MERCURY
MerCruiser

SERVICE MANUAL

Number 25

MARINE ENGINES

GM V-6
262 CID (4.3L)

Printed in U.S.A.

90-861328--1 1199

MerCruiser #25 GM V-6
262 CID (4.3L)

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90-861328--1

Notice

Throughout this publication, “Dangers,” “Warnings” and “Cautions” (accompanied by the International HAZARD Symbol ⚠) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. **OBSERVE THEM CAREFULLY!**

These “Safety Alerts” alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus “Common Sense” operation, are major accident prevention measures.

⚠ DANGER

DANGER - Immediate hazards which WILL result in severe personal injury or death.

⚠ WARNING

WARNING - Hazards or unsafe practices which COULD result in severe personal injury or death.

⚠ CAUTION

Hazards or unsafe practices which could result in minor personal injury or product or property damage.

Notice to Users of This Manual

This service manual has been written and published by the Service Department of Mercury Marine to aid our dealers’ mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, or like or similar products manufactured and marketed by Mercury Marine, that they have been trained in the recommended servicing procedures of these products which includes the use of mechanics’ common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the products safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell and/or service these products.

It should be kept in mind, while working on the product, that the electrical system and ignition system are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note, during any maintenance procedure replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, while most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for reuse in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

We reserve the right to make changes to this manual without prior notification.

Refer to dealer service bulletins for other pertinent information concerning the products described in this manual.

Engine Mechanical Components

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation and, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement parts, will void the warranty on those parts which are damaged as a result of the use of other than recommended replacement parts.

Replacement Parts

⚠ WARNING

Electrical, ignition and fuel system components on MerCruiser Engines and Sterndrives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Service Manual Outline

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IMPORTANT INFORMATION

Section 1A - General Information

1 A

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Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs or tune-up, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

How to Use This Manual

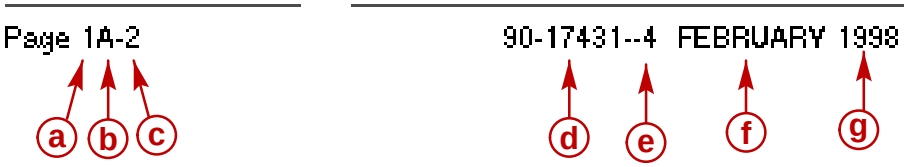
This manual is divided into sections which represent major components and systems.

Some sections are further divided into parts which more fully describe the component.

Sections and section parts are listed on the “Service Manual Outline” page following “V-6 Models Covered in This Manual” page.

Page Numbering

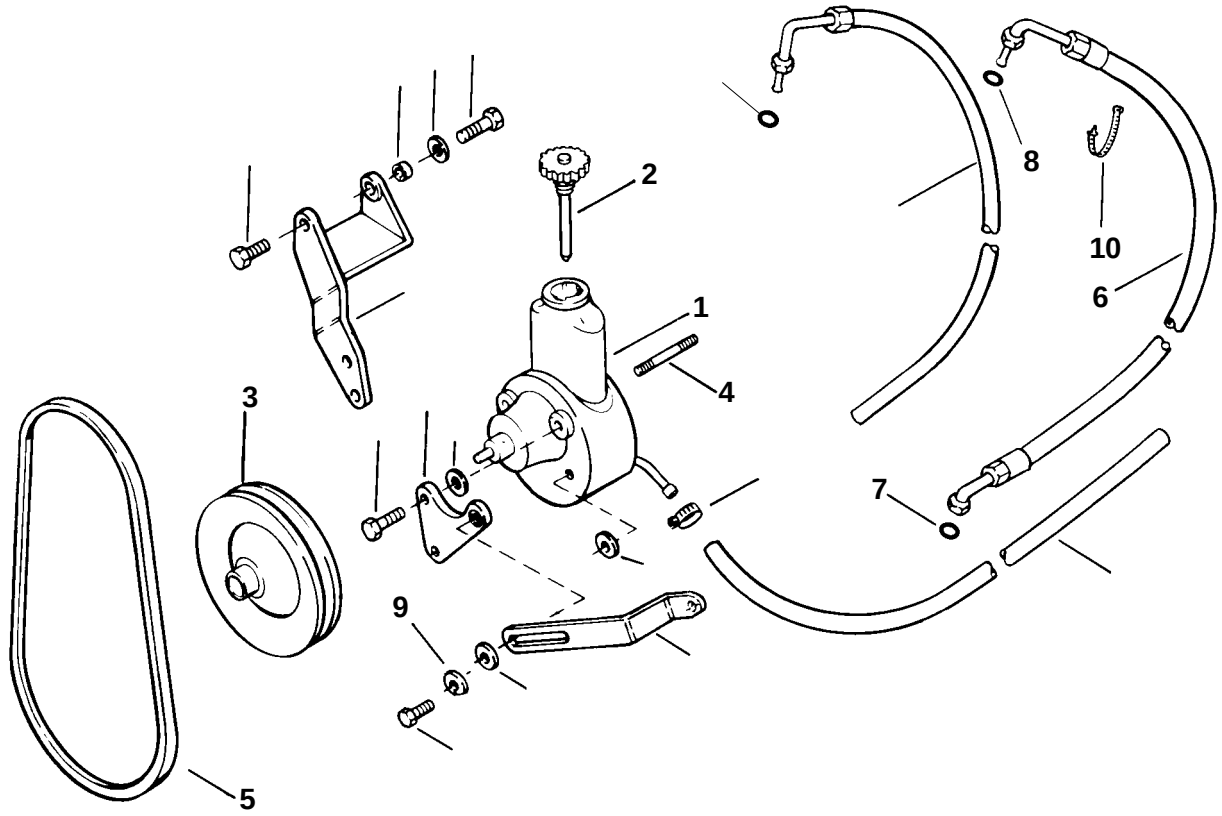
Two number groups appear at the bottom of each page. Following is an example and description.



a - Section Number
b - Section Part
c - Page Number
d - Manual Part Number
e - Revision Number
f - Month Printed
g - Year Printed

How to Read a Parts Manual

Power Steering Pump Assembly



REF. NO.	PART NO.	SYM.	QTY.	DESCRIPTION
1	90507A12		1	PUMP ASSEMBLY–Power Steering
2	36- 95805		1	CAP
3	73873A1		1	PULLEY
4	16- 41877		1	STUD
5	57- 65607T		1	V-BELT
6	32- 806684		1	HOSE–Pressure **(FITTINGS ON BOTH ENDS)**
7	25- 89879		1	O-RING
8	25- 806232		1	O-RING
9	13- 35048		1	LOCKWASHER (3/8 in.)
10	61990		1	CABLE TIE

REF. NO. : Number shown next to part on exploded view

PART NO. : Mercury Part Number for ordering. If NSS (not sold separately) sometimes GM part number will be given in description column.

QTY. : The quantity that must be ordered.

DESCRIPTION : Description of part, what parts are included with a part (all indented items come with the main item above the indented parts), serial number information, and special information.

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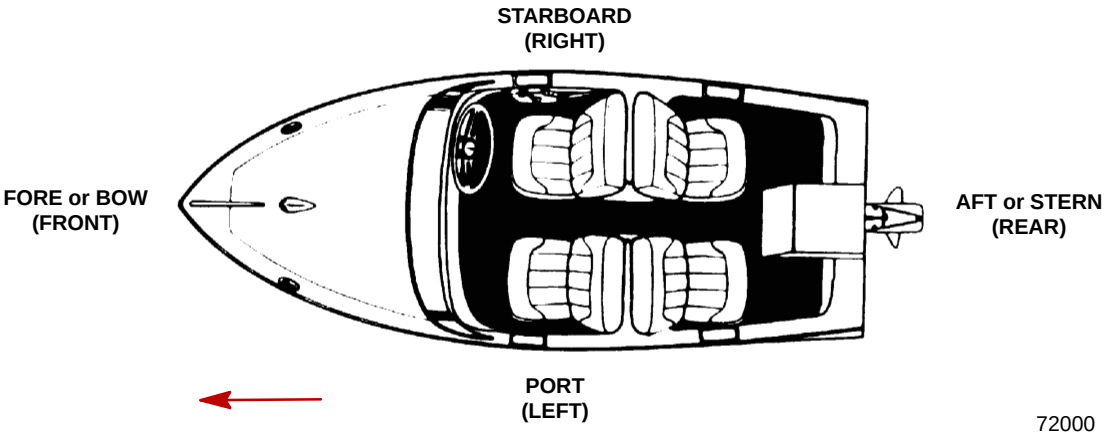
Directional References

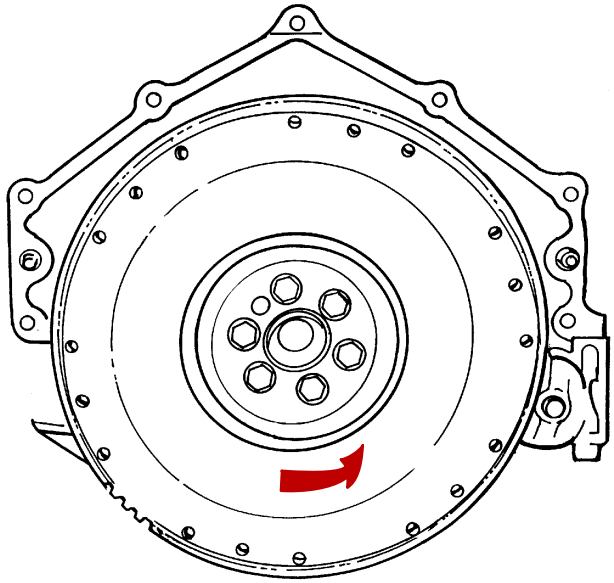
Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this manual, all directional references are given as they appear when viewing boat from stern looking toward bow.



72000

Engine Rotation

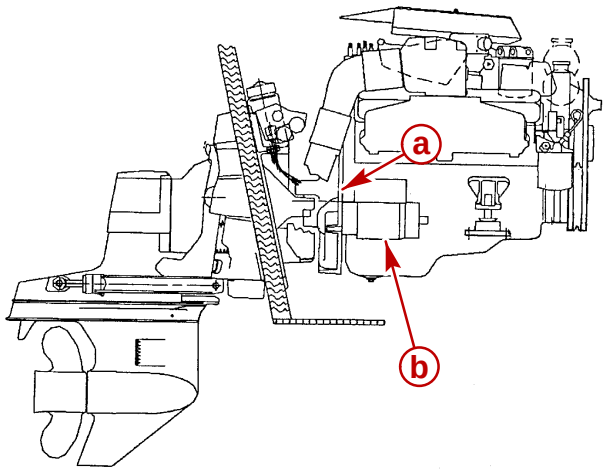
Engine rotation is determined by observing flywheel rotation from the rear (stern end) of the engine looking forward (toward water pump end). Propeller rotation is not necessarily the same as engine rotation. When ordering replacement engine, short blocks or parts for engine, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



72001

Left Hand Rotation

Engine Serial Number Location



72975

a - Serial Number Plate
b - Starter Motor

Propeller Information

Refer to the “Propeller” section in appropriate Mercury MerCruiser Sterndrive Service Manual, or order publication 90-8614492, “What You Should Know About Quicksilver Propellers.”

Changing diameter, pitch or coupling of a propeller will affect engine rpm and boat performance. The blade configuration also will affect performance. Two like propellers, same pitch and diameter, from two different manufacturers also will perform differently.

It is the responsibility of the boat manufacturer and/or selling dealer to equip the boat with the correct propeller to allow the engine to operate within its specified rpm range at wide open throttle (WOT).

Because of the many variables of boat design and operation, only testing will determine the best propeller for the particular application.

To test for correct propeller, operate boat (with an average load onboard) at WOT and check rpm with an accurate tachometer. Engine rpm should be near top of the specified range so that, under heavy load, engine speed will not fall below specifications.

If engine exceeds the specified rpm, an increase in pitch and/or diameter is required.

If engine is below rated rpm, a decrease in pitch and/or diameter is required.

Normally, a change of approximately 200 rpm will be achieved for each one inch pitch change of a propeller.

⚠ CAUTION

If a propeller is installed that does not allow engine rpm to reach the specified full-throttle rpm range, the engine will “labor” and will not produce full power. Operation under this condition will cause excessive fuel consumption, engine overheating and possible piston damage (due to detonation). On the other hand, installation of a propeller, that allows engine to run above the specified rpm limit, will cause excessive wear on internal engine parts which will lead to premature engine failure.

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Water Testing New Engines

Use care during the first 20 hours of operation on new Mercury MerCruiser engines or possible engine failure may occur. If a new engine has to be water-tested at full throttle before the break-in period is complete, follow this procedure.

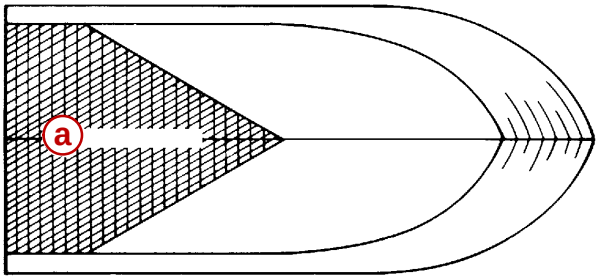
1. Start engine and run at idle rpm until normal operating temperature is reached.
2. Run boat up on plane.
3. Advance engine rpm (in 200 rpm increments) until engine reaches its maximum rated rpm.

IMPORTANT: Do not run at maximum rpm for more than 2 minutes.

Boat and Engine Performance

Boat Bottom

For maximum speed, a boat bottom should be as flat as possible in a fore-aft direction (longitudinally) for approximately the last 5 ft (1.5 m).



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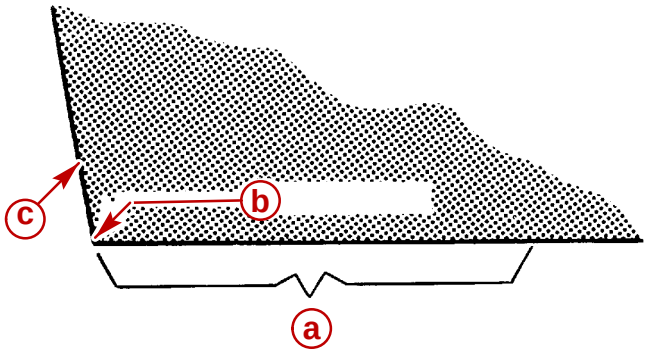
a - Critical Bottom Area

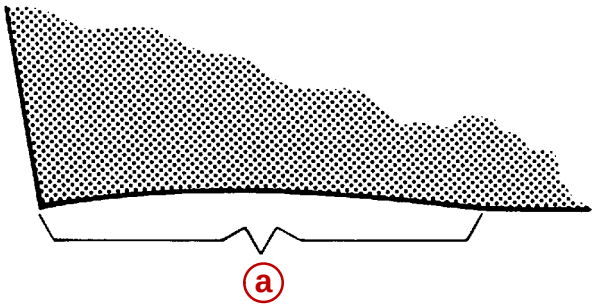
For best speed and minimum spray, the corner between the bottom and the transom should be sharp.



72003

a - Bottom
b - Corner
c - Transom

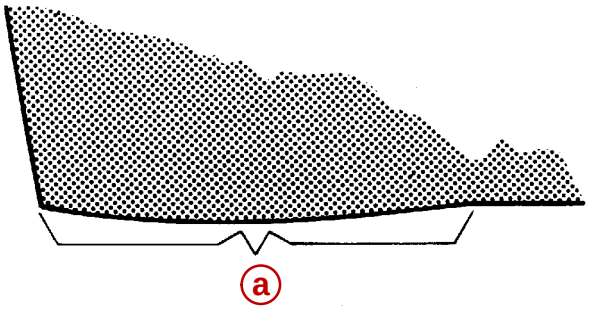
The bottom is referred to as having a “hook” if it is concave in the fore-and-aft direction. A hook causes more lift on the bottom near the transom and forces the bow to drop. This increases wetted surface and reduces boat speed. A hook, however, aids in planing and reduces any porpoising (rhythmical bouncing) tendency. A slight hook is often built in by the manufacturer. A hook also can be caused by incorrect trailering or storing the boat with support directly under the transom.



72004

a - Hook

A “rocker” is the reverse of a hook. The bottom is convex or bulged in the fore-and-aft direction. It can cause the boat to porpoise.



72005

a - Rocker

Any hook, rocker or surface roughness on the bottom, particularly in the all-important center-aft portion will have a negative effect on speed, often several miles per hour on a fast boat.

Marine Fouling

Fouling is an unwanted build-up (usually animal-vegetable-derived) occurring on the boat’s bottom and drive unit. Fouling adds up to drag, which reduces boat performance. In fresh water, fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals and other pollutants. In salt water, barnacles, moss and other marine growth often produce dramatic build-up of material quickly. Therefore, it is important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Antifouling paint, if required, may be applied to boat hull observing the following precautions.

IMPORTANT: DO NOT paint anodes or MerCathode System reference electrode and anode, as this will render them ineffective as galvanic corrosion inhibitors.

⚠ CAUTION
Avoid corrosion damage. Do not apply antifouling paint to Mercury MerCruiser drive unit or transom assembly.

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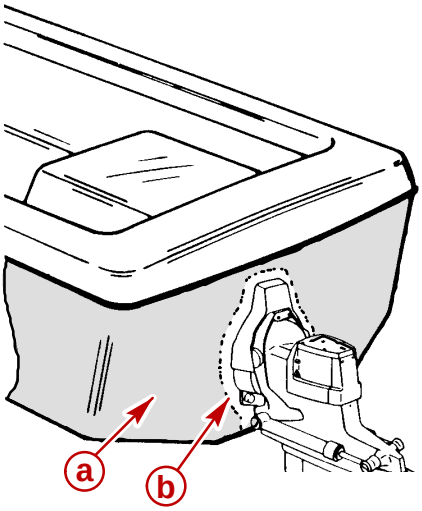
IMPORTANT: If antifouling protection is required, Tri-Butyl-Tin-Adipate (TBTA) base antifouling paints are recommended on Mercury MerCruiser boating applications. In areas where Tri-Butyl-Tin-Adipate base paints are prohibited by law, copper base paints can be used on boat hull and boat transom. Corrosion damage that results from the improper application of antifouling paint will not be covered by the limited warranty. Observe the following:

Avoid an electrical interconnection between the Mercury MerCruiser Product, Anodic Blocks, or MerCathode System and the paint by allowing a minimum of 1-1/2 in. (40mm) UNPAINTED area on transom of the boat around these items.



71176

a - Anti-Fouling Paint
b - Minimum 1-1/2 in. (40 mm) UNPAINTED Area

Weight Distribution

Weight distribution is extremely important; it affects a boat's running angle or attitude. For best top speed, all movable weight - cargo and passengers - should be as far aft as possible to allow the bow to come up to a more efficient angle (3 to 5 degrees). On the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.

Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit his/her needs.

Weight and passenger loading placed well forward increases the "wetted area" of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution. Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

Water in Boat

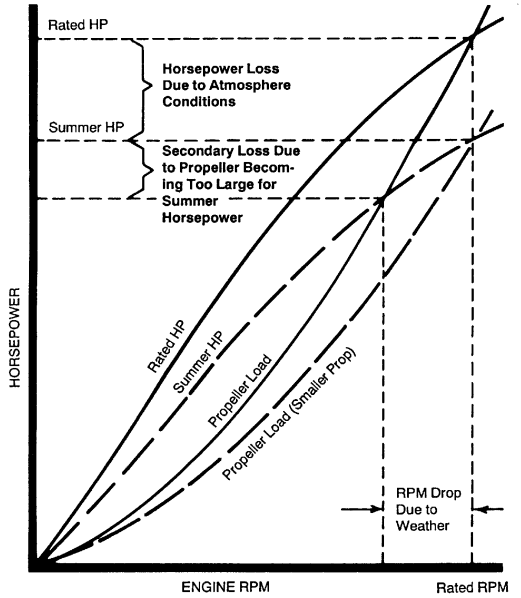
When a boat loses performance, check bilge for water. Water can add considerable weight to the boat, thereby decreasing the performance and handling.

Make certain that all drain passages are open for complete draining.

Elevation and Climate

Elevation has a very noticeable effect on the wide-open-throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This phenomenon can become particularly apparent when an engine is propped out on a cool dry day in spring and later, on a hot, humid day in August, does not have the same performance. See chart below.

Although some performance can be regained by dropping to a lower pitch propeller, the basic problem still exists. The propeller is too large in diameter for the reduced power output. The experienced marine dealer or a Quicksilver Propeller Repair Station can determine how much diameter to remove from a lower-pitch propeller for specific high-elevation locations. In some cases, a gear-ratio change to the drive unit to more reduction is possible and very beneficial. It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated rpm under a specific combination of weather conditions.



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IMPORTANT INFORMATION

Section 1B - Maintenance

1 B

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Tools

Description	Part Number
Timing Light	91-99379
Quicksilver Scan Tool	91-823686A2

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Loctite Pipe Sealant With Teflon	Obtain Locally
Quicksilver U-Joint and Gimbal Bearing Grease	92-828052A2

Maintenance Schedules

Maintenance Intervals

Maintenance intervals and the tasks to be performed, as shown in this current schedule, or as found in a previously printed schedules, are generally based on an average boating application and environment. However, individual operating habits and personal maintenance preferences can have an impact on the suggested intervals. In consideration of these factors, Mercury MerCruiser has adjusted some maintenance intervals and corresponding tasks to be performed. In some cases, this may allow for more individual tasks to be performed in a single visit to the serving dealer, rather than multiple visits. Therefore, it is very important that the boat owner and servicing dealer discuss the current Maintenance Schedule and develop appropriate maintenance intervals to coincide with the individual operating habits, environment, and maintenance requirements.

⚠ CAUTION

Always disconnect battery cables from battery BEFORE working around electrical systems components to prevent injury to yourself and damage to electrical system should a wire be accidentally shorted.

Gas Sterndrive

Routine Maintenance *	Each Day Start	Each Day End	Weekly	Every Two Months
Check crankcase oil (interval can be extended based on experience).	●★			
If operating in salt, brackish or polluted waters, flush cooling system after each use.		●★		
Check drive unit oil level, trim pump oil level and power steering pump fluid level.			●★	
Check water pickups for debris or marine growth. Check water strainer and clean. Check coolant level.			●★	
Inspect drive unit anodes and replace if 50 percent eroded.			●★	
Inspect fuel pump sight tube and have pump replaced if fuel is present.			●★	
Check battery connections and fluid level.				●★
Lubricate propeller shaft and the retorque nut (if operating in only freshwater, this maintenance may be extended to every four months).				●★
Operating in Saltwater Only: treat engine surface with corrosion guard.				●★
Clean air filter every 50 hours of operation.				●★

* Only perform maintenance which applies to your particular power package

● Standard Models

★ Horizon Models

Gas Sterndrive(Continued)

Scheduled Maintenance *

	Annually	Every 100 hours or Annually	Every 200 hours or 3 years	Every 300 hours or 3 years	Every 2 years	Every 5 years
Touch-up paint power package and spray with corrosion guard.	●★					
Change crankcase oil and filter.		●★				
Change drive unit oil and retorque connection of gimbal ring to steering shaft.		●★				
Replace fuel filter(s).		●★				
Check steering system and remote control for loose, missing or damaged parts. Lubricate cables and linkages.		●★				
Inspect U-joints, splines and bellows. Check clamps. Check engine alignment. Lubricate U-joints splines.		●	★			
Lubricate gimbal bearing and engine coupler.		●8	★			
Check continuity circuit for loose or damaged connections. Test MerCathode® unit output on Bravo Models.		●	★			
Retorque engine mounts.		●		★		
Check spark plugs, wires, distributor cap and ignition timing. Check and adjust idle speed.		●		★		
Clean flame arrestor and crankcase ventilation hoses. Replace PCV valve.		●		★		
Check electrical system for loose, damaged or corroded fasteners.		●		★		
Inspect condition and tension of belts.		●		★		
Check cooling system and exhaust system hose clamps for tightness. Inspect both systems for damage or leaks.		●		★		
Disassemble and inspect seawater pump and replace worn components.		●		★		
Clean seawater section of closed cooling system. Clean, inspect and test pressure cap.		●		★		
Replace coolant.					♠	●★

* Only perform maintenance which applies to your particular power package

● Standard Models

★ Horizon Models

◆ Whichever Occurs First

♠ Interval will be reduced if not using extended life coolant.

8 Lubricate engine coupler every 50 hours if operated at idle for prolonged periods of time.

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Engine and Tune-Up Specifications

MCM (Sterndrive)

Model	MCM 4.3L ALPHA / BRAVO	MCM 4.3LH ALPHA / BRAVO	MCM 4.3L EFI ALPHA / BRAVO
Propshaft Horsepower (SAV1 Rating)	190	205 (190)[2]	210[1] (188)2
Propshaft Kilowatts (SAV1 Rating)	142	153 (142)[2]	157[1] (146)[2]
Number of Cylinders	V-6		
Displacement	262 cid (4.3 l)		
Bore / Stroke - in. (mm)	4.0 x 3.48 (101.6 x 88.4)		
Compression Ratio	9.4:1		9.4:1
Compression Pressure	Minimum 100 psi (690 kPa)[7]		
Idle rpm In Neutral[3]	650 rpm[5]		600 rpm[5]
Maximum rpm (at WOT)[3]	4400-4800 rpm		
Oil Pressure (at 2000 rpm)	Minimum 30 psi (207 kPa)		
Minimum Oil Pressure (at Idle)	Minimum 4 psi (28 kPa)		
Fuel Pressure (1800 rpm)	3-7 psi (21-48 kPa)		30 psi (kPa)
Electrical System	12 V Negative (–) Ground		
Alternator Rating	55 or 65 amp [8]		
Minimum Battery Requirements	375 cca / 475 mca / 90 Ah		
Firing Order	1-6-5-4-3-2		
Spark Plug Type	AC - MR43LTS Champion - RS12YC NGK - BPR6EFS		
Spark Plug Gap	.045 in. (1.1 mm)		
Timing (at idle rpm)[4]	10° BTDC		8° BTDC
Preliminary Idle Mixture	1 1/4 Turns		DNA
Thermostat	160° F (71° C)		

[1] Power Rated in Accordance with NMMA (National Marine Manufacturers' Association) rating procedures.

[2] Power Rated in Accordance with SAV1 rating procedures. This rating procedure is used to certify that the engine complies with "Stage 1" Bodensee and Swiss Regulations. Horsepower differences shown result from differences in test rpm, allowable test tolerances, and/or installation of special kit components.

[3] Measured using an accurate service tachometer with engine at normal operating temperature.

[4] Timing must be set using a special procedure as outlined in the appropriate section of this manual. Timing cannot be properly set using the conventional method.

[5] A special procedure must be followed to adjust idle rpm. Consult your Authorized Mercury MerCruiser Dealer before attempting this procedure.

[6] Idle speed on EFI models is not adjustable.

[7] Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.

[8] Serial Number Break for 65 Amp alternator: OL619083 and above.

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Fluid Capacities

NOTICE
Unit Of Measurement: U.S. Quarts (Liters)
All capacities are approximate fluid measures.

Sterndrive Engines

Model	All Models
Crankcase Oil (With Filter) [1]	4-1/2 (4.3)
Seawater Cooling System [2]	15 (14.1)
Closed Cooling System	20 (19)

[1] Always use dipstick to determine exact quantity of oil or fluid required.

[2] Seawater Cooling System capacity information is for winterization use only.

Sterndrives

NOTICE
Unit Of Measurement: U.S. Fluid Ounces (Milliliters)
All capacities are approximate fluid measures.

Model	ALPHA ONE
Drive Unit Oil Capacity (With Gear Lube Monitor)	64 (1892)

Model	BRAVO ONE	BRAVO TWO	BRAVO THREE
Drive Unit Oil Capacity (With Gear Lube Monitor)	88 (2603)	104 (3076)	96 (2839)

20-Hour Break-In Period

IMPORTANT: The first 20 hours of operation is the engine break-in period. Correct break-in is essential to obtain minimum oil consumption and maximum engine performance. During this break-in period, the following rules must be observed:

- Do not operate below 1500 rpm for extended periods of time for first 10 hours. Shift into gear as soon as possible after starting and advance throttle above 1500 rpm **if conditions permit safe operation.**
- Do not operate at one speed consistently for extended periods.
- Do not exceed 3/4 throttle during first 10 hours. During next 10 hours, occasional operation at full throttle is permissible (5 minutes at a time maximum).
- Avoid full throttle acceleration from IDLE speed.
- Do not operate at full throttle until engine reaches normal operating temperature.

After Break-in Period

To help extend the life of your Mercury MerCruiser power package, the following recommendations should be considered:

- Use a propeller that allows the engine to operate at or near the top of the maximum rpm range (refer to “Specifications” section) when at full throttle with a normal boat load.
- Operation at 3/4 throttle setting or lower is recommended. Refrain from prolonged operation at maximum (full throttle) rpm.

End of First Season Checkup

At the end of the first season of operation, an Authorized Mercury MerCruiser Dealer should be contacted to discuss and/or perform various scheduled maintenance items. If you are in an area where the product is operated continuously (year-round operation), you should contact your dealer at the end of the first 100 hours of operation, or once yearly, whichever occurs first.

CA261

Specifications

Fuel Recommendations

IMPORTANT: Use of improper gasoline can damage your engine seriously. Engine damage resulting from use of improper gasoline is considered misuse of engine, and damage caused thereby will not be covered under the limited warranty.

FUEL RATINGS

Mercury MerCruiser engines will operate satisfactorily when using a major brand of unleaded gasoline as follows:

USA and Canada - having a posted pump Octane Rating of 87 (R+M)/2 minimum. Premium gasoline [92 (R+M)/2 Octane] is also acceptable. DO NOT use leaded gasoline.

Outside USA and Canada - having a posted pump Octane Rating of 90 RON minimum. Premium gasoline (98 RON) is also acceptable. If unleaded gasoline is not available, use a major brand of leaded gasoline.

CA291

USING REFORMULATED (OXYGENATED) GASOLINES (USA ONLY)

This type of gasoline is required in certain areas of the USA. The two types of “oxygenates” used in these fuels are Alcohol (Ethanol) or Ether (MTBE or ETBE). If Ethanol is the “oxygenate” that is used in the gasoline in your area, refer to “Gasolines Containing Alcohol.”

These “Reformulated Gasolines” are acceptable for use in your Mercury MerCruiser engine.

VAPOR LOCKING

Fuels containing alcohol and winter grade fuels will aggravate vapor lock problems. A vapor lock condition can be identified by the following problems:

- Engine starts and, upon advancing throttle, shuts off and will not restart.
- If engine does restart, it shuts off when advancing throttle.
- Engine is difficult to restart after operating the boat and then leaving the engine off for 1 to 3 hours.

Other factors may combine to increase vapor locking. These factors include but are not limited to:

- air temperature
- fuel tank location
- fuel supply system
- engine coolant temperature
- temperature and vacuum of fuel to engine
- engine compartment air temperature and ventilation

Other conditions should be ruled out before treating the problem as vapor locking.

Index

GASOLINES CONTAINING ALCOHOL

If the gasoline in your area contains either “methanol” (methyl alcohol) or “ethanol” (ethyl alcohol), you should be aware of certain adverse effects that can occur. These adverse effects are more severe with “methanol.” Increasing the percentage of alcohol in the fuel can also worsen these adverse effects.

Some of these adverse effects are caused because the alcohol in the gasoline can absorb moisture from the air, resulting in a separation of the water/alcohol from the gasoline in the fuel tank.

The fuel system components on your Mercury MerCruiser engine will withstand up to 10% alcohol content in the gasoline. We do not know what percentage your boat’s fuel system will withstand. Contact your boat manufacturer for specific recommendations on the boats fuel system components (fuel tanks, fuel lines and fittings). Be aware that gasolines containing alcohol may cause increased:

- Corrosion of metal parts.
- Deterioration of rubber or plastic parts.
- Fuel permeation through rubber fuel lines.
- Starting and operating difficulties.

⚠ WARNING

FIRE AND EXPLOSION HAZARD: Fuel leakage from any part of fuel system can be a fire and explosion hazard which can cause serious bodily injury or death. Careful periodic inspection of entire fuel system is mandatory, particularly after storage. All fuel components including fuel tanks, whether plastic metal or fiberglass, fuel lines, fittings, fuel filters and carburetors/fuel injection components should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration requires replacement before further engine operation.

Because of possible adverse effects of alcohol in gasoline, it is recommended that only alcohol-free gasoline be used where possible. If only fuel containing alcohol is available, or if the presence of alcohol is unknown, increased inspection frequency for leaks and abnormalities is required.

IMPORTANT: When operating a Mercury MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods should be avoided. Long periods of storage, common to boats, create unique problems. In cars alcohol-blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

Test For Alcohol Content In Gasoline

The following is an acceptable and widely used field procedure for the detection of alcohol in gasoline. Use any small transparent bottle or tube that can be capped and is, or can be, provided with graduations or a mark at about 1/3 full. A pencil mark on a piece of adhesive tape may be used.

PROCEDURE

1. Fill the container with water to the mark.
2. Add fuel almost to fill the container, leaving some air space, then cap the container. The proportions of fuel to water are not critical, but there should be 2 to 3 times as much fuel as water.
3. Shake container vigorously and allow it to sit **upright for 3 to 5 minutes**. If the volume of water appears to have increased, alcohol is present. If you are not sure, there is no need for concern. If the dividing line between water and fuel becomes cloudy, use the middle of the cloudy band.

Power Steering Fluid

Use Quicksilver Power Trim and Steering Fluid or automatic transmission Fluid (ATF) Dexron III.

Coolant for Closed Cooling System

⚠ CAUTION

Alcohol or Methanol base antifreeze or plain water, are not recommended for use in fresh water section of cooling system at any time.

We recommend that the coolant section of closed cooling system be filled with Extended Life Ethylene Glycol 5/100 Antifreeze/Coolant mixed 50/50 with purified water. In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

If any non-compatible coolant is added to this coolant, coolant must be changed every 2 years or 400 hours, whichever occurs first. All coolants other than Extended Life 5/100 Ethylene Glycol Antifreeze/Coolant must be changed every 2 years or 400 hours, whichever occurs first.

Mercury MerCruiser V-8 engines can use any type of permanent antifreeze or any brand antifreeze solution that meets GM specification 1825M.

CA693

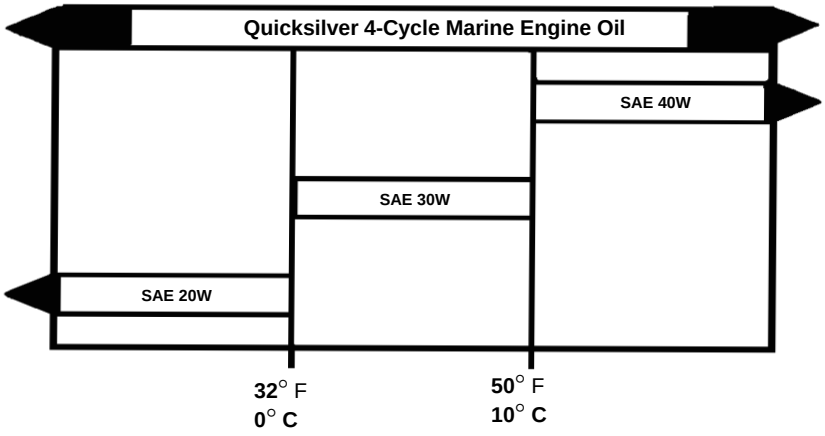
Crankcase Oil

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-Cycle 25W-40 Marine Engine Oil. This oil is a special blend of 25-weight and 40-weight oils for marine engines. If not available, a good grade, straight weight, detergent automotive oil of correct viscosity, with an API classification of SH,CF/CF-2, may be used.

In those areas where Quicksilver 4-Cycle 25W-40 Marine Engine Oil or a recommended straight weight oil are not available, a multiviscosity 20W-40 (SH, CF/CF-2) or, as a second but less preferable choice, 20W-50, with API service ratings of SH, CF/CF-2 may be used.

IMPORTANT: The use of non-detergent oils, multi-viscosity oils (other than Quicksilver 25W-40 or a good quality 20W-40 or 20W-50), synthetic oils, low quality oils or oils that contain solid additives are specifically not recommended.

The chart below is a guide to crankcase oil selection. The oil filter should always be changed with oil.



Overfilled Crankcase Oil

Overfilled crankcases (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm “clatter” on Mercury MerCruiser engines. The over-full condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to “bleed down.” This, in turn, results in rocker arm “clatter” and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking engine oil level. Oil level must be maintained between the ADD mark and the FULL mark on the dipstick. To ensure that you are not getting a “false reading,” make sure the following steps are done before checking the oil level.

- Boat “at rest” in the water, or
- If boat is on a trailer, raise or lower bow until the boat is setting at the approximate angle that it would be if setting “at rest” in the water.
- Allow sufficient time for oil to drain into the crankcase if engine has just been run or oil has just been added.

Checking Engine Oil Level / Filling

IMPORTANT: ENGINE CRANKCASE OIL MUST BE CHECKED AT INTERVALS SPECIFIED IN "MAINTENANCE SCHEDULE" CHART. It is normal for an engine to use a certain amount of oil in the process of lubrication and cooling of the engine. The amount of oil consumption is greatly dependent upon engine speed, with consumption being highest at wide-open-throttle and decreasing substantially as engine speed is reduced.

1. Stop engine and allow boat to come to a rest.
2. Allow oil to drain back into oil pan - approximately 5 minutes.
3. Remove dipstick.
4. Wipe clean and reinstall. Push dipstick all the way into dipstick tube.
5. Remove dipstick and note the oil level.
6. Oil level must be between the FULL or OP RANGE and ADD marks.
7. If oil level is below ADD mark, proceed to Steps 8. and 9.
8. Remove oil filler cap from valve rocker arm cover.
9. Add required amount of oil to bring level up to, but not over, the FULL mark on dipstick.

Changing Oil and Filter

1. Start engine and run until it reaches normal operating temperatures.

IMPORTANT: Change oil when engine is warm from operation, as it flows more freely, carrying away more impurities.

2. Stop engine.
3. Remove drain plug from oil pan or from oil drain hose.

IMPORTANT: If engine is factory equipped with Quick Drain Oil Hose, pull tether through bilge drain before removing drain plug from oil drain hose.

NOTE: *If drain plug is not accessible because of boat construction, oil may be removed through dipstick tube, using a Quicksilver Crankcase Oil Pump. (See Quicksilver Accessory Guide.)*

4. After oil has drained completely, reinstall drain plug (if removed) and tighten securely.
5. Remove and discard oil filter and its sealing ring.
6. Coat sealing ring on new filter with engine oil and install. Tighten filter securely (following filter manufacturer's instructions). Do not overtighten.
7. Fill crankcase with oil. See "Specifications" for type of oil and quantity.
8. Check dipstick to ensure oil level is up to, but not over, FULL or OP RANGE mark on dipstick.
9. Start engine and check for leaks.

Changing Water Separating Fuel Filter

⚠ WARNING

Be careful when changing water separating fuel filter. Gasoline is extremely flammable and highly explosive under certain conditions. Be sure ignition key is OFF. Do not smoke or allow spark or open flame in area when changing fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure no fuel leaks exist before closing engine hatch.

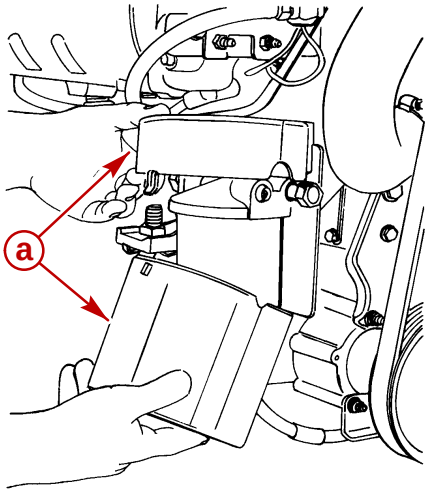
⚠ CAUTION

The electric fuel pump and factory installed water separating fuel filter have been carefully designed to function properly together. Do not install additional fuel filters and/or water separating fuel filters between fuel tank and engine.

The installation of additional filters may cause:

- Fuel Vapor Locking
- Difficult Warm-Starting
- Piston Detonation Due to Lean Fuel Mixture
- Poor Driveability

1. Unsnap latch and slide top and bottom cover pieces, if equipped, from around the water separating fuel filter and bracket.

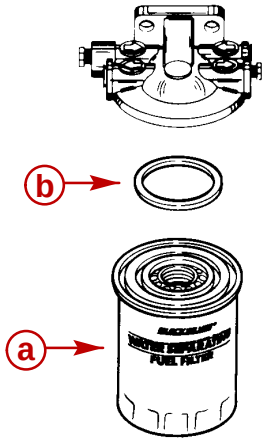


75034

a - Fuel Filter Cover

NOTE: *Top and bottom cover pieces are formed with a groove on each side that slides around the brackets outer edges.*

2. Remove water separating fuel filter and sealing ring from mounting bracket and discard.



70573

a - Fuel Filter
b - Sealing Ring

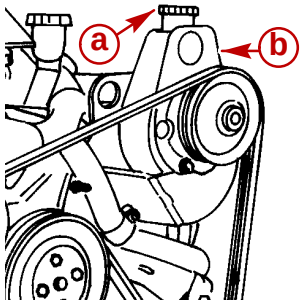
3. Coat sealing ring on new filter with motor oil.
4. Thread filter onto bracket and tighten securely by hand. Do not use a filter wrench.
5. Start and run engine.
6. Check filter connection for gasoline leaks. If leaks exist, recheck filter installation.
7. Install cover pieces around fuel filter. Be certain top part of cover latches to lower part.

Power Steering System

Checking Fluid Level

ENGINE WARM

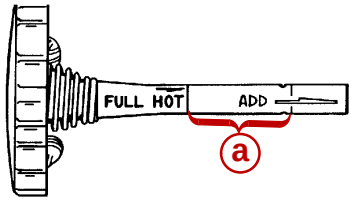
1. Stop engine. Position drive unit so that it is straight back.
2. Remove fill cap / dipstick from power steering pump and note fluid level.



74908

a - Fill Cap / Dipstick
b - Power Steering Pump

3. Level should be between the FULL HOT mark and ADD mark on dipstick.



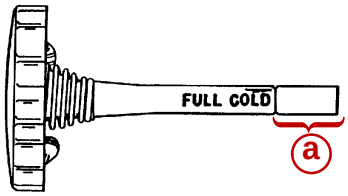
72518

a - Proper Fluid Level with Engine Warm

4. If level is below ADD mark, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF) Dexron III through fill cap opening, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL.
5. If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

Engine Cold

1. With engine stopped, position drive unit so that it is straight back.
2. Remove fill cap / dipstick from power steering pump and note fluid level.
3. Level should be between FULL COLD mark and bottom of dipstick.



72519

a - Proper Fluid Level with Engine Cold

4. If level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic Dexron III transmission fluid (ATF), through fill cap opening, to bring level up to FULL COLD mark on dipstick. DO NOT OVERFILL.

If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

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Filling and Bleeding

IMPORTANT: Power steering system must be filled exactly as explained in the following to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause power steering system to become spongy, which may result in poor boat control.

1. With engine stopped, position drive unit so that it is straight back.
2. Remove fill cap / dipstick from power steering pump.
3. Add Quicksilver Power Trim and Steering Fluid or Dexron III automatic transmission fluid (ATF), as required, to bring level up to FULL COLD mark on dipstick.

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid or Dexron III automatic transmission fluid (ATF), in power steering system.

4. Turn steering wheel back and forth to end of travel in each direction several times.
5. Recheck fluid level and add fluid, if necessary.
6. Install vented fill cap. Tighten securely.

⚠ CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump, or pump impeller may be damaged and subsequent overheating damage to engine may result.

7. Start engine and run at fast idle (1000-1500 rpm) until engine reaches normal operating temperature. During this time, turn steering wheel back and forth to end of travel in each direction several times.
8. Position drive unit so that it is straight back and stop engine.
9. Remove fill cap from pump.
10. Allow any foam in pump reservoir to disperse.
11. Check fluid level and add fluid, as required, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL**.**
12. Reinstall fill cap. Tighten securely.

IMPORTANT: Drive unit must be positioned straight back and power steering fluid must be hot to accurately check fluid level.

13. If fluid is still foamy (in Step 5.), repeat Steps 7. through 12. until fluid does not foam and level remains constant.

Closed Cooling System

Checking Coolant Level

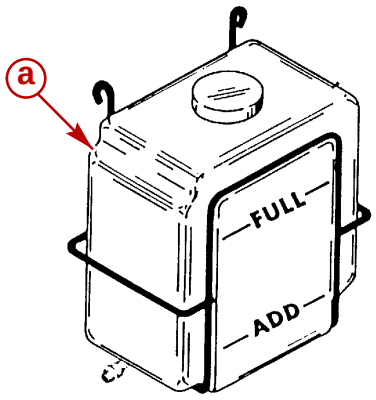
⚠ CAUTION

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

1. Coolant level in heat exchanger should be full (to bottom of filler neck).

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts on filler neck.

2. Coolant level should be between the ADD and FULL marks on coolant recovery reservoir with the engine at normal operating temperature.



72520

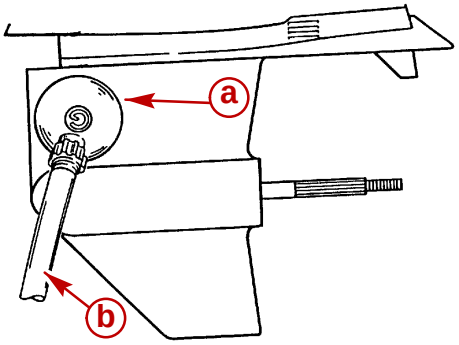
a - Coolant Recovery Reservoir

Flushing System

If engine is operated in salty, polluted or mineral-laden water, flush seawater cooling system (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Thoroughly flush the seawater cooling system prior to storage.

NOTE: *For additional protection against freezing and rust to the exhaust manifolds and other components, a 50-50 mixture of antifreeze and water can be run through the engine during Power Package Layup.*

1. Install flushing attachment and water hose over the water pickup holes in gear housing.



72693

a - Flushing Attachment
b - Hose

⚠ WARNING

When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.

⚠ CAUTION

Do not run engine above 1500 rpm when flushing. Suction created by seawater pick-up pump may collapse flushing hose, causing engine to overheat.

⚠ CAUTION

Watch temperature gauge on dash to ensure that engine does not overheat.

2. Open water tap enough to cool the engine, about ½ of its maximum capacity. Adjust as required so that the engine does not overheat.
3. With drive in neutral gear, start engine and advance the throttle until the engine reaches 1300 rpm.

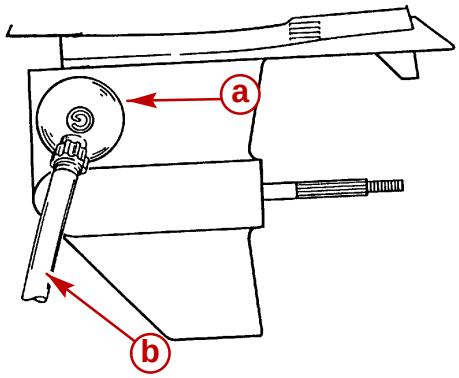
IMPORTANT: DO NOT run the engine at idle rpm. Watch engine temperature gauge on dash. Do not run the engine above 1500 rpm or engine overheating may occur.

4. Run engine for 10 minutes or until the discharge water is clear.
5. Slowly return the throttle to the idle position and turn engine off.

IMPORTANT: DO NOT rapidly advance or return throttle as this can cause water ingestion.

BOAT IN WATER

1. Raise drive unit to full UP / OUT position.
2. Install flushing attachment over water pickup holes in gear housing as shown.
3. Attach a water hose between the flushing attachment and a water tap.



72693

a - Flushing Attachment
b - Hose

4. Lower drive unit to full DOWN / IN position.

⚠ CAUTION

Do not run engine above 1500 rpm when flushing. Suction created by seawater pick-up pump may collapse flushing hose, causing engine to overheat.

⚠ CAUTION

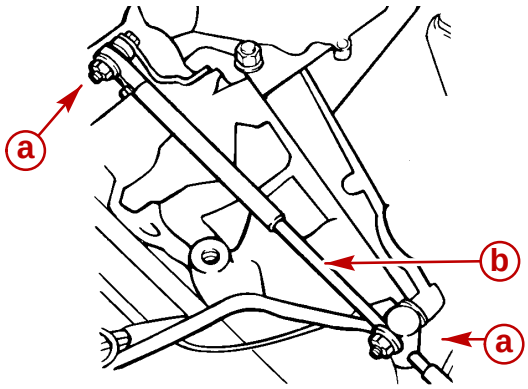
Watch temperature gauge on dash to ensure that engine does not overheat.

5. Partially open water tap (approximately 1/2 maximum capacity). DO NOT use full water pressure.
6. Place remote control in neutral, idle speed position, and start engine.
7. Operate engine at idle speed in neutral for 10 minutes, then stop engine.
8. Shut off water tap.
9. Raise drive unit to full UP / OUT position.
10. Remove water hose and flushing attachment.

Lubrication

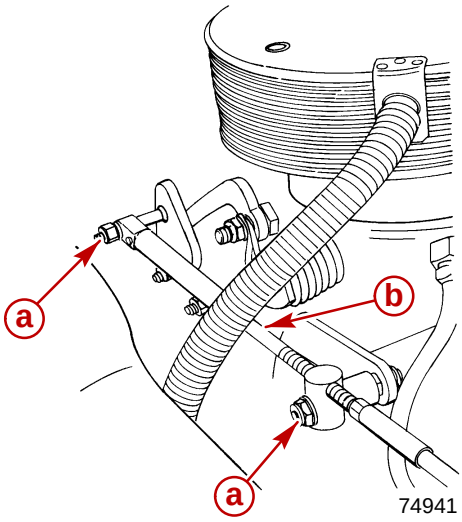
Throttle Cable

1. Lubricate pivot points and guide contact surfaces with SAE 30W motor oil.



71359

2 Barrel Carbureted Models



74941

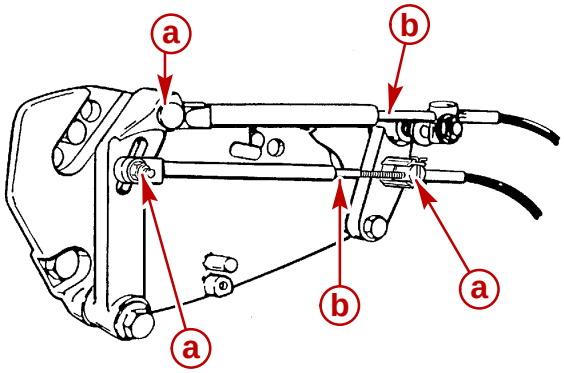
EFI Models

a - Pivot Points
b - Guide Contact Surface

Shift Cable

MCM (STERNDRIVE) MODELS

1. Lubricate pivot points and guide contact surfaces with SAE 30W motor oil.



72016

Typical Shift Cable

a - Pivot Points
b - Guide Contact Surface

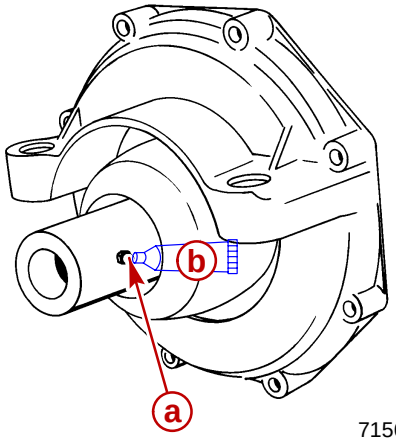
Engine Coupler / U-Joint Shaft Splines

NOTE: *Engine coupler and shaft splines are greased with Quicksilver Engine Coupler Spline Grease, 92-816391A4; universal joints are greased with Quicksilver 2-4-C Marine Lubricant.*

NOTE: *Refer to Mercury MerCruiser Sterndrive Service Manual for sterndrive unit removal and installation, if necessary.*

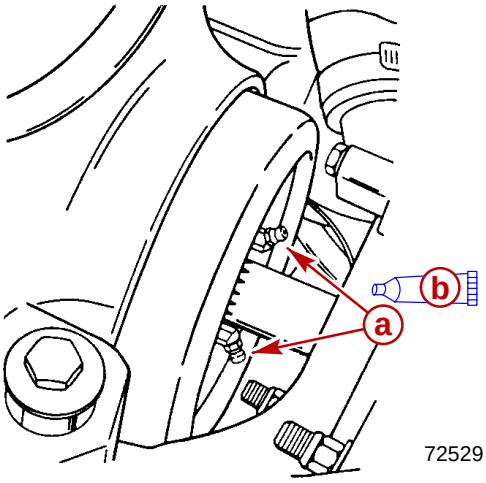
IMPORTANT: Sterndrive Unit does not have to be removed to grease coupler.

1. Lubricate engine coupler splines through grease fitting on coupler by applying approximately 8-10 pumps of grease from a typical hand-operated grease gun.



71569

Typical Alpha Drive Coupler

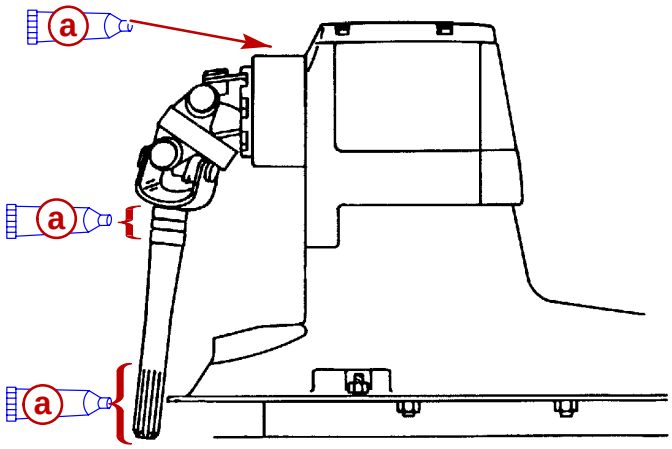


72529

Typical Bravo Drive Coupler

IMPORTANT: Later Bravo Models may be equipped with a coupler that is similar to the Alpha Coupler.

a - Grease Fitting
b - Quicksilver Engine Coupler Spline Grease



72531

Typical Bravo Drive

a - Quicksilver Engine Coupler Spline Grease

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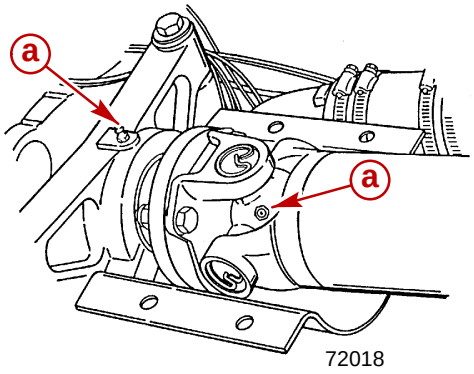
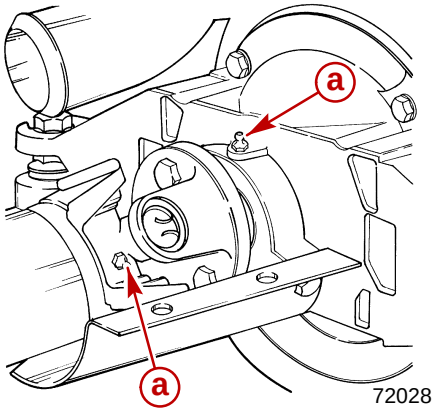
Sterndrive Drive Shaft Extension Models



Transom End



Engine End

a - Grease Fitting

Cleaning Flame Arrestor

⚠ WARNING

Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. Be careful when cleaning flame arrestor and crankcase ventilation hoses. Be sure that ignition is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hoses.

⚠ WARNING

Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. NEVER use gasoline as a cleaning solvent.

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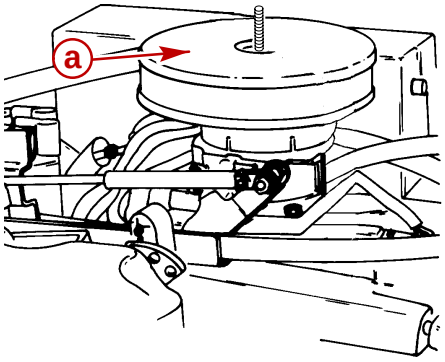
Top Mounted Flame Arrestor

1. Remove flame arrestor cover.
2. Remove crankcase ventilation hose from fitting on side of flame arrestor housing.
3. Remove flame arrestor.



76501

a - Flame Arrestor

4. Clean flame arrestor in solvent. Blow dry with compressed air.
5. Clean crankcase ventilation hose in solvent. Blow dry with compressed air.
6. Inspect crankcase ventilation hose for cracks or deterioration and replace if necessary.
7. Reinstall flame arrestor and crankcase ventilation hose.
8. Reinstall flame arrestor cover.

Serpentine Drive Belt

Component Location

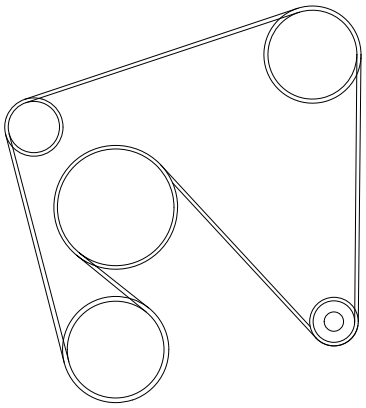
⚠ WARNING

Avoid possible serious injury. Make sure engine is shut off and ignition key is removed before inspecting belt.

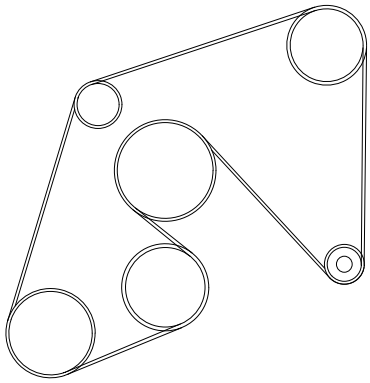
NOTE: *Some models will have components arranged in a different order. All configurations are not shown. Checking, replacing and adjustment procedures are the same.*

Serpentine Belt Routing

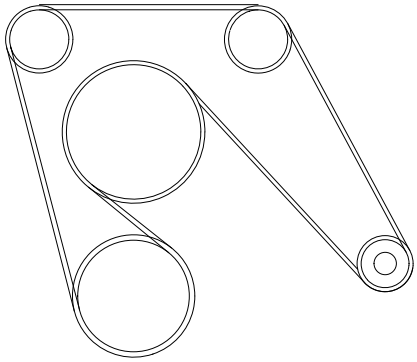
S/N 0L619083 and Below



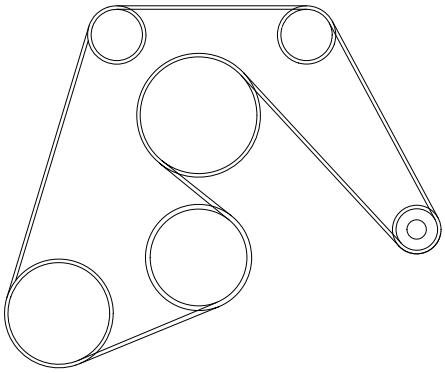
Alpha With Power Steering



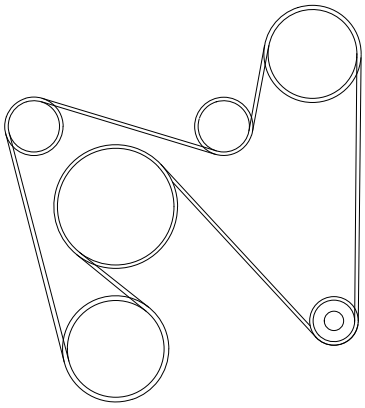
Bravo With Power Steering



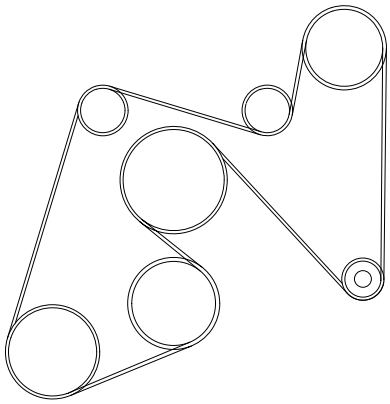
Alpha With Closed Cooling Without Power Steering



Bravo Without Power Steering



Alpha With Closed Cooling and Power Steering



Bravo With Closed Cooling and Power Steering

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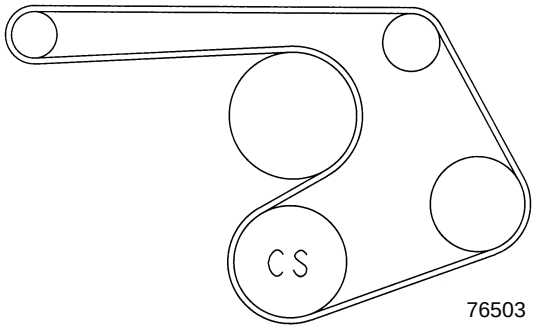
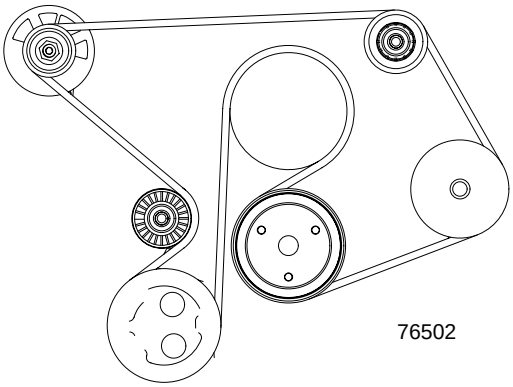
Serpentine Belt Routing (Continued)

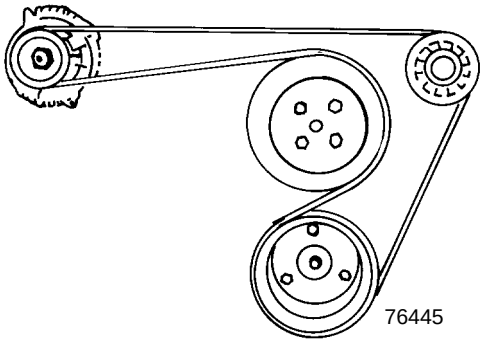
S/N 0L619084 and Above



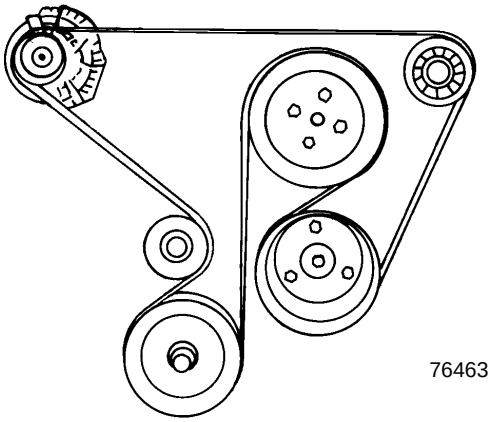
Alpha With Power Steering



Bravo With Power Steering



Alpha Without Power Steering



Bravo Without Power Steering

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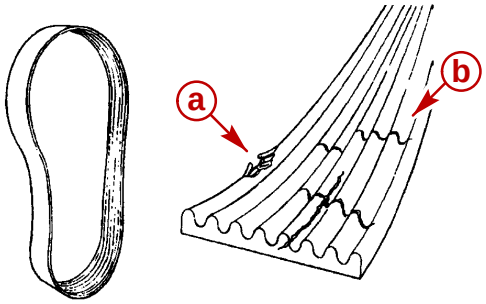
Inspection

1. Inspect drive belt for the following:

- Excessive wear
- Cracks

NOTE: Minor, transverse cracks (across the belt width) may be acceptable. Longitudinal cracks (in direction of belt length) that join transverse cracks are NOT acceptable.

- Fraying
- Glazed surfaces



75130

a - Fraying
b - Cracks

Replacing and/or Adjusting Tension

REMOVAL

1. Loosen 5/8 in. locking nut on adjustment stud.
2. Turn adjustment stud and loosen belt.
3. Remove drive belt.

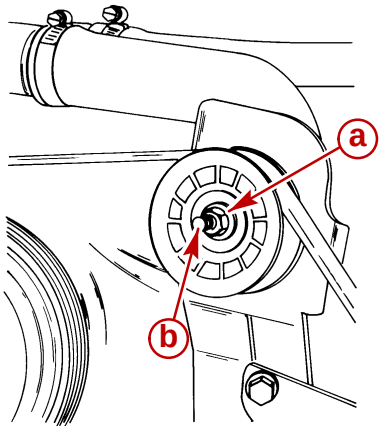
INSTALLATION AND ADJUSTMENT

4. Install drive belt on pulleys.
5. Adjust tension by loosening 5/8 in. locking nut on adjustment stud. Leave wrench on adjustment stud.

NOTE: *Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys. Proper tension is 1/4 in. (6 mm) deflection with moderate thumb pressure.*

6. Use 5/16 in. socket and tighten adjusting stud until the correct deflection of the belt is obtained at location specified above.

7. While holding adjustment stud at the correct belt tension, tighten 5/8 in. locking nut.
8. Run engine for a short period of time and recheck belt adjustment.



74908

a - 5/8 in. Locking Nut
b - 5/16 in. Adjusting Stud

Ignition Timing

Thunderbolt V Models

1. Connect timing light to number 1 spark plug wire.
2. Connect a shop tachometer to the engine.

IMPORTANT: Before starting the engine, connect a jumper wire from the ignition timing lead to a good ground. This has to be done before the ignition key is turned ON to lock the ignition module into Base Timing Mode.

3. Before starting the engine, connect jumper wire from timing lead to a good ground.

NOTE: *The PUR/WHT timing lead is located towards the front of the engine near the fuel line or near the distributor, as equipped for your model.*

4. Start engine and run at 1300 rpm until it reaches normal operating temperature.
5. Disconnect throttle cable from the carburetor.
6. With engine at idle rpm, adjust the carburetor idle rpm screw to the specified engine idle rpm.
7. With the engine still at idle rpm, check the ignition timing. If incorrect, rotate the distributor until timing is correct. Torque clamping screw to 18 lb-ft (25 Nm).
8. Adjust the idle mixture screw. Inward is LEAN, outward is RICH.
9. Recheck ignition timing.
10. Stop engine. Remove timing light, jumper wire and shop tachometer.

IMPORTANT: Timing jumper wire has to be removed or the ignition module will stay locked in the Base Timing Mode and it will not be able to advance the ignition timing correctly when the engine rpm is increased.

11. Adjust and reinstall throttle cable. Open and close remote control throttle lever. Ensure that the carburetor throttle lever is contacting the idle rpm adjusting screw every time.
12. Restart the engine, increase rpm to 1300 then return to idle position slowly and shut the engine off. Ensure that the carburetor throttle lever is contacting the idle rpm screw.
13. Shut engine off.

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EFI

1. Connect timing light to number 1 spark plug wire.
2. Start engine and run at 1300 rpm until it reaches normal operating temperature.
3. Stop engine and connect the scan tool or timing tool to the DLC connector on the EFI wiring harness.
4. Start engine, allow rpm to stabilize.

NOTE: *MEFI-1 models only, manually adjust remote control throttle lever to get 1200 engine rpm.*

NOTE: *MEFI-3 models only, ECM will automatically adjust engine rpm to approximately 1200 rpm when put in the service mode on a scan tool or when using the timing tool.*

5. Check ignition timing. If incorrect, rotate the distributor until timing is correct. Torque clamping screw to 18 lb-ft (25 Nm).
6. Recheck ignition timing.
7. Disconnect scan tool or timing tool from DLC connector.
8. If required, return remote control throttle lever to idle position and shut off engine.
9. Restart engine, increase rpm to 1300 then return to idle position slowly. Ensure that engine returns to idle rpm. Readjust throttle cable, if required.
10. Shut engine off.

Cold Weather or Extended Storage

Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark and/or open flames in the area. Wipe up any spilled fuel immediately.

⚠ WARNING

Avoid Fire or Explosion: To prevent a potential fire hazard, be sure that engine compartment is well ventilated and that there are no gasoline vapors present during starting or fogging of engine.

⚠ WARNING

Avoid Fire or Explosion: Fuel injection system is pressurized during operation. Use care when removing water separating fuel filter. Fuel could spray on hot engine causing fire or explosion. Allow engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it to help avoid fuel spraying on the engine.

⚠ CAUTION

If boat is in the water, seacock (water inlet valve), if equipped, must be closed until engine is to be restarted, to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure attach a tag to the ignition switch or steering wheel of the boat with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting engine.

⚠ CAUTION

DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.

⚠ CAUTION

If engine is equipped with Closed Cooling System, Closed Cooling section must be kept filled with a solution of ethylene glycol antifreeze and water (mix antifreeze to manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). DO NOT USE PROPYLENE GLYCOL antifreeze in closed cooling section. Seawater section, however, must be drained completely.

⚠ CAUTION

A discharged battery can be damaged by freezing.

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⚠ CAUTION

Seawater section of cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exists. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine.

⚠ WARNING

When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.

⚠ CAUTION

DO NOT run engine above 1500 rpm, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

⚠ WARNING

Be sure that engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE or EXPLOSION.

IMPORTANT: Observe the following information to ensure complete draining of cooling system.

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages.**

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting during storage, reinstall drain plugs. Never leave drain plugs out during storage.

NOTE: *If possible, place a container under drains and hoses to prevent water from draining into boat.*

Power Package Layup

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

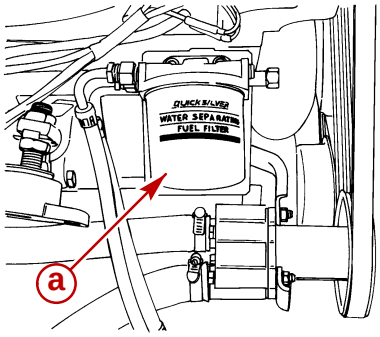
IMPORTANT: Mercury MerCruiser strongly recommends that this service be performed by an Authorized Mercury MerCruiser Dealer. Damage caused by freezing IS NOT covered by the MerCruiser Limited Warranty.

1. Fill fuel tank(s) with fresh gasoline that does not contain alcohol and a sufficient amount of Quicksilver Gasoline Stabilizer for Marine Engines to treat gasoline. Follow instructions on container.
2. **If boat is to be placed in storage with fuel containing alcohol in fuel tanks (if fuel without alcohol is not available):** Fuel tanks should be drained as low as possible and Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Refer to “Fuel Requirements” for additional information.

NOTE: *If desired, a portable fuel tank can be used to perform the remainder of the power package layup procedures. Be sure to add an appropriate amount of Gasoline Stabilizer to the portable tank.*

3. Run engine sufficiently to bring it up to normal operating temperature and allow fuel with Quicksilver Gasoline Stabilizer to circulate through fuel system.
4. Shut off engine.
5. Change oil and oil filter.
6. Flush cooling system. Refer to “Flushing Cooling System” procedure.
7. Close the fuel shutoff valve, if equipped. If no fuel shutoff valve is present, a suitable method must be employed to STOP the flow of fuel from the fuel tank to the engine before proceeding.

8. Prepare EFI fuel system for extended storage as follows:
   a. Allow engine to cool down.
   b. Remove the water separating fuel filter.
   c. Pour out a small amount of fuel into a suitable container, then add approximately 2 fluid ounces (60 ml) of Quicksilver 2-Cycle Outboard Oil to fuel in the water separating fuel filter.
   d. Reinstall water separating fuel filter.
   e. Start and operate engine at idle speed until the water separating fuel filter and fuel injection system are empty and engine stops.
   f. Remove and discard water separating fuel filter.
   g. Install new filter.



75533

a - Water Separating Fuel Filter

9. Prepare carbureted fuel system for extended storage as follows:
   a. Remove flame arrestor assembly and start engine.
   b. While operating engine at fast idle (1000-1500 rpm), fog internal surfaces of induction system and combustion chambers by squirting approximately 8 ounces (227 grams) of Quicksilver Storage Seal or SAE 20W engine oil into carburetor bores.
   c. Squirt the remaining 2 ounces (57 g) of Storage Seal (or oil) rapidly into carburetor, just as the engine begins to stall due to lack of fuel. Allow engine to stop.
10. Turn ignition key to OFF position.
11. Refer to “Flushing Cooling System” and appropriately remove water supply to the seawater pickup pump.
12. Clean flame arrestor and crankcase ventilation hoses and reinstall.
13. Lubricate all items listed in “Lubrication” section.
14. Drain seawater section of cooling system as outlined in “Draining Instructions” section.
15. **On Models with Closed Cooling System:** Test coolant to ensure that it will withstand the lowest temperature expected during storage.
16. Service batteries per manufacturer’s instructions.
17. Clean outside of engine and repaint any areas required with Quicksilver Primer and Spray Paint. After paint has dried, spray Quicksilver Corrosion and Rust Preventive Type II or wipe down with Quicksilver Storage Seal or SAE 20W engine oil.
18. For sterndrive unit layup, refer to appropriate sterndrive service manual.

NOTE: *For additional protection against freezing and rust to the exhaust manifolds and other components, a 50-50 mixture of antifreeze and water can be run through the engine during Power Package Layup.*

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Draining Instructions

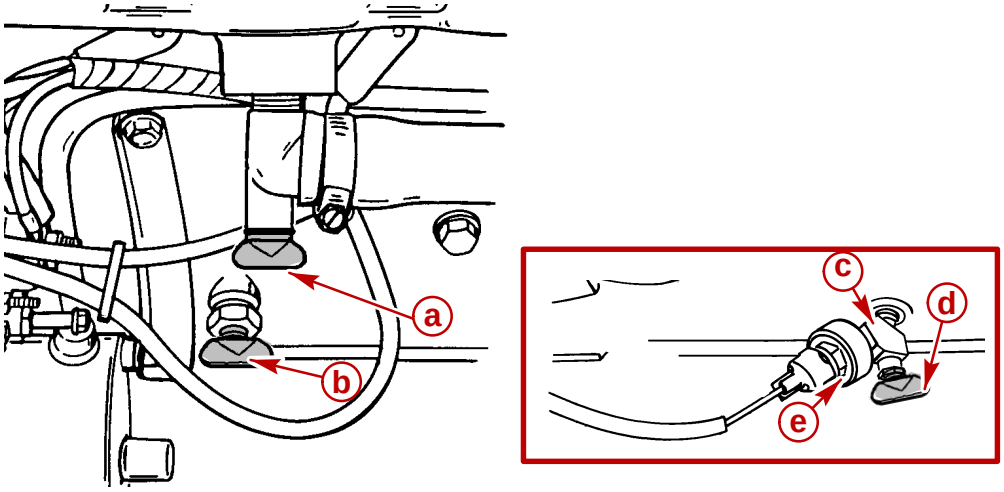
DRAINING SEAWATER (RAW-WATER) COOLED MODELS

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

IMPORTANT: Engine must be as level as possible to ensure complete draining of cooling system.

1. Remove drain plugs from bottom of port and starboard manifold fittings.
2. Remove drain plugs (port and starboard) from cylinder block or cylinder block Y-fitting.

⚠ CAUTION
Avoid product damage. Do not disturb the Y-fitting when removing the drain plug. There is an ignition control “Knock Sensor” in the upper hole of the fitting. This sensor must not be loosened or removed. It is tightened to a critical specification at the factory.



74073

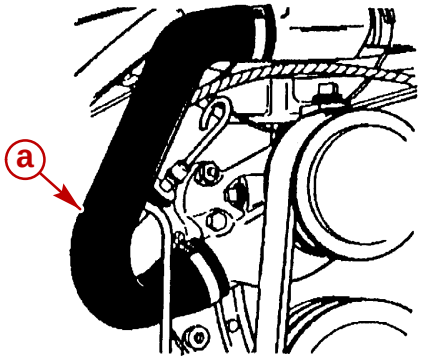
Starboard Side Shown (Port Similar)

- **a** - Exhaust Elbow Drain Plug
- **b** - Cylinder Block Drain Plug
- **c** - Y-Fitting (Fuel Injected Only)
- **d** - Cylinder Block Drain Plug (Fuel Injected Only)
- **e** - Knock Sensor

3. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend or lower hoses to allow water to drain completely when hoses are disconnected.*

4. Remove the engine water circulating pump hose or drain plug, as equipped.



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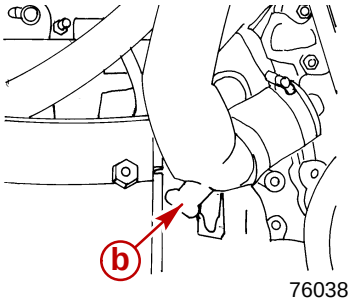
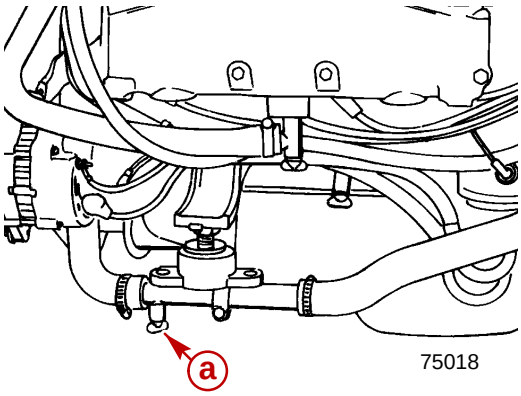


76038

a - Hose, Water Circulating Pump To Thermostat Housing
b - Water Circulating Pump Hose Drain Plug

5. Remove the drain plug from the water tube or Cool Fuel System cooler, as equipped.



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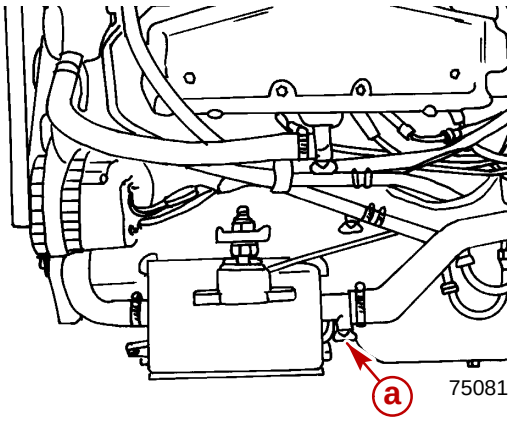
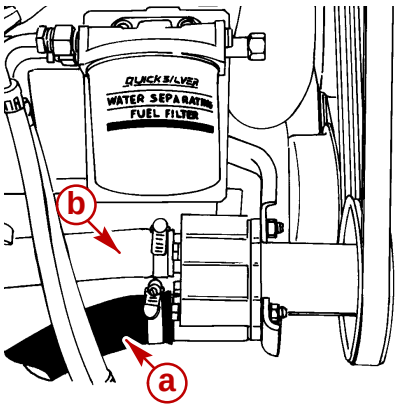


75081

Some Carbureted Models **Fuel Injected Models**

a - Drain Plug

6. Remove seawater pump inlet hose as shown.



75533

a - Seawater Inlet Hose
b - Hose To Cooler

7. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

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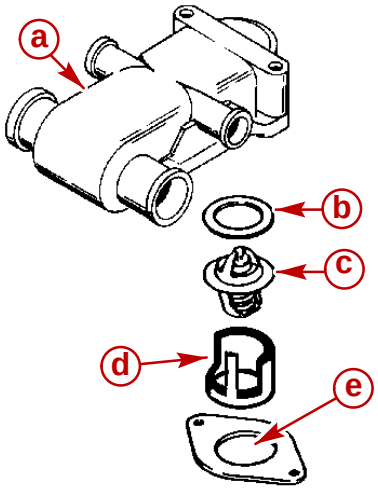
8. After seawater section of cooling system has been drained completely:
   a. Install all drain plugs and tighten securely.
   b. Reconnect hoses and tighten all hose clamps securely.
   c. **If NOT equipped with seacock:** Seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

IMPORTANT: Mercury MerCruiser recommends that propylene glycol antifreeze (nontoxic and biodegradable) be used in seawater section of the cooling system for cold weather or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

9. For additional assurance against freezing and corrosion in the internal water passages:
   a. Remove the thermostat cover and thermostat.
   b. Fill the engine seawater cooling system with a mixture of antifreeze and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage.
   c. Using a new gasket, reinstall thermostat and cover. Tighten cover bolts to 30 lb-ft (41 Nm).

NOTE: *Hoses shown removed for visual clarity. Do not remove hoses.*



74493

a - Housing
b - Gasket
c - Thermostat
d - Spacer
e - Fill Here

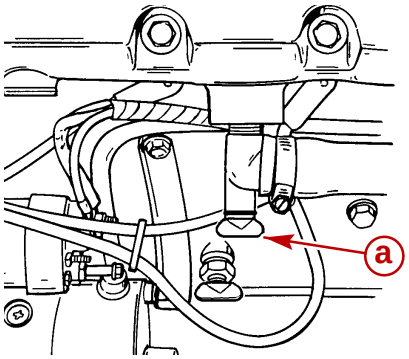
DRAINING SEAWATER SECTION OF CLOSED COOLED (COOLANT) MODELS

NOTICE
Refer to “Precautions” in this section BEFORE proceeding.

IMPORTANT: Drain seawater section of closed cooling system only.

IMPORTANT: Engine must be as level as possible to ensure complete draining of cooling system.

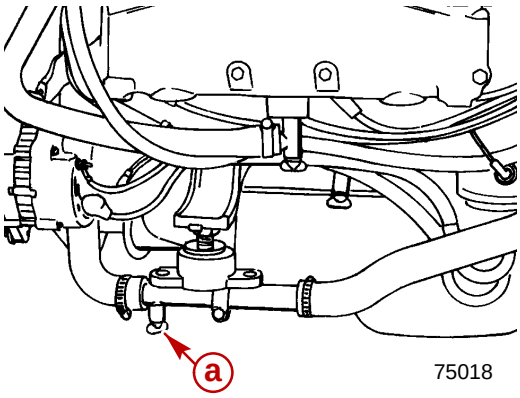
1. Remove drain plug from bottom of port and starboard exhaust manifolds.



74073

a - Drain Plug

2. Remove the drain plug from the water tube or Cool Fuel System cooler, as equipped.



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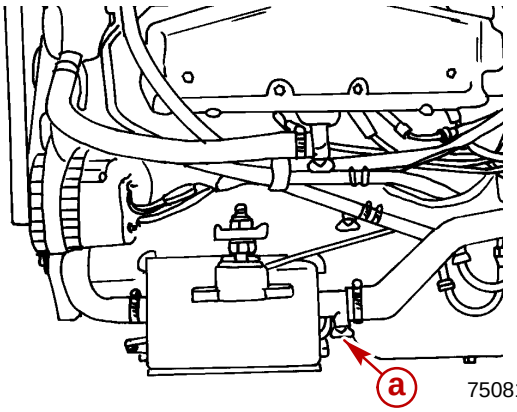
Some Carbureted Models



75081

Fuel Injected Models

a - Drain Plug

NOTE: *It may be necessary to lift, bend or lower hoses to allow water to drain completely when hoses are disconnected.*

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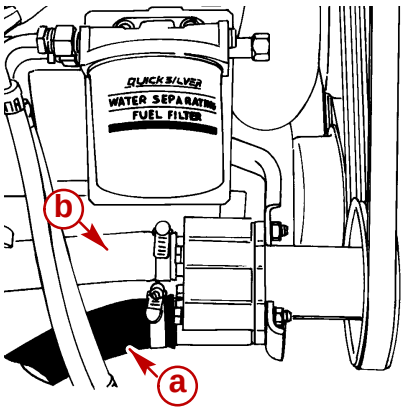
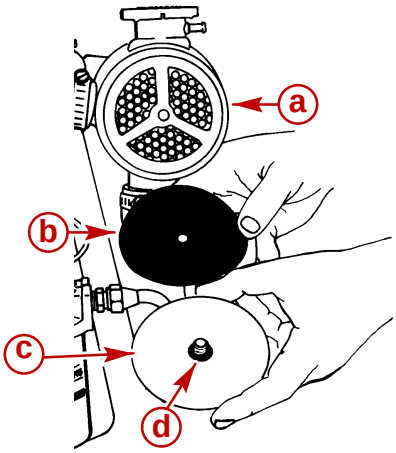
3. Remove seawater pump inlet hose.



75533

a - Seawater Inlet Hose
b - Hose To Cooler

4. Remove end caps, sealing washers and gaskets from the heat exchanger. Allow tubes to drain.



71515

a - Heat Exchanger
b - Sealing Washer
c - End Cap
d - Gasket

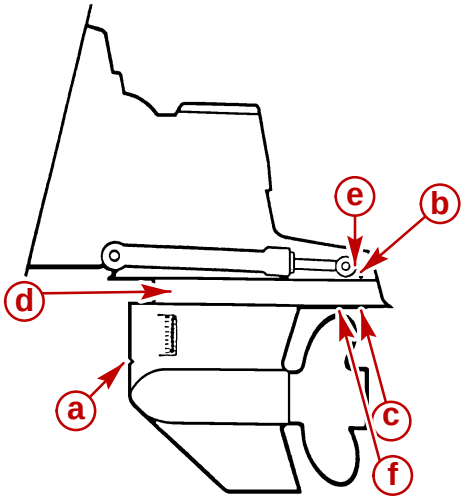
IMPORTANT: Use compressed air to blow any remaining water from the tubes in the heat exchanger.

5. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.
6. After seawater section of cooling system has been drained completely:
   a. Install all drain plugs and tighten securely.
   b. Reconnect hoses and tighten all hose clamps securely.
   c. Apply Quicksilver Perfect Seal to both sides of new end plate gaskets.
   d. Assemble new gaskets, new sealing washers and end plates onto heat exchanger. Torque end plate screws to 36-72 lb-in. (4-8 Nm).
   e. **If NOT equipped with seacock:** Seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

Draining Sterndrive

NOTICE
Predelivery Preparation Instructions Must Be Performed Before Delivering Boat To The Product Owner.

1. **On Bravo Drive Equipped Models:** Insert a small wire (repeatedly) to make sure that speedometer pitot tube, anode cavity vent hole and anode cavity drain passage are unobstructed and drained.

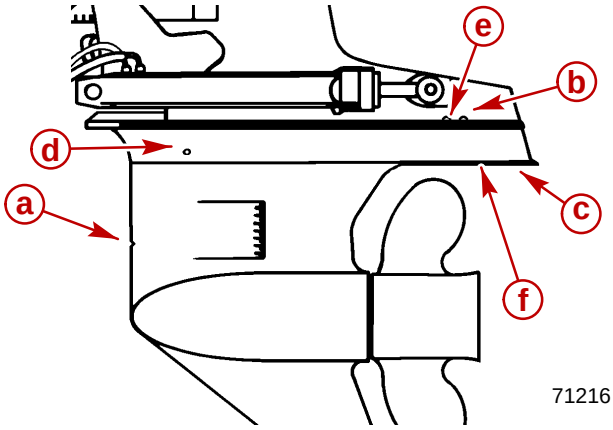


71217

Typical

- **a** - Speedometer Pitot Tube
- **b** - Anode Cavity Vent Hole
- **c** - Anode Cavity Drain Passage
- **d** - Gear Housing Water Drain Hole (One Each - Port and Starboard)
- **e** - Gear Housing Cavity Vent Hole
- **f** - Gear Housing Cavity Drain Hole

2. **On Alpha Drive Equipped Models:** Insert a small wire (repeatedly) to make sure that speedometer pitot tube, trim tab cavity vent hole and trim tab cavity drain passage are unobstructed and drained.



71216

- **a** - Speedometer Pitot Tube
- **b** - Trim Tab Cavity Vent Hole
- **c** - Trim Tab Cavity Drain Passage
- **d** - Gear Housing Water Drain Hole (One Each - Port and Starboard)
- **e** - Gear Housing Cavity Vent Hole
- **f** - Gear Housing Cavity Drain Hole

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Recommissioning

NOTICE

Refer to “Precautions” in this section BEFORE proceeding.

1. Ensure that all cooling system hoses are connected and tight.
2. Ensure all petcocks and drain plugs are installed and tight.
3. Inspect serpentine drive belt for condition and proper tension.
4. Perform all lubrication and maintenance specified for completion “Annually” and “Every 100 hours or Annually” in maintenance schedule, except items which were performed at time of engine layup.
5. For sterndrive unit recommissioning, refer to appropriate Sterndrive Service Manual.

⚠ CAUTION

When installing battery (in next step), be sure to connect positive battery cable to positive (+) terminal and negative (grounded) battery cable to negative (–) battery terminal. If battery cables are reversed, damage to electrical system WILL result.

6. Install fully charged battery. Clean battery cable clamps and terminals to help retard corrosion.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

7. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
8. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
9. Check steering system, shift and throttle controls for proper operation.

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IMPORTANT INFORMATION

Section 1C - Troubleshooting

1 C

Table of Contents

Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak. Follow specific procedures given in this manual for all fuel line connections.

⚠ WARNING

Make sure no fuel leaks exist before closing engine hatch.

⚠ WARNING

When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.

⚠ WARNING

BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark and/or open flames in the area. Wipe up any spilled fuel immediately.

⚠ WARNING

Avoid Fire or Explosion: Fuel injection system is pressurized during operation. Use care when removing water separating fuel filter. Fuel could spray on hot engine causing fire or explosion. Allow engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it to help avoid fuel spraying on the engine.

⚠ WARNING

Be sure that engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE or EXPLOSION.

⚠ WARNING

DO NOT leave helm unattended while performing idle speed adjustment.

⚠ CAUTION

DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.

⚠ CAUTION

DO NOT run engine above 1500 rpm, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

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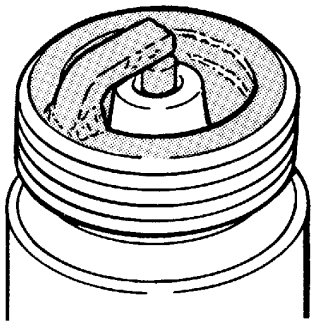
Used Spark Plug Analysis

Use the following illustrations for determining serviceability of spark plug. Spark plug condition also can suggest a variety of possible engine malfunctions and, therefore, can indicate needed engine repairs. When old plugs are replaced, replace entire set. Perform plug service only on those plugs suitable for additional service, using the following procedures:

1. Remove any oil deposits with solvent and dry plugs thoroughly.
2. Open electrode gap wide enough to permit cleaning and filing.
3. Remove combustion deposits from firing end of spark plug with a plug cleaner. Blow off with compressed air to remove abrasives.
4. File electrode surfaces to restore clean, sharp edges. Again remove filings with compressed air.
5. Reset gap to specifications by bending only side electrode with proper tool.

Normal Condition

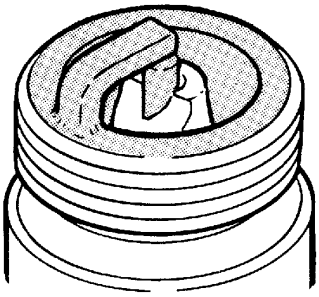
Few deposits are present and probably will be light tan or gray in color. This plug shows that plug heat range is compatible with engine, and engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file and re-gap), this plug can be reinstalled with good results.



72420

Chipped Insulator

Chipped insulator usually results from careless plug re-gapping. Under certain conditions, severe detonation also can split insulator firing ends. Replace spark plug.

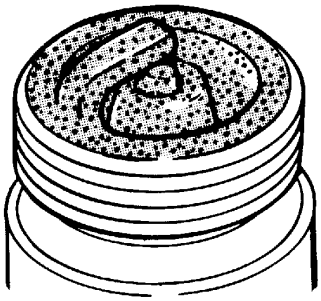


72420

Wet Fouling (Oil Deposits)

Plug becomes shorted by excessive oil entering combustion chamber, usually in engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

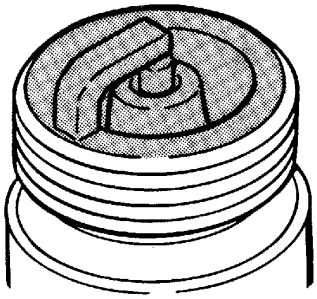
IMPORTANT: New engines or recently overhauled engines may wet foul plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file and re-gap) and reinstalled.



72420

Cold Fouling

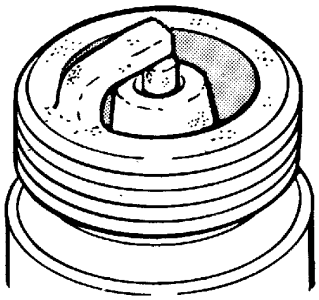
Dry, black deposits indicate rich fuel mixture or weak ignition. Clogged flame arrestor, flooding carburetor, sticky choke or weak ignition components all are probable causes. If, however, only one or two plugs in set are fouled, check for sticking valves or bad ignition leads. After correcting cause, service (clean, file and re-gap) plugs and reinstall.



72421

Overheating

Insulator is dull white or gray and appears blistered. Electrodes are eroded and there is an absence of deposits. Check that correct plug heat range is being used. Also check for over-advanced ignition timing, cooling system malfunction, lean fuel/air mixtures, leaking intake manifold or sticking valves. Replace spark plugs.



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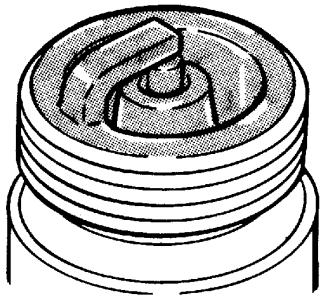
High Speed Glazing

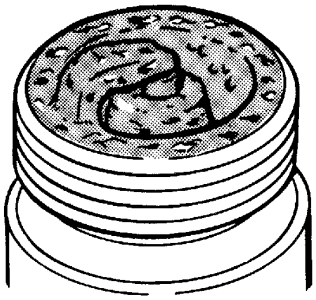
Insulator has yellowish, varnish-like color, indicating that temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace plugs. If condition recurs, use colder heat range plug and service plugs more frequently.



72421

Scavenger Deposits

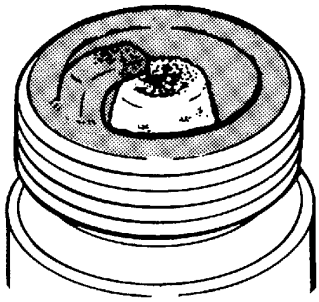
Powdery white or yellow deposits are built up on shell, insulator and electrodes. This is normal appearance with certain branded fuels. Accumulation on ground electrodes and shell areas may be unusually heavy, but may be easily chipped off. Plugs may be serviced (clean, file and re-gap) and reinstalled.



72422

Pre-Ignition Damage

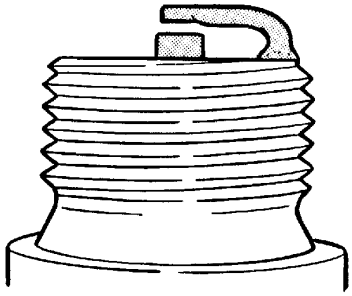
Pre-ignition damage is caused by excessive high temperatures. Center electrode melts first, followed by ground electrode. Normally, insulators are white but may be dirty if plug has been misfiring. Check for correct plug heat range, advanced ignition timing, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold or lack of lubrication. Replace spark plugs.



72422

Reversed Coil Polarity

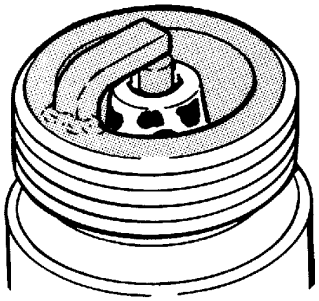
Concave erosion of ground electrode is an indication of reversed polarity. Center electrode will show only normal wear. Engine will misfire and idle rough. To correct, reverse primary coil leads. Replace spark plugs.



72422

Splashed Deposits

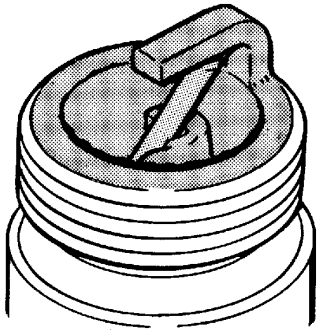
Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon installation of new plugs, deposits loosen from top of piston and head and are thrown against hot insulator. Plugs may be serviced (clean, file and re-gap) and reinstalled.



72423

Mechanical Damage

Mechanical damage to spark plug firing end is caused by foreign object in combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, intake manifold and exhaust material to prevent further damage. Replace spark plugs.



72423

IMPORTANT: When working on engine, spark plug holes and carburetor throat should be kept covered to prevent foreign objects from entering combustion chamber.

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Poor Boat Performance and/or Poor Maneuverability

Symptom	Cause
Bow too low	A. Improper drive unit trim angle
	B. Improper weight distribution
	C. Boat is underpowered
	D. Permanent or power hook in boat bottom
	E. False bottom full of water
	F. Improperly adjusted anode (after planes)
	G. Dirty boat bottom (marine growth)
Bow too high	A. Improper drive unit trim angle
	B. Propeller pitch too great
	C. Dirty boat bottom (marine growth)
	D. Poor running engine
	E. Improper weight distribution
	F. Rocker in boat bottom
	G. False bottom full of water
	H. Improperly adjusted anode (after planes)
Propeller ventilating	A. Drive unit installed too high on transom
	B. Dirty or rough boat bottom
	C. Damaged propeller; pitch too small; diameter too small
	D. Keel located too close to propeller or too deep in the water
	E. Water pickup or through hull fittings located too close to propeller
	F. Hook in boat bottom
	G. Propeller plugged up with weeds

Improper Full Throttle Engine RPM

RPM Too High

Cause	Special Information
Propeller	Damaged; pitch too low; diameter too small; propeller hub slipping.
Boat	Water pickup or through hull fittings mounted too close to propeller (ventilation); keel located too close to propeller and/or too deep in the water (ventilation). Drive installed too high on transom; wrong gear ratio.
Operation	Unit trimmed out too far.
Engine coupler slipping	

RPM Too Low

Cause	Special Information
Propeller	Damaged; pitch too great; diameter too great.
Boat	Dirty or damaged bottom; permanent or power hook in bottom; false bottom full of water. Drive installed too low on transom; wrong gear ratio.
Operation	Unit trimmed in too far.

Engine Cranks Over But Will Not Start Or Starts Hard

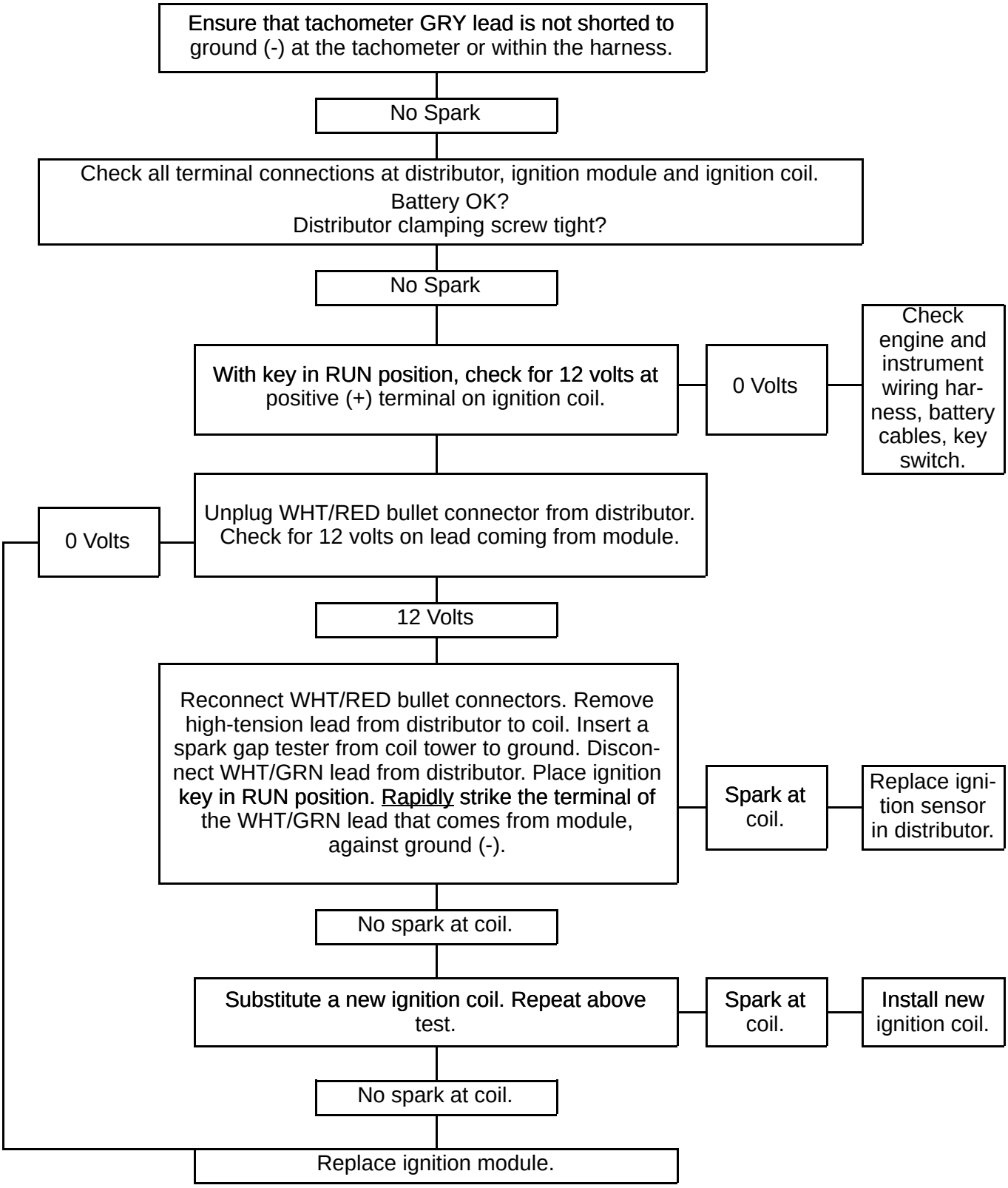
Important Information

1. First, determine which engine system is causing the problem. To make an engine run, basic components - fuel, spark (ignition), and compression - are required. If all three components are present, the engine should run. If any one of the three are missing, weak, or arriving at the wrong time the engine will not run.
2. Check ignition system operation. Remove coil wire from tower on distributor cap. Hold coil wire near ground and check for spark while cranking engine over. Repeat procedure with spark plug wires. If there is spark at the spark plug wires, remove the spark plugs and make sure they are correct type and heat range, and not fouled or burned.
3. Run a compression check on engine to make sure the engine is mechanically OK.

Thunderbolt V Ignition (No Spark)

Cause	Special Information
Moisture on ignition components	Distributor cap or spark plug wires arcing
Battery, electrical connections, damaged wiring	
Ignition switch	
Shift interrupter switch (Alpha One Models Only)	
Shorted tachometer	Disconnect tachometer and try again
Ignition timing	
Spark plugs	Fouled, burned, cracked porcelain
Spark plug wires	Faulty insulation, broken wires
Cracked or dirty distributor cap	
Faulty ignition components	Check components
Engine synchronizer (if equipped) hooked up series on purple ignition wire (dual engines only)	Synchronizers must be hooked up directly coil terminal (parallel chute)

Testing Thunderbolt V Ignition System



IMPORTANT: The WHT/GRN lead must be touched against ground (–) 2-3 times per second to simulate a running engine. Repeat this test several times to ensure that spark is present.

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Fuel System Rich

Cause	Special Information
Clogged flame arrestor	
Excessive fuel pump pressure	
Fuel pressure regulator defective	

Fuel System Lean

Cause	Special Information
Empty fuel tank	
Fuel shut-off valve closed (if equipped)	
Vapor lock	Engine will not start after warm engine shut down

Miscellaneous

Cause	Special Information
Low grade or stale fuel	
Water in fuel	

Engine Will Not Crank Over

Cause	Special Information
Remote control lever not in neutral position	
Battery charge low; damaged wiring; loose electrical connections	
Circuit breaker tripped	
Blown fuse	
Ignition switch	
Slave solenoid	
Faulty neutral start safety switch	Open circuit
Starter solenoid	
Starter motor	
Mechanical engine malfunction	

Charging System Inoperative

Cause	Special Information
Loose or broken serpentine belt	
Engine rpm too low on initial start	Rev engine to 1500 rpm
Loose or corroded electrical connections	
Faulty battery gauge	Best way to test is to replace gauge
Battery will not accept charge	Low electrolyte or failed battery
Faulty alternator or regulator	
Refer to SECTION 4C for complete “Charging System” diagnosis procedures	

Noisy Alternator

Cause	Special Information
Loose mounting bolts	
Drive belt	Worn, frayed, loose
Loose drive pulley	
Worn or dirty bearings	
Faulty diode trio or stator	

Instrumentation Malfunction

Cause	Special Information
Faulty wiring, loose or corroded terminals	
Faulty key switch	Test, as outlined in SECTION 4D
Faulty gauge	Test, as outlined in SECTION 4D
Faulty sender	Test, as outlined in SECTION 4D

Radio Noise

Cause	Special Information
A “popping” noise that will increase with engine rpm. Noise will stop as soon as engine is turned off.	Ignition System - wrong spark plugs; cracked distributor cap; cracked coil tower; leaking spark plug wires; moisture on ignition components
“High pitched whine” in the radio	Alternator - poor brush contact on the slip rings
A “hissing or crackling” noise when instruments are jarred with ignition on	Instrumentation - loose connections, or antennae wire routed too close to instruments
Varying unexplained noises	Accessories - bilge pump, bilge blower; fish finder, depth locator; cabin heater motor, etc. Disconnect one at a time until noise disappears.

Poor Fuel Economy

Cause	Special Information
Fuel leaks	
Operator habits	Prolonged idling; slow acceleration; failure to cut back on throttle once boat is on plane; boat overloaded; uneven weight distribution
Engine laboring	Bent, damaged, or wrong propeller. Water test boat for proper operating rpm at wide-open-throttle
Clogged flame arrestor	
Engine compartment sealed too tight	Not enough air for engine to run properly
Boat bottom	Dirty (marine growth), hook, rocker
Improper fuel	
Crankcase ventilation system not working	
Engine running too cold or too hot	
Plugged or restricted exhaust	
Engine	Low compression

Engine Runs Poorly at Idle

Symptoms	Cause
Engine surges	Refer to “Fuel Injection System Trouble-shooting,” SECTION 5H
Low top speed or lack of power	
Poor cold engine operation	
Engine stalls	
Hard starting	Refer to “Engine Starts Hard”

Engine Runs Poorly At High RPM

Cause	Special Information
Also refer to “Poor Boat Performance”	
Crankcase overfilled with oil	Check oil level with boat at rest in the water.
Anti-siphon valve (if equipped)	Restricting fuel supply
Plugged fuel tank vent	
Fuel supply	Refer to “Fuel Injection System Troubleshooting,” SECTION 5H
Ignition timing	
Low grade of fuel or water in the fuel	
Spark plugs	Fouled, burned, cracked porcelain, incorrect heat range
Spark plug wires	Poor insulation, broken wires
Distributor cap or rotor	Dirty or cracked
Coil	
Distributor	Excessive play in shaft
Engine overheating	Refer to “Engine Overheats”
Low compression	Worn valves, rings, cylinders, etc.
Restricted exhaust	

Engine Acceleration Is Poor

Cause	Special Instructions
Also refer to “Poor Boat Performance”	
Idle mixture screws	
Incorrect ignition timing	
Incorrect distributor or amplifier advance curve	Refer to SECTION 4B
Cracked or dirty distributor cap or rotor	
Vacuum leak	Intake manifold
Spark plugs	Fouled, burned; wrong heat range; cracked porcelain
Low compression	

Troubleshooting with Vacuum Gauge

Reading	Cause
Steady reading between 15-21 inches at idle rpm	Normal
Extremely low reading, but steady at idle rpm	Vacuum leak; incorrect timing; underpowered boat; faulty boat bottom
Fluctuates between high and low at idle rpm	Blown head gasket between two adjacent cylinders
Fluctuates 4 or 5 inches very slowly at idle rpm	Spark plug gap too narrow, valves are sticking
Fluctuates rapidly at idle, steadies as rpm is increased	Valve guides are worn
Continuously fluctuates between low and normal reading at regular intervals at idle rpm	Burned or leaking valve

Engine Noise

Important Information

No definite rule or test will positively determine source of engine noise; therefore, use the following information only as a general guide to engine noise diagnosis.

1. Use a timing light to determine if noise is timed with engine speed or one-half engine speed. Noises timed with engine speed are related to crankshaft, rods, pistons, piston pins and flywheel. Noises timed to one-half engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source. However, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe noise is confined to one particular cylinder, ground spark plug leads, one at a time. If noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to location in engine: front to back, top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: flywheel or coupler; exhaust flappers rattling against exhaust pipe; crankshaft striking (pan, pan baffle, or dipstick tube); rocker arm striking valve cover; and loose flywheel cover. In many cases if this is found to be the problem, a complete engine teardown is not necessary.
6. When noise is isolated to a certain area and component, removal and inspection will be required. Refer to proper sections of service manual for information required for service.
7. If noise cannot be distinguished between engine and drive unit, remove drive from boat. Run a water supply directly to engine. Run engine without the drive to determine if noise is still there.

Valve Cover Area

Location	Possible Causes
Valve cover area, timed to one-half engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders	Rocker arm striking valve cover
	Rocker arm out of adjustment
	Worn rocker arm
	Bent push rod
	Collapsed lifter

Cylinder Area

Location	Possible Causes
Cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed	Sticking valve
	Carbon build-up
	Connecting rod installed wrong
	Bent connecting rod
	Piston
	Piston rings
	Piston pin
	Cylinder worn

Camshaft Area

Location	Possible Causes
Camshaft area, front of engine, timed to one half engine speed	Crankshaft timing sprocket
	Timing chain
	Valve Lifter
	Cam Bearings
Camshaft area, center of engine, timed to one half engine speed	Fuel Pump
	Valve Lifter
	Cam bearing
Camshaft area, rear of engine, timed to one half engine speed	Distributor gear
	Valve lifter
	Cam bearings
Camshaft area, throughout engine, timed to one half engine speed	Loss of oil pressure
	Valve lifters
	Cam bearings

Crankshaft Area

Location	Possible Causes
Crankshaft area, front of engine, timed to engine speed	Crankshaft timing sprocket
	Timing chain
	Main bearing
	Rod bearing
Crankshaft area, center of engine, timed to engine speed	Crankshaft striking pan or pan baffle
	Main bearing
	Rod bearing
Crankshaft area, rear of engine, timed to engine speed	Loose flywheel cover
	Loose coupler
	Loose flywheel
	Main bearing
	Rod bearing
Crankshaft area, throughout engine, timed to engine speed	Loss of oil pressure
	Main bearings
	Rod bearings

Miscellaneous

Noise	Possible Cause
Engine spark knock	Advanced timing
	Low octane fuel
	Engine running hot
	Carbon deposits in engine
Hissing	Vacuum leak
	Leaking exhaust (manifolds or pipes)
	Loose cylinder heads
	Blown head gasket
Whistle	Vacuum leak
	Dry or tight bearing in an accessory
Sparks jumping	Leaking high tension lead
	Cracked coil tower
	Cracked distributor cap
Squeaks or squeals	Serpentine drive belt slipping
	Dry or tight bearing in an accessory
	Parts rubbing together
Rattling in exhaust pipe area	Exhaust shutters

Oil Pressure

Miscellaneous

Cause	Special Information
Measuring oil pressure	Use a good automotive oil pressure test gauge. Do not rely on the oil pressure gauge in the boat.
Check engine oil level with boat at rest in the water	Oil level should be between the ADD and FULL / OP RANGE / OK marks
Oil level in crankcase above FULL mark	May cause loss of engine rpm, oil pressure gauge fluctuation, drop in oil pressure, and hydraulic valve lifter noise at high rpm
Oil level in crankcase below ADD mark	Low oil pressure; oil pressure gauge fluctuation; internal engine noise and/or damage
Change in oil pressure	This may be a normal condition. Oil pressure may read high in the cooler times of the day, and when engine is not up to operating temperature. As the air temperature warms up and engine is running at normal opening temperature, it is normal for oil pressure to drop.
Low engine oil pressure at idle	With modern engines and engine oils, low oil pressure readings at idle do not necessarily mean there is a problem. If valve lifters do not “clatter” (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and, also, the oil will get thin somewhat from heat.
Low engine oil pressure at idle after running at a high rpm	Refer to the two preceding steps
Boats with dual engines	It is not uncommon to see different oil pressure readings between the two engines, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, etc.
Boats with dual stations	

Low Oil Pressure

Cause	Special Information
Low oil level in crankcase	
Defective oil pressure gauge and/or sender	Verify with an automotive test gauge. Refer to SECTION 4D for instrument testing.
Thin or diluted oil	Oil broken down; contains water or gas; wrong viscosity; engine running too hot or too cold; excessive idling in cold water (condensation)
Oil pump	Relief valve stuck open; pickup tube restricted; worn parts in oil pump; air leak on suction side of oil pump or pickup oil tube
Oil leak can be internal or external	Oil passage plugs leaking, cracked or porous cylinder block
Excessive bearing clearance	Cam bearings, main bearings, rod bearings

High Oil Pressure

Cause	Special Information
Oil too thick	Wrong viscosity, oil full of sludge or tar
Defective oil pressure gauge and/or sender	Verify with an automotive test gauge
Clogged or restricted oil passage	
Oil pump relief valve stuck closed	

Excessive Oil Consumption

Cause	Special Information
Normal consumption.	One quart of oil consumed in 5-15 hours of operation at wide-open-throttle (especially in a new or rebuilt engine) is normal
Oil leaks	Clean bilge, run engine with clean white paper on bilge floor, locate oil leak(s)
Oil too thin	Oil diluted or wrong viscosity
Oil level too high	
Drain holes in cylinder head plugged	Oil will flood valve guides
Defective valve seals	
Intake manifold gasket leaking	
Worn valve stems or valve guides	
Defective oil cooler (if equipped)	Crack in cooler tubes
Defective piston rings	Glazed, scuffed, worn, stuck, improperly installed; ring grooves worn; improper break-in; wrong end gap
Defective cylinders	Out of round, scored, tapered, glazed; excessive piston to cylinder clearance; cracked piston
Excessive bearing clearance	

Water In Engine

Important Information

IMPORTANT: First determine location of water in engine. This information can help determine where the water came from and how it got into the engine. The three most common problems are water on top of pistons, water in crankcase oil or water in crankcase oil and on top of pistons.

After locating water remove all the water from the engine by removing all spark plugs and pumping cylinders out by cranking engine over. Change oil and filter. Replace spark plugs. Start engine and see if problem can be duplicated. If problem can be duplicated, there is a mechanical problem. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If water is contained to cylinder(s) only, it is usually entering through the intake system, exhaust system, or head gasket.

If the water is contained to crankcase only, it is usually caused by a cracked or porous block, a flooded bilge or condensation.

If the water is located in both the cylinder(s) and the crankcase, it is usually caused by water in the cylinders getting past the rings and valves, or complete submersion.

Checking for rust in the intake manifold or exhaust manifolds is a good idea. Rust in these areas will give clues if the water entered these areas.

Water on Top of Pistons

Cause	Special Information
Operator shut engine off at high rpm	
Engine “diesels” or tries to run backwards	Poor fuel, high idle rpm, timing set too high
Rain water running into flame arrestor	Hatch cover
Spark plug misfiring	Improper combustion causes moisture in the air to accumulate in the cylinder
Backwash through the exhaust system	
Improper engine or exhaust hose installation	
Cracked exhaust manifold	
Improper manifold to elbow gasket installation	
Loose cylinder head bolts	
Blown cylinder head gasket	Check for warped cylinder head or cylinder block
Cracked valve seat	
Porous or cracked casting	Check cylinder heads, cylinder block, and intake manifold

Water in Crankcase Oil

Cause	Special Information
Water in boat bilge	Boat has been submerged or bilge water was high enough to run in through dipstick tube
Water seeping past piston rings or valves	Refer to “Water in Engine” (“On Top of Pistons”)
Engine running cold	Defective thermostat, missing thermostat; prolonged idling in cold water
Intake manifold leaking near a water passage	
Cracked or porous casting	Check cylinder head, cylinder block, and intake manifold

Engine Overheats

Mechanical

Cause	Special Information
Engine rpm below specifications at wide-open-throttle (engine laboring)	Damaged or wrong propeller; growth on boat bottom; false bottom full of water
Wrong ignition timing	Timing too far advanced or retarded
Sticking distributor advance weights	
Spark plug wires crossed (wrong firing order)	
Lean fuel mixture	
Wrong heat range spark plugs	
Exhaust restriction	
Valve timing off	Jumped timing chain, or improperly installed
Blown head gasket(s)	A blown head gasket(s) normally cannot be detected by a compression check. Normally the engine will run at normal temperature at low rpm, but will overheat at speeds above 3000 rpm. **Engines that are seawater cooled**: Using a clear plastic hose, look for air bubbles between seawater pump and engine. If there are no bubbles present, install clear plastic hose between thermostat housing and manifold(s). If air bubbles are present at a higher rpm, it is a good indication there is a blown head gasket.
Insufficient lubrication to moving parts of engine	Defective oil pump, plugged oil passage, low oil level

Engine Overheats

Cooling System

Cause	Special Information
IMPORTANT: The first step is to verify if the engine is actually overheating or the temperature gauge or sender is faulty. **IMPORTANT: Best way to test gauge or sender is to replace them.**	
Loose or broken drive belt	
Seawater shutoff valve partially or fully closed (if equipped)	
Clogged or improperly installed sea strainer	
Loose hose connections between seawater pickup and seawater pump inlet (models with belt driven seawater pump only)	Pump will suck air. Pump may fail to prime or will force air bubbles into cooling system.
Seawater inlet hose kinked or collapsed	
Seawater pickup clogged	
Obstruction on boat bottom causing water turbulence	Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
Defective thermostat	
Exhaust elbow water outlet holes plugged	
Insufficient seawater pump operation	Worn pump impeller
Obstruction in cooling system such as casting flash, sand, rust, salt, etc.	Refer to water flow diagram for engine type being serviced
Engine circulating pump defective	
Also refer to “Engine Overheats - Mechanical”	
IMPORTANT: In addition to previous checks, make the following checks if engine is equipped with closed cooling.	
Low coolant level	
Antifreeze not mixed properly	Antifreeze should be mixed 50/50 or maximum 60/40 (60% antifreeze, 40% water)
Heat exchanger cores plugged	
Water hoses reversed at the water distribution block	Refer to water flow diagram in SECTION 6

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Insufficient Water Flow from Belt Driven Seawater Pickup Pump

Cause	Special Information
Drive belt	Loose, worn or broken
Seawater shutoff valve partially or fully closed	
Clogged or improperly installed sea strainer	
Loose hose connections between seawater pickup and seawater pump inlet	Pump will suck air, pump may fail to prime or will force air bubbles into cooling system
Seawater inlet hose kinked or plugged	
Seawater pickup plugged	
Obstruction on boat bottom causing water turbulence.	Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
Faulty seawater pump	

Power Steering

Poor, Erratic or No Assist

Cause	Special Information
Drive belt	Worn, broken or out of adjustment
Low fluid level	
Air in system	Air leak in lines, pump or air from installation. Refer to SECTION 9A for bleeding procedure.
Leaking hoses	Refer to SECTION 9A for bleeding procedure.
Steering cables and/or steering helm	Cable or helm partially frozen from rust or corrosion; cable over-lubricated; improper cable installation.
Binding in sterndrive unit	Refer to appropriate Sterndrive Service Manual
Restriction in hydraulic hoses	Causes a loss of pressure
Control valve not positioned properly, not balanced properly, or the mounting nut is loose	
Mounting bracket adjusting screw loose or mounting tube is loose	
Faulty pump	Flow control valve may be sticking
Worn piston ring or scored housing bore in cylinder.	Causes loss of pressure
Leaking valve body or loose fitting spool	

Noisy Pump

Cause	Special Information
Drive belt	Check belt tension
Low fluid level	
Air in fluid	Air leak in lines, pump or air from installation
Faulty pump	Use stethoscope to listen for noise in pump
Restricted fluid passages	Kinks or debris in hoses or debris in passages
Stop nut adjusted improperly	Refer to appropriate Sterndrive Service Manual
Steering cables installed that do not meet BIA standards	Refer to appropriate Sterndrive Service Manual

Fluid Leaks

Cause	Special Information
Loose hose connections	Refer to SECTION 9A for bleeding instructions
Damaged hose	
Oil leaking from top of pump	System overfilled; fluid contains water; fluid contains air
Cylinder piston rod seal	
Faulty seals in valve	
Faulty seals in o-rings in pump	
Cracked or porous metal parts	

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REMOVAL AND INSTALLATION

Section 2A - MCM Models

Table of Contents

Torque Specifications

Fastener Location		lb-in.	lb-ft	Nm
Drive Unit Shift Cable	Cable Barrel	Spread Cotter Key		
	Cable End Guide	See Note		
Hose Clamps		Securely		
Rear Engine Mounts			35-40	47-54
Power Steering Fluid Hose Fitting			23	31
Remote Control Shift Cables	Cable Barrel	Securely		
	Cable End Guide	See Note		

NOTE: *Tighten, then loosen nut 1/2 turn.*

Tools

Description	Part Number
Engine Alignment Tool	91-805475A1

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Engine Coupler Spline Grease	91-816391A4
Quicksilver Liquid Neoprene	92-27511-2
Loctite 592 Pipe Sealant With Teflon	Obtain Locally

Removal

IMPORTANT: Sterndrive unit must be removed prior to engine removal. Refer to Sterndrive Service Manual.

1. Disconnect battery cables from battery.
2. Remove instrument harness connector plug from engine harness receptacle after loosening clamp.

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

3. Using wrench to stabilize brass filter nut at fuel inlet, loosen fuel line fitting. Disconnect and suitably plug fuel line to prevent fuel in tank from leaking into bilge.
4. Disconnect throttle cable from carburetor or throttle body and retain locknuts and hardware.
5. Disconnect trim sender bullet connectors from transom assembly from engine harness.

NOTE: *After wires are disconnected be sure to loosen them from clamps or sta-straps retaining them to engine or hoses.*

6. **Alpha Models:** Slide sleeves back on BLK and WHT/GRN or GRY wires and disconnect engine harness wires from shift cut-out switch harness.
7. Disconnect MerCathode wires from MerCathode controller if mounted on engine, if equipped.
8. Disconnect seawater inlet hose from gimbal housing.
9. Disconnect exhaust elbow hoses (bellows).
10. Remove both shift cables from shift plate. Retain locknuts and hardware.
11. Disconnect any grounding wires and accessories connected to engine.
12. Disconnect and plug fluid hoses from power steering control valve on transom.

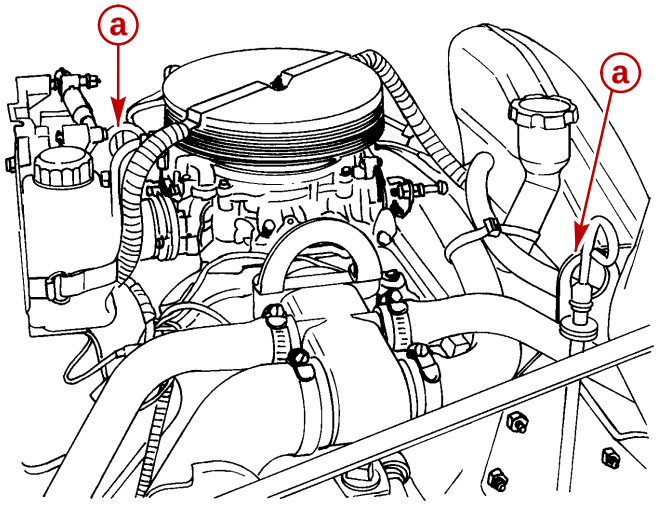
⚠ CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

⚠ CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage will occur.

13. Support engine with suitable sling through lifting eyes on engine and remove front and rear engine mounting bolts. Retain hardware.



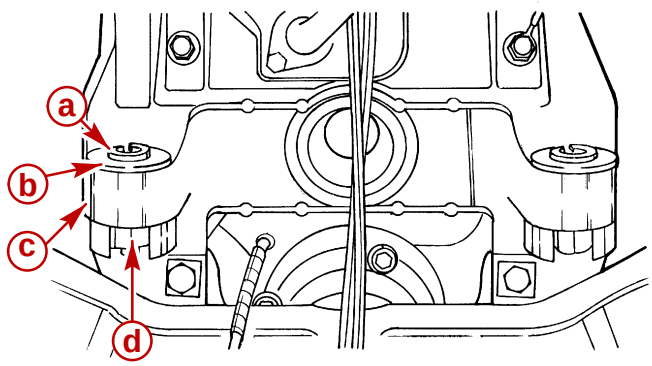
75847

a - Engine Lifting Eyes

14. Carefully remove engine. DO NOT hit power steering control valve.

Installation and Alignment

1. Inspect fiber washers (cemented in place) on inner transom plate. Replace if worn or damaged.
2. Install double wound lockwashers onto inner transom plate inside fiber washer.
3. Ensure that rear engine mount locknuts are in position.
4. Lubricate exhaust bellows with soap and water to ease installation.
5. Lubricate engine coupler splines with Quicksilver Engine Coupler Spline Grease.



72023

a - Double Wound Lockwasher
b - Fiber Wound Lockwasher (Cemented In Place)
c - Inner Transom Plate Mount (Engine Support)
d - Locknuts (Engine Mounting Bolts)

⚠ CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

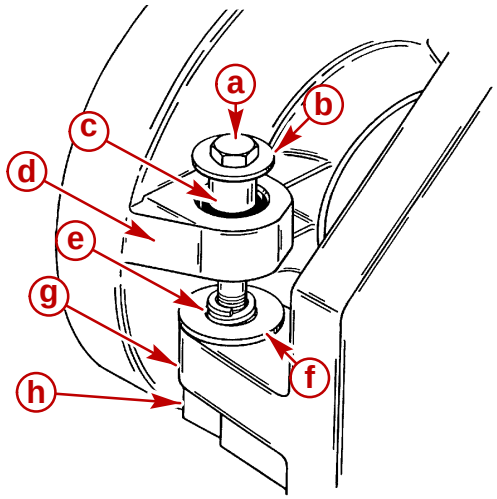
⚠ CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage will occur.

6. Attach a suitable sling to lifting eyes on engine and adjust so that engine is level when suspended.
7. Lift engine into position (in boat), using an overhead hoist.
8. Align rear engine mounts with inner transom plate mounts while simultaneously aligning exhaust tubes with exhaust pipe hoses (bellows).

IMPORTANT: Engine attaching hardware must be installed in sequence shown.

9. Install both rear engine mounting bolts and hardware as shown. Torque to 37 lb-ft (50 Nm).



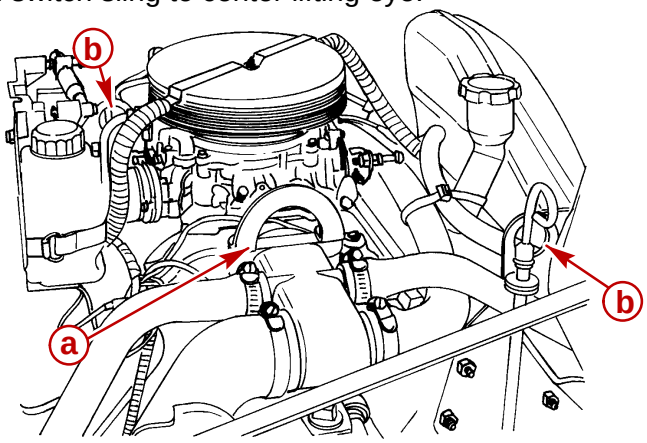
72535

a - Rear Engine Mounting Bolt
b - Large Steel Washer
c - Metal Spacer
d - Rear Engine Mount
e - Double Wound Lockwasher
f - Fiber Washer (Cemented in Place)
g - Inner Transom Plate Mounts
h - Locknut (Hidden In This View)

⚠ CAUTION

When lowering engine into position DO NOT set engine on shift cable. Shift cable outer casing can be crushed causing difficult or improper shifting.

10. Set engine down on stringers and relieve hoist tension. Disconnect sling from engine lifting eyes and switch sling to center lifting eye.



75847

a - Center Lifting Eye
b - Engine Lifting Eyes

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⚠ CAUTION

DO NOT use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tool 91-805475A1, may cause improper alignment and damage to gimbal bearing and/or engine coupler.

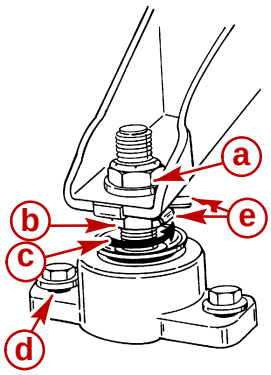
⚠ CAUTION

To avoid damage to gimbal bearing, engine coupler, or alignment tool:

- **DO NOT attempt to force alignment tool!**
- **DO NOT raise or lower engine with alignment tool inserted (or partially inserted) in gimbal bearing or engine coupler.**

⚠ CAUTION

Avoid damage to exhaust system. On engines with single piece manifolds, stress can be placed on the lower exhaust pipe if front of engine is raised too high while performing engine alignment procedure. Ensure that engine is not raised higher than the top of engine mount adjusting stud.



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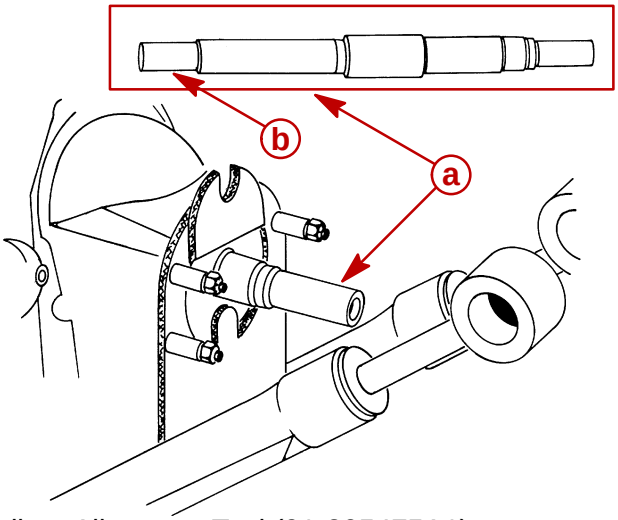
Engine Mount

- **a** - Nut and Lockwasher
- **b** - Adjustment Nut
- **c** - Turn Adjustment Nut in This Direction (Counterclockwise)
- **d** - Slotted Hole Toward Front of Engine
- **e** - Tab Washer

11. Align engine as follows:

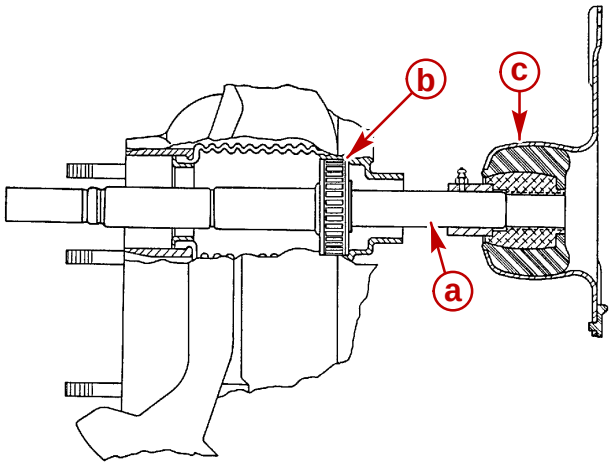
    a. Attempt to insert solid end of Quicksilver Alignment Tool through gimbal bearing and into engine coupler splines. If it will not insert easily proceed to following.

    b. While observing the above precautions, CAREFULLY raise and lower front of engine with hoist, as required, until tool will SLIDE FREELY all the way in and out of engine coupler splines.



70013

a - Quicksilver Alignment Tool (91-805475A1)
b - Insert This End of Alignment Tool through Gimbal Housing Assembly



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a - Alignment Tool (91-80547A1)
b - Gimbal Bearing
c - Engine Coupler

IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in direction required to align engine.

    c. Adjust front engine mounts until they rest on boat stringers.

    d. Relieve hoist tension entirely and fasten both front mounts to boat stringer using appropriate hardware (lag bolts or through-bolts, etc.).

    e. Recheck alignment with alignment tool. Tool must enter coupler splines freely. If not, readjust front mounts.

    f. When alignment is correct, tighten locknut or nut with lockwasher on each mount securely.

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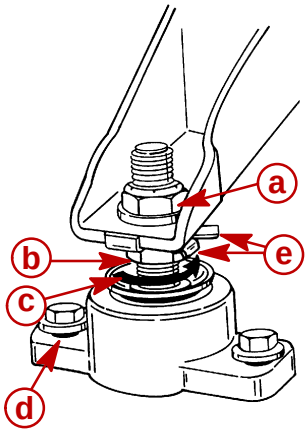
g. Bend tab washer down against flat on adjusting nut.



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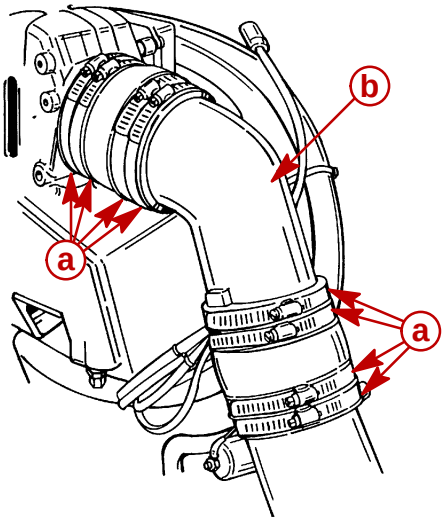
a - Locknut
b - Adjustment Nut
c - Turn Adjustment Nut In This Direction (Counterclockwise) To Raise Front Of Engine
d - Slotted Hole To Front Of Engine
e - Tab Washer

h. Remove alignment tool if not already removed.

12. Tighten all exhaust system hose clamps securely (use two hose clamps on each connection):

a. **On Engines with Thru-Prop Exhaust:**



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Thru Prop Exhaust Shown

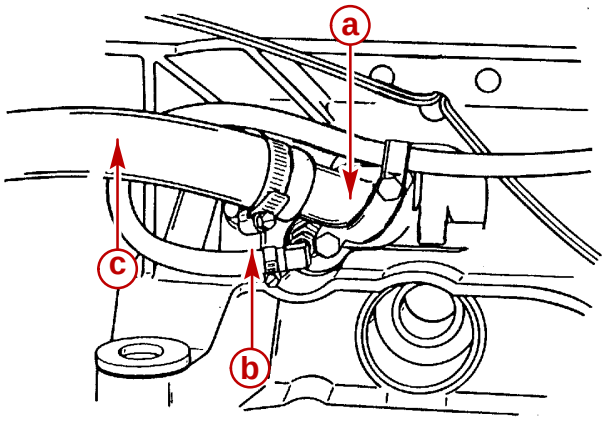
a - Hose Clamps
b - Exhaust Tube - Long Tube, Port Side - Short Tube, Starboard Side

Engine Connections

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

1. Connect seawater hose to water tube at gimbal housing with hose clamp. Tighten clamp securely.

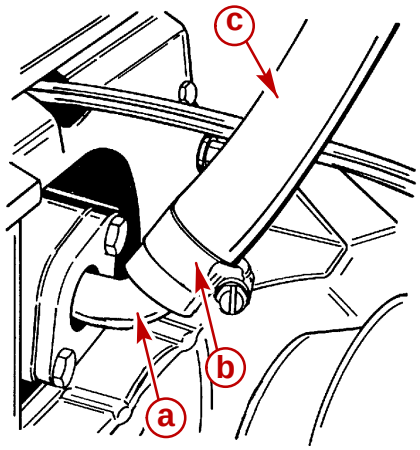
NOTE: *For visual clarity the engine is not shown in position.*



72590

Bravo Models

a - Water Inlet Tube
b - Hose Clamp
c - Seawater Inlet



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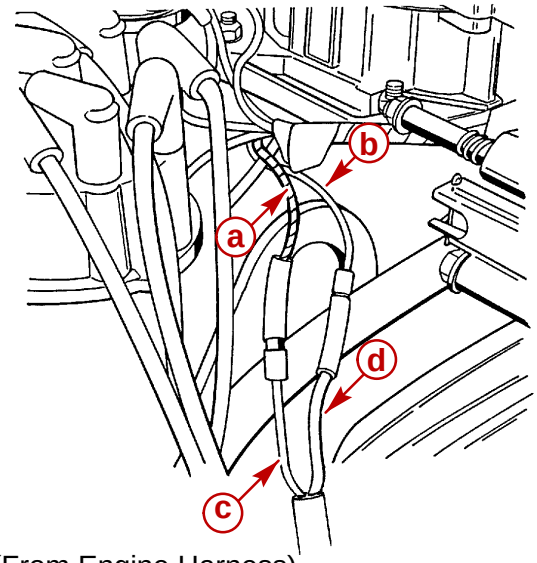
Alpha Models

a - Water Inlet Tube
b - Hose Clamp
c - Seawater Inlet

Electrical Connections

1. Connect instrument harness to engine harness with hose clamp. Tighten clamp securely.
2. Connect trim position sender leads from gimbal housing to leads from engine harness.



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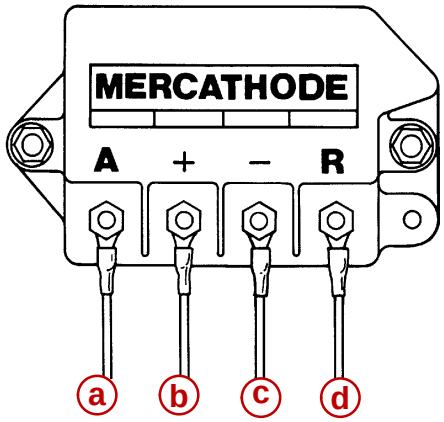
a - BRN/WHT (From Engine Harness)
b - BLK (From Engine Harness)
c - BLK (From Transom)
d - BLK (From Transom Assembly)

IMPORTANT: Do not attach any accessory ground (–) wires to transom plate ground point. Accessory ground wires should only be attached to ground stud on engine.

3. Connect any grounding wires or accessories that may have been disconnected.

Mercathode Connections (if equipped)

1. Connect MerCathode wires to MerCathode controller assembly. Apply a thin coat of Quicksilver Liquid Neoprene to all connections.



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a - ORG Wire - From Electrode on Transom Assembly
b - RED/PUR Wire - To Positive (+) Battery Terminal
c - BLK Wire - From Engine Harness
d - BRN Wire - From Electrode on Transom Assembly

IMPORTANT: Adjust shift cables as outlined in appropriate Sterndrive Service Manual.

Shift Cable Installation

1. Refer to appropriate Sterndrive Service Manual and install and adjust drive unit and remote control shift cables, using hardware retained.

Power Steering Connections

IMPORTANT: After fluid hose installation in the following, bleed power steering system as outlined in SECTION 1B - "Maintenance" or refer to appropriate Sterndrive Service Manual.

1. Connect power steering fluid hoses to control valve (large fitting first).

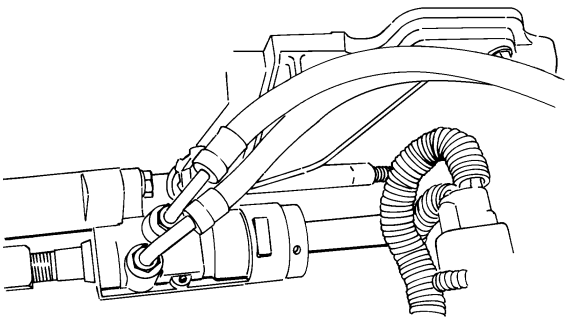
⚠ CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hose.

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leakage.

IMPORTANT: DO NOT cross-thread or overtighten fittings.

2. Torque both fittings to 23 lb-ft (31 Nm).



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3. Connect battery cables to battery by FIRST connecting POSITIVE (+) battery cable (usually RED) to POSITIVE (+) battery terminal. Tighten clamp securely. Then, connect NEGATIVE (–) battery cable (usually BLK) to NEGATIVE (–) battery terminal. Tighten clamp securely.

NOTE: *Spray terminals with a battery connection sealant to help retard corrosion.*

Fuel Supply Connections

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER TIGHTEN.**
- **Install fuel line. To prevent over tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

⚠ WARNING

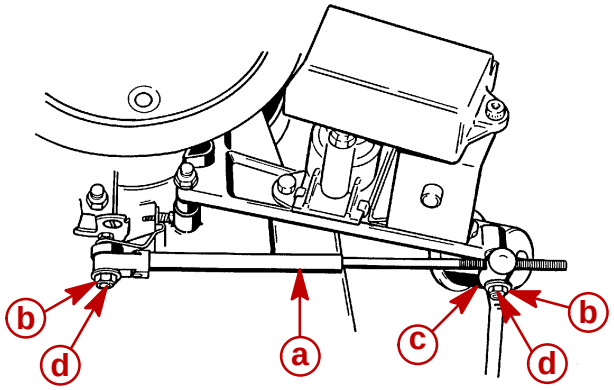
Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

1. Connect fuel line from fuel tank(s) to engine. Tighten connections securely.
2. Check for leaks.

Throttle Cable Installation and Adjustment

1. Connect throttle cable using hardware retained and adjust as follows:

CARBURETED ENGINES



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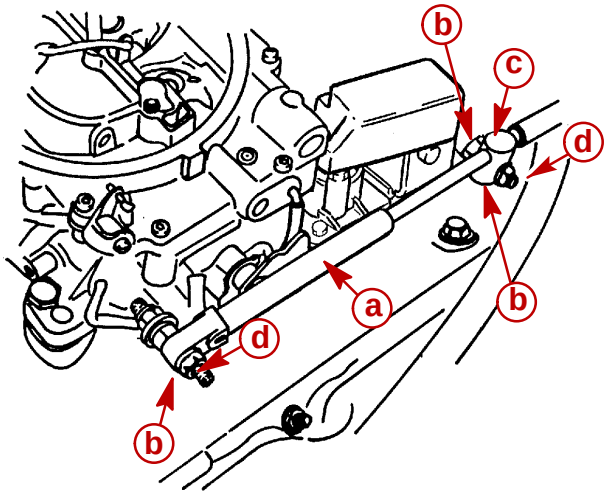
MerCarb 2 Barrel Carburetor

- **a** - Cable End Guide
- **b** - Attaching Hardware
- **c** - Cable Barrel
- **d** - Anchor Studs



72014

Weber 4 Barrel Carburetor

- **a** - Cable End Guide
- **b** - Attaching Hardware (DO NOT Overtighten)
- **c** - Cable Barrel
- **d** - Anchor Studs

1. Place remote control handle(s) in neutral, idle position.

IMPORTANT: Be sure that cable is routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

2. Install cable end guide on throttle lever, then push cable barrel lightly toward throttle lever end. (This will place a slight preload on cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with anchor stud.

3. Secure throttle cable with hardware (retained). Tighten cable end guide nut until it contracts and then loosen 1/2 turn. Tighten cable barrel securely. DO NOT OVERTIGHTEN, as cable must pivot freely.

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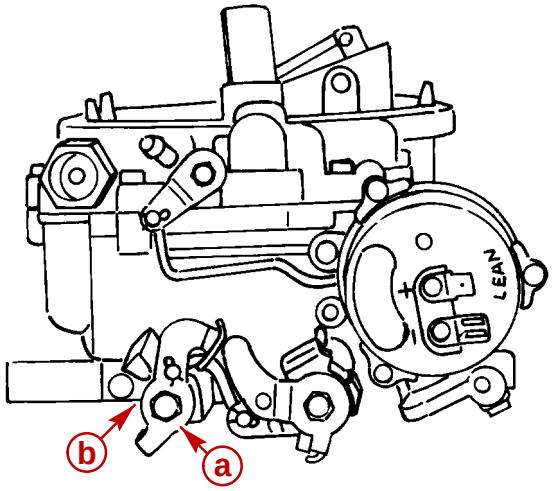
4. Place remote control throttle lever in the wide-open-throttle (WOT) position. Ensure that throttle shutters (valves) are completely open and throttle shaft lever contacts carburetor body casting.
5. Return remote control throttle lever to idle position and check to ensure that throttle lever contacts idle speed adjustment screw.



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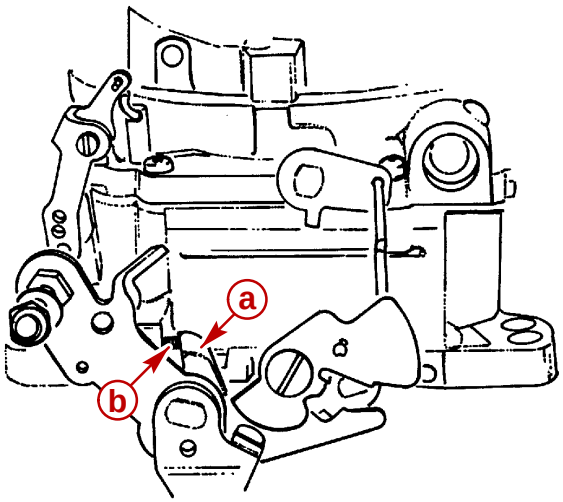
Weber 4 Barrel Carburetor Wide-Open-Throttle

a - Throttle Shaft Lever
b - Carburetor Body Casting



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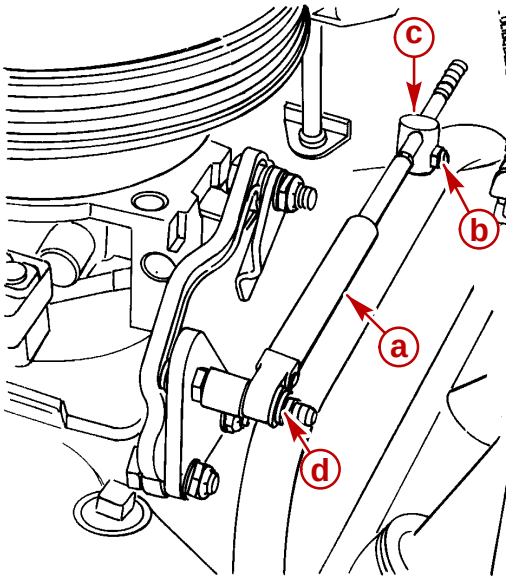
Weber 4 Barrel Carburetor Idle Position

a - Throttle Lever
b - Idle Speed Adjustment Screw

1. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever). Adjust barrel on throttle cable to align with hole in anchor plate.
2. Secure throttle cable with hardware as shown and tighten securely. Tighten locknut until it contacts, then loosen one-half turn.
3. Place remote control throttle level in the wide open throttle (WOT) position. Ensure that throttle plates are completely open.
4. Return remote control throttle lever to idle position.



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a - Cable End Guide
b - Flat Washer and Locknut
c - Cable Barrel
d - Flat Washer and Locknut

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ENGINE

Section 3A - 262 cid (4.3L) Engines

Table of Contents

Torque Specifications 262 cid (4.3L) Engines

Description	lb-in.	lb-ft	Nm
Alternator Brace to Alternator	192		28
Alternator Brace to Engine		30	41
Alternator to Mounting Bracket		35	48
Alternator Mounting Bracket		30	41
Balance Shaft Drive Gear Retaining Stud	120		14
Balance Shaft Driven Gear Bolt **(Torque Plus 35°)**		15	20
Balance Shaft Thrust Plate	120		14
Camshaft Sprocket		20	27
Camshaft Thrust Plate	106		12
Carburetor	132		15
Connecting Rod Cap Nuts **(Torque Plus 70°)**		20	27
Coupler/Flywheel		35	48
Crankcase Front Cover	124		14
Crankshaft Pulley Bolt (Cast Aluminum)		40	54
Cylinder Head Bolts - First Sequence		22	30
Angle Torque Second Sequence			
Short Bolt		55 Degrees	
Medium Bolt		65 Degrees	
Long Bolt		75 Degrees	
Distributor Hold Down		25	34
Exhaust Manifold		20	27
Flywheel		75	100
Flywheel Housing to Block		30	41
Flywheel Housing Cover	80		9
Front Mount Bracket		30	41
Fuel Filter Bracket Bolt		25	25
Fuel Pump Bracket Bolt		25	25
Fuel Pump Inlet Fitting (Large Diameter See Note)	96		10.8
Fuel Pump Inlet Fitting (Small Diameter See Note)	84		9.6
Intake Manifold Bolts		11	15
Knock Sensor		15	20

NOTE: *Hold fuel pump using flat surface at outlet before tightening brass fitting.*

Torque Specifications 262 cid (4.3L) Engines (continued)

Description	lb-in	lb-ft	Nm
Main Bearing Cap		75	100
Oil Filter Adapter Bolts		15	20
Oil Pan Drain Plug		15	20
Oil Pan Screw (1/4-20)	80		9
Oil Pan Nuts (5/16-20)	165		19
Oil Pump		65	68
Oil Pump Cover	80		9
Power Steering Pump Brace to Block		30	41
Power Steering Pump Bracket		30	41
Rear Crankshaft Oil Seal Retainer Screws and Nuts	133		15
Rear Mount (MCM)		40	54
Rocker Arm Cover	106		12
Rocker Arm Nuts		22	30
Roller Lifter Restrictor Plate		12	16
Seawater Pump Brace (if equipped)		30	41
Seawater Pump Bracket (if equipped)		30	41
Spark Plugs		15	20
Starter Motor		50	68
Thermostat Housing		30	41
Torsional Damper		40	54
Water Circulating Pump		30	41
Water Temperature Sender		20	27

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Loctite 27131	92-809820
Quicksilver RTV Sealer	92-91601-1
Quicksilver Perfect Seal	92-34227--1
Quicksilver Needle Bearing Assembly Lubricant	92-825265A1
General Motors Cam and Lifter Prelube or Equivalent	Obtain Locally

Tools

Mercury Marine Special Tools	
Description	**Part Number**
Piston Ring Expander	91-24697
Engine Coupler Wrench	91-35547

Special Tools

Snap-On Special Tools (see note)	
Description	**Part Number**
Torque Angle Gauge (Degree Wheel Torquing)	TA 360

NOTE: *Snap-On Tools can be ordered from your nearest Snap-On branch sales office or distributor.*

Kent-Moore Special Tools	
Kent-Moore Special Tools 29784 Little Mack Roseville, MI 48066 (800) 345-2233	
Description	**Part Number**
Valve Spring Compressor	J5892
Valve Spring Compressor	J8062
Valve Spring Tester	J8056
Valve Guide Cleaner	J8101
Valve Guide Reamer	J5830-2
Carbon Remover Brush	J8089
Piston Pin Remover Kit	J24086-B
Piston Ring Groove Cleaner	J3936-03
Piston Ring Compressor	J8037
Connecting Rod Bolt Guide Set (3/8-24)	J5239
Oil Pump Suction Pipe Installer	J21882
Camshaft Bearing Remover and Installer Set	J6098-01
Ball Socket Adaptor Tool Kit (Lift Indicator)	J8520-1
Torsional Damper Remover and Installer	J23523-E
Crankcase Front Cover Seal Installer	J35468
Crankshaft Gear and Sprocket Puller	J5825-A
Crankshaft Gear and Sprocket Installer	J5590
Air Adaptor	J23590
Main Bearing Remover/Installer	J8080
Rear Main Seal Installer	J26817-A
Balance Shaft Rear Bearing Remover	J26941
Balance Shaft Bearing Remover/Installer	J33834

Specifications

262 CID / 4.3L Engine Specifications

NOTICE
Unit Of Measurement: Inches (Millimeters)

Displacement	262 cid (4.3 L)
Bore	4.00 (101.6)
Stroke	3.48 (88.39)
Compression Ratio	9.2:1
Heads	Cast Iron
Intake manifold	Cast Iron
Block	Cast Iron (2 Bolt Main Bearing Caps)
Rods	Forged Steel
Pistons	Cast Aluminum
Crankshaft	Cast Iron
Camshaft	Steel

CYLINDER BORE

Diameter			4.0007-4.0017 (101.6178-1016431)
Out-of-Round		Production	.0005 (0.0127) Maximum
		Service	.002 (0.05) Maximum
Taper	Production	Thrust Side	.0005 (0.0127) Maximum
		Relief Side	.001 (0.02) Maximum
	Service		.001 (0.02) Over Production

PISTON

Clearance	Production	.0007-.002 (0.017 - 0.05)
	Service	.002 (0.60) Maximum

262 CID / 4.3L Engine Specifications

NOTICE
Unit Of Measurement: Inches (Millimeters)

PISTON RING

Compression	Groove Side Clearance	Production	Top	.02-.06 (0.508-1.524)
			2nd	.04-.08 (1.016-2.032)
		Service		.004 (0.10) Maximum
	Gap	Production	Top	.010-.016 (0.25-0.40)
			2nd	.018-.026 (0.46-0.66) Maximum
		Service		.06-.035 (1.52-0.88) Maximum
Oil	Groove Side Clearance	Production		.02-.07 (0.508-0.177)
		Service		.02-.08 (0.50-2.03) Maximum
	Gap	Production		.015-.050 (0.381-1.27)
		Service		.009-.065 (0.23-1.65) Maximum

PISTON PIN

Diameter		.9267-.9271 (23.545-23.548)
Clearance in Piston	Production	.0002-.0007 (0.0051-0.0177)
	Service	.001 (0.02) Maximum
Fit in Rod		.0008-.0016 (0.021-0.040) Interference

262 CID / 4.3L Engine Specifications

CRANKSHAFT

NOTICE
Unit Of Measurement: Inches (Millimeters)

Main Journal	Diameter	No. 1	2.4488-2.4495 (62.199-62.217)
		No. 2, 3	2.4485-2.4494 (62.191-62.215)
		No. 4	2.4479-2.4489 (62.179-62.203)
	Taper	Production	.0003 (0.007) Maximum
		Service	.001 (0.02) Maximum
	Out-of-Round	Production	.0002 (0.005) Maximum
		Service	.001 (0.02) Maximum
Main Bearing Clearance	Production	No. 1	.0008-.0020 (0.0203-0.0508)
		No. 2, 3, 4	.0011-.0023 (0.0279-0.0584)
	Service	No. 1	.001-.002 (0.03-0.05)
		No. 2, 3, 4	.001-.002 (0.25-0.06)
Crankshaft End Play			.002-.008 (0.05-0.20)
Crankshaft Runout			.001 (0.025) Maximum
Connecting Rod Journal	Diameter		2.2487-2.2497 (57.1170-57.1423)
	Taper	Production	.0003 (0.00508) Maximum
		Service	.001 (0.02) Maximum
	Out-of-Round	Production	.0002 (0.007) Maximum
		Service	.001 (0.02) Maximum
Rod Bearing Clearance		Production	.0013-.0035 (0.0330-0.0889)
		Service	.001-.003 (0.02-0.07) Maximum
Rod Side Clearance			.006-.017 (0.152-0.44)

262 CID / 4.3L Engine Specifications

NOTICE
Unit Of Measurement: Inches (Millimeters)

VALVE SYSTEM

Lifter			Hydraulic Roller
Rocker Arm Ratio			1.50:1
Valve Lift		Intake	.414 (10.52)
		Exhaust	.428 (10.87)
Valve Lash (Intake and Exhaust)			Net Lash No Adjustment
Face Angle (Intake & Exhaust)			45°
Seat Angle (Intake & Exhaust)			46°
Seat Runout (Intake & Exhaust)			.002 (0.05) Maximum
Seat Width		Intake	.035-.060 (0.89-1.52)
		Exhaust	.062-.093 (1.58-2.38)
Stem Clearance	Production	Intake	.0011-.0027 (0.0279-0.069)
		Exhaust	
	Service	Intake	.001 (0.025) Maximum
		Exhaust	.002 (0.51) Maximum
Stem Diameter		Intake	.341 (8.64)
		Exhaust	
Valve Margin Intake and Exhaust			.031 (0.79)

VALVE SPRING

Valve Spring	Free Length		2.03 (51.6)
	Pressure	Valve Closed	76-84 Lb. (338-374 N) at 1.7 in (43.16 mm)
		Valve Open	187-203 Lb. (832-903 N) at 1.27 in (32.25 mm)
	Installed Height Intake		1.78 in (45.2 mm)
	Installed Height Exhaust		1.69-1.71 in. (42.9-43.43)

262 CID / 4.3L Engine Specifications

NOTICE
Unit Of Measurement: Inches (Millimeters)

CAMSHAFT AND DRIVE

Lobe Lift ±. 002(0.051)	Intake	.286-.290 (7.26-7.36)
	Exhaust	.292-.296 (7.42-7.52)
Journal Diameter		1.8682-1.8692 (47.452-47.478)
Journal Out of Round		.001 (0.025) Maximum
Camshaft Runout		.002 (0.051) Maximum
Camshaft End Play		.001-.009 (0..0254-0.2286)
Timing Chain Deflection		.375 (9.5) from taut position [total .75 (19)]

FLYWHEEL

Runout	.008 (0.203) Maximum

CYLINDER HEAD

Gasket Surface Flatness	.010 (0.254) Overall Maximum

BALANCE SHAFT

Front Bearing Journal		2.1648-2.1654 (55.985-55.001)
Rear Bearing Journal		1.4994-1.500 (38.084-38.100)
Rear Bearing Inside Diameter Assembled	Production	1.5014-1.503 (37.525-37.575)
Rear Bearing Outside Diameter	Production	1.875-1.876 (46.875-46.900)
Rear Cylinder Block Housing Bore	Production	1.873-1.874 (46.825-46.850)
Rear Bearing Journal Clearance		.001-.0036 (.025-.091)

General

Some of the repairs in this section must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

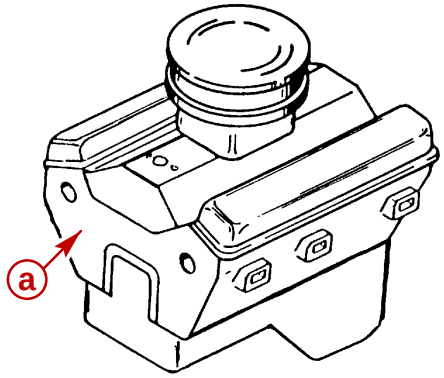
When engine removal is not required, make certain that battery cables are disconnected at the battery prior to performing any on-board engine repair procedure.

Lubricate all moving parts (during reassembly) with engine oil. Apply Quicksilver Perfect Seal on threads of and under heads of cylinder head bolts and on threads of all cylinder block external bolts, screws and studs.

Engine Identification

The Mercury MerCruiser Model can be determined by looking at the last two letters of the engine code stamped into the cylinder block. This code number is stamped on all Mercury MerCruiser power packages and replacement partial engines, but not replacement cylinder block assemblies.

If the engine serial number and/or model decals are missing, the engine code letters may help in determining the engine models.

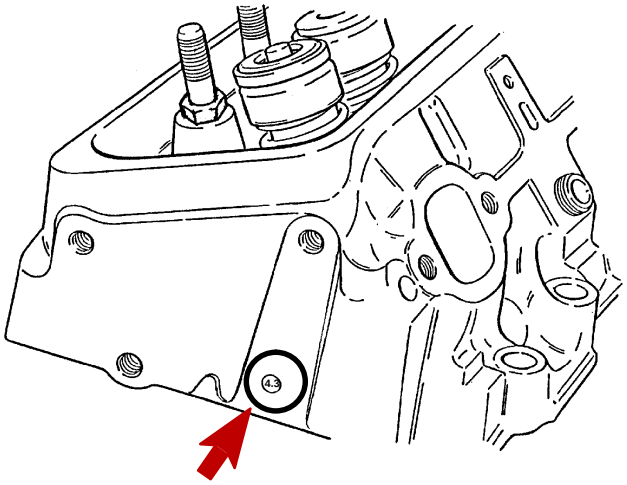


72873

a - Location of GM Engine Code (Front Starboard Side, Near Cylinder Head Mating Surface)

MCM (Sterndrive)	Code	Rotation
4.3L	LJ	LH
4.3LH	LK	
4.3L EFI	LK	

Cylinder Head Identification



72875

a - Left Hand Rotation (CCW) - All Sterndrive Engines

Crankshaft

The crankshaft is supported in the block by four insert type bearings. Crankshaft end thrust is controlled by flanges on the No. 4 bearing. A torsional damper on the forward end of the crankshaft serves to help dampen any engine torsional vibration.

Piston and Connecting Rods

Piston pins are offset slightly toward the thrust side of the pistons to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins have a floating fit in the piston and a press fit in the connecting rod (to hold them in place).

Connecting rods are made of forged steel and are connected to the crankshaft through insert type bearings.

Camshaft and Drive

Camshafts are generally cast iron. However, engines with roller lifters have steel camshafts. All camshafts are driven at 1/2 crankshaft speed by a timing chain and sprockets, and are supported by four main bearings, which are pressed into the block.

A helical gear on the aft end of the camshaft drives the distributor and oil pump.

Balance Shaft

The balance shaft is located in the engine block valley directly above and parallel to the camshaft. The balance shaft extends the entire length of the engine and is supported on each end by a bearing. It is also driven by the camshaft through a helical gear set. The function of the balance shaft is to equalize the dynamic forces inherent in particular engine designs, thus minimizing engine vibration.

Cylinder Head

The cylinder heads are made of cast iron and have individual intake and exhaust ports for each cylinder.

Stainless steel or graphite composition head gaskets are used to retard corrosion.

Valve Train

The valves and valve springs are of a heavy-duty design to withstand the high engine speeds encountered. Valve tips have been hardened to extend valve life. Exhaust valve rotators are used to help extend valve life.

Hydraulic valve roller lifters ride directly on the camshaft lobes and transmit the thrust of the lobes to the push rods which in turn actuate the valves through the rocker arm.

In addition to transmitting thrust of the cam lobes, the hydraulic lifters also serve to remove any clearance (lash) from the valve train to keep all parts in constant contact.

The roller lifters are restrained from rotating by two retainers (restrictors) located in the valley. The valve lifters also are used to lubricate the valve train bearing surfaces.

Intake Manifold

The manifold is of the single level design for efficient fuel distribution. All passages are of approximately equal length to assure more even fuel-air mixture to the cylinders.

Lubrication System

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the crankshaft, connecting rods, camshaft bearings and valve lifters, and is supplied under controlled volume to the push rods and rocker arms. All other moving parts are lubricated by gravity flow or splash.

A positive displacement gear-type oil pump is mounted on the rear main bearing cap and is driven by an extension shaft from the distributor (which is driven by the camshaft). Oil from the bottom of the pump in the rear of the oil pan is drawn into the oil pump through an oil pickup screen and pipe assembly.

If the screen should become clogged, a relief valve in the screen will open and continue to allow oil to be drawn into the system. Once the oil reaches the pump, the pump forces the oil through the lubrication system. A spring-loaded relief valve in the pump limits the maximum pump output pressure.

After leaving the pump, the pressurized oil flows through a full-flow oil filter. On engines with an engine oil cooler, the oil also flows through the cooler before returning to the block. A bypass valve allows oil to bypass the filter and oil cooler should they become restricted.

Some of the oil, after leaving the oil cooler and/or filter, is routed to the No. 4 crankshaft main bearing. The remainder of the oil is routed to the main oil gallery, which is located directly above the camshaft and runs the entire length of the block. From the main oil gallery, the oil is routed through individual oil passages to an annular groove in each camshaft bearing bore. Some of the oil is then used to lubricate camshaft bearings. The remainder of the oil is routed to the valve lifter oil galleries and No. 1, 2 and 3 crankshaft main bearings by means of individual oil passages which intersect with the annular grooves.

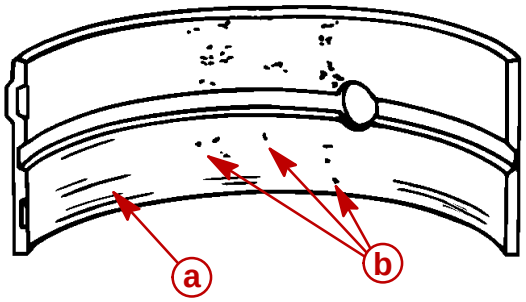
The camshaft bearings have holes which align with the oil passages or annular grooves in the block and allow oil to flow in-between the bearings and the camshaft journals. The oil that is forced out the front end of the No. 1 camshaft bearing drains down onto the camshaft drive and keeps it lubricated.

The oil which reaches the crankshaft main bearings is forced through a hole in the upper half of each bearing and flows in-between the bearings and the crankshaft journals. Some of the oil is then routed to the connecting rod bearings through grooves in the upper half of the crankshaft main bearings and oil passages in the crankshaft. Oil which is forced out the ends of the connecting rod bearings and crankshaft main bearings is splashed onto the camshaft, cylinder walls, pistons and piston pins, keeping them lubricated. Oil which is forced out the front end of the No. 1 crankshaft main bearing also assists in lubricating the camshaft drive.

Oil which reaches the valve lifter oil galleries is forced into each hydraulic valve lifter through holes in the side of the lifter. From here, the oil is forced through the metering valve in each of the lifters (which controls the volume of oil flow) and then up through the push rods to the rocker arms. A hole in each rocker arm push rod seat allows the oil to pass through the rocker arm and lubricate the valve train bearing surfaces. After lubricating the valve train, oil drains back to the oil pan through oil return holes in the cylinder head and block.

The distributor shaft and gear also is lubricated by the oil flowing through the right valve lifter oil gallery.

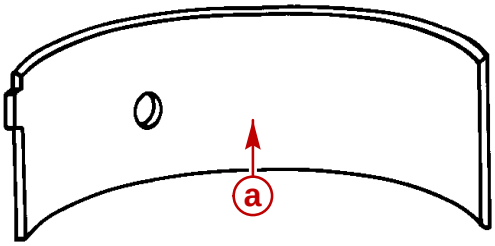
Bearing Failures



70436

Scratched By Dirt

a - Scratches
b - Dirt Imbedded In Bearing Material

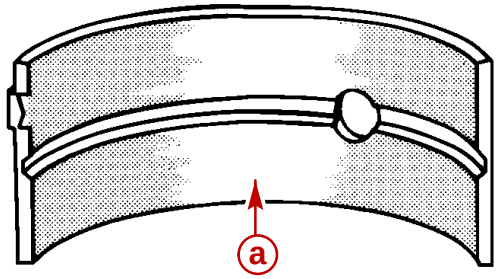


70436

Tapered Journal

a - Overlay Gone From Entire Surface

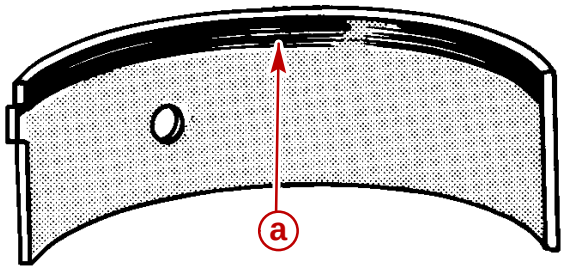
Bearing Failures (Continued)



70436

Lack Of Oil

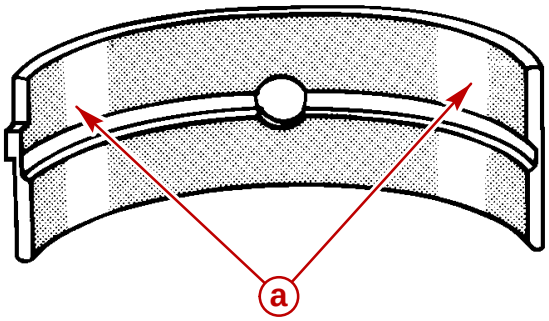
a - Overlay Worn Off



70436

Radius Ride

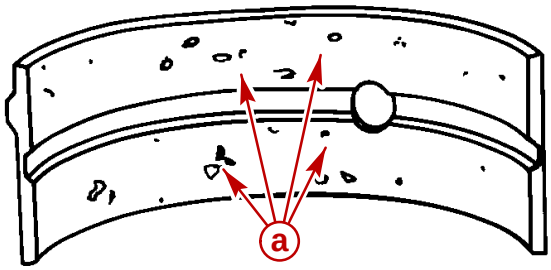
a - Worn Area



70436

Improper Seating

a - Bright Or Polished Sections



70436

Fatigue Failure

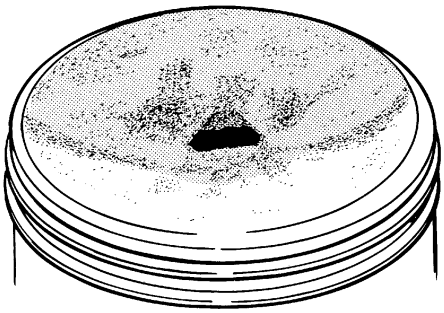
a - Craters or Pockets

Piston Failures

NOTE: *Engine failure due to pre ignition or detonation are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.*

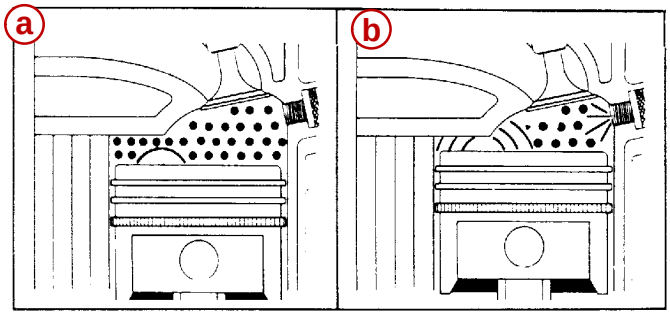
Pre-Ignition

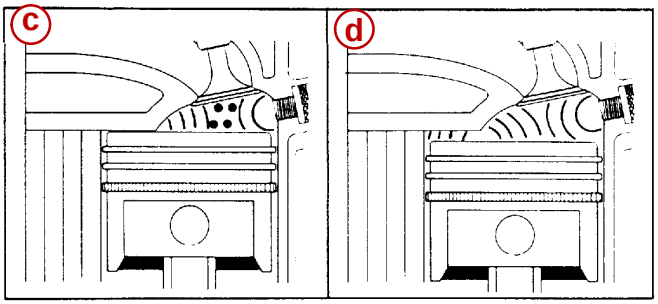
Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion on the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.



72424

Pre-Ignition Damage





72314

Combustion Differences

- **a** - Ignited By Hot Deposits
- **b** - Regular Ignition Spark
- **c** - Ignites Remaining Fuel
- **d** - Flame Front Collide

PRE-IGNITION CAUSES

1. Hot spots in the combustion chamber from glowing deposits (due in turn to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material which can serve as a source.

Detonation

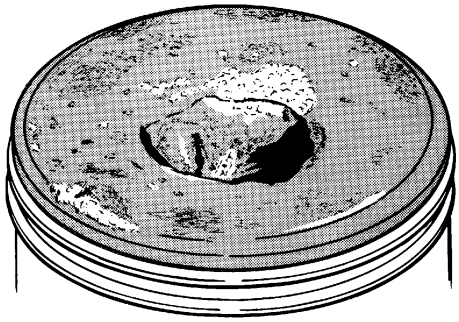
Detonation, commonly called “fuel knock,” “spark knock” or “carbon knock,” is abnormal combustion of the fuel which causes the fuel to explode violently. The explosion, in turn, causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition.

Use of low octane gasoline is one of the most common causes of detonation. Even with high octane gasoline, detonation could occur if engine maintenance is neglected.

OTHER CAUSES OF DETONATION

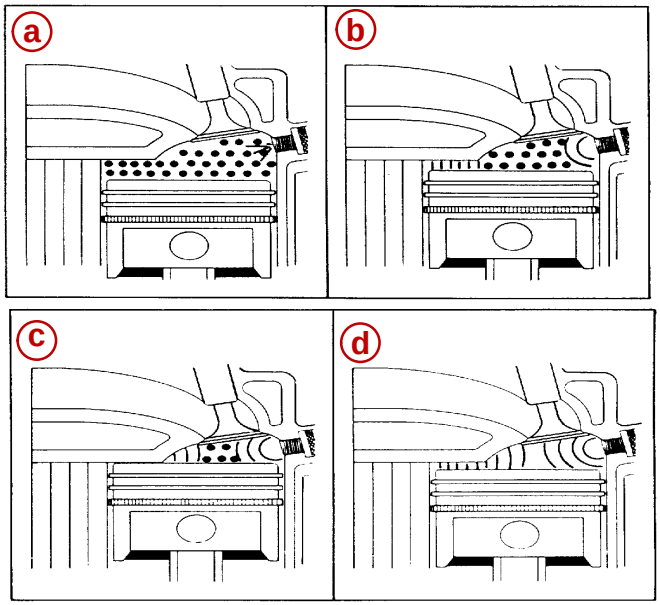
IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

1. Over-advanced ignition timing.
2. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
3. Cross-firing spark plugs.
4. Excess accumulation of deposits on piston and/or combustion chamber (results in higher compression ratio).
5. Inadequate cooling of engine by deterioration of cooling system.



72425

Detonation Damage

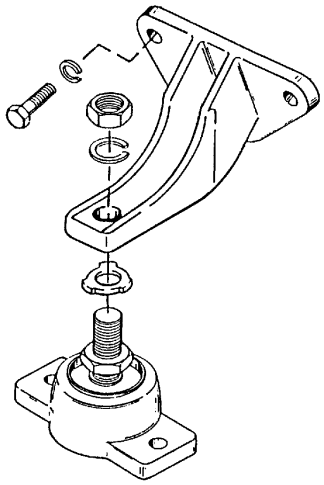


72315

Combustion Description

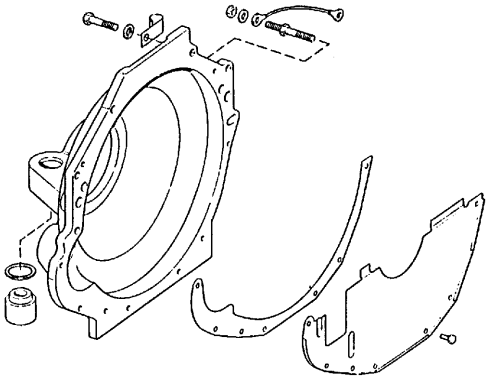
a - Spark Occurs
b - Combustion Begins
c - Combustion Continues
d - Detonation Occurs

Engine Mounts



72316

Front Mount



72318

Rear Mount/Flywheel Housing

IMPORTANT: Press rear mount out with press.

Rocker Arm Cover

Removal

It may be necessary to remove exhaust manifold before removing rocker arm cover. (Refer to Section 7B)

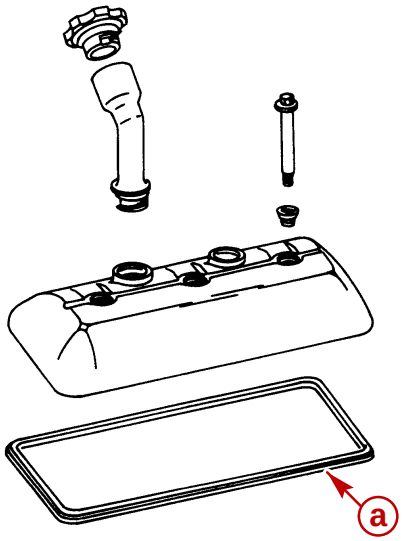
1. Disconnect crankcase ventilation hoses.
2. Remove any items that interfere with the removal of rocker arm covers.

IMPORTANT: DO NOT pry rocker arm cover loose. Gaskets, which may adhere to cylinder head and rocker arm cover, may be loosened by bumping end of rocker cover from the rear with palm of hand or a rubber mallet.

3. Remove rocker arm cover.

Installation

1. Clean sealing surfaces on cylinder head and rocker arm cover with degreaser.
2. Place new rocker arm cover gasket in position in rocker arm cover.



75853

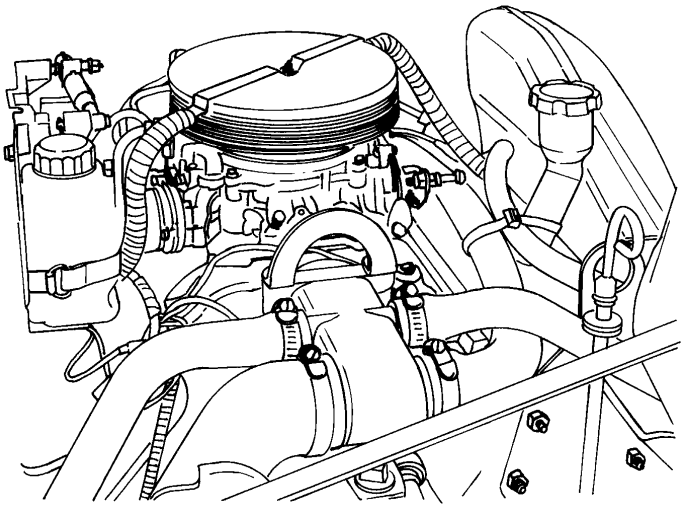
a - Rocker Arm Cover Gasket

3. Install rocker arm cover. Torque screws to 106 lb-in. (12 Nm).
4. Install exhaust manifolds, if removed.
5. Install any items which were removed to allow removal of rocker arm covers.
6. Connect crankcase ventilation hoses to rocker arm covers.
7. Start engine and check for oil leaks.

Intake Manifold

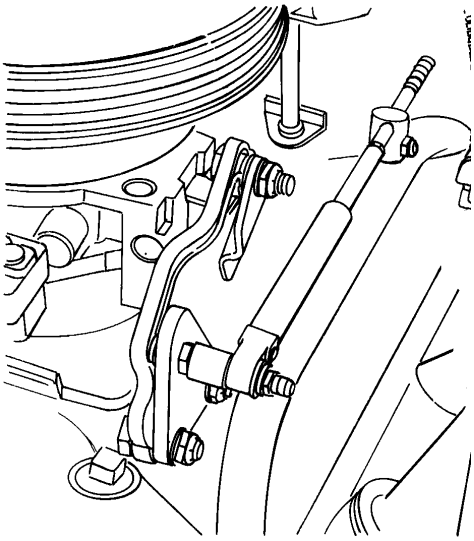
Removal

1. Drain engine cooling system.
2. Disconnect hoses from thermostat housing.



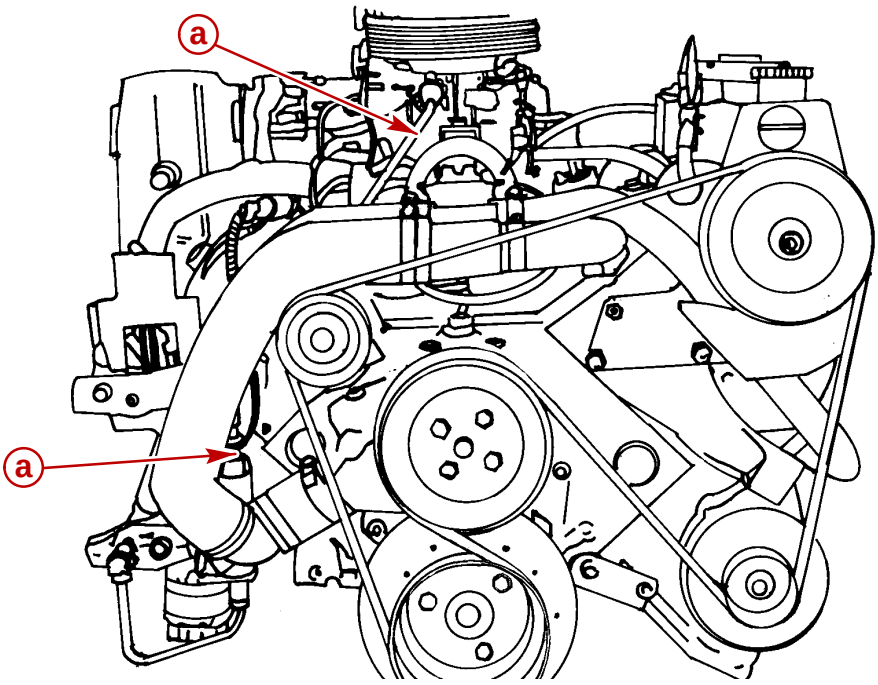
75847

3. Disconnect electrical leads interfering with removal.
4. Disconnect crankcase ventilation hoses from rocker arm covers.
5. Disconnect throttle cable from carburetor or throttle body.



75867

6. Remove fuel line running between fuel pump and carburetor or throttle body.



76404

a - Fuel Line

7. Remove distributor cap and mark position of rotor on distributor housing. Also, mark position of distributor housing on intake manifold.
8. Remove distributor.

IMPORTANT: Do not crank engine over after distributor has been removed.

9. Remove other ignition components.
10. Remove oil sending unit.
11. Disconnect any other miscellaneous items that will prevent removal of manifold.

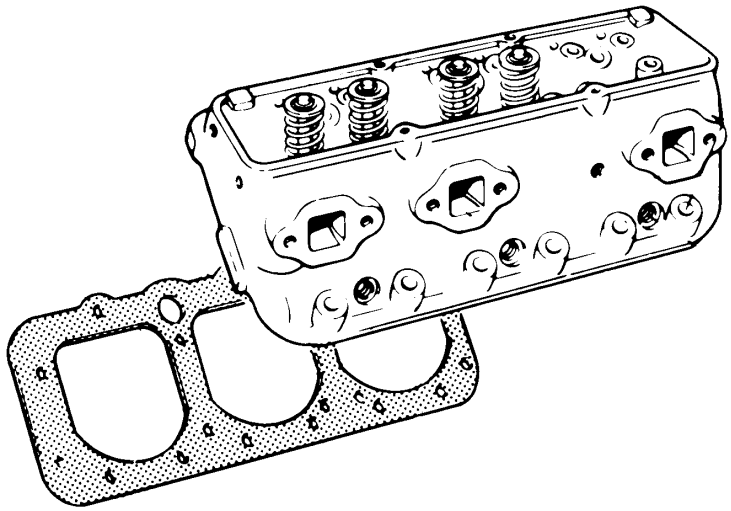
IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block, in next step. Use extreme care to prevent damage to sealing surfaces.

12. Remove intake manifold bolts, then remove intake manifold and carburetor assembly.

NOTE: *If intake manifold requires replacement, transfer all remaining parts to new manifold.*

Cleaning and Inspection

1. Clean gasket material from all mating surfaces.



75853

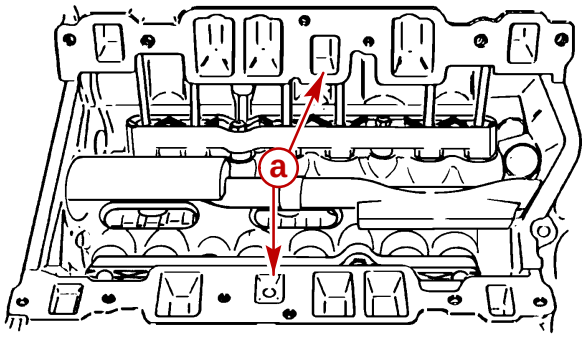
IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase or cylinder head ports.

2. Inspect manifold for cracks or scratches. Machined surfaces must be clean and free of all marks and deep scratches or leaks may result.
3. Check intake passages for varnish buildup and other foreign material. Clean as necessary.

Installation

IMPORTANT: When installing intake manifold gaskets, in next step, observe the following:

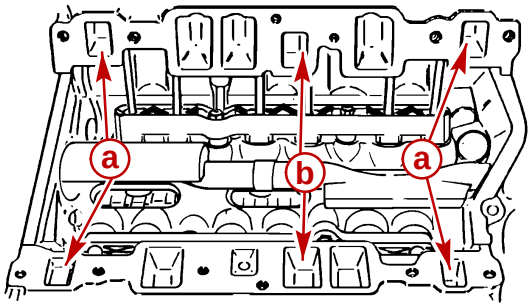
- **Be sure to install gasket with marked side up. Both gaskets are identical.**
- **On engines with 2 barrel carburetor, remove metal insert from manifold gasket to be used on starboard (right) cylinder head to provide clearance for heat pipe on intake manifold.**
- **All Mercury MerCruiser V-6 GM engines that have “automatic” carburetor chokes must use an intake gasket that has an opening for the exhaust crossover port in the intake manifold. Without this opening the “automatic” carburetor choke will not operate properly. The choke will remain ON longer causing rough engine operation and wasted fuel.**



71850

a - Exhaust Crossover Port Opening

1. Apply Quicksilver Perfect Seal to intake manifold gaskets especially around coolant passages (both sides).
2. Place gaskets on cylinder heads.

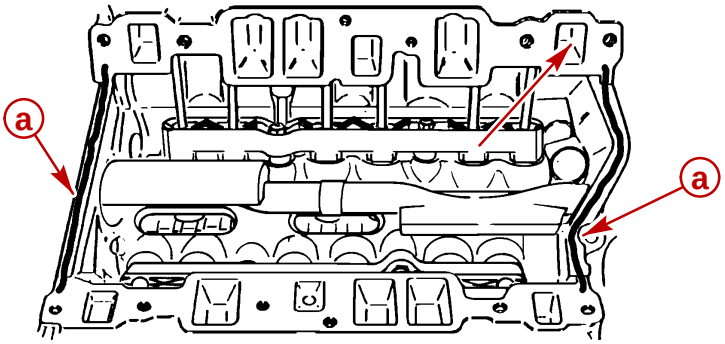


71850

a - Coolant Passages
b - Gaskets

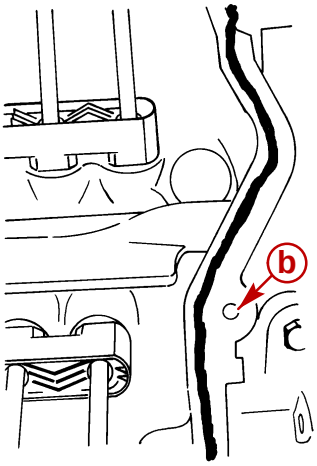
3. Apply a 3/16 in. (5 mm) wide bead of Quicksilver RTV Sealer to engine block as shown. Extend sealer 1/2 in. (13 mm) up on intake gaskets.

IMPORTANT: DO NOT get Quicksilver RTV Sealer into oil sending unit hole at rear of engine.



71850

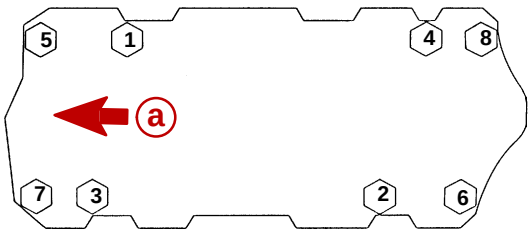
a - RTV Sealer (Typical Both Ends)



71851

b - Oil Sending Unit Hole

4. Carefully install manifold assembly and torque bolts to 35 lb-ft (48 Nm) in sequence as shown.



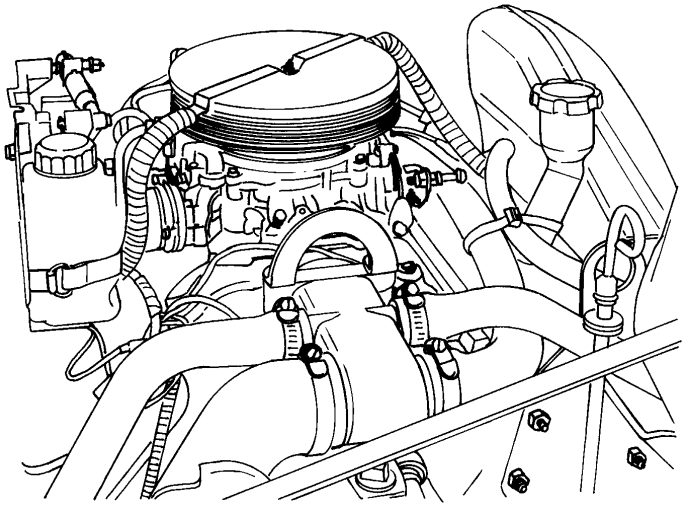
72878

Intake Manifold Torque Sequence

a - Front

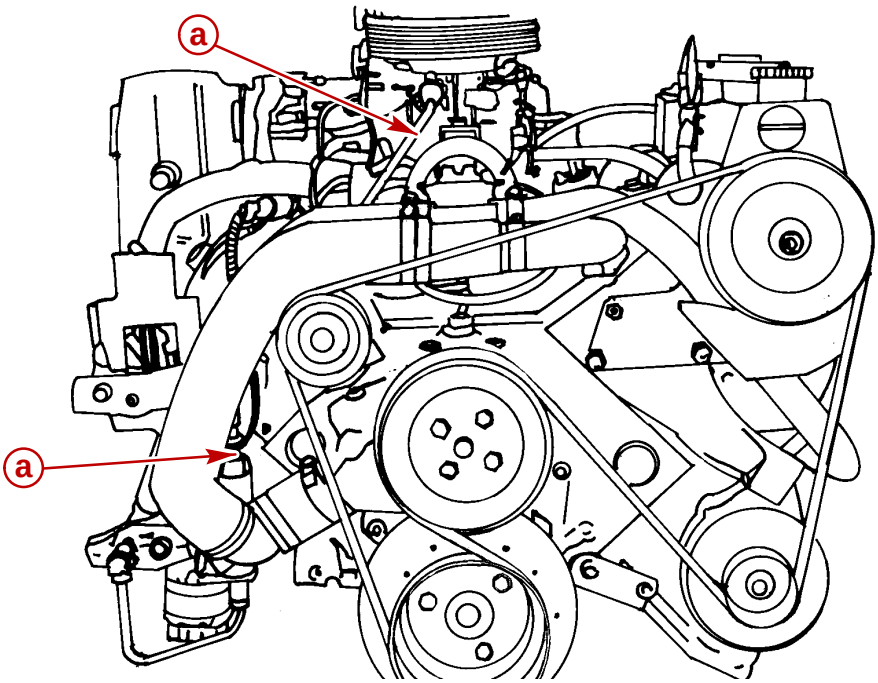
5. Connect all electrical leads.

6. Connect hoses to thermostat housing.



75847

7. Install fuel line to carburetor and fuel pump.



76404

a - Fuel Line

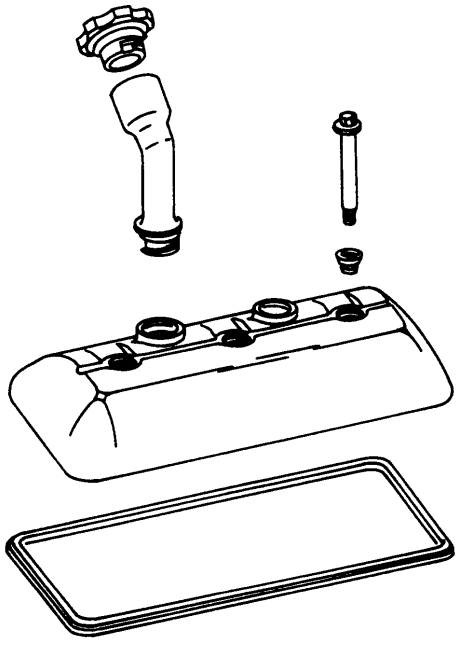
8. Connect crankcase ventilation hoses to rocker arm covers.
9. Install distributor. Position rotor and housing to align with marks made during removal, then install distributor cap.
10. Install other ignition components and reconnect wires.
11. Coat threads of oil pressure sending unit with Quicksilver Perfect Seal and install.
12. Connect any other items which were disconnected from manifold during removal.
13. Start engine.
14. Adjust ignition timing and carburetor.
15. Check hose connections, gaskets and seals for leaks.
16. Inspect fuel line connections for fuel leaks.

Rocker Arm/Push Rod

Removal

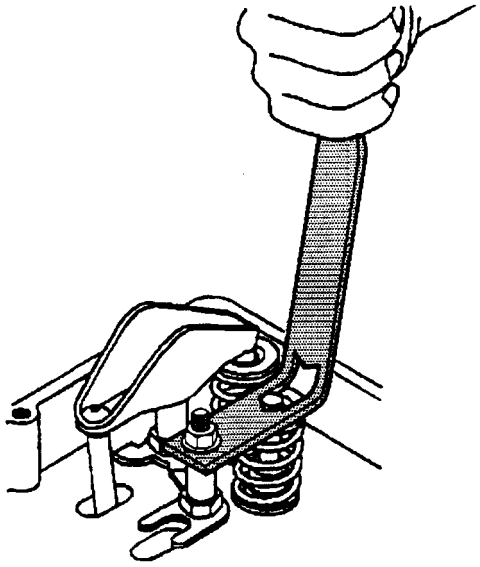
NOTE: *When servicing only one cylinder's rocker arms, bring that cylinder's piston up to TDC before removing rocker arms. When servicing all rocker arms, bring No. 1 piston up to TDC before removing rocker arms.*

1. Remove rocker arm covers.



75853

2. Remove rocker arm assemblies and push rods.



75674

IMPORTANT: Place rocker arm assemblies and push rods in a rack for reassembly in their original locations.

Cleaning and Inspection

1. Clean parts with solvent and dry with compressed air.
2. Inspect all contact surfaces for wear. Replace all damaged parts.

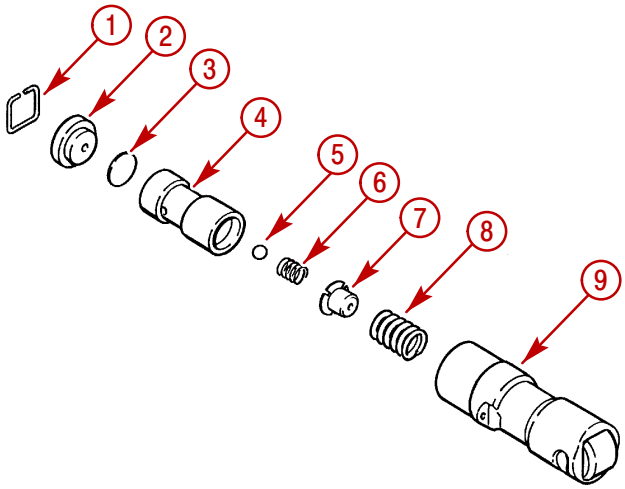
Installation

IMPORTANT: When installing rocker arms and rocker arm balls, coat bearing surfaces of rocker arms and rocker arm balls with engine oil.

1. Install push rods in their original locations. Be sure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts in their original locations.
3. Torque rocker arm nuts to 22 lb-ft (30 Nm). No valve adjustment is required. Valve lash is automatically set when rocker arm nuts are torqued to specification.

Hydraulic Roller Valve Lifters

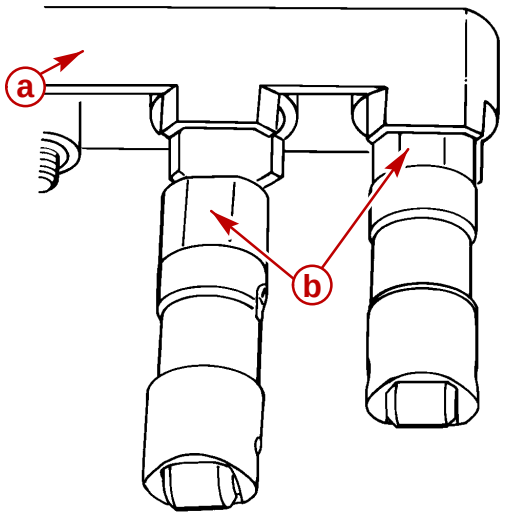
Hydraulic valve lifters require little attention. Lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.



72031

1 - Push Rod Seat Retainer
2 - Push Rod Seat
3 - Metering Valve
4 - Plunger
5 - Check Ball
6 - Check Ball Spring
7 - Check Ball Retainer
8 - Plunger Spring
9 - Lifter Body

Valve lifters are retained in position and prevented from rotating by two valve retainers, one on each side of the engine beneath the intake manifold. Care should be exercised when installing the retainers to see that the flat portions of the lifters are properly positioned into the retainers.



71853

a - Retainer
b - Roller Lifter Flat Portion

Locating Noisy Lifters

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft (1.2 m) in length. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. In this manner, sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

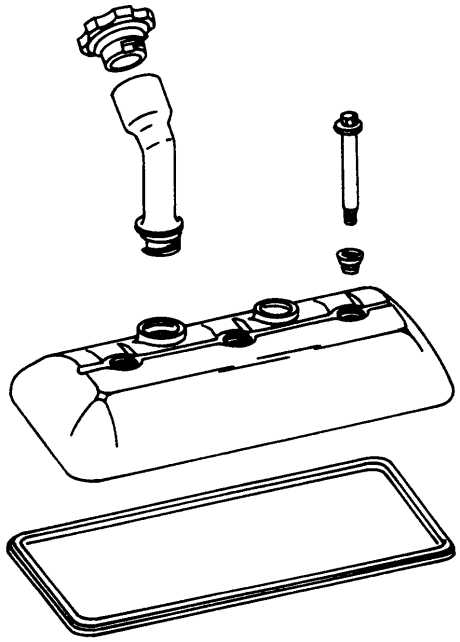
General types of valve lifter noise are as follows:

1. Hard rapping noise - usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit, causing abnormal stickiness.
   b. Galling or “pickup” between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise - probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train - this will, in most cases, be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent clicking - probable causes are:
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out of round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc., is shown to exist in one unit, it more likely exists in all the units; thus it would only be a matter of time before all lifters caused trouble.

Removal

1. Remove rocker arm covers.

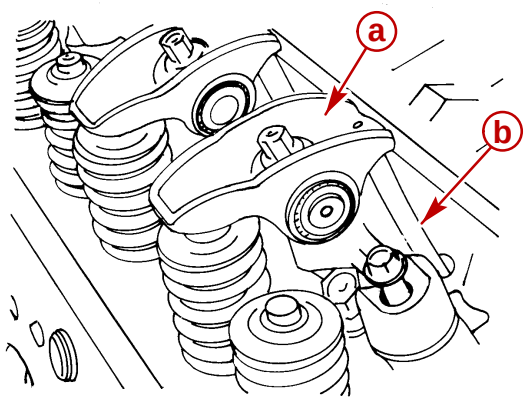


75853

2. Remove intake manifold.

IMPORTANT: Keep valve push rod and hydraulic lifter from each valve together as a matched set and mark or store them so they can be reinstalled in the same location later.

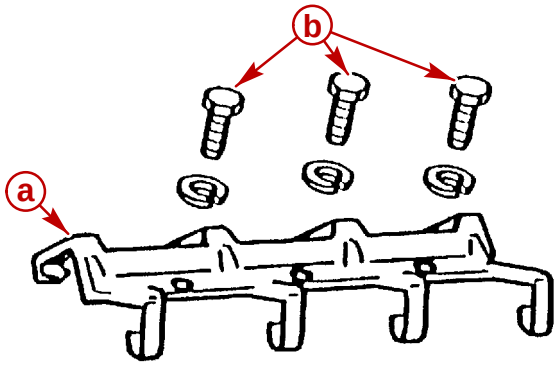
3. Remove rocker arm assemblies and push rods.



75670

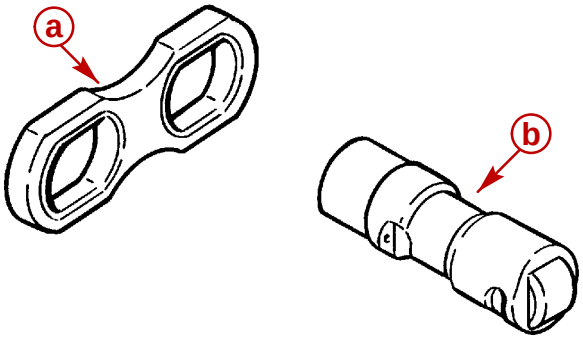
a - Rocker Arm Assembly
b - Push Rods

NOTE: *Engines with roller lifters have additional valve train components shown below.*



72329

a - Lifter Restrictor Retainer
b - Fasteners

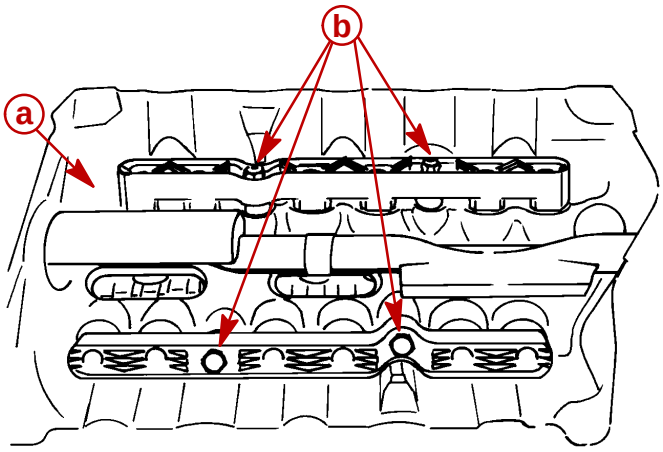


72340

a - Roller Lifter Restrictor
b - Roller Lifter

4. Remove lifter restrictors and lifters.

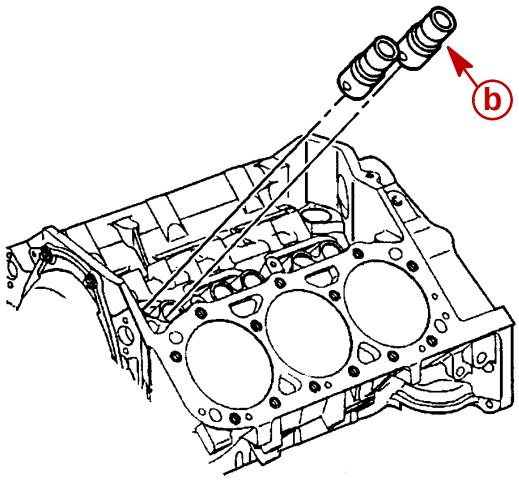
5. Remove fasteners from lifter retainers (restrictors) and remove retainers. Do not disturb lifters at this time.



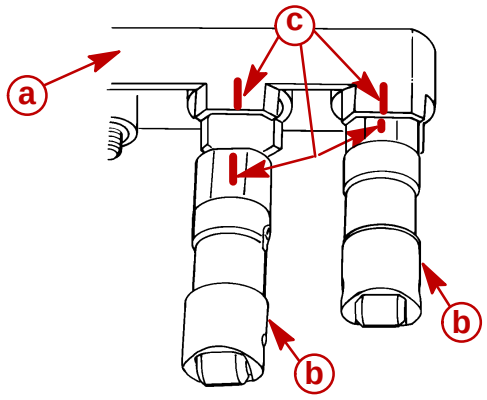
71852

a - Lifter Retainer (Restrictor)
b - Fasteners

6. Make matching marks on all retainers and lifters as to location and orientation in bores, to allow reassembly in exact position on camshaft lobes (so that the roller's bearing and roller will roll in the same direction on the same lobe, if reused).
7. Remove valve lifters.



76586



71853

a - Roller Lifter Retainer
b - Roller Lifter(s)
c - Matching Marks

Cleaning and Inspection

1. Thoroughly clean all parts in cleaning solvent and inspect them carefully.
2. If any parts are damaged or worn, entire lifter assembly should be replaced.
3. If outer lifter body wall is scuffed or worn, inspect cylinder block lifter bore.
4. If roller is worn or damaged, inspect camshaft lobe.
5. If push rod seat is scuffed or worn, inspect push rod.

Installation

IMPORTANT: It is recommended that the engine oil be changed and a new oil filter be installed whenever servicing valve lifters or camshaft.

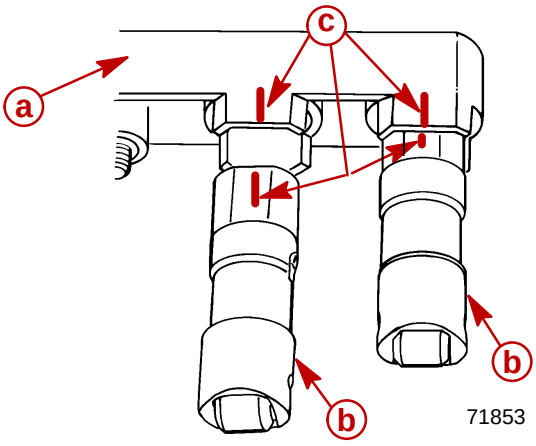
IMPORTANT: Before installing roller lifters, coat the roller with engine oil. If new lifters or a new camshaft have been installed, an additive containing EP lube (such as General Motors Cam and Lifter Prelube or equivalent) should be poured over camshaft lobes before installing lifters.

IMPORTANT: Before installation, coat entire valve lifter with engine oil.

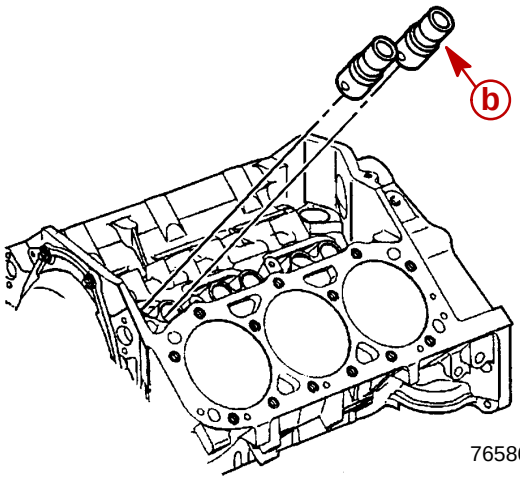
IMPORTANT: DO NOT install used valve lifters if a new camshaft has been installed.

1. Align matching marks made prior to disassembly, and install hydraulic valve lifters and components. Torque roller lifter retainer (restrictor) plate fasteners to 12 lb-ft (16 Nm).

NOTE: *Components shown removed in left drawing for visual clarity*

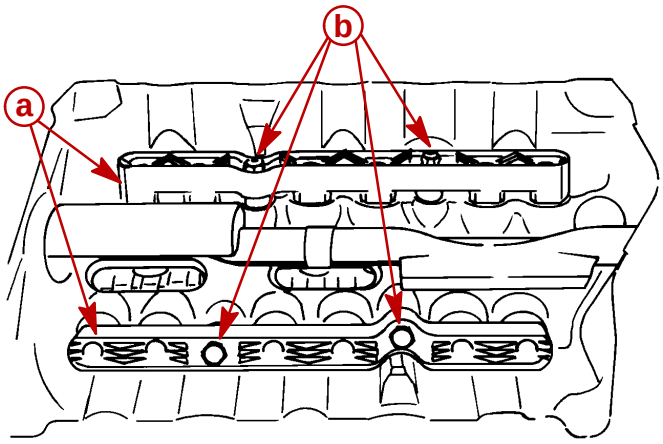


71853



76586

a - Roller Lifter Retainer
b - Roller Lifter(s)
c - Matching Marks



71852

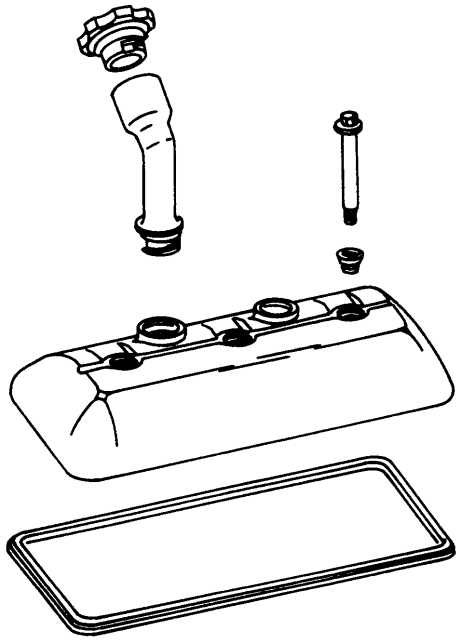
a - Lifter Retainer (Restrictor)
b - Fasteners

2. Install intake manifold.
3. Install push rods. Ensure push rods seat in lifter socket.
4. Install rocker arms and rocker arm nuts. Torque nuts to 22 lb-ft (30 Nm).
5. Install rocker arm cover. Torque fasteners to 106 lb-in. (12 Nm).
6. Start engine and check for leaks.

Valve Stem Oil Seal / Valve Spring Replacement

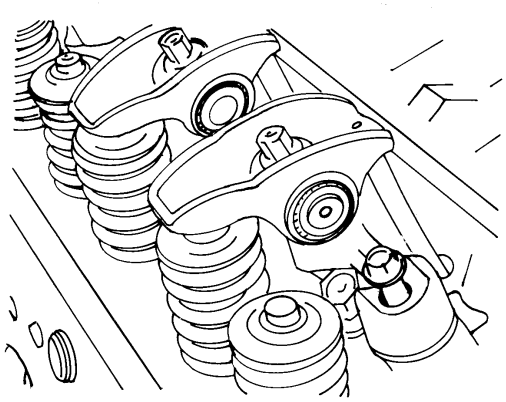
Removal - Head Installed

1. Remove rocker arm cover.



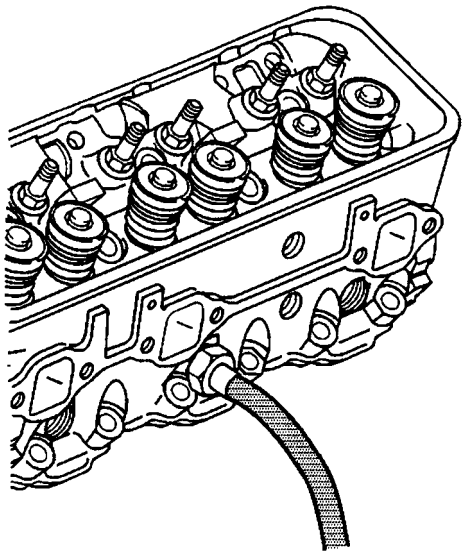
75853

2. Remove spark plug of affected cylinder.
3. Remove rocker arm assembly.



75670

4. Install air line adaptor tool (J-23590) in spark plug hole and apply compressed air to hold valves in place.

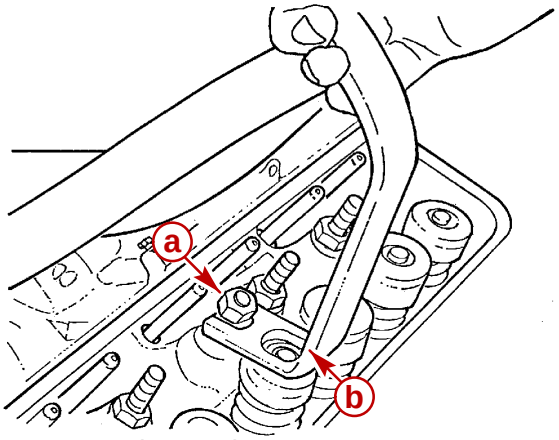


76572

NOTE: *If compressed air is not available, piston may be brought up to TDC and used to keep valves from falling out of valve guides.*

IMPORTANT: Do not turn crankshaft while valve springs, retainers and locks are removed or valves will fall into cylinder.

5. Using valve spring compressor as shown, compress valve spring and remove valve locks.



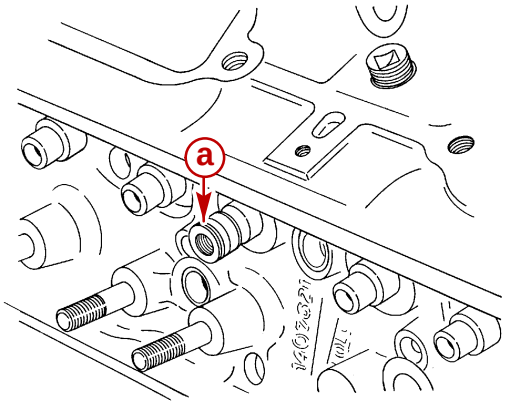
72881

a - Valve Spring Compressor (J-5892)
b - Rocker Arm Nut

6. Slowly release valve spring compressor. Remove cap, retainer or rotator, and valve spring.

IMPORTANT: Keep air pressure in cylinder while springs, caps and valve locks are removed or valves will fall into cylinder.

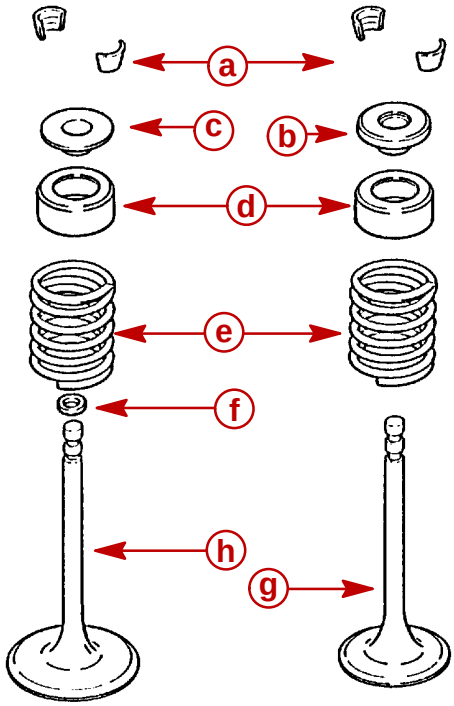
7. Remove seals from valve stems and valve guide.



72330

a - Intake Valve Guide Seal

Valve Assembly (Exploded View)



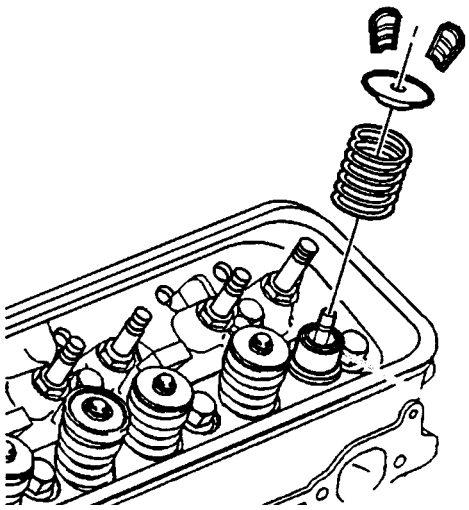
75843

a - Valve Locks
b - Retainer
c - Rotator
d - Cap
e - Outer Spring
f - Valve Stem Oil Seal
g - Intake Valve
h - Exhaust Valve

1. Lubricate valve guides and valve stems with engine oil.
2. Install each valve in the port from which it was removed or to which it was fitted.

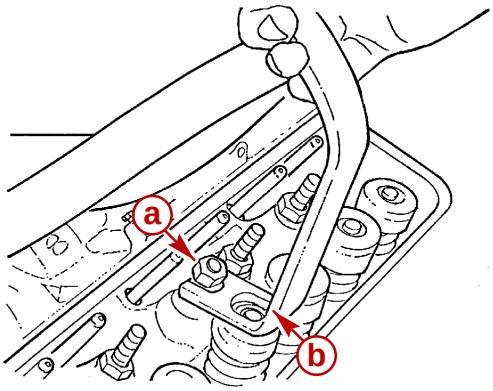
Installation - Head Installed

1. Install valve guide seal (intake valve only) over valve stem and push down until seated against head.
2. Set valve spring (with damper installed) and cap in place.
3. Place retainer on intake valve and/or rotator on exhaust valve.



76573

4. While compressing valve spring with valve spring compressor, install oil seal in lower groove of valve stem, making sure seal is not twisted. A light coating of oil will help prevent twisting.
5. Install valve locks (Quicksilver Needle Bearing Assembly Lubricant may be used to hold them in place) and slowly release tool, making sure locks seat properly in upper grooves of valve stem.

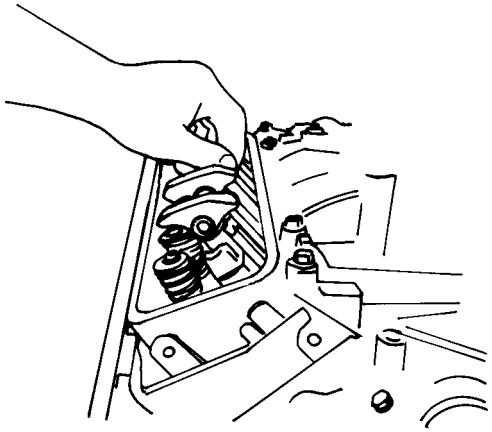


72881

a - Valve Spring Compressor (J-5892)
b - Rocker Arm Nut

6. Install push rods and rocker arm assemblies.

7. Torque rocker arm nuts to 22 lb-ft (30 Nm).



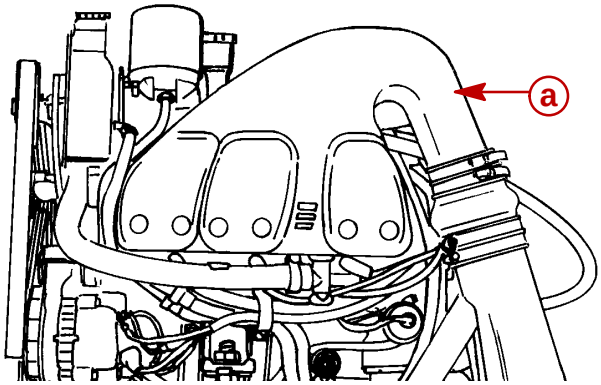
76569

8. Install rocker arm cover. Torque to 106 lb-in. (12 Nm).
9. Install spark plug torque to 15 lb-ft (20 Nm).

Cylinder Head

Removal

1. Drain engine cooling system.
2. Remove exhaust manifolds.



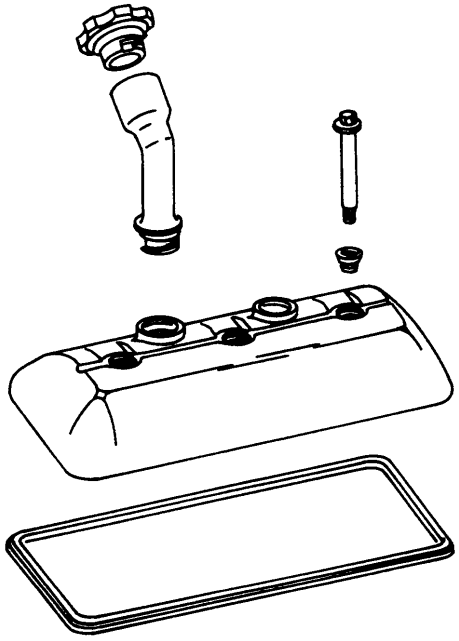
75052

One Piece Exhaust Manifold Shown

a - Exhaust Manifold

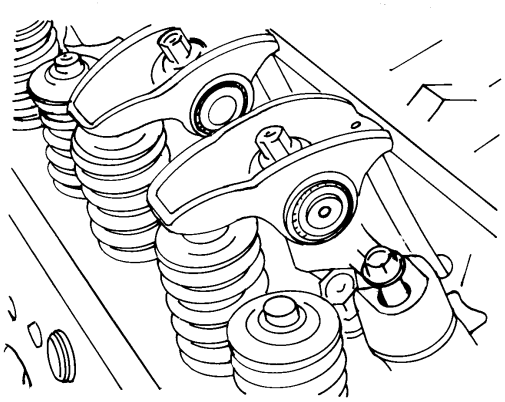
3. Remove intake manifold.

4. Remove rocker arm covers.



75853

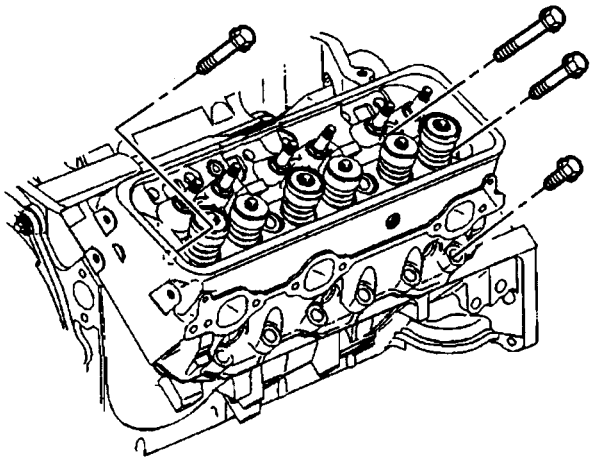
5. Remove rocker arm assemblies and push rods (keep in order for reassembly in their original locations).



75670

6. Remove any components attached to front or rear of cylinder head.
7. Remove spark plugs.

8. Remove head bolts.

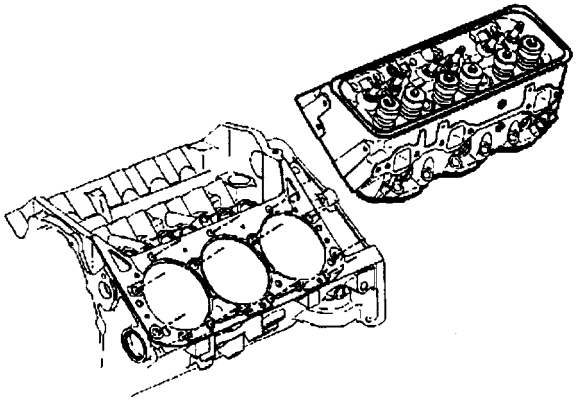


76589

⚠ CAUTION

The head gasket may be holding cylinder head to block. Use care when prying off cylinder heads. DO NOT damage gasket surfaces. DO NOT drop cylinder heads.

9. Place cylinder head on wooden blocks to prevent damage to gasket surfaces.



76576

Cleaning and Inspection

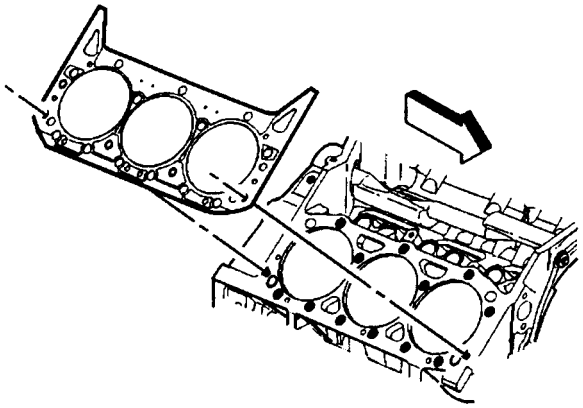
1. Clean gasket material and sealer from engine block and cylinder heads.
2. Inspect sealing surfaces for deep nicks and scratches.
3. Inspect for corrosion around cooling passages.
4. Clean head bolt threads and engine block bolt hole threads, making sure no dirt, old oil or coolant remain.

Installation

⚠ CAUTION

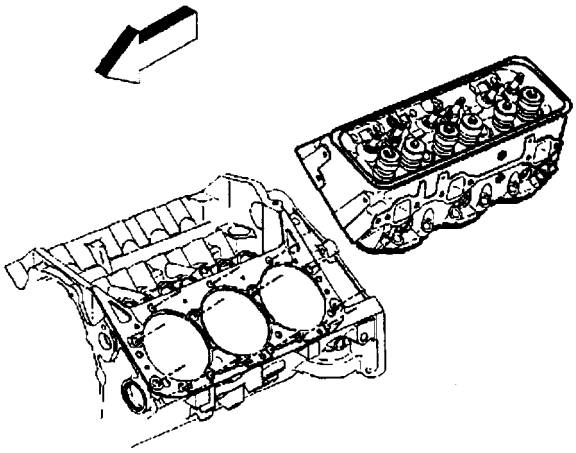
When using ribbed stainless steel head gaskets, apply a thin coating of Quicksilver Perfect Seal to both sides of gasket. Too much sealer may hold gasket away from head or block causing leakage. DO NOT use sealer on graphite composition head gaskets.

1. Place head gasket in position over dowel pins.



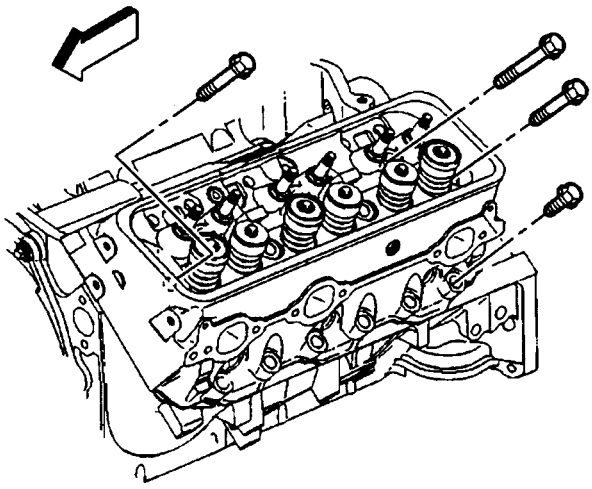
76588

2. Carefully set cylinder head in place over dowel pins.



76576

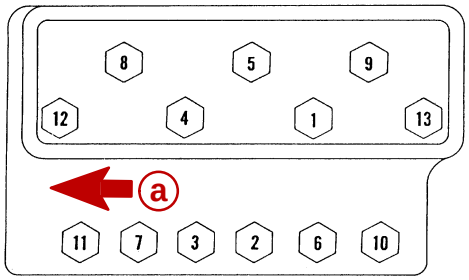
3. Coat threads of head bolts with Quicksilver Perfect Seal and install finger-tight.



76589

4. Torque cylinder heads in two steps. First pass, torque all bolts to 22 lb-ft (30 Nm). Second pass is an angle torque sequence as follows:

First Pass	Short Bolt Medium Bolt Long Bolt	22 lb-ft (30 Nm)
Second Pass (Angle Torque)	Short Bolt	+ 55 Degrees
	Medium Bolt	+ 65 Degrees
	Long Bolt	+ 75 Degrees

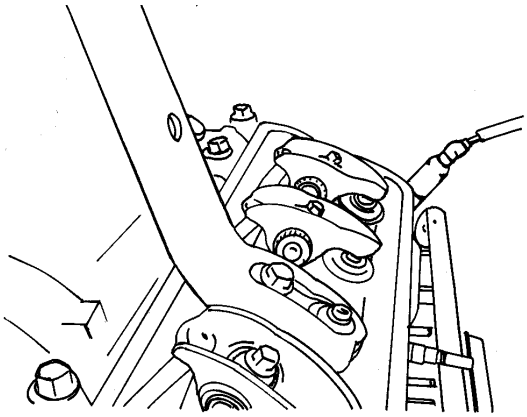


72883

Cylinder Head Torque Sequence

a - Front

5. Install push rods, rocker arm assemblies and lifter restrictors in their original positions.



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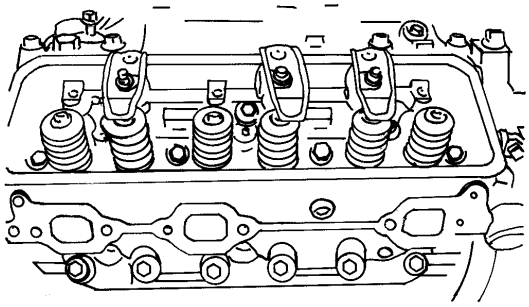
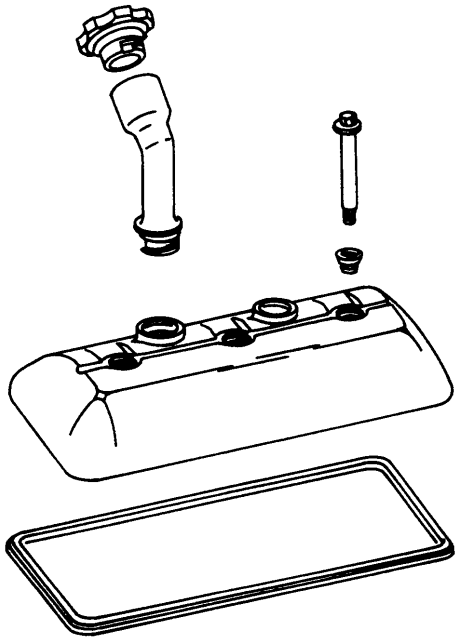


76568

6. Torque rocker arm nuts to 22 lb-ft (30 Nm).
7. Install intake manifold.
8. Install rocker arm covers.



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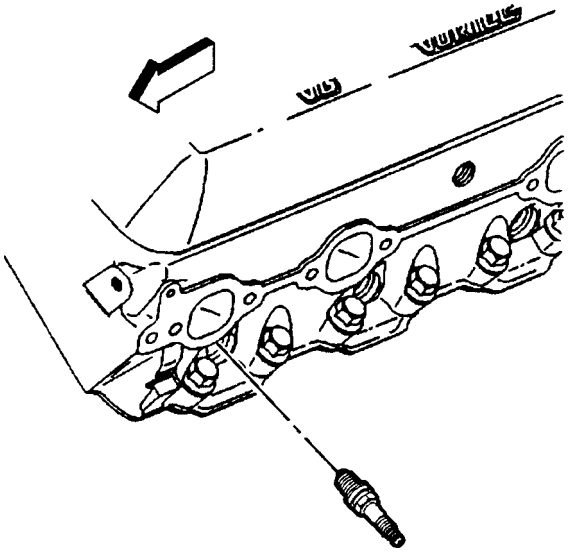
9. Install exhaust manifolds.

10. Install spark plugs.



76587

11. Install any components removed from front or rear of cylinder heads.

12. Follow procedures below for your model. Refer to SECTION 6A or 6B of this manual.

Seawater Cooled Models: Provide for adequate water supply to seawater pickup (see Section 6A).

Closed Cooled Models: Refill closed cooling section (see Section 6B), and provide adequate water supply to seawater pickup.

⚠ CAUTION

Ensure that cooling water supply is available before starting the engine.

13. Start engine.

14. Set timing.

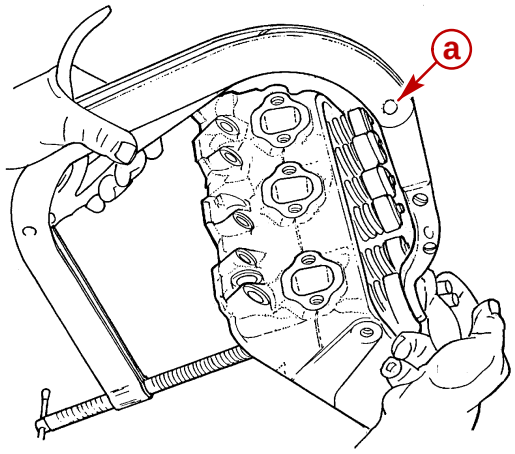
15. Set idle speed.

16. Check for leaks.

Cylinder Head and Valve Conditioning

Disassembly

1. Using valve spring compressor, compress valve spring and remove valve locks. Slowly release tool.



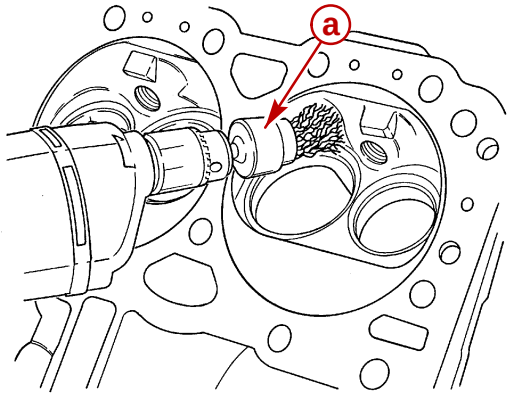
72884

a - Valve Spring Compressor (J-8062)

2. Remove all valve components.
3. Remove valves from cylinder head and place in a rack, in order, for reassembly in their original locations.

Cleaning

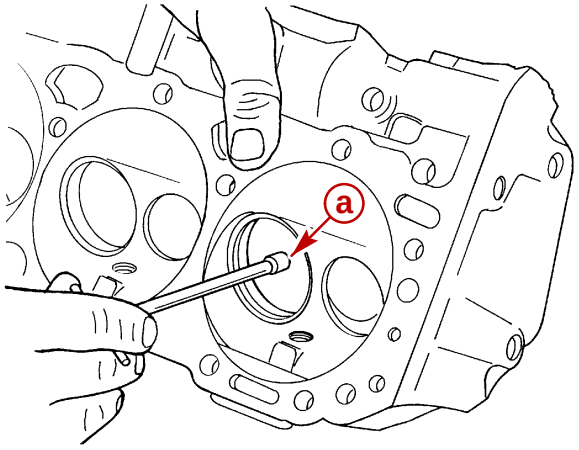
1. Clean push rods and rocker arm assemblies.
2. Clean carbon from valves using a wire wheel.
3. Clean gasket material from cylinder head mating surfaces.
4. Clean all carbon from combustion chambers and valve ports using carbon remover brush.



72334

a - Carbon Remover Brush (J-8089)

5. Thoroughly clean valve guides with valve guide cleaner.

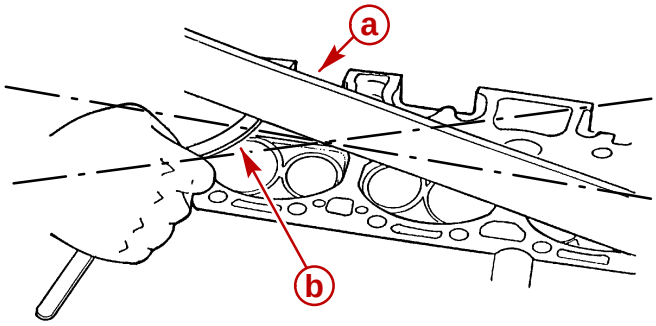


72335

a - Valve Guide Cleaner (J-8101)

Inspection

1. Inspect cylinder heads for cracks in exhaust ports, water jackets, and combustion chambers (especially around spark plug holes and valve seats). Replace heads if any cracks are found.
2. Inspect cylinder head gasket surface for burrs, nicks, erosion or other damage. Also, check flatness of cylinder head gasket surface, using a machinist's straight edge and feeler gauges as shown. Take measurements diagonally across head (both ways) and straight down center head. Refer to "Specifications."



72885

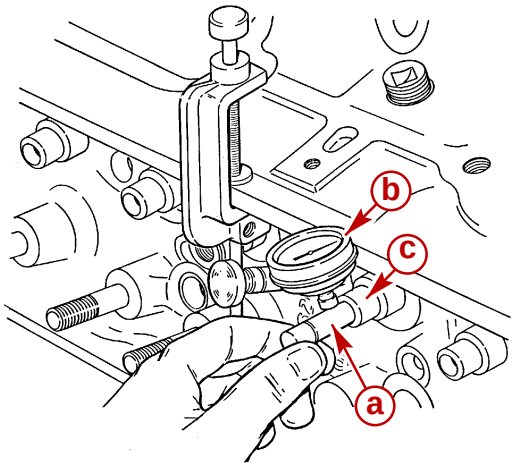
a - Straight Edge
b - Feeler Gauge

IMPORTANT: Cylinder head-to-block gasket surface should be resurfaced if warped more than specified. When head resurfacing is required, cylinder head-to-intake manifold gasket surface on head must be milled to provide proper alignment between intake manifold and head.

3. Inspect valves for burned heads, cracked faces or damaged stems.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky valves.

4. Measure valve stem clearance as follows:
   a. Attach a dial indicator to cylinder head, positioning it against the valve stem and close to the valve guide.
   b. Holding valve head off seat about 1/16 in. (2 mm), move valve stem back and forth in direction shown. Compare stem clearance with specifications.
   c. If clearance exceeds specifications, it will be necessary to ream valve guides for oversized valves, as outlined under “Valve Guide Bore Repair.”



72336

a - Valve Stem
b - Dial Indicator
c - Valve Guide

Valve Guide Bore Repair

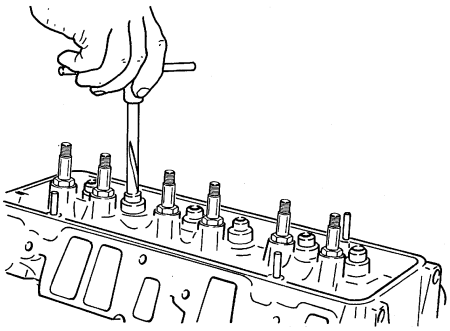
IMPORTANT: Be sure to measure valve stem diameter of both the intake and exhaust valve, as valve stem diameter may or may not be the same for both valves.

If .015 in. oversize valves are required, ream valve guide bores for oversize valves, as follows:

1. Measure valve stem diameter of old valve being replaced and select proper size valve guide reamer from chart below.

Standard Valve Stem Diameter	Reamer Required for .015 in. Oversize Valve
.341 in.	J-5830-2

2. Ream valve guide bores, as shown.



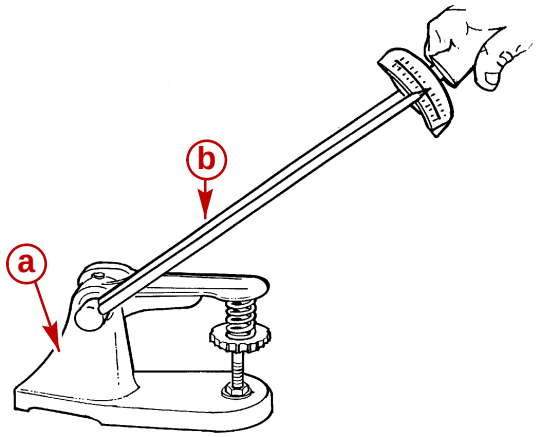
72886

3. Remove the sharp corner created by reamer at top of valve guide.

Valve Springs - Checking Tension

Using valve spring tester, as shown, check valve spring tension with dampers removed. Refer to “Specifications.”

IMPORTANT: Springs should be replaced if not within 10 lbs. (44 N) of specified tension.



72308

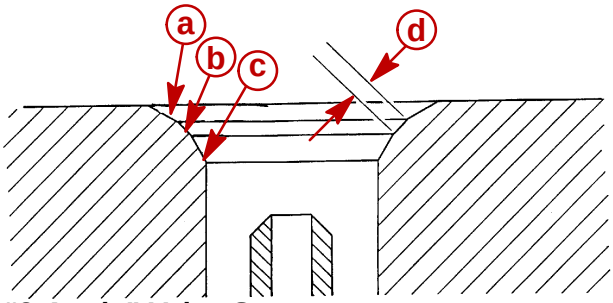
a - Valve Spring Tester (J-8056)
b - Torque Wrench

Valve Seat Repair

Valve seat reconditioning is very important, since seating of valves must be perfect for engine to deliver maximum power and performance.

Another important factor is valve head cooling. Good contact between each valve and its seat in head is important to ensure that heat in valve head will be properly dispersed.

Several different types of equipment are available for reseating valve seats. Equipment manufacturer’s recommendations should be followed carefully to attain proper results.

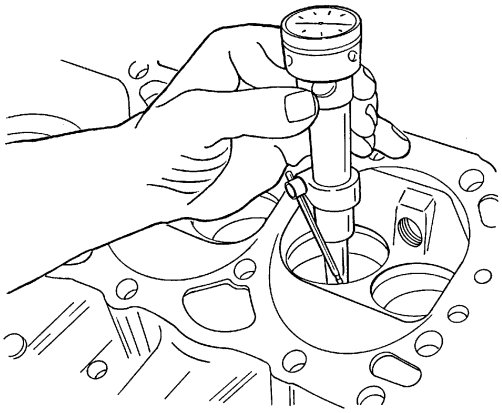


50668

Typical “3-Angle” Valve Seat

a - Top Angle (30°)
b - Seat Angle (46°)
c - Bottom Angle (60°)
d - Seat Width

Regardless of type of equipment, however, it is essential that valve guide bores be free from carbon or dirt to achieve proper centering of pilot in valve guide, ensuring concentricity.



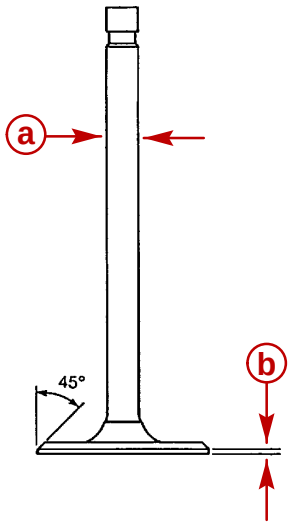
72338

Measuring Valve Seat Concentricity

Valve Grinding

Valves that are pitted must be refaced to the proper angle. Valve stems which show excessive wear, or valves that are warped excessively, must be replaced. When a valve head which is warped excessively is refaced, a knife edge will be ground on part or all of the valve head, due to the amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning, or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 1/32 in. (0.8 mm) after grinding, replace the valve.

Several different types of equipment are available for refacing valves. The recommendation of the manufacturer of the equipment being used should be carefully followed to attain proper results.



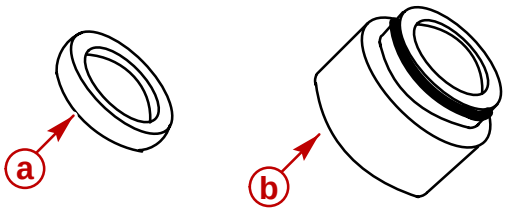
50695

a - 1/3 [.341 in] (8.16 mm)
b - 1/32 [.031 in] (0.79 mm) Min

Reassembly

1. Lubricate valve guides and valve stems with engine oil.
2. Install each valve in the port from which it was removed or to which it was fitted.
3. Install valve guide seal (intake valve only) over valve stem and push down until seated against head.
4. Install quad ring over exhaust valve stem until it touches cylinder head with valve closed.

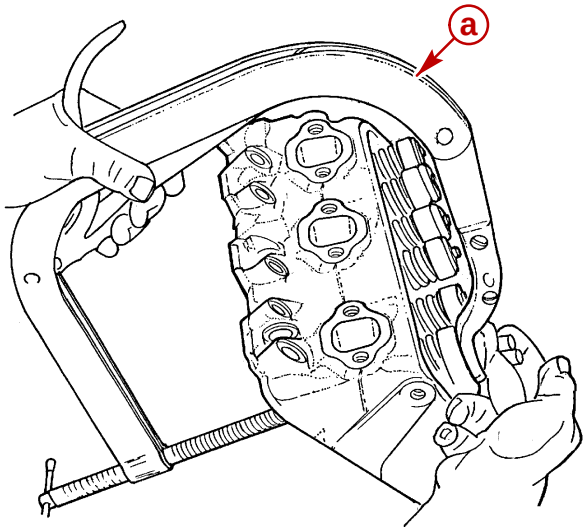
IMPORTANT: The exhaust valve guide seals have been removed. They are replaced with a quad ring as shown below. If repairing heads with seals, replace them with the quad ring upon reassembly.



75307

a - Quad Ring
b - Valve Seal

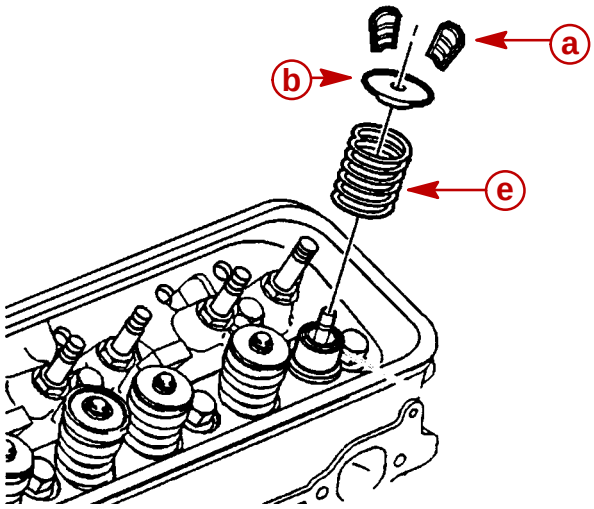
5. Set valve spring (with damper installed) and cap in place.
6. Place retainer on intake valve and/or rotator on exhaust valve.
7. While compressing valve spring with valve spring compressor, install oil seal in lower groove of valve stem, making sure seal is not twisted. A light coating of oil will help prevent twisting.



72884

a - Valve Spring Compressor (J-8062)

8. Install valve locks (Quicksilver Needle Bearing Assembly lube may be used to hold them in place) and slowly release tool, making sure locks seat properly in upper grooves of valve stem.



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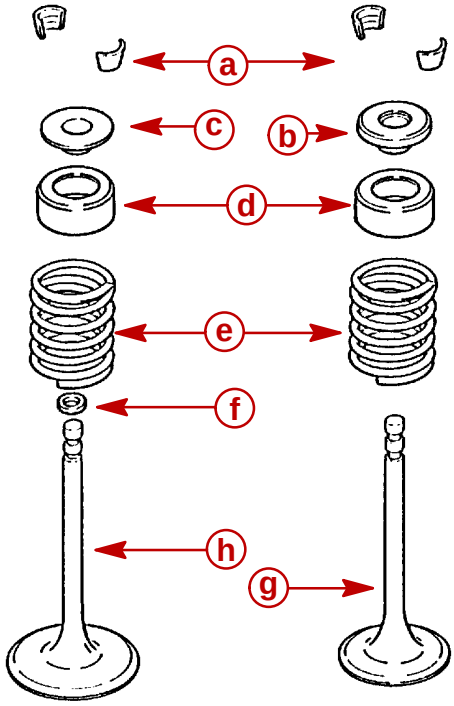
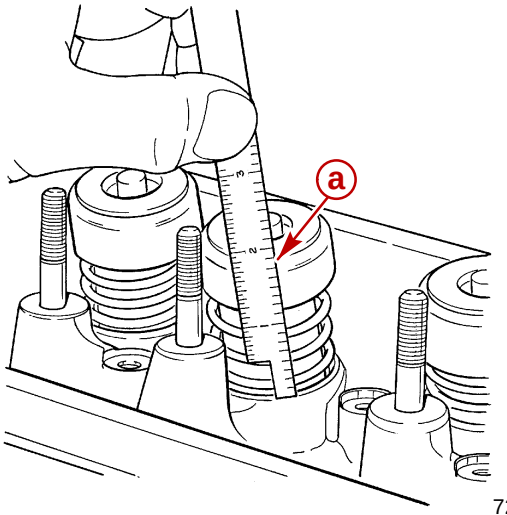


75843

a - Valve Locks
b - Retainer
c - Rotator
d - Cap
e - Valve Stem Oil Seal
f - Outer Spring
g - Intake Valve
h - Exhaust Valve

9. Check installed height of valve springs using a narrow, thin scale. Measure from spring seat to top of valve spring, as shown. If measurement exceeds specified height, install a valve spring shim and recheck. DO NOT shim valve springs to give an installed height less than the minimum specified.

05037

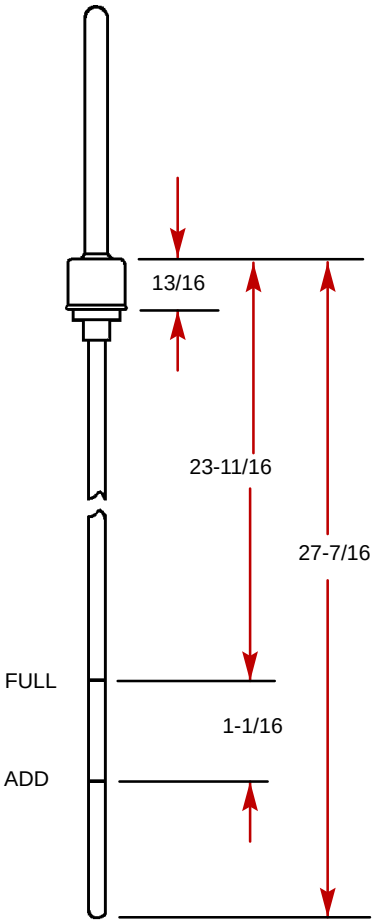


72339

a - Valve Spring Installed Height
b - Cut Away Scale (Grind Out This Portion)

Dipstick Specifications

All Engines



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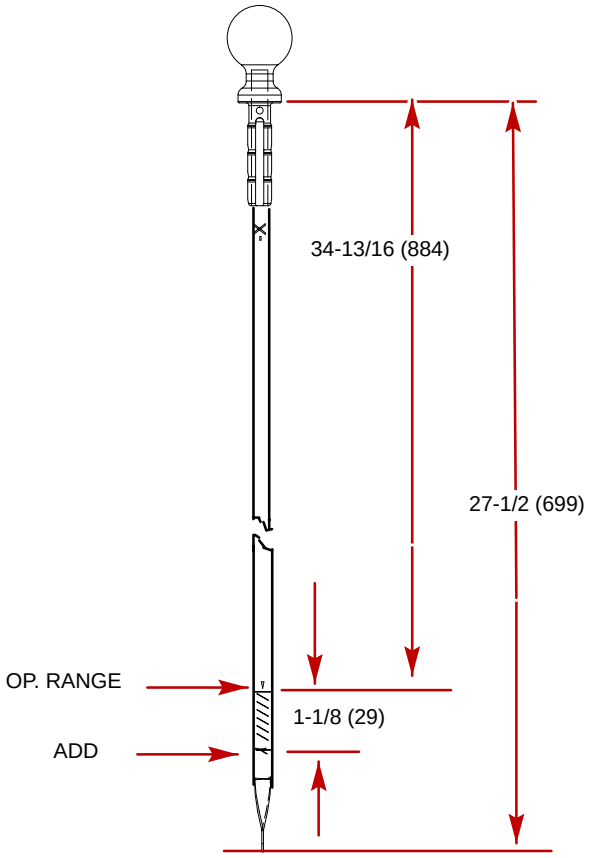


76497

Oil Pan

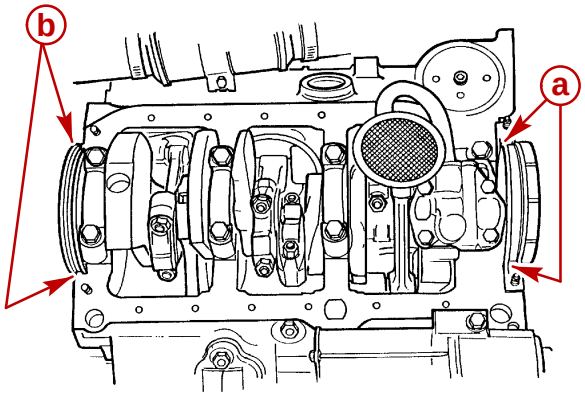
Removal

1. Drain crankcase oil.
2. Remove dipstick and tube.
3. Remove oil pan.

Installation

1. Clean sealing surfaces of engine block and oil pan.
2. Apply a small amount of Quicksilver RTV Sealer to joints of rear seal retainer and joints of front cover.

IMPORTANT: Quicksilver RTV Sealer sets up in about 15 minutes. Be sure to complete assembly promptly.

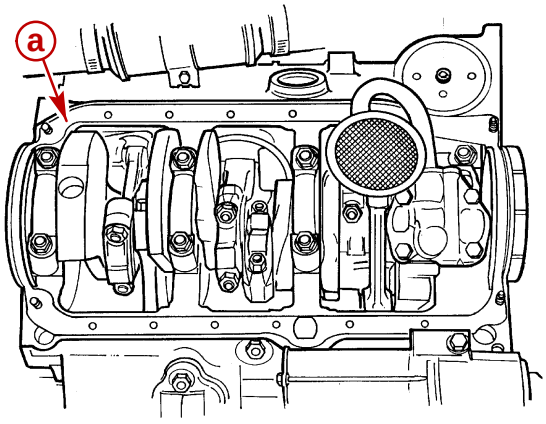


72888

a - Joints of Rear Seal Retainer
b - Joints of Front Cover

3. Install oil pan gasket in position.

NOTE: *A one-piece oil pan gasket may be reused if it is still pliable and is not cracked, torn or otherwise damaged.*

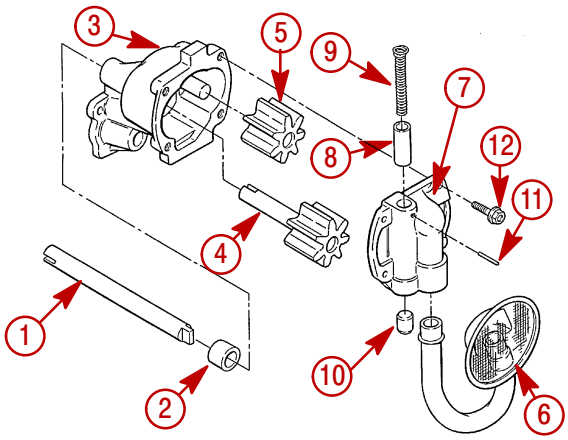


72889

a - Oil Pan Gasket

4. Install oil pan. Starting from the center and working outward in each direction, torque nuts and bolts to 18 lb-ft (25 Nm).
5. Install dipstick tube and dipstick.
6. Fill crankcase with required quantity of oil of specified viscosity. Refer to SECTION 1B - “Maintenance.”

Oil Pump



72145

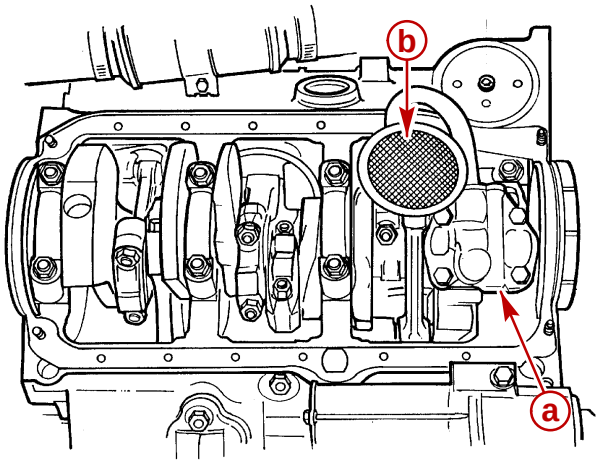
Oil Pump Assembly

1 - Extension Shaft
2 - Shaft Coupling
3 - Pump Body
4 - Drive Gear and Shaft
5 - Idler Gear
6 - Pickup Screen and Pipe
7 - Pump Cover
8 - Pressure Regulator Valve
9 - Pressure Regulator Spring
10 - Plug
11 - Retaining Pin
12 - Screws

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. Oil pump is driven by distributor shaft which is driven by a helical gear on camshaft.

Removal

1. Remove oil pan.
2. Remove gasket carefully, the one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn or damaged.



72889

a - Oil Pump
b - Pickup Screen and Pipe

3. Remove oil pump.

Disassembly

1. Remove pump cover.

IMPORTANT: Mark gear teeth for reassembly with same teeth indexing.

2. Remove idler gear and drive gear from pump body.
3. Remove retaining pin, spring, and pressure regulator valve from pump cover.

IMPORTANT: Do not remove pickup screen and pipe assembly, unless replacement is necessary. Loss of press fit condition could result in an air leak and loss of oil pressure.

IMPORTANT: Do not disturb pickup screen on pipe. This is serviced as an assembly.

4. If pickup screen and pipe assembly requires replacement, mount pump in a soft-jawed vise and extract pipe from pump.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage and excessive wear.
4. Check for loose drive gear shaft in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen and pipe.
7. Check pressure regulator valve for fit.

IMPORTANT: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replacement of entire oil pump assembly is necessary.

Reassembly

⚠ CAUTION

Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to oil pan bottom when oil pump is installed.

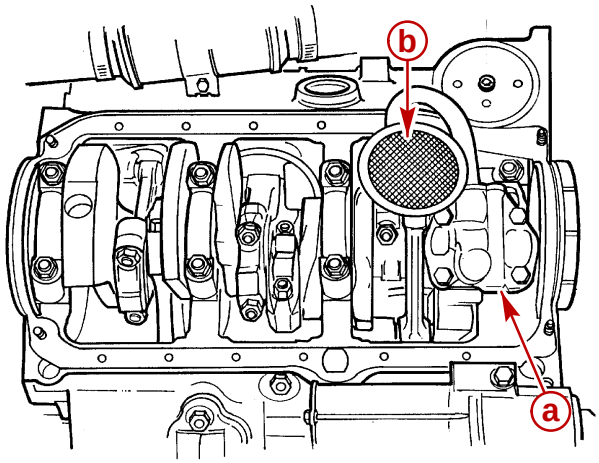
If pickup screen and pipe assembly was removed, mount pump in a soft-jawed vise, apply Quicksilver Perfect Seal to end of new pipe and, using oil pump suction pipe installer (J-21882), tap the pipe in place with a hammer.

IMPORTANT: Oil internal parts liberally before installation.

1. Install pressure regulator valve and related parts.
2. Install drive gear in pump body.
3. Install idler gear in pump body with smooth side of gear toward pump cover opening. Align marks made in disassembly.
4. Fill gear cavity with engine oil.
5. Install pump cover and torque attaching bolts to 106 lb-in. (12 Nm).
6. Turn extension shaft by hand to check for smooth operation.

Installation

1. Install pump, with extension shaft, to rear main bearing, aligning extension shaft with distributor drive shaft.
2. Tighten oil pump bolt to 65 lb-ft (88 Nm).



72889

a - Oil Pump
b - Pickup Screen and Pipe

3. Install oil pan. The one-piece oil pan gasket may be reused if still pliable and not damaged.

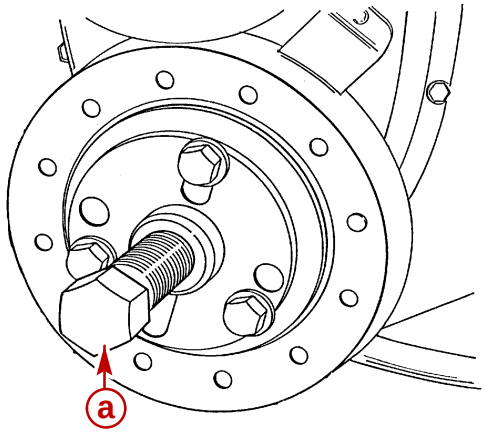
Torsional Damper

Removal

1. Remove drive belt.
2. Remove drive pulley, then remove torsional damper retaining bolt.

IMPORTANT: Do not use a universal claw type puller to remove torsional damper (in next step) as outside ring of torsional damper is bonded in rubber to the hub and use of claw type puller may break the bond.

3. Remove torsional damper with torsional damper remover and installer.



72890

a - Torsional Damper Remover and Installer (J-23523-E)

Installation

IMPORTANT: The inertia weight section of torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

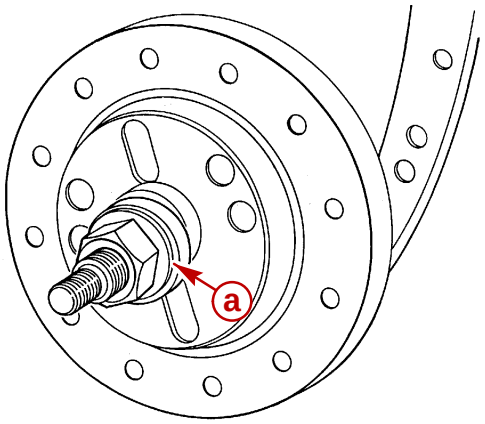
1. Replace key in crankshaft if it is damaged.
2. Coat seal surface of torsional damper with engine oil.
3. Install torsional damper on crankshaft, using torsional damper remover and installer as follows:

   b. Install appropriate end of threaded rod into crankshaft.

IMPORTANT: Be sure to install threaded rod in crankshaft at least 1/2 in. (13 mm) to prevent damage to threads.

   c. Install plate, thrust bearing, washer and nut on rod.

   d. Install torsional damper on crankshaft by turning nut until it contracts.



72346

a - Torsional Damper Remover and Installer (J-23523-E)

   b. Remove tool from crankshaft.

   c. To prevent oil leakage, apply Quicksilver RTV sealant to torsional damper keyway.

   d. Install torsional damper bolt. Torque to 74 lb-ft (100 Nm).

4. Install drive pulley(s). Torque bolts to 35 lb-ft (48 Nm).
5. Install and adjust drive belt.

Crankcase Front Cover Oil Seal

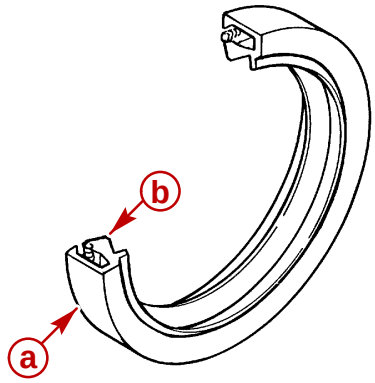
Oil Seal Replacement (Without Removing Front Cover)

REMOVAL

1. Remove torsional damper.
2. Pry seal out of cover from the front with a large screwdriver, being careful not to distort front cover or damage crankshaft.

INSTALLATION

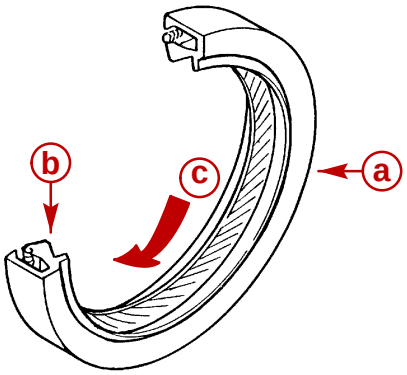
IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.



73123

Front Seal WITHOUT Helical Grooves

- **a** - Can Be Used on Any Rotation Engine
- **b** - Seal Lip Toward Inside of Engine

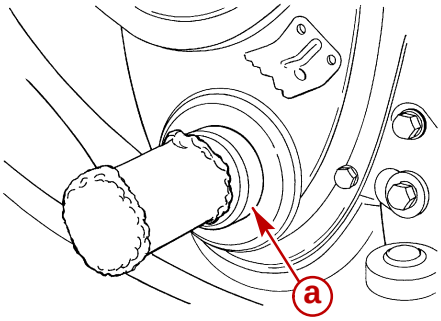


73124

Front Seals WITH Helical Grooves

- **a** - MCM (LH) Rotation Engines
- **b** - Seal Lip Toward Inside of Engine
- **c** - Rotation of Crankshaft as Viewed from Front End Looking Toward Flywheel End

1. Apply Quicksilver Perfect Seal to seal retainer mating surface and apply grease to seal lips.
2. Install new seal with open end of seal inward, using crankcase front cover seal installer. Drive seal in until it just contracts. Do not use excessive force.



72347

a - Crankcase Front Cover Seal Installer (J-35468)

3. Reinstall torsional damper.

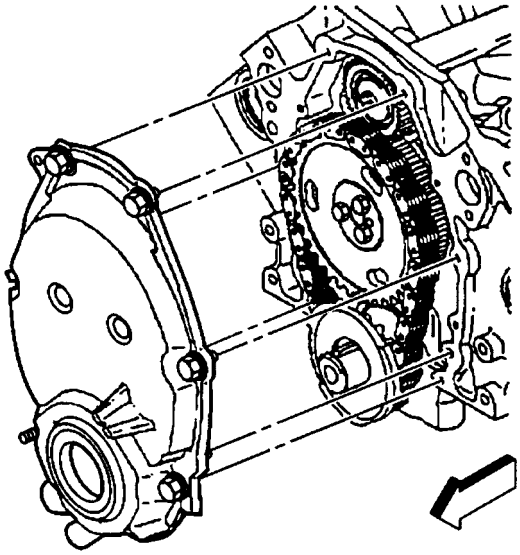
Crankcase Front Cover

Removal

1. Remove engine from boat if necessary to gain access to cover.
2. Remove torsional damper and oil pan.
3. Remove water circulating pump.

IMPORTANT: Crankcase front cover is not reusable per G.M. Specification. It must be replaced if removed.

4. Remove crankcase front cover.



76577

5. Drive oil seal out of front cover (from the rear) using a punch.

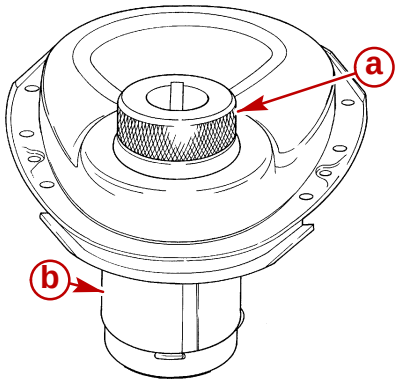
Cleaning and Inspection

1. Clean old gasket material and sealer from mating surface on cylinder block.
2. Surfaces must be clean and flat or oil leakage may result.

Installation

IMPORTANT: Crankcase front cover is not reusable per G.M. Specification. It must be replaced if removed.

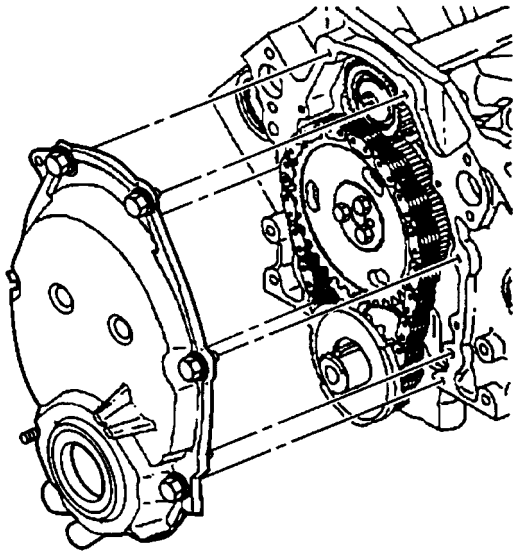
1. Install oil seal in cover with lip of seal toward inside of engine, using crankcase front cover seal installer. To prevent distortion support cover around seal area with an appropriate tool as shown.



72348

a - Crankcase Front Cover Seal Installer (J-35468)
b - Support

2. Coat both sides of front cover gasket with Quicksilver Perfect Seal and place in position on engine.
3. Install front cover, making sure holes in cover align with dowel pins in block. Torque front cover attaching screws to 100 lb-in. (11 Nm).



76577

4. Install oil pan and torsional damper.
5. Install water circulating pump.
6. Install engine in boat.
7. Fill crankcase with engine oil.

8. Follow procedures in SECTION 6A or 6B of this manual:

Seawater Cooled Models: Provide for adequate water supply to seawater pickup (Refer to SECTION 6A).

Closed Cooled Models: Refill closed cooling section (Refer to SECTION 6B), and provide adequate water supply to seawater pickup.

⚠ CAUTION

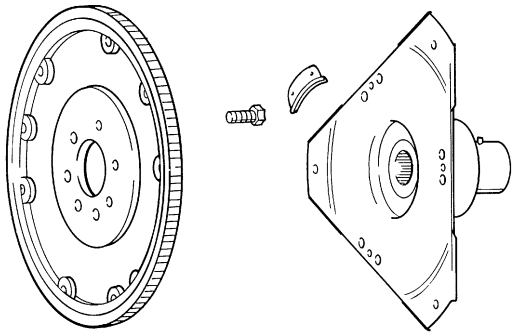
Ensure that cooling water supply is available before starting the engine.

9. Start engine and check for water and oil leaks.

Flywheel

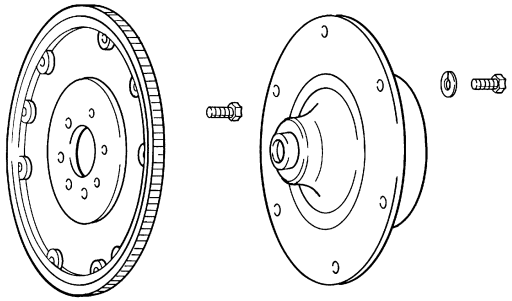
Removal

1. Remove engine from boat. Refer to SECTION 2 - “Removal and Installation”.
2. Refer to “Flywheel Housing” description in this section and remove flywheel housing and related parts.
3. Remove coupler.
4. Remove flywheel.



72349

Alpha One Coupler



72350

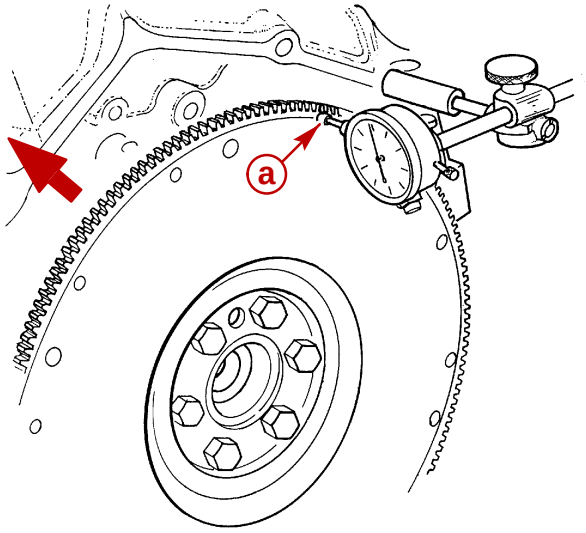
Bravo Coupler

Inspection

1. Inspect splines in coupler for wear.
2. Check flywheel ring gear for worn and missing teeth.

Installation

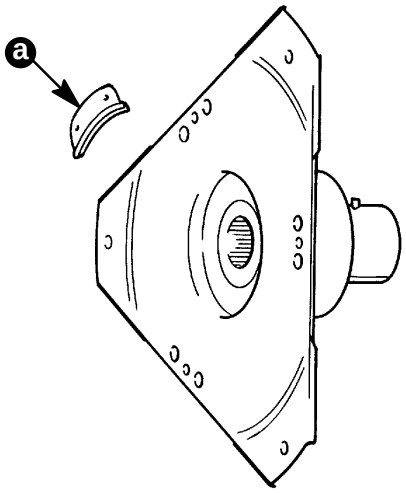
1. Clean mating surfaces of flywheel and crankshaft. Remove any burrs. Mating surfaces must be clean bare metal.
2. Aligning dowel hole in flywheel with dowel in crankshaft, install flywheel. Torque bolts to 75 lb-ft (100 Nm).
3. Check flywheel runout as follows:
   a. Attach a dial indicator to engine block.
   b. Take readings around outer edge of flywheel. Push in on flywheel as far as it will go to remove crankshaft end play.
   c. Maximum runout - .008 in. (0.203 mm).



72353

a - .008 In. (0.203 mm) Max Runout

IMPORTANT: Insert three rubber bumpers in Alpha coupler before installation on flywheel.



72354

a - Rubber Bumper

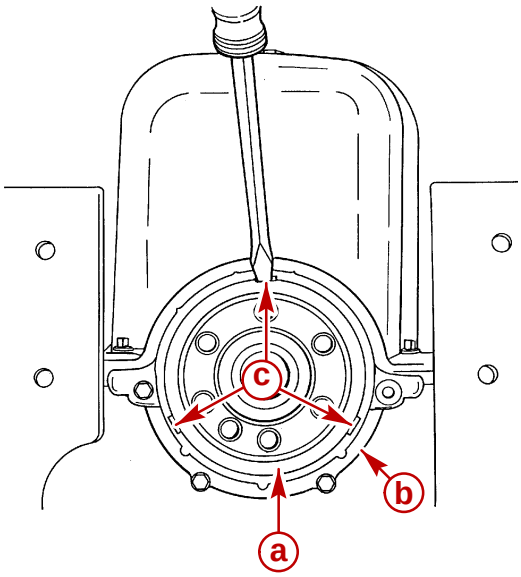
4. Install drive coupler. Torque bolts to 35 lb-ft (48 Nm).
5. Install flywheel housing and related parts. Torque bolts to 30 lb-ft (41 Nm).
6. Install flywheel housing cover. Torque bolts to 80 lb-in. (9 Nm).
7. Refer to SECTION 2 “Removal and Installation” and install engine.

Rear Main Oil Seal

The rear crankshaft oil seal can be replaced without removing the oil pan or rear main bearing cap from engine.

Removal

Remove seal by using a screwdriver to pry it out of retainer as shown.



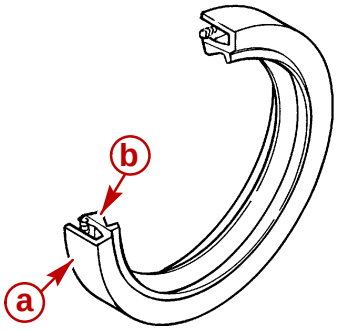
72355

a - Rear Seal
b - Seal Retainer
c - Slots (Three)

Cleaning and Inspection

Clean crankshaft/seal running surface and seal retainer.

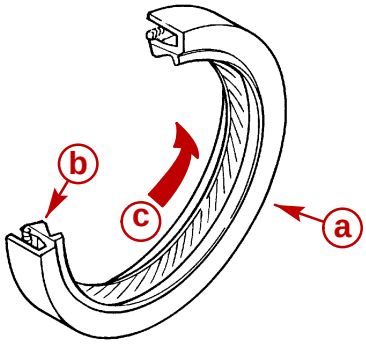
IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.



73126

Rear Seal WITHOUT Helical Grooves

a - Can Be Used On Any Rotation Engine
b - Seal Lip Toward Inside Of Engine



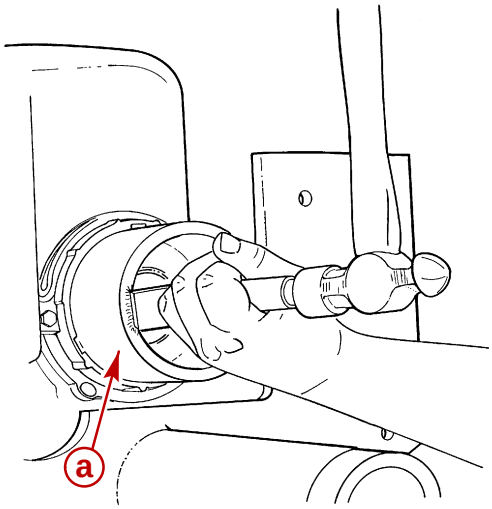
73127

Rear Seal WITH Helical Grooves

a - MCM (LH) Rotation Engines
b - Seal Lip Toward Inside Of Engine
c - Rotation Of Crankshaft As Viewed From Flywheel End Looking Forward

Installation

1. Apply Quicksilver Perfect Seal to seal retainer mating surface. Apply grease to seal lips.
2. Install seal using rear main seal installer. (J-26817-A)



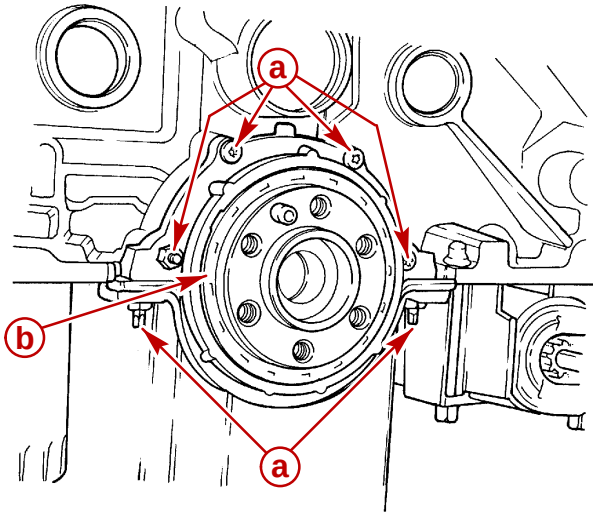
72356

a - Rear Main Seal Installer

Rear Main Oil Seal Retainer

Removal

1. Remove oil pan.
2. Remove oil seal retainer fasteners.
3. Remove oil seal retainer.



72464

a - Fasteners
b - Oil Seal Retainer

Cleaning and Inspection

1. Clean gasket material from mating surfaces.
2. Inspect oil seal retainer for cracks or scored surface.
3. Inspect oil seal for worn, dry or torn rubber. Replace if necessary, refer to “Rear Main Oil Seal.”
4. Inspect alignment pin for damage; replace if necessary.

Installation

1. Coat seal lips with clean 30W motor oil.
2. Install gasket and oil seal retainer with rear main seal.
3. Coat threads of oil seal retainer fasteners with Loctite Pipe Sealant with Teflon.
4. Install fasteners and torque to 133 lb-in.(15 Nm).
5. Install oil pan fasteners. Torque engine oil pan nuts and bolts 18 lb-ft (25 Nm).

NOTE: *A one-piece oil pan gasket may be reused if it is still pliable and is not damaged.*

Main Bearings

IMPORTANT: Before removing main bearing caps or connecting rod caps, mark them for reassembly in their original locations.

Main bearings are of the precision insert type and do not use shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and .001 in., .010 in. and .020 in. undersize.

Selective fitting of both rod and main bearing inserts is necessary in production in order to obtain close tolerances. For this reason you may find one half of a standard insert with one half of a .001 in. undersize insert which will decrease the clearance .0005 in. from using a full standard bearing.

IMPORTANT: If crankshaft has an undersize journal and a new bearing is required, journal must be reconditioned to accept a .010 or .020 in. undersize bearing as .009 in. undersize bearings are not available for service.

Inspection

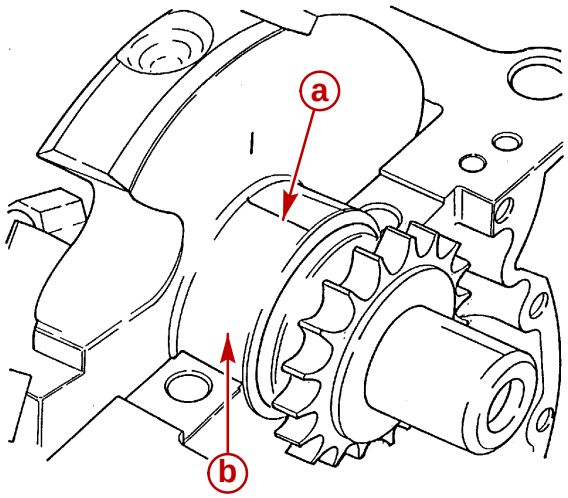
In general, the lower half of the bearing (except No. 1 bearing) shows a greater wear and the most distress from fatigue. If, upon inspection, the lower half is suitable for use, it can be assumed that the upper half is also satisfactory. If the lower half shows evidence of wear or damage, both upper and lower halves should be replaced. Never replace one half without replacing the other half.

Checking Clearances

To obtain accurate measurements while using Plastigage, or its equivalent, engine must be out of the boat and upside down so crankshaft will rest on the upper bearings and total clearance can be measured between lower bearing and journal.

To ensure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, before to checking fit of bearings, the surface of the crankshaft journal and bearing should be wiped clean of oil.

1. With the oil pan and oil pump removed, remove bearing cap and wipe oil from journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing (parallel to the crankshaft) on the journal as shown.



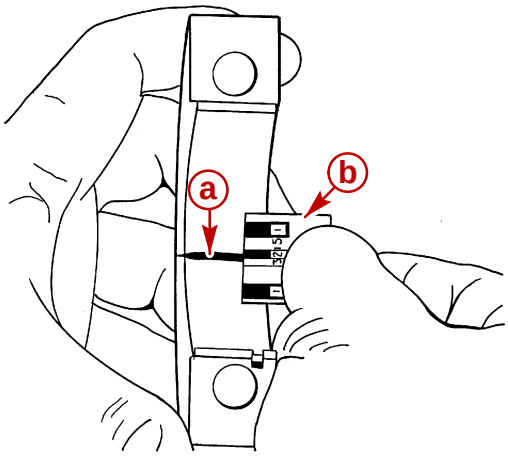
72357

a - Gauging Plastic
b - Journal

3. Install the bearing cap and evenly torque the retaining bolts to specifications. Bearing cap MUST be torqued to specification in order to assure proper reading. Variations in torque affect the compression of the plastic gauge.

IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.

4. Remove bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or journal.
5. On the edge of the gauging plastic envelope there is a graduated scale correlated in thousandths of an inch. Without removing the gauging plastic, measure its compressed width (at the widest point) with the graduations on the gauging plastic envelope.



72358

a - Compressed Gauging Plastic
b - Graduated Scale

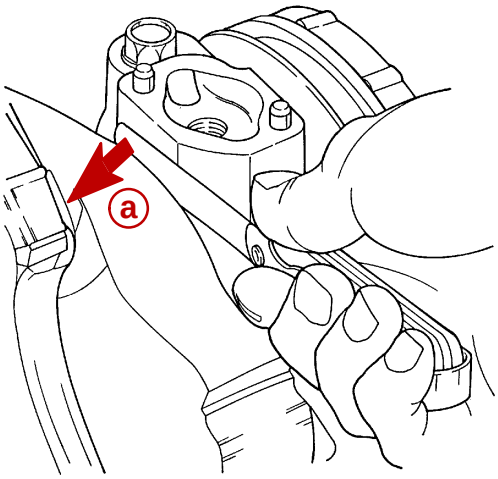
NOTE: *Normally main bearing journals wear evenly and are not out of round. However, if a bearing is being fitted to an out-of-round journal (.001 in. max.), be sure to fit to the maximum diameter of the journal: If the bearing is fitted to the minimum diameter, and the journal is out of round .001 in., interference between the bearing and journal will result in rapid bearing failure. If the flattened gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal. Be sure to measure the journal with a micrometer if the flattened gauging plastic indicates more than .001 in. difference.*

6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
7. A standard, or .001 in., undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.

   c. After selecting new bearing, recheck clearance.

8. Proceed to the next bearing. After all bearings have been checked, rotate the crankshaft to see that there is no excessive drag. When checking No. 1 main bearing, loosen accessory drive belts to prevent tapered reading with plastic gauge.

9. Measure crankshaft end play by forcing the crankshaft to the extreme front position. Measure at the front end of the rear main bearing with a feeler gauge as shown [Specifications - .002-.006 (0.06-0.15)].

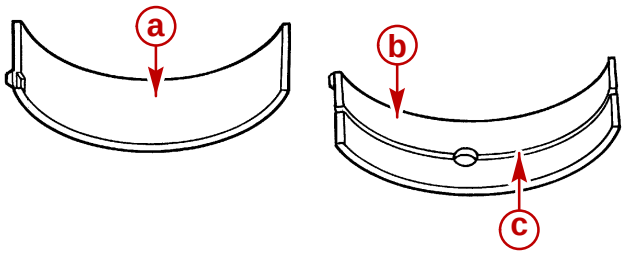


72360

a - Force Crankshaft to Extreme Forward Position

Replacement

NOTE: *Main bearings may be replaced with or without removing crankshaft.*



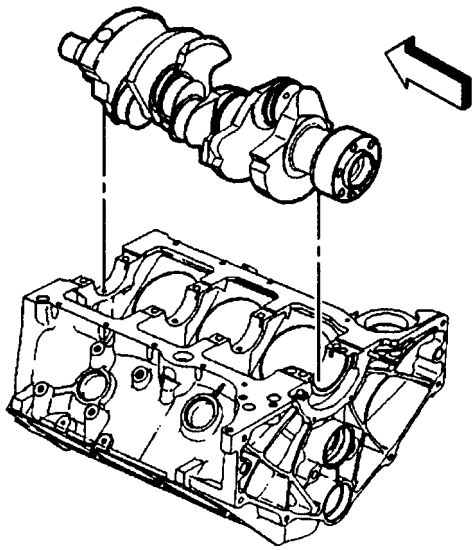
72359

Main Bearing Inserts

a - Lower Bearing Insert (Install in Cap)
b - Upper Bearing Insert (Install in Block)
c - Oil Groove

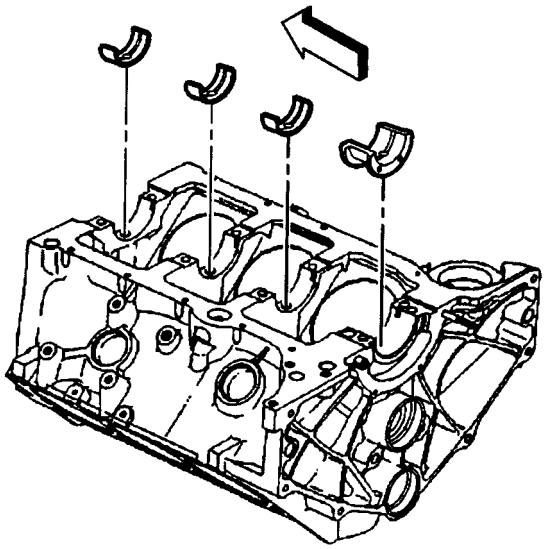
WITH CRANKSHAFT REMOVED

1. Remove and inspect the crankshaft.



76580

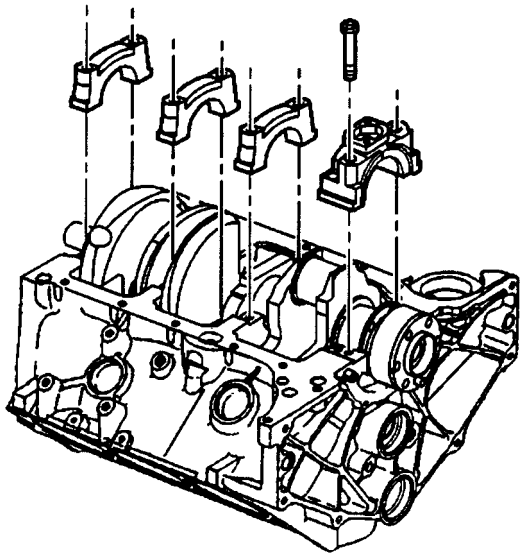
2. Remove the main bearings from the cylinder block and main bearing caps.



76582

3. Coat bearing surfaces of new, correct size, main bearings with oil and install in the cylinder block and main bearing caps.

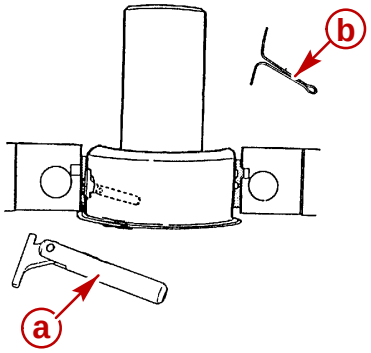
4. Install the crankshaft.



76579

WITHOUT CRANKSHAFT REMOVED

1. With oil pan, oil pump and spark plugs removed, remove cap on main bearing requiring replacement and remove bearing from cap.
2. Install main bearing remover/installer in oil hole in crankshaft journal. If such a tool is not available, a cotter pin may be bent, as shown, to do the job.



72622

a - Main Bearing Remover/Installer (J-8080)
b - Cotter Pin

3. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll upper bearing out of block.
4. Oil new selected size upper bearing and insert plain (un-notched) end between crankshaft and indented or notched side of block. Rotate the bearing into place and remove tool from oil hole in crankshaft journal.
5. Oil new lower bearing and install in bearing cap.
6. Install main bearing cap with arrows pointing toward front of engine.
7. Torque all main bearing caps, EXCEPT THE REAR MAIN CAP, to 75 lb-ft (102 Nm). Torque rear main bearing cap to 10-12 lb-ft (14-16 Nm); then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Torque rear main bearing cap to 75 lb-ft (102 Nm).

Connecting Rod Bearings

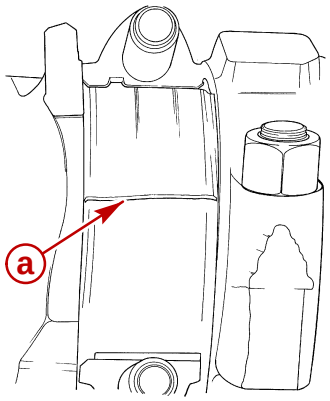
Connecting rod bearings are of the precision insert type and do not use shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and .001 in. and .002 in. undersize for use with new and used standard size crankshafts, and in .010 in. and .020 in. undersize for use with reconditioned crankshafts.

On removing a connecting rod cap, it is possible to find a .010 in. undersize bearing. These are used in manufacturing for selective fitting.

Inspection and Replacement

IMPORTANT: Before you remove the connecting rod cap, mark the side of the rod and cap with the cylinder number to assure matched reassembly of rod and cap.

1. With oil pan and oil pump removed, remove the connecting rod cap and bearing.
2. Inspect the bearing for evidence of wear and damage. Do not reinstall a worn or damaged bearing.
3. Wipe both upper and lower bearing shells and crankpin clean of oil.
4. Measure the crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition the crankshaft. If within specifications and a new bearing is to be installed, measure the maximum diameter of the crankpin to determine new bearing size required.
5. If within specifications, measure new or used bearing clearances with gauging plastic or its equivalent. If a bearing is being fitted to an out-of-round crankpin, be sure to fit to the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter, and the crankpin is out of round .001 in., interference between the bearing and crankpin will result in rapid bearing failure.
   a. Place a piece of gauging plastic, the length of the bearing (parallel to the crankshaft), on the crankpin or bearing surface as shown. Position the gauging plastic in the middle of the bearing shell. (Bearings are eccentric and false readings could occur if placed elsewhere.)



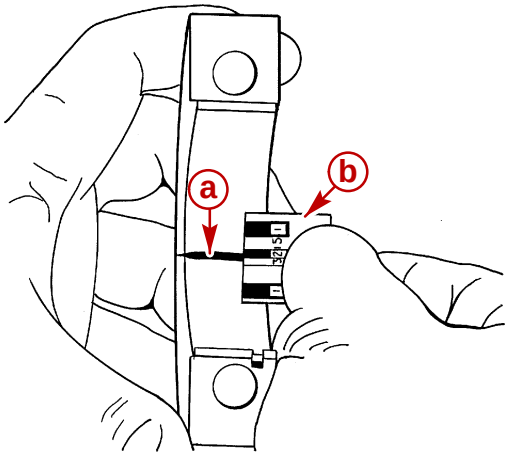
72361

a - Gauging Plastic

   b. Install the bearing in the connecting rod and cap.
   c. Install the bearing cap and evenly torque nuts to 45 lb-ft (61 Nm).

IMPORTANT: Do not turn the crankshaft with the gauging plastic installed.

d. Remove the bearing cap and using the scale on the gauging plastic envelope, measure the gauging plastic width at the widest point as shown.

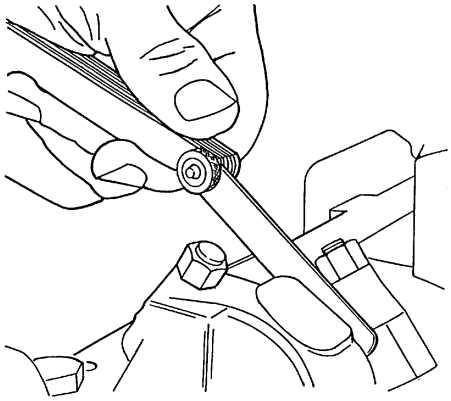


72358

6. If the clearance exceeds specifications, select a new, correct size bearing and measure the clearance.

NOTE: *Be sure to check what size bearing is being removed in order to determine proper replacement size bearing. If clearance cannot be brought within specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace crankshaft.*

7. Coat the bearing surface with oil, install the rod cap and torque nuts to 45 lb-ft (61 Nm).
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) to make sure they have clearance.
9. Measure all connecting rod side clearances between connecting rod caps as shown [Specifications - .006-.014 (0.152-0.356)].

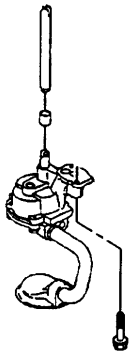


72891

Connecting Rod/Piston Assembly

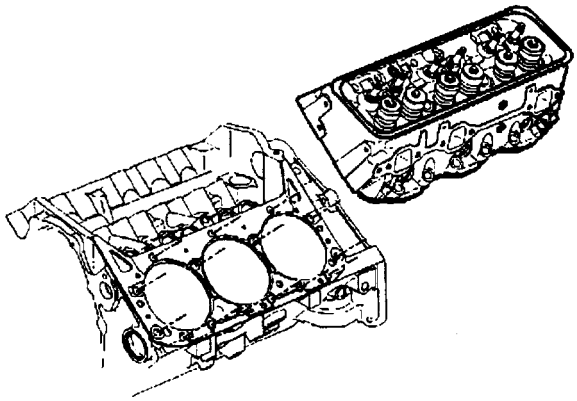
Removal

1. Remove oil pan and dipstick tube.
2. Remove oil pump.



76571

3. Remove distributor and intake manifold.
4. Remove cylinder heads.



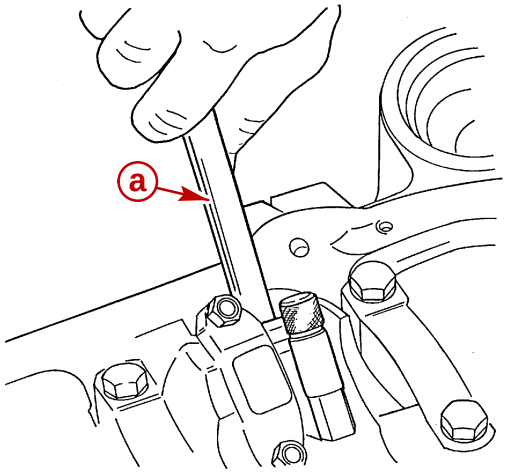
76576

5. Use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.

IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and / or deposits are removed, turn crankshaft until piston is at top of stroke, then remove cloth and cuttings.

6. Mark connecting rods and bearing caps (left bank 1, 3 and 5; right bank 2, 4 and 6 from front to rear on same side as piston thrust).
7. Remove connecting rod cap and install connecting rod bolt guide (3/8-24) on bolts. Push connecting rod and piston assembly out of top of cylinder block.

NOTE: *It will be necessary to turn crankshaft slightly to disconnect and remove some connecting rod and piston assemblies.*

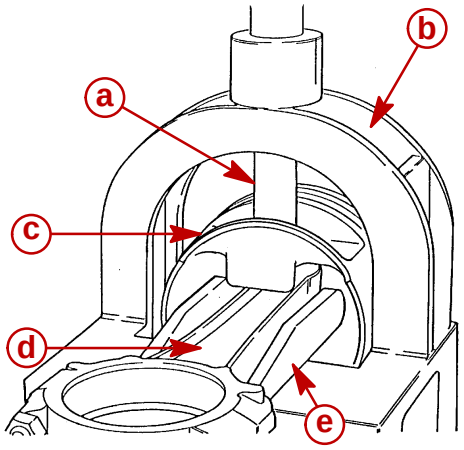


72892

a - Connecting Rod Bolt Guide (3/8-24) [J-5239]

Disassembly

Disassemble piston from connecting rod using piston pin remover.



72893

a - Piston Pin Remover (J-24086-B)
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

Cleaning and Inspection

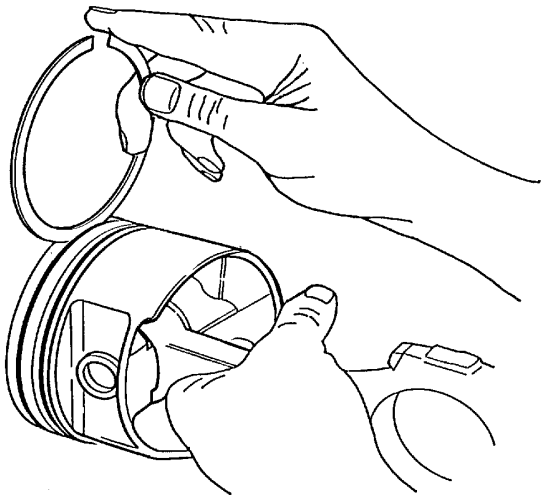
CONNECTING RODS

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted and bent rods and inspect for nicks and cracks. Replace damaged connecting rods.

PISTONS

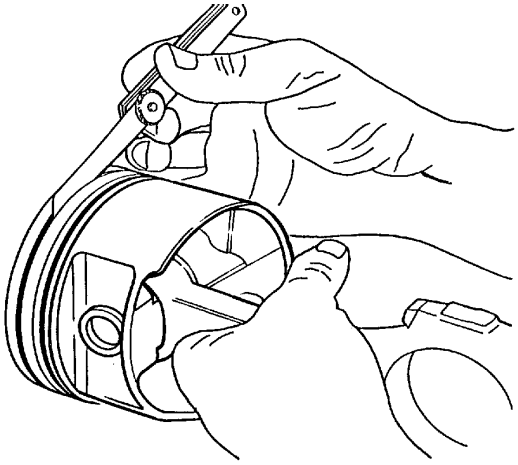
NOTE: *Cylinder bore and taper must be within specifications before pistons can be considered for re-use.*

1. Clean varnish from piston skirts with a cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with a groove cleaner and make sure oil ring holes are clean.
2. Inspect piston for damaged ring lands, skirts and pin bosses, wavy or worn ring lands, scuffed or damaged skirts and eroded areas at top of piston.
3. Inspect grooves for nicks and burrs that might cause rings to hang up.
4. Measure piston skirt and check clearance as outlined under “Piston Selection.”
5. Slip outer surface of a new top and second compression ring into respective piston ring groove and roll ring entirely around the groove to make sure that ring does not bind. If ring groove causes binding, remove by dressing with a fine cut file. If a distorted ring causes binding, recheck with another ring.



72894

6. Proper clearance of piston ring in its groove is necessary for proper ring action. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured. See “Specifications.”



72895

PISTON PINS

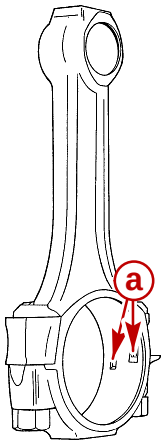
1. Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.
2. Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish and scuffing when measured. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of the .001 in. (0.02 mm) wear limit, replace piston and piston pin assembly.

Reassembly

PISTONS AND PISTON PINS

IMPORTANT: When reassembling pistons and connecting rods, be aware that:

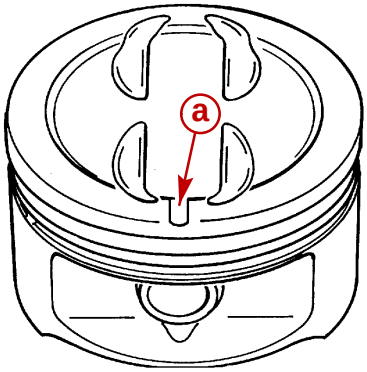
- **Piston and pin are machine fitted to each other and must remain together as a matched set. Do not intermix pistons and pins.**
- **If original pistons and/or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they were removed.**
- **Connecting rod bearing tangs are always toward outside of cylinder block.**



72368

a - Rod Bearing Tangs

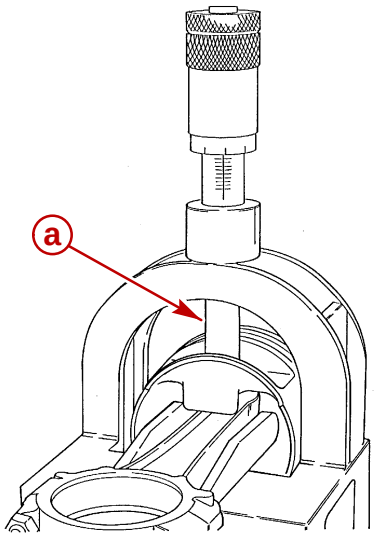
IMPORTANT: Notch in piston must be positioned facing toward the front of the engine.



72896

a - Notch

1. Assemble piston to connecting rod using piston pin remover as shown. Follow instructions supplied with kit.



72897

a - Piston Pin Remover (J-24086-B)

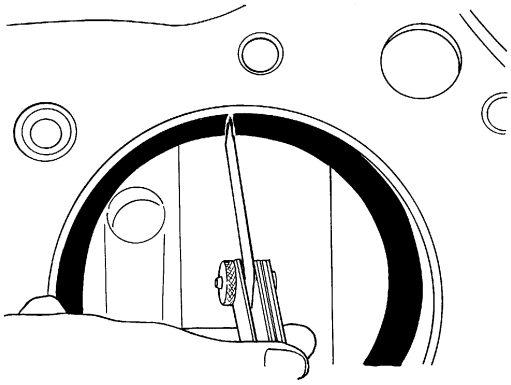
2. Once assembled, check piston for freedom of movement in all directions on connecting rod; piston should move freely. If it does not, piston pin bore is tight and piston/pin assembly must be replaced.
3. If a new connecting rod has been installed, mark connecting rod and cap (on side of rod and cap with slots for connecting rod bearing tangs) with cylinder number in which it will be installed.

PISTON RINGS

All compression rings are marked on upper side of ring. When installing compression rings, make sure that marked side is toward top of piston.

Oil control rings are a three-piece type, consisting of two rings and a spacer.

1. Select rings comparable in size to cylinder bore and piston size.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about 1/4 in. (6 mm) (below ring travel). Be sure that ring is square with cylinder wall.
3. Measure gap between ends of ring with a feeler gauge as shown.



72372

4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it is going to be used.
6. Clean and inspect pistons.

7. Install piston rings as follows:
   a. Install oil ring spacer in groove and insert anti-rotation tang in oil hole.
   b. Hold spacer ends together and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex the oil ring assembly to make sure ring is not binding. If ring groove is causing binding, remove with a fine cut file. If a distorted ring is causing binding, use a new ring.

IMPORTANT: Use piston ring expander (91-24697) for compression ring installation.

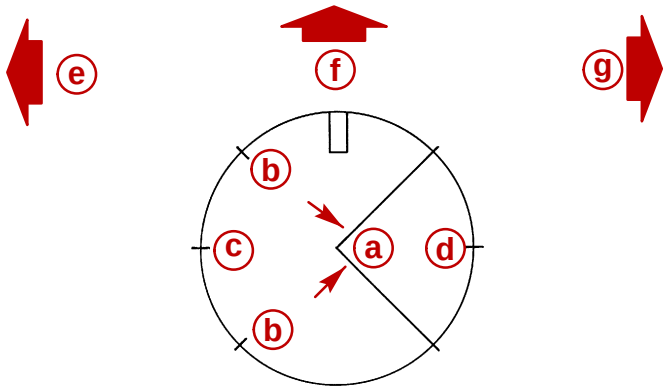
   e. Install lower compression ring with marked side up, using ring expander.
   f. Install top compression ring with marked side up, using ring expander.

Installation

IMPORTANT: Cylinder bores must be clean before piston installation. Clean with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, swab bores several times with light engine oil and clean cloth, then wipe with a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install connecting rod bolt guide (3/8-24) (J-5239) on connecting rod bolts.

IMPORTANT: Be sure ring gaps are properly positioned as shown.



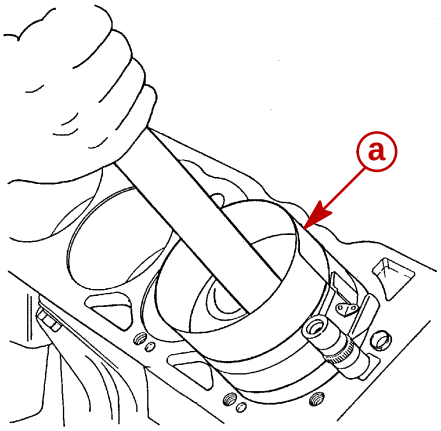
72373

Ring Gap Location

- **a** - Oil Ring Spacer Gap (Tang In Hole Or Slot Within Arc)
- **b** - Oil Ring Gaps
- **c** - 2nd Compression Ring Gap
- **d** - Top Compression Ring Gap
- **e** - Port Side
- **f** - Engine Front
- **g** - Starboard Side

4. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tangs toward outside of cylinder block. Use piston ring compressor to compress rings. Guide connecting rod into place on crankshaft journal with connecting rod bolt guide. Use a hammer handle with light blows to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted, and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3 and 5 in left bank and 2, 4 and 6 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.



72552

a - Piston Ring Compressor (J-8037)

5. Remove connecting rod bolt guide.
6. Install bearing caps and torque nuts to 20 lb-ft (27 Nm), then tighten nuts an additional 70 degrees angular torque using a Torque Angle Gauge.
7. Check connecting rod side clearance.

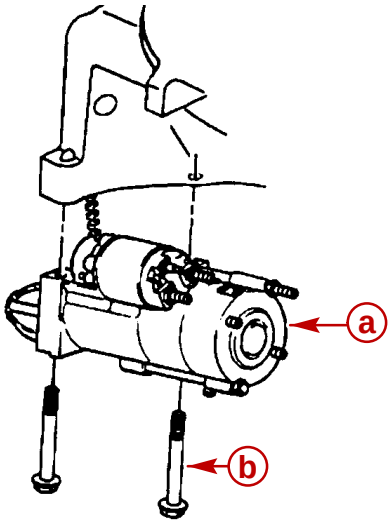
NOTE: *If bearing replacement is required, refer to "Connecting Rod Bearings."*

8. Install oil pump.
   a. Install dipstick and oil pan.
   b. Install cylinder heads.
   c. Install intake manifold.
   d. Install distributor.
9. Fill crankcase with oil. Refer to SECTION 1 - "Maintenance."
10. Torque rocker arm nuts to 22 lb-ft (30 Nm).

Crankshaft

Removal

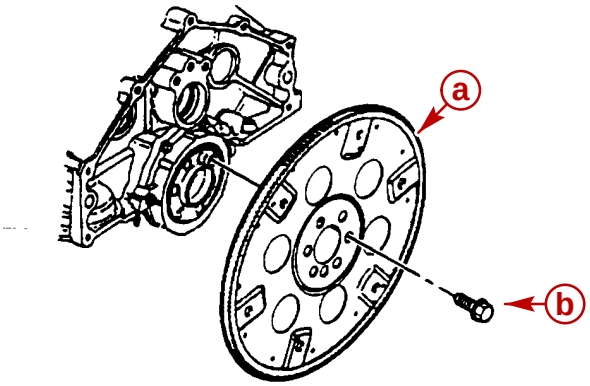
1. Remove engine from boat.
2. Drain crankcase oil.
3. Remove starter.



76489

a - Starter
b - Mounting Bolts

4. Remove flywheel housing.
5. Remove drive coupler and flywheel.

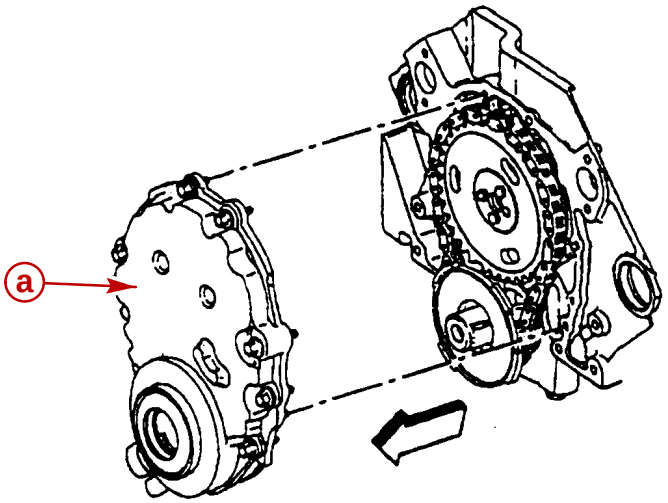


76490

a - Flywheel
b - Bolts

6. Remove belts.
7. Remove water pump.
8. Remove crankshaft pulley and torsional damper.
9. Remove spark plugs.
10. Remove oil pan and dipstick tube.
11. Remove oil pump.

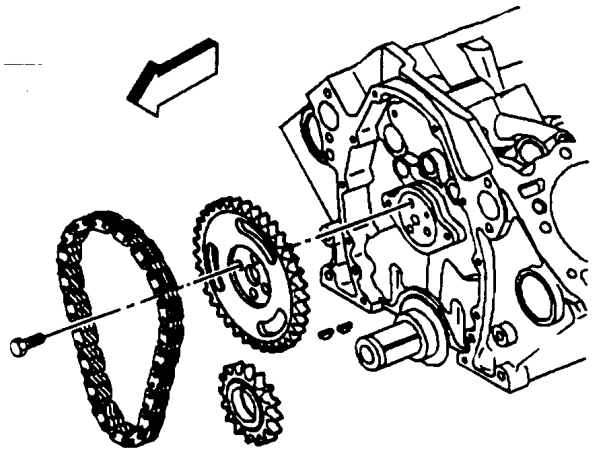
12. Timing chain cover.



76491

a - Timing Chain Gear Cover

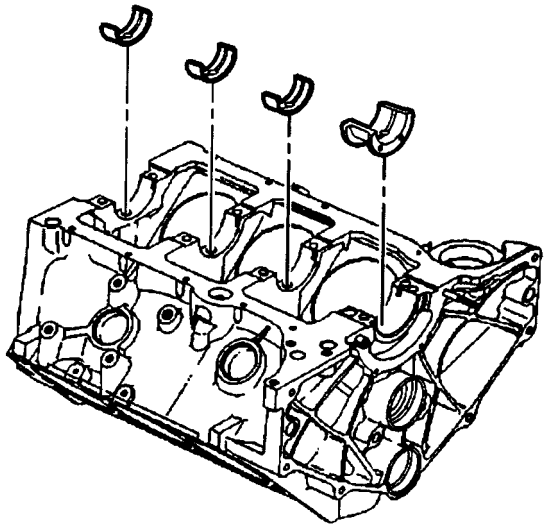
13. Turn crankshaft to align timing mark with camshaft mark.
14. Remove camshaft sprocket.



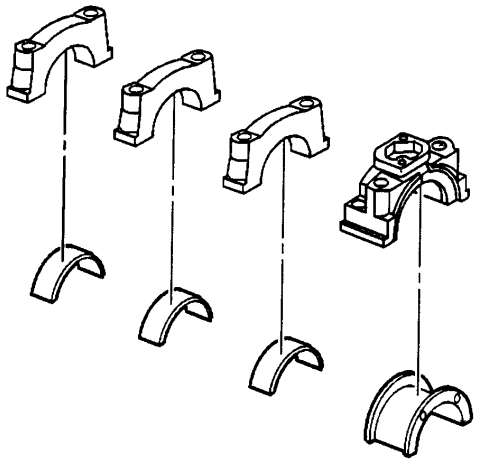
76488

15. Remove rear main seal and retainer.
16. Make sure all bearing caps (main and connecting rods) are marked so they can be reinstalled in their original locations.
17. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.
18. Remove main bearing caps and carefully lift crankshaft out of cylinder block.

19. If new main and/or connecting rod bearings are to be installed, remove main bearing inserts from cylinder block and bearing caps, and/or connecting rod bearing inserts from connecting rod and caps. Install new bearings following procedures outlined.



76582



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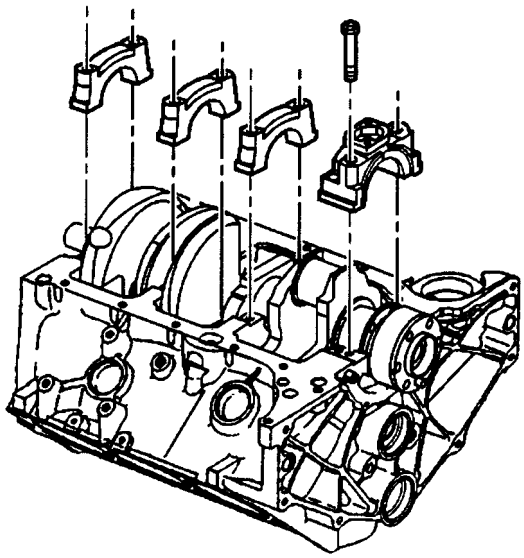


76579

Cleaning and Inspection

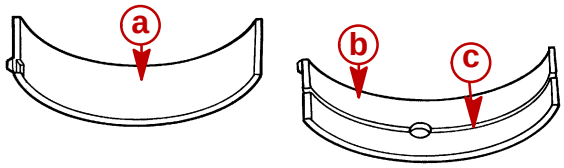
1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals and crankpin dimensions with a micrometer for out-of-round, taper or undersize. Refer to “Specifications.”
3. Check crankshaft for runout (by supporting at front and rear main bearings journals in V-blocks) and check at front and rear intermediate journals with a dial indicator. Refer to “Specifications.”
4. Replace or recondition crankshaft if not within specifications.

Installation

1. If a new crankshaft is being installed, remove timing sprocket from old crankshaft and reinstall on new crankshaft as outlined.

IMPORTANT: Be sure that all bearings and crankshaft journals are clean.

2. Install main bearings in engine block as follows.



72359

Main Bearing Inserts

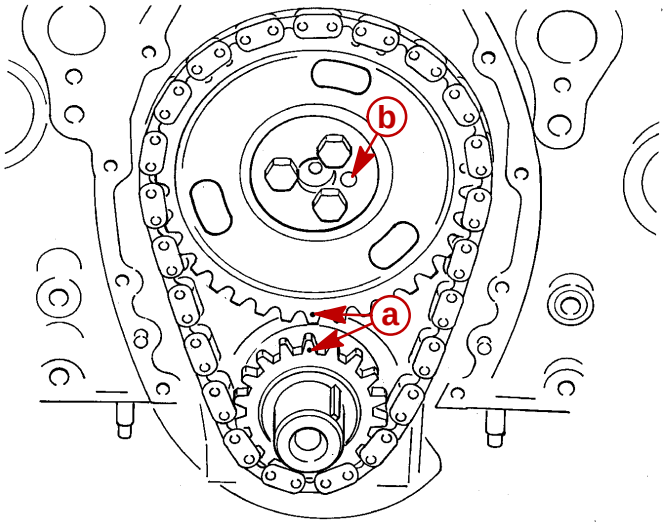
a - Lower Bearing Insert (Install in Cap)
b - Upper Bearing Insert (Install in Block)
c - Oil Groove

3. Carefully lower crankshaft into place. Be careful not to damage bearing surface.
4. Check clearance of each main bearing. If bearing clearances are satisfactory, apply engine oil to journals and bearings.
5. Install main bearing caps. Torque bolts to 75 lb-ft (102 Nm). Refer to “Main Bearings” when tightening rear main bearing cap.
6. Check crankshaft end play.
7. Install rear main seal retainer and seal. Torque fasteners to 133 lb-in. (15 Nm).
8. Check clearance for each connecting rod bearing. If bearing clearances are satisfactory, apply engine oil to journals and bearings.
9. Install rod caps and torque nuts to 45 lb-ft (61 Nm).
10. Reverse Steps 3 - 13 in Removal.
11. Install new oil filter.
12. Fill crankcase with oil.

Timing Chain and Sprocket

Removal

1. Remove torsional damper, oil pan and crankcase front cover.
2. Turn crankshaft until timing marks on crankshaft and camshaft sprockets are in alignment.



72899

a - Timing Marks Aligned
b - Locating Pin

3. Remove camshaft sprocket and timing chain. (If sprocket does not come off easily, a light tap on the lower edge of the sprocket using a plastic mallet, should dislodge it.)
4. Remove crankshaft sprocket if it requires replacement.

Cleaning and Inspection

1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing chain for wear and damage.
3. Inspect sprockets for wear and damage.

Installation - Timing Chain

1. Install crankshaft sprocket if removed.

⚠ CAUTION

When timing marks are aligned in this procedure, the No. 4 cylinder is on compression (TDC); therefore, if the distributor is to be installed, the rotor MUST BE positioned at the No. 4 post on the distributor cap.

2. Install timing chain on camshaft sprocket. Hold sprocket vertical with chain hanging down. Align marks on camshaft and crankshaft sprockets.

IMPORTANT: Do not attempt to drive sprocket on camshaft, as welsh plug at rear of engine can be dislodged.

3. Install sprocket on camshaft. Torque bolts to 18 lb-ft (24 Nm).
4. Lubricate timing chain with engine oil.
5. Install crankcase front cover and torsional damper.

Index

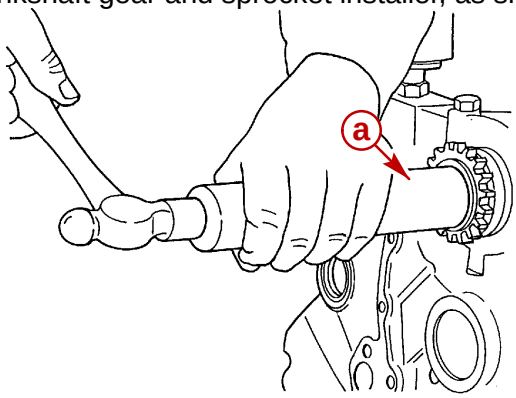
Crankshaft Sprocket

Removal

1. Remove torsional damper and crankcase front cover.
2. Remove camshaft timing chain.
3. Using crankshaft gear and sprocket puller (P/N J-5825-A), remove crankshaft sprocket.

Installation

1. Using crankshaft gear and sprocket installer, as shown, install sprocket on crankshaft.



72377

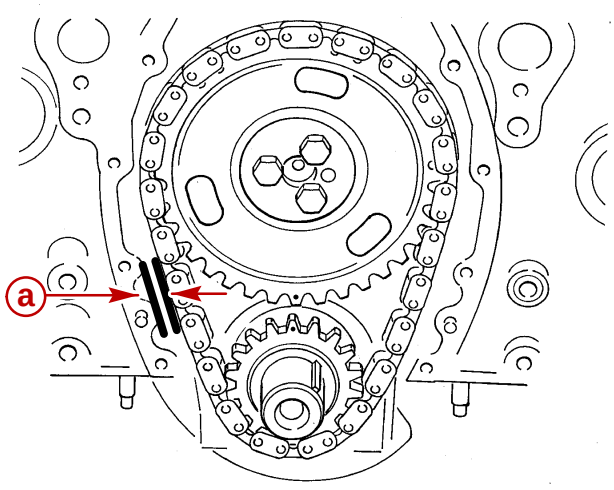
a - Crankshaft Gear and Sprocket Installer (J-5590)

2. Install timing chain.
3. Install crankcase cover and torsional damper.

Checking Timing Chain Deflection

With timing chain and sprockets installed, check timing chain deflection, as follows:

1. Rotate camshaft (in either direction) to place tension on one side of the chain.
2. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
3. Rotate camshaft in the opposite direction to slacken the chain, then force chain out with fingers and again measure the distance between reference point and timing chain.
4. The deflection is the difference between these two measurements. If the deflection exceeds 3/4 in. (19 mm), timing chain should be replaced.



72899

a - Reference Point

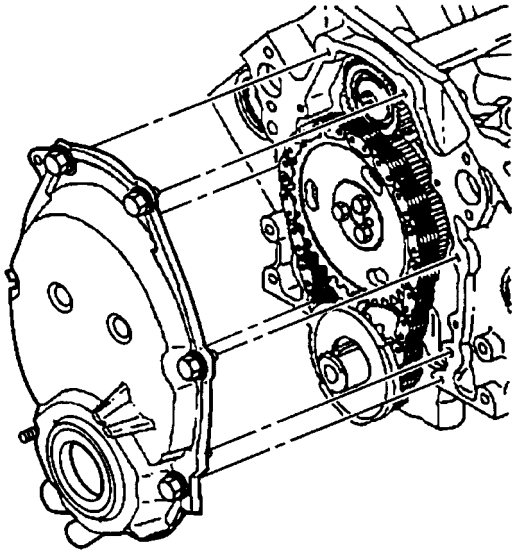
Balance Shaft / Gears

Removal

1. Remove manifold.

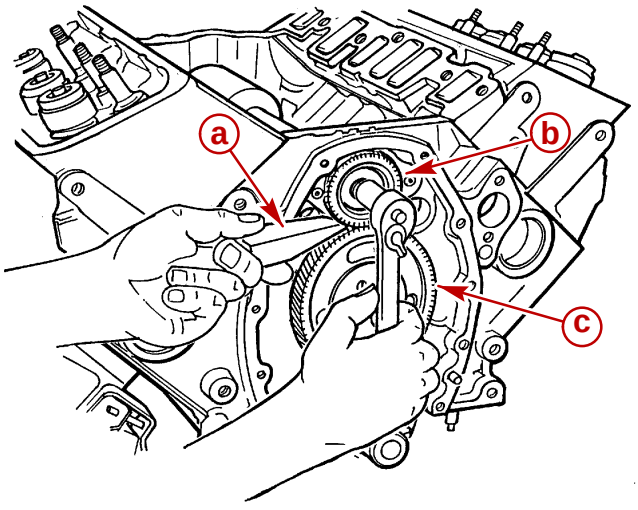
IMPORTANT: Crankcase front cover is not reusable per G.M. Specification. It must be replaced if removed.

2. Remove crankcase front cover.



76577

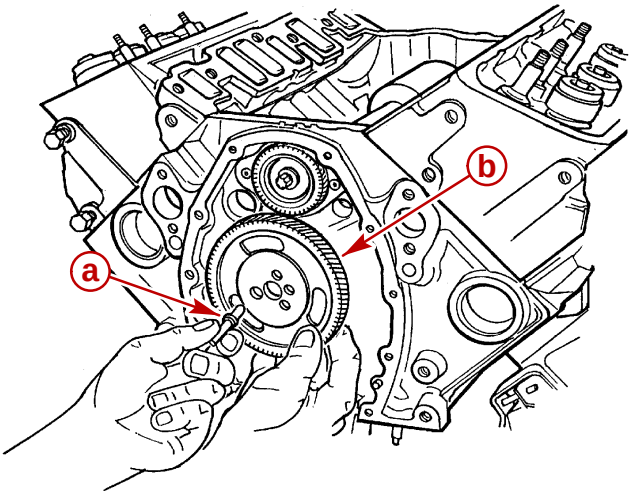
3. Remove timing chain.
4. Insert hard wood wedge between gear teeth and remove TORX bolt retaining balance shaft driven gear. Remove gear.



72900

a - Wedge
b - Driven Gear
c - Drive Gear

5. Unscrew stud and remove balance shaft drive gear on camshaft as shown.



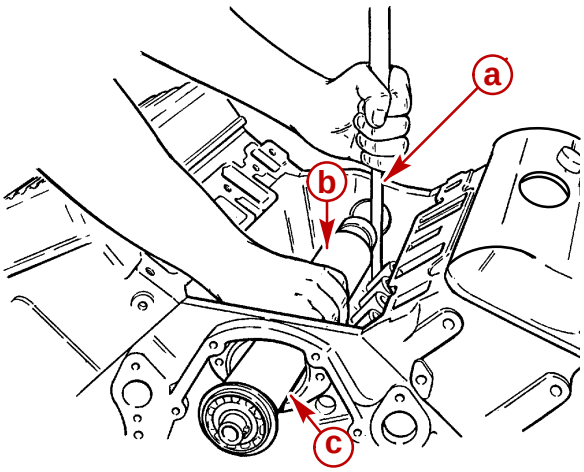
72901

a - Stud
b - Drive Gear

6. Remove two TORX bolts retaining balance shaft thrust plate.

IMPORTANT: Care should be taken in next step as damage to cylinder block and/or balance shaft could result.

7. Insert pry bar in aft section between balance shaft and cylinder block. Gently apply forward pressure and remove balance shaft.

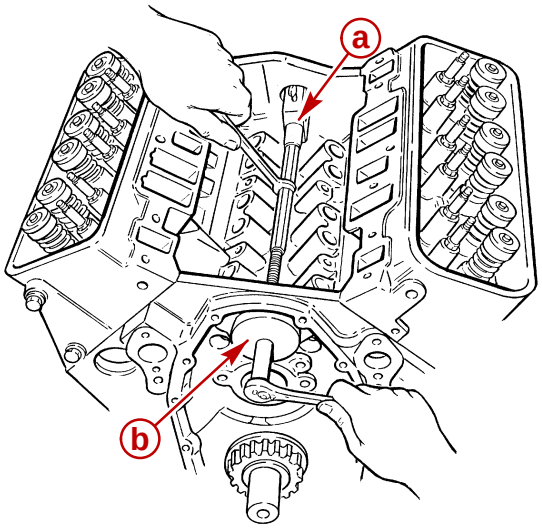


72902

a - Pry Bar
b - Balance Shaft
c - Bearing Housing

NOTE: *When replacing balance shaft rear bearing, place a cloth in valley to prevent any debris from entering the crankcase.*

8. Balance shaft rear bearing can be replaced using balance shaft removal and installer tool in conjunction with bearing puller.



72903

a - Balance Shaft Removal and Installation Tool
b - Bearing Puller

Cleaning and Inspection

1. Wash balance shaft in solvent and blow dry with compressed air.
2. Inspect rear bearing for wear or damage. See “Specifications.”

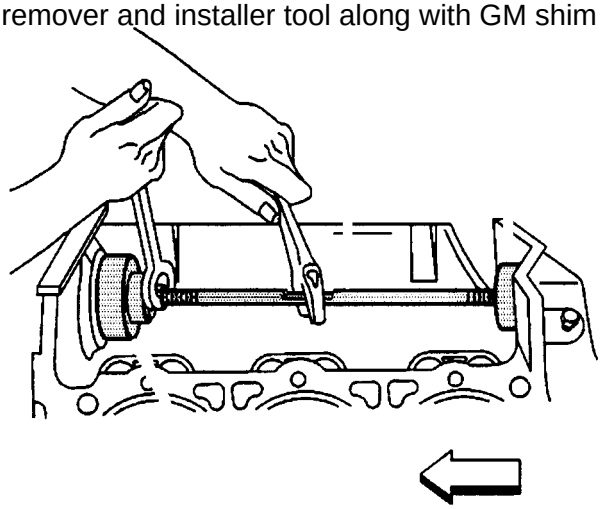
NOTE: *Front bearing is not serviceable and may be replaced only with the balance shaft assembly.*

3. Inspect front bearing for secure fit on shaft or excessive side to side play. Also check for scored bearings or roughness while rotating.
4. Inspect front cylinder block bore for scoring or evidence of bearing spinning in bore.
5. Inspect gears for chips or excessive wear on teeth.
6. Inspect balance shaft gear key way and shaft dowel pin for excessive wear.

Installation

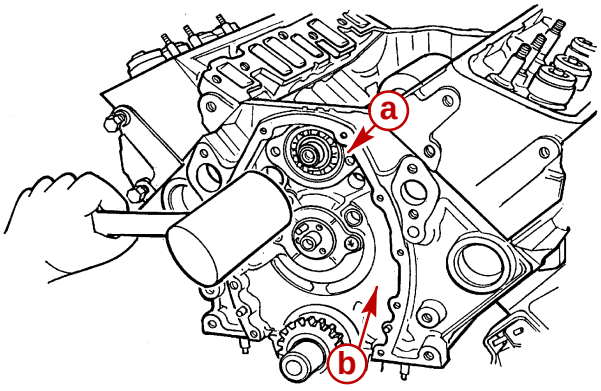
NOTE: *GM shim (10229872) is placed on installer tool prior to the bearing. This will assure proper depth setting of rear bearing when installed.*

1. Use balance shaft remover and installer tool along with GM shim to insert bearing.



76590

2. Lubricate bearings with engine oil and install balance shaft.
3. Using a soft face mallet, tap shaft until front bearing retaining ring seats against cylinder block.

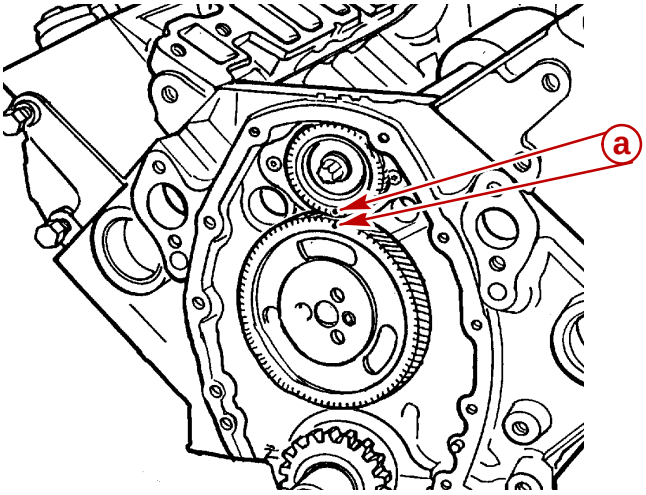


72904

a - Retaining Ring
b - Cylinder Block

4. Install thrust plate and two TORX bolts. Torque to 120 lb-in. (14 Nm).
5. Install driven gear on balance shaft.

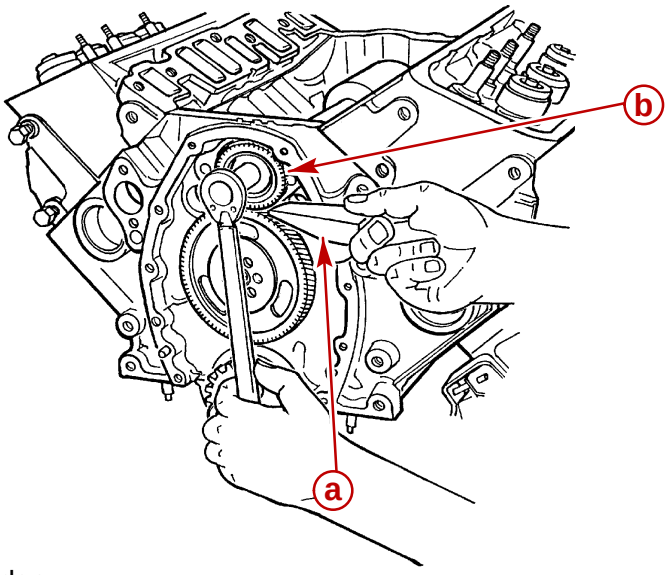
6. Align marks on drive and driven gear and install drive gear on camshaft.



72905

a - Alignment Marks

7. Install bolts to retain camshaft sprocket and torque to 20 lb-ft (27 Nm).
8. Apply thread adhesive to threads of balance shaft bolt and install.
9. Insert hard wood wedge between gear teeth and torque driven gear retaining bolt to 15 lb-ft (20 Nm), then tighten bolt an additional 35 degrees angular torque using a Torque Angle Gauge.



72906

a - Wedge
b - Driven Gear

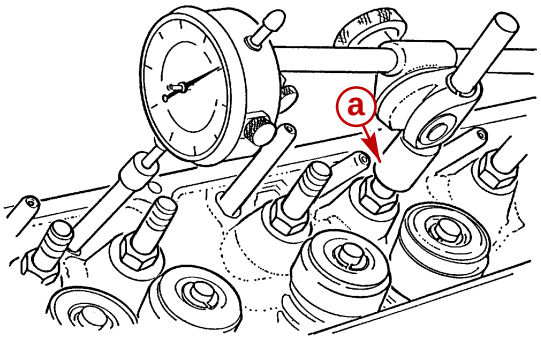
10. Install timing chain.
11. Install crankcase front cover.
12. Install manifold.

Camshaft

Measuring Lobe Lift

NOTE: *Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record readings.*

1. Remove valve mechanism.
2. Position indicator with ball socket adaptor tool on push rod. Ensuer that push rod is in lifter socket.



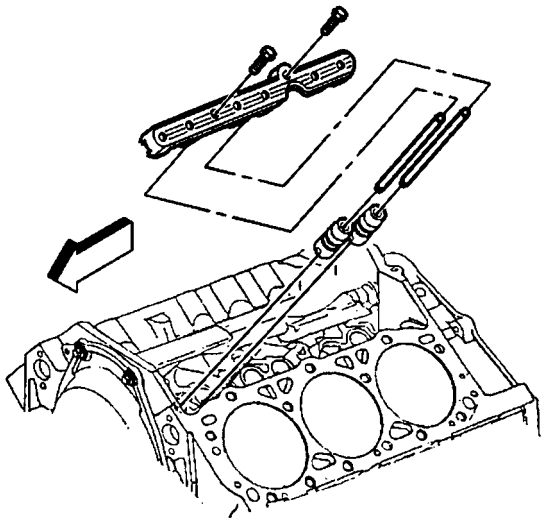
72907

a - Ball Socket Adaptor Tool (J-8520-1)

3. Rotate crankshaft torsional damper slowly in direction of engine rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.
4. Set dial indicator on zero, then rotate balancer slowly (or attach an auxiliary starter switch and “bump” engine over) until push rod is in fully raised position.
5. Compare total lift, recorded from dial indicator, with “Specifications.”
6. Continue to rotate engine until indicator reads zero. This will be a check on accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install rocker arm and push rod. Torque nuts to 20 lb-ft (27 Nm).

Removal

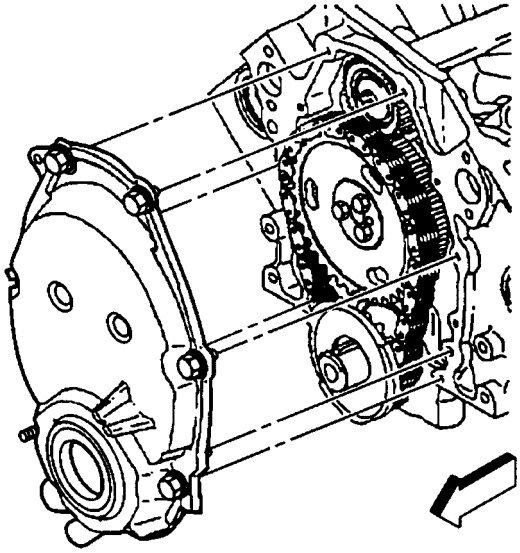
1. Remove valve lifters.



76585

IMPORTANT: Crankcase front cover is not reusable per G.M. Specification. It must be replaced if removed.

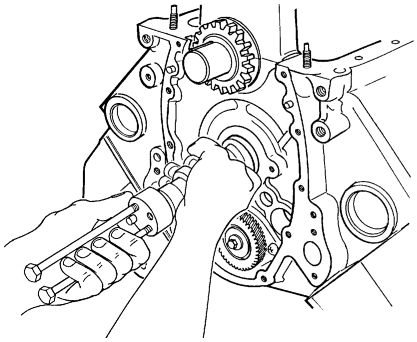
2. Remove crankcase front cover.



76577

3. Remove camshaft as follows:
   a. Remove timing chain, sprocket and camshaft thrust plate.

b. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes and carefully remove camshaft as shown.

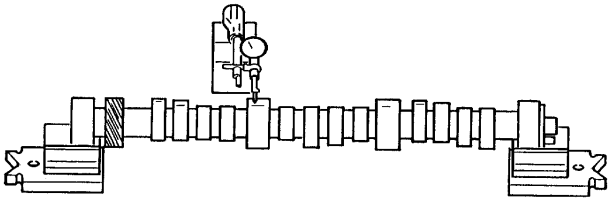


72908

Inspection

Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001 in. (0.025 mm) out-of-round, camshaft should be replaced.

Also check camshaft for alignment with V-blocks and dial indicator which indicates exact amount camshaft is out of true. If out more than .002 in. (0.05 mm) (dial indicator reading) camshaft should be replaced.



72909

Checking Camshaft Alignment

Installation

1. Install camshaft as follows:
   a. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes, then lubricate camshaft journals with engine oil and install camshaft. DO NOT damage bearings.
   b. Lubricate camshaft lobes with General Motors Cam and Lifter Prelube or equivalent.
   c. Install timing chain.
2. Install crankcase front cover and valve lifters.

Camshaft Bearings

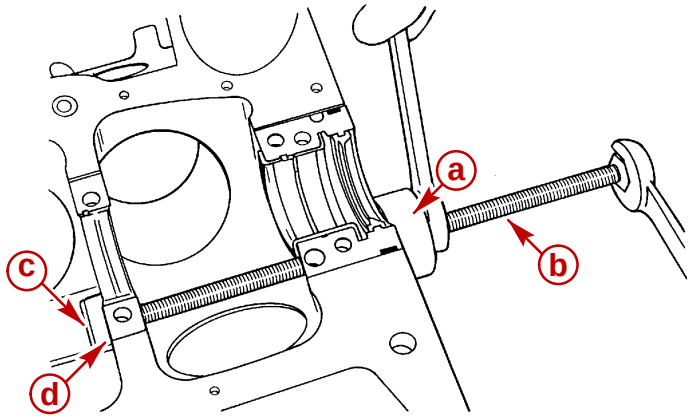
Removal

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, fasten connecting rods against sides of engine so that they will not interfere while replacing camshaft bearings.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

NOTE: *This procedure is based on removal of bearings from center of engine first, thus requiring a minimum amount of turns to remove all bearings.*

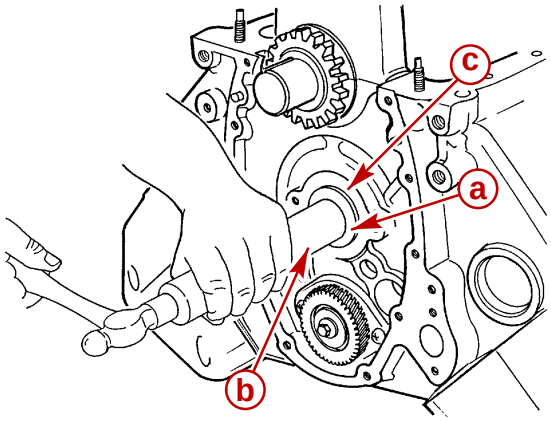
2. Using camshaft bearing remover and installer set (J-6098-01) (with nut and thrust washer installed to end of threads), position pilot in front camshaft bearing and install puller screw through pilot.
3. Install tool with shoulder toward bearing. Ensure a sufficient amount of threads are engaged.
4. Using two wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove tool and bearing from puller screw.
5. Remove remaining bearings (except front and rear) in same manner. You must position pilot in rear camshaft bearing to remove rear intermediate bearing.



72383

a - Index Point
b - Puller Screw
c - Driver
d - Bearing

6. Assemble driver on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block.



72870

a - Driver
b - Driver Handle
c - Bearing (Hidden In This View)

Inspection

Clean camshaft bearing bores in cylinder block with solvent and blow out with compressed air. Be sure grooves and drilled oil passages are clean.

Installation

Front and rear bearings must be installed last as pilot will not fit into bearing bores if bearings are installed.

Lubricate outer surface of new camshaft bearings with engine oil to ease installation.

IMPORTANT: All camshaft bearings are not the same. Be sure to install bearings in proper locations (Indicated by bearing manufacturer) and to position bearings as follows (directional references are in reference to engine in its normal operating position):

- **Front bearing must be positioned so that oil holes are equal distance from 6 o'clock position in the block. Intermediate and center bearings must be positioned so that oil holes are at the 5 o'clock position (toward left side of block and at a position even with bottom of cylinder bore). Rear bearing must be positioned so that oil hole is at the 12 o'clock position.**

1. Installing intermediate and center bearings:
   a. Install nut and thrust washer all the way onto puller screw, then position pilot in front camshaft bearing bore and insert screw through pilot.
   b. Index center camshaft bearing, then position appropriate size remover and installer tool in bearing and thread puller screw into tool. Be sure at least 1/2 in. (13 mm) of threads are engaged.
   c. Using two wrenches, hold puller screw and turn nut until bearing has been pulled into position. Remove the remover and installer tool and check to ensure that oil hole(s) in bearing are positioned correctly.
   d. Install intermediate bearings in same manner being sure to index bearings correctly. It will be necessary to position pilot in rear camshaft bearing bore to install rear intermediate bearing.

2. Installing front and rear bearings:
   a. Install appropriate size remover and installer tool on drive handle.
   b. Index front bearing (as explained in “Important” above), and drive it into position with tool. Check position of oil hole(s) in bearing to ensure bearing is positioned correctly.
   c. Install rear bearing in same manner, being sure to index bearing correctly.
3. Install a new camshaft rear plug.

IMPORTANT: Plug must be installed flush to 1/32 in. (0.8 mm) deep and must be parallel with rear surface of cylinder block.

4. Install crankshaft and camshaft.

Cylinder Block

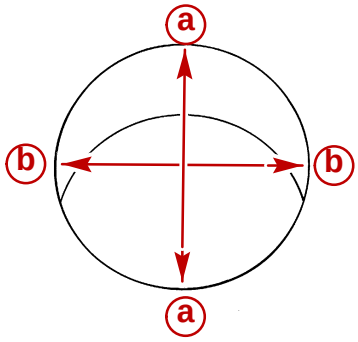
Cleaning and Inspection

1. Remove all engine components.
2. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
3. Remove oil gallery plugs and clean all oil passages.
4. Remove expansion plugs.

NOTE: *These plugs may be removed with a sharp punch or they may be drilled and pried out.*

5. Clean and inspect water passages in cylinder block.
6. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.

7. Measure cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, boring and/or honing will be necessary.



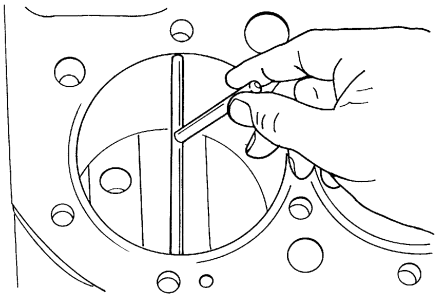
72385

Cylinder Measurement

a - At Right Angle To Centerline Of Engine
b - Parallel to Centerline Of Engine

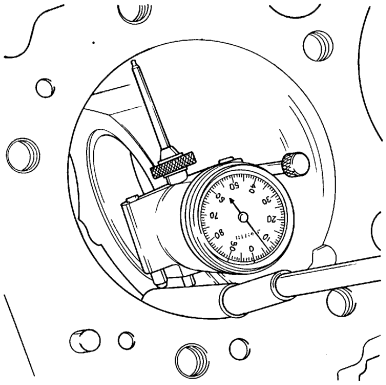
"Out Of Round" Equals The Difference Between "red a" and "red b"

Measurement At Top Of Cylinder Bore and
Measurement At Bottom Of Cylinder Bore



72386

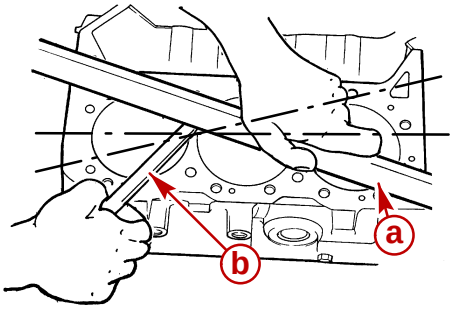
Measuring Cylinder Bore with Telescope Gauge



72387

Measuring Cylinder Bore with Dial Indicator

8. Check cylinder head gasket surfaces for warp with a machinist's straight-edge and a feeler gauge. Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are warped more than .003 in. (0.07 mm) in a 6 in. area or .007 in. (0.2 mm) overall, block must be resurfaced by an automotive machine shop.



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a - Machinist's Straight Edge
b - Feeler Gauge

CYLINDER CONDITIONING

1. Performance of the following operation depends upon engine condition at time of repair.
2. If cylinder block inspection indicates that block is suitable for continued use (except for out-of-round or tapered cylinders), they can be conditioned by honing or boring.
3. If cylinders have less than .005 in. (0.127 mm) taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of more than .005 in. wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to bore for an oversize piston. If more than .005 in. taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
4. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

CYLINDER BORING

1. Before using a boring bar, file off top of cylinder block to remove dirt or burrs. This is very important to prevent boring bar tilt. Boring bar tilt causes the bored cylinder wall to not be at right angles to crankshaft.
2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

NOTE: *Hone cylinders as outlined under "Cylinder Honing" and "Piston Selection," following.*

3. Carefully observe instructions furnished by manufacturer of equipment being used.

CYLINDER HONING

1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during the honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a crosshatch pattern of approximately 30 degrees to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.
4. Permanently mark piston (for cylinder to which it has been fitted) and proceed to hone cylinders and fit remaining pistons.

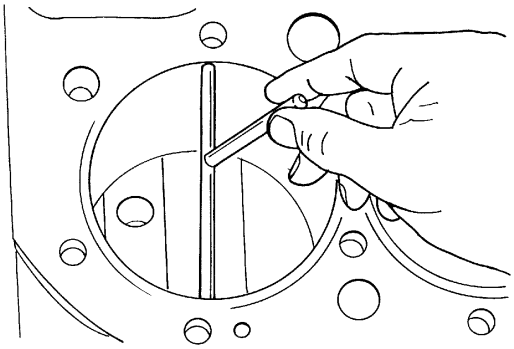
IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size, as this type piston can be distorted by careless handling.

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by the contaminated oil. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

Index

PISTON SELECTION

1. Check used piston to cylinder bore clearance as follows:
   a. Measure cylinder bore diameter with a telescope gauge 2-1/2 in. (64 mm) from top of cylinder bore as shown.



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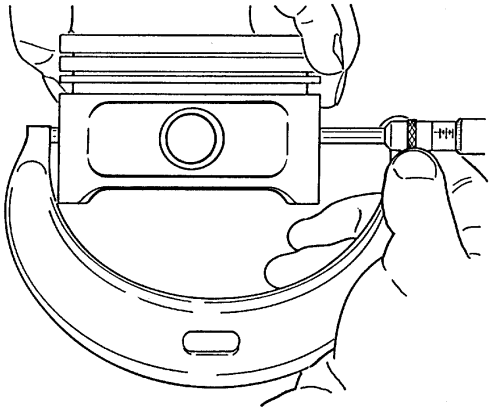
   b. Measure piston diameter at skirt across center line of piston pin as shown.



72911

   c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.

Determine if piston-to-bore clearance is in acceptable “Specifications” range.

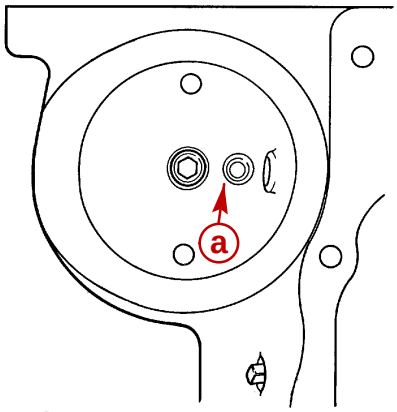
2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (preferable range).
4. Mark piston to identify cylinder for which it was fitted.

Oil Filter By-Pass Valve

Inspection and/or Replacement

Oil by-pass valve should be inspected whenever engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

1. Remove oil filter from cylinder block and remove by-pass valve.
2. Clean by-pass valve in solvent and blow dry with compressed air.
3. Inspect fiber valve for cracks or other damage. Ensure that valve fits tightly against its seat on the seal. Push valve down and release it. Valve should return freely to its seat. If valve operation is questionable, by-pass valve should be replaced.



72912

Typical By-Pass Valve

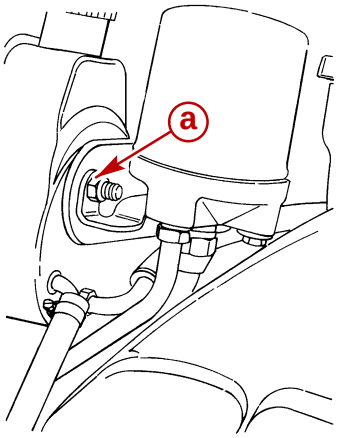
a - Fiber Valve

4. Wipe out valve chamber in cylinder block to remove any foreign material.
5. Install by-pass valve and cylinder block adaptor to engine block.
6. Lubricate oil filter rubber seal and install hand-tight only.

Remote Oil Filter

Inspection and/or Replacement

1. Remove nut from back side of power steering pump bracket.

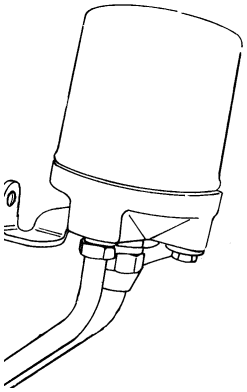


75010

Typical

a - Nut

2. The outer oil line on the oil filter housing must be removed in order to install the bracket.

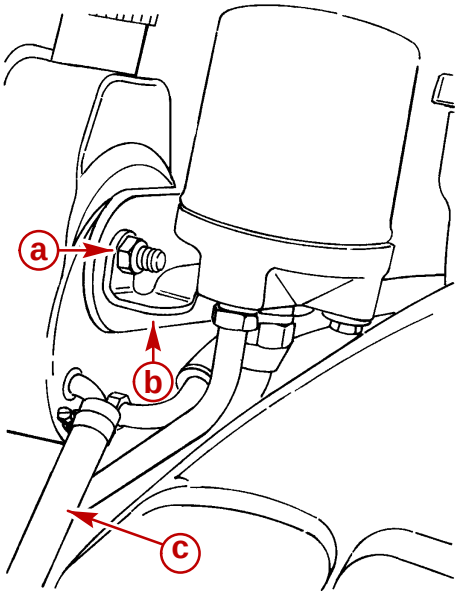


75010

a - Remove This Line

NOTE: *Oil lines must be routed under the return line to the power steering pump. Ensure that the oil lines do not rub or chafe on the exhaust manifold or engine mount.*

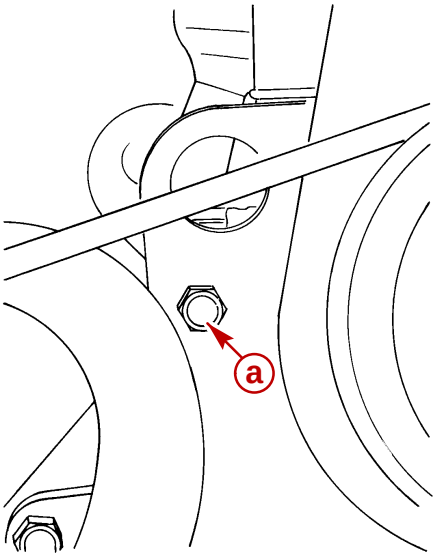
3. Place bracket over the stud and install nut. Torque nut to 12 lb-ft (16 Nm).



75010

a - Bracket
b - Nut
c - Power Steering Return Line

4. Install bracket screw from the front side of power steering bracket.

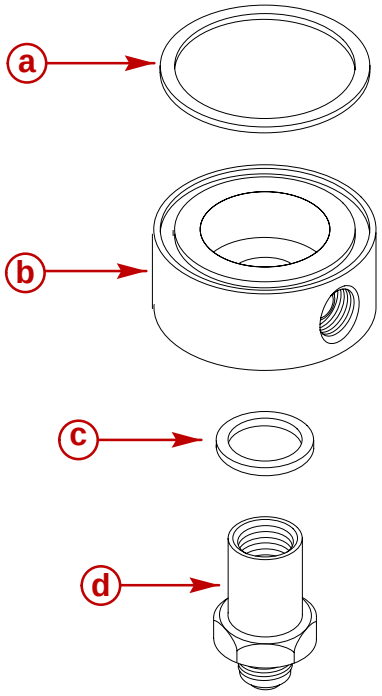


75011

a - Bracket Screw

5. Install previously removed oil line into oil filter housing. Torque fitting 20 to lb-ft (27 Nm).
6. Lightly lubricate seal on oil filter with engine oil. Install oil filter on oil filter adapter. Hand tighten only.
7. Route oil lines past engine mount. Use hose clip to retain hoses. Remove upper screw from port side engine mount. Place hose clip over screw and reinstall screw.

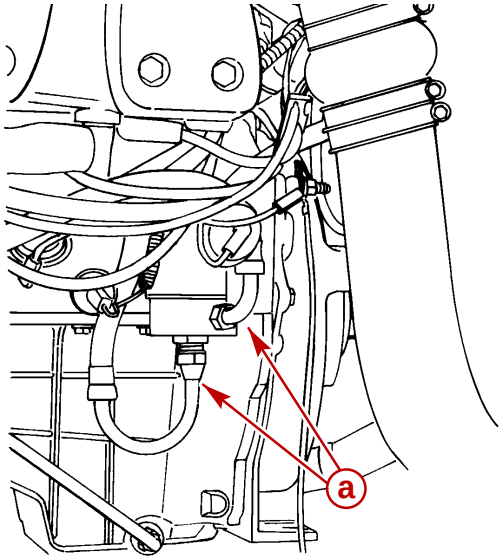
8. Place the seal in adapter and lightly lubricate with engine oil. Position adaptor over engine block and install the bushing in the block. Torque bushing to 40 ft-lb (50 Nm).



75175

a - Engine Block To Adapter Seal
b - Adapter
c - Quad Ring
d - Bushing

9. Install oil lines in adapter and orientate as shown. Torque fittings to 20 lb-ft (27 Nm).



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a - Oil Lines

10. Check oil level and fill if necessary.
11. Start engine and check for oil leaks.

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