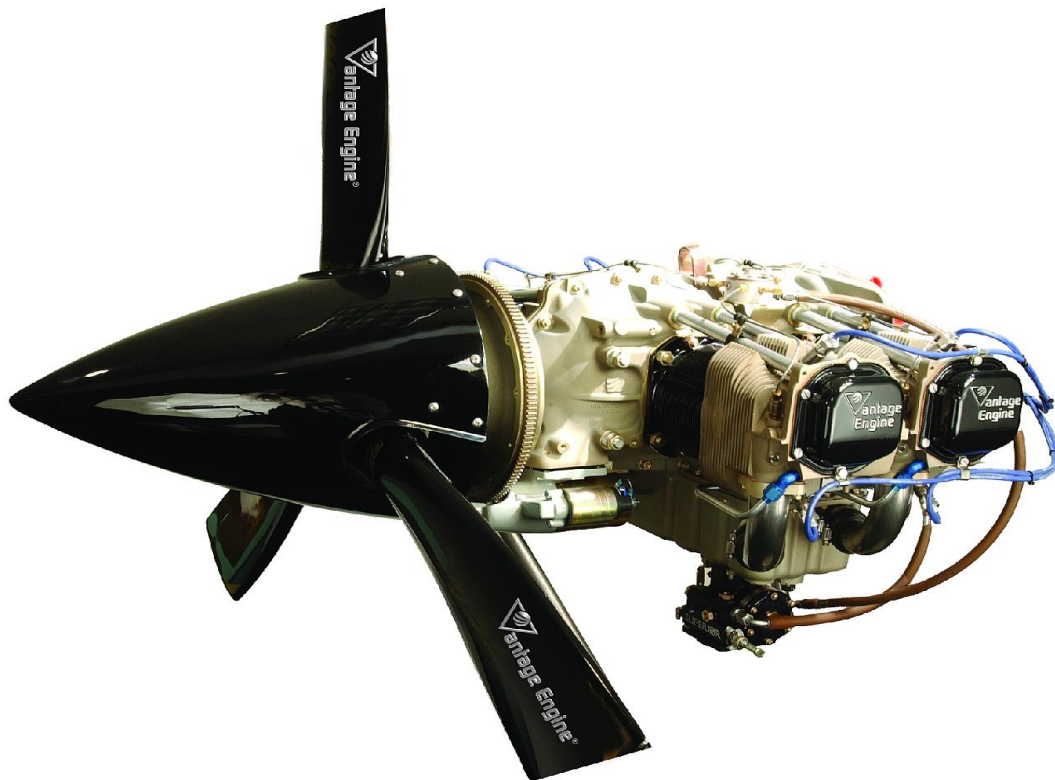




O-360 & IO-360 SERIES ENGINES

OVERHAUL MANUAL



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Manual P/N SVOHM01 Revision C October, 2014

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Manual Number SVOHM01

Revision History

Revision Letter	Effective Date	Description	Pages Revised
A	05/13/05	Initial Release	All
B	02/28/07	Added Data For Models 360-C, -D and -E	72-00-11 pg. 2
		Added Celsius Temperatures	72-00-04 All
		"	72-00-12 All
		"	72-00-13 pgs 10-32
		Added Effective Page List	Pgs. iv-vii
		Added information for Front Prop Governor model	02-00-00 pgs. 1-6
		Moved Torque Values & Fits and Clearances to Appendix C, SSD001 Table of limits; Oil Crush Gasket angular value was 90°	App. C pgs. 1-7
		Revised Airworthiness Limitations Section to reference Maint. Manual No. SVMM01	04-00-00 pgs. 1-2
		Revised Testing and Fault Isolation Section to refer to Maint. Manual SVMM01	72-00-03 pg. 1
		Revised Special Procedures Section, Break-in Procedure	72-00-04 pg. 1
C	10/20/14	Revise Engine Removal Section to reference use of specific aircraft maint. Manual	72-00-05
		Revise Engine Installation Section to reference use of specific aircraft maint. Manual	72-00-10 pg. 1
		Revise Preservation and Storage Section to apply to o'hailed engines only.	72-00-11 pgs. 1-3
		Revise Testing Section to provide engine acceptance testing after o'haul only. Remove break-in procedure, refer to SVMM01	72-00-13 pgs. 1-5
		Add stud driving torque and install height	Appendix C, pgs. 4-5
		Editorial changes to clarify and add missing information	All

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SAFETY ADVISORY

WARNING: BEFORE MATERIALS CALLED OUT IN THIS PUBLICATION ARE USED, KNOW THE HANDLING, STORAGE AND DISPOSAL PRECAUTIONS RECOMMENDED BY THE MANUFACTURER OR SUPPLIER. FAILURE TO COMPLY WITH THE MANUFACTURERS' OR SUPPLIERS' RECOMMENDATION CAN RESULT IN PERSONAL INJURY.

The user must know the manufacturer or supplier information and keep to the procedures, recommendations, warnings and cautions set forth for the use, handling, storage, and disposal of materials. The WARNINGS used in this manual inform the user about dangerous materials or equipment that can cause injury; they do not replace the manufacturer's instructions.

This Safety Advisory has all the warnings included in this manual.

WARNING: OPERATION OF A DEFECTIVE ENGINE WITHOUT A PRELIMINARY EXAMINATION CAN CAUSE FURTHER DAMAGE TO A DISABLED COMPONENT AND POSSIBLE INJURY TO PERSONNEL. MAKE SURE THOROUGH INSPECTION AND TROUBLESHOOTING PROCEDURES ARE ACCOMPLISHED. THIS WILL HELP TO PREVENT INJURIES TO PERSONNEL AND/OR DAMAGE TO THE EQUIPMENT.

WARNING: FUEL IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. USE IN A WELL VENTILATED AREA FREE FROM SPARKS, FLAME, OR HOT SURFACES. AVOID EYE AND SKIN CONTACT. PUT ON SPLASH GOGGLES, SOLVENT-RESISTANT GLOVES AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

WARNING: HOT OIL MAY CAUSE BURNS TO EYES AND SKIN. PUT ON SPLASH GOGGLES AND INSULATED GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

WARNING: ENGINE OIL IS HAZARDOUS AND MAY CAUSE INJURY TO SKIN AND EYES. PUT ON PERSONNEL PROTECTIVE GEAR.

WARNING: USE THE CORRECT PERSONAL PROTECTION. HEATED PARTS WILL CAUSE BURNS.

WARNING: WHEN YOU USE COMPRESSED AIR TO CLEAN OR DRY PARTS, MAKE SURE THAT THE PRESSURE IS NOT MORE THAN 30 PSI. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. PUT ON GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF YOU GET AN EYE INJURY, GET MEDICAL ATTENTION.

WARNING: LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. BEFORE YOU USE, READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER. USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

WARNING: USE THE CORRECT PERSONAL PROTECTION. POLISHING WILL CAUSE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.

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WARNING: PUT ON SAFETY GOGGLES WHEN INSTALLING OR REMOVING SAFETY WIRE.

WARNING: USE THE CORRECT PERSONAL PROTECTION EQUIPMENT TO AVOID INJURY. ENSURE AREA IS FREE OF MOVABLE OBJECTS THAT COULD IMPACT BY PROPELLER AIR BLAST.

WARNING: ADHESIVE SEALANT IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. AVOID EYE AND SKIN CONTACT. USE PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

WARNING: SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT EYE AND SKIN CONTACT AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

WARNING: DO NOT INSTALL THE IGNITION HARNESS “B” NUTS ON THE SPARK PLUGS UNTIL THE PROPELLER INSTALLATION IS COMPLETED. FAILURE TO COMPLY COULD RESULT IN BODILY INJURY WHEN THE PROPELLER IS ROTATED DURING INSTALLATION.

WARNING: IF ONE SURFACE IS POLISHED TO UNDERSIZE, ALL CORRESPONDING SURFACES MUST BE POLISHED TO THE SAME SIZE.

WARNING: PLACE A SUITABLE STAND UNDER THE AIRCRAFT TAILCONE IF NEEDED BEFORE REMOVING THE ENGINE. THE LOSS OF WEIGHT MAY CAUSE THE AIRCRAFT TAIL TO DROP.

WARNING: DO NOT DAMAGE THE NITRIDED SURFACES OF THE CRANKSHAFT.

WARNING: USE CORRECT PERSONAL PROTECTION. SOME CHEMICAL SOLUTIONS CAN CAUSE EYE, SKIN, AND LUNG DAMAGE. FOLLOW THE MANUFACTURER’S INSTRUCTIONS FOR EACH STRIPPING SOLUTION.

WARNING: USE THE CORRECT PERSONAL PROTECTION. USE OF A HAMMER CAN CAUSE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.

WARNING: DO NOT ROTATE ENGINE OR CRANKSHAFT BEFORE REMOVAL OF TIMING LOCATOR PINS.

WARNING: TO PREVENT THE POSSIBILITY OF SERIOUS BODILY INJURY OR DEATH, BEFORE MOVING THE PROPELLER DO THE FOLLOWING:

- VERIFY ALL SPARK PLUG LEADS ARE DISCONNECTED.
- VERIFY MAGNETO SWITCHES ARE CONNECTED TO MAGNETOS AND THAT THEY ARE IN THE “OFF” POSITION AND “P” LEADS ARE GROUNDED.
- THROTTLE POSITION “CLOSED.”
- MIXTURE CONTROL “IDLE-CUT OFF.”
- SET BRAKES AND BLOCK AIRCRAFT WHEELS. ENSURE THAT AIRCRAFT TIE DOWNS ARE INSTALLED AND VERIFY THAT THE CABIN DOOR LATCH IS OPEN.
- DO NOT STAND WITHIN THE ARC OF THE PROPELLER BLADES WHILE TURNING THE PROPELLER.

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INTRODUCTION

About This Manual

“Information contained in this Engine Maintenance Manual fulfills the content requirements of FAR 33.4 Appendix A33.3(a)” and has been found “Acceptable to the Federal Aviation Administration (FAA)”. The purpose of this Overhaul Manual is to provide the necessary instructions for major repair and replacement of Superior Vantage O-360 and IO-360 series engines. Maintenance information may be found in the Maintenance Manual, SVMM01.

The information in this publication is based on data available at the time of publication and is updated, supplemented, and automatically amended by Service Bulletins and Publication Revisions that are issued by Superior Air Parts Inc.

This manual is divided into separate sections relating to the general and specific overhaul instructions required for the engine. These general and specific instructions are generally organized and numbered per the recommendations of the General Aviation Manufacturers Association (GAMA). In this way, information may be located in a conventional manner to aid in both accuracy and timeliness.

Page numbering is organized within each section. The section number (e.g., 72-00-01) is displayed in the right hand section of the footer on each page. The page number is displayed in the center of the footer on each page.

Superior Air Parts has made clear and accurate information available for those who maintain, own and repair the Vantage O-360 and IO-360

Series Engines. Superior Air Parts values your input regarding revisions and additional information for our manuals. Please forward your comments and input to:

Superior Air Parts
Attn: Engineering Department
621 South Royal Lane Suite 100
Coppell, Texas 75019

Related Publications

The following are related engine and accessory publications.

O & IO-360 Installation and Operation Manual, SVIOM01
O & IO-360 Maintenance Manual, SVMM01

Obtaining Service Information

All Vantage Series Engine manuals and service information may be downloaded at: www.superiorairparts.com

All Vantage Series Engine manuals and service information may be purchased by contacting:

Superior Air Parts
621 South Royal Lane, Suite 100
Coppell, Texas 75019

or call: 972-829-4600

Abbreviations

A list of abbreviations used in this manual is shown in Table 01-00-00.1 below.

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Table 01-00-00.1 • Abbreviations	
Abbreviation	Definition
AMS	Aerospace Material Standard
Assy	Assembly
BTC / BTDC	Before Top Center / Before Top Dead Center
CHT	Cylinder Head Temperature
DIA	Diameter
F	Fahrenheit
Fig.	Figure
Ft-Lb	Foot-Pounds
IAW	In Accordance With
I.D.	Inside Diameter
In-Lb	Inch-Pounds
Lb	Pounds
No.	Number
NPT	National Pipe Thread
O.D.	Outside Diameter
Oz.	Ounce
P/N	Part Number
Prop	Propeller
PSI	Pounds per Square Inch
RPM	Revolutions Per Minute
SAE	Society of Automotive Engineers
TIR	Total Indicator Reading
UNF	Unified National Fine
°	Degree

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Consumable Materials List

Refer to Table 01-00-00.2 below for consumable materials used during repair of the Vantage O-360 and IO-360 series engines.

NOTE: Equivalent substitutes may be used.

Table 01-00-00.2 • Consumable Materials	
Material	Source
Acetone or Methyl Ethyl Ketone (MEK)	Commercially Available
Assembly Grease – Lubriplate No. 105	Commercially Available
Cleaning Solvent	Commercially Available
Copper Based Anti-seize, Fel-Pro™ C5-A	Commercially Available
Fuelube™	Ohio Industrial Lubricants
Isopropyl alcohol	Commercially Available
Loctite™ 271, P/N 27183	Commercially Available
Loctite™ No. 2 Gasket Sealant P/N 30514	Commercially Available
Lubricating Oil, SAE 10	Commercially Available
Lubricating Oil, SAE 50	Commercially Available
Mineral Oil (MIL-L-6082), SAE 50 weight	Commercially Available
Permatex™, P/N 27100	Commercially Available
Pliobond™ #20	Commercially Available
Pre-Lube Mixture – approx. 15% pre-lubricant (STP™ brand or equivalent) plus 85% SAE 50 straight weight mineral oil	Locally Prepared Mixture
Preservative oil mix (MIL-C-6529, type 1 plus MIL-L-6082)	Locally Prepared Mixture
RTV™ 102 Silicon Sealant	General Electric
Safety Wire (0.032) Type 304 Stainless Steel, P/N MS20995 C32	Commercially Available
Safety Wire (0.041) Type 304 Stainless Steel, P/N MS20995 C41	Commercially Available
Silastic™ 140 Sealant	Commercially Available
Silk thread, size 00 (100% Silk)	Commercially Available
STP™ High Viscosity Oil Treatment	Commercially Available
Titeseal™ No. 2 Gasket and Joint Compound P/N T2-01	Commercially Available
Phthalate resin-type enamel AMS3125C or equivalent MIL-E-7729 Randolph Black (#303)	Commercially Available
Toluene or equivalent AMS3180 (or equivalent Federal Spec TT-T-548)	Commercially Available
Zinc Chromate Primer	Commercially Available

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DESCRIPTION AND OPERATION

General Description

Superior Vantage Engines are four-cylinder, horizontally opposed, air-cooled, direct drive powerplants incorporating a wet sump, bottom mounted induction, bottom exhaust with either carbureted or port injected fuel systems. Provisions exist for both front and rear mounted accessories. All engine components will be referenced as they are installed in the airframe. Therefore, the “front” of the engine is the propeller end and the “rear” of the engine is the accessory mounting drive area. The oil sump is on the “bottom” of the engine and the cylinder shroud tubes are on the “top”. The terms “left” and “right” are defined as being viewed from the rear of the engine looking toward the front. Cylinder numbering is from the front to the rear with odd numbered cylinders on the right side of the engine. The direction of crankshaft rotation is clockwise as viewed from the rear of the engine looking forward unless otherwise specified. Accessory drive rotation direction is defined as viewed from the rear of the engine looking forward.

Continued Airworthiness

Vantage Engines discussed in this document must be installed and operated in accordance with the limitations, conditions and operating procedures described in the Installation and Operation Manual (SVIOM01). They must also be maintained in accordance with this manual and the applicable Maintenance Manual (SVMM01). For RSA-5 Fuel Servo, refer to Precision Airmotive Operation and Service Manual (15-338E). For the carburetor, refer to Marvel-Schebler Carburetor Service Manual (MSACSM). Sky-Tec starters and Slick magnetos must be returned to their mfr. for service or overhaul. The engine’s time between overhaul (TBO) period is currently defined as 1500 hours. A TBO extension program is in process.

Model Designations

The model number designation is defined in a way that the digits of the model number can easily identify the basic configuration of the engine as described in Figure 02-00-00.1.

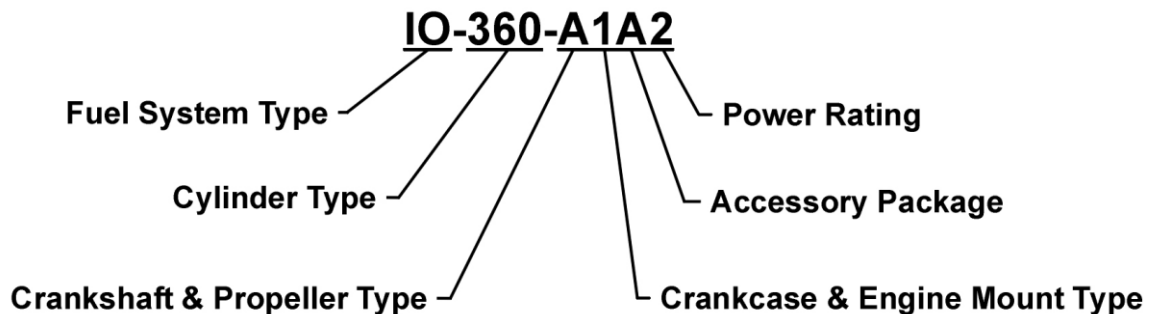


Figure 02-00-00.1 • Engine Model Number Designation

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Fuel System Type

IO Denotes Port Fuel Injection System and “opposed cylinder” arrangement.

O Denotes a carbureted system and “opposed cylinder” arrangement.

Cylinder Type

360 Parallel valve cylinder, 361 cubic inches.

Model Suffix Denotes detail engine configuration

1st Digit Crankshaft & Propeller Type

- A Fixed-Pitch, Thin-wall front main
- B Constant-Speed, Thin-wall front main
- C Fixed-Pitch, Heavy-wall front main
- D Constant-Speed, Heavy-wall front main
- E Fixed-Pitch, Solid front main

2nd Digit Crankcase & Engine Mount Type

- 1 #1 Dynafocal Mount
- 2 #2 Dynafocal Mount
- 3 Conical Mount
- 4 #1 Dynafocal Mount, Front Propeller Governor
- 5 #2 Dynafocal Mount, Front Propeller Governor
- 6 Conical Mount, Front Propeller Governor

3rd Digit Accessory Package

	Ignition System	Fuel System	
		Carbureted (O-360)	Fuel Injected (IO-360)
A	Unison Magnetos	Precision Carburetor	Precision Fuel Injection

4th Digit Power Rating: Piston Compression Ratio

	Cylinder Type	
	360	
	CR	HP
1	7.2:1	168
2	8.5:1	180

Engine Components General Description

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The O-360 and IO-360 series engines are air-cooled, four cylinder, horizontally opposed, direct drive engines. See Installation & Operation Manual (SVIOM01) for Manufacturer's General Specifications.

The complete engine (and engine overhaul) includes the following components and assemblies (note that the fuel system components, ignition components and starter must be overhauled by an approved FAA Repair Station or the manufacturer):

- Crankcase Assembly
- Crankshaft Assembly
- Camshaft Assembly
- Valve Train Assembly
- Cylinder Assemblies
- Connecting Rod Assemblies
- Oil Sump Assembly
- Intercylinder Baffles
- Starter
- Lubrication System (Includes Oil Filter)
- Accessory Drive
- Ignition System (Includes Spark Plugs)
- Fuel System
- Starter Support Assembly
- Oil Gage
- Induction System
- Accessories

NOTE: Complete engine does not include outer cylinder baffles, propeller governor, and airframe to engine control cables, attaching hardware, hose clamps, vacuum pump, exhaust system, or fittings. Fuel pump is included, unless otherwise specified, on carbureted engines. Alternator may be included, if specified.

Specifications

The manufacturer's physical specifications, Accessory Drive Specifications, Physical Specifications for the engines and Accessories and the Model Specification Data (MSD) are available in the Installation & Overhaul Manual (SVIOM01) available from Superior Air Parts, Inc.

Illustrated views of the O-360 and IO-360 engines identifying key components and sub-assemblies, the engine wiring diagram and oil system schematic are shown in the installation & Overhaul Manual (SVIOM01) available from Superior Air Parts.

Features and Operating Mechanisms

Crankshaft - The crankshaft is made from high quality, aerospace grade steel. All bearing journal surfaces are nitrided. There are 3 kinds of crankshafts: thin-wall, thick-wall, and solid front mains which can be identified by looking at the center of the front of the crankshaft or prop oil cavity. The thin-wall and thick-wall crankshafts are each available as fixed-pitch or constant-speed. Fixed-pitch versions have a plug installed in the inner diameter of the front main, or prop oil, cavity which prevents escape of oil out the front, since there isn't a prop governor or constant-speed prop for the oil pressure to act upon.

Connecting Rods - The connecting rods are made from aerospace grade, high quality steel. They have replaceable bearing inserts in the crankshaft ends and bronze bushings in the piston ends. The bearing caps on the crankshaft ends are retained by two bolts with self locking nuts per cap. Caps are tongue and groove type for improved alignment and rigidity.

Camshaft - Valve Operating Mechanism - The camshaft is located above and parallel to the crankshaft. The camshaft actuates hydraulic lifters that operate the valves through pushrods and valve rockers.

Crankcase - The crankcase is made from aerospace grade, stabilized structural aluminum alloy. The assembly consists of two reinforced aluminum alloy castings fastened together by means of studs, bolts, and nuts. The main bearing bores are machined for use with precision type main bearing inserts.

Accessory Housing - The accessory housing is made from an aluminum casting and is fastened to the rear of the crankcase and the top rear of the sump.

Oil Sump - The sump incorporates an oil drain plug, oil suction screen, mounting pad for carburetor or fuel injector, the intake riser, and intake pipe connections.

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Cylinders - *Millennium®* Cylinders are used exclusively. These air-cooled cylinders are manufactured by screwing and shrinking the two major parts, head and barrel, together. The cast heads are made from a special aluminum alloy. All barrels are made from forgings produced to aerospace specifications. They are internally choked and honed to allow optimal operating conditions for the rings and pistons at operating temperatures.

Pistons - The pistons are made from an aluminum alloy. The piston pin is a full floating type with a plug located in each end of the pin. The piston is a 3-ring type with 2 compression rings and 1 oil control ring.

Cooling System – Superior Vantage Engines are designed to be air-cooled. Baffles are provided to build up air pressure and force the air between the cylinder fins. The air is exhausted to the atmosphere through the rear of the cowling.

Induction System - The distribution of the air to each cylinder is through the center zone of the induction system. This is integral with the oil sump.

Fuel Systems

Carbureted - Superior Air Parts O-360 engines are equipped with a float type carburetor. The MA-4-5 carburetors are of the single barrel float type equipped with a manual mixture control and an idle cut-off.

Fuel Injected - IO-360 series engines are equipped with a direct cylinder injected RSA-5 fuel injector. The fuel injection system schedules fuel flow in proportion to airflow. Fuel vaporization takes place at the intake ports. The RSA fuel injection system is based on the principle of measuring airflow and using the air pressure in a stem type regulator, converting the air pressure into a fuel pressure. The fuel pressure (fuel pressure differential), when applied across the fuel metering section (jetting system), makes fuel flow proportional to airflow.

Lubrication System - The full pressure wet sump lubrication system is supplied by a gear

type pump. It is contained within the accessory housing.

Priming System - A manual primer system is provided on all engines using a carburetor. Fuel injected engines do not require a manual priming system, relying instead on the fuel injectors for priming.

Ignition System - Dual ignition is furnished by two Unison magnetos with two spark plugs per cylinder.

Electrical System – Engines may be furnished with an alternator, if provided for in the model specification. If an alternator is furnished, installation brackets, hardware and belt are provided. Alternators are available in either 12 or 24 volt systems and a range of amperages.

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AIRWORTHINESS LIMITATIONS SECTION

Mandatory Intervals or Procedures

Refer to the Superior Vantage O/IO-360
Maintenance Manual, SVMM01 for
Airworthiness Limitations information.

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TESTING AND FAULT ISOLATION

Please refer to the Superior O/IO-360 Maintenance Manual No. SVMM01 for detailed instructions for Testing and Fault Isolation.

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SPECIAL PROCEDURES

Break-In Procedures

Break-In Procedures after the overhauled engine has been installed in the aircraft may be found in the Superior Vantage O/IO-360 Maintenance Manual No. SVMM01. Information on acceptance testing after overhaul is provided in this manual in section 72-00-13.

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ENGINE REMOVAL

General

Due to the complexity and variation in aircraft design, instructions for the removal of the engine from the airframe are not provided here. The airframe Maintenance Manual instructions for engine removal must always be closely adhered to, in order to avoid damage to the engine and aircraft and injury to personnel. Refer to Superior Vantage Maintenance Manual SVMM01 for additional information.

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ENGINE DISASSEMBLY

General

This section contains disassembly procedures. When necessary, disassembly illustrations are also provided. All item number references in the text are specific to this manual and the figures cited.

Disassembly Materials

The materials required for disassembly are listed in Table 72-00-06.1.

NOTE: Equivalent substitutes may be used.

Table 72-00-06.1 • Disassembly Materials

Description	Source
Penetrating Oil	Commercially Available

Parts for Discard

Parts to be discarded are listed in Table 72-00-06.2.

Table 72-00-06.2 • Discard Parts

Nomenclature
All Engine Oil, Air and Fuel Hoses
Gaskets, Oil Seals, and O-Rings
Bearing Inserts (Connecting Rod and Crankshaft)
Piston Rings and Piston Pins
Connecting Rod and Crankshaft Gear Bolts
Intake and Exhaust Valves, Valve Guides and Valve Keepers
Crankshaft Gear Attaching Bolt
Connecting Rod Nuts and Bolts
All Lock Washers, Circlips, Retaining Rings, Locktabs and Locknuts
Counterweight Bushings in Crankshaft and Counterweights (if applicable)
Counterweight Washers (if applicable)
Vermatherm (Oil Temperature Bypass Valve)

Special Tools and Equipment

Special tools and equipment required for disassembly are listed in Table 72-00-06.3.

NOTE: Standard reciprocating engine aviation shop tools and equipment are used unless otherwise specified.

Table 72-00-06.3 • Special Tools and Equipment

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Nomenclature	Source
Compressor, Piston Ring	Commercially Available
Expander, Piston Ring	Commercially Available
Puller, Slide Hammer-Medium	Commercially Available
Compressor, Valve Spring Bar	Commercially Available
Inter cylinder Baffle Tool	Commercially Available
Puller, Valve Guide	Commercially Available
Puller Set, Oil Seal	Commercially Available
Stand, Vertical Nose Support	Commercially Available
Tool, Hydraulic Tappet Removal	Commercially Available

General Disassembly Procedures

- Place engine in horizontal position on a transfer cart.

WARNING: ENGINE OIL IS HAZARDOUS AND MAY CAUSE INJURY TO SKIN AND EYES. PUT ON PERSONNEL PROTECTIVE GEAR.

- Remove the oil drain plug and drain the oil from the engine, if not previously drained.
- Remove the starter ring gear support.
- Perform visual inspection during disassembly and immediately after disassembly. All individual parts should be laid out in an orderly manner as they are removed.
- All loose studs, cracked baffles, and loose or damaged fittings should be identified using a card paper tag and tie wire to prevent being overlooked during regular inspection.
- Paper Tag all components and parts as they are removed using tie wire. Maintain identity of loose assemblies or attaching hardware by placing them together in a suitable bag or other container.
- Prior to starting the component or parts disassembly phase, engine may be placed on a vertical nose support stand.

Disassembly

WARNING: FUEL IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. AVOID EYE AND SKIN CONTACT. USE PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

WARNING: PUT ON SAFETY GOGGLES WHEN INSTALLING OR REMOVING SAFETY WIRE.

Removal of Carburetor and Priming System

- (1) Remove engine fuel lines (30, Figure 72-00-09.37) and all attaching hardware.
 - (a) Remove engine fuel priming system attaching hardware clamps, (25, 30, 45 Figure 72-00-09.36) screws (35) and nuts, (40). Disconnect tube (1, 5, 10, 15) coupling nuts at cylinder head and attaching tee tubes (20).
- (2) Remove the carburetor on O-360 series engines as follows.
 - (a) Remove nuts (1, Figure 72-00-09.37), lockwashers (2) and flat washers (3) from studs in four places.
 - (b) Remove carburetor (7) from studs and discard gasket (4).
 - (c) Remove elbow (5) and discard o-ring (6).

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Fuel injection system removal

- (1) Remove engine fuel injection manifold tubing clamps (70, 75 Figure 72-00-09.39), nuts (85), and screws (80).
- (2) Disconnect injector tubing (55, 60), eight places at fittings (40), elbow (25), and injector nozzle assembly (90). Remove nozzle assemblies (90) four places.
- (3) Remove fuel manifold bracket (1) retaining nuts, washers, (5) and bolts (10). Remove manifold (15) retaining bolts (25) and washer (20).
- (4) Disconnect and remove fuel hoses (30, 35, Figure 72-00-09.38). Remove nuts, (25) lockwashers (20), and flat washers (15) from studs. Remove injector servo assembly (10) and remove gasket and spacer (5).

Magneto and harness removal

- (1) Unscrew ignition wiring harness leads (5, 10, Figure 02-00-00.10) from the top and bottom spark plugs (50). Remove harness attaching caps (5), two places, from the magneto. Remove spark plugs (50) from cylinder.
- (2) Remove magneto (15, Figure 72-00-09.40) attaching nut (30), washer (25), and clamp (20). Remove the magneto (15) and discard gasket (10). Remove the adapter (5) and gasket (1). Remove cotter pin (40), nut, and washer. Remove magneto gear (35) and install nut back on threads to prevent damage to drive shaft threads.

Oil level gage housing Removal

- (1) Unscrew the oil gage (10, Figure 72-00-09.28) and remove the oil gage housing (5). Discard seals (15, 20).

Fuel pump removal (as required)

- (1) Remove fuel pump screws (15, Figure 72-00-09.32) and washers (10). Remove fuel pump (5) and gasket (1). Remove elbows (25, 30) and discard o-rings (20).

Oil filter and Adapter removal

- (1) Unscrew the oil filter (40, Figure 72-00-09.35). Remove the vernatherm (temperature control valve) (35). Remove screws (30), washers (15, 20), and nut (25) that secure the oil

filter adapter (10) to the accessory housing. Discard gasket (5). Remove cooler bypass plug (55), and discard gasket (50).

Vacuum pump or cover removal

- (1) Remove the vacuum pump (or cover) attaching nuts (40, Figure 72-00-09.31), lockwashers (35) and flat washers (30). Remove pump (or cover (20) as appropriate) and discard gasket (15). Remove adapter assembly (25). Discard gasket (10) and remove vacuum gear (1) and thrust washer (5) from housing. Remove oil seal (55) and discard.

Rear Propeller governor Adapter removal (as required)

- (1) Remove the propeller governor oil line (Figure 72-00-09.34). Remove any clamps. Remove elbows (10, 15) and any attaching hardware, as required, to allow hose removal, discard o-ring (20).
- (2) Remove the cover nuts (30) as required, (Figure 72-00-09.33), lockwashers (25), and flat washers (20). Remove cover (65) and discard gasket (60). Remove retaining ring (55) and thrust washer (5). Remove adapter nuts (30), lockwashers (25), and flat washers (20). Remove propeller governor adapter (15). Discard gasket (10). Tag and save thrust washer (5). Remove gear shaft (1) from housing.

Accessory Housing Assembly Removal

- (1) Remove the accessory housing assembly by removing the bolts (15, Figure 72-00-09.23), lockwashers (10), and flat washers (5). Remove bolt (20), washer (10), and nut (25) two places. Remove accessory housing (40) and gasket (35). Remove fuel pump plunger (1, Figure 72-00-09.24).
 - (a) Remove nuts (90) and washers (85) to remove oil pump housing assembly (80). Remove oil pump drive shaft (115) and impeller gears (105, 110).

Idler gears and shaft removal

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- (1) Remove idler gears (15,20, Figure 72-00-09.20). Remove idler shaft mount screws (5) and nut (10). Remove idler shafts (1) from crankcase.

Starter and alternator attaching hardware removal

- (1) Remove starter mount bolt (15, Figure 72-00-09.42), nuts (20), lockwashers (10), and flat washers (5). Remove starter (1) from crankcase.
 - (a) Remove alternator mount bolt (10, Figure 72-00-09.43) and washer (5) to loosen drive belt. Remove cotter pin (45), slotted nut (40), support bolt (25), and shims (35). Remove cotter pin (45), slotted nut (40), shims (35), and support bolt (30). Remove bolts (20, 90) and flat washers (15, 85) from strut bracket (80). Remove strut support (80) and remove alternator.
 - (b) Remove alternator bracket (55) by removing bolts (60) and lock plate (50). Remove bolt (75), flat washer (70), and adjusting link (65). Visually inspect hardware and bag for reuse if not damaged.

Oil sump and induction disassembly

- (1) Remove screws (25, Figure 72-00-09.29), lock washers (20), and flat washers (15) from intake pipe flange (10). Discard gaskets (1).
- (2) Remove clamps (35), intake hoses (30), and intake tubes (5) from oil sump assembly.
- (3) Remove oil screen plug (85, Figure 72-00-09.27), discard gasket (80), and remove oil suction screen (75). Inspect for debris.
- (4) Remove bolts (15,20), flat washers (25, 30), lockwashers (25), and nuts (35) from sump assembly flange. Discard gasket (11) and remove intake connection pipes (12) from sump assembly.

Cylinder drain tubes removal

- (1) Loosen hose clamps (85, Figure 72-00-09.17) on hose (80) at drain nipple (75). Slide away from drain nipple (75). Loosen gland nut at cylinder head fitting and remove tube assembly (90) from cylinder.

Intercylinder cooling baffle removal

- (1) Remove the intercylinder cooling baffles (1, Figure 72-00-09.26) using intercylinder baffle tool. Turn the baffle retaining hook (10) so that it disengages the retainer (5). Remove the baffle (1) and hook (10) from between the cylinders.

Cylinder removal

- (1) Remove the valve cover screws (130, Figure 72-00-09.15) and cover (125) and discard gasket (120). Rotate the crankshaft to place the piston of the No. 1 cylinder at top center of the compression stroke.

NOTE: With the piston in this position both valves will be closed and the piston extended away from the crankcase to avoid damage when the cylinder is removed.

- (2) Remove the valve rocker shaft caps (20), the valve rocker shaft (15), valve rocker arms (5), and the exhaust valve stem cap (115) from cylinder assembly. Remove the pushrod (1) by grasping the rod end and pulling it through the rod tube (40). Remove nut (60), spring (55), and lockplate (50). Pull rod tube through cylinder head and discard tube seals (35, 45).
 - (a) Remove cylinder assembly by removing nuts from cylinder base. Remove cylinder by pulling straight away from crankcase. As the cylinder is being pulled away, hold the piston to prevent damaged. Discard cylinder base seal.

CAUTION: THE CONNECTING ROD MUST BE SUPPORTED TO PREVENT DAMAGE TO THE ROD AND CRANKCASE. SUPPORT EACH CONNECTING ROD WITH HOLD DOWN PLATES TOOL OR RUBBER BANDS (OR DISCARDED CYLINDER BASE SEALS)

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LOOPED AROUND THE CYLINDER BASE STUD.

- (3) Remove the piston pin (35, Figure 72-00-09.6) using a piston pin drive tool. Drive pin (35) from piston to remove piston (30) from the connecting rod (5).

NOTE: Removal of the remaining cylinders and pistons may be done in any sequence, but less turning of the crankshaft is involved if the cylinders are removed in firing order 1-3-2-4.

- (4) Compress valve springs (90, 95, Figure 72-00-09.15) with spring compressor tool, while supporting cylinder, far enough to remove the valve cylinder keys (105, 110).

NOTE: If the valve keys are stuck in the spring seat, a light blow with a leather mallet on top of the compressor tool will release keys.

CAUTION: DO NOT DRIVE THE VALVES THROUGH THE GUIDES.

- (a) Remove upper valve spring seats (95, 100), inner and outer springs (85, 90), and lower valve spring seats (75, 80) from rocker box. Keep parts for each valve (65, 70) separate. Hold valves by the stems to keep them from dropping out of the cylinder and remove cylinder from the holding block. Reach inside and remove valves. If valves are difficult to remove, push valves back in and clean carbon from stems.

CAUTION: BE CAREFUL NOT TO SCRATCH OR SCORE PISTONS WHEN REMOVING THE RINGS.

- (b) Using the piston ring expander tool, remove the rings (40, 45, Figure 72-00-09.6) from all pistons. Remove the rings in order starting with the top ring and work down.

- (5) Remove and disassemble the hydraulic lifter assembly.

CAUTION: MAINTAIN THE PARTS OF EACH TAPPET ASSEMBLY TOGETHER DURING ALL OVERHAUL OPERATIONS. ALL COMPONENT PARTS ARE TO BE REASSEMBLED WITH THEIR ORIGINAL MATING PARTS AND EACH ASSEMBLY REINSERTED IN ITS ORIGINAL LOCATION.

- (a) Using hydraulic tappet tool, remove the pushrod socket (30, Figure 72-00-09.15) by placing heavy grease on ball end of the "T". By inserting the ball end in the tappet and withdrawing, the socket will adhere to the grease.
- (b) Using the hollow end of the tool, push it over the plunger and withdraw the plunger. If the tool is not available, remove the pushrod socket with fingers or by using needle nose pliers. Insert a piece of wire bent at a right angle into the plunger between the plunger and the lifter body. Turn 90 degrees to engage a coil of spring and draw out the plunger assembly.

Crankcase Disassembly

- (1) Remove nuts (25, 45, 70, 85, Figure 72-00-09.11 and 72-00-09.12), bolts (5, 30, 55, 90, 95), and washers (15, 20, 35, 40, 60, 65, 80). Draw or pull the thru-bolts (1) from the crankcase using cylinder base nuts and washers and/or spacers.
- (2) Separate crankcase using care not to allow camshaft to fall to floor. Caution should be used to keep the right case thru-studs from becoming misaligned when separating the crankcase halves (60, Figure 72.00-09.5).

NOTE: Carefully pull crankshaft nose seal from crankcase forward on crankshaft to aid in crankcase half separation.

- (3) Remove the bearing inserts (5, 10, Figure 72-00-09.2), lifter bodies (20), and camshaft. Remove and discard o-ring seals (10, 75).

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NOTE: Place each lifter body in its proper location in a cleaning basket. The lifter bodies must be assembled in their original locations if reused.

- (4) Remove all threaded plugs and discard oil seals.
- (5) Propeller Governor Drive (Located on the front left side of crankcase). See Figure 72-00-09.5. Remove the hex head plug(6) and gasket (5) from the crankcase. Remove the idler shaft (4) through the opening in the crankcase at the same time supporting the idler gear (9) to prevent dropping and damaging. The idler shaft is pinned and staked to the housing. Pull the Governor driven gear (8) from the crankcase

Crankshaft Disassembly

- (1) With the crankshaft firmly supported at the front and rear main bearing journals

(or secured on a nose stand), remove rod nuts (15, Figure 72-00-09.6). Remove the rods (5) by tapping on the rod bolts (10) with a soft hammer. Discard the connecting rod bearing (1), bolts (10), and nuts (15).

NOTE: Maintain each cap and rod as an assembly. Rods and caps are not interchangeable.

- (2) To remove the crankshaft gear (5, Figure 72-00-09.3), flatten the lockplate (10) and remove screw (15). Tap the gear lightly with a soft mallet or brass drift. Remove the crankshaft oil seal and discard.

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CLEANING

General

Cleanliness of the aircraft engine is crucial to its optimum performance. This section provides information on materials, tools, and guidelines for cleaning.

After the initial visual inspection of internal engine parts, it is necessary to thoroughly clean the engine components for detailed inspection. Since this visual inspection is made during and after disassembly, the components should be cleaned afterwards and tagged to facilitate further non-destructive inspection methods. This identification procedure will also help prevent these components from being overlooked.

It is important to remember to visually inspect an engine prior to cleaning. Residue from the engine's operation can provide information as to hidden defects or other dangerous conditions.

Tools and Materials

For tools required during cleaning, refer to Table 72-00-07.1. For consumable materials required during cleaning, refer to Table 72-00-07.2.

Table 72-00-07.1 Equipment Required for Cleaning	
Item	Vendor
Brush (soft and stiff bristles)	Commercially Available
Immersing tank	Commercially Available
Scraper (wood)	Commercially Available
Grit blaster	Commercially Available

NOTE: Equivalent substitutes may be used.

Cleaning Instructions

Two (2) processes are used in cleaning engine parts; degreasing to remove dirt and sludge (soft carbon) and the removal of hard carbon by decarbonizing, brushing or scraping and grit blasting.

CAUTION: DO NOT USE SAND OR METALLIC ABRASIVES WITH THE GRIT BLASTING EQUIPMENT.

Degreasing

Degreasing is accomplished by immersing or spraying the part in solution of white furnace oil (38-40 specific gravity) or another suitable solvent such as Varsol or Perm-A-Chlor.

Table 72-00-07.2 Materials Required for Cleaning	
Item	Vendor
Cleaning solvent or degreaser such as white furnace oil, Varsol, or Perm-A-Chlor	Commercially Available
Decarbonizing solutions such as Gunk, Penetrol, Carbrax, Super-Chemco, or Gerlach #70	Commercially Available
Isopropyl Alcohol	Commercially Available
Aerosol electrical contact cleaner	Commercially Available
Lubricating Oil (SAE 20)	Commercially Available
Corrosion preservative oil	Commercially Available
Abrasive cloth (crocus cloth)	Commercially Available

NOTE: Residue from the solvent washing must be captured and contained to prevent contamination of the surrounding environment.

WARNING: USE THE CORRECT PERSONAL PROTECTION. SOME CHEMICAL SOLUTIONS CAN CAUSE SKIN, EYE AND LUNG DAMAGE. FOLLOW THE MANUFACTURER'S INSTRUCTIONS FOR EACH CLEANING SOLUTION.

CAUTION: IF ANY WATER-MIXED DEGREASING SOLUTIONS CONTAINING CAUSTIC COMPOUNDS OR SOAP ARE USED, EXTREME CARE MUST BE EXERCISED. THESE COMPOUNDS IN ADDITION TO BEING POTENTIALLY

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DANGEROUS TO ALUMINUM AND MAGNESIUM, MAY BECOME IMPREGNATED IN THE PORES OF THE METAL AND CAUSE OIL FOAMING WHEN THE ENGINE IS RETURNED TO SERVICE. WHEN USING THESE WATER-MIXED SOLUTIONS ALWAYS THOROUGHLY RINSE THE PART IN CLEAN BOILING WATER. REGARDLESS OF METHOD OR SOLUTION USED ALWAYS COAT AND SPRAY ALL PARTS WITH LUBRICATING OIL IMMEDIATELY AFTER CLEANING IN ORDER TO PREVENT CORROSION.

CAUTION: USE THE CORRECT PERSONAL PROTECTION. HEATED PARTS WILL CAUSE BURNS.

Decarbonizing

Decarbonizing is usually accomplished by immersion of the part in a decarbonizing solution (usually heated). Decarbonization solutions such as Gunk, Penetrol, Carbrax, Super-Chemco, Gerlach No. 70 or any suitable solution. Refer to the above caution for water-soluble decarbonizers. Remove hard carbon deposits after degreasing by brushing, scraping or grit blasting. After cleaning, rinse the parts in petroleum solvent, dry, and remove loose particles by blowing the particles out with compressed air. Use a shop air supply with an appropriate water trap.

Decarbonizing solutions will usually remove most of the enamel from machined surfaces. All remaining enamel should be removed by grit blasting particularly in the narrow areas between cylinder cooling fins.

Valve seats may be left unprotected during decarbonizing processes. This will facilitate the reconditioning of the valve seat in later procedures.

CAUTION: EXTREME CAUTION SHOULD BE EXERCISED WHEN USING A DECARBONIZING SOLUTION. IT IS RECOMMENDED THAT THE USE OF HEATED SOLUTIONS BE AVOIDED UNLESS THE OPERATOR IS THOROUGHLY FAMILIAR WITH THE PARTICULAR SOLUTION BEING USED. IN ADDITION THE OPERATOR IS STRONGLY ADVISED AGAINST IMMERSING STEEL AND MAGNESIUM PARTS IN THE

SAME DECARBONIZING TANK, BECAUSE THIS PRACTICE OFTEN RESULTS IN DAMAGE TO THE MAGNESIUM PARTS FROM CORROSION.

CAUTION: DO NOT DAMAGE MACHINED SURFACES. MASK ALL MACHINE SURFACES. PLUG ALL DRILLED OIL PASSAGES TO PREVENT DAMAGE OR ENTRY OF FOREIGN MATTER.

CAUTION: WHEN YOU USE COMPRESSED AIR TO CLEAN OR DRY PARTS, MAKE SURE THAT THE PRESSURE IS NOT MORE THAN 20 PSI. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. PUT ON GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. THIS WILL HELP PREVENT INJURIES TO PERSONNEL OR DAMAGE TO THE EQUIPMENT. IF YOU GET AN EYE INJURY, SEEK MEDICAL ATTENTION

CAUTION: DO NOT USE WIRE BRISTLE BRUSHES OR METAL SCRAPERS ON ANY BEARING, MACHINED OR CONTACT SURFACES.

CAUTION: DO NOT USE GRIT BLASTING ON THE PISTON RING GROOVES. USE A WOODEN SCRAPER.

Scratch and Corrosion Removal

Remove corroded or pitted surfaces on the fillets at the edges of crankshaft main and crankpin journal surfaces, and thrust bearing races by polishing with crocus cloth or fine grit abrasive paper. Refer to the Table of Limits section of this manual for size limits.

Shallow or small scratches, minor abrasions, or pitting on gears or screwed fittings may be dressed out with a fine abrasive (crocus) cloth, small file, or polishing stone. Refer to the Table of Limits Appendix C of this manual for limits.

Note: If pits, scratches, corrosion, abrasions cannot be removed using crocus cloth or another specifically defined material, the part must be rejected. Reference Repair No. 2.

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Accessory Mounts

Clean mounting pads and studs by wiping with a clean cloth moistened with solvent. Use care to remove sludge and debris from around the bases of the studs.

NOTE: Use care to not force debris into drilled areas, passages, ports, or threaded receptacles.

WARNING: SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT EYE AND SKIN CONTACT AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

Fuel Injector and Primer Nozzles

Remove the nozzle. Submerge in a cleaning solvent such as Stoddard Solvent or MEK or equivalent. Allow soaking for several hours. Remove from solvent and dry with dry and clean compressed air. Ultra-sound cleaning methods may also be used. Refer to Precision Airmotive SIL RS-82 for approved cleaning methods.

WARNING: SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT EYE AND SKIN CONTACT AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

WARNING: WHEN YOU USE COMPRESSED AIR TO CLEAN OR DRY PARTS, MAKE SURE THAT THE PRESSURE IS NOT MORE THAN 30 PSI. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. PUT ON GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF YOU GET AN EYE INJURY, GET MEDICAL ATTENTION.

CAUTION: DO NOT USE A SHARP TOOL TO CLEAN OR DISASSEMBLE FUEL OR AIR BLEED NOZZLES.

NOTE: Under normal conditions, the shield and screen are NOT removed from the nozzle assembly. If removal is necessary, both must be thoroughly cleaned prior to reassembly. The shield must have a tight fit on the body.

Screens and Filters

- A. Fuel system filters
 - (1) Fuel screens may be soaked and rinsed in clean solvent and dried with compressed air.
- B. Oil system filters
 - (1) Oil screens may be soaked and rinsed in clean solvent and dried with compressed air.
 - (2) Disposable external oil filter elements are not cleaned.
- C. Air induction system filters
 - (1) Foam air filters may be rinsed in clean solvent then washed with mild detergent and water and reinstalled.

Paper air filter elements are not cleaned

WARNING: SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT EYE AND SKIN CONTACT AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

WARNING: WHEN YOU USE COMPRESSED AIR TO CLEAN OR DRY PARTS, MAKE SURE THAT THE PRESSURE IS NOT MORE THAN 30 PSI. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. PUT ON GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF YOU GET AN EYE INJURY, GET MEDICAL ATTENTION.

Accessories

Refer to the various manufacturers' manuals for information regarding the cleaning of these components.

↑

- Precision Airmotive fuel injector components-SIL RS-82
- Marvel-Schebler carburetor components-Service Bulletin No. A1-76.

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Preservation and Corrosion Prevention

- A. Upon conclusion of visual inspection and all cleaning operations, rinse parts with petroleum solvent. Dry and remove any loose particles by air blast. Apply a liberal coating of preservative oil to all surfaces.
- B. For parts that will be repainted, do the following:
 - (1) Be sure that the part is thoroughly degreased, clean, and dry.
 - (2) Prime and paint in accordance with Repair section.

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INSPECTION AND CHECK

General

The inspection of engine parts consists of three (3) categories: visual, structural and dimensional. Visual and structural inspections deal primarily with structural defects. The dimensional checks are concerned with the size, shape, and fit of a given part. Upon successful completion of inspection, coat all steel parts with preservative oil.

Visual inspections should be accomplished during teardown to isolate to identify components that are cracked, worn or otherwise appear damaged. No cleaning operation should be permitted until a complete initial visual inspection is made of the part in question. Residue from the engine's operation can provide additional information as to hidden defects or other dangerous conditions. Refer to the Cleaning section of this manual for cleaning of parts prior to structural and dimensional inspection

Structural inspections for structural failures will be accomplished using several common non-destructive testing (NDT) processes. These include magnetic particle (for steel parts) and dye penetrant (for all non-magnetic alloys) procedures as well as eddy-current, ultra-sonic, or other NDT methods.

Dimensional inspections must be accomplished to determine the serviceability or the need for repair or replacement of parts. Dimensions and tolerances are provided in the Table of Limits Appendix C of this manual.

For repairs required prior to a final inspection or dimensional check of a part, refer to the Repairs Section 72-00-11 of this manual.

The use of a recording form is recommended during the inspection procedures. The form should be prepared so that all inspection and subsequent repair and reassembly procedures can be noted as they are completed. This usage will also help prevent the omission of components during the inspections and will provide a place to record findings and comments resulting from the inspections.

Materials and Tools

Methods to be used for inspection are listed Table 72-00-08.1. Special tools and equipment required for inspection are listed Table 72-00-08.2.

**Table 72-00-08.1
Inspection Methods**

Item	Method
Magnetic Particle Inspection (MPI)	ASTM E1444 or MIL-STD-1947
Florescent Penetrant Inspection (FPI)	ASTM E1417, AMS 2647 or MIL-STD-1907

**Table 72-00-08.2
Special Tools and Equipment**

Item	Source
Calipers and micrometers: ID and OD	Commercially Available
10X Magnifying Glass	Commercially Available
Machinist's Ruler	Commercially Available
Small Flashlight	Commercially Available
Vee Blocks	Commercially Available
Dial Indicator	Commercially Available
Spring Tension Tester	Commercially Available
Magnetic Particle Inspection Equipment	Commercially Available

NOTE: Equivalent substitutes may be used.

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General Inspection Procedures

All journal surfaces must be checked for galling, scores, misalignment, and out-of-round condition. Pins and shafts must be inspected for straightness. Detailed instructions and acceptance criteria are in the following pages for Crankshafts, camshafts, connecting rods, etc.

Examine gears for evidence of pitting and excessive wear. This evidence is of special importance when found on the involute of the gear teeth. Deep pit marks in this area are reason to reject the part. Bearing surfaces of all gears may have minor abrasions dressed out with fine abrasive cloth but should be free from deep scratches.

Excessively worn or mutilated threads should be rejected. Small defects (such as slight nicks or burrs) may be dressed out with a small file, fine abrasive cloth (crocus cloth), or oil stone. If distortion, galling, or mutilation resulting from over tightening is discovered, the part must be replaced.

Inspection of highly stressed areas for corrosion is necessary. These areas are susceptible to pitting and can cause failure of the part. The following are components requiring particular attention with respect to this issue: the fillets at the edges of crankshaft main and crankpin journal surfaces, and thrust bearing races. If pitting is discovered in these areas and cannot be removed by polishing with crocus cloth or other fine abrasive, the part must be replaced. For polishing procedures, see the Repairs section of this manual.

Inspect all threaded inserts, fasteners, studs, fittings, plugs, etc., for condition of threads.

General Non-Destructive Testing

All parts must be thoroughly clean and dry prior to the start of the test and again upon completion of the test procedures. Refer to Cleaning Section 72-00-07 of this manual. It is important to carefully consider the results of the test to provide accurate interpretation.

All Ferro-magnetic steel parts should be inspected using a magnetic particle inspection (MPI) method (Refer to Table 72-00-08.1), performed by qualified personnel in accordance with ANSI/ASNT-CP-189 Standard for

Qualification and Certification of Nondestructive Testing Personnel. This inspection is especially effective when used on highly stressed parts such as keyways, gear teeth, splines, roots of threads, small holes, and fillets.

NOTE: Perform the magnetic particle inspection strictly in accordance with the MPI specification guidelines. Failure to do so can result in erroneous readings and the reuse of critical components with hidden damage that may cause engine failure.

NOTE: Care must be taken to prevent overheating or burning of the part as a result of the applied electricity during this test.

All aluminum and other non-magnetic alloy parts should be inspected using a fluorescent penetrant (inspection (FPI) method (Refer to Table 72-00-08.1), performed by qualified personnel in accordance with ANSI/ASNT-CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel.

Parts subjected to MPI or FPI must be thoroughly cleaned of all penetrant and developer residue upon completion of the test. Any oils or other fluids used for other non-destructive procedures must be thoroughly cleaned from the part upon completion of the test.

NOTE: Upon completion of any cleaning procedure, be sure to coat all steel parts with preservative oil. Do not handle cleaned parts any more than necessary prior to their reassembly into the engine as this handling reintroduces dirt and corrosive substances to the parts.

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Accessory Housing

Initially inspect accessory housing as illustrated in Figure 72-00-08.2. Remove all accessories (magnetos, pumps, valves, etc.) for separate inspection.

- Obvious excessive damage Reject

Visually inspect accessory housing.

(1) Inspect accessory housing flange and drive pad surfaces.

- Deep scratches Reject
- Minor scratches Blend/hand polish per Repair No.2

(2) Inspect accessory case threaded and drilled areas and passages.

- Worn or mutilated, distorted, galled Reject/Repair
- Slight nicks or burrs Blend/hand polish per Repair No. 2
- Obstructions or plugs See Cleaning section of this manual
- Stud damage See Repair No. 1

FPI accessory housing

- Cracks Reject

Dimensionally inspect accessory housing.

(1) Inspect accessory housing bearing bores.

- Inside diameters See Table of Limits

(2) Inspect accessory housing flange for flatness

- Flat See Table of Limits

Crankcase Assembly

Perform initial inspection of crankcase assembly per Figure 72-00-08.3.

- Obvious excessive damage or wear Reject

(1) Inspect all crankcase bearing bores and journals, saddle supports, support webs, tang slots, and flange surfaces.

- Deep scratches Reject
- Fretting, heavy wear, flat spots Reject
- Minor scratches Blend/hand polish per Repair No.2
- Misalignment of mating surfaces Reject
- Out of round conditions on journals Reject

(2) Inspect crankcase threaded studs and drilled holes and passages.

- Worn, mutilated, distorted, or galled Reject/See Repair No. 1
- Slight nicks or burrs Blend/hand polish per Repair No.1

NOTE: Surfaces may be checked visually and by feel for roughness, flaking, and pitting of races and for scoring on the outside of the bearing races. Shafts, pins, etc., may be checked using vee blocks and dial indicators.

NOTE: Aluminum surfaces can withstand considerable scratching and light scoring without harming the engine integrity or performance provided these problems fall within the limits set forth in the Table of Limits section of this manual.

NOTE: Fretting on the saddle supports in the crankcase has a frosted appearance and tiny pit holes. This usually indicates a change in the size of the bearing saddles that can be sufficient to cause an excessively tight crankshaft bearing fit.

FPI Crankcase Halves

- Cracks Reject

Dimensionally inspect assembled crankcase. See Table of Limits for thru bolt torque.

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(1) Inspect crankcase main and camshaft bearing bores.

- Inside diameters See Table of Limits

(2) Inspect crankcase front propeller governor (if applicable) idler shaft and drive gear bores.

- Inside diameters See Table of Limits

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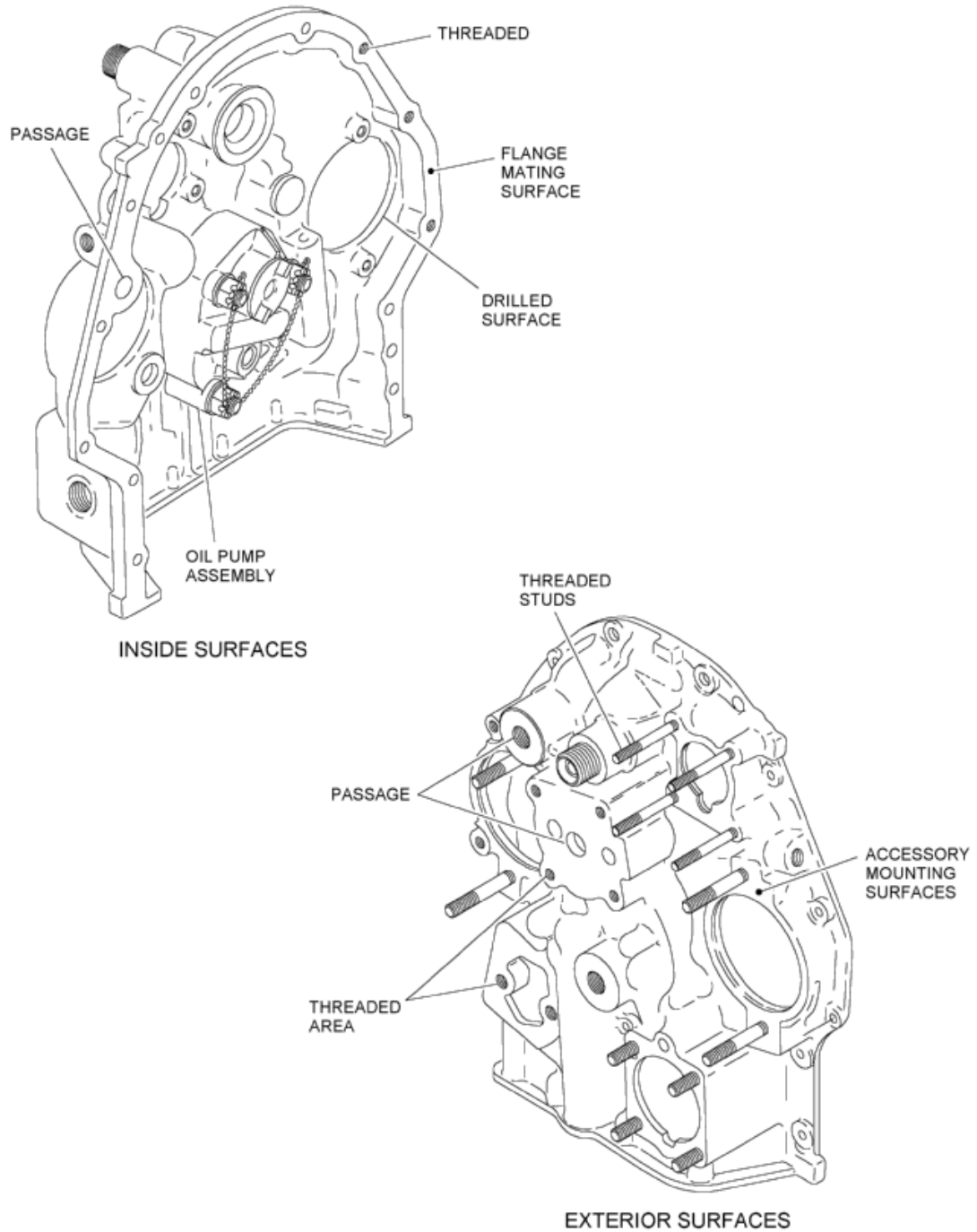


Figure 72-00-08.2 • Accessory Housing

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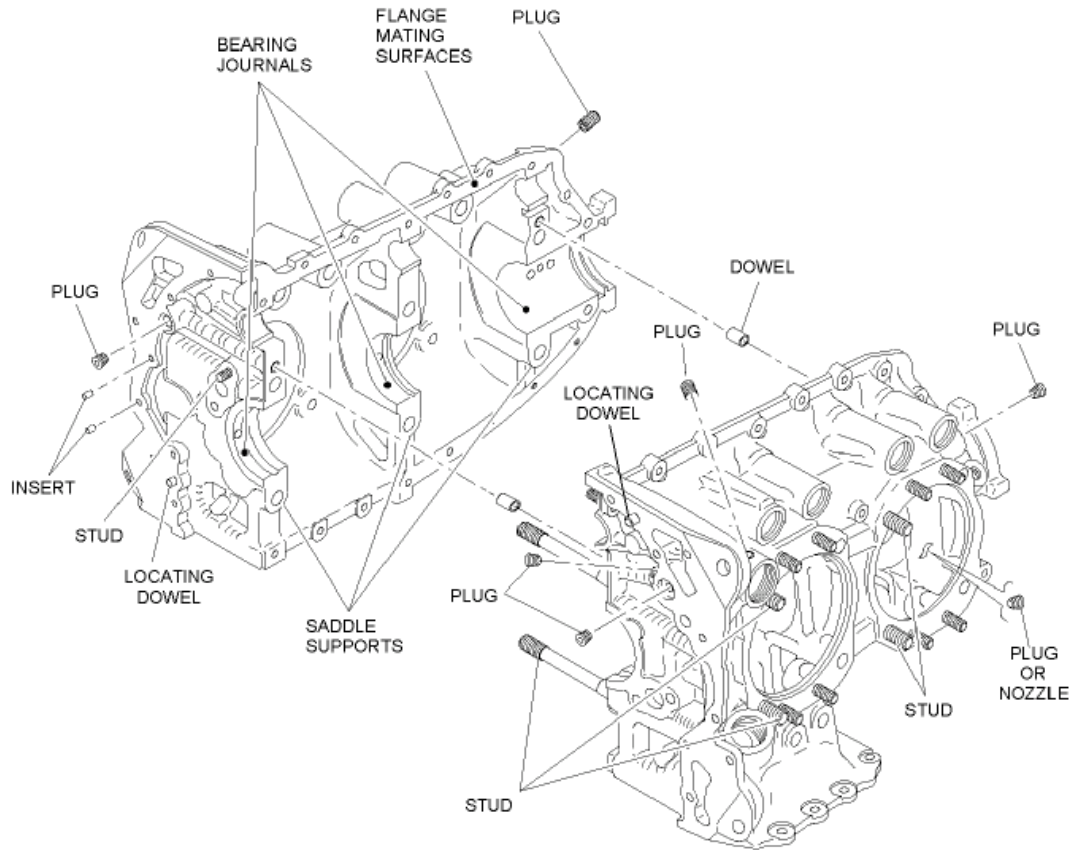


Figure 72-00-08.3 • Crankcase Bearing and Flange Surfaces

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Cylinder Head

Initially inspect cylinder head. Refer to Figure 72-00-08.4.

- Obvious excessive damage to cylinder head Reject

Visually inspect cylinder head.

(1) Inspect cylinder head valve seats.

- Loose, scored, or pitted valve seats Reject

(2) Inspect cylinder for loose or damaged studs.

- Loose or damaged studs See Repair No. 1

(3) Inspect cylinder head spark plug helical coil inserts.

- Loose or damaged inserts See Repair No. 12

(4) Inspect cylinder rocker box covers, intake and exhaust ports.

- Nicked, scored or dented mounting pads Blend/hand polish per Repair No.2

(5) Inspect cylinder head cooling fins for cracks.

- Fin adjacent to the exhaust port flange See Repair No.10
- Physically damaged, broken, or bent fins See Repair No.10

Visually inspect cylinder barrel for general condition. Refer to Figure 72-00-08.4.

- Cracks. Reject

Visually inspect cylinder barrel cooling fins.

- Notches and nicks Blend with hand grinder or file. See Repair No. 10

Visually inspect cylinder barrel to head junction area for evidence of leakage

- Dark Stains Reject

Visually inspect cylinder barrel skirt.

- Bent, cracked, or broken Reject

Visually inspect cylinder barrel mounting flange.

- Nicks Blend with file or crocus cloth. See Repair No. 2

Visually inspect cylinder barrel interior.

- Minor scoring or corrosion Repair by honing. See Repair No. 6
- Deep scoring or pitting Reject
- Glazing or possible barrel wear Repair by honing. See Repair No. 6

Cylinder Head Dimensional Inspections

Inspect the rocker shaft bushings.

- Check the ID of the rocker shaft bushings a minimum of two (2) positions, 90 degrees apart. Several check locations are preferred. Refer to Table of Limits

Cylinder Barrel Inspections

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Cylinder Barrel Dimensional Inspections

Visually inspect cylinder barrel dimensions. Refer to Figure 72-00-08.4 and 72-00-12.1.

- Fit between piston skirt and cylinder Refer to Table of Limits
- Maximum taper of cylinder walls Refer to Table of Limits
- Maximum out of roundness Refer to Table of Limits
- Bore diameter Refer to Table of Limits

NOTE: All cylinder barrel diameter measurements must be taken at a two (2) locations, 90 degrees apart at the plane specifically being measured.

Cylinder Assembly Inspection

Perform a fluorescent penetrant inspection of the cylinder heads.

- Cracks Reject

Piston Inspections

Visually inspect piston general condition. Refer to Figure 72-00-08.5.

- Inspect the top of the piston for excessive pitting, cavities or surface distortion. Reject
- Inspect the piston lands, piston pin holes, and bosses for excessive wear or damage. Reject

Inspect pistons for correct dimensions. Refer to Figures 72-00-08.5 and 72-00-08-6.

- Side clearance between piston and ring Refer to Table of Limits

NOTE: These pistons are ground with a slight taper from the skirt to the head. The exception is the lands between the top compression and oil control rings, which are ground parallel. The clearance on wedge type compression rings must be measured with ring flush to outside edge of piston as shown in Figure 72-00-08.6 in order to obtain a true check of the side clearance.

- Inside diameter of piston pin hole Refer to Table of Limits

NOTE: No pitting or corrosion is permitted in this area.

- Clearance between piston skirt and cylinder and piston diameter at top and bottom Refer to Table of Limits

Perform a fluorescent penetrant inspection of the pistons.

- Cracks Reject

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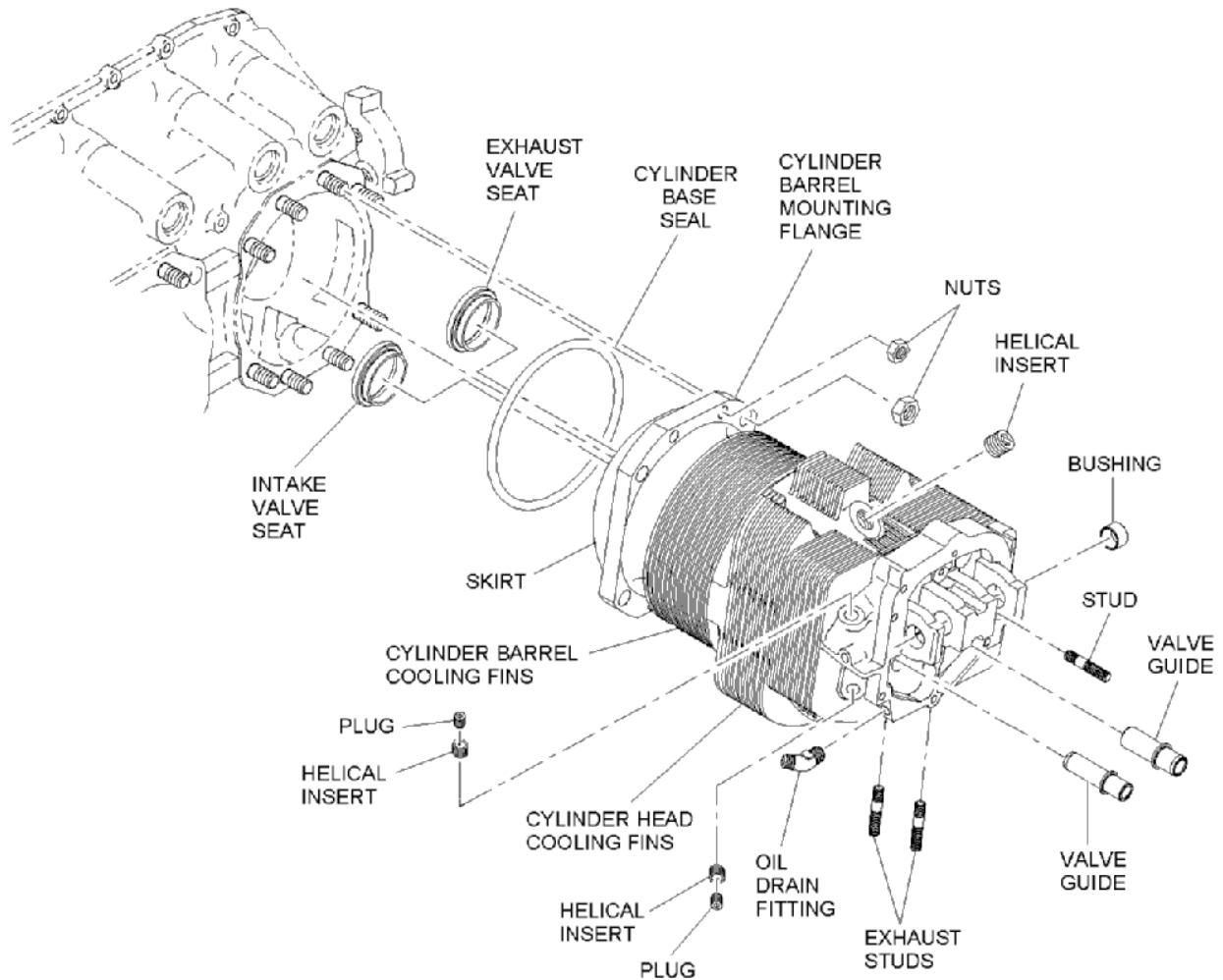


Figure 72-00-08.4 • Cylinder Assembly

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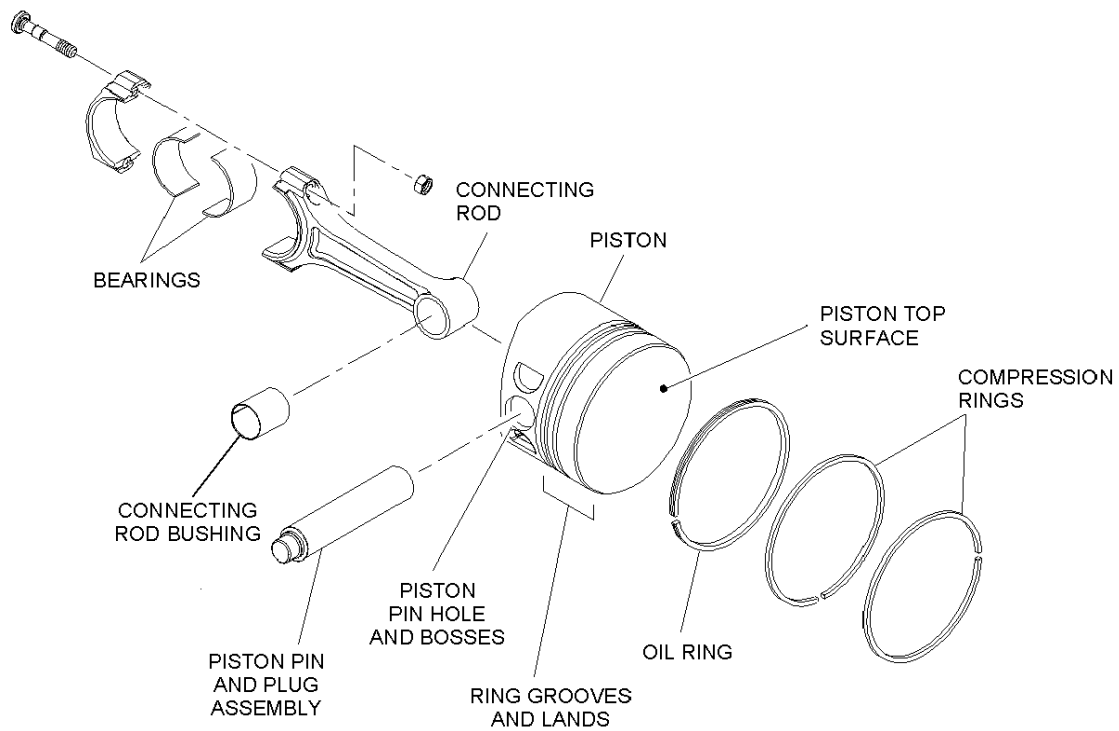


Figure 72-00-08.5 • Piston Assembly

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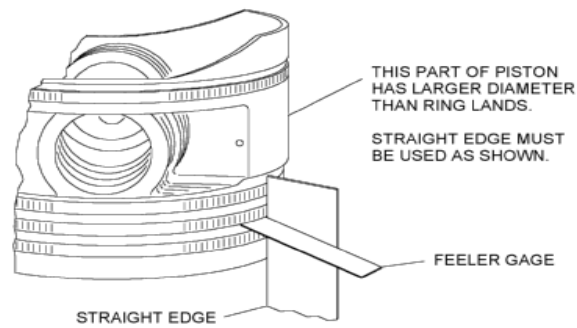


Figure 72-00-08.6 • Piston Rings and Lands

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Valve Rockers

Inspect valve rocker for damage. Refer to Figure 72-00-08.7.

- Check for damaged, badly worn, pitted or scored tips and rod sockets. Reject

Dimensionally inspect valve rocker bushing bore

- Inside Diameter See Table of Limits.
Replace bushing per Repair No. 13

MPI valve rocker assembly

- Cracks Reject

Pushrod Inspection

Inspect pushrods for wear, fit, and alignment. Refer to Figure 72-00-08.8.

- Inspect for excessive wear or damage. Reject if in excess
- Rod must be straight within 0.010 inch Reject if in excess

Valve Springs Inspection

Check valve springs using a spring tester. Refer to Figure 72-00-08.7.

- Reference spring load and deflection limits in Table of Limits Appendix C of this manual. Replace if weak

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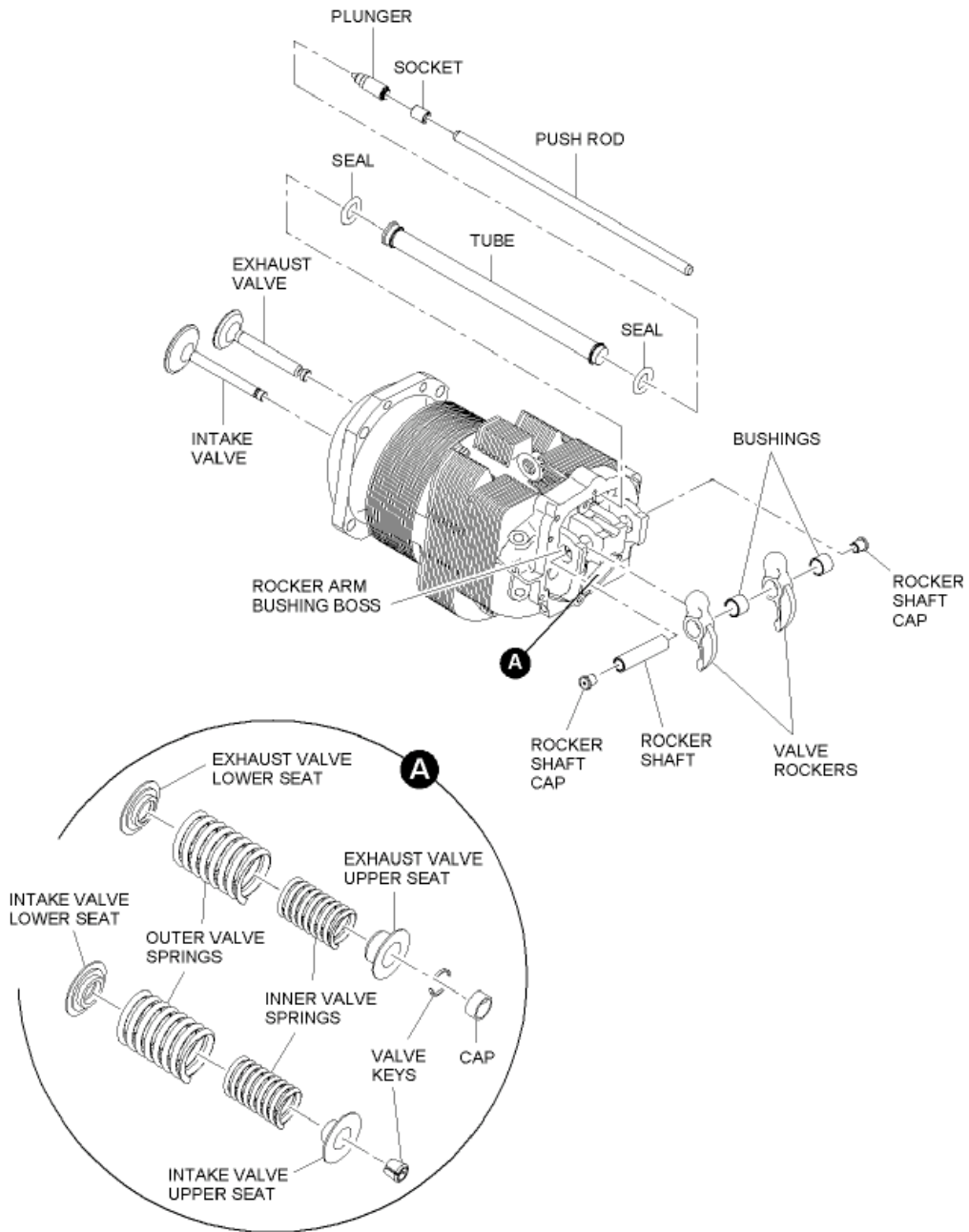


Figure 72-00-08.7 • Valve Train

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Crankshaft

Visually inspect the shaft.

- Scoring, galling, pitting, corrosion, cracks **Reject**

Visually inspect the bearing surfaces.

- Scoring, scratching, etching **Reject**

Dimensionally inspect the bearing surfaces.

- Refer to Table of Limits of this manual **Reject if beyond acceptable limits. See Repair No. 3**

Visually inspect the ID of the forward end of the shaft.

- Deterioration of the cadmium plating **See Repair No. 7**

Measure the run-out of the crankshaft center main bearings and flange by supporting the crankshaft on a flat surface in vee blocks on the front and rear main bearing.

- Measure run-out of the crankshaft center main bearing **Reject if run-out exceeds limits of the Table of Limits.**
- Measure run-out of crankshaft prop flange **Reject if run-out exceeds limits of the Table of Limits**

MPI the crankshaft.

- Cracks **Reject**

Inspection of the counterbored gear mounting flange surface.

- Fretting, galling, scoring, pitting **Reject**
- Check threads in gear retaining hole for nicks or burrs Check for hole depth by measuring with a gear retaining bolt threaded all the way in. Compare the exposed length of the bolt with the thickness of the gear and lockplate. **See Repair No. 1**
- Inspect dowel for damage, out of roundness. Refer to Caution Note below. **Replace**
- Inspect pilot diameter of the counterbore for size and damage. The diameter should not exceed 2.1262 inches at any place **See Repair No. 4**

CAUTION: IF THE DOWEL MUST BE REMOVED, BE CAREFUL NOT TO DAMAGE THE CRANKSHAFT HOLE. DRILL A 1/8 INCH DIAMETER HOLE THROUGH THE CENTER OF THE DOWEL. FILL THE HOLE WITH OIL AND INSERT A PIECE OF 1/8 INCH DIAMETER DRILL ROD IN THE HOLE. STRIKE THE END OF THE DRILL ROD WITH A SHARP BLOW. THE RESULTING HYDRAULIC PRESSURE SHOULD FORCE THE DOWEL OUT.

NOTE: If the crankshaft requires repairs other than those specified above, measure the crankshaft counterbore face. If the crankshaft measures more than the minimum dimension shown, the surface may be reworked to the dimensions shown (do not plate the surface). The surface must be true within 0.001 inch T.I.R. The surface finish must be held to 45 to 90 microns.

Camshaft Inspection

Visual inspection.

- Entire shaft for fretting, galling, scoring, **Reject**

- pitting, cracks, pitting, or other damage
- Cam lobes for indications of distress, **Reject**

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surface irregularity, or feathering along the edges.

NOTE: If the hydraulic lifter bodies have been rejected for spalling, inspect the corresponding cam lobe(s).

Dimensional inspection.

NOTE: Refer to Table of Limits section of this manual.

- Runout at center bearing in excess of 0.001 T.I.R. Reject
- Difference between camshaft bearing journals and crankcase bore 0.002 minimum to 0.004 in. maximum Reject if outside

MPI the Camshaft.

- Cracks Reject

Connecting Rods Inspection

Visual inspection.

- Inspect for wear or fretting on the rod and cap mating surfaces. Reject
- Inspect for nicks and similar damage See Repair No. 2 in this manual

Dimensional inspection.

NOTE: Refer to Table of Limits , Appendix C, of this manual.

- Inspect bore in large end of connecting rod. Replace or repair if tolerances are outside the limits
- Inspect bushing bore in small end of connecting rod. Replace bushing per Repair No 11
- Check connecting rod parallelism. Refer to Replace rod if tolerances are outside the limits
- Check connecting rod squareness. Refer to Figure 72-00-08.15. Replace if tolerances are outside the limits

MPI Connecting Rods.

- Cracks Reject

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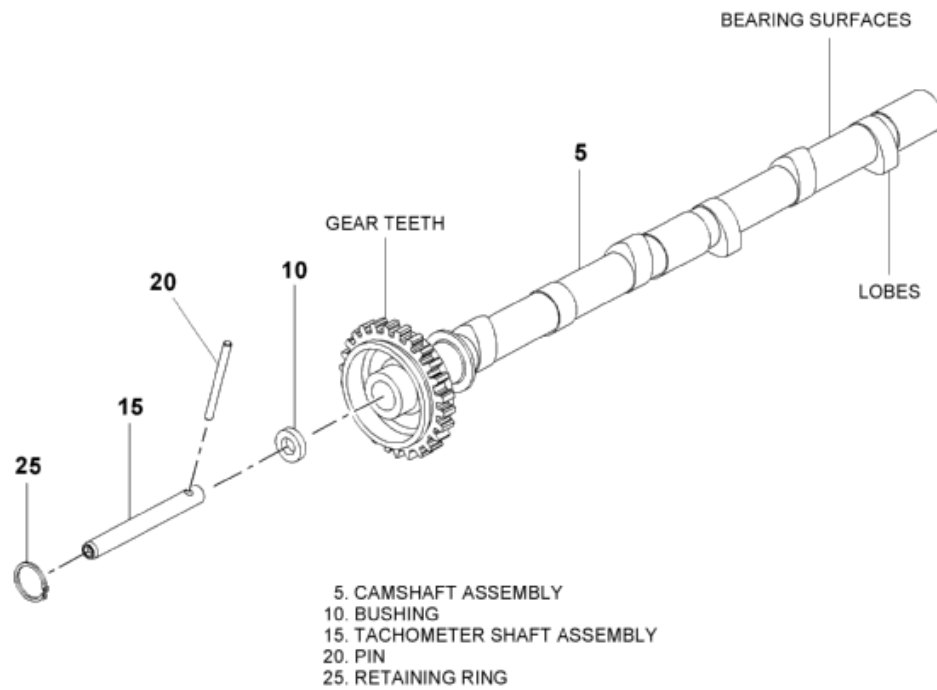


figure 72-00-08.8 • Camshaft Assembly

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ENGINE ASSEMBLY

General

This section has the procedures and illustrations necessary to assemble the Vantage O-360 and IO-360 series engine.

Fits, Clearances and Torque Values

Fits, clearances and torque values to be established during repair or assembly are listed in the Table of Limits appendix C at the back of this manual.

NOTE: Limits followed by a letter “T” indicate “tight”, i.e., interference fit. An example is the valve guide in the cylinder head. Where no “T” exists, the fit is a clearance dimension.

Materials Required for Assembly

Materials required for assembly are listed in SSD0002. See attached appendix B

NOTE: Equivalent substitutes may be used for listed items.

Special Tools and Equipment

Special tools and equipment required for assembly are listed in Table 72-00-09.1 below.

NOTE: Standard reciprocating engine aviation shop tools and equipment are used, unless otherwise specified.

NOTE: Unless otherwise specified, all gaskets are installed dry.

Table 72-00-09. 1 • Special Tools and Equipment

Description	Source
Compressor, Valve Spring & Bar	Commercially Available
Piston Ring Expander	Commercially Available
Puller Set, Oil Seal	Commercially Available
Puller, Slide Hammer – Medium	Commercially Available
Puller, Valve Guide	Commercially Available
Socket, Connecting Rod Nut	Commercially Available
Stand, Engine	Commercially Available
Tool, Crankcase Separating	Commercially Available
Tool, Intercylinder Baffle	Commercially Available
Cylinder Base Wrenches, 3/4” and 9/16”	Commercially Available
Piston Ring Grinder	Commercially Available
Piston Ring Compressor	Commercially Available
Nose Seal Installation Tool	Commercially Available
Snap Ring Pliers	Commercially Available

Revision C

Engine Assembly

WARNING: PUT ON SAFETY GOGGLES WHEN INSTALLING OR REMOVING SAFETY WIRE.

WARNING: LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. BEFORE YOU USE, READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER. USE IN A WELL-VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

NOTE: Unless otherwise specified, all torque loads listed for nuts, bolts, and screws are for use with pre-lube oil.

Crankcase Inspection and Preparation for Assembly.

- (1) Place crankcase halves on workbench. Check for handling damage. Inspect for slight nicks and burrs surface finish, split lines, bearing and cam bores, mating surfaces, and tappet bores.
- (2) Inspect studs for thread damage, bent condition.
- (3) Inspect tang slots for deformation. Install center and aft main bearings in case halves.
- (4) Check front main bearing retention dowels for correct installation height. See Table of Limits Appendix C (SSD001) for value. Refer to Figure 72-00-09.1.

WARNING: WHEN YOU USE COMPRESSED AIR TO CLEAN OR DRY PARTS, MAKE SURE THAT THE PRESSURE IS NOT MORE THAN 30 PSI. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHTWEIGHT OBJECTS. PUT ON GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF YOU SUFFER AN EYE INJURY, GET MEDICAL ATTENTION.

- (5) Inspect oil galleys in each crankcase half to ensure they are clean and that they properly intersect. Compressed air may be used.

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- (6) Apply a light coat of pre-lube oil to main bearings (5, Figure 72-00-09.2). Install crankshaft (25, Figure 72-00-09.3) in right crankcase half.
- (7) Using a feeler gage, check thrust and slinger clearances. Clearances must be per the table of limits (SSD001) appendix C of this manual. Rotate crankshaft 360 degrees to ensure adequate cheek to case clearance and record. Refer to Figure 72-00-09.4.
- (8) Repeat steps 6 and 7 in the left crankcase half and record clearances.
- (9) Lightly lubricate camshaft bore journals and temporarily install the camshaft and rotate in each crankcase half. Using feeler gage measure and record end clearance in each half. Clearances must be within limits per table of limits (SSD001) appendix C of this manual.
- (10) Check threaded areas of crankcase halves. Install external pipe plugs using Tite Seal™ thread sealant. Torque plug (40, Figure 72-00-09.5) per SSD001 (Appendix C). Torque is based on plug thread size.
- (11) Install piston cooling nozzle, if furnished, (95, Figure 72-00-09.5) using Loctite™ and torque to value found in the Table of Limits appendix C (SSD001).

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NOTE: Plug(s) MS27769-1 may be used in place of piston nozzle(s) as required by the engine model. Install the same as previous external pipe plugs (40, Figure 72-00-09.5).

Propeller Governor Drive (Located on the Left crankcase half).

See figure 72-00-09.5. This drive assembly must be installed before the crankcase halves are assembled. This is accomplished in the following manner.

- (1) Lubricate the drive gear bore, gear teeth, and gear shaft with pre-lube oil and install the governor drive gear (8) into the left crankcase half.
- (2) Lubricate idler bores and shaft with pre-lube oil and insert the idler shaft (4) part of the way through the hole in the crankcase.
- (3) Select the .060 inch thick thrust washer (2). Lubricate the washer and gear assembly (9) with pre-lube oil and place them onto the idler shaft (4).
- (4) Insert the shaft into the crankcase until it bottoms and check the end clearance using a feeler gage. The end gap must be within range per the Table of Limits Appendix C of this manual. If the measured clearance is more than this value, select the washer thickness that provides the proper clearance.
- (5) Once the gap is correct with the appropriate thrust washer, rotate the idler shaft until the countersunk hole is aligned with the threaded hole in the crankcase. Place a drop of Loctite® 271 on the set screw threads and insert the set screw (7). Tighten to tighten per Table of limits Appendix C of this manual and stake the crankcase with a pointed tool such as an awl to secure screw.
- (6) Assemble gasket (5) and hex head plug (6) into the crankcase. Torque plug per table of Limits Appendix C of this manual. Install safety wire (0.032 in.) from the plug (6) to the hole provided in the crankcase

Crankshaft Inspection and Preparation for Assembly

- (1) Visually inspect crankshaft for handling damage. Check bearing, slinger and thrust face surfaces.
- (2) Measure and record main journal dimensions with micrometer. Dimensions must be within limits per Table of limits Appendix C of this manual.
- (3) Measure and record rod journal dimensions with micrometer. Dimensions must be within limits per Table of limits Appendix C of this manual.

Crankshaft Front Oil seal Installation

1. Remove spring from new front oil seal (15, Figure 72-00-09.2). Apply pre-lube oil mixture to the crankshaft propeller flange and I.D. of oil seal. Install oil seal with flat side out to prop flange. Use tool to carefully stretch seal over flange.
2. Re-install the spring in seal (15) groove.
3. Clean oil from the prop flange.
4. Apply oil to crankshaft and front oil seal (15) at their fit locations.
5. If required, apply pre-lube and install the propeller flange bushings (50, 55, 60, Figure 72-00-09.3). Pull through with puller tool. Refer to Figure 72-00-09.3 for bushing positions.
6. Install and secure the crankshaft to a vertical support stand.

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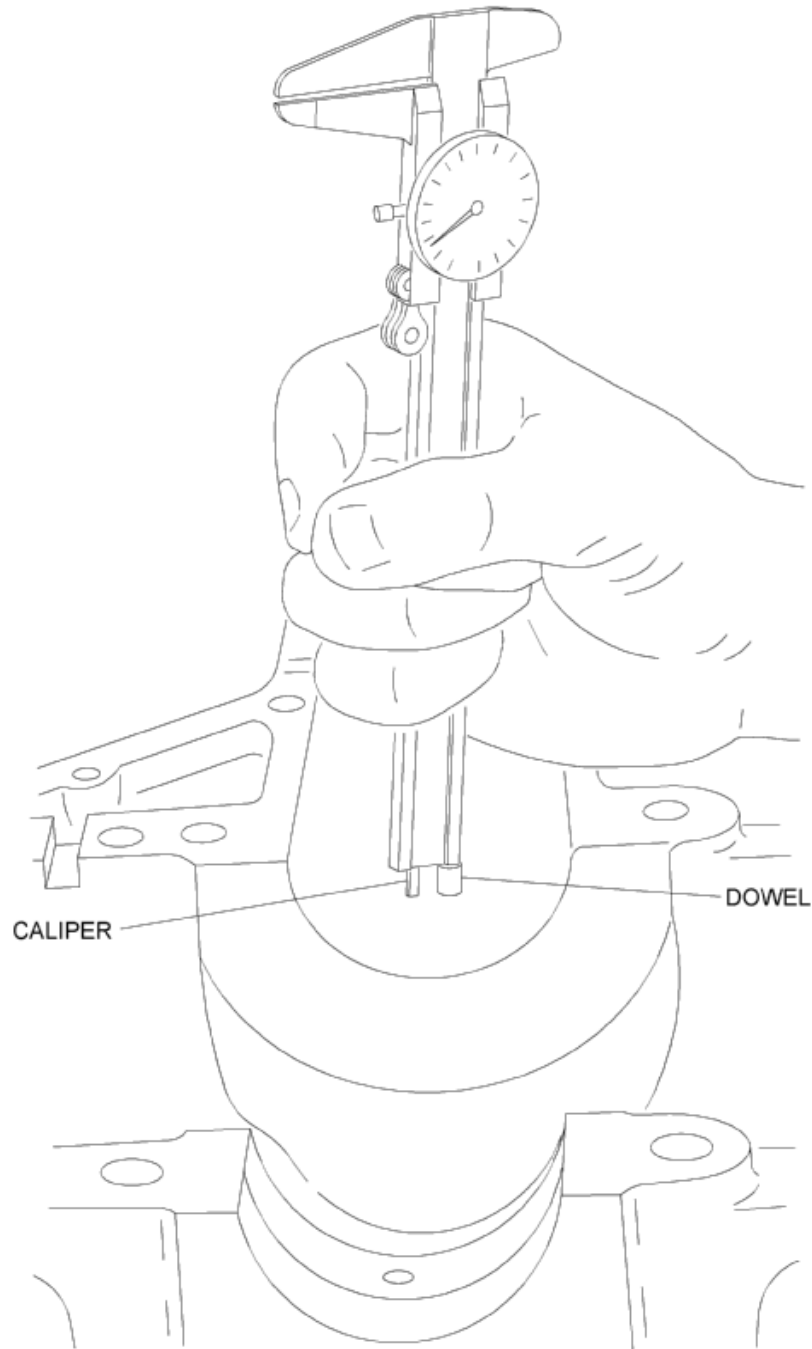
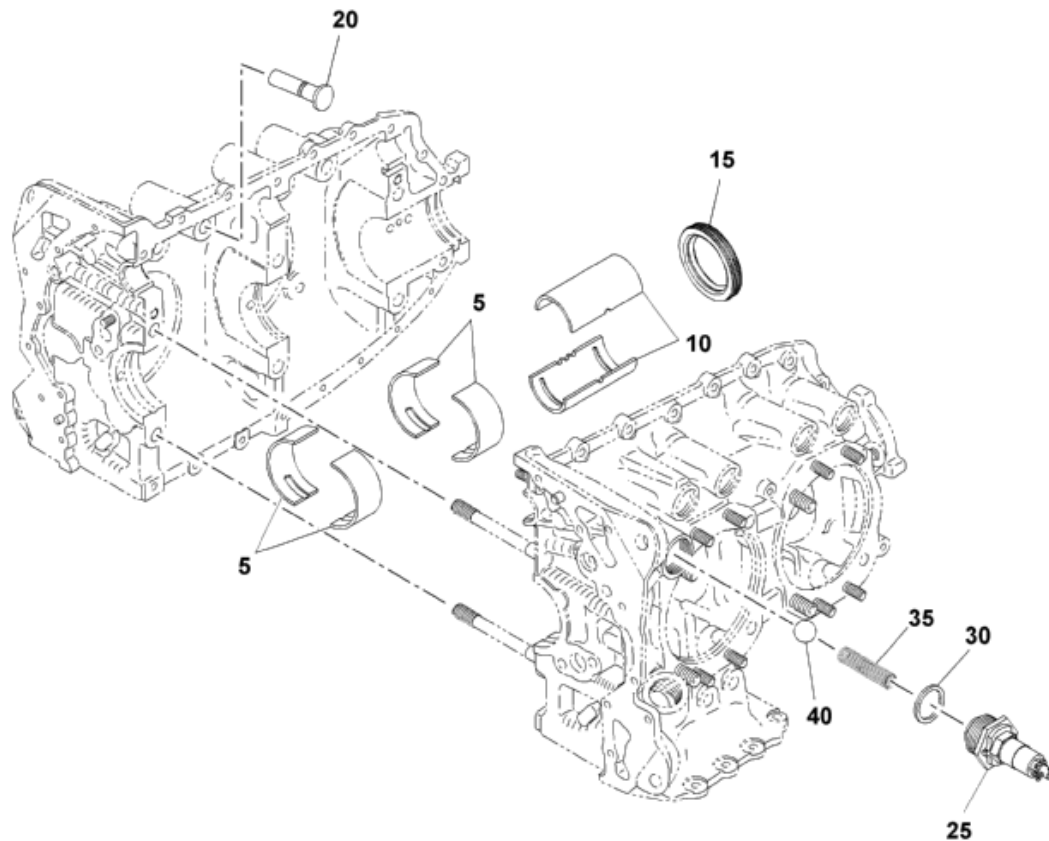


Figure 72-00-09.1 • Crankcase Bearing Retention Dowel

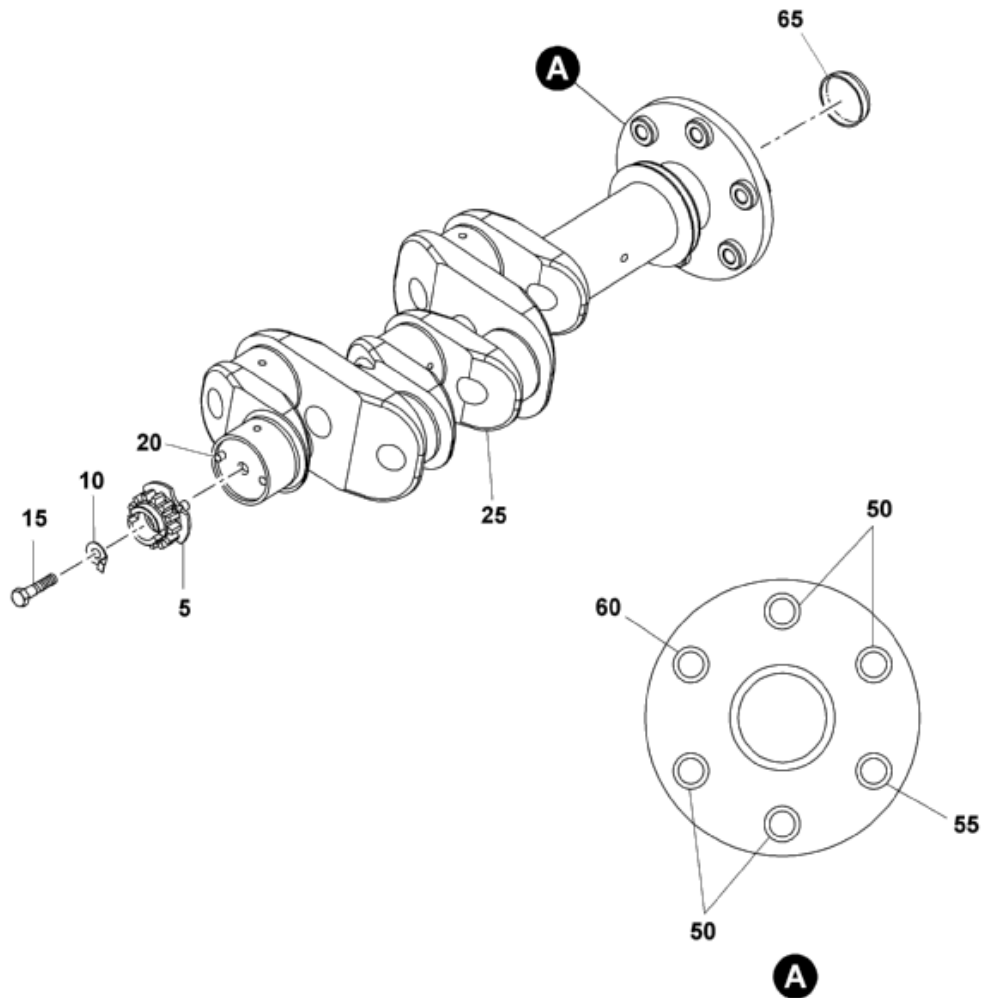
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- 5. MAIN BEARINGS
- 10. FRONT MAIN BEARINGS
- 15. SEAL - OIL FRONT
- 20. LIFTER BODY
- 25. VALVE ASSY - OIL RELIEF
- 30. GASKET - COPPER
- 35. SPRING
- 40. BALL

Figure 72-00-09.2 • Crankshaft Bearing and Oil Pressure Relief Valve

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- 5. GEAR - CRANKSHAFT
- 10. LOCKPLATE
- 15. SCREW
- 20. DOWEL - STEPPED
- 25. CRANKSHAFT ASSY
- 50. BUSHING - LONG
- 55. BUSHING - INDEXED
- 60. BUSHING - SHORT
- 65. PLUG - EXPANSION

Figure 72-00-09.3 • Crankshaft Assembly

Revision C

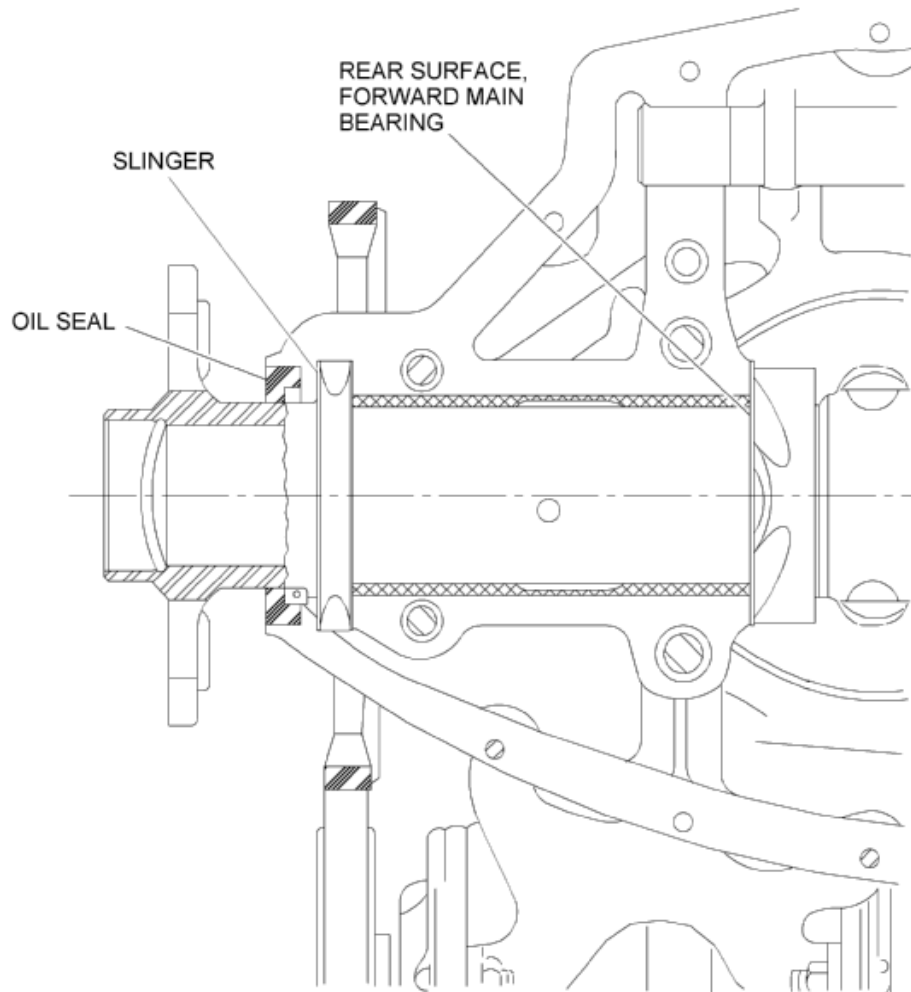
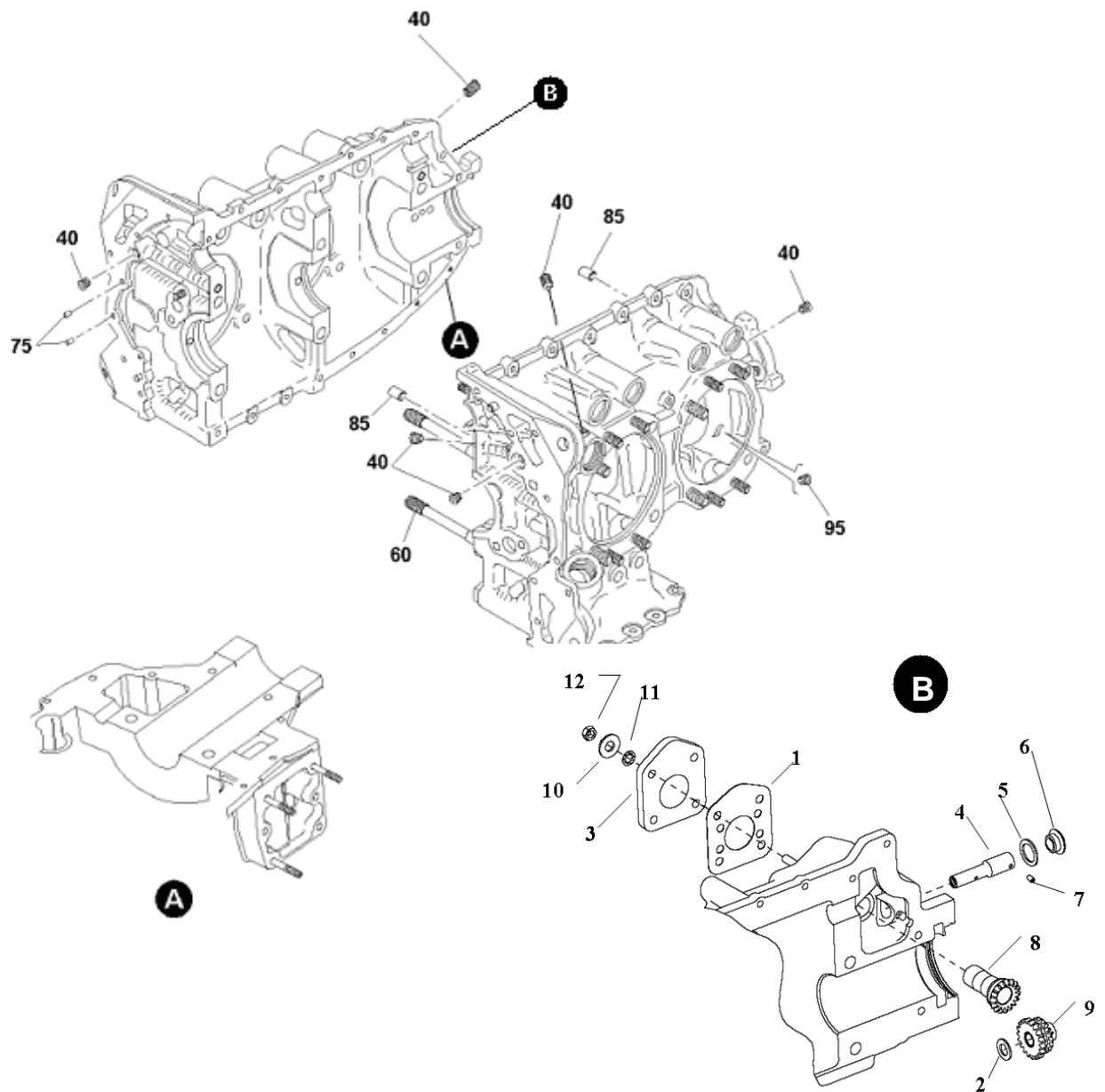


Figure 72-00-09.4 • Crankshaft Thrust and Slinger Clearance

Revision C



- | | | |
|---------------------|-------------------------------|--|
| 1. GASKET | 7. SET SCREW | 40. PLUG |
| 2. THRUST WASHER | 8. PROP. GOVERNOR DRIVEN GEAR | 60. STUD |
| 3. COVER | 9. PROP. GOVERNOR GEAR | 75. INSERT |
| 4. IDLER GEAR SHAFT | 10. WASHER | 85. DOWEL |
| 5. GASKET | 11. LOCK WASHER | 95. PLUG OR PISTON COLLING NOZZLE
(AS REQUIRED) |
| 6. HEX HEAD PLUG | 12. NUT | |

Figure 72-00-09.5 • Crankcase Assembly and Front Prop. Gov. Gear Assembly

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Connecting Rod Assembly Inspection

- (1) Visually inspect the rod assembly (5, Figure 72-00-09.6) for handling damage, defects, and corrosion.
- (2) Inspect the bore finish. This must be smooth and free of burrs.
- (3) Verify correct rod part number.
- (4) Verify the serial number match for each rod and cap assembly.
- (5) Verify and record each rod assembly weight.

NOTE: Difference in rod assembly weights must not exceed 2 grams in opposing pairs.

- (6) Check each piston pin (35) in each rod (5) for fit. The pins must slide freely through the rod.

Subassembly of Connecting Rods to Crankshaft

- (1) Visually inspect the rod bolts and nuts (10, 15 Figure 72-00-09.6). Lightly lubricate bolt shanks and threads with pre-lube oil.
- (2) Verify bearing part number and size for crankshaft and model application.
- (3) Install the connecting rod bearing shell (1) in each rod and cap (5).
- (4) Apply pre-lube oil to the bearing shell (1).
- (5) Apply pre-lube oil to the rod bearing journals of crankshaft.
- (6) Insert 2 rod bolts through each rod cap. Begin with the lowest serial number rod cap and install it to the crankshaft with its matching rod (5) at the #1 (most forward) rod location.
 - (a) Install with serial numbers in same plane and down towards oil sump. Refer to Figure 72-00-09.7.
 - (b) Install the nuts with flat side to connecting rod. Refer to Figure 72-00-09.7. Tighten moderately to check fit prior to torque.
- (7) Tighten each rod nut to bolt (10,15, Figure 72-00-09.6) evenly per Table of Limits section 6.0 Appendix C.
- (8) Rotate each connecting rod (5) after torque to check for smooth and free rotation.

- (9) Measure and record connecting rod to crankshaft side clearance. Clearance must be within limits per Table of Limits Appendix C of this manual.

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Installation of Crank Gear to Crankshaft

- (1) Inspect the crank gear (5, Figure 72-00-09.3), bolt (15), and lockplate (10) for defects.
- (2) Lightly lubricate with pre-lube crank bolt threads and install the gear (5) to crankshaft with bolt (15) and new lockplate (10). Ensure that the gear (5) fits evenly in crank recess, aligns with dowel, and sits flat when torqued. Tapping the gear with a soft aluminum or brass drift will help ensure the seal is properly seated. Torque crankshaft gear bolt (15) per Table of Limits section 6.0 Appendix C (SSD01) of this manual. Attempt to insert a pointed 0.001 in. feeler gage or piece of shim stock between the gear and the crankshaft at each of the three scallops. There is no allowable clearance between crankshaft and gear. Bend lockplate (10) tab up to secure bolt head.

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Assembly of Case and Crankshaft Assembly

- (1) With crankcase halves lying on bench with interior sides up, ensure that center and rear main bearings (5, Figure 72-00-09.2) are installed and lubricated with pre-lube.
- (2) Lubricate tappet bore holes and tappet bodies (20) (shank) and install bodies in case.
- (3) Apply cam pre-lube liberally to tappet (20) faces and camshaft lobes. (5, Figure 72-00-09.8). A moly-graphite grease is recommended.
- (4) Place camshaft (5) on bench beside case halves.
- (5) Clean mating surfaces of both case halves including nose seal area with fast dry solvent.
- (6) Clean nose seal OD with fast dry solvent.
- (7) Place front main (10, Figure 72-00-09.2) bearing temporarily in place in the left crankcase half making sure the bearing is properly seated on the 2 locator dowels.

NOTE: The front main bearing (10), unlike the center and rear main bearings, splits on the horizontal centerline of the engine.

- (8) Use a felt marker to trace on the front bearings halves at the intersection between the crankcase parting flanges and the bearing. Make a vertical reference mark on both the bearing half and each case half at a convenient point along the line of intersection. This locates the bearing both radially and axially. Make two parallel marks across both bearing shells at their intersection for alignment reference. Refer to Figure 72-00-09.9.

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ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

- (9) Remove front main bearings. Lubricate bearing surfaces liberally with pre-lube oil and fit to crankshaft aligning the two parallel marks. Refer to Figure 72-00-09.10.
- (10) Install two 3/8 in. bolts (5, Figure 72-00-09.11) with their corresponding flat washers(15) through the right case half and install 2 O-rings (10).
- (11) Install 2 O-rings (75) on rear through studs of right case half.
- (12) Lubricate crankshaft main bearing journals and cam bores with pre-lube oil.
- (13) Lay out crankcase assembly hardware per Figure 72-00-09.11 and 72-00-09.12 together with appropriate hand tools.

**- STOP -
PERFORM IN-PROCESS QUALITY
INSPECTION #1. REFER TO APPENDIX A.**

- (14) Ensure that case mating surfaces are clean and dry.

WARNING: ADHESIVE SEALANT IS TOXIC AND FLAMMABLE. WEAR PROTECTIVE GEAR. DO NOT BREATHE VAPORS. AVOID EYE AND SKIN CONTACT. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

- (15) Apply a thin, even coat of approved sealant to the backbone and breastbone surfaces of the left case half only and to the front nose seal bore (both case halves) as well as the nose seal OD. Do not apply sealant to the seal surface itself.
- (16) A thin translucent coating is sufficient. Wipe off any excess on the inside and outside edges. Refer to Figure 72-00-09.13. Because this sealant will dry quickly when applied this thinly, it is important to proceed quickly until case halves are together and snug. A assistant is required during this assembly process.

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(17) Lay a single line of silk thread on the sealant at the centerline of the sealing surface and loop each bolt hole on the interior side. The tail of the thread should extend beyond the mating surface approximately 0.25 in. to the accessory gasket surface at the rear, the nose seal surface at the front and the sump gasket surface at the bottom. Refer to Figure 72-00-09.13.

(18) The assistant places the left case half up to the crank assembly with the connecting rods protruding through their appropriate cylinder holes and allows the assembler to align the front main bearing inserts with the dowels in the crankcase. The assistant uses light pressure against case half as the assembler adjusts front main bearing until it snaps in place.

NOTE: Using a tool to gently lift up on bearing while holding case half-tight to crankshaft will aid in determining if bearing is properly seated. When properly seated, the bearing and case will move slightly up and down together as the front of the bearing is pried up and down.

(19) With the left case half and bearing properly seated, the assistant places a tool inserted through the #4 connecting rod piston pin hole. The case is rotated to wedge the tool against the case half. Firm pressure is maintained on crankcase. Refer to Figure 72-00-09.14.

NOTE: It is imperative that the assistant maintains constant pressure on the left case half throughout the assembly process until case halves are snugged together. Enough case assembly hardware must be installed to not allow the front main bearing to shift from the locating dowels.

(20) Check thread and nose seal (15, Figure 72-00-09.2) for proper placement.

(21) Install camshaft in left case half and have the assistant hold in place.

(22) Mate the right case half to the left case half by carefully aligning rear through studs and front 3/8 in. nose bolts.

NOTE: NOTE: Care should be taken not to push out the 3/8 in. nose bolts (5, Figure 72-00-09.11) causing the o-rings (10) to fall out.

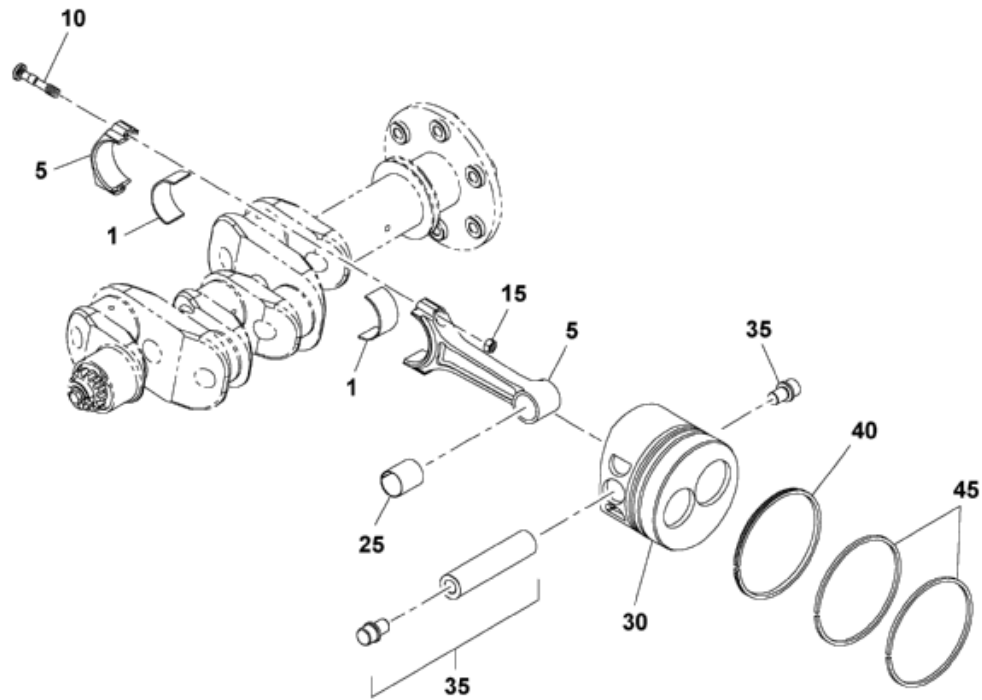
(23) Ensure that nose seal is properly in place.

(24) Install backbone bolts (30), breastbone bolts (90, 95), and nose bolts (5) with appropriate hardware. Snug all uniformly. Check for free case to crank rotation.

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(25) Lightly lubricate shank and threads of the 1/2 in. Dia. through bolts (1, Figure 72-00-09.12), with pre-lube oil. Install using a soft faced (dead blow) hammer as far as possible. Finish installation with sufficiently sized ball-peen hammer or equivalent using a nut or threaded cap to protect the threads and thru-bolt end. Thru bolts are properly installed when an equal number of threads protrude from each case half.

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- 1. BEARING
- 5. ROD ASSY
- 10. BOLT - ROD
- 15. NUT - ROD
- 25. BUSHING
- 30. PISTON
- 35. PIN AND PLUG ASSY
- 40. RING - OIL CONTROL
- 45. RING - COMPRESSION

Figure 72-00-09.6 • Connecting Rod and Piston Assembly

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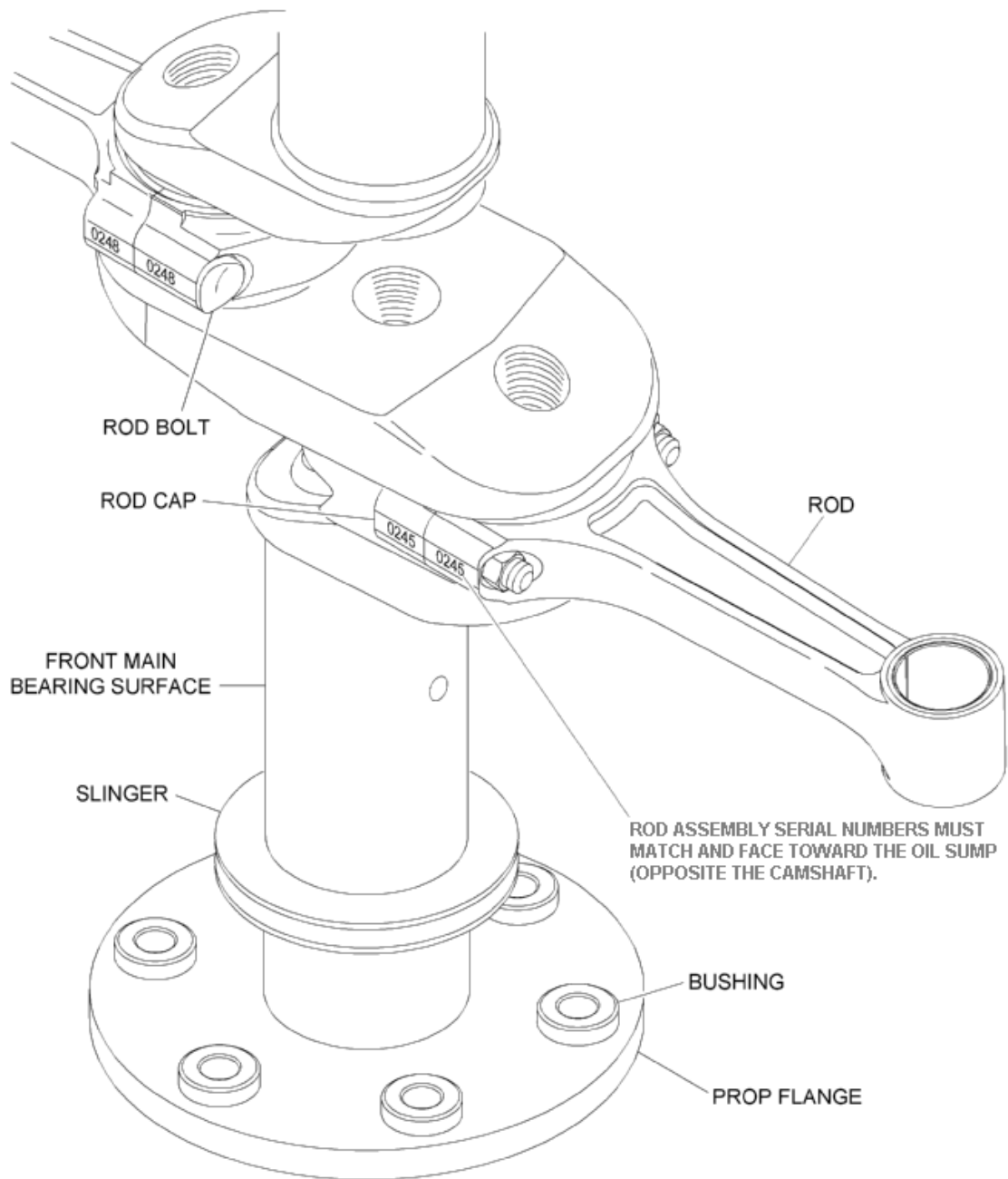
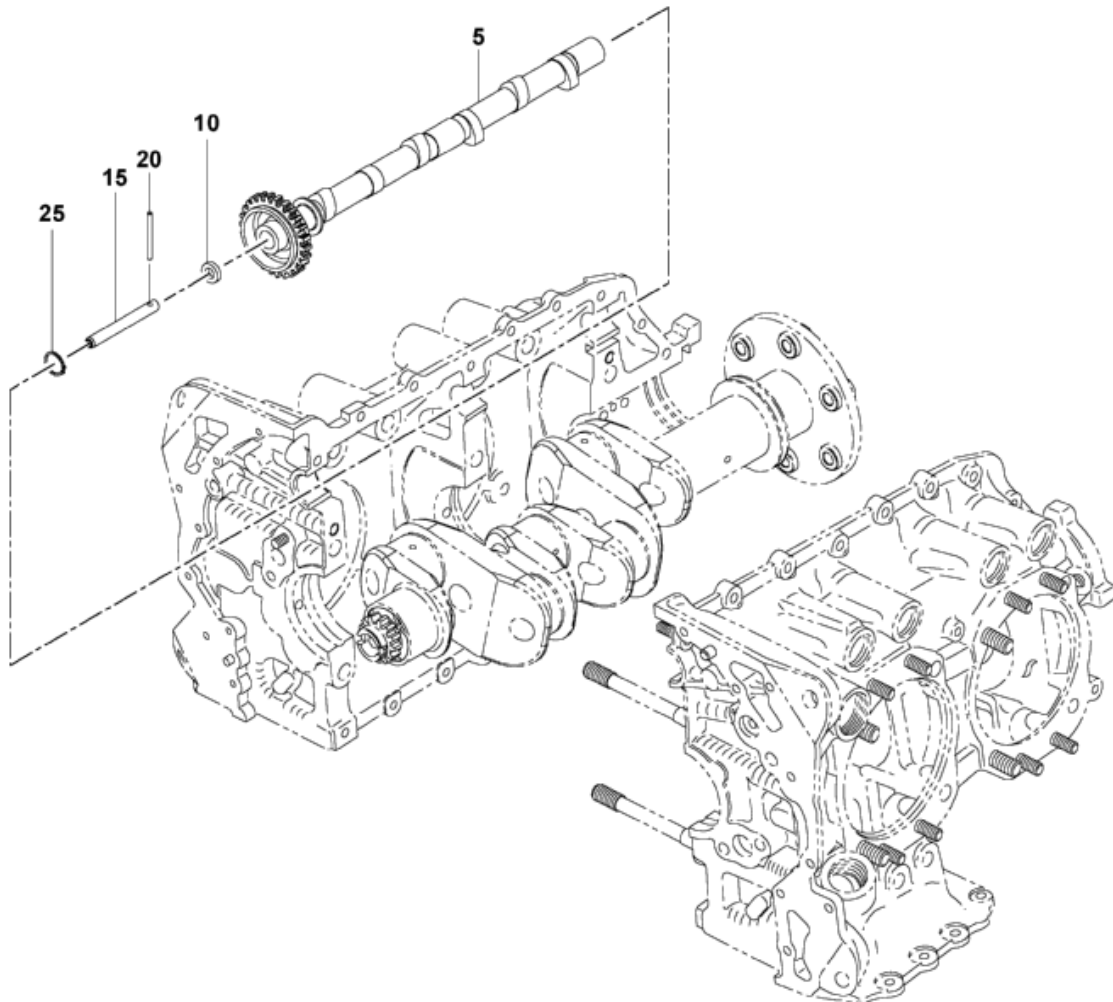


Figure 72-00-09.7 • Connecting Rod Installation

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- 5. CAMSHAFT ASSEMBLY
- 10. BUSHING
- 15. TACHOMETER SHAFT ASSEMBLY
- 20. PIN
- 25. RETAINING RING

Figure 72-00-09.8 • Camshaft Assembly

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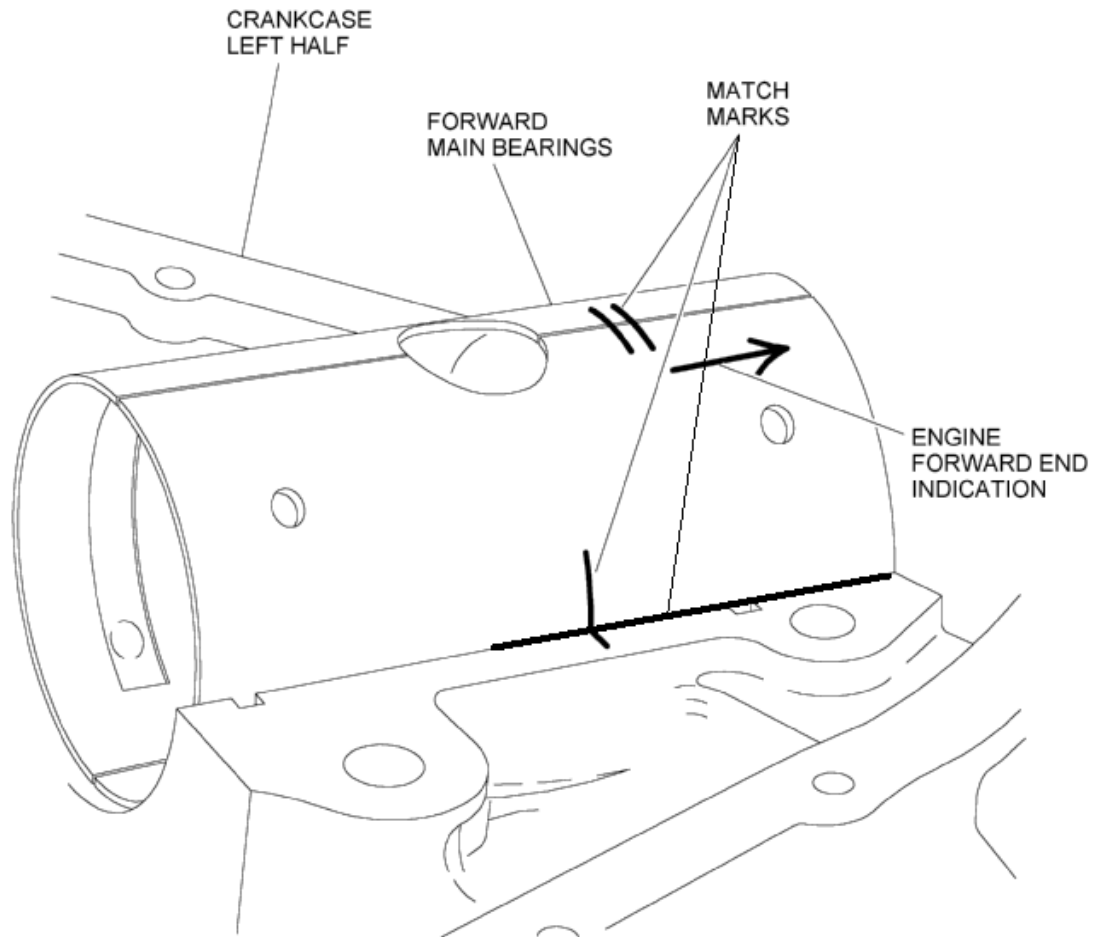


Figure 72-00-09.9 • Main Bearing Reference Marks

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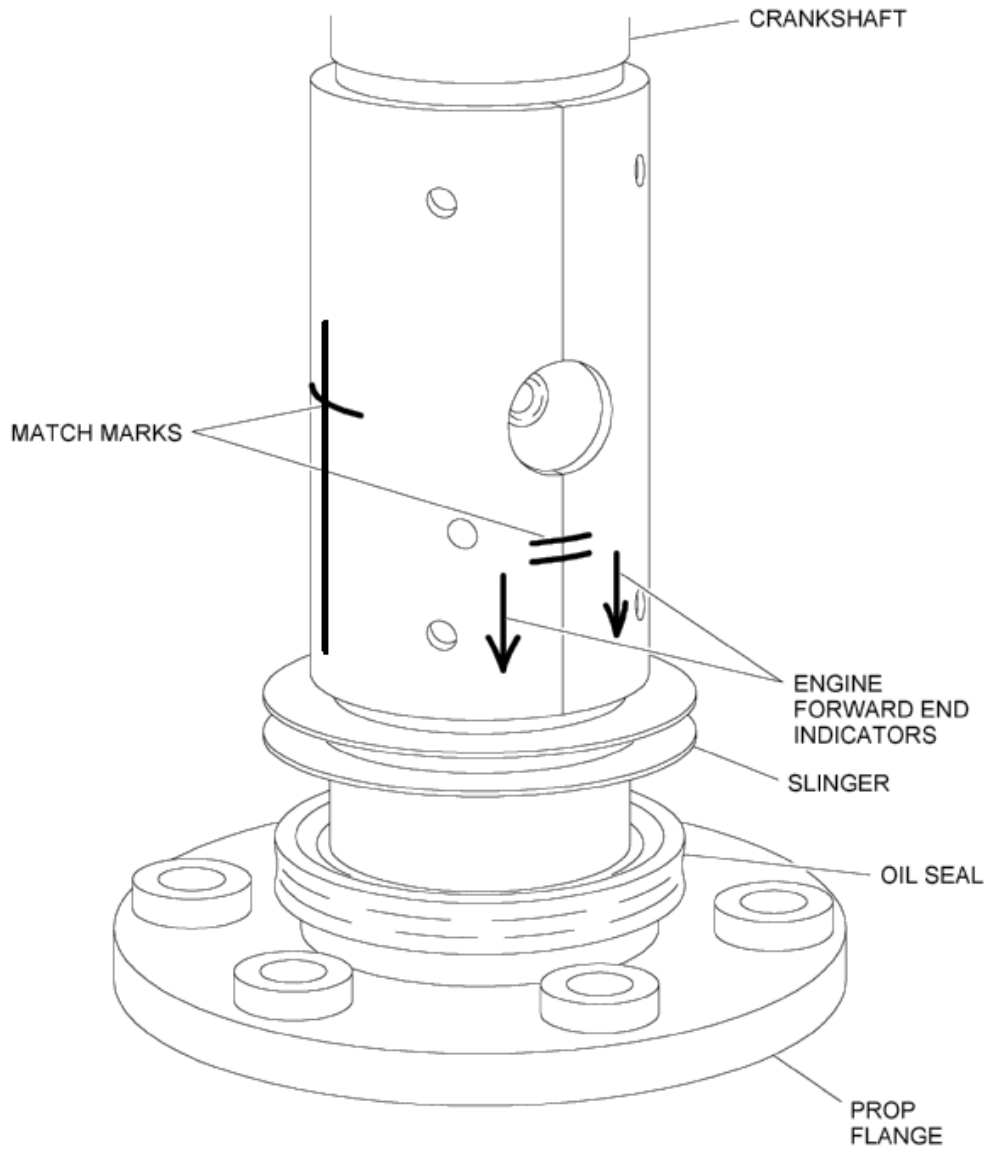
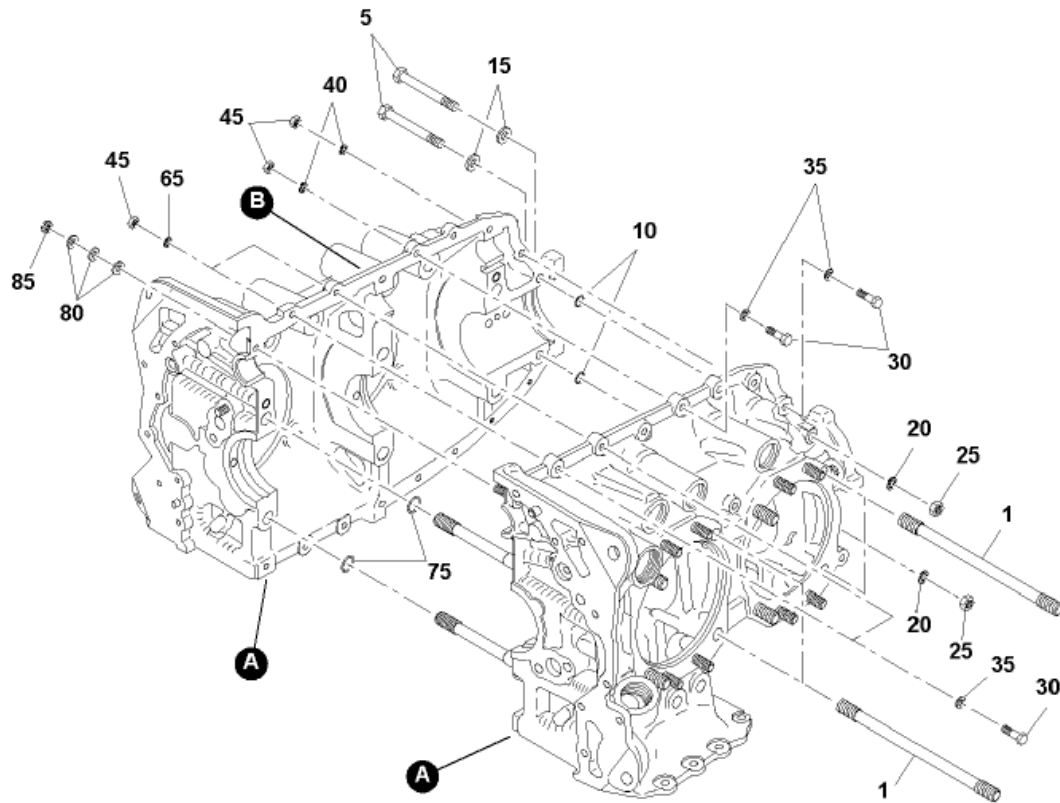


Figure 72-00-09.10 • Main Bearing Installation

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- | | |
|------------------------------|-------------------------------|
| 1. STUD (1/2-20 X 10-11/16) | 55. BOLT (1/4-20 X 2") |
| 5. BOLT (3/8-24 X 3-37/64) | 60. WASHER - FLAT (1/4 INCH) |
| 10. SEAL - OIL RING | 65. WASHER - LOCK (1/4 INCH) |
| 15. WASHER - FLAT (3/8 INCH) | 70. NUT - PLAIN (1/4-20) |
| 20. WASHER - LOCK (3/8 INCH) | 75. SEAL - OIL |
| 25. NUT - PLAIN (3/8-24) | 80. WASHER - PLAIN (3/8 INCH) |
| 30. BOLT (1/4-20 X 1-1/2) | 85. NUT - SLOTTED (3/8-24) |
| 35. WASHER - FLAT (1/4 INCH) | 90. BOLT (1/2-20 X 1-1/8) |
| 40. WASHER - LOCK (1/4 INCH) | 95. BOLT (1/4 INCH) |
| 45. NUT - PLAIN (1/4-20) | 100. NUT - SLOTTED (1/4-20) |
| 50. STRAP - LIFTING | |

Figure 72-00-09.11 • Crankcase Attaching Hardware

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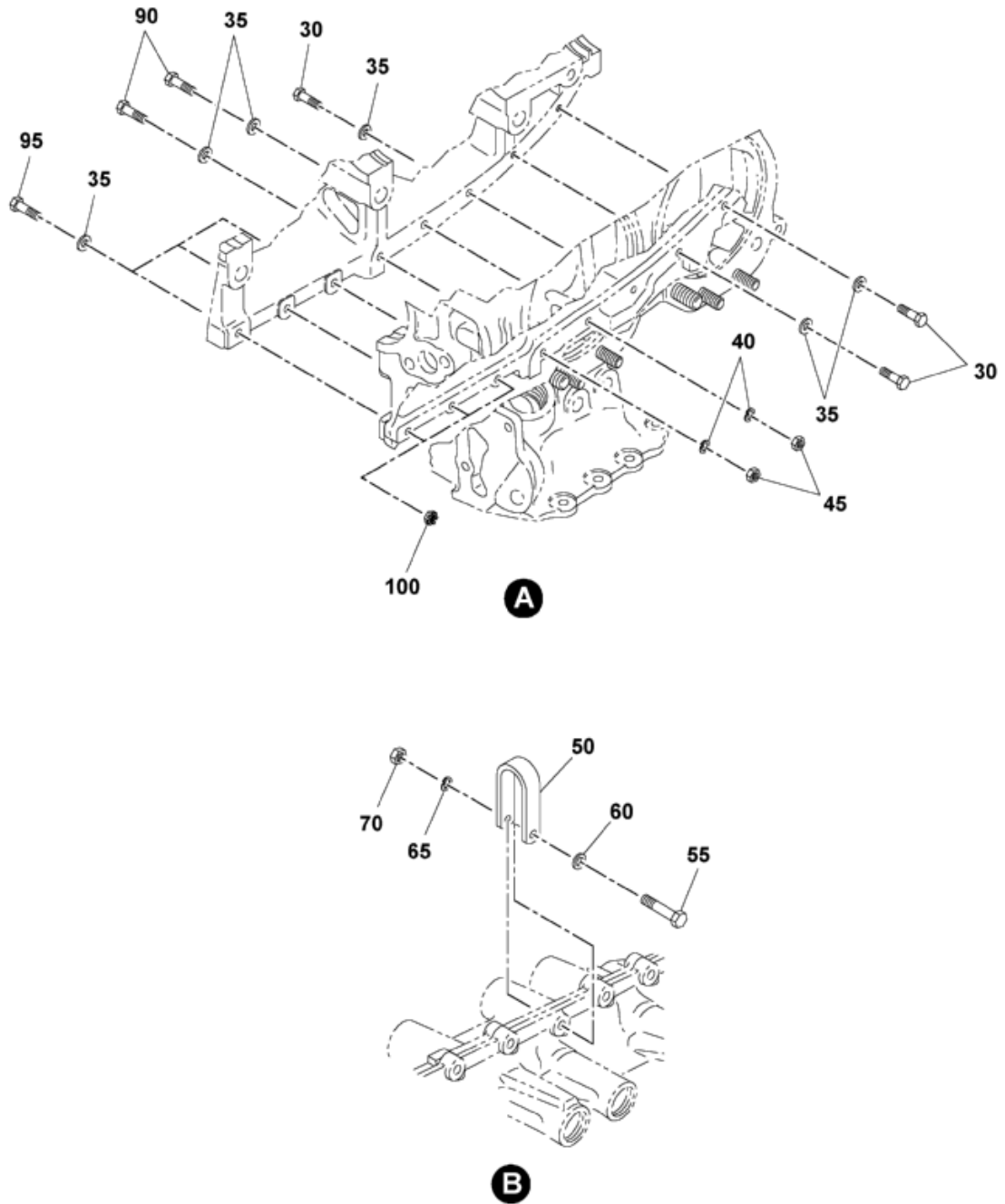


Figure 72-00-09.12 • Crankcase Attaching Hardware (cont'd.)

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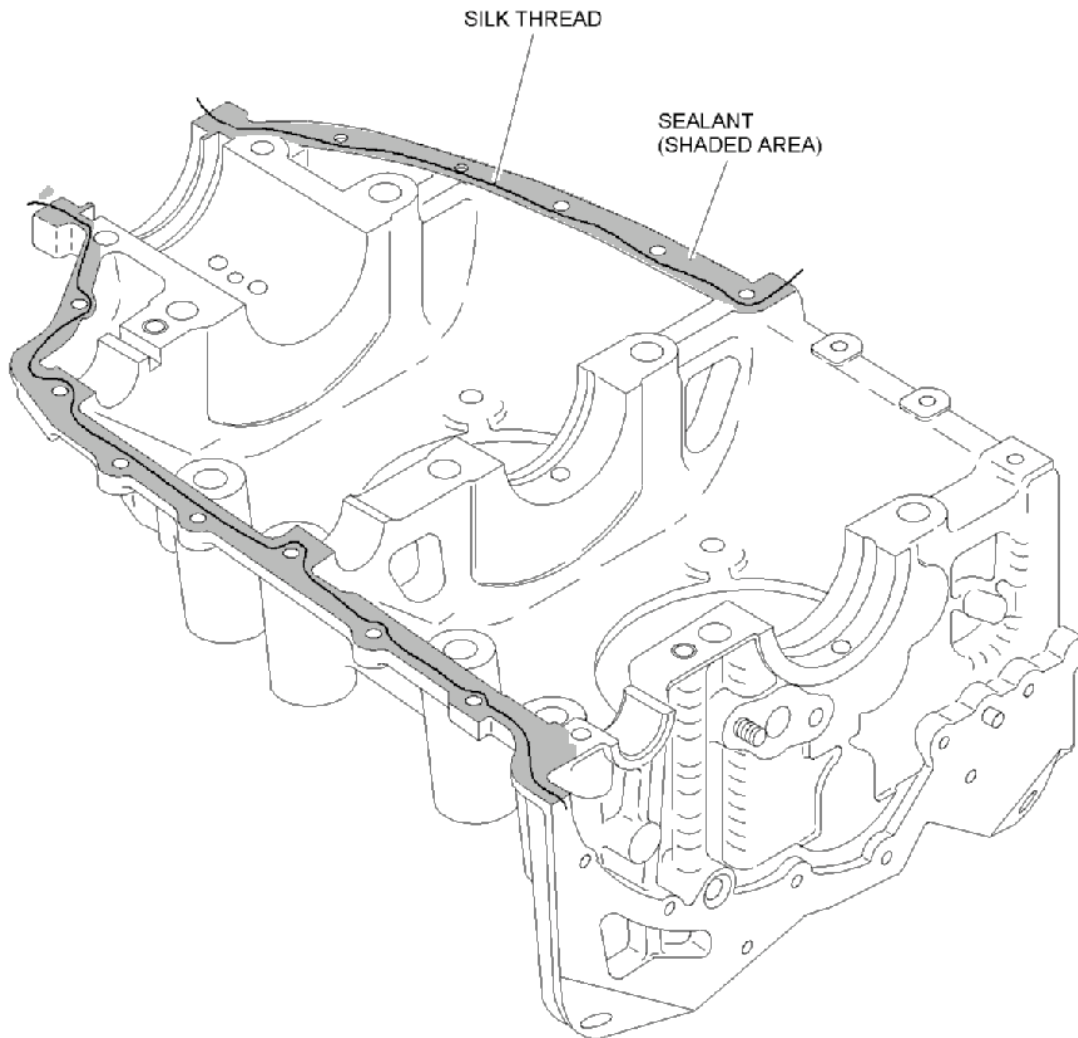


Figure 72-00-09.13 • Sealant Compound and Silk Thread Application

Revision C

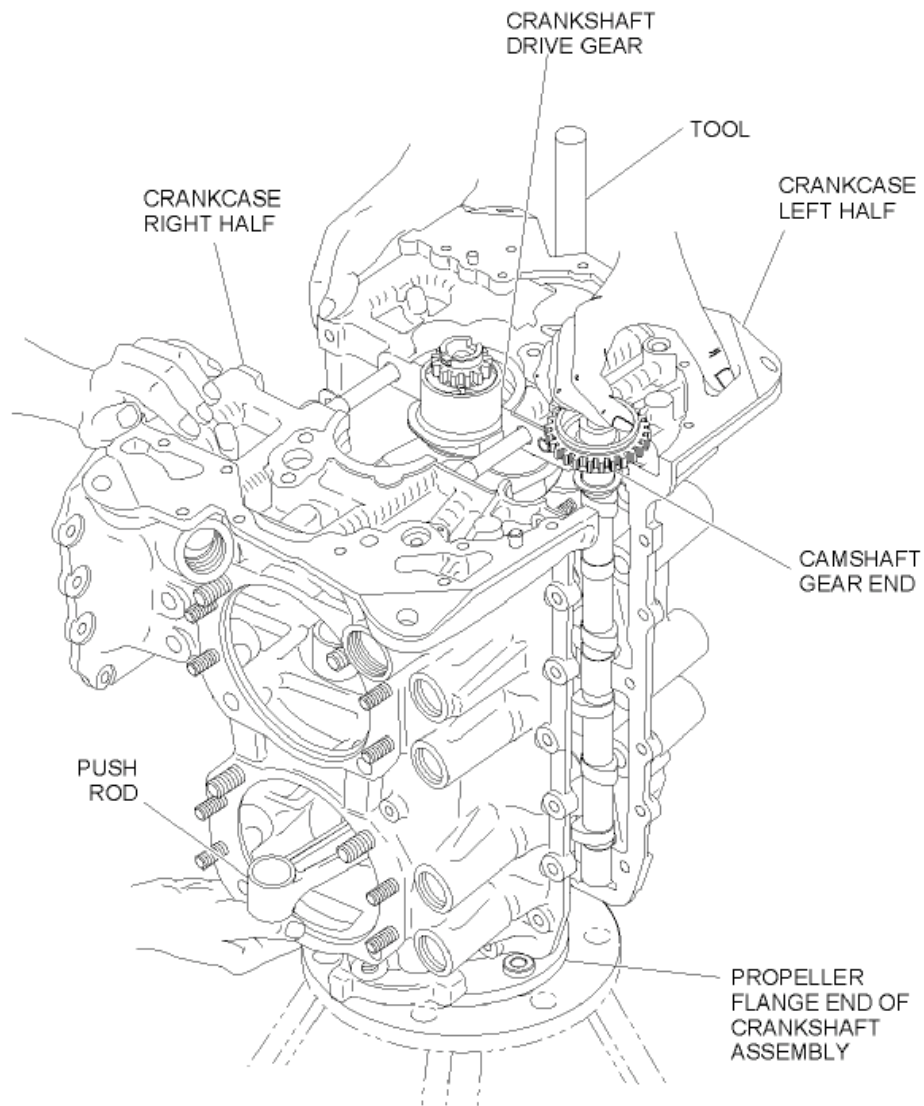


Figure 72-00-09.14 • Crankcase Halves Assembly

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Cylinder Assembly Inspection

- (1) Verify cylinder part number and serial number.
- (2) Visually inspect general condition of cylinder for handling or shipping damage.
- (3) Verify the valve, spring, and key (65, 70, 85, 90, 105, 110, Figure 72-00-09.15) installations.
- (4) Visually check threaded holes for thread integrity and helical coil insert if required. Ensure the absence of foreign matter.

WARNING: SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT EYE AND SKIN CONTACT AND DO NOT BREATHE VAPORS IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

- (5) Wipe cylinder bores clean with lint-free rag saturated with fast dry solvent.
- (6) Inspect piston (30, Figure 72-00-09.6) part number and weight.

NOTE: Piston weight differences should not exceed 2 grams in opposing pairs.

- (7) Clean piston pins (35) with fast dry solvent and check fit to each piston.

NOTE: Piston pins are a push fit with light lubrication. Refer to Figure 72-00-09.16.

- (8) Verify piston ring (40, 45) part numbers.
- (9) Check ring gaps of compression rings (45, Figure 72-00-09.6) and oil control ring (40) with feeler gauge. End gap at 1"-4" from flange and gap at top of piston stroke must be within limits per the Table of Limits Appendix C of this manual.
- (10) Insert piston rings, one at a time in their respective grooves.
- (11) Using a ring expander, install rings to piston with the lower ring first, then middle and top.

NOTE: Numbers on the ring face indicate top of the piston or up.

- (12) Check side clearance of each ring. Piston compression ring (45) in top groove, Piston compression ring (45) in 2nd groove and piston oil control ring (40) in 3rd groove per specifications in the Table of Limits Appendix C of this manual.

NOTE: Side clearance is checked with ring in its respective groove and flush with outside edge of piston.

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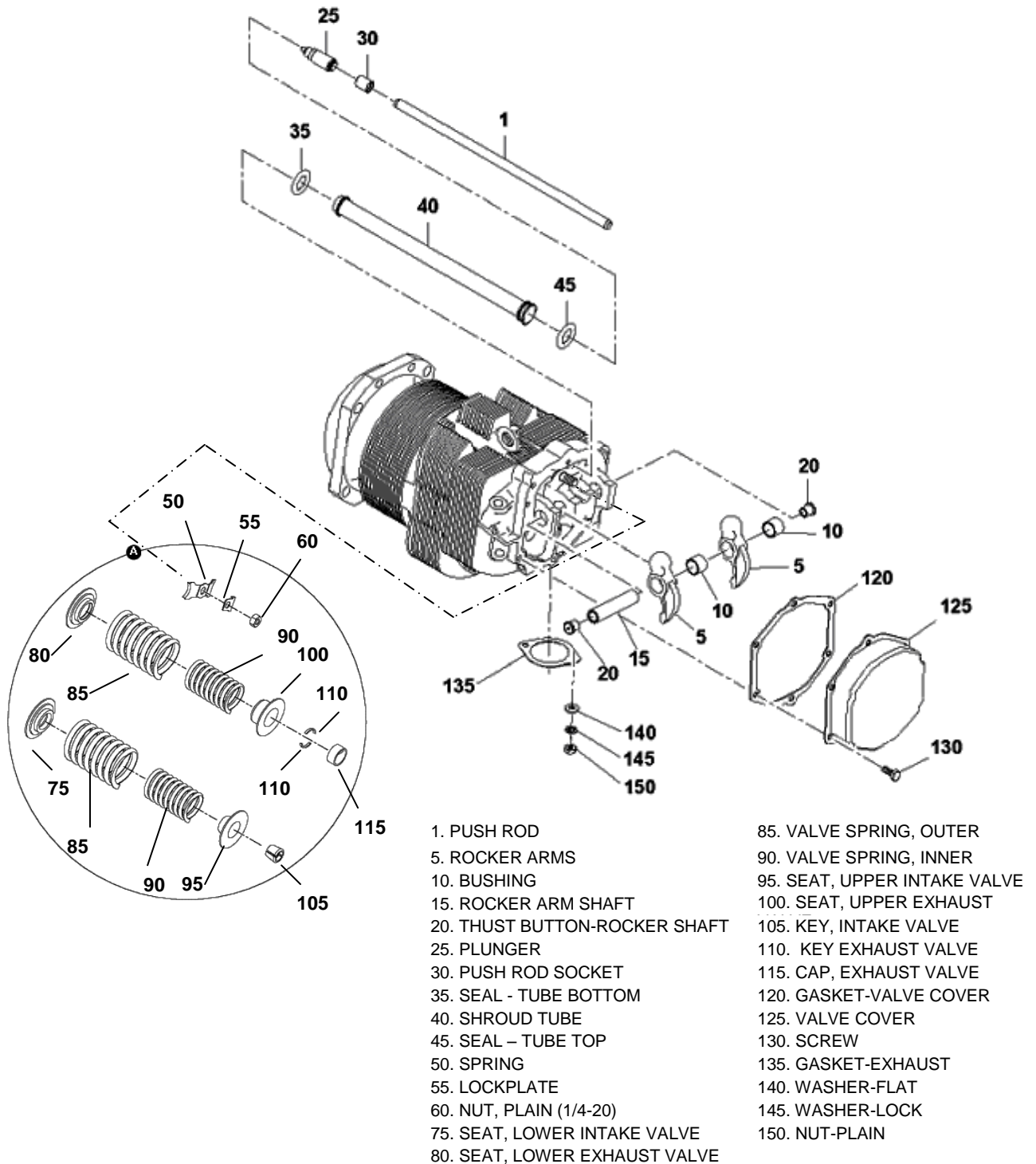


Figure 72-00-09.15 • Cylinder Valve Train and Spring Assembly

Revision C

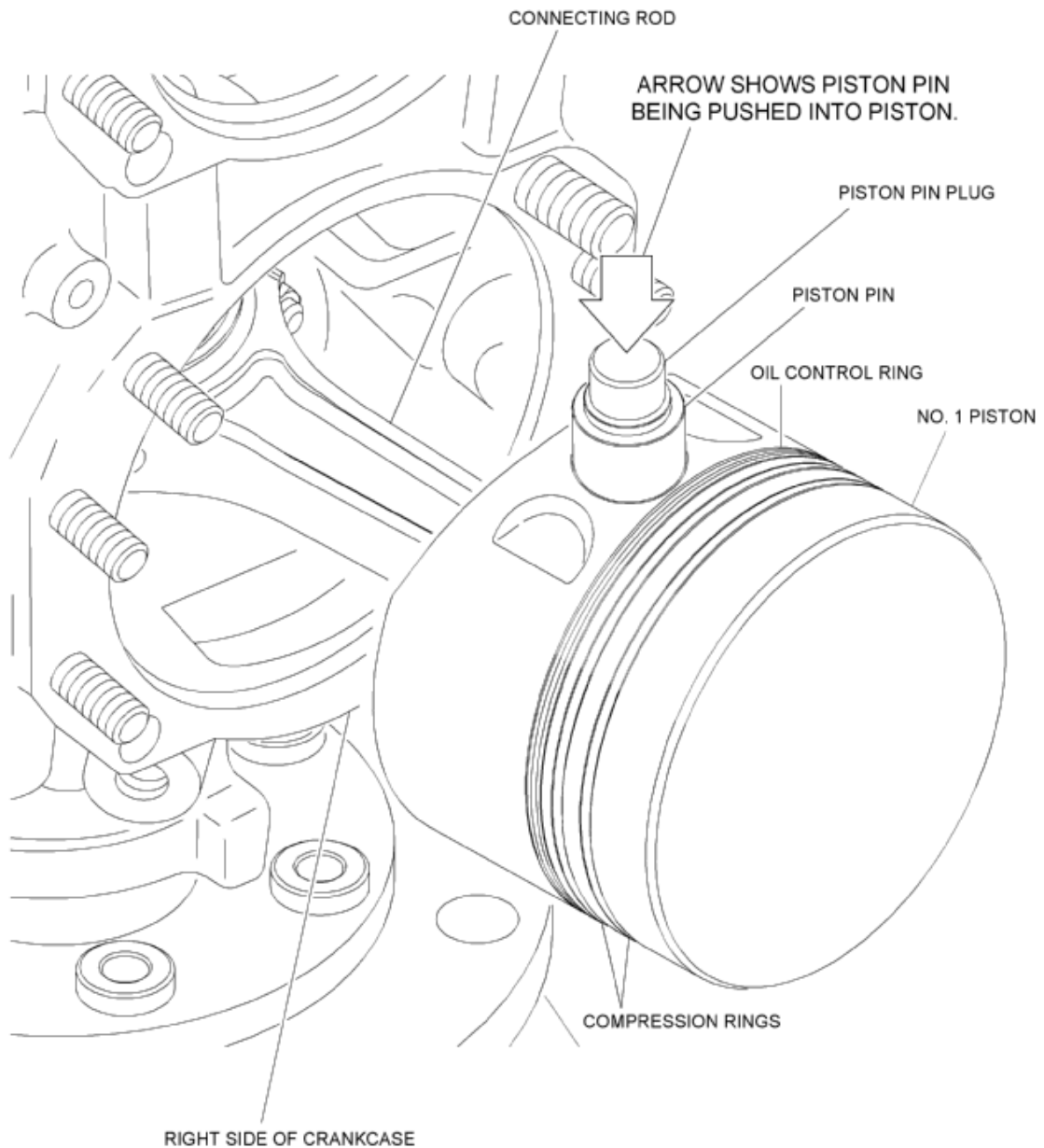


Figure 72-00-09.16 • Piston Assembly to Connecting Rod

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Cylinder Assembly Installation to Engine

- (1) Lubricate the rings and ring grooves on the piston with straight weight, non-detergent (mineral) aviation grade oil.
- (2) Stagger the ring gaps as follows: Top ring gap is at approximately the 10 o'clock position, 2nd ring gap is at approximately 2 o'clock; and the oil control ring gap is at approximately 11 o'clock.

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NOTE: Oil control expander spring is installed in piston groove underneath the oil control ring and with its split line 180° from the ring gap.

- (3) Lubricate the cylinder bores, piston pins and piston pin bushing in connecting rod with straight weight, non-detergent (mineral) aviation grade oil.
- (4) Lubricate the cylinder base o-ring (5, Figure 72-00-09.17) with oil and install over the cylinder base.
- (5) Lightly lubricate cylinder deck studs and through bolts with pre-lube oil.
- (6) Rotate the engine so that the #1 connecting rod is at the top of the stroke. Install the #1 piston to the #1 connecting rod with the piston pin. Refer to Figure 72-00-09.16.

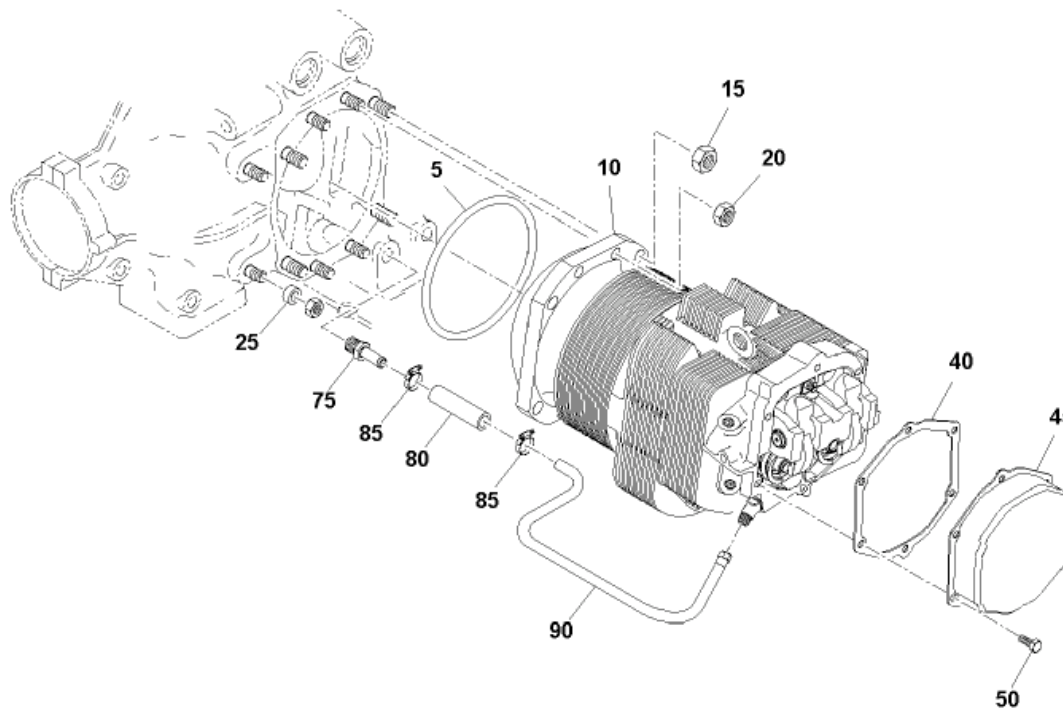
NOTE: Ensure that piston is installed with ring gaps towards the top of the engine.

- (7) Slide the ring compressor tool over the piston and rings far enough to allow the cylinder bore to fit over the piston top.
- (8) Install cylinder #1: Position the top of cylinder facing the top of the engine over the piston. Push on until the ring compressor is pushed off the piston skirt and can be removed at notch over the connecting rod. Continue to slide the cylinder over the cylinder base studs until flush with the case deck. Refer to Figure 72-00-09.18.
- (9) Secure the cylinder assembly with the cylinder base nuts (15, 20, Figure 72-00-09.17) as required and tighten to snug.
- (10) Continue process with cylinders #2, then #3, and #4 in that order. Rotate the case and crank so that the connecting rod of the cylinder to be installed is at top dead center.
- (11) Torque the large cylinder hold down nuts (15, Figure 72-00-09.17) and small hold down nuts (20) per the Table of Limits Appendix C of this manual. Do this in the sequence shown in Figure 72-00-09.19.
- (12) Torque all crankcase assembly hardware (Figure 72-00-09.11) in accordance with the Table of Limits Appendix C of this manual. Do this in the sequence shown in Figure 72-00-09.19.

WARNING: PUT ON SAFETY GOGGLES WHEN INSTALLING OR REMOVING SAFETY WIRE.

- (13) Torque slotted 3/8in. nut (85, Figure 72-00-09.11) per the Table of Limits Appendix C section 6.0. Install safety wire (0.041 in.) at accessory location by cam gear.
- (14) Torque the three, drilled-shank, 1/4in. belly bolts (95) and slotted nuts (100) per the Table of Limits Appendix C section 6.0. Install safety wire (0.032 in.).

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- | | |
|----------------------------|--------------------|
| 5. SEAL - CYLINDER BASE | 75. NIPPLE - DRAIN |
| 10. CYLINDER ASSEMBLY | 80. HOSE |
| 15. NUT - PLAIN (1/2 X 20) | 85. CLAMPS |
| 20. NUT - PLAIN (3/8 X 24) | 90. TUBE ASSEMBLY |
| 25. SPACER | |
| 40. GASKET | |
| 45. COVER | |
| 50. SCREW | |

Figure 72-00-09.17 • Cylinder Assembly and Head Oil Drain Line

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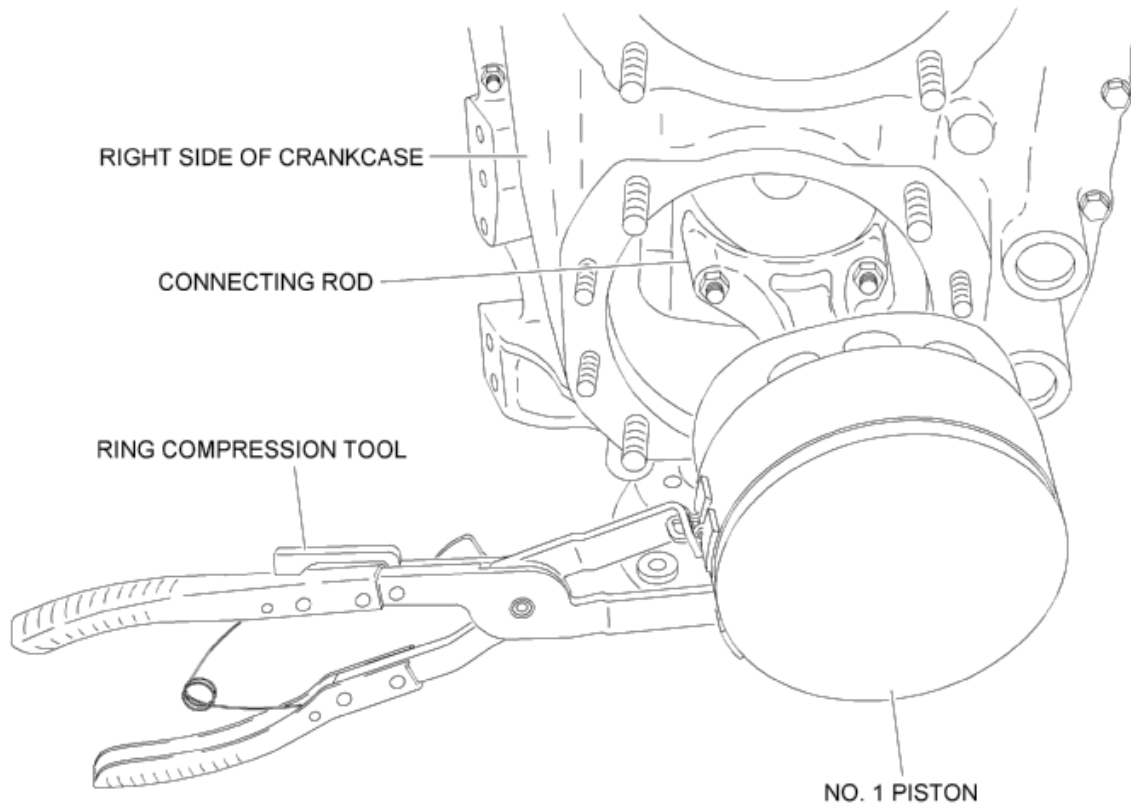
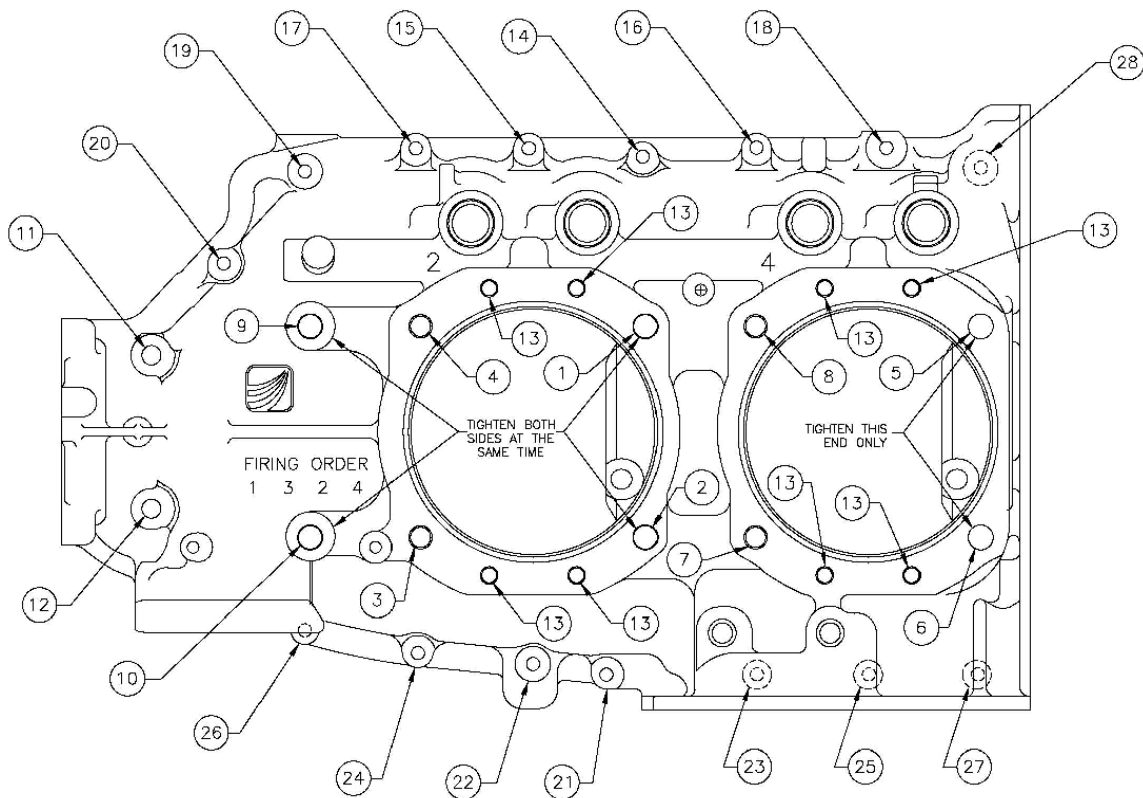


Figure 72-00-09.18 • Piston Assembly with Ring Compressor Tool

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**Figure 72-00-09.19 • Cylinder Base Nuts Sequence of Tightening
(Left Side Shown)**

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Installation of Idler Shafts and Gears and Internal Gear Timing

- (1) Install 2 each idler shafts (1, Figure 72-00-09.20) with 3 bolts (5) and one nut (10). Torque the bolts (5) and nut (10) in accordance with the torque specifications per the Table of Limits Appendix C section 6.0. Safety the nuts and bolts with 0.032 in. safety wire to idler shaft flange holes. Refer to Figure 72-00-09.21.

WARNING: PUT ON SAFETY GOGGLES WHEN INSTALLING OR REMOVING SAFETY WIRE.

- (2) Inspect idler gears and for handling damage, burrs, and general condition.

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- (3) Apply pre-lube oil to idler shafts (1) and gear bushing (25).
- (4) Highlight with a marker the timing marks on the camshaft, crank gear, and fuel pump drive idler gear (15).
- (5) Place the left-hand idler gear (fuel pump drive idler gear) over the left idler shaft aligning its timing marks with the corresponding timing marks on cam and crank. Rotate cam and crank as needed to align with marks on the idler gear. See Figure 72-00-09.22.
- (6) Install the right hand idler gear (20) on the right side idler shaft.

NOTE: It is not necessary to align timing marks on this gear.

- (7) Check gear backlash of both idler gears with feeler gauge or dial indicator. Backlash limits must be within limits specified in the Table of Limits Appendix C section 5.0 of this manual.

- (8) Install tachometer shaft assembly (15, Figure 72-00-09.8) with retaining ring (25) in camshaft (5) at gear end.

- STOP -

PERFORM IN-PROCESS QUALITY INSPECTION #2. REFER TO APPENDIX A.

Cleaning, Inspection, and Installation of Hydraulic Plunger and Cup Assembly

- (1) Visually inspect and clean hydraulic plunger assemblies (25, Figure 72-00-09.15) with fast dry solvent.

WARNING: SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT EYE AND SKIN CONTACT AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

- (2) Depress hydraulic plunger piston with thumb to ensure proper spring action.
 - (a) If unit does not compress, use blunt end of a 3/32 in. diameter rod to dislodge check ball allowing trapped air, oil, or solvent to escape.
 - (b) Remove rod and try depressing piston again.

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- (3) Apply a light coat of pre-lube oil to the OD of each plunger.
- (4) Insert plunger, small tube end first, into tappet body in crankcase. Refer to Figure 72-00-09.15.
- (5) Insert tappet cup or socket (30) into tappet body on top of plunger assembly. Put the cup side out (flat side against plunger). Refer to Figure 72-00-09.15.

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PROTECT YOUR EYES. IF YOU GET AN EYE INJURY, GET MEDICAL ATTENTION.**Installation of Pushrod Tubes, Pushrods, and Rocker Arms**

- (1) Visually inspect the pushrod tubes (40, Figure 72-00-09.15) for handling damage, dents, or burrs. Check I.D. of each tube for debris.

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- (2) Apply a light coat of Fuelube™ or equivalent to 8 O-ring seals (45) and 8 bottom tube seals (35). Install O-rings to pushrod tube (40) at top groove locations.
- (3) Insert pushrod tubes through holes at the top of each cylinder then install bottom seal (35). Seat each tube into its crankcase lifter hole using a rotary or twisting motion. Ensure that o-ring seal and bottom seal are properly seated.
- (4) Install spring clip (50) over stud in cylinder and over the edge of each pushrod tube.
- (5) Secure spring clip with lock plate (55) and 1/4in. nut (60).
- (6) Torque nut (60) per Table of Limits Appendix C of this manual. Bend lock tab with screwdriver or pliers to secure nut.
- (7) Inspect pushrods for bends or damage.
 - (a) Blow clean, dry air through each pushrod (1).
 - (b) Visually inspect I.D. of each pushrod to verify each is clear, clean, and open.

WARNING: WHEN YOU USE COMPRESSED AIR TO CLEAN OR DRY PARTS, MAKE SURE THAT THE PRESSURE IS NOT MORE THAN 30 PSI. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. PUT ON GOGGLES OR A FACE SHIELD TO

Revision C

- (8) Install pushrods in pushrod tubes.

NOTE: There are different lengths of pushrods available for this engine model to aid in adjusting the dry tappet clearance. Use the appropriate length to achieve proper clearance of 0.028 to 0.080 inch.

- (9) Install exhaust valve rotator cap (115) on valve stem of each exhaust valve (65).

NOTE: A drop of pre-lube or spot of grease on the inside of each rotator cap will help retain it in place until the rocker arms are installed.

- (10) Inspect rocker arms (5) for general condition.
- (a) Ensure bushing (10) is properly installed.
 - (b) Check rocker shaft (15) in bushing and shaft in cylinder head for correct fit. Clearance must be within limits specified in the Table of Limits Appendix C of this manual.

- (c) Lubricate the rocker arm socket and oil feed hole to ensure clear passage.

- (11) Rotate the engine until cylinder #1 is at top dead center (TDC).

- (12) Apply a light film of pre-lube oil to the rocker shafts. Install rocker arms and shafts in the #1 cylinder head.

- (13) Check dry tappet (lifter) clearance. Clearance must be within limits per the Table of Limits Appendix C of this manual. Check valve rocker side clearance with a feeler gauge. Clearance must be within limits specified in the Table of Limits Appendix C of this manual.

- (a) Repeat for all remaining cylinders.
- (b) Install the rocker shaft thrust buttons (20) in each end of the rocker shaft (15) immediately before installing rocker cover.

NOTE: Change the pushrod length as required to achieve proper clearance.

NOTE: A light coat of grease applied to the thrust buttons will aid in retaining them in position until the rocker covers (45, Figure 72-00-09.17) are installed.

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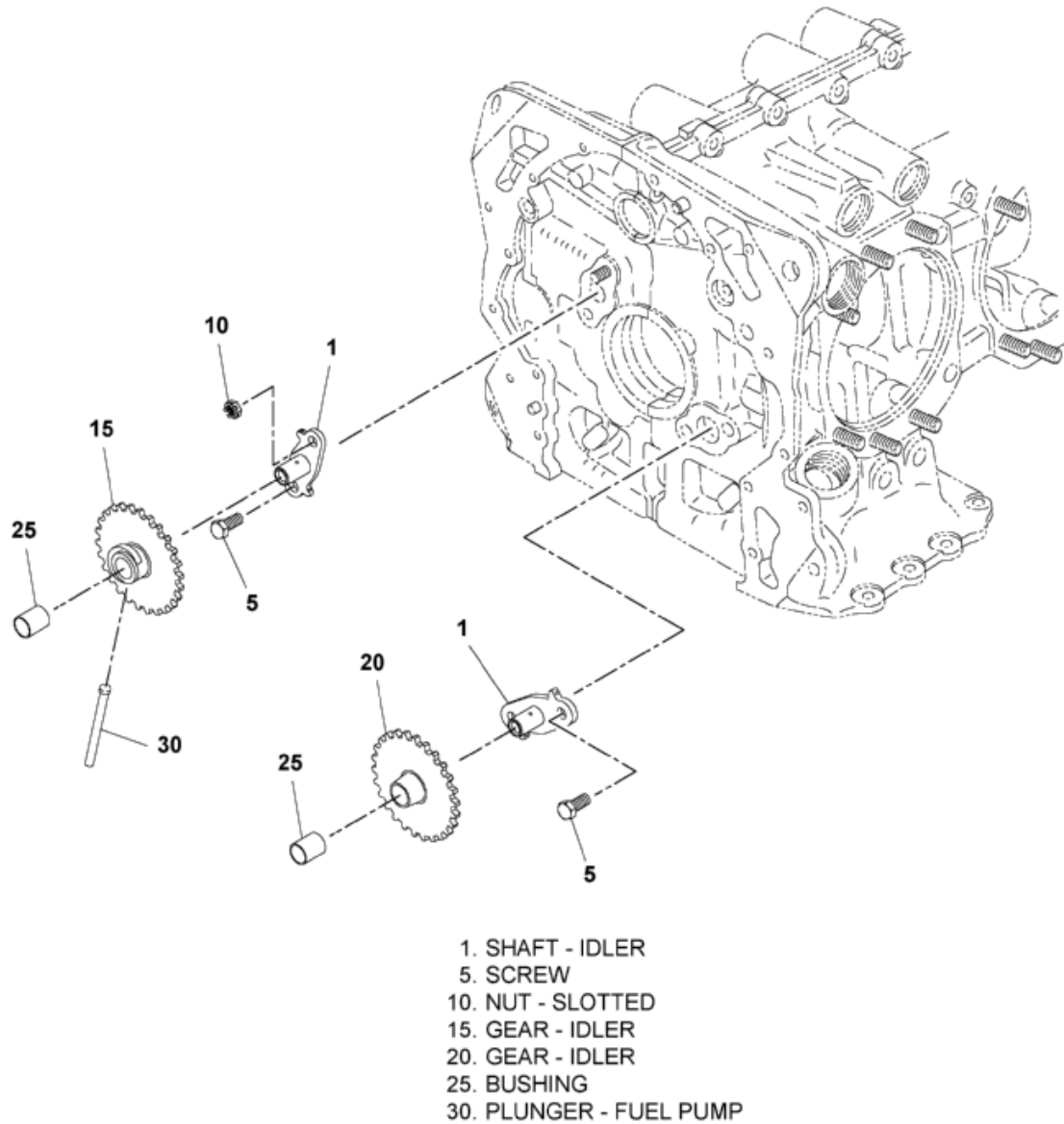


Figure 72-00-09.20 • Idler Gear in Crankcase

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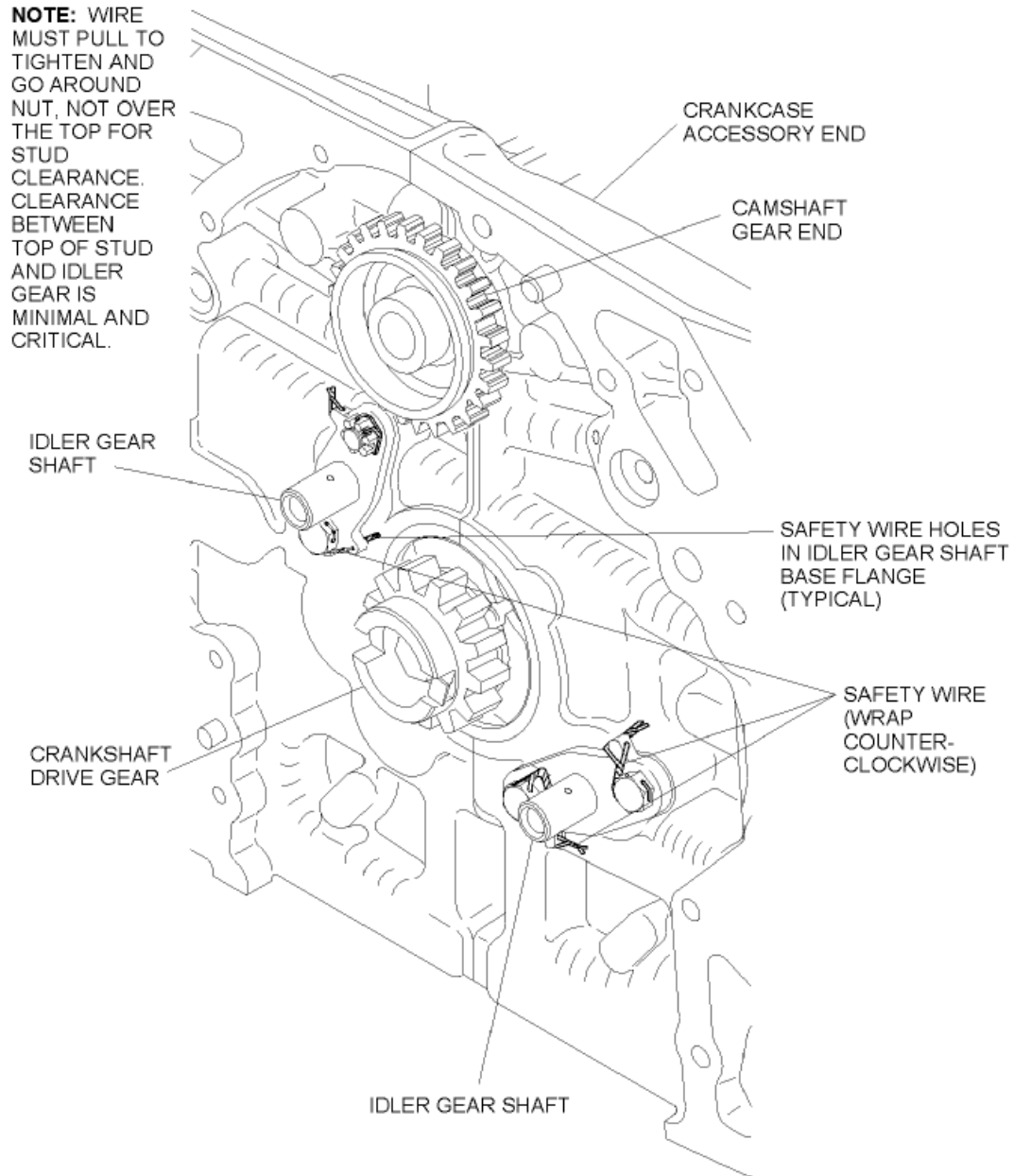


Figure 72-00-09.21 • Idler Gear in Crankcase (cont'd.)

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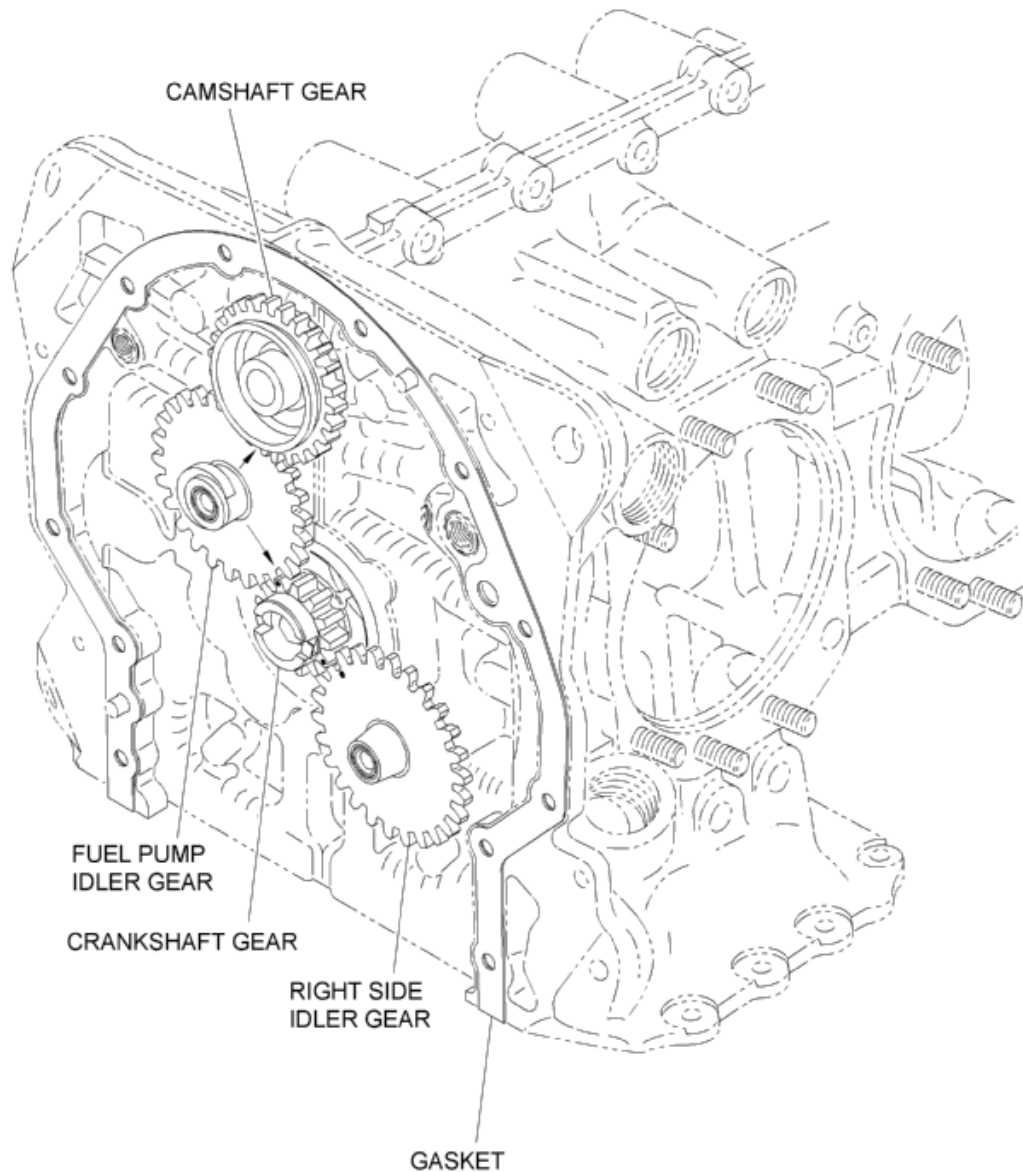


Figure 72-00-09.22 • Accessory Drive Gear Arrangement

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Accessory Housing Inspection and Subassembly

- (1) Inspect the accessory housing (1, Figure 72-00-09.23) for damage. Check the studs, threaded holes, and mating surfaces for damage or debris.
- (2) Install new tachometer drive seal (30).
- (3) Install the fitting (45, Figure 72-00-09.23) and/or oil pressure fitting removed for cleaning. Tighten per torque specifications in the Table of Limits Appendix C section 6.0 of this manual.
- (4) Install plug (55) and crush gasket (50) per Figure 72-00-09.35 and tighten per torque specifications in the Table of Limits Appendix C section 6.0 of this manual.
- (5) Inspect the oil pump housing (95, Figure 72-00-09.23) for damage. Verify plug (100) installation.
- (6) Inspect the oil pump gears (105, 110) and oil pump drive shaft (115) for damage.
- (7) Install the oil pump gears (105, 110) and drive shaft (115) into oil pump housing. Inspect gear backlash, gear to housing, and shaft to accessory case clearance per specifications in the Table of Limits Appendix C of this manual.

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- (8) Apply pre-lube oil liberally to gears and shaft in housing.
- (9) Install the oil pump assembly (80) over studs in accessory housing.
- (10) Install the flat washers (85) and slotted nuts (90) to the studs. Tighten the installation hardware to snug.
- (11) Rotate the oil pump drive shaft (115) to ensure smooth fit. The gears must rotate smoothly.

NOTE: It may be necessary to twist or move the oil pump housing slightly to achieve a smooth rotation of the oil pump assembly gears.

WARNING: PUT ON SAFETY GOGGLES WHEN INSTALLING OR REMOVING SAFETY WIRE.

- (12) Tighten the slotted nuts (90) per torque specifications in the Table of Limits Appendix C of this manual. Install safety wire (0.032 in.). Refer to Figure 72-00-09.24.
- (13) Check fuel pump plunger (Figure 72-00-92.24) to accessory case clearance. Clearance must be within limits specified in the Table of Limits Appendix C of this manual. Lubricate and install the fuel pump plunger in the accessory housing.

- STOP -
PERFORM IN-PROCESS QUALITY INSPECTION #3. REFER TO APPENDIX A.

Assembly of Accessory Housing to Engine

- (1) Check tachometer drive shaft (Figure 72-00-92.24) to accessory case clearance. Clearance must be within limits specified in the Table of Limits Appendix C of this manual. Apply pre-lube oil to the tach shaft (15, Figure 72-00-09.8) as well as to the gear teeth of cam, crank and idler gears.

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- (2) Ensure the mating surfaces of the crankcase and accessory housing are clean, flat, and free from burrs or scoring.

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- (3) Verify the dowels are installed in the proper location in the crankcase.
- (4) Install the accessory housing gasket (35, Figure 72-00-09.23) to the crankcase over the dowels.
- (5) Install the accessory housing assembly (1) over the tach shaft taking care to align oil pump drive with the crankshaft gear.
 - (a) Lightly tap the accessory housing in place over the dowels with a soft face or dead blow hammer as required.
- (6) Secure the accessory housing with washer (5), lock washer (10), and bolt (15) 10 places. Secure with the bolt (20), washer (5) and lock washer (10) 2 places. Tighten per the Table of Limits Appendix C of this manual.
- (7) Trim the protruding gasket ends flush with the sump mating surfaces. See Figure 72-00-09.25.

Installation of the Rocker Cover and Baffles

- (1) Install the rocker box covers with the gaskets (120,125, Figure 72-00-09.15) and screws (130).
- (2) Torque the rocker cover screws (130) in accordance with torque specifications in the Table of Limits Appendix C of this manual.
- (3) Install the inner cylinder baffles with the hooks and retainers. See Figure 72-00-09.26.

Inspection of the Sump and Subassembly

- (1) Inspect the sump (5, Figure 72-00-09.27) for general condition, handling damage, stud damage, mating surface condition, and security of the roll swaged intake pipe extensions (70).

WARNING: PUT ON SAFETY GOGGLES WHEN INSTALLING OR REMOVING SAFETY WIRE.

- (2) Install the oil suction screen (75) with its gasket (80) and plug (85). Ensure the gasket seam faces the sump (5).

- Tighten the plug (85) until the plug body contacts the gasket (80) then turn an additional approx. 135 degrees. Install safety wire (0.032 in.) on the plug (85).
- (3) Install the sump gasket over sump studs.
 - (4) Install the sump with bolt (15, Figure 72-00-09.27) lock washers (30), washers (25), and nuts (35) 14 places. Install the bolts (20), lock washers (30), washers (25), and nuts (35) 2 places. Install the lock washers (30), washers (25), and nuts (35) on the sump studs 4 places. Torque the bolts (15, 20) and nuts (35) per the Table of Limits Appendix C of this manual.

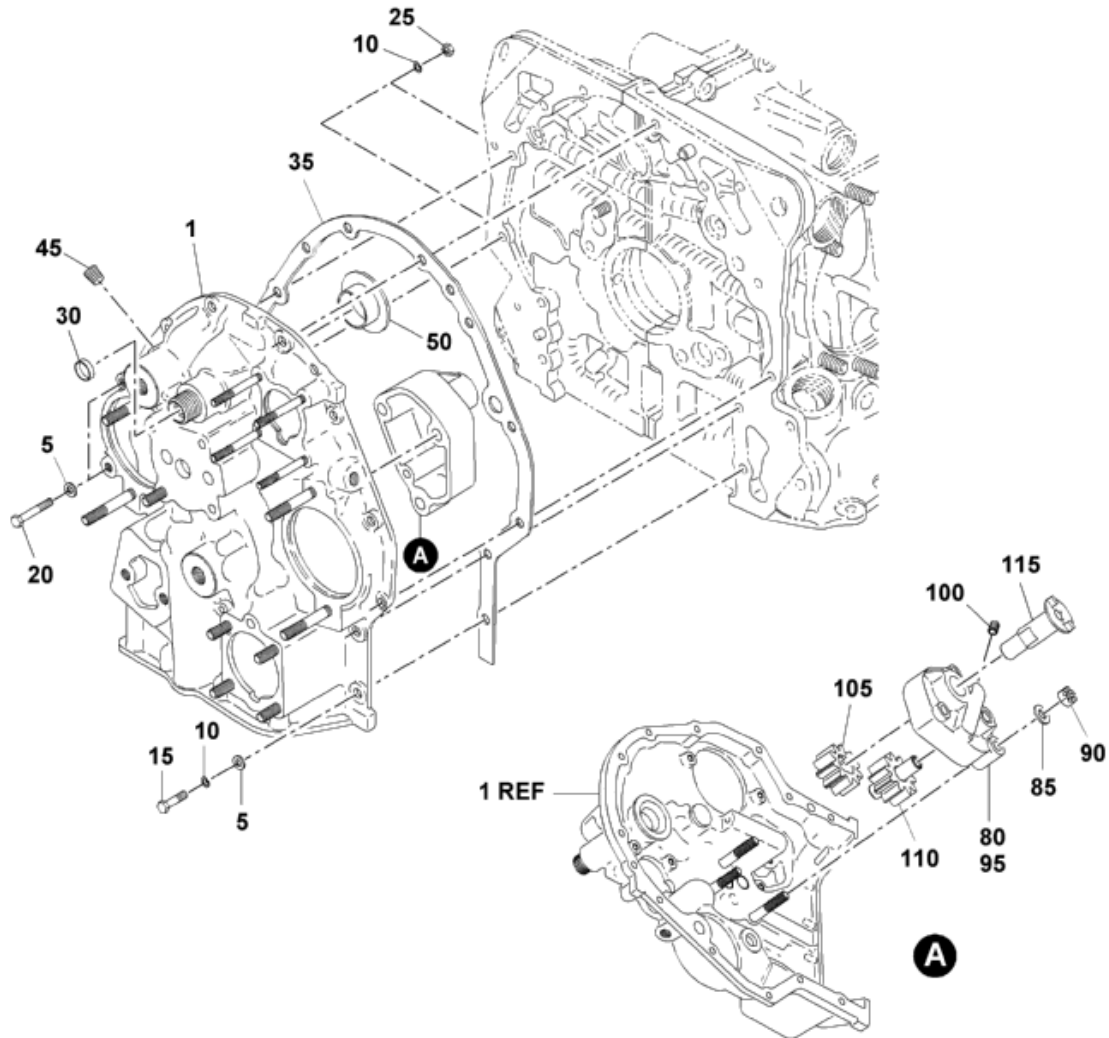
Installation of the Oil Pressure Relief Valve Assembly

- (1) Apply pre-lube oil in the crankcase at the oil pressure relief valve location.
- (2) Insert the ball (40, Figure 72-00-09.2) into the hole in the crankcase.
- (3) Install the spring (35) into the oil pressure relief valve housing (25).
- (4) Install the gasket (30) to the relief valve housing (25).
- (5) Apply pre-lube oil to the threads of the oil pressure relief valve housing and install the housing in the crankcase.
- (6) Tighten the relief valve assembly (25, Figure 72-00-09.2) until the valve body contacts gasket (30) then turn an additional approx. 90°. Install safety wire (0.032 in.) from the relief valve assembly (25) to the hole provided in the crankcase.

Oil Level Gage and Housing

- (1) Install the oil level gage housing (5, Figure 72-00-09.28) with the gasket into the crankcase. Tighten per the Table of Limits Appendix C of this manual. Install safety wire (0.032 in.) between the oil level gage housing (5) and crankcase.
- (2) Install the oil level gage (10) with its O-ring seal (15) into the housing.

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| 1. HOUSING ASSEMBLY - ACCESSORY | 50. SHIELD - OIL BREATHER |
| 5. WASHER - FLAT | 80. HOUSING ASSEMBLY - OIL PUMP |
| 10. WASHER - LOCK | 85. WASHER - FLAT |
| 15. BOLT | 90. NUT - SLOTTED |
| 20. BOLT | 95. HOUSING |
| 25. NUT - HEX | 105. GEAR - IMPELLER |
| 30. SEAL | 110. GEAR - IMPELLER |
| 35. GASKET | 115. SHAFT - OIL PUMP DRIVE |
| 45. SET SCREW - PLUG | |

Figure 72-00-09.23 • Accessory Housing

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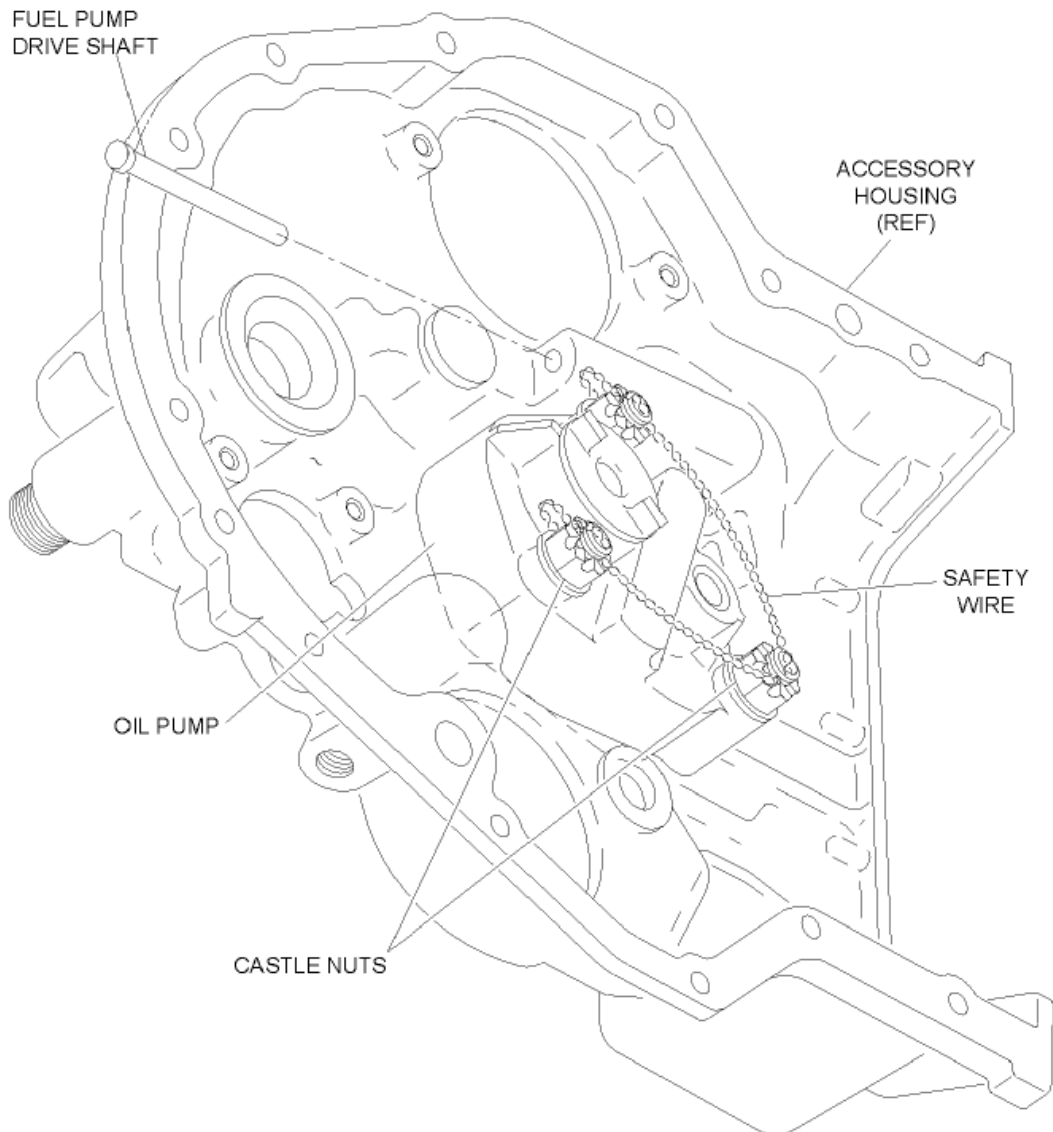


Figure 72-00-09.24 • Oil Pump Assembly

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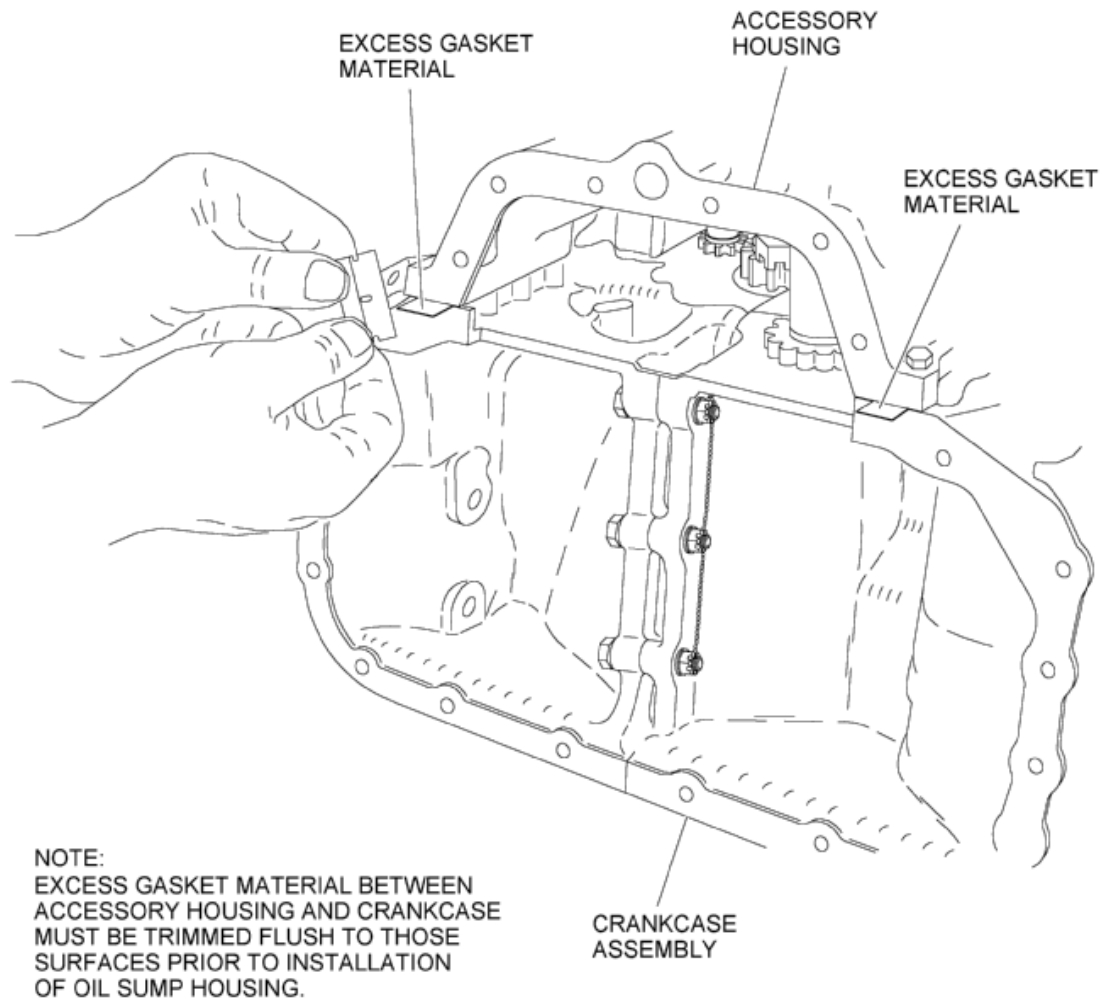


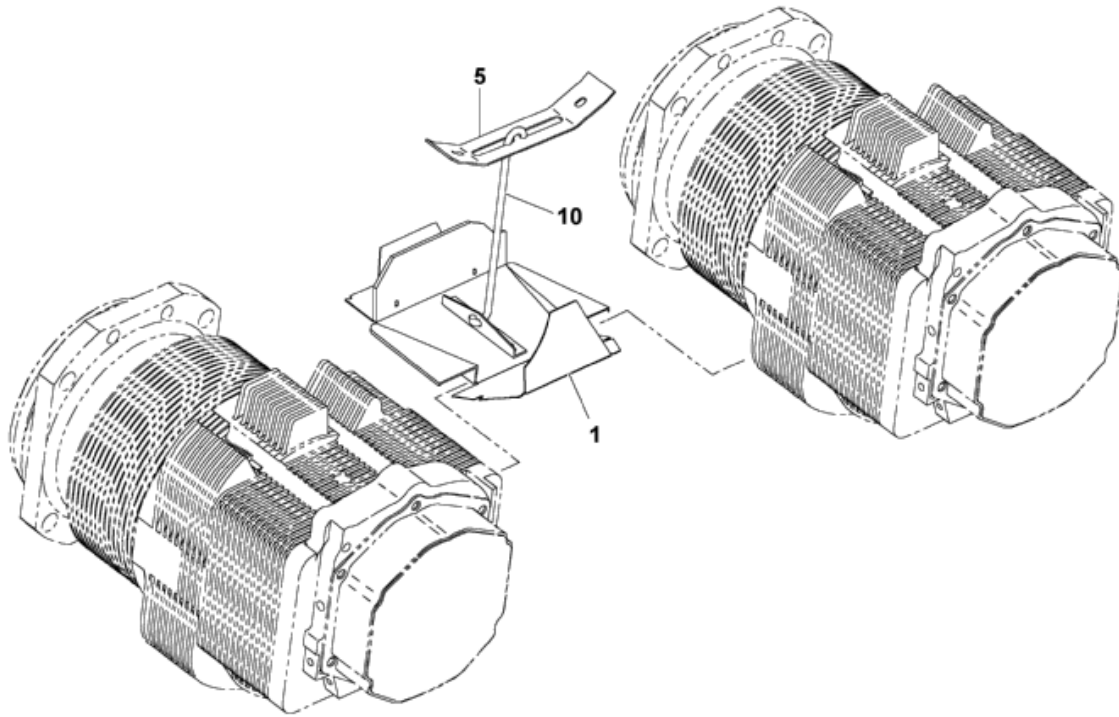
Figure 72-00-09.25 • Accessory Housing Gasket Trimming

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Installation of Intake Pipes

- (1) Slide the intake flange (10, Figure 72-00-09.29) onto the intake elbow (5). Allow the flanged end of the elbow to seat in the recessed flat side of the intake flange.
- (2) Install the rubber hose coupler (30) onto other end of the elbow along with 2 clamps (35).
- (3) Place the bolts (25) with the appropriate lock washer (20) and flat washer (15) through the holes in the intake flange. Install the gasket (1) over the bolts.
- (4) Attach the elbow assembly to the engine with the hose connection to sump and the flange coupling to the intake port of the cylinder head. Refer to Figure 72-00-09.30.
- (5) Slide the hose coupler over the intake extension in the sump. Center the hose coupler over the joint and tighten the bolts (25) into the cylinder head until snug.
- (6) Ensure that the flange end of the intake elbow fits completely in the recess in the aluminum hold down flange (10). This must lay flat against the cylinder port. Torque the bolts (25) per the Table of Limits appendix C of this manual.
- (7) Position the clamps (35) over the hose coupler (30) to secure each side of the connection. Tighten per the Table of Limits Appendix C.

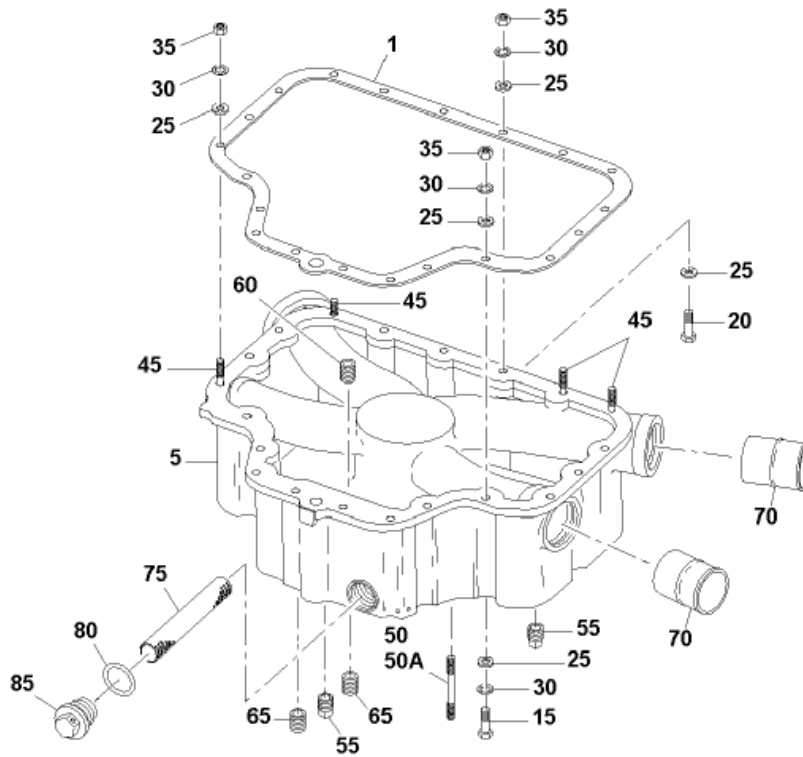
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- 1. BAFFLE ASSEMBLY
- 5. RETAINER
- 10. HOOK - RETAINER

Figure 72-00-09.26 • Inner Cylinder Cooling Baffle

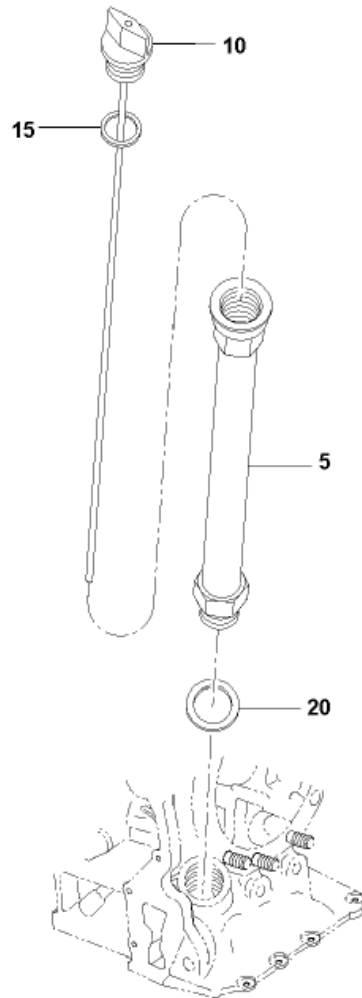
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- | | |
|----------------------|-------------------|
| 1. GASKET | 55. PLUG |
| 5. OIL SUMP ASSEMBLY | 60. PLUG |
| 15. BOLT | 65. PLUG |
| 20. BOLT | 70. PIPE - INTAKE |
| 25. WASHER - PLAIN | 75. SCREEN |
| 30. WASHER - LOCK | 80. GASKET |
| 35. NUT - PLAIN | 85. PLUG |
| 45. STUD | |
| 50. STUD | |
| 50A. STUD | |

Figure 72-00-09.27 • Oil Sump and Induction System

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- 5. OIL GAGE TUBE
- 10. OIL GAGE
- 15. SEAL - GAGE
- 20. SEAL - TUBE

Figure 72-00-09.28 • Oil Level Gage

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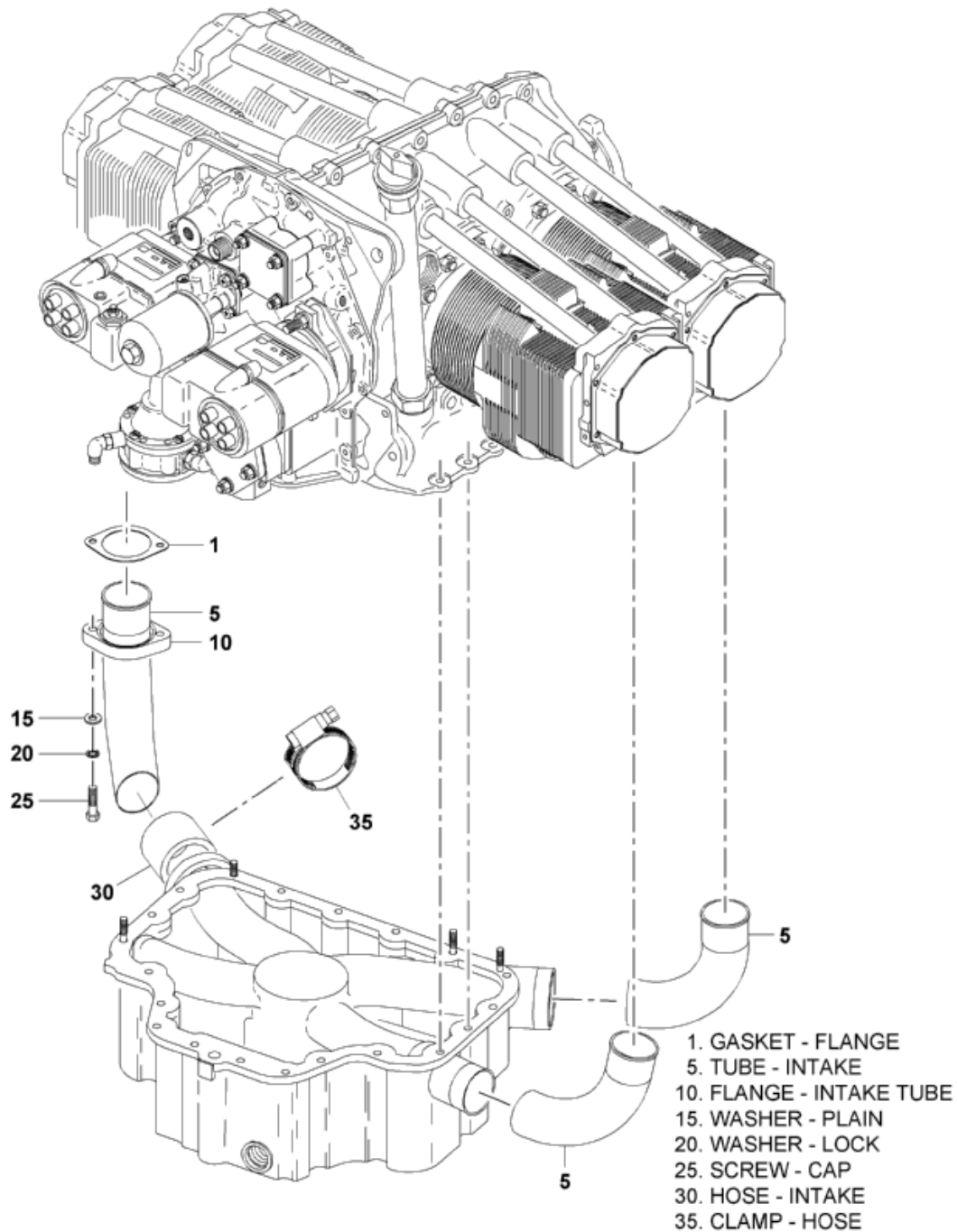


Figure 72-00-09.29 • Induction System

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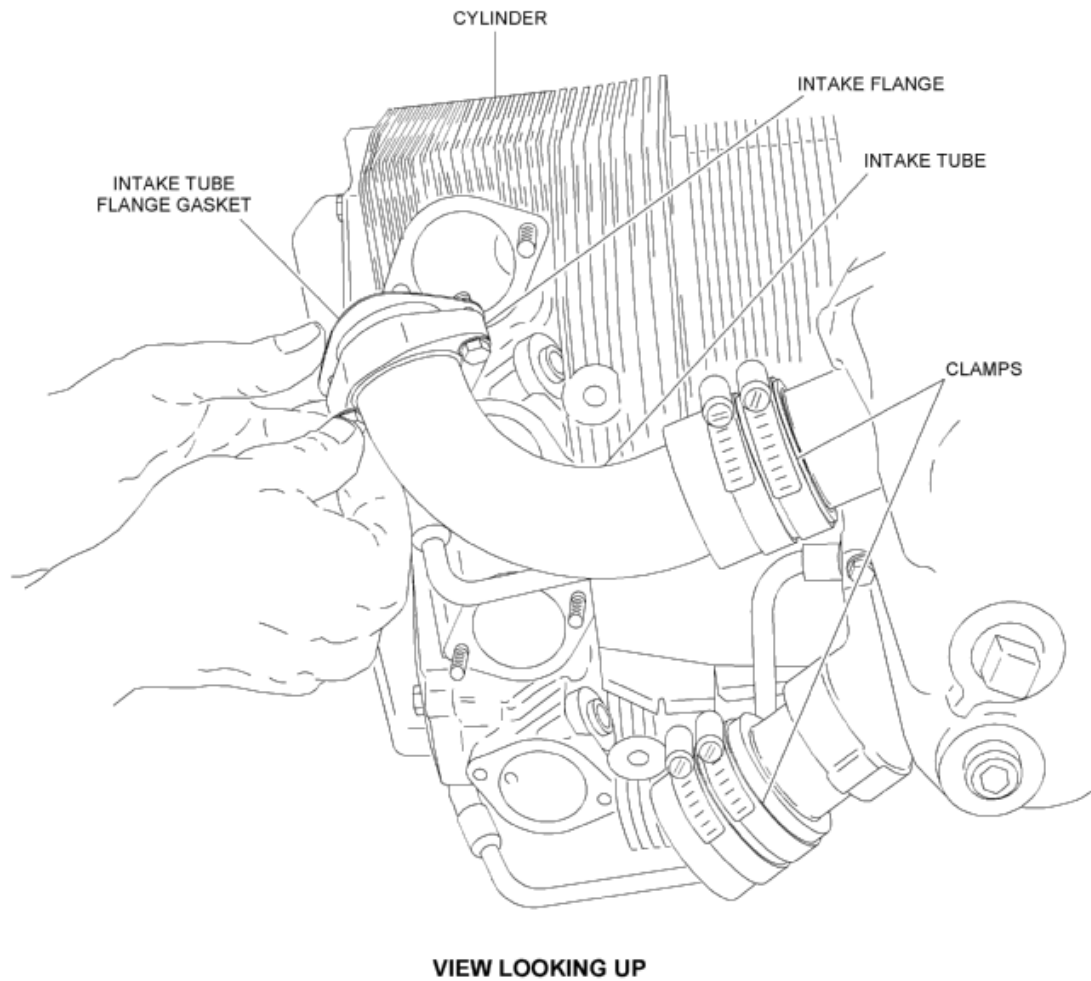


Figure 72-00-09.30 • Intake Tube Assembly

Installation of Cylinder Drain Tubes

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- (1) Secure the cylinder drain tubes (90, Figure 72-00-09.17) to their corresponding cylinders. Do this by installing the drain back hose (80) to the case nipple (75) and the drain tube using the clamps (85). Fasten the B-nut end of the drain tube to 45° fitting in cylinder head. Torque the 2 clamps (85) to specification in the Table of Limits Appendix C of this manual. Torque the drain tubes (90) B-nuts per the Table of Limits Appendix C.

NOTE: Ensure that the cylinder drain fitting is tight and pointed in the correct position for the drain tube (90) installation. The tube should not touch the intake pipe, cylinder, or inner cylinder baffle.

Installation of Vacuum Pump Adapter

- (1) Install new oil seal (55, Figure 72-00-09.31) in the vacuum pump adapter (25).
 - (a) Lightly lubricate the seal OD with Fuelube™ or equivalent. Press into the adapter, flat side up, until it bottoms out.

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- (2) Apply pre-lube oil and thrust washer to the shaft gear (1) and install the gear in the housing. Rotate the gear upon installation to ease it through the seal and to ensure it turns smoothly.
- (3) Install the gasket (10) over the studs in the accessory housing. Align holes in gasket to correspond with holes in the housing. Refer to Figure 72-00-09.31.
- (4) Install the vacuum pump adapter (25) and the gear assembly (1) over the studs in the accessory housing. Align the holes and dowel pin. Ensure that the drive gear teeth mesh with the idler gear teeth.
- (5) Check the gear endplay and backlash. Values must be within limits per the Table of Limits section of this manual.
- (6) Install the gasket (15), and cover plate (20) with the washer (30), lockwasher (35), and nuts (40). Torque the nuts (40) per the Table of Limits Appendix C.

Installation of Accessories

- (1) Install the engine accessories per instructions given later in this section.

- STOP -

PERFORM IN-PROCESS QUALITY INSPECTION #4. REFER TO APPENDIX A.

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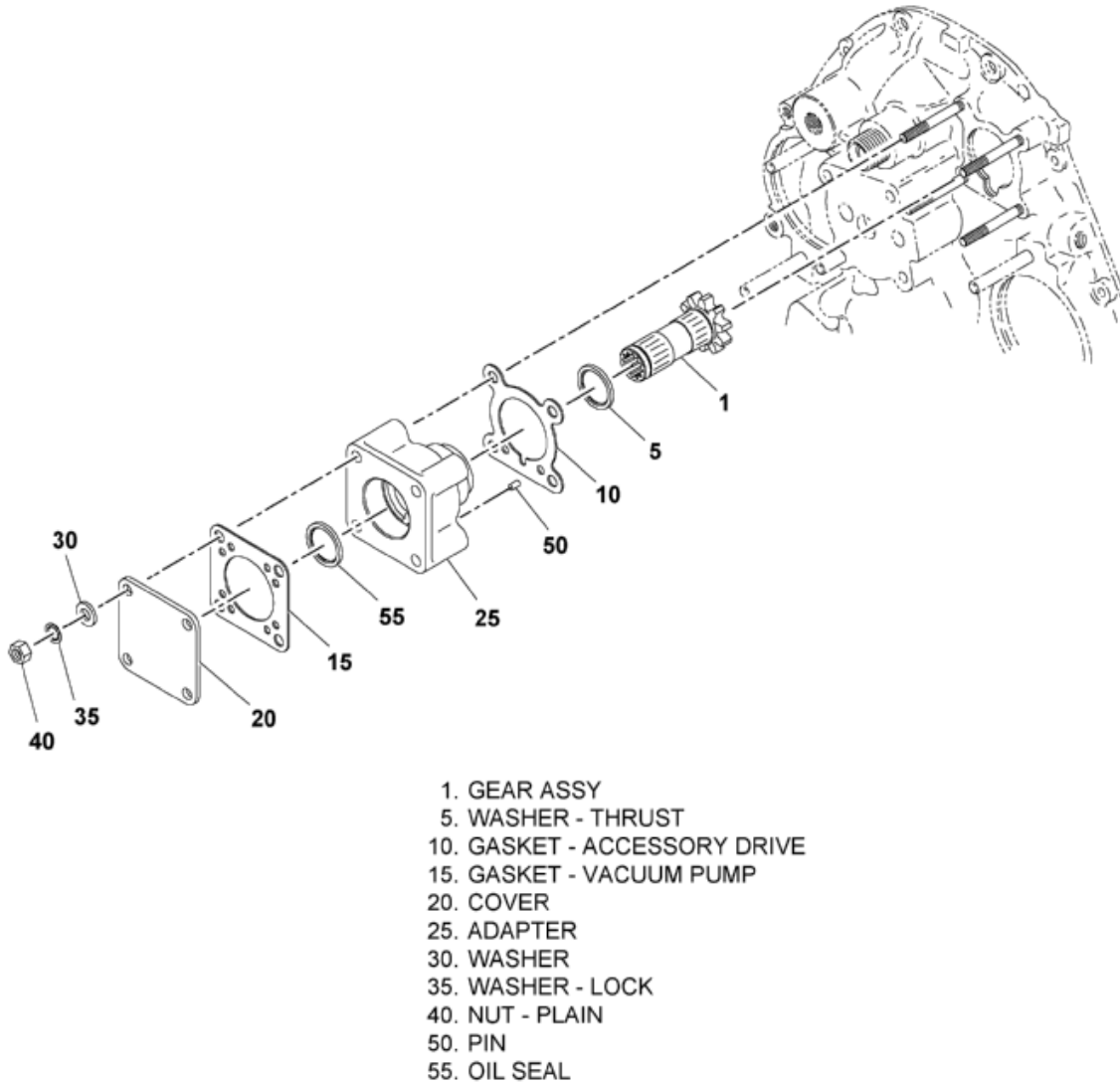


Figure 72-00-09.31 • Vacuum Pump Drive

Engine Accessory Assembly Installation

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NOTE: Unless otherwise specified, all torque loads listed for nuts, bolts, and screws are for use with pre-lube oil.

Installation of Fuel Pump (if furnished)

- (1) Verify new fuel pump part number.

WARNING: LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. BEFORE YOU USE, READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER. USE IN A WELL-VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

- (2) Apply pre-lube oil to threads of 90° elbow (25, Figure 72-00-09.32) and o-ring (20). Install into fuel pump (5) outlet port. Position elbow (25) to point straight back and torque lock nut per the Table of Limits Appendix C.
- (3) Apply pre-lube oil to the threads of the 45° elbow (30) and o-ring (20). Install into the fuel pump (5) inlet port. Position the elbow (30) to point up and torque the lock nut per Table of Limits Appendix C.
- (4) Rotate the engine to provide least amount of fuel pump plunger extension.
- (5) Apply grease to the fuel pump arm and plunger where they will make contact on the wear surfaces.
- (6) Install the fuel pump (5) with the gasket (1), drilled sockethead screws(15), and flat washers (10).

WARNING: PUT ON SAFETY GOGGLES WHEN INSTALLING OR REMOVING SAFETY WIRE.

- (7) Torque the screws (15) per Table of Limits Appendix C. Install safety wire (0.032 in.).

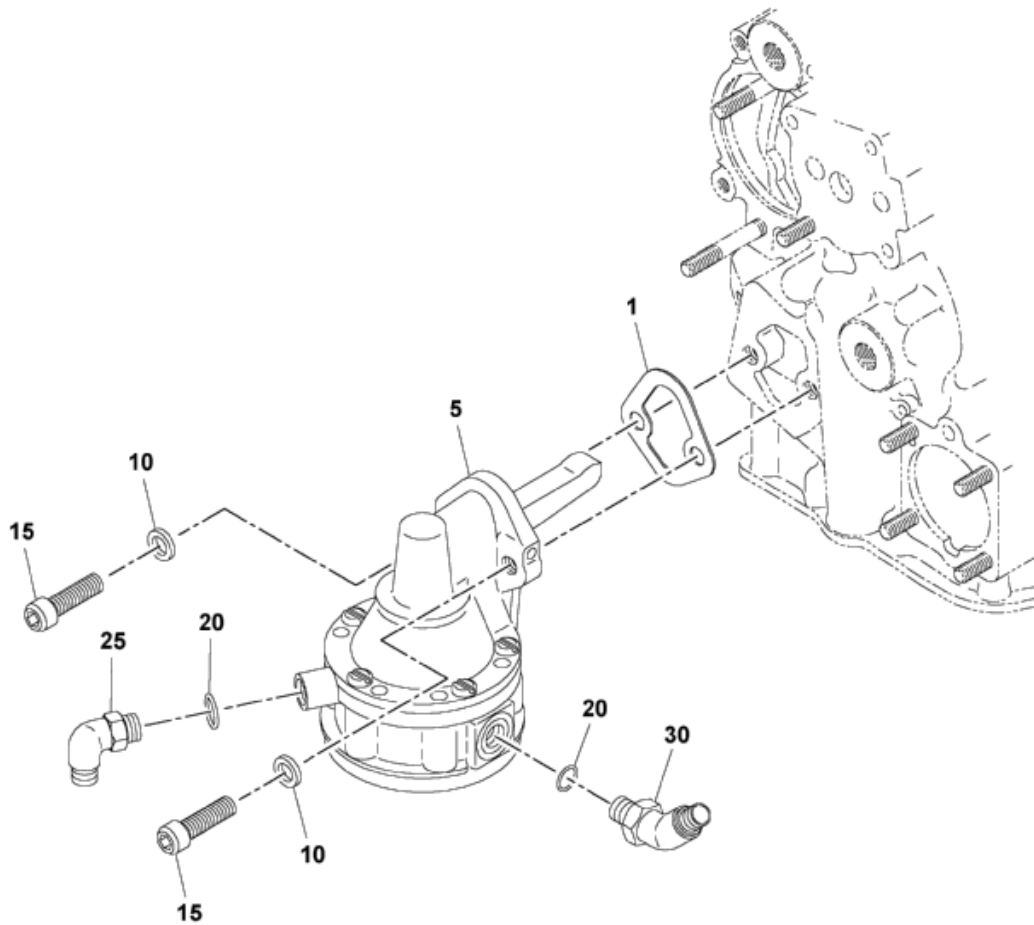
Installation of Propeller Governor Adapter Assembly

- (1) This instruction applies to engine models requiring a prop governor installation.
- (2) Lubricate the governor shaft gear (1, Figure 72-00-09.33) and the bore in the adapter (15) with pre-lube oil. Install the shaft gear in the adapter.

WARNING: LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. BEFORE YOU USE, READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER. USE IN A WELL-VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

- (3) Place the thrust washer (5) on the shaft gear. Secure the shaft gear in the adapter with snap ring (55). Refer to Figure 72-00-09.33.
- (4) Ensure free spin of the gear in the adapter and check the end clearance. End clearance must be within limits specified in the Table of Limits Appendix C of this manual.
- (5) Install the adapter assembly to the accessory housing with the gasket (10), washer (20), lock washer (25), and nut (30) per Figure 72-00-09.33. Torque the nuts (30) per the Table of Limits Appendix C of this manual.
- (6) Check the gear lash to the idler gear. Backlash must be within limits specified in the Table of Limits Appendix C of this manual.
- (7) Lightly lubricate the threads of the 45° elbow (15, Figure 72-00-09.34) and its o-ring (20) with pre-lube oil and install in the propeller governor adapter. Torque per the Table of Limits Appendix C of this manual.

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- 1. GASKET
- 5. PUMP - FUEL
- 10. WASHER - FLAT
- 15. SCREW
- 20. O-RING
- 25. ELBOW - 90°
- 30. ELBOW - 45°

Figure 72-00-09.32 • Fuel Pump

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WARNING: ADHESIVE SEALANT IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. AVOID EYE AND SKIN CONTACT. USE PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

- (8) Apply TiteSeal™ thread sealant or equivalent to the threads of 90° elbow fitting (10) and install in the right crankcase half, forward of No.1 cylinder. Refer to Figure 72-00-09.34.
- (9) Position fittings per Figure 72-00-09.34 and install the propeller governor oil hose (1). Torque the oil hose (1) nuts per the Table of Limits Appendix C of this manual.

Installation of Propeller Governor Cover Plate

- (1) This instruction applies to all engine models not requiring a prop governor, and models having the prop governor in the front of the engine.
- (2) For the engine models where no propeller governor is used, install cover (65, Figure 72-00-09.33), gasket (60), washer (30), and lockwasher (25). Torque the 5/16 in. nuts (30) per the Table of Limits Appendix C.

Installation of Oil Filter Adapter (if furnished)

- (1) Install the Vernatherm valve (45, Figure 72-00-09.35) with the aluminum gasket and torque per the Table of Limits Appendix C of this manual. Install safety wire (0.032 in.) from the Vernatherm to the adapter.
- (2) Install the oil filter adapter (10) to the accessory housing with the gasket (5), washers (15), lock washers (20), 1 nut (25), and 3 screws (30). Torque per the Table of Limits Appendix C.

WARNING: PUT ON SAFETY GOGGLES WHEN INSTALLING OR REMOVING SAFETY WIRE.

INSTALLATION OF SPIN-ON OIL FILTER

- (1) Apply light coat of Dow Corning #4 lubricant or equivalent to the rubber seal at base of the oil filter (40, 72-00-09.35) and lightly lubricate the filter threads then install to the adapter (10) and torque per the Table of Limits Appendix C of this manual. Reference SVMM01, Maintenance Manual. Install safety wire (0.032 in.) from the oil filter to the adapter.

WARNING: PUT ON SAFETY GOGGLES WHEN INSTALLING OR REMOVING SAFETY WIRE.

WARNING: LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. BEFORE YOU USE, READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER. USE IN A WELL-VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

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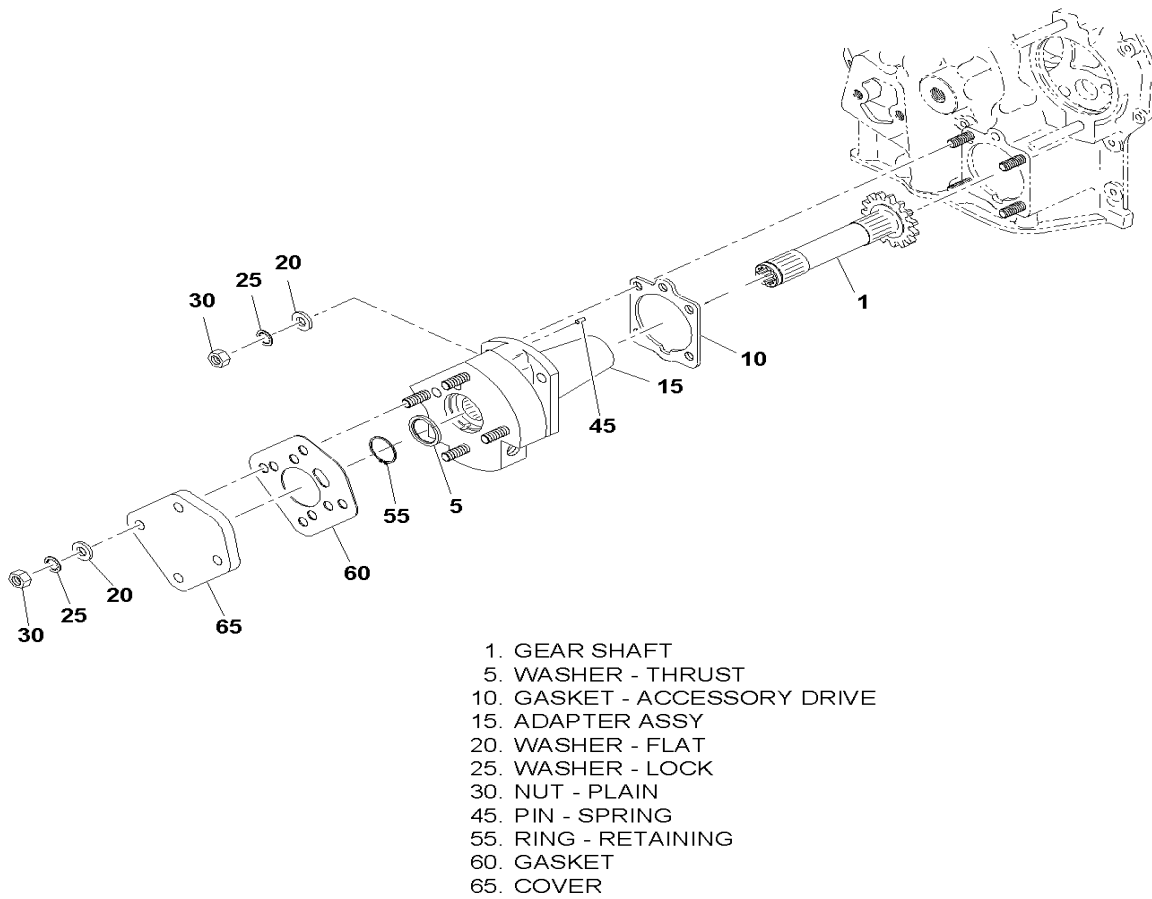
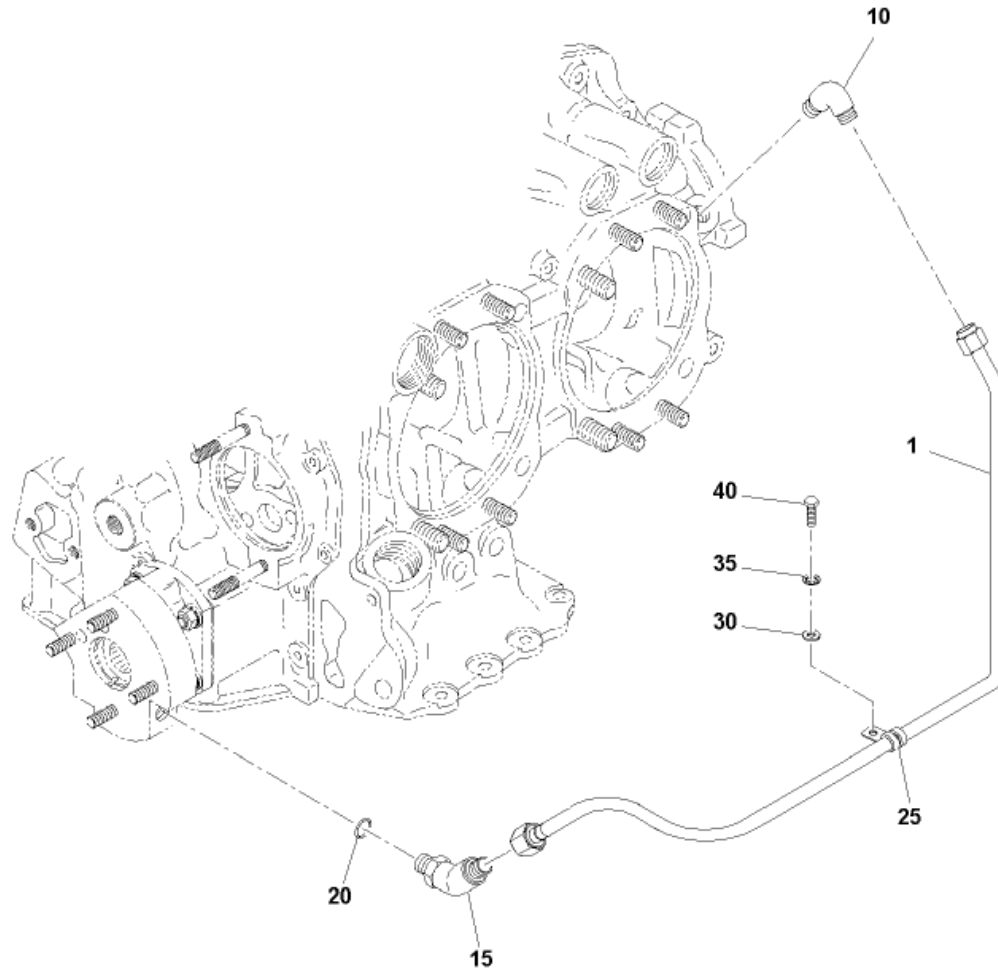


Figure 72-00-09.33 • Propeller Governor Adapter

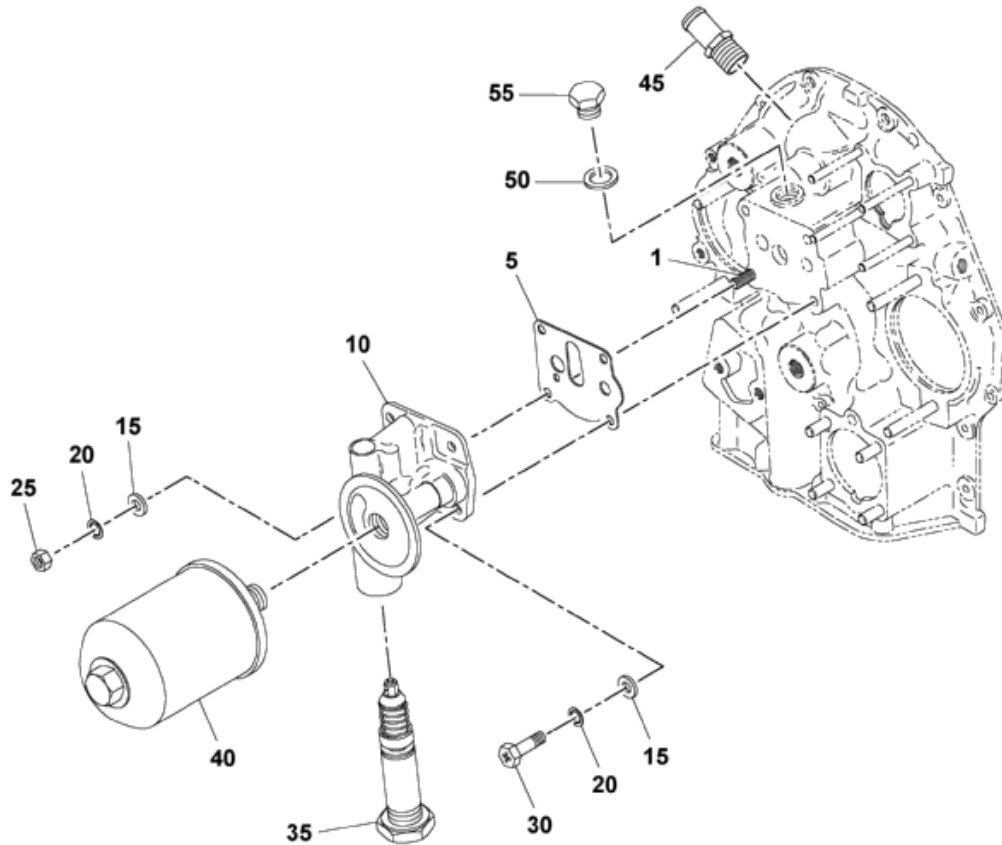
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- 1. HOSE
- 10. ELBOW - 90°
- 15. ELBOW - 45°
- 20. O-RING
- 25. CLAMP
- 30. WASHER - FLAT
- 35. WASHER - LOCK
- 40. BOLT

Figure 72-00-09.34 • Propeller Governor Oil Line

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- 1. STUD (1/4-20 X 1-1/4)
- 5. GASKET - ADAPTER
- 10. ADAPTER - OIL FILTER
- 15. WASHER - FLAT (1/4 INCH)
- 20. WASHER - LOCK (1/4 INCH)
- 25. NUT - PLAIN (1/4 INCH)
- 30. SCREW (1/4-20 X 31/32)
- 35. VALVE CONTROL ASSY - VERNATHERM
- 40. OIL FILTER - SPIN ON
- 45. FITTING - CRANKCASE BREATHER
- 50. GASKET - COPPER
- 55. PLUG - OIL COOLER BYPASS

Figure 72-00-09.35 • Oil Filter Assembly

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Installation of Carburetor and Primer System

NOTE: This section applies to carbureted engine models only.

- (1) Verify the correct part number of the carburetor.
- (2) Install the carburetor (5, Figure 72-00-09.37), gasket (1), washers (10), lockwashers (15), and nuts (20) per Figure 72-00-09.37. Torque the nuts (20) per the Table of Limits Appendix C.
- (3) Apply anti-seize to the threads of the primer nozzles (1, Figure 72-00-09.36).
- (4) Install the primer nozzles in cylinder numbers 1, 2, and 4 (lower ports, Fig. 72-00-09.36). Torque the nozzles (1) per the Table of Limits Appendix C of this manual.
- (5) Install the primer lines (1, 5, 10, 15) to nozzles and "T" junctions (20). Torque nuts per Table of Limits Appendix C. Clamp to the induction elbows and sump flange.

Installation of Fuel Injection System

NOTE: This section applies to fuel injected engines only.

- (1) Verify the correct part number of the fuel injection unit (servo), flow divider, and nozzles.
- (2) Install the servo to the sump with gaskets (1, Figure 72-00-09.38), spacer (5), washer (15), lock washers (20), and nuts (25). Torque the attaching nuts (25) per the Table of Limits Appendix C of this manual.
- (3) Install the fuel injector fittings, appropriate pipe plugs and nipples per Figure 72-00-09.39 into the flow divider. Use anti-seize on the male threads and torque per the Table of Limits Appendix C of this manual.
- (4) Install the flow divider bracket (1) to the flow divider with screws (25) and lock washers (20). Torque the screws per the Table of Limits Appendix C.
- (5) Install the flow divider and bracket assembly to the engine backbone (top) per Figure 72-00-09.39 and torque the attaching hardware to per the Table of Limits Appendix C.

NOTE: Remove and reinstall the appropriate backbone hardware to accommodate bracket

- (6) Install the bolt (10) with lock washer (5).
- (7) Apply anti-seize to the fuel injectors (90). Install in the cylinders. Torque the injectors per the Table of Limits Appendix C.
- (8) Install the fuel lines (55) between the fuel injectors (90) and the flow divider (15). Tighten per the Table of Limits Appendix C. Install clamps.
- (9) Install the fuel hose (30, Figure 72-00-09.38) between the fuel pump and fuel servo. Install the fuel hose (35, Figure 72-00-09.38) between the fuel servo and flow divider. Torque the hose (30, 35) B-nuts per the Table of Limits Appendix C of this manual.

Magneto and Harness Installation

- (1) Verify the correct magneto part numbers.
- (2) Assemble the magnetos as follows:
 - (a) Install the drive gear (35, Figure 72-00-09.40) to the magneto (15) by removing the gear retaining nut, washer, and cotter pin (40) from the magneto.
 - (b) Install the drive gear (35) with the washer and nut. Torque the nut per the Table of Limits Appendix C of this manual. Secure with cotter pin (40).
- (3) Repeat for the 2nd magneto's assembly.
- (4) Install the magneto gasket (1) and spacer (5), as appropriate, to the accessory housing at each magneto location.
- (5) Remove the harness cover cap from each magneto as required. Retain screws for harness installation.
- (6) Determine direction of rotation. Refer to magneto data plate.
- (7) Insert the alignment pin in appropriate hole "R" or "L" in magneto, as determined by the direction of rotation, and slowly rotate the magneto drive shaft "backwards" until the alignment pin

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drops into position (to the first shoulder),
locking the shaft.

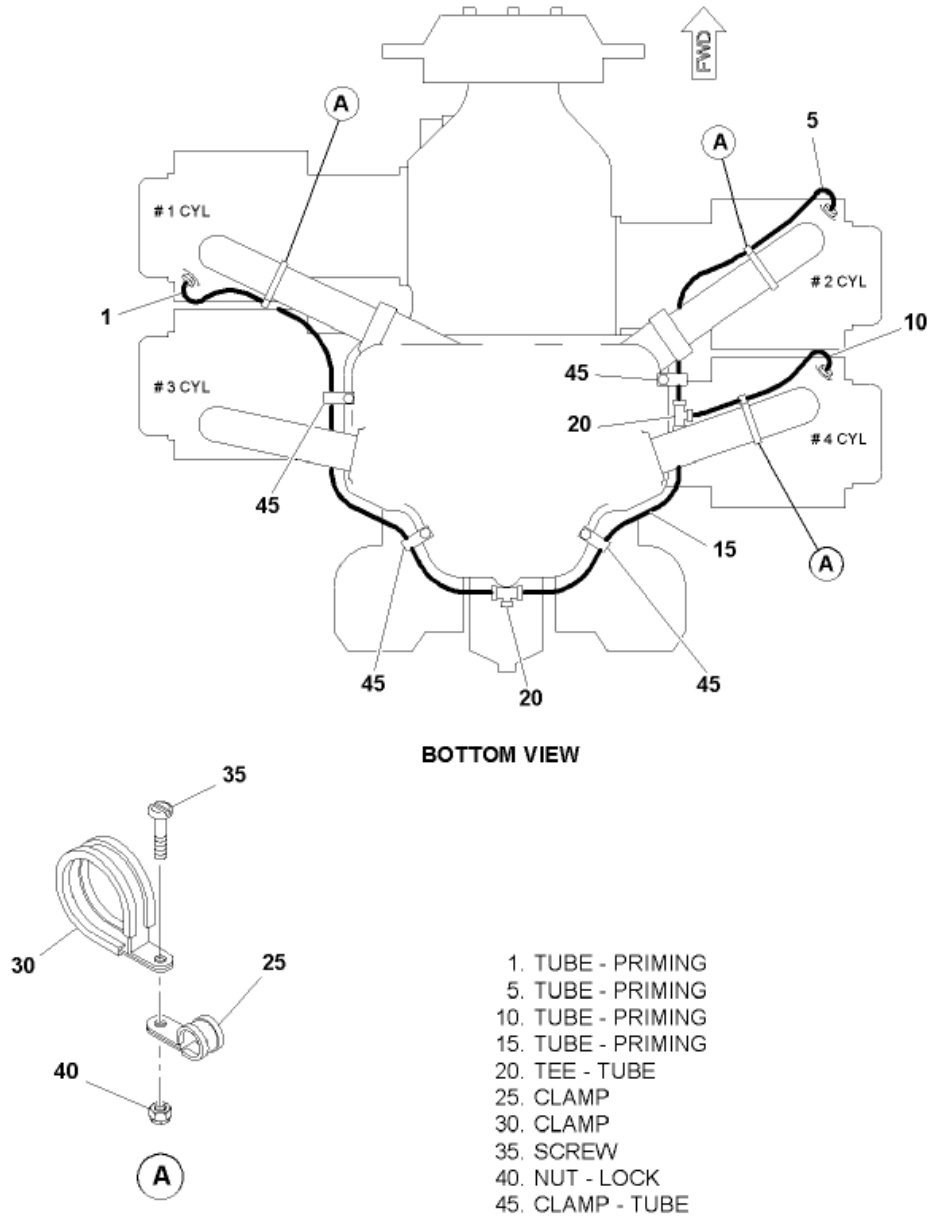
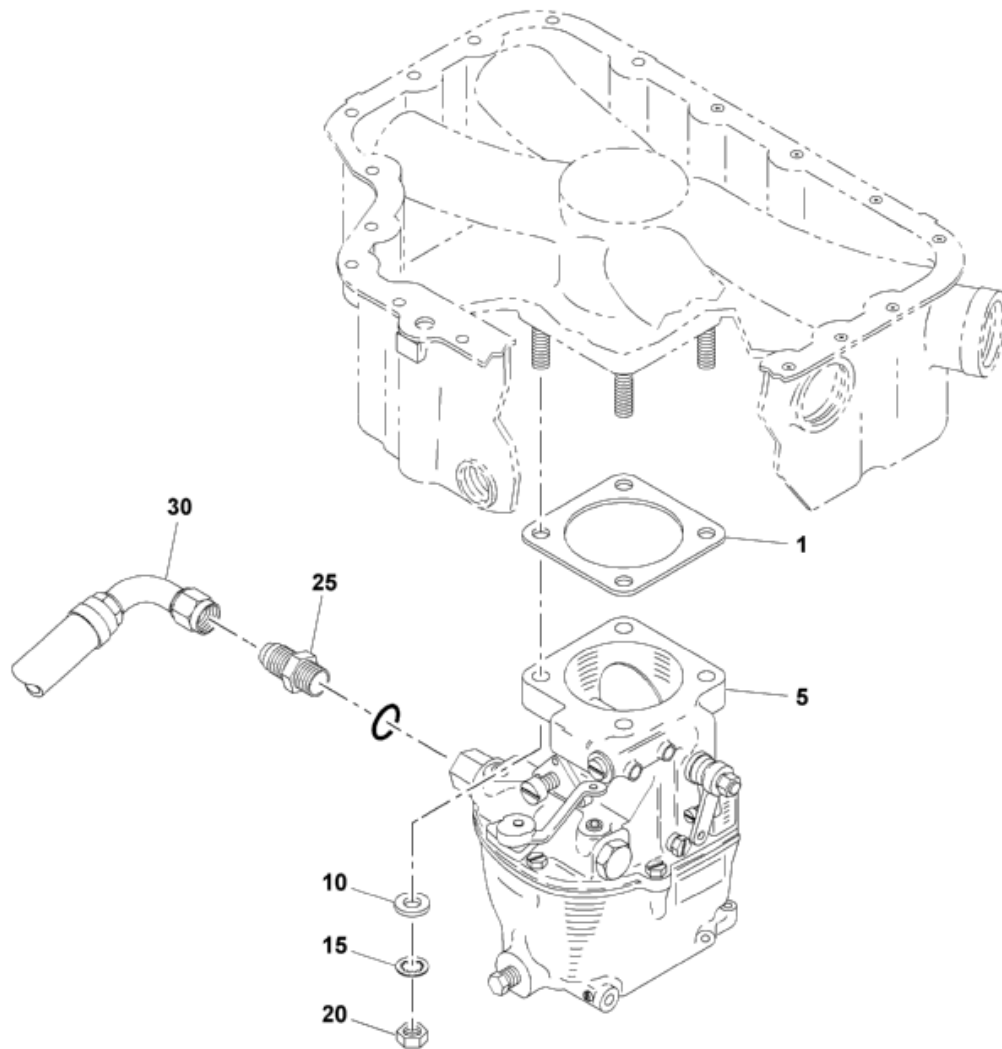


Figure 72-00-09.36 • Fuel Priming System

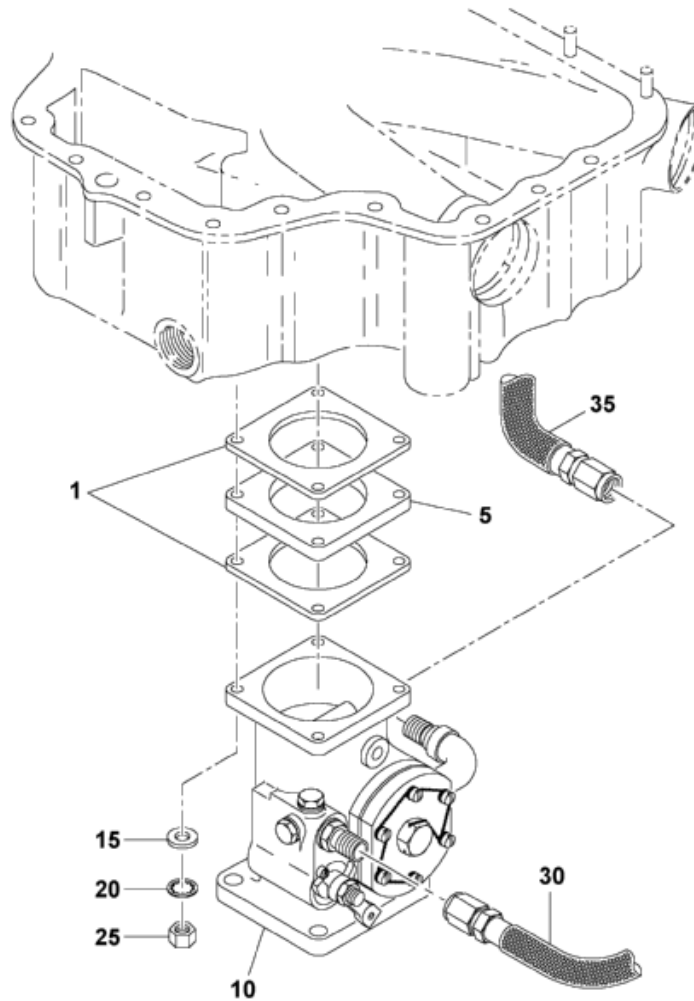
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- 1. GASKET
- 5. CARBURETOR
- 10. WASHER - PLAIN
- 15. WASHER - LOCK
- 20. NUT - PLAIN
- 25. FITTING
- 30. HOSE ASSEMBLY - FUEL

Figure 72-00-09.37 • Carburetor Installation

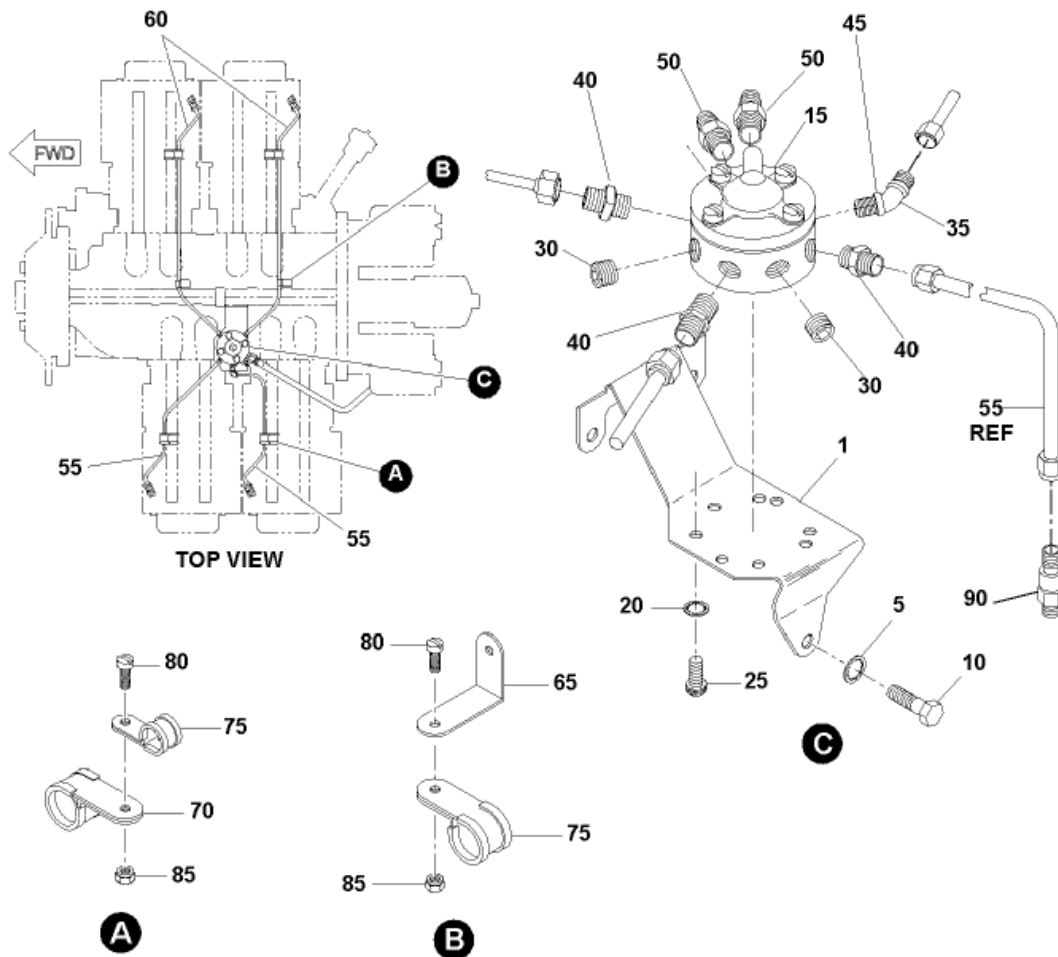
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- 1. GASKET
- 5. SPACER
- 10. THROTTLE BODY - FUEL INJECTION SERVO
- 15. WASHER - FLAT
- 20. WASHER - LOCK
- 25. NUT - PLAIN
- 30. HOSE ASSY
- 35. HOSE ASSY

Figure 72-00-09.38 • Fuel Injection Servo Installation

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- | | |
|-----------------------|-----------------------|
| 1. BRACKET - MANIFOLD | 50. NIPPLE |
| 5. WASHER - LOCK | 55. TUBING - INJECTOR |
| 10. BOLT | 60. TUBING - INJECTOR |
| 15. DIVIDER - FLOW | 65. BRACKET |
| 20. WASHER - LOCK | 70. CLAMP |
| 25. SCREW | 75. CLAMP |
| 30. PLUG | 80. SCREW |
| 35. ELBOW - TUBE | 85. NUT - LOCK |
| 40. FITTING | 90. NOZZLE ASSEMBLY |
| 45. FITTING - 45 | |

Figure 72-00-09.39 • Fuel Injection Manifold Installation

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NOTE: While rotating the magneto shaft backwards with alignment pin in hole, if the shaft stops turning due to internal interference against the alignment pin prior to pin seating, pull pin out just far enough to allow the shaft to continue to rotate. Re-insert the pin and continue rotation until the pin seats as previously described. This procedure locates the magneto at the No.1 cylinder firing position.

- (8) Repeat for the 2nd magneto's alignment.
- (9) Bring the engine to the compression stroke on the No. 1 cylinder.
- (10) Rotate engine to approx. 25° before top dead center using a timing indicator installed in a spark plug hole of the No. 1 cylinder or equivalent method.

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- (11) Apply pre-lube oil to the idler gear teeth and magneto drive gear teeth (35) and apply light coat of Dow Corning™ #4 or Fuelube™, per Appendix B section 3.0, to the magneto gasket (10). Install each magneto with the clamp (20), lock washers (25), and nut (30). Tighten moderately.

NOTE: Magnetos must be able to move for final timing. This will be accomplished later with the engine horizontal, disconnected from nose stand, and with the ring gear and starter installed.

WARNING: DO NOT ROTATE ENGINE OR CRANKSHAFT BEFORE REMOVAL OF TIMING LOCATOR PINS.

- (12) Remove the timing locator pins from the magnetos (15) and install the harness. Ensure correct harness locations. Align the harness cover caps properly. Secure with the screws removed from the cap removal.

Starter Installation

- (1) Verify the starter part number.
- (2) Install the starter IAW the starter manufacturer's installation instructions. Tighten the bolt and nuts per the Table of Limits Appendix C of this manual.

Alternator Installation (if furnished)

- (1) Verify the alternator part number is correct.
- (2) Install pulley, as required, to alternator IAW manufacturer's installation instructions.
- (3) Attach mounting bracket (55, Figure 72-00-09.43) to engine with bolts (60) and lock plate (50) and tighten until snug (finger tight).
- (4) Attach alternator to mounting bracket (55) using drilled shank bolts (25, 30) with shim washers (35) and hardware as required for alternator pulley/belt alignment to starter ring gear assembly.
- (5) Attach strut support (80) to alternator bracket in forward location using bolt (25).
- (6) Install adjusting link (65) to crankcase and alternator with drilled head bolts (75, 10). Use single washer (70) at the crankcase attach point and two (2) washers (5) at slotted alternator attach point for strength.

NOTE: Leave all attach hardware snug or finger tight as required to allow for alignment and belt tension adjustment.

- (7) Install alternator belt (not shown) to starter ring gear assembly and install starter ring gear assembly to crankshaft flange. Reference SVMM01, Maintenance Manual. A "slave" bolt may be used to temporarily hold starter

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ring gear assembly in place if propeller and spinner are to be installed later.

- (8) Install new belt to alternator pulley and adjust alternator and/or brackets to achieve proper alignment.
- (9) Adjust belt tension to allow a midspan deflection per the Table of Limits Appendix C of this manual.

NOTE: An alternate method of checking belt tension is to measure the torque required to slip the belt at the small alternator pulley. A new belt is properly tensioned when alternate value per the Table of Limits Appendix C is required to cause it to slip.

- (10) Torque and safety the 3/8-24 slotted nuts (40) per SSD001.
- (11) Torque and safety all other attaching hardware in accordance with values listed in the Table of Limits Appendix C section of this manual.

Engine Removal

- (1) Remove the engine from nose stand and place horizontal on transfer cart.

Final Magneto Timing and Adjustment

NOTE: Magneto assembly to the engine is outlined in the accessory installation instructions of this section.

- (1) Install the ring gear to the crankshaft propeller flange and retain with one slave bolt.
- (2) Rotate the crankshaft, using ring gear, to compression stroke of number one cylinder.

NOTE: It may be necessary to rotate the crankshaft just beyond top dead center to allow the magneto impulse couplings to release. Upon release of the couplings, rotate the crankshaft back in the opposite direction, to correct timing degree mark.

- (3) Align the correct timing mark on the ring gear with the mark on the starter housing. See Figure 72-00-09.41.
- (4) Attach the timing indicator leads of the magneto synchronizer (timing box) to the magneto P-lead connections and ground lead to an appropriate ground.
- (5) Rotate or adjust the magnetos until each magneto synchronizer lights indicate that the magneto points are just opening.
- (6) Snug the magneto nut (30, Figure 72-00-09.40) and rotate the crankshaft back a few degrees before the correct timing. Slowly rotate the crankshaft in the direction of rotation until the timing lights simultaneously indicate the magneto points are just opening.
- (7) Repeat the process above for minor adjustments as needed to achieve the correct timing.
- (8) Torque the magneto nut (30) per the Table of Limits appendix C of this manual.
- (9) Remove the timing indicator leads of the magneto synchronizer from the magneto P-lead connections and ground lead.
- (10) Install the spark plugs into the top and bottom spark plug ports of each cylinder. Torque per Table of Limits Appendix C of this manual. Reference SVMM01, Maintenance Manual.
- (11) Attach the harness leads. Refer to wiring diagram Figure 02-00-00.10. Secure to each spark plug.
- (12) Install the clamps provided with the harness kit to prevent wire chafing.

NOTE: Assembly steps 10, 11 and 12 above may be replaced by assembly of dehydrator plugs if the engine will be stored prior to engine test. In this event, spark plug leads should be neatly coiled and stowed with the clamps for later assembly.

Storage After Assembly

If not immediately proceeding to engine testing section, preserve the engine for storage per instructions in the Preservation and Storage section of this manual.

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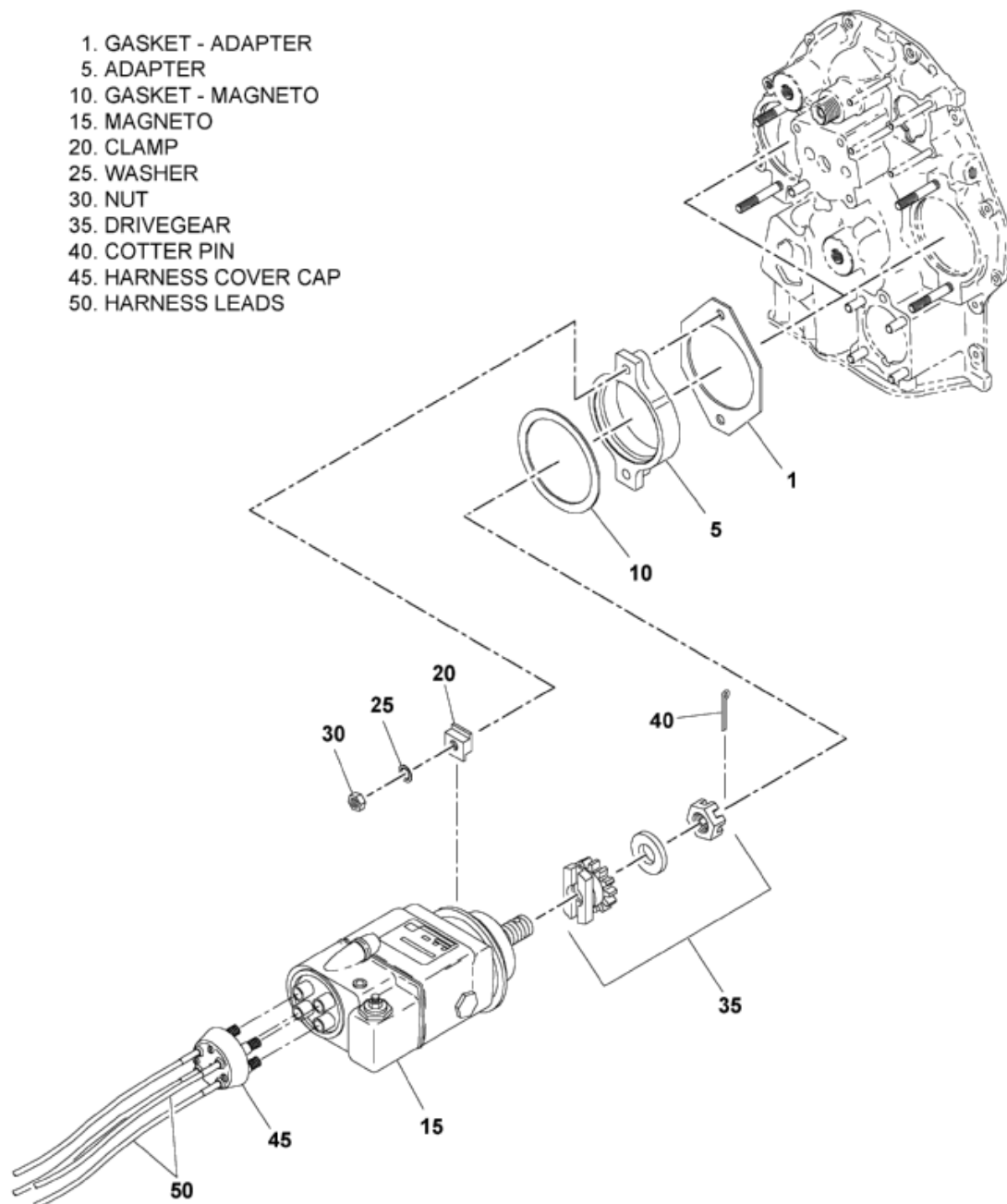


Figure 72-00-09.40 • Magneto and Adapter Installation

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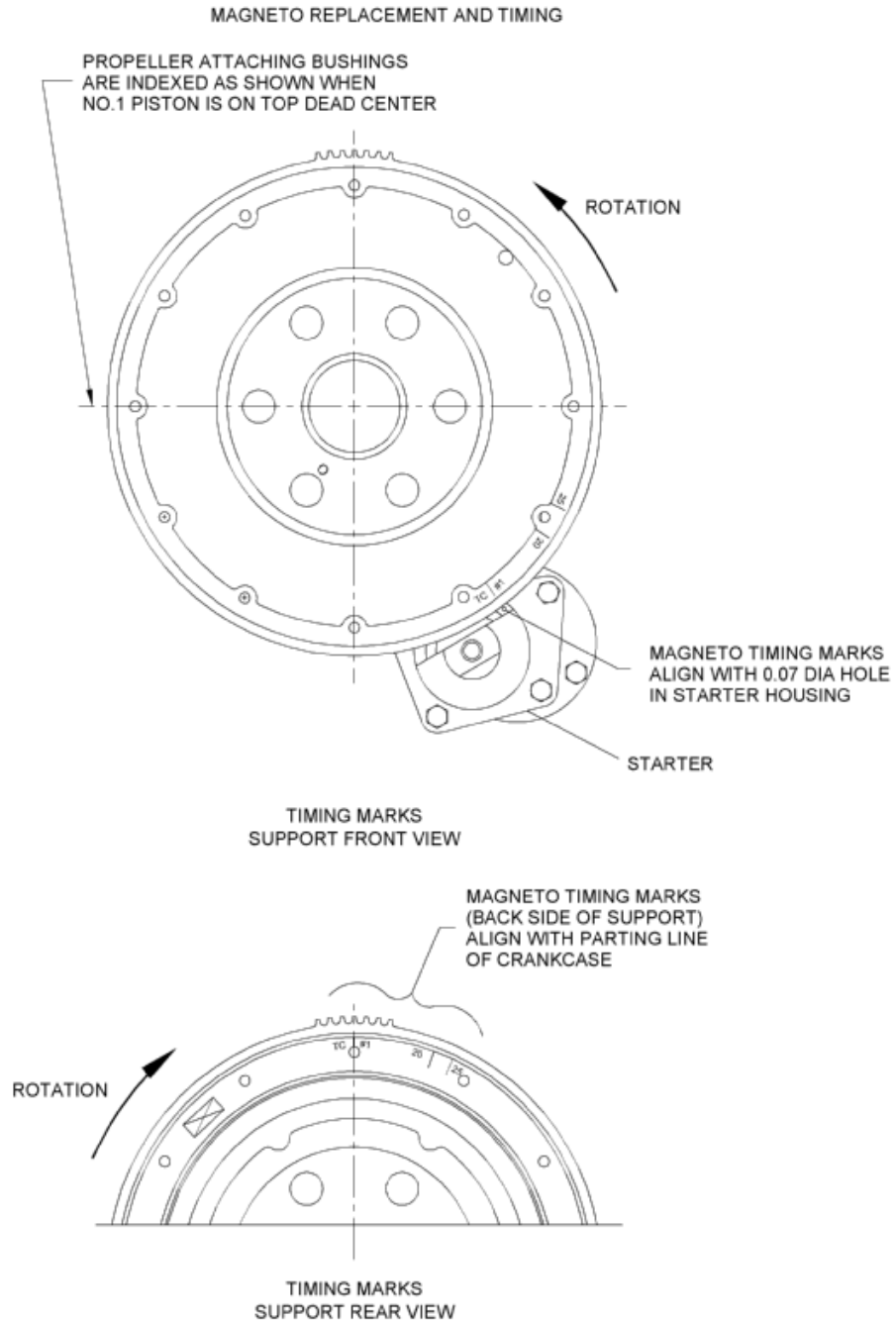


Figure 72-00-09.41 • Starter Ring Gear Alignment

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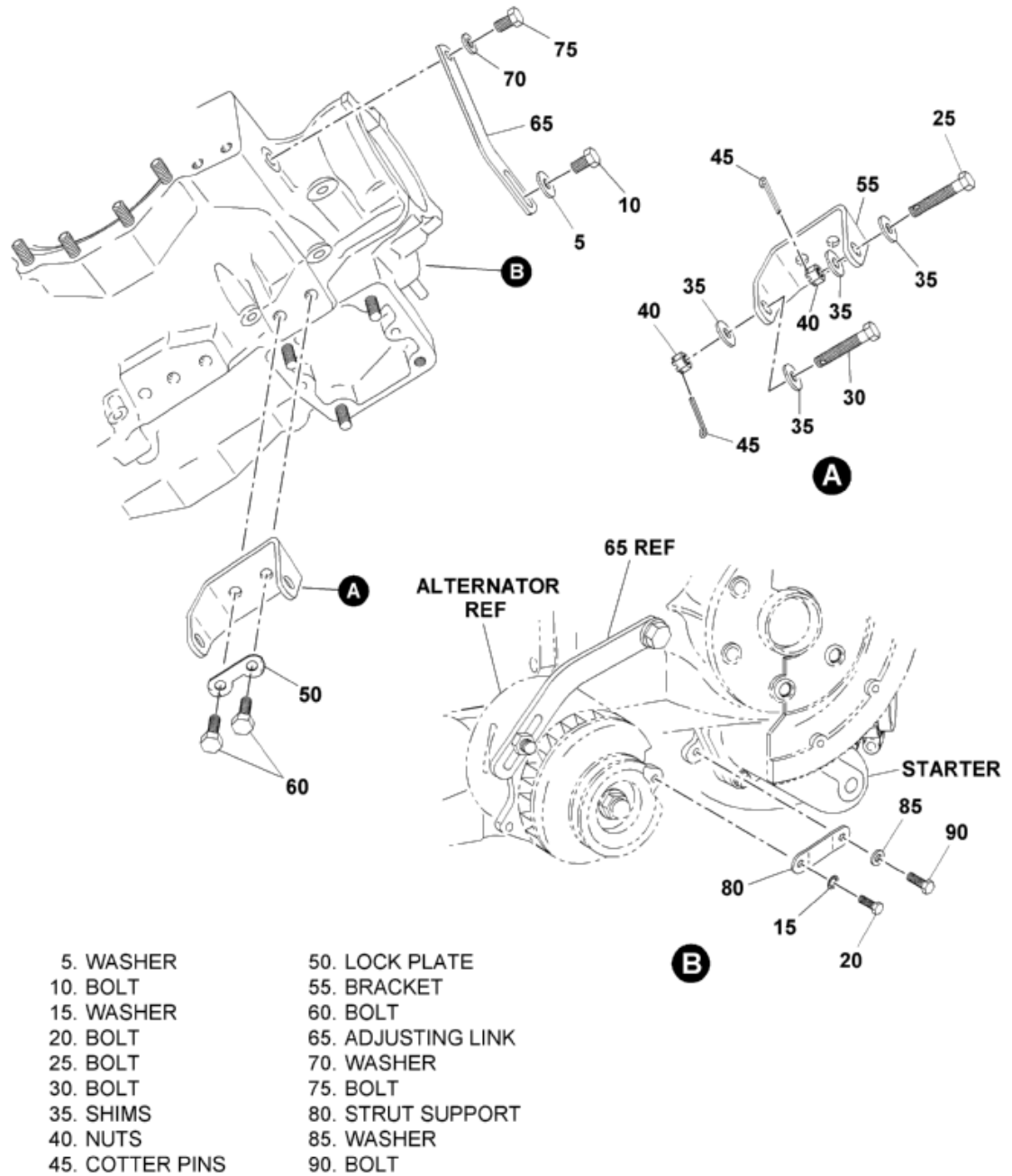


Figure 72-00-09.43 • Alternator Installation

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ENGINE INSTALLATION

General

Due to the complexity and variation in aircraft design, instructions for the installation of the engine in the airframe are not provided here. The airframe Maintenance Manual instructions for engine installation must always be closely adhered to, in order to avoid damage to the engine and aircraft and injury to personnel. Refer to Superior Vantage Installation and Operation Manual No. SVIOM01 for additional information.

PRESERVATION AND STORAGE

General

This section provides preservation instructions for the engine after overhaul and prior to installation in the aircraft and is suitable for temporary storage. For preservation of the engine for long term storage or on the aircraft, refer to the Superior Vantage Maintenance Manual No. SVMM01.

NOTE: Corrosion may reduce engine service life. Primary wear concerns are cylinders, piston rings, camshaft and lifters.

WARNING: HOT OIL MAY CAUSE BURNS TO EYES AND SKIN. PUT ON SPLASH GOGGLES AND INSULATED GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

WARNING: ENGINE OIL IS HAZARDOUS AND MAY CAUSE INJURY TO SKIN AND EYES. PUT ON PERSONNEL PROTECTIVE GEAR.

Table 72-00-11.1 • Storage Materials

NOMENCLATURE	VENDOR
Preservative Oil MIL-L-46002, Grade 1, or equivalent	Commercially Available
Cortec VpCI-326 Preservative Oil Concentrate, or equivalent	Cortec Corp. 4119 White Bear Pkwy St. Paul, MN 55510 612-429-1100
Dehydrator plugs, AN4062-1 or MS27215-2	Commercially Available
Covers, as required	Commercially Available
Moisture Resistant Caps	Commercially Available
Moisture Resistant Tape	Commercially Available

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Temporary Preservation

The following preservation procedure should follow acceptance testing as soon as possible if the engine is not to be immediately installed in the aircraft and operated.

- Remove oil sump drain plug and drain oil, preferably while engine is still warm. Replace drain plug, torque and safety. Remove oil filter used for testing if not already accomplished. Install new oil filter, torque and safety.
- Remove all spark plug leads and remove the top spark plugs. Protect the ignition lead ends with AN-4060 protectors or equivalent. Rotate crankshaft so that all pistons are at approximately mid stroke. Using a common garden sprayer or equivalent, spray approximately 2-3 ounces of atomized preservative oil MIL-P-46002 Grade I, or Cortec VpCI-326, at room temperature through the upper spark plug hole of each cylinder.
- Remove carburetor or fuel injection servo, drain all fuel from system and lines and cap lines. Spray 1-2 ounces of preservative into the intake port, as described above. Insert desiccant bag in intake port. Attach a red "Remove Before Flight" streamer to each bag of desiccant and seal the openings.
- Re-pack the carburetor or fuel injection servo in the manufacturer's packaging to avoid damage and contamination.
- Install dehydrator plugs in top spark plug holes. Make sure each plug is blue in color when installed. Install caps in bottom spark plug holes
- Seal all engine openings exposed to the atmosphere using suitable plugs and covers.
- Identify using red tag with tie wire, on the propeller flange, with the following notation on the tag, : "Do Not Turn Crankshaft – Engine Preserved – (Preservation Date)"

NOTE: If the engine is not returned to flyable status on or before the 90 day expiration it must be preserved in accordance with "Indefinite Storage" procedures.

Returning an Engine to Aircraft Service After Storage

- Remove all seals and all desiccant bags.
- Remove cylinder dehydrators and plugs from lower spark plug holes.
- Rotate crankshaft by hand for several revolutions to remove preservative oil.
- Remove oil sump drain plug and drain the corrosion preventive oil mixture. Replace drain plug, torque and safety. Temporarily replace the cylinder dehydrators to prevent contamination of the cylinders. Allow any preservative oil to drain away that is in the intake port. Wipe away any excess oil.
- The engine is now ready to install on the aircraft in compliance with Superior Vantage Installation and Operation Manual, No. SVIOM01 and the specific aircraft Maintenance Manual instructions.

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REPAIR

General

The following sections contain Minor repair procedures required to return the Superior Vantage O-360 and IO-360 series engine to serviceable condition. Replace all parts that do not meet requirements after repair. A list of repairs is provided in Table 72-00-12.1.

- Materials required for repair are listed in Table 72-00-12.2.
- Equipment used for repair is listed in Table 72-00-12.3.
- Codes used for repair are listed in Table 72-00-12.4
- Symbols used for repair are listed in Table 72-00-12.5

Repair Procedures

Perform repair procedures as listed in Table 72-00-12.1 when components do not meet requirements specified in the Inspection and Check section of this manual.

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Table 72-00-12.1 • List of Repairs

Repair Procedure	Title	Description
Repair No.1	Threaded area repair and stud replacement	Repairs threaded areas and replaces studs and threaded inserts.
Repair No.2	Nick and scratch repair	Blends nicks, scratches in mounting/mating flanges and other flat surfaces.
Repair No.3	Crankshaft or crankpin repair	Repairs crankshaft or crankpin bearing journals.
Repair No.4	Crankshaft counterbored gear mounting surface	Repairs the gear mounting surface. Contact Superior Air Parts for Approved Repair Station.
Repair No.5	Painted parts	Paints parts stripped during degreasing or inspection procedures.
Repair No.6	Crankshaft oil seal surface	Reconditions the oil seal area at the prop flange surface.
Repair No.7	Crankshaft flange	Allows grinding of the flange area to reduce distortion. Contact Superior Air Parts for Approved Repair Station.
Repair No.8	Crankshaft forward counterbore	Polishes and re-plates pilot diameter of crankshaft forward end. Contact Superior Air Parts for Approved Repair Station.
Repair No.9	Cylinder interior surface	Hones glazed interior surfaces of hardened cylinders.
Repair No.10	Cylinder head cooling fins	Repairs nicks, chips, cracks
Repair No.11	Valve, valve seat, and valve guide	Reseats, polishes, re-faces valves and adjoining parts.
Repair No.12	Spark plug threaded insert	Replaces the spark plug threaded insert.
Repair No.13	Rocker bushing replacement	Replaces the bushing in intake and exhaust rockers.
Repair No.14	Connecting Rod bushing replacement	Replaces the bushing in small end of the connecting rod.

NOTE: Repair Nos. 4, 7 and 8 must be accomplished by an Approved FAA Repair Station. Contact Superior Air Parts for approved sources at 866-845-7624.

Table 72-00-12.2 • List of Materials

Material	Source
Dress wheel (polishing)	Commercially Available
Thread lubricant	Commercially Available
Loctite™	Commercially Available
Abrasive (crocus) cloth	Commercially Available

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Zinc chromate primer (AMS 3110 or equivalent per MIL-P-8585)	Commercially Available
Sodium dichromate	Commercially Available
Enamel paint (AMS 3125C or equivalent per MIL-E-7729)	Commercially Available
Toluene (AMS 3180 or equivalent per TT-T-548)	Commercially Available
Alodine (Mil-C-5541 Class 1A or equivalent)	Commercially Available

Table 72-00-12.3 • List of Equipment

Material	Source
Stud extractor	Commercially Available
Lathe	Commercially Available
Collet grip tool	Commercially Available
Spray gun (paint)	Commercially Available
Carborundum wheel (GA54-J5-V10 or equivalent)	Commercially Available
Hand file	Commercially Available
Reamer set	Commercially Available
Bushing puller kit	Commercially Available
Tap & die set	Commercially Available
Extraction tool for threaded inserts	Commercially Available
Insertion tool for threaded inserts	Commercially Available

Table 72-00-12.4 • List of Repair Codes

Material	Source
M03MP	Main and crankpin journals 0.003 inch undersize
M03M	Main bearing journals 0.003 inch undersize
M03P	Crankpin bearing journals 0.003 inch undersize

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REPAIR NO. 1
THREADED AREA REPAIR AND STUD REPLACEMENT

Repair and Replacement

- (1) Repair defective threaded areas on studs with a suitable die or tap. Small nicks can be removed satisfactorily with files or small, edged stones.
- (2) Replace defective studs with a collet grip tool, or other appropriate tool.
 - (a) If stud is broken and tool cannot be used, drill a hole into the stud to use a pilot bushing. A stud extractor may then be utilized to remove the stud.
 - (b) After defective stud is removed, check hole threads for damage. Repair or reject as required. Also check thread size to determine replacement stud thread size.
 - (c) Use compressed air to clean out shavings prior to installation of new stud.

WARNING: WHEN YOU USE COMPRESSED AIR TO CLEAN OR DRY PARTS, MAKE SURE THAT THE PRESSURE IS NOT MORE THAN 30 PSI. DO NOT DIRECT THE AIRSTREAM AT PERSONNEL OR LIGHT OBJECTS. PUT ON GOGGLES OR A FACE SHIELD TO PROTECT YOUR EYES. IF YOU GET AN EYE INJURY, GET MEDICAL ATTENTION.

WARNING: LUBRICANTS ARE TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. BEFORE YOU USE, READ THE MATERIAL SAFETY DATA SHEET (MSDS) FROM THE MANUFACTURER OR SUPPLIER. USE IN A WELL VENTILATED AREA FREE FROM SPARKS. WEAR PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

- (d) Coat threads of new stud with lubricant or Loctite™ and drive stud to correct depth with suitable stud driver. Torque IAW Table of Limits Appendix C of this manual.

Preservation

Coat threads of repaired threaded areas or studs with lubricant or preservative oil.

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REPAIR NO. 2
NICK AND SCRATCH REPAIR

Repairs

- (1) Using hand file or abrasive (crocus) cloth, remove minor nicks and scratches on mating surfaces of accessory housing, crankcase and accessory assemblies, and mounting flanges or bodies of other components.
- (2) If necessary, lap mating surfaces on a surface plate to remove abnormal damage.
- (3) Clean to remove all abrasive dust and other debris. If lapping was performed, check the part with its mate to assure that the clearances are still within tolerances. Refer to the Table of Limits Appendix C of this manual for limits.

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REPAIR NO. 3
CRANKSHAFT OR CRANKPIN REPAIR

Repairs

Measure crankshaft main and crankpin journals.

- (1) Determine if the components in question are standard or undersize bearing journals. Determine this information prior to beginning any polishing or grinding operation.
- (2) Measure the OD of the crankshaft main and rod bearing journals and compare results to the limits shown in the Table of Limits Appendix C of this manual. If dimensions do not fall within specified limits, the shaft must be brought to undersize.
- (3) Check the crankshaft flange for a code symbol stamped as a suffix to the part number. Possible code symbols are: M03MP (main and crankpin journals 0.003 in. undersize); M03M (main bearing journals 0.003 in. undersize); M03P (crankpin bearing journals 0.003 in. undersize).

If the maximum service limits are exceeded, standard shafts may be polished to 0.003 in. undersize and fitted with 0.003 in. undersize bearing inserts.

CAUTION: DO NOT ALLOW LATHE SPEED TO EXCEED 150 RPM DURING ANY POLISHING OPERATION.

Polish crankshaft or crankpin journals as needed to reestablish proper fits and clearances. Refer to the Table of Limits Appendix C of this manual for size limits.

WARNING: DO NOT DAMAGE THE NITRIDED SURFACES OF THE CRANKSHAFT.

WARNING: IF ONE SURFACE IS POLISHED TO UNDERSIZE, ALL CORRESPONDING SURFACES MUST BE POLISHED TO THE SAME SIZE.

WARNING: USE THE CORRECT PERSONAL PROTECTION. POLISHING WILL CAUSE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.

NOTE: Main bearing surfaces may be polished without affecting crankpin surfaces and likewise, the crankpin bearing surfaces may be polished without affecting the main bearing surfaces.

Inspection After Resurface Procedure

- (1) Upon completion of the polishing procedure, thoroughly clean the part. Buff the surface to a high finish.
- (2) After polishing operation, clean the part and perform a complete magnetic particle inspection of the shaft or pin. If any cracks or checks are found, the part must be rejected.
- (3) Coat the clean surfaces of approved parts with preservative oil and store until ready for reassembly.

WARNING: USE CORRECT PERSONAL PROTECTION. SOME CHEMICAL SOLUTIONS CAN CAUSE SKIN, EYE AND LUNG DAMAGE. FOLLOW THE MANUFACTURER'S INSTRUCTIONS FOR EACH CLEANING SOLUTION.

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REPAIR NO. 5
PAINTED PARTS

Painted Parts Repair

Some parts may have had paint removed from either normal operation or during the cleaning and inspection procedures. The new crankcase and other aluminum cast components have been alodined after machining and prior to any hardware installation per MIL-C-5541, Class 1A.

Parts requiring the use of paint for protection should be painted in accordance with the following recommendations using material from the list of approved materials. See Table 72-00-12.6.

All paint used in these procedures should be sprayed on. If it is necessary to brush the paint on, extreme care must be exercised to prevent excessive accumulation of paint in small corners or void areas of the crankcase.

NOTE: All machined bosses should be masked before painting. Do not paint areas under hold-down nuts or bolt heads where torque is required.

Table 72-00-12.6 • Consumable Materials for Paint Procedures

Material	Source
Resin-type enamel, AMS 3125C or equivalent MIL-E-7729 (such as Randolph Black #303)	Commercially Available
Toluene or equivalent AMS3180 (or equivalent Federal Spec. TT-T-548)	Commercially Available
Zinc chromate primer	Commercially Available

- A. Aluminum and steel parts
 (1) Clean and degrease all parts prior to paint procedures.

WARNING: SOLVENT IS TOXIC. USE IN WELL-VENTILATED AREA. PREVENT EYE AND SKIN CONTACT AND DO NOT BREATHE VAPORS. IN CASE OF EYE CONTACT, FLUSH WITH WATER FOR 15 MINUTES AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.

- (2) Apply one coat zinc chromate primer, thinned with approximately 2 parts toluene, and allow to air dry.

NOTE: Parts from which the paint has not been removed may be repainted without the primer coat.

- (3) Apply one coat of enamel and bake at 250°F for ½ hour. If allowed to air dry, an inferior finish will result.

WARNING: USE THE CORRECT PERSONAL PROTECTION. HEATED PARTS WILL CAUSE BURNS.

- B. Cylinder Barrels
 (1) Thoroughly clean all old paint from the cylinder. A vapor degreaser is well suited for this purpose.
 (2) Superior Air Parts does not recommend painting of cylinder heads for optimum cooling. Only alodine is required for cylinder head surface protection.
 (3) Mask off the cylinder head, plug flange bolt holes and cover cylinder bore.

NOTE: Masking materials may include tape, corks, plugs, foil, metal covers, etc.

- (4) Spray a very light coat of zinc chromate primer (0.0005 in. maximum thickness) on the cylinder flange. A correct thickness of paint will appear green with a yellow tint and allow the metal to show

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through. Paint that is too thick will appear zinc chromate yellow.

CAUTION: THICKNESS OF PRIMER MUST BE NO MORE THAN 0.0005 IN. USE EITHER A TINSLEY THICKNESS GAGE OR A MICROMETER TO MEASURE THE THICKNESS OF THE FLANGE BEFORE AND AFTER PAINTING. IF THE PRIMER IS TOO THICK IT MUST BE REMOVED AND THE BARREL REPAINTED.

- (5) Mask off the flange area around nut seating surface. Paint the cylinder with an enamel resin or equivalent that has been properly thinned with toluene or equivalent.
- (6) Use a cloth wet with thinner to clean paint from any surfaces where overspray paint may have adhered.
- (7) Allow the cylinder to air dry for 15 minutes then bake in an oven until completely dry.

REPAIR NO. 6
CRANKSHAFT OIL SEAL SURFACE

Crankshaft Oil Seal Flange Recondition

- (1) If the crankshaft oil seal surface on the shaft itself is damaged to the point that the oil seal might leak, use the following procedure to recondition this area.

WARNING: DO NOT DAMAGE THE NITRIDED SURFACES OF THE CRANKSHAFT.

- (2) Use crocus cloth to polish the oil seal area of the shaft while the shaft is rotated counterclockwise (viewed from the front or flange end of the shaft). To

prevent the occurrence of spiral marks, do not move the cloth while polishing. The surface roughness of the oil seal area should not exceed 8 microinches Ra. Clean the shaft so that all traces of debris are removed.

Preservation

Coat steel parts with preservative oil per MIL-L-6529.

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REPAIR NO. 9
CYLINDER INTERIOR SURFACE

Cylinder Interior Surface Reconditioning

The Superior Vantage O-360 and IO-360 series engines utilize cylinders constructed of through-hardened steel. These do not include nitride-hardened or chrome plated interior surfaces.

WARNING: USE THE CORRECT PERSONAL PROTECTION. POLISHING AND GRINDING WILL CAUSE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.

CAUTION: DO NOT ALLOW THE HONING WHEEL TO RUN PAST THE BARREL MORE THAN 1/8 IN. INTO THE COMBUSTION CHAMBER.

- 1) Place the cylinder on a honing stand. If the cylinder exceeds allowable service limits in taper, diameter, or out-of-roundness, regrind to 0.010 oversize.
- 2) Recommended equipment information for honing is as follows:
 - (a) Wheel:
 - Friable bond material – 2A; grain size – 54; grade – K; structure – 5 porous; vitrify bond treatment – V92; diameter – 3 ½ to 4 inches.
 - (b) Wheel speed:
 - 3 ½ inch wheel: 5600 to 6000 surface feet per minute.
 - 4 inch wheel: 5350 to 5730 surface feet per minute.
 - (c) Work speed: 250 RPM.

- 3) Oversize allowance is determined by adding 0.004 in. to the barrel diameter at the point of greatest wear. This must not exceed 0.002 in. per wall. Grind the barrel to the oversize above this amount.
- 4) Grind the surface of the steel barrel to 25-35 microinches Ra. This can be obtained by grinding the barrel diameter to within 0.0005 to 0.001 in. of the desired ID with rough-in cuts.
- 5) Redress the wheel and make a finish pass. Allow the wheel to run over the work up to five more times to ensure a proper surface finish.

NOTE: The surface finish must be properly crosshatched along the entire length of the barrel. The crosshatch pattern must be 35°-37° from a line parallel with the cylinder base. Refer to Figure 72-00-12.1.

- 6) If oversizing must occur, the cylinder must be fitted with P010 (.010 in.) oversize pistons and piston rings. These must be used in opposing pairs to maintain the dynamic balance of the engine.

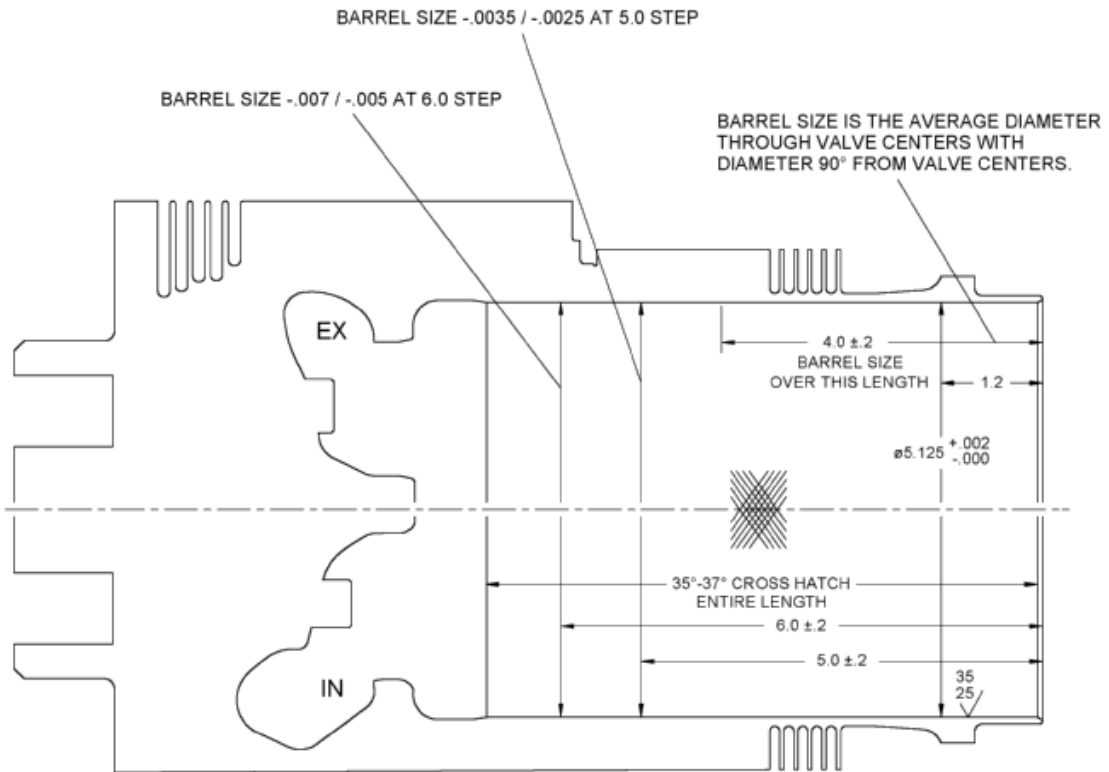


Figure 72-00-12.1 • Cylinder Interior Resurface Crosshatch

REPAIR NO. 10
CYLINDER HEAD COOLING FIN

Cylinder Head Cooling Fin Repair

The Superior Vantage O-360 and IO-360 series engines utilize cylinders constructed of through-hardened steel and heads of cast aluminum. Only the fins on the aluminum head may be repaired. Cooling fins on the steel barrels may **NOT** be repaired by this process.

The cooling fins on these cylinders are finely balanced to provide appropriate cooling to the overall cylinder assembly.

CAUTION: REFER TO THE INSPECTION AND CHECK SECTION OF THIS MANUAL TO DETERMINE DAMAGE LIMITS FOR COOLING FIN ON ANY CYLINDER PRIOR TO REPAIRS.

Perform repairs as follows:

- (1) For cracks in the fin, it is permissible to drill a 0.19 in diameter hole (a stop drill) at the end of the crack provided the crack is at least 0.25 in. from the root of the fin.
- (2) For fins cracked almost all the way across, it is permissible to remove a portion of the fin as follows. Refer to Figure 72-00-12.2.
 - (a) The maximum material removed is no more than ½ the total fin width.
 - (b) No burrs or sharp edges remain.

- (c) The minimum fillet at the root of the removed portion of the fin is 0.25 in. radius. Minimum corner at top of fin adjacent to the removed portion is 0.50 in. radius.
- (3) For damaged, cracked, or broken fins, it is permissible to perform the following repairs:
 - (a) A damaged area may be blended. The blended area for any one fin shall not exceed 0.38 in. square area or 0.38 in. depth.
 - (b) There may be no more than two blended areas on one fin.
 - (c) No more than four blended areas on the pushrod side of the cylinder head. No more than six blended fins on the side opposite the pushrod side of the cylinder head.
- (4) It is recommended that a fluorescent penetrant inspection be performed upon completion of any of these repairs.
 - (a) Pay special attention to the area on exhaust port side of the cylinder.
 - (b) Pay special attention to the area around the lower spark plug counterbore.

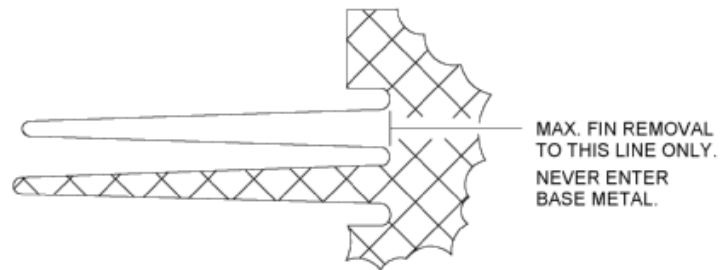


Figure 72-00-13.2 • Cooling Fin Removal Maximum

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REPAIR NO. 11
VALVE, VALVE SEAT, AND VALVE GUIDE

General

Valves and valve guides must be replaced at overhaul. The surfaces of the valves and their seats can normally be resurfaced and reconditioned if the engine is being repaired not overhauled.

Valves must be removed from the cylinder and cleaned of all sludge and carbon build-up prior to repairs. Refer to the Cleaning section of this manual. Refer to the Inspection and Check section of this manual for appropriate inspection procedures and limits on damage and wear.

Valve seat grinding

- (1) The ID of the valve guide is used as a pilot for all valve seat reconditioning operations.

WARNING: USE THE CORRECT PERSONAL PROTECTION. POLISHING AND GRINDING WILL CAUSE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.

- (2) Grind valve seats with suitable grinding equipment to a 30° angle on intake valve seats and a 45° angle on exhaust valve seats. Grind valve seats to 16 RA max. (ref) concentric to guide bore within 0.002 in.
 - (a) On intake valve seats, use a 15° grinding wheel to grind the top surfaces of the valve seat to produce the outer face diameter. Bring the face of the intake valve seats to the specified width (Dimension "B") by narrowing the throat with a 75° wheel. Refer to Figure 72-00-12.3.
 - (b) On exhaust valve seats, use a 15° grinding wheel to grind the top surface of the valve seats to produce the outer face diameter. The width of the exhaust valve seats should conform to dimension "D". Refer to Figure 72-00-12.3.
 - (c) If the seat wear has progressed to the extent that the entire face of the 15° narrowing wheel must be brought into contact with the seat in

order to achieve the specified diameter, the seat must be replaced.

Valve seat replacement

- (3) Valve seats that are damaged, worn, or loose must be replaced. Use the following procedure or an equivalent.

NOTE: The valve guide must be replaced at the same time as a valve seat is replaced. This ensures concentric grinding of the valve seat. See discussions later in this Repair for guide replacement procedures.

NOTE: For the purpose of removing valve seats, a tool may be fabricated from threaded bar stock, hardware and sponge material.

NOTE: The valve seats are an interference fit installation. The cylinder must be heated and the valve seat cooled. The resulting difference in size will allow the seat to be removed from the cylinder head.

WARNING: USE THE CORRECT PERSONAL PROTECTION. HEATED PARTS WILL CAUSE BURNS.

- (4) Heat the cylinder to 575°F (302°C) and secure to a fixture.
- (5) Soak the removal tool sponge in cold (refrigerated) water. Insert the tool through the valve seat. The seat should shrink slightly and stick to the sponge. Pull the tool back out with the seat. Use care to not tilt the seat during this process.

NOTE: This procedure must be performed as quickly as possible.

- (6) Measure the ID of the valve seat recess to determine which oversize seat must be installed. Refer to Tables in section 9.0 and 10.0 of the Table of Limits Appendix C of this manual.

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WARNING: USE THE CORRECT PERSONAL PROTECTION. POLISHING AND GRINDING WILL CAUSE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.

- (7) Use an appropriately sized cutter installed with its pilot and drive on a drill press. Cut the recess in the cylinder head to proper oversize. Remove no more metal than required to clean the major diameter of the seat recess.

NOTE: The cutter pilot shall engage the ID of the valve guide hole in the cylinder head.

- (8) Place the new valve seat onto a replacement drift.

WARNING: USE THE CORRECT PERSONAL PROTECTION. HEATED PARTS WILL CAUSE BURNS.

- (9) Heat the cylinder to 575°F (302°C) and secure to a fixture. Place the new seat on a replacement drift. Drive the new seat into the recess by tapping the drift with a hammer.
- (10) Grind the face of the new seat as described above in this Section.

Valve guide replacement

- (1) Remove valve guides as follows:
 - (a) Use a valve guide puller to the head of a ¾-16 bolt. Place the tool retainer over the valve guide inside the rocker box. Insert the ¾-16 bolt into the retainer and valve guide. From inside the cylinder, insert the 3/8-24 bolt into the end of the larger ¾ bolt. Tighten the 3/8 bolt until it is against the valve guide. Turn the nut in the rocker box clockwise until

the valve guide is out of the cylinder head.

- (2) Install valve guides as follows:
 - (a) Prior to installation of a new valve guide, measure the guide hole to determine if an oversize guide must be used. Refer to section 11.0 and 12.0 of the Table of Limits Appendix C of this manual. Use a hole plug gage and measure each valve guide hole. Determine if a standard size or oversize guide must be used. Refer to the Table of limits section 11.0 and 12.0.
 - (b) Fasten the cylinder in place on a guide replacement tool. Set the tool to the appropriate angle for the guide being installed.
 - (c) If an oversize guide must be installed, use an appropriate size reamer in a drill press. Ream the valve guide hole to the specified size. Measure the hole again and confirm proper size.
 - (d) Heat the cylinder to between 350°F-425°F (176°-218°C) for a minimum of 1 hour. Position the new guide onto the end of a valve guide installation drift and insert the guide in the hole in the cylinder head.
 - (e) Drive the guide into the hole with firm hammer blows on the end of the drift.

WARNING: USE THE CORRECT PERSONAL PROTECTION. USE OF A HAMMER CAN CAUSE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.

- (f) Allow the cylinder to cool. Ream the valve guide with an appropriate ID reamer. Check the finished ID with a hole plug gage.

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Intake valve face grinding

CAUTION: DO NOT ATTEMPT TO BEND OR STRAIGHTEN THE VALVE FACE OR STEM.

NOTE: Intake valves require replacement at overhaul.

- 1) Intake valve faces that have minor pitting or warping may be refaced by grinding.

WARNING: USE THE CORRECT PERSONAL PROTECTION. POLISHING AND GRINDING WILL CAUSE LOOSE PARTICLES THAT CAN GET IN YOUR EYES.

- (a) Set the valve refacing equipment to 30° for intake valves. Use a soft #80 grit wheel to grind only enough of the valve face to remove small pits.
 - (b) Round off any burrs or sharp edges with a polishing stone while the valve is still turning in the refacing equipment.
- 2) After grinding and cleaning, the valve stem may be polished to remove superficial scratches.

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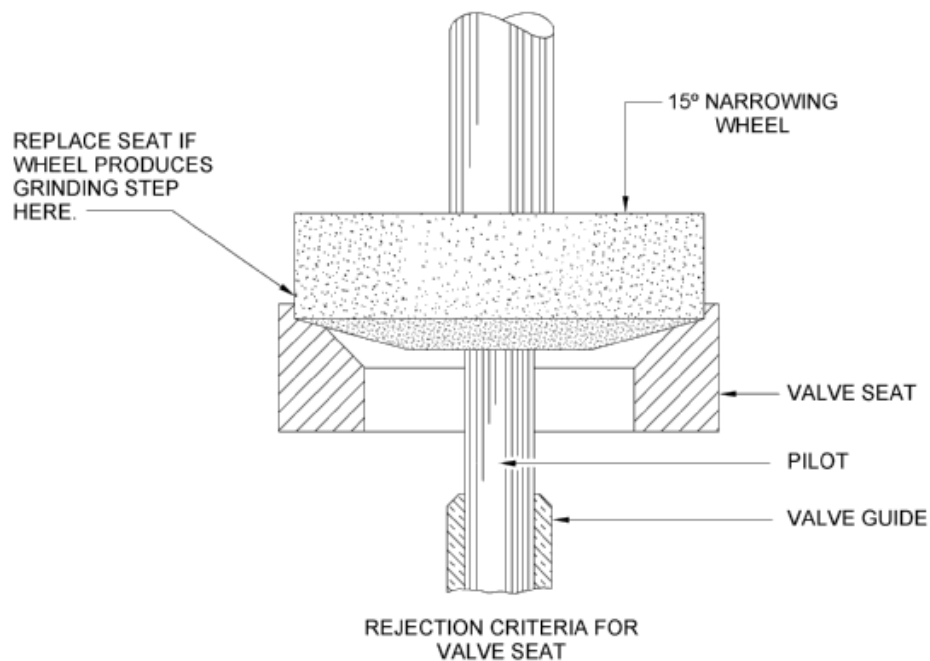
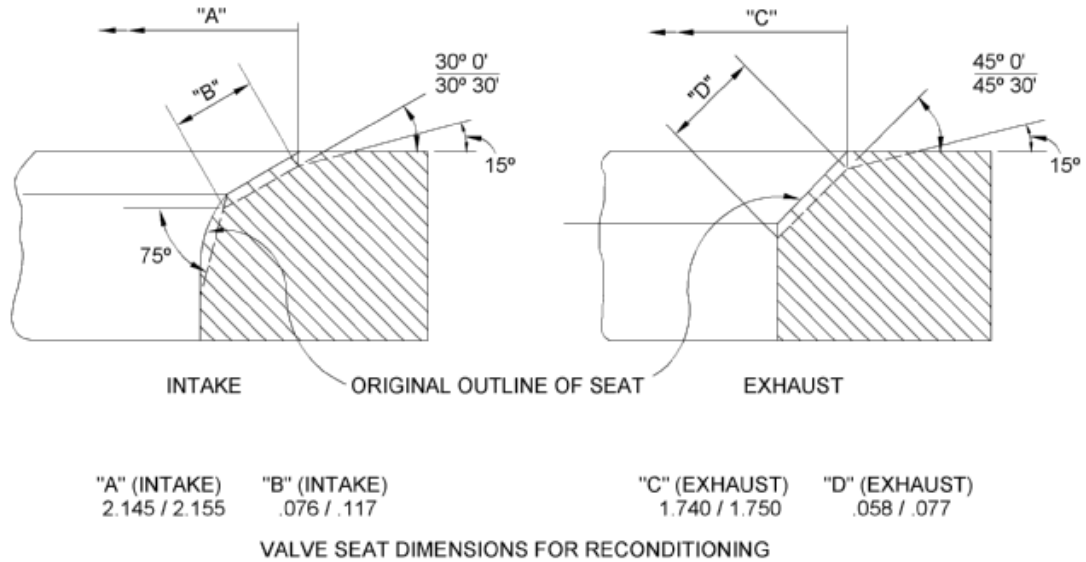


Figure 72-00-12.3 • Valve Seat Dimensions

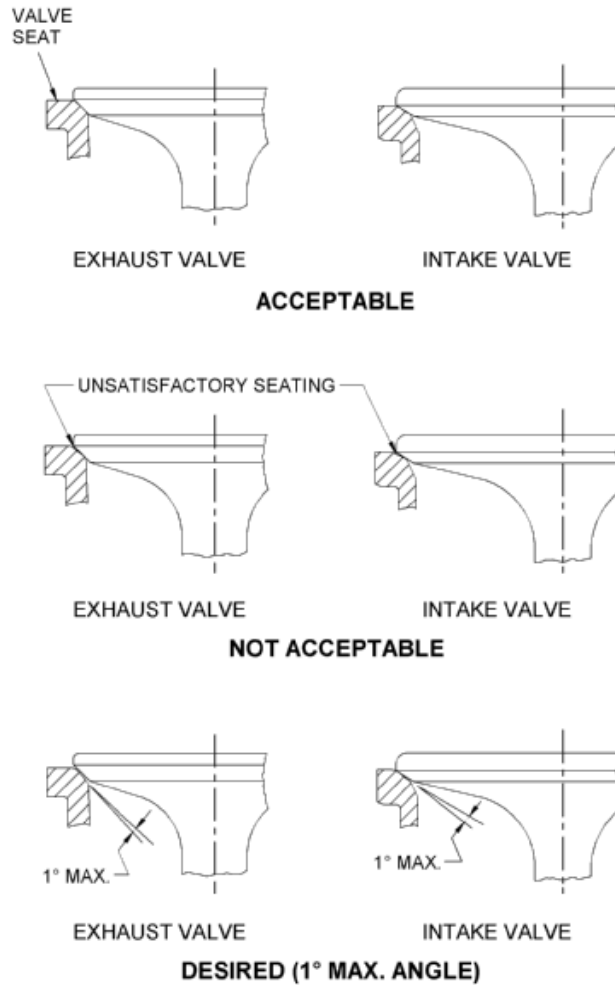


Figure 72-00-12.4 • Valve to Seat Fit Acceptable Criteria

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REPAIR NO. 12
SPARK PLUG THREADED INSERT

Spark Plug Threaded Insert Replacement

Spark plug threaded inserts that were rejected during inspection must be removed and replaced as described in this section. Use an extraction tool to remove the rejected insert as follows:

- (1) Insert the tool in the spark plug hole so that the edges of the tool cut into the top thread of the insert.
- (2) Rotate the tool counterclockwise to unscrew and remove the threaded insert from the hole.

Inspect the condition of the tapped hole after removal of the insert in accordance with the Inspection and Check section of this manual. Assemble the insertion tool with new insert as follows:

- (1) Withdraw the mandrel portion of the tool beyond the recessed section of the sleeve. Place insert into the recess area.
- (2) Allow the mandrel to advance to engage its slotted end with the tang of the insert.
- (3) Rotate the mandrel clockwise and press slightly. This engages the insert in the threaded end of the sleeve.
- (4) Continue to rotate the mandrel while holding the sleeve. This secures the insert firmly on the insertion tool.
- (5) Wind the insert through the threaded portion of the tool sleeve to within one-half turn of the end of the coil.
- (6) Keep the insert tight on the tool to prevent unwinding and facilitate the installation of the insert. Wind the insert so that the adjacent turns of the insert are in contact with each other. This eliminates the possibility of crossed threads.

- (7) Screw the insert into the hole.
 - (a) Be sure that the first coil of the insert picks up the first thread of the hole. As the tool is turned, the insert will advance into the hole.
 - (b) When the face of the sleeve is approximately 0.13 in. from the face of the boss, the inserting tool should be held tightly by the handle. The sleeve must be rotated counterclockwise which will free the left half turn of the insert.
 - (c) Slide the sleeve toward the top of the mandrel and check that the top of the insert projects above the boss.
 - (d) Rotate the mandrel until the insert disappears from sight. Stop the turning action and remove the tool.
 - (e) The top of the insert should be one half turn from the face of the boss and the tang end should not protrude into the combustion chamber.
- (8) Set the insert as follows:
 - (a) Break off the tang of the insert at the location of the notch.
 - (b) Use an expander tool to secure the insert in the plug hole. Set the limit of expansion by fixing the stop nut on the expanding tool at the correct position.
 - (c) Assemble a staking sleeve over the mandrel until the sleeve meets the boss. Stake the insert by striking the top of the sleeve a light blow with a hammer. This will create a slight chamfered edge around the edge of the tapped hole.
 - (d) Remove the staking sleeve, release the adjusting screw, and remove the expanding mandrel from the insert.

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REPAIR NO. 13
ROCKER ARM BUSHING REPLACEMENT

Rocker Arm Bushing Replacement

Rocker bushings that were rejected during inspection must be removed and replaced as described in this section.

Use an arbor press and an extraction/insertion tool (piloted shoulder press tool) to remove the rejected bushing as follows:

- (1) Support the rocker arm on the base of the arbor press such that the center bore of the rocker arm is directly supported and the bushing can be freely pressed from the rocker arm.

NOTE: Avoid supporting the rocker arm in such a way that bending loads are placed on the rocker arms in order to prevent damage to the rocker arms.

- (2) Insert the tool in the rocker arm bushing so that the shoulder of the tool rests on the edge face of the bushing and is clear of the ID of the rocker bore
- (3) Press out the rocker arm bushing.
- (4) Clean rocker arm bore and oil holes thoroughly as described in the Cleaning section of this manual and inspect the condition of the rocker arm bore. Repair scratches as required per the Cleaning section of this manual.

Assemble a new rocker arm bushing using the arbor press and extraction/insertion tool described above as follows:

- (1) Support the rocker arm on the base of the arbor press such that the center bore of the rocker is directly supported.

NOTE: Avoid supporting the rocker arm in such a way that bending loads are placed on the rocker arms in order to prevent damage to the rocker arm.

- (2) Rotate to align the bushing so that the lubrication hole is aligned with the oil hole on the pushrod side of the rocker arm bore.
- (3) Insert the tool in the rocker arm bushing so that the shoulder of the tool rests on the edge face of the bushing and is clear of the ID of the rocker arm bore
- (4) Insert rocker arm bushing until the lubrication hole of the bushing is centered on the oil hole on the pushrod side of the rocker arm bore and the bushing is flush with the sides of the rocker arm.
- (5) Ream or hone the bushing ID to size per the Table of Limits.

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REPAIR NO. 14
CONNECTING ROD BUSHING REPLACEMENT

Connecting Rod Bushing Replacement

Connecting Rod bushings (small end) that were rejected during inspection must be removed and replaced as described in this section.

Use an arbor press and an extraction/insertion tool (piloted shoulder press tool) to remove the rejected bushing as follows:

- (1) Support the connecting rod on the base of the arbor press such that the small end bushing bore of the connecting rod is directly supported and the bushing can be freely pressed from the connecting rod.

NOTE: Avoid supporting the connecting rod in such a way that bending loads are placed on the length of the connecting rod in order to prevent damage to the connecting rod.

- (2) Insert the tool in the connecting rod small end bushing so that the shoulder of the tool rests on the edge face of the bushing and is clear of the ID of the connecting rod bore
- (3) Press out connecting rod bushing.
- (4) Clean connecting rod thoroughly as described in the Cleaning section of this manual and inspect the condition of the connecting rod bushing bore. Repair scratches as required per the Cleaning section of this manual.

Assemble a new connecting rod bushing using the arbor press and extraction/insertion tool described above as follows:

- (1) Support the connecting rod on the base of the arbor press such that the connecting rod bushing bore is directly supported.

NOTE: Avoid supporting the connecting rod in such a way that bending loads are placed on the length of the connecting rod in order to prevent damage to the connecting rod.

- (2) Insert the tool in the bushing so that the shoulder of the tool rests on the edge face of the bushing and is clear of the ID of the connecting rod bore
- (3) Insert bushing until the bushing is centered within the bore of the connecting rod and bushing is flush with the sides of the connecting rod.
- (4) Broach the bushing ID to size per SSD001 section 4.0 part 4.

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POST OVERHAUL ACCEPTANCE TESTING

General

This section defines the testing that each Superior Vantage O-360 and IO-360 series engine must undergo to determine its acceptability after assembly/overhaul. It is preferred that acceptance testing be accomplished in an appropriate aircraft engine test cell. However, testing after installation in the aircraft is an acceptable alternative. The Fault Isolation/Trouble Shooting section of the Superior Vantage Maintenance Manual, No. SVMM01, should be consulted as required.

NOTE: Refer to the Disassembly/Assembly sections of this manual for replacement of defective components.

Special Tools and Equipment

Standard aviation shop tools and equipment are required.

Engine Installation and Testing Procedures

NOTE: The order of installation for fuel system hoses, oil hoses, instrumentation wires and connections, fittings, exhaust system components and cooling baffles and shrouds may be changed as deemed appropriate by the installation personnel. This will allow for the flexibility of having more than one person attach and/or remove the engine to and from the test bed as well as aid in the work flow.

- Install slave oil cooler and oil pressure fittings to engine using anti-seize on fitting threads.
- Attach appropriate engine mount to engine with appropriate hardware and isolator mounts.
- Install Test Run oil filter.
- Install oil temperature probe.
- Remove engine assembly from build stand.
- If engine is to be installed on a Dynamometer Stand, ensure that a Hubbard Plug installed in the front of the crankshaft and that the starter ring is properly installed.
- Attach engine and mount assembly to test bed

frame and secure with appropriate locking devices and lock pins.

- Ensure magneto and fuel switches are “OFF”.
- If the engine is configured for constant speed propellers, install temporary Hubbard plug in front of crankshaft, as required, when testing with a fixed pitch prop or test club and remove after test run is completed.
- Install fuel delivery hose from test rig to engine driven fuel pump inlet and primer line, as required, along with engine breather hose.
- Connect oil cooler hoses and oil pressure hose to engine using appropriate “quick connect” ports.
- Install appropriate intake connection/duct to carburetor or servo as required.
- Install exhaust system.
- Install instrumentation:
 - Tachometer
 - Fuel Flow
 - Manifold Pressure
 - Oil Temperature
 - Intake Air Temperature
 - Cylinder Head Temperature (CHT, to all cylinders recommended)
 - Exhaust Gas Temperature (EGT, to all cylinders recommended)
- Verify that magneto switch is in “OFF” position, then install magneto P-leads.
- Attach Operating Control Cables.
 - Throttle cable
 - Mixture cable
 - Propeller cable (if required)
- Install ring gear to crankshaft propeller flange and install test club or attach Dyno drive.
- Rotate ring gear to compression stroke of number one cylinder.

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NOTE: It may be necessary to rotate crankshaft just beyond top dead center to allow magneto impulse couplings to release. Upon release, rotate crankshaft in opposite direction, back to correct timing degree mark.

- Align applicable timing mark on ring gear with mark on starter housing.

WARNING: DO NOT INSTALL THE IGNITION HARNESS "B" NUTS ON THE SPARK PLUGS UNTIL THE PROPELLER INSTALLATION IS COMPLETED. FAILURE TO COMPLY COULD RESULT IN BODILY INJURY WHEN THE PROPELLER IS ROTATED DURING INSTALLATION.

WARNING: USE THE CORRECT PERSONAL PROTECTION EQUIPMENT TO AVOID INJURY. ENSURE AREA IS FREE OF MOVABLE OBJECTS THAT COULD IMPACT BY PROPELLER AIR BLAST.

- Attach timing indicator leads of timing box (buzz box) to magneto p-lead connectors.
- Rotate/adjust magnetos until each indicator light just comes on (or goes out depending on light configuration) indicating that magneto points are just opening.
- Snug magneto attach hardware and rotate crankshaft back, just a few degrees before correct timing degree, then slowly rotate crank in the direction of rotation until the timing lights each, simultaneously, indicate magneto points are just opening. Repeat process above for minor adjustments as needed to achieve correct timing.

- Torque magneto attachment hardware I/A/W EO 242 "Table of Limits", "Torque Limit Table".

- Install spark plugs and ignition leads.
- Use of Test (Slave) plugs is acceptable; verify plug gap is within limits. (.016 to .021)
- Connect ground cable from test stand to engine.
- Connect starter cable to starter.

- Secure hoses, lines, wires, etc. as required to reduce chaffing and excessive movement during test run.

- Tie wraps may be used to aid in security.

- Fill engine with appropriate quantity of oil.

- Reference Superior Vantage Installation and Operations Manual SVIOM01 for proper oil level.

- Check/verify oil level on oil level gage.

- Pressurize fuel system, check for leaks.

- Install cooling hood to engine and secure safety cable and lock pin.

- Inspect engine and test bed for any oil and/or fuel leaks as well as for installation security of all connections.

NOTE: If the engine acceptance test is to be accomplished with the engine installed in the aircraft, install the engine in accordance with Superior Vantage Installation and Operation Manual No. SVIOM01 and the aircraft Maintenance manual. All aircraft cooling baffles and cowling must be in place to assure proper cooling. Face the aircraft into the wind to assure the optimum cooling.

Engine Test Run Instructions

General

- The following instructions reference RPM as the set-point for engine operation for use with a fixed pitch propeller
- Document requested readings on a "Green Sheet" or Engine Run Sheet. See form at the end of this section or prepare a similar form.
- If, at any time during the test run, fuel or oil leaks are noted, shut down engine; determine the cause and correct.
- During the engine test run, allow appropriate cooling periods as needed so as not to exceed the following maximum operating temperatures:
 - Oil temperature, 245°F.
 - Cylinder head temperature, 475°F.

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Leak Check

Start engine per engine starting instructions. Refer to SVIOM01 (Vantage Installation and Operation Manual)

- Verify oil pressure (indicated within 30 seconds of operation) is at least 20 psi, and does not exceed 115 psi (cold).
- If oil pressure parameters are not met, shut engine down; determine the cause and correct prior to restart.
- Run engine for five (5) minutes at 1000 RPM \pm 200 RPM and record instrumentation readings.
- Shut down engine and check for fuel and oil leaks.
- Remove oil level gage, wipe clean and re-install in housing. Remove gage and record oil level.

Engine Warm-up

- Re-start engine per starting instructions SVIOM01.
- Operate engine at 1000 RPM \pm 200 RPM until oil temperature reaches 75°F and record run time and instrumentation readings.

Note: Under cold conditions it is permissible to increase RPM to 1400 after oil temperature reaches at least 65°F to continue warm-up to 75°F.

- Increase RPM to 1700 \pm 50 RPM.

Magneto Performance Check

- Select left magneto or turn right magneto "OFF". Note and record magneto RPM drop. Return switch to "BOTH" position or turn right magneto "ON".
- Acceptance range for magneto RPM drop is 25 RPM to 150 RPM.
- Select right magneto or turn left magneto "OFF". Note and record magneto RPM drop. Return switch to "BOTH" position or turn left magneto "ON".
- Acceptance range for magneto RPM drop is 25 RPM-150 RPM with a maximum difference in the left and right RPM drops not to exceed 75 RPM.
- Continue engine run at 1700 RPM \pm 50 RPM for five (5) minutes and document instrumentation readings.

Engine Performance Check

- Increase engine RPM to 2000 \pm 50 RPM and run for ten (10) minutes.
- Verify oil pressure to be 55 psi to 95 psi. Adjust oil pressure relief valve as required.

Note: Shut down engine or Reduce engine RPM If oil pressure parameters are not met as required to make necessary adjustments.

- Document instrumentation readings.

Full Power Acceptance Check

- Increase engine to full RPM or Wide Open Throttle, ("WOT") for five (5) minutes and document RPM and instrumentation readings.

Note: Refer to the Superior Vantage Installation and Operation Manual No. SVIOM01 for the Horsepower and RPM limits for your model. The raw horsepower readings must be corrected to Standard Day conditions. Acceptance Tolerance is \pm 3.0 percent for horsepower.

Cool Down

- Decrease engine RPM to 2300 \pm 50 RPM for ten (10) minutes and document instrumentation readings.
- Decrease engine RPM to 2000 \pm 50 RPM for ten (10) minutes and document instrumentation readings.
- Decrease engine RPM to 1600 \pm 50 RPM for five (5) minutes and document instrumentation readings.
- Decrease engine RPM to 1200 \pm 50 RPM for five (5) minutes and document instrumentation readings.
- Decrease engine RPM to 600 \pm 200 RPM and allow cylinder heads to cool to 300°F.

Idle mixture and cut-off check

- Pull mixture to idle cut-off position and note RPM change. Just before engine shuts down, restore mixture to full rich. Shut down engine and adjust idle mixture, restart engine and repeat procedure as necessary to achieve a 50 RPM rise \pm 25 RPM.
- After idle mixture is set correctly, pull mixture to idle cut-off and allow engine to shut down. Verify and record clean shut down and RPM rise.

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Oil Consumption Check

- Remove oil level gage and wipe clean. Re-install in housing and remove again to determine oil quantity.
- Calculate oil consumption for one hour and document.

Note: Oil consumption not to exceed .75 quarts per hour.

Engine reservation and Storage After Testing
Refer to the Preservation and Storage Section of this manual for storage instructions.

APPENDIX A
ASSEMBLY IN-PROCESS QUALITY INSPECTIONS

Inspection 1

- A. Inspect and verify correctness of all parts and procedures prior to further assembly of crankcase halves to the crankshaft assembly.
- B. This quality inspection shall include visual inspection of parts and written records (paperwork) in accordance with the assembly guidelines in this Overhaul Manual.
- C. This inspection shall be accomplished during the engine assembly process as noted in the Assembly section of this manual.
- D. Perform the inspections as follows:
 - (3) Verify the case serial numbers match each case half.
 - (4) Verify correct crankshaft part number.
 - (5) Verify correct camshaft part number.
 - (6) Verify the correct main bearing part number and ensure proper fit.
 - (7) Verify that all pipe plugs and fittings are properly installed in the case halves.
 - (8) Check the tappet body fit in lifter bore and ensure that all tappet bodies are installed.
 - (9) Rotate the camshaft in each case half to verify smooth fit.
 - (10) Verify that all mating surfaces are clean and absent of burrs and/or scoring.
 - (11) Verify thrust bearing and slinger clearance of crankshaft. Verify the end clearance of camshaft. See the Table of Limits appendix C of this manual.
 - (12) Inspect fit of connecting rods to crankshaft.
 - (a) Verify the correct rod installation with rod serial numbers in the same plane and oriented toward oil sump.
 - (b) Verify the correct rod nut assembly with the lip out.
 - (c) Rotate or spin each rod on the crankshaft to verify smooth rotation.

- (d) Verify proper side clearance of each rod in accordance with the Table of Limits appendix C of this manual.
- (e) Check the torque on each rod nut in accordance with the Table of Limits appendix C of this manual.
- (13) Verify that nose bolts are installed with o-rings in the right case half.
- (14) Verify the presence of o-rings on rear through bolts in right case half.
- (15) Verify the crankshaft gear installation.
 - (a) Ensure the gear is properly seated in the crankshaft recess in accordance with the Table of Limits appendix C of this manual. Verify security of the lock tab.
- (16) Verify the nose seal installation.
 - (a) Verify that the seal is installed with the flat side toward crankshaft prop flange.
 - (b) Verify that the seal spring is correctly installed in the seal groove or lip.
- (17) Verify that the front main bearing on the crankshaft has the correct part number and check its alignment marks.

Inspection 2

- A. Inspect and verify the correct installation of cylinders and assembly hardware, including proper torque and safety techniques. Verify the internal timing of the crankshaft gear, camshaft gear, and idler gear as well as proper clearances and gear lash.
- B. This quality inspection shall include visual and physical inspection of parts and assemblies in accordance with the assembly guidelines in this Overhaul Manual.
- C. This inspection shall be accomplished during the engine assembly process as noted in the Assembly section of this manual.
- D. Perform the inspections as follows:

Revision C

- (1) Check the torque of cylinders and assembly hardware.
 - (a) Check the torque on the cylinder base nuts in accordance with the Table of Limits appendix C of this manual
 - (b) Check the torque on all crankcase assembly hardware in accordance with the Table of Limits appendix C of this manual.
- (2) Verify correct safety techniques.
 - (a) Verify the safety of the slotted nut and drilled stud at accessory location, under the camshaft gear.
 - (b) Verify the safety of the drilled belly bolts/nuts at sump location.
 - (c) Verify the safety of the idler shaft hardware.

NOTE: Ensure clearance between the idler shaft stud and idler gear.

- (3) Verify that the timing marks align correctly between the crankshaft gear, camshaft gear, and idler gear with #1 cylinder on TDC (top dead center).
- (4) Verify the gear lash of the idler gears with the crankshaft gear and camshaft gear. Refer to the Table of Limits Appendix C section 5.0 of this manual.
- (5) Verify installation of the tachometer shaft, bushing and snap ring in the camshaft.

Inspection 3

- A. Inspect and verify proper installation, safety, and clearances of the cylinder valve train and accessory housing subassembly prior to rocker cover and accessory housing installation.
- B. This quality inspection shall include visual inspection of assembly and safety techniques. A physical check of clearances shall be performed as described in this list.
- C. This inspection shall be accomplished during the engine assembly process as

- noted in the Assembly section of this manual.
- D. Perform the inspections as follows:
 - (1) Perform a valve train inspection as follows:
 - (a) Inspect the pushrod tube seals for proper installation.
 - (b) Verify security and installation of the nut and lock tab securing the spring clip to each pushrod tube.
 - (c) Verify installation of the exhaust valve rotator cap on the valve stem of each exhaust valve.
 - (d) Verify the dry tappet clearance for each rocker arm in accordance with the Table of Limits Appendix C section 4.0 of this manual.
 - (e) Verify installation of the rocker shaft caps (thrust buttons) in each rocker shaft.
 - (2) Perform inspection of the accessory housing as follows:
 - (a) Visually inspect the housing for damage and general condition.
 - (b) Verify proper installation of the plugs and fittings.
 - (c) Verify proper installation of the tachometer shaft seal.
 - (d) Verify safety of the oil pump housing.
 - (e) Ensure smooth rotation of the oil pump drive shaft.
 - (f) Verify correct installation of the fuel pump plunger as required.

Inspection 4

- A. Inspect and verify proper installation of the accessory housing, rocker covers, inner cylinder baffles, sump, cylinder drain tubes, induction/intake system, accessory adapters, and accessories.
- B. This quality inspection shall include visual and physical inspections of the complete engine assembly.
- C. This inspection shall be accomplished after the engine assembly has been completed and prior to engine test.
- D. Perform the inspections as follows:
 - (1) Perform complete visual and physical inspections of the engine as follows:

Revision C

- (a) Inspect for loose or missing parts or components.
- (b) Verify security of the accessory housing and accessory adapters to housing.
- (c) Verify security of the accessories including magnetos, carburetor or fuel injector servo, starter, and alternator.
- (d) Verify security of the cylinder drain tubes.
- (e) Verify security of the rocker covers.
- (f) Verify security of the sump.
- (g) Verify security and installation of the inner cylinder baffles.
- (h) Verify security of the intake elbows. Ensure that the flange of intake elbow fits completely in the recess of the aluminum flange at the cylinder port.
- (i) Verify installation and safety of the oil pressure relief valve.
- (j) Verify installation and safety of the oil level gage housing and the oil level gage.
- (k) Verify safety of the fuel pump attachment hardware.
- (l) Verify correct installation of the magneto harnesses.
- (m) Check security and routing of the primer lines or fuel injection lines and fuel hoses as applicable.

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Overhaul Manual

O-360 and IO-360 Series Engines

Appendix B Approved Assembly Materials

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1.0 Complementary Documents

There are no complementary documents.

2.0 Scope

This document provides a listing of common manufacturer's products approved as engine assembly materials. This is not meant to limit use to only the listed products. Another manufacturer's product that is equivalent to the listed product will be acceptable.

3.0 Lubricants

3.1 Assembly grease – Lubriplate No. 105

3.2 Mineral Oil – SAE 50 Aviation Mineral Oil

3.3 Fuelube – #44

3.4 EZ TURN MIL-G-6032D

3.5 STP High Viscosity Oil Treatment - Pre-Lube mixture – Approximately 15% STP and 85% SAE 50 Aviation Mineral Oil

3.6 Dow Corning 4, Electrical insulating compound

3.7 CRC Sta-Lube, Extreme Pressure anti-seize engine assembly lubricant

4.0 Gasket/ Joint Cement and Adhesives

4.1 Titesal No. 2 Gasket and Joint Compound

4.2 Loctite No. 2 Gasket Sealant

4.3 EZ TURN MIL-G-6032D

4.4 General Electric RTV 102 Silicon Sealant (Crankcase Parting Surface Sealant)

4.5 Dow Corning 737 RTV Sealant

4.6 Loctite 515 Gasket Eliminator (Crankcase Parting Surface Sealant)

4.7 Pliobond Contact Cement

4.8 Silastic 140 Adhesive (for fin stabilizers)

Overhaul Manual

O-360 and IO-360 Series Engines

5.0 Thread Lock and Sealant

- 5.1 Loctite 262
- 5.2 Loctite 271
- 5.3 Permatex High Strength Threadlocker RED

6.0 Anti-Seize Compound

- 6.1 Copper Based Anti-seize, Fel-Pro or Loctite C5-A
- 6.2 Loctite Food Grade Anti-Seize

7.0 Safety Wire

- 7.1 .020 dia. Type 304 Stainless Steel Wire, MS20995 C20
- 7.2 .025 dia. Type 304 Stainless Steel Wire, MS20995 C25
- 7.3 .032 dia. Type 304 Stainless Steel Wire, MS20995 C32
- 7.4 .041 dia. Type 304 Stainless Steel Wire, MS20995 C41

8.0 Silk Thread

- 8.1 #50 ("OO") Silk Thread (100% Silk)

9.0 Solvents

- 9.1 Fast dry solvent – Acetone (preferred) or Methyl Ethyl Ketone

10.0 Lapping Compound

- 10.1 Clover Brand 180 grit silicon carbide in grease

11.0 Preservative Oil

- 11.1 Mixture of twenty parts Exxon Rust Ban 392 to one part Chevron Snow White Grease
- 11.2 Cortec VpCI-326 or MIL-P-46002 Grade I
- 11.3 LPS 3 Heavy Duty Rust Inhibitor

12.0 Penetrant Oil

- 12.1 Mouse Milk

13.0 Engine Test Lubricating Oil

- 13.1 Aeroshell 100, or other aviation approved oil company, straight mineral oil (select appropriate grade for ambient air temp)
- 13.2 Exxon Aviation Oil 20W-50, or other aviation approved oil company, mineral based non-dispersant oil.

14.0 Engine Test Oil Filter

- 14.1 WIX part no. 51515, NAPA part no. 21515, Champion part no. CH48108 or 48108-1

TABLE OF LIMITS – SUPERIOR ENGINE ASSEMBLIES

**APPENDIX C
TABLE OF LIMITS
SUPERIOR ENGINE ASSEMBLIES**

**Doc No.: SSD001
Revision: A Date: 03/04/08**

TABLE OF LIMITS – SUPERIOR ENGINE ASSEMBLIES

1.0 Reference Documents

There are no other applicable documents.

2.0 Purpose

The purpose of this document is to provide criteria for the common assembly of Vantage O/ IO-360 and XP-360 Engines.

3.0 Scope

This table of fits and clearances is provided for use in the assembly of Superior Engines and applies to all personnel involved in the building of these engines.

4.0 Vantage O/IO-360 Dimensional Table of Limits (in inches)

DESCRIPTION OF LIMITS	Min	Max
1. Piston		
Piston in Cylinder (Bottom of Skirt Clear).....	0.0065	0.0095
2. Piston Rings		
Piston Ring in Groove Side Clearance (Top Comp.).....	0.0025	0.0055
Piston Ring in Groove Side Clearance (2 nd Comp.).....	0	0.004
Piston Ring in Groove Side Clearance (3 rd Oil).....	0.002	0.004
End Gap (Top Comp).....	0.045	0.055
End Gap (2 nd Comp).....	0.045	0.055
End Gap (Oil Control).....	0.015	0.03
<i>NOTE: Measure end gaps 1.0" to 4.0" from bottom of barrel. Minimum top compression ring gap at top of stroke is .008" (approx. 6.6" from bottom of barrel).</i>		
3. Piston Pin		
Piston Pin and Plug in Cylinder (End Clear).....	0.025	0.057
Piston Pin in Piston (Diameter).....	0.0003	0.0014
Piston Pin in Connecting Rod Bushing	0.0008	0.0021
4. Connecting Rod		
Bearing to Crankpin.....	0.0008	0.0038
Connecting Rod to Crankshaft (Side Clear).....	0.004	0.01
Connecting Rod Bushing ID	1.1254	1.1262
5. Crankshaft Main Bearings		
Crankshaft in Front Bearing (End Clear).....	0.009	0.016
Crankshaft in Front Bearing (Diameter).....	0.0015	0.0045
Crankshaft in Center and Rear Bearing (Diameter).....	0.0015	0.0045
Crankshaft Oil Slinger.....	0.002	0.007

TABLE OF LIMITS – SUPERIOR ENGINE ASSEMBLIES

4.0 Continued

DESCRIPTION OF LIMITS	Min	Max
6. Crankcase Main Bearing Retention Dowel Height		
	.070	.090
7. Crankshaft Rod Journal Diameter.....		
	2.124	2.125
8. Crankshaft Run-Out (Center Main).....		
	-	.005 T.I.R.
9. Crankshaft Main Bearing Journal Diameter		
	2.375	2.376
10. Camshaft Journal		
Camshaft Center Bearing Journal Run-Out.....	-	.001 T.I.R.
Journals in Crankcase	0.002	0.004
Rear Journal in Crankcase (End Clearance).....	0.002	0.009
11. Valve Tappet in Crankcase		
	0.001	0.0033
12. Rocker Shaft		
Rocker Shaft in Rocker Bushings.....	0.0007	0.0017
Rocker Shaft in Cylinder Head.....	0.0001	0.0013
13. Valves in Guides		
Exhaust Valve in Guide.....	0.004	0.006
Intake Valve in Guide.....	0.001	0.0028
14. Oil Seal in Propeller Governor Adapter.....		
	.001T	.003T
15. Valve Rocker (Side Clearance).....		
	0.005	0.013
16. Dry Tappet Clearance.....		
	0.028	0.08
17. Gears in Oil Pump Housing		
	0.002	0.006
18. Oil Pump Gear Shaft in Accessory Case.....		
	0.0015	0.003
19. Crankshaft Gear in Crankshaft Pilot.....		
	.0005T	.0010L
20. Oil Seal in Accessory Tachometer Housing		
	.001T	.003T

TABLE OF LIMITS – SUPERIOR ENGINE ASSEMBLIES

4.0 Continued

DESCRIPTION OF LIMITS	Min	Max
21. Fuel Pump Plunger, in Accessory Case.....		
	0.0015	0.003
DESCRIPTION OF LIMITS	Min	Max
22. Tachometer Drive Shaft in Accessory Case.....		
	0.0015	0.0035
23. Alternator Belt Midspan Deflection with Load at 14lb		
Midspan Deflection with Load at 14lb	0.31	
Tension required to cause slippage for new belt	11 ft-lb	13 ft-lb

5.0 Vantage O/IO-360 Table of Backlash and End Clearance Limits (in inches)

DESCRIPTION OF LIMITS	Min	Max
Oil Pump Gear	0.008	0.015
Crankshaft Gear to Idler Gear.....	0.004	0.015
Magneto Drive Gears to Idler Gears.....	0.004	0.015
Camshaft Gear to Idler Gear.....	0.004	0.015
Vacuum Pump Gear to Camshaft Gear.....	0.004	0.015
Vacuum Pump Gear (End Clear).....	0.01	0.057
Idler Gears (End Clear).....	0.005	0.04
Rear Propeller Governor Drive Gear to Crankshaft Idler Gear.	0.004	0.015
Rear Propeller Gov Gear (End Clearance).....	0.002	0.024
Front Propeller Governor Idler Gear to Camshaft	0.004	.015
Front Propeller Gov. Drive and Idler Bevel Gear	0.004	0.008
Front Propeller Governor Gear(End Clearance)	0.008	0.016

6.0 Vantage O/IO-360 Table of Torque Limits (in inch-pounds) and Install Height (inches)

STUD DRIVE TORQUE AND INSTALL HEIGHT ($\pm .030$)	Min Torque	Height
SL38-13 Cylinder Deck.....		.80
SL38D-17 Crankcase Thru Stud, Rear.....	100	1.27
SL38-22 Crankcase Thru Stud, Front.....		1.94
SL50-15 Cylinder Deck Studs.....	250	.86
SL31-12 Exhaust port Studs.....	40	.78
SL31C -13 Propeller Gov Studs.....		1.125
SL31C-12 Propeller Gov Adapter Pad Studs.....		.75
SL31C-12 Magneto Pad Studs.....	25	.94
SL31C-16 Magneto Pad Studs.....		1.50
SL31C-19 Magneto Pad Studs.....		1.78

TABLE OF LIMITS – SUPERIOR ENGINE ASSEMBLIES

6.0 Continued

STUD DRIVE TORQUE AND INSTALI HEIGHT (± .030)	Min Torque	Height
SL38CD-17 Oil Pump Pad Studs.....	25	1.44
SL25C-10 Oil Filter Adapter Studs	15	.63
SL25C-12 Vacuum Pump Studs		.75
SL25C-22 Vacuum Pump Studs		2.22

SPECIAL TORQUE REQUIREMENTS	Torque Limits
Spark Plug.....	420
Slotted Nut 5/16" (Idler Shaft).....	140-160
Slotted Nut 5/16" (Oil Pump Housing) 180-200.....	180-200
Nut 1/2-20 Cylinder to Crankcase.....	600
Nut 3/8-24 Cylinder to Crankcase.....	300
Nut 3/8-24 Crankcase Parting Flange	300
Slotted Nut ¼ "(Nut and Cap Screw) Crankcase Parting Flange.....	55-60
3/8-24 Nut Connecting Rod Bolts.....	480
Slotted Nut 3/8-24 (Drilled Stud Over Camshaft).....	300
5/16 Crankshaft Gear Bolt.....	204
¼-20 Push Rod Shroud Retaining Nut.....	50-70
¼-20 Rocker Cover Screws.....	50
Piston Cooling Nozzles (1/16-27 NPT).....	100
Oil Gage Tube (1-1/8-12).....	300
Drain Back Tube Nut.....	35
Drain Back Hose Clamp.....	10
5/16 Hex Head Hose Clamps.....	45
Fuel Pump Vent Fitting.....	96
Fuel Pump and Prop Governor Hose Nuts.....	35
Fuel Injector Hose Nuts.....	30
Fuel and Prop Governor Elbow Lock Nuts.....	110
Spin-on Oil Filter.....	192-216
Fuel Pump to Accessory Cover Socket Head Bolts (3/8-16).....	225-250
Vernatherm Valve.....	300
Injector and Primer Nozzle.....	60
Primer and Injector Tubing Nuts.....	25
Slotted Nut, 3/8-24 Magneto Gear.....	120-300
Slotted Nut 3.8-24 Alternator to Bracket	360

TABLE OF LIMITS – SUPERIOR ENGINE ASSEMBLIES

6.0 Continued

STANDARD TORQUE UNLESS OTHERWISE LISTED	Torque
Plug and Fitting (1/2-14 NPT).....	160
Plug and Fitting (1/16-27 NPT).....	40
Plug and Fitting (1/8-27 NPT).....	40
Plug and Fitting (1/4-18 NPT).....	85
Plug and Fitting (3/8-18 NPT).....	110
Nut 1/4 "(Nut and Cap Screws).....	96-108
Nut 5/16" (Nut & Cap Screws).....	200
Nut and Cap Screws (10-24, 10-32).....	49
Nut 3/8 (Nut & Cap Screw)	360

7.0 SV-360 Table of Spring Limits (in pounds)

DESCRIPTION OF LIMITS	Wire Diameter	Compress To:	Lbs Min	Lbs Max
Spring Valve, Inner,	0.135	1.17	59	67
Spring Valve, Outer,	0.177	1.3	111	122

8.0 SV-360 Table of Crush Type Gasket Tightening Angles (angular)

DESCRIPTION OF LIMITS	Angle
Oil Suction Screen Gasket.....	135°
Pressure Relief Valve Gasket.....	135°
Oil Cooler Bypass Plug Gasket.....	135°

Note: Install Crush Gasket with seam toward aluminum case. Tighten thread until cap or valve body contacts gasket. Turn additional angle shown above. Lock wire in place.

9.0 Exhaust valve Seat Standard and Oversize Dimensions

Exhaust Valve Seat Part Number	Standard and Oversize (In)	"A" Diameter (In)
SL72058A	STD	1.7387-1.7402
SL72058A P05	+0.005	1.7437-1.7452
SL72058A P10	+0.010	1.7487-1.7502
SL72058A P20	+0.020	1.7587-1.7602
SL72058A P30	+0.030	1.7687-1.7702

TABLE OF LIMITS – SUPERIOR ENGINE ASSEMBLIES

10.0 Intake valve Seat Standard and Oversize Dimensions

Intake Valve Seat Part Number	Standard and Oversize (In)	"A" Diameter (In)
SL72057A	STD	2.0807-2.0822
SL72057A P05	+0.005	2.0857-2.0872
SL72057A P10	+0.010	2.0907-2.0922
SL72057A P20	+0.020	2.1007-2.1022
SL72057A P30	+0.030	2.1107-2.1122

11.0 Exhaust valve guide Standard and Oversize Dimensions

Exhaust Valve Guide Part Number	Standard and Oversize (In)	"A" Diameter (In)
SL74230A	STD	0.6638-0.6633
SL74230A P05	+0.005	0.6688-0.6683
SL74230A P10	+0.010	0.6738-0.6733
SL74230A P20	+0.020	0.6838-0.6833
SL74230A P30	-0.030	0.6938-0.6933
SL74230A P40	+0.040	0.7038-0.7033

12.0 Intake valve guide Standard and Oversize Dimensions

Intake Valve Guide Part Number	Standard and Oversize (In)	"A" Diameter (In)
SL61681A	STD	0.5932-0.5940
SL61681A P05	+0.005	0.5982-0.5990
SL61681A P10	+0.010	0.6032-0.6040
SL61681A P20	+0.020	0.6132-0.6140
SL61681A P30	-0.030	0.6232-0.6240
SL61681A P40	+0.040	0.6332-0.6340