ENGINE

Section 3A - 350 cid / 5.0L/ 305 cid / 5.7L Engines

Table of Contents

Index

Torque Specifications

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
Camshaft Sprocket Gear			216		24
Carburetor or Throttle Body			132		15
Connecting Rod Cap Nuts	First Pass			20	27
	Final Pass (Angle Torque)			+ 55 Degrees	+ 55 Degrees
Coupler-to-Flywheel (MCM)				35	48
Crankshaft Pulley				43	58
Crankcase Front Cover (Timing Chain/Gear Cover)			106		12
Cylinder Head Bolt 111	First Pass	Short Bolt Medium Bolt Long Bolt		22	30
	Final Pass (Angle Torque)	Short Bolt Medium Bolt Long Bolt	+ 55 Degrees + 65 Degrees + 75 Degrees		
Distributor Hold Down				18	25
Exhaust Manifold				20	27
Filter Adapter (5/16-18)					
Flywheel				75	100
Flywheel Drive Plate (MIE)				35	48
Flywheel Housing to Block				30	41
Flywheel Housing Cover			80		9
Front Mount Bracket				30	41
Fuel Pump				25	34
Intake Manifold				18	24
Main Bearing Cap	First Pass			15	20
	Final Pass (Angle Torque)			+ 73 Degrees	
Main Bearing Cap (Optional - Without Angular Torque)				77	105

Index

Torque Specifications (Continued)

Description	lb-in.	lb-ft	Nm
Oil Baffle Nuts		25	34
Oil Filter Adapter Bolt		15	20
Oil Pan Drain Plug		15	20
Oil Pan Corner Nut		18	25
Oil Pan Nuts (5/16-18)	106		12
Oil Pump		65	88
Oil Pump Cover	80		9
Power Steering Pump Brace to Block		30	41
Power Steering Pump Bracket			
Rear Crankshaft Oil Seal Retainer Bolts and Nuts	106		12
Rear Mount (MCM)		40	54
Rear Mount (MIE)		50	68
Remote Oil Connector (1/2 in. x 13)		25	34
Remote Oil Filter Adapter Nut / Fitting		20	27
Rocker Arm Cover	106		12
Roller Lifter Restrictor Retainer Plate		18	25
Seawater Pump Brace		30	41
Seawater Pump Bracket			
Spark Plugs (New Cylinder Head)		22	30
Spark Plugs (All Others)		15	20
Starter Motor		50	50
Thermostat Housing		30	41
Torsional Damper		40	54
Transmission To Housing		50	68
Water Circulating Pump		33	45
Water Temperature Sender		20	27

Index

Special Tools

KENT-MOORE SPECIAL TOOLS	
Kent-Moore Special Tools 29784 Little Mack Roseville, MI 48066 Phone: (313) 574-2332	
Description	**Part Number**
Valve Spring Compressor (Head on)	J5892
Valve Spring Compressor (Head off)	J8062
Valve Spring Tester	J8056
Valve Guide Cleaner	J8101
Valve Guide Reamer (Standard)	J7049
Valve Guide Reamer (.015 in. oversize)	J5830-02
Rocker Arm Stud Remover	J5802-01
Rocker Arm Stud Installer	J6880
Stud Bore Reamer (.003 in. oversize)	J5715
Stud Bore Reamer (.013 in. oversize)	J6036
Carbon Remover Brush	J8089
Piston Pin Tool	J24086-B
Piston Ring Groove Cleaner	J3936-03
Piston Ring Compressor	J8037
Connecting Rod Guide Tool (3/8 -24)	J5239
Oil Pump Suction Pipe Installer	J21882
Camshaft Bearing Installer/Remover Tool	J6098-01
Ball Socket Adapter	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 Adapter	J23590
Main Bearing Remover and Installer	J8080
Rear Main Seal Installer	J26817-A

Index

Specifications

General Specifications

Engine Model	305 cid (5.0L)
Displacement	305 cid (5.0 L)
Bore	3.735 (94.89)
Stroke	3.479 in. (88.39 mm)
Firing Order	1-8-4-3-6-5-7-2
Compression Ratio	9.4:1
Heads	Cast Iron
Intake Manifold	Cast Iron
Block	Cast Iron (2 Bolt Main Bearing Caps)
Rods	Forged Steel
Crankshaft	Cast Iron
Pistons	Cast Aluminum
Camshaft	Cast Iron

Engine Model	350 cid (5.7L)
Displacement	350 cid (5.7 l)
Bore	4.00 (101.6)
Stroke	3.479 in. (88.39 mm)
Firing Order	1-8-4-3-6-5-7-2
Compression Ratio	9.3:1
Heads	Cast Iron
Intake Manifold	Cast Iron (Carbureted and EFI Models) Aluminum (MPI Models)
Block	Cast Iron (2 Bolt Main Bearing Caps)
Rods	Forged Steel
Crankshaft	Cast Iron
Pistons	Cast Aluminum
Camshaft	Steel

Engine Specifications

NOTICE
Unit Of Measurement: Inches (Millimeters)

CYLINDER BORE

Engine			305 cid (5.0L)	350 cid (5.7L)
Diameter			3.7350-3.7384 (94.881-94.958)	4.00-4.001 (101.618-101.643)
Out of Round		Production	0.001 (0.025) Max	
		Service	0.002 (0.05) Max	
Taper	Production	Thrust Side	0.0005 (0.012) Max	
		Relief Side	0.001 (0.025) Max	
	Service Limit		0.001 (0.025) Over Production	

PISTON CLEARANCE

Production	0.0007-0.002 (0.018-0.053) Max
Service	0.0007-0.0026 (0.018-0.068) Max

PISTON RING: COMPRESSION

Groove Clearance	Production	Top	0.0012-0.0027 (0.030-0.070)
		2nd	0.0015-0.003 (0.040-0.080)
	Service	Top	0.0012-0.0035 (0.030-0.090)
		2nd	0.0015-0.004 (0.040-0.100)
Gap	Production	Top	0.009-0.020 (0.25-0.51)
		2nd	0.010-0.020 (0.46-0.66)
	Service	Top	0.010-0.025 (0.25-0.65)
		2nd	0.018-0.035 (0.46-0.90)

PISTON RING: OIL

Groove Clearance	Production	0.002-0.006 (0.051-0.17)	
	Service	0.002-0.008 (0.051-0.22)	0.002-0.0076 (0.051-0.195)
Gap	Production	0.009-0.029 (0.25-0.76)	
	Service Limit	0.009-0.035 (0.25-0.89)	0.009-0.030 (0.25-0.785)

Index

PISTON PIN

Diameter		0.9269-0.9270 (23.545-23.548)
Clearance	Production	0.0005-0.0009 (0.013-0.023)
	Service Limit	0.0005-0.00098 (0.013-0.025) Max
Fit in Rod		0.00082-0.00157 (0.021-0.040) Interference

CRANKSHAFT

Engine			305 cid (5.0L)	350 cid (5.7L)
Main Journal	Diameter	No.1	2.4483-2.4492 (62.189-62.212)	
Main Journal	Diameter	No. 2, 3, 4	2.4480-2.4490 (62.181-62.207)	
		No.5	2.4479-2.4490 (62.177-62.207)	
	Taper	Production	0.00019 (0.005) Max	
		Service	0.001 (0.02) Max	
	Out of Round	Production	0.00019 (0.005) Max	
		Service	0.00098 (0.025) Max	
Main Bearing Clearance	Production	No.1	0.0007-0.0022 (0.018-0.053)	
		No. 2, 3, 4	0.00086-0.0024 (0.022-0.061)	
		No.5	0.00098-0.0027 (0.025-0.069)	
	Service	No.1	0.00098-0.002 (0.025-0.051)	
		No. 2, 3, 4	0.00098-0.0025 (0.025-0.064)	
		No.5	0.00149-0.0029 (0.038-0.076)	
Crankshaft End Play			0.0019-0.0078 (0.05-0.20)	
Connecting Rod Journal	Diameter		2.0977-2.0997 (53.284–53.334)	
	Taper	Production	0.00027 (0.007) Max	
		Service	0.00098 (0.025) Max	
	Out of Round	Production	0.00027 (0.007) Max	
		Service	0.00098 (0.025) Max	
Rod Bearing Clearance		Production	0.00129-0.00346 (0.033-0.088)	
		Service	0.00098-0.0029 (0.025-0.076)	
Rod Side Clearance			0.0059-0.0240 (0.15-0.61)	
Crankshaft Runout			0.0019-0.0078 (0.05-0.20)	

Index

VALVE SYSTEM

Engine			305 cid (5.0L)	350 CID (5.7L)
Lifter Type			Roller Hydraulic	
Rocker Arm Ratio			1.50 to 1	
Valve Lift		Intake	0.2744-.2783 (6.97-7.07)	
		Exhaust	0.2834-.2874 (7.20-7.30)	
Valve Lash (Intake and Exhaust)			1 Turn Down from Zero Lash	
Face Angle		Intake	45°	
		Exhaust	45°	
Seat Angle (Intake & Exhaust)			46°	
Seat Runout (Intake & Exhaust)			0.0019 (0.05) Max	
Seat Width		Intake	0.03448-0.070 (1.14-1.78)	0.0401-0.0649 (1.02-1.65)
		Exhaust	0.0649-0.098 (1.65-2.49)	0.059-0.100 (1.50-2.56)
Stem Clearance	Production	Intake	0.00098-0.0027 (0.025-0.069)	
		Exhaust	0.00098-0.0027 (0.025-0.069)	
	Service	Intake	0.00098-0.0037 (0.025-0.094)	
		Exhaust	0.00098-0.0037 (0.025-0.094)	0.0010-0.0076 (0.025-0.194)
Stem Diameter		Intake	.341 (8.66)	
		Exhaust	.341 (8.66)	
Valve Diameter		Intake	1.84 (46.74)	1.94 (49.28)
		Exhaust	1.50 (38.1)	
Valve Margin After Surfacing - Intake and Exhaust			0.031 (0.79) Minimum	

VALVE SPRING

Engine			5.0l / 305 cid / 350 cid (5.7L)
Valve Spring	Free Length		2.019 (51.3)
	Pressure	Valve Closed	76-84 Lb. (338-374 N) at 1.7 (43.2)
		Valve Open	187-203 Lb. (832-903 N) at 1.27 (32.3)
	Installed Height	Intake	1.68-1.70 (42.92-43.43)
		Exhaust	1.68-1.70 (42.92-43.43)
	Free Length		2.019 (51.3)
	Approximate Number of Coils		4

Index

CAMSHAFT AND DRIVE

Engine	305 cid (5.0L)	350 cid (5.7L)
Journal Diameter	1.8677-1.8661 (47.440-47.490)	
Journal Out Of Round	0.001 (0.025) Maximum	
Camshaft Runout	0.0026 (0.06) Maximum	
Timing Chain Deflection	0.43 (11) Maximum	

FLYWHEEL

Engine	305 cid (5.0L)	350 cid (5.7L)
Runout	0.008 (0.203) Maximum	

CYLINDER HEAD

Engine	305 cid (5.0L)	350 cid (5.7L)
Surface Flatness (At Exhaust Manifold Deck)	0.0019 (0.05)	
Surface Flatness (At Engine Block Deck)	0.0039 (0.10)	
Surface Flatness (At Intake Manifold Deck)	0.0039 (0.10)	

General Information

Repair Procedures

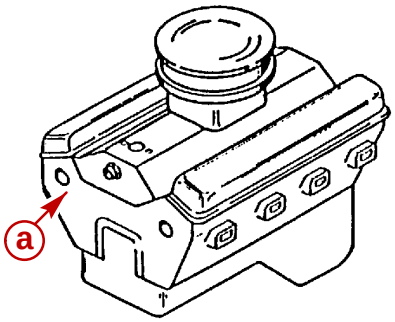
Some of the repairs in this section must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

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.



72312

a - Location Of G.M. Engine Code

Following is a list of GM engines and their respective code letters.

MCM (Sterndrive)	Code
5.0L Alpha and Bravo	ZA
5.7L Alpha and Bravo	MH
5.0L EFI Alpha and Bravo	MH
5.7L EFI Alpha and Bravo	MH
350 Mag MPI Alpha and Bravo	MH
350 Mag MPI Alpha and Bravo Horizon	MH

MIE (Ski and Inboard)	Code
5.7L Ski	MH
350 Mag MPI Ski	MH
Black Scorpion	MH
5.7L Inboard	MK
350 Mag MPI Inboard	MK
350 Mag MPI Horizon Inboard	MK

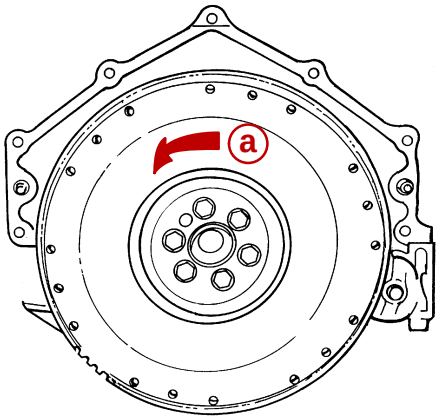
Index

Engine Rotation

Engine rotation terminology at times has caused confusion. To clarify, engine rotation is determined by observing flywheel rotation from the rear (transmission or stern drive end) of the engine looking forward (water pump end).

PROPELLER ROTATION IS NOT NECESSARILY THE SAME as engine rotation.

When ordering replacement engines, short blocks or parts for engines, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



72001

a - Left-Hand Rotation (CCW) - All Stern Drive Engines, MIE Inboard LH (Standard) Rotation

Description

Crankshaft

The crankshaft is supported in the block by five insert type bearings. Crankshaft end thrust is controlled by flanges on the No. 5 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 made of cast iron. However engines with roller lifters have camshafts made of steel. All camshafts are driven at one-half crankshaft speed by a timing chain and sprockets, or by timing gears. The camshafts are supported by five main bearings that are pressed into the block.

A helical gear on the aft end of the camshaft drives the distributor and oil pump. An eccentric cam on the front of the camshaft drives the fuel pump through a push rod. The fuel pump push rod is made of different material when used on engines with steel camshafts and roller lifters, than for engines with cast iron camshafts.

⚠ CAUTION

Avoid rapid and severe camshaft and fuel pump push rod wear that could result in engine damage. Always use the fuel pump push rod specified for use with the cast iron or steel camshaft in your engine.

Engines with cast iron camshaft and flat faced lifters, have a taper on the lobes and a spherical foot on the hydraulic valve lifters. This causes the valve lifters to rotate, thus reducing wear. Engines with steel camshaft and roller lifters, have eight restrictors held in place by a retaining plate to keep the hydraulic valve lifters from rotating so that they follow the cam lobes precisely.

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 heavy-duty to withstand the high engine speeds encountered. Valve tips have been hardened to extend valve life. Exhaust valve rotators are used on some engines to help extend valve life.

Hydraulic valve lifters ride directly on the camshaft lobes and transmit the thrust of the lobes to the push rods that 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 valve lifters also are used to lubricate the valve train bearing surfaces.

Intake Manifold

The carbureted and throttle body fuel injection manifolds are a double level design for efficient fuel distribution. The upper level of passages feeds cylinders 2, 3, 5 and 8 while the lower level passages feed cylinders 1, 4, 6 and 7.

The multi-port injection manifold is a tunnel ram design with the injectors mounted directly above the intake ports in cylinder head.

Lubrication System

The engine lubrication system is a force-feed type. 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.

Index

Some of the oil, after leaving the oil cooler and/or filter, is routed to the No. 5 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, 3, and 4 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 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.

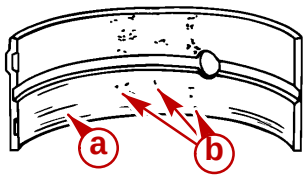
The oil that reaches the crankshaft main bearings is forced through a hole in the upper half of each bearing and flows between the bearings and the crankshaft journals. Some of the oil is then routed to the connecting rod bearings through grooves in the upper half of the crankshaft main bearings and oil passages in the crankshaft. Oil that is forced out the ends of the connecting rod bearings and crankshaft main bearings and splashes onto the camshaft, cylinder walls, pistons and piston pins, keeping them lubricated. Oil is forced out the front end of the No. 1 crankshaft main bearing to assist in lubricating the camshaft drive. A baffle plate, mounted on the bottom of the main bearings or in the oil pan, prevents oil thrown from the crankshaft and connecting rods from aerating the oil in the oil pan.

Oil that 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 is lubricated by the oil flowing through the right valve lifter oil gallery. The fuel pump push rod is lubricated by oil thrown off from the camshaft eccentric.

Index

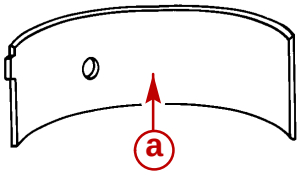
Bearing Failures



70436

Scratched By Dirt

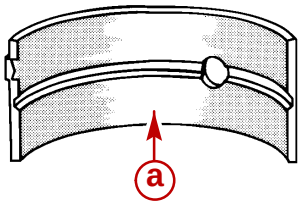
a - Scratches
b - Dirt Imbedded In Bearing Material



70436

Tapered Journal

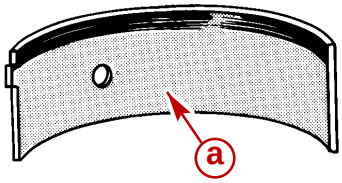
a - Overlay Gone From Entire Surface



70436

Lack Of Oil

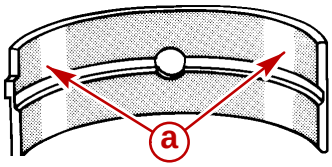
a - Overlay Worn Off



70436

Radius Ride

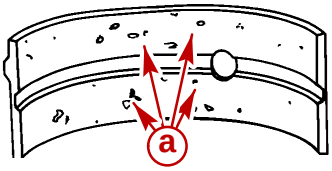
a - Worn Area



70436

Improper Seating

a - Bright Or Polished Sections



70436

Fatigue Failure

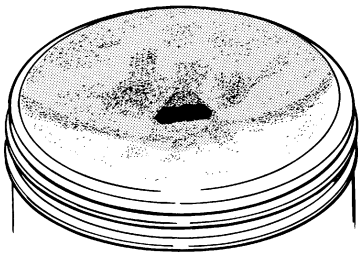
a - Craters or Pockets

Index

Piston Failures

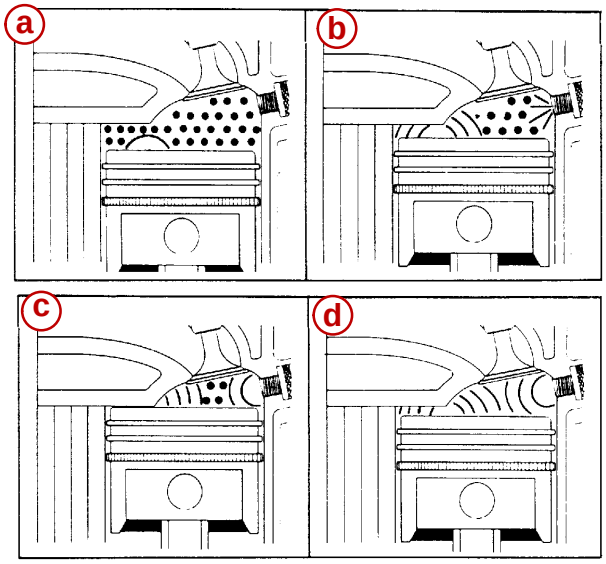
Pre-Ignition

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

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 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 that could serve as a source for pre-ignition problems.

NOTE: *Engine failures that result from the foregoing conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.*

Index

Detonation

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

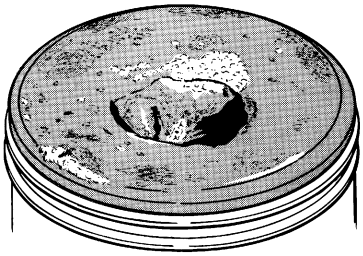
DETONATION CAUSES

1. Use of low octane gasoline or neglecting engine maintenance.

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

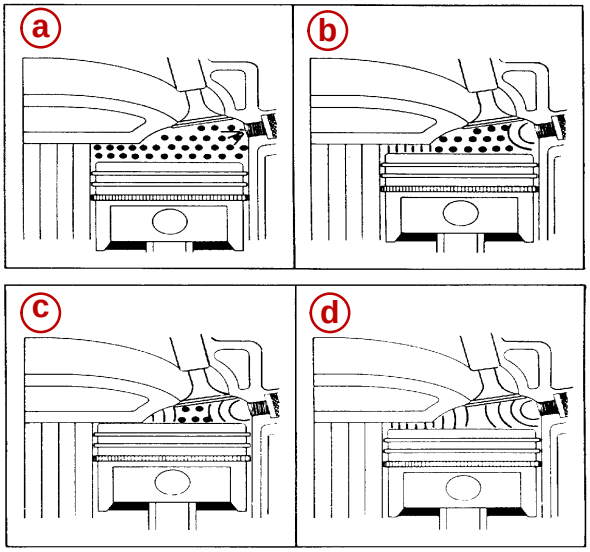
2. Over-advanced ignition timing.
3. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
4. Cross-firing spark plugs.
5. Excess accumulation of deposits on piston and/or combustion chamber that result in higher compression ratio.
6. Inadequate cooling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

NOTE: *Engine failures, that result from the foregoing conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.*



72425

Detonation Damage

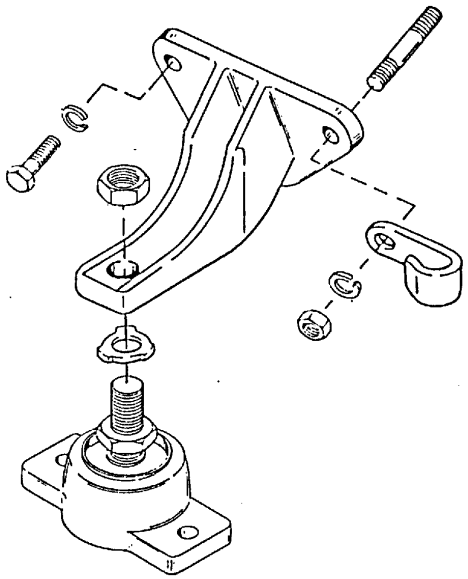


72315

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

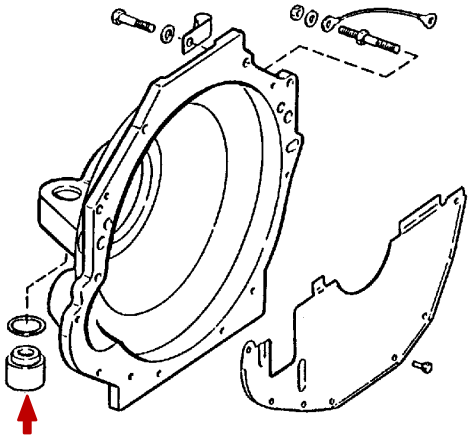
Index

Engine Mounts



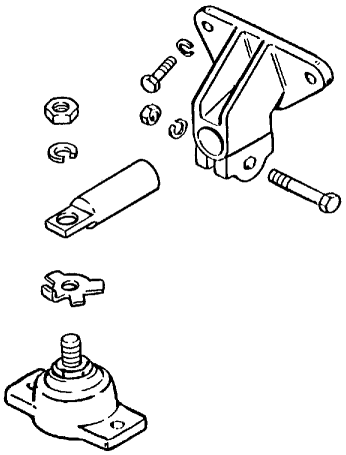
72317

Front Mount - All MCM (Sterndrive) Models



72318

Rear Mount / Flywheel Housing - All MCM (Sterndrive) Models

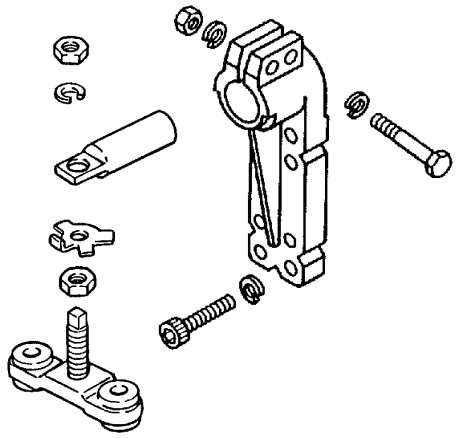


72319

Front Mount Assembly - All MIE Models

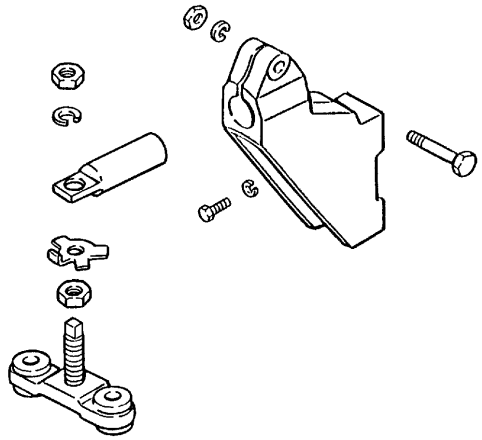
Index

Engine Mounts (Continued)



73055

Rear Mount Assembly - Most MIE Models



73056

Rear Mount Assembly - MIE Models with Velvet Drive In-Line Transmission

Rocker Arm Cover

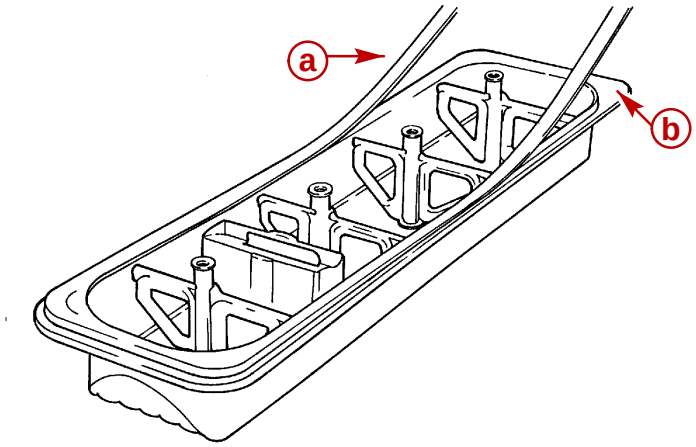
Removal

NOTE: *It may be necessary to remove exhaust manifold before removing rocker arm cover. Refer to SECTION 7B for exhaust manifold removal.*

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



72324

a - Rocker Arm Cover Gasket
b - Sealing Surface

3. Install rocker arm cover. Torque screws to 90 lb-in. (10 Nm).
4. Reinstall any items that were removed.
5. Connect crankcase ventilation hoses.
6. Start engine and check for oil leaks.

Intake Manifold

Removal

1. Drain engine cooling system.
2. Disconnect hoses from thermostat housing.
3. Disconnect electrical leads interfering with removal.
4. Disconnect crankcase ventilation hoses from rocker arm covers.
5. Disconnect throttle cable.
6. Disconnect fuel line from carburetor or throttle body.
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 pressure sending unit.
11. Disconnect any items that interfere with 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.
13. Remove intake manifold and carburetor or throttle body 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.

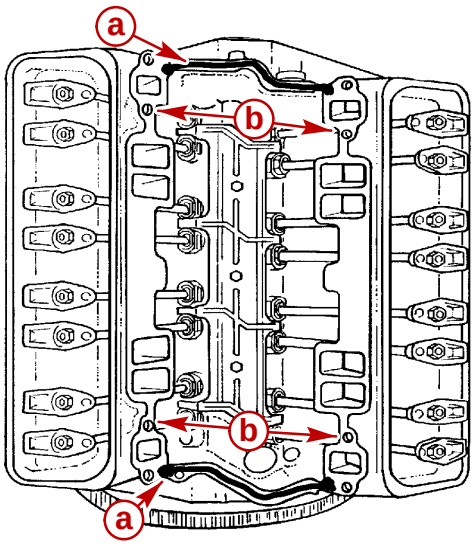
IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase or intake ports.

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. Inspect intake passages for varnish buildup and other foreign material. Clean as necessary.

Installation

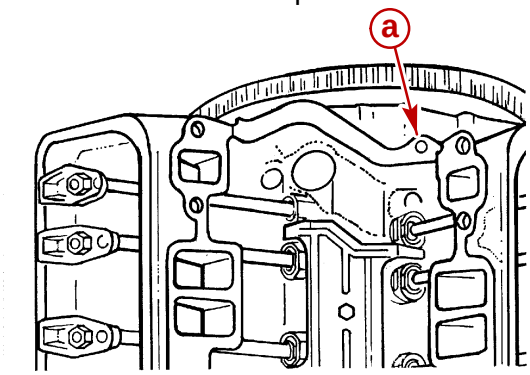
IMPORTANT: DO NOT get Quicksilver RTV Sealer into oil sending unit hole at rear of engine.

1. 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.
2. Apply Loctite Pipe Thread Sealant to the threads of the four inner manifold bolts.



72325

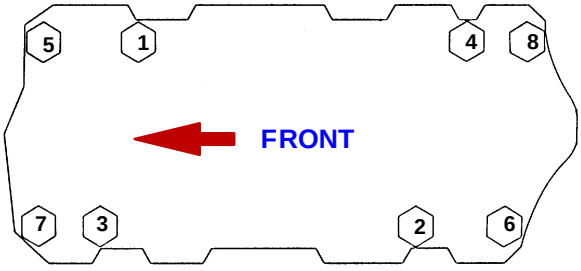
a - 3/16 Bead Of RTV Sealer
b - Inner Manifold Bolts With Loctite Pipe Thread Sealant



72326

a - Oil Sending Unit Hole

3. Carefully install manifold assembly and torque bolts to 18 lb-ft (24 Nm) in sequence as shown.



72878

4. Connect all electrical leads.
5. Connect hoses to thermostat housing.
6. Install fuel line.

Index

7. Connect crankcase ventilation hose(s).
8. Install distributor. Position rotor and housing to align with marks made during removal, then install distributor cap.
9. Install other ignition components and reconnect wires.
10. Coat threads of oil pressure sending unit with Quicksilver Perfect Seal and install.
11. Connect any items that were disconnected.
12. Start engine.
13. Adjust ignition timing. Adjust carburetor, if equipped.
14. Check hose connections, gaskets and seals for leaks.
15. 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.
2. Remove rocker arm assemblies and push rods.

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.

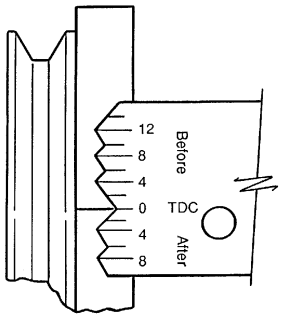
1. Install push rods in their original locations. Ensure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts in their original locations.
3. Adjust valves.

Valve Adjustment

Engine Stopped

With valve cover removed, adjust valves when lifter is on low part of camshaft lobe.

1. Crank engine with starter or turn over in normal direction of rotation until mark on torsional damper lines up with center “0” mark on timing tab. Ensure engine is in No. 1 firing position by placing fingers on No. 1 valve as mark on torsional damper comes near “0” mark on timing mark. If valves move as mark comes up to timing tab, engine is in No. 6 firing position and should be turned over one more time to reach No. 1 position.



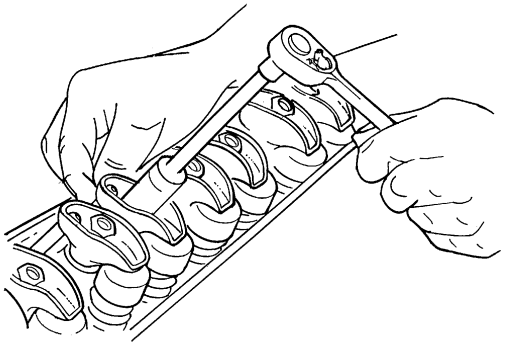
72328

2. **Adjust the following valves:**

MCM and MIE Left-Hand (Standard) Rotation Engines

Exhaust - 1-3-4-8 Intake - 1-2-5-7

3. Loosen adjusting nut until lash is felt at push rod, and then tighten adjusting nut until all lash is removed. Lash can be checked by moving push rod up and down while tightening adjusting nut until all play is removed.



72300

4. Hydraulic lifters can be adjusted by tightening adjustment nut an additional one turn (360 degrees). No other adjustment is required.
5. Crank engine one revolution until pointer “0” mark and torsional damper mark are again in alignment. This is No.6 firing position. With engine in this position, the following valves may be adjusted as previously outlined.

MCM and MIE Left-hand (Standard) Rotation Engines

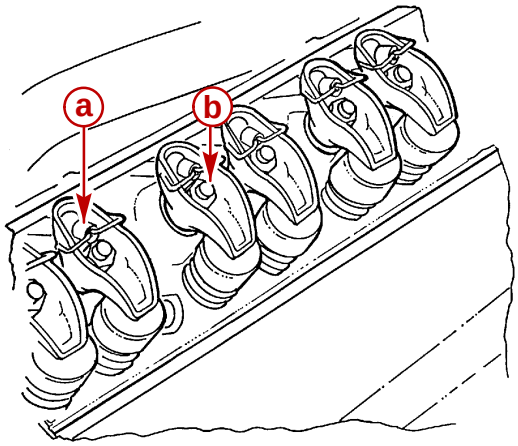
Exhaust - 2-5-6-7 Intake - 3-4-6-8

Index

Engine Operating

Following procedure is performed with engine operating:

1. Check engine for normal operating temperature.
2. Remove rocker arm covers and install rocker stoppers as shown.



72301

a - Rocker Stoppers (91-66273)
b - Rocker Arm Nuts

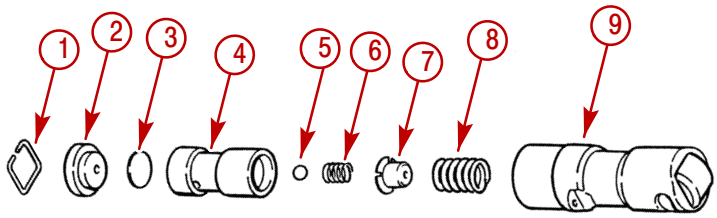
3. With engine operating at idle, loosen one rocker arm nut until rocker arm starts to clatter.
4. Turn rocker arm nut down until clatter just stops. This is zero lash position.

IMPORTANT: The following one-turn preload adjustment must be done slowly to allow the lifter to adjust itself. This will prevent the valves from hitting the pistons and causing internal damage and/or bent push rods.

5. Turn nut down 1/4 additional turn (90 degrees) and pause 10 seconds until engine runs smoothly. Repeat until nut has been turned down one turn (360 degrees) from the zero lash position.
6. Repeat Steps 2, 3, 4 to adjust other valves.
7. Remove rocker stoppers after all valves are adjusted.
8. Install rocker arm covers; torque screws to 106 lb-in. (12 Nm).
9. Adjust carburetor, if equipped, idle mixture and idle speed. Check for leaks.

Index

Hydraulic Valve Lifters



72031

Roller Lifter

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

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.

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 and 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. Probable causes are:
   a. Insufficient oil supply.
   b. Improper adjustment.

Index

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 may be out of round or have a flat spot.
   c. Improper adjustment.

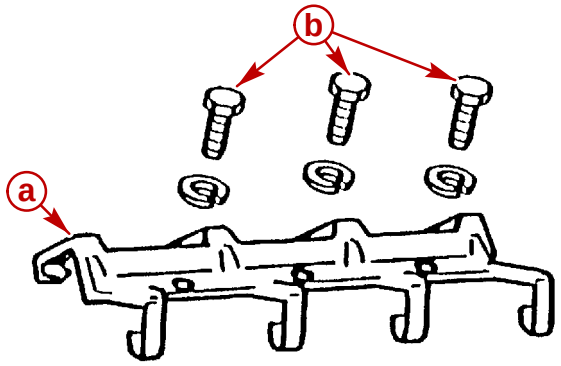
In most cases where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc., is shown to exist in one unit, it probably exists in all the units. Thus it would only be a matter of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

Removal

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

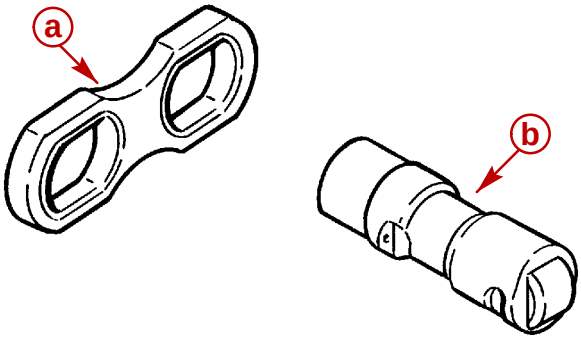
1. Remove rocker arm covers.
2. Remove intake manifold.
3. Remove lifter restrictor retainer on roller lifter models.
4. Remove rocker arm assemblies and push rods.

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

5. Remove lifter restrictors and lifters.

Cleaning and Inspection

1. Thoroughly clean all parts in cleaning solvent and inspect them carefully. If any parts are damaged or worn, entire lifter assembly should be replaced.
2. If outer lifter body wall is scuffed or worn, inspect cylinder block lifter bore.
3. If roller of lifter is scuffed or worn, inspect camshaft lobe.
4. 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 lifters/rollers, coat the bottom of the lifter/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. Install roller lifters and components.
2. Torque roller lifter restrictor retainer plate fasteners to 18 lb-ft (25 Nm).
3. Install intake manifold.
4. Install and adjust valve mechanism.
5. Install rocker arm cover.
6. Start engine and check for leaks.

Valve Stem Oil Seal / Valve Spring

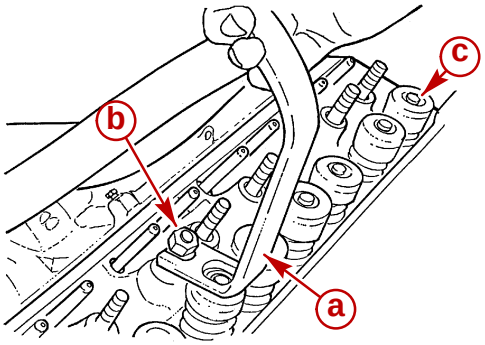
Removal - Head Installed

1. Remove rocker arm cover.
2. Remove spark plug of affected cylinder.
3. Remove rocker arm assembly.
4. Install air line adaptor tool (J-23590) in spark plug hole and apply compressed air to hold valves in place.

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.



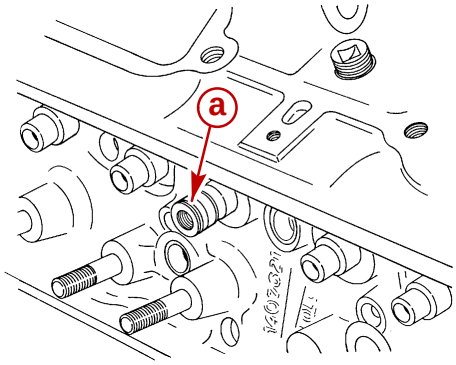
72306

a - Valve Spring Compressor (J5892)
b - Rocker Arm Nut
c - Valve Locks

6. Slowly release valve spring compressor.
7. Remove cap, shield, and valve spring.

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

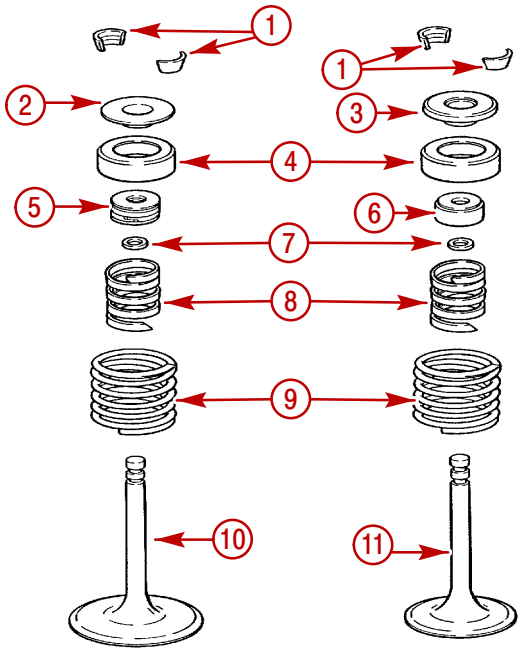
8. Remove seals from valve stems and valve guide.



72330

a - Valve Guide Seal

Valve Assembly (Exploded View)



72331

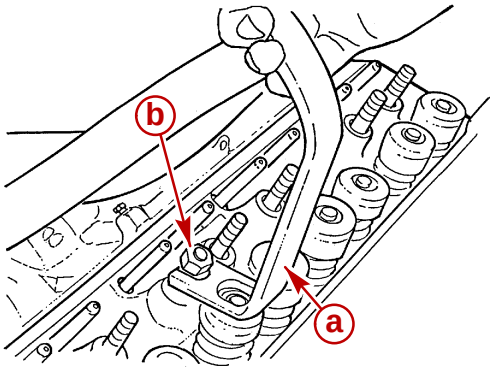
Intake **Exhaust**

1 - Valve Locks
2 - Retainer
3 - Rotator
4 - Cap
5 - Valve Guide Oil Seal
6 - Oil Shield
7 - Valve Stem Oil Seal
8 - Inner Spring
9 - Outer Spring
10 - Intake Valve
11 - Exhaust Valve

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 shield in place.
3. Place cap on intake valve and/or rotator on exhaust valve.
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.



72306

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

6. Install push rods and rocker arm assemblies.
7. Adjust valves as outlined under “Valve Adjustment - Engine Stopped.”
8. Install rocker arm cover [torque to 90 lb-in. (10 Nm)].
9. Install spark plug [torque to 15 lb-ft (20 Nm)].

Cylinder Head

Removal

1. Drain engine cooling system.
2. Remove exhaust manifolds.
3. Remove intake manifold.
4. Remove rocker arm covers.
5. Remove rocker arm assemblies and push rods (keep in order for reassembly in their original locations).
6. Remove any components attached to front or rear of cylinder head.
7. Remove spark plugs.
8. Remove head bolts.

⚠ 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.

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.

Index

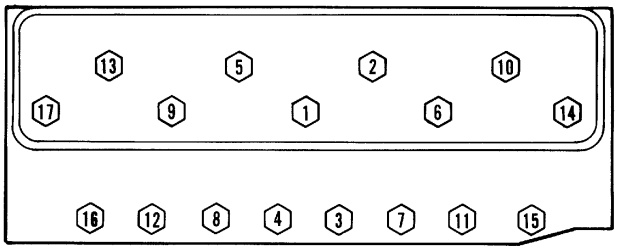
Installation

⚠ 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.
2. Carefully set cylinder head in place over dowel pins.
3. Coat threads of head bolts with Quicksilver Perfect Seal and install finger-tight.
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



72332

5. Install push rods and rocker arm assemblies in their original positions.
6. On roller cam engines, install lifter restrictors and retainer.
7. Adjust valves as outlined under “Valve Adjustment - Engine Stopped.”
8. Install as outlined:
   a. Intake manifold.
   b. Rocker arm covers.
   c. Exhaust manifolds.
   d. Spark plugs.
   e. Any components removed from front or rear of cylinder heads.

9. Follow procedures in 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

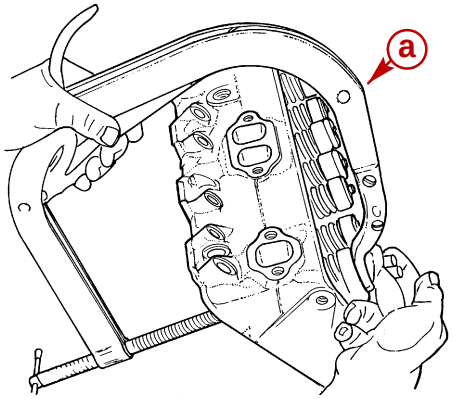
Ensure that cooling water supply is available before starting the engine.

10. Start engine.
11. Set timing.
12. Set idle speed.
13. Check for leaks.

Cylinder Head and Valve Conditioning

Disassembly

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



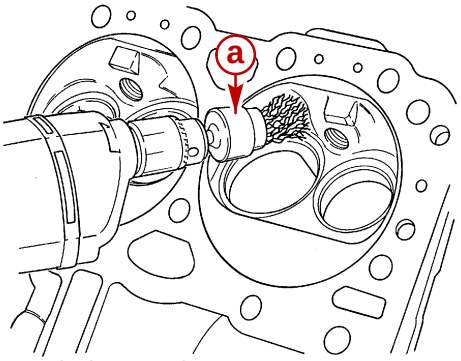
72333

a - Valve Spring Compressor (J-8062)

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

Cleaning and Inspection

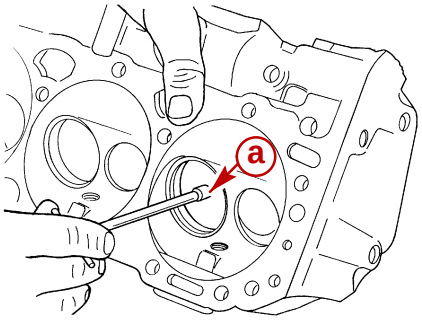
1. Clean push rods and rocker arm assemblies.
2. Clean carbon from valves using a wire wheel.
3. Clean gasket material from cylinder head mating surfaces.
4. Clean all carbon from combustion chambers and valve ports using carbon remover brush.



72334

a - Carbon Remover Brush (J-8089)

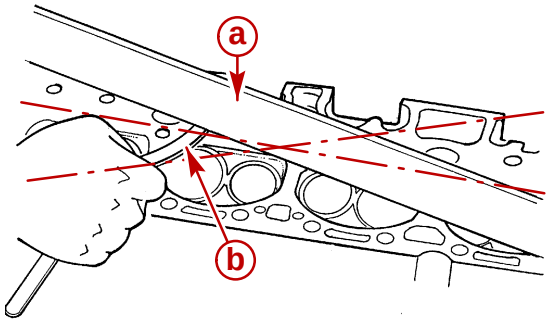
5. Thoroughly clean valve guides with valve guide cleaner.



72335

a - Valve Guide Cleaner (J-8101)

6. 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.
7. Inspect cylinder head gasket surface for burrs, nicks erosion or other damage.
8. Check flatness of cylinder head gasket surface, using a machinist's straight edge and feeler gauges as shown. Refer to "Specifications." Take measurements diagonally across head both ways) and straight down center of head.



72307

a - Straight Edge
b - Feeler Gauge

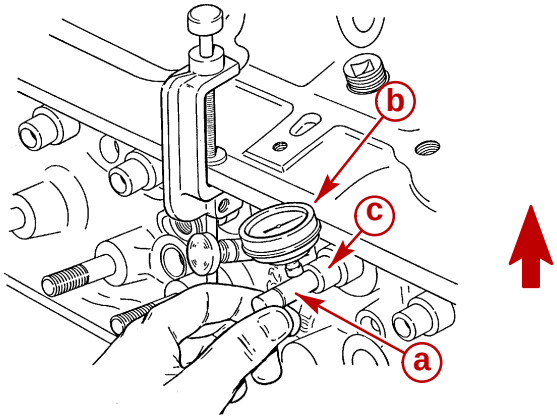
Index

IMPORTANT: Cylinder head surfaces should be resurfaced if warped more than specified to provide proper alignment.

9. 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.

10. 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. Refer to “Valve Guide Bore Repair.”



72336

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

Valve Guide Bore Repair

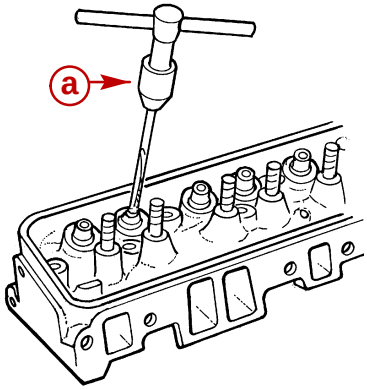
IMPORTANT: Measure valve stem diameter of both the intake and exhaust valve, as valve stem diameter may or may not be the same for both valves.

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. (8.66)	J-5830-02

2. Ream valve guide bores.



72337

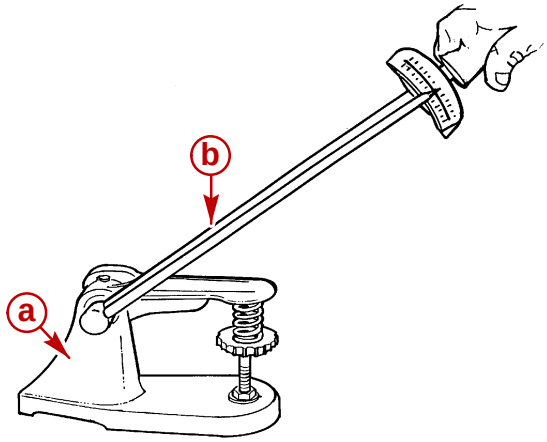
a - Valve Guide Reamer

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

Valve Springs - Checking Tension

Use valve spring tester to check valve spring tension with dampers removed. Refer to “Specifications.”

IMPORTANT: Replace the spring if the spring tension is less than 76 lb. (338 N) at 1.70 in (43.2 mm) length.

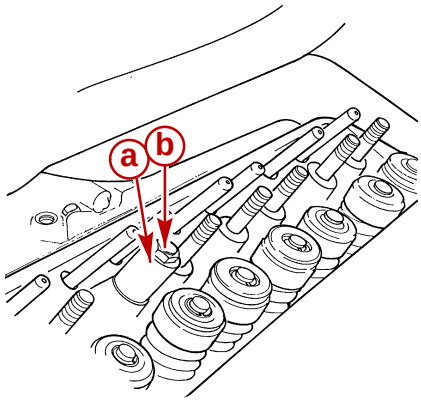


72308

a - Valve Spring Tester (P/N J-9666)
b - Torque Wrench

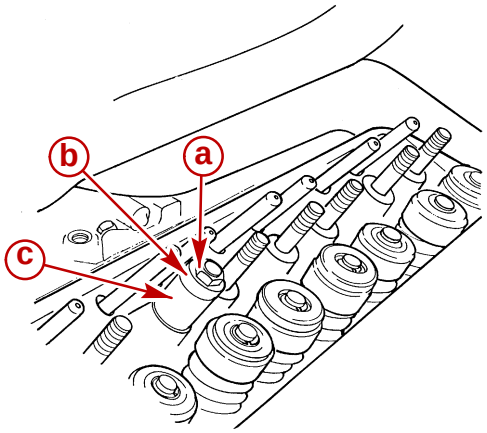
Rocker Arm Stud Replacement

1. Replace worn or loose rocker arm studs with oversize studs.
2. Use rocker arm stud remover to partially remove old stud as follows:
   a. Place large sleeve, flat washer and nut over stud.
   b. Turn nut until it contacts stud threads.
3. Remove nut and install small sleeve on stud.
4. Install nut on stud and turn nut to remove stud.



72309

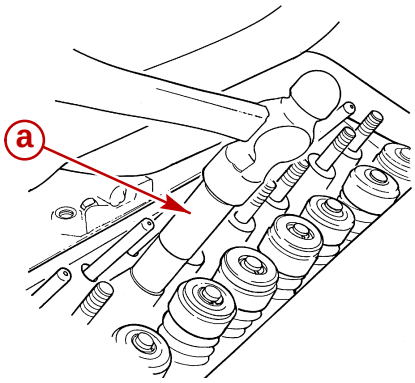
a - Large Sleeve
b - 3/8-24 Thd. Nut



72310

a - Nut
b - Small Sleeve
c - Large Sleeve

5. When installing an oversize stud ream stud hole using appropriate reaming tool.
6. Install new stud with rocker arm stud installer.



72311

a - Rocker Arm Stud Installer (J-6880)

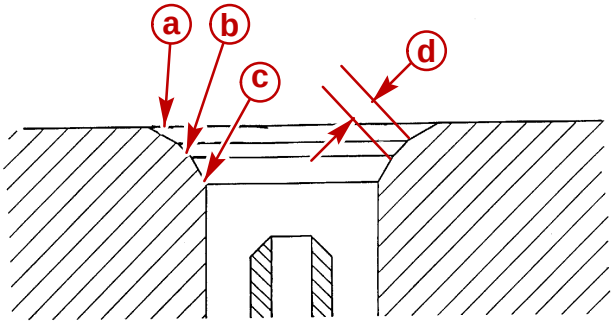
Index

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 valve head is important to ensure that heat will be properly dispersed.

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

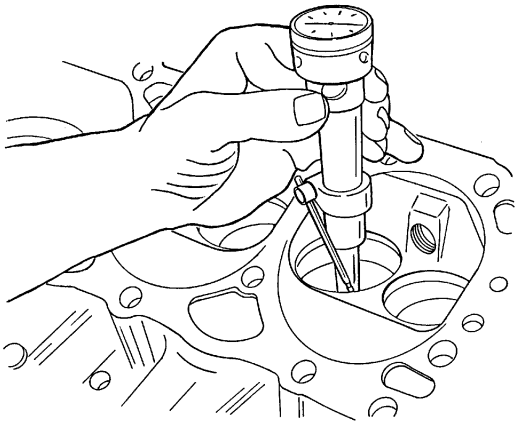


50668

Typical "3 Angle" Valve Seat

a - Top Angle (30°)
b - Seat Angle (46°)
c - Bottom Angle (60°)
d - Seat Width
Intake 1/32-1/16 [.031-.063] In. (0.8-1.5 mm)
Exhaust 1/16-3/32 [.063-.094] In. (1.6-2.3 mm)

Regardless of type of equipment, 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

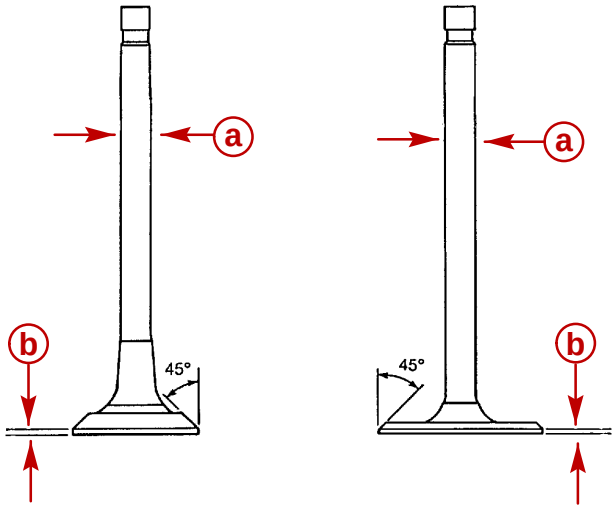
Measuring Valve Seat Concentricity

Index

Valve Grinding

Valves that are pitted must be refaced to the proper angle. Valve stems that show excessive warp or wear, must be replaced. When a warped valve head 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. Heat will localize on this edge and lead to breakage, burning or pre-ignition. If the edge of the valve head (valve margin) is less than 0.031 in. (0.79 mm) after grinding, replace the valve.

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



50695

Exhaust **Intake**

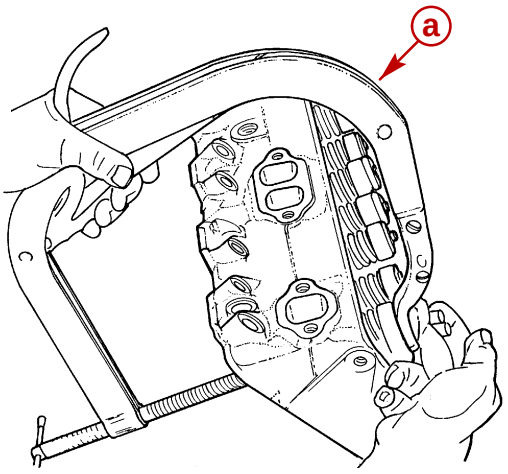
a - .341 In. (8.16 mm)
b - 0.031 (0.79) Minimum

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. Set valve spring (with damper installed) and shield in place.
5. Place cap on intake valve and/or rotator on exhaust valve.

Index

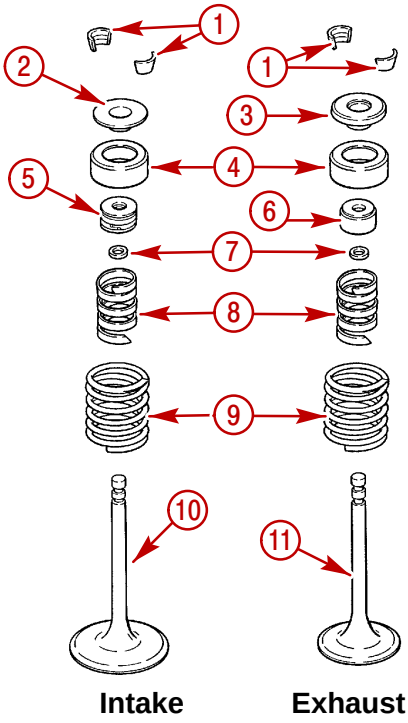
6. While compressing valve spring install oil seal in lower groove of valve stem. Ensure seal is not twisted. A light coating of oil will help prevent twisting.



72333

a - Valve Spring Compressor (J-8062)

7. Install valve locks (grease may be used to hold them in place) and slowly release tool. Ensure locks seat properly in upper grooves of valve stem.



72331

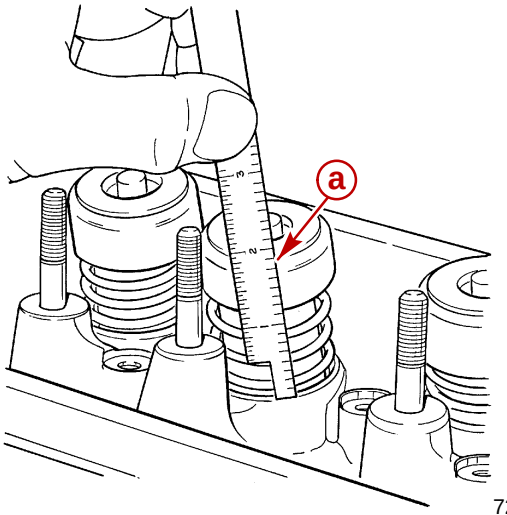
1 - Valve Locks
2 - Retainer
3 - Rotator
4 - Cap
5 - Valve Guide Oil Seal
6 - Oil Shield
7 - Valve Stem Oil Seal
8 - Inner Spring
9 - Outer Spring
10 - Intake Valve
11 - Exhaust Valve

8. Check installed height of valve springs using a narrow, thin scale. Measure from spring seat to top of valve spring, as shown.

Index

IMPORTANT: If measurement exceeds specified height, install a valve spring shim and re-check. DO NOT shim valve springs to give an installed height less than the minimum specified.

05037

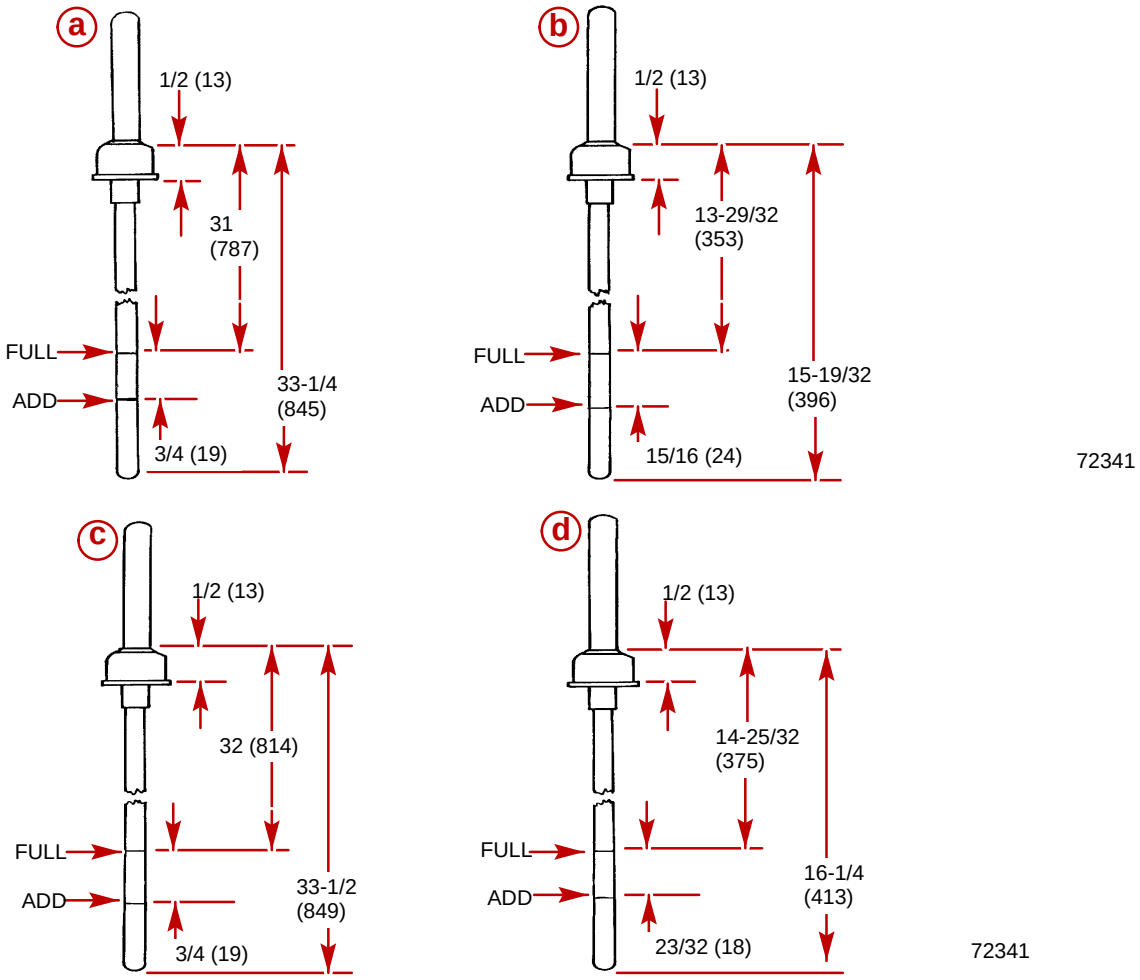


72339

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

Crankcase Oil Dipstick Specifications

All Engines



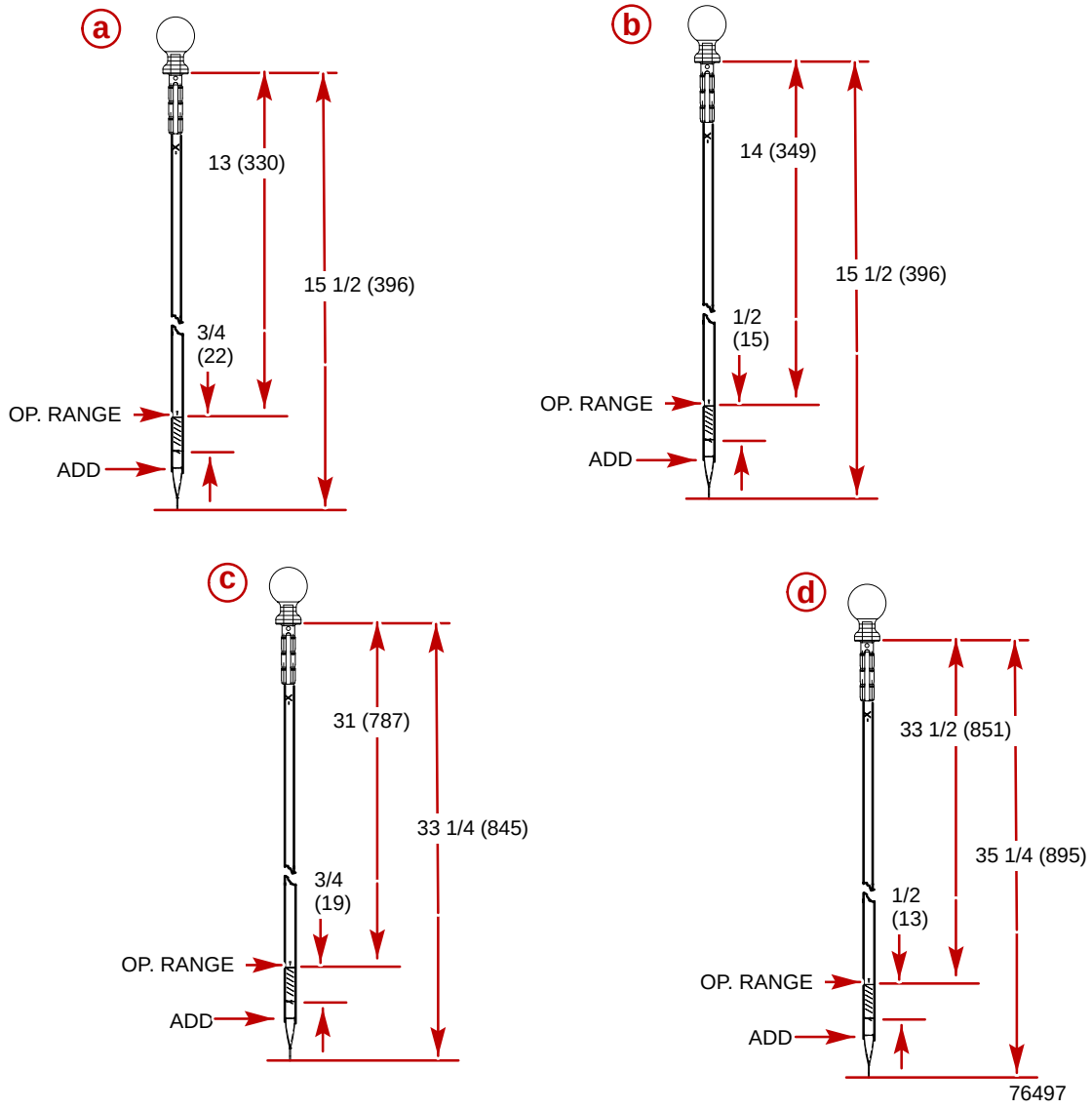
Earlier Models

- **a** - All MCM Engines (15297)
- **b** - MIE Inboard Engines With In-Line or Down Angle Transmissions (805395) [1]
- **c** - All MIE Ski Engines (16482)
- **d** - MIE Inboard Engines With V-Drive Transmissions (805394) [1]

[1] Engines with Plastisol Coated Oil Pans

Index

Crankcase Oil Dipstick Specifications (Continued)



Later Models

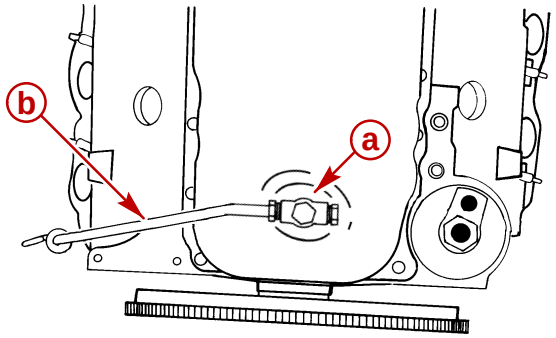
- **a** - All MIE Engines (861942-2)
- **b** - All MIE Engines Remote Drive Transmissions(861942-3)
- **c** - All MCM Service And Ski (861942-7)
- **d** - All MCM Engines (861942-9)

Index

Oil Pan

Removal

1. Drain crankcase oil.
2. If necessary, disconnect outlet hose from seawater pump.
3. Remove dipstick and tube. **On MIE models, be careful not to disturb orientation of banjo fitting on bottom of pan.**



71859

a - Banjo Fitting
b - Dipstick Tube

4. Remove oil pan.

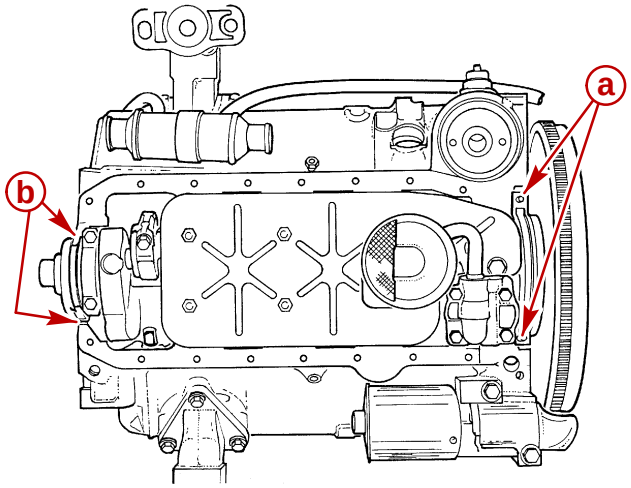
Cleaning and Inspection

1. Clean sealing surfaces of engine block and oil pan.

Installation

1. 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.

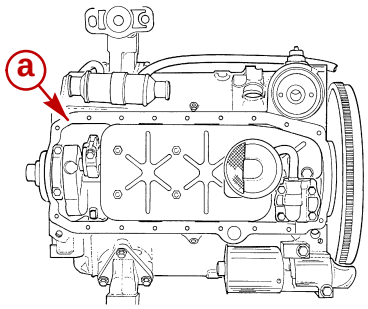


72343

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

2. Install oil pan gasket in position as shown.

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



72344

a - Oil Pan Gasket

3. Install oil pan. Starting from the center and working outward in each direction, tighten oil pan stud nuts to 18 lb-ft (25 Nm) and oil pan reinforcement bolt or stud to 106 lb-in. (12 Nm).

4. Install dipstick tube and dipstick. **On MIE models, install dipstick tube as follows:**

   a. Install banjo fitting as shown. Do not tighten banjo fitting bolt at this time.

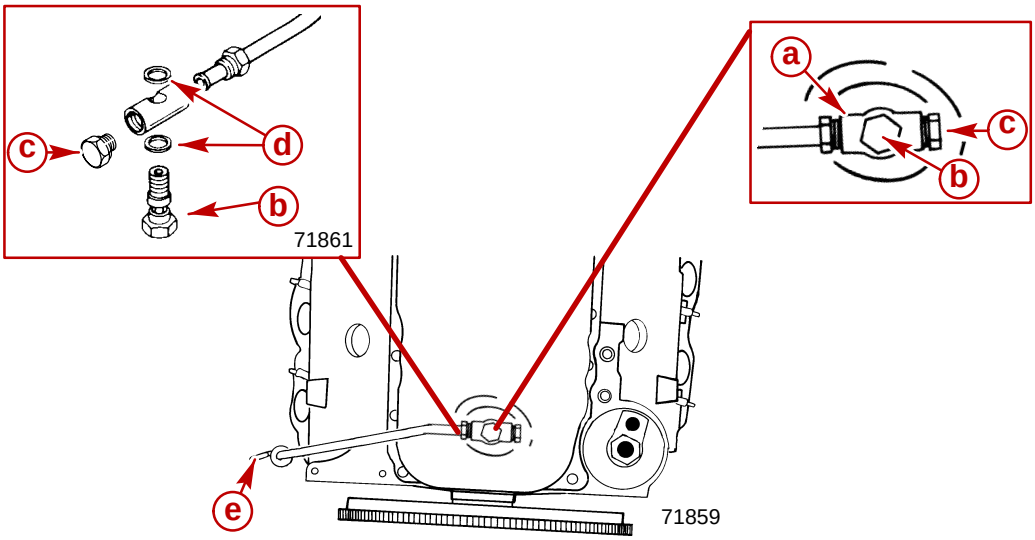
NOTE: *Dipstick tube can be positioned on either side of engine.*

   b. Install dipstick tube and secure with hardware as shown. Do not tighten tube at banjo fitting.

   c. Secure tube at manifold.

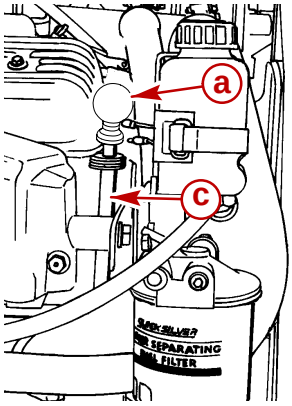
   d. Tighten tube at banjo fitting.

   e. Install plug in banjo fitting.

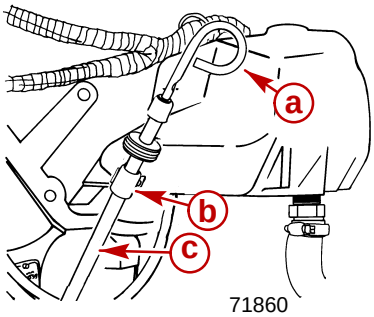


a - Banjo Fitting
b - Banjo Fitting Bolt
c - Plug
d - Gaskets
e - Dipstick Tube

f. Tighten all connections on banjo fitting at this time. Torque banjo fitting bolt to 180 lb-in. (20 Nm). Tighten dipstick tube and plug securely.



76386



71860

Typical Dipstick Styles

a - Gage
b - Clamp (Secured by Manifold Screw)
c - Dipstick Tube

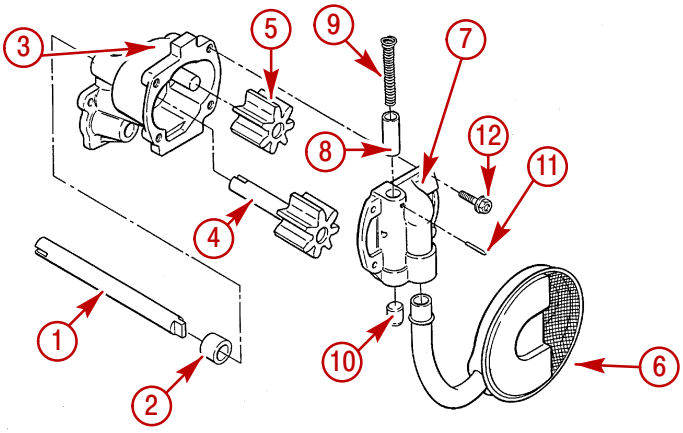
g. Install appropriate gage.

5. Fill crankcase with required quantity of oil of specified viscosity. See SECTION 1B - “Maintenance.”

Oil Pump

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. It is only available as an assembly. The oil pump is driven by the distributor shaft, which is driven by a helical gear on camshaft.

Exploded View



72146

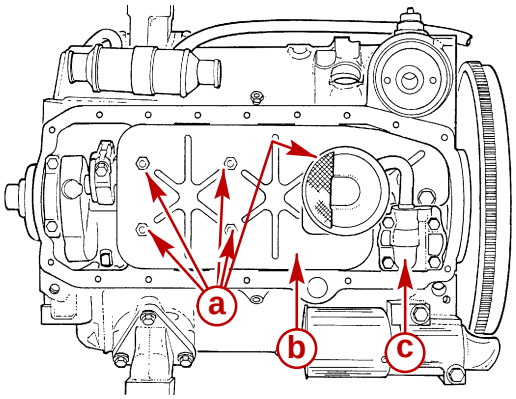
Oil Pump Assembly

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

Index

Removal

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



72344

a - Nuts (5)
b - Baffle
c - Oil Pump

4. Remove oil pump.

Disassembly

Refer to “Exploded View” in this section.

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.

Index

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.

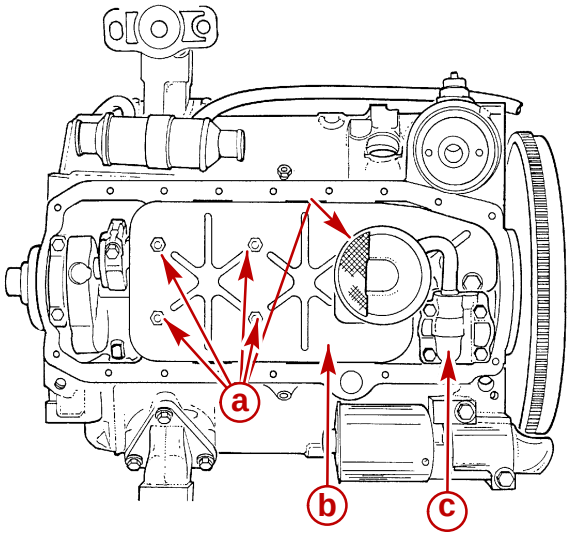
1. If pickup screen and pipe assembly was removed:
   a. Mount pump in a soft-jawed vise.
   b. Apply Quicksilver Perfect Seal to end of new pipe.
   c. Using oil pump suction pipe installer (J-21882), tap the pipe in place with a hammer.

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.
4. Align marks made in disassembly.
5. Fill gear cavity with engine oil.
6. Install pump cover and torque attaching screws to 80 lb-in. (9 Nm).
7. Turn extension shaft by hand to check for smooth operation.

Installation

1. Install pump and extension shaft to rear main bearing, aligning extension shaft with distributor drive shaft.
2. Install baffle. Tighten baffle nuts to 25 lb-ft (34 Nm).
3. Tighten oil pump bolt to 65 lb-ft (88 Nm).



72344

a - 5 Nuts
b - Baffle
c - Oil Pump

4. Install oil pan as outlined. The one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn or otherwise damaged.

Index

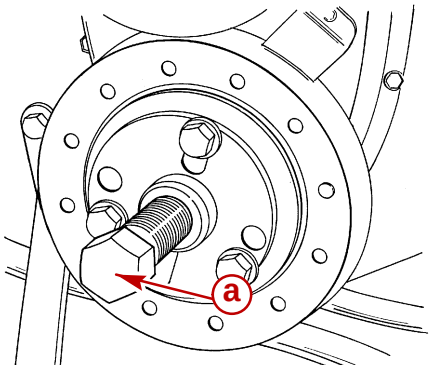
Torsional Damper

Removal

1. Remove drive belts.
2. Remove drive pulley,
3. 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.

4. Remove torsional damper with torsional damper remover and installer. (J-23523-E)



72345

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

Installation

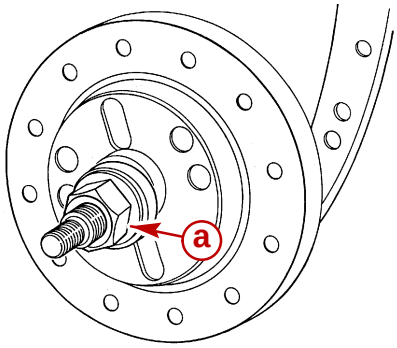
IMPORTANT: The inertia weight section of the torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

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:
   a. 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.

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

c. Install torsional damper on crankshaft by turning nut until it contacts.



72346

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

d. Remove tool from crankshaft.

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

f. Install torsional damper bolt. Torque to 60 lb-ft (81 Nm).

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

Crankcase Front Cover Oil Seal

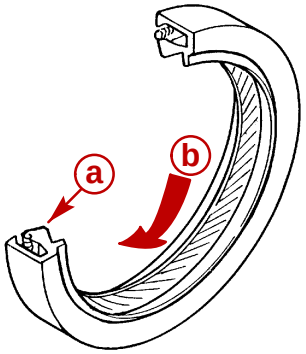
Oil Seal Replacement (Without Removing Front Cover)

REMOVAL

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

INSTALLATION

1. Apply Quicksilver Perfect Seal to seal retainer mating surface and apply grease to seal lips.

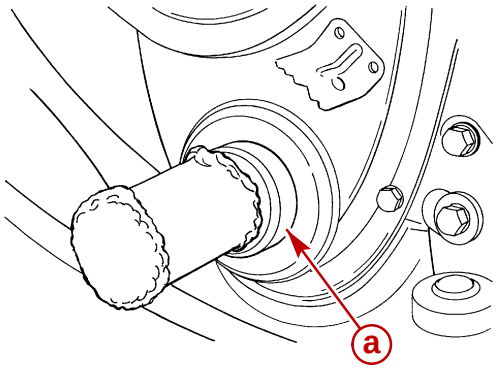


73124

a - Seal Lip Toward Inside of Engine
b - Rotation of Crankshaft as Viewed from Front End Looking Toward Flywheel End

2. Install new seal with open end of seal inward, using crankcase front cover seal installer. Drive seal in until it just contacts.

IMPORTANT: Do not use excessive force.



72347

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

3. Reinstall torsional damper as outlined.

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.
5. If damaged, drive oil seal out of front cover (from the rear) using a punch.

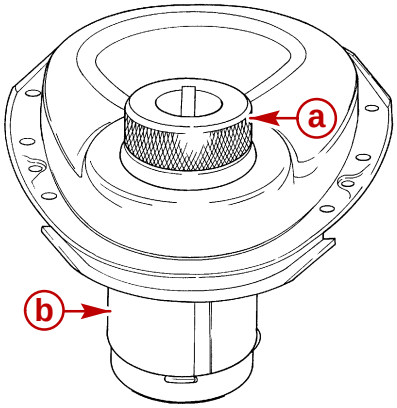
Cleaning and Inspection

1. Clean old gasket material and sealer from mating surfaces on cylinder block.

IMPORTANT: Surfaces must be clean and flat or oil leakage may result.

Installation

1. Install oil seal in new cover with lip of seal toward inside of engine, using crankcase front cover seal installer. Support cover around seal area with appropriate tool as shown.



72348

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

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 106 lb-in. (12 Nm).

4. Install oil pan and torsional damper as outlined.
5. Install water circulating pump.
6. Reinstall 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 (see SECTION 6A).

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

⚠ CAUTION

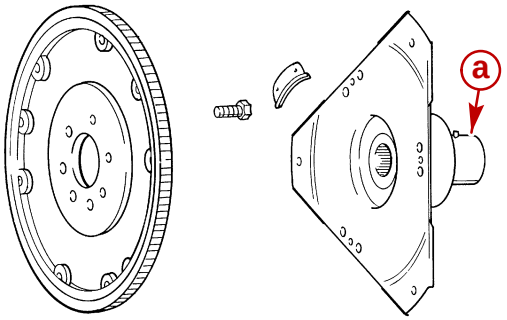
Ensure that cooling water supply is available before starting the engine.

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

Flywheel

Removal

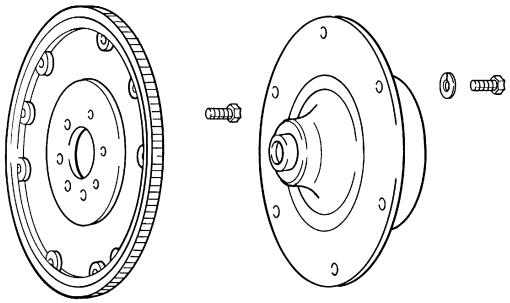
1. Remove engine from boat.
2. Remove transmission, if equipped.
3. Remove flywheel housing and related parts.
4. Remove MCM coupler or MIE drive plate.
5. Remove flywheel.



72349

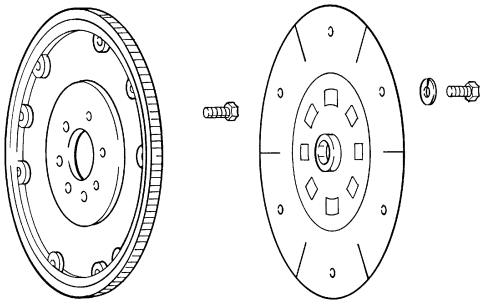
Alpha Coupler

a - Some earlier models did not have sealed, steel hub coupler.



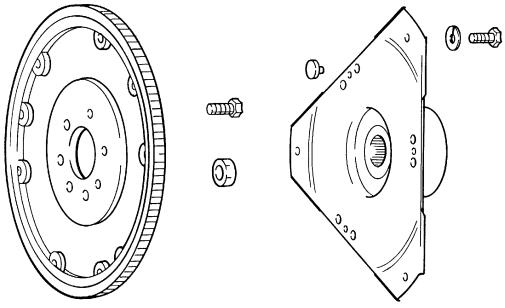
72350

Bravo Coupler



72351

MIE Drive Plate



72352

Drive Shaft Extension Coupler

Index

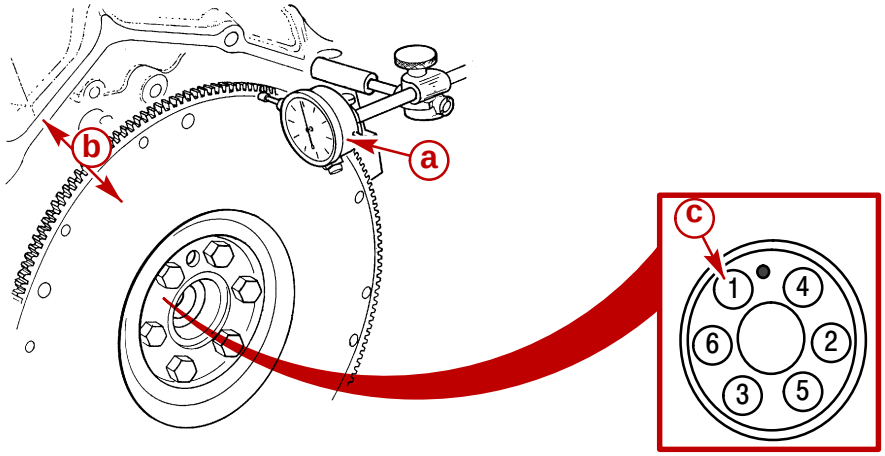
Cleaning and Inspection

1. Inspect splines in drive plate or coupler for wear.
2. Check flywheel ring gear for worn and missing teeth.
3. Clean mating surfaces of flywheel and crankshaft. Remove any burrs. Mating surfaces must be clean bare metal.

Installation

NOTE: *Pilot bushing can be reused. The pilot bushing can be removed without damage by filling pilot bushing cavity with grease, then inserting an old transmission input shaft in bore of bushing and hitting it with a hammer. This will create hydraulic pressure in pilot bushing cavity that should force bushing out.*

1. Install flywheel while aligning dowel hole in flywheel with dowel in crankshaft. Apply Loctite 27131 to threads of flywheel bolts. Torque bolts in sequence to 75 lb-ft (100 Nm).
2. 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 to remove crankshaft end play.
   c. Maximum runout - .008 in. (0.203 mm).

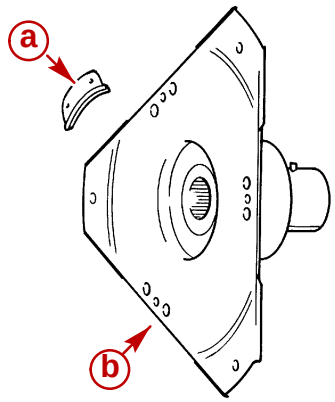


72353

a - Dial Indicator
b - Push Flywheel and Crankshaft Forward as Far as It Will Go When Taking Reading
c - Torque Sequence

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

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



72354

Typical

a - Rubber Bumper (Alpha Coupler Only)
b - Coupler

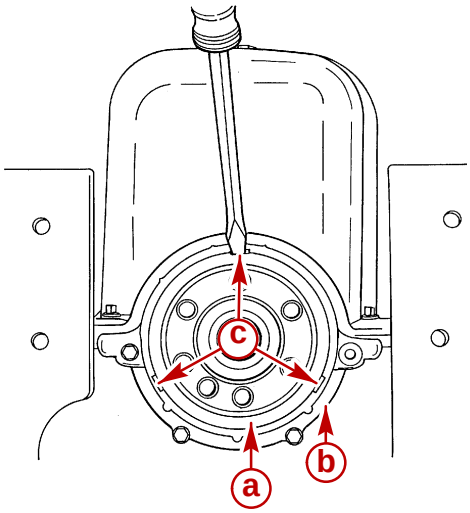
4. Install drive coupler or drive plate. Torque bolts to 35 lb-ft (48 Nm).
5. Install flywheel housing and related parts. Torque bolts to 30 lb-ft (41 Nm).
6. Install flywheel housing cover. Torque bolts to 80 lb-in. (9 Nm).
7. Install transmission (MIE). Torque bolts to 50 lb-ft (68 Nm).
8. Install 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

1. Remove the flywheel.
2. Remove seal by using a screwdriver to pry it out of the seal retainer as shown.



72355

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

Index

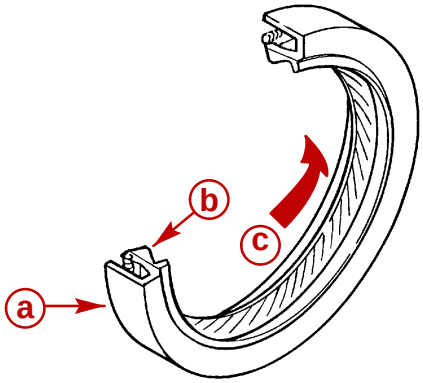
Cleaning and Inspection

1. Clean crankshaft seal running surface.
2. Clean the seal retainer bore.

Installation

1. Apply a thin coat of clean engine oil to the bore of the seal retainer.
2. Apply a thin coat of clean engine oil to the outer diameter of the seal.

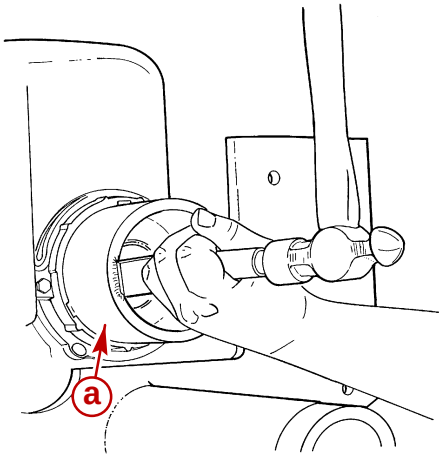
IMPORTANT: Do not allow oil or other lubricants to contact the seal surface of the rear oil main seal.



73127

a - Rear Main Oil Seal
b - Seal Lip Toward Inside of Engine
c - Rotation of Crankshaft as Viewed from Flywheel End Looking Forward

3. Install seal using rear main seal installer as shown.



72356

a - Rear Main Seal Installer (J-26817-A)

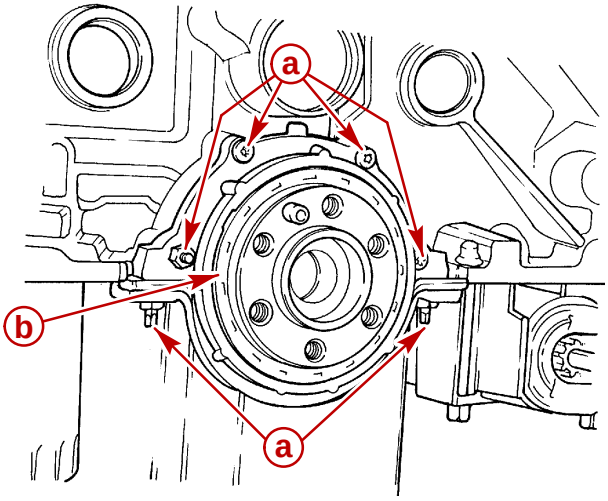
NOTE: *Tool J35621-A (not shown) may also be used to install the seal. This tool holds the seal and attaches to the crankshaft. The seal is then pressed into the seal retainer by turning the large wing nut on the tool.*

Rear Main Oil Seal Retainer

The rear main oil seal retainer can only be replaced with the oil pan removed.

Removal

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



72464

a - Fasteners
b - Oil Seal Retainer

4. Remove old gasket.

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” as outlined).
4. Inspect alignment pin for damage. Replace if necessary.

Installation

IMPORTANT: Always use a new crankshaft rear main oil seal and new oil seal retainer gasket when installing the crankshaft rear main oil seal retainer.

1. Install new oil seal retainer gasket.

IMPORTANT: Do not allow oil or other lubricants to contact the seal surface of the rear main oil seal.

2. Install the crankshaft rear oil seal retainer on to the studs.
3. Install retainer nuts and bolts. Torque to 106 lb-in. (12 Nm).
4. If not already installed, install the Rear Main Oil Seal as outlined.
5. Install oil pan as outlined.

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

Index

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 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.

When a production crankshaft cannot be precision fitted by this method, it is then ground .009 in. undersize ON ONLY THOSE MAIN JOURNALS THAT CANNOT BE PROPERLY FITTED. ALL JOURNALS WILL NOT NECESSARILY BE GROUND UNDERSIZE. A .009 in. undersize bearing and .010 in. undersize bearing may be used for precision fitting in the same manner as previously described.

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.

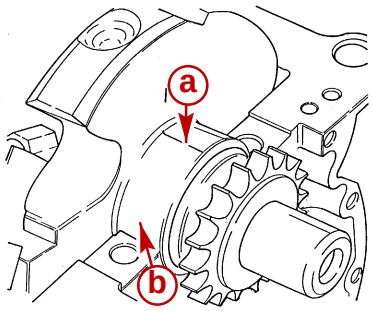
Checking Clearances

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 assure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, preparatory 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.

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

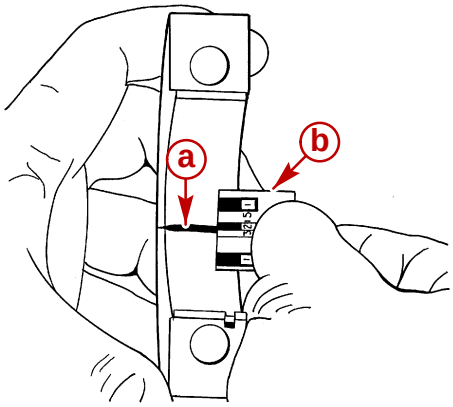


72357

a - Gauging Plastic
b - Journal

Index

3. Install the bearing cap and evenly torque the retaining bolts to specifications. Bearing cap MUST be torqued to specification to ensure proper reading. Variations in torque affect the compression of the plastic gauge.
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 which is 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 as shown.



72358

a - Compressed Gauging Plastic
b - Graduated Scale

NOTE: *Normally main bearing journals wear evenly and are not out of round.*

- *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.*
- *Measure the journal with a micrometer if the flattened gauging plastic indicates more than .001 in. difference.*

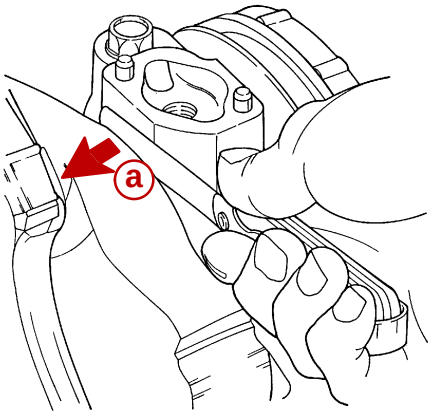
6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
7. A standard or .001 in. undersize bearing may produce the proper clearance. If not, it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

IMPORTANT: After selecting new bearing, recheck clearance.

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

Index

9. Measure crankshaft end play (see “Specifications”) 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.

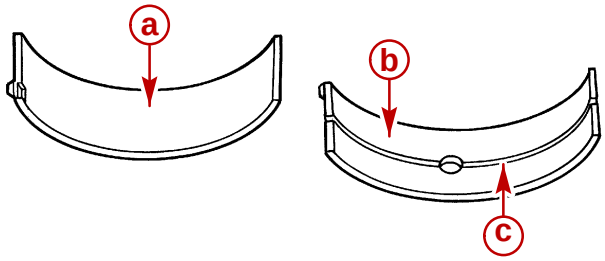


72360

a - Force Crankshaft to Extreme Forward Position

Replacement

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



72359

Main Bearing Inserts

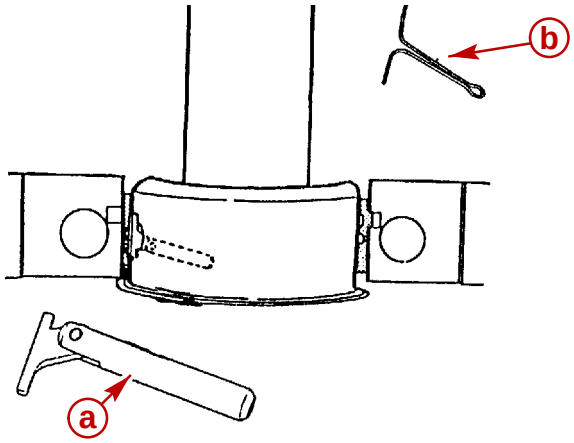
a - Lower Bearing Insert
b - Upper Bearing Insert
c - Oil Groove

WITH CRANKSHAFT REMOVED

1. Remove and inspect the crankshaft.
2. Remove the main bearings from the cylinder block and main bearing caps.
3. Coat bearing surfaces of new main bearings with oil.
4. Install the upper bearings in cylinder block.
5. Install the lower bearings in main bearing caps.
6. Install the crankshaft.

WITHOUT CRANKSHAFT REMOVED

1. Remove oil pan, oil pump and spark plugs.
2. Remove cap on main bearing requiring replacement.
3. Remove bearing from cap.
4. 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, and used.



72622

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

5. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll upper bearing out of block.
6. Oil new upper bearing.
7. Insert plain (unnotched) end between crankshaft and indented or notched side of block.
8. Rotate the bearing into place and remove tool from oil hole in crankshaft journal.
9. Oil new lower bearing and install in bearing cap.
10. Install main bearing cap with arrows pointing toward front of engine.
11. Torque all main bearing caps, EXCEPT THE REAR MAIN CAP, to specifications.
12. Torque rear main bearing cap to 15 lb-ft (20 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.
13. Torque rear main bearing cap to specification.

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. They are also available in .010 in. and .020 in. undersize for use with reconditioned crankshafts.

When removing a connecting rod cap, you may find a .010 in. undersize bearing. These are used in manufacturing for selective fitting.

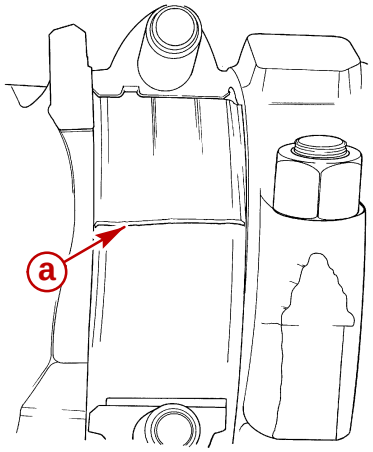
Inspection and Replacement

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. Remove oil pan and oil pump.
2. Remove connecting rod cap and bearing.
3. Inspect bearing for evidence of wear and damage. Do not reinstall a worn or damaged bearing.
4. Wipe both upper and lower bearing shells and crankpin clean of oil.
5. Measure the crankpin for out-of-round or taper with a micrometer.
   a. Not within specifications, replace or recondition the crankshaft.
   b. Within specifications and a new bearing is to be installed, measure the maximum diameter of the crankpin to determine required bearing size.

NOTE: *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.*

6. Measure bearing clearances.
   a. Place a piece of gauging plastic, the length of the bearing (parallel to the crankshaft), on the crankpin or bearing surface as shown.
   b. 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

Index

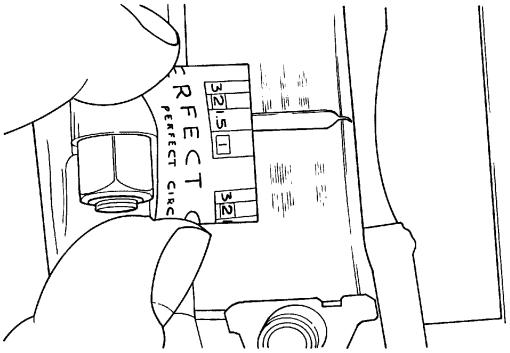
c. Install the bearing in the connecting rod and cap.

d. Install the bearing cap. Bearing cap MUST be torqued to specification in order to ensure proper reading. Variations in torque affect the compression of the plastic gauge.

e. Evenly,and in a two pass sequence, torque nuts to 20 lb-ft (27 Nm) on first pass. Then, torque nuts an additional 55 degrees angular torque.

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

f. Remove the bearing cap and use the scale on the gauging plastic envelope to measure the gauging plastic width at the widest point.

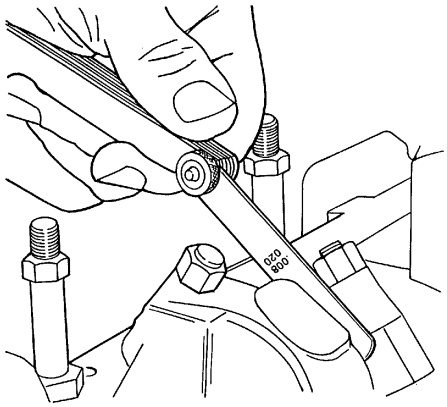


72362

7. If the clearance exceeds specifications, select a new, correct size bearing and remeasure 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 to within specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace crankshaft.*

8. Coat the bearing surface with oil.
9. Install the rod cap.
10. Evenly,and in a two pass sequence, torque nuts to 20 lb-ft (27 Nm) on first pass. Then, torque nuts an additional 55 degrees angular torque.
11. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) to ensure clearance.
12. Measure all connecting rod side clearances (see “Specifications”) between connecting rod caps as shown.



72363

Connecting Rod / Piston Assembly

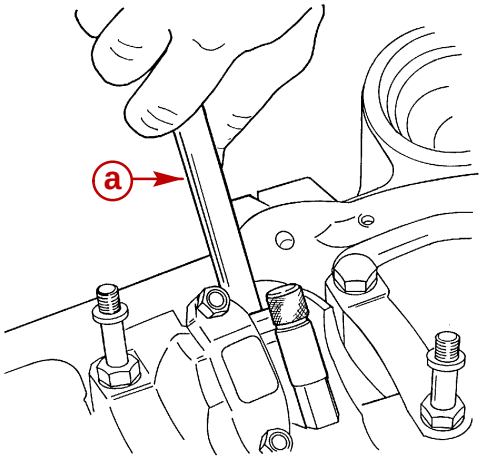
Removal

1. Remove oil pan and dipstick tube.
2. Remove baffle and oil pump.
3. Remove distributor and intake manifold.
4. Remove cylinder heads.

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.

5. Use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.
6. Mark connecting rods and bearing caps (left bank 1, 3, 5 and 7; right bank 2, 4, 6 and 8 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: *Turn crankshaft slightly to disconnect and remove some connecting rod and piston assemblies.*

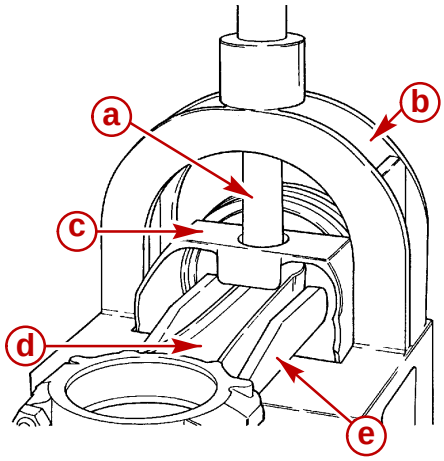


72364

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

Disassembly

Disassemble piston from connecting rod using piston pin remover as shown. Follow instructions supplied with kit.



72365

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

Cleaning and Inspection

CONNECTING RODS

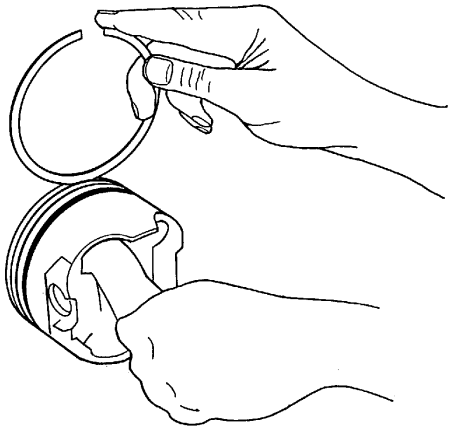
1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted and bent rods and inspect for nicks and cracks. Replace damaged connecting rods.

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 is free as shown. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, recheck with another ring.



72366

6. Proper clearance of piston ring in its groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured. See “Specifications.”
7. Replace pistons that are damaged or show signs of excessive wear.

72367

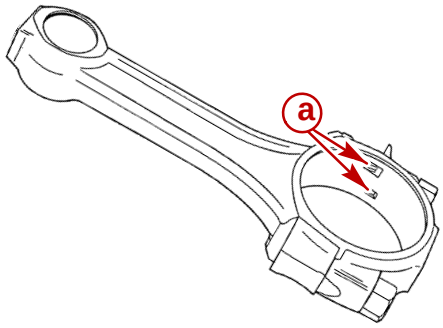
PISTON PINS

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. (0.025 mm) wear limit, replace piston and piston pin assembly.

Reassembly

IMPORTANT: When reassembling pistons and connecting rods, the following must be kept in mind.

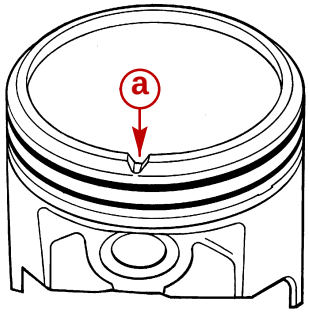
- **Piston and pin are machine fitted to each other and must remain together as a matched set. Do not intermix pistons and pins.**
- **If original pistons and/or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they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



72368

a - Rod Bearing Tangs

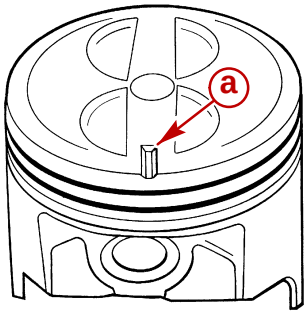
- **To determine if engine is left-hand (standard) rotation or right-hand (opposite) rotation, inspect camshaft drive. If engine has a timing chain, engine is left-hand rotation. If engine has timing gears, engine is right-hand rotation. All MCM engines are left-hand rotation.**
- **Notch on piston must be positioned correctly for engine that is being repaired.**



72369

305 cid / 5.0L Engines

a - Notch - Toward Front



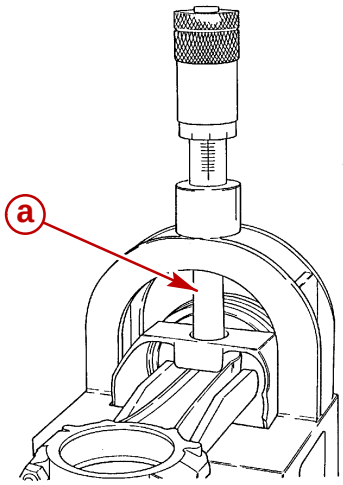
72370

350 cid / 5.7L Engines

a - Notch - Toward Front

Index

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



72371

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

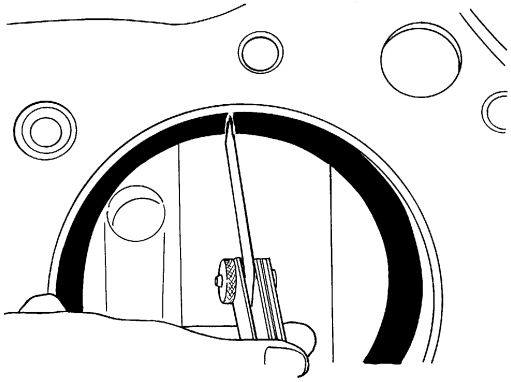
2. Once assembled, check piston for freedom of movement (back and forth and up and down) on connecting rod. Piston should move freely in all directions. If it does not, piston pin bore is tight and piston / pin assembly must be replaced.
3. If a new connecting rod has been installed, mark connecting 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, if not previously done.
7. Install piston rings as follows:

Index

a. Install oil ring spacer in groove and insert anti- rotation tang in oil hole.

b. Hold spacer ends butted 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 free. If binding occurs at any point, the cause should be determined. If binding is caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, use a new ring.

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

e. Using ring expander, install lower compression ring with marked side up.

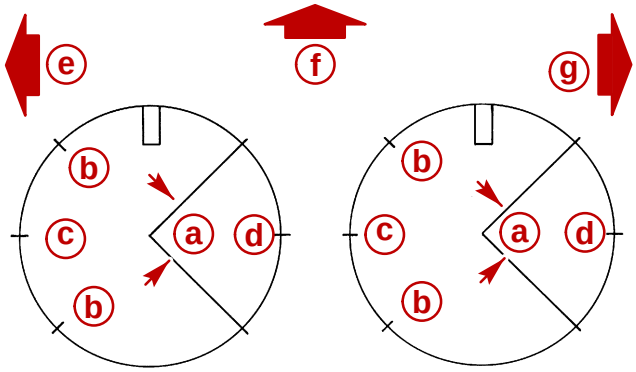
f. Using ring expander, install top compression ring with marked side up.

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.
2. Install connecting rod bearings in rods and rod caps.
3. Lightly coat pistons, rings and cylinder walls with light engine oil.
4. 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

1-3-5-7 Cylinders **2-4-6-8 Cylinders**

Ring Gap Location

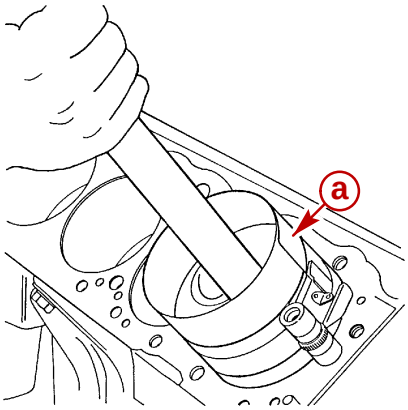
a - Oil Ring Spacer Gap (Tang in Hole or Slot Within Arc)
b - Oil Ring Rail Gaps
c - 2nd Compression Ring Gap
d - Top Compression Ring Gap
e - Engine Left
f - Engine Front
g - Engine Right

5. Install each connecting rod and piston assembly in its respective bore with connecting rod bearing tangs toward outside of cylinder block.
6. Use piston ring compressor to compress rings.
7. 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.

Index

8. 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, 5 and 7 in left bank and 2, 4, 6 and 8 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.



72374

a - Piston Ring Compressor (J-8037)

9. Remove connecting rod bolt guide.
10. Install bearing caps and torque nuts to 45 lb-ft (61 Nm).
11. Check connecting rod side clearance as previously described.

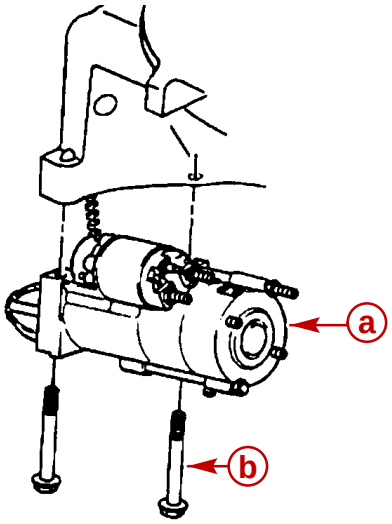
NOTE: *If bearing replacement is required, refer to "Connecting Rod Bearings."*

12. Install oil pump and baffle.
13. Install dipstick and oil pan.
14. Install cylinder heads.
15. Install intake manifold.
16. Install distributor.
17. Fill crankcase with oil. Refer to SECTION 1 - "Maintenance."
18. Adjust valves as outlined under "Valve Adjustment - Engine Stopped."

Crankshaft

Removal

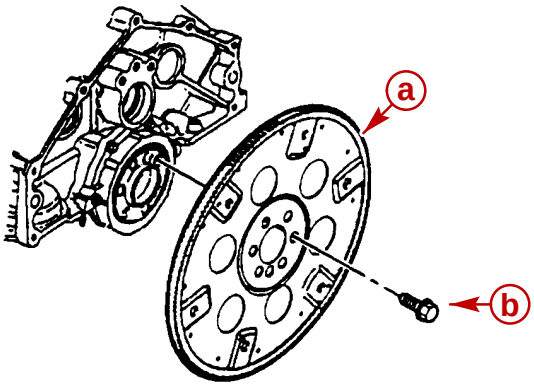
1. Remove engine from boat.
2. Drain crankcase oil.
3. Remove starter.



76489

a - Starter
b - Mounting Bolts

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



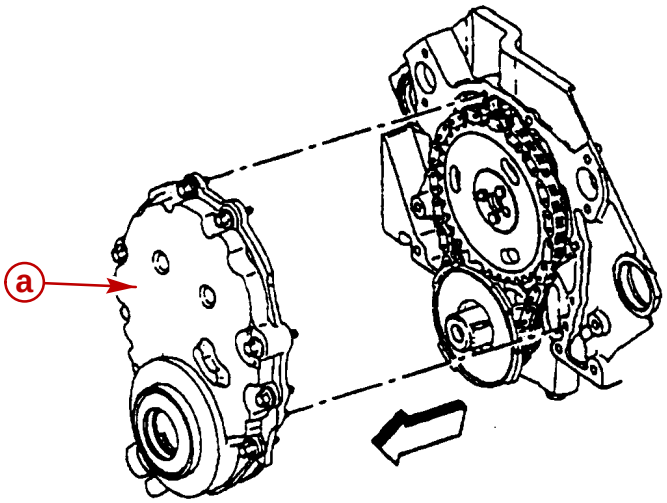
76490

a - Flywheel
b - Bolts

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

Index

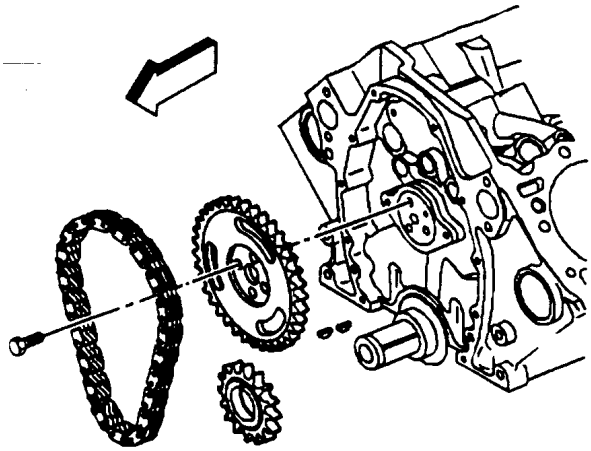
12. Remove timing chain gear cover.



76491

a - Timing Chain Gear Cover

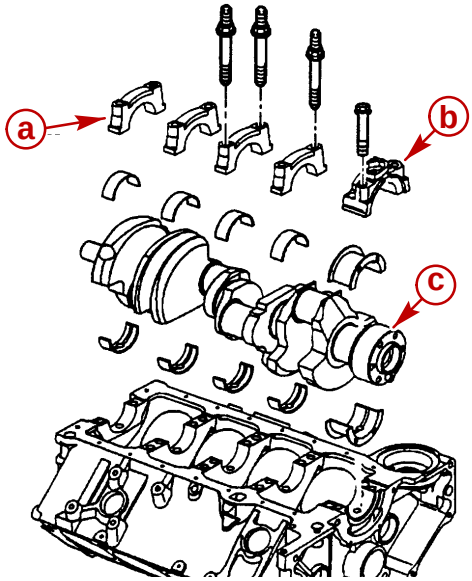
13. Remove timing chain.
14. Turn crankshaft to align timing mark with camshaft mark.
15. Remove camshaft sprocket or gear.



76488

16. Remove rear main seal and retainer.
17. Ensure all bearing caps (main and connecting rods) are marked so they can be reinstalled in their original locations.
18. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.

19. Remove main bearing caps and carefully lift crankshaft out of cylinder block.



76492

a - Connecting Rod Bearing Caps
b - Main Bearing Cap
c - Crankshaft

20. 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.

Cleaning and Inspection

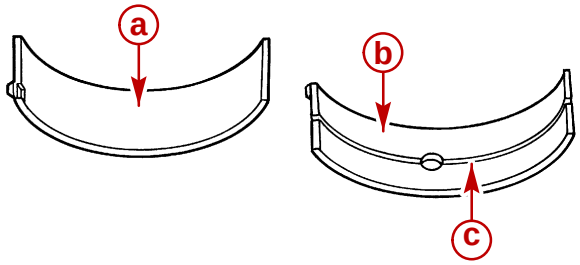
1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals and crankpin dimensions with a micrometer for out-of-round, taper or undersize (see “Specifications”).
3. Check crankshaft for runout (by supporting at front and rear main bearings journals in V-blocks) and check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

Installation

1. Remove timing sprocket or gear from old crankshaft and reinstall on new crankshaft as outlined.
2. On jackshaft models, if old pilot bushing is to be reused, bushing can be removed without damage. by
   a. Fill pilot bushing cavity with grease, then insert an old transmission input shaft in bore of bushing and hit it with a hammer. This will create hydraulic pressure in pilot bushing cavity that should force bushing out.

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

3. Install main bearings in engine block.



72359

Main Bearing Inserts

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

4. Carefully lower crankshaft into place. Be careful not to damage bearing surface.
5. Check clearance of each main bearing, following procedure outlined under “Main Bearings.” If bearing clearances are satisfactory, apply engine oil to journals and bearings.
6. Install main bearing caps.
7. Torque bolts to specifications. When tightening rear main bearing cap, follow procedure outlined under “Main Bearings.”
8. Check crankshaft end play as outlined.
9. Install rear main seal retainer and seal.
10. Torque fasteners to 106 lb-in. (12 Nm).
11. Check clearance for each connecting rod bearing, following procedure under “Connecting Rod Bearings.” If bearing clearances are satisfactory, apply engine oil to journals and bearings.
12. Coat the bearing surface with oil, install the rod cap.
13. Torque nuts to 20 lb-ft (27 Nm) on first pass. Then, torque nuts an additional 55 degrees angular torque.
14. Turn crankshaft so mark on timing sprocket or gear is facing camshaft.

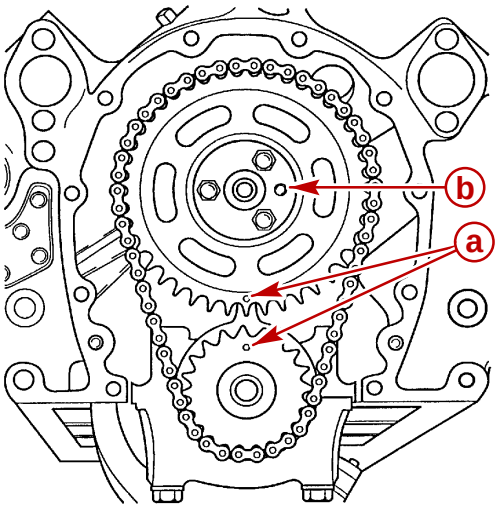
15. Install timing chain and sprocket or gear on camshaft -align marks with crankshaft.
16. Install timing chain/gear cover.
17. Install oil pump and baffle.
18. Install dipstick tube and oil pan.
19. Install spark plugs.
20. Install torsional damper and crankshaft pulley.
21. Install water pump.
22. Install belts.
23. Install flywheel and drive coupler / plate.
24. Install flywheel housing.
25. Install starter.
26. Install new oil filter.
27. Fill crankcase with oil.
28. Install engine in boat.

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.

NOTE: *Flat lifter timing gear is shown. Roller lifter gears have similar timing marks.*



72376

Standard (LH) Rotation Shown

a - Timing Marks Aligned
b - Locating Pin

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

Index

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.
4. Inspect timing gears for worn and damaged teeth.
5. Inspect camshaft gear-to-cylinder block contact surfaces for damage.

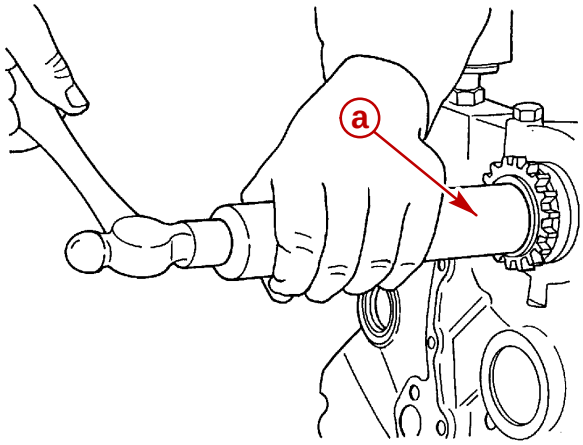
Crankshaft Sprocket/Gear

Removal

1. Remove torsional damper and crankcase front cove.
2. Remove camshaft timing chain/gear.
   a. On left-hand rotation engines, remove crankshaft sprocket using crankshaft gear and sprocket puller (J-5825-A).
   b. On right-hand rotation engines, remove crankshaft gear using a universal puller.

Installation

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



72377

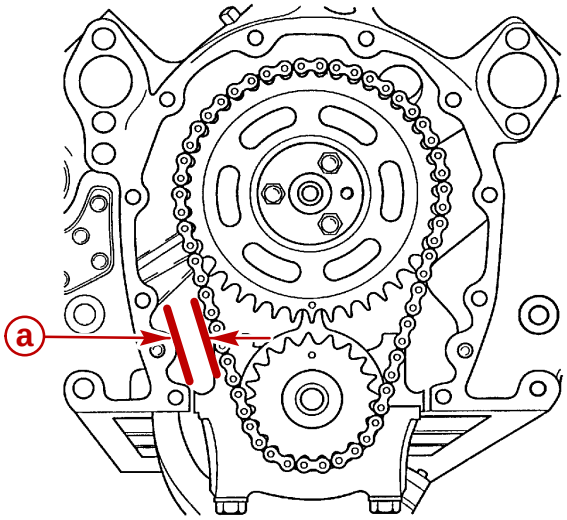
a - Crankshaft Gear and Sprocket Installer (J-5590)

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

Checking Timing Chain Deflection

1. Install timing chain and sprockets.
2. Rotate camshaft (in either direction) to place tension on one side of the chain.
3. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
4. 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.

5. The deflection is the difference between these two measurements. If the deflection exceeds 3/4 in. (19 mm), timing chain should be replaced.



72376

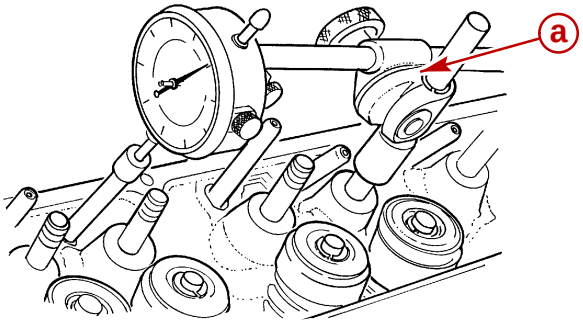
a - Reference Point

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. Be sure that push rod is in lifter socket.



72380

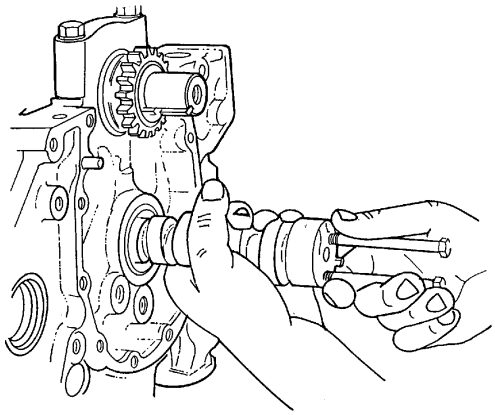
a - Ball Socket Adapter Tool (J-8520-1)

3. Rotate crankshaft torsional damper slowly in direction of 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 check accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install and adjust valve mechanism.

Index

Removal

1. Remove valve lifters.
2. Remove crankcase front cover.
3. Remove fuel pump and fuel pump push rod.
4. Remove camshaft as follows:
   a. Remove timing chain and sprocket or timing gears as outlined. On the 5.7L engine only, remove camshaft thrust plate.
   b. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes and carefully remove camshaft as shown.



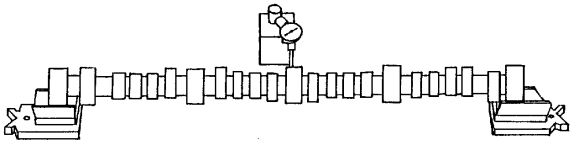
72381

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 of true more than .002 in. (0.051 mm) (dial indicator reading) camshaft should be replaced.

On engines with timing gears, inspect camshaft gear and thrust plate for wear and damage.



72382

Checking Camshaft Alignment

Installation

1. Install camshaft as follows:
   a. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes.
   b. Lubricate camshaft journals with engine oil and install camshaft. Be careful not to damage bearings.
   c. Lubricate camshaft lobes with General Motors Cam and Lifter Prelube or equivalent.
   d. Install camshaft thrust plate (retainer) and bolts. Torque the bolts to 106 lb-in. (12 Nm).
   e. Install timing chain or gears as outlined.
2. Install fuel pump push rod and fuel pump.
3. Install crankcase front cover and valve lifters as outlined.

Index

Camshaft Bearings

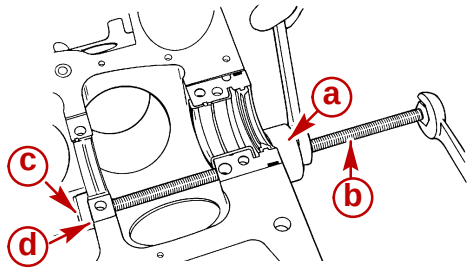
Removal

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

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.*

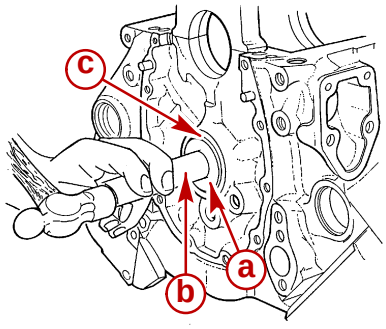
2. Using Install nut and thrust washer to end of threads on camshaft bearing remover and installer set (P/N J-6098-01).
3. Position pilot in front camshaft bearing.
4. Install puller screw through pilot.
5. Install tool with shoulder toward bearing. Be sure a sufficient amount of threads are engaged.
6. Using two wrenches, hold puller screw while turning nut.
7. Pull bearing bore.
8. Remove tool and bearing from puller screw.
9. Remove remaining bearings (except front and rear) in same manner.
10. Position pilot in rear camshaft bearing to remove rear intermediate bearing.



72383

- **a** - Index Pilot
- **b** - Puller Screw
- **c** - Driver
- **d** - Bearing

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



72384

- **a** - Driver
- **b** - Driver Handle
- **c** - Bearing

Index

Cleaning and 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.

INDEXING BEARING

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.**

INTERMEDIATE AND CENTER BEARINGS

1. Install nut and thrust washer onto puller screw.
2. Position pilot in front camshaft bearing bore and insert screw through pilot.
3. Index center camshaft bearing.
4. Position appropriate size removal and installation tool in bearing and thread puller screw into tool. Be sure at least 1/2 in. (13 mm) of threads are engaged.
5. Using two wrenches, hold puller screw and turn nut until bearing has been pulled into position.
6. Remove the removal and installation tool and ensure that oil hole(s) in bearing are positioned correctly.
7. Install intermediate bearings in same manner. Ensure bearings are indexed correctly. Position pilot in rear camshaft bearing bore to install rear intermediate bearing.

FRONT AND REAR BEARINGS

1. Install appropriate size removal and installation tool on drive handle.
2. Index front bearing and drive it into position with tool.
3. Ensure bearing is positioned correctly. Index rear bearing and drive it into position with tool.
4. 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.

5. Install crankshaft and camshaft.

Index

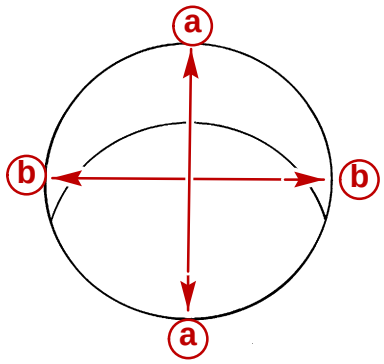
Cylinder Block

Cleaning and Inspection

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

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

7. Clean and inspect water passages in cylinder block.
8. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.
9. 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.



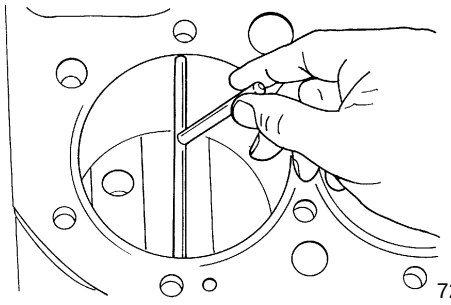
72385

Cylinder Measurement

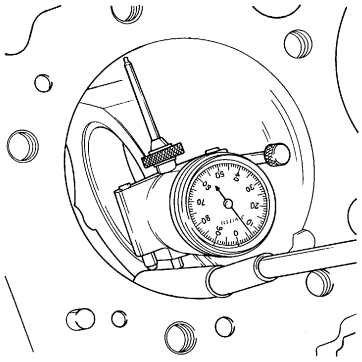
a - At right angle to centerline of engine
b - Parallel to centerline of engine

"Out-of-Round" = Difference between "a" and "b"

"Taper" = Difference between measurement "a" at top of cylinder bore and "a" measurement at bottom of cylinder bore



72386

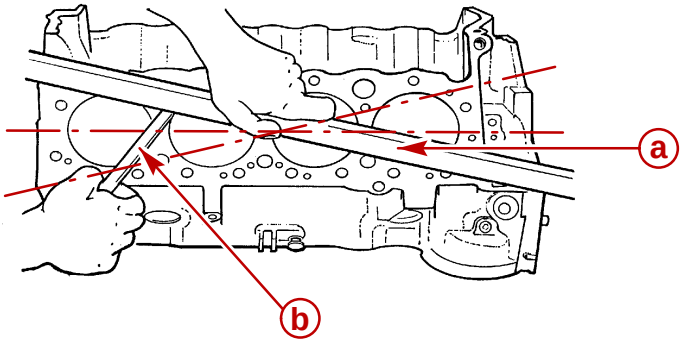


72387

Measuring Cylinder Bore

Index

10. 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.



72388

a - Machinist's Straight-Edge
b - Feeler Gauge

CYLINDER CONDITIONING

NOTE: *Performance of the following operation depends upon engine condition at time of repair.*

NOTE: *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.*

1. 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 rebore 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.
2. 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

IMPORTANT: Before using any type boring bar, file top of cylinder block to remove dirt or burrs. This prevents boring bar tilt, (the rebored cylinder wall is not at right angles to crankshaft.)

1. File top of cylinder block to remove dirt and burrs.
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.

Index

CYLINDER HONING

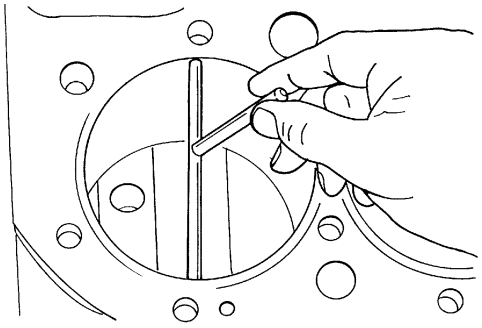
1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during the honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up and 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, cylinder bores and 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.

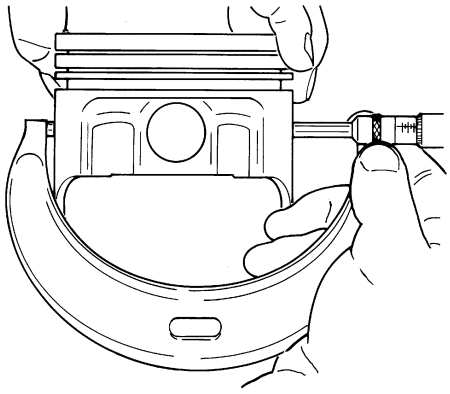
PISTON SELECTION

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 follows.



72386

b. Measure piston diameter at skirt across center line of piston pin as shown.



72624

c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.

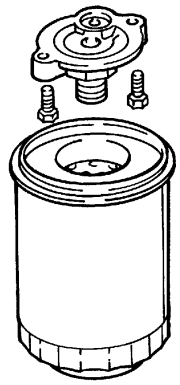
d. Determine if piston-to-bore clearance is in acceptable range shown in “Specifications.”

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 (acceptable range).

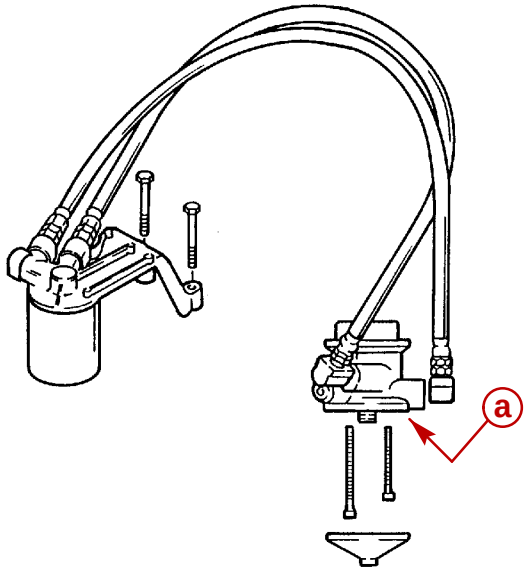
4. Mark piston to identify cylinder for which it was fitted.

Oil Filter By-Pass Valve and Adaptor Assembly



72389

Without Remote Oil Filter



72390

With Remote Oil Filter

a - Fiber Valve

IMPORTANT: Oil by-pass valve and adaptor assembly should be inspected whenever engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

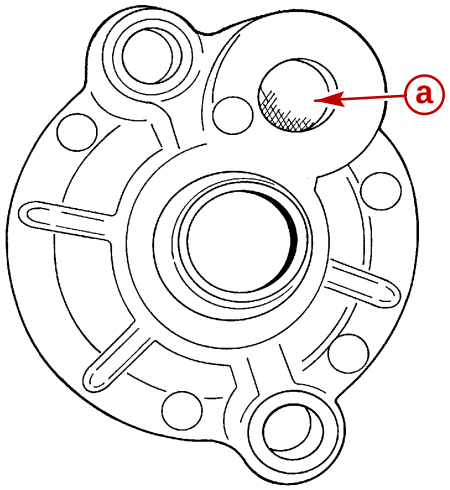
IMPORTANT: Refer to “Engine Parts List” when ordering parts for oil filter by-pass valve, adaptor assembly or remote oil filter parts.

Removal

1. Remove oil filter (on engines with block mounted filter) or cylinder block adaptor (on engines with remote oil filter).
2. Remove by-pass valve and adaptor assembly.

Cleaning and Inspection

1. Clean by-pass valve and adaptor assembly in solvent and blow dry with compressed air.
2. Inspect fiber valve for cracks or other damage.
3. Ensure that valve fits tightly against its seat.
4. Push valve down and release it. Valve should return freely to its seat. If valve operation is questionable, by-pass valve and adaptor assembly should be replaced. Bypass valve may be replaced separately on remote filter assembly.



72391

Typical By-Pass Valve and Adaptor Assembly

a - Fiber Valve

5. Wipe out valve chamber in cylinder block to remove any foreign material.

Installation

1. Install by-pass valve and adaptor assembly or cylinder block adaptor to engine block. Tighten bolts to 20 lb-ft (27 Nm).
2. Lubricate oil filter rubber seal and install hand-tight only.

Index

THIS PAGE IS INTENTIONALLY BLANK