POWERHEAD

Section 4A

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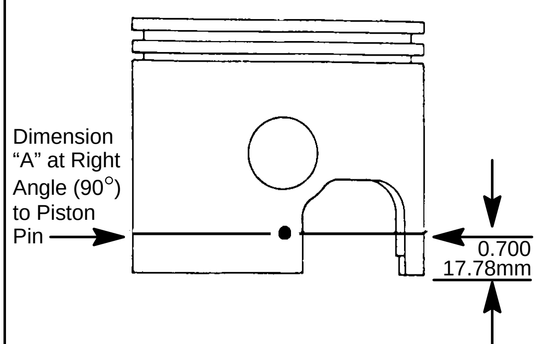
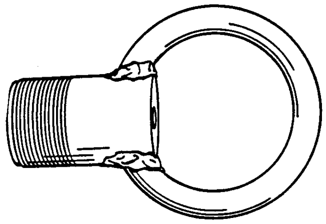
4
A

Powerhead Specifications

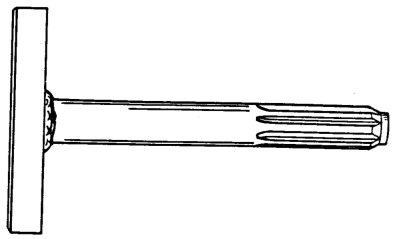
CYLINDER BLOCK	**Type** **Displacement** **Thermostat**	V–6 Cylinder, Two Cycle, Direct Injected 153 cu. in. (2508 cc) 60° Vee 142° F (61° C)
STROKE	**Length (All Models)**	2.65 in. (67.3 mm)
CYLINDER BORE	**Diameter (Std)** **Diameter 0.015 in. Oversize** **Taper/Out of Round/Wear Maximum** **Bore Type**	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		3.4925 in. ± .0005 in. (88.7095 mm ± .0127 mm) **Using a micrometer, measure dimension “A” at location shown. Dimension “A” should be 3.4925 in. ± .0005 for a STANDARD size piston (new) Dimension “A” will be 0.001 – 0.0015 less if coating is worn off piston (used)**
REEDS	**Reed Stand 0pen (Max.)**	0.020 in. (0.50 mm)

Special Tools

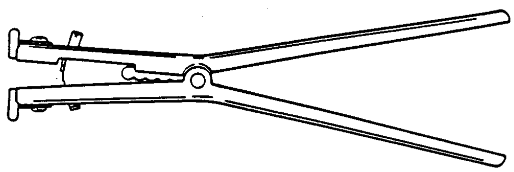
1. Lifting Eye 91-90455T



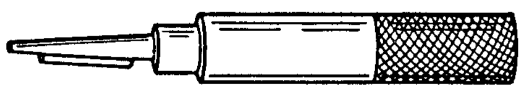
2. Powerhead Stand 91-30591T1



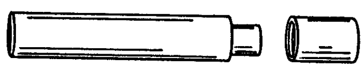
3. Piston Ring Expander 91-24697



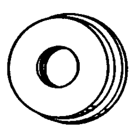
4. Lockring Removal Tool 91-52952T1



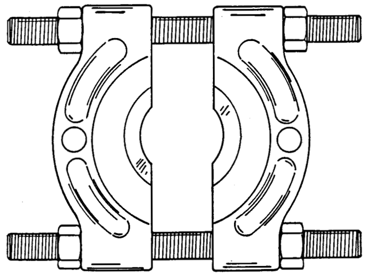
5. Piston Pin Tool 91-74607A1



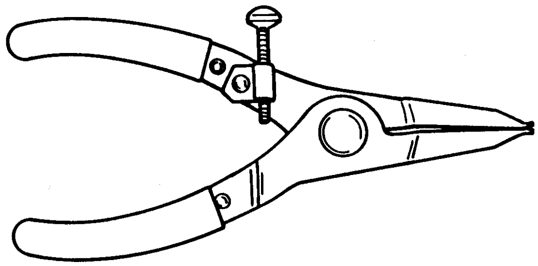
6. Driver Head 91-55919



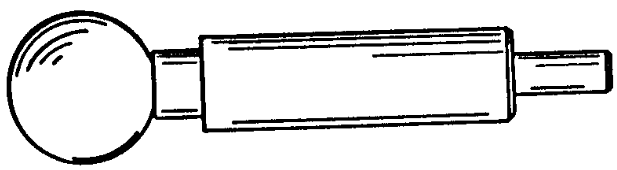
7. Universal Puller Plate 91-37241



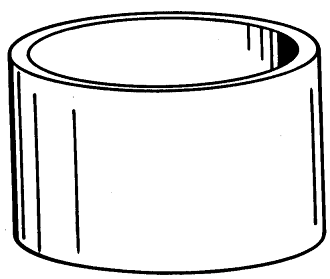
8. Snap Ring Pliers 91-24283



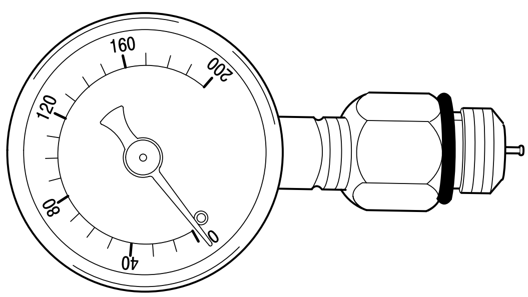
9. Lockring Installation Tool 91-77109A3



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



11. Compression Tester 91-29287



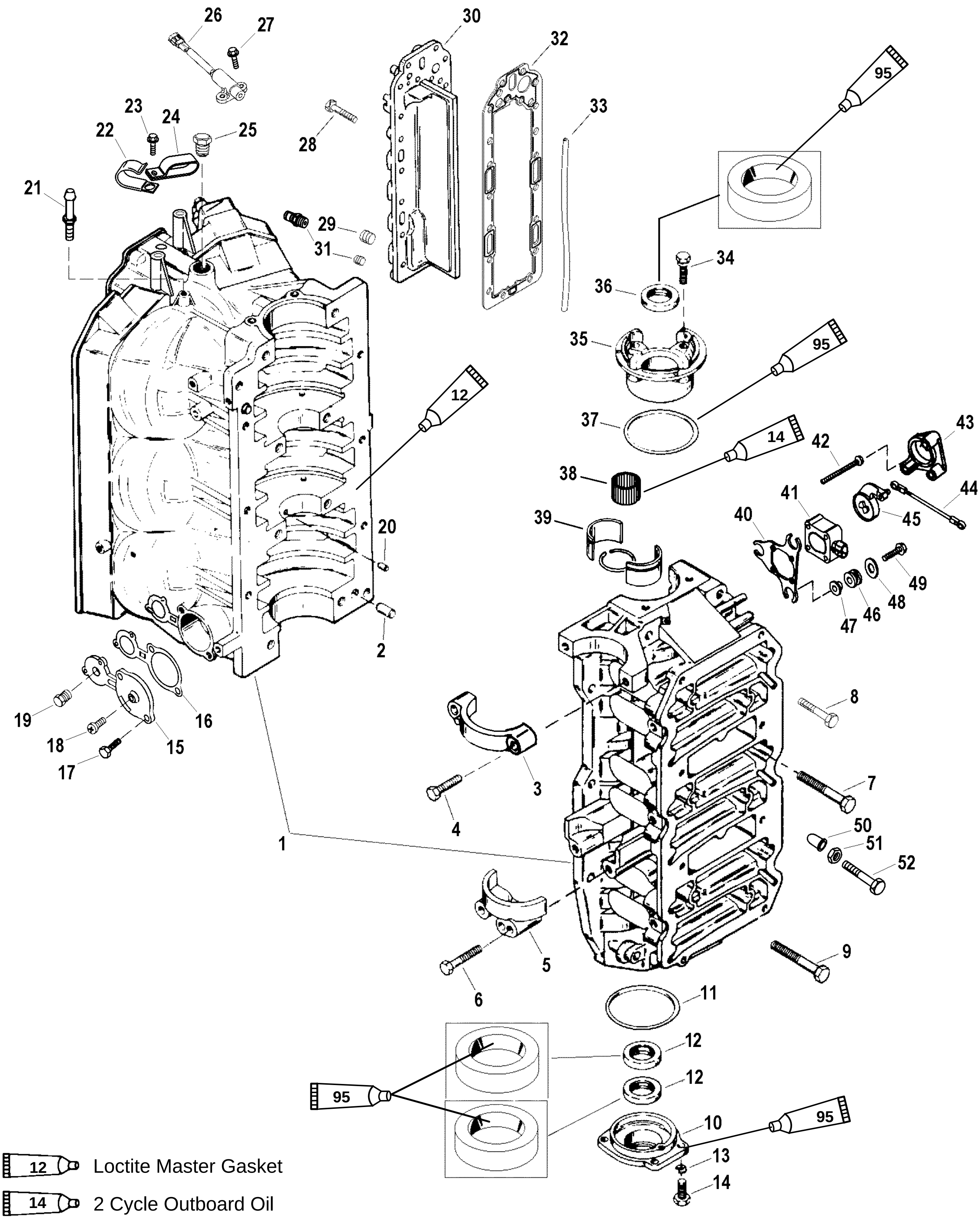
Powerhead Repair Stand

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

Notes:

Cylinder Block Assembly

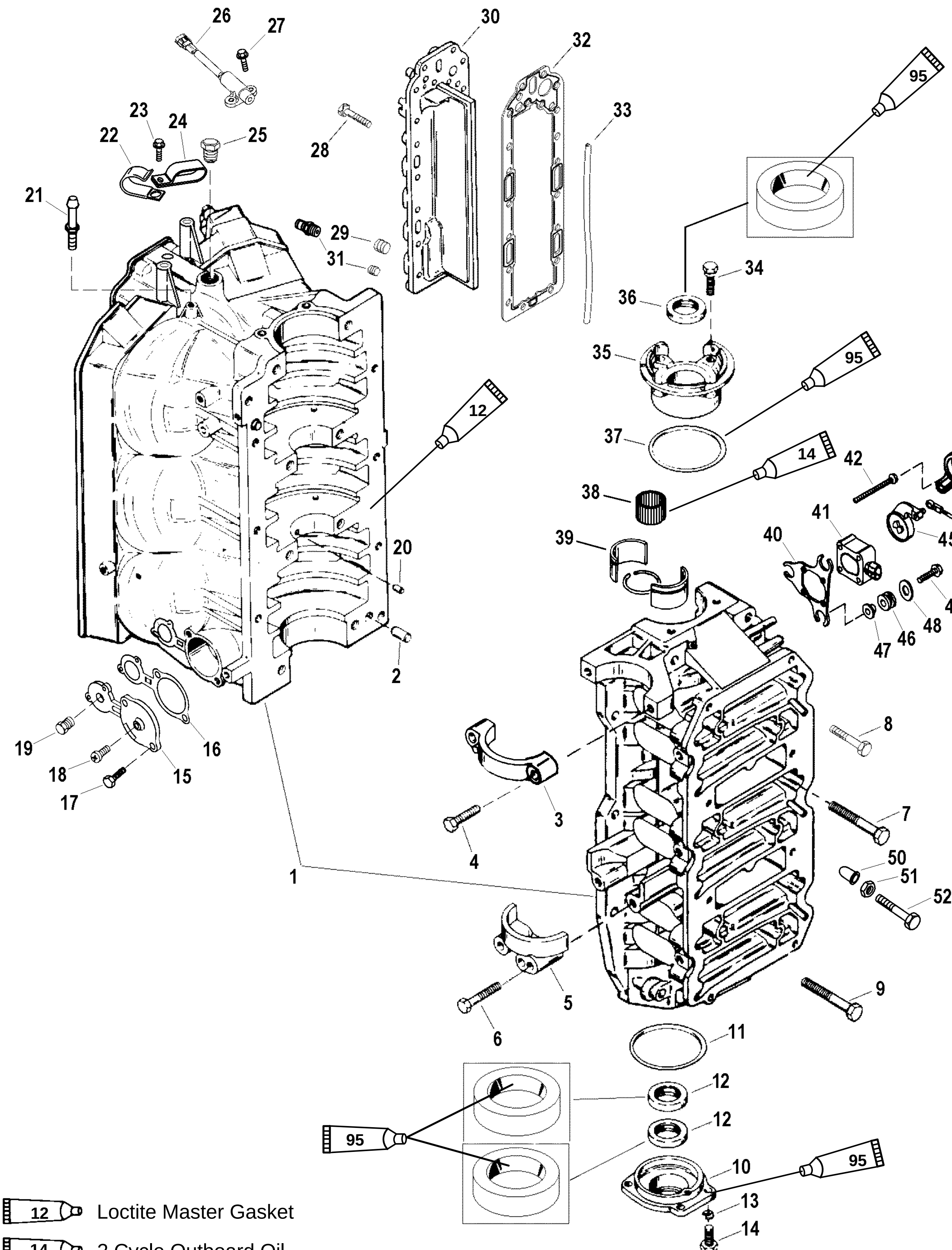


12	Loctite Master Gasket
14	2 Cycle Outboard Oil
95	2-4-C With Teflon

Cylinder Block Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm
1	1	CYLINDER BLOCK ASSEMBLY			
2	2	DOWEL PIN (0.375 x 0.620) locating			
3	1	COVER – Top Starter Mounting			
4	2	SCREW (0.312-18 x 1.50)			
5	2	COVER – Bottom Starter Mounting			
6	2	SCREW (0.312-18 x 2.00)		17.5	24
7	7	SCREW (0.312-16 x 3.250)		37	50
8	6	SCREW (0.312-18 x 1.250)		15	20
9	1	SCREW (0.312-16 x 3.250)		37	50
10	1	END CAP ASSEMBLY-lOWER			
11	1	O-RING (3-1/4 IN. I.D.)			
12	2	SEAL-Oil			
13	4	LOCKWASHER (0.250)			
14	4	SCREW (0.250-20 x 0.750)	80		9
15	1	COVER – Relief Valve			
16	1	GASKET			
17	4	SCREW with LOCKWASHER (0.312-18 x 0.875)		13	18
18	1	SCREW (#6-32 x 0.250)	9		1
19	1	PLUG (0.250-18 x 0.620)			
20	2	DOWEL PIN (Center Main)			
21	1	PIN (Special)			
22	1	J CLIP (Wire Harness Support)			
23	1	SCREW (M6 x 16)			
24	1	CLAMP – Hose Support			
25	1	PLUG – Pipe (0.500–14)			
26	1	SENSOR ASSEMBLY – Crank Position			
27	2	SCREW (M5 x 16)	45		5
28		SCREW (0.312-18 x 1.00) (2 each) SCREW (0.312-18 x 1.500) (17 each) SCREW (0.312-18 x 1.750) (1 each)		13	18
29	1	PLUG (0.750 – 14 Hex Head – Brass)			
30	1	PLATE KIT – Exhaust Divider			
31		PLUG (0.125–27 Brass) (1 each) FITTING (Straight – 0.125–27) (1 each)			
32	1	GASKET – Exhaust Manifold			
33	1	SEAL – Exhaust Manifold (12.5 in) (31.75 cm)			
34	4	SCREW & LOCKWASHER (0.312-18 x 1.00)		17	23
35	1	END CAP ASSEMBLY-Upper			
36	1	SEAL – Oil			
37	1	O-RING			
38	1	BEARING (Needle Rollers)			
39	1	RACE – Bearing			
40	1	BRACKET ASSEMBLY			
41	1	THROTTLE POSITION INDICATOR			
42	3	SCREW (#10-32 x 2.00)	15		1.7

Cylinder Block Assembly



12 Loctite Master Gasket

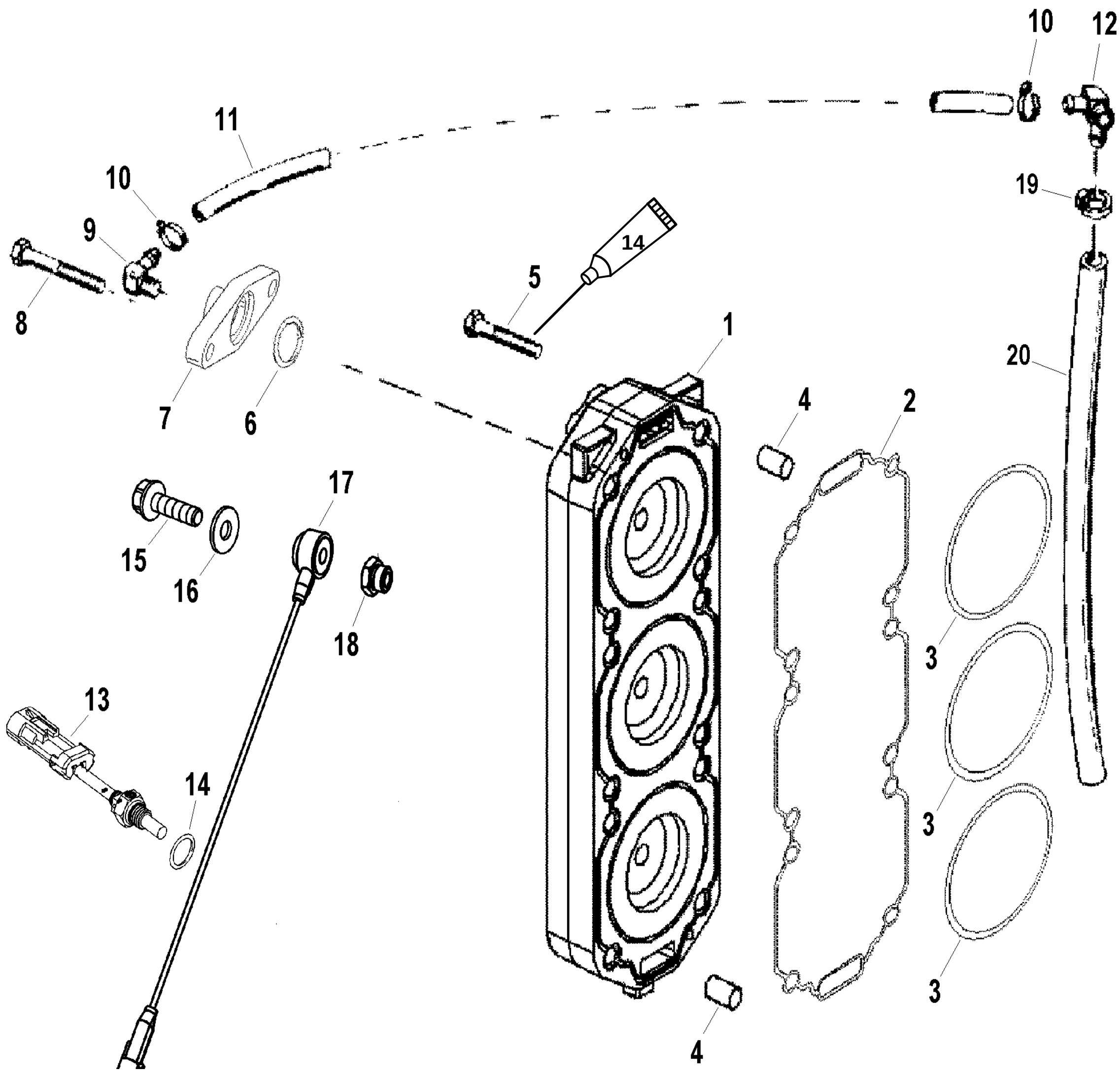
14 2 Cycle Outboard Oil

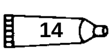
95 2-4-C With Teflon

Cylinder Block Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
43	1	COVER		13	18
44	1	LINK ASSEMBLY – Throttle			
45	1	LEVER – TPI			
46	3	GROMMET			
47	3	BUSHING			
48	3	WASHER			
49	3	SCREW (M6 x 25)	70		8
50	1	CAP (Nylon)			
51	1	NUT (0.250-20)			
52	1	SCREW (0.250-20 x 1.750)			

Cylinder Head Assembly



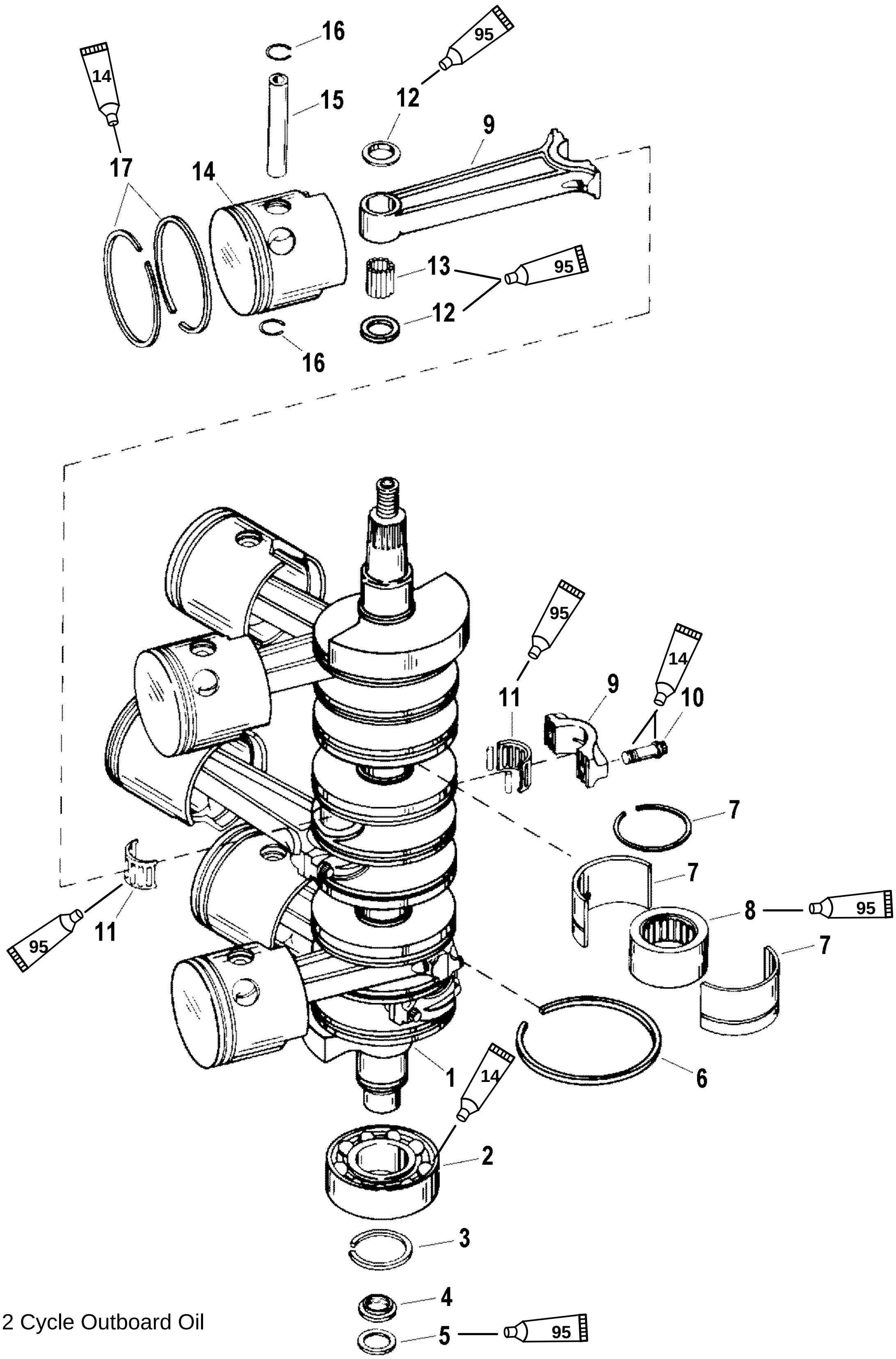


2 Cycle Outboard Oil

Cylinder Head Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm
1	2	HEAD ASSEMBLY – Cylinder			
2	2	SEAL–Cylinder Head			
3	6	SEAL–Cylinder Bore			
4	4	DOWEL PIN (0.250 x 0.625)			
5	24	SCREW (0.375-16 x 2.750)	30 lb-ft (41 Nm), then tighten additional 90 degrees		
6	2	O-RING			
7	2	COVER-Thermostat			
8	4	SCREW (M8 x 25)	120		13.5
9	1	FITTING (90 Degree) (0.250–18 Brass)			
10	2	CLAMP (Worm Gear)			
11	1	HOSE (12.75 in.) (32.4 cm)			
12	1	FITTING			
13	2	SENSOR ASSEMBLY – Temperature (Port and Starboard)	14		1.6
14	2	O-RING			
15	2	SCREW (M10 x 35)		15	20.3
16	2	WASHER			
17	2	SENSOR – Knock			
18	2	ADAPTOR – Knock Sensor			
19	1	CLAMP (Worm Gear)			
20	1	HOSE (To Thru Hull Fitting) (Order Part Thru Boat Manufacturer)			

Crankshaft, Pistons and Connecting Rods



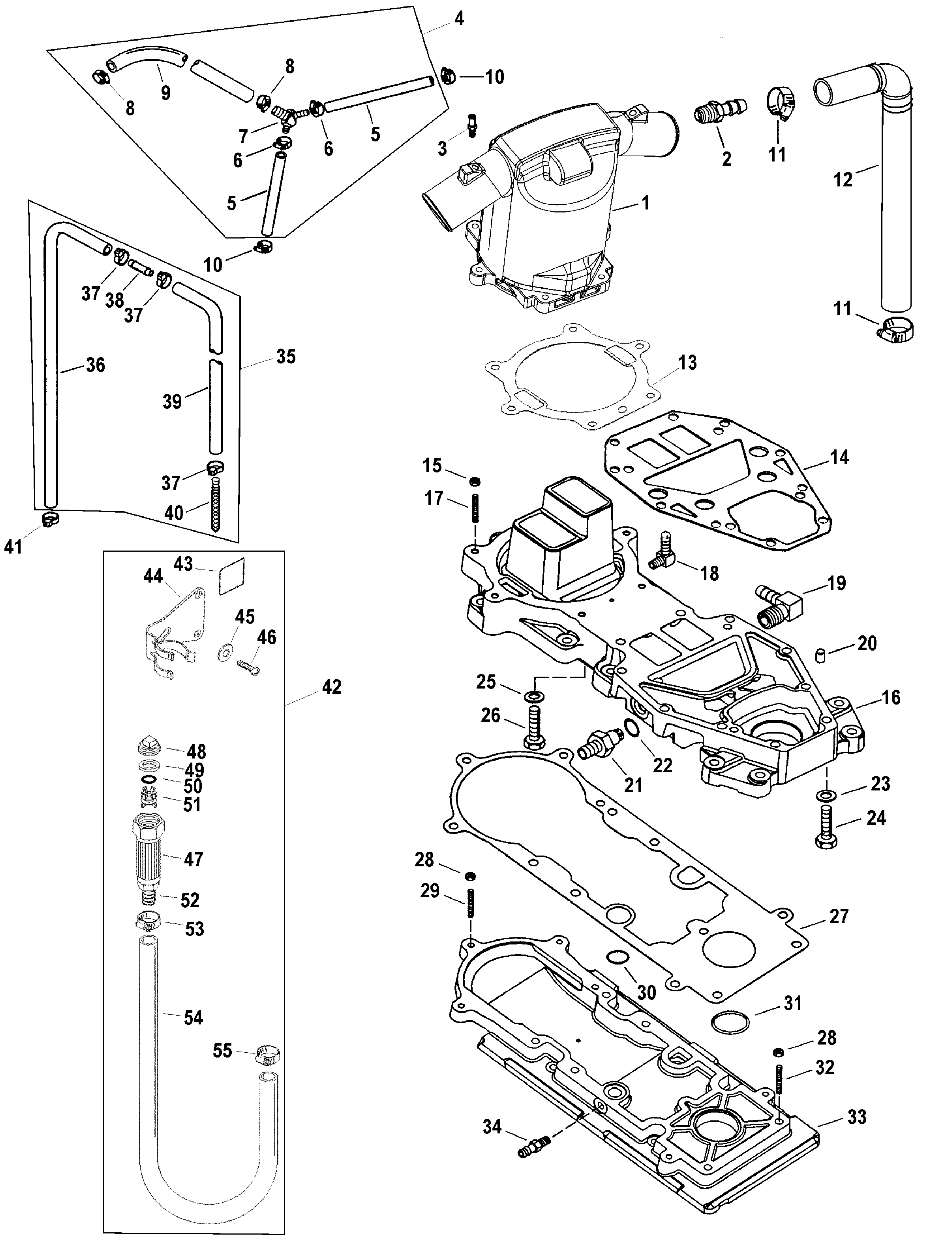
14 2 Cycle Outboard Oil

95 2-4-C With Teflon

Crankshaft, Pistons and Connecting Rods

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm
1	1	CRANKSHAFT ASSEMBLY			
2	1	BALL BEARING (LOWER)			
3	1	RETAINING RING			
4	1	CARRIER ASSEMBLY			
5	1	PACKING-Carrier			
6	7	RING–Sealing			
7	2	BEARING–Race (Center Main)			
8	2	BEARING–Needle (Center Main)			
9	6	CONNECTING ROD ASSEMBLY			
10	12	SCREW (0.312-24 x 0.875)	1st Torque: 15 lb-in 2nd Torque: 20 lb-ft Turn screw additional 90 degrees after 2nd torque. ▼		
11	12	BEARING–Roller			
12	12	WASHER–Needle Locating			
13	174	NEEDLE BEARING–piston end			
14	3	PISTON **(STARBOARD)**			
	3	PISTON **(PORT**)			
15	6	PIN–Piston			
16	12	LOCK RING			
17	12	RING SET-Piston (Upper and Lower - 12 Rings)			

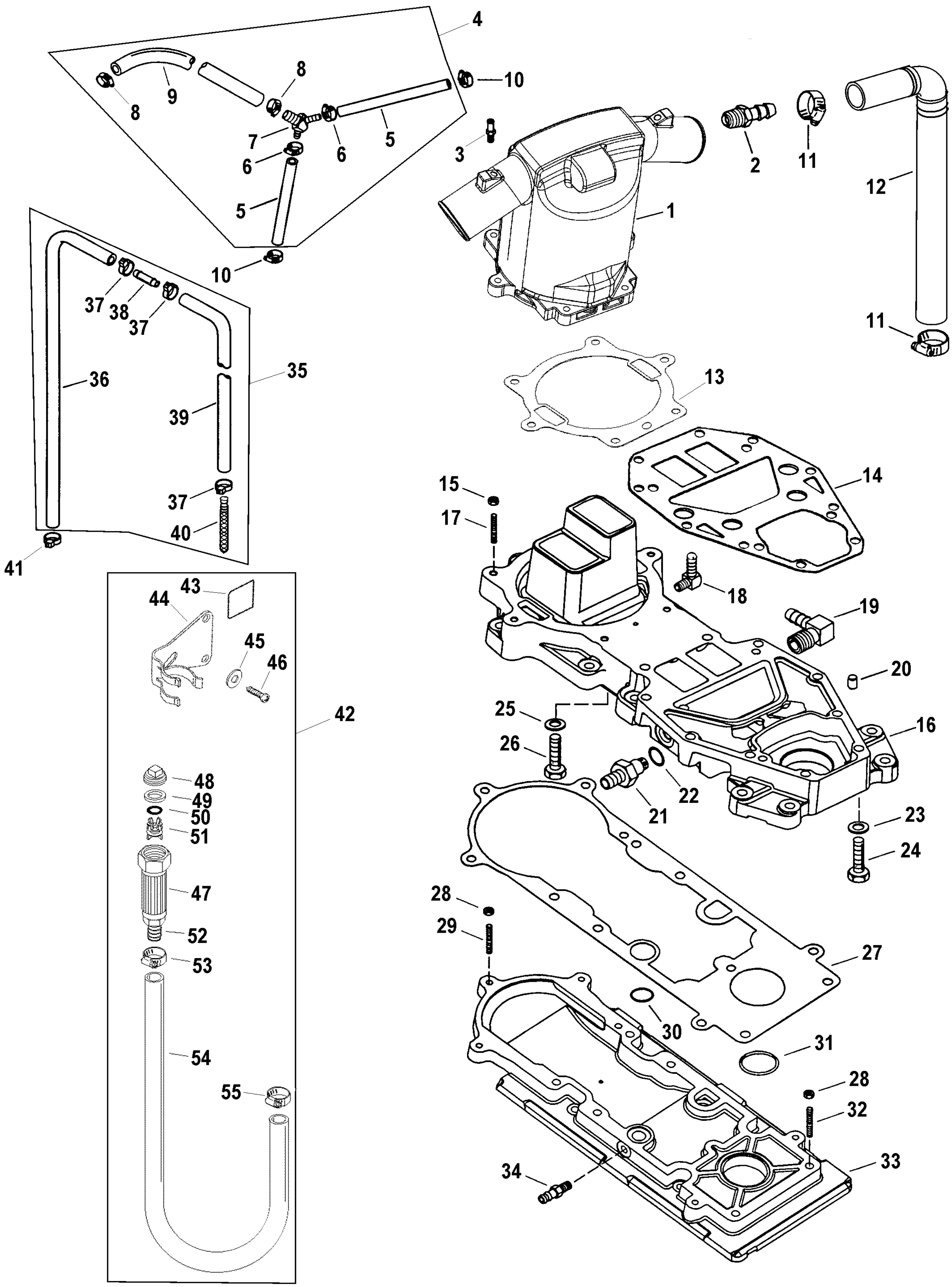
Expansion Chamber and Adaptor Plates



Expansion Chamber and Adaptor Plates

REF. NO.	QTY.	DESCRIPTION	TORQUE lb. in.	TORQUE lb. ft.	TORQUE N·m
1	1	CHAMBER-Expansion			
2	1	CONNECTOR (0.750–14)			
3	2	CONNECTOR (0.125–27)			
4	1	HOSE ASSEMBLY			
5	2	TUBING (6 in.) (15.2 cm)			
6	2	CLAMP (Worm Gear)			
7	1	FITTING			
8	2	CLAMP (Worm Gear)			
9	1	HOSE (32 in.) (81.3 cm)			
10	2	CLAMP (Worm Gear)			
11	2	CLAMP (Worm Gear)			
12	1	HOSE ASSEMBLY			
13	1	GASKET (Expansion Chamber)			
14	1	GASKET (Block to Exhaust Chamber)			
15	6	NUT (M8)		20	27
16	1	ADAPTOR ASSEMBLY–Engine			
17	1	STUD (M8 x 50)			
18	1	ELBOW (0.125–27)			
19	1	ELBOW			
20	2	PIN–Dowel (Locating)			
21	1	FITTING–Strainer			
22	1	O-RING (Strainer Fitting)			
23	8	WASHER			
24	8	SCREW (0.375–16 x 2.250)		35	47
25	2	WASHER			
26	2	SCREW (0.375–16 x 3.750)		35	47
27	1	GASKET (Engine Adaptor)			
28	11	NUT (M10)		35	47
29	5	STUD (M10 x 53)		30	40
30	1	O RING (Top Cover)			
31	1	O RING (Top Cover)			
32	6	STUD (M10 x 101)		30	40
33	1	COVER (Top of Drive Housing)			
34	1	CONNECTOR (0.250–18)			
35	1	STRAINER ASSEMBLY			
36	1	HOSE–Siphon (42 in.) (106.7 cm)			
37	3	CABLE TIE (8 in.) (20.3 cm)			
38	1	SIPHON BREAK			
39	1	HOSE–Siphon (18 in.) (45.7 cm)			
40	1	STRAINER–Siphon Hose			
41	1	CABLE TIE (8 in.) (20.3 cm)			
42	1	ADAPTOR ASSEMBLY			

Expansion Chamber and Adaptor Plates

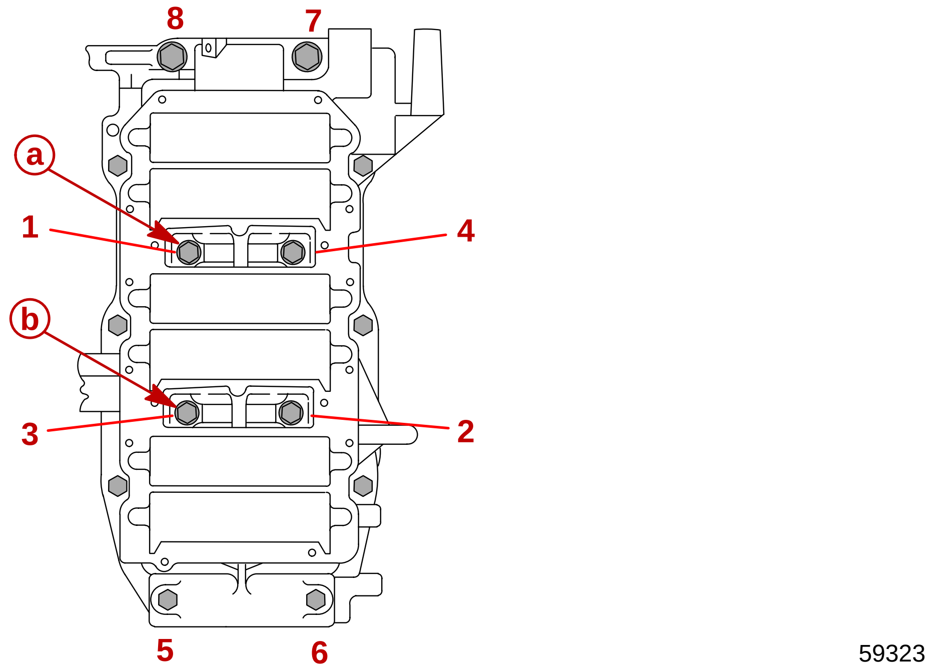


Expansion Chamber and Adaptor Plates

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
43	1	DECAL–Flushing Adaptor			
44	1	CLIP–Flushing Assembly Holder			
45	3	WASHER			
46	3	SCREW			
47	1	ADAPTOR ASSEMBLY FITTING–Flushing Adaptor			
48	1	PLUG–Top			
49	1	WASHER			
50	1	O RING			
51	1	VALVE–Check			
52	1	CONNECTOR			
53	1	CLAMP (Worm Gear)			
54	1	HOSE (60 in.) (152.4 cm)			
55	1	CLAMP (Worm Gear)			

Torque Sequence

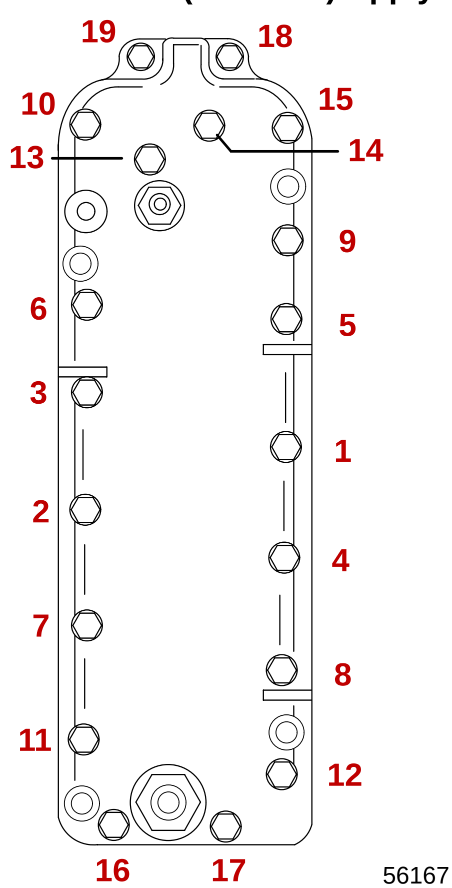
CRANKCASE COVER BOLTS (AND TORQUE SEQUENCE)



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

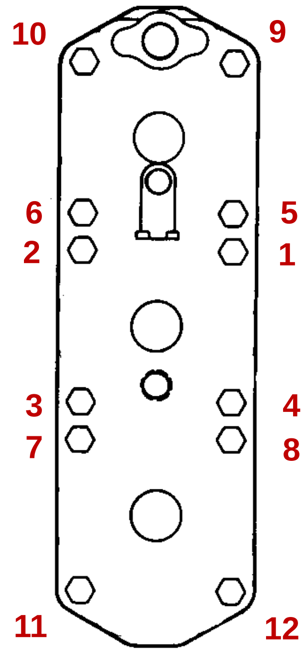
b - Bolts (5/16 in. - 18) 180 lb. in. (20 N·m)

EXHAUST DIVIDER PLATE BOLTS 16.5 lb. ft. (22.5 N·m) Apply Loctite 271 to threads



CYLINDER HEAD BOLTS

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



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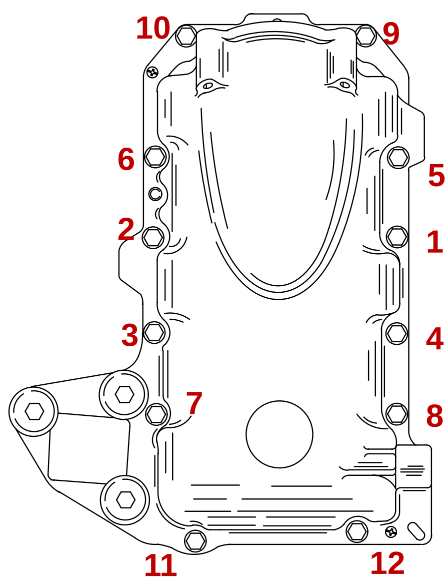
AIR PLENUM/REED BLOCK ASSEMBLY PLATE BOLTS

14.5 lb. ft. (19.5 N·m)



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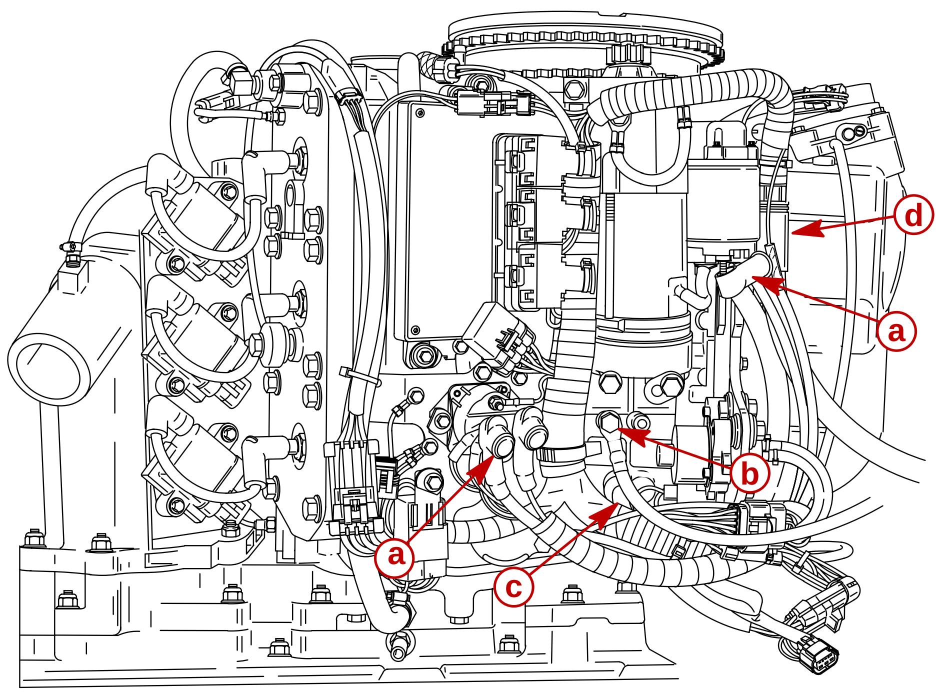
General Information

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 the pump unit.

Powerhead Removal from Pump Unit

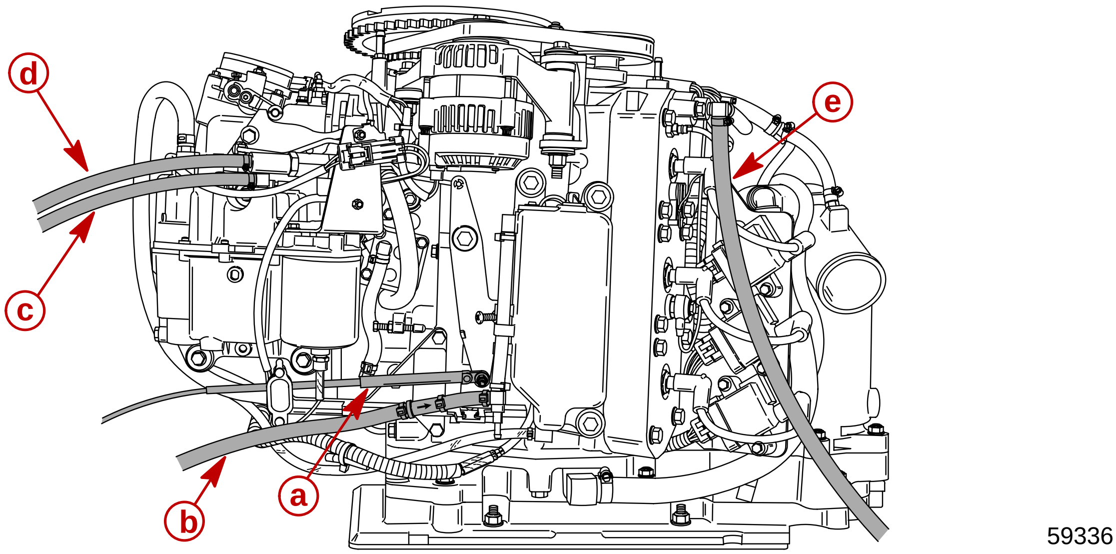
1. Disconnect battery cables from battery terminals. Remove positive battery cable from starter solenoid. Remove negative battery cable from lower front starter mounting bolt.
2. Disconnect remote oil tank hose.
3. Disconnect remote control harness from powerhead harness connector.



59229

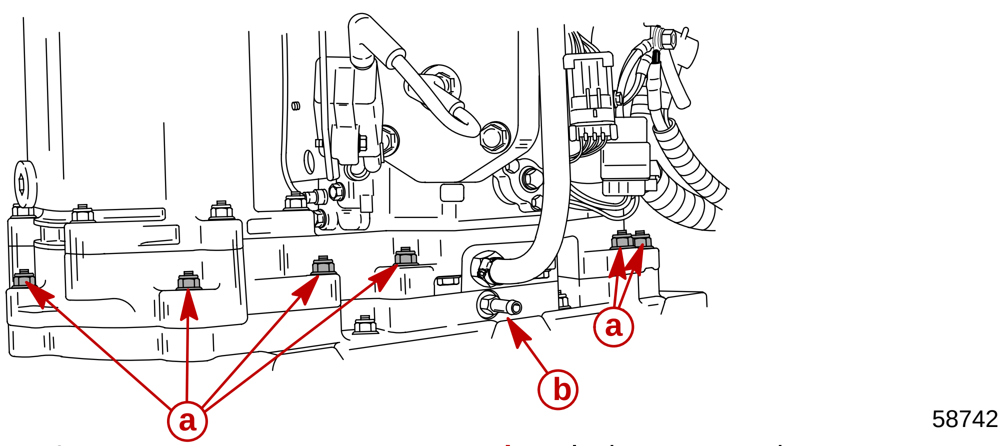
a - Positive Battery Cable
b - Negative Battery Cable
c - Remote Oil Tank Hose
d - Remote Control Harness

4. Remove throttle cable.
5. Remove fuel inlet line.
6. Disconnect water by-pass hose.
7. Disconnect oil inlet hose.
8. Disconnect vapor separator vent hose between vapor separator and boat hull.



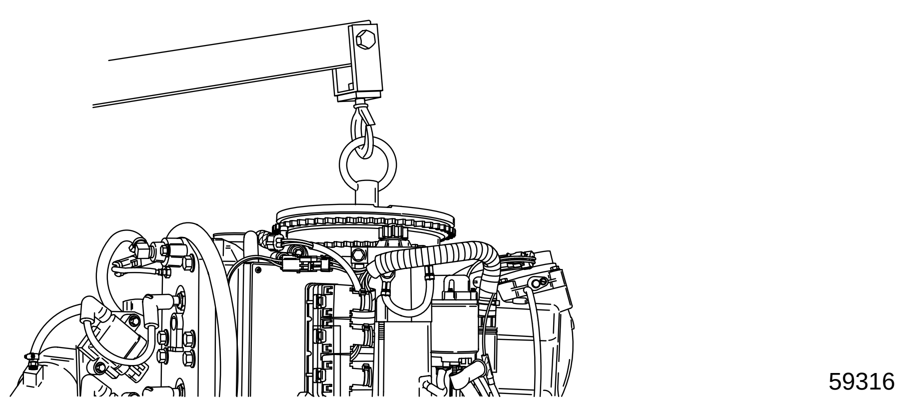
a - Throttle Cable
b - Oil Inlet Hose
c - Fuel Inlet
d - Vent Hose
e - Water By-Pass

9. Remove 11 nuts (5 nuts on opposite side) securing powerhead to housing cover.



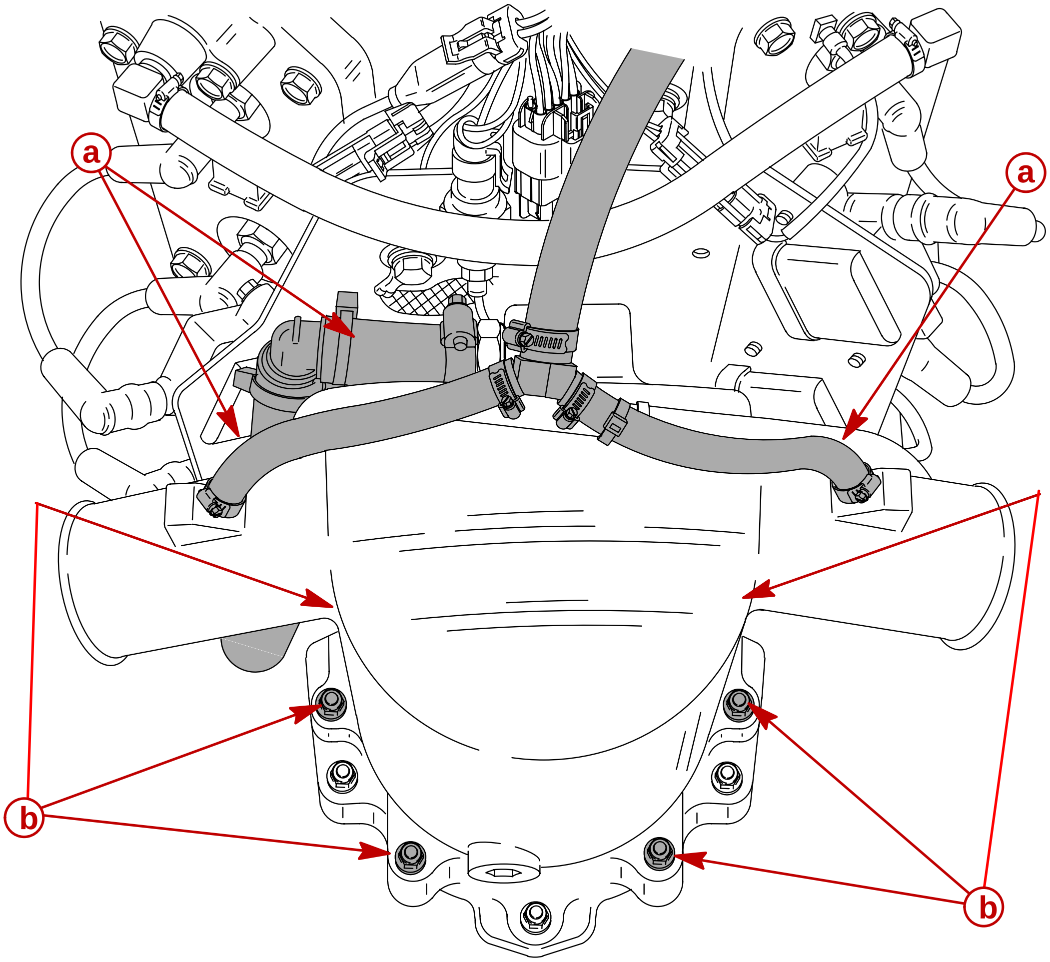
a - M10 x 1.5 Nuts
b - Flush Hose Attachment

10. Remove plastic cap from center of flywheel and install LIFTING EYE (91-90455) into flywheel at least five full turns. Using a hoist, lift powerhead assembly from pump unit.



11. Remove expansion chamber coolant hoses.

12. Remove 6 nuts securing expansion chamber and remove expansion chamber.



59312

a - Coolant Hose
b - Nuts (6)

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
Electronic Control Module
Ignition Coils
Slave Solenoid
Alternator
Flywheel

Section 3
Air Plenum
Fuel Rail and Injectors
Vapor Separator Assembly
Pulse Fuel Pump
Oil Pump
Oil Reservoir

Removing Engine Components as an Assembly

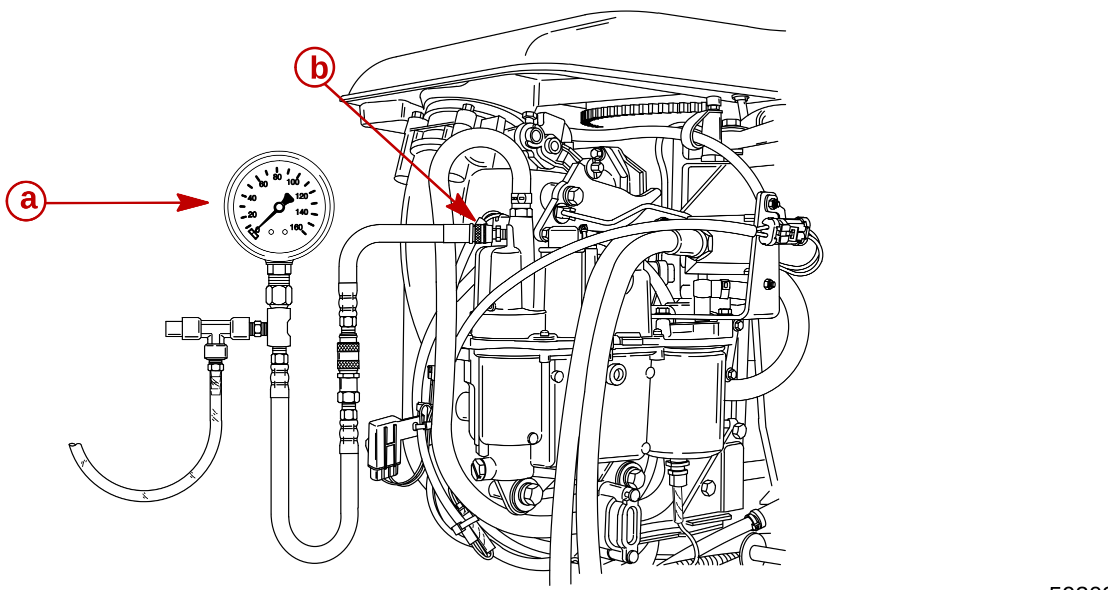
VAPOR SEPARATOR TANK (VST) REMOVAL

CAUTION

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

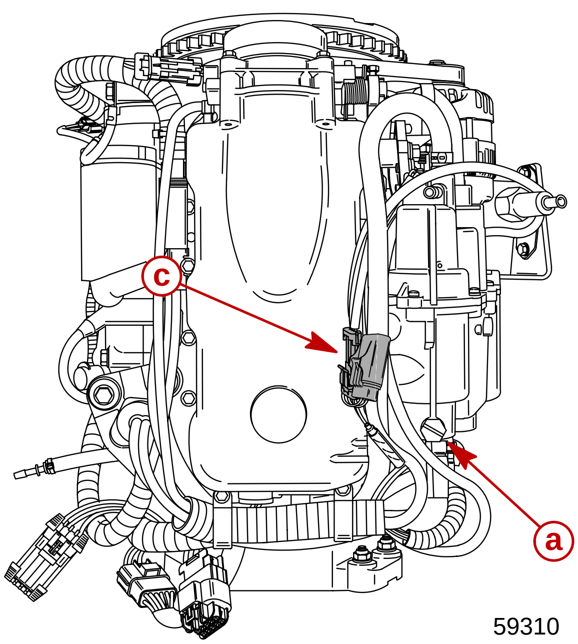
NOTE: *Use Fuel/Air Pressure Gauge 91-16850--1 or 91-852087A1/A2/A3 to de-pressurize air hose first and then fuel hose.*

1. De-pressurize fuel system.

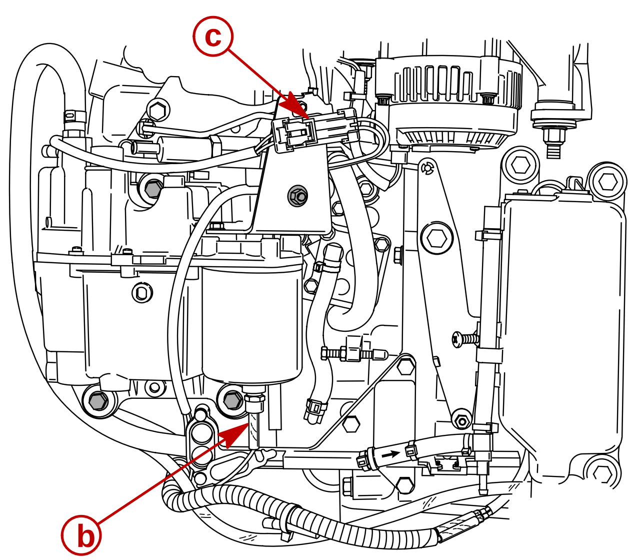


a - Fuel Pressure Gauge 91-881834A1 b - Fuel Pressure Port

2. Place suitable container underneath vapor separator drain plug and remove plug.
3. Disconnect water separator sensor lead.
4. Disconnect electric fuel pump harness connectors.

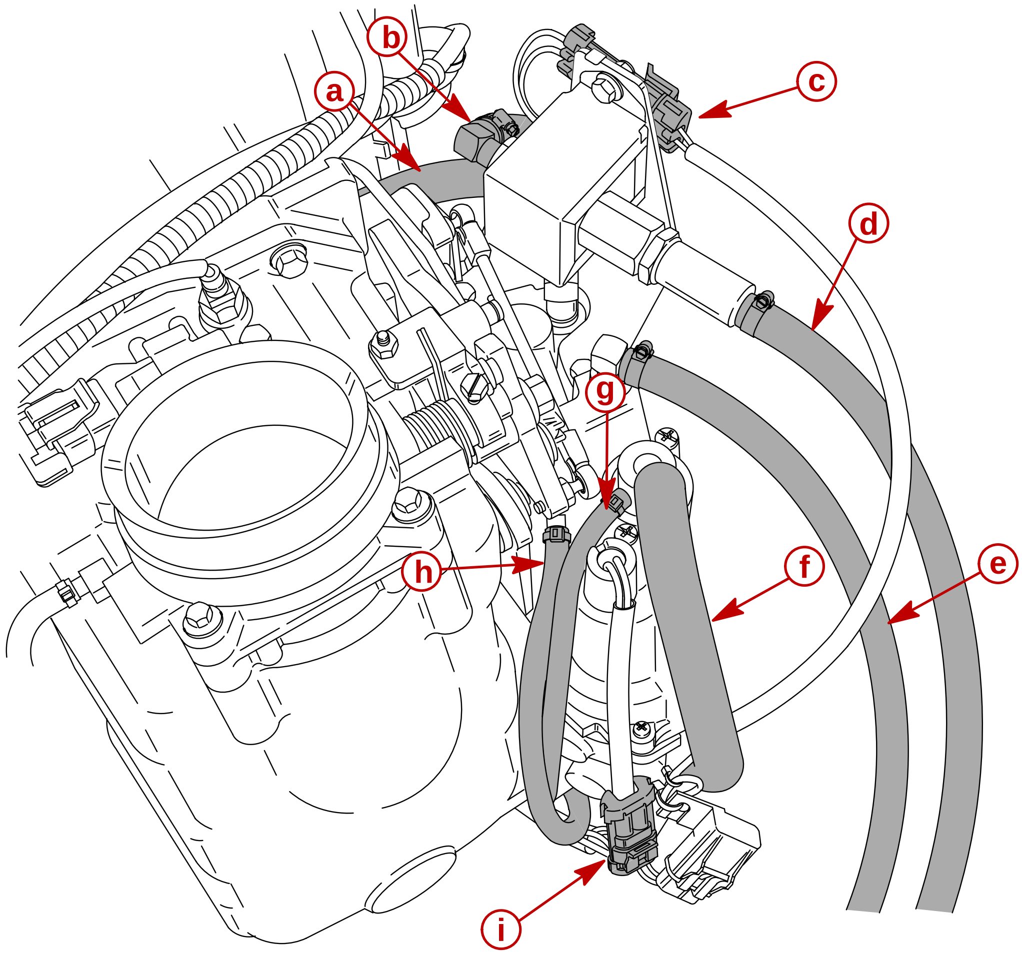


a - Drain Plug
b - Sensor Lead



c - Harness Connectors

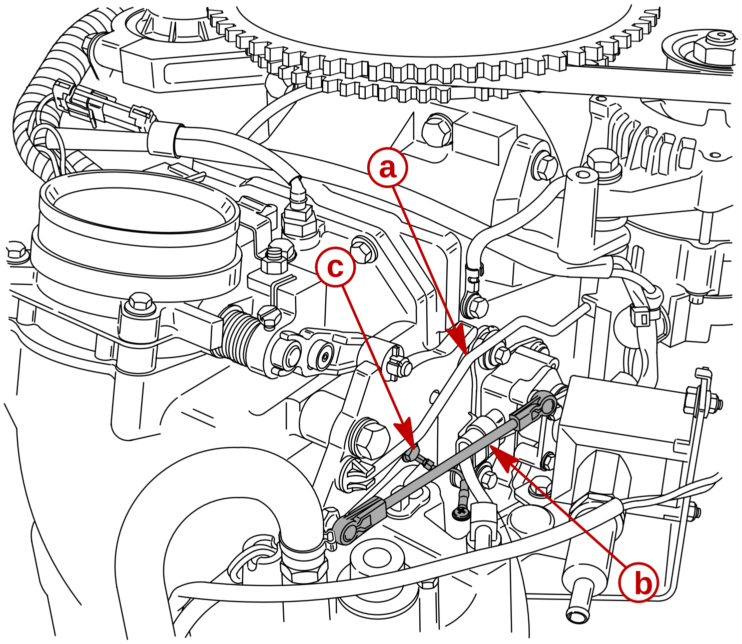
5. Disconnect the following hoses and connectors:



59302

a - Fuel Hose from Pulse Pump to Fuel/Water Separator
b - Fuel Hose from Fuel Lift Pump to Pulse Pump
c - Fuel Lift Pump Harness Connector
d - Fuel Hose from Fuel Tank to Fuel Lift Pump
e - VST Vent Hose
f - VST Output Fuel Hose
g - Fuel Pressure Regulator Vent Hose
h - VST Oil Input Hose
i - VST Electric Fuel Pump Harness Connector

6. Remove ground lead between VST and air plenum.
7. Disconnect throttle cam link rod and the Throttle Position Sensor link rod.



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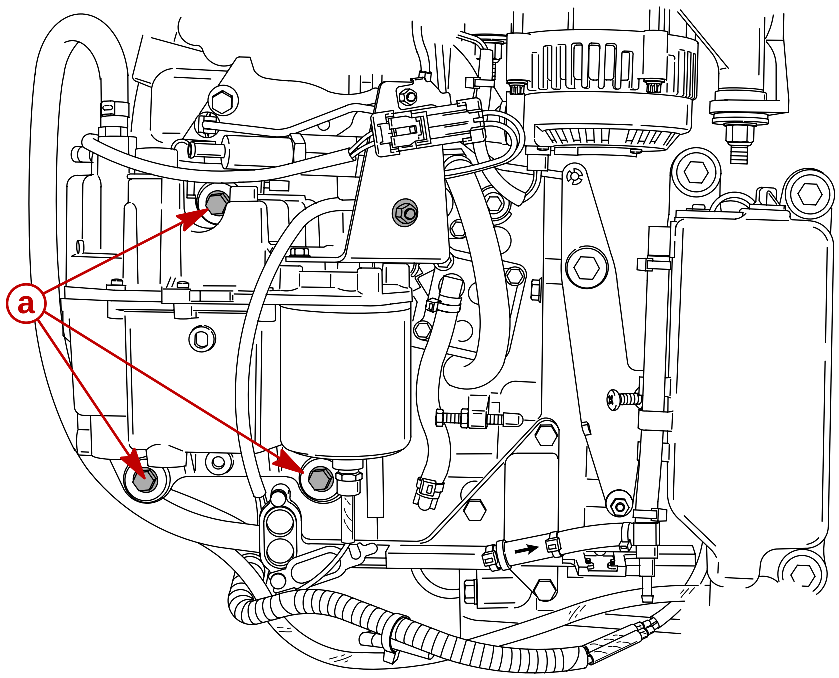
a - Throttle Cam Link Rod
b - TPS Link Rod
c - VST Ground Lead

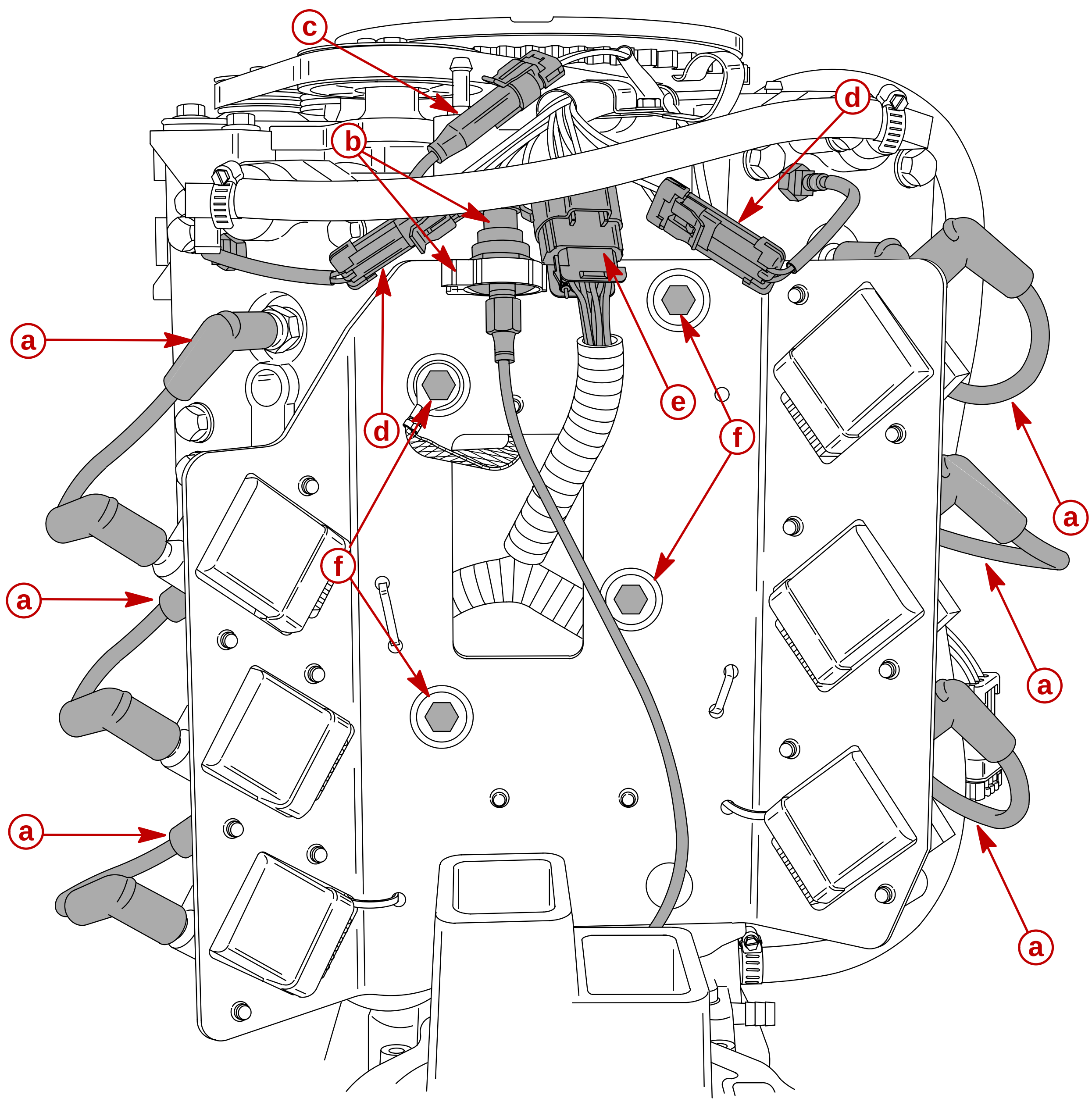
8. Remove 3 bolts securing VST to air plenum and remove VST.



59226

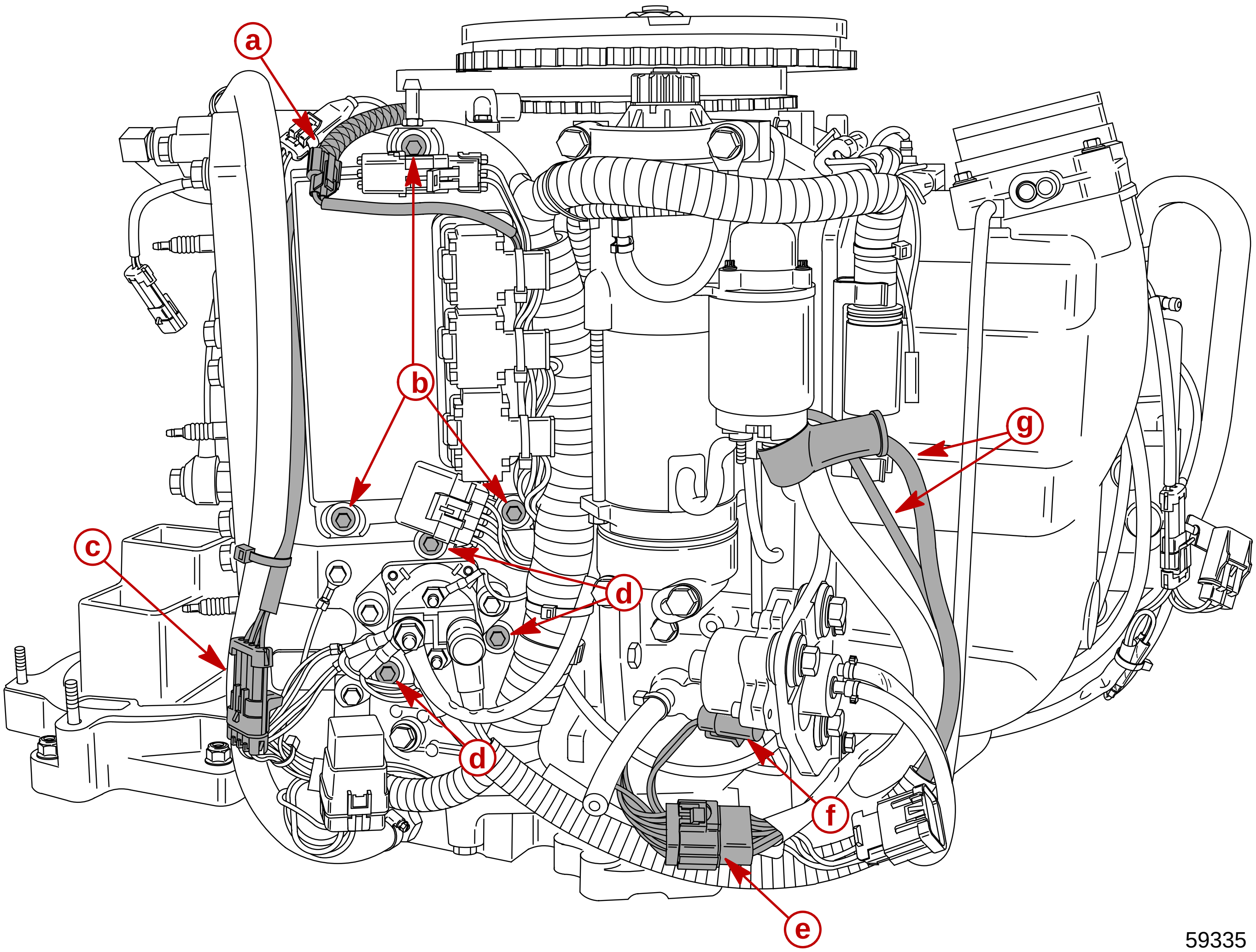
a - VST Attaching Bolts

Electrical Harness Removal

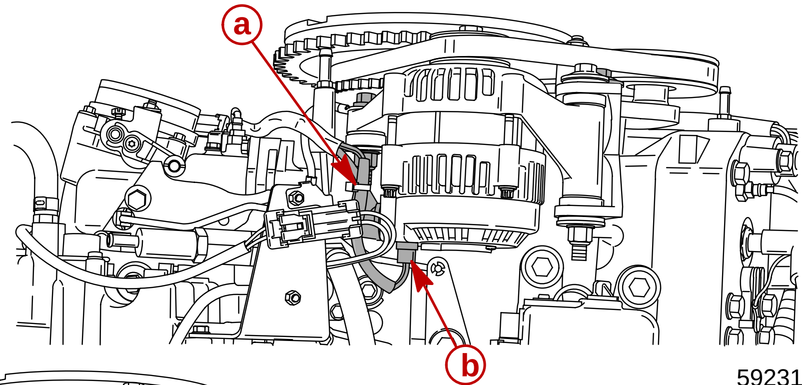


59313

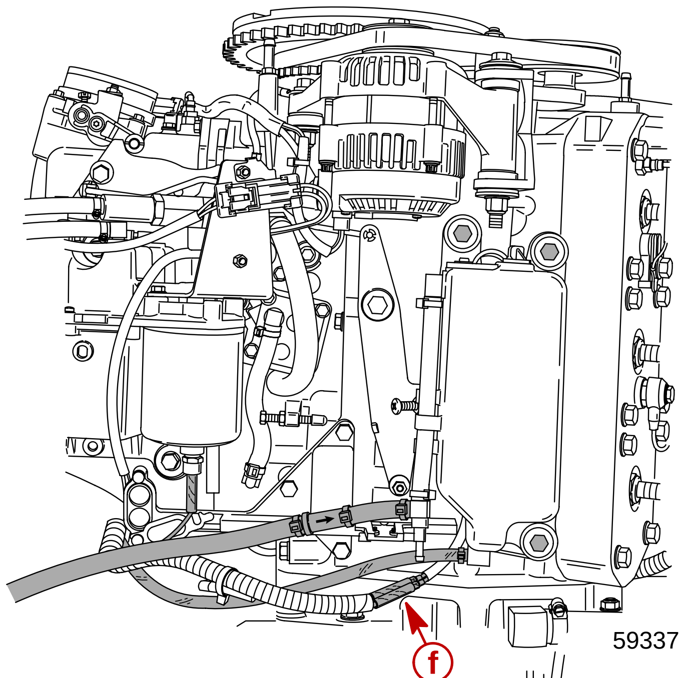
a - Disconnect Spark Plug Leads from Spark Plugs
b - Disconnect Water Pressure Sensor Harness and Sensor Retainer
c - Disconnect Detonation Sensor Harnesses (2)
d - Disconnect Temperature Sensor Harnesses
e - Disconnect Ignition Coil Harness Connector
f - Remove 4 Screws Securing Electrical Plate



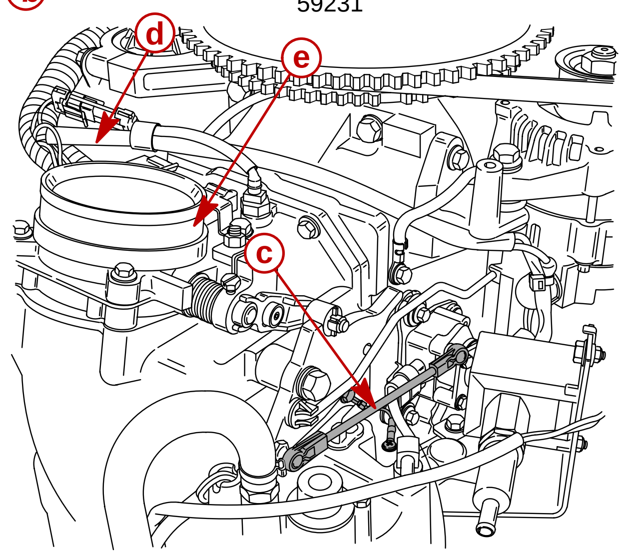
a - Disconnect Crank Position Sensor
b - Remove 3 screws securing ECM
c - Disconnect Knock Sensor Harness
d - Remove 3 screws securing Slave Solenoid Plate
e - Disconnect Fuel Injector Harness
f - Disconnect Oil Pump Harness
g - Disconnect RED and RED/YELLOW leads from Starter Solenoid



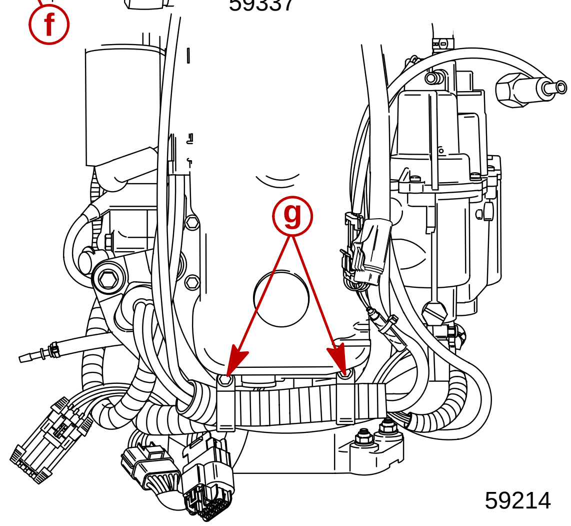
59231



59337



59224

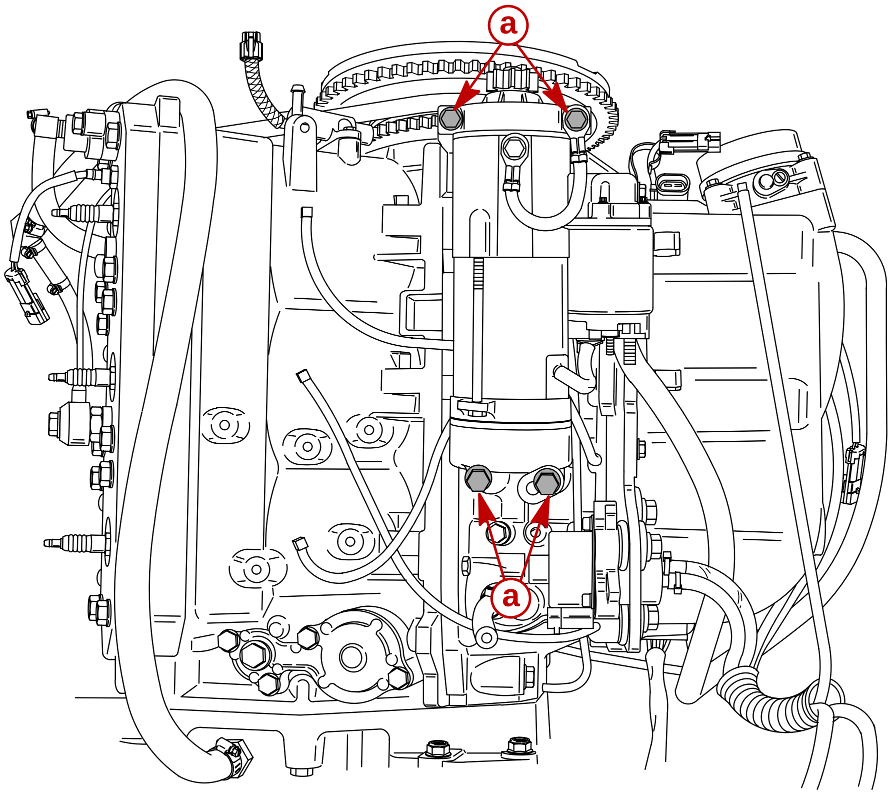


59214

a - Remove Output lead from Alternator
b - Remove Sense lead from Alternator
c - Disconnect TPS Harness Connection
d - Disconnect Air Temperature Sensor
e - Disconnect MAP Sensor
f - Disconnect Low Oil Sensor Bullet Connectors
g - Remove 2 screws securing harness clamps

9. Remove electrical harness assembly from engine.

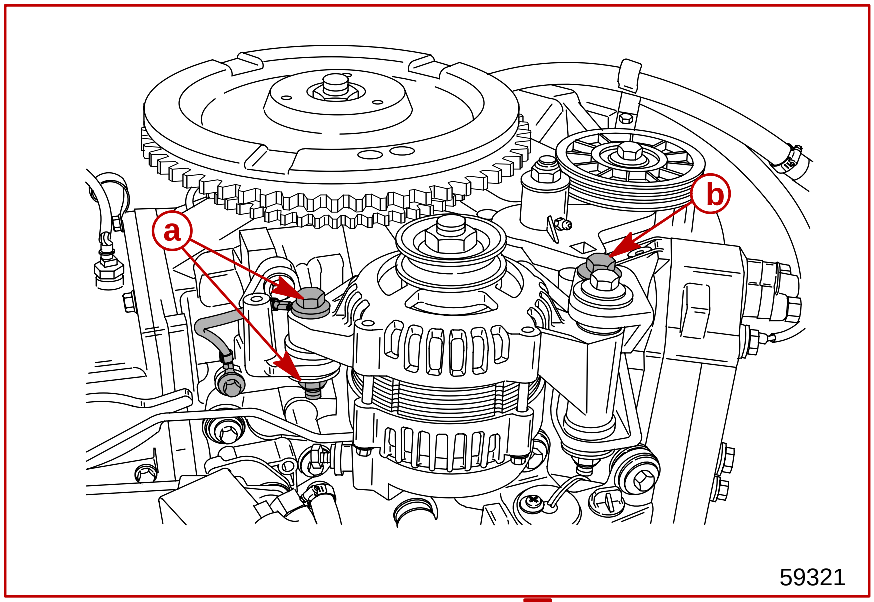
STARTER MOTOR REMOVAL

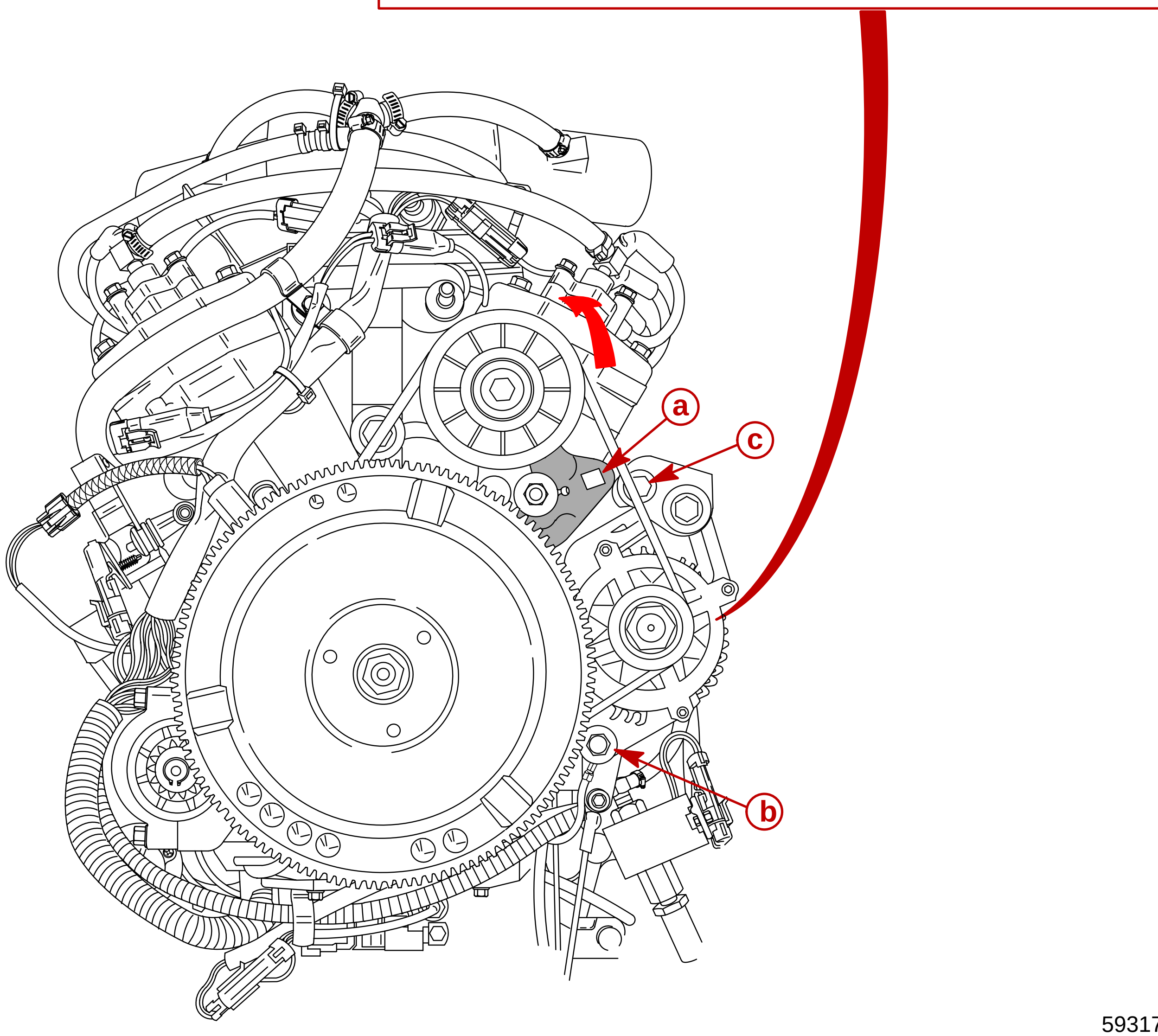


59325

a - Remove 4 Bolts Securing Starter Motor

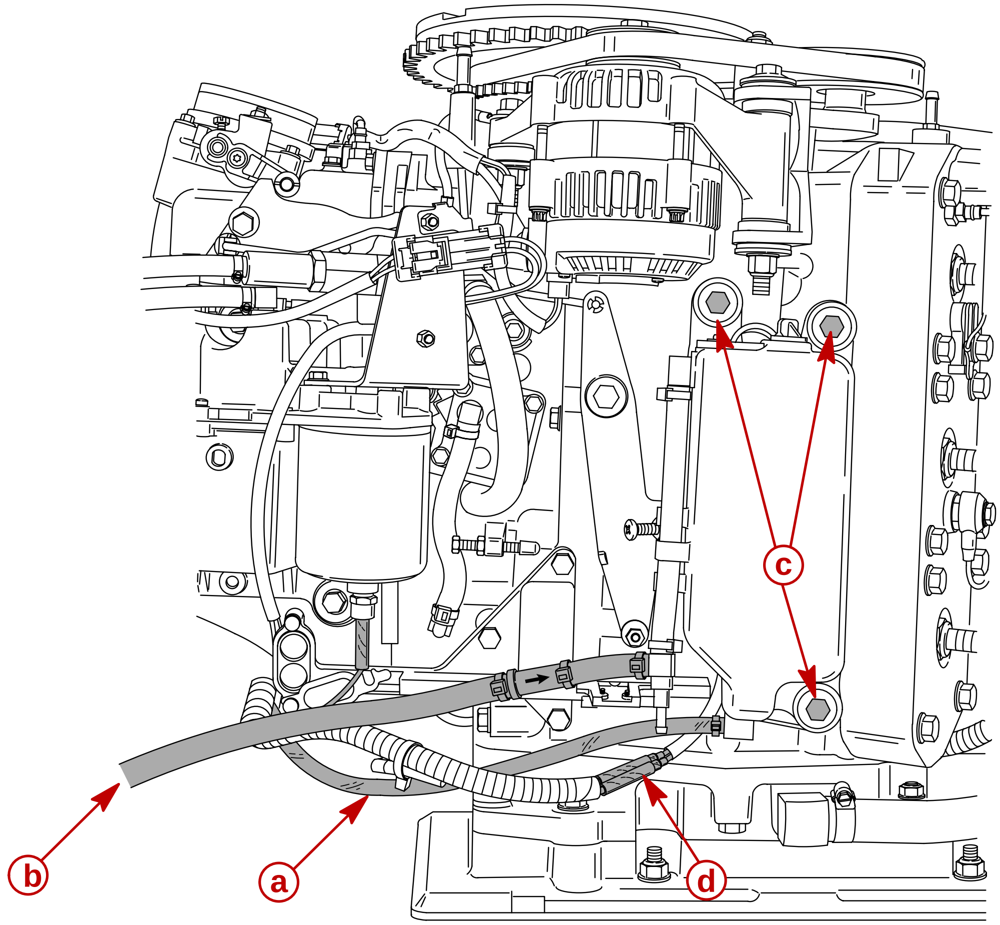
ALTERNATOR REMOVAL





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

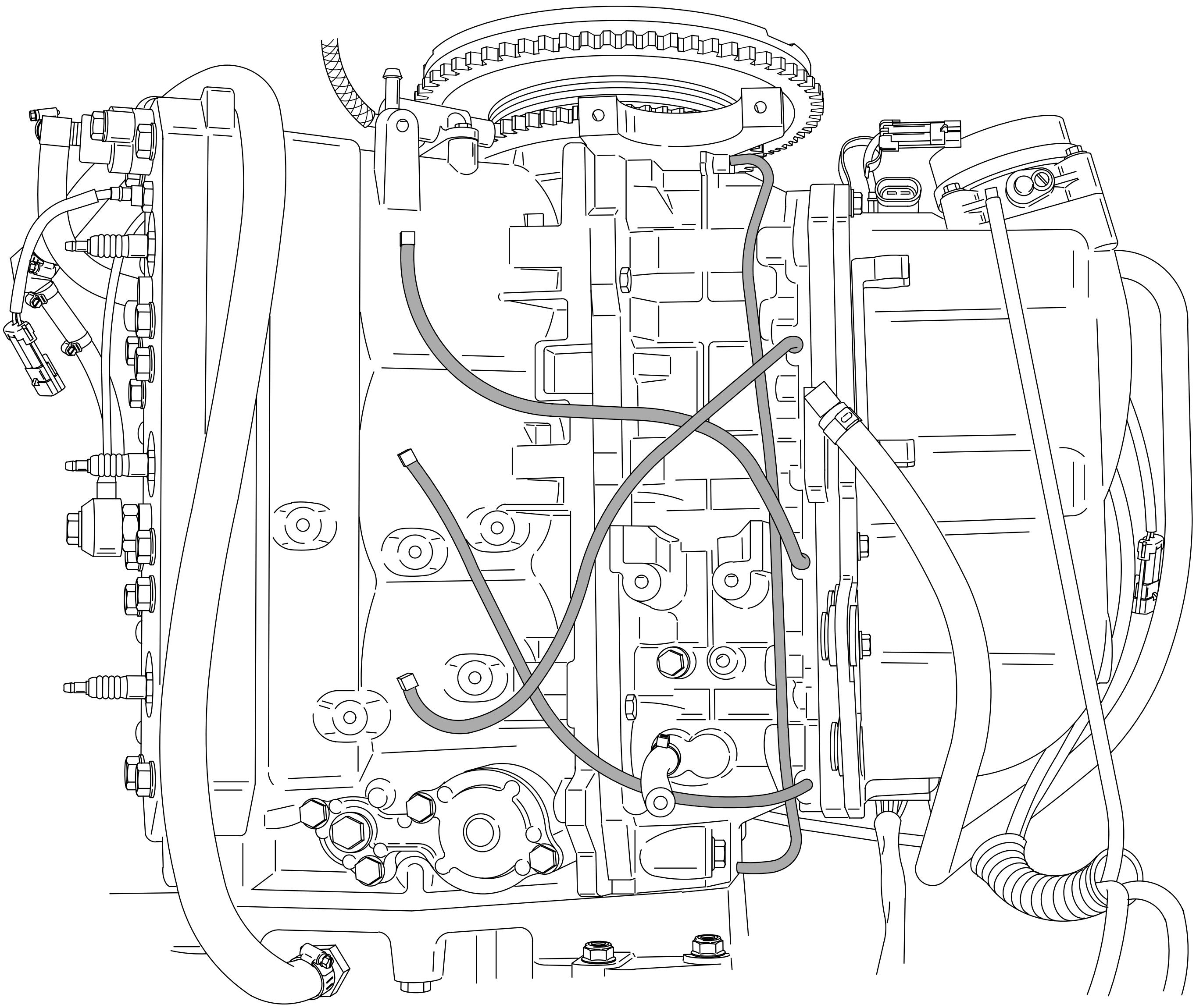
OIL RESERVOIR REMOVAL



59337

a - Plug Off Oil Hose to Oil Pump
b - Plug Off Incoming Oil Hose
c - Remove 3 Bolts Securing Reservoir
d - Disconnect Low Oil Sensor Bullet Connectors

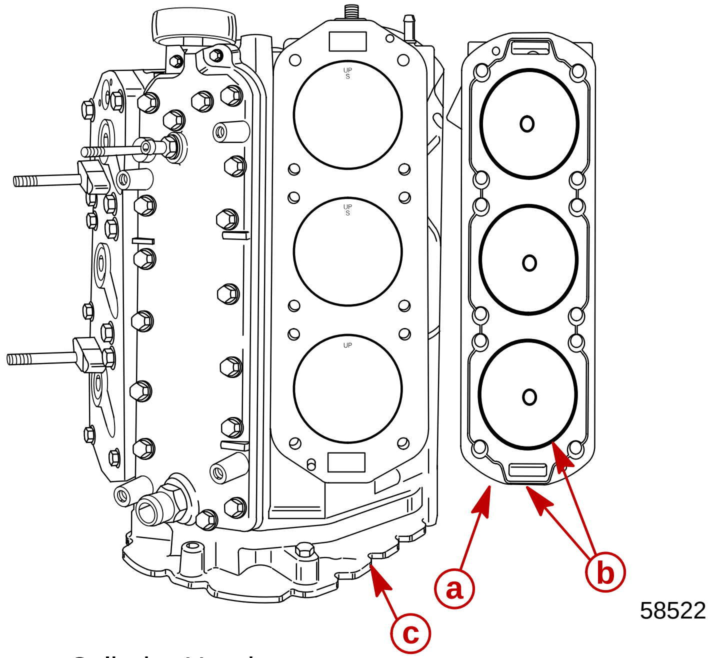
Starboard Side Oil Hose Routing



59324

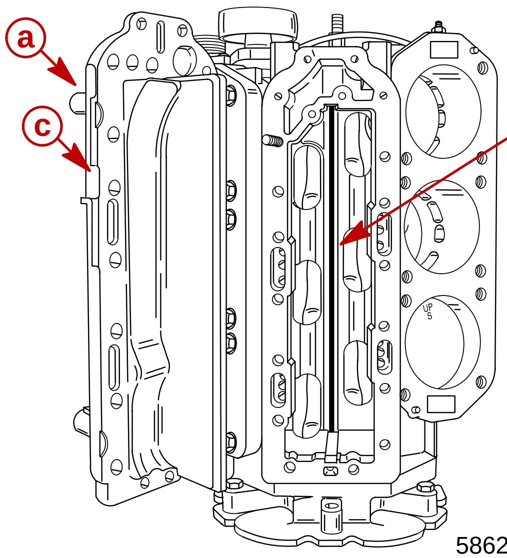
Powerhead Disassembly

1. Place powerhead in repair stand or on a bench.
2. Remove cylinder heads from engine block.

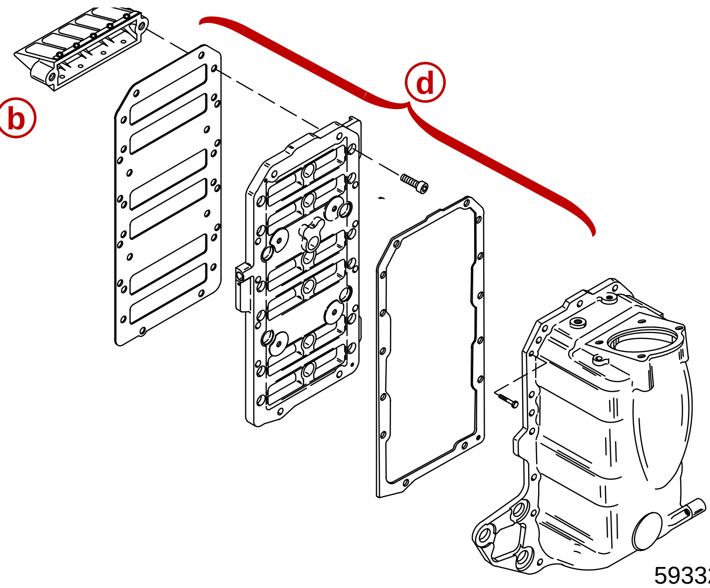


a - Cylinder Head
b - O-Rings
c - Engine Block

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



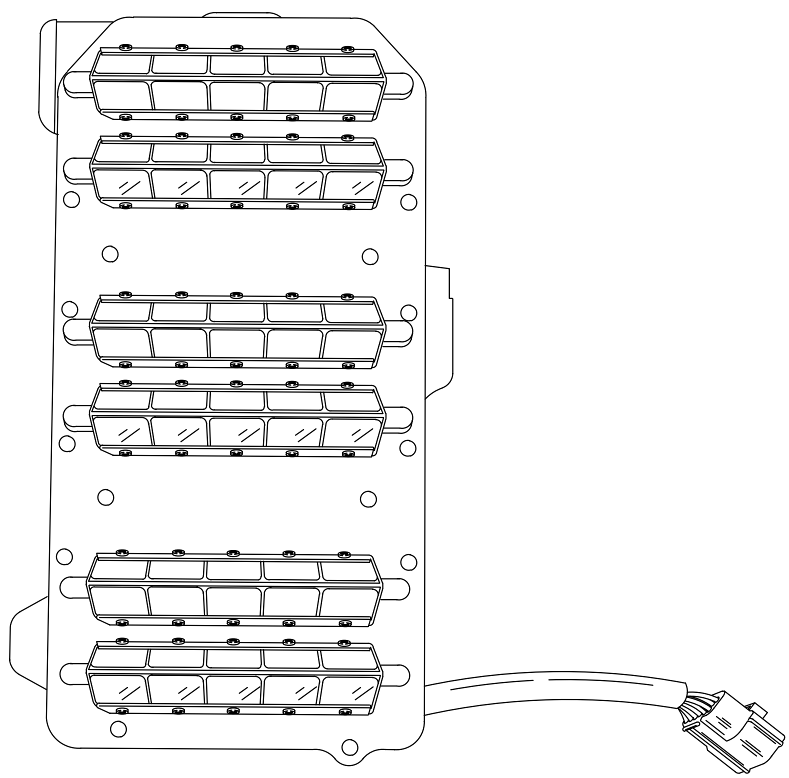
58623



59332

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

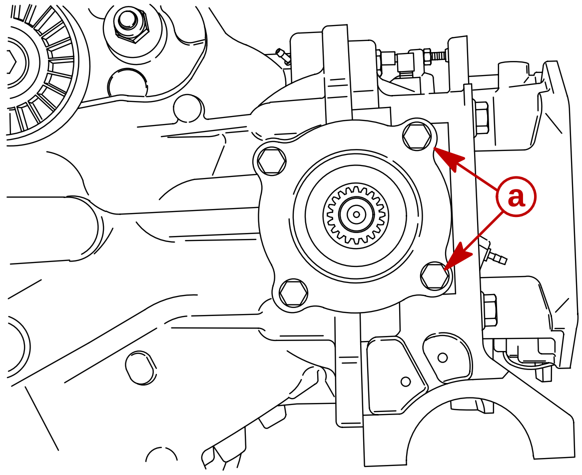
5. Inspect reeds as outlined in “Cleaning and Inspection”.



59328

6. Remove bolts from end caps.

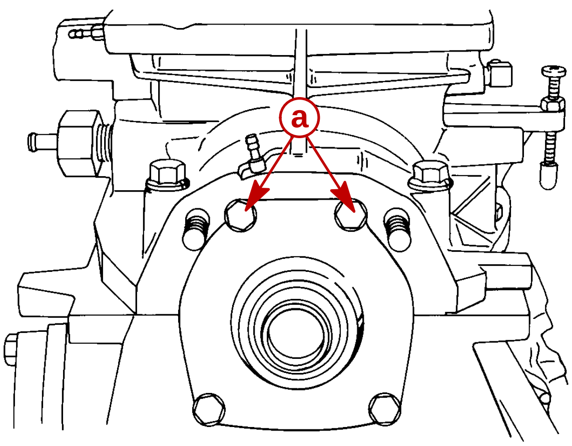
UPPER END CAP



59338

a - Crankcase Attaching End Cap Bolts

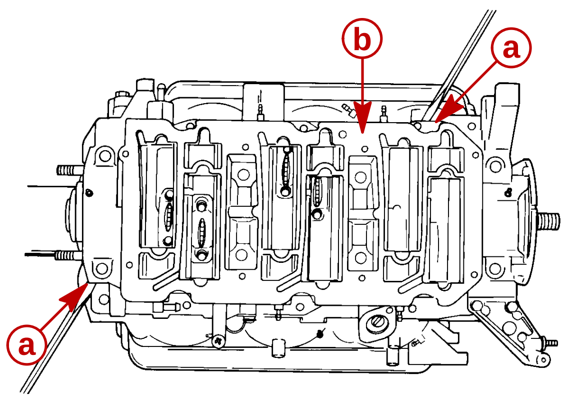
LOWER END CAP



51849

a - Crankcase Attaching End Cap Bolts

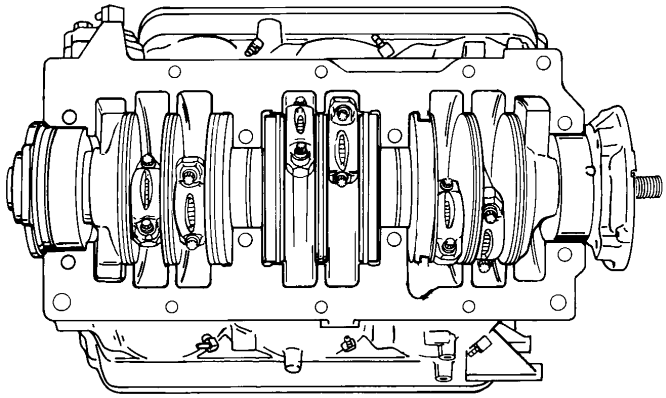
7. Remove bolts which secure crankcase cover to cylinder block.
8. Pry crankcase cover off cylinder block using pry bars in locations shown.



51845

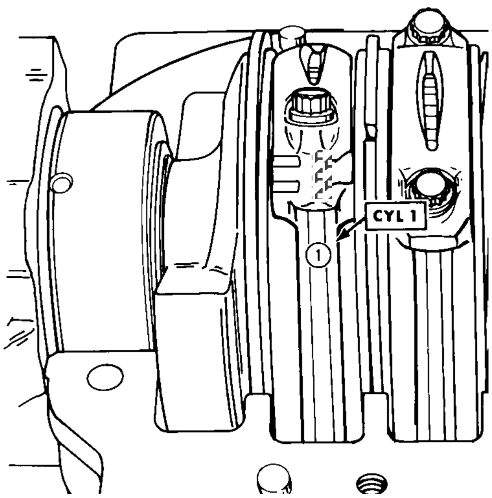
a - Pry Points
b - Crankcase Cover

CRANKCASE COVER REMOVED



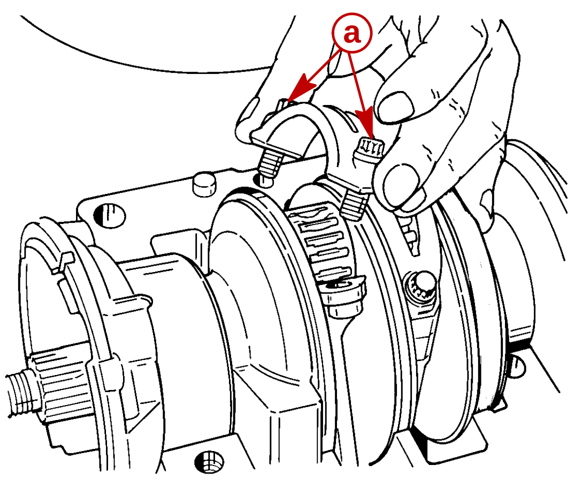
51848

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

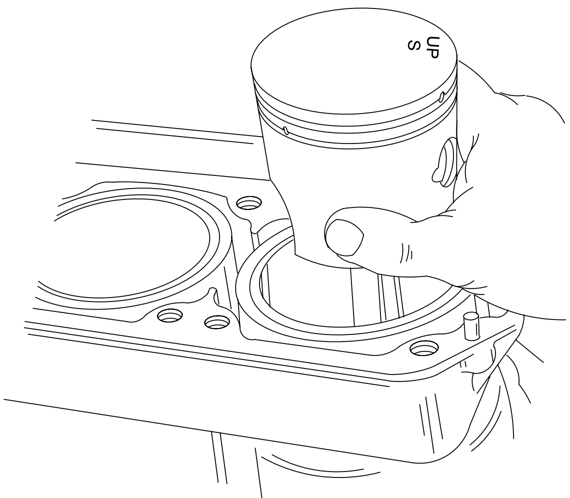
a - Connecting Rod Bolts

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

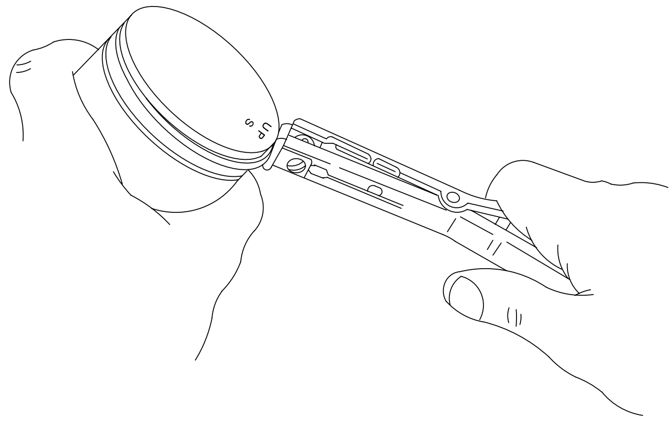
⚠ CAUTION

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.

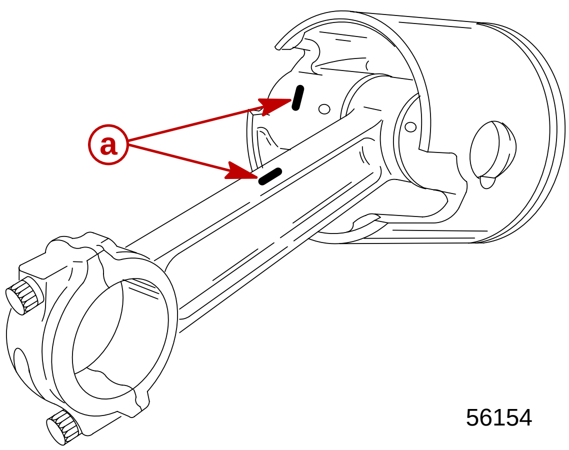


56153

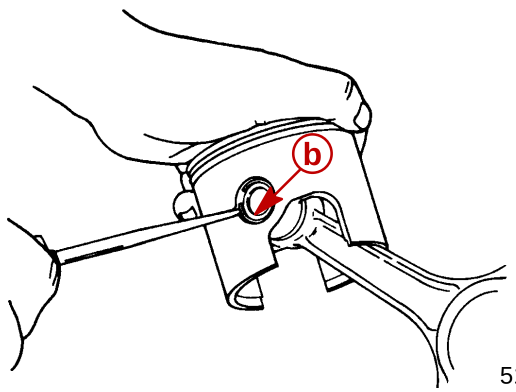


56155

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



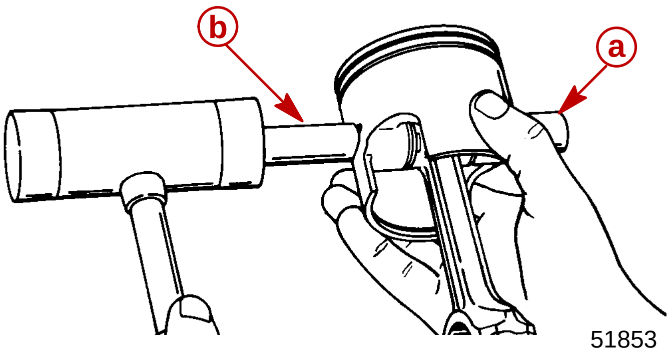
51083

a - Scribe Identification Number
b - Lockring

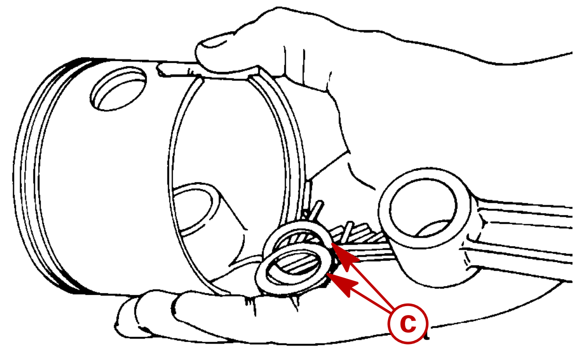
IMPORTANT: Warming the piston dome using a torch lamp will ease removal and installation of piston pin.

10. Support piston and tap out piston pin using service tool (91-92973A1) as shown.
11. Remove piston pin needle bearings (35 per piston) 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.



51853

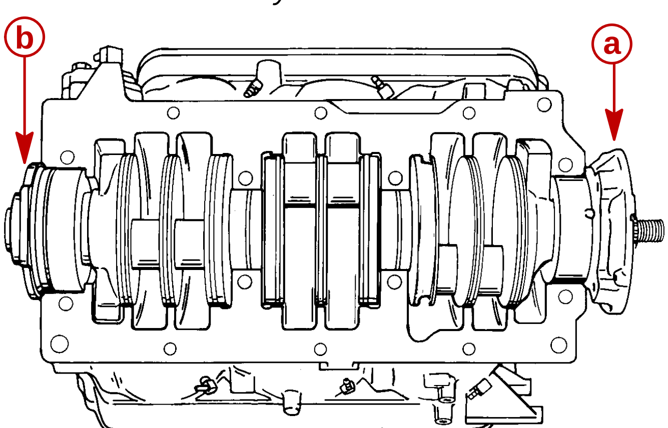


51088

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

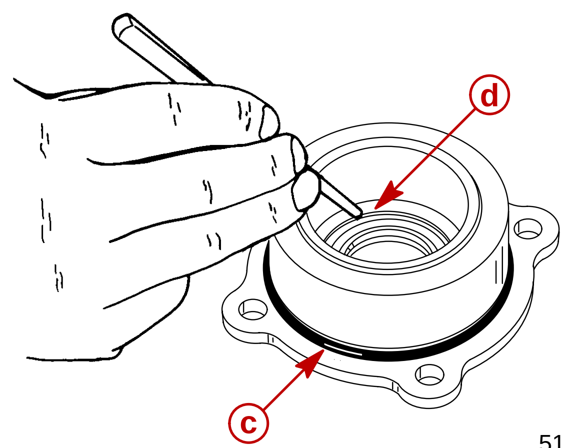
12. Remove upper end cap and lower end cap from crankshaft.
13. Remove and discard O-ring seals from each end cap.
14. Remove oil seal(s) from end of each end cap by driving seal out with a punch and hammer.
15. Inspect roller bearing in upper end cap as outlined in “Cleaning and Inspection”.

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



51848

a - Upper End Cap
b - Lower End Cap



51853

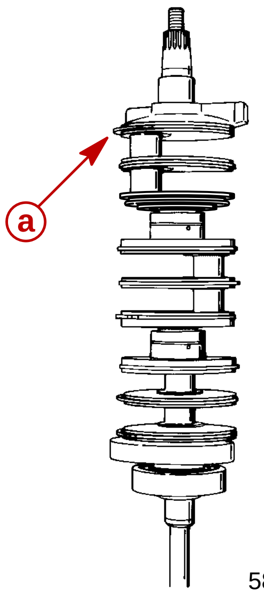
c - O-Ring
d - Seal

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

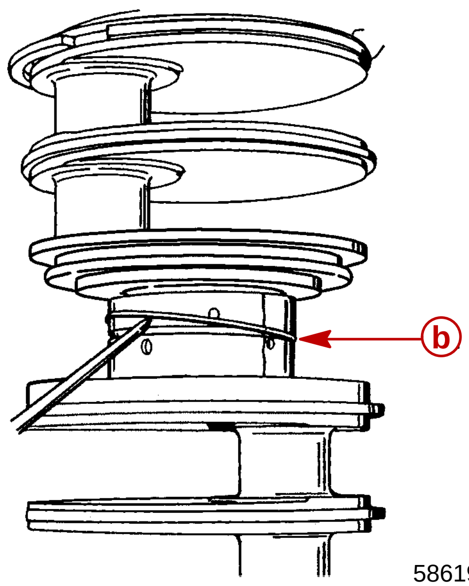
IMPORTANT: DO NOT remove crankshaft sealing rings from crankshaft, unless replacement of a sealing ring(s) is necessary. Usually, crankshaft sealing rings do not require replacement, unless broken.

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

17. Remove retaining ring as shown.



58617

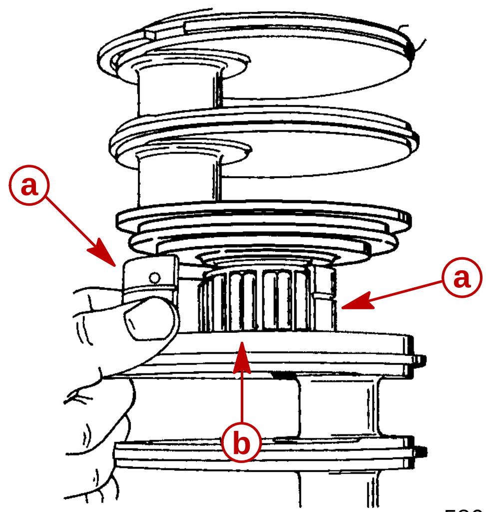


58619

a - Sealing Rings
b - Retaining Ring

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

IMPORTANT: Keep same bearing races and roller bearings together.



58614

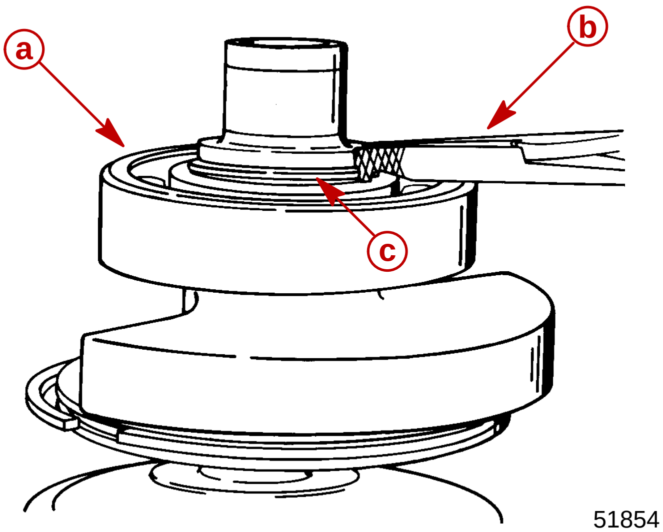
a - Bearing Race Halves
b - Roller Bearings

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

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

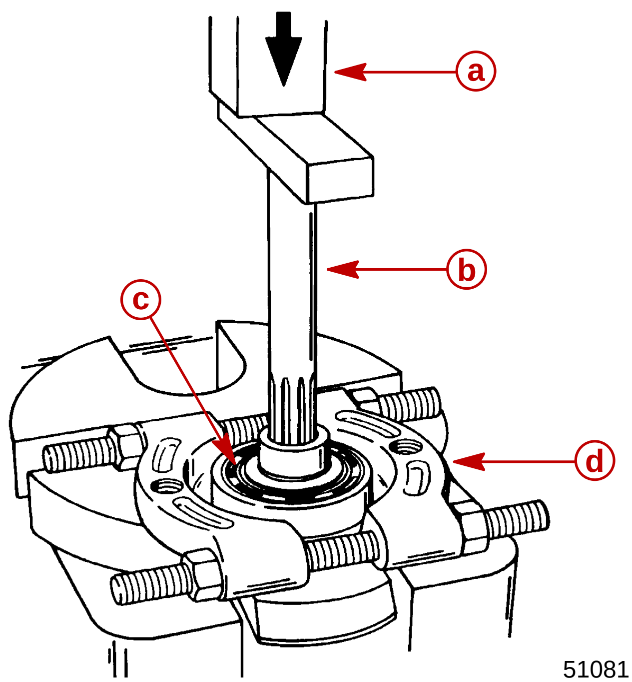
19. Remove lower ball bearing from crankshaft as follows:

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



a - Crankshaft Ball Bearing
b - Pliers
c - Retaining Ring

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

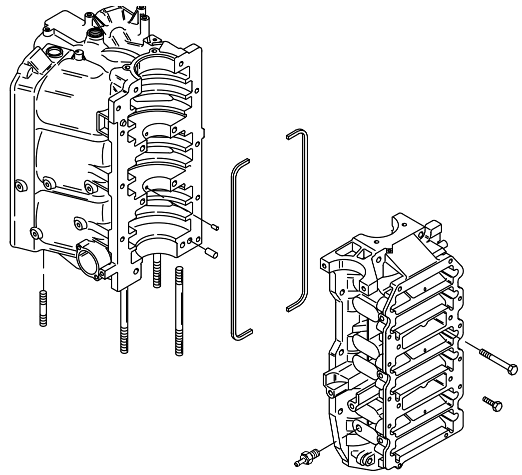


a - Press
b - Powerhead Stand (91-30591A1)
c - Crankshaft Ball Bearing
d - Universal Puller Plate (91-37241)

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.



59343

⚠ 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.

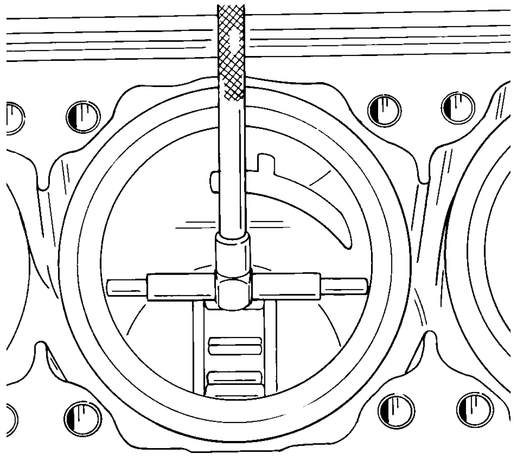
c. Start stroking at smallest diameter. Maintain firm stone pressure against cylinder wall to assure fast stock removal and accurate results.

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)
0.015 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

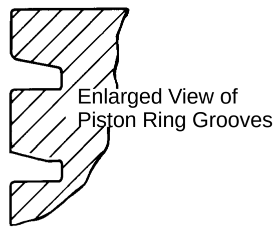
Keystone (tapered) ring grooves

⚠ 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



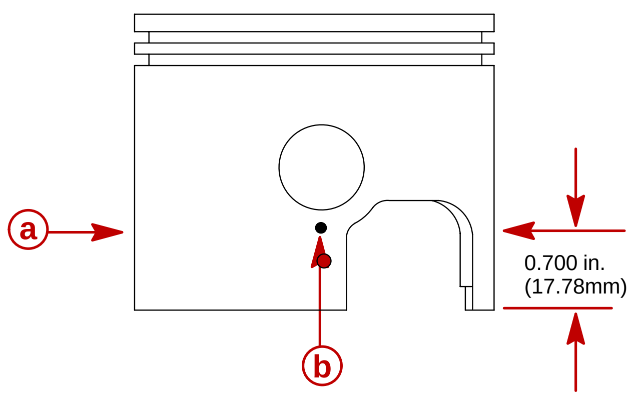
MEASURING PISTON ROUNDNESS

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. ± 0.0005 in.
0.015 in. Oversize Piston	3.5075 in. ± 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

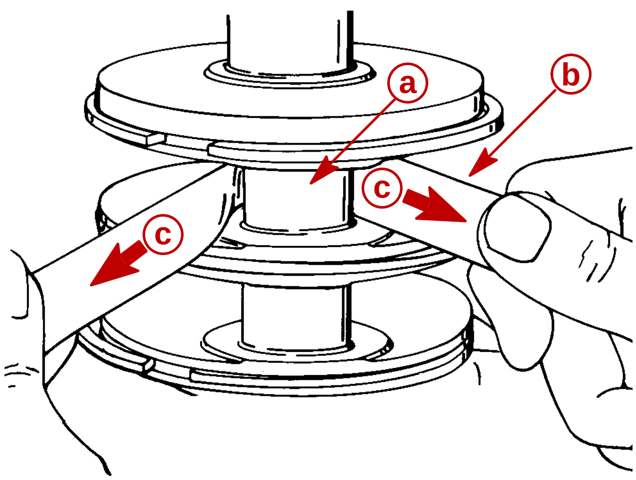
1. Inspect internal surface of cylinder heads for possible damage (as a result of piston or foreign material striking cylinder heads).

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

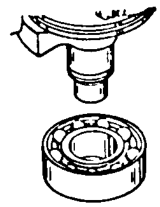
a - Crankshaft Journals
b - Crocus Cloth
c - Work Cloth "Back-and-Forth"

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

6. Thoroughly clean (with solvent) and dry crankshaft and crankshaft ball bearing. Recheck 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").

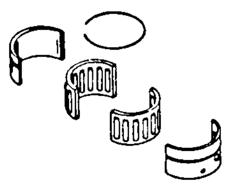


Lower Ball Bearing

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

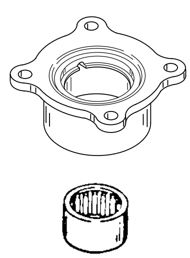
⚠ CAUTION
DO NOT intermix halves of upper and lower crankshaft center main roller bearings. Replace bearings in pairs only.

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.



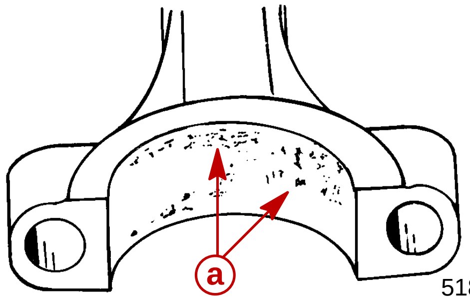
Upper Roller Bearing

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 through check valve "one way" only. If air can pass through a check valve both ways, valve is not working properly and must be replaced.

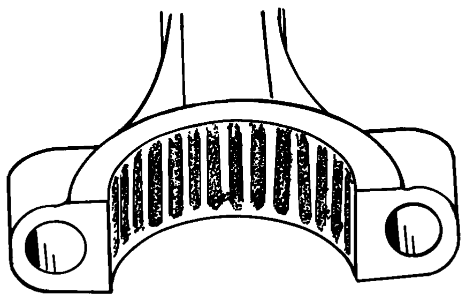
Connecting Rods

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).

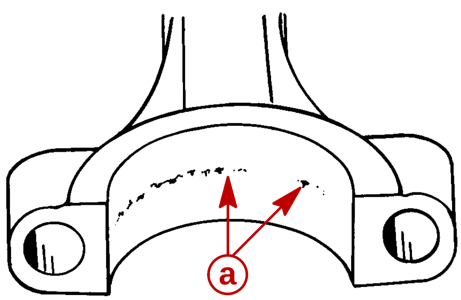


a - Pitting

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

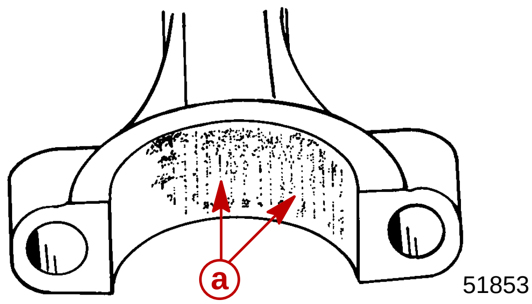


5. **Spalling:** Spalling is the loss of bearing surface, and it resembles flaking or chipping. Spalling will be most evident on the thrust portion of the connecting rod in line with the "I" beam. General bearing surface deterioration could be caused by or accelerated by improper lubrication.



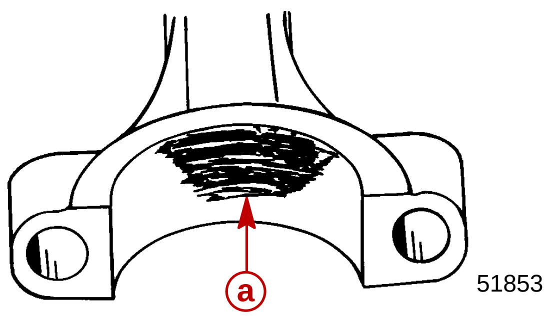
a - Spalling

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:

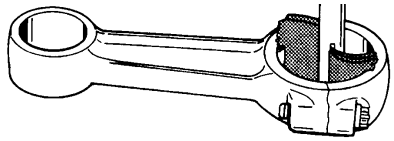
   a. Be sure that "etched" marks on connecting rod (crankshaft end) are perfectly aligned with "etched" marks on connecting rod cap. Tighten connecting rod cap attaching bolts securely.

⚠ 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.

   b. **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.



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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.

Powerhead Reassembly and Installation

General

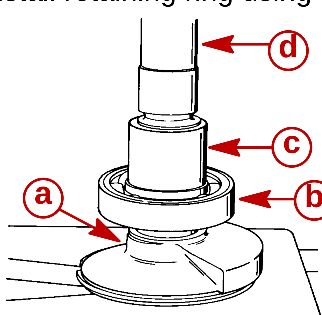
Before proceeding with powerhead reassembly, be sure that all parts to be re-used have been carefully cleaned and thoroughly inspected, as outlined in “Cleaning and Inspection,” preceding. Parts, which have not been properly cleaned (or which are questionable), can severely damage an otherwise perfectly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

During reassembly, lubricate parts with 2-Cycle Outboard Lubricant whenever “light oil” is specified. 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.



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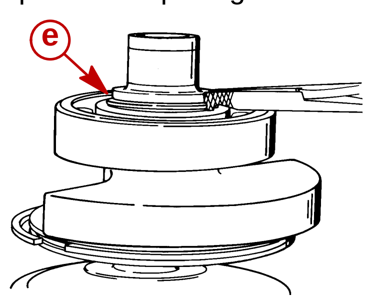
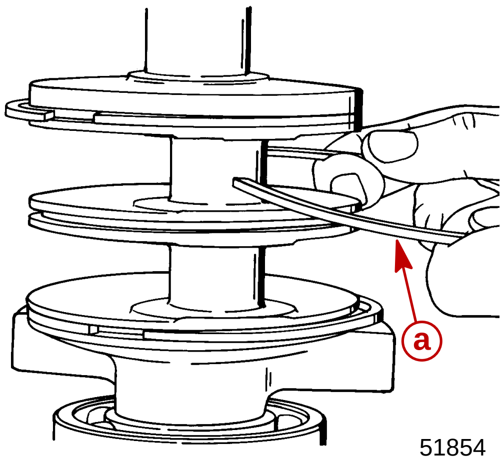


51854

a - Crankshaft
b - 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.



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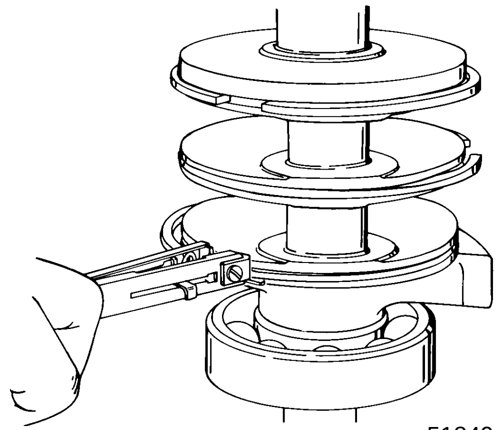
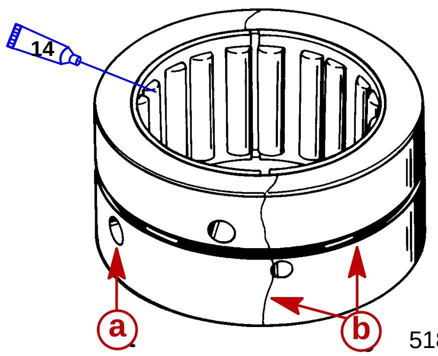


51849

a - Crankshaft Sealing Rings

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



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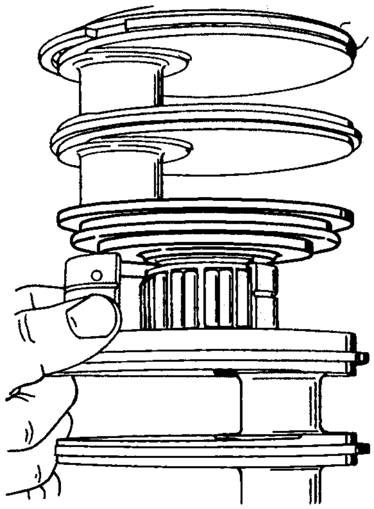
14 2 Cycle Outboard Oil

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.

FLYWHEEL END



DRIVE SHAFT END

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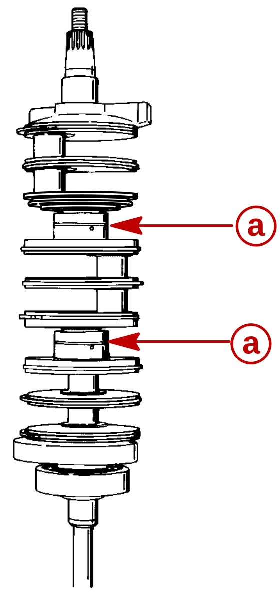
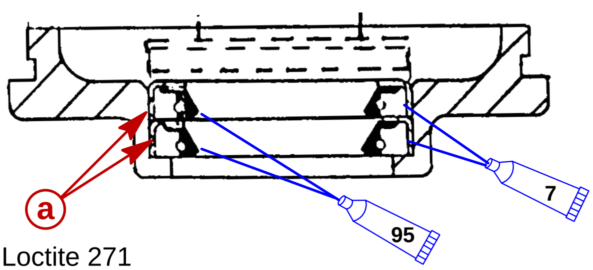
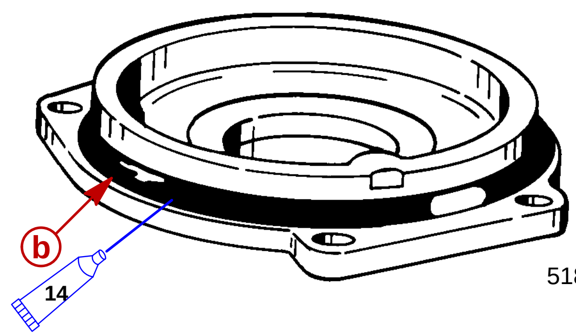


58617

a - Center Main Bearing Races

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 2-4-C with Teflon.
   e. Lubricate O-ring seal surface on end cap with 2 cycle oil. Install o-ring over lower end cap.





51849

7 Loctite 271

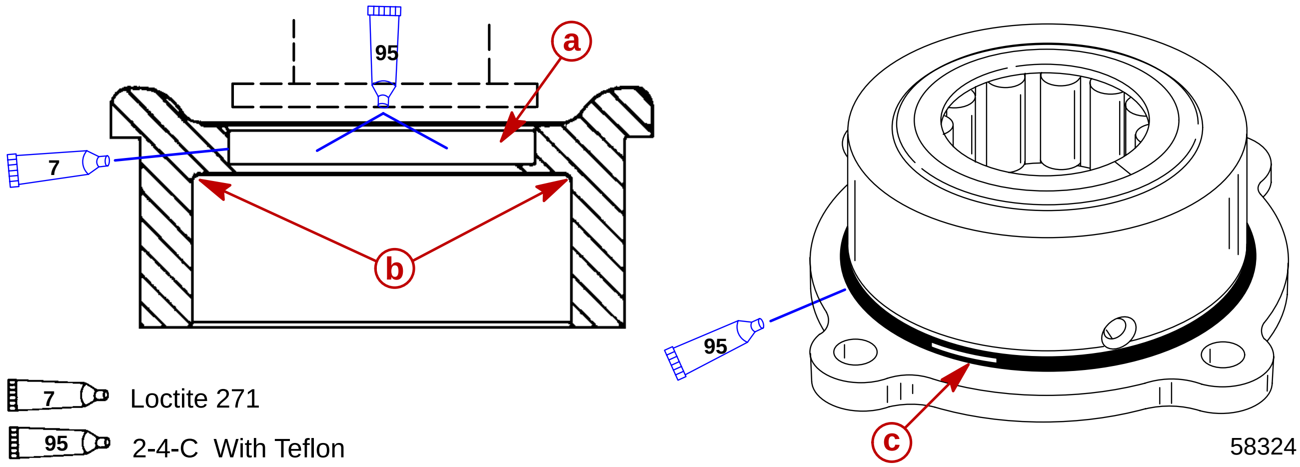
14 2 Cycle Outboard Oil

95 2-4-C With Teflon

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 2-4-C with Teflon.
    d. Lubricate O-ring seal surface on end cap with 2-4-C with Teflon. Install O-ring on end cap.



a - Oil Seal
b - Lip of End Cap
c - O-ring

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.

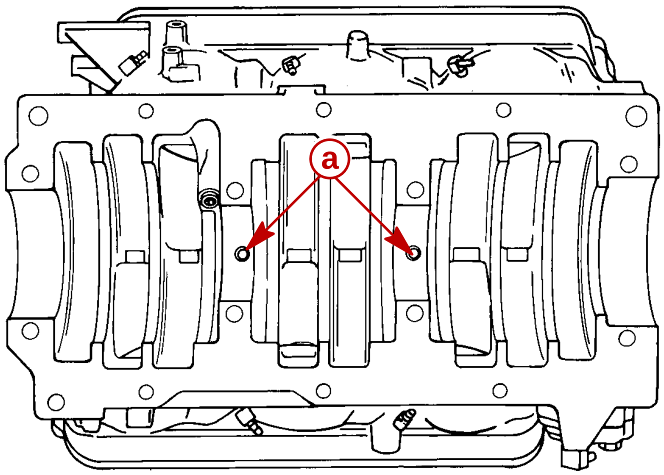
Before installing crankshaft, remove any burrs that may exist on groove edges.

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.

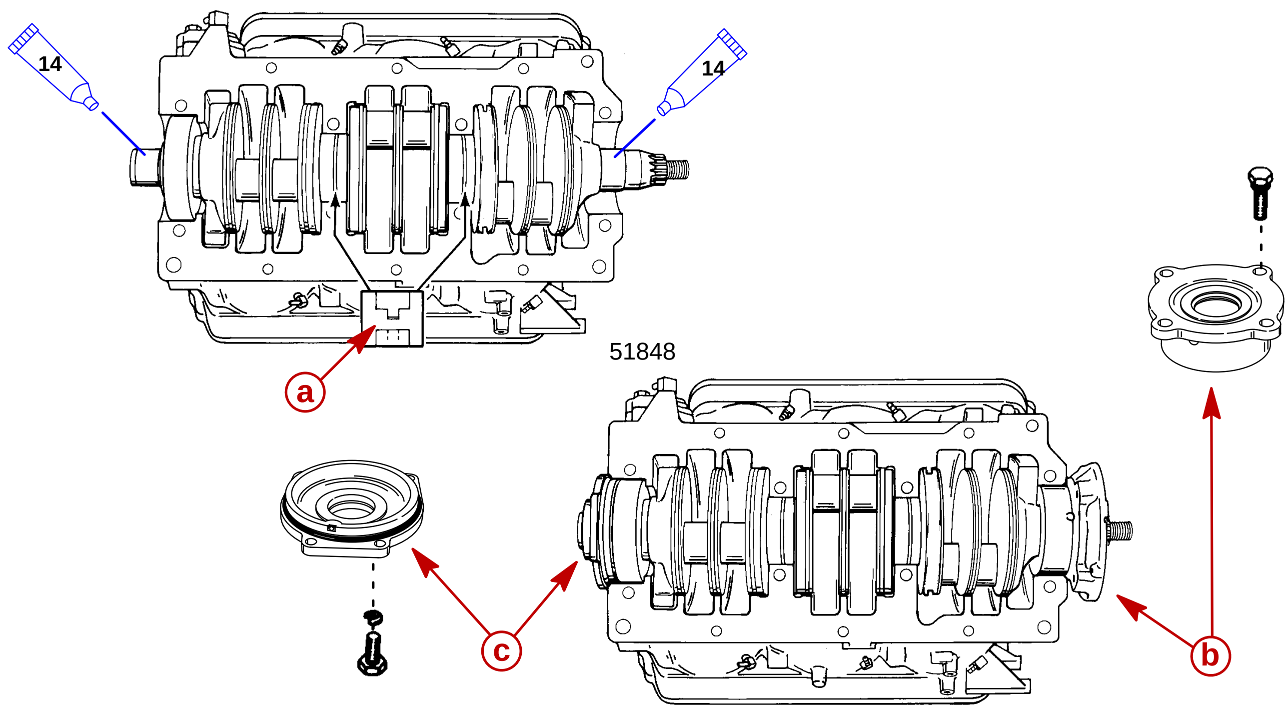
Install crankshaft as follows:

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



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.



14 2 Cycle Outboard Oil

a - Dowel Pin
b - Upper End Cap
c - Lower End Cap

Piston and Connecting Rod Reassembly

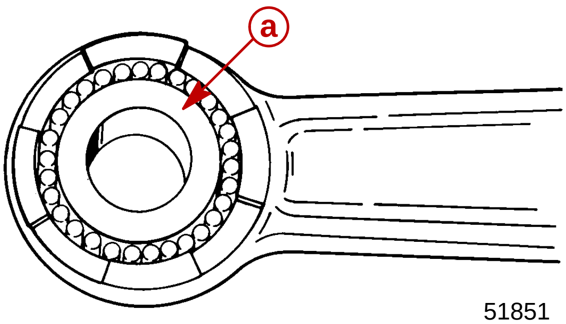
1. Place needle bearings on a clean piece of paper and lubricate with 2-4-C with Teflon Marine Lubricant.

NOTE: *There are 35 needle bearings per piston*

2. Place sleeve which is part of piston pin tool (91-92973A1) 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.



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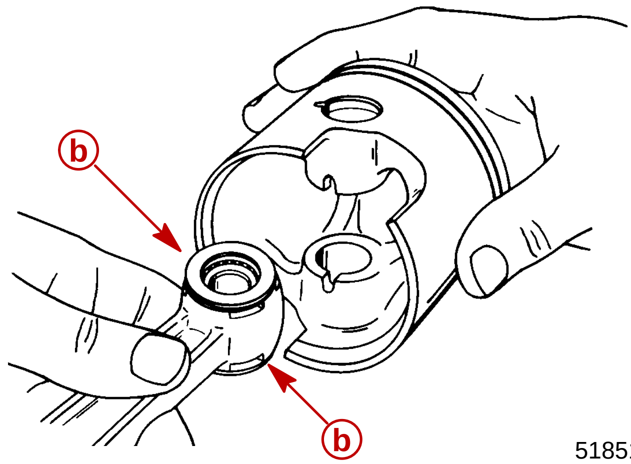

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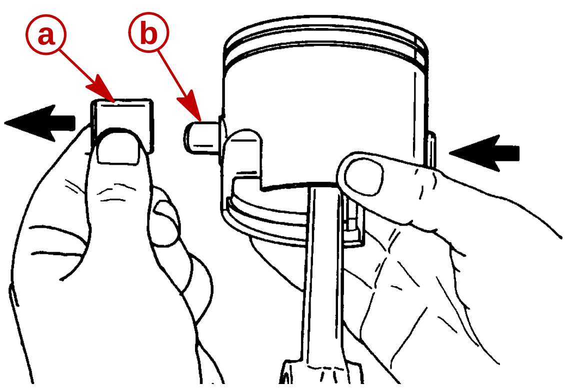
a - Sleeve
b - Locating Washers

4. Insert piston pin tool (91-92973A1) 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.



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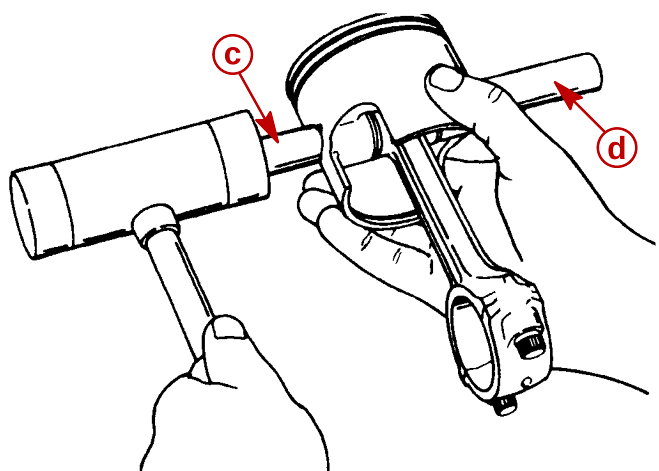

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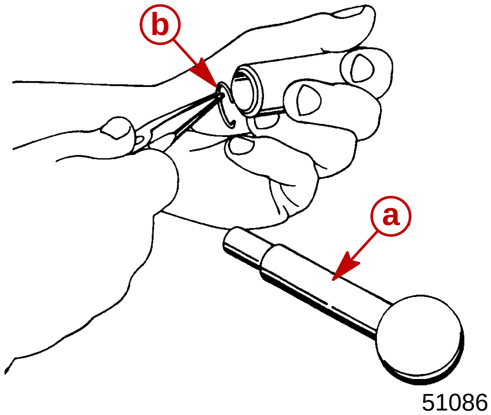
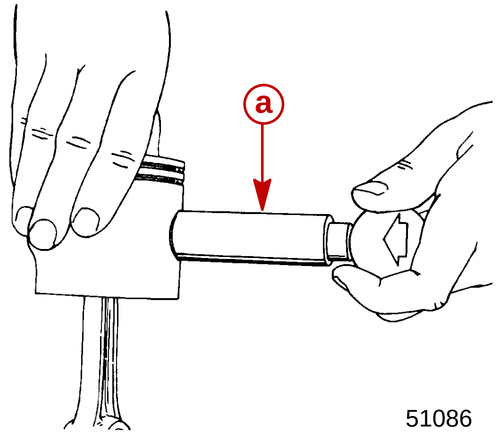
a - Piston Pin Tool
b - Sleeve

c - Piston Pin
d - Piston Pin Tool

6. Install new piston pin lockrings (one each end of piston pin) with Lockring Installation Tool (91-93004A2).

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



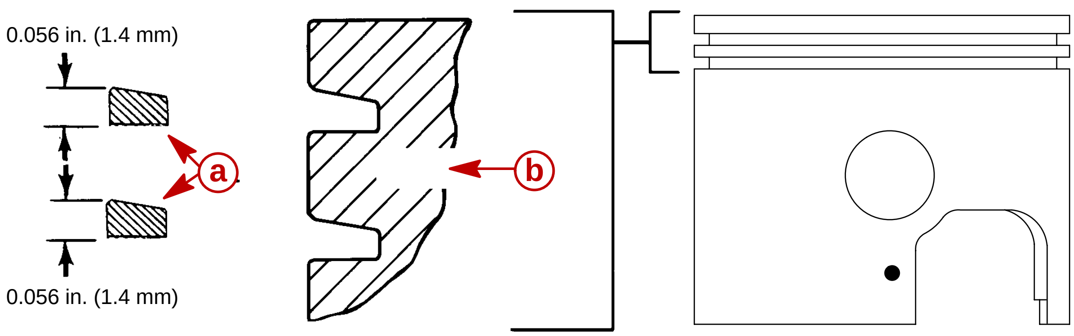


a - Lockring Installation Tool
b - Lockring

Piston and Piston Ring Combinations

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

Pistons with two half keystone (half tapered) rings

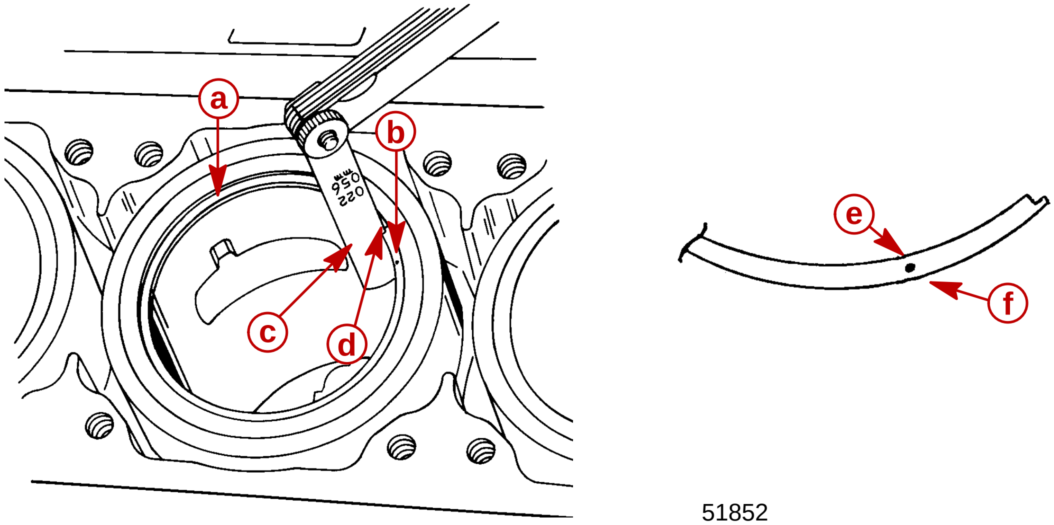


a - Half Keystone (half tapered) Piston Ring
b - Enlarged View of Piston Ring Grooves

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.



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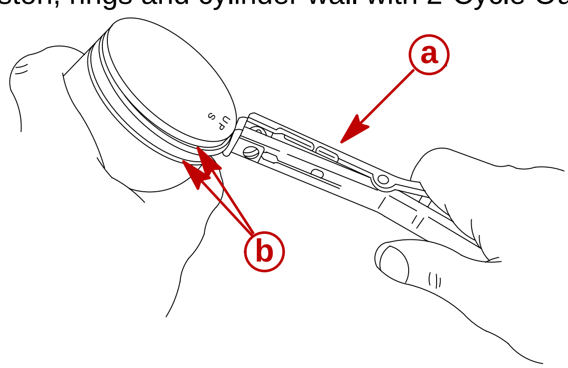
a - Piston Ring
b - Dots (Faces Up)
c - Feeler Gauge
d - Ring End Gap
e - Dot or Letter
f - Piston Ring

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.



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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.

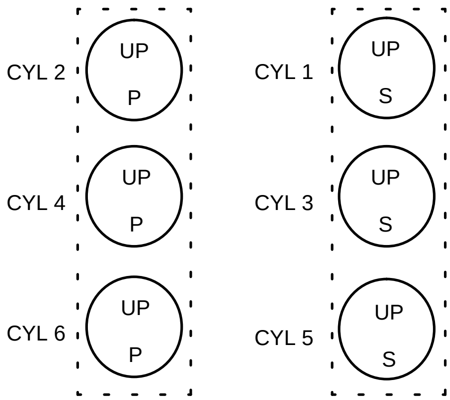
IMPORTANT: Piston must be correctly installed and positioned as shown.

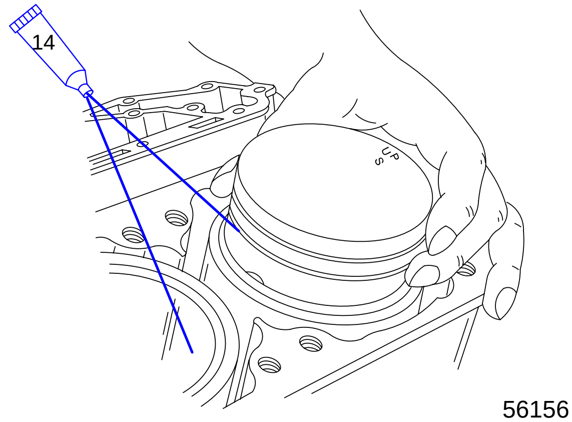
Pistons marked with the word “UP” and with the letter “P” or “S” on top of piston.

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 starboard 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.





14 2 Cycle Outboard Oil

10. Apply 2-4-C with Teflon to bearing surface of connecting rod and install bearing assembly as shown.

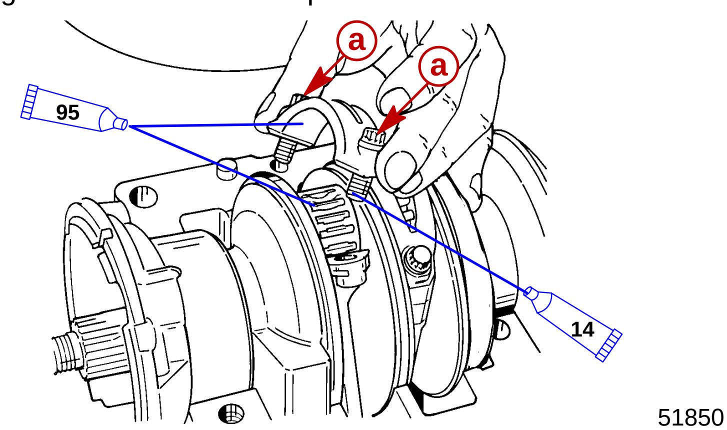
11. Place connecting rod cap on connecting rod. Apply light oil to threads and face of connecting rod bolts. Thread connecting rod bolts finger-tight while checking for correct alignment of the rod cap as shown.

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 20 lb. ft. (27 N·m). Turn each bolt an additional 90° after 2nd torque is attained. Recheck alignment between rod cap and rod as shown.



14 2 Cycle Outboard Oil

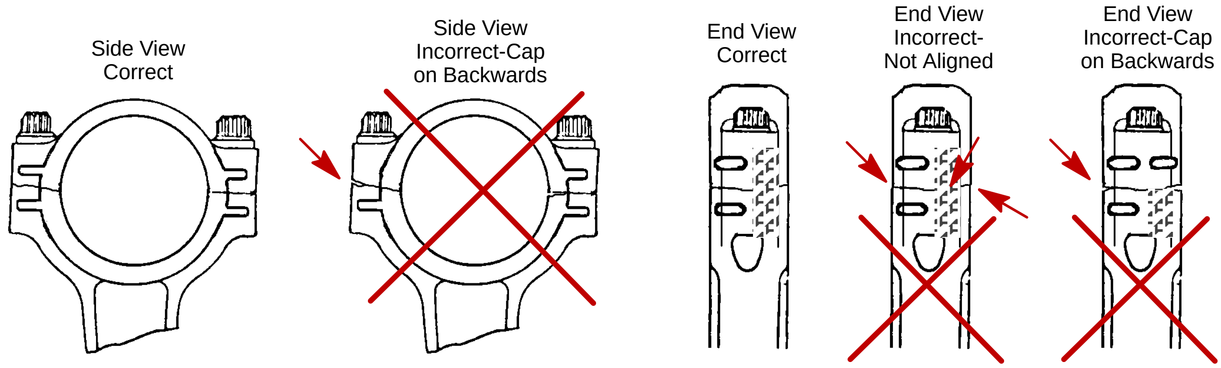
95 2-4-C With Teflon

a - Connecting Rod Screws

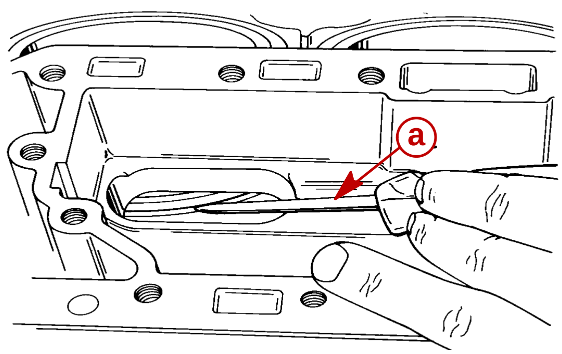
13. Rotate crankshaft several times (using powerhead stand) to assure free operation (no binds and catching).

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.



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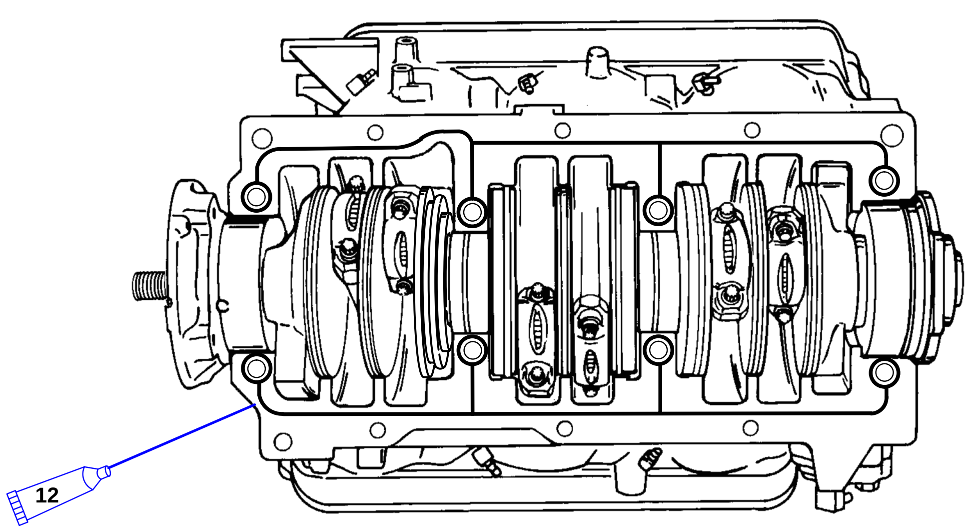
a - Screwdriver

Crankcase Cover Installation

1. Remove all oil from mating surfaces of crankcase cover and cylinder block with Loctite 7649 Primer.
2. Apply a thin, even coat of Loctite Master Gasket #203 on mating surfaces of crankcase cover or cylinder block.

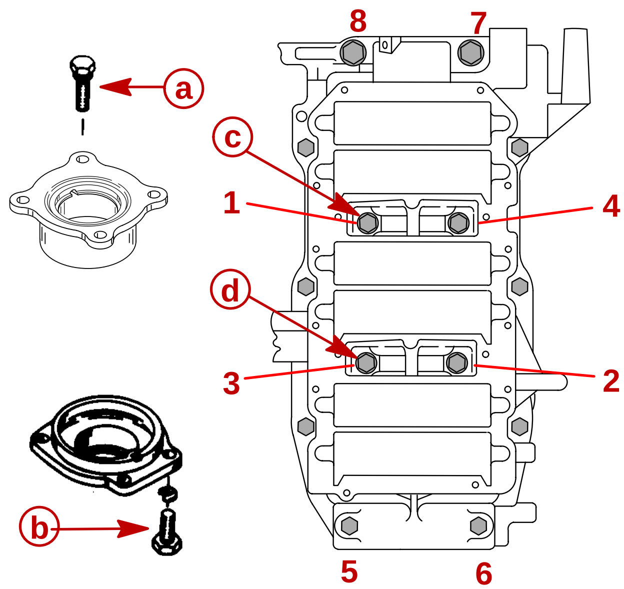


58620

12 Loctite Master Gasket

a - Loctite Master Gasket

3. 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).
4. Install remaining crankcase cover flange bolts.
5. Tighten end cap bolts to specified torque.



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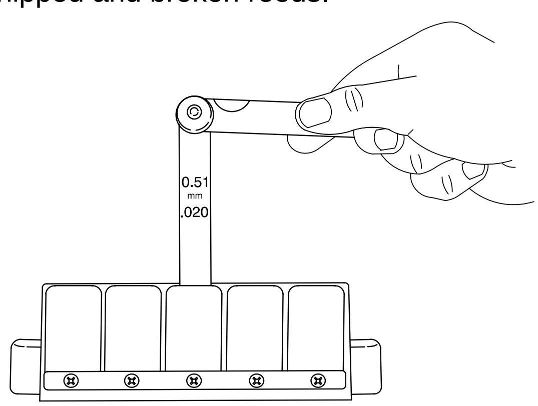
- **a** - Upper End Cap Bolts – Torque to 17 lb. ft. (23 N·m)
- **b** - Lower End Cap Bolts – Torque to 80 lb. in. (9 N·m)
- **c** - Add Light Oil to Threads and Bolt Face – 8 Bolts (3/8 in.-18) Torque to 38 lb. ft. (51.5 N·m)
- **d** - Bolts (5/16 in.-18) Torque to 180 lb. in. (20 N·m)

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 abraisions. Replace reed block(s) as required.
3. Check for chipped and broken reeds.



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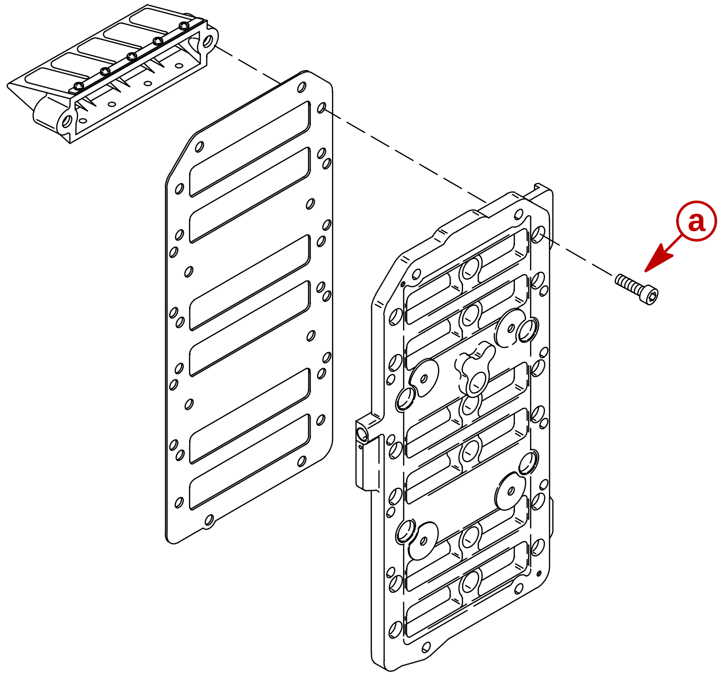
Allowable reed opening is 0.020 in. (0.51 mm) or less. Replace reeds if either reed is standing open more than 0.020 in. (0.51 mm).

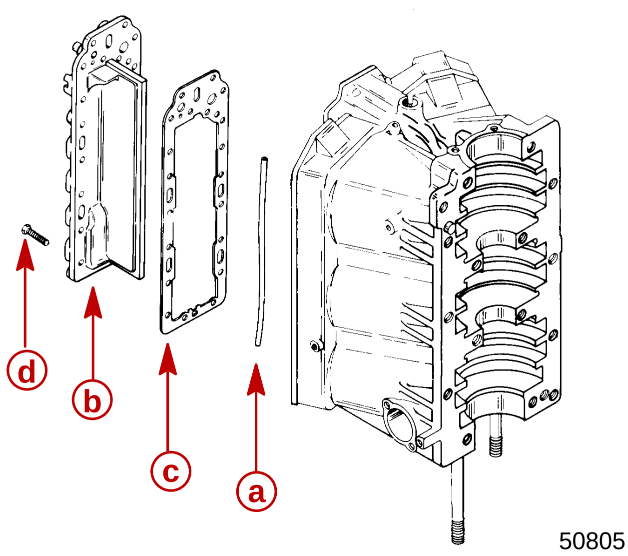
Assembly of Reed Blocks to Reed Block Adaptor Plate

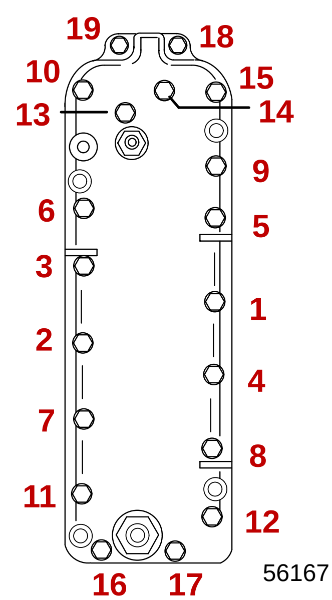


a - Torque to 90 lb. in. (10 N·m)

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.
3. Apply Loctite 271 to bolt threads and torque bolts to 16.5 Ib. ft. (22 Nm).
4. Torque exhaust divider plate bolts in following sequence.

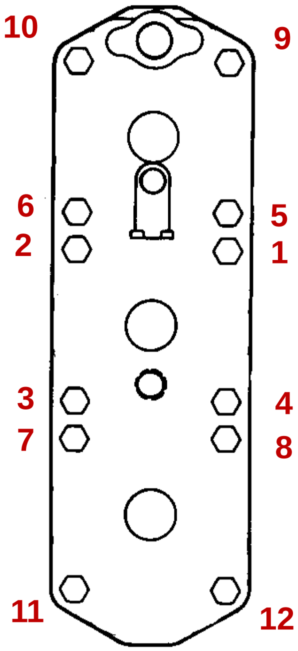


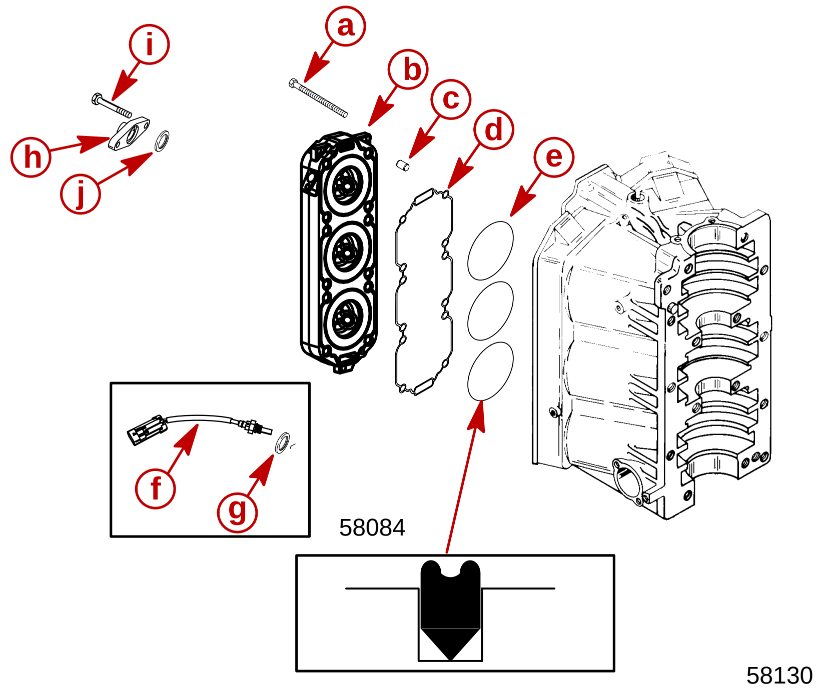


a - Divider Seal
b - Exhaust Divider Plate
c - Gasket
d - Attaching Bolt

Cylinder Head Installation

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. Install temperature sensors in STARBOARD and PORT cylinder heads.



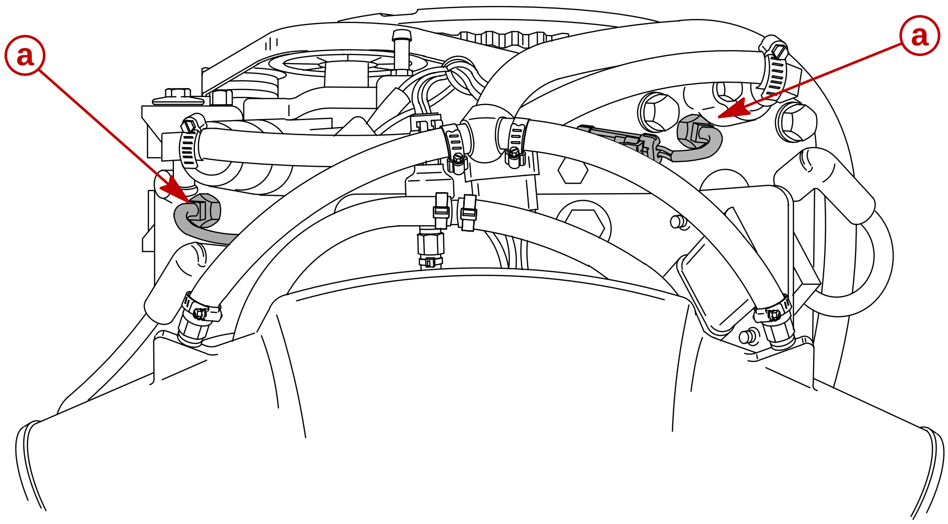


NOTE: *Cylinder head o-rings are directional in their installation. The grooved side faces the cylinder block. The pointed side faces into the cylinder head. Failure to install the o-rings correctly may result in cylinder head leakage. O-rings should not be damaged or twisted. Replace as required.*

a - Bolt [Torque to 30 lb. ft. (41 N·m) and then turn 90°]
b - Cylinder Head
c - Dowel Pin
d - Seal
e - O-ring
f - Temperature Sensor
g - O-ring
h - Cover
i - Bolt [Torque to 10 lb. ft. (13.0 N·m)]
j - 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. Temperature sensor installed.



a - Overheat Temperature Sensor

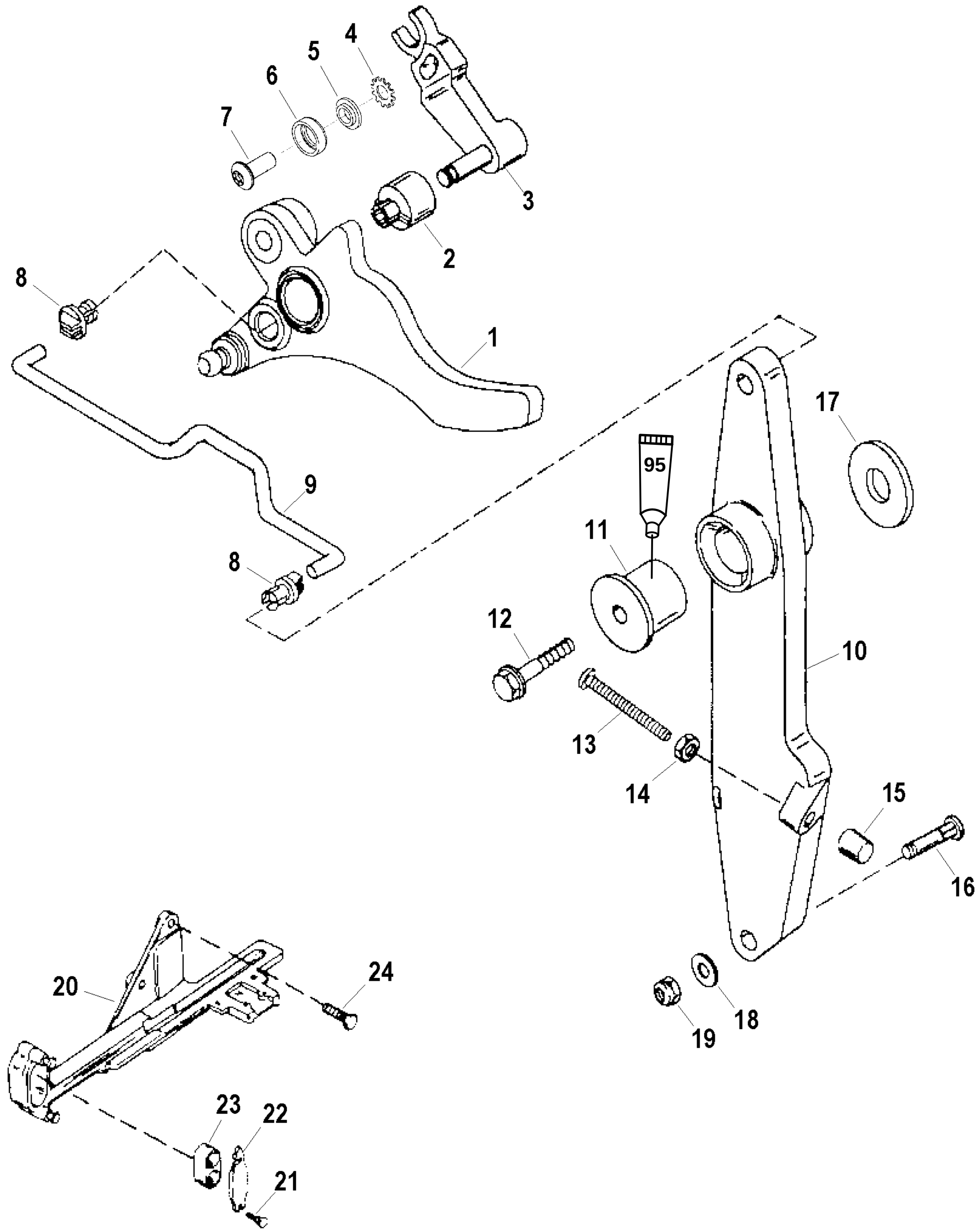
Reinstalling Engine Components

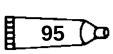
NOTE: *Components can be reinstalled individually or as an assembly. If reinstalling components individually, refer to the following sections. If reinstalling components as an assembly, refer to* ***Removing Engine Components as an Assembly****, page 4A-20 through 4A-29, and reinstall in reverse sequence.*

Section 2
Starter Motor
Electronic Control Module
Ignition Coil
Starter Solenoid
Alternator
Flywheel
Throttle Position Sensor

Section 3
Direct Fuel Injection
Fuel Pump
On-Board Oil Tank
Oil Pump
Fuel Lift Pump

Throttle Lever/Throttle Cam Assembly





2-4-C With Teflon

Throttle Lever/Throttle Cam Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb. in.	lb. ft.	Nm
1	1	CAM-Throttle			
2	1	ROLLER			
3	1	LEVER–Throttle Roller			
4	1	LOCKWASHER (#10)			
5	1	WASHER–Spool			
6	1	WASHER–Cup			
7	1	SCREW	Drive Tight		
8	2	BUSHING–Swivel			
9	1	ROD-Throttle Control			
10	1	LEVER ASSEMBLY–Throttle Control			
11	1	BUSHING			
12	1	SCREW (0.375-16 x 1.750)		20	27
13	1	SCREW (0.250-20 x 2.125)			
14	1	NUT (0.250-20)			
15	1	CAP (Nylon)			
16	1	INSERT			
17	1	SPACER			
18	1	WASHER			
19	1	NUT (M6)	50		6
20	1	BRACKET-Anchor			
21	2	SCREW-Drive			
22	1	Latch-Control Lever			
23	1	CUP-Barrel Retainer			
24	3	SCREW (0.312-18 x 0.880)		13	18

Powerhead Installation on Pump Unit

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

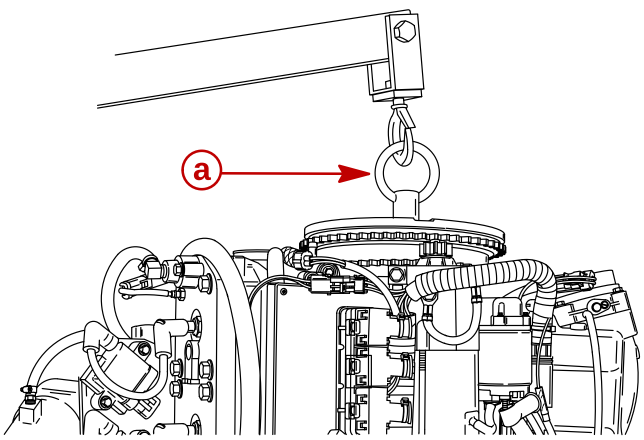
⚠ WARNING

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 gasket surface of adaptor plate.

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

3. Apply a small amount of Special Lubricant 101 onto driveshaft splines.
4. Use hoist to lower powerhead onto pump unit. It may be necessary to turn flywheel (aligning crankshaft splines with driveshaft splines) so that powerhead will be fully installed.
5. Install 11 locknuts which secure powerhead to exhaust extension plate/driveshaft housing. Torque locknuts in 3 progressive steps until secured.
6. Disconnect hoist from Lifting Eye and remove Lifting Eye from flywheel.
7. Reinstall plastic cap into center of flywheel cover.



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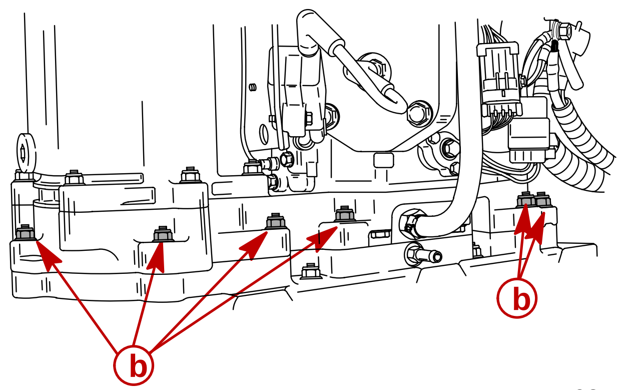

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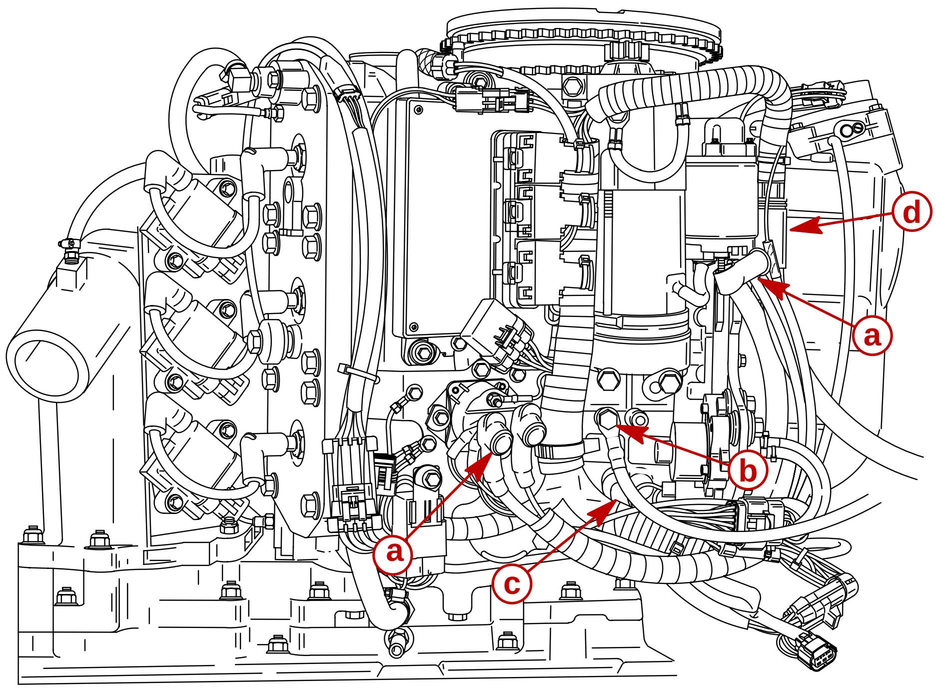
a - Lifting Eye (91-90455)
b - Powerhead Attaching Locknuts – Torque Nuts to 35 lb. ft. (47 N·m)

Refer to Section 1D, Sport Jet Installation to complete powerhead installation and cable adjustment.

Follow Timing, Synchronizing and Adjusting as outlined in Section 2C.

8. Connect positive battery cable to starter solenoid.
9. Connect negative battery cable to lower front starter mounting bolt.
10. Connect remote oil tank pressure hose.
11. Connect remote control harness to powerhead harness connector.



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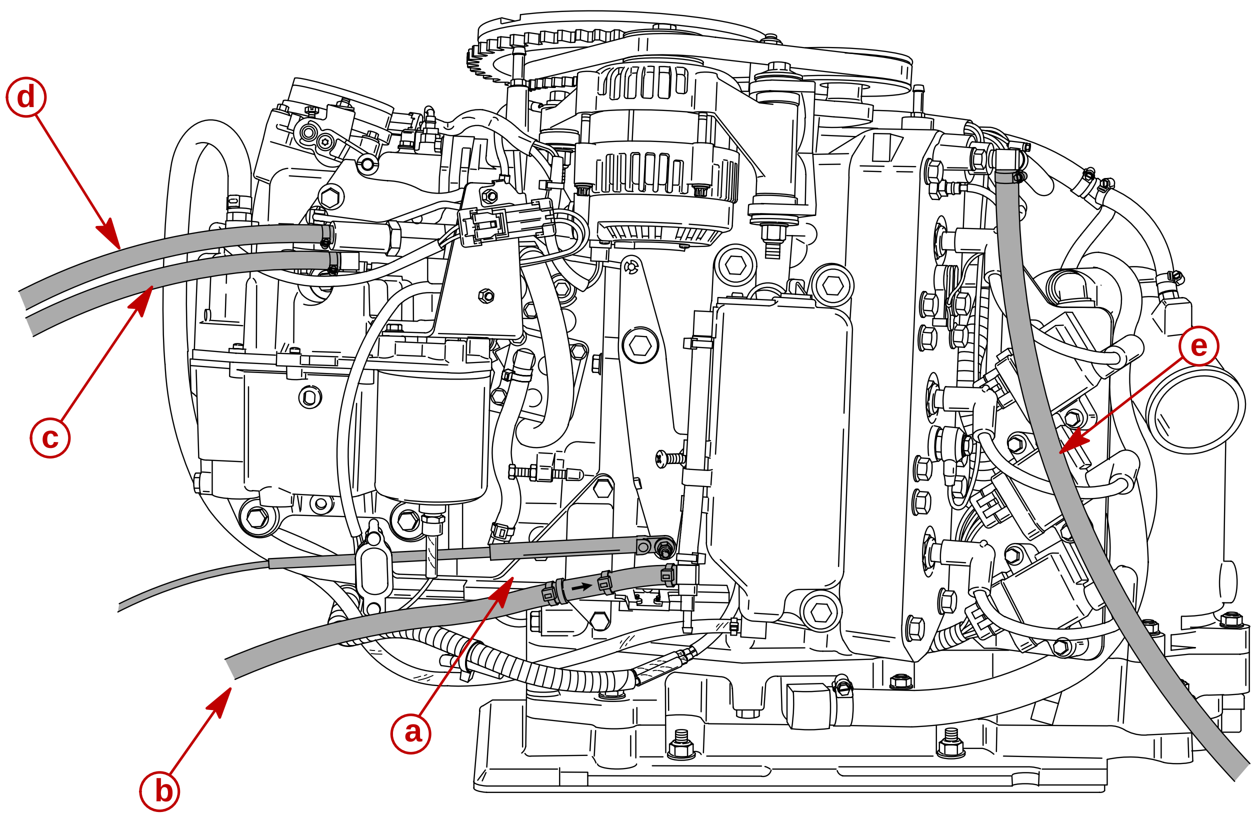
a - Positive Battery Cable
b - Negative Battery Cable
c - Remote Oil Tank Hose
d - Remote Control Harness

12. Install throttle cable. Secure with washer and locknut. Tighten locknut and then back off 1/4 turn.
13. Install oil inlet hose to onboard oil reservoir.
14. Install fuel inlet line. Secure hose with stainless hose clamp.
15. Install vapor separator vent hose. Secure hose with stainless hose clamp.

IMPORTANT: High Pressure Pump Connector MUST BE routed on the outside of VST vent fitting.

16. Install water by-pass hose. Secure hose with stainless hose clamp.



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- **a** - Throttle Cable
- **b** - Oil Inlet Hose
- **c** - Fuel Inlet
- **d** - Vent Hose
- **e** - Water By-Pass

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 40:1 @ 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.
- Short bursts of full throttle for periods up to 10 seconds are acceptable.

Next 3 Hours

- Change engine speed every 10 minutes.