operational Checklist

Date:	
Aircraft ID:	
Total Engine Time:	
Tech Name:	
Pressure Altitude:	
Outside Air Temp:	

Idle RPM					Acceleration	Wide Open Throttle					RPM Mixture Rise
RPM	EGT	CHT	OIL PRESS	OIL TEMP	Smooth?	RPM	EGT	CHT	OIL PRESS	OIL TEMP	

Mixture Adjustments		Idle RPM Adjustments	
CW	CCW	CW	CCW

Flight Check Data

WOT RPM	Pressure Altitude	EGT °F	CHT °F	Oil Pressure (PSI)	Oil Temp °F

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Table 6-9. 25-Hour Initial Operation Inspection Checklist		
Engine Model Number: __________________ Engine Serial Number: ________________ Total Time Engine Has Been in Service: ______________ Time Since Major Overhaul (TSMOH) _________________ Engine in Storage? ________ Date Inspection Performed: ________ Inspection Performed by:____________________		
Complete the 25-hour inspection according to the instructions referenced in the table, heeding all warnings, cautions and notes. Initial the block beside the procedure upon completion. Note discrepancies in the Inspector Comments or Remarks sections.		
Inspection Item	**Initials**	**Inspector Comments**
"Visual Inspection" (Section 6-3.5)		
Check Oil Consumption (Section 6-3.1)		
Collect an oil sample and submit to laboratory for spectrographic analysis. (Section 6-3.7.4 and Section 6-3.7.5)		
"Induction System Inspection" (Section 6-3.12)		
Change Engine Oil and Filter (Section 6-3.7.2)		
Engine Run (Section 7-3.2)		
•Idle RPM:		
•Idle Mixture Cutoff Rise		
•Acceleration		
Remarks:		
Approval Block:		
Checklist Page 1 of 1		

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Table 6-10. 50-Hour Engine Inspection Checklist		
Engine Model Number: ________________ Engine Serial Number: _______________ Total Time Engine Has Been in Service: _____________ Time Since Major Overhaul (TSMOH) _______________ Engine in Storage? _______ Date Inspection Performed: _______ Inspection Performed by:__________________		
Complete the 50-hour inspection according to the instructions referenced in the table, heeding all warnings, cautions and notes. Initial the block beside the procedure upon completion. Note discrepancies in the Inspector Comments or Remarks sections.		
Inspection Item	Initials	Inspector Comments
Oil Consumption and Trend Monitoring		
Oil Analysis Profile Established? (Section 6-3.7.5)		
Oil Analysis Laboratory used?		
Date of last oil sample analysis:		
Silicone content of last sample:		
Oil consumption quantity noted during oil change:		
Is oil consumption excessive? ❑ Yes ❑ No		
“Visual Inspection” (Section 6-3.5)		
Oil and Filter Change (Section 6-3.7.2)		
“Induction System Inspection” (Section 6-3.12)		
Engine Run (Section 7-3.2)		
•Idle RPM:		
•Idle Mixture Cutoff Rise		
•Acceleration		
Remarks:		
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Checklist Page 1 of 1		

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Table 6-11. 100-Hour Engine Inspection Checklist

Engine Model Number: ________________ Engine Serial Number: ______________

Total Time Engine Has Been in Service: ____________

Time Since Major Overhaul (TSMOH) _______________ Engine in Storage? ______

Date Inspection Performed: ______ Inspection Performed by:_________________

Complete the 100-hour inspection according to the instructions referenced in the table, heeding all warnings, cautions and notes. Initial the block beside the procedure upon completion. Note discrepancies in the Inspector Comments or Remarks sections.

Inspection Item	Initials	Inspector Comments
Engine Operational Check(Section 6-3.6)		
Oil Consumption and Trend Monitoring		
Oil Analysis Profile Established? (Section 6-3.7.5)		
Oil Analysis Laboratory used?		
Date of last oil sample analysis:		
Silicone content of last sample:		
Oil consumption quantity noted during oil change:		
Is oil consumption excessive? ❑ Yes ❑ No		
"Visual Inspection" (Section 6-3.5)		
Accessory Mounting and Security Inspection (Step 13 in Section 6-3.3)		
"Cylinder Inspections"(Section 6-3.9) using the Cylinder Inspection Checklist (Table 6-13 on page 77)		
"Crankcase Inspection"(Section 6-3.10)		
"Engine Mount Inspection" (Section 6-3.11)		
"Induction System Inspection" (Section 6-3.12)		
"Ignition System Inspection" (Section 6-3.13)		
"Engine Gauge Inspection" (Section 6-3.14)		
"Fuel System Inspection" (Section 6-3.15)		
"Engine Control Linkage Inspection" (Section 6-3.16)		
Oil and Filter Change (Section 6-3.7.2)		
Engine Operational Check (Section 6-3.6)		

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Table 6-11. 100-Hour Engine Inspection Checklist

Engine Model Number: ___________________ Engine Serial Number: _________________ Total Time Engine Has Been in Service: _______________ Time Since Major Overhaul (TSMOH) __________________ Engine in Storage? ________ Date Inspection Performed: ________ Inspection Performed by:_____________________
Remarks:
Approval Block:
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Table 6-12. 500-Hour Engine Inspection Checklist

Engine Model Number: ___________________ Engine Serial Number: _________________

Total Time Engine Has Been in Service: _______________

Time Since Major Overhaul (TSMOH) __________________ Engine in Storage? ________

Date Inspection Performed: ________ Inspection Performed by:____________________

Complete the 500-hour inspection according to the instructions referenced in the table, heeding all warnings, cautions and notes. Initial the block beside the procedure upon completion. Note discrepancies in the Inspector Comments or Remarks sections.

Inspection Item	Initials	Inspector Comments
Engine Operational Check(Section 6-3.6)		
Oil Consumption and Trend Monitoring		
Oil Analysis Profile Established? (Section 6-3.7.5)		
Oil Analysis Laboratory used?		
Date of last oil sample analysis:		
Silicone content of last sample:		
Oil consumption quantity noted during oil change:		
Is oil consumption excessive? ❑ Yes ❑ No		
"Visual Inspection" (Section 6-3.5)		
Accessory Mounting and Security Inspection (Step 13 in Section 6-3.3)		
Paper Induction Filter Replacement (Section 6-3.4)		
"Cylinder Inspections"(Section 6-3.9) using the "Cylinder Inspection Checklist" (Table 6-13)		
"Crankcase Inspection"(Section 6-3.10)		
"Engine Mount Inspection" (Section 6-3.11)		
"Induction System Inspection" (Section 6-3.12)		
"Ignition System Inspection" (Section 6-3.13)		
500-Hour (Continental Motors Magneto) Inspection or (non-Continental Motors) magneto replacement (Section 6-3.13)		
"Engine Gauge Inspection" (Section 6-3.14)		
"Fuel System Inspection" (Section 6-3.15)		
"Engine Control Linkage Inspection" (Section 6-3.16)		
"Alternator Inspection" (Section 6-3.17)		
Oil and Filter Change (Section 6-3.7.2)		
Engine Operational Check (Section 6-3.6)		

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Table 6-12. 500-Hour Engine Inspection Checklist

Engine Model Number: ___________________ Engine Serial Number: _________________ Total Time Engine Has Been in Service: _______________ Time Since Major Overhaul (TSMOH) __________________ Engine in Storage? ________ Date Inspection Performed: ________ Inspection Performed by:_____________________
Remarks:
Approval Block:
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Table 6-13. Cylinder Inspection Checklist

Engine Model Number: __________________ Engine Serial Number: ________________				
Total Time Engine Has Been in Service: ______________				
Time Since Major Overhaul (TSMOH) _________________ Engine in Storage? ________				
Date Inspection Performed: ________ Inspection Performed by:____________________				
Complete the 500-hour inspection according to the instructions referenced in the table, heeding all warnings, cautions and notes. Initial the block beside the procedure upon completion. Note discrepancies in the Inspector Comments or Remarks sections.				
Complete a visual inspection of the cylinder exterior and power stroke areas for signs of cracks, leaks, rust or pitting (Section 6-3.9.1).				
Cylinders				
1	2	3	4	
❑	❑	❑	❑	
Complete a visual inspection of the cylinder head barrel, fins, ports and bosses for evidence of fuel oil or soot (Section 6-3.9.1)				
Cylinders				
1	2	3	4	
❑	❑	❑	❑	
Inspect the cylinder to crankcase mounting deck for visible signs of RTV sealant (Section 6-3.9.4).				
Cylinders				
1	2	3	4	
❑	❑	❑	❑	
Differential Pressure Check (Section 6-3.9.2)				
Baseline Master Orifice Reading Calibration:				
Cylinders				
1	2	3	4	
NOTES:				
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Table 6-13. Cylinder Inspection Checklist

Engine Model Number: __________________ Engine Serial Number: ________________

Total Time Engine Has Been in Service: ______________

Time Since Major Overhaul (TSMOH) _________________ Engine in Storage? _______

Date Inspection Performed: _______ Inspection Performed by:___________________

Cylinder Borescope Findings (Section 6-3.9.3)

Place a check mark in the column of any cylinder exhibiting the characteristics described in the left column.

Condition	1	2	3	4
Normal Wear.	❑	❑	❑	❑
Light Rust (acceptable in absence of excessive oil consumption or leaks)	❑	❑	❑	❑
Small areas of heavy rust (less than ½ inch diameter)	❑	❑	❑	❑
Heavy rust (greater than ½ inch)	❑	❑	❑	❑
Pitting of on cylinder wall.	❑	❑	❑	❑
Heavy wear	❑	❑	❑	❑
Scoring	❑	❑	❑	❑
Static seal leakage	❑	❑	❑	❑
Other discrepancies	❑	❑	❑	❑

Cylinder Inspection Summary

Place a check mark in the column of any cylinder exhibiting the characteristics described in the left column. Cylinders exhibiting the following characteristics must be removed and repaired or replaced according to the instructions in Section 10-7, “Engine Cylinder Maintenance.”

Condition	1	2	3	4
Heavy rust, characterized by pitting of the cylinder wall	❑	❑	❑	❑
Scoring or scratches in the honed surface of the cylinder wall (or bore)	❑	❑	❑	❑
Blistered paint on the cylinder barrel/other evidence of excessive wear and internal heat	❑	❑	❑	❑
Cylinder subjected to overheating/ detonation/piston scoring or piston pin damage to the cylinder bore.	❑	❑	❑	❑
Cylinder with radial fin crack extending to root of fin	❑	❑	❑	❑

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Table 6-13. Cylinder Inspection Checklist

Engine Model Number: ________________ Engine Serial Number: ______________

Total Time Engine Has Been in Service: ____________

Time Since Major Overhaul (TSMOH) _______________ Engine in Storage? ______

Date Inspection Performed: ______ Inspection Performed by:_________________

Cylinder with barrel fin crack	❑	❑	❑	❑
Cylinder head turned in relation to barrel flange	❑	❑	❑	❑
Heavy bore wear	❑	❑	❑	❑
Cylinder leaks	❑	❑	❑	❑
Low differential pressure/ excessive oil consumption	❑	❑	❑	❑
Static seal leakage/head to barrel leakage, or crack in head or barrel	❑	❑	❑	❑

Inspection Follow-up

Check all column(s) that apply to the scope of inspection and repair.

Condition	1	2	3	4
Cylinder passed inspection	❑	❑	❑	❑
Repaired Cylinder	❑	❑	❑	❑
Replaced Cylinder	❑	❑	❑	❑

Remarks:

Approval Block:

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Chapter 7. Engine Operation

7-1. Introduction

CAUTION: This section pertains to engine operations under various operating conditions. Normal operations are presented first, followed by emergency and abnormal operating conditions. The pilot must read and thoroughly understand Section 6-4 and Section 6-5 of the Engine Operating Instructions in the Engine Installation and Operation Manual (OI-2) prior to the occurrence of such conditions. Whenever abnormal conditions arise, timely response is critical.

This chapter contains the O-200 engine ground operating instructions to facilitate maintenance personnel during:

- Normal Engine Operation
- Engine Operation in Abnormal Environments

7-2. Flight Prerequisites

If the engine is newly installed and/or has been repaired/overhauled, perform the sequential tasks listed in the “Engine Operational Check” instructions in Section 6-3.6 prior to releasing the engine for normal operation.

WARNING

The “Engine Operational Check” in Section 6-3.6 must be completed on an engine that has been installed, inspected, repaired, or overhauled before the aircraft can be released for normal operation.

DO NOT FLY THE AIRCRAFT UNTIL ALL FLIGHT PREREQUISITES HAVE BEEN MET.

NOTE: Environmental conditions (humidity), seasonal changes, and engine usage influence susceptibility to corrosion. Engines that are flown occasionally (less than one time per week) are more vulnerable to corrosion under these conditions. The best method of reducing the risk of corrosion is to fly the aircraft weekly for at least one hour. The owner/ operator is ultimately responsible for recognizing corrosion and taking appropriate corrective action.

After successful completion of the Engine Operational Check, perform a Flight Check according to instructions in Section 7-2.3.

7-2.1. Oil Change Interval

NOTE: After the first 25 hours of operation, perform an oil change according to the “Engine Oil Servicing”instructions in Section 6-3.7.

The Oil Change Interval is specified in Table 6-1, “Engine Inspection and Maintenance Schedule.”

7-2.2. Engine Fuel Requirements

WARNING

The engine is certified for operation with 100-LL aviation fuel. If the minimum fuel grade is not available, use the next higher grade. Never use a lower grade fuel. The use of lower octane fuel may result in damage to, or destruction of, an engine the first time high power is applied.

If the aircraft is inadvertently serviced with the incorrect grade of aviation fuel or jet fuel, the fuel system must be completely drained and the fuel tanks serviced in accordance with the aircraft manufacturer's recommendations. After the fuel system is decontaminated, inspect the engine according to the “Contaminated Fuel System Inspection” instructions in Section 6-4.5.

7-2.3. Flight Check and Break-In

New and factory rebuilt Continental Motors engines are calibrated in a test cell prior to shipment. A flight check ensures the engine meets operational and performance specifications after installation in the airframe, prior to release for normal service. The recommended break-in period for Continental Motors engines is 25 hours. Adhere to the following instructions and the “Engine Specifications” in Section 2-3 applicable to your engine model.

Perform an “Engine Operational Check” according to instructions in Section 6-3.6 and a normal preflight ground run-up in accordance with the Airplane Flight Manual or Pilot's Operating Handbook (AFM/POH) before the A&P mechanic can approve the airplane for a Flight Check. Perform a Flight Check according to instructions in Section 7-2.3.2 after engine installation, inspection, repairs, or adjustments. Follow the protocol specified in Section 7-2.3.1 to complete the recommended 25 hour engine break-in period.

WARNING

Avoid long descents at high engine RPM to prevent undesirable engine cooling. If power must be reduced for long periods, adjust the propeller to minimum governing RPM, if equipped, to obtain desired performance levels. If outside air temperature is extremely cold, it may be desirable to increase drag to maintain engine power without gaining excess airspeed. Do not permit cylinder head temperature to drop below 300°F (149°C).

CAUTION: High power ground operation resulting in cylinder and oil temperatures exceeding normal operating limits can be detrimental to cylinders, pistons, valves, and rings.

7-2.3.1. Engine Break-In

Operate the engine within the limits specified in the "Engine Specifications" in Section 2-3 at all times for twenty-five hours to complete the recommended break-in period. Descend at low cruise power settings. Avoid long descents or descents with cruise power RPM and manifold pressure below 18 inches Hg. If necessary, reduce engine RPM to the bottom of the specified operating range to maintain sufficient manifold pressure. Carefully monitor engine instrumentation to maintain levels above the minimum specified cylinder head temperature and oil temperature.

1. Conduct a normal engine start, ground run-up and take-off according to the AFM/POH.
2. Monitor a) engine RPM, b) fuel flow, c) oil pressure and temperature, d) cylinder head temperature and e) exhaust gas temperature to ensure the engine does not exceed the parameters in Section 2-3.
3. Reduce engine speed to climb power according to the AFM/POH instructions. maintain a shallow climb attitude to achieve optimum airspeed and cooling airflow.
4. At cruise altitude:

   NOTE: Best power mixture setting is 100°-150°F rich of peak exhaust gas temperature. Adjust engine controls or aircraft attitude to maintain indicated engine operation within specifications.

   a. Maintain level flight cruise at 75% power with best power or richer mixture for the first hour of operation.

   b. For the second and subsequent hours of flight, alternate cruise power settings between 65% and 75% power with appropriate best power mixture settings.

WARNING

Avoid long descents at high engine RPM to prevent undesirable engine cooling. If power must be reduced for long periods, adjust the propeller to minimum governing RPM, if equipped, to obtain desired performance levels. If outside air temperature is extremely cold, it may be desirable to increase drag to maintain engine power without gaining excess airspeed. Do not permit cylinder head temperature to drop below 300°F (149°C).

5. Descend at low power cruise settings. Avoid long descents or descents at cruise power RPM with manifold pressure below 18 in. Hg. If necessary, reduce engine RPM to the lower limit of the operating range to maintain sufficient manifold pressure. Carefully monitor engine instrumentation to maintain levels above the minimum specified cylinder head temperature and oil temperature.

7-2.3.2. Flight Check

1. Conduct a normal engine start, ground run-up and take-off according to the AFM/POH.
2. Monitor the following engine instrument panel indications: a) engine RPM, b) fuel flow, c) oil pressure and temperature, d) cylinder head temperature and e) exhaust gas temperature.
3. If the engine fails to reach the rated full throttle RPM during ground operations, ascend to cruise altitude (>2000' above field elevation) and verify the engine achieves full throttle, full rich, rated RPM at cruise altitude and operates within the limits specified in Section 2-3; If full power, rated RPM is achieved, proceed to step 4. If the aircraft indicated values fail to meet the published limits, repeat the Engine Operational Check and Flight Check.

WARNING

All abnormal conditions must be corrected prior to releasing the aircraft for normal operation.

4. Release the engine to normal service.

7-3. Normal Operation

Information in this section is extracted from the Engine Installation Manual (OI-2) for the convenience of maintenance personnel. Adhere to the aircraft AFM/POH operating procedures aircraft flight operating instructions.

WARNING

Before flying the aircraft, ensure all “Flight Prerequisites” in Section 7-2 have been completed, in addition to the aircraft manufacturer's instructions found in the AFM/POH.

Operation of a malfunctioning engine can result in additional damage to the engine, bodily injury or death.

Supplemental instructions for normal operation in this section are:

- Pre-operational Requirements
- Engine Start
- Ground Run-up
- Engine Shutdown

7-3.1. Pre-operational Requirements

1. Check the oil level, and verify the quantity is with specified limits.
2. Verify oil fill cap and gauge rod are secure.
3. Drain the fuel sumps and strainers according to the airframe manufacturer's recommendations into a clean container. If water or foreign matter is noted in the drained fuel, continue to drain until only clean fuel flows from the drains
4. Check the fuel system according to the Airplane Flight Manual (AFM) / Pilot's Operating Handbook (POH) and verify compliance with Section 7-2.2, “Engine Fuel Requirements.”
5. Check propeller and propeller hub for cracks, oil leaks, and security.
6. Check engine nacelle for signs of damage, leaks, and debris. Verify the engine cowling is securely fastened.
7. Verify all baffles and baffle seals are installed, correctly positioned, and serviceable.
8. Ensure engine controls operate freely through their full range of travel and are properly adjusted in accordance with airframe manufacturer's instructions.

7-3.2. Engine Start

Refer to the aircraft POH for detailed engine starting procedures. Complete Section 7-3.1, "Pre-operational Requirements" prior to engine start. Be familiar with the quantity and location of the engine fuel system drains.

WARNING

Do not attempt to start an engine with an over-primed or flooded induction system. Starting an engine with a flooded induction system can result in hydraulic lock and subsequent engine malfunction or failure. Allow excess fuel to drain from the intake manifold and/or cylinder prior to attempting to start the engine.

When starting the engine, ensure the battery is completely charged, especially in sub-freezing temperatures.

CAUTION: Attempting to start an engine with a partially discharged aircraft battery may result in damage to the starter relay or possible engine kick-back resulting in a broken starter adapter clutch spring.

Verify the tasks listed in Table 7-2, "Flight Prerequisites," have been completed in addition to those required by the aircraft POH, aircraft manufacturer, or Supplemental Type Certificate (STC) holder. Note the following:

- If the engine is being started in extreme cold, preheating may be required. Refer to Section 7-4.1, "Engine Operation in Extreme Cold."
- If the engine is started in hot weather, refer to Section 7-4.2, "Engine Operation in Hot Weather."
- If the engine is being started at high altitude, refer to Section 7-4.3, "Ground Operation at High Density Altitude."

WARNING

Ensure the propeller arc is clear of personnel and obstructions before starting the engine.

NOTE: Check oil pressure frequently. Oil pressure indication must be noted within 30 seconds in normal weather. If no oil pressure is observed, stop the engine and investigate the cause.

1. Propeller.. Clear
2. Master Switch .... ON
3. Ignition Switch.. BOTH
4. Mixture Control .... FULL RICH
5. Fuel Selector Valve .... ON or Fullest Tank
6. Throttle.. FULL OPEN

NOTE: The amount of prime required depends on engine temperature. Familiarity and practice will enable to operator to accurately estimate the amount of prime to use. If the engine is hot, do not prime before starting. After priming, turn the primer handle to the “LOCKED” position to prevent the engine from drawing fuel from the primer.

7. Prime (if equipped) .... Operate 3-5 strokes
8. Throttle.. Open approximately one (1) inch

WARNING

Ensure the propeller plane of rotation is clear before engaging the starter.

CAUTION: Release starter switch as soon as engine fires. Never engage the starter while the propeller is still turning. Do not engage the starter for longer than 10 seconds. Allow 20 seconds for the starter to cool after each engagement. If engine start is unsuccessful after six attempts, release the starter switch and allow the starter motor to cool for 30 minutes before another starting attempt is made.

9. Ignition Switch... START

   NOTE: Check oil pressure frequently. Oil pressure indication must be noted within 30 seconds in normal weather. If no pressure is observed, stop the engine and investigate the cause.

10. Oil Pressure.. Check

RESULT: Engine starts and runs smoothly at idle; indicated oil pressure is greater than 10 psi. If the engine fails to start, refer to the troubleshooting instructions in Section 8.

7-3.2.1. Cold Start

Follow the AFM/POH instructions, using the same procedure as for a normal start.

7-3.2.2. Flooded Engine

If prolonged starting occurs, verify fuel. Do not attempt further starting until excess fuel has drained from the engine. Hydraulic lock may be a cause of engine starting problems. Hydraulic lock is a condition where fluid accumulates in the Induction System or the cylinder assembly.

WARNING

Do not operate the engine if hydraulic lock is suspected. Engine damage may occur. Perform a “Hydraulic Lock Inspection” according to instructions in Section 6-4.2. If no fuel drainage is observed, discontinue starting attempts until the cause is determined.

7-3.2.3. Hot Start

NOTE: For several minutes after stopping a hot engine, heat soaked components, (especially the fuel pump, if equipped) may cause fuel vaporization resulting in restarting difficulties.

To reduce difficulty, supplement the AFM/POH normal starting instructions with the following steps:

1. Fuel Selector Valve .... ON
2. Throttle.. CLOSED
3. Mixture Control: .... IDLE CUT OFF
4. Allow fuel to drain from intake prior to engine start; follow AFM/POH starting instructions.

7-3.3. Ground Run-up

CAUTION: DO NOT operate the engine at run-up speed unless the oil temperature is at least 75°F (24°C) and the oil pressure is within the 30-60 psi range. Operating the engine above idle before reaching minimum oil temperature may cause a loss of oil pressure and engine damage. Avoid prolonged engine operation at low RPM to prevent spark plug fouling.

1. Maneuver aircraft nose into wind
2. Throttle.. IDLE
3. Mixture.. FULL RICH
4. Throttle.. 900-1000 RPM
5. Maintain engine RPM between 900 and 1000 RPM for at least one minute or until engine oil temperature exceeds 75°F (24°C).

WARNING

Absence of RPM drop during the magneto check may be an indication of a faulty ignition circuit resulting in a condition known as "Hot Magneto." Should the propeller be turned by hand, the engine may inadvertently start and cause personal injury or death. This condition must be corrected prior to continued aircraft operation.

CAUTION: Do not underestimate the importance of the magneto check. When operating on single ignition, some RPM drop should be noted. Normal indications are 25-75 RPM drop and slight engine roughness as each magneto is switched off. RPM drop exceeding 150 RPM may indicate a faulty magneto or fouled spark plugs.

NOTE: If the engine runs roughly after single magneto operation, increase engine speed to 2200 RPM in the BOTH position and lean the mixture control until the RPM peaks for ten seconds before returning to the full rich position to clear the spark plugs and smooth operation before returning to single magneto operation.

Limit ground operation to time necessary to complete engine warm-up and pre-flight checkout.

6. Throttle..1700 RPM

   a. Magneto Checkout

      1) Ignition Switch......................................R
         RESULT: Noticeable RPM (not to exceed 150 RPM) drop and slight engine roughness; record Left Magneto channel drop results. Maximum allowable RPM drop spread between magneto channels is 75 RPM.

      2) Ignition Switch......................................BOTH
         RESULT: Engine speed returns to normal. Allow Ignition switch to remain in BOTH for approximately 30 seconds to clear engine.

      3) Ignition Switch......................................L
         RESULT: Noticeable RPM (not to exceed 150 RPM) drop and slight engine roughness. The difference between magnetos individual operation should not exceed 75 RPM. Maximum RPM drop for either magneto is 150 RPM. Observe engine smoothness during magneto switching.

   CAUTION: Do not operate the engine at speeds in excess of 2000 RPM longer than necessary to complete ground checks. Proper engine cooling depends upon forward motion of aircraft. Discontinue testing if temperature or pressure limits are approached.

   b. Minor spark plug fowling can be cleared as follows:

      1) Ignition Switch......................................BOTH

      2) Throttle...2200 RPM

      3) Mixture Control.....................................lean until RPM peaks for 10 seconds.

      4) Mixture Control.....................................FULL RICH

7. Throttle..1200 RPM

7-3.4. Engine Shutdown

Supplement the AFM/POH engine shutdown procedures with the following:

1. Throttle..1700 RPM

WARNING

Absence of RPM drop during the magneto check may be an indication of a faulty ignition circuit resulting in a condition known as “Hot Magneto.” Should the propeller be turned by hand, the engine may inadvertently start and cause personal injury or death. This condition must be corrected prior to continued aircraft operation.

CAUTION: When operating on single ignition, some RPM drop should be noted. Normal indications are up to 150 RPM drop and slight engine roughness as each magneto is switched off. RPM drop in excess of 150 RPM may indicate a faulty magneto or fouled spark plugs. Avoid prolonged single magneto operation to preclude spark plug fouling.

NOTE: The difference between magnetos individual operation should not exceed 50 RPM. Maximum RPM drop for either magneto is 150 RPM. Observe engine smoothness during magneto switching.

NOTE: If the engine runs roughly after single magneto operation, increase engine speed to 2200 RPM in the BOTH position and lean the mixture control until the RPM peaks for ten seconds before returning to the full rich position to clear the spark plugs and restore smooth operation before returning to single magneto operation.

2. Ignition Switch.. R
   RESULT: Noticeable RPM (not to exceed 150 RPM) drop and slight engine roughness. Maximum allowable RPM drop spread between magneto channels is 75 RPM.
3. Ignition Switch.. BOTH
   RESULT: Engine speed returns to normal. Allow Ignition switch to remain in BOTH for approximately 30 seconds to clear engine.
4. Ignition Switch.. L
   RESULT: Noticeable RPM (not to exceed 150 RPM) drop and slight engine roughness. Maximum allowable RPM drop spread between magneto channels is 75 RPM.
5. Ignition Switch.. BOTH
6. Throttle.. IDLE
7. Mixture Control .... IDLE CUTOFF

   Wait for the propeller to stop...

WARNING

Do not turn the propeller by hand while the Ignition Switch is in the BOTH, LEFT or RIGHT positions. Do not turn the propeller on a hot engine even if the Ignition Switch is in the OFF position. The engine could kick back as a result of auto-ignition caused by a small amount of fuel remaining in the cylinders. Auto-ignition could restart the engine and cause serious bodily injury or death.

8. Ignition Switch.. OFF
9. Fuel Selector Valve .... OFF

7-4. Engine Operation in Abnormal Environments

The anticipated types of abnormal environments are:

- Extreme cold weather
- Extreme hot weather
- High density altitude ground operation

7-4.1. Engine Operation in Extreme Cold

Engine starting during extreme cold weather is generally more difficult. Cold soaking causes the oil to become thicker (more viscous), making it difficult for the starter to crank the engine which results in slow cranking speeds and an abnormal drain on the battery capacity. At low temperatures, aviation gasoline does not vaporize readily, further complicating the starting procedure.

WARNING

Over priming can cause a flooded intake resulting in a "hydraulic lock" event and subsequent engine malfunction or failure. If you over-prime (flood) the engine, make certain that excess fuel has drained from the intake manifold and/or cylinder prior to attempting engine start.

CAUTION: Use an external power source when attempting to start aircraft engine in cold weather. Attempting to start an engine with a partially discharged aircraft battery may result in damage to the starter relay or possible engine kick-back resulting in a broken starter adapter clutch spring

False starting (failure to continue running after starting) often results in condensation on spark plug electrodes. This moisture can freeze and must be eliminated either by preheating the engine or removing and cleaning the spark plugs.

Engine preheating and an auxiliary power unit (APU) are required to facilitate engine starting when the engine has been exposed to temperatures below 20ºF (-7°C) for more than two hours. Refer to Section 7-4.1.1 and the AFM/POH for specific instructions. At ambient temperatures between 20º and 40ºF (-7º and 4ºC), refer to Section 7-4.1.1.3.

WARNING

Failure to properly preheat a cold-soaked engine may result in oil congealing within the engine, oil hoses, and oil cooler with subsequent loss of oil flow, possible internal damage to the engine, and subsequent engine failure.

Superficial application of preheat to a cold soaked engine can cause damage to the engine. An inadequate application of preheat may warm the engine enough to permit starting but will not decongeal oil in the sump, lines, cooler, filter, etc. Congealed oil in these areas require considerable preheat. The engine may start and appear to run satisfactorily, but can be damaged from lack of lubrication due to the congealed oil

blocking proper oil flow through the engine. The amount of damage will vary and may not become evident for many hours. However, the engine may be severely damaged and may fail shortly after application of high power.

Prior to operation and/or storage in cold weather, ensure the engine is serviced with the correct viscosity oil for the ambient air temperature. In the event of temporary cold weather operation, store the aircraft in a heated hangar between flights. Service the oil sump as required with the specified oil grade according to the "Engine Oil Servicing" instructions in Section 6-3.7.

7-4.1.1. Engine Preheating

CAUTION: Proper engine preheating procedures require thorough application of preheat to all parts of the engine. Apply hot air directly to the oil sump and external oil lines as well as the cylinders, air intake, and oil cooler. Because excessively hot air can damage non-metallic components such as seals, hoses, and drive belts, do not attempt to hasten the preheat process.

The preferred method of preheating is to place the aircraft in a heated hangar for a minimum of four hours prior to flight. Optional preheating methods are:

- A high volume combustion heater with ducts directed to the engine oil sump, cylinders, and oil cooler; refer to Section 7-4.1.1.1.

OR

- An engine mounted preheating system; refer to Section 7-4.1.1.2.

7-4.1.1.1. Engine Preheat with a Combustion Heater

If a heated hangar is not available and the aircraft and engine have been exposed to temperatures below 20ºF (-7ºC) for two hours or more, without an engine mounted preheating system, use the following method:

1. Select a high-volume air heater.

   NOTE: Small electric heaters inserted in the cowling opening do not appreciably warm the oil and may result in superficial preheating.

2. Preheat all engine parts. Apply preheated air directly to the listed parts for at least 30 minutes:

   a. Oil sump

   b. Oil filter

   c. External oil lines

   d. Oil cooler

   e. Cylinder assemblies

   f. Air intake

3. Periodically feel the top of the engine for warmth. Apply heat directly to the induction tubes and cylinders will promote vaporization and ease starting. Alternately heat the sump and engine cylinders until engine start.
4. Start the engine immediately after completion of the preheating process. Since the engine will be warm, follow the normal start instructions in Section 7-3.2.

   CAUTION: If oil pressure is not indicated within 30 seconds, shut down the engine and determine the cause. Operating the engine without oil pressure may result in engine damage.

   Do not close the cowl flaps in an attempt to hasten engine warm-up.

5. Operate the engine at 1000 RPM until some oil temperature is indicated.
   a. Monitor the oil pressure closely. If necessary, retard the throttle to maintain oil pressure below 100 psi. If oil pressure is less than 30 psi, or cannot be maintained below 100 psi, shut the engine down and repeat the preheat process. Do not close the cowl flaps to facilitate engine warm-up.
   b. Monitor the oil temperature until it reaches at least 75°F (24°C).

   CAUTION: DO NOT operate the engine at run-up speed unless the oil temperature is at least 75°F (24°C) and the oil pressure is within the 30-60 psi range. Operating the engine above idle before reaching minimum oil temperature may cause a loss of oil pressure and engine damage.

6. Run the engine up to 1700 RPM; in 100 RPM increments to prevent oil pressure from exceeding 100 psi.

   WARNING

   Operating the engine above 1700 RPM before reaching the minimum oil temperature may result in engine malfunction, engine failure, injury or death.

   CAUTION: Continually monitor oil pressure during run up.

7. When oil temperature has reached 75°F (24°C) and oil pressure does not exceed 60 psi at 2500 RPM, the engine has been warmed sufficiently to accept full rated power.

7-4.1.1.2. Engine Preheat with an Engine-Mounted Preheater

WARNING

Do not leave an engine-mounted pre-heater system on for more than 24 hours prior to flight. Continuous operation of engine-mounted preheater systems may result in aggressive internal engine corrosion.

If a heated hangar is not available and the aircraft and engine have been exposed to temperatures below 20ºF (-7ºC) for two hours or more and has an engine-mounted preheating system the following procedure may be used.

Engine mounted preheating systems should include individual cylinder head heater thermocouples, oil sump heater pad and crankcase heater pad. The use of a nacelle blanket will increase the effectiveness of engine preheating.

1. Follow the preheating system's manufacturer's installation and operation instructions.
2. Begin preheating of the engine at least five hours prior to expected departure. Do not operate an engine preheating system continuously for more than 24 hours.

   NOTE: The use of an approved thermal blanket or cover will help reduce the effects of wind and cold air circulation when the aircraft is not stored in a hangar. The preheating system manufacturer should have thermal blankets available.

3. Start the engine immediately after completion of the preheating process using the normal start procedure in Section 7-3.2.

   CAUTION: If oil pressure is not indicated within 30 seconds, shut down the engine and determine the cause. Operating the engine without oil pressure may result in engine damage.

Do not close the cowl flaps in an attempt to hasten engine warm-up.

4. Operate the engine at 1000 RPM until some oil temperature is indicated.
   a. Monitor the oil pressure closely. If necessary, retard the throttle to maintain oil pressure below 100 psi. If oil pressure is less than 30 psi, or cannot be maintained below 100 psi, shut the engine down and repeat the preheat process. Do not close the cowl flaps to facilitate engine warm-up.
   b. Monitor the oil temperature until it reaches at least 75°F (24°C).

   CAUTION: Do not operate the engine at speeds above 1700 RPM unless the oil temperature is at least 75°F (24°C) and the oil pressure is between 30 to 60 psi.

5. Run the engine up to 1700 RPM; approach this RPM in increments to prevent oil pressure from exceeding 100 psi.

   WARNING

   Operating the engine above 1700 RPM before reaching the minimum oil temperature may result in engine malfunction, engine failure, injury or death.

   CAUTION: Continually monitor oil pressure during run up.

6. When oil temperature has reached 100°F (38°C) and oil pressure does not exceed 60 psi at 2500 RPM, the engine has been warmed sufficiently to accept full rated power.

7-4.1.1.3. Cold Weather Starting Without Preheating

At ambient temperature between 20° to 40ºF (-7°to 4°C), perform the following:

CAUTION: Attempting to start your engine with a partially discharged aircraft battery may result in damage to the starter relay or possible engine kickback, resulting in a broken starter adapter clutch spring.

1. Use an external power source or ensure the aircraft battery is fully charged.
2. Use the normal start procedure in Section 7-3.2 and the aircraft AFM/POH. Do not overprime the engine.

WARNING

Overpriming can cause a flooded intake resulting in a "hydraulic lock" event and subsequent engine malfunction or failure. If you over prime, or flood your engine, ensure excess fuel has drained from the intake manifold and/or cylinder prior to attempting engine starting.

CAUTION: If oil pressure is not indicated within 30 seconds, shut down the engine and determine the cause. Operating the engine without oil pressure may result in engine damage.

CAUTION: Do not close the cowl flaps in an attempt to hasten engine warm-up.

3. Operate the engine at 1000 RPM until some oil temperature is indicated.
4. Monitor the oil pressure closely. If necessary, retard the throttle to maintain oil pressure below 100 psi. If oil pressure is less than 30 psi, or cannot be maintained below 100 psi, shut the engine down and follow the preheat instructions to prevent engine damage. Do not close the cowl flaps to facilitate engine warm-up.
5. Check the oil temperature; it should be at least 75°F (24°C).

CAUTION: DO NOT operate the engine at run-up speed unless the oil temperature is at least 75°F (24°C) and the oil pressure is within the 30-60 psi range. Operating the engine above idle before reaching minimum oil temperature may cause a loss of oil pressure and engine damage.

6. Run the engine up to 1700 RPM; approach this RPM in increments to prevent oil pressure from exceeding 100 psi.

WARNING

Operating the engine above 1700 RPM before reaching the minimum oil temperature may result in engine malfunction, engine failure, injury or death.

CAUTION: Continually monitor oil pressure during run up.

7. When oil temperature has reached 100°F (38°C) and oil pressure does not exceed 60 psi at 2500 RPM, the engine has been warmed sufficiently to accept full rated power.

7-4.2. Engine Operation in Hot Weather

"Hot weather" is defined as ambient temperature exceeding 90 F (32 C). After an engine is shutdown, the temperature of various components will begin to stabilize. The hotter parts such as cylinders and oil will cool, while other parts will begin to heat up due to lack of air flow or heat convection from those engine parts that are cooling. At some point following engine shutdown, the entire unit will stabilize near the ambient temperature. This time period will be determined by temperature and wind conditions and may take several hours.

Heat soaking occurs between 30 minutes to one hour following shutdown. During this time, the fuel system will warm causing the fuel in the pump and fuel lines to "boil" or vaporize. During subsequent starting attempts, the fuel pump will initially be pumping a combination of fuel and fuel vapor. At the same time, the fuel lines will be filled with varying amounts of fuel and vapor. Until the entire fuel system becomes filled with liquid fuel, difficult starting and unstable engine operation can be expected.

Three hot weather operation situations requiring special instructions are:

- "Cooling an Engine in Hot Weather" (Section 7-4.2.1)
- "Engine Restart in Hot Weather" (Section 7-4.2.2)
- "Take-off and Initial Climb Out in Hot Weather" (Section 7-4.2.4)

Ensure the engine is serviced with the correct viscosity oil specified in Section 3-2.1, "Engine Oil Specifications" prior to starting the engine. In the event of temporary cold weather exposure, store the aircraft in a hangar between flights. Service the oil sump, as required, to maintain the oil capacity specified for the engine model in Section 2-3, "Engine Specifications" according to the "Engine Oil Servicing" instructions in Section 6-3.7.

Operating Tips

- Inspect the induction air filter frequently for contamination; be prepared to clean or replace it, if necessary.
- If the aircraft is flown in dusty conditions, Continental Motors recommends more frequent oil changes.
- Use dust covers over openings in the cowling for additional protection.

7-4.2.1. Cooling an Engine in Hot Weather

- Reduce ground operation to a minimum to keep engine temperatures down.
- Open cowl flaps fully while taxiing.
- Face the nose of aircraft into the wind to take advantage of the cooling effect.

7-4.2.2. Engine Restart in Hot Weather

Restarting attempts will be the most difficult between thirty minutes and one hour after engine shutdown. Following that interval, fuel vapor will decrease and present less of a restart problem.

WARNING

Allow excess fuel to drain from the induction system prior to starting the engine.

1. Fuel selector .... ON
2. Throttle.. CLOSED
3. Mixture Control .... IDLE/CUTOFF
4. Follow the “Engine Start” instructions in the AFM/POH and Section 7-3.2.

7-4.2.3. Ground Operation in Hot Weather

1. Monitor oil and cylinder temperatures closely during taxiing and engine run up.
2. Operate with cowl flaps full open.
3. Do not operate the engine at high RPM except for necessary operational checks.
4. If take-off is not to be made immediately following engine run-up, face the aircraft into the wind with the engine idling at 900-1000 RPM.

7-4.2.4. Take-off and Initial Climb Out in Hot Weather

1. Mixture control .... FULL RICH

   NOTE: Under extreme conditions, it may be necessary to manually lean the mixture to sustain engine operation at low RPM.

2. Do not operate the engine at maximum power longer than necessary to establish the climb configuration recommended by the aircraft manufacturer.
3. Monitor temperatures closely.
4. Maintain sufficient airspeed and attitude to provide engine cooling.
5. Cowl flaps .... FULLY OPEN (if equipped)

7-4.3. Ground Operation at High Density Altitude

CAUTION: Reduced engine power will result from higher density altitude associated with high temperature.

Idle fuel mixture may be rich during high density altitude conditions. Lean the fuel mixture to sustain operation at low RPM. When practical, operate the engine at higher idle speed.

NOTE: A FULL RICH mixture is required during takeoff.

If higher than desired temperatures are experienced during the climb phase, establish a lower angle of attack or higher climb speed, consistent with safe operating practices to provide increased engine cooling.

- Monitor oil and cylinder temperatures closely during taxiing and engine run up.
- Operate with cowl flaps full open.
- Do not operate the engine at high RPM except for necessary operational checks.
- If take-off is not to be made immediately following engine run-up, face the aircraft into the wind with the engine idling between 900-1000 RPM.

Chapter 8. Troubleshooting

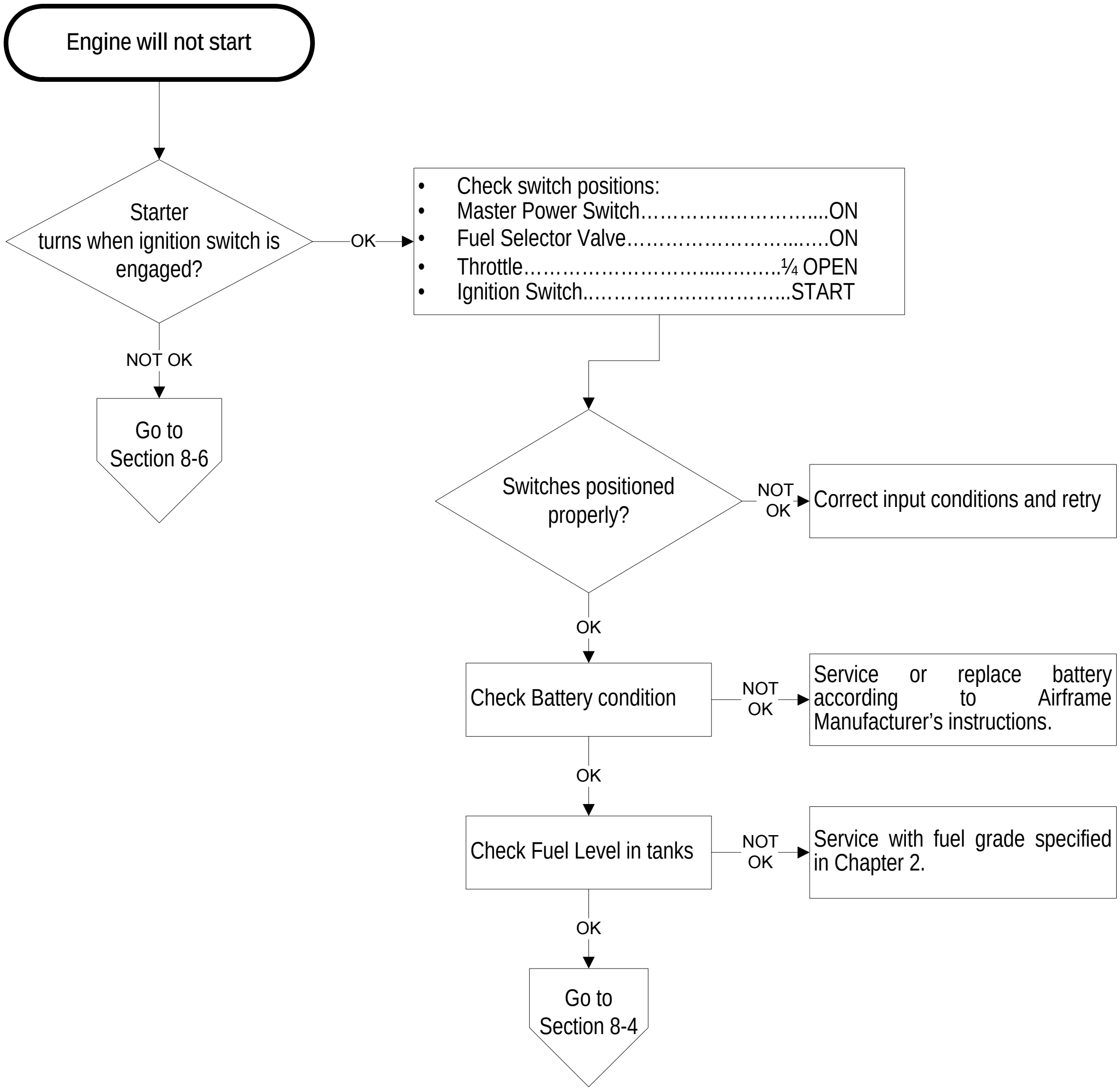
The Troubleshooting Charts discuss symptoms, probable causes, and appropriate corrective action to be taken. Troubleshooting procedures for specific systems and components are provided after the general troubleshooting chart.

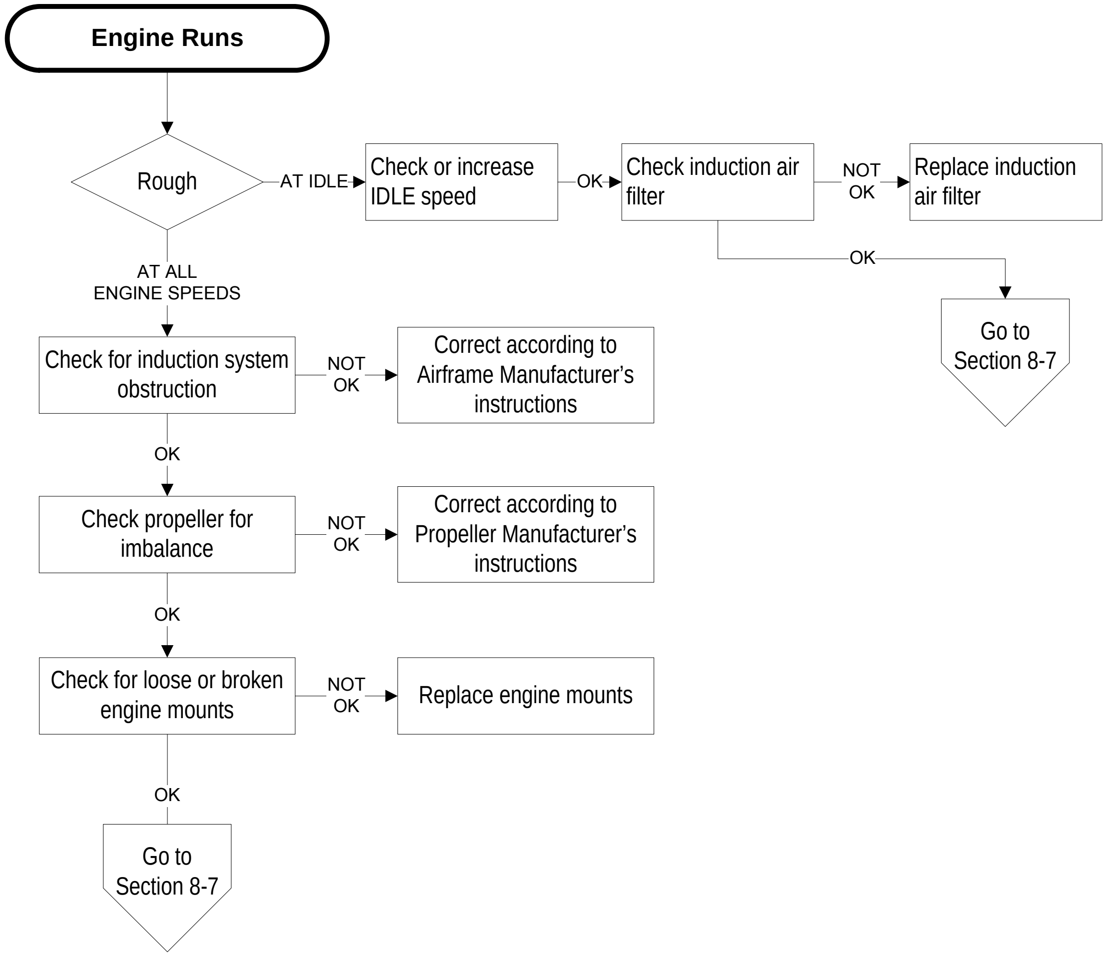
The fault isolation paths and repair procedures are developed using real world scenarios (log book entries) and best known practices. New symptoms, fault isolation methods, and corrective actions may be added in the future, when warranted.

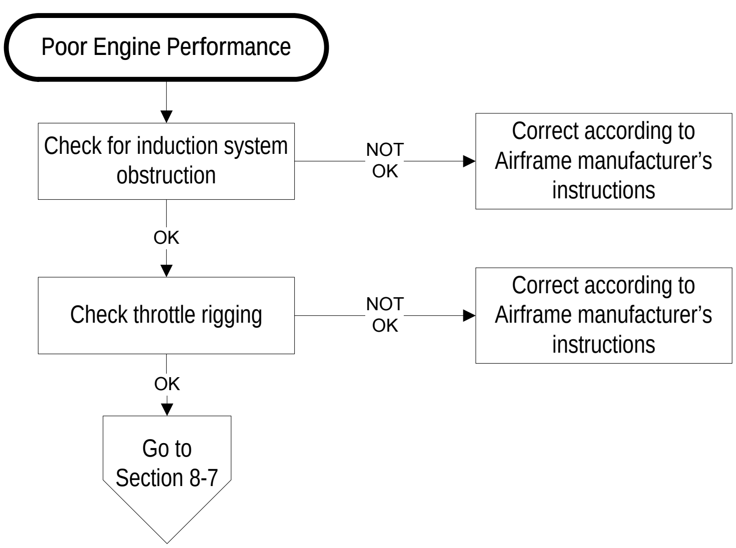
WARNING

Any attempt by unqualified personnel to adjust, repair, or replace any parts may result in engine malfunction or failure. Continued operation of a malfunctioning engine can cause further damage to a disabled component and possible injury to personnel. Do not return an engine to service unless it functions according to specifications.

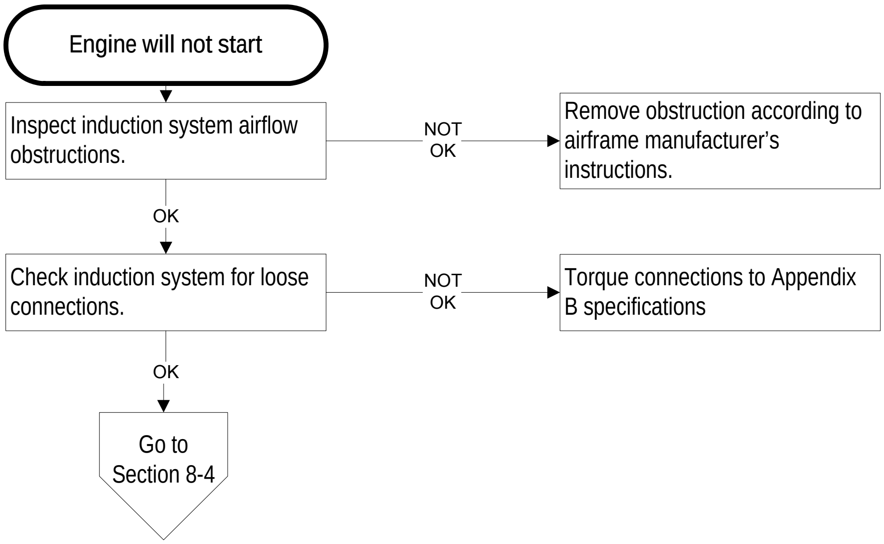
8-1. General Troubleshooting

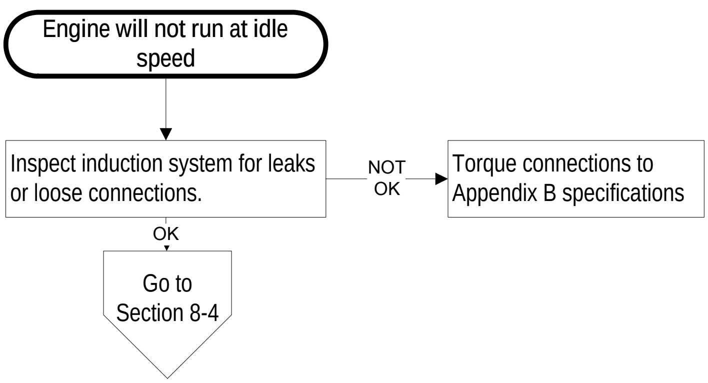


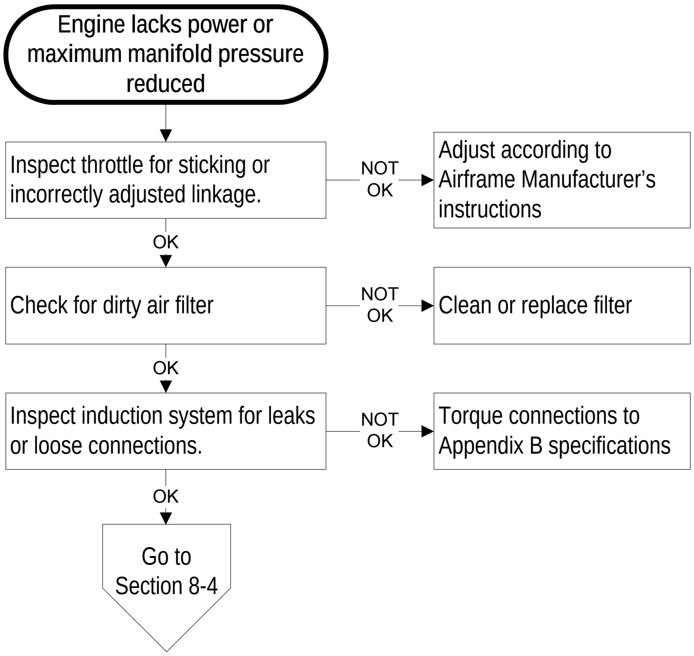

Engine Runs
Rough
AT IDLE
Check or increase IDLE speed
OK
Check induction air filter
NOT OK
Replace induction air filter
OK
Go to Section 8-7
AT ALL ENGINE SPEEDS
Check for induction system obstruction
NOT OK
Correct according to Airframe Manufacturer's instructions
OK
Check propeller for imbalance
NOT OK
Correct according to Propeller Manufacturer's instructions
OK
Check for loose or broken engine mounts
NOT OK
Replace engine mounts
OK
Go to Section 8-7


Poor Engine Performance
Check for induction system obstruction
NOT OK
Correct according to Airframe manufacturer's instructions
OK
Check throttle rigging
NOT OK
Correct according to Airframe manufacturer's instructions
OK
Go to Section 8-7

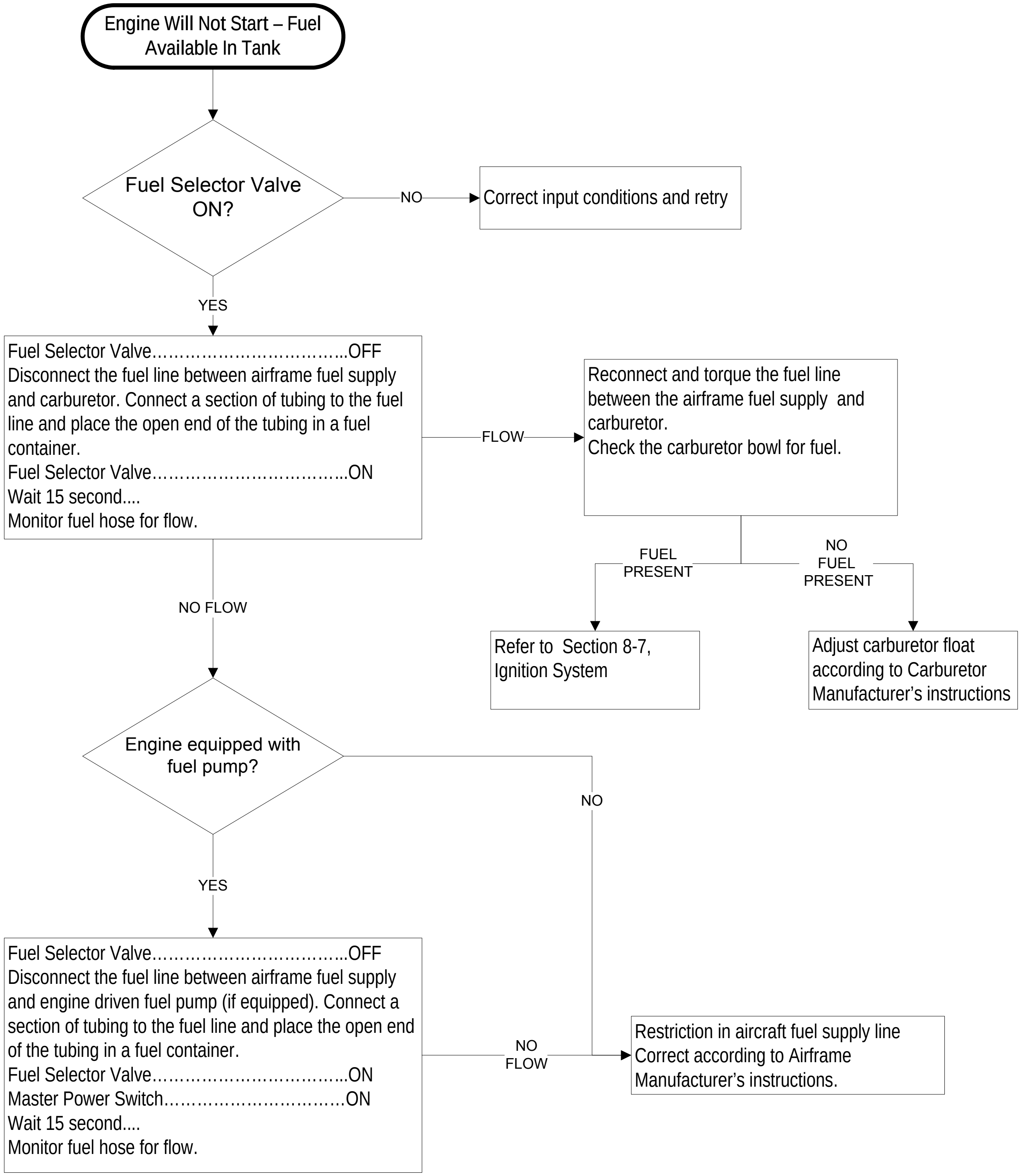
8-2. Induction System

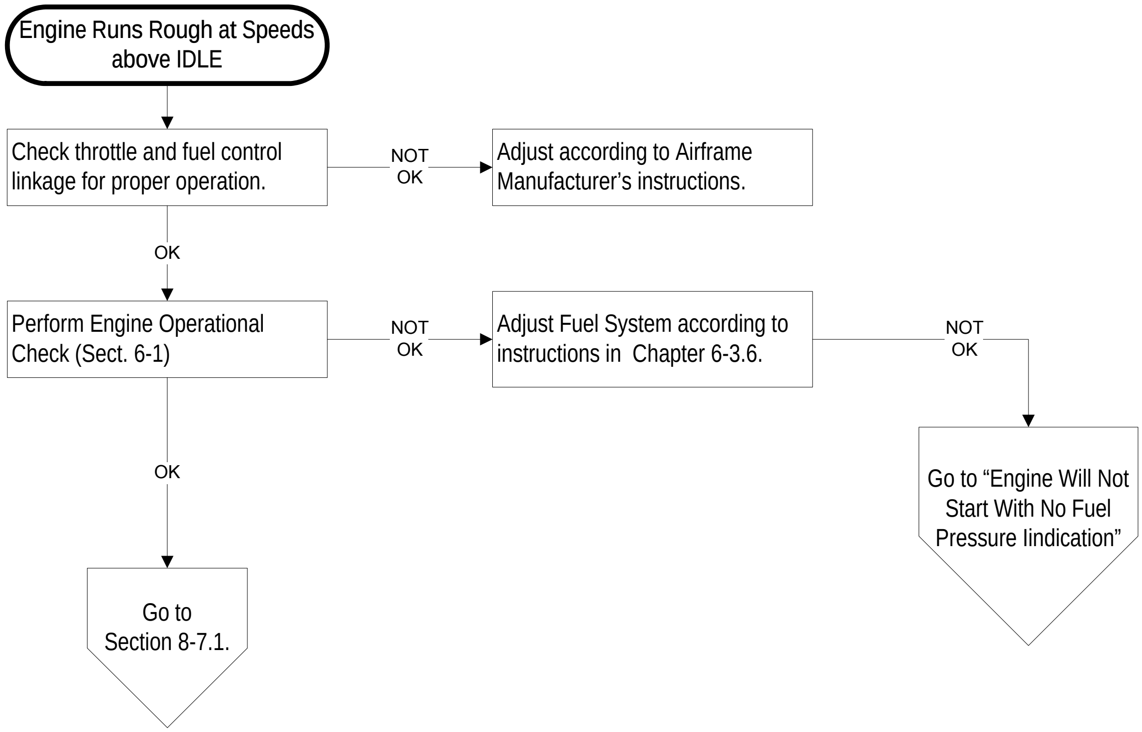


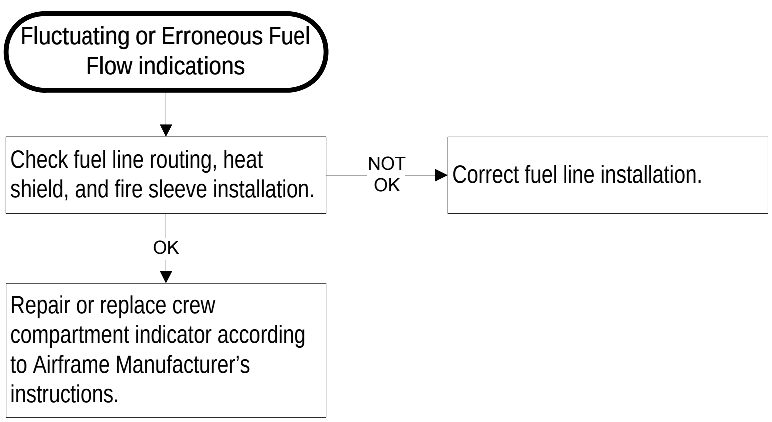



Engine lacks power or maximum manifold pressure reduced
Inspect throttle for sticking or incorrectly adjusted linkage.
NOT OK
Adjust according to Airframe Manufacturer's instructions
OK
Check for dirty air filter
NOT OK
Clean or replace filter
OK
Inspect induction system for leaks or loose connections.
NOT OK
Torque connections to Appendix B specifications
OK
Go to Section 8-4

8-3. Fuel System



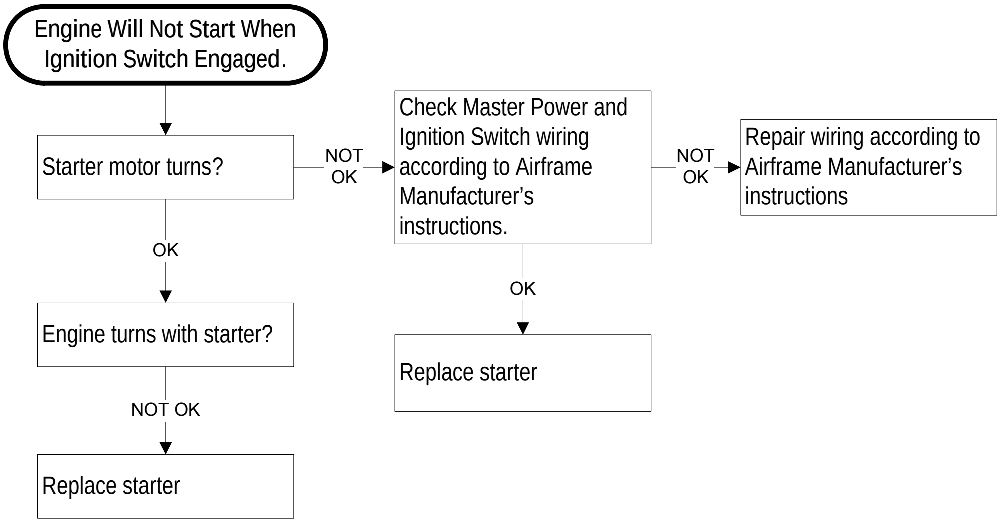


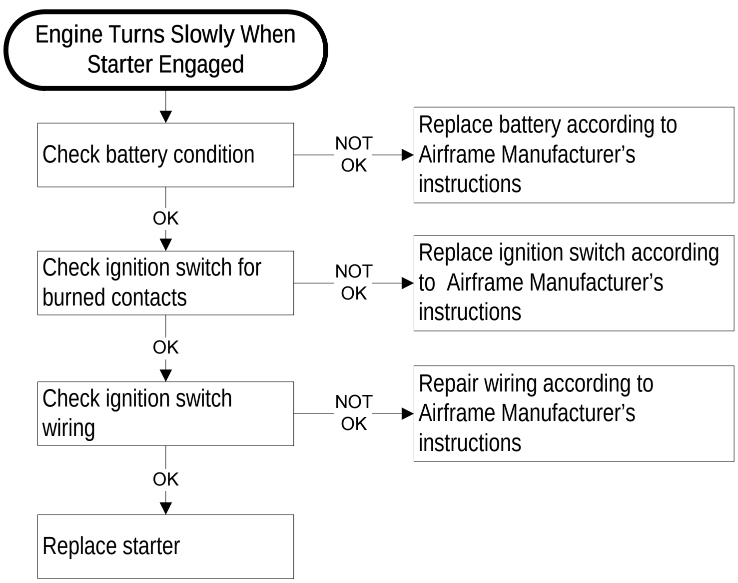


8-4. Charging System

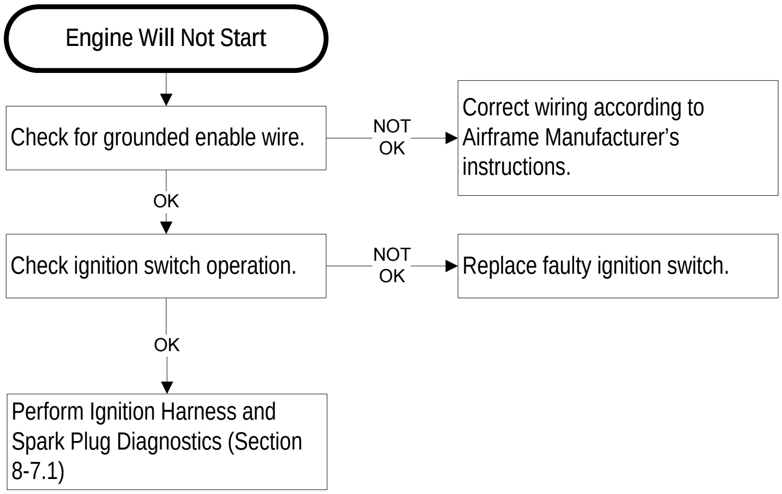
Refer to the airframe and alternator manufacturer's applicable charging system troubleshooting instructions.

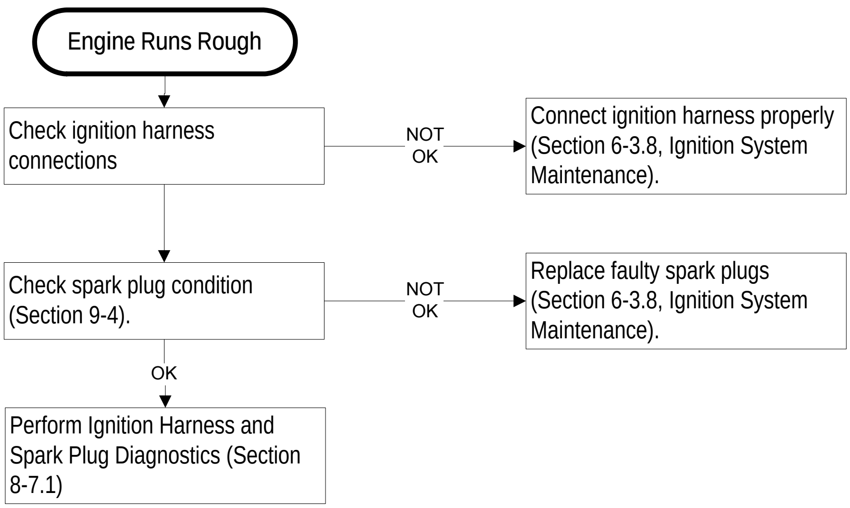
8-5. Starting System

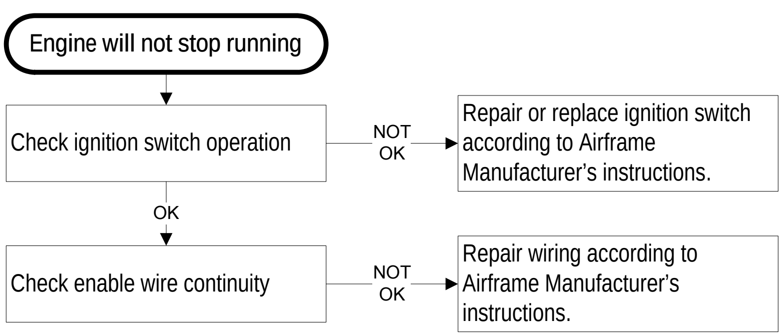




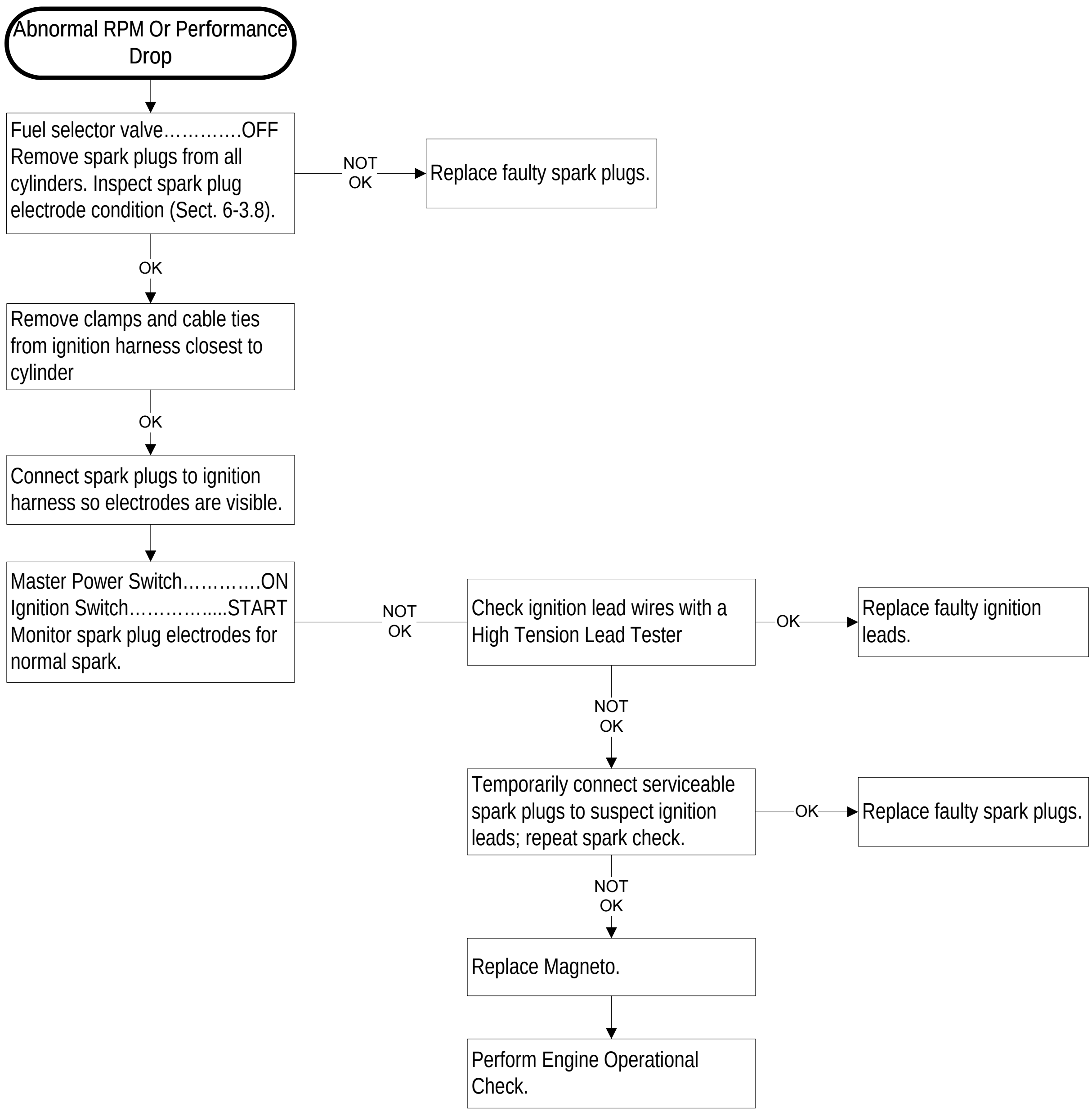
8-6. Ignition System



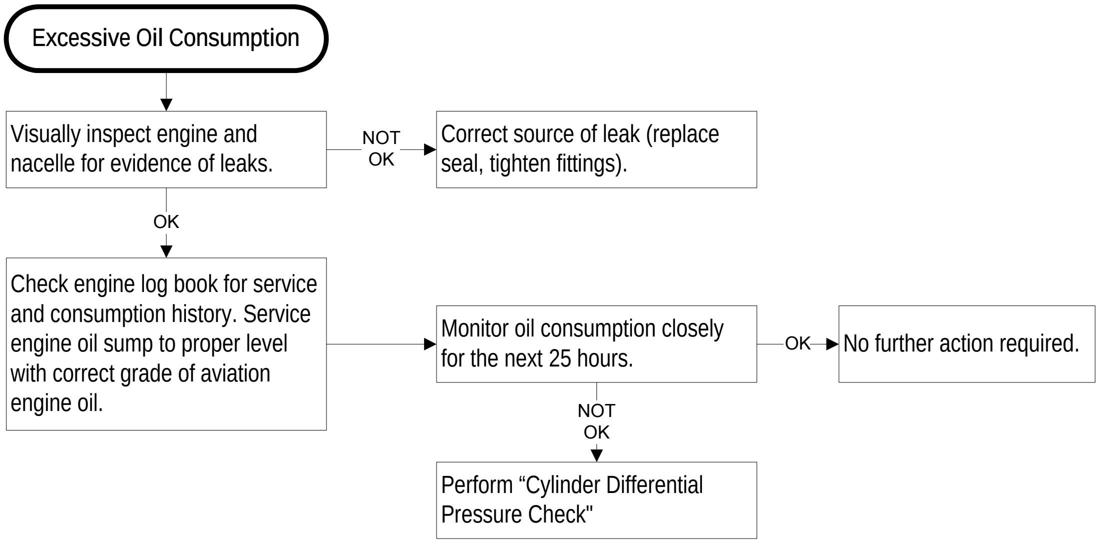


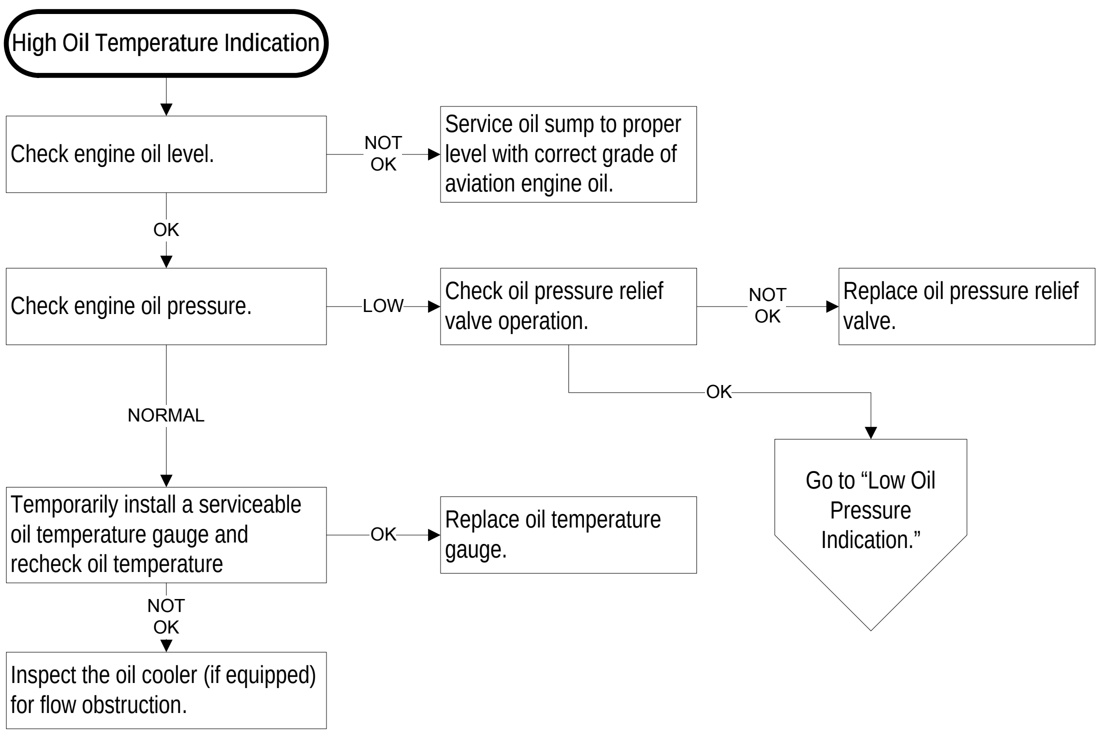


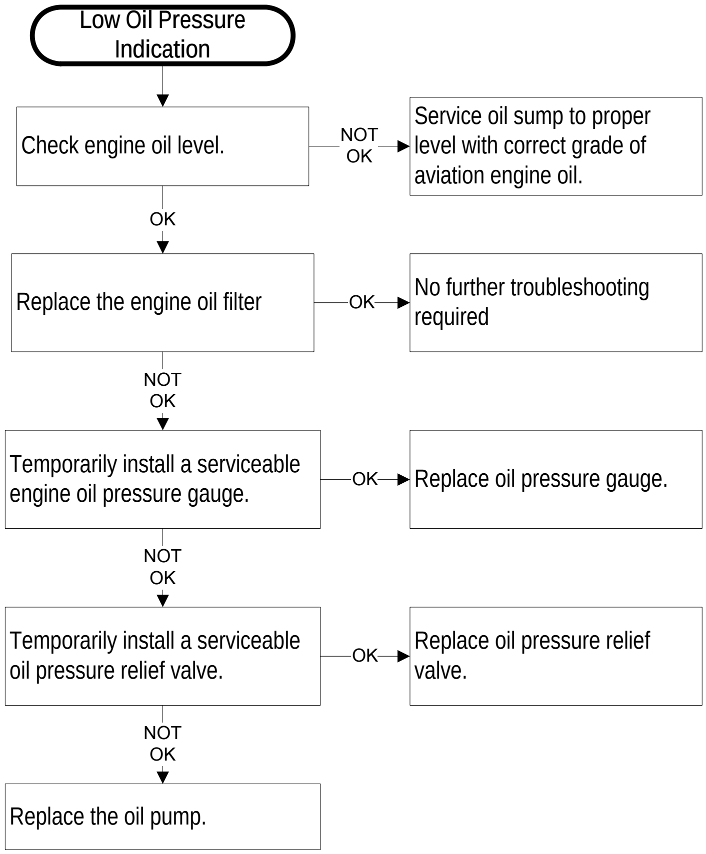
8-6.1. Ignition Harness and Spark Plug Diagnostics



8-7. Lubrication System





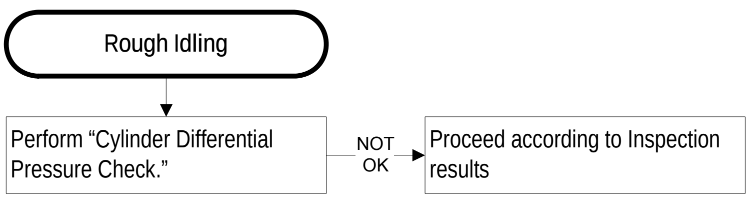

Low Oil Pressure Indication
Check engine oil level.
NOT OK
Service oil sump to proper level with correct grade of aviation engine oil.
OK
Replace the engine oil filter
OK
No further troubleshooting required
NOT OK
Temporarily install a serviceable engine oil pressure gauge.
OK
Replace oil pressure gauge.
NOT OK
Temporarily install a serviceable oil pressure relief valve.
OK
Replace oil pressure relief valve.
NOT OK
Replace the oil pump.

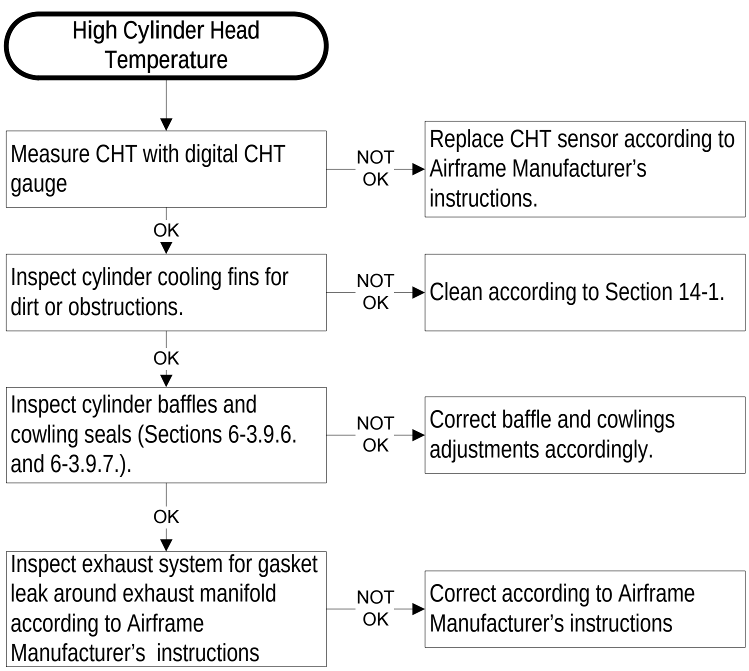
8-8. Engine Cylinders

Items in the table are listed in sequence of approximate ease of checking, not in the order probability.

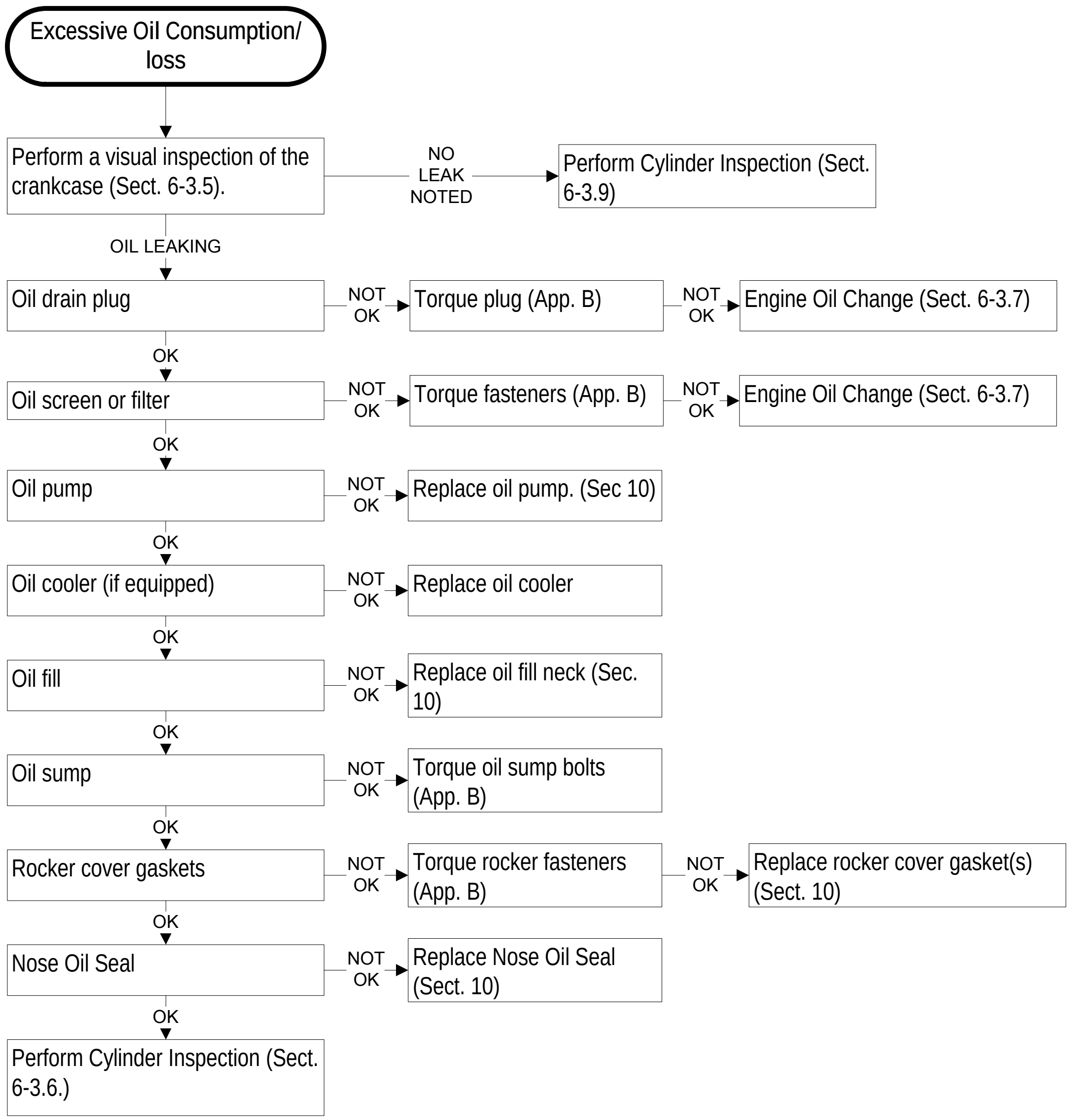
In addition, refer to the following:
Refer to the following sections in Chapter 6, Engine Inspection and Service:

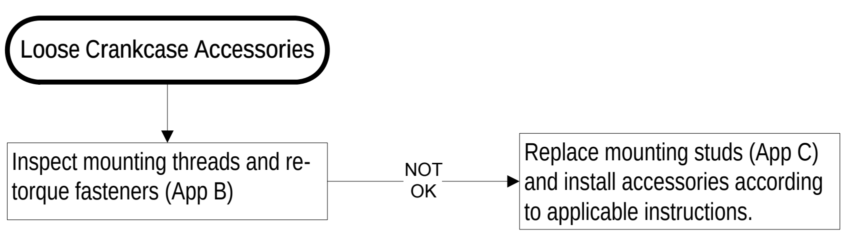
- Cylinder Inspection
- Cylinder Differential Pressure Test
- Summary of Dynamic and Static Seal Checks and Corrective Action
- Cylinder Borescope Inspection
- “Cylinder Repair vs. Replacement Guidelines”in Section 15-6.3



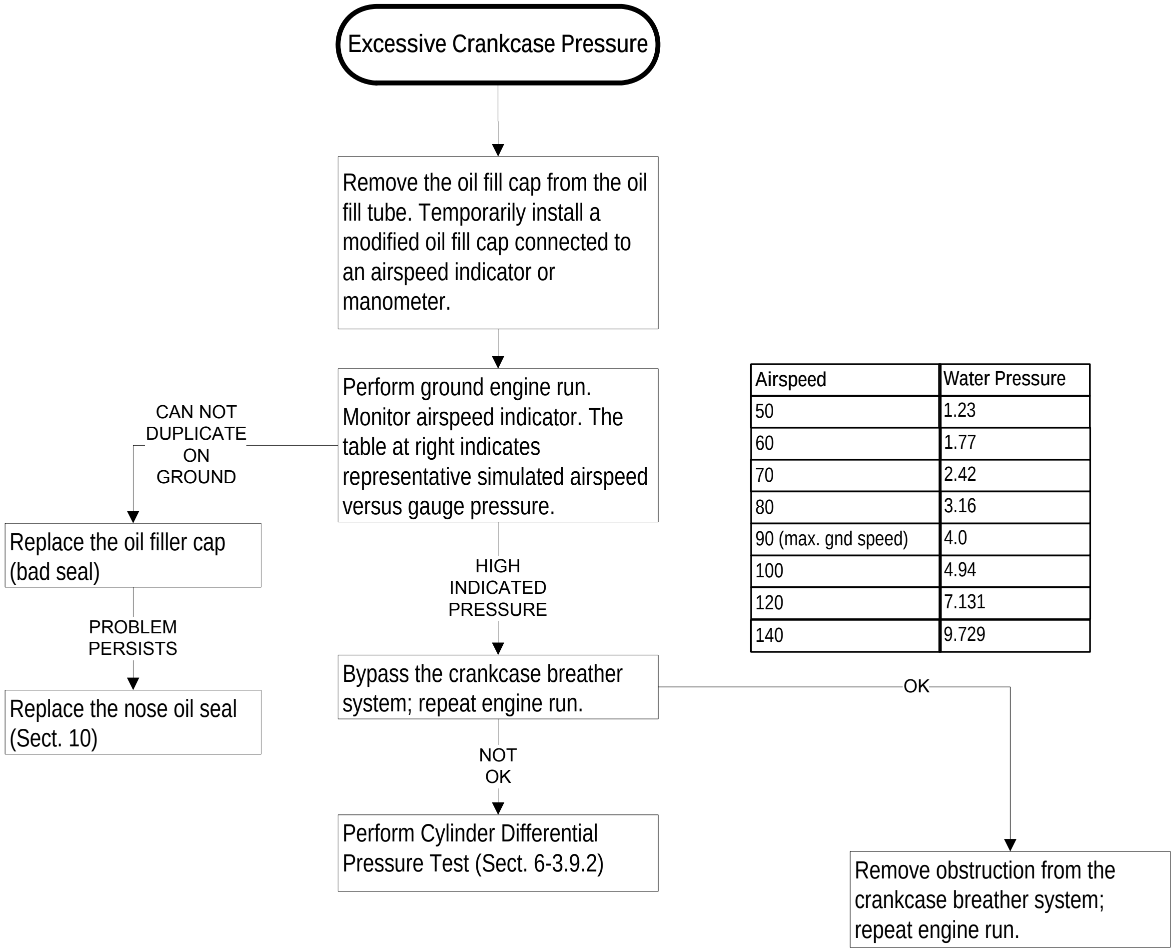


8-9. Crankcase or Accessory Case





8-9.1. Excess Crankcase Pressure



Airspeed	Water Pressure
50	1.23
60	1.77
70	2.42
80	3.16
90 (max. gnd speed)	4.0
100	4.94
120	7.131
140	9.729

8-10. Exhaust System

Refer to the airframe manufacturer’s instructions.

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Chapter 9. Engine Preservation and Storage

9-1. Preserving and Storing an Engine

An engine which has been uncrated and not installed and/or operated within 30 days after uncrating should be placed in storage. There are separate instructions for temporary (from 30 days up to 90 days) and indefinite (90 days or more) storage.

9-1.1. Engine Preservation Checklist

Make a copy of the "Engine Preservation Checklist" on page 9-5. Record the serial number, date placed in storage and projected next inspection date for each engine placed in storage. The checklist covers a 90-day storage cycle. Complete and attach a new checklist for each 90-day storage cycle until the engine is returned to service.

9-1.2. New or Unused Engine Storage

1. Determine the projected length of storage and refer to the appropriate section for preservation instructions.
   a. If the engine storage period is less than 90 days, follow the "Temporary Storage" instructions in Section 9-1.3.
   b. If the engine storage period is greater than 90 days, follow the "Indefinite Storage" instructions in Section 9-1.4.
2. After preservation, cover the engine with a plastic bag.
3. Install and attach the container cover to the base (if not already done).

9-1.3. Temporary Storage

Continental Motors defines temporary storage as a period of 30 to 90 days when the engine will not be used. If the storage period will exceed 90 days, prepare the engine for long term storage according to Section 9-1.4.

1. Perform an oil change according to "Engine Oil Servicing" instructions in Section 6-3.7. Service the engine to the proper sump capacity with oil conforming to MIL-C-6529 Type II.

WARNING

If preheater are used to warm the engine, do not leave preheaters on for longer than 24 hours to prevent corrosion.

2. Perform a Preflight Inspection; correct any discrepancies noted.
3. Perform an "Engine Start" (Section 7-3.2) and "Ground Run-up" (Section 7-3.3).
4. Fly the aircraft for one hour at normal operating temperatures.
5. Allow the engine to cool after flight.
6. Disconnect and remove all spark plug leads.
7. Remove the upper spark plugs from the engine.
8. Cover the ignition leads with AN-4060 protectors.

WARNING

Before removing the propeller:

Disconnect all spark plug leads, place the Throttle in the CLOSED position, set the brake and chock the aircraft wheels. Install aircraft tie-downs, Do not stand or place equipment within the arc of the propeller.

9. With the piston at the Bottom Dead Center position, use a common garden sprayer with clean reservoir and nozzle to spray atomized cylinder preservation oil that meets MIL-P-46002, Grade 1 through the upper spark plug hole of each engine cylinder, with the pistons at bottom dead center. Rotate the crankshaft as opposite cylinders are sprayed.
10. Stop the crankshaft at a position where no pistons are at Top Dead Center.
11. Spray each cylinder again; thoroughly coat all interior cylinder surfaces by moving the nozzle from top to bottom of the cylinder while spraying. When all cylinder walls are thoroughly coated, ensure no piston is positioned at Top Dead Center.
12. Install the top spark plugs; do not install the spark plug leads.
13. Seal all engine openings exposed to the atmosphere using suitable plugs and covers. Attach a "REMOVE BEFORE FLIGHT" streamer to each location.
14. Attach a tag in a prominent location on the engine, preferably the propeller (or storage container, if installed) with the following information:

    CAUTION: DO NOT TURN PROPELLER - ENGINE PRESERVED (preservation date)

15. Make a copy of the "Engine Preservation Checklist" on page 9-5. Enter the serial number, storage date and next inspection due date on the form. Attach the form to the engine.

    NOTE: If the engine is not returned to service within 90 days of initial temporary storage, it must be preserved according to the "Indefinite Storage" instructions in Section 9-1.4.

9-1.4. Indefinite Storage

WARNING

Perform this procedure in an area free of sparks, flames, or other ignition sources.

1. Perform an engine oil change according to the “Engine Oil Servicing” instructions in Section 6-3.7. Service the engine oil sump to the proper capacity with oil conforming to MIL-C-6529.

WARNING

If preheater are used to warm the engine, do not leave preheaters on for longer than 24 hours to prevent corrosion.

2. Perform a Preflight Inspection; correct any discrepancies noted.
3. Perform an “Engine Start” (Section 7-3.2) and “Ground Run-up” (Section 7-3.3).
4. Fly the aircraft for one hour at normal operating temperatures.
5. Allow the engine to cool after flight.

WARNING

Before removing the propeller:

Disconnect all spark plug leads, place the Throttle in the CLOSED position, set the brake and chock the aircraft wheels. Install aircraft tie-downs, Do not stand or place equipment within the arc of the propeller.

6. Disconnect and remove all spark plug leads.
7. Remove the upper spark plugs from the engine.
8. Cover the ignition leads with AN-4060 protectors.
9. Install protective plugs (P/N 22671) in the lower spark plug holes.
10. With the piston at the Bottom Dead Center position, use a common garden sprayer with clean reservoir and nozzle to spray atomized cylinder preservation oil that meets MIL-P-46002, Grade 1 through the upper spark plug hole of each engine cylinder, with the pistons at bottom dead center. Rotate the crankshaft as opposite cylinders are sprayed.
11. Spray each cylinder again; thoroughly coat all interior cylinder surfaces by moving the nozzle from top to bottom of the cylinder while spraying. When all cylinder walls are thoroughly coated, ensure no piston is positioned at Top Dead Center.
12. Install dehydrator plugs MS27215-1 or MS27215-2 in each of the upper spark plug holes. Ensure each dehydrator plug is dark blue in color when installed.
13. Attach a “REMOVE BEFORE FLIGHT” streamer tag to desiccant bags and place the tagged desiccant bag in the exhaust pipes. Seal the exhaust pipe openings.
14. Seal all other exposed engine openings with suitable plugs and covers. Attach “REMOVE BEFORE FLIGHT” streamers to installed plugs and covers.

15. Affix a readily visible tag to the propeller (or storage container, if installed) with the following information:

    CAUTION: DO NOT TURN PROPELLER - ENGINE PRESERVED (preservation date)

16. Make a copy of the “Engine Preservation Checklist” on page 9-5. Enter the serial number, storage date and next inspection due date on the form. Attach the form to the engine.
17. For indefinite storage, visually inspect the dehydrator plugs at 15-day intervals. Change the dehydrator plugs at the first indication (if any plug is not dark blue, replace the dehydrator plug) of color change. If more thane half the dehydrator plugs change color, replace all desiccant material on the engine.
18. Repeat application of cylinder preservative at 90 intervals.

9-1.5. Return an Engine to Service after Storage

1. Remove seals and desiccant bags.
2. Remove cylinder dehydrators (or plugs) from upper and lower spark plug holes.
3. Perform an engine oil change according to the “Engine Oil Servicing” instructions in Section 6-3.7. Service the engine to the proper sump capacity with oil conforming to MIL-C-6529 Type II (Break-in oil - SAEJ 1966 non-dispersant mineral oil).
4. Rotate propeller several revolutions by hand to remove preservative oil.
5. Service and install spark plugs and ignition harness leads according to the instructions in Section 6-3.8.2, “Spark Plug Maintenance” and Section 6-3.8.3, “Ignition Harness Maintenance.”
6. Clean and service engine and aircraft according to the airframe manufacturer's instructions. Perform a visual inspection and correct any discrepancies noted.
7. Perform a normal engine start according to the Airplane Flight Manual or Pilot's Operating Handbook.
8. Conduct an “Engine Operational Check” according to instructions in Section 6-3.6; correct any discrepancies.
9. Perform a “Flight Check” according to instructions in Chapter 7; correct any discrepancies before releasing the aircraft for normal service.
10. Change engine oil and filter after first 25 hours of operation.

Table 9-1. Engine Preservation Checklist

Engine Serial Number:		Date Placed in Storage		
Inspection Item	**Status**	**Inspection Due Date**	**Completion Date**	**Performed by**
Engine preserved and stored according to the instructions in Section 9-1.4	❑ YES	N/A	/ /	
15 day inspection	❑ PASSED ❑ CORRECTED	/ /	/ /	
30 day inspection	❑ PASSED ❑ CORRECTED	/ /	/ /	
45 day inspection	❑ PASSED ❑ CORRECTED	/ /	/ /	
60 day inspection	❑ PASSED ❑ CORRECTED	/ /	/ /	
75 day inspection	❑ PASSED ❑ CORRECTED	/ /	/ /	
90 day inspection	❑ PASSED ❑ CORRECTED	/ /	/ /	
90 day cylinder treatment	❑ PASSED ❑ CORRECTED	/ /	/ /	
Engine removed from storage	❑ PASSED ❑ CORRECTED	/ /	/ /	

* Check condition of dehydrator plug for discoloration. Contents should be dark blue in color. If plugs are discolored, remove and replace with new plugs. If more than half the dehydrator plugs on the engine require replacement, remove and replace the desiccant bags in the exhaust pipes with fresh desiccant bags and reseal the exhaust pipe.

** Treat each cylinder bore with MIL-P-46002, Grade 1. With the piston at the bottom dead center position, use a clean garden sprayer to spray atomized cylinder preservation oil that meets MIL-P-46002, Grade 1 (at room temperature) through the upper spark plug hole of each engine cylinder. Thoroughly cover all interior cylinder surfaces by moving the nozzle from top to bottom. Rotate the crankshaft as opposite cylinders are sprayed. Leave no piston positioned at top dead center.

Inspector Notes:

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Chapter 10. Non-Overhaul Repair and Replacement

10-1. Parts Replacement

Procedures in this section apply to instances outside of overhaul when parts can be repaired or replaced as a maintenance practice; some parts cannot be repaired and must be replaced. Table 10-1, “Non-Overhaul Parts Replacement Reference” indicates items that must be replaced, along with respective references for replacement instructions. Table 10-2, the “Parts Repair Reference” lists items that may be repaired along with corresponding references to the repair instructions. Unless otherwise indicated, instructions are in this chapter.

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

NOTE: When replacing components according to the maintenance procedures in this section, adhere to the *service limits,* in line with the procedure as a guide for part re-use for each component. Use the overhaul dimensional limits in Appendix D when performing maintenance repairs if service limits are not provided.

S*ervice limits* in this section apply only to maintenance procedures and in many cases are not identical to the tolerances in Appendix D.

Table 10-1. Non-Overhaul Parts Replacement Reference

Replaceable Item	Reference
Individual Engine Cylinder	Section 10-7, “Engine Cylinder Maintenance”
Carburetor	Section 10-2.1, “Carburetor Removal” Section , “”
Lifters	Section 10-7.3, “Lifter Removal” and Section 10-7.7, “Lifter Installation”
Crankshaft Nose Oil Seal	Section 10-8, “Crankshaft Nose Oil Seal Replacement”
Crankcase Studs	Section 15-7.7.3, “Crankcase Cylinder Deck Stud Replacement”
Starter	Section 10-3, “Starter Replacement”
Alternator	Section 10-4, “Alternator Replacement”
Oil Pump	Section 10-6.1, “Oil Pump Repair and Replacement”
Oil Filter	Section 6-3.7, “Engine Oil Servicing”
Oil Filter Adapter Stud	Section 10-6.1, “Oil Pump Repair and Replacement”
Oil Sump or Oil Suction Tube	Section 10-6.2, “Oil Sump or Oil Suction Tube Repair and Replacement”
Oil Cooler Adapter	Section 10-6.3, “Oil Cooler Repair and Replacement”
Oil Pressure Relief Valve	Section 10-6.4, “Oil Pressure Relief Valve Repair and Replacement”
Magneto	Section 10-5, “Magneto Replacement”

Table 10-2. Parts Repair Reference

Repairable Item	Reference
Engine Cylinder	Section 10-7, “Engine Cylinder Maintenance”
Crankcase Cracks	Section 15-7.7, “Crankcase Overhaul Repair”
Oil Pump	Section 10-6.1, “Oil Pump Repair and Replacement”
Oil Pressure Relief Valve	Section 10-6.4, “Oil Pressure Relief Valve Repair and Replacement”
Magneto	See Magneto Manufacturer’s Service Manual
Alternator	See Alternator Manufacturer’s Service Manual

Table 10-3. Parts Handling Guidelines

Parts/Components	Handling Instructions
Wrapped new or rebuilt parts	Parts that require protection from atmospheric dust and moisture should be wrapped or boxed after acceptance inspection and remain wrapped until time of installation
Spark plugs	Handle spark plugs with clean, dry hands. Avoid dropping a spark plug. If a spark plug is either dropped or damaged, discard it. Do not install any spark plug that has been dropped or damaged.

10-2. Induction and Fuel System Parts Replacement

10-2.1. Carburetor Removal

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Turn the ignition switch to the OFF position and disconnect engine electrical power.

   NOTE: Mark or tag hose connections as they are removed to eliminate confusion during installation.

2. Disconnect the airframe control rigging from the throttle lever, mixture control lever, and carburetor heat lever according to the airframe manufacturer's instructions.

   NOTE: Place protective caps over open fuel system connections to prevent contamination.

3. Place a fuel safe container under the fuel supply hose to catch residual fuel in the line. Disconnect the fuel supply hose from the carburetor fitting. Plug the fuel supply hose to prevent contamination.
4. Remove four nuts (Figure 10-1) (11) and lock washers (10) from the air intake housing (23) to separate the air intake housing from the carburetor. Remove and discard the gasket (22).
5. Remove four each nuts (11), lock washers (10), and washers (9) from the carburetor (21) at the intake manifold (23); discard the lock washers (10). Remove the carburetor (21) from the intake manifold studs. Remove and discard the gasket (20).
6. Cover the carburetor and intake manifold ports to prevent contamination. Plug the carburetor fuel inlet to prevent contamination.

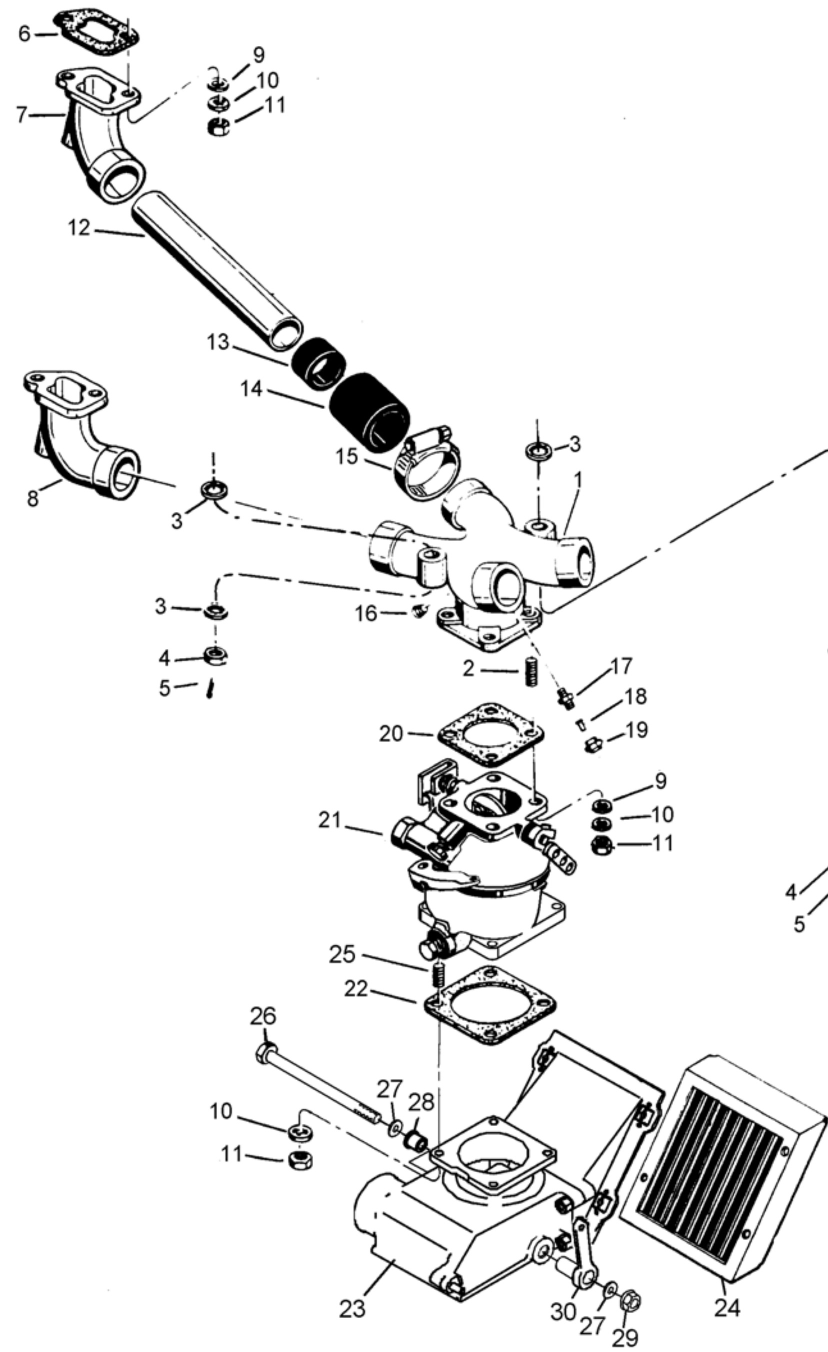


Figure 10-1. Induction System and Carburetor

1	Intake Manifold Assembly	9	Washer	17	Nipple- primer	25	Stud
2	Stud	10	Lock Washer	18	Union	26	Bolt
3	O-lock Seal	11	Nut	19	Nut	27	Washer
4	Castle Nut	12	Intake Pipe	20	Carburetor Gasket	28	Bushing
5	Cotter Pin	13	Hose- 1.50 X 0.88	21	Carburetor	29	Lock Nut
6	Intake Manifold Gasket	14	Hose - 1.75 X 2.00	22	Carburetor Gasket	30	Lever
7	Induction Elbow - Cyl 1 & 4	15	Clamp	23	Air Intake Housing		
8	Induction Elbow - Cyl 2 & 3	16	Plug - 0.25	24	Filter		

10-2.2. Carburetor Installation

1. Apply Part No. 642188 (Copper Coat) Gasket Sealant to both sides of the new gaskets (Figure 10-1) (20 & 22).
2. Install a new gasket (20) on the upper carburetor flange.
3. Install a new gasket (22) on the lower carburetor flange.
4. Install the carburetor (21) on the intake manifold studs with four washers (9), new lock washers (10) and nuts (11). Torque the nuts (11) evenly to Appendix B specifications.
5. Connect the fuel supply hose to the carburetor inlet fitting.
6. Install the air intake housing (23) on the carburetor (21) studs and secure with four washers (10) and nuts (11). Align the screw holes of the support bracket to the front of the air intake housing and secure with two screws (31) and washers (32). Torque the nuts (11) evenly to Appendix B specifications.
7. Connect the airframe control rigging to the throttle lever, mixture control lever and carburetor heat lever according to the airframe manufacturer's instructions. Verify smooth operation of the carburetor heat, throttle and mixture controls from the cabin and correct, if necessary.
8. Perform an “Engine Operational Check” according to Section 6-3.6 instructions.

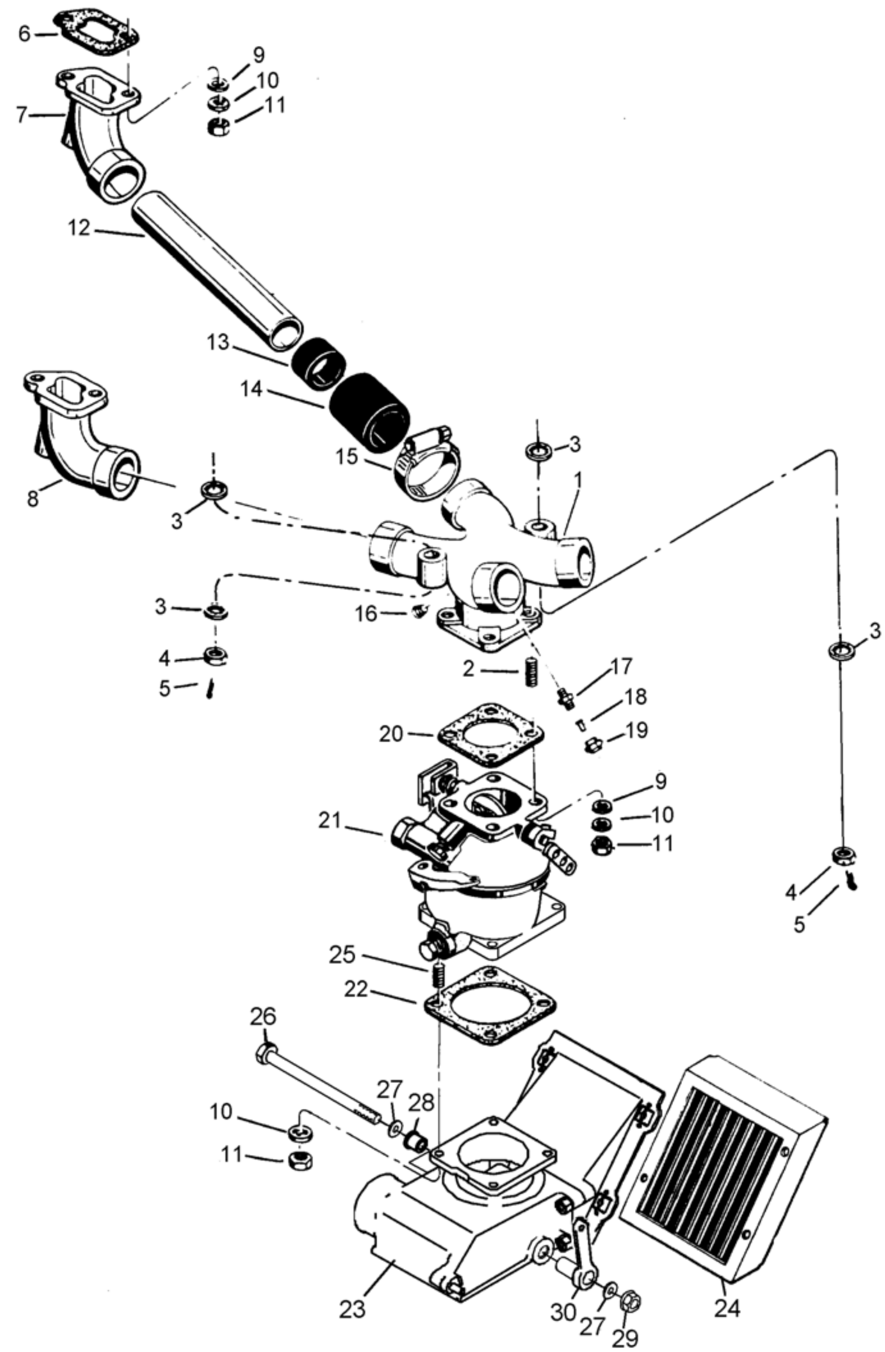


Figure 10-1 repeated for reference

10-3. Starter Replacement

10-3.1. Starter Removal

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Turn the Ignition Switch to the OFF position; disconnect the aircraft battery and electrical cable from the starter motor according to the airframe manufacturer's instructions.
2. Remove the bolts (Figure 10-2) (8), lock washers (4), washers (6), and spacers (7) from the accessory case and the rear engine lifting eye. Discard the lock washers (4).
3. Remove three sets of nuts (5), lock washers (4) and washers (3) from the starter mounting flange. Carefully remove the starter assembly without damaging the mounting stud threads. Discard the lock washers.
4. Remove and discard the gasket (1).

WARNING

If damage is discovered in step 5 or 6, perform a “Foreign Object Contamination Inspection” according to instructions in Section 6-4.6.

5. Perform a “Gear Tooth Inspection” on the starter shaft gear according to the instruction in Section 15-3.1. If the gear teeth are chipped, broken, or otherwise damaged, inspect the starter according to instructions in Section 15-6.4 using the service limits in Section 10-3.3, perform the necessary starter adapter repairs according to instructions in Section 15-7.3 and perform a “Foreign Object Contamination Inspection” according to instructions in Section 6-4.6.
6. Perform a “Gear Tooth Inspection” on the crankshaft gear according to instruction in Section 15-3.1. If the gear teeth are chipped, broken, or otherwise damaged, disassemble the engine and replace the crankshaft gear.

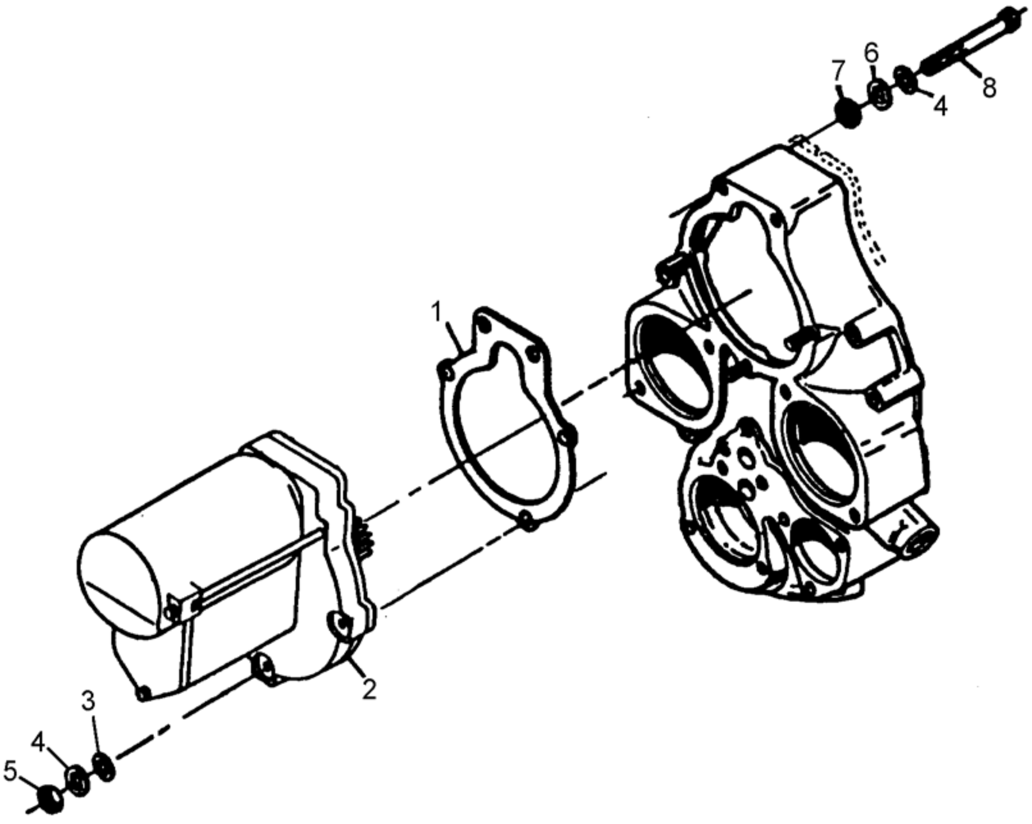


Figure 10-2. Starter

1	Gasket	3	Washer	5	Nut	7	Spacer
2	Starter Assembly	4	Lock Washer	6	Washer	8	Bolt

10-3.2. Starter Service Limits

O-200-D and subsequent engine model starters are not field-repairable, no service limits are provided.

10-3.3. Starter Installation

WARNING

Turn the Ignition Switch OFF and disconnect engine electrical power before commencing maintenance or inspections. Confirm continuity between the magneto capacitor and aircraft ground to prevent accidental engine start during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Thoroughly clean the crankcase mounting surface to remove any gasket residue.
2. Apply Part No. 642188 (Copper Coat) Gasket Sealant to both sides of the new gasket (Figure 10-2) (1).
3. Install the new gasket (1) on the accessory case.
4. Liberally lubricate the starter pinion gear with Molyshield grease.
5. Carefully insert the starter into the upper flange of the accessory and align the starter gear with the crankshaft gear.
6. Align the starter upper bolt holes with the bolt holes in the accessory case. Insert two bolts (8) with new lock washers (4), washers (6) and spacers (7) through the holes in the front of the accessory case into the upper threaded holes in the starter.
7. Secure the starter to the accessory case with three sets of washers (3), new lock washers (4), and nuts. Evenly tighten and torque the starter nuts (5) and bolts (8) to Appendix B specifications.
8. Verify the integrity of the electrical cable. Replace frayed or cracked wiring.
9. Reconnect the starter electrical cable and aircraft battery according to the airframe manufacturer's instructions.
10. Perform an “Engine Start” according to the instructions in Section 7-3.2 to verify starter operation.

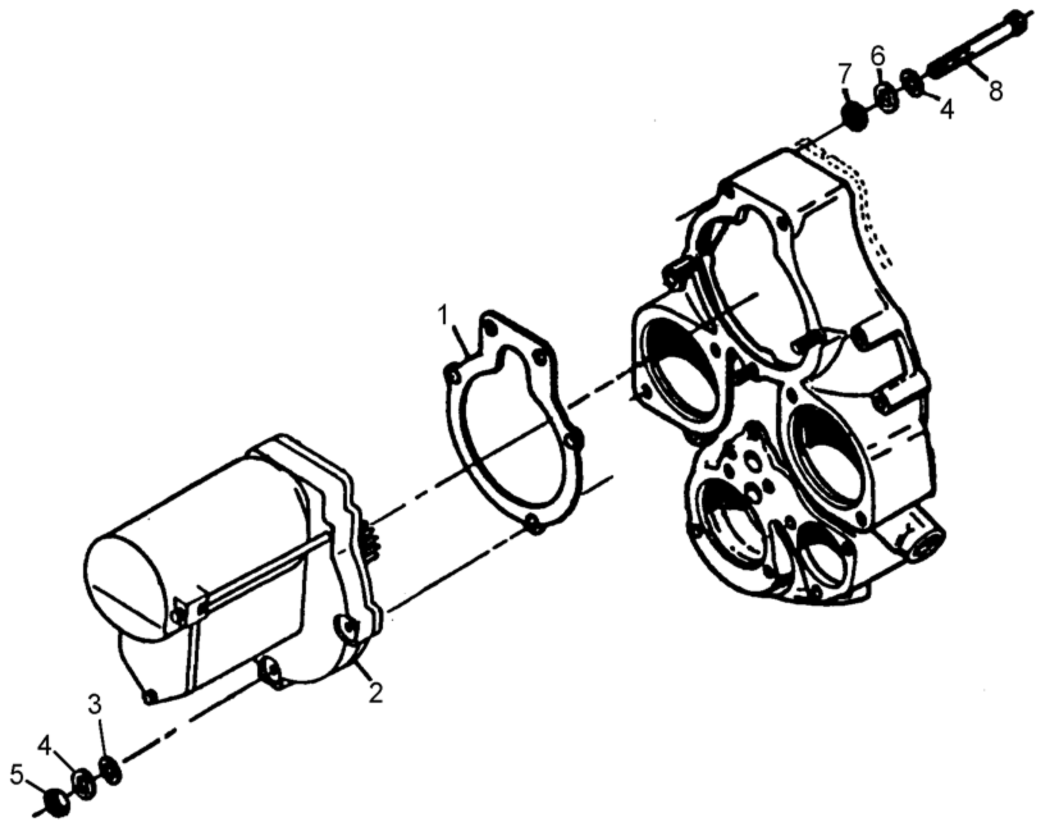


Figure 10-2 repeated for reference

10-4. Alternator Replacement

Replace the alternator if it fails to deliver the specified voltage and amperage to the aircraft electrical system. O-200 engines are equipped with a direct-drive, rear mounted alternator.

10-4.1. Alternator Removal

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Turn the Ignition Switch to the OFF position and disconnect engine electrical power.
2. Remove three nuts (Figure 10-3) (5), lock washers (4), and washers (3); discard the lock washers (4).
3. Remove the alternator (1) from the crankcase; remove the gasket (2) and clean any remaining gasket residue from the crankcase flange according to instructions in Chapter 14.

10-4.1.1. Alternator Drive Hub Removal

1. Remove the alternator from the crankcase according to the instructions in Section 10-4.1.
2. Remove the cotter pin (7) and nut (6); discard the cotter pin (7).
3. Remove the drive hub assembly (8, 9, 10, 11, 12, 13) from the alternator shaft; Discard the bushings (11) and woodruff key (13). Inspect the remaining drive hub assembly parts for serviceability.

   CAUTION: Exercise care when cleaning the residue from the mounting flange. mask the crankcase opening to avoid contaminating the engine oil supply.

4. Remove and discard the gasket (2); clean any remaining gasket residue from the crankcase flange according to instructions in Chapter 14.
5. Perform a "Gear Tooth Inspection" on the alternator drive hub gear according to the instruction in Section 15-3.1. If the drive hub gear teeth are chipped, broken, or otherwise damaged, replace the drive hub according to instructions in Section 10-4.1.1 and perform a "Foreign Object Contamination Inspection" according to instructions in Section 6-4.6.
6. Inspect the drive hub coupling bushings for serviceability. If the bushings exhibits damage or missing material, replace the bushings and perform a "Foreign Object Contamination Inspection" according to instructions in Section 6-4.6.

7. Perform a "Gear Tooth Inspection" on the crankshaft gear according to instruction in Section 15-3.1. If the gear teeth are chipped, broken, or otherwise damaged, disassemble the engine and replace the crankshaft gear.
8. Inspect, disassemble, troubleshoot, repair, and assemble the alternator according to the appropriate Alternator Service Instructions.

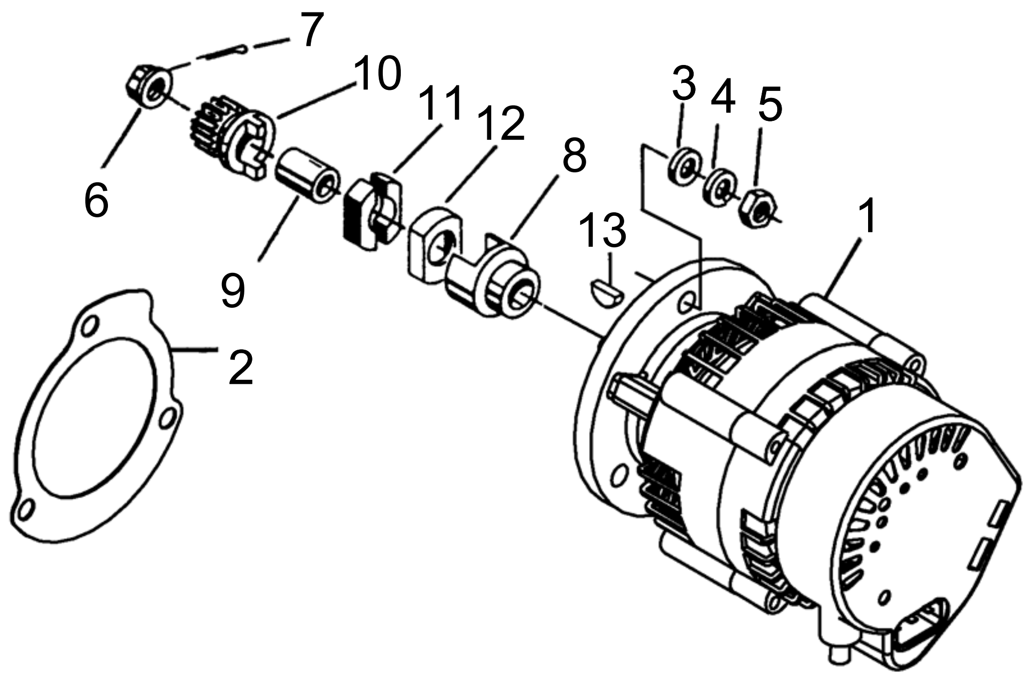


Figure 10-3. Alternator and Drive Hub

1	Alternator	5	Nut	9	Sleeve	13	Woodruff Key
2	Gasket	6	Slotted Nut	10	Gear		
3	Washer	7	Cotter Pin	11	Bushing		
4	Lock Washer	8	Alternator Coupling Hub	12	Retainer		

10-4.1.2. Alternator Drive Hub Installation

1. Install a new woodruff key (Figure 10-3) (13) in the shaft keyway.
2. Align the keyway of the alternator coupling hub with the woodruff key and press the coupling hub (8) onto the shaft with the two outside lugs facing outward on the shaft.
3. Fit the retainer (12) inside the lugs of the alternator coupling hub (9) with the open side facing outward.
4. Install the sleeve (9) on the shaft in the center of the alternator coupling hub (9).
5. Install two new bushings (11) inside the retainer (12), followed by the gear assembly (10). The bushings will sandwich the two lugs on the back side of the gear assembly.
6. Install the nut (6) on the threaded end of the alternator shaft and hand tighten.

   CAUTION: Do not exceed the fastener torque limit to align the slots in a castellated nut with a cotter pin hole. Tighten the nut to the minimum torque limit and check cotter pin hole alignment. If the slots in the nut do not align with the hole, gradually increase the torque, up to the maximum limit, until alignment is achieved.

7. Using a currently calibrated torque wrench, torque the nut according to the lower limit specified in Appendix B. If the cotter pin does not align, gradually increase torque to align the castellated nut with the cotter pin hole. If alignment cannot be achieved within the torque limits, replace the nut (6). Do not over torque!
8. Install a new cotter pin (7) and secure it according to Appendix C instructions.

10-4.2. Alternator Installation

WARNING

Turn the Ignition Switch OFF and disconnect engine electrical power prior to commencing maintenance. Do not stand or place equipment within the rotational arc of the propeller.

1. If the drive hub assembly was removed, install the drive hub assembly according to instructions in Section 10-4.1.2, “Alternator Drive Hub Installation.”
2. Apply Part No. 642188 (Copper Coat) Gasket Sealant to both sides of the new gasket (Figure 10-3) (2) Install the alternator (1) on accessory case studs with a new gasket (2).
3. Verify the alternator enters the crankcase without binding and the mounting flange is properly seated against the crankcase. Do not force the alternator into position. If there is stud interference with the mounting lug holes while mounting the alternator, do not force the alternator over the studs.

WARNING

Forceful alternator installation can cause mount lug fracture. If interference exists, inspect the mounting studs for bending; replace bent studs.

4. Verify the alternator enters the crankcase without binding and the mounting flange is properly seated against the crankcase. Do not use force to install the alternator. Do not attempt to tighten the alternator fasteners if the flange does not seat against the crankcase. If the mounting studs do not align with the mounting lug holes, inspect the studs with a tool maker's square.
5. Verify the alternator pilot enters the accessory case pilot bore squarely. Do not force the alternator pilot to fit into the pilot bore.
6. Secure the alternator with washers (3), new lock washers (4), and nuts (5); torque the nuts (5) to Appendix B specifications.
7. Connect the alternator wiring according to the airframe manufacturer's instructions. If the alternator had a grounding strap when it was removed, install the grounding strap when installing the alternator.
8. Connect aircraft electrical power according to the airframe manufacturer's instructions.
9. Start the engine according to the “Engine Start” instructions in Section 7-3.2 and test the alternator output according to the instructions in the Aircraft Maintenance Manual.

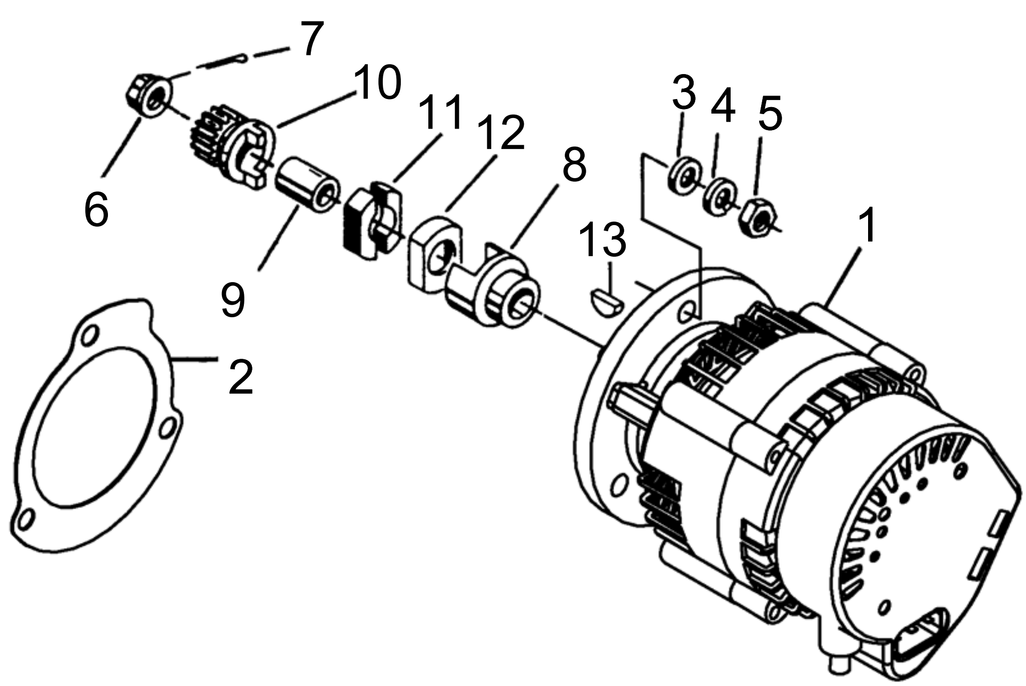


Figure 10-3 repeated for reference

10-5. Magneto Replacement

10-5.1. Continental Motors Magneto Removal

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Turn the Ignition Switch to the OFF position and disconnect engine electrical power.
2. Remove four screws (Figure 10-9) (11) from the cable outlet plate (metallic part of item 3).
3. Remove the nut (8) and lock washer (9). Remove the magneto ground wire (not shown) from the magneto.
4. Remove nuts (5), lock washers (6), and washers (7) from either side of magneto; discard the lock washers (6). Remove the magneto from the accessory case. Remove and discard the magneto gasket (4).
5. Perform an “Ignition System Inspection” according to Section 6-3.13 instructions.

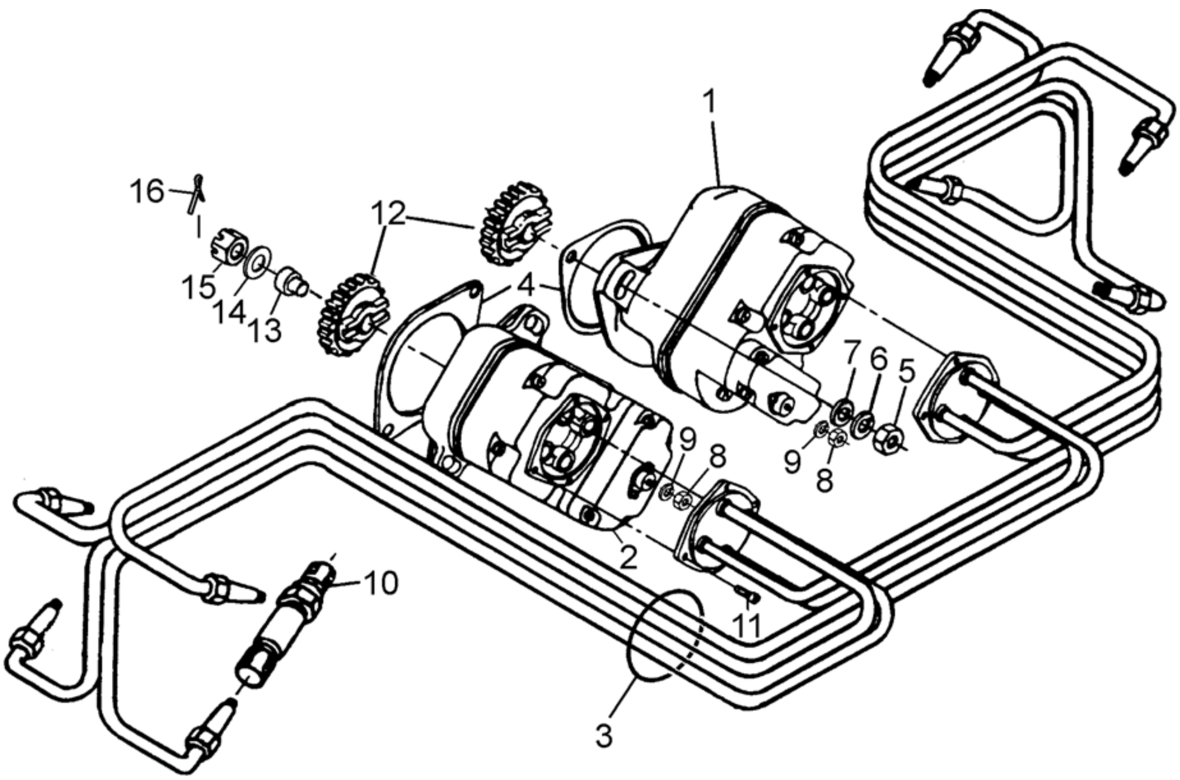


Figure 10-4. Continental Motors Ignition System

1	Left Magneto	5	Nut	9	Lock Washer	13	Bushing
2	Right magneto	6	Lock Washer	10	Spark Plug	14	Washer
3	Ignition Harness	7	Washer	11	Screw	15	Nut
4	Flange Gasket	8	Nut	12	Gear	16	Cotter Pin

10-5.2. Continental Motors Magneto Installation

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Turn the Ignition Switch to the OFF position and disconnect engine electrical power.
2. Complete the “Crankshaft Top Dead Center Alignment” in Section 6-3.8.1.1.
3. Perform steps 1-3 of the “Magneto to Engine Timing” in Section 6-3.8.1.2.
4. Remove the inspection hole plug from the magneto(s). Turn the impulse coupling backward until the marked distributor gear tooth is centered in the window.
5. Without turning the magneto drive shaft, hold the magneto in the position it will occupy when installed.
   a. Align the drive gear and impulse coupling lugs by pulling the magneto gear out and turning it to the desired position.
   b. Push the gear back into the meshed position.
   c. Install the inspection hole plug.
6. Apply Dow Corning No. 4 lubricant to both sides of a new magneto gasket Figure 10-4 (3) and install the new gasket on the magneto flange.
7. Carefully insert the magneto in the crankcase, aligning the drive gear with the camshaft. Install four sets of holding washers (7), lock washers (6) and nuts (5); hand-tighten the nuts at this time.
8. If the removed magneto is fitted with a magneto tachometer sensor (2), install the sensor in the magneto housing and torque the tachometer sensor to Appendix B specifications.
9. Complete “Magneto to Engine Timing” in Section 6-3.8.1.2.
10. Torque nuts (5) to Appendix B specifications.
11. Disconnect the timing light from magnetos. Attach the airframe wiring harness to the magneto ground terminal according the airframe manufacturer’s instructions.
12. Install the spark plugs and ignition harness according to instructions “Ignition System Maintenance” in Section 6-3.8.
13. Start the engine according to the “Engine Start” instructions in Section 7-3.2 instructions and perform a “Magneto Drop Check” according to the instructions in Section 6-3.6.4.

10-5.3. Slick Magneto Removal

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Turn the Ignition Switch to the OFF position and disconnect engine electrical power.
2. Disconnect the airframe wiring from the magneto ground terminal according to the airframe manufacturer's instructions.
3. Remove three screws (Figure 10-5) (not numbered) from the cable outlet plate (metallic part of item 2) and separate the cable outlet plate from the magneto.
4. Remove nuts (5), lock washers (6), and magneto retainers (7) from either side of magneto; discard the lock washers (6). Remove the magneto from the accessory case.
5. Remove and discard the gasket (3).
6. Replace the magneto with a new, rebuilt, or serviceable unit.

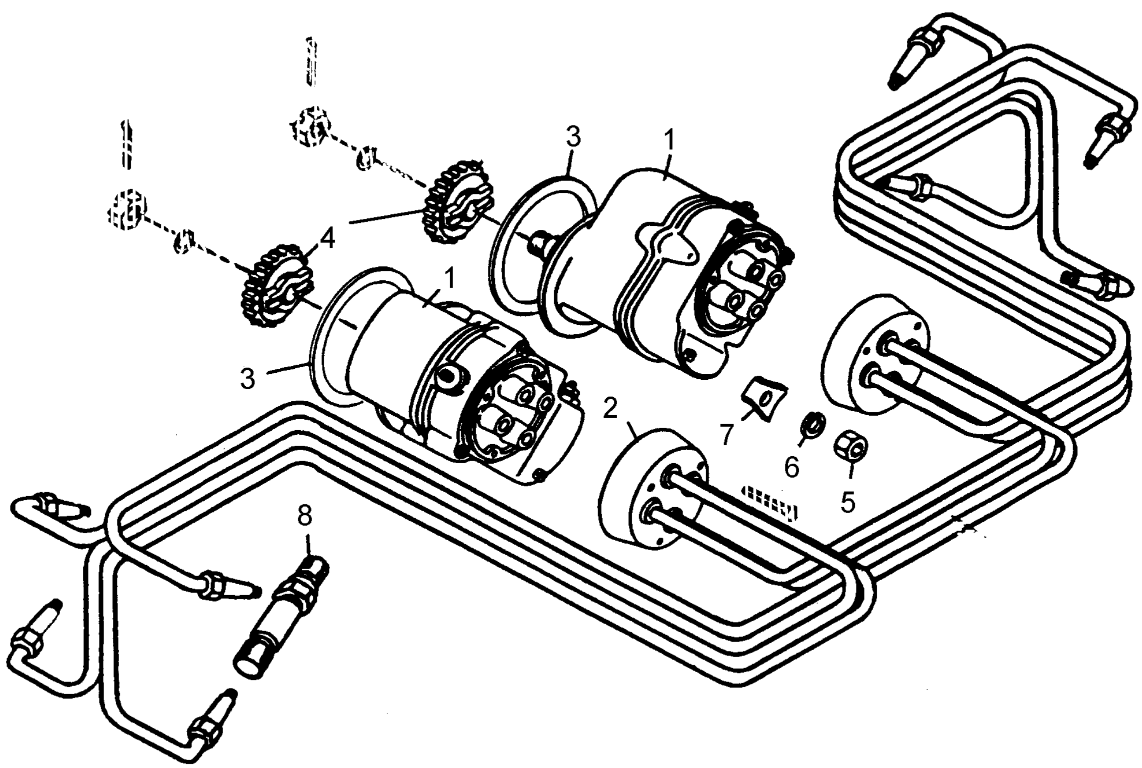


Figure 10-5. Slick Ignition System

1	Magneto	3	Gasket	5	Nut	7	Magneto Retainer
2	Ignition Harness	4	Magneto Drive Gear	6	Lock Washer	8	Spark Plug

10-5.4. Slick Magneto Installation

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Turn the Ignition Switch to the OFF position and disconnect engine electrical power.
2. Complete the “Crankshaft Top Dead Center Alignment” in Section 6-3.8.1.1.
3. Perform steps 1-3 of the “Magneto to Engine Timing” in Section 6-3.8.1.2.
4. Insert T118 timing pin in “L” or “R” hole (depending on magneto rotation) in the distributor block. Turn rotor in the opposite direction of rotation until pin engages the gear.
5. Without turning the magneto drive shaft, hold the magneto in the position it will occupy when installed.
   a. Align the drive gear and impulse coupling lugs by pulling the magneto gear out and turning it to the desired position.
   b. Push the gear back into the meshed position.
   c. Remove the T118 timing pin from the magneto
6. Verify the magneto drive gear is serviceable and properly installed. Apply Dow Corning No. 4 lubricant to both sides of a new magneto gasket (Figure 10-5) (3) and install the new gasket on the magneto flange.
7. Carefully insert the magneto in the crankcase, aligning the drive coupling lugs with the drive bushing slot. Secure the magneto to the crankcase with retainers (6), lock washers (5) and nuts (4); hand-tighten the nuts at this time.Install the ventilation plug removed for inspection.
8. Complete “Magneto to Engine Timing” in Section 6-3.8.1.2.
9. Torque nuts (4) according to Appendix B specifications.
10. Disconnect timing light from magnetos. Attach the magneto ground wire according the airframe manufacturer’s instructions.
11. Install the spark plugs and ignition harness according to instructions “Ignition System Maintenance” in Section 6-3.8.
12. Start the engine according to the “Engine Start” instructions in Section 7-3.2 instructions and perform a “Magneto Drop Check” according to the instructions in Section 6-3.6.4.

10-6. Lubrication System Repair

10-6.1. Oil Pump Repair and Replacement

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

NOTE: The O-200 oil pump is an integral part of the accessory case. Depending on the installation, the engine may need to be removed from the aircraft to access the oil pump. Refer to the “Engine Removal” instructions in Section 5-1.

1. Turn the Ignition Switch to the OFF position and disconnect engine electrical power.
2. Remove the magnetos according to instructions in Section 10-5.1 or Section 10-5.3, depending on the engine specification.
3. Remove the alternator according to instructions in Section 10-4.1.
4. Remove the starter according to instructions in Section 10-3.1.
5. Remove the accessory case according to instructions in Section 12-9.
6. Remove the oil pump assembly according to instructions in Section 13-3.
7. Inspect the oil pump components according to the Lubrication Component Service Limits in Section 10-6.5. Replace parts that do not meet the dimensional specifications.
8. Install the oil pump assembly in the accessory case according to “Accessory Case Assembly” instructions in Section 16-6.

   NOTE: Repairs other than smoothing nicks on parting surfaces, replacing studs and worn parts, and refacing the oil pressure relief valve seat on the oil pump housing are prohibited. The pump gear chamber must not be enlarged. If it becomes scored or enlarged, discard and replace the accessory case. Scoring on the gear contact area of the oil pump cover renders it unserviceable unless the parting surfaces can be lapped smooth and perfectly flat.

9. Install the accessory case according to instructions in Section 17-8.
10. Install the alternator according to instructions in Section 10-4.2.
11. Install the starter according to instructions in Section 10-3.3.
12. Install the magnetos according to instructions in Section 10-5.2 or Section 10-5.4.
13. Service the engine oil according to instructions in Section 6-3.7.
14. Perform an “Engine Operational Check” according to instructions in Section 6-3.6.

10-6.2. Oil Sump or Oil Suction Tube Repair and Replacement

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Turn the Ignition Switch to the OFF position and disconnect engine electrical power.

   NOTE: For most engine installations, the engine must be removed from the airframe to remove the oil sump. Follow appropriate engine removal instructions in Chapter 5.

2. Remove the oil sump or suction tube according to the “Oil Sump Removal” instructions in Section 12-8.
3. Install a new oil sump or suction tube according to the “Oil Sump Installation” instructions in Section 17-12.
4. Perform an “Engine Operational Check” according to instructions in Section 6-3.6.

10-6.3. Oil Cooler Repair and Replacement

The O-200 may be equipped with an oil cooler. The oil cooler is an airframe accessory; refer to the airframe manufacturer's instructions for Oil Cooler Replacement.

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance or inspections to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

NOTE: Remove and replace the oil cooler according to the airframe manufacturer's instructions.

10-6.3.1. Oil Cooler Adapter Removal

1. Turn the Ignition Switch to the OFF position and disconnect engine electrical power.
2. Drain the engine oil according to instructions in Section 6-3.7, “Engine Oil Servicing.”
3. Disconnect the oil cooler supply and return hoses from the adapter fittings (17).
4. Remove the nuts (Figure 10-6) (5), lock washers (4), and washers (3); Discard the lock washers (12).
5. Remove the oil cooler adapter assembly and gasket (2) from the crankcase; discard the gasket.
6. Disassemble the oil cooler adapter according to the oil cooler adapter disassembly instructions in Section 13-4.

10-6.3.2. Oil Cooler Adapter Installation

1. Apply Part No. 642188 (Copper Coat) Gasket Sealant to both sides of a new gasket (Figure 10-6) (2) and install the assembled oil cooler adapter assembly and new gasket (2) on the left crankcase half at through-bolt position 32L with washers (4), new lock washers (3), and nuts (5); torque nuts to Appendix B specifications.
2. Connect the oil cooler supply and return hoses to the fittings (17). The oil supply to the cooler connects to the lower fitting. The return line connects to the upper fitting.
3. Service the engine with fresh oil according to the "Engine Oil Servicing" instructions in Section 6-3.7.

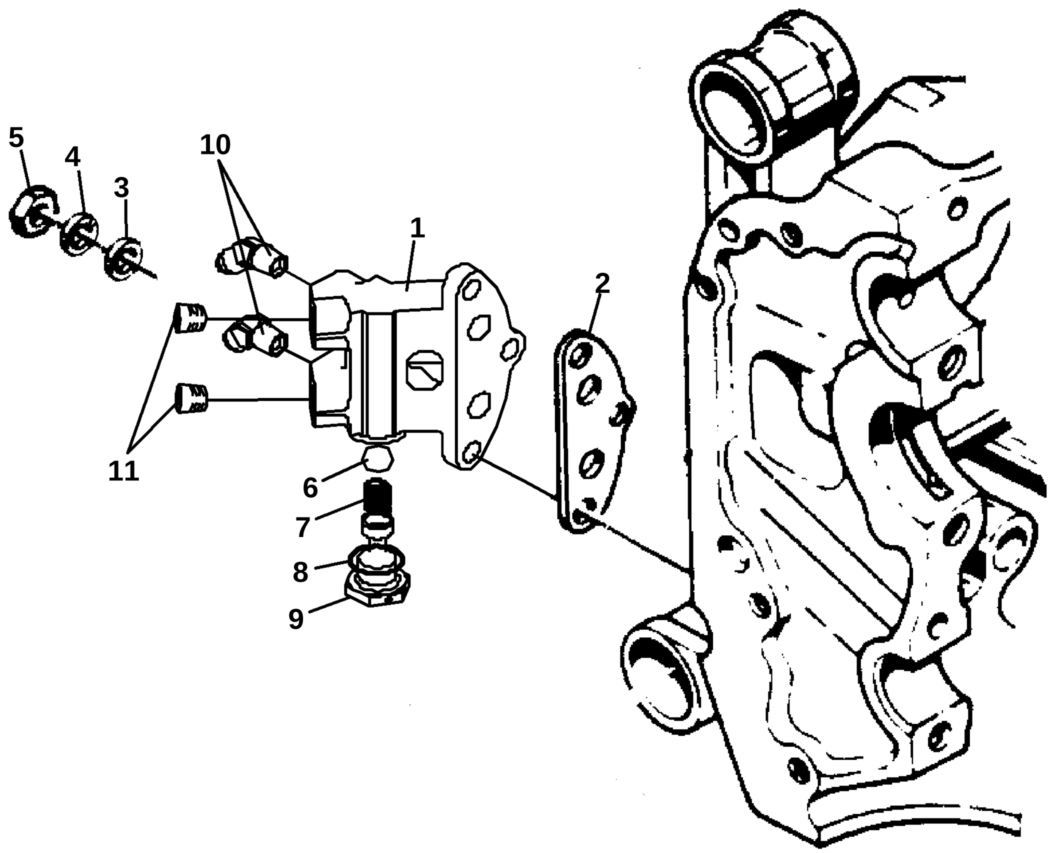


Figure 10-6. Oil Cooler Adapter

1	Oil Cooler Adapter	6	Pipe Plug	11	Plug	16	Oil Cooler Pad Adapter
2	Oil Cooler Adapter Gasket	7	Countersunk Pipe Plug	12	-------------	17	Fitting
3	Washer	8	Ball - 0.437 steel	13	Oil Cooler Gasket	18	Bolt
4	Lock Washer	9	Spring	14	Washer		
5	Nut	10	Copper Gasket	15	Nut		

10-6.4. Oil Pressure Relief Valve Repair and Replacement

1. Turn the Ignition Switch to the OFF position and disconnect engine electrical power.

WARNING

Turn the Ignition Switch OFF, disconnect engine electrical power and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

2. Remove the relief valve cap (Figure 10-7) (28); discard the gasket.
3. Remove the spring (26) and plunger (25) from the cavity.
4. Clean the parts thoroughly according to the Cleaning instructions in Chapter 14.
5. Inspect the spring (26) for bends, corrosion, or damage; replace if necessary. Check the spring tension using the Service Limits specified in Section 10-6.5.
6. Inspect the relief valve seat in the cavity of the accessory case for debris, nicks, or gouges. If the relief valve seat exhibits nicks or gouges, remove the accessory case from the engine, lap the seat according to instructions in Section 15-7.4.1. Inspect the plunger face for nicks, gouges, or spalling; Smooth small nicks with crocus cloth and rinse the residue from the plunger with mineral spirits.
7. Liberally coat the plunger face with clean 50 weight aviation engine oil. Insert the spring in the plunger and insert both in the cavity. Install a new gasket on the cap. Apply a light coating of anti-seize lubricant to the cap threads and install the cap; torque the cap to Appendix B specifications.

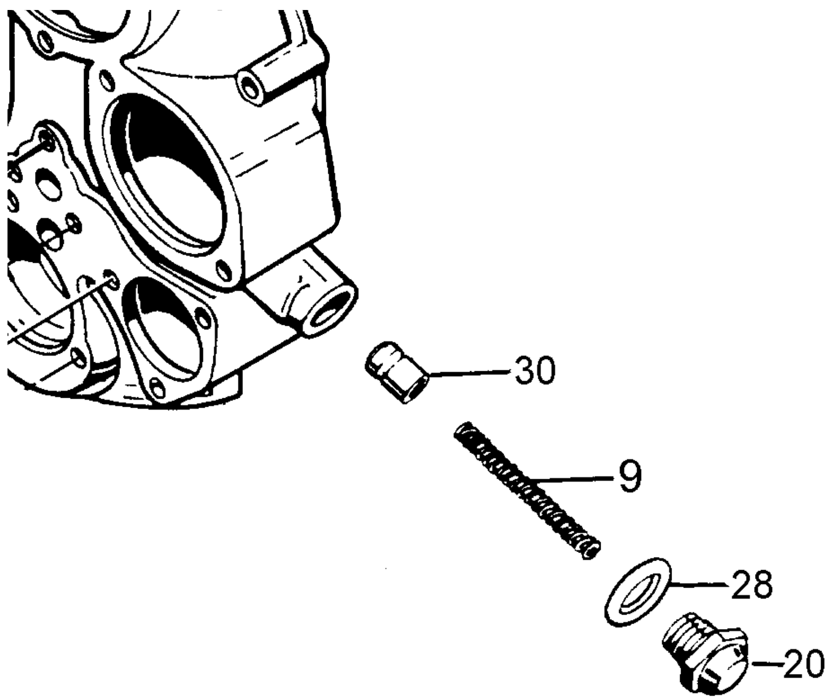


Figure 10-7. Oil Pressure Relief Valve

10-6.5. Lubrication Component Service Limits

The lubrication system component service limits are shown in Table 10-4. Item numbers in the first column correspond to the item numbers in Figure 10-8.

Table 10-4. Lubrication System Component Service Limits

Index	Part	Service Limit	New Dimensions (inches) Minimum	Maximum
Oil Pressure Relief Valve Assembly				
1	Oil pump gear in pump housing .... end clearance:	0.0070L	0.0020L	0.0050L
2	Oil pump driver gear in housing.................................... diameter:	0.0080L	0.0030L	0.0060L
3	Oil pump gear shafts in accessory case and plate .... diameter:	0.0045L	0.0015L	0.0030L
4	Oil pump gear cavity .... diameter:	1.501	1.4990	1.5010
5	Oil pump gear shaft bore .... diameter:	0.5630	0.5620	0.5630
6	Oil pump gear cavity .... depth:	0.626	0.6240	0.6260
7	Square drive to camshaft gear.................................... clearance:	0.0135	0.0055L	0.0135L
8	Oil pump driver and driven gears ....backlash:	0.025	0.014	0.022
Spring Test Data				
9	Oil press. relief valve spring (0.041) compressed to 1.56 inch length .... load:	5.75 lbs.	6.06 lbs.	6.31 lbs.
T= Tight L=Loose				

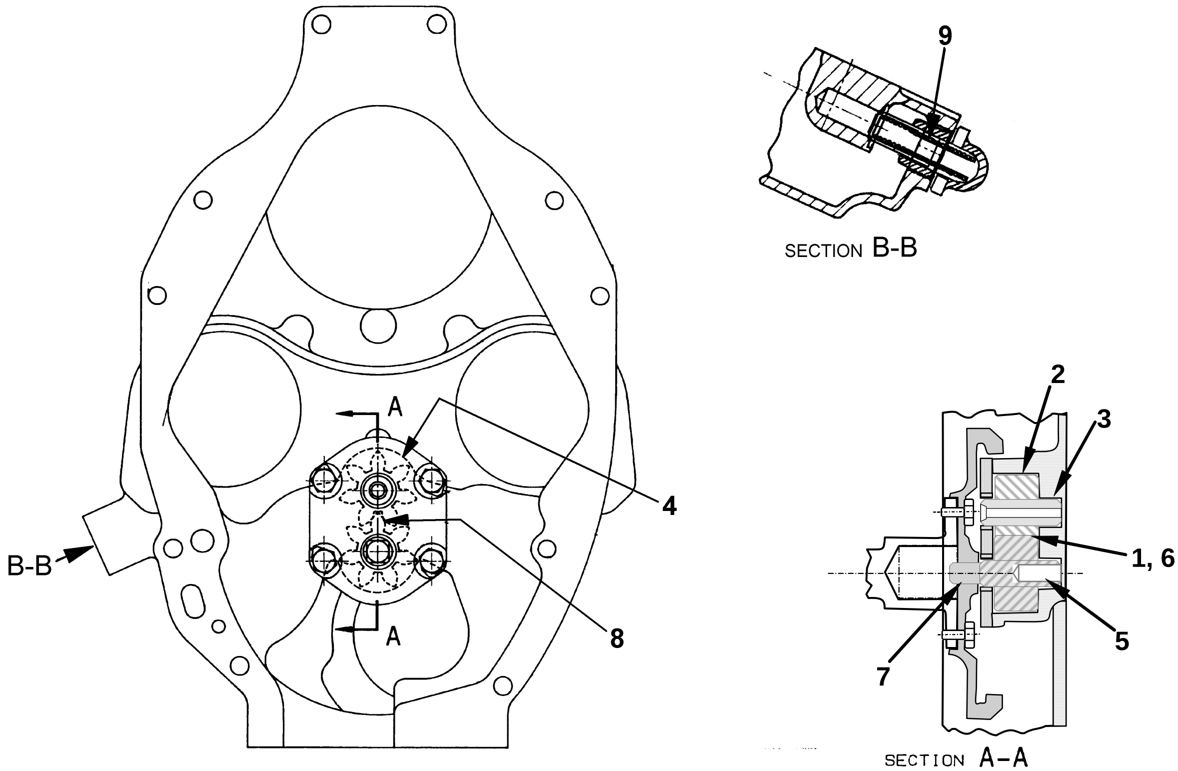


Figure 10-8. Lubrication System Service Limits

10-7. Engine Cylinder Maintenance

Procedures in this section apply only to individual engine cylinder repair, service, or replacement on condition as a maintenance item and not for engine overhaul. Refer to instructions in Chapters 12 - 17 for multiple engine cylinder repair or replacement.

10-7.1. Rocker Arm Removal

WARNING

Turn the Ignition Switch OFF, disconnect the battery from the engine and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Turn the Ignition Switch to the OFF.
2. Remove cowling and any airframe supplied accessories according to the airframe manufacturer's instructions.
3. Disconnect the battery according to the airframe manufacturer's instructions.
4. Disconnect the top and bottom spark plug leads from the spark plugs on the cylinder(s) to be removed.
5. Place a tag on the propeller with the warning “DO NOT TURN PROPELLER.”
6. Position the crankshaft so the piston is at top dead center and both intake and exhaust valves of the rocker arms to be removed are closed.

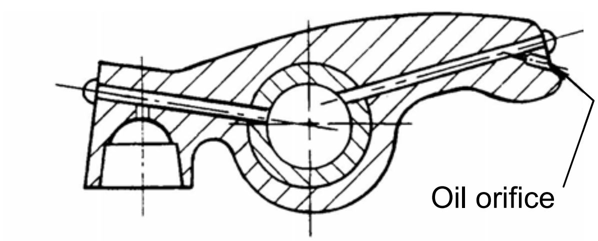


Figure 10-9. Exhaust Rocker Arm Oil Orifice

CAUTION: Intake and exhaust rocker arms are not interchangeable. Exhaust rocker arms feature an oil orifice (Figure 10-9) to lubricate the exhaust valve stem; intake rocker arms have no oil orifice.

1. Remove six sets of fillister head screws (Figure 10-10) (32), lock washers (31), and washers (30) from the rocker cover (29); discard the lock washers (30). Remove the rocker cover (29) and gasket (28) from the cylinder; discard the gasket (28).
2. Check rocker arm end play to verify valve spring tension is relaxed. Reposition the crankshaft, if required, to close the intake and exhaust valves.

CAUTION: Do not allow the rocker arms to free fall from the cylinder as the rocker shaft is removed from the boss. Impact from a fall may damage the rocker arm.

3. Remove the bolt (27) and washer (26) from the rocker shaft (25).

4. Push the rocker shaft (25) out of the boss with a drift. Grasp the rocker arms (22), in turn, as they are freed from the rocker shaft, and remove them from the cylinder head. Clearly identify the cylinder and valve the rocker arms are removed from.
5. Inspect the rocker shafts (25) and rocker arms (22).
6. Withdraw the pushrods (41) from the pushrod housing (12).

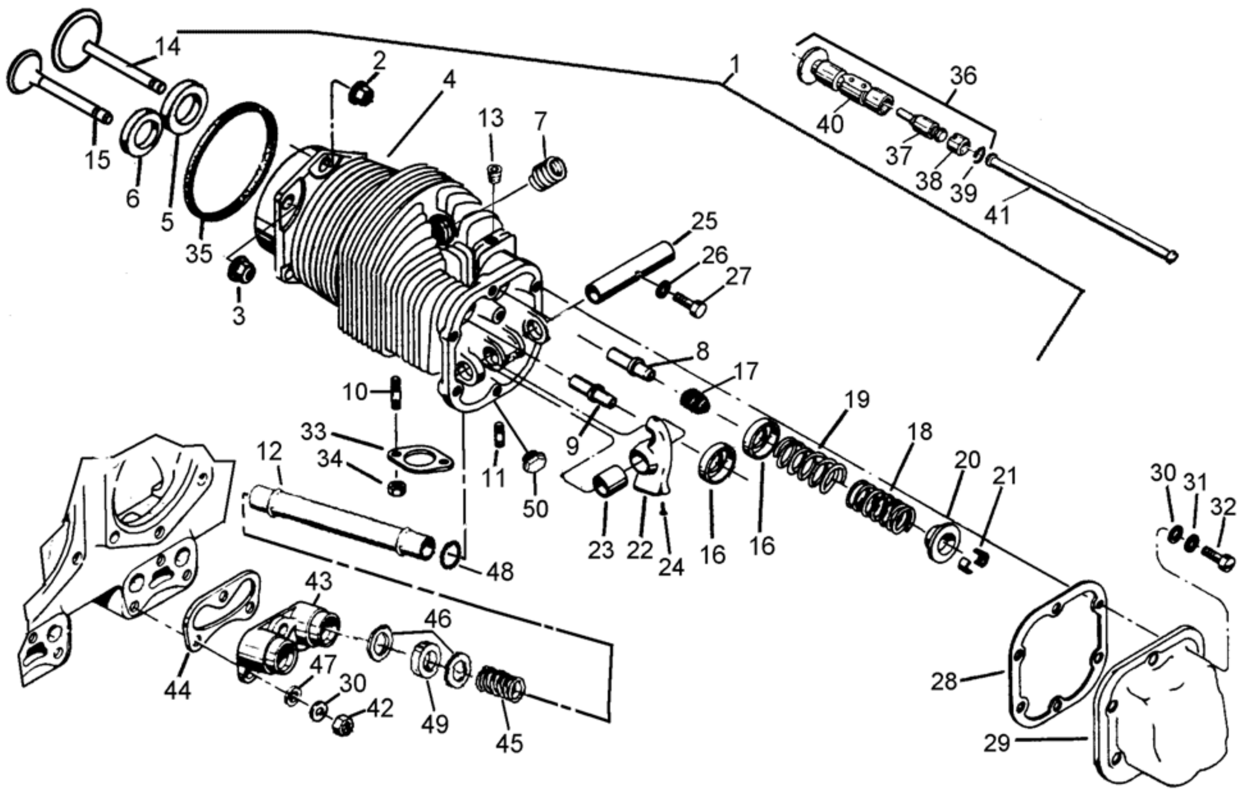


Figure 10-10. Cylinder Assembly

1	Cylinder & Valve Assembly	13	Plug	25	Rocker Shaft	38	Socket
2	Nut	14	Intake Valve	26	Washer	39	Snap Ring
3	Nut	15	Exhaust Valve	27	Bolt	40	Lifter Body
4	Cylinder Assembly	16	Valve Spring Seat	28	Rocker Cover Gasket	41	Push Rod
5	Intake Valve Seat Insert	17	Intake Valve Guide Seal	29	Rocker Cover	42	Lock Nut
6	Exhaust Valve Seat Insert	18	Inner Valve Spring	30	Washer	43	Pushrod Adapter
7	Helical Coil Insert	19	Outer Valve Spring	31	Lock Washer	44	Pushrod Housing Gasket
8	Intake Valve Guide	20	Valve Spring Retainer	32	Bolt	45	Spring
9	Exhaust Valve Guide	21	Valve Spring Key	33	Exhaust Flange Gasket	46	Washer
10	Stud	22	Rocker Arm Assembly	34	Lock Nut	47	Washer
11	Stud	23	Rocker Arm Bushing	35	O-ring	48	O-ring Seal
12	Pushrod Housing	24	Screw	36	Lifter Assembly	49	Pushrod Housing Seal
				37	Plunger Assembly	50	Spark Plug Insert

10-7.2. Pushrod Housing Removal

1. Remove the rocker cover and rocker arms according to instructions in Section 10-7.1.
2. Grasp each push rod housing (Figure 10-11) (12) and push it inward toward the crankcase, compressing the push rod housing spring (45); move the pushrod housing away from the cylinder head and remove the push rod housing (12) from the crankcase.
3. Remove the O-rings (48), washers (46), pushrod housing seals (49) and springs (45). Discard the O-rings (48), pushrod housing seals (49) and springs (45).
4. Remove the nuts (42), lock washers (30), and washers (47) from the pushrod adapter (43).
5. Remove the pushrod adapter (43) and gasket (44) from the crankcase studs. Discard the lock washers (30) and gasket (44).

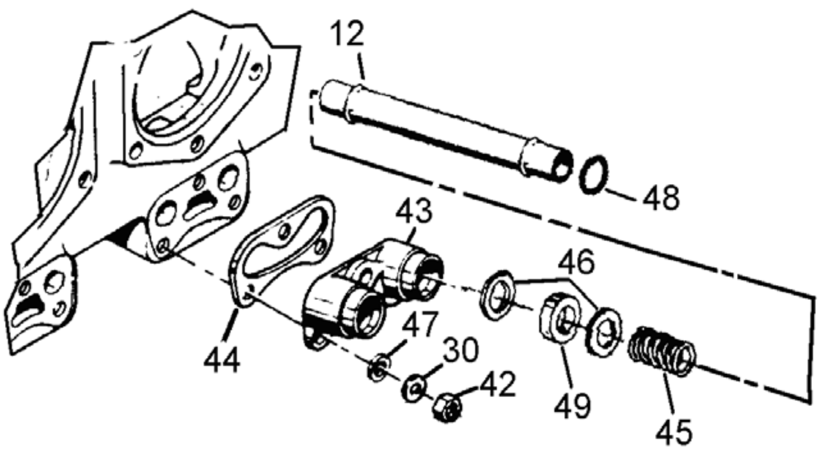


Figure 10-11. Pushrod Housing and Adapter Detail

12	Pushrod Housing	45	Spring
30	Lock Washer	46	Washer
42	Lock Nut	47	Washer
43	Pushrod Adapter	48	O-ring Seal
44	Pushrod Adapter Gasket	49	Pushrod Housing Seal

10-7.3. Lifter Removal

1. Remove the rocker arm assemblies according to instructions in Section 10-7.1.
2. Remove the pushrod housing assemblies according to instructions in Section 10-7.2.
3. Remove the snap ring (Figure 10-12) (39) from the lifter body (40). Extract the socket (38) and plunger assembly (37) from the lifter body (40). Identify each lifter assembly's removed location (cylinder and valve), lifter assembly components must remain in the same set, installed in the same location, unless replaced.
4. Inspect the socket (38) and plunger (37) for abnormal wear. If the plunger is collapsed or the spring will not compress, replace the plunger. Examine the lifter body (40) collar for damage; if the snap ring will not securely fit in the lifter body, replace the lifter as an assembly (this requires crankcase disassembly). Replace lifter assemblies which exhibit faulty snap rings, damaged socket cups, or appear to have collapsed springs or plungers.

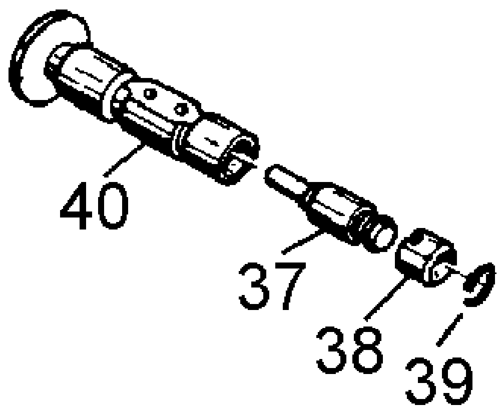


Figure 10-12. Lifter Assembly

37	Plunger	39	Snap Ring
38	Socket	40	Lifter Body

10-7.4. Engine Cylinder Removal

WARNING

Turn the Ignition Switch OFF, disconnect the battery from the engine and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Turn the Ignition Switch to the OFF position.
2. Disconnect the battery according to the airframe manufacturer's instructions.
3. Remove cowling and any airframe supplied accessories according to the airframe manufacturer's instructions to gain access to the cylinder.
4. Disconnect all spark plug leads.
5. Remove the Induction System components according to with instructions in Section 12-5.
6. Remove the exhaust system components according to the airframe manufacturer's instructions.
7. Remove the inter-cylinder baffles adjacent to the cylinder to be removed according to instructions in Section 12-10.
8. Remove the rocker arm assemblies according to instructions in Section 10-7.1.
9. Remove the pushrod housing assemblies according to instructions in Section 10-7.2.
10. Tag the propeller with the warning, "DO NOT TURN PROPELLER."
11. During engine cylinder component removal, inspect components for wear and conformance to dimensional limits. Replace components based on the following:
    a. Only parts that meet *service limits* may remain in service or be re-used.
    b. If a part fails to meet a service limit tolerance, replace it with a part that meets the specified service limits.
12. Using the appropriate wrenches, carefully remove the flange nuts (Figure 10-13) (2 and 3) from the cylinder base flange.
13. As the last pieces of fastening hardware are removed, cradle the cylinder in your arm for support.

    CAUTION: The piston will be damaged if allowed to drop as the cylinder is withdrawn.
14. While supporting the cylinder, carefully pull the cylinder outward in a straight plane with one hand, keeping the other hand free to catch the piston as the cylinder is withdrawn to prevent damage to the crankcase or cylinder.

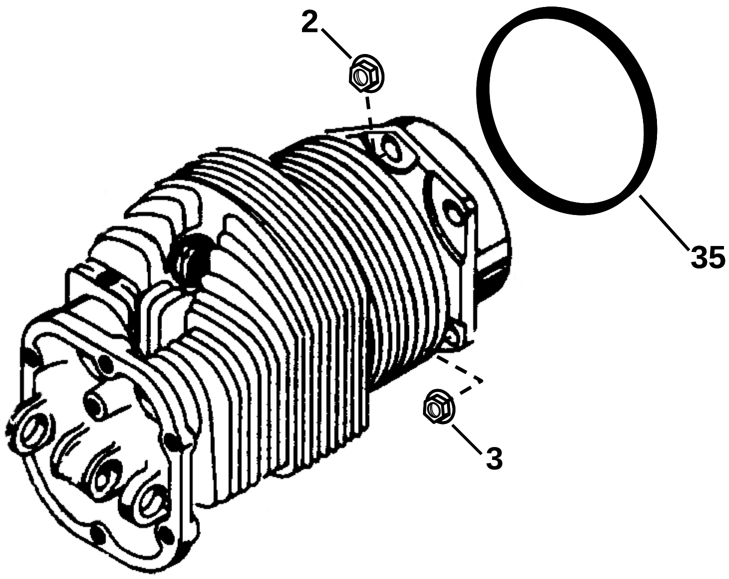


Figure 10-13. Cylinder Flange Detail

15. Remove the cylinder base O-ring (35). Wrap the old cylinder base O-ring in a figure 8 pattern (Figure 10-14) around four of the crankcase studs and stretch the two vertical segments of the O-ring over the connecting rod to secure it.

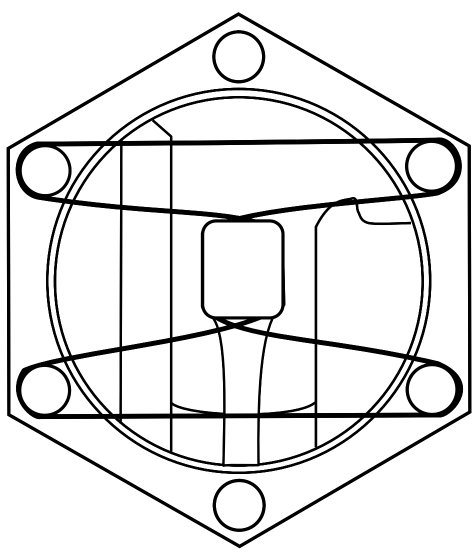


Figure 10-14. Cylinder Base O-ring used to secure the Connecting Rod

16. Remove the piston pin (Figure 10-15) (5) and piston (1) from the connecting rod. Inspect the piston pin (5). Remove the piston rings (2, 3 & 4) with a piston ring expander.

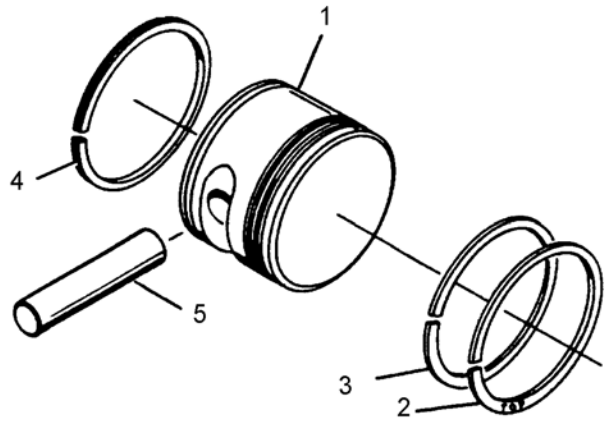


Figure 10-15. Piston Assembly

17. Perform a static leak check to check the cylinder static seal (Figure 10-16).
    a. Place a fiber drift on the rocker arm directly over the valve stem.

    CAUTION: Do not allow the fiber drift to contact the valve spring retainer or rotocoil.

    b. Tap the drift several times with a hammer to dislodge any debris that may be between the valve face and seat.
    c. Invert the removed cylinder with the spark plug installed.
    d. Fill the inverted cylinder bore with nonflammable solvent.
    e. Look for leaks in the static seal area of the cylinder. Pay particular attention to the barrel to cylinder head junction. If the cylinder head and barrel seal is leaking, discard the cylinder. If the intake or exhaust seat seals or the spark plug seals are leaking, note the discrepancy and perform the appropriate repairs in Chapter 15.

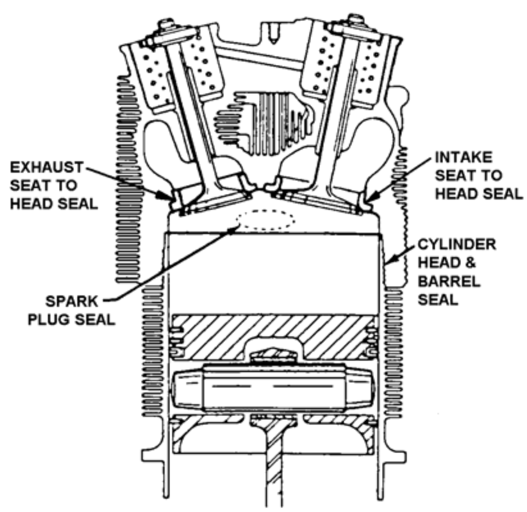


Figure 10-16. Cylinder Static Seal

18. Temporarily insert the rocker shaft (Figure 10-17) (26) in the cylinder head boss. Secure the cylinder in a cylinder holding fixture. Use a valve spring compressor to compress the intake valve assembly. Carefully remove and discard the two valve spring keys (21) from the valve stem with long nose pliers.
19. Repeat step 18 to remove the exhaust valve spring keys. Remove the rocker arm shaft from the boss.

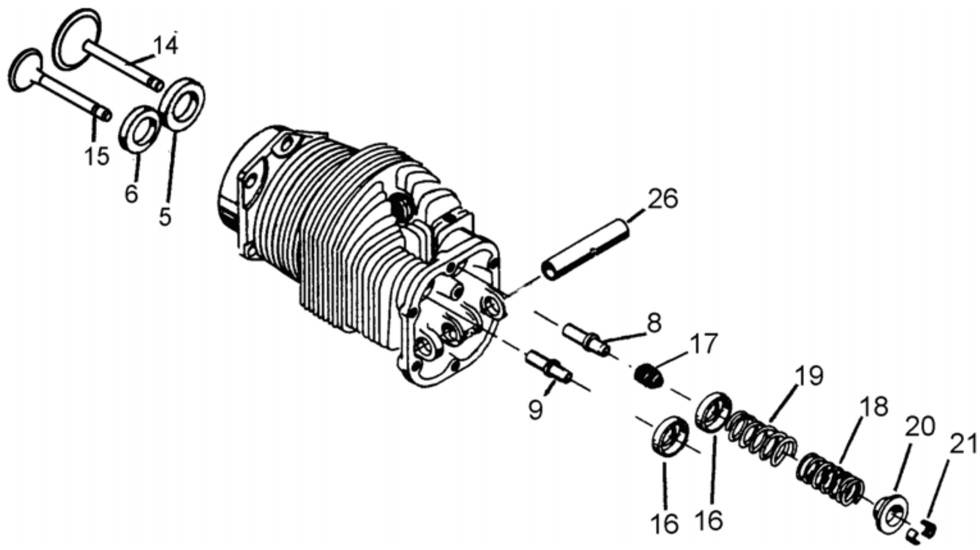


Figure 10-17. Cylinder Valve & Spring Assembly

5	Intake Valve Seat Insert	9	Exhaust Valve Guide	17	Intake Valve Guide Seal	21	Valve Spring Key
6	Exhaust Valve Seat Insert	14	Intake Valve	18	Inner Valve Spring	26	Rocker Shaft
7	Helical Coil Insert	15	Exhaust Valve	19	Outer Valve Spring		
8	Intake Valve Guide	16	Valve Spring Seat	20	Valve Spring Retainer		

20. Remove the valve spring retainers (21), outer springs (19), inner springs (18) and valve spring seats (16) from the cylinder.
21. Grasp the cylinder assembly by the valve stems and remove it from the holding fixture. Place the cylinder assembly on its side and remove the valves (14 & 15) from the cylinder.
22. Refer to Chapter 13 though Chapter 15 for instructions on cylinder disassembly, cleaning, inspection and repair.
    a. Clean the cylinder according to Section 14-1.2, "Cylinder Cleaning" instructions.
    b. Clean the piston (55) according to Section 14-1.3, "Piston Cleaning" instructions

    CAUTION: Do not use automotive-type piston scrapers to clean piston ring lands.

    c. Perform "Fluorescent Penetrant Inspection" and "Magnetic Particle Inspection" according to instructions in Chapter 15.

d. Perform a dimensional inspection on the cylinder, the piston, and components according to the "Engine Cylinder Dimensional Inspection" instructions in Section 10-7.5, using the "Cylinder Service Limits" in Section 10-7.5.1.

23. Assemble serviceable cylinders according to the "Engine Cylinder Assembly" instructions in Section 16-5 and install the cylinder according to the "Cylinder Installation" instructions in Section 10-7.6.

10-7.5. Engine Cylinder Dimensional Inspection

1. Inspect the "power stroke stress areas" according to instructions in Section 6-3.9.1, "Cylinder Visual Inspections."
2. Inspect cylinder bore dimensions according to the specifications in Section 10-7.5.1. Grind cylinder bores that do not conform to the standard size dimensions to the next oversize dimension up to 0.15 inches oversize maximum. (Refer to "Cylinder Bore Honing" in Section 15-7.5.6 for cylinder barrel grinding and honing instructions.)
3. Inspect the cylinder base flanges for flatness with a straightedge and a feeler gauge. If a flange exceeds 0.001 inches out of flat, replace the cylinder.
4. Inspect the intake and exhaust flange studs for security. If studs are loose, or bent or if the threads are damaged or disfigured, determine the appropriate oversize stud and replace according to instructions in Appendix C.
5. If the intake or exhaust flange studs are removed for replacement, dimensionally inspect the stud holes using a thread gauge to determine the appropriate oversize replacement stud.
6. Inspect the pushrods for cracks, nicks, burrs, pitting or corrosion. Inspect the rod caps for cracks or erosion. Inspect the pushrods using "Cylinder Service Limits" in Section 10-7.5.1. Verify the rod cap oil passages are clear and the bores meet service limits. Inspect the pushrods length and cap diameter with a micrometer. Rotate the pushrods on a surface plate to inspect for bends. The total runout service limit is 0.003" over the length of the pushrods.
7. Inspect pushrod housings for cracks, dents, bending or chafing damage; discard pushrod housings exhibiting these conditions. Inspect pushrod housings for rust, pitting or missing cadmium plating; discard pushrod tubes exhibiting these conditions.
8. Inspect the inside diameter of the valve guides using the "Cylinder Service Limits" in Section 10-7.5.1. Replace cracked, eroded, burned, or pitted valve guides or valve guides which fail to meet service limits.
9. Inspect the valve seats for indications of burning, pitting erosion, or cracks. Check the valve seat dimensions according to the "Cylinder Service Limits" in Section 10-7.5.1. Replace valve seats that are cracked, eroded, burned or pitted or valve seats that are not within the service limits according to instructions in Section 15-7.5.
10. Perform a visual inspection on the intake and exhaust valves; if the valve face is mushroomed, or if the valve face exhibits seat pounding (face angle is concave), or the valve exhibits burns, cracks, pitting, erosion, or corrosion, replace the valves.

WARNING

Do not regrind intake or exhaust valves. Intake and exhaust valves are heat treated during the manufacturing process to meet hardness requirements. Grinding destroys the hardened finish. Replace valves if the grind angle or surface finish does not meet service limit specifications.

11. Using a V-block with a surface plate and a dial indicator, inspect each intake and exhaust valve face for run out (eccentricity). Discard valves if they exceed "Cylinder Service Limits" in Section 10-7.5.1 run-out specifications.
12. Inspect the length of the valve from tip to gauge line according to the dimensions in "Cylinder Service Limits" in Section 10-7.5.1. Replace valves if the gauge line length does not conform to the service limits.
13. Inspect the outside diameter of the intake and exhaust valve stems using a micrometer and the "Cylinder Service Limits" in Section 10-7.5.1. Replace the valve if the outside diameter of the valve stem measures less than the service limits.
14. Inspect the intake and exhaust valve head gauge line diameter using a micrometer and the "Cylinder Service Limits" in Section 10-7.5.1. Replace the valve if the gauge line diameter measure less than the service limit.
15. Perform a "Magnetic Particle Inspection" (Section 15-5) on the valves. Discard any valve with cracks or indications of cracks.
16. Clean the valves using mineral spirits and air dry. When valves have dried, coat all valve surfaces thoroughly with clean 50 weight aviation engine oil.
17. Visually inspect the connecting rods for corrosion pitting, rust, discoloration (bluing), galling, impact damage, nicks, bending and twisting. Scrap connecting rods with any of these indications.
18. Inspect connecting rod piston pin bushings for excessive wear or missing material. Verify the bushing split line is no closer than 40 degrees to the connecting rod centerline; replace piston pin bushings that fail to meet service limit specifications.
19. Dry fit the rocker arms in the rocker arm boss to dimensionally inspect the rocker arm thrust width using "Cylinder Service Limits" in Section 10-7.5.1 specifications; replace rocker arms which fail to meet service limits.
    a. Inspect the rocker arm foot contact area for wear, galling, spalling, scoring, or grooves; discard rocker arms exhibiting these conditions.
    b. Inspect the rocker arm ball seat for wear and smoothness; discard rocker arms with gouged, scratched, etched, pitted or mushroomed ball seats.
    c. Inspect the thrust surfaces of the rocker arm shaft bore for displaced metal, spalling, or galling; discard rocker arms exhibiting these conditions.
    d. Inspect rocker arm exhibiting peeling copper plating, which can be a source of contamination in oil and spectrographic oil analysis. Use a scotch-brite pad to remove loose copper plating material.

e. Inspect for and discard rocker arms with loose or missing oil passage drive screws. Inspect rocker arm oil passages for obstructions. Use an oil squirt bottle with clean 50 weight aviation engine oil to check oil passages for free flow. Discard rocker arms with blocked oil passages which cannot be cleared with solvent.

20. Inspect the Intake and Exhaust Valve Springs according to the “Cylinder Service Limits” in Section 10-7.5.1. Replace valve springs which fail the dimensional inspection or exhibit cracks, abnormal curvature or excessive wear.

21. Measure the diameter of the removed piston pin at three equally spaced points along the length of the piston pin in comparison to the dimensions specified in Section 10-7.5.1 Rotate the piston pin 90° and repeat the measurements. The piston pin must meet the dimensional limits at each point, out of round is limited to 0.0002.” Discard piston pins exceeding the dimensional limits or out of round tolerance.

22. Measure the piston pin bore inside diameter to verify it meets Section 10-7.5.1 dimensions. Insert the piston pin in the piston bore to verify the fit meets Section 10-7.5.1 specifications.

23. Insert the piston rings in the cylinder, individually, with the ring part number to the top of the cylinder, Use the piston to position the ring to the depth specified for ring gap measurement in Section 10-7.5.1. If the piston ring fails to meet the ring gap, side clearance or tension service limits, replace the piston ring according to instructions in Section 15-7.5.15.

10-7.5.1. Cylinder Service Limits

Refer to the “Cylinder Assembly Service Limits” in Table 10-5 and corresponding Figure 10-18. Clean and dry the parts thoroughly according to “Engine Cleaning” instructions in Section 14. Remove oil and preservative material before performing the dimensional inspection. Discard and replace parts that do not conform to the specified tolerances.

WARNING

Use only parts that meet the specified service limits.

Table 10-5. Cylinder Assembly Service Limits

Index	Part	Dimensions (inches)		
		Service	Minimum	Maximum
	Pistons, Rings, and Pins			
1	Top Land in Cylinder bore..diameter:	0.042	0.038L	0.042L
2	Second Land in Cylinder bore ....diameter:	0.038	0.034L	0.038L
3	Top of Skirt in Cylinder bore ....diameter:	0.018	0.012L	0.015L
4	Bottom of Skirt (above oil control ring) in Cylinder bore .diameter:	0.0110	0.009L	0.012L
5	Top piston ring in groove .... side clearance:	0.0040L	0.006L	0.008L
6	Second piston ring in groove .... side clearance:	0.0040L	0.0045L	0.0065L
7	Oil Control ring in groove..................................... side clearance:	0.0065L	0.002L	0.004L

Table 10-5. Cylinder Assembly Service Limits

Index	Part	Dimensions (inches)		
		Service	Minimum	Maximum
8	Top ring at 1 ± 0.50” into cylinder barrel .... gap:	0.039	0.020	0.034
9	Second ring at 1 ± 0.50” into cylinder barrel .... gap:	0.045	0.026	0.040
10	Oil control ring at 1 ± 0.50” into cylinder barrel .... gap:	0.033	0.012	0.028
11	Compression ring (closed to specified gap)......................tension:	8.0 lbs	9.0 lbs.	12.0 lbs.
12	Oil control ring (closed to specified gap)..........................tension:	10.0	11.0 lbs.	15.0 lbs.
13	Piston pin in piston... diameter:	0.0015L	0.0001L	0.0007L
14	Piston pin in connecting rod bushing .... diameter:	0.004L	0.0014L	0.0021L
15	Piston pin in cylinder...end clearance:	0.080	0.010	0.32
16	Bushing in connecting rod .... diameter:	0.0045T	0.0020T	0.0045T
17	Cylinder bore .... diameter	See Figure 10-19		
18	Cylinder bore ....out-of-round	See Figure 10-19		
19	Cylinder bore ....allowable oversize	See Figure 10-19		
20	Cylinder bore surface (nitrided barrel) .... diameter: Cross hatch.. angle Finish (measured in direction of piston travel) (micro inches)	 -- --	 22° - 32° 30	 — 60
21	Cylinder barrel in crankcase .... diameter:	0.110L	0.0030L	0.0120L
22	Intake valve seat insert in cylinder head....................... diameter:	0.0055T	0.0055T	0.0085T
23	Intake valve seat...width:	Figure 10-20	0.0828	0.1001
24	Intake valve seat-to-valve guide .... axis angle:	45°30’		
25	Intake valve guide in cylinder head............................... diameter:	0.0010T	0.0010T	0.0030T
26	Exhaust valve seat insert in cylinder head.................... diameter:	0.0055T	0.0050T	0.0080T
27	Exhaust valve seat..width:	Figure 10-20	0.0608	0.0820
28	Exhaust valve seat-to-valve guide .... axis angle:	60°30’	46° 00'	46° 15'
29	Exhaust valve guide in cylinder head .... diameter:	0.0010T	0.0010T	0.0030T
30	Rocker Shaft .... diameter:	0.6087	0.6082	0.6087
	Rocker shaft in rocker arm bushing ....clearance:	0.006L	0.0010L	0.0025L
33	Rocker shaft in cylinder head boss...............................clearance:	0.002L	0.0002L	0.0015L
32	Rocker arm bushing bore .... diameter:	0.719	0.810	0.813
	Rocker arm bushing bore .... surface finish:	80	80	---
	Rocker arm bushing – finish bore ....inside diameter:	0.5955	0.7505	0.7515
	Rocker arm bushing.. surface finish	32	32	---
33	Rocker arm to support boss.................................. side clearance:	0.015	0.0020	0.0150
34	Rocker are-to-valve spring retainer ....clearance:	0.020	0.020	---
35	Rocker arm ....grind width:	0.34	---	0.34
36	Rocker arm foot to valve stem (deflated lifter) .... gear lash	0.200	0.030	0.110
37	Rocker arm ....width	0.994	0.991	0.994
38	Intake valve guide..inside diameter: Intake valve in guide... diameter:	Figure 10-20 0.005L	0.4350 0.0010L	0.4377 0.0040L

Table 10-5. Cylinder Assembly Service Limits

Index	Part	Dimensions (inches)		
		Service	Minimum	Maximum
39	Exhaust valve guide .... inside diameter: Exhaust valve in guide..diameter:	Figure 10-20 0.005L	0.4375 0.0025L	0.4395 0.0040L
40	Pushrod ....length:	10.787	10.797	10.827
T= Tight L= Loose				

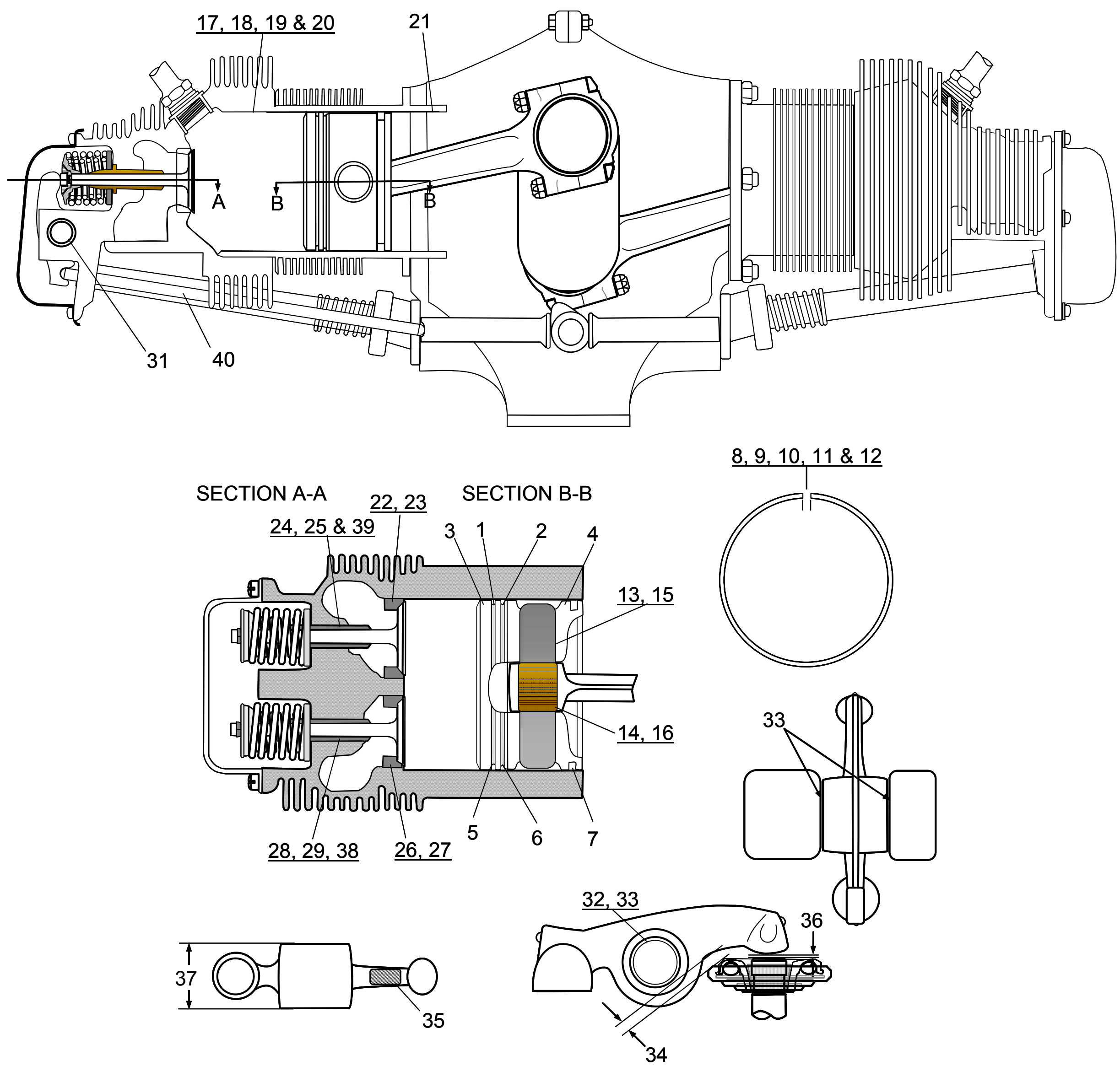


Figure 10-18. Cylinder Assembly Service Limits

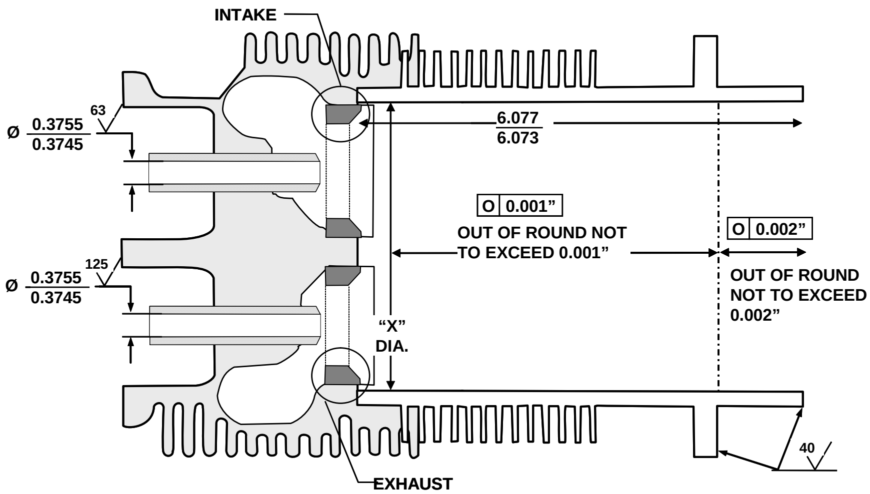


Figure 10-19. Cylinder Head and Barrel Service Limits

Table 10-6. Cylinder Barrel Service Limits

Size	“X” Diameter (NEW) (inches)		“X” Diameter (inches)
	Minimum	Maximum	Service Limits (max)
STD	4.0615	4.0635	4.0665
.005[1]	4.0665	4.0685	4.445
.010[1]	4.0715	4.0735	4.450
.015[1]	4.0765	4.0785	4.455
NOTE: Dimensions in the table above are shown in finish size after honing. Cylinder bore out of round service limit must not exceed (service) 0.003 inches at measured diameters.			

1. Requires use of corresponding oversize pistons and rings

Table 10-7. Valve Train Dimensions

Index	Part	Dimensions (inches)	
		Minimum	Maximum
1	Intake valve face-to-stem.. axis angle:	61°00'	60°15'
2	Exhaust valve face-to-stem.. axis angle:	45°45’	46°15'
3	Intake valve gauge line-to-stem ....length:	Figure 10-21 (Replace 100%)	
4	Exhaust valve face-to-stem...length:	Figure 10-21 (Replace 100%)	
5	Intake valve face-to-stem... runout:	0.0000	0.0020
6	Exhaust valve face-to-stem.. runout:	Replace 100%	

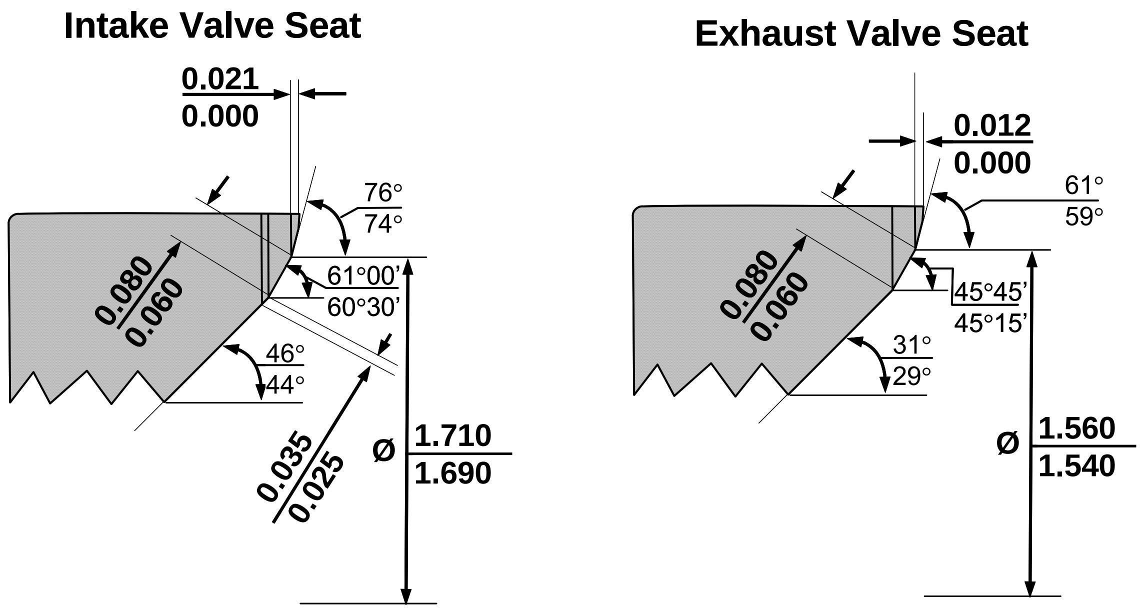
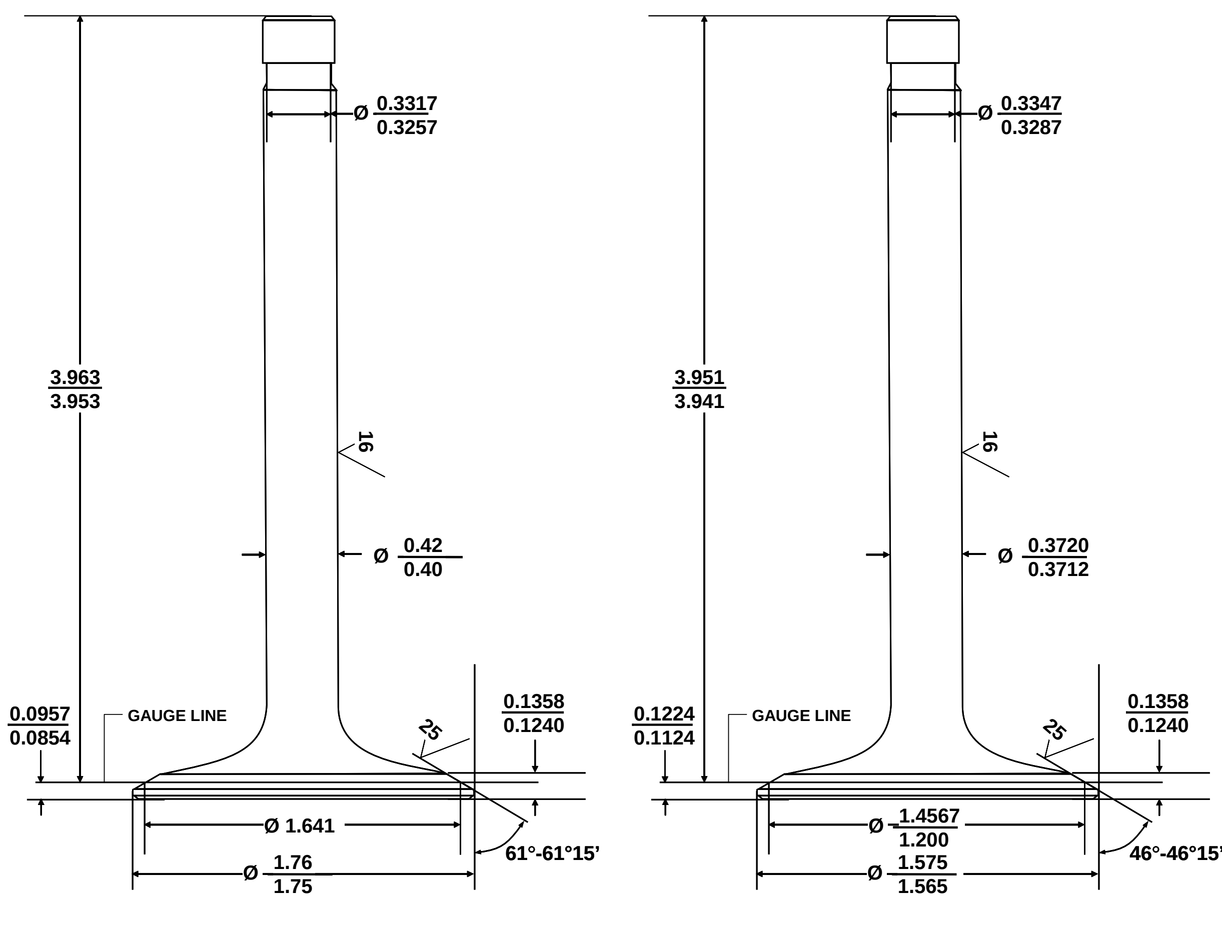


Figure 10-20. Valve Seat Insert Dimensions



Intake Valve **Exhaust Valve**

Figure 10-21. Valve Service Limits

10-7.6. Cylinder Installation

Replace worn or out of tolerance components based on the following criteria:

- Only allow parts that meet the *service limits* may remain in service.
- If a part has reached a service limit tolerance, it must be replaced with a part that conforms to the specified new part tolerances or service limits.
- Clean the cylinders according to Section 14-1.1, “Cylinder Cleaning” instructions.
- Clean pistons according to Section 14-1.2, “Piston Cleaning” instructions.
- Perform fluorescent penetrant, magnetic particle, and dimensional inspections on specified cylinder and piston parts according to instructions in Chapter 15.
- Assemble cylinders which meet the inspection criteria and service limits with serviceable pistons and new piston rings.

1. Turn the Ignition Switch to the OFF position and disconnect engine electrical power.
2. Thoroughly clean the cylinder deck, stud and nut threads with Stoddard solvent and a narrow brush. The deck and stud holes must be free of damage, dirt or debris.
3. Lubricate cylinder through bolt and deck stud threads using clean 50 weight aviation engine oil.
4. Inspect a new cylinder base packing (Figure 10-13) (35) for cracks or deformities.

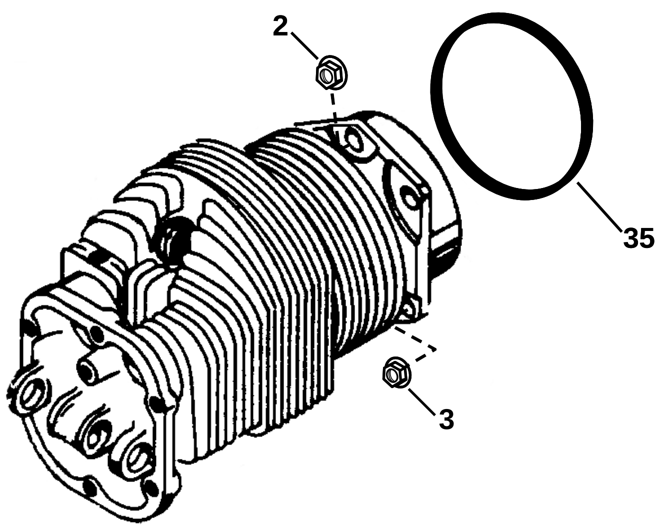


Figure 10-13 repeated for reference

WARNING

Do not apply <u>any</u> form of sealant to the crankcase cylinder deck, chamfer, cylinder mounting flange, cylinder base O-ring, or cylinder fastener threads. The use of RTV, silicone, Gasket Maker or <u>any</u> other sealant on the areas listed above during engine assembly will cause a loss of cylinder deck stud or through-bolt torque. Subsequent loss of cylinder attachment load, loss of main bearing crush and/or fretting of the crankcase parting surfaces will occur. The result will be cylinder separation, main bearing movement, oil starvation and

catastrophic engine failure. USE ONLY CLEAN 50 WEIGHT AVIATION ENGINE OIL ON SURFACES LISTED.

5. Lubricate the serviceable, new cylinder base packing (35) with clean 50-weight aviation engine oil and install the new cylinder base packing on the cylinder base flange; verify the packing is not twisted on the cylinder base flange after installation.
6. Install a conforming piston pin (Figure 10-15) (5) with serviceable piston (1) and serviceable piston rings (2, 3 & 4) partially in the cylinder bore.

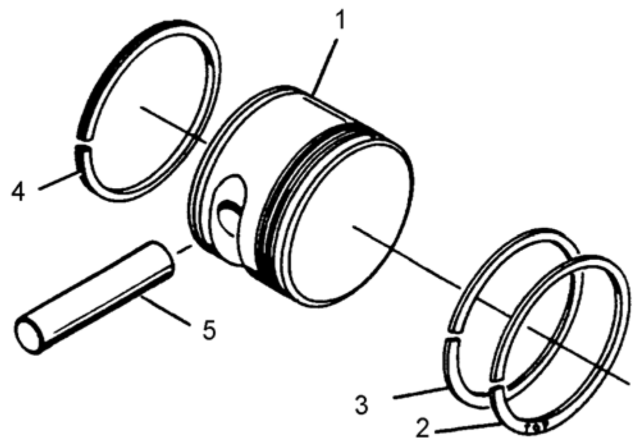


Figure 10-15 repeated for reference

7. When installing the piston on the connecting rod, use care not to drop the connecting rod on the cylinder deck to avoid damaging the crankcase cylinder deck. Carefully rotate the crankshaft, placing the connecting rod of the cylinder being installed in the outermost position. Remove the packing (Figure 10-14) that was installed for connecting rod support.
8. Back the piston pin (Figure 10-15) (5) out far enough to install the piston (1) on the connecting rod. Align the cylinder and piston with the connecting rod.
9. Align the connecting rod with the piston pin bore and slide the piston pin (5) through the piston and connecting rod.
10. Compress the oil control ring with a ring compressor; push the cylinder until the piston ring enters the cylinder barrel.
11. Remove the ring compressor and push the cylinder assembly against the crankcase cylinder deck with the stud holes aligned.
12. While supporting the cylinder, install, but do not torque, the cylinder flange nuts (Figure 10-13)(2 and 3).
13. Torque the cylinder fastening hardware according to the “Cylinder Torque” instructions in Section 10-7.10.
14. Install the pushrod housings according to instructions in Section 10-7.8.
15. Install the rocker arms according to instructions in Section 10-7.9.
16. Install the Induction System components according to instructions in Section 17-14.

17. Install the spark plugs and ignition harness according to the "Ignition System Maintenance" instructions in Section 6-3.8.
18. Install the Exhaust System according to the airframe manufacturer's instructions.
19. Install the Inter-cylinder baffles according to instructions in Section 17-3.3.
20. Install the baffle supports, perimeter baffles, and airframe-supplied accessories, as required, according to the airframe manufacturer's instructions.

    CAUTION: Service the engine with SAE J-1966 mineral oil for engine break-in.

21. Service the engine with mineral oil according to instructions in Section 6-3.7.
22. Install the aircraft cowling and airframe-supplied accessories according to the airframe manufacturer's instructions.
23. Perform an "Engine Operational Check" according to instructions in Section 6-3.6.
24. Perform the "25-Hour Initial Operation Inspection" in Section 6-3.1 after the first 25 hours of engine operation. When oil consumption has stabilized, replace the mineral oil with ashless dispersant aviation engine oil according to Section 6-3.7.
25. After 25 hours of operation, complete the steps in the "25-hour Initial Operation Inspection" in Chapter 7, Maintenance Inspections.

10-7.7. Lifter Installation

1. Perform the dimensional inspection listed in Section 10-7.5 that apply to the lifters, pushrod housings and pushrods. Replace parts which fail to meet service limits.
2. Gather the replacement parts necessary to satisfy the "100% Parts Replacement Requirements" criteria in Section C-2.3.
3. Install the serviceable plunger (Figure 10-12) (37) and socket (38) in the lifter body (40) from which they were removed and secure with a new snap ring (39). Install new plungers and sockets and snap rings to replace those which failed inspection.
4. Install the pushrod housings according to instructions in Section 10-7.8.
5. Install the rocker arms according to instruction in Section 10-7.9.

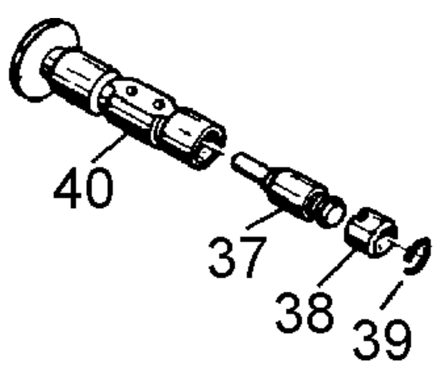


Figure 10-12 repeated for reference

10-7.8. Pushrod Housing Installation

1. Apply Part No. 642188 (Copper Coat) Gasket Sealant to both sides of a new gasket (Figure 10-11) (44) and install the pushrod housing adapter (43) with a new gasket (44) on the crankcase. Secure the adapter with three sets of washers (47), new lock washers (30), and nuts (42). Torque the nuts (42) to Appendix B specifications.
2. Using a Borroughs 68-3 Pushrod Spring Compressor (Section 3-1, “Special Tools”) or equivalent, compress the pushrod tube spring (45) on the pushrod housing (12).
3. Sandwich a new packing (49), lubricated with clean 50-weight aviation engine oil, between two steel washers (46) and slide the assembly on the crankcase end of the pushrod housing (12).
4. Insert the crankcase end of the pushrod housing, with spring, washers and packing in place, in the pushrod housing adapter (43).
5. While the spring is compressed and the housing is inserted in the adapter, install a new O-ring (48), lubricated with clean 50-weight aviation engine oil, on the *cylinder* end of the pushrod housing (12).
6. Guide the pushrod tube housing into the cylinder head opening and slowly release the tension on the spring pushrod spring compressor.
7. Remove the Pushrod Spring Compressor Tool and verify the O-ring (37), packing (49), and washers (46) are properly positioned.

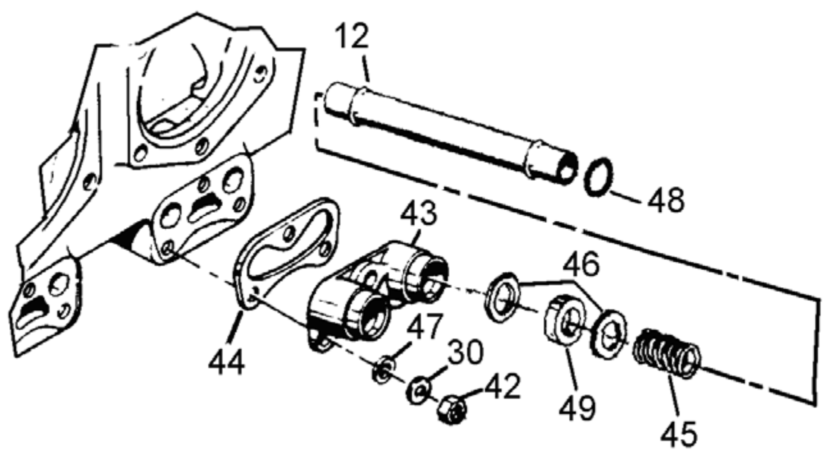


Figure 10-11 repeated for reference

8. Install the pushrods, rocker arms, and rocker covers according to instruction in Section 10-7.9.
9. Install any airframe equipment, accessories, and cowling removed to facilitate lifter replacement according to the airframe manufacturer’s instructions.
10. Perform an “Engine Operational Check” according to instructions in Section 6-3.6.

10-7.9. Rocker Arm Installation

1. With the engine upright, lubricate the pushrods (Figure 10-10) (41) with clean 50-weight aviation engine oil and install the pushrods (41) in their respective housings (12).
2. Bleed the lifters and lubricate the rocker arms (22) and rocker shaft (25) with clean 50-weight aviation engine oil.
3. Position the crankshaft so the piston is at top dead center and both intake and exhaust valves of the cylinder being assembled are closed.

CAUTION: Intake and exhaust rocker arms are not interchangeable. Exhaust rocker arms feature an oil orifice (Figure 10-9) to lubricate the exhaust valve stem; the intake rocker arm has no oil orifice.

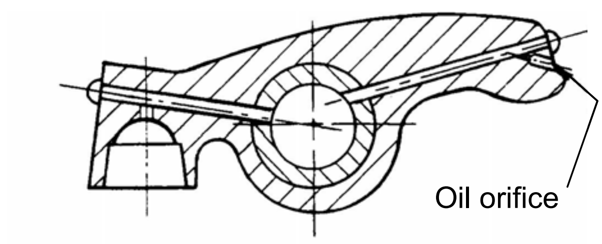


Figure 10-9 repeated for reference

4. Slide the rocker shaft (Figure 10-10) (25) in the cylinder head rocker shaft boss from the intake side of the cylinder. Align the intake rocker arm (23) bore with the cylinder head boss and slide the rocker shaft through the center rocker shaft boss.
5. Align the exhaust rocker arm (22) bore with the cylinder head boss and slide the rocker shaft through the center rocker shaft boss.
6. Measure and compare the dry valve gear lash at the valve tip to the rocker foot to the service limits in Section 10-7.5.1. If the clearance does not conform to the service limits, disassemble the pushrod assembly and replace the plunger (37), socket (38) and snap ring (39).
7. Check the rocker arm-to-retainer clearance (Figure 10-22) with the valve in the closed position and the foot of the rocker in contact with the valve stem tip.

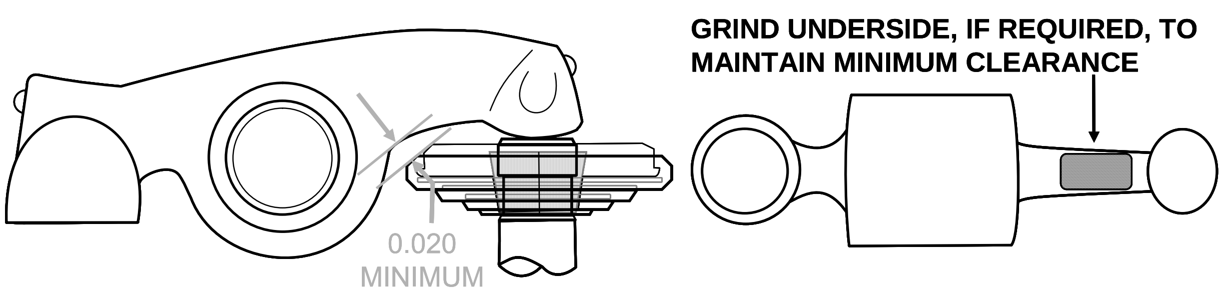


Figure 10-22. Rocker Arm to Valve Spring Retainer Clearance

8. If necessary, smoothly grind the underside of the rocker arm to attain the specified minimum clearance according to “Rocker Arm-to-Retainer Clearance” in Section 15-7.5.18.
9. Align the threaded hole in the rocker shaft with the screw hole in the center rocker shaft boss. Install a bolt (Figure 10-10) (27) and washer (26) through the hole in the center rocker shaft boss and torque the bolt (27) to Appendix B specifications.
10. Install the rocker covers (28) with new rocker cover gaskets (27) on the cylinder head and secure with six fillister head screws (31), new lock washers (30) and washers (29). Torque the screws to Appendix B specifications.
11. Install the airframe cowling according to the airframe manufacturer's instructions.
12. Perform an “Engine Operational Check” according to instructions in Section 6-3.6.

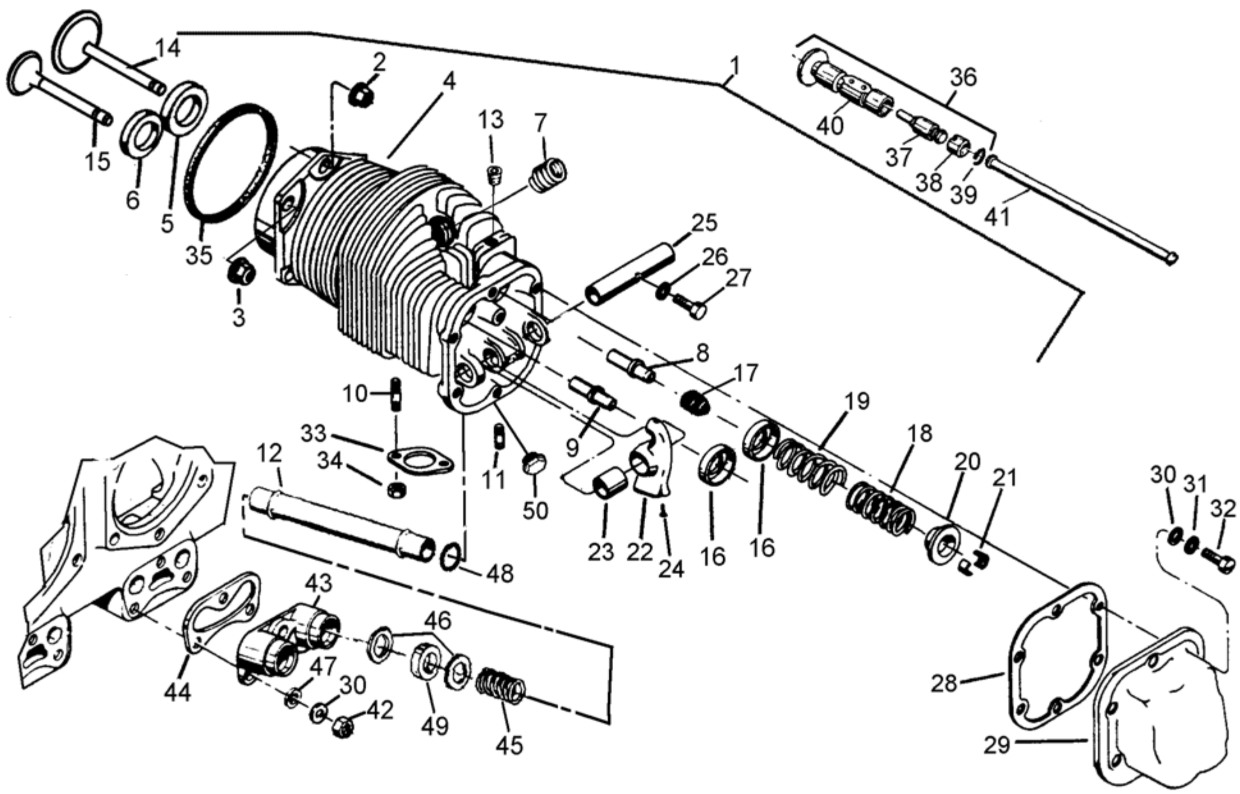


Figure 10-10 repeated for reference

10-7.10. Cylinder Torque

CAUTION: This cylinder torque procedure is for single cylinder installation. For complete engine assembly and torque, refer to instructions in Chapter 17.

Proper cylinder installation requires adherence to the torque sequence listed below using two people:

1. Lubricate the cylinder base stud threads, through bolt threads and nut threads **<u>on BOTH sides</u>** of the engine with clean, 50-weight aviation oil.

WARNING

Failure to torque through bolt nuts on both sides of the engine may result in a loss of main bearing crush, main bearing shift, crankshaft fracture, and engine failure.

Do not apply <u>any</u> form of sealant to the crankcase cylinder deck, chamfer, cylinder mounting flange, cylinder base O-ring, or cylinder fastener threads. The use of RTV, silicone, Gasket Maker or <u>any</u> other sealant on the areas listed above during engine assembly will cause a loss of cylinder deck stud or through-bolt torque. Subsequent loss of cylinder attachment load, loss of main bearing crush and/or fretting of the crankcase parting surfaces will occur. The result will be cylinder separation, main bearing movement, oil starvation and catastrophic engine failure. USE ONLY CLEAN 50 WEIGHT AVIATION ENGINE OIL ON SURFACES LISTED.

2. Install and torque the through bolt nuts and cylinder base nuts to one half (1/2) of the final torque value specified in Appendix B in the sequence shown in Figure 10-23.
3. Torque the through bolt nuts and cylinder base nuts to the full final torque value specified in Appendix B in the sequence shown in Figure 10-23. Torque the through bolt nuts on both sides of the engine (even if only one cylinder is being installed).

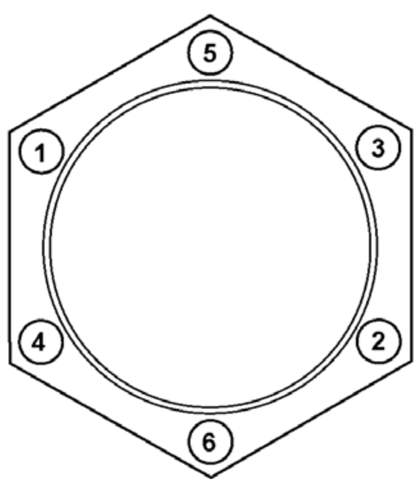


Figure 10-23. Single Cylinder Torque Sequence

10-8. Crankshaft Nose Oil Seal Replacement

Replace the crankshaft nose oil seal if it is damaged or if the following conditions exist:

- Ram air is entering the engine interior
- Oil leaks from the nose seal or nose seal retainers

10-8.1. Crankshaft Nose Oil Seal Removal

WARNING

Turn the Ignition Switch OFF, disconnect the battery from the engine and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Turn the Ignition Switch OFF and disconnect engine electrical power.
2. Disconnect all spark plug leads.
3. Set the brakes and block the aircraft wheels.
4. Ensure that aircraft tie-downs are installed and the cabin door latch is open.
5. Remove the propeller according to the propeller and airframe manufacturers' instructions.

   CAUTION: Do not scratch, mar, or damage the crankshaft or crankcase while removing the crankshaft nose oil seal.

6. Remove the crankshaft nose oil seal, (made up of two components, a seal and spring, shown in Figure 10-24). The seal was installed using Gasket Maker, gentle force may be required to extract the seal parts from the counterbore.
7. Clean the Gasket Maker residue out of the counterbore recess using a chlorinated solvent such as Loctite Chisel or methylene chloride followed by a naptha solvent such as Loctite ODC-Free Cleaner and Degreaser. Remove all residue and debris from the bore.
8. Restore the crankshaft helix pattern according to instructions in Section 15-7.8.2.1.

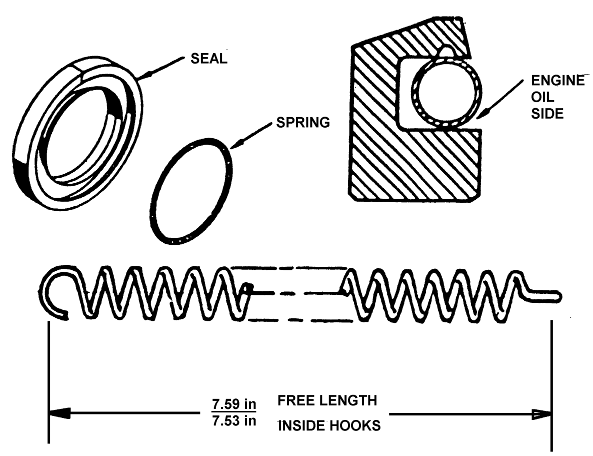


Figure 10-24. Crankshaft Nose Oil Seal Parts

10-8.2. Crankshaft Nose Oil Seal Installation

WARNING

Turn the Ignition Switch OFF, disconnect the battery from the engine and confirm continuity between the magneto capacitor and aircraft ground before commencing maintenance to avoid uncommanded engine starts during maintenance. Do not stand or place equipment within the arc of the propeller.

1. Prepare the exposed portion of the crankshaft with a fresh helix pattern according to instructions in Section 10-8.
2. Remove the new spring from the new crankshaft nose oil seal.
3. Unhook the spring ends using an unwinding motion.
4. Verify the seal spring length matches the dimension specified in Figure 10-24. If the spring length is not within this tolerance, replace it.
5. Place the spring around the crankshaft in the helix area.
6. Hook the two spring ends to one another.
7. Apply Shell Alvania No. 2 Grease to the lip of the new seal and the propeller flange.
8. Install the seal on the crankshaft with the oil seal cavity facing inward.
9. Verify the outer diameter of the oil seal is clean and dry.
10. Install the spring in the oil seal cavity.
11. Apply Part No. 654663 Gasket Sealant to the mating crankcase flange.
12. Spray Part No. 653692 Gasket Sealant Primer on the oil seal counterbore and allow it to dry for 1 to 2 minutes.
13. Apply a translucent coat of Part No. 646942 Gasket Maker on the wall of the oil seal counterbore. Refer to Gasket Maker application instructions in Appendix C.
14. Using thumb pressure, work the seal into the crankcase counterbore with the oil seal split line positioned at the 10 or 2 o'clock position.
15. After the seal is in place, wipe any remaining sealant from the seal and crankshaft.
16. Spray the exposed portion of the lightly scratched crisscross area with aluminum primer and allow it to dry.
17. Inspect the propeller according to the propeller manufacturer’s and airframe manufacturer’s instructions.
18. Install the propeller according to the propeller manufacturer’s and airframe manufacturer’s instructions.
19. Perform a normal “Engine Start”(Section 7-3.2) and “Ground Run-up”(Section 7-3.2). Run the engine for a minimum of five minutes to reach normal operating temperatures. Shut down the engine according to the “Engine Shutdown”(Section 7-3.4) instructions and inspect the Crankcase Nose Oil Seal area for leaks.

10-9. Crankcase Repair

See Section 15-7.7, “Crankcase Overhaul Repair.”

Chapter 11. Engine Overhaul Introduction

11-1. Engine Overhaul

During overhaul, all engine parts and accessories are removed, cleaned and inspected. Specified parts are replaced while others may be restored according to product specifications. All engine parts and accessories must conform with the engine and accessory manufacturer's specifications prior to being re-installed on the engine. The intent of overhaul is to restore the engine to a condition conforming to its type certificate and be in compliance with Federal Aviation Regulations.

Information in this manual defines practices for overhauling engines. Chapters are arranged in sequential order of tasks to be performed during overhaul starting with engine removal and disassembly, followed by component disassembly, cleaning, inspection and repair, component assembly, engine assembly and installation, and post-overhaul testing.

Overhaul procedures in this manual apply only to the engines for which it is written and not the aircraft. Overhaul procedures described herein must be complied with in addition to all aircraft manufacturer and accessory manufacturer overhaul requirements.

New part limits essential to performing an engine overhaul applicable to engines covered in this manual are provided in Appendix D. Torque Specifications for all fasteners on the engine are located in Appendix B. Appendix C contains standard practices for recurring common procedures, like cotter pin and safety wire installation, and helical coil replacement. These sections will be referred to often throughout the procedures.

This manual does not contain overhaul requirements for engines modified by installation of components or systems under supplemental type certificate.

11-2. Overhaul Schedule

Recommended engine time between overhaul (TBO) is determined by the engine model certification data submitted to and accepted by the FAA. Refer to the “Recommended Time Between Overhaul” entry under the “General” heading for the engine model in Section 2-3, “Engine Specifications” to determine when to overhaul your engine model.

11-3. Overhaul Sequence

Perform engine overhaul in the sequence described in Table 11-1.

Table 11-1. Overhaul Sequence

Action	Reference
1. Remove the engine from the airframe.	Section 5-1, “Engine Removal”
2. Disassemble the engine.	Chapter 12, “Engine Disassembly”
3. Disassemble engine components.	Chapter 13, “Component Disassembly”
4. Clean engine parts.	Chapter 14, “Engine Cleaning”
5. Inspect engine parts for serviceability.	Perform inspections and complete the Overhaul Inspection Checklist: Chapter 15, “Overhaul Inspection and Repair” Appendix D, “Overhaul Dimensional Limits”
6. Repair or replace unserviceable parts or parts identified as 100% replacement parts or mandatory overhaul replacement parts.	Repair or replace parts specified in Section 15-7, “Overhaul Repair”
7. Apply protective coating to engine parts.	Section 14-4, “Protective Coatings”
8. Assemble the engine components.	Chapter 16, “Component Assembly”
9. Assemble the engine.	Chapter 17, “Engine Assembly”
10. Install the engine in the airframe.	“Section 5-2, “Engine Installation”
11. Test the overhauled engine.	Chapter 18, “Post-Overhaul Test and Adjustments”

11-4. Overhaul Checklists

Overhaul Checklists serve as guides during the overhaul process of disassembly, inspection, mandatory component replacement, refurbishing and assembly. Checklists provide a comprehensive record of the overhaul procedures:

- "Engine Removal and Disassembly Checklist" , Table 11-2
- "Engine Overhaul Visual Inspection Checklist" , Table 11-3
- "Fluorescent Penetrant Inspection Checklist" , Table 11-4
- "Magnetic Particle Inspection Checklist" , Table 11-5
- "Dimensional Inspection Checklist" , Table 11-6
- "Engine Cylinder Overhaul Inspection Checklist" , Table 11-7
- "Engine Drive Train Inspection Checklist" , Table 11-8
- "Replacement Parts Inventory" , Table 11-9

Overhaul inspection items listed in the checklists contain references to the procedures containing the overhaul actions required when overhauling engines covered by this manual. For convenient reference, make a copy of the checklists and complete them during engine overhaul.

Perform items listed in the checklists, according the referenced procedures to remove, disassemble, and repair components on an engine which has reached Time between Overhaul (TBO):

Section 5-1, "Engine Removal"

Section 12, "Engine Disassembly"

Section 13, "Component Disassembly"

Section 14, "Engine Cleaning"

Section 15, "Overhaul Inspection and Repair"

During the overhaul process, assemble, install, and test the overhauled engine according to instruction in the following chapters:

- Section 16, "Component Assembly"
- Section 17, "Engine Assembly"
- Section 5-2, "Engine Installation"
- Section 18, "Post-Overhaul Test and Adjustments"

Table 11-2. Engine Removal and Disassembly Checklist

Overhaul Step	Initials	Findings
Complete a Cylinder Visual Inspection (Section 6-3.9.1) Document results on the "Cylinder Inspection Checklist" (Table 6-13).		
Complete a Cylinder Differential Pressure Test. (Section 6-3.9.2). Document results on the "Cylinder Inspection Checklist" (Table 6-13).		
Remove the engine from the airframe (Section 5-1).		
Remove the Ignition System (Section 12-2).		
Remove the Fuel Pump Cover (Section 12-3).		
Remove the Induction System (Section 12-4).		
Remove the Oil Cooler Adapter (Section 12-5).		
Remove the Starter Assembly (Section 12-6).		
Remove the Alternator(s) (Section 12-7).		
Remove the Oil Sump (Section 12-8).		
Remove the Accessory Case (Section 12-9).		
Remove the Intercylinder Baffles (Section 12-10).		
Remove the Engine Cylinders and Pistons (Section 12-11).		
Disassemble the Ignition System (Section 13-1).		
Disassemble the Accessory Case (Section 13-3).		
Disassemble the Oil Cooler Adapter (Section 13-4).		
Disassemble the Induction System (Section 13-5).		
Disassemble the Crankcase (Section 13-6).		
Disassemble the Drive Train (Section 13-7).		
Disassemble the Engine Cylinders (Section 13-8).		
Perform a visual inspection prior to cleaning the engine parts (Section 15-3).		
Clean engine parts (Section 14-1).		
Perform detailed visual parts inspection (Section 15-3 and Table 11-3).		
Perform Fluorescent Penetrant Inspections (Section 15-4).		
Perform Magnetic Particle Inspections (Section 15-5).		
Perform Dimensional Inspections (Section 15-6).		
Perform authorized overhaul repairs (Section 15-7).		
Assemble the alternator (Section 16-2).		
Assemble the Induction System (Section 16-3).		
Assemble the Lubrication System (Section 16-4).		
Assemble the Engine Cylinders (Section 16-5).		
Assemble the Accessory Case (Section 16-6).		
Assemble the Crankcase (Section 16-7).		
Assemble the engine drive train (Section 16-8).		
Seal and thread the crankcase (Section 17-2.1).		

Table 11-2. Engine Removal and Disassembly Checklist

Overhaul Step	Initials	Findings
Install the Drive Train (Section 17-2.2).		
Install the Crankcase hardware (Section 17-2.3).		
Install the Engine Cylinders (Section 17-3).		
Torque the Crankcase and Cylinders (Section 17-3.1).		
Install the Crankcase Nose Oil Seal (Section 17-3.2).		
Install the Valve Train (Section 17-4).		
Install the Oil Cooler Adapter (Section 17-5).		
Install the Vacuum Pump Adapter Pad Cover (Section 17-6).		
Install the Accessory Case (Section 17-8).		
Install the Alternator (Section 17-9).		
Install the Starter (Section 17-10).		
Install the Engine Mount Isolators (Section 17-11).		
Install the Oil Sump (Section 17-12).		
Install the Exhaust System (Section 17-13).		
Install the Induction System (Section 17-14).		
Install the Ignition System (Section 17-15).		
Install the engine in the airframe (Section 5-2).		
Complete Post-Overhaul Test and Adjustments (Section 18).		

Table 11-3. Engine Overhaul Visual Inspection Checklist

Inspection Item	Initials	Findings
Complete the cursory visual inspection according to Section 15-3 during disassembly to avoid cleaning parts which ultimately will be replaced. After disassembly and cleaning, inspect all parts which are not identified as 100% replacement items (Ref. Section C-2.3) or mandatory replacement items during overhaul (Ref. Section C-2.4). Collect faulty part (not required overhaul replacements) information at the end of each subsystem for a replacement parts list.		
Induction System		
Inspect induction tubes, risers, and intake manifold for cracks, dents, and chafing. Check tube ends and flanges on the surface plate for warpage or deformities.		
Inspect fittings and hardware on the induction system for damaged threads or stripped heads.		
Inspect tapped holes and helical coils on the induction system (including aftercooler) for distorted or stripped threads, cracks or dents.		
Inspect the induction brackets, manifold, throttle, and induction tubes with a 10X magnifying glass.		
Replacement Part Description	Part Number	Reason
Exhaust System		
Inspect exhaust system according to the airframe manufacturer's instructions.		
Exhaust System Replacement Part Description	Part Number	Reason

Table 11-3. Engine Overhaul Visual Inspection Checklist

Inspection Item	Initials	Findings
Lubrication System		
Inspect the oil pump driver and driven gear shafts for security and scoring.		
Inspect the oil pressure relief valve plunger for scoring and nicks and the face for roughness.		
Inspect the oil sump and sump bolt holes.		
Inspect the oil drain plug boss and drain plug for damaged threads and damaged wrench flats.		
Inspect the oil suction tube assembly for dents, cracks, distorted or restricted openings.		
Inspect the oil pump housing and tachometer drive housing studs for distorted or stripped threads.		
Inspect the lubrication system fastening studs.		
Replacement Part Description	Part Number	Reason

Table 11-3. Engine Overhaul Visual Inspection Checklist

Inspection Item	Initials	Findings
Engine Cylinders		
Inspect for obvious cracks, missing or bent fins. Inspect the studs for corrosion, distortion, stripped or incomplete threads, or looseness.		
Inspect the cylinders using Table 11-7, “Engine Cylinder Overhaul Inspection Checklist” .		
Replacement Part Description	Part Number	Reason
Crankcase		
Inspect for obvious cracks, missing or bent hardware.		
Inspect fasteners for loose or bent studs and damaged threads		
Inspect interior after disassembly for worn, scored, or otherwise damaged journals.		
Replacement Part Description	Part Number	Reason

Table 11-3. Engine Overhaul Visual Inspection Checklist

Inspection Item	Initials	Findings
Accessory Case		
Inspect for obvious cracks, missing or bent hardware.		
Inspect fasteners for loose or bent studs and damaged threads		
Inspect interior after disassembly for worn, scored, or otherwise damaged journals.		
Replacement Part Description	Part Number	Reason
Engine Drive Train		
Inspect the drive train components using the “Engine Drive Train Inspection Checklist” (Section 11-8)		
Replacement Part Description	Part Number	Reason

Table 11-4. Fluorescent Penetrant Inspection Checklist

Inspect clean, aluminum or non-ferrous metal parts IAW ASTM E1417, E1208, E1209, and E1219. Use Type I, Penetrant Method A, B, C, or D and the "Fluorescent Penetrant Inspection" instructions in Section 15-4.		
Inspection Item	**Focus**	**Initials**
General Look for discontinuities such as: •Fatigue cracks •Grinding •Cracks from heat treatment or brittle-ness •Seams •Laps or ruptures	Pay particular attention to: •Bearing bosses. •Mounting flanges. •Shaft bores. •Mating surfaces where hardware has been previously torqued. •Areas where oil seals or bushings are pressed in or seated. •Look for indications of weakness in corners, edges, holes, or fillets. Identify parts that contain linear indications that cannot be reworked.	
Cylinders	Pay particular attention to: •Rocker boss areas •Valve seat insert areas •Valve guide areas •Intake and exhaust flanges •Intake and exhaust ports •Between cylinder head cooling fins •Cylinder-to-barrel mating area •Mounting flanges	
Alternator housing	•Mounting flanges •Bolt holes	
Crankcase and Accessory Case	Pay particular attention to: •Cylinder-to-barrel mating area •Bearing bosses •Mounting flanges •Shaft bores •Through-bolt hole areas •Crankcase/crankshaft exit area •oil seals or bushing seats	
Aluminum alloy brackets	•Mounting flanges •Bolt holes	
Aluminum alloy Induction System components	•Mounting flanges •Bolt holes •Studs	
Oil pump housing	•Bearing bosses •Oil pump cavity area •Mounting flanges •Oil seal or bushing seats	
Oil pump cover	•Oil pump cavity area •Mounting flanges	
Oil cooler adapter	•Mounting flanges •Oil seal or bushing seats	

Table 11-4. Fluorescent Penetrant Inspection Checklist

Inspect clean, aluminum or non-ferrous metal parts IAW ASTM E1417, E1208, E1209, and E1219. Use Type I, Penetrant Method A, B, C, or D and the "Fluorescent Penetrant Inspection" instructions in Section 15-4.		
Inspection Item	Focus	Initials
Cast aluminum oil sump	•Mounting flanges •Bolt holes	
Oil filter adapter	•Mounting flanges •Bolt holes •Studs	
Record parts which do not pass the inspection on Table 11-9, "Replacement Parts Inventory," on page 21 for an accurate inventory of required parts to rebuild. Mark the faulty parts as defective and discard.		

Table 11-5. Magnetic Particle Inspection Checklist

Use the fluorescent method wet continuous procedure on all ferrous parts. Follow the latest ASTM E1444 procedure and the "Magnetic Particle Inspection" instructions in Section 15-5.		
Inspection Item	Initials	Inspector Notes
Crankshaft •Journals •Fillets •Oil holes •Thrust flanges •Prop flange		
Cylinder Barrels •Fin tips •Fin roots		
Camshaft •Lobes •Journals •Drilled hole edges		
Rocker arms •Pad •Socket under side arms and boss		
Lubrication System: •Oil pump gears •Bevel gears		
•Crankshaft gears •Camshaft gear		
Connecting rods (Section 15-5.1)		
Record parts which do not pass the inspection on Table 11-9, "Replacement Parts Inventory," on page 21 for an accurate inventory of required parts to rebuild. Mark the faulty parts as defective and discard.		

Table 11-6. Dimensional Inspection Checklist

Reference “Dimensional Inspection” (Section 15-6) and “Overhaul Dimensional Limits” in Appendix D							
Inspection Item	Dimension						Initials
Crankcase (Section 15-6)							
Crankshaft in main bearing diameter (A)							
Crankshaft in main bearing diameter (B)							
Crankshaft in main bearing diameter (C)							
Crankshaft in thrust bearing end clearance							
Camshaft in crankcase diameter							
Camshaft in crankcase end clearance							
Starter jack adapter plug bore							
Crankshaft front journal bore							
Crankshaft rear journal bore							
Crankshaft intermediate journal bore							
Thrust washer lands diameter							
Camshaft bore diameter							
Tappet guides diameter		1	2	3	4		
Intake							
Exhaust							
Camshaft Journal Bore Diameter							
Camshaft journal diameter 1							
Camshaft journal diameter 2							
Camshaft journal diameter 3							
Connecting Rods (Section 15-6.2)							
Bushing bore diameter (bushing not installed)							
Bushing center to crankpin center							
Pin bushing after installation and reaming							
Crankpin bore ID							
Crankshaft end width							
Bushing in connecting rod diameter							

Table 11-6. Dimensional Inspection Checklist

Reference "Dimensional Inspection" (Section 15-6) and "Overhaul Dimensional Limits" in Appendix D							
Inspection Item	Dimension						Initials
Bolt in connecting rod diameter							
Connecting rod bearing on crankpin diameter							
Connecting rod on crankpin end clearance							
Connecting rod bearing and bushing twist or convergence per inch of length							
Hydraulic tappet in crankcase diameter							
Piston pin in connecting rod bushing diameter							

Table 11-6. Dimensional Inspection Checklist

Reference “Dimensional Inspection” (Section 15-6) and “Overhaul Dimensional Limits” in Appendix D							
Inspection Item	Dimension						Initials
Drive Train (Section 15-6.2)							
Crank pins out of round							
Main journals out-of-round							
Crankshaft front journal							
Crankshaft rear journal diameter							
Crankshaft intermediate journal diameter							
Crankshaft front journal diameter							
Crankpin diameter							
Crankshaft run-out at center main journals (shaft supported at thrust and rear journal) full indicator reading							
Taper over crankshaft journal width							
Crankshaft run-out at propeller flange (when supported at front and rear main journals) full indicator reading							
Crankshaft gear on crankshaft diameter							
Camshaft run-out at center journals (shaft support at end journals) full indicator reading							
Camshaft gear on camshaft flange diameter							
Camshaft gear backlash							
Connecting rod side clearance							
Engine Cylinders (Section 15-6.3)		1	2	3	4		
Cylinder bore							
Cylinder bore out-of-round							
Cylinder bore – allowable oversize							
Cylinder bore surface (Nitrided Barrels) Cross hatch angle Finish in micro-inches R_a							
Cylinder barrel in crankcase diameter							

Table 11-6. Dimensional Inspection Checklist

Reference “Dimensional Inspection” (Section 15-6) and “Overhaul Dimensional Limits” in Appendix D							
Inspection Item	Dimension						Initials
Engine Cylinders (cont.)		1	2	3	4		
Intake valve seat insert in cylinder head diameter							
Intake valve guide in cylinder head diameter							
Exhaust valve guide in cylinder head diameter							
Exhaust valve seat insert in cylinder head diameter							
New intake valve seat width							
New exhaust valve seat width							
Rocker shaft in cylinder head bosses diameter							
Rocker arm bushing bore diameter							
Rocker arm bushing inside diameter – finish bore							
Rocker arm side clearance							
Intake valve guide inside diameter							
Intake valve in guide diameter							
Exhaust valve guide inside diameter							
Exhaust valve in guide diameter							
Rocker arm foot to valve stem (dry valve gear lash)							
Piston, graphite coated (bottom of skirt) in cylinder diameter							
Top piston ring in groove side clearance							
Second piston ring in groove side clearance							
Third piston ring in groove side clearance							
Top ring gap							
Second ring gap							
Third ring gap							
Piston pin in piston diameter							
Piston Pin diameter							
Piston pin in cylinder end clearance							
Piston pin in connecting rod bushing diameter							

Table 11-6. Dimensional Inspection Checklist

Reference "Dimensional Inspection" (Section 15-6) and "Overhaul Dimensional Limits" in Appendix D							
Inspection Item	Dimension						Initials
Engine Cylinders (cont.)		1	2	3	4		
Bushing in connecting rod diameter							
Connecting rod bearing on crankpin diameter							
Connecting rod on crankpin end clearance							
Connecting rod bearing and bushing twist or convergence per inch of length							
Hydraulic tappet in crankcase diameter							
Cylinder assembly intake valve guide bore							
Cylinder assembly exhaust valve guide bore							
Intake valve stem diameter							
Exhaust valve stem diameter							
Piston diameter at top							
Piston diameter below 1st groove							
Piston diameter at bottom							
Piston pin bore diameter							
Piston third ring groove width							
Piston pin length w/plugs							
Rocker arm thrust width							
Cylinder dimension STD D							
Cylinder dimension 0.005 D							
Cylinder dimension STD X							
Lubrication System (Section 15-6.5)							
Oil pump gears in housing end clearance							
Oil pump gears in housing diameter							
Oil pump gear shafts in accessory case and plate diameter							
Oil pump driver gear cavity diameter							
Oil pump driver gear shaft diameter							
Oil pump driven gear cavity diameter							
Oil pump driven gear shaft diameter							

Table 11-6. Dimensional Inspection Checklist

Reference “Dimensional Inspection” (Section 15-6) and “Overhaul Dimensional Limits” in Appendix D							
Inspection Item	Dimension						Initials
Oil pump gear cavity depth							
Square drive to camshaft gear clearance							
Oil pump driver gear to driven gear backlash							
Oil pressure relief valve spring compressed to 1.58 inch load							
Alternator (Section 15-6.6)	Overhaul according to manufacturer’s instructions						
Stud Height Settings (Section 15-6.6)							
Oil Filter to Adapter (1)							
Oil Filter Adapter to Acc. Case (1)							
Oil Filter Adapter to Acc. Case (2)							
Starter to Accessory Case (1)							
Starter to Accessory Case (2)							
Magneto to Accessory case (1)							
Magneto to Accessory case (2)							
Magneto to Accessory case (3)							
Magneto to Accessory case (4)							
Alternator to accessory case (1)							
Alternator to accessory case (2)							
Alternator to accessory case (3)							
Oil sump to accessory case (1)							
Oil sump to accessory case (2)							
Oil sump to accessory case (3)							
Oil sump to accessory case (4)							
Oil sump to accessory case (5)							
Oil sump to accessory case (6)							
Cylinder		1	2	3	4		
Exhaust flange stud (1)							
Exhaust flange stud (2)							
Intake flange stud (1)							
Intake flange stud (2)							
Cylinder Mount Deck (1)							
Cylinder Mount Deck (2)							
Accessory case mount flange(3.25)							
Accessory case mount flange(2.06)							

Table 11-6. Dimensional Inspection Checklist

Reference "Dimensional Inspection" (Section 15-6) and "Overhaul Dimensional Limits" in Appendix D		
Inspection Item	Dimension	Initials
Dowel, accessory case mount flange		
Oil sump flange		
Accessory drive pad (0.81)		
Accessory drive pad (0.78)		
Accessory pad (0.88)		
Fuel pump mount pad		
Oil cooler adapter pad		
Plug, Engine front		
Plug, #1 cylinder lower		
Dowel, starter adapter plug		
1-3 case half breather		
Oil sump bracket		
Crankcase through stud (2.82)		
Crankcase through stud (2.62)		
Helical coil		
Starter jack adapter plug		
Oil seal		
Install crankcase studs according to Section 15-6.6 and App. D.		
Record parts which do not pass the inspection on Table 11-9, "Replacement Parts Inventory," on page 21 for an accurate inventory of required parts to rebuild. Mark the faulty parts as defective and discard.		

Table 11-7. Engine Cylinder Overhaul Inspection Checklist

Fluorescent Penetrant Inspection (on all non-ferrous metal parts) Perform the inspection in accordance with ASTM E1417, 1208, E1209, and E1219. Use Type I, Penetrant Method A, B, C, or D. and the “Fluorescent Penetrant Inspection” in Section 15-4.						
Cylinder		1	2	3	4	
Cylinder Heads						
Cylinder Heads after Valve Seat or Valve Guide Installation						
Magnetic Particle Inspection (on all ferrous parts) Use the fluorescent wet continuous method and follow the latest ASTM E1444 procedure. Also refer to the section “Magnetic Particle Inspection” in Section 15-5.						
Engine cylinder barrel inner and outer surfaces using the close coil shot method.						
Engine cylinder intake valve, and rocker arms using circular and longitudinal magnetization						
Dimensional Inspection Refer to the Section 15-6, “Dimensional Inspection” and Appendix D						
Cylinders						
Cylinder Components						

Table 11-8. Engine Drive Train Inspection Checklist

Item to Check	Initials	Action
Inspect the crankshaft, camshaft, connecting rods, and engine drive train components for rusting, pitting, and cracks.		
Using a 10X magnifying glass, inspect the camshaft journals and lobes for scoring, pitting, corrosion, or any other indication of wear.		
Inspect the camshaft gear splines for wear.		
Inspect the camshaft gear flange for nicks, peening, and other irregularities. (This flange must be smooth to align gears.)		
Inspect the bolt holes on the camshaft gear flange for distorted or stripped threads.		

Table 11-8. Engine Drive Train Inspection Checklist

Item to Check	Initials	Action
Using Borroughs 8087A polishing tool or equivalent, rotate the crankshaft in a lathe and polish the mains and crank pins to a finish of 8 R_a maximum. Inspect the finish using a profilometer. Perform a dimensional inspection on the crankshaft mains and crankshaft pins according to the “Drive Train Dimensional Inspection” in Section 15-6.2.		
Inspect the crankshaft main journals, crank pins, and oil seal area for scoring and burning.		
Inspect the crankshaft gear bolt holes for distorted or stripped threads.		
Check the oil passages on the crankshaft for obstruction or loose oil tubes.		
Check the gear dowel for the desired snug fit.		
Verify the crankshaft connecting rod and cap mate marks are adjacent to each other and the position numbers are stamped on or adjacent to the bolt boss match.		
Inspect the connecting rod for corrosion, pitting, rust, discoloration (blue), galling, impact damage, nicks, bending, or twisting.		
Remove the nuts and bolts from the connecting rod and separate the rod and the cap (accomplished during disassembly). Inspect the connecting rod and cap parting surface. Contact signatures resulting from assembly forces are normal and acceptable. Fretting signatures resulting in the loss of metal indicated by removal of original machining marks are not acceptable.		
Inspect the connecting rod nut seat area for loss of material or edge loading signatures. Inspect dowel surfaces at the connecting rod and cap bolt holes for distortion or scoring.		
Assemble the connecting rod and caps by installing one bolt through the cap and rod. Verify the mate marks align. With the cap seated firmly against the connecting rod, a bolt should be easily installed using hand pressure.		
Verify the tin plating on the oil control collar is intact.		
Inspect studs on the oil control collar for corrosion, pitting, incomplete threads, or looseness.		
Inspect the connecting rods according to Section 15-6.2.1, “Connecting Rod Dimensional Inspection.”		
Remove the piston pin bushing from the connecting rod; inspect the piston pin bushing bore and surrounding area for nicks, gouges and mechanical damage.		
Inspect the rod channel rails for nicks, gouges or mechanical damage.		

Table 11-9. Replacement Parts Inventory

Part Description	Part Number	Reason/Comment

Table 11-9. Replacement Parts Inventory

Part Description	Part Number	Reason/Comment

Table 11-9. Replacement Parts Inventory

Part Description	Part Number	Reason/Comment

Table 11-9. Replacement Parts Inventory

Part Description	Part Number	Reason/Comment

Chapter 12. Engine Disassembly

12-1. Engine Disassembly Sequence

Disassemble the engine following the procedures in the sequential steps listed below. Once the engine is disassembled as described herein, disassemble components, clean, and inspect them as described in subsequent chapters. Refer to the corresponding sections in this chapter for detailed instructions for each step:

1. Ignition System Removal
2. Induction System Removal
3. Oil Cooler Adapter Removal
4. Starter Removal
5. Alternator Removal
6. Oil Sump Removal
7. Accessory Case Removal
8. Engine Cylinder and Piston Removal

12-2. Ignition System Removal and Disassembly

Ignition systems may be Slick or Continental Motors series magnetos. Magnetos may be fitted with a tachometer drive sensor. Removal and installation procedures are similar, with only minor differences. Separate instructions are provided for Continental Motors and Slick Magnetos.

12-2.1. Continental Motors Ignition System Removal

1. Remove the ignition harness (Figure 12-1) (3) from each spark plug (10). Remove and discard cable ties and clamps.
2. On each magneto, remove four screws (11) from the cable outlet plate (part of ignition harness (3)). Remove the ignition harness clamps to free the ignition harness from the engine; discard the ignition harness (3).
3. Remove the nut (5), lock washer (6), and washer (7); discard the lock washer (6).
4. Carefully remove the magneto (1 and 2) and gasket (4) from the accessory case; discard the gasket (3).
5. Replace and/or overhaul the magneto according to instructions the Continental Motors Magneto Service Manual, X42002.

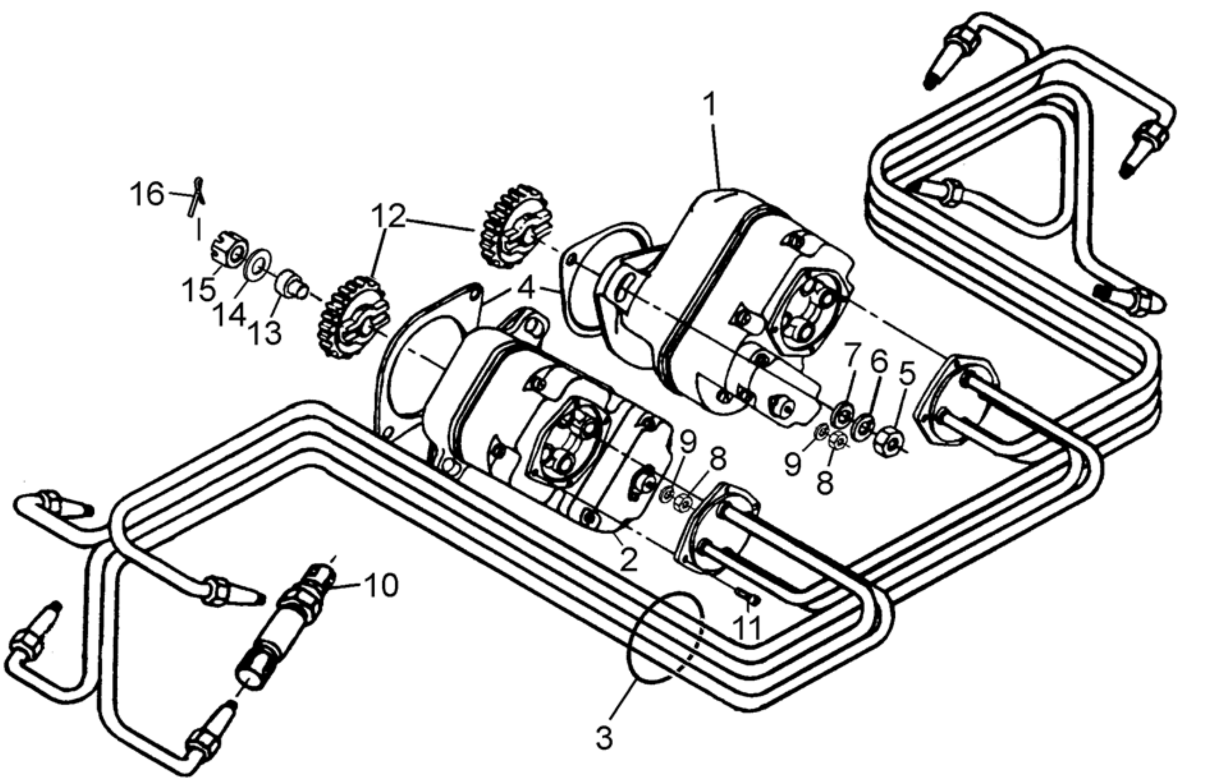


Figure 12-1. Continental Motors Ignition System

1	Left Magneto	5	Nut	9	Lock Washer	13	Bushing
2	Right magneto	6	Lock Washer	10	Spark Plug	14	Washer
3	Ignition Harness	7	Washer	11	Screw	15	Nut
4	Flange Gasket	8	Nut	12	Gear	16	Cotter Pin

12-2.2. Slick Ignition System Removal

1. Remove three screws (Figure 12-2) (not numbered) from the cable outlet plate.
2. Remove the ignition harness (2) from all eight spark plugs (8); remove and discard the spark plugs (8). Remove and discard the ignition harness (2).
3. Remove nuts (5), lock washers (6), and magneto retainers (7) from either side of magneto; discard the lock washers. Carefully remove the magneto from the accessory case, disengaging the drive coupling lugs from the drive bushing slot.
4. Remove the magneto (1) from the engine.
5. Remove and discard the gasket (3).
6. Replace the magneto with a new or rebuilt unit, or replace the unit with a unit overhauled according to a FAA approved procedure.

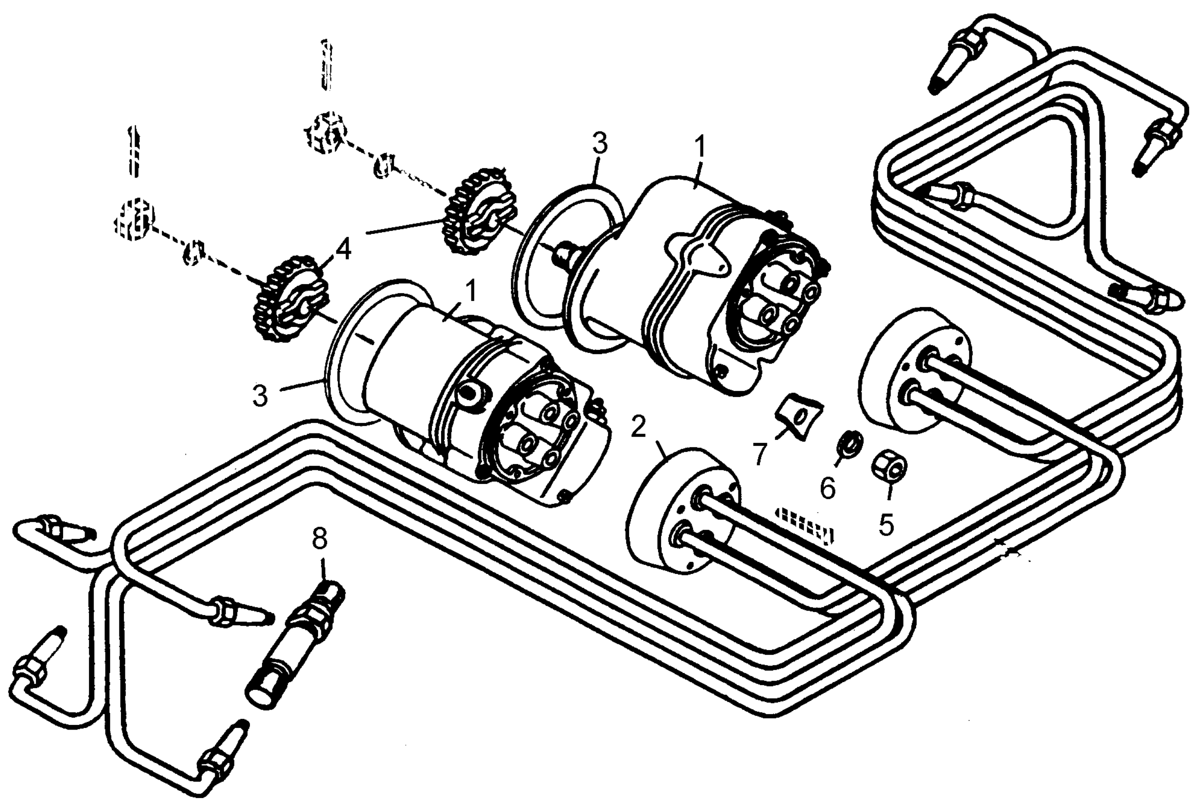


Figure 12-2. Slick Ignition System

1	Magneto	3	Gasket	5	Nut	7	Magneto Retainer
2	Ignition Harness	4	Magneto Drive Gear	6	Lock Washer	8	Spark Plug

12-3. Fuel Pump Pad Cover Removal

The O-200 crankcase features a fuel pump mounting pad, which is not used; a fuel pump pad cover is installed for crankcase integrity.

1. Remove two nuts (Figure 12-3) (5), lock washers (4), and washers (3) from the crankcase studs at the base of the fuel pump pad cover; discard the lock washers (3).
2. Remove the fuel pump pad cover (2) from the crankcase studs. Remove and discard the gasket (1).

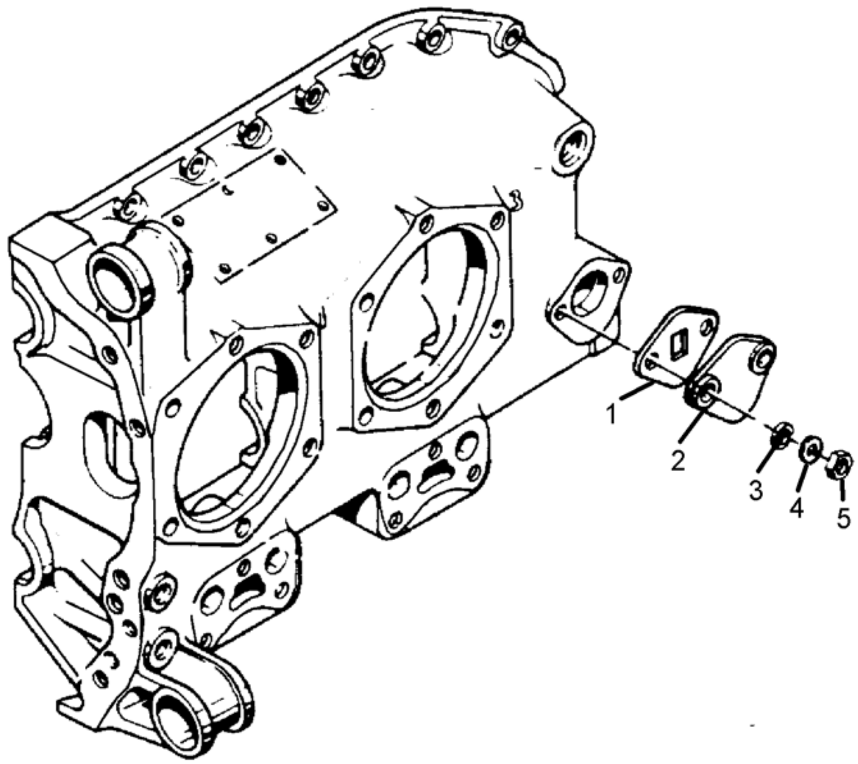


Figure 12-3. Fuel Pump Pad Cover

1	Gasket	4	Lock Washer
2	Cover	5	Nut
3	Washer		

12-4. Induction System Removal

1. Remove eight sets of nuts (Figure 12-4) (11), lock washers (10), and washers (9) from the intake flanges (7 & 8). Discard the lock washers (10).
2. Loosen the induction tube clamps (15) and slide them outboard over the intake pipes (12); push the large hoses outboard until free of the intake manifold ports. Remove the intake assemblies (7 or 8, 12, 13, 14 & 15) from the cylinders. Remove and discard the gaskets (6) from each cylinder intake port.
3. Remove and discard the cotter pins (5) from the crankcase mounting studs. Remove the castellated nuts (4). Slide the intake manifold (1), seal-o-locks (3), carburetor (21) and air intake housing (23) off the crankcase mounting studs and store for disassembly. Discard the seal-o-locks (3).

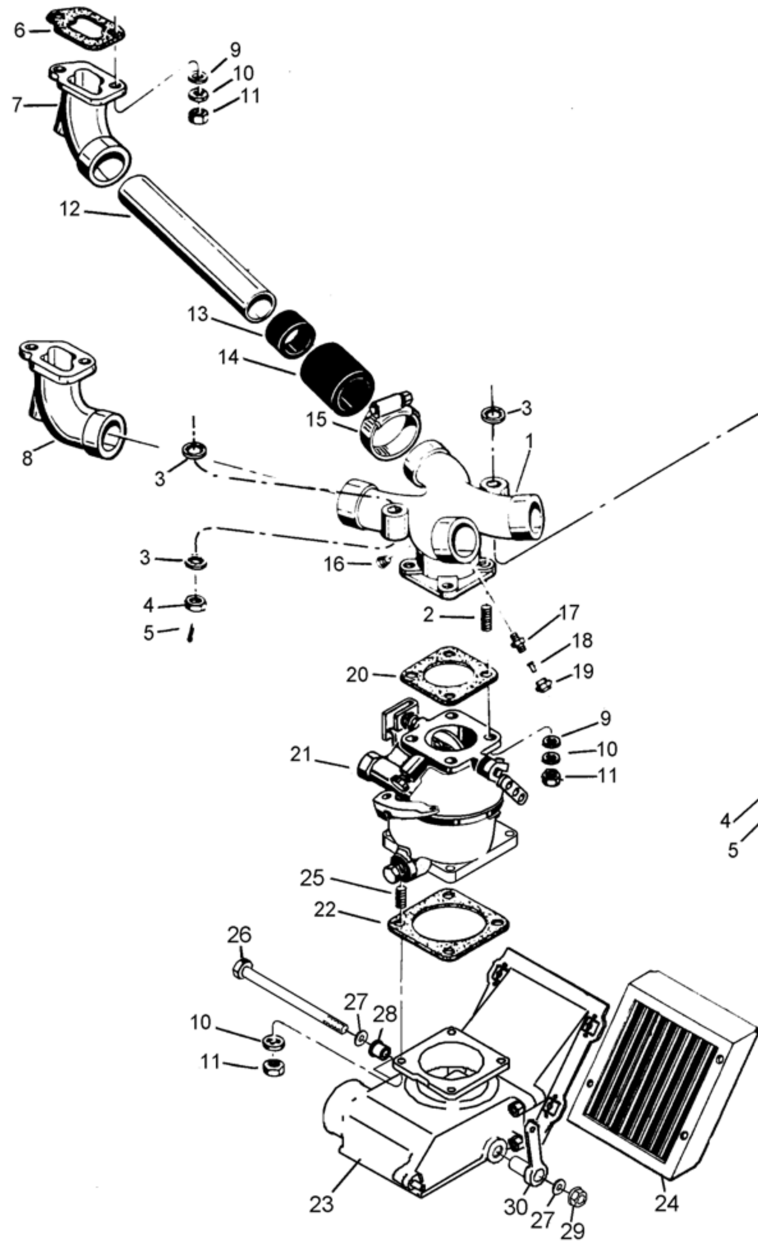


Figure 12-4. Induction System

1	Intake Manifold Assembly	9	Washer	17	Nipple- primer	25	Stud
2	Stud	10	Lock Washer	18	Union	26	Bolt
3	O-lock Seal	11	Nut	19	Nut	27	Washer
4	Castle Nut	12	Intake Pipe	20	Carburetor Gasket	28	Bushing
5	Cotter Pin	13	Hose- 1.50 X 0.88	21	Carburetor	29	Lock Nut
6	Intake Manifold Gasket	14	Hose - 1.75 X 2.00	22	Carburetor Gasket	30	Lever
7	Induction Elbow - Cyl 1 & 4	15	Clamp	23	Air Intake Housing		
8	Induction Elbow - Cyl 2 & 3	16	Plug - 0.25	24	Filter		

12-5. Oil Cooler Adapter Removal

Some O-200 engines feature a crankcase mounted oil cooler adapter. Follow the appropriate removal instructions based on the engine configuration.

NOTE: Remove and replace the oil cooler according to the airframe manufacturer's instructions.

1. Remove the nuts (Figure 12-5 or Figure 12-6) (5), lock washers (3) and washers (4). Discard the lock washers (3).
2. Remove the oil cooler adapter (or pad cover) (1) and gasket (2) from the 2-4 side of the crankcase.

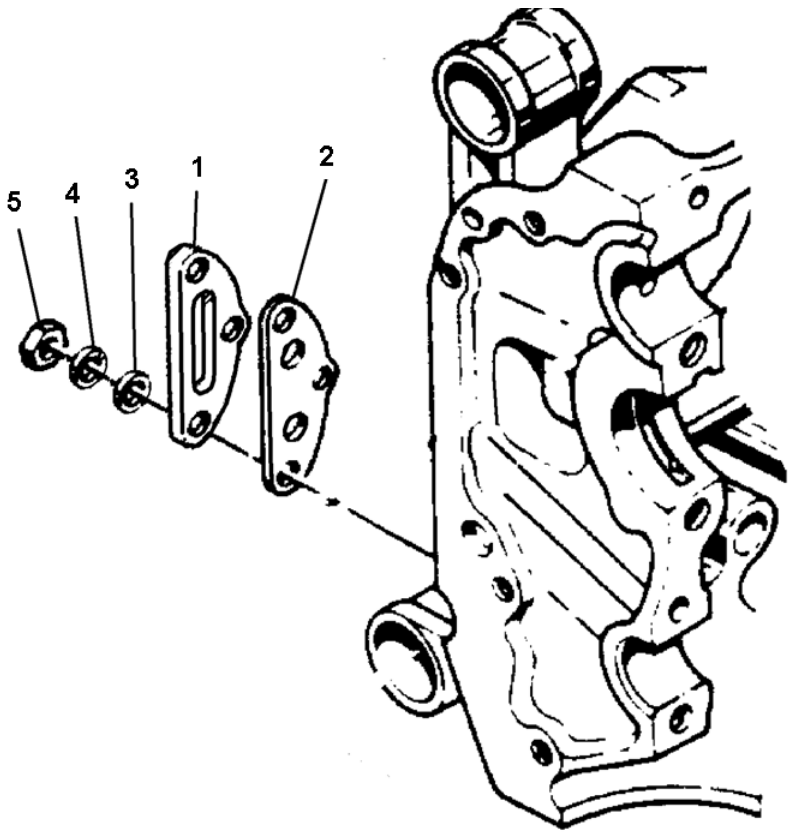


Figure 12-5. Oil Cooler Adapter Pad Cover

1	Oil Cooler Adapter Pad Cover	4	Lock Washer
2	Oil Cooler Adapter Gasket	5	Nut
3	Washer		

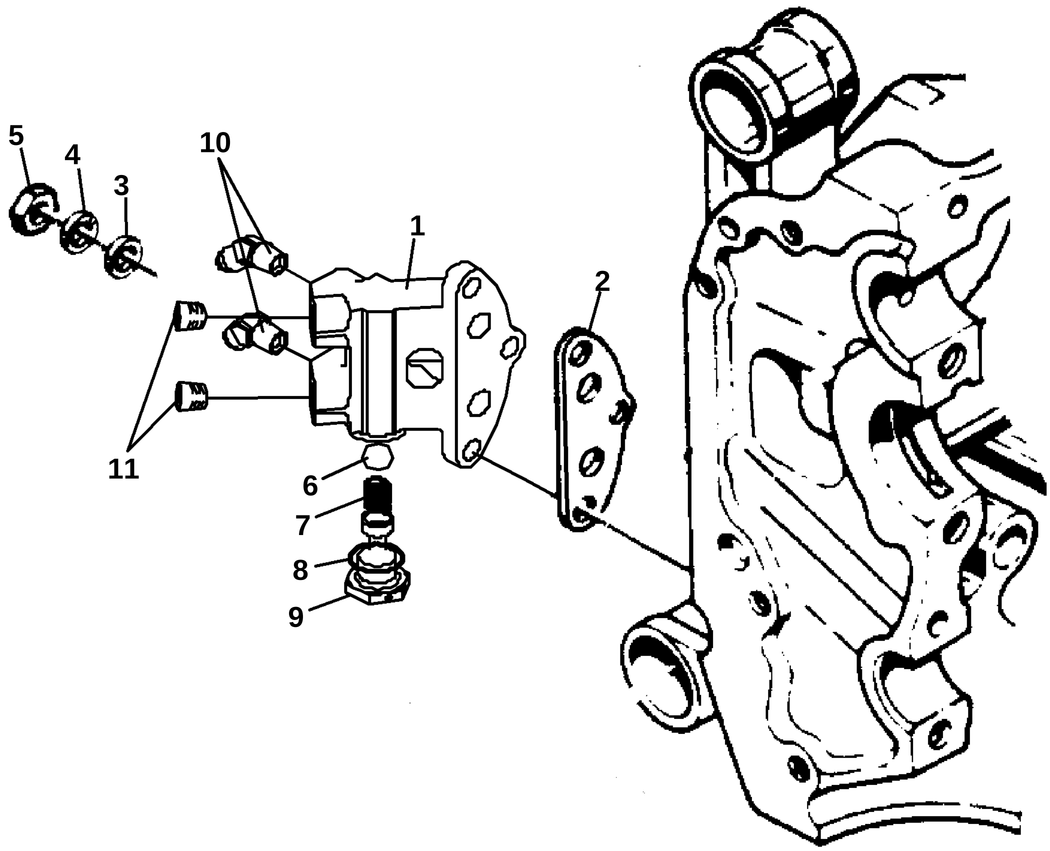


Figure 12-6. Oil Cooler Adapter

1	Oil Cooler Adapter	4	Lock Washer	7	Spring	10	45° degree fitting
2	Oil Cooler Adapter Gasket	5	Nut	8	Copper Gasket	11	.025”-18 Plug
3	Washer	6	Ball - 0.437 steel	9	Plug		

12-6. Starter Removal

NOTE: The O-200 engine may have a Continental Motors starter or a starter installed by the airframe manufacturer. These instructions apply to engines with the Continental Motors starter only. Refer to the airframe manufacturer's instructions to remove non-Continental Motors starters.

1.Remove two sets of bolts (Figure 12-7) (7), lock washers (4), lifting eye, and washers (6) from the rear of the accessory case and rear lifting eye. Discard the lock washers.

2.Remove three sets of nuts (5), lock washer (4), washers (3) and spacers (8) from the starter mounting flange. Carefully remove the starter assembly without damaging the mounting stud threads. Discard the lock washers.

NOTE: Overhaul instructions are not available for the O-200-D or -X starter. Replacement starters (new, rebuilt, or overhauled) are available from Continental Motors. Obtain a replacement starter prior to engine assembly.

3.Remove and discard the gasket (1). Remove and retain the starter for core exchange.

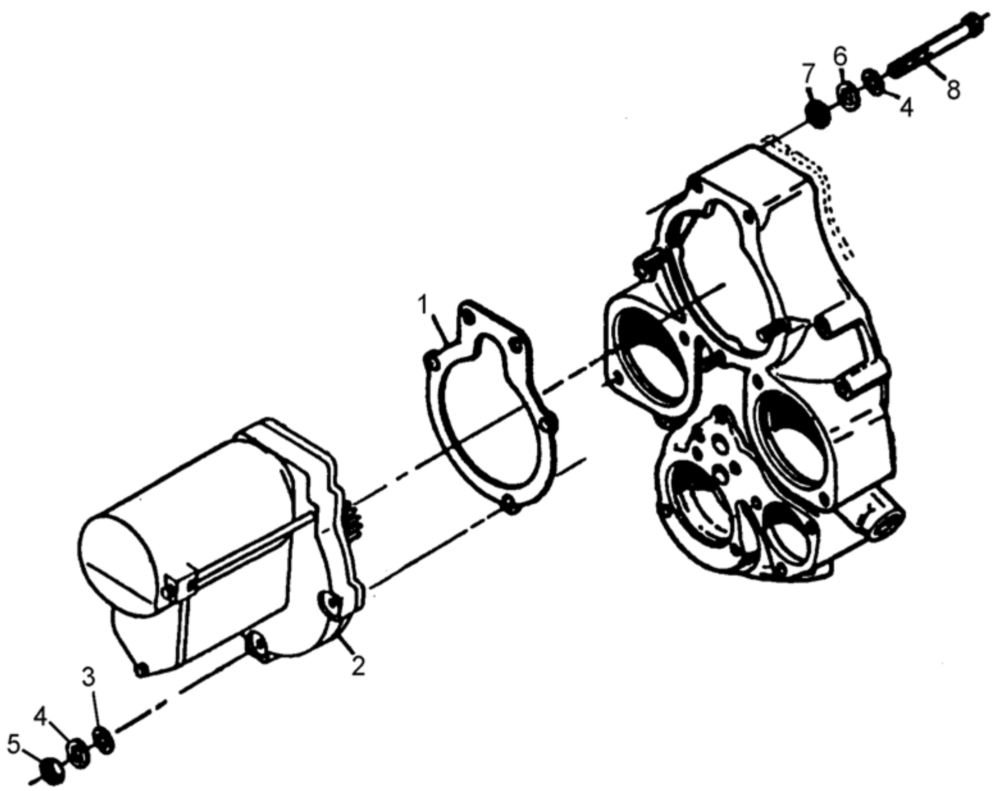


Figure 12-7. Starter

1	Gasket	3	Washer	5	Nut	7	Spacer
2	Starter Assembly	4	Lock Washer	6	Washer	8	Bolt

12-7. Alternator Removal

Continental Motors overhaul policy requires accessory overhaul or replacement coincident with engine overhaul. No overhaul instructions are available for the available alternators installed on O-200 engines. Continental Motors offers new or recertified alternators as replacements for the alternators which cannot be overhauled.

1. Remove three nuts (Figure 12-8) (5), lock washers (4), and washers (3); discard the lock nuts (4).
2. Remove the alternator (1) from the crankcase; remove and discard the alternator gasket (2).
3. Remove the cotter pin (7) and nut (6); discard the cotter pin (7).
4. Remove the drive hub assembly (10, 9, 11, 12, 8 & 13) from the alternator shaft; Discard the bushings (12) and woodruff key (13).

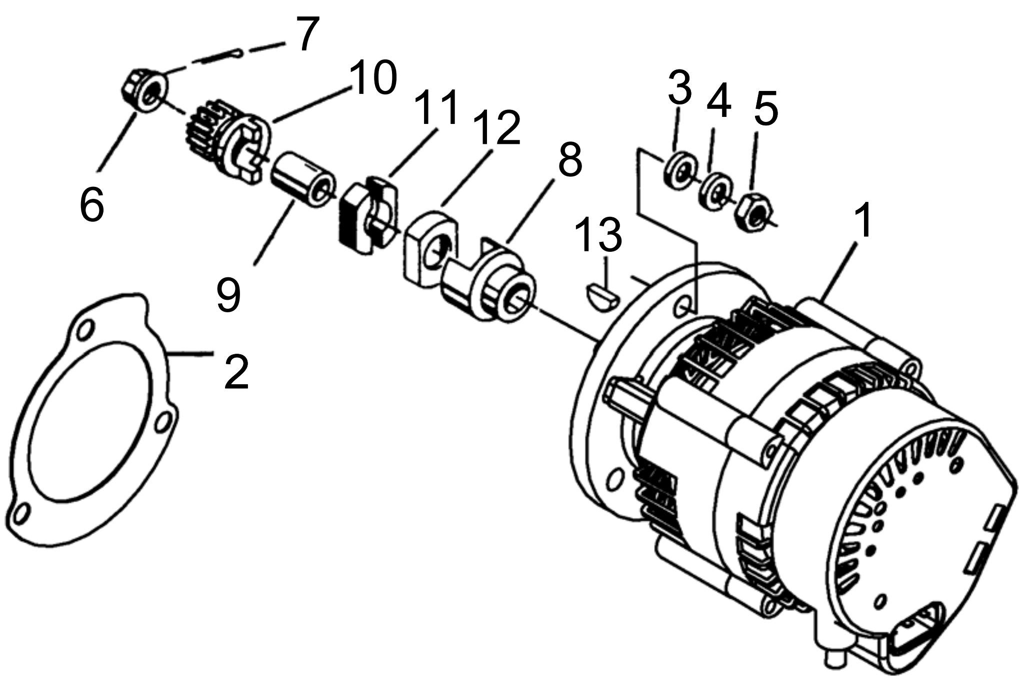


Figure 12-8. Alternator

1	Alternator	5	Nut	9	Sleeve	13	Woodruff Key
2	Gasket	6	Slotted Nut	10	Gear		
3	Washer	7	Cotter Pin	11	Bushing		
4	Lock Washer	8	Alternator Coupling Hub	12	Retainer		

12-8. Oil Sump Removal

NOTE: The oil should have been drained prior to engine removal. The safety wire should have been removed and discarded, and the oil drain plug (4) and copper gasket (3) should have been removed. Discard the copper gasket (3).

NOTE: Oil sumps are available with fill tubes on the left (2-4) or right (1-3) side of the engine. Sumps are not interchangeable; install the sump with the fill neck on the same side from which it was removed.

1. Remove the oil gauge rod (Figure 12-9) (7) from the oil sump (1).
2. Remove the lock nuts (6) and washers (5) from the sump flange; discard the lock nuts (6).
3. Separate the oil sump (1) from the accessory case and crankcase.
4. Remove and discard the oil sump gasket (8).

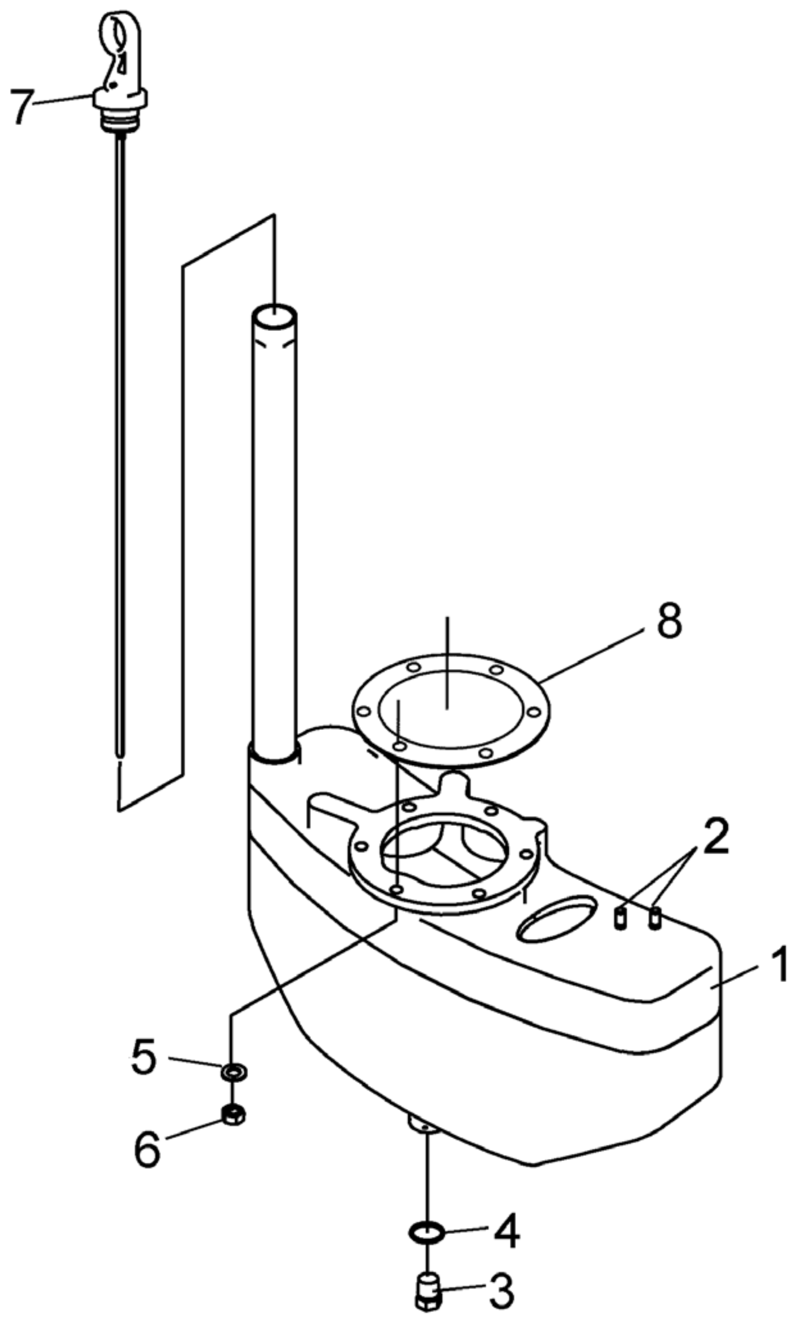


Figure 12-9. Oil Sump

1	Oil Sump Assembly	5	Washer
2	Stud	6	Lock Nut
3	Plug	7	Oil Gauge Rod
4	Copper Gasket	8	Gasket

12-9. Accessory Case Removal

1. Remove five sets of nuts (Figure 12-10) (12), lock washers (11), and washers (10). Discard the lock washers (11).
2. Gently tap the accessory case cover (1) with a soft rubber or rawhide mallet and separate it from the crankcase.
3. Remove and discard the gasket (5).

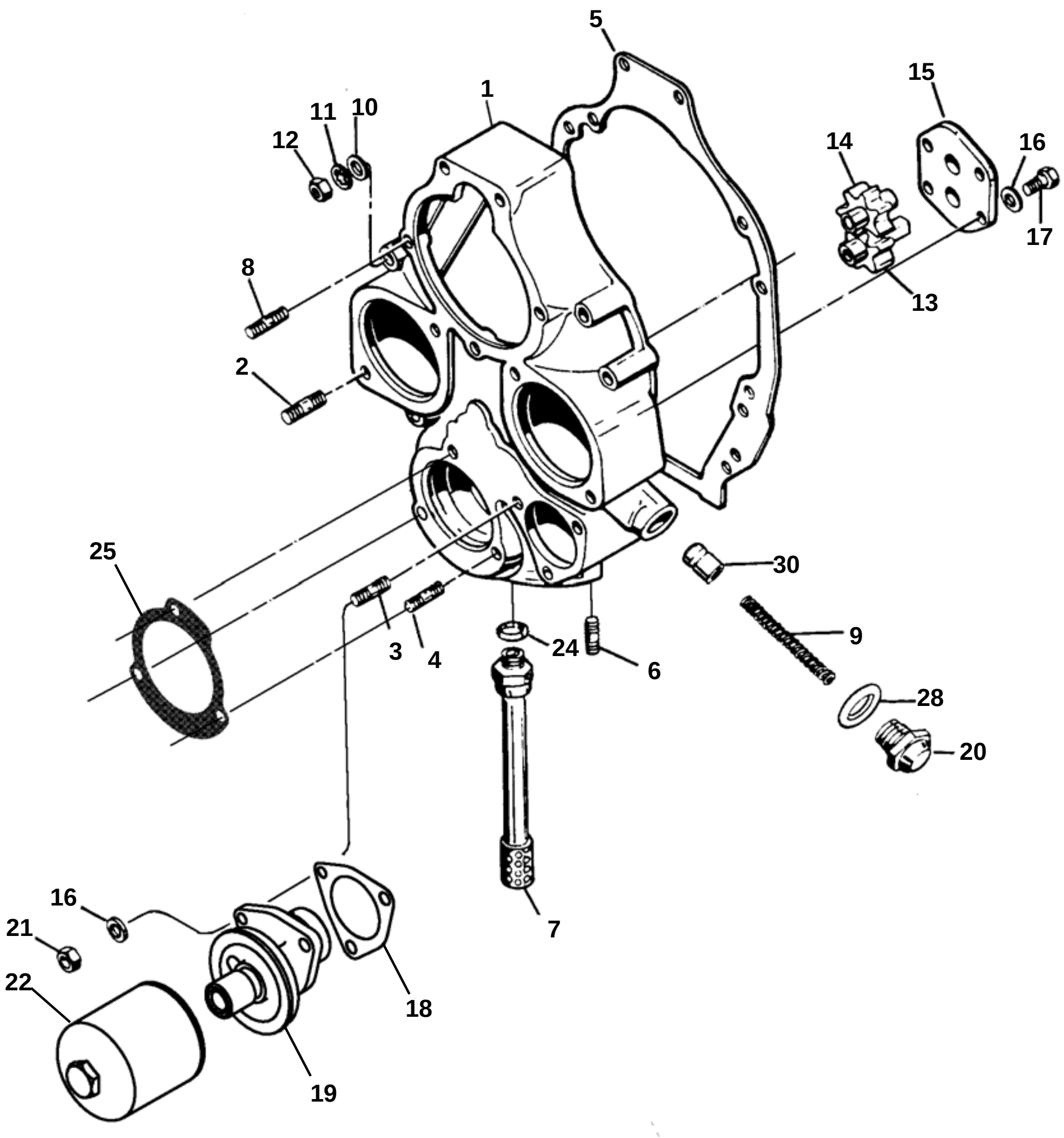


Figure 12-10. Accessory Case

1	Accessory Case w/studs	9	Spring	17	Screw	25	Gasket
2	Stud	10	Washer	18	Gasket	26	Not Used
3	Stud	11	Lock Washer	19	Oil Screen Housing	27	Not Used
4	Stud	12	Nut	20	Not Used	28	Copper Gasket
5	Gasket	13	Oil Pump Drive Gear	21	Nut	29	Not Used
6	Stud	14	Oil Pump Driven Gear	22	Oil Filter	30	Plunger
7	Suction Tube Assembly	15	Oil Pump Cover	23	Not Used	21	Oil Pump Kit
8	Stud	16	Washer	24	Not Used		

12-10. Inter-cylinder Baffle Removal

Identical inter-cylinder baffle assemblies are installed between the 1-3 and 2-4 cylinders. Repeat the instructions for each side of the engine.

1. Extend the eyelet of the spring (Figure 12-11) (2) with a spring hook to free it from the retainer (1). Remove the retainer (1) from the top of the cylinders.
2. Lower the baffles (3) away from the 1-3 and 2-4 cylinders.
3. Separate the spring (2) and clevis pin (4); discard the spring (2).
4. Store the inter-cylinder baffles (3), retainers (1), and clevis pins (4) for reassembly.

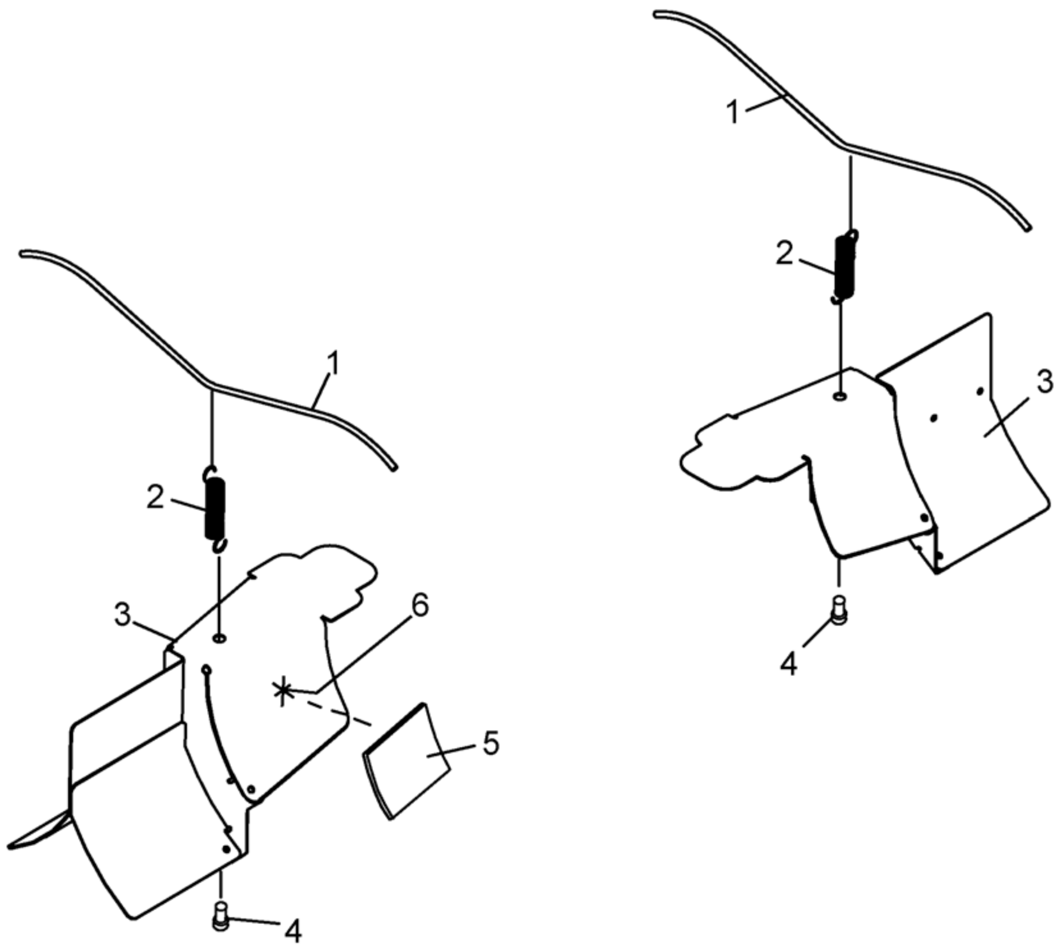


Figure 12-11. Inter-cylinder Baffles

1	Baffle Retainer	4	Clevis Pin
2	Spring	5	Isolator
3	Baffle	6	Adhesive

12-11. Engine Cylinder and Piston Removal

1. Remove the bolts (Figure 12-12) (32), lock washers (31), and washers (30) from the rocker cover (29) and remove the rocker cover from the cylinder; discard the lock washers (31). Repeat for the remaining three rocker covers.
2. Remove and discard six rocker cover gaskets (28).

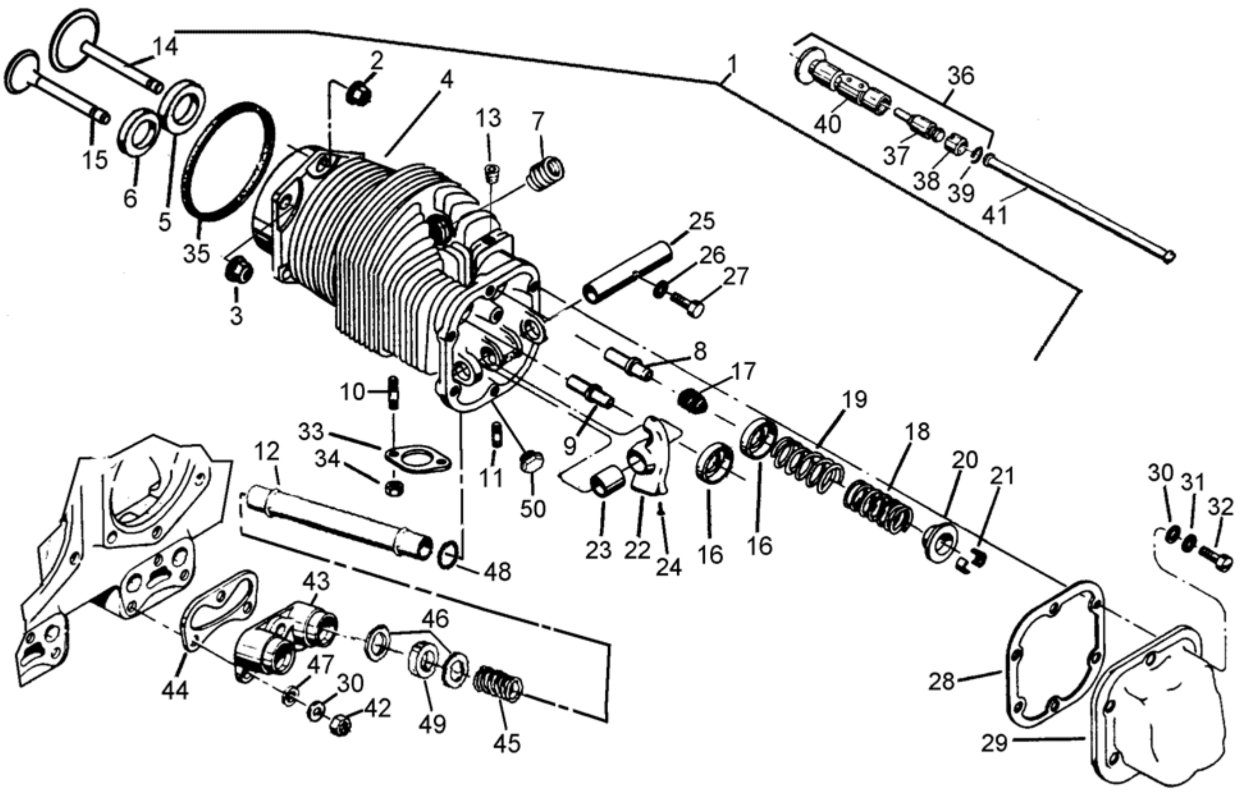


Figure 12-12. Cylinder Assembly

1	Cylinder & Valve Assembly	13	Plug	25	Rocker Shaft	38	Socket
2	Nut	14	Intake Valve	26	Washer	39	Snap Ring
3	Nut	15	Exhaust Valve	27	Bolt	40	Lifter Body
4	Cylinder Assembly	16	Valve Spring Seat	28	Rocker Cover Gasket	41	Push Rod
5	Intake Valve Seat Insert	17	Intake Valve Guide Seal	29	Rocker Cover	42	Lock Nut
6	Exhaust Valve Seat Insert	18	Inner Valve Spring	30	Washer	43	Pushrod Adapter
7	Helical Coil Insert	19	Outer Valve Spring	31	Lock Washer	44	Pushrod Housing Gasket
8	Intake Valve Guide	20	Valve Spring Retainer	32	Bolt	45	Spring
9	Exhaust Valve Guide	21	Valve Spring Key	33	Exhaust Flange Gasket	46	Washer
10	Stud	22	Rocker Arm Assembly	34	Lock Nut	47	Washer
11	Stud	23	Rocker Arm Bushing	35	Packing	48	O-ring Seal
12	Pushrod Housing	24	Screw	36	Lifter Assembly	49	Pushrod Housing Seal
				37	Plunger Assembly	50	Spark Plug Insert

3. Position the crankshaft so the cylinder #1 piston is at top dead center of the compression stroke and both intake and exhaust valves of the cylinder to be removed are closed.
4. Remove the bolt (27) and washer (26) securing the rocker shaft (25).
5. Remove the rocker shaft (25) and rocker arms (22) from the cylinder head boss.

6. Rotate the crankshaft to position the #3 cylinder is at top dead center of the compression stroke and repeat steps 4 and 5.
7. Rotate the crankshaft to position the #2 cylinder at top dead center of the compression stroke and repeat steps 4 and 5.
8. Rotate the crankshaft to position the #4 cylinder at top dead center of the compression stroke and repeat steps 4 and 5.
9. Withdraw the push rods (41) from their respective pushrod housings (12).
10. Grasp each push rod housing (12) and push it inward toward the crankcase, compressing the push rod housing spring (45); move the pushrod housing away from the cylinder head and remove the push rod housing (12) from the crankcase. Remove the O-rings (48), washers (46), pushrod housing seals (49) and springs (45). Discard the O-rings (48), pushrod housing seals (49) and springs (45).
11. Remove the nuts (2 and 3) from the cylinder base flange. As the fastening hardware is removed, cradle the cylinder in your arm for support. Discard the nuts (2 and 3).

CAUTION: The piston will be damaged if allowed to drop as the cylinder is withdrawn.

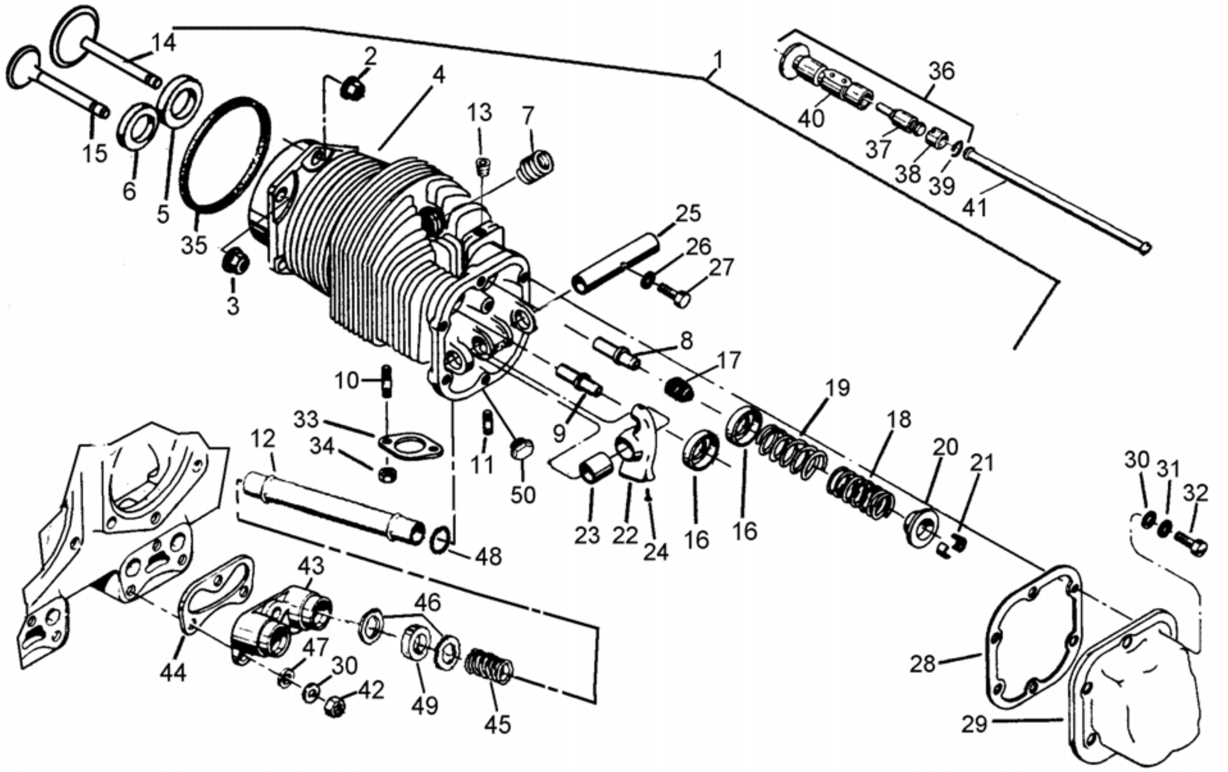


Figure 12-12 repeated for reference

12. While supporting the cylinder, carefully and slowly pull the cylinder away from the crankcase with one hand. Use the other hand to catch the piston as the cylinder is withdrawn to prevent crankcase or cylinder damage.

13. Remove the cylinder base packing (35). Install the old packing over the cylinder base studs in the shape of a figure 8 (Figure 12-13) to support the connecting rod.
14. Remove the nuts (Figure 12-12) (42), lock washers (30), and washers (47) from the pushrod adapter (43).
15. Remove the pushrod adapter (43) and gasket (44) from the crankcase studs. Discard the lock washers (30) and gasket (44).

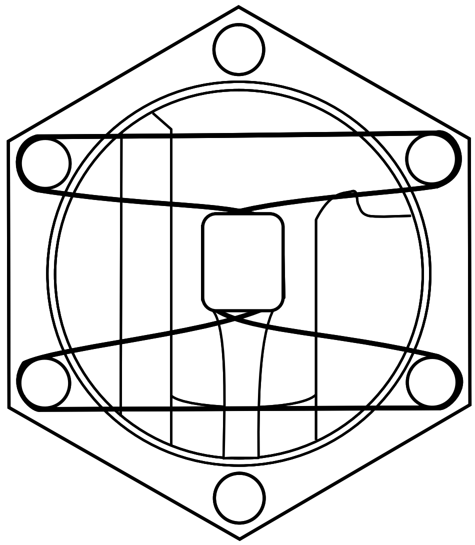


Figure 12-13. Cylinder Base Packing Supports Connecting Rod

16. Remove the piston pin (5) (Figure 12-14) to separate the piston from the connecting rod. Discard the piston (1), piston pin (5), and rings (2, 3 & 4).

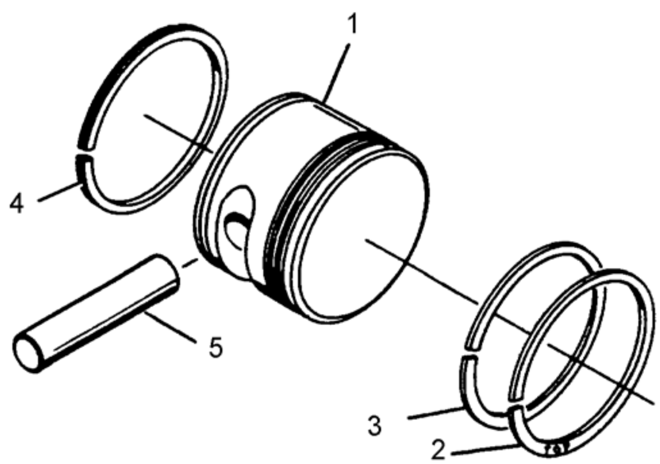


Figure 12-14. Piston Assembly

1	Piston	4	Oil Control Ring
2	Piston Compression Ring	5	Piston Pin
3	Piston Compression Ring		

17. Place the cylinders in a clean, protected area until disassembly in Section 13-8.

Chapter 13.Component Disassembly

13-1. Ignition System

Replace Slick Magnetos with a new or rebuilt unit, or replace the unit with a unit overhauled according to a FAA approved procedure. Replace Continental Motors Magnetos with a new, rebuilt, or overhaul the magneto according to instructions in Continental Motors Magneto Service Manual, X42002.

13-2. Starter Disassembly

Starter overhaul is not authorized; replace the starter at engine overhaul.

13-3. Accessory Case Disassembly

1. Refer to Figure 13-1; cut and remove the safety wire.
2. Remove the oil pressure relief valve assembly cap (20), copper gasket (28), spring (9) and plunger (30). Discard the spring (29) and gasket (28).
3. Cut and remove the safety wire from the oil suction tube (7).
4. Remove the oil suction tube (7) and O-ring (24). Discard the O-ring (24).

   NOTE: The safety wire was removed from the oil filter when the oil was drained from the engine.

5. Remove and discard the oil filter (22).
6. Remove the nuts (21) and washers (16) from the accessory case studs securing the oil filter adapter (19). Remove the oil filter adapter (19) and gasket (18); discard the gasket (18).
7. Disassemble the oil pump according to instructions in Section 13-3.1.

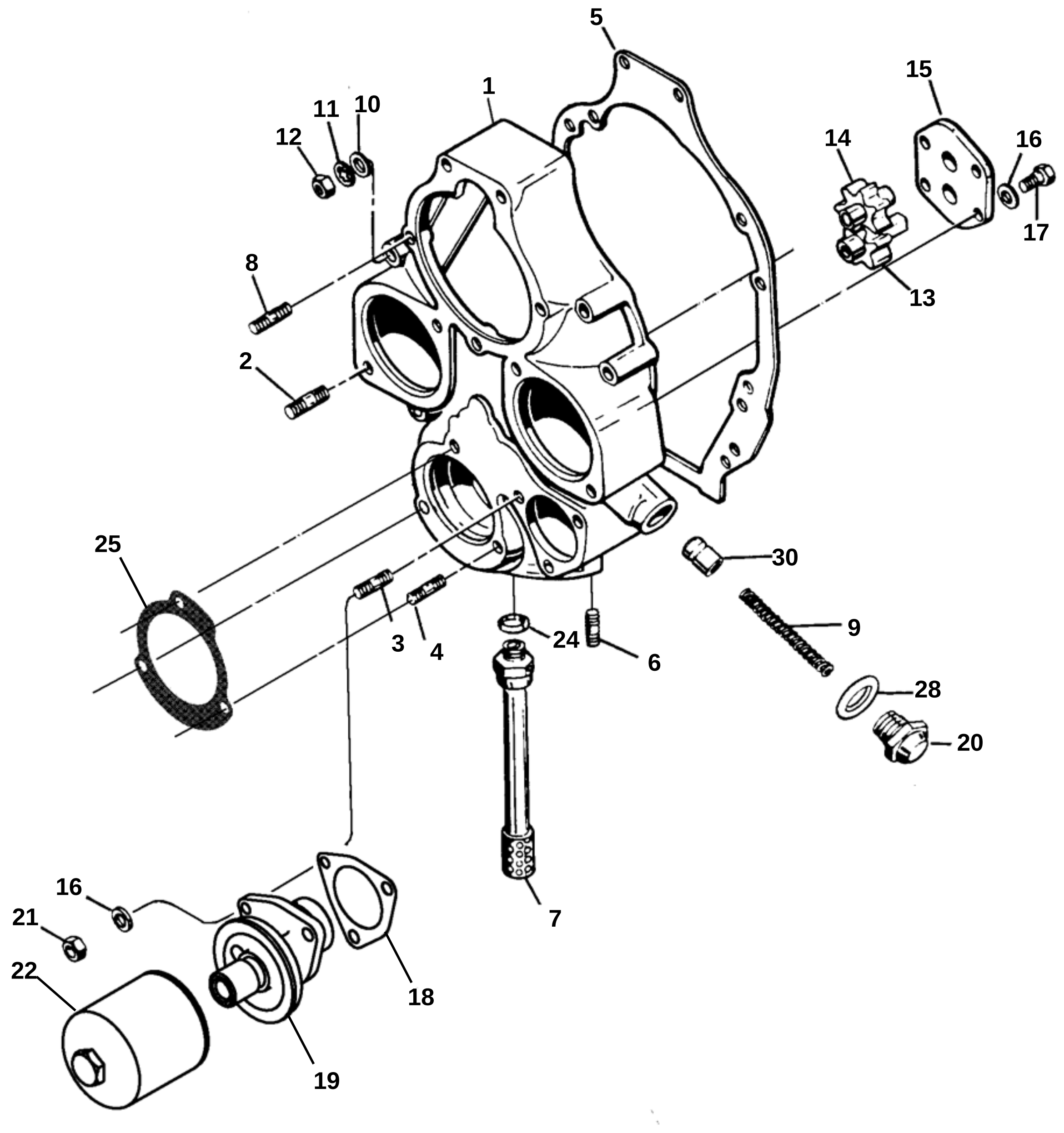


Figure 13-1. Accessory Case

1	Accessory Case w/studs	9	Spring	17	Screw	25	Gasket
2	Stud	10	Washer	18	Gasket	26	Not Used
3	Stud	11	Lock Washer	19	Oil Screen Housing	27	Not Used
4	Stud	12	Nut	20	Not Used	28	Copper Gasket
5	Gasket	13	Oil Pump Drive Gear	21	Nut	29	Not Used
6	Stud	14	Oil Pump Driven Gear	22	Oil Filter	30	Plunger
7	Suction Tube Assembly	15	Oil Pump Cover	23	Not Used	21	Oil Pump Kit
8	Stud	16	Washer	24	Not Used		

13-3.1. Oil Pump Disassembly

1. Refer to Figure 13-2; cut and remove the safety wire.
2. Bend the tabs on the tab washers (4) down.
3. Remove the bolts (5) and four washers (4).
4. Separate the oil pump cover (3) from the oil pump cavity and remove the gears (1 & 2).
5. Place the oil pump components and accessory case in protected area for cleaning and inspection.

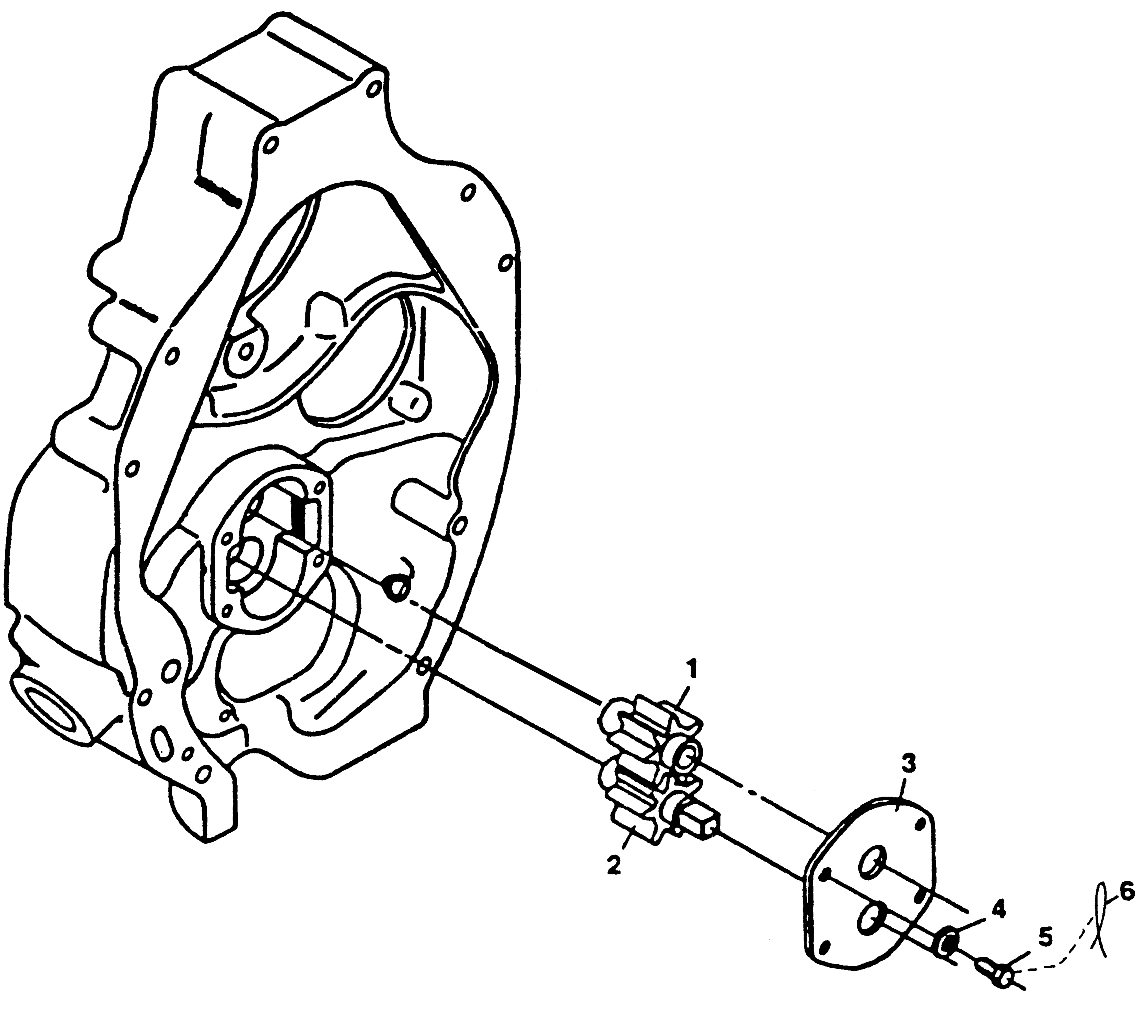


Figure 13-2. Oil Pump

1	Oil Pump Driven Gear	4	Washer (4)
2	Oil Pump Drive Gear	5	Bolts (4)
3	Oil Pump Cover	6	Safety Wire

13-4. Oil Cooler Adapter Disassembly

1. Remove the adapter fittings (Figure 13-3) (10) from the oil cooler adapter.
2. Remove the plug (9), spring (7), and ball (6) from the oil cooler adapter (1). Remove the copper gasket (8); discard the ball (6), spring (7) and copper gasket (8).
3. Remove the plugs (11) from the rear of the adapter (1).

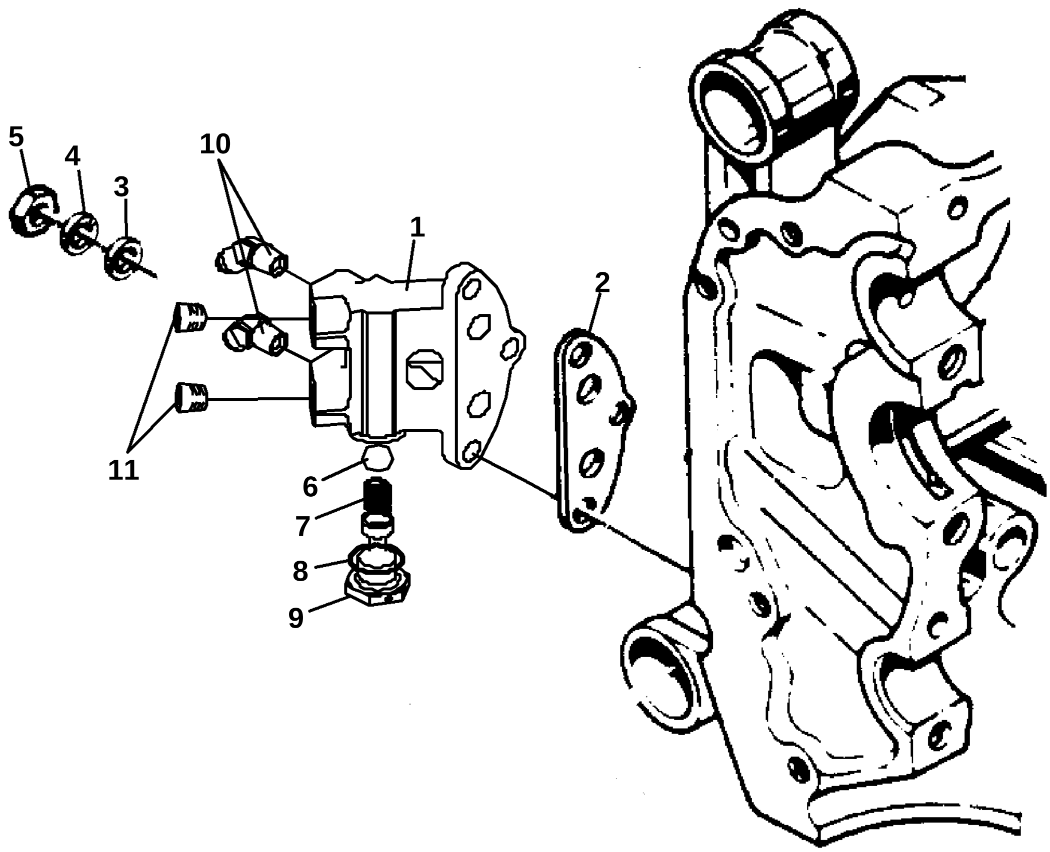


Figure 13-3. Offset Oil Cooler Adapter

1	Oil Cooler Adapter	4	Lock Washer	7	Spring	10	45° degree fitting
2	Oil Cooler Adapter Gasket	5	Nut	8	Copper Gasket	11	0.25”-18 Plug
3	Washer	6	Ball - 0.437 steel	9	Plug		

13-5. Induction System Disassembly

1. Turn each of the studs (Figure 13-4) one quarter turn counter-clockwise to release the air filter assembly (24) from the air intake housing (23). Remove and discard the air filter assembly (24).
2. Remove the nuts (11) and lock washers (10) from the air intake housing (23); discard the lock washers (10). Remove and discard the gasket (22).
3. Remove the nuts (11), lock washers (10) and washers (9); discard the lock washers (10) from the base of the carburetor (21). Remove and discard the gasket (20).
4. Remove the nut (19), union (18) and primer nipple (17) from the intake manifold. Remove the plug (16) from the intake manifold.
5. Inspect the intake manifold (1), tubes (12), and elbows (7 & 8) according to instructions in Chapter 15.
6. Inspect the air intake housing (23) assembly for serviceability.
   a. Inspect the nut plates for security on the flange.
   b. Inspect the flanges for flatness with a straightedge.
   c. Inspect the air intake housing levers or smooth operation.
7. Replace the carburetor with a new or rebuilt unit, or a unit overhauled according to a FAA approved procedure.

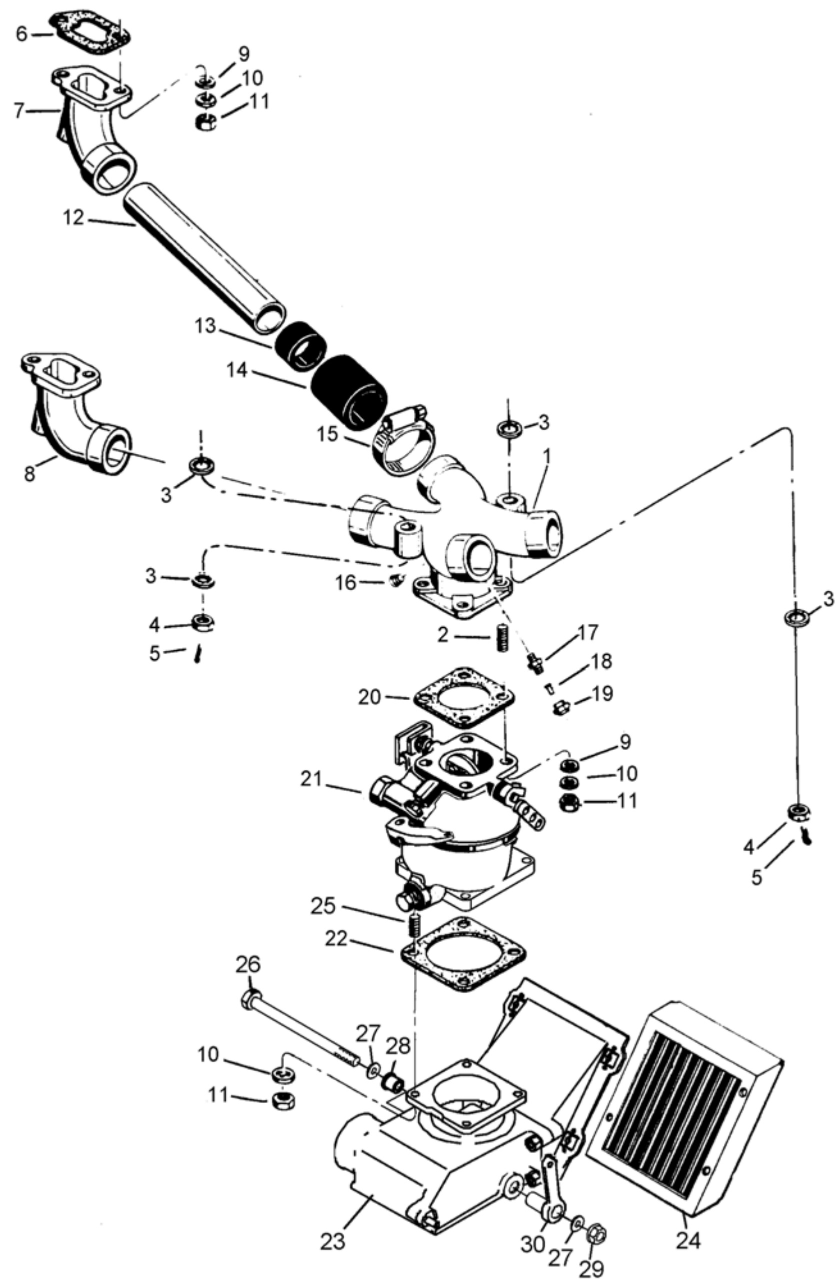


Figure 13-4. Induction System

1	Intake Manifold Assembly	9	Washer	17	Nipple- primer	25	Stud
2	Stud	10	Lock Washer	18	Union	26	Bolt
3	O-lock Seal	11	Nut	19	Nut	27	Washer
4	Castle Nut	12	Intake Pipe	20	Carburetor Gasket	28	Bushing
5	Cotter Pin	13	Hose- 1.50 X 0.88	21	Carburetor	29	Lock Nut
6	Intake Manifold Gasket	14	Hose - 1.75 X 2.00	22	Carburetor Gasket	30	Lever
7	Induction Elbow - Cyl 1 & 4	15	Clamp	23	Air Intake Housing		
8	Induction Elbow - Cyl 2 & 3	16	Plug - 0.25	24	Filter		

13-6. Crankcase Disassembly

1. Remove the vacuum pump pad cover from the bottom of the crankcase.
   a. Remove the nuts (Figure 13-6) (5 & 7), lock washers (4 & 8) and washers (6 & 9) from the vacuum pump pad cover (10).
   b. Remove the cover (10) and gasket (11) from the crankcase; discard the gasket (11).

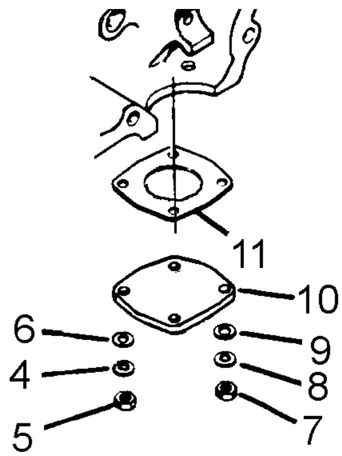


Figure 13-5. Vacuum Pump Pad Cover

4	Lock Washer	7	Washer	10	Accessory Drive Cover
5	Nut	8	Lock Washer	11	Acc. Housing Gasket
6	Washer	9	Washer		

2. Cut, remove and discard the safety wire from the camshaft gear screws (3). Insert a screwdriver through one of the camshaft gear (2) holes to prevent turning, and loosen the four camshaft gear screws (3).
3. Remove and discard the screws (3); remove the gear from the camshaft (1) pilot.

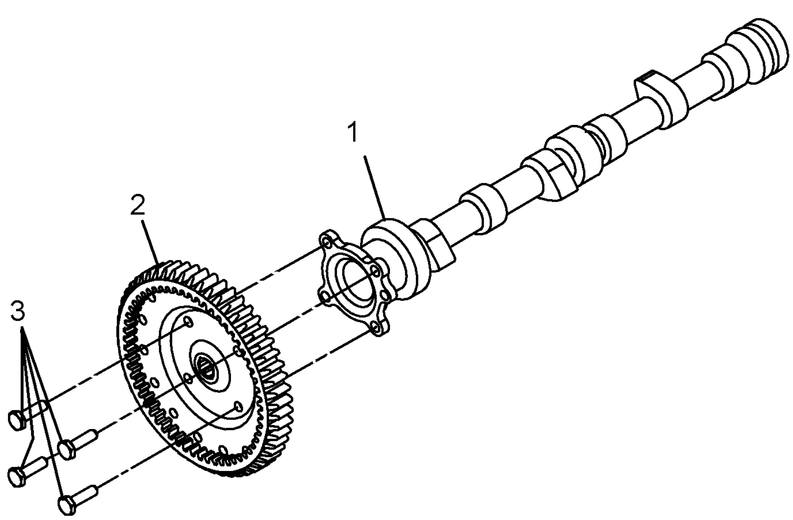


Figure 13-6. Camshaft Assembly

1	Camshaft	2	Gear	3	Screws

4. Remove and discard the safety wire; loosen, remove and discard the four drilled-head, crankshaft gear retaining screws (Figure 13-7) (4).
5. Remove the gear cluster (3) and dowel (2) from the crankshaft by tapping the circumference of the gear with a rawhide mallet.

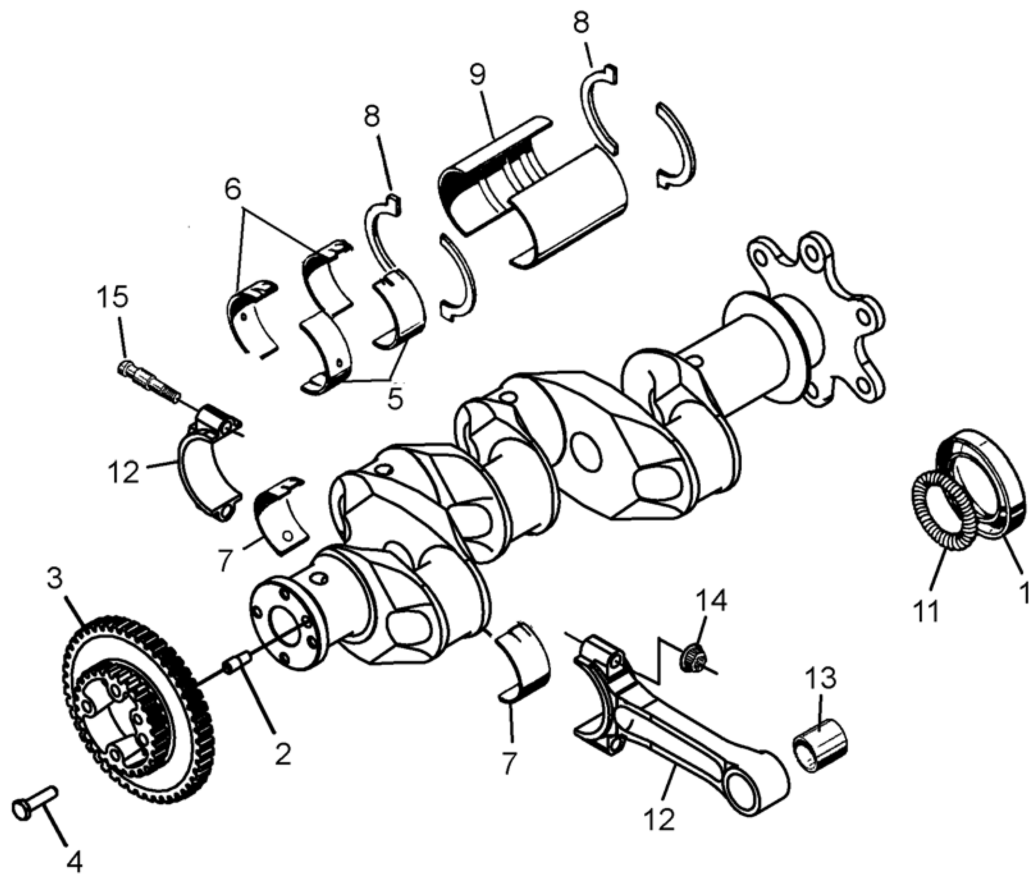


Figure 13-7. Crankshaft Assembly

1	Crankshaft	5	Main Bearing	9	Front Crankshaft Bearing	13	Piston Pin Bushing
2	Dowel Pin	6	Main Bearing	10	Nose Oil Seal	14	Spiral Lock Nut
3	Gear	7	Connecting Rod Bearing	11	Spring	15	Connecting Rod Bolt
4	Screw	8	Thrust Washer	12	Connecting Rod		

6. Unscrew and remove the breather elbow (Figure 13-8) (37) ahead of No. 3 cylinder.
7. Remove the bolt (30) and washer (28A) above the 1-3 side lower mount leg.
8. Remove the oil plugs (Figure 13-9) (19 & 20) from the crankcase. Remove and discard the gaskets (18).
9. Remove the engine mount bushings (Figure 13-8) (38-44) from each of the four engine mount arms.
10. Remove the nuts (24), washers (27, 28A, & 45), and lifting eye (25), and special washers (26) from the 2-4 crankcase side parting flange screws (23, 28, 29 & 30).

Remove the parting flange screws (23, 28, 29 & 30) and washers (27, 28A, & 45) from the 1-3 crankcase side parting flange.

11. Remove the nuts (Figure 13-9) (32 & 35) and washers (31 & 34) from the crankcase through studs (14, 15, 16) and through bolt (Figure 13-8) (33).

NOTE: A non marring hammer may be used to loosen the through bolt and drive it through the crankcase

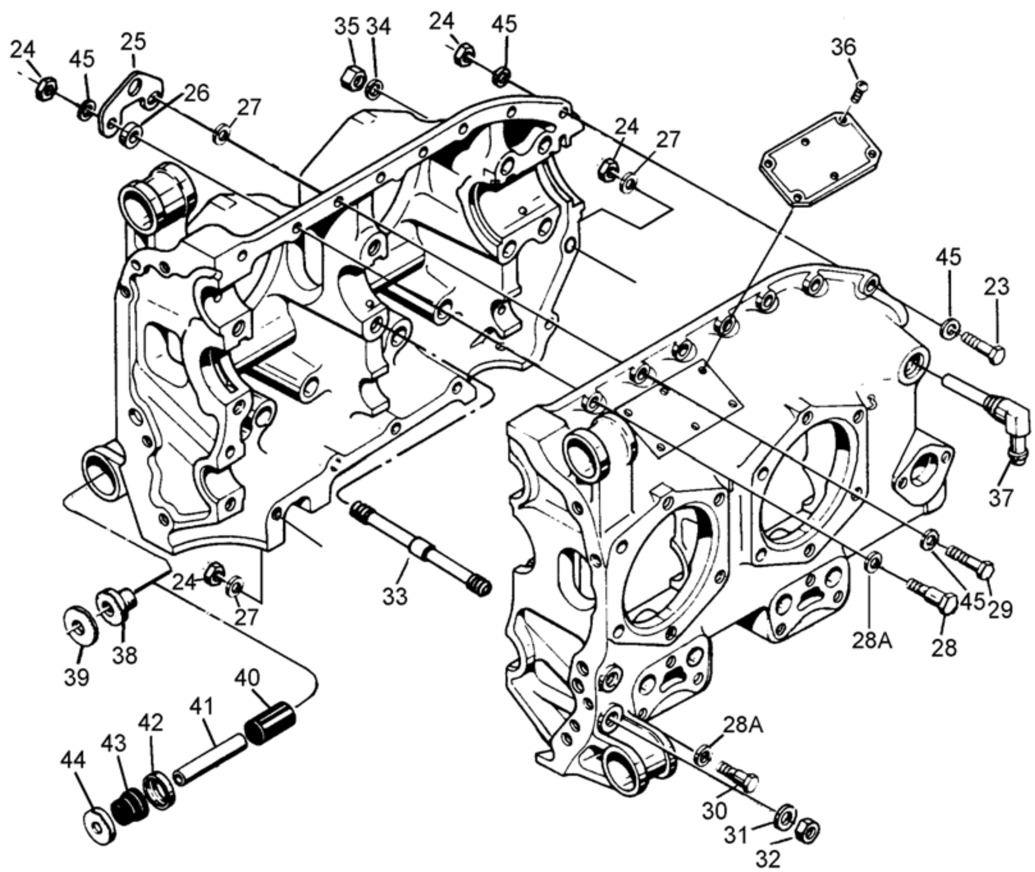


Figure 13-8. Crankcase Fasteners (A)

23	Screw	28	Screw	32	Nut	41	Engine Mount Spacer
24	Nut	28A	Washer	33	Through Bolt	42	Engine Mount Seat
25	Lifting Eye	29	Screw	34	Washer	43	Engine Mount Bushing
26	Special Washer	30	Screw	35	Nut	44	Cup Washer
27	Washer	31	Washer	36	Screw	45	Washer

12. Use a crankcase through-bolt remover tool (Chapter 3, Special Tools and Supplies) to remove the through bolt; catch the bolts as they are freed from the crankcase.

13. Disconnect the 1-3 side crankcase half from the engine stand. Carefully lift the right crankcase half while an assistant supports the connecting rods to prevent the connecting rods from hitting the cylinder decks. Remove the 1-3 side crankcase half from the 2-4 side crankcase half and store it for cleaning and inspection.

14. Before further disassembly, check and record gear backlash with dial indicators according to the gear backlash fits and limits in Appendix D.

15. Remove the crankshaft and connecting rod assemblies; collect and discard the thrust washers (Figure 13-7) (8) at the front main journal. Place the crankshaft and connecting rod assemblies on a holding fixture to prevent damage.
16. Remove and discard the connecting rod bearings (7) and main bearings (5, 6 & 9).
17. Remove the camshaft (Figure 13-6) and store on a holding fixture for cleaning and inspection.
18. Remove and discard the lifter assemblies from the crankcase tappet bores.

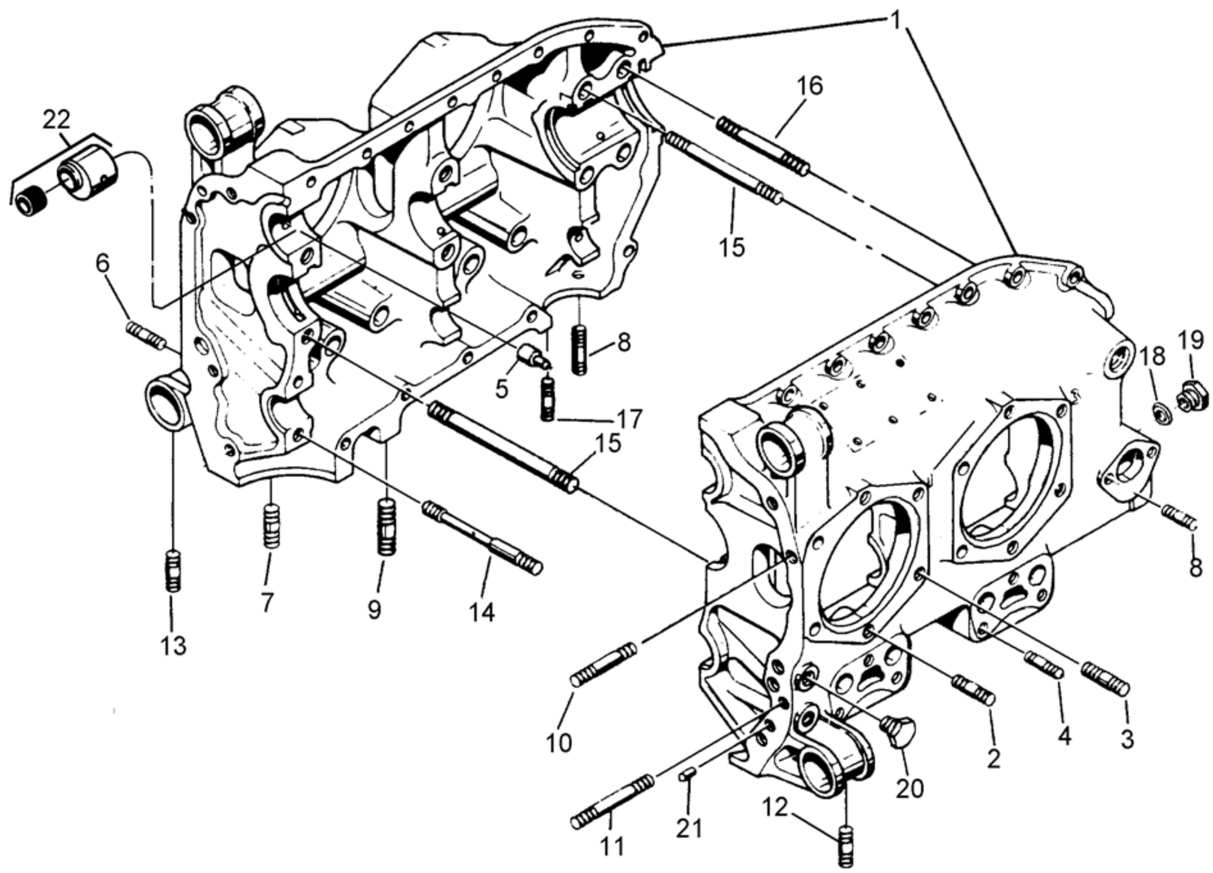


Figure 13-9. Crankcase Fasteners (B)

1	Crankcase Assembly	7	Stud	13	Stud	19	Plug
2	Stud	8	Stud	14	Stud	20	Plug
3	Stud	9	Stud	15	Stud	21	Dowel
4	Stud	10	Stud	16	Stud	22	Starter Adapter Assembly
5	Dowel	11	Stud	17	Stud		
6	Stud	12	Stud	18	Gasket		

19. Remove the starter adapter (Figure 13-9) (22) from the crankcase.
20. Remove the 2-4 crankcase half from the stand and store it for cleaning and inspection.

NOTE: Do not attempt to remove the oil squirt nozzles; field replacement is not possible.

21. Inspect the crankcase oil control plugs for wear; replace worn plugs.
22. Inspect crankcase studs, dowels and helical coils for condition and security.

13-7. Crankshaft Disassembly

1. Place the crankshaft front and rear main journals on wooden v-block supports.
2. Remove and discard all spiral lock nuts (Figure 13-7) (14) and connecting rod bolts (15). Separate the connecting rod caps from the connecting rod with their position numbers matched.

   CAUTION: Do not scratch, mar, or damage the crankshaft while removing the crankshaft nose oil seal.

3. Work the oil seal spring (11) from the oil seal groove and detach it from the oil seal (10). Unhook the spring ends using an unwinding motion and discard the oil seal spring (11).
4. Twist and remove the crankshaft nose oil seal (11) from the crankshaft. Gentle prying may be required to extract the seal from the counterbore. Discard the crankshaft nose oil seal (11).
5. Clean the Gasket Maker residue out of the counterbore recess using a chlorinated solvent Loctite Chisel or methylene chloride followed by a naptha solvent such as Loctite ODC-Free Cleaner and Degreaser. Remove all debris to render the bore clean, without any trace of debris.

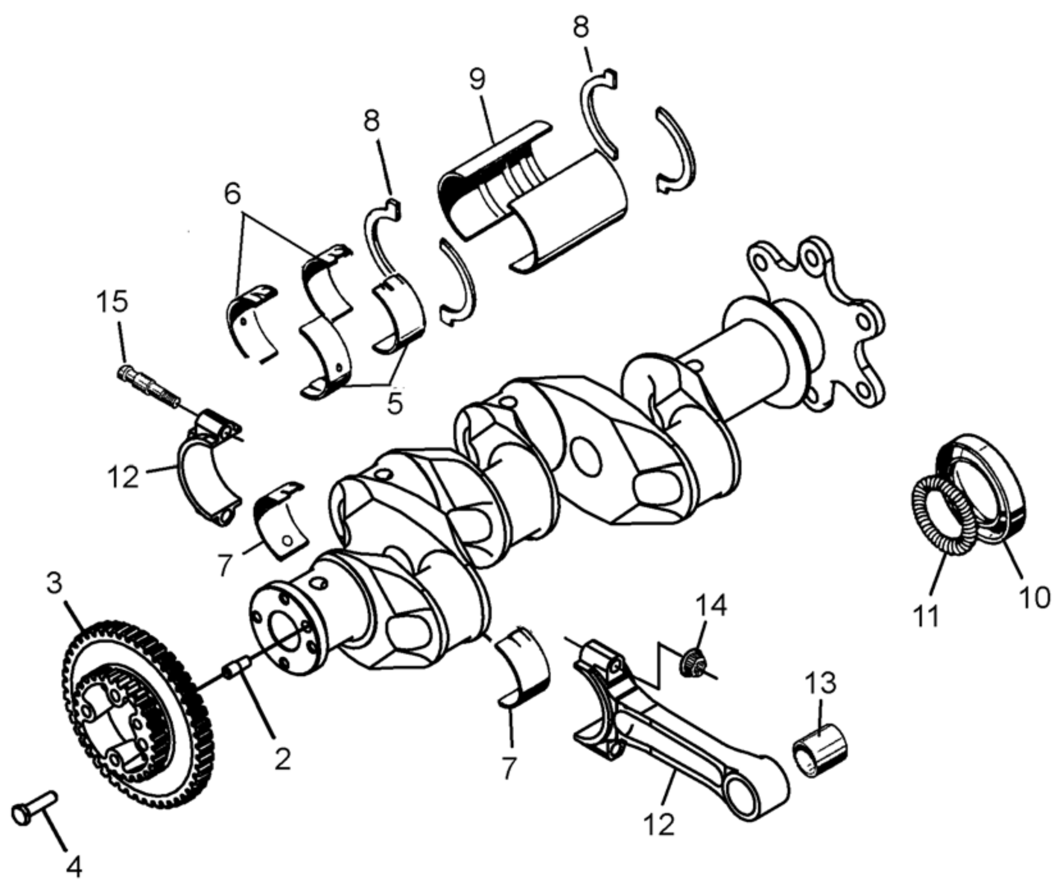


Figure 13-7 repeated for reference

13-8. Engine Cylinder Disassembly

1. Temporarily insert the rocker shaft (Figure 13-10) (25) in the cylinder head boss. Secure the cylinder in a cylinder holding fixture on a work bench. Use a valve spring compressor to compress the intake valve spring. Carefully remove the two valve spring retainer keys (21) from the valve stem with long nose pliers. Discard the valve spring retainer keys (21).
2. Repeat step 1 to remove the exhaust valve spring keys. Remove the rocker shaft (25) from the cylinder head boss.
3. Remove the valve spring retainers (20), inner springs (18), outer springs (19) and valve spring seats (16).
4. Grasp the cylinder assembly by the valve stems and remove it from the holding fixture. Place the cylinder assembly on its side. Remove and discard the intake and exhaust valves (14 & 15) from the cylinder.

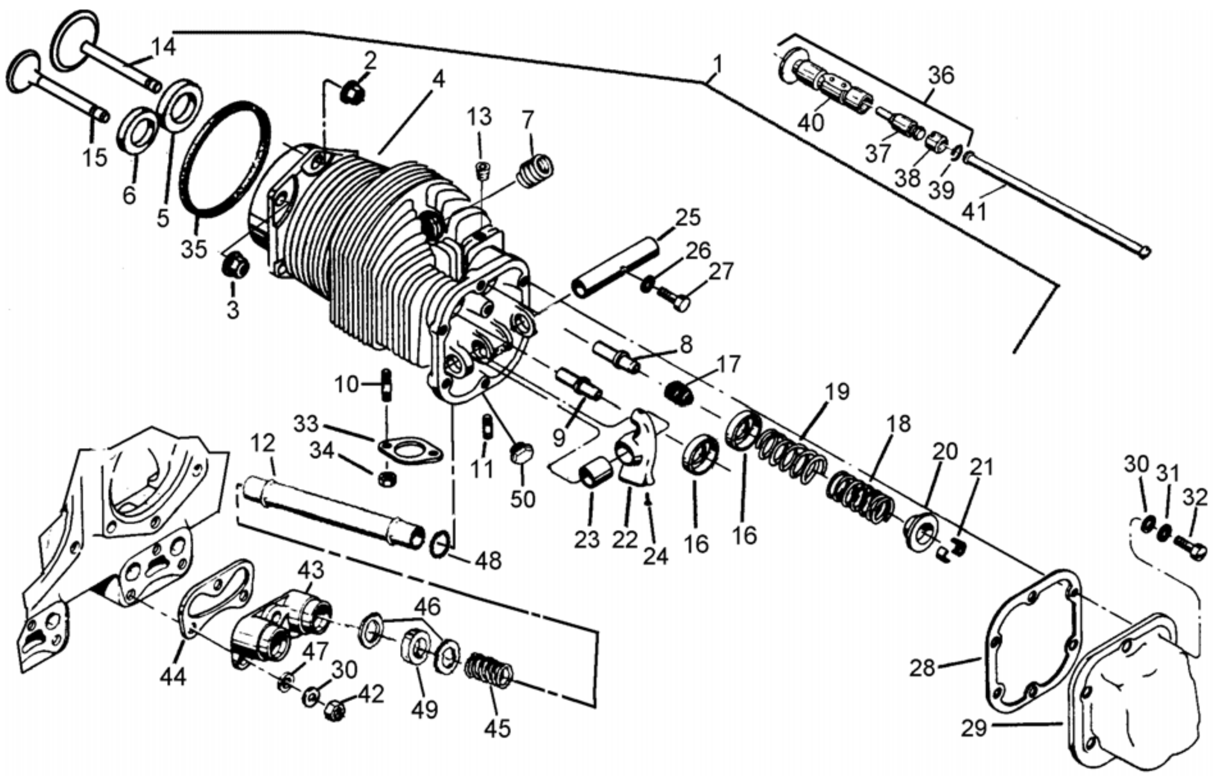


Figure 13-10. Cylinder and Valve Assembly

1	Cylinder & Valve Assembly	13	Plug	25	Rocker Shaft	38	Socket
2	Nut	14	Intake Valve	26	Washer	39	Snap Ring
3	Nut	15	Exhaust Valve	27	Bolt	40	Lifter Body
4	Cylinder Assembly	16	Valve Spring Seat	28	Rocker Cover Gasket	41	Push Rod
5	Intake Valve Seat Insert	17	Intake Valve Guide Seal	29	Rocker Cover	42	Lock Nut
6	Exhaust Valve Seat Insert	18	Inner Valve Spring	30	Washer	43	Pushrod Adapter
7	Helical Coil Insert	19	Outer Valve Spring	31	Lock Washer	44	Pushrod Housing Gasket
8	Intake Valve Guide	20	Valve Spring Retainer	32	Bolt	45	Spring
9	Exhaust Valve Guide	21	Valve Spring Key	33	Exhaust Flange Gasket	46	Washer
10	Stud	22	Rocker Arm Assembly	34	Lock Nut	47	Washer
11	Stud	23	Rocker Arm Bushing	35	Packing	48	O-ring Seal
12	Pushrod Housing	24	Screw	36	Lifter Assembly	49	Pushrod Housing Seal
				37	Plunger Assembly	50	Spark Plug Insert

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Chapter 14. Engine Cleaning

14-1. Engine and Component Cleaning

The goal of cleaning engine components is to remove dirt and contamination. A "cleaned" part is free of dirt, carbon, varnish, and gum substances. The "Aircraft Engine Parts Cleaning Guidelines" (Table 14-1) offer instructions for specific engine parts during overhaul or maintenance. Refer to the "Cleaning Tips" in Table 14-2 for additional guidelines.

WARNING

Consult the manufacturer's Material Safety Data Sheet (MSDS) for specific handling, storage and disposal instructions, including personal protective equipment requirements.

To prevent death or injury, do not smoke or introduce sources of ignition or flame to the work area when using flammable cleaning fluids such as mineral spirits.

Do not use gasoline, kerosene, abrasive cleaning paste, or cleansing powder to clean the engine or engine parts.

Do not pressure blast gears with abrasive media. Blasting will remove surface hardening.

When cleaning with alkaline solutions, remove all traces of alkaline residue to prevent corrosion. Alkaline cleaning solutions induce corrosion if not completely removed.

NOTE: Prior to cleaning engine parts, visually inspect for leakage and metal shavings, rust or other obvious signs of wear.

Table 14-1. Aircraft Engine Parts Cleaning Guidelines

Item to Clean	Instructions/References/Tips
Carburetor	Clean according to the carburetor manufacturer's instructions.
CAUTION: Never insert any object (wire, pipe cleaner, brush, etc.) in the fuel injector nozzle. If stain or obstruction cannot be removed with solvent or air, replace the nozzle.	
Fuel filters/screen	Immerse in an ultrasonic cleaner bath, adhere to the ultrasonic cleaner manufacturer's instructions. If ultrasonic cleaner is not available, flush with clean Stoddard solvent into white filter paper until no particulate residue is evident on the filter/screen or the filter paper.
Throttle control linkage pivot point areas	Stoddard solvent
Soiled aluminum alloy parts with carbon or gum deposits	Refer to “Cleaning Aluminum Alloy Parts”in Section 14-1.4.
Electrical charging system gears[1] with bushings[2]	Mineral spirits and a brass wire brush
Electrical charging system gears[1] without bushings	•Mineral spirits •Alkaline stripping bath followed by steam rinse to remove all alkaline traces (to prevent corrosion), inspect for traces of alkaline residue and re-spray with steam if alkaline residue found; flush with mineral spirits
Gears without bushings	Flush with mineral spirits (preferred cleansing agent) Alkaline stripping bath followed by steam rinse to remove all alkaline traces (to prevent corrosion); Dry with compressed air and inspect for traces of alkaline residue. Re-spray with steam if alkaline residue found; flush thoroughly with mineral spirits
Starter/starter adapter gears[1] with bushings[2]	Mineral spirits and a brass wire brush
•Accessory Case •Oil sump •Oil pump housing •Oil filter adapter •Lubrication System gears without bushings	Flush with mineral spirits (preferred cleansing agent). Alkaline stripping bath followed by steam rinse to remove all alkaline traces (to prevent corrosion); Dry with compressed air and inspect for traces of alkaline residue. Re-spray with steam if alkaline residue found; flush thoroughly with mineral spirits
NOTE: All oil passages must be clear	
Oil suction tube assembly	Mineral spirits
Oil cooler	Must be cleaned by an FAA-certified repair facility
Lubrication System gears[1] with bushings[2]	Mineral spirits and a brass wire brush
Engine cylinders[3]	Refer to “Cylinder Cleaning” instructions in Section 14-1.4.
Piston tops	To remove heavy carbon deposits on the piston tops, use vapor grit method - Refer to “Vapor Blasting”in Section 14-3.

Table 14-1. Aircraft Engine Parts Cleaning Guidelines

Item to Clean	Instructions/References/Tips
Engine cylinder intake valves	Degrease intake valves with mineral spirits. Remove all carbon, varnish and gum either using a carbon solvent or by dry blasting according to instructions in Section 14-2, "Dry Blasting." If dry blasting is performed, clean the valve with mineral spirits and air dry.
Pushrods and rocker arms	Soak in mineral spirits. Ensure passages within the pushrod and rocker arm are open by flushing the passages with mineral spirits using a squirt bottle. Discard and replace any pushrod or rocker arm that has obstructed passages and cannot be cleared. Do NOT clean pushrods or rocker arms by dry blasting
Cylinder baffles and cylinder hardware	Mineral spirits
Crankcase oil passages Oil squirt nozzles	Pressure flush with mineral spirits to remove clogs or free obstructed passages. (Use caution flushing the oil squirt nozzles, they are not field replaceable)
Engine mount brackets	Mineral spirits
Crankcase casting	Flush with mineral spirits (preferred cleansing agent) Alkaline stripping bath followed by steam rinse to remove all alkaline traces (to prevent corrosion); after drying, inspect for traces of alkaline residue and re-spray with steam if alkaline residue found; flush with mineral spirits.
Gasket surfaces on castings	Remove all old adhesive gasket material using the organic solvents listed below: •Acetone •Naptha •Methyl ethyl ketone (MEK) When removing the crankshaft nose oil seal, clean the Gasket Maker residue out of the counterbore recess using a chlorinated solvent Loctite Chisel® or methylene chloride followed by a naptha solvent such as Loctite ODC-Free Cleaner and Degreaser. Remove all debris to render the bore clean, without any trace debris.
CAUTION: When utilizing compressed air, wear OSHA approved protective eye wear. Never exceed 30 psi when using compressed gases for cleaning purposes. (OSHA 1910.242(b))	
Connecting rods, caps, bolts, and nuts	Thoroughly clean connecting rods using mineral spirits. Ensure that all surfaces are free of varnish, oil and residue. Place a sheet of crocus cloth on a flat surface plate and dampen with mineral spirits. Lightly rub the parting surface of the rod, cap and rod across crocus cloth to remove burrs or nicks. Clean the connecting rods, caps, bolts and nuts thoroughly. Dry the cleaned part with compressed air and place on a clean cloth.
Connecting rod bearing inserts	Clean the new bearing inserts in mineral spirits and blow dry.

Table 14-1. Aircraft Engine Parts Cleaning Guidelines

Item to Clean	Instructions/References/Tips
Camshaft Crankshaft	Degrease with mineral spirits (brushing or spraying). Remove all varnish or gummy deposits. Place the crankshaft or camshaft in a machinist's lathe and rotate at approximately 100 RPM, smooth the following with crocus cloth moistened in mineral spirits: •Crankshaft crank pins •Main journals •Oil seal race •Camshaft journals •Gear mount flange Clean all debris from bolt holes, threads, oil passages, and recesses
Crankshaft and camshaft gears[1] with bushings[2]	Mineral spirits and a brass wire brush
Crankshaft and camshaft gears without bushings	Flush with mineral spirits (preferred cleansing agent) Alkaline stripping bath followed by steam rinse to remove all alkaline traces (to prevent corrosion); after drying, inspect for traces of alkaline residue and re-spray with steam. Flush alkaline residue with mineral spirits
Small steel parts	Spray or brush on mineral spirits to degrease the part. Soak heavily soiled parts for 15 minutes in mineral spirits.
Spark Plugs	Degrease with mineral spirits. Remove carbon, varnish and gum either using a carbon solvent or by dry blasting according to instructions in Section 14-2, "Dry Blasting." If dry blasting is performed, clean the spark plug with mineral spirits and air dry.
WARNING **Except when removing carbon deposits and gum (oil varnish), do not use alkaline (caustic) cleaning solutions for external engine cleaning. Alkaline solutions remove the alodine finish of aluminum parts.**	
Engine exterior and components	Spray or brush cleaning solvent (mild detergent or mineral spirits) on the engine exterior or component
Connectors	•Electrical contact cleaner CR4 •Do not use water-base or petroleum-base solvent to clean connectors •If a cleaning fluid is suspected to have entered a connector, blow the excess away from the connector and place the effected component(s) in a warm dry environment; i.e. 90°F (32°C), overnight or until thoroughly dry. •As applicable, replace the sealant strip in the connector if any damage to the seal is evident.

1. Do not pressure blast gears or counterweights to clean them; blasting can remove the surface hardening.
2. Do not use alkaline cleaning solutions.
3. Do not use sand, glass shot, or metal grit to clean engine cylinders.

Table 14-2. Cleaning Tips

Dos	Don’ts
Use a cloth or compressed air to blow off the solvent.	Except when removing carbon deposits and gum (oil varnish), do not use alkaline (caustic) cleaning solutions for external engine cleaning. Alkaline solutions remove the alodine finish.
Remove dirt (especially caked dirt) and debris from bolts, nuts, and engine parts.	Do not use any of the following to clean the engine or parts: •Gasoline •Kerosene •Abrasive cleaning paste •Cleaning powder
Dispose of cleaning solvents in accordance with Environmental Protection Agency (EPA) regulations.	Do not scrape parts or use wire brushes, sandpaper, abrasive cloth or abrasive wheels to clean or polish parts to prevent concentrated stress to scratched areas and fatigue failure.
Dry blast only with plastic media or natural materials such as wheat grains	Do not use sand, metal grit, or glass beads for any type of cleaning or dry blasting.
After a part is cleaned, machined or repaired, or if the alodine finish is worn, apply alodine to aluminum surfaces, according to instruction in Section 14-4.1.	Do not tumble blast wrought or die cast smooth surface parts such as rocker covers or intake tubes.

14-1.1. Cylinder Cleaning

CAUTION: When utilizing compressed air, wear OSHA approved safety glasses, goggles or face shield. Never exceed 30 psi when using compressed gases for cleaning purposes. (OSHA 1910.242(b))

1. Soak the engine cylinders in mineral spirits for 15 minutes. Dry the cylinder with compressed air. Verify the cylinder is free of dirt and deposits. If the cylinder is satisfactorily cleaned after a mineral spirit bath, proceed to step 4.
2. If caked on carbon deposits remain, remove oil and loose materials from engine cylinders by spraying or brushing on a mild alkaline cleaner.
   a. Spray the cylinder with steam to remove all traces of alkaline residue.
   b. After the cylinder dries, inspect it again for traces of alkaline residue; respray with steam if alkaline residue is still present (to prevent corrosion) and repeat step 1.
3. For persistent carbon, varnish and gum deposits, dry blasting may be required.
   a. Seal and protect all machined surfaces on the cylinder such as the cylinder mount flange nut seats, barrel wall, small holes, and finished surfaces.

   CAUTION: Do not use sand, glass, shot or metal grit when dry blasting. These abrasives can damage engine components. This type of shot will become embedded in aluminum parts rendering them useless.

   b. Dry blast the cylinder to remove persistent carbon, varnish and gum deposits according to instructions in “Section 14-2, “Dry Blasting.”
   c. Clean the cylinder with hot, soapy water and a stiff bristled (non-wire) scrub brush to remove blasting materials from the cylinder.
   d. Thoroughly rinse the cylinder with hot water.
   e. Dry the cylinder completely.
4. Coat all bare steel surfaces thoroughly with clean, 50-weight aviation oil to prevent cylinder bore damage due to rust and contamination.

14-1.2. Piston Cleaning

CAUTION: When utilizing compressed air, wear OSHA approved safety glasses, goggles or face shield. Never exceed 30 psi when using compressed gases for cleaning purposes. (OSHA 1910.242(b))

1. Soak the cylinder and piston in mineral spirits.
2. If carbon deposits do not yield to solvent and deposits remain, install a tight fitting skirt protector and dry blast the piston heads with soft grit or employ the vapor grit method (to clean the piston top). Refer to Section 14-2, “Dry Blasting.”and Section 14-3, “Vapor Blasting.”

WARNING

When dry blasting, do not use sand, glass, shot or metal grit which can damage engine components. This media will become embedded in aluminum parts rendering them unusable.

3. Clean the piston with hot, soapy water and a stiff bristled (non-wire) scrub brush to remove all blasting materials from the piston. Thoroughly rinse all soap residue from the piston and cylinder bore using hot water.

CAUTION: Do not use wire brushes or scrapers of any kind to clean the piston.

4. Clean the piston ring grooves by pulling lengths of binder twine or very narrow strips of crocus cloth through the groove. Do not use automotive ring grooves scrapers, since the corner radii at the bottom of the grooves and side clearances must not be altered. Do not use abrasive cloth on the piston skirts because the diameters and cam-ground contour must not be altered.
5. Discard scored or burned pistons.
6. After cleaning, thoroughly rinse pistons using a Stoddard solvent to remove all debris.

14-1.3. Cleaning Exhaust Parts

1. Clean the exhaust system parts (except for the multi-segment V-band clamps) with Stoddard solvent. Allow the solvent to drain and wipe the parts dry with a clean cloth.
2. Clean V-band clamps using crocus cloth on the outer band clamp assembly.

14-1.4. Cleaning Aluminum Alloy Parts

Degrease aluminum alloy parts with mineral spirits. Soak heavily soiled parts for 15 minutes in mineral spirits. To remove carbon and gum deposits, perform the following:

1. Immerse the part in a hot bath of any of the following *long enough to remove the deposit*:
   a. Inhibited, mild alkaline cleaning solution.
   b. Hot, soapy water.
   c. Carbon solvent (only for hard, thick carbon deposits).

   CAUTION: Do not use an alkaline etching solution.
2. Remove the cleaned part from the solvent bath.

   CAUTION: Remove all solvent residue (especially if soap or alkaline solvent used), paying particular attention to crevices, recesses, and holes to prevent engine oil contamination on re-assembly. If not removed completely, the alkaline residue can corrode the part.
3. Rinse thoroughly to remove all traces of the cleaning solution.

   CAUTION: When utilizing compressed air, wear OSHA approved safety glasses, goggles or face shield. Never exceed 30 psi when using compressed gases for cleaning purposes. (OSHA 1910.242(b))
4. Dry the part with dry compressed air.
5. If carbon deposits remain on the part, refer to Section 14-2, “Dry Blasting.”
6. Remove protective seals and masking material.
7. If the Alodine finish was removed during cleaning, restore the alodine finish according to Section 14-4.1, “Alodine.”

14-2. Dry Blasting

Dry blast cleaning entails aiming plastic pellets or processed natural materials such as wheat grains, crushed fruit pits/shells under pressure toward an area to be cleaned. To clean using the dry blast method, perform the following procedure:

> *CAUTION: Do not use sand, glass, shot or metal grit when dry blasting as this can damage engine components. This type of shot will become embedded in aluminum parts rendering them useless.*

1. Prior to dry blasting any component, seal and protect all machined surfaces on the holes and finished surfaces.
2. Using plastic pellets or processed natural materials such as wheat grains, crushed fruit pits/shells. Adjust blast pressure to the lowest setting that will produce the desired cleaning action and aim toward the paint, varnish, or carbon deposit.

   > *CAUTION: When utilizing compressed air, wear OSHA approved safety glasses, goggles or face shield. Never exceed 30 psi when using compressed gases for cleaning purposes. (OSHA 1910.242(b))*

3. Blow off all dust with dry, compressed air.
4. Verify that no blasting material has lodged in crevices, recesses, or holes.

14-3. Vapor Blasting

Vapor blasting is used in specific, limited applications such as piston tops. This vapor grit method of cleaning employs high-pressure steam and a very fine abrasive to remove heavy carbon deposits. Clean parts thoroughly after vapor blasting to remove all traces of the blast media.

> NOTE: Vapor blasting should not be used on bearing surfaces. Follow the equipment manufacturer’s instructions when employing this type of cleaning.

14-4. Protective Coatings

Protective or anti-corrosive coatings include:

- Alodine
- Zinc chromate primer
- Enamel paint
- 50 weight aviation oil

Apply a protective coating after machining or repairing aluminum surfaces with an aluminum conversion coating. Continental Motors recommends alodine, also known by the brand name Accelagold, to prevent corrosion on aluminum surfaces, see Section 14-4.1, “Alodine.”

14-4.1. Alodine

Apply a protective coating of alodine to any of the following:

- Parts with aluminum surfaces that have been cleaned, machined, or repaired.
- Aluminum alloy castings.
- Sheet metal.
- Aluminum or metal tubing.

If the original aluminum conversion coating has been removed or deteriorated, it must be restored. Apply Alodine or Accelagold solution in accordance with the manufacturer's instructions. For Accelagold, refer to Technical Data Bulletin Number 108-31 Turcoat® Accelagold Aluminum Conversion Coating.

14-4.2. Aviation Oil

Apply clean 50-weight aviation oil to cleaned, machined steel surfaces.

14-4.3. Paint

1. Mask all connection joints and mating surfaces.
2. Follow instructions in Table 14-3 to prepare and paint engine parts. Apply zinc chromate primer and enamel paint to the respective types of external parts. Do not prime or paint internal parts or interior surfaces of the engine.

   CAUTION: Do not apply primer or enamel paint to internal engine parts or any part that contacts the engine oil supply. The paint or primer may flake or break off during engine operation and contaminate the engine oil.

Table 14-3. Painting External Parts

Aluminum Parts	Ferrous Parts	Magnesium Parts
1. Apply alodine according to manufacturer’s instructions. 2. Apply enamel to the part.	1. Apply zinc chromate primer. 2. Apply enamel to the parts. 3. Bake for 15 minutes using infrared heat or oven-dry for 60 minutes at 275 to 300°F (135 to 149°C).	1. Pickle the part. 2. Apply zinc chromate primer. 3. Apply enamel to the part. 4. Bake for 15 minutes using infrared heat or oven-dry for 60 minutes at 275 to 300°F (135 to 149°C).

Chapter 15.Overhaul Inspection and Repair

15-1. Engine Overhaul Inspection

Engine Overhaul Inspection consists of inspection procedures cited in this chapter. The inspections apply only to the engines covered in this manual and are intended to support the continued airworthiness of the engine.

15-2. Engine Overhaul Inspection Checklists

Use the Engine Overhaul Inspection Checklists in Chapter 11 as guides for performing the inspections required during engine overhaul. Print a copy of the checklist to record inspection progress and document actions taken during overhaul.

Perform the items on the checklists (in the order listed) on an engine which has been removed from the airframe, disassembled, and cleaned according to the instructions provided.

15-3. Visual Inspection

Perform a visual inspection on all parts not specified as 100% replacement at overhaul. Examine parts prior to being cleaned for obvious evidence of wear or leakage. Reject obviously damaged parts during the preliminary visual inspection, there is no need to clean and perform non-destructive inspection on parts which cannot be used. If condition is uncertain, clean with remaining parts after the preliminary exam, according to the "Engine Cleaning"instructions in Chapter 14. Verify the parts are clean and free of all dirt, carbon, varnish, gum, and paint.

1. Visually inspect the parts using at least a 10X (power) magnifying glass under good lighting. Look for the following unacceptable conditions:

   •Nicks
   •Dents
   •Gouges
   •Cracks
   •Distortion
   •Burned areas
   •Pitting
   •Metal transfer
   •Corrosion
   •Erosion
   •Enamel coating wear

2. Inspect all studs for bending, looseness or partial removal.
3. Inspect all threaded parts for nicks, damaged or deformed threads, faces, or heads.
4. Identify areas that warrant further cleaning.
5. Label parts which fail inspection; indicating reason for failure and if repair is possible or if replacement is required.
6. Record inspection findings on a copy of the "Engine Overhaul Visual Inspection Checklist", on page 11-6.

15-3.1. Gear Tooth Inspection

Inspect the gear teeth for signs of overheating and wear. Normal wear produces a fine polish on the tooth thrust faces. Gears with uneven teeth profiles, score marks, burning, or pitting are unacceptable. Refer to Figure 15-1 for sample illustrated comparisons of acceptable and unacceptable gear wear.

Discard and replace unacceptable gears. Indicate the need to replace the gear(s) on the Engine Overhaul Inspection Checklist.

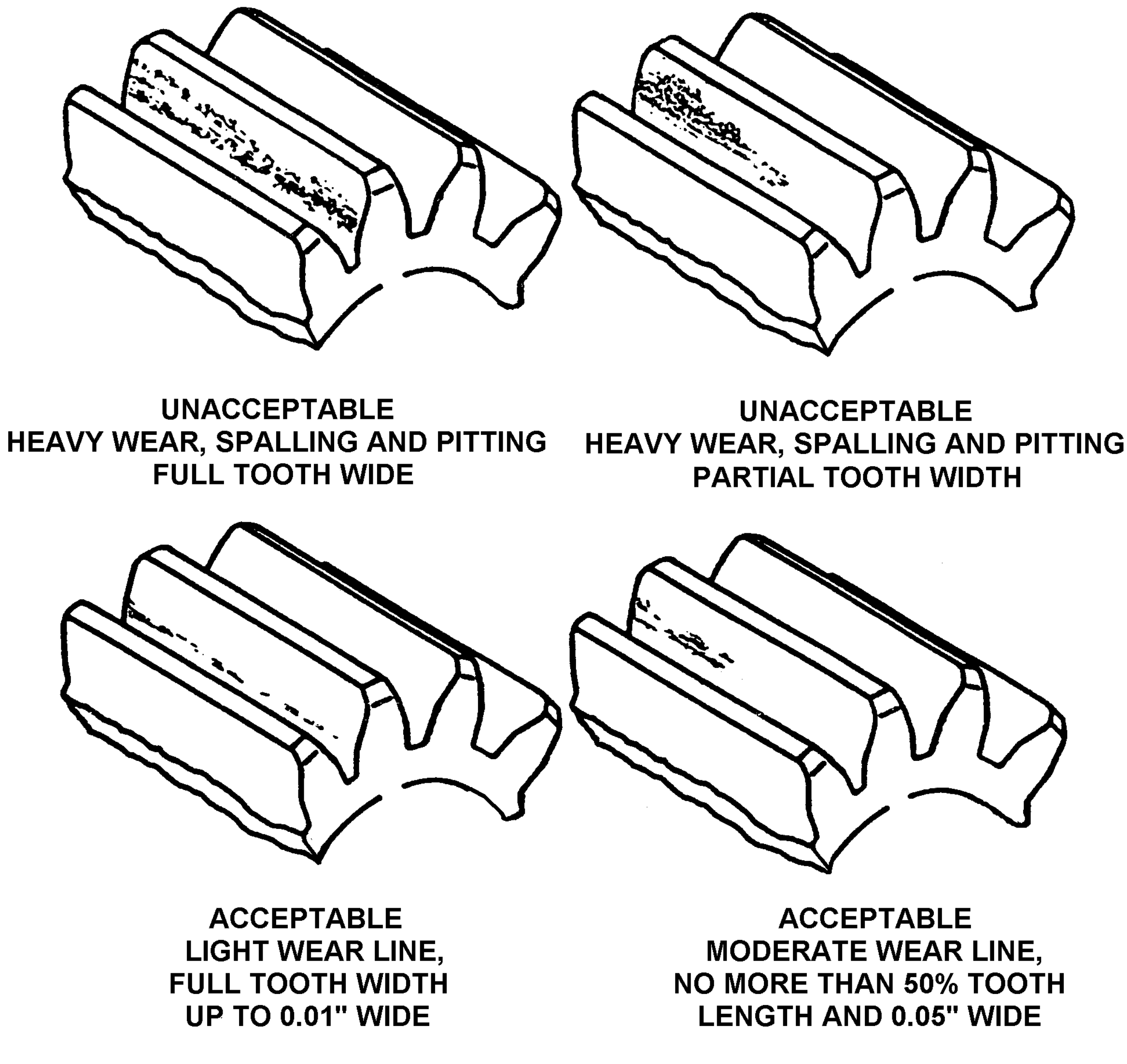

Figure 15-1. Gear Inspection Criteria

15-4. Fluorescent Penetrant Inspection

Perform this inspection on all cleaned, aluminum or non-ferrous metal parts, including the parts listed below in accordance with ASTM E1417, E1208, E1209, E1219, and Type 1 Fluorescent Penetrant Method A, B, C, or D.

Table 15-1. Parts Requiring Fluorescent Penetrant Inspection

Inspect:	Pay particular attention to:	
•Crankcase halves •Cylinder heads •Accessory case, including oil pump cavity •Starter housings •Oil sumps •Engine mounts •Induction tubes •Induction risers •Brackets	•Rocker boss areas •Valve seat insert areas •Valve guide areas •Intake and exhaust flanges •Intake and exhaust ports •Between cylinder head cooling fins •Cylinder-to-barrel mating area •Bearing bosses	•Oil pump cavity area mounting flanges •Shaft bores •Mounting and attaching areas where hardware has been previously torqued •Through-bolt hole areas •Crankcase/crankshaft exit area •Areas where oil seals or bushings are pressed in or seated

1. Inspect parts for the following conditions:
   a. Cracks or indications of the start of cracks
   b. Grinding encountered after the manufacturing process
   c. Seams
   d. Laps or ruptures

Unless Section 15-7 contains specific instructions to remedy unsatisfactory conditions discovered during the inspection, discard parts which exhibit any of the conditions described in steps 1a through 1d.

2. Look for indications which break into corners, edges, holes, or fillets on parts. Identify parts that contain linear indications which cannot be reworked.
3. Follow the fluorescent penetrant manufacturer's instructions for the equipment and materials used to perform the inspection regarding use, safety data, and disposal.
4. Label each part's inspection status and required action.
5. Follow the fluorescent penetrant manufacturer's instructions to remove penetrant residue from the inspected, serviceable parts.
6. Record inspection findings on the “Fluorescent Penetrant Inspection Checklist” on page 11-10.

15-5. Magnetic Particle Inspection

Prior to performing a Magnetic Particle Inspection, verify the parts are clean and free of dirt, carbon, varnish, gum, and paint.

CAUTION: Prior to Magnetic Particle Inspection, ensure that the parts have been thoroughly cleaned and dried according to "Engine Cleaning"instructions in Chapter 14.

The Magnetic Particle Inspection must be performed by a certified technician on cleaned, ferrous parts according to ASTM E1444 using the wet continuous method and full wave rectified alternating current and fluorescent particles. Follow the particular magnetic particle media manufacturer's instructions regarding use, safety data, and disposal.

1. On the cleaned parts to be inspected, plug small holes leading to obscure cavities with tight-fitting wooden plugs or with a hard grease (soluble in lubricating oil) to prevent particles from lodging in the cavities.
2. Follow the equipment and materials manufacturer's instructions to perform the inspection regarding use, safety data, and disposal. Use the corresponding method of magnetization and amperage listed in Table 15-2.
3. Inspect parts for the following conditions:
   a. Cracks or indications of the start of cracks
   b. Grinding encountered after the manufacturing process
   c. Seams
   d. Laps or ruptures

Unless Section 15-7 contains specific instructions to remedy unsatisfactory conditions discovered during the inspection, discard parts which exhibit any of the conditions described in steps 3a through 3d.

4. Record repair or replacement requirements on the Engine Overhaul Inspection Checklist.
5. Look for linear indications which break into corners, edges, holes, thread roots, fillets, gear tooth roots or keyways on parts. Identify parts which contain linear indications which cannot be reworked.
6. Label parts which fail inspection as such; indicate reason for failure and if repair or replacement action is required.
7. Remove plugs or grease from holes of inspected parts.
8. Clean the inspected parts thoroughly according to the "Engine Cleaning" instructions in Chapter 14.

CAUTION: When utilizing compressed air, wear OSHA approved protective eye wear. Never exceed 30 psi when using compressed gases for cleaning purposes (OSHA 1910.242(b)).Dry the parts with compressed air.

9. Demagnetize the inspected parts.

Table 15-2. Magnetic Particle Inspection Reference

Part	Method of Magnetization	AC or DC Amperes	Focus	Inspect for
Crankshaft	Circular	2000	•Journals •Fillets •Oil holes	•Cracks •Heat cracks
	Longitudinal		•Thrust flanges •Prop flange	•Flange cracks from prop strike
Connecting rod[1]	Circular and Longitudinal	1500	All areas	Cracks
Camshaft	Circular and Longitudinal	1500	•Lobes •Journals •Drilled hole edges	•Heat stress cracks •Cracks
Rocker arms	On conductor bar and single	1000	•Pad •Socket under side arms and boss	Cracks
	Between heads	800		
Gears up to and including six inches in diameter	Circular or on Center Conductor	1000 to 1500	•Teeth •Splines •Keyways	Cracks
Gears over six inches in diameter	Shaft Circular Teeth between heat two times 90°	1000 to 1500	•Teeth •Splines	Cracks
Shafts	Circular and Longitudinal	1000 to 1500	•Splines •Keyways •Section transitions	•Cracks •Heat stress cracks
Through-bolts and connecting rod bolts[2]	Circular and Longitudinal	500	Threads under head	Cracks
Cylinder barrels	Circular and Longitudinal	1500	•Fin tips •Fin roots	•Cracks •Heat stress cracks

1. Inspect connecting rod and cap according to the “Connecting Rod Magnetic Particle Inspection”in Section 15-5.1.
2. Perform only on in service parts; replace 100% at overhaul

15-5.1. Connecting Rod Magnetic Particle Inspection

Before performing the Connecting Rod Magnetic Particle Inspection, the connecting rod and cap must be clean and free of rust, scale, oil, or other residue that may affect the reliability of the Magnetic Particle Inspection. Inspect the connecting rods using both the circular and longitudinal method of magnetization. Use the fluorescent method, wet continuous procedure, reference ASTM standards for non-destructive testing; D.C. amperage is preferred.

Refer to the Table 15-3 for inspection pass/fail criteria. Record inspection findings on the "Magnetic Particle Inspection Checklist" on page 11-11.

NOTE: Reject connecting rod or caps exhibiting the unacceptable indications listed in the Fail column of Table 15-3.

Table 15-3. Connecting Rod Magnetic Particle Inspection Criteria

Pass	Fail
Steel inclusions or shallow imperfections on the forging surface - light indications running parallel to the rod axis or around the pin boss and cap ends less than ½-inch in length	Indications associated with forging laps or with heat treatment are cracks
Blend area between the piston pin boss extending 1-inch into connecting rod I beam, the bolt spot face areas and the channel rail edges are free of any indications of cracks/wear	Area of blend between the piston pin boss extending 1-inch into connecting rod I beam, the bolt spot face areas and the channel rail edges shows indications of cracks/wear
	Any indication transverse to the rod axis.

15-6. Dimensional Inspection

Continental Motors uses new parts dimensions and assembly clearances for engine overhaul. New part dimensions listed in Appendix D are based on production drawings in effect at the time of publication.

Clearances in the new part limits apply to mating parts.

CAUTION: Prior to dimensional inspection, ensure the part conforms to all Visual, Fluorescent Penetrant, Magnetic Particle, and Ultrasonic Inspection requirements.

Ensure the parts have been thoroughly cleaned and dried according to the "Engine Cleaning"instructions in Chapter 14.

1. Measure part dimensions in comparison to the dimensional limits specified in Appendix D. Record the measurements on the "Dimensional Inspection Checklist"(page 11-12).
2. If the part dimension fits within the minimum and maximum range specified in Appendix D, the part may be re-used during overhaul provided it meets all other inspection requirements.

WARNING

Use only the Appendix D dimensions during engine overhaul.

3. Label each part's inspection status and required action.
4. Record inspection results on the Engine Overhaul Inspection Checklist.

15-6.1. Crankcase Dimensional Inspection

This inspection verifies the crankcase structural and dimensional integrity.

Equipment Required

- Mechanic's hand tools and calibrated torque wrench
- Inspection light
- Mirror

1. Inspect the exterior of the crankcase halves for cracks. Carefully inspect the entire external surface of the crankcase using an inspection light and mirror. Pay particular attention to areas adjacent to the cylinder mount flanges, tappet guides, case flange, nose seal land and bearing bosses.
2. Look for scoring on the old crankshaft bearings, tappet guides, and camshaft bearings and journals.
3. Inspect the main bearing boss parting surfaces for fretting.
4. Inspect the bearing saddles for elongation of the bearing lock slot and for any indication of bearing movement.
5. Inspect all machined surfaces for nicks and roughness.

6. Inspect the crankcase for cracks and the progression of any cracks identified during maintenance inspections:

   a. Cracks in the cylinder deck (white/non-shaded - critical areas in Figure 15-2) requires immediate replacement of the crankcase.

   b. Cracks smaller than two inches (5.08 cm) in a shaded (non-critical) section of Figure 15-2 requires repair or replacement of the crankcase.

   NOTE: Cracks are frequently accompanied by oil seepage, investigate oil leaks.

   WARNING

   An FAA-approved repair facility is the only facility authorized to perform crankcase weld repairs. No weld repairs are authorized in the critical (non-shaded) areas of the crankcase (Figure 15-2) or the bearing support structures.

   c. If a crack is found in any area on the crankcase, do one of the following:

      1) Repair the crankcase: if there is no oil leakage and the crack is less than two inches in a *non-critical* (shaded area of Figure 15-2), the crankcase may be welded. Welding is an acceptable repair only on *non-critical* (shaded) stress areas of the crankcase and only when performed by an FAA Part 145 repair station certified to perform crankcase repairs. The dimensional integrity of the crankcase must be maintained.

      2) Replace the crankcase: if a crack of any length is in the critical (white/unshaded) stress section or if oil is leaking from a crack of any length on the non-critical (shaded) section of the crankcase or the crack is two inches or longer.

   NOTE: Cracks longer than two inches in length may not be repaired; replace the crankcase.

7. Inspect the breather for cracks and dents. Inspect tube ends for scoring and out of roundness that may cause a bad seal and oil leakage. Discard and replace components with any of these indications.

8. Inspect engine mount brackets for cracks, dents and wear. Inspect hardware for distorted or stripped threads and damaged wrench flats. Discard and replace any components exhibiting these indications.

9. Inspect all crankcase helical coils and studs for stripped or distorted threads. Inspect studs for corrosion, rusting, pitting, incomplete threads and looseness.

10. Inspect crankcase studs with a tool maker's square for alignment. Check studs for looseness. Check crankcase stud height settings versus Appendix D specifications. Remove, discard, and replace non-conforming studs with new studs.

11. Visually inspect the starter jack (or bearing) bore inside diameter for any damage. Replace the starter jack (or bearing) exhibiting any signs of damage. Inspect the dowel for damage, corrosion, and physical security; verify the dowel meets

Appendix D stud height specifications. Replace the dowel if it is loose, bent, missing, or fails to meet Appendix D dimensional specifications.

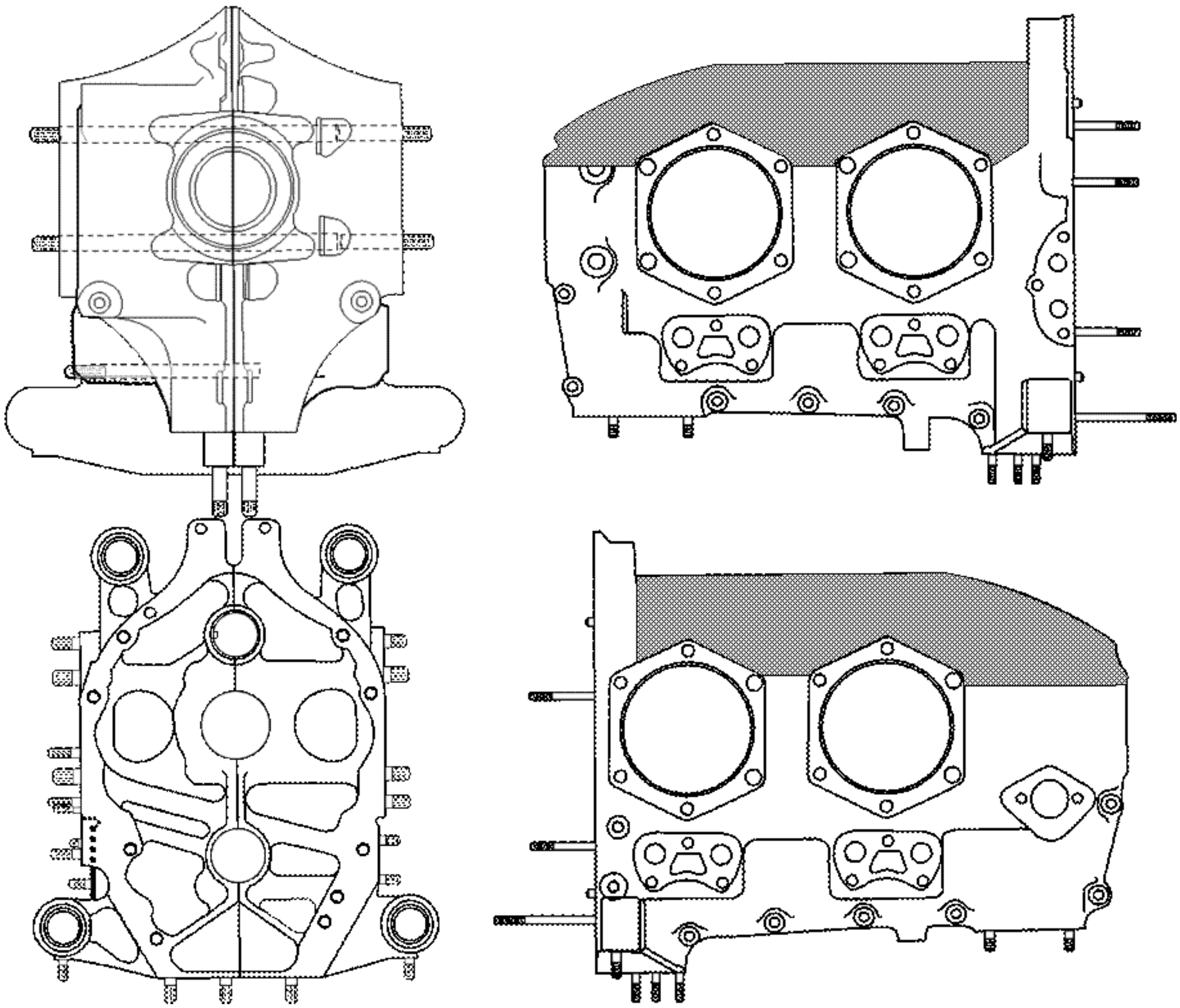

Figure 15-2. Crankcase Critical (White) Stress Areas

CAUTION: proper oil feed hole chamfer at the crankcase main bearing is required to prevent cracks from forming in that area.

12. Inspect the main bearing oil feed passages and determine if they conform to the illustration of the crankcase main bearing oil feed hole chamfer in Appendix D. The subject passages are located in the left (2-4) case half and begin in the rear main bearing saddle, counting forward.

Prerequisites

Prior to the completing the dimensional inspections of the crankcase, crankshaft, and camshaft bores, temporarily assemble and torque the crankcase specifically for this inspection using the torque sequence shown in Figure 15-3.

13. For the preliminary torque, torque the crankcase fasteners in Figure 15-3 to ½ the value specified in Appendix B.
14. Repeat the torque sequence in Figure 15-3 using the full value for the fastener indicated in Appendix B.

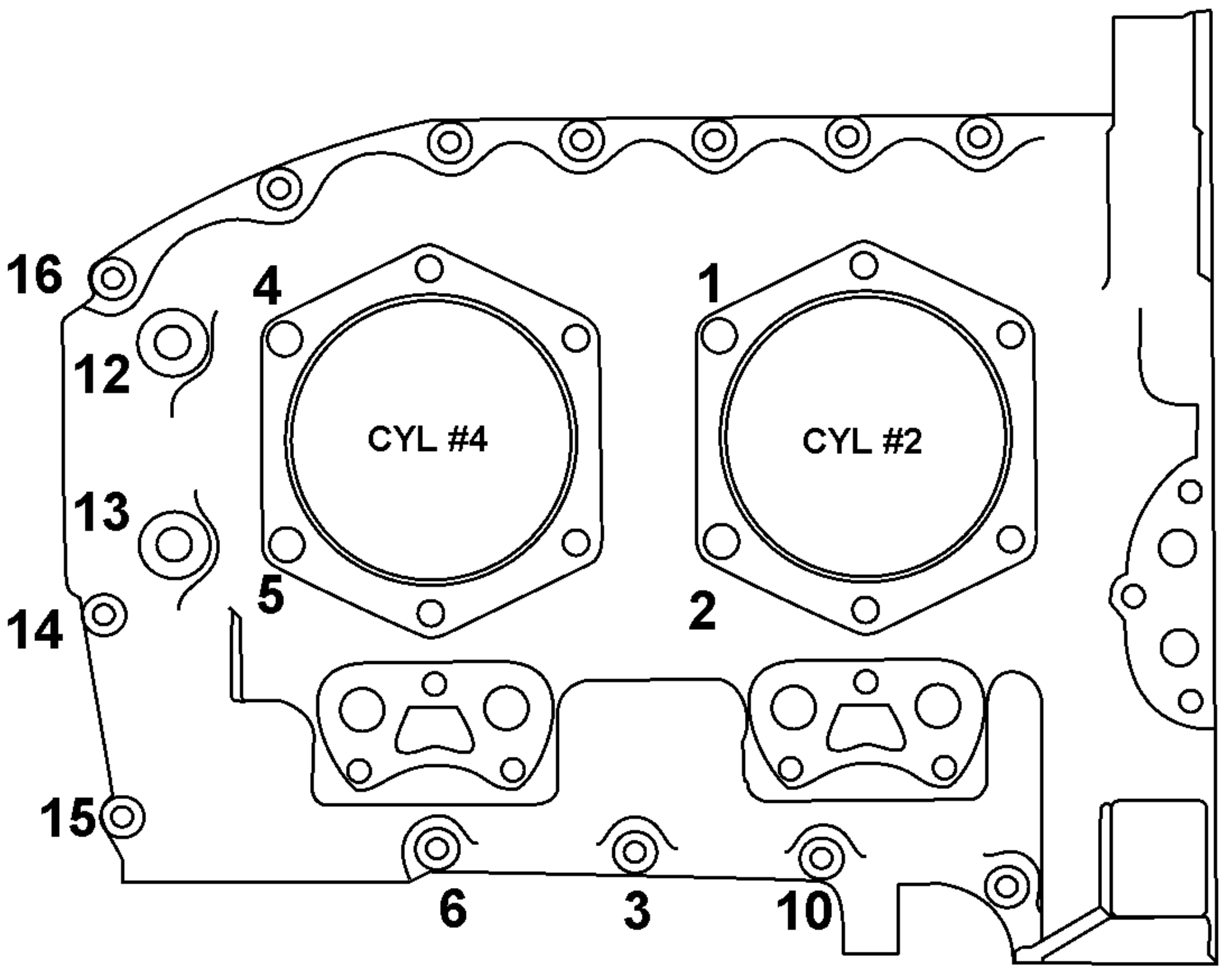

Figure 15-3. Crankcase Dimensional Inspection Torque Sequence

15. Measure dimensional clearances for the assembled crankcase in Appendix D, inside and outside dimensions, with bearings out and repeat with bearings installed to check running clearance.
16. Record inspection results on “Dimensional Inspection Checklist”(page 11-12).

15-6.2. Drive Train Dimensional Inspection

Equipment required

- A surface plate
- Metalworking lathe or two matched V-blocks
- Dial indicator
- Two blocks of ground flat steel stock of equal height
- Leaf-type feeler gauge
- 8-inch long arbors

NOTE: Precise setup is critical for the crankshaft and camshaft dimensional inspections. Pass/fail criteria is measured in thousandths of an inch (.001").

1. Center the crankshaft between the headstock and tailstock of a lathe (or place the crankshaft on matched V-blocks, mounted on a surface plate, supporting the front and rear main journals). Check the parallelism at the front and rear main journals with the dial indicator before inspecting runout.
2. Inspect the crankshaft journal and crankpin diameter compared to the new part dimensions in Appendix D. Inspect the circumference of the crankshaft journals and crankpins to ensure the out of round limits in Appendix D are not exceeded.
3. Rotate the crankshaft under a dial indicator placed on the center main journal to detect bending (run out).
4. Rotate the crankshaft propeller flange under a dial indicator to detect runout (bending) (see Figure 15-4).

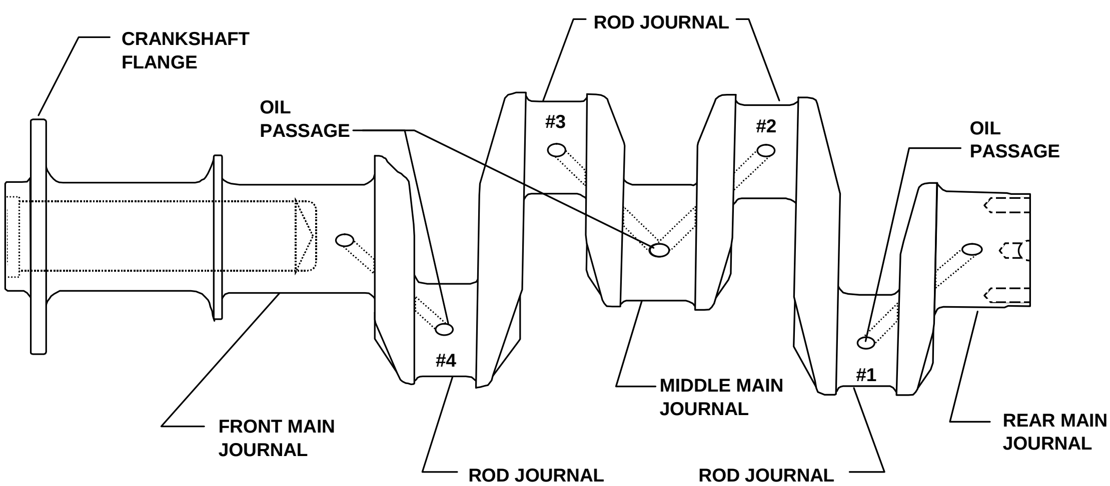

Figure 15-4. Crankshaft Journals

5. Mount the camshaft front and rear main journals on matched V-blocks.
6. Rotate the camshaft under a dial indicator placed on the center main journal to detect bending (run out).

15-6.2.1. Connecting Rod Dimensional Inspection

1. Verify the connecting rod and cap mate marks are aligned and the position numbers stamped on or adjacent to the bolt boss match. Scrap connecting rods and caps with mate marks that do not align.
2. Visually inspect the connecting rods for corrosion, pitting, discoloration (bluing), galling, bending, twisting, impact damage or nicks. Scrap connecting rods with any of these indications.

   CAUTION: To attain dynamic balance, connecting rod assemblies are paired with a maximum weight variation of 1/2 ounce between opposing bays. For this reason, replacement connecting rods must be ordered in pairs.

3. Weigh the opposing cylinder connecting rod pairs (1 vs. 2 and 3 vs. 4) with a calibrated scale (accurate to 0.1 ounce) and record the weight variation. Discard connecting rod pairs exceeding 0.5 ounce weight variation.
4. Visually inspect the connecting rod and cap parting surface. Contact signatures resulting from assembly forces are normal and acceptable. Connecting rods exhibiting fretting signatures, indicated by erosion of the original machining marks, either locally or over the entire surface, are not acceptable for continued service. Scrap connecting rods with fretting at the parting surfaces; do not attempt rework.
5. Visually inspect the nut seat area. Fretting signatures indicate material loss. Scrap connecting rods with edge loading under the bolt head surface contact area.
6. Visually inspect dowel surfaces at the rod and cap bolt holes. Scrap connecting rods with fretting at the dowel surface.
7. Align the mate marks on matching position numbers and assemble the connecting rod and cap by installing a bolt through the cap and rod. With the cap seated firmly against the rod, you must be able to install the remaining bolt using hand pressure only. Scrap connecting rods if the bolts cannot be installed by hand.
8. Lubricate the connecting rod bolt and nut threads with clean 50 weight aviation oil.
9. Install and torque the nuts and bolts to Appendix B specifications.
10. Inspect the inside diameter joint of the rod to cap with both bolts and nuts installed and torqued; mismatch (or a step) must be less than 0.001 inch.

    To check for a mismatch: place the rod on a surface plate with the split line at the 6 and 12 o'clock position; use V-blocks to hold the connecting rod in place. Use a dial indicator mounted on a height gauge, zero out on one side of the split line and move the indicator across the split line; a mismatch (or a step) of more than 0.001 inch is not acceptable.

WARNING

Removing and installing the piston pin bushing with makeshift tools will damage connecting rods.

11. Remove the piston pin bushings from the connecting rod using a Connecting Rod Bushing Removal/Installation Set (Burroughs 8098, or equivalent) and an arbor press.
12. Inspect the piston pin bushing bore and surrounding area for nicks, gouges and mechanical damage. Scrap connecting rods with any of these indications.
13. Use precision measuring equipment, such as a dial bore gauge or air gauge; verify the connecting rod meets the dimensional specifications in Figure D-8. Measure the inside diameter of the rod and cap within 30° of the rod and cap joint; take a second measurement 90° from the first. Both measurements must meet Appendix D dimensions; the difference between these two measurements is an indication of out-of round and must not exceed 0.0015 inches. Scrap connecting rods and caps which fail to meet Appendix D dimensional limits or exceed 0.0015" out-of-round. Scrap connecting rods and caps which fail to meet these specifications.
14. Inspect the connecting rod channel rails for damage such as nicks, gouges or mechanical damage. Scrap connecting rods with any of these indications.
15. Inspect the connecting rod using Appendix D dimensional specifications. Measure alignment using two push fit (8 inch long) arbors: one for the bushing bore (piston pin end) and another for the bearing seat (crank pin end) to verify the connecting rod piston pin bushing is aligned with the crank pin end bearing bore. Measure as follows:
    a. Twist and insert the arbors into the rod bores.
    b. Place the large end arbor (crank pin end) in the V-blocks on the surface plate.
    c. Place the ground steel blocks under the ends of the bushing arbor (piston pin end) a measured distance apart.
    d. Use a leaf-type feeler gauge to measure the clearance under the arbor ends.

    NOTE: Twist measurement/distance in inches = Twist/inch

    e. Divide the measured clearance by the distance (in inches) of separation between the blocks which will equal the twist per inch of length.
16. Measure the bushing and bearing convergence:
    a. Mount a dial indicator on a surface gauge and swing the rod around the crank pin end arbor to the vertical position against a firm stop.
    b. Pass the indicator over the bushing arbor on both sides of the connecting rod at points which are an exact number of inches apart. For exact parallelism, the two measurements must be the same.

15-6.3. Engine Cylinder Dimensional Inspection

Refer to Section D-4 for cylinder dimensional limits.

1. Perform the “Cylinder Visual Inspections”according to instructions in Section 6-3.9.1. Replace cylinders that fail the inspection criteria.
2. Inspect cylinder bore dimensions using the appropriate illustrations and tables in the Section D-4, “Engine Cylinders.” Cylinders may be honed (see Section 15-7.5.6, “Cylinder Bore Honing”) to hone the standard size dimensions in Appendix D to the next authorized oversize dimension.
3. Inspect the cylinder base flanges for flatness. If a flange exceeds 0.001 inches out of flat, replace the cylinder.
4. Dimensionally inspect the intake flange studs, cylinder exhaust flange studs, and stud rocker hold down stud holes using a thread gauge. Determine the appropriate oversize stud if replacement is required.
5. If the intake flange studs have been removed, dimensionally inspect the stud holes using a thread gauge. Determine the appropriate oversize stud for replacement.
6. Dimensionally inspect the inside diameter and geometry of the of the valve guides. Valve guide dimensions must be within specifications the entire length of the guide. Replace worn or non-conforming guides.
7. Inspect the intake and exhaust valve seats for indication of burning, pitting erosion, or cracks. Check the valve seat dimensions according to Appendix D specifications. Regrind or replace valve seats which fail to conform to Appendix D specifications or if the valve seat is cracked, eroded, burned or pitted
8. Inspect the pushrods for cracks, nicks, burrs, pitting or corrosion. Inspect the rod caps for cracks or erosion. Verify the rod cap oil passages are clear and the bores meet Appendix D specifications. Dimensionally inspect the pushrods length and cap diameter with a micrometer and Appendix D specifications. Inspect runout with V-blocks and an air gauge according to Appendix D specifications.
9. Inspect pushrod housings for cracks, dents, bending or chafing damage; discard pushrod housings exhibiting these conditions. Inspect pushrod housings for rust, pitting or missing cadmium plating; discard pushrod tubes exhibiting these conditions.

   Inspect early O-200 engine cylinders with pushrod housings swaged in the cylinder head for looseness, evidence of leakage or physical damage; replace pushrod housings if loose, leaking or damaged.
10. Dry fit the rocker arms in the rocker arm boss to dimensionally inspect the rocker arm thrust width. Refer to the overhaul tolerances in Appendix D and verify that the thrust width specified for the engine being overhauled conforms to Appendix D specifications. Replace the rocker arm if the thrust width is out of tolerance.
    a. Inspect the rocker arm foot contact area for wear, galling, spalling, scoring, or grooves; discard rocker arms exhibiting these conditions.

b. Inspect the rocker arm ball seats for wear and smoothness; discard rocker arms with gouged, scratched, etched, pitted or mushroomed ball seats.

c. Inspect the thrust surfaces of the rocker arm shaft bore for displaced metal, spalling, or galling; discard rocker arms exhibiting these conditions.

d. Inspect rocker arm exhibiting peeling copper plating, which can be a source of contamination in oil and spectrographic oil analysis. Use a scotch-brite pad to remove loose copper plating material.

e. Inspect for and discard rocker arms with loose or missing oil passage drive screws. Inspect oil passages for obstructions. Use an oil squirt bottle with clean 50 weight aviation engine oil to check oil passages for free flow. Discard rocker arms with blocked oil passages which cannot be cleared with solvent.

11. Record inspection results on the "Engine Cylinder Overhaul Inspection Checklist."

15-6.4. Starter Dimensional Inspection

Starter repair and field overhaul of the starter is not permitted.

15-6.5. Lubrication System Dimensional Inspection

1. Perform a "Gear Tooth Inspection" according to instructions in Section 15-3.1 on the oil pump gears for damage or wear; replace worn or damaged gears.
2. Inspect the lubrication system components according to the dimensional specifications in Section D-3. Test the oil pressure relief and oil temperature relief valve springs for proper tension according to Section D-3.
3. Inspect the oil pump cavity for scoring. Verify the oil pump gears and accessory case oil pump cavity meet Appendix D dimensional specifications. Replace the accessory case if it fails to meet the dimensional limits.
4. Test the new oil pressure relief valve spring for proper tension according to Appendix D. Compress the spring to 1.56 inches and verify the spring tension is within the limits specified in Appendix D with a push-pull gauge.
5. Inspect the remaining lubrication system components according to the dimensional specifications in Appendix D.
6. Record inspection results a copy of the "Dimensional Inspection Checklist."

15-6.6. Stud Height Dimensional Inspection

1. Inspect studs listed in Table 15-4 for damage, corrosion and security. Measure stud heights using the measurements in Section D-6. Replace studs that fail the inspection criteria.
2. Record inspection results on the “Dimensional Inspection Checklist.”

Table 15-4. Stud Height Settings

<table>
<tr><td colspan="2">Illustration and Tables in Section D-6 provide stud sizes and heights for the items listed below. Items in the tables match the referenced item numbers in the illustrations.</td></tr>
<tr><td>Inspection Item</td><td>Inspect for:</td></tr>
<tr><td>Intake Manifold</td><td rowspan="5">•Inspect the studs for corrosion, distortion, stripped or incomplete threads, or looseness.
•Check the stud alignment using a tool maker's square.
•Studs should measure within the limits provided in Section D-6.
•Replace unserviceable studs according to instructions in Section C-8.
•If studs installed in helical coil inserts are loose, the helical coil insert may require replacement according to instructions in Section C-6</td></tr>
<tr><td>Accessory Case</td></tr>
<tr><td>Lubrication System</td></tr>
<tr><td>Crankcase</td></tr>
<tr><td>Cylinder</td></tr>
</table>

15-7. Overhaul Repair

15-7.1. Induction System Overhaul Repair

1. Collect the induction system parts identified in Section C-2, “Replacement Parts” , Section C-2.3, “100% Parts Replacement Requirements” and Section C-2.4, “Mandatory Overhaul Replacement Parts” to prepare for induction system assembly.
2. Overhaul the carburetor according to the instructions in the carburetor manufacturer's service instructions.
3. Repair or replace the air intake housing based on inspection results.

15-7.2. Alternator Overhaul

1. Overhaul the COntinental Motors 12 Volt, 60 ampere alternator according to the latest revision of the alternator manufacturer's instructions (See Table 1-1); overhaul instructions are not available for the remaining alternator configurations, which must be replaced at engine TBO.
2. Collect the alternator drive coupling parts identified in Section C-2, “Replacement Parts” , Section C-2.3, “100% Parts Replacement Requirements” and Section C-2.4, “Mandatory Overhaul Replacement Parts” to prepare for alternator assembly.

15-7.3. Accessory Case Overhaul

1. Collect the accessory case replacement parts identified in Section C-2.3, “100% Parts Replacement Requirements” and Section C-2.4, “Mandatory Overhaul Replacement Parts.”
2. Replace the accessory case if it fails to meet Appendix D dimensional specifications.
3. Reface the oil pressure relief valve seat according to Section 15-7.4.1, “Oil Pressure Relief Valve Seat Repair” instructions. If the seat cannot be refaced within the dimensional specifications in Appendix D, replace the accessory case.
4. Replace the accessory case if:
   a. The accessory case exhibits cracks or the oil pump gear shaft bores or oil pump gear chambers are enlarged or scored.
   b. Oil pump housing gear shafts are loose.
   c. Oil pump housing gear shafts exceed new parts dimensions specifications.
   d. The oil pump housing flange exhibits nicks or gouges which cannot be lapped smooth without exceeding new parts dimensional specifications.

15-7.4. Lubrication System Overhaul

NOTE: An oil cooler must be cleaned by an appropriately rated Part 145 repair station. No structural repairs are allowed on the oil cooler. Replace an oil cooler that has structural damage, bent/broken or cracked cooling fins with a new or serviceable oil cooler. Weld repairs to the oil cooler mounting flange are permitted only by an appropriately rated repair station (i.e., FAA-approved Part 145 repair station).

Reface the oil pressure relief valve according to instructions in Section 15-7.4.1.

Collect the lubrication system parts identified in Section C-2.3, “100% Parts Replacement Requirements” and Section C-2.4, “Mandatory Overhaul Replacement Parts” to prepare for lubrication system assembly.

15-7.4.1. Oil Pressure Relief Valve Seat Repair

Reface the oil pressure relief valve seat in the oil pump housing during engine overhaul by applying light finger pressure while using an 8048 Oil Pressure Relief Valve Spot Facer (Chapter 3, Special Tools and Supplies) to reface the valve seat. Do not exceed the 0.005 inch depth to maintain 1.25 inch distance shown in Figure 15-5 after refacing.

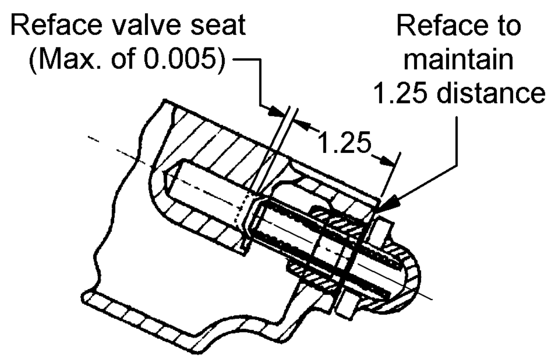

Figure 15-5. Oil Pressure Relief Valve Rework

Thoroughly clean the oil pressure relief valve cavity of any debris after refacing the valve seat. No debris is permitted in the oil pump housing at assembly.

15-7.4.2. Oil Filter Adapter Stud Replacement

NOTE: This procedure applies only to screw-on type oil filters.

1. Remove the oil filter adapter stud.
2. Inspect the adapter housing threads for damage or cracks. If thread damage or cracks are evident, replace the adapter housing.
3. Clean the adapter housing threads thoroughly to remove all adhesive or oil residue.
4. Temporarily install the new oil filter adapter stud in the oil filter adapter to check fit.
5. Verify that the incomplete thread on the new oil filter adapter stud stops at the first thread in the adapter housing and does not continue into the housing below the minimum depth specified in Appendix D. If the extension is less than the specified minimum, replace the adapter housing.
6. After stud height verification, remove the oil filter adapter stud from the adapter housing.
7. Clean the adapter housing and stud threads with Part No. 653693 primer (Loctite 7471) and allow to dry.
8. Apply a line of Part No. 646941 Adhesive (Loctite 271) along the large threads of the oil filter adapter stud and torque the stud to Appendix B specifications.
9. Confirm the installed stud matches the illustration in Figure 15-6.
10. Allow the parts to cure at least 30 minutes prior to oil filter installation. Curing times may vary depending on ambient temperature. Consult the Loctite instructions.

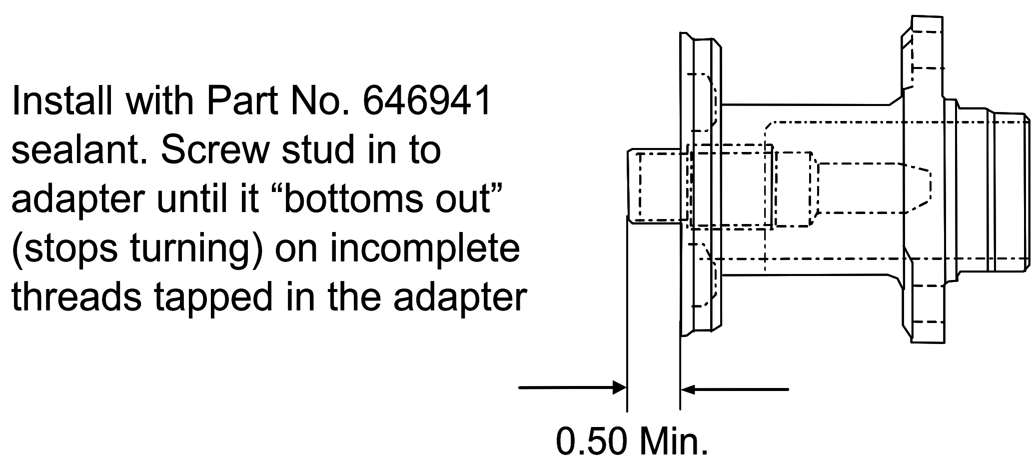

Figure 15-6. Oil Filter Adapter Stud

15-7.5. Engine Cylinder Overhaul Repair

Engine cylinder assemblies must be replaced at overhaul or leak checked, removed, cleaned, inspected and restored to the equivalent of new cylinder assemblies. Section C-2.3, “100% Parts Replacement Requirements” and Section C-2.4, “Mandatory Overhaul Replacement Parts” itemize the engine parts which must be replaced at overhaul.

Before performing any cylinder overhaul repair, establish a baseline inspection point for cylinder head-to-barrel movement and inspect the baseline throughout cylinder rework procedures to verify joint integrity is not compromised.

1. Mask off a ¼-inch wide X 1-inch high area across the cylinder head to the barrel junction on the intake port side of the cylinder.
2. Apply a heavy coat of high temperature paint.
3. Allow the paint to dry thoroughly.
4. Remove the masking material.
   Once the baseline inspection point is established, replace the valve seat as follows:

WARNING

Do not use a torch to heat the cylinder assembly. Heat the cylinder using uniform heating methods only. After heating the cylinder assembly, do not bump the head or barrel which could cause movement in this area. Inspect the cylinder assembly to ensure the cylinder head did not turn in relation to the barrel. Movement of the cylinder head in relation to the barrel destroys the assembly preload; discard the cylinder.

5. Heat soak the cylinder assembly via a uniform heating method up to 450°F (232°C) for 1 hour.
6. Verify no cylinder head-to-barrel movement by referring to the baseline inspection point. Discard cylinder assemblies exhibiting head-to-barrel movement.

15-7.5.1. Cylinder Repair versus Replacement Guidelines

Table 15-5 indicates possible cylinder symptoms and appropriate corrective actions.

Table 15-5. Cylinder Repair vs. Replacement Guidelines

Condition	Corrective Action
Cylinder with radial fin crack extending to the root of a fin	Replace[1] the cylinder
Broken, bent (or straightened), or pitted cylinder head or barrel fins	Replace[1] the cylinder
Power stroke stress on cylinder barrel; heavy rust or pitting, indentation; chafing or cracks on cylinder barrel	Replace[1] the cylinder
Cracks in cylinder head structure	Replace[1] the cylinder
Cracked or eroded valve seat bore	Replace[1] the cylinder
Static seal leakage or leakage from head to barrel seal or crack in head or barrel	Replace[1] the cylinder
Discolored/burned paint, Piston pin scoring or damage to the cylinder bore (usually due to overheating)	Replace[1] the cylinder Do Not Repair[2]
Blistered paint on the cylinder barrel	Replace[1] the cylinder
Cylinder head-to-barrel flange movement	Replace[1] the cylinder
Low differential pressure coupled with excessive oil consumption	Repair or replace[3] the cylinder
Scratches in the honed surface of the cylinder wall or cylinder bore	Repair the cylinder
Pitting, sharp dents or chafing in fin tips less than 0.050 inches (1.3 mm) deep	Repair the cylinder

1. Replacement cylinders are available in several configurations, starting with a basic assembly and progressing to cylinders with more components installed:
   - Cylinder and Valve Assembly (includes the Basic Cylinder Assembly plus valve components).
   - Loaded Cylinder and Valve Assembly (Cylinder and Valve Assembly plus rocker shaft, piston, piston rings, and gasket set).
   - Consult Continental Motors Internet Services for the latest parts information.
2. Do not attempt to remove overheating damage by grinding the cylinder bore to the next allowable oversize. Cylinder barrel overheating destroys material strength.
3. If the cylinder is otherwise acceptable on inspection and the fits and clearances provide enough tolerance that the cylinder can be ground and honed, repair the cylinder; otherwise replace the cylinder.

15-7.5.2. New Cylinder Position Numbers

Original cylinders have a position number stamped on the edge of the base flange. New cylinders must have a position number stamped in the location shown in Figure 15-7.

CAUTION: Do not metal stamp or etch the piston.

NOTE: Pistons are not stamped with position numbers.

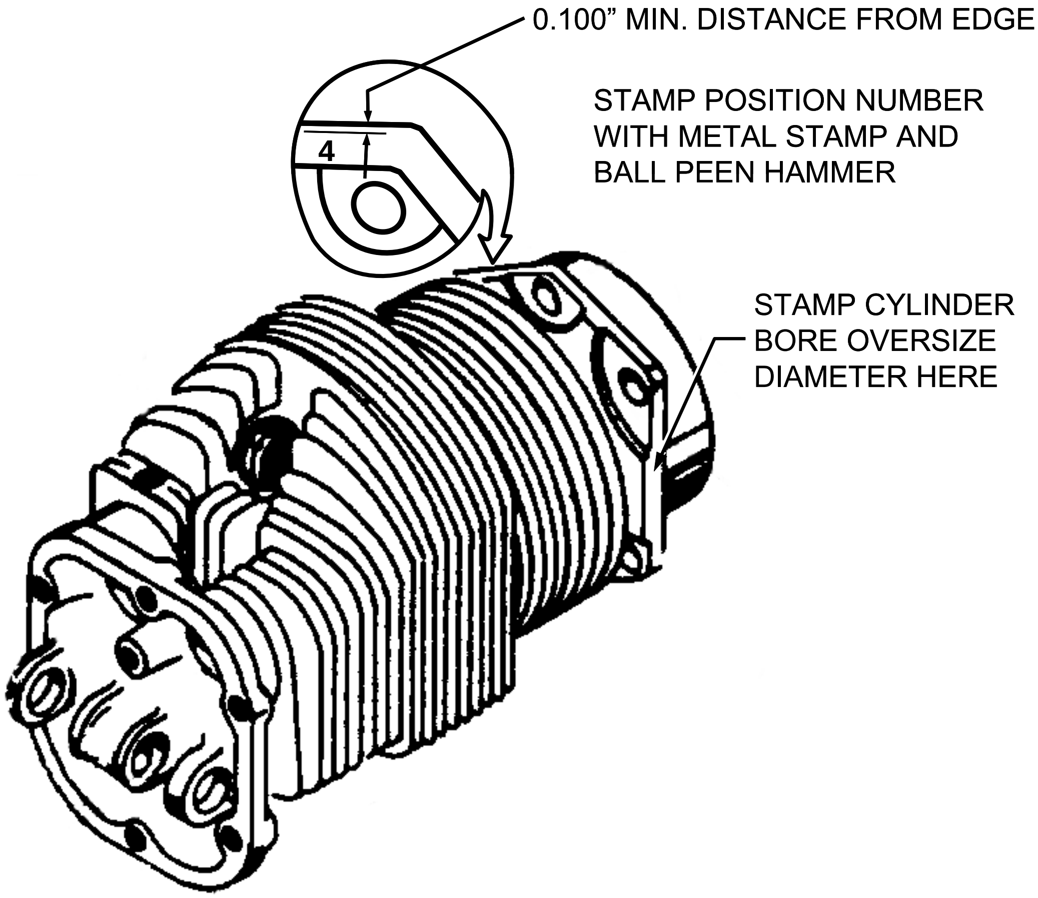

Figure 15-7. Cylinder Position Number

15-7.5.3. Cylinder Head Repair

Replace cracked or damaged cylinders. Do not attempt to repair a cracked cylinder head.

WARNING

Do not perform any structural weld repairs on the cylinder head. Welding the cylinder head structure can destroy the assembly preloads and casting strength resulting in cylinder assembly failure.

15-7.5.4. Cylinder Fin Tip Repair

CAUTION: Do not attempt to straighten bent cylinder fins.

15-7.5.5. Cylinder Barrel Repair

WARNING

Cylinder Barrel Repair requires FAA certification. If you are not certified, do not attempt to repair the cylinder barrel.

If the cylinder passes the visual inspection and static leak check at the cylinder head to barrel junction, the cylinder barrel may be ground to the next authorized oversize dimension by an FAA Part 145 Repair Stations certified to grind engine cylinders. These facilities grind and hone the cylinder bore using a cam-controlled grinder to grind the cylinder barrel to the next larger authorized oversize dimension specified in Appendix D.

After grinding the cylinder barrel to the next authorized oversize dimensions, perform a Magnetic Particle Inspection on the cylinder bore and identify the cylinder with the correct bore size by steel-stamping the barrel flange with the appropriate oversize designation.

CAUTION: Replace the engine cylinder if the barrel fins exhibit pitting, sharp indentation, or chafing damage. Do NOT weld cylinder barrel fins or cylinder barrels.

If a cylinder has been ground, the cylinder bore must be honed according to instructions in Section 15-7.5.6, “Cylinder Bore Honing.”

15-7.5.6. Cylinder Bore Honing

Perform this procedure under any of the following circumstances:

- after grinding a cylinder barrel
- when replacing piston rings
- to restore the cylinder bore cross hatch pattern

1. Hone the cylinder bore using a wet honing process and hone stones that will produce a surface finish as specified in Table 15-6.
2. Inspect the cylinder barrel wall for corrosion, pitting and scoring. Discard any cylinder exhibiting any of these unacceptable, non-conforming conditions.
3. Measure the surface finish using a Hommel Tester T500 Part No. 191800. The software for interpreting tester data is Hommel America TIOOO Turbo.
4. Set the tester to the following parameters:
   a. Inch units
   b. Traverse lengths Lt of 0.19 and Lm of 0.16
   c. Cutoff length (Lc) of 0.03
   d. Ml filter
   e. R profile (Prof)
5. After wet honing, the bore finish must show a cross hatch pattern. The included angle of the cross hatch measured perpendicular to the axis of the cylinder is 22°-32°. Inspect the hone pattern taken at 100X magnification. An acceptable cross hatch pattern must be cleanly cut and free of torn and folded metal.

   NOTE: Honed turnaround areas up to 0.5 inch from the skirt and barrel stop are exempt from cross hatch angle requirements.
6. After honing, clean the cylinder thoroughly using hot soapy water and a stiff bristled scrub brush to remove all honing material from the cylinder.
7. Rinse the cylinder with hot water to remove soap residue.
8. Dry the cylinder completely; repeat step 2 to verify cylinder serviceability. If the honed cylinder passes inspection, thoroughly coat the cylinder bare steel surfaces with clean 50 weight aviation engine oil.
9. The surface finish of the cylinder barrel bore must conform to the specifications listed in Table 15-6.

Table 15-6. Cylinder Bore Surface FInish Specifications

Symbol	Description	Range
R_a	Arithmetic average surface roughness	30-50 micro inches
Sk	Skew, measure of plateau	-1 to -3.5
R3Z	Three point height, distance between third highest peak and third lowest valley	130-275 micro inches
RPM/Rz	Ratio of mean peak to total depth of pattern	<0.35

15-7.5.7. Valve Seat Removal

Equipment Required

- Burroughs Part No. 5221B, Cylinder Holding Fixture, or equivalent
- Burroughs Part No. 5221-13A, Holding Fixture Adapter, or equivalent
- Burroughs Part No. 8086, Valve Seat Insert Remover and Replacer Tool, or equivalent
- Burroughs Part No. 8122A, Common Drive Handle, or equivalent
- Burroughs Part No. 8116, Universal Drive from common parts kit, or equivalent
- Valve stem or valve guide hole pilot of correct size
- Valve seat boss cutter equal in size to the new valve seat outside diameter
- Heavy duty drill press

1. Inspect the cylinder head to barrel junction baseline (Section 15-7.5); discard cylinders exhibiting movement.

WARNING

Do not use a torch to heat the cylinder assembly. Heat the cylinder using uniform heating methods only. After heating the cylinder assembly, do not bump the head or barrel which could cause movement in this area. Inspect the cylinder assembly to ensure the cylinder head did not turn in relation to the barrel. Movement of the cylinder head in relation to the barrel destroys the assembly preload; discard the cylinder.

2. Heat soak the cylinder assembly via a uniform heating method up to 450°F (232°C) for one hour.
3. Using the correct special tool, remove the worn valve seats and allow the heated cylinder to cool to room temperature.
4. Inspect the valve seat bore for cracks and erosion. Discard any cylinder with a cracked valve seat bore or a valve seat bore that has eroded beyond the allowable valve seat oversize bore repair.
5. Select the proper size valve seat bore cutter based on the new valve seat insert outside diameter. See Section D-4.
6. Install the cylinder in the Cylinder Holding Fixture.
7. Using the specified special tools, machine the valve seat bore(s) to the correct diameter. Do not exceed the new part (overhaul) tolerances specified in Appendix D for the respective intake and/or exhaust valve seat illustrations, as applicable.
8. Deburr the valve seat bore and clean the cylinder, removing all debris created during the machining procedure.
9. Inspect and record the valve seat bore inside diameter and new valve seat outside diameter on the “Engine Cylinder Overhaul Inspection Checklist”(Table 11-7). Refer to Appendix D for the valve seat dimensional limits.
10. Install a new valve seat according to Section 15-7.5.8, “Valve Seat Installation.”

15-7.5.8. Valve Seat Installation

WARNING

Do not use a torch to heat the cylinder assembly. Heat the cylinder using uniform heating methods only. After heating the cylinder assembly, do not bump the head or barrel which could cause movement in this area. Inspect the cylinder assembly to ensure the cylinder head did not turn in relation to the barrel. Movement of the cylinder head in relation to the barrel destroys the assembly preload; discard the cylinder.

1. Inspect the cylinder head to barrel junction baseline (Section 15-7.5); discard cylinders exhibiting movement.
2. While the cylinder is hot, install the valve seat firmly against the bottom of the valve seat bore using the required special tools.

WARNING

Misaligned or improperly installed valve seat(s) will cause valve leakage and burning.

3. Install new valve guides according to instructions in Section 15-7.5.9 and Section 15-7.5.10 followed by a "Fluorescent Penetrant Inspection"on the newly installed valve seat(s) and valve guide(s).

15-7.5.9. Valve Guide Removal

Equipment Required

- Burroughs Part No. 5221B, Cylinder Holding Fixture, or equivalent
- Burroughs Part No. 5221-15A, Holding Fixture Adapter, or equivalent
- Burroughs Part No. 4981, Valve Guide Remover, or equivalent
- Burroughs Part No. 8116-1R through 15R Valve guide stem hole reamer, or equivalent
- Burroughs Part No. 8116-1 through 16, Expanding guide bores, or equivalent
- Burroughs Part No. 3170, Floating Holder, or equivalent
- Proper size morse adapter
- Heavy duty drill press

1. Inspect the cylinder head to barrel junction baseline (Section 15-7.5); discard cylinders exhibiting movement.
2. Install proper size head on Valve Guide Remover and attach the assembly to a cold water supply.
3. Heat the cylinder assembly via a uniform heating method to 350°F (177°C) maximum and heat soak the cylinder assembly for 10 minutes.

WARNING

Do not use a torch to heat the cylinder assembly. Heat the cylinder using uniform heating methods only. After heating the

cylinder assembly, do not bump the head or barrel which could cause movement in this area. Inspect the cylinder assembly to ensure the cylinder head did not turn in relation to the barrel. Movement of the cylinder head in relation to the barrel destroys the assembly preload; discard the cylinder.

4. Install the cylinder in the holding fixture.
5. Install the pilot into the valve guide.
6. Hold the Valve Guide Remover down firmly pressed into guide bore with one hand and the other hand on the water release mechanism.
7. Release the water and drive out the valve guide while water is running.
8. Remove the other valve guide.
9. Allow the cylinder to cool to room temperature.
10. Measure the cylinder head valve guide bore and select the proper size reamer.

    CAUTION: Always ream the guide bore to the proper oversize.

11. Ream the cylinder head valve guide bore to the required size.
12. The guide bore must be free of grooves.
13. Deburr the valve guide bore and clean the cylinder; remove all machining debris.
14. Inspect the valve guide bore new inside diameter (Appendix D).

15-7.5.10. Valve Guide Installation

1. Inspect the cylinder head to barrel junction baseline (Section 15-7.5); discard cylinders exhibiting movement.
2. Apply a small amount of LUBRIPLATE® 930AA to the outside diameter of the valve guide to prevent binding during installation.

WARNING

Do not use a torch to heat the cylinder assembly. Heat the cylinder using uniform heating methods only. After heating the cylinder assembly, do not bump the head or barrel which could cause movement in this area. Inspect the cylinder assembly to ensure the cylinder head did not turn in relation to the barrel. Movement of the cylinder head in relation to the barrel destroys the assembly preload; discard the cylinder.

3. Heat soak the cylinder assembly via a uniform heating method to 350°F (177°C) for 10 minutes.
4. While the cylinder is hot, install the new valve guides:

    CAUTION: The intake and exhaust valve guides are different and must be installed in the correct positions.

    Never install an oversize valve guide in a standard size valve seat.

a. Install the exhaust valve guide in the side of the cylinder with the smaller diameter valve seat.

b. Install the intake valve guide in the side of the cylinder with the larger diameter valve seat.

5. Hang the cylinder with the flange up; allow the cylinder to stabilize to room temperature. Inspect the valve guide inside diameter.
6. Ream the valve guides according to the “Valve Guide Bore Reaming” instructions in Section 15-7.5.11.
7. After reaming the valve guide to the proper inside dimension, perform a “Fluorescent Penetrant Inspection”(Section 15-4) on the new valve guide and the valve seat.

15-7.5.11. Valve Guide Bore Reaming

CAUTION: Do not attempt reaming the valve guide bore with a hand held power tool.

1. Install the Cylinder Holding Fixture into a drill press.
2. Index the Cylinder Holding Fixture to the proper angle and install the cylinder in the fixture.
3. Zero in the valve guide with the dial indicator.
4. Using the proper size reamer tool bit, ream the valve guides while applying generous amounts of lubricant at 400 RPM for high speed steel reamers and 700 RPM for carbide tip reamers.
5. Inspect the finished bore size using Appendix D specifications for the valve stem bore inside diameter. The valve guide finish must be 63 Ra finish measured with a profilometer.
6. Perform a “Fluorescent Penetrant Inspection”(Section 15-4) on the cylinder in the area surrounding the newly installed valve guide to verify no cracks developed during installation.

15-7.5.12. Valve Seat Machining

Equipment Required:

- Burroughs Part No. 5221B, Cylinder Holding Fixture, or equivalent
- Burroughs Part No. 5221-13A, Holding Fixture Adapter, or equivalent
- Sioux brand Part No. 1675 Valve Seat Grinder Set, or equivalent.
- Valve Seat Grinder Pilot 0.437 diameter check inside diameter of valve guide for proper size.
- Grinding stones:
    - K106 roughening for intake valve seats
    - K46 finishing for intake valve seats
    - K95 roughening for exhaust valve seats
    - K25 finishing for exhaust valve seats.

NOTE: Valve seats and valves may be lapped after refacing, if desired. Lapping compounds are extremely abrasive, be sure to completely remove compound residue from the valves, valve seats and cylinder by thorough cleansing with hot soapy water and a stiff bristled scrub brush. Rinse the cylinder thoroughly with hot water to remove soap residue.

1. Reface the valve seats according to the specifications in Appendix D using the valve seat grinder. Wash the cylinder with soapy water and rinse thoroughly.
2. Dry the cylinder completely.
3. Coat all bare steel surfaces thoroughly with clean 50 weight aviation engine oil.

15-7.5.13. Spark Plug Helical Coil Insert Replacement

Equipment Required

- Helical Coil Extracting Tool
- Helical Coil Installation Tool
- No. 520-2 Expanding Tool

1. Before attempting to remove a damaged helical coil insert, use a sharp pointed tool to pry the teeth at the outer helical coil end away from the cylinder head metal.
2. Tap the Helical Coil Extracting Tool into the insert until firmly seated; remove the helical coil.
3. Inspect the spark plug boss (hole) diameter and thread condition. If threads are damaged or missing, drill and tap the threads to the next allowable oversize helical coil size according to the instructions in Appendix C.
4. Using the proper size mandrel on the Helical Coil Installation Tool, place a new stainless steel helical coil in the cutout side of the Helical Coil Installation Tool and engage the driving tang toward the threaded end.
5. Engage the tang with the slotted end of the driving mandrel and wind the insert into the sleeve thread, compressing the insert.
6. Hold the sleeve so the helical coil can be seen through the slot in the threaded end.
7. Turn the mandrel crank until the insert starts into the cylinder head hole. If the sleeve is not in contact with the head surface, grip the sleeve and mandrel and turn until the sleeve touches lightly.

WARNING

The helical coil insert end must not protrude into the combustion chamber after it has been installed.

8. Wind the helical coil into the cylinder head until its toothed end lies within the first full thread. The teeth should be in position to enter the depressions made by the original insert. If driven too far, the insert will emerge in the combustion chamber and will have to be wound through and removed.
9. When the helical coil is in the correct position, use long-nose pliers to bend the driving tang back and forth across the hole until it breaks off at the notch.
10. Coat the threaded end of the No. 520-2 Expanding Tool with Alcoa thread lube or a mixture of white lead and oil.
11. Screw the No. 520-2 Expanding Tool into the new insert until its final thread forces the teeth firmly into the cylinder head metal.

15-7.5.14. Cylinder Stud Installation

Replace exhaust manifold studs, regardless of condition, replace studs that are loose or fail to meet Appendix D specifications according to the “Rosan® Stud Installation” instructions in Appendix C-7.2.1. Install the new studs to the specified heights listed in Appendix D. Check the stud alignment using a tool maker's square.

Install the appropriate oversize new exhaust flange studs, rocker shaft hold down studs, and intake flange studs according to the “Engine Cylinder Dimensional Inspection” in Section 15-6.3 and Appendix D.

15-7.5.15. Piston Ring Replacement

Install new pistons and piston rings on each engine cylinder during the engine assembly.

NOTE: Whenever piston rings are replaced in an engine cylinder, hone the cylinder bore prior to assembly according to“Cylinder Bore Honing” in Section 15-7.5.6.

15-7.5.16. Cylinder Protective Coatings

1. Clean the exterior cylinder head surface.
2. Apply a protective coating of Alodine on the cylinder surface according to instructions in Section 14-4, “Protective Coatings.”
3. Thoroughly clean the entire cylinder with mineral spirits and air dry.
4. Mask the cylinder flange nut seat contact surfaces, cylinder skirt and flange-to-crankcase mating surfaces.
5. Apply a protective coating of specified enamel paint or equivalent (Chapter 3, Special Tools and Supplies) to the cylinder barrel according to instructions in Section 14-4.3, “Paint.”

   CAUTION: Do not paint the cylinder flange nut seats, skirt, or flange-to-crankcase mating surface.

6. After the paint dries completely, remove all masking materials.
7. Coat all bare steel surfaces with clean 50 weight aviation engine oil.
8. Store the cylinder assembly in a clean protected area until cylinder assembly.

15-7.5.17. Rocker Arm Bushing Replacement

1. Remove the old bushings from the rocker arm(s).
2. Measure the rocker arm bushing bore inner and outer diameter; verify it conforms to the Appendix D dimensional specifications.

WARNING

Incorrectly positioned bushing oil passages will result in a loss of rocker arm shaft lubrication, severe wear of the rocker arm bushing, shaft, and valve guide and possible engine failure.

3. Lubricate the new bushings with clean 50 weight aviation engine oil.

4. Using the Burroughs Rocker Arm Bushing Remover/lnstaller (8118) or equivalent and an arbor press, carefully press the bushing into the rocker arm bushing bore.
5. Plug the bushing oil passages with beeswax to prevent debris from entering the oil passages.
6. Ream the new bushings to the diameter specified in Figure 15-8.
7. Lightly break the sharp edge at each end of the new bushings.
8. Inspect the bushing bore size and surface finish to verify it meets Appendix D specifications.
9. After reaming, clean and flush the oil passages with clean mineral spirits to remove the beeswax; ensure the oil passages are clean and free of debris.
10. Perform a “Visual Inspection”(Section 15-3) and “Magnetic Particle Inspection” (Section 15-5) on the rocker arm assembly.
11. Clean obstructed oil passages in rocker arms or pushrods by soaking the parts in clean mineral spirits and blowing compressed air through them. Discard rocker arms or pushrods with clogged oil passages.

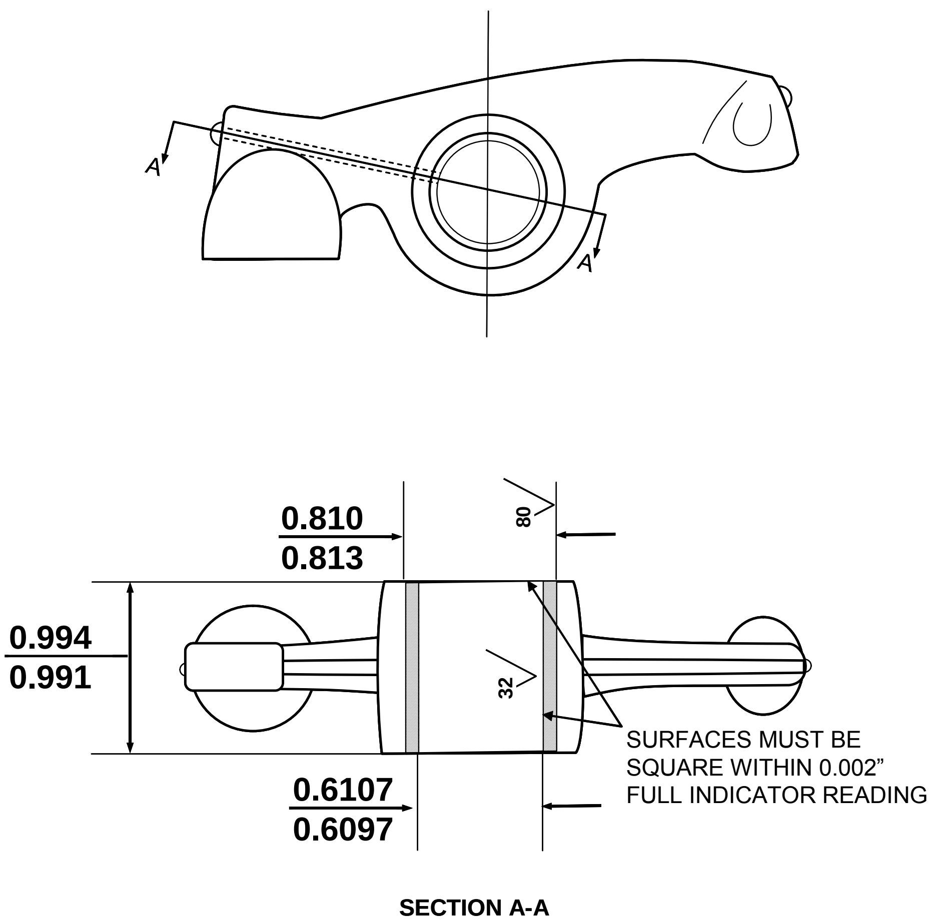

Figure 15-8. Rocker Arm Bushing Replacement

15-7.5.18. Rocker Arm-to-Retainer Clearance

Maintain a minimum clearance of 0.020 inches (0.508 mm) between the rocker arm and valve spring retainer. If 0.020 inches (0.508 mm) clearance is not met, proceed as follows.

WARNING

Grinding marks or cracks in the rocker arm may cause the rocker arm to fail.

1. Temporarily install the rocker arm on the cylinder to verify rocker arm to retainer clearance.
2. Smoothly grind across the forging flash line on the underside of the rocker arm to obtain the specified clearance. The grind must be smooth and uniform and must not exceed the width illustrated in Figure 15-9. Cover the rocker arm bushing bore and oil passage to prevent contamination. If the required clearance cannot be met without exceeding the grind width, discard and replace the rocker arm.
3. Polish the entire ground surface to remove grinding marks.
4. Remove the protective coverings from the rocker arm and clean thoroughly.
5. Perform a "Magnetic Particle Inspection" (Section 15-5) on the polished rocker arm to inspect for cracks.
6. Remove and thoroughly clean the rocker arm(s) before final engine assembly.

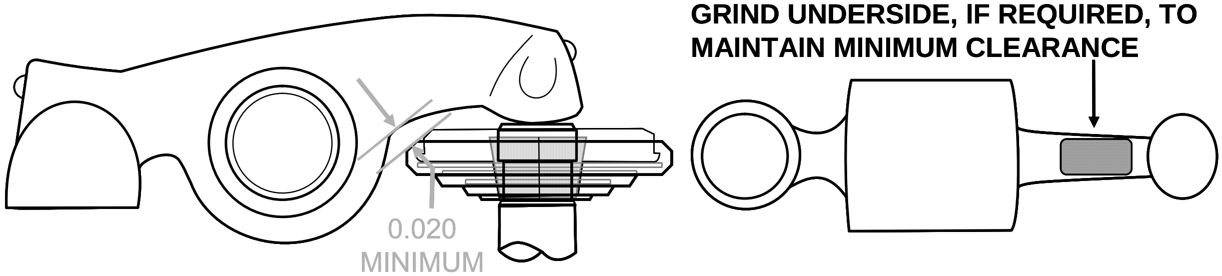

Figure 15-9. Rocker Arm to Retainer Clearance

15-7.6. Inter-Cylinder Baffle Repair

1. Inspect the inter-cylinder baffle for physical damage or missing parts. Missing or faulty rivets may be replaced if the baffle material is sound. Replace baffles damaged by mishandling, or baffles exhibiting stress cracks or missing material.

   a. Inspect the baffles for cracks and missing parts; replace baffles with stress cracks or cracks around riveted points.

   b. Dry fit the baffles to the contour of the cylinders to verify proper fit. Straighten dents and bent edges with a hammer and anvil.

   c. Inspect installed rivets for security; replace loose or faulty rivets.

2. Inspect the isolator pads for physical damage and security. Replace loose or damaged isolator pads.

   a. Remove and discard the faulty isolator pad.

   b. Clean the baffles according to the instructions in Chapter 14. Restore the alodine protective coating, if necessary.

   NOTE: Isolators are required on each side of the baffle.

   c. Mount the isolator pad on the baffle according to the illustration in Figure 15-10even with the cylinder barrel baffle with Part No. 655700 adhesive 0.20” from the bottom of the baffle, 0.015” from the baffle edge.

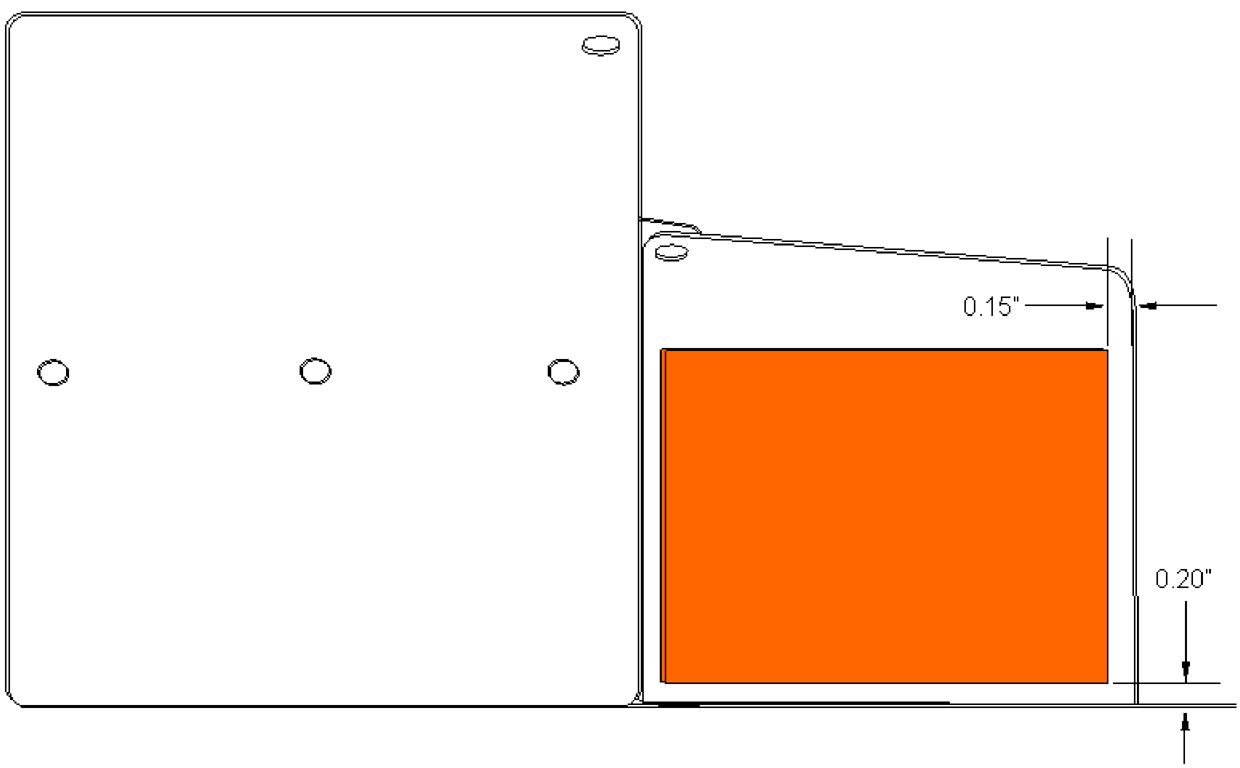

Figure 15-10. Baffle Assembly

15-7.7. Crankcase Overhaul Repair

1. Collect the crankcase replacement parts specified in Section C-2, "Replacement Parts" , Section C-2.3, "100% Parts Replacement Requirements" and Section C-2.4, "Mandatory Overhaul Replacement Parts."
2. Replace any crankcase or associated part worn beyond the overhaul limits in Appendix D or failing to meet inspection criteria. Discard and replace all non-conforming components.

15-7.7.1. Crankcase Welding

WARNING

No weld repairs are permitted in the critical (non-shaded) areas of the crankcase or the bearing support structures. An FAA-approved repair facility is the only facility authorized to perform a crankcase weld repair.

Welding is only permitted on non-critical areas of the crankcase identified in the Figure 15-2. Only an FAA-certified weld repair facility for specialized crankcase repairs may complete the weld repair. The dimensional integrity of the crankcase must be maintained.

15-7.7.2. Starter Adapter Preparation

1. Remove the plug from the starter adapter assembly with a ½" expandable bushing/ bearing puller and slide hammer.
2. Visually inspect the inside diameter of the starter adapter assembly bore for damage. If the starter adapter assembly bore exhibits damage or wear, replace the starter adapter assembly.
3. Use an arbor press and a three inch long 0.375-16 UNC-2B bolt to install a new plug. Coat the new plug with Loctite 609, screw the bolt into the plug and install as specified in Figure 15-11.

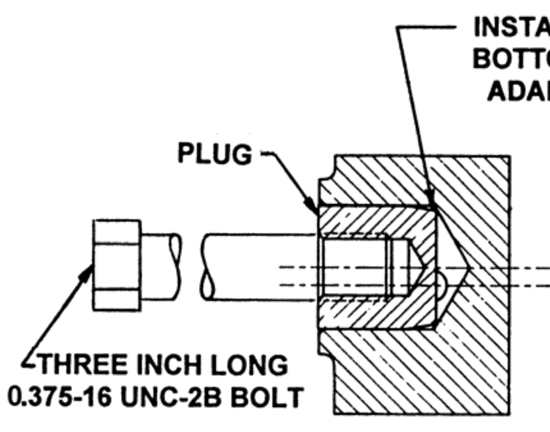

Figure 15-11. Starter Jack Adapter

15-7.7.3. Crankcase Cylinder Deck Stud Replacement

Replace crankcase studs which fail to meet Appendix D stud height specifications according to stud replacement instructions in Appendix C. Refer to the crankcase figures in Appendix D for the proper stud height settings.

WARNING

Do not attempt to repair the 2 and 4 o'clock crankcase cylinder deck stud positions by installing helical coil inserts.

1. Verify the studs, threads tapped holes are free of damage and are clean and dry.
2. Apply Part No. 653693 Primer (Loctite 7471) to the stud and cylinder deck threads and allow appropriate drying time according to manufacturer's recommendations.
3. Apply Part No. 646941 High Strength Adhesive (Loctite 271) to the stud and the cylinder deck tapped hole threads.
4. Install the studs to the appropriate cylinder stud height setting in Appendix D-6.
5. Wipe excess adhesive from the cylinder deck.
6. After two hours minimum cure time, test the installed stud breakaway torque. Studs must resist movement with a torque load of 100 in-lbs. If studs break away, replace with a new stud.

15-7.7.4. Crankcase Line Boring

Either discard or line-bore crankcases with crankshaft or camshaft bearing bores that exceed the Appendix D specifications. Only a certified repair facility for specialized crankcase repairs is authorized to perform line bore repairs. Only a certified repair station for specialized crankcase repairs is authorized to perform line bore repairs. Refer to Appendix D for overhaul limits and Section 15-6.1, “Crankcase Dimensional Inspection” for information on performing a crankshaft and camshaft bore dimensional inspection.

15-7.7.5. Crankcase Machining

Discard and replace or machine crankcases exhibiting fretting. Crankcase machining is only permitted at a certified crankcase repair facility. The crankcase cylinder deck dimensions are listed in Appendix D. After machining, the cylinder deck height must meet Appendix D specifications. Discard crankcase halves failing to meet this dimension.

CAUTION: Gear backlashes must not be less than the specified minimum after machining.

The crankcase half-parting line surface must be flat within 0.005 inches (true indicator reading). The sum total of the parting line surface for both crankcase halves must not exceed 0.008 (true indicator reading). Discard crankcase halves that exceed these dimensions. After all machining is complete, perform a “Fluorescent Penetrant Inspection” on the crankcase halves according to instructions in Section 15-4.

15-7.8. Engine Drive Train Overhaul

CAUTION: Engine Drive Train Overhaul is beyond the scope of field repairs. Special fixtures, special tools and air gauges are required to inspect the components for serviceability after repairs are accomplished. Overhaul repairs to the camshaft, crankshaft and connecting rods may only by performed by an FAA Part 145 Repair Station using FAA approved repair procedures.

1. The engine drive train consists of the camshaft assembly and crankshaft assembly, gears and connecting rods. Overhauling the engine drive train entails disassembling, verifying the integrity of parts, replacing parts, and re-assembling these components as instructed in the subsection herein. Replace any parts worn beyond Appendix D limits or parts which do not meet inspection criteria.
2. Collect the engine drive train replacement parts specified in Section C-2.3, “100% Parts Replacement Requirements” and Section C-2.4, “Mandatory Overhaul Replacement Parts.”
3. Refer to the appropriate subsections to accomplish camshaft and crankshaft repairs.

Table 15-7. Engine Drive Train Parts Replacement

Part to Consider for Replacement	Discard and Replace Criteria
Crankshaft	Discard/replace a crankshaft with any of the following conditions: •Cracks •Rust •Pitting
Oil Control Plugs	Discard/replace loose or leaking oil plugs
Connecting Rods	Discard/replace any connecting rods: •With a bore exhibiting nicks or gouges •If the rod and cap do not align properly

15-7.8.1. Camshaft Repair

WARNING

Camshafts may only be repaired by an approved FAA Part 145 Repair Stations. Do not attempt camshaft repair without the proper tooling and FAA required certification.

Continental Motors offers new camshafts in the nominal new part specification to 0.020” undersize in 0.005” increments. Camshaft repairs must be performed by an FAA Part 145 Repair Station certified to perform the camshaft repair. Camshaft repair procedures must be accomplished in accordance with Federal Aviation Regulations to return the camshaft to the dimensional limits in Appendix D. Camshaft grinding is limited to 0.020” authorized undersize. Undersize camshafts require line boring of the crankcase journals. The camshaft lobes and bearing surfaces must be heat treated and carburized to a finished core hardness of HRC 25-45. A finish coating of AMS 2481 is required. Perform a “Magnetic Particle Inspection”(Section 15-5) on the camshaft after rework.

15-7.8.2. Crankshaft Repair

WARNING

Crankshafts may only be repaired by an approved FAA Part 145 Repair Stations. Do not attempt crankshaft repair without the required FAA certification.

CAUTION: Do not attempt to repair a scored or overheated crankshaft. Discard and replace scored or scorched crankshafts.

If a crankshaft is repaired by an FAA Repair Station, the nitride treatment must be restored.

The crankshaft may be repaired by grinding the crank pins and journals to 0.010 inches (0.254 mm) under the new shaft limits per Appendix D and re-nitriding. This repair is only authorized at an FAA Part 145 Repair Station certified to perform crankshaft repairs. Crankshaft repair procedures must be accomplished according to Federal Aviation Regulations. The repaired crankshaft must meet the new part dimensional limits specified in Appendix D.

15-7.8.2.1. Crankshaft Plating Overhaul

1. Remove any tin plating on the crankshaft in the one inch area shown in Figure 15-12 by rubbing a piece of very fine emery cloth, buffing around the shaft to attain a smooth uniform finish without any scratches.
2. Apply a ½-inch wide strip of 180 grit emery cloth against the newly polished one inch area on the crankshaft with firm hand pressure to lightly scratch (not score or gouge) a new helix design in a 30° pattern in the plated area as shown in Figure 15-12. The helix promotes proper seating of the crankshaft oil seal and a better seal to help prevent leakage.
3. After preparing the first quarter portion, rotate the crankshaft by hand so that the next portion is visible and continue rubbing with the 180 grit emery cloth until the entire one inch plated area (Figure 15-12) around the crankshaft is lightly scratched with the helical design.
4. Flush the particles from the crankshaft with mineral spirits.
5. Wipe the plated area with the lightly scratched helical pattern on the crankshaft with acetone. Ensure the crankshaft is free of any debris or particulate matter to facilitate clean sealing.
6. Mask the crankshaft except for the area prepared in the previous steps to prevent overspray. Apply a uniform coat of aluminum primer to the portion of the crankshaft which will be exposed to the elements. Allow the primer to dry to the touch.

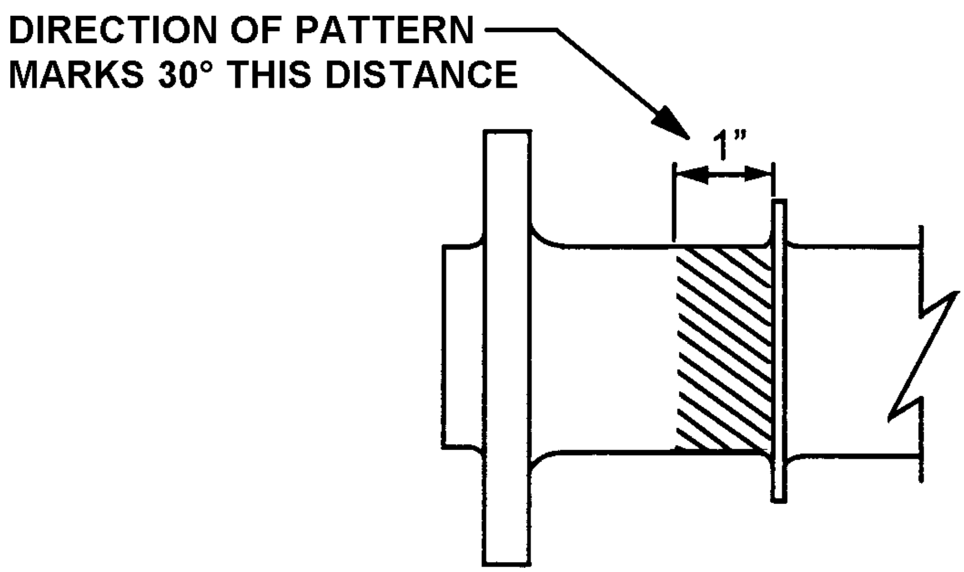

Figure 15-12. Crankshaft Helix Pattern

15-7.8.2.2. Connecting Rod Piston Pin Bushing Replacement

Replace all connecting rod piston pin bushings at overhaul.

Equipment Required

- Burroughs Part No. 8098, Connecting Rod Bushing Removal/Installation Set, or eq.
- Burroughs Part No. 8111A, Connecting Rod Boring and Alignment Fixture, or eq.
- Burroughs Part No. 8042C, Adapter Kit, or equivalent
- High speed borer of the correct size
- Vertical mill or equivalent capable of maintaining 1750 RPM
- Arbor press
- Federal Dimension Air Gage with a 1.1268 setting ring and 1.1268 air plug, or eq.
- Profilometer

WARNING

Use only the special tools listed. Removing and installing connecting rod bushings with makeshift tools can damage the connecting rods.

Verify the piston pin bushing being installed is the correct part number for the application. Use a Connecting Rod Bushing Removal/Installation Set (Burroughs 8098 or equivalent) and an arbor press to install the piston pin bushing as follows:

1. Press out the old piston pin bushing using the Connecting Rod Bushing Removal/ Installation Set and an arbor press. Verify the connecting rod bore is smooth.
2. Verify the new bushing part number. Dip the new piston pin bushing in clean 50 weight aviation engine oil before placing it in position. The bushing may be chilled to aid installation.
3. Inspect the piston pin bushing bore and assess the condition based on information in Table 15-7, “Engine Drive Train Parts Replacement” to determine acceptability of parts. No nicks or gouges are permissible on the bore after the bushing is removed. Discard the connecting rod if nicks/gouges are found.
4. Position the connecting rod over the pilot so the mate marks and piston pin bore chamfer are facing up.
5. Place the piston pin bushing on the pilot so that the bushing split is located 45° ± 5° from the center line of the connecting rod, facing the crankpin end. Refer to the Connecting Rod Dimensions in Appendix D.
6. Position the ram onto the pilot.
7. Using the arbor press, carefully press the new piston pin bushing flush with the piston pin bore.
8. Bore the new piston pin bushing to the diameter specified in Appendix D according to Section 15-7.8.2.3, “Piston Pin Bushing Boring” instructions.

9. Visually inspect the connecting rod for nicks or damage that may have occurred during bushing installation. Scrap connecting rods exhibiting these conditions.
10. Verify the piston pin bushing split line is correctly positioned according to Figure D-8 specifications.
11. Because of the close tolerances required, inspect the new piston pin bushing; note the bushing bore inner diameter must meet Appendix D specifications:
    a. Use a Federal Dimension Air Gauge (with the appropriate setting ring and air plug) to verify that the piston pin bushing is within the connecting rod minimum and maximum limits specified in Appendix D.
    b. Check the piston pin bushing surface finish with a profilometer. The surface finish must not exceed 16 Ra.
    c. Check the connecting rod bushing for alignment and twist after bushing installation using the Connecting Rod Boring and Alignment Fixture (Burroughs 8111A or equivalent).
    d. To check the connecting rod twist, insert the push to fit arbors into the pin and crank end of the rod.
    e. Place the connecting rod crank pin end onto the V-blocks.
    f. Place the pin end arbor on the two machined parallel steel blocks spaced equal distance from the center line of the rod, but not less than 6 inches apart.
    g. Use a flat feeler gauge to detect clearance between the machined steel blocks and the pin end arbor. Refer to the connecting rod dimensions in Appendix D for specified limits.
    h. To check the connecting rod alignment, rotate the pin end of the connecting rod to a vertical position and with the arbor resting against a positive stop.

    NOTE: The piston pin bushing must be bored to the proper inside diameter according to the “Piston Pin Bushing Boring”instructions in Section 15-7.8.2.3.

    i. Using a dial indicator mounted on a vertical stand resting on the surface plate, measure the vertical distance of the pin end arbor from the surface plate at points of equal distance from the centerline of the connecting rod. Compare the connecting rod measurements to the connecting rod dimensions in Appendix D. Connecting rods exceeding Appendix D limits must have the piston pin bushing replaced and reamed or the connecting rod must be scrapped.
    j. Inspect the connecting rod bushing alignment with the large end bearing seat according to the connecting rod dimensions in Appendix D.
12. Inspect the connecting rod alignment using push fit (8 inch) arbors for the bushing bore (piston pin end) and bearing seat (crank pin end). Verify the connecting rod piston pin bushing is aligned with the crank pin end bearing bore:
    a. Insert the arbors into the connecting rod bores.

b. Place the large end arbor (crank pin end) in the V-blocks on the surface plate.

c. Place the ground steel blocks under the ends of the bushing arbor (piston pin end) a measured distance apart.

d. Use a leaf-type feeler gauge to detect any clearance under the arbor ends.

e. Divide this measurement by the distance in inches of separation between the blocks which will equal the twist per inch of length.

NOTE: Twist measurement/distance in inches = Twist/inch

13. Measure the bushing and bearing convergence as follows:

a. Mount a dial indicator on a surface gauge and swing the rod around the crank pin end arbor to the vertical position against a firm stop.

b. Pass the indicator over the bushing arbor on both sides of the connecting rod at points which are an exact number of inches apart. For exact parallelism, the two measurements must be the same.

c. Inspect the connecting rod bushing alignment with the large end bearing seat according to the connecting rod dimensions in Appendix D.

15-7.8.2.3. Piston Pin Bushing Boring

Equipment Required

- Burroughs Part No. 8111A, Connecting Rod Boring and Alignment Fixture, or equivalent
- Burroughs Part No. 8042C, Adapter Kit, or equivalent
- Vertical mill, or equivalent, capable of maintaining 1750 RPM
- Boring tool of the correct sizes

1. Place the connecting rod on the base plate and secure with retainers provided.
2. Select the correct adapter kit and boring tool for the connecting rod.
3. Using a vertical mill, or equivalent, bore the connecting rod bushing to size. Maintain 1750 RPM during the boring process.

15-7.8.2.4. Connecting Rod Replacement

Connecting rod assemblies are selected in pairs with a maximum weight variation not to exceed ½ ounce in opposing bays. Connecting rods are supplied only in matched sets; replace connecting rods only in pairs.

WARNING

Never remove material from a connecting rod. Connecting rods are matched to limit engine vibration with no more than ½ ounce weight variance between connecting rods in opposing cylinders. Removing material from the connecting rod will destroy the shot peen treatment and may cause stress risers.

Chapter 16. Component Assembly

16-1. Starter Assembly

The starter is replaced during engine overhaul; starter installation instructions are in Chapter 17.

16-2. Alternator Drive Hub Installation

1. Install a new woodruff key (Figure 16-1) (13) in the shaft keyway.
2. Align the alternator coupling hub (8) keyway with the woodruff key (13) and press the coupling hub (8) onto the shaft with the lugs facing away from the alternator.
3. Fit the retainer (12) inside the lugs of the generator coupling hub (8) with the open side facing outward.
4. Install the sleeve (9) on the shaft in the center of the alternator coupling hub (8).
5. Install two new bushings (11) inside the retainer (12), followed by the gear assembly (10). The bushings will sandwich the two lugs on the back side of the gear assembly.
6. Install the nut (6) on the threaded end of the alternator shaft and hand tighten.

   CAUTION: Do not exceed the fastener torque limit to align the slots in a castellated nut with a cotter pin hole. Tighten the nut to the minimum torque limit and check cotter pin hole alignment. If the slots in the nut do not align with the hole, gradually increase the torque until alignment is achieved.

7. Using a currently calibrated torque wrench, torque the nut according to the lower limit specified in Appendix B. If the cotter pin holes do not align, gradually increase torque to align the castellated nut with the cotter pin hole. If alignment cannot be achieved within the torque limits, replace the nut (6). Do not over torque!
8. Install a new cotter pin (7) and secure it according to Appendix C instructions.

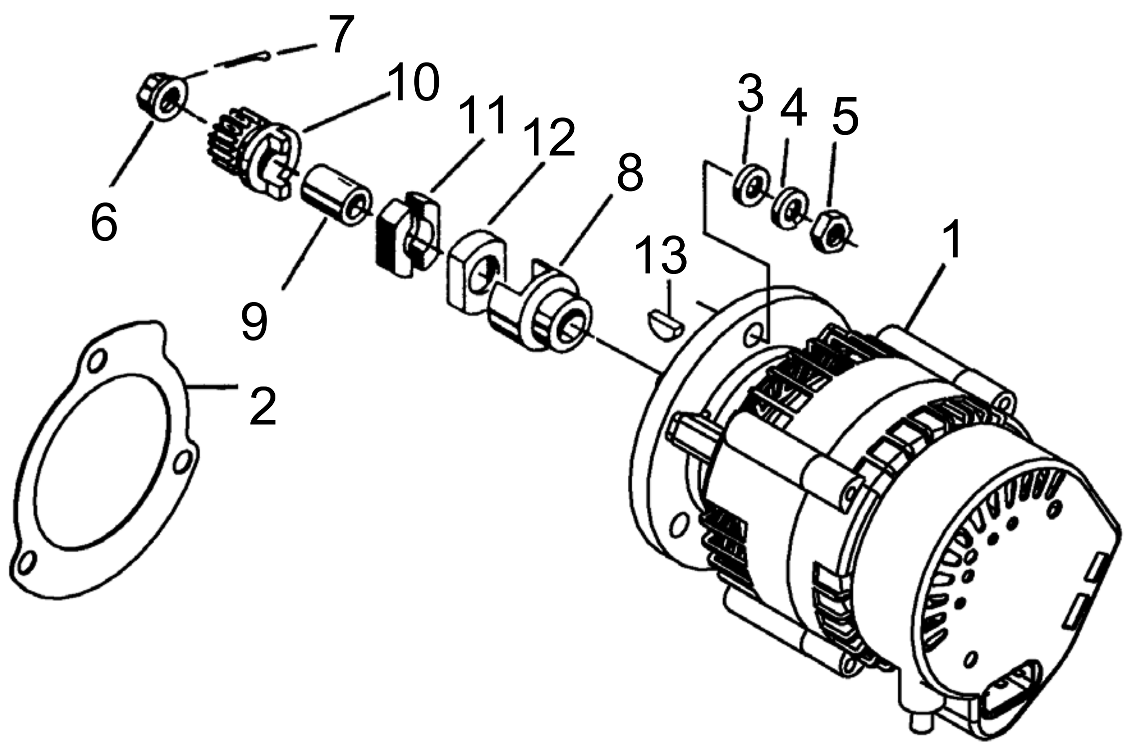

Figure 16-1. Alternator and Drive Hub

1	Alternator	5	Nut	9	Sleeve	13	Woodruff Key
2	Gasket	6	Slotted Nut	10	Gear		
3	Washer	7	Cotter Pin	11	Bushing		
4	Lock Washer	8	Alternator Coupling Hub	12	Retainer		

16-3. Induction System Assembly

NOTE: Obtain a new or rebuilt carburetor or have the carburetor overhauled according to FAA Approved procedures.

1. Inspect the intake pipe (Figure 16-2) (12) ends for roundness.
2. Center the width of four new inner hoses (13) in four new outer hoses (14).
3. Lubricate the inside of the inner hoses (13) with WD-40 or a mild soapy water solution and slide the new inner hoses on to the intake pipes (12).
4. Lubricate the inside of the outer hose (14) with WD-40 or a mild soapy water solution and slide the intake pipe (12), inner hose (13) and outer hose (14) assembly onto an open intake manifold (1) port.

   NOTE: Hose clamps will be torqued after installation on the engine. Do not torque the hose clamps until final assembly.

5. Center a new hose clamp (15) over the outer hose (14) and intake manifold (1) connection; orient the clamp adjustment screw toward the carburetor flange and tighten the hose clamp (15) enough to secure it in place. Repeat for each outer hose (14) to intake manifold (1) connection.
6. Center a new hose clamp (15) over the inner hose (13) and intake pipe (12) connection; orient the clamp adjustment bolt (or screw) toward the carburetor flange and tighten the hose clamp (15) enough to secure it in place. Repeat for each inner hose (13) to intake pipe (12) connection.

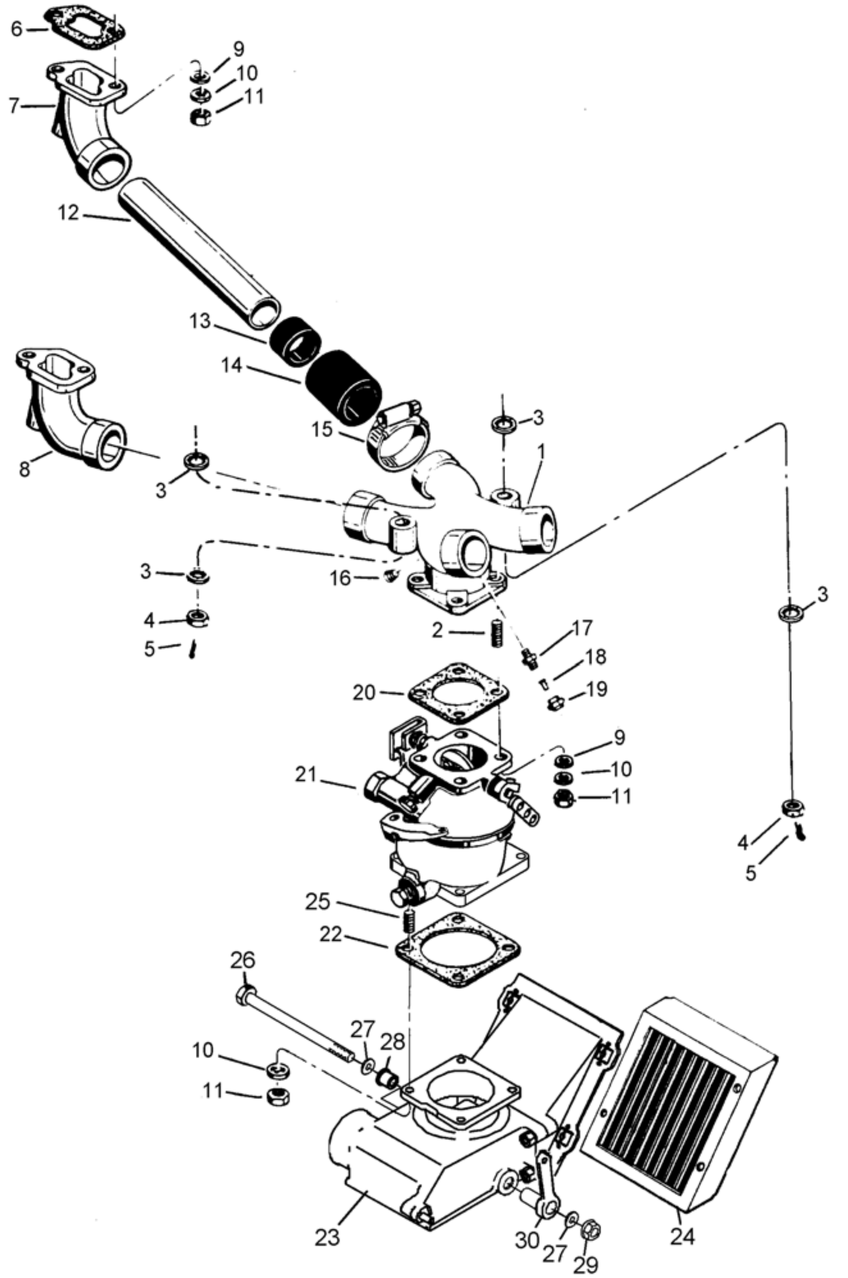

Figure 16-2. Induction System

1	Intake Manifold Assembly	9	Washer	17	Nipple- primer	25	Stud
2	Stud	10	Lock Washer	18	Union	26	Bolt
3	O-lock Seal	11	Nut	19	Nut	27	Washer
4	Castle Nut	12	Intake Pipe	20	Carburetor Gasket	28	Bushing
5	Cotter Pin	13	Hose- 1.50 X 0.88	21	Carburetor	29	Lock Nut
6	Intake Manifold Gasket	14	Hose - 1.75 X 2.00	22	Carburetor Gasket	30	Lever
7	Induction Elbow - Cyl 1 & 4	15	Clamp	23	Air Intake Housing		
8	Induction Elbow - Cyl 2 & 3	16	Plug - 0.25	24	Filter		

16-4. Lubrication System Assembly

CAUTION: Never use Teflon tape on Lubrication System fittings.

1. Lubricate the accessory case cavity, gear contact areas and oil pump gears (Figure 16-3) (1 & 2) with clean Molyshield grease.
2. Install the gears (1 & 2) into the accessory case oil pump cavity.
3. Align the gears in their respective positions in the accessory case. The drive gear has a square drive that mates with the camshaft and installs in the bottom of the oil pump cavity.
4. Inspect the oil pump cover with a straight edge for flatness. If the cover is bend or warped, replace the oil pump cover.
5. Install the oil pump cover (3) with new tab washers (4) and bolts (5). Torque the bolts per Appendix B. Install the tab washers (4) and safety wire the bolts according to instructions in Appendix C.
6. Verify the oil pump gears rotate freely in the cavity.

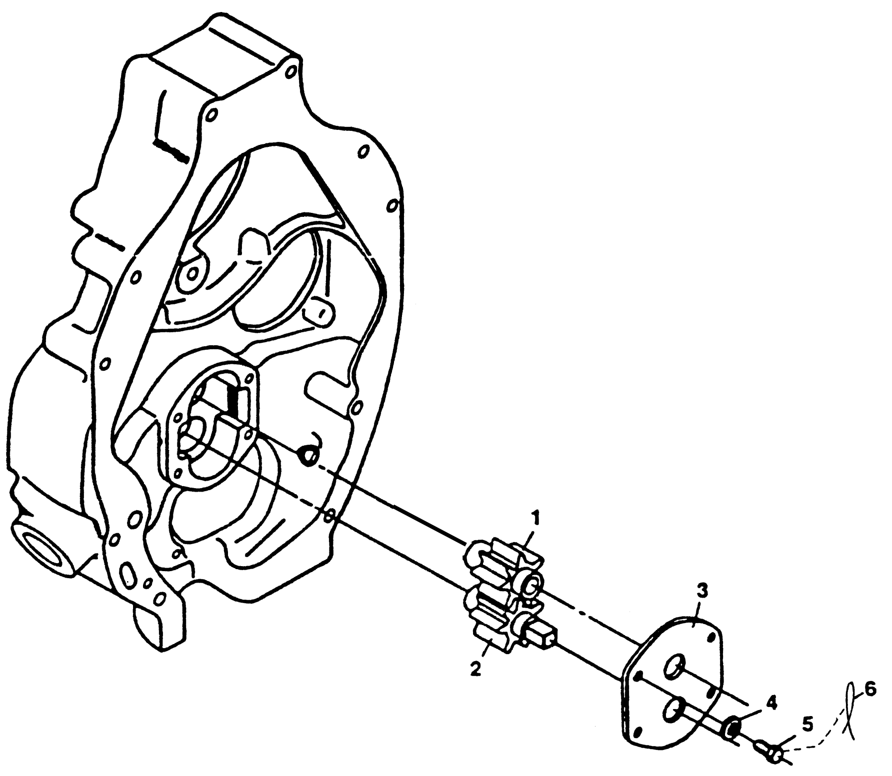

Figure 16-3. Oil Pump Assembly

1	Oil Pump Driven Gear	4	Washer (4)
2	Oil Pump Drive Gear	5	Bolts (4)
3	Oil Pump Cover	6	Safety Wire

16-4.1. Oil Cooler Assembly

The oil cooler (if equipped), an airframe component, must be cleaned, overhauled, and assembled by an appropriately rated repair station (i.e., FAA-approved Part 145 repair station). Refer to the airframe manufacturer's instruction for assembly requirements.

16-4.2. Offset Oil Cooler Adapter Assembly

1. Apply a thin film of Loctite 592 to all except the first two male threads of the socket head pipe plugs (Figure 16-4) (11) and the bypass valve plug (9).
2. Install the socket head plugs (11) in the aft threaded ports on the oil cooler adapter (1) and torque to Appendix B specifications.
3. Insert a new check valve ball (6), followed by a new spring (7) and plug (9), with a new copper gasket (8) in the threaded bore at the bottom of the adapter. Torque the plug (9) to Appendix B specifications.
4. Apply a thin film of Loctite 592 to all except the first two male threads of the fittings (10). Install the fittings (10) in the oil cooler adapter pad (10) and torque to Appendix B specifications.

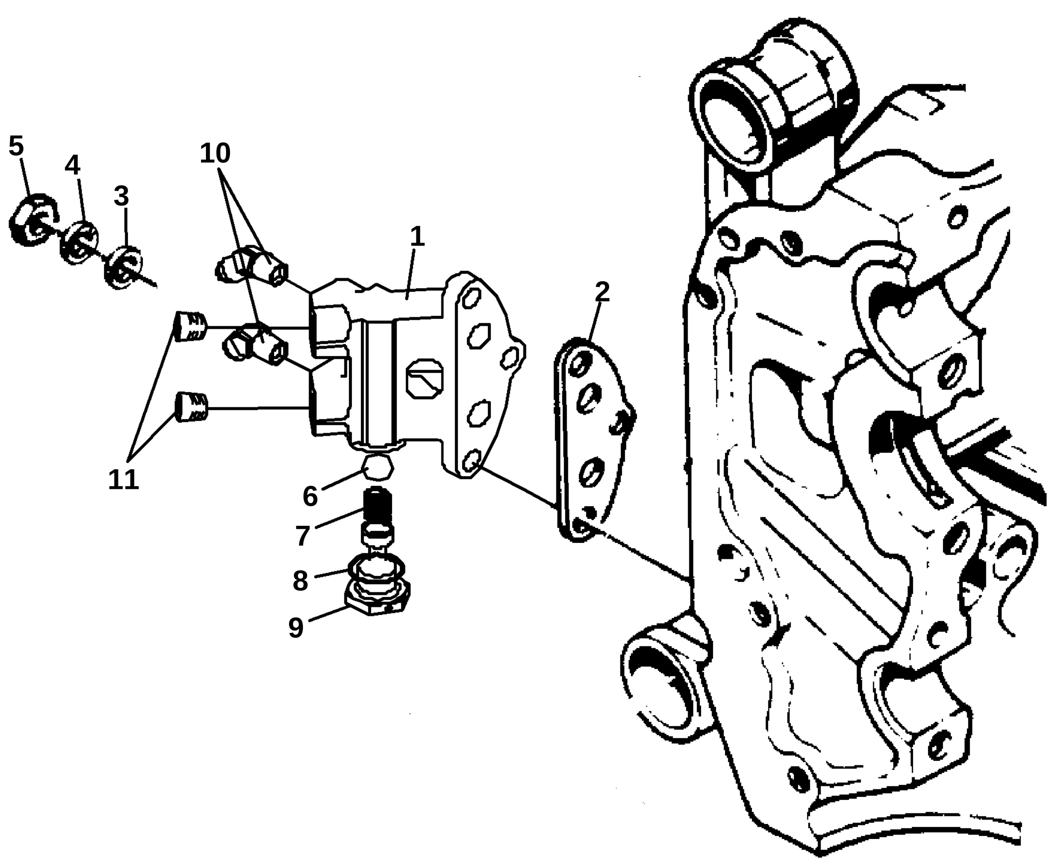

Figure 16-4. Oil Cooler Adapter

1	Oil Cooler Adapter	4	Lock Washer	7	Spring	10	45° degree fitting
2	Oil Cooler Adapter Gasket	5	Nut	8	Copper Gasket	11	.025”-18 Plug
3	Washer	6	Ball - 0.437 steel	9	Plug		

16-5. Engine Cylinder Assembly

1. Spread a film of Molyshield grease on the intake valve (Figure 16-7)(14) and new exhaust valve (15) stems.
2. If the intake and exhaust valves were lapped, install the valves into the lapped positions.
3. Grasp the cylinder assembly by the valve stems and install the cylinder on a cylindrical block of wood anchored to a work bench.
4. Reapply Molyshield grease to the exposed valve stems.
5. Place the new valve spring seats (16) over the valve guides (8 & 9), cupped side up.
6. Coat the sealing surface of a new intake valve guide seal (18) with clean 50-weight aviation engine oil and install the new intake valve guide seal (18) by hand. Tap the new seal onto the guide with a plastic mallet until it is firmly seated.
7. Install new inner and outer springs (19 and 20) over the valve guides (8 & 9) and a new retainer (20). The valve springs must be installed with the closed coils toward the cylinder head as shown in Figure 16-5.

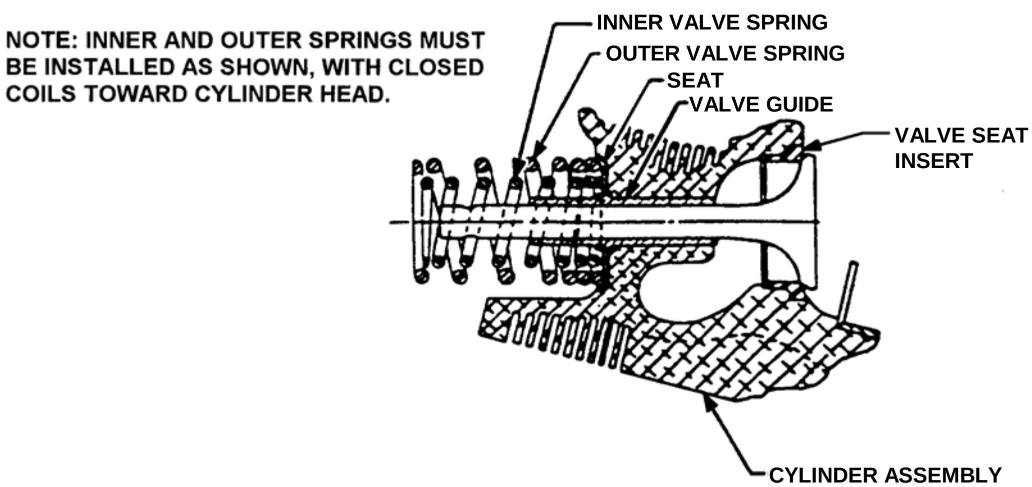

Figure 16-5. Valve Spring Installation

WARNING

Contact with the retainers will damage the valve stems. Before releasing pressure on the springs, ensure the keys are properly seated in the valve stem grooves.

8. Compress the valve springs with the Valve Spring Compressor Tool and insert the new valve stem retainer keys (Figure 16-7) (21) in the grooves at the end of the valve stem as shown in Figure 16-6. Depress the springs only enough to allow the keys to seat into the valve stem grooves. If the keys drop, they may damage the valve stem when spring tension is released.

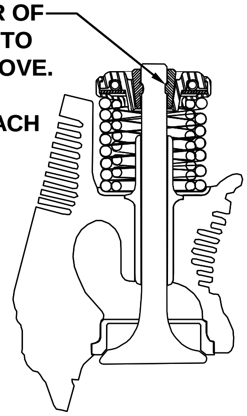

Figure 16-6. Retainer Key Installation

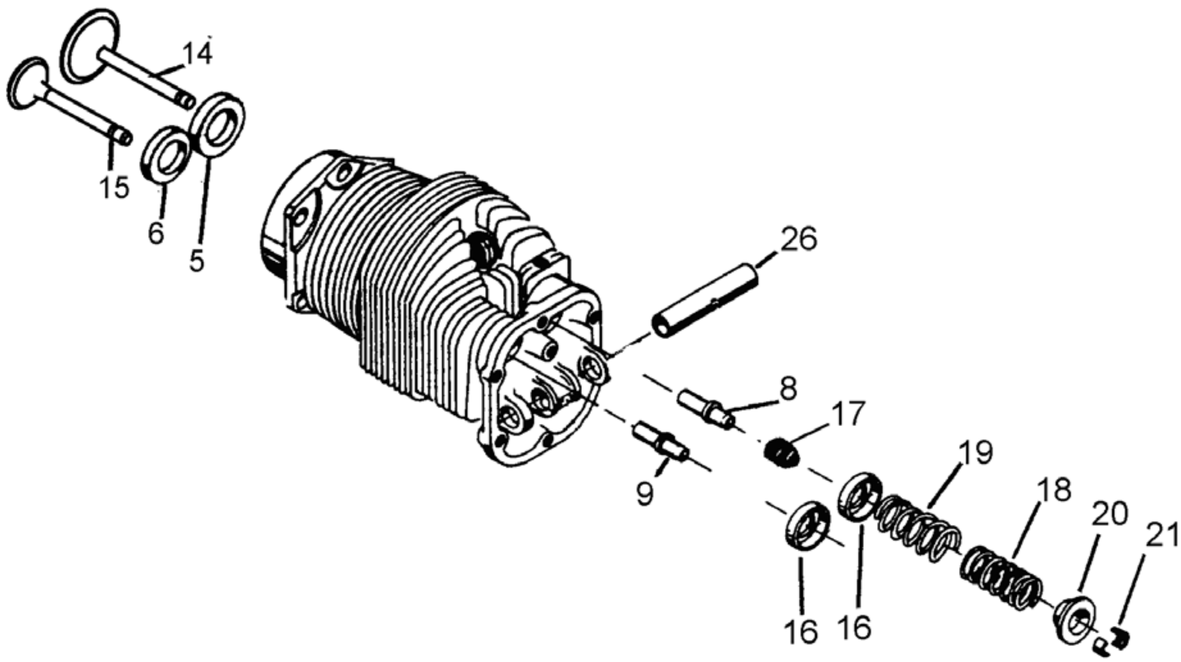

Figure 16-7. Cylinder and Valve Assembly

5	Intake Valve Seat Insert	9	Exhaust Valve Guide	17	Intake Valve Guide Seal	21	Valve Spring Key
6	Exhaust Valve Seat Insert	14	Intake Valve	18	Inner Valve Spring	26	Rocker Shaft
7	Helical Coil Insert	15	Exhaust Valve	19	Outer Valve Spring		
8	Intake Valve Guide	16	Valve Spring Seat	20	Valve Spring Retainer		

9. Remove the cylinder from the fixture and place it upright on a workbench.
10. Place a plastic mallet squarely on the end of the valve stem and strike the plastic mallet sharply with a rawhide mallet to seat the valve spring retainer keys. DO NOT STRIKE THE VALVE SPRING RETAINER.
11. Verify the valve spring retainer keys (Figure 16-7) (21) are properly positioned on the valve stem, with two keys on each valve stem as depicted in Figure 16-6.
12. Invert the cylinder assembly on the bench with the cylinder bore facing upward and the cylinder resting on the rocker shaft mounting bosses.

13. Coat the cylinder barrel wall thoroughly with clean 50-weight aviation engine oil.
14. Ensure the new pistons (Figure 16-8) (1) and new piston rings (2 through 5) are the correct size for the cylinder bore. Inspect the piston-to-cylinder clearance of each matching piston and cylinder.

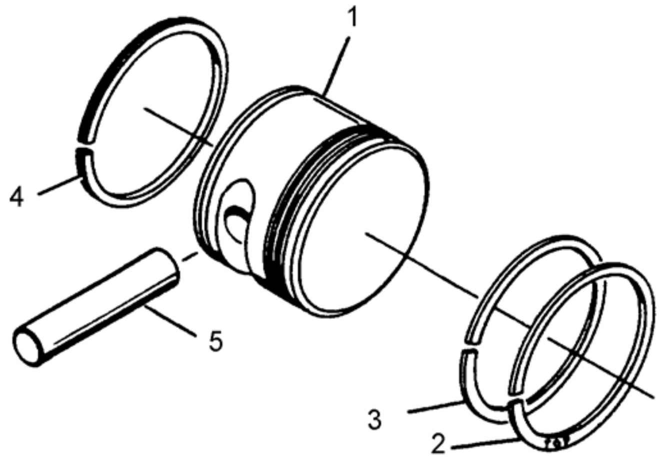

Figure 16-8. Piston, Rings and Pin

15. Insert one piston ring at a time into the cylinder bore. Use the piston to push the ring 1"±0.5" into the cylinder bore.
16. Remove the piston and measure the installed piston ring gap with a leaf type feeler gauge.
17. If the ring gap is less than the minimum specified amount, remove the excess material from the ring with a fine-toothed flat file mounted in a vise. File the ring ends evenly across the end of the piston ring and deburr the filed edges with crocus cloth. Clean the finished piston ring with mineral spirits and air dry.
    a. If the ring gap is smaller than specified, record the actual gap size and remove the ring from the cylinder bore.
    b. Mount a fine toothed flat file in a vise. While holding the ring ends firmly and squarely against the file, remove the desired amount of material.
    c. To attain the correct ring gap, deburr the ring gap ends using crocus cloth.
    d. Thoroughly clean the piston ring with mineral spirits and air dry.
    e. Install the new piston ring in the cylinder bore to the correct position and inspect the ring gap again. Repeat the tasks in this step until all piston ring gaps meet Appendix D specification.
18. Install new piston rings (2-4) on the new pistons (1) with the part number facing the top of the piston.
19. Install a ring expander into the third ring groove first by disconnecting it and then reconnecting it fully.

20. Using a ring expander, place the new oil control ring (4) over the expander with the ring gap positioned 180° from the expander joint.

21. Using the ring expander, install new compression rings (3) in the second and third ring grooves.

22. Using the ring expander, install a new compression ring (2) in the top ring grooves.

23. Inspect ring side clearances with the ring edge flush with the piston outside diameter. Ring side clearances must conform to the Appendix D dimensions.

    NOTE: The weight of opposing bay piston pairs varies no more than 1/2 ounce (14.175 grams).

24. Lubricate the piston pin and piston and ring assemblies with clean 50-weight aviation engine oil.

25. Place the new piston and ring assembly with the cylinder assembly for which it was previously sized and gapped. Install new piston pins (5) in the piston pin bores. The piston pins must slide freely in the piston pin bores.

26. Position the rings (2-4) so the ring gaps are 180° apart with the first ring gap toward the top of the piston.

27. Using a ring compressor, install each piston into its cylinder with upper (above the piston pin bore) rings in the cylinder barrel and the piston pin accessible for connecting rod installation.

28. Install a new O-ring seal (Figure 16-9) (48) on the cylinder end of the pushrod housings (35). Place two each, pushrod housings, new springs (45), washers (46), new packing (49), and second washer (46) with each cylinder on the bench.

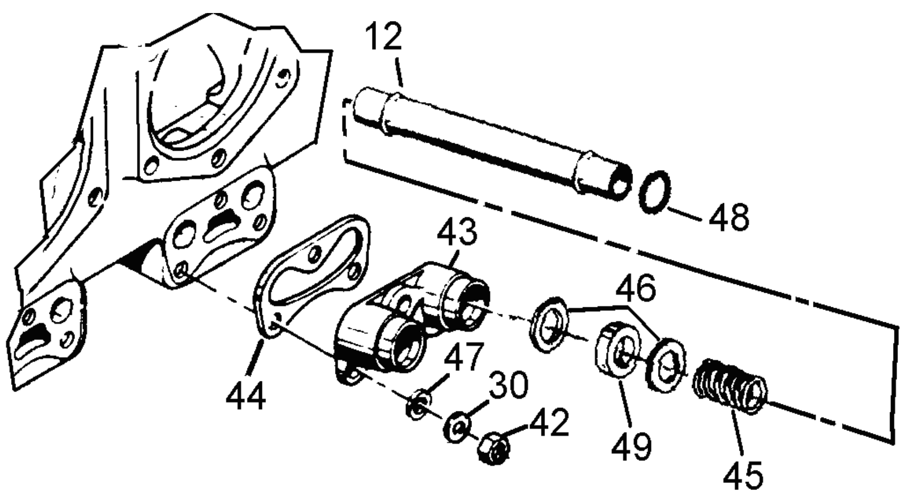

Figure 16-9. Pushrod Housing Assembly

12	Pushrod Housing	43	Pushrod Adapter	45	Spring	48	O-ring Seal
30	Lock Washer	44	Pushrod Adapter Gasket	46	Washer	49	Pushrod Housing Seal
42	Lock Nut	43	Pushrod Adapter	47	Washer		

16-6. Accessory Case Assembly

1. Coat the oil pressure relief valve plunger (Figure 16-10) (30) with grade 50 aviation engine oil. Insert the plunger (30) in accessory case bore, followed by the spring (9). Secure the plunger (30) and spring (9) with the oil pressure relief valve cap (20), fitted with a new copper washer (28) liberally lubricated with grade 50 aviation engine oil. Torque the cap (20) to Appendix B specifications.
2. Apply a thin film of Part No. 642188 (Copper Coat) to both sides of a new oil filter adapter gasket (18).
3. Install the oil suction tube (7) with a new gasket (24) in the bottom of the accessory case (1). Torque the oil suction tube (7) to Appendix B specifications.
4. Install the oil filter adapter (19) and new gasket (18) on the crankcase studs and secure with three washers (16) and nuts (21). Torque the nuts (21) to Appendix B specifications.

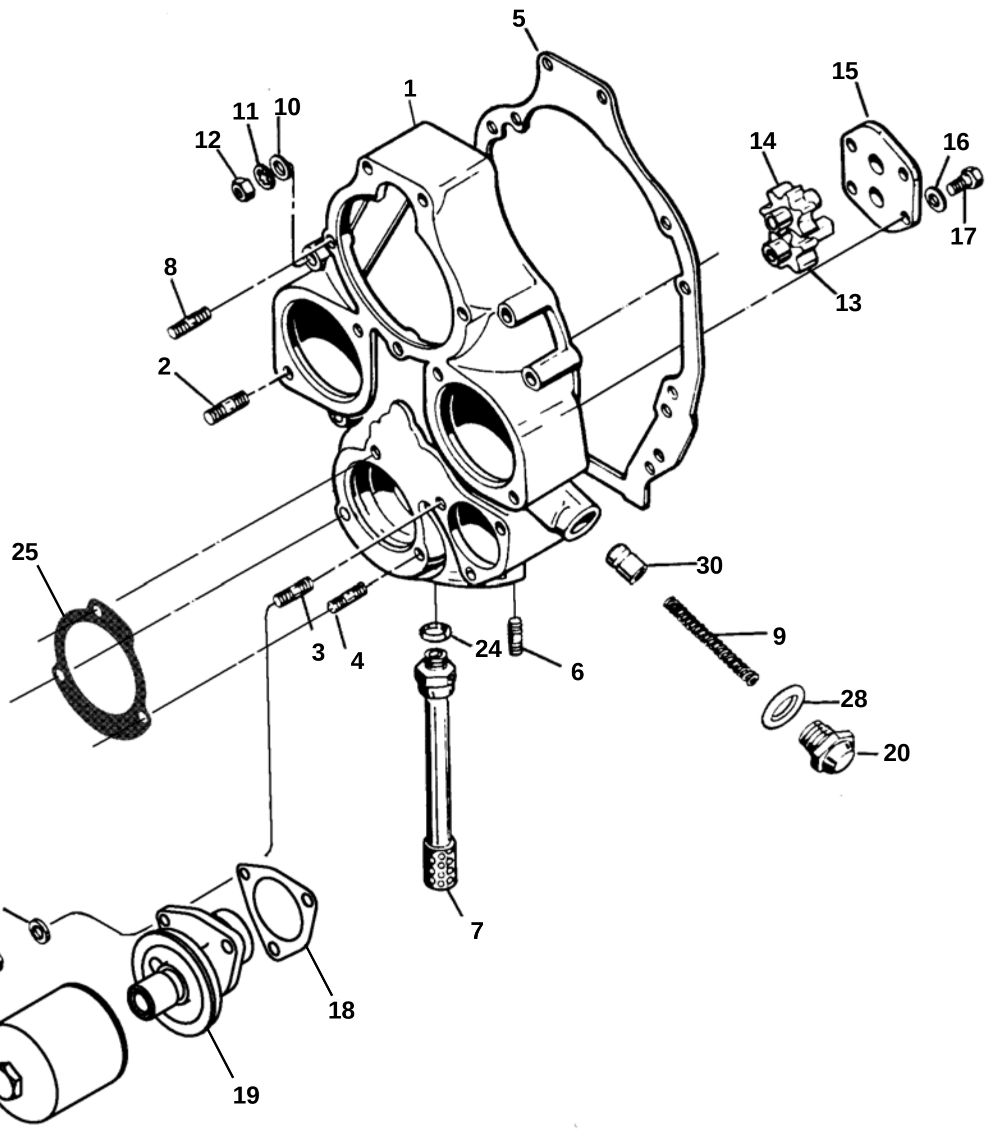

Figure 16-10. Accessory Case

1	Accessory Case w/studs	9	Spring	17	Screw	25	Gasket
2	Stud	10	Washer	18	Gasket	26	Not Used
3	Stud	11	Lock Washer	19	Oil Screen Housing	27	Not Used
4	Stud	12	Nut	20	Not Used	28	Copper Gasket
5	Gasket	13	Oil Pump Drive Gear	21	Nut	29	Not Used
6	Stud	14	Oil Pump Driven Gear	22	Oil Filter	30	Plunger
7	Suction Tube Assembly	15	Oil Pump Cover	23	Not Used	21	Oil Pump Kit
8	Stud	16	Washer	24	Not Used		

16-7. Crankcase Assembly

1. Spread a thin film of Loctite 592 on the threads of the front oil gallery plugs (Figure 16-12) (19); Install the plugs (19), with new copper gaskets (18) into the oil galleries. Torque the plugs (19) Appendix B specifications.
2. Spread a thin film of Loctite 592 on the aft oil gallery plug (20); Install the plug (20) in the oil gallery and torque the plugs (20) to Appendix B specifications.

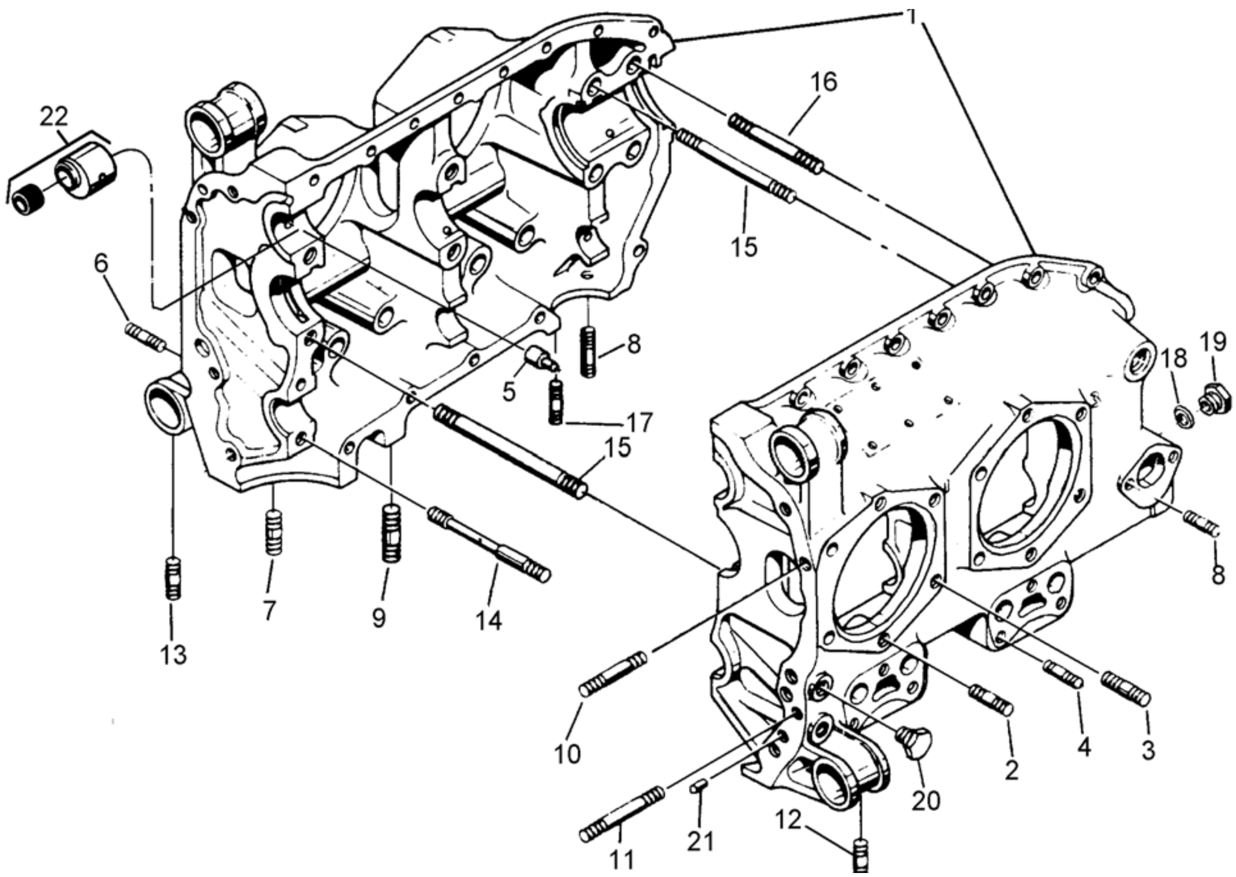

Figure 16-11. Crankcase Fasteners (B)

1	Crankcase Assembly	7	Stud	13	Stud	19	Plug
2	Stud	8	Stud	14	Stud	20	Plug
3	Stud	9	Stud	15	Stud	21	Dowel
4	Stud	10	Stud	16	Stud	22	Starter Adapter Assembly
5	Dowel	11	Stud	17	Stud		
6	Stud	12	Stud	18	Gasket		

3. Spread a thin film of Loctite 592 on the threads of the breather elbow (Figure 16-12) (37). Screw the elbow into the boss forward of the No. 3 cylinder pad on the 1-3 side crankcase. Tighten the elbow enough to prevent loosening and orient the breather elbow at 195 degrees (15 degrees aft of straight down).

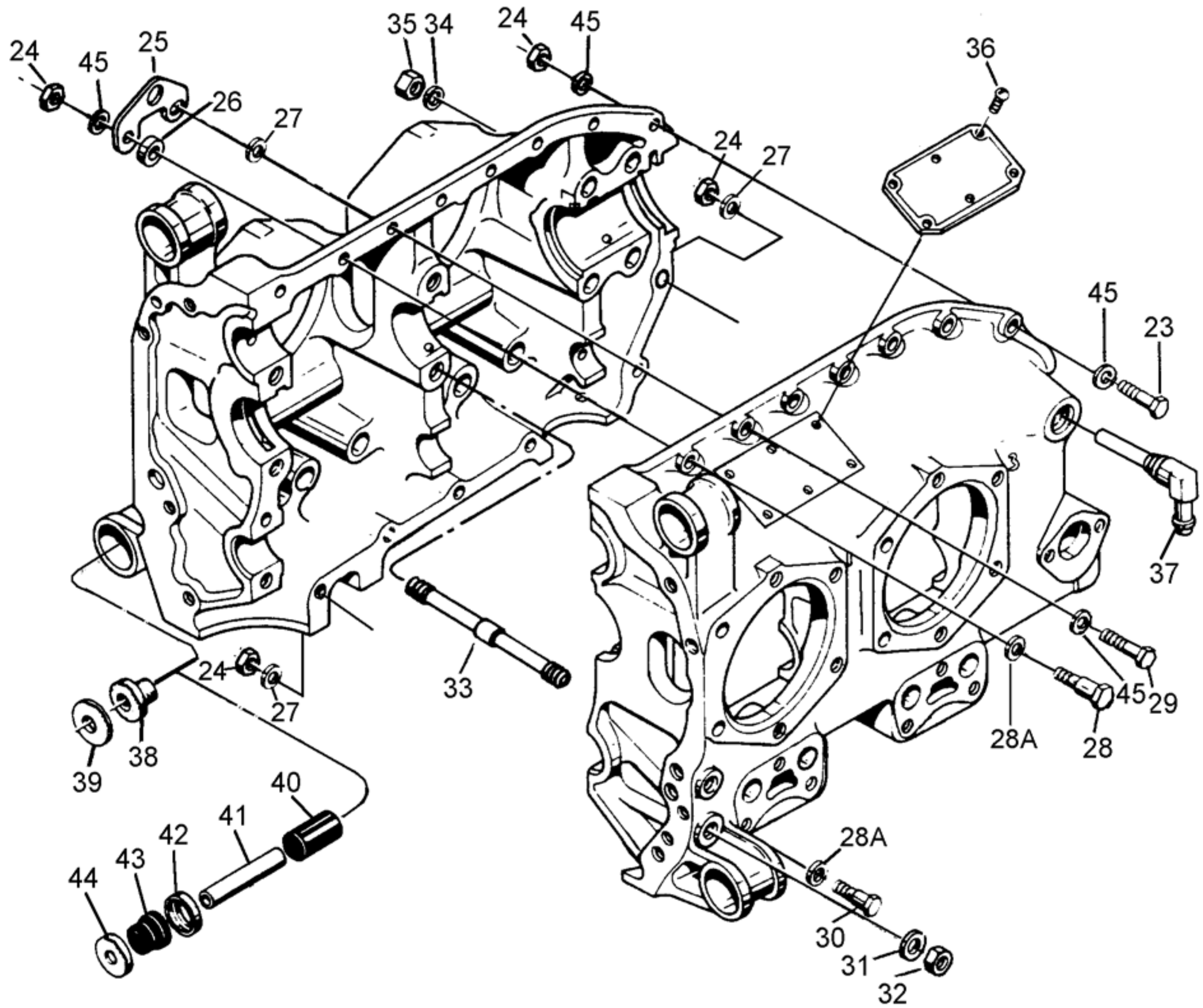

Figure 16-12. Crankcase Fasteners (A)

23	Screw	28	Screw	32	Nut	41	Engine Mount Spacer
24	Nut	28A	Washer	33	Through Bolt	42	Engine Mount Seat
25	Lifting Eye	29	Screw	34	Washer	43	Engine Mount Bushing
26	Special Washer	30	Screw	35	Nut	44	Cup Washer
27	Washer	31	Washer	36	Screw	45	Washer

16-8. Engine Drive Train Assembly

The section contains camshaft, crankshaft, and connecting rod assembly instructions.

16-8.1. Camshaft Assembly

1. Install the camshaft (Figure 16-13) (1) in a suitable holding fixture.
2. Coat the gears and camshaft with 50-weight aviation engine oil.
3. Align the holes in the camshaft gear (3) with the camshaft (1) screw holes. Lubricate four screws (3) with 50 weight aviation engine oil and secure the camshaft gear to the camshaft with the screws (3); torque the screws to Appendix B specifications.
4. Safety wire the screws (3) in pairs according to the safety wire instructions in Section C-4.

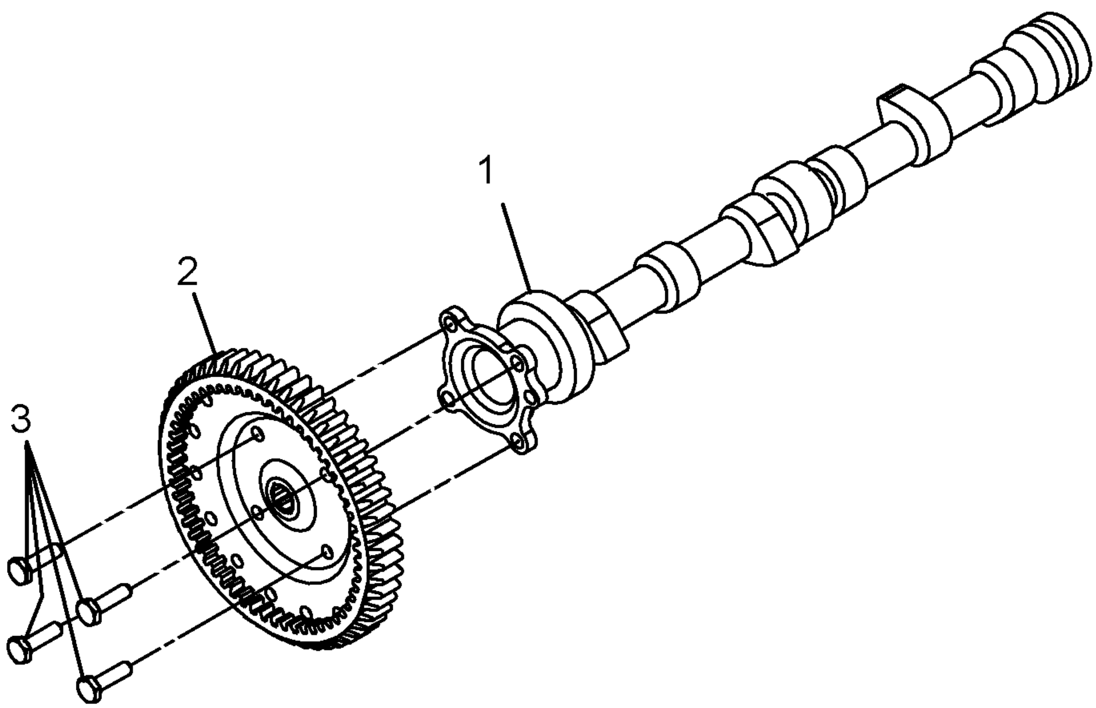

Figure 16-13. Camshaft Assembly

1	Camshaft	2	Gear	3	Screws

16-8.2. Crankshaft Assembly

1. Place the crankshaft on a bench with a notched wooden block under the front and rear main journals.

   CAUTION: Do not heat the gear cluster more than 10 minutes. Handle the gear with protective gloves after heating.

2. Using a uniform heating method (not a torch), heat the crankshaft small gear cluster (Figure 16-14) (24) to 300°F (149°C) for 5 to 10 minutes. Heating the gear is necessary for a shrink fit installation.
3. While the gear is still hot, align the gear dowel hole with the crankshaft dowel and install the small gear cluster on the crankshaft.
4. Attach the gear cluster (3) to the crankshaft (1) using four new drilled head screws (4). Torque the screws in a crisscross pattern to Appendix B specifications. Safety wire the drilled head screws (22) according to the "Safety Wiring Hardware" instructions in Section C-4.

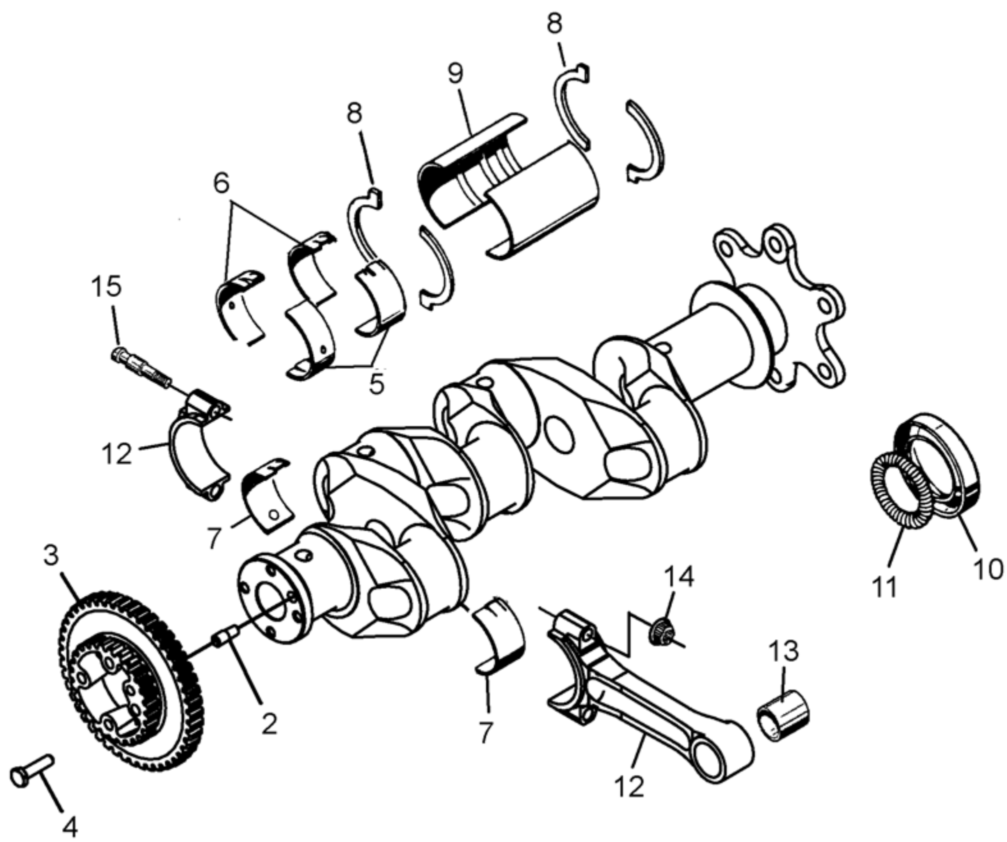

Figure 16-14. Crankshaft Assembly

1	Crankshaft	5	Main Bearings	9	Front Camshaft Bearings	13	Piston Pin Bushing
2	Dowel Pin	6	Main Bearings	10	Nose Oil Seal	14	Spiral Lock Nut
3	Gear	7	Connecting Rod Bearings	11	Spring	15	Connecting Rod Bolt
4	Screw	8	Thrust Washer	12	Connecting Rod		

5. Install a new oil seal spring (11) around the crankshaft in the oil seal area. Turn the spring ends in an unwinding direction, allowing one end of the spring to wind into the other end then hook the spring ends together.
6. Install the new oil seal (10) on the crankshaft.
7. Apply Shell Alvania No. 2 Grease to the lip of the new oil seal (10) and crankshaft propeller flange.
8. Press the new oil seal spring (15) into the oil seal cavity. Refer to Figure 16-15 for crankshaft nose oil seal and spring installation details.

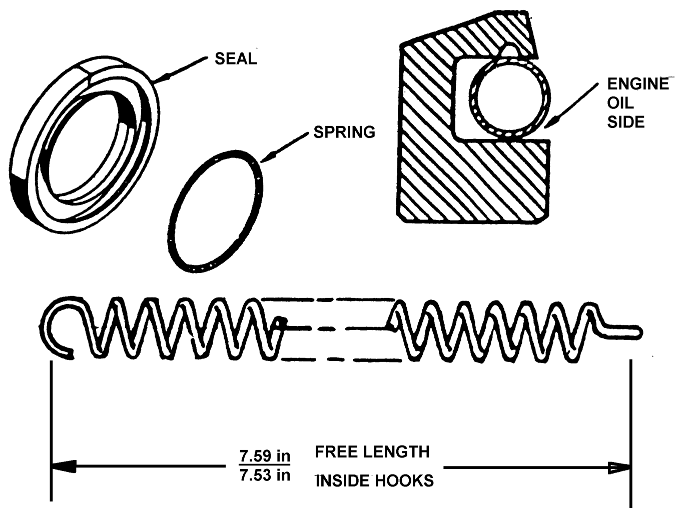

Figure 16-15. Crankshaft Nose Oil Seal Parts

9. With the oil seal in place on the crankshaft, wipe all Shell Alvania No. 2 Grease from the oil seal and crankshaft. Verify the oil seal outside diameter is clean and dry before installing the crankshaft in the crankcase.
10. Place a sheet of crocus cloth on a flat surface plate and dampen the cloth with solvent.
11. Lightly rub the parting surface of the cap and rod across the crocus cloth to remove any burrs or nicks. Inspect the parting surfaces, bolt holes and bolt hole edges to ensure there are no nicks, burrs, or sharp edges.
12. Original connecting rods have a position number stamped on the end cap and rod bolt boss. Check that the new connecting rod has the correct position number, 1 through 4, as applicable, vibro-etched in the location shown in Figure 16-16 that corresponds to the connecting rod being replaced. Replacement connecting rods must match the position of the connecting rod being replaced.

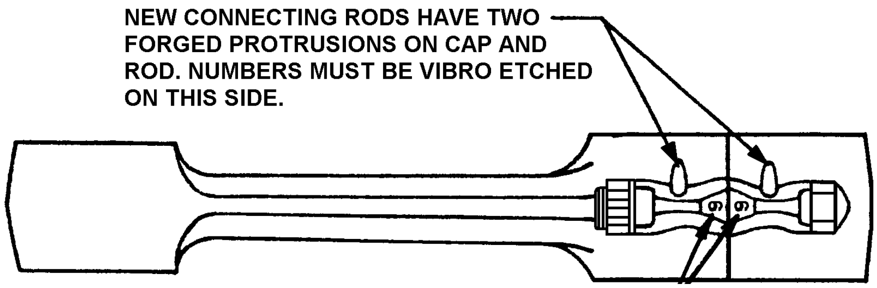

Figure 16-16. Connecting Rod Position Number

13. Install a new connecting rod bearing (Figure 16-14) (7) in each connecting rod cap (12) and rod (12). Ensure that the bearing ends project the same distance even with the parting surface and they are properly seated.
14. Look closely for any metal that may have shaved from the bearing back onto the parting surface during installation. Remove the metal shavings.
15. Lubricate each connecting rod cap and bearing with 50 wt aviation engine oil and install each rod, cap and bearing assembly at the correct position on the crankshaft. Install the connecting rod and cap with the position numbers on top when odd number rods are extended to the right and even number rods are to the left when viewing the crankshaft from the rear (gear end) forward.
16. Lubricate the threads of the new connecting rod bolt (15) and new spiral lock nut (14) using clean 50 weight aviation engine oil. Note different part numbers are available for connecting rod bolt and nut pairs - do not intermingle bolt and nut pairs; only the specified bolt and nut in the pair are to be installed. If new connecting rod fasteners are required, bolt and nut sets must match.
17. Secure rods and caps using the new connecting rod bolt (15) and new spiral lock nut (14). Torque the fasteners to Appendix B specifications.
18. Verify the connecting rod to crankshaft pin end clearance meets Appendix D specifications.

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Chapter 17. Engine Assembly

17-1. Engine Assembly Sequence

Assemble the engine in the sequential steps listed below, referring to corresponding sections in this chapter (and specified references) for detailed instructions:

1. Lubricate the engine components
2. Assemble the crankcase
3. Install the engine cylinders
4. Torque the engine cylinders and crankcase
5. Install the valve train
6. Install the oil cooler adapter (if equipped)
7. Install the accessory case
8. Install the alternator
9. Install the starter
10. Install the oil sump
11. Install the induction system
12. Install the fuel pump (if equipped)
13. Install the ignition system
14. Install the engine in the airframe according to instructions in Section 5-2

17-1.1. Component Lubrication

WARNING

Lubricate hardware according to instructions in Chapter 3 and Appendix B. Inspect fasteners for proper plating and thread form. Verify fastener serviceability and correctly lubricate the fastener for proper fastener pre-loading and torque application.

Prior to engine assembly, apply clean 50-weight aviation engine oil liberally to bare steel surfaces, journals, and bushings, except where special lubricants are required. Section 3-2 includes a comprehensive list of authorized lubricants, sealants and adhesives.

17-2. Crankcase Assembly

17-2.1. Seal and Thread the Crankcase

1. Attach the upper and lower mounting arms of the 2-4 crankcase casting securely to an engine stand; rotate the crankcase so the open side of the casting faces upward.
2. Place the 1-3 crankcase casting on the work bench, with the open side upward.
3. Shake (or mix) thoroughly full strength, non-thinned Part No. 654663 Gasket Sealant (Loctite PN 30516).

   CAUTION: Do not allow Gasket Sealant to run into the interior of the case. Do not apply Gasket Sealant anywhere except as indicated in Figure 17-1.

4. Apply a thin, even coating of Part No. 654663 Gasket Sealant using short light brush strokes to the 2-4 crankcase half in the areas shown in Figure 17-1. Do not apply Part No. 654663 Gasket Sealant to the crankshaft nose seal area. The Gasket Sealant should be viscous enough that most of the brush marks disappear; if not, obtain a fresh container of Part No. 654663 Gasket Sealant. Allow the Gasket Sealant to air dry to a tacky condition before threading.
5. Apply a thin translucent coat of Part No. 646942 Gasket Maker (Loctite 515) not to exceed 0.010 inch thick to 1-3 case half. Apply Gasket Maker in all areas that will mate with areas where Part No. 654663 Gasket Sealant was applied on the 2-4 case half, except the through bolt bosses. Refer to Appendix C for detailed Gasket Maker application instructions.
6. Apply grade D silk thread to the tacky Part No. 654663 Gasket Sealant on the 2-4 case half in the locations identified in Figure 17-1. Ensure the free ends of the thread are covered by gaskets except at the nose oil seal.

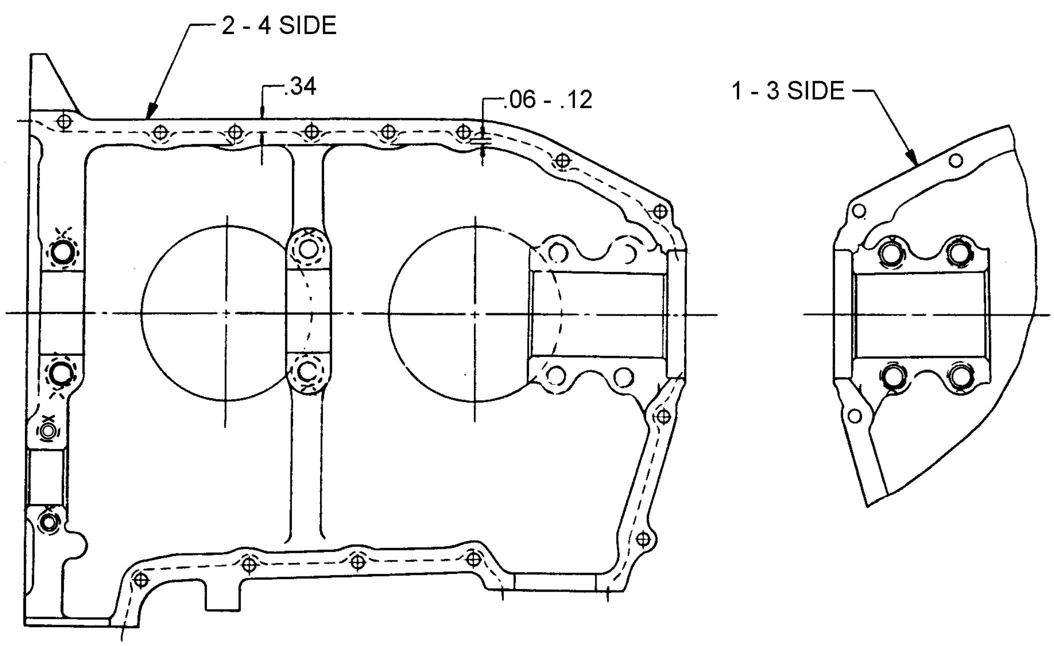

Figure 17-1. Crankcase Sealing and Threading

17-2.2. Drive Train Installation

CAUTION: All parts must be clean and free of debris before the crankcase can be assembled. Perform the assembly in a clean, dry, dust-free environment.

1. Seal and thread the crankcase according to Section 17-2.1.

CAUTION: Do not apply engine oil on the crankshaft bearing saddles. Main bearing saddles must be dry when installing the crankshaft main bearings.

2. With the exception of the crankshaft bearing saddles, thoroughly coat the crankcase journals and camshaft bearing surfaces surface with clean, 50-weight aviation engine oil.
3. In succession, dip each new lifter body in grade 50 aviation engine oil and install it the crankcase guide from the inside. As each lifter body is installed in the 1-3 side casting, push a used pushrod housing rubber connector over its outer end to temporarily hold it in place.
4. Coat the camshaft with oil, and place it in the 2-4 crankcase side bearings. Coat the camshaft lobes and lifter faces with Dow Corning G-N paste.
5. Check camshaft end clearance between camshaft rear bearing flange and the bearing end.

NOTE: The starter adapter plug assembly is used on all current production engines. The starter pinion pivot is only used with pull type starters. The starter jack adapter is used with Prestolite (or equivalent manufactured under PMA) starters.

6. Install the starter adapter plug assembly (Figure 17-2) (22) on the dowel (5) in the upper boss at the rear of the crankcase.

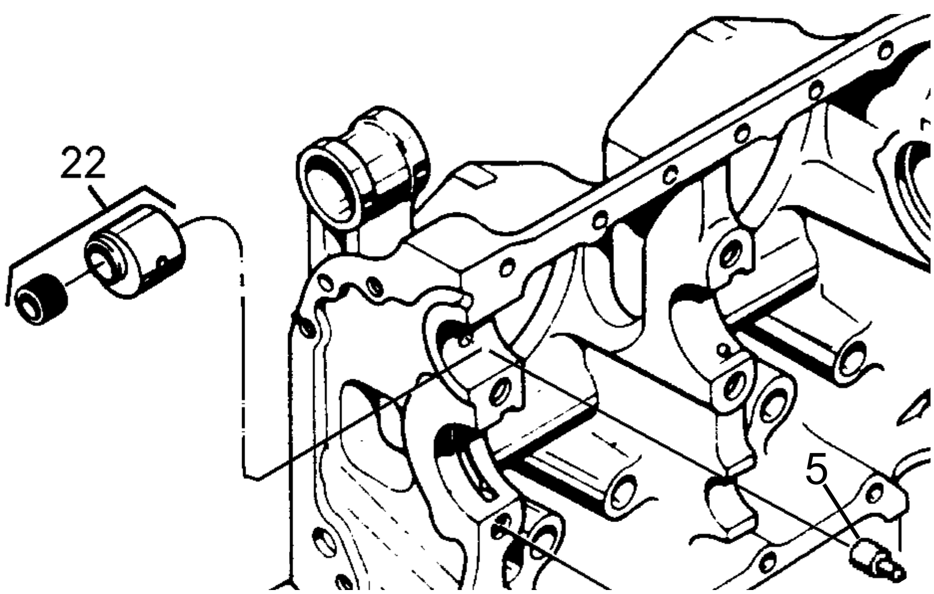

Figure 17-2. Starter Adapter Plug

CAUTION: Do not apply engine oil to the crankshaft bearing saddles. Bearing saddles must be dry when installing the crankshaft main bearings.

7. Install the new crankshaft main bearings (Figure 17-3) (5, 6 & 9) in the crankcase bearing saddles. Lubricate only the crankshaft side of the main bearing with clean 50-weight aviation engine oil. Do not lubricate the back side of the bearing.

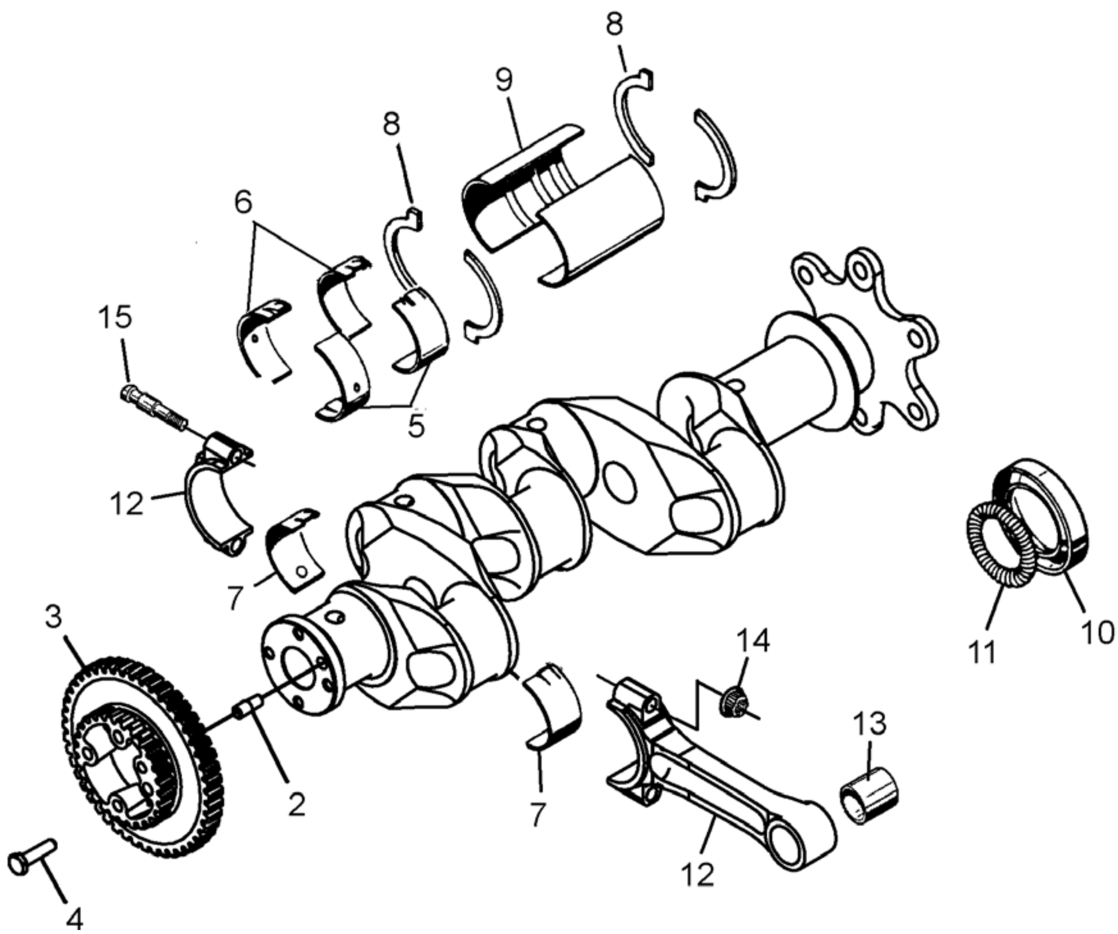

Figure 17-3. Crankshaft Assembly

1	Crankshaft	5	Main Bearing	9	Front Crankshaft Bearing	13	Piston Pin Bushing
2	Dowel Pin	6	Main Bearing	10	Nose Oil Seal	14	Spiral Lock Nut
3	Gear	7	Connecting Rod Bearing	11	Spring	15	Connecting Rod Bolt
4	Screw	8	Thrust Washer	12	Connecting Rod		

8. Apply clean 50-weight aviation engine oil to the thrust washer lands in the crankcase to prevent the thrust washer halves from falling out during final assembly.

9. With the aid of an assistant, lift the crankshaft assembly by the Nos. 1 and 3 connecting rods. Guide the crankshaft and Nos. 2 and 4 connecting rods into position in the 2-4 side crankcase half. Align the camshaft and crankshaft timing marks (Figure 17-4) as the gears mesh.

10. Install new thrust washer halves (Figure 17-3) (8). Ensure the main bearing (5 & 6) and thrust washer (8) ends project equally and are properly seated in the lands.

11. Connecting rod position numbers, if properly installed, will face the upper case flange. Carefully lower the odd-numbered connecting rods to the crankcase flange.
12. The No. 1 connecting rod on the crankshaft should be in its fully extended (top dead center (TDC)) position.

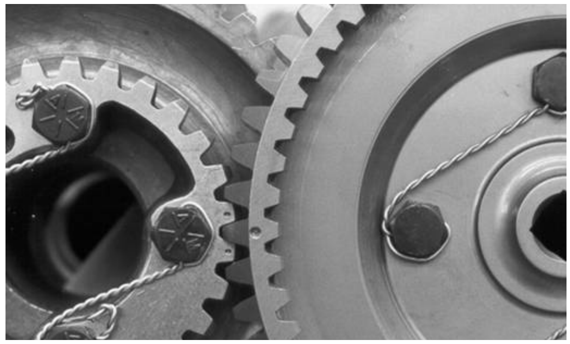

Figure 17-4. Timing Mark Alignment

13. Compare camshaft-crankshaft gear backlash to Appendix D specifications. If the crankcase has been machined, the gear backlash must not be less than the specified minimum. (If the gear backlash is not within tolerance, inspect the gear, camshaft, and crankcase to determine the cause of non-conformance).
14. Pull the crankshaft toward the front of the crankcase to seat the front main bearing against the bearing support boss. Measure the crankshaft end clearance with a feeler gauge between the front thrust flange and the thrust washer. End clearance must conform to Appendix D specifications.
15. Measure the camshaft end clearance to verify it meets Appendix D specification.

NOTE: Cautiously assemble the crankcase halves to prevent dislodging the silk thread or scraping the Gasket Maker material.

16. Have the assistant hold the numbers 1 and 3 connecting rod upright and carefully lower the 1-3 crankcase half onto the 2-4 crankcase half and drive train assembly.

CAUTION: If the connecting rods are not secured (Figure 17-5), the connecting rods or the cylinder mounting deck could be damaged.

17. Secure the connecting rods with old cylinder base O-rings (Figure 17-5) or rubber bands to prevent damage to the cylinder deck.

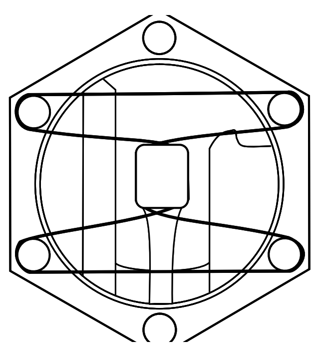

Figure 17-5. Cylinder Base O-Ring Used to Secure Connecting Rod

18. Verify the starter adapter plug and thrust washers remain in position during crankcase half assembly.

WARNING

Failure to lubricate designated fasteners may results in damage to the crankcase bearing bore, crankshaft bearing, and crankshaft that can cause engine malfunction or failure.

19. Lubricate all studs and through-bolts according to the Section 3-2, “Lubricants, Sealants and Adhesives.”
20. Install crankcase hardware according to Section 17-2.3, “Crankcase Hardware Installation.”
21. Install the Crankshaft Nose Oil Seal according to instructions in Section 17-3.2, “Crankshaft Nose Oil Seal Installation.”

17-2.3. Crankcase Hardware Installation

WARNING

Replace all fasteners identified as 100% replacement items in Appendix C. Lubricate and torque crankcase hardware in the proper sequence. Failure to do so may result in crankcase damage or engine failure.

1. Lubricate all crankcase through-bolts, through studs and studs according to instructions in Appendix B with approved lubricants (Section 3-2, “Lubricants, Sealants and Adhesives.”).

   NOTE: Positions mentioned in these instructions refer to Figure 17-7. Indexed parts in parentheses refer to Figure 17-6. Unless otherwise noted, snug, but do not torque nuts during installation. Fasteners will be torqued after cylinder installation.

2. Install 1.25" X 0.25" dowel screws (Figure 17-6) (30), with washers (28A) at positions 26 and 27 to align the crankcase halves from the 1-3 crankcase side through the crankcase flanges and secure with washers (27) and nuts (24)
3. Insert a 1.63" X 0.25" dowel screw (29), with washer (28A) in position 33 from the 1-3 crankcase side through the crankcase flange, special washer (26) and lifting eye (25). Insert a 1.50" X 0.25" screw (28) and washer (45) in position 31 from the 1-3 crankcase side. Place two special washers (26) followed by the lifting eye (25), on the 2-4 side crankcase on the screws at positions 31 and 33. Secure the assembly with a washer (45) and nut (24) at position 31 and a washer (27) and nut (24) at position 33.
4. Install two new 10.50" through-bolts (33) in the bosses above and below the intermediate crankshaft journal at positions 1 and 4. Center the installed through-bolts (33) in the crankcase with a rawhide mallet.
5. Install screws (23) and washers (45) through the remaining crankcase flange screw holes in the 1-3 crankcase half; secure with washers (45) and nuts (24) on the 2-4 side of the crankcase.

6. Install washers (34) and nuts (35) on the two through studs protruding from the 2-4 crankcase half forward of the No. 4 cylinder.
7. Install washers (31) and nuts (32) on the two through studs protruding from the 1-3 crankcase half even with the rear camshaft journals.

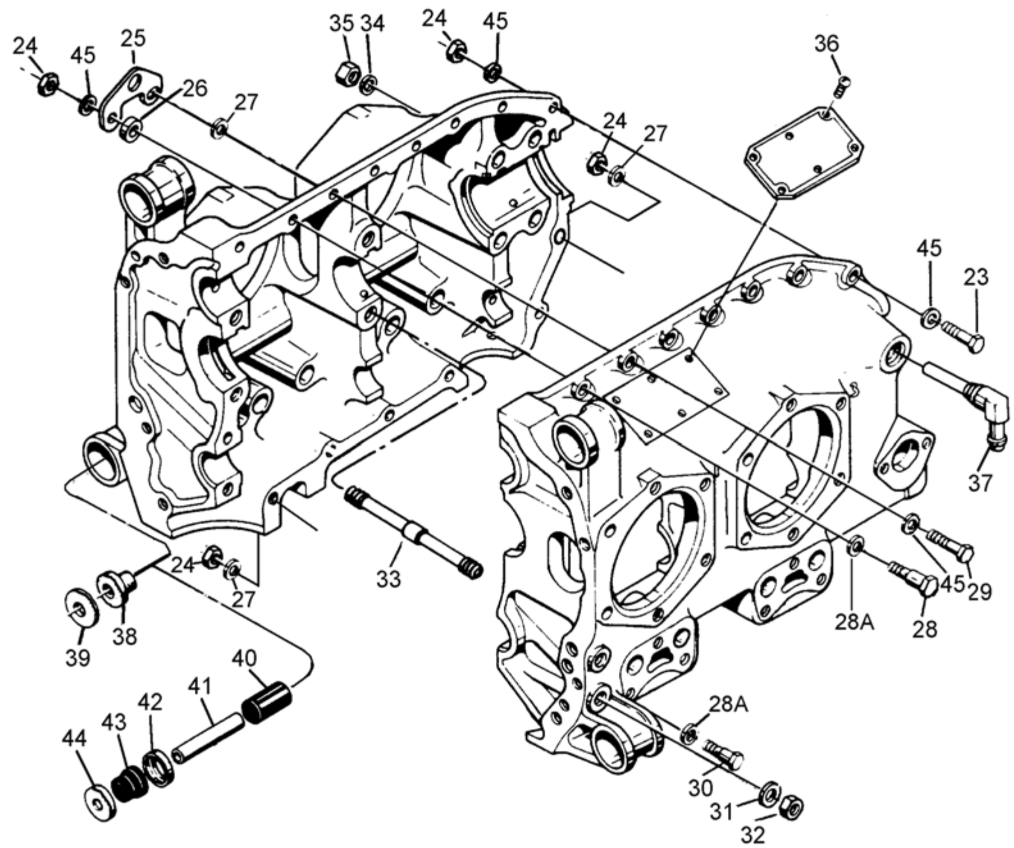

Figure 17-6. Crankcase Fasteners (A)

23	Screw	28	Screw	32	Nut	41	Engine Mount Spacer
24	Nut	28A	Washer	33	Through Bolt	42	Engine Mount Seat
25	Lifting Eye	29	Screw	34	Washer	43	Engine Mount Bushing
26	Special Washer	30	Screw	35	Nut	44	Cup Washer
27	Washer	31	Washer	36	Screw	45	Washer

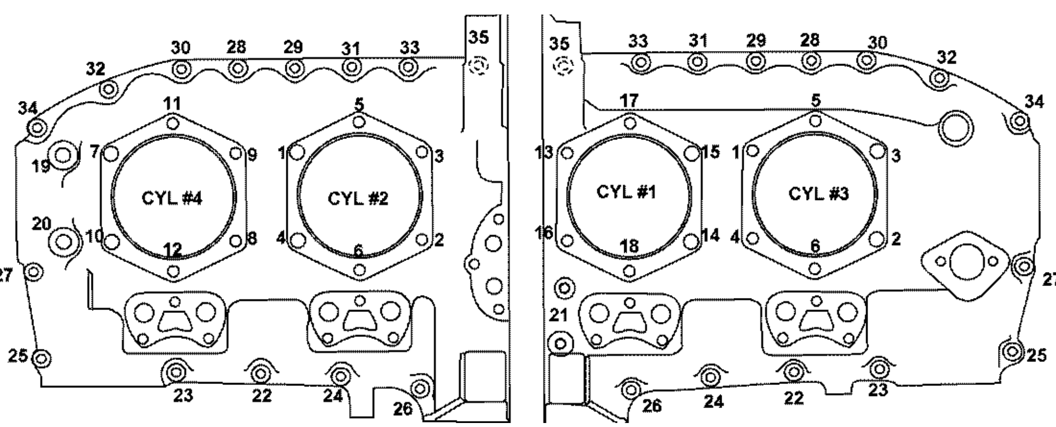

Figure 17-7. Crankcase Torque Sequence

17-3. Cylinder Installation

WARNING

Do <u>not</u> install a cylinder that does not conform to the Appendix D overhaul dimensional inspection criteria cited in Chapter 15, Inspection and Repair. Ensure each cylinder has the required new parts and the cylinder barrel is clean, free of cracks, nicks, scratches, pitting, and rust before installation.

1. Gently lower the connecting rods to the crankcase cylinder mounting flange
2. Lubricate all cylinder through-bolt and deck stud threads with clean 50-weight aviation engine oil cited in Section 3-2, “Lubricants, Sealants and Adhesives.”
3. Carefully rotate the crankshaft until the Nos. 1 and 2 connecting rods are in the outermost position.

WARNING

Do not apply <u>any</u> form of sealant to the crankcase cylinder deck, chamfer, cylinder mounting flange, cylinder base O-ring, or cylinder fastener threads. The use of RTV, silicone, Gasket Maker or <u>any</u> other sealant on the areas listed above during engine assembly will cause a loss of cylinder deck stud or through-bolt torque. Subsequent loss of cylinder attachment load, loss of main bearing crush and/or fretting of the crankcase parting surfaces will occur. The result will be cylinder separation, main bearing movement, oil starvation and catastrophic engine failure. USE ONLY CLEAN 50 WEIGHT AVIATION ENGINE OIL ON SURFACES LISTED.

4. Lubricate a new cylinder base packing (Figure 17-9) (35) with grade 50 aviation engine oil and install the new packing on the cylinder base flange. Ensure the new cylinder base packing is not twisted.
5. Back the No. 1 new piston (Figure 17-8) (1) and pin (5) out of the cylinder far enough to provide clearance to install the new piston (1) on the connecting rod.
   a. Place the No. 1 cylinder and piston (1) on the connecting rod.
   b. Align the piston (1) with the connecting rod and slide the piston pin (5) into the connecting rod.
   c. Compress the oil control piston ring with a ring compressor and push the cylinder until the fourth piston ring is inside the cylinder barrel.
   d. On cylinders with swaged pushrod housings only, align the pushrod housings with the holes in the pushrod housing adapter.
   e. Remove the ring compressor and push the cylinder assembly against the crankcase cylinder deck with the stud holes aligned.

f. While supporting the cylinder, install, but do not torque, the 0.375" cylinder flange nuts (Figure 17-9) (2) at the 6 and 12 o'clock stud positions. Install the 0.4375" (3) flange nuts on the remaining cylinder mounting deck studs.

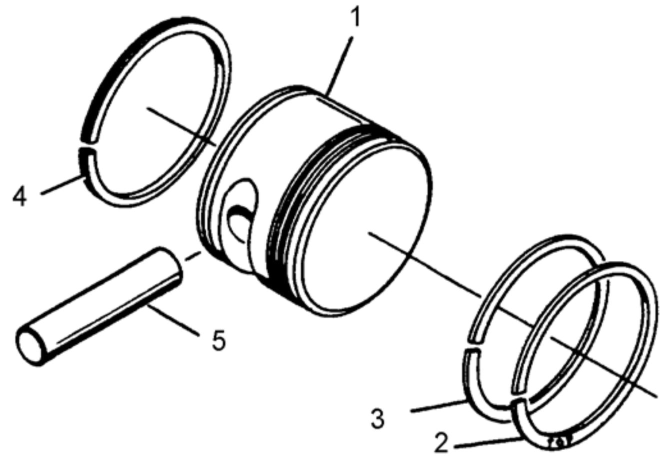

Figure 17-8. Piston, Pin and Rings

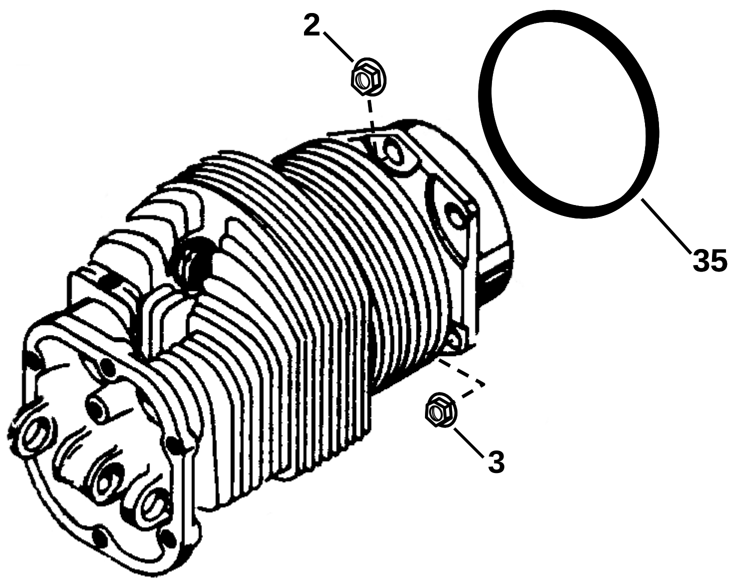

Figure 17-9. Cylinder and Valve Assembly

6. Repeat step 3- 5f for cylinder No. 2.
7. Rotate the crankshaft until connecting rod Nos. 3 and 4 are in their outermost position.
8. Repeat steps 3- 5f for cylinder Nos. 3 and 4.
9. Proceed to Section 17-3.1, “Cylinder and Crankcase Torque.”

17-3.1. Cylinder and Crankcase Torque

Before torquing the crankcase, use a straight edge to confirm the rear crankcase half ends are flush with each other. Do not proceed with final torque unless the crankcase halves are flush.

NOTE: Crankcase and cylinder torque requires two people; the torque is applied in two stages: first in a preliminary torque sequence, followed by a final torque sequence.

WARNING

Torque values specified for engine assembly are for use with clean nuts, bolts and studs with threads that are free of damage, distortion which have been pre-lubricated with clean 50-weight aviation engine oil prior to assembly. The torque wrench must be currently calibrated and traceable to the National Bureau of Standards. Incorrect through-bolt and deck stud torque may result in subsequent engine malfunction and failure.

1. After cylinders and hardware is installed, have an assistant hold the fastener on the opposite side of crankcase and simultaneously torque the crankcase fasteners in the sequence shown in Figure 17-7. Torque all the fasteners to ½ the value listed in Appendix B.

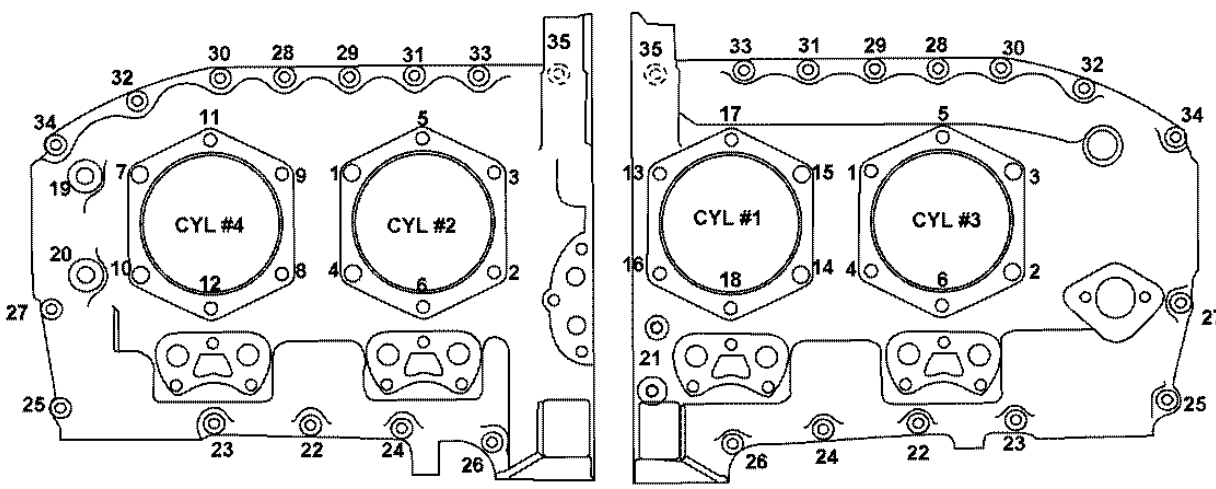

Figure 17-7 repeated for reference

2. Using the torquing sequence shown in Figure 17-7, torque nuts in the numbered sequence to the final torque values listed Appendix B.

17-3.2. Crankshaft Nose Oil Seal Installation

CAUTION: Use care to prevent displacement or damage to the crankshaft nose seal and silk thread.

1. Apply Part No. 654663 Gasket Sealant to the mating crankcase flange.
2. Spray Part No. 653692 Gasket Sealant Primer on the oil seal counterbore and allow it to dry for 1 to 2 minutes.
3. Apply a translucent coat of Part No. 646942 Gasket Maker on the wall of the oil seal counterbore. Refer to Gasket Maker application instructions in Appendix C.
4. Using thumb pressure, work the seal into the crankcase counterbore with the oil seal split line positioned at the 10 or 2 o'clock position.
5. After the seal is in place, wipe any remaining sealant from the seal and crankshaft.
6. Spray the exposed portion of the crankshaft (with the new helix pattern restored by the “Crankshaft Plating Overhaul” procedure in Section 15-7.8.2.1) with aluminum primer and allow it to dry.

17-3.3. Inter-Cylinder Baffle Installation

1. Insert a clevis pin (Figure 17-10) (4) through the hole in the center of the bottom of the inter-cylinder baffles (3).
2. Loop a new spring (2) through the hole in the clevis pin (4).
3. Insert a spring hook through the upper eye of the spring and position the inter-cylinder baffles (3) between the 1-3 and 2-4 cylinders. Verify proper positioning of the baffles (3).

   CAUTION: Do not overextend the spring (2) during installation. Overstretching the spring will cause deformation of the spring and a poor fit to the cylinders.

4. Extend the eyelet of the spring (2) with the spring hook high enough to insert the end of a retainer (1) through the eye of the spring. Center the spring on the lowest point on the retainer (1).
5. Position the retainer equal distance over each cylinder barrel.

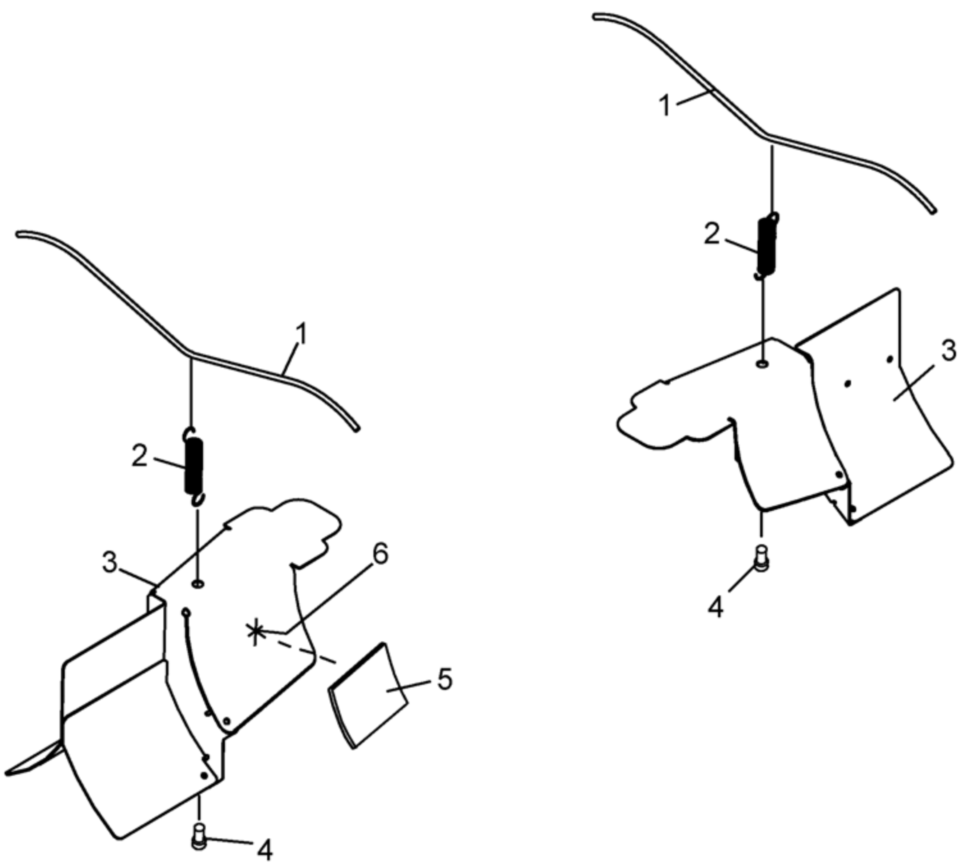

Figure 17-10. Inter-Cylinder Baffle Assembly

1	Baffle Retainer	4	Clevis Pin
2	Spring	5	Isolator
3	Baffle	6	Adhesive

17-4. Valve Train Installation

17-4.1. Pushrod Housing Installation

1. Apply Part No. 642188 Gasket Sealant (Copper Coat) to both sides of the new gasket (Figure 17-11) (44). Install the new gasket (44) and adapter (43) below each cylinder flange. Secure the adapters to the crankcase with large washers (47), smaller washers (30) and new lock nuts (42). Torque the lock nuts to Appendix B specifications.
2. Use a Borroughs 68-3 (or equivalent) Pushrod Spring Compressor to compress the new spring (45) on the pushrod housing (12). Install a washer (46), packing (49) and washer (46) on the end of the pushrod housing with the compressed spring (45).
3. Insert the compressed pushrod assembly (48, 12, 45, 46, 49 & 46) in the pushrod adapter (43).
4. Place a new O-ring (48), lubricated with clean 50 weight aviation engine oil on the free end of the pushrod housing (12).
5. While the spring (45) is compressed and the lower portion of the pushrod housing is inserted in the pushrod adapter (43), guide the top of the pushrod housing (12) into the cylinder head pushrod housing flange.
6. Slowly release pressure on the spring while verifying the pushrod housing (12) and O-ring (48) are properly seated in the cylinder head flange.
7. Remove the Pushrod Spring Compressor Tool.

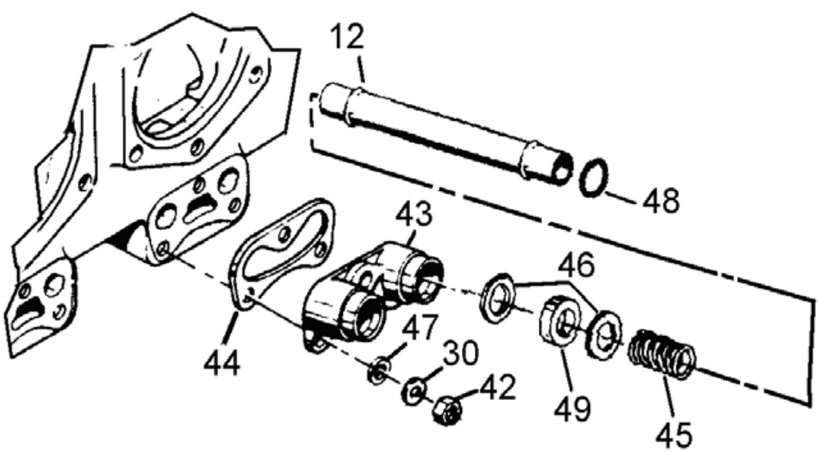

Figure 17-11. Pushrod Housing and Adapter Detail

12	Pushrod Housing	45	Spring
30	Lock Washer	46	Washer
42	Lock Nut	47	Washer
43	Pushrod Adapter	48	O-ring Seal
44	Pushrod Adapter Gasket	49	Pushrod Housing Seal

17-4.2. Rocker Arm Installation

1. Lubricate the pushrods (Figure 17-14) (41) with clean 50 weight aviation engine oil and install through the cylinder openings into the pushrod housings (12).
2. Before installing valve actuating parts on each cylinder, completely bleed the lifters and turn the crankshaft until the intake and exhaust valves in No. 1 and No. 2 cylinders are closed.
3. Lubricate the rocker arms (23) and rocker shaft (26) for the No. 1 cylinder with clean 50 weight aviation engine oil.

   CAUTION: Intake and exhaust rocker arms are not interchangeable. Exhaust rocker arms feature an oil orifice (Figure 17-12) to lubricate the exhaust valve stem; the intake rocker arm has no oil orifice.

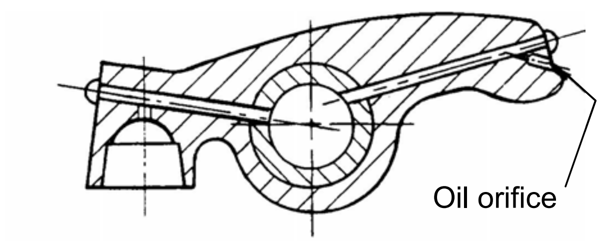

Figure 17-12. Exhaust Rocker Arm Oil Orifice

4. Slide the rocker shaft (Figure 17-14) (25) in the cylinder head rocker shaft boss from the intake side of the cylinder. Align the intake rocker arm (22) with the cylinder head boss and slide the rocker shaft (25) into the center rocker shaft boss.
5. Align the exhaust rocker arm (22) bore with the cylinder head boss and slide the rocker shaft (25) through the center rocker shaft boss.
6. Using a feeler gauge, verify the side clearance between the rocker arms and rocker arm boss conforms to Appendix D specifications.
7. Check the rocker arm-to-retainer clearance (Figure 17-13) with the valve in the closed position and the foot of the rocker in contact with the valve stem tip.

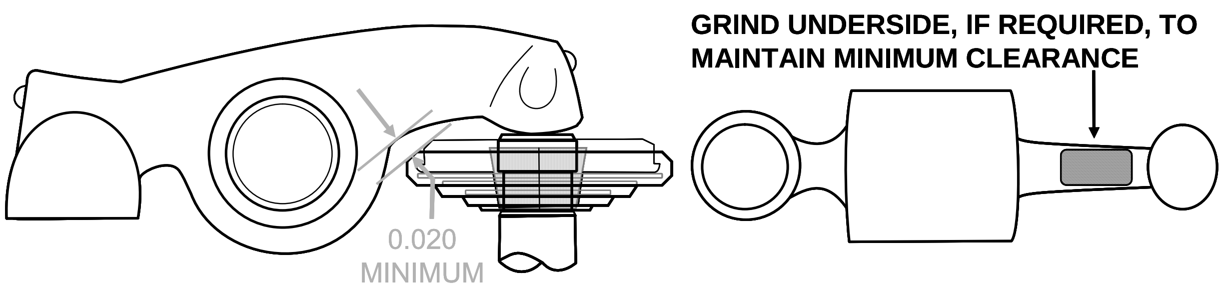

Figure 17-13. Rocker Arm to Retainer Clearance

8. If the clearance does not conform to the dimensions in Appendix D and Figure 17-13, refer to the Section 15-7.5.17, “Rocker Arm Bushing Replacement” and

Section 15-7.5.18, “Rocker Arm-to-Retainer Clearance” for rocker arm servicing procedures.

9. Measure and compare the dry valve lash at the valve tip to the rocker foot to Appendix D dimensional limits.

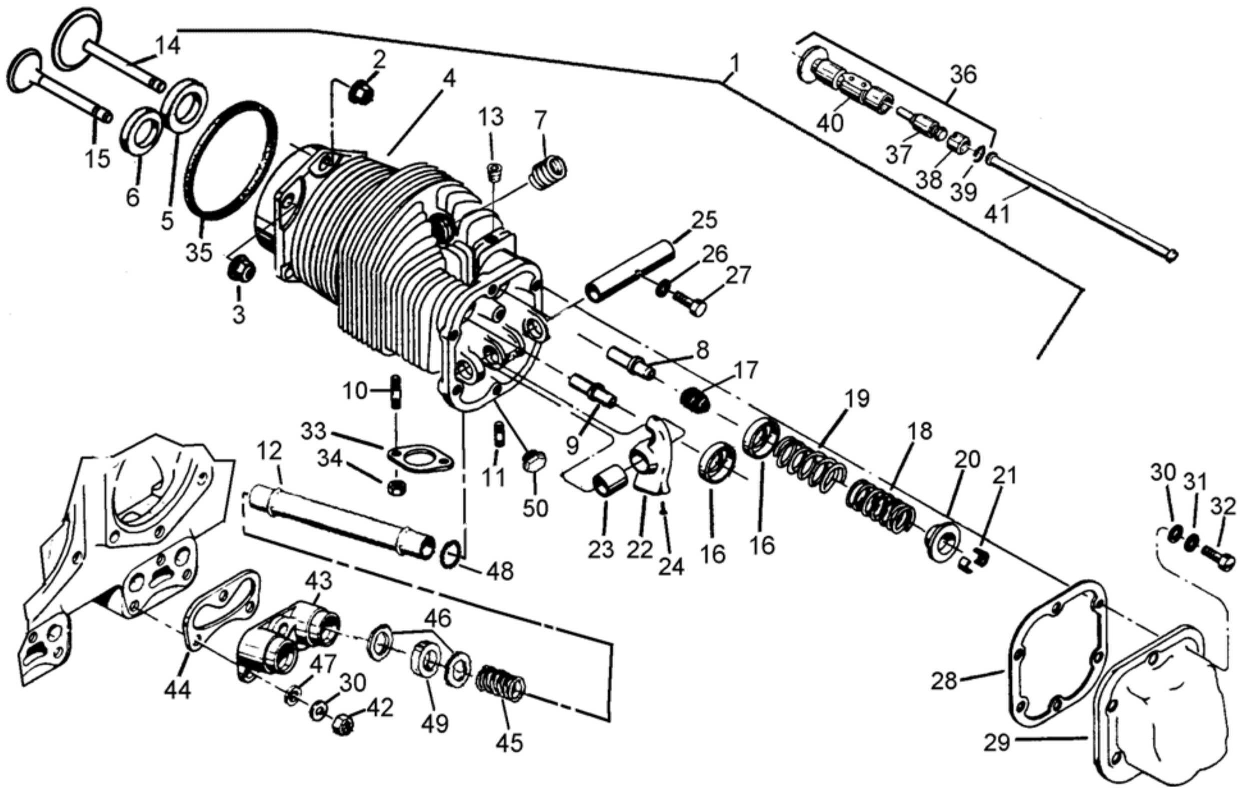

Figure 17-14. Cylinder Assembly

1	Cylinder & Valve Assembly	13	Plug	25	Rocker Shaft	38	Socket
2	Nut	14	Intake Valve	26	Washer	39	Snap Ring
3	Nut	15	Exhaust Valve	27	Bolt	40	Lifter Body
4	Cylinder Assembly	16	Valve Spring Seat	28	Rocker Cover Gasket	41	Push Rod
5	Intake Valve Seat Insert	17	Intake Valve Guide Seal	29	Rocker Cover	42	Lock Nut
6	Exhaust Valve Seat Insert	18	Inner Valve Spring	30	Washer	43	Pushrod Adapter
7	Helical Coil Insert	19	Outer Valve Spring	31	Lock Washer	44	Pushrod Housing Gasket
8	Intake Valve Guide	20	Valve Spring Retainer	32	Bolt	45	Spring
9	Exhaust Valve Guide	21	Valve Spring Key	33	Exhaust Flange Gasket	46	Washer
10	Stud	22	Rocker Arm Assembly	34	Lock Nut	47	Washer
11	Stud	23	Rocker Arm Bushing	35	Packing	48	O-ring Seal
12	Pushrod Housing	24	Screw	36	Lifter Assembly	49	Pushrod Housing Seal
				37	Plunger Assembly	50	Spark Plug Insert

10. Align the threaded hole in the rocker shaft with the screw hole in the center rocker shaft boss. Install a bolt (Figure 17-14) (27) and washer (26) through the hole in the center rocker shaft boss and torque the bolt (27) to Appendix B specifications.

11. Repeat steps 3 through 10 for the #2 cylinder.

12. Turn the crankshaft until the intake and exhaust valves in cylinders 3 and 4 are closed. Install the pushrods (41) and valve actuating mechanism (23 through 25) on remaining cylinders by repeating steps 3 through 11, replacing the references to cylinders Nos. 1 and 2 with cylinder Nos. 3 and 4.

13. Temporarily install the rocker covers (28) with new gaskets (27) with washers (29), new lock washers (29), and six fillister head screws (30). Do not torque screws (30) at this time (the rocker covers will be removed for engine pre oiling during engine installation).

17-5. Oil Cooler Adapter Installation

The O-200 features an oil cooler adapter to direct engine oil to a remote mounted oil cooler. The oil cooler, if installed, is supplied by the airframe manufacturer; consult the airframe manufacturer's instructions for oil cooler mounting and connection instructions. If the engine is configured without an oil cooler adapter, the oil cooler adapter pad cover must be installed to route the oil back to the crankcase oil gallery.

17-5.1. Oil Cooler Adapter Installation

1. Apply Part No. 642188 Gasket Sealant (Copper Coat) to both sides of a new gasket (Figure 17-15) (2). Install the assembled oil cooler adapter (1) and a new gasket (2) on the mounting pad at the rear of the 2-4 crankcase half (Figure 17-7) with washers (3), new lock washers (4), and nuts (5).
2. Torque the nuts (Figure 17-15) (5) to Appendix B specifications.

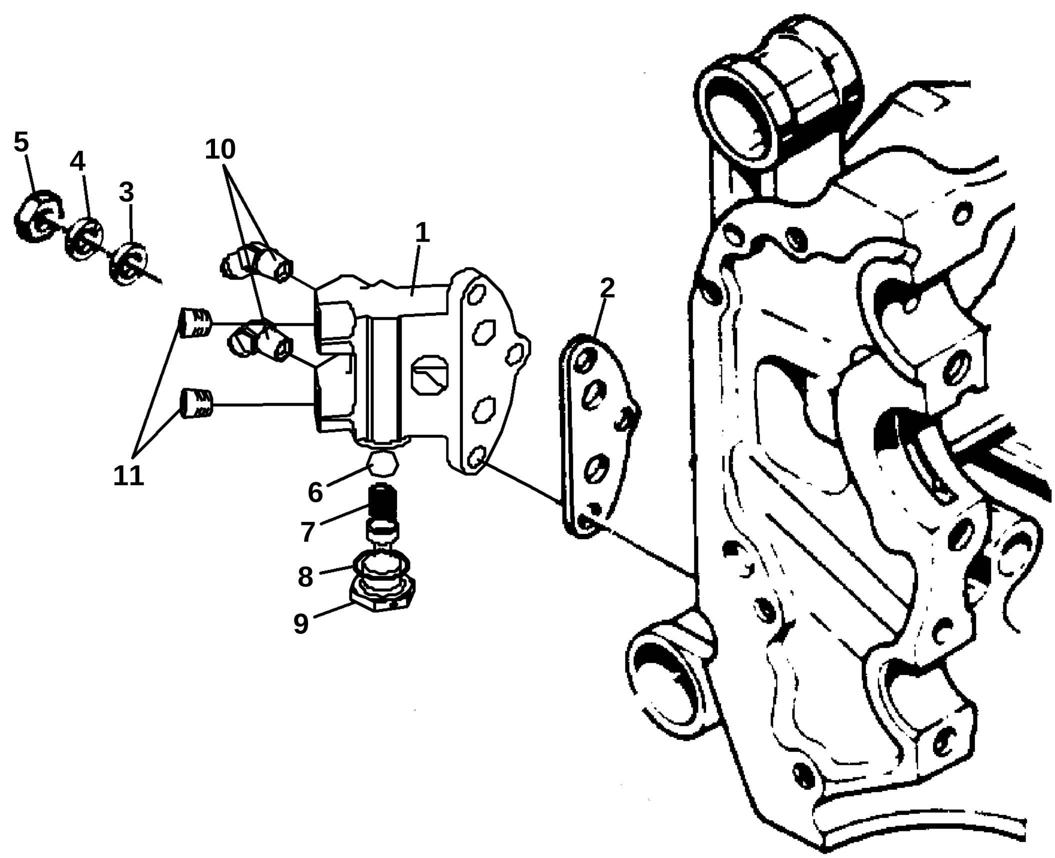

Figure 17-15. Oil Cooler Adapter

1	Oil Cooler Adapter	4	Lock Washer	7	Spring	10	45° degree fitting
2	Oil Cooler Adapter Gasket	5	Nut	8	Copper Gasket	11	0.25”-18 Plug
3	Washer	6	Ball - 0.437 steel	9	Plug		

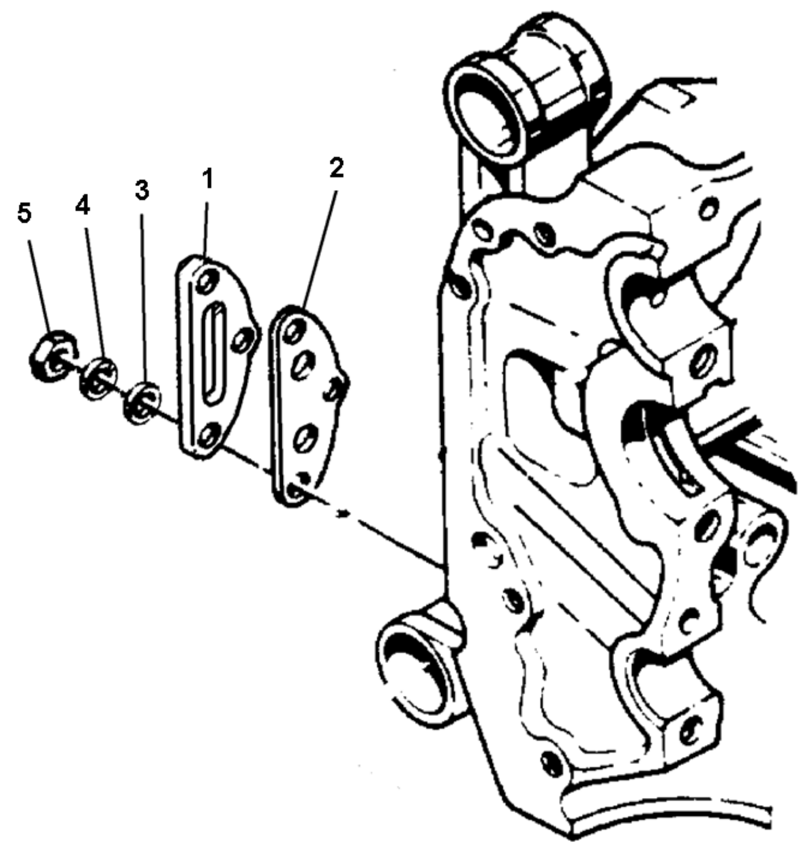

Figure 17-16. Oil Cooler Adapter Pad Cover

1	Oil Cooler Adapter Pad Cover	4	Lock Washer
2	Oil Cooler Adapter Gasket	5	Nut
3	Washer		

17-6. Vacuum Pump Adapter Pad Cover Installation

1. Apply Part No. 642188 Gasket Sealant (Copper Coat) to the both surfaces of the new gasket (Figure 17-17) (11) and install the new gasket (11) on the crankcase accessory drive mounting flange.
2. Mount the accessory drive cover on the crankcase studs surrounding the open flange at the bottom of the crankcase with washers (6 & 9), new lock washers (4 & 8), and nuts (6 & 9). Tighten and torque the nuts (6 & 9) evenly to Appendix B specifications to prevent damage to the gasket.

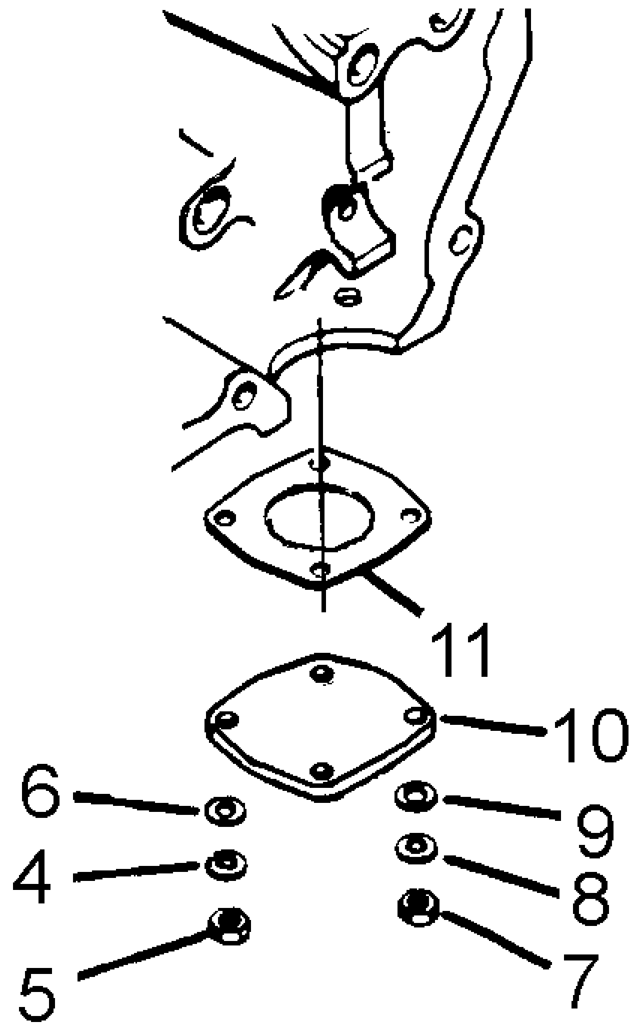

Figure 17-17. Vacuum Pump Pad Cover

4	Lock Washer	7	Washer	10	Accessory Drive Cover
5	Nut	8	Lock Washer	11	Gasket
6	Washer	9	Washer		

17-7. Fuel Pump Pad Cover Installation

NOTE: Refer to the “Hose and Tubing Installation” instructions in Section C-12 when installing and tightening fuel hoses.

1. Apply Part No. 642188 Gasket Sealant (Copper Coat) to both sides of the new gasket (1).
2. Install the fuel pump pad cover (Figure 17-18)) (2) with a new gasket (1) on the crankcase studs forward of the No. 3 cylinder.
3. Secure the assembly with two sets of washers (3), new lock washers (4), and nuts (5).

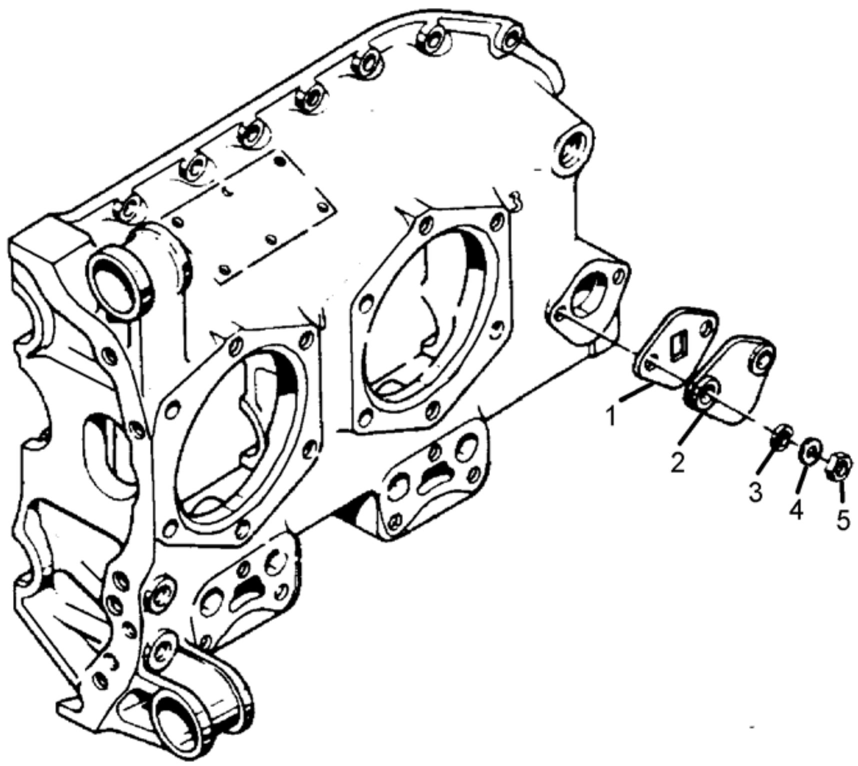

Figure 17-18. Fuel Pump Pad Cover

1	Gasket	4	Lock Washer
2	Cover	5	Nut
3	Washer		

17-8. Accessory Case Installation

1. Lubricate the accessory case stud threads with clean 50 weight aviation engine oil.
2. Apply Part No. 642188 Sealant (Copper Coat) to the non-beaded side of the accessory case to crankcase gasket.
3. Install a new accessory case gasket (Figure 17-20) (5) on the crankcase case studs.
4. Mount the accessory case on the crankcase and secure with five sets of washers (10), new lock washers (11), and nuts (12). Verify the accessory case mates properly with the crankcase.
5. Torque the accessory case nuts (12) to ½ the final value specified in Appendix B using the sequence illustrated in Figure 17-19.
6. Torque the nuts (12) to the final value specified in Appendix B in the torque sequence shown in Figure 17-19.

   CAUTION: Do not cut or scratch mounting flange surfaces.

7. Remove excess gasket material protruding from the bottom section of the accessory case and oil sump mating surface with a utility knife.

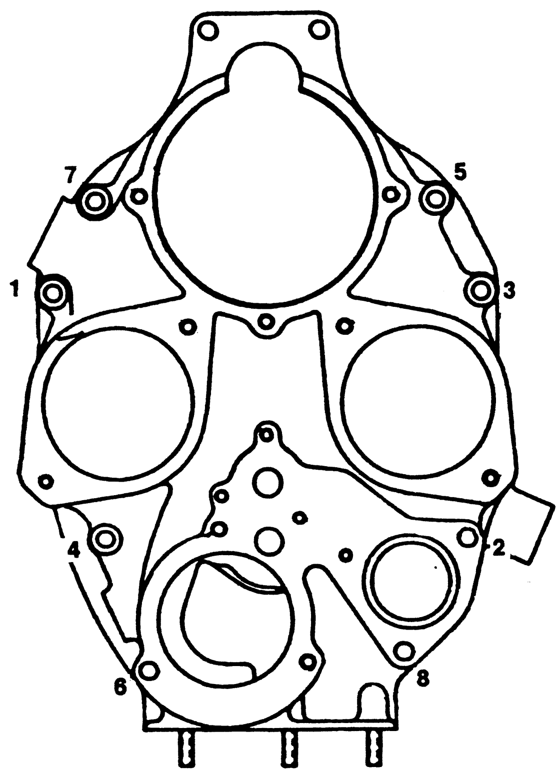

Figure 17-19. Accessory Case Torque Sequence

8. Sparingly apply Dow Corning® No. 4 to a new oil filter (Figure 17-20) (22) rubber seal.

9. Install a new oil filter (22) on the adapter stud. Torque the filter (22) to Appendix B specifications and safety wire the oil filter to the provided holes in the base of the oil filter adapter according to instructions in Section C-4.

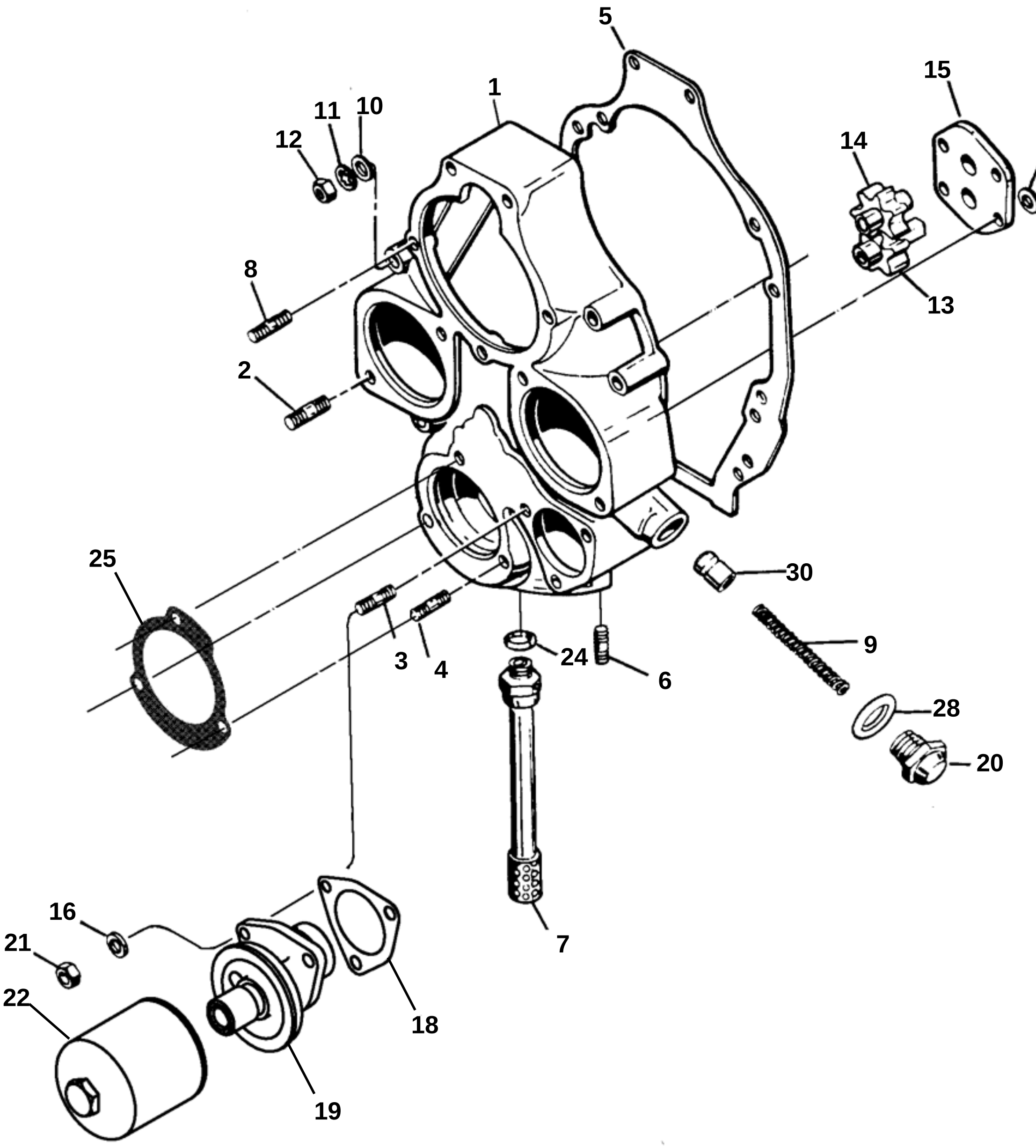

Figure 17-20. Accessory Case

1	Accessory Case w/studs	9	Spring	17	Screw	25	Gasket
2	Stud	10	Washer	18	Doesn't	26	Not Used
3	Stud	11	Lock Washer	19	Oil Screen Housing	27	Not Used
4	Stud	12	Nut	20	Not Used	28	Copper Gasket
5	Gasket	13	Oil Pump Drive Gear	21	Nut	29	Not Used
6	Stud	14	Oil Pump Driven Gear	22	Oil Filter	30	Plunger
7	Suction Tube Assembly	15	Oil Pump Cover	23	Not Used	21	Oil Pump Kit
8	Stud	16	Washer	24	Not Used		

17-9. Alternator Installation

1. Install the alternator (Figure 17-21) (1) on the accessory case studs with a new gasket (2).

   CAUTION: Forcing the alternator installation may damage gear teeth or can cause mount lug failure. If interference exists, inspect the mounting studs for bending. Replace bent studs.

   NOTE: Verify the alternator pilot squarely enters the accessory case bore. Turn the hub assembly slightly to align gear teeth.

2. Verify the alternator enters the crankcase without binding and the mounting flange seats properly against the accessory case. Do not force the alternator into position. If there is stud interference with the mounting lug holes while mounting the alternator, do not force the alternator over the studs.
3. Secure the alternator with washers (3), new lock washers (4) and nuts (5); torque the nuts (5) to Appendix B specifications.
4. If a grounding strap was removed during disassembly, reinstall the grounding strap.

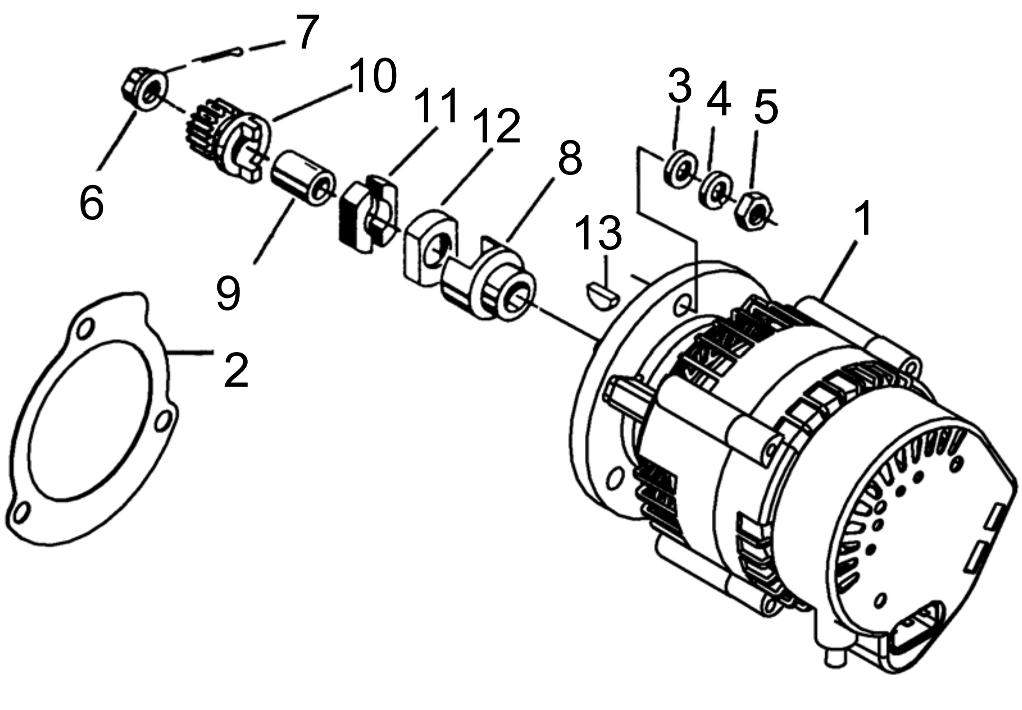

Figure 17-21. Alternator

1	Alternator	5	Nut	9	Sleeve	13	Woodruff Key
2	Gasket	6	Slotted Nut	10	Gear		
3	Washer	7	Cotter Pin	11	Bushing		
4	Lock Washer	8	Alternator Coupling Hub	12	Retainer		

17-10. Starter Installation

1. Apply Part No. 642188 Gasket Sealant (Copper Coat) to both sides of the new gasket (Figure 17-22) (1) and install the new gasket (1) on the accessory case.
2. Align the starter gear with the crankshaft gear; align the starter mounting holes with the accessory case studs and slide the starter in position against the accessory case.

   NOTE: Spacers (7) are used only if the bolt (8) bottoms out before the starter is tight against the accessory case.

3. Place new lock washers (4), washers (6) and spacers (7 (if required)) on new upper through bolts (8). Install the bolts (8), lock washers (4), washers (6) and spacers (7), as required, through the accessory case rear flange holes and thread into the starter.
4. Install washers (3), new lock washers (4) and nuts (5) on the three studs.
5. Tighten the nuts (5) and bolts (8) evenly to avoid misalignment. Torque the nuts (5) and bolts (8) evenly to Appendix B specifications.

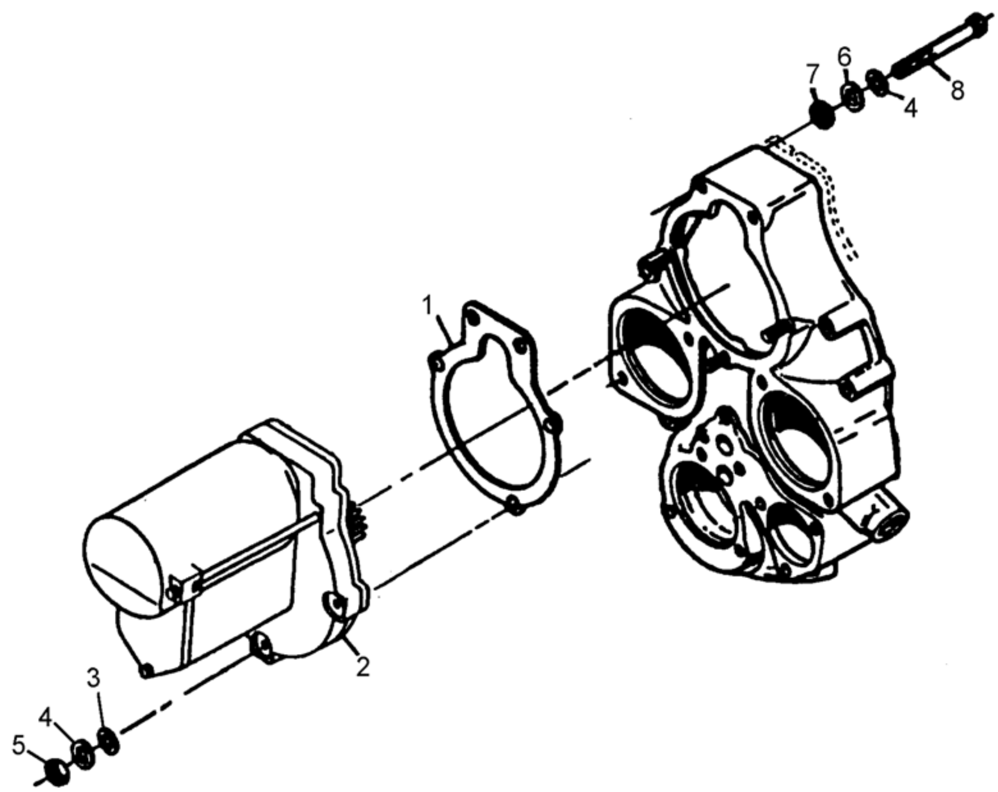

Figure 17-22. Starter

1	Gasket	3	Washer	5	Nut	7	Spacer
2	Starter Assembly	4	Lock Washer	6	Washer	8	Bolt

17-11. Engine Isolator Mount Installation

Engine mounting arms are part of the crankcase casting. The engine isolator mounts are provided by Continental Motors but cannot be assembled without the bolt provided by the airframe manufacturer. Install the engine isolator mounts according to the airframe manufacturer's instructions.

1. Insert a seat (Figure 17-23) (42) in the back side of the mounting arm, followed by a bushing (43) and the number of cup washers (44) necessary to align the engine in the airframe shock mounts in the back side of each engine mount arm.
2. Align the engine with the airframe mounting bolts and slowly move the engine backward over the bolts according to the airframe manufacturer's instructions.
3. On the front side of the engine mounts, install a spacer (41) and hose (40) over the mounting bolt. Insert a seat (42) in the mounting arm hole, followed by a bushing (38) and cup washer (44).
4. Tighten and torque the assembly according to the airframe manufacturer's instructions.

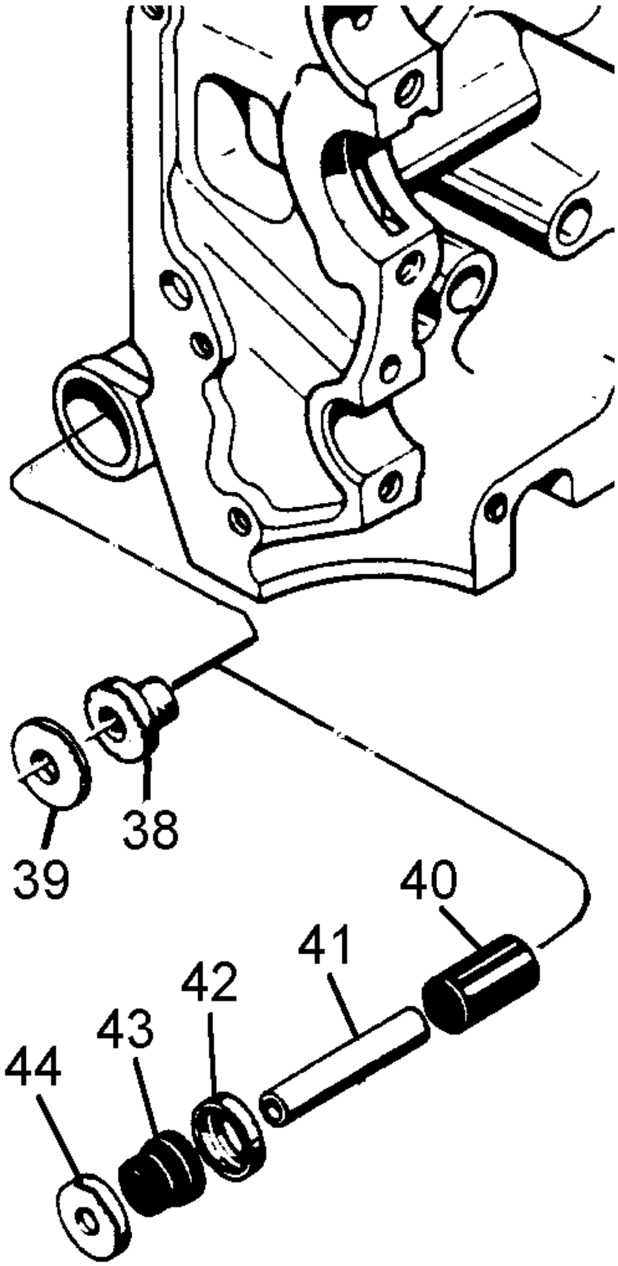

Figure 17-23. Engine Isolator Mount

38	Engine Mount Bushing	40	Hose	42	Seat	44	Cup Washer
39	Washer	41	Spacer	43	Bushing		

17-12. Oil Sump Installation

NOTE: Oil sumps are available with fill tubes on the left (2-4) or right (1-3) side of the engine. Sumps are not interchangeable; install the sump with the fill neck on the same side from which it was removed.

1. Apply a thin, translucent coat of Gasket Maker to the crankcase oil sump mounting flange and oil sump flange; allow the Gasket Maker to dry.
2. Align the bolt holes and install a new gasket (Figure 17-25) (3) on the oil sump (1) mounting flange.
3. Install the oil sump (1) on the crankcase studs. Secure with washers (6) and new lock nuts (7).
4. Torque the new lock nuts (7) to ½ the torque value specified in Appendix B, following the torque sequence in Figure 17-24. Verify the oil sump and crankcase flanges mate evenly.
5. Torque the lock nuts (Figure 17-25) (7) to the final torque according to Appendix B specifications using the torque sequence in Figure 17-24.
6. Install the oil drain plug (Figure 17-25) (4) with a new copper gasket (5) in the bottom of oil sump. Torque the plug (4) to Appendix B specifications.
7. Safety wire the oil drain plug according to Appendix C instructions.
8. Install the oil gauge rod (2) with a new oil gauge gasket in the oil sump filler neck.

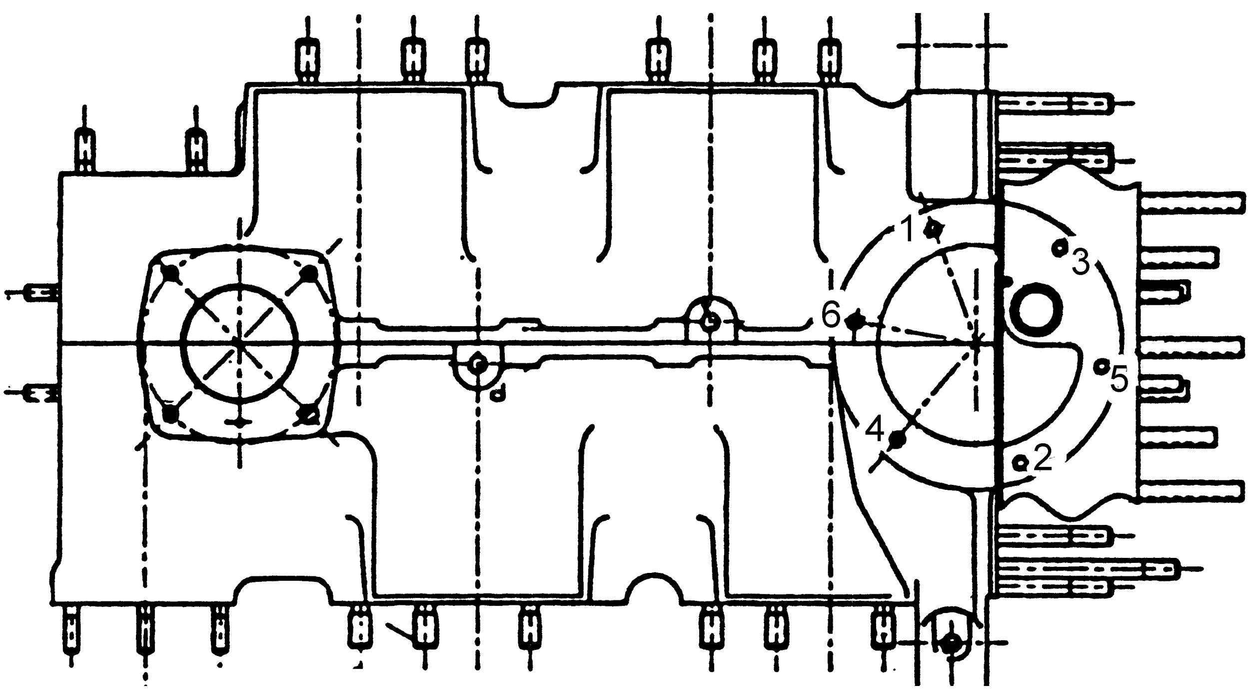

Figure 17-24. Oil Sump Torque Sequence

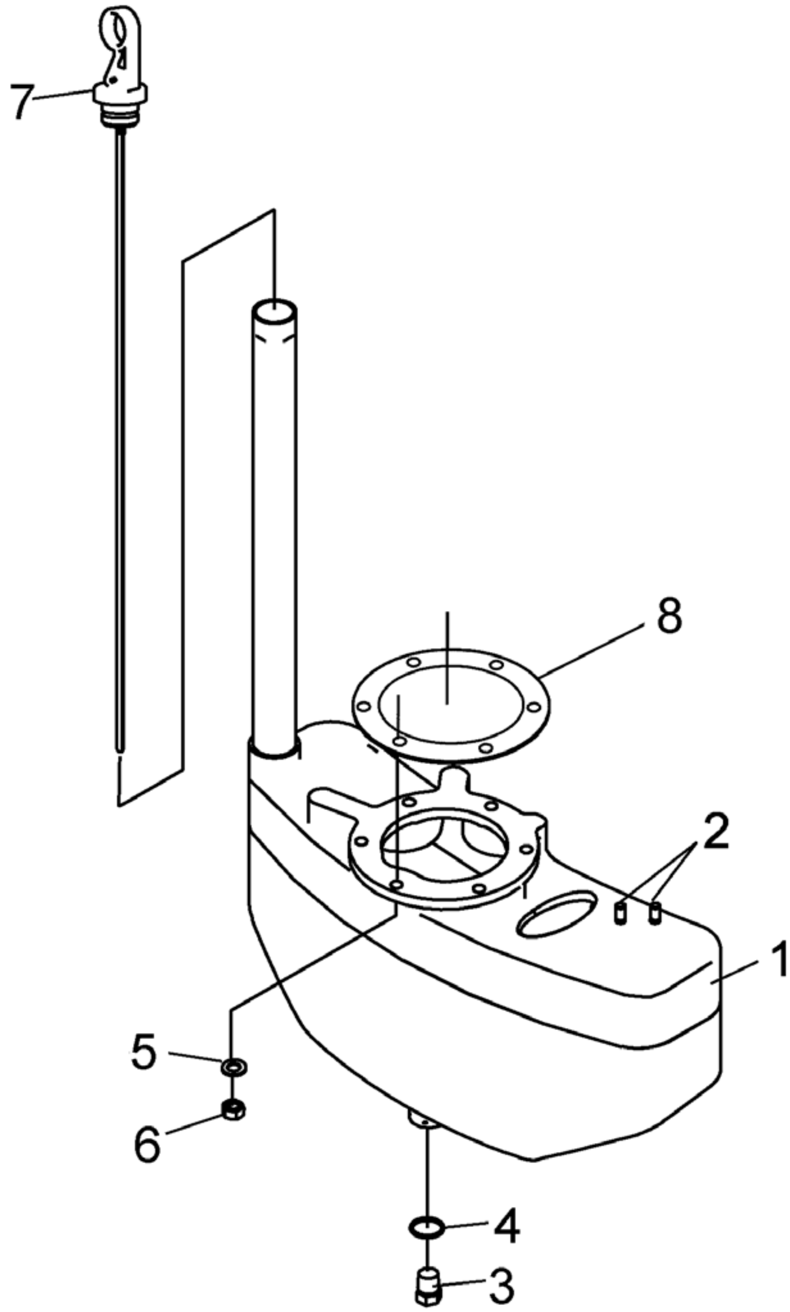

Figure 17-25. Oil Sump

1	Oil Sump Assembly	5	Washer
2	Stud	6	Lock Nut
3	Plug	7	Oil Gauge Rod
4	Copper Gasket	8	Gasket

17-13. Exhaust System Installation

Exhaust system installation is more practical after the engine is installed in the airframe. Install the exhaust system according to the airframe manufacturer's instructions.

17-14. Induction System Installation

1. Center two new seal-o-locks (Figure 17-27) (3) on top of the intake manifold assembly (1) mounting bosses. Slide the intake manifold assembly (1), with new seal-o-locks (3) on the manifold support studs (Figure 17-26). Install a second new seal-o-lock (3) on the mounting studs and loosely secure with castellated nuts (4).

   CAUTION: Do not over-torque the nut to align the cotter pin holes. If the cotter pin holes will not align within the allowable torque limits, replace the nut.

2. Torque the two castellated nuts (Figure 17-27) (4) to the lowest torque specified in Appendix B and check castellated nut alignment with the cotter pin hole in the stud. If the cotter pin hole and slots in the nut align, insert the cotter pin and secure according to Appendix C instructions. If the nut and cotter pin hole do not align, advance the nut in small increments until the hole and slot align and install the cotter pin (5).
3. Slide intake elbows (7 and 8) on the ends of the intake tube assemblies built up in Chapter 16. Install the intake elbows (7 or 8) with new gaskets (6) on the cylinder intake ports with washers (9), new lock washers (10), and nuts (11). Torque the nuts (11) to Appendix B specifications.

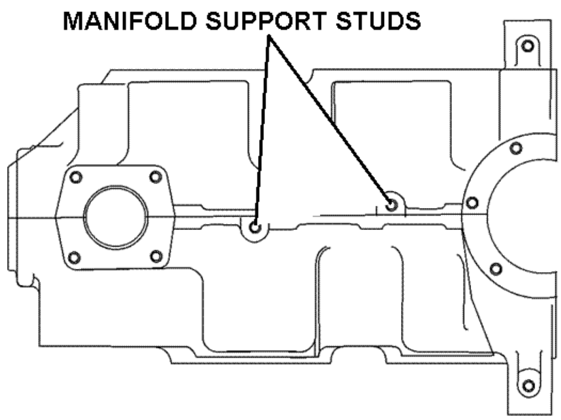

Figure 17-26. Intake Manifold Support Studs

4. Install a new gasket (20) and the carburetor (21) on the intake manifold with the throttle lever on the 1-3 side of the engine. Secure the carburetor to the manifold with four washers (9), new lock washers (10) and nuts (11). Torque the nuts (11) to Appendix B specifications.
5. Install the air intake housing (23) with a new gasket (22) on the carburetor (21) with four new lock washers (10) and nuts (11). Torque the nuts to Appendix B specifications.
6. Install a new air filter assembly (24) on the air intake housing (23). Secure the filter assembly (24) to the air intake housing (23) by aligning the four quarter turn fasteners with the nut plates and turning the fasteners until they lock in the nut plate.

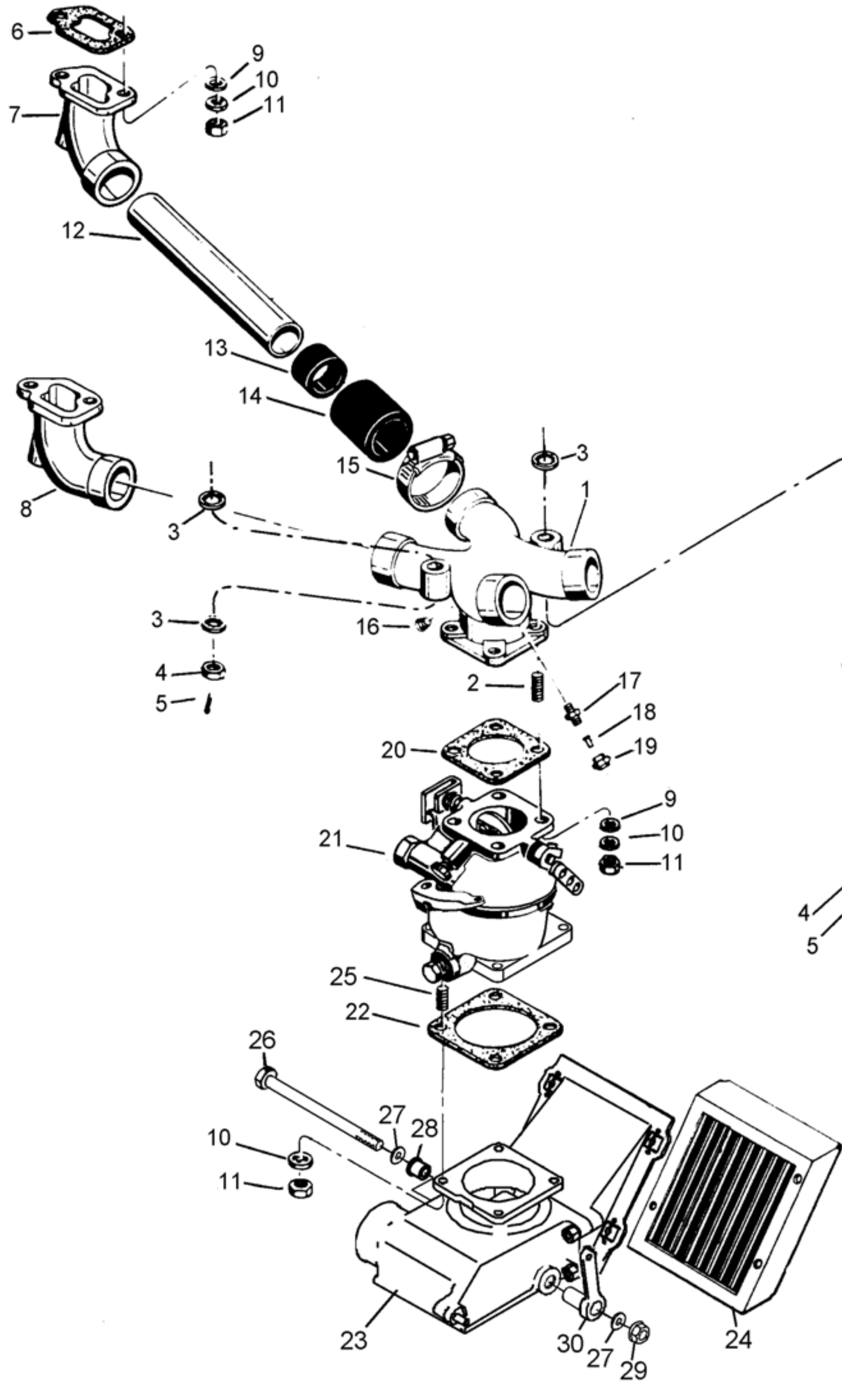

Figure 17-27. Induction System

1	Intake Manifold Assembly	9	Washer	17	Nipple- primer	25	Stud
2	Stud	10	Lock Washer	18	Union	26	Bolt
3	O-lock Seal	11	Nut	19	Nut	27	Washer
4	Castle Nut	12	Intake Pipe	20	Carburetor Gasket	28	Bushing
5	Cotter Pin	13	Hose- 1.50 X 0.88	21	Carburetor	29	Lock Nut
6	Intake Manifold Gasket	14	Hose - 1.75 X 2.00	22	Carburetor Gasket	30	Lever
7	Induction Elbow - Cyl 1 & 4	15	Clamp	23	Air Intake Housing		
8	Induction Elbow - Cyl 2 & 3	16	Plug - 0.25	24	Filter		

17-15. Ignition System Installation

The O-200 ignition system may be manufactured by either Slick (Unison) or Continental Motors. Refer to the installation instructions, based on the magneto model.

CAUTION: The magnetos must be replaced or overhauled according to the manufacturer's instruction prior to installation.

17-15.1. Continental Motors Ignition System Installation

1. Complete “Crankshaft Top Dead Center Alignment” procedure in Section 6-3.8.1.1.
2. Remove inspection hole plugs from the magneto(s). Turn the impulse coupling backward so latches will not engage until the timing pointer inside the inspection hole is aligned with the marked distributor gear tooth.
3. Without turning the magneto shaft, hold the magneto in the position it will occupy when installed.
   a. Align the gear slot and impulse coupling lugs by pulling the magneto gear out and turning it to the desired position.
   b. Push the gear back into the meshed position.
4. Lubricate both sides of a new gasket (Figure 17-28) (4) with Dow Corning No. 4 and install the gasket on the magneto flange.
5. Carefully insert the magneto in the crankcase, aligning the drive gear teeth with the camshaft gear. Secure the magneto with washers (7), new lock washers (6) and nuts (5); hand-tighten the nuts (5) at this time.
6. Install the ignition harness cable outlet plates and secure with screws (11), torque the screws to Appendix B specifications.
7. Repeat steps 2 through 6 for the second magneto
8. Complete “Magneto to Engine Timing” in Section 6-3.8.1.2. Torque nuts according to Appendix B specifications upon completion of magneto timing.
9. Disconnect timing light from magnetos.

   NOTE: Do not install the spark plugs until after the engine is installed in the airframe and engine pre-oiling (Section 5-3.3.1) is complete.

10. Secure the harness with cushion clamps according to the harness routing instructions in Section C-13.

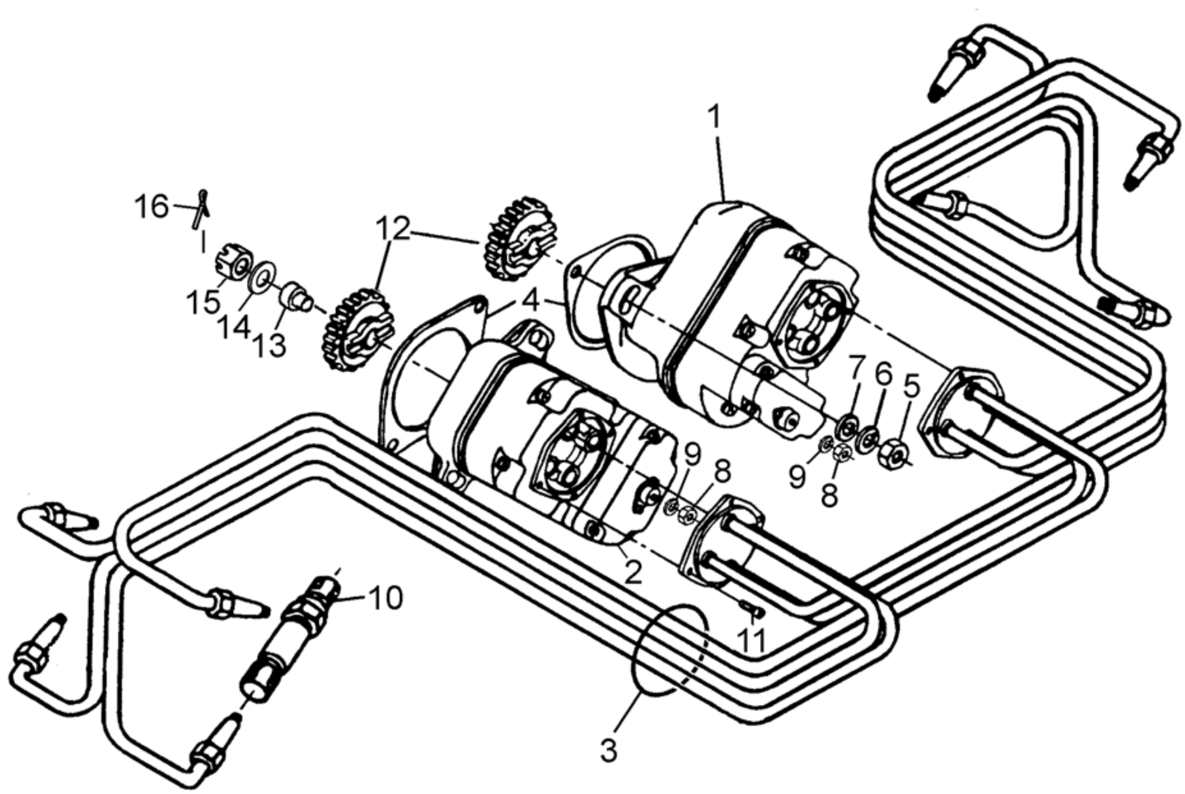

Figure 17-28. Continental Motors Ignition

1	Left Magneto	5	Nut	9	Lock Washer	13	Bushing
2	Right magneto	6	Lock Washer	10	Spark Plug	14	Washer
3	Ignition Harness	7	Washer	11	Screw	15	Nut
4	Flange Gasket	8	Nut	12	Gear	16	Cotter Pin

17-15.2. Slick Ignition System Installation

1. Complete "Crankshaft Top Dead Center Alignment" procedure in Section 6-3.8.1.1.
2. Insert a T118 timing pin in "L" or "R" hole (depending on magneto rotation) in the distributor block. Turn the rotor in the opposite direction of rotation until the pin engages the gear.
3. Without turning the magneto shaft, hold the magneto in the position it will occupy when installed.
   a. Align the magneto drive gear with the camshaft gear by pulling the magneto gear out and turning it to the desired position.
   b. Push the gear back into the meshed position.
   c. Verify the magneto drive coupling bushings and retainers are properly installed.

   CAUTION: Remove the T118 timing pin before rotating the crankshaft to prevent magneto damage.
4. Remove the T118 timing pin and replace the inspection hole plug.
5. Lubricate both sides of a new gasket (Figure 17-29) (3) with Dow Corning No. 4 and install the gasket on the magneto flange.
6. Carefully insert the magneto in the crankcase, aligning the drive gear with the camshaft gear. Install four sets of holding washers (7), new lock washers (6) and nuts (5); hand-tighten the nuts at this time.
7. Complete "Magneto to Engine Timing" in Section 6-3.8.1.2. Upon completion of magneto timing, torque the nuts (5) to Appendix B specifications.
8. Disconnect the timing light from magnetos. Attach the magneto grounding wire and torque according the airframe manufacturer's instructions.
9. Install the ignition harness (2) cable outlet plate on the left and right magnetos. Secure the cable outlet plate with three screws. Torque the screws to Appendix B specifications.

   NOTE: Do not install the spark plugs until after the engine is installed in the airframe and engine pre-oiling (Section 5-3.3.1) is complete.
10. Secure the harness with cushion clamps according to the harness routing instructions in Section C-13.

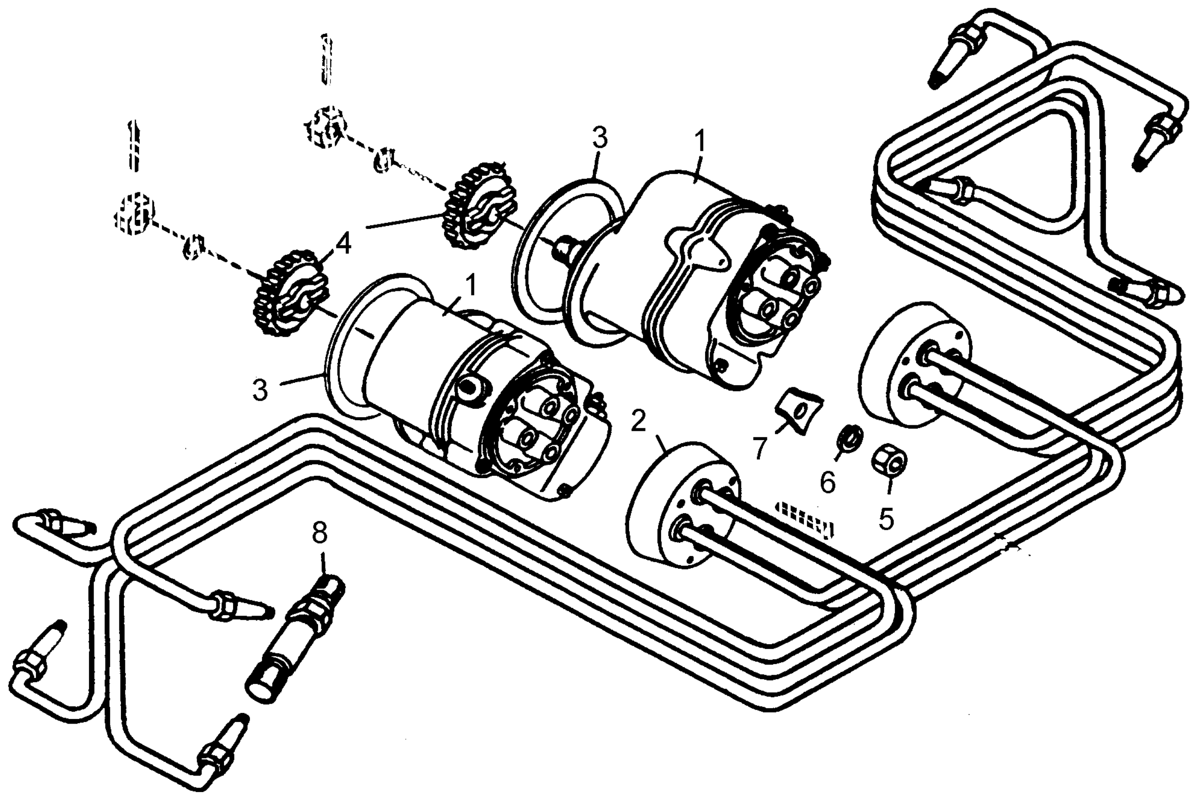

Figure 17-29. Slick Ignition System

1	Magneto - Slick 4301	3	Gasket	5	Nut	7	Magneto Retainer
2	Ignition Harness	4	Magneto Drive Gear	6	Lock Washer	8	Spark Plug

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Chapter 18. Post-Overhaul Test and Adjustments

18-1. Introduction

Specific procedures listed in sections of this chapter must be completed after engine overhaul before the aircraft can be released for normal flight operations.

WARNING

The tasks listed in the Engine Operation Prerequisite Table must be completed in the order listed on an engine before the aircraft is authorized for flight.

Table 18-1. Engine Operation Prerequisites

Sequence	Requirement	Section References
1	Prepare the Engine for Operation	“Maintenance Preflight Inspection” in Section 6-3.6.1
2	Maintenance Test Run	“Standard Acceptance Test” in Section 18-4
3	Complete Operational Checklist	“Engine Operational Checklist” in Section 6-8
4	Check Oil Consumption	“Oil Consumption Test” in Section 18-5
5	Perform Flight Check	“Flight Check” instructions in Section 7-2.3[1]

1. And in accordance with the Pilot’s Operating Handbook (POH).

18-2. Post-Overhaul Testing Prerequisites

Install the engine in the aircraft or an engine test stand (per the applicable test stand or airframe manufacturer’s instructions). The following will be required to conduct post-overhaul testing:

- Fill the engine with oil according to the “Engine Oil Servicing” instructions in Section 6-3.7.
- A flight propeller (if the engine is installed in the aircraft)
  OR
- A test club mated to the propeller flange, capable of sustaining the minimum moment of inertia specified for the engine propeller in Section 2-3. The test club will absorb the brake horsepower (BHP) at the RPM specified in test operating limits. Use the test club in combination with the cell, test stand and operating limits for which it was calibrated.
- A cooling air scoop designed to fit over the tops of all cylinders, with padded seals for rear cylinders and valve rocker covers, to direct an adequate flow of air downward through the cylinder fins.
- Vanes to direct cooling air to the center cylinder and the oil cooler.
- An air duct to the alternator vent tube.
- A throttle control capable of operating the throttle shaft through its complete range and a five position (OFF/R/L/BOTH/START) Ignition Switch connecting the engine with the airframe electrical system.
- A storage battery must be connected by a No. 0 stranded copper cable from its positive terminal to the power terminal of the starter through a starter solenoid. The battery

negative terminal must be connected to the engine or both battery terminal and engine may be grounded. A small insulated wire should connect the starter solenoid coil terminal to a 5 ampere push-button switch. The other switch terminal must be connected to the engine or a common ground.

- Control panel equipped with the following calibrated engine instruments:
  - An oil pressure gauge and tube connection
  - An oil temperature gauge and capillary assembly
  - A water manometer with rubber hose connection to the vacuum pump oil return hole at the rear of the crankcase
  - An ammeter connected in the generator or alternator circuit
  - A fuel flow gauge
- A clean, substantial hose of 5/8 inch inner diameter must be installed on the crankcase breather elbow and supported so it leads to a point above and to the rear of engine.
- Fuel system capable of sustained 2-2.5 psi indication on fuel pressure gauge

18-3. Post-Overhaul Test Operating Limits

Table 18-2. Post Overhaul Test Operating Limits

ITEM	Specification
Full Throttle Speed ±25 RPM	2750 RPM
Idle RPM	675-925, application dependent
Manifold AIr Pressure at Idle	11.5 in. Hg
Manifold Air Pressure at Full Throttle (Max.)	29.5 in. Hg
Engine Intake Air Temperature	Ambient
Engine Intake Air Pressure	Ambient
Minimum Fuel Grade (Octane)	100-LL
Oil Temperature Limits	75 - 240°F (23.9 -115°C)
Oil Pressure (Max.) (Cold Oil)	100 psi
Oil Consumption	0.006 pounds x (rated power of engine) x (%power at which measured/100) x (hours duration) = oil consumption (lbs.) 1 quart of oil = 1.875 lbs Refer to the “Oil Consumption Test” in Section 18-5
Oil Sump Capacity (quarts)	5
Minimum Oil Pressure at Idle	10 psi at or below 200°F (93°C)
Crankcase Pressure (Max.) [1]	2.0 in. H^2O
Ignition Timing	28 ±1° BTC
Cylinder Head Temperature (Max.)	460°F (238°C)

1. A sudden increase in crankcase pressure during which the liquid in the manometer fluctuates rapidly typically indicates sticking piston rings. However, before removing cylinders, investigate the breather and manometer. Refer to Chapter 8 for troubleshooting details.

18-4. Standard Acceptance Test

Perform a standard acceptance test according to the protocol listed in Table 18-3.

Table 18-3. Standard Acceptance Test Requirements

Engine Run Period	Time Duration (Minutes)	Engine RPM
1	5	1200 ± 25 RPM
2	5	1600 ± 25 RPM
3	5	2450 ± 25 RPM[1]
4	10	Rated Power RPM[2]
5	10	75% Power RPM Check Fuel and Oil Pressures. Check Temperatures.
6	5	Idle RPM (cooling period -300° Max. CHT at shut down.)[3]
7	---	Stop engine and perform leak check.[4]
8	15	75% Power RPM
9	15	5% Power RPM

1. Do not run the engine above 1800 RPM until oil temperature has reached 160°F (71°C) and cylinder head temperatures have reached 200°F (93°C).
2. Make one check on performance of each magneto channel alone at 1700 RPM. Clear the spark plugs by operating with both magnetos on for a few seconds between checks.
3. Do not shut engine down until oil temperature is below 200°F (93°C) and cylinder temperatures are below 300°F (149°C).
4. Fuel and oil leaks are not acceptable.

Engines failing the acceptance test for high oil consumption, major oil leaks, low power, damaged components, excessive noise, excessive roughness, low oil pressure, excessive oil filter contamination require further investigation. Correct discrepancies and repeat the Standard Acceptance Test.

18-5. Oil Consumption Test

The Oil Consumption Test must be accomplished in addition to the Standard Acceptance Test. Use Table 18-4 to complete the oil consumption.

Table 18-4. Oil Consumption Test Requirements

Engine Run Period	Time Duration (Minutes)	Engine RPM
1	5	1200 ± 25 RPM
2	5	1600 ± 25 RPM
3	5	2450 ± 25 RPM[1]
4	10	Rated Power RPM [2]
5	10	75% Power RPM Check Fuel and Oil Pressures. Check Temperatures.
6	5	Idle RPM (cooling period 300°F (149°C) maximum at shutdown)[3]
Stop engine, drain and weigh oil for oil consumption determination[4]		
7	5	Warm up to rated RPM
8	30	Rated Power. Take engine readings every 10 minutes[4]
9	5	Idle RPM (cooling period 300° Max. CHT at shutdown.) [3 4 5]

1. Do not run the engine above 1800 RPM until oil temperature has reached 160°F (71°C).and cylinder head temperatures have reached 200°F (93°C).
2. Make one check on performance of each magneto alone at 1700 RPM. Clear spark plugs by operating with both magnetos on for a few seconds between checks.
3. Do not shut the engine down until the oil temperature is below 200°F (93°C) and cylinder temperatures are below 300°F (149°C).
4. Oil consumption of 0.39 lb. is considered acceptable for this test. One repeat of this test run is acceptable. If oil consumption is in excess of 0.39 pound, return the engine to the overhaul shop for a complete inspection.
5. Fuel and oil leaks are not acceptable.

Engines failing to pass the acceptance test for high oil consumption, major oil leaks, low power, damaged components, excessive noise, excessive roughness, low oil pressure, excessive oil filter contamination require further investigation. Correct discrepancies and repeat the Oil Consumption Test. Refer to troubleshooting instructions in Chapter 8 for remedial action, if necessary.

Appendix A. Glossary

A-1. Acronyms

The following acronyms are commonly used throughout Continental Motors publications:

Acronym	Definition
A & P	Airframe & Powerplant
AD	Airworthiness Directive
AFM	Airplane Flight Manual
AO	Authorized Oversize
APU	Auxiliary Power Unit
AU	Authorized Undersize
BHP	Brake Horsepower
BSOC	Brake Specific Oil Consumption
BTC	Before Top Dead Center
CFM	Cubic Feet per Minute
CHT	Cylinder Head Temperature
CSB	Critical Service Bulletin
DVM	Digital Volt-ohm Meter
EGT	Exhaust Gas Temperature
EMI	Electromagnetic Interference
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FBO	Fixed Base Operator
HP	Horsepower
IAW	In accordance with
ICA	Instructions for Continued Airworthiness
MAP	Manifold Air Pressure
MAT	Manifold Air Temperature
MEK	Methyl Ethyl Ketone
MHS	Material Handling Specifications
MJ	Main Journal
MSB	Mandatory Service Bulletin
OEM	Original Equipment Manufacturer
NATO	North Atlantic Treaty Organization
POH	Pilot's Operating Handbook
PMA	Parts Manufacture Approval
RMS	Root Mean Square
RPM	Revolutions per Minute
SB	Service Bulletin
SID	Service Information Directive
SIL	Service Information Letter
STANAG	Standardization Agreement (STANAG)

Acronym	Definition
STC	Supplemental Type Certificate
TBO	Time Between Overhauls
TC	Type Certificate
TDC	Top Dead Center
TIT	Turbine Inlet Temperature
TSO	Technical Standard Order
TSMOH	Time Since Major Overhaul
WOT	Wide Open Throttle

A-2. Glossary

Term	Definition
Airworthiness Approval Tag	FAA Tag 8130-3 that identifies a part or group of parts that has been deemed airworthy by an authorized FAA representative.
Burning	In reference to the engine valves, indicates roughening or erosion due to high temperature gases escaping past valve faces. In other instances, it indicates drawing of the temper of steel parts to a soft (blue) condition, as a result of overheating, during an absence of lubrication on moving surfaces, such as gear teeth subject to high loading.
Burr	Sharp or rough projection of metal.
Chafing	Condition caused by a rubbing action between adjacent or contacting parts under light pressure which results in wear.
Crack	Partial separation of material usually caused by vibration, overloading, internal stresses, improper assembly, or fatigue.
Critical Service Bulletin	Service document based on determination by the product manufacturer to constitute a threat to continued safe operation of an aircraft or to persons or property on the ground unless the owner or operator takes some specific action (inspection, repair, replacement, etc.). Documents in this category are candidates for incorporation into an Airworthiness Directive issued by the FAA.
Dent	Rounded depressed, pushed-in area on a surface.
Dynamic Seal	Vital seal in the engine cylinder that consists of valve-to-valve seat seals, spark plug-to-spark plug port seals, and cylinder head-to-barrel seal.
Elongate	To stretch out or lengthen.
Erosion	Wearing away of material due to flow, hot gases, grit, or chemicals.
Fretting	Surface erosion caused by slight movement between two parts that are fastened together.
Galling	Severe chafing or fretting that results in transfer of metal from one part to another; usually caused by slight movement of mated parts that have limited relative motion and are under heavy loads.
Grooved Surface	Shallow channels, wider than scratches and usually smooth resulting from wear affected by concentrated contact stress.

Term	Definition
Hydraulic Lock	Condition where fluid accumulates in the induction system or the cylinder assembly. The liquid restricts the piston from traveling during the compression stroke. Damage to the engine occurs when the other cylinders fire, which forces the piston in the fluid-filled cylinder through the compression stroke. Damage to an engine from hydraulic lock can be extensive due to the extreme stress load and can adversely affect connecting rods, pistons, cylinder assemblies, piston pins, the crankcase, and the crankshaft.
Mandatory Service Bulletin	Service document relating to known or suspected hazards to safety that may have been incorporated in whole or in part into an Airworthiness Directive (AD) issued by the FAA, or have been issued at the direction of the FAA by the manufacturer requiring compliance with an already-issued AD (or an equivalent issued by another country's airworthiness authority).
Nick	Sharp-sided gouge or depression with a V-shaped bottom.
Peening	Series of blunt depressions in a surface.
Pitting	Formation of pockets of corrosion products on the surface of a metal.
Propeller Strike	Any incident that requires repair (other than minor dressing of the blade) to a propeller blade. Either the propeller strikes an object or an object strikes the propeller and causing a propeller imbalance. Propeller strikes are serious because they can result in engine failure. Even if the propeller still continues to rotate, other components critical to engine operation may be damaged.
Runout	Eccentricity or wobble of a rotating part; eccentricity of two bored holes or two shaft diameters; a hole or bushing out of square with a flat surface. Runout is usually measured with a dial indicator, and limits stated indicate full deflection of indicator needle in one revolution of part or indicator support.
Scoring	Deep grooves in a surface caused by abrasion from fine hard particles wedged between moving surfaces, as in a bearing and journal, or caused by galling when a moving part is not supplied with lubricant.
Service Bulletin	Service document that contains information considered by the product manufacturer to constitute a substantial improvement to the inherent safety of an aircraft or component of an aircraft; also may include updates of instructions for continued airworthiness.
Service Information Directive	Service document that contains information determined by the manufacturer to be of value to an owner/operator in the use of a product by enhancing safety, maintenance, or economy.
Service Information Letter	Service information communiqué that may be of use to the owner/operator or maintained of the aircraft.
Spalling	Distress to a loaded surface where chips of the hardened surface are broken out.
Static Seal	Cylinder seal that consists of the piston rings to the cylinder wall seal.
Technical Standard Order	FAA-designated number and identification mark indicating that the part or appliance meets applicable design standards and was manufactured in accordance with the requirements of FAR 21 Subpart O.

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Appendix B.Torque Specifications

B-1. General Information

Tables in this appendix list torque values for Continental Motors aircraft engine hardware. Refer to the appropriate manufacturer's overhaul instructions for airframe or engine accessory torque specifications. Table B-1 is for bolts, nuts, screws, driving studs, and pipe plugs; Table B-2 is for fittings; Table B-3 is for hose fittings; Table B-4 lists specific component torque values. Torque values provided in Table B-5 must be used for the listed applications.

WARNING

Torque values listed are for use with clean 50 weight aviation engine oil applied to the threads, unless otherwise specified in Table B-5, which lists specific torque values for non-lubricated hardware.

Prior to torquing any hardware, unless otherwise specified, apply SAE 50 weight aviation oil to hardware listed in Table B-1 through Table B-4. If an application is not listed in the specific torque limits tables (Table B-4 and Table B-5), use the general torque limits in Table B-1 through Table B-3.

WARNING

Before installing nuts and bolts, verify the fastening hardware is lubricated according to instructions. Inspect all fasteners for proper plating and thread form. Failure to verify a fastener's serviceability or to correctly lubricate the fastener prior to installation will result in the fastener not being properly pre-loaded. Subsequent failure of the fastener may occur.

B-1.1. Torque Tips

WARNING

The use of sealants or lubricants other than those specified by Continental Motors on mating threads and between mating surfaces can cause incorrect torque application and subsequent engine damage or failure.

- Check Table B-4 and Table B-5 first to determine if the hardware to be torqued requires a specific torque or treatment other than those for general hardware sizes listed in Table B-1 through Table B-3.
- Before installing hardware, verify the fastener size is correct.
- The accuracy of any torque indicating wrench depends on a smooth application of force and current calibration traceable to the National Institute of Standards and Technology, verifiable by the calibration data label affixed to the tool.
- If cotter pin holes must be aligned, set the torque wrench at the low limit and tighten the nut to the first hole beyond this torque, but do not exceed the maximum specified torque limit. This torquing procedure must be followed for all applications requiring cotter pin hole alignment except for connecting rod nuts.

- If a nut slot cannot be aligned with a cotter pin hole within the specified limits, substitute another serviceable nut to attain alignment.
- If the cotter pin hole in a stud lies beyond the nut slots, when the nut has been torqued properly, check the stud for proper installation or for backing out.
- Check studs for necking.
- Check the part for reduced thickness resulting from wear or incorrect part.

B-2. Cylinder Torque Procedure

Proper cylinder installation requires the bolts be torqued in multiple stages. Replace all through bolts and nuts at overhaul. Cylinder base stud threads, through bolt threads and nuts must be lubricated with clean 50 weight aviation oil. Through bolt nuts at cadmium plated washers require a lower torque value to achieve the same through-bolt pre-load since the lubricity of the cadmium plating reduces joint friction.

1. Torque cylinder through bolt nuts and cylinder base nuts to ½ of the specified torque value for the fastener.
2. Torque the cylinder through bolt nuts and cylinder base nuts to the specified value for the cylinder base stud nuts. Through bolt nuts must be torqued on both sides of the engine, even if only one cylinder is being installed.

WARNING

Failure to torque through bolt nuts on both sides of the engine can result in a loss of main bearing crush with main bearing shift and subsequent engine failure.

NOTE: Through-bolt nuts P/N 634505 and 649496 have been superseded by P/N 652541.

Nut P/N 634505 is a flanged six-point (hex) nut requiring a torque value of 690-710 inch-pounds. Nut P/N 649496 is a flanged six-point (hex) nut requiring a torque value of 790-810 inch-pounds. At engine overhaul, all P/N 634505 and P/N 649496 flanged through bolt nuts must be replaced with 652541 flanged twelve-point nuts. If replacing P/N 634505 and P/N 649496 with 652541 in less than a complete set prior to engine overhaul, torque the 652541 twelve-point nuts to the torque value of the original fastener (P/N 634505 or P/N 649496).

3. Torque through-bolt nuts on both sides of the engine to the specified torque value.

B-3. Torque Wrench and Extension Calculations

Torque wrenches measure the force applied to the fastener on the axis of the square drive socket adapter.

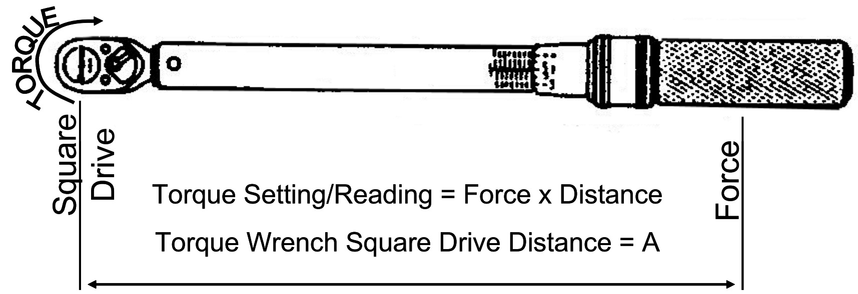


Figure B-1. Torque Wrench

Straight extensions and wobble extensions up to 15 degrees, which extend the square drive length, do not alter the amount of force applied to the square drive enough to cause concern. An offset adapter may be used with a torque wrench without affecting applied torque if the extension is positioned at a 90 degree angle in relation to the square drive adapter. In any other orientation, the extension alters the force applied to the fastener.

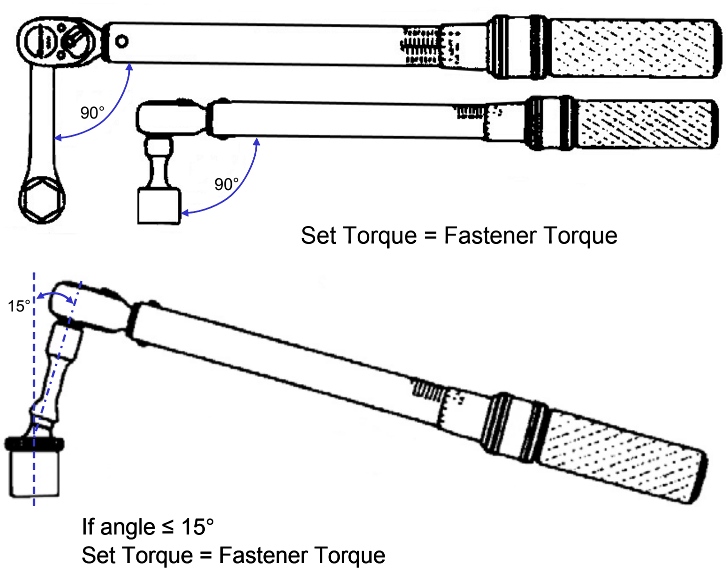
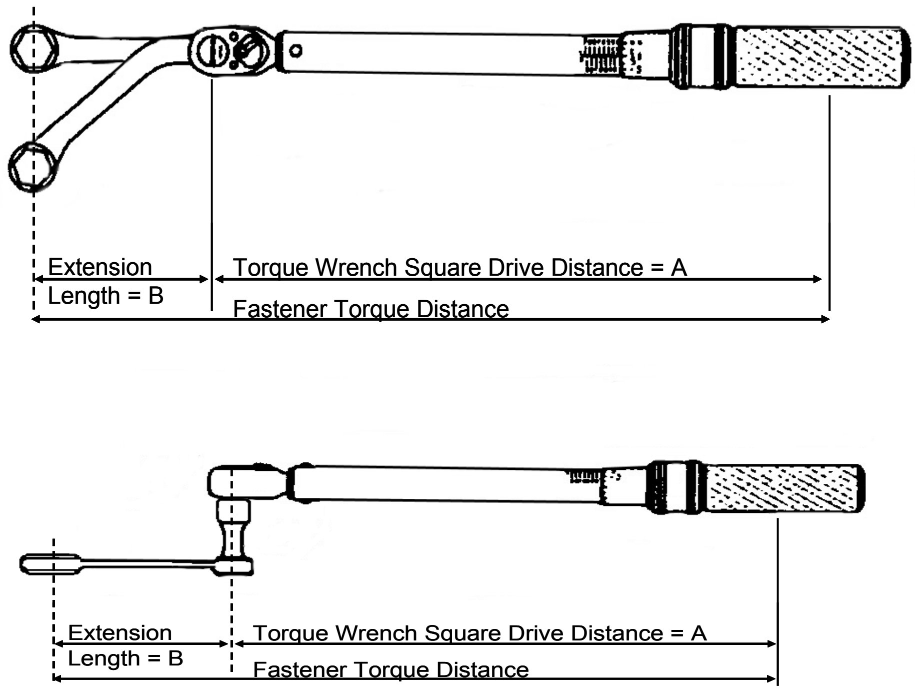


Figure B-2. Drive extensions

Apply the formula below to determine the appropriate torque wrench setting when using an extension:

$$S = \frac{T}{A + B} \times A$$

Where:
S = desired torque setting or reading
T= torque applied at square drive adapter
A= length of handle in inches
B= length of extension in inches



$$\text{Set Torque} = \frac{\text{Fastener Torque}}{A + B} \times A$$

Figure B-3. Extension increases applied torque

Examples in Figure B-3 and Figure B-4 illustrate how extensions can alter the torque applied to the fastener. Examples in Figure B-3 adds the length of the extension to the torque wrench, increasing the leverage applied to the fastener. The position of the extension in Figure B-4 reduces the effective length of the handle and the applied leverage. The length of the extension (variable B) is subtracted from variable A in Figure B-4.

Let’s assume the torque wrench has an effective length of 12 inches and the extension measures six inches from the center of the drive adapter to the center of the wrench. If we need to torque a nut and bolt to 45 inch-pounds, we set the dial on the wrench in Figure B-3 to 30 (45 ÷ (12+6) x 12). The same torque wrench, used with the extension in Figure B-4 must be set to 90 (45 ÷ (12-6) x 12) to apply 45 inch pounds of torque to the same nut and bolt.

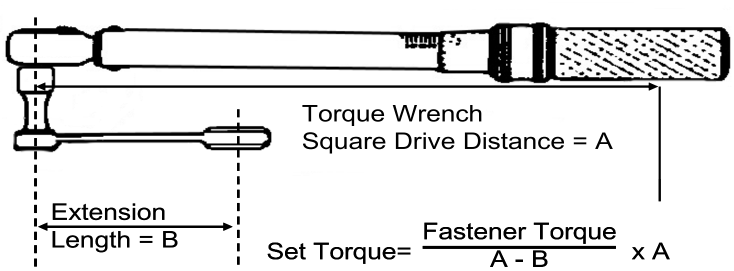


Figure B-4. Extension decreases applied torque

Table B-1. General Torque Specification

Bolts, Nuts, Screws		
	Torque	
Size	In. lbs.	Ft. lbs.
#2-56	1.4-2.6	N/A
#4-40	2.9-5.5	N/A
#6-32	5.3-10.1	N/A
#8-32	17.5-22.5	1.5-1.9
#10-32	36-50	3.0-4.2
#10-24	21-25	1.7-2.0
.250-20	75-85	6.3-7.1
.250-28	90-100	7.5-8.3
.3125-18	155-175	12.9-14.6
.3125-24	180-220	15.0-18.3
.375-16	220-260	18.3-21.7
.375-24	275-325	22.9-27.1
.44-20	400-450	33.3-37.5
.50-20	550-600	45.8-50.0
Driving Studs		
.250-20	50-70	4.2-5.8
.3125-18	100-150	8.3-12.5
.375-16	200-275	16.7-22.9
.44-14	300-425	25.0-35.4
Pipe Plugs		
.062-27	30-40	2.5-3.3
.125-27	60-80	5.0-6.7
.250-18	130-150	10.8-12.5
.375-18	185-215	15.4-18.0
.500-14	255-285	21.3-23.8
.750-14	310-350	25.8-29.2

Table B-2. Tube Fitting Torque Specifications

Size	Hose Assembly	Tube O.D.	Torque (In-lbs)
.31-24	#2 Brass / Aluminum	.125	15-30
.31-24	#2 Steel	.125	15-50
.38-24	#3 Brass / Aluminum	.188	40-65
.38-24	#3 Steel	.188	50-90
.44-20	#4 Brass / Aluminum	.250	60-80
.44-20	#4 Steel	.250	70-120
.44-24	Steel	.190	60-80
.56-18	#6 Brass / Aluminum	.375	75-125
.56-18	#6 Steel	.375	90-150
.75-16	#8 Brass / Aluminum	.500	150-250
.75-16	#8 Steel	.500	135-250
.88-14	#10 Brass / Aluminum	.625	200-350
.88-14	#10 Steel	.625	300-400

Table B-3. Hose Fitting (“B” Nut) Torque Specification

Hose Size	Hose End Fitting Material	Torque (In-lbs)
#2 (.31-24)	Brass/Aluminum Fitting	50-80
#2 (.31-24)	Steel Fitting	75-120
#3 (.38-24)	Brass/Aluminum Fitting	70-105
#3 (.38-24)	Steel Fitting	95-140
#4 (.4375-20)	Brass/Aluminum Fitting	100-140
#4 (.4375-20)	Steel Fitting	135-190
#5 (.500-20)	Brass/Aluminum Fitting	130-180
#5 (.500-20)	Steel Fitting	170-240
#6 (.5625-18)	Brass/Aluminum Fitting	150-195
#6 (.5625-18)	Steel Fitting	215-280
#8 (.750-16)	Brass/Aluminum Fitting	270-350
#8 (.750-16)	Steel Fitting	470-550
#10 (.875-14)	Brass/Aluminum Fitting	360-430
#10 (.875-14)	Steel Fitting	620-745
#12 (1.063-12)	Brass/Aluminum Fitting	460-550
#12 (1.063-12)	Steel Fitting	855-1055

Table B-4. Component Specific Torque Specifications

Size	Fastener	Torque Value In-Lbs	Torque Value Ft-Lbs	Models Affected
Crankcase				
.25-28	Nut-Crankcase Flange	100-125	8.3-10.4	All Models (AR)
.31-24	Nut-Crankcase Backbone	240-280	20.0-20-3	(AR) Stainless Steel hardware Only
.31-24	Nut, Magneto to Crankcase	100-120	8.3-10.0	All Models (AR)
.38-24	Nut-Crankcase Through Studs	275-325	22.9-27.1	All Models (AR)
.38-24	Nut-Crankcase Tie Bolts	370-390	30.8-32.5	All Models (AR)
.38-24	Nut-Cylinder to Crankcase Stud	410-430	34.2-35.8	All Models (AR)
.38-24	Nut-Mounting Bracket to Crankcase	275-325	22.9-27.1	All Models (AR)
.44-20	Nut-Crankcase Tie-Bolts-Nose & Below Camshaft	440-460	36.7-38.3	All Models (AR)
.44-20	Nut-Cylinder to Crankcase Studs (including 7th stud)	490-510	40.8-42.5	All Models (AR)
.44-20	Nut-Front & Rear Crankcase Bearing Through Studs	490-510	40.8-42.5	O-200
.44-20	Nut-Through Bolt at Cadmium Plated Washer	440-460	36.7-38.3	All Models (AR)
.44-20	Nut-Through Bolt at Cylinder Flange	490-510	40.8-42.5	All Models (AR)
.44-20	Nut-Through Stud at Cylinder Flange	490-510	40.8-42.5	O-200
.44-20	Nut-Through Bolt at Front Mount Belt-Driven Alternator	490-510	40.8-42.5	All Models (AR)
.50-20	Nut-Crankcase Nose Tie Bolts	640-660	53.5-55.0	All Models (AR)
.62-18	Plug-(with crush washer)	190-210	15.8-17.5	All Models (AR)
Gears				
.25-28	Bolt, Gear to Camshaft	140-160	11.7-13.3	All Models (AR)
.25-28	Bolt, Gear to Crankshaft (P/N 22532)[1]	140-160	11.7-13.3	All Models (AR)
.31-24	Nut- Generator or Alternator Gear	175-200	14.6-16.7	All Models (AR)

Table B-4. Component Specific Torque Specifications

Size	Fastener	Torque Value In-Lbs	Torque Value Ft-Lbs	Models Affected
Connecting Rods				
.38-24	Nut, Connecting Rod (Nuts: 24804 or 626140 w/bolt P/N 530213)[2 & 3]	400-475	33.3-39.6	All Models (AR)
.38-24	Nut, Connecting Rod (Spiralock (Nut P/N 654487 w/bolt P/N 654693)	490-510	40.8-42.5	All Models (AR)
Miscellaneous Lubrication System Fasteners				
.25-20	Bolt, Oil Pump Cover to Crankcase	75-85	6.3-7.1	All Models (AR)
.62-18	Plug, OIl Cooler (w/crush washer)	190-210	15.8-17.5	All Models (AR)
.62-18	Plug, Oil Cooler Adapter Bypass (w/crush washer)	190-210	15.8-17.5	All Models (AR)
.62-18	Plug, OIl Suction Tube (w/ crush washer)	190-210	15.8-17.5	All Models (AR)
.62-18	Plug, OIl Sump Drain	190-210	15.8-17.5	All Models (AR)
.62-18	OIl Filter Cartridge	180-216	15.0-18.0	All Models (AR)
.75-16	OIl Filter, Disposable	192-216	16.0-18.0	All Models (AR)
.88-16	Cap, Oil Pressure Relief Valve	190-210	15.8-17.5	All Models (AR)
1.00-14	Vernatherm (Oil Temperature Control Valve)	190-210	15.817.5	All Models (AR)
1.375-16 LH	Housing, Tachometer Drive	250-350	20.8-29.2	All Models (AR)
1.75-16	Oil Filter Screen (w new crush gasket) (Install Gasket with parting line against screen face)	500-520	41.6-43.3	All Models (AR)
Miscellaneous Cylinder Hardware				
.071 (18mm)	Spark Plug [4]	300-360	25.0-30.0	All Models (AR)
.125-27	Connector, Cylinder Drain	60-80	5.0-6.7	All Models (AR)
.19-32	Screw, Cylinder Baffle	10-20	.84-1.7	All Models (AR)
.25-20	Screw, Rocker Cover	55-65	4.6-5.4	All Models (AR)
.25-20	Screw, Intake Flange	85-110	7.1-9.2	All Models (AR)

Table B-4. Component Specific Torque Specifications

Size	Fastener	Torque Value In-Lbs	Torque Value Ft-Lbs	Models Affected
.25-20	Set Screw, Rocker Shaft, Locking	45-55	3.8-4.6	All Models (AR)
.25-28	Nut, Exhaust (self locking)	120-130	10.0-10.8	All Models (AR)
.25-28	Nut, Exhaust Manifold Flange (Spirotallic Gasket)	100-110	8.3-9.2	All Models (AR)
.31-24	Nut, Exhaust Manifold Flange (Spirotallic Gasket)	200-210	16.7-17.5	All Models (AR)
Miscellaneous Fasteners				
---	Clamp, Hose Induction	25-35	2.0-2.9	All Models (AR)
#10-14	Nut, Airbox Alternate Air Control Lever	9-10	0.75-0.83	All Models (AR)
.31-24	Nut, Generator Gear	175-200	14.6-16.7	All Models (AR)
.56-24	Tach Sensor, Magneto	35-40	2.9-3.3	All with Magneto Tach Sensor
.68-24	Tach Sensor, Magneto	35-40	2.9-3.3	All with Magneto Tachometer Sensor

1. Heat crankshaft gear to 300º F; install on gear on crankshaft immediately for shrink fit. Ensure the gear seats tightly against the end of the crankshaft by tapping lightly with a brass hammer.
2. Torque to low limit. If cotter pin will not align with holes, increase torque gradually, up to high limit only. If cotter pin holes will not align within torque range, replace the nut and repeat. In no case shall nuts be tightened below the minimum or above the maximum torque limit. Refer to the most current revision of Service Document SIL93-15 for special cotter pin installation instructions in 360 series engine connecting rods.
3. A) P/N 530184 connecting rod (identified by forging number 530186), P/N A35159 (identified by forging 5561) and P/N A35160 (also identified by forging number 5561) must be assembled with P/N 530213 bolt, P/N 24804 or 626140 and P/N 639292 cotter pin.
   B) Assemble P/N 36121 connecting rods utilizing the P/N 632041 forging with the part numbers indicated in current technical data. Assemble P/N A36121 connecting rod assemblies utilizing the P/N 40742 forging with P/N 35972 connecting rod bolt, P/N 24804 nut and P/N MS24665-132 cotter pin.
4. Lubricate spark plug threads with spark plug manufacturer’s recommended lubricant.

Table B-5. Specific Torque for Non-Lubricated Hardware

Size	Fastener	Torque Value In-lbs	Torque Value Ft-lbs	Model Affected
#10-32	Nut, Magneto Ground Terminal	15-17	1.25-1.41	S-20/200 Magnetos
#10-32	Nut, Magneto Ground Terminal	13-15	1.08-1.25	Slick Magnetos
Various	Screw, Ignition Harness Cable Outlet Plate	25-35	2.08-2.91	S-20/200 Magnetos
Various	Screw, Ignition Harness Cable Outlet Plate	18-25	1.5-2.08	Slick Magnetos
1.12-18	Oil Pressure Relief Valve Housing	240-260	20.0-21.7	All

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Appendix C. Standard Practices

C-1. Handling Parts

When removing, replacing, or re-installing parts, heed the following precautions, warnings, and tips:

WARNING

Turn the Ignition Switch OFF and disconnect engine electrical power before commencing maintenance or inspections. Confirm continuity between the magneto capacitor and aircraft ground to prevent accidental engine start during maintenance. Do not stand or place equipment within the arc of the propeller.

- If the engine is installed, disconnect engine electrical (battery) power and verify the Ignition Switch is turned OFF. Confirm continuity between the magneto capacitor and aircraft ground before commencing engine maintenance.
- Inspect replacement parts for deterioration or wear. Do not install parts that appear worn, deteriorated, or beyond published (service or overhaul) limits.
- Prevent safety wire, nuts, washers, dirt, etc. from entering the engine.
- If any foreign object accidentally falls into the engine, stop working on the engine immediately and retrieve the dropped object(s).
- Tag unserviceable parts or units for investigation and possible repair.
- To ensure proper re-installation of usable parts, tag or mark all parts and hardware as they are removed or disassembled.
- Use protective caps, plugs, and covers to ensure openings are unexposed. Install dust caps **over** the tube ends of open lines and **NOT IN** the tube ends. Be sure to remove the dust caps and covers after the maintenance or repair work is complete.
- Cover stored engine sub-assemblies.
- Inspect new parts for transit damage. **Do not install damaged or non-conforming parts**. Re-seal or rewrap the new part until the part is ready to be cleaned, prepared, and installed.
- Check the shelf life of new parts to be installed. Do not install parts with an expired shelf life.
- Thoroughly clean parts according to instructions in Chapter 14 of the Maintenance and Overhaul Manual (M-2).
- Use only a plastic or rawhide mallet made to tap engine parts during assembly; never use a hammer.
- Always install new gaskets, o-rings, rubber components, seals, packing, cotter pins, tab washers, safety wire, and lock washers when servicing components.
- Use only new, shake proof or split lock washers, tab washers, elastic stop nuts, cotter pins, and corrosion-resistant safety wire.
- Do not replate cadmium-plated fasteners or washers. If the cadmium plating has been removed, discard the item and replace it with a new part.

- Do not re-install any worn, deformed, or single use fasteners.
- Torque hardware to Appendix B torque specifications.

WARNING

Do not apply any form of sealant to the crankcase cylinder deck, chamfer, cylinder mounting flange, cylinder base O-ring, or cylinder fastener threads. The use of RTV, silicone, Gasket Maker or any other sealant on the areas listed above during engine assembly will cause a loss of cylinder deck stud or through-bolt torque. Subsequent loss of cylinder attachment load, loss of main bearing crush and/or fretting of the crankcase parting surfaces will occur. The result will be cylinder separation, main bearing movement, oil starvation and catastrophic engine failure. USE ONLY CLEAN 50 WEIGHT AVIATION ENGINE OIL ON SURFACES LISTED.

- Before installing nuts and bolts, verify the fastening hardware is lubricated according to Chapter 3 and Appendix B instructions. Inspect all fasteners for proper plating and thread form. Failure to verify a fastener's serviceability or to correctly lubricate the fastener as instructed prior to installation will result in the fastener not being properly pre-loaded. Subsequent fastener failure may occur.

C-2. Replacement Parts

C-2.1. Background

An increasing amount of replacement parts (including standard parts), materials, appliances, and instruments are represented as being of aircraft quality when actually the quality and origin of these units is unknown. Users of such units are usually not aware of the potential hazards involved with replacement parts that are not eligible for use on certified aircraft. Frequently, such units are deceptively advertised or presented as "unused," "like new," or "remanufactured," implying the quality of such units is equal to an original or appropriately repaired or overhauled unit.

The performance rules for replacement of parts and materials used in the maintenance and alteration of U.S.-certified aircraft are specified in Federal Aviation Regulations (FAR) 43.13 and FAR 145.205. The responsibility for the continued airworthiness of the aircraft, which includes the replacement of parts, is the responsibility of the owner/operator as outlined in FAR 91.7, FAR 121.363, and FAR 135.419.

C-2.2. Acceptable Replacement Parts

Continental Motors provides Instructions for Continued Airworthiness (ICAs) based on the design, testing, and certification of engines and parts for which Continental Motors is the holder of the Type Certificate (TC) or Parts Manufacture Approval (PMA) issued by the Federal Aviation Administration (FAA). These instructions, which include maintenance, repair limits, overhaul, and installation are applicable only to engines and parts supplied by Continental Motors. Continental Motors does not provide instructions relating to the installation or use of parts not manufactured or supplied by Continental Motors. Instructions provided by other engine parts manufacturers or resellers should be used for their parts. Continental Motors has not participated in design, test, or certification in regards to aftermarket parts manufacturers and has no experience with respect to such parts.

FAA regulations require only FAA-approved parts be used on a type certified product. FAA-approved parts may be identified in accordance with the information given below. Continental Motors does not play any role in the FAA approval of such parts; does not have any responsibility for the design, certification, service life, repair, overhaul, or quality of such parts; and has made no determination regarding the effect, if any, that using such parts may have on Continental Motors supplied engines or parts.

C-2.2.1. Know Your Supplier

Some reproduced parts and components, particularly instruments, have been manufactured by entities other than the original equipment manufacturer and are available for purchase and installation on U.S.-certified aircraft. Often, an original part is used as a sample to produce duplicates. The reproduced parts *appear* to be as good as the original part. However, there are many unknown factors to be considered that may not be readily apparent to the purchaser, such as heat-treating, plating, inspections, tests, and calibrations. All too often, the faulty part is not discovered until a malfunction or an accident occurs.

Therefore, in accordance with FARs, certification of materials, parts, and appliances for aircraft return to service is the responsibility of the person or agency who signs the approval. The owner/operator is responsible for the continued airworthiness of the aircraft. To ensure continued safety in aircraft operation, it is essential that great care be used when inspecting, testing, and determining the acceptability of all parts and materials. Particular caution should be exercised when the identity of materials, parts, and appliances cannot be established or when their origin is in doubt.

C-2.3. 100% Parts Replacement Requirements

> NOTE: Service documents published or revised subsequent to the issuance of this publication may mandate the replacement of components and parts not included in these instructions. At engine overhaul, the technician must review all service bulletins to ensure compliance with the manufacturer’s requirements for continued airworthiness.

Replace all gaskets, seals, packing, hoses, O-rings, cotter pins, retaining rings (snap rings), safety wire, self locking fasteners (including exhaust nuts), and lock washers with new parts during assembly, regardless of the type of maintenance.

Do not re-use worn, damaged or deformed fasteners. Do not replate cadmium plated fasteners or washers. If the cadmium plating has been removed, discard the item and replace it with a new part.

Engine mounted accessories must be maintained in accordance with the manufacturer’s instructions. Additionally, accessories must be overhauled during engine overhaul, or more frequently, in accordance with the manufacturer’s instructions.

At engine overhaul the starter, alternator, magnetos and engine fuel system must be overhauled. On turbocharged engines, the turbocharger, wastegate, controller and exhaust system must be overhauled. All engine baffles must be repaired or replaced and all flexible baffle seals replaced.

Items such as spark plugs, alternator drive belts and air-conditioning drive belts are replaced on condition.

C-2.4. Mandatory Overhaul Replacement Parts

In addition to the items listed in Section C-2.4, the following parts must be discarded and replaced with new parts during engine overhaul.

• Bearings: connecting rod, crankshaft main and thrust, needle, ball, and roller	• Hydraulic valve lifters (tappets)
• Bushings: crankshaft, connecting rod, rocker arm	• Ignition system harness
• Camshaft gear bolts	• Inner and outer valve springs
• Connecting rod bolts and nuts	• Intake valves
• Crankshaft alternator face gear bolts and lock plates	• Intake valve rotocoils (replace intake valve rotocoils with solid valve retainers)
• Crankshaft gear bolts	• Intake and exhaust valve keepers
• Crankcase through bolts	• Magneto drive rubber bushings
• Cylinder deck stud nuts and through bolt nuts	• Pistons
• Exhaust flange studs & nuts	• Piston pins
• Exhaust valves	• Piston rings
• Exhaust valve rotocoils	• Rocker shafts
	• Rockers shaft thrust washers
	• Woodruff keys

C-2.5. Authorized Oversize/Undersize Parts

Replacement authorized oversize (AO) or authorized undersize (AU) parts must be used with the proper AO and AU mating parts. Example: use 0.015 oversize piston and piston rings with 0.015 oversize cylinder assembly.

C-3. Torque

Torque hardware with calibrated torque wrenches according to Appendix B specifications.

C-4. Safety Wiring Hardware

Safety wiring secures two or more parts together so any tendency of the parts to loosen will be counteracted by increasing the tension on the safety wire attached to the other part(s). The only way to loosen the fasteners is to remove the safety wire. Always use new safety wire to secure hardware. Safety wire on these engines must conform to MS20995 Condition A.

1. Verify the hardware (bolts or nuts) to be safety wired has been correctly torqued to Appendix B specifications.

   CAUTION: Do not apply torque above or below specified limits to align holes.

2. Insert half of the required length of new safety wire through the first piece of hardware and do the following:

   a. For *right-hand* threaded hardware, install the safety wire so the strand will pull and lock *clockwise*.

   b. For *left-hand* threaded hardware, install the safety wire so the strand will pull and lock *counter-clockwise.*

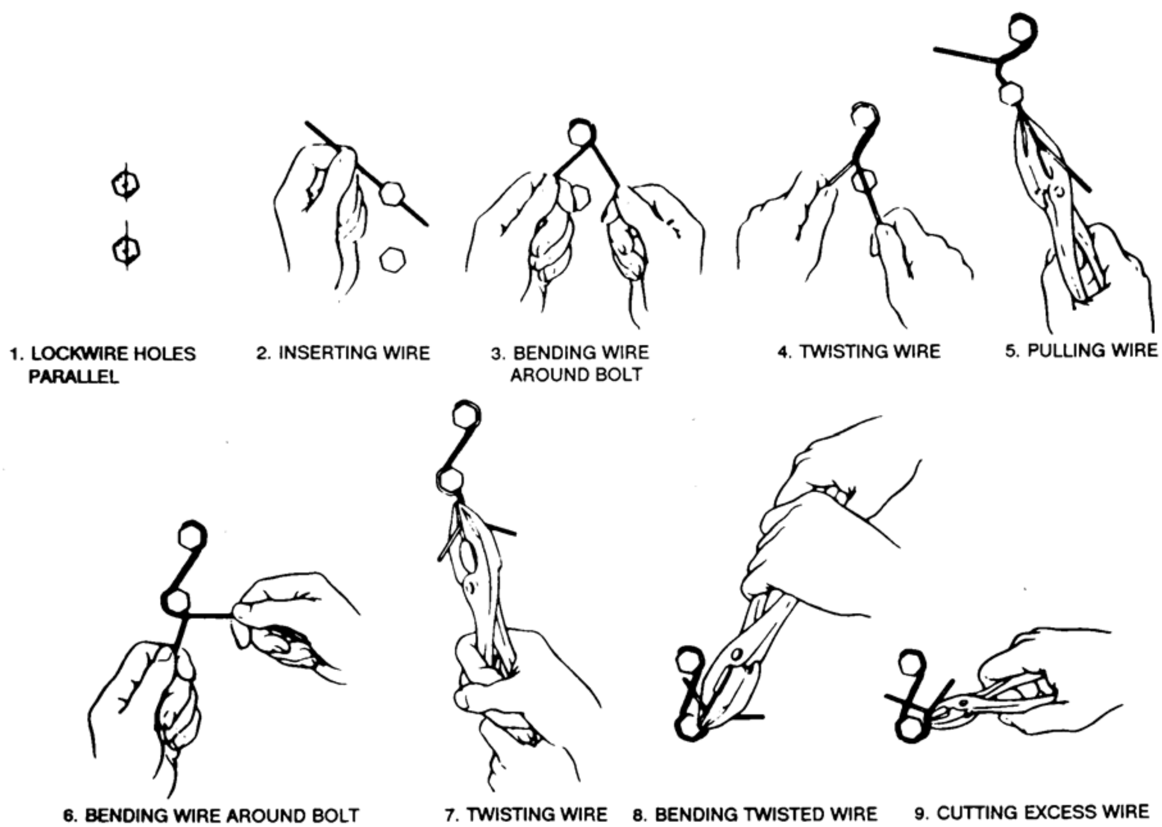


Figure C-1. Right-hand-thread safety wire installation
(Reverse application for left hand threads)

3. As shown in Figure C-1, bend the safety wire to tightly loop around the head of the hardware so force is exerted in the tightening direction. Ensure there is no slack in

the loop and the loop is under the protruding strand that will wrap around the opposing piece of hardware to ensure the loop is held in place on the first device. Pull the protruding strand of safety wire with pliers until it is taut (but not overstressed).

4. While keeping the protruding strand of safety wire taut, twist the strands (based on the wire gauge specified below) until the twisted part is just short of a hole in the next unit. The twisted portion should be within one-eighth (1/8) inch from the hole in either unit:
   a. Twist 0.032” diameter safety wire at a rate of 7 to 10 twists per inch.
   b. Twist smaller diameter safety wire at a rate of 9 to 12 twists per inch.
5. Pull the braided safety wire strand with pliers until it is taut (but not overstressed).
6. Insert the uppermost strand through the hole in the second piece of hardware.
7. Bend and wrap the twisted wire braid around the second piece of hardware, pulling the wire taut as described in the previous steps, which will counter-lock the hardware joined by the safety wire. Repeat the previous steps for any subsequent hardware to be safety wired by this strand. Refer to Figure C-2 for various safety wire patterns. All safety wire must fit snugly.
8. After safety wiring the last piece of hardware, continue twisting the safety wire to form a pigtail, providing sufficient twists (four minimum) to ensure the pigtail will not unravel.

   CAUTION: Do not allow the safety wire pigtail to extend above the bolt head.

9. Trim excess safety wire and bend the pigtail toward the hardware and against the bolt head flats.

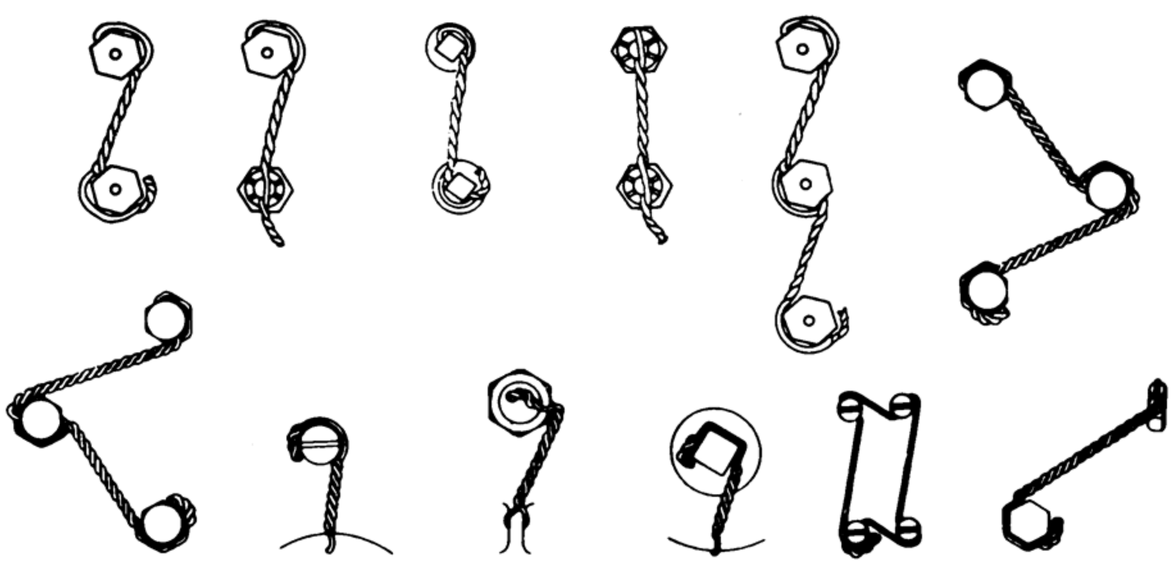


Figure C-2. Safety wire Patterns for Right-Hand Threads
(Reverse the wire orientation for left-hand threads)

C-5. Tab Washer Installation

Tab washers are used in various locations in Continental Motors engines. Do not re-use tab washers. Always install new tab washers.

1. Insert the locator tab (bent part of the tab washer) in the predrilled hole.
2. Lubricate and torque hardware to Appendix B specifications.
3. Using a soft drift, bend the locking tabs up to rest against the bolt or nut flats as shown in Figure C-3. Ensure the lock tabs rest firmly against the hardware as shown in top and side views of Figure C-3 to properly lock the fastener in place and prevent the lock tabs from breaking off.

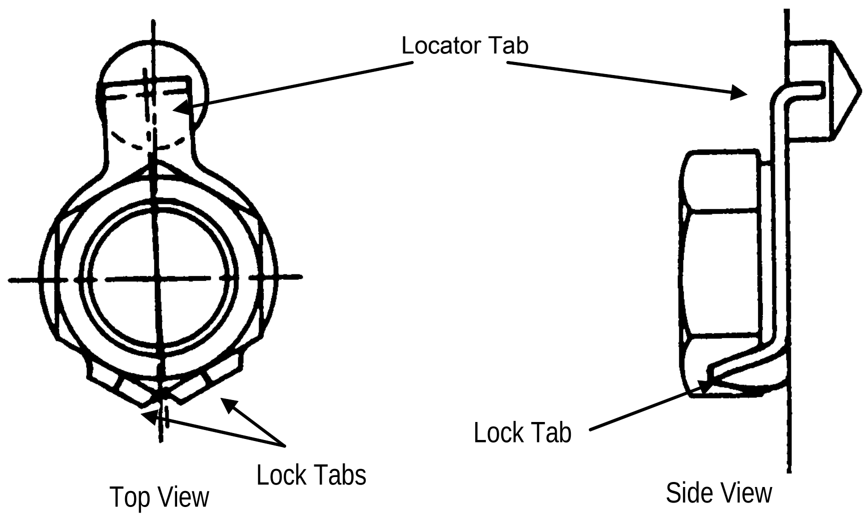


Figure C-3. Tab Washer Installation

C-6. Helical Coil Insert Replacement

Helical coil inserts are made of wire with a diamond-shaped cross section forming both a male and female thread. Helical coil inserts are factory-installed in various tapped holes of some engine components. Stainless steel helical coil inserts of special design are installed in all spark plug holes.

Tools, inserts, and information are available through HeliCoil®, Emhart Fastening Teknologies. The latest revision of the manufacturer's bulletins 959A, 995, 943, T4000, and 1000 list manual and power-driven installing tools, tang break-off tools, special taps, plug gauges, and tap/drill information.

Helical coil inserts are available in both National Course and National Fine series in lengths equal to 1, 1½, and 2 times nominal diameter and in pipe thread sizes. They are made of carbon steel, phosphor bronze, or stainless steel, as specified by part number. They are supplied with or without a notch above the driving tang. The notch is provided to facilitate breaking off the tang in open holes.

When compressed into a special tapped hole at the widest part of the wire between male and female threads, the diameter of the insert is equal to the nominal screw size. The special finishing taps size the threaded hole to allow the pitch diameter of the female thread of the installed insert to conform to Class 3 fit with standard bolt threads or Class 4 (tight) fit with standard-size studs. The difference in fit is due to a difference in pitch diameters of bolts and studs.

Only one set of helical coil special taps is required for installing these inserts in both bolt holes and stud holes. Tap drilling depths and tapping depth for helical coil inserts to be installed in blind holes must conform to the recommendations relative to inserts of length equal to 2 times nominal diameter, as tabulated in the latest revision of the manufacturer's bulletin numbers 1000 and T4000.

Run helical coil tap drills and special taps perpendicular to the machined surface to follow the alignment of the existing hole.

For drilling and tapping aluminum alloy castings, use a commercial-grade cutting lubrication oil to prevent overheating of the metal and tearing of the thread.

Helical coils are prohibited in certain areas; verify that a helical coil repair for a certain area is approved prior to installing the helical coil.

Replace helical coils in approved areas when they are damaged in accordance with the manufacturer's instructions.

C-6.1. Helical Coil Removal

1. Use the proper size extracting tool (Figure C-4) for the nominal thread size.
2. Tap the extracting tool into the helical coil insert until the sharp edges of the tool dig firmly into the helical coil insert.
3. Turn the tool to the left and back out the helical coil until it is free.

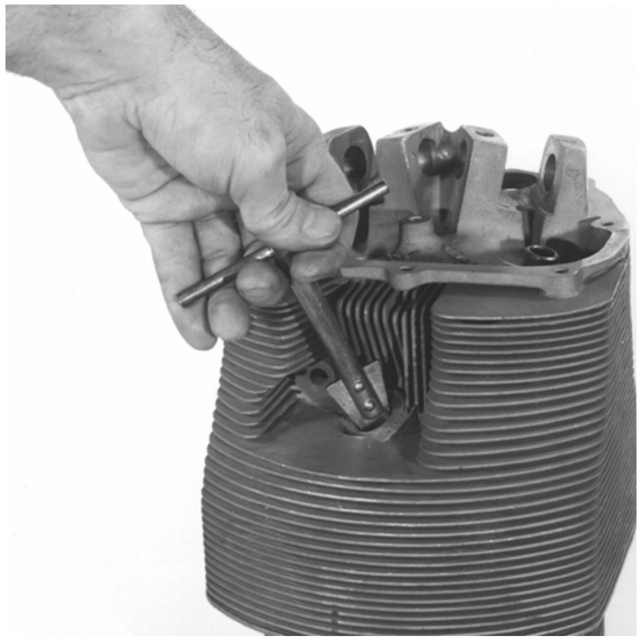


Figure C-4. Helical Coil Extraction Tool

C-6.2. Helical Coil Insertion

1. Blow all debris and liquid out of the tapped hole.
2. Use a proper size installation tool and slide the new helical coil insert over the slotted end of the driving mandrel of the tool.
3. Engage the driving tang (bent end) of the helical coil in the mandrel slot.
4. Wind the insert slowly into the tapped hole (as shown in Figure C-5).
5. The outer end of the insert must lie within the first full thread of the hole.
6. Break off the driving tang of a notched helical coil by bending it back and forth across the hole with long, needle nose pliers or with a special tang break-off tool.
7. Once the helical coil insert is installed, the remaining wall thickness (edge distance) to the helical coil must not be less than one half the helical coil diameter or 0.08 inches, whichever is greater.

WARNING

On the crankcase, the 2 and 4 o'clock cylinder deck stud positions must not be repaired by helical coil insert installation.

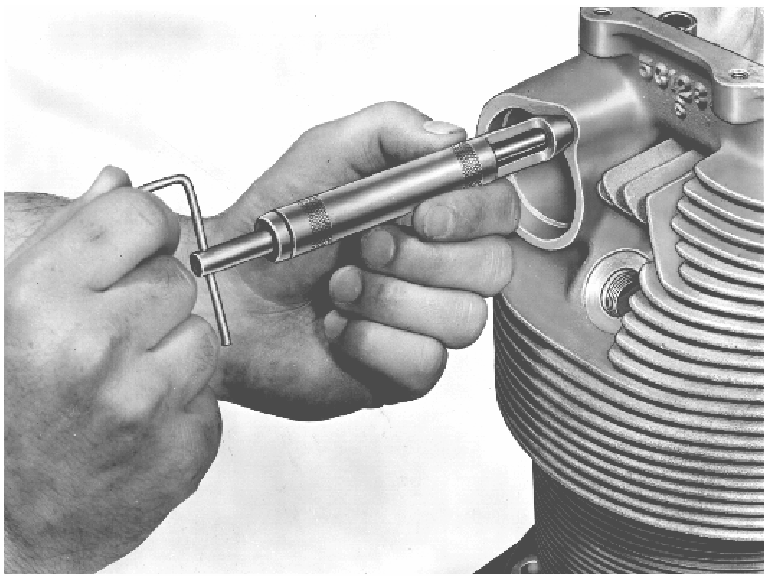


Figure C-5. Installing a Helical Coil Insert

C-7. Stud Replacement

Studs that are damaged or broken must be replaced. Rosan® ring-locked studs are installed in the cylinder exhaust ports. These studs are either “size-on-size” or “step type.”

The step type captive lock ring studs have a larger lock ring than the size-on-size type. The size-on-size captive lock ring studs utilize a small external diameter lock ring for applications where edge distance is a factor. The lock ring is so small in diameter that the use of a typical Rosan® “SM” or “BT” series-milling tool is impractical and could cause unwanted removal of cylinder head material in the lock ring area.

C-7.1. Stud Removal

NOTE: For Rosan® Size-on-Size Stud Removal, refer to instructions in Section C-8. To remove Rosan® Step-Type Stud Removal, refer to instructions in Section C-8.

For standard stud removal:

1. Place a stud extractor tool on the stud to be removed and turn the tool slowly to avoid heating the casting.
2. To remove a stud which cannot be removed with a standard stud extractor tool, drill a hole matching the diameter of a splined stud extractor tool through the center of the stud. Insert the splined stud extractor through the drilled center of the stud and unscrew the stud.
3. Examine the course thread end of the damaged stud before discarding it to determine the correct stud size for oversize replacement stud.

C-7.1.1. Size-on-Size Rosan® Stud Removal

To prevent damage to the engine cylinder, use the following instructions when removing a Size-on-Size Rosan® stud.

1. Carefully cut the damaged stud flush with the cylinder head. Do not come in contact with or mark the cylinder head.
2. Score the remaining portion of the stud with a center punch.
3. Position the proper size primary removal drill (Table C-1) directly over the center of the stud and drill to the depth specified in Table C-1.
4. Center the secondary removal drill (Table C-1) over the small hole and drill to the depth specified in Table C-1. This method should cut the engagement between the stud serrations and the internal serrations of the lock ring.
5. The remaining lock ring will have a very thin wall. Carefully use a sharp punch to break away the remaining portion from the cylinder head.
6. Drive an “Ezy Out” bolt extraction tool into the small hole in the stud and apply removal torque.
7. Remove the stud and clean the hole.

Table C-1. Rosan® Stud Primary & Secondary Bore Specifications

Cylinder Exhaust Port Stud		Primary Removal Drill		Secondary Removal Drill	
Basic Stud Number		Diameter	Minimum Depth	Diameter	(+0.015) Depth
(0.164 dia.)	SFC164	1/16(0.062)	0.250	3/16(0.188)	0.080
(0.190 dia.)	SFC190	1/16(0.062)	0.250	7/32(0.219)	0.090
(0.250 dia.)	SFC250	3/32(0.093)	0.250	19/64(0.296)	0.105
(0.312 dia.)	SFC312	1/8(0.125)	0.312	R(0.339)	0.120
(0.375 dia.)	SFC375	1/8(0.125)	0.375	13/32(0.406)	0.120

C-7.1.2. Step-Type Rosan® Stud Removal

There are two methods for removing step-type Rosan® studs. The first method uses a special tool; the second method provides machining instructions to cut the stud, drill a pilot hole and remove the stud with an bolt extractor.

C-7.1.2.1. Step-Type Rosan® Stud Removal Method 1

1. Use the Rosan® Stud Remover (Figure C-6 and Figure C-6Figure C-7) to mill the lock ring to the appropriate depth.
2. Apply removal torque to remove the stud.
3. Lift out the remaining portions of the lock ring.
4. Carefully use a sharp punch to break away the remaining portion of the stud from the cylinder head.

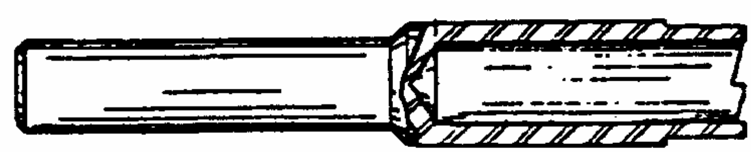


Figure C-6. Rosan® Stud Removal Tool

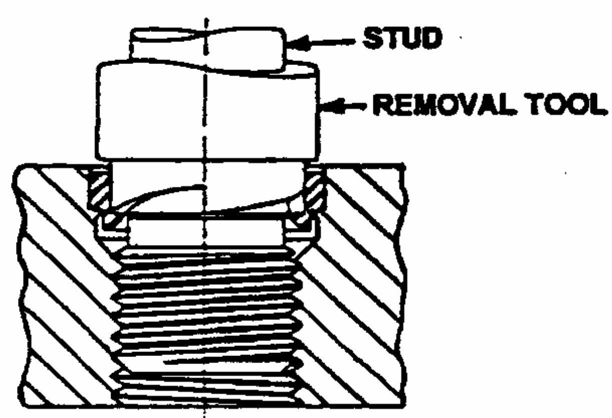


Figure C-7. Rosan® stud removal tool installed on stud

C-7.1.2.2. Step-Type Rosan® Stud Removal Method 2

1. Follow the “Size-on-Size Rosan® Stud Removal” instructions in Appendix C-7.1.1.
2. Select the appropriate removal drill sizes with regard to the stud end dimension.

   NOTE: **Example:** To remove a step-type stud with a 0.250-inch diameter nut end and a 0.312- inch diameter stud end, use the appropriate removal drill for a 0.312-inch “size-on-size” stud.

C-7.2. Stud Installation

Standard studs may be replaced using the instructions in this section. For “Rosan® Stud Installation”, refer to instructions in Appendix C-7.2.1.

1. Standard studs have no marking. Refer to the table below to determine the proper stud size required or to identify oversize studs.

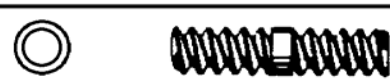
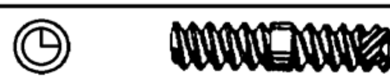
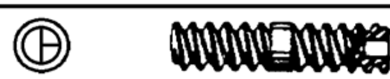
Example Part Number	Oversize	Identification	Identification Color Code
XXXXXX	Standard		None
XXXXXXP003	0.003		Red
XXXXXXP007	0.007		Blue
XXXXXXP012	0.012		Green

Figure C-8. Stud Sizes

2. Clean the casting tapped hole with solvent and blow dry any debris or liquid out of the hole using compressed air.
3. Examine the thread. If it is not torn, obtain the next larger oversize stud. If the old stud was of the maximum oversize or if the thread is damaged, tap the hole and insert a helical coil insert according to instructions in Appendix C-6.2.

WARNING

Helical coils can only be installed where authorized.

4. A helical coil insert (Figure C-9) may be used on a rocker shaft retaining stud provided that a minimum wall thickness of more than half of the helicoil diameter remains after tapping for the helical coil insert.
5. If the hole is blind or if the hole goes through to a cavity subject to leakage, coat the new stud’s course thread with Pat No. 646941 High Strength Adhesive.
6. Drive the new stud with a tee handle stud driver. Turn it slowly and compare the torque values listed in Appendix B.

7. Drive the stud in until it reaches the desired length specified in Appendix D.

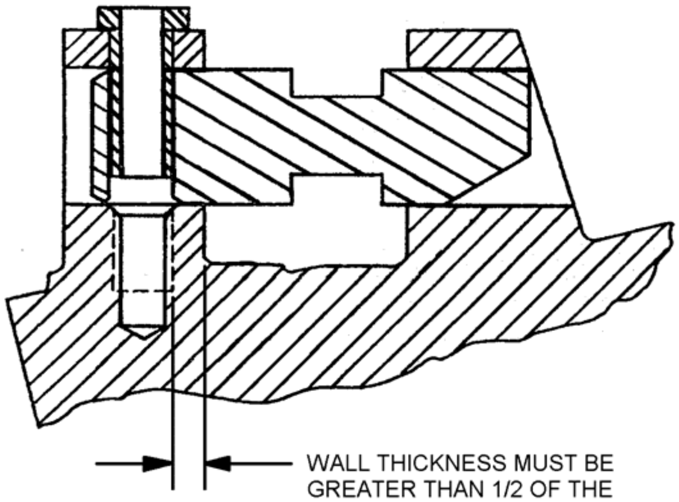


Figure C-9. Minimum Material Thickness for Helical Coil insertion

C-7.2.1. Rosan® Stud Installation

Any type of Rosan® stud (size-on-size type or step type) may be installed using the appropriate wrench. Install the stud to the dimensions specified in Figure C-10.

CAUTION: Location of the flange is important in preventing the lock ring drive tool from making contact with surface "A" in Figure C-10. Any impact or pressure on surface A may damage the threads in the cylinder head resulting in a loose fit.

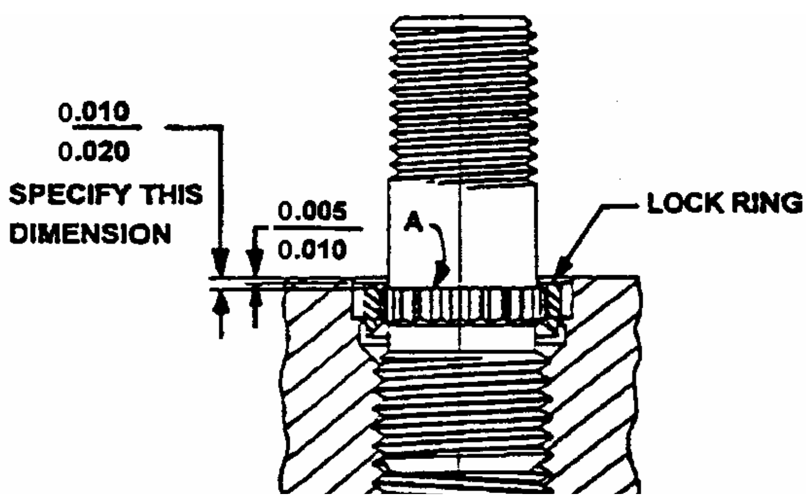


Figure C-10. Rosan® Stud Installation Dimensions

C-8. Cotter Pin Installation

Cotter pins are not reusable. Replace used cotter pins with the specified new cotter pins made of corrosion-resistant steel.

1. Install the nut on the bolt.
2. Torque the nut where the cotter pin is to be inserted to the lowest torque setting for the fastener specified in Appendix B.
3. If the slots in the nut do not align with drilled hole in the bolt, gradually increase the torque until the slot and hole align. Do not exceed the upper limit of the fastener torque specification. Change the nut if necessary.
4. Insert the cotter pin through a hole with the head seated firmly in the slot of the nut.
5. Spread the exposed ends of the cotter pin. Bend the ends over the flat on the nut and the end of the bolt.

   CAUTION: Do not use side-cutting type pliers to bend back the cotter pin ends. These pliers cause nicks which can weaken the cotter pin to the extent that it can become detached.

6. Seat the ends firmly against the bolt and nut (Figure C-11).
7. Trim the protruding ends as necessary.
8. All cotter pins must fit snugly in holes drilled in specific hardware. On castellated nuts, unless otherwise specified, the cotter pin head must fit into a recess of the nut with the other end bent such that one leg is back over the stud and the other is down flat against the nut as shown in Figure C-11.

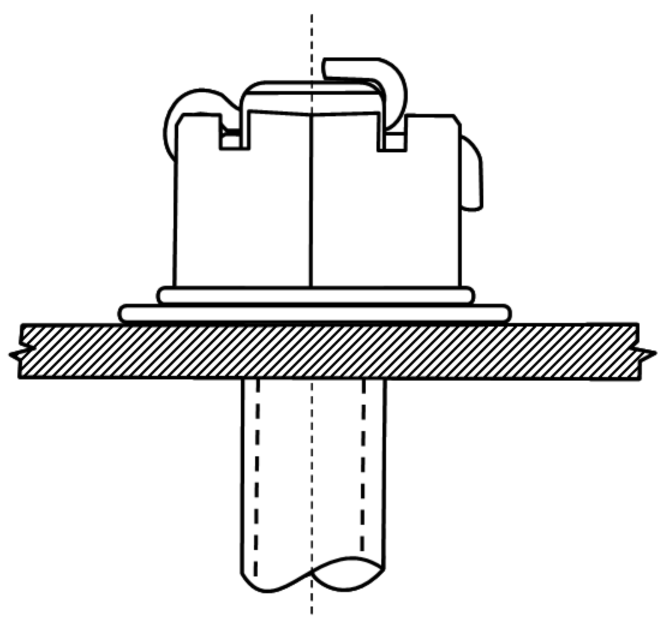


Figure C-11. Cotter Pin Installation

C-9. Fuel System Service

CAUTION: Fuel system contamination may lead to component damage, erratic engine operation, loss of power, or engine shutdown. Flush new fuel system parts, hoses and test equipment prior to connection to the system.

Fuel system service includes any inspection, service or repair action which requires opening fuel system connections, including engine operational checks. Avoid introducing contaminants into the fuel system:

- Exercise caution when installing fuel injection system parts
- Clean surrounding component surfaces and fittings before removing parts or disconnecting hoses or fittings
- Cap or plug open fuel system hoses or fittings immediately upon disconnection. Caps and plugs should remain in place until the time of reassembly
- Use only clean tools and test equipment
- Purge fuel system components, regardless of source, at the time of installation

C-9.1. Fuel System Purge

1. Remove the cap from the fuel inlet fitting of the fuel system component (hose, pump, manifold valve, fuel control unit, inline filter, or test equipment).
2. Connect the aircraft or engine fuel supply to the inlet fitting and tighten to prevent leakage.
3. Connect a clean section of fuel hose to the component fuel outlet(s) and direct the end of the hose through a paper filter in to an approved fuel container.
4. Turn the fuel selector valve ON.
5. Allow at least one quart (.95L) of fuel to flow through the component in to the paper filter. If the component features a mixture or throttle control lever, cycle the lever through the full range of operation several times while fuel is flowing through the component.
6. Turn the fuel selector valve OFF and inspect the filter for contamination. If contamination is found, troubleshoot and correct the source of the contamination before proceeding with component installation. Replace the paper filter and repeat the fuel system purge process until no contamination is found in the filter.
7. Proceed with component installation according the appropriate instructions in the manual.

C-10. Gasket Maker® Application

Gasket Maker is an easily workable tacky gel which can be applied onto one side of a flange surface from a tube and evenly spread.

WARNING

Do not apply any form of sealant to the crankcase cylinder deck, chamfer, cylinder mounting flange, cylinder base O-ring, or cylinder fastener threads. The use of RTV, silicone, Gasket Maker or any other sealant on the areas listed above during engine assembly will cause a loss of cylinder deck stud or through-bolt torque. Subsequent loss of cylinder attachment load, loss of main bearing crush and/or fretting of the crankcase parting surfaces will occur. The result will be cylinder separation, main bearing movement, oil starvation and catastrophic engine failure. USE ONLY CLEAN 50 WEIGHT AVIATION ENGINE OIL ON SURFACES LISTED.

1. Verify the surface where the sealant will be applied is clean and free of nicks, burrs, oil, and grit.
2. For the engine nose seal, apply Part No. 653692 General Purpose Primer to prepare the sealant surface before applying Gasket Maker at the engine nose seal area.
3. Apply and spread a thin, translucent coat of Part No. 646942 Gasket Maker (not to exceed 0.010 inches in thickness) to the surface directly from the tube. For small parts, use a polyester urethane sponge or a short nap roller saturated with Gasket Maker to apply the sealant to the part.
4. Once Gasket Maker has been applied, evenly torque the assembly into place.
5. Wipe away excess sealant with chlorinated solvent.
6. To remove Gasket Maker from your hands, apply waterless mechanics hand soap followed by soap and water.

C-11. Gasket Installation

WARNING

Do not apply any form of sealant to the crankcase cylinder deck, chamfer, cylinder mounting flange, cylinder base O-ring, or cylinder fastener threads. The use of RTV, silicone, Gasket Maker or any other sealant on the areas listed above during engine assembly will cause a loss of cylinder deck stud or through-bolt torque. Subsequent loss of cylinder attachment load, loss of main bearing crush and/or fretting of the crankcase parting surfaces will occur. The result will be cylinder separation, main bearing movement, oil starvation and catastrophic engine failure. USE ONLY CLEAN 50 WEIGHT AVIATION ENGINE OIL ON SURFACES LISTED.

Gaskets and components must be properly positioned with the hardware torqued and safety wired, as required, during assembly to prevent oil loss.

Install only new gaskets. Prior to installation, inspect each gasket for brittleness, cracks, wrinkles, damage, or deformities. Do not use a gasket with obvious defects, even if new; replace with a new manufacturer-specified gasket. Verify that gasket surfaces are clean and free of nicks, burrs, oil, and grit.

CAUTION: Do not install brittle, dirty, cracked, or wrinkled gaskets. Never reuse a gasket removed during disassembly.

1. Apply a thin coat of Part No. 642188 Gasket Sealant to both sides of the gasket unless otherwise specified.
2. Install the gasket, following the contour of the mating surface.
3. Install the assembly and evenly torque the hardware to Appendix B specifications to prevent damage to the gasket
4. Safety wire the hardware where indicated.

C-12. Hose and Tubing Installation

Hoses and tubing to fuel, induction, lubrication, and turbocharger system fittings must be properly installed.

WARNING

Failure to properly support component fittings can result in fitting and/or component damage and a resulting loss of system pressure or fluid.

1. Use a wrench on both mating connections to avoid applying excessive torque to the fittings. Securely tighten fittings and torque to the specified value in Appendix B. Torque the hose or tubing end fitting while maintaining sufficient force on adjacent fittings to prevent twisting and shear loads.

   CAUTION: Do not exceed specified torque values

2. Support the last fitting in the assembly on components that contain multiple fittings coupled in one location. DO NOT over-torque fittings.

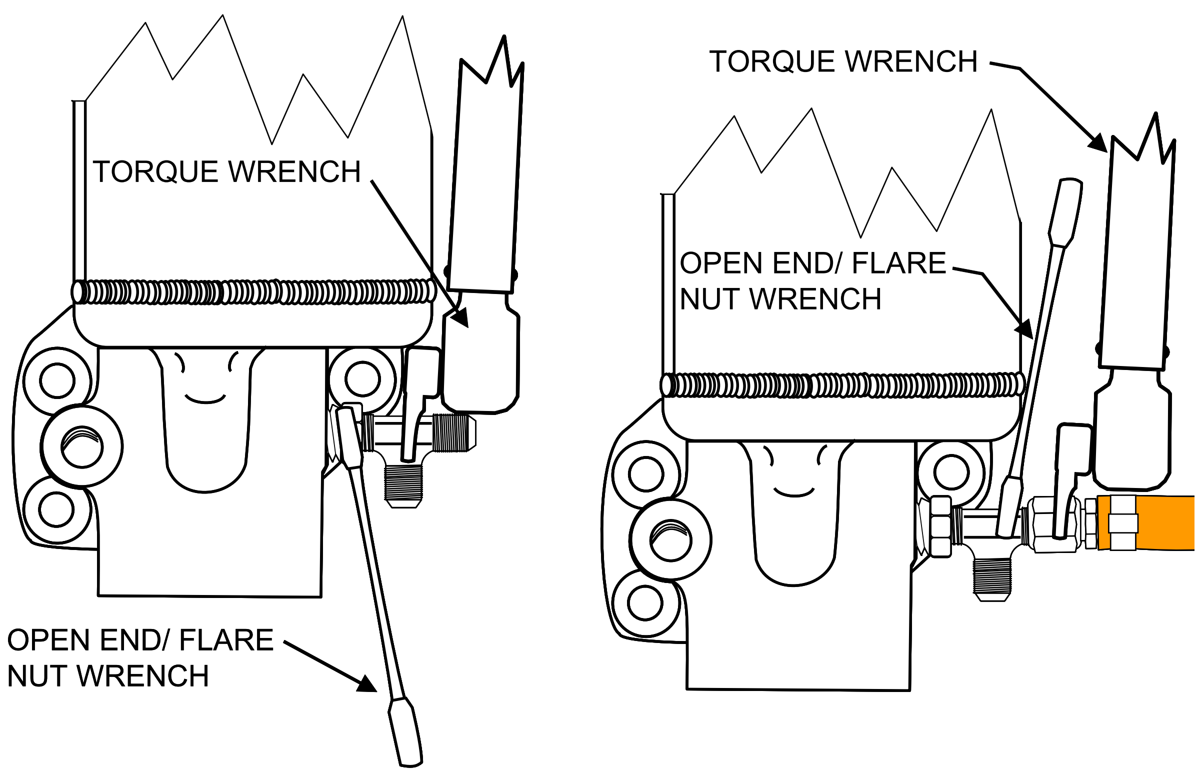


Figure C-12. Installing Hoses and Fittings

C-13. Harness Routing

1. Inspect all proposed harness routes. Consider normal movement and relative motion of the various engine or aircraft parts that will be attached to the harness.
2. Do not route harnesses near belts or pulleys without the use of belt guards; belt failure may damage the wiring harness.
3. Do not secure the harnesses to fuel lines.
4. Use cushion clamps, with stand--off spacers, where necessary to secure the harness to existing baffle supports and brackets where practical.
5. Secure harnesses to minimize the possibility of chafing, vibration, and excessive heat exposure.
6. The largest allowable unsecured segment of wiring harnesses is eight (8) inches (20.32 cm).
7. Route the wiring harnesses through baffles where necessary. All baffle penetrations by a harness must be lined with a suitable grommet to prevent damage.

Appendix D. Overhaul Dimensional Limits

D-1. Overhaul Dimensional Limits=New Part Dimensions

New part dimensions are used for the Overhaul Dimensional Inspection. Overhaul tolerances are not the same as the service limits used for maintenance in Chapter 10. New parts dimensions are based on production drawings in effect at the time of publication.

WARNING

Use only new part dimensional limits during engine overhaul.

D-2. Starter

O-200 starter assemblies are removed and replaced as an assembly; no dimensional limits are provided.

D-3. Lubrication System

Refer to **Figure D-1** and **Table D-1** for lubrication system dimensions. Numbers in the index column of **Table D-1** correspond to the numbered items in **Figure D-1**. Additional lubrication system dimensions are listed in **Table D-2**.

Clean and dry parts thoroughly according to Chapter 14, "Engine Cleaning" instructions before performing the dimensional inspection. Discard and replace any parts that do not conform to the specified new part tolerances.

Table D-1. Lubrication System Dimensions

Index	Part	Dimensions (inches)	
		Minimum	Maximum
1	Oil pump gear in pump housing ....end clearance:	0.0020L	0.0050L
2	Oil pump driver gear in housing .... diameter:	0.0030L	0.0060L
3	Oil pump gear shafts in accessory case and plate .... diameter:	0.0015L	0.0030L
4	Oil pump gear cavity .... diameter:	1.4990	1.5010
5	Oil pump gear shaft bore .... diameter:	0.5620	0.5630
6	Oil pump gear cavity .... depth:	0.6240	0.6260
7	Square drive to camshaft gear..clearance:	0.0055L	0.0135L
8	Oil pump driver and driven gears .... backlash:	0.014	0.022
Spring Test Data			
9	Oil press. relief valve spring (0.041) compressed to 1.56 inch length ....load:	6.06 lbs.	6.31 lbs.
T= Tight L= Loose			

Table D-2. Accessory Case Dimensions not found in Table D-2

Index	Part	Dimensions (inches)	
		Minimum	Maximum
1	Oil pressure relief valve seat ....depth:	1.24	1.26
2	Oil pump gear cavity...diameter:	1.5290	1.5300
3	Oil pump gear shaft ....diameter:	0.5600	0.5605
T= Tight L= Loose			

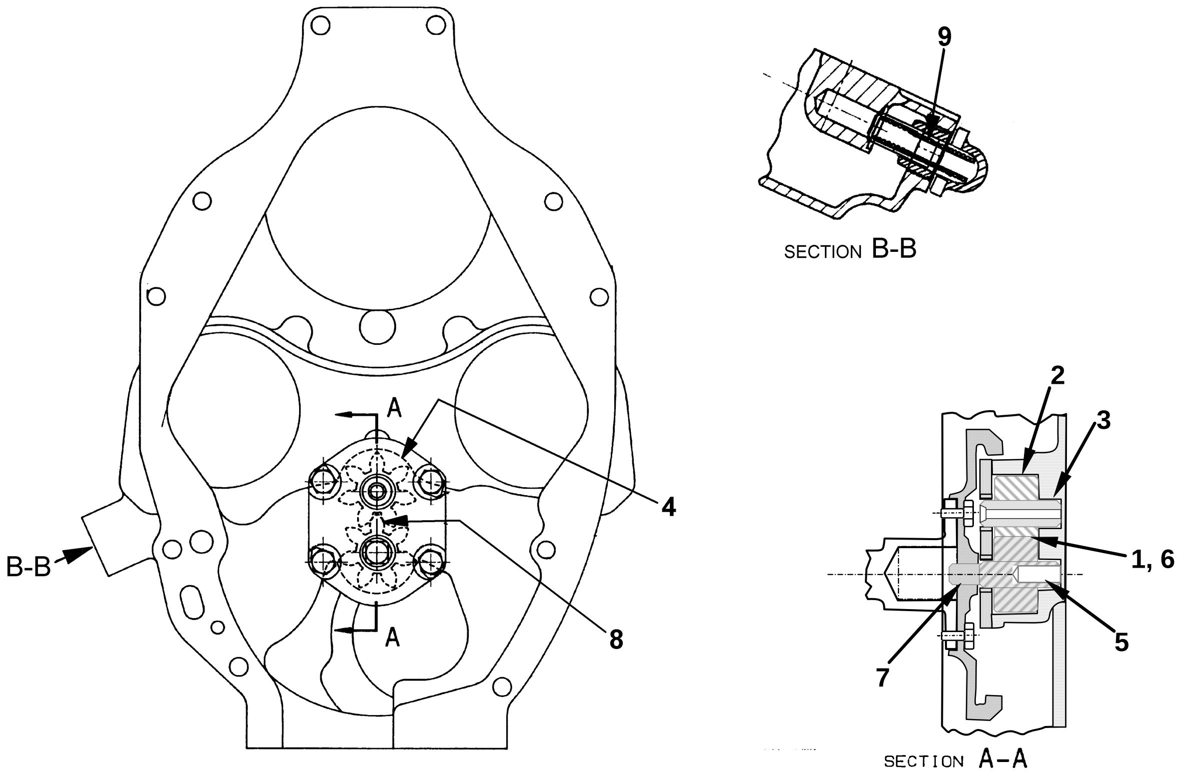


Figure D-1. Accessory Case and Oil Pump

D-4. Engine Cylinders

Refer to **Figure D-2** and **Table D-3** for cylinder dimensional limits. The numbers in the index column of table correspond to the numbered items in the illustrations. Additional illustrations and dimensions are provided in **Figure D-3** through **Figure D-5** and **Table D-4** through **Table D-5**. Clean and dry parts thoroughly according to Chapter 14, "Engine Cleaning" instructions before performing the dimensional inspection. Discard and replace parts that do not conform to the dimensional specifications in the tables.

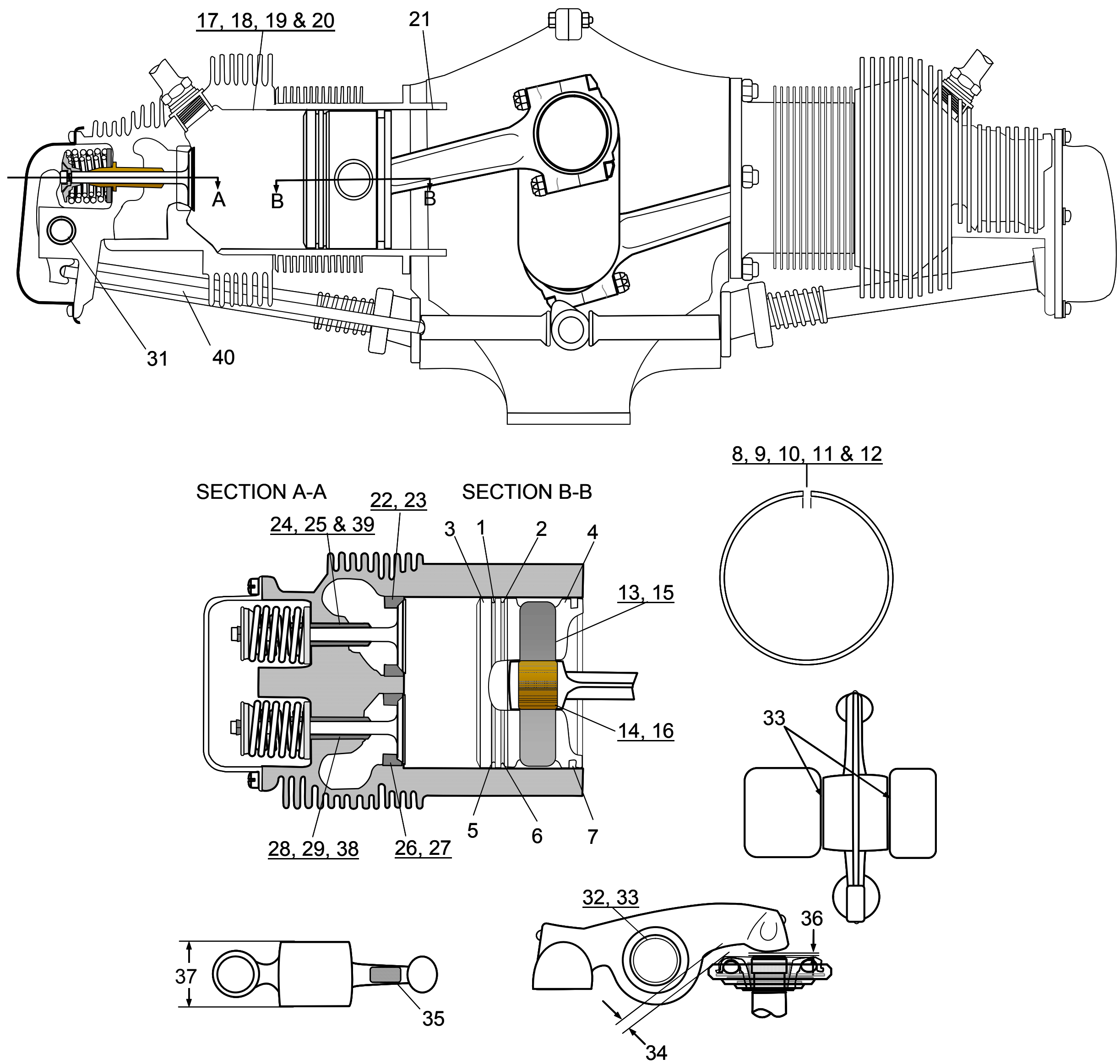


Figure D-2. Cylinder Assembly Dimensions

Table D-3. Engine Cylinder Assembly Dimensions

Index	Part	Dimensions (inches)	
		Minimum	Maximum
	Pistons, Rings, and Pins		
1	Top Land in Cylinder bore....diameter:	0.038L	0.042L
2	Second Land in Cylinder bore....diameter:	0.034L	0.038L
3	Top of Skirt in Cylinder bore....diameter:	0.012L	0.015L
4	Bottom of Skirt (above oil control ring) in Cylinder bore....diameter:	0.009L	0.012L
5	Top piston ring in groove.... side clearance:	0.006L	0.008L
6	Second piston ring in groove.... side clearance:	0.0045L	0.0065L
7	Oil Control ring in groove.... side clearance:	0.002L	0.004L
8	Top ring at 1.00 ± 0.50" depth in cylinder barrel....gap:	0.020	0.034
9	Second ring at 1.00 ± 0.50" depth in cylinder barrel....gap:	0.026	0.040
10	Oil control ring at 1.00 ± 0.50" depth in cylinder barrel....gap:	0.012	0.028
11	Compression ring (closed to specified gap)....tension:	9.0 lbs.	12.0 lbs.
12	Oil control ring (closed to specified gap)....tension:	11.0 lbs.	15.0 lbs.
13	Piston pin in piston....diameter:	0.0001L	0.0007L
14	Piston pin in connecting rod bushing....diameter:	0.0014L	0.0021L
15	Piston pin in cylinder.... end clearance:	0.010	0.32
16	Bushing in connecting rod....diameter:	0.0020T	0.0045T
17	Cylinder bore....diameter	See Figure D-3	
18	Cylinder bore....out-of-round	See Figure D-3	
19	Cylinder bore.... allowable oversize	See Figure D-3	
20	Cylinder bore surface (nitrided barrel)....diameter: Cross hatch....angle Finish (measured in direction of piston travel) (micro inches)	 22° - 32° 30	 — 60
21	Cylinder barrel in crankcase....diameter:	0.0030L	0.0120L
22	Intake valve seat insert in cylinder head....diameter:	0.0055T	0.0085T
23	Intake valve seat.... width:	0.0828	0.1001
24	Intake valve seat-to-valve guide.... axis angle:	See Figure D-4	
25	Intake valve guide in cylinder head....diameter:	0.0010T	0.0030T
26	Exhaust valve seat insert in cylinder head....diameter:	0.0050T	0.0080T
27	Exhaust valve seat.... width:	0.0608	0.0820
28	Exhaust valve seat-to-valve guide.... axis angle:	46° 00'	46° 15'
29	Exhaust valve guide in cylinder head....diameter:	0.0010T	0.0030T
30	Rocker Shaft....diameter:	0.6082	0.6087
	Rocker shaft in rocker arm bushing....clearance:	0.0010L	0.0025L
31	Rocker shaft in cylinder head boss....clearance:	0.0002L	0.0015L
32	Rocker arm bushing bore....diameter:	0.810	0.813
	Rocker arm bushing bore.... surface finish:	80	---
	Rocker arm bushing – finish bore.... inside diameter:	0.7505	0.7515
	Rocker arm bushing.... surface finish	32	---

Table D-3. Engine Cylinder Assembly Dimensions

Index	Part	Dimensions (inches)	
		Minimum	Maximum
33	Rocker arm to support boss.. side clearance:	0.0020	0.0150
34	Rocker are-to-valve spring retainer...clearance:	0.020	---
35	Rocker arm ....grind width:	---	0.34
36	Rocker arm foot to valve stem (deflated lifter) ....gear lash	0.030	0.110
37	Rocker arm ....width	0.991	0.994
38	Intake valve guide..inside diameter: Intake valve in guide .... diameter:	0.4350 0.0010L	0.4377 0.0040L
39	Exhaust valve guide...inside diameter: Exhaust valve in guide .... diameter:	0.4375 0.0025L	0.4395 0.0040L
40	Pushrod..length:	10.797	10.827
T= Tight L= Loose			

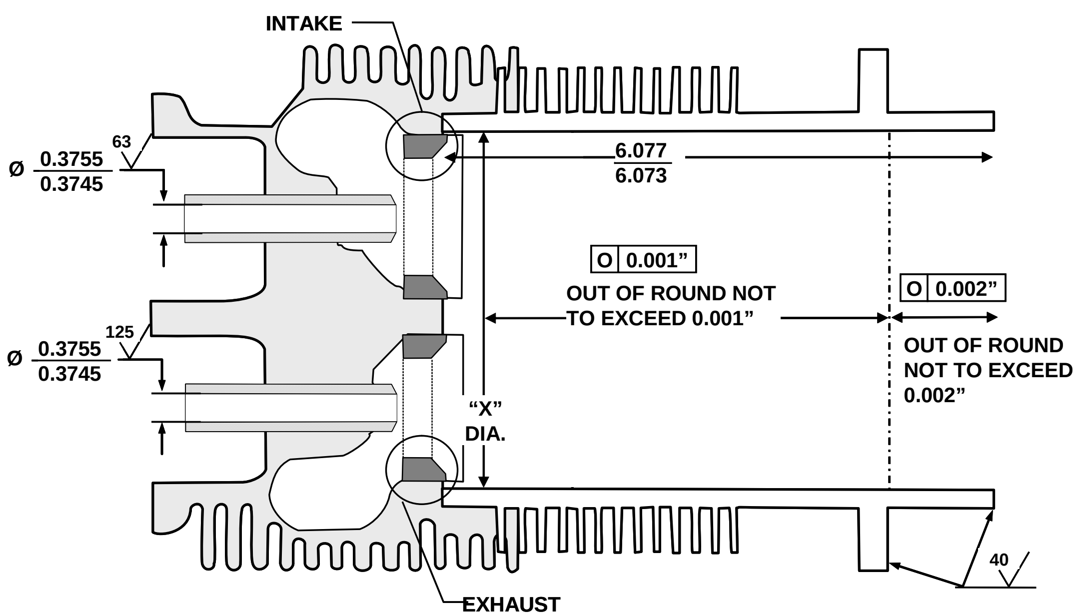


Figure D-3. Finished Cylinder Dimensions (after honing)

Table D-4. Cylinder Barrel Dimensions

Size	"X" Diameter (inches)		"Y" Diameter (inches)
	Minimum	Maximum	Straight Barrel- No Choke
STANDARD	4.0615	4.0635	
0.005	4.0665	4.0685	
0.010	4.0715	4.0735	
0.015	4.0765	4.0785	
Cylinder bore out of round must not exceed 0.002 at measured diameters			

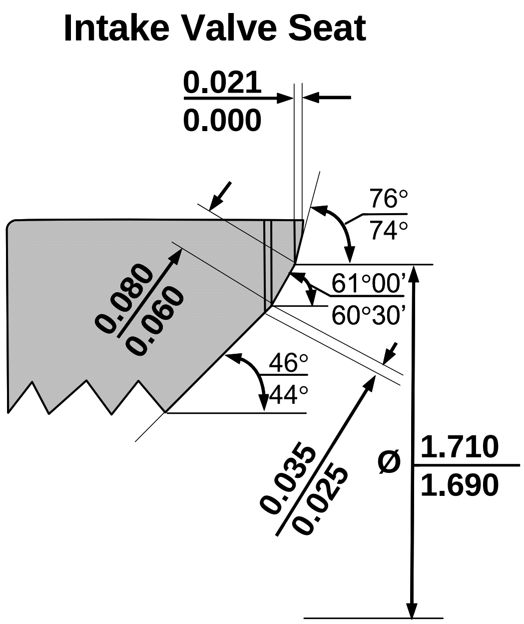
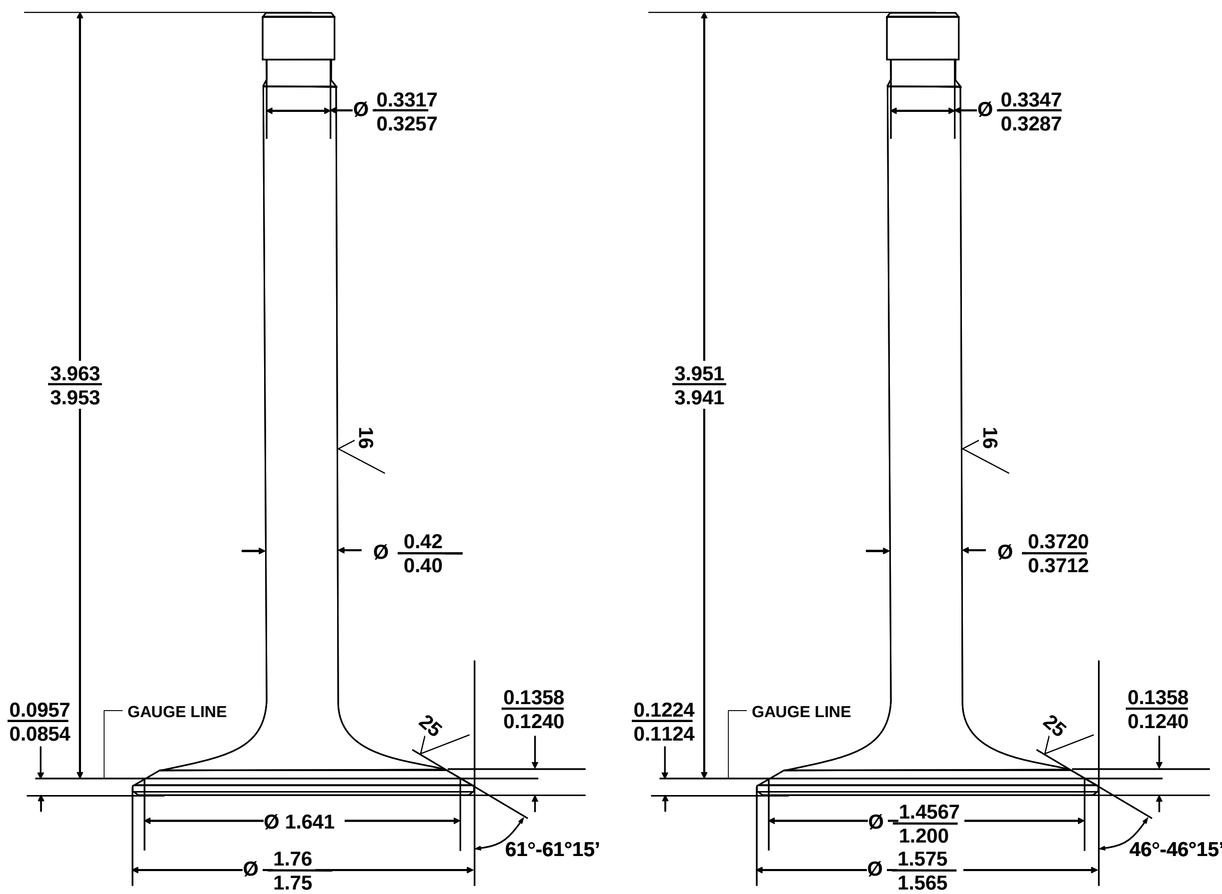


Figure D-4. Valve Seat Insert Dimensions

Table D-5. Valve Train Dimensions

Index	Part	Dimensions (inches) Minimum	Maximum
1	Intake valve face-to-stem........ axis angle:	61°00'	60°15'
2	Exhaust valve face-to-stem........ axis angle:	45°45'	46°15'
3	Intake valve gauge line-to-stem........length:	Figure D-5 (Replace 100%)	
4	Exhaust valve face-to-stem........length:	Figure D-5 (Replace 100%)	
5	Intake valve face-to-stem........ runout:	0.0000	0.0020
6	Exhaust valve face-to-stem........ runout:	Replace 100%	



Intake Valve **Exhaust Valve**

Figure D-5. New Intake and Exhaust Valve Dimensions

D-5. Crankcase and Engine Drive Train

Refer to **Figure D-6** and **Table D-6** for engine drive train dimensional limits. Index numbers in the first column of **Table D-6** correspond to the numbered items in **Figure D-6**. Additional dimensions are listed in **Table D-7 and Table D-8.** Clean and dry parts thoroughly according to Chapter 14 “Engine Cleaning” instructions before performing the dimensional inspection. Discard and replace parts that do not meet the specified dimensions.

Table D-6. Crankcase and Engine Drive Train Dimensions

Index	Part	Dimensions (inches)	
		Minimum	Maximum
1	Crank pins[1] .... out-of-round:	0.0000	0.0005
2	Main journals[1] .... out-of-round:	0.0000	0.0005
3	Crankshaft rear & intermediate journals[1] .... diameter:	2.373	2.374
	Crankshaft front main journal[1] .... diameter:	1.8720	1.8730
4	Crank pin .... diameter:	1.9360	1.9370
5	Crankshaft center main journal .... runout: with crankshaft shaft supported at thrust and rear journal	0.0000	0.0100
6	Propeller Flange .... runout: with crankshaft supported at front and rear journal	0.0000	0.0050
7	Crankshaft gear on crankshaft .... diameter:	0.0005T	0.0020L
8	Camshaft journal .... diameter:	1.3725	1.3735
9	Camshaft gear on pilot .... diameter:	0.000	0.002L
10	Connecting rod .... side clearance	0.0060	0.0110
11	Camshaft journal in crankcase bearing .... diameter:	0.001L	0.003L
	Camshaft bearings .... diameter:	1.3745	1.3755
12	Camshaft rear journal to crackcase .... end clearance:	0.004	0.008
13	Starter adapter plug bore .... diameter:	0.0010L	0.0030L
14	Crankshaft to Thrust Washer .... end clearance	0.004	0.020
15	Main bearing bore .... diameter:	2.0615	2.0625
T= Tight L= Loose			

1. If the crankshaft is worn beyond limits, the crankshaft may be repaired by grinding the crank pins and journals to 0.010” under new shaft limits and re-nitriding. Crankshaft machining must be accomplished by a repair station certified to perform crankshaft repair by the FAA or equivalent government aiworthiness authority.

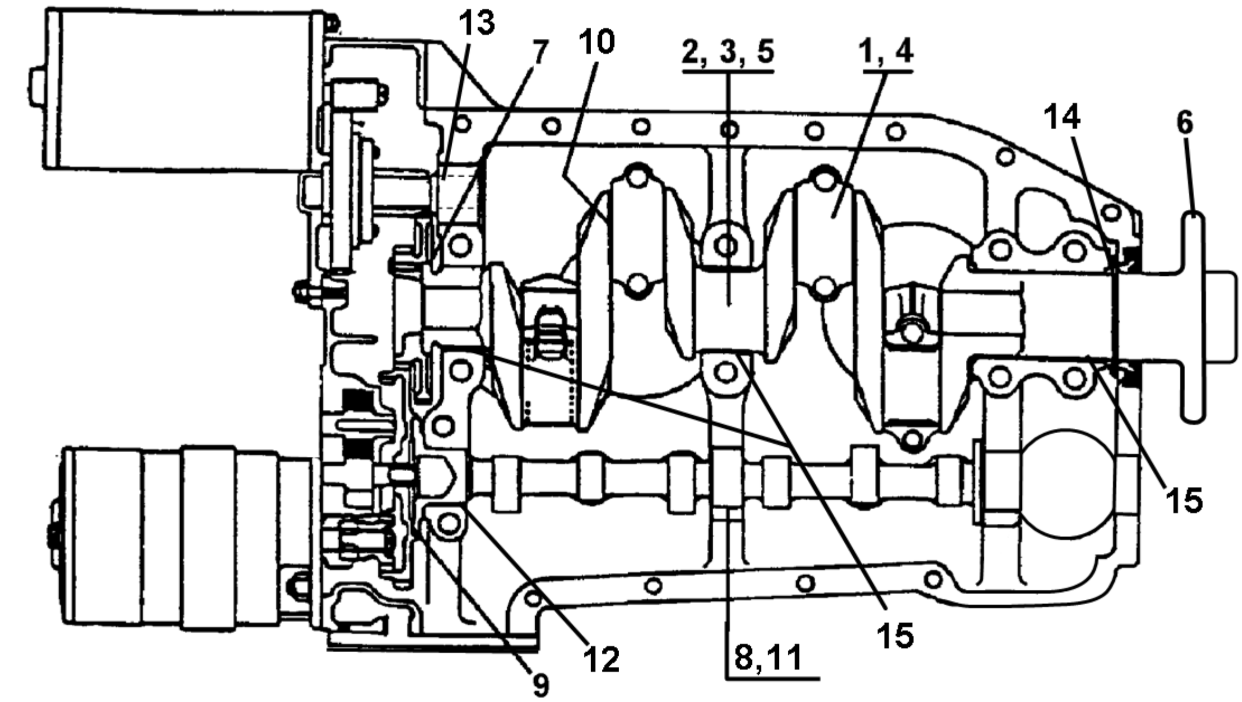


Figure D-6. Engine Drive Train

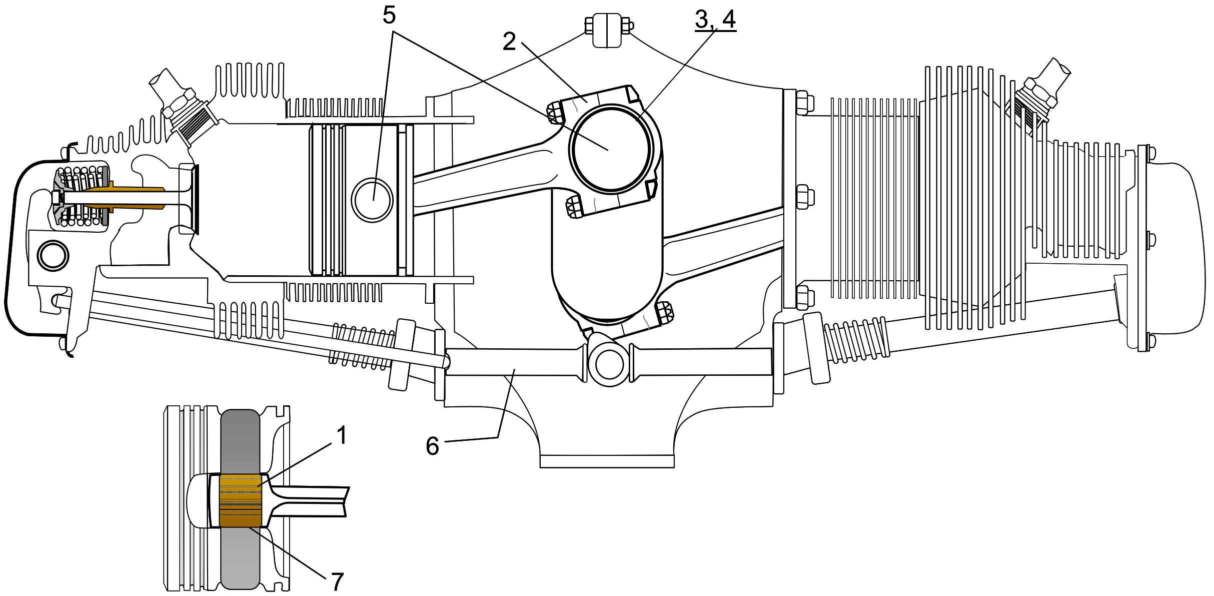


Figure D-7. Installed Connecting Rod Fits & Limits

Table D-7. Installed Connecting Rod Fits & Limits

Index	Part (Figure D-7)	Dimensions (inches) Minimum	Maximum
1	Bushing in connecting rod ....diameter:	0.0020T	0.0045T
2	Bolt in connecting rod ....diameter:	0.0005L	0.0023L
3	Connecting rod bearing on crankpin....diameter:	0.0005L	0.0030L
4	Connecting rod on crankpin.... end clearance:	0.0060L	0.0110L
5	Connecting rod bushing (convergence per inch of length) .... twist:	See Figure D-8	
6	Lifter in crankcase....diameter:	0.0005	0.0020
7	Piston pin in connecting rod bushing....diameter:	0.0014L	0.0021L
T= Tight L= Loose			

Table D-8. Connecting Rod Dimensions

Index	Part (not shown in Figure D-7)	Dimensions (inches) Minimum	Maximum
	Bushing bore....diameter:	See Figure D-8	
	Bushing center to crankpin center ....length:	See Figure D-8	
	Piston pin bushing after installation and reaming .... inside diameter:	See Figure D-8	
	Crankpin bore .... inside diameter:	See Figure D-8	
	Crankshaft end .... width:	See Figure D-8	
	Connecting rod bushing .... twist: (convergence) per inch of length	See Figure D-8	

WARNING

FAILURE TO COMPLY WITH THESE SPECIFICATIONS AND INSTRUCTIONS MAY RESULT IN ENGINE MALFUNCTION AND STOPPAGE.

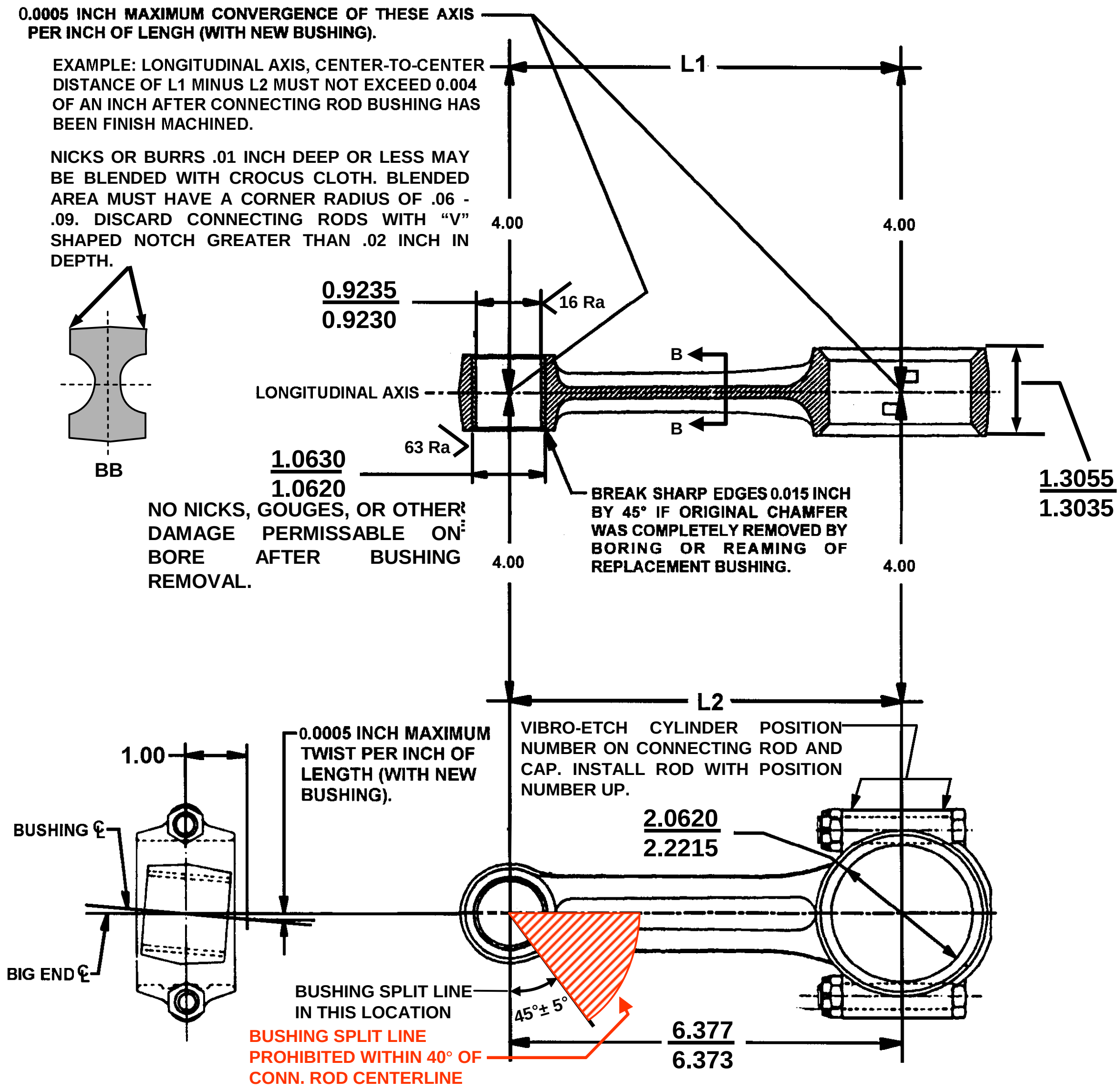


Figure D-8. Connecting Rod Dimensions

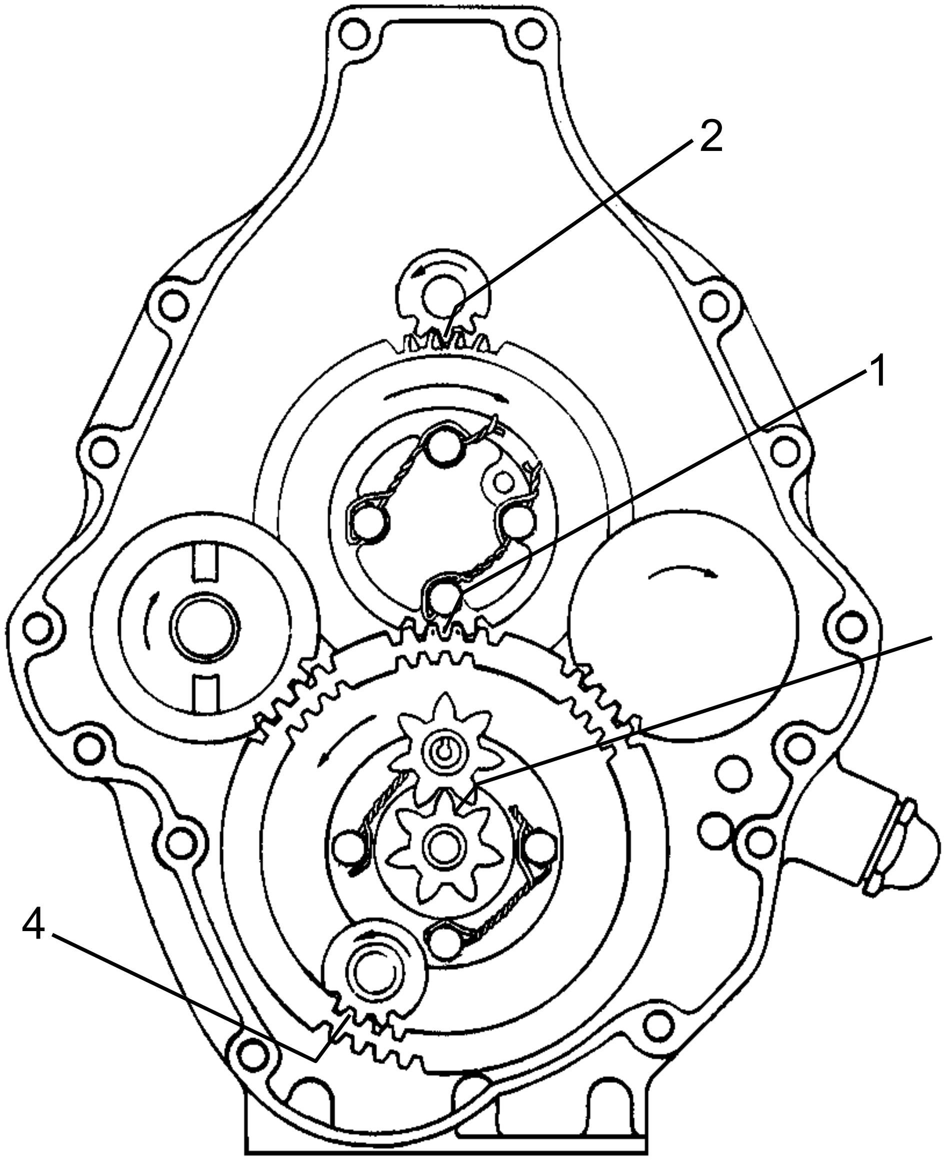


Figure D-9. Gear Backlash

Table D-9. Gear Backlash

Index	Description	Dimensions (inches)	
		Minimum	Maximum
1	Crankshaft gear to camshaft gear .... backlash	0.006	0.009
2	Starter gear to crankshaft gear... backlash	0.029	0.043
3	Oil pump gears .... backlash	0.014	0.022
4	Alternator drive gear to camshaft gear .... backlash	0.010	0.014
5	Magneto gear to camshaft... backlash	0.012	0.014

D-6. Stud Height Settings

Inspect the studs for corrosion, distortion, stripped or incomplete threads, or looseness. Check the stud alignment using a tool maker's square. No stud should exceed the specified settings.

D-6.1. Lubrication System Stud Heights

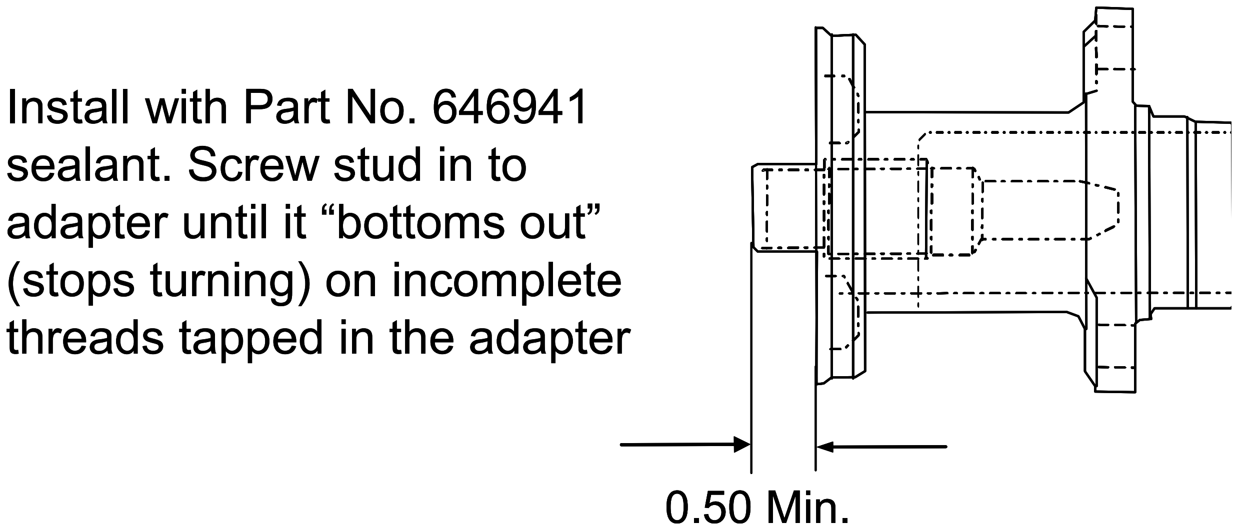


Figure D-10. Oil Filter Adapter Stud

D-6.2. Induction System Stud Heights

Table D-10. Induction Manifold Stud Heights

Item	Location	Thread Size	Stud Height (inches)	Quantity
1	Stud, Induction Manifold	5/16-18-24	0.843-0.845	4
2	Stud, Carburetor Flange	5/16-18-24	0.47-0.50	4

D-6.3. Cylinder Stud Height Settings

Table D-11. Cylinder Stud Heights

Item	Location (Figure D-11)	Thread Size	Stud Height (inches)	Quantity
1	Stud, intake flange	1/4"-20-28	1.12	2
2	Stud, exhaust flange (ring lock)	5/16"-18-24	0.75	2

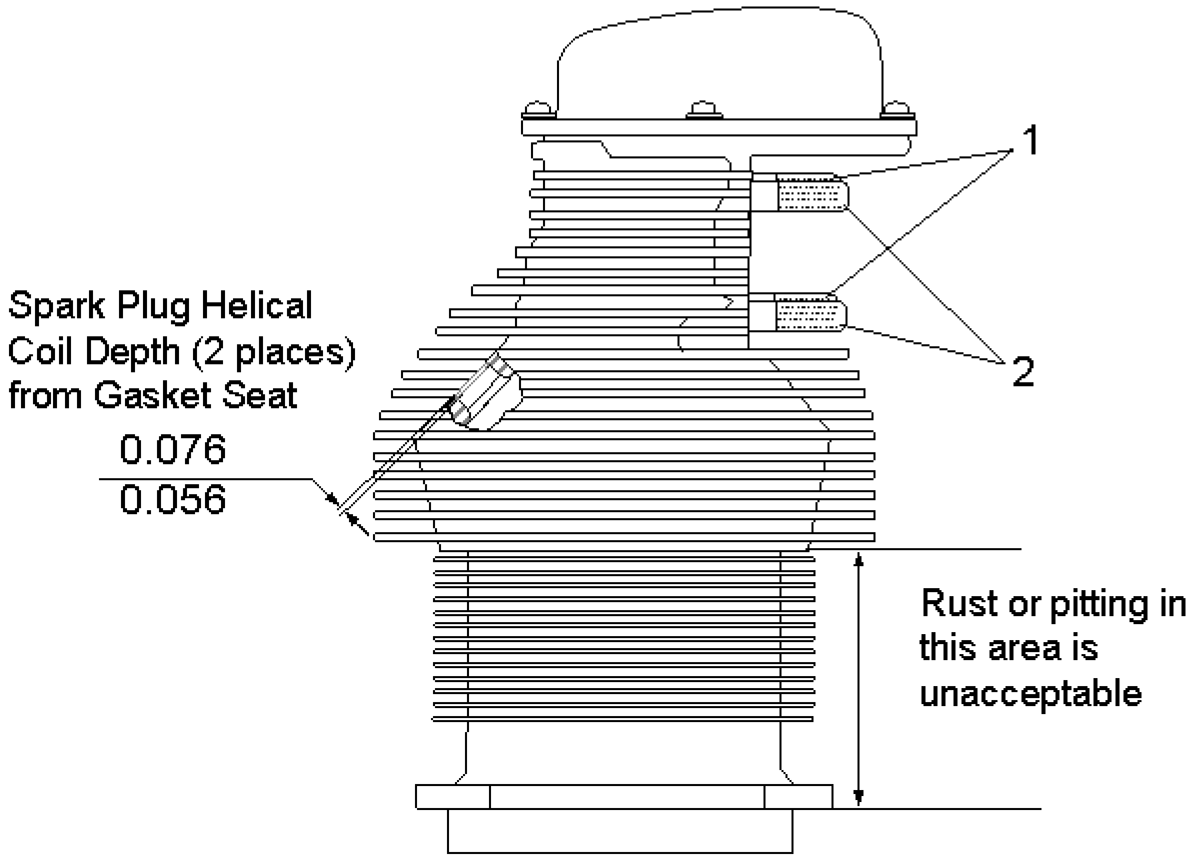


Figure D-11. Cylinder Studs

D-6.4. Accessory Case Stud Height Settings

Table D-12. 654641-3 Accessory Case Stud Heights

Item	Location (Figure D-12)	Thread Size	Stud Height (inches)	Quantity
1	Stud, Starter	5/16”-18-24	1.03	3
2	Stud, Magneto	5/16”-18-24	1.00	4
3	Stud, Oil Filter Adapter	1/4”-20-28	0.69	1
4	Stud, Alternator	5/16”-18-24	0.88	2
5	Stud, Oil Sump	1/4”-20-28	0.82	3

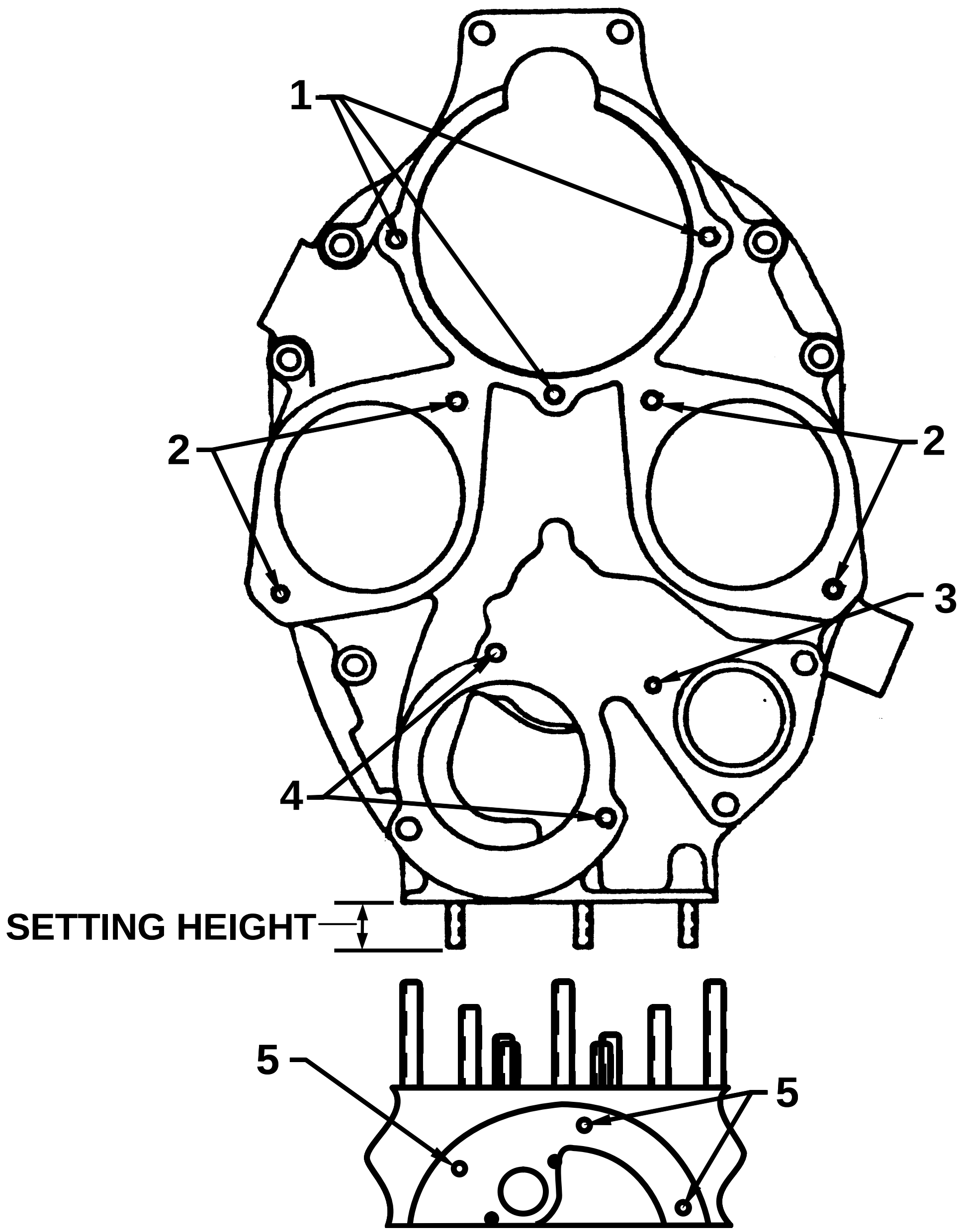


Figure D-12. Accessory Case Stud Heights

D-6.5. Crankcase Stud Height Settings

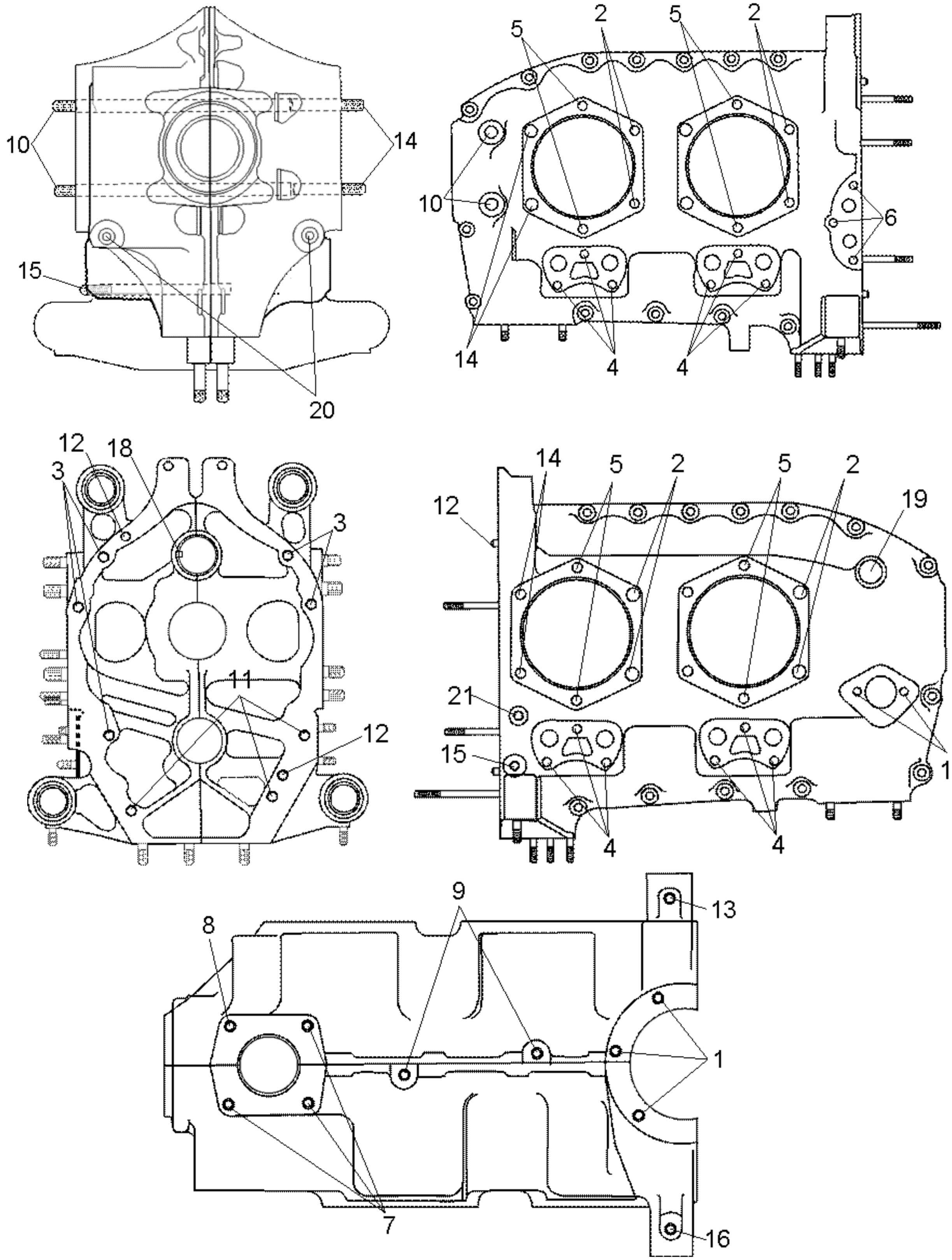


Figure D-13. Crankcase Stud Detail

Table D-13. Crankcase Stud Height Settings

Index	Location (Figure D-13)	Thread Size	Setting Height	Quantity
1	Stud, Oil Sump Flange	1/4”X20-28X1.06	0.75	3
2	Stud, Cylinder Mount Deck	7/16”X14-20X1.56	0.72	8
3	Stud, Accessory Case Mount Flange	5/16”X18	2.06	5
4	Stud, Pushrod Housing to Crankcase	1/4”X20-28X1.06	0.62	12
5	Stud, Cylinder Mount Deck	3/8”X16-24X1.56	0.68	8
6	Stud, Oil Cooler Adapter Pad	5/16”X18-24X1.31	0.91	3
7	Stud, Vacuum Pump Adapter (or Cover)	5/16”X18	0.75	1
8	Stud, Vacuum Pump Adapter (or Cover)	1/4”X20-28X1.12	0.66	3
9	Stud, Intake Manifold Support	3/8”X16-24	1.61	2
10	Through Stud, CC to CC	7/16”X14-20X3.62	2.41	2
11	Stud, Oil Screen Adapter	5/16”X18	3.25	3
12	Dowel, Accessory Case	1/4”X0.56	---	2
13	Stud, Lower CC Arm	5/16”-18-24	0.75	1
14	Stud, Cylinder Mount Deck	7/16”X14-20X6.09	2.41	4
15	Through Stud, CC to CC	3/8”X16-24X5.00	4.38	1
16	Stud, Lower CC Arm	5/16”-18	0.64	1
17	Stud, Fuel Pump Mount Pad	5/16”-18	0.75	2
18	Dowel, Starter Jack Adapter	1/4”X0.64	0.31	1
19	Breather, 1-3 Case Half	---	clock 15° aft	1
20	Plug, Front Oil Gallery	---	install with gaskets	2
21	Plug, 1-3 CC Oil Gallery	---	---	1

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