LYCOMING™

Engine Maintenance Manual
(Principal Manual)

IO-360-N1A Engine

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Part No. MM-IO-360-N1A

IO-360-N1A Engine
Maintenance Manual

Lycoming Part Number: MM-IO-360-N1A

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RECORD OF REVISIONS

Revision	Revision Date	Revised By	Revision Description
Original			Original Release of Maintenance Manual - Part No. MM-IO-360-N1A

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SERVICE DOCUMENT LIST

NOTICE: The following is a list of service documents referenced in or incorporated into the information in this manual. Always refer to the latest revision of any service document (including any supplements) for changes or additional information.

Number	Incorporation Date	Subject
S.B. 201	02/16	Inspection of Crankshaft Flange
S.B. 240	02/16	Mandatory Parts Replacement at Overhaul and During Repair or Maintenance
S.B. 342	02/16	Fuel Line (Stainless Steel Tube Assy.) and Support Clamp Inspection and Installation
S.B. 369	02/16	Engine Inspection after Overspeed
S. B. 388	02/16	Procedure to Determine Exhaust Valve and Guide Condition
S.B. 398	02/16	Recommended Corrective Action for Use of Incorrect Fuel
S.B. 399	02/16	Action to Take If Loss of Oil Pressure
S.B. 401	02/16	Recommendations for Aircraft Struck by Lightning
S.B. 475	02/16	Crankshaft Gear and Crankshaft Gear End Inspection and Corrective Action
S.B. 505	02/16	Inspection of Crankshaft I.D. for Corrosion
S.B. 533	02/16	Recommended Action for Sudden Engine Stoppage, Propeller/Rotor Strike or Loss of Propeller/Rotor Blade or Tip
S.I. 1009	02/16	Recommended Time Between Overhaul Periods
S.I. 1011	02/16	Tappets and Lifters
S.I. 1029	02/16	Tightening Procedures for Crankcase Thru-Studs and Bolts
S.I. 1037	02/16	Approved Pistons, Rings and Cylinders for Use on Lycoming Aircraft Engines
S.I. 1042	02/16	Approved Spark Plugs
S.I. 1043	02/16	Spark Plug Heli-Coil® Insert Replacement
S.I. 1047	02/16	Inspection and Reconditioning Procedures for Nitride Hardened Steel Cylinders
S.I. 1059	02/16	Pre-Lubrication of Parts Before Assembly
S.I. 1060	02/16	Push Rod Identification
S.I 1070	02/16	Specified Fuels for Spark Ignited Gasoline Aircraft Engine Models

SERVICE DOCUMENT LIST (CONT.)

Number	Incorporation Date	Subject
S.I. 1080	02/16	Maintenance Items for Special Attention
S.I. 1098	02/16	Propeller Flange Bushing Location
S.I. 1154	02/16	FAA-Approved Starters and Alternators
S.I. 1243	02/16	Piston Identification
S.I. 1285	02/16	Non-Destructive Testing of Lycoming Engine Parts
S.I. 1301	02/16	Identification of Primer and Fuel Injector Lines
S.I. 1324	02/16	Crankshaft Oil Seals
S.I. 1425	02/16	Suggested Maintenance Procedures to Reduce the Possibility of Valve Sticking
S.I. 1427	02/16	Field Run-In and Break-In
S.I. 1458	02/16	Connecting Rod Bolts (Identification and Installation)
S.I. 1514	02/16	Roller Tappets Part Information Update
S.I. 1530	02/16	Engine Inspection in Particulate-Laden Environments
S.I. 1555	02/16	Piston Removal, Cleaning, Inspection, and Installation
L114	02/16	Reciprocating Engine and Accessory Maintenance Publications
L180	02/16	Engine Preservation for Active and Stored Aircraft
L197	02/16	Recommendations to Avoid Valve Sticking
L221	02/16	Warranty Repair of Precision Airmotive Corporation Fuel Control Products
L247	02/16	Shelf Life Requirements
L253	02/16	Warranty Repair of AVStar Fuel Systems, Inc. Fuel Control Products

TABLE OF CONTENTS

Subject **Page**

ABBREVIATIONS AND ACRONYMS

A	
ATA	Air Transport Association
C	
C	Celsius
cm	Centimeter
E	
EGT	Exhaust Gas Temperature
F	
F	Fahrenheit
FAA	Federal Aviation Administration
FAR	Federal Aviation (and Space) Regulation
ft.-lb	Foot Pound (torque)
FPI	Fluorescent Penetrant Inspection
G	
Gal.	Gallon
H	
HET	Hartzell Engine Technologies
I	
ICAs	Instructions for Continued Airworthiness
ID	Inside Diameter
in.-lb.	Inch Pound (torque)
in.	Inch, inches
IOM	Engine Installation and Operation Manual
K	
kPa	Kilopascal
L	
l	Liter
lb.	Pound
M	
MEK	Methyl-Ethyl-Ketone
mm	Millimeter
MPI	Magnetic Particle Inspection
N	
NDT	Non-Destructive Testing
Nm	Newton Meter
O	
oz	Ounce
P	
P/N	Part Number
psi	Pounds per square inch

ABBREVIATIONS AND ACRONYMS (CONT.)

R	
rpm	Revolutions per Minute
S	
SAE	Society of Automotive Engineers (oil viscosity)
SB	Service Bulletin
SI	Service Instruction
SL	Service Letter
SM	Engine Service Manual
T	
TBO	Time Between Overhaul
TDC	Top Dead Center

INTRODUCTION

The Lycoming IO-360-N1A Engine (Figure 1) is a direct-drive, four-cylinder, horizontally opposed, fuel-injected, air-cooled engine. The engine has tuned induction and a down exhaust.

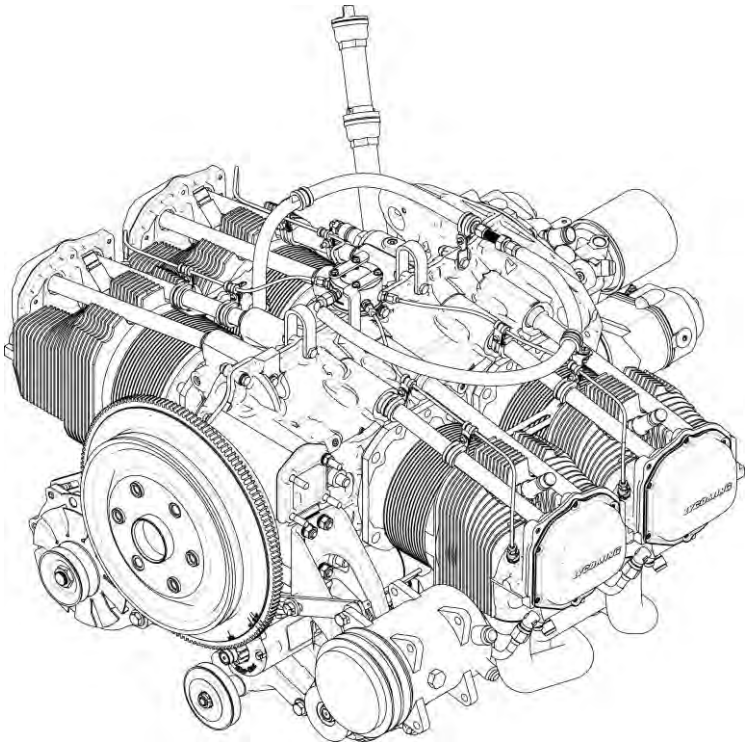

Figure 1
IO-360-N1A

Engine Model Nomenclature

The table below shows the definition of each letter and number for IO-360-N1A.

Model Number	Meaning
I	Fuel Injected
O	Horizontally Opposed
360	Displacement in cubic inches

Engine Serial Number

Every engine sent from the factory is identified by a unique serial number. The engine serial number is identified on the engine data plate on the oil sump on the right side of the engine (Figure 2). Do not remove the engine data plate.

Figure 2
Engine Data Plate

Cylinder Number Designations

- The propeller is at the front of the engine.
- When viewed from the top of the engine, the left side cylinders are 2-4. Cylinder 2 is at the front of the engine. Refer to Figure 3.
- When viewed from the top of the engine, the cylinders on the right are 1-3. Cylinder 1 is at the front of the engine. Refer to Figure 3.
- The firing order of the cylinders is 1-3-2-4.

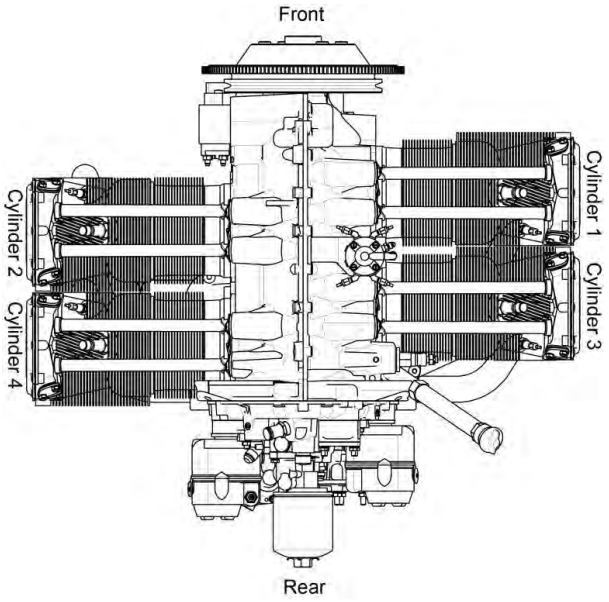

Figure 3
Top View of Engine – Cylinder Number Designations

Scope of this Manual

This manual supplies instructions (in compliance with FAR 33.4) for maintenance of the Lycoming IO-360-N1A engine. The information includes airworthiness limitations, fault isolation guidelines and procedures for component replacement, engine disassembly, and engine assembly. Refer to the ***IO-360-N1A Illustrated Parts Catalog*** to identify spare parts.

Compliance Requirements

⚠WARNING: FOR CORRECT ENGINE MAINTENANCE, COMPLETE THE NECESSARY MAINTENANCE PROCEDURES IN THIS MANUAL AND APPLICABLE SERVICE DOCUMENTS. LYCOMING ENGINES' SERVICE DOCUMENTS WRITTEN AT A LATER DATE OVERRIDE PROCEDURES IN THIS MANUAL UNLESS OTHERWISE SPECIFIED.

PROCEDURES IN THIS MANUAL MUST BE DONE BY QUALIFIED PERSONNEL WITH THE REQUISITE CERTIFICATIONS.

Before you do maintenance on the IO-360-N1A engine, read this manual in its entirety. Obey all procedures and inspections in this manual.

NOTICE: If you do not obey the maintenance procedures in this manual for this engine, you can void the engine warranty. Please consult your warranty for a full statement of your rights, limitations, and obligations that exist there under.

Refer to the ***IO-360-N1A Engine Installation and Operation Manual*** for engine description, uncrating procedures, acceptance check, engine lift procedure, engine preservation and storage, depreservation, engine installation requirements, engine installation, engine start, operation, and stop procedures, pre-flight test, operational test, fuels to be used, and operating specifications.

Refer to the ***IO-360-N1A Engine Service Manual*** for required maintenance (service information) for oil changes, oil addition, oil filter replacement, routine time-interval inspections, routine service, spark plug replacement/inspection procedures, cylinder inspection, fuel system inspection, and scheduled servicing procedures.

Refer to the latest revision of the ***Service Table of Limits - SSP-1776,*** for dimensions, clearances, measurements, and torque values.

⚠ WARNING: OPERATE THIS ENGINE IN ACCORDANCE WITH SPECIFICATIONS IN APPENDIX A OF THE IO-360-N1A ENGINE INSTALLATION AND OPERATION MANUAL. OPERATION OF THE ENGINE OUTSIDE OF THE SPECIFIED OPERATING LIMITS CAN CAUSE PERSONAL INJURY AND/OR DAMAGE TO THE ENGINE.

Environmental Compliance

Lycoming Engines recommends that engine owners and engine service personnel be in compliance with all federal, state, and local environmental regulations when solvents, paint, fuel, oil, chemicals, or other consumables are used in engine service.

Warnings, Cautions, and Notices

Be sure to read and obey the Warnings, Cautions, and Notices in this manual and in service documents. Although Lycoming Engines cannot know all possible hazards or damages, it makes a reasonable effort to supply the best known guidance and recommended practices for safe operation and maintenance of its engines.

The table below defines the four types of safety advisory messages used in this manual as per the American National Standard and ANSI Z535-6-2006.

Safety Advisory Conventions	
Advisory Word	**Definition**
DANGER:	Indicates a hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.
⚠ WARNING:	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION:	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury. It also can be used without the safety alert symbol as an alternative to **"NOTICE."**
NOTICE:	The preferred signal word to address practices not related to personal injury.

NOTICE: In this manual, the word "recommend" refers to "best practices."

Service Bulletins, Service Instructions, and Service Letters

As advancements in technological applications on this engine continue, Lycoming will make future revisions to this manual. However, if more timely distribution is necessary, Lycoming supplies subscribers with up-to-date Service Bulletins (SBs), Service Instructions (SIs) and Service Letters (which are abbreviated with a capital "L" followed by the number, example L180). Special Advisories (SAs) are supplied as necessary without a subscription.

For subscription information, look on Lycoming's website (Lycoming.com) or speak to Lycoming by telephone: U.S. and Canada toll free: +1(800) 258-3279; or Direct: +1 (570) 323-6181.

Applicable information from Lycoming Engines' Service Bulletins, Service Instructions, and Service Letters are included in this manual at the time of publication. Any new service information will be included in the next update of the manual.

Reminder: Unless otherwise specified, Lycoming Engines' service documents (which have a later date than this manual) override procedures in this manual.

For reference, the Service Document List at the front of this manual shows the editions of the service documents referenced or included in this manual.

List of Publications

Refer to the latest revision of Service Letter No. L114 for a list of Lycoming Engines' publications available for purchase.

Instructions for Continued Airworthiness

This manual, together with the ***IO-360-N1A Engine Service Manual***, latest revision of the ***Service Table of Limits - SSP-1776,*** service documents, and related publications make up the complete set of Instructions for Continued Airworthiness (ICAs). The ICAs are prepared by Lycoming Engines and are approved by the Federal Aviation Administration (FAA).

Simplified Technical English

The text in the manual is written in the form of Simplified Technical English in compliance with FAA requirements and to make translation into other languages easier.

Format

Chapters in this manual are identified in Air Transport Association (ATA) format.

Figures

Figures in this manual are for illustration purposes only. Figures always start as Figure 1 in each chapter.

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Feedback

To supply comments, suggestions, or corrections to this manual, either make a call to customer service or use the Lycoming.com website.

Customer Service

Additionally, Lycoming has a Customer Service Hot Line to supply information and assistance to owners, operators, and maintenance personnel servicing Lycoming engines.

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Change of Address Notification

The owner of the manual is responsible for supplying a change of address to Lycoming Engines.

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AIRWORTHINESS LIMITATIONS

1. General

   This Airworthiness Limitations chapter sets forth each mandatory replacement time, inspection interval, and related procedure required for type certification. The Airworthiness Limitations section is FAA approved and specifies maintenance required under 14 CFR §§ 43.16 and 91.403 of the Federal Aviation Regulations (FAR) unless an alternative program has been FAA-approved.

2. Mandatory Inspection - Fuel Injector Lines

   At every 100 hours of operation and after any maintenance has been done on the engine where the fuel injector lines have been disconnected, moved or loosened, examine the fuel lines per the "Fuel System Inspection" procedure in Chapter 73-10 of the ***IO-360-N1A Engine Service Manual.***

3. Mandatory Inspection

   At every 500 hours of operation, examine the magnetos in accordance with the applicable magneto manufacturer's instructions.

4. Mandatory Inspection - Exhaust Valve and Guide

   At every 1000 hours of operation for IO-360-N1A engines, examine the exhaust valve and guide conditions. Refer to the section "Exhaust Valve and Guide Inspection" in Chapter 72-30 of the ***IO-360-N1A Engine Service Manual.***

Approved by: Kevin Sowlsby

Gaetano Sciortino
FAR Manager, New York Aircraft Certification Office
Federal Aviation Administration

Date: 2/25/2016

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05-00 - REQUIRED MAINTENANCE

1. Required Maintenance

   Required maintenance on these engines includes time-interval routine inspections, oil changes, oil addition, oil filter replacement, routine time-interval inspections, routine service, spark plug replacement/inspection procedures, cylinder inspection, fuel system inspection and other procedures identified in the checklists in the Chapter 5-20 of the ***IO-360-N1A Engine Service Manual.*** If you complete these checklists, you will have done all the required maintenance for this engine.

2. General

   A. For continued airworthiness, this manual includes airworthiness limitations, fault isolation guidelines, and procedures for, component replacement, engine disassembly, and engine assembly. Refer to the ***IO-360-N1A Illustrated Parts Catalog*** to identify spare parts.

   B. Engine description, uncrating procedures, acceptance check, engine lift procedure, engine preservation and storage, depreservation, engine installation requirements, engine installation, engine start, operation, and stop procedures, pre-flight test, operational test, fuels to be used, and operating specifications are included in the ***IO-360-N1A Engine Installation and Operation Manual.***

   C. List of Tools for Service and Maintenance

      Table 1 identifies tools used for service and maintenance.

Table 1
Tools for Service and Maintenance

Tool	Purpose
Champion Tool CT-470 or Airwolf Cutter AFC-470 or equivalent	Cut open oil filter
Borescope	Cylinder Borescope Inspection
Wrench Sets	
Mirror and Flashlight	
Aviation Mechanic's Tools	
Differential Compression Tester	Cylinder Compression Check
Valve Clearance Gage	Dry tappet clearance
High Tension Lead Tester	Ignition lead test
Intercylinder Baffle Tool	
Timing Pin (Champion/Slick P/N T-118 or equivalent)	Magneto-to-Engine Timing
Magneto Timing Light	Magneto-to-Engine Timing
Plug Gage	Measure inner diameter of the valve guide
0.010 in. (0.254 mm) Feeler Gage	
Imada DPS-220R or equivalent	Spring Tester - Available from Tool Vendor
Dial Bore Gage	Measure cylinder diameter

Table 1 (Cont.)
Tools for Service and Maintenance

Tool No.	Nomenclature and Description
ST-23	Gage, Valve Clearance 0.028 to 0.080 in. (0.711 to 2.032 mm)
ST-25	Compressor, Valve Spring
*ST-71	Gage, Check Bell-Mouthing of Exhaust Valve Guides
ST-115	Tool, Install and Remove Propeller Flange Bushings
ST-131	Tension Dial Gage Belt
ST-222	Plate, Torque Hold-Down
ST-271	Puller, Crankcase Thru-Stud
ST-317	Driver, Crankcase Thru-Stud
ST-383	Tool, Crankshaft Oil Seal Installation
ST-389	Tool, Crankcase Separating
ST-483	Test Plate
ST-485	Compressor, Piston Ring
64530	Connecting Rod Parallelism and Squareness Gage
64593	Expanding and Staking Tool, 0.71 in. (18 mm) Spark Plug Heli-Coil® Insert
64594	Inserting Tool, 18 MM Spark Plug Heli-Coil® Insert
64596-1	Tap, 18 mm Heli-Coil® Spark Plug Bottom Tap 0.010 in. (0.254 mm) OS
64713	Expander, Piston Ring
* ST-71, Gage, Check Bell-Mouthing of Exhaust Valve Guides includes ST-71-8, Gage Adapter	

3. Time Between Overhaul (TBO)

   The TBO for the IO-360-N1A engine is 2000 hours or 12 years (whichever comes first).

   Refer to the latest revision of Service Instruction No. SI-1009 for any changes or special circumstances for the recommended TBO.

4. Safety Precautions - Before Engine Maintenance

⚠WARNING: TURN OFF THE IGNITION SWITCH AND DISABLE ALL POWER TO THE ENGINE TO PREVENT ACCIDENTAL ENGINE START-UP WHILE WORKING ON THE ENGINE. FAILURE TO DISABLE POWER COULD CAUSE ACCIDENTAL ENGINE START-UP, INJURY, OR DEATH. IF IT IS NECESSARY TO COMPLETE OPERATIONAL TESTS ON THE ENGINE WITH POWER ON, KEEP ALL PERSONNEL AWAY FROM THE ROTATIONAL RADIUS OF THE PROPELLER TO PREVENT INJURY OR DEATH ON ENGINE START-UP.

IF WORK IS DONE AROUND FUEL LINES, FUEL SOURCES, DO NOT SMOKE OR HAVE AN OPEN FIRE FLAME OR ANY DEVICE THAT CAN MAKE SPARKS. SMOKE, FLAMES, OR SPARKS CAN CAUSE FUEL IGNITION WHICH CAN CAUSE SERIOUS BURNS, INJURY OR DEATH.

5. Maintenance Practices

   A. Obey all safety precautions.

   B. Do not reuse a gasket, O-ring, or seal. Install a new gasket, O-ring, or seal during component installation where a gasket, O-ring, or seal was removed.

   C. Remove all traces of dirt, dust, debris and accumulated matter from parts. All parts must be clean before they are installed on the engine. For specific cleaning guidelines, refer to Chapter 05-30.

   D. If adhesive tape has been applied to any part, remove the tape and clean the part completely. Remove all tape and residue.

   E. If it is necessary to use a hammer to install a part, use only a plastic or rawhide hammer.

   F. Hardware

      (1) All cotter pins that are removed must be discarded and not reused. Install a new cotter pin where a cotter pin was removed.

      (2) All safety wire and cotter pins must be made of corrosion-resistant steel and installed as a snug fit in holes in studs and bolts for correct locking.

      (3) The cotter pin head must install as a snug fit into the castellation of the nut. Unless otherwise specified, bend one end of the cotter pin back over the stud or bolt and the other end flat against the nut.

   G. If safety wire or safety cable was removed during component removal, be sure to install new safety wire or safety cable during component installation.

   H. Unless otherwise specified in this manual, refer to the latest revision of the ***Service Table of Limits - SSP-1776*** for torque values for hardware fasteners.

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05-10 - TIME LIMITS / INSPECTIONS

Refer to the ***IO-360-N1A Engine Service Manual*** for the time-interval-based Engine Inspection Schedule for IO-360-N1A engines.

NOTICE: All engine inspections are mandatory and must be completed no later than 10 hours after the specified time interval for the inspection. More frequent inspections could be necessary for engines operated in particulate-laden or extremely humid, cold, damp environments.

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05-30 - CLEANING

1. Cleaning Guidelines

   A. Refer to Table 1 for cleaning guidelines for engine components.

   ⚠ **CAUTION:** IF VOLCANIC ASH IS SUSPECTED ON THE ENGINE, DO NOT TOUCH IT WITH BARE HANDS OR GET IT IN YOUR EYES. WEAR PERSONAL PROTECTIVE EQUIPMENT. DO NOT USE WATER TO RINSE IT OFF. THE VOLCANIC ASH CAN CONTAIN ACIDIC COMPOUNDS WHICH MUST NOT BE INHALED OR TOUCHED SINCE IT CAN CAUSE INJURY. REFER TO THE SECTION "VOLCANIC ASH/PARTICULATE CONTAMINATION" IN CHAPTER 05-50.

   NOTICE: Except for parts contaminated with suspect volcanic ash, before cleaning engine parts, complete a visual inspection (per Chapter 05-20 of the ***IO-360-N1A Engine Service Manual***) of engine parts to identify any stains and residues and sources thereof.

   B. After the initial visual inspection (in Chapter 05-20 of the ***IO-360-N1A Engine Service Manual***), clean engine parts thoroughly per instructions in this chapter.

   ⚠ **CAUTION:** DO NOT USE ALKALINE (CAUSTIC) CLEANING SOLUTIONS SUCH AS DETERGENTS ON ENGINE PARTS. ALKALINE SOLUTIONS REMOVE THE FINISH ON ALUMINUM PARTS AND MAGNESIUM PARTS.

   ALKALINE COMPOUNDS CAN GET INTO THE PORES OF THE METAL WHICH CAN CAUSE OIL FOAMING WHEN THE PART IS PUT BACK INTO SERVICE.

   OBEY STANDARD SAFETY PRACTICES REGARDING THE HANDLING OF CLEANING MATERIALS AND THE USE OF PERSONAL PROTECTIVE EQUIPMENT.

   NOTICE: If you are not sure of the correct cleaning agent or whether the component contains aluminum or magnesium, contact Field Service at Lycoming Engines at the phone numbers in the front of the manual.

   C. There are two processes for cleaning: degreasing and decarbonizing.

      (1) Degreasing removes dirt and sludge (soft carbon). Soak the component or part in mineral spirits or other degreaser. Refer to the “Soft Carbon Removal” procedure in this chapter.

      ⚠ **CAUTION:** DO NOT USE ANY HEATED DECARBONIZING SOLVENT ON STEEL OR MAGNESIUM PARTS. THE DECARBONIZING SOLVENT CAN DAMAGE OR CORRODE THE MAGNESIUM AND STEEL PARTS.

      (2) Decarbonzing removes hard carbon with an initial soak of the part in a warm or heated decarbonizing solution. After the soak, use a (non-wire) bristle brush, wooden scraper, or grit-blasting (with non-abrasive media as per the “Grit-Blasting” procedure in this chapter) to physically remove the hard carbon. Refer to the “Hard Carbon Removal” procedure in this chapter.

      NOTICE: Since decarbonizing can remove most of the enamel from exterior surfaces, remove any remaining enamel by grit-blasting.

Table 1
Cleaning Guidelines for Engine Components

Component or Part	Cleaning Agent*	Guidelines
Crankshaft	Mineral spirits, MIL-PRF-680 or equivalent	Refer to the "Crankshaft Cleaning" and "Crankshaft Counterbore Cleaning" procedures in this chapter
Crankshaft Gear	Mineral spirits, MIL-PRF-680 or equivalent or Stoddard Solvent	Refer to the "Crankshaft Gear Cleaning" procedure in this chapter.
Camshaft	Mineral spirits, MIL-PRF-680 or equivalent	
Tappets	Petroleum-based solvent	Refer to the "Tappet Cleaning" procedure in this chapter.
Crankcase	Petroleum-based solvent	Refer to the "Crankcase Cleaning" procedure in this chapter.
Removal of silk thread and/or gasket material from crankcase mating flanges	Methyl-ethyl-ketone (MEK) Acetone Wood Alcohol	
Accessory Housing		Refer to the "Soft Carbon Removal" procedure in this chapter
Cylinders	Mineral spirits (MIL-PRF-680), kerosene or equivalent degreasing agent	Refer to the "Cylinder Cleaning" procedure in this chapter.
Deposits in cylinder combustion chamber		Refer to the "Grit-Blasting the Combustion Chamber in an Engine Cylinder" procedure in this chapter.
Connecting Rods	Mineral spirits, MIL-PRF-680 or equivalent	
Interior surfaces of aluminum parts with hard carbon or oil varnish (gum) deposits	Paint & Ink Remover solution (in ultrasonic cleaner) Heated petroleum-based decarbonizing solution	Refer to the "Hard Carbon Removal" procedure in this chapter.
Valve rockers		Clean with Scotch-Brite™ or equivalent. Remove debris with clean lint-free wipes.
Stabilizers, valve components, starter drive, fuel control inlet screen	Mineral spirits (MIL-PRF-680), kerosene or equivalent degreasing agent	
Piston	Mineral spirits (MIL-PRF-680), Safety Solvent or equivalent degreasing agent	Refer to the "Piston Cleaning" procedure in this chapter.

Table 1 (Cont.)
Cleaning Guidelines for Engine Components

Component or Part	Cleaning Agent*	Guidelines
Piston cooling nozzles	Oil-based solvent: mineral spirits, Stoddard Solvent or equivalent	
Small steel parts	Cold Dip Tanks (or closed tank system) NALCO 1704	Refer to the "Steel, Aluminum or Magnesium Parts Cleaning" procedure in this chapter.
Large steel parts covered with light oil	NALCO S-44 in hot steam or water at 130ºF (54ºC)	Refer to the "Steel, Aluminum or Magnesium Parts Cleaning" procedure in this chapter.
Aluminum or magnesium parts		Refer to the "Steel, Aluminum or Magnesium Parts Cleaning" procedure in this chapter.
Oil Pump	Mineral spirits, MIL-PRF-680 or equivalent	
Oil suction screen	Mineral spirits, or equivalent degreasing solvent	Refer to Chapter 12-10 in the ***IO-360-N1A Engine Service Manual*** for additional details.
Oil cooler bypass valve	Mineral spirits, MIL-PRF-680 or equivalent degreasing solvent	⚠ **CAUTION:** DO NOT USE RAGS OR ANY LINT CLOTH TO CLEAN THIS VALVE. (1) Soak the oil cooler bypass valve in filtered mineral spirits (or equivalent). (2) Blow dry with compressed air.
Spark plug, spark plug lead connector, cable ends, spark plug walls, and ceramics	Methyl-ethyl-ketone (MEK) Acetone Wood Alcohol	Refer to the section "Spark Plug Cleaning" procedure in this chapter.
Lead deposits		Refer to the "Lead Deposit Removal" procedure in this chapter.
Removal of gasket material	Methyl-ethyl-ketone (MEK) Acetone Naptha or equivalent	Apply solvent to gasket material Use wooden scraper to remove gasket material. Wipe away all debris with clean lint-free wipe.
Precision fuel injector nozzles	Hoppes® No. 9 Gun Cleaning Solvent, Alkon Cleaner, Methyl-ethyl-ketone (MEK) Acetone	Refer to the "Injection Nozzle Cleaning" section in this chapter.
AVStar fuel injector nozzles	Methyl-ethyl-ketone (MEK) Acetone	Refer to the "Injection Nozzle Cleaning" section in this chapter.

Table 1 (Cont.)
Cleaning Guidelines for Engine Components

Component or Part	Cleaning Agent*	Guidelines
Fuel filter screen, fuel servo inlet screen	Methyl-ethyl-ketone (MEK) Acetone	
Connectors	CR4 or equivalent	Refer to contact cleaning solvent manufacturer's instructions.
Hartzell Engine Technologies (HET) (formerly Kelly Aerospace) starter	Mineral spirits, MIL-PRF-680 or equivalent degreaser solvent	Remove corrosion from electrical terminals. Clean the starter drive and shaft with mineral spirits. Lubricate with silicon spray.
All other parts	Parts washer solvent using Whirlwash-L or equivalent	
Final spot cleaning/touch up cleaning	Parts washer solvent Naptha spray booth	
Volcanic ash on engine		Refer to the "Volcanic Ash Removal" procedure in this chapter.
Engine exterior and components NOT contaminated with volcanic ash		Use a brush or spray to apply degreaser (hydrocarbon-base solvent) to parts to remove grease, oil, and dirt.
*Refer to the manufacturer's instructions for usage, safety data, and disposal of all cleaning agents.		

2. Crankshaft Cleaning

⚠ **CAUTION:** DO NOT MAKE SCORES, SCRATCHES, OR ETCH MARKINGS OF ANY KIND ON THE CRANKSHAFT. A MARK IN ANY OF THESE AREAS CAN CAUSE THE PART TO WEAKEN AND TO FAIL.

DO NOT USE WIRE BRUSHES OR METAL SCRAPERS ON BEARINGS OR CONTACT SURFACES.

   A. Clean the inside of all crankpin journals, main bearing journals, and all oil passages with the bristle (non-wire) brushes.
   B. Clean all parts thoroughly with mineral spirits (MIL-PRF-680) or equivalent,
   C. Dry the crankshaft with compressed air.
   D. Apply lubricating oil to the crankshaft to prevent corrosion.

3. Crankshaft Counterbore Cleaning
   A. Flush the crankshaft counterbore and alignment dowel pin with mineral spirits (MIL-PRF-680) or equivalent or Stoddard's Solution or equivalent solvent to remove any debris.
   B. Dry the crankshaft counterbore threads with compressed air.
   C. Examine the threads in the crankshaft counterbore for any wear.

D. Make sure the tapped hole is clean and the threads are not stripped, galled, or damaged. If the threads are stripped, galled, or damaged, discard the crankshaft and replace it with a new crankshaft.

E. Clean the threads of the recessed counterbore on the crankshaft as follows:

(1) Use the correct sized undamaged standard threading tap for a 5/16-24 thread size.

⚠ **CAUTION:** TO PREVENT MAKING THE THREADS IN THE CRANKSHAFT COUNTERBORE TOO LARGE, USE THE CORRECTLY SIZED TAP. IF THE INCORRECT TAP IS USED, THE BORE CAN BE MADE TOO LARGE TO CORRECTLY ENGAGE THE THREADS ON THE CRANSKHAFT GEAR BOLT WHEN THE CRANKSHAFT GEAR IS INSTALLED ON THE CRANKSHAFT. IF THE BOLT THREADS ARE TOO LARGE, DISCARD THE CRANKSHAFT AND REPLACE IT WITH A NEW CRANKSHAFT.

(2) Install the selected tap into the recessed counterbore on the crankshaft.

(3) Turn the tap five turns to clean the threads.

(4) Remove the tap.

4. Crankshaft Gear Cleaning

A. Soak the crankshaft gear in mineral spirits (MIL-PRF-680) or equivalent or Stoddard Solvent, or equivalent solvent.

B. Remove all dirt and debris from the crankshaft gear with a lint-free wipe.

C. Dry with compressed air.

5. Tappet Cleaning

A. Roller tappets are replaced during overhaul or after a propeller strike or sudden engine stoppage. However if the roller tappets have been removed during a non-overhaul event, clean the roller tappets using the same cleaning procedure for tappets in the next steps. Refer to the latest revision of Service Instructions SI-1011 and SI-1514 for details about tappets.

NOTICE: During disassembly and cleaning, keep the tappet parts together.

B. Put tappets in a special cleaning basket that has separate compartments to keep the parts for each tappet as a set, identified but segregated from other tappets.

C. Put the cleaning basket with the tappets immersed in a petroleum-based solvent.

D. Hold the ball check valve in each plunger cylinder off of its seat and insert a bronze or copper wire through the tube on the cylinder. Like floss, move the wire back and forth until there are no dirt particles under the ball seat.

E. Put the cleaned part back in the corresponding compartment in the cleaning basket.

F. After all plungers have been cleaned, soak the parts again in the cleaning basket in clean petroleum-based solvent.

NOTICE: If the cleaned tappets are acceptable per the “Tappet Inspection” in Chapter 72-20, they can be re-installed

G. Apply a light coat of engine oil to the lifter parts before tappet assembly.

6. Crankcase Cleaning

NOTICE: Clean the crankcase after all grit-blasting is complete.

A. Remove all plugs from oil passages in the crankcase.

B. Use a stiff bristle fiber (not wire) brush to clean oil passages.

OR

C. Grit-blast the crankcase (as necessary) to remove all coatings on the crankcase and engine mount bosses. Refer to the sections "Grit-Blasting," "Grit-Blast Media," and "Grit Blast Procedure" in this chapter. Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable fluorescent penetrant inspection (FPI) or subsequent oil flow.

D. Use air to blow out debris from the oil passages.

E. Apply clean petroleum solvent to the cleaned oil passages.

7. Cleaning Methods for Non-Destructive Testing

Use any of the following cleaning methods as long as it is not harmful to the component or its intended function:

A. Vapor Degreasing

B. Solvent Degreasing

C. Ultrasonic Cleaning

D. Chemical Cleaning

E. Aqueous-Based Cleaning

F. Mechanical Cleaning - "Grit Blasting" in this Chapter

NOTICE: If grit blasting is to be used without a subsequent etching process, make sure the grit blasting does not peen the surface. Typically, a fine abrasive of 150-grit or finer is acceptable.

8. Grit-Blasting

Do not grit-blast the following:

- Piston ring grooves
- Valve stems
- Valve guides
- Bearing surfaces
- Bushings

A. Grit-Blast Media

⚠ **CAUTION:** DO NOT USE SAND OR METALLICALLY ABRASIVE MATERIALS TO GRIT-BLAST.

(1) During grit-blasting, use mildly abrasive organic blast media such as rice, baked wheat, plastic pellets, or crushed walnut shells.

(2) Walnut shells (Type 12/20 Grit 17) are the only blasting material approved for cylinder cleaning.

B. Grit-Blast Procedure

NOTICE: Make sure you are using the correct grit-blast media identified in the "Grit-Blast Media" section in this chapter. Only grit-blast the areas identified in the "Grit-Blasting" section in this chapter.

⚠ **CAUTION:** ALWAYS REMOVE ANY COMPONENT OR PART FROM THE ENGINE BEFORE GRIT-BLASTING THE COMPONENT OR PART.

(1) Remove any component to be grit-blasted from the engine per the removal procedures in this manual.

NOTICE: It is not necessary to protect the valve seats when grit-blasting the cylinder head combustion chamber.

(2) To grit-blast the engine cylinders, refer to the section "Grit-Blasting the Combustion Chamber in an Engine Cylinder" in this chapter.

(3) Operate the grit-blast gun as per the manufacturer's instructions.

(4) Unless otherwise specified in the manufacturer's instructions, use approximately 35 to 45 psi (241 to 310 kPa) of air pressure during grit-blasting.

(5) Use air pressure and the vacuum cleaner to remove any debris and residue.

(6) After all cleaning is complete:

(a) Rinse the part in a petroleum solvent.

(b) Dry the part with an air blast to remove all loose particles.

(c) Apply a coating of preservative oil to the entire part.

(d) Put cleaned bearings, oil and fuel system components in a clean sealed container until ready for assembly.

(e) Install clean plastic caps or covers over each open end of a cleaned hollow tube, hose or line to prevent debris from entering these areas.

(f) Put remaining cleaned parts on clean bench surfaces where there is no particulate, dirt, grit, or other unwanted materials.

9. Soft Carbon Removal
   A. Unless otherwise directed, put the component in a bath tank fully immersed in mineral spirits or equivalent for 10 minutes.
   B. Remove the component from the bath tank.
   C. Remove any remaining soft carbon (dirt or sludge) from the component with a lint-free wipe.
   D. Apply a spray coating of lubricating oil on the component to prevent corrosion.
   E. If the component is not to be installed immediately, put the component in a sealed plastic bag to prevent the oil from drying out.
10. Hard Carbon Removal

⚠ **CAUTION:** DO NOT PUT STEEL AND MAGNESIUM PARTS INTO THE SAME DECARBONIZING SOLUTION, BECAUSE IT CAN CAUSE CORROSION OF THE MAGNESIUM PARTS.

NOTICE: If you are not sure if the component is steel or contains magnesium, contact Field Service at Lycoming Engines at the phone numbers in the front of the manual.

⚠ **CAUTION:** DO NOT USE WIRE BRUSHES OR METAL SCRAPERS ON BEARINGS OR CONTACT SURFACES.

NOTICE: Hard carbon can remain on interior surfaces of cylinders and combustion chambers after using a degreasing solvent to clean a part.

   A. Put the component with the hard carbon fully immersed into a warm decarbonizing solution (examples: Gunk®, Penetrol®, or equivalent) in a heated bath tank.
   B. Soak for 10 minutes (to loosen the hard carbon).
   C. Remove the component from the bath tank.
   D. Use a (non-wire) bristle brush, wooden scraper, or grit-blasting (with non-abrasive media as per the section “Grit-Blast Media” in this chapter) to physically remove the hard carbon.
   E. Remove any remaining hard carbon from the component with a lint-free wipe.
   F. Apply a spray coating of lubricating oil on the component to prevent corrosion.
   G. If the component is not be installed immediately, put the component in a sealed plastic bag to prevent the oil from drying out.
11. Cylinder Cleaning
   A. Clean the internal barrel of the cylinder by flushing it with a hydrocarbon-based solvent (mineral spirits MIL-PRF-680 or equivalent) under air pressure. Use a soft bristle brush in conjunction with flushing to remove abrasive build-up from areas that are otherwise difficult to reach.
   B. Wipe the cylinder with a clean, white cloth dipped in SAE 10 engine oil. Examine the cloth under a light for evidence of any abrasive residue remaining in the cylinder. If any residual abrasive is found, repeat the previous step until there is no abrasive residue.
   C. Remove all oil accumulation from the external sides of the cylinders by washing with mineral spirits (MIL-PRF-680), kerosene, or equivalent degreasing solvent.
   D. Thoroughly dry the cylinder with compressed air.

E. Clean the cylinder head fin areas thoroughly with mineral spirits (MIL-PRF-680), kerosene or equivalent, to remove all traces of grease, dirt, or other foreign matter, and air dry with compressed air.

F. Grit-Blasting the Combustion Chamber in an Engine Cylinder

⚠ **CAUTION:** ALWAYS REMOVE THE CYLINDER FROM THE ENGINE BEFORE GRIT-BLASTING THE COMBUSTION CHAMBER.

(1) Review the steps in the "Grit-Blast Procedure" in this chapter.

NOTICE: Only use walnut shells (Type 12/20 Grit 17) on engine cylinders.

(2) Remove the intake and exhaust valves from the cylinder to be cleaned. Refer to Chapter 72-30.

(3) Remove the spark plugs from the cylinder. Refer to the section "Spark Plug Removal" in Chapter 74-20 of the ***IO-360-N1A Engine Service Manual***.

(4) Record the cleaning for future reference to identify trends and engine operating time for lead build up to occur.

12. Piston Cleaning

⚠ **CAUTION:** DO NOT GRIT-BLAST PISTON GROOVES. DO NOT USE A STEEL BUFFING BRUSH TO CLEAN THE RING LANDS AND SKIRT OF A PISTON. THESE METHODS CAN PREVENT CORRECT PISTON RING SEATING DURING PISTON ASSEMBLY.

A. Remove all oil or preservative oil accumulation from the piston by a soak or wash in a clean bath of mineral spirits, Safety Solvent, or equivalent degreasing solvent in compliance with MIL-PRF-680 specifications.

B. Remove any remaining deposits with a wooden scraper.

C. Gently clean the piston bore on each side of the piston with a soft bristle non-metallic brush (Figure 1). Use a gentle twist motion to clean each bore.

Figure 1
Cleaning the Piston Bore with a Soft Bristle Non-Metallic Brush

D. Soak the piston again in a new clean bath of mineral spirits, Safety Solvent, or equivalent degreasing solvent in compliance with MIL-PRF-680 specifications to remove remaining deposits.

E. Clean the piston ring grooves thoroughly. Make sure the piston ring grooves are completely clean and that there is no debris in the grooves.

13. Steel, Aluminum, or Magnesium Parts Cleaning

⚠ **CAUTION:** DO NOT USE ANY HEATED DECARBONIZING SOLVENT ON STEEL OR MAGNESIUM PARTS. THE DECARBONIZING SOLVENT CAN DAMAGE OR CORRODE THE MAGNESIUM AND STEEL PARTS.

ONLY USE PETROLEUM-BASED DECARBONIZING SOLUTIONS ON ALUMINUM PARTS.

DO NOT USE WATER-MIXED SOLVENTS THAT CONTAIN CAUSTIC COMPOUNDS AND/OR SOAP, BECAUSE THEY CAN CAUSE DAMAGE TO ALUMINUM AND MAGNESIUM PARTS. WHEN THE ENGINE IS RETURNED TO SERVICE, THESE MATERIALS CAN ENTER THE PORES OF THE METAL AND CAUSE OIL FOAMING.

NOTICE: If you are not sure if the component is steel or contains magnesium or aluminum, contact Field Service at Lycoming Engines at the phone numbers in the front of this manual.

A. Put the component fully immersed in mineral spirits or equivalent in a bath tank.

B. Remove the component from the bath tank.

C. Remove any remaining soft carbon (dirt or sludge) from the component with a lint-free wipe.

D. Apply a spray coating of lubricating oil on the component to prevent corrosion.

E. If the component is not to be installed immediately, put the component in a sealed plastic bag to prevent the oil from drying out.

14. Spark Plug Cleaning

A. Remove the spark plug as per the "Spark Plug Removal" procedure in Chapter 74-20 of the ***IO-360-N1A Engine Service Manual***.

B. Clean the ignition lead, cable ends, spark plug walls, and ceramic of the spark plugs (new or reused) as per the spark plug manufacturer's instructions.

C. Wipe the spark plug lead connector clean using a lint-free cloth moistened with Methyl-ethyl-ketone (MEK), acetone, or wood alcohol.

D. Remove all cleaning residue from the spark plug lead connector.

E. Dry all parts using compressed air.

F. Install the spark plug as per the "Spark Plug Installation" procedure in Chapter 74-20 of the ***IO-360-N1A Engine Service Manual***.

15. Lead Deposit Removal

    A. Grit-blast (the component with lead deposits) with 17 grit walnut shells or any comparable, mildly abrasive organic substance such as rice or baked wheat or plastic pellets at 35 to 45 psi (241 to 310 kPa). Refer to the section "Grit-Blast Media" and "Grit-Blast Procedure" in this chapter.

    B. Remove all debris from the component and nacelle to prevent problems caused by foreign object debris.

16. Injection Nozzle Cleaning

    A. Remove the injection nozzle as per the "Injection Nozzle Removal" procedure in Chapter 73-10.

    ⚠ **CAUTION:** NEVER USE A SHARP TOOL SUCH AS A WIRE OR PIN TO CLEAN AN INJECTION NOZZLE. DAMAGE TO THE INLET AND OUTLET FUEL RESTRICTORS COULD OCCUR WHICH WOULD CHANGE THE FUEL FLOW.

Clean the Precision fuel injection nozzle with:

- Hoppes No. 9 Gun Cleaning Solvent
  (1) Soak the nozzles in Hoppes® No. 9 Gun Cleaning Solvent for 20 minutes.
  (2) Rinse the nozzles with Stoddard solvent and blow dry with compressed air.
- Alkon Cleaner
  (1) The solution concentration of Alkon cleaner to water is 7 to 8 oz./gal. (207 to 237 cc/3.8 l).
  (2) Heat the Alkon/water solution to 140°F (60°C).
  (3) Soak the nozzles in the Alkon/Water solution for one hour.
  (4) Rinse the nozzles with clean hot water and blow dry with compressed air.
- MEK (methyl-ethyl ketone)
  (1) Soak the nozzles in MEK for one hour.
  (2) Rinse the nozzles with clean hot water and blow dry with compressed air.
- Acetone
  (1) Soak the nozzles in acetone for one hour.
  (2) Rinse the nozzles with clean hot water and blow dry with compressed air.

Clean the AVStar fuel injection nozzle with:

- MEK (methyl-ethyl ketone)
  (1) Soak the nozzles in MEK for one hour.
  (2) Rinse the nozzles with clean hot water and blow dry with compressed air.
- Acetone
  (1) Soak the nozzles in acetone for one hour.
  (2) Rinse the nozzles with clean hot water and blow dry with compressed air.

    B. Install the injection nozzle as per "Injection Nozzle Installation" procedure in Chapter 73-10.

17. Volcanic Ash Removal

⚠ **CAUTION:** DO NOT TOUCH THE VOLCANIC ASH WITH BARE HANDS OR GET IT IN YOUR EYES. WEAR PERSONAL PROTECTIVE EQUIPMENT.

DO NOT USE WATER INITIALLY TO REMOVE THE VOLCANIC ASH. WHEN VOLCANIC ASH COMES INTO CONTACT WITH WATER, IT CAN BECOME A HARDENED, CORROSIVE COMPOUND.

A. Engine exterior and components NOT contaminated with volcanic ash:
   (1) Remove grease, oil, dirt, and soft carbon deposits from the parts.
   (2) Spray or brush the components with a hydrocarbon-base solvent.
B. Examine the induction filters, induction system, and engine baffles for blockage or damage.
C. Refer to the section "Volcanic Ash/Particulate Contamination" in Chapter 05-50.
D. Refer to the aircraft manufacturer's instructions for additional information
E. After the engine is returned to service and has been operated for 10 hours, examine the external engine, cowling, and nacelle for any remaining ash. Remove all volcanic ash.

05-50 - UNSCHEDULED CORRECTIVE MAINTENANCE

1. Unscheduled corrective maintenance is necessary when any of the following conditions occur:

- Lightning strike
- Engine overspeed
- Incorrect fuel or fuel contamination
- Soaked engine
- Engine on fire or near fire
- Hydraulic lock
- Volcanic ash/particulate contamination
- Valve sticking
- Oil starvation/sudden loss of oil pressure
- Propeller strike, sudden engine stoppage or loss of blade tip

A. Lightning Strike

(1) After a lightning strike:

(a) Before next flight, examine the engine and compartment. Examine external surfaces and internal parts for discoloration, cracks, and other indications of arcing and heat damage.

NOTICE: Heat from a lightning strike can cause internal damage to the hardened surfaces of parts such as crankshaft bearing surfaces, camshaft lobes, gear teeth, etc.

(b) It is recommended the engine be sent to Lycoming Engines for evaluation.

OR

Complete the following in the field in accordance with this manual

(a) Remove, disassemble, and clean the engine (per Chapters 72-00, 72-05, and 05-30)

(b) Complete an inspection of the engine and its components per chapters in this manual and in the ***IO-360-N1A Engine Service Manual.***

NOTICE: Refer to the latest revision of Service Bulletin No. SB-240 which identifies certain parts that must be replaced on engine reassembly.

(c) Assemble the engine (per Chapter 72-10) and complete an operational check (per Chapter 72-00 in the ***IO-360-N1A Engine Service Manual***) to ensure correct engine operation.

B. Engine Overspeed

(1) In *engine overspeed*, the engine operates above its rated (speed) revolutions per minute (rpm). *Momentary overspeed* is an increase of no more than 10% of rated engine rpm for a period not exceeding 3 seconds.

NOTICE: Refer to the engine specifications in Appendix A of the ***IO-360-N1A Engine Installation and Operation Manual*** for rated engine speed.

All incidents of engine overspeed must be recorded in the engine logbook along with any corrective action identified herein.

(2) If any engine is operated at overspeed for more than 3 seconds, identify the category of percent of overspeed based on the three categories of overspeed shown in Table 1.

Table 1
Overspeed Values for IO-360-N1A Engine

Overspeed Category	rpm	Corrective Action
Engine overspeed in excess of maximum rated rpm or less than 5% of rated engine speed for 3 seconds or less	2701 to 2835	a. Identify and correct the cause of the overspeed. b. In the engine logbook, make a record of the overspeed incident and any inspections and corrective action.
Between 5 and 10% or rated engine speed (5 and up to 10% overspeed) for 3 seconds or less	2836 to 2970	a. Identify and correct the cause of the overspeed. b. Complete the "Cylinder Overspeed Inspection" procedure in this chapter. c. Refer to Chapter 12-10 in the ***IO-360-N1A Engine Service Manual:*** (1) Drain the lubricating system. (2) Remove oil screens. (3) Examine all screens in the lubrication system for metal contamination. If any unexplained metal accumulation is found, identify and correct the cause before putting the engine back into service. d. Complete the "Valve Train Overspeed Inspection" procedure in this chapter. e. Complete the "Magneto Overspeed Inspection" in this chapter. f. In the engine logbook, make a record of the overspeed incident and any inspection and corrective action.
More than 10% of rated speed (10% or more overspeed)	2971 or more for any length of time	a. Remove the engine from the aircraft. Refer to the "Engine Removal" procedure in Chapter 72-00. b. It is recommended the engine be sent to Lycoming Engines for customized evaluation. Include a description of the overspeed incident, amount of overspeed, and duration. c. In the engine logbook, make a record of the overspeed incident and any inspections and corrective action. OR Refer to Chapter 72-05 and the latest revision of Service Bulletin No. SB-240 to: • Disassemble the engine • Complete an inspection of the engine • Replace any parts that are damaged or not in compliance • Replace any other parts that must be replaced at overhaul or upon removal

(2) Cylinder Overspeed Inspection

(a) Complete the cylinder compression pressure check on all cylinders as a check for the sealing quality of the rings and valves. Refer to the section "Cylinder Compression Check Procedure" in Chapter 72-30 of the ***IO-360-N1A Engine Service Manual.***

(b) Use a borescope or equivalent instrument to examine the walls of each cylinder for scoring which could be caused by a stuck or broken piston ring. Refer to the "Cylinder Borescope Inspection" procedure in Chapter 72-30 of the ***IO-360-N1A Engine Service Manual.***

(3) Magneto Overspeed Inspection

(a) Remove the magnetos per the "Magneto Removal" procedure in Chapter 74-30. Examine the magnetos for damage; recondition or replace parts as necessary.

(b) Examine the magneto drive gears for looseness which is an indication that the supporting idler shafts are loose due to failure of safety attachments.

(c) Test the magnetos in accordance with the magneto manufacturer's instructions.

(d) Replace the magneto if damaged.

(4) Valve Train Overspeed Inspection

(a) Either repeated moments or short periods of operation in the overspeed region increase the rate of wear at an accelerated rate in the parts that make up the valve train and consequently decrease engine reliability. In addition to the checks completed on the engine during a 100-hour maintenance inspection (in the ***IO-360-N1A Engine Service Manual***), complete the following steps to examine the valve train before putting the engine back into service.

(b) Use a borescope or equivalent illuminated magnifying optical device to examine the condition of the intake and exhaust valve faces and seat faces. If there is evidence of excessive wear, pounding, or grooving, replace the valve and seat.

(c) Refer to the section "Exhaust Valve and Guide Inspection" in Chapter 72-30 of the ***IO-360-N1A Engine Service Manual*** and the latest revision of Service Bulletin No. SB-388 to determine exhaust valve condition and stem-to-valve guide clearance condition.

(d) Examine the external condition of valve keys, rockers, and exhaust valve guides for damage (per Chapter 72-30 in the ***IO-360-N1A Engine Service Manual***). Examine valve springs for coil strikes or severe bottoming of the coils. If damage to the valve springs is evident, remove them and complete the check of the compression load. Replace any valve spring that is not within limits as specified in the latest revision of the ***Service Table of Limits - SSP-1776***.

(e) Turn the crankshaft by hand to see if the valve lift is uniform or equal for all cylinders. See if valve rockers lift freely when the valves are closed. Unequal valve lift is an indication of bent push rods. Tight rockers, when valves are closed, are an indication of a tuliped valve or a damaged valve lifter. Refer to Chapter 72-30 and correct any suspected damage before putting the engine back into service.

C. Incorrect Fuel or Fuel Contamination

⚠ **CAUTION:** ONLY USE APPROVED FUELS IDENTIFIED IN THE LATEST REVISION OF SERVICE INSTRUCTION NO. SI-1070 IN THIS ENGINE. USE OF ANY UNAPPROVED FUEL CAN DAMAGE THE ENGINE.

(1) Refer to the latest revision of Service Instruction No. SI-1070 for a list of approved fuels, octane ratings, and the use of a higher grade fuel for this engine.

(2) Actual damage to the engine from incorrect fuel could be in a range from unnoticeable to severe damage or failure. Primary damage to the engine caused by incorrect fuel occurs in the combustion chambers. Tuliped intake valves and burnt pistons from excessive cylinder head and oil temperatures are evidence of primary damage. If detonation has been severe enough, further damage will occur to crank pins, main bearings, and valve train components. The extent of damage can vary accordingly based on the duration of operation, engine power level and the type of fuel used.

⚠ **WARNING:** AVOID FLIGHT IF JET FUEL OR A LOWER OCTANE OR INCORRECT GRADE OF FUEL OR JET FUEL (DIFFERENT FROM FUEL IDENTIFIED IN THE LATEST REVISION OF SERVICE INSTRUCTION NO. SI-1070) IS USED TO OPERATE THE ENGINE. UNUSUAL DETONATION CAN INCREASE ENGINE TEMPERATURE AND PRESSURE WHICH CAN DAMAGE THE ENGINE.

(3) Any mixture of unapproved fuels and additive materials that change the octane rating from the specifications in the latest revision of Service Instruction No. SI-1070 could be harmful to the engine.

(4) Because of many variables, it is impossible to be sure of the airworthiness of an engine that has been operated with incorrect fuel - except by detailed inspection of the engine by qualified personnel. Therefore, after the engine has been operated with incorrect fuel, regardless of the power setting or time of operation:

(a) Do not continue flight and engine operation with incorrect fuel.

(b) Drain the aircraft fuel system until all fuel tanks are empty in accordance with the aircraft manufacturer's installation.

(c) If the aircraft manufacturer has a procedure for cleaning and/or purging the aircraft fuel system after the use of an incorrect fuel, follow the aircraft manufacturer's procedure. If there is no aircraft cleaning and/or purging procedure, service the aircraft fuel tanks in accordance with the aircraft manufacturer's instructions.

(d) Remove the engine in accordance with the "Engine Removal Procedure" in Chapter 72-00.

(e) Examine external engine components. Carefully look for signs of detonation such as tuliped intake valves and burnt pistons.

(f) It is recommended the engine be sent to Lycoming Engines for evaluation.

OR

Complete the following in the field in accordance with this manual:

1 Remove, disassemble, and clean the engine per Chapters 72-00, 72-05, and 05-30.

2 Complete an inspection of engine components per chapters in this manual.

3 During inspection of engine components, carefully look for signs of detonation such as tuliped intake valves, burnt pistons, and damage to: crankpins, main bearings, and drive train components, and other conditions that can cause engine failure.

NOTICE: Refer to the latest revision of Service Bulletin No. SB-240 which identifies certain parts that must be replaced on engine reassembly.

4 Assemble the engine per Chapter 72-10 and complete an operational check per Chapter 72-00 in the ***IO-360-N1A Engine Service Manual***.

D. Soaked Engine

⚠ **CAUTION:** WHEN AN ENGINE HAS BEEN SOAKED IN WATER, MOISTURE AND UNWANTED MATERIALS CAN CAUSE DAMAGE TO ALL SYSTEMS OF THE ENGINE. DO NOT OPERATE AN ENGINE THAT HAS BEEN SOAKED OR IMMERSED IN ANY KIND OF LIQUID. THE ENGINE MUST BE DISASSEMBLED AND EXAMINED.

NOTICE: The composition of the substance that the engine has been exposed to can affect the type and extent of the damage.

It is recommended the engine be sent to Lycoming Engines for evaluation. Include a description of the liquid in which the engine was soaked.

OR

Complete the following in the field in accordance with this manual:

(1) Remove, disassemble, and clean the engine (per Chapters 72-00, 72-05, and 05-30)

(2) Complete an inspection of engine components per chapters in this manual.

NOTICE: Refer to the latest revision of Service Bulletin No. SB-240 which identifies certain parts that must be replaced on engine reassembly.

(3) Assemble the engine per Chapter 72-10 and complete an operational check per Chapter 72-00 in the ***IO-360-N1A Engine Service Manual***.

E. Engine on Fire or Near a Fire

Replace any components exposed to the heat of a fire.

It is recommended the engine be sent to Lycoming Engines for evaluation. Include a description that the engine was in or near a fire or external heat.

OR

Complete the following in the field in accordance with this manual:

(1) Remove, disassemble, and clean the engine (per Chapters 72-00, 72-05, and 05-30)

(2) Complete an inspection of engine components per chapters in this manual.

NOTICE: Refer to the latest revision of Service Bulletin No. SB-240 which identifies certain parts that must be replaced on engine reassembly.

(3) Assemble the engine per Chapter 72-10 and complete an operational check per Chapter 72-00 in the ***IO-360-N1A Engine Service Manual***.

F. Hydraulic Lock

⚠ WARNING: DO NOT OPERATE THE ENGINE IF HYDRAULIC LOCK IS SUSPECTED.

Hydraulic lock is caused by liquid accumulation in either the Induction System or the cylinder assembly.

(1) The liquid prevents movement of the piston during the compression stroke.

(2) Damage to the engine occurs when the other cylinders fire, which forces the piston in the liquid-filled cylinder through the compression stroke.

(3) Damage to an engine from hydraulic lock can be extensive due to the high forces. These forces can damage connecting rods, pistons, cylinder assemblies, piston pins, the crankcase, and the crankshaft.

(4) Hydraulic lock can occur as a result of any of the following:

- Incorrect operation of the fuel drain valve adapter assembly.
- Incorrect starting procedures.
- Failure to remove preservative oil from an engine that had been in storage.

(5) It is recommended the engine be sent to Lycoming Engines for evaluation. Include a description and details of the hydraulic lock.

OR

Examine the engine for hydraulic lock in the field as follows:

(a) Remove all cylinders as per the section “Cylinder Removal” in Chapter 72-30.

(b) Refer to Chapter 72-20 to remove and examine the connecting rods.

(c) If all connecting rods are in compliance with the specified criteria in the latest revision of the ***Service Table of Limits - SSP-1776***, install the connecting rods.

(d) If any connecting rod is not in compliance with acceptance criteria, disassemble the engine to examine the crankcase and crankshaft as per Chapters 72-05 and 72-20.

G. Volcanic Ash/Particulate Contamination

⚠ CAUTION: IF VOLCANIC ASH IS SUSPECTED ON THE ENGINE, DO NOT INHALE IT OR TOUCH IT WITH BARE HANDS OR GET IT IN YOUR EYES. WEAR PERSONAL PROTECTIVE EQUIPMENT. **DO NOT USE WATER** TO RINSE IT OFF. THE VOLCANIC ASH CAN CONTAIN ACIDIC COMPOUNDS WHICH MUST NOT BE INHALED OR TOUCHED SINCE IT CAN CAUSE INJURY.

(1) Given the dynamic conditions of volcanic ash, Lycoming recommends that engines not be operated in areas where volcanic ash is seen in the air or on the ground. Ash on the ground and runways can inadvertently get into the engine compartment and cause engine damage during landing or take-off.

(2) If volcanic ash or particulates get into the engine oil, engine malfunction and/or failure can occur from abrasive wear.

(3) If you know in advance of potential flight in volcanic or particulate-laden environments, as a precaution, install inlet and exhaust covers to prevent airborne volcanic ash from entry into the static engine.

(4) Inlet air which contains volcanic ash or other particulates can cause damage to piston engines. Solid deposits can collect on engine baffles or other engine surfaces to prevent engine cooling. Accumulation of deposits on the induction air filter can prevent air flow to the engine and decrease engine power.

(5) However, if during flight, the engine is in a particulate-laden atmosphere, do the following:

(a) Monitor the engine temperature during flight. (Damaged or blocked cooling baffles or heavy deposits on engine cooling surfaces can decrease cooling efficiency and cause the engine to overheat.)

(b) If the engine is not operating smoothly in flight, make a safe landing as soon as possible.

(6) In the event that the engine has been in particulate-laden atmospheres, especially volcanic ash clouds or with ash on the ground, complete the standard actions in Table 2.

Table 2
Action to Take in Volcanic Ash Conditions

Maintenance after flight…	**Maintenance after 10 hours of operation or the next flight…**
Wear personal protective equipment (gloves, respiratory, and eye protection). Per the aircraft manufacturer's instructions, thoroughly remove the ash or particulate from the aircraft by hand brushing or air/vacuuming. Make sure that all ash is removed from the engine, nacelle and cowling.	Wear personal protective equipment. Examine the external engine, cowling, and nacelle for any particulate or ash residue. Remove any particulate or ash residue per the aircraft manufacturer's instructions.
Complete the post-flight inspection. Particularly, examine the induction filters, induction system, and engine baffles for blockage or damage.	Complete the pre-flight inspection.
Immediately, complete an oil change and replace the oil filter. Collect an oil sample and have a spectrographic analysis done on the oil sample. Compare this analysis with past oil analyses to determine engine wear or contamination. Refer to Chapter 12-10 in the ***IO-360-N1A Engine Service Manual***.	Change the oil and replace the oil filter. Collect another oil sample for spectrographic analysis. Compare the results against the last oil sample to identify engine wear or effects of contamination. As a precaution, complete another oil change and analysis of another oil sample again. Refer to Chapter 12-10 in the ***IO-360-N1A Engine Service Manual***.

Table 2 (Cont.)
Action to Take in Volcanic Ash Conditions

Maintenance after flight…	Maintenance after 10 hours of operation or the next flight
Replace the intake air filter, as per the aircraft manufacturer's instructions to remove any internal contamination that can cause premature wear because of the highly abrasive effects from most solid particles.	Replace the intake air filter as a precaution to be sure there are no effects from particulate contamination. Replace the intake air filter again after the next flight.
Examine the external condition of the engine, all accessories, compressor, external fuel and oil cooling air baffles, oil lines, and all other components for corrosion or scoring. Identify any possible damage caused by the high speed impact from solid particles and corrosive effects caused by the chemical composition of volcanic ash.	Examine the external condition of the engine, all accessories, compressor, external fuel and oil cooling air baffles, oil lines, and all other components for corrosion or scoring. Identify any possible damage caused by high speed impact from solid particles and corrosive effects caused by the chemical composition of the volcanic ash. Complete this inspection again as necessary.
Drain all other fuel/fluids from the engine and replace with clean fluids. Replace the disposable fuel filter or remove and clean the fuel inlet screen, as per the aircraft manufacturer's instructions.	Remove and examine the fuel filter or fuel inlet screen to identify any remnants of contamination. Replace the fuel filter or clean the fuel inlet screen if contamination is found.
Examine seals for damage and leaks. Replace damaged or leaky seals.	Monitor oil temperature and pressure for indications of engine problems.
Clean the engine with a high pressure air spray. Be sure to clean the cooling fins on the cylinders.	
In volcanic ash fall-out or high sand or dust areas, after the engine cools, install inlet and exhaust covers to prevent airborne volcanic ash or particulate from entry into the static engine.	

H. Valve Sticking

(1) The primary causes of intake or exhaust valve sticking are:

(a) Accumulated contaminants in the oil and oil filter can collect on valve stems and/or guides to prevent valve movement and cause intermittent engine hesitation or "miss." If the contamination deposits are not removed, the valve becomes stuck and causes engine damage.

(b) Conditions that can increase oil contamination and valve sticking include:

- High ambient temperature
- Slow flight with reduced cooling
- High lead content in fuel
- Oil changes and oil filter replacement not done as frequently as necessary. Refer to the sections "Oil Change Procedure" and "Oil Filter Replacement" in Chapter 12-10 in the ***IO-360-N1A Engine Service Manual***.
- Induction system not sealed - unfiltered air enters engine
- Cooling air baffles and/or baffle strip deterioration
- Sudden cool down of the engine that can occur with a rapid descent with reduced power or engine shutdown without sufficient engine cooling.

NOTICE: If valve sticking is a recurring problem on an IO-360-N1A engine, refer to the ***IO-360-N1A Engine Service Manual*** and complete the 1000 hour inspection after every 400 hours of engine operation. Refer to the section "Corrective Action for Valve Sticking" in Chapter 72-30.

I. Oil Starvation/Sudden Loss of Oil Pressure

(1) To operate correctly at various attitudes, the engine must be supplied with a sufficient quantity of lubricating oil. Unless there is an adequate quantity of lubricating oil at all times during flight, loss of oil pressure can occur.

NOTICE: Refer to Appendix A of the ***IO-360-N1A Engine Installation and Operation Manual*** for the minimum oil quantity.

(2) During various attitudes of flight, the risk of oil not covering the inlet to the oil pump increases as the quantity of oil decreases. In certain attitudes, the oil in the oil sump cannot be drawn into the oil pickup which can cause a momentary loss of oil pressure. If there is insufficient oil during flight, oil starvation can occur. Yet, not all low oil pressure incidents result in oil starvation.

(3) Very often a sudden loss of oil pressure is quickly followed by a sudden rise in oil temperature.

(4) As a preventive measure, before every take-off, complete a check of the engine oil level as per instructions in "Oil Level Check" in Chapter 12-10 in the ***IO-360-N1A Engine Service Manual***. Make sure the oil level is above the minimum specified level.

NOTICE: Circumstances which cause loss of oil pressure can be different which makes prediction of the extent of damage to the engine or future engine reliability difficult. In case of oil pressure loss or engine operation with oil below the minimum operating level, the most conservative action is to remove the engine, (Chapter 72-00), disassemble (Chapter 72-05), and completely examine all engine components per chapters herein. Any decision to operate an engine that had loss of oil pressure without an inspection must be the responsibility of the agency putting the aircraft back into service.

(5) Any time oil pressure falls below the minimum level, identify the root cause as per the following protocol progressive steps:

(a) Complete the check of the oil level in the oil sump. Drain the oil if necessary to measure the oil quantity.

(b) If the oil level is sufficient, complete the check of the oil pressure indication system accuracy. If the oil pressure gage is not operating correctly, replace it.

(c) Examine oil line connections for leaks. Tighten any loose connections as per the torque values in the latest revision of the ***Service Table of Limits - SSP-1776*** and look for leaks. Replace leaking oil lines.

(d) Examine the oil suction screen at the oil sump and oil filter for blockage or metal deposits. If metal or blockage is found, remove the material and identify the origin of material and correct the root cause.

(e) Examine the oil pump for malfunction. Replace the oil pump if it is not operating correctly. Refer to Chapter 72-25.

(f) If the oil pressure indication system is operating correctly and there has been confirmation that oil pressure loss/oil starvation has occurred, remove the engine (Chapter 72-00) and disassemble the engine for evaluation (Chapter 72-05).

J. Propeller Strike, Sudden Engine Stoppage or Loss of a Propeller Blade Tip

(1) This section includes recommendations for aircraft engines that have had propeller/rotor damage as well as any of the following.

- Separation of the propeller/rotor blade from the hub
- Loss of a propeller or rotor blade tip
- Sudden stoppage

(2) A propeller strike includes:

- Any incident, whether or not the engine is operating, where repair of the propeller is necessary
- Any incident during engine operation where the propeller has impact on a solid object which causes a decrease in rpm and where a structural repair of the propeller is necessary. This incident includes propeller strikes against the ground. Although the propeller can continue to turn, damage to the engine can occur, possibly with progression to engine failure.
- Sudden rpm drop on impact to water, tall grass, or similar yielding medium where propeller damage does not usually occur.

(3) A propeller strike can occur at taxi speeds, including instances of touch and go operations with propeller tip ground contact. In addition, propeller strikes also include situations where an aircraft is stationary and a landing gear collapse occurs causing one or more blades to be bent, or where a hangar door (or other object) hits the propeller blade. These instances are cases of sudden engine stoppage because of potentially severe side loading on the crankshaft flange, front bearing, and seal.

(4) Recommended Corrective Action for Propeller Strikes

⚠ **CAUTION:** BASED UPON THE ACCUMULATED ENGINEERING, TECHNICAL AND HISTORICAL DATA AVAILABLE, LYCOMING ENGINES **PROHIBITS** STRAIGHTENING OR GRINDING OF BENT CRANKSHAFT FLANGES TO RESTORE MAXIMUM RUN-OUT SPECIFICATION AS NOTED IN THE LATEST REVISION OF THE TABLE OF LIMITS, SSP-1776. IF THE CRANKSHAFT FLANGE IS BENT, REPLACE THE CRANKSHAFT. **DO NOT TRY TO STRAIGHTEN OR GRIND THE CRANKSHAFT FLANGE.** REFER TO THE LATEST REVISION OF SERVICE BULLETIN NO. SB-201. DAMAGE TO A PROPELLER IS SERIOUS AND CAN CAUSE THE ENGINE TO BE UNAIRWORTHY.

(a) Circumstances of a propeller strike cannot always be used as predictors of the extent of engine damage or its future reliability. There can be varying degrees of damage to an engine and propeller from a propeller strike. The initial damage can be hidden but could become progressively worse with time and wear.

(b) Given these possibilities and the fact that there is no identified clear, quantifiable threshold limit or gradient standard to reliably measure the extent of damage to an engine, Lycoming Engines can only recommend BEFORE FURTHER FLIGHT, that you complete the tasks in the sequential order shown in the Engine Inspection Checklist After Propeller Strike for IO-360-N1A Engine Models (in this chapter) as corrective action for a propeller strike.

NOTICE: The agency that returns the aircraft to service is responsible for the decision to operate an engine that had a propeller strike. Lycoming Engines does not take responsibility for the decision to return the engine to service after a propeller strike.

(5) Make a copy of the Engine Inspection Checklist After Propeller Strike; complete it and keep it as a service record. Record all results and any corrective action taken.

Engine Inspection Checklist After Propeller Strike for IO-360-N1A Engine Models			
Engine Model:		**Engine Serial Number:**	
Date Inspection Started:		**Date Inspection Completed:**	
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
1.	Remove the propeller.	As per airframe and propeller manufacturer's instructions.	
2.	Examine the propeller for extent of damage; record condition of propeller.	Condition of Propeller/Corrective Action: ☐ Propeller satisfactory ☐ Repair propeller in accordance with propeller manufacturer's instructions ☐ Replace propeller in accordance with the airframe manufacturer's instructions.	

Engine Inspection Checklist After Propeller Strike for IO-360-N1A Engine Models (Cont.)			
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
3.	Remove the engine.	In accordance with the airframe manufacturer's instructions.	
CRANKCASE P/N:		**MATCH NO:**	
4.	Disassemble the engine where the crankshaft, camshaft, connecting rods, crankshaft gear, and internal steel parts are removed.	Refer to Chapter 72-05	
5.	Complete grit-blast cleaning of the crankcase with 17 grit walnut shells or any comparable, mildly abrasive organic substance such as rice or baked wheat or plastic pellets at 35 to 45 psi (241 to 310 kPa); remove all coatings on the crankcase and engine mount bosses.	Refer to the "Grit-Blast Procedure" and "Crankcase Cleaning" in Chapter 05-30. Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable Fluorescent Penetrant Inspection (FPI) or subsequent oil flow.	
6.	Complete grit-blast cleaning of the oil sump and engine mount bosses with 17 grit walnut shells or any comparable, mildly abrasive organic substance such as rice or baked wheat or plastic pellets at 35 to 45 psi (241 to 310 kPa)	Refer to the "Grit-Blast Procedure" and "Crankcase Cleaning" in Chapter 05-30. Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable FPI or subsequent oil flow.	
7.	Complete grit-blast cleaning of the engine mount brackets (if used) with 17 grit walnut shells or any comparable, mildly abrasive organic substance such as rice or baked wheat or plastic pellets at 35 to 45 psi (241 to 310 kPa).	Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable FPI or subsequent oil flow.	
8.	Complete grit-blast cleaning of the accessory housing with 17 grit walnut shells at 35 to 45 psi (241 to 310 kPa).	Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable FPI or subsequent oil flow.	
9.	Remove and discard the existing crankshaft gear retaining bolt and lockplate.	Refer to the "Crankshaft Disassembly" procedure in Chapter 72-20.	

Engine Inspection Checklist After Propeller Strike for IO-360-N1A Engine Models (Cont.)			
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
10.	Examine the crankshaft.	Refer to the "Crankshaft Inspection" procedure and checklist in Chapter 72-20.	
11.	Examine, the crankshaft counter-bored recess, the alignment dowel especially at the base where it goes into the crankshaft, the bolt hole threads, and the crankshaft gear for wear, galling, corrosion, and fretting.	Refer to the latest revision of Service Bulletin No. SB-475. If the bolt hole threads are damaged, they cannot be repaired. Replace the crankshaft.	
12.	Clean the crankshaft, camshaft, crankshaft gear.	Refer to Chapter 05-30. Make sure there is no dirt, debris, sludge, paint, or any other substance that could prevent reliable magnetic particle inspection or subsequent oil flow.	
13.	Clean the following internal parts made of steel: • Connecting Rods • Piston pins • Rocker shafts • Accessory drive gears • Magneto gears • Idler and oil pump shafts • Shaft gears and impellers	Refer to Chapter 05-30.	
14.	Measure the flange run-out on the crankshaft.	Refer to the latest revisions of both Service Bulletin SB-240 and Part I of the ***Service Table of Limits - SSP-1776*** for crankshaft flange run-out tolerance.* Record the crankshaft flange run-out measurement.	☐ Flange run-out within acceptable limits ☐ Replace crankshaft

Engine Inspection Checklist After Propeller Strike for IO-360-N1A Engine Models (Cont.)			
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
BASED UPON THE ACCUMULATED ENGINEERING, TECHNICAL, AND HISTORICAL DATA AVAILABLE, LYCOMING ENGINES PROHIBITS STRAIGHTENING OR GRINDING OF BENT CRANKSHAFT PROPELLER FLANGES TO RESTORE MAXIMUM RUN-OUT SPECIFICATION PER THE LATEST REVISION OF THE SERVICE TABLE OF LIMITS SSP-1776. IF THE CRANKSHAFT PROPELLER FLANGE IS BENT, REPLACE THE CRANKSHAFT. DO NOT TRY TO STRAIGHTEN OR GRIND THE CRANKSHAFT PROPELLER FLANGE.			
CRANKSHAFT P/N:		**S/N:**	
15.	Measure the main bearing run-out on the crankshaft.	Refer to the latest revision of Part I of the ***Service Table of Limits - SSP-1776*** for the main bearing run-out tolerance Record the main bearing run-out measurement.*	☐ Main bearing run-out within acceptable limits ☐ Replace crankshaft
16.	Measure the polished dimensions on the main journals.	Refer to the latest revision of Part I of the ***Service Table of Limits - SSP-1776*** for the dimensions on the main journals Record the dimensions of the main journals.*	
17.	Measure the polished dimensions on the pin journals.	Refer to the latest revision of Part I of the ***Service Table of Limits - SSP-1776*** for the dimensions on the pin journals Record the dimensions of the pin journals.*	
18.	Complete a check of the connecting rod parallelism.	Record measurement. Refer to the "Connecting Rod Parallelism/Squareness Check" in Chapter 72-20 for measurement instructions.	
* If the measurement or dimension is out of tolerance, discard the crankshaft and replace it with a serviceable crankshaft. Install the crankshaft per "Crankshaft Installation" in Chapter 72-20.			
NOTICE: The magnetic particle inspection must be done by a qualified and certified technician as per the latest revision of Service Instruction No. SI-1285.			
19.	Complete a magnetic particle inspection on the crankshaft. Refer to the section "Non-Destructive Testing" in this chapter.	Record test results.	☐ Magnetic particle test results acceptable ☐ Replace crankshaft
20.	Complete a magnetic particle inspection on the camshaft.*	Record test results.	☐ Magnetic particle test results acceptable ☐ Replace camshaft

Engine Inspection Checklist After Propeller Strike for IO-360-N1A Engine Models (Cont.)			
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
21.	Complete a magnetic particle inspection on the connecting rods.*	Record test results.	Replace connecting rod bolts and nuts -regardless of condition. Refer to the latest revision of Service Instruction SI-1458 for assembly instructions.
22.	Complete a magnetic particle inspection on the crankshaft gear.* Examine the gear end as per the latest revision of Service Bulletin No. SB-475.	Record test results.	☐ Magnetic particle test results acceptable ☐ Replace crankshaft gear
23.	Complete a magnetic particle inspection on the following internal parts made of steel: • Accessory drive gears • Magneto gears • Idler and oil pump shafts • Shaft gears and impellers • Piston pins • Connecting rods	Record test results.	Use Replace ☐ ☐ Accessory drive gears ☐ ☐ Magneto gears ☐ ☐ Idler and oil pump shafts ☐ ☐ Shaft gears and impellers ☐ ☐ Piston pins ☐ ☐ Connecting Rods
NOTICE: Complete the visual inspection and Fluorescent Penetrant Inspection (FPI) in steps 24 through 28.			
24.	Crankcase Refer to the latest revision of Service Instruction No. SI-1285. Closely examine the forward crankcase bearing support and adjacent structure.	Record test results.	☐ Use crankcase ☐ Replace crankcase
25.	Oil sump	Record test results.	☐ Use oil sump ☐ Replace oil sump
26.	Engine mounts and, if used, the lower mount rings (on helicopter engines)	Record test results.	☐ Use engine mounts ☐ Replace engine mounts
27.	Accessory housing	Record test results.	☐ Use accessory housing ☐ Replace accessory housing
28.	Aluminum oil pump impeller	Record test results.	☐ Use impeller ☐ Replace impeller
29.	Examine the magneto in accordance with the magneto manufacturer's instructions.	Record test results.	☐ Replace magneto
30.	Examine the pistons per instructions in Chapter 72-30 and the latest revision of Service Instruction No. SI-1243.	Record test results.	☐ Pistons acceptable ☐ Replace pistons
* Refer to the section "Non-Destructive Testing" in this chapter.			

Engine Inspection Checklist After Propeller Strike for IO-360-N1A Engine Models (Cont.)			
Sequential Task		**Additional Information**	**Corrective Action Done/Comments**
31.	Refer to the latest revision of Service Bulletin No. SB-240 to identify any parts that must be replaced during engine assembly.	Record parts that must be replaced.	
32.	Install a new crankshaft gear retaining bolt and lockplate.	Refer to the "Crankshaft Gear Installation" procedure in Chapter 72-20.	
33.	Review the documents of all other rotating components on the engine, propeller governor (if installed), etc. for instructions on what to do for components exposed to sudden engine stoppage.		
34.	Assemble and install the engine. Install the propeller and test the engine. Complete an operational check of the engine.	In accordance with instructions in Chapter 72-10 and the latest revision of Service Instruction No. SI-1427.	
35.	Record maintenance findings and any corrective action.		
UNAIRWORTHY PARTS:			
ADDITIONAL WORK/INSPECTIONS NECESSARY:			
OUTCOME OF INSPECTION- SUMMARY NOTES:			

2. Non-Destructive Testing (Magnetic Particle Inspection and Fluorescent Penetrant Inspection.)

   A. Non-destructive testing (NDT) includes Magnetic Particle Inspection (MPI) and Fluorescent Penetrant Inspection (FPI). The purpose of the NDT is to identify the presence or potential of structural failures in an engine component.

      The MPI is used for detection of discontinuities on the surface and/or sub-surface of ferroelectric materials such as iron, nickel, cobalt, and some of their alloys.

      The FPI is used to identify casting, forging and welding surface defects such as hairline cracks, surface porosity, leaks in new products, and fatigue cracks on in-service components.

   B. Penetrant Materials Used for NDT

      Do not use visible dye for MPIs or FPIs because visible dye penetrant materials have an adverse effect on future penetrant inspections which can cause indications to be tightly closed and therefore missed during future inspections.

   C. Requirements for NDT Personnel

      Personnel who complete the Magnetic Particle and Fluorescent Penetrant Inspections on Lycoming engine components must be qualified and certified to a written procedure in accordance with *NAS-410, Certification and Qualification of NDT personnel.* Also, personnel who make the "accept" or "reject" decisions during the inspections must be qualified and certified to at least Level II in accordance with NAS-410.

   D. NDT Inspection Procedure Requirements and Guidelines

      (1) There must be written procedures for the Magnetic Particle Inspection and the Fluorescent Penetrant Inspection that have been approved by someone who is qualified and certified to Level III in accordance with NAS-410.

      (2) The inspections must be done per established acceptance criteria to ensure component conformance.

      (3) The procedures must identify:

      - Information requirements
      - Materials and equipment to be used
      - Instructions/steps to complete the inspection based on technique
      - Processing parameters.

      NOTICE: All procedure steps, process verification, materials, processing parameters, and techniques must be in compliance with the requirements in ASTM E 1444 for the Magnetic Particle Inspection and ASTM E 1417 for the Fluorescent Penetrant Inspection. Refer to the latest revision of Service Instruction No. SI-1285 for details.

      (4) The NDT Level III approved technique for the Magnetic Particle Inspection must be able to identify the smallest indication regardless of its orientation to the magnetic flux field. This technique must establish at least two magnetic fields, perpendicular to one another in a plane parallel to the surface examined. The technique must include all applicable processing parameters, including acceptance criteria, for correct inspection of the engine parts.

(5) A 3 power to 10 power magnifying glass must be used to evaluate indications.

(6) The Fluorescent Penetrant Inspection must use an NDT Level III approved technique that includes all processing parameters, including acceptance criteria for correct inspection of the engine parts.

E. Before NDT, clean the components as follows remove all traces of:

- Paint
- Gasket materials
- Oil
- Grease
- Dirt
- Corrosion
- Smeared metal
- Plating
- Chemical residues.

F. Use any of the "Cleaning Methods for Non-Destructive Testing" in Chapter 05-30.

G. Magnetic Particle Inspection is usually done to identify whether parts are acceptable for continued service.

NOTICE: If a Magnetic Particle Inspection is difficult to do on an odd-shaped part, the Fluorescent Penetrant Inspection can be used if the acceptance criteria apply only to surface indication.

12-30 - FAULT ISOLATION

1. Recommended Approach to Fault Isolation
   A. Refer to the section “Fault Isolation Guide” in this chapter.
   B. Visually examine the engine for indications of obvious problems, such as intake and exhaust leaks, physical damage to ignition wires and wiring harness, blocked breathers, fuel and oil stains, etc.
   C. Review maintenance logs to identify any trends or possible causes.
   D. Discuss any operational problems with the pilot to identify background, details or incidents of unusual operation.
   E. Record all findings and corrective action.
2. Fault Isolation Guide
   A. The Fault Isolation Guide in Table 1 applies to IO-360-N1A engines. The table shows the more common and recurring problems, causes, and corrective actions. Continue from the simplest to the most complex possible causes.
   B. The "Ref." column in Table 1 contains references to the following:
      (1) A numeric entry such as "72-00" refers to a chapter in this manual.
      (2) IOM refers to the ***IO-360-N1A Engine Installation and Operation Manual***.
      (3) SM refers to the ***IO-360-N1A Engine Service Manual***.

Table 1
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Engine will not start or starts with difficulty	Discharged battery	Replace with a charged battery in accordance with aircraft manufacturer’s instructions.	
	Incorrect starting procedure	Obey engine start procedures or the Aircraft Flight Manual.	
	Non-conforming starter	Complete the “Starter Replacement” procedure.	72-70
	No fuel or low fuel level	Complete the check of the fuel supply. Service as required.	
	No fuel flow Blockage in fuel line	1. Disconnect the fuel line. 2. Complete the “Injection Nozzle Fuel Flow Check” of the fuel flow. 3. Examine for evidence of leaks and correct as required.	73-10
		4. Clean the filters, strainers, lines, or fuel selector valve.	05-30
	Water in fuel system	Refer to the manufacturer’s instructions.	

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Engine will not start or starts with difficulty (Cont.)	Throttle valve open too far	Set the throttle control approximately 1/4 (of the length of throttle control travel) open for about 800 rpm.	
	Cylinder compression problem	1. Complete the "Cylinder Compression Check Procedure." 2. Complete the "Cylinder Borescope Inspection Procedure" to determine if further corrective action is necessary.	SM 72-30
	Ignition lead worn	Examine the ignition leads for breaks and cracks. Refer to the sections: • Spark Plug and Ignition Lead Inspection • Ignition Harness Inspection	SM 74-20
		• Ignition Harness Removal • Ignition Harness Installation	74-20
	Magneto incorrectly timed to engine.	Complete the "Magneto-to-Engine Timing" procedure.	SM 74-30
	Magneto internal timing not adjusted correctly or "E" gap drifting because of point or follower wear.	1. Replace magneto with a serviceable unit as per the "Magneto Replacement Procedure."	74-30
		2. Complete the "Magneto-to-Engine Timing" procedure.	SM 74-30
	Damaged spark plug	Complete the following procedures: • Spark Plug Removal • Spark Plug and Ignition Lead Inspection • Spark Plug Cleaning • Spark Plug Gap Setting • Spark Plug Rotation • Spark Plug Installation	SM 05-30 74-20
	Damaged ignition harness	Replace the ignition harness with a new harness as per the following sections: • Ignition Harness Removal • Ignition Harness Installation	74-20
	Incorrect crankshaft-to-camshaft timing	Complete the "Crankshaft-to-Camshaft Timing Check."	72-20

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Poor idle cut-off	Incorrect rigging of mixture control linkage	Adjust the mixture control in accordance with aircraft manufacturer's instructions.	
	Mixture control valve in the fuel injector is scored or not seating properly Leaky mixture control valve	1. Look for fuel leaks; disconnect the fuel line at the entrance to the fuel manifold. Put the throttle mixture in the OFF position and turn the boost pump ON. 2. Look for little or no fuel flow. If fuel is leaking more than 5 cc per minute, the mixture control valve is leaking. Remove the fuel injector. Either send it to a manufacturer-approved repair facility or replace it as per the "Fuel Injector Replacement" procedure.*	73-10
	Valve sticking in fuel manifold	1. Complete the "Fuel Manifold Removal" procedure. 2. Send to a manufacturer approved repair facility. 3. Complete the "Fuel Manifold Installation" procedure.	73-10
	Dirt in the air bleed hole of the injection nozzle	1. Complete the "Injection Nozzle Removal" procedure.	73-10
		2. Complete the "Injection Nozzle Cleaning" procedure.	05-30
		3. Install the injection nozzle as per "Injection Nozzle Installation" procedure.	73-10
	Loose fuel line at the fuel manifold or injection nozzle	1. Make sure the fuel line connections at the fuel manifold and injection nozzles are tight. 2. Make sure that all injection nozzles are tightly secured at the cylinders and not cross-threaded.	73-10
*Review any applicable warranty information relative to replacement of a fuel component as per the latest revision of Service Letters L221 and L253.			

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Rough Idle	Leak in induction system	Complete the "Induction System Inspection" procedure.	SM 72-80
	Internal fuel injector leak	Complete the "Fuel Injector Leak Check Procedure."	SM 73-10
	Blocked injection nozzles	1. Identify whether the cylinder with the suspected blocked injection nozzle is cold or hot. (The cylinder will be cold after 2 minutes of engine operation.)	
		2. Complete the "Injection Nozzle Fuel Flow Check." 3. Complete the "Injection Nozzle Removal" procedure.	73-10
		4. Clean the injection nozzle.	05-30
		5. Complete the "Injection Nozzle Installation" procedure.	73-10
	Dirt on injection nozzle screen and shroud blocking air bleed hole	1. Complete the "Injection Nozzle Removal" procedure.	73-10
		2. Complete the "Injection Nozzle Cleaning" procedure.	05-30
		3. Install the injection nozzle as per "Injection Nozzle Installation" procedure.	73-10
	Valve sticking in fuel manifold	Refer to "Corrective Action for Valve Sticking."	72-30
		1. Complete the "Fuel Manifold Removal" procedure. 2. It is recommended the engine be sent to Lycoming Engines for evaluation. 3. Complete the "Fuel Manifold Installation" procedure.	73-10
	Loose ignition lead(s)	Make sure all ignition leads are secure.	

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Rough Idle (Cont.)	Fault in the ignition system	1. Visually examine the harness for physical damage. 2. Examine leads using a high-tension lead tester. 3. Replace worn or damaged components as necessary. 4. Complete the following procedures: • Spark Plug Removal • Spark Plug and Ignition Lead Inspection • Spark Plug Cleaning • Spark Plug Gap Setting • Spark Plug Rotation • Spark Plug Installation.	SM 05-30 74-20
	Lean idle mixture	1. Adjust the idle mixture per instructions in the section "Idle Speed and Mixture Adjustment." 2. Readjust idle speed.	SM 72-00
	Low fuel pressure	1. Examine the fuel filter for blockage. Clean a blocked fuel filter as per the aircraft manufacturer's instructions. 2. Replace fuel pump as per fuel pump replacement procedure.*	73-10
	Worn Camshaft Lobes	Replace the camshaft.	72-20
	Uneven cylinder compression	1. Complete the "Cylinder Compression Check Procedure." 2. Complete the "Cylinder Borescope Inspection Procedure" to determine if further corrective action is necessary.	SM 72-30
	Cracked engine mounts or defective mount bushings	Replace engine mounts in accordance with aircraft and part manufacturer's instructions.	
	Engine mount bushing incorrectly installed	Install the engine mount bushing in accordance with manufacturer's instructions.	
*Review any applicable warranty information relative to replacement of a fuel component as per the latest revision of Service Letters L221 and L253.			

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Engine will not idle unless the boost pump is on	Lean idle mixture	1. Enrich the idle mixture as per the section "Idle Speed and Mixture Adjustment." 2. Readjust the idle speed.	SM 72-00
	Fuel pressure too low at idle speed (engine could also lose fuel pressure as the aircraft climbs)	1. Look for loose fuel line fitting. Torque any loose fuel line fitting as per the latest revision in the ***Service Table of Limits - SSP-1776***. 2. Make sure the fuel pump is operating properly.	73-10
	Idle mixture is extremely rich (evident by excess black exhaust)	1. Lean the idle mixture as per the section "Idle Speed and Mixture Adjustment." 2. Readjust the idle speed.	SM 72-00
	Fuel vaporizing in lines	1. Operate with cowl flaps in the FULL OPEN position and keep ground operation to a minimum. 2. Operate with boost pump ON as necessary.	
High fuel flow	Blocked injection nozzles evident by high flow reading on pressure type fuel flow indicator	1. Complete an "Injection Nozzle Fuel Flow-Check." 2. Complete the "Injection Nozzle Removal" procedure.	73-10
		3. Clean the injection nozzle.	5-30
		4. Complete the "Injection Nozzle Installation" procedure.	73-10
	Broken flow gage	1. Install the master fuel flow gage and operate the engine to compare gages. 2. Replace the non-conforming fuel flow gage.	
	Fuel injector rich	Remove the fuel injector. Either send it to a manufacturer-approved repair facility or replace it as per the "Fuel Injector Replacement" procedure.*	73-10
*Review any applicable warranty information relative to replacement of a fuel component as per the latest revision of Service Letters L221 and L253.			

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Low fuel flow	Dirty fuel filter screen	Remove and clean the fuel filter screen with acetone or MEK. Blow out with compressed air.	5-30
	Damaged fuel flow gage	1. Install the master fuel flow gage and operate the engine to compare gages. 2. Replace a damaged fuel flow gage.	
	Fuel manifold does not open all the way at times.	1. Complete the "Fuel Manifold Removal" procedure.* 2. Send to Lycoming Engines or a repair facility. 3. Complete the "Fuel Manifold Installation" procedure.	73-10
	Fuel line to fuel flow gage is broken, loose, or blocked	Look for fuel dye stains to identify leaky, cracked, damaged or loose fuel lines. Replace any cracked or damaged fuel line. Refer to the "Fuel Line Replacement" procedure. To identify a blocked fuel line, disconnect the line at both ends and blow it out with compressed air. Re-connect the fuel line. Torque as per the latest revision of the ***Service Table of Limits - SSP-1776***. Make sure the fuel line is no longer blocked.	73-10
	Low fuel pressure	1. Examine the fuel filter for plugs; replace a plugged fuel filter as per the aircraft manufacturer's instructions. 2. Adjust the fuel pressure in accordance with the aircraft manufacturer's instructions. 3. Replace a fuel pump* or fuel pressure regulator. Refer to the "Fuel Pump Replacement" procedure.	73-10
*Review any applicable warranty information relative to replacement of a fuel component as per the latest revision of Service Letters L221 and L253.			

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Engine will not turn static rpm or will not develop rated rpm	Decreased air flow in the air induction system. Blockage in the induction system.	1. Complete the "Induction System Inspection Procedure." 2. Make sure that the air box is installed in accordance with the aircraft manufacturer's specifications.	SM 72-80
	Propeller or propeller governor is out of adjustment (not reaching specified low pitch)	Adjust in accordance with aircraft and/or propeller manufacturer's instructions.	
	Muffler's internal baffles are broken and blocking the exhaust outlet **NOTICE:** Broken baffles can move around freely in the muffler. The engine could turn static rpm's intermittently.	Examine the baffles in accordance with the aircraft manufacturer's instructions.	
	Air filter dirty	Remove and replace the air filter in accordance with the aircraft manufacturer's instructions. **NOTICE:** Occasionally new air filters will have an excessive air drop through them. If this condition is suspected, remove the air filter and operate the engine to full throttle on a hard surface in a dust-free area.	
	Incorrect magneto-to-engine timing	Complete the "Magneto-to-Engine Timing" procedure.	SM 74-30

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Engine will not turn static rpm or will not develop rated rpm (Cont.)	Fouled spark plugs	Complete the following procedures: • Spark Plug Removal • Spark Plug Cleaning • Spark Plug Gap Setting • Spark Plug Rotation • Spark Plug Installation	SM 74-20 05-30
	Injector rich or lean	1. Operate the engine at a given power setting FULL RICH. 2. Recalibrate and/or overhaul fuel injector servo that is out of specification.	
	Incorrect fuel flow	1. Look for blocked fuel lines to the engine. 2. Remove the fuel injector inlet screen and flush out with acetone or MEK. Blow out with compressed air. 3. Disconnect the fuel flow gage and install a master fuel flow gage to make sure the aircraft fuel flow gage is accurate. 4. Replace the fuel injector* as necessary. Refer to the "Fuel Injector Replacement" procedure.	73-10
	Blockage in air inlet or manifold.	1. Make sure that the air filters are clean. 2. Complete the "Induction System Inspection" procedure.	SM 72-80
	Incorrect type of fuel	1. Refer to "Incorrect Fuel or Fuel Contamination." 2. Refer to the latest revision of Service Instruction No. SI-1070 for correct fuel.	5-50
*Review any applicable warranty information relative to replacement of a fuel component as per the latest revision of Service Letters L221 and L253.			

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Engine will not turn static rpm or will not develop rated rpm (Cont.)	Throttle lever is incorrectly adjusted	Adjust the throttle lever in accordance with the aircraft manufacturer's instructions.	
	Insufficient combustion	1. Complete the "Cylinder Compression Check" procedure. 2. Complete the "Cylinder Borescope Inspection" procedure to determine if further corrective action is necessary.	SM 72-30
		3. Replace cylinders as necessary. Refer to the sections "Cylinder Removal" and "Cylinder Installation."	72-30
	Incorrect crankshaft-to-camshaft timing **NOTICE:** This could also cause the engine not to start.	Complete the "Crankshaft-to-Camshaft Timing Check."	72-20
Engine hesitates, misses	Valve sticking	Refer to "Corrective Action for Valve Sticking."	72-30
Engine surges	Dirty injection nozzle.	Complete the "Injection Nozzle Cleaning" procedure.	5-30
	Damaged propeller governor	Complete the "Propeller Oil Control Leak Test." Replace the propeller governor if necessary.	SM 72-20
	Incorrect propeller governor	Make sure that the propeller governor is the correct part number.	
	Propeller blades are intermittently sticking in hub	Remove and overhaul the propeller.	Propeller manufacturer's instructions
	Front main bearing has too much clearance	Complete the "Propeller Oil Control Leak Test."	SM 72-20
Low oil pressure or excessive oil pressure delay during start-up	Oil not of the correct viscosity for ambient temperature	Make sure oil of the correct viscosity for the ambient temperature is used.	IOM Appendix A

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Low oil pressure or excessive oil pressure delay during start-up (Cont.)	Low engine oil level	Complete the "Oil Level Check" procedure. Add oil if necessary as per the procedure "Add Oil to the Engine."	SM 12-10
	Oil pressure relief valve is out of adjustment	To increase the oil pressure, turn the adjustment screw clockwise; to decrease the oil pressure, turn the adjustment screw counterclockwise.	SM 72-50
	Dirt or metal chips under the oil pressure relief valve	Complete the following procedures: • Oil Pressure Relief Valve Removal • Oil Pressure Relief Valve Inspection • Oil Pressure Relief Valve Installation	72-50
	Damaged oil pressure relief seat	Replace the oil pressure relief as per the following procedures: • Oil Pressure Relief Valve Removal • Oil Pressure Relief Valve Installation	72-50
	High oil temperature	Examine the engine for these conditions: 1. Low oil level 2. Incorrect grade/weight of oil 3. Oil cooler bypass valve seating and operation 4. Partial or full blockage in oil cooler lines 5. Excess blow-by 6. Blockage in air duct to the oil cooler 7. Non-conforming temperature gage.	IOM Appendix A

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Low oil pressure or excessive oil pressure delay during start-up (Cont.)	Excess internal oil leakage	Look for: • Loose or missing plugs in oil galley • Piston cooling nozzles to lock open during idle rpm • Too much bearing clearance • Cracks in the oil galley area of the crankcase	
	Air leak on suction side	1. Examine the conditions of these components: • Oil suction screen gasket • Oil sump gasket • Oil pump mating surface to accessory housing 2. Replace cracked or damaged parts.	SM 12-10 72-50
	Relocated oil pressure take-off point on the engine	Use only the approved oil pressure take-off point.	
	Failed or failing bearings **NOTICE:** Metal in the oil filter element or oil suction screen is a sign of excessive bearing wear.	Open the crankcase and examine the bearings. or It is recommended the engine be sent to Lycoming Engines for evaluation. Include a description of the problem.	72-20
Low oil pressure during normal flight	Oil suction screen clogged	Remove and clean the oil suction screen as per the "Oil Suction Screen Removal/ Inspection/Cleaning/ Installation" procedure.	SM 12-10
	Oil pressure gage not operating correctly	Test the oil pressure gage. Take corrective action per aircraft manufacturer's instruction.	
	Oil pump not operating correctly	Remove and examine the oil pump.	72-25
	Oil pressure needs to be adjusted	Complete the "Oil Pressure Adjustment" procedure.	SM 72-50

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Excessive oil loss	Restriction in breather hose (oil loss overboard through oil return line and oil separator)	Remove, clean or replace the breather hose as per the following procedures: • Breather Hose Removal • Breather Hose Cleaning • Breather Hose Installation	Aircraft manufacturer's instructions
Excessive oil consumption	Incorrect grade of oil	Use correct grade of oil.	IOM Appendix A
	Oil level too high	Do not fill the engine with oil above the maximum oil sump capacity.	IOM Appendix A
	Oil leaks	Examine the external area of the engine for leaks, identify and correct the cause of any leak.	
	New rings are incorrectly seated.	On new, rebuilt, and overhauled engines or after installation of new piston rings, use mineral oil until oil consumption stabilizes (usually between 50 to 100 hours) then change to ashless dispersant oil or other specified oil. For best ring seating, always use full throttle take-off when applicable. Also, use a high cruise power setting for break-in. Climb to cruise altitude at full power, then operate at 75% power for break-in.	IOM Appendix A

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
Excessive oil consumption (Cont.)	Piston rings are worn or incorrectly installed OR Cylinder barrels are glazed or worn too much	1. Complete the "Cylinder Compression Check Procedure." 2. Complete the "Cylinder Borescope Inspection Procedure" to determine if further corrective action is necessary **NOTICE:** Listen for a hissing sound at the breather entrance of the crankcase which is an indication of air leaks around the rings.	SM 72-30
		3. Remove the cylinders, replace the piston rings, deglaze the cylinder barrels, and re-install the cylinders as per the following sections: • Cylinder Removal • Piston Removal • Piston Inspection • Installation of Piston Rings • Barrel Glaze and Varnish Removal from Interior Cylinder Barrel • Piston Installation • Cylinder Installation	72-30
	Worn valve guides	1. Measure the valve guides for wear as per instructions in the section "Exhaust Valve and Guide Inspection." 2. Replace worn valve guides.	SM 72-30 72-30
High oil temperature	Oil level is too low	Complete the "Oil Level Check" at regular intervals. Keep oil at the specified level.	SM 12-10 & IOM Appendix A
	Incorrect grade of oil	Use only the correct specified oil grade.	IOM Appendix A
	Oil cooler or oil cooler lines are fully or partially blocked	1. Remove the oil cooler and oil cooler lines. 2. Flush out the oil cooler and oil cooler lines.	Aircraft manufacturer's instructions

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
High oil temperature (Cont.)	Leaks in the induction system	Complete the "Induction System Inspection." Look for leaks. Identify and correct the cause of any leak. There must not be any leaks.	SM 72-80
	Partially blocked injection nozzles	Remove, clean, and re-install the injection nozzles as per the following procedures: • Injection Nozzle Removal • Injection Nozzle Cleaning • Injection Nozzle Installation	73-10 05-30
	Fuel lines with incorrect diameter installed	Measure the inside diameter of the fuel line which must be between 0.085 to 0.090 in. (2.159 to 2.286 mm). (Do not mark the inside of the fuel line while measuring.)	
	Incorrect magneto-to-engine timing	Complete the "Magneto-to-Engine Timing" procedure. **NOTICE:** The correct advance timing is stamped on the engine data plate.	SM 74-30
	Engine is operating excessively lean	Make sure that the engine is operating at the correct fuel flow rates for various power settings. Never lean the engine below minimum fuel flows.	IOM Appendix C
	Mixture control is incorrectly installed	Make sure that full travel of the cockpit mixture control lever is calibrated to the correct FULL RICH and IDLE CUT-OFF stops.	
	Oil temperature gage not operating correctly	Replace the oil temperature gage.	Aircraft manufacturer's instructions
	Cooling baffles are missing, broken, or incorrectly installed	Verify that all cooling baffles are installed correctly and none are broken. Replace as necessary. **NOTICE:** Never modify, relocate, or eliminate any cooling baffles.	Aircraft manufacturer's instructions

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
High oil temperature (Cont.)	Insufficient cooling air	1. Make sure the air inlet and outlet ducting to the oil cooler are operating correctly. 2. Repair or replace parts in accordance with the aircraft manufacturer's manual as necessary.	
	Oil cooler bypass valve is not operating correctly or seating accurately	Replace the oil cooler bypass valve as per the following sections: • Oil Cooler Bypass Valve Removal • Oil Cooler Bypass Valve Installation	72-50
	Excess blow-by	1. Complete the “Cylinder Compression Check Procedure.” 2. If there are indications of worn or broken rings, complete the “Cylinder Borescope Inspection Procedure.”	SM 72-30
		3. Replace the cylinder per the “Cylinder Removal” and “Cylinder Installation” procedures.	72-30
Increased cylinder head temperature, Exhaust Gas Temperature (EGT), or oil temperature	Incorrect operation of the fuel manifold	Complete the “Fuel Manifold Replacement” procedure.	73-10
High manifold pressure at idle	Incorrectly adjusted fuel control	1. As per the "Idle Speed and Mixture Adjustment” procedure, adjust the idle mixture to get a 25 to 50 rpm rise when moving the mixture control from FULL RICH to IDLE CUT-OFF. 2. Adjust idle speed after making mixture adjustments.	SM 72-00
	Air leak in induction system	Complete the “Induction System Inspection.” Look for leaks. Identify and correct the cause of any leak. There must not be any leaks.	SM 72-80

Table 1 (Cont.)
Fault Isolation Guide

Problem	Cause	Corrective Action	Ref.
High oil pressure	Oil pressure incorrectly adjusted	Decrease the oil pressure as per the "Oil Pressure Adjustment" procedure.	SM 72-50
	Incorrect weight of oil used	Use the recommended viscosity of oil for the ambient temperature.	IOM Appendix A
	Oil passage is blocked from the pressure relief valve to the oil sump	Remove, clean, and re-install the oil pressure relief valve as follows: • "Oil Pressure Relief Valve Removal" procedure. • Push a soft copper wire through the oil passage to the oil sump to remove blockage. • "Oil Pressure Relief Valve Installation" procedure. **NOTICE:** If blockage continues, remove the oil sump and clean the passage.	72-50
	Relocated oil pressure take-off point on the engine	Use only the approved oil pressure take-off point.	IOM
	Oil temperature is too cold	Use only the approved oil temperature take-off point.	IOM
Sluggish propeller operation	Propeller oil control leak	Complete the "Propeller Oil Control Leak Test."	SM 72-20
Engine does not hold rpm during cruise, climb, or descent	Propeller oil control leak	Complete the "Propeller Oil Control Leak Test."	SM 72-20
Propeller goes into feather during landing rollout with decreased power control setting	Propeller oil control leak	Complete the "Propeller Oil Control Leak Test."	SM 72-20

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72-00 - ENGINE REMOVAL AND RETURN TO SERVICE

1. Engine Removal Prerequisites

⚠ WARNING: DURING ALL MAINTENANCE PROCEDURES AND INSPECTIONS, ENSURE THAT THE ENGINE IGNITION SWITCH IS IN THE 'OFF' POSITION, ALL POWER TO THE AIRCRAFT IS DISCONNECTED, AND ALL PERSONNEL ARE CLEAR OF THE PROPELLER'S ROTATIONAL ARC.

A. Before engine removal from the aircraft:

(1) Make sure that all electrical switches, circuit breakers, Ignition Switch, and the Fuel Selector Valve are in the OFF position.

(2) In accordance with the aircraft manufacturer's instructions, remove all cowling, baffling and nacelle access panels to enable engine removal.

(3) Disconnect electrical power to the engine.

(4) Remove the propeller in accordance with the aircraft manufacturer's instructions.

(5) Disconnect the ground terminal battery.

(6) Disconnect the positive terminal of the battery.

(7) Disconnect and examine the leads and wiring for damage or frayed wiring. Replace damaged or frayed wiring per aircraft manufacturer's instructions.

(8) Remove accessories.

(9) If the engine is to be stored, complete the engine preservation procedure before engine removal. Refer to instructions in the ***IO-360-N1A Engine Installation and Operation Manual.***

2. Engine Removal Procedure

A. Remove the engine as follows:

(1) Complete the prerequisites in the section "Engine Removal Prerequisites" in this chapter.

(2) Drain oil from engine. Refer to the "Oil Change Procedure" in Chapter 12-10 of the ***IO-360-N1A Engine Service Manual***.

(3) During removal of tubes or engine parts, look for indications of scoring, burning or other unacceptable conditions.

(4) Disconnect all connecting control cables.

(5) Disconnect any relays, gages, or other indicating devices as per the aircraft manufacturer's procedure.

⚠ CAUTION: USE CARE TO PREVENT DUST, DIRT, SAFETY WIRE, NUTS, WASHERS OR OTHER FOREIGN MATTER FROM ENTERING THE ENGINE. DURING ENGINE REMOVAL, IF ITEMS ACCIDENTALLY FALL INTO THE ENGINE, STOP WORK, FIND AND REMOVE ALL OF THE DROPPED ARTICLES. USE CORRECT PLUGS, CAPS, AND OTHER COVERINGS TO COVER EXPOSED OPENINGS. INSTALL DUST CAPS OVER, NOT IN, TUBE ENDS.

⚠ **CAUTION:** DO NOT PUT TAPE OR PLUGS INSIDE OPEN LINES OR FITTINGS.

(6) Apply a cap over oil and fuel lines and connections to prevent spillage and debris from entering the engine.

(7) Apply tags to identify ports, clips, tubes, wires, etc. for reference to make correct connections during engine installation. Identify the location of each part during removal. Attach a tag to unserviceable parts and units for examination or replacement.

(8) Disconnect the alternator from the engine.

(9) Remove all wiring bundle attaching clamps and hardware.

(10) Remove the manifold pressure gage line and aircraft fuel supply lines in accordance with the aircraft manufacturer's instructions.

(11) Refer to the aircraft manufacturer's instructions to disconnect any accessory connection or to remove any external accessories to enable removal of the engine from the aircraft.

(12) Make sure that all wires, lines, and attachments between the engine and airframe are disconnected and capped.

(13) Attach an engine-lifting cable (with a minimum capacity of 750 lb (340 kg)) to the lifting straps on the engine in accordance with Figure 1.

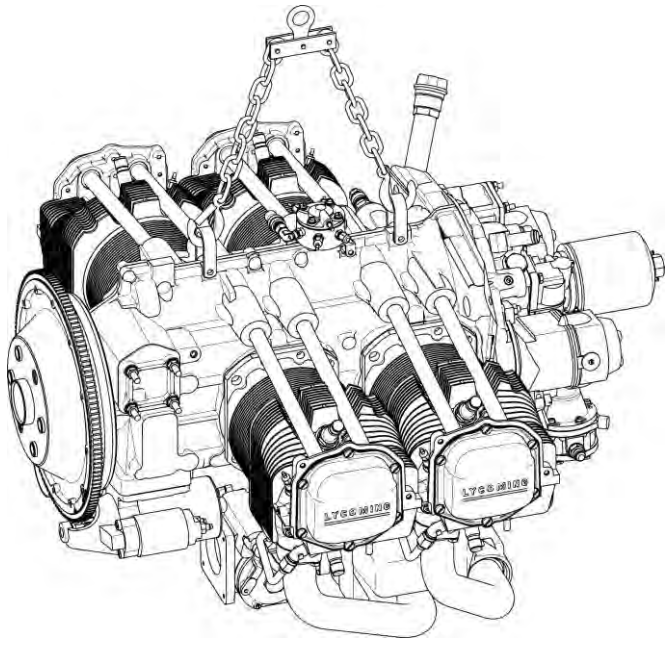

Figure 1
Lifting Straps

(14) Use a crane or overhead hoist (with a minimum load of 750 lb (340 kg)) to take up slack on the lifting cable until there is enough tension to hold the weight of the engine.

⚠ **CAUTION:** MAKE SURE THE AREA IS CLEAR WHEN LIFTING THE ENGINE. DO NOT ALLOW THE FRONT, REAR, SIDES OR BOTTOM OF THE ENGINE TO BUMP OR STRIKE ANY OBJECTS TO PREVENT DAMAGE TO THE ENGINE OR ITS COMPONENTS.

(15) Remove the hardware that attaches the engine to the airframe and isolation mounts.

(16) Carefully lift the engine slowly out of the airframe.

(17) Put the engine on an engine stand, transport dolly, or engine shipping container base.

3. Engine Installation Preparation Requirements

To prevent delays on engine re-installation, have the following materials and new spare parts available (refer to the applicable parts catalog) identified in Table 1. Follow the procedures in Table 1 to prepare the engine for installation (if the engine was not in storage). If the engine was in storage, refer to the ***IO-360-N1A Engine Installation & Operation Manual*** for instructions to prepare an engine that has been in storage.

Table 1
Materials and Procedures to Prepare a Serviced Engine for Installation

New gaskets, seals, O-rings, and packing (Make sure the new parts are not brittle, torn, cut, or cracked and do not have flashings, deterioration/wear or deformities.)*	Always install new gaskets, seals, O-rings, or packing.
⚠ **CAUTION:** ALWAYS INSTALL NEW SAFETY WIRE, NEW LOCK WASHERS, NEW LOCK NUTS, NEW TAB WASHERS, AND NEW COTTER PINS.	
New safety wire, lock nuts, lock washers, tab washers, and cotter pins	Always install new gaskets, seals, O-rings, or packing.
New replacement part for any part that had to be discarded*	
Oil per specifications in Appendix A of the ***IO-360-N1A Engine Installation and Operation Manual***	"Add Oil to the Engine" in Chapter 12-10 in the ***IO-360-N1A Engine Service Manual***
Cleaning solvents and lint –free wipes (identified in Chapter 05-30)	Cleaning procedures in Chapter 05-30
*Before installing a component, complete a check of the shelf-life of the part as per the latest revision of Service Letter No. L247	

After all inspections and maintenance tasks are complete, install the engine per the ***IO-360-N1A Engine Installation and Operation Manual.***

4. Return to Service Procedure

Complete the "Operational Ground Check," "Idle Speed and Mixture Adjustment," and "Engine Mount Inspection" in Chapter 72-00 of the ***IO-360-N1A Engine Service Manual*** to make sure the engine operates in accordance with specifications in Appendix A of the ***IO-360-N1A Engine Installation and Operation Manual.***

Before you return this engine to service, make sure that you correct all problems and complete all of the necessary maintenance.

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72-05- ENGINE DISASSEMBLY

Engine disassembly begins after the oil has been drained from the engine per instructions in Chapter 12-10 of the ***IO-360-N1A Engine Service Manual*** and the engine is removed from the airframe (per instructions in this manual and the applicable Airframe Maintenance Manual).

Follow the procedures for engine disassembly for the IO-360-N1A engines in the sequence identified in Table 1.

Table 1
Sequence of Engine Disassembly Procedures

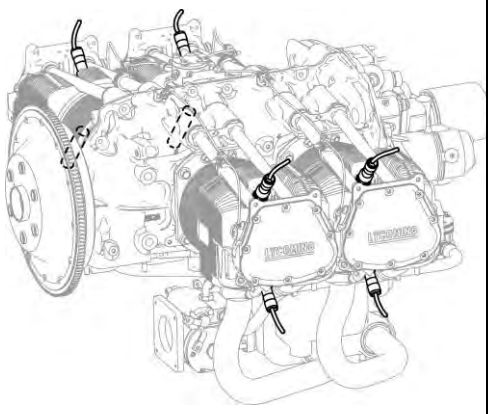
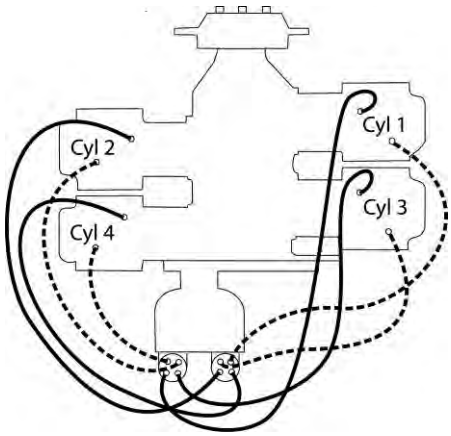
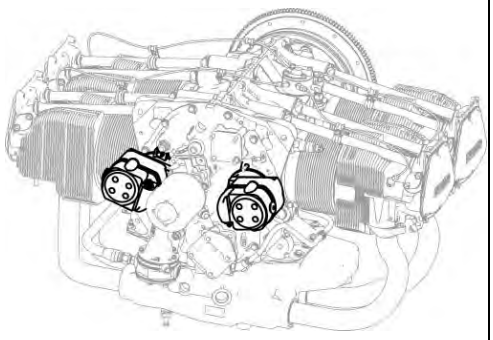
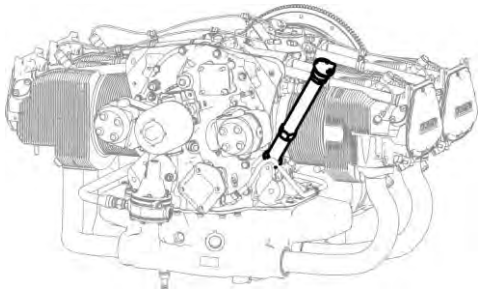
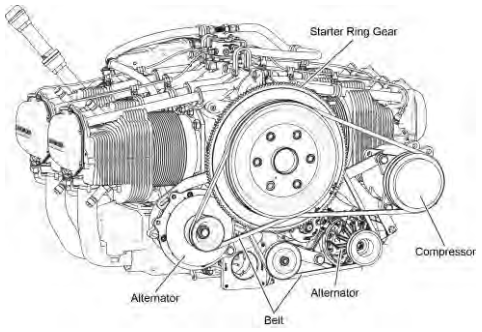
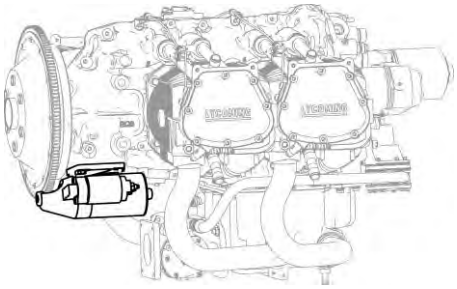
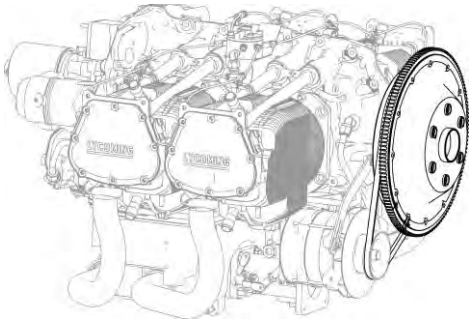
Step	Reference
Step 1 Remove the spark plugs (Figure 1).	"Spark Plug Removal" procedure in Chapter 74-20 of the ***IO-360-N1A Engine Service Manual***  **Figure 1** **Spark Plugs**
Step 2 Remove the ignition harness and ignition leads (Figure 2).	"Ignition Harness Removal" procedure in Chapter 74-20  **Figure 2** **Ignition Harness**
Step 3 Remove the two magnetos (Figure 3).	"Magneto Removal" procedure in Chapter 74-30  **Figure 3** **Magnetos**
Step 4 Remove the oil level gage tube and dipstick (Figure 4).	"Oil Level Gage Removal" procedure in Chapter 72-50  **Figure 4** **Oil Level Gage Tube**

Table 1 (Cont.)
Sequence of Engine Disassembly Procedures

Step	Reference
Step 5 Remove the alternator, alternator bracket, and alternator belt (Figure 5).	"Alternator and Bracket Removal" and "Alternator Belt Removal" procedures in Chapter 72-70  **Figure 5** **Alternator Bracket, Alternator, and Alternator Belt**
Step 6 Remove the starter (Figure 6).	"Starter Removal" procedure in Chapter 72-70  **Figure 6** **Starter**
Step 7 Remove the starter ring gear support and starter ring gear (Figure 7).	"Starter Ring Gear Support Removal" and "Starter Ring Gear Removal" procedures in Chapter 72-70  **Figure 7** **Starter Ring Gear**

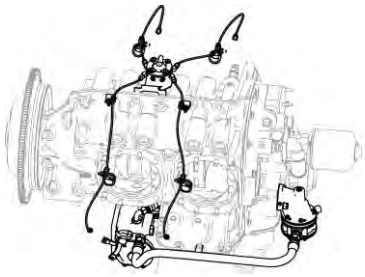
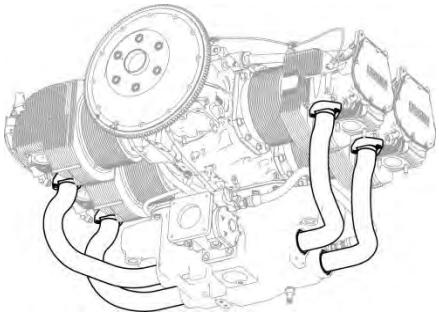
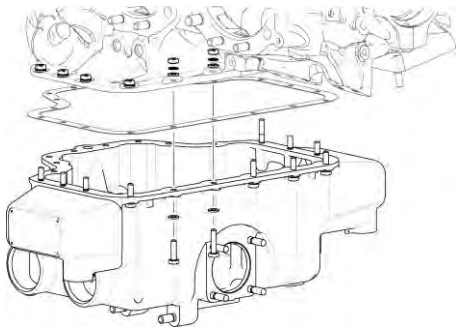
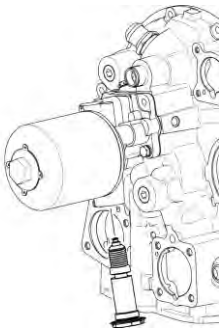
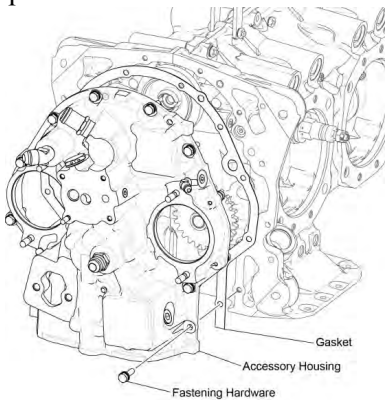
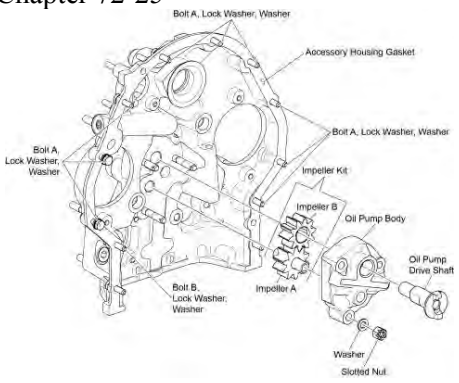
Step	Reference
Step 8 Remove the fuel lines, fuel injector, injection nozzles, fuel manifold, and, fuel pump (Figure 8).	Procedures in Chapter 73-10 • Fuel Line Removal • Fuel Injector Removal • Injection Nozzle Removal • Fuel Manifold Removal • Fuel Pump Removal  **Figure 8** **Fuel Lines and Fuel Components**
Step 9 Remove the intake pipes (Figure 9).	"Intake Pipe Removal" procedure in Chapter 72-80  **Figure 9** **Intake Pipes**
Step 10 Remove the oil sump (Figure 10).	"Oil Sump Removal" procedure in Chapter 72-50  **Figure 10** **Oil Sump**

Table 1 (Cont.)
Sequence of Engine Disassembly Procedures

Step	Reference
Step 11 Remove the oil cooler bypass valve, oil filter, and oil filter base (Figure 11).	Procedures in Chapters 12-10 and 72-50  **Figure 11 Oil Cooler Bypass Valve, Oil Filter, and Oil Filter Base**
Step 12 Remove the accessory housing (Figure 12).	"Accessory Housing Removal" in Chapter 72-25  **Figure 12 Accessory Housing**
Step 13 Remove the oil pump and the fuel pump plunger (Figure 13).	Chapter 72-25  **Figure 13 Oil Pump**

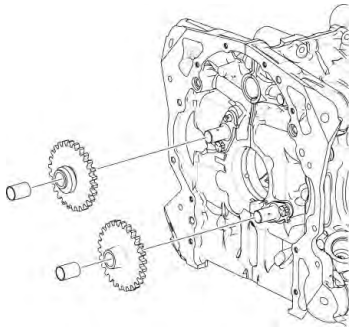
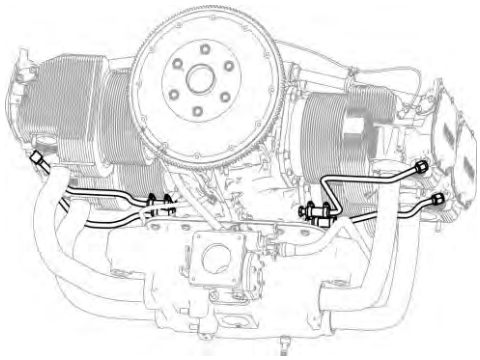
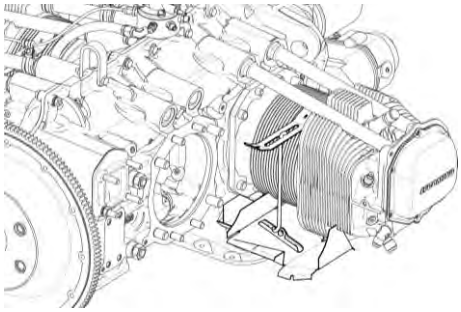
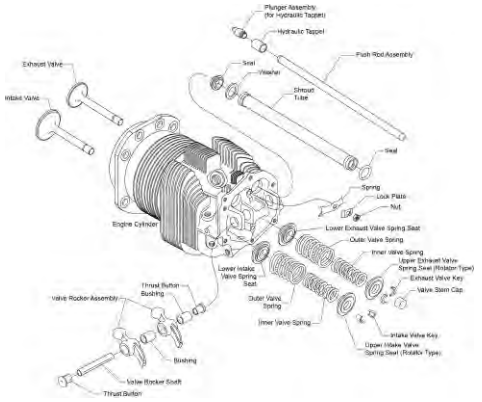
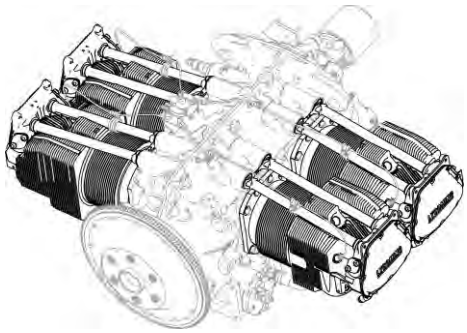
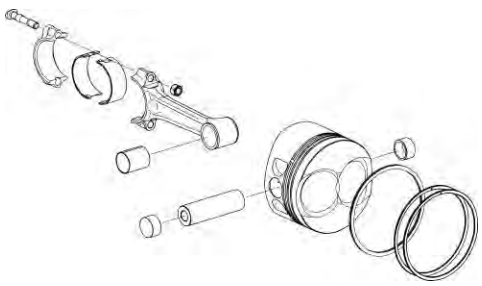
Step	Reference
Step 14 Remove both crankshaft idler gears (Figure 14).	"Crankshaft Idler Gear and Bushing Removal" procedure in Chapter 72-20  **Figure 14 Crankshaft Idler Gears**
Step 15 Remove the oil drain tubes from the engine cylinder heads and crankcase (Figure 15).	"Oil Drain Tube Removal" procedure in Chapter 72-30  **Figure 15 Oil Drain Tubes**
Step 16 Remove the inter-cylinder baffles (Figure 16).	"Intercylinder Baffle Removal" procedure in Chapter 72-30  **Figure 16 Intercylinder Baffles**

Table 1 (Cont.)
Sequence of Engine Disassembly Procedures

Step	Reference
Step 17 Remove the rocker covers, valve rockers, rocker shafts, push rods, and shroud tubes (Figure 17).	Chapter 72-30 in this manual  **Figure 17** **Rockers, Shroud Tubes, and Push Rods**
Step 18 Remove the engine cylinders (Figure 18).	"Cylinder Removal" procedure in Chapter 72-30  **Figure 18** **Engine Cylinders**
Step 19 Remove the pistons (Figure 19).	"Piston Removal" procedure in Chapter 72-30  **Figure 19** **Piston**

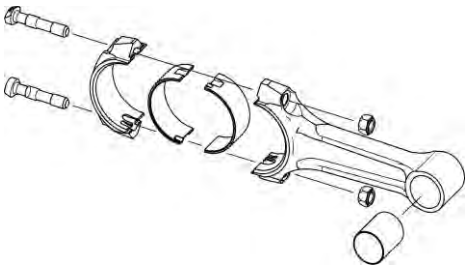
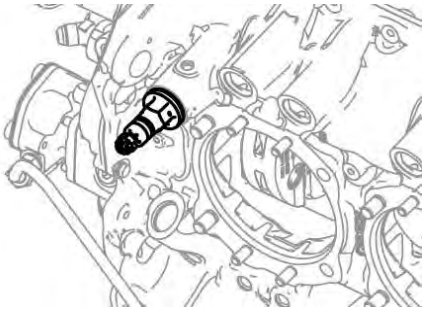
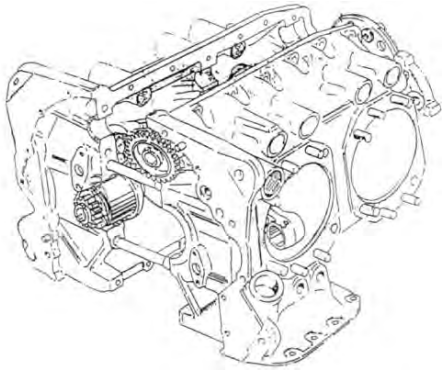
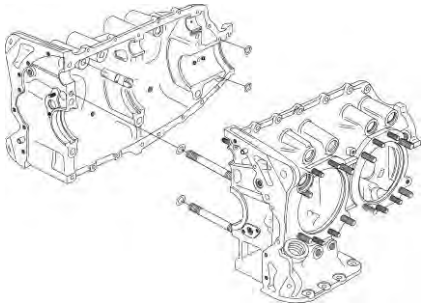
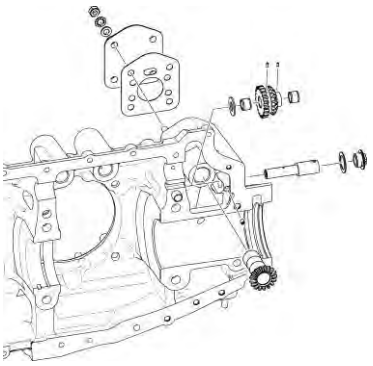
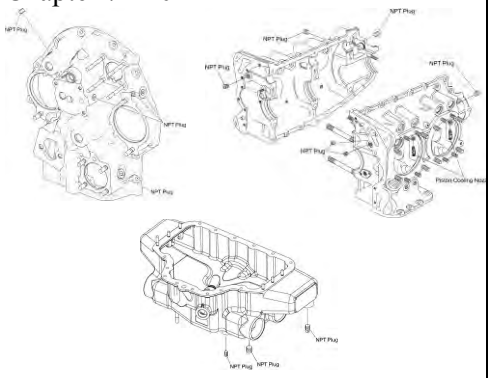
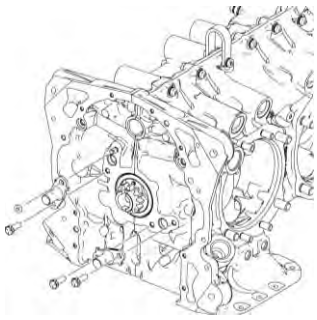
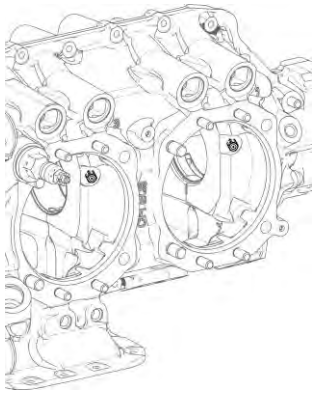
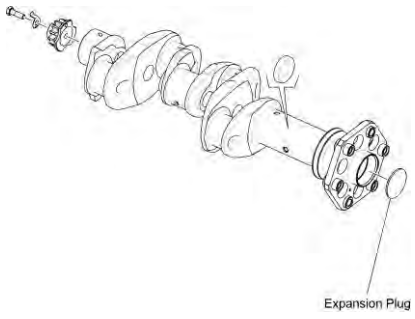
Step	Reference
Step 20 Remove the connecting rods (Figure 20).	"Connecting Rod Removal" in Chapter 72-20  **Figure 20** **Connecting Rod**
Step 21 Remove the oil pressure relief valve (Figure 21).	"Oil Pressure Relief Valve Removal" procedure in Chapter 72-50  **Figure 21** **Oil Pressure Relief Valve**
Step 22 Separate the crankcase halves (Figure 22).	"Crankcase Disassembly" procedure in Chapter 72-20  **Figure 22** **Crankcase Halves**

Table 1 (Cont.)
Sequence of Engine Disassembly Procedures

Step	Reference
Step 23 Remove the tappets, main bearings, and O-rings (Figure 23).	"Tappet, Main Bearing and O-Ring Removal" in Chapter 72-20  **Figure 23 Tappets, Main Bearings and O-Rings**
Step 24 Remove the propeller governor drive (Figure 24).	"Propeller Governor Drive Removal/Disassembly" in Chapter 72-20  **Figure 24 Propeller Governor Drive**
Step 25 Remove the oil plugs (Figure 25).	"Oil Plug Removal" procedure in Chapter 72-20  **Figure 25 Oil Plugs**

Step	Reference
Step 26 Remove the crankshaft idler gear shafts (Figure 26).	"Crankshaft Idler Gear Shaft Removal" procedure in Chapter 72-20  **Figure 26 Crankshaft Idler Gear Shafts**
Step 27 Remove the piston cooling nozzle (Figure 27).	"Piston Cooling Nozzle Removal" in Chapter 72-20  **Figure 27 Piston Cooling Nozzles**
Step 28 Disassemble the crankshaft (Figure 28).	"Crankshaft Disassembly" in Chapter 72-20  **Figure 28 Crankshaft Disassembled**

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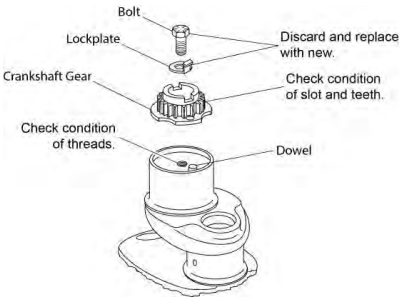
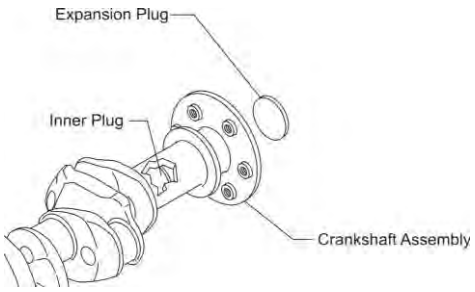
72-10 - ENGINE ASSEMBLY

1. Engine Assembly Procedure
   A. Complete the sequence of steps in Table 1.
   B. Complete the ***Engine Assembly Checklist*** in the chapter.

Table 1
Sequence of Engine Assembly Procedures

Step	Reference
Step 1	Review the "General Assembly Practices" in this chapter
Begin "Crankshaft Assembly" procedure. Examine the alignment dowel, and if necessary, replace the alignment dowel per instructions in Chapter 72-20.	
Step 2 Install the crankshaft gear on the crankshaft (Figure 1).	"Crankshaft Gear Installation" procedure in Chapter 72-20  **Figure 1** **Crankshaft Gear and Expansion Plug**
Step 3 Install the expansion plug on the crankshaft (Figure 2).	"Expansion Plug Installation" procedure in Chapter 72-20  **Figure 2** **Expansion Plug**

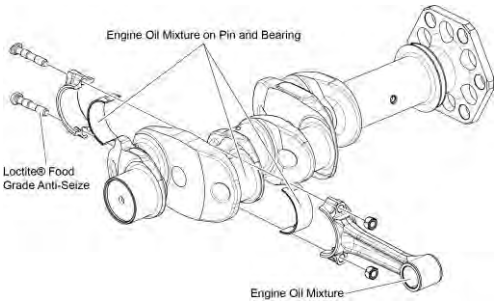
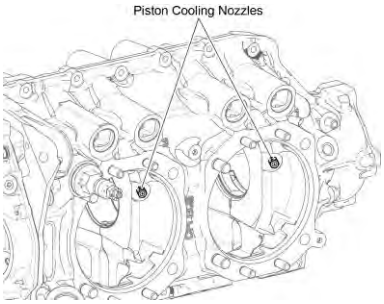
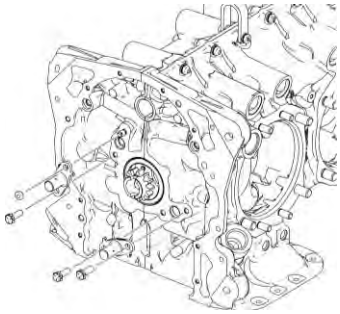
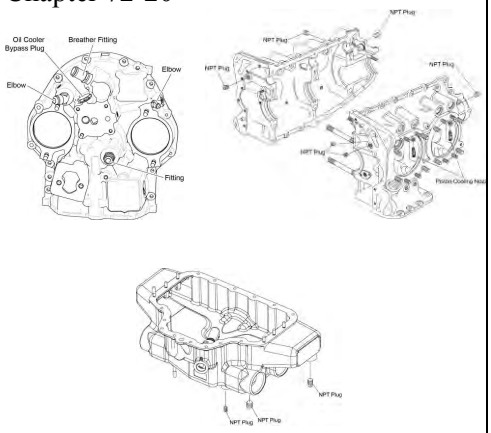
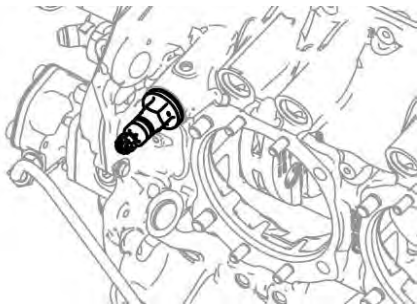
Step	Reference
Step 4 Install the crankshaft solid-ring oil seal (Figure 3). (or install the split oil seal later on)	"Crankshaft Solid-Ring Oil Seal Installation" procedure in Chapter 72-20  **Figure 3** **Crankshaft Solid-Ring Oil Seal**
Step 5 Install the connecting rods on the crankshaft (Figure 4).	"Connecting Rod Installation" procedure in Chapter 72-20  **Figure 4** **Connecting Rods**
Step 6 Install piston cooling nozzle (if removed) (Figure 5).	"Piston Cooling Nozzle Installation (if removed)" procedure in Chapter 72-20  **Figure 5** **Piston Cooling Nozzles**

Table 1 (Cont.)
Sequence of Engine Assembly Procedures

Step	Reference
Step 7 Install the crankshaft idler gear shafts (Figure 6).	"Crankshaft Idler Gear Shaft Installation" procedure in Chapter 72-20  **Figure 6** **Crankshaft Idler Gear Shafts**
Step 8 Install the oil plugs (if removed) (Figure 7).	"Oil Plug Installation" procedure in Chapter 72-20  **Figure 7** **Oil Plugs**
Step 9 Install the oil pressure relief valve (Figure 8).	"Oil Pressure Relief Valve Installation" procedure in Chapter 72-50  **Figure 8** **Oil Pressure Relief Valve**

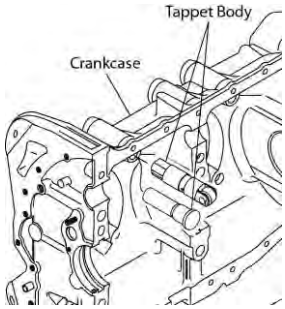
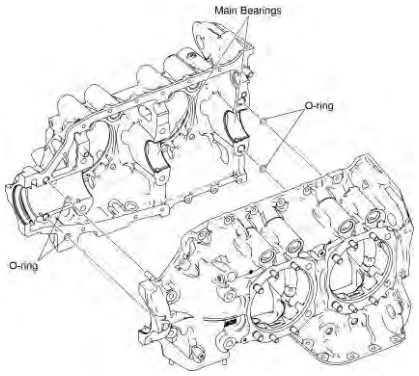
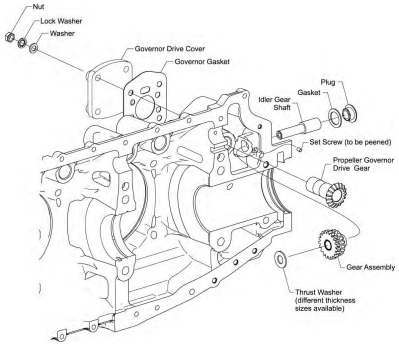
Step	Reference
Step 10 Install the tappet assemblies (Figure 9).	"Tappet Assembly Installation" procedure in Chapter 72-20  **Figure 9** **Tappets and Oil Seal Rings**
Step 11 Install the main bearings, bolts, and O-rings in the crankcase (Figure 10).	"Crankshaft Bearing and O-Ring Installation" procedure in Chapter 72-20  **Figure 10** **Main Bearings and O-Rings**
Step 12 Install the propeller governor drive (Figure 11).	"Propeller Governor Drive Installation" in Chapter 72-20  **Figure 11** **Propeller Governor Drive**

Table 1 (Cont.)
Sequence of Engine Assembly Procedures

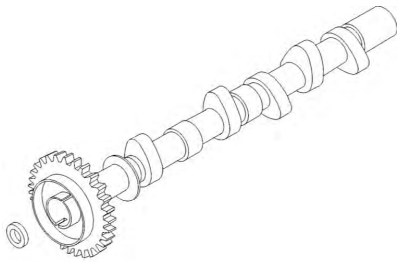
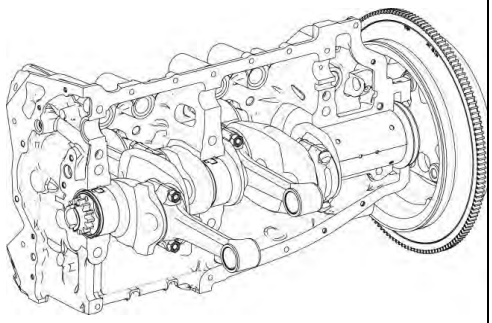
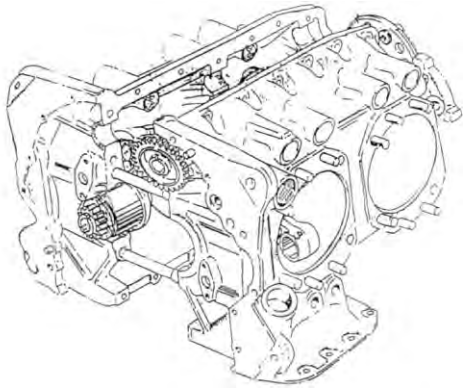
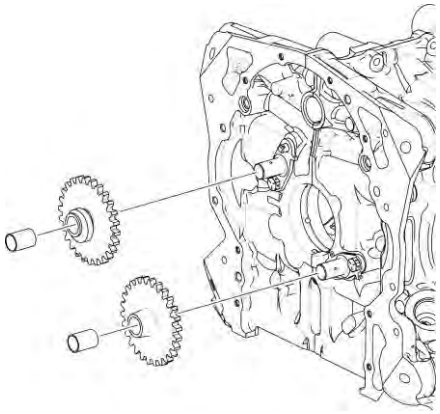
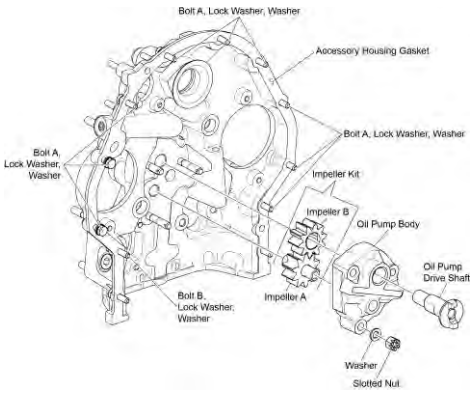
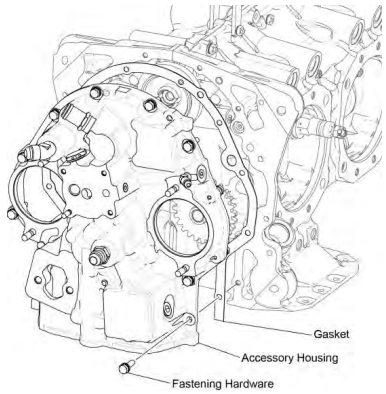
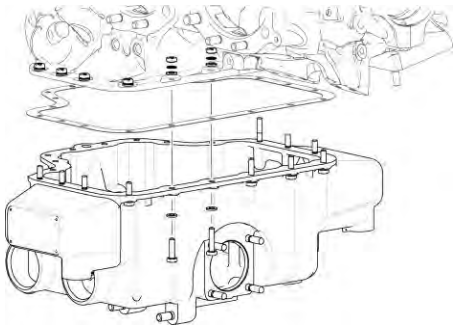
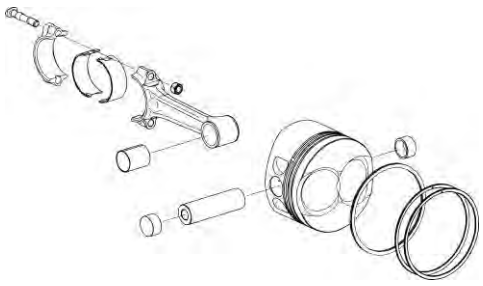
Step	Reference
Step 13 Assemble and install the camshaft in the crankcase (Figure 12).	"Camshaft Assembly and Installation" procedure in Chapter 72-20  **Figure 12** **Camshaft**
Step 14 Install the crankshaft in the crankcase (Figure 13).	"Crankshaft Installation" procedure in Chapter 72-20  **Figure 13** **Crankshaft**
Step 15 Assemble the crankcase halves (Figure 14)	"Crankcase Assembly" procedure in Chapter 72-20  **Figure 14** **Crankcase Halves**
Step 16 Install the crankshaft oil seal in the crankcase (Figure 15)	"Crankshaft Oil Seal Installation" procedure in Chapter 72-20  **Figure 15** **Split Oil Seal and Solid-Ring Oil Seal**
Step 17 Install the crankshaft idler gears (Figure 16).	"Crankshaft Idler Gear Installation" procedure in Chapter 72-20  **Figure 16** **Crankshaft Idler Gears**
Step 18 Install the oil pump and the fuel pump plunger on the accessory housing (Figure 17).	Chapter 72-25  **Figure 17** **Oil Pump**

Table 1 (Cont.)
Sequence of Engine Assembly Procedures

Step	Reference
Step 19 Install the accessory housing, fuel pump, oil filter base, oil cooler bypass valve, and oil filter (Figure 18)	Chapters 72-25, 72-50, and 73-10  **Figure 18 Accessory Housing**
Step 20 Install the oil sump on the crankcase (Figure 19)	"Oil Sump Installation" in Chapter 72-50  **Figure 19 Oil Sump**
Step 21 If removed install the piston in each engine cylinder (Figure 20)	"Piston Installation" procedure in Chapter 72-30  **Figure 20 Piston**

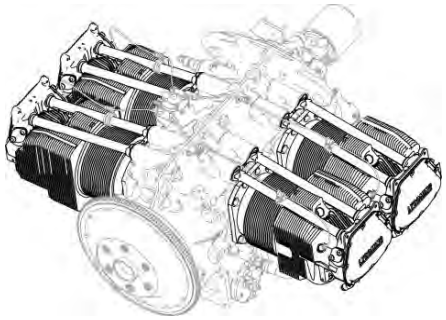
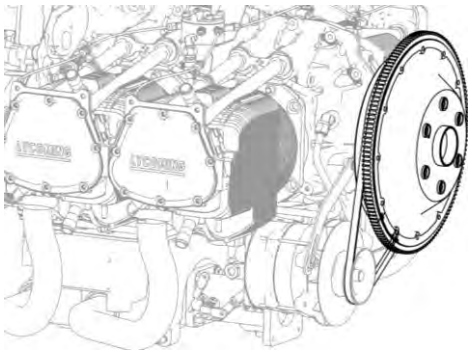
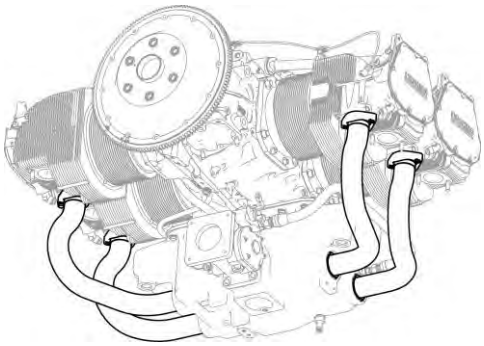
Step	Reference
Step 22 Install all four engine cylinders on the crankcase (Figure 21)	"Cylinder Installation" section in Chapter 72-30  **Figure 21 Engine Cylinders**
Step 23 Install the starter ring gear support on the engine (Figure 22)	"Starter Ring Gear Support Installation" procedure in Chapter 72-70  **Figure 22 Starter Ring Gear**
Step 24 Install the intake pipes, each to the correspond-ing cylinder (Figure 23).	"Intake Pipe Installation" procedure in Chapter 72-80  **Figure 23 Intake Pipes**

Table 1 (Cont.)
Sequence of Engine Assembly Procedures

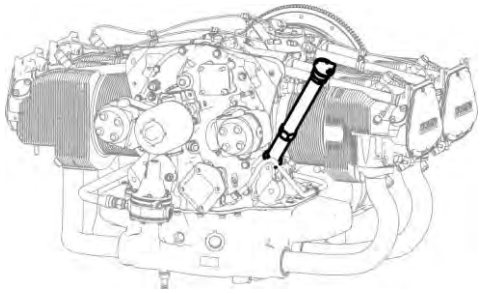
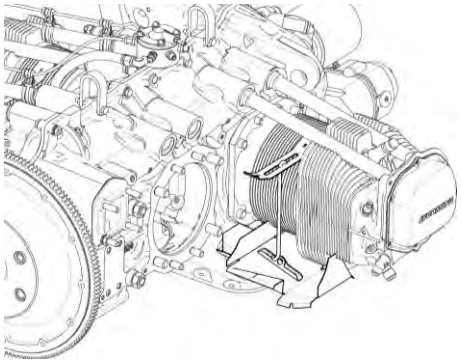
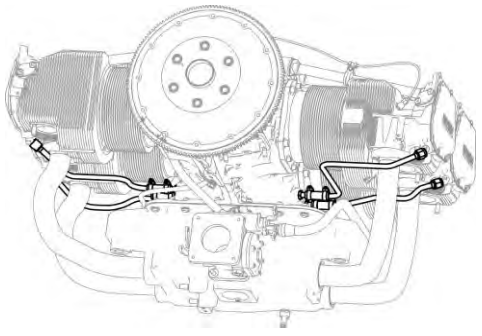
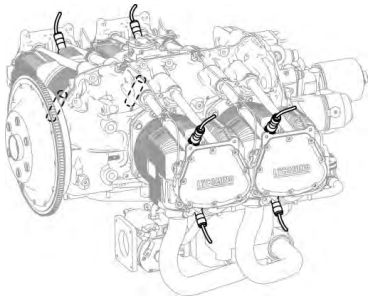
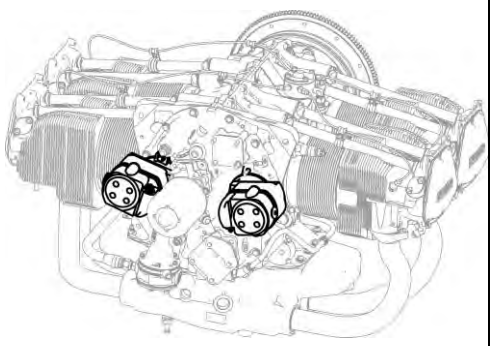
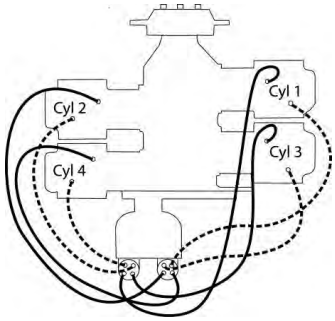
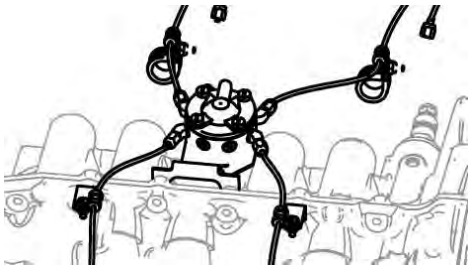
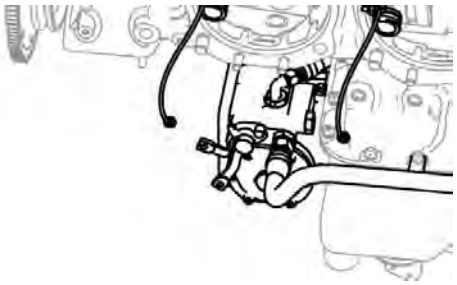
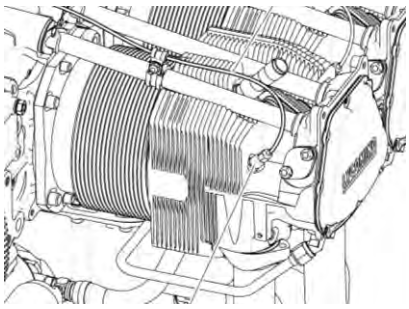
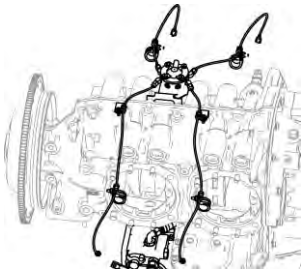
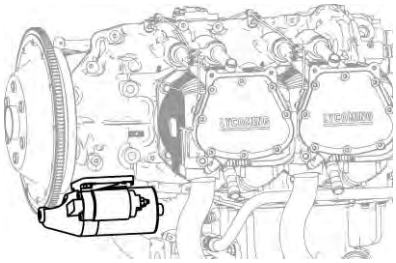
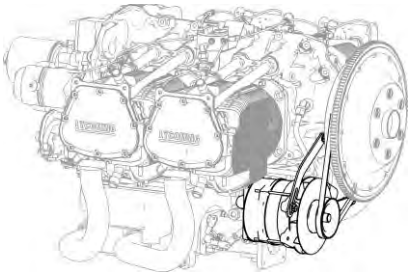
Step	Reference
Step 25 Install the oil level gage tube and dipstick (Figure 24).	"Oil Level Gage Installation" procedure in Chapter 72-50  **Figure 24 Oil Level Gage Tube**
Step 26 Install inter-cylinder baffles (Figure 25).	"Intercylinder Baffle Installation" procedure in Chapter 72-30  **Figure 25 Intercylinder Baffle**
Step 27 Attach four new oil drain tubes, one on each engine cylinder head and the crankcase (Figure 26).	"Oil Drain Tube Installation" procedure in Chapter 72-30  **Figure 26 Oil Drain Tubes**
Step 28 Examine, set the gap, and install all spark plugs (one in the top and bottom of each engine cylinder) (Figure 27).	"Spark Plug Gap Setting" and "Spark Plug Installation" procedures in Chapter 74-20 in the ***IO-360-N1A Engine Service Manual***  **Figure 27 Spark Plugs**
Step 29 Install both magnetos on the engine (Figure 28).	"Magneto Installation" procedure in Chapter 74-30  **Figure 28 Magnetos**
Step 30 Install the ignition harness on the engine (Figure 29).	"Ignition Harness Installation" procedure in Chapter 74-20  **Figure 29 Ignition Harness**

Table 1 (Cont.)
Sequence of Engine Assembly Procedures

Step	Reference
Step 31 Install the fuel manifold (Figure 30).	"Fuel Manifold Installation" procedure in Chapter 73-10  **Figure 30** **Fuel Manifold**
Step 32 Install the fuel injectors (Figure 31).	"Fuel Injector Installation" procedure in Chapter 73-10  **Figure 31** **Fuel Injector**
Step 33 Install the injection nozzles (Figure 32).	"Injection Nozzle Installation" procedure in Chapter 73-10  **Figure 32** **Injection Nozzles**
Step 34 Install the fuel lines (Figure 33).	"Fuel Line Installation" procedure in Chapter 73-10  **Figure 33** **Fuel Lines**
Step 35 Install the starter (Figure 34).	"Starter Installation" procedure in Chapter 72-70  **Figure 34** **Starter**
Step 36 Install the alternator, bracket, and belt (Figure 35).	"Alternator and Bracket Installation" and "Alternator Belt Installation" procedures in Chapter 72-70  **Figure 35** **Alternator Bracket, Alternator, and Alternator Belt**
Step 37 Install the Engine in the Airframe Install the engine in the airframe per instructions in this manual, ***IO-360-N1A Engine Installation and Operation Manual***, and applicable airframe maintenance manual.	

General Assembly Practices

1. Corrosion Prevention

⚠ **CAUTION:** DO NOT USE PLAIN LUBRICATING OIL DURING ASSEMBLY.

A. Pre-Lubrication of Parts Before Assembly

Before assembly of each subassembly, clean all of the parts to remove the preservative oil, grease, and unwanted dirt per instructions in Chapter 05-30.

As preventive action, during engine assembly, apply the approved lubricant for specified components identified in the latest revision of Service Instruction No. SI-1059.

If parts are not correctly lubricated, or if an unapproved lubricant is applied to a part, engine parts could become scored before the engine oil has lubricated the engine during the first cycle of operation. This scoring can cause premature part failure, or, in some cases, engine failure.

2. Painting the Engine and Engine Components

Lycoming recommends that the engine be painted as an assembly (minus accessories, intake tubes, fluid lines, wiring harness), but if it is necessary to paint an individual component:

- Do not get paint on any mating surfaces or under the cylinder hold down nuts.
- There must be metal to metal contact to ensure proper torque.
- Mask mating surfaces and the area where the nut will contact the component surface.

All paint should be sprayed; however, if it is necessary to use a brush, care should be taken to avoid an accumulation of pockets of paint. Refer to the paint manufacturer's instructions for drying and curing times.

Parts requiring use of paint for protection or appearance should be painted in accordance with the following recommendations using material from the following list of approved materials:

- Thinner - Toluene or equivalent (AMS3180 or equivalent Federal Spec. TT-T-548).
- Primer - Zinc chromate (AMS3110 or equivalent MIL-P-8585).
- Enamel - Phthalate resin type (AMS3125C or equivalent MIL- E-7729).

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

A. Aluminum and Steel Parts

NOTICE: It is not necessary to apply the primer coat if paint has not been removed from the part.

(1) Clean and degrease the parts with Varsol® or equivalent.

(2) Apply one coat of zinc chromate primer, thinned with two parts toluene.

(3) Air dry.

(4) Apply one coat of enamel and bake at 250° F, to 300° F, for one-half hour. Enamel may be allowed to air dry but an inferior finish will result.

B. Magnesium Parts

(1) Clean all traces of oil and grease from the part using a neutral, non-corrosive, degreasing medium followed by a rinse.

(2) Immerse the part for 45 minutes in a hot dichromate solution (3/4 lb. of sodium dichromate to one gallon of water at 180°F. to 200°F. (as required).

(3) Wash the part thoroughly in cold running water, dipped in hot water, and dried in an air blast.

(4) Immediately paint the part with a prime coat and engine enamel, the same as aluminum parts.

C. Shroud Tubes

(1) Clean and degrease the shroud tube with Varsol® or equivalent..

(2) Dip the shroud tube in zinc chromate primer, thinned to spraying consistency.

(3) Allow the primer to dry.

(4) Paint the outside of the shroud tube with engine enamel.

D. Cylinder Painting

(1) Remove all old paint from the cylinder. A vapor degreaser is best suited for this purpose.

NOTICE: Masking tape, corks, plugs, metal covers, etc. are acceptable for masking purposes.

(2) Mask off the following parts of the cylinder:

- Rocker box section, including the rocker box flange
- Both valve ports and flanges
- Thermocouple hole
- Spark plug holes
- Push rod shroud tube holes
- All other exposed threaded surfaces in which paint might accumulate

⚠ **CAUTION:** MAXIMUM THICKNESS OF THE PAINT ON THE CYLINDER FLANGE MUST BE 0.0005 IN. (0.0127 MM). MEASURE THE THICKNESS OF THE PAINT WITH A TINSLEY THICKNESS GAGE OR EQUIVILANT. IF A THICKNESS GAGE IS NOT AVAILABLE, USE A MICROMETER TO MEASURE THE THICKNESS OF THE FLANGE BEFORE AND AFTER PAINTING. IF THE PAINT IS OVER 0.0005 IN. (0.0127 MM) THICK IT MUST BE REMOVED AND THE CYLINDER FLANGE REPAINTED.

(3) Spray a very light coat of zinc chromate primer to a maximum thickness of (0.0005 in. (0.0127 mm) on the cylinder flange. If the correct amount of paint has been applied the color of the paint will be green with a yellowish tint and the metal will show through. If the paint is too thick the color will be zinc chromate yellow.

(4) Mask off the flange area to prevent paint being applied where the cylinder hold-down nuts contact the cylinder flange. Proceed to paint the cylinder with a Phthalate resin type enamel (AMS3125C or equivalent WL-E-7729) properly thinned with Toluene or equivalent (AMS3180 or equivalent Federal Spec. TT-T-548).

(5) Clean paint from all surfaces where paint may have accidentally accumulated with a cloth dipped in thinner.

(6) Air-dry the cylinder for fifteen minutes and then bake in an oven until completely dry.

3. Limits and Clearances

Refer to the latest revision of the ***Service Table of Limits - SSP-1776***, for the following.

- Backlash and end clearance of gears
- Clearance between mating machined parts
- Clearance between moving parts that touch
- Torque limits for various nuts, screws, and fastenings.

4. Inspections

A. Bearing shell surface inspection

(1) Examine all bearing surfaces for scoring, galling, and wear. If a part has one of the defects, discard it and replace it with a new one.

NOTICE: It is not necessary to discard aluminum bearings that are scratched and/or lightly scored.

(2) Make sure that the clearance of each bearing agrees with the specification in the latest revision of the ***Service Table of Limits - SSP-1776***.

(3) If a bearing is not in the applicable limits, discard it and replace it with a new one.

(4) Examine all journal surfaces for galling, scores, misalignment, and out-of-round condition.

(5) Examine the shafts and pins for straightness.

B. Gear Inspection

(1) Examine the involutes of the gear teeth for pitting and excessive wear.

(2) If pit marks are found, discard the gear and replace it with a new one.

(3) Examine the bearing surfaces of all gears for deep scratches.

(4) Remove minor abrasions with a fine abrasive cloth.

C. Screwed Fitting Inspection

(1) Examine the condition of the threads on screwed fittings (threaded fastenings or plugs).

(2) Remove small nicks and burrs with a small file, fine abrasive cloth, or stone.

(3) If the part cannot be repaired by polishing it, discard it and replace it with a new one.

(4) If the part has too much distortion, galling, or mutilation (caused by over-tightening or use of an incorrect tool) replace it.

Engine Assembly Checklist

The Engine Assembly Checklist is a guide and a record of completion for engine assembly.

Engine Assembly Checklist for IO-360-N1A Engine Models		
Engine Model Number_____ **Engine Serial Number:**_____ **Engine Time:**_____ **Date Inspection Done:** _____ **Inspection done by:**_____		
NOTICE Replace all roller tappets as a complete set if engine assembly is close to TBO. If a new or reconditioned camshaft is to be installed, install new tappet bodies. Refer to the latest revision of Service Instruction No. SI-1011 for guidelines on replacing the camshaft when new tappets are installed in the engine.		
Item	**Comments**	**Done**
Review the "General Assembly Practices" in this Chapter.		
⚠ **CAUTION:** FOR CORRECT ENGINE OPERATION, THE CRANKSHAFT GEAR MUST BE INSTALLED CORRECTLY WITH NO GAP IN THE MATING SURFACES BETWEEN COUNTERBORED-END OF THE CRANKSHAFT AND THE CRANKSHAFT GEAR.		
Start with a clean crankshaft which passed the "Crankshaft Inspection" in Chapter 72-20.		
Inspect the alignment dowel and if necessary, replace the alignment dowel per instructions in Chapter 72-20.		
Install the crankshaft gear with a **new** crankshaft gear bolt per instructions in Chapter 72-20.		
Install a **new** expansion plug in the crankshaft per the "Expansion Plug Installation" procedure in Chapter 72-20.		
Either install a **new** solid-ring oil seal on the crankshaft per the "Solid-Ring Oil Seal Installation" procedure in Chapter 72-20 or later on install a split oil seal per the "Crankshaft Oil Seal Installation" procedure in Chapter 72-30.		
Assemble and install the connecting rods (on the crankshaft) each with a pair of new bearing inserts, a new connecting rod bolt, and a new nut – per the "Connecting Rod Installation" procedure in Chapter 72-20.		
Measure the inside diameter of the bearing per the "Connecting Rod Installation" section in Chapter 72-20.	**Measurement:	
Start with a clean crankcase which passed the "Crankcase Inspection" in Chapter 72-20.		
** Measurements must be within tolerances specified in the latest revision of the ***Service Table of Limits - SSP-1776.***		

Engine Assembly Checklist for IO-360-N1A Engine Models (Cont.)		
Item	**Comments**	**Done**
Complete the "Piston Cooling Nozzle Installation" procedure in Chapter 72-20.		
Complete the "Crankshaft Idler Gear Shaft Installation" procedure in Chapter 72-20.		
Install the oil plugs (if removed) per the "Oil Plug Installation" procedure in Chapter 72-20.		
Complete the "Oil Pressure Relief Valve Installation" procedure in Chapter 72-50.		
Complete the "Tappet Assembly Installation" procedure on Chapter 72-20. Identify the types of tappets installed in the engine logbook.		
Complete the "Crankshaft Bearing and O-Ring Installation" procedure in Chapter 72-20.		
Complete the "Propeller Governor Drive Installation" procedure in Chapter 72-20.		
Complete the "Camshaft Assembly and Installation" procedure in Chapter 72-20.		
Measure the camshaft endplay in the left crankcase half per the "Camshaft Installation" procedure in Chapter 72-20.	**Measurement:	
Measure the camshaft endplay in the right crankcase half per the "Camshaft Installation" procedure in Chapter 72-20.	**Measurement:	
Complete the "Crankshaft Installation" procedure in Chapter 72-20.		
Measure the slinger clearance per the "Crankshaft Installation" procedure in Chapter 72-20.	**Measurement:	
Measure the crankshaft endplay per the "Crankshaft Installation" procedure in Chapter 72-20. Record the endplay measurement.	**Measurement:	
Assemble the crankcase halves per the "Crankcase Assembly" procedure and follow the torque sequence in Chapter 72-20.		
Complete the "Crankshaft Oil Seal Installation" procedure in Chapter 72-20		
Complete the "Crankshaft Idler Gear Installation" procedure in Chapter 72-20.		
Complete the "Oil Pump Installation" and "Fuel Pump Plunger Installation" procedures in Chapter 72-25.		
** Measurements must be within tolerances specified in the latest revision of the ***Service Table of Limits - SSP-1776.***		

Engine Assembly Checklist for IO-360-N1A Engine Models (Cont.)		
Item	**Comments**	**Done**
Complete the "Accessory Housing Installation" procedure in Chapter 72-25.		
Complete the "Fuel Pump Installation" procedure in Chapter 73-10.		
Complete the "Oil Filter Base Installation" procedure in Chapter 72-50.		
Complete the "Oil Cooler Bypass Valve Installation" procedure in Chapter 72-50.		
Complete the "Oil Sump Installation" procedure in Chapter 72-50.		
Complete the "Piston Installation" procedure in Chapter 72-30 for all four pistons.		
Complete the "Cylinder Installation" procedure in Chapter 72-30 for all four cylinders.		
Install the starter ring gear support per the "Starter Ring Gear Support Installation" procedure in Chapter 72-70.		
Complete the "Intake Pipe Installation" procedure in Chapter 72-80.		
Complete the "Oil Level Gage Installation" procedure in Chapter 72-50.		
Complete the "Intercylinder Baffle Installation" procedure in Chapter 72-30.		
Install a new oil drain tube at each cylinder head and at the crankcase per the "Oil Drain Tube Installation" procedure in Chapter 72-30.		
Examine, set the gap, and install the spark plugs per the "Spark Plug Gap Setting" and Spark Plug Installation" procedures in Chapter 74-20 of the ***IO-360-N1A Engine Service Manual***.		
Complete the "Magneto Installation" procedure in Chapter 74-30.		
Complete the "Ignition Harness Installation" procedure in Chapter 74-20.		
Complete the "Fuel Manifold Installation" procedure in Chapter 73-10.		
Complete the "Fuel Injector Installation" procedure in Chapter 73-10.		

Engine Assembly Checklist for IO-360-N1A Engine Models (Cont.)		
Item	**Comments**	**Done**
Complete the "Injection Nozzle Installation" procedure in Chapter 73-10.		
Install new fuel lines and complete the "Fuel Line Installation" procedure in Chapter 73-10.		
Complete the "Starter Installation" procedure in Chapter 72-70.		
Complete the "Alternator and Bracket Installation" and "Alternator Belt Installation" procedures in Chapter 72-70.		
Install the engine in the airframe per instructions in the ***IO-360-N1A Engine Installation and Operation Manual*** and applicable Airframe Maintenance Manual.		
Add oil to the engine in accordance with the procedure "Add Oil to the Engine" in Chapter 12-10 of the ***IO-360-N1A Engine Service Manual***..		
Complete an "Operational Ground Check" per Chapter 72-00 of the ***IO-360-N1A Engine Service Manual***.		

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72-15- PROPELLER FLANGE BUSHING REPLACEMENT

1. Propeller Flange Bushing Removal

   NOTICE: Designated bushings are installed in specified locations on the propeller in a particular indexed configuration.

   A. During removal of the bushings from the propeller flange (also known as the crankshaft flange), attach a removable non-adhesive label/tag on the bushing that identifies the correct bushing part number and location for reference on reassembly.

   B. Refer to the latest revision of Service Instruction No. SI-1098 for the latest part number and propeller flange bushing location (since an update of Service Instruction No. SI-1098 is more likely to occur before the parts catalog update.)

   C. Use the Propeller Flange Bushing Removal/Installation Tool ST-115 to remove each bushing from the propeller flange.

2. Propeller Flange Bushing Installation

⚠ **CAUTION:** IF THE PROPELLER FLANGE BUSHING OF THE CORRECT PART NUMBER IS NOT INSTALLED IN THE SPECIFIED LOCATION, THE PROPELLER WILL NOT BE INDEXED CORRECTLY. EXCESSIVE PROPELLER BLADE STRESSES CAN OCCUR.

   A. As per the latest revisions of Service instruction No. SI-1098, identify the correct bushing part numbers for your engine and the location of each bushing.

   B. Use the Propeller Flange Bushing Removal/Installation Tool ST-115 to install the bushings of the correct part number on the propeller flange on the crankshaft in the location designated for your engine model specified in the latest revision of Service Instruction No. SI-1098.

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72-20 - RECIPROCATING ENGINE – CRANKCASE MAINTENANCE

1. Crankcase Disassembly

   A. Put the crankcase upright on a suitable work surface

   B. Crankshaft Idler Gear and Bushing Removal

      (1) Remove the idler gears and bushings (Figure 1) from the idler gear shafts.

      (2) Discard the bushings.

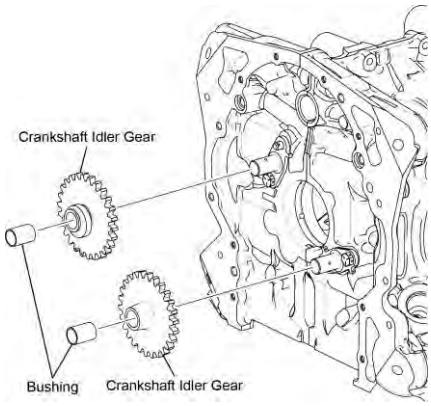


Figure 1
Crankshaft Idler Gears

⚠ **CAUTION:** TO PREVENT DAMAGE TO THE CRANKCASE, REMOVE ALL THRU-STUDS, NUTS, AND BOLTS FROM THE CRANKCASE HALVES BEFORE YOU SEPARATE THE CRANKCASE HALVES.

C. Use a slide hammer, a crankcase thru-stud puller ST-271 or crankcase thru stud driver ST-317 or a plastic hammer to remove the four thru-studs from the crankcase (Figure 2).

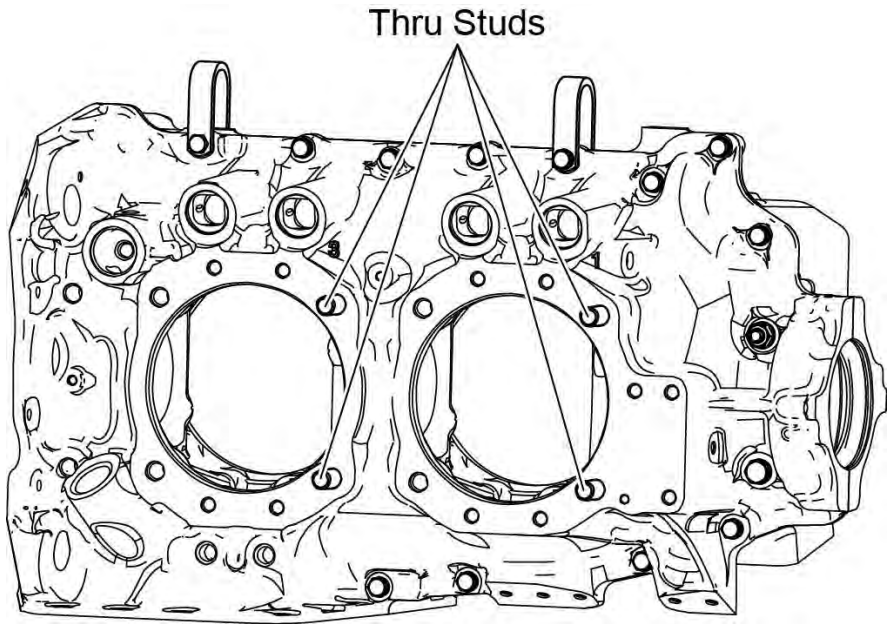


Figure 2
Crankcase Assembly

D. Remove the remaining bolts and nuts that attach the crankcase halves.

E. Insert one used pushrod into each of the four holes where the thru-studs were removed to support the camshaft and crankshaft when the crankcase halves are separated.

F. Separate the crankcase with a Crankcase Separating Tool ST-389 or with a slide-hammer attached to one of the base studs as shown in Figures 3, 4, and 5.

Figure 3
Attach the Slide-Hammer to a Base Stud

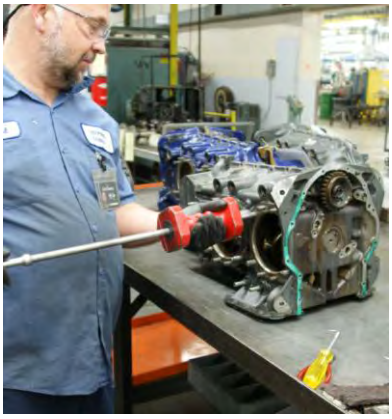


Figure 4
Strike the Slide Part of the Tool Against the Back of the Tool

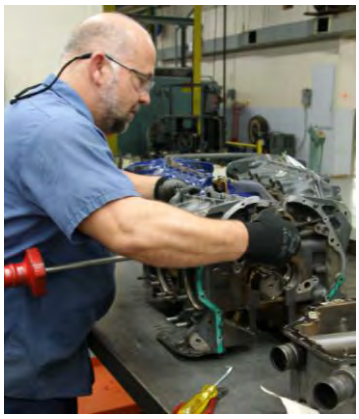


Figure 5
Separate the Crankcase Halves

G. Remove the camshaft when the crankcase halves are separated enough to allow for removal (Figure 6).

H. Continue separating the crankcase halves until the crankshaft can be removed from the crankcase (Figure 7).

Figure 6
Remove the Camshaft

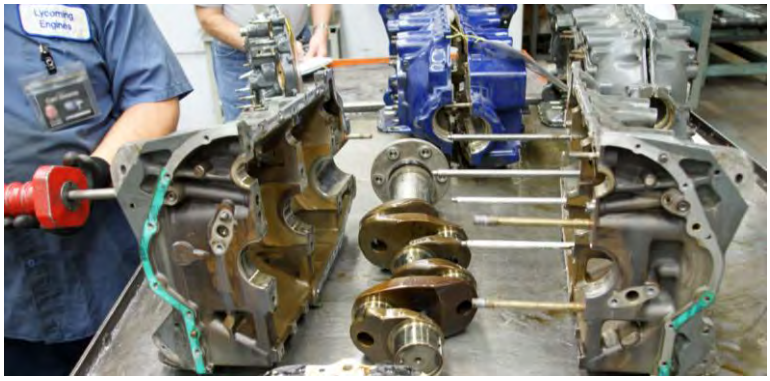


Figure 7
Remove the Crankshaft

I. Put the crankshaft in a suitable V-block-type fixture as shown in Figure 8.

NOTICE: Undersize crankshafts are identified by a code symbol stamped on the front of the flange as a suffix to the part number. In addition to the code symbols, the letters "RN" are stamped as a suffix to the serial number, indicating that the crankshaft has been renitrided.

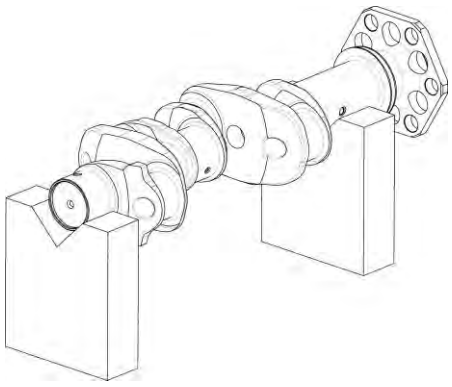


Figure 8
Crankshaft in V-Block-Type Fixture

J. Tappet, Main Bearing, and O-Ring Removal

(1) Remove the hydraulic tappet plungers using the hydraulic tappet tool.

⚠ **CAUTION:** IF A HYDRAULIC TAPPET TOOL IS NOT AVAILABLE, REMOVE THE PUSH ROD SOCKETS BY HAND OR BY MAKING A LOOP FROM A SHORT LENGTH OF SAFETY WIRE. DO NOT USE A MAGNET TO REMOVE THE SOCKET OR THE PLUNGER ASSEMBLY FROM THE ENGINE, AS THIS COULD CAUSE THE BALL TO REMAIN OFF ITS SEAT AND MAKE THE UNIT INOPERATIVE.

(2) Remove the push rod socket (Figure 9) by placing heavy grease on the ball end. Insert the ball end into the socket and withdraw it. The socket will adhere to the grease.

(3) Push the hollow end of the tool over the hydraulic tappet plunger and withdraw the plunger.

(4) Bend a right angle in one end of a piece of wire and insert this end into the space between the plunger assembly and the tappet body. Turn the wire 90º to engage a coil of the spring and draw out the hydraulic tappet plunger assembly. Refer to Figure 10.

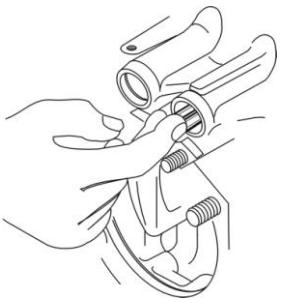


Figure 9
Removing Push Rod Socket

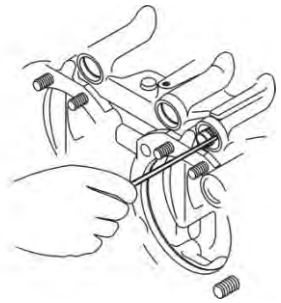


Figure 10
Removing Hydraulic Tappet Plunger Assembly

(5) Remove and discard the crankshaft bearings, crankshaft front bearings, and O-rings (Figure 11).

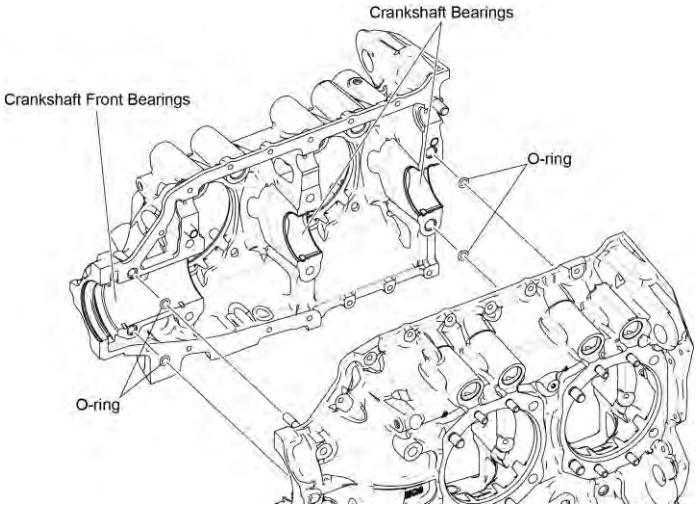


Figure 11
Main Bearings and O-Rings

K. Propeller Governor Drive Removal/Disassembly

(1) Remove the plug and gasket from the propeller governor idler gear shaft (Figure 12). Discard the gasket.

(2) Remove and discard the set screw from the propeller governor idler gear shaft. If the set screw was peened or staked in the hole, remove any debris.

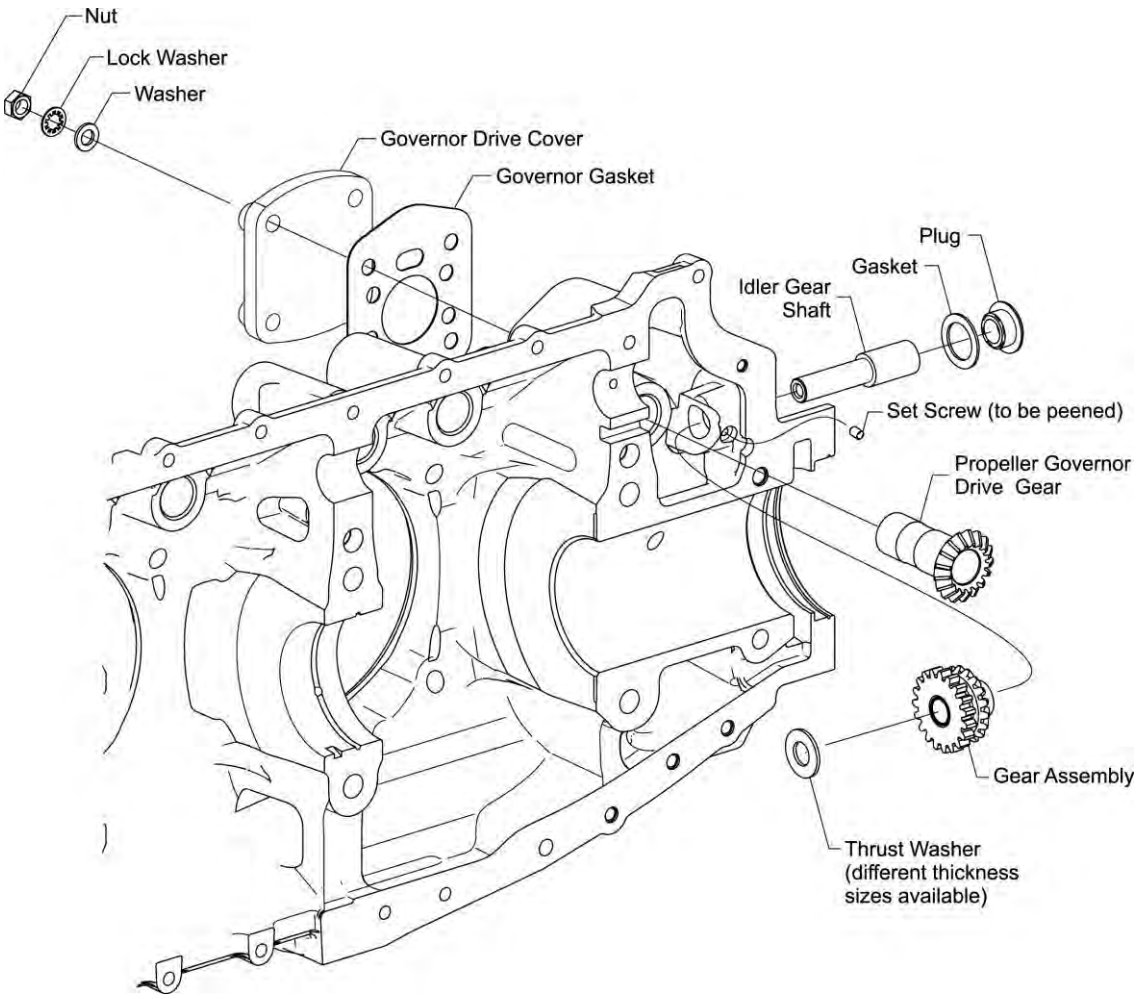


Figure 12
Propeller Governor Drive

(3) Support the propeller governor idler gear shaft assembly and, simultaneously remove the idler gear shaft, gear assembly, and thrust washer. Discard the thrust washer.

(4) Pull the propeller governor drive gear away from the crankcase.

(5) Remove the gear assembly and thrust washer.

(6) Remove the four nuts, lock washers and washers (Figure 12) from the propeller governor drive cover. Discard the lock washers.

(7) Remove the governor drive cover and governor gasket. Discard the governor gasket.

L. Oil Plug Removal

(1) Remove the threaded NPT plugs from the accessory housing, oil sump, and crankcase to facilitate cleaning (Figures 13, 14, and 15).

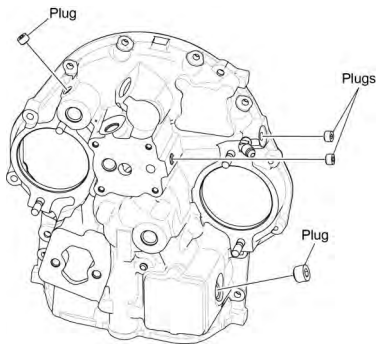


Figure 13
Oil Plugs in the Accessory Housing

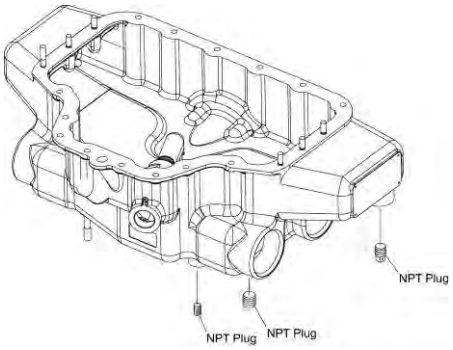


Figure 14
Oil Plugs in the Oil Sump

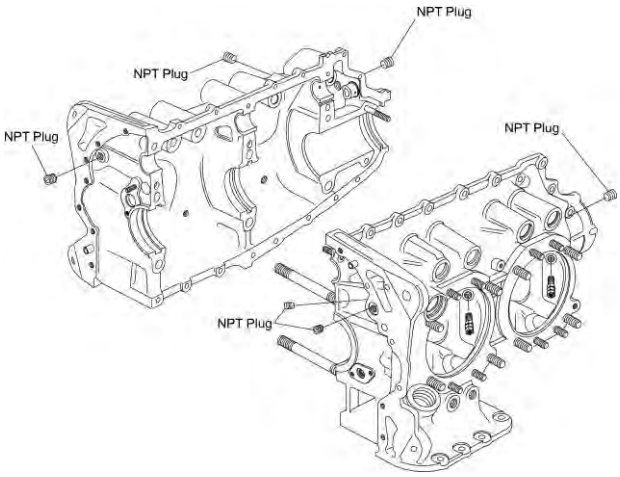


Figure 15
Oil Plugs in the Crankcase

M. Crankshaft Idler Gear Shaft Removal

(1) Remove the safety wire (Figure 16) from the nut and three bolts that attach the crankshaft idler gear shafts to the crankcase halves.

(2) Remove the nut and three bolts (Figure 17) that attach the crankshaft idler gear shafts to the crankcase halves.

(3) Remove the two crankshaft idler gear shafts from the rear of the crankcase halves (Figure 17).

Figure 16
Safety Wire on the Crankshaft Idler Gear Shaft

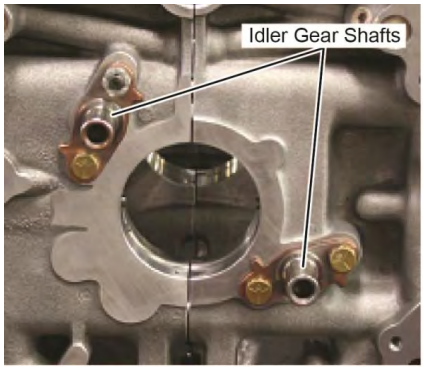


Figure 17
Crankshaft Idler Gear Shafts

N. Piston Cooling Nozzle Removal

(1) Remove the four piston cooling oil nozzles from the crankcase (Figure 18).

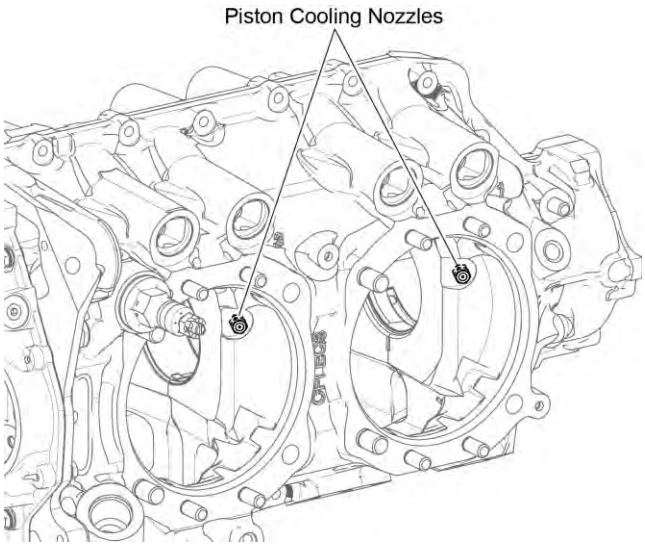


Figure 18
Piston Cooling Nozzles

2. Crankshaft Disassembly

⚠WARNING: USE CARE WHEN HANDLING THE CRANKSHAFT AND ITS PARTS – DO NOT ETCH OR MAKE MARKS ON THE CRANKSHAFT. AN ETCH OR A MARK CAN CAUSE WEAKNESS AND FATIGUE IN THE CRANKSHAFT, AND ULTIMATELY CRANKSHAFT FAILURE.

A. Connecting Rod Removal

⚠CAUTION: DO NOT RE-USE THE CONNECTING ROD BEARINGS, BOLTS, AND NUTS.

(1) Remove and discard the two nuts (Figure 19) and the two bolts that attach the connecting rod cap to the connecting rod.

(2) If the two nuts in the connecting rod cap cannot easily be removed, use a soft (plastic head) mallet and gently tap on the end of the two bolts to remove the nuts and the bolts. Discard the connecting rod bolts and nuts.

(3) Remove the connecting rod cap and connecting rod; keep them together, label the throw position of the connecting rod.

(4) Remove and discard the two connecting rod bearing halves.

(5) Keep the connecting rod cap with its corresponding rod.

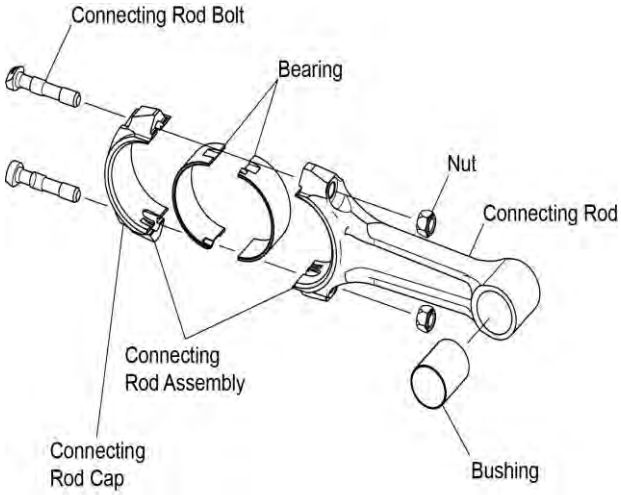


Figure 19
Connecting Rod Parts

B. Crankshaft Gear Removal

(1) Bend the tabs of the crankshaft gear bolt lockplate down, flat against the crankshaft gear.

(2) Remove the crankshaft gear bolt, lockplate, and crankshaft gear from the crankshaft (Figure 20). Discard the bolt and the lockplate.

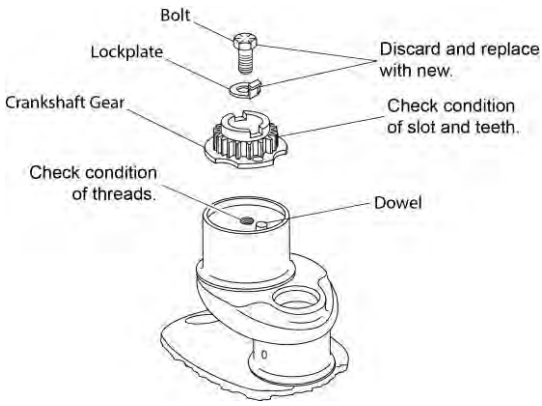


Figure 20
Crankshaft Gear and Associate Parts

NOTICE: Any time the crankshaft gear bolt (Figure 20) is removed, discard the bolt and replace it with a new bolt for the applicable crankshaft gear.

Do not remove the alignment dowel (Figure 20) from the end of the crankshaft unless it is damaged. Replace a damaged alignment dowel per the "Alignment Dowel Replacement" procedure in this chapter.

Do not remove the propeller flange bushings unless they are loose or damaged.

NOTICE: The expansion plug is not installed in the crankshaft if a constant speed propeller is used.

C. If installed, remove the larger expansion plug and inner plug (Figure 21) from the crankshaft by punching a 1/8 in. (3.175 mm) to 3/16 in. (4.763 mm) hole in the center of the plug. Use a hook or bent rod to pull out the plug. Remove any little pieces of plug remnants. Discard the expansion plug and inner plug.

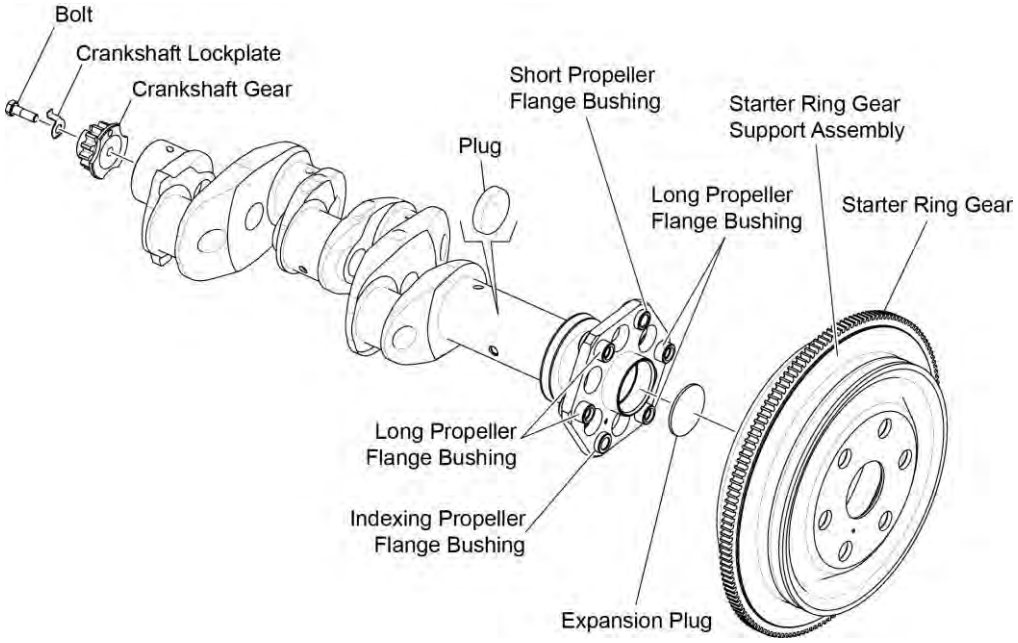


Figure 21
Crankshaft

3. Crankcase Inspection

A. The external crankcase inspection is done to:

- Identify any oil leaks, cracks, and mechanical damage on the crankcase.
- Make sure that hardware fasteners are torqued correctly.

⚠WARNING: REPLACE A CRACKED CRANKCASE. DO NOT TRY TO WELD OR REPAIR A CRACKED CRANKCASE. IF A CRACKED CRANKCASE IS NOT REPLACED, OIL CAN LEAK OUT OF THE CRANKCASE AND CAUSE ENGINE DAMAGE.

(1) Examine the exterior surface of the crankcase for cracks and damage. Replace a crankcase with one or more cracks.

(2) Complete a check of the torque on the crankcase hardware fasteners per the latest revision of the ***Service Table of Limits - SSP-1776***.

(3) Replace any crankcase hardware fastener that is distorted or has stripped threads per instructions in this manual.

B. Crankcase Dimensional Inspection

The crankcase dimensional inspection is done to make sure that the crankshaft bearings and camshaft bearings formed by the crankcase are within allowable limits.

Complete the crankshaft dimensional inspection as follows:

(1) Install new crankshaft bearings at all main bearing locations in the crankcase halves (Figure 11).

(2) Assemble the crankcase halves and install thru-studs (Figure 2).

(3) Install the torque hold down plates (ST-222, Figure 83) at the cylinder pads over the thru-studs.

(4) Attach the plates with washers and nuts on the thru-studs. Tighten the nuts only finger tight at this time.

(5) Make sure that the plates remain parallel with the cylinder decks of the crankcase.

(6) Temporarily torque the nuts to 300 in.-lb. (34 Nm).

(7) Attempt to insert a 0.004 in. tapered feeler gage between the crankcase mating faces. If the gage will not enter between the crankcase parting faces, the crankcase is considered satisfactory.

(8) Measure the Inside Diameter (I.D.) of the crankshaft bearings and record the measurements in the Crankcase Inspection Checklist for IO/AEIO-390-A Engine Models.

(9) Measure the Inside Diameter (I.D.) of the camshaft bearings formed by the crankcase. Record the measurements in the Crankcase Inspection Checklist for IO/AEIO-390-A Engine Models.

(10) Remove the nuts, washers, and hold down plates (ST-222), and separate the crankcase halves.

The Crankcase Dimensional Inspection Checklist is used to record the measurements of the crankshaft bearings and camshaft bearings formed by the crankcase.

Crankcase Dimensional Inspection Checklist for IO-360-N1A Engine Models			
Engine Model Number_____ **Engine Serial Number:**_____ **Engine Time:**_____ **Date Inspection Done:** _____ **Inspection done by:**_____			
Item	**Comments**	**Findings/ Corrective Action**	**Done**
Measure the I.D. of the crankshaft bearings installed in the crankcase.	Refer to the "Crankcase Dimensional Inspection" in this chapter.	Center main bearing measurement _____ inches Rear main bearing measurement _____ inches	
Measure the O.D. of the crankshaft at the center and rear bearing locations.		Crankshaft at center main bearing measurement _____ inches Crankshaft at rear main bearing measurement _____ inches	
Compare the difference between each main bearing I.D. measurement and crankshaft O.D. measurement to the Main Bearings and Crankshaft allowable clearance in the latest revision of the ***Service Table of Limits - SSP-1776***.			
Measure the I.D. of the camshaft bearings formed by the crankcase.	Refer to the "Crankcase Dimensional Inspection" in this chapter.	Front bearing measurement _____ inches Center bearing measurement _____ inches Rear bearing measurement _____ inches	
Measure the O.D. of the camshaft at the bearing locations.		Front camshaft bearing location measurement _____ inches Center camshaft bearing location measurement _____inches Rear camshaft bearing location measurement _____inches	
Compare the difference between each camshaft bearing I.D. measurement and camshaft O.D. measurement to the Camshaft and Crankcase allowable clearance in the latest revision of the ***Service Table of Limits - SSP-1776***.			

4. Crankshaft Inspection

The Crankshaft Inspection Checklist is used to record the condition of the crankshaft and any corrective action.

⚠ **CAUTION:** DO NOT MAKE SCORES, SCRATCHES, OR ETCH MARKINGS OF ANY KIND ON THE CRANKSHAFT. A MARK IN ANY OF THESE AREAS CAN CAUSE THE CRANKSHAFT TO WEAKEN AND TO FAIL.

NOTICE: Before crankshaft inspection, clean the crankshaft per "Crankshaft Cleaning" and "Crankshaft Counterbore Cleaning" procedures in Chapter 05-30.

Crankshaft Inspection Checklist for IO-360-N1A Engine Models

Engine Model Number_____ **Engine Serial Number:**_____

Engine Time:_____ **Date Inspection Done:** _____

Inspection done by:_____

Item	Comments	Findings/ Corrective Action	Done
Carefully examine all surfaces of the crankshaft for cracks, gouges, nicks, dents, or damage.	If a crack is found, replace the crankshaft. **Do NOT try to repair a cracked or damaged crankshaft.**		
Complete a magnetic particle inspection on the crankshaft per the latest revision of Service Instruction No. SI-1285.			
Use a flashlight, magnifying glass, and angled inspection mirror to visually examine the inner diameter of the crankshaft bore, starting at the crankshaft flange end. Look for pit marks and corrosion. "Pitting" looks like holes, cracks, or fissures of unspecified depth or direction.	If corrosion is found, refer to the section "Crankshaft Corrosion Removal Guidelines" in this chapter. If pitting is found, complete a Fluorescent Penetrant Inspection (FPI) (per the section "Non-Destructive Testing" in Chapter 05-50.		

Crankshaft Inspection Checklist for IO-360-N1A Engine Models (Cont.)			
Item	**Comments**	**Findings/ Corrective Action**	**Done**
Measure the inner diameter of the crankshaft. Record the measurement. Refer to Figure 22 and the latest revision of Service Bulletin No. SB-505.	For a crankshaft to be acceptable, the inner diameter must not be more than 1.910 in. (4.851 cm). If the inner diameter of the crankshaft is more than 1.910 in. (4.851 cm), replace the crankshaft.	Inner diameter measurement: _____ inches or _____ centimeters	
Examine the crankshaft bearing surfaces.	Refer to the "Crankshaft Bearing Surface Inspection" section in this chapter.		
Examine the crankshaft gear counter-bored mounting surface for galling or fretting.	If galling or fretting is found, replace the crankshaft.		

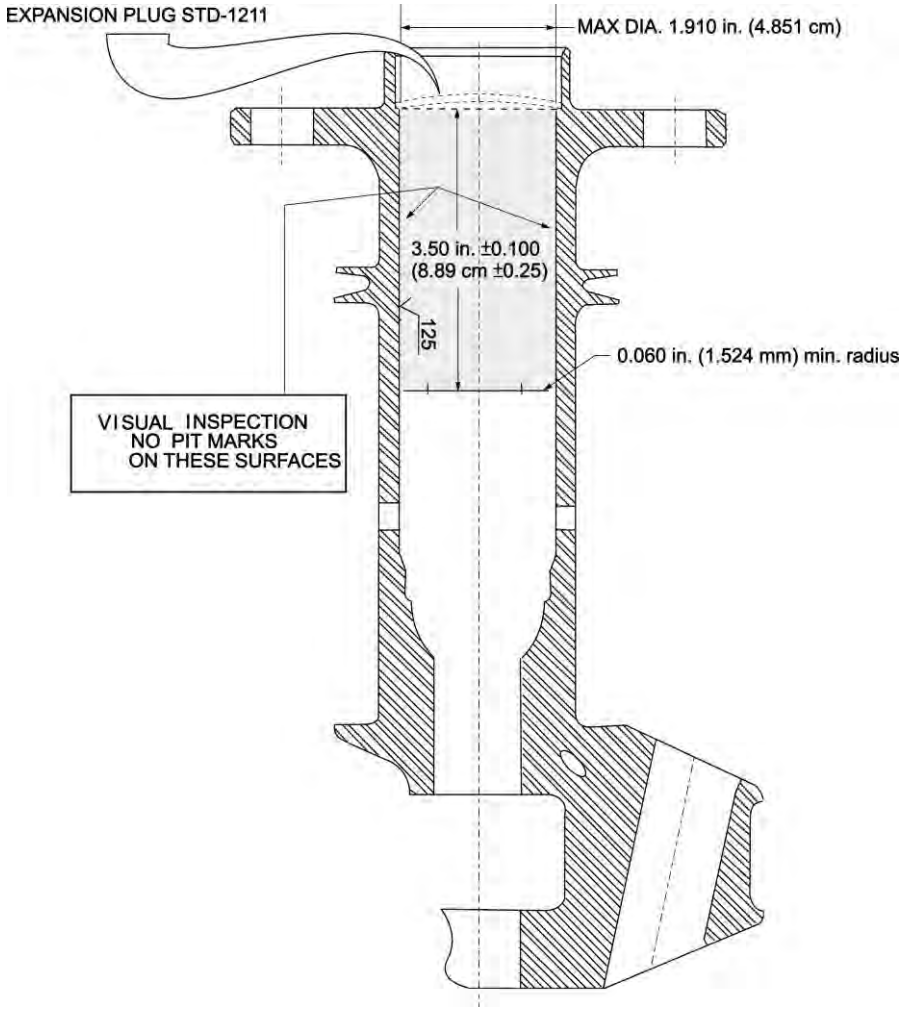


Figure 22
Area to be Examined

Crankshaft Inspection Checklist for IO-360-N1A Engine Models (Cont.)

⚠ **CAUTION:** LYCOMING ENGINES NO LONGER APPROVES STRAIGHTENING OR GRINDING OF BENT CRANKSHAFT FLANGES TO RESTORE MAXIMUM RUN-OUT. IF THE CRANKSHAFT FLANGE IS BENT, REPLACE THE CRANKSHAFT. DO NOT TRY TO STRAIGHTEN OR GRIND THE CRANKSHAFT FLANGE. (REFER TO THE LATEST REVISION OF SERVICE BULLETIN NO. SB-201)

Item	Comments	Findings/ Corrective Action	Done
Measure the crankshaft flange thickness and compare it with the dimensions below to calculate the minimum permissible thickness.	If the crankshaft flange is bent, replace the crankshaft. Do NOT straighten or grind a bent crankshaft. Refer to the latest revision of Service Bulletin No. SB-201 for any additional details.		

Crankshaft Flange Thickness

Inches	Millimeters	Inches	Millimeters
0.440 ± 0.010	11.176 ± 0.254	0.420	10.668

Measure the run-out of the crankshaft flange with a dial indicator at the location shown in Figures 23 and 24. The maximum Total Indicator Reading (TIR) must not be more than 0.005 in. (0.127 mm). As shown in Figure 23, make sure that the pilot diameter runs true with the front and rear main bearings within 0.003 in. (0.076 mm).	If run-out exceeds 0.002 in. (0.051 mm) total indicator reading, replace the crankshaft. Do not try to repair or grind a warped or bent crankshaft flange.		

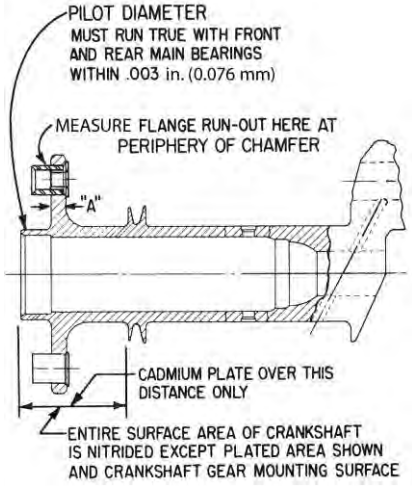


Figure 23
Crankshaft Flange

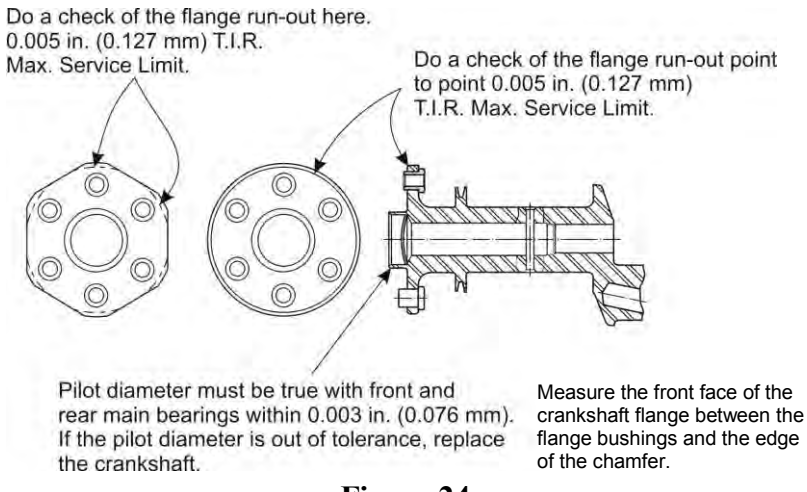


Figure 24
Crankshaft Flange Run-out and Pilot Diameter

Crankshaft Inspection Checklist for IO-360-N1A Engine Models (Cont.)
Crankshaft Gear Inspection
Any time the crankshaft gear bolt (Figure 25) and lockplate are removed from the crankshaft gear, the bolt and lockplate are to be discarded and replaced with a new bolt and new lockplate for the applicable crankshaft gear. The discarded bolt and lockplate are not to be re-installed on any engine.

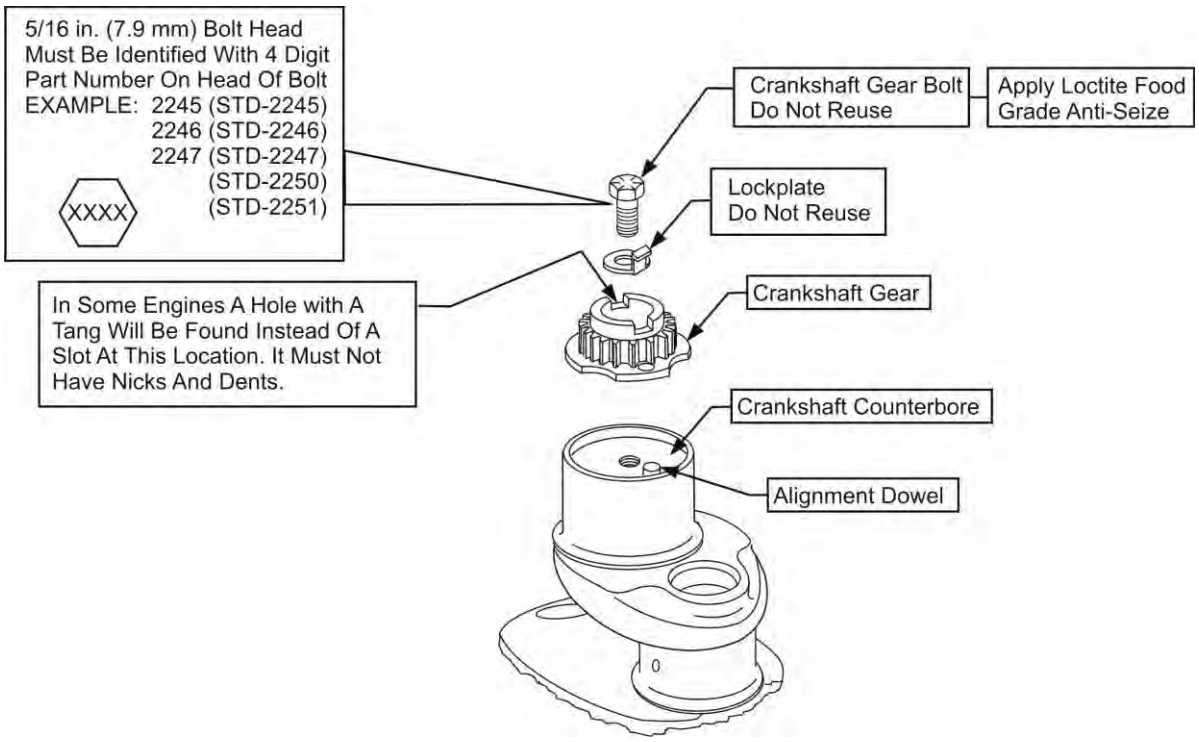
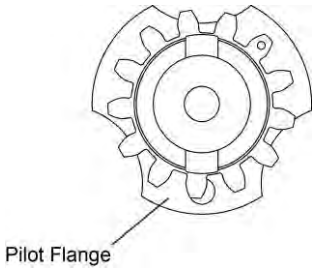


Figure 25
Crankshaft Gear Bolt and Lockplate

Item	Comments	Findings/ Corrective Action	Done
 **Figure 26** **Pilot Flange**	The crankshaft gear has three scallops as shown in Figure 26.		

Crankshaft Inspection Checklist for IO-360-N1A Engine Models (Cont.)			
Item	**Comments**	**Findings/ Corrective Action**	**Done**
Crankshaft Gear Inspection (Cont.)			
Measure the diameter of the crankshaft gear pilot flange (Figure 27).	If the diameter of the pilot flange is less than 2.125 in. (53.975 mm) do not install this gear on the crankshaft. Replace the crankshaft gear with a serviceable crankshaft gear.		
Measure dimensions on the crankshaft gear per those shown in Figure 27.		Acceptable O Replace O	

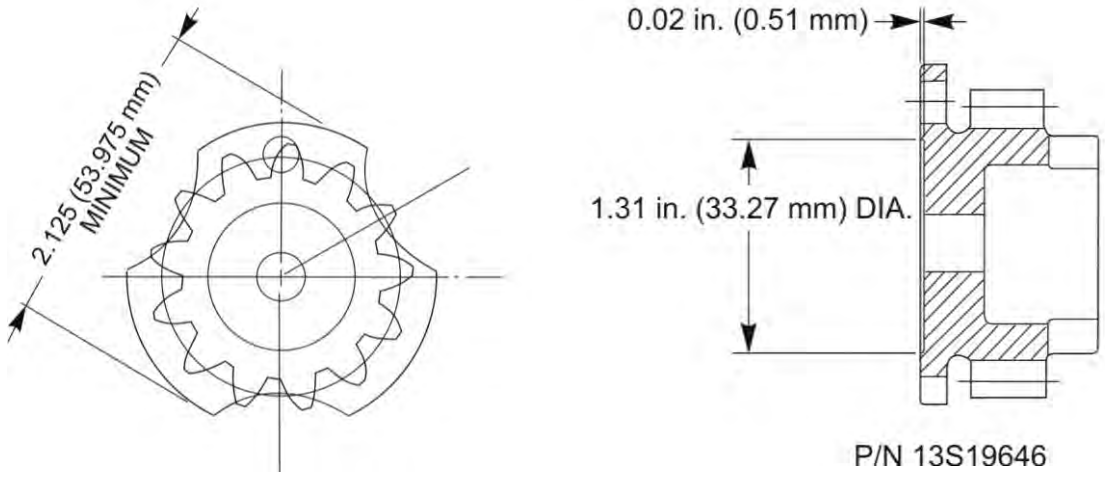


Figure 27
Details for Crankshaft Gear

Examine the crankshaft gear for pitting and wear.	Replace a pitted or worn crankshaft gear.	Acceptable O Replace O	
Examine the pilot flange diameter of the crankshaft gear for damage from galling or fretting.	If the pilot flange of the crankshaft gear is damaged, replace the crankshaft gear.	Acceptable O Replace O	
If there is a hole or slot on the crankshaft gear, examine the slot for any nicks or dents.	If nicks or dents are found, replace the crankshaft gear.	Acceptable O Replace O	
Complete a magnetic particle inspection of the crankshaft gear.	Refer to the "Non-Destructive Testing" section in Chapter 05-50.	Acceptable O Replace O	

Crankshaft Inspection Checklist for IO-360-N1A Engine Models (Cont.)			
Item	**Comments**	**Findings/ Corrective Action**	**Done**
Crankshaft Counterbore Inspection			
⚠ **CAUTION:** DO NOT TRY TO REPAIR THE CRANKSHAFT COUNTERBORE THREADS IN THE FIELD. IF THIS TYPE OF REPAIR IS NECESSARY, IT IS RECOMMENDED THE CRANKSHAFT BE SENT TO THE FACTORY (THROUGH AN AUTHORIZED LYCOMING DISTRIBUTOR) WITH PAPERWORK THAT IDENTIFIES THE NECESSARY REPAIR. **NOTICE:** Prior to inspection, the crankshaft counterbore must be clean, dry, and free of debris. Refer to the "Crankshaft Counterbore Cleaning" procedure in Chapter 05-30.			
Make sure the threads in the counterbored end of the crankshaft are intact and not galled, stripped, or damaged.	If the threads are galled, stripped or damaged, it is recommended the crankshaft be sent to the factory with paperwork that identifies the type of damage. Do not try to repair the threads in the field.		
Measure the Inside Diameter (ID) of the crankshaft counterbore at the rear of the crankshaft to make sure there is a correct fit between the ID of the crankshaft and the Outside Diameter (OD) of the crankshaft gear pilot flange. The crankshaft counterbore diameter at the rear of the crankshaft must not be more than 2.126 in. (54.000 mm) when measured at any location.	If the diameter is oversized, replace the crankshaft.		
Examine the gear mounting face of the crankshaft counterbore.	If the mounting face of the crankshaft counterbore is damaged, replace the crankshaft.		
If there is a hole or tang on the crankshaft gear (instead of a slot), examine the tang for any nicks or dents.	If nicks or dents are found, replace the crankshaft gear with a new three-scallop pilot flange gear (Figure 26).		
Examine and measure the alignment dowel per instructions in the "Alignment Dowel Inspection" section in this chapter.			

Rejection Criteria for a Crankshaft
A crankshaft must be replaced under any of the following conditions:
• Inner diameter measures more than 1.910 in. (4.851 cm) • Corrosion cannot be removed • Crack(s) or pitting with crack(s) in the crankshaft inner bore • Crankshaft fails FPI
Findings/Comments:

Results of Fluorescent Penetrant Inspection of Crankshaft		
Crankshaft P/N	**Inspector**	
Crankshaft S/N	**Date of Inspection**	
Black Light Inspection of Crankshaft Bore (inner diameter)		
Inspection Item	**Guidelines and Corrective Action**	**Findings and Action Taken**
Look for fatigue crack(s) or start of crack(s) in crankshaft bore Look for cracks caused by heat or brittleness	Start of cracks or crack(s) found - replace the crankshaft	Acceptable O Replace O
Look for inappropriate repair, such as grinding to remove corrosion, in or near crankshaft bore	Evidence of grinding - replace the crankshaft	Acceptable O Replace O
Look for ruptures inside the crankshaft bore	Rupture found - replace the crankshaft	Acceptable O Replace O
Additional check necessary?	Discontinuity found - replace the crankshaft	
Comments/Notes:		

5. Crankshaft Corrosion Removal Guidelines

NOTICE: Corrosion pits on the inside wall located immediately after of the pilot diameter can cause structural failure of the crankshaft on engines installed on fixed pitch propeller aircraft. Engine aging, short engine runs less than 1 hour, or infrequency of engine operation (less than one time per month), humid environments, and incorrect crankshaft cleaning, can increase corrosion which can cause structural damage to the crankshaft. Because of these contributing factors, examine the inner diameter of the crankshaft for corrosion.

Tools to be used include:

Scotch-Brite™ or equivalent	Micrometer	Magnifying glass (power x4)
Corrosion removal tool that follows the contour of the crankshaft	Cleaning solvent	
	Lint-free cloths/wipe rags	Angled inspection mirror.
Fine abrasive cloth	Flashlight	

A. Remove the Urethabond from the inner diameter of the crankshaft as follows:

NOTICE: The hollow inner diameter of the crankshaft has a gray coating called Urethabond. This coating must be removed before crankcase inspection.

The front expansion plug must have been removed from the crankshaft before the Urethabond coating can be removed from the crankshaft.

(1) Put the crankshaft in a lathe with the gear end in chuck jaws that have a brass lining.

(2) Clamp the chuck jaws on the #4 main journal diameter.

(3) Secure the steady rest on the #1 main journal diameter.

(4) Set the lathe at an approximate speed of 170 rpm and the feed rate at approximately 30 IPM for sufficient stock removal.

(5) Use the lathe to bore the inner diameter of the crankshaft within specified limits to remove the Urethabond. Do not exceed the bore dimensions.

(6) Gauge the bore dimensions before removal of the crankshaft from the lathe. If the bore is insufficient, bore more until the gauge bore is correct.

(7) If the bore gauge dimension is correct, remove the crankshaft from the lathe.

(8) Remove any machining chips from the inner diameter bore of the crankshaft.

B. Clean the first 3.50 in. (8.89 cm) at the crankshaft flange end of the inside crankshaft wall behind the expansion plug seat with solvent. Use care to prevent damage to the oil transfer tube. Dry with compressed air.

NOTICE: For a crankshaft to be acceptable, the inner diameter must not measure more than 1.910 in. (4.851 cm). If the inner diameter of the crankshaft is more than 1.910 in. (4.851 cm), replace the crankshaft.

C. Use a flashlight, magnifying glass, and angled inspection mirror to visually examine the inner diameter of the crankshaft bore, starting at the crankshaft flange end. Look for pit marks and corrosion. "Pitting" looks like holes, cracks, or fissures.

D. Measure and record the inner diameter of the crankshaft.

E. If corrosion is found, remove corrosion from the inner diameter of the crankshaft per the instructions in Table 1 in relation to the inner diameter measurement of the crankshaft.

F. If mild corrosion is found (the inner diameter of the crankshaft measures between 1.900 and 1.910 in. (4.826 and 4.851 cm), remove the corrosion per the Corrosion Removal Procedure A in Table 1. If more extensive corrosion is found and the crankshaft inner diameter measures less than 1.900 in. (4.826 cm), remove the corrosion using the Corrosion Removal Procedure B in Table 1.

G. Try to remove corrosion using the applicable procedures in Table 1. If the corrosion cannot be removed, the crankshaft is unacceptable and must be discarded and replaced with a new crankshaft.

H. If the crankshaft is acceptable, apply a coating of Urethabond to the inner diameter of a serviceable crankshaft per instructions in the latest revision of Service Bulletin No. SB-505.

⚠ **CAUTION:** PITTING TENDS TO WEAKEN A CRANKSHAFT. DO NOT TRY TO REMOVE PITS FROM THE CRANKSHAFT USING ABRASIVE MATERIALS. THIS ABRASION CAN CAUSE STRESS RISERS AND FRACTURES.

DO NOT APPLY A PROTECTIVE COATING OVER THE PITTED AREA TO CORRECT THE PITTING. THE PROTECTIVE COATING WILL NOT STOP DAMAGE CAUSED BY PITTING.

REPLACE A PITTED CRANKSHAFT WITH A SERVICEABLE CRANKSHAFT.

NOTICE: If pitting is found, complete a Fluorescent Penetrant Inspection.

Table 1
Corrosion Removal Guidelines

Corrosion Removal Procedure A	Corrosion Removal Procedure B
If the inner diameter of crankshaft is 1.910 in. (4.851 cm):	**If the inner diameter of the crankshaft is less than 1.900 in. (4.826 cm):**
Use Scotch-Brite™ or equivalent to uniformly remove the corrosive coating from the inner diameter of the crankshaft. Do not remove any additional material, otherwise the crankshaft must be discarded and replaced with a new crankshaft.	On the first pass, use a corrosion removal tool that follows the contour of the inner diameter of the crankshaft to uniformly remove surface corrosion from the inner diameter of the crankshaft.
Measure the inner diameter of the crankshaft again.	Use a fine abrasive cloth to remove debris and superficial fine corrosive dust.
The crankshaft inner diameter must be clean. Slight waviness is acceptable as long as the inner diameter does not exceed the maximum 1.910 in. (4.851 cm).	After this first pass, measure the inner diameter of the crankshaft again to make sure the inner diameter does not exceed 1.910 in. (4.851 cm).
	Look for remaining corrosion on the inner diameter of the crankshaft.
	If the inner diameter is less than or equal to 1.900 in. (4.826 cm) and corrosion is still on the inner diameter of the crankshaft, complete the previous steps again. If the inner diameter is nearly 1.910 in. (4.851 cm), complete the "Corrosion Removal Procedure "A in Table 1.
	The crankshaft inner diameter must be clean. Slight waviness is acceptable as long as the inner diameter does not exceed the maximum 1.910 in. (4.851 cm).

6. Alignment Dowel Inspection
   A. Examine the alignment dowel installed in the end of the crankshaft.
   B. Make sure the alignment dowel is perfectly smooth and round, without nicks or deformation.
   C. If the alignment dowel is smooth and round, make sure that it is installed correctly.
   D. The shoulder of the dowel is 0.010 to 0.020 in. (0.25 to 0.51 mm) below the surface of the crankshaft as shown in Figure 28.

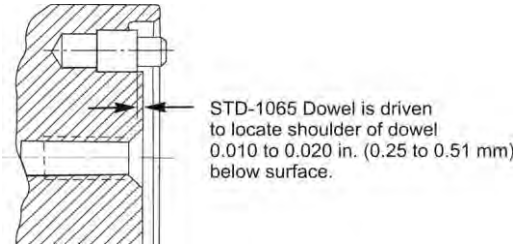


Figure 28
Section Through Counterbore End of Crankshaft Showing Driven Height of Dowel

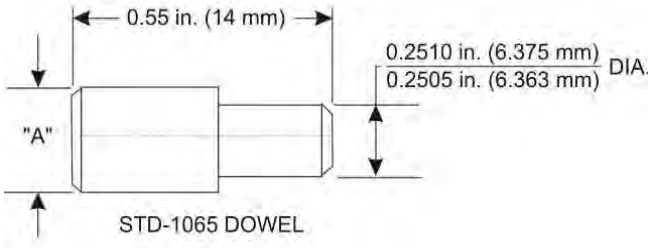


Figure 29
Details of Crankshaft Dowel

   E. Measure the diameter of the alignment dowel (Dimension A) shown in Figure 29 and determine if the measurement conforms to the values in Table 2 for the different alignment dowel part numbers.
   F. If the alignment dowel is out of tolerance or out of round, replace the dowel with a new one per the "Alignment Dowel Replacement" procedure in this chapter.

Table 2
Alignment Dowels and Alignment Dowel Holes

Alignment Dowel Part No.	Size Code on Alignment Dowel	Diameter of Alignment Dowel "A" (Figure 29)		Diameter of Alignment Dowel Hole in Crankshaft	
		in.	mm	in.	mm
STD-1065	None	0.3095 to 0.3100	7.861 to 7.874	0.3085 to 0.3095	7.836 to 7.871
STD-1065-P02	P02	0.3115 to 0.3120	7.921 to 7.925	0.3105 to 0.3115	7.887 to 7.925
STD-1065-P05	P05	0.3145 to 0.3150	7.988 to 8.001	0.3135 to 0.3145	7.963 to 7.988
STD-1065-P10	P10	0.3195 to 0.3200	8.115 to 8.128	0.3185 to 0.3195	8.090 to 8.115
STD-1065-P15	P15	0.3245 to 0.3250	8.242 to 8.255	0.3235 to 0.3245	8.217 to 8.242

7. Crankshaft Bearing Surface Inspection
   A. Examine all bearing surfaces for scoring, galling, and wear. If a part has one of these conditions, discard it and replace it with a new one.
   B. Refer to the latest revision of the ***Service Table of Limits - SSP-1776*** to identify the nominal manufactured specifications of the bearing journals. Undersize crankshaft bearing journals listed in Table 3 are identified by a code symbol stamped on the front of the flange as a suffix to the part number.

Table 3
Crankshaft Undersize Codes

Journals	0.003 in. (0.076 mm)	0.006 in. (0.152 mm)
Main Bearing Journals	M03M	M06M

C. Using a micrometer, measure and record the dimensions.

D. If the actual undersize is between the service limit (0.0015 in. and 0.003 in.), complete the following:

(1) Polish to 0.003 in. (0.076 mm) undersize.

(2) Fit with 0.003 in. (0.076 mm) bearing insert.

(3) Repeat for all bearings.

⚠ **CAUTION:** DURING POLISHING, DO NOT ALLOW THE LATHE SPEED TO EXCEED 150 RPM.

NOTICE: Polishing undersize is preferable to grinding undersize because shafts that are polished do not require re-nitriding.

If one bearing journal is polished to 0.003 in. or 0.006 in. undersize, all corresponding journals must be polished to the same size.

E. If the actual undersize is greater than 0.003 in. (0.076 mm), complete the following:

(1) Polish to 0.006 in. (0.152 mm) undersize.

(2) Fit with 0.006 in. (0.152 mm) bearing insert.

(3) Repeat for all like bearings.

F. If the actual undersize is greater than 0.006 in. (0.152 mm), replace the crankshaft.

8. Bearing Shell Surface Inspection

A. Examine all bearing surfaces for scoring, galling, and wear. If a part has any of these defects, discard it and replace it with a new one.

B. Make sure that the clearance of each bearing agrees with the specification in the latest revision of the ***Service Table of Limits - SSP-1776***.

C. If a bearing is not in the applicable limits, discard it and replace it with a new one.

D. Examine all journal surfaces for galling, scores, misalignment, and out-of-round condition.

E. Examine the shafts and pins for straightness.

9. Gear Inspection

A. Examine the involutes of the gear teeth for pitting and excessive wear.

B. If pit marks are found, then discard the gear and replace it with a new one.

C. Examine the bearing surfaces of all gears for deep scratches.

D. Remove minor abrasions with a fine abrasive cloth.

10. Screwed Fitting Inspection

A. Examine the condition of the threads on screwed fittings (threaded fastenings or plugs).

B. Remove small nicks and burrs with a small file, fine abrasive cloth, or stone.

C. If the part cannot be repaired by polishing it, discard it and replace it with a new one.

D. If the part has too much distortion, galling, or mutilation (caused by over-tightening or incorrect tool) replace it.

11. Camshaft Inspection

A. Camshaft - Visual Inspection (refer to Figure 30).

NOTICE: Refer to the latest revision of Service Instruction No. SI-1011 for guidance as to whether or not to replace the camshaft with a new camshaft if new tappets are to be installed for the first time. Examine the new camshaft per this visual inspection.

(1) Refer to Figure 30. Carefully examine all surfaces of the camshaft for cracks, scoring, galling, corrosion, pitting, or other damage, paying particular attention to the bearing surfaces and camshaft lobes.

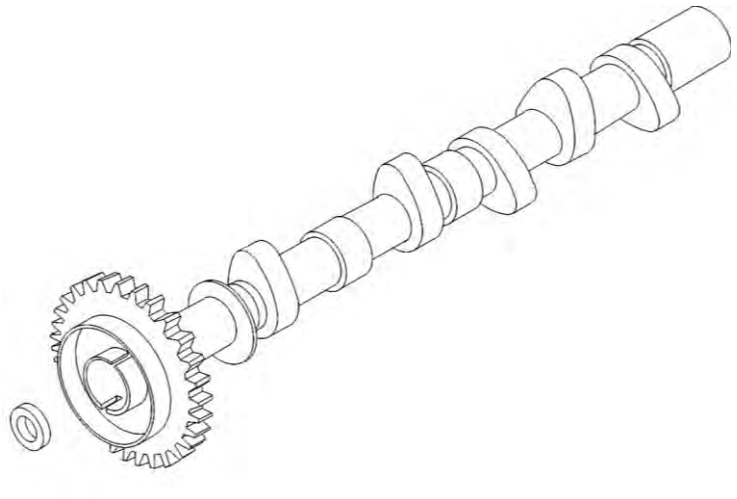


Figure 30
Camshaft with Integral Gears

(2) Replace the camshaft if there is any evidence of the following:

- Cracks
- Corrosion
- Feathering
- Scoring
- Pitting
- Damage
- Galling
- Distress
- Surface irregularity

(3) If a hydraulic tappet body has been rejected for spalling, carefully examine the corresponding camshaft lobe for evidence of distress, surface irregularity, or feathering on the edges.

(4) Replace the camshaft if there is any evidence of distress, surface irregularity, or feathering at the edge of the camshaft lobes or bearing is found.

B. Camshaft - Dimensional Inspection

Refer to the latest revision of the ***Service Table of Limits - SSP-1776***.

(1) Support the camshaft in V-blocks and check the run-out. For mounting locations and clearances, refer to the latest revision of the ***Service Table of Limits - SSP-1776***.

(2) Measure the O.D. of the camshaft at the bearing locations and compare the results to the bearings formed by the crankcase. If the diameter is not within the satisfactory limits, replace the camshaft. (Refer to the "Crankcase Dimensional Inspection" in this chapter.)

12. Connecting Rod Inspection

Copy the Connecting Rod Inspection Checklist is used to record the condition of all of the connecting rods and any corrective action.

Connecting Rod Inspection Checklist for IO-360-N1A Engine Models		
Engine Model Number_____ **Engine Serial Number:**_____ **Engine Time:**_____ **Date Inspection Done:** _____ **Inspection done by:**_____		
Task or Inspection	**Measurements, Findings and/or Corrective Action**	
Disassemble the connecting rod; clean the rod and its cap thoroughly. Visually examine the connecting rod for damage.		
Examine the connecting rod bore for wear.	If the rod bore is worn, replace the connecting rod assembly.	
	o Rod bore not worn	o Worn rod bore/connecting rod replaced
Examine the mating face of the connecting rod and its cap face for fretting (Figure 31).	If fretting is found, replace the connecting rod assembly.	
	o No fretting	o Fretting found/connecting rod replaced
Use a 6 power magnifying glass (minimum) or bench microscope to examine the critical areas on the connecting rod identified in Figure 31 for galling.*	If galling is found, replace the connecting rod assembly.	
	o No galling	o Galling found/connecting rod replaced
* Do not mistake stains or discoloration for galling. Surface blemishes are easily removed with a fine abrasive cloth, chemical cleaner or steel wool. Whereas, galling cannot be removed. If galling is found in the bearing bore, replace the connecting rod. To identify whether blemishes (stains or discolorations) are caused by galling, try to remove the surface blemishes with a fine abrasive cloth, chemical cleaner or steel wool. Blemishes caused by galling cannot be removed. Also, gall marks vary in size and shape. Some gall marks can be as small as pin heads. Other gall marks can be circular, oval, or thin, or look like rods.		

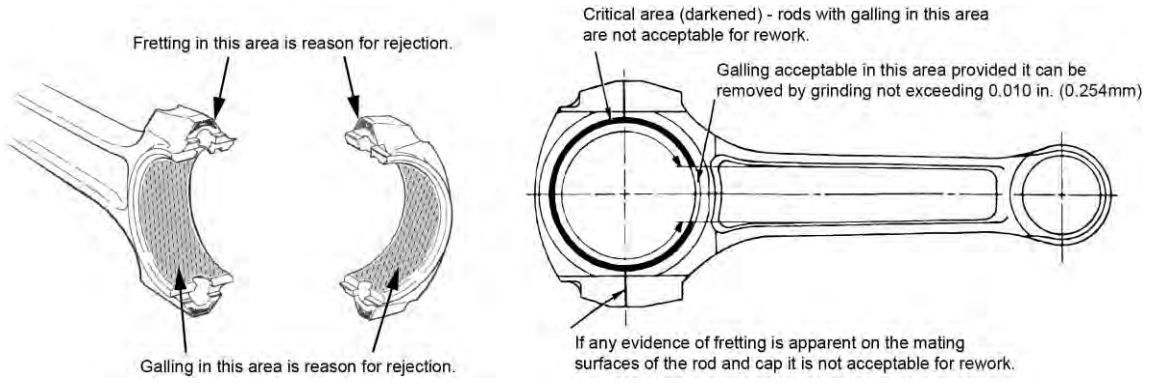
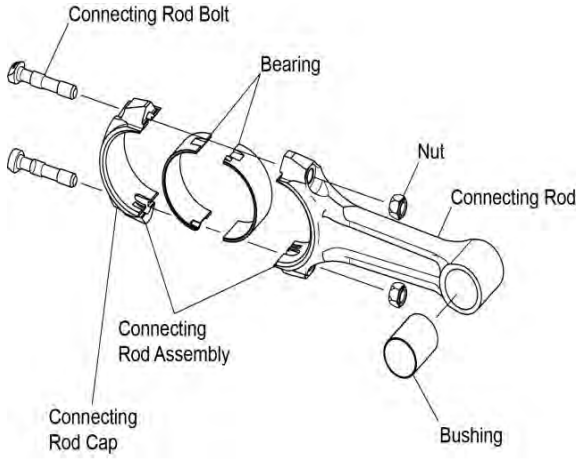


Figure 31
Areas on Connecting Rod to Examine for Fretting and Galling

Connecting Rod Inspection Checklist for IO-360-N1A Engine Models (Cont.)

Item	Comments	Findings/ Corrective Action		Done
Measure the Inner Diameter (ID) of the connecting rod bushing using an inside micrometer (Figure 32).	If the connecting rod bushing is worn beyond service limits per the latest revision of the ***Service Table of Limits - SSP-1776***, remove the bushing per "Connecting Rod Removal" in this chapter.	**Bushing ID Measurement**		
		Connecting Rod 1		
		Connecting Rod 2		
		Connecting Rod 3		
		Connecting Rod 4		

Item	Findings/Corrective Action		
 **Figure 32 Connecting Rod**	**Complete a Magnetic Particle Inspection on all connecting rods that pass the visual inspection per "Non-Destructive Testing" section in Chapter 05-50.**		
	Findings/ Corrective Action of Magnetic Particle Inspection		**Done**
	Connecting Rod 1	Acceptable O Replace O	
	Connecting Rod 2	Acceptable O Replace O	
	Connecting Rod 3	Acceptable O Replace O	
	Connecting Rod 4	Acceptable O Replace O	

Measure the distance between arbors (Figure 34). For exact parallelism or alignment, the distances measured on both sides are to be the same. Measure clearance at the points where the arbors rest on the parallel blocks (Figure 35) using a feeler gage. Compare the clearance between each arbor and the parallel blocks against the values in the latest revision of the ***Service Table of Limits - SSP-1776.*** Refer to the "Connecting Rods - Parallelism / Squareness Check" in this chapter.		Parallelism Measurement	Squareness Measurement
	Connecting Rod 1		
	Connecting Rod 2		
	Connecting Rod 3		
	Connecting Rod 4		

Connecting Rod Inspection Checklist for IO/AEIO-390-A Engine Models (Cont.)

Connecting Rod Bearing and Crankshaft Clearance

To complete this inspection:

NOTICE: For this inspection the connecting rods, bearings, connecting rod bolts, and nuts (Figure 32) are assembled, but not installed on the crankshaft.

1. Assemble and torque each connecting rod with acceptable bearings per instructions in the "Connecting Rod Installation" section in this chapter.
2. Measure the inside diameter of the bearing in each connecting rod and record the measurement below.
3. Measure the crankshaft diameter at the crankpin journal for each connecting rod and record the measurement below.
4. Subtract the crankshaft diameter at the crankpin journal from the inside diameter of the bearings for each connecting rod to calculate the connecting rod and crankshaft clearance. Record the measurement below.
5. Compare the connecting rod bearing and crankshaft clearance to the acceptable clearance measurement in the latest revision of the ***Service Table of Limits - SSP-1776***.
6. Remove and discard the connecting rod bolts and nuts from the connecting rod assembly.
7. If the connecting rod bearing and crankshaft clearance is within limits the connecting rod bearings are acceptable.
8. If the connecting rod bearing and crankshaft clearance is not within limits the connecting rod bearings must be replaced with oversize bearings to bring the clearance within acceptable limits.

Measurement	Inside Diameter of the Bearings	Crankshaft Diameter at the Crankpin Journal	Connecting Rod Bearing and Crankshaft Clearance
Cylinder 1			
Cylinder 2			
Cylinder 3			
Cylinder 4			

13. Connecting Rods - Parallelism / Squareness Check

NOTICE: The connecting rod parallelism and squareness gage P/N 64530 (Figure 33) is necessary for this check.

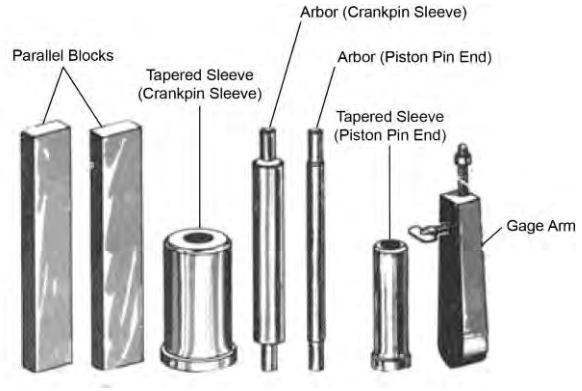


Figure 33
Connecting Rod Parallelism and Squareness Gage P/N 64530

A. Verify that the bearing cap is assembled correctly and is tightened securely.
B. Insert the tapered sleeves (Figure 34) of the connecting rod parallelism and squareness gage P/N 64530 in the bearing holes in the connecting rod.
C. Pull the arbors through the sleeves.
D. Install the gage arm on the arbor as shown in Figure 34.
E. Turn the adjusting screw on the gage arm until it just touches the arbor.
F. Use the wing nut to lock the adjusting screw.
G. Make sure the adjusting screw just touches the arbor.
H. Remove the gage arm and install it on the other end of the arbor.
I. Measure the distance between arbors. For exact parallelism or alignment, the distances measured on both sides must be the same. Record the measurement in the Connecting Rod Inspection Checklist in this chapter.
J. Remove the gage arm.
K. Keep the sleeves and arbors in place.
L. Put the parallel blocks (Figure 35) of the connecting rod parallelism and squareness gage on the surface plate.
M. Put the ends of the arbors on the parallel blocks.
N. For the squareness check measure the clearance at the four check points in Figure 35 where the arbors rest on the parallel blocks using a feeler gage. Record the measurement in the Connecting Rod Inspection Checklist in this chapter
O. Compare the clearance between each arbor and the parallel blocks against the values in the latest revision of the ***Service Table of Limits - SSP-1776***.

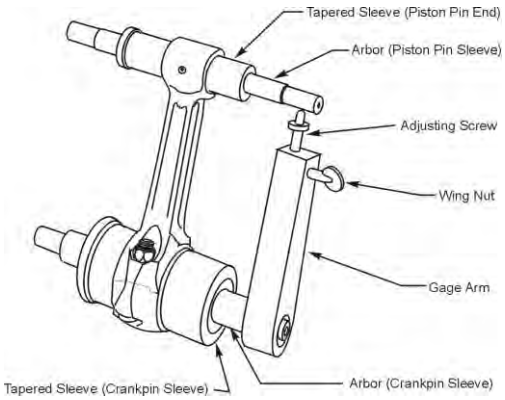


Figure 34
Parallelism Check of Connecting Rods

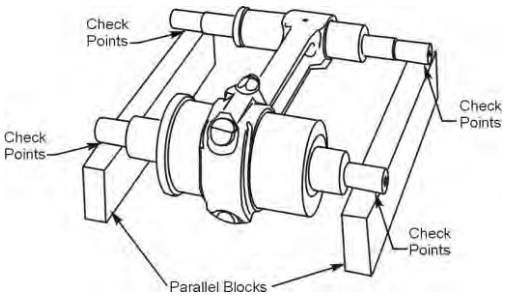


Figure 35
Squareness Check of Connecting Rods

14. Tappet Inspection

NOTICE: The roller tappets are not field repairable and no disassembly is allowed. During maintenance, complete a visual inspection of each roller tappet (Figure 36) for integrity and free rotation of the roller action is acceptable to return in-use roller tappets to service. Replace a damaged or corroded roller tappet or one that does not turn freely with a serviceable tappet.

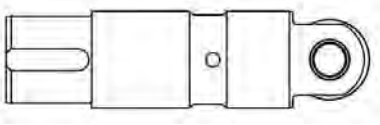


Figure 36
Hydraulic Roller Tappet

15. Crankshaft Assembly

A. Alignment Dowel Replacement

(1) Use a center punch to mark the center of the exposed surface of the installed alignment dowel.

(2) Mark a 1/8 in. (3.18 mm) drill bit to limit the depth of the drilled hole to 0.6 in. (15.14 mm).

⚠ **CAUTION:** USE CARE NOT TO DRILL DEEPER THAN THE MARKED DEPTH LIMIT OF THE DRILL. DO NOT LET THE DRILL MAKE CONTACT WITH THE REAR OF THE CRANKSHAFT.

(3) Drill a 1/8 in. (3.18 mm) diameter hole through the center of the installed alignment dowel, not to exceed 0.6 in. (15.2 mm).

(4) Fill the new drilled hole with oil.

(5) Put a piece of 1/8 in. (3.18 mm) diameter drill rod in the drilled hole.

(6) Use a hammer or mallet to hit the end of the drill rod.

(7) Hydraulic pressure from the oil will push out the alignment dowel from the crankshaft. Remove and discard the alignment dowel.

(8) Examine the bottom of the alignment dowel hole to make sure that the drill bit did not make contact with the bottom of the hole. If the drill bit made contact with the bottom of the hole, send the crankshaft to the factory for evaluation.

(9) Refer to Table 2 for the correct type and size of alignment dowel.

(10) Press the replacement alignment dowel into the alignment dowel hole to the required driven height. Refer to the applicable Figure 37 for the correct driven height.

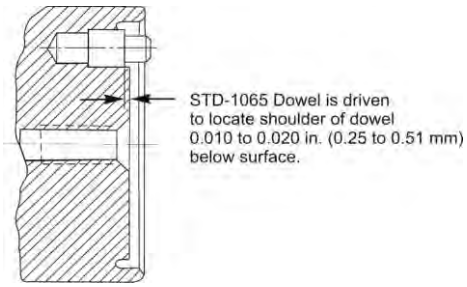


Figure 37
Section Through Counterbore End of Crankshaft Showing Driven Height of Dowel

B. Crankshaft Gear Installation

(1) Start with a clean crankshaft that passed the "Crankshaft Inspection" in this chapter.

(2) Make sure the mating surfaces of the crankshaft gear and crankshaft counterbored end are clean and dry and that there is no debris. Refer to the procedure "Crankshaft Cleaning" and Crankshaft Counterbore Cleaning" in Chapter 5-30 in this manual.

(3) Install the crankshaft gear on the alignment dowel of the crankshaft counterbored end as shown in Figure 38.

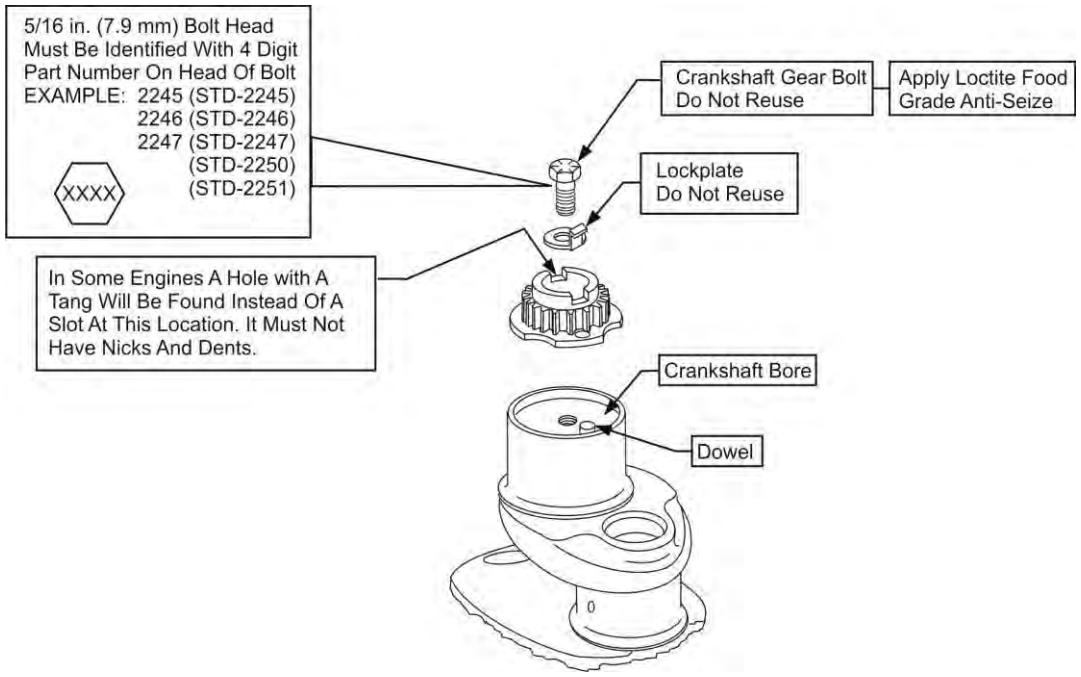


Figure 38
Crankshaft Gear Bolt and Lockplate

⚠ **CAUTION:** DURING CRANKSHAFT ASSEMBLY, ALWAYS INSTALL A NEW CRANKSHAFT GEAR BOLT AND NEW LOCKPLATE. DO NOT REUSE EITHER THE CRANKSHAFT GEAR BOLT OR LOCKPLATE.

(4) Refer to the latest revision of Service Bulletin No. SB-475 or the ***IO-360-N1A Illustrated Parts Catalog*** to identify the correct part number for the new crankshaft gear bolt and lockplate for the applicable crankshaft gear part number.

(5) Make sure that the threads on the new crankshaft gear bolt (Figure 38) and the threads in the counterbored end of the crankshaft are clean and dry and that there is no debris.

(6) Apply a small amount of Loctite® Food-Grade Anti-Seize Lubricant, (Table 4), to the bottom three or four threads of the new crankshaft gear bolt. Wipe away any excess lubrication.

NOTICE: Do not bend the tab on the lockplate yet.

(7) Install a new lockplate and new crankshaft gear bolt with the part number on the top of the bolt head.

Table 4
Loctite® Food-Grade Anti-Seize

Original Loctite® Manufacturer's P/N	Legacy #	Package Size		New Loctite® Manufacturer's P/N
209749	51168	8 oz.	227 g	1167237
234271	51170	2 lb.	907 g	1169241
234274	51171	40 lb.	18 kg	1170163

(8) Initially torque the crankshaft gear bolt (regardless of size) to 125 in.-lb (14.12 Nm) torque. Do not bend the lockplate at this time.

⚠ **CAUTION:** FOR CORRECT ENGINE OPERATION, THE CRANKSHAFT GEAR MUST BE INSTALLED CORRECTLY WITH NO GAP BETWEEN THE MATING SURFACES OF THE COUNTERBORED-END OF THE CRANKSHAFT AND THE CRANKSHAFT GEAR PILOT FLANGE (FIGURE 39).

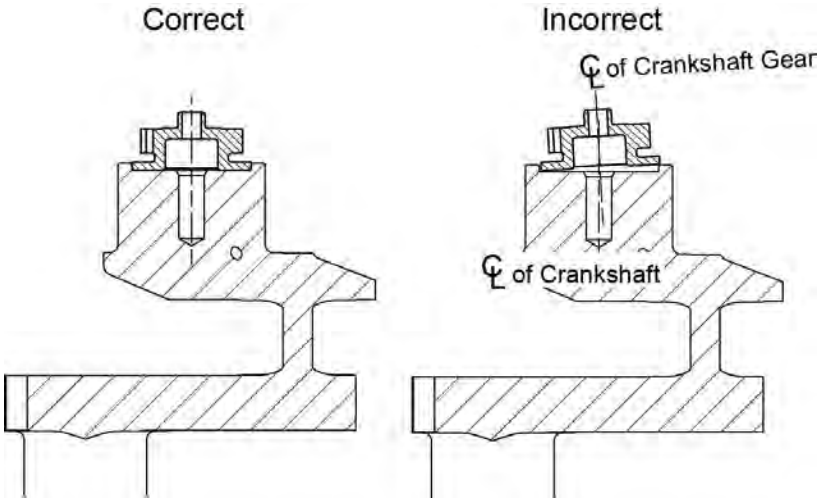


Figure 39
Crankshaft Gear Position

(9) Make sure the crankshaft gear seats firmly and is perpendicular (not at a slanted angle) to the crankshaft as shown in Figure 39:

(a) Try to put a pointed 0.001 in. (0.025 mm) feeler gage or shim stock between the crankshaft gear pilot flange and crankshaft counterbore at each of the three scallops on the crankshaft gear pilot flange. The feeler gage must NOT fit between the two surfaces at any location. There must not be any clearance between the crankshaft and crankshaft gear pilot flange.

(b) If clearance is found, remove the crankshaft gear bolt, lockplate, and crankshaft gear.

(c) Make sure the mating surfaces of the crankshaft gear and crankshaft counterbore are clean and dry and that there is no debris.

(d) Reinstall the crankshaft gear, lockplate, and crankshaft gear bolt. Repeat the initial torque and seating check above.

(e) Try again to put a pointed 0.001 in. (0.025 mm) feeler gage or shim stock between the crankshaft gear pilot flange and crankshaft counterbore at each of the three scallops on the crankshaft gear pilot flange.

(f) If there is still clearance, replace the crankshaft gear.

(g) If there was no clearance, the crankshaft gear is seated correctly. Complete the final torque of the crankshaft gear bolt.

- Final torque the 5/16 in. crankshaft gear bolt to 204 in.-lb (23.05 Nm).
- Final torque the 1/2 in. crankshaft gear bolt to 660 in.-lb (74.57 Nm).

⚠ **CAUTION:** IN THE NEXT STEP, DO NOT BEND TABS OVER THE CORNERS OF THE CRANKSHAFT GEAR BOLT HEAD UNTIL AFTER THE BOLT IS FINAL TORQUED. DO NOT DECREASE THE TORQUE ON THE CRANKSHAFT GEAR BOLT TO ALIGN THE LOCKPLATE TABS.

(10) If necessary, turn the crankshaft gear bolt up to one additional hex to align the flats of the bolt head with the tabs on the lockplate. Bend the tabs on the lockplate onto the flats of the crankshaft gear bolt to hold the bolt securely in place.

C. Expansion Plug Installation

NOTICE: A new expansion plug is necessary for this procedure. Refer to the ***IO-360-N1A Illustrated Parts Catalog*** for the part number.

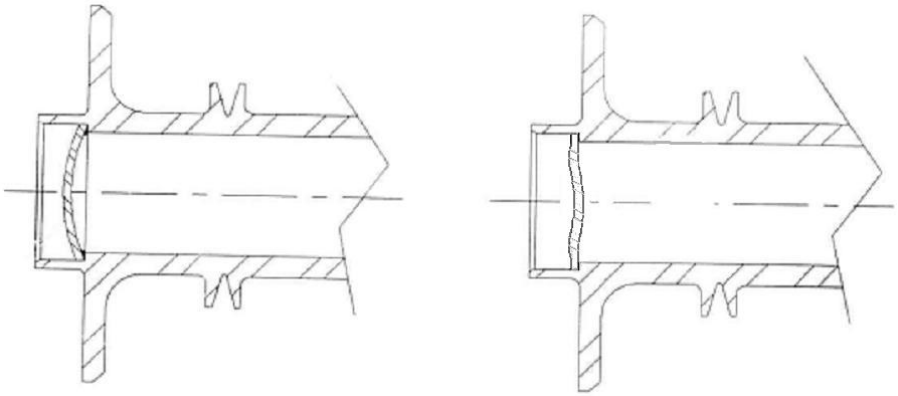
(1) Apply a bead of Loctite® #2 Non-Hardening Gasket Maker to the perimeter of a new expansion plug.

NOTICE: A driver and a press table can be used to press the expansion plug in the crankshaft bore.

(2) Install the new expansion plug with the convex side out (Figure 40).

(3) Install the plug where it is seated firmly in the bottom of the crankshaft bore.

(4) Remove excess gasket material with a clean cloth soaked with acetone.



Initial Plug Installation (Convex Side Out) **Correct Plug Seating**

Figure 40
Installed Expansion Plug

D. Solid-Ring Crankshaft Oil Seal Installation

NOTICE: Install a ***new*** crankshaft oil seal during crankshaft assembly. There are two types of crankshaft oil seals: a split oil seal (Figure 41) and the solid-ring stretch oil seal (Figure 42). The split oil seal is open for easy assembly around the crankshaft. The solid-ring oil seal has more elasticity and can be stretched over the crankshaft propeller flange. The solid-ring oil seal is installed on the crankshaft ***before*** the crankshaft is installed in the crankcase. The split oil seal is installed ***after*** the crankshaft is installed in the crankcase per the "Crankshaft Oil Seal Installation" procedure later in this chapter.

Figure 41
Split Oil Seal

Figure 42
Solid-Ring Oil Seal

NOTICE: For correct sealing remove all traces of the oil sealant and oil from the crankcase before a new crankshaft oil seal is installed.

(1) Remove the spring from the groove (open portion) of a new solid-ring oil seal (Figure 42) and unhook the spring.

(2) Apply a thin film of Lubriko M-6 grease or equivalent on the sealing surface of the seal, around the crankshaft at the sealing surface, and on the outer edge of the crankshaft flange.

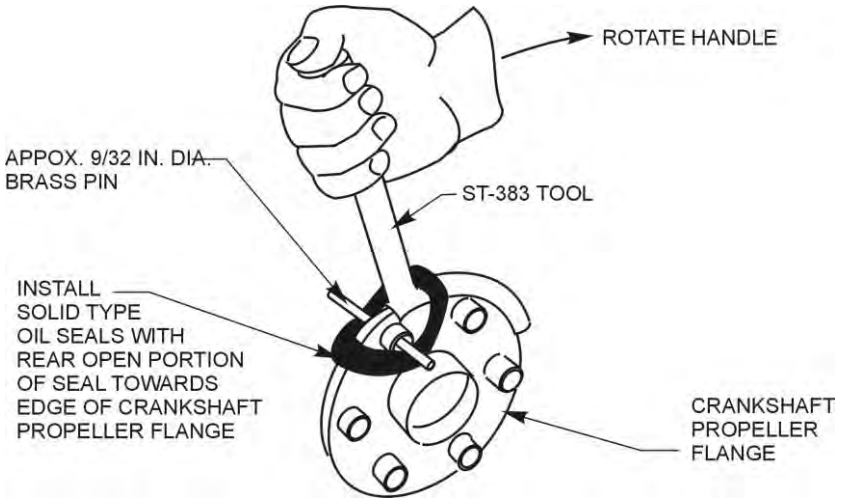


Figure 43
Crankshaft Propeller Flange Showing the Installation of the Solid-Ring Oil Seal

(3) Install the seal over edge of crankshaft propeller flange with the rear (open portion) of the seal toward the flange. See Figure 43.

(4) Put a brass pin approximately 9/32 in. (7.14 mm) diameter by 3 in. (76.20 mm) long through the crankshaft propeller flange bushing to hold both sides of the seal.

(5) Install tool ST-383 under the seal and over the edge of the crankshaft propeller flange as shown in Figure 43. Use even pressure with your hand, carefully turn the tool to force the seal over the crankshaft propeller flange and use care not to damage the seal.

(6) Put the seal spring around the crankshaft, join the two ends together, and hook the spring. The spring must be a continuous circle around the crankshaft with no kinks or twists.

(7) Work the spring into position in the groove (open portion) in the rear side of the seal.

(8) Refer to the latest revision of Service Instruction No. SI-1324 for any new details.

E. Connecting Rod Installation

NOTICE: Each connecting rod is identified by a letter (A, E, S, etc.) as a designation for weight class. All of the connecting rods installed on the crankshaft must be of the same weight class.

(1) Ensure that all of the connecting rods have the same weight class letter.

(2) Apply specified lubricant in the latest revision of Service Instruction No. SI-1059 where shown in Figure 44. Different lubricants are used on the various areas on the connecting rod and bearing surfaces.

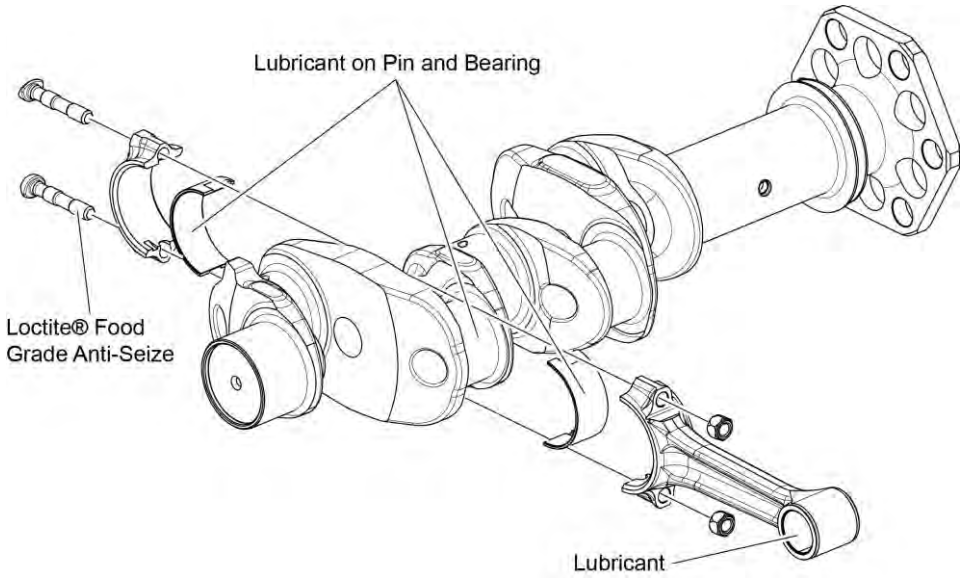


Figure 44
Connecting Rod Assembly Lubrication

NOTICE: Anytime either the connecting rod bolt and/or nut are removed from a Lycoming engine, replace **both** the bolt and nut pairs with new hardware regardless of apparent condition.

(3) Refer to the latest revision of Service Instruction No. SI-1458 to identify the correct P/Ns for the new connecting rods bolts.

(4) Make sure the new connecting rod bolt and new nut pairs are clean, free of dirt and debris and that the threads are not damaged.

(5) Unless otherwise specified in the latest revision of Service Instruction No. SI-1059, apply engine oil mixture (15% pre-lubricant and 85% SAE No. 50 mineral base aviation grade lubricating oil) to the crankpin journals (Figure 44).

(6) Install the new matched set bearing insert pair on each connecting rod, one bearing insert on the connecting rod and the other bearing insert on the connecting rod cap. Ensure that the tang of each bearing insert fits and seats within the slot of either the connecting rod as well as the connecting rod cap.

(7) Apply Loctite® Food-Grade Anti-Seize Lubricant to the bottom two or three threads of the new connecting rod bolts (Figure 44). Wipe away excess lubricant with a clean, lint-free cloth.

(8) Install each connecting rod end cap (with the bearing inserts installed) on their respective crank pins on the crankshaft (where the numbers on the connecting rods and caps point down - toward the oil sump.)

⚠ **CAUTION:** CORRECT INSTALLATION OF THE NEW NUT ON EACH NEW CONNECTING ROD BOLT IS NECESSARY FOR CORRECT CONNECTING ROD ASSEMBLY. EACH CONNECTING ROD NUT HAS TWO DIFFERENT SURFACES, ONCE SURFACE IS FLAT AND THE OTHER IS CHAMFERED AND HAS A RAISED LIP. BE SURE TO INSTALL EACH NUT ON THE CONNECTING ROD BOLT WITH THE FLAT FACE TOUCHING THE ROD. THE CHAMFERED RAISED LIP SURFACE IS AWAY FROM THE ROD.

(9) Install a new nut on each new connecting rod bolt where the flat face of the nut touches the connecting rod as shown in Figure 45.

(10) Torque the connecting rod bolts per the torque values in the latest revision of Service Instruction No. SI-1458. (Stretch bolts require an initial torque and are then torqued to the correct stretched length.)

(11) Measure the journal to rod clearance with a feeler gage where shown in Figure 46. The clearance is to be 0.004 to 0.016 in. (service). Compare the results to the measurements previously recorded.

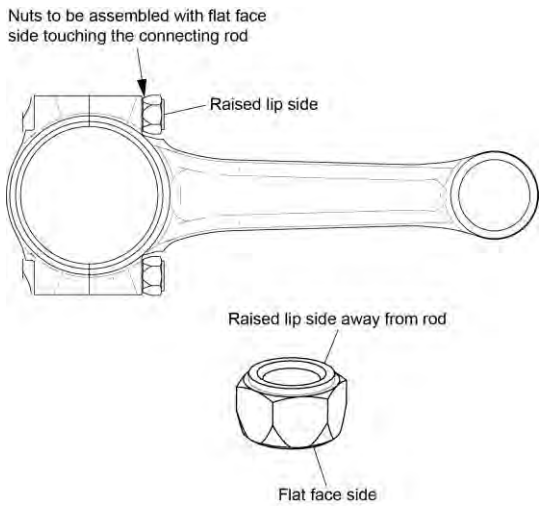


Figure 45
Connecting Rod Nut Installation

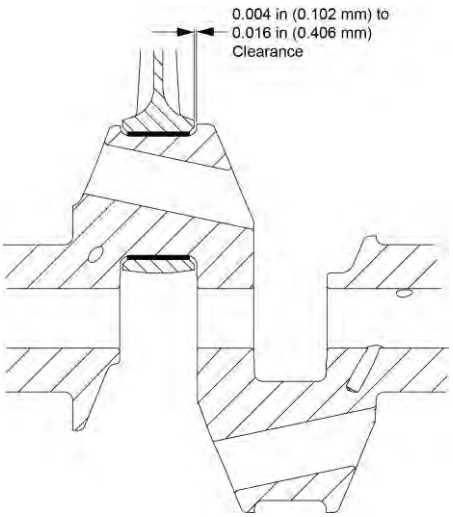


Figure 46
Connecting Rod Clearance

16. Piston Cooling Nozzle Installation (if removed)

    A. Apply a coating of engine oil to all of the cleaned and inspected/acceptable piston cooling nozzles.

    B. Install two piston cooling nozzles in each crankcase half (Figure 47).

    C. Torque each piston cooling nozzle to 100 in.-lb. (11 Nm).

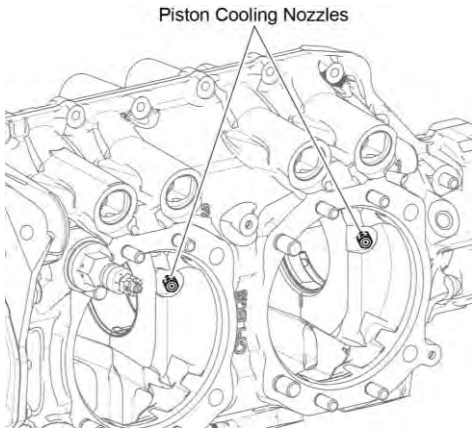


Figure 47
Piston Cooling Nozzle

17. Crankshaft Idler Gear Shaft Installation

    A. Install the crankshaft idler gear shaft (for the left idler gear) in the crankcase with a nut and bolt (Figure 48). Torque the bolt to 17 ft.-lb. (23 Nm). Torque the nut to 12 ft.-lb. (16 Nm). Safety wire the nut and bolt as shown in Figure 49.

    B. Install the crankshaft idler gear shaft (for the right idler gear) in the crankcase with two bolts (Figure 48). Torque the bolts to 17 ft.-lb. (23 Nm). Safety wire the two bolts.

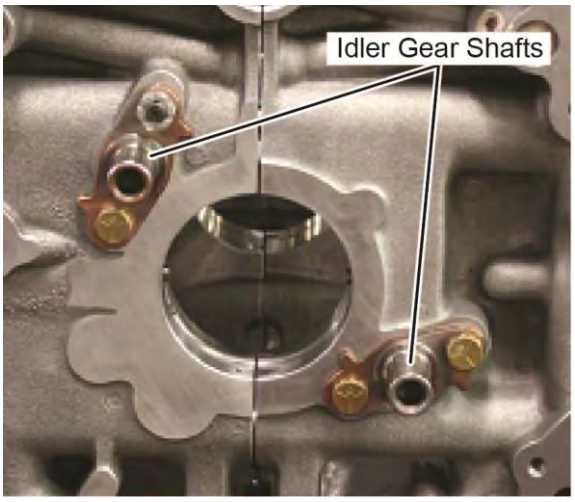


Figure 48
Shaft Installation in the Crankcase for Left and Right Crankshaft Idler Gears

Figure 49
Safety Lockwiring the Crankshaft Idler Gear Shaft

18. Oil Plug Installation (if removed)

    A. Make sure the 1/8 NPT oil plugs are acceptable, not damaged or cracked. Replace any worn, damaged or cracked NPT plug.

    B. Apply of coating of Loctite® 564 to all six of the 1/8 NPT oil plugs.

    C. Install three of 1/8 NPT oil plugs in each crankcase half (Figures 50 A, B, and C).

    D. Torque each 1/8 NPT oil plug to 40 in.lb. (4.5 Nm).

Figure A

Figure B

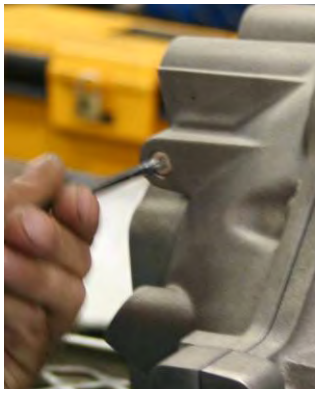


Figure C

Figures 50 A, B and C
Oil Plug Installation Steps

19. Tappet Assembly Installation

NOTICE: Roller tappets (Figure 51) are installed on Lycoming IO-360-N1A engine models. If a new or reconditioned camshaft is installed, lubricate and install new roller tappets per guidelines in the latest revision of Service Instruction Nos. SI-1011, SI-1059, and SI-1514 for details..

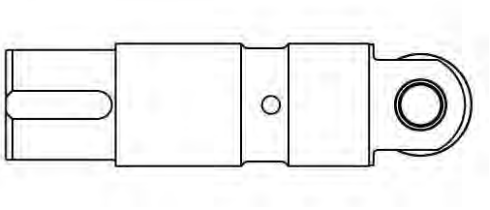


Figure 51
Roller Tappet

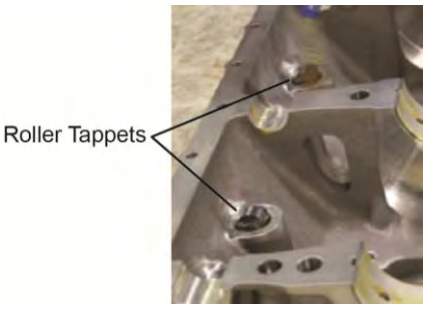


Figure 52
Installed Roller Tappets

A. Plunger Assembly Installation

⚠ **CAUTION:** DO NOT MIX PLUNGER OR LIFTER ASSEMBLIES WITH DIFFERENT PART NUMBERS IN THE SAME ENGINE. THE DIFFERENT LEAK DOWN RATES WILL CAUSE INCORRECT ENGINE OPERATION.

ALL PARTS OF EACH HYDRAULIC PLUNGER ASSEMBLY ARE SELECTIVELY FITTED AND ARE NOT INTERCHANGEABLE. MATING PARTS MUST BE KEPT TOGETHER. IF THERE IS ANY DOUBT AS TO WHETHER THE PARTS HAVE BECOME MIXED, INSTALL NEW PLUNGER ASSEMBLIES.

(1) Clean and lightly coat the lifter parts with engine oil before assembly.

(2) To assemble the unit, unseat the ball by inserting a thin clean bronze wire through the oil inlet hole.

(3) With the ball off its seat, insert the plunger and turn it clockwise until the spring engages.

B. Tappet Installation

NOTICE During maintenance, complete a visual inspection of roller tappets for integrity and free rotation of the roller action is acceptable to return an in-use roller tappet to service. However, during overhaul or in the event the engine is disassembled for a propeller strike or sudden engine stoppage, replace the roller tappets.

(1) If the time is close to overhaul, replace all of the roller tappets as a complete set with a new set of roller tappets. Otherwise, install the same serviceable tappets.

NOTICE Roller tappets are not field repairable and are not to be disassembled for parts re-use.

(2) Before installation, apply lubrication to the roller tappets per the latest revision of Service Instruction Nos. SI-1011 and SI-1059.

(3) Install serviceable hydraulic roller tappets in each crankcase half during assembly.

(4) Lubricate the camshaft lobes and the faces of the roller tappets (Figure 52) per the latest revision of Service Instruction No. SI-1059.

20. Crankshaft Bearing and O-Ring Installation

NOTICE: The crankshaft front bearings are installed on the crankshaft, not in the crankcase halves.

A. Install the center and rear crankshaft bearings. Make sure the tangs are seated in the lock slots (Figures 53 and 54).

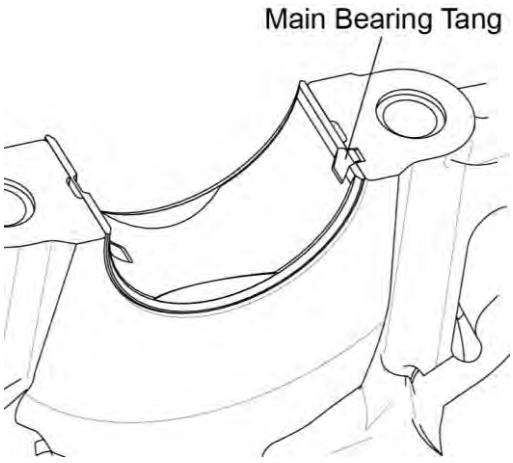


Figure 53
Main Bearing Tang

NOTICE: If O-ring holes have a countersink, apply Lubriko grease to the countersink before installing the O-rings.

B. Apply engine oil to eight new O-rings.

C. Install the eight new O-rings (Figure 54).

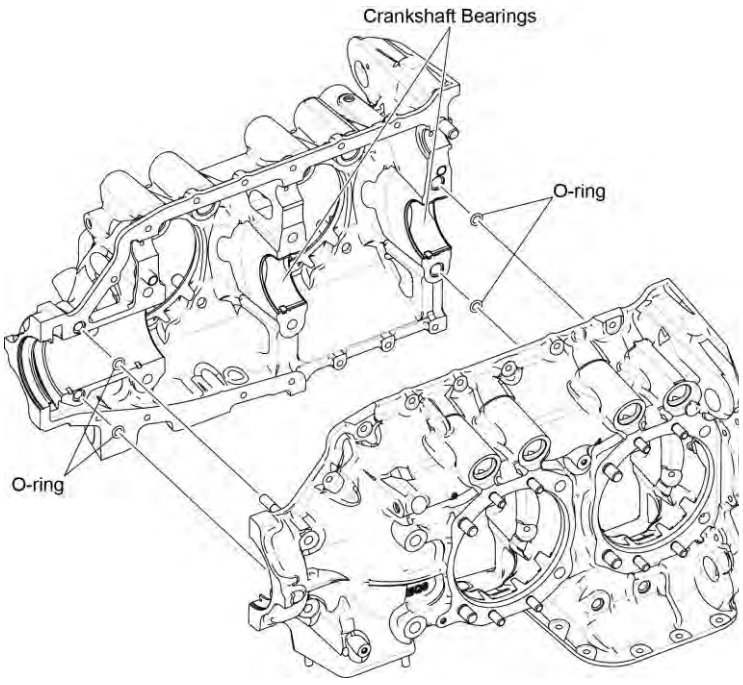


Figure 54
Center and Rear Main Bearings, Bolts, and O-Rings

21. Propeller Governor Drive Installation

NOTICE: Examine each component to be installed on the propeller governor assembly. Replace any damaged or worn part with a new part. The gear assembly was to have been installed in the left crankcase half before crankcase assembly.

The following **new** parts must be available to install the propeller governor drive:

- Four lock washers
- Governor gasket
- Governor drive cover gasket
- Gear Assembly (Figure 12)
- Set screw
- Thrust washer (different thickness sizes available - Table 7 - requires measurement of clearance in subsequent steps to identify the correct thrust washer)

Table 7
Thrust Washer Thickness

Thrust Washer Part Number	Thrust Washer Thickness	
	in.	mm
73249	0.0585 to 0.0595	1.4859 to 1.5113
73250	0.062 to 0.063	1.575 to 1.600
73251	0.0655 to 0.0665	1.6637 to 1.6891
73252	0.069 to 0.070	1.753 to 1.778
01L21418	0.055 to 0.056	1.397 to 1.422

A. Governor Drive Gear Installation
   (1) Lubricate the shaft of the governor drive gear with engine oil and install the governor drive gear in the left half of the crankcase.
   (2) Apply Lubriko grease or equivalent to the rear face of the propeller governor idler gear.
   (3) Install the propeller governor idler gear assembly, and thrust washer into the crankcase (Figure 55).
   (4) Install the propeller governor idler shaft into the crankcase through the propeller governor idler gear assembly and thrust washer (Figure 56).

B. Backlash Check:
   (1) To complete a check of the low limit backlash, insert a 0.008 in. (0.203 mm) shim between the spacer and crankcase (Figure 57).
   (2) Turn the propeller governor idler gear and insert the 0.008 in. (0.203 mm) shim at 90° intervals.

   NOTICE: During maintenance, use a 0.017 in. (0.432 mm) shim for the high limit backlash check.

   (3) During assembly, to complete a check of the high limit backlash, try to insert a shim 0.021 in. (0.533 mm) between the spacer and crankcase. For acceptable high limit backlash, the shim is not supposed to fit.

Figure 55
Propeller Governor Idler Gear Assembly and Thrust Washer

Figure 56
Propeller Governor Idler Gear Shaft

C. Propeller Governor Set Screw

NOTICE: To ensure that there is adequate material in the set screw hole to peen on top of the screw, use a new set screw that is shorter than the one previously removed. A smaller diameter center punch could be necessary. Refer to Figure 58.

(1) Apply a light coat of Loctite® 290™ to the new set screw. Wipe away any excess Loctite® 290™ with a clean lint-free cloth.

(2) Install the set screw into the crankcase (Figure 58). Align the idler gear shaft with the set screw to enable the set screw to lock into the indentation in the idler gear shaft to hold the idler gear shaft in place.

(3) Torque the set screw 32 to 38 in.-lb. (3.6 to 4.3 Nm).

Figure 57
Shim Between Spacer and Crankcase – Backlash Check

Figure 58
Set Screw Location

(4) Use a smaller center punch (peening tool) with a 3/32-inch (2.38 mm) diameter at an approximate 50°/60° angle to peen the threads of the hole at the top of the taper above the set screw to prevent the set screw (as shown in Figure 59) from backing out.

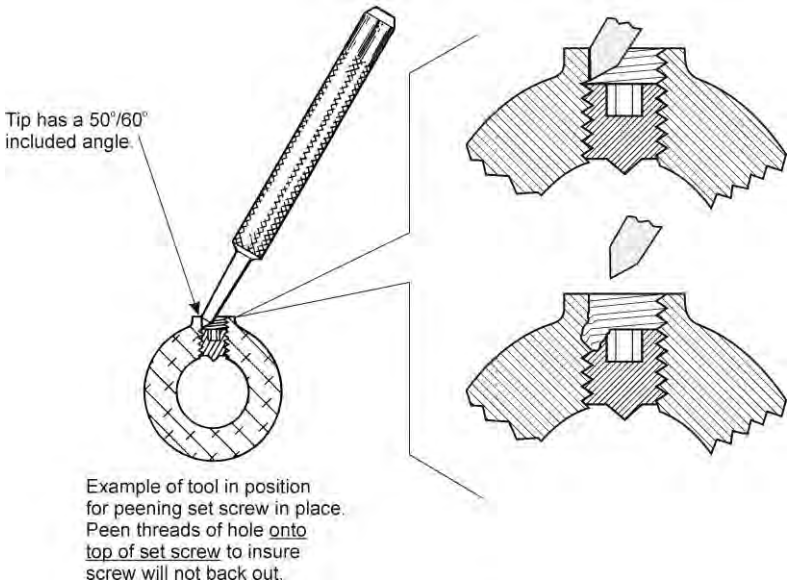


Figure 59
Center Punch (Peening Tool) for Set Screw

D. Install the Propeller Governor Plug

(1) Examine the propeller governor plug (Figure 60) to make sure it is not damaged or cracked. Replace a damaged or cracked propeller governor plug.

(2) Lubricate the threads of the propeller governor plug with Anti-Seize.

(3) Install the plug into the crankcase with a new gasket.

(4) Torque the propeller governor plug between 150 to 180 in.-lb. (17 to 20 Nm).

(5) Safety wire the propeller governor plug.

Figure 60
Propeller Governor Plug

E. Apply heavy lubricant such as Modoc or equivalent to the teeth on the propeller governor idler gear and the governor drive gear.

F. Install the governor drive cover and new governor gasket (Figure 12) with four nuts, new lock washers, and washers. Torque the nuts to 96 in.-lb. (11 Nm).

22. Camshaft Assembly and Installation

A. Camshaft Assembly

(1) Install a new tachometer shaft centering spacer (Figure 61) on the camshaft assembly.

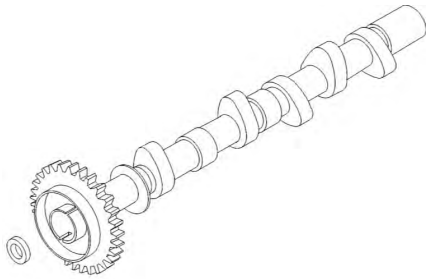


Figure 61
Camshaft Assembly

B. Camshaft Installation

NOTICE: Although there is only one camshaft, you will need to first install the camshaft in one crankcase half, complete an end play clearance check, remove the camshaft and install it in the other crankcase half to complete an end play clearance check. If a ***new*** camshaft is to be installed, install a new set of tappets per the "Tappet Assembly Installation" procedure in this chapter.

(1) Apply engine oil mixture to the camshaft bearing saddles and main bearings on each crankcase half (Figure 62).

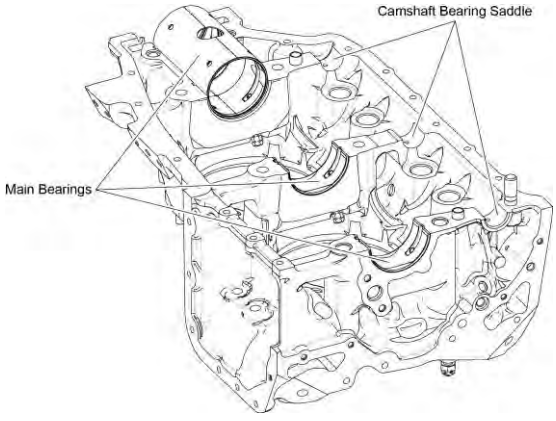


Figure 62
Main Bearing and Camshaft Bearing Saddles in Crankcase Half

(2) Put the camshaft in the left crankcase half.

(3) Complete a check of the end play clearance of the camshaft using a feeler gage (Figure 63).

(4) Remove the camshaft from the left crankcase half and install it in the right crankcase half and complete a check of the camshaft end play clearance.

Acceptable end play clearance.	0.002 to 0.015 in. (0.051 to 0.381 mm)

NOTICE: If the end play clearance values are not within the allowable limits, examine the crankcase and/or camshaft for wear or damage. Replace a damaged or worn camshaft. If one crankcase half is worn or damaged, replace both crankcase halves as a matched set.

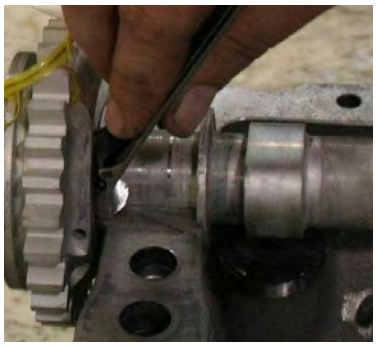


Figure 63
Camshaft End Play Clearance Check

(5) Refer to the latest revision of Service Instruction SI-1059 and apply the specified lubricant to the following:

- Thrust faces of each crankshaft half (Figure 64)
- Roller tappets (Figure 65) and camshaft lobes
- Camshaft slots on each crankcase half (Figure 66).

Figure 64
Thrust Faces on Each Crankcase Half

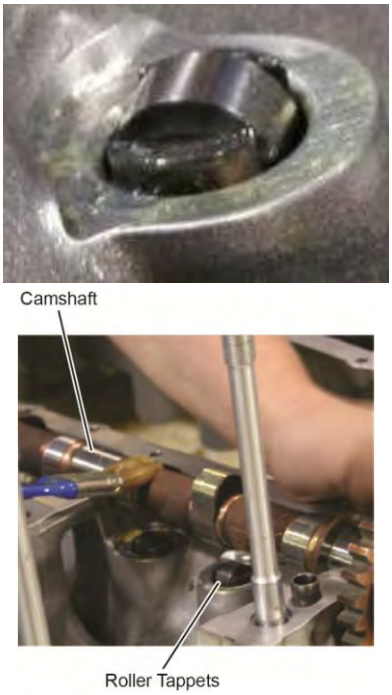


Figure 65
Lubrication to Roller Tappets and Camshaft Lobes

(6) Tie a loop of soft wire around the camshaft and left crankcase half (as shown in Figure 67) to hold the camshaft securely in place.

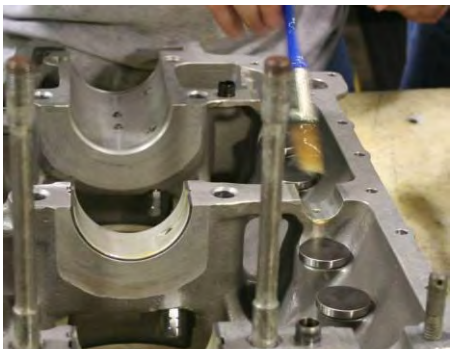


Figure 66
Lubricant Application to Camshaft Slot in Crankcase Half

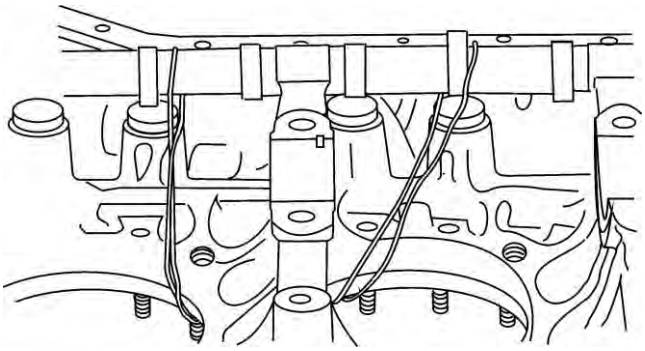


Figure 67
Example of Camshaft Wired to Crankcase Half

23. Crankshaft Installation

⚠ **CAUTION:** BEFORE INSTALLATION, MAKE SURE THE CRANKSHAFT HAS SATISFACTORILY PASSED THE MAGNETIC PARTICLE INSPECTION AND DOES NOT HAVE ANY CRACKS. DO NOT INSTALL A CRANKSHAFT WITH A CRACK. ENGINE MALFUNCTION CAN OCCUR IF A CRANKSHAFT WITH A CRACK IS INSTALLED.

NOTICE: The connecting rods are to have been already installed on the crankshaft per the "Connecting Rod Installation" procedure in this chapter.

A. Refer to the latest revision of Service Instruction No. SI-1059 and apply the specified lubricant to the main bearing journals of the crankshaft and the rear and center main bearing inserts in the right crankcase half.

B. Install the Front Bearing Halves on the Crankshaft

(1) Apply a coating of engine oil mixture to the front bearing halves (Figure 11).

(2) Install the front bearing halves, where they touch (butt together) around the crankshaft.

(3) Lift the crankshaft assembly by the connecting rods. Lower the crankshaft assembly into the crankcase half (Figure 68). Let the connecting rods extend through the bored holes (for the cylinders).

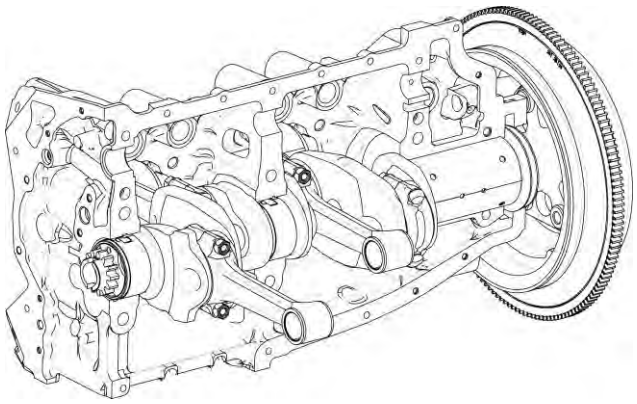


Figure 68
Crankshaft Installed in Crankcase Half

(4) With the crankshaft assembly in the crankcase, align the dowel holes in the front bearing halves with the dowels in the crankcase.

(5) Make sure the front bearings are seated squarely over the locating dowels on the crankcase.

C. Measure the Thrust Face Clearances Between the Crankshaft and Crankcase

(1) With the crankshaft installed in the crankcase, move the crankshaft as far forward as possible.

(2) Use a feeler gage to measure the slinger clearance at Point A (Figure 69). Refer to the limits in Table 8. If the slinger clearance is not within the limits in Table 8, the front face of the slinger can be reground to restore the slinger clearance to within allowable limits.

(3) Move the crankshaft to the rear as far as possible.

(4) Use a feeler gage to measure the end play clearance with the crankcase thrust at Point B in Figure 69. Refer to the limits in Table 9. If the endplay clearance is not within the limits in Table 9, examine the crankcase and/or crankshaft for wear or damage. Replace a worn or damaged component.

Table 8
Slinger Clearance at Point A
(Figure 69)

Inches	Millimeters
0.002 to 0.007	0.051 to 0.178

Table 9
Endplay Clearance at Point B
(Figure 69)

Inches	Millimeters
0.009 to 0.026	0.229 to 0.660

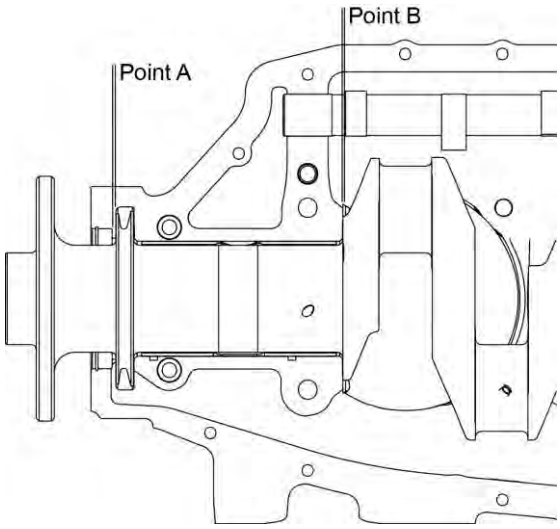


Figure 69
Clearance Between Crankshaft and Crankcase

24. Crankcase Assembly

NOTICE: If a crankcase stud is bent, broken, damaged, loose, rusted, corroded, or cannot be cleaned, refer to the "Crankcase Stud Replacement" procedure in Appendix A.

A. Assemble the Crankcase Halves

⚠ **CAUTION:** ONLY LYCOMING-APPROVED SEALANTS ARE TO BE USED DURING CRANKCASE ASSEMBLY. USE OF ANY OTHER NON-APPROVED SEALANT COULD RESULT IN A LOSS OF CLAMPING FORCE AND/OR TORQUE.

⚠ **CAUTION:** IN THE NEXT STEP, DO NOT GET THE GASKET COMPOUND IN THE BORE OF THE NOSE SEAL OR IN ANY CRANKCASE BORE. IF ANY NON-HARDENING GASKET COMPOUND GETS INTO THE NOSE SEAL BORE OR ANY CRANKCASE BORE, CAREFULLY REMOVE THE GASKET COMPOUND WITH A SOFT CLOTH AND SOLVENT (ACETONE, MEK, OR EQUIVALENT).

(1) Apply a thin layer of non-hardening gasket material such as POB #4 Perfect Seal gasket compound or equivalent to the outside mating surfaces of each crankcase half (darker area shown in Figure 70.)

(2) Measure and cut a total of four continuous lengths of "00" silk threads (four for only one crankcase half). Two of the lengths will extend along the entire length of the top of the crankcase flange as shown in Figure 70, and two silk thread lengths will be shorter to cover the distance shown on the bottom flange of the same crankcase half. Do not apply silk thread pairs to both crankcase halves.

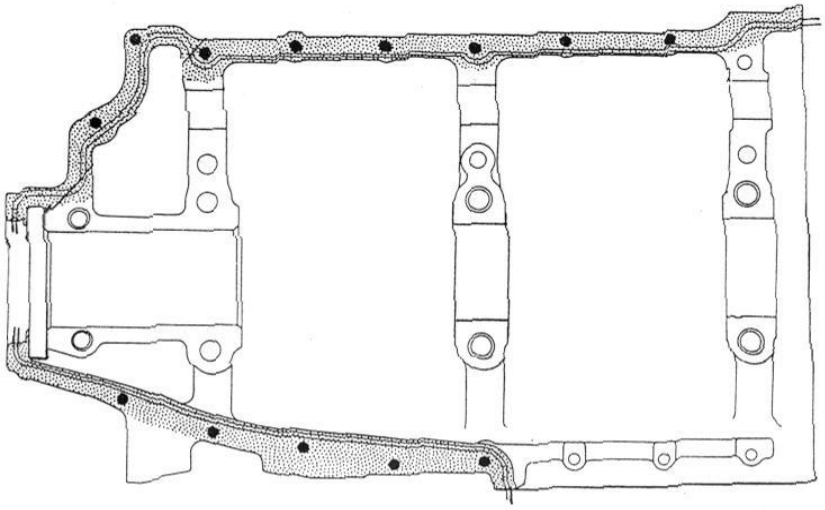


Figure 70
Area on the Crankcase Flange to Apply the POB Sealant and Silk Thread

Figure 71
Placement of Silk Threads Along Inside Edge of Crankcase Flange

⚠ **CAUTION:** TO ENSURE CORRECT SEALING, MAKE SURE THE SILK THREADS RUN THE LENGTH, AS A CONTINUOUS PIECE, OF THE INSIDE OF THE CRANKCASE FLANGE (FIGURE 70) AND THERE ARE NO BREAKS IN THE ANY OF THE THREADS. BREAKS IN THE SILK THREAD CAN CAUSE THE CRANKCASE TO LEAK. MAKE SURE THE THREADS DO NOT CROSS OVER OR LAY OVER EACH OTHER (FIGURE 71) OR COVER A HOLE IN THE CRANKCASE FLANGE.

(3) Press two lengths of "00" silk threads in the gasket compound on the top and bottom flange sides (of the crankcase half) (Figure 70) firmly in the gasket compound where both silk threads are oriented in the area between the bolt holes and the inside flange edge of the crankcase half (approximately between 0.020 to 0.040 in. (0.508 to 1.106 mm) apart as shown in Figure 71. Make sure that the silk thread lengths do not touch or cross over one another or cover a bolt hole.

(4) All continuous silk thread lengths must extend not more than ¼-in. (6.35 mm) beyond the front and rear end of the crankcase half. Figure 72 shows the thread overhand extension into the seal groove on the front end of the crankcase half. Figure 73 shows the silk thread overhang extending from the rear of the crankcase half.

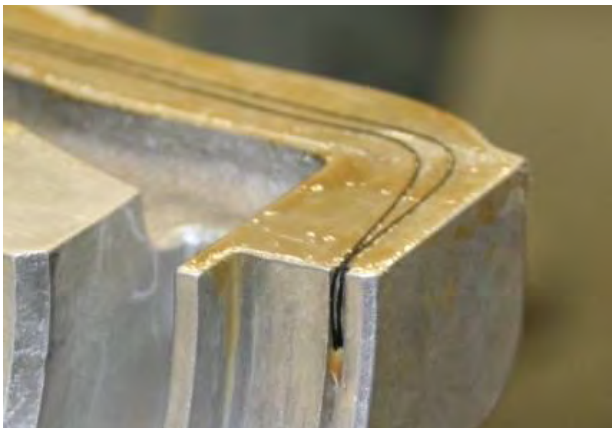


Figure 72
Silk Thread Extending into Seal Groove on the Front End of the Crankcase

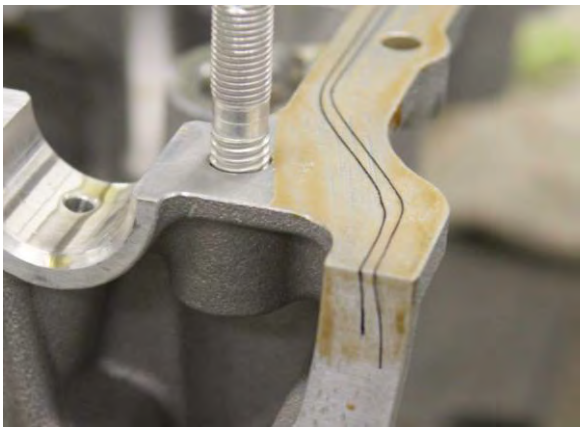


Figure 73
Silk Thread Extending into the Rear End of the Crankcase

(5) Wipe all excess sealant from the inside edges of the crankcase.

NOTICE: If a solid-ring stretch oil seal was installed on the crankshaft, make sure it is positioned toward the crankshaft flange and does not touch either crankcase half when the crankcase is assembled.

(6) Lift the right half of the crankcase while keeping the halves parallel, lower the right half of the crankcase over and onto the left crankcase half for the studs to align.

(7) When the crankcase halves are aligned correctly, tap the right half of the crankcase with a rubber mallet to make sure the crankcase halves are aligned and mated firmly all around and that there are no gaps between the mating flange surfaces. Do not continue if the crankcase halves are not aligned. Repeat the previous steps until the crankcase halves align.

(8) Apply a coat of #2 Permatex® to the thru-studs at the dowel section.

⚠ **CAUTION:** BE SURE TO LUBRICATE THE CRANKCASE THRU-STUDS TO ENSURE CORRECT FASTENING OF THE CRANKCASE HALVES.

(9) Lubricate each crankcase thru-stud with the specified lubricant identified in the latest revision of Service Instruction No. SI-1029.

(10) Install all of the thru-studs in the crankcase with a thru-stud driver ST-317. Refer to Figure 74.

(11) To ensure uniform loading on the main bearings, torque the anchored thru-studs and the free thru-studs in sequence, beginning at the center of the crankcase and then progressing alternately to the rear and front of the engine.

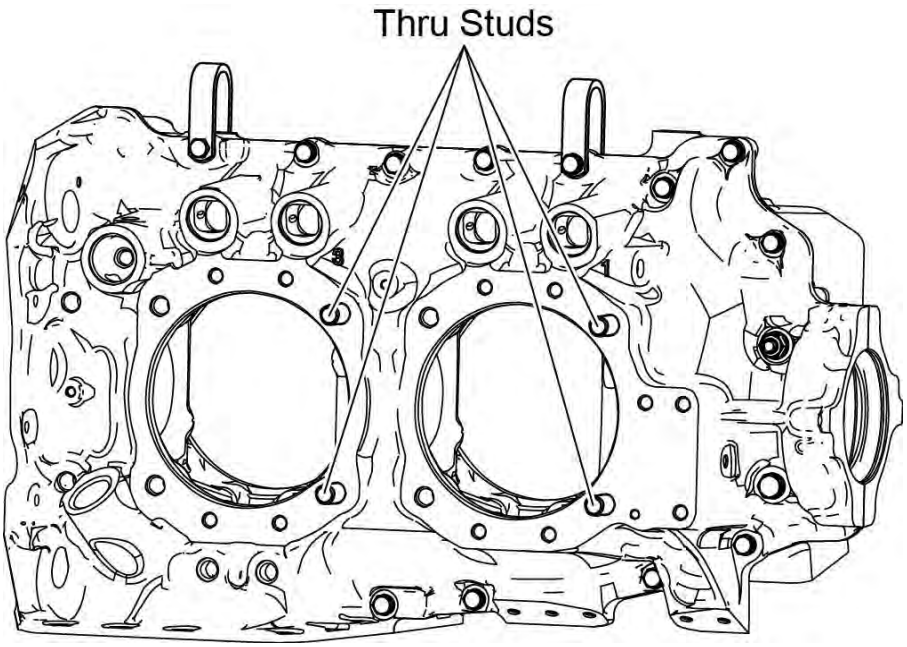


Figure 74
Right Side of Crankcase Showing Thru-Studs Installed

(12) Install the torque hold down plate (ST-222, Figure 75) at the cylinder pads over the thru-studs.

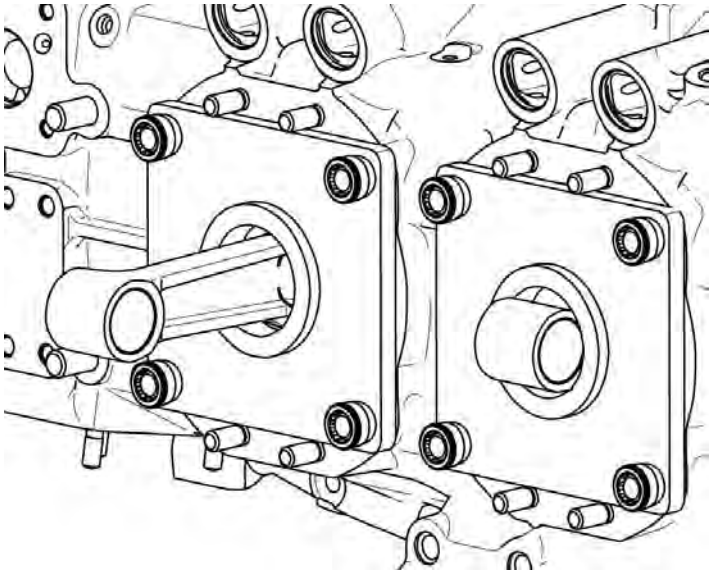


Figure75
Torque Hold-Down Plates (ST-222)

(13) Attach the plates with washers and nuts on the thru-studs. Tighten the nuts only finger tight at this time.

(14) Make sure that the plates remain parallel with the cylinder decks of the crankcase and sit flush on the cylinder faces.

NOTICE: Before tightening the thru-studs, make sure that they extend equally for both sides of the crankcase.

⚠ **CAUTION:** TO ENSURE CORRECT ENGINE ASSEMBLY, FOLLOW THE TORQUE SEQUENCE FOR TIGHTENING ALL CRANKCASE NUTS.

(15) Torque the nuts installed on the thru-studs at the mating flanges on the crankcase halves in the sequence shown in Figure 76 to attach the crankcase halves securely as follows:

(a) Tighten the thru-studs at the rear of Cylinder 2 (tighten both sides simultaneously.)

(b) Tighten the thru-studs at the rear of Cylinder 4 (tighten on the left side.)

(c) Tighten the thru-studs at the front of Cylinder 1 (tighten both sides simultaneously.)

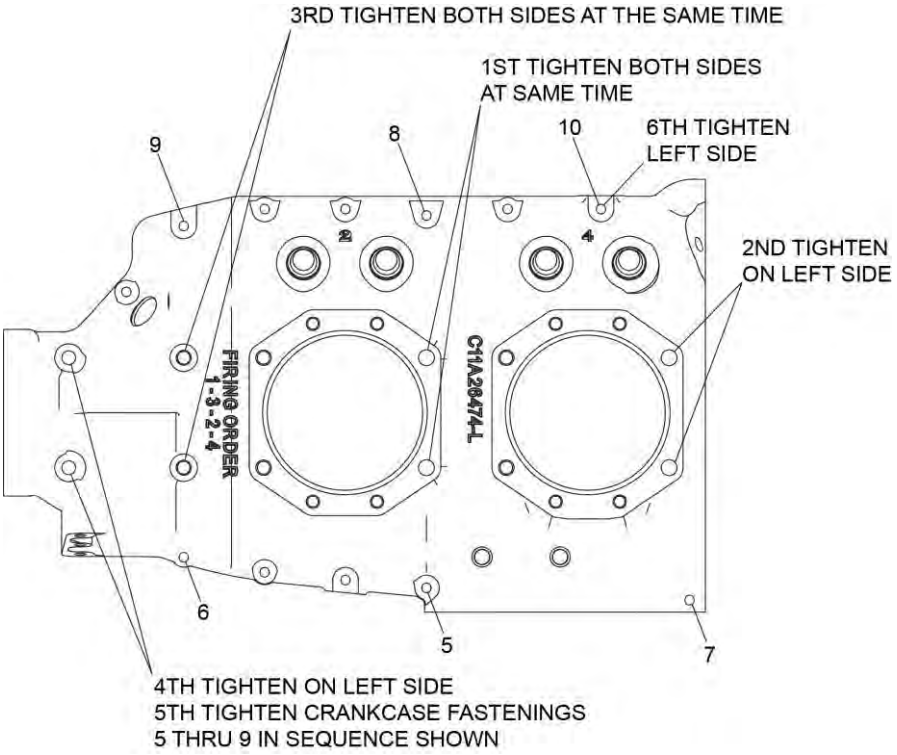


Figure 76
Crankcase Tightening Sequence

(d) Torque positions 1st, 2nd, and 3rd in order to 25 ft.-lb (34 Nm).

(e) Re-torque positions 1st, 2nd, and 3rd in order to 50 ft.-lb. (68 Nm).

(f) Torque the front bolts at position 4 on the left side to 25 ft.-lb (34 Nm).

(g) Torque the ¼-in. nuts at positions 5 thru 9 (in the order shown in Figure 76) to 96 in.-lb. (11 Nm).

(h) Torque the 3/8-in. nut at position 10 at the rear camshaft bearing location on the left side to 25 ft.-lb. (34 Nm).

(i) Torque the remaining crankcase fasteners as indicated in Table 10.

(16) Make sure all fasteners on the crankcase are torqued correctly and none are loose.

(17) Install the 3/8 in. (9.53 mm) slotted nut and washer on the stud at the rear camshaft bearing (Figure 77). Torque the nut to 215 in.-lb. (24 Nm). Safety wire the nut as shown in Figure 77.

(18) Apply Loctite® 564 to the threads of the bolt (Figure 78) to be installed behind the governor pad.

(19) Install the bolt behind the governor pad (Figure 78). Torque the bolt per the torque values listed in Table 10.

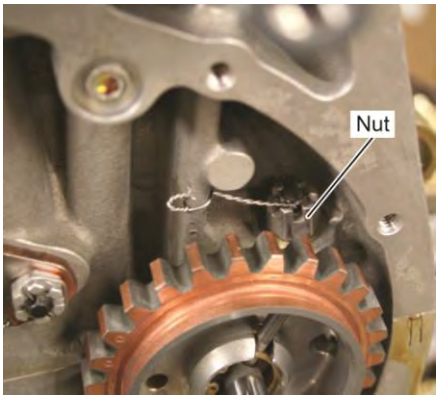


Figure 77
Nut on Stud at Rear Camshaft Bearing

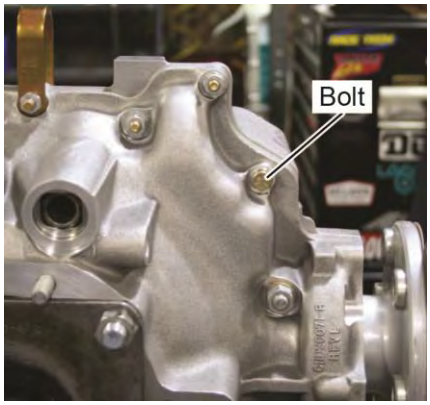


Figure 78
Bolt Behind Governor Pad

⚠ **CAUTION:** MAKE SURE ALL FASTENERS ON THE CRANKCASE ARE TORQUED CORRECTLY AND NONE ARE LOOSE.

Table 10
Torque Values for Crankcase Fasteners

Size	Type	Torque Value
3/8 in.	nuts	300 in.-lb (25 ft.-lb) (33.9 Nm)
1/4 in.	nuts and capscrews	96 to 108 in.-lb (10.9 to 12.2 Nm)
1/4 in.	shear nuts	55 to 65 in.-lb (6.2 to 7.3 Nm)

NOTICE: Any additional crankcase fastenings not specifically called out in this procedure can be tightened in any sequence using the torque values shown above.

(20) Before the oil sump is installed, safety wire the nuts that will be inside the oil sump (Figure 79).

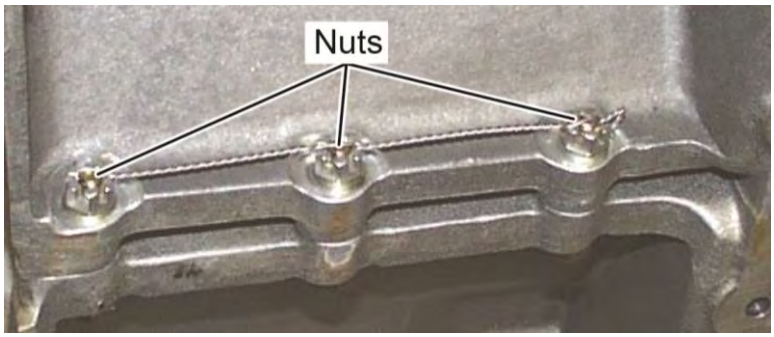


Figure 79
Safety Wire Nuts in Crankcase Oil Sump

25. Crankshaft Oil Seal Installation

If a solid-ring oil seal (Figure 42) is installed on the crankshaft:

A. Use solvent and wipe excess grease from the crankshaft flange, outer surface of the seal and from the crankcase seal bore recess.

⚠ **CAUTION:** USE A BRUSH AND BUTYL RUBBER GLOVES WHEN APPLYING SEALANT AND INSTALLING THE OIL SEAL (FIGURES 80 AND 81).

NOTICE: In the next step, do not get sealant on the crankshaft. If any sealant gets on the crankshaft, use acetone to remove all traces of sealant.

Apply a liberal coating of Dow Corning® 737 Neutral Cure Sealant to the outside diameter of the crankshaft seal (Figure 80) to allow the excess sealant to squeeze out between the crankcase and the oil seal when the oil seal is installed.

B. Apply a coat of sealant (Dow Corning® 737 Neutral Cure Sealant) to the outside diameter of the solid-ring oil seal.

NOTICE: If Dow Corning® 737 Neutral Cure Sealant is not available, Pliobond® #20 or Pliobond® #25 may be used. Refer to the Pliobond® manufacturer's instructions for application instructions.

C. Press the seal firmly against the seat in the crankcase bore.

D. Spread the excess sealant smoothly over the oil seal and crankcase (Figure 81)

Figure 80
Apply the Sealant to the Oil Seal

Figure 81
Spread the Excess Sealant

E. Let the Dow Corning® 737 Neutral Cure Sealant cure for 24 hours.

NOTICE: If substituting the Dow Corning® sealant with Pliobond® #20 or Pliobond® #25, refer to the Pliobond® manufacturer's instructions for cure time.

If a solid-ring oil seal is not already installed on the crankshaft, install a split oil seal (Figure 41) as follows:

A. Apply a thin film of Lubriko M-6 grease or equivalent on the sealing surface of the seal and around the crankshaft at the sealing surface.

B. Assemble the split oil seal on the crankshaft with the front face of the seal toward the crankshaft propeller flange. Note that the seal part number is on the front of the seal.

C. Use solvent and wipe excess grease from the crankshaft flange, outer surface of the seal and from the crankcase seal bore recess.

⚠ **CAUTION:** USE A BRUSH AND BUTYL RUBBER GLOVES WHEN APPLYING SEALANT AND INSTALLING THE OIL SEAL (FIGURES 80 AND 81).

NOTICE: In the next step, do not get sealant on the crankshaft. If any sealant gets on the crankshaft, use acetone to remove all traces of sealant.

Apply a liberal coating of Dow Corning® 737 Neutral Cure Sealant to the outside diameter of the crankshaft seal (Figure 80) to allow the excess sealant to squeeze out between the crankcase and the oil seal when the oil seal is installed.

D. Apply a coat of sealant (Dow Corning® 737 Neutral Cure Sealant*) to the split of the seal and the outside diameter of the split oil seal.

NOTICE: If Dow Corning® 737 Neutral Cure Sealant is not available, Pliobond® #20 or Pliobond® #25 may be used. Refer to the Pliobond® manufacturer's instructions for application instructions.

E. Face the propeller end of the crankshaft and assemble the split oil seal with the split at the 1:00 o'clock position with the front face of the seal toward the crankshaft propeller flange.

F. Press the seal firmly against the seat in the crankcase bore.

G. Spread the excess sealant smoothly over the oil seal and crankcase (Figure 81)

H. Let the Dow Corning® 737 Neutral Cure Sealant cure for 24 hours.

NOTICE: Make sure the split oil seal does not turn in the crankcase seal bore recess.

If substituting the Dow Corning® sealant with Pliobond® #20 or Pliobond® #25, refer to the manufacturer's instructions for cure time.

I. Install the starter ring gear support on the crankshaft propeller flange per instructions in Chapter 72-70 of this manual.

J. Install the propeller per the airframe manufacturer's instructions.

26. Crankshaft Idler Gear Installation

NOTICE: The left crankshaft idler gear has etched circles in two locations. The location with etched circles on two teeth side-by-side aligns with the single etched circle on the crankshaft gear (Figure 82). The other location with the etched circle is on a single gear tooth (Figure 83) and aligns between the two teeth with the etched circles on the camshaft gear. The correct orientation of these etched circles is necessary to ensure correct valve timing.

Figure 82
Correct Alignment Between the Crankshaft Gear and the Left Crankshaft Idler Gear

Figure 83
Correct Alignment Between the Camshaft Gear and the Right Crankshaft Idler Gear

A. Install the left crankshaft idler gear (Figure 84) with a new bushing in place on the crankshaft idler gear shaft located to the left of the crankshaft gear. Turn the crankshaft gear and/or the camshaft gear to align the gears.

B. Install the right crankshaft idler gear with a new bushing on the crankshaft idler gear shaft located to the right of the crankshaft gear.

C. Install a rubber band around the gears to hold them in place (Figure 85).

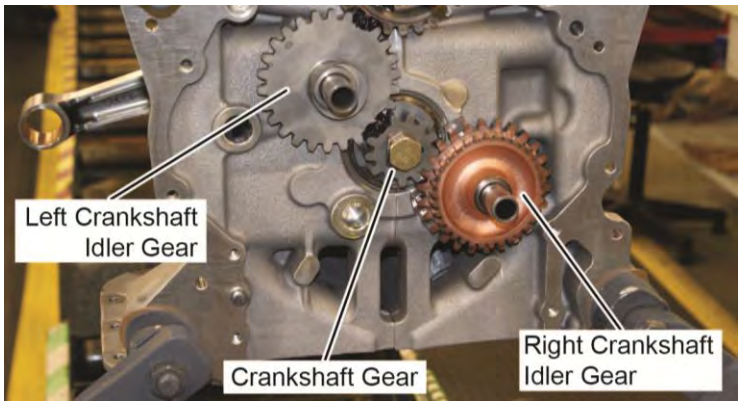


Figure 84
Crankshaft Idler Gears Installed

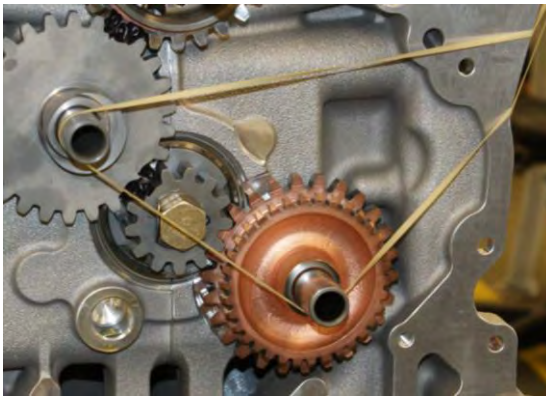


Figure 85
Rubber Band to Hold Crankshaft Idler Gears

27. Propeller Oil Control Leak Test

    Refer to Chapter 72-10 in the ***IO-360-N1A Engine Service Manual*** for the Propeller Oil Control Leak Test.

28. Propeller Governor Replacement.

    Replace in the propeller governor in accordance with the aircraft manufacturer's instructions.

29. Crankshaft-to-Camshaft Timing Check

NOTICE: This timing check is completed on a partially or fully assembled engine without removing the accessory housing.

A. Make sure the ignition and all electrical switches are OFF.

B. Disconnect all spark plug leads.

C. Disconnect the starter.

D. Remove the top spark plug on Cylinder 1 as per the "Spark Plug Removal" procedure in Chapter 74-20 in the ***IO-360-N1A Engine Service Manual***.

E. Remove the rocker box cover on Cylinder 2 as per the "Exhaust Valve and Guide Inspection" procedure in Chapter 72-30 in the ***IO-360-N1A Engine Service Manual***.

F. Rotate the crankshaft to position Cylinder 1 piston at Top Dead Center (TDC) on the compression stroke.

G. Monitor the movement of the intake and exhaust valves in Cylinder 2 as you rotate the crankshaft to move the piston just past TDC of Cylinder 1.

H. The crankshaft-to-camshaft timing is correct if the intake valve and the exhaust valve in Cylinder 2 just begins to close as the intake valve starts to open as the piston in Cylinder 1 goes over TDC on compression.

I. If this simultaneous opening and closing of the intake and exhaust valves just past TDC does not occur, the crankshaft-to-camshaft timing is not correct. Repeat this timing check. If the results are the same, remove the accessory housing and check the alignment of the crankshaft idlers gears per the ”Crankshaft Idler Gear Installation” section in this chapter.

J. If the crankshaft-to-camshaft timing is correct:

(1) Install the rocker box cover on Cylinder 2 with a new rocker box cover gasket as per the “Cylinder Installation” procedure in Chapter 72-30.

(2) Install the top spark plug on Cylinder 1 as per the “Spark Plug Installation” procedure in Chapter 74-20 of the ***IO-360-N1A Engine Service Manual***.

(3) Reconnect the starter.

(4) Reconnect all spark plug leads

72-25 - ACCESSORY HOUSING MAINTENANCE

1. Accessory Housing Removal
   A. Remove all of the Bolts A and B, lock washers, and washers from the external side of the accessory housing shown in Figure 1. Discard the lock washers.

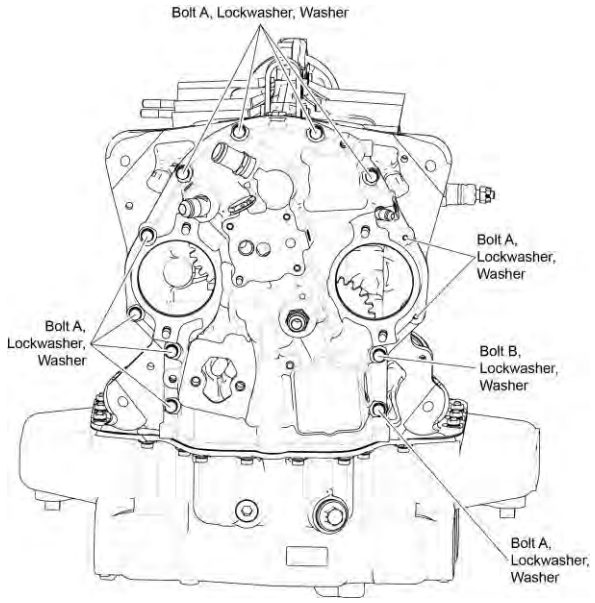


Figure 1
Hardware on External Side of Accessory Housing

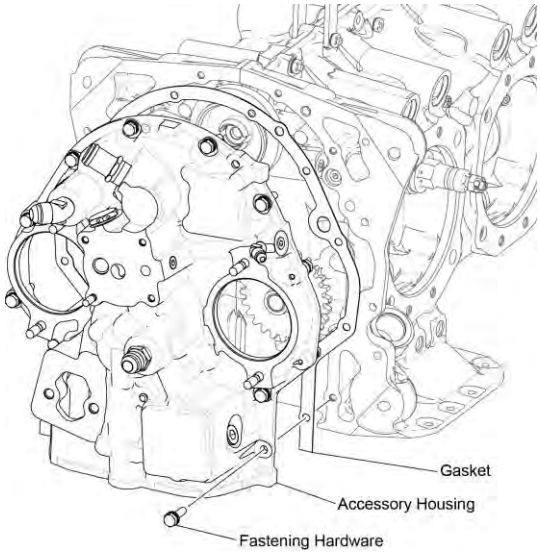


Figure 2
Accessory Housing

   B. While one person supports the accessory housing, remove the two bolts, lock washers, and washers from the other side of the accessory housing as shown in Figure 1. Discard the lock washers.
   C. Remove the accessory housing from the engine.
   D. Remove and discard the accessory housing gasket (Figure 2).
2. Oil Pump Removal
   A. Remove the safety wire (Figure 3) from the slotted nuts that attach the oil pump body to the accessory housing.

Figure 3
Safety Wire Oil Pump Fasteners

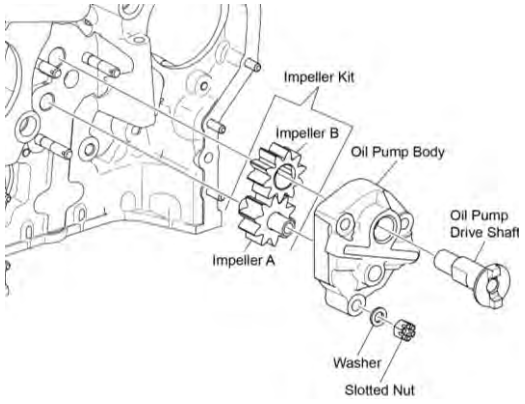


Figure 4
Oil Pump and Internal Side of the Accessory Housing

B. Remove and discard the three slotted nuts and three washers that attach the oil pump body to the accessory housing.

C. Remove the oil pump drive shaft from impeller B (Figure 4).on the oil pump.

D. Remove the impellers A and B from the oil pump

3. Oil Pump Installation

A. Unless otherwise instructed in the latest revision of Service Instruction No. SI-1059, lubricate all parts of the oil pump with a mixture of 15% pre-lubricant and 85% SAE No. 50 mineral base aviation grade lubricating oil.

B. Install impellers A and B in their respective compartments in the oil pump body (Figure 4).

C. Install the oil pump drive shaft into the oil pump body and through impeller B (Figure 4).

D. Install the oil pump over the mounting studs on the accessory housing.

E. Install a washer and new slotted nut on each of the three studs on the accessory housing.

F. Tighten the three slotted nuts gradually and evenly, turning the drive gear shaft while tightening to ensure free movement of the impellers.

NOTICE: If the drive gear shaft binds while tightening the slotted nuts, remove the oil pump, examine all parts of the oil pump for wear or damage. Replace worn or damaged parts if necessary and re-install the oil pump.

G. Torque the slotted nuts to 17 ft.-lb. (23 Nm).

H. Safety wire the three slotted nuts as shown in Figure 3.

4. Fuel Pump Plunger Removal

Remove the fuel pump plunger from the accessory housing (Figure 5).

5. Fuel Pump Plunger Inspection

A. Clean the fuel pump plunger per instructions in Chapter 05-30.

B. Inspect the fuel pump plunger for cracks or damage.

C. Replace a cracked or damaged fuel pump plunger.

6. Fuel Pump Plunger Installation

A. Apply a coat of Castrol® Moly Grease NLGI#1 or equivalent to approximately 1 in. of the plunger end and the head

B. Install the fuel pump plunger in the accessory housing as shown in Figure 5.

Figure 5
Fuel Pump Plunger

7. Accessory Housing Installation

   A. Examine plugs and fittings for damage. Replace any damaged plug or fitting.

   B. Install plugs and fittings in the accessory housing (Figures 6 and 7) with a new O-ring as required.

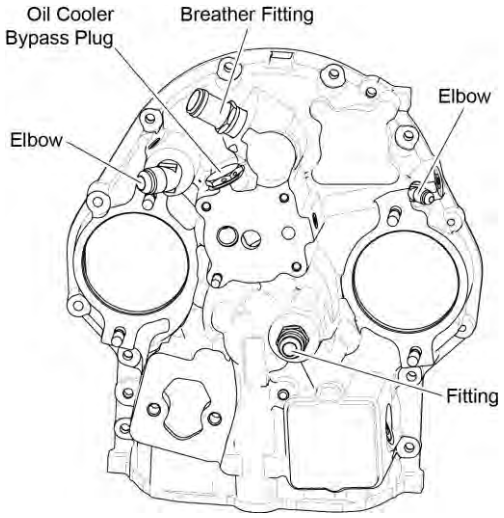


Figure 6
Plugs and Fittings in Accessory Housing

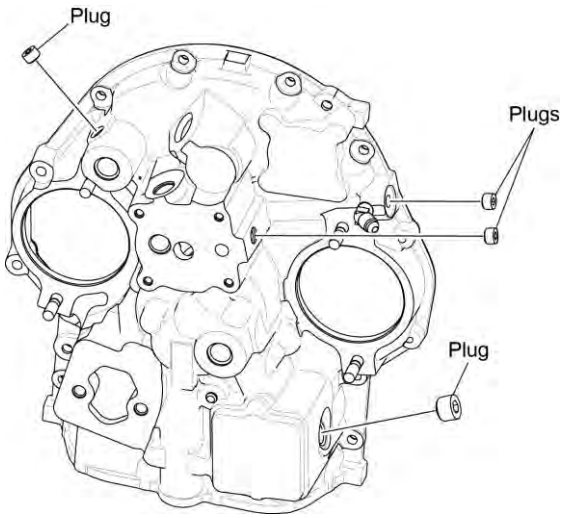


Figure 7
Plugs in Accessory Housing

   C. Turn the crankshaft to position cylinder 1 at TDC.

   D. Place a new accessory housing gasket (Figure 2) over the locating dowels on the rear of the crankcase.

   E. Apply a liberal coating of engine oil to all contact surfaces, such as gear teeth and the idler gear hubs.

   F. Fit the accessory housing into place on the rear of the crankcase.

   G. Install all Bolts A and B with plain washers and new lock washers (Figure 1). Torque the hardware per the latest revision of the ***Service Table of Limits - SSP-1776***.

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72-30 - CYLINDER MAINTENANCE

NOTICE: Routine time-interval-based inspections for cylinders are identified in Chapter 05-20 in the ***IO-360-N1A Engine Service Manual.***

1. Cylinder Removal

   A. Disable all power to the engine and disconnect the engine wiring harness from the airframe.

   B. If not already done:

• Disconnect the ignition leads to the spark plugs. Remove the top and bottom spark plugs from the cylinder.	"Spark Plug Removal" procedure in Chapter 74-20 of the ***IO-360-N1A Engine Service Manual.***
• Remove the intake and exhaust pipes from the cylinder to be removed.	"Intake Pipe Removal" procedure in Chapter 72-80 and the airframe manufacturer's instructions.
• Remove the clamps that attach the fuel line to the shroud tube, disconnect the fuel line from the injection nozzle (Figure 1), remove the injection nozzle from the cylinder, and reconnect the removed injection nozzle to the fuel line.	"Injection Nozzle Removal" procedure in Chapter 73-10.

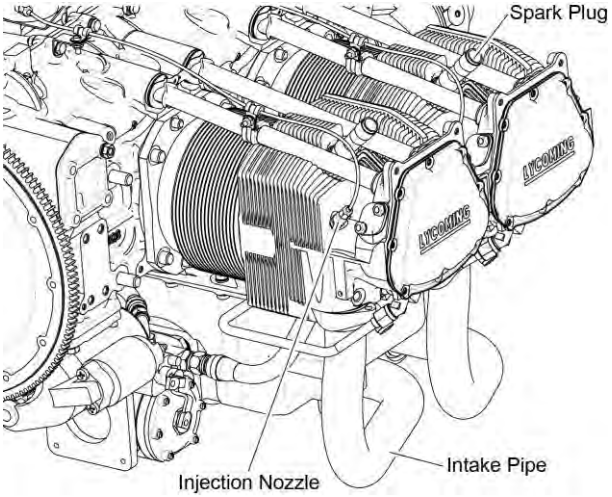

Figure 1
Spark Plugs, Intake Pipes, and Injection Nozzles

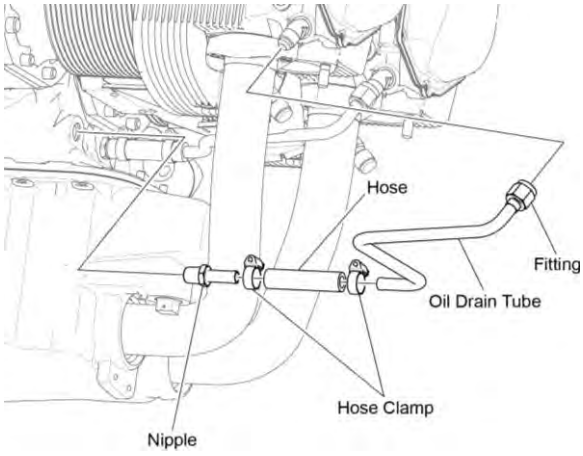

Figure 2
Oil Drain Tube

   C. Oil Drain Tube Removal

      (1) Remove and discard the hose clamps (Figure 2).

      (2) Disconnect the oil drain tube fitting from the engine cylinder.

      (3) Remove and discard the hose (Figure 2).

      (4) Remove the oil drain tube from the cylinder.

      (5) Examine the oil drain tube for cracks or damage.

      (6) Replace a cracked or damaged oil drain tube.

NOTICE: Remove the cylinders by firing order 1-3-2-4 (Figure 3). Remove each cylinder as an assembly.

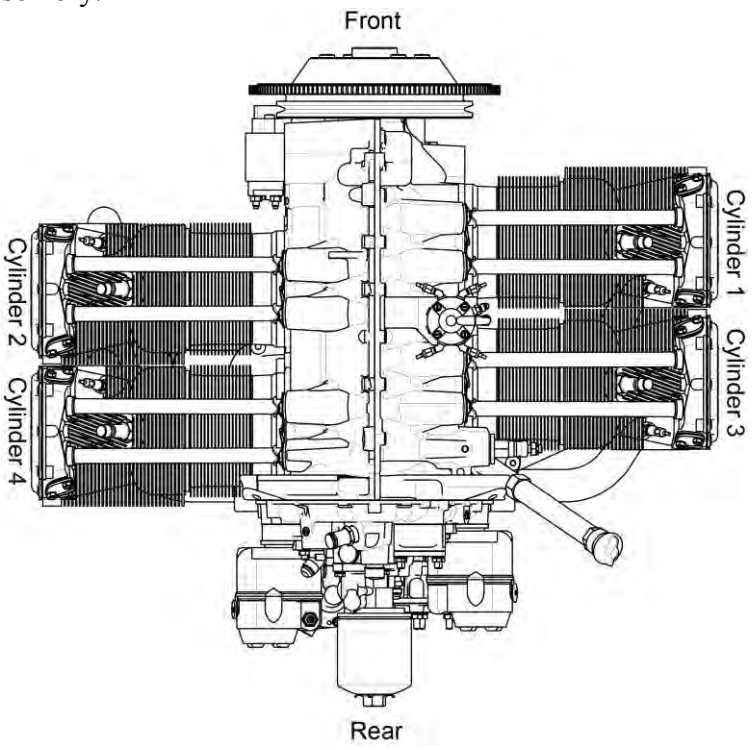

Figure 3
Engine Cylinder Firing Order

NOTICE: During cylinder removal, identify and label the cylinder, piston, and other parts by location (i.e., cylinder number) as they are removed for reference on assembly (to ensure that each part is installed in the same location from which it was removed).

D. Intercylinder Baffle Removal

(1) Turn the baffle retainer hook to disengage the retainer on the intercylinder baffle (Figure 4).

(2) Remove the intercylinder baffle and hook from between the cylinders.

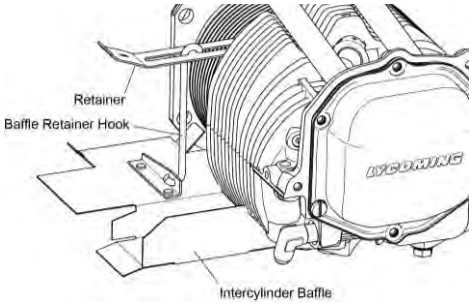

Figure 4
Intercylinder Baffles

E. Remove the screws from the rocker box cover (Figure 5).

F. Remove the rocker box cover and gasket. Discard the gasket.

G. Turn the crankshaft to put the piston at TDC of the compression stroke of the cylinder to be removed. (With the piston in this position, both intake and exhaust valves are closed and the piston is extended away from the crankcase to prevent damage when the cylinder is removed.).

H. Remove both thrust buttons from the ends of the valve rocker shaft.

I. Push the valve rocker shaft (Figure 5) outward and remove of valve rocker assemblies and bushings.

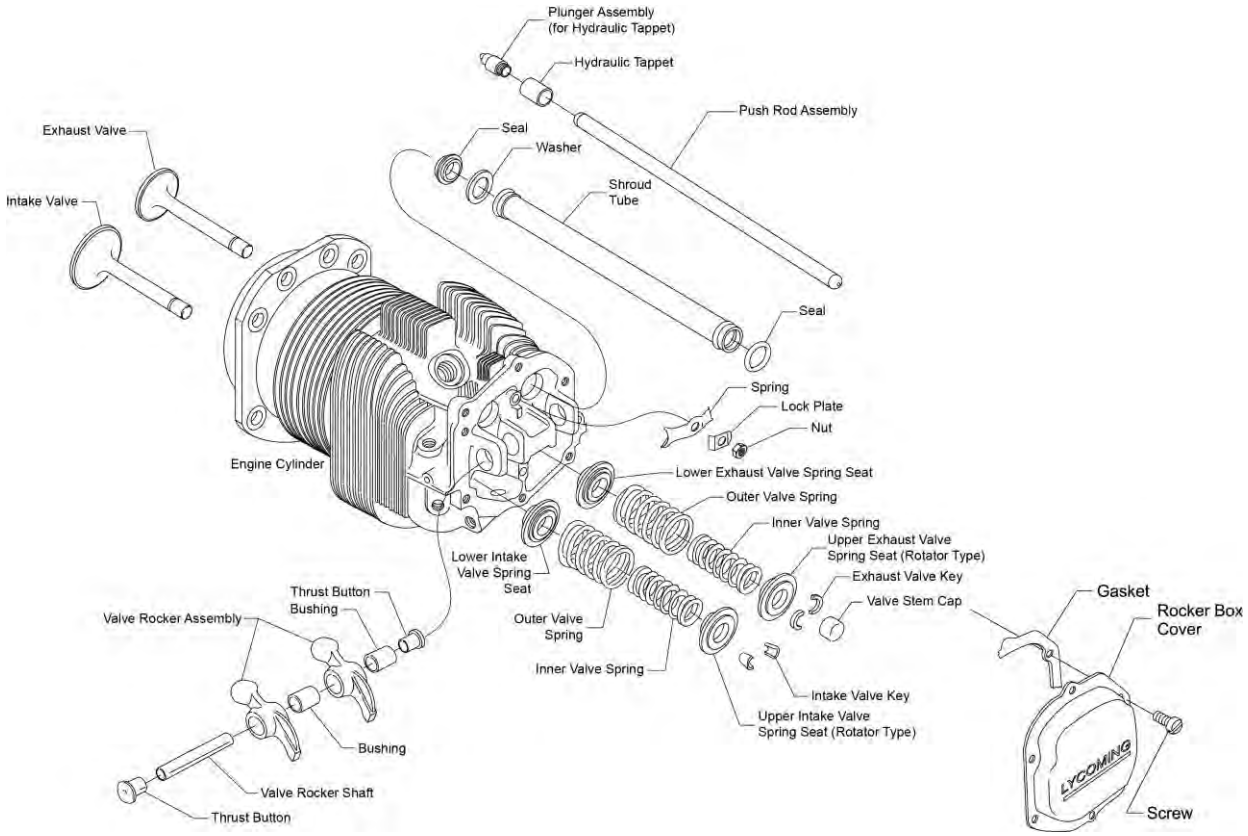

Figure 5
IO-360-N1A Engine Valve Components

J. Remove push rods and the valve stem caps.

⚠ **CAUTION:** DO NOT REMOVE VALVE ROCKER SHAFT UNTIL THE CYLINDER IS REMOVED.

K. Remove the shroud tubes by first releasing them from the seal seats in the cylinder head and withdrawing the tubes.

L. Remove the seals from the ends of the shroud tubes. Discard the seals.

M. Remove the seals from the crankcase. Discard the seals.

N. Remove the valve stem keys, valve spring seats, and valve springs.

O. Remove the cylinder base hold-down nuts (Figure 6).

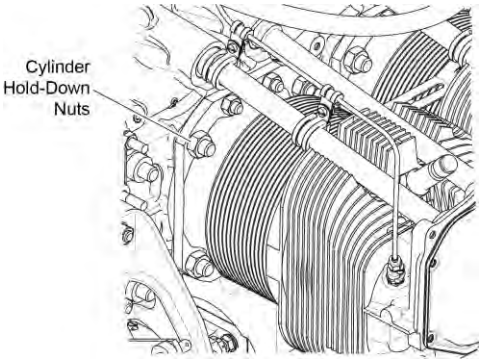

Figure 6
Cylinder Base Hold-Down Nuts

⚠ **CAUTION:** AS EACH CYLINDER IS SEPARATED FROM THE CRANKCASE, CATCH AND HOLD THE PISTON TO PREVENT IT FROM FALLING AGAINST THE CRANKCASE AND BEING DAMAGED.

P. Remove the cylinder.

Q. Remove the cylinder base oil ring from the cylinder (Figure 7) and keep it to use as support for the connecting rods after the pistons are removed.

R. Remove the valve rocker shaft (Figure 5) from the engine cylinder.

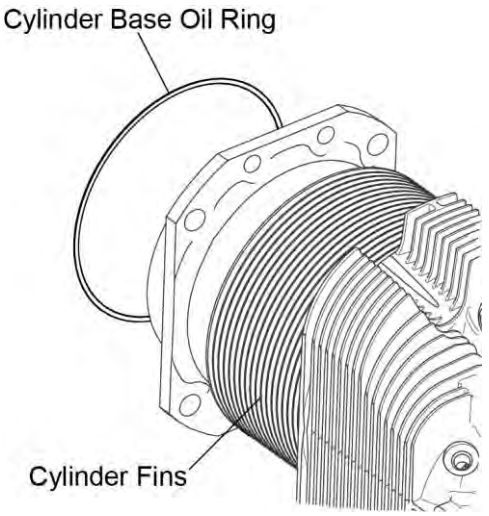

Figure 7
Cylinder Base Oil Ring and Cylinder Fins

2. Piston Removal

NOTICE: During removal of each piston pin (Figure 8), the piston will disconnect from the connecting rod.

A. Support the piston and remove the two piston pin plugs (Figure 8) and piston pin.

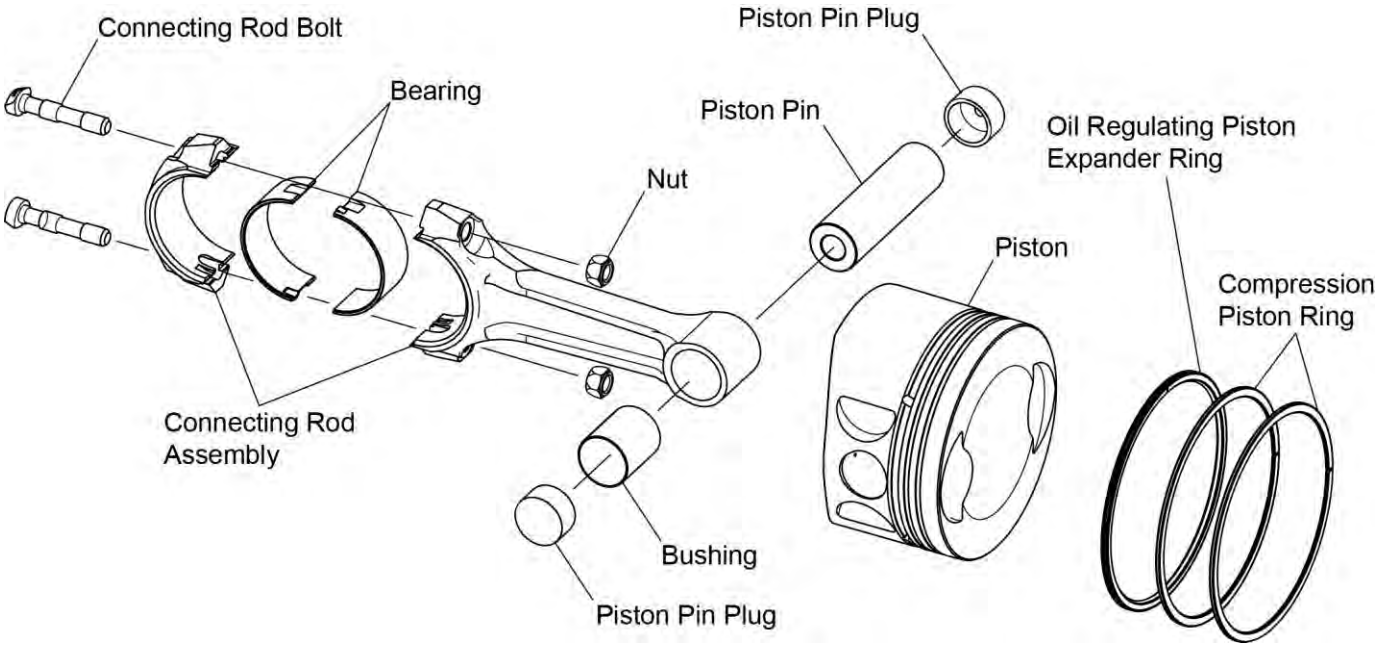

Figure 8
Piston Assembly

B. After piston removal, support the connecting rod one of two ways to prevent damage to the connecting rods and crankcase:

(1) Install torque hold-down plates (ST-222) as shown in Figure 9.

OR

(2) Make a loop around the cylinder base studs and connecting rod using a rubber band or the cylinder base seal (removed during cylinder removal) as shown in Figure 10.

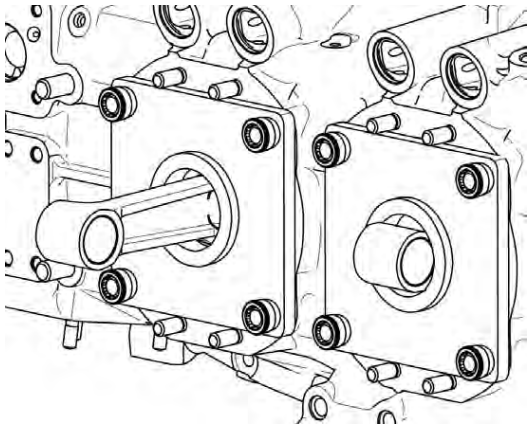

Figure 9
Torque Hold-Down Plates (ST-222)

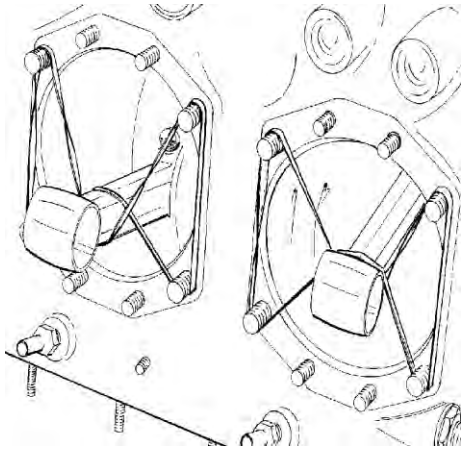

Figure 10
Loop Cylinder Base Oil Seal Around Cylinder Base Studs and on Connecting Rods

⚠ **CAUTION:** DURING REMOVAL OF THE THREE PISTON RINGS IN THE NEXT STEP, USE CARE NOT TO SCRATCH THE INNER WALL OF THE PISTON.

C. Start from the top down, use the Piston Ring Expander (P/N 64713) to remove the two top compression rings and the oil regulating piston expander ring (Figure 8).

3. Cylinder Assembly Inspection

Copy and complete the Cylinder Assembly Inspection Checklist.

Cylinder Assembly Inspection Checklist

Item to Examine and Corrective Action	Cylinder No.	Findings / Corrective Action
Look for wear or broken parts in the area of the valve, springs, and spring seats. **Corrective Action:** Replace all loose, scored, pitted, defective, or damaged valve seats (Figure 5).	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	

Cylinder Assembly Inspection Checklist (Cont.)

Item to Examine and Corrective Action	Cylinder No.	Findings / Corrective Action
Examine the intake and exhaust valve seats for looseness, scoring, pitting damage or non-conformities. Look for cracked or eroded valve seat bores. **Corrective Action:** Replace all loose, scored, pitted, defective, or damaged valve seats.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	
Examine intake and exhaust valve guides for looseness, cracks or scoring. **Corrective Action:** Replace all loose, scored, pitted, defective, or damaged valve guides.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	
Look for rust/pitting on: • Cylinder barrel fins and fin tips in power stroke areas • Cylinder barrel and base flange **Corrective Action:** Replace the cylinder if rust/pitting is found **<u>Do not grind the cylinder bore</u>** to remove pitting or damage caused by overheating.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	
Look for discolored/burnt paint or scored cylinder barrel bores. Look for blistered paint on the cylinder barrel. **Corrective Action:** Replace the cylinder if the cylinder barrel bores are scored or the paint is discolored/burnt/ blistered.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	

Cylinder Assembly Inspection Checklist (Cont.)

Item to Examine and Corrective Action	Cylinder No.	Findings / Corrective Action
Examine the exhaust flange for damage or warping. **Corrective Action:** Replace the cylinder if the exhaust flange is warped or damaged. **Do not grind or repair the exhaust flange** to correct a bent warped flange.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	
Look for any radial fin crack extending to the root of a fin. **Corrective Action:** Replace the cylinder if there is radial a fin crack extending to the root of the fin.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	
Look for broken, bent (or straightened), or pitted cylinder head or barrel fins. **Corrective Action:** Replace the cylinder if the cylinder head or barrel fins are bent or pitted.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	
Look for cracks in cylinder head. **Corrective Action:** Replace any cylinder that has a crack in the cylinder head.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	

Cylinder Assembly Inspection Checklist (Cont.)

Item to Examine and Corrective Action	Cylinder No.	Findings / Corrective Action
Look for static seal leakage or leakage from the head to barrel seal or crack in the head or barrel. **Corrective Action:** Replace any cylinder that has leakage at the cylinder head or barrel.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	
Look for scratches in the honed surface of the cylinder wall or cylinder bore. **Corrective Action:** Hone the cylinder to remove the scratches. Refer to the latest revision of the ***Service Table of Limits - SSP-1776*** for dimensions and limits.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	
Make sure there is not any cylinder head-to-barrel flange movement. **Corrective Action:** Replace any cylinder that has any cylinder head-to-barrel flange movement.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	
Examine intake and exhaust ports for nicks, scoring or dents. **Corrective Action:** Replace the cylinder.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	
Examine rocker box covers and rocker box cover mounting surfaces for nicks, scoring or dents. **Corrective Action:** Replace all nicked, scored, or dented rocker box covers or replace cylinders with nicked, scored, or dented rocker box cover mounting surfaces.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	

Cylinder Assembly Inspection Checklist (Cont.)

Item to Examine and Corrective Action	Cylinder No.	Findings / Corrective Action
Examine the spark plug Heli-Coil® inserts for looseness or damage. **Corrective Action:** Replace all loose or damaged spark plug Heli-Coil® inserts with oversize inserts per the "Heli-Coil® Replacement" procedure in this chapter.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	
Examine studs on the cylinder head for looseness of damage. **Corrective Action:** Replace all loose or damaged studs with the next higher applicable oversize studs.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	
Measure the inside diameter of the rocker shaft bushings. Refer to the latest revision of the ***Service Table of Limits - SSP-1776*** for dimensions. **Corrective Action:** Replace the rocker shaft bushings if they are not in accordance with specifications.	Cylinder 1	
	Cylinder 2	
	Cylinder 3	
	Cylinder 4	

4. Piston Inspection

   A. Copy and complete the Piston Inspection Checklist.

      (1) Examine the entire piston for damage or discoloration from burns.

      (2) Examine the piston grooves for wear. Measure the piston ring clearance and compare to measurements in the latest revision of the ***Service Table of Limits - SSP-1776***.

Piston Inspection Checklist

<table>
<tr><th>Inspection Item</th><th colspan="2">Findings/Corrective Action</th></tr>
<tr><td rowspan="4">Before cleaning the piston examine the following areas on the piston for pitting, cavities and surface distortion (which can be an indication of detonation or pre-ignition):
• Top of the piston
• Piston ring lands and grooves
• Piston pin holes
• Piston pin whole bosses
• Look for deposits or damage
• Complete the “Piston Cleaning” procedure in Chapter 05-30.
<u>NOTICE:</u> Surface distortion can be an indication of detonation or pre-ignition.</td><td>Cylinder 1</td><td></td></tr>
<tr><td>Cylinder 2</td><td></td></tr>
<tr><td>Cylinder 3</td><td></td></tr>
<tr><td>Cylinder 4</td><td></td></tr>
<tr><td rowspan="4">After Cleaning:
• Look for cracks on the piston head or skirt. Replace the piston if a crack is found.
• Look for bent or broken lands. Replace the piston if the land is broken or bent.
• Look for scoring on the piston skirt, damage or discoloration from burns. Replace the piston if scoring, damage or discoloration found.
• Examine the piston grooves for wear. Replace the piston if high ridges are on the lower lands.*</td><td>Cylinder 1</td><td></td></tr>
<tr><td>Cylinder 2</td><td></td></tr>
<tr><td>Cylinder 3</td><td></td></tr>
<tr><td>Cylinder 4</td><td></td></tr>
<tr><td colspan="3">* High ridges of displaced metal can interfere with operation of new piston rings. The displaced metal can cause excessive piston ring clearance in the valleys.</td></tr>
<tr><td colspan="3"><u>NOTICE:</u> Lycoming manufactures pistons with a taper that extends from the top to the bottom of the skirt with the smaller diameter at the top.</td></tr>
</table>

Piston Inspection Checklist (Cont.)

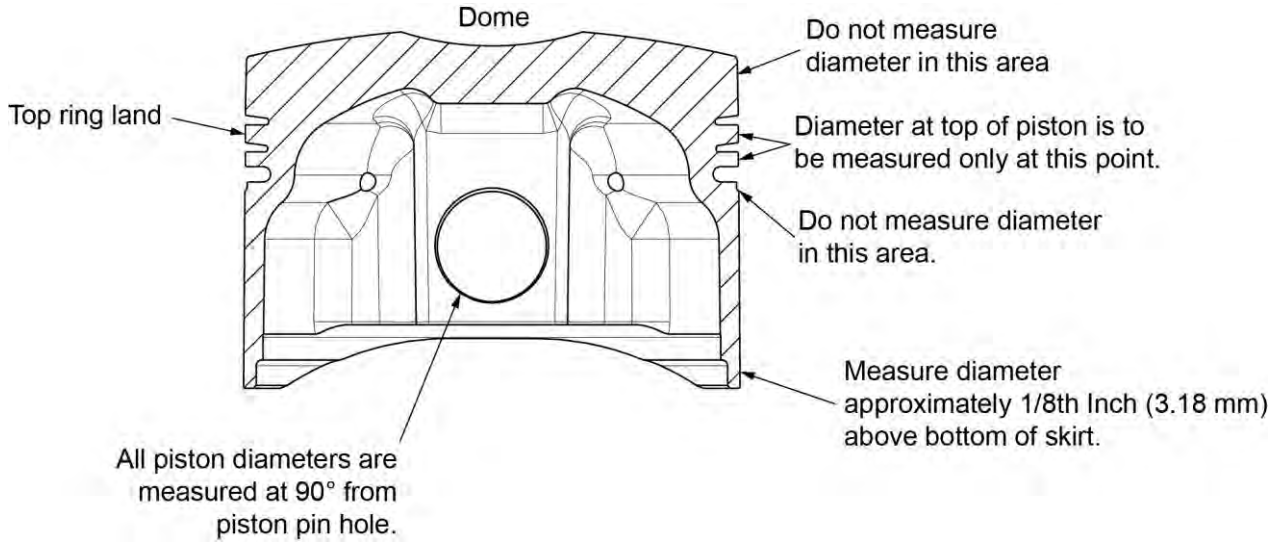

Figure 11
Section Through Piston Showing Points for Measuring Diameter

Inspection Item		Findings/Corrective Action			
		Cylinder 1	Cylinder 2	Cylinder 3	Cylinder 4
Measure the inside diameter of the piston pin hole (Figure 11).	Actual Measurement**				
	SSP-1776				
Measure the piston diameter at the top ring land of the piston between the top and second compression ring grooves (at a right angle to the piston pin hole) (Figure 11).	Actual Measurement**				
	SSP-1776				
Measure the diameter approximately 1/8 in. (3.18 mm) above the bottom of the piston skirt. (at a right angle to the piston pin hole) (Figure 11).	Actual Measurement**				
	SSP-1776				
Measure the piston ring groove clearance (without the piston ring installed.)	Actual Measurement**				
	SSP-1776				

Compare the actual measurement against the limits in the latest revision of the ***Service Table of Limits - SSP-1776*. Replace the piston if any of the measurements are out of tolerance.

Piston Inspection Checklist (Cont.)

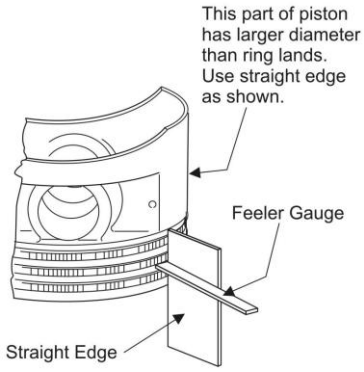

Figure 12
Checking Piston Ring Side Clearance

Inspection Item		Findings/Corrective Action			
		Cylinder 1	Cylinder 2	Cylinder 3	Cylinder 4
Measure the side clearance between the piston rings and piston with a feeler gauge and straight edge (Figure 12).	Actual Measurement**				
	SSP-1776				
Measure the piston ring gap with feeler gauges (Figure 12). Complete "Piston Ring End Gap Check" in this chapter.	Actual Measurement**				
	SSP-1776				
Measure the cylinder diameter parallel to the piston pin in the lower least worn portion of the cylinder.					
Calculate the piston clearance (difference between the cylinder diameter and the piston diameter.)					
Complete "Piston Ring End Gap Check" in this chapter.					

Compare the actual measurement against the limits in the latest revision of the ***Service Table of Limits - SSP-1776*. Replace the piston if any of the measurements are out of tolerance.

Comments:

If inspection of the piston shows the original ground surface of the piston skirt to be undamaged, the piston is acceptable and can be re-installed.

If any of the following conditions are found on the piston, replace the piston.

- Damage
- Cracked, bent, or broken lands, scored skirts or any out-of-tolerance dimensional limits
- Piston grooves worn to the extent that relatively high steps or ridges are on the lower lands

NOTICE: Refer to the latest revisions of Service Instructions No. SI-1243, SI-1037, and SI-1555 to identify a replacement piston and associated rings and any new details of piston inspection.

B. Piston Ring End Gap Check:

(1) Put the piston ring in the cylinder in which it will be used.

(2) To square the piston ring in the cylinder bore, install the piston in the cylinder and use a soft mallet to tap the dome end of the piston on the inside, until the bottom of the piston skirt is flush with the end of the cylinder barrel. Remove the piston from the cylinder.

(3) Measure the piston ring end gap with feeler gauges. Record the measurement in the Piston Inspection Checklist. Compare the measurement with the ring end gap measurement in the latest revision of the ***Service Table of Limits - SSP-1776***.

(4) If necessary to increase the gap, carefully file the ends of the piston ring.

5. Piston Ring Replacement

⚠ **CAUTION:** DO NOT ***UNDER ANY CIRCUMSTANCES*** INSTALL CHROME-PLATED PISTON RINGS IN AN ENGINE HAVING CHROME-PLATED CYLINDER BARRELS. IF YOU ARE UNSURE OF THE PROPER COMBINATION OF RINGS TO BE USED, CONTACT THE SERVICE DEPARTMENT AT LYCOMING ENGINES.

DURING REMOVAL OF THE THREE PISTON RINGS IN THE NEXT STEP, USE CARE NOT TO SCRATCH OR SCORE THE INNER WALL OF THE PISTON.

NOTICE: Use either the Lycoming Piston Ring Expander (P/N 64713) or a commercially available piston ring expander tool to remove and install the piston rings.

A. Start from the top down, use the Piston Ring Expander (P/N 64713) to remove the two top compression rings and the oil regulating ring (Figures 8 and 13).

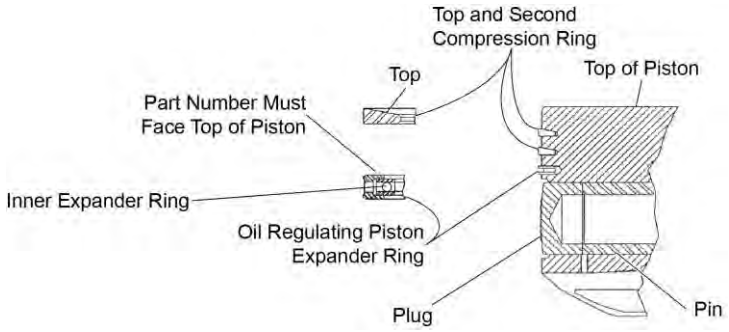

Figure 13
Piston Ring Positions

NOTICE: New cylinders made by Lycoming will have the correct piston ring finish and do not need further honing. Otherwise, hone the cylinder per the latest revision of Service Instruction No. SI-1047 to ensure correct seating of the new piston rings.

For new piston rings, refer to the latest revision of Service Instruction No. SI-1037 to identify the correct new piston rings to be installed on the piston.

Piston rings are not supplied in oversize widths as compensation for ring groove wear.

B. Make sure that the gap in the oil regulating piston expander ring is 180º opposite the gap in the inner expander ring (Figure 13).

C. With the piston top side up on a workbench, install the oil regulating piston expander ring (Figure 13) in the first groove above the piston hole, with the part number facing the top of the piston.

D. Install the two top compression rings (Figure 13) with the word "Top" toward the top of the piston in the remaining top grooves.

E. Compress each of the two top compression piston rings several times with your fingers to make sure the rings are situated freely and loosely in the groove.

F. To ensure correct installation, measure the side clearance of the rings in the grooves with a feeler gage and a straight edge per Figure 12. If the actual measurement is greater than the maximum allowable side clearance, per the latest revision of the ***Service Table of Limits - SSP-1776***, replace the piston.

NOTICE: A field run-in must be completed on field-overhauled engines, after field-replacement of one or more cylinders, or field-replacement of piston rings in one of more cylinders. Refer to the latest revision of Service Instruction No. SI-1427.

Engine break-in must be done on all engines regardless of whether they are new, rebuilt, overhauled, or had one or more cylinders replaced or piston rings replaced. Refer to the "Flight Test" chapter of the ***IO-360-N1A Engine Installation and Operation Manual.***

6. Piston Installation

A. Clean the pistons as per instructions in the "Piston Cleaning" procedure in Chapter 5-30.

B. If not already done, starting with piston Number 1, apply a generous coating of a mixture of 15% pre-lubricant (STP or equivalent) and 85% SAE 50 mineral-base aviation-grade lubricating oil (unless otherwise directed per the latest revision of Service Instruction No. SI-1059) to the piston rings, working the mixture into the ring grooves, the piston pins, and to the ID of the piston pin holes.

⚠ **CAUTION:** DO NOT ATTEMPT TO TURN THE CRANKSHAFT UNLESS THE CONNECTING RODS ARE SUPPORTED.

C. Turn the crankshaft so that when the Number 1 piston is inserted, it will be at TDC of its firing stroke, with both tappets on the base circle of the cam lobes.

D. Remove the Torque Hold-Down Plates (ST-222), rubber bands, or cylinder base oil seals from the crankcase.

E. Install the piston on the connecting rod where the number stamped on the bottom of the piston head is toward the front of the engine.

F. Insert the piston pin into the piston and through the connecting rod using only palm pressure (Figure 8).

NOTICE: If the original piston pin is tighter than a palm push fit, look for burrs or slight carbon in the pin bore of the piston. Remove any burrs with a stone. Remove carbon as per instructions in Chapter 5-30. If a new piston or piston pin is installed, use a pin that will give a palm push fit at 60º to 70ºF (15º to 20ºC).

G. Insert a piston pin plug at each end of the piston pin.

H. Thoroughly lubricate the piston pin plug faces with a coating of Castrol® Contractor Special NLGI#1 to the intake valve stem (or other lubricant identified in the latest revision of Service Instruction No. SI-1059.)

7. Intake Valve Replacement
   A. Intake Valve Removal
      (1) Remove the cylinder from the engine per the "Cylinder Removal" procedure in this chapter.
      (2) Remove the valve stem key (Figure 5), valve spring seats, and valve springs from the intake valve.

      NOTICE: Use care not to scratch the inside of the cylinder barrel when removing the intake valve.

      (3) Remove the intake valve from the valve guide, through the cylinder barrel.
   B. Intake Valve Installation

   NOTICE: Use care not to scratch the inside of the cylinder barrel when installing the intake valve (Figure 5).

      (1) Apply a coating of Castrol® Contractor Special NLGI#1 to the intake valve stem (or other lubricant identified in the latest revision of Service Instruction No. SI-1059.)
      (2) Install a serviceable intake valve in the valve guide, through the cylinder barrel.
      (3) Install the valve stem key, valve spring seats, and valve springs on the intake valve.
      (4) Install the cylinder on the engine per the "Cylinder Installation" procedure in this chapter.
8. Exhaust Valve Replacement
   A. Exhaust Valve Removal
      (1) Remove the cylinder from the engine per the "Cylinder Removal" procedure in this chapter.
      (2) Remove the exhaust valve stem cap (Figure 14).
      (3) Remove the valve stem key (Figure 5), valve spring seats, and valve springs from the exhaust valve.

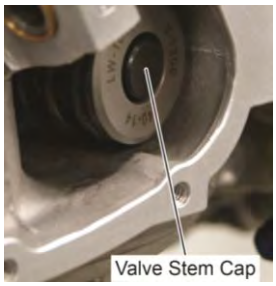

Figure 14
Exhaust Valve Stem Cap

      NOTICE: Use care not to scratch the inside of the cylinder barrel when removing the exhaust valve.

      (4) Remove the exhaust valve from the valve guide, through the cylinder barrel.
   B. Exhaust Valve Installation

   NOTICE: Use care not to scratch the inside of the cylinder barrel when installing the exhaust valve.

      (1) Apply a coating of Castrol® Contractor Special NLGI#1 to the exhaust valve stem (or other lubricant identified in the latest revision of Service Instruction No. SI-1059.)
      (2) Install a serviceable exhaust valve in the valve guide, through the cylinder barrel.
      (3) Install the valve stem key, valve spring seats, and valve springs.
      (4) Install the valve stem cap (Figure 14) on the exhaust valve.
      (5) Install the cylinder on the engine per the "Cylinder Installation" procedure in this chapter.

9. Cylinder Installation

NOTICE: If all cylinders are to be installed, install them by their firing order 1 - 3 - 2 - 4.

⚠ **CAUTION:** INSTALL ONLY THE CYLINDER BASE OIL RING AROUND THE CYLINDER BASE. DO NOT USE ANY ADDITIONAL SEALANT OR GASKET MATERIAL WHICH COULD DETERIORATE WHICH COULD CAUSE A REDUCED TORQUE ON THE CYLINDER BASE STUDS.

A. Install a new cylinder base oil ring (Figure 7) around the cylinder base.

B. Apply a light coat of engine oil mixture to the cylinder base oil seal ring.

C. Lubricate the inside diameter of the cylinder barrel with engine oil mixture (15% pre-lubricant (STP or equivalent) and 85% SAE No. 50 mineral base aviation grade lubricating oil) to the depth of the piston rings, approximately 2 in. (5 cm).

D. Lubricate the crankcase thru-stud threads and cylinder hold-down stud threads (Figure 15) with Food Grade Anti-Seize on the outer three threads.

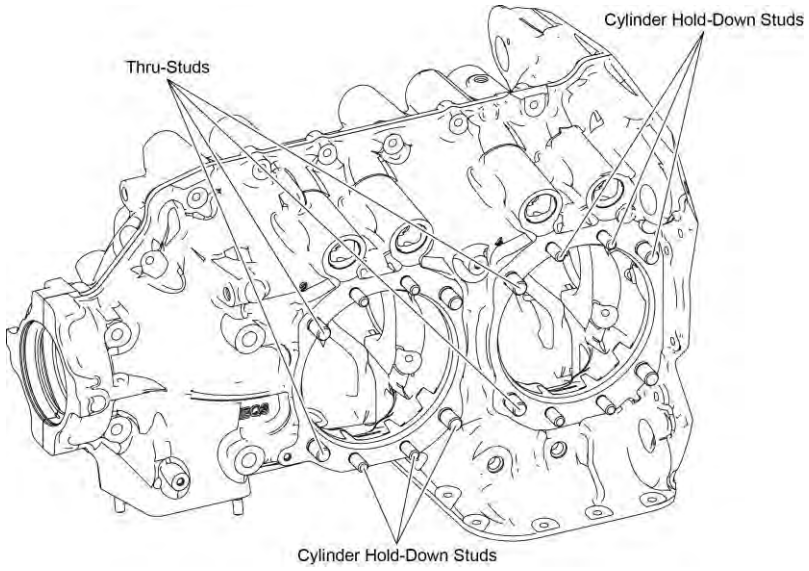

Figure 15
Crankcase Thru Studs and Cylinder Hold-Down Studs

E. Use the Piston Ring Compressor (ST-485) to install the cylinders (Figure 16) as follows:

(1) Assemble the piston ring compressor (ST-485) over the top piston rings and install the cylinder over the piston, pushing the piston ring compressor ahead with the cylinder barrel (Figure 17).

(2) As the cylinder barrel approaches the crankcase, catch the piston ring compressor as it drops off the piston skirt.

(3) As the cylinder assembly pilot is entering the crankcase, align the cylinder hold-down studs with the holes in the cylinder flange.

(4) Push the cylinder until the cylinder flange makes contact with the crankcase.

(5) Install a vented plug in each spark plug hole to prevent the entrance of foreign materials.

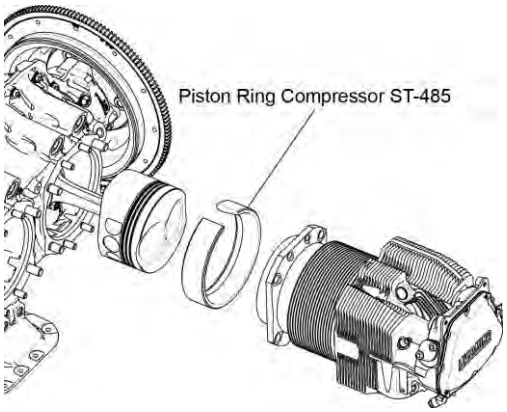

Figure 16
Piston Ring Compressor (ST-485)

Figure 17
Install the Cylinder

F. Install the cylinder base hold-down nuts (Figure 6) on the thru-studs and cylinder hold-down studs.

⚠ **CAUTION:** TORQUE THE CYLINDER NUTS MUST IN A SPECIFIC SEQUENCE.

G. Torque for cylinder base hold-down nuts as follows:

(1) Tighten the 1/2-20 nuts on the cylinders in the sequence shown in Figure 18, as per the applicable torque values:

- For 1/2 in. nuts, 600 in.-lb (50 ft.-lb) (67.8 Nm),
- For 3/8 in. nuts, 300 in.-lb (25 ft.-lb) (33.9 Nm),

(2) Tighten both ends of the free thru-studs simultaneously at the all locations. Make sure all thru-studs have at least 1-1/2 threads above attaching nuts at both ends.

(3) Make sure all cylinder base hold-down nuts are torqued. Complete a torque check of all nuts on the cylinder base using the torque wrench to apply the appropriate torque on each nut for 5 seconds. If the nut does not turn, it is correctly torqued.

(4) Apply torque seal to all cylinder hold-down nuts.

⚠ **CAUTION:** MAKE SURE ALL CYLINDER FASTENERS ON THE CRANKCASE ARE TORQUED CORRECTLY AND NONE ARE LOOSE.

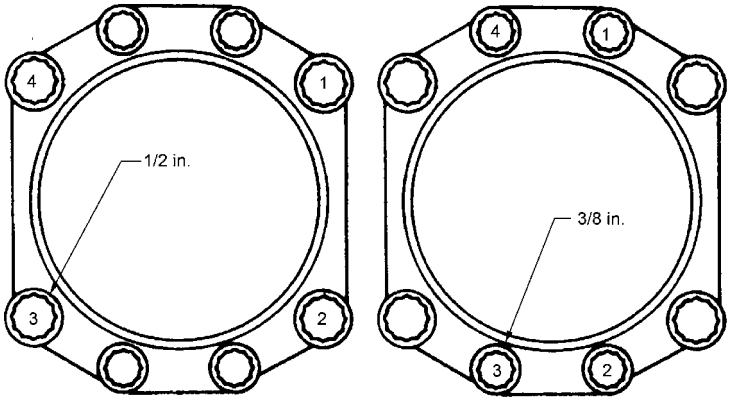

Figure 18
Sequence of Tightening Cylinder Base Nuts

H. Shroud Tube Installation

⚠ **CAUTION:** BE SURE THERE IS NO OIL INSIDE THE TAPPET BODIES AND THAT THE PLUNGER ASSEMBLY AND CYLINDER ASSEMBLY ARE THOROUGHLY CLEAN AND DRY. WASH ANY LUBRICATING OR PRESERVATIVE OIL (MINERAL SPIRITS, STODDARD SOLUTION, OR EQUIVALENT) FROM THESE PARTS, SINCE PLUNGER ASSEMBLIES MUST BE ABSOLUTELY DRY FOR THE TAPPET CLEARANCE CHECK.

NOTICE: Install the shroud tube oil seals in the crankcase first.

One shroud tube installs on the exhaust port of the cylinder and another shroud tube installs on the intake port.

(1) For each of the two shroud tubes, install the plunger assembly and hydraulic socket in the tappet body in the crankcase (Figure 19).

(2) Apply engine oil mixture (15% pre-lubricant (STP or equivalent) and 85% SAE No. 50 mineral base aviation grade lubricating oil) to all four of the shroud tube oil seals, two for each shroud tube.

(3) Install the shroud tube oil seals and washers into the cups in the tappet bores of the crankcase (Figure 20).

(4) On each shroud tube, assemble the other shroud tube oil seal over the outer end of the shroud tube (Figure 21).

(5) Insert each shroud tube through the hole in the rocker box and seat the end firmly into the crankcase.

(6) Install the spring, lockplate, and nut (Figure 22) in the rocker box to hold both shroud tubes.

(7) Torque the nut to 96 in.-lb. (11 Nm).

(8) Bend the lockplate against the nut. If necessary the nut can be tightened to the next aligning position with the lock tab.

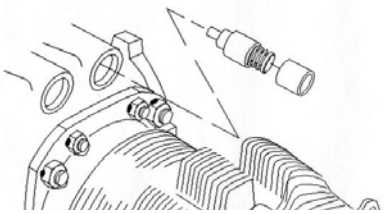

Figure 19
Tappet Plunger and Socket

Figure 20
Shroud Tube Oil Seals in Crankcase

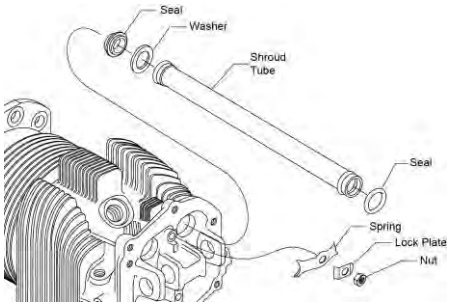

Figure 21
Insert the Shroud Tube

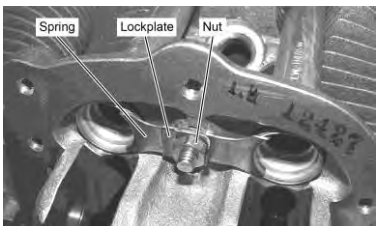

Figure 22
Shroud Tube Spring, Lockplate, and Nut

I. Push Rod Installation
   (1) Make sure that the valves are closed on the top dead center of the compression stroke.
   (2) Dip two push rods (Figure 5) into a mixture of 15% STP or equivalent and 85% SAE No. 50 mineral-based aviation-grade lubricating oil. Refer to the latest revision of Service Instruction No. SI-1059 for any new details.
   (3) Install the push rods into the full length of the shroud tube.
   (4) Press the push rods tightly from the outer end of the shroud tube to test the spring tension and free travel of the unloaded or dry hydraulic tappet plungers. Make sure the springs compress and return.

J. Install the valve stem cap over the exhaust valve stem.

⚠ **CAUTION:** EXHAUST AND INTAKE ROCKER ASSEMBLIES ARE DIFFERENT. MAKE SURE THAT THE ROCKERS ARE CORRECTLY ASSEMBLED.

K. Install the rockers with the cupped end on the push rod.

L. Align the valve rocker assemblies and bushing with the rocker shaft.

M. Slide the rocker shaft through the valve rocker assemblies and bushing (Figure 5) to seat the valve rockers in place.

N. Install the thrust buttons, one on each end of the valve rocker shaft

O. Make sure the valve rocker assemblies are in the correct position on the intake and exhaust valves.

⚠ **CAUTION:** BE SURE THERE IS NO OIL INSIDE THE TAPPET BODIES AND THAT THE TAPPET PLUNGER AND CYLINDER ASSEMBLY IS THOROUGHLY CLEAN AND DRY. WASH ANY LUBRICATING OR PRESERVATIVE OIL (MINERAL SPIRITS, STODDARD SOLUTION, OR EQUIVALENT) FROM THESE PARTS, SINCE TAPPET ASSEMBLIES MUST BE ABSOLUTELY DRY FOR THE TAPPET CLEARANCE CHECK.

P. Measure the clearance between the valve rocker and cylinder head. Refer to the latest revision of the ***Service Table of Limits - SSP-1776***.

NOTICE: If the clearance between the valve rocker and the cylinder head cannot be brought within the ***Service Table of Limits - SSP-1776***, determine whether the valve rocker or cylinder is not to specifications and replace the worn component.

Q. Use a Valve Clearance Gage (ST-23), to measure the dry tappet clearance:
   (1) Push on the push rod end of the valve rocker to seat the push rod against the plunger.
   (2) Use a valve clearance gage to measure the distance between the rocker arm and the valve stem tip.
   (3) The clearance must be between 0.028 and 0.080 in. (0.711 to 2.032 mm).

   NOTICE: If the clearance is not within the prescribed limit, insert a longer or shorter push rod to obtain correct clearance. Refer to the latest revision of Service Instruction No. SI-1060 for push rod information.

R. Recheck the valve rocker clearance on all cylinders and make any adjustments as required by using a different length push rod.

S. Lubricate rocker contact surfaces with Modoc® Oil 175.

T. Install a new rocker box cover gasket (Figure 5) and cover with screws on each rocker box; Torque the screws to 50 in.-lb (5.6 Nm).

U. Remove the vented plug from each spark plug hole.

V. Install the top and bottom spark plugs as per the section "Spark Plug Installation" in Chapter 74-20 in the ***IO-360-N1A Engine Service Manual***.

W. Remove the fuel injection nozzle from the fuel line, install the fuel injection nozzle (Figure 1) on the cylinder per the "Fuel Injection Nozzle Installation" procedure in Chapter 73-10, and reconnect the fuel line to the injection nozzle.

X. Install the clamps that attach the fuel line to the shroud tube per instructions in the latest revision of Service Bulletin No. SB-342.

Y. Install the applicable intake pipe (Figure 1) on the cylinder per the "Intake Pipe Installation" procedure in Chapter 72-80. Install the applicable exhaust pipe on the cylinder per the airframe manufacturer's instructions.

Z. Intercylinder Baffle Installation

(1) Engage the "S-Type" retaining hook (Figure 4) through the hole in the baffle.

(2) Put the baffle in position beneath and between the cylinders and turn the hook up between the cylinder barrels.

(3) Put a baffle retainer in place between the cylinders and bring the retainer hook through the slot in the retainer. The retainer is forced down until the hook comes above the surface of the retainer far enough to be engaged over the bridge between the slots in the retainer.

AA. Oil Drain Tube Installation

(1) Connect a new hose to the nipple (Figure 23) in the crankcase.

(2) Install and tighten a hose clamp on the hose closest to the crankcase.

(3) Connect the oil drain tube to the elbow at the cylinder with a flange nut. Torque the nut per the latest revision of the ***Service Table of Limits - SSP-1776***.

(4) Connect the hose to the oil drain tube.

(5) Install and tighten a hose clamp on the hose and oil drain tube connection.

(6) Torque both hose clamps per instruction in the latest revision of the ***Service Table of Limits - SSP-1776***.

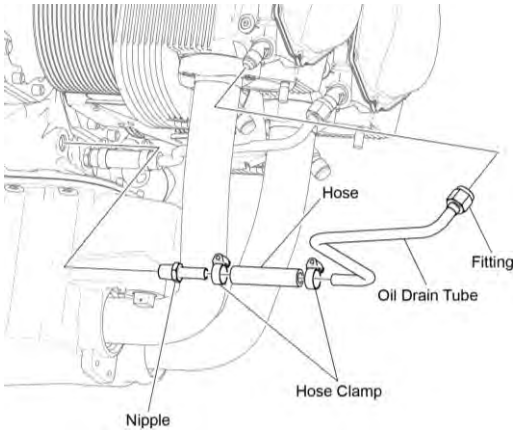

Figure 23
Oil Drain Tube

NOTICE: A field run-in must be completed on field-overhauled engines, after field-replacement of one or more cylinders, or field-replacement of piston rings in one of more cylinders. Refer to the latest revision of Service Instruction No. SI-1427.

Engine break-in must be done on all engines regardless of whether they are new, rebuilt, overhauled, or had one or more cylinders replaced or piston rings replaced. Refer to the "Flight Test" chapter of the ***IO-360-N1A Engine Installation and Operation Manual.***

10. Corrective Action for Valve Sticking

NOTICE: Sticking between the valve stem and guide (on intake and exhaust valves) can severely change valve opening and closing. If the valve cannot open or close correctly, incomplete combustion will occur, which can cause formation of more deposits and increased valve sticking. Because a correctly-timed sequence of valve opening and closing is essential to efficient and reliable engine operation, valve sticking is a serious problem any time either valve sticks for any reason.

⚠ WARNING: A STUCK VALVE CAN CAUSE ENGINE FAILURE.

NOTICE: If one valve is sticking, examine all other valves on all of the engine cylinders as a precaution.

A. Per Chapter 12-10 in the ***IO-360-N1A Engine Service Manual*** complete an oil and filter change and have an analysis done on the oil and filter to identify the contamination and find the source to correct the problem.

B. If the source of the oil contamination cannot be found or corrected:

(1) Replace the oil filter (more often) every 25 hours of operation.

(2) Complete an oil change every 25 hours of operation.

C. Complete an air filter change.

D. Examine the cooling air baffles and baffle strips for contamination. Remove any contamination.

E. Identify with a tag and remove the top spark plugs from the engine cylinders per the "Spark Plug Removal" procedure in Chapter 74-20 of the ***IO-360-N1A Engine Service Manual***.

F. Identify the location of each cylinder and valve train component for reference on assembly and remove the cylinder and valve train components per the "Cylinder Removal" section in this chapter.

G. Remove the intake and exhaust valves per the "Intake Valve Removal" and "Exhaust Valve Removal" sections in this chapter.

H. Examine the valve stem keys (Figure 5) for wear. Look for any distinct, uniform patterns. Replace worn valve stem keys.

NOTICE: Refer to the latest revision of the ***Service Table of Limits - SSP-1776*** for valve guide dimensions to use the correct reamer.

Use reamer tools to remove hardened carbon from the valve guides.

I. Apply ordinary cup grease on the flutes of the reamer to remove the deposits on the reamer.

J. Ream the valve guide as follows:

(1) Apply force on the reamer to ensure the reamer has gone through the full length of the valve guide. The 1 in. (2.54 cm) pilot must be visible through the exhaust port or through spark plug hole using an angled mirror.

(2) Clean the valve guide per the "Hard Carbon Removal" procedure in Chapter 05-30 for additional cleaning details.

(3) Measure the inner diameter of the valve guide using the correct plug gage.

(4) Examine the reamed hole to see if the reamer has cut all the way to the exhaust port end of the guide. If it has not, and the exhaust port end of the hole looks dark, the valve guide is bell-mouthed and must be replaced.

(5) If the valve is acceptable, apply lubricant to the valve guide.

⚠ **CAUTION:** NEVER USE THE PISTON TO PUSH THE VALVE THROUGH THE GUIDE.

K. Install the valves that are satisfactory, in the same position from where they were removed. Refer to the "Intake Valve Installation" and "Exhaust Valve Installation" procedures in this chapter.

L. Install the valve springs and valve spring seats.

M. Remove and clean the hydraulic lifter and remove all oil.

N. Examine the lifter for any malfunction.

O. Clean the inner diameter of the tappet body.

P. Install the hydraulic lifter.

Q. Install the cylinder in the same position as removed. Refer to the "Cylinder Installation" procedure in this chapter.

R. Install spark plugs. Refer to Chapter 74-20 in the ***IO-360-N1A Engine Service Manual*** for spark plug inspection and installation instructions.

11. Intake and Exhaust Valve Guide Replacement

Send the engine cylinder to a vendor who can complete this replacement.

12. Barrel Glaze and Varnish Removal from Interior Cylinder Barrel

A. Use a self-centering, self-bottoming hone that follows a choke located in the top of the cylinder barrel.

B. Use kerosene or light engine oil for lubrication while honing.

C. Put the deglazing hone in a low-speed drill.

D. Surface hone each cylinder barrel with a minimum of six to eight passes over the glazed surface, using a smooth up and down motion of the hone to achieve a good cross-hatch pattern on the cylinder barrel wall.

E. Thoroughly clean the hone.

F. Wipe as much of the abrasive build-up from the cylinder walls and recesses as possible, especially the recesses formed by the top of the cylinder barrel and the bottom of the cylinder head.

G. Make a hooked tool from soft wire and rub the tool back and forth in the recess to loosen any built-up abrasive. Complete this task each time the cylinder is flushed. There must not be any abraded material in this area.

H. Complete the "Cylinder Cleaning" procedure in Chapter 05-30.

I. Lubricate the internal cylinder barrel thoroughly with SAE 50 engine oil or a rust preventative oil that conforms with MIL-C-6529.

NOTICE: If wear step is found inside the cylinder barrel, measure it using the dial bore gage usually used to measure cylinder diameter. If the depth of the wear step is less than 0.0025 in. (0.0635 mm), remove the step as per the previous steps to remove cylinder barrel glaze. If the barrel contains a wear step exceeding 0.0025 in. (0.0635 mm), replace the cylinder.

In some cylinders, a small rough area can be found at either end of the barrel extending less than 0.250 in. (6.35 mm) from the end. This condition is a result of the manufacturing process and has no effect on the quality or condition of the barrel.

13. Heli-Coil® Replacement

NOTICE: The IO-360-N1A has short reach spark plugs.

A. Replace the spark plug Heli-Coil® insert (Figure 24) in the cylinder head if the threads in the spark plug hole in the cylinder are damaged (usually occurs when hard carbon on the end of the spark plug causes the insert to unwind during spark plug removal).

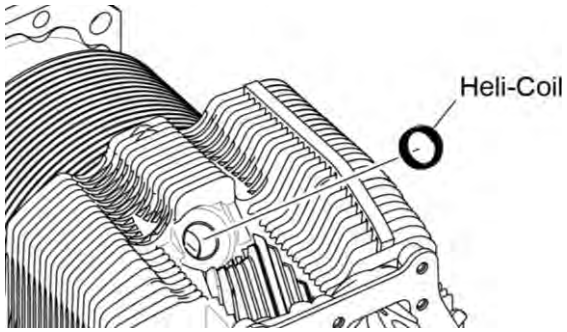

Figure 24
Heli-Coils®

NOTICE: Always install a larger oversized 0.010 in. (0.254 mm) Heli-Coil® insert in the spark plug hole on the cylinder head to replace a standard sized Heli-Coil® insert. Never replace a standard sized Heli-Coil® insert with another standard sized Heli-Coil® insert. The oversize Heli-Coil® inserts are identified by three marks on the tang of the Heli-Coil® insert as shown Figure 25.

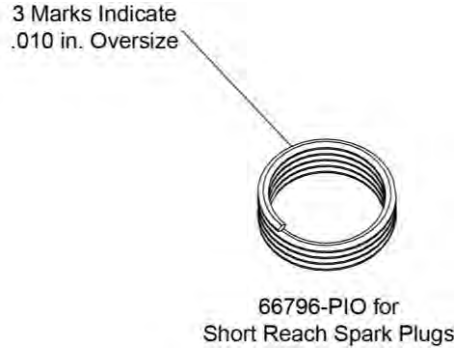

Figure 25
Heli-Coil® Inserts for Short Reach Spark Plugs

The "P10" Heli-Coil® insert part number identified in Table 1 is correct for the depth of the spark plug hole in the IO-360-N1A engine.

Table 1
Available Oversized Heli-Coil® Inserts

Part Number	Description/Application
66796-P10	Heli-Coil® spark plug thread insert for short reach spark plugs

The following tools are necessary to install the oversized "P10" Heli-Coil® insert:

64596-1 Spark plug thread tap (for installation of . 010 in. oversize Heli-Coil® inserts)

64594 Heli-Coil® inserting tool

64593 Heli-Coil® insert expanding and staking tool

(1) Disable all power to the engine to prevent propeller rotation and engine start. Disconnect ignition leads from all spark plugs.

(2) If not already done, remove and discard the Heli-Coil® insert from the spark plug hole.

(3) Apply of coat of grease liberally to the oversize tap 64596-1.

(4) If the Heli-Coil® insert is replaced while the cylinder is installed on the engine, take precautions to prevent metal shavings from falling into the combustion chamber.

(5) Turn the crankshaft to the start of the compression stroke.

(6) Put 8 ft. (2.4 m) of 3/8 in. (9.5 mm) nylon rope through the opposite spark plug hole.

(7) Turn the crankshaft to force the rope against the bottom of the spark plug hole that is to be tapped.

(8) Use the 0.010 in. oversize tap, No. 64596-1 to drill a larger oversize hole for the oversize insert.

(9) Install the new oversize 0.010 in. (0.254 mm) Heli-Coil® insert (Table 1) in the spark plug hole. Refer to Figure 24.

(10) Remove all chips and shavings to prevent contamination from foreign object debris.

(11) Remove the rope from the spark plug hole.

(12) Record replacement of the standard sized Heli-Coil® insert with a new oversized Heli-Coil® insert for the applicable cylinder number.

72-50 - LUBRICATION SYSTEM MAINTENANCE

1. Oil Line Replacement
   A. Disconnect and discard the oil line.

   ⚠ **CAUTION:** REPLACE A BRITTLE, CRACKED, KINKED, OR DAMAGED OIL LINE.

   B. Install a new oil line; do not let the oil line touch a heat source.

   ⚠ **CAUTION:** MAKE SURE THERE ARE NO SHARP BENDS OR KINKS IN THE OIL LINE ROUTING TO PREVENT INTERRUPTIONS TO OIL FLOW. MAKE SURE OIL LINES ARE NOT TOUCHING HEAT SOURCES THAT COULD DAMAGE THE LINE AND CAUSE OIL LOSS.

   C. Make sure there are no sharp bends or kinks in the oil line routing
   D. Torque the fitting connections on the oil line ends in accordance with the torque values in the latest revision of the ***Service Table of Limits - SSP-1776*** and aircraft manufacturer's instructions.
2. Oil Level Gage Removal
   A. Remove and discard the safety wire from the oil level gage tube (Figure 1).
   B. Carefully turn the oil level gage tube (Figure 2) to remove this tube as a unit (with the dipstick, oil level gage ring, and oil level gage gasket) from the engine.

   NOTICE: Make sure the oil level gage gasket is not on the crankcase.

   C. Put the tube assembly on clean surface in a safe place to prevent damage to the tube.

Figure 1
Safety Wire on the Oil Level Gage

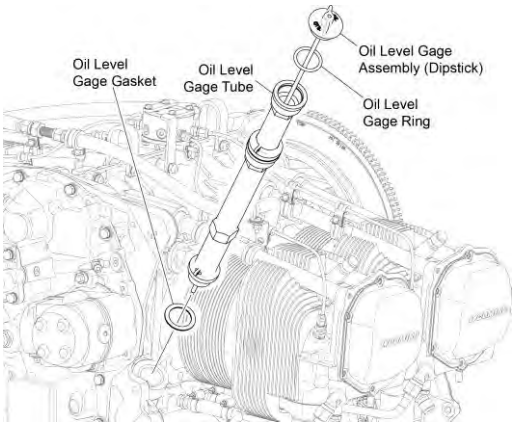

Figure 2
Oil Level Gage

3. Oil Level Gage Installation
   A. Install a new oil level gage gasket on the oil level gage tube (Figure 2).
   B. Apply Food-Grade Anti-Seize to the threads of the oil level gage tube.
   C. Install (turn) the oil level gage tube on the engine and safety wire the oil level gage tube (Figure 1).
   D. Install a new oil level gage ring on the dipstick (Figure 2).
   E. Install the oil level gage assembly (dipstick) in the oil level gage tube.

4. Oil Pressure Relief Valve Removal
   A. Remove and discard the safety wire from the oil pressure relief valve (Figure 3).
   B. Remove the oil pressure relief valve, spring, ball, and gasket (Figure 4) from the crankcase. Discard the gasket.

Figure 3
Safety Wire on the Oil Pressure Relief Valve

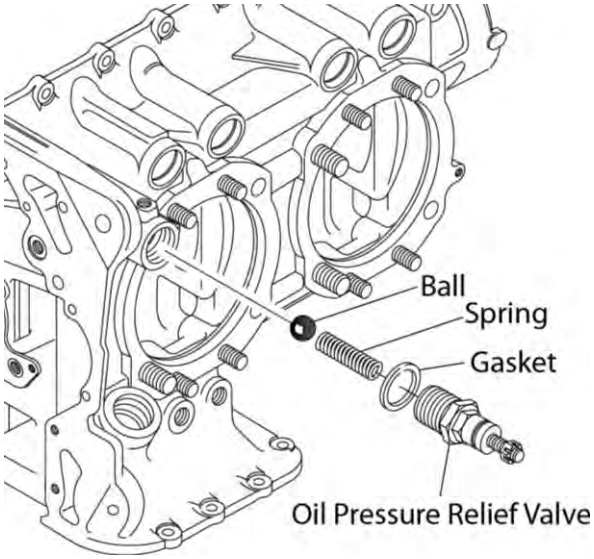

Figure 4
Oil Pressure Relief Valve

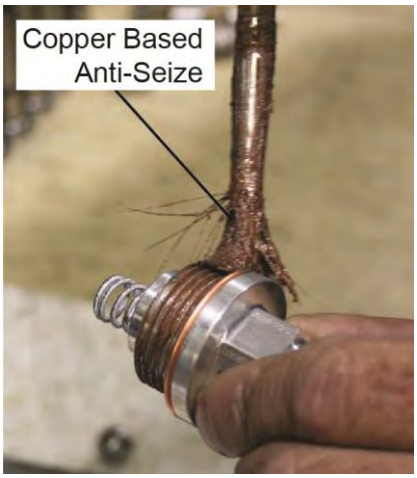

Figure 5
Apply Copper Based Anti-Seize to Threads

5. Oil Pressure Relief Valve Inspection
   A. Examine the oil pressure relief valve spring to be sure it meets specifications in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.
   B. Examine the threads on the oil pressure relief valve. If the threads are stripped or galled, replace the valve.
6. Oil Pressure Relief Valve Installation
   A. Install a new gasket on the oil pressure relief valve (Figure 4).

   NOTICE: Refer to the latest revision of ***Service Table of Limits - SSP-1776*** to select the correct spring. The spring must allow a minimum of three threads exposed on the adjusting screw to allow field adjustment.

   B. Install the spring in the oil pressure relief valve (Figure 4).
   C. Apply Copper-Based Anti-Seize to the threads of the oil pressure relief valve as shown in Figure 5.
   D. Install the ball in the crankcase.
   E. Install the oil pressure relief valve in the crankcase and torque to 300 in.-lb. (34 Nm).
   F. Safety wire the oil pressure relief valve (Figure 3).

7. Oil Cooler Bypass Valve Removal

   A. Remove and discard the safety wire from the oil cooler bypass valve (Figure 6).

   B. Remove the oil cooler bypass valve (Figure 7) from the oil filter base. Discard the gasket.

8. Oil Cooler Bypass Valve Cleaning

   Clean the oil cooler bypass valve per instructions in the table in Chapter 05-30.

9. Oil Cooler Bypass Valve Installation

   A. Apply Food Grade Anti-Seize on the threads of the oil cooler bypass valve.

   B. Install the oil cooler bypass valve with a new gasket on the oil filter base as shown in Figure 7.

   C. Torque the oil cooler bypass valve to 300 in.-lbs. (34 Nm).

   D. Safety wire the oil cooler bypass valve (Figure 6).

10. Oil Filter Base Removal

   A. Refer to the "Oil Filter Replacement" procedure in Chapter 12-10 of the ***IO-360-N1A Engine Service Manual*** for oil filter removal instructions.

   B. Remove the hardware fasteners (nut, bolts, washers, and lock washers) from the oil filter base (Figure 8). Discard the lock washers.

   C. Remove the oil filter base (Figure 8).

   D. Remove and discard the gasket.

11. Oil Filter Base Installation

   A. Mount the oil filter base with a new gasket on the mounting pad where shown in Figure 8 with three bolts with flat washers and new lock washers.

   B. Install the nut, new lock washer and washer on the stud.

   C. Torque all hardware in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.

Figure 6
Safety Wire on the Oil Cooler Bypass Valve

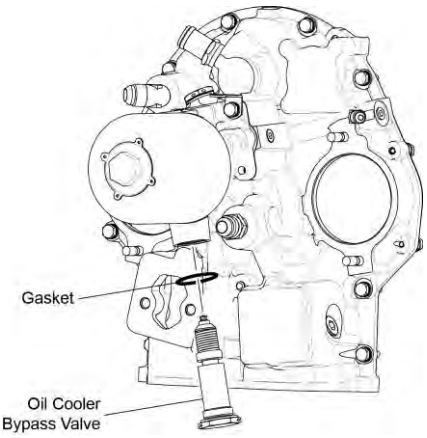

Figure 7
Oil Cooler Bypass Valve

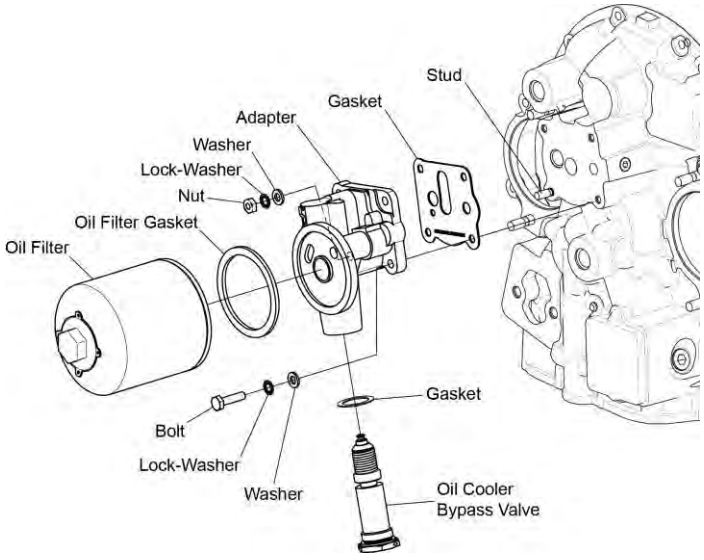

Figure 8
Oil Filter Base

12. Oil Sump Removal

A. Drain oil from the oil sump per the "Oil Change Procedure" in Chapter 12-10 of the ***IO-360-N1A Engine Service Manual.***

B. Remove all engine components attached to the oil sump.

C. Remove the six nuts, lock washers, and washers from the six A Studs (Figure 9) that attach the oil sump to the crankcase. Discard the lock washers.

D. Remove the 12 A Bolts along with lock washers, and washers from the oil sump. Discard the lock washers.

NOTICE: Keep the B Bolts separated from the A Bolts.

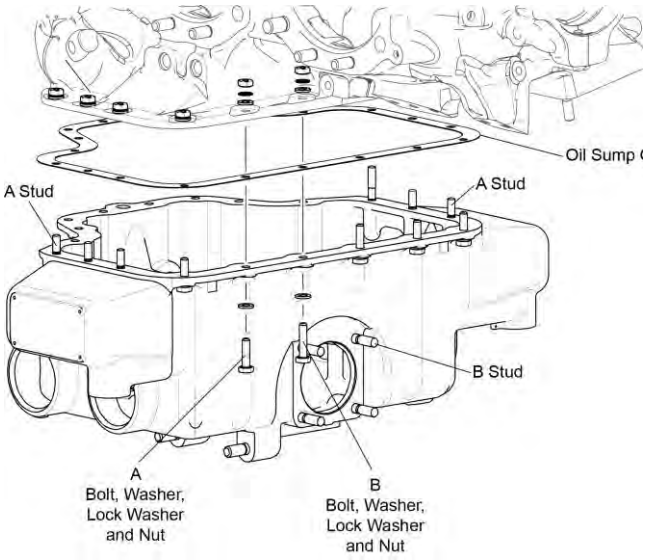

Figure 9
Oil Sump

E. While one person holds the oil sump, remove the two B Bolts, along with four washers, and two lock washers from the locations shown in Figure 9 on the oil sump.

F. Remove the oil sump from the engine.

G. Remove and discard the oil sump gasket.

H. Turn over or cover the oil sump to prevent dirt and debris from getting in the oil sump.

13. Oil Sump Installation

A. Clean the mating flange and interior of the oil sump. Remove all gasket material on the flange.

B. Make sure the oil sump has no cracks or damage, is clean and has no dirt, debris, or other foreign object matter that could contaminate the oil supply for the engine.

C. Remove (cut away) any excess accessory housing gasket material that extends to the oil sump mounting surface. Excess gasket material must not extend between the accessory housing and crankcase. The gasket must be flush with the oil sump flange (Figure 10).

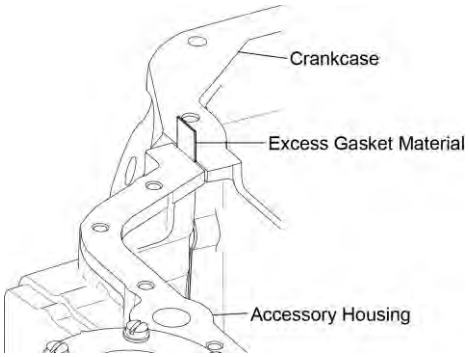

Figure 10
Remove Excess Accessory Housing Gasket to Make It Flush with the Oil Sump Flange

⚠ **CAUTION:** MAKE SURE THE OIL SUMP IS NOT CRACKED OR DAMAGED. THE OIL SUMP MUST BE CLEAN, WITHOUT DIRT, DEBRIS, OR OTHER FOREIGN OBJECT MATTER THAT COULD CONTAMINATE THE OIL SUPPLY. CONTAMINATED OIL CAN ADVERSELY AFFECT ENGINE OPERATION.

D. Apply a dab of Gasket Sealant #4 (or equivalent) to three places in the split line between the accessory housing and crankcase where they mate with the oil sump (Figure 11).

E. Install a new oil sump gasket in either the oil sump flange (Figures 9 and 12) or on the mating flange of the crankcase.

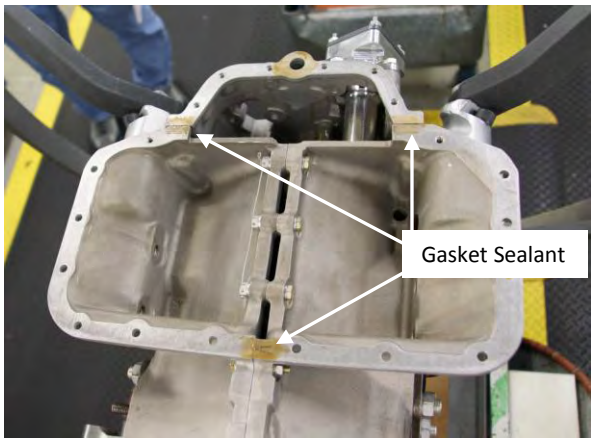

Figure 11
Gasket Sealant# 4 (or Equivalent) to Three Places on Oil Sump

Figure 12
Oil Sump Gasket

F. Align the oil sump flange with the bottom of the mated crankcase halves as shown in Figure 13.

Figure 13
Oil Sump Aligned with Crankcase

⚠ **CAUTION:** ALL OF THE OIL SUMP FASTENERS (STUDS, BOLTS, AND NUTS) MUST BE INTACT TO ENSURE CORRECT AND SECURE TIGHTENING TO PREVENT OIL LEAKAGE AT THE OIL SUMP MATING FLANGE WITH THE CRANKCASE. NO OIL IS TO LEAK OUT OF THE OIL SUMP.

G. Examine all of the oil sump fasteners identified as A and B, in Figure 9, that were to be kept separate when the oil sump was removed. Make sure the bolts, studs, and nuts are not damaged are intact and have no stripped threads. Replace any damaged or stripped fastener.

H. Install the A Studs on the oil sump in the locations shown in Figure 9.

I. Install the two B Bolts each with a nut, two washers and a new lock washer at the location shown in Figure 9. Torque the nuts to 96 in.-lb. (11 Nm).

J. Install the 12 A Bolts, each with a nut, two washers and new lock washer as shown in Figure 9. Torque the nuts to 96 in.-lb. (11 Nm).

K. Install the six nuts on the A Studs each with a washer and new lock washer. Torque the nuts to 96 in.-lb. (11 Nm).

⚠ **CAUTION:** TO PREVENT OIL LEAKAGE, MAKE SURE THAT THE OIL DRAIN PLUG IS INSTALLED -TIGHTLY IN THE OIL SUMP. SAFETY THE OIL DRAIN PLUG.

L. Install the oil drain plug in the threaded hole of the oil sump. Torque the oil drain plug per the torque value in the latest revision of the ***Service Table of Limits - SSP-1776***.

M. Safety the oil drain plug in accordance with the best standard practices per the latest revision of AC43.13-B.

N. Install all engine components that had been removed during oil sump removal.

O. After maintenance is completed, add the correct oil to the engine per instructions in Chapter 12-10 of the ***IO-360-N1A Engine Service Manual.***

72-70 - ELECTRICAL SYSTEM MAINTENANCE

1. Alternator and Bracket Removal

⚠ **CAUTION:** DISCONNECT THE BATTERY AND ENSURE MAGNETOS ARE PROPERLY GROUNDED TO PREVENT ELECTRICAL SHOCK AND ACCIDENTAL ENGINE START.

A. To remove the alternator:

(1) Cut and remove the safety wire from the two bolts on the alternator adjusting link where shown in Figure 1.

(2) Remove the two bolts and two different washers (STD-1727 and STD-35) from the alternator adjusting link (Figure 2).

(3) Remove the alternator adjusting link.

(4) Remove the two cotter pins (STD-713), two bolts, two slotted nuts, shims and three washers from the alternator bracket, strut, and alternator (Figure 2). Discard the cotter pins and slotted nuts.

(5) Remove the alternator and alternator belt.

Figure 1
Safety Wire on Bolts of Alternator Adjusting Link

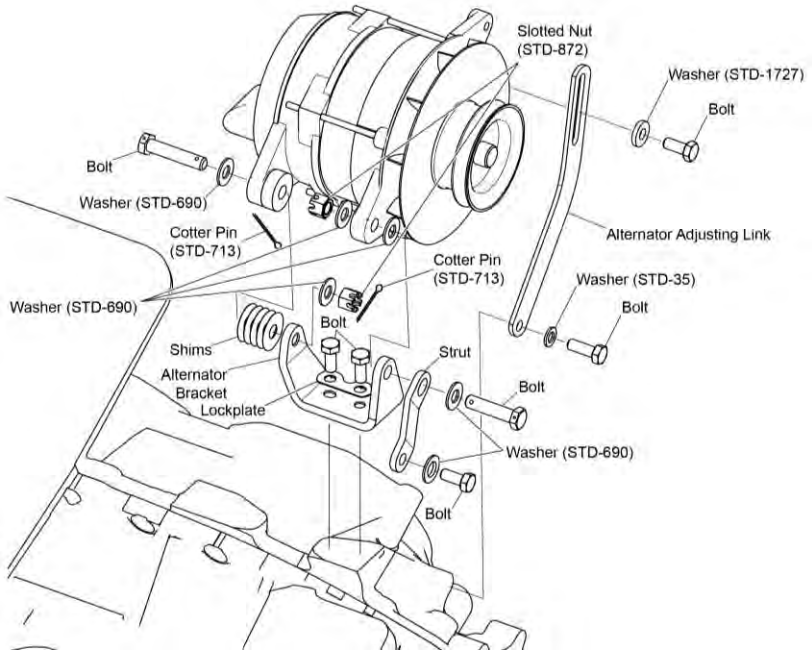

Figure 2
Alternator and Alternator Bracket

B. To remove the alternator bracket:

(1) Remove the two bolts and lockplate from the alternator bracket (Figure 2).

(2) Remove the two bolts and washer (STD-690) from the strut and alternator bracket.

(3) Remove the strut and alternator bracket.

2. Alternator and Bracket Installation

   A. To install the alternator bracket:

      (1) Mount the alternator bracket on the engine.

      (2) Install the lockplate with two bolts and washers on the alternator bracket (Figure 2). Torque the bolts in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.

      (3) Bend the tabs of the lockplate against the bolts.

      (4) Attach the strut to the alternator bracket with the two bolts and washers. Torque the bolts in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.

   B. To install the alternator:

   NOTICE: Refer to the latest revision of Service Instruction No. SI-1154 to ensure the correct approved alternator for your engine is installed.

      (1) Mount the alternator on the alternator bracket (Figure 2).

      (2) Install the bolt, two new slotted nuts, shims (as many as necessary) and three washers on the alternator bracket and alternator as shown in Figure 2. Install a new cotter pin in each new slotted nut.

      (3) Install the alternator adjusting link with the two bolts and different washers (STD-1727 and STD-35) where shown in Figure 2.

      (4) Examine the alternator belt per Chapter.72-70 in the ***IO-360-N1A Engine Service Manual***.

      (5) Install the alternator belt on the alternator per the "Alternator Belt Installation" procedure in this chapter.

3. Alternator Belt Replacement

   A. Alternator Belt Removal

      (1) Remove the safety wire from both bolts on the alternator adjusting link (Figure 1).

      (2) Loosen the bolt that attaches the alternator adjusting link to the alternator (Figure 2).

      (3) Loosen the bolt that attaches the alternator adjusting link to the crankcase (Figure 2).

      (4) Rotate the alternator on the bracket towards the starter ring gear.

      (5) Remove the alternator belt from the alternator pulley and the starter ring gear (Figure 3).

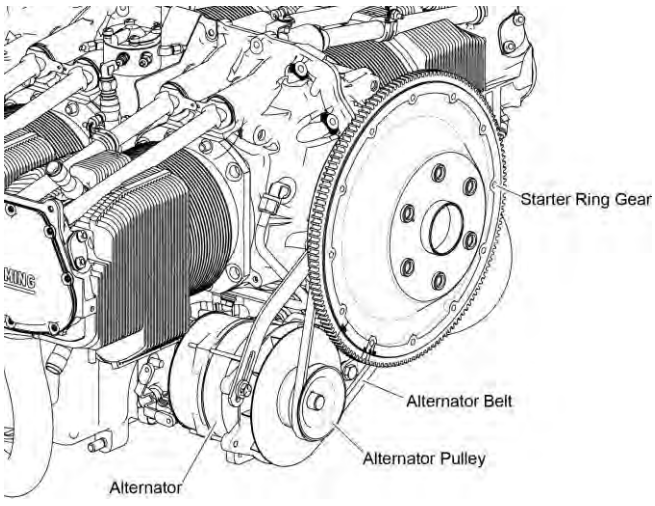

Figure 3
Alternator and Alternator Belt

B. Alternator Belt Installation

(1) Install the alternator belt in the alternator belt groove on the starter ring gear support.

(2) Install the alternator belt in the groove on the alternator pulley (Figure 3).

(3) Adjust the alternator belt tension. Refer to the "Alternator Belt Tension Check/Adjustment" procedure in Chapter 72-70 of the ***IO-360-N1A Engine Service Manual.***

(4) Torque the bolts that attach the alternator adjusting link to the alternator and to the crankcase to (Figure 2) to 17 ft.-lb. (23 Nm).

(5) Install new safety wire on the two bolts on the alternator adjusting link as shown in Figure 1.

4. Starter Replacement

A. Starter Removal

⚠ **CAUTION:** DISCONNECT THE BATTERY AND ENSURE MAGNETOS ARE PROPERLY GROUNDED TO PREVENT ELECTRICAL SHOCK AND ACCIDENTAL ENGINE START.

(1) Disconnect the starter from electrical power.

(2) Remove the three nuts and three lock washers, from the studs on the starter mounting plate (Figure 4) on the engine. Discard the lock washers.

(3) Hold the starter, remove the bolt and lock washer. Discard the lock washer.

(4) Remove the starter.

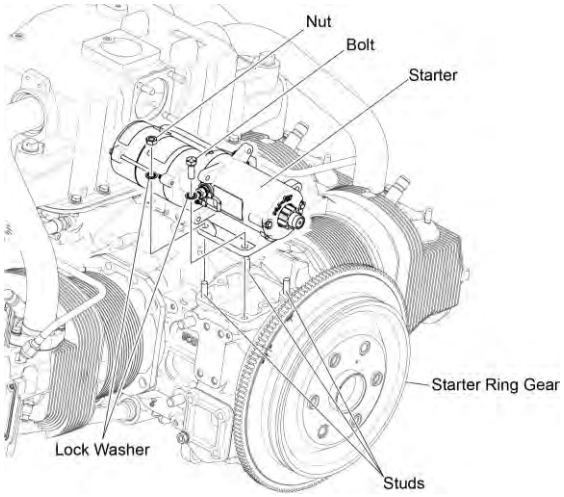

Figure 4
Starter

B. Starter Installation

NOTICE: Refer to the latest revision of Service Instruction No. SI-1154 to ensure the correct approved starter for your engine is installed.

(1) Align the starter with the three studs on the mounting plate (Figure 4).

(2) Install a nut with a new lock washer on each of the three studs. Install the bolt and new lock washer. Torque the three nuts and bolt to 17 ft.-lb. (23 Nm).

5. Starter Ring Gear Support Replacement
   A. Starter Ring Gear Support Removal
      (1) If not already done, release the tension on the alternator belt.
      (2) Lightly tap with your hand on the rear face of the starter ring gear support.
      (3) Remove the alternator belt from the starter ring gear support.
      (4) Remove the starter ring gear support from the crankshaft propeller flange.
   B. Starter Ring Gear Support Installation
      (1) Put the alternator belt in the pulley of the starter ring gear support.
      (2) Assemble the ring gear support over the propeller flange bushings.

      NOTICE: Make sure the bushing hole in the ring gear support marked with an "0" is assembled over the flange busing also identified with an "0" etched on the crankshaft flange next to the bushing.

      (3) Locate the starter ring gear so that the "0" on the ring gear support aligns with the "0" on the crankshaft flange.

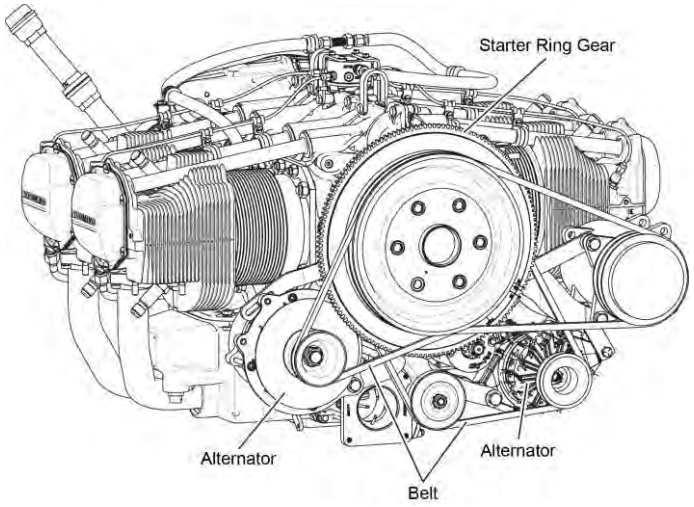

Figure 5
Alternator, Alternator Belt, and Starter Ring Gear

6. Starter Ring Gear Replacement

NOTICE: The following procedure is for replacing a worn or damaged starter ring gear (Figure 5) without replacing the starter ring gear support.

   A. Make sure that none of the propeller bolt holes in the starter ring gear support are worn or out-of-round.
   B. If you find defective holes, replace the entire starter ring gear assembly.

⚠ **CAUTION:** DO NOT GRIND INTO THE STARTER RING GEAR SUPPORT.

   C. If the propeller bolt holes are satisfactory, grind through the ring gear until there is only a thin section of gear material remaining. Do not grind into the starter ring gear support.
   D. Put the starter ring gear assembly on a flat metal surface and break the section of ring gear material left after grinding. The starter ring gear will spring open for easy removal.

E. Examine the starter ring gear support face for defects. If the ring gear support is damaged, replace it as per instructions in this chapter. Do not use it again.

F. Put the starter ring gear support on a flat surface with the alternator/generator belt groove upward as shown in Figure 6.

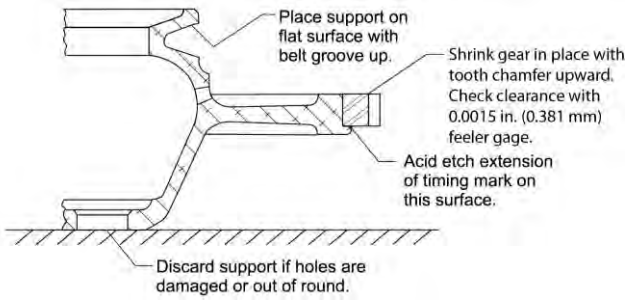

Figure 6
Ring Gear Support

G. Heat the new starter ring gear to approx. 450°F (232°C) in an oven or with a torch.

H. Assemble the heated gear on the ring gear support (with the tooth chamfer up).

NOTICE: As the starter ring gear cools, it will shrink to the support.

I. Use a 0.0015 in. (0.0381 mm) feeler gage to measure the clearance between the ring gear and support where the ring gear and support surfaces make contact. Measure around the entire circumference. The clearance measurements must be same to ensure correct seating of the ring gear against the support face. Different clearance measurements are an indication of incomplete assembly or warpage and must be corrected.

J. Align the timing marks on the crankshaft flange (Figure 7) with the timing mark on the starter ring gear assembly (Figure 8).

K. For new ring gears, find the timing mark on the ring gear support and extend it across the ring gear. Make a timing mark on the surface of the ring gear to a depth of 0.001 to 0.006 in. (0.025 to 0.152 mm).

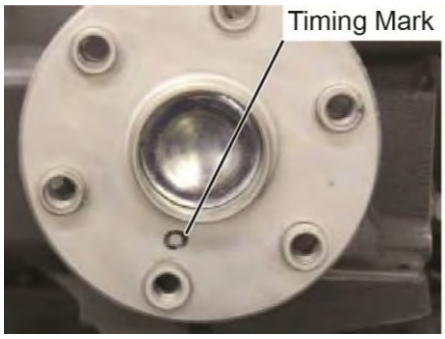

Figure 7
Timing Mark
on the Crankshaft Flange

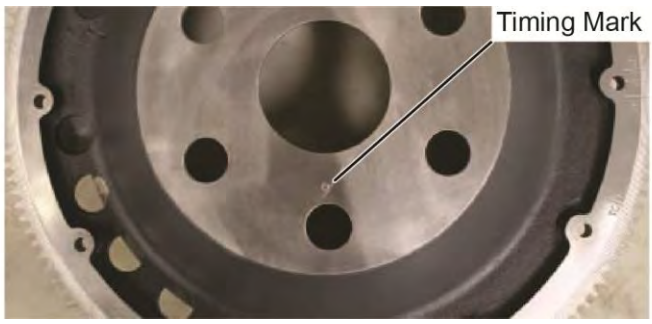

Figure 8
Timing Mark on the Starter Ring Gear

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72-80 - INDUCTION SYSTEM MAINTENANCE

1. Intake Pipe Replacement

NOTICE: Each engine cylinder has a corresponding intake pipe of a different part number. Be sure to replace the intake pipe with the correct replacement intake pipe that corresponds to the engine cylinder number (Figure 1).

A. Intake Pipe Removal

(1) Remove the two bolts, lock washers, and washers from the intake pipe flange at the engine cylinder (Figure 1). Discard the lock washers.

(2) Remove the gasket from the intake pipe, discard the gasket.

(3) If the intake pipe is not to be replaced, attach a label to the intake pipe that identifies the corresponding engine cylinder number for reference on assembly.

(4) Remove the intake pipe and ring seal at the oil sump connection. Discard the oil seal.

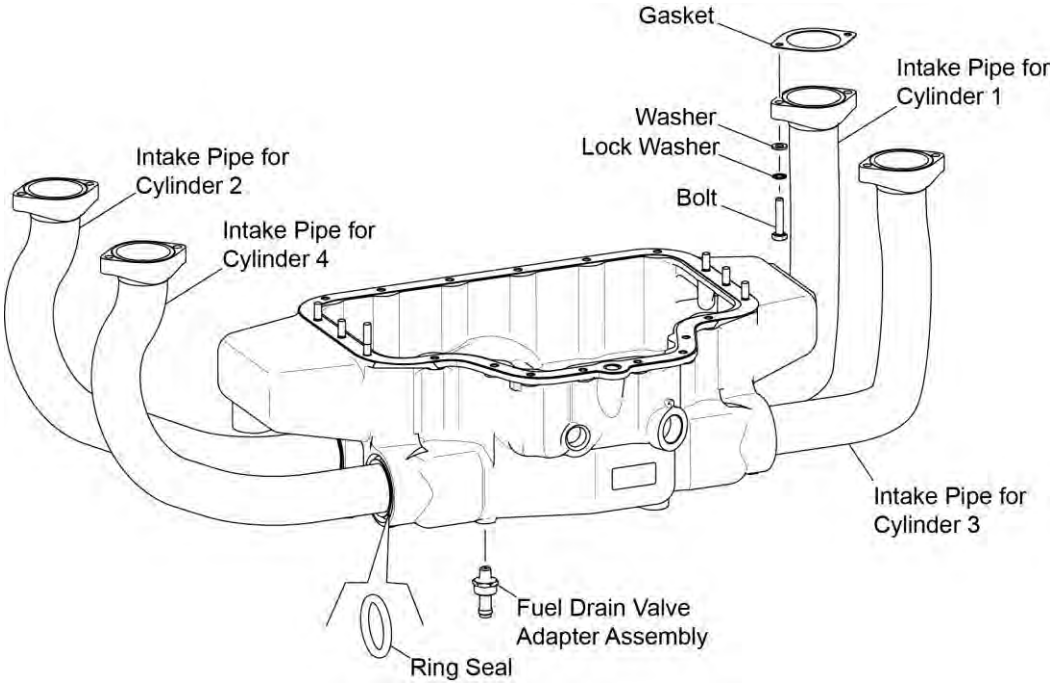

Figure 1
Intake Pipes and Attaching Parts

B. Intake Pipe Installation

NOTICE: Since there is a corresponding intake pipe for each engine cylinder, make sure the correct intake pipe is installed for the respective engine cylinder.

(1) Apply a coating of clean engine oil to a new ring seal.

(2) Install the intake pipe with a new ring seal at the oil sump (Figure 1).

(3) Attach the corresponding intake pipe to the correct engine cylinder flange with a new gasket, two bolts, two new lock washers, and two washers. Torque the two bolts to 96 to 108 in.-lb. (11 to 12 Nm).

2. Fuel Drain Valve Adapter Assembly Inspection

   The fuel drain valve adapter assembly (Figure 1) is a valve in the induction system that closes during engine operation and opens when the engine is shut down to allow excess fuel to drain from the induction system. If the valve is not operating correctly it can either allow outside air into the induction system during engine operation or fail to drain excess fuel from the induction system when the engine is shut down.

   If your engine has fuel drain valve adapter assembly installed, examine the assembly as follows:

   A. Remove the fuel drain valve adapter assembly from the oil sump.

   B. Examine the fuel drain valve adapter assembly for damage.

   C. Make sure the fuel drain valve adapter assembly is operating correctly:

      (1) The valve is operating correctly if it is open with no air pressure applied.

      (2) The valve is operating correctly if it closes when 0.75 to 1.0 psi (5.2 to 6.9 kPa) of air pressure is applied to the inboard side of the fuel drain valve adapter assembly, then repeated with the outboard side.

   D. If the valve is not operating correctly or if the fuel drain valve adapter assembly is damaged, replace the fuel drain valve adapter assembly.

   E. Install a serviceable fuel drain valve adapter assembly in the oil sump. Torque the assembly to 40 in.-lb. (4.5 Nm).

73-10 - ENGINE FUEL AND CONTROL – DISTRIBUTION

1. Fuel Line Replacement

⚠WARNING: DO NOT SMOKE OR HAVE AN OPEN FIRE/FLAME OR USE ANY DEVICES THAT CAN MAKE SPARKS DURING THIS REPLACEMENT PROCEDURE. SMOKING, FLAMES, OR SPARKS CAN IGNITE THE FUEL WHICH CAN CAUSE SERIOUS INJURY OR DEATH.

NOTICE: If this fuel line replacement procedure is completed with the engine installed in the airframe, refer to the airframe manufacturer's instructions for shutting off the fuel and grounding the aircraft.

A. Fuel Line Removal

(1) Put a fuel collection container under the fuel line (Figure 1) at each fitting connection.

(2) Make a sketch to identify clamps that attach to brackets for reference on assembly.

(3) Remove and discard the P and L clamps (Figures 2 and 3) from the fuel line.

(4) Disconnect the fuel line from the fitting on each end.

(5) Discard the fuel line. (Keep the fuel fittings if they are not part of the fuel line.)

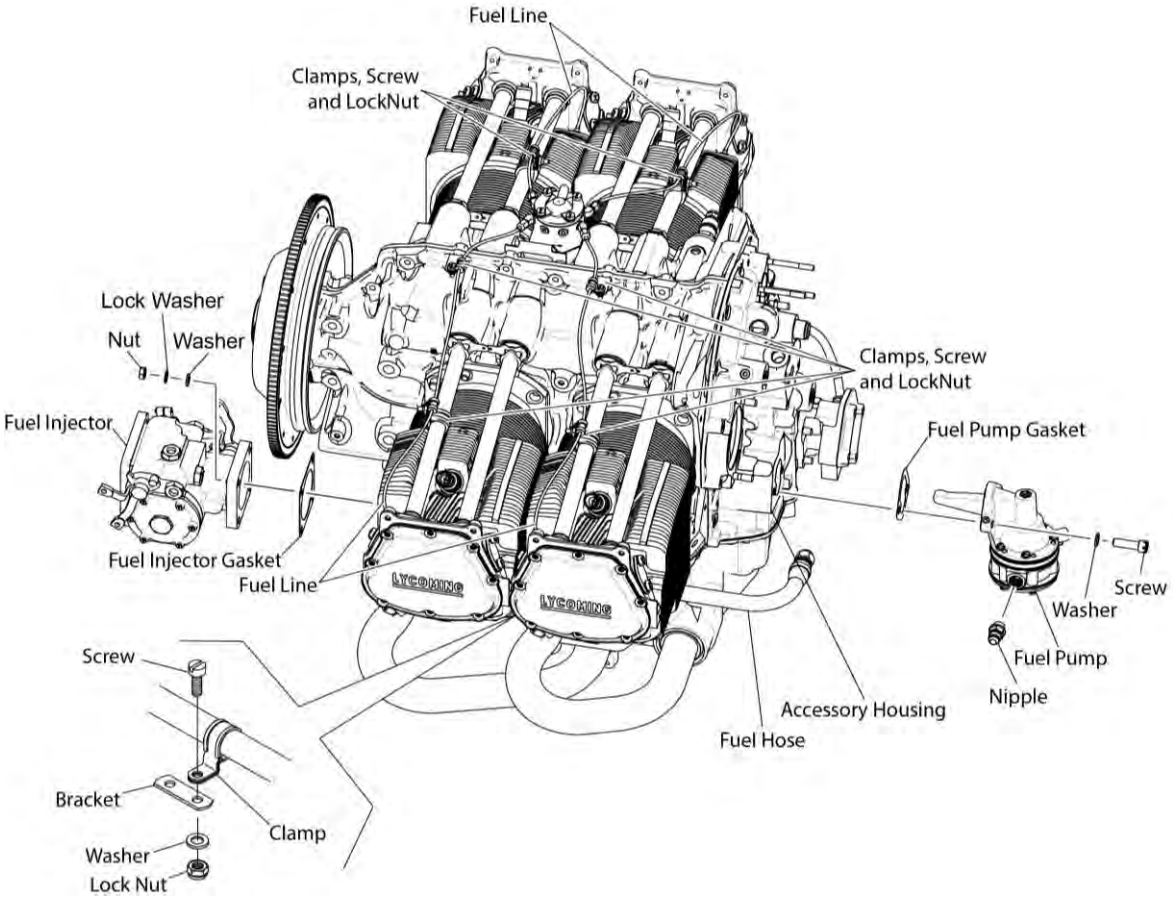

Figure 1
Fuel System Components

B. Fuel Line Installation

WARNING: DO NOT LET THE FUEL LINE TOUCH THE ENGINE OR AIRCRAFT BAFFLE HARDWARE. DO NOT ROUTE FUEL LINES CLOSE TO HEAT SOURCES. HEAT CAN DAMAGE THE FUEL LINE AND CAUSE A FUEL LEAK WHICH COULD LEAD TO CATASTROPHIC ENGINE FAILURE.

NOTICE: Refer to the latest revision of Service Instruction No. SI-1301 for superseded fuel line part numbers.

(1) Make sure there is a minimum clearance of 3/16 in. (4.76 mm) between a fuel line and any engine or aircraft surface.

(2) Make sure the fuel line is not crimped or kinked, there are no cracks at solder joints, and the fuel line is in compliance with Figure 4 for the minimum acceptable dimension for a bend in the fuel line.

NOTICE: If installing a new fuel line where fittings were not attached as part of the fuel line assembly, the fitting can be installed if the threads are not damaged.

(3) Connect the fuel line to the fuel fitting on each end.

(4) Torque each fuel line fitting in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.

(5) Make sure that the fuel lines are securely held in place, attached to the engine (to dampen vibration during flight) with the necessary cushioned clamps and hardware. Install clamps on the fuel line as per the following guidelines:

(a) Make sure each clamp securely supports the fuel line to prevent fuel line movement due to vibration, friction, or motion frequencies during flight. **Do NOT use plastic tie straps as clamps.**

(b) Install clamps (preferably with cushions) on the fuel line. Make sure the cushion is not missing and is intact, and completely covers the fuel line diameter. If cushions are deteriorated or missing, replace the clamp with a new clamp with the cushion intact.

(c) Refer to Figures 2 and 3 which show how the fasteners are to be installed on P-clamps and L-shaped clamps.

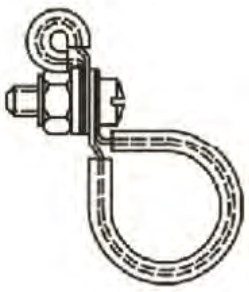

Figure 2
P-Clamp

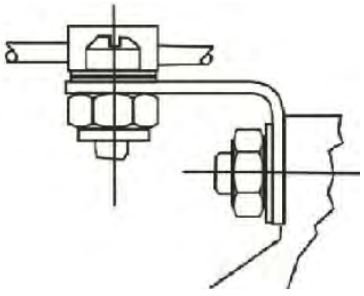

Figure 3
L-Shape Clamp

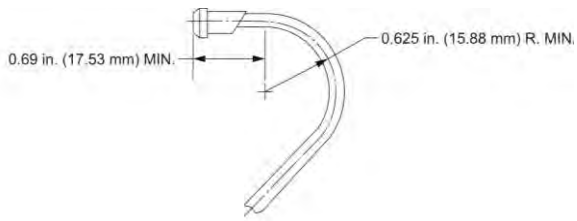

Figure 4
Minimum Acceptable Dimension for a Bend in a Fuel Line

(d) Make sure the clamps are securely attached to support the fuel line and to prevent movement from vibration or motion frequencies.

(e) On engines that used metal clamps with no cushion, use the P/N LW-12598 fuel line sleeve at each of those clamping locations. (Do not use the fuel line sleeve with the cushioned clamps.)

(f) Torque the fuel line union nut (Figure 5) between 35 to 50 in.-lbs. (4 to 6 Nm).

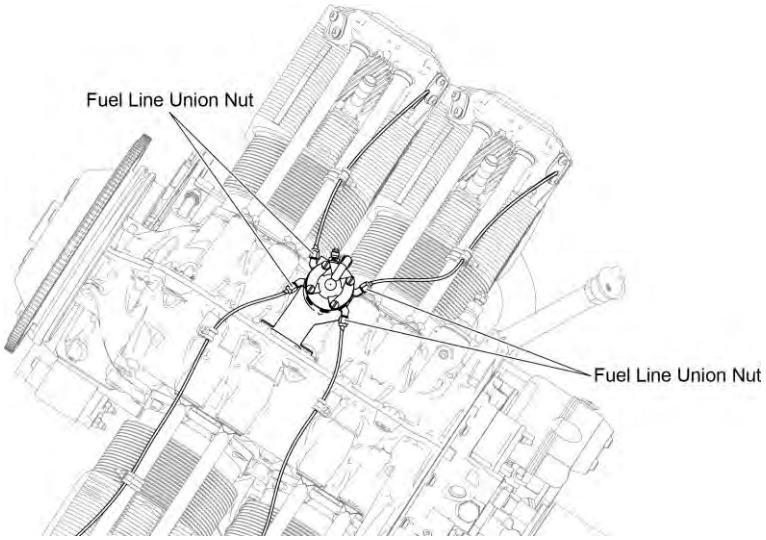

Figure 5
Fuel Line Union Nuts

⚠ WARNING: DO NOT RETURN THE ENGINE TO SERVICE UNLESS THE ENGINE IS OPERATING CORRECTLY AND DOES NOT HAVE ANY LEAKS.

⚠ CAUTION: TO ENSURE CORRECT ENGINE OPERATION AND FLIGHT SAFETY, THERE MUST NOT BE ANY FUEL LEAK AND ALL FUEL LINES MUST BE SECURED WITH CLAMPS. IDENTIFY AND CORRECT THE CAUSE OF ANY FUEL LEAK.

(6) During the operational check after all maintenance is complete, look for fuel leaks at the fuel lines and connections during engine operation. Identify and correct the cause of any fuel leak. There must not be any fuel leaks when the engine is returned to service.

(7) Remove the fuel collection container and dispose of the fuel in accordance with environmental regulations.

2. Fuel Injector Replacement

⚠ WARNING: DO NOT SMOKE OR HAVE AN OPEN FIRE/FLAME OR USE ANY DEVICES THAT CAN MAKE SPARKS DURING THIS REPLACEMENT PROCEDURE. SMOKING, FLAMES, OR SPARKS CAN IGNITE THE FUEL WHICH CAN CAUSE SERIOUS INJURY OR DEATH.

NOTICE: If this fuel injector replacement procedure is completed with the engine installed in the airframe, refer to the airframe manufacturer's instructions for shutting off the fuel and grounding the aircraft.

NOTICE: The fuel injector is not repairable. If damaged, the fuel injector must be replaced.

A. Fuel Injector Removal

(1) Put a fuel collection container under the fuel injector (Figure 6).

(2) Apply an identification label to each fuel line and disconnect the fuel lines attached to the fuel injector.

(3) Let fuel drain out of the fuel injector and fuel hoses into the fuel collection container.

(4) Hold the fuel injector and remove the four nuts, lock washers, and washers from the fuel injector. Discard the lock washers.

(5) Remove the fuel injector and its gasket. Discard the gasket.

(6) Remove the fuel collection container.

B. Fuel Injector Installation

(1) Align the fuel injector on the engine with a new gasket (Figure 6).

(2) Install four nuts, each with a washer and a new lock washer hand tight.

(3) Refer Figure 6 for the crisscross pattern torque sequence and torque the nuts to:

(a) an initial torque of 48 in.-lb. (5 Nm)

(b) a final maximum torque of 96 in.-lb. (11 Nm)

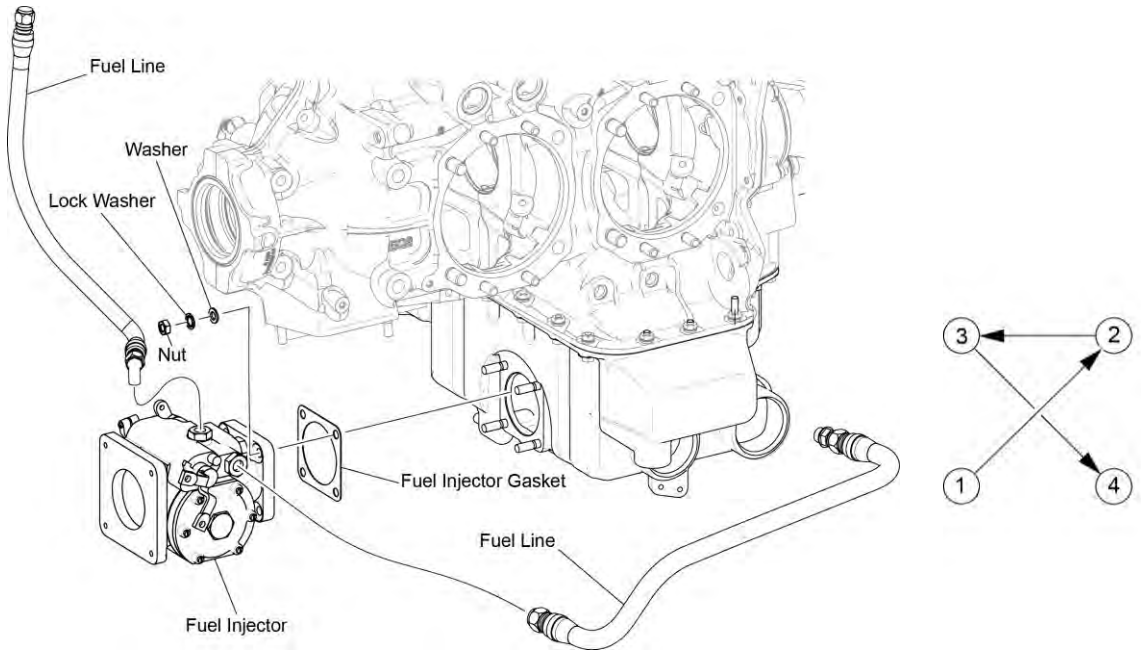

Figure 6
Fuel Injector

(4) During the operational check after all maintenance is complete, look for fuel leaks at the fuel lines and connections during engine operation. Identify and correct the cause of any fuel leak. There must not be any fuel leaks when the engine is returned to service.

3. Injection Nozzle Replacement

⚠WARNING: DO NOT SMOKE OR HAVE AN OPEN FIRE/FLAME OR USE ANY DEVICES THAT CAN MAKE SPARKS DURING THIS REPLACEMENT PROCEDURE. SMOKING, FLAMES, OR SPARKS CAN IGNITE THE FUEL WHICH CAN CAUSE SERIOUS INJURY OR DEATH.

NOTICE: If this injection nozzle replacement procedure is completed with the engine installed in the airframe, refer to the airframe manufacturer's instructions for shutting off the fuel and grounding the aircraft.

A. Injection Nozzle Removal

(1) Disconnect the fuel line from the injection nozzle (Figure 7).

(2) Remove the injection nozzle from the engine cylinder.

B. Injection Nozzle Cleaning

⚠CAUTION: NEVER USE A SHARP TOOL SUCH AS A WIRE OR PIN TO CLEAN OUT AN INJECTION NOZZLE. DAMAGE TO THE INLET AND OUTLET FUEL RESTRICTORS COULD OCCUR WHICH WOULD CHANGE THE FUEL FLOW.

Complete the "Injection Nozzle Cleaning" procedure in Chapter 5-30.

NOTICE: Injection nozzles are not repairable.

C. Injection Nozzle Installation

(1) Lightly lubricate the injection nozzle threads with engine oil mixture.

(2) Install the injection nozzle (Figure 7) on the engine cylinder.

(3) Torque the injection nozzle to 60 in.-lbs. (7 Nm). Continue to torque the injection nozzle until the letter or number stamped on the nozzle points downward.

(4) Connect the fuel line to the injection nozzle.

(5) During the operational check after all maintenance is complete, look for fuel leaks at the fuel lines and connections during engine operation. Identify and correct the cause of any fuel leak. There must not be any fuel leaks when the engine is returned to service.

(6) (Optional) Complete the "Injection Nozzle Fuel Flow Check" in this chapter.

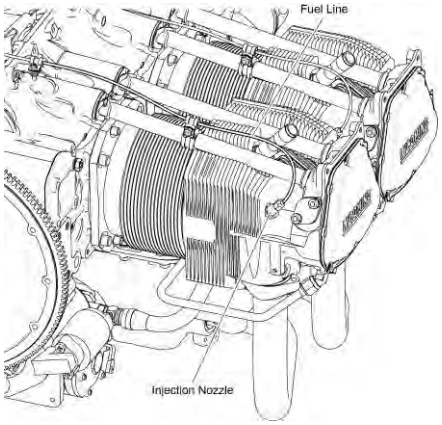

Figure 7
Injection Nozzle

4. Injection Nozzle Fuel Flow Check
   A. Label each fuel injector and fuel line according to cylinder number.
   B. Disconnect the fuel line from the injection nozzle (Figure 7).
   C. Remove the injection nozzle from the engine cylinder.
   D. Connect the fuel lines to the injection nozzles according to cylinder number.
   E. Put the injection nozzles into four clear containers of equal size on a flat surface.
   F. Turn the boost pump on and move the throttle and mixture control full forward.
   G. Let approximately 4 to 6 oz. (120 to 180 ml) of fuel to flow into each container. Close the throttle and mixture control and turn off the boost pump.
   H. Measure the level of the fuel. All containers must have the same amount of fuel. A container with less fuel is an indication of a fuel flow restriction.
   I. Examine the fuel flow from each injection nozzle to make sure the fuel stream is not scattered (which is an indication of blockage in the injection nozzle) identified as "Incorrect" in Figure 8.

NOTICE: If the fuel flow is incorrect, disconnect the injection nozzle and clean the nozzle according to the "Injection Nozzle Cleaning" procedure in Chapter 05-30. Repeat the fuel flow check. If cleaning does not correct the scattered stream, replace the injection nozzle. Fuel injection nozzles are not repairable.

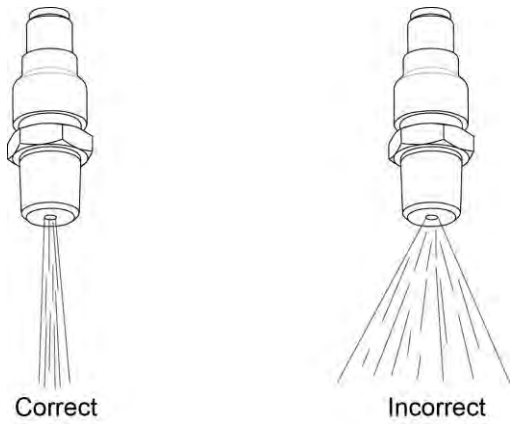

Figure 8
Injection Nozzle Stream

   J. Disconnect the fuel lines from the injection nozzles.
   K. Install acceptable injection nozzles in the cylinders and connect the fuel lines.

5. Fuel Manifold Replacement

⚠WARNING: DO NOT SMOKE OR HAVE AN OPEN FIRE/FLAME OR USE ANY DEVICES THAT CAN MAKE SPARKS DURING THIS REPLACEMENT PROCEDURE. SMOKING, FLAMES, OR SPARKS CAN IGNITE THE FUEL WHICH CAN CAUSE SERIOUS INJURY OR DEATH.

NOTICE: If this fuel manifold replacement procedure is completed with the engine installed in the airframe, refer to the airframe manufacturer's instructions for shutting off the fuel and grounding the aircraft.

A. Fuel Manifold Removal

(1) Put a fuel collection container under the fuel manifold.

(2) Identify the fuel line ports on the fuel manifold (Figure 9).

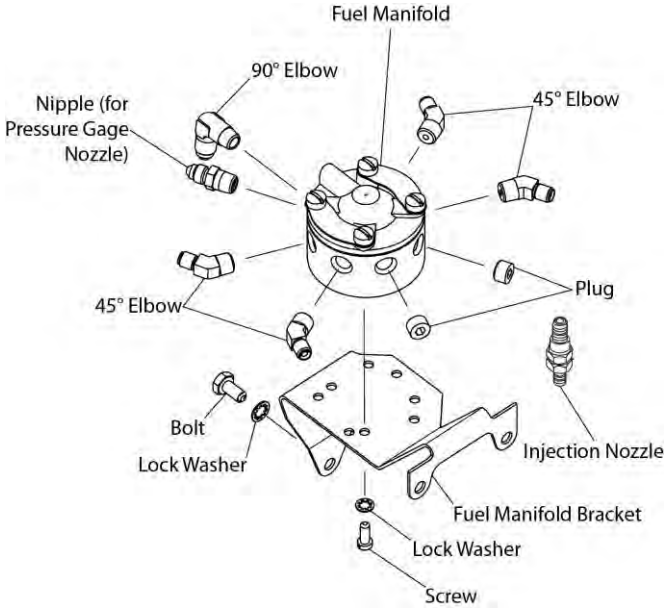

Figure 9
Fuel Manifold

Figure 10
Safety Wire the Screws

(3) Apply a label and disconnect all fuel lines attached to the fuel manifold.

(4) Let fuel drain out of the fuel manifold and fuel lines into the collection container.

(5) Remove the safety wire (Figure 10) from hardware fasteners on the brackets on the fuel manifold.

(6) Remove the bolts, screws, lock washers, bracket, and the fuel manifold from the fuel injector (Figure 9). Discard the lock washers.

(7) Remove the fuel collection container.

B. Fuel Manifold Installation

(1) Install the fuel manifold and the bracket (Figure 9) on the fuel injector with the hardware fasteners. Torque the bolts and screws on the bracket to 25 to 30 in.-lbs (2 to 3 Nm).

(2) Safety wire the bolts and screws on the bracket as shown in Figure 10.

(3) Attach all fuel fittings with fuel line to the corresponding identified ports on the fuel manifold.

(4) Torque the fuel line fittings in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.

(5) During the operational check after all maintenance is complete, look for fuel leaks at the fuel lines and connections during engine operation. Identify and correct the cause of any fuel leak. There must not be any fuel leaks when the engine is returned to service.

6. Fuel Pump Replacement

⚠WARNING: DO NOT SMOKE OR HAVE AN OPEN FIRE/FLAME OR USE ANY DEVICES THAT CAN MAKE SPARKS DURING THIS REPLACEMENT PROCEDURE. SMOKING, FLAMES, OR SPARKS CAN IGNITE THE FUEL WHICH CAN CAUSE SERIOUS INJURY OR DEATH.

NOTICE: If this fuel pump replacement procedure is completed with the engine installed in the airframe, refer to the airframe manufacturer's instructions for shutting off the fuel and grounding the aircraft.

The fuel pump is not repairable. If the fuel pump is damaged or non-operational, replace the fuel pump with a serviceable unit.

A. Fuel Pump Removal

(1) Put a fuel collection container under the fuel line connections at the AC-type fuel pump (Figure 11).

(2) Apply a label and disconnect the fuel lines to the fuel pump.

(3) Remove the two screws and washers from the fuel pump.

(4) Remove the fuel pump and gasket from the accessory housing. Discard the gasket.

(5) Remove the fuel collection container.

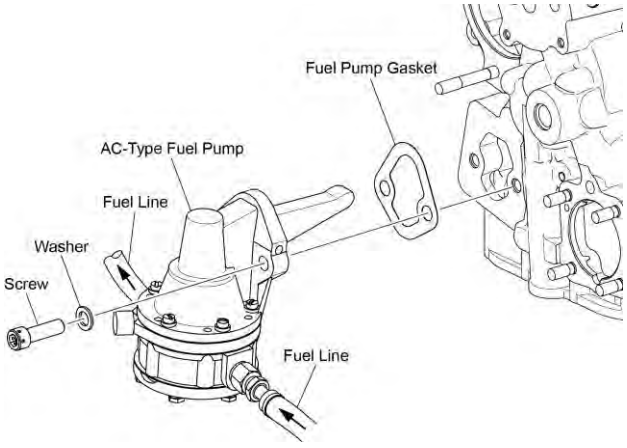

Figure 11
AC-Type Fuel Pump

B. Fuel Pump Installation

(1) Turn the crankshaft to move the fuel pump plunger to the highest position.

(2) Apply Lubriko grease to the shaft of the AC-type fuel pump.

(3) Apply Loctite® 564 to the fuel pump screws.

(4) Install the fuel pump with a new gasket on the accessory housing as shown in Figure 11 with the two washers and two screws.

(5) Torque the screws to 225 to 250 in.-lbs. (25 to 28 Nm).

(6) Connect the fuel lines to the fuel pump. Torque the fuel fitting to 23 to 24 ft.-lb. (31 to 35 Nm). Make sure that the fuel lines are securely connected.

(7) During the operational check after all maintenance is complete, look for fuel leaks at the fuel lines and connections during engine operation. Identify and correct the cause of any fuel leak. There must not be any fuel leaks when the engine is returned to service.

74-20 - IGNITION SYSTEM - MAINTENANCE

NOTICE: For spark plug inspection and replacement, refer to Chapter 74-20 in the ***IO-360-N1A Engine Service Manual***.

1. Ignition Harness Removal

   A. Remove the ignition harness (Figure 1) from the engine harness.

      (1) Disconnect the clamps that attach the ignition harness to the engine.

      (2) Remove the screws which attach the harness cap to the magneto.

      (3) Disconnect the ignition leads from the spark plugs.

      (4) Remove the ignition harness.

      NOTICE: The left ignition harness is marked "left." The right ignition harness is marked "right."

2. Ignition Harness Inspection

   Refer to Chapter 74-20 in the ***IO-360-N1A Engine Service Manual*** for the Ignition Harness Inspection procedure.

3. Ignition Harness Installation

   A. Attach the left ignition harness to the left magneto (Figure 1).

   B. Attach the right ignition harness to the right magneto.

   NOTICE: Each spark plug ignition harness nut is marked with a letter and number identifying the spark plug position on each respective cylinder. A spark plug nut marked "T1" identifies the top spark plug on cylinder #1 to which that ignition lead is to be connected. A spark plug nut marked "B4" identifies the bottom spark plug on cylinder #4 to which that ignition lead is to be connected.

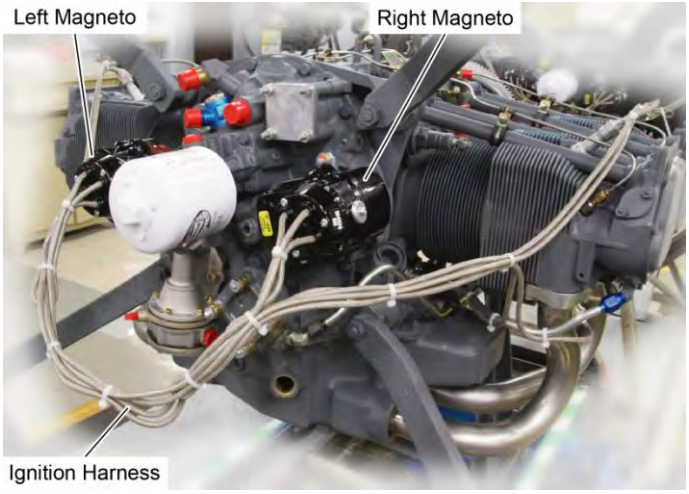

Figure 1
Ignition Harness

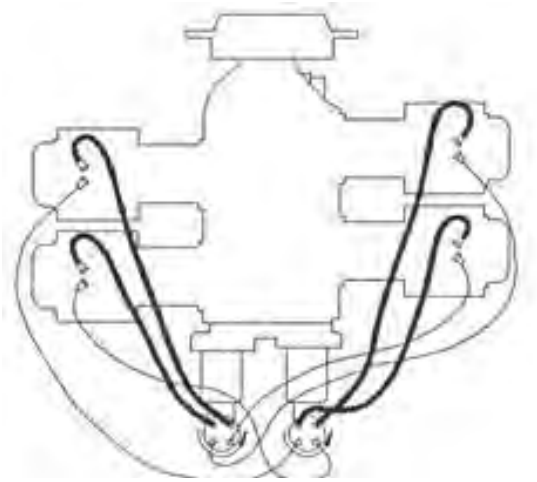

Figure 2
Example of Ignition Harness Routing

NOTICE: Figure 2 is an example of an ignition harness routing. The routing configuration on your engine could be different.

C. Route and connect the ignition leads to the spark plugs:

(1) Route the ignition leads to the appropriate spark plug position as indicated by the alpha-numeric markings on each spark plug nut.

(2) When the spark plug nut thread makes contact with the spark plug threads, push the ferrule against the spark plug while turning the spark plug nut clockwise.

(3) Continue turning the spark plug nut until it seats and is finger-tight.

⚠ **CAUTION:** HOLD FERRULES WHILE TORQUING THE SPARK PLUG COUPLING NUT TO PREVENT TWISTING CONDUIT OR CABLE.

(4) Torque the spark plug lead nut per instructions in the latest revision of Service Instruction No. SI-1042.

D. Position the ignition harness (Figures 1 and 2) to prevent chafing by baffles or engine parts. There must not be any kinks or sharp bends in the ignition lead wire routing.

NOTICE: When installed, a hex ferrule will protrude above the spark plug mounting nut. Hold this hex ferrule with a 7/16 in. wrench while tightening the spark plug nuts to prevent twisting of the ignition lead.

74-30 - IGNITION SYSTEM - MAGNETO MAINTENANCE

1. Magneto Replacement Procedure

⚠WARNING: BEFORE THIS PROCEDURE, MAKE SURE ALL POWER IS DISABLED TO THE ENGINE TO PREVENT ELECTRICAL SHOCK AND INJUIRY.

A. Magneto Removal

(1) Disconnect the harness (Figure 1) from the magneto to be removed.

(2) Hold the magneto and remove the two nuts, two lock washers and two clamps from the magneto. Discard the lock washers.

(3) Remove the magneto.

(4) Remove and discard the gasket.

B. Magneto Installation

NOTICE: This procedure applies to Slick magnetos only. Refer to the manufacturer's instructions for other types of magnetos.

A new or serviceable magneto, new magneto gasket, new adapter gasket and two new lock washers are necessary to install the magneto. Refer to the applicable parts catalog.

(1) Apply a light coat of C5-A Copper-Based Anti-Seize compound to the tapered section of the magneto driveshaft (Figure 2).

(2) Install the magneto impulse coupling gear (Figure 1) on the magneto.

(3) Remove excess anti-seize compound from the magneto driveshaft.

(4) Torque the gear nut to 120 to 360 in.-lb. (14 to 41 Nm).

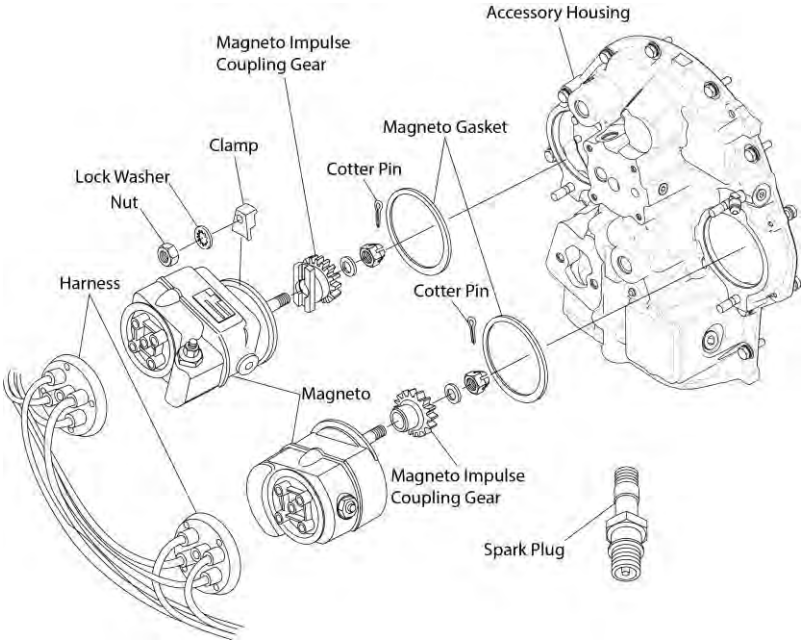

Figure 1
Magnetos

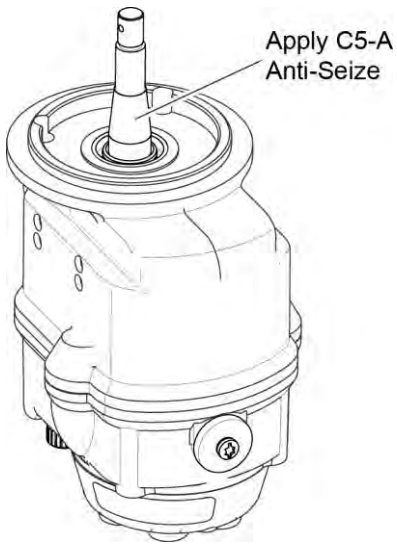

Figure 2
Anti-Seize Application

(5) Install a new cotter pin through the stud and castle nut. Bend the top prong on the cotter pin over the stud and bend the bottom prong of the cotter pin down.

(6) Verify the magneto direction of rotation as per the magneto data plate.

(7) Install a timing pin (Figure 3) in the hole marked Left or Right on the face of the distributor block based on the magneto rotation requirements.

Figure 3
Timing Pin

Figure 4
Timing Marks on the Starter Ring Gear Support

(8) Apply a slight inward pressure to the pin and slowly turn the magneto drive shaft in the direction of normal rotation until the shoulder of the pin seats against the distributor block. When correctly engaged, the timing pin will be inserted 7/8 in. (22 mm) into the distributor block.

(9) If not already done, turn the crankshaft in the direction of normal rotation until the correct advance timing mark on the starter ring gear support (Figure 4) aligns with the crankcase parting flange.

(10) Apply Lubriko grease to the mating flange and install a new gasket on the mating flange of the magneto.

(11) Remove the timing pin and install the magneto on the engine with the clamp, nuts, and new lock washers (Figure 1).

(12) Torque the two nuts on the magneto clamps to 48 in.-lb. (5 Nm) in increments, alternating between the two nuts until both nuts are torqued to 15 to 18 ft.-lb. (20 to 24 Nm).

(13) Connect the harness to the magneto.

(14) Complete the “Magneto-to-Engine Timing” procedure in Chapter 74-30 in the ***IO-360-N1AEngine Service Manual***.

APPENDIX A

Crankcase Stud Replacement

NOTICE: This procedure does not apply to crankcase thru-studs. Refer to Chapter 72-20 for crankshaft thru-stud removal.

The procedure for replacement of crankcase studs depends on the type of stud and how it was damaged.

1. Replace all crankcase studs that are bent, broken, damaged, loose, rusted, corroded, or cannot be cleaned.
2. To remove and replace a crankcase stud (Figure A-1):

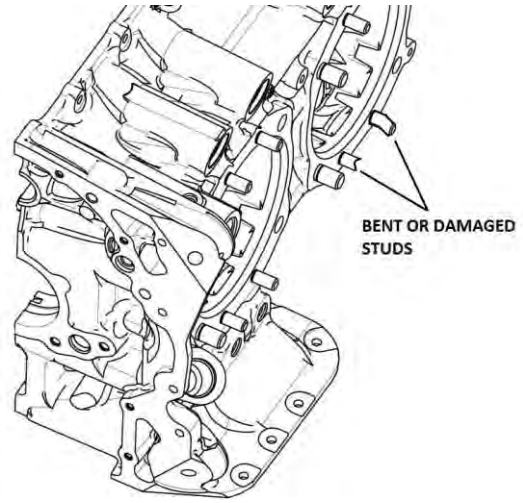

Figure A-1
Damaged Crankcase Stud

Figure A-2
Stud Remover Tool

A. If the stud has sufficient thread area, use a stud removal tool (Figure A-2). Refer to the tool manufacturer's instructions.

B. If you cannot use a stud removal tool or if the stud is broken beneath the surface of the crankcase:
   (1) Drill a small hole in the stud.
   (2) Use a pilot bushing to guide the drill into the center of the stud
   (3) Drill again to adjust the size of the hole to the necessary extractor.
   (4) Remove the stud with the extractor.

C. After stud removal, examine the size and condition of the threads in the stud holes in the crankcase.

D. If necessary, replace the regular size studs with oversize studs.

E. Apply a layer Loctite® Food-Grade Anti-Seize to the threads on the new stud.

F. Drive the new stud to the correct depth in the crankcase with an applicable stud driver. Refer to the minimum drive torque in the latest revision of the ***Service Table of Limits - SSP-1776***.