



POWERHEAD

Section 4A

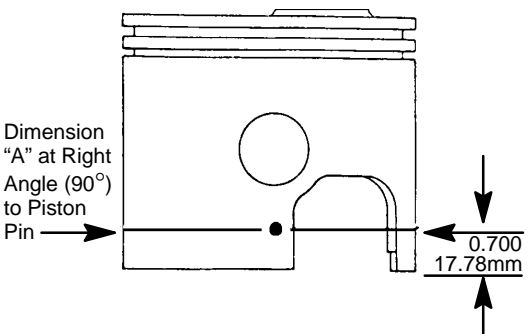
Table of Contents

Powerhead Specifications	4A-1	Special Service Information	4A-41
Special Tools	4A-2	Cylinder Bores	4A-42
Powerhead Repair Stand	4A-3	Pistons and Piston Rings	4A-43
Cylinder Block and End Caps	4A-4	Cylinder Heads and Exhaust Divider Plate	4A-45
Exhaust Manifold and Exhaust Plate	4A-6	Crankshaft	4A-45
Cylinder Head	4A-8	Crankshaft (and End Cap) Bearings	4A-46
Crankshaft, Pistons and Connecting Rods ..	4A-10	End Bearing Bleed System	4A-47
Torque Sequence	4A-11	Connecting Rods	4A-47
General Information	4A-13	Thermostats	4A-49
Powerhead Removal from Driveshaft		Powerhead Reassembly and Installation ...	4A-50
Housing	4A-13	General	4A-50
Removing Engine Components	4A-17	Crankshaft Installation	4A-53
Removing Engine Components		Piston and Connecting Rod Reassembly	4A-55
Individually	4A-17	Piston and Piston Ring Combinations ...	4A-56
Removing Engine Components as an		Piston Installation	4A-57
Assembly	4A-18	Crankcase Cover Installation	4A-59
Model Year 2000 Starboard Side Oil Hose		Reed Block Assembly	4A-61
Routing	4A-27	Assembly of Reed Blocks to Reed Block	
Model Year 2000 Port Side Oil Hose Routing	4A-28	Adaptor Plate	4A-61
Model Year 2001 Starboard Side Oil Hose		Assembly of Exhaust Divider Plate to	
Routing	4A-29	Block	4A-61
Model Year 2001 Port Side Oil Hose Routing	4A-30	Reinstalling Engine Components	4A-64
Thermostat Hose Routing	4A-31	Notes	4A-65
Powerhead Disassembly	4A-32	Throttle Lever and Shift Shaft	4A-66
Water Pressure Relief Valve Components	4A-40	Powerhead Installation on Driveshaft	
Torque Specifications	4A-40	Housing	4A-68
Cleaning and Inspection	4A-41	Front Clamp Reassembly	4A-73
Cylinder Block and Crankcase Cover ...	4A-41	Break-In Procedure	4A-75

Powerhead Specifications

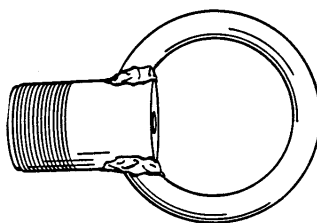
CYLINDER BLOCK	Type Displacement Thermostat	V-6 Cylinder, Two Cycle, Direct Injected 153 cu. in. (2508 cc) 60° Vee 142° F (61° C)
STROKE	Length (All Models)	2.65 in. (67.3 mm)
CYLINDER BORE	Diameter (Std) Diameter 0.015 in. Oversize Taper/Out of Round/Wear Maximum Bore Type	3.501 in. (88.925 mm) 3.516 in. (89.306 mm) 0.003 in. (0.076 mm) Cast Iron
CRANKSHAFT	Maximum Runout	0.006 in. (0.152 mm)
PISTON	Piston Type Diameter Standard Diameter 0.015 in. Oversize	Aluminum 3.4925 in. ± .0005 in. (88.7095 mm ± 0.0127 mm) 3.5075 in. ± 0.0005 in. (89.0905 mm ± 0.0127 mm)



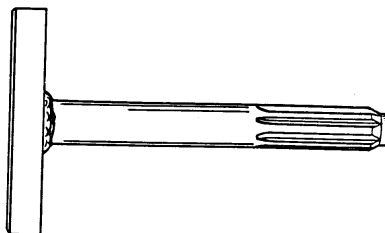
PISTON DIAMETER	 <p>Dimension "A" at Right Angle (90°) to Piston Pin</p> <p>0.700 17.78mm</p>	<p>3.4925 in. \pm .0005 in. (88.7095 mm \pm .0127 mm)</p> <p>Using a micrometer, measure dimension "A" at location shown. Dimension "A" should be 3.4925 in. \pm .0005 for a STANDARD size piston (new) Dimension "A" will be 0.001 – 0.0015 less if coating is worn off piston (used)</p>
REEDS	Reed Stand Open (Max.)	0.020 in. (0.50 mm)

Special Tools

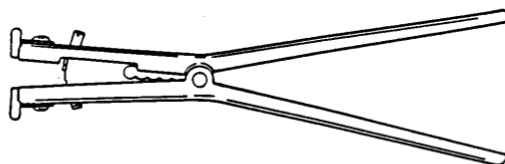
1. Lifting Eye 91-90455T



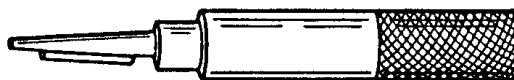
2. Powerhead Stand 91-30591T1



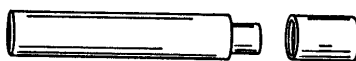
3. Piston Ring Expander 91-24697



4. Lockring Removal Tool 91-52952T1



5. Piston Pin Tool 91-74607A1

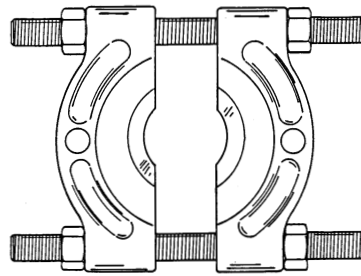


6. Driver Head 91-55919

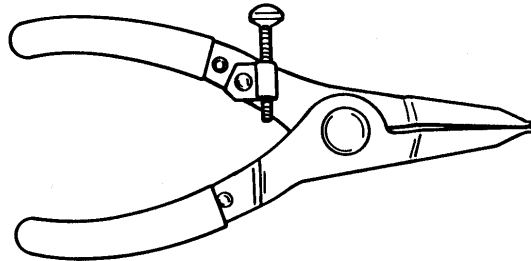




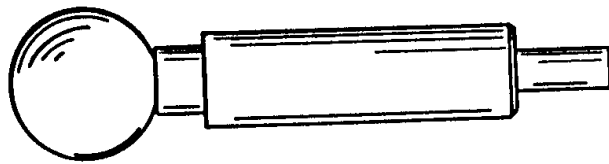
7. Universal Puller Plate 91-37241



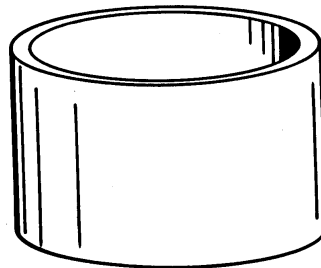
8. Snap Ring Pliers 91-24283



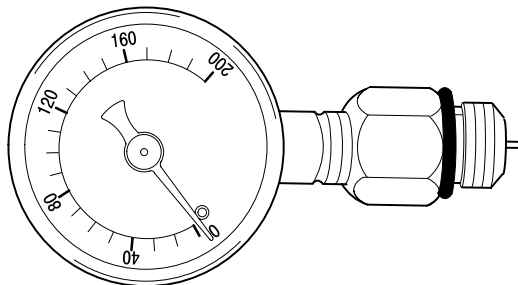
9. Lockring Installation Tool 91-77109A3



10. Piston Ring Compressor for 2.5 Litre (153 cu. in.) 91-818773T



11. Compression Tester 91-29287



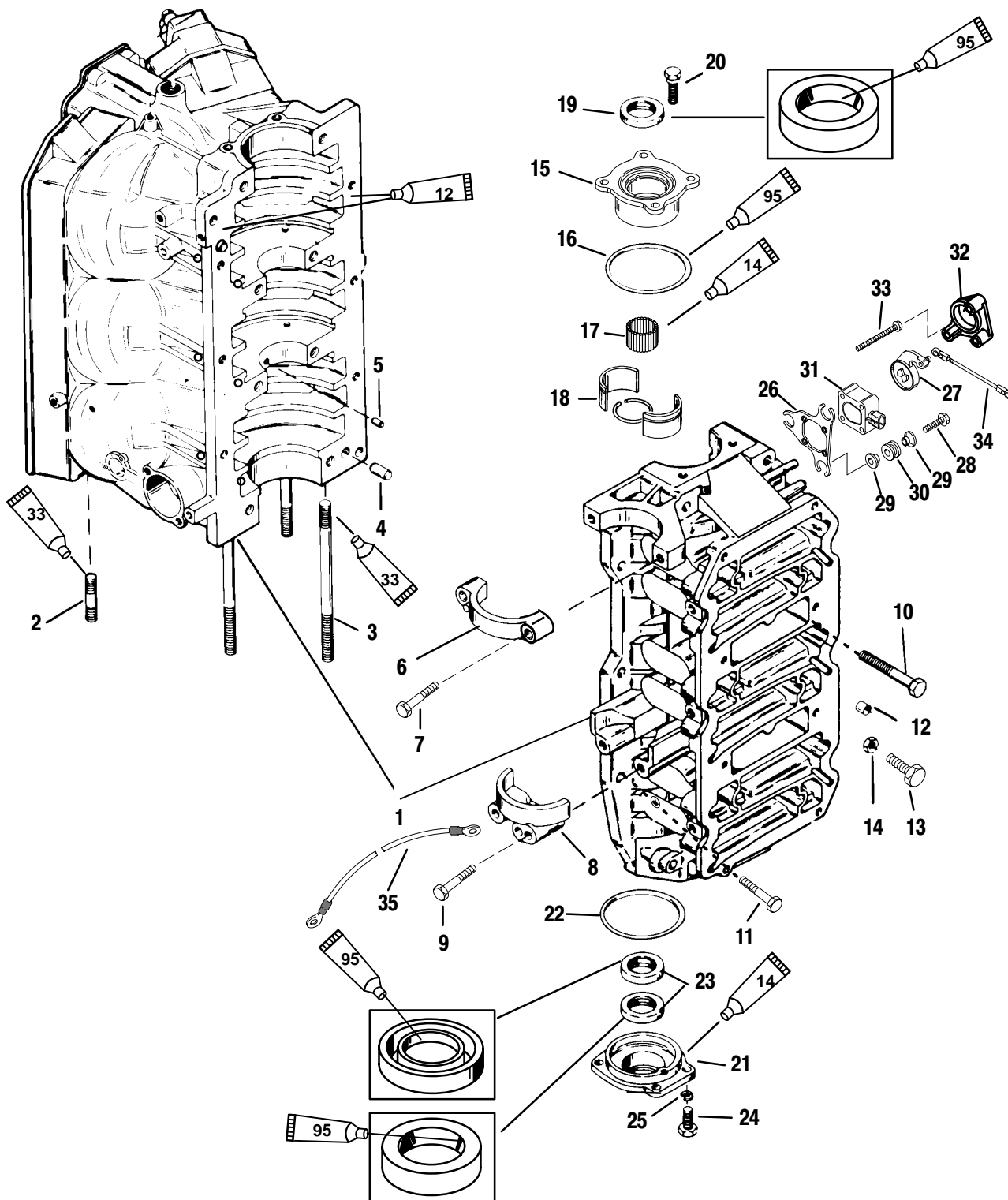
Powerhead Repair Stand

A powerhead repair stand may be purchased from:

Bob Kerr's Marine Tool Co.
P.O. Box 1135
Winter Garden, FL 32787
Telephone: (305) 656-2089

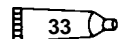


Cylinder Block and End Caps



 12 Loctite Master Gasket (92-12564-2)

 14 2 Cycle Outboard Oil (92-826666A24)

 33 Loctite 680 (92-809833)

 95 2-4-C With Teflon (92-825407A12)

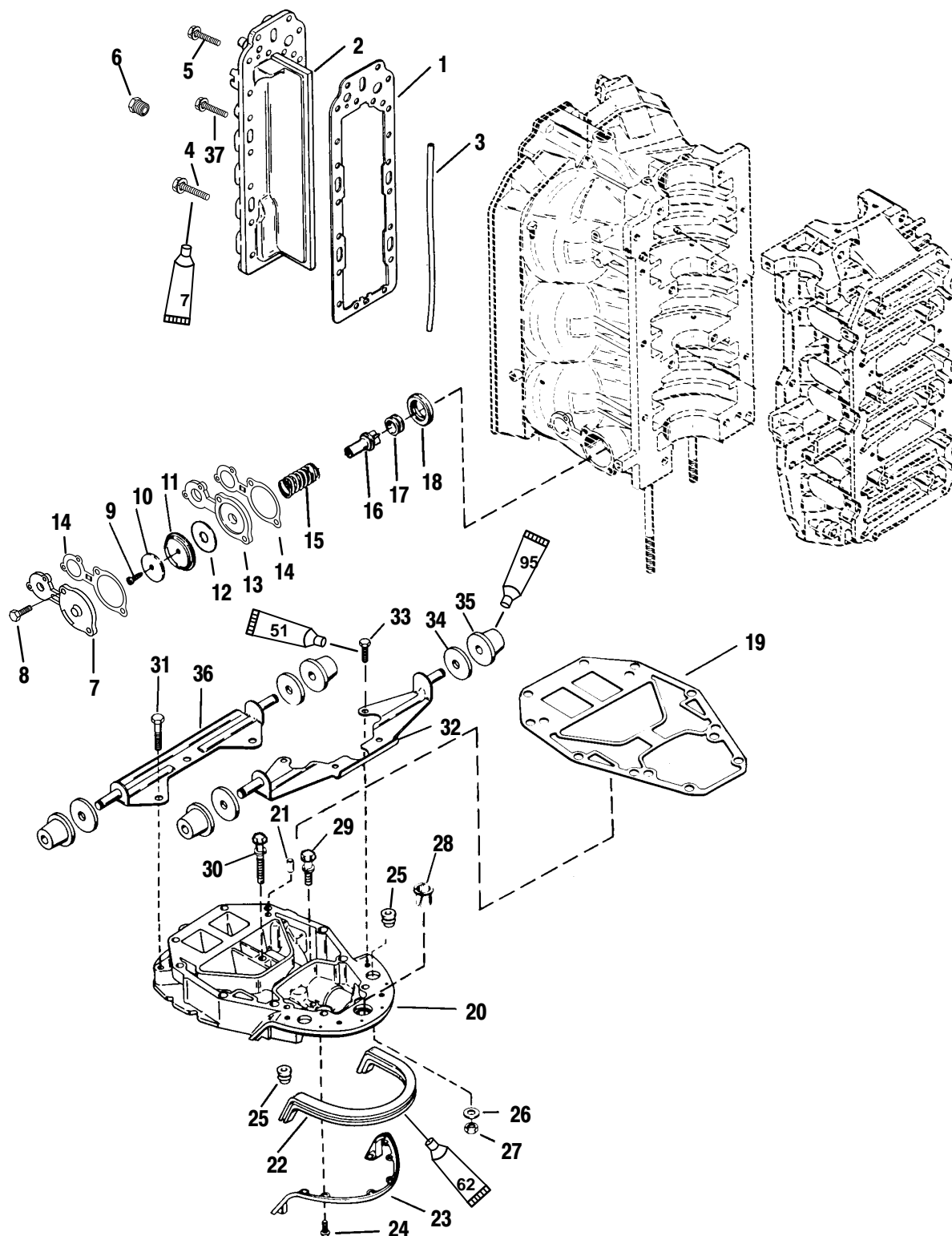


Cylinder Block and End Caps

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	CYLINDER BLOCK ASSEMBLY			
2	6	STUD-powerhead (1-3/4 IN.)			
3	2	STUD-powerhead (5-1/2 IN.)			
	2	STUD-powerhead (6-3/4 IN.)			
4	2	DOWEL PIN-locating			
5	2	DOWEL PIN (BEARING RACE)			
6	1	COVER			
7	2	SCREW			
8	1	COVER (BOTTOM)			
9	2	SCREW		21	28.5
10	8	SCREW (3/8-16 x 3-1/4)		37	50
11	6	SCREW (.312-18 x 1-1/4)		15	20
12	1	CAP			
13	1	ADJUSTING SCREW (1/4-20 x 1-3/4)			
14	1	JAM NUT			
15	1	UPPER END CAP			
16	1	O-RING			
17	1	ROLLER BEARING			
18	1	BEARING RACE			
19	1	OIL SEAL			
20	4	SCREW (5/16-18 x 1)	205	17	23
21	1	LOWER END CAP			
22	1	O-RING (3-1/4 IN. I.D.)			
23	2	OIL SEAL			
24	4	SCREW (1/4-20 x 3/4)	80		9
25	4	LOCKWASHER			
26	1	BRACKET			
27	1	TPI LEVER			
28	3	SCREW -Bracket to crankcase	70		8
29	6	BUSHING			
30	3	GROMMET			
31	1	THROTTLE POSITION SENSOR (INSIDE)			
32	1	TPS COVER			
33	3	SCREW -TPS to bracket (#10-32 x 2.00 IN.)	15		1.7
34	1	THROTTLE LINK			
35	1	BATTERY CABLE (NEGATIVE)			



Exhaust Manifold and Exhaust Plate



 Loctite 271 (92-809820)

 Permabond 105 Cyanacrylate Adhesive (Obtain Locally)

 Loctite 222 (92-809818)

 2-4-C With Teflon (92-825407A12)

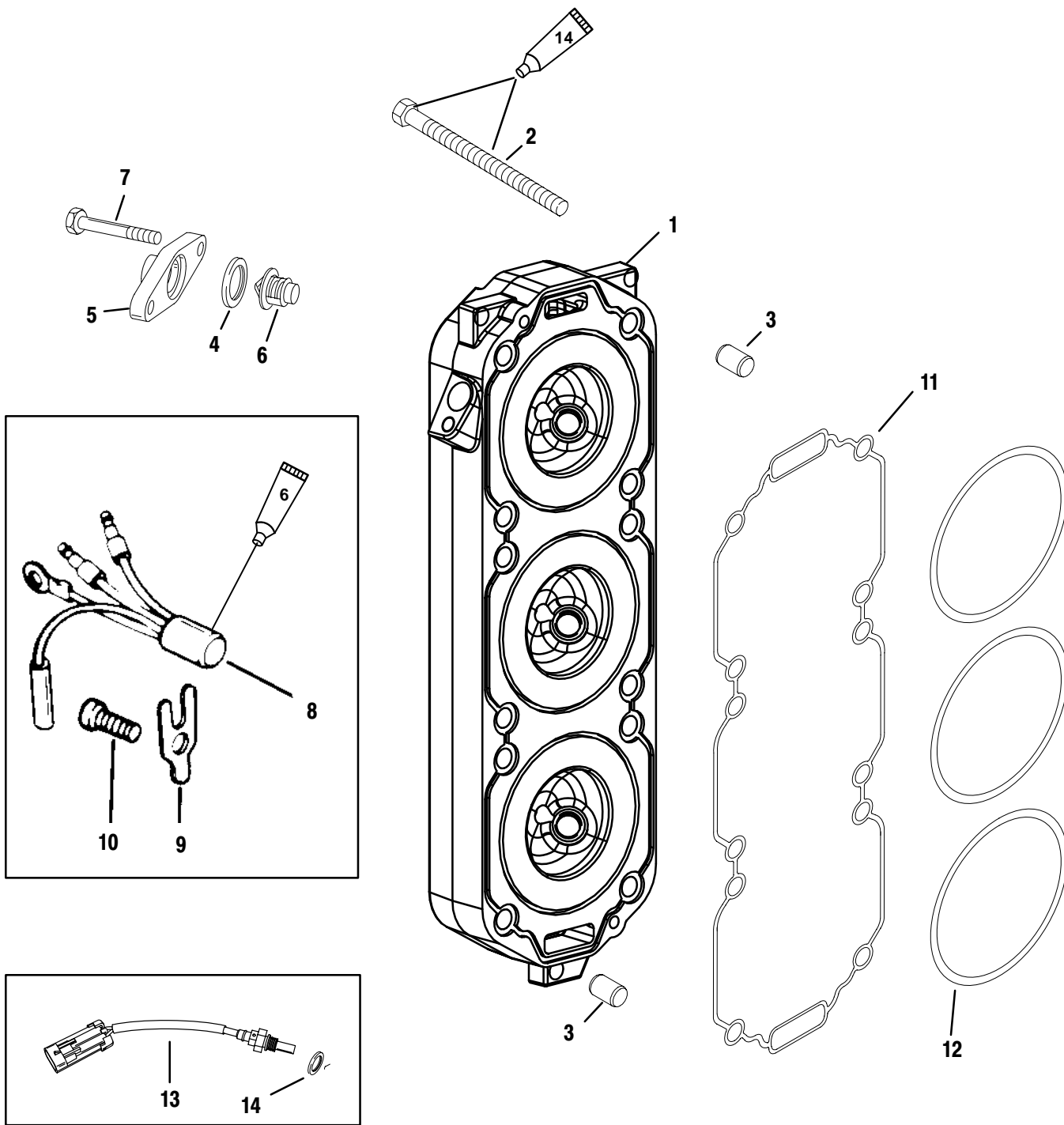


Exhaust Manifold and Exhaust Plate

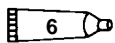
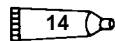
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	GASKET			
2	1	DIVIDER PLATE			
3	1	SEAL			
4	17	SCREW (5/16-18 x 1-1/2 IN.)	160	13	18
5	2	SCREW (5/16-18 x 1 IN.)	160	13	18
6	1	PLUG			
7	1	COVER-relief valve			
8	4	SCREW (5/16-18 x 1-1/4 IN.)	150	12.5	17
9	1	SCREW (10-16 x 3/4 IN.)	25		3
10	1	WASHER			
11	1	DIAPHRAGM			
12	1	WATER DEFLECTOR			
13	1	PLATE			
14	2	GASKET			
15	1	SPRING			
16	1	POPPET			
17	1	GROMMET			
18	1	CARRIER			
19	1	GASKET			
20	1	EXHAUST PLATE			
21	2	DOWEL PIN			
22	1	SEAL			
23	1	BRACKET			
24	8	SCREW (10-16 x 1/2 IN.)	80		9
25	2	GROMMET			
26	4	WASHER			
27	6	NUT		23	31
28	1	BUSHING			
29	1	SCREW (5/16-18 x 1-1/4 IN.)		45	61
30	1	SCREW (5/16-18 x 2-1/2 IN.)		45	61
31	3	SCREW (3/8-16 x 3-1/2 IN.)		23	31
32	1	FRONT BRACKET ASSEMBLY			
33	4	SCREW (5/16-18 x 1/2 IN.)		17	23
34	4	WASHER			
35	4	GROMMET			
36	1	REAR BRACKET ASSEMBLY			
37	1	SCREW (.312-18 x 1-3/4 IN.)(SLAVE)			



Cylinder Head



58084

-  6 Dielectric Grease (92-823506--1)
-  14 2 Cycle Outboard Oil (92-826666A24)

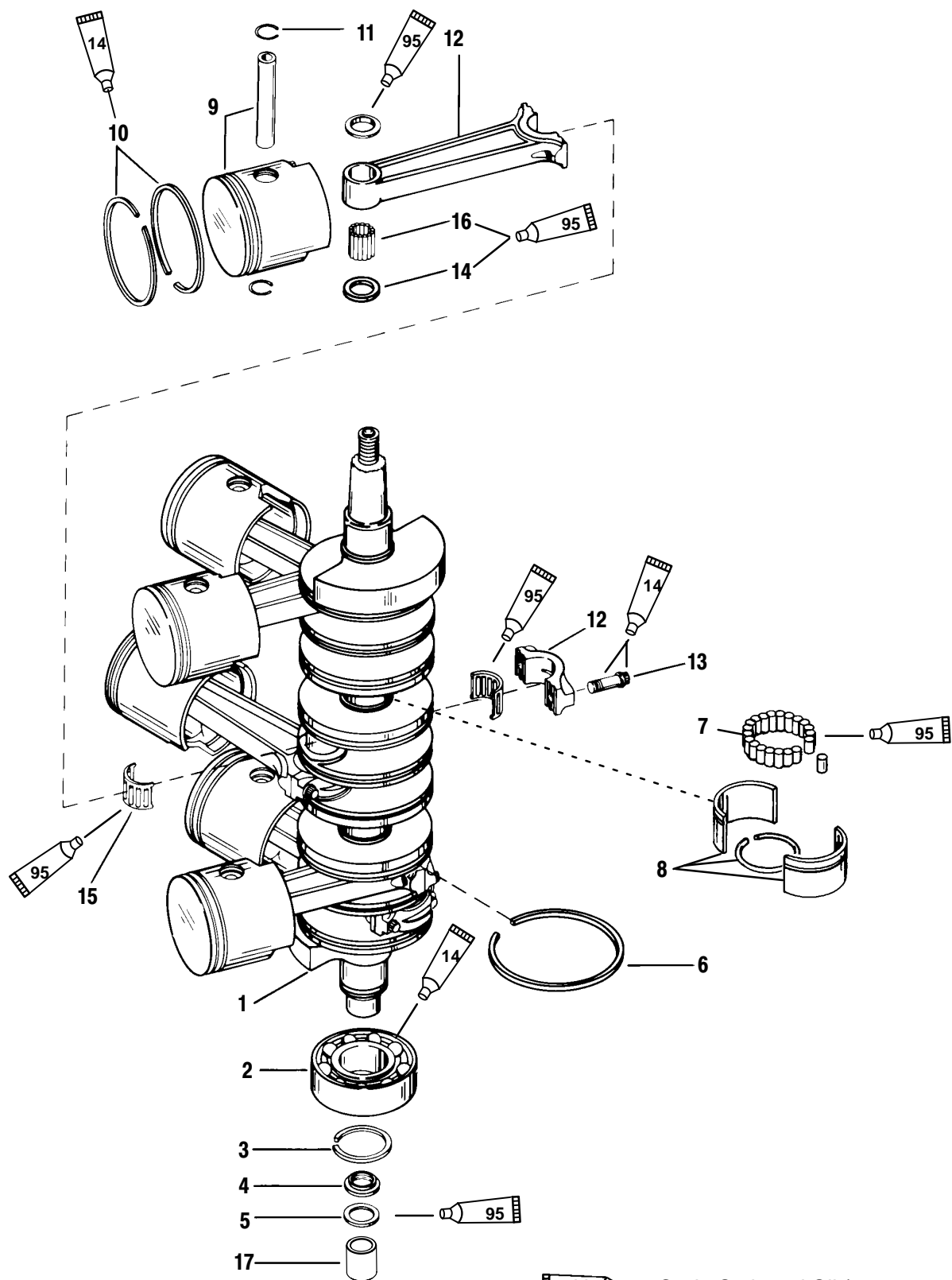


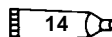
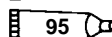
Cylinder Head

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	CYLINDER HEAD (PORT)			
	1	CYLINDER HEAD (STARBOARD)			
2	24	BOLT (2 IN)			30 lb-ft (41 Nm), then tighten additional 90 degrees
3	4	DOWEL PIN			
4	2	GASKET			
5	2	COVER			
6	2	THERMOSTAT (143 degrees)			
7	4	SCREW (M6 x 25)	200	16.5	22.5
8	1	TEMPERATURE SENSOR (STARBOARD)(MODEL YEAR 2000)			
9	1	RETAINER			
10	1	SCREW (M8 x 12)	200	16.5	22.5
11	2	SEAL-CYLINDER HEAD			
12	6	SEAL-CYLINDER BORE			
13	2	TEMPERATURE SENSOR (STARBOARD AND PORT)(MODEL YEAR 2001)			
14	2	O-RING			



Crankshaft, Pistons and Connecting Rods



-  14 2 Cycle Outboard Oil (92-826666A24)
-  95 2-4-C With Teflon (92-825407A12)

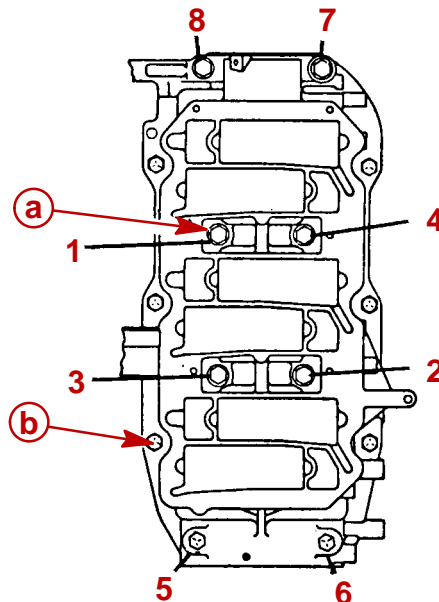


Crankshaft, Pistons and Connecting Rods

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	CRANKSHAFT ASSEMBLY			
2	1	BALL BEARING (LOWER)			
3	1	RETAINING RING			
4	1	CARRIER ASSEMBLY			
5	1	SEAL			
6	7	RING-sealing			
7	2	ROLLER BEARING			
8	2	RACE			
9	3	PISTON (STARBOARD)			
	3	PISTON (PORT)			
10	12	PISTON RING			
11	12	LOCK RING			
12	6	CONNECTING ROD ASSEMBLY			
13	12	SCREW	1st Torque: 15 lb-in 2nd Torque: 20 lb-ft Turn screw additional 90 degrees after 2nd torque. ▼		
14	12	WASHER			
15	12	ROLLER BEARING ASSEMBLY			
16	174	NEEDLE BEARING-piston end			
17	1	WEAR SLEEVE			

Torque Sequence

CRANKCASE COVER BOLTS (AND TORQUE SEQUENCE)

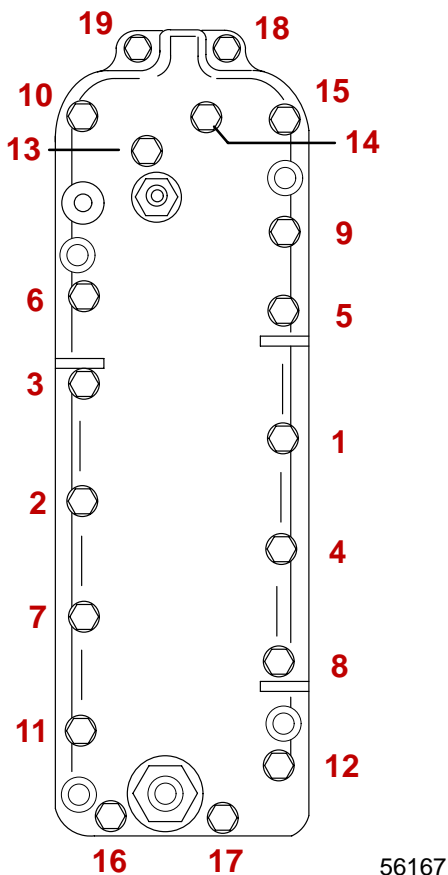


a - Add light oil to threads and bolt face: 8 Bolts (3/8 in. - 16 in.) 38 lb. ft. (51.5 N·m)

b - Bolts (5/16 in. - 18) 180 lb. in. (20 N·m)



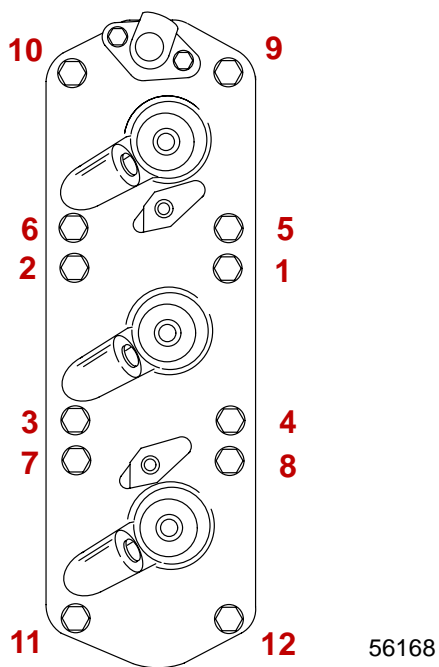
7 EXHAUST DIVIDER PLATE BOLTS 200 lb. in. (22.5 N-m) Apply Loctite 271 to threads



56167

CYLINDER HEAD BOLTS

Add light oil to threads and bolt face: 30 lb. ft. (41 N-m) then turn an additional 90°.

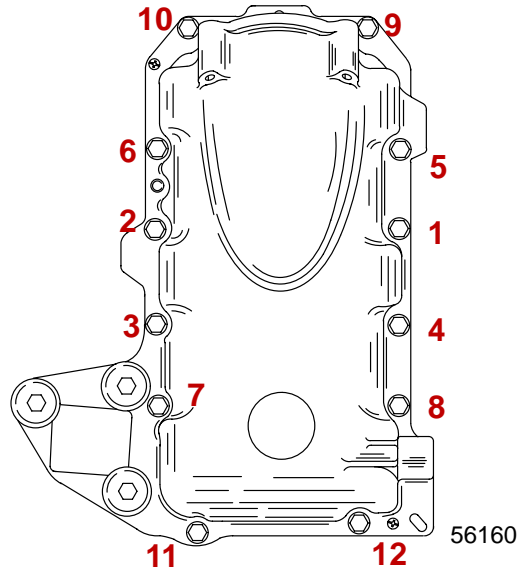


56168



AIR PLENUM/REED BLOCK ASSEMBLY PLATE BOLTS

175 lb. in. (19.8 N·m)



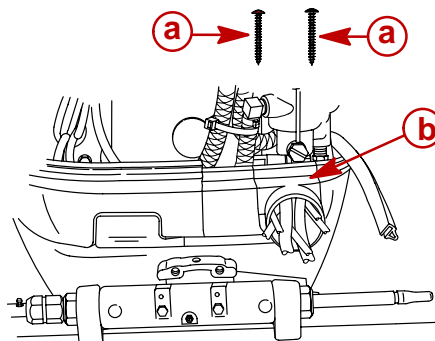
General Information

Powerhead “Disassembly” and “Reassembly” instructions are printed in a sequence that should be followed to assure best results when removing or replacing powerhead components. If complete disassembly is not necessary, start reassembly at point disassembly was stopped. (Refer to “Table of Contents,” preceding.) Usually, complete disassembly of powerhead will be required.

If major powerhead repairs are to be performed, remove powerhead from drive shaft housing. Removal of powerhead is not required for 1) inspection of cylinder walls and pistons (refer to “Powerhead Removal and Disassembly,” following, and remove cylinder heads and exhaust cover), 2) minor repairs on components, such as ignition system, fuel injection, reed blocks and cylinder heads and checking operation of thermostats.

Powerhead Removal from Driveshaft Housing

1. Disconnect battery cables from battery terminals.
2. Disconnect fuel tank hose from outboard.
3. Remove top cowling.
4. Remove two screws which secure remote control harness retainer and remove retainer.

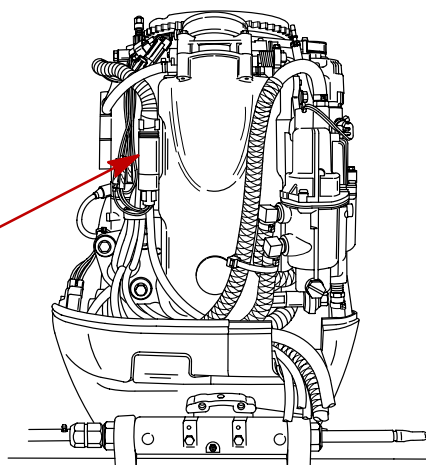
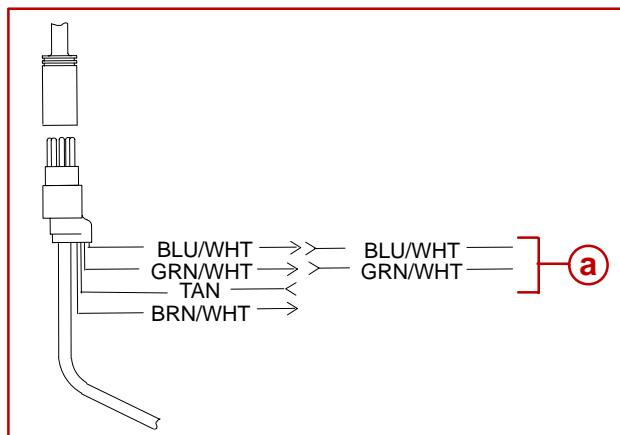


a - Screws

b - Retainer



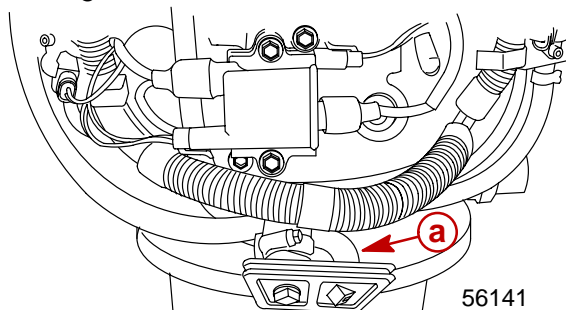
5. Disconnect remote oil tank hose connector.
6. Disconnect remote control harness from powerhead harness connector and wires as shown.



57835

a - Power Trim Connections

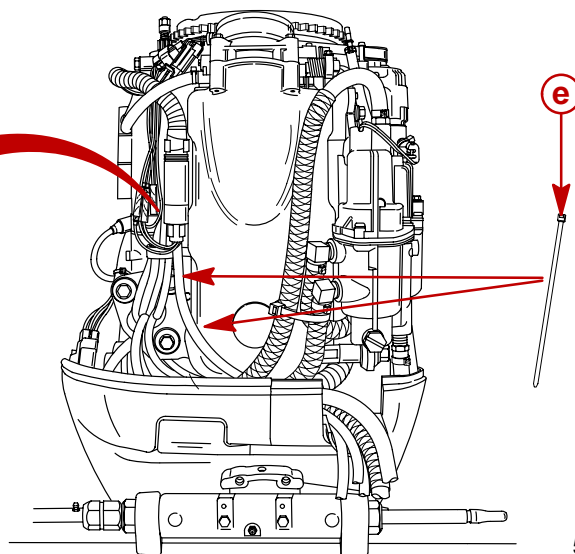
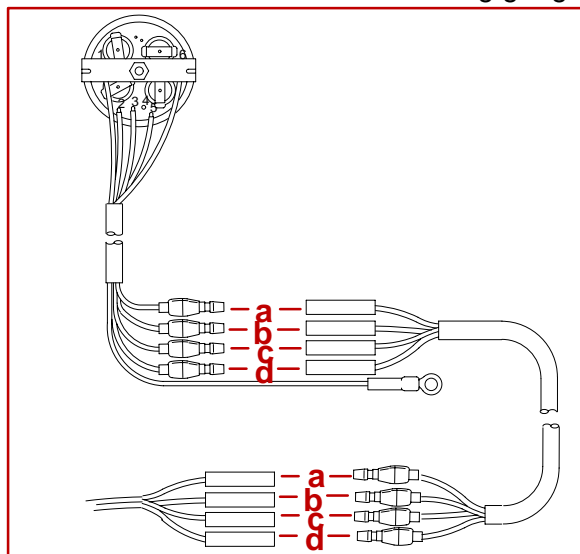
7. Remove sta-strap which secures tell-tale hose to fitting on lower cowl and remove hose from fitting.



56141

a - Tell-tale Hose

8. Disconnect warning gauge harness.



57835

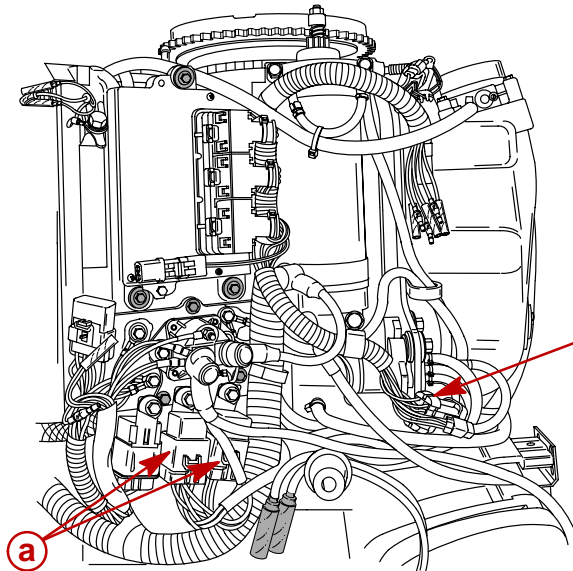
MODEL 2000

- a** - TAN/BLACK
- b** - TAN/WHITE
- c** - PINK/LT. BLUE

- d** - ORANGE
- e** - Sta-Straps

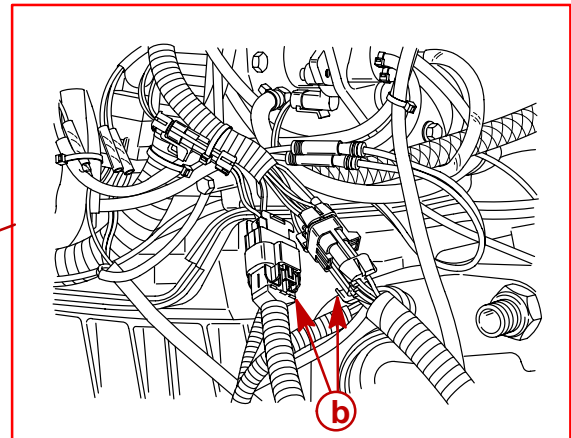


- 9. Remove BLUE and GREEN trim harness leads from trim relays.
- 10. Disconnect System Monitor/Digital Sensor harness connectors.



a - Trim Relays

57695

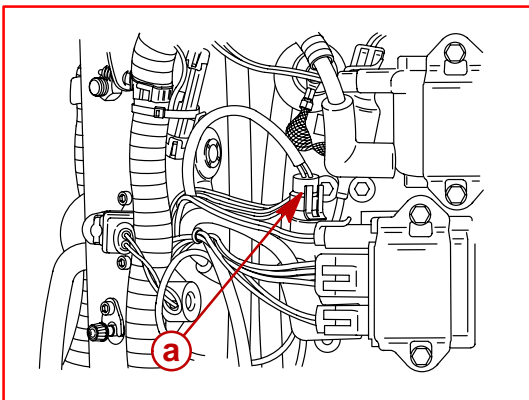


MODEL 2001

58616

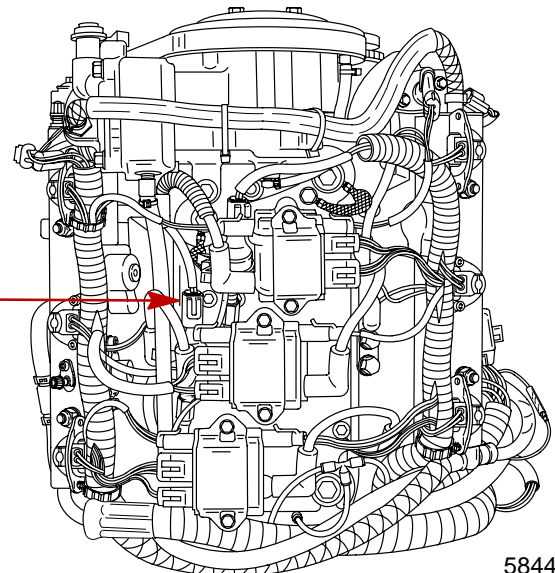
b - Harness Connectors

- 11. Disconnect water pressure sensor harness.



58615

a - Water Pressure Sensor Harness

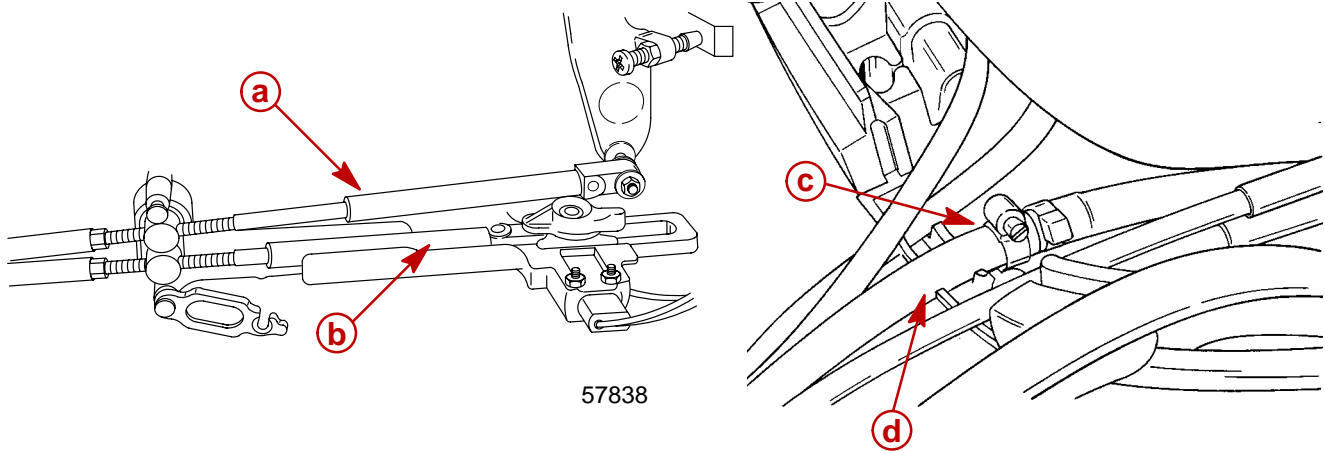


58443

- 12. Slide outboard shift lever into neutral position.
- 13. Remove throttle cable.
- 14. Remove locknut that secures shift cable latch assembly and remove latch, flat washer, nylon wear plate, spring and shift cable from control cable anchor bracket.



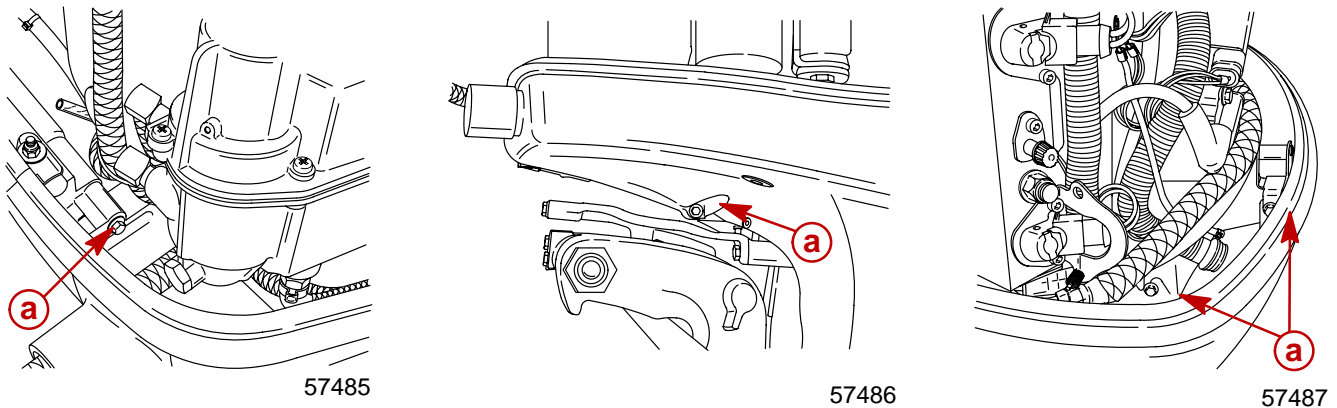
15. Disconnect input fuel line.



a - Throttle Cable
b - Shift Cable

c - Hose Clamp
d - Fuel Line

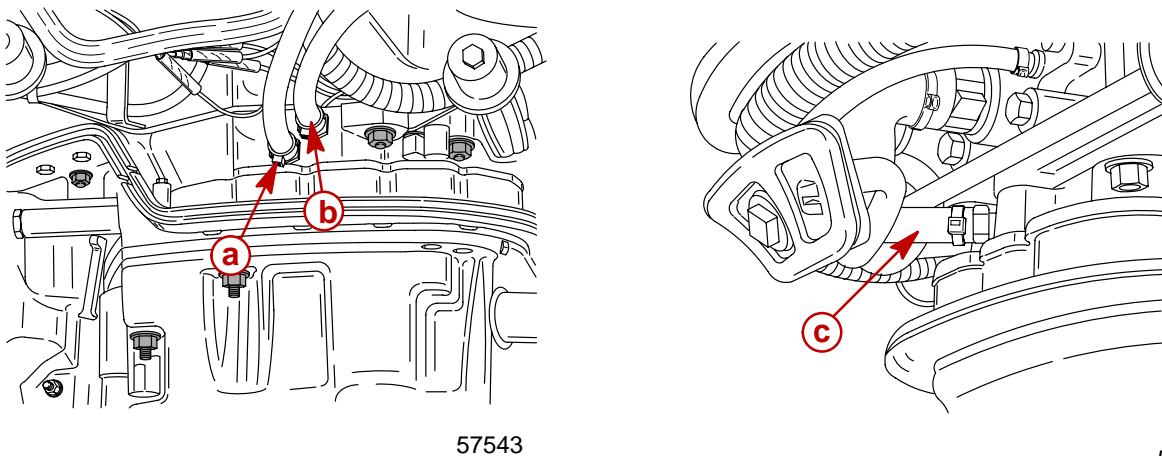
16. Remove 4 bolts securing bottom cowl halves and remove bottom cowl.



a - Bolt

17. Remove port fuel rail inlet water hose from fitting on exhaust adaptor plate. Remove excess air hose (from port fuel rail) from fitting on exhaust adaptor plate.

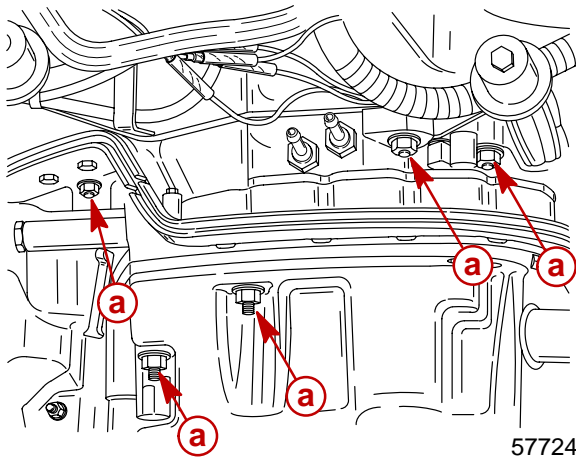
18. Remove thermostat outlet hose from exhaust adaptor plate.



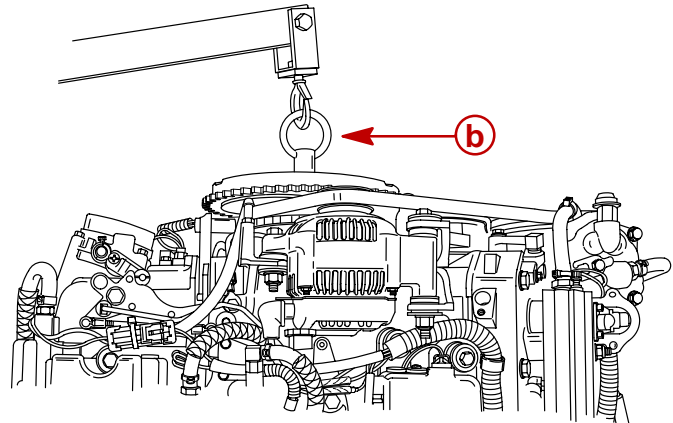
a - Excess Air to Adaptor Plate
b - Fuel Rail Inlet Water Hose
c - Thermostat Outlet Hose



19. Remove 10 nuts and washers (five each side) from powerhead base.
20. Remove plastic cap from center of flywheel and install LIFTING EYE (91-90455T) into flywheel at least five full turns. Using a hoist, lift powerhead assembly from driveshaft housing.



57724



57497

- a** - Nuts and Washers (5 Each Side)
b - Lifting Eye

Removing Engine Components

NOTE: Engine components can be removed individually or in some cases as an assembly.

Removing Engine Components Individually

Section 2 Starter Motor

Starter Motor

*Electronic Control Module

*Ignition Coil

*Starter Solenoid

Alternator

Flywheel

Section 3

Direct Fuel Injection

Fuel Pump

On-Board Oil Tank

Oil Pump

Section 7

Shift Cable Latch Assembly

Control Cable Anchor Bracket

***All ignition and electrical components should remain attached to electrical plate. Plate with components can be removed as an assembly.**



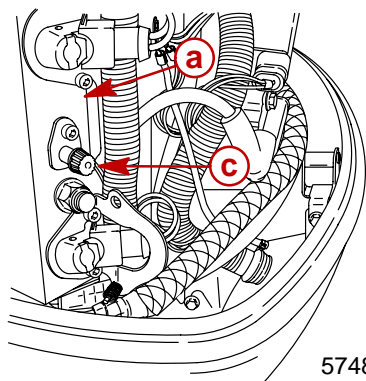
Removing Engine Components as an Assembly

VAPOR SEPARATOR TANK (VST) REMOVAL

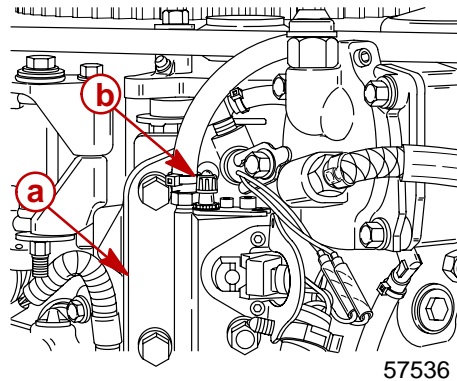
⚠ CAUTION

Fuel system must be bled off prior to removal of fuel system components.

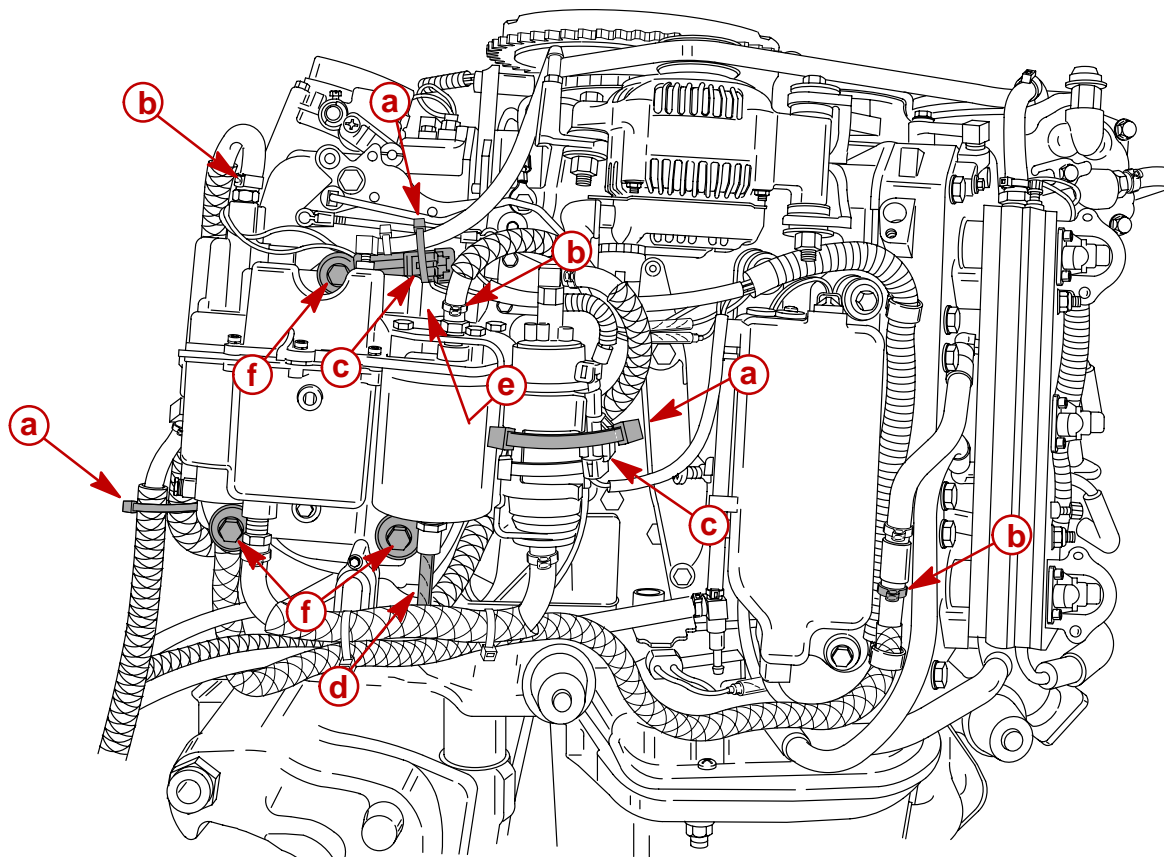
NOTE: Use Fuel/Air Pressure Gauge 91-16850--1 or 91-852087A1/A2A3 to de-pressurize air hose first and then fuel hose.



- a** - Port Fuel Rail
- b** - Fuel Pressure Port



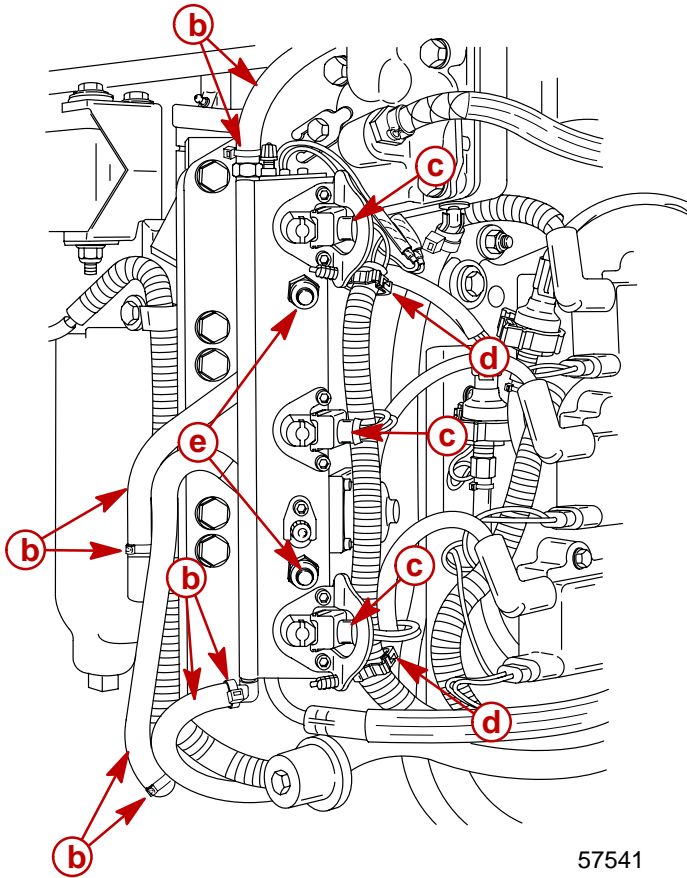
- c** - Air Pressure Port



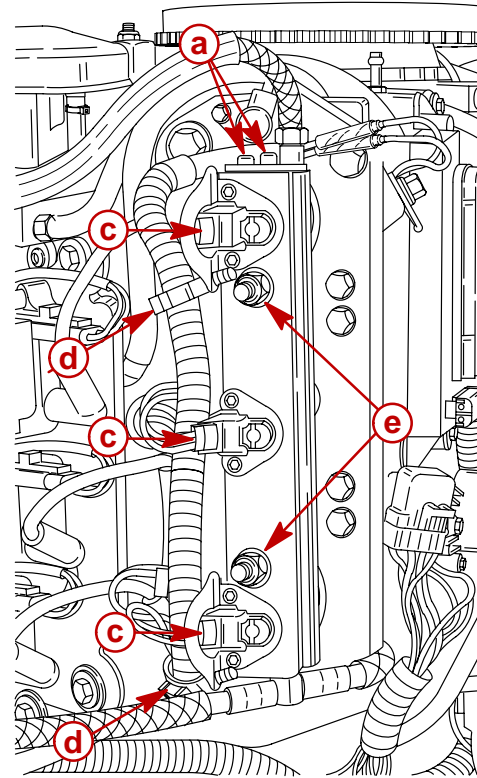
- a** - Remove Sta- straps
- b** - Remove Stainless Clamps
- c** - Disconnect Electric Fuel Pump Connectors
- d** - Disconnect Water Sensor Wire
- e** - Remove VST Ground Wire (hidden)
- f** - Remove VST Attaching Bolts



FUEL RAIL REMOVAL



57541



57534

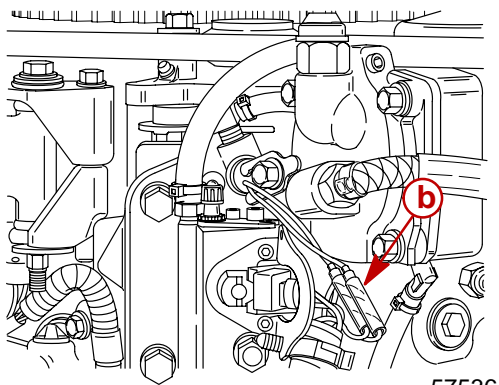
Port Fuel Rail Connections

Starboard Fuel Rail Connections

- a** - Remove Air Hose Retainer Screws
- b** - Remove 4 Sta-Straps and Remove Hoses (4)
- c** - Disconnect Fuel Injector Connectors (6)
- d** - Open Harness Retainers
- e** - Remove Fuel Rail Retaining Nuts and Remove Rails

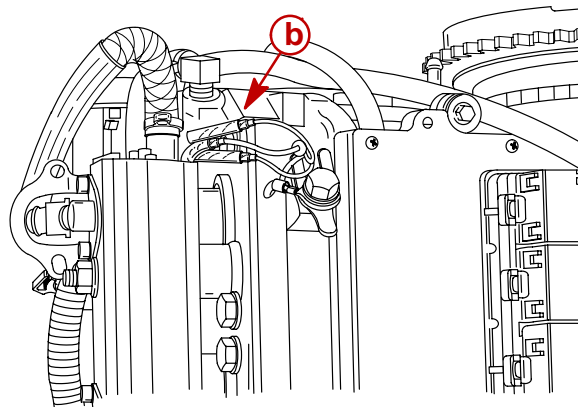


ELECTRICAL PLATE AND HARNESS REMOVAL



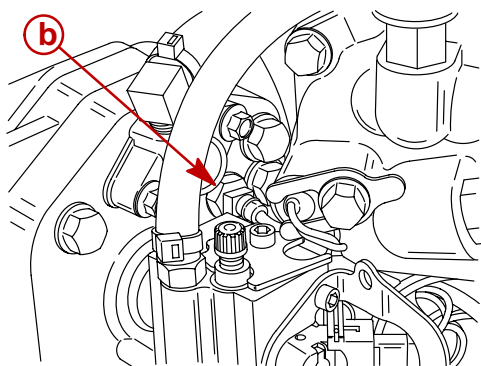
MODEL 2000 PORT

57536



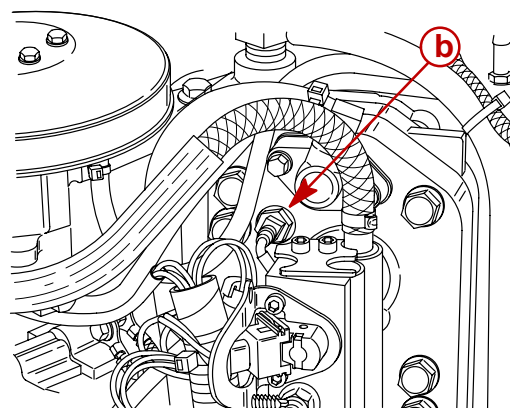
MODEL 2000 STARBOARD

57682



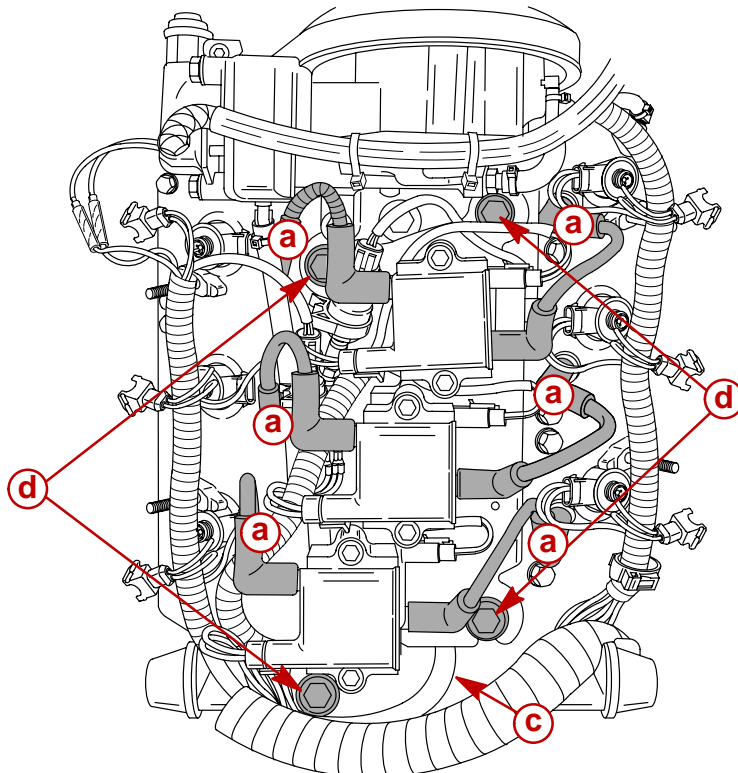
MODEL 2001 PORT

58442



MODEL 2001 STARBOARD

58441

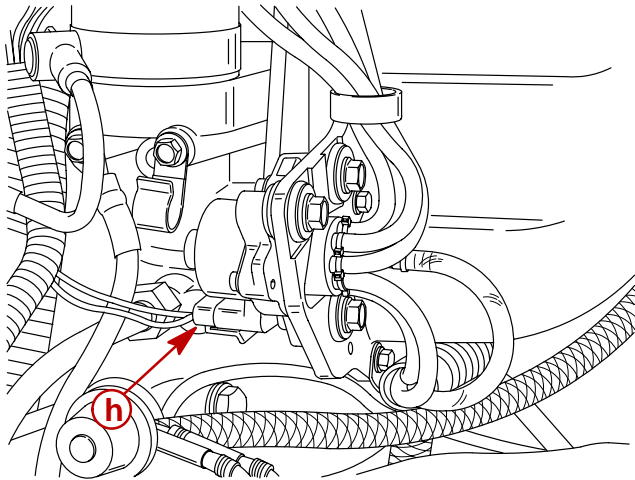


57720

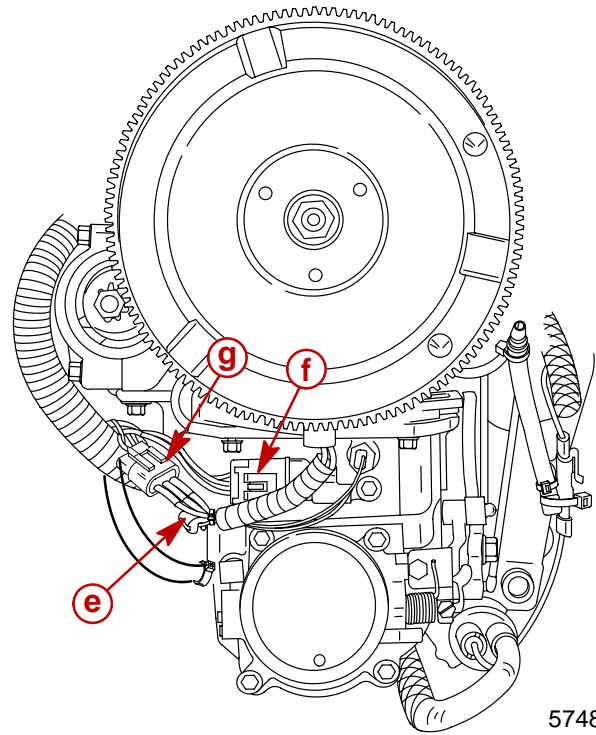
- a** - Remove Spark Plug Leads (6)
- b** - Disconnect Temperature Sensor Connectors
- c** - Disconnect Water Pressure Sensor Hose
- d** - Remove Coil Plate Bolts (4)



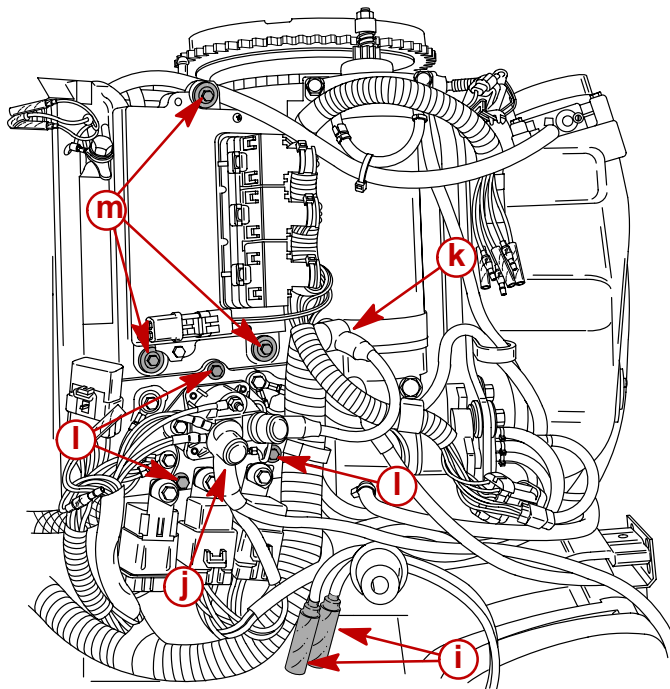
ELECTRICAL PLATE AND HARNESS REMOVAL (CONTINUED)



57686

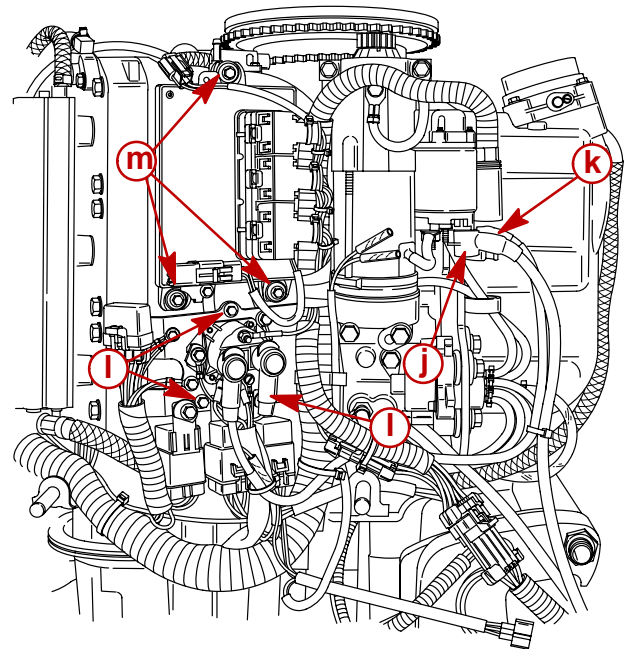


57489



57695

MODEL 2000



58426

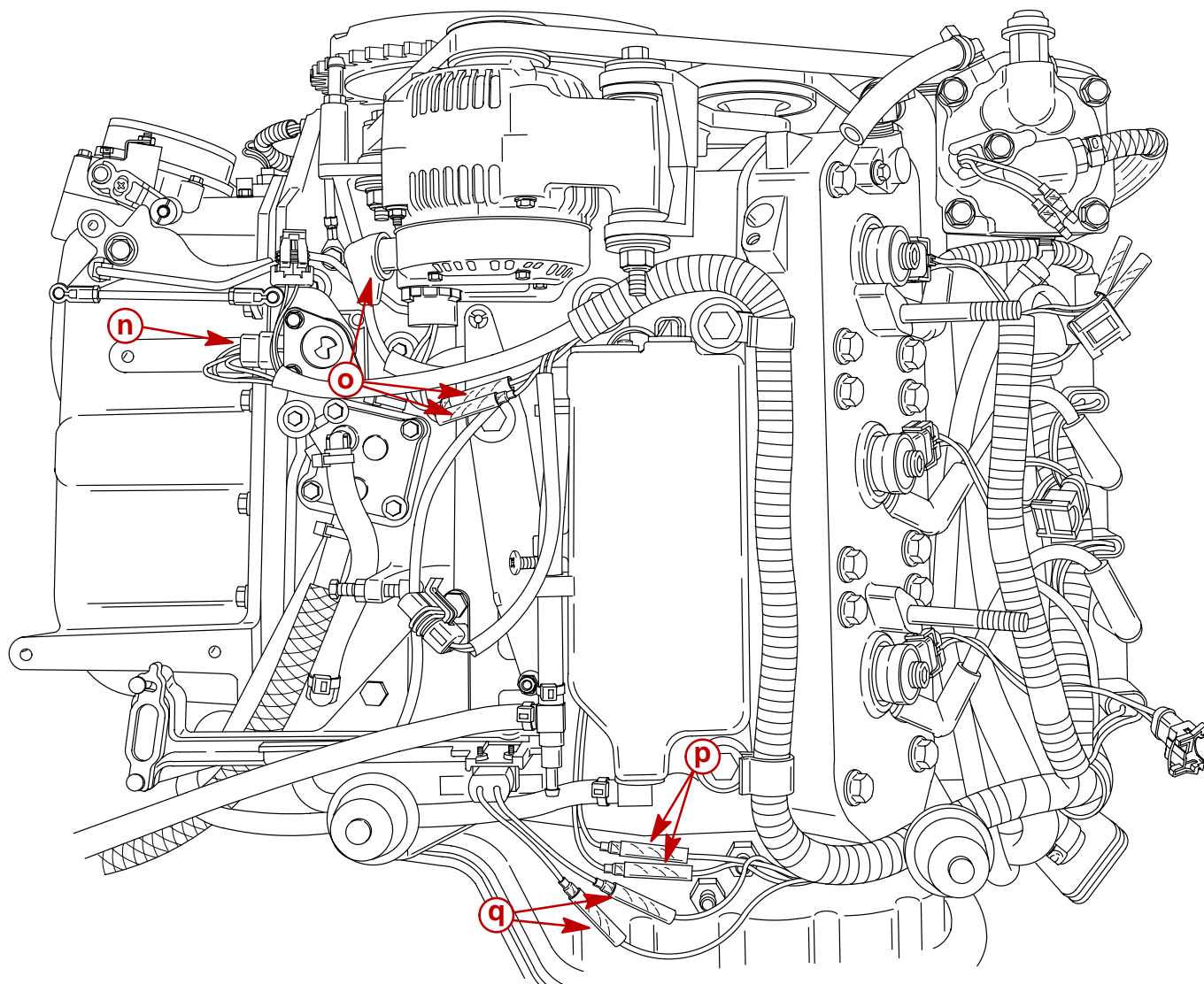
MODEL 2001

- e** - Disconnect Air Temperature Sensor
- f** - Disconnect MAP Sensor
- g** - Disconnect Crank Position Sensor
- h** - Disconnect Oil Pump Connector
- i** - Disconnect Trim Motor Wires (2)

- j** - Remove Positive (+) Battery Cable at Starter Solenoid
- k** - Remove Starter Motor Cable at Starter
- l** - Remove Electrical Plate Bolts (3)
- m** - Remove ECM Bolts (3)



ELECTRICAL PLATE AND HARNESS REMOVAL (CONTINUED)

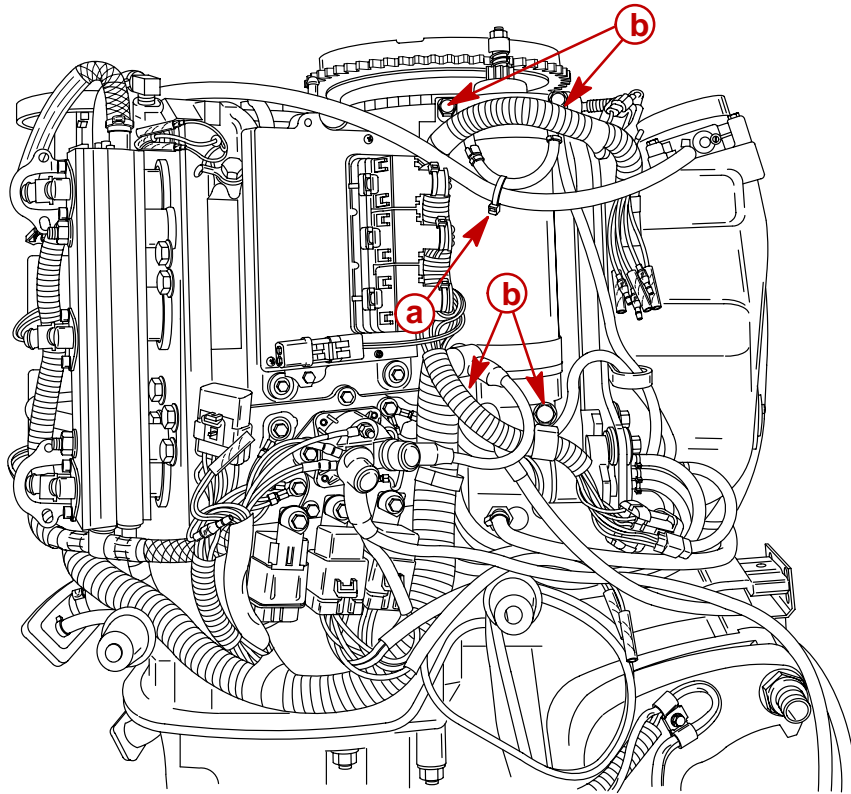


57697

- n** - Disconnect TPI Connector
- o** - Disconnect Alternator Leads (3)
- p** - Disconnect Oil Reservoir Float Sensor Leads
- q** - Disconnect Shift Switch Leads

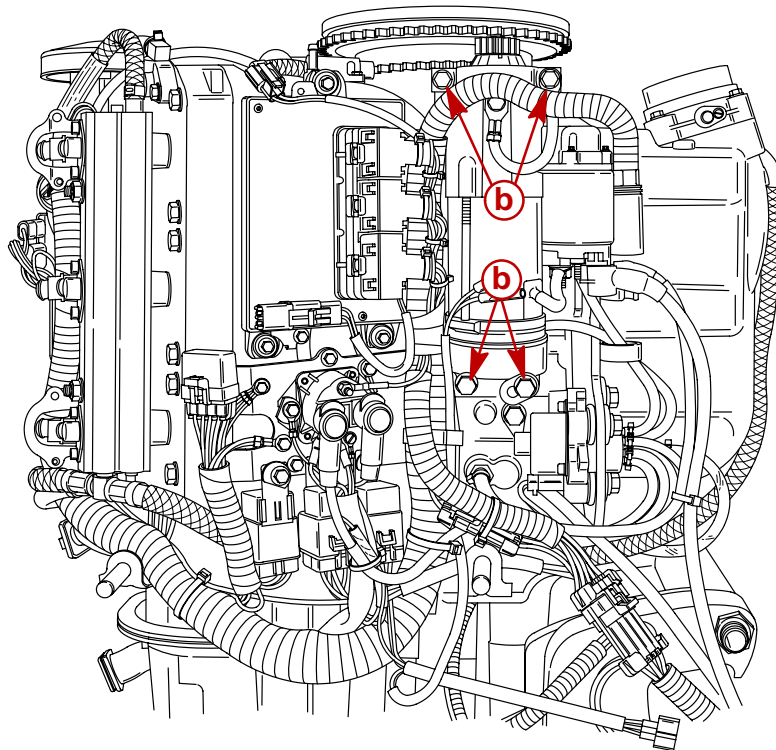


STARTER MOTOR REMOVAL



MODEL 2000

57490



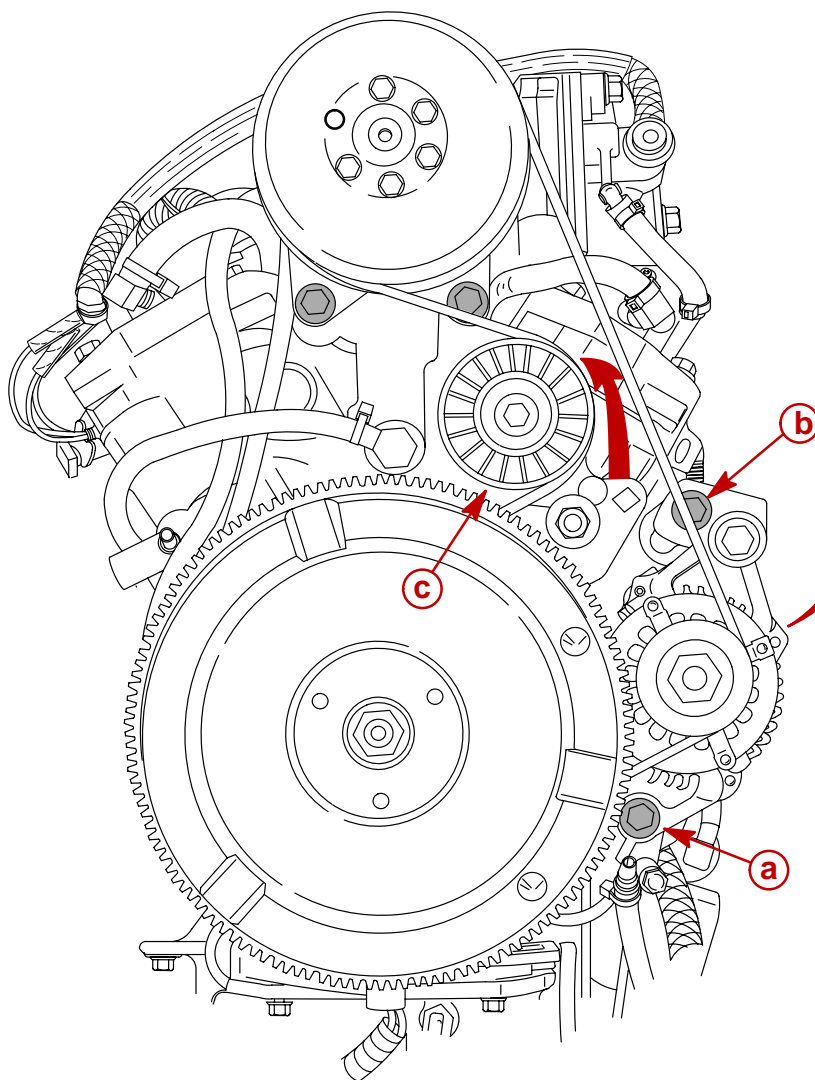
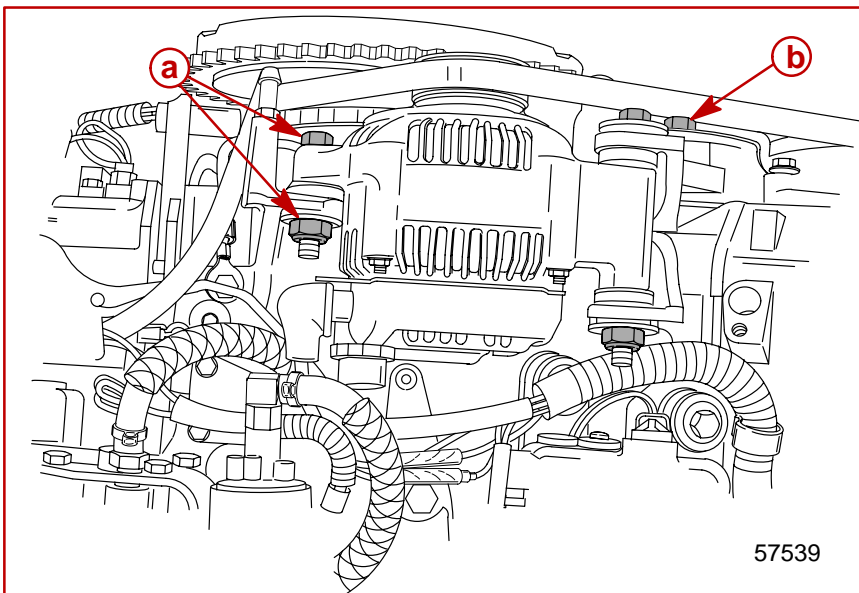
MODEL 2001

58426

- a** - Remove Sta-Strap
- b** - Remove 4 Bolts



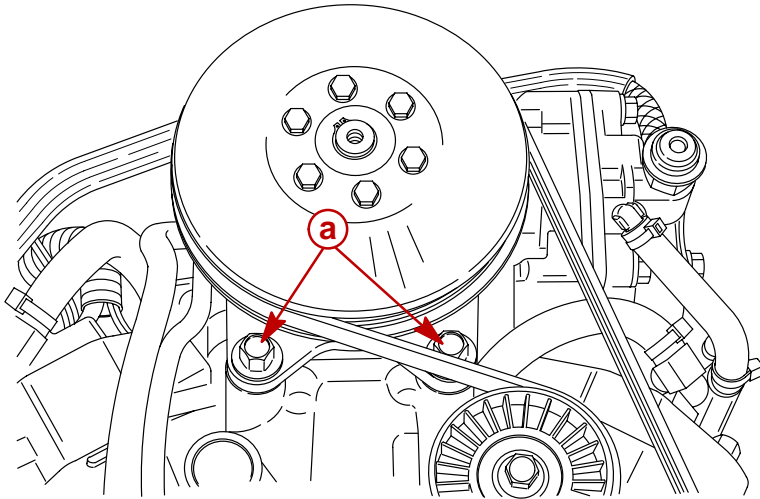
ALTERNATOR REMOVAL



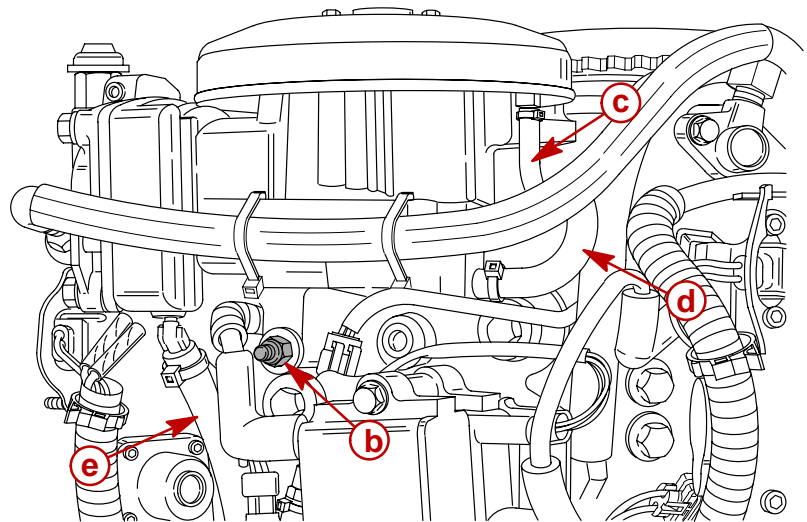
- a** - Remove Bolt and Nut
- b** - Remove Bolt
- c** - Rotate Belt Tensioner



AIR COMPRESSOR REMOVAL



57683

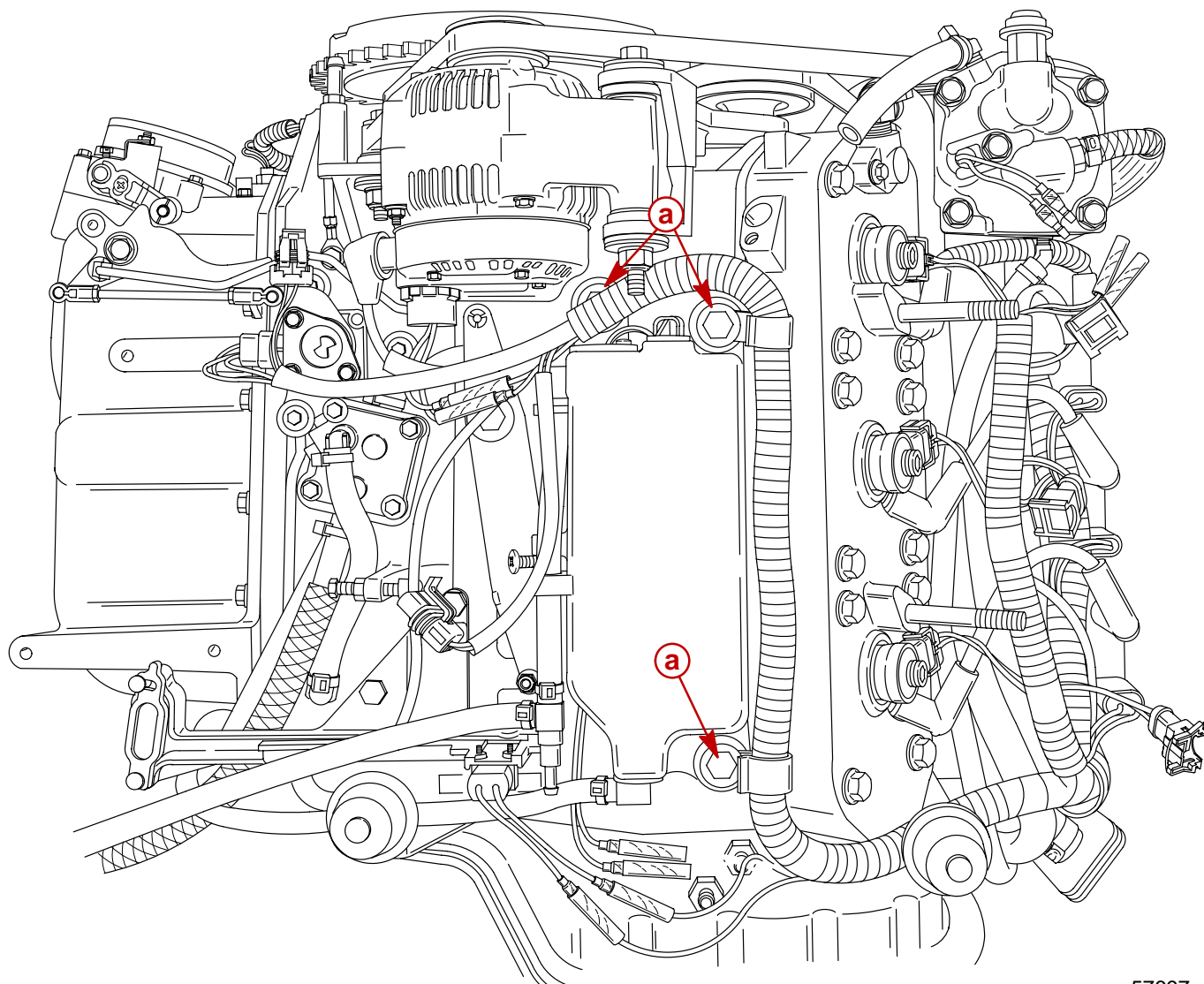


57542

- a** - Remove 2 Bolts (top)
- b** - Remove Nut
- c** - Remove Oil Input Hose
- d** - Remove Oil Return Hose(s)
- e** - Remove Water Out (tell-tale) Hose



OIL RESERVOIR REMOVAL

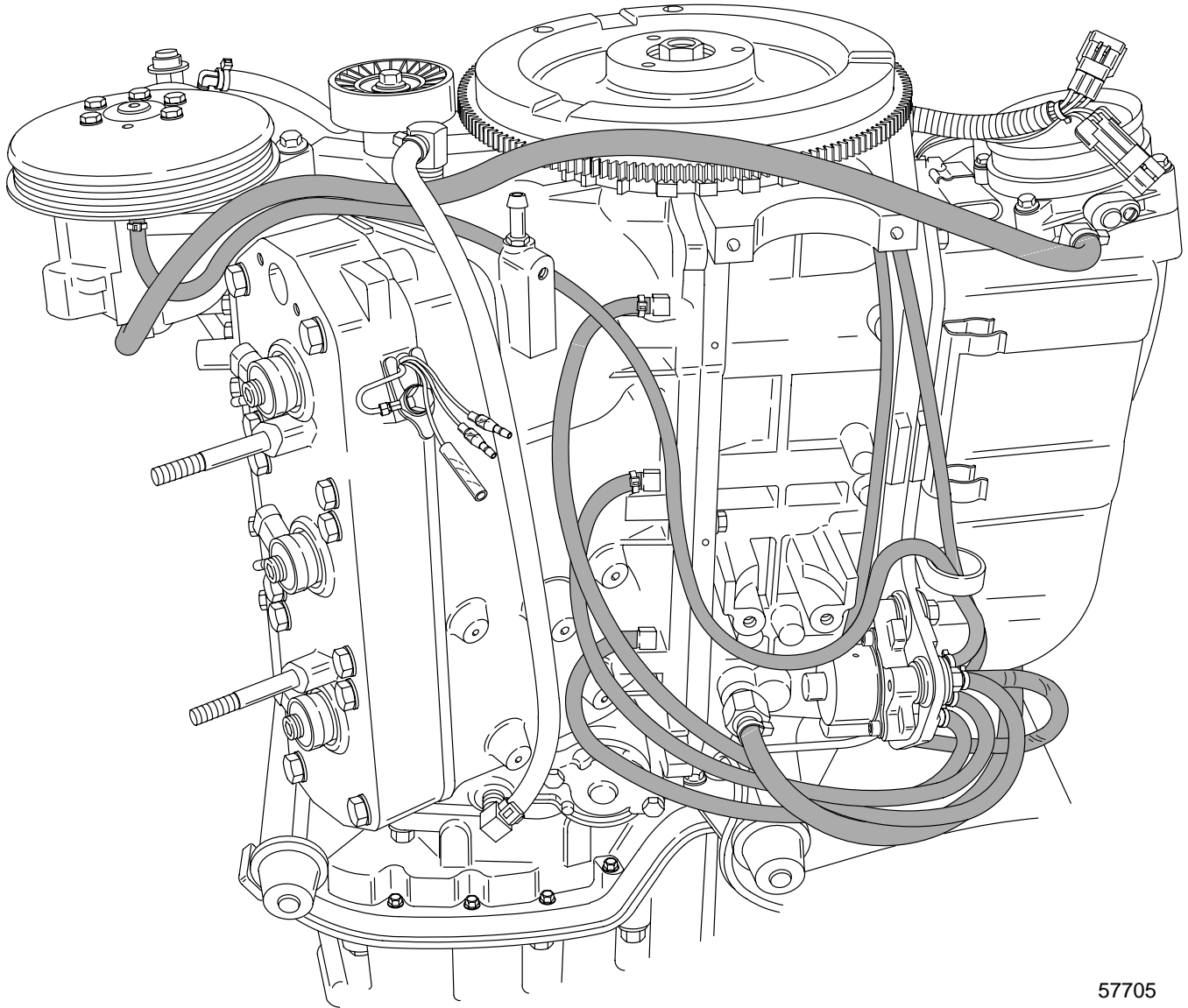


a - Remove 3 Bolts

57697



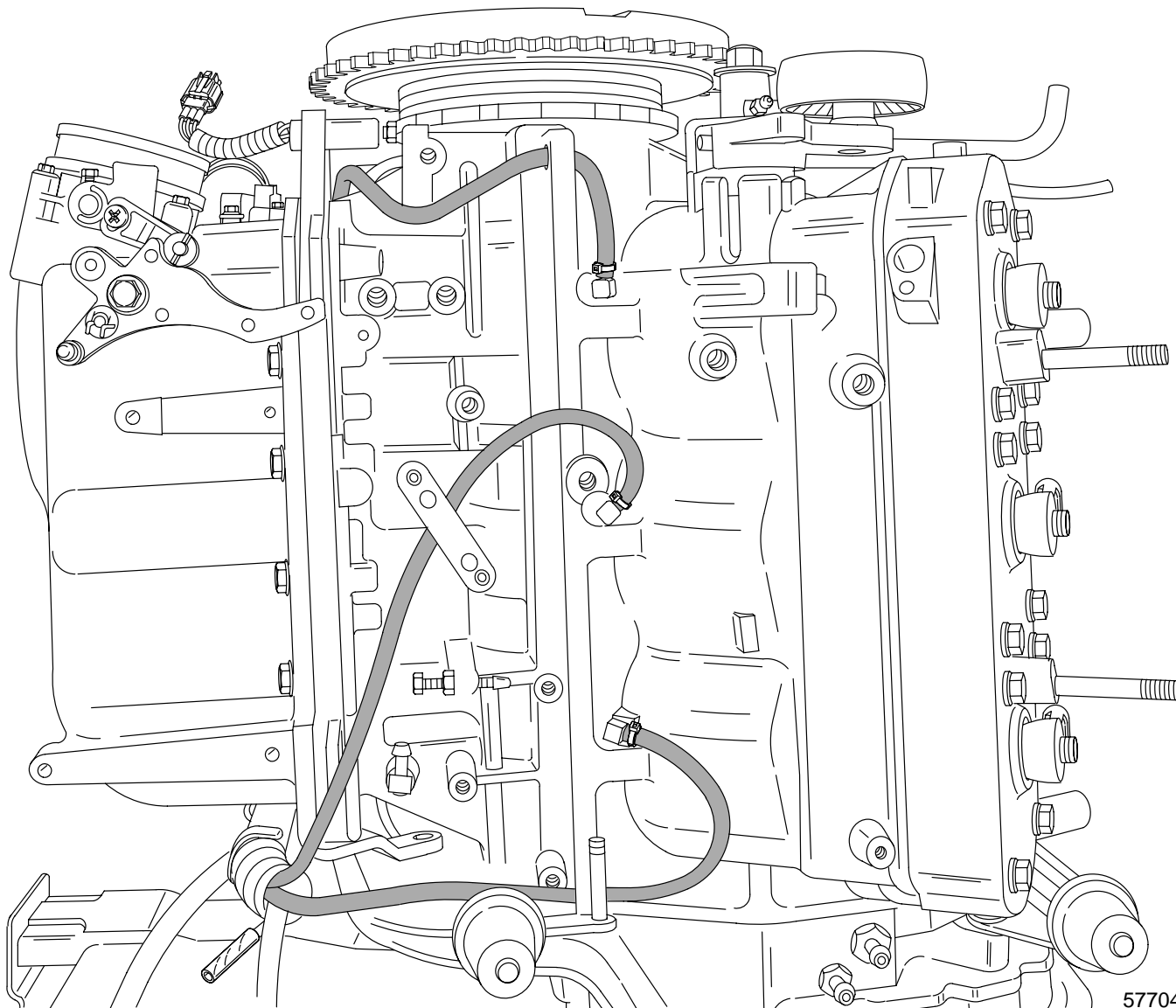
Model Year 2000 Starboard Side Oil Hose Routing



57705



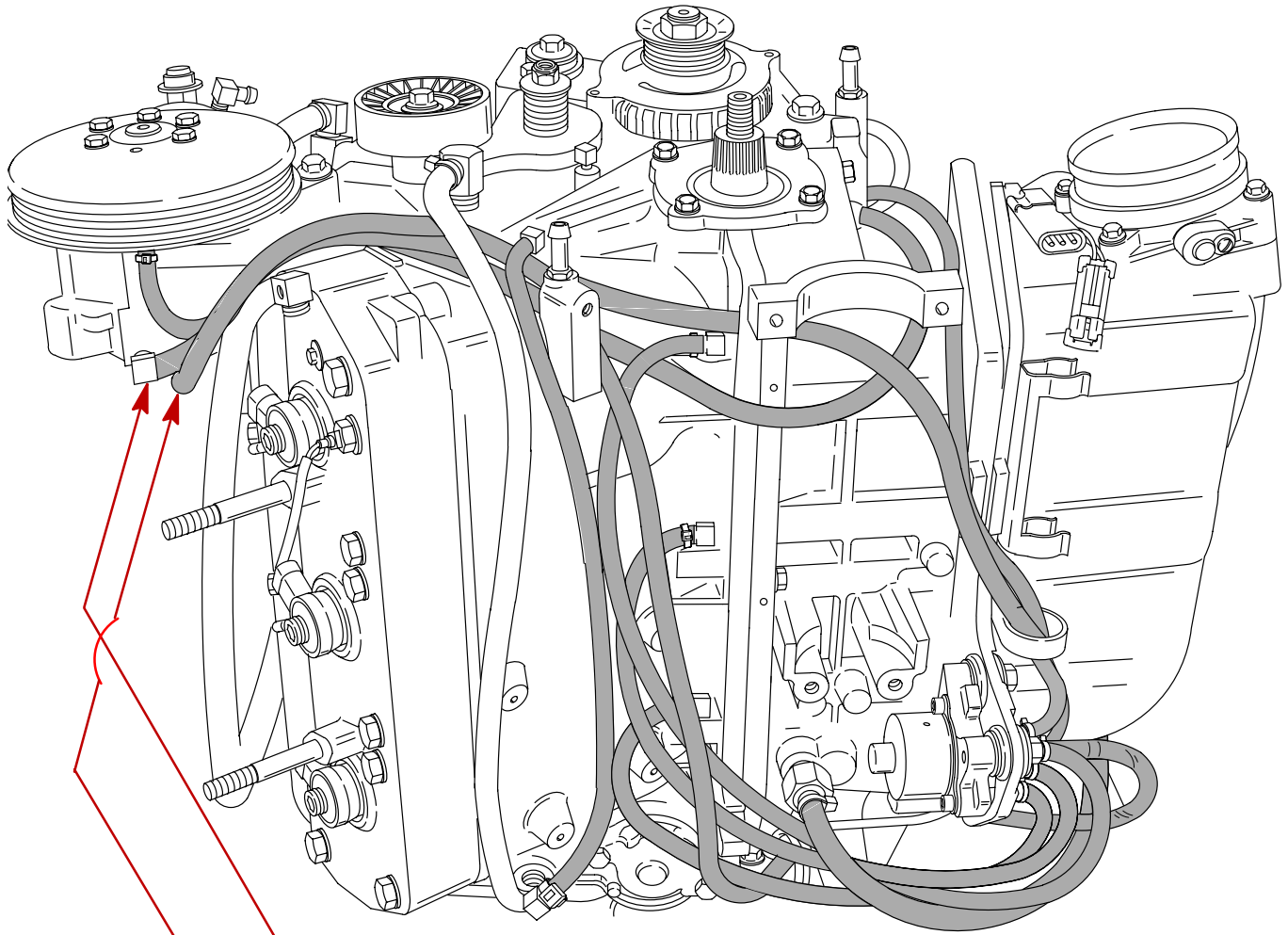
Model Year 2000 Port Side Oil Hose Routing



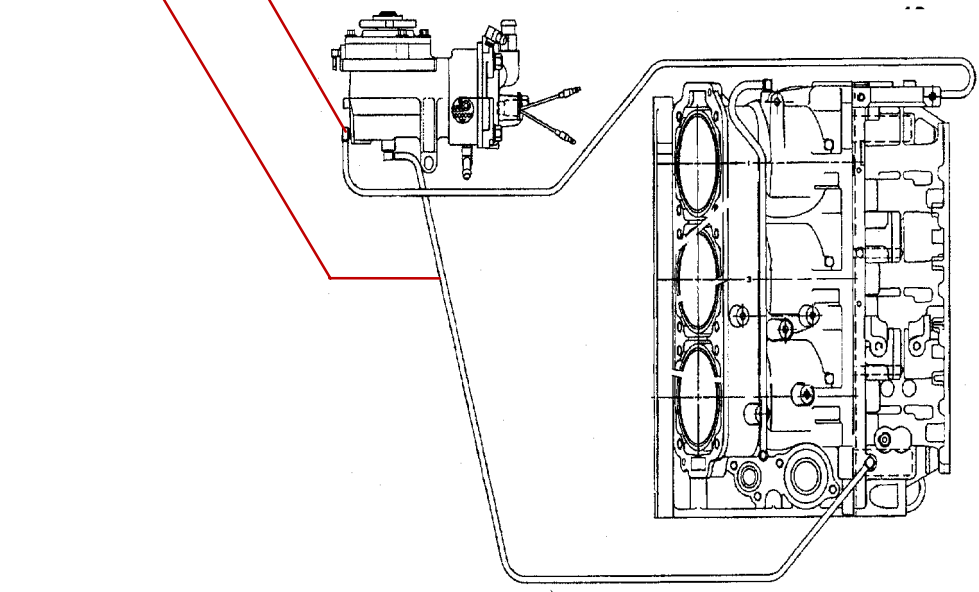
57704



Model Year 2001 Starboard Side Oil Hose Routing

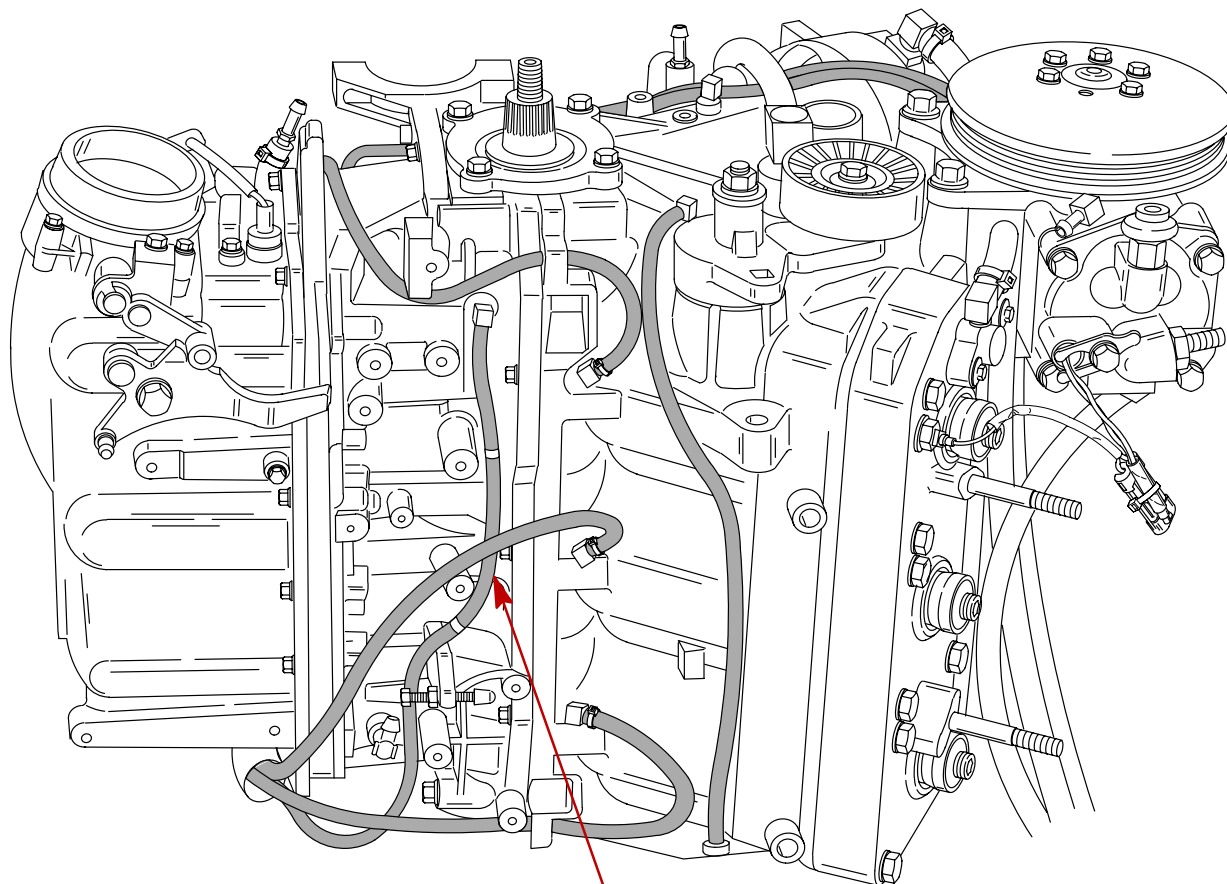


58422

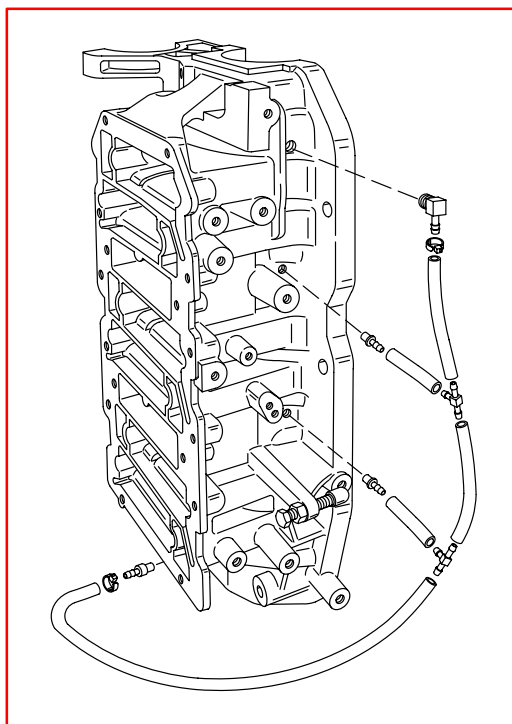




Model Year 2001 Port Side Oil Hose Routing



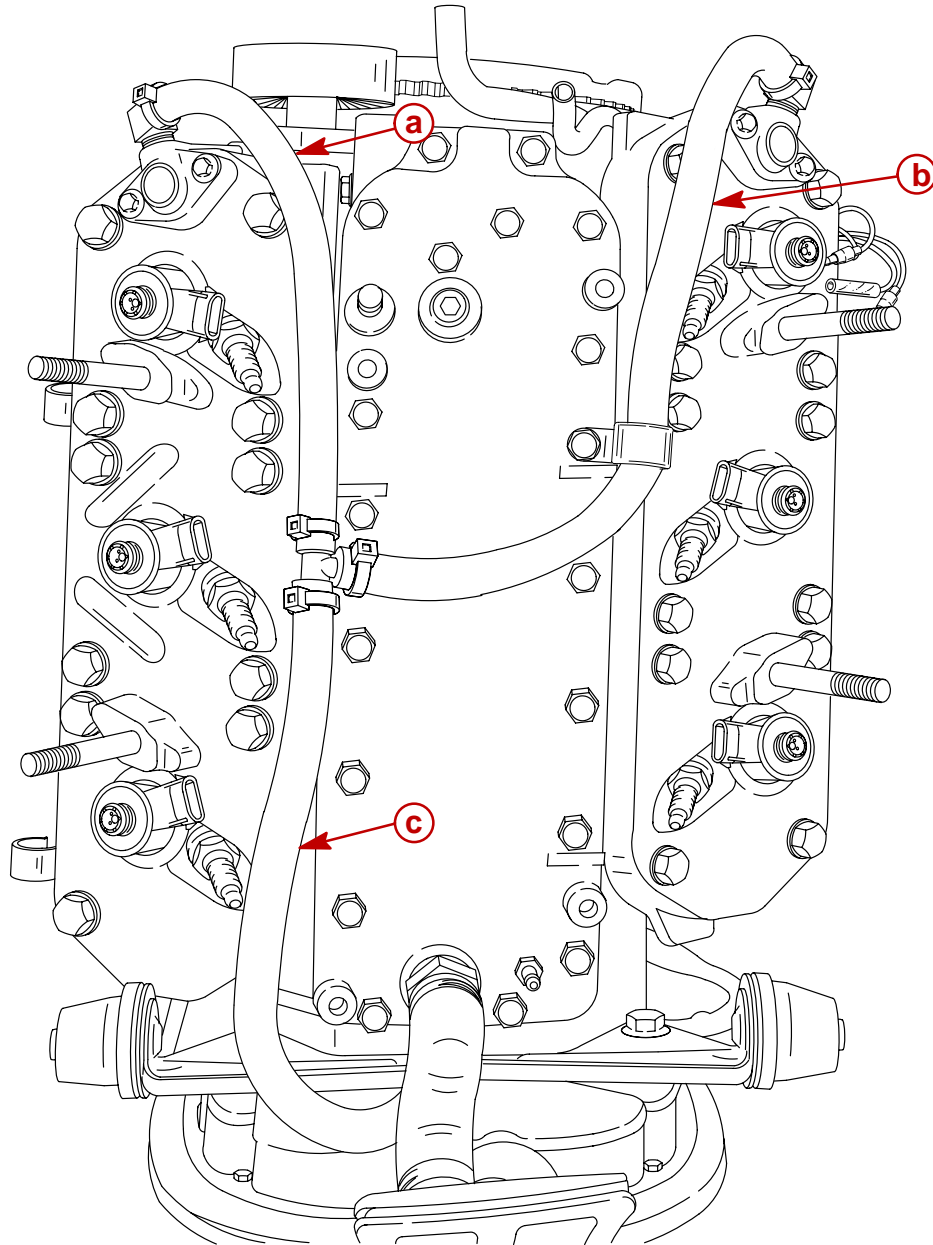
58309



58618



Thermostat Hose Routing



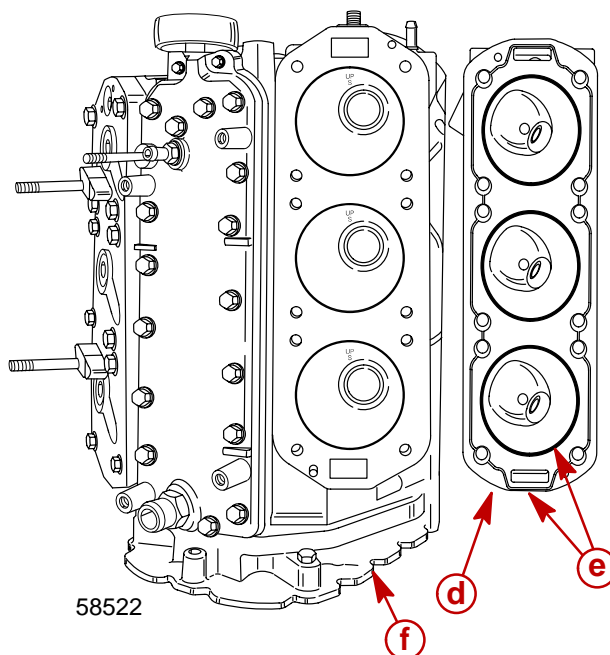
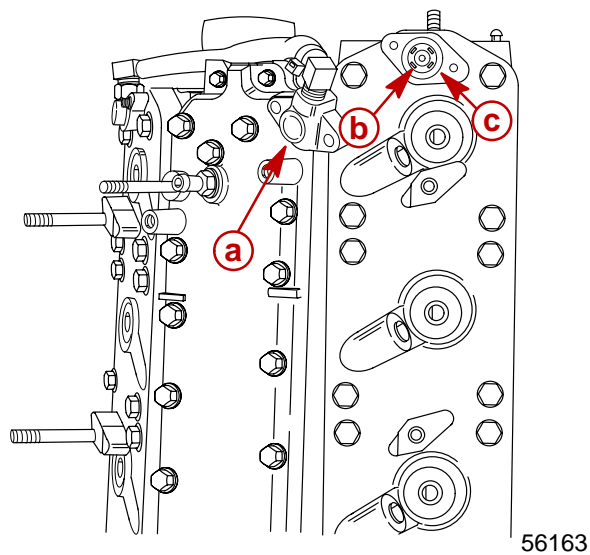
57702

- a** - Port Thermostat Hose
- b** - Starboard Thermostat Hose
- c** - To Exhaust Adaptor Plate



Powerhead Disassembly

1. Place powerhead in repair stand or on a bench.
2. Remove thermostat covers, thermostats and gaskets.
3. Remove cylinder heads from engine block.

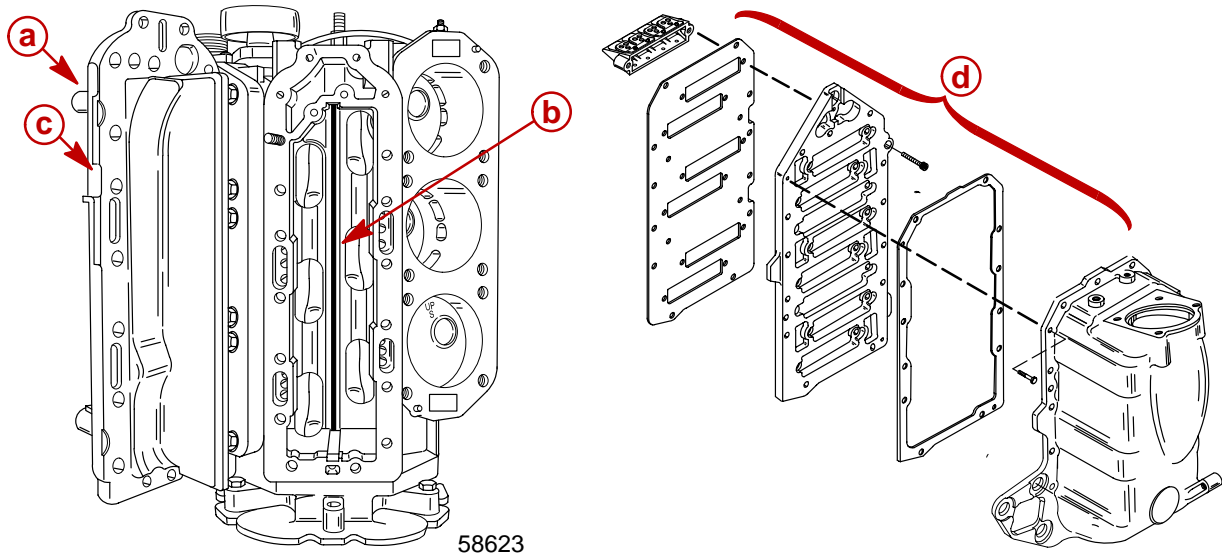


- a** - Thermostat Cover
- b** - Thermostat
- c** - Gasket

- d** - Cylinder Head
- e** - O-Rings
- f** - Engine Block

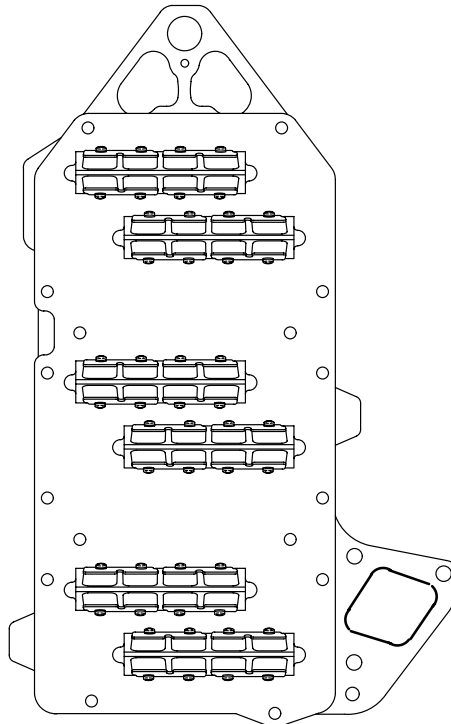


4. Remove exhaust manifold cover and seal.
5. Referring to Section 3B, remove air plenum/reed block/adaptor plate assembly from cylinder block.



- 58623
- a** - Exhaust Manifold Cover
 - b** - Seal
 - c** - Gasket
 - d** - Air Plenum/Reed Block/Adaptor Plate Assembly

6. Inspect reeds as outlined in "Cleaning and Inspection".

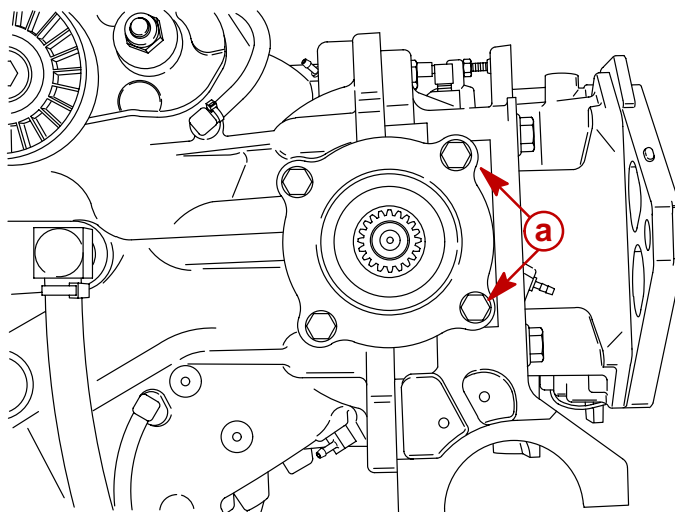


56169

7. Remove bolts from end caps.



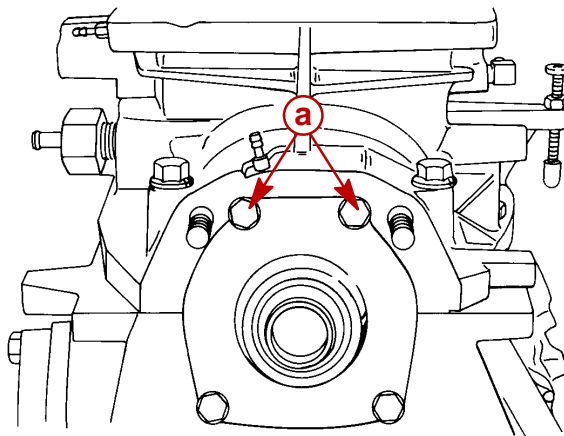
UPPER END CAP



a - Crankcase Attaching End Cap Bolts

58350

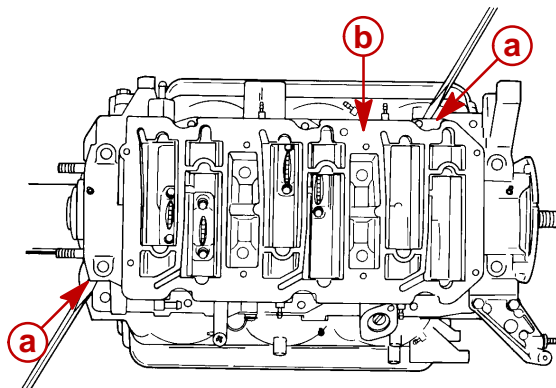
LOWER END CAP



a - Crankcase Attaching End Cap Bolts

51849

8. Remove bolts which secure crankcase cover to cylinder block.
9. Pry crankcase cover off cylinder block using pry bars in locations shown.

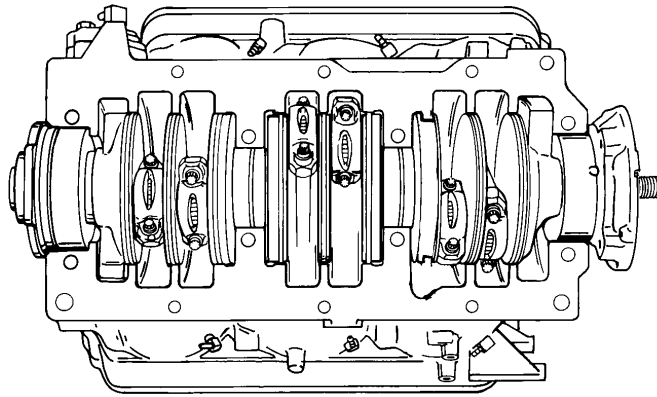


a - Pry Points
b - Crankcase Cover

51845

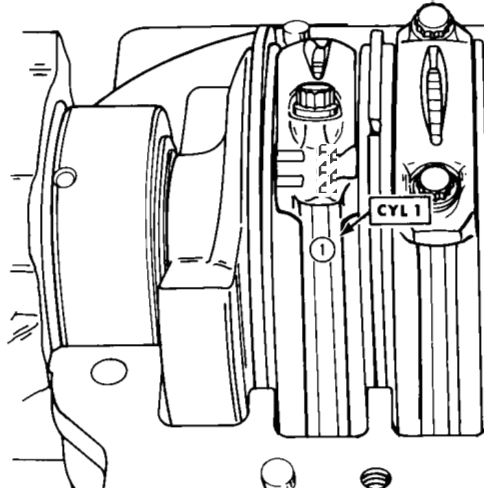


CRANKCASE COVER REMOVED



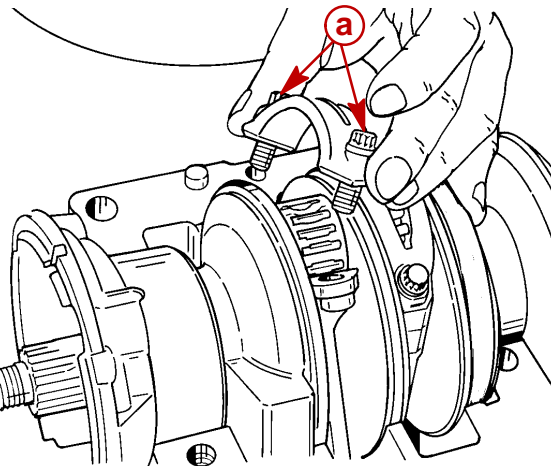
51848

1. Use Powerhead Stand (91-30591A1) for rotating crankshaft to desired position for removal of connecting rods.
2. Using an awl or electric pencil, scribe the cylinder identification number on each connecting rod as shown. Reassemble connecting rods in same cylinder.



51849

3. Use a 5/16 in. 12 point socket to remove connecting rod bolts, then remove rod cap, roller bearings and bearing cage from connecting rod.



51850

a - Connecting Rod Bolts

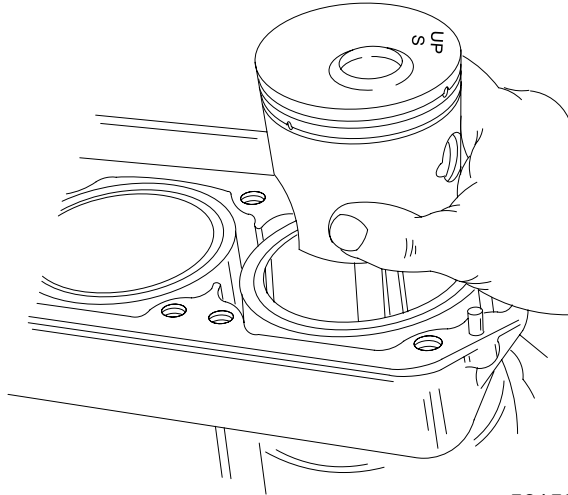
4. Push piston out of cylinder block.
5. After removal, reassemble each piston and connecting rod assembly.



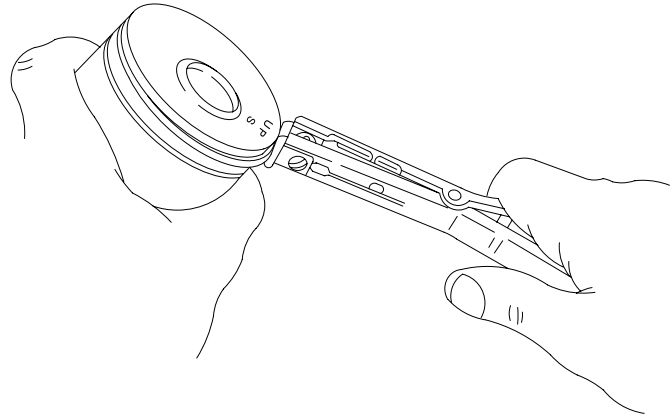
⚠ CAUTION

Each connecting rod and end cap are a matched machined set and must never be mismatched.

6. Inspect pistons as outlined in "Cleaning and Inspection," following.
7. Use Piston Ring Expander (91-24697) to remove piston rings. Always install new piston rings.

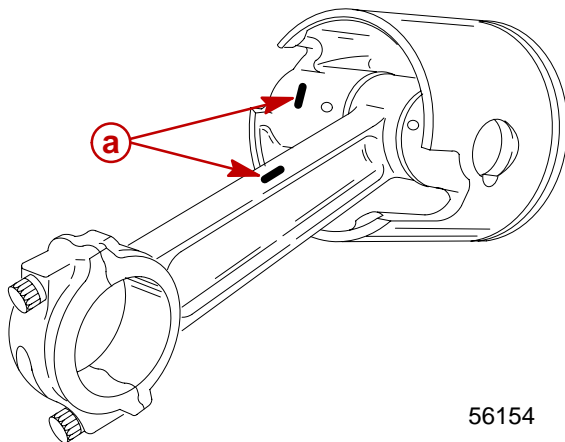


56153

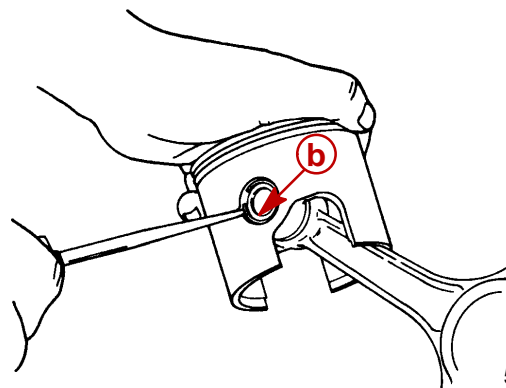


56155

8. Using an awl, scribe identification number of connecting rod on inside of piston. Reassemble piston on same connecting rod.
9. Using tool (91-52952A1), remove piston pin lockrings from both ends of piston pin. Never re-use piston pin lockrings.



56154



51083

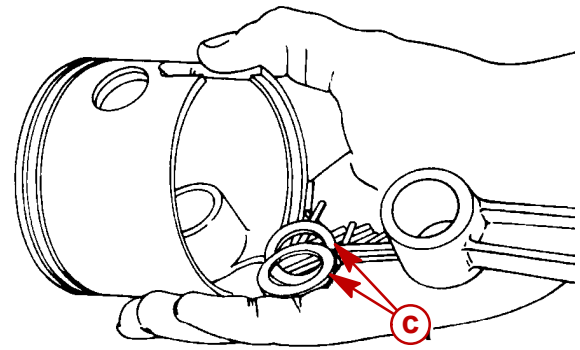
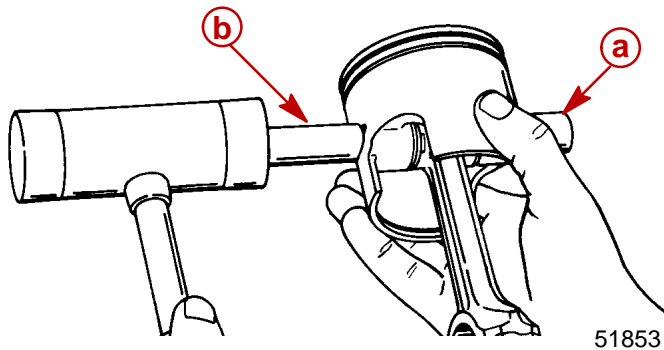
- a** - Scribe Identification Number
- b** - Lockring

IMPORTANT: Warming the piston dome using a torch lamp will ease removal and installation of piston pin.



10. Support piston and tap out piston pin using service tool [91-76159A1 (Model Year 2000) or [91-92973A1 (Model Year 2001)] as shown.
11. Remove piston pin needle bearings (29 per piston – Model Year 2000) (35 per piston – Model Year 2001) and locating washers (2 per piston) as shown.

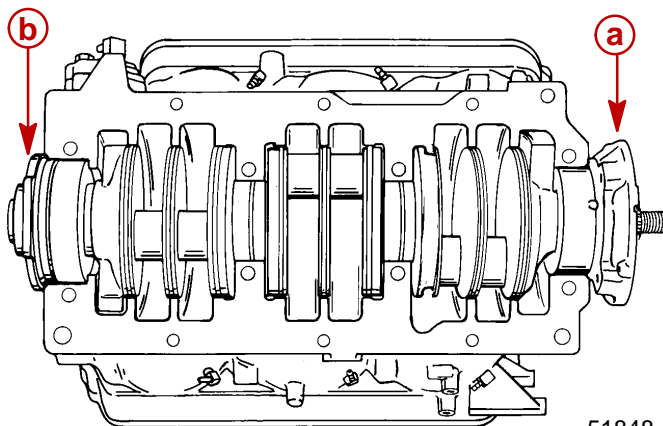
IMPORTANT: We recommend that you use new needle bearings at reassembly for lasting repair. However, if needle bearings must be re-used, keep each set of bearings identified for reassembly on same connecting rod.



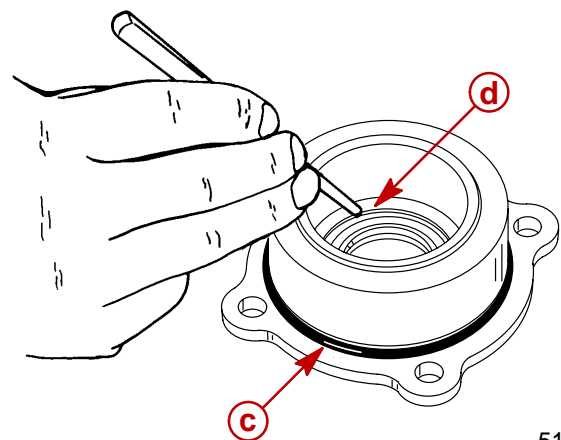
- a - Piston Pin
- b - Piston Pin Tool
- c - Needle Bearing Locating Washers

12. Remove upper end cap and lower end cap from crankshaft.
13. Remove and discard O-ring seals from each end cap.
14. Remove oil seal(s) from end of each end cap by driving seal out with a punch and hammer.
15. Inspect roller bearing in upper end cap as outlined in “Cleaning and Inspection”.

NOTE: If roller bearing is damaged, replace upper end cap and roller bearings as an assembly.



- a - Upper End Cap
- b - Lower End Cap



- c - O-Ring
- d - Seal



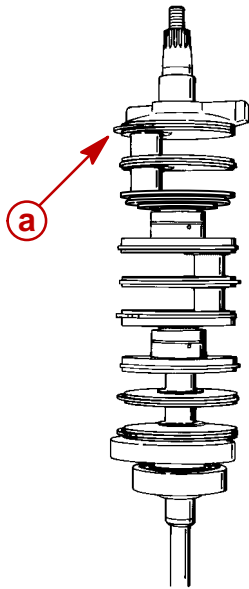
16. Remove crankshaft and place in powerhead stand as shown.

IMPORTANT: DO NOT remove crankshaft sealing rings from crankshaft, unless replacement of a sealing ring(s) is necessary. Usually, crankshaft sealing rings do not require replacement, unless broken.

CAUTION

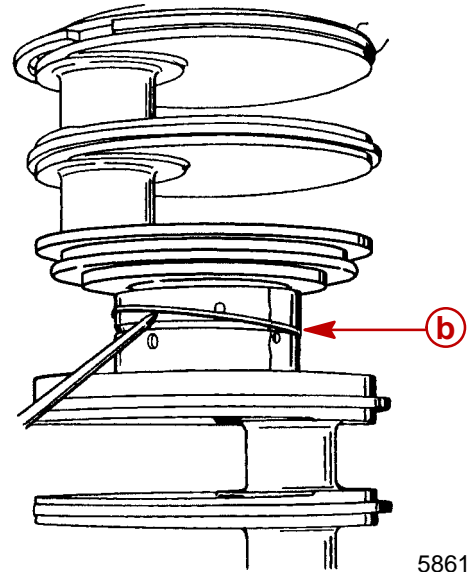
Safety glasses should be worn when removing or installing crankshaft sealing rings.

17. Remove retaining ring as shown.



58617

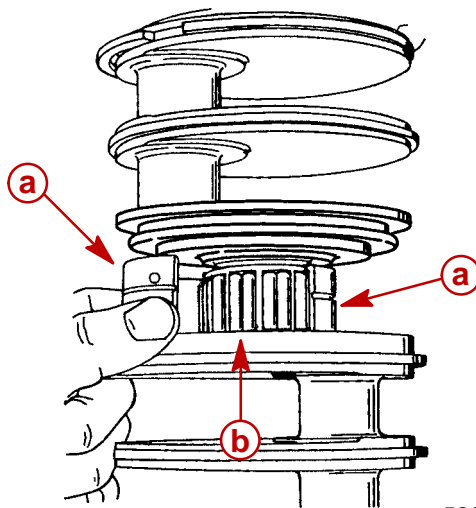
a - Sealing Rings
b - Retaining Ring



58619

18. Remove bearing race halves and roller bearings from crankshaft.

IMPORTANT: Keep same bearing races and roller bearings together.



58614

a - Bearing Race Halves
b - Roller Bearings

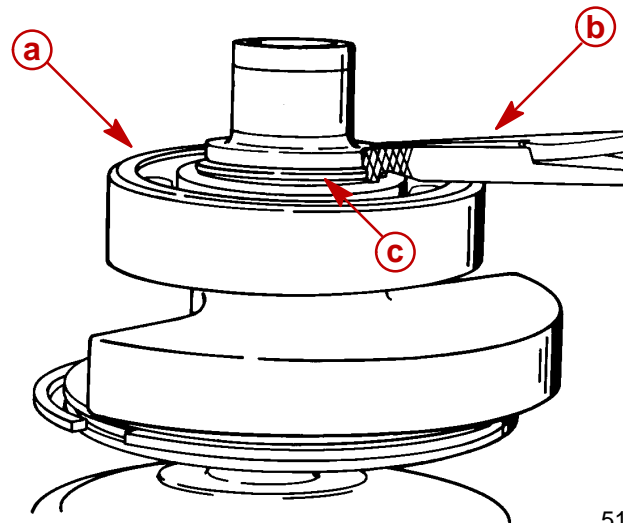


Inspect crankshaft ball bearing as outlined in "Cleaning and Inspection," following.

IMPORTANT: DO NOT remove crankshaft ball bearing, unless replacement is required.

19. Remove lower ball bearing from crankshaft as follows:

a. Remove retaining ring using a pair of snap ring pliers.



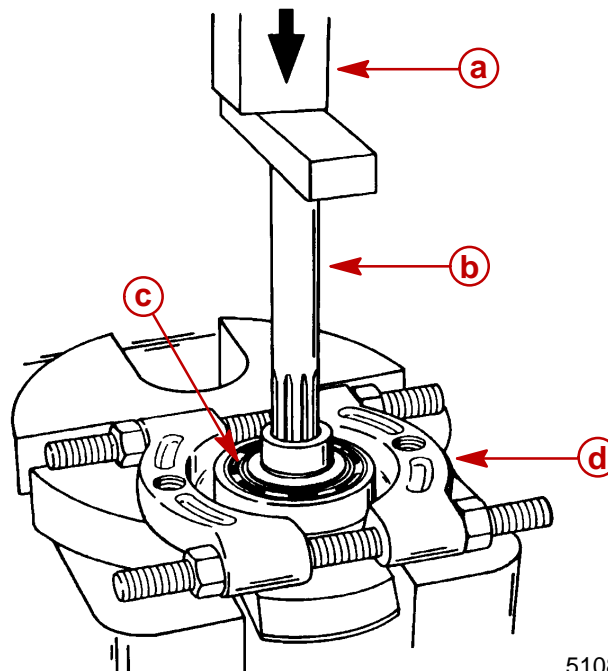
51854

a - Crankshaft Ball Bearing

b - Pliers

c - Retaining Ring

b. Press crankshaft out of lower ball bearing as shown.



51081

a - Press

b - Powerhead Stand (91-30591A1)

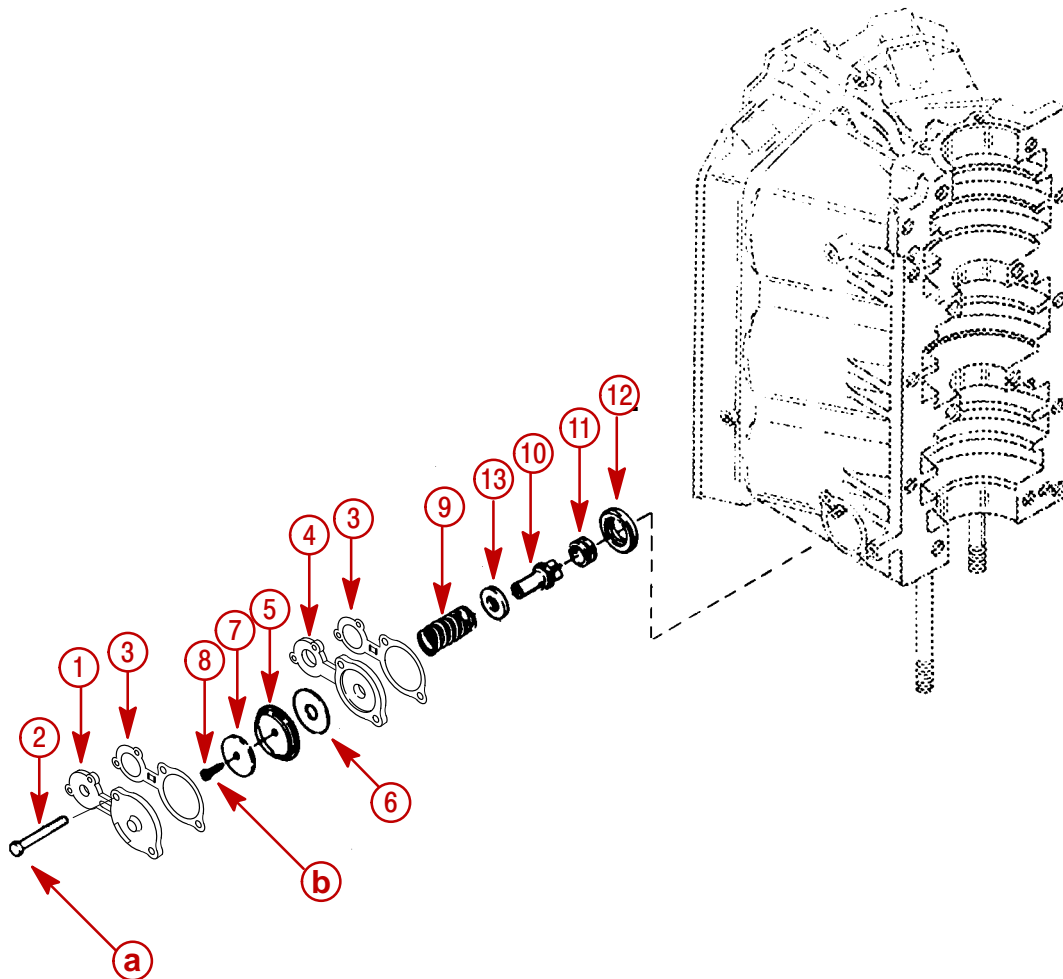
c - Crankshaft Ball Bearing

d - Universal Puller Plate (91-37241)



Water Pressure Relief Valve Components

1. If necessary, remove water pressure relief valve components as shown.



50803

- 1 - Cover
- 2 - Bolt
- 3 - Gasket
- 4 - Relief Valve Plate
- 5 - Diaphragm
- 6 - Water Deflector
- 7 - Washer
- 8 - Screw
- 9 - Spring
- 10 - Poppet Valve
- 11 - Grommet
- 12 - Carrier
- 13 - Washer

Torque Specifications

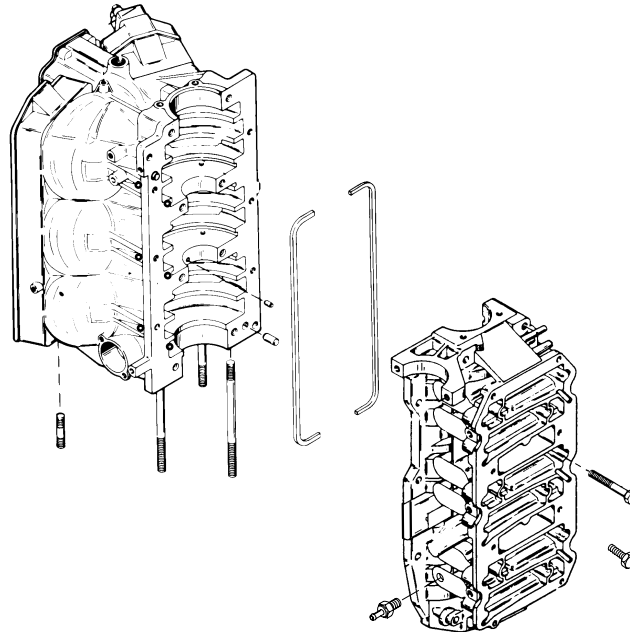
- a** 150 lb. in. (17 N·m)
- b** 25 lb. in. (3 N·m)



Cleaning and Inspection

Cylinder Block and Crankcase Cover

IMPORTANT: Crankcase cover and cylinder block are a matched, line-bored assembly and never should be mismatched by using a different crankcase cover or cylinder block.



CAUTION

If crankcase cover or cylinder block is to be submerged in a very strong cleaning solution, it will be necessary to remove the oil system to prevent damage to hoses and check valves.

1. Thoroughly clean cylinder block and crankcase cover. Be sure that all sealant and old gaskets are removed from matching surfaces. Be sure that carbon deposits are removed from exhaust ports.
2. Inspect cylinder block and crankcase cover for cracks or fractures.
3. Check gasket surfaces for nicks, deep grooves, cracks and distortion that could cause compression leakages.
4. Check all water and oil passages in cylinder block and crankcase cover to be sure that they are not obstructed and that plugs are in place and tight.

Special Service Information

Grooves in Cylinder Block Caused By Crankshaft Sealing Rings

Grooves in cylinder block caused by crankshaft sealing rings are not a problem, except if installing a new crankshaft and the new sealing rings on crankshaft do not line up with existing grooves in cylinder block. If installing a new crankshaft, refer to crankshaft installation, Powerhead Reassembly section to determine if powerhead can be used.



Cylinder Bores

1. Inspect cylinder bores for scoring, scuffing or a transfer of aluminum from piston to cylinder wall. Scoring or scuffing, if NOT TOO SEVERE, can normally be removed by honing. If a transfer of aluminum has occurred, an acidic solution such as "TIDY BOWL CLEANER" should be applied to the areas of the cylinder bore where transfer of aluminum has occurred. After the acidic solution has removed the transferred aluminum, thoroughly flush the cylinder bore(s) to remove any remaining acid. Cylinder walls may now be honed to remove any glaze and to aid in the seating of new piston rings.

HONING PROCEDURE

- a. When cylinders are to be honed, follow the hone manufacturer's recommendations for use of the hone and cleaning and lubrication during honing.
- b. For best results, a continuous flow of honing oil should be pumped into the work area. If pumping oil is not practical, use an oil can. Apply oil generously and frequently on both stones and work area.

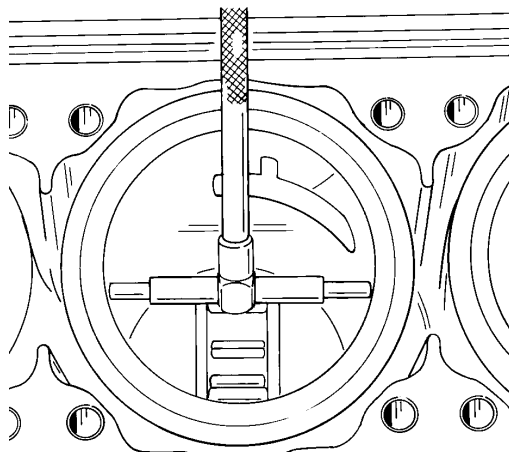
CAUTION

When honing cylinder block, remove hone frequently and check condition of cylinder walls. DO NOT hone any more than absolutely necessary, as hone can remove cylinder wall material rapidly.

- c. Start stroking at smallest diameter. Maintain firm stone pressure against cylinder wall to assure fast stock removal and accurate results.
 - d. Localize stroking in the smallest diameter until drill speed is constant throughout length of bore. Expand stones, as necessary, to compensate for stock removal and stone wear. Stroke at a rate of 30 complete cycles per minute to produce best cross-hatch pattern. Use honing oil generously.
 - e. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. A good cleaning is essential. If any of the abrasive material is allowed to remain in the cylinder bore, it will cause rapid wear of new piston rings and cylinder bore in addition to bearings. After cleaning, bores should be swabbed several times with engine oil and a clean cloth, then wiped with a clean, dry cloth. Cylinders **should not** be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.
2. Hone all cylinder walls **just enough** to de-glaze walls.



3. Measure cylinder bore diameter (with a snap gauge micrometer) of each cylinder, as shown below. Check for tapered, out-of-round (egg-shaped) and oversize bore.



51846

Models	Cylinder Block Finish Hone
Standard Piston Bore	3.501 in. (88.93mm)
.015 in. (0.381mm) Oversize Piston Bore	3.516 in. (89.31mm)

4. If a cylinder bore is tapered, out-of-round or worn more than 0.003 in. (0.076mm) from standard "Cylinder Block Finish Hone" diameter (refer to chart, preceding), it will be necessary to re-bore that cylinder(s) to 0.015 in. (0.381mm) oversize or re-sleeve and install oversize piston(s) and piston rings during reassembly.

NOTE: The weight of an oversize piston is approximately the same as a standard size piston; therefore, it is not necessary to re-bore all cylinders in a block just because one cylinder requires re-boring.

5. After honing and thoroughly cleaning cylinder bores, apply light oil to cylinder walls to prevent rusting .

Pistons and Piston Rings

IMPORTANT: If engine was submerged while engine was running, piston pin and/or connecting rod may be bent. If piston pin is bent, piston must be replaced. (Piston pins are not sold separately because of matched fit into piston.) If piston pin is bent, connecting rod must be checked for straightness (refer to "Connecting Rods," following, for checking straightness).

1. Inspect pistons for scoring and excessive piston skirt wear.
2. Check tightness of piston ring locating pins. Locating pins must be tight.
3. Thoroughly clean pistons. Carefully remove carbon deposits from pistons, with a soft wire brush or carbon remove solution. Do not burr or round off machined edges.

Inspect piston ring grooves for wear and carbon accumulation. If necessary, scrape carbon from piston ring grooves **being careful not to scratch sides of grooves**. Refer to procedure following for cleaning piston ring grooves.



CLEANING PISTON RING GROOVES

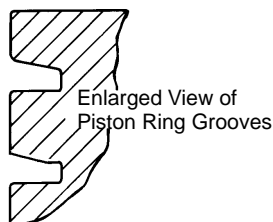
Keystone (tapered) ring grooves

⚠ CAUTION

Care must be taken not to scratch the side surfaces of the ring groove. Scratching the side surface of the ring groove will damage the ring groove.

1. Use a bristle brush and carbon remover solution to remove carbon from side surfaces.
2. A tool can be made for cleaning the inner diameter of the tapered ring grooves. The tool can be made from a broken tapered piston ring with the side taper removed to enable the inside edge of the ring to reach the inner diameter of the groove. Carefully scrape carbon from inner diameter of ring grooves. Care must be taken not to damage the grooves by scratching the side surfaces of the grooves.

Piston with two half keystone (half tapered) rings (135/150 Models)



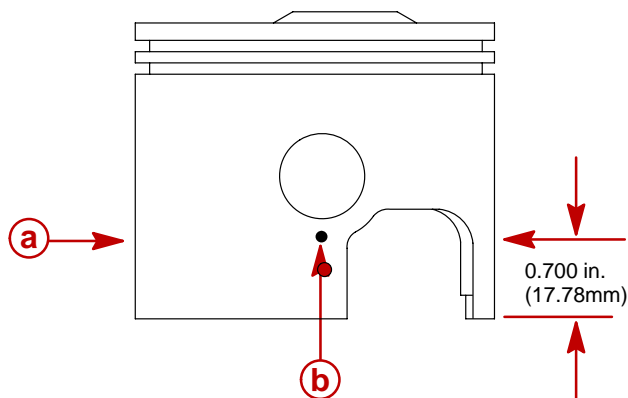
MEASURING PISTON ROUNDNESS

Piston has a barrel profile shape and is not a true diameter.

1. Using a micrometer, measure dimension "A" at location shown. Dimension "A" should be as indicated in chart following.

Piston	Dimension "A"
Standard Piston	3.4925 in. \pm 0.0005 in.
0.015 in. Oversize Piston	3.5075 in. \pm 0.0005 in.

2. Using a micrometer, measure dimension "B" at location shown. Dimension "B" should be within 0.008 in. of dimension "A."



- a** - Dimension "A" at RIGHT Angle (90°) to Piston Pin
b - Dimension "B" (in line with Piston Pin)



Cylinder Heads and Exhaust Divider Plate

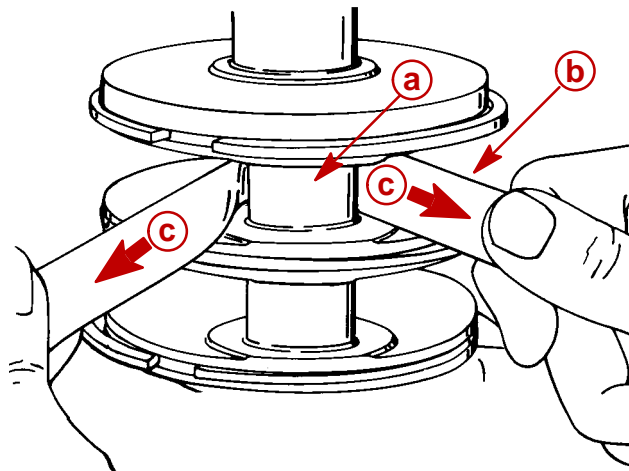
1. Inspect internal surface of cylinder heads for possible damage (as a result of piston or foreign material striking cylinder heads).

IMPORTANT: Cylinder head warpage should not exceed 0.004 in. (0.1 mm) over the ENTIRE length of the cylinder head. If measured warpage, as determined on a surface block, exceeds 0.004 in. (0.1 mm) or a discontinuity of up to 0.004 in. (0.1 mm) exists in a narrow portion of the cylinder head's surface length, then the cylinder head should be replaced. It is recommended that the cylinder head not be resurfaced as the o-ring groove depth in the head will be reduced resulting in possible cylinder leakage.

2. Replace cylinder head(s) as necessary.
3. Thoroughly clean gasket surfaces of exhaust divider plate.
4. Inspect exhaust divider plate for deep grooves, cracks or distortion that could cause leakage. Replace parts as necessary.

Crankshaft

1. Inspect crankshaft to drive shaft splines for wear. (Replace crankshaft, if necessary.)
2. Check crankshaft for straightness. Maximum runout is 0.006 in. (0.152 mm). (Replace as necessary.)
3. Inspect crankshaft oil seal surfaces. Sealing surfaces must not be grooved, pitted or scratched. (Replace as necessary.)
4. Check all crankshaft bearing surfaces for rust, water marks, chatter marks, uneven wear and/or overheating. (Refer to "Connecting Rods".)
5. If necessary, clean crankshaft surfaces with crocus cloth .



51847

- a - Crankshaft Journals
- b - Crocus Cloth
- c - Work Cloth "Back-and-Forth"

⚠ WARNING

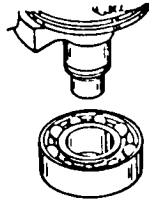
DO NOT spin-dry crankshaft ball bearing with compressed air.

6. Thoroughly clean (with solvent) and dry crankshaft and crankshaft ball bearing. Re-check surfaces of crankshaft. Replace crankshaft, if surfaces cannot be properly "cleaned up." If crankshaft will be re-used, lubricate surfaces of crankshaft with light oil to prevent rust. DO NOT lubricate crankshaft ball bearing at this time.



Crankshaft (and End Cap) Bearings

1. After cleaning crankshaft, grasp outer race of crankshaft ball bearing (installed on lower end of crankshaft) and attempt to work race back-and-forth. There should not be excessive play.
2. Lubricate ball bearing with light oil. Rotate outer bearing race. Bearing should have smooth action and no rust stains. If ball bearing sounds or feels "rough" or has "catches," remove and discard bearing. (Refer to "Powerhead Removal and Disassembly - Crankshaft Removal and Disassembly").



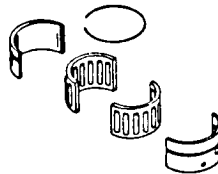
Lower Ball Bearing

3. Thoroughly clean (with solvent) and dry crankshaft center main roller bearings. Lubricate bearings with 2-Cycle Outboard Oil.

CAUTION

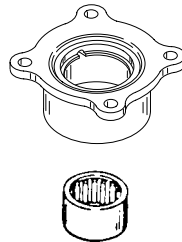
DO NOT intermix halves of upper and lower crankshaft center main roller bearings. Replace bearings in pairs only.

4. Thoroughly inspect center main roller bearings. Replace bearings if they are rusted, fractured, worn, galled or badly discolored.



Center Main Roller Bearing

5. Clean (with solvent) and dry crankshaft roller bearing that is installed in upper end cap. Lubricate bearing with light oil.
6. Thoroughly inspect upper end cap roller bearing. If roller bearing is rusted, fractured, worn, galled, badly discolored or loose inside of end cap replace end cap and roller bearing as an assembly.



Upper Roller Bearing

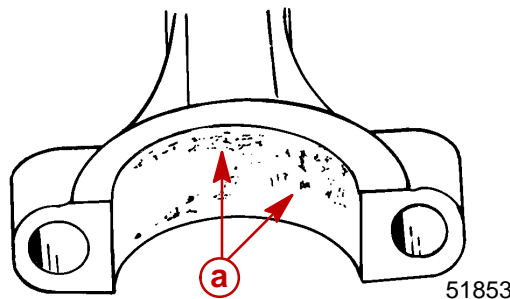


End Bearing Bleed System

1. Check rubber bleed hoses. Replace any hose that is cracked, cut or deteriorating.
2. Check operation of lower end cap check valve. If valve is working properly, air can be drawn thru check valve “one way” only. If air can pass thru a check valve both ways, valve is not working properly and must be replaced.

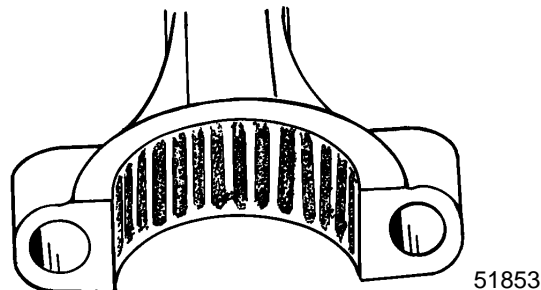
Connecting Rods

1. Check connecting rods for alignment by placing rods on a surface plate. If light can be seen under any portion of machined surfaces, if rod has a slight wobble on plate, or if a 0.002 in. (0.051 mm) feeler gauge can be inserted between any machined surface and surface plate, rod is bent and must be discarded.
2. **Overheating:** Overheating is visible as a bluish bearing surface color that is caused by inadequate lubrication or excessive RPM.
3. **Rust:** Rust formation on bearing surfaces causes uneven pitting of surface(s).

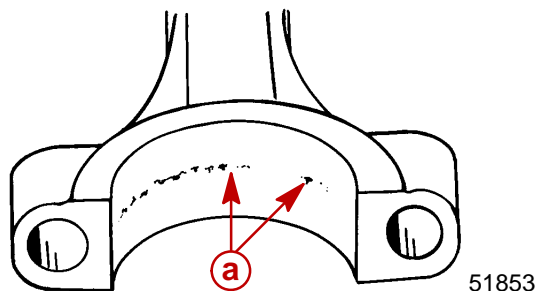


a - Pitting

4. **Water Marks:** When bearing surfaces are subjected to water contamination, a bearing surface “etching” occurs. This etching resembles the size of the bearing.



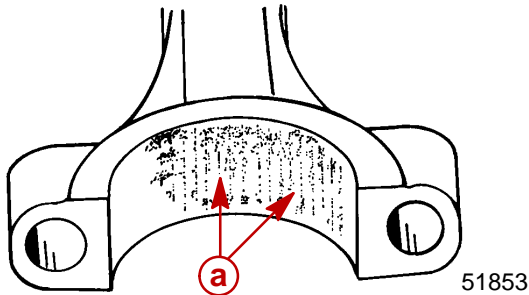
5. **Spalling:** Spalling is the loss of bearing surface, and it resembles flaking or chipping. Spalling will be most evident on the thrust portion of the connecting rod in line with the “I” beam. General bearing surface deterioration could be caused by or accelerated by improper lubrication.



a - Spalling

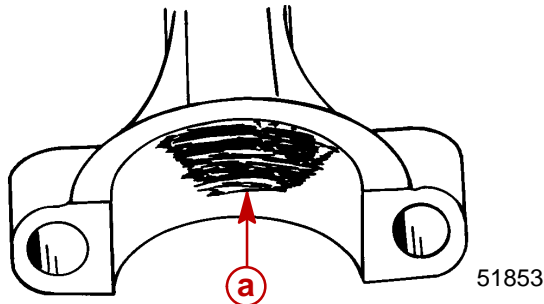


6. **Chatter Marks:** Chatter marks are the result of a combination of low speed - low load - cold water temperature operation, aggravated by inadequate lubrication and/or improper fuel. Under these conditions, the crankshaft journal is hammered by the connecting rod. As ignition occurs in the cylinder, the piston pushes the connecting rod with tremendous force, and this force is transferred to the connecting rod journal. Since there is little or no load on the crankshaft, it bounces away from the connecting rod. The crankshaft then remains immobile for a split second until the piston travel causes the connecting rod to catch up to the waiting crankshaft journal, then hammers it. The repetition of this action causes a rough bearing surface(s) which resembles a tiny washboard. In some instances, the connecting rod crank pin bore becomes highly polished. During operation, the engine will emit a “whirr” and/or “chirp” sound when it is accelerated rapidly from idle speed to approximately 1500 RPM, then quickly returned to idle. If the preceding conditions are found, replace both the crankshaft and connecting rod(s).



a - Chatter Marks Between Arrows

7. **Uneven Wear:** Uneven wear could be caused by a bent connecting rod.



a - Uneven Wear Between Arrows

8. If necessary, clean connecting rod bearing surfaces, as follows:
- Be sure that “etched” marks on connecting rod (crankshaft end) are perfectly aligned with “etched” marks on connecting rod cap. Tighten connecting rod cap attaching bolts securely.

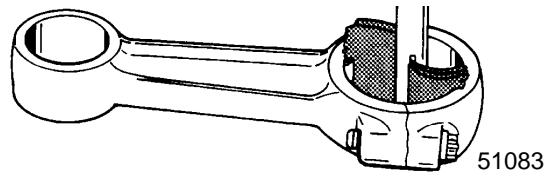
⚠ CAUTION

Crocus cloth MUST BE USED to clean bearing surface at crankshaft end of connecting rod. DO NOT use any other type of abrasive cloth.

- Clean CRANKSHAFT END of connecting rod by using CROCUS CLOTH** placed in a slotted 3/8 in. (9.5 mm) diameter shaft, as shown. Chuck shaft in a drill press and operation press at high speed while keeping connecting rod at a 90° angle to slotted shaft.



IMPORTANT: Clean connecting rod just enough to clean up bearing surfaces. DO NOT continue to clean after marks are removed from bearing surfaces.

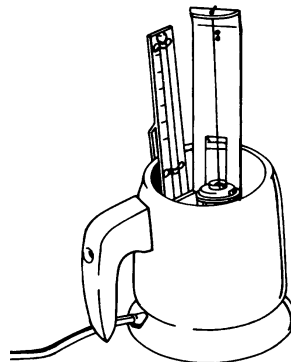


- c. **Clean PISTON PIN END of connecting rod**, using same method as in Step “b”, preceding, but using 320 grit carborundum cloth instead of crocus cloth.
- d. Thoroughly wash connecting rods to remove abrasive grit. Recheck bearing surfaces of connecting rods. Replace any connecting rod(s) that cannot be properly “cleaned up.” Lubricate bearing surfaces of connecting rods (which will be re-used) with light oil to prevent rust.

Thermostats

1. Inspect thermostat covers and cylinder head covers (thermostat opening) for cracks and corrosion damage that could cause leakage. Replace parts as necessary.
2. Remove and discard gasket from each thermostat.
3. Wash thermostats with clean water.
4. Using a thermostat tester, similar to the one shown, test each thermostat as follows:
 - a. Open thermostat valve, then insert a thread between valve and thermostat body. Allow valve to close against thread.
 - b. Suspend thermostat (from thread) and thermometer inside tester so that neither touches the container. Bottom of thermometer must be even with bottom of thermostat to obtain correct temperature of thermostat opening.
 - c. Fill thermostat tester with water to cover thermostat.
 - d. Plug tester into electrical outlet.
 - e. Observe temperature at which thermostat begins to open. (Thermostat will drop off thread, that was installed in Step “a”, when it starts to open.) Thermostat must begin to open when temperature reaches 140°-145° F (60°-63° C).
 - f. Continue to heat water until thermostat is completely open.
 - g. Unplug thermostat tester.
 - h. Replace thermostat, if it fails to open at the specified temperature, or if it does not fully open.

NOTE: BE SURE that water in thermostat tester is allowed to cool sufficiently [below 130° F (56° C)] before testing the other thermostat.



51087



Powerhead Reassembly and Installation

General

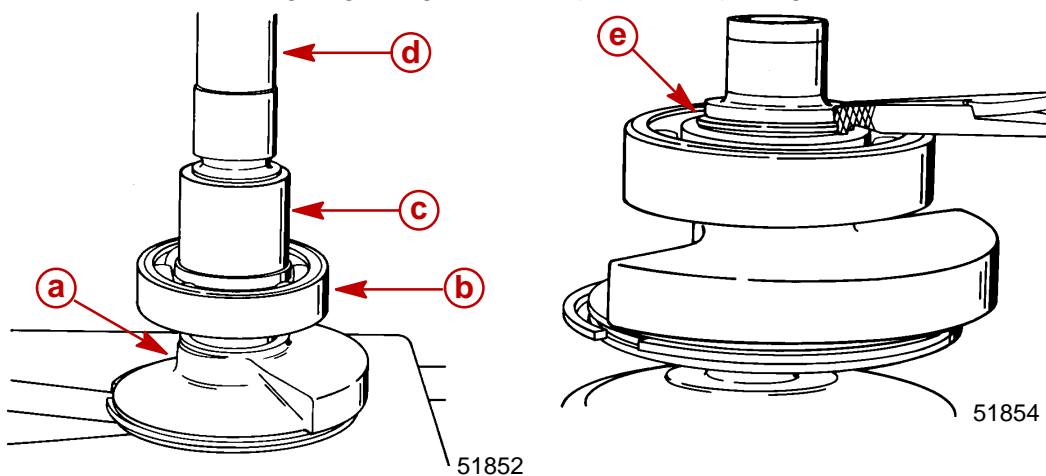
Before proceeding with powerhead reassembly, be sure that all parts to be re-used have been carefully cleaned and thoroughly inspected, as outlined in "Cleaning and Inspection," preceding. Parts, which have not been properly cleaned (or which are questionable), can severely damage an otherwise perfectly good powerhead within the first few minutes of operation. All new powerhead gaskets **MUST BE** installed during reassembly.

During reassembly, lubricate parts with Quicksilver 2-Cycle Outboard Lubricant whenever "light oil" is specified. Quicksilver part numbers of lubricants, sealers and locking compounds and tools are listed in "Powerhead General Information," preceding.

A torque wrench is **essential** for correct reassembly of powerhead. **DO NOT** attempt to reassemble powerhead without using a torque wrench. Attaching bolts for covers, housings and cylinder heads **MUST BE** torqued by tightening bolts in 3 progressive steps (following specified torque sequence) until specified torque is reached (see "Example," following).

EXAMPLE: If cylinder head attaching bolts require a torque of 30 lb. ft. (41 N·m), a) tighten all bolts to **10 lb. ft. (13.5 N·m)**, following specified torque sequence, b) tighten all bolts to **20 lb. ft. (27 N·m)**, following torque sequence, then finally c) tighten all bolts to **30 lb. ft. (41 N·m)**, following torque sequence.

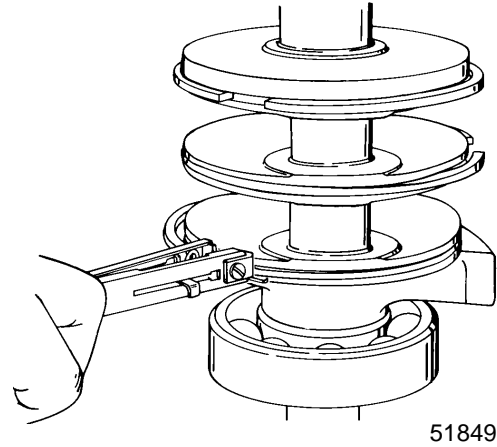
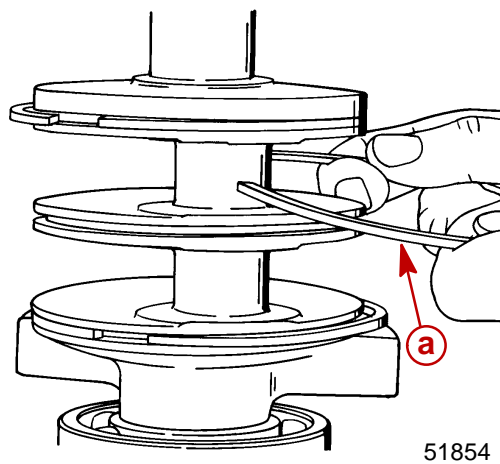
1. If removed, press lower crankshaft ball bearing onto crankshaft as shown. Be sure bearing is pressed firmly against counterweight.
2. Reinstall retaining ring using a suitable pair of Snap Ring Pliers.



- a - Crankshaft
- b - Crankshaft Ball Bearing
- c - Suitable Mandrel
- d - Press
- e - Retaining Ring

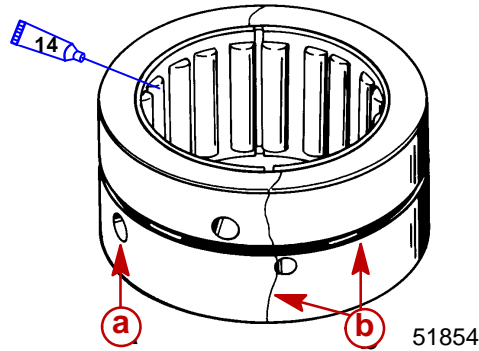


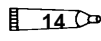
3. If removed, spread new crankshaft sealing rings just enough to slide over crankshaft journal.
4. Use Piston Ring Expander (91-24697) and install crankshaft sealing rings into groove.



a - Crankshaft Sealing Rings

5. Lubricate center main crankshaft roller bearings and races with light oil.

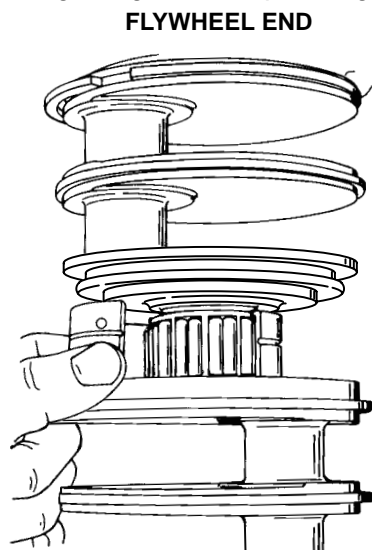


 14 2 Cycle Outboard Oil (92-826666A24)

- a** - Install so LARGER of the 3 holes is toward DRIVE SHAFT end of crankshaft
- b** - Verify retaining ring bridges the separating lines of the bearing race



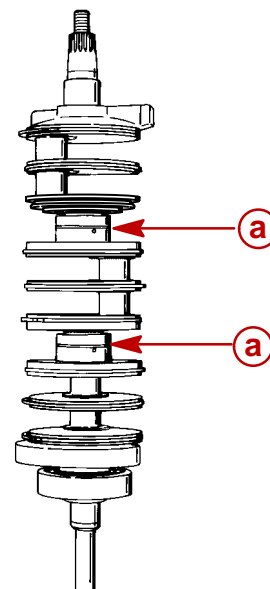
6. Place center main crankshaft roller bearings on upper and lower main bearing journals as shown.
7. Install center main bearing races as shown.
8. Secure center main bearing races together with retaining rings. Make sure retaining ring bridges the separating lines of the bearing race.



DRIVE SHAFT END

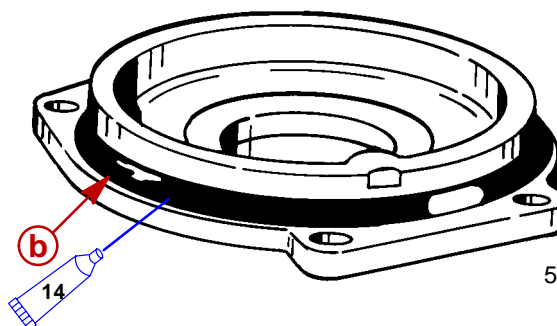
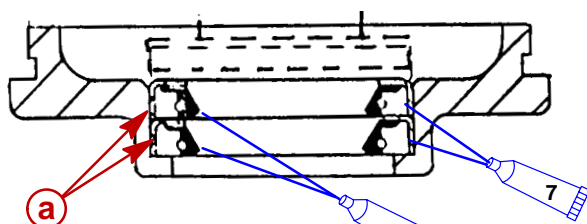
58614

a - Center Main Bearing Races

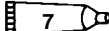
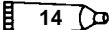
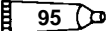


58617

9. Install oil seals into lower end cap as follows:
 - a. Apply a thin bead of Loctite 271 to outer diameter on 2 lower end cap oil seals (a).
 - b. Using driver head (91-55919) press one oil seal (lip facing down) into lower end cap until firmly seated. Remove any excess Loctite.
 - c. Press second oil seal (lip facing down) until firmly seated on first oil seal. Remove any excess Loctite.
 - d. Lubricate oil seal lips with Quicksilver 2-4-C w/Teflon (92-825407A12).
 - e. Lubricate O-ring seal surface on end cap with 2 cycle oil. Install o-ring over lower end cap.



51849

-  Loctite 271 (92-809820)
-  2 Cycle Outboard Oil (92-826666A24)
-  2-4-C With Teflon (92-825407A12)

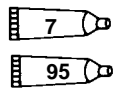
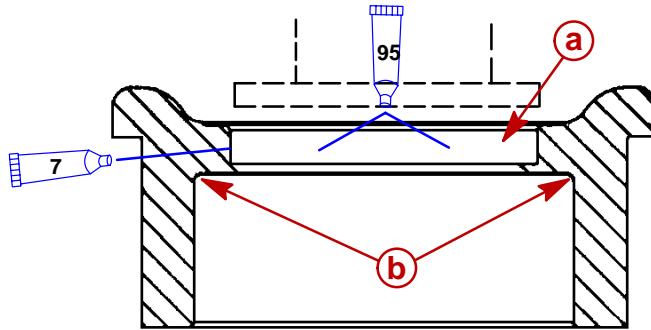
a - Oil Seal

b - O-ring



10. Install oil seal into upper end cap as follows:

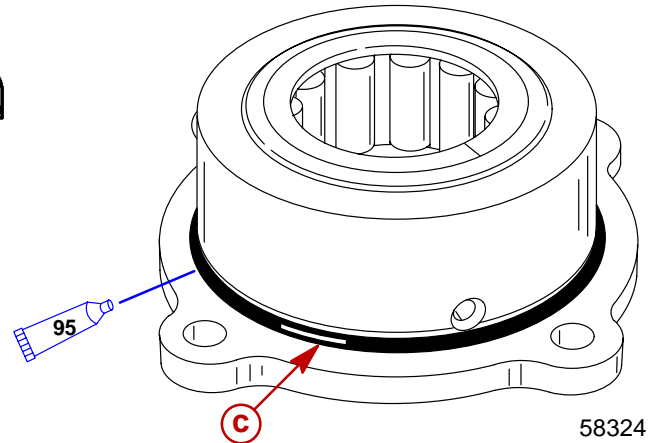
- a. Apply a thin bead of Loctite 271 to outer diameter of upper end cap oil seal.
- b. Use a suitable mandrel, press oil seal into upper end cap (lip facing down) until bottomed out on lip of end cap. Remove any excess Loctite.
- c. Lubricate oil seal lip with Quicksilver 2-4-C w/Teflon (92-825407A12).
- d. Lubricate O-ring seal surface on end cap with Quicksilver 2-4-C w/Teflon (92-825407A12). Install O-ring on end cap.



Loctite 271 (92-809820)

2-4-C With Teflon (92-825407A12)

a - Oil Seal
b - Lip of End Cap



c - O-ring

58324

Crankshaft Installation

SPECIAL INFORMATION

Installing A New Crankshaft Assembly Into Cylinder Block

Check the crankshaft sealing ring mating surfaces in the cylinder block and crankcase cover for wear grooves that were caused by the crankshaft sealing rings from the previous crankshaft. If wear grooves are present, the sealing rings on the new crankshaft will have to fit into the grooves without binding the crankshaft.

Before installing crankshaft, remove any burrs that may exist on groove edges.

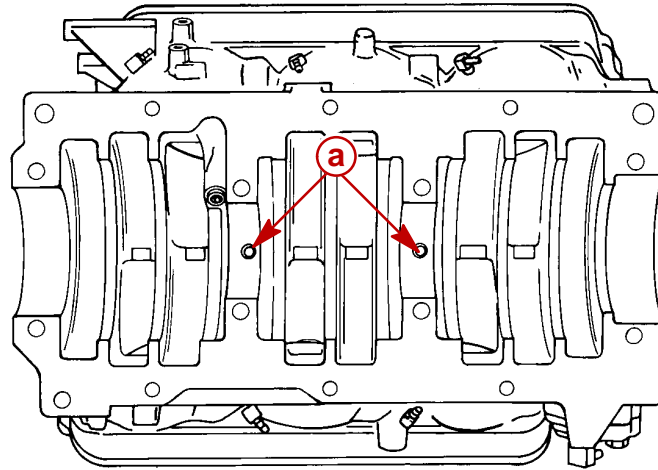
Lubricate sealing rings with light oil and install new crankshaft as instructed.

Install upper and lower end caps and then inspect fit between sealing rings and grooves. Temporarily install crankcase cover and rotate crankshaft several times to check if sealing rings are binding against crankshaft. (You will feel a drag on the crankshaft.) If sealing rings are binding, recheck grooves for burrs. If this does not correct the problem, it is recommended that the cylinder block be replaced.



Install crankshaft as follows:

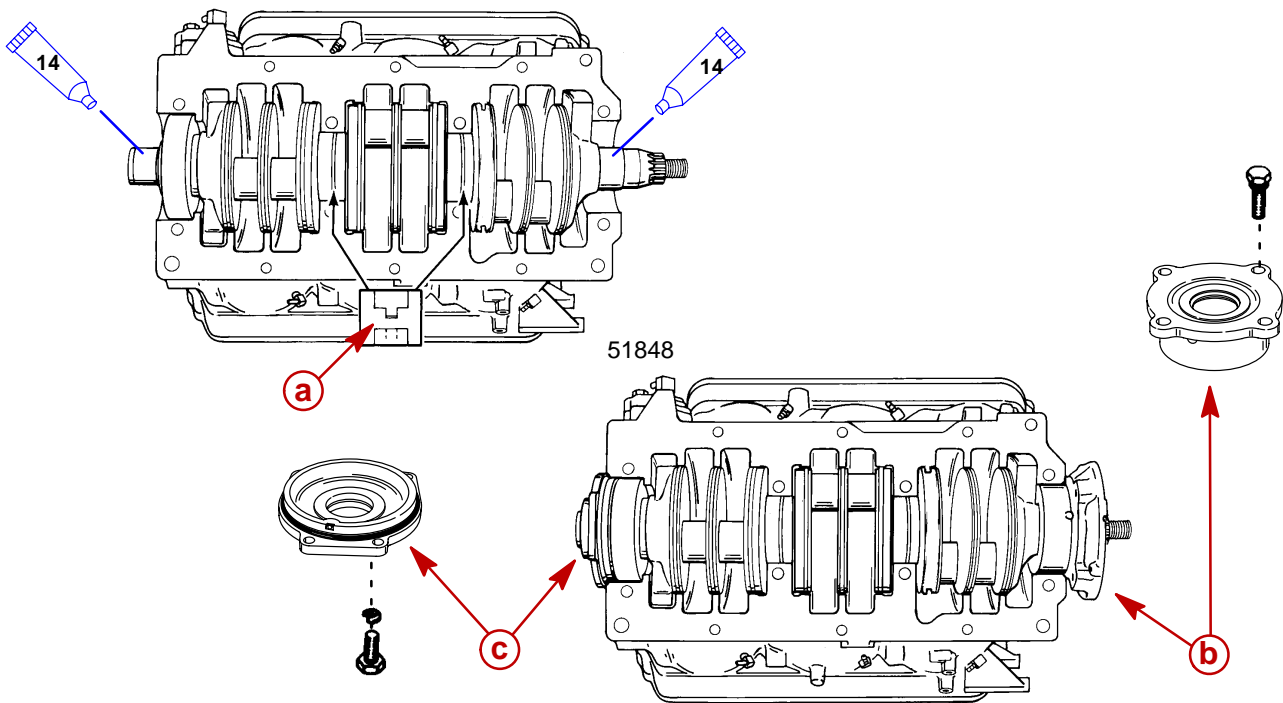
1. Lubricate crankshaft sealing rings with light oil.
2. Check cylinder block to be sure that dowel pins are in place.



51848

a - Dowel Pins

3. Position all crankshaft seal ring gaps straight up.
4. Align hole in each center main bearing race with dowel pin.
5. Gently push crankshaft down into position making sure that the dowel pins are lined up with the holes in center main bearings and crankshaft seal rings are in place.
6. Lubricate crankshaft ends (oil seal areas) with light oil, then install upper and lower end caps ("a" and "b"). Secure end caps to cylinder block with attaching bolts. **DO NOT** tighten end cap bolts at this time.



51848

51848

14 2 Cycle Outboard Oil (92-826666A24)

a - Dowel Pin
b - Upper End Cap

c - Lower End Cap



Piston and Connecting Rod Reassembly

1. Place needle bearings on a clean piece of paper and lubricate with Quicksilver 2-4-C w/Teflon Marine Lubricant.

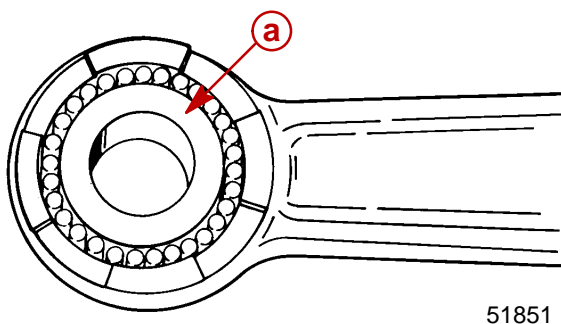
NOTE: There are 29 needle bearings per piston for Model Year 2000.

NOTE: There are 35 needle bearings per piston for Model Year 2001

2. Place sleeve which is part of piston pin tool (91-74607A1 – Model Year 2000) (91-92973A1 – Model Year 2001) into connecting rod and install needle bearings around sleeve as shown.
3. Place locating washers on connecting rod.

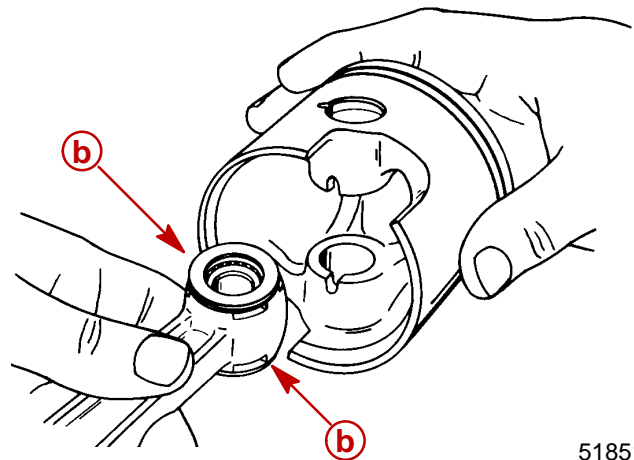
IMPORTANT: Position connecting rod part number facing towards flywheel.

Carefully position piston over end of rod. Make sure locating washers remain in place.



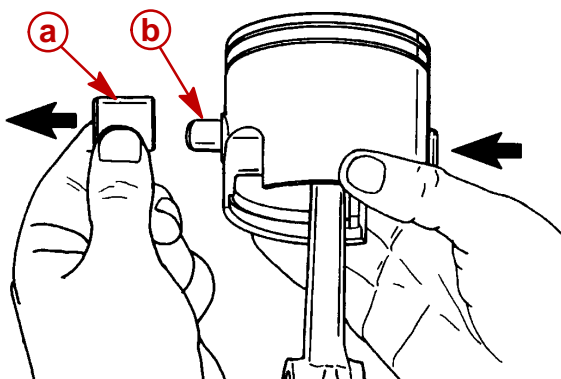
51851

- a - Sleeve
- b - Locating Washers



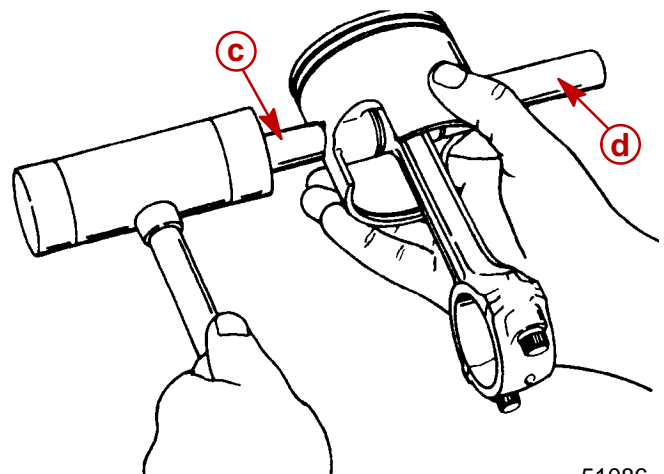
51851

4. Insert piston pin tool (91-74607A1 – Model Year 2000) (91-92973A1 – Model Year 2001) and push sleeve out of piston. Keep piston pin tool in piston.
5. Use a mallet and tap piston pin into piston and push piston pin tool out.



51080

- a - Piston Pin Tool
- b - Sleeve



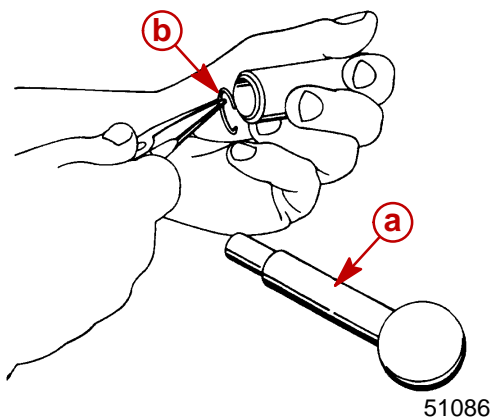
51086

- c - Piston Pin
- d - Piston Pin Tool

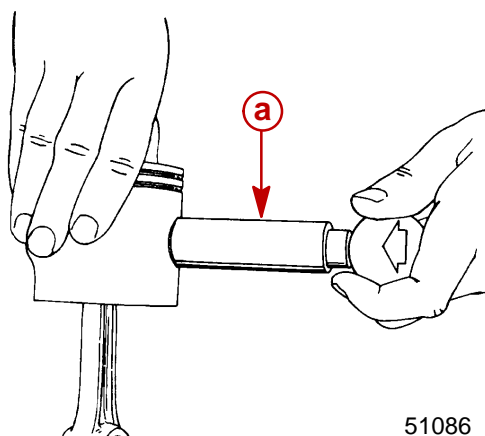
6. Install new piston pin lockrings (one each end of piston pin) with Lockring Installation Tool (91-77109A1 – Model Year 2000) (91-93004A2 – Model Year 2001).



7. Make sure lockrings are properly seated in piston grooves.



a - Lockring Installation Tool

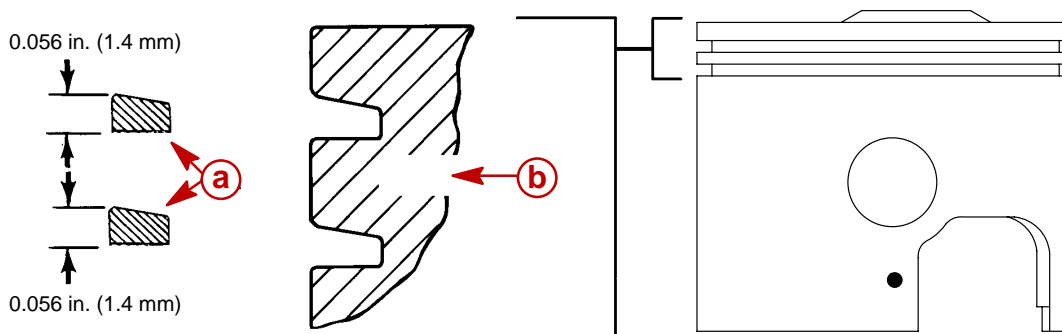


b - Lockring

Piston and Piston Ring Combinations

All models have two half keystone (half tapered) rings.

Pistons with two half keystone (half tapered) rings



a - Half Keystone (half tapered) Piston Ring

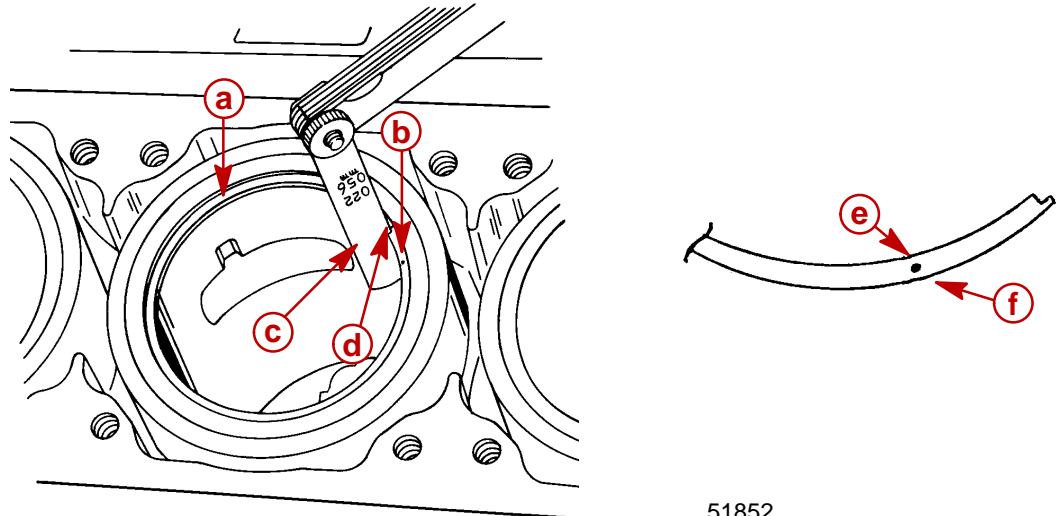
b - Enlarged View of Piston Ring Grooves



Piston Installation

1. Before installing new piston rings, check gap between ring ends by placing each ring in its respective cylinder, then pushing ring about 1/2 in. (12.7 mm) into cylinder using piston to assure proper position.
2. Check end gap of each new piston ring with a feeler gauge. End gap must be within 0.010 in. to 0.018 in. (0.25 mm to 0.45 mm). If end gap is greater, check other piston rings in cylinder bore, until rings (within tolerance) are found.

IMPORTANT: Piston ring side with dot or letter must be facing up.

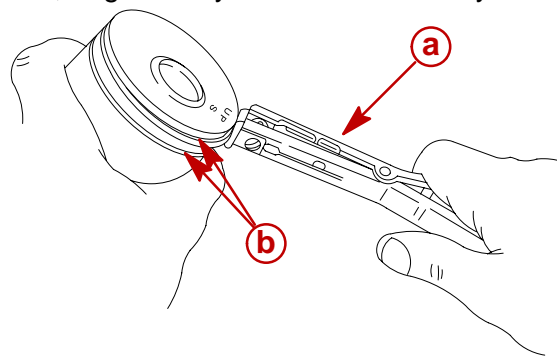


a - Piston Ring
b - Dots (Faces Up)
c - Feeler Gauge

51852

d - Ring End Gap
e - Dot or Letter
f - Piston Ring

3. Use Piston Ring Expander (91-24697) and install piston rings (dot side up) on each piston. Spread rings just enough to slip over piston.
4. Check piston rings to be sure that they fit freely in ring groove.
5. Lubricate piston, rings and cylinder wall with 2-Cycle Outboard Oil.



56155

a - Piston Ring Expander
b - Dot Side "Up" on Piston Ring

6. Rotate each piston ring so end of ring is aligned with locating pin as shown.
7. Install Piston Ring Compressor.
8. Remove screws and connecting rod cap from piston rod assembly being installed.

IMPORTANT: Piston must be correctly installed and positioned as shown.

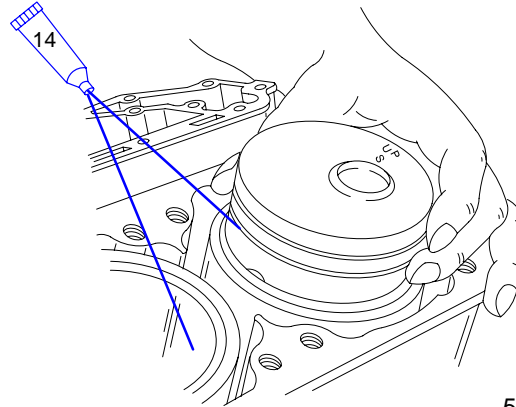
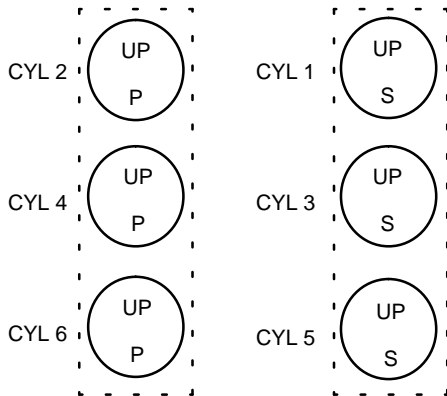
Pistons marked with the word "UP" and with the letter "P" or "S" on top of piston.



Pistons with the letter “P” must be installed in the port side of engine and the word “UP” facing toward top of engine.

Pistons with the letter “S” must be installed in the star-board side of engine and the word “UP” toward top of engine.

9. Coat cylinder bore with 2-cycle oil. Match piston assembly with cylinder it was removed from, and position piston as described below. Push piston into cylinder.



56156

2 Cycle Outboard Oil (92-826666A24)

10. Apply Quicksilver 2-4-C w/Teflon to bearing surface of connecting rod and install bearing assembly, as shown.

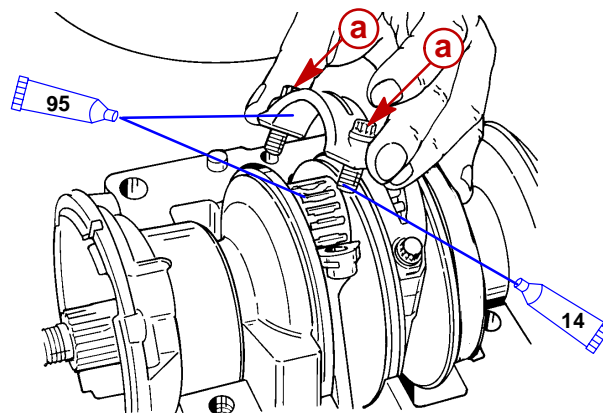
11. Place connecting rod cap on connecting rod. Apply light oil to threads and face of connecting rod bolts. Thread connecting rod bolts finger-tight while checking for correct alignment of the rod cap as shown.

IMPORTANT: Connecting rod and connecting rod caps are matched halves. Do not torque screws before completing the following procedure.

- Run a pencil lightly over ground area.
- If pencil stops at fracture point, loosen bolts, retighten, and check again.

NOTE: *If you still feel the fracture point, discard the rod.*

12. Tighten connecting rod bolts (using a 5/16 in. - 12 point socket). First torque to 15 lb. in. (1.7 N-m) then 30 lb. ft. (41 N-m). Turn each bolt an additional 90° after 2nd torque is attained. Recheck alignment between rod cap and rod as shown.



51850

2 Cycle Outboard Oil (92-826666A24)

2-4-C With Teflon (92-825407A12)

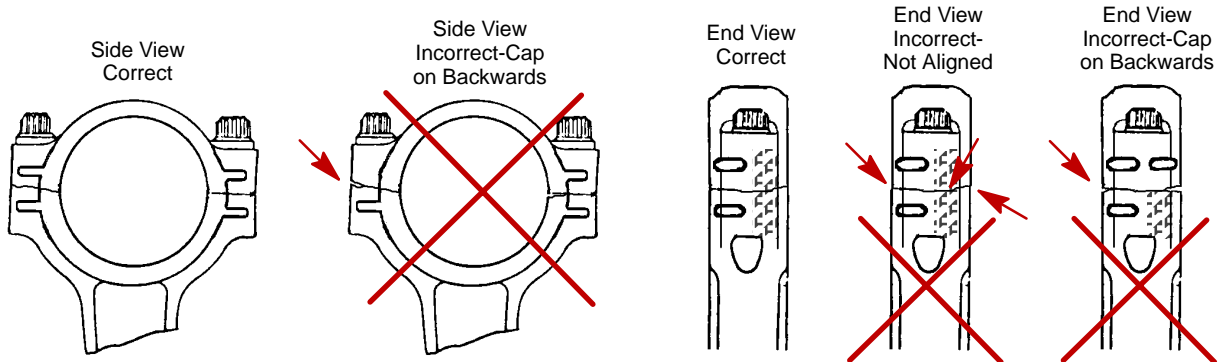
a - Connecting Rod Screws

13. Rotate crankshaft several times (using powerhead stand) to assure free operation (no binds and catching).

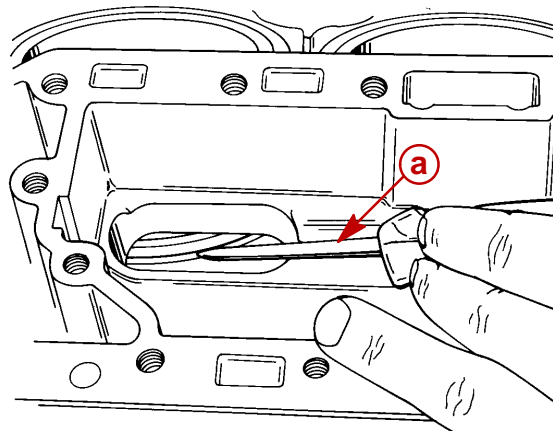


Connecting Rod Cap Alignment

Check each connecting rod cap for correct alignment. If not aligned, a ridge can be seen or felt at the separating line as shown below. Correct any misalignment.



14. Verify that no piston rings were broken during installation by pressing in on each piston ring thru exhaust port using a screwdriver. If no spring tension exists (ring fails to return to position), it's likely ring is broken and must be replaced.



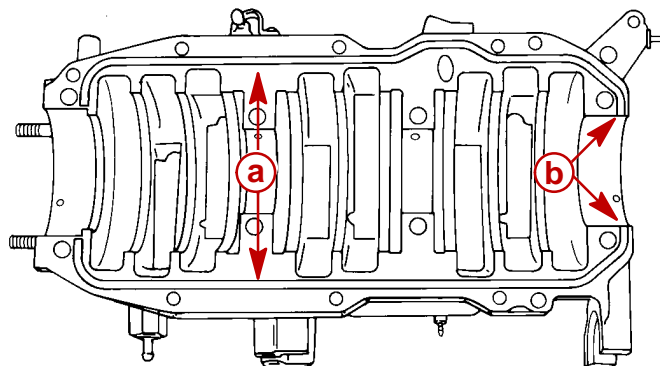
51852

a - Screwdriver

Crankcase Cover Installation

1. Remove all oil from mating surfaces of crankcase cover and cylinder block with Loctite 7649 Primer (92-809824).
2. Install gasket strips (Model Year 2000) into grooves in crankcase cover. Trim end of each gasket strip flush with edge of cover as shown.

NOTE: Model Year 2001 does not use gasket strips on the crankcase cover.



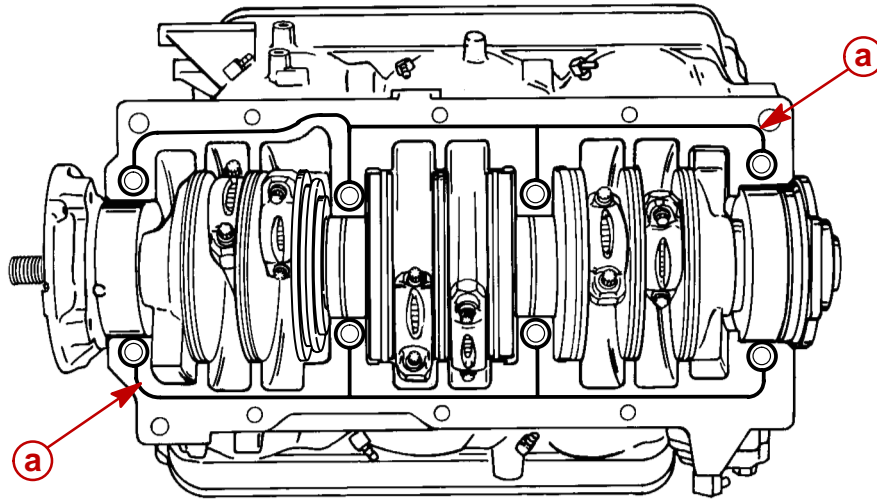
a - Gasket Strips

b - Edge of Cover

51852



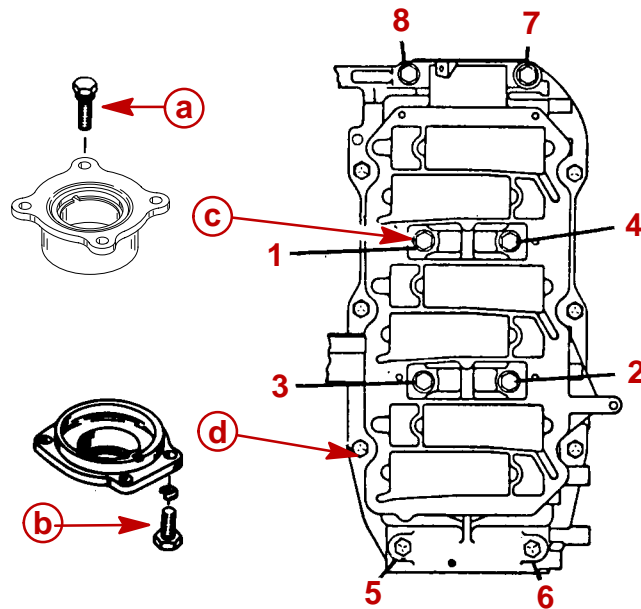
- Apply a thin, even coat of Loctite Master Gasket #203 on mating surfaces of crankcase cover or cylinder block.



58620

a - Loctite Master Gasket (92-12564-2)

- Place crankcase cover in position on cylinder block. Turn the 8 center main bolts in a LITTLE at a time, (following torque sequence) compressing crankshaft seal rings until crankshaft cover has been drawn down to cylinder block. Tighten eight bolts (a) evenly in three progressive steps (following torque sequence).
- Install remaining crankcase cover flange bolts.
- Tighten end cap bolts to specified torque.



a - Upper End Cap Bolts – Torque to 150 lb. in. (17 N·m)

b - Lower End Cap Bolts – Torque to 80 lb. in. (9 N·m)

c - Add Light Oil to Threads and Bolt Face – 8 Bolts (3/8 in.-18) Torque to 38 lb. ft. (51.5 N·m)

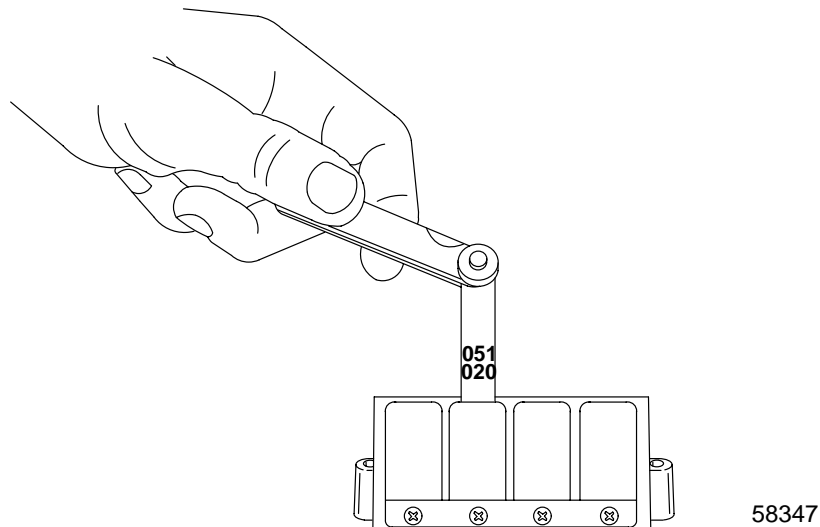
d - Bolts (5/16 in.-18) Torque to 180 lb. in. (20 N·m)



Reed Block Assembly

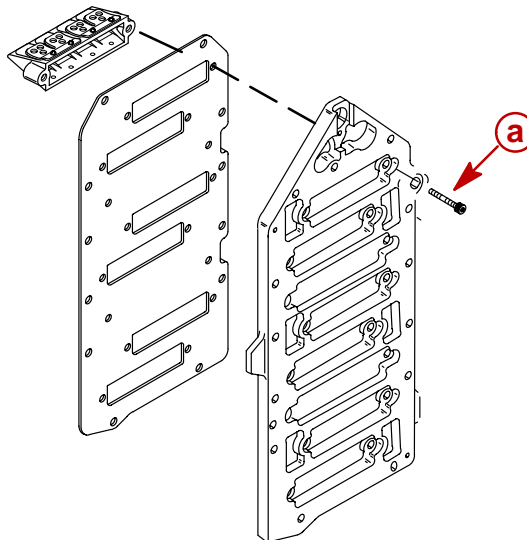
IMPORTANT: DO NOT remove reeds from reed blocks, unless replacement is necessary. **DO NOT** turn used reeds over for re-use. Replace reeds in sets only.

1. Thoroughly clean gasket surfaces of reed blocks and reed block housing. Check for deep grooves, cracks and distortion that could cause leakage. Replace parts as necessary.
2. Inspect reed block neoprene surface for wear, cuts or abrasions. Replace reed block(s) as required.
3. Check for chipped and broken reeds.



Allowable reed opening is 0.020 in. (0.51 mm) or less. Replace reeds if either reed is standing open more than 0.020 in. (0.51 mm).

Assembly of Reed Blocks to Reed Block Adaptor Plate



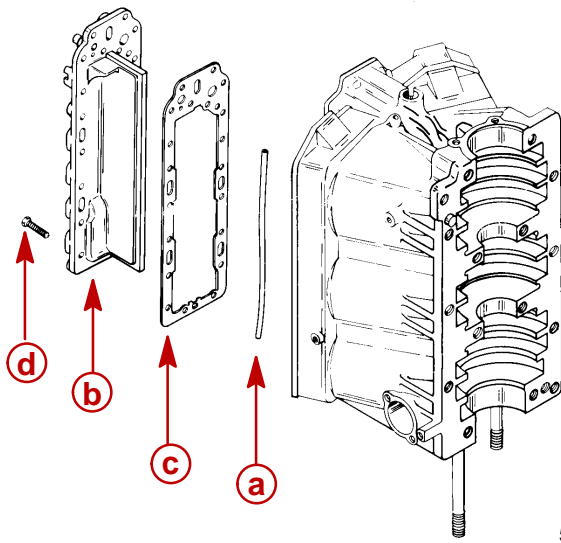
a - Torque to 105 lb. in. (12 N·m)

Assembly of Exhaust Divider Plate to Block

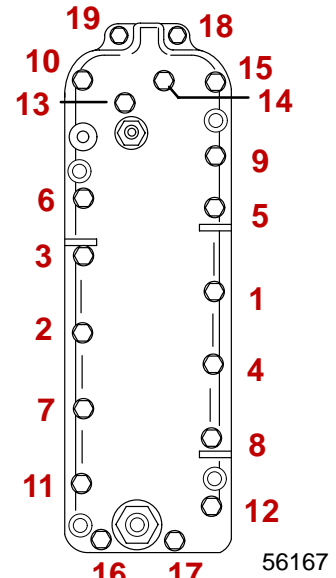
1. Place exhaust divider seal into slot in block and install divider plate with gasket.
2. Clean bolt threads with Loctite 7649 Primer (92-809824).
3. Apply Loctite 271 to bolt threads and torque bolts to 16.5 lb. ft. (22 Nm).



4. Torque exhaust divider plate bolts in following sequence.



50805

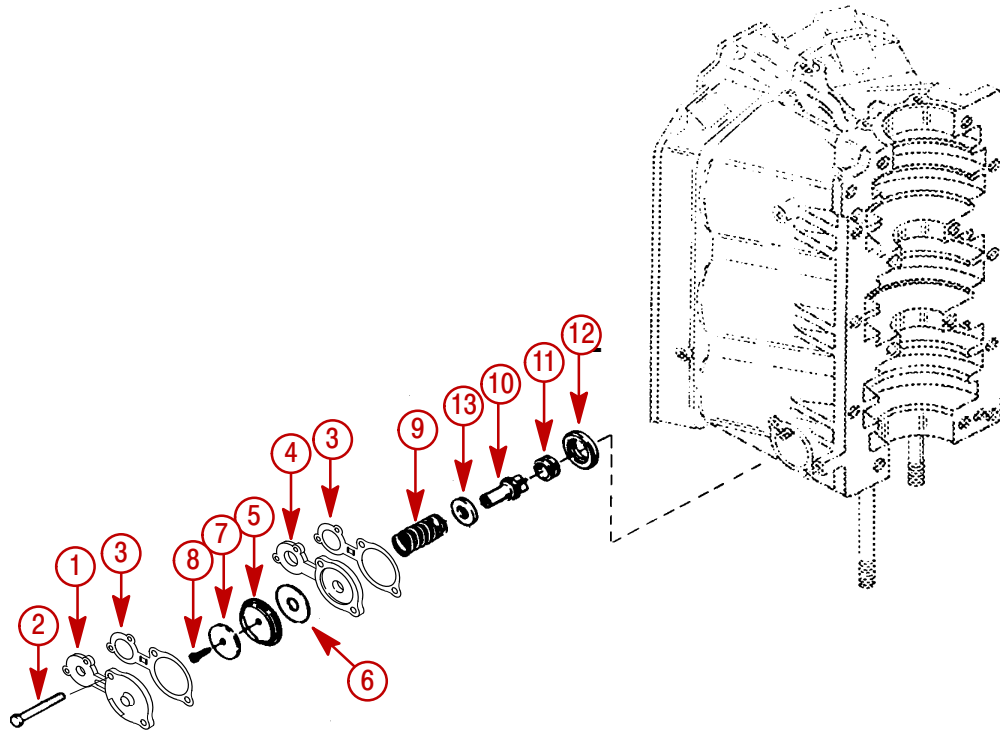


56167

- a** - Divider Seal
- b** - Exhaust Divider Plate

- c** - Gasket
- d** - Attaching Bolt

5. If removed, install water pressure relief valve components as shown. Torque bolts to specifications.



50803

- 1** - Cover
- 2** - Bolt - 150 lb. in. (17 N·m)
- 3** - Gasket
- 4** - Relief Valve Plate
- 5** - Diaphragm
- 6** - Water Deflector
- 7** - Washer

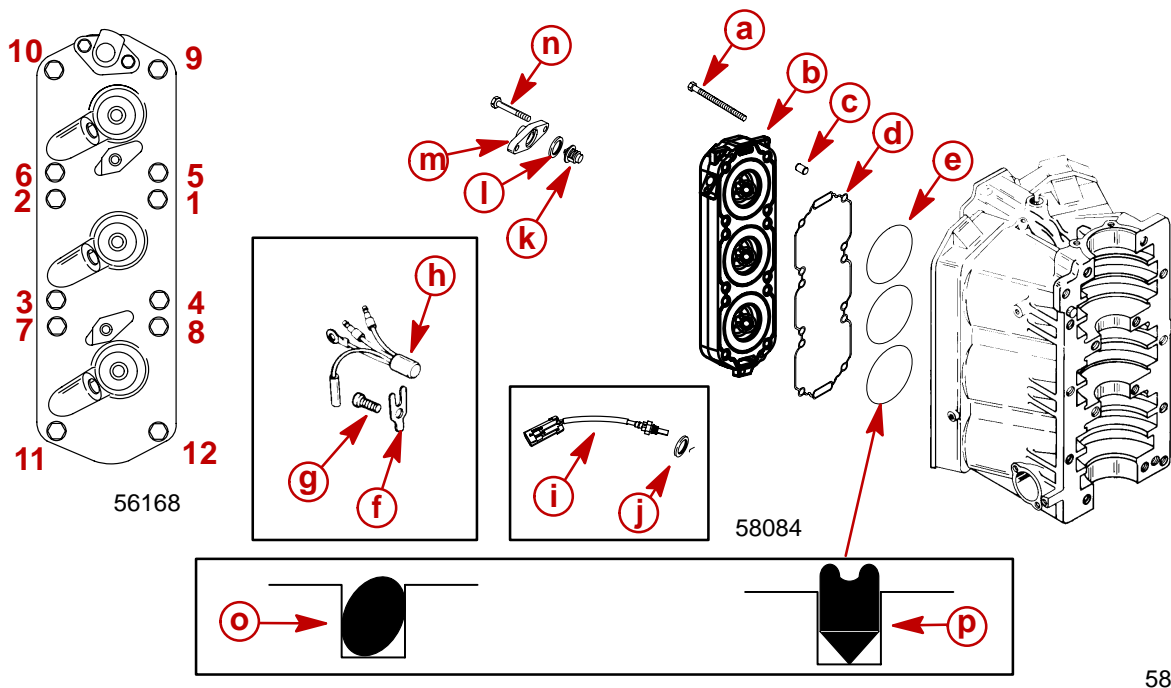
- 8** - Screw - 25 lb. in. (3 N·m)
- 9** - Spring
- 10** - Poppet Valve
- 11** - Grommet
- 12** - Carrier
- 13** - Washer



Cylinder Head Installation

NOTE: 115/135/150 cylinder heads are the same and are interchangeable. 175 heads are not interchangeable with 115/135/150. 175 heads are thinner and require head bolts 1/4 (0.063 mm) shorter than 115/135/150 head bolts. 175 heads have a more open combustion chamber design for more power. 175 heads should not be installed on 115/135/150 engines as a performance loss will result due to improper ECU calibration.

1. Install each cylinder head to engine block with thermostat pocket "UP". Apply light oil to new cylinder head bolt threads and torque bolts to 30 lb. ft. (41 N·m), then turn an additional 90°. Install thermostat assembly into each cylinder head.
2. **Model Year 2000** – Install overheat temperature sensor into STARBOARD cylinder head below #1 spark plug .
Model Year 2001 – Install temperature sensors in STARBOARD and PORT cylinder heads.



NOTE: Model Year 2000 – Cylinder head o-rings are oval shaped and are not directional in their installation. O-rings should not be damaged or twisted. Replace as required.

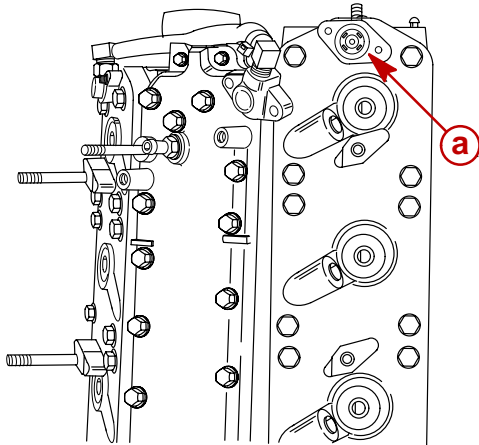
Model Year 2001 – Cylinder head o-rings are directional in their installation. The grooved side faces the cylinder block. The pointed side faces into the cylinder head. Failure to install the o-rings correctly may result in cylinder head leakage. O-rings should not be damaged or twisted. Replace as required. The 2001 style o-rings supercede and backfit to 2000 Model Year outboards.

- | | |
|---|---|
| a - Bolt [Torque to 30 lb. ft. (41 N·m) and then turn 90°] | i - Temperature Sensor (2001) |
| b - Cylinder Head | j - O-ring |
| c - Dowel Pin | k - Thermostat (143°) |
| d - Seal | l - Gasket |
| e - Seal | m - Cover |
| f - Retainer | n - Bolt [Torque to 17 lb. ft. (23.0 N·m)] |
| g - Bolt [Torque to 17 lb. ft. (23.0 N·m)] | o - Model Year 2000 Cylinder Head O-ring |
| h - Temperature Sensor (2000) | p - Model Year 2001 Cylinder Head O-ring |

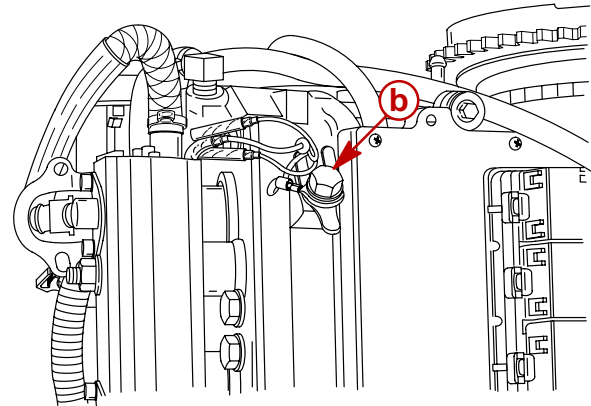


NOTE: The temperature sender provides continuous temperature information to the ECU while the engine is running. Should temperature reach pre-programmed levels, the ECU will activate a warning horn and warning light.

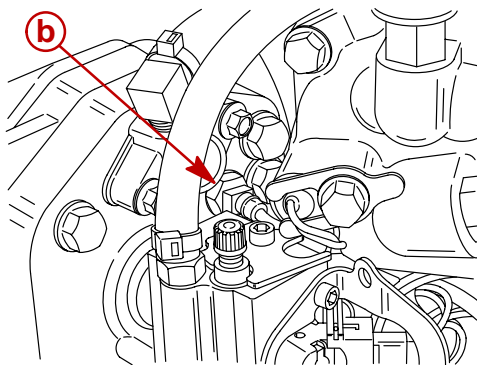
3. Thermostat and temperature sensor installed.



56163

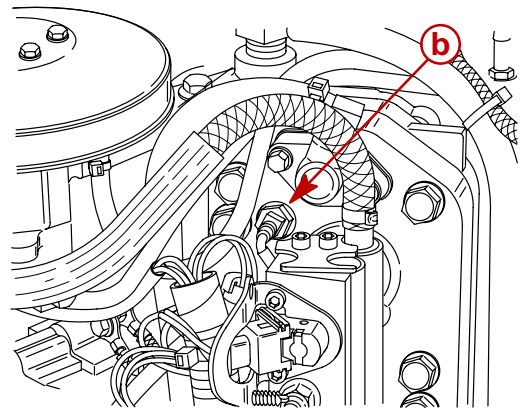


MODEL 2000 STARBOARD



MODEL 2001 PORT

58442



MODEL 2001 STARBOARD

- a** - Thermostat (143° F 61.7° C)
b - Overheat Temperature Sensor

Reinstalling Engine Components

NOTE: Components can be reinstalled individually or as an assembly. If reinstalling components individually, refer to the following sections. If reinstalling components as an assembly, refer to **Removing Engine Components as an Assembly**, page 4A-18 through 4A-29, and reinstall in reverse sequence.

Section 2

Starter Motor
 Electronic Control Module
 Ignition Coil
 Starter Solenoid
 Alternator
 Flywheel

Section 3

Direct Fuel Injection
 Fuel Pump
 On-Board Oil Tank
 Oil Pump

Section 7

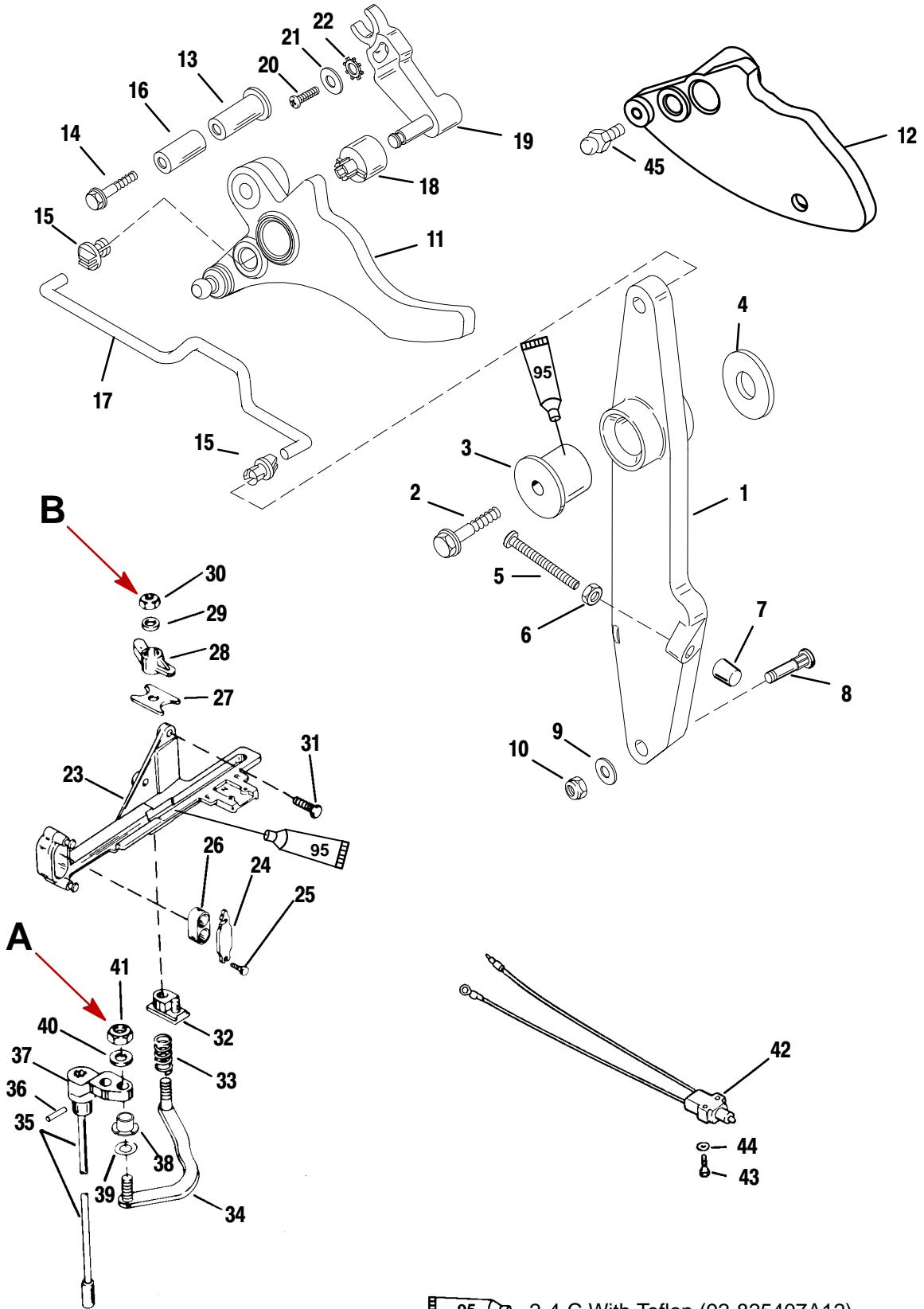
Shift Cable Latch Assembly
 Control Cable Anchor Bracket



Notes



Throttle Lever and Shift Shaft



95 2-4-C With Teflon (92-825407A12)

A – Tighten and back off 1/2 turn

B – Stud must come through nylon on nut



Throttle Lever and Shift Shaft

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb. in.	lb. ft.	Nm
1	1	THROTTLE CONTROL LEVER			
2	1	SCREW (.375-16 x 1-3/4 IN.)		20	27
3	1	BUSHING			
4	1	SPACER			
5	1	SCREW (2-1/8 IN.)			
6	1	NUT (1/4-20)			
7	1	CAP			
8	1	INSERT			
9	1	WASHER			
10	1	NUT	50		5.5
11	1	CAM (135/150/175)			
12	1	CAM (115)			
13	1	BUSHING			
14	1	SCREW (M8 x 40)	145		16
15	2	SWIVEL BUSHING			
16	1	BEARING		Drive Tight	
17	1	LINK			
18	1	ROLLER			
19	1	THROTTLE ROLLER			
20	1	SCREW (M5 x 16)		Drive Tight	
21	1	WASHER			
22	1	STAR WASHER			
23	1	ANCHOR BRACKET			
24	1	LATCH			
25	2	SCREW-Drive			
26	1	CAP			
27	1	WEAR PLATE			
28	1	LATCH			
29	1	WASHER			
30	1	NUT			
31	3	SCREW (.312-18 x 7/8)	160		18
32	1	GUIDE BLOCK			
33	1	SPRING			
34	1	LINK ROD ASSEMBLY			
35	1	SHIFT SHAFT ASSEMBLY (LONG)			
	1	SHIFT SHAFT ASSEMBLY (X-LONG)			
36	1	ROLL PIN			
37	1	SHIFT SHAFT LEVER-UPPER			
38	1	BUSHING			
39	1	WAVE WASHER			
40	1	WASHER			
41	1	NUT			
42	1	IDLE STABILIZING SHIFT KIT			
43	2	SCREW (6-32)	15		1.7
44	2	WASHER			
45	1	BALL -threaded			



Powerhead Installation on Driveshaft Housing

1. Install Lifting Eye (91-90455) into flywheel.

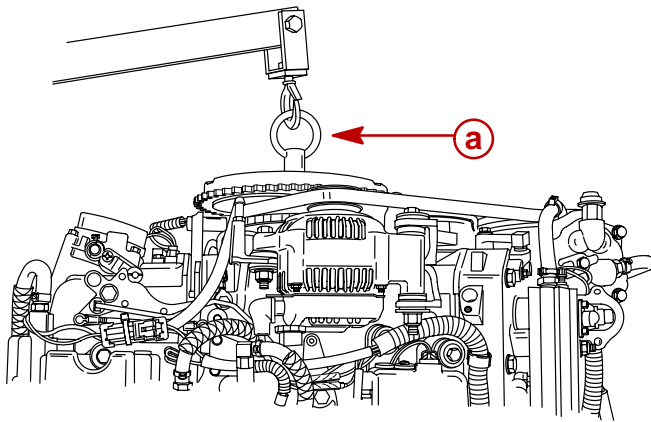
⚠ WARNING

BE SURE that Lifting Eye is threaded into flywheel as far as possible BEFORE lifting powerhead.

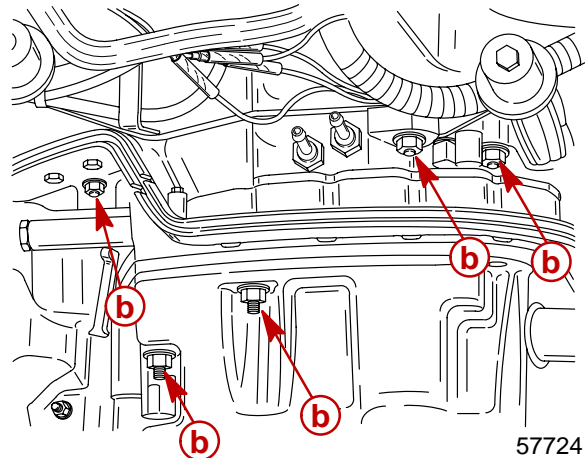
2. Using a hoist, lift powerhead high enough to allow removal of powerhead from repair stand. Remove powerhead from repair stand, being careful not to damage drive shaft housing gasket surface of powerhead.
3. Place a new gasket around powerhead studs and into position on base of powerhead.

IMPORTANT: DO NOT apply lubricant to top of driveshaft as this will prevent driveshaft from fully engaging into crankshaft.

4. Apply a small amount of 2-4-Cw/Teflon Marine Lubricant (92-90018A12) onto driveshaft splines.
5. Use hoist to lower powerhead onto driveshaft housing. It may be necessary to turn flywheel (aligning crankshaft splines with driveshaft splines) so that powerhead will be fully installed.
6. Install 10 flat washers and 10 locknuts which secure powerhead to exhaust extension plate/driveshaft housing. Torque locknuts in 3 progressive steps until secured.
7. Disconnect hoist from Lifting Eye and remove Lifting Eye from flywheel.
8. Reinstall plastic cap into center of flywheel cover.



56162



57724

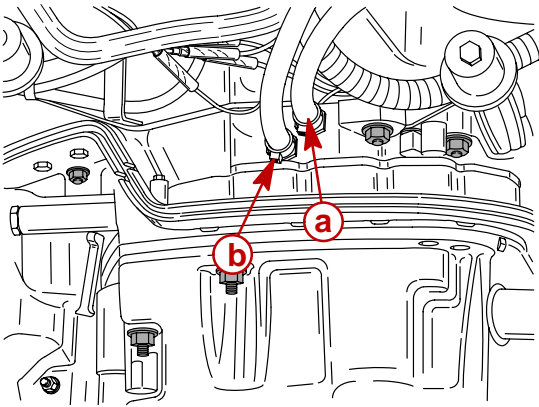
a - Lifting Eye (91-90455)

b - Powerhead Attaching Locknuts and Flat Washers – Torque Nuts to 20 lb. ft. (27 N·m)

9. Install fuel cooler inlet and outlet water hoses to fittings on exhaust adaptor plate and poppet valve cover. Install air hose from port fuel rail to fitting on exhaust adaptor plate. Secure all hoses with sta-straps.

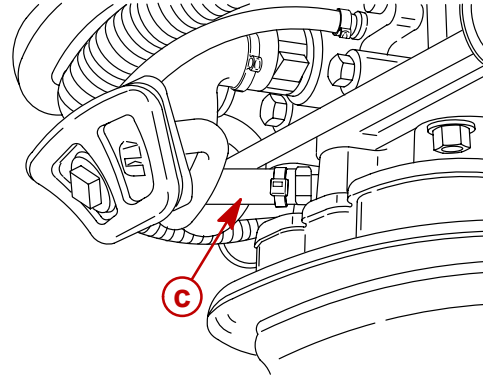


10. Install thermostat cover hose to exhaust adaptor plate.



57543

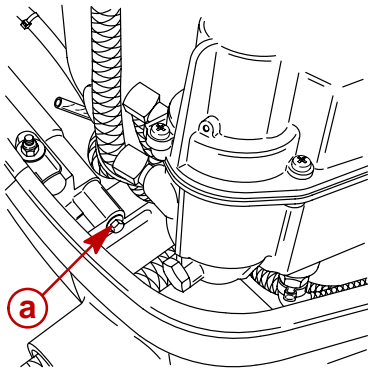
- a** - Fuel Rail Inlet Water Hose
- b** - Excess Air to Adaptor Plate



57730

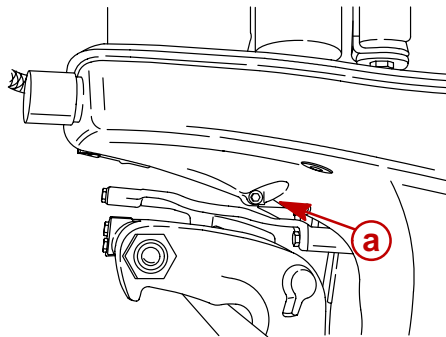
- c** - Thermostat Cover Hose

11. Install 4 bolts securing bottom cowl halves and install bottom cowling.

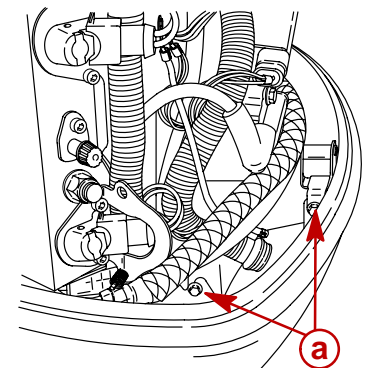


57485

- a** - Bolt



57486

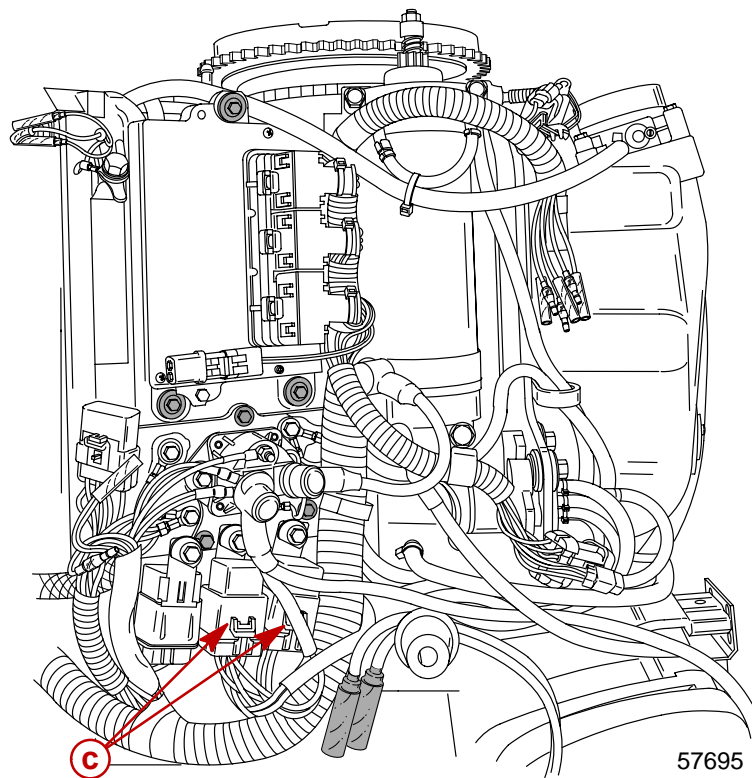
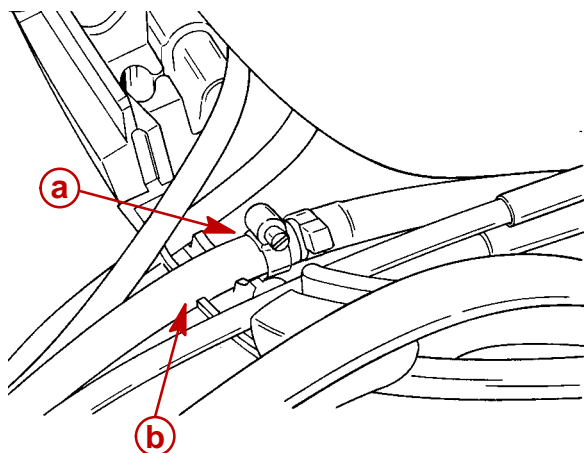


57487



12. Reconnect input fuel line.

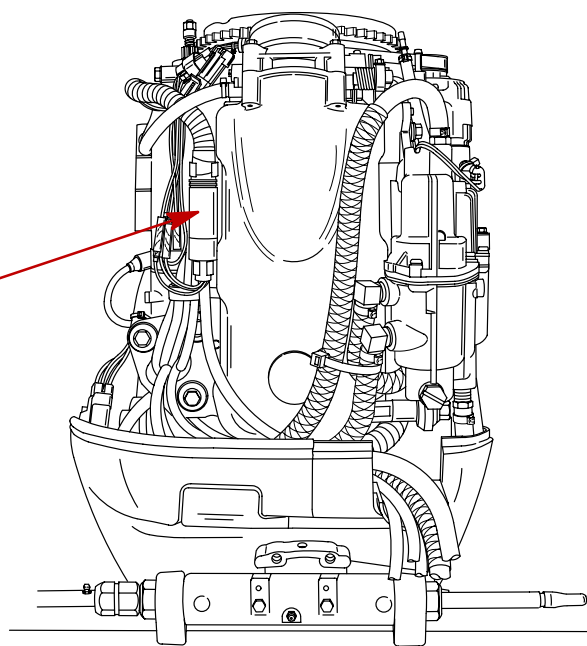
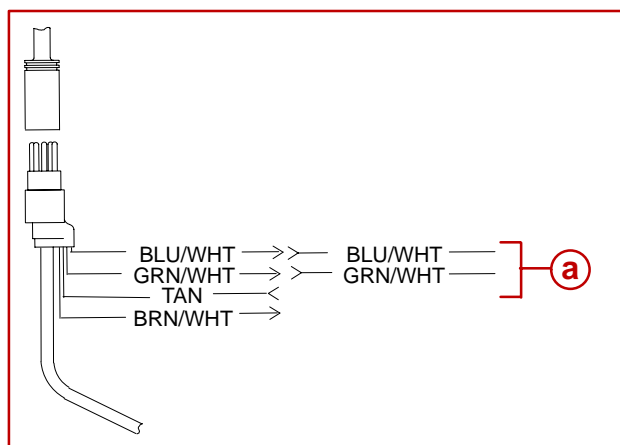
13. Reconnect BLUE and GREEN trim harness leads to trim solenoids.



a - Hose Clamp
b - Fuel Line

c - Trim Solenoids

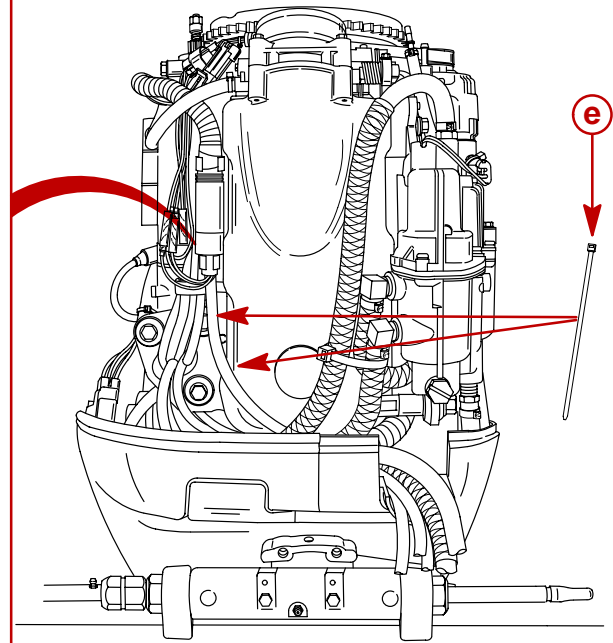
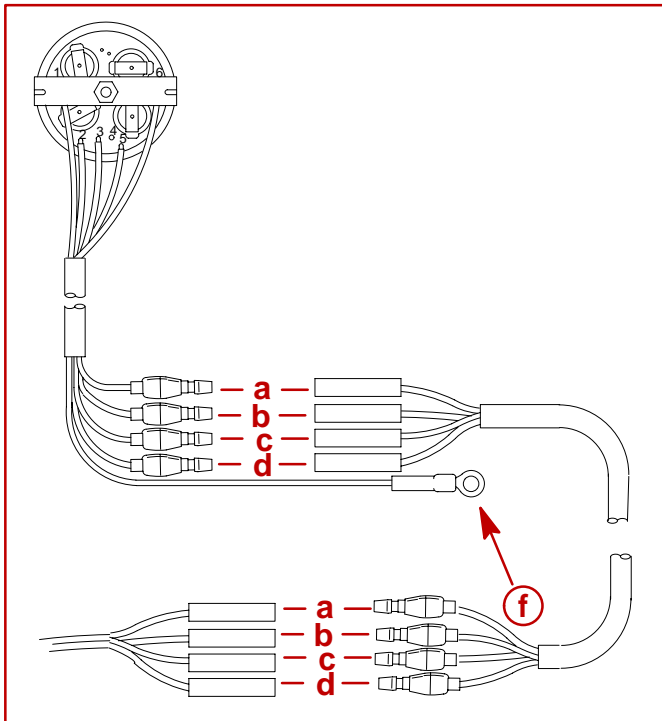
14. Reconnect remote control harness to powerhead harness connector and wires as shown.



a - Power Trim Connections



15. Reconnect warning gauge harness.



57835

MODEL 2000

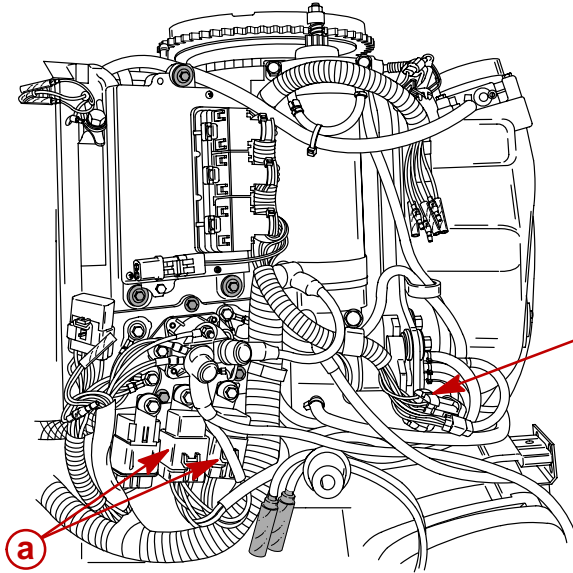
- a** - TAN/BLACK
- b** - TAN/WHITE
- c** - PINK/LT. BLUE
- d** - ORANGE

- e** - Sta-Straps
- f** - Connect PURPLE to 12 Volt Source or Adjacent Gauge



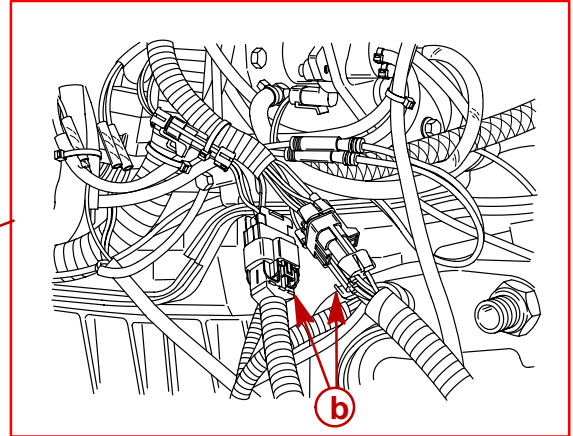
16. Reconnect BLUE and GREEN trim harness leads trim relays.

17. Reconnect System Monitor/Digital Sensor harness connectors.



a - Trim Relays

57695

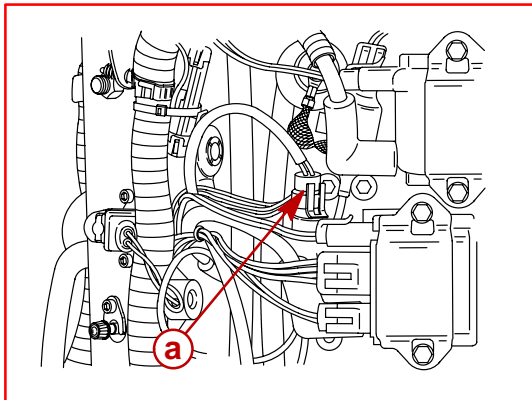


MODEL 2001

58616

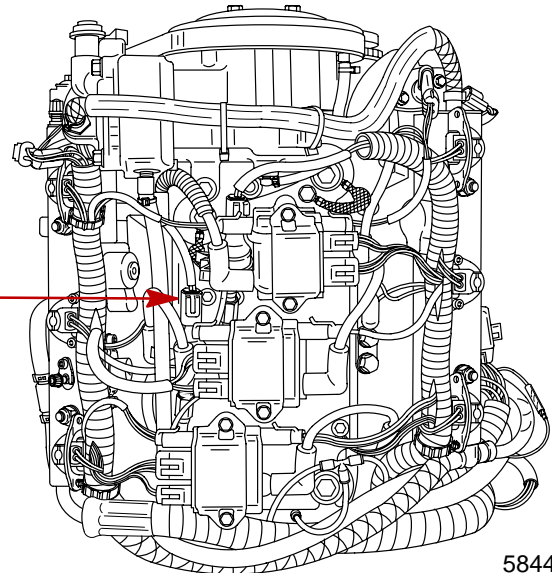
b - Harness Connectors

18. Reconnect water pressure sensor harness.



58615

a - Water Pressure Sensor Harness



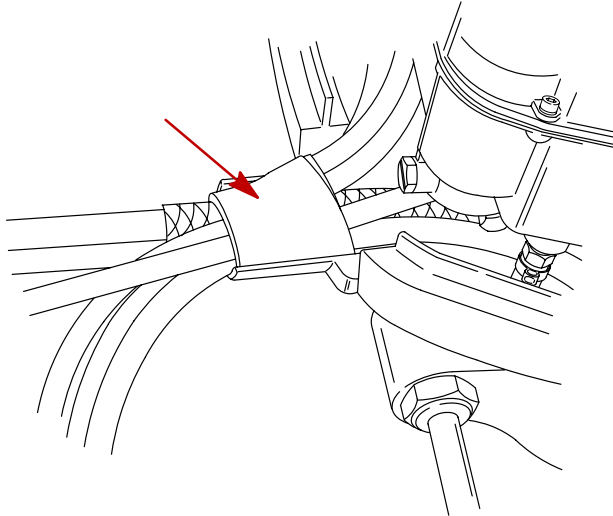
58443



Front Clamp Reassembly

IMPORTANT: Sufficient slack must exist in engine wiring harness, battery cables, fuel hose, and oil hoses routed between clamp and engine attachment point, to relieve stress and prevent hoses from being kinked or pinched.

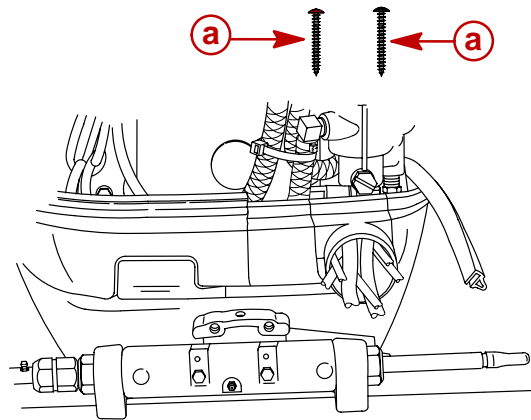
1. Place the neoprene wrap over the wiring, hoses, and control cables as shown.



57840



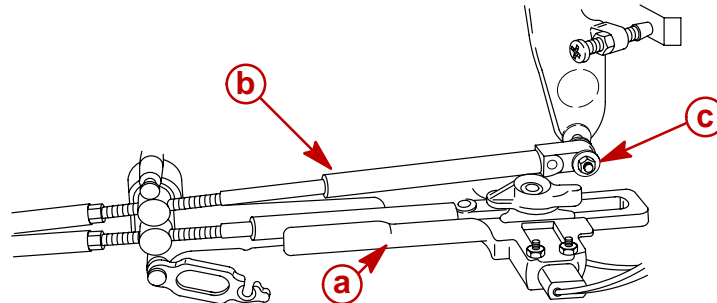
- Fasten clamp together with two screws.



a - Screws

57841

- Slide outboard shift lever into neutral position.
- Install shift cable and secure with spring, nylon wear plate, flat washer, latch and lock nut. Install throttle cable and secure with washer and locknut. Tighten locknut and then back off 1/4 turn.



a - Shift Cable

b - Throttle Cable

c - Washer and Locknut – Tighten Locknut and then back off 1/4 turn

57838

Refer to Section 2 of this Service Manual “Timing/ Synchronizing/Adjusting” for engine set-up procedures.



Break-In Procedure

⚠ CAUTION

Severe damage to the engine can result by not complying with the Engine Break-in Procedure.

FUEL REQUIREMENTS

Do not use pre-mixed gas and oil in this engine. Use straight gasoline during engine break-in and after engine break-in. The ECM is programmed to signal the oil pump to provide additional oil (50:1 ratio) during the first 120 minutes of operation. The ECM will monitor this period through its own internal clock. At the end of this period, the ECM will signal the oil pump to go to a standard ratio of 300 – 400:1 @ idle and 60:1 @ W.O.T.

INITIATING ENGINE BREAK-IN SEQUENCE

Refer to Section 3C for proper procedures.

ENGINE BREAK-IN PROCEDURE (ALL MODELS)

First Hour

- Allow engine to warm up for 30 – 60 seconds.
- Avoid continuous operation at idle speed for more than 10 minutes.
- Run engine for the majority of the time between 3000 and 4500 rpm; approximately 3/4 throttle.
- Vary engine speed; change engine speed approximately every 2 minutes.
- Avoid trimming outboard out (up) beyond a vertical trim position during operation.
- Short bursts of full throttle for periods up to 10 seconds are acceptable.

Next 3 Hours

- Change engine speed every 10 minutes.