Service Manual Outline

Notice

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

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

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

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

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

Notice to Users of This Manual

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

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

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

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

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

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

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

Cleanliness and Care of Outboard Motor

A marine power product is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the ten thousands of an inch/mm. When any product component is serviced, care and cleanliness are important. Throughout this manual, it should be understood that proper cleaning, and protection of machined surfaces and friction areas is a part of the repair procedure. This is considered standard shop practice even if not specifically stated.

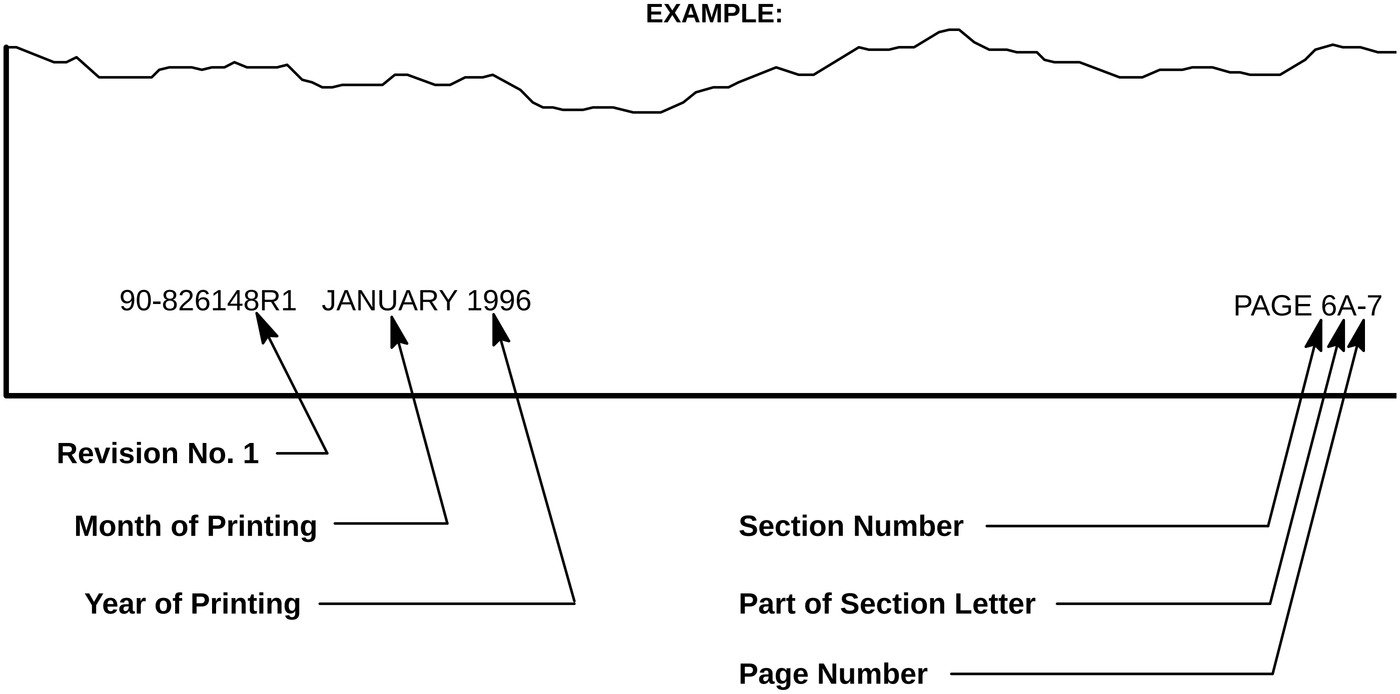
Whenever components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

Personnel should not work on or under an outboard which is suspended. Outboards should be attached to work stands, or lowered to ground as soon as possible.

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

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

EXAMPLE:



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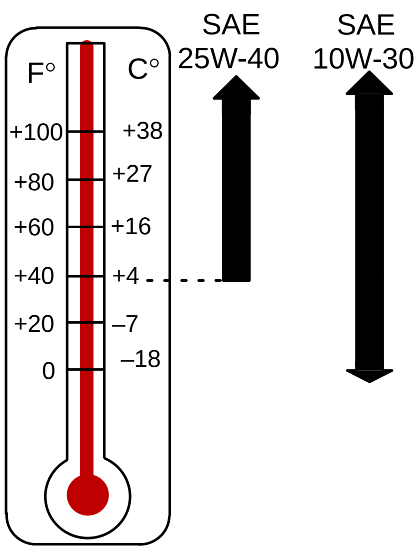
IMPORTANT INFORMATION

Section 1A - Specifications

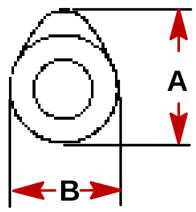
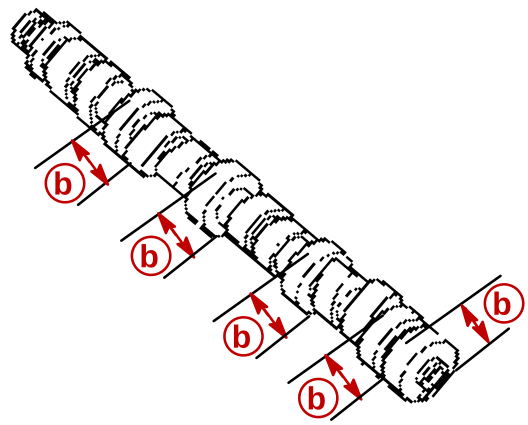
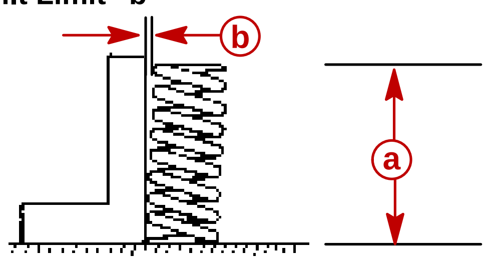
Table of Contents

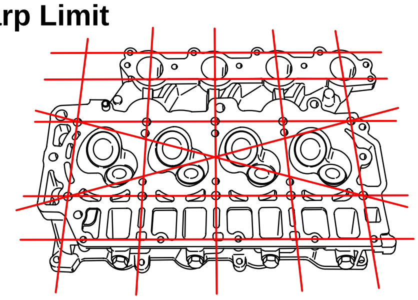
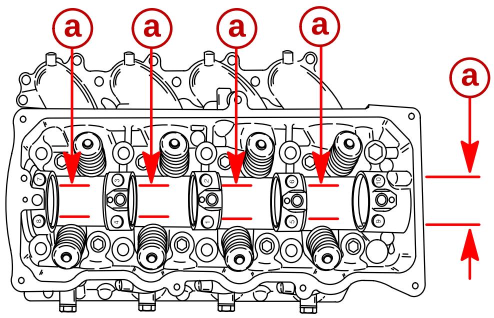
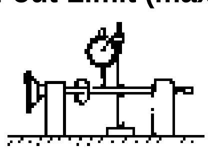
Specifications

Models 40/50/60 EFI (4-Stroke)		
HORSEPOWER (kW)	**Model 40** **Model 50** **Model 60**	40 hp (29.8 Kw) @ 5750 rpm 50 hp (37.7 Kw) @ 5750 rpm 60 hp (44.7 Kw) @ 5750 rpm
OUTBOARD WEIGHT	**Electric** **40/50/60 ELPT** **40/50/60 ELPT BIGFOOT**	 248 lb (112.7 kg) 264 lb (119.9 kg)
FUEL	**RECOMMENDED GASOLINE**	Automotive Unleaded with a Minimum Pump Posted Octane Rating of 87
OIL	**OIL FILTER** **OIL FILTER WRENCH** **ENGINE OIL CAPACITY** **ENGINE OIL** 	p/n 35-822626A2 p/n 91-802653Q1 Either 3 Quarts or 3 Liters SAE 10W-30 viscosity oil is recommended for use in all temperatures. SAE 25W-40 viscosity oil may be used at temperatures above 40° F (4° C). Use Quicksilver 4-Cycle Marine Oil with the proper viscosity for the expected temperature in your area (see range thermometer on left). If not available, use a premium quality 4-cycle engine oil, certified to meet or exceed anyone of the following American Petroleum Institute (API) service classifications SH, SG, SF, CF-4, CE, CD, CDll.

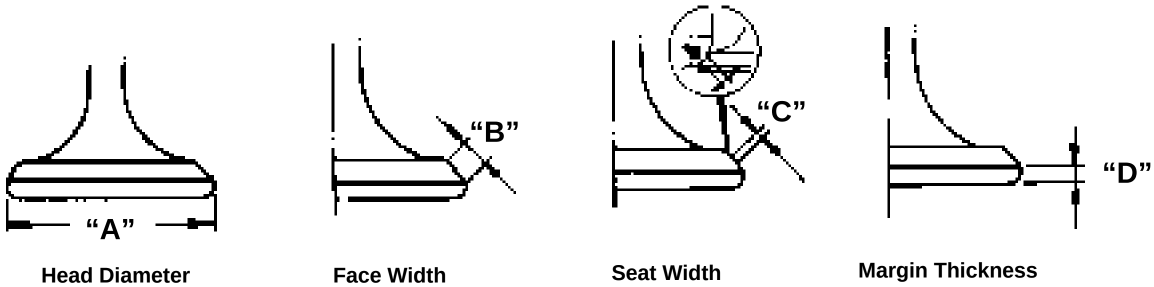
IGNITION SYSTEM **Readings taken @ 68°F (20°C).**	**Type**	Capacitor Discharge Ignition
	Spark Plug:	
	Type	Champion RA8HC
	Gap	0.040 in. (1.0 mm)
	Hex Size	5/8 in. (16 mm)
	Torque	150 lb-in. (17 Nm)
	Hole Size	12 mm
	Firing Order	1-3-4-2
	Ignition Timing:	
	@Idle	Controlled by ECM
	@1500-1800	14° B.T.D.C
	@ WOT (6000 rpm)	28° B.T.D.C
	Stator Resistance	0.20 - 0.30 Ω (YEL-YEL)
	Crank Position Sensor (CPS) Resistance	300 - 350 Ω (RED - WHT)
	Ignition Coil Resistance:	
	Internal Shielding	0 - 10.0 KΩ (Pin A - Mounting Bracket)
	Electronic Spark Trigger (EST)	8.5 - 12KΩ (Pin B - Pin C)
	Secondary	3.0 - 7.0 kΩ (Pin A - Coil Tower)
	High Tension Lead/Boot Resistance	0.600 - 1.100 KΩ
	ECM Engine Speed Limiter	
	Fuel/Spark Cut-out on Cylinders #2 and #3	6225 rpm
	Fuel/Spark Cut-out on All Cylinders	6350 rpm
	ECM Overheat Speed Control	Guardian System is activated. Power limit will vary with level of overheat.
	ECM Low Oil Pressure Speed Control	Guardian System is activated. Engine power is limited to 10% of maximum (Approximately 2000 RPM)
	MAT/ECT Temperature Sensor	See Graph Section 3B - EFI
	Manifold Absolute Pressure (MAP) Sensor Resistance	See Table Section 3B - EFI
	Fuel Injector Resistance	10.0 - 13.5Ω
	Main Power Relay	81-99 Ω (Pin 85 - Pin 86)
	Idle Air Control (IAC)	24-30 Ω (Between Pins)
	Throttle Position Sensor Typical Range	
	Output Voltage @Idle	0.39-1.00 Volts
	Output Voltage @WOT (6000)	3.66-4.80 Volts
CHARGING SYSTEM **Readings taken @ 68°F (20°C).**	**Alternator Type:**	Single Phase (12 Pole)
	20 Amp. Electric Alternator Output	12.6 V-20 Amps. (252 Watts) (Rectified/Regulated)
	Stator Resistance	0.20 - 0.30 Ohms (YEL-YEL)
	Quicksilver Tachometer Setting	“6P” or “4”
STARTING SYSTEM	**Electric Start:**	
	Starter Type	Bendix
	Output	1.1 kW
	Ampere Draw Under:	
	(Load)	174.0 Amps
	(No Load)	23.7 Amps

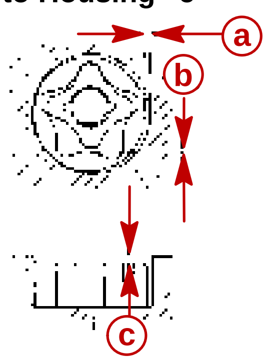
BATTERY	**Battery Rating** **Minimum Requirement** **For operation below 32° F (0° C)** **Ampere-Hours (Ah) Minimum** **For operation above 32° F (0° C)** **For operation below 32° F (0° C)**	 465 Marine Cranking Amps (MCA) or 350 Cold Cranking Amps (CCA) 1000 Marine Cranking Amps (MCA) or 775 Cold Cranking Amps (CCA) 70 105
FUEL SYSTEM	**Fuel Pump Type** **Fuel Pump:** **Pressure** **Fuel Tank Capacity**	Mechanical Water Cooled (Plunger/Diaphragm) 3-6 psi Accessory
FUEL INJECTION	**Fuel Injector System** **Idle rpm (Out Of Gear)** **Idle rpm (In Forward Gear)** **Wide Open Throttle rpm (WOT)** **Range** **Fuel Pump Pressure - Electric**	Batch (1 & 4) - (2 & 3) 725 ± 25 rpm 725 ± 25 rpm 5500–6000 42-44 psi (290-303 kPa)
CYLINDER BLOCK	**Type** **Displacement** **Number of Cylinders**	4 Stroke Cycle – Over Head Camshaft 60.8 cu. in. (995 cc) 4
STROKE	**Length**	2.953 in. (75 mm)
CYLINDER BORE	**Diameter** **Standard** **Oversize-0.010 in. (0.25 mm)** **Oversize-0.020 in. (0.50 mm)** **Taper/Out of Round Maximum** **Bore Type**	 2.5591 in. (65 mm) 2.5689 in. (65.25 mm) 2.5787 in. (65.5 mm) 0.003 in. (0.08 mm) Cast Iron
PISTON	**Piston Type** **O.D. at Skirt** **Standard** **Oversize-0.010 in. (0.25 mm)** **Oversize-0.020 in. (0.50 mm)**	Aluminum 2.5570 - 2.5578 in. (64.950 - 64.965 mm) 2.5669 - 2.5675 in. (65.2 - 65.215 mm) 2.5768 - 2.5774 in. (65.450 - 65.465 mm)
PISTON CLEARANCE	**Piston to Cylinder Clearance**	0.0014 - .0026 in. (0.035 - 0.065 mm)
RINGS	**Ring End Gap (Installed)** **Top** **Middle** **Bottom (Oil Ring)** **Side Clearance:** **Top** **Middle**	 0.006 - 0.012 in. (0.15 - 0.03 mm) 0.012 - 0.020 in. (0.30 - 0.50 mm) 0.008 - 0.028 in. (0.20 - 0.70 mm) 0.0008 - 0.0024 in. (0.02 - 0.06 mm) 0.0008 - 0.0024 in. (0.02 - 0.06 mm)
COMPRESSION RATIO	**Compression Ratio** **Cylinder Compression*** **(Electric Models Only, Cold Engine @ W.O.T.)**	9.7:1 180 - 210 psi (Peak)
PISTON PIN	**Piston Pin Diameter**	0.6285 - 0.6287 in. (15.965 - 15.970 mm)
CONNECTING ROD	**Oil Clearance (Big End)** **Small End Inside Diameter**	0.0008 - 0.0020 in. (0.020 - 0.052 mm) 0.6293 - 0.6298 in. (15.985 - 15.998 mm)

CRANKSHAFT	**Main Bearing Clearance** **Crankshaft Run-out**	0.0005 - 0.0017 in. (0.012 - 0.044 mm) 0.0018 in. (0.046 mm)
CAMSHAFT	**Camshaft Dimensions** **Intake "A"** **Exhaust "A"** **Intake "B"** **Exhaust "B"**  **Run-out Limit** **Camshaft Bearing Diameter "b"** 	 1.214 - 1.222 in. (30.83 - 31.03 mm) 1.214 - 1.222 in. (30.83 - 31.03 mm) 1.020 - 1.028 in. (25.90 - 26.10 mm) 1.020 - 1.028 in. (25.90 - 26.10 mm) 0.0039 in. (0.1 mm) 1.4541 - 1.4549 in. (36.935 - 36.955 mm)
VALVE SPRING	**Free Length "a"** **Tilt Limit "b"**  **Compressed Pressure (Installed)** **Intake** **Exhaust** **Tilt Limit (Intake & Exhaust)** **Dir. of Winding (Intake & Exhaust)**	1.491-1.569 in. (37.85-39.85 mm) Less than 0.060 in. (1.7 mm) 19.8 - 22.0 lbs. (9.0 - 10.0 kg) 19.8 - 22.0 lbs. (9.0 - 10.0 kg) 0.043 in. (1.1 mm) Left Hand

CYLINDER HEAD	**Warp Limit**  *** Lines indicate straight edge measurement**	0.004 in. (0.1 mm)
	Camshaft Bore Inside Diameter “a” 	1.4567 - 1.4577 in. (37.000 - 37.025 mm)
VALVES	**Valve/Valve Seat/Valve Guides:**	
	Valve Clearance (cold)	
	Intake	0.006 - 0.010 in. (0.15 - 0.25 mm)
	Exhaust	0.010 - 0.014 in. (0.25 - 0.35 mm)
	Valve Dimensions:	
	“A” Head Diameter	
	Intake	1.256 - 1.264 in. (31.9 - 32.1 mm)
	Exhaust	1.020 - 1.028 in. (25.9 - 26.1 mm)
	“B” Face Width	
	Intake	0.079 - 0.124 in. (2.00 - 3.14 mm)
	Exhaust	0.079 - 0.124 in. (2.00 - 3.14 mm)
	“C” Seat Width	
	Intake	0.035 - 0.043 in. (0.9 - 1.1 mm)
	Exhaust	0.035 - 0.043 in. (0.9 - 1.1 mm)
	“D” Margin Thickness	
	Intake	0.020 - 0.035 in. (0.5 - 0.9 mm)
	Exhaust	0.020 - 0.035 in. (0.5 - 0.9 mm)
	Stem Outside Diameter	
	Intake	0.2156 - 0.2161 in. (5.475 - 5.490 mm)
	Exhaust	0.2150 - 0.2156 in. (5.460 - 5.475 mm)
	Guide Inside Diameter	
	Intake	0.2165 - 0.2170 in. (5.500 - 5.512 mm)
	Exhaust	0.2165 - 0.2170 in. (5.500 - 5.512 mm)
	Stem To Guide Clearance	
	Intake	0.0004 - 0.0015 in. (0.010 - 0.037 mm)
	Exhaust	0.0010 - 0.0020 in. (0.025 - 0.052 mm)
	Stem Run-out Limit (max.) 	0.0006 in. (0.016 mm)

Valve Dimensions



ROCKER SHAFT	**Outside Diameter**	0.6288 - 0.6296 in. (15.971 - 15.991 mm)
ROCKER ARM	**Inside Diameter of Bore**	0.6299 - 0.6306 in. (16.000 - 16.018 mm)
THERMOSTAT	**Valve Opening Temperature** **Full Open Temperature**	118° F - 123° F (48° C - 51° C) 145° F (63° C)
LUBRICATION SYSTEM	**Pump Type** **Engine Oil Pressure (Warm Engine)** @ **3000 rpm** **Engine Oil Pan Capacity** **Oil Pump:** **Outer Rotor to Housing “a”** **Inner Rotor to Outer Rotor “b”** **Rotor to Housing “c”** 	Trochoid 30-40 psi (207-278 kPa) Either 3 Qts. **or** 3 Liters 0.0045 - 0.009 in. (0.11 - 0.23 mm) 0.005 in. (0.12 mm) 0.0015 - 0.003 in. (0.04 - 0.08 mm)
MID-SECTION	**Transom Height:** **Long Shaft** **Steering Pivot Range:** **Tiller** **Remote** **Full Tilt Up Angle** **Allowable Transom Thickness**	 20 in. (51 cm) 90° 60° 71° 2-3/4 in. (69.8 mm)

GEAR HOUSING (1.83:1)	**Gear Ratio** **Gearcase Capacity** **Lubricant Type** **Forward Gear** **Number of Teeth** **Pinion Gear** **Number of Teeth** **Pinion Height** **Forward Gear Backlash** **Water Pressure (Warm Engine)** **@ 800 rpm** **@ 6000 rpm (WOT)** **Leak Test Pressure**	1.83:1 11.5 fl oz (340 mL) Quicksilver Gear Lube-Premium Blend 22 Spiral/Bevel 12 Spiral/Bevel 0.025 in. (0.64 mm) Pinion Gear Locating Tool (91-817008A2) 0.011-0.017 in. (0.28-0.43 mm) Backlash Indicator Tool (91-19660--1) MARK #4 or 0.366 in. (9.3 mm) 1–3 psi (7-21 kPa) 12–25 psi (83-172 kPa) 10-12 psi (68-83 kPa) for 5 Minutes
GEAR HOUSING BIGFOOT (2.3:1)	**Gear Ratio** **Gearcase Capacity** **Lubricant Type** **Forward Gear** **Number of Teeth** **Pinion Gear** **Number of Teeth** **Pinion Height** **Pinion Gear Locating Tool** **Flat Number** **Disc Number** **Forward Gear Backlash** **Backlash Indicating Tool** **Mark Number** **Water Pressure** **@ 800 rpm (Idle)** **@ 6000 rpm (WOT)** **Leak Test Pressure**	2.31:1 24 fl oz (710 mL) Quicksilver Gear Lube-Premium Blend 30 Spiral/Bevel 13 Spiral/Bevel 0.025 in. (0.64 mm) 91-12349A2 #8 #3 0.012-0.019 in. (0.30-0.48 mm) 91-78473 #4 2-6 psi (14-41 kPa) 12-25 psi (83-172 kPa) 10-12 psi (69-83 kPa) for 5 Minutes

Propeller Information Charts

Mercury/Mariner 40 EFI (4-Stroke) 1.83:1 Non-Bigfoot

Wide Open Throttle RPM : 5500-6000
Recommended Transom Heights : 20”, 22.5”
Right Hand Rotation Standard
Gear Reduction : 1.83:1

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt. (lbs)	Approx. Boat Length	Speed Range (mph)	Propeller Part Number
10”	17”	3	Alum	Up to 800	Up to 15’	43-50	48-73144A40
10”	16”	3	Steel	800-1000	Up to 15’	39-46	48-91818A5
10”	16”	3	Alum	800-1000	Up to 15’	39-46	48-73142A40
10-1/8”	15”	3	Steel	900-1200	13-15’	36-43	48-855862A5
10-1/8”	15”	3	Alum	900-1200	13-15’	36-43	48-73140A40
10-1/4”	14”	3	Steel	1000-1200	14-16’	33-39	48-855860A5
10-1/4”	14”	3	Alum	1000-1200	14-16’	33-39	48-73138A40
10-3/8”	13”	3	Steel	1100-1400	14-17’	30-35	48-855858A5
10-3/8”	13”	3	Alum	1100-1400	14-17’	30-35	48-73136A40
10-5/8”	12”	3	Steel	1300-1600	15-17’	27-32	48-855856A5
10-5/8”	12”	3	Alum	1300-1600	15-17’	27-32	48-73134A40
11-5/8”	10.5”	3	Steel	1500-1900	16-18’	24-29	48-823478A5
10-7/8”	11”	3	Alum	1500-1900	16-18’	24-29	48-85632A40
11-5/8”	10-1/2”	3	Alum	1600-2000	16’ +	21-25	48-827312A10
11-1/4”	10”	3	Alum	1700-2200	17’ +	19-24	48-73132A40
12-1/4”	9”	3	Steel	2000+	pontoon	17-21	48-97868A10
12-1/4”	9”	3	Alum	2000+	pontoon	17-21	48-87818A10
12-1/2”	8”	3	Alum	2500+	Pontoon/ houseboat	1-18	48-42738A10
12-1/2”	8” Cup	3	Alum		pontoon		48-42738A12

Mercury/Mariner 50 EFI (4-Stroke) 1.83:1 Non-Bigfoot

Wide Open Throttle RPM : 5500-6000
Recommended Transom Heights : 20”, 22.5”
Right Hand Rotation Standard
Gear Reduction : 1.83:1

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt. (lbs)	Approx. Boat Length	Speed Range (mph)	Propeller Part Number
10”	19”	3	Alum	Up to 800	Up to 14’	49-58	48-73146A40
10”	17”	3	Alum	Up to 900	Up to 15’	43-50	48-73144A40
10”	16”	3	Steel	900-1300	Up to 15’	39-46	48-91818A5
10”	16”	3	Alum	900-1300	Up to 15’	39-46	48-73142A40
10-1/8”	15”	3	Steel	1000-1400	13-15’	36-43	48-855862A5
10-1/8”	15”	3	Alum	1000-1400	13-15’	36-43	48-73140A40
10-1/4”	14”	3	Steel	1100-1600	14-16’	33-39	48-855860A5
10-1/4”	14”	3	Alum	1100-1600	14-16’	33-39	48-73138A40
10-3/8”	13”	3	Steel	1300-1800	14-17’	30-35	48-855858A5
10-3/8”	13”	3	Alum	1300-1800	14-17’	30-35	48-73136A40
10-5/8”	12”	3	Steel	1400-2000	15-17’	27-32	48-855856A5
10-5/8”	12”	3	Alum	1400-2000	15-17’	27-32	48-73134A40
11-5/8”	11”	3	Steel	1700-2400	16-18’	24-29	48-823478A5
10-7/8”	11”	3	Alum	1700-2400	16-18’	24-29	48-85632A40
11-5/8”	10-1/2”	3	Alum	1900-2700	16’ +	21-25	48-827312A10
11-1/4”	10”	3	Alum	2100-3000	17’ +	19-24	48-73132A40
12-1/4”	9”	3	Steel	2500+	pontoon	17-21	48-97868A10
12-1/4”	9”	3	Alum	2500+	pontoon	17-21	48-87818A10
12-1/2”	8”	3	Alum	3000+	Pontoon/ houseboat	1-18	48-42738A10
12-1/2”	8” Cup	3	Alum		pontoon		48-42738A12

Mercury/Mariner 60 EFI (4-Stroke) 1.83:1 Non-Bigfoot

Wide Open Throttle RPM : 5500-6000
Recommended Transom Heights : 20”, 22.5”
Right Hand Rotation Standard
Gear Reduction : 1.83:1

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt. (lbs)	Approx. Boat Length	Speed Range (mph)	Propeller Part Number
10”	19”	3	Alum	Up to 1000	Up to 14’	49-58	48-73146A40
10”	17”	3	Alum	Up to 1200	Up to 15’	43-50	48-73144A40
10”	16”	3	Steel	1200-1600	Up to 16’	39-46	48-91818A5
10”	16”	3	Alum	1200-1600	Up to 16’	39-42	48-73142A40
10-1/8”	15”	3	Steel	1300-1700	14-16’	36-43	48-855862A5
10-1/8”	15”	3	Alum	1300-1700	14-16’	36-43	48-73140A40
10-1/4”	14”	3	Steel	1400-2000	15-17’	33-39	48-855860A5
10-1/4”	14”	3	Alum	1400-2000	15-17’	33-39	48-73138A40
10-3/8”	13”	3	Steel	1600-2200	15-18’	30-35	48-855858A5
10-3/8”	13”	3	Alum	1600-2200	15-18’	30-35	48-73136A40
10-5/8”	12”	3	Steel	1800-2500	16-18’	27-32	48-855856A5
10-5/8”	12”	3	Alum	1800-2500	16-18’	27-32	48-73134A40
11-5/8”	11”	3	Steel	2300-3000	17-19’	24-29	48-823478A5
10-7/8”	11”	3	Alum	2300-3000	17-19’	24-29	48-85632A40
11-5/8”	10-1/2”	3	Alum	2500-3300	17’ +	21-25	48-827312A10
11-1/4”	10”	3	Alum	2800-3600	18’ +	19-24	48-73132A40
12-1/4”	9”	3	Steel	3300+	pontoon	17-21	48-97868A10
12-1/4”	9”	3	Alum	3300+	pontoon	17-21	48-87818A10
12-1/2”	8”	3	Alum	4000+	Pontoon/ houseboat	1-18	48-42738A10
12-1/2”	8” Cup	3	Alum		pontoon		48-42738A12

Mercury/Mariner 40 EFI (4-Stroke) 2.3:1 Bigfoot

Special soft rubber hub propellers designed to reduce clutch rattle

Wide Open Throttle rpm: 5500-6000
Recommended Transom Heights : 20”, 25”
Right Hand Rotation Standard
Gear Reduction : 2.31:1

IMPORTANT: These specially designed rubber hub propellers are rated for 60 horsepower MAXIMUM.

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt. (lbs)	Approx. Boat Length	Speed Range (mph)	Propeller Part Number
13-3/4”	15”	3	Alum	1200-1500	14-16’	27-32	48-77342A33
14”	13”	3	Alum	1500-2000	16-18’	22-27	48-77340A33
14”	11”	3	Alum	2000-3000	pontoon	17-21	48-77338A33
14”	10”	3	Alum	2500+	pontoon/work	14-19	48-854342A33
14”	9”	3	Alum	3500+	houseboat/ work	1-15	48-854340A33

Mercury/Mariner 50 EFI (4-Stroke) 2.3:1 Bigfoot

Special soft rubber hub propellers designed to reduce clutch rattle

Wide Open Throttle rpm: 5500-6000
Recommended Transom Heights : 20”, 25”
Right Hand Rotation Standard
Gear Reduction : 2.31:1

IMPORTANT: These specially designed rubber hub propellers are rated for 60 horsepower MAXIMUM.

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt. (lbs)	Approx. Boat Length	Speed Range (mph)	Propeller Part Number
13-3/4”	15”	3	Alum	1500-2000	14-16’	25-32	48-77342A33
14”	13”	3	Alum	1800-2600	16-18’	23-27	48-77340A33
14”	11”	3	Alum	2800-4000	pontoon	17-21	48-77338A33
14”	10”	3	Alum	3000+	pontoon/work	14-19	48-854342A33
14”	9”	3	Alum	5000+	houseboat/ work	1-16	48-854340A33

Mercury/Mariner 60 EFI (4-Stroke) 2.3:1 Bigfoot

Special soft rubber hub propellers designed to reduce clutch rattle

Wide Open Throttle rpm: 5500-6000
Recommended Transom Heights : 20”, 25”
Right Hand Rotation Standard
Gear Reduction : 2.31:1

IMPORTANT: These specially designed rubber hub propellers are rated for 60 horsepower MAXIMUM.

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt. (lbs)	Approx. Boat Length	Speed Range (mph)	Propeller Part Number
13-3/4”	15”	3	Alum	2000-2500	16-18’	25-32	48-77342A33
14”	13”	3	Alum	2300-3200	17-20’	23-27	48-77340A33
14”	11”	3	Alum	3000-4300	pontoon	17-21	48-77338A33
14”	10”	3	Alum	3500+	pontoon/work	14-19	48-854342A33
14”	9”	3	Alum	5500+	houseboat/ work	1-16	48-854340A33

IMPORTANT INFORMATION

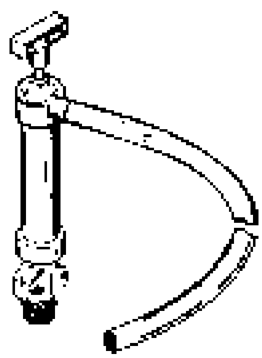
Section 1B - Maintenance

1
B

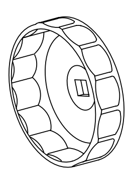
Table of Contents

Special Tools

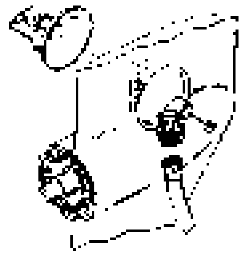
1. Crankcase Oil Pump P/N 90265A5



2. Oil Filter Wrench P/N 91-802653Q1

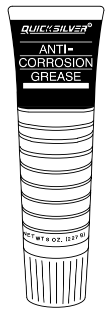


3. Flushing Attachment P/N 44357A2

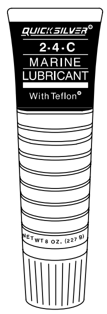


Quicksilver Lubricant/Sealant

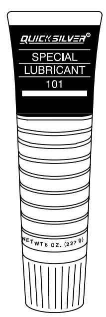
1. Quicksilver Anti-Corrosion Grease P/N 92-850735A1



2. 2-4-C Marine Lubricant with Teflon P/N 92-850736A1

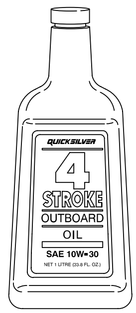


3. Special Lubricant 101 P/N 92-13872A1



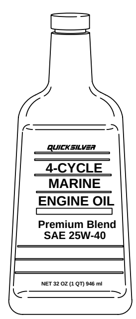
4. Quicksilver Power Trim and Steering Fluid P/N 92-90100A12

5. Quicksilver 4-Stroke Outboard Oil P/N 92-828000A12



6. Gear Lube-Premium Blend P/N 92-850737A1

7. Quicksilver 4-Cycle Marine Engine Oil P/N 92-832111A1



Inspection And Maintenance Schedule

To keep your outboard in the best operating condition, it is important that your outboard receive the periodic inspections and maintenance listed in the Inspection and Maintenance Schedule. We urge you to keep it maintained properly to ensure the safety of you and your passengers and retain its dependability.

WARNING
Neglected inspection and maintenance service of your outboard or attempting to perform maintenance or repair on your outboard if you are not familiar with the correct service and safety procedures could cause personal injury, death, or product failure.

Before Each Use

1. Check engine oil level.
2. Check that lanyard stop switch stops the engine.
3. Visually inspect the fuel system for deterioration or leaks.
4. Check outboard for tightness on transom.
5. Check steering system for binding or loose components.
6. Visually check steering link rod fasteners for proper tightness.
7. Check propeller blades for damage.

After Each Use

1. Flush out the outboard cooling system if operating in salt or polluted water.
2. If operating in salt water, wash off all salt deposits and flush out the exhaust outlet of the propeller and gear case with fresh water.

Every 100 Hours of Use or Once yearly, Whichever occurs first

1. Lubricate all lubrication points. Lubricate more frequently when used in salt water.
2. Change engine oil and replace the oil filter. The oil should be changed more often when the engine is operated under adverse conditions such as extended trolling.
3. Inspect thermostat visually for corrosion, broken spring, and to determine that the valve is completely closed at room temperature. If questionable, inspect thermostat as outlined in Section 4B **“Thermostat**”.
4. Inspect and clean spark plugs.
5. Check engine fuel filter for contaminants.
6. Check engine timing setup.
7. Check corrosion control anodes. Check more frequently when used in salt water.
8. Drain and replace gear case lubricant.
9. Lubricate splines on the drive shaft.
10. Check and adjust valve clearance, if necessary.
11. Check power trim fluid.
12. Inspect battery.
13. Check control cable adjustments.
14. Inspect timing belt.
15. Remove engine deposits with Quicksilver Power Tune Engine Cleaner.
16. Check tightness of bolts, nuts, and other fasteners.

Every 300 Hours of Use or Three Years

1. Replace water pump impeller (more often if overheating occurs or reduced water pressure is noted).

Before Periods of Storage

1. Refer to Storage procedure (this section).

Flushing the Cooling System

Flush the internal water passages of the outboard with fresh water after each use in salt, polluted or muddy water. This will help prevent a buildup of deposits from clogging the internal water passages.

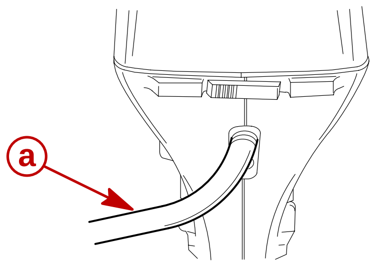
IMPORTANT: The engine must be run during flushing in order to open the thermostat and circulate water through the water passages.

NOTE: *You can have the outboard tilted or in the vertical operating position during flushing.*

WARNING

To avoid possible injury when flushing, remove the propeller. Refer to Propeller Replacement.

1. Place the outboard in either the operating position (vertical) or in a tilted position.
2. Remove propeller (refer to Propeller Replacement).
3. Thread a water hose into the rear fitting. Partially open the water tap (1/2 maximum). Do not open the water tap all the way, as this allows a high pressure flow of water.



a - Water Hose Threaded into Rear Fitting

IMPORTANT: Do not run engine above idle when flushing.

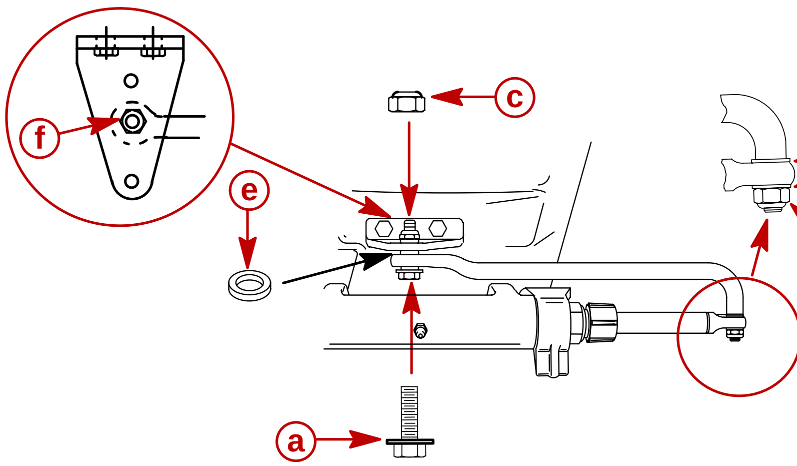
4. Shift outboard into neutral. Start the engine and flush the cooling system for at least 5 minutes. Keep engine speed at idle.
5. Stop the engine. Turn off the water and remove hose. Reinstall the propeller.

Steering Link Rod Fasteners

⚠ WARNING

Disengagement of a steering link rod can result in the boat taking a full, sudden, sharp turn. This potentially violent action can cause occupants to be thrown overboard exposing them to serious injury or death.

IMPORTANT: The steering link rod that connects the steering cable to the engine must be fastened using special washer head bolt (“a” – Part Number 10-90041) and self locking nylon insert locknuts (“b” & “c” – Part Number 11-34863). These locknuts must never be replaced with common nuts (non locking) as they will work loose and vibrate off, freeing the link rod to disengage.



- **a** - Washer Head Bolt (10-90041)
- **b** - Nylon Insert Locknut (11-34863)
- **c** - Nylon Insert Locknut (11-34863)
- **d** - Flat Washers
- **e** - Spacer (12-71970)
- **f** - Link Rod Mount Hole

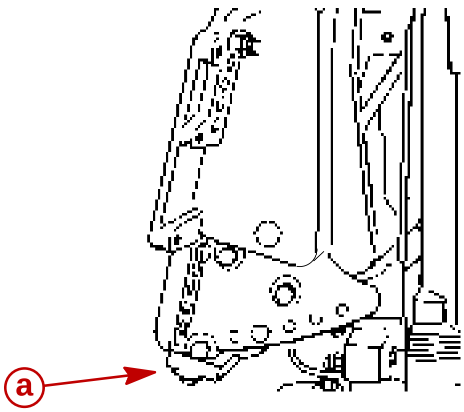
1. Assemble steering link rod to steering cable with two flat washers (d) and nylon insert locknut (“b” – Part Number 11-34863). Tighten locknut (b) until it seats, then back nut off 1/4 turn.
2. Assemble steering link rod to engine with special washer head bolt (“a” – Part Number 10-90041), locknut (“c” – Part Number 11-34863) and spacer (“e” – 12-71970). First torque bolt (a) to 20 lb. ft. (27 N·m), then torque locknut (c) to 20 lb. ft. (27 N·m).

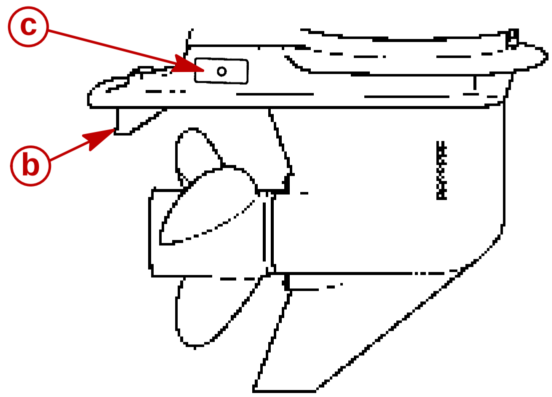
Corrosion Control Anode

Your outboard has control anodes at different locations. An anode helps protect the outboard against galvanic corrosion by sacrificing its metal to be slowly eroded instead of the outboard metals.

Each anode requires periodic inspection especially in salt water which will accelerate the erosion. To maintain this corrosion protection, always replace the anode before it is completely eroded. Never paint or apply a protective coating on the anode as this will reduce effectiveness of the anode.

1. The gear case has two corrosion control anodes. Another anode is installed on the bottom of the transom bracket assembly.





a - Bottom Anode
b - Trim Tab
c - Side Anodes (Big Foot Models Only)

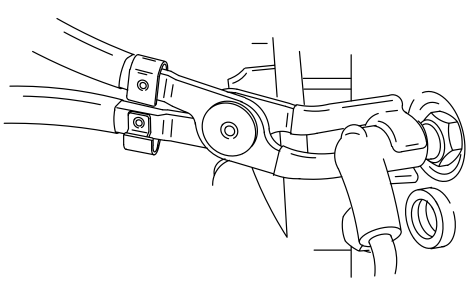
Spark Plug Inspection and Replacement

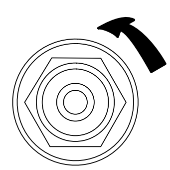
Inspect spark plugs at the recommended intervals.

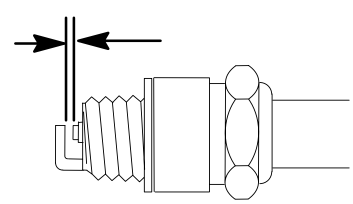
⚠ WARNING

Avoid serious injury or death from fire or explosion caused by damaged spark plug boots. Damaged spark plug boots can emit sparks. Sparks can ignite fuel vapors under the engine cowl. To avoid damaging spark plug boots, do not use any sharp object or metal tool such as pliers, screwdriver, etc. to remove spark plug boots.

1. Remove the spark plug leads by twisting the rubber boots slightly and pulling off.
2. Remove the spark plugs to inspect and clean. Replace spark plug if electrode is worn or the insulator is rough, cracked, broken, blistered or fouled.







3. Set the spark plug gap. See Specification Chart.
4. Before reinstalling spark plugs, clean away dirt on the spark plug seats. Install plugs finger tight, and tighten 1/4 turn or torque to 12.5 lb-ft (17 Nm).

Battery Inspection

The battery should be inspected at periodic intervals to ensure proper engine starting capability.

IMPORTANT: Read the safety and maintenance instructions which accompany your battery.

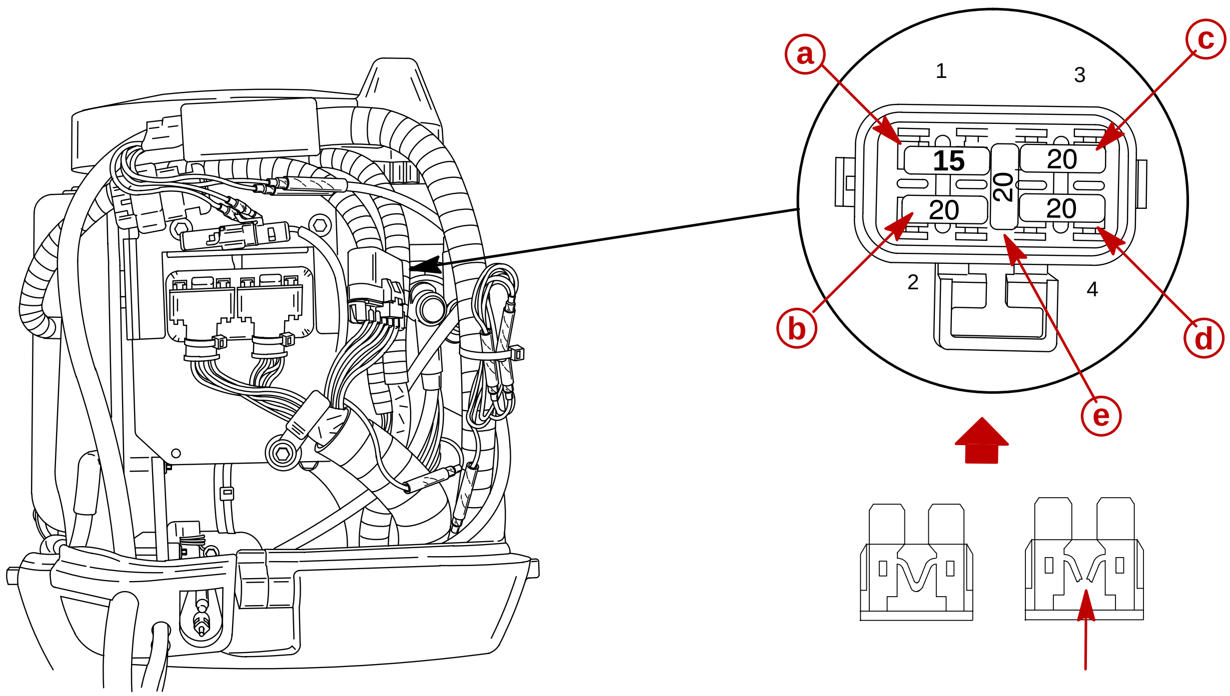
1. Turn off the engine before servicing the battery.
2. Add water as necessary to keep the battery full.
3. Make sure the battery is secure against movement.
4. Battery cable terminals should be clean, tight, and correctly installed. Positive to positive and negative to negative.
5. Make sure the battery is equipped with a nonconductive shield to prevent accidental shorting of battery terminals.

Fuse Replacement – Electric Start Models

IMPORTANT: Always carry spare 20 AMP Fuses.

The electrical wiring circuits on the outboard are protected from overload by fuses in the wiring. If the fuse is blown, try to locate and correct the cause of the overload. If the cause is not found, the fuse may blow again.

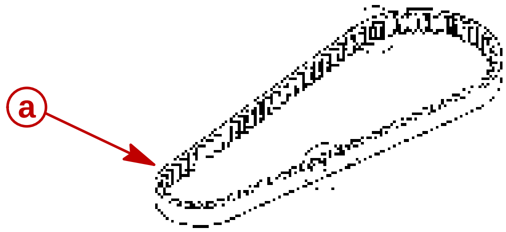
1. Open the fuse holder and look at the silver colored band inside the fuse. If band is broken replace the fuse. Replace fuse with a new fuse with the same amperage rating.



a - SmartCraft Data Bus Circuit - 15 AMP Fuse
b - Fuel Pump/Idle Air Control/Fuel Injector Circuits - 20 AMP Fuse
c - Main Relay/Accessories - 20 AMP Fuse
d - Ignition Coil Circuit - 20 AMP Fuse
e - Spare 20 AMP Fuse

Timing Belt Inspection

1. Inspect the timing belt and replace if any of the following conditions are found.
   a. Cracks in the back of the belt or in the base of the belt teeth.
   b. Excessive wear at the roots of the cogs.
   c. Rubber portion swollen by oil.
   d. Belt surfaces roughened.
   e. Signs of wear on edges or outer surfaces of belt.

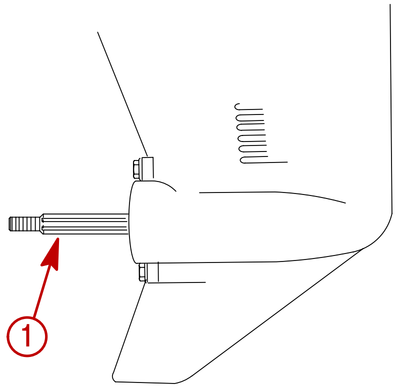


a - Timing Belt

Lubrication Points

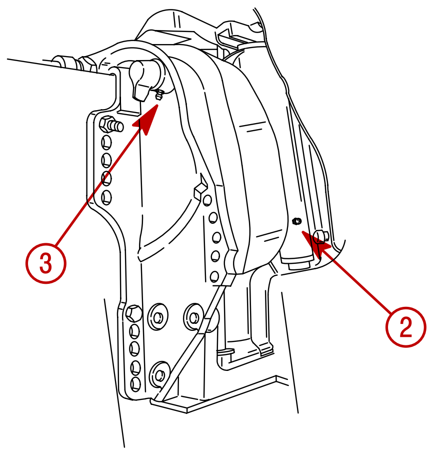
Lubricate Point 1 with Quicksilver or Mercury Precision Lubricants Anti-Corrosion Grease or 2-4-C Marine Lubricant with Teflon.

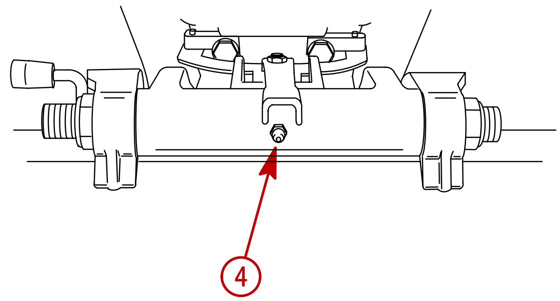
1. Propeller Shaft – Refer to Propeller Replacement for removal and installation of the propeller. Coat the entire propeller shaft with lubricant to prevent the propeller hub from corroding and seizing to the shaft.



Lubricate Points 2 thru 6 with Quicksilver or Mercury Precision Lubricants 2-4-C Marine Lubricant with Teflon or Special Lubricant 101.

2. Swivel Bracket – Lubricate through fitting.
3. Tilt Support Lever – Lubricate through fitting.
4. Tilt Tube – Lubricate through fitting.

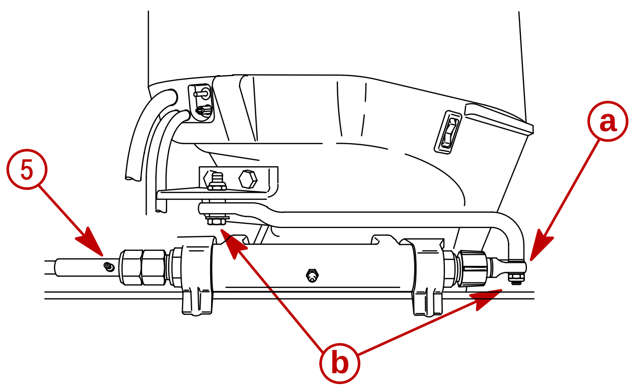


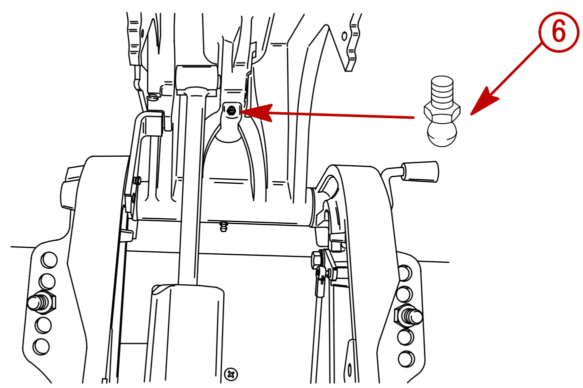


5. Steering Cable Grease Fitting (If equipped) – Rotate steering wheel to fully retract the steering cable end into the outboard tilt tube. Lubricate through fitting.

Lubricate Points b with light weight oil.

6. This grease fitting is for lubricating the threaded rod for the co-pilot.





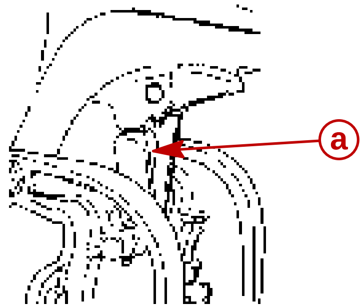
a - Steering Cable End
b - Pivot Points

⚠ WARNING

The end of the steering cable must be fully retracted into the outboard tilt tube before adding lubricant. Adding lubricant to steering cable when fully extended could cause steering cable to become hydraulically locked. An hydraulically locked steering cable will cause loss of steering control, possibly resulting in serious injury or death.

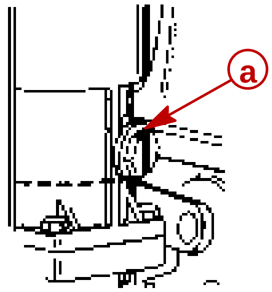
Checking Power Trim Fluid

1. Tilt outboard to the full up position and engage the tilt support lock.



a - Tilt Support Lock

2. Remove fill cap and check fluid level. The fluid level should be even with the bottom of the fill hole. Add Quicksilver Power Trim & Steering Fluid. If not available, use automotive (ATF) automatic transmission fluid.



a - Fill Cap

Fuel System

⚠ WARNING

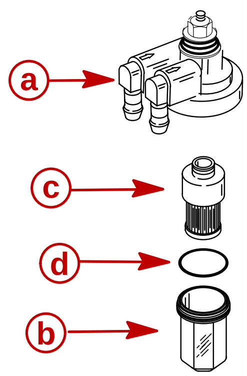
Avoid serious injury or death from gasoline fire or explosion. Carefully follow all fuel system service instructions. Always stop the engine and DO NOT smoke or allow open flames or sparks in the area while servicing any part of the fuel system.

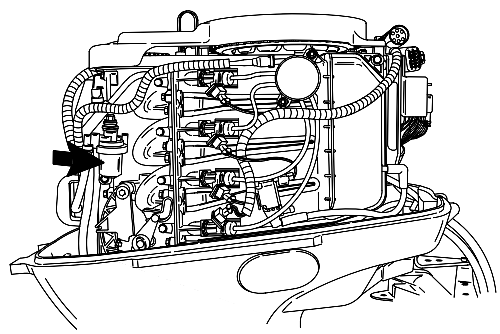
Before servicing any part of the fuel system, stop engine and disconnect the battery. Drain the fuel system completely. Use an approved container to collect and store fuel. Wipe up any spillage immediately. Material used to contain spillage must be disposed of in an approved receptacle. Any fuel system service must be performed in a well ventilated area. Inspect any completed service work for signs of fuel leakage.

Fuel Filter

IMPORTANT: Visually inspect for fuel leakage from the filter by squeezing the primer bulb until firm, forcing fuel into the filter.

Check the fuel filter for water accumulation or sediment. If water is in the fuel, remove the sight bowl and drain the water. If the filter appears to be contaminated, remove and replace.





a - Cover
b - Sight Bowl
c - Filter Element
d - O-Ring

REMOVAL

1. Read Fuel System servicing information and Warning on the previous page.
2. Pull out the filter assembly from mount. Hold onto the cover to prevent it from turning and remove the sight bowl. Empty contents into an approved container.
3. Pull out the filter element and replace it if necessary.

INSTALLATION

4. Push the filter element into the cover.
5. Place the O-Ring seal into it’s proper position on the sight bowl and screw the sight bowl hand tight into the cover.
6. Push filter assembly back into mount.

Fuel Line Inspection

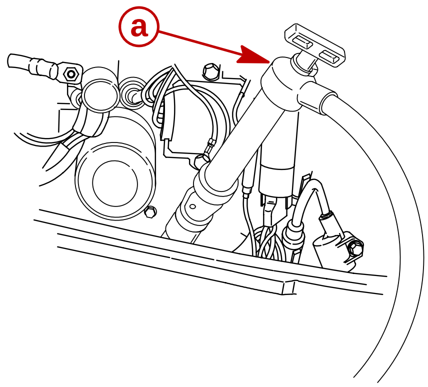
Visually inspect the fuel line and primer bulb for cracks, swelling, leaks, hardness, or other signs of deterioration or damage. If any of these conditions are found, the fuel line or primer bulb must be replaced.

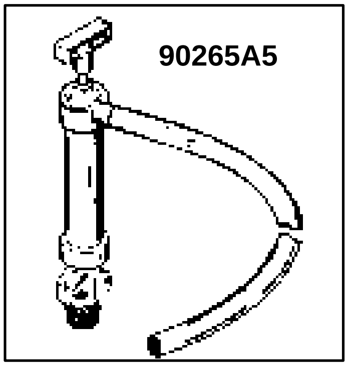
Changing Engine Oil

Oil Changing Procedure

Pump Method

1. Place the outboard in an vertical upright position.
2. Remove dipstick and slide adaptor tube/pump down dipstick tube. Pump out the engine oil into an appropriate container.

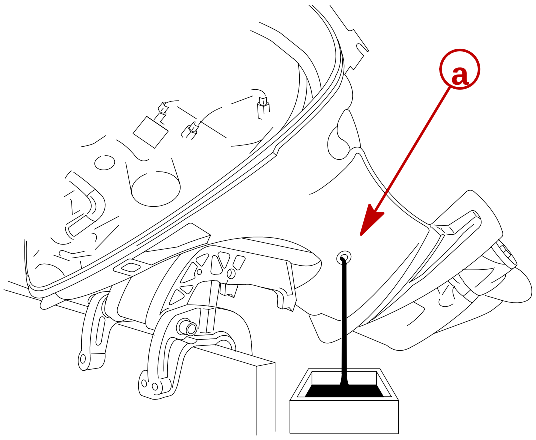




a - Crankcase Oil Pump

Drain Plug Method

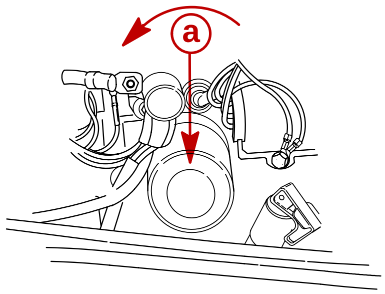
1. Tilt the outboard up to the trailer position.
2. Turn the steering on the outboard so that the drain hole is facing downward. Remove drain plug and drain engine oil into an appropriate container. Lubricate the seal on the drain plug with oil and reinstall.

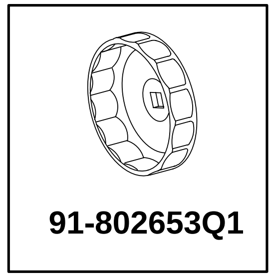


a - Drain Hole

Changing Oil Filter

1. Place a rag or towel below the oil filter to absorb any spilled oil.
2. Unscrew old filter by turning the filter counterclockwise.
3. Clean the mounting base. Apply film of clean oil to filter gasket. Do not use grease. Screw new filter on until gasket contacts base, then tighten 3/4 to 1 turn.



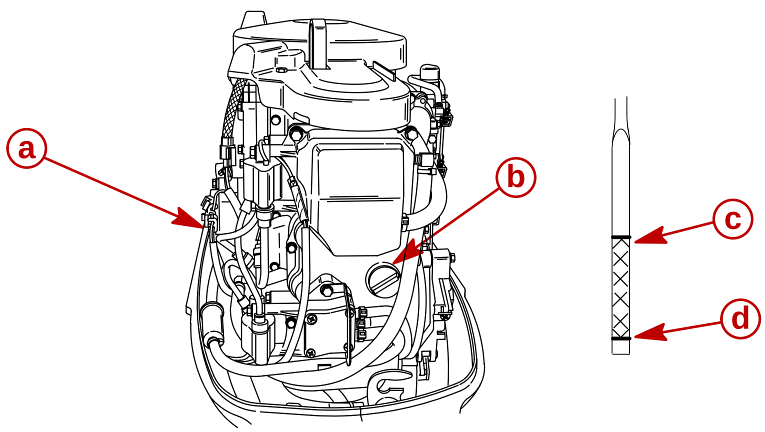


a - Oil Filter

Checking and Adding Engine Oil

IMPORTANT: Do not overfill. Be sure that the outboard is upright (not tilted) when checking oil.

1. Remove the oil fill cap and add oil to to proper operating level.
2. Idle engine for five minutes and check for leaks. Stop engine and check oil level on dipstick. Oil must be between full mark and add mark. Add oil if necessary.



a - Dipstick
b - Oil Fill Cap
c - Full Mark
d - Add Mark

Engine Oil Capacity
3 U.S. Quarts or (3.0 Liters)

Changing Gear Case Lubricant

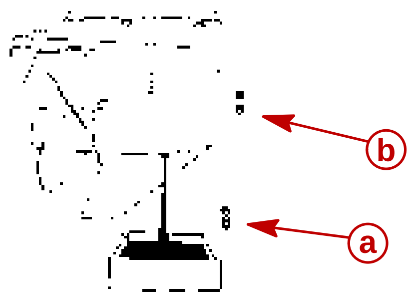
3-1/4 In. (83mm) Diameter Gear Case

When adding or changing gear case lubricant, visually check for the presence of water in the lubricant. If water is present, it may have settled to the bottom and will drain out prior to the lubricant, or it may be mixed with the lubricant, giving it a milky colored appearance. If water is noticed, have the gear case checked by your dealer. Water in the lubricant may result in premature bearing failure or, in freezing temperatures, will turn to ice and damage the gear case.

Examine the drained gear case lubricant for metal particles. A small amount of fine metal particles indicates normal gear wear. An excessive amount of metal filings or larger particles (chips) may indicate abnormal gear wear and should be checked by an authorized dealer.

DRAINING GEAR CASE

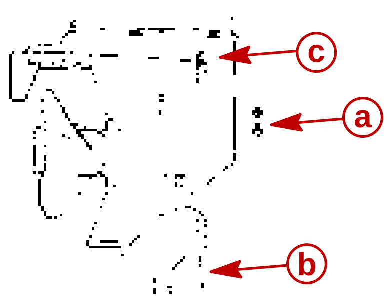
1. Place outboard in a vertical operating position.
2. Place a drain pan below outboard.
3. Remove vent plugs and fill/drain plug and drain lubricant.

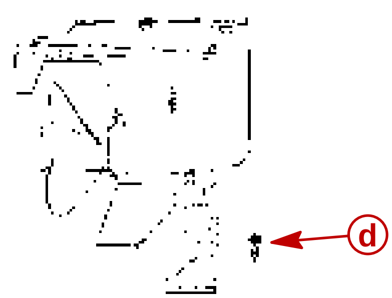


a - Fill/drain Plug
b - Vent Plug

CHECKING GEAR CASE LUBRICANT LEVEL AND REFILLING GEAR CASE

Gear Case Lubricant Capacity
11.5 fl oz (340 ml)





1. Place outboard in a vertical operating position.
2. Remove vent plug (a).
3. Place lubricant tube (b) into the fill hole and add lubricant until it appears at the vent hole (c).

IMPORTANT: Replace sealing washers if damaged.

4. Stop adding lubricant. Install the vent plug and sealing washer (a) before removing the lubricant tube.
5. Remove lubricant tube and reinstall cleaned fill/drain plug and sealing washer (d).

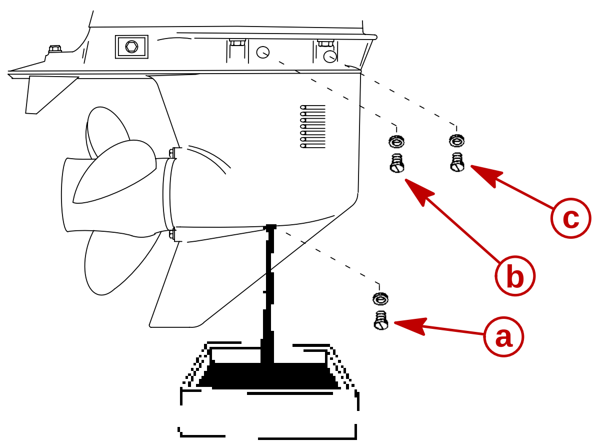
4-1/4 In. (108mm) Diameter Gear Case

When adding or changing gear case lubricant, visually check for the presence of water in the lubricant. If water is present, it may have settled to the bottom and will drain out prior to the lubricant, or it may be mixed with the lubricant, giving it a milky colored appearance. If water is noticed, have the gear case checked by your dealer. Water in the lubricant may result in premature bearing failure or, in freezing temperatures, will turn to ice and damage the gear case.

Whenever you remove the fill/drain plug, examine the magnetic end for metal particles. A small amount of metal filings or fine metal particles indicates normal gear wear. An excessive amount of metal filings or larger particles (chips) may indicate abnormal gear wear and should be checked by an authorized dealer.

DRAINING GEAR CASE

1. Place outboard in a vertical operating position.
2. Place a drain pan below outboard.
3. Remove vent plugs and fill/drain plug and drain lubricant.

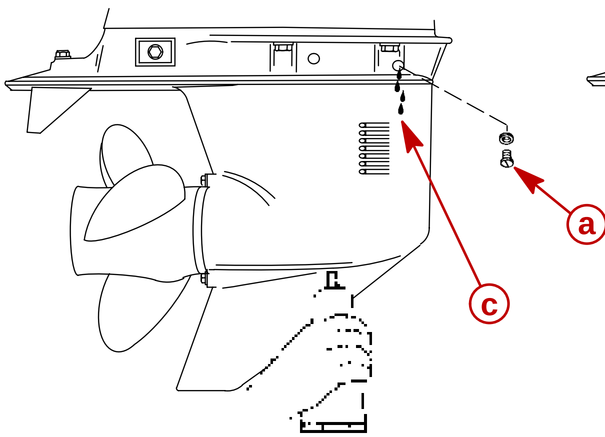


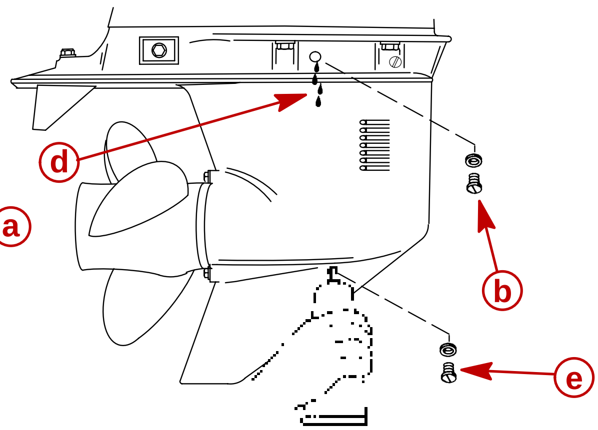
a - Fill/drain Plug
b - Rear Vent Plug
c - Front Vent Plug

CHECKING LUBRICANT LEVEL AND FILLING GEAR CASE

Gear Case Lubricant Capacity
24 fl oz (710 ml)

1. Place outboard in a vertical operating position.
2. Remove the front vent plug and rear vent plug.
3. Place lubricant tube into the fill hole and add lubricant until it appears at the front vent hole. At this time install the front vent plug and sealing washer.
4. Continue adding lubricant until it appears at the rear vent hole.
5. Stop adding lubricant. Install the rear vent plug and sealing washer before removing lubricant tube.
6. Remove lubricant tube and reinstall cleaned fill/drain plug and sealing washer.





a - Front Vent Plug
b - Rear Vent Plug
c - Front Vent Hole
d - Rear Vent Hole
e - Fill/Drain Plug and Sealing Washer

Storage Preparation

The major consideration in preparing your outboard for storage is to protect it from rust, corrosion, and damage caused by freezing of trapped water.

The following storage procedures should be followed to prepare your outboard for out-of-season storage or prolonged storage (two months or longer).

⚠ CAUTION
Never start or run your outboard (even momentarily) without water circulating through the cooling water intake in the gear case to prevent damage to the water pump (running dry) or overheating of the engine.

Fuel System

IMPORTANT: Gasoline containing alcohol (ethanol or methanol) can cause a formation of acid during storage and can damage the fuel system. If the gasoline being used contains alcohol, it is advisable to drain as much of the remaining gasoline as possible from the fuel tank, remote fuel line, and engine fuel system.

Fill the fuel tank and engine fuel system with treated (stabilized) fuel to help prevent formation of varnish and gum. Proceed with following instructions.

1. Portable Fuel Tank – Pour the required amount of Quicksilver Gasoline Stabilizer (follow instructions on container) into fuel tank. Tip fuel tank back and forth to mix stabilizer with the fuel.
2. Permanently Installed Fuel Tank – Pour the required amount of Quicksilver Gasoline Stabilizer (follow instructions on container) into a separate container and mix with approximately one quart (one liter) of gasoline. Pour this mixture into fuel tank.
3. Remove the fuel filter sight bowl (see “Fuel Filter” above) and empty contents in a suitable container. Add 3 cc (1/2 teaspoon) of gasoline stabilizer into the fuel filter sight bowl and reinstall.
4. Place the outboard in water or connect flushing attachment for circulating cooling water. Run the engine for 15 minutes to allow treated fuel to fill the engine fuel system.

Protecting External Outboard Components

1. Lubricate all outboard components listed in the Inspection and Maintenance Schedule.
2. Touch up any paint nicks.
3. Spray Quicksilver or Mercury Precision Lubricants Corrosion Guard on external metal surfaces (except corrosion control anodes).

Protecting Internal Engine Components

1. Remove the spark plugs and inject a small amount of engine oil inside of each cylinder.
2. Rotate the flywheel manually several times to distribute the oil in the cylinders. Reinstall spark plugs.
3. Change the engine oil.

Gear Case

1. Drain and refill the gear case lubricant (refer to maintenance procedure).

Positioning Outboard for Storage

Store outboard in an upright (vertical) position to allow water to drain out of outboard.

⚠ CAUTION

If outboard is stored tilted up in freezing temperature, trapped cooling water or rain water that may have entered the propeller exhaust outlet in the gear case could freeze and cause damage to the outboard.

Battery Storage

1. Follow the battery manufacturer’s instructions for storage and recharging.
2. Remove the battery from the boat and check water level. Recharge if necessary.
3. Store the battery in a cool, dry place.
4. Periodically check the water level and recharge the battery during storage.

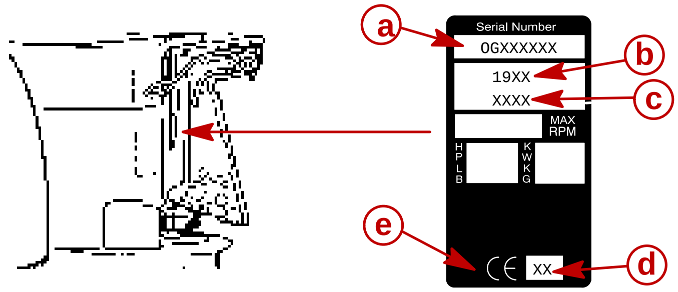
IMPORTANT INFORMATION

Section 1C - GENERAL INFORMATION

Table of Contents

Serial Number Location

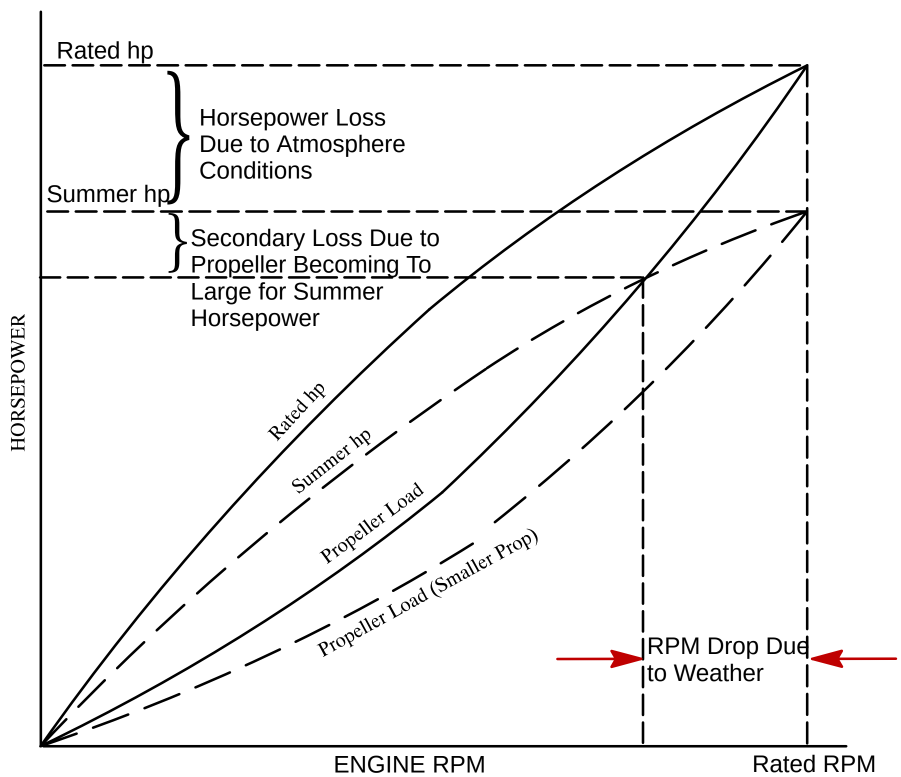
The Outboard serial number is located on the lower starboard side of the engine block. A serial number is also located on the top side of the swivel bracket.



a - Serial Number
b - Model Year
c - Model Description
d - Year Manufactured
e - Certified Europe Insignia

Conditions Affecting Performance

Weather



It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated rpm under a specific combination of weather conditions.

Corporations internationally have settled on adoption of I.S.O. (International Standards Organization) engine test standards, as set forth in I.S.O. 3046 standardizing the computation of horsepower from data obtained on the dynamometer. All values are corrected to the power that the engine will produce at sea level, at 30% relative humidity, at a temperature of 77° F (25° C) and a barometric pressure of 29.61 inches of mercury.

Summer conditions of high temperature, low barometric pressure and high humidity all combine to reduce the engine power. This, in turn, is reflected in decreased boat speeds--as much as 2 or 3 miles-per-hour (3 or 5 Km per-hour) in some cases. (Refer to previous chart.) Nothing will regain this speed for the boater, but the coming of cool, dry weather.

In pointing out the practical consequences of weather effects, an engine--running on a hot, humid summer day--may encounter a loss of as much as 14% of the horsepower it would produce on a dry, brisk spring or fall day. The horsepower that any internal combustion engine produces, depends upon the density of the air that it consumes, and in turn, this density is dependent upon the temperature of the air, its barometric pressure, and water vapor (or humidity) content.

Accompanying this weather-inspired loss of power is a second but more subtle loss. At rigging time in early spring, the engine was equipped with a propeller that allowed the engine to turn within its recommended rpm range at full throttle. With the coming of the summer weather and the consequent drop in available horsepower, this propeller will, in effect, become too large. Consequently, the engine operates at less than its recommended rpm.

Due to the horsepower/rpm characteristics of an engine, this will result in further loss of horsepower at the propeller with another decrease in boat speed. This secondary loss, however, can be regained by switching to a smaller pitch propeller that allows the engine to again run at recommended rpm.

For boaters to realize optimum engine performance under changing weather conditions, it is essential that the engine have the proper propeller, to allow it to operate at or near the top end of the recommended maximum rpm range at wide-open-throttle with a normal boat load.

Not only does this allow the engine to develop full power, but equally important, is the fact that the engine also will be operating in an rpm range that discourages damaging detonation. This, of course, enhances overall reliability and durability of the engine.

Boat

WEIGHT DISTRIBUTION

1. Proper positioning of the weight inside the boat (persons and gear) has a significant effect on the boat’s performance, for example:
   a. Shifting weight to the rear (stern).
      (1.) Generally increases top speed.
      (2.) If in excess, can cause the boat to porpoise.
      (3.) Can make the bow bounce excessively in choppy water.
      (4.) Will increase the danger of the following - wave splashing into the boat when coming off plane.
   b. Shifting weight to the front (bow).
   c. Adjusting tilt pin to achieve best performance and handling.
      (1.) Improves ease of planing off.
      (2.) Generally improves rough water ride.
      (3.) If excessive, can make the boat veer left and right (bow steer).

BOTTOM

For maximum speed, a boat bottom should be nearly a flat plane where it contacts the water and particularly straight and smooth in fore-and-aft direction.

1. **Hook:** Exists when bottom is concave in fore-and-aft direction when viewed from the side. When boat is planing, “hook” causes more lift on bottom near transom and allows bow to drop, thus greatly increasing wetted surface and reducing boat speed. “Hook” frequently is caused by supporting boat too far ahead of transom while hauling on a trailer or during storage.
2. **Rocker:** The reverse of hook and much less common. “Rocker” exists if bottom is convex in fore-and-aft direction when viewed from the side, and boat has strong tendency to porpoise.
3. **Surface Roughness:** Moss, barnacles, etc., on boat or corrosion of outboard’s gear housing increase skin friction and cause speed loss. Clean surfaces when necessary.

WATER ABSORPTION

It is imperative that all through hull fasteners be coated with a quality marine sealer at time of installation. Water intrusion into the transom core and/or inner hull will result in additional boat weight (reduced boat performance), hull decay and eventual structural failure.

CAVITATION

Cavitation is caused by water vapor bubbles forming either from a sharp edge or angle on the gear case, from an irregularity in the propeller blade itself or from improper engine installation (too high). These vapor bubbles flow back and collapse when striking the surface of the propeller blade resulting in the erosion of the propeller blade surface. If allowed to continue, eventual blade failure (breakage) will occur.

Engine

DETONATION

Detonation in a 4-cycle engine resembles the “pinging” heard in an automobile engine. It can be otherwise described as a tin-like “rattling” or “plinking” sound.

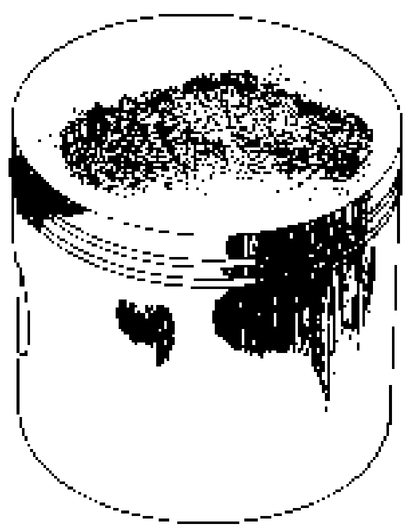
Detonation is an explosion of an unburned portion of the fuel/air charge after the spark plug has fired. Detonation creates severe shock waves in the engine, and these shock waves often find or create a weakness: The dome of a piston, cylinder head/gasket, piston rings or piston ring lands, piston pin and bearings.

A few of the most common causes of detonation in a marine 4-cycle application are as follows:

- Over-advanced ignition timing.
- Use of low octane gasoline.
- Propeller pitch too high (engine rpm below recommended maximum range).
- Lean fuel mixture at or near wide-open-throttle.
- Spark plugs (heat range too hot - incorrect reach - cross-firing).
- Inadequate engine cooling (deteriorated cooling system).
- Combustion chamber/piston deposits (result in higher compression ratio).

Detonation usually can be prevented if:

1. The engine is correctly set up.
2. Diligent maintenance is applied to combat the detonation causes.



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Damaged Piston Resulting from Detonation

Following Complete Submersion

Submerged While Running (Special Instructions)

When an engine is submerged while running, the possibility of internal engine damage is greatly increased. If, after engine is recovered and with spark plugs removed, engine fails to turn over freely when turning flywheel, the possibility of internal damage (bent connecting rod and/or bent crankshaft) exists. If this is the case, the powerhead must be disassembled.

Salt Water Submersion (Special Instructions)

Due to the corrosive effect of salt water on internal engine components, complete disassembly is necessary before any attempt is made to start the engine.

Fresh Water Submersion (Special Instructions)

1. Recover engine as quickly as possible.
2. Remove cowling.
3. Flush exterior of outboard with fresh water to remove mud, weeds, etc. DO NOT attempt to start engine if sand has entered powerhead, as powerhead will be severely damaged. Disassemble powerhead if necessary to clean components.
4. Remove spark plugs and get as much water as possible out of powerhead. Most water can be eliminated by placing engine in a horizontal position (with spark plug holes down) and rotating flywheel.
5. Drain water from fuel system as follows:
   a. Disconnect remote fuel hose from engine.
   b. Loosen drain screw of vapor separator and drain fuel/water into a suitable container. Tighten drain screw after draining.

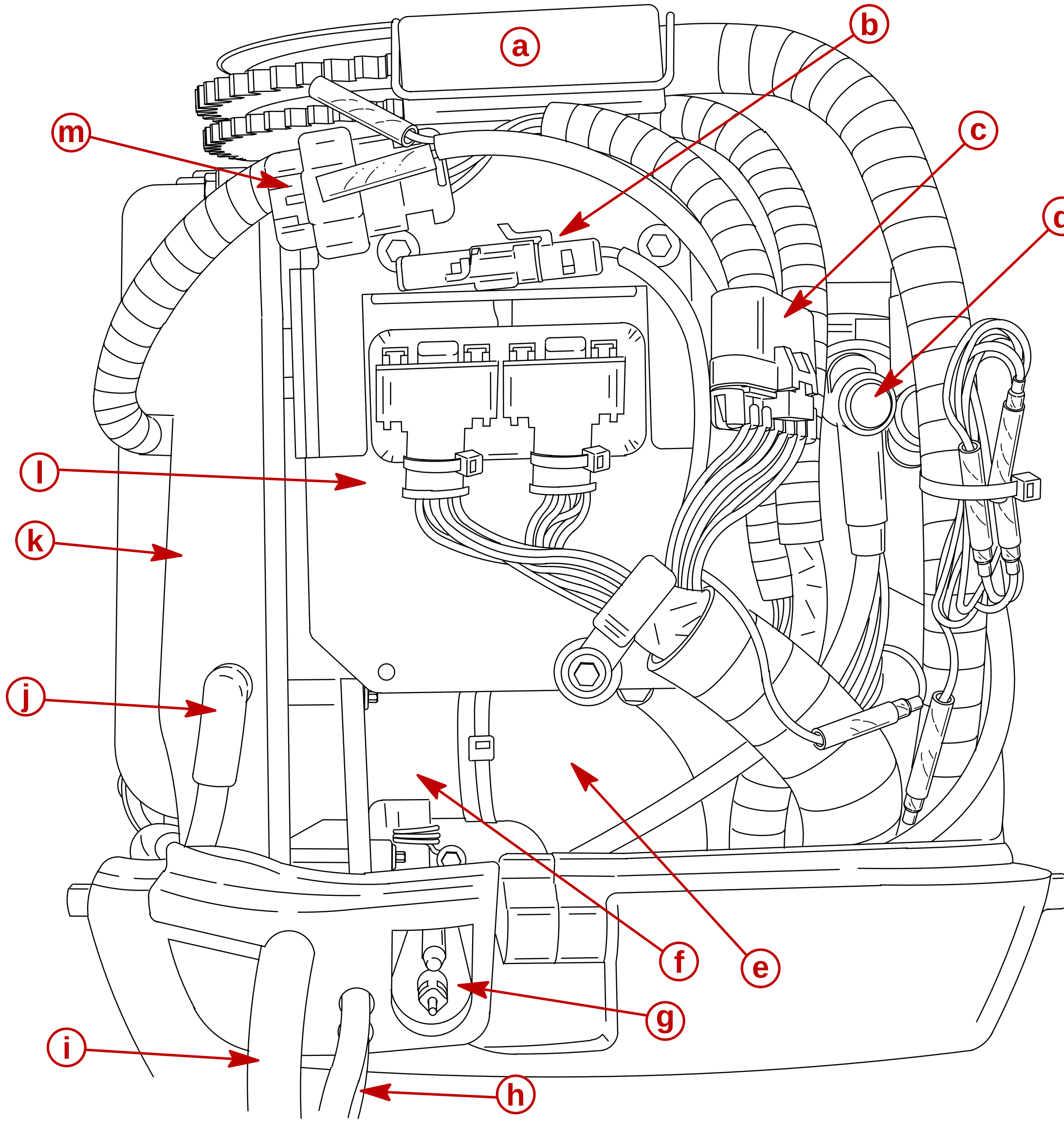
⚠ WARNING

Always release the fuel pressure in the high-pressure fuel line before servicing the line or the vapor separator. If the fuel pressure is not released, pressurized fuel may spray out.

   c. Release fuel pressure. Refer to **Releasing Fuel Pressure in the High Pressure Fuel Line**, Section 3C. Remove high-pressure fuel line from bottom of vapor separator fuel cooler and drain fuel/water into suitable container. Replace in-line fuel filter of high-pressure fuel line and reconnect fuel line to connection on fuel cooler.
   d. Remove fuel distribution manifold and empty contents into suitable container. Inspect and clean fuel injectors. Reinstall fuel injectors/fuel distribution manifold.
   e. Empty contents of water separating fuel filter into suitable container.
6. Change engine oil and filter as outlined in **Section 1B "Changing Engine Oil".** Run outboard for short time and check for presence of water in oil. If water present (milky appearance) drain and refill as previously mentioned.
7. Pour alcohol into engine through throttle body (alcohol will absorb water). Again rotate flywheel.
8. Turn engine over and pour alcohol into spark plug openings and rotate flywheel.
9. Turn engine over (place spark plug openings down) and pour engine oil into intake manifold plug holes (plugs removed) while rotating flywheel to distribute oil throughout crankcase.

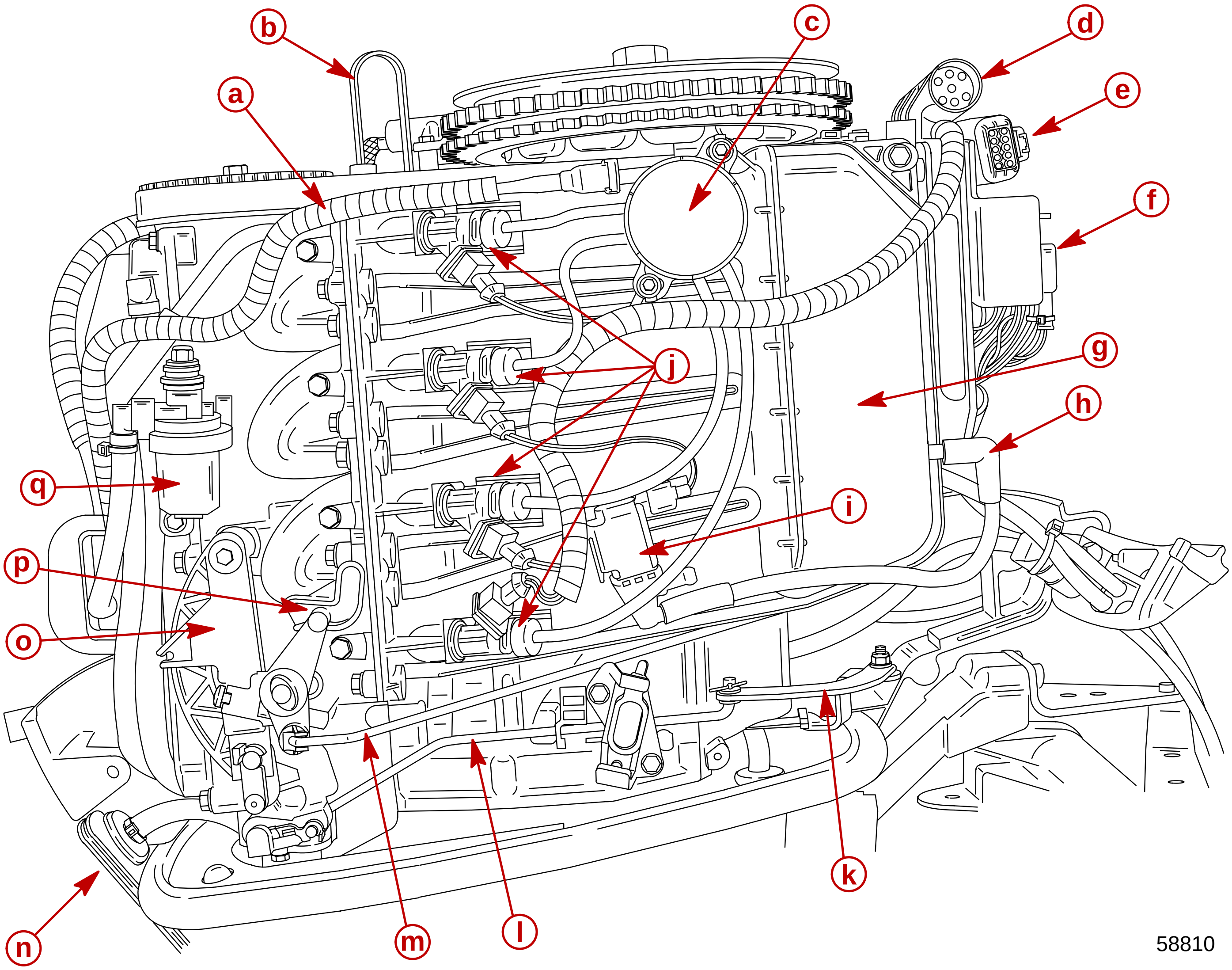
10. Again turn engine over and pour approximately one teaspoon of engine oil into each spark plug opening. Again rotate flywheel to distribute oil in cylinders.
11. Remove and clean intake manifold assembly and fuel pump assembly.
12. Dry all wiring and electrical components using compressed air.
13. Disassemble the engine starter motor and dry the brush contacts, armature and other corrodible parts.
14. Reinstall spark plugs, intake manifold and fuel pump.
15. Attempt to start engine, using a fresh fuel source. If engine starts, it should be run for at least one hour to eliminate any water in engine.
16. If engine fails to start, determine cause (fuel, electrical or mechanical). Engine should be run within 2 hours after recovery of outboard from water, or serious internal damage may occur. If unable to start engine in this period, disassemble engine and clean all parts. Apply oil as soon as possible.

Model 50/60 EFI (4-Stroke) Powerhead Front View



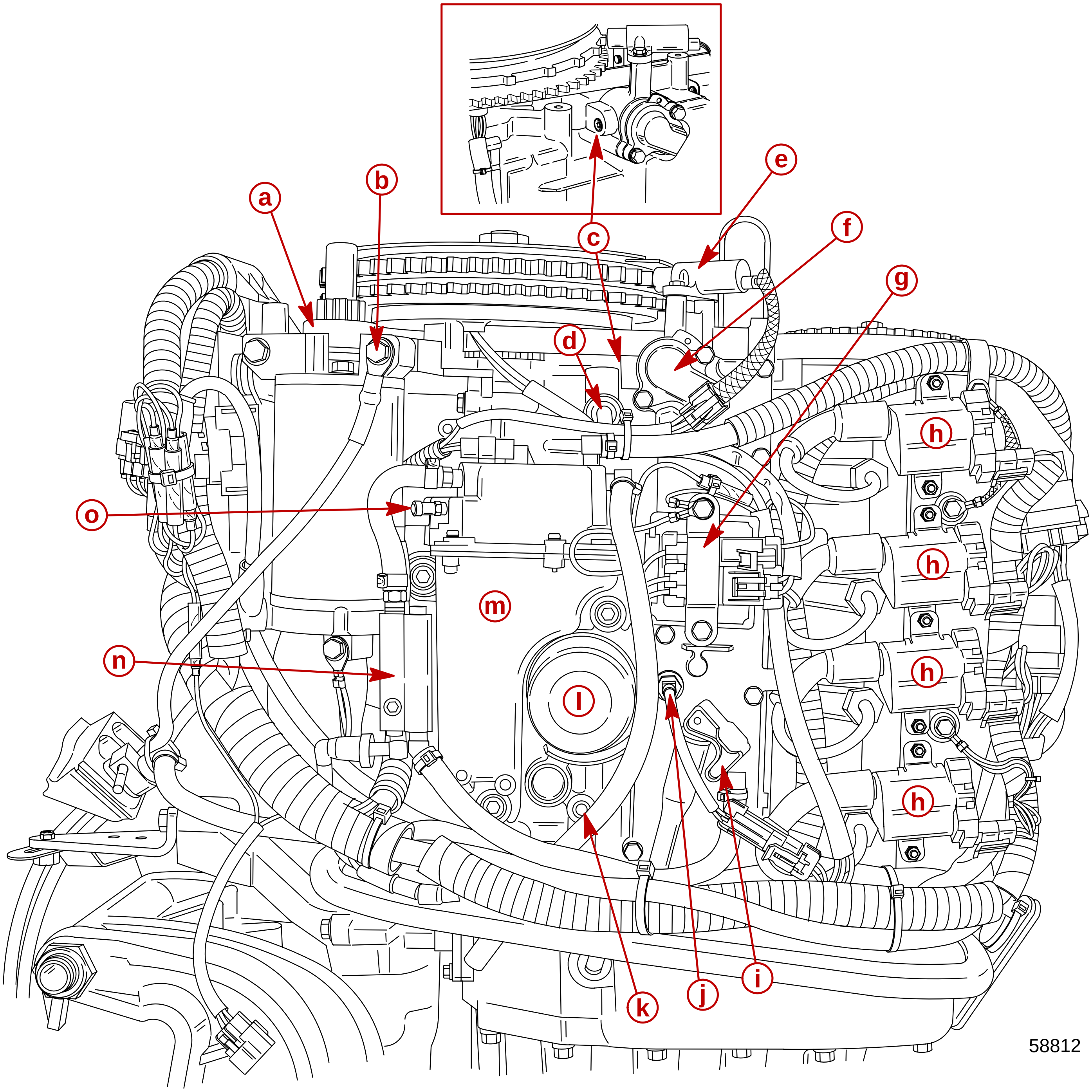
- **a** - Remote Control and Engine Harness Connection
- **b** - DDT Test Port
- **c** - Fuses – 3-20 Amp. , 1-15 Amp.
- **d** - Positive 12 Volt Battery Connection
- **e** - Sound Attenuator
- **f** - Throttle Body
- **g** - Fuel Connection
- **h** - Throttle and Shift Cables
- **i** - Remote Control Harness
- **j** - Throttle Air By-Pass Hose
- **k** - Intake Manifold
- **l** - ECM
- **m** - 10 Pin SmartCraft Connection

Model 50/60 EFI (4-Stroke) Powerhead Starboard View



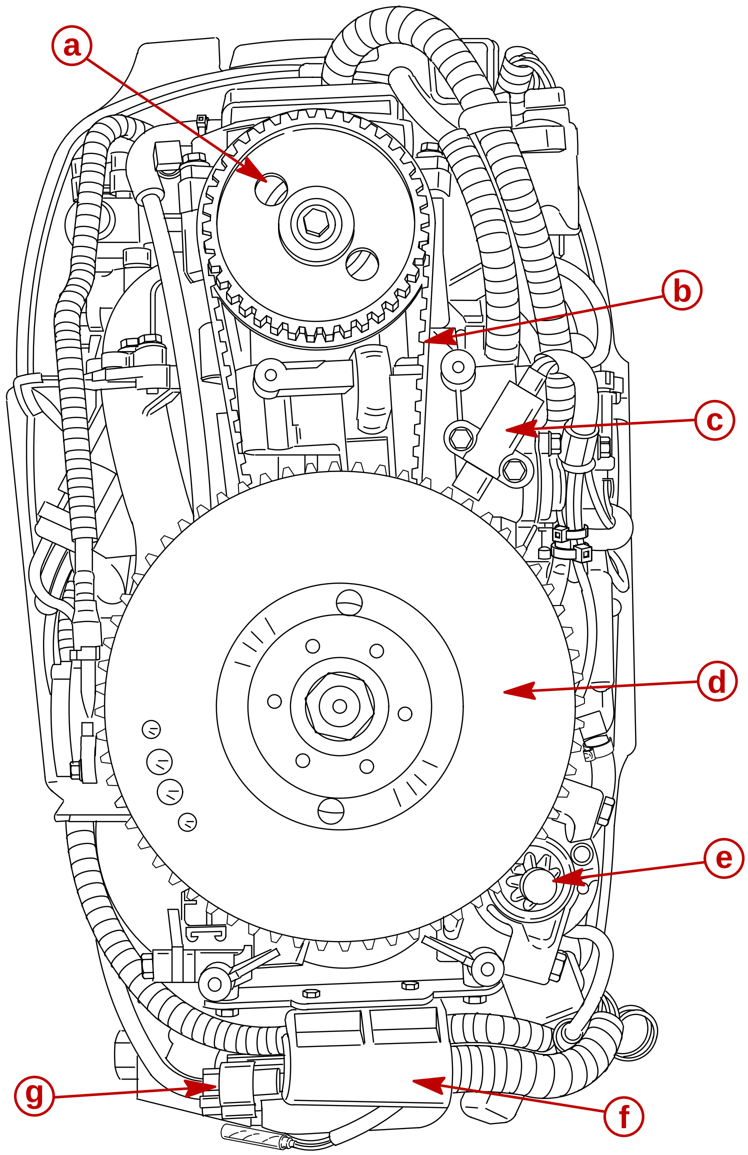
- **a** - High Pressure Fuel Line from VST
- **b** - Lifting Eye
- **c** - Fuel Distribution Manifold
- **d** - Engine Harness Connection to Remote Control Harness
- **e** - 10 Pin SmartCraft Connection
- **f** - Engine Harness Connections to ECM
- **g** - Intake Manifold
- **h** - Throttle Air By-Pass Hose
- **i** - Idle Air Control (IAC)
- **j** - Fuel Injectors
- **k** - Shift Arm
- **l** - Shift Linkage
- **m** - Throttle Linkage
- **n** - Tell-Tale
- **o** - Throttle Lever
- **p** - Throttle Cam
- **q** - Fuel Filter

Model 50/60 EFI (4-Stroke) Powerhead Port View



- **a** - Starter Motor
- **b** - Negative Battery Connection
- **c** - Access Port, Water Pressure/ Temperature Sender Accessory
- **d** - Oil Pressure Switch
- **e** - Crank Position Sensor (CPS)
- **f** - Thermostat Housing
- **g** - Voltage Regulator
- **h** - Ignition Coils
- **i** - Oil Dip Stick
- **j** - Engine Coolant Temperature (ECT) Sender
- **k** - Oil Pressure Port
- **l** - Oil Filter
- **m** - Vapor Separator Tank (VST)
- **n** - Fuel Cooler
- **o** - Schrader Test Valve

Model 50/60 EFI (4-Stroke) Powerhead Top View



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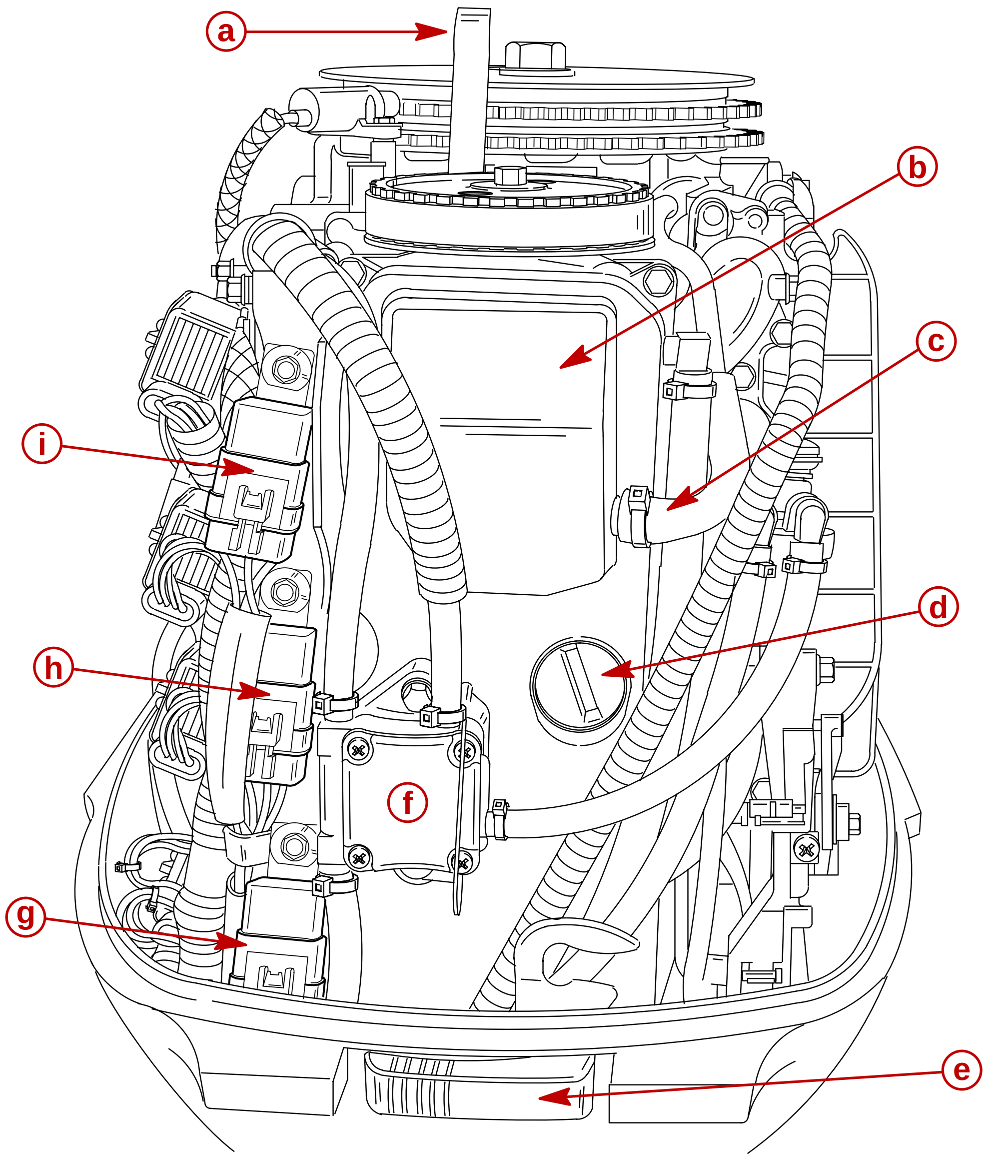
a - Cam Shaft Timing Gear
b - Timing Belt
c - Crank Position Sensor
d - Flywheel
e - Starter Motor
f - Remote Control and Engine Harness Connection
g - 10 Pin SmartCraft Connection

Model 50/60 EFI (4-Stroke) Powerhead Aft View



- **a** - Lifting Eye
- **b** - Valve Cover
- **c** - Crankcase Breather Hose
- **d** - Oil Fill Plug
- **e** - Bottom Cowl Latch
- **f** - Fuel Pump (Water Cooled)
- **g** - Main Power Relay
- **h** - Trim Down Relay
- **i** - Trim Up Relay

Propeller Selection

For in-depth information on marine propellers and boat performance - written by marine engineers - see your Authorized Dealer for the illustrated "**What You Should Know About Quicksilver Propellers...and Boat Performance Information**" (Part No. 90-86144).

For best all around performance from your outboard/boat combination, select a propeller that allows the engine to operate in the upper half of the recommended full throttle rpm range with the boat normally loaded (refer to Specifications). This rpm range allows for better acceleration while maintaining maximum boat speed.

If changing conditions cause the rpm to drop below the recommended range (such as warmer, more humid weather, operation at higher elevations, increased boat load or a dirty boat bottom/gear case) a propeller change or cleaning may be required to maintain performance and ensure the outboard's durability.

Check full-throttle rpm using an accurate tachometer with the engine trimmed out to a balanced-steering condition (steering effort equal in both directions) without causing the propeller to "break loose".

Refer to "Quicksilver Accessory Guide" for a complete list of available propellers.

1. Select a propeller that will allow the engine to operate at or near the top of the recommended full throttle rpm range (listed in "**Specifications**," preceding) with a normal load. Maximum engine speed (rpm) for propeller selection exists when boat speed is maximum and trim is minimum for that speed. (High rpm, caused by an excessive trim angle, should not be used in determining correct propeller.) Normally, there is a 150-350 rpm change between propeller pitches.
2. If full throttle operation is below the recommended range, the propeller MUST BE changed to one with a lower pitch to prevent loss of performance and possible engine damage.
3. After initial propeller installation, the following common conditions may require that the propeller be changed to a lower pitch:
   a. Warmer weather and great humidity will cause an rpm loss.
   b. Operating in a higher elevation causes an rpm loss.
   c. Operating with a damaged propeller or a dirty boat bottom or gear housing will cause an rpm loss.
   d. Operation with an increased load (additional passengers, equipment, pulling skiers, etc.).

Propeller Removal/Installation

3-1/4 In. (83mm) Diameter Gear Case

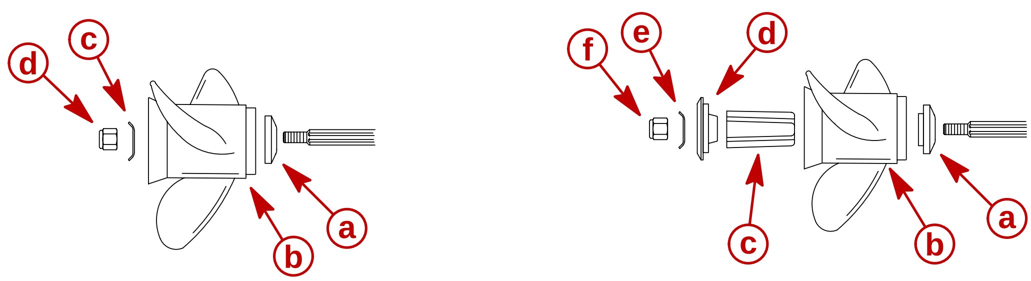
⚠ WARNING

If the propeller shaft is rotated while the engine is in gear, there is the possibility that the engine will crank over and start. To prevent this type of accidental engine starting and possible serious injury caused from being struck by a rotating propeller, always shift outboard to neutral position and remove spark plug leads when you are servicing the propeller.

1. Shift outboard to neutral (N) position.
2. Remove the spark plug leads to prevent engine from starting.

3. Straighten the bent tabs (a) on the propeller nut retainer.
4. Place a block of wood between gear case and propeller to hold propeller and remove propeller nut. Pull propeller straight off shaft.
5. Coat the propeller shaft with Quicksilver or Mercury Precision Lubricants Anti-Corrosion Grease or 2-4-C Marine Lubricant with Teflon.

IMPORTANT: To prevent the propeller hub from corroding and seizing to the propeller shaft, especially in salt water, always apply a coat of the recommended lubricant to the entire propeller shaft at the recommended maintenance intervals and also each time the propeller is removed.



Flo-Torque I Drive Hub Propellers   Flo-Torque II Drive Hub Propellers

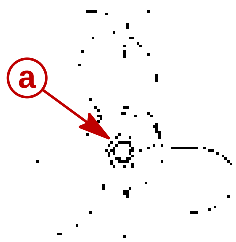
6. Flo-Torque I Drive Hub Propellers – Install forward thrust hub (a), propeller (b), propeller nut retainer (c) and propeller nut (d) onto the shaft.
7. Flo-Torque II Drive Hub Propellers – Install forward thrust hub (a), propeller (b), replaceable drive sleeve (c), rear thrust hub (d), propeller nut retainer (e) and propeller nut (f) onto the shaft.
8. Place propeller nut retainer over pins. Place a block of wood between gear case and propeller and tighten propeller nut to 55 lb. ft. (75 N·m), aligning flat sides of the propeller nut with tabs on the propeller nut retainer.
9. Secure propeller nut by bending tabs up and against the flats on the propeller nut.
10. Reinstall spark plug leads.

4-1/4 In. (108mm) Diameter Gear Case

⚠ WARNING

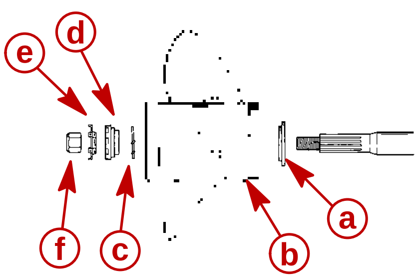
If the propeller shaft is rotated while the engine is in gear, there is the possibility that the engine will crank over and start. To prevent this type of accidental engine starting and possible serious injury caused from being struck by a rotating propeller, always shift outboard to neutral position and remove spark plug leads when you are servicing the propeller.

1. Shift outboard to neutral (N) position.
2. Remove the spark plug leads to prevent engine from starting.

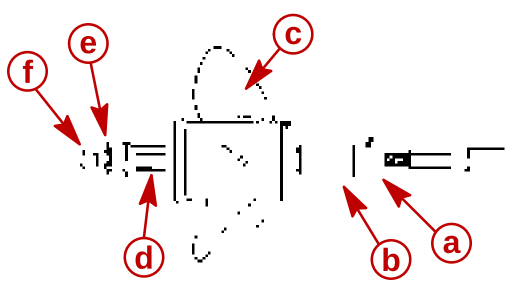


3. Straighten the bent tabs (a) on the propeller nut retainer.
4. Place a block of wood between gear case and propeller to hold propeller and remove propeller nut. Pull propeller straight off shaft.
5. Coat the propeller shaft with Quicksilver or Mercury Precision Lubricants Anti-Corrosion Grease or 2-4-C Marine Lubricant with Teflon.

IMPORTANT: To prevent the propeller hub from corroding and seizing to the propeller shaft, especially in salt water, always apply a coat of the recommended lubricant to the entire propeller shaft at the recommended maintenance intervals, and also each time the propeller is removed.



Flo-Torque I Drive Hub Propellers



Flo-Torque II Drive Hub Propellers

6. Flo-Torq I Drive Hub Propellers – Install thrust washer (a), propeller (b), continuity washer (c), thrust hub (d), propeller nut retainer (e), and propeller nut (f) onto the shaft.
7. Flo-Torq II Drive Hub Propellers – Install forward thrust hub (a), replaceable drive sleeve (b), propeller (c), thrust hub (d), propeller nut retainer (e) and propeller nut (f) onto the shaft.
8. Place a block of wood between gear case and propeller and torque propeller nut to 55 lb. ft. (75 N·m).
9. Secure propeller nut by bending three of the tabs into the thrust hub grooves.
10. Reinstall spark plug leads.

Power Trim System

General Information

The power trim system is filled at the manufacturer and is ready for use.

Trim outboard through entire trim and tilt range several times to remove any air from the system.

The trim system is pressurized and is not externally vented.

Power Trim Operation

With most boats, operating around the middle of the "trim" range will give satisfactory results. However, to take full advantage of the trimming capability there may be times when you choose to trim your outboard all the way in or out. Along with an improvement in some performance aspects comes a greater responsibility for the operator, and this is being aware of some potential control hazards. The most significant control hazard is a pull or "torque" that can be felt on the steering wheel or tiller handle. This steering torque results from the outboard being trimmed so that the propeller shaft is not parallel to the water surface.

WARNING

Avoid possible serious injury or death. When the outboard is trimmed in or out beyond a neutral steering condition, a pull on the steering wheel or tiller handle in either direction may result. Failure to keep a continuous firm grip on the steering wheel or tiller handle when this condition exists can result in loss of boat control as the outboard can turn freely. The boat can now "spin out" or go into a very tight maximum turn which, if unexpected, can result in occupants being thrown within the boat or out of the boat.

Consider the following lists carefully:

TRIMMING IN OR DOWN CAN:

1. Lower the bow.
2. Result in quicker planing off, especially with a heavy load or a stern heavy boat.
3. Generally improve the ride in choppy water.
4. Increase steering torque or pull to the right (with the normal right hand rotation propeller).
5. In excess, lower the bow of some boats to a point where they begin to plow with their bow in the water while on plane. This can result in an unexpected turn in either direction called "bow steering" or "over steering" if any turn is attempted or if a significant wave is encountered.

WARNING

Avoid possible serious injury or death. Adjust outboard to an intermediate trim position as soon as boat is on plane to avoid possible ejection due to boat spin-out. Do not attempt to turn boat when on plane if outboard is trimmed extremely in or down and there is a pull on the steering wheel or tiller handle.

TRIMMING OUT OR UP CAN:

1. Lift the bow higher out of the water.
2. Generally increase top speed.
3. Increase clearance over submerged objects or a shallow bottom.

4. Increase steering torque or pull to the left at a normal installation height (with the normal right hand rotation propeller).
5. In excess, cause boat “porpoising” (bouncing) or propeller ventilation.
6. Cause engine overheating if any water intake holes are above the water line.

Trim “In” Angle Adjustment

Some outboard boats, particularly some bass boats, are built with a greater than normal transom angle which will allow the outboard to be trimmed further “in” or “under”. This greater trim “under” capability is desirable to improve acceleration, reduce the angle and time spent in a bow high boat, altitude during planing off, and in some cases, may be necessary to plane off a boat with aft live wells, given the variety of available propellers and height range of engine installations.

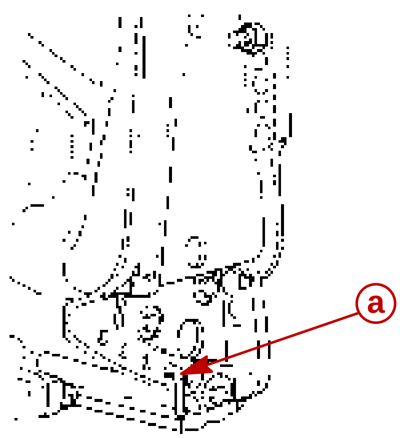
However, once on plane, the engine should be trimmed to a more intermediate position to a avoid a bow-down planing condition called “plowing”. Plowing can cause “bow steering” or “over steering” and inefficiently consumes horsepower. In this condition, if attempting a turn or encountering a diagonal, moderate wake, a more abrupt turn than intended may result.

In rare circumstances, the owner may decide to limit the trim in. This can be accomplished by repositioning the tilt stop pins into whatever adjustment holes in the transom brackets is desired.

WARNING

Avoid possible serious injury or death. Adjust outboard to an intermediate trim position as soon as boat is on plane to avoid possible ejection due to boat spin-out. Do not attempt to turn boat when on plane if outboard is trimmed extremely in or down and there is a pull on the steering wheel or tiller handle.

If an adjustment is required, purchase a stainless steel tilt pin (P/N 17-49930A1) and insert it through whatever pin hole is desired. The non-stainless steel shipping bolt should not be used in this application other than on a temporary basis.



a - Optional Tilt Pin

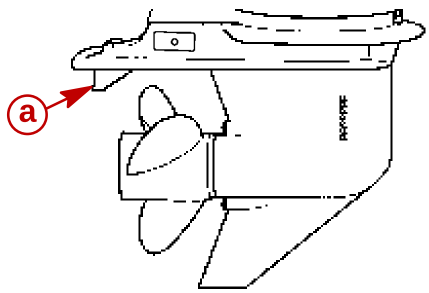
Trim Tab Adjustment

Propeller steering torque will cause your boat to pull in one direction. This steering torque is a normal thing that results from your outboard not being trimmed so the propeller shaft is parallel to the water surface. The trim tab can help to compensate for this steering torque in many cases and can be adjusted within limits to reduce any unequal steering effort.

NOTE: *Trim tab adjustment will have little effect reducing steering torque if the outboard is installed with the anti-ventilation plate approximately 2 inches (50mm) or more above the boat bottom.*

Operate your boat at normal cruising speed, trimmed to desired position. Turn your boat left and right and note the direction the boat turns more easily.

If adjustment is necessary, loosen trim tab bolt and make small adjustments at a time. If the boat turns more easily to the left, move the trailing edge of trim tab to the left. If the boat turns more easily to the right move the trailing edge of trim tab to the right. Retighten bolt and retest.



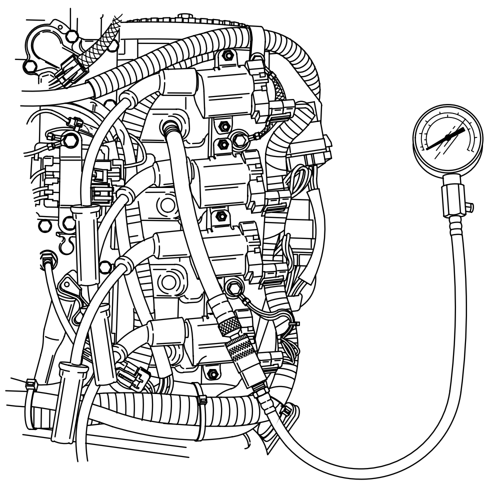
a - Trim Tab

Compression Check

> **⚠ CAUTION**
>
> **Compression/Cylinder Leakage Tests Must be performed with the ignition/injection system disabled. To do this, the lanyard stop switch MUST BE placed to the “OFF” position.**

IMPORTANT: Compression check should be done with throttle in WOT position.

1. Check valve clearance (refer to **“Valve Clearance Adjustment”** in section 4A), adjust if out of specification.
2. Warm up the engine. Remove all spark plugs.
3. Lubricate threads in cylinder head and on compression gauge. Install compression gauge in spark plug hole.



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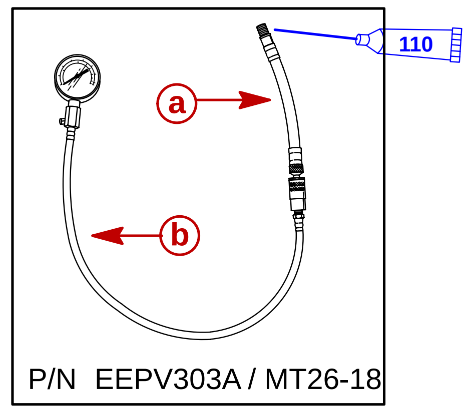


110 4-Stroke Outboard Oil (92-828000A12)

a - Compression Gauge (EEPV303A - Snap-on)
b - Adaptor (MT26-18 - Snap-on)

4. Hold throttle plate at W.O.T. and crank the engine over until the compression reading peaks on the gauge. Record the reading.
5. Check and record compression of each cylinder. The highest and lowest reading recorded should not differ by more than 15% (see example chart below). A reading below 120 psi might indicate a total engine wear problem.

Compression Pressure (Minimum)
135 psi (950 Kpa, 9.5 kg/cm^2)

Example of compression test differences:

Maximum (psi)	Minimum (psi)
180	162
150	127.5

6. Remove compression gauge. Install spark plugs.

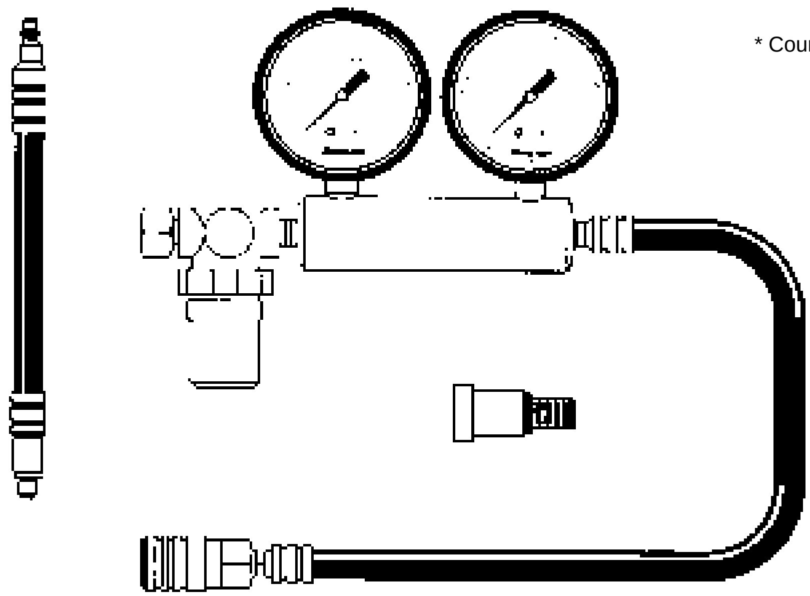
***NOTE:** Compression check is important because an engine with low or uneven compression cannot be tuned successfully to give peak performance. It is essential, therefore, that improper compression be corrected before proceeding with an engine tuneup.*

Cylinder Leakage Testing

CAUTION

Compression/Cylinder Leakage Tests Must be performed with the ignition/injection system disabled. To do this, the lanyard stop switch MUST BE placed to the “OFF” position.

NOTE: *Cylinder leakage testing*, along with compression testing, can help the mechanic pinpoint the source of a mechanical failure by gauging the amount of leakage in an engine cylinder. Refer to the manufactures tester instructions for proper testing procedures.*



* Courtesy of Snap-On-Tools

Cylinder Leakage Tester (Snap-On-Tools EEPV309A)

NOTE: *Spark plug hole is a 12 mm diameter. Use Snap-On Tool MT26-18 adapter with valve core removed.*

Analysis

Due to standard engine tolerances and engine wear, no cylinder will maintain a 0% of leakage. It is important only that cylinders have somewhat consistent reading between them. Differences of 15 to 30% indicate excessive leakage. Larger engines tend to have a larger percentage of cylinder leakage than smaller engines.

If excessive leakage is present, first check that the piston is at top dead center of it’s compression stroke. Leakage will naturally occur if the exhaust or intake valve is open.

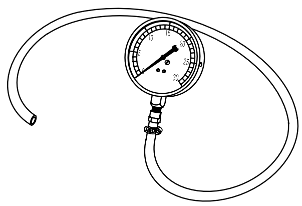
To determine the cause of high percentage leaks, you must locate where the air is escaping from. Listen for air escaping through the intake manifold, adjacent spark plug holes, exhaust pipe, crankcase fill plug. Use the following table to aid in locating the source of cylinder leakage:

Air Escaping From:	Indicates Possible Defective:
Intake Manifold	Intake Valve
Exhaust System	Exhaust Valve
Crankcase Fill Plug	Piston or Rings
Cylinder	Head Gasket

Water Pressure Measurement

1. Warm up engine.
2. Remove plug.
3. Attach hose fitting and water pressure gauge to cylinder block.

NOTE: *Water pressure measurements should be done on a warm engine with thermostat operating 140°F (60°C).*



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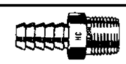

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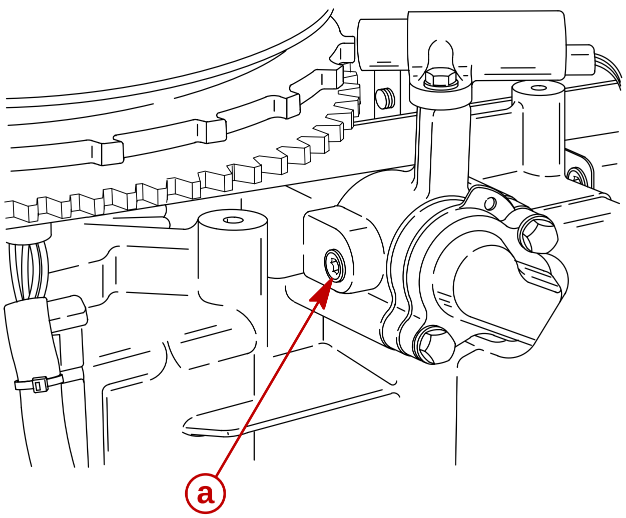
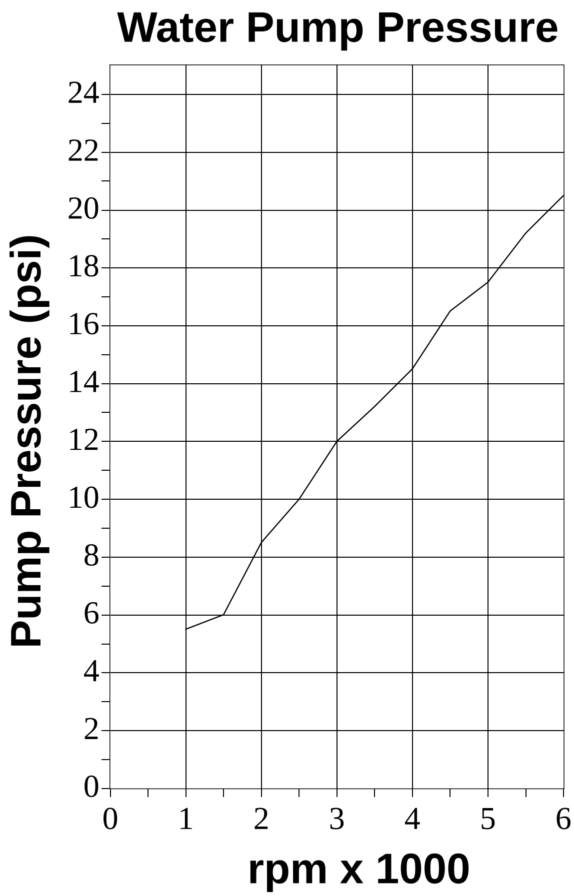




a **-** Plug

Painting Procedures

Cleaning & Painting Aluminum Propellers & Gear Housings

⚠ WARNING

Avoid serious injury from flying debris. Avoid serious injury from airborne particles. Use eye and breathing protection with proper ventilation.

PROPELLERS

1. Sand the entire area to be painted with 3M 120 Regalite Polycut or coarse Scotch-Brite, disc or belts.
2. Feather edges of all broken paint edges. Try not to sand through the primer.
3. Clean the surface to be painted using PPG Industries DX330 Wax and Grease Remover or equivalent (Xylene or M.E.K.).
4. If bare metal has been exposed, use Quicksilver's Light Gray Primer.
5. Allow a minimum of 1 hour dry time and no more than 1 week before applying the finish coat.
6. Apply the finish coat using Quicksilver's EDP Propeller Black.

GEAR HOUSINGS

The following procedures should be used in refinishing gear housings. This procedure will provide the most durable paint system available in the field. The materials recommended are of high quality and approximate marine requirements. The following procedure will provide a repaint job that compares with a properly applied factory paint finish. It is recommended that the listed materials be purchased from a local Ditzler Automotive Finish Supply Outlet. The minimum package quantity of each material shown following is sufficient to refinish several gear housings.

Procedure:

1. Wash gear housing with a muriatic acid base cleaner to remove any type of marine growth, and rinse with water, if necessary.
2. Wash gear housing with soap and water, then rinse.
3. Sand blistered area with 3M 180 grit sandpaper or P180 Gold Film Disc to remove paint blisters only. Feather edge all broken paint edges.
4. Clean gear housing thoroughly with (DX-330) wax and grease remover.
5. Spot repair surfaces where bare metal is exposed with (DX-503) alodine treatment.

IMPORTANT: Do not use any type of aerosol spray paints as the paint will not properly adhere to the surface nor will the coating be sufficiently thick to resist future paint blistering.

6. Mix epoxy chromate primer (DP-40) with equal part catalyst (DP-401) per manufacturers instructions, allowing proper induction period for permeation of the epoxy primer and catalyst.
7. Allow a minimum of one hour drying time and no more than one week before top coating assemblies.
8. Use Ditzler Urethane DU9000 for Mercury Black, DU34334 for Mariner Grey, and DU35466 for Force Charcoal, and DU33414M for Sea Ray White. Catalyze all four colors with Ditzler DU5 catalyst mixed 1:1 ratio. Reduce with solvents per Ditzler label.

CAUTION

Be sure to comply with instructions on the label for ventilation and respirators. Using a spray gun, apply one half to one mil even film thickness. Let dry, flash off for five minutes and apply another even coat of one half to one mil film thickness. This urethane paint will dry to the touch in a matter of hours, but will remain sensitive to scratches and abrasions for a few days.

9. The type of spray gun used will determine the proper reduction ratio of the paint.

IMPORTANT: Do not paint sacrificial zinc trim tab or zinc anode.

10. Cut out a cardboard “plug” for trim tab pocket to keep paint off of mating surface to maintain good continuity circuitry between trim tab and gear housing.

Decal Removal/Application

Removal

1. Mark decal location before removal to assure proper alignment of new decal.
2. Carefully soften decal and decal adhesive with a heat gun or heat blower while removing old decal.
3. Clean decal contact area with a 1:1 mixture of isopropyl alcohol and water.
4. Thoroughly dry decal contact area and check for a completely cleaned surface.

Instructions for “Wet” Application

NOTE: *The following decal installation instructions are provided for a “Wet” installation.* ***All*** *decals should be applied wet.*

TOOLS REQUIRED

1. Plastic Squeegee*
2. Stick Pin
3. Dish Washing **Liquid/Detergent without ammonia**** “Joy” and “Drift” are known to be compatible for this process.

* Automotive Body Filler Squeegee

** Do not use a soap that contains petroleum based solvents.

SERVICE TIP: Placement of decals using the “Wet” application will allow time to position decal. Read entire installation instructions on this technique before proceeding.

TEMPERATURE

IMPORTANT: Installation of vinyl decals should not be attempted while in direct sunlight. Air and surface temperature should be between 60°F (15°C) and 100°F (38°C) for best application.

SURFACE PREPARATION

IMPORTANT: Do not use a soap or any petroleum based solvents to clean application surface.

Clean entire application surface with mild dish washing liquid and water. Rinse surface thoroughly with clean water.

DECAL APPLICATION

1. Mix $^1/_2$ ounce (16 ml) of dish washing liquid in one gallon (4 l) of cool water to use as wetting solution.

NOTE: *Leave protective masking, if present, on the face of decal until final steps of decal installation. This will ensure that the vinyl decal keeps it's shape during installation.*

2. Place the decal face down on a clean work surface and remove the paper backing from "adhesive side" of decal.
3. Using a spray bottle, flood the entire "adhesive side" of the decal with the pre-mixed wetting solution.
4. Flood area where the decal will be positioned with wetting solution.
5. Position pre-wetted decal on wetted surface and slide into position.
6. Starting at the center of the decal, "**lightly**" squeegee out the air bubbles and wetting solution with overlapping strokes to the outer edge of the decal. Continue going over the decal surface until all wrinkles are gone and adhesive bonds to the cowl surface.
7. Wipe decal surface with soft paper towel or cloth.
8. **Wait 10 - 15 minutes.**
9. Starting at one corner, "carefully and slowly" pull the masking off the decal surface at a 180° angle.

NOTE: *To remove any remaining bubbles, pierce the decal at one end of the bubble with stick pin and press out the entrapped air or wetting solution with your thumb (moving toward the puncture).*

1 D

IMPORTANT INFORMATION

Section 1D - Outboard Motor Installation

Table of Contents

Electric Fuel Pump

If an electric fuel pump is used, the fuel pressure must not exceed 4 psi at the engine. If necessary, install a pressure regulator to regulate the pressure.

Boat Horsepower Capacity

U.S. COAST GUARD CAPACITY	
MAXIMUM HORSEPOWER	XXX
MAXIMUM PERSON CAPACITY (POUNDS)	XXX
MAXIMUM WEIGHT CAPACITY	XXX

Do not overpower or overload the boat. Most boats will carry a required capacity plate indicating the maximum acceptable power and load as determined by the manufacturer following certain federal guidelines. If in doubt, contact your dealer or the boat manufacturer.

⚠ WARNING

Using an outboard that exceeds the maximum horsepower limit of a boat can:
1. Cause loss of boat control
2. Place too much weight at the transom, altering the designed flotation characteristics of the boat or,
3. Cause the boat to break apart, particularly around the transom area.
Overpowering a boat can result in serious injury, death, or boat damage.

Start in Gear Protection

The remote control connected to the outboard must be equipped with a start-in-gear protection device. This prevents the engine from starting in gear.

⚠ WARNING

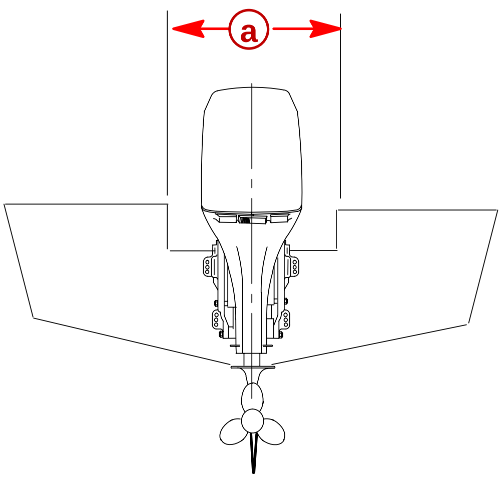
Avoid serious injury or death from a sudden unexpected acceleration when starting your engine. The design of this outboard requires that the remote control used with it must have a built in start-in-gear protection device.

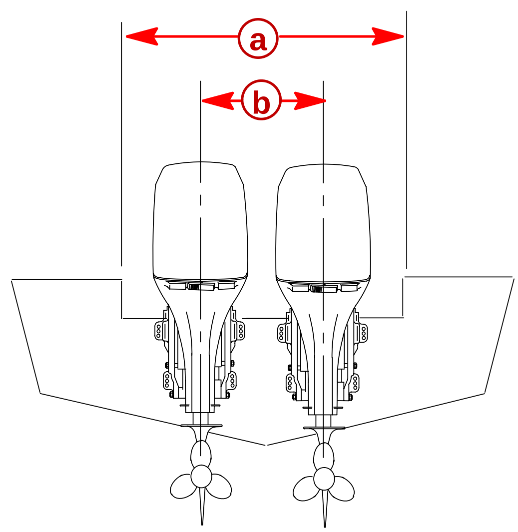
Selecting Accessories For The Outboard

Genuine Quicksilver Parts and Accessories have been specifically designed and tested for this outboard.

Some accessories not manufactured or sold by Quicksilver are not designed to be safely used with this outboard or outboard operating system. Acquire and read the Installation, Operation, and Maintenance manuals for all selected accessories.

Installation Specifications



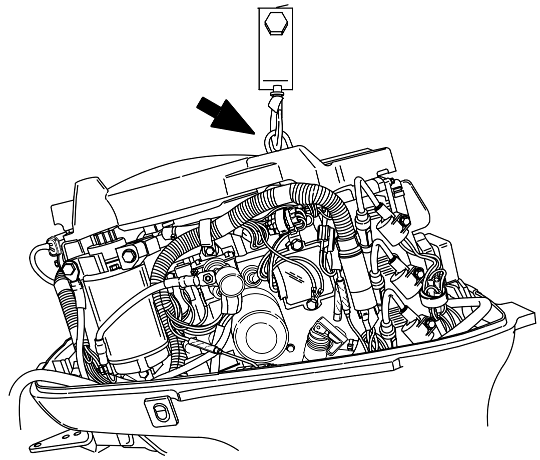


Transom Opening "A" (Minimum)	
Single Engine (Remote)	19 in. (483 mm)
Single Engine (Tiller)	30 in. (762 mm)
Dual Engines	40 in. (1016 mm)

Engine Center Line For Dual Engines "B" (Minimum)
26 in. (660mm)

Lifting Outboard

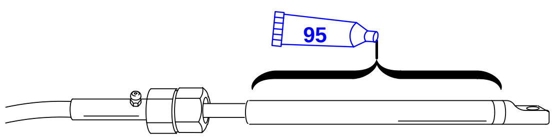
Use lifting eye on engine.



Steering Cable

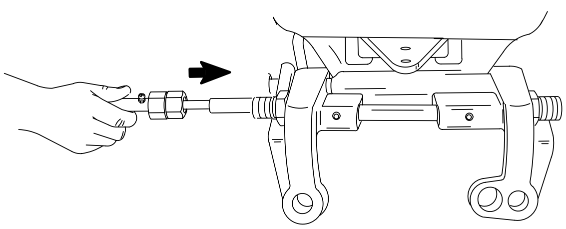
STARBOARD SIDE ROUTED CABLE

1. Lubricate the entire cable end.

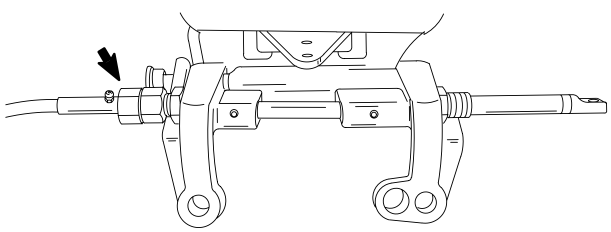


95 2-4-C w/Teflon (92-850736A1)

2. Insert steering cable into tilt tube.

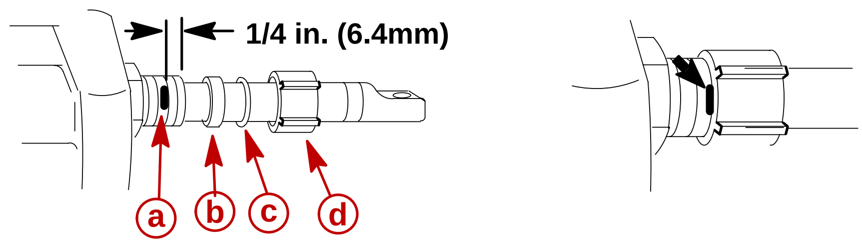


3. Torque nut to 35 lb. ft. (47.5 N·m).



Steering Cable Seal

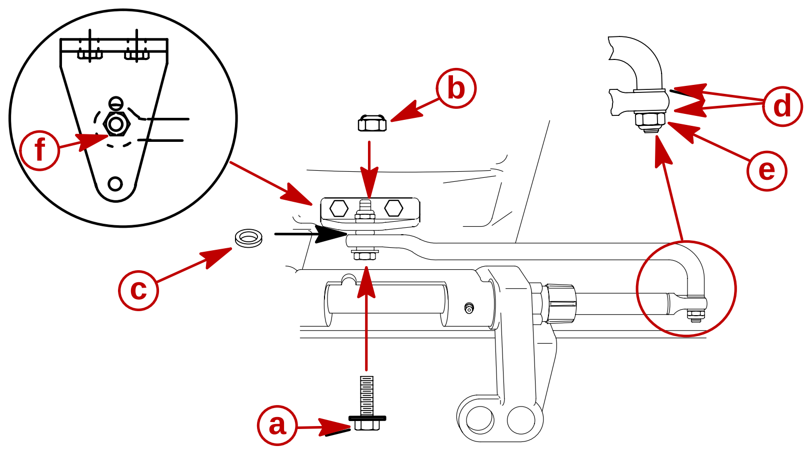
1. Mark tilt tube 1/4 in. (6.4 mm) from end. Install seal components.
2. Thread cap to the mark.



a - 1/4 in. (6.4 mm) Mark
b - Plastic Spacer
c - O-Ring Seal
d - Cap

Steering Link Rod

1. Install steering link rod per illustration.



a - Special Bolt (10-90041) Torque to 20 lb. ft. (27.1 N·m)
b - Nylon Insert Locknut (11-34863) Torque to 20 lb. ft. (27.1 N·m)
c - Spacer (12-71970)
d - Flat Washer (2)
e - Nylon Insert Locknut (11-34863) Tighten Locknut Until it Seats, Then Back Nut Off 1/4 Turn
f - Use Middle Hole – Steer Outboard to the Side to Gain Hole Access

IMPORTANT: The steering link rod that connects the steering cable to the engine must be fastened using special bolt ("a" - Part Number 10-90041) and self locking nuts ("b" & "e" - Part Number 11-34863). These locknuts must never be replaced with common nuts (non locking) as they will work loose and vibrate off, freeing the link rod to disengage.

⚠ WARNING

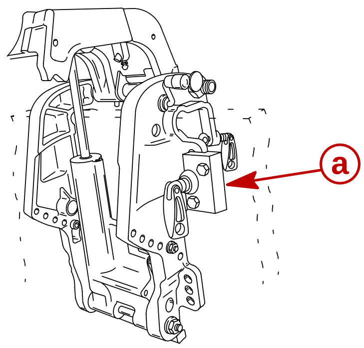
Disengagement of a steering link rod can result in the boat taking a full, sudden, sharp turn. This potentially violent action can cause occupants to be thrown overboard exposing them to serious injury or death.

Installing Outboard – Thumb Screw Models

⚠ WARNING

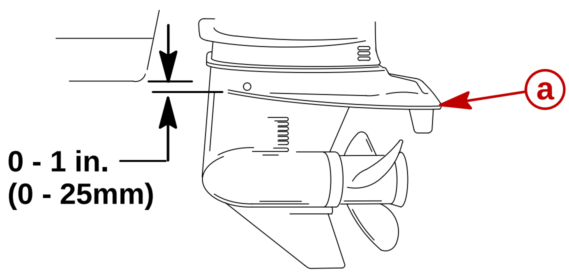
Outboard must be fastened to boat transom one of two ways: 1. permanently fastened to transom with thumb screws, and mounting bolts (provided), or 2. secured to the transom using the optional outboard mounting kit (shown below). Should the outboard strike an underwater object or be steered into a sharp turn, failure to fasten outboard correctly to the boat transom with mounting bolts or optional mounting kit could result in outboard ejecting suddenly off boat transom causing serious injury, death, boat damage, or loss of outboard.

IMPORTANT: Optional outboard mounting kits shown, must be used if outboard will not be permanently fastened to the transom with mounting bolts**.**



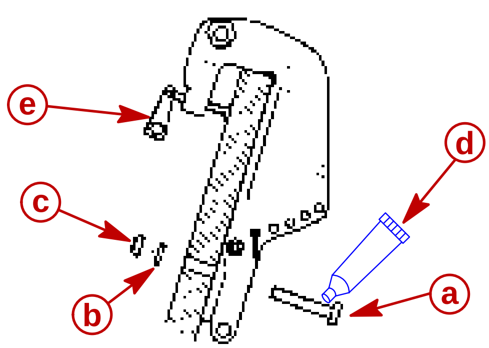
a - Outboard Mounting Kit Part No. 812432A4

1. Center outboard on the transom. Install the outboard so that the anti-ventilation plate is in line or within 1 in. (25 mm) below the bottom of the boat.



a - Anti-Ventilation Plate

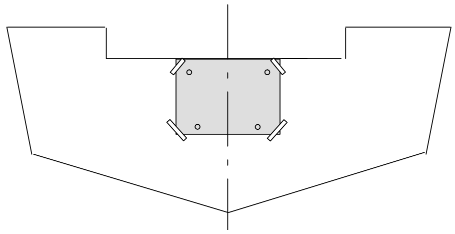
2. Fasten outboard with provided mounting hardware shown.



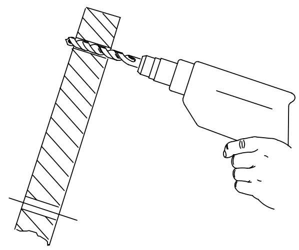
a - 1/2 in. Diameter Bolts (2)
b - Flat Washers
c - Locknuts
d - Marine Sealer - Apply to Shanks of Bolts, Not Threads
e - Thumb Screws - Tighten Securely

Installing Outboard – Non Thumb Screw Models

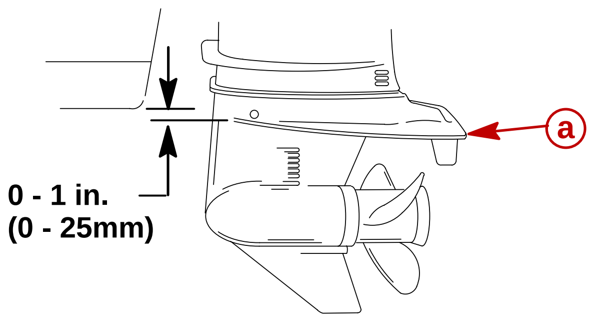
1. Attach (tape) engine mounting template to boat transom.



2. Mark and drill four 17/32 in. (13.5mm) mounting holes.

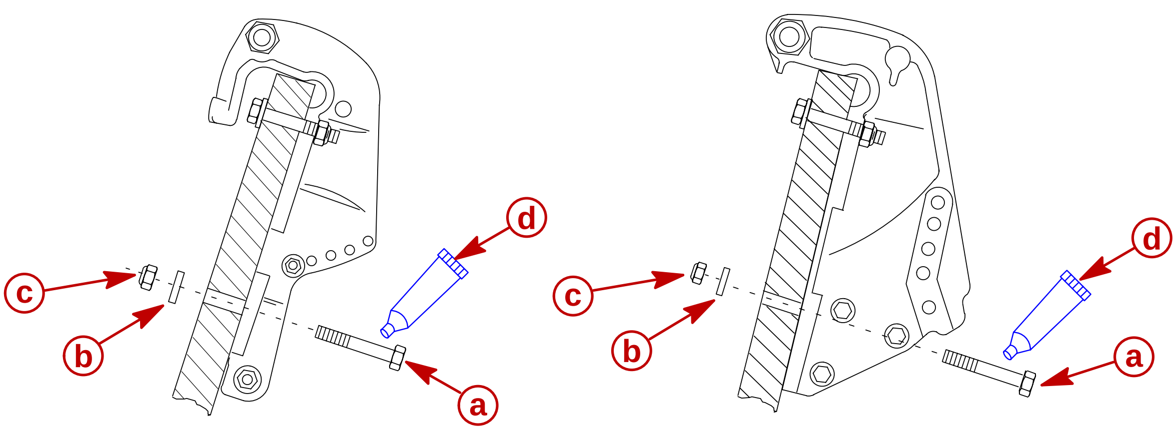


3. Install the outboard so that the anti-ventilation plate is in-line or within 1 in. (25 mm) below the bottom of the boat.



a - Anti-Ventilation Plate

4. Fasten outboard with provided mounting hardware shown.

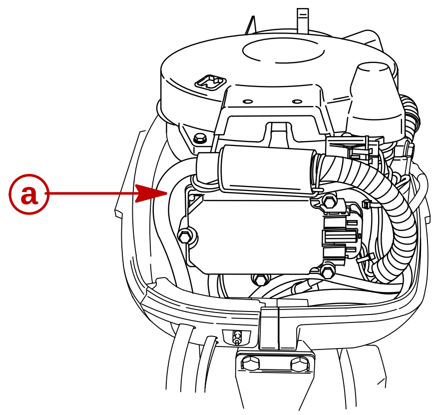


a - 1/2 in. Diameter Bolts (2)
b - Flat Washers
c - Locknuts
d - Marine Sealer - Apply to Shanks of Bolts, Not Threads

Wiring Harness

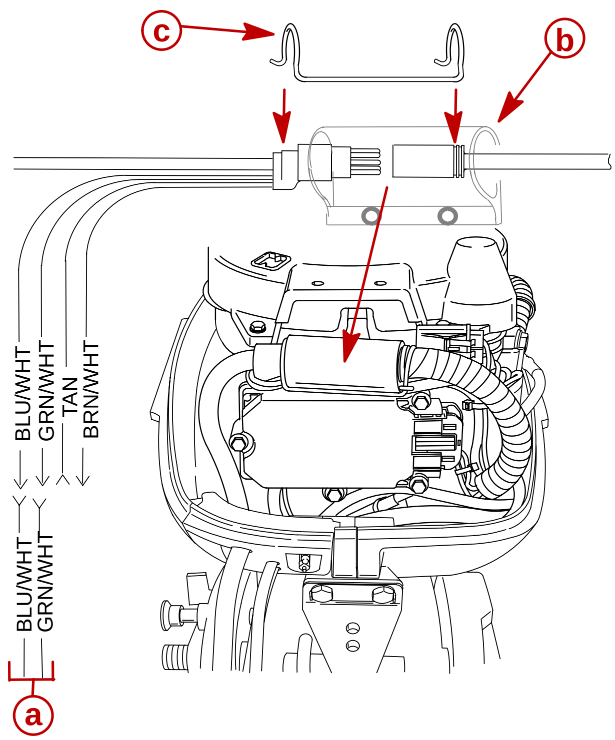
IMPORTANT: Warning Horn Requirement – The remote control or key switch assembly must be wired with a warning horn. This warning horn is used with the engine warning system.

1. Route wiring harness into bottom cowl.



a - Wiring Harness

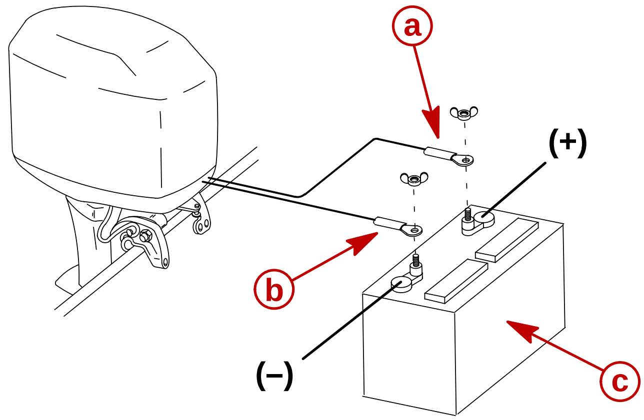
2. Connect wiring. Push the wiring harness connectors together inside the rubber sleeve. Push the retainer over the exposed ends of the connectors. This will hold the connectors together.



a - Power Trim Connections
b - Rubber Sleeve – Place Harness Connectors Inside
c - Retainer – Push Over Connector Ends

Battery Cable Connections

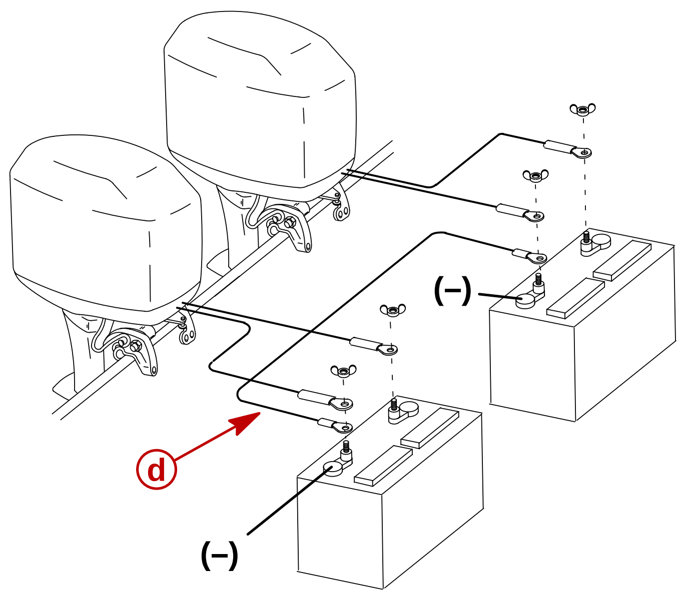
SINGLE OUTBOARD



a - Red Sleeve (Positive)
b - Black Sleeve (Negative)
c - Starting Battery

DUAL OUTBOARDS

Connect a common ground cable (wire size same as engine battery cables) between negative (–) terminals on starting batteries.



d - Ground Cable (Same Wire Size As Engine Battery Cable) – Connect Between Negative (–) Terminals

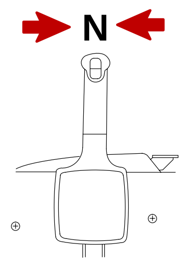
Shift and Throttle Cable Installation

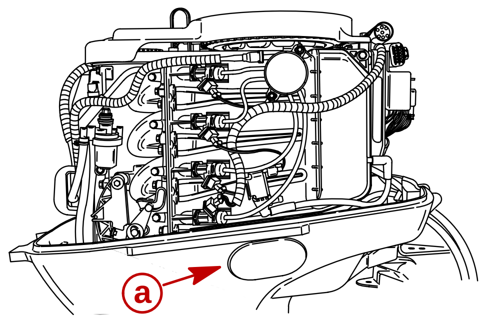
Install cables into the remote control following the instructions provided with the remote control.

***NOTE:** Install the shift cable to the engine first. The shift cable is the first cable to move when the remote control handle is moved out of neutral.*

Shift Cable Installation

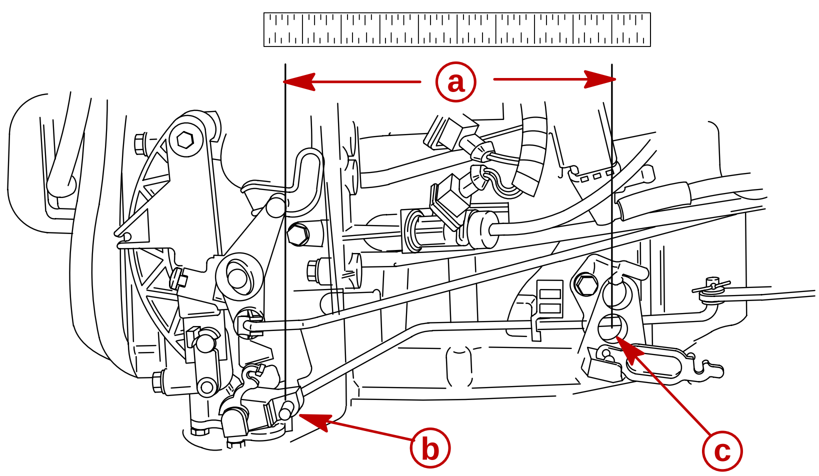
1. Position remote control into neutral.
2. Remove access cover from side of bottom cowl.





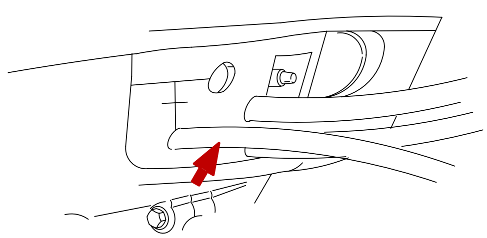
a - Access Cover

3. Shift outboard into neutral.
4. Measure the distance (a) between pin and center of lower hole.

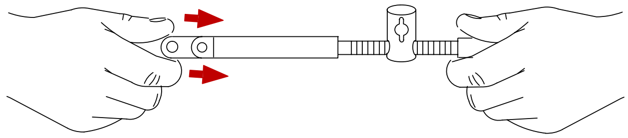


a - Distance Between Pin And Center of Lower Hole
b - Pin
c - Lower Hole

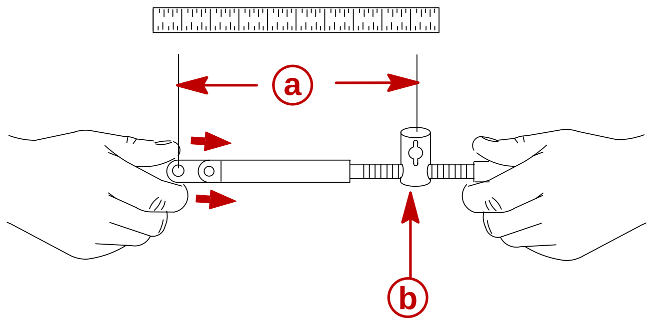
5. Fit shift cable through rubber grommet.



6. Push in on the cable end until resistance is felt.

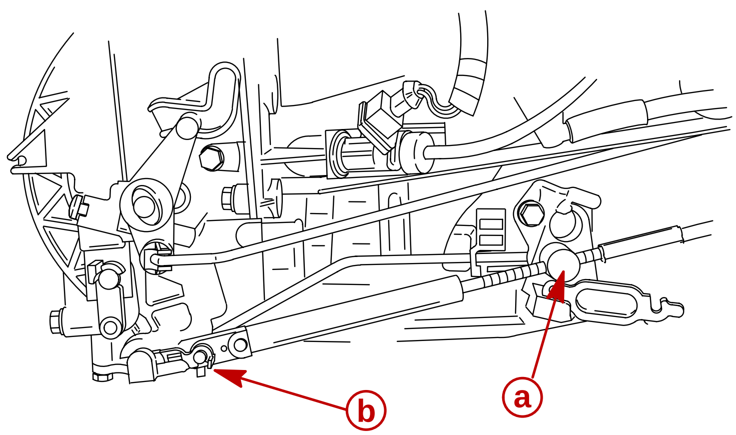


7. While pushing in on the cable end, adjust the cable barrel (b) to attain the measured distance (a) taken in Step 3.



a - Adjust Cable Barrel To Attain The Measured Distance Taken In Step 3
b - Cable Barrel

8. Place cable barrel into the barrel holder. Fasten cable with retainer.

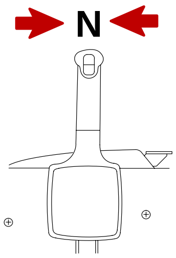


a - Place Barrel Into Barrel Holder
b - Retainer

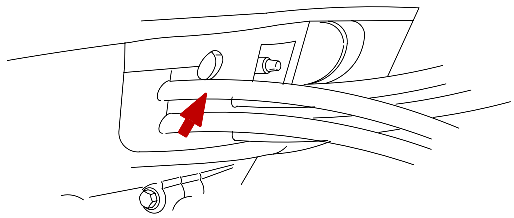
9. Check shift cable adjustments as follows:
   a. Shift remote control into forward. The propeller shaft should be locked in gear. If not, adjust the barrel closer to the cable end.
   b. Shift remote control into neutral. The propeller shaft should turn freely without drag. If not, adjust the barrel away from the cable end. Repeat steps a and b.
   c. Shift remote control into reverse while turning propeller. The propeller shaft should be locked in gear. If not, adjust the barrel away from the cable end. Repeat steps a thru c.
   d. Shift remote control back to neutral. The propeller shaft should turn freely without drag. If not, adjust the barrel closer to the cable end. Repeat steps a thru d.

Throttle Cable Installation

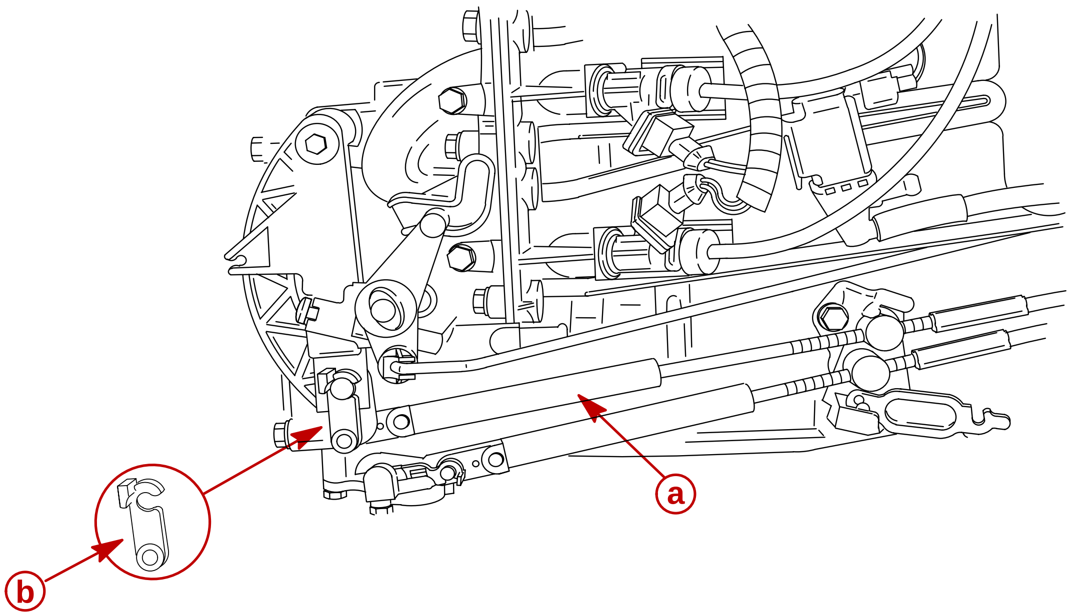
1. Position remote control into neutral.



2. Fit throttle cable through rubber grommet.

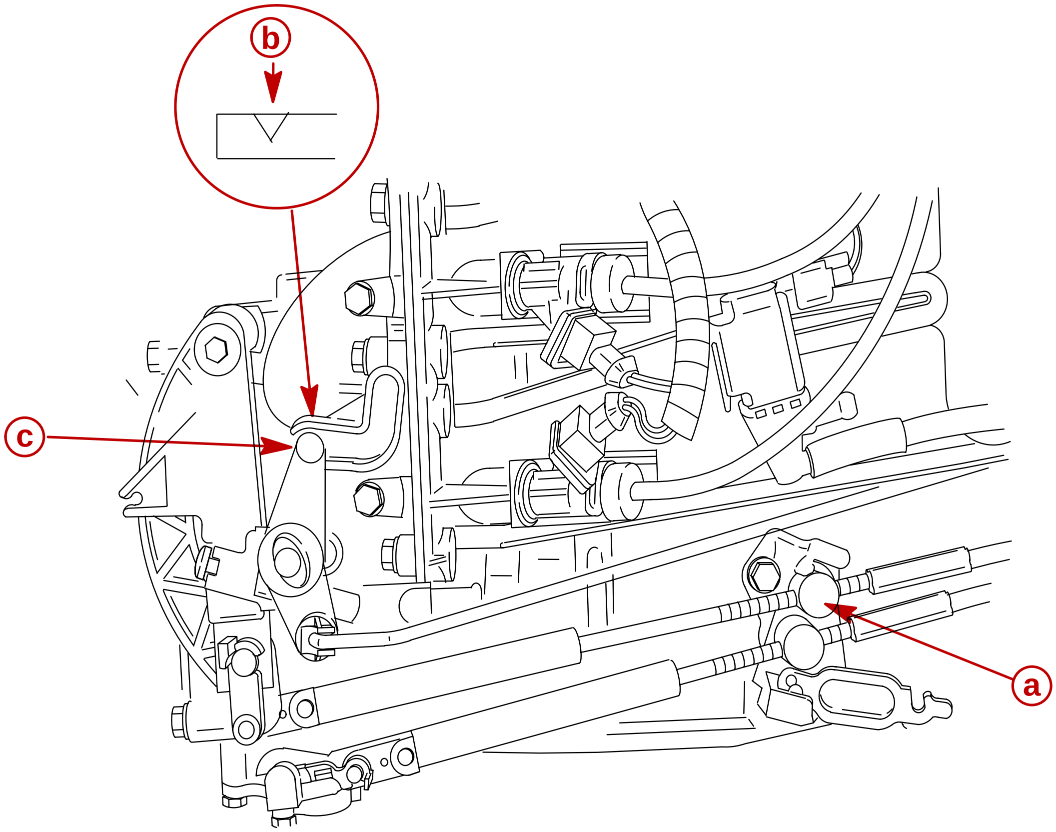


3. Install throttle cable with retainer pin. Lock retainer pin in place.
4. Place throttle cable onto the throttle lever pin. Lock in place with retainer.



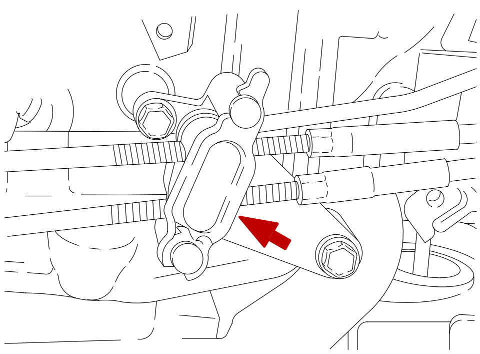
a - Throttle Cable
b - Retainer

5. Adjust cable barrel until the center of the roller lines up with the alignment mark on the cam.

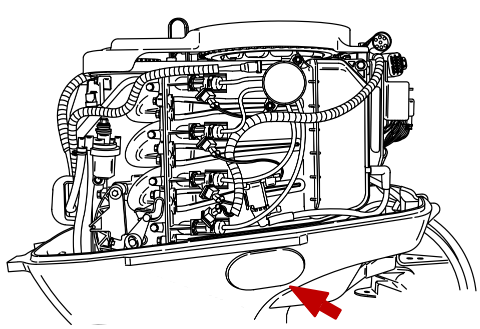


a - Cable Barrel
b - Alignment Mark
c - Roller

6. Fasten control cables with the cable latch.

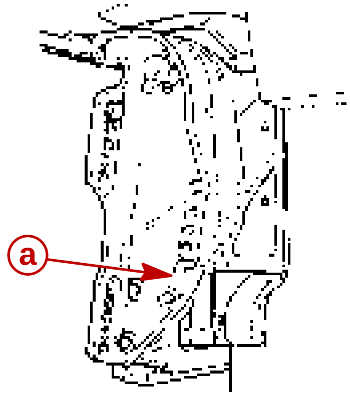


7. Install the access cover.



Trim-In Stop Adjustment – Power Trim Models

If an adjustment is required, purchase a stainless steel tilt pin (P/N 17-49930A1) and insert it through whatever pin hole is desired. The non-stainless steel shipping bolt should not be used in this application other than on a temporary basis.



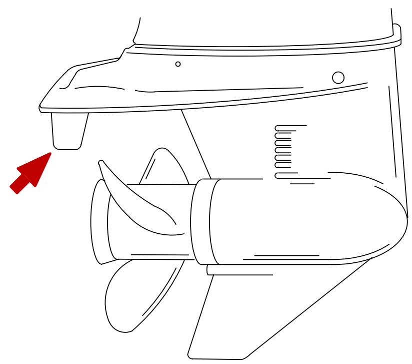
a - Tilt Pin

Trim Tab Adjustment

The trim tab can be adjusted within limits to help compensate for steering torque.

Adjust trim tab as follows:

1. If boat tends to pull to the right, move the rear edge of the trim tab to the right.
2. If boat tends to pull to the left, move the rear edge of the trim tab to the left.

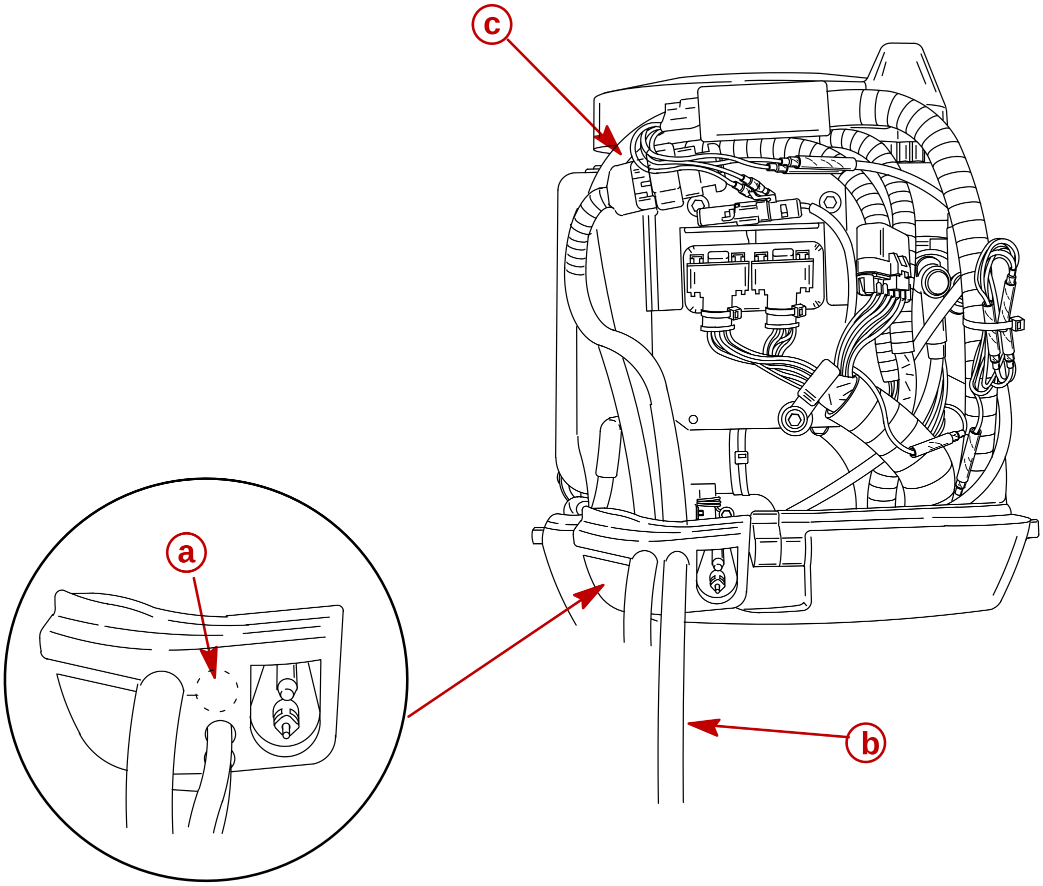


NOTE: *Trim tab adjustment will have little effect reducing steering torque if the anti-ventilation plate is raised 2 inches (50mm) or more above the boat bottom.*

Wiring for SmartCraft Gauges – EFI Models

SmartCraft Wiring Harness Connection to the Engine

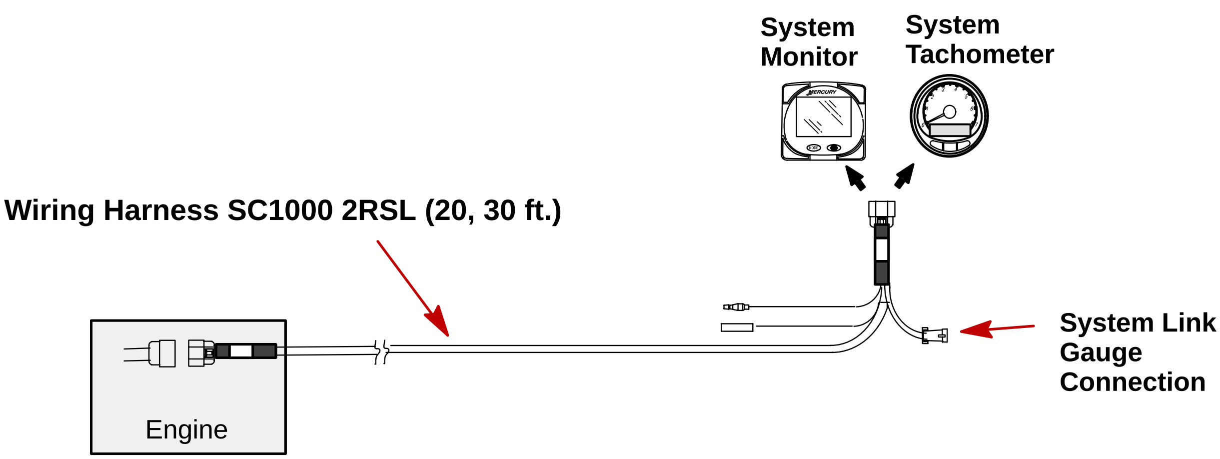
1. Cutout the harness opening in the front rubber grommet.
2. Route the SmartCraft wiring harness into the bottom cowl and connect as shown.



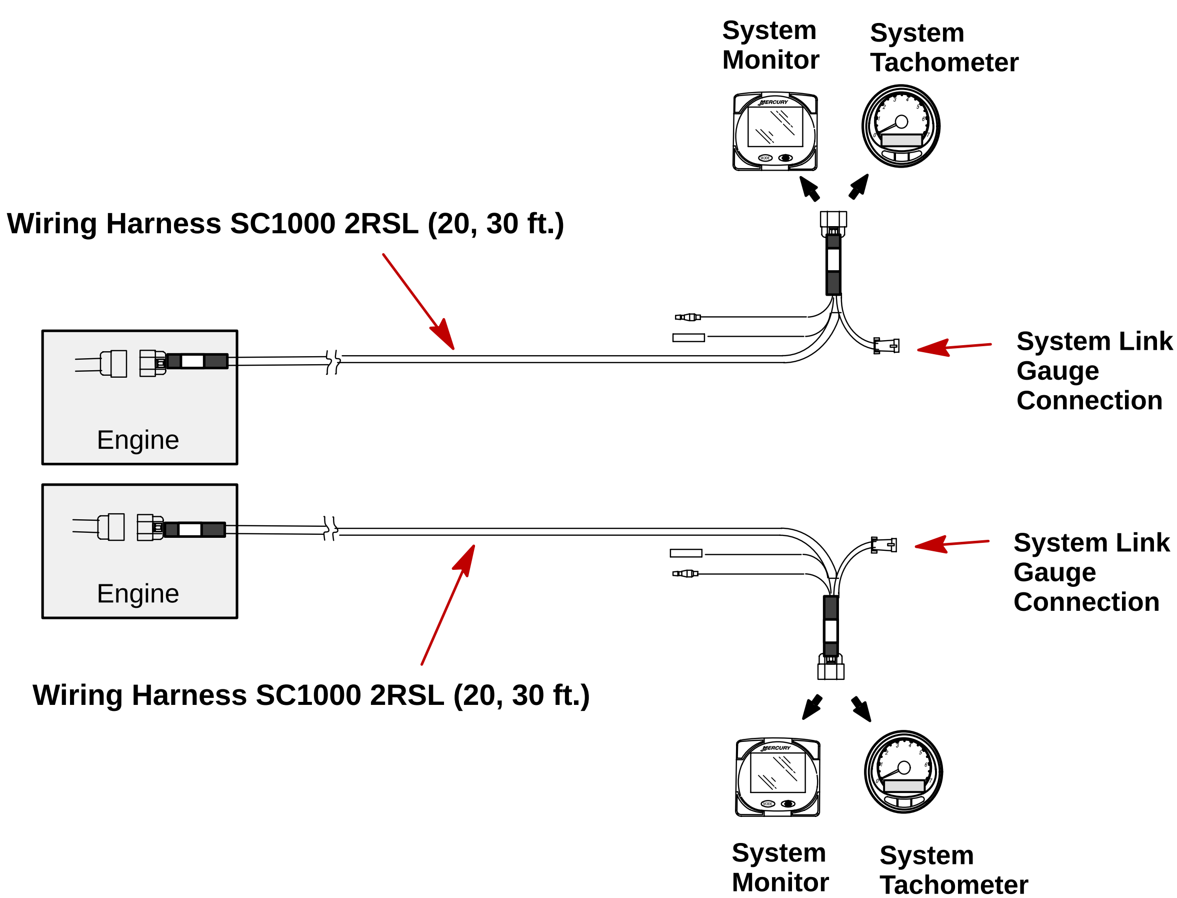
a - Front Rubber Grommet - Cutout Harness Opening
b - SmartCraft Harness
c - Connection for SmartCraft Harness

Typical SmartCraft Installation Configurations – EFI Models

Single Engine Applications

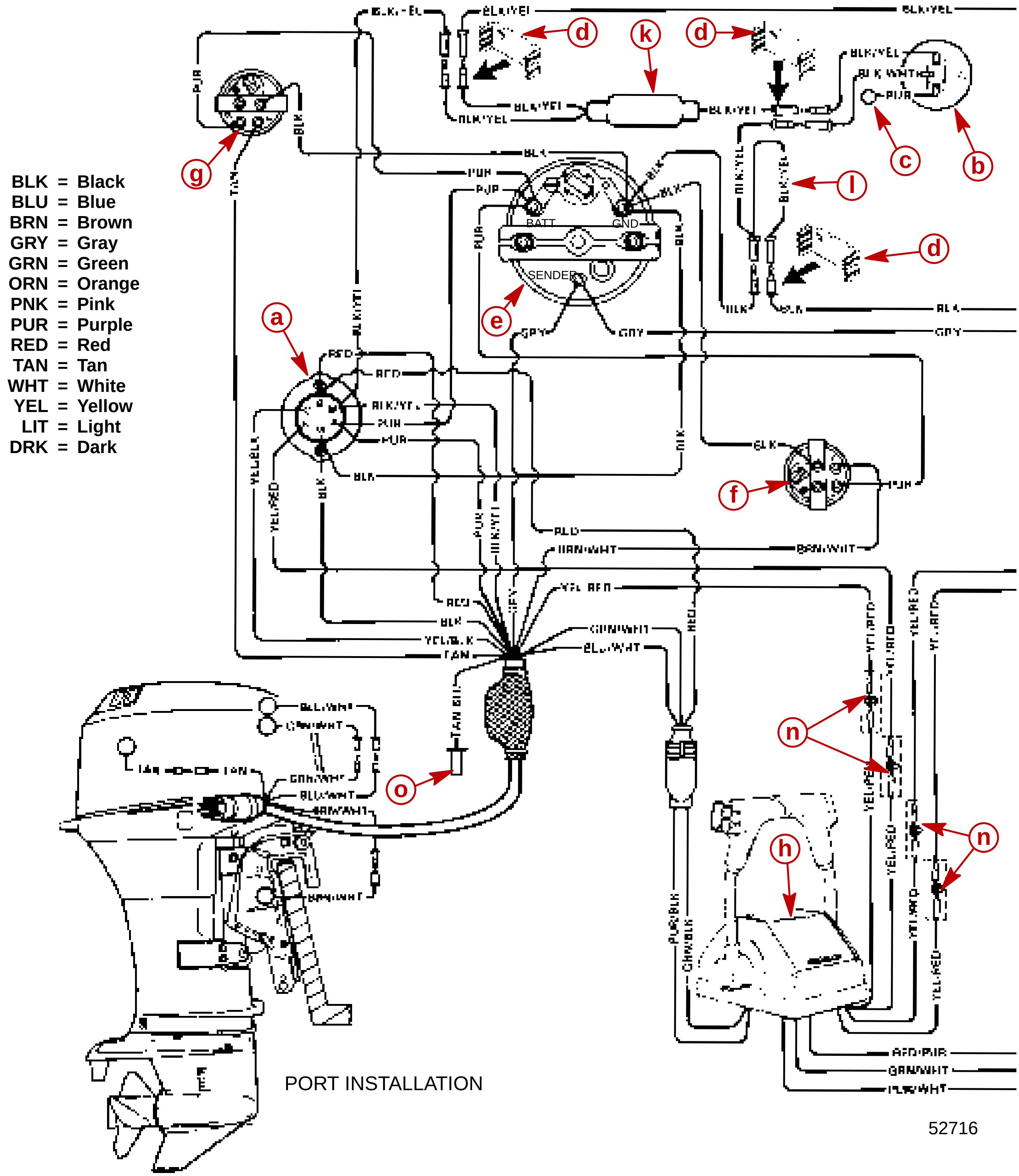


Dual Engine Applications



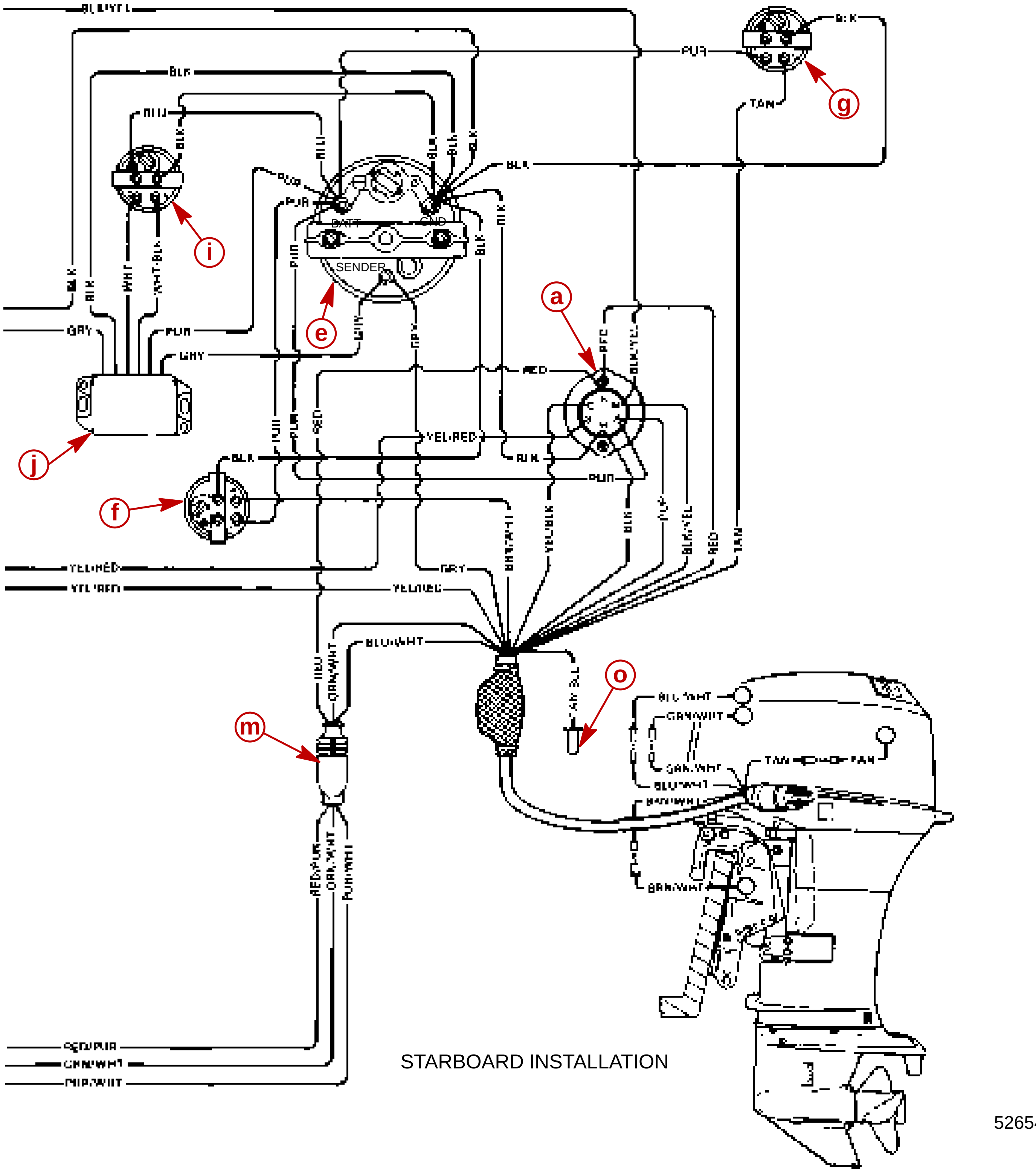
Notes:

Instrument/Lanyard Stop Switch Wiring Diagram (Dual Outboard)



a - Ignition/Choke Switch
b - Lanyard Stop Switch
c - Lead Not Used on Outboard Installations
d - Retainer
e - Tachometer
f - Trim Indicator Gauge
g - Temperature Gauge
h - Remote Control
i - Synchronizer Gauge
j - Synchronizer Box

IMPORTANT: On installations where gauge options will not be used, tape back and isolate any unused wiring harness leads.



STARBOARD INSTALLATION

5265

k - Lanyard/Diode
l - “Y” Harness
m - Power Trim Harness Connector
n - Connect Wires Together with Screw and Hex Nut (4 Places);Apply Quicksilver Liquid Neoprene to Connections and Slide Rubber Sleeve over Each Connection.
o - Lead to Visual Warning Kit

ELECTRICAL

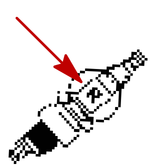
Section 2A - Ignition

Table of Contents

Specifications

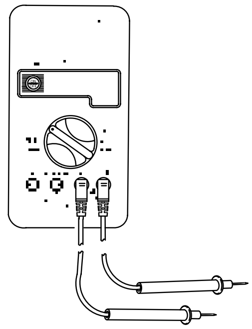
IGNITION SYSTEM Readings taken @ 68°F (20°C).	**Type**	Capacitor Discharge Ignition
	Spark Plug:	
	Type	Champion RA8HC
	Gap	0.040 in. (1.0 mm)
	Hex Size	5/8 in. (16 mm)
	Torque	150 lb-in. (17 Nm)
	Hole Size	12 mm
	Firing Order	1-3-4-2
	Ignition Timing:	
	@Idle	Controlled by ECM
	@1500-1800	14° B.T.D.C
	@ WOT (6000 rpm)	28° B.T.D.C
	Stator Resistance	0.20 - 0.30 Ω (YEL-YEL)
	Crank Position Sensor (CPS) Resistance	300 - 350 Ω (RED - WHT)
	Ignition Coil Resistance:	
	Internal Shielding	0 - 10.0 KΩ (Pin A - Mounting Bracket)
	Electronic Spark Trigger (EST)	8.5 - 12KΩ (Pin B - Pin C)
	Secondary	3.0 - 7.0 kΩ (Pin A - Coil Tower)
	High Tension Lead/Boot Resistance	0.600 - 1.100 KΩ
	ECM Engine Speed Limiter	
	Fuel/Spark Cut-out on Cylinders #2 and #3	6225 rpm
	Fuel/Spark Cut-out on All Cylinders	6350 rpm
	ECM Overheat Speed Control	Guardian System is activated. Power limit will vary with level of overheat.
	ECM Low Oil Pressure Speed Control	Guardian System is activated. Engine power is limited to 10% of maximum (Approximately 2000 RPM)
	MAT/ECT Temperature Sensor	See Graph Section 3B - EFI
	Manifold Absolute Pressure (MAP) Sensor Resistance	See Table Section 3B - EFI
	Fuel Injector Resistance	10.0 - 13.5Ω
	Main Power Relay	81-99 Ω (Pin 85 - Pin 86)
	Idle Air Control (IAC)	24-30 Ω (Between Pins)
	Throttle Position Sensor Typical Range	
	Output Voltage @Idle	0.39-1.00 Volts
	Output Voltage @WOT (6000)	3.66-4.80 Volts

IMPORTANT: Use resistive spark plugs only.



Special Tools

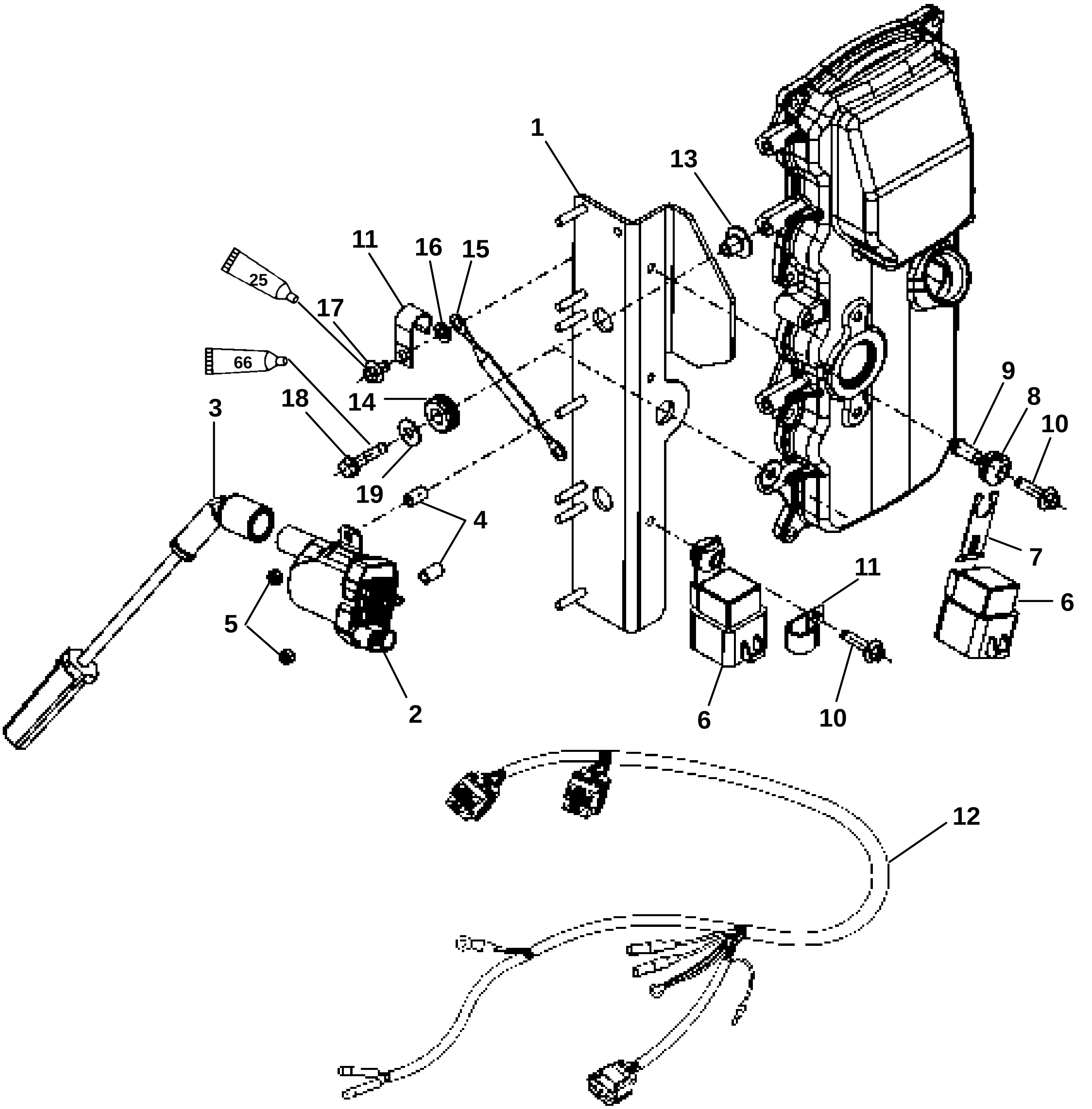
1. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1



IGNITION COIL MOUNTING

25 Liquid Neoprene (92-25711--3)

66 Loctite 242 (92-809821)



IGNITION COIL MOUNTING

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	COIL PLATE			
2	4	IGNITION COIL			
3	4	HIGH TENSION CABLE			
4	7	SPACER			
5	7	NUT	30		3.4
6	3	TRIM RELAY			
7	3	BRACKET			
8	3	GROMMET			
9	3	BUSHING			
10	3	SCREW (M6 X 25)	60		6.8
11	2	J CLIP			
12	1	TRIM HARNESS			
13	3	BUSHING			
14	3	GROMMET			
15	1	CABLE			
16	1	WASHER			
17	1	SCREW (M6 X 10)	45		5.1
18	3	SCREW (M6 X 30)	75		8.5
19	3	WASHER			

Ignition Description

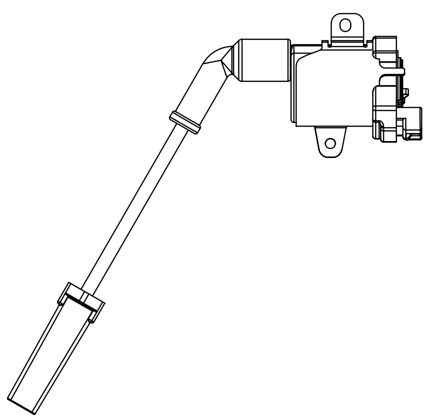
When the ignition key switch is turned to the “RUN” position battery voltage is applied to both the Electronic Control Module (ECM) through the purple wire, and the main power relay through the red/purple wire. As the ECM receives the “RUN” signal it internally completes the ground circuit of the main relay for a period of two seconds, energizing the ignition/injection systems for start-up. As the engine is cranked with the starter motor, the ECM receives the run signal from the Crank Position Sensor (CPS) and completes the ground circuit to the main relay for engine operation.

With the main relay closed (completed circuit) D.C. current from the battery/charging system is transferred through the 20 ampere main relay fuse to the positive terminal of all ignition coil primary windings. The negative terminals of the ignition coil primaries are connected to the engine ground through the coils internal driver, which is triggered by the ECM. With the coil drivers closed, an electric magnetic field is allowed to build up within the ignition coil.

As the flywheel rotates, the CPS senses the location of the 54 teeth on the flywheel and supplies the trigger signal information to the ECM. The ECM utilizes the CPS information and determines when to remove the trigger signal from the coil driver of each ignition coil. The coil driver then opens the coil primary ground circuit which allows it’s magnetic field to rapidly collapse across the coil secondary winding which induces a high voltage charge (50,000 volts) that fires the spark plug.

Ignition Component Description

Ignition Coils (EST)



The negative terminals of the ignition coil primaries are connected to the engine ground through the coils internal driver, which is triggered by the ECM. With the coil drivers closed, an electric magnetic field is allowed to build up within the ignition coil.

As the flywheel rotates, the CPS senses the location of the 54 teeth on the flywheel and supplies the trigger signal information to the ECM. The ECM utilizes the CPS information and determines when to remove the trigger signal from the coil driver of each ignition coil. The coil driver then opens the coil primary ground circuit which allows it’s magnetic field to rapidly collapse across the coil secondary winding which induces a high voltage charge (50,000 volts) that fires the spark plug.

Ignition Test Procedures

⚠ WARNING

DANGER – HIGH VOLTAGE/SHOCK HAZARD! Do not touch ignition components and/or metal test probes while engine is running and/or being "cranked". STAY CLEAR OF SPARK PLUG LEADS. To assure personal safety, each individual spark plug lead should be grounded to engine.

⚠ WARNING

When testing or servicing the ignition system, high voltage is present. DO NOT TOUCH OR DISCONNECT any ignition parts while engine is running, while key switch is on or while battery cables are connected.

⚠ CAUTION

Failure to comply with the following items may result in damage to the ignition system.

1. DO NOT reverse battery cable connections. The battery negative cable is (–) ground.
2. DO NOT "spark" battery terminals with battery cable connections to check polarity.
3. DO NOT disconnect battery cables while engine is running.
4. DO NOT crank engine with Ignition Coils/Coil Mounting Plate not grounded.

⚠ CAUTION

To protect against meter and/or component damage, observe the following precautions:

IMPORTANT: The metal housing of the ECM is isolation mounted and MUST NOT be externally grounded. Should the housing become externally grounded, the engine will not run until the ground is removed and battery cables are momentarily disconnected from the battery to re-set the ECM.

- ALL COMPONENTS MUST BE GROUNDED during tests. Running or "cranking" engine with Ignition Coils/Coil Mounting Plate ungrounded may damage components.

Ignition Troubleshooting

Refer to Section **3B “Electronic Fuel Injection”** - **“Troubleshooting and Diagnostics”** for complete system troubleshooting/diagnostics procedures.

Ignition Diagnostic Procedures

TROUBLESHOOTING TIP: With engine running, use inductive timing light to check spark advance of each cylinder as throttle is opened and closed. If timing advances and retards on each cylinder, ignition system is MOST LIKELY functioning properly.

IMPORTANT: If outboard appears to have an ignition system failure, it is recommended that before beginning in-depth troubleshooting:

a. Ensure that the engine is mechanically sound condition. (Fuel System, Cylinder Compression etc.).

b. Check all engine ground leads for loose or corroded connections.

c. Disconnect and reconnect ignition harness connectors to verify proper continuity.

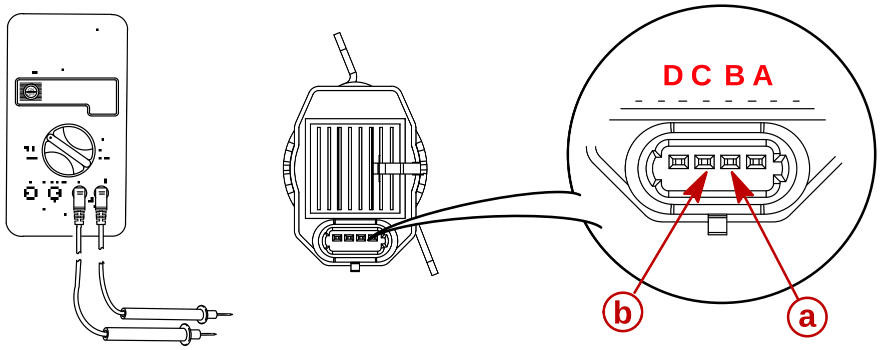
Testing Ignition Coil

Resistance Tests

Readings may very slightly due to temperature changes. Readings listed taken at 68° F (20° C).

NOTE: *If using DMT 2000 turn the selector switch to . Allow the meter to auto-range.*

ELECTRONIC SPARK TRIGGER (EST) TO EST GROUND



a - Red Meter Test Lead
b - Black Meter Test Lead

METER TEST LEADS		METER SCALE (ANALOG)	READING (Ω)
RED	**BLACK**	**RX1K**	**8.5 - 12.0K**
PIN B	PIN C		

NOTE: *Ohm readings may not be in range specified because of sensitivity of your multi-meter. Meter should show almost full continuity or near zero resistance condition.*

High Tension Lead Removal/Installation

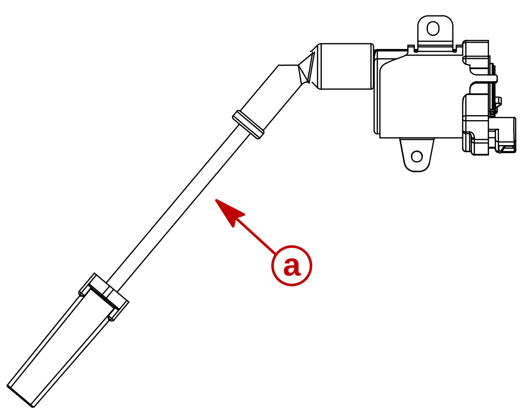
REMOVAL

1. Slightly twist high tension lead while removing.

INSTALLATION

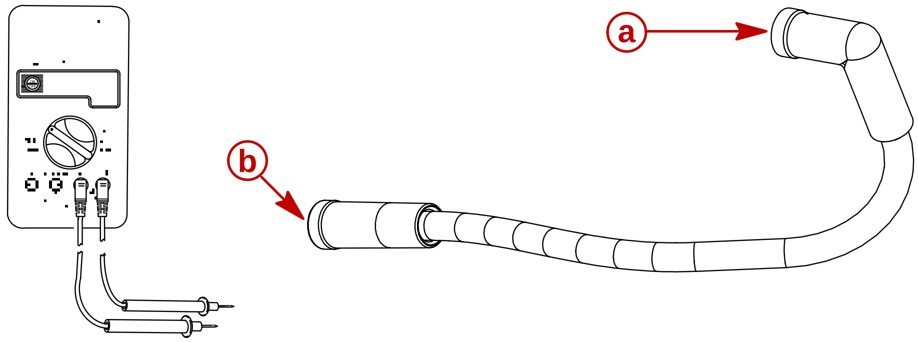
1. Push high tension lead on until it snaps in place.

NOTE: *High tension leads must be removed before testing. Leads contain 5k ohm resistor.*



a - High Tension Lead

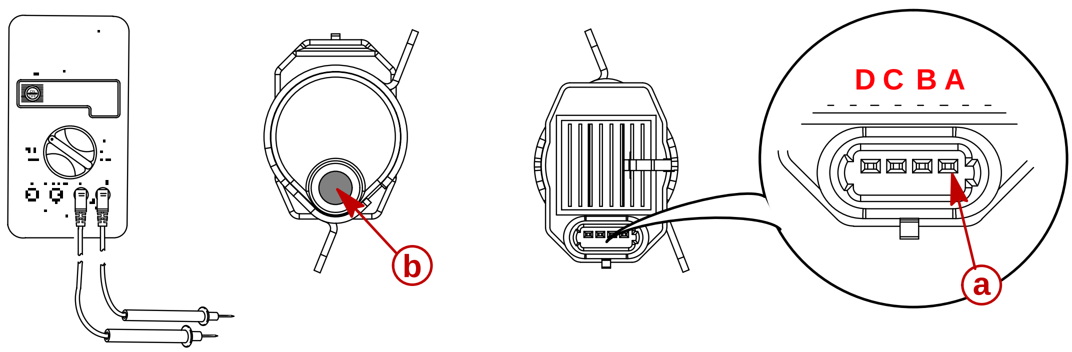
High Tension Lead Resistance



a - Coil End
b - Spark Plug End

METER TEST LEADS		METER SCALE (ANALOG)	READING (Ω)
RED	**BLACK**	**RX100**	**0.600 - 1.100K**
COIL END	PLUG END		

IGNITION COIL (SECONDARY)

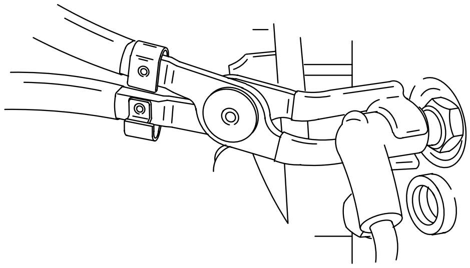


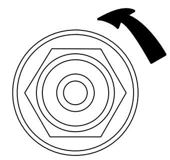
a - Pin A
b - Coil Tower

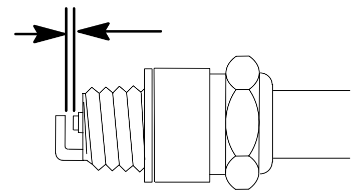
METER TEST LEADS		METER SCALE (ANALOG)	READING (Ω)
RED	**BLACK**	**RX1K**	**3.0 - 7.0**
COIL TOWER	PIN A		

Ignition Coil Removal and Installation

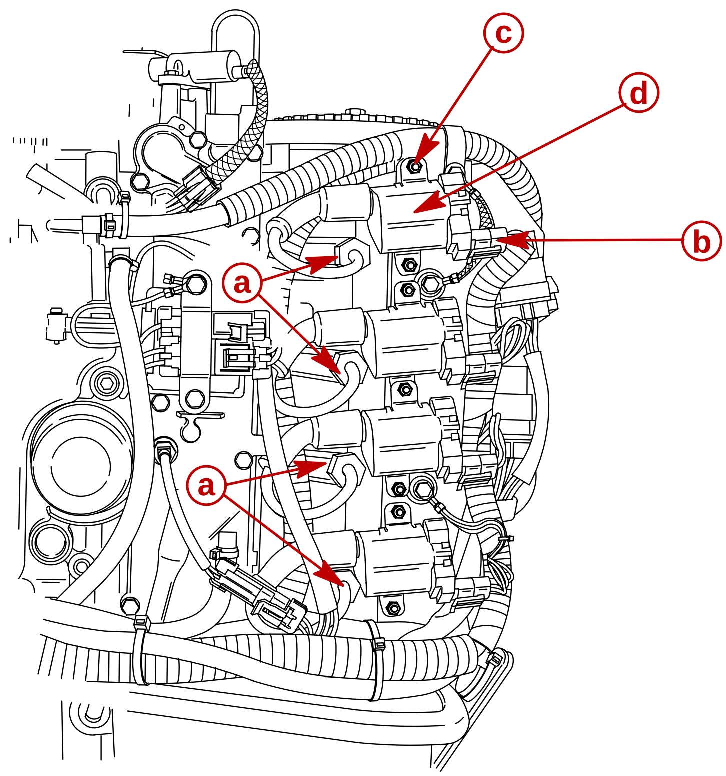
⚠ WARNING
Avoid serious injury or death from fire or explosion caused by damaged spark plug boots. Damaged spark plug boots can emit sparks. Sparks can ignite fuel vapors under the engine cowl. To avoid damaging spark plug boots, do not use any sharp object or metal tool such as pliers, screwdriver, etc. to remove spark plug boots.







1. Disconnect spark plug leads from spark plugs.
2. Disconnect ignition coil harness connectors.
3. Remove ignition coil mounting screws.
4. Reverse steps for installation.



a - Spark Plug Lead (4)
b - Ignition Coil Harness Connector (4)
c - Ignition Coil Mounting Nut (7)
d - Ignition Coil (4)

Ignition Coil Mounting Nut Torque
30 lb. in. (3.4 N·m)

ELECTRICAL

Section 2B - Charging & Starting System

2
B

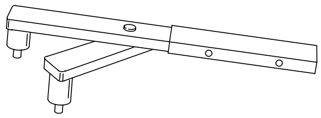
Table of Contents

Specifications

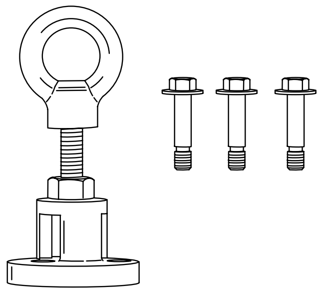
CHARGING SYSTEM **Readings taken @ 68°F (20°C).**	**Alternator Type:** **20 Amp. Electric Alternator Output** **Stator Resistance** **Quicksilver Tachometer Setting**	Single Phase (12 Pole) 12.6 V-20 Amps. (252 Watts) (Rectified/Regulated) 0.20 - 0.30 Ohms (YEL-YEL) “6P” or “4”
STARTING SYSTEM	**Electric Start:** **Starter Type** **Output** **Ampere Draw Under:** **(Load)** **(No Load)**	 Bendix 1.1 kW 174.0 Amps 23.7 Amps
BATTERY	**Battery Rating** **Minimum Requirement** **For operation below 32° F (0° C)** **Ampere-Hours (Ah) Minimum** **For operation above 32° F (0° C)** **For operation below 32° F (0° C)**	 465 Marine Cranking Amps (MCA) or 350 Cold Cranking Amps (CCA) 1000 Marine Cranking Amps (MCA) or 775 Cold Cranking Amps (CCA) 70 105

Special Tools

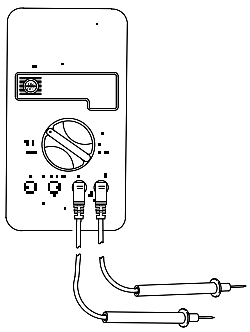
1. Flywheel Holder P/N 91-83163M



2. Flywheel Puller P/N 91-83164M

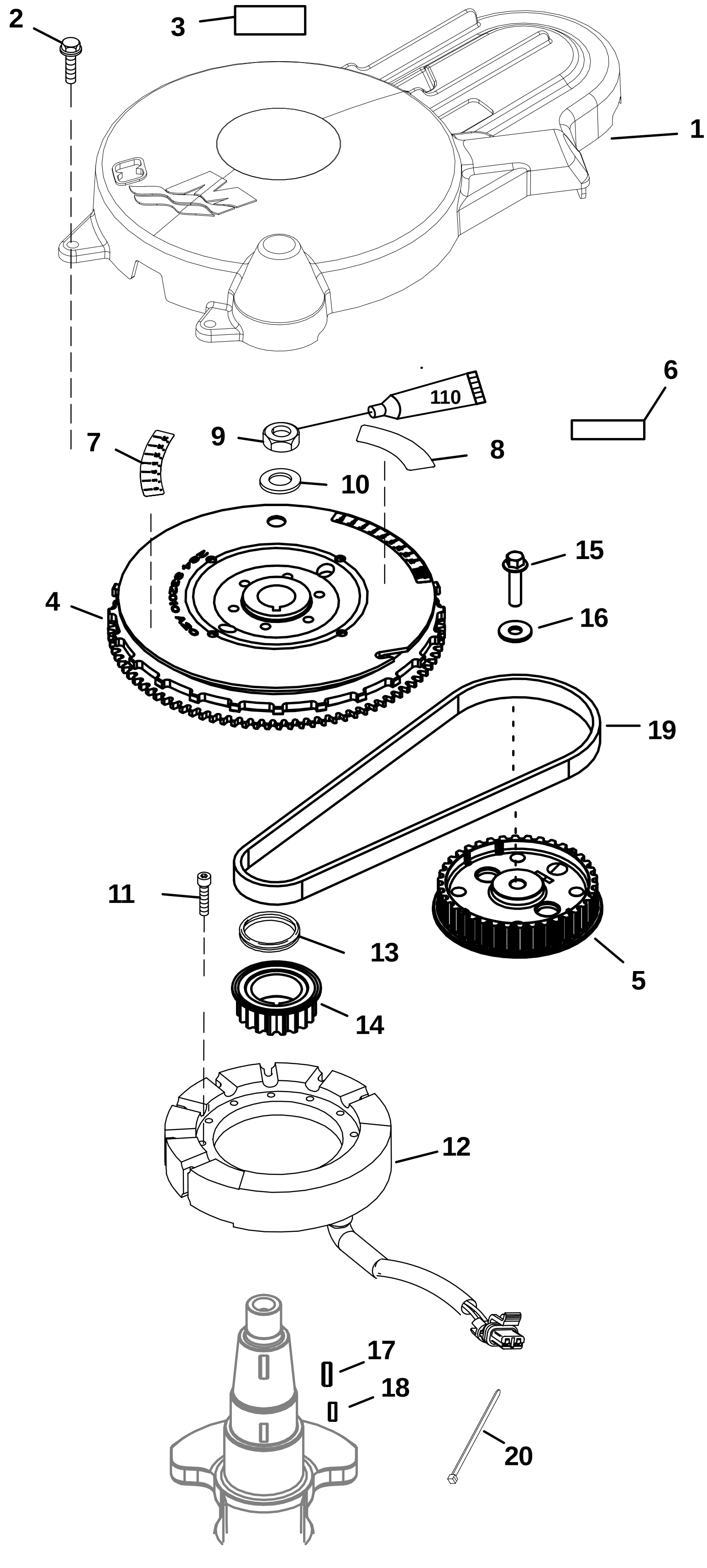


3. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1



Notes:

FLYWHEEL



110 4-Stroke Outboard Oil (92-828000A12)

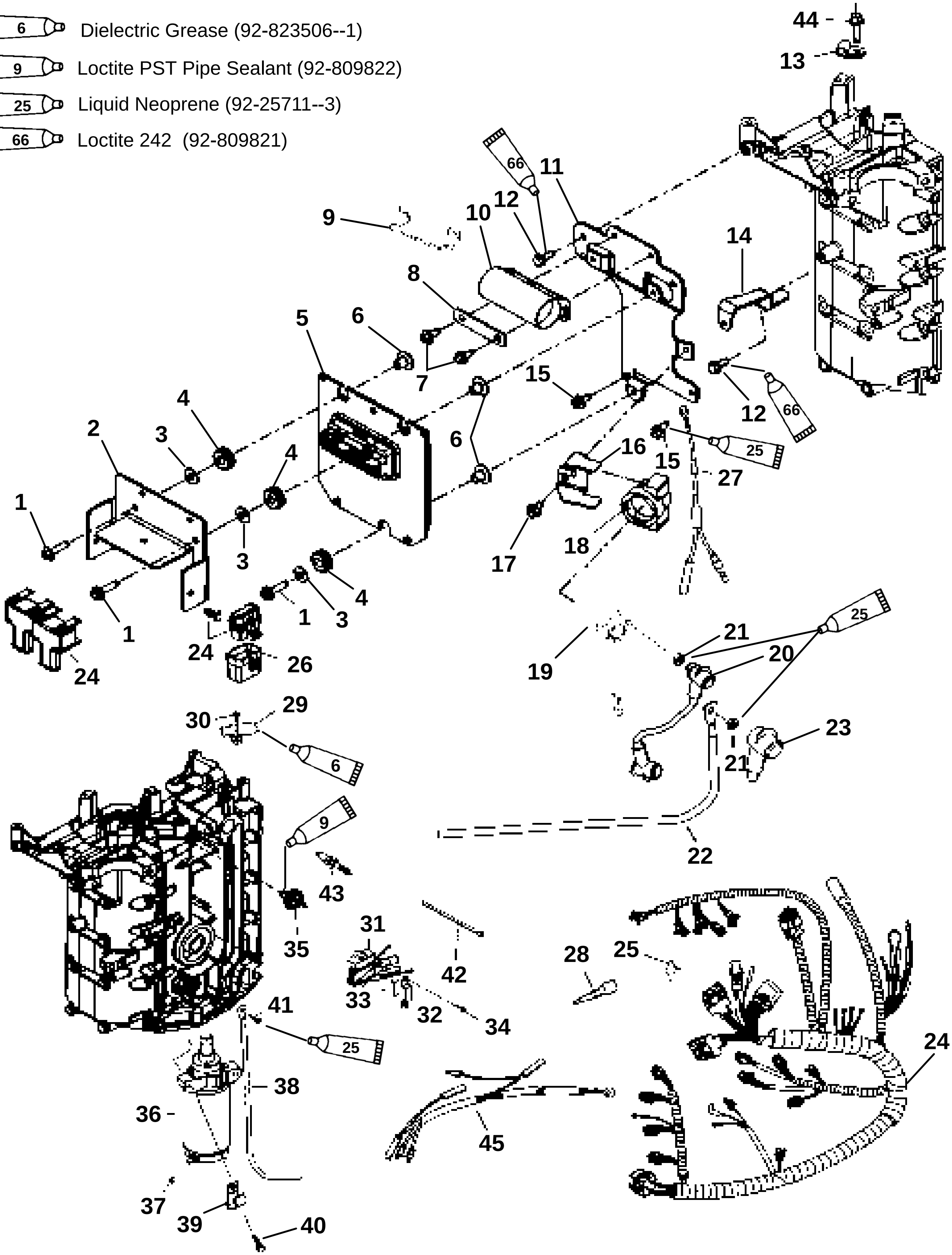
FLYWHEEL

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	FLYWHEEL COVER			
2	4	SCREW (M6 X 25)	75		8.5
3	1	DECAL - EPA INFORMATION **(SEE NOTE)**			
4	1	FLYWHEEL			
5	1	DRIVEN GEAR			
6	1	DECAL - WARNING SPINNING FLYWHEEL			
7	1	DECAL - TIMING MARKS			
8	1	DECAL - WARNING-NEUTRAL			
9	1	NUT		115	155.9
10	1	WASHER			
11	3	SCREW (M5 X 30)	85		9.6
12	1	STATOR			
13	1	LOAD RING			
14	1	DRIVE GEAR			
15	1	SCREW (M10 X 40)		28	38
16	1	WASHER			
17	1	KEY			
18	1	KEY			
19	1	TIMING BELT			
20	1	STA-STRAP			

NOTE: *THE EPA LABEL HAS IMPORTANT INFORMATION REGARDING EPA EMISSION REGULATIONS. REPLACE ANY MISSING OR UNREADABLE EPA LABEL.*

ELECTRICAL COMPONENTS

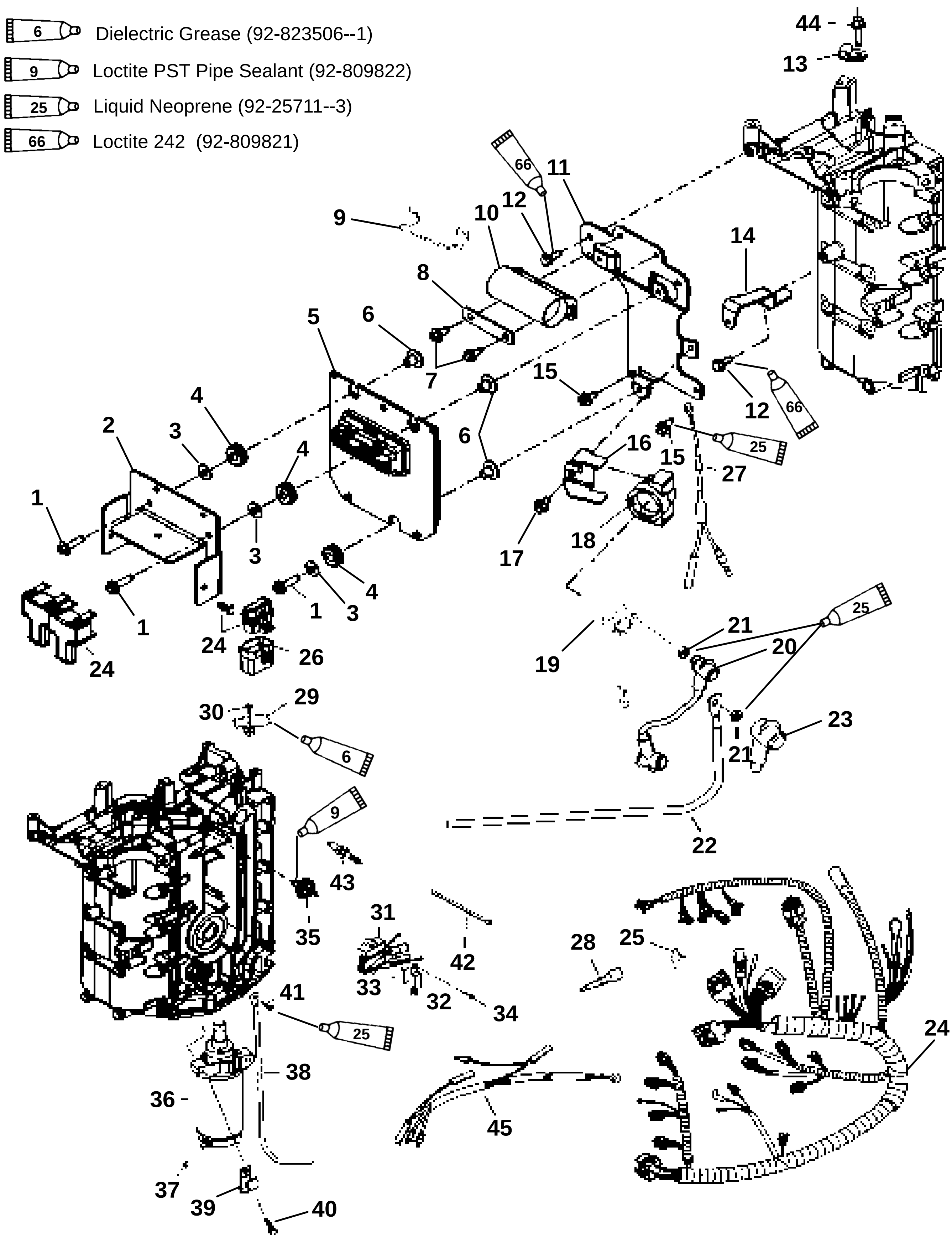
- 6 Dielectric Grease (92-823506--1)
- 9 Loctite PST Pipe Sealant (92-809822)
- 25 Liquid Neoprene (92-25711--3)
- 66 Loctite 242 (92-809821)



ELECTRICAL COMPONENTS

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	3	SCREW (M6 X 25)	45		5.1
2	1	PLATE			
3	3	WASHER			
4	3	GROMMET			
5	1	ECM **(50)**			
	1	ECM **(60)**			
	3	ECM **(40)**			
6	3	BUSHING			
7	2	SCREW	45		5.1
8	1	BRACKET			
9	1	RETAINER			
10	1	RETAINER			
11	1	PLATE			
12	3	SCREW (M6 X 16)	75		8.5
13	1	J CLAMP			
14	1	BRACE			
15	2	SCREW (M6 X 14)	45		5.1
16	1	SOLENOID PLATE			
17	1	SCREW (M6 X 14)	45		5.1
18	1	BRACKET			
19	1	SOLENOID			
20	1	CABLE			
21	2	NUT	60		6.8
22	1	BATTERY CABLE (POSITIVE)			
23	1	BOOT (RED)			
24	1	ENGINE WIRING HARNESS			
25	4	FUSE **(20 AMP)**			
	1	FUSE **(15 AMP)**			
26	1	COVER			
27	1	DIODE ADAPTOR CABLE			
28	1	PLUG (MALE)			
29	1	CRANK POSITION SENSOR			
30	2	SCREW (M5 X 16)	45		5.1
31	1	VOLTAGE REGULATOR			
32	1	BRACKET			
33	1	FOAM PAD			
34	2	SCREW (M6 X 40)	75		8.5
35	1	PRESSURE SWITCH	75		8.5
36	1	STARTER MOTOR (SEE BREAKDOWN ON STARTER MOTOR)			
37	1	NUT (1/4-20)	60		6.8
38	1	BATTERY CABLE (NEGATIVE)			
39	1	J CLIP			

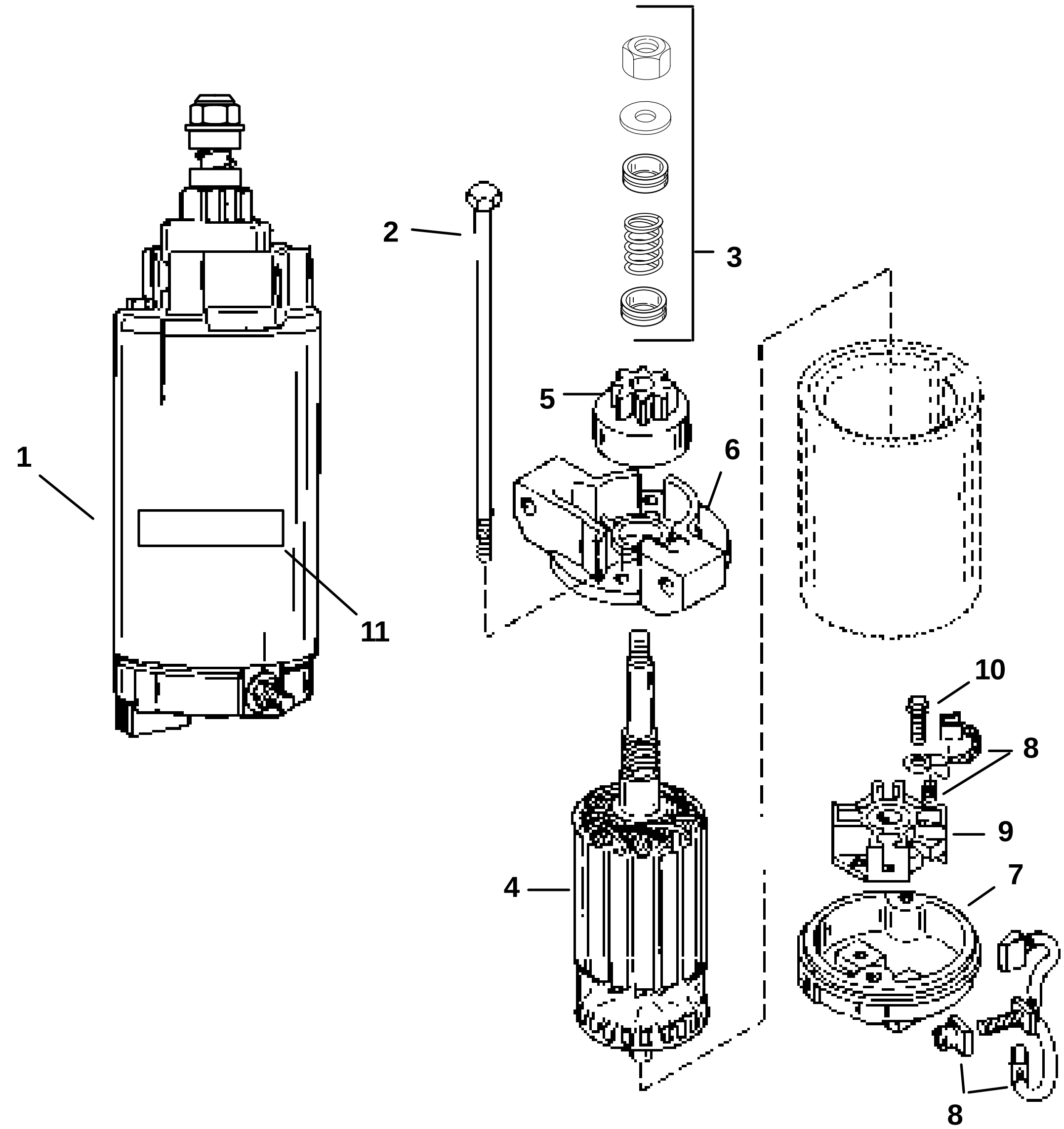
ELECTRICAL COMPONENTS



ELECTRICAL COMPONENTS

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
40	3	SCREW (M8 X 45)		21.7	29.4
41	2	SCREW (M6 X 25)	75		8.5
42	AR	STA-STRAP			
43	4	SPARK PLUG (RA8HC)		20	21.1
44	1	SCREW (M5 X 12)	45		5.1
45	1	EXTENSION HARNESS **(HANDLE)**			

STARTER MOTOR



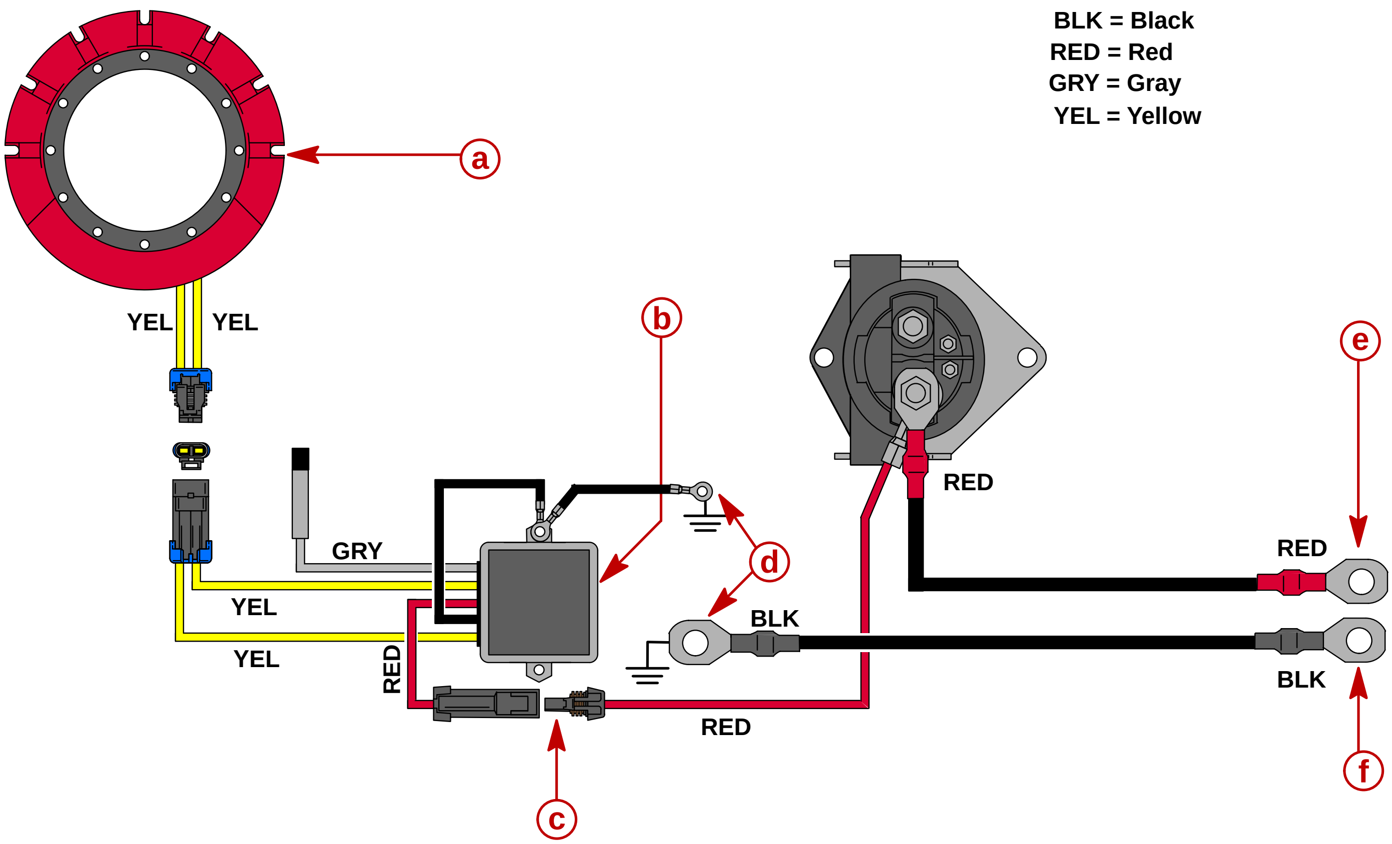
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	STARTER MOTOR			
2	2	THRU BOLT	70		8.0
3	1	DRIVE KIT			
4	1	ARMATURE			
5	1	PINION			
6	1	DRIVE CAP			
7	1	COMMUTATOR CAP			
8	1	BRUSH & SPRING KIT			
9	1	BRUSH HOLDER			
10	2	SCREW			
11	1	DECAL-Warning-High voltage			

Battery Charging System

Description (20 Ampere)

The battery charging system components are the flywheel, stator, regulator/rectifier, and battery. Alternating current (generated in battery charge coils) flows to the regulator/rectifier, which changes the alternating current to a regulated direct current for charging the battery.

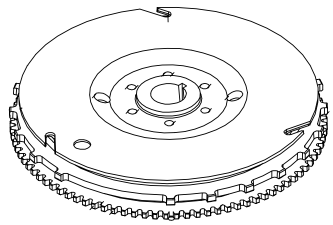
Wiring Diagram (20 Ampere)



a - Stator
b - Voltage Regulator/Rectifier
c - Connector
d - To Engine Ground
e - To Battery Positive **(Red)** Terminal
f - To Battery Negative (**Black**) Terminal

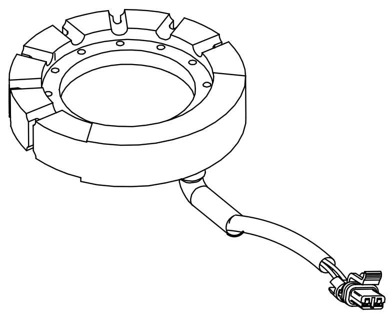
Charging System Description

Flywheel Assembly



The flywheel assembly contains six permanently charged magnet segments which are bonded and retained to the inner wall of the flywheel. Each magnet contains a north and a south pole providing a 12 pole system.

Stator Assembly



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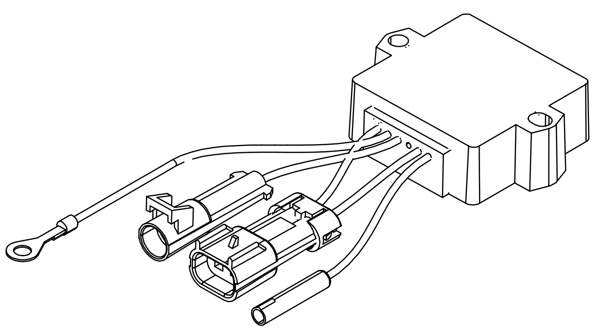
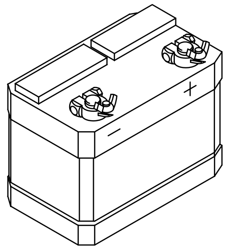
The stator assembly located under the flywheel contains the battery charge coils. As the flywheel permanent magnets pass the respective stator coil windings, an AC pulse current is produced at each coil winding when magnet polarity changes. (South to North), (North to South) etc.

Voltage Regulator/Rectifier Assembly



The voltage regulator converts the alternating current from the stator to direct current that can be stored in the battery.

Battery



A 12 volt battery with a minimum rating of 465 marine cranking amps (MCA) or 350 cold cranking amps (CCA). For operation below 32° F (0° C) a rating of 1000 Marine Cranking Amps (MCA) or 775 Cold Cranking Amps (CCA) is recommended.

Battery Charging System Troubleshooting

⚠ CAUTION

The charging system may be damaged by: 1) reversed battery cables, 2) an open circuit, such as a broken wire or loose connection.

A fault in the battery charging system usually will cause the battery to become undercharged. Check battery electrolyte level, and charge battery.

If battery will NOT accept a satisfactory charge, replace battery.

If battery accepts a satisfactory charge, determine the cause of the charging system problem as follows.

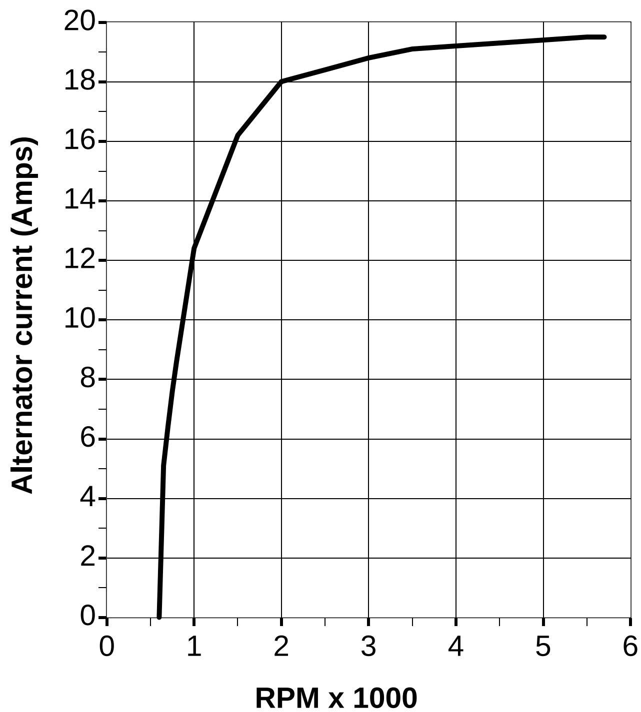
1. Check for correct battery polarity [RED cable to POSITIVE (+) battery terminal]. If polarity was incorrect, check for damaged regulator/rectifier. See “REGULATOR/RECTIFIER DIODE TEST”.
2. Check for loose or corroded battery connections.
3. Visually inspect wiring between stator and battery for cuts, chafing, and a disconnected, loose or corroded connection.
4. Excessive electrical load (from too many accessories) will cause battery to run down.

If visual inspection determines that battery connections and wiring are OK, perform the following stator and regulator/rectifier tests.

Alternator System Test

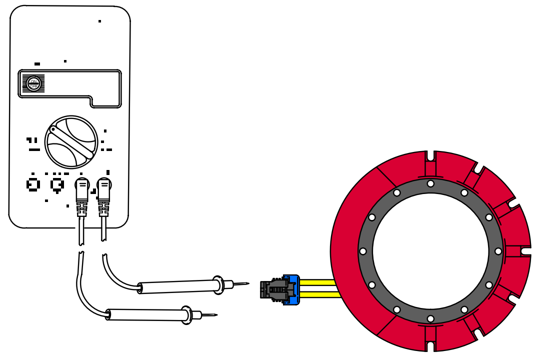
20 AMPERE STATOR

1. Check battery voltage at battery with engine running.
2. If battery voltage is above 15.0 volts, replace voltage regulator/rectifier. Check condition of battery as overcharging may have damaged battery.
3. If battery voltage is below 12.5 volts, charge battery. If battery can NOT be satisfactorily charged, replace battery.
4. If battery accepts a satisfactory charge, check battery voltage while cranking engine. If cranking voltage is not acceptable, replace battery.
5. If cranking voltage is acceptable, disconnect the RED (voltage regulator) connector.
6. Connect RED (+) ammeter lead to RED voltage regulator wire, and the BLACK (–) ammeter lead to the RED wiring harness wire.
7. Secure stator wires away from flywheel.
8. With engine running at the indicated RPM's, the ammeter should indicate the following appropriate amperes:



9. A reading of 19.5 amperes at 5000 RPM indicates the charging system is functioning properly.
10. If ammeter reads less than required amperes @ 5000 RPM, test the stator (refer to "**Stator Resistance Test**"). If stator tests OK, replace rectifier/regulator.

Stator Resistance Test - 20 Amp. Stator



METER TEST LEADS		METER SCALE (ANALOG)	READING (Ω)
RED	BLACK	RX1	0.20 - 0.30
YEL	YEL		

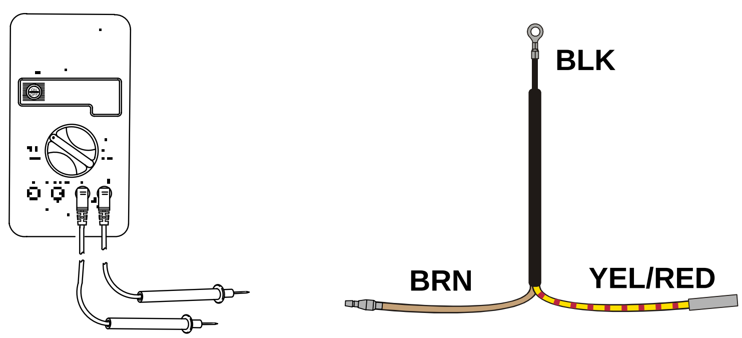
NOTE: *If using DMT 2000 turn the selector switch to . Allow the meter to auto-range.*

Suppression Diode Tests

The suppression diode is located between the brown start solenoid lead, the yellow/red key switch lead (within the engine harness) and connects to engine ground. The purpose of the suppression diode is to eliminate the inductive spike created as the start solenoid is de-energized (key switch turned from START to RUN).

Symptoms of a failed suppression diode:

1. Open circuit - Longer crank times during engine start-up (3 seconds warm engine).
2. Short circuit - Blown fuse #3 (Main Power Relay/Accessory).



DIODE TEST

BLK \ RED	YEL/RED	BRN	BLK
YEL/RED	X	0V or SHORT	0.4 - 0.8V
BRN	0V or SHORT	X	0.4 - 0.8V
BLK	OUCH, OL, ∞	OUCH, OL, ∞	X

RESISTANCE TEST

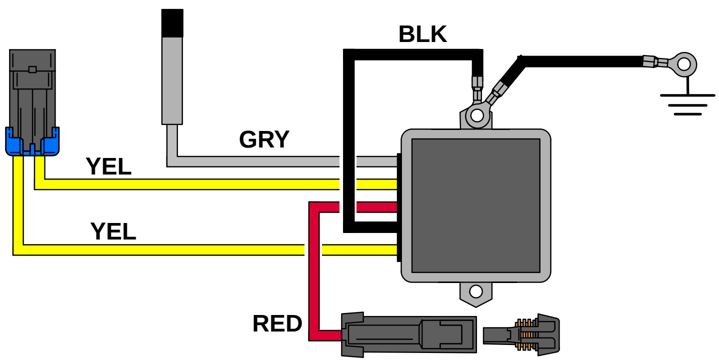
BLK \ RED	YEL/RED	BRN	BLK
YEL/RED	X	< 0.5Ω	1 - 3MΩ

BRN	< 0.5Ω	X	1 - 3MΩ
BLK	OUCH, OL, ∞	OUCH, OL, ∞	X

Regulator/Rectifier (P/N 854514-1) Diode Test

ANALOG METER

NOTE: *Voltage regulator/rectifier specifications are given for informational purposes only. Use the appropriate troubleshooting techniques previously mentioned to find the faulty component in the charging system.*



DIODE TEST:

1. Set Ohm meter to R X 10 scale.
2. Connect Red (+) meter lead to RED regulator lead.
3. Connect Black (–) meter lead to either YELLOW regulator lead.

TEST RESULTS:
100 - 400 OHMS

DIODE TEST:

1. Set Ohm meter to R X 1k scale.
2. Connect Black (–) meter lead to RED regulator lead.
3. Connect Red (+) meter lead to YELLOW regulator lead. Test. Then change Red (+) meter lead to the other YELLOW regulator lead for 2ND test reading.

TEST RESULTS (1ST READING):
20,000 to ∞ OHMS

TEST RESULTS (2ND READING):
∞ OHMS (No needle movement)

SCR TEST:

1. Set Ohm meter to R X 1k scale.
2. Connect Red (+) meter lead to regulator case.
3. Connect Black (–) meter lead to one YELLOW regulator lead. Test. Connect Black (–) meter lead to the other YELLOW lead.

TEST RESULTS (BOTH TESTS):
8,000 - 15,000 OHMS (8k - 15K)

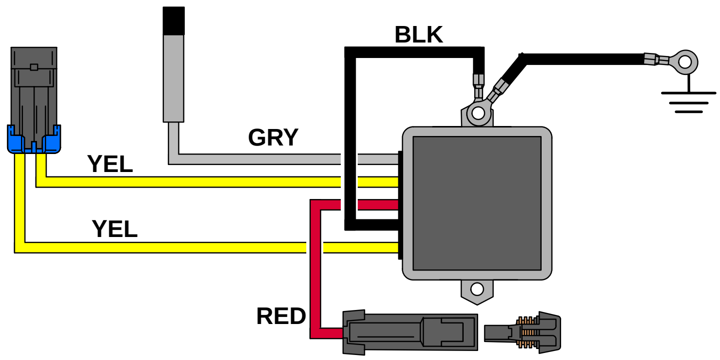
TACHOMETER CIRCUIT TEST:

1. Set Ohm meter to R X 1k scale.
2. Connect Red (+) meter lead to GREY regulator lead.
3. Connect Black (–) meter lead to regulator case.

TEST RESULTS:
10,000 - 50,000 OHMS (10k - 50k)

DIGITAL METER

NOTE: *Voltage regulator/rectifier specifications are given for informational purposes only. Use the appropriate troubleshooting techniques previously mentioned to find the faulty component in the charging system.*



DIODE TEST:

1. Set meter to ⟶|⊢.
2. Connect Black (–) meter lead to RED regulator lead.
3. Connect Red (+) meter lead to either YELLOW regulator lead.

TEST RESULTS:
0.4-0.8 V

DIODE TEST:

1. Set meter to ⟶|⊢.
2. Connect Red (+) meter lead to RED regulator lead.
3. Connect Black (–) meter lead to either YELLOW regulator lead.

TEST RESULTS (1ST READING):
∞ or OUCH or OL

SCR TEST:

1. Set meter to ⟶|⊢.
2. Connect Black (–) meter lead to regulator case.
3. Connect Red (+) meter lead to either YELLOW regulator lead.

TEST RESULTS (BOTH TESTS):
1.5 V - ∞ or OUCH or OL

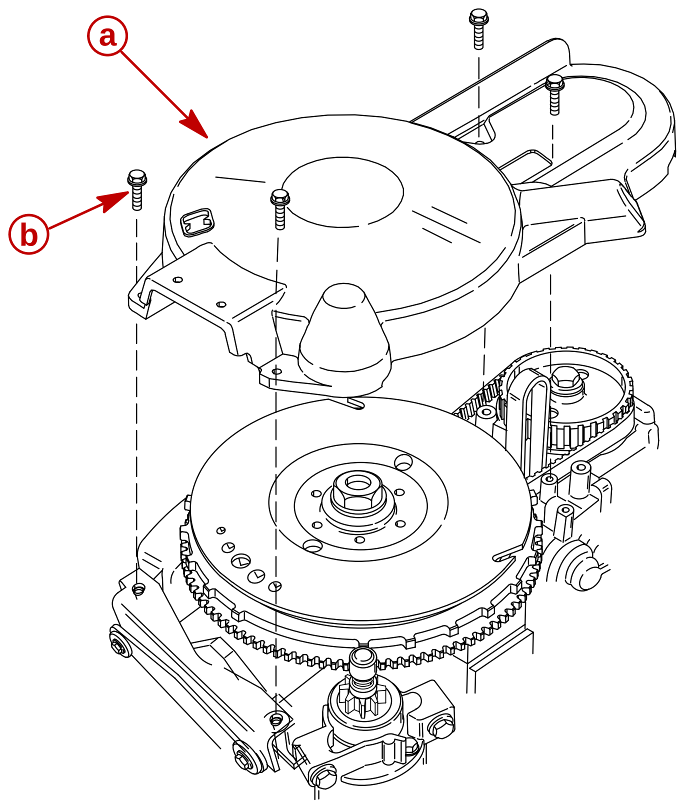
Flywheel Removal/Installation

⚠ WARNING

Engine could possibly start when turning flywheel during removal and installation. To prevent this type of accidental engine starting and possible serious injury, always remove spark plug leads from spark plugs.

Removal

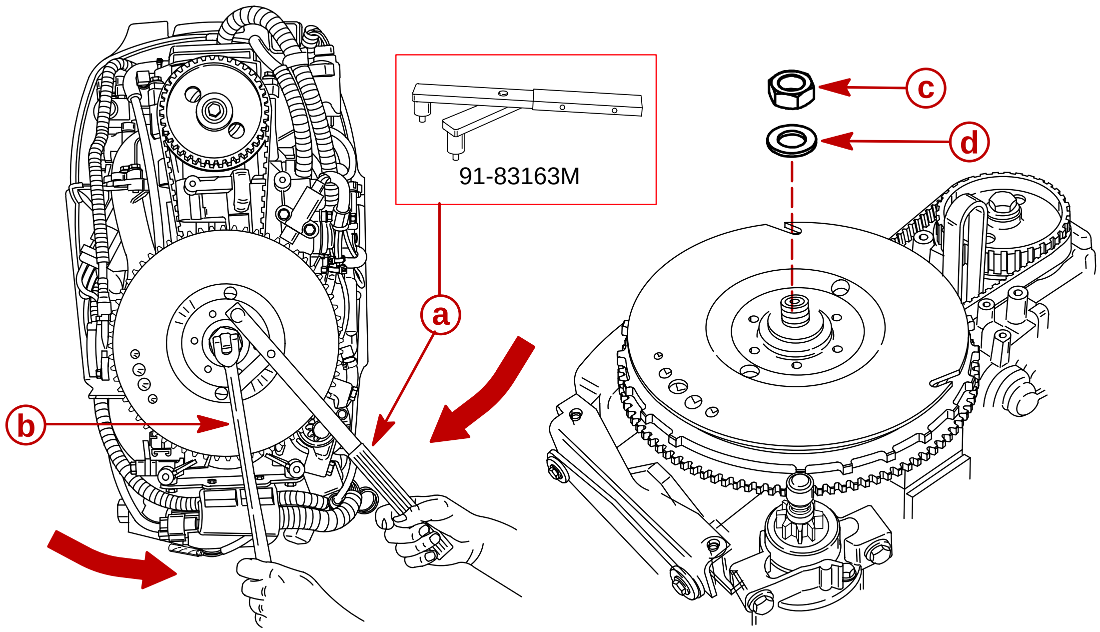
1. Remove flywheel cover.



a - Flywheel Cover
b - Screw (4) M6 x 25

2. Loosen flywheel nut. Hold flywheel using flywheel holder (91-83163M).
3. Remove nut and washer.

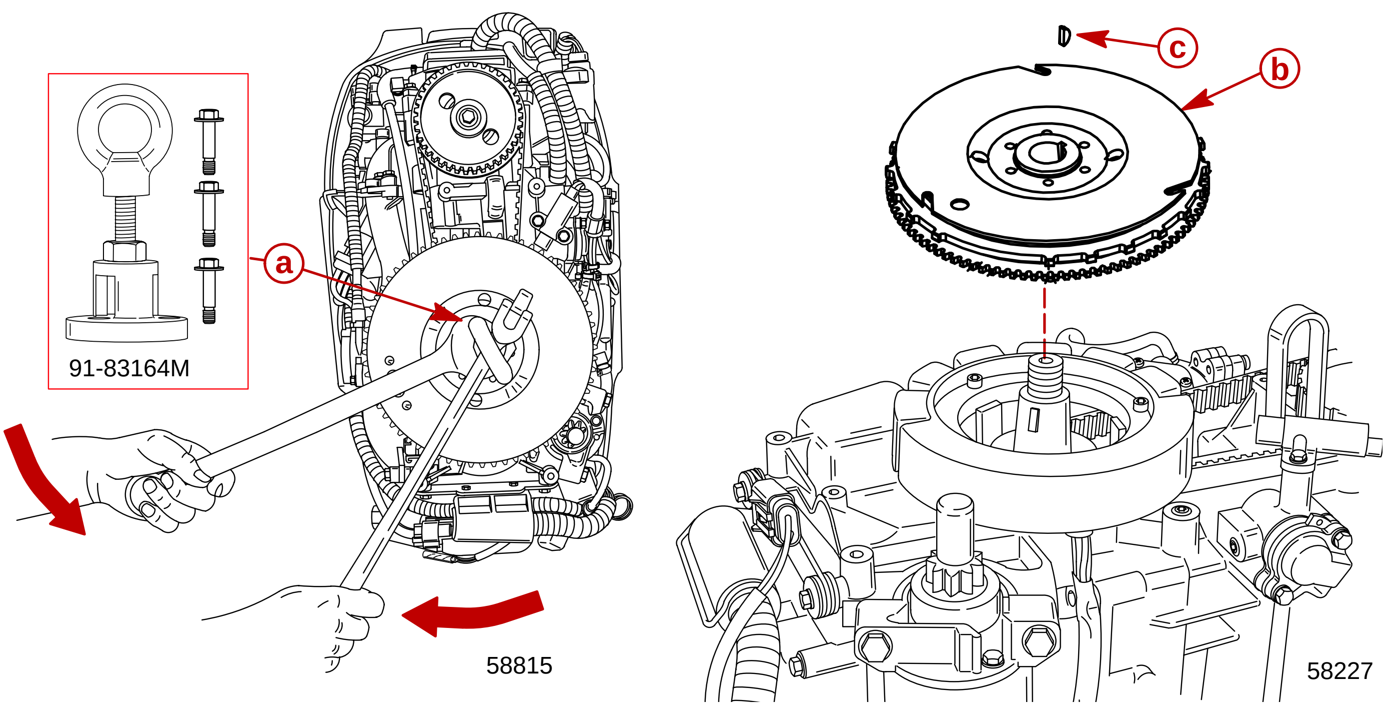
NOTE: *Removal of the nut may require the use of an impact tool.*



a - Flywheel Holder (91-83163M)
b - Breaker Bar with 30 mm Socket
c - Nut
d - Washer

4. Loosen flywheel using puller (91-83164M). Remove flywheel and key.

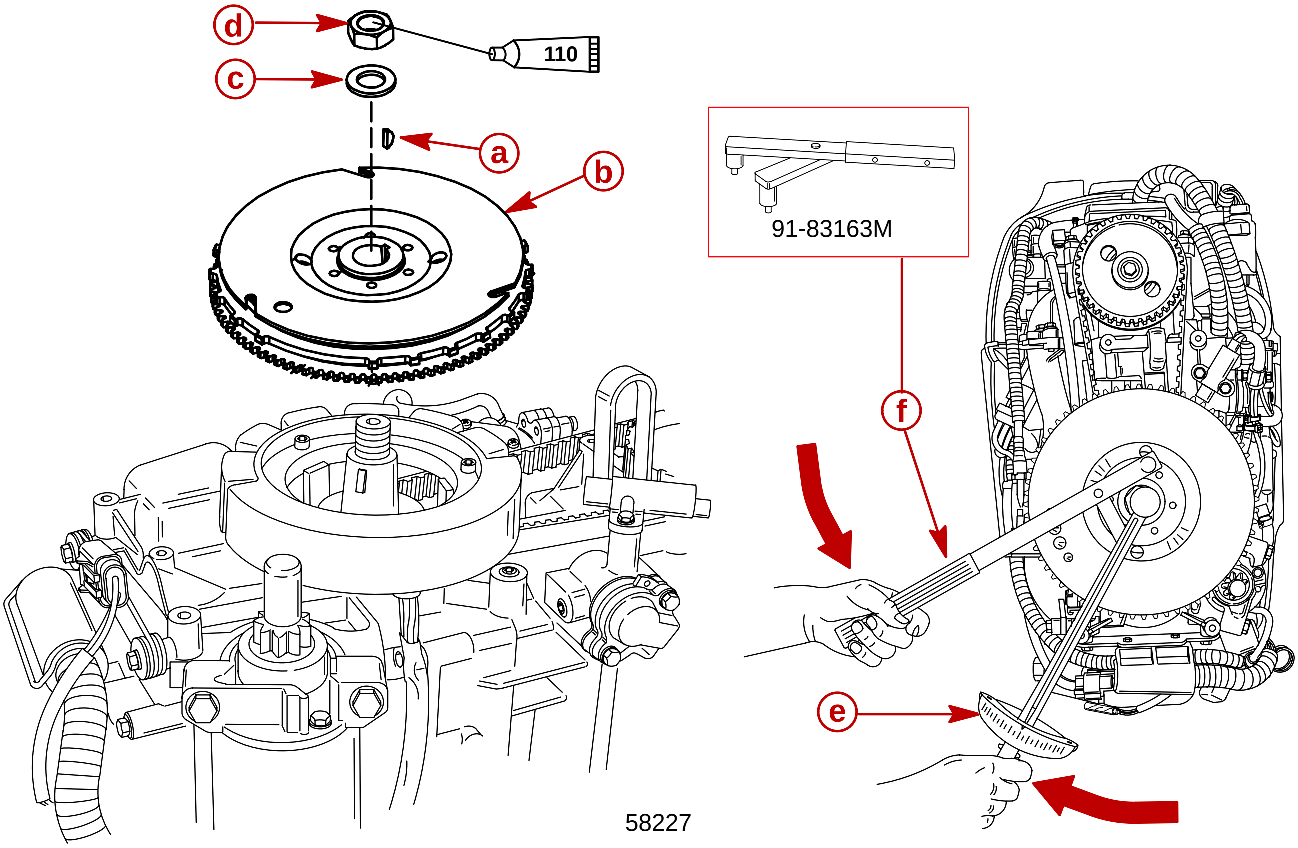
NOTE: *Apply a small amount of grease to the end of the crankshaft before installing puller.*



a - Flywheel Puller (91-83164M)
b - Flywheel
c - Key

Installation

1. Place flywheel key into slot.
2. Install flywheel. Apply oil to threads on crankshaft.
3. Install washer and nut.
4. Hold flywheel using flywheel holder (91-83163M) and tighten nut to the specified torque.



110 4-Stroke Outboard Oil (92-828000A12)

a - Key
b - Flywheel
c - Washer
d - Nut
e - Torque Wrench with 30mm socket
f - Flywheel Holder (91-83163M)

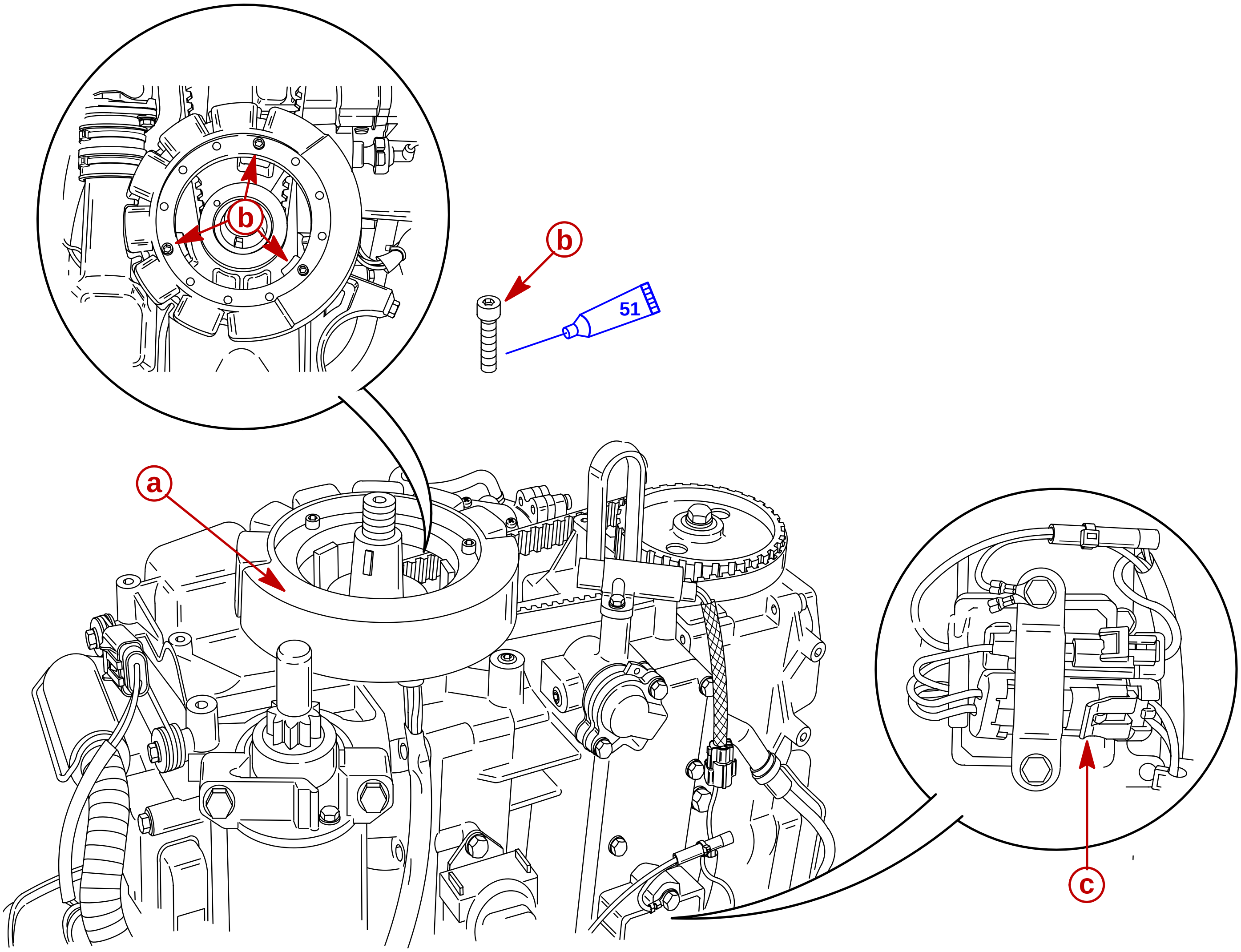
Flywheel Nut Torque
115 lb. ft. (155.9 N·m)

Stator Removal/Installation

NOTE: *Remove flywheel as outlined in "Flywheel Removal and Installation" section of service manual.*

1. Disconnect stator wires. The 2 pin connector disconnects from voltage regulator.
2. Remove stator mounting screws.
3. Reverse steps for installation (refer to wiring diagram in **Section 8** for correct stator wire connections).

NOTE: *Apply Loctite 222 to threads of stator mounting screws.*



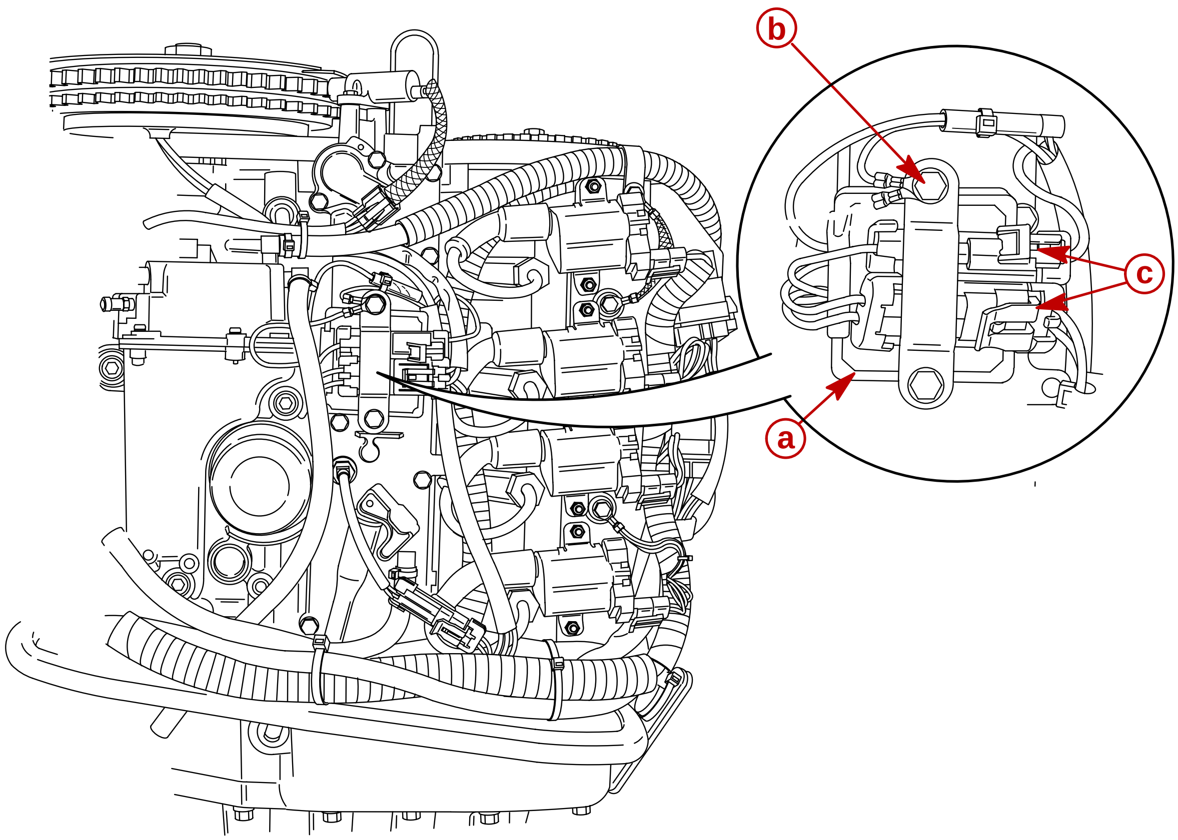
51 Loctite "222" (92-809818)

a - Stator
b - Screw (3) M5 x 30
c - 2 Pin Connector

Stator Screw Torque
85 lb. in. (9.6 N·m)

Voltage Regulator/Rectifier Removal and Installation

1. Disconnect voltage regulator/rectifier wire connectors.
2. Remove mounting screws and remove voltage regulator/rectifier.
3. Reverse steps for installation (refer to wiring diagram **section 8** for correct wire connections).



a - Voltage Regulator/Rectifier
b - Screw (2) M6 x 40
c - Connectors

Voltage Regulator/Rectifier Mounting Screw Torque
75 lb. in. (8.5 N·m)

Starting System Components

Description

The function of the starting system is to crank the engine. The battery supplies electrical energy to crank the starter motor. When the ignition switch is turned to “START” position, the starter solenoid is activated and completes the starting circuit between the battery and starter.

The neutral start switch opens the start circuit when the shift control lever is not in neutral. This prevents accidental starting when engine is in gear.

The starting system consists of the following components.

1. Battery
2. Starter Solenoid
3. Neutral Safety Switch
4. Starter Motor
5. Ignition Switch

CAUTION

The starter motor may be damaged if operated continuously. DO NOT operate continuously for more than 30 seconds. Allow a 2 minute cooling period between starting attempts.

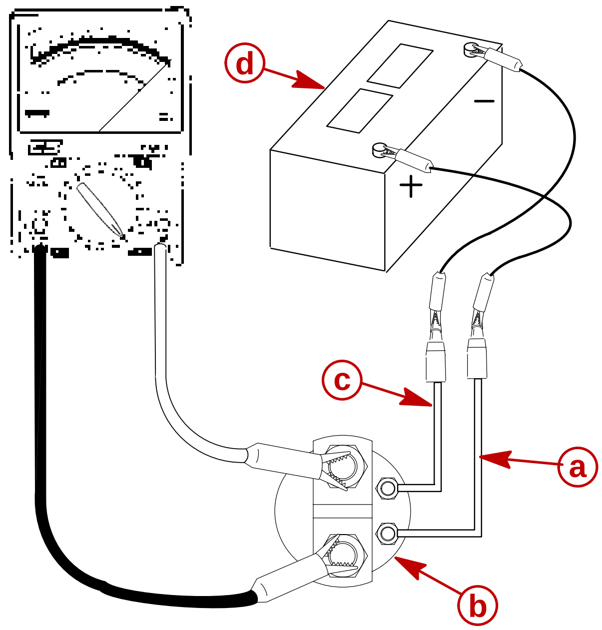
Troubleshooting the Starting Circuit

Before beginning the starting circuit troubleshooting flow chart, following, check first for the following conditions:

1. Make sure that battery is fully charged.
2. Check that control lever is in “NEUTRAL” position.
3. Check battery terminals for corrosion and loose connections.
4. Check start solenoid and starter for corrosion and loose connections.
5. Check cables and wiring for frayed and worn insulation.
6. Check 20 Amp fuse.

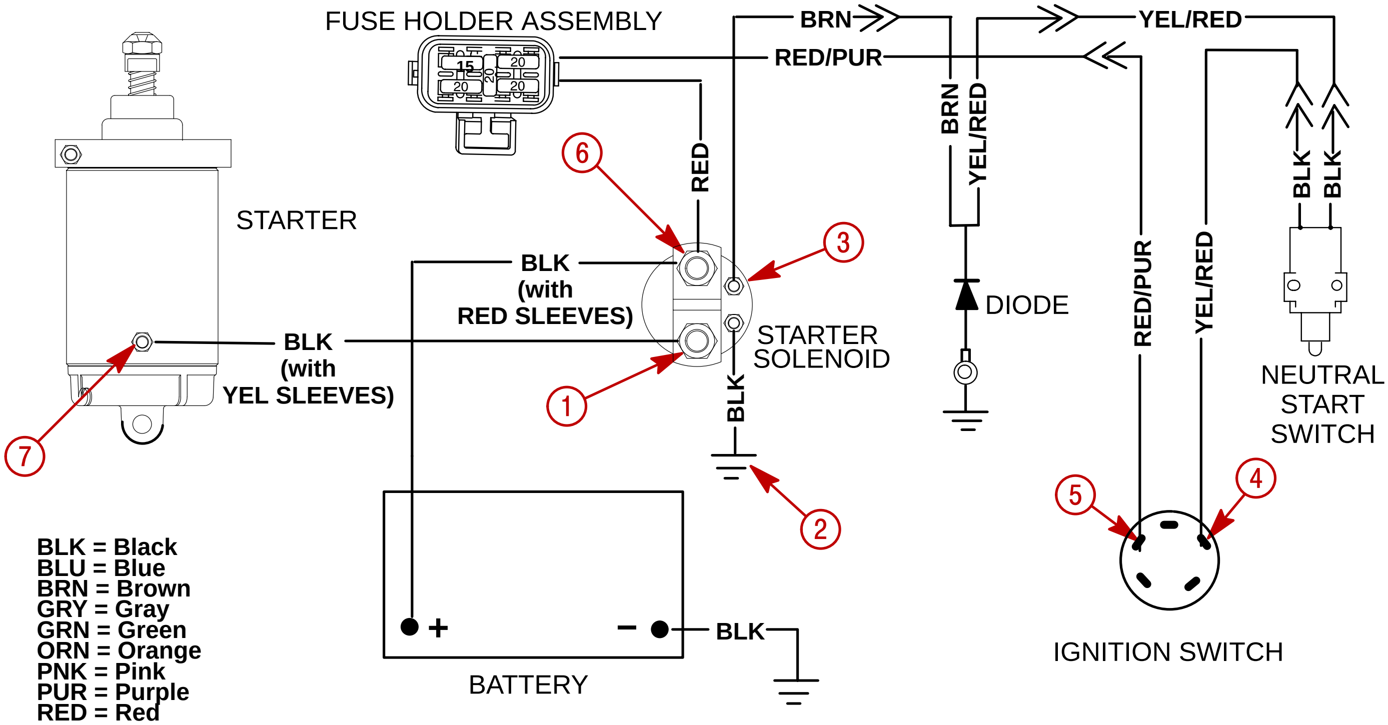
Starter Solenoid Test

1. Inspect starter solenoid for cracks, loose terminals or loose terminal lead connections.
2. Connect ohm meter between terminals of starter solenoid.
3. Connect the BLACK lead from solenoid to battery negative (–) terminal and momentarily connect the BROWN lead to the positive (+) terminal of battery.
4. Verify continuity between the starter solenoid terminals when 12 volts are applied.



a - BROWN Lead
b - Starter Solenoid
c - BLACK Lead
d - Battery

The following “STARTING CIRCUIT TROUBLESHOOTING FLOW CHART” is designed as an aid to troubleshooting the starting circuit. This flow chart will accurately locate any existing malfunction. Location of “TEST POINTS” (called out in the chart) are numbered in diagram below.



BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
TAN = Tan
WHT = White
YEL = Yellow

Starting Circuit Troubleshooting Flow Chart

Starter Motor Does Not Turn

SAFETY WARNING: Disconnect BLACK (with Yellow Sleeve) (starter motor) cable from starter solenoid test point 1 BEFORE making tests 1-thru-7 to prevent unexpected engine cranking.

TEST 1

Use an ohmmeter (R x 1 scale) and connect meter leads between NEGATIVE (-) battery post and common powerhead ground.

No continuity indicated; there is an open circuit in the BLACK NEGATIVE (-) battery cable between the NEGATIVE (-) battery post and the powerhead.

- Check cable for loose or corroded connections.
- Check cable for open.

Continuity Indicated

Proceed to TEST 2, on next page.

** Battery Voltage*

TEST 2

a. Disconnect BLACK ground wire(s) from Test Point 2.
b. Connect voltmeter between common engine ground and Test Point 2.
c. Turn ignition key to "Start" position.

No voltage reading; proceed to TEST 3.

12 Volt Reading*

Check BLACK ground wire for poor connection or open circuit. Reconnect ground wire to starter solenoid; proceed to TEST 7.

TEST 3

a. Reconnect BLACK ground wire(s).
b. Connect voltmeter between common engine ground and Test Point 3.
c. Turn ignition key to "Start" position.

No voltage reading; proceed to TEST 4.

12 Volt Reading

Defective starter solenoid.

Electric Start Tiller Handle Model

Neutral start switch is open or BLACK leads are disconnected or damaged.

TEST 4

a. Connect voltmeter between common engine ground and Test Point 4.
b. Turn ignition key to "Start" position.

No voltage reading; proceed to TEST 5.

12 Volt Reading*

Neutral start switch is open, or BROWN, or YEL/RED, or BLACK wire is open between Test Points 4 and 3. Check diode adaptor if equipped.

TEST 5

Connect voltmeter between common engine ground and Test Point 5.

No voltage reading; proceed to TEST 6.

12 Volt Reading*

Defective ignition switch.

TEST 6

Connect voltmeter between common engine ground and Test Point 6.

No voltage reading; check BLACK (with RED sleeve) wire between battery (+) positive terminal and Test Point 6.

12 Volt Reading*

Check fuse in RED wire between test points 5 and 6. Check for open RED or RED/PUR wire between test points 5 and 6.

TEST 7

a. Connect voltmeter between common engine ground and Test Point 1.
b. Turn ignition key to "Start" position.

No voltage reading; Defective starter solenoid.

12 Volt Reading*

Should hear solenoid click; proceed to TEST 8.

TEST 8

a. Reconnect BLACK (with YELLOW sleeve) (starter motor) cable to starter solenoid Test Point 1.
b. Connect voltmeter between common engine ground and Test Point 7
c. Turn ignition key to "Start" position.

No voltage reading; check BLACK (with YELLOW sleeve) cable for poor connection or open circuit.

12 Volt Reading*

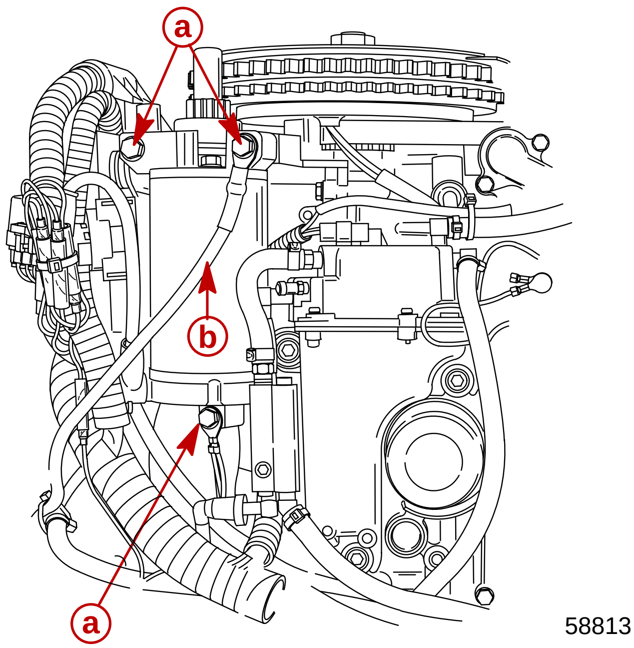
Check BLACK (with YELLOW sleeve) cable at starter for loose or corroded connection, or open circuit. If cable is O.K., check starter motor.

Starter Motor Servicing

Removal

> **⚠ WARNING**
>
> **Always disconnect the battery and remove spark plug leads from spark plugs before working on motor.**

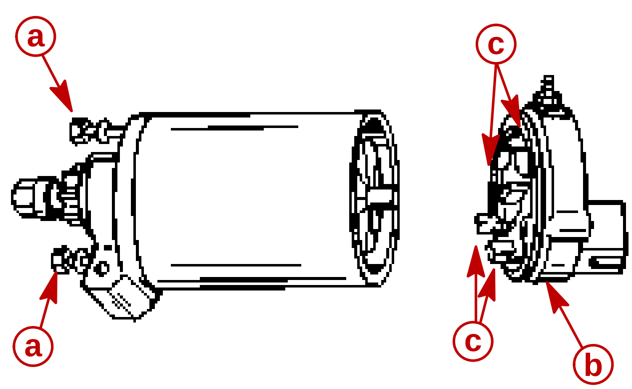
1. Disconnect battery leads from battery and black starter motor lead from starter solenoid.
2. Remove upper mounting screws. Loosen bottom screw, lift up and remove starter.



a - Starter Mounting Screw (3) M8 x 45
b - Starter Motor Lead

Disassembly

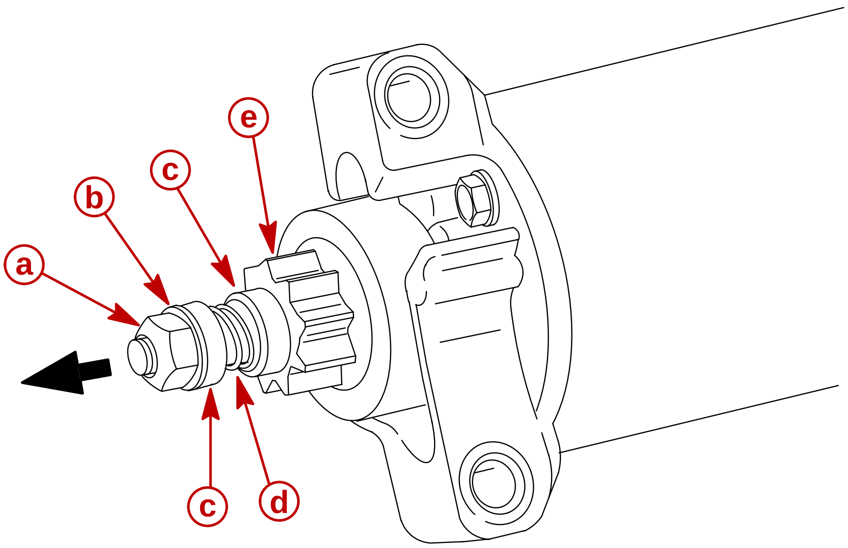
1. Remove 2 thru bolts and commutator end cap, taking care not to lose brush springs.



a - Thru Bolts
b - Commutator End Cap
c - Brush Springs

2. Remove the nut, washer, spring, pinion stopper and pinion drive assembly. You may need to lightly clamp the armature in a vise while removing the nut.

NOTE: **DISPOSE OF NUT AFTER REMOVING IT AND USE A NEW ONE FOR REASSEMBLY.**



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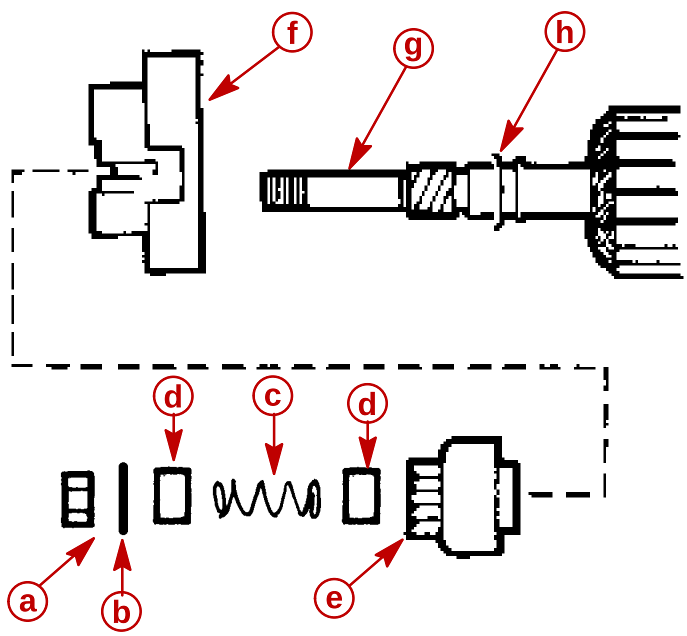
a - Nut
b - Washer
c - Pinion Stopper
d - Spring
e - Pinion

3. Pull armature from starter frame.



a - Nut
b - Washer
c - Spring
d - Pinion Stopper (2)
e - Pinion
f - Drive End Cap
g - Armature Shaft
h - Washer

Cleaning and Inspection

1. Clean all motor parts.
2. Check pinion teeth for chips, cracks or excessive wear.
3. Replace the drive clutch spring and/or collar, if tension is not adequate, or if wear is excessive.
4. Check that the brush holder is not damaged or is not holding the brushes against the commutator.
5. Replace brushes that are pitted or worn to less than 1/4 in. (6.4mm) in length. Refer to "BRUSH REPLACEMENT", following.
6. Replace a damaged or excessively worn bushing in the end cap.
7. Check the armature conductor (commutator bar junction) for a firm connection. A poor connection usually results in a burned commutator bar.
8. Re-surface and undercut a rough commutator, as follows:

⚠ CAUTION

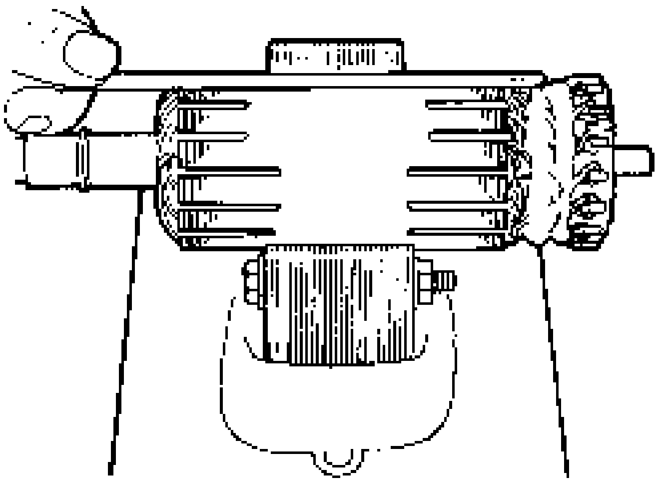
Do not turn down the commutator excessively.

   a. Re-surface the commutator and undercut the insulation between the commutator bars 1/3 in. (0.8mm) to the full width of the insulation, make sure that the undercut is flat.
   b. Clean the commutator slots after undercutting.
   c. De-burr the commutator lightly with No. 00 sandpaper, then clean the commutator.
   d. Check the armature on a growler for shorts. See "TESTING", following.
9. Open-circuited armatures often can be saved where an open circuit is obvious and repairable. The most likely place for an open circuit is at the commutator bars. Long cranking periods overheat the starter motor so that solder in the connections melts. The poor connections cause arcing and burning of the commutator bars.
10. Repair bars, that are not too badly burned, by re-soldering the leads in bars (using rosin flux solder) and turning down the commutator in a lathe to remove burned material, then undercut the mica.
11. Clean out the copper or brush dust from slots between the commutator bars.
12. Check the armature for shorts and ground. See "TESTING".

Testing

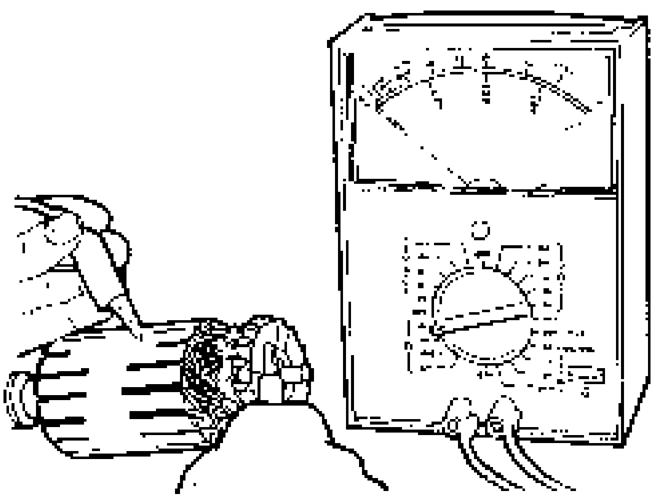
ARMATURE TEST FOR SHORTS

Check armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. If saw blade vibrates, armature is shorted. Recheck after cleaning between commutator bars. If saw blade still vibrates, replace armature.



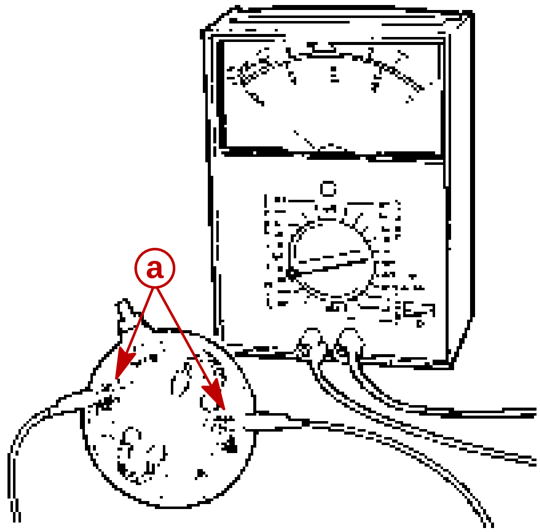
ARMATURE TEST FOR GROUND

1. Set ohmmeter to (R x 1 scale). Place one lead of ohmmeter on armature core (or shaft) and other lead on commutator, as shown.
2. If meter indicates continuity, armature is grounded and must be replaced.



CHECKING POSITIVE BRUSHES AND TERMINALS

1. Connect ohmmeter (R x 1 scale) leads between positive brushes.
2. Ohmmeter must indicate full continuity (zero resistance). If resistance is indicated, check lead to positive terminal solder connection. If connection cannot be repaired, brushes must be replaced. Refer to “BRUSH REPLACEMENT”.



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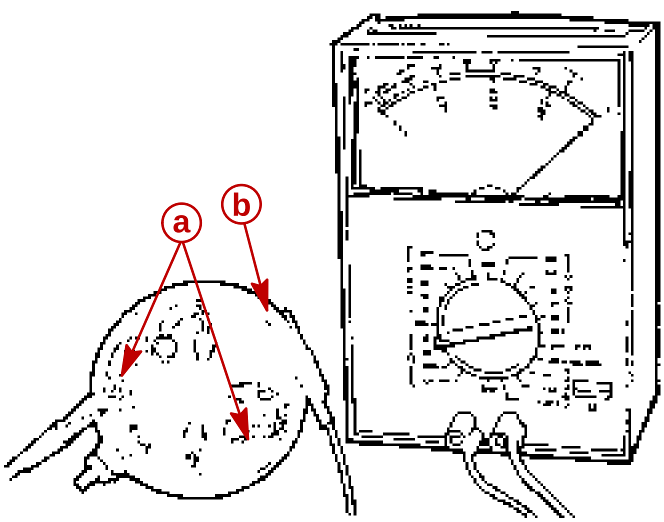
a - Positive Brushes

TESTING NEGATIVE BRUSHES FOR GROUND

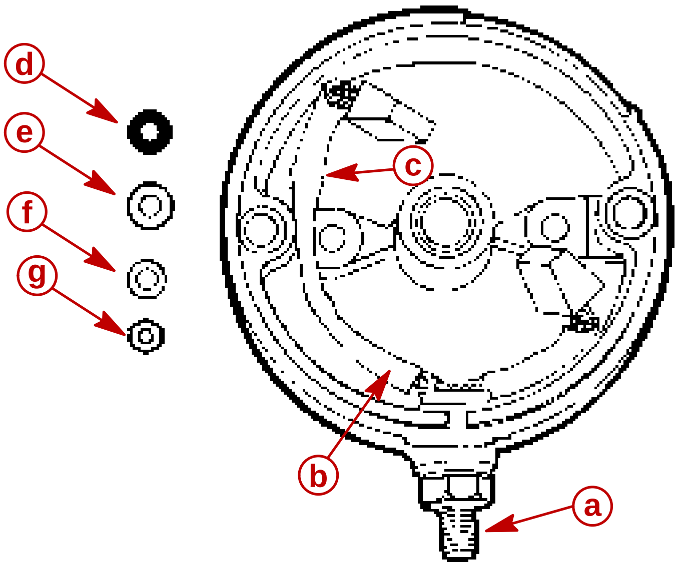
Set ohmmeter to (R x 1 scale). Place one lead of ohmmeter on the negative brush and the other lead on the end cap (bare metal). If the meter indicates NO continuity, replace the negative brush. Repeat this procedure on the other negative brush.



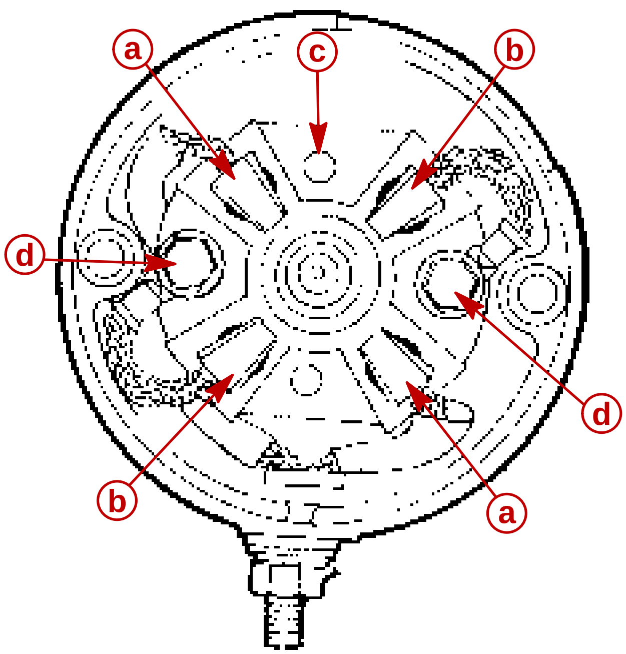
a - Negative (–) Brushes
b - End Cap

Brush Replacement

IMPORTANT: Replace brushes that are pitted or worn to less than 1/4 in. (6.4mm) in length.



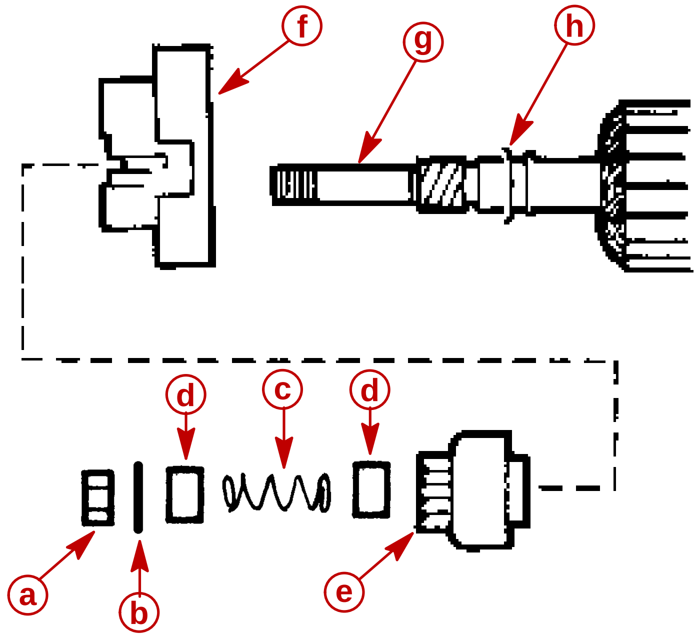
a - Positive (+) Terminal
b - Long Brush Lead
c - Push Lead Into Slot
d - Insulating Washer
e - Flat Washer
f - Lock Washer
g - Nut



a - Positive (+) Brushes
b - Negative (–) Brushes
c - Brush Holder
d - Bolts (Fasten Negative Brushes and Holder)

Reassembly

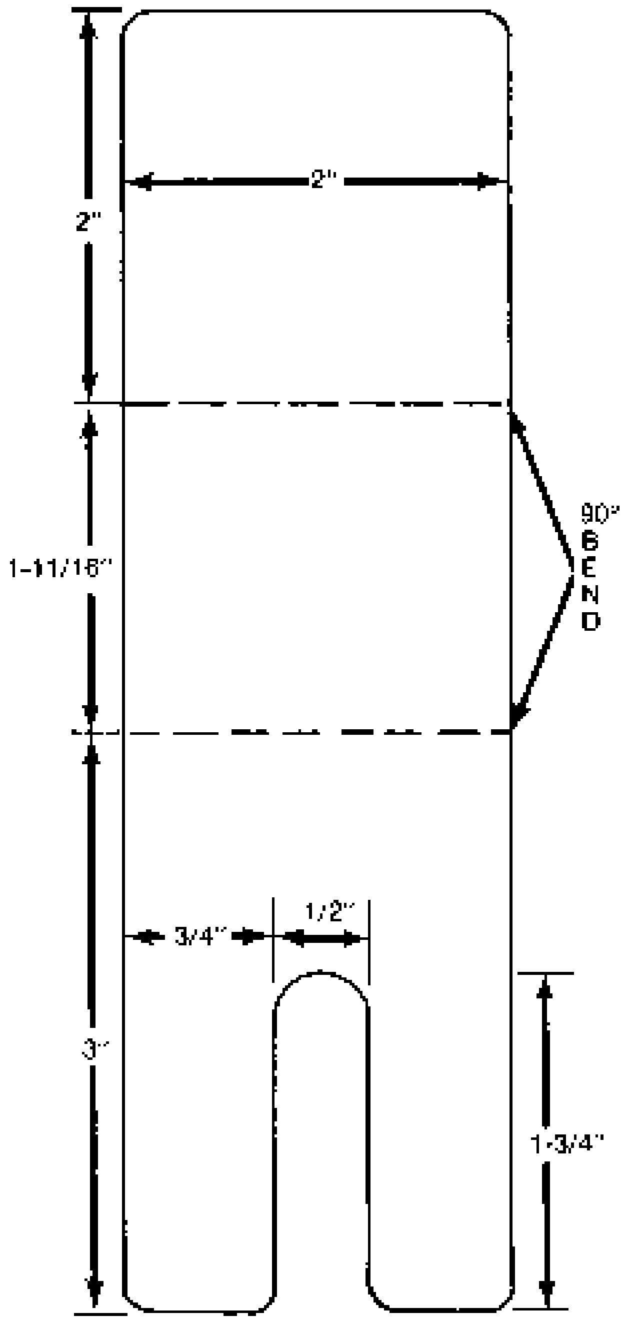
1. Lubricate helix threads and drive end cap bushing with **SAE 10W oil.**
2. Install the pinion, pinion stopper, spring, second pinion stopper, washer, and **NEW** nut onto armature shaft.
3. Lightly clamp the armature in a vise and torque nut to specified torque.



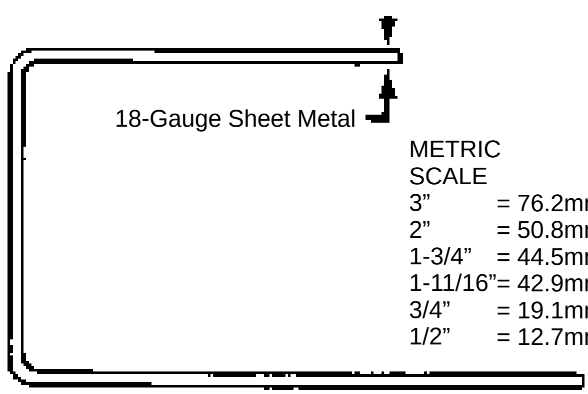
a - Nut
b - Washer
c - Spring
d - Pinion Stopper (2)
e - Pinion
f - Drive End Cap
g - Armature Shaft
h - Washer

Starter Shaft Nut Torque
22.5 lb.-ft. (30.5 N·m)

4. Construct a brush retainer tool as shown.



Brush Retainer Tool Layout (Full Size)

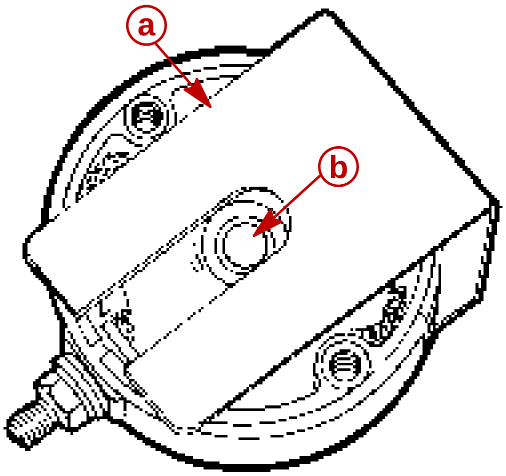


METRIC SCALE

3”	= 76.2mm
2”	= 50.8mm
1-3/4”	= 44.5mm
1-11/16”	= 42.9mm
3/4”	= 19.1mm
1/2”	= 12.7mm

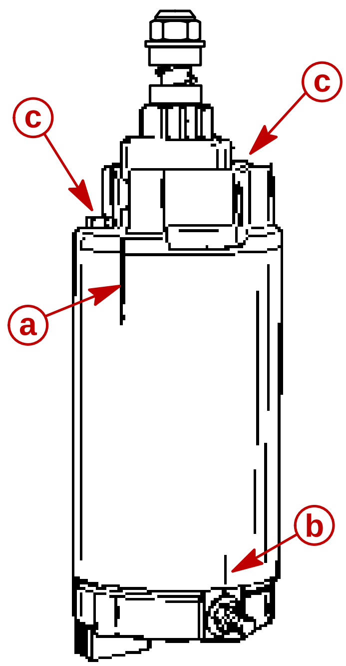
Brush Retainer Tool Side View (Full Size)

5. Place springs and brushes into brush holder and hold in place with brush retainer tool.
6. Lubricate bushing with one drop of SAE 10W oil. DO NOT over-lubricate.



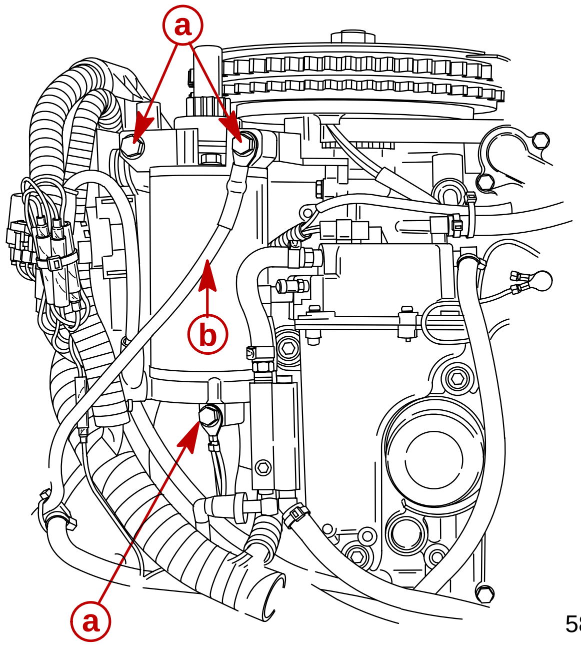
a - Brush Retainer Tool
b - Bushing

7. Position armature into starter frame so that commutator end of armature is at end of starter frame where permanent magnets are recessed 1 in. (25.4mm). Align marks (a) as shown.
8. Install commutator end cap onto starter frame; align marks (b) as shown, and remove brush retainer tool.
9. Install thru bolts (c) and torque to 70 lbs. in. (7.9 N·m).



Installation

1. Secure starter to block with (3) mounting screws. Tighten screws to specified torque. Secure starter motor lead as shown.



a - Starter Mounting Screw (3) M8 x 45
b - Starter Motor Lead

Starter Motor Mounting Screw Torque
22 lb. ft. (29 N·m)

ELECTRICAL

Section 2C - Timing, Synchronizing, & Adjusting

Table of Contents

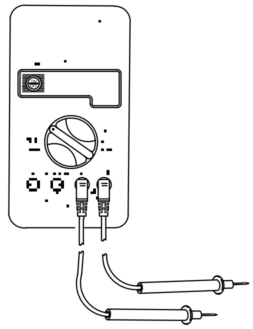
Specifications

IGNITION SYSTEM **Readings taken @ 68°F (20°C).**	**Type**	Capacitor Discharge Ignition
	Spark Plug:	
	Type	Champion RA8HC
	Gap	0.040 in. (1.0 mm)
	Hex Size	5/8 in. (16 mm)
	Torque	150 lb-in. (17 Nm)
	Hole Size	12 mm
	Firing Order	1-3-4-2
	Ignition Timing:	
	@Idle	Controlled by ECM
	@1500-1800	14° B.T.D.C
	@ WOT (6000 rpm)	28° B.T.D.C
	Stator Resistance	0.20 - 0.30 Ω (YEL-YEL)
	Crank Position Sensor (CPS) Resistance	300 - 350 Ω (RED - WHT)
	Ignition Coil Resistance:	
	Internal Shielding	0 - 10.0 KΩ (Pin A - Mounting Bracket)
	Electronic Spark Trigger (EST)	8.5 - 12KΩ (Pin B - Pin C)
	Secondary	3.0 - 7.0 kΩ (Pin A - Coil Tower)
	High Tension Lead/Boot Resistance	0.600 - 1.100 KΩ
	ECM Engine Speed Limiter	
	Fuel/Spark Cut-out on Cylinders #2 and #3	6225 rpm
	Fuel/Spark Cut-out on All Cylinders	6350 rpm
	ECM Overheat Speed Control	Guardian System is activated. Power limit will vary with level of overheat.
	ECM Low Oil Pressure Speed Control	Guardian System is activated. Engine power is limited to 10% of maximum (Approximately 2000 RPM)
	MAT/ECT Temperature Sensor	See Graph Section 3B - EFI
	Manifold Absolute Pressure (MAP) Sensor Resistance	See Table Section 3B - EFI
	Fuel Injector Resistance	10.0 - 13.5Ω
	Main Power Relay	81-99 Ω (Pin 85 - Pin 86)
	Idle Air Control (IAC)	24-30 Ω (Between Pins)
	Throttle Position Sensor Typical Range	
	Output Voltage @Idle	0.39-1.00 Volts
	Output Voltage @WOT (6000)	3.66-4.80 Volts

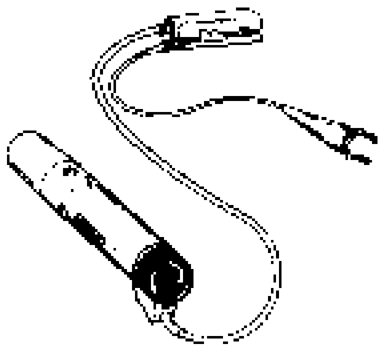
NOTE: *The 50/60 EFI (4-stroke) ECM unit electronically controls the ignition timing, therefore making the ignition timing non–adjustable. When initially running the outboard, use a timing light to verify that the ignition timing falls within the timing windows (as outlined in this section).*

Special Tools

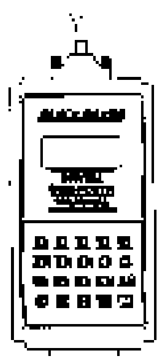
1. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1



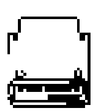
2. Timing Light P/N 91-99379



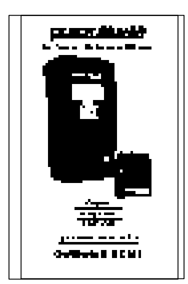
3. Digital Diagnostic Tester 91-823686A2



4. DDT Cartridge 91-880118--2 and DDT Reference Manual 90-881204--2.

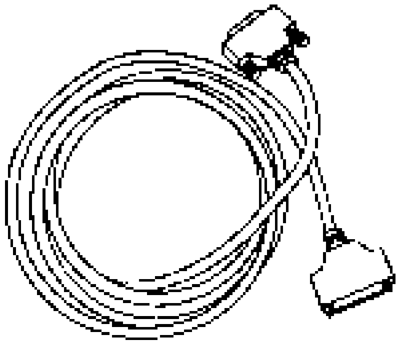


91-880118--2

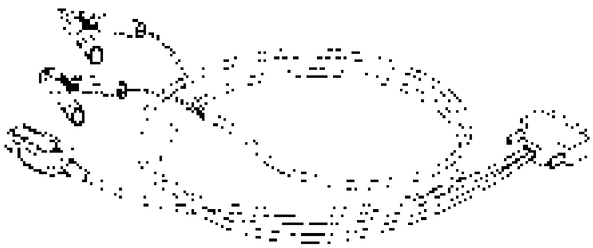


90-881204--2

5. DDT Cable 10’ (3.05m) Extension 84-825003A1



6. DDT Test Harness 84-822560A5

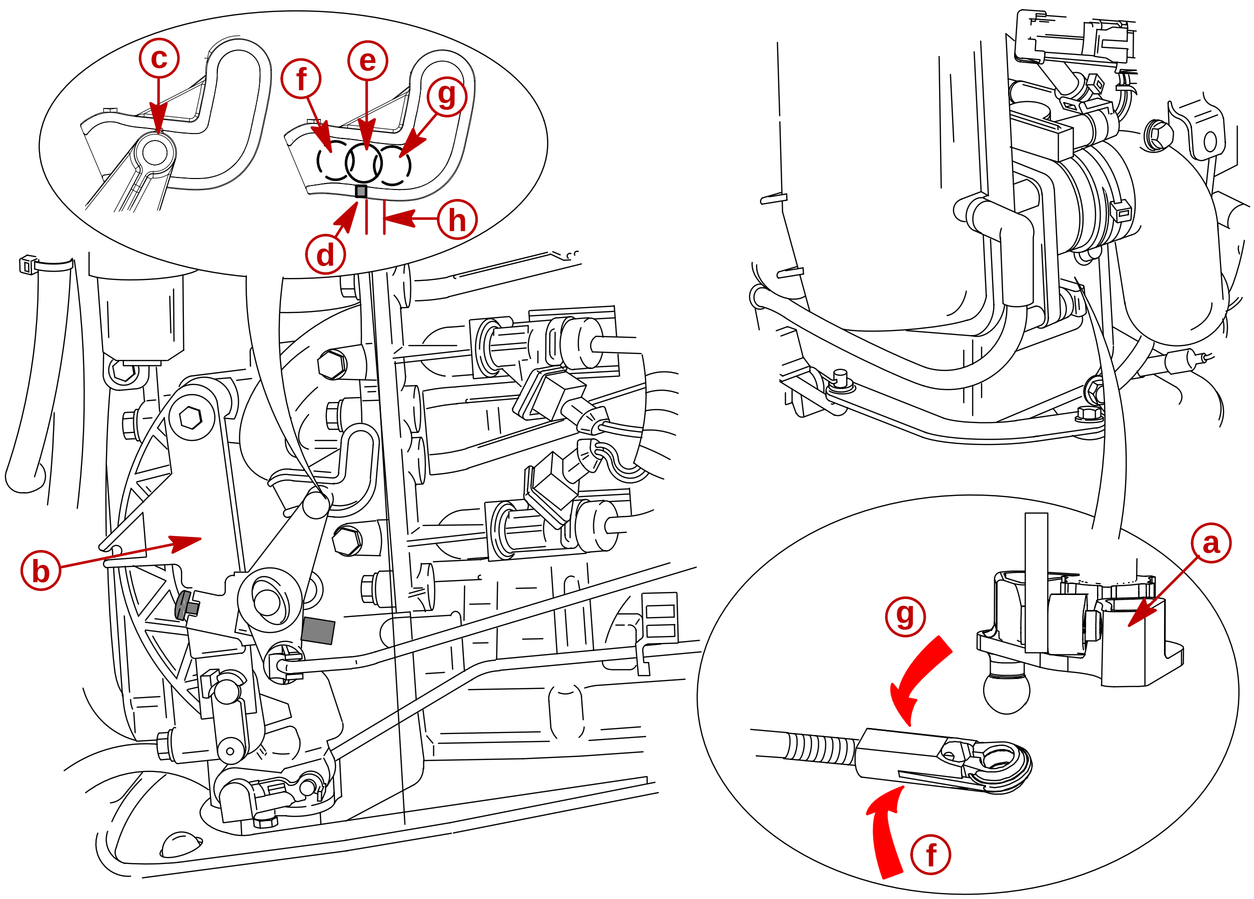


Throttle Link Setting

Idle

***NOTE:** For remote control models, remove remote control throttle cable during throttle link adjustment. For tiller handle models, throttle cables remain attached and throttle twist grip should be used to advance throttle during throttle link adjustment.*

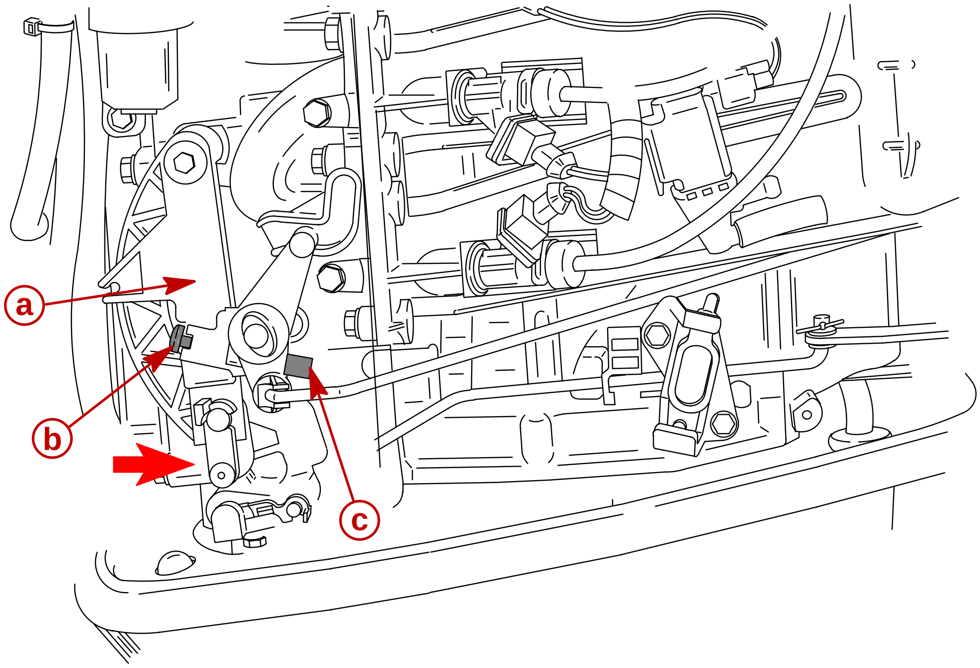
1. Lightly hold throttle body arm against idle stop.
2. Slowly push throttle lever forward until you feel the throttle body arm start to move. The center of throttle arm roller should line up with the throttle cam alignment mark. Tolerance may range from mark to 1/8 inch (3.2 mm) after mark.
3. If adjustment is needed refer to **Throttle Link Adjustment** section 7A .



a - Throttle Body Arm
b - Throttle Lever
c - Throttle Arm Roller
d - Throttle Cam Alignment Mark
e - Correct
f - Shorten Link Rod
g - Lengthen Link Rod
h - Alignment Tolerance - 1/8 inch (3.2mm)

Maximum Throttle

1. With throttle cable(s) attached, advance throttle (remote control handle or throttle twist grip) to wide open throttle position.
2. Throttle stop should lightly contact adjoining surface. To ensure the throttle shutter is fully open, back the throttle stop screw out until there is a gap between the throttle stop screw and adjoining surface (at WOT position). Keep turning the throttle stop screw **"in"** until the throttle stop lightly contacts the adjoining surface.



a - Throttle Lever
b - Throttle Stop Screw
c - Throttle Stop

Timing

⚠ WARNING

To prevent personal injury or possible death, from loss of balance or stability while servicing the motor, DO NOT attempt to check timing while boat is in motion. Failure to follow one of the recommended servicing procedures may result in the person falling overboard or causing personal injury from fall in boat.

⚠ WARNING

To prevent personal injury from spinning flywheel, Do Not attempt to remove flywheel cover or place hands on top of cover when checking ignition timing.

Ignition timing is not adjustable. The Electronic Control Module unit electronically controls the ignition timing.

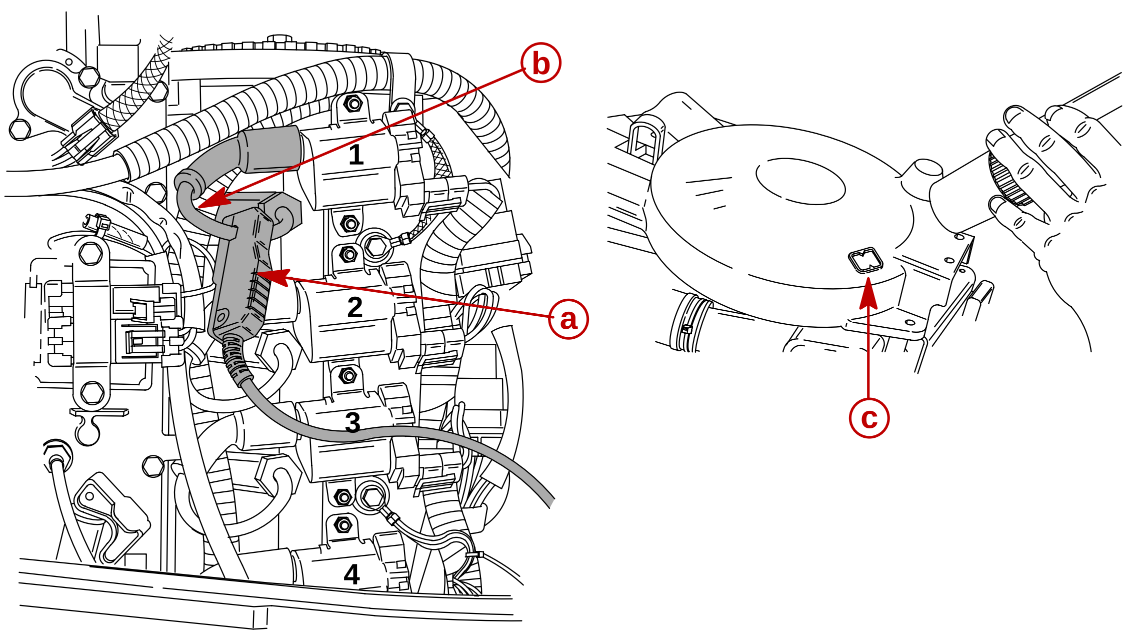
When initially running the outboard, use a timing light to verify that the ignition timing falls within the timing windows as described within the following tests.

IMPORTANT: When checking the timing with the engine running, one of the following test procedures must be followed.

Check maximum timing per specification while running the outboard:

- IN A TEST TANK
- ON A DYNAMOMETER
- ON A BOAT SECURED ON A TRAILER “**Backed in Water”**

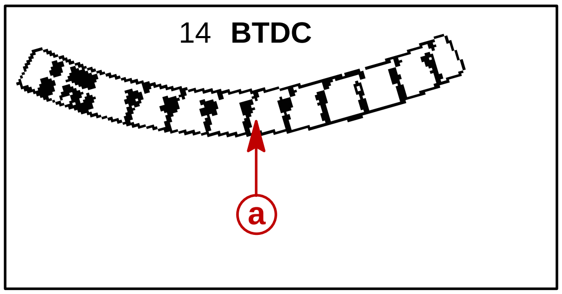
1. Attach timing light to #1 spark plug lead.

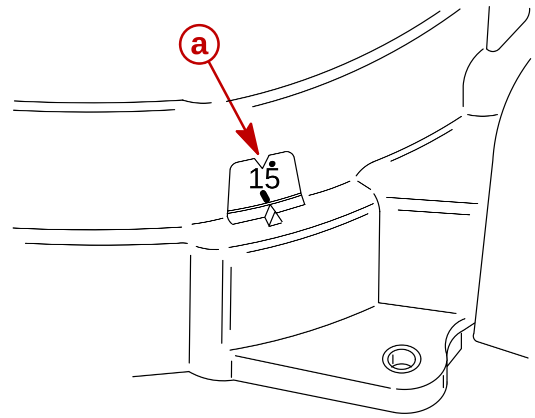


a - Timing Light Clamp
b - #1 Spark Plug Lead
c - Timing Window-Electric Start Models

NOTE: *Idle timing is controlled by the ECM and will vary for idle speed control. Checking the ignition timing marks using a timing light will not be stable until 1500-1800 rpm.*

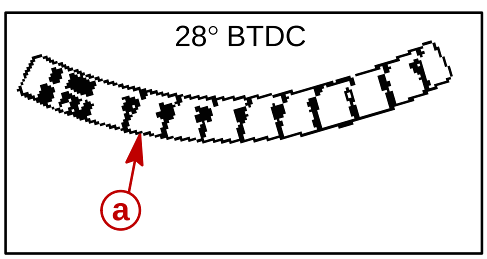
2. Start the engine and place the outboard in “Forward” gear. Check timing at 1500 - 1800 rpm, timing should be 14° BTDC. If timing is not within specification refer to **section 3B EFI Troubleshooting and Diagnostics.**

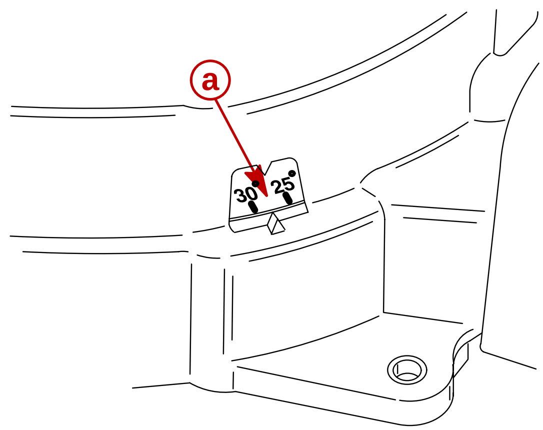




a - Timing Mark (1500-1800 rpm)

3. Slowly increase the engine RPM while watching the ignition timing marks. The timing should increase to the maximum timing specification “Full Advance” at approximately 6000 RPM. If not within specification window, refer to **section 3B - EFI Troubleshooting and Diagnostics.**





a - Timing Mark (Full Advance)

Idle Speed

Engine idle speed is maintained by the ECM and is therefore not adjustable. The parameters affecting idle speed can be checked and monitored using the Digital Diagnostic Terminal (DDT). Refer to **section 3B - EFI Troubleshooting and Diagnostics.**

Throttle Position Sensor (TPS)

The Throttle Position Sensor (TPS) is not adjustable. TPS voltage reading can be monitored with the DDT through the ECM. If readings are not within specifications, refer to **section 3B EFI Troubleshooting and Diagnostics.**

ELECTRONIC FUEL INJECTION

Section 3A - Theory of Operation

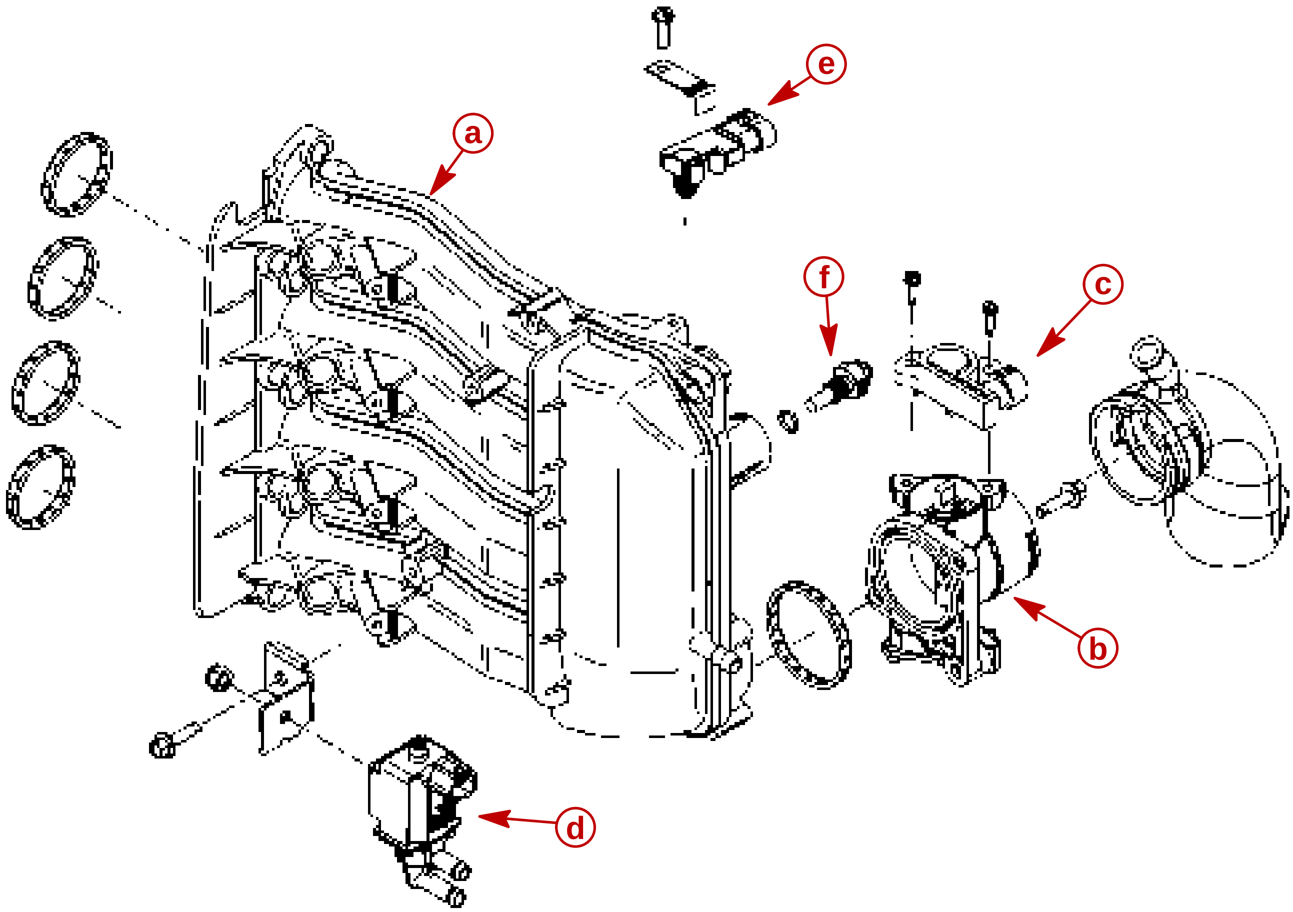
Table of Contents

3
A

Electronic Fuel Injection System

Air Induction System

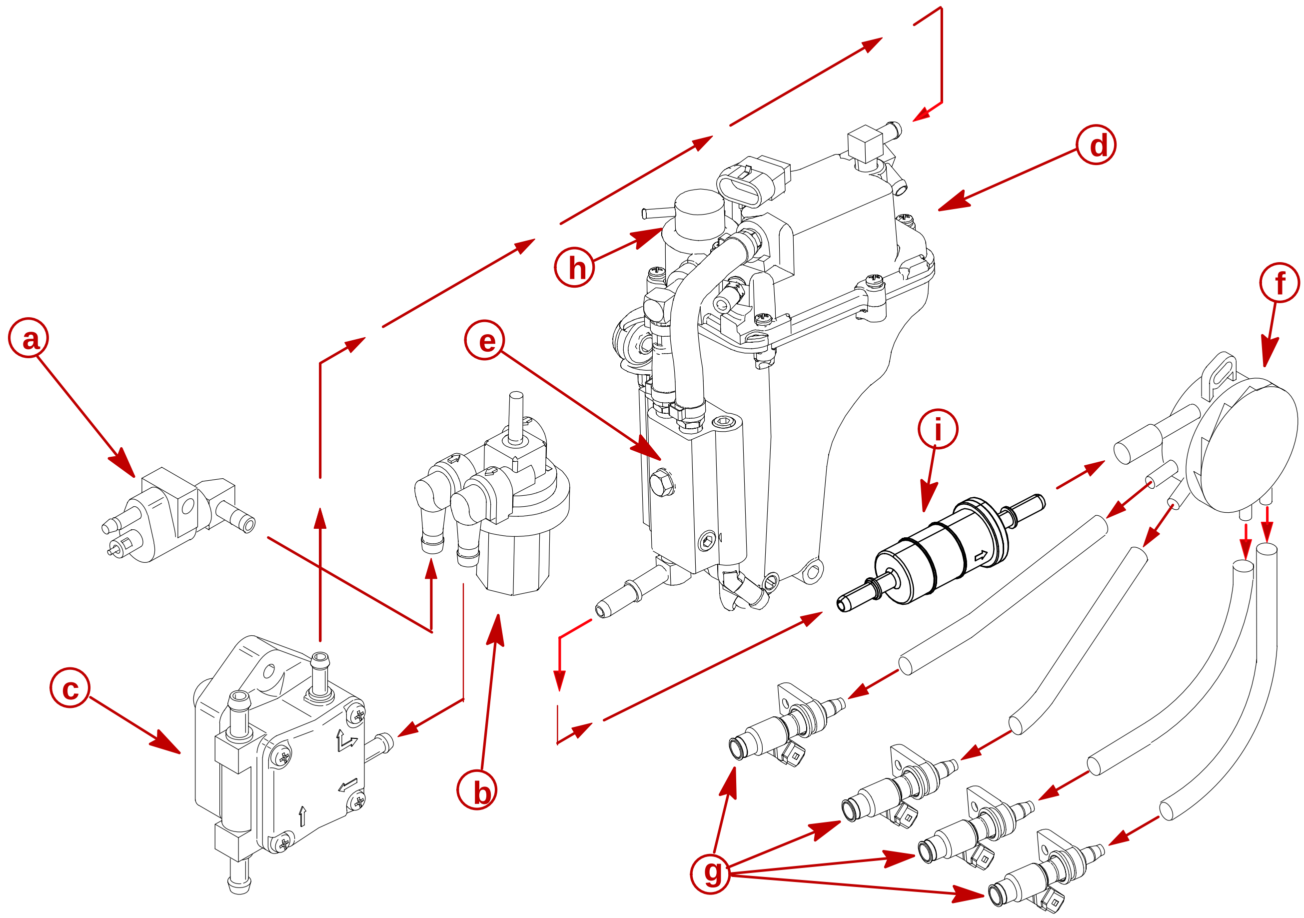
The air induction system consists of an intake manifold (an intake runner for each cylinder joined to a common air box), a single throttle body/shutter with attached Throttle Position Sensor (TPS), an Idle Air Control (IAC), a Manifold Absolute Pressure (MAP) sensor, and a Manifold Air Temperature (MAT) sensor. The intake manifold also mounts the fuel distribution manifold and the fuel injectors.



- **a** - Intake Manifold
- **b** - Throttle Body/Shutter
- **c** - Throttle Position Sensor (TPS)
- **d** - Idle Air Control (IAC)
- **e** - Manifold Absolute Pressure (MAP) Sensor
- **f** - Manifold Air Temperature (MAT) Sensor

Fuel System

The fuel system consists of a fuel line connector, a water separating fuel filter, a low-pressure mechanical fuel pump, a high-pressure electric fuel pump, a fuel distribution manifold, fuel injectors, a fuel cooler and a fuel pressure regulator. The low-pressure mechanical fuel pump draws fuel from the fuel tank, through the fuel line connector and fuel filter, then delivers it to the high-pressure fuel pump within the vapor separator tank. High-pressure fuel is circulated through the fuel cooler and supplied to the fuel distribution manifold and fuel injectors to be sprayed into the intake manifold. Fuel not used by the fuel injectors (fuel not entering the high-pressure fuel line to the fuel distribution manifold) circulates through the fuel cooler, then flows through pressure regulator, and returns to the vapor separator tank.



a - Fuel Line Connector
b - Water Separating Fuel Filter
c - Low-Pressure Mechanical Fuel Pump
d - Vapor Separator Tank/High Pressure Electric Fuel Pump
e - Fuel Cooler
f - Fuel Distribution Manifold
g - Fuel Injectors (4)
h - Pressure Regulator
i - High Pressure Fuel Filter

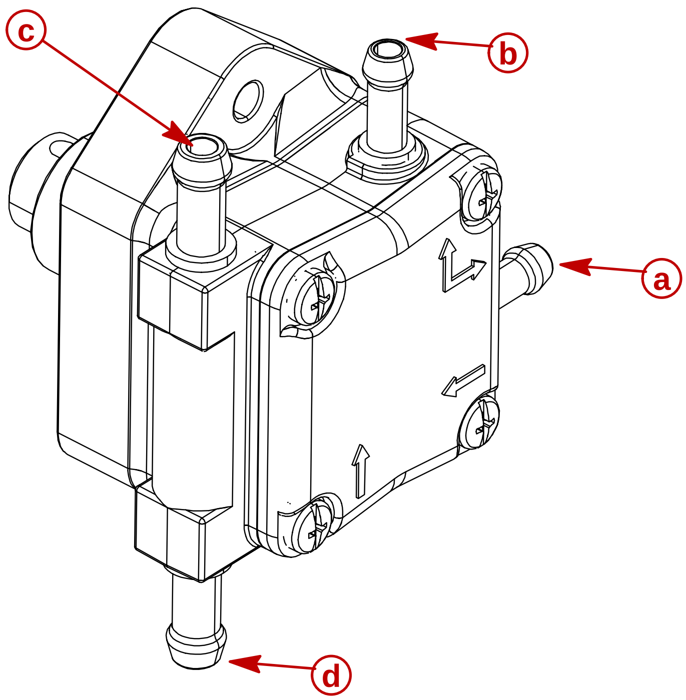
Fuel System Components

Fuel Pump

The fuel pump is a diaphragm pump which is mechanically driven off of the rocker arm.

The pump base insulates the fuel pump from the heat of the engine block. The fuel pump is water cooled to help prevent vapor lock by cooling the fuel.

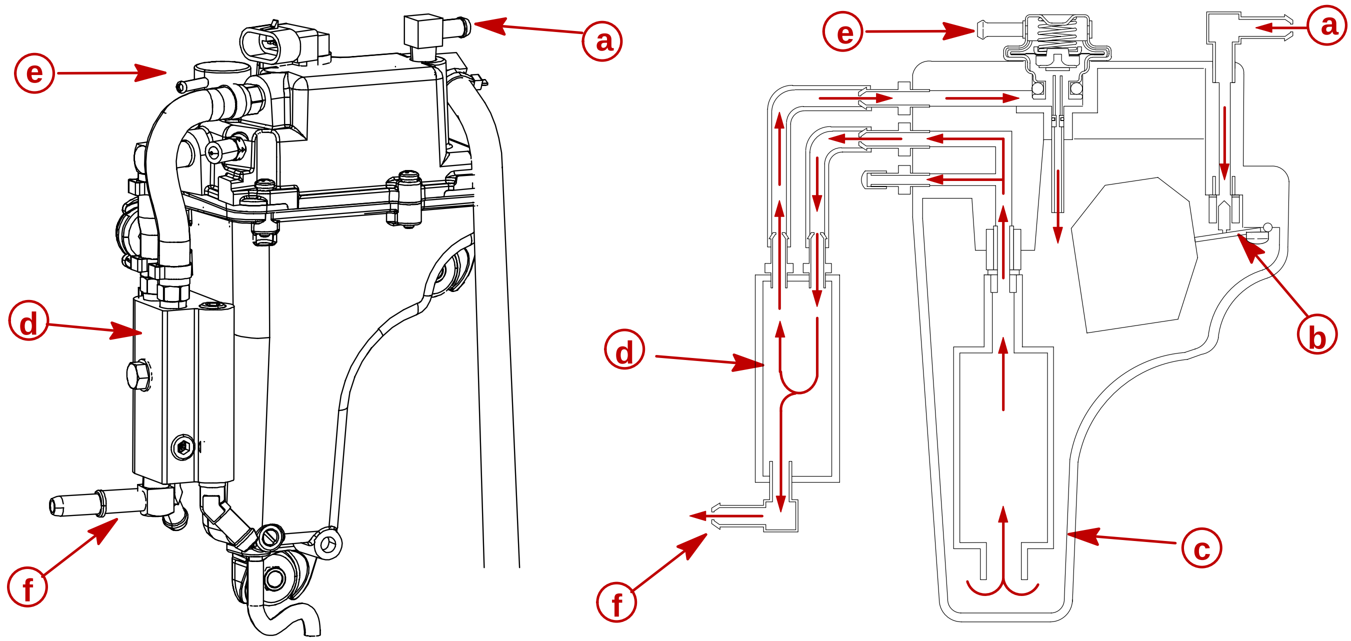
If the engine runs out of fuel, or has a restriction (on the inlet side of the pump) preventing adequate fuel flow, the pump will make a “clicking” noise.



a - Fuel From Filter/Tank
b - Fuel Outlet to VST
c - Water Inlet From VST Fuel Cooler
d - Water Outlet to Tell-tale

Vapor Separator

The vapor separator maintains a liquid fuel supply for the high pressure fuel pump located in the vapor separator tank. Fuel delivered from the mechanical low-pressure fuel pump is supplied to the top of the vapor separator and is controlled by the inlet needle/float assembly. Pressurized fuel from the high-pressure pump circulates through the fuel cooler, to the fuel distribution manifold and injectors. Excess fuel flows through the pressure regulator back to the vapor separator tank.

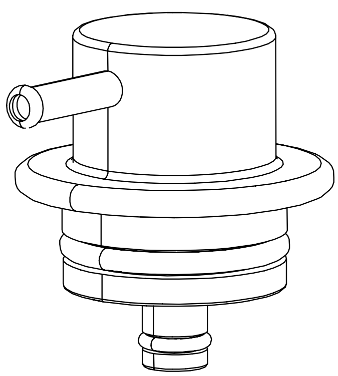


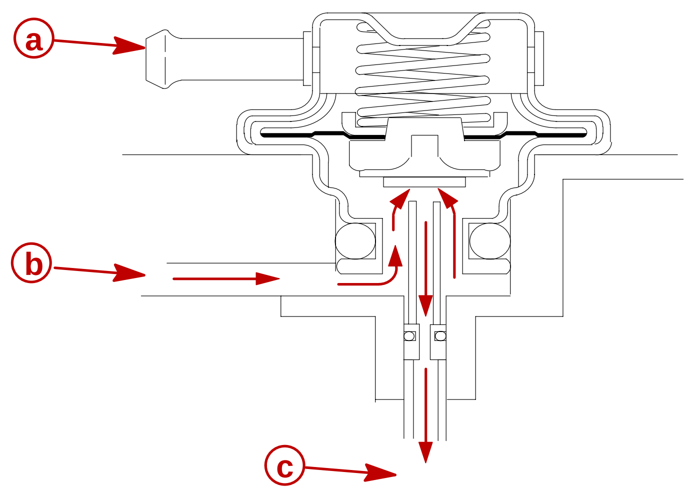
a - Fuel From Mechanical Fuel Pump
b - Inlet Needle and Float Valve
c - High Pressure Electric Fuel Pump
d - Fuel Cooler
e - Pressure Regulator
f - Fuel Outlet to Fuel Distribution Manifold

Fuel Pressure Regulator

The fuel pressure regulator mounted on top of the vapor separator maintains a stable fuel pressure between the high-pressure fuel pump and the fuel injectors. The pressure regulator consists of a spring-loaded diaphragm which actuates a valve/seat assembly. Excess fuel pressure unseats the valve returning fuel to the vapor separator tank. The excess fuel is channeled below the fuel level in the vapor separator tank through an internal pipe to prevent fuel vaporization.

The spring side of the diaphragm is vented to atmosphere allowing barometric conditions to act on the diaphragm in addition to spring pressure.

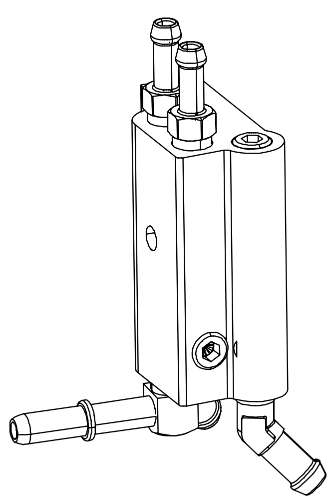




a - Vent to Atmosphere
b - High Pressure Fuel From Fuel Cooler
c - Excess Fuel Flows to VST

Fuel Cooler

A fuel cooler (heat exchanger) is attached to the vapor separator, and uses engine cooling water to cool the high-pressure fuel supply to the fuel injectors as well as a return circuit to the VST. Removing heat from the circulating high-pressure fuel prevents the formation of fuel vapors.



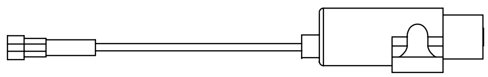
Sensors

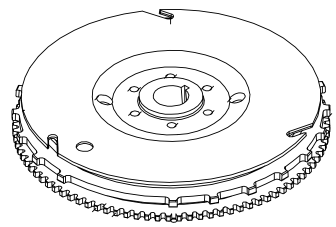
Sensors send input signals to the ECM regarding engine operating conditions.

Crank Position Sensor (CPS)

As the flywheel rotates, the CPS senses the location of the 54 teeth on the flywheel and supplies the trigger signal information to the ECM. The ECM utilizes the CPS information and determines when to trigger each ignition coil and fuel injector.

The CPS provides the ECM with crank angle position and engine speed information, which the ECM uses in determining fuel delivery and spark timing.



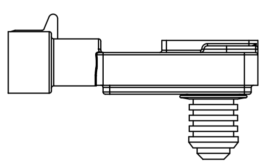


Engine Coolant Temperature (ECT) Sensor

The ETC sensor is located on the engine's exhaust cover and protrudes into the return water passage. The sensor monitors the temperature of the cooling water that has passed through the engine as controlled by the thermostat and sends signals to the ECM for processing.

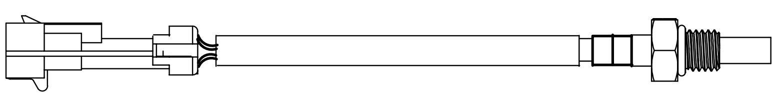
Manifold Absolute Pressure (MAP) Sensor

The MAP sensor is mounted into the intake manifold, and measures the absolute pressure within the intake manifold. This information is then used to calculate fuel delivery and spark timing.



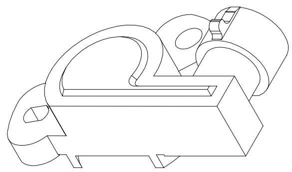
Manifold Air Temperature (MAT) Sensor

The MAT sensor is mounted into the intake manifold and measures the charge air temperature. This information is then conducted to the ECM for processing.



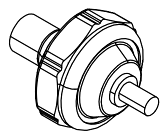
Throttle Position Sensor (TPS)

The TPS sensor is located on the throttle body and connected to the throttle shaft. It provides the ECM with throttle angle information.



Oil Pressure Switch

The oil pressure switch is located port side of the engine and protrudes into the pressurized oil galley between the oil pump and the oil filter. The sensor sends a low oil pressure signal to the ECM, which activates ignition/injection cut-off/warning horn.



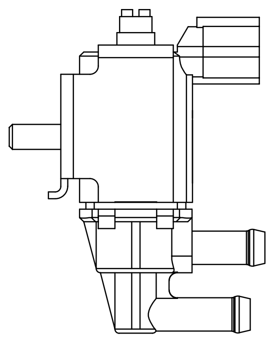
Actuators

Actuators receive input signals from the ECM and perform functions, which control air-fuel ratios, spark advance, and idle rpm.

Idle Air Control (IAC)

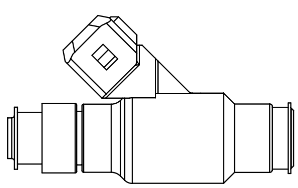
The Idle Air Control (IAC) is an electrically operated spring-loaded solenoid valve, which controls the amount of intake air that bypasses the closed throttle shutter. Signals from the ECM regulate the duty cycle that the IAC valve remains open, or (spring-loaded) closed. Duty cycle of the IAC valve ranges from 0% to 100% open. The IAC controls three operating functions:

1. Provides additional intake air (bypass) for engine start-up and allows increased idle rpm during engine warm-up.
2. Controls idle speed according to varying engine loads and running conditions.
3. Functions as an electronic dashpot by providing additional bypass air as the throttle quickly closes during a rapid deceleration, preventing engine stalling.



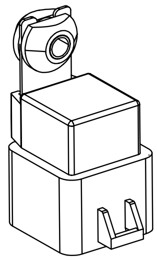
Fuel Injector

The fuel injector is an electrically operated spring-loaded solenoid, which delivers a metered amount of fuel into the intake manifold runner, just ahead of the intake valve. The injectors are electrically charged as the key switch is set to the “RUN” position. The ECM controls the injection by completing the ground circuit, lifting the solenoid, which allows high-pressure fuel to flow. The ECM then opens the ground circuit allowing the spring to close the injector and stop the fuel flow.



Main Power Relay

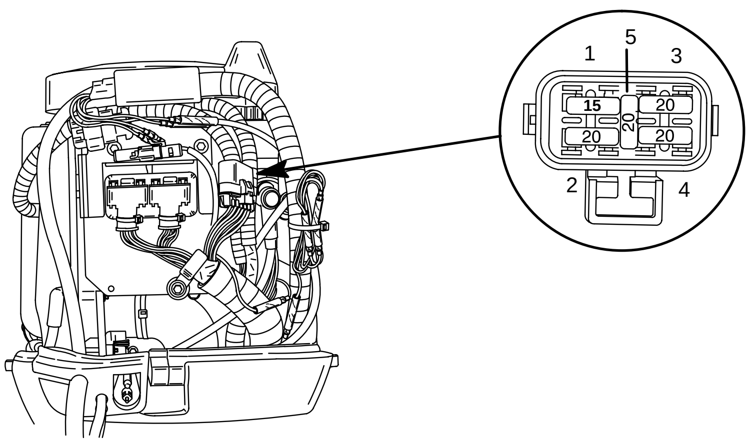
The main power relay is controlled by the ECM. It provides power to the ignition coils, idle air control, injectors, and high pressure fuel pump.



Fuse Holder Assembly

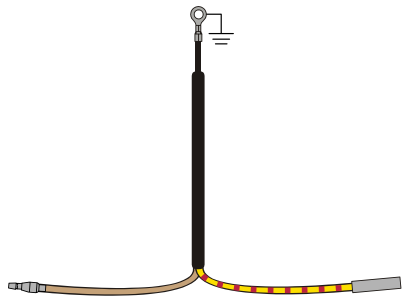
The fuse holder hold four function fuses and one spare fuse.

1. Fuse number one protects the SmartCraft wiring.
2. Fuse number two is powered by the main relay. It protects red/blue leads on the engine. This fuse provides power to the injectors, idle air control, and electric fuel pump.
3. Fuse number three protects red/purple leads on the engine, the main power relay, and key switch. When the key switch is on, the purple leads on the engine, key switch and dash gauges are also powered/protected through this fuse.
4. Fuse number four is powered by the main relay. It protects red/yellow leads on the engine. This fuse provides power to the ignition coils.
5. Fuse number 5 is a spare 20 AMP fuse.



Suppression Diode

The suppression diode is located between the brown start solenoid lead and the yellow/red key switch lead (within the engine harness), and connects to the engine ground. The purpose of the suppression diode is to eliminate the inductive spike created as the start solenoid is de-energized (key switch turned from START to RUN).



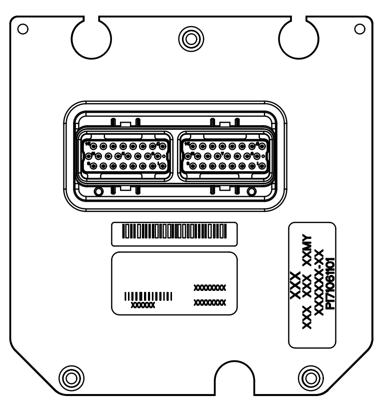
Electronic Control Module

The ECM requires 6 volts DC to operate. If the ECM should fail, the engine will stop running.

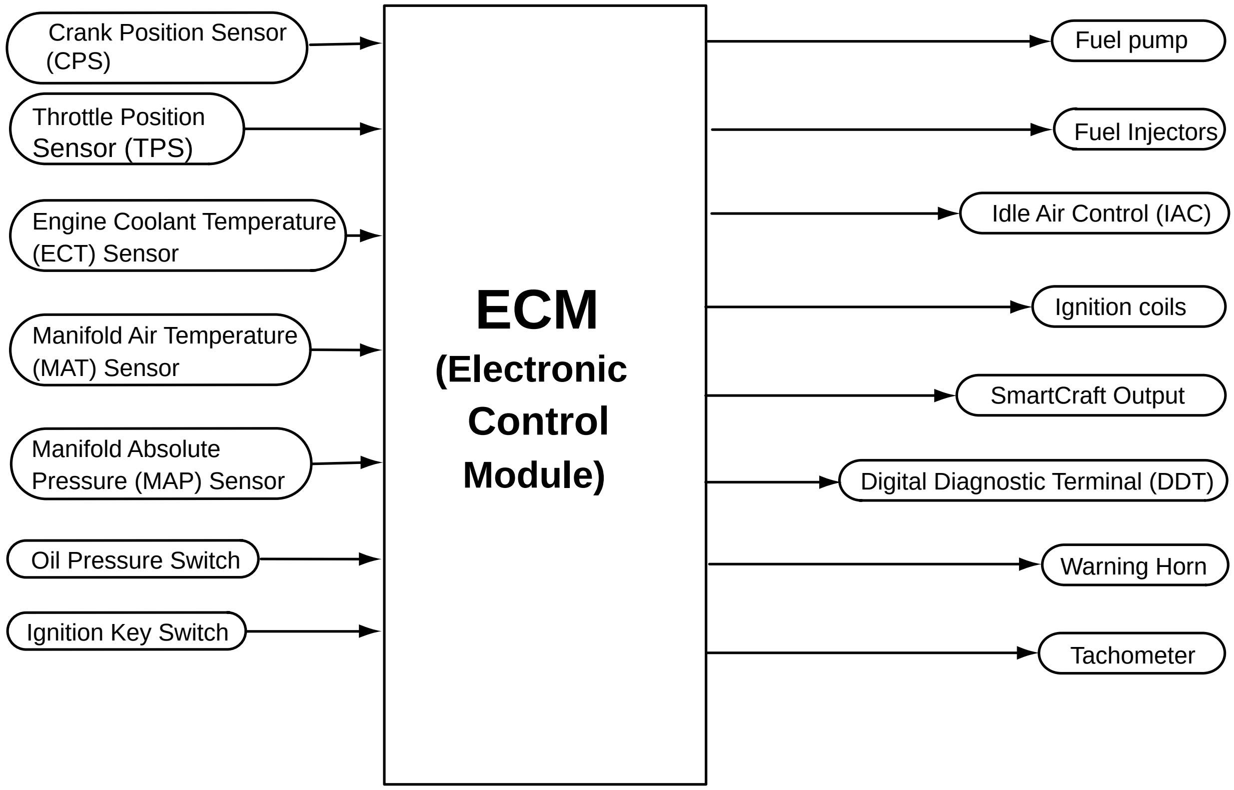
The inputs to the ECM can be monitored and tested by the Digital Diagnostic Terminal P/N 91-823686A2 and adapter harness 84-822560A5.

The ECM performs the following functions:

1. Calculates the precise fuel and ignition timing requirements based on engine speed, throttle position, manifold pressure, manifold air temperature and engine coolant temperature
2. Directly controls the ground circuit of fuel injectors, ignition coils, and idle air control
3. Indirectly controls the positive circuit of fuel injectors, ignition coils, and idle air control through the main relay
4. Controls alarm horn and warning functions
5. Controls RPM limit function
6. Records engine running information



Electronic Control Module Functions



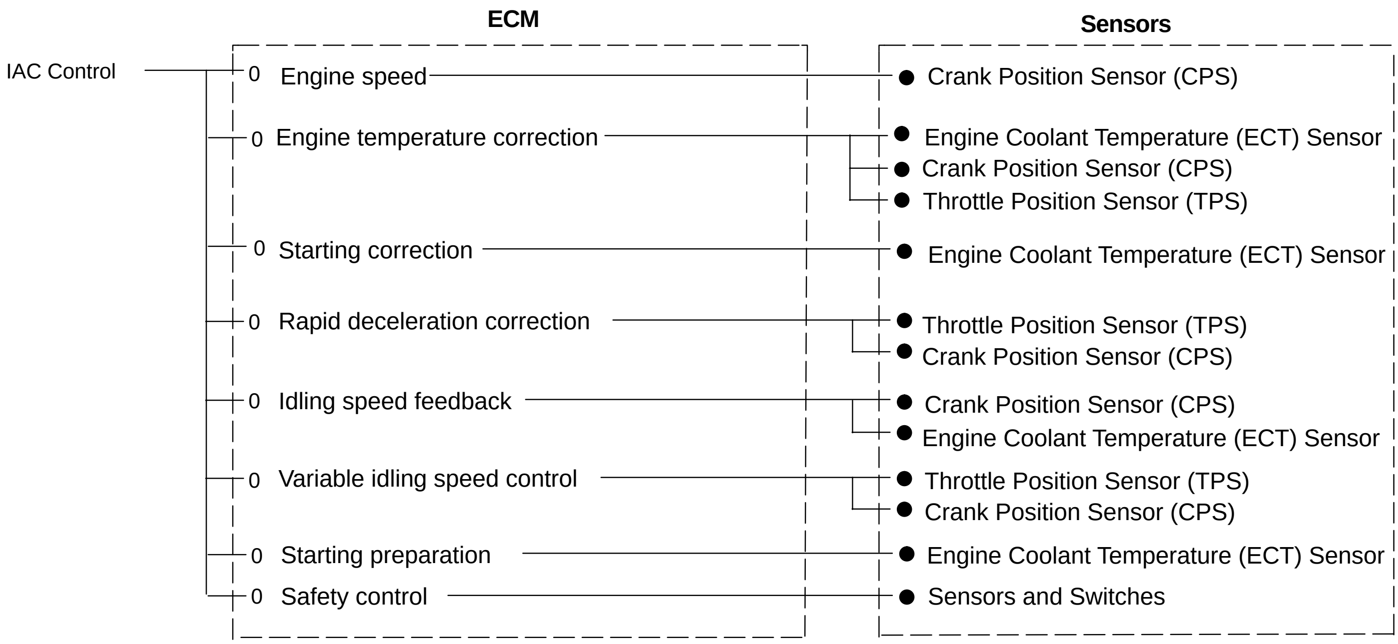
Outline of Control System

Ignition Timing Control

ECM	Sensors
Engine load / Engine speed map	Manifold Absolute Pressure (MAP) Sensor Crank Position Sensor (CPS) Manifold Air Temperature (MAT) Sensor
Engine temperature correction	Engine Coolant Temperature (ECT) Sensor
Starting correction	Engine Coolant Temperature (ECT) Sensor Crank Position Sensor (CPS)
Ignition cutoff for decreased engine speed	Crank Position Sensor (CPS) Engine Coolant Temperature (ECT) Sensor Oil Pressure Switch
Over-revolution prevention	Crank Position Sensor (CPS)
Engine cutoff	Ignition Key Switch Stop Switch
Idling stabilizer	Crank Position Sensor (CPS)
Safety control	Sensors and Switches

Fuel system

ECM	Sensors
Engine load / Engine speed map	Manifold Absolute Pressure (MAP) Sensor Manifold Air Temperature (MAT) Sensor
Engine temperature correction	Engine Coolant Temperature (ECT) Sensor
Starting correction	Engine Coolant Temperature (ECT) Sensor
Rapid acceleration correction	Throttle Position Sensor (TPS) Crank Position Sensor (CPS)
Rapid deceleration correction	Throttle Position Sensor (TPS) Crank Position Sensor (CPS)
Fuel cutoff for decreased engine speed	Crank Position Sensor (CPS) Oil Pressure Switch Engine Coolant Temperature (ECT) Sensor Battery Voltage
Over-revolution prevention	Crank Position Sensor (CPS)
Safety control	Sensors and Switches



Control and Function

	Ignition	Fuel	IAC	Function
Crank Position Sensor (CPS)	○	○	○	Detects the crankshaft position and engine speed
Throttle Position Sensor (TPS)	○	○	○	Detects the open degree of the throttle valve
Engine Coolant Temperature (ECT) Sensor	○	○	○	Detects engine temperature
Manifold Absolute Pressure (MAP) Sensor	○	○		Detects intake air pressure of the intake manifold
Manifold Air Temperature (MAT) Sensor	○	○		Detects intake air temperature
Oil Pressure Switch	○	○		Detects Oil Pressure

3
B

ELECTRONIC FUEL INJECTION

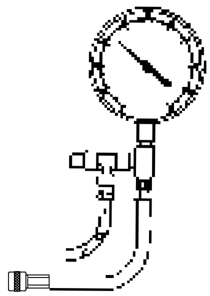
Section 3B - Troubleshooting and Diagnostics

Table of Contents

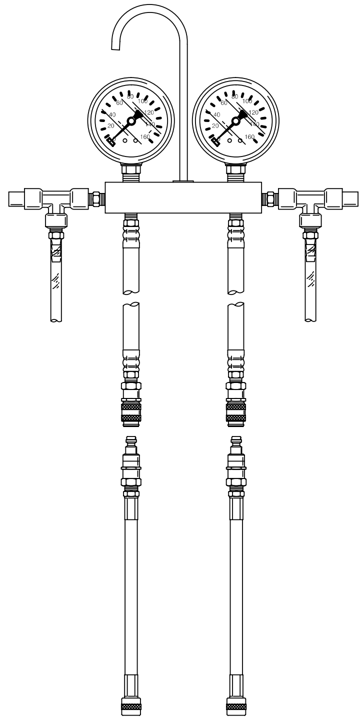
FUEL SYSTEM	**Fuel Pump Type** **Fuel Pump:** **Pressure** **Fuel Tank Capacity**	Mechanical Water Cooled (Plunger/Diaphragm) 3-6 psi Accessory
FUEL INJECTION	**Fuel Injector System** **Idle rpm (Out Of Gear)** **Idle rpm (In Forward Gear)** **Wide Open Throttle rpm (WOT)** **Range** **Fuel Pump Pressure - Electric**	Batch (1 & 4) - (2 & 3) 725 ± 25 rpm 725 ± 25 rpm 5500–6000 42-44 psi (290-303 kPa)

Special Tools

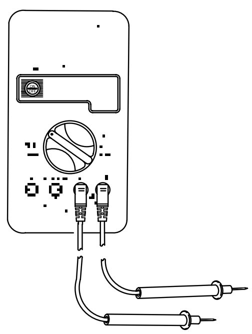
1. Fuel Pressure Gauge 91-16850A7 or Fuel Pressure Gauge 91-852087A3.



91-16850A7

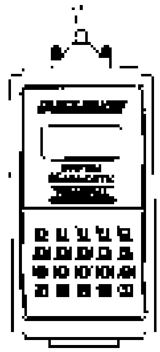


2. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1

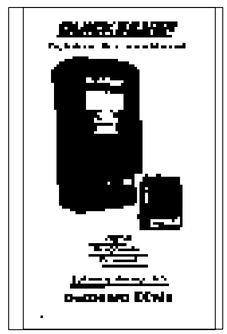


3. Cartridge 91-880118--2

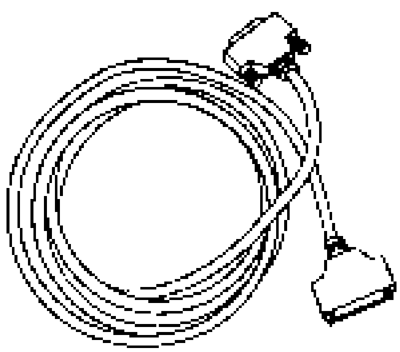
4. Digital Diagnostic Tester 91-823686A2



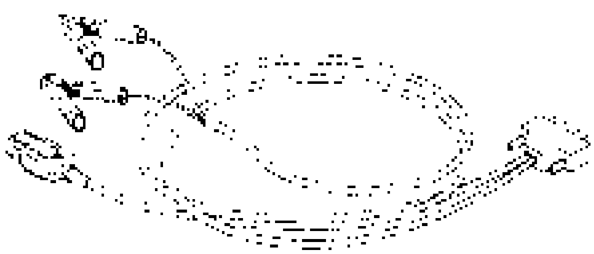
5. DDT Reference Manual 90-881204--2



6. DDT Cable 10’ (3.05m) Extension 84-825003A1



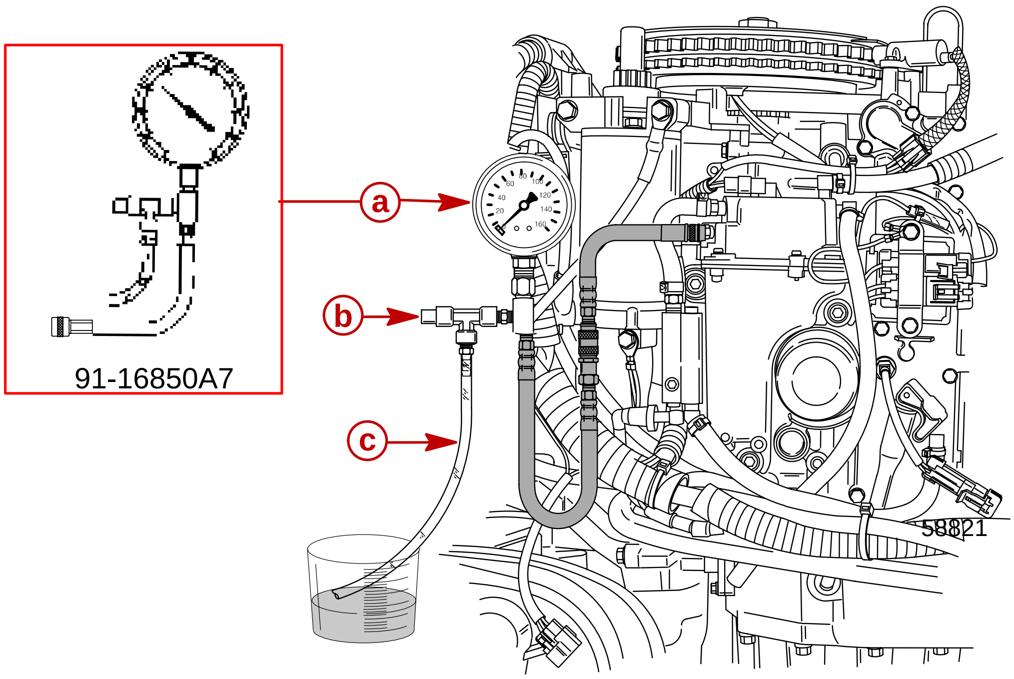
7. DDT Test Harness 84-822560A5



EFI System Diagnostic Procedures

Pressure Regulator Test

1. Install the fuel pressure gauge onto the pressure check valve (located on the VST).
2. Start the engine. Fuel pressure should be within specification.



a - Fuel Pressure Gauge
b - Pressure Relief Button
c - Drain Hose

Mechanical Fuel Pump Test

Checking for Restricted Fuel Flow Caused by Anti-Siphon Valves

While anti-siphon valves may be helpful from a safety stand-point, they clog with debris, they may be too small, or they may have too heavy a spring. Summarizing, the pressure drop across these valves can, and often does, create operational problems and/or powerhead damage by restricting fuel to the fuel pump and VST. Some symptoms of restricted (lean) fuel flow, which could be caused by use of an anti-siphon valve, are:

1 - Loss of fuel pump pressure
2 - Loss of power
3 - High speed surging
4 - Preignition/detonation (piston dome erosion)
5 - Outboard cuts out or hesitates upon acceleration
6 - Outboard runs rough
7 - Outboard quits and cannot be restarted
8 - Outboard will not start
9 - Vapor lock

Since any type of anti-siphon device must be located between the outboard fuel inlet and fuel tank outlet, a simple method of checking [if such a device (or bad fuel) is a problem source] is to operate the outboard with a separate fuel supply which is known to be good, such as a remote fuel tank.

If, after using a separate fuel supply, it is found that the anti-siphon valve is the cause of the problem, there are 2 solutions to the problem; either 1) replace the anti-siphon valve with one that has lighter spring tension or 2) replace it with a solenoid-operated fuel shut off valve.

Vacuum (Lift) Test

Fuel system vacuum can be checked using a short piece of extra fuel hose, vacuum gauge, and a “TEE” fitting.

1. Conduct test with water to the engine cooling system using one of the following methods:
   - In a test tank.
   - With boat/outboard lower unit in water
2. Disconnect fuel hose from inlet fitting of mechanical fuel pump.
3. Connect extra fuel hose onto the inlet fitting of pump.
4. Install “TEE” fitting into extra hose making connection as close to pump as possible.
5. Connect vacuum gauge and fuel inlet hose onto “TEE” fitting.
6. Start engine and run at 1000 RPM, normal fuel system vacuum (lift) should be to specifications.

NOTE: *The system vacuum test is normally performed at 1000 RPM. As engine RPM is increased there will be a slight increase in vacuum; this increase should not exceed normal readings.*

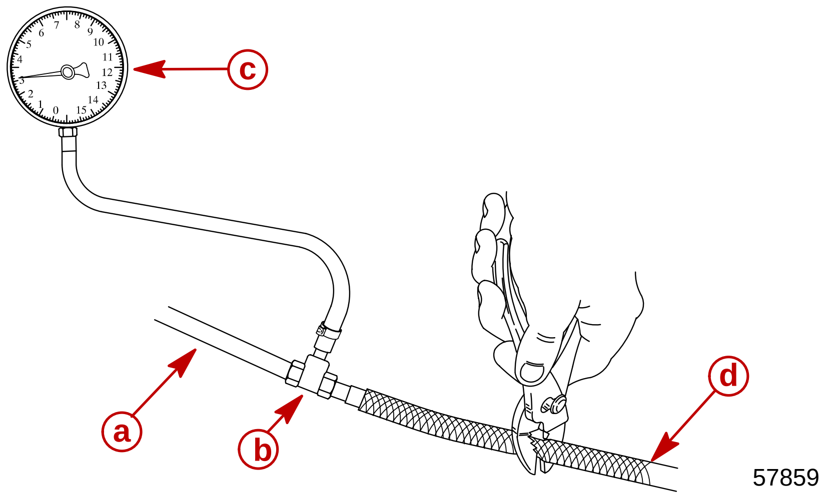
Normal Fuel System Vacuum (Lift) @ 1000 RPM
1 – 2 in. Hg (25 – 50 mm Hg)

7. To isolate the mechanical fuel pump from the rest of the fuel system:
   a. Pinch off/restrict the fuel supply hose between the vacuum gauge and the fuel tank.
   b. The mechanical fuel pump vacuum (lift) should be to specifications.
   c. If vacuum reading for the pump is below specifications, the pump needs rebuilding.

Mechanical Fuel Pump Vacuum (Lift) @ 1000 RPM
4 in. Hg (101.6 mm Hg)

8. If vacuum reading is not within specifications, refer to "Vacuum (Lift) Troubleshooting" table.
9. Stop engine, remove gauge, and reconnect fuel line to inlet fitting of fuel pump.

The fuel pump is designed to lift fuel (vertically) about 60 in. (1524 mm) if there are no other restrictions in the system using a fuel hose that is 5/16 in. (7.9 mm) minimum diameter. As restrictions are added, such as filters, fittings, valves etc., the amount of fuel pump lift decreases.



a - Extra Hose - To Inlet Fitting of Mechanical Fuel Pump
b - "TEE"-fitting
c - Vacuum Gauge
d - Fuel Supply Hose - From Fuel Tank

Vacuum (Lift) Troubleshooting		
Condition	**Cause**	**Correction**
Fuel system vacuum (lift) above specification	Restricted anti-siphon valve	Refer to “Checking for Restricted Fuel Flow caused by Anti-Siphon Valves” preceding
	Plugged fuel tank pick-up screen	Clean/replace fuel pick-up screen
	Pinched/collapsed fuel hose	Inspect/replace fuel hose(s)
	Dirty/plugged water separating fuel filter	Clean/replace water separating fuel filter
	Restriction in fuel line thru-hull fitting	Clean/replace fitting
	Restriction in fuel tank switching valve	Clean/replace valve
	Restriction within primer bulb	Rebuild/replace primer bulb
Fuel system vacuum (lift) below specifications	Low fuel level in fuel tank	Fill tank with fuel
	Hole/cut in pick-up tube of fuel tank	Replace fuel pick-up tube
	Loose fuel line connection	Check/tighten all connections
	Hole/cut is fuel line	Inspect/replace fuel hose(s)
	Loose fuel pump screws	Torque screws to specification
	Fuel pump gasket(s) worn or leaking	Rebuild/replace fuel pump
	Fuel pump check valves/seals leaking	Rebuild/replace fuel pump
	Leaky fuel pump diaphragm	Rebuild/replace fuel pump
	Worn/broken fuel pump springs	Rebuild/replace fuel pump
	Leaky fuel pump seals	Rebuild/replace fuel pump
	Fuel filter bowl loose	Tighten fuel filter bowl
	Fuel filter gasket cut/worn	Replace gasket
	Fuel vaporization	Check for plugged fuel pump water cooling circuit

Pressure Test

Fuel system pressure/trouble shooting can be performed using piece of clear fuel hose 4 in. (10 cm) long, a pressure gauge, and a “TEE” fitting.

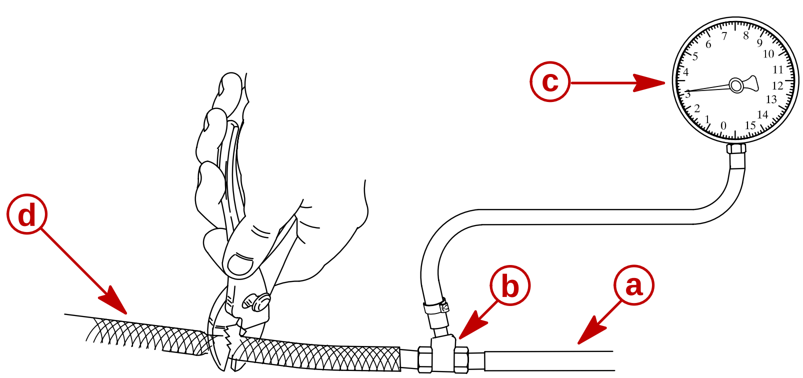
1. Conduct test with water to the engine cooling system using one of the following methods:
   - In a test tank
   - With boat/outboard lower unit in water
2. Disconnect fuel hose from outlet fitting of mechanical fuel pump.
3. Connect clear fuel hose onto the inlet fitting of pump.
4. Install “TEE” fitting onto clear fuel hose.
5. Connect pressure gauge and fuel outlet hose (to VST) onto “TEE” fitting.
6. Start engine and run at 1000 RPM, normal fuel system pressure should be to specifications.

Normal Fuel System Pressure @ 1000 RPM
Pressure should exceed 2 psi (13.7 kPa)

7. To isolate the mechanical fuel pump from the rest of the fuel system:
   a. Pinch off/restrict the fuel hose between the “TEE” fitting and the VST.
   b. The mechanical fuel pump pressure should be to specifications.
   c. If pressure reading for the pump is below specifications, the pump needs rebuilding.

Mechanical Fuel Pump Pressure @ 1000 RPM
Pressure should exceed 3 psi (20.7 kPa)

8. If fuel pressure reading is below specifications, refer to “Fuel Pressure Troubleshooting” table.
9. Stop engine, remove gauge/clear hoses and reconnect fuel line to outlet fitting of fuel pump.



a - Clear Hose - From Mechanical Fuel Pump Outlet to “Tee” Fitting
b - “TEE”-fitting
c - Fuel Pressure Gauge
d - Fuel Hose - To VST

Fuel Pressure Troubleshooting		
Condition	**Cause**	**Correction**
Fuel system pressure below specification	Restricted anti-siphon valve	Refer to "Checking for Restricted Fuel Flow caused by Anti-Siphon Valves" preceding
	Low fuel level in fuel tank *	Fill tank with fuel
	Plugged fuel tank pick-up screen	Clean/replace fuel pick-up screen
	Hole/cut in pick-up tube of fuel tank *	Replace fuel pick-up tube
	Loose fuel line connection *	Check/tighten all connections
	Hole/cut in fuel line *	Inspect/replace fuel hose(s)
	Fuel line primer bulb check valves not opening	Replace fuel line primer bulb
	Fuel hose/line internal diameter too small	Use 5/16 in. (8mm) fuel hose
	Restriction in fuel line thru-hull fitting	Clean/replace fitting
	Restriction in fuel tank switching valve	Clean/replace valve
	Restriction within primer bulb	Rebuild/replace primer bulb
	Pinched/collapsed fuel hose	Inspect/replace fuel hose(s)
	Dirty/plugged water separating fuel filter	Clean/replace water separating fuel filter
	Fuel filter bowl loose *	Tighten fuel filter bowl
	Fuel filter gasket cut/worn *	Replace gasket
	Loose fuel pump screws *	Torque screws to specification
	Fuel pump gasket(s) worn or leaking *	Rebuild/replace fuel pump
	Fuel pump check valves/seals leaking	Rebuild/replace fuel pump
	Leaky fuel pump diaphragm *	Rebuild/replace fuel pump
	Worn/broken fuel pump springs	Rebuild/replace fuel pump
	Leaky fuel pump seals	Rebuild/replace fuel pump
	Fuel vaporization	Check for plugged fuel pump water cooling circuit

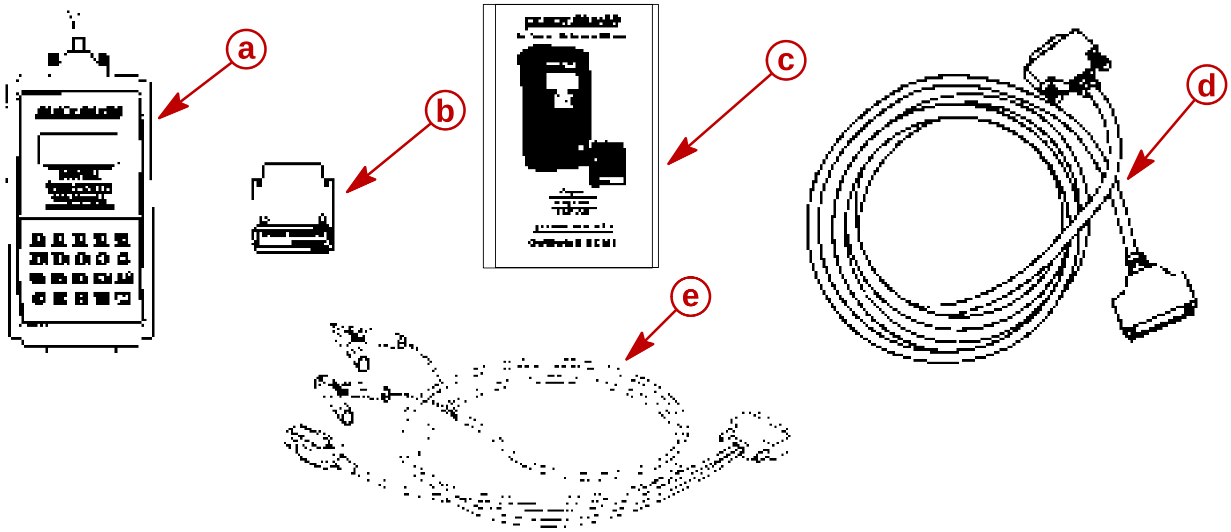
NOTE: * Air bubbles may also be visible as fuel passes through the clear fuel (test) hose installed between the mechanical fuel pump outlet fitting and the VST.

EFI System Troubleshooting

The ECM is designed such that if a sensor fails the ECM will compensate so that the engine does not go into an over-rich condition. Because of this, disconnecting a sensor for troubleshooting purposes may have no noticeable effect.

Using the Digital Diagnostical Terminal (DDT)

IMPORTANT: Any sensor that is disconnected while the engine is running will be recorded as a fault in the ECM Fault History. Use the DDT to view and clear the fault history when troubleshooting/repair is completed.



a - Digital Diagnostic Terminal (91-823686A2)
b - Software Cartridge (91-880118--2)
c - DDT Reference Manual (90-881204--2)
d - DDT Cable 10ft. (3.05m) Extension (84-825003A1)
e - Adaptor Harness (84-822560A5)

The Quicksilver Digital Diagnostic Terminal (DDT) has been developed specifically to help technicians diagnose and repair Mercury Marine 2 and 4 cycle engines.

Attach the diagnostic cable to the ECM diagnostic connector and plug in the software cartridge. You will be able to monitor sensors and ECM data values including status switches. The ECM program can help diagnose intermittent engine problems. It will record the state of the engine sensors and switches for a period of time and then can be played back to review the recorded information.

Refer to the Digital Diagnostic Terminal Reference Manual for complete diagnostic procedures.

DDT Functions – 4-Stroke EFI Models
Software Version 1.2 (P/N 91-880118-2)

SmartCraft Monitor
1 – Mercury Marine
2 – Tool Setup

THIS ENGINE IS A
xx MY EFI xxx HP xxxcc
PRESS 1 to CONTINUE

Select Function:
1 - AUTO SELF TEST
2 - MANUAL TEST

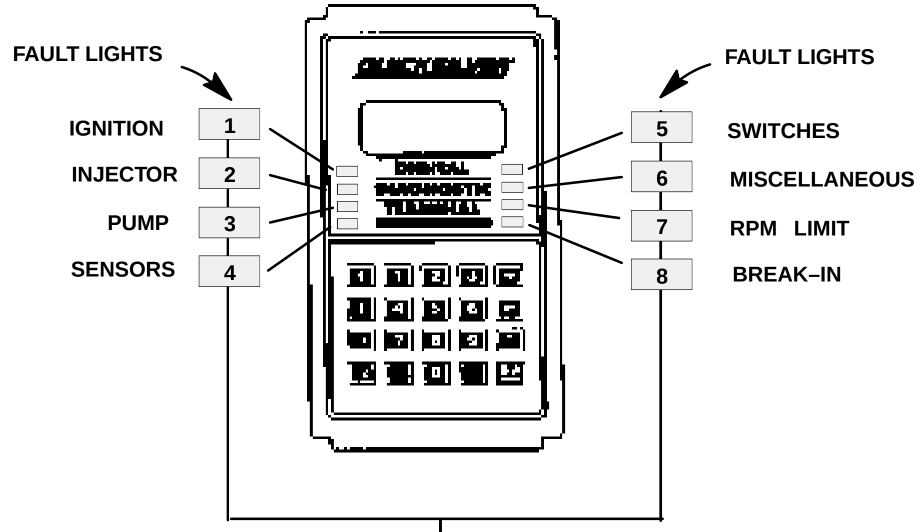
Select Auto Test:
1 – STATIC TEST

Select Function:
1 - DATA MONITOR
2 - FAULT STATUS
3 - SYSTEM INFO
4 - HISTORY
5 - SPECIAL FUNCTIONS

ENGINE RPM
BATTERY VOLTS
PWR 1 VOLTS
MAP PSI
TRIGGER ERR
AVAILABLE PWR %
IAC PWM %
SPARK ANG _TDC
ECT °F
TPS 1 VOLTS
TPS %
MAT °F

02MY EFI xx HP 995cc
ECM #859613-X
CODE
SPARK PLUG
CHAMPION RA8HC
GAP 0.040 (1 mm)
FIRING ORDER
1 - 3 - 4 - 2
BATV 12.6 - 15.0
IGNITION TIMING:
IDLE ECM CONTROL
1500 - 1800 14° BTDC
6000 RPM 28° BTDC
STATOR
0.2 - 0.3 ohm
CPS 300 - 500 ohm
IGN SEC 3 - 7 K ohm
FINJ 10.0 - 13.5 ohm
PWR RLY 81 - 99 ohm
IAC 24 - 30 ohm
MAT/ECT
10 K ohm @ 77F/25C
RPM LIMIT 6200
PROP RPM 5500 - 6000
TYPICAL TPS RANGE
TPI 0.39 - 1.00v IDLE
3.66 - 4.80v WOT
MAP 3.5 - 15 psi
24 - 103 kPa
FUEL 42 - 44 psi
290 - 303 kPa
1 FUSE - BUS +12 V
2 FUSE - INJ/IAC/PMP
3 FUSE - MAIN RELAY
4 FUSE - IGN COIL
OVERTEMP/LOW OIL
PRESSURE LIMITS
ARE CONTROLLED BY
ENGINE GUARDIAN

Any fault will turn on fault light. Refer to Fault Status to identify fault



Fault Status List

MAT INPUT HI or LO	Manifold Air Temperatrure (engine) sensor input is high or low
BATT VOLT HI or LOW	Battery voltage is high or low
ECT INPUT HI or LO	Engine Coolant Temperature sensor input is high or low
EST 1 thru 4 SHORT or OPEN	Electronic spark trigger signal (1 thru 4) is short or open circuit
FINJ 1 thru 4 SHORT or OPEN	Fuel injector (1 thru 4) is short or open circuit
GUARDIAN	Guardian system activated
MAP INPUT HI or LO	MAP sensor input high or low
MPRLY BACKFEED	Main Power Relay is Receiving a Current Back feed
MPRLY OUTPUT	Main Power Relay Output
OVERSPEED	Overspeed is activated
COOL TMP OVRHT	Engine overheat
TPS1 CKT HI or LO	TPS #1 sensor input is high or low
TPS1 NO ADAPT	ECM is unable to adapt to the current position of the TPS
TPS1 RANGE HI or LO	TPS #1 is above or below the allowable range
WARNING HORN	Warning horn fault

Select Function:
1 - FAULT HISTORY
2 - RUN HISTORY
3 - CLEAR FAULT HIST
4 - CLEAR RUN HIST

Select Fault Hist:
1 – FREEZE FRAME
2 – FAULT SECONDS

FREEZE FRAME BUFFERS
0 thru 9
Note: Select Desired Buffer

FREEZE FRAME BUFFERS
Selected Buffer: x - xxxxx
BARO PSI
BATT VOLTS
BLOCK PSI
BOAT SPEED
AIR TMP °F
COOL TMP °F
DEMAND %
ENGINE RPM
ENGINE STATE
FPC TOTAL
FREQ COUNTER
FUEL LEVEL %
SHIFT
LAKE/SEA TMP °F
LOAD%
MPRLY REQ
MAP PSI
OIL LEVEL %
PORT TAB POS
AVAILABLE PWR %
RUN TIME
STAR TAB POS
TPI %
TRIM POSITION

FAULT SECONDS
BATT VOLT HIGH
BATT VOLT LOW
BLOCK PSI LOW
COMP OVERHEAT
ETC MOTOR OPEN
ETC MOTOR SHORT
FUEL PSI IN HI
FUEL PSI IN LO
GUARDIAN
KNOCK SENS1
KNOCK SENS2
OIL PSI STR
OIL REMOTE STR
OIL RESERVE STR
MAP INPUT HI
MAP INPUT LO
MAP IDLE CHECK
OIL PUMP
OVERSPEED
PORT OVERHEAT
STAR OVERHEAT
WARNING HORN
H2O IN FUEL

RUN TIME HR.
RPM 0 – 799
RPM 800 – 1499
RPM 1500 – 1999
RPM 2000 – 2999
RPM 3000 – 3999
RPM 4000 – 4499
RPM 4500– 4999
RPM 5000 – 5999
RPM 6000 +
BREAK-IN LEFT
RPM LIMIT Sec
GRD LIMIT Sec
CTS TMP Sec

Select Function:
1 - OIL PUMP PRIME
2 - CYLINDER MISFIRE
3 - OUTPUT LOAD TEST
4 - RESET BREAK-IN OIL
5 - CHANGE FUEL OFFSET
6 - ENGINE LOCATION
7 - TRIM LIMIT

Select Load Test:
1 - IGNITION
2 - FUEL INJECTOR
3 - DIRECT INJECTOR
4 - OIL PUMP
5 - FUEL PUMP
6 - HORN
7 - MISCELLANEOUS
   1 - IDLE AIR CONTROL
8 - TACHOMETER
9 - RELAYS
   1 - MAIN POWER RELAY
   2 - FUEL PUMP RELAY

Troubleshooting Without Digital Diagnostic Terminal

Troubleshooting without the DDT is limited to checking resistance on some of the sensors.

Typical failures usually do not involve the ECM. Connectors, set-up, and mechanical wear are most likely at fault.

- Verify spark plug wires are securely installed (pushed on) on the coil tower.
- The engine may not run or may not run above idle with the wrong spark plugs installed.
- Swap ignition coils to see if the problem follows the coil or stays with the particular cylinder.

NOTE: *ECMs are capable of performing a cylinder misfire test to isolate problem cylinders. Once a suspect cylinder is located, an output load test on the ignition coil or fuel injector can be performed using the DDT.*

- Any sensor or connection can be disconnected and reconnected while the engine is operating without damaging the ECM. Disconnecting the crank position sensor will stop the engine.

IMPORTANT: Any sensor that is disconnected while the engine is running will be recorded as a Fault in the ECM Fault History. Use the DDT to view and clear the fault history when troubleshooting/repair is completed.

- If all cylinders exhibit similar symptoms, the problem is with a sensor or harness input to the ECM.
- If problem is speed related or intermittent, it is probably connector or contact related. Inspect connectors for corrosion, loose wires or loose pins. Secure connector seating; use dielectric compound 92-823506-1.
- Inspect the harness for obvious damage: pinched wires, chaffing.
- Secure grounds and all connections involving ring terminals (coat with Liquid Neoprene 92-25711--3).
- Check fuel pump connections and fuel pump pressure.

Guardian Protection System

The guardian protection system monitors critical engine functions and will reduce engine power accordingly in an attempt to keep the engine running within safe operating parameters.

IMPORTANT: The Guardian System cannot guarantee that powerhead damage will not occur when adverse operating conditions are encountered. The Guardian System is designed to (1) warn the boat operator that the engine is operating under adverse conditions and (2) reduce power by limiting maximum rpm in an attempt to avoid or reduce the possibility of engine damage. The boat operator is ultimately responsible for proper engine operation.

Warning Horn/Guardian System Operation		
Sound	**Condition**	**Description**
One Beep on key up	Normal	System Test
Six Beeps on key up, or during a running failure.	Failure detected with MAP, MAT *, TPS, or Flash Check Sum (ECM)	Engine should run well however, service will be required.
Three Beeps every 4 Minutes.	Failure detected with: • Battery Voltage * • EST *- Open detected at key up. Short detected with engine running • Fuel Injector - Detected while cranking/running * • Coolant Sensor * • IAC **	Engine will start hard, run rough and/or stall. Utilizing the neutral fast idle feature may assist starting. Service is required.
Intermittent Beeps	Failure detected with: • Fuel Pump - May start momentarily ** • Main Power Relay - No start ** • ECM Reference Voltage to MAP/TPS - Starts but stalls under load	Engine may or may not start. If engine starts it easily stalls. Service is required.
Continuous	Engine Overheat	Engine Guardian System is activated. Power limit will vary with level of overheat. Stop engine and check water intake for obstruction. Advancing throttle above idle may provide additional cooling.
	Low Oil Pressure	Guardian System is activated. Engine power is limited to 10% of maximum. Stop engine and check oil level. Add oil if necessary.
	Battery Voltage Less Than 10v or More Than 16v	Engine Guardian System is activated. Engine power is limited to 75% of maximum.
	Coolant Sensor Failure	Engine Guardian System is activated. Engine power is limited to 50% of maximum. Engine overheat protection is compromised.
	Engine Speed Limiter	Exceeding 6200 rpm cuts spark/injection on cylinders #2 and #3 to reduce engine speed. Exceeding 6350 rpm cuts spark/injection on all cylinders to reduce engine speed.

* Horn Beeps once on key up, plus failure code.

** Sticky Fault requires key off to reset.

EFI System Troubleshooting Guide

IMPORTANT: In all instances check wiring harness integrity (especially ground connections) in boat and on engine.

Condition	Cause/Fault	Warning Mode	Check
Engine cranks but will not start	Lanyard stop switch is in the "OFF" position	None	Set lanyard stop switch to "RUN"
	Weak battery or bad starter motor. Battery voltage drops below 8 volts while cranking (ECM cuts out below 6 volts) (Fuel pump requires 8 volts).	3 Beeps every 4 minutes for low battery voltage.	Check condition of battery/starter solenoid terminals and cables. Charge/replace battery. Inspect condition of starter motor.
	Blown Fuse	None	Replace fuse. Inspect engine wiring harness and electrical components. Fuse #2 - Fuel Injectors/IAC/Fuel Pump Fuse #3 - Main Power Relay/Accessory Fuse #4 - Ignition Coils
	Main Power Relay	Intermittent Beeps	Listen for relay to "click" when key switch is turned to "ON" 81 - 99 ohms Between pin #22 (YEL/PUR) of port ECM connector and (RED/BLU) wire of fuse #3 (fuse removed) - or - Between pin #85 and pin #86 of relay
	Crank Position Sensor (CPS)	None Note: No rpm reading at tachometer	300 – 350 ohms Between pin #5 (RED) and pin #6 (WHT) of starboard ECM connector. - or - Between pin #1 (RED) and pin #2 (WHT) of CPS connector.
	Electric fuel pump	Intermittent Beeps	Listen for pump. Fuel pump should run 2 seconds after key switch is turned to "RUN" position. 32 - 41 ohms Between pin #19 (BLK/BLU) and pin # 23 (RED/BLU) - or - Between pins of fuel pump connector.
	Flywheel misaligned	None	Remove flywheel and inspect flywheel key/key way
	Engine Coolant Temperature (ECT) sensor	3 Beeps every 4 minutes	See ECT sensor resistance chart - Section 3B "ELECTRONIC FUEL INJECTION". Advancing the remote control fast idle feature or advancing the tiller handle throttle grip half way may assist starting.

IMPORTANT: In all instances check wiring harness integrity (especially ground connections) in boat and on engine.

Condition	Cause/Fault	Warning Mode	Check
Engine cranks, starts and stalls	Remote control to engine wiring harness connection is poor	None	Clean and inspect male and female connections.
	Air in fuel system/lines	None	Crank and start engine several times.
	Manifold Absolute Pressure (MAP) sensor	6 Beeps at key up or failure	See MAP sensor resistance chart - Section 3B “ELECTRONIC FUEL INJECTION”.
	Throttle Position Sensor (TPS)	6 Beeps at key up or failure	Typical TPI range with DDT: Idle 0.39-1.0 volts, WOT 3.66-4.80 volts.
	Idle Air Control (IAC)	3 Beeps every 4 minutes	20 - 24 ohms Between pin #20 (WHT/ORG) and pin #23 (RED/BLU) of starboard ECM connector. - or - Between pin A and pin B of IAC.
	ECM reference voltage to MAP/TPS	Intermittent Beeps	5 volts Between PUR/YEL pin of MAP sensor wiring harness connector and engine ground (key switch to “RUN”).
	Fuel pressure at VST fitting	None	See fuel pressure test - Section 3B “ELECTRONIC FUEL INJECTION”.
	Flywheel misaligned	None	Remove flywheel and inspect flywheel key and key way
Engine Idles Fast after warm-up (900-1100rpm)	Engine Coolant Temperature (ECT) sensor	3 Beeps every 4 minutes	See ECT sensor resistance chart - Section 3B “ELECTRONIC FUEL INJECTION”.
Poor off idle or WOT running quality	Fuel injector	3 Beeps every 4 minutes	10.0 - 13.5 ohms Between fuel injector pin #1 and pin #2. - or - Between (removed) fuse #2 (RED/BLU) wire and port ECM connector: Pin #17 (PNK/BRN) Fuel Injector #1 Pin #2 (PNK/RED) Fuel Injector #2 Pin #1 (PNK/ORG) Fuel Injector #3 Pin #18 (PNK/YEL) Fuel Injector #4
	Ignition coil (EST) ***	3 Beeps every 4 minutes	See ignition coil resistance chart - Section 2A “IGNITION”
	Fuel pressure at VST fitting	None	See fuel pressure test - Section 3B “ELECTRONIC FUEL INJECTION”.
	Fuel filter plugged	None	Replace fuel filter
	Improper spark plugs	None	Use recommended resistive spark plugs
	Loose grounds	None	Check all ground connections.
	Flywheel timing tooth pattern	None	Check tooth pattern for partially missing or damaged teeth
	Fouled spark plug(s)	None	Replace spark plug(s).

IMPORTANT: In all instances check wiring harness integrity (especially ground connections) in boat and on engine.

Condition	Cause/Fault	Warning Mode	Check
Poor idle quality	Crank Position Sensor (CPS)	None	300 - 350 ohms Between pin #5 (RED) and pin #6 (WHT) of starboard ECM connector. - or - Between pin #1 (RED) and pin #2 (WHT) of CPS connector.
	Manifold Absolute Pressure (MAP) sensor	6 Beeps at key up or failure	See MAP sensor resistance chart - Section 3B “ELECTRONIC FUEL INJECTION”.
	Throttle Position Sensor (TPS)	6 Beeps at key up or failure	Typical TPI range with DDT: Idle 0.39-1.0 volts, WOT 3.66-4.80 volts.
	Engine Coolant Temperature (ECT) sensor	3 Beeps every 4 minutes	See ECT sensor resistance chart - Section 3B “ELECTRONIC FUEL INJECTION”.
	Manifold Air Temperature (MAT) sensor	6 Beeps at key up or failure	See MAT sensor resistance chart –- Section 3B “ELECTRONIC FUEL INJECTION”.
	Fuel injector	3 Beeps every 4 minutes	10.0 - 13.5 ohms Between fuel injector pin #1 and pin #2. - or - Between (removed) fuse #2 (RED/BLU) wire and port ECM connector: Pin #17 (PNK/BRN) Fuel Injector #1 Pin #2 (PNK/RED) Fuel Injector #2 Pin #1 (PNK/ORG) Fuel Injector #3 Pin #18 (PNK/YEL) Fuel Injector #4
	Ignition coil (EST) ***	3 Beeps every 4 minutes	See ignition coil resistance chart - Section 2A “IGNITION”
	Idle Air Control (IAC)	3 Beeps every 4 minutes	20 - 24 ohms Between pin #20 (WHT/ORG) and pin #23 (RED/BLU) of starboard ECM connector. - or - Between pin A and pin B of IAC.
	Fuel pressure at VST fitting.	None	See fuel pressure test - Section 3B “ELECTRONIC FUEL INJECTION”.
	Loose grounds	None	Check all ground connections.
	Fouled spark plug(s)	None	Replace spark plug(s).

*** The ECM will only monitor the EST connection to the ignition coil, use resistance tests and/or spark gap test to confirm an ignition coil failure.

IMPORTANT: In all instances check wiring harness integrity (especially ground connections) in boat and on engine.

Condition	Cause/Fault	Warning Mode	Check
Engine runs rich	Fuel pressure regulator	None	42 - 44 psi (290 – 303 kPa) at VST fitting - Section 3B "ELECTRONIC FUEL INJECTION"
	Engine Coolant Temperature (ECT) Sensor	3 Beeps every 4 minutes	See ECT sensor resistance chart - Section 3B Electronic Fuel Injection
	Thermostat stuck open	None	Remove and inspect thermostat. Section 4A "CYLINDER HEAD"
Speed Reduction Engine RPM Limited to 2000	Low oil pressure or grounded oil pressure switch lead	GUARDIAN Continuous Horn Above 10% Power Setting	Check engine oil level and add oil as needed. Remove oil pressure switch and install oil pressure gauge, (warm engine) oil pressure should be: Above 2.9 psi (20.0 kPa) at idle 30-40 psi. (207-278 kPa) at 3000 rpm. See Oil Pressure Switch test - Section 4B "Cylinder Block/Crankcase". Check for short between pin #7 (BLU) of starboard ECM connector and open connector of oil pressure switch.
Speed Reduction Engine RPM Limited	Engine Overheat	GUARDIAN Continuous	Engine Guardian System is activated. Power limit will vary with level of overheat. Stop engine and check water intake for obstruction. Advancing throttle above idle may provide additional cooling.
	Battery Voltage Less Than 10v or More Than 16v	GUARDIAN Continuous Horn Above 75% Power Setting	Engine Guardian System is activated. Engine power is limited to 75% of maximum.
	Engine Coolant Temperature (ECT) Sensor Failure	GUARDIAN Continuous Horn Above 50% Power Setting	Engine Guardian System is activated. Engine power is limited to 50% of maximum. Engine overheat protection is compromised

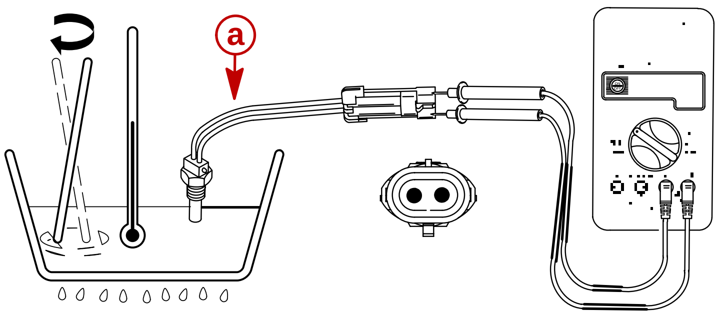
Component Resistance Tests

NOTE: *Refer to section* ***1C General Information*** *(powerhead reference views) for location of sensors.*

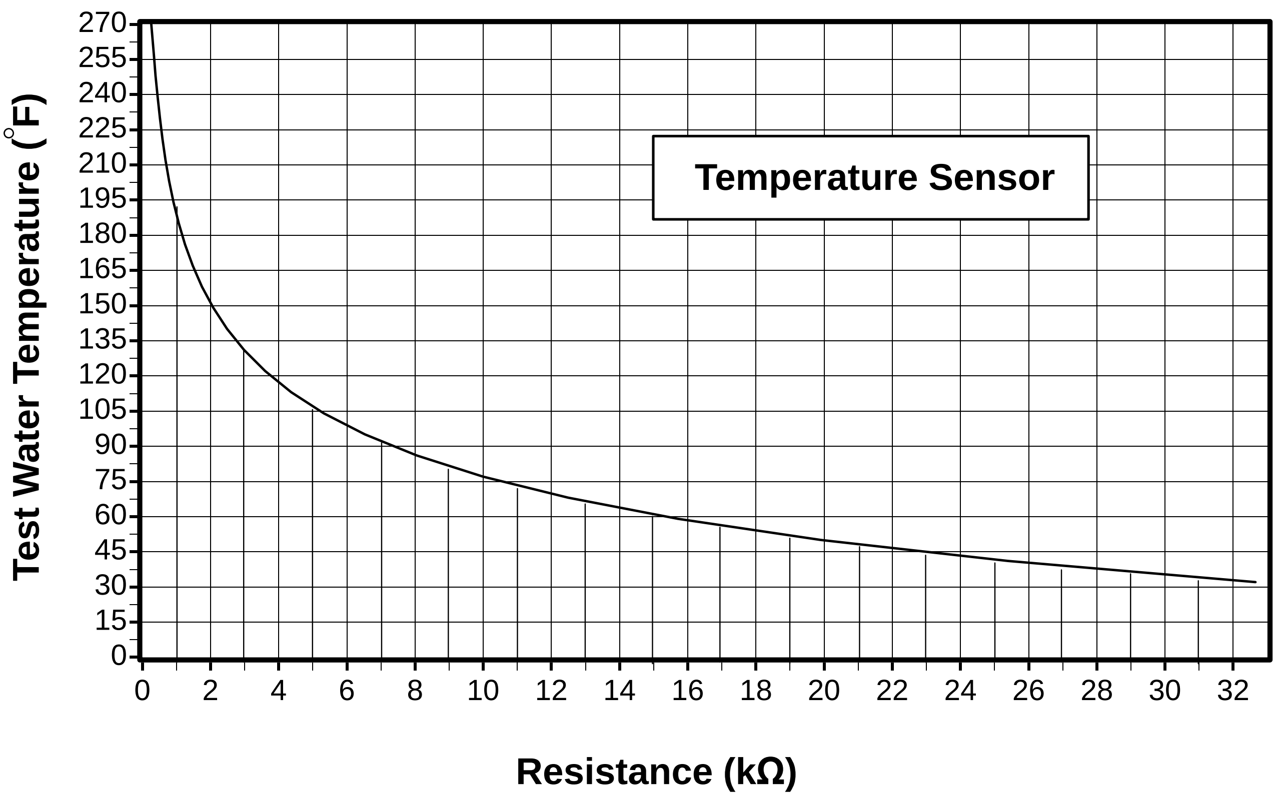
NOTE: *If using DMT 2000 turn the selector switch to Ω Allow the meter to auto-range.*

Engine Coolant Temperature (ECT) Sensor
Manifold Air Temperature (MAT) Sensor

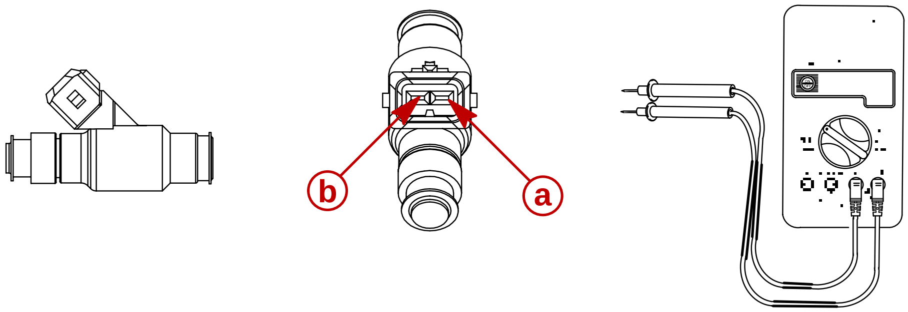
1. Place the engine coolant temperature sensor in a container filled with water.
2. Place a thermometer in the water and slowly heat the water.
3. Measure the resistance when the specified temperature is reached. If the reading is out of specification, replace the sensor.



a - Engine Coolant Temperature(ECT) Sensor

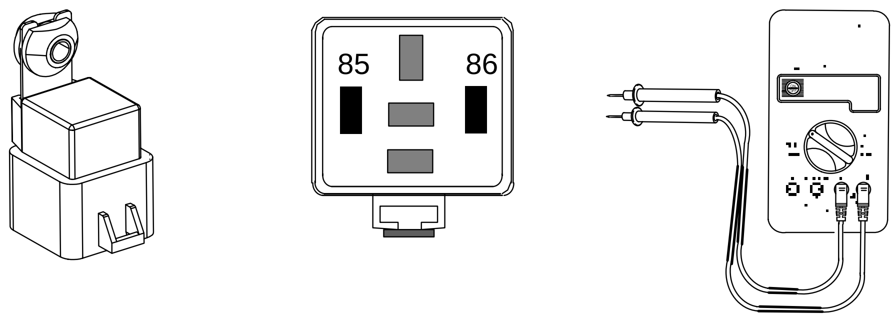


Fuel Injector



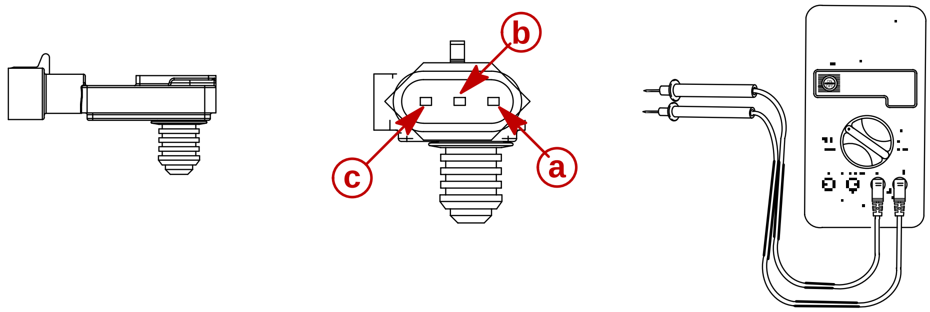
METER TEST LEADS		METER SCALE (ANALOG)	READING (Ω)
RED	BLACK	RX1	10 - 13.5
PIN A	PIN B		

Main Power Relay



METER TEST LEADS		METER SCALE (ANALOG)	READING (Ω)
RED	BLACK	RX1	81 - 91
PIN 85	PIN 86		

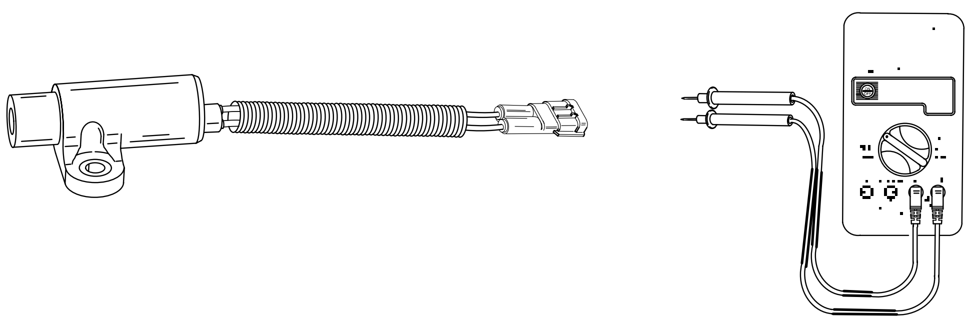
Manifold Absolute Pressure (MAP) Sensor



a - Black/Orange
b - Yellow
c - Purple/Yellow

METER TEST LEADS		METER SCALE (ANALOG)	READING (Ω)
RED	**BLACK**		
PIN A	PIN B	**RX1K**	**95 - 105 K**
PIN A	PIN C		**3.9 - 4.3 K**
PIN B	PIN C		**95 - 105 K**

Crank Position Sensor



METER TEST LEADS		METER SCALE (ANALOG)	READING (Ω)
RED	**BLACK**		
RED	WHT	**RX1**	**300 - 350**

ELECTRONIC FUEL INJECTION

Section 3C - Service Procedures

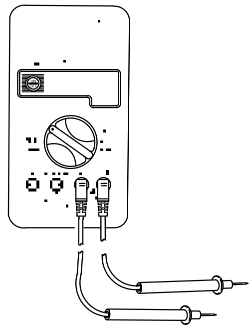
Table of Contents

Specifications

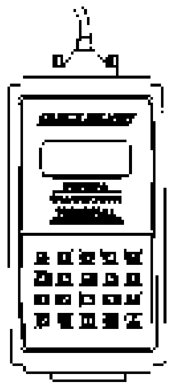
FUEL SYSTEM	**Fuel Pump Type** **Fuel Pump:** **Pressure** **Fuel Tank Capacity**	Mechanical Water Cooled (Plunger/Diaphragm) 3-6 psi Accessory
FUEL INJECTION	**Fuel Injector System** **Idle rpm (Out Of Gear)** **Idle rpm (In Forward Gear)** **Wide Open Throttle rpm (WOT)** **Range** **Fuel Pump Pressure - Electric**	Batch (1 & 4) - (2 & 3) 725 ± 25 rpm 725 ± 25 rpm 5500–6000 42-44 psi (290-303 kPa)

Special Tools

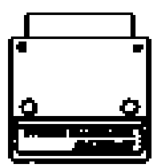
1. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1.



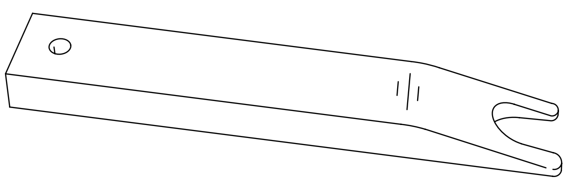
2. Digital Diagnostic Terminal P/N 91-823686A2



3. DDT Cartridge 91-822608-2



4. Fuel Injector Cap Tool 91-883877A1



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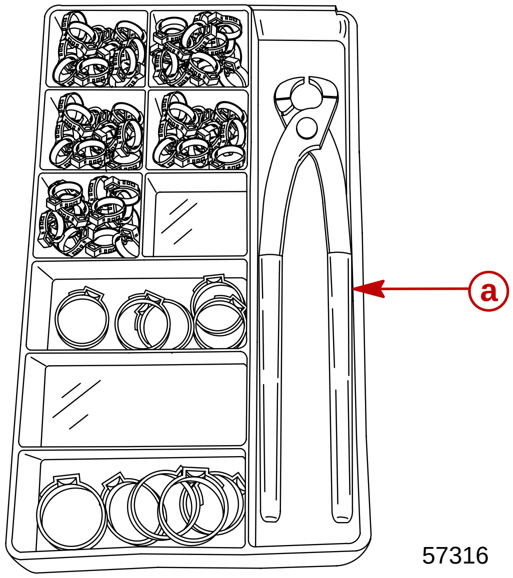
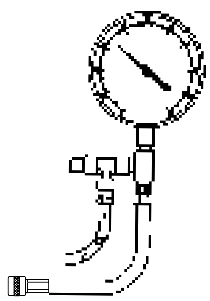
5. Clamp Tool Kit 91-803146A2

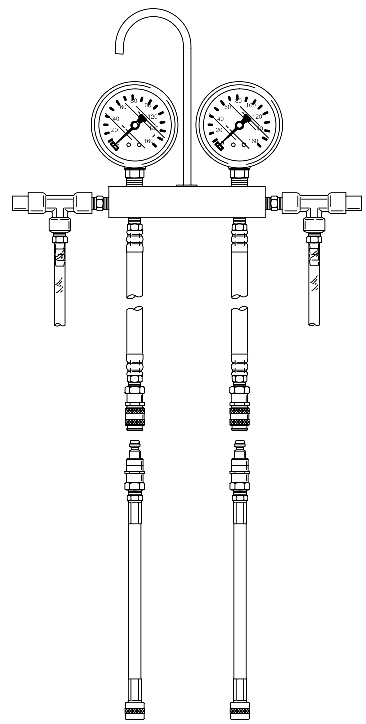


a - Clamp Tool 91-803146T

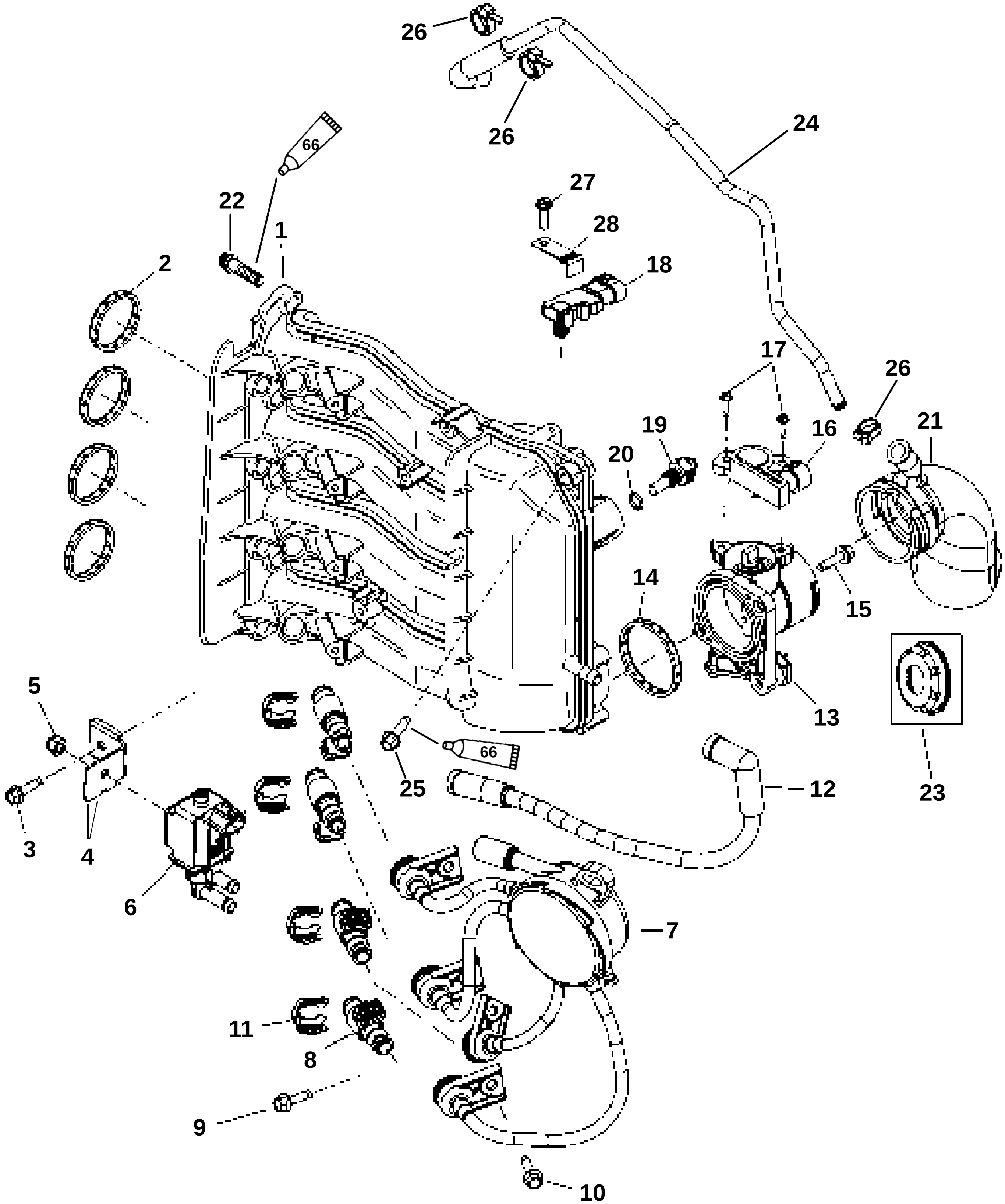
6. Fuel Pressure Gauge 91-16850A7 or Fuel Pressure Gauge 91-852087A3.



91-16850A7



INTAKE MANIFOLD

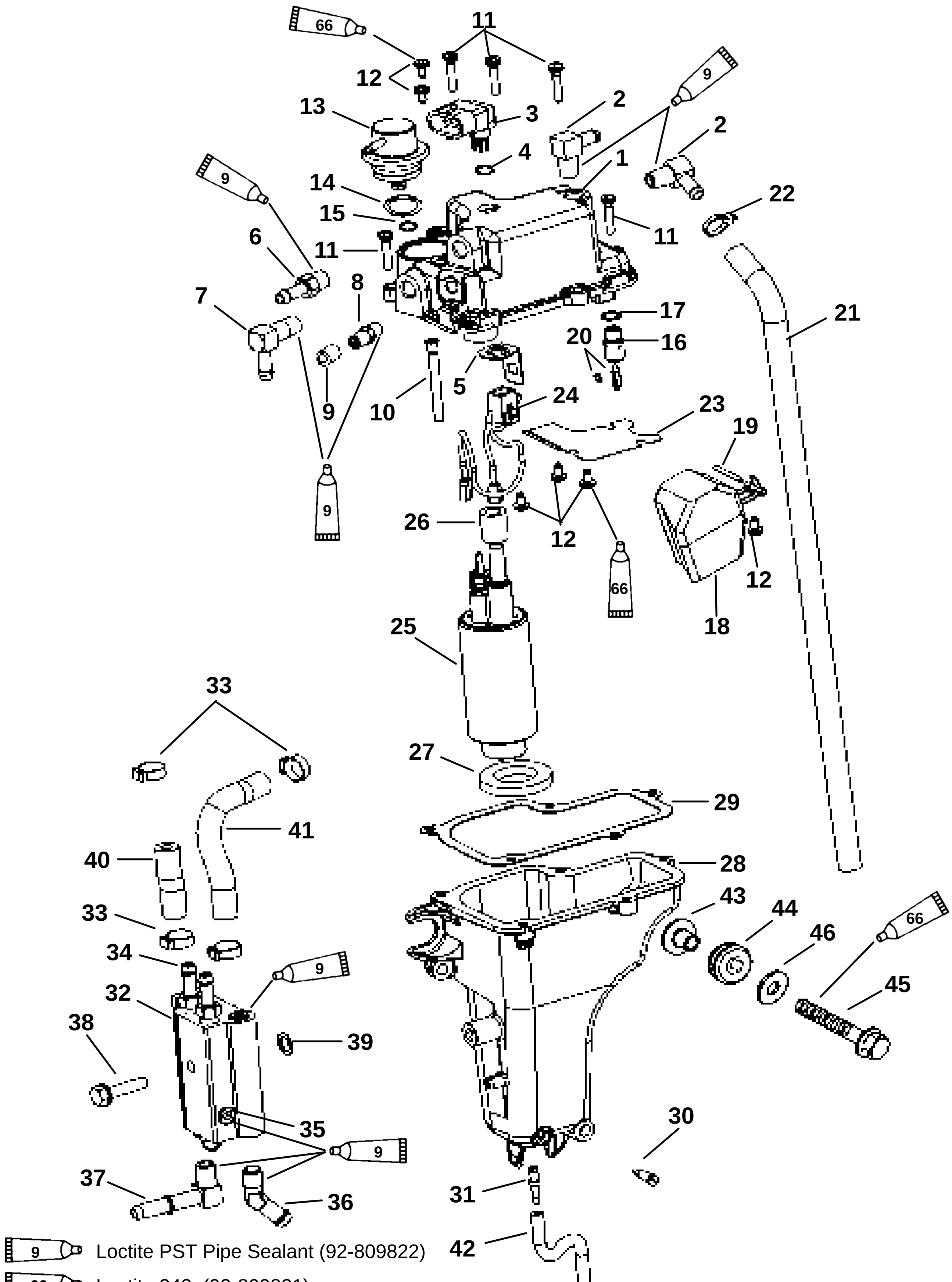


66 Loctite 242 (92-809821)

INTAKE MANIFOLD

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	lb-ft	Nm.
1	1	INTAKE MANIFOLD			
2	4	GASKET			
3	1	SCREW	31		3.5
4	1	BRACKET			
5	1	NUT	75		8.5
6	1	IDLE AIR CONTROL (IAC)			
7	1	FUEL DISTRIBUTION MANIFOLD			
8	4	INJECTOR			
9	2	SCREW	31		3.5
10	4	SCREW	31		3.5
11	4	CLIP			
12	1	HOSE			
13	1	THROTTLE BODY			
14	1	GASKET			
15	2	SCREW	31		3.5
16	1	THROTTLE POSITION SENSOR (TPS)			
17	2	SCREW	18		2
18	1	MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR			
19	1	MANIFOLD AIR TEMPERATURE (MAT) SENSOR	12.5		1.4
20	1	O RING			
21	1	SOUND ATTENUATOR			
22	8	SCREW (M6 X 25)	75		8.5
23	1	RESTRICTOR **(50)**			
	1	RESTRICTOR **(40)**			
24	1	BREATHER HOSE			
25	1	SCREW (M6 X 30)	75		8.5
26	3	STA-STRAP			
27	1	SCREW (10-16 X .625)	Drive Tight		
28	1	RETAINER			

VAPOR SEPARATOR COMPONENTS



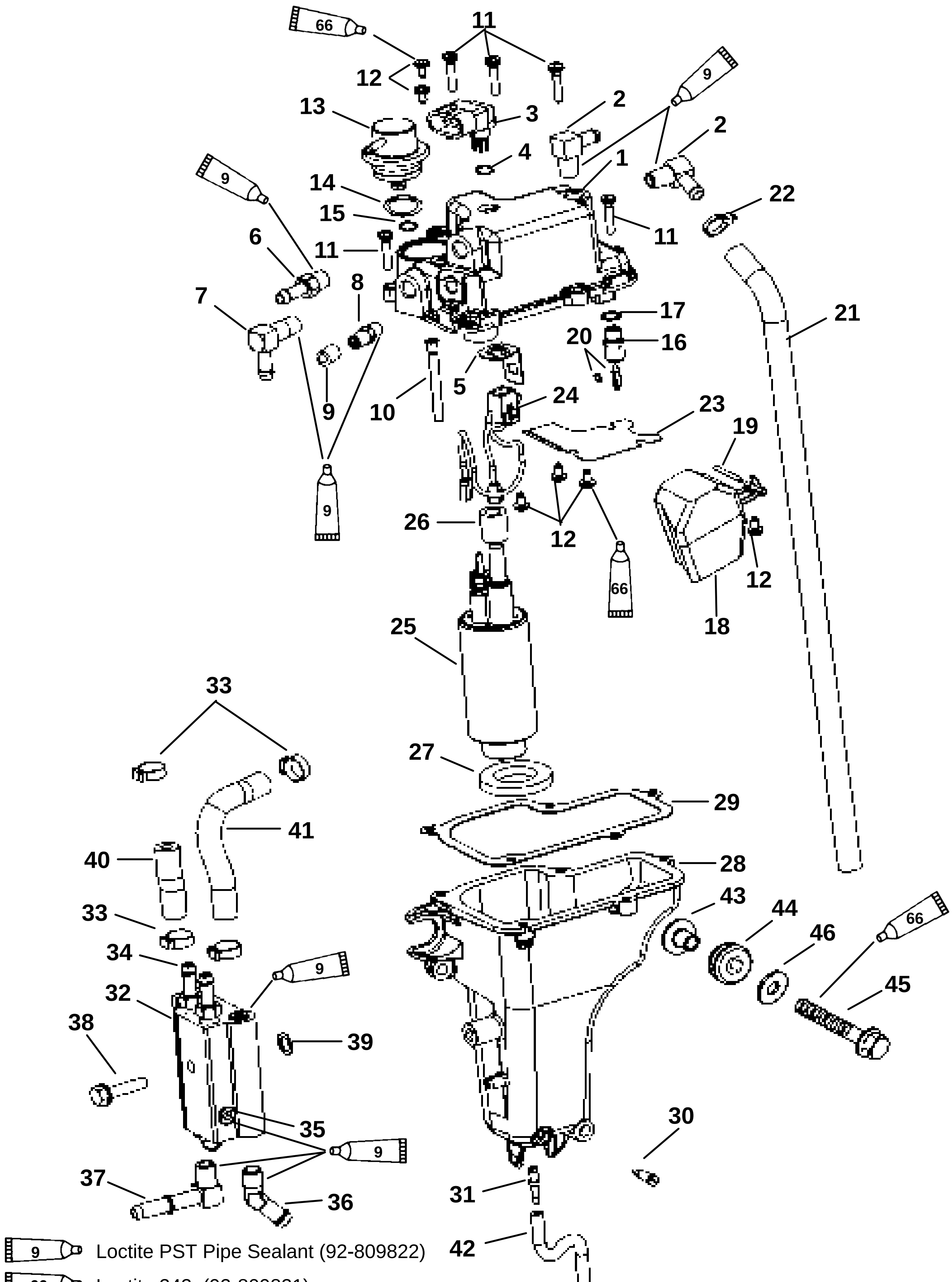
9 Loctite PST Pipe Sealant (92-809822)

66 Loctite 242 (92-809821)

VAPOR SEPARATOR COMPONENTS

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	COVER KIT			
2	2	FITTING			
3	1	ELECTRICAL PASS-THRU KIT	45-55		5.1-6.2
4	1	O RING			
5	1	RETAINER			
6	1	FITTING	45-55		5.1-6.2
7	1	FITTING	45-55		5.1-6.2
8	1	DIAGNOSTIC VALVE	40-50		4.5-5.7
9	1	CAP			
10	1	DRAIN TUBE			
11	5	SCREW	35-40		4-4.5
12	6	SCREW	20-24		2.3-2.7
13	1	REGULATOR			
14	1	O RING			
15	1	O RING			
16	1	SEAL KIT	30-35		3.4-4
17	1	GASKET			
18	1	FLOAT KIT			
19	1	FLOAT SHAFT			
20	1	INLET NEEDLE KIT			
21	1	VENT HOSE			
22	1	STA STRAP			
23	1	FUEL BAFFLE			
24	1	HARNESS			
25	1	PUMP KIT			
26	1	SLEEVE			
27	1	GROMMET			
28	1	FUEL BOWL KIT			
29	1	GASKET			
30	1	DRAIN SCREW	30-35		3.4-4
31	1	FITTING	Press to Shoulder		
32	1	FUEL COOLER BODY KIT			
33	4	CLAMP			
34	2	FITTING	45-55		5.1-6.2
35	5	PLUG			
36	2	ELBOW FITTING	Install 5 to 7 Turns		
37	1	ELBOW FITTING	45-55		5.1-6.2
38	1	SCREW		10.8-12.5	14.7-17
39	1	GASKET			
40	1	HOSE (1-5/8)			
41	1	HOSE (4-1/2)			
42	1	DRAIN HOSE			

VAPOR SEPARATOR COMPONENTS



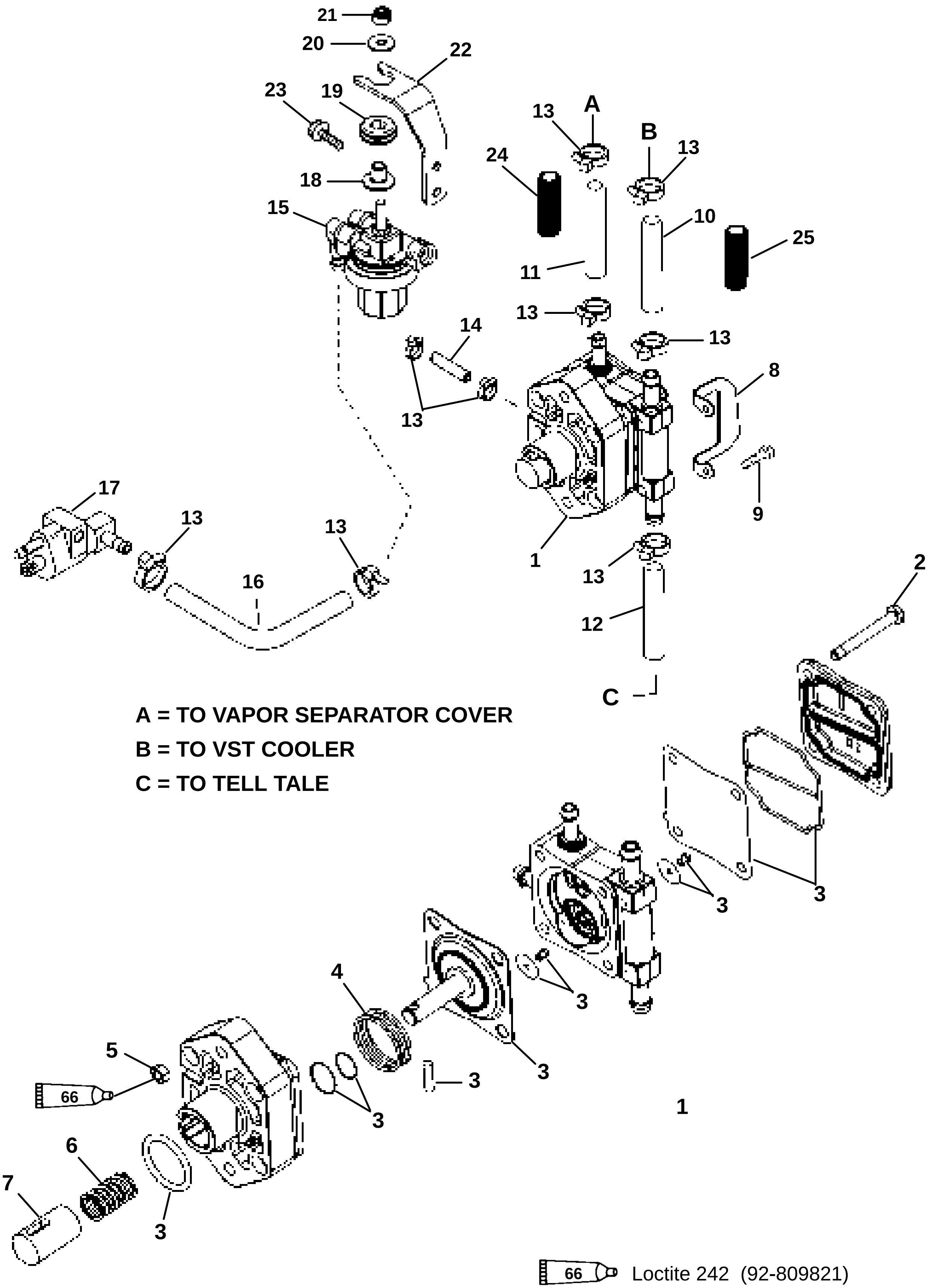
9 Loctite PST Pipe Sealant (92-809822)

66 Loctite 242 (92-809821)

VAPOR SEPARATOR COMPONENTS

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
43	3	BUSHING			
44	3	GROMMET			
45	3	SCREW (M6 X 25)	45		5.1
46	3	WASHER			

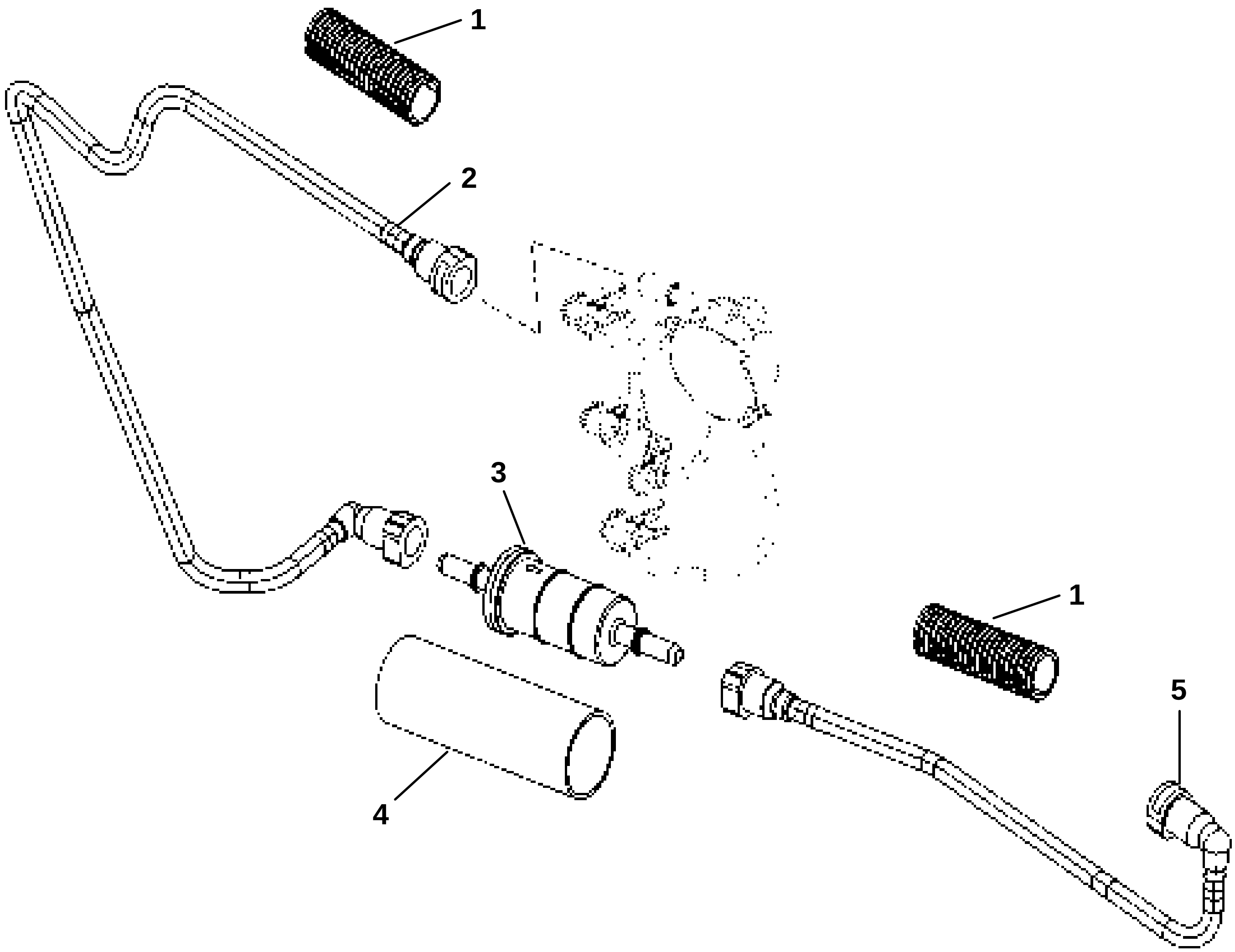
FUEL PUMP


21
20
22
23
19
13
A
B
13
24
18
10
15
25
11
13
13
14
8
13
17
9
13
13
1
16
13
2
12
C
A = TO VAPOR SEPARATOR COVER
B = TO VST COOLER
C = TO TELL TALE
3
3
4
3
5
3
3
66
3
1
6
7
3
66
Loctite 242 (92-809821)

FUEL PUMP

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	FUEL PUMP			
2	4	SCREW			
3	1	DIAPHRAGM/O-RING KIT			
4	1	SPRING			
5	4	NUT			
6	1	SPRING			
7	1	CAP			
8	1	COWL DEFLECTOR			
9	2	SCREW (M6 X 30)	75		8.5
10	1	TUBING (34 IN.)			
11	1	TUBING (19 IN.)			
12	1	TUBING (6 IN.)			
13	AR	STA STRAP			
14	1	TUBING (8 IN.)			
15	1	FUEL FILTER			
16	1	TUBING (38 IN.)			
17	1	FUEL CONNECTOR			
18	1	BUSHING			
19	1	GROMMET			
20	1	WASHER			
21	1	NUT (M6)	45		5.1
22	1	BRACKET			
23	2	SCREW (M6 X 13)	75		8.5
24	1	CONDUIT (13 IN.)			
25	1	CONDUIT (26 IN.)			

FUEL LINES

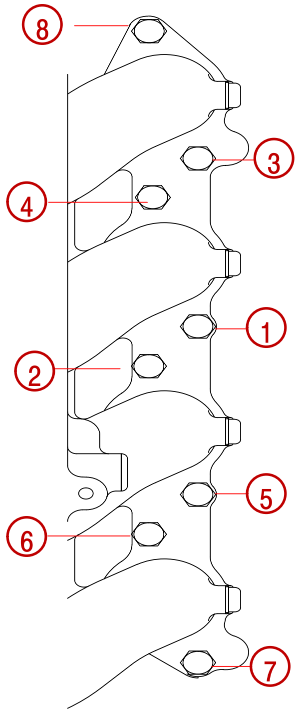


FUEL LINES

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	CONDUIT (24 IN.)			
2	1	FUEL LINE			
3	1	FUEL FILTER			
4	1	PROTECTIVE SLEEVE			
5	1	FUEL LINE			

Torque Sequence

INTAKE MANIFOLD FLANGE



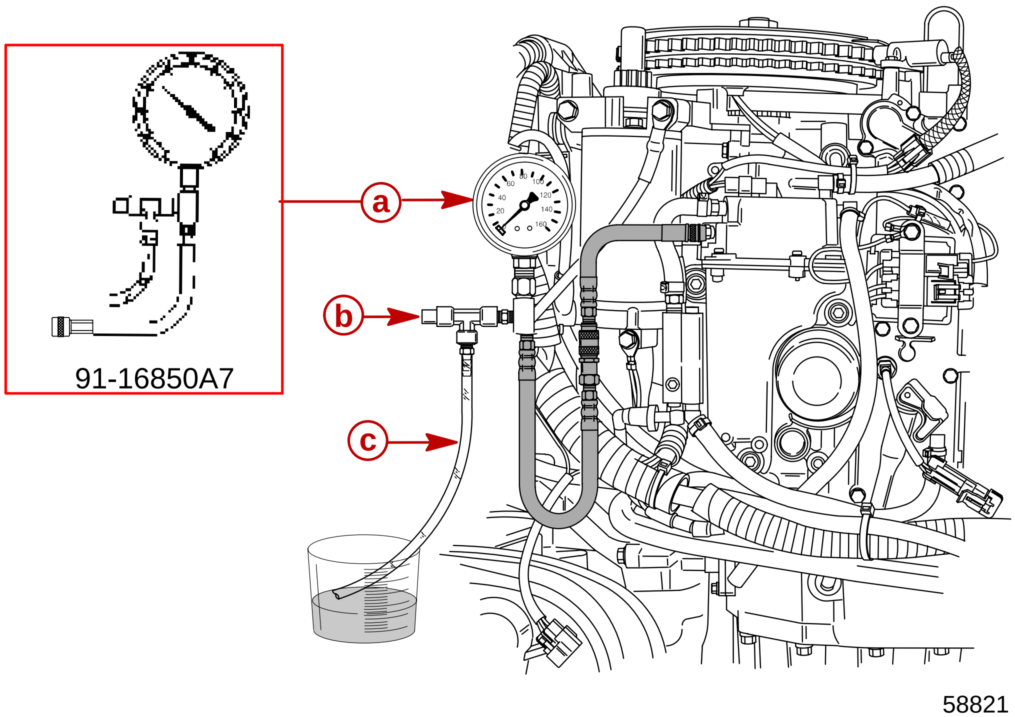
Intake Manifold Assembly

⚠ WARNING

Always release the fuel pressure in the high-pressure fuel line before servicing the line or the vapor separator. If the fuel pressure is not released, pressurized fuel may spray out.

Releasing Fuel Pressure in the High-Pressure Fuel Line

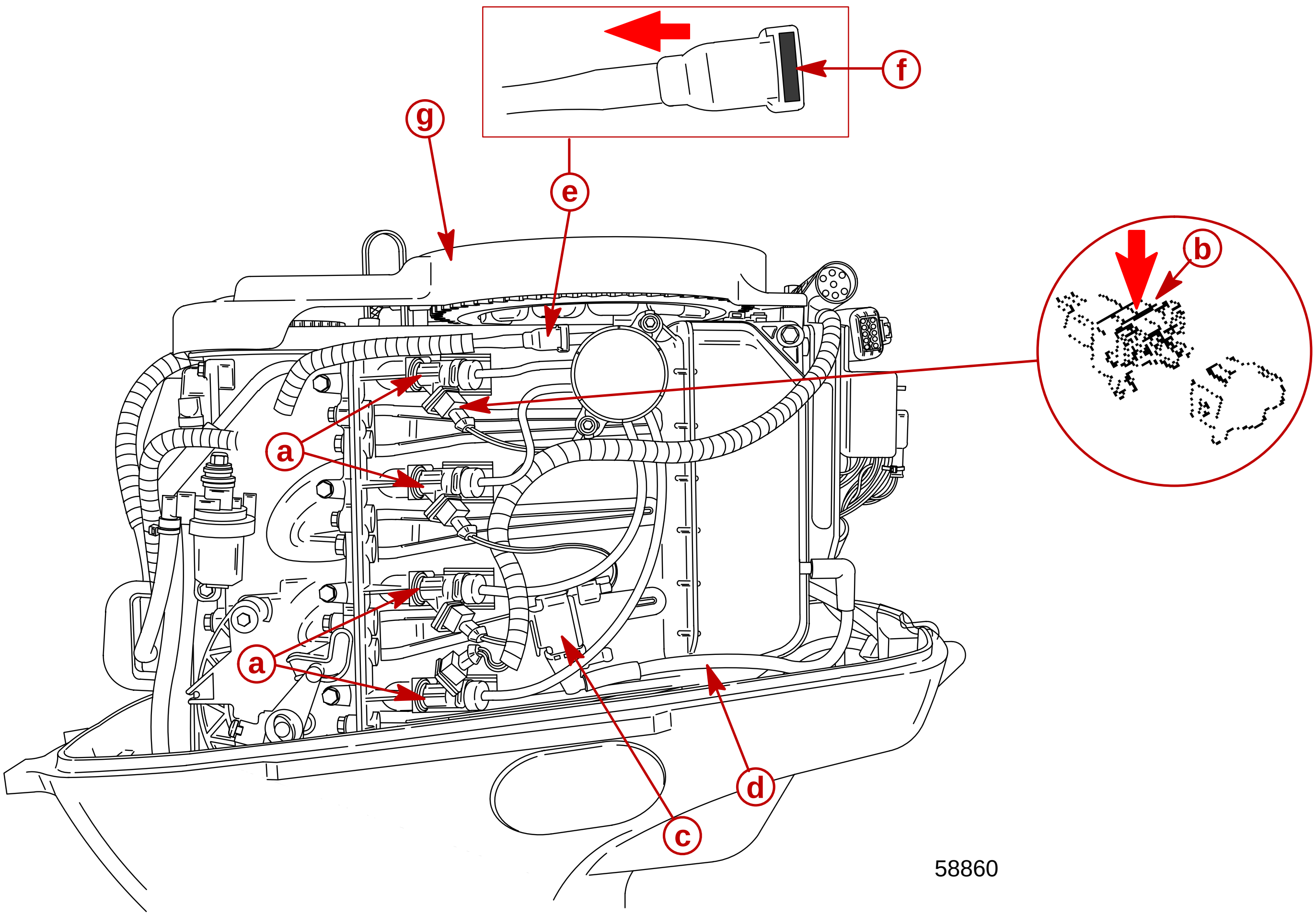
1. Install the fuel pressure gauge onto the pressure check valve.
2. Place the drain hose into a container.
3. Push the relief button and release the pressure.



a - Fuel Pressure Gauge
b - Pressure Relief Button
c - Drain Hose

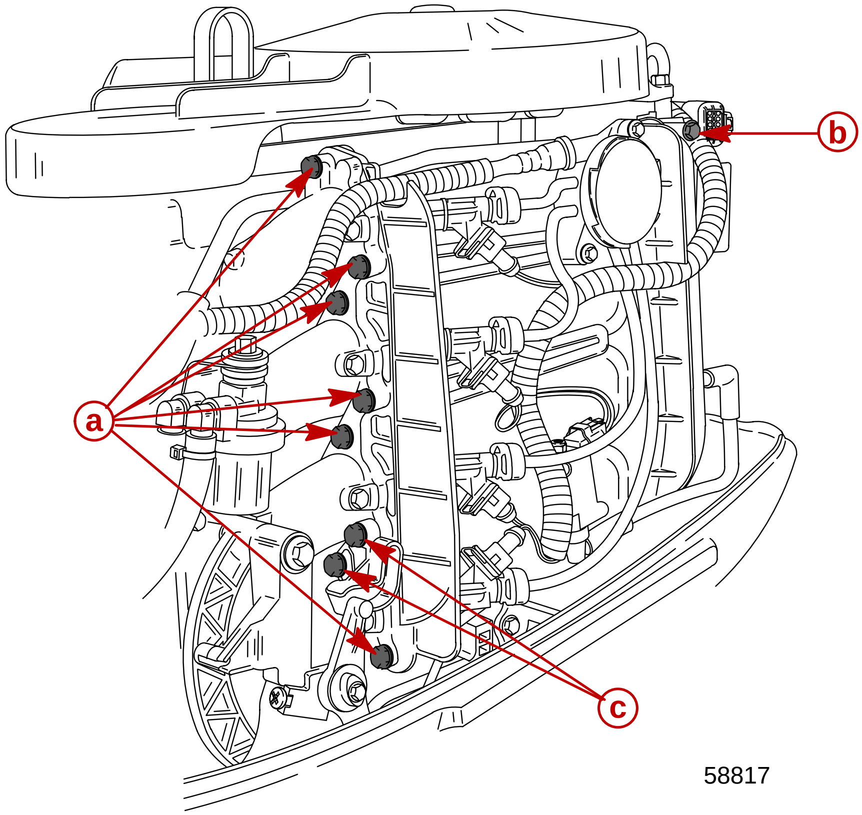
Removal

4. Push in on the fuel injector harness connector retaining clip and unplug the harness from each fuel injector. It is not necessary to remove the retaining clip from the connector.
5. Unplug the Idle Air Control (IAC) connector.
6. **AFTER RELIEVING PRESSURE** disconnect the high pressure fuel line from the fuel distribution manifold by depressing the locking tab and pulling back on the fuel line.
7. Remove the flywheel cover.



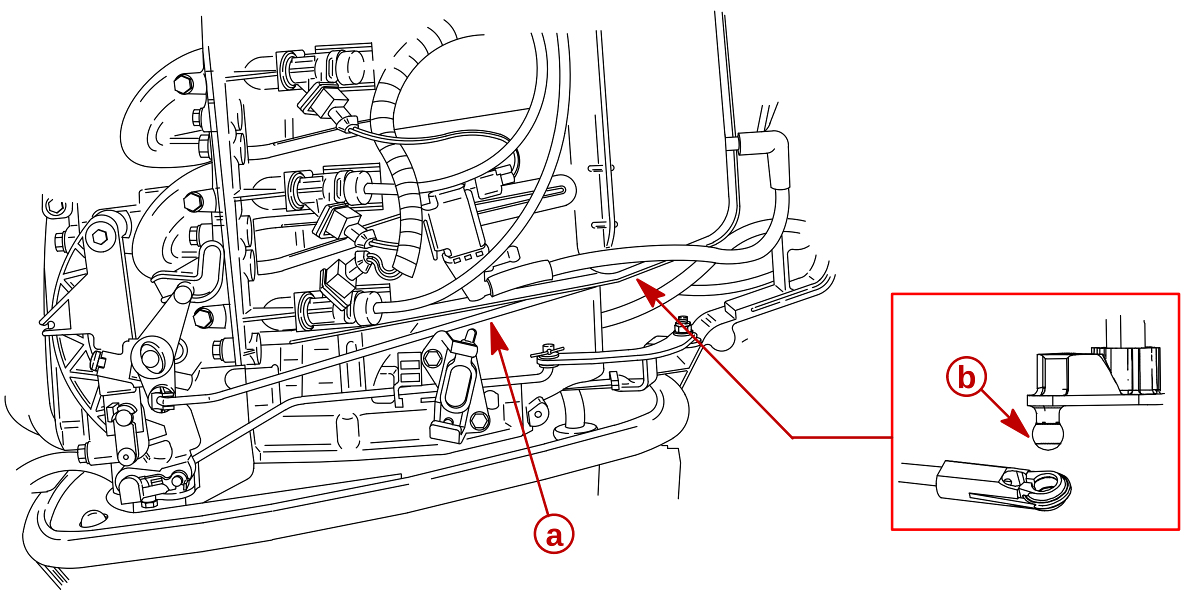
a - Fuel Injector (4)
b - Harness Connector Retaining Clip
c - Idle Air Control (IAC) Connector
d - Throttle Air Bypass Hose
e - High Pressure Fuel Line
f - Locking Tab
g - Flywheel Cover

8. Remove intake assembly mounting screws and remove intake assembly.



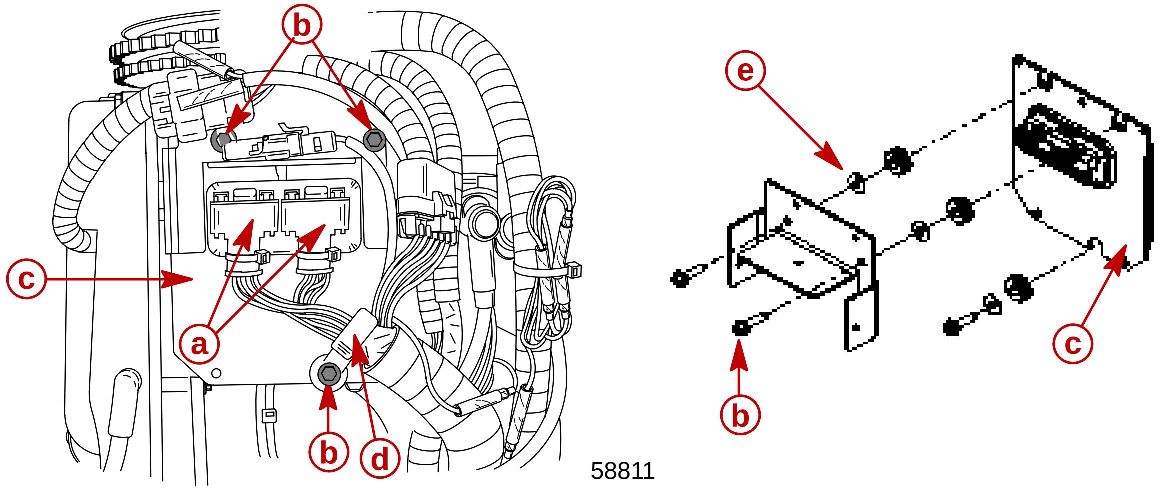
a - Intake Assembly Mounting Screw (6) M6 x 25
b - Intake Assembly Mounting Screw (1) M6 x 30
c - Intake Assembly Mounting Screw (2) M6 x 40

9. Disconnect throttle link rod from the throttle body ball socket.



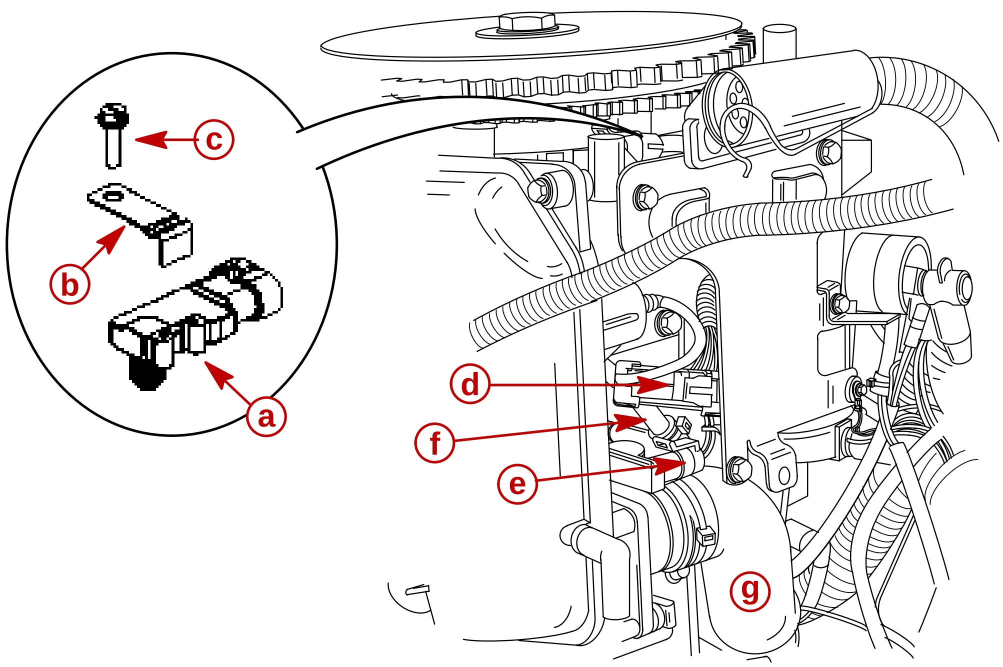
a - Throttle Link Rod
b - Throttle Body Ball Socket

10. Disconnect ECM harness connectors.
11. Remove the ECM mounting screws and washers. Remove the ECM from the mounting plate.



a - ECM Harness Connectors
b - ECM Mounting Screw (3) M6 x 25
c - ECM
d - J-Clip
e - Washers (3)

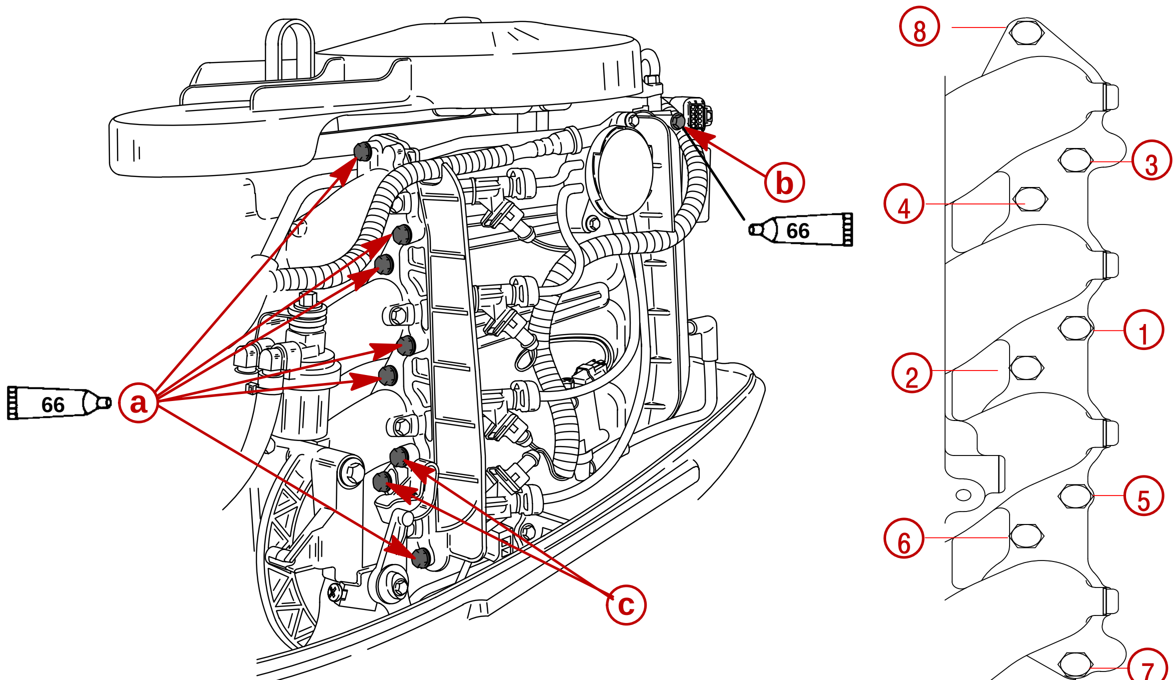
12. Disconnect the following sensors: Manifold Absolute Pressure (MAP), Manifold Air Temperature (MAT), and Throttle Position Sensor (TPS).
13. Cut sta-strap and remove crankcase breather hose from sound attenuator. Remove intake assembly from engine.



a - Manifold Absolute Pressure (MAP) Sensor
b - MAP Sensor Retaining Clip
c - Screw (10-16 x .625)
d - Manifold Air Temperature (MAT) Sensor Connector
e - Throttle Position Sensor (TPS) Connector
f - Crankcase Breather Hose
g - Sound Attenuator

Installation

1. Install intake manifold assembly to engine. Make sure O-rings are in place. Tighten screws (in sequence shown) to specified torque.



58817

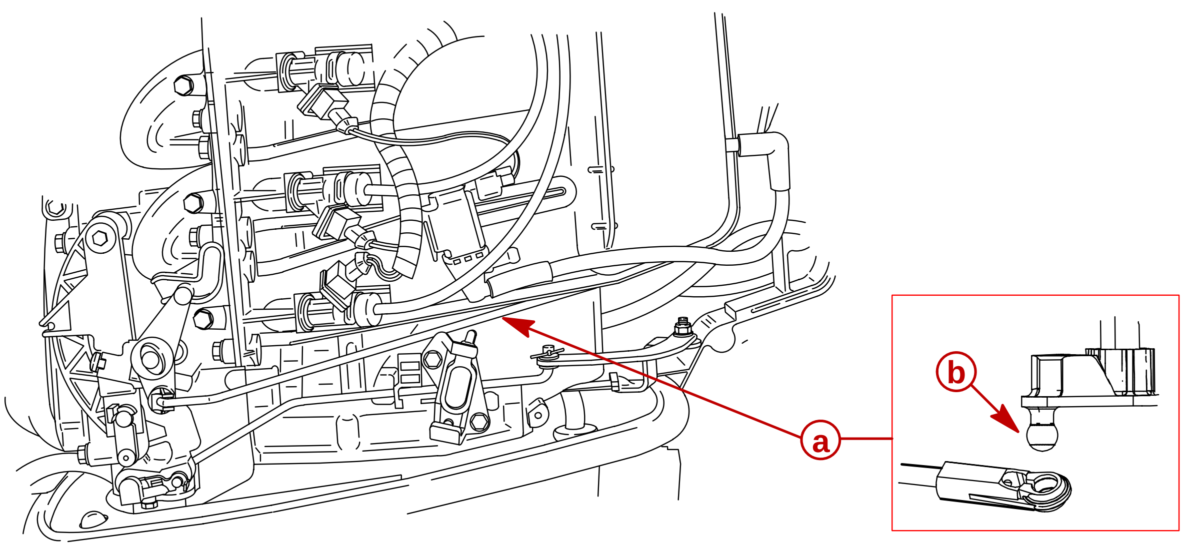
66 Loctite 242 (92-809821)

a - Intake Assembly Mounting Screw (6) M6 x 25
b - Intake Assembly Mounting Screw M6 x 30
c - Intake Assembly Mounting Screw M6 x 40

Intake Assembly Mounting Screw Torque
75 lb-in (8.5 Nm)

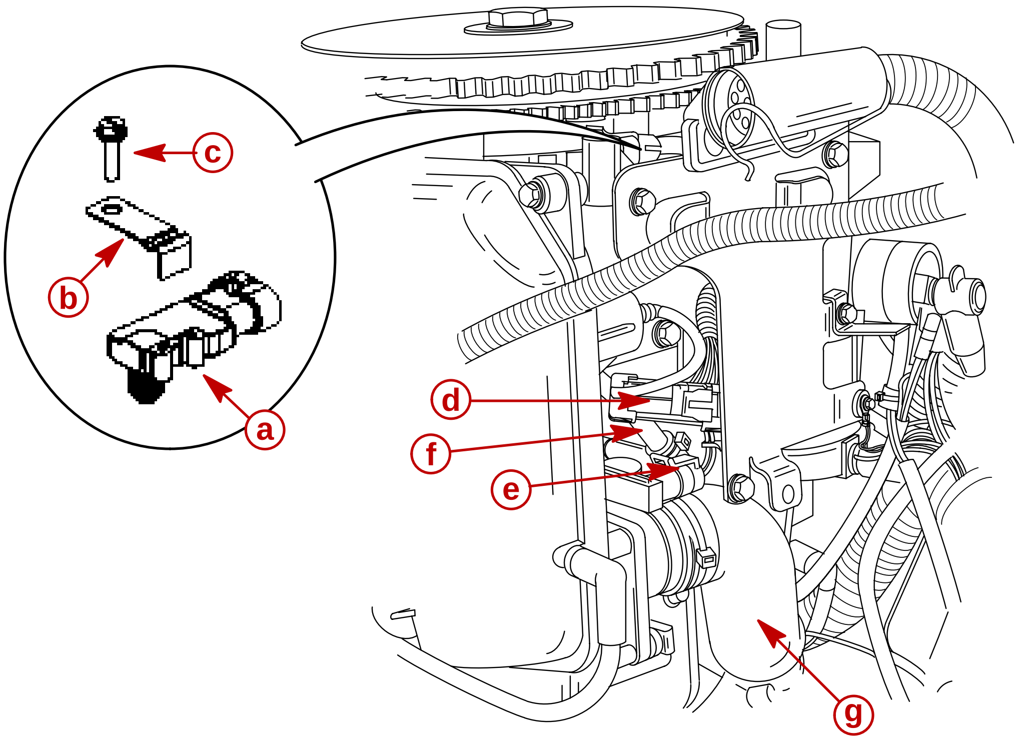
2. Connect throttle link rod to the throttle body ball socket.

IMPORTANT: Check for proper throttle link rod adjustment as outlined in section 7A.



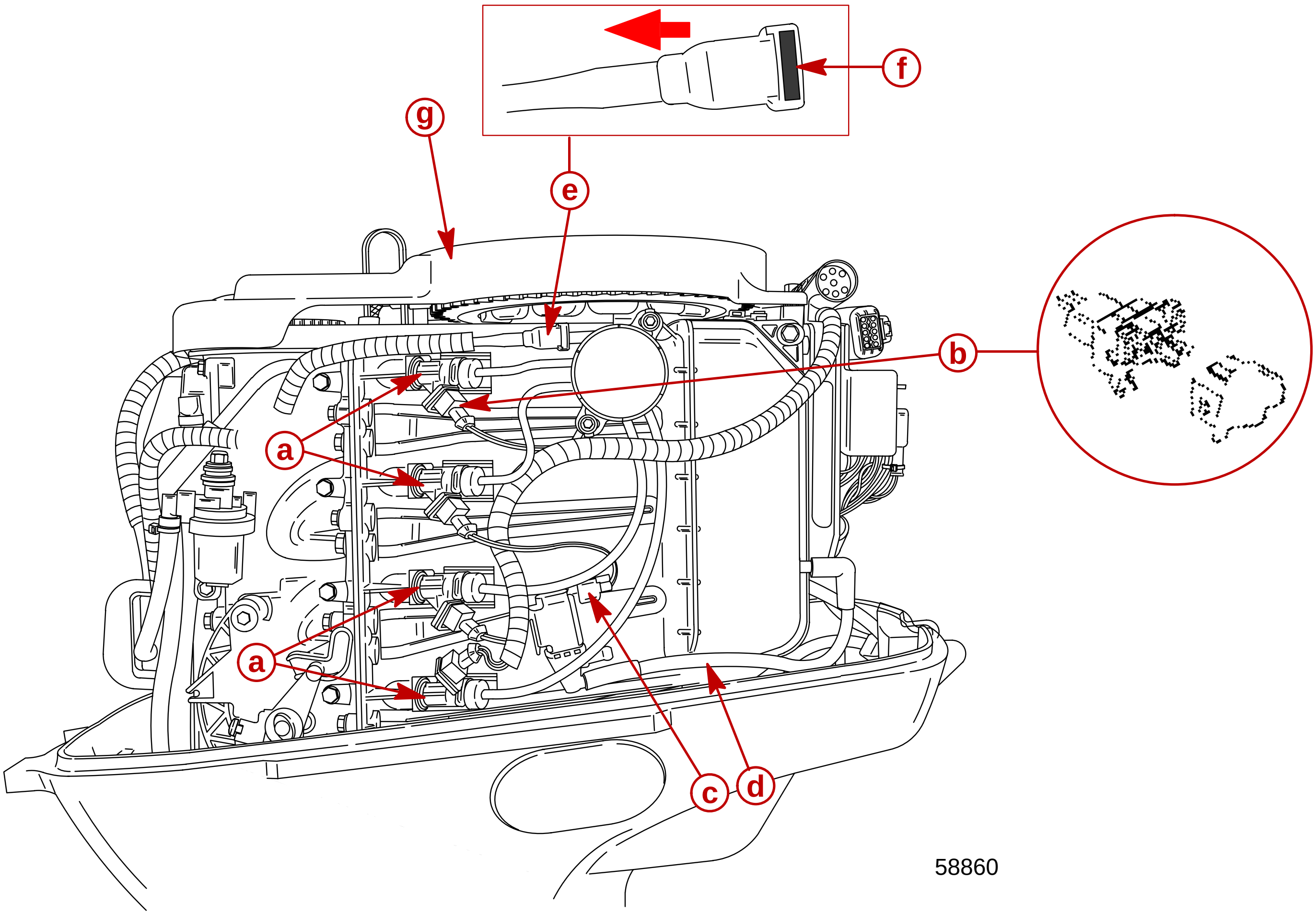
a - Throttle Link Rod
b - Throttle Body Ball Socket

3. Connect the following sensors: Manifold Absolute Pressure (MAP), Manifold Air Temperature (MAT) Sensor, and Throttle Position Sensor (TPS).
4. Install MAP sensor retaining clip and tighten screw to specified torque.
5. Install crankcase breather hose into sound attenuator. Secure with sta-strap.



a - Manifold Absolute Pressure (MAP) Sensor
b - MAP Sensor Retaining Clip
c - Screw (10-16 x .625)
d - Manifold Air Temperature (MAT) Sensor
e - Throttle Position Sensor (TPS)
f - Crankcase Breather Hose
g - Sound Attenuator

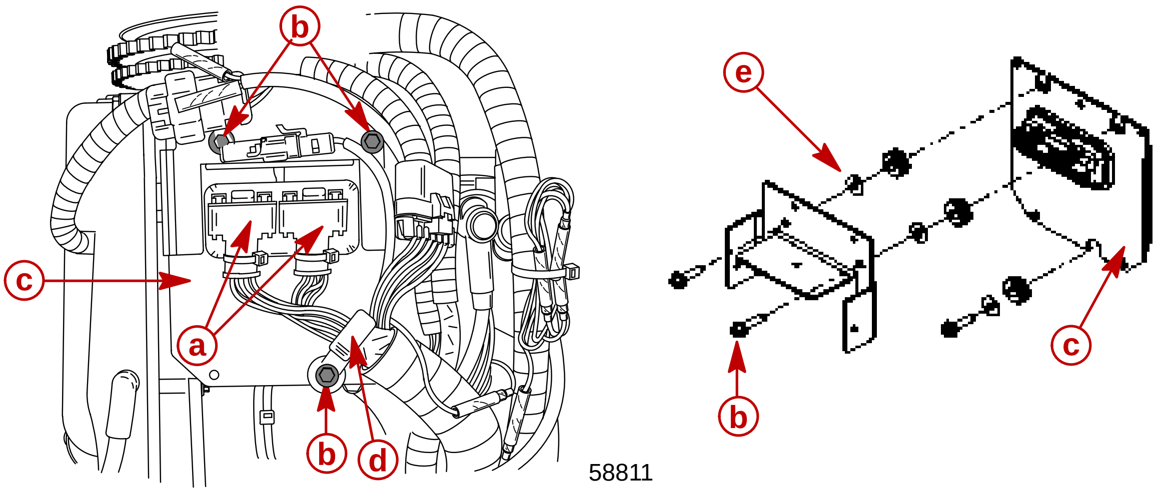
6. Connect the fuel line to the fuel distribution manifold. Push on until locked into place.
7. Route injector harness as shown and plug-in the fuel injector and IAC connectors.
8. Install flywheel cover. Tighten screws to specified torque.



a - Fuel Injector (4)
b - Fuel Injector Connector (4)
c - Idle Air Control (IAC) Connector
d - Throttle Air Bypass Hose
e - Fuel Line
f - Locking Tab
g - Flywheel Cover

Flywheel Cover Screw Torque
75 lb-in (8.5 Nm)

9. Install ECM to mounting plate. Tighten mounting screws to specified torque.
10. Plug in ECM harness connectors.



a - ECM Harness Connectors
b - ECM Mounting Screw (3) M6 x 25
c - ECM
d - J-Clip
e - Washers (3)

ECM Mounting Screw Torque
45 lb-in (5.1 Nm)

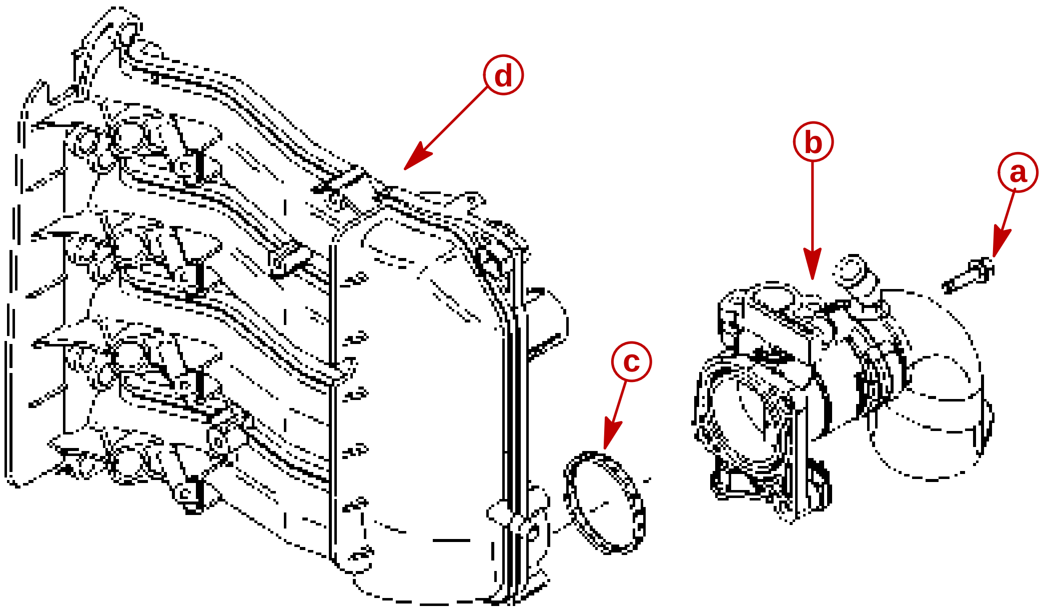
Throttle Body Removal/Installation

REMOVAL

1. Remove the intake manifold assembly. Refer to **Intake Manifold Assembly Removal.**
2. Remove throttle body mounting screws and remove throttle body assembly from the intake assembly.

INSTALLATION

1. Lubricate O-ring and install throttle body to intake assembly. Tighten screws to specified torque.
2. Install the intake assembly. Refer to **Intake Assembly Installation.**



a - Throttle Body Mounting Screws (2) 25mm long
b - Throttle Body Assembly
c - Seal
d - Intake Assembly

Throttle Body Mounting Screw Torque
31 lb-in (3.5 Nm)

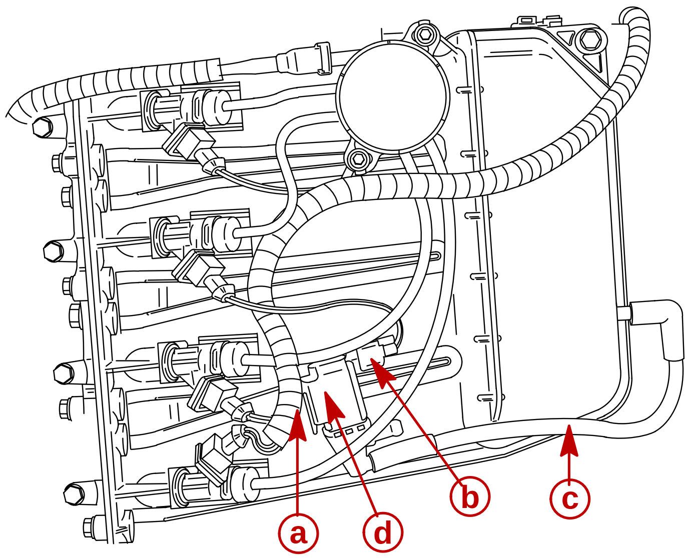
Idle Air Control (IAC) Removal/Installation

REMOVAL

1. Disconnect the IAC harness connector.
2. Remove IAC mounting screw.
3. Disconnect the throttle air bypass hose and remove the IAC valve.

INSTALLATION

1. Install IAC and secure with mounting screw.
2. Connect IAC harness connector and bypass hose.



a - IAC Mounting Screw
b - IAC Harness Connector
c - Throttle Air Bypass Hose
d - Idle Air Control (IAC) Valve

IAC Mounting Screw Torque
31 lb-in (3.5 Nm)

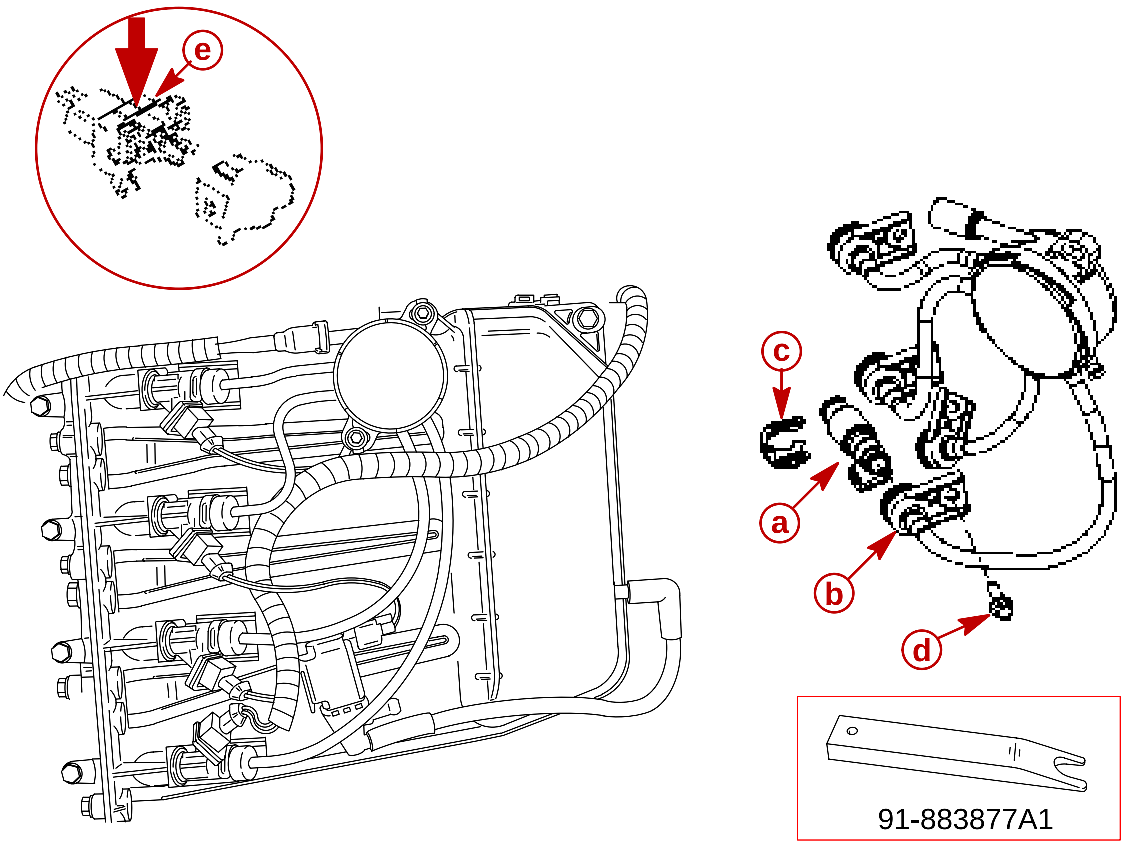
Fuel Injectors

⚠ WARNING

Always release the fuel pressure in the high-pressure fuel line before servicing the line or the vapor separator. If the fuel pressure is not released, pressurized fuel may spray out.

Removal

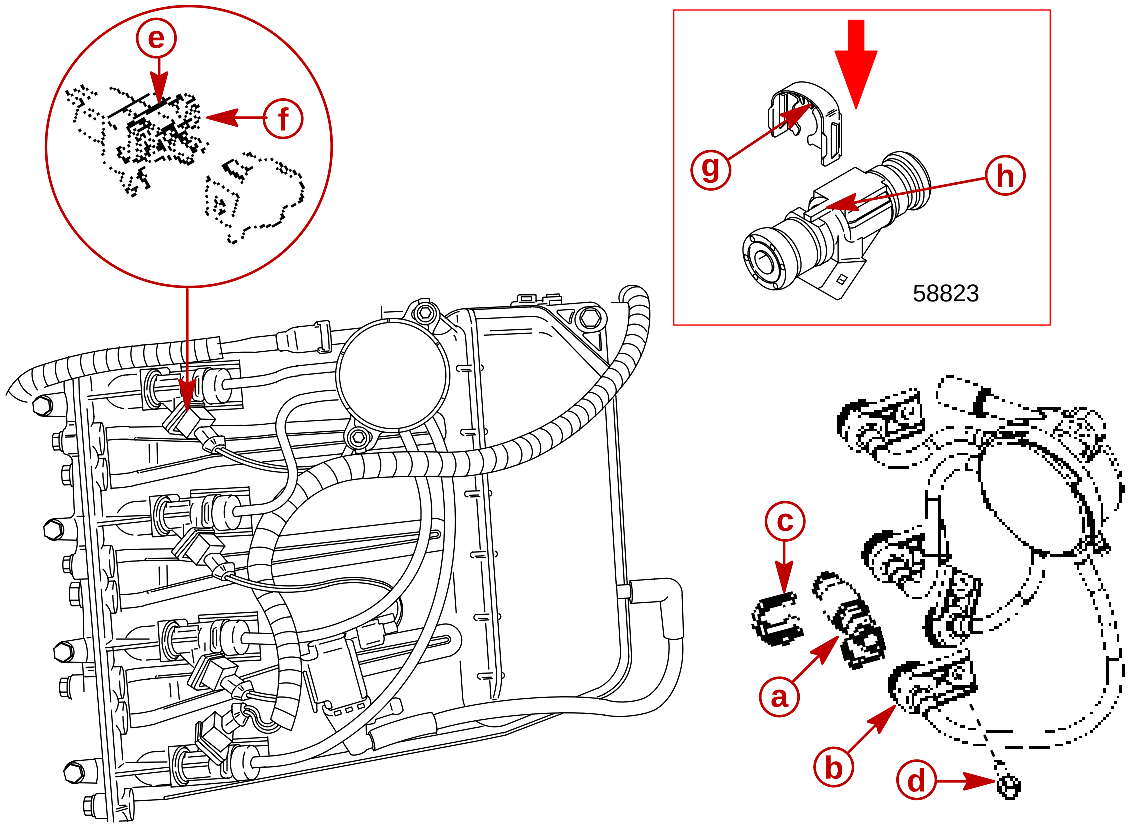
1. Remove fuel injector cap retaining clips and screws.
2. Push in on the harness connector retaining clip and unplug the harness from each fuel injector.
3. Using service tool 91-883877A1, pry injector cap from the injector.
4. Remove fuel injectors from intake manifold.



a - Fuel Injector (4)
b - Fuel Injector Cap (4)
c - Fuel Injector Cap Retaining Clip (4)
d - Screw (4)
e - Harness Connector Retaining Clip (4)

Installation

1. Install fuel injector cap by pushing it on the fuel injector until it bottoms out.
2. Lubricate O-rings and install fuel injectors into intake manifold.
3. Install fuel injector cap retaining screws and tighten to specified torque. Install fuel injector cap retaining clips so that the locking teeth line up with the locking rib on the fuel injector (as shown).
4. Connect the harness connectors to each fuel injector. Push the connector on until the retaining clip locks in place.



a - Fuel Injector (4)
b - Fuel Injector Cap (4)
c - Fuel Injector Cap Retaining Clip (4)
d - Fuel Injector Cap Retaining Screw (4)
e - Fuel Injector Harness Retaining Clip (4)
f - Fuel Injector Harness Connector (4)
g - Locking Teeth
h - Locking Rib

Fuel Injector Cap Retaining Screw Torque
31 lb-in (3.5 Nm)

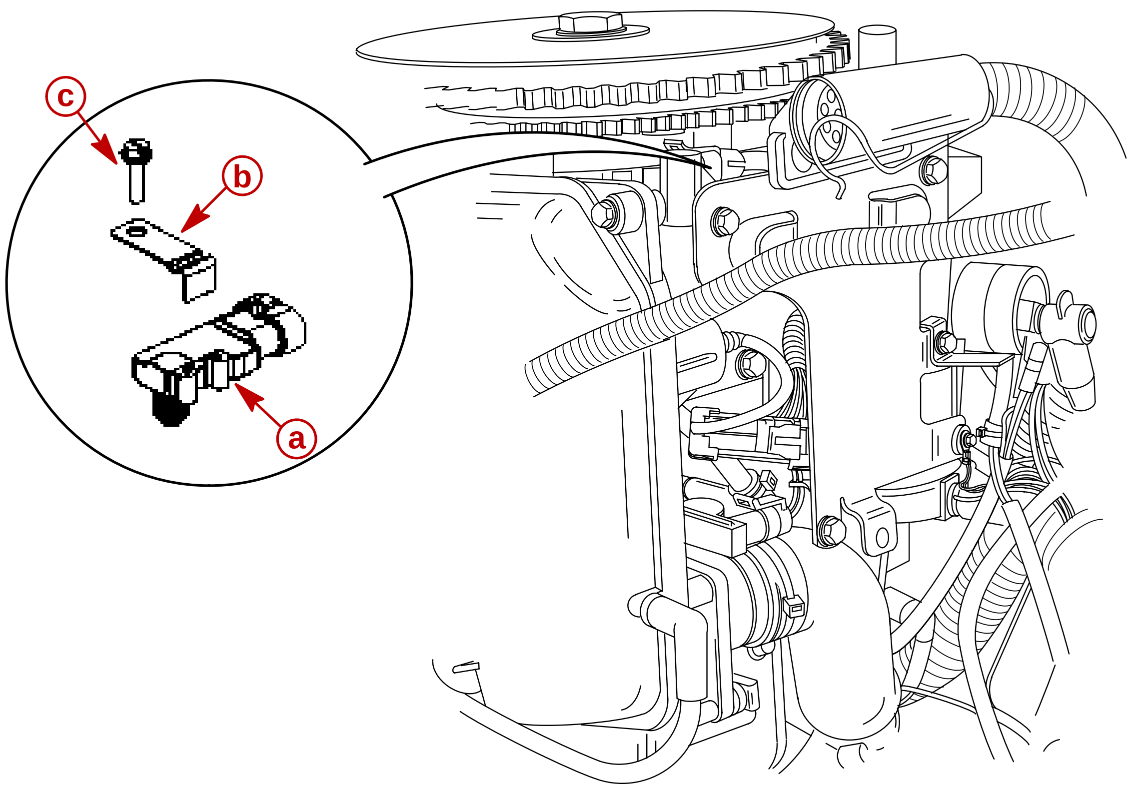
Manifold Absolute Pressure (MAP) Sensor Removal/Installation

REMOVAL

1. Remove the intake assembly. Refer to **Intake Assembly Removal.**
2. Remove the MAP sensor retaining screw and bracket. Remove the MAP from the intake by pulling and twisting simultaneously (pulls out hard).

INSTALLATION

1. Lubricate seal and push MAP into intake assembly.
2. Install retaining clip and screw. Tighten screw securely.
3. Install intake assembly. Refer to **Intake Assembly Installation.**



a - MAP Sensor
b - Retaining Clip
c - Screw

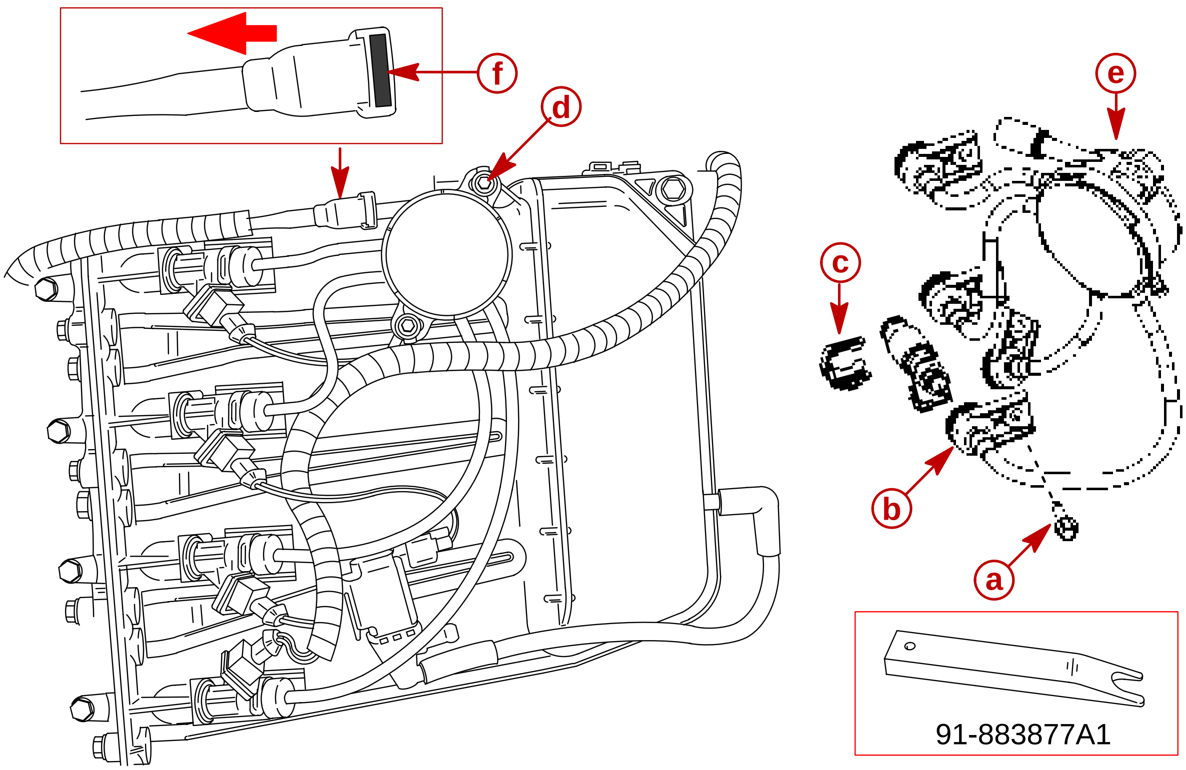
Fuel Distribution Manifold

⚠ WARNING

Always release the fuel pressure in the high-pressure fuel line before servicing the line or the vapor separator. If the fuel pressure is not released, pressurized fuel may spray out.

Removal

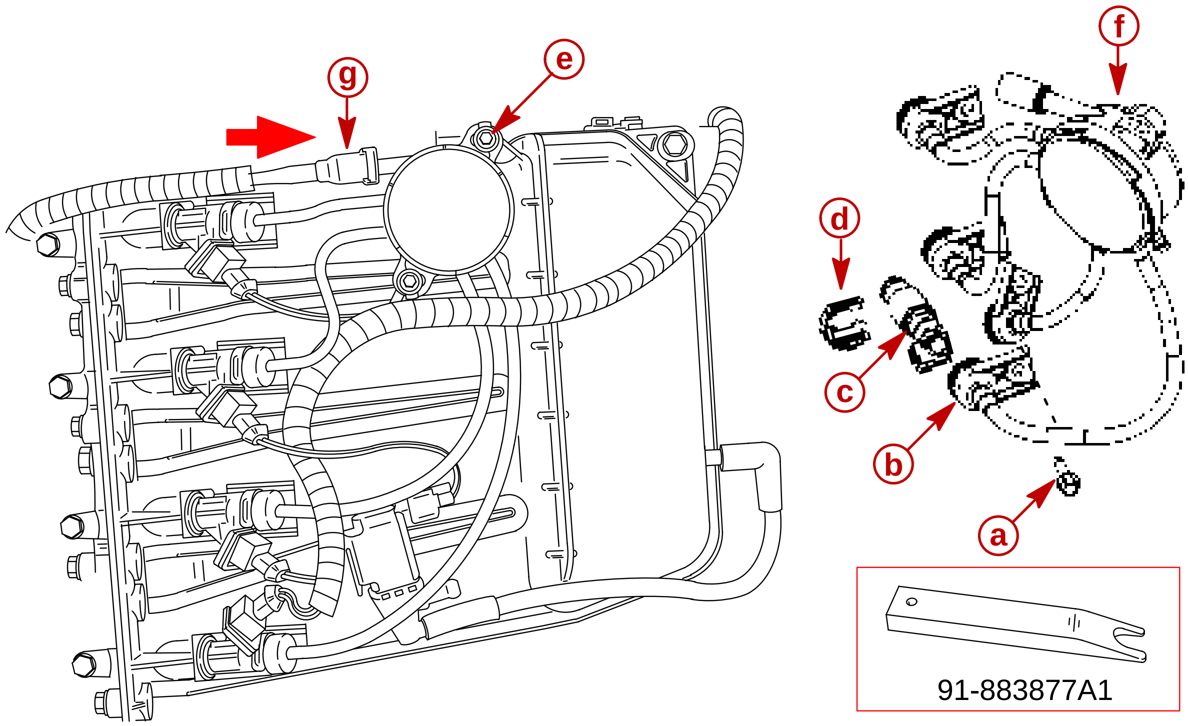
1. Remove fuel injector cap retaining screws.
2. Remove the fuel injector cap retaining clips.
3. Using service tool 91-883877A1, pry the fuel injector cap off of each fuel injector.
4. Remove fuel distribution manifold mounting screws.
5. **AFTER RELIEVING FUEL PRESSURE** disconnect the high pressure fuel line by depressing the locking tab and pulling back. Remove fuel distribution manifold.



a - Fuel Injector Cap Retaining Screw (4)
b - Fuel Injector Cap (4)
c - Fuel Injector Cap Retaining Clip (4)
d - Fuel Distribution Manifold Mounting Screw (2)
e - Fuel Distribution Manifold
f - High Pressure Fuel Line Locking Tab

Installation

1. Install fuel distribution manifold and tighten mounting screws to specified torque.
2. Push fuel injector cap onto the fuel injector until the cap bottoms out on the injector.
3. Install fuel injector cap retaining screws and tighten securely. Install fuel injector cap retaining clips so that the locking teeth line up with the locking rib on the fuel injector (as shown).
4. Connect high pressure fuel line. Push on until locking tab snaps in place.



a - Fuel Injector Cap Retaining Screw (4)
b - Fuel Injector Cap (4)
c - Fuel Injector (4)
d - Fuel Injector Cap Retaining Clip (4)
e - Fuel Distribution Manifold Mounting Screw (2)
f - Fuel Distribution Manifold
g - High Pressure Fuel Line

Mounting Screw Torque
31 lb-in (3.5 Nm)

Manifold Air Temperature (MAT) Sensor Removal/Installation

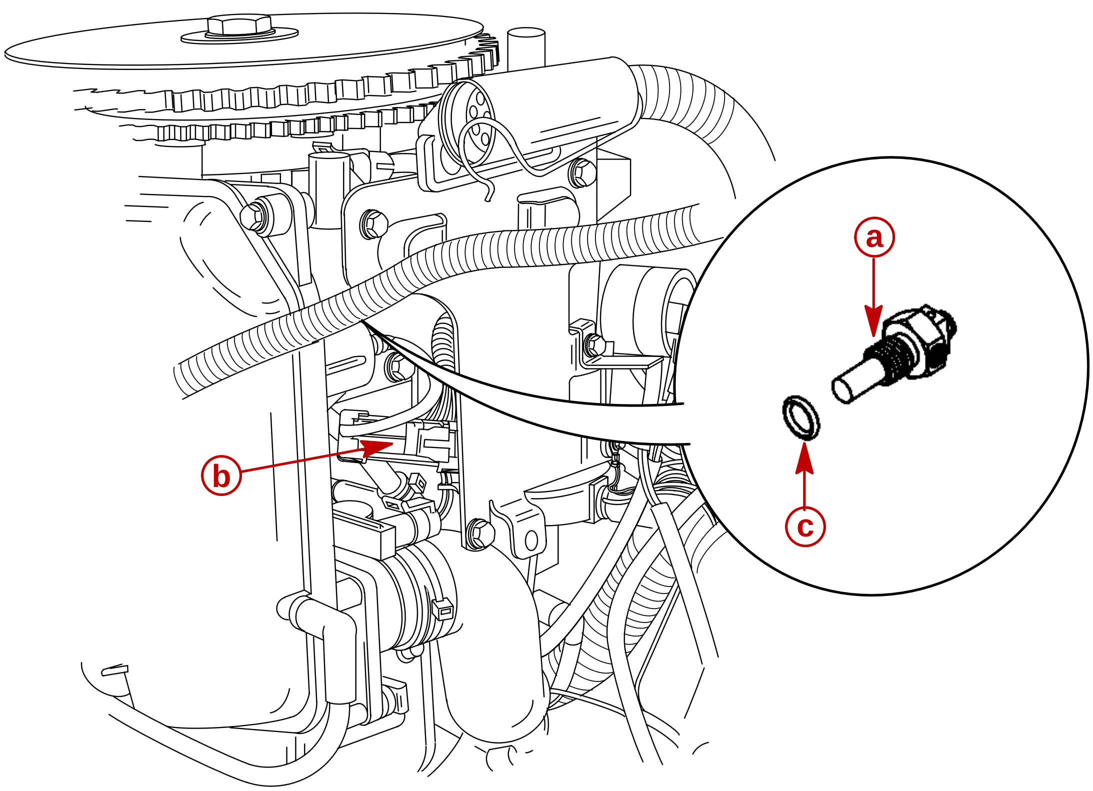
REMOVAL

1. Remove the intake manifold assembly. Refer to **Intake Manifold Assembly Removal.**
2. Disconnect manifold air temperature (MAT) sensor connector.
3. Unscrew MAT sensor from the intake manifold assembly. Inspect o-ring and replace if necessary.

INSTALLATION

CAUTION
Overtightening the manifold air temperature (MAT) sensor can lead to failing the plastic threads. Be sure to tighten to the specified torque.

1. Lubricate O-ring and screw in air temperature sensor. Tighten to specified torque.
2. Connect MAT sensor connector.
3. Install the intake manifold assembly. Refer to **Intake Manifold Assembly Installation.**



a - Manifold Air Temperature (MAT) Sensor
b - MAT Sensor Connector
c - O-ring

Air Temperature Sensor Torque
12.5 lb-in. (1.4 Nm)

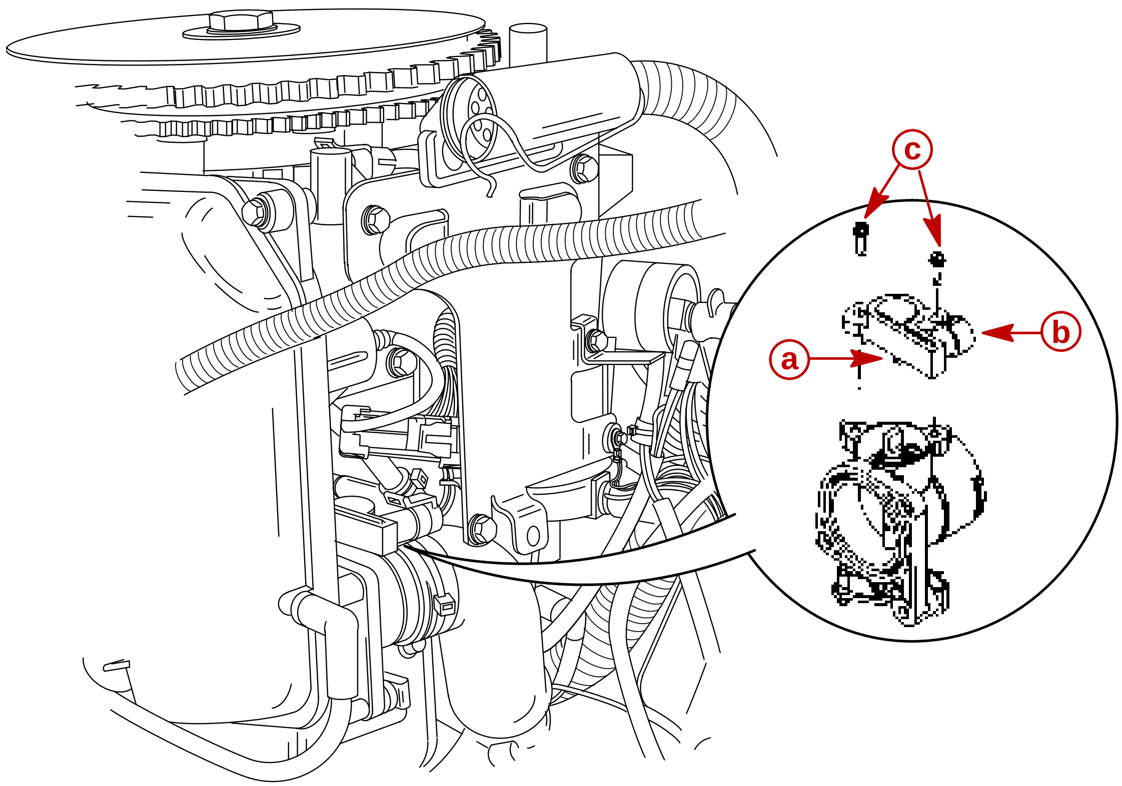
Throttle Position Sensor (TPS) Removal/Installation

REMOVAL

1. Remove the intake manifold assembly. Refer to **Intake Manifold Assembly Removal.**
2. Disconnect throttle position sensor (TPS) connector.
3. Remove mounting screws and remove throttle position sensor.

INSTALLATION

1. Install throttle position sensor. Tighten screws to specified torque.
2. Connect throttle position sensor connector.
3. Install the intake manifold assembly. Refer to **Intake Manifold Assembly Installation.**



a - Throttle Position Sensor (TPS)
b - TPS Connector
c - TPS Mounting Screws(2) 15 mm long

Throttle Position Sensor Mounting Screw Torque
18 lb-in (2 Nm)

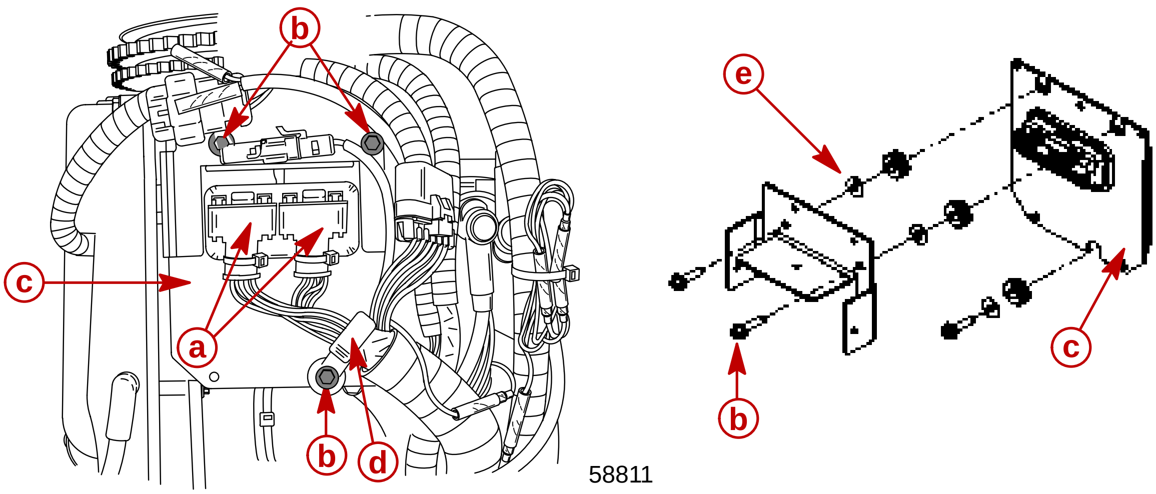
ECM Removal/Installation

Removal

1. Remove ECM harness connectors.
2. Remove the ECM mounting screws and washers. Remove the ECM from the mounting plate.

Installation

1. Install ECM onto mounting bracket (position the j-clip as shown). Install screws and washers. Tighten screws to specified torque.
2. Connect ECM harness connectors.



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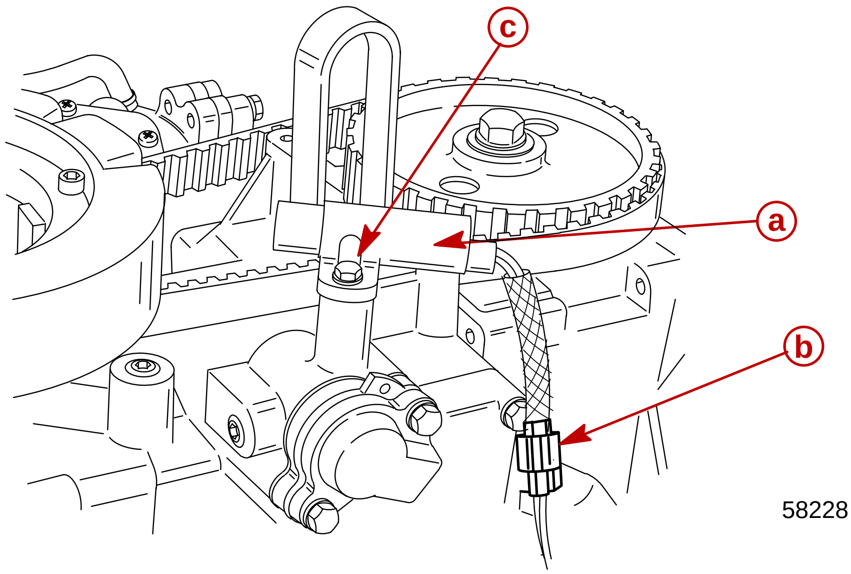
a - ECM Harness Connectors
b - ECM Mounting Screw (3) M6 x 25
c - ECM
d - J-clip
e - Washers (3)

ECM Mounting Screw Torque
45 lb. in. (5.1 N·m)

Crank Position Sensor Removal/Installation

1. Disconnect sensor from wiring harness.
2. Remove sensor mounting screws.
3. Reverse steps for installation. Tighten screws to specified torque.



a - Crank Position Sensor
b - Harness Connector
c - Screw (2) M5x16

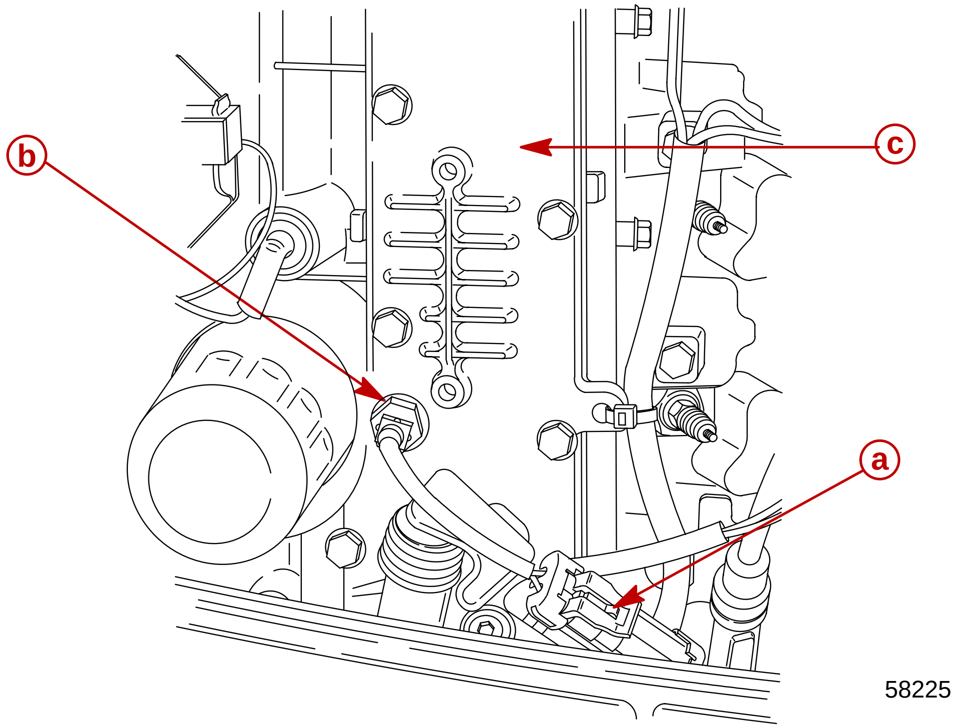
Crank Position Sensor Mounting Screw Torque
45 lb. in. (5.1 N·m)

Engine Coolant Temperature (ECT) Sensor Removal/Installation

1. Disconnect sensor from wiring harness.
2. Remove sensor from exhaust cover.
3. Reverse steps for installation. Tighten to specified torque.

⚠ CAUTION

Over-tightening the coolant temperature sensor can lead to failing the plastic threads. Be sure to tighten to the specified torque.



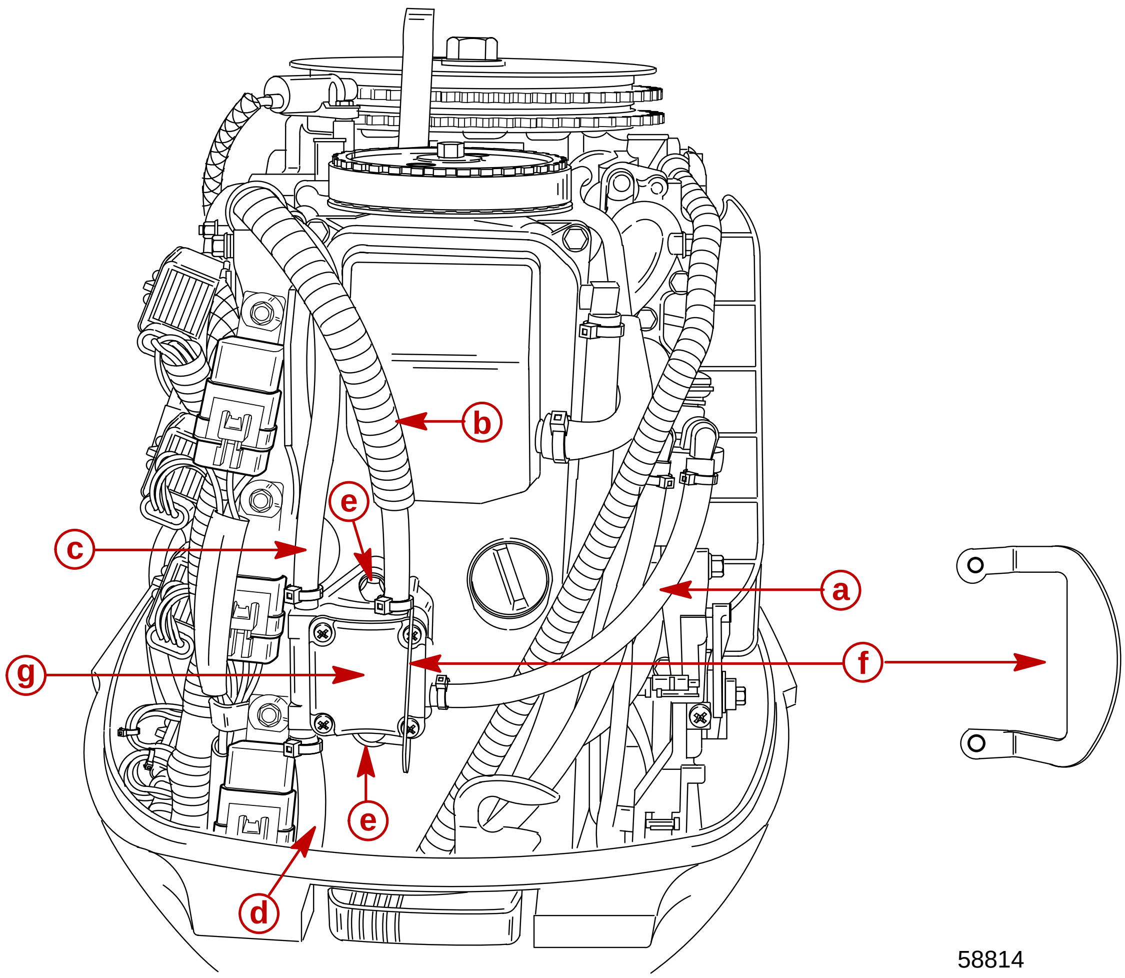
a - Harness Connector
b - Temperature Sensor
c - Exhaust Cover

Temperature Sensor Mounting Torque
15 lb. in. (1.7 N·m)

Low Pressure Fuel Line/Fuel Pump

Removal

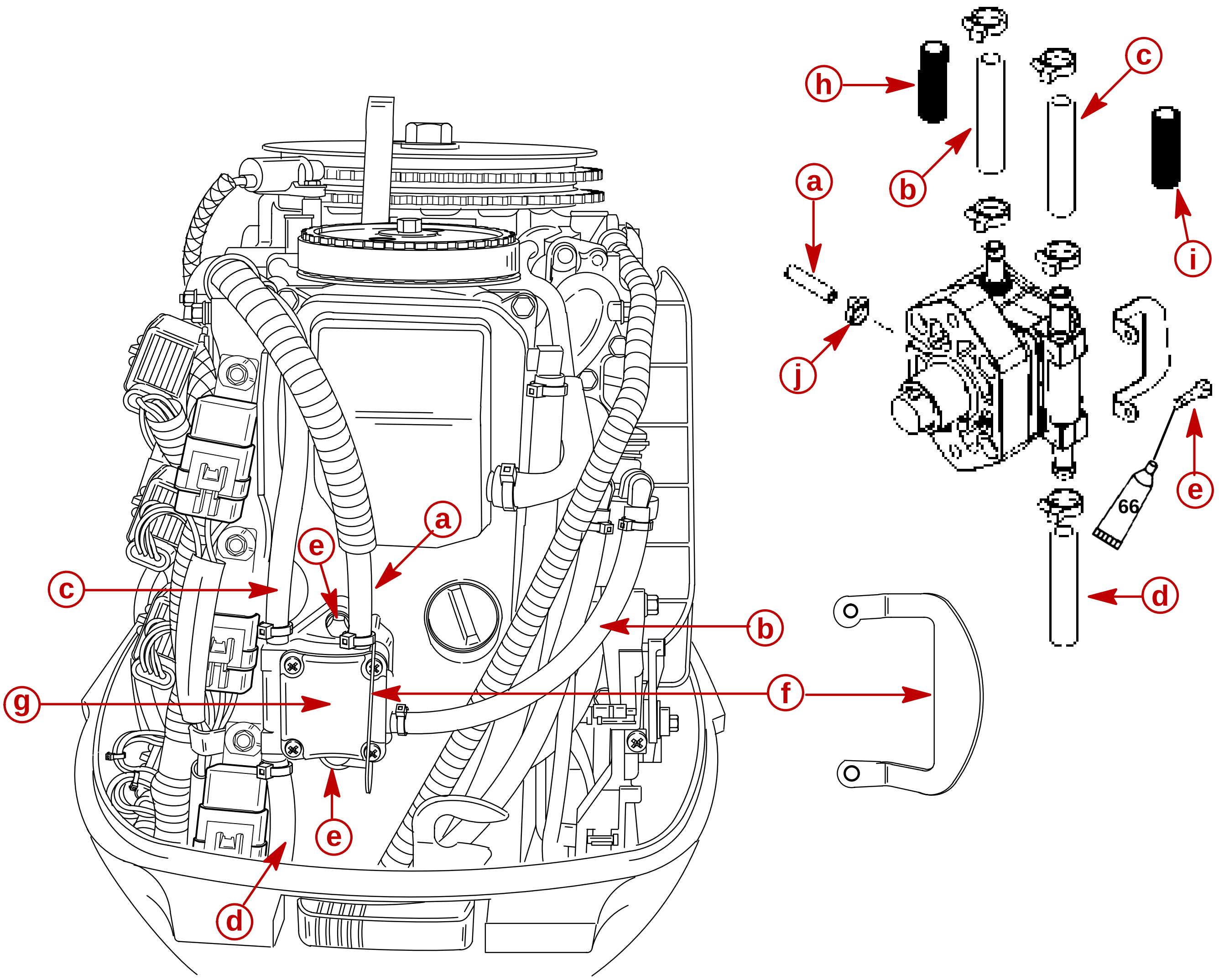
1. Cut sta-straps and remove fuel pump inlet/outlet hoses, and fuel cooler water inlet/outlet hoses.
2. Remove fuel pump mounting bolts and cowl deflector.
3. Separate fuel pump from cylinder head cover.



a - Inlet Fuel Hose (from filter)
b - Outlet Fuel Hose (to VST)
c - Fuel Cooler Water Inlet Hose (from VST fuel cooler)
d - Fuel Cooler Water Outlet Hose (to tell-tale outlet)
e - Mounting Screw (2) M6 x 30
f - Cowl Deflector
g - Fuel Pump

Installation

1. Secure fuel pump and cowl deflector to cylinder head cover with screws. Tighten to specified torque.
2. Connect fuel lines to pump and secure with new sta-straps.



66 Loctite 242 (92-809821)

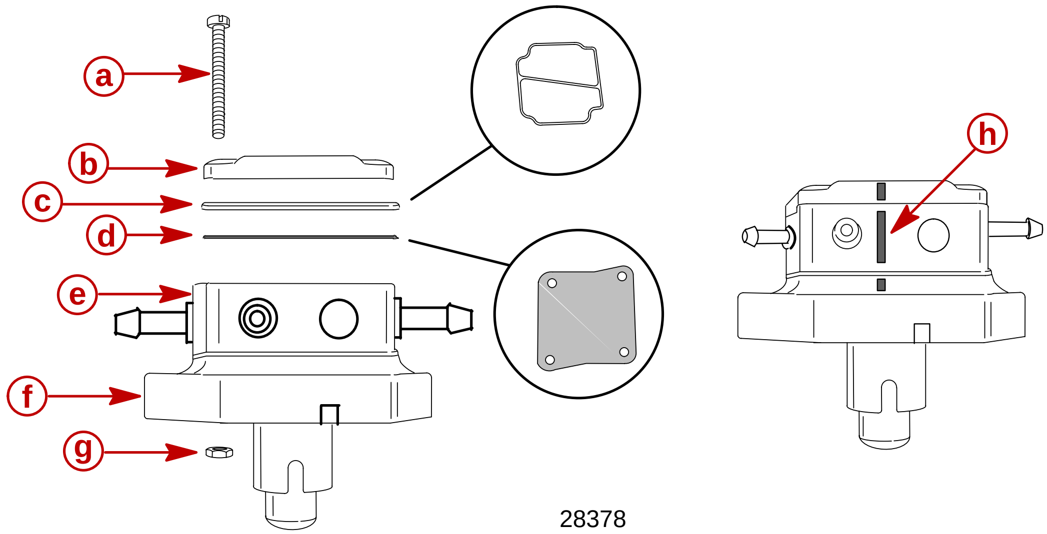
a - Inlet Fuel Hose (from fuel filter)
b - Outlet Fuel Hose (to VST)
c - Fuel Cooler Water Inlet Hose (from VST fuel cooler)
d - Fuel Cooler Water Outlet Hose (to tell-tale outlet)
e - Mounting Screw (2) M6 x 30
f - Cowl Deflector
g - Fuel Pump
h - Conduit (13 in.)
i - Conduit (21 in.)
j - Sta-strap

Fuel Pump Mounting Screw Torque
75 lb. in. (8.5 N·m)

Disassembly

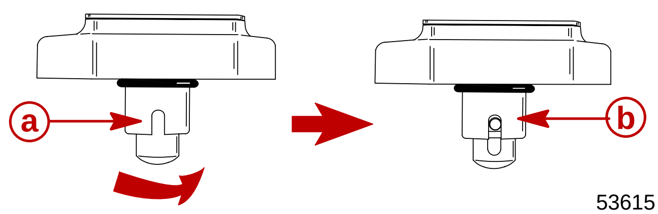
IMPORTANT: Before separating fuel pump components mark each component with an awl or marker. This will ensure the components are oriented correctly during reassembly.

1. Remove screws to separate pump cover, cover seal, diaphragm and valve body from pump base.



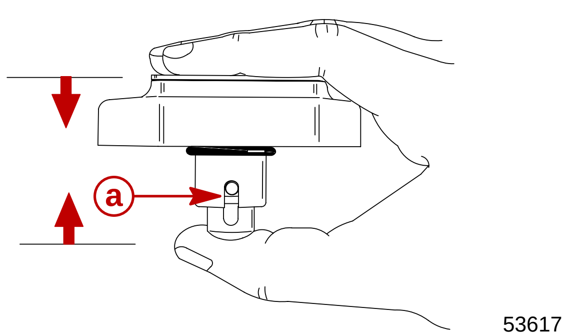
a - Screws (4)
b - Pump Cover
c - Cover Seal
d - Diaphragm
e - Valve Body
f - Pump Base
g - Nuts (4)
h - I.D. Marks (Create These)

2. Rotate plunger to line up slots.



a - Slots Offset
b - Slots Aligned

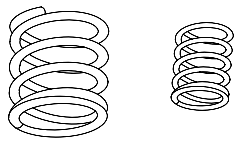
3. Compress pump assembly to free spring load on pin.
4. Tilt assembly to allow pin to slide out.



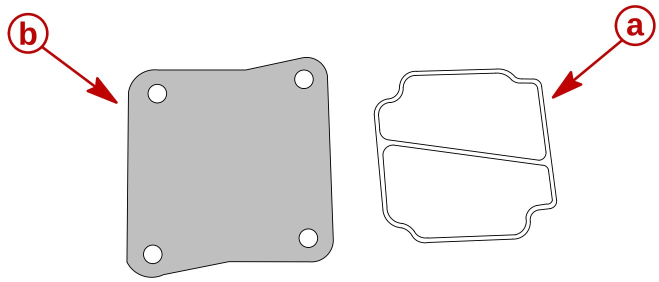
a - Pin

Cleaning/Inspection/Repair

1. Inspect springs for damage, replace if necessary.



2. Inspect cover seal and diaphragm, replace if damaged.



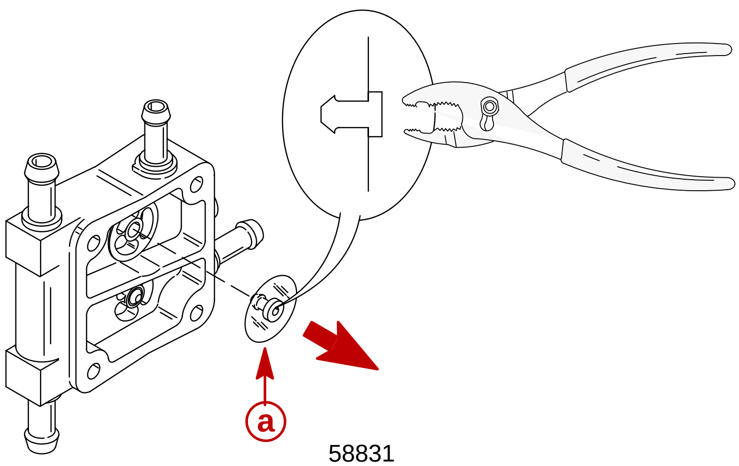
a - Cover Seal
b - Diaphragm

Check Valve Inspection/Replacement

1. Inspect the check valves for damage, replace if necessary.

REMOVAL

2. If replacement is needed remove old check valves by grabbing the seal and pulling.

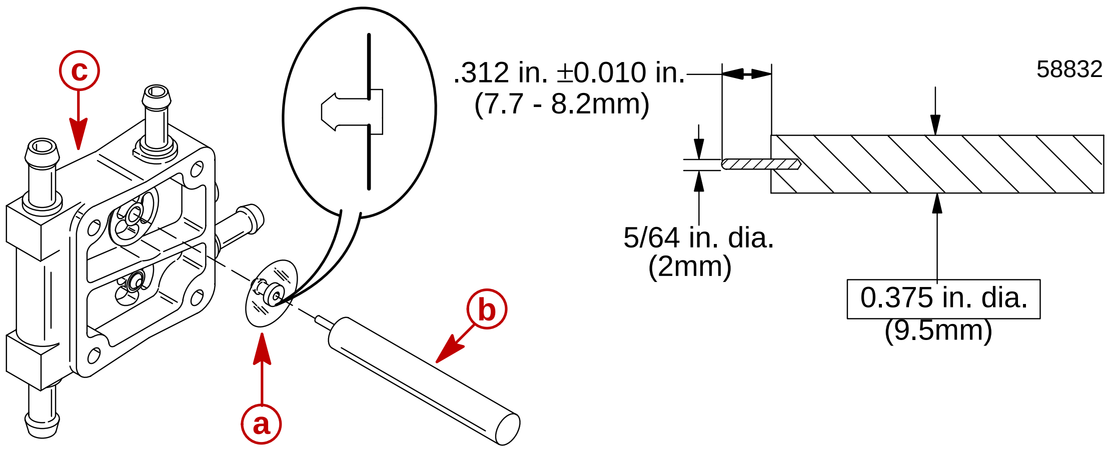


a - Check Valve/Seal Assembly (2)

INSTALLATION

1. Fabricate an installation tool to the dimensions specified.
2. Lubricate the end of the seal and push the assembly into the valve body.

NOTE: *Drill into the handle using a 5/64 in. (2mm) drill bit. Insert the peg into the drilled hole until 0.312 in. (8mm) remains exposed.*

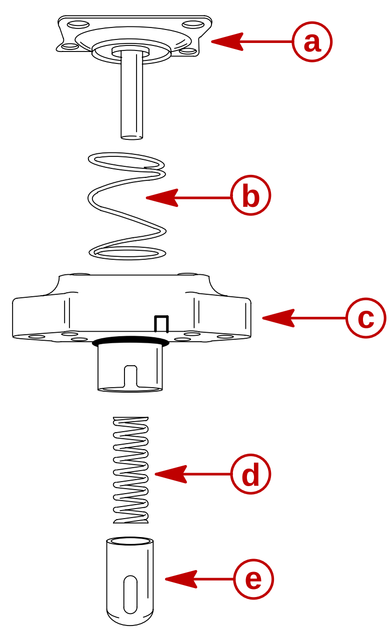


58831

a - Check Valve/Seal Assembly (2)
b - Installation Tool (make yourself)
c - Valve Body

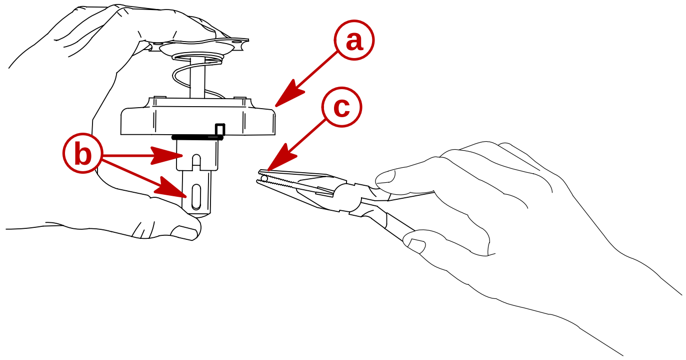
Assembly

1. Assemble springs, diaphragm, and plunger onto pump base.



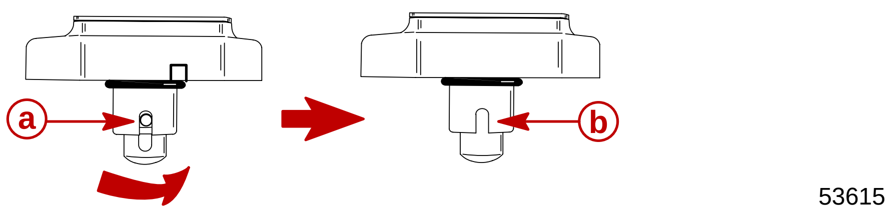
a - Diaphragm
b - Diaphragm Spring
c - Pump Body
d - Spring
e - Plunger

2. Line up slots and compress assembly.
3. Insert pin into hole.



a - Pump Body
b - Slots
c - Pin

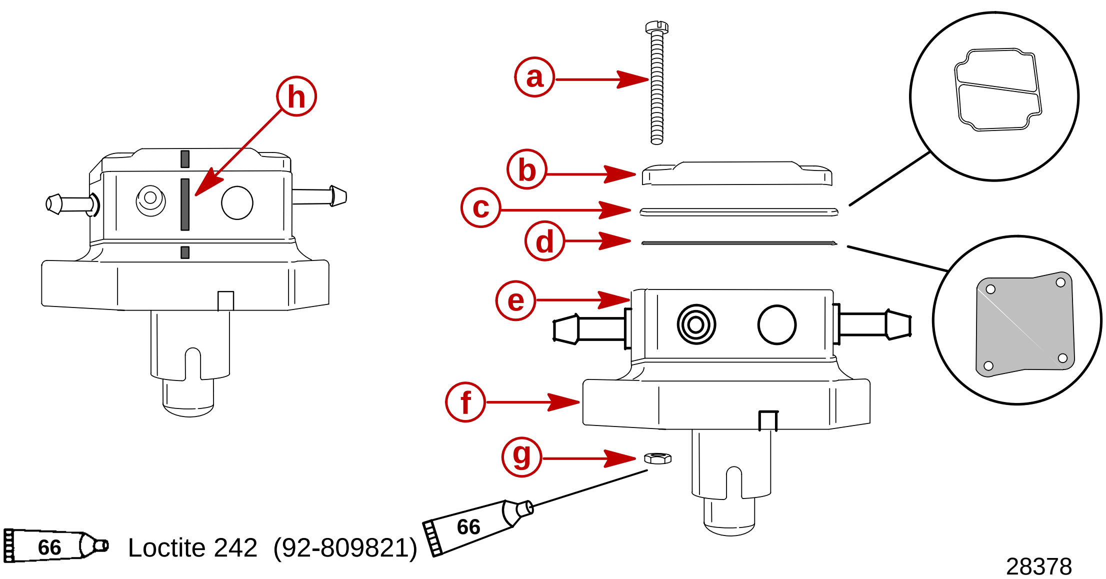
4. Rotate plunger 90° to offset slots.



a - Slots Aligned
b - Slots Offset

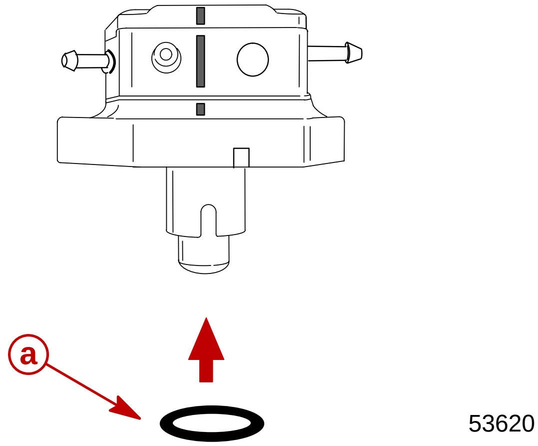
5. Assemble valve body, diaphragm, seal, and cover to pump base. **Be sure to line up I.D. marks that were made before disassembly.** Apply Loctite 242 to screws and secure with nuts.

NOTE: *Seal installs in one direction only.*



a - Screws (4)
b - Pump Cover
c - Cover Seal
d - Diaphragm
e - Valve Body
f - Pump Base
g - Nuts (4)
h - I.D. Marks

6. Inspect O-ring and replace if necessary. Install onto fuel pump assembly.



a - O-ring

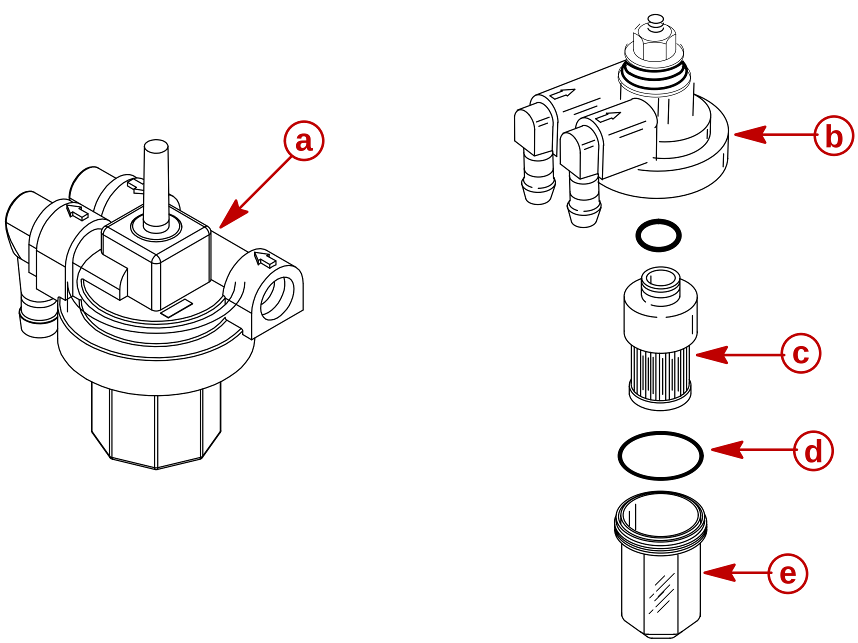
Fuel Filter Disassembly/Assembly

DISASSEMBLY

1. Unscrew fuel filter cup and remove fuel filter element and o-rings.
2. Inspect o-rings and replace if necessary.
3. Clean fuel filter cup and replace fuel filter element if needed.

ASSEMBLY

1. Lubricate o-rings and install fuel filter element.
2. Install fuel filter cup and hand tighten.



a - Fuel Filter Assembly
b - Fuel Filter Cap
c - Fuel Filter Element
d - O-ring
e - Fuel Filter Cup

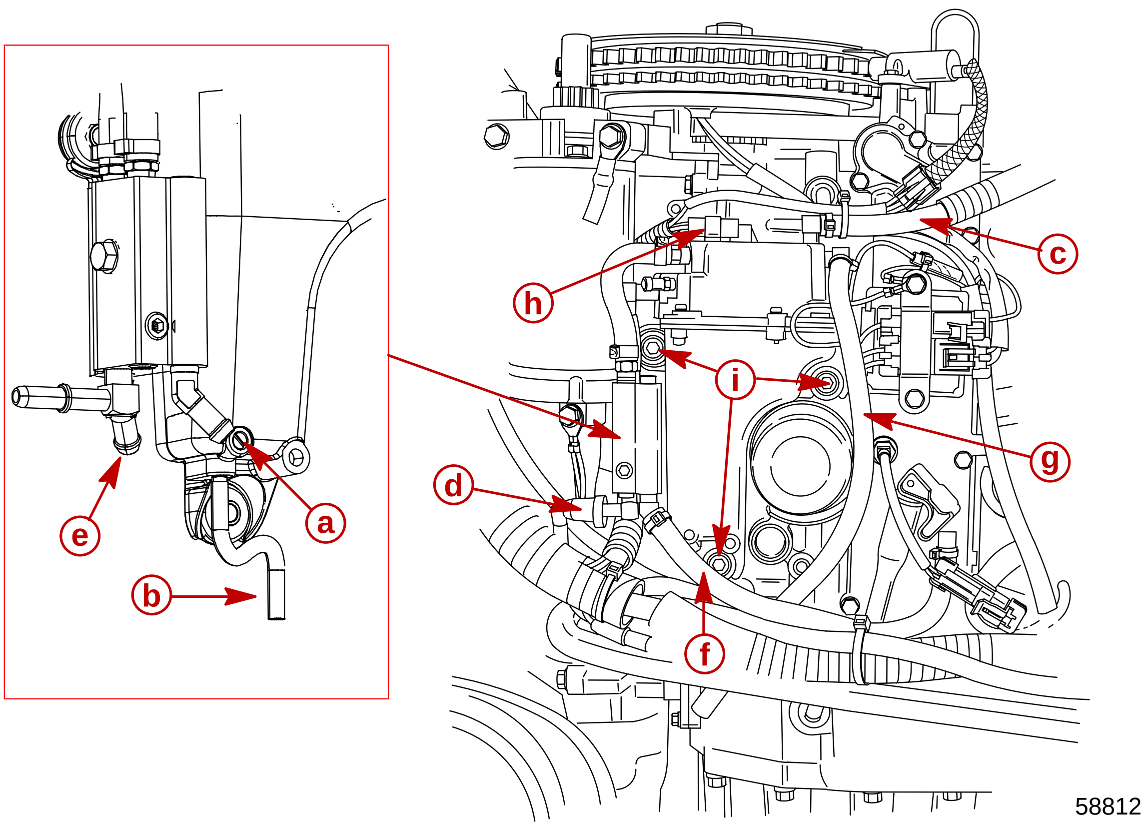
Vapor Separator (VST)

⚠ WARNING

Always release the fuel pressure in the high-pressure fuel line before servicing the line or the vapor separator. If the fuel pressure is not released, pressurized fuel may spray out.

Removal

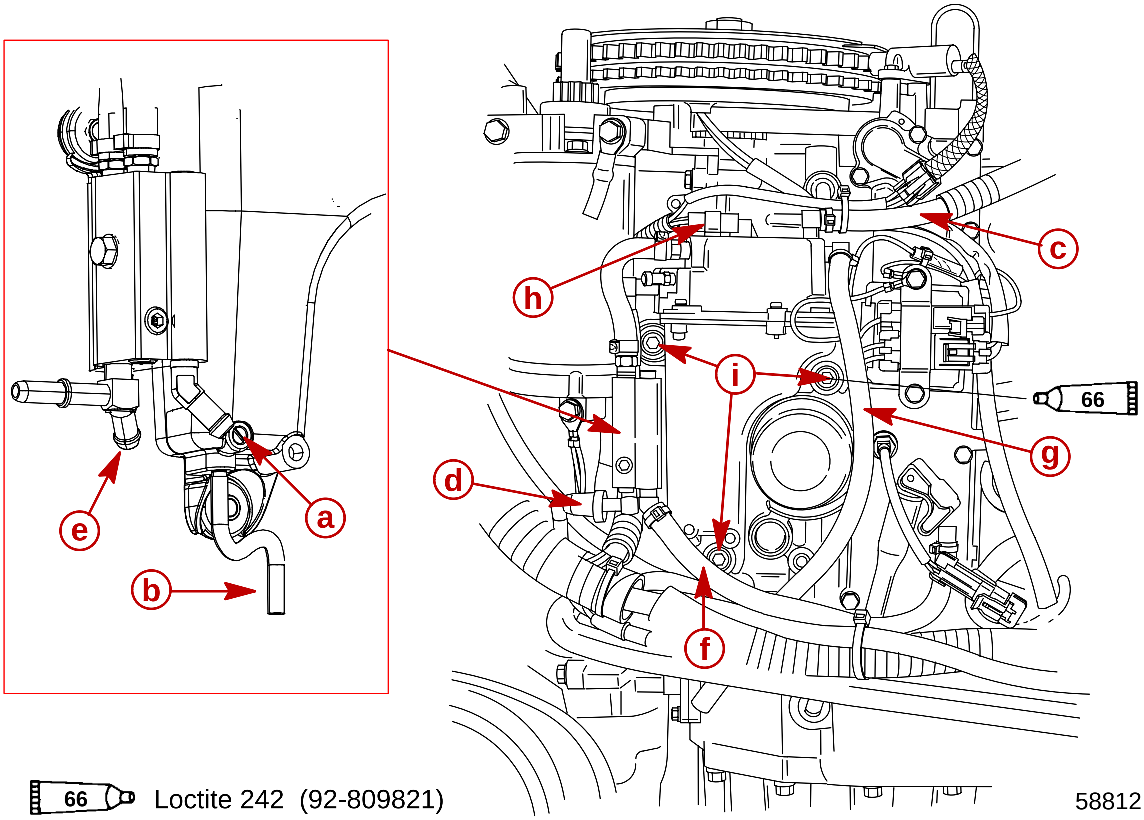
1. Release fuel pressure. Refer to **Releasing Fuel Pressure in the High Pressure Fuel Line**.
2. Remove the lower cowl. Drain the fuel from the VST into a suitable container.
3. Disconnect fuel lines, water lines and high pressure fuel pump harness connector.
4. Remove vapor separator (VST) mounting screws and remove VST from engine.



a - VST Drain Valve
b - VST Drain Hose
c - Fuel Hose (Mechanical Fuel Pump to VST)
d - High Pressure Fuel Hose (Fuel Cooler to Fuel Distribution Manifold)
e - Water Hose (VST Fuel Cooler to Mechanical Fuel Pump Fuel Cooler)
f - Water Hose (Exhaust Cover to Fuel Cooler)
g - VST Vent Hose
h - High Pressure Fuel Pump Harness Connector
i - Vapor Separator Mounting Screws (3) M6 x 25

Installation

1. Tighten drain valve and install VST to engine. Tighten mounting screws to specified torque.
2. Connect fuel and water hoses as shown below. Secure with sta-straps.
3. Plug in high pressure fuel pump harness connector.

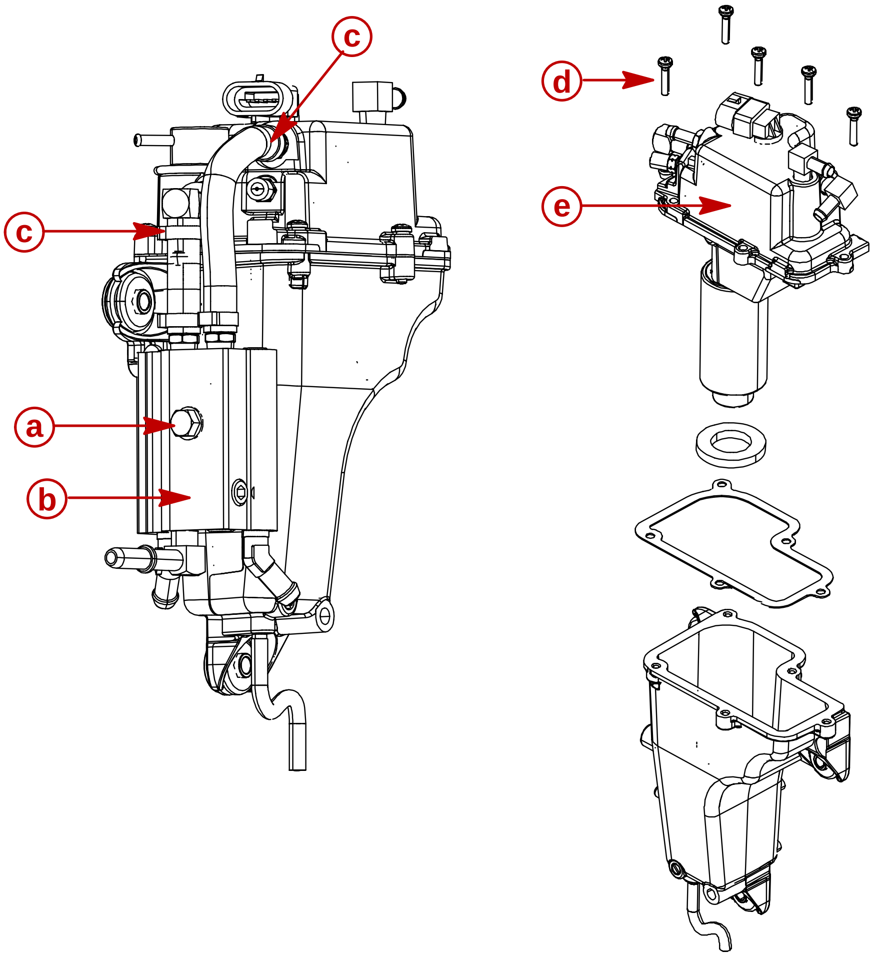


a - VST Drain Valve
b - VST Drain Hose
c - Fuel Hose (Mechanical Fuel Pump to VST)
d - High Pressure Fuel Hose (Fuel Cooler to Fuel Distribution Manifold)
e - Water Hose (VST Fuel Cooler to Mechanical Fuel Pump Fuel Cooler)
f - Water Hose (Exhaust Cover to Fuel Cooler)
g - VST Vent Hose
h - High Pressure Fuel Pump Harness Connector
i - Vapor Separator Mounting Screws (3) M6 x 25

Vapor Separator Mounting Screw Torque
45 lb. in. (5 N·m)

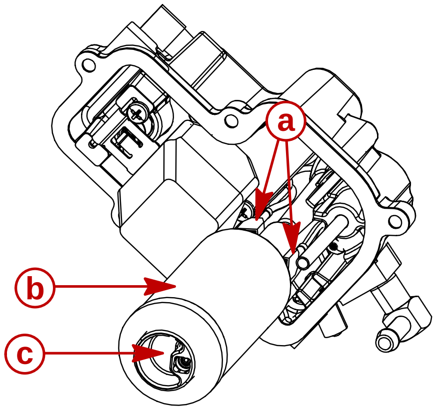
Disassembly

1. Remove fuel cooler mounting screw.
2. If removal of fuel cooler is required (because of damaged/plugged hoses or fuel cooler replacement), cut metal hose clamps and remove fuel hoses from VST cover. Remove fuel cooler.
3. Remove VST cover screws and remove cover assembly.



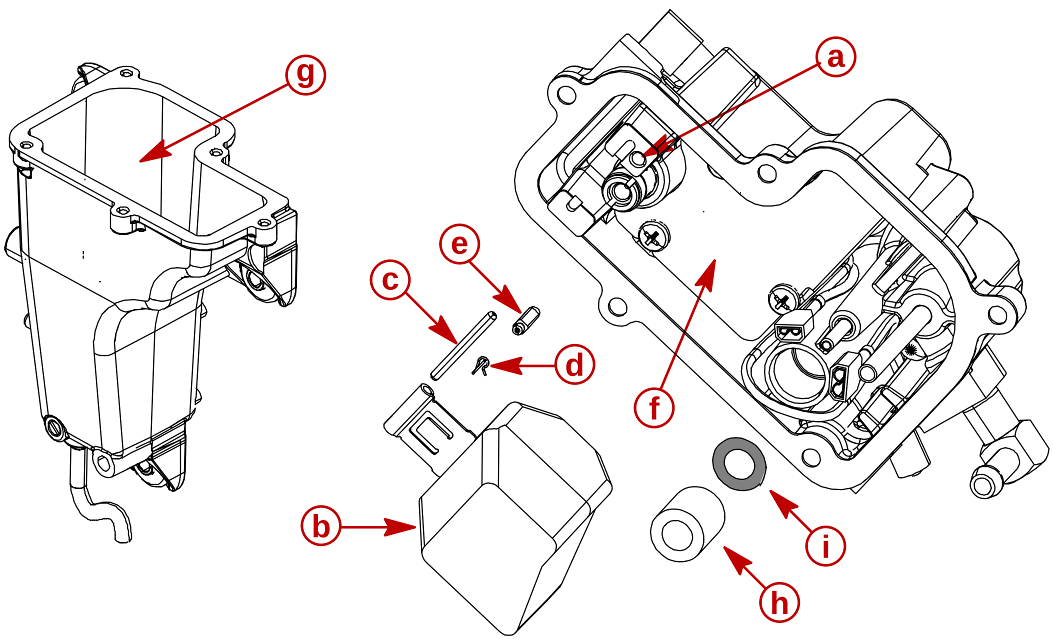
a - Fuel Cooler Mounting Screw (1) M6 x 25
b - Fuel Cooler
c - Metal Hose Clamp
d - VST Cover Screws (5)
e - VST Cover Assembly

4. Disconnect high pressure fuel pump connectors and remove high pressure fuel pump.
5. Inspect and clean high pressure fuel pump screen.



a - Connectors
b - High Pressure Fuel Pump
c - Screen

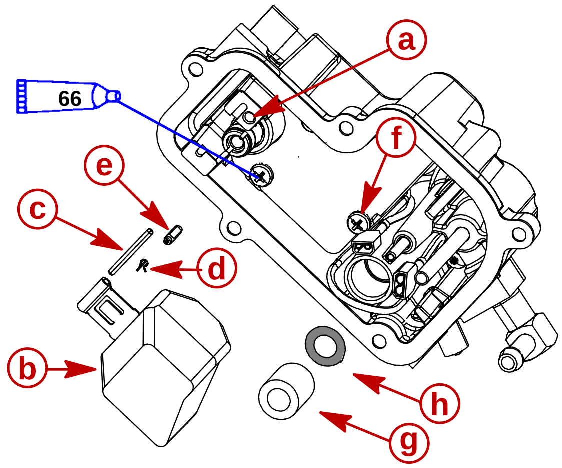
6. Loosen float pin retaining screw and remove float assembly.
7. Remove baffle plate (if desired).
8. Remove and inspect seat.
9. Inspect and clean VST float chamber.



a - Float Pin Retaining Screw
b - Float
c - Float Shaft
d - Clip
e - Needle
f - Baffle Plate
g - VST Float Chamber
h - Seat
i - Gasket

Assembly

1. Apply Loctite 242 to screws and install baffle plate (if removed). Tighten screws to specified torque.
2. Install seat (with new gasket) and tighten.
3. Install float assembly as shown. Install float pin and tighten retaining screw to specified torque.

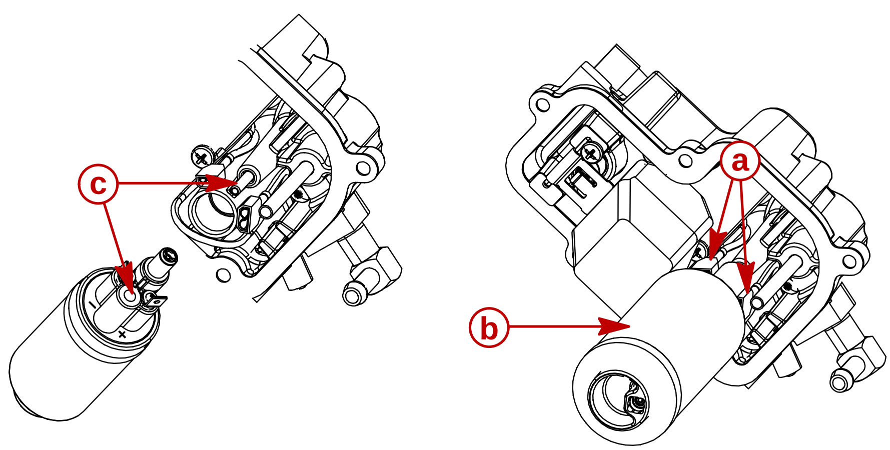


66 Loctite 242 (92-809821)

a - Float Pin Retaining Screw
b - Float
c - Float Shaft
d - Clip
e - Needle
f - Baffle Plate Screw (3)
g - Seat
h - Gasket

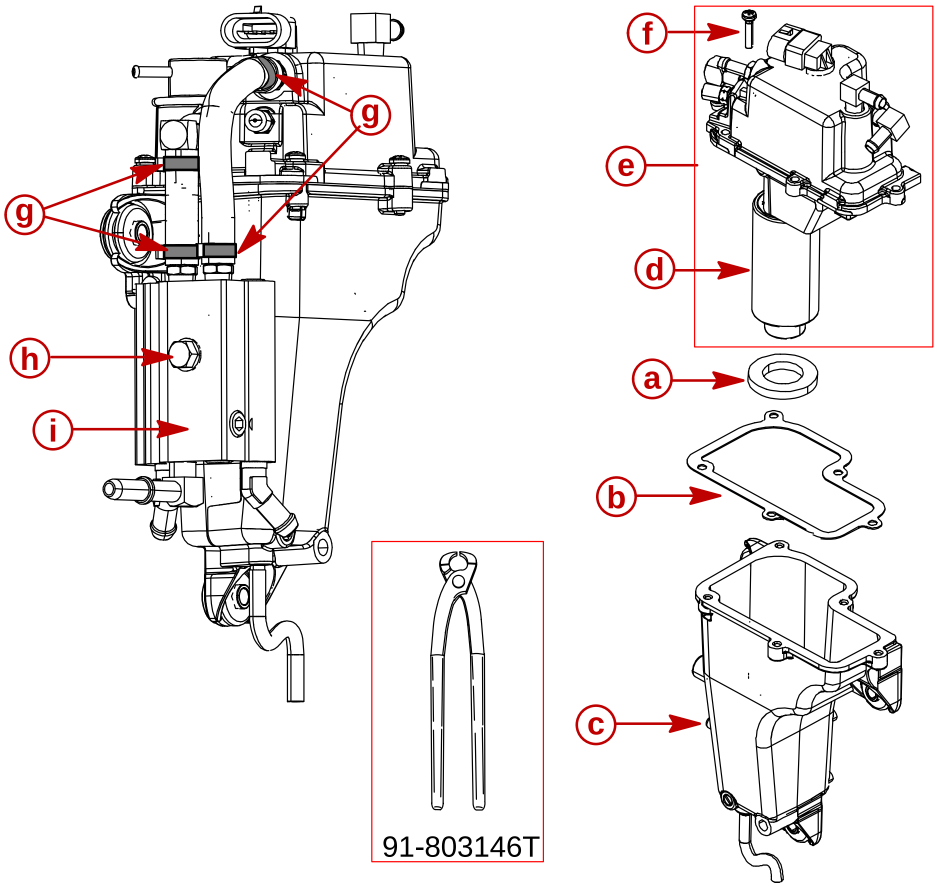
Screw Torque
22 lb. in. (2.5 N·m)

4. Connect the high pressure fuel pump connectors. Push the nozzle into the rubber grommet (lubricate with light oil if necessary). Make sure the alignment pin is positioned properly and lines up with hole in the high pressure fuel pump.



a - Connectors
b - High Pressure Fuel Pump
c - Alignment Pin

5. Install grommet to the bottom of the high pressure fuel pump.
6. Lightly clamp the VST float chamber in a vise. Position the VST cover assembly so the high pressure fuel pump is horizontal. This will prevent the grommet from falling off.
7. Install VST cover assembly and new gasket, into float chamber. Push the cover and float chamber together, this will compress the grommet and allow the screws to be threaded in.
8. Install VST cover screws and tighten to specified torque.



a - Grommet
b - Gasket
c - VST Float Chamber
d - High Pressure Fuel Pump
e - VST Cover Assembly
f - VST Cover Screws (5)
g - Metal Hose Clamp (4)
h - Fuel Cooler Mounting Screw(1) M4 x 20
i - Fuel Cooler

Screw Torque
32 lb. in. (3.5 N·m)

Pressure Regulator Removal/Installation

⚠ WARNING
Always release the fuel pressure in the high-pressure fuel line before servicing the line or the vapor separator. If the fuel pressure is not released, pressurized fuel may spray out.

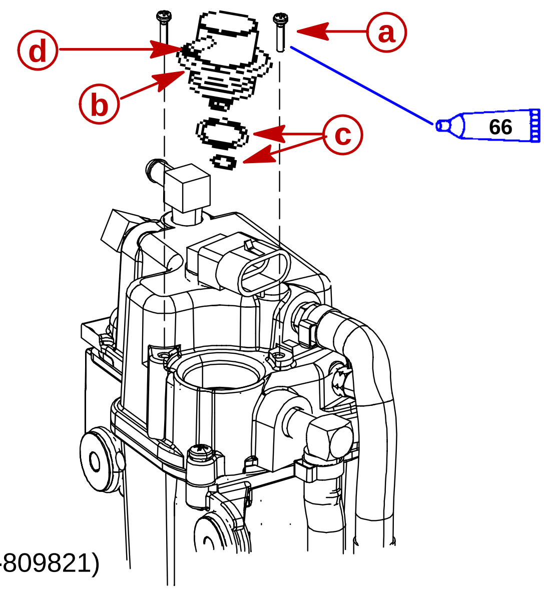
NOTE: *The pressure regulator vent is an open fitting that does not require a hose to be attached.*

Removal

1. Release fuel pressure. Refer to **Releasing Fuel Pressure in the High Pressure Fuel Line**.
2. Remove fuel pressure regulator mounting screws and remove regulator from VST cover.
3. Inspect o-rings. Replace if necessary. Inspect and clean screen.

Installation

1. Lubricate o-rings with light lubricant and reassemble the pressure regulator to the VST cover (twist while pushing in).
2. Apply Loctite 242 to mounting screws and tighten to specified torque.



66 Loctite 242 (92-809821)

a - Mounting Screw (2)
b - Fuel Pressure Regulator
c - O-rings
d - Vent (no hose)

Pressure Regulator Mounting Screw Torque
22 lb. in. (2.5 N·m)

High Pressure Fuel Line Removal/Installation

⚠ WARNING

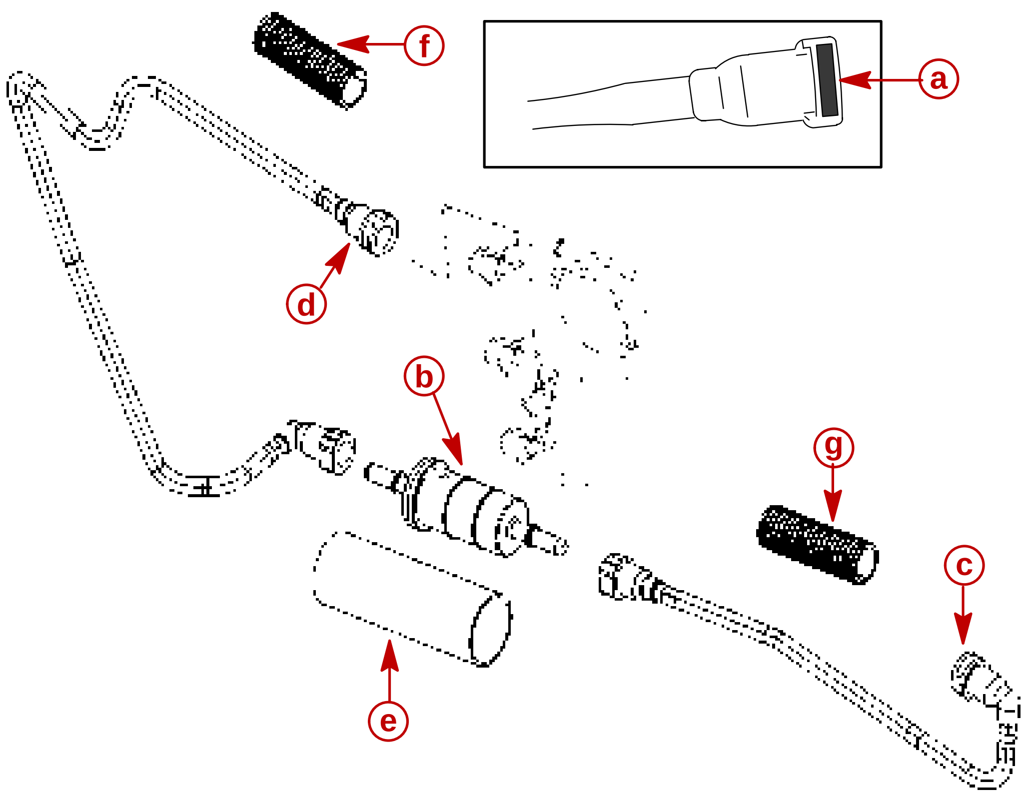
Always release the fuel pressure in the high-pressure fuel line before servicing the line or the vapor separator. If the fuel pressure is not released, pressurized fuel may spray out.

REMOVAL

1. Disconnect the fuel line from the fuel distribution manifold by depressing the locking tab.
2. Disconnect the fuel line from the fuel cooler by depressing the locking tab.
3. Remove the high pressure fuel line assembly.
4. Inspect filter for cracks/debris. Replace if necessary.

INSTALLATION

1. Connect fuel lines as shown.



a - Locking Tab
b - Fuel Filter
c - Fuel Line (to VST fuel cooler)
d - Fuel Line (to fuel distribution manifold)
e - Protective Sleeve
f - Conduit
g - Conduit

ELECTRONIC FUEL INJECTION

Section 3D – Emissions

Table of Contents

3
D

Exhaust Emissions Standards

Through the Environmental Protection Agency (EPA), the federal government has established exhaust emissions standards for all new marine engines sold in the U.S.

What Are Emissions?

Emissions are what comes out of the exhaust system in the exhaust gas when the engine is running. They are formed as a result of the process of combustion or incomplete combustion. To understand exhaust gas emissions, remember that both air and fuel are made of several elements. Air contains oxygen and nitrogen among other elements; gasolene contains mainly hydrogen and carbon. These four elements combine chemically during combustion. If combustion were complete, the mixture of air and gasoline would result in these emissions: water, carbon dioxide and nitrogen, which are not harmful to the environment. But combustion is not usually complete. Also, potentially harmful gases can be formed during and after combustion.

All marine engines must reduce the emission of certain pollutants, or potentially harmful gases, in the exhaust to conform with levels legislated by the EPA. Emissions standards become more stringent each year. Standards are set primarily with regard to three emissions: hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NOx).

Hydrocarbons – HC

Gasoline is a hydrocarbon fuel. The two elements of hydrogen and carbon are burned during combustion in combination with oxygen. But they are not totally consumed. Some pass through the combustion chamber and exit the exhaust system as unburned gases known as hydrocarbons.

Carbon Monoxide – CO

Carbon is one of the elements that make up the fuel burned in the engine along with oxygen during the combustion process. If the carbon in the gasoline could combine with enough oxygen (one carbon atom with two oxygen atoms), it would come out of the engine in the form of carbon dioxide (CO_2). CO_2 is a harmless gas. But carbon often combines with insufficient oxygen (one carbon atom with one oxygen atom). This forms carbon monoxide, CO. Carbon monoxide is the product of incomplete combustion and is a dangerous, potentially lethal gas.

Oxides of Nitrogen - NOx

NOx is a slightly different byproduct of combustion. Nitrogen is one of the elements that makes up the air going into the engine. Under extremely high temperatures it combines with oxygen to form oxides of nitrogen (NOx). This happens in the engine's combustion chambers when temperatures are too high. NOx itself is not harmful, but when exposed to sunlight it combines with unburned hydrocarbons to create the visible air pollutant known as smog. Smog is a serious problem in California as well as many other heavily populated areas of the United States.

Controlling Emissions

There are two principle methods of reducing emissions from a two-stroke-cycle marine engine. The first method is to control the air/fuel ratio that goes into the combustion chamber. The second is to control the time when this air/fuel mixture enters the combustion chamber. Timing is important, to prevent any unburned mixture from escaping out of the exhaust port.

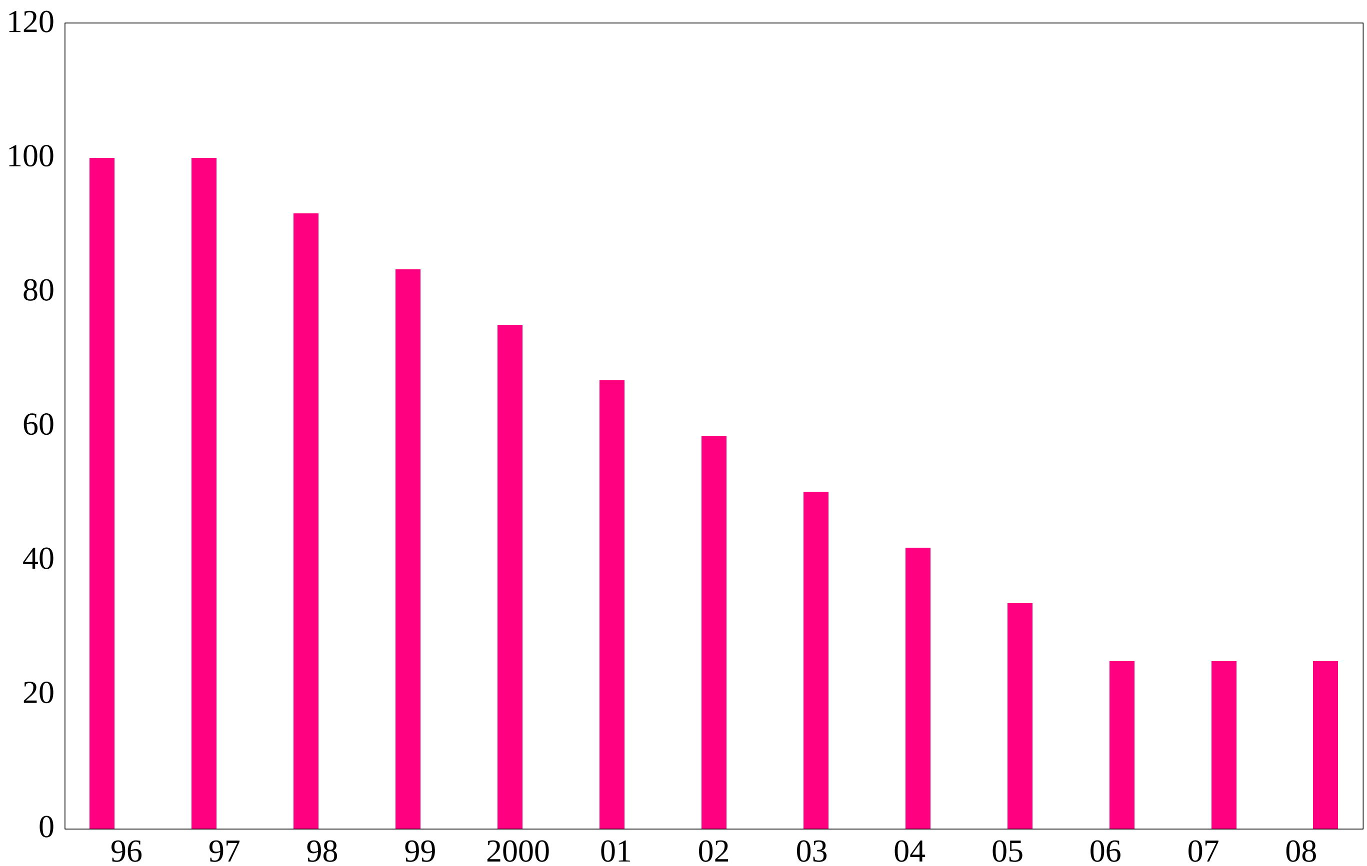
Stoichiometric (14.7:1) Air/Fuel Ratio

In the search to control pollutants and reduce exhaust emissions, engineers have discovered that they can be reduced effectively if a gasoline engine operates at an air/fuel ratio of 14.7:1. The technical term for this ideal ratio is stoichiometric. An air/fuel ratio of 14.7:1 provides the best control of all three elements in the exhaust under almost all conditions. The HC and CO content of the exhaust gas is influenced significantly by the air/fuel ratio. At an air/fuel ratio leaner than 14.7:1, HC and CO levels are low, but with a ratio richer than 14.7:1 they rise rapidly. It would seem that controlling HC and CO by themselves might not be such a difficult task; the air/fuel ratio only needs to be kept leaner than 14.7:1. However, there is also NOx to consider.

As the air/fuel ratio becomes leaner, combustion temperatures increase. Higher combustion temperatures raise the NOx content of the exhaust. But, enrichening the air/fuel ratio to decrease combustion temperatures and reduce NOx also increases HC and CO, as well as lowering fuel economy. So the solution to controlling NOx - as well as HC and CO - is to keep the air/fuel ratio as close to 14.7:1 as possible.

OUTBOARD HYDROCARBON EMISSIONS REDUCTIONS

8 1/3% △PER YEAR OVER 9 MODEL YEARS

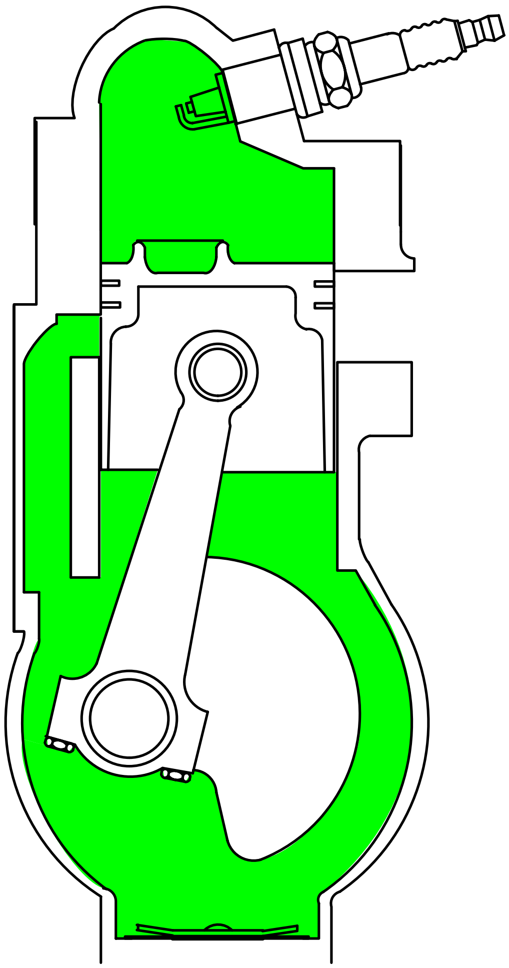


STRATIFIED VS HOMOGENIZED CHARGE

DFI engines use a stratified charge inside the combustion chamber to aid in reducing emissions. All other models use a homogenized charge. The difference between the two is:

Homogenized Charge

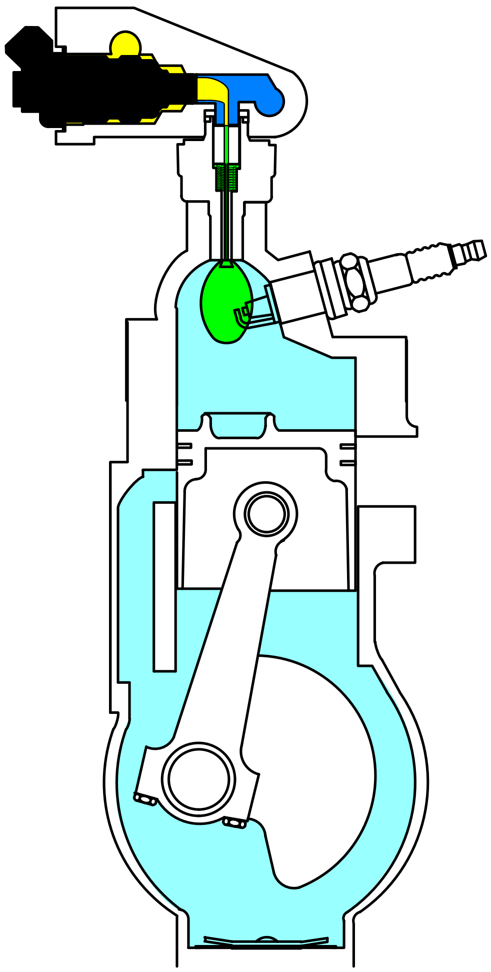
A homogenized charge has the fuel/air particles mixed evenly throughout the cylinder. This mixing occurs inside the carburetor venturi, reed blocks and crankcase. Additional mixing occurs as the fuel is forced through the transfer system into the cylinder. The homogenized charge is easy to ignite as the air/fuel ratio is approximately 14.7:1.



Stratified Charge

A stratified charge engine only pulls air through the transfer system. The fuel required for combustion is forced into the cylinder through an injector placed in the top of the cylinder (head). The injector sprays a fuel/air mixture in the form of a bubble into the cylinder. Surrounding this bubble is air supplied by the transfer system. As the bubble is ignited and burns, the surrounding air provides almost complete combustion before the exhaust port opens.

A stratified charge is hard to ignite, the fuel/air bubble is not evenly mixed at 14.7:1 and not easily ignited.



Emissions Information

Manufacturer's Responsibility:

Beginning with 1998 model year engines, manufacturers of all marine propulsion engines must determine the exhaust emission levels for each engine horsepower family and certify these engines with the United States Environmental Protection Agency (EPA). A certification decal/emissions control information label, showing emission levels and engine specifications directly related to emissions, **must** be placed on each engine at the time of manufacture.

Dealer Responsibility:

When performing service on all 1998 and later outboards that carry a certification, attention must be given to any adjustments that are made that affect emission levels.

Adjustments must be kept within published factory specifications.

Replacement or repair of any emission related component must be executed in a manner that maintains emission levels within the prescribed certification standards.

Dealers are **not** to modify the engine in any manner that would alter the horsepower or allow emission levels to exceed their predetermined factory specifications.

Exceptions include manufacturers prescribed changes, such as that for altitude adjustments.

Owner Responsibility:

The owner/operator is required to have engine maintenance performed to maintain emission levels within prescribed certification standards.

The owner/operator is **not** to modify the engine in any manner that would alter the horsepower or allow emissions levels to exceed their predetermined factory specifications.

Exceptions:

- Carburetor jets may be changed for high altitude use in accordance with factory recommendations.
- Single engine exceptions may be allowed with permission from the EPA for racing and testing.

EPA Emission Regulations:

All new 1998 and later outboards manufactured by Mercury Marine are certified to the United States Environmental Protection Agency as conforming to the requirements of the regulations for the control of air pollution from new outboard motors. This certification is contingent on certain adjustments being set to factory standards. For this reason, the factory procedure for servicing the product must be strictly followed and, whenever practicable, returned to the original intent of the design.

The responsibilities listed above are general and in no way a complete listing of the rules and regulations pertaining to the EPA laws on exhaust emissions for marine products. For more detailed information on this subject, you may contact the following locations:

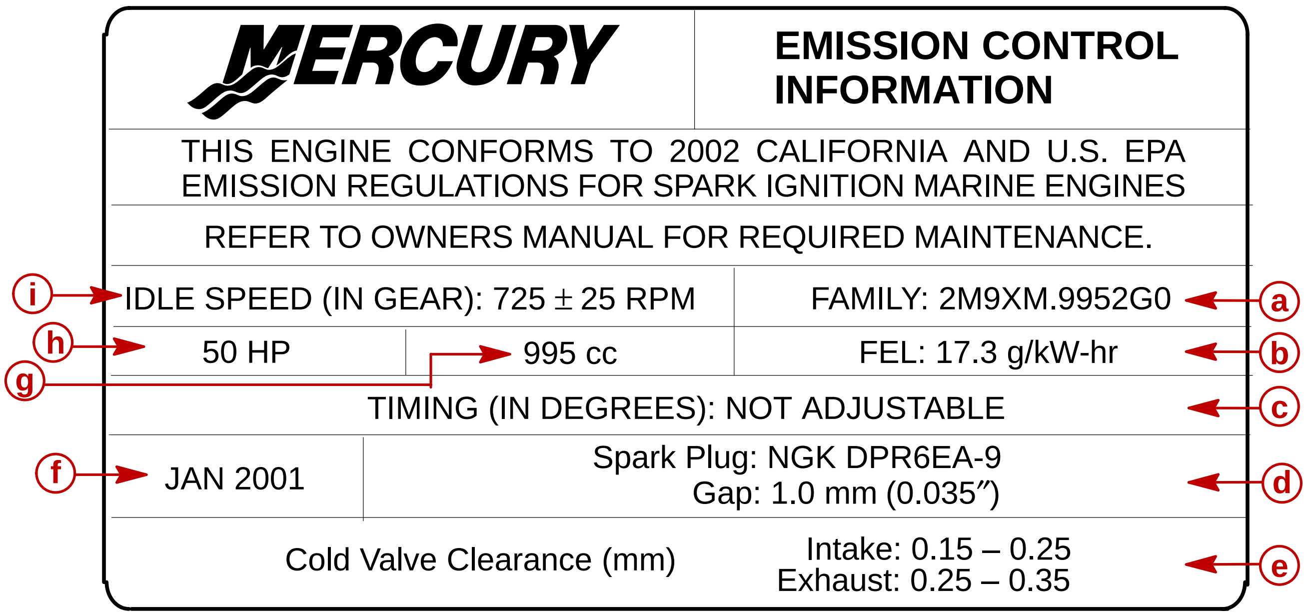
VIA U.S. POSTAL SERVICE:
Office of Mobile Sources
Engine Programs and Compliance Division
Engine Compliance Programs Group (6403J)
401 M St. NW
Washington, DC 20460

VIA EXPRESS or COURIER MAIL:
Office of Mobile Sources
Engine Programs and Compliance Division
Engine Compliance Programs Group (6403J)
501 3rd St. NW
Washington, DC 20001

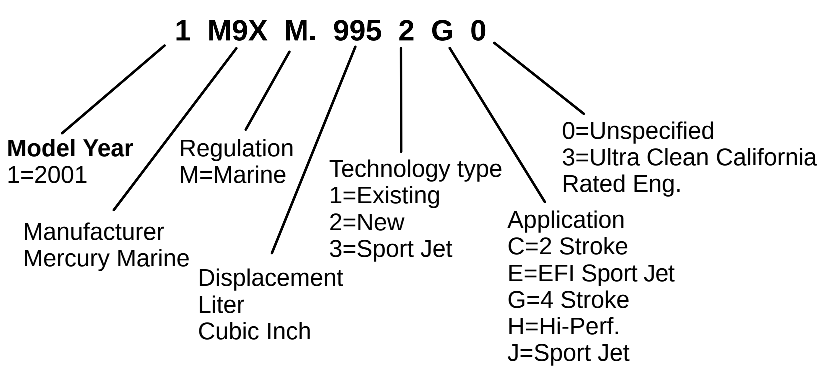
EPA INTERNET WEB SITE:
http:/www.epa.gov/omswww

CERTIFICATION LABEL:

The certification label must be placed on each engine at the time of manufacture and must be replaced in the same location if damaged or removed. Shown below is a typical certification label and is not representative of any one model. Label shown below is not to scale; (shown at twice the normal size).



a-Family Example
b-FEL: Represents (Mercury Marine) statement of the maximum emissions output for the engine family
c-Timing specifications when adjustable
d-Recommended spark plug for best engine performance
e-Valve Clearance (Four Stroke engines only)
f-Date of Manufacture
g-Cubic Centimeter
h-Engine Horsepower rating
i-Idle Speed (In Gear)



Decal Location

Model	Service Part No.	Location on Engine
2001 Merc/Mar 995 cc	37-804655AO1	Flywheel/Rewind Cover
2002 Merc/Mar 995 cc	37-804655AO2	Flywheel/Rewind Cover

Service Replacement Certification Label

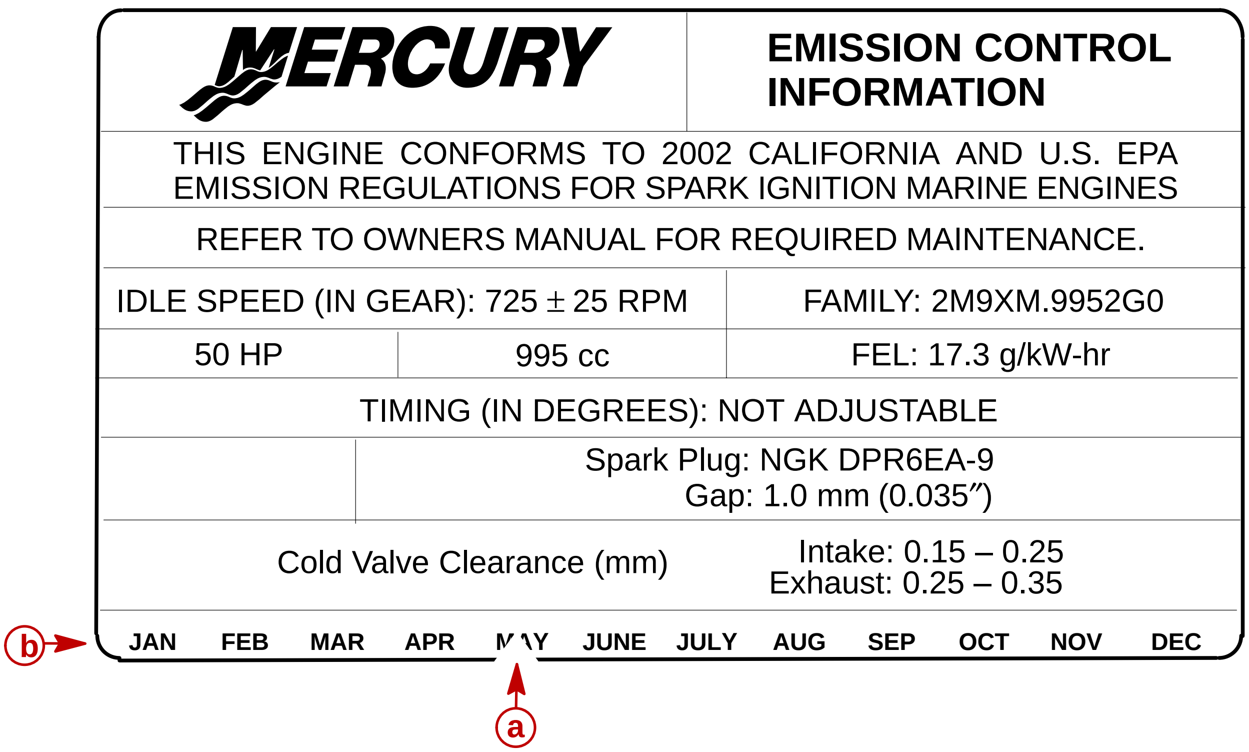
IMPORTANT: By federal law, it is required that all 1998 and newer Mercury Marine outboards have a visible and legible emission certification label. If this label is missing or damaged, contact Mercury Marine Service for replacement if appropriate.

Removal

Remove all remaining pieces of the damaged or illegible label. Do not install new label over the old label. Use a suitable solvent to remove any traces of the old label adhesive from the display location.

Date Code Identification

Cut and remove a "V" notch through the month of engine manufacture before installing the new label. The month of manufacture can be found on the old label. If the label is missing or the date code illegible, contact Mercury Marine Technical Service for assistance.



a-"V" Notch
b-Month of Manufacture

Installation

Install the label on a clean surface in the original factory location.

Decal Location:

Model	Service Part No.	Location on Engine
2001 Merc/Mar 995 cc	37-804655AO1	Flywheel/Rewind Cover
2001 Merc/Mar 995 cc	37-804655AO2	Flywheel/Rewind Cover

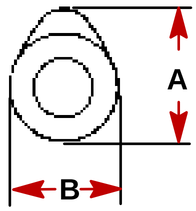
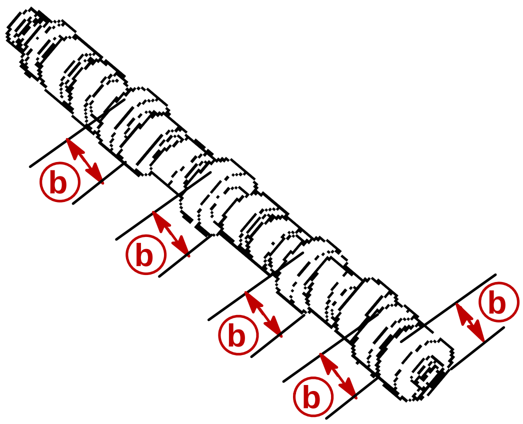
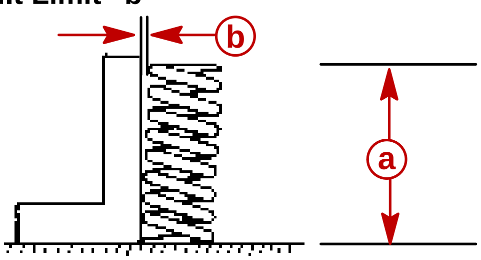
POWERHEAD

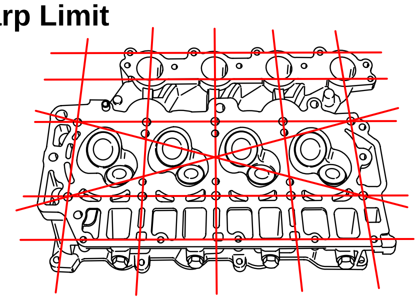
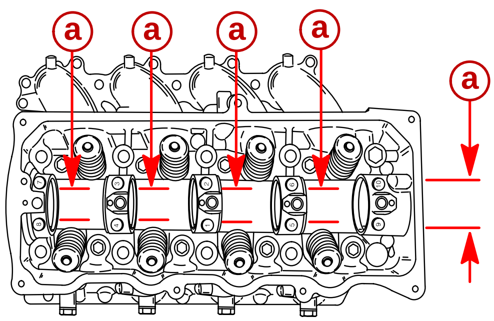
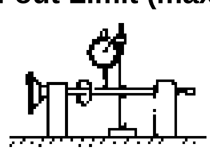
Section 4A - Cylinder Head

Table of Contents

4
A

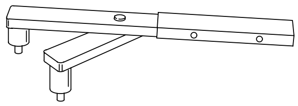
Specifications

CAMSHAFT	**Camshaft Dimensions** **Intake “A”** **Exhaust “A”** **Intake “B”** **Exhaust “B”**  **Run-out Limit** **Camshaft Bearing Diameter “b”**  	 1.214 - 1.222 in. (30.83 - 31.03 mm) 1.214 - 1.222 in. (30.83 - 31.03 mm) 1.020 - 1.028 in. (25.90 - 26.10 mm) 1.020 - 1.028 in. (25.90 - 26.10 mm) 0.0039 in. (0.1 mm) 1.4541 - 1.4549 in. (36.935 - 36.955 mm)
VALVE SPRING	**Free Length “a”** **Tilt Limit “b”**  **Compressed Pressure (Installed)** **Intake** **Exhaust** **Tilt Limit (Intake & Exhaust)** **Dir. of Winding (Intake & Exhaust)**	1.491-1.569 in. (37.85-39.85 mm) Less than 0.060 in. (1.7 mm) 19.8 - 22.0 lbs. (9.0 - 10.0 kg) 19.8 - 22.0 lbs. (9.0 - 10.0 kg) 0.043 in. (1.1 mm) Left Hand

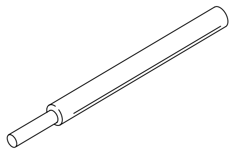
CYLINDER HEAD	**Warp Limit**	0.004 in. (0.1 mm)
		
	*** Lines indicate straight edge measurement**	
	Camshaft Bore Inside Diameter “a”	1.4567 - 1.4577 in. (37.000 - 37.025 mm)
		
VALVES	**Valve/Valve Seat/Valve Guides:**	
	Valve Clearance (cold)	
	Intake	0.006 - 0.010 in. (0.15 - 0.25 mm)
	Exhaust	0.010 - 0.014 in. (0.25 - 0.35 mm)
	Valve Dimensions:	
	“A” Head Diameter	
	Intake	1.256 - 1.264 in. (31.9 - 32.1 mm)
	Exhaust	1.020 - 1.028 in. (25.9 - 26.1 mm)
	“B” Face Width	
	Intake	0.079 - 0.124 in. (2.00 - 3.14 mm)
	Exhaust	0.079 - 0.124 in. (2.00 - 3.14 mm)
	“C” Seat Width	
	Intake	0.035 - 0.043 in. (0.9 - 1.1 mm)
	Exhaust	0.035 - 0.043 in. (0.9 - 1.1 mm)
	“D” Margin Thickness	
	Intake	0.020 - 0.035 in. (0.5 - 0.9 mm)
	Exhaust	0.020 - 0.035 in. (0.5 - 0.9 mm)
	Stem Outside Diameter	
	Intake	0.2156 - 0.2161 in. (5.475 - 5.490 mm)
	Exhaust	0.2150 - 0.2156 in. (5.460 - 5.475 mm)
	Guide Inside Diameter	
	Intake	0.2165 - 0.2170 in. (5.500 - 5.512 mm)
	Exhaust	0.2165 - 0.2170 in. (5.500 - 5.512 mm)
	Stem To Guide Clearance	
	Intake	0.0004 - 0.0015 in. (0.010 - 0.037 mm)
	Exhaust	0.0010 - 0.0020 in. (0.025 - 0.052 mm)
	Stem Run-out Limit (max.)	0.0006 in. (0.016 mm)
		

Special Tools

1. Flywheel Holder P/N 91-83163M

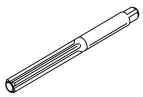


2. Valve Guide Remover P/N 91-809495A1

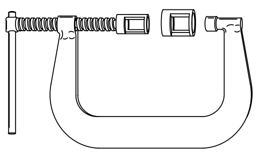


3. Valve Guide Installer Bushing P/N 91-809496A1

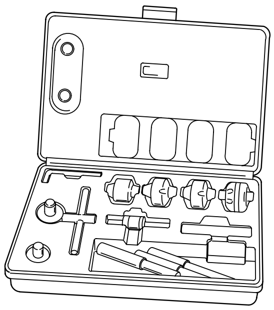
4. Valve Guide Reamer P/N 91-809497A1



5. Valve Spring Compressor P/N 91-809494A1

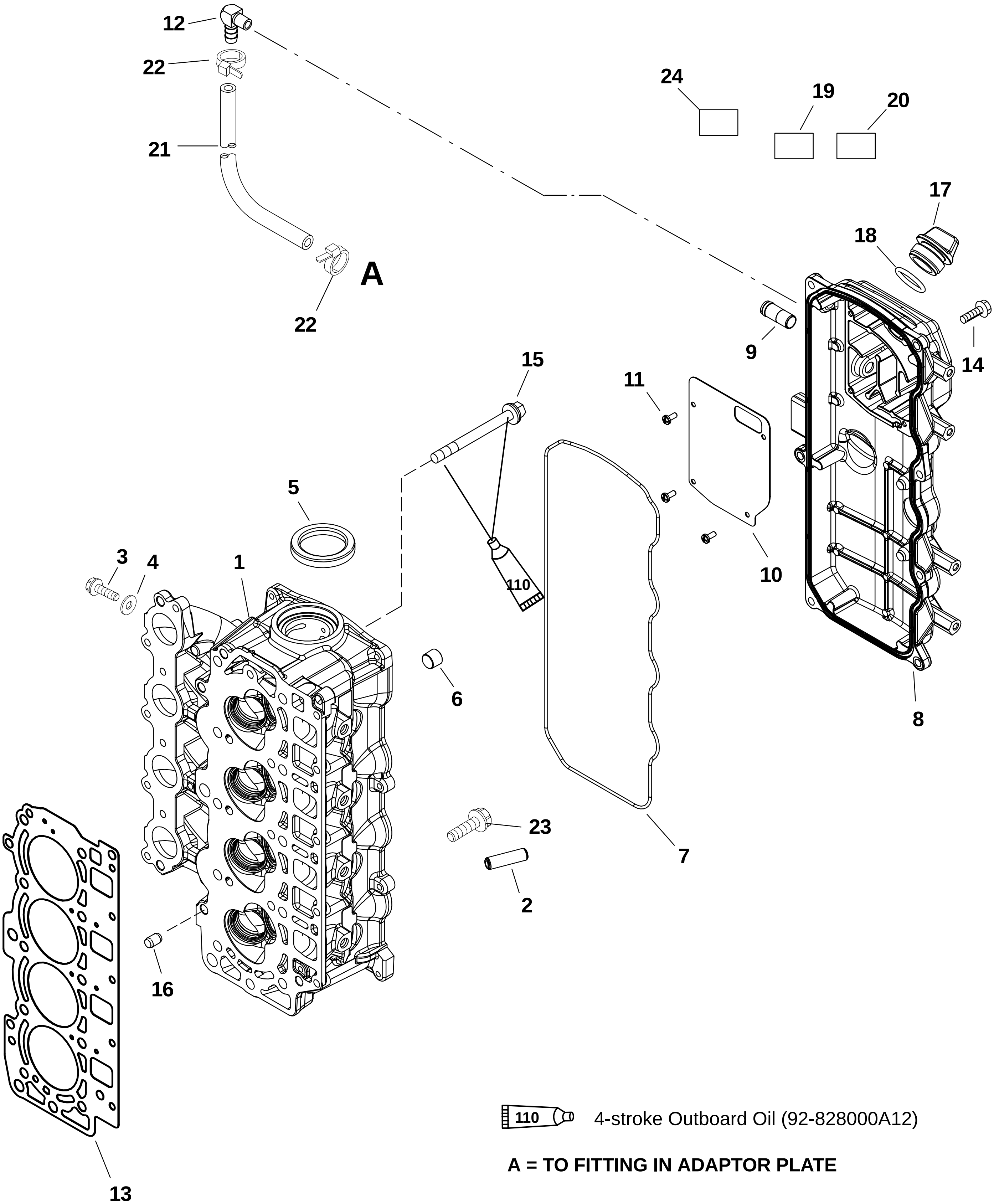


6. Valve Seat Cutter Kit (Obtain Locally).



Notes:

CYLINDER HEAD



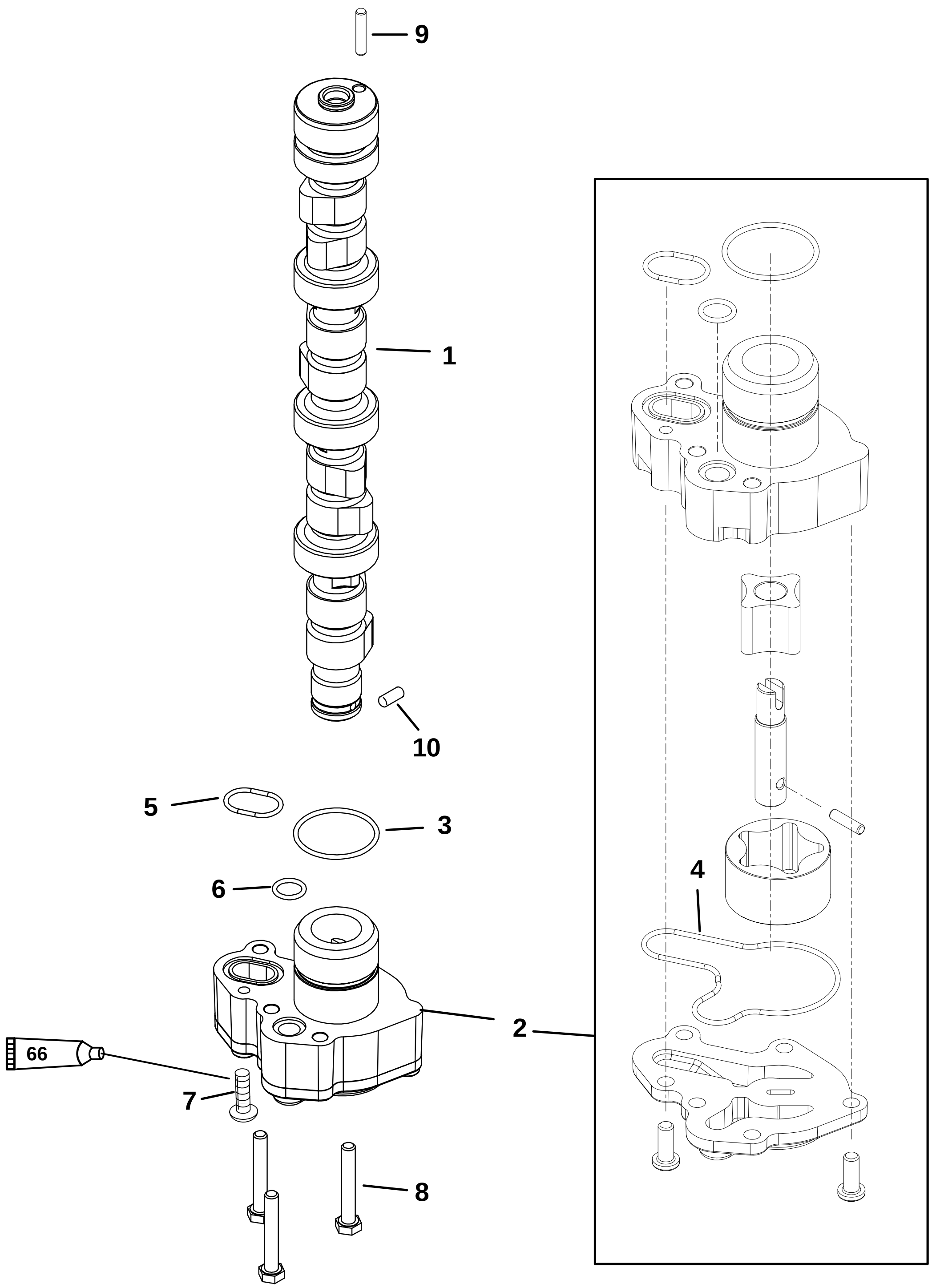
110 4-stroke Outboard Oil (92-828000A12)

A = TO FITTING IN ADAPTOR PLATE

CYLINDER HEAD

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
–	**1**	**CYLINDER HEAD**			
1	1	CYLINDER HEAD			
2	8	GUIDE	70		7.9
3	4	SCREW	70		7.9
4	4	WASHER			
5	1	OIL SEAL			
6	8	PIPE PLUG		14.7	19.9
7	1	O RING			
8	1	COVER			
9	1	BREATHER PIPE			
10	1	BAFFLE PLATE			
11	4	SCREW (M4 X 10)	Drive Tight		
12	1	ELBOW	Drive Tight		
13	1	GASKET			
14	7	SCREW (M6 X 20)	70		7.9
15	10	SCREW (M9 X 95)		34	46.1
16	2	DOWEL PIN			
17	1	PLUG			
18	1	O RING			
19	1	DECAL - SERVICING REFERRAL			
20	1	DECAL - ENGINE OIL/VALVE CLEARANCE			
21	1	HOSE (19 IN.)			
22	2	STA-STRAP			
23	5	SCREW (M6 X 25)		8.8	12
24	1	DECAL - HP ID			

CAMSHAFT

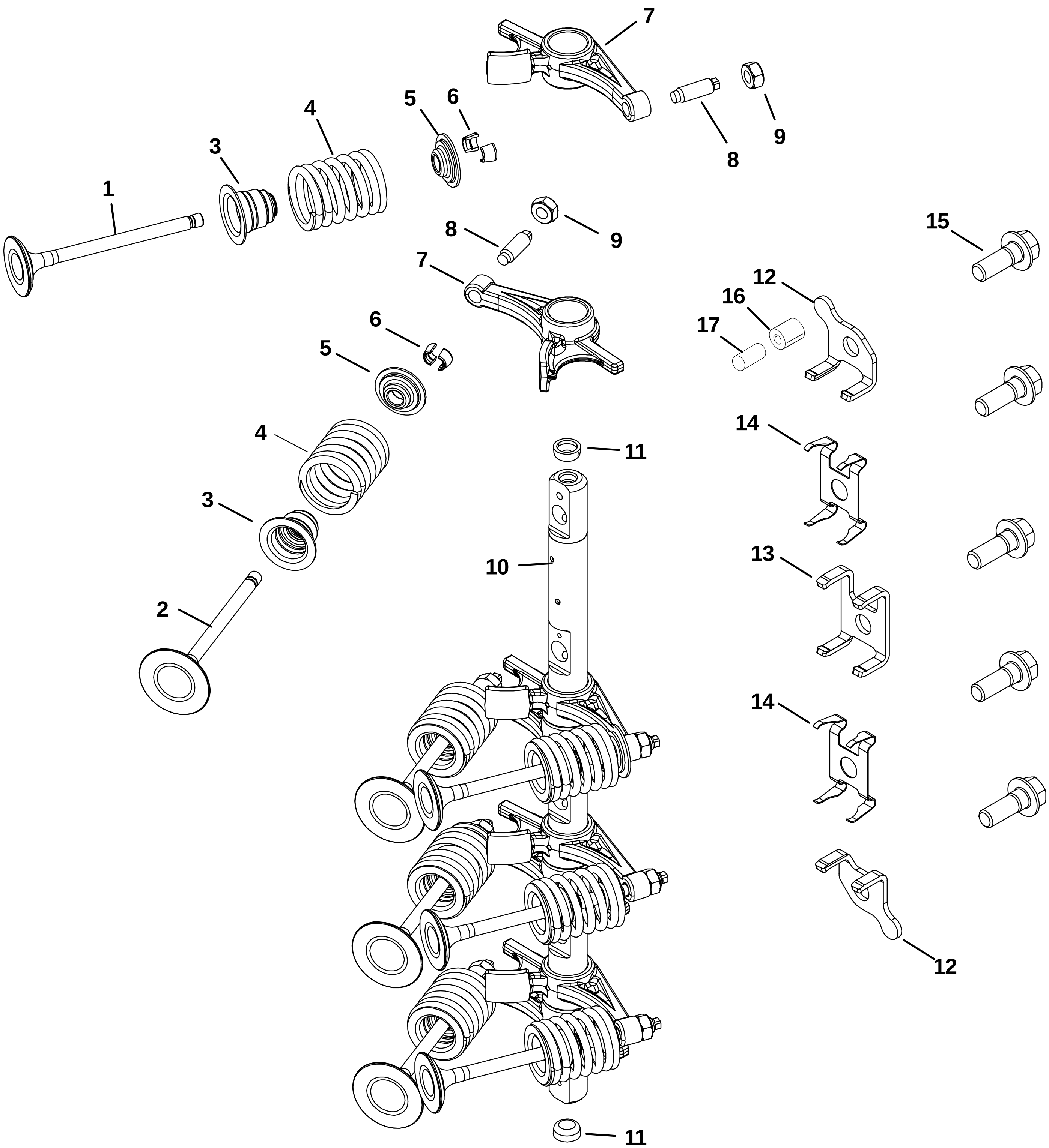


66 Loctite 242 (92-809821)

CAMSHAFT

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	CAMSHAFT			
2	1	OIL PUMP ASSEMBLY			
3	1	O RING			
4	1	O RING			
5	1	O RING			
6	1	O RING			
7	2	SCREW (M6 x 16)	70		8
8	4	SCREW (M6 x 40)	70		8
9	1	DOWEL PIN			
10	1	PIN			

INTAKE/EXHAUST VALVE

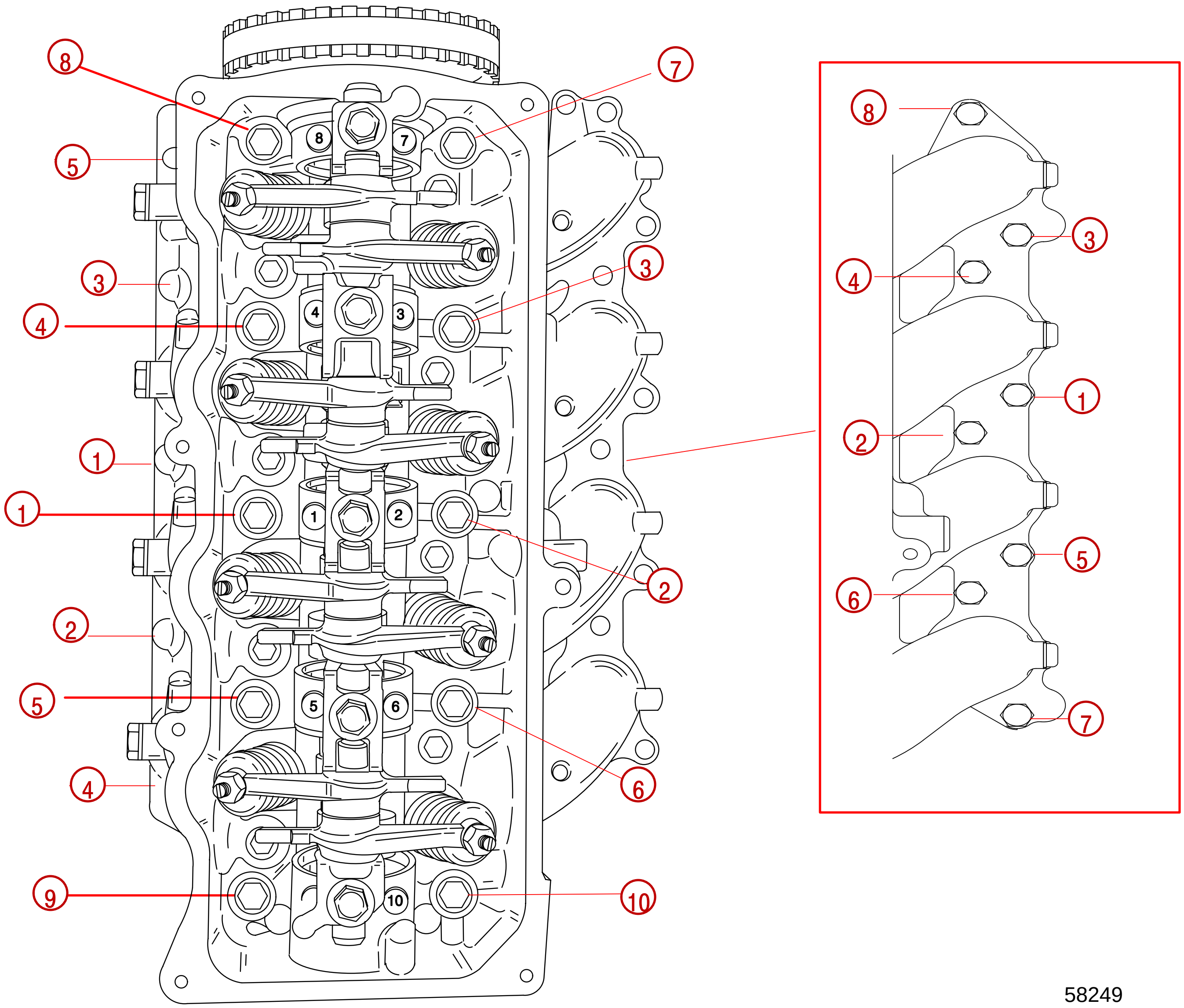


INTAKE/EXHAUST VALVES

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	4	EXHAUST VALVE			
2	4	INTAKE VALVE			
3	8	SEAL-Valve Stem			
4	8	VALVE SPRING-Outer			
5	8	RETAINER			
6	16	KEY			
7	8	ROCKER ARM			
8	8	SCREW			
9	8	NUT	120		13.5
10	1	ROCKER SHAFT			
11	2	PLUG			
12	2	BRACKET			
13	1	BRACKET			
14	2	SPRING			
15	5	SCREW (M8 x 23)	160		18
16	1	GASKET			
17	1	PIN-Cam Thrust			

Torque Sequence

Torque center bolts in sequence and in two steps, than torque the Cylinder Head and intake manifold flange bolts.

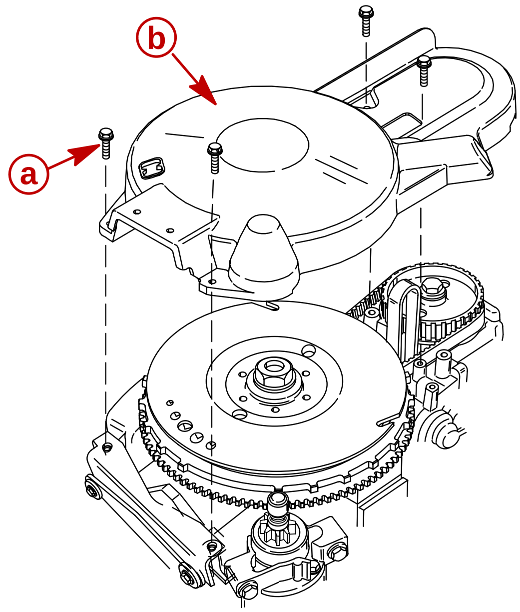


Cylinder Head Bolt Torque
Center Bolts Qty. 10 (Larger Dia. M9) 1st: 17 lb-ft (23 Nm) 2nd: 34.7 lb-ft (47 Nm) Cyl. Head Flange Bolts Qty. 5 (Smaller Dia. M6) 1st: 53 lb-in. (6 Nm) 2nd: 106 lb-in. (12 Nm) Intake Manifold Screws Qty. 8 (Smaller Dia. M6) 70 lb-in. (8 Nm)

Valve Cover

Removal

1. Disconnect spark plug leads and remove spark plugs.
2. Remove flywheel cover.



a - Screw (4) - M6x25
b - Flywheel Cover

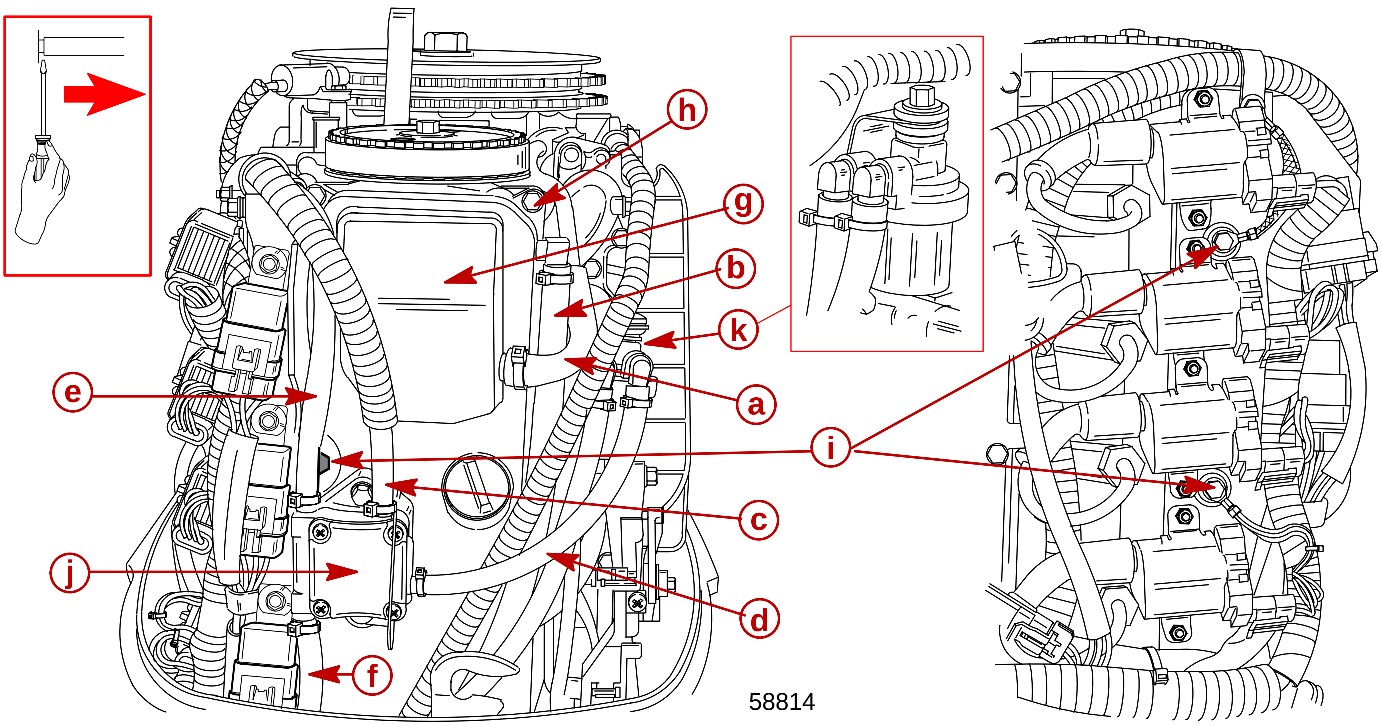
3. Disconnect the crankcase breather hose and vent hose, fuel pump input/output hose and fuel cooler in/out hoses.

IMPORTANT: The hose fittings on the fuel pump can break if you try twisting or pulling off the hoses. Remove fuel pump hoses by slowly prying them off using a small screwdriver.

4. Remove fuel pump from valve cover.

⚠ WARNING
Always release the fuel pressure in the high-pressure fuel line before servicing the line or the vapor separator. If the fuel pressure is not released, pressurized fuel may spray out.

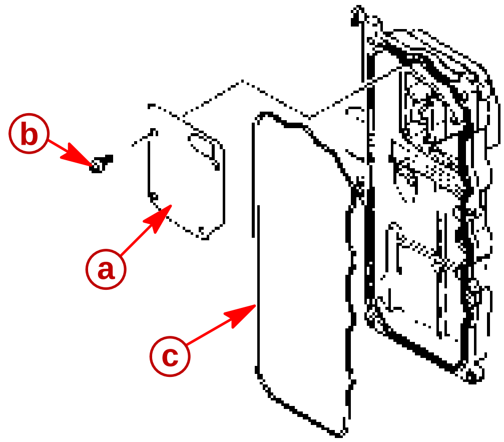
5. Disconnect high pressure fuel line from fuel distribution manifold by depressing locking tab. Refer to **section 3C Releasing Fuel Pressure in the High Pressure Fuel Line**.
6. Remove coil plate fasteners and swing the coil plate assembly to the side.
7. Loosen water separating fuel filter nut, pull the assembly from the mounting bracket and place it out of the way.
8. Remove valve cover.



a - Crankcase Breather Hose
b - Crankcase Vent Hose
c - Fuel Pump Output Hose
d - Fuel Pump Input Hose
e - Fuel Cooler IN Hose
f - Fuel Cooler OUT Hose
g - Valve Cover
h - Screw (7) M6 x 20
i - Coil Plate Screw (& Washer) (3) M6 x 30
j - Fuel Pump
k - Water Separating Fuel Filter

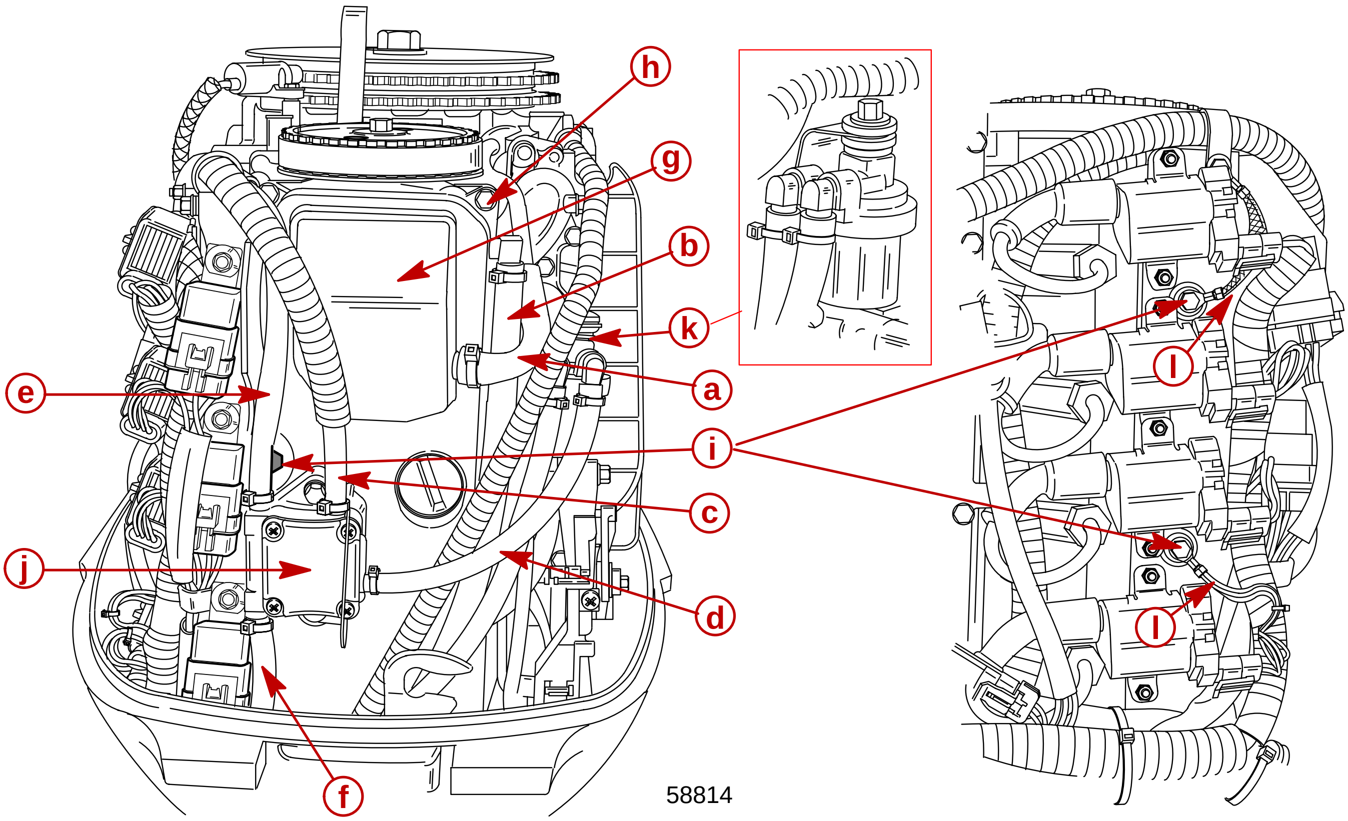
Installation

1. Install valve cover seal into groove.
2. If removed, reinstall baffle plate. Tighten screws securely.



a - Baffle Plate
b - Screw (4) M4x10
c - Cover Seal

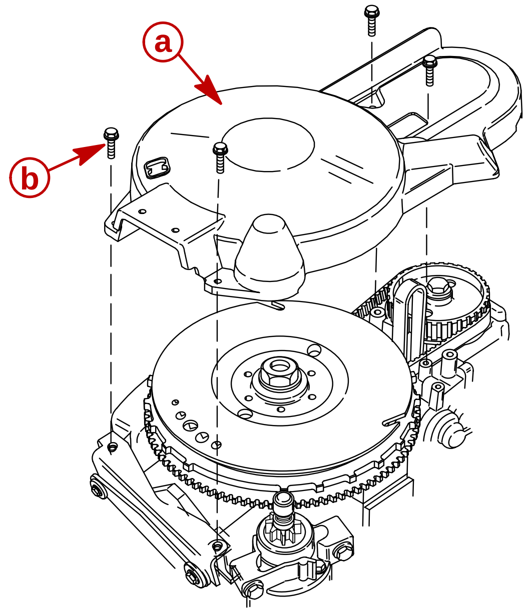
3. Reinstall the valve cover. Tighten screws to the specified torque.
4. Install water separating fuel filter onto bracket and tighten nut.
5. Install coil plate. Install screws (and washers) and tighten screws to specified torque. Be sure coil ground wires are secured with screws.
6. Install fuel pump. Tighten screws to specified torque.
7. Connect fuel pump in/out hoses, fuel cooler in/out hoses, crankcase breather and vent hose. Secure all with sta-straps. Connect high pressure fuel line to fuel distribution manifold.
8. Reinstall spark plugs and spark plug leads.



a - Crankcase Breather Hose
b - Crankcase Vent Hose
c - Fuel Pump Outlet Hose
d - Fuel Pump Inlet Hose
e - Fuel Cooler IN Hose
f - Fuel Cooler OUT Hose
g - Valve Cover
h - Screw (7) M6 x 20
i - Coil Plate Screw (& Washer) (3) M6 x 30
j - Fuel Pump
k - Water Separating Fuel Filter
l - Coil Ground Wire (2)

Valve Cover Screw Torque
70 lb-in. (8 Nm)

9. Install flywheel cover.



a - Flywheel Cover
b - Screw (4) - M6x25

Flywheel Cover Screw Torque
45 lb. in. (5.1 N·m)

Valve Clearance Adjustment

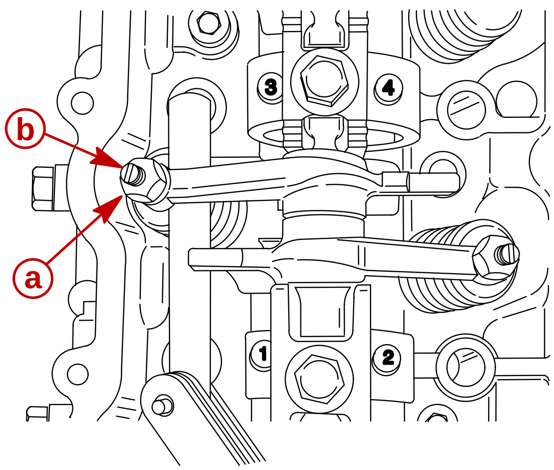
NOTE: *Valves should be adjusted when engine is cold.*

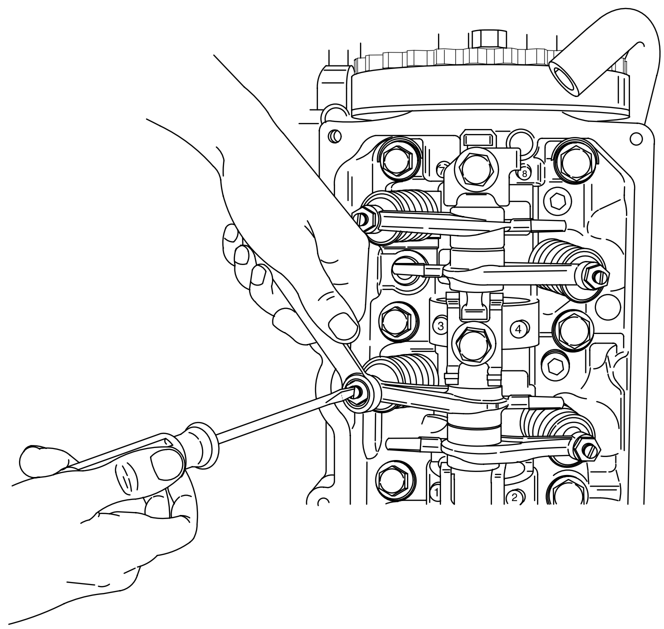
⚠ WARNING
Engine could possibly start when turning flywheel during adjustment. To prevent this type of accidental engine starting and possible serious injury, always remove spark plug leads from spark plugs.

Adjusting Valves

1. Remove valve cover as outlined in **“Valve Cover Removal”**.
2. Measure valve clearance with a feeler gauge. Adjust if out of specification.

NOTE: *When loosening lock nuts, hold the adjusting screw with a screw driver to prevent it from moving.*

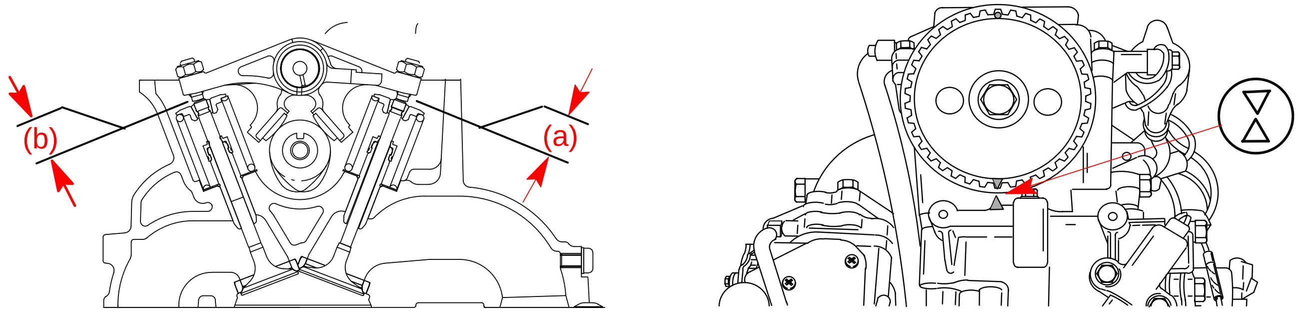




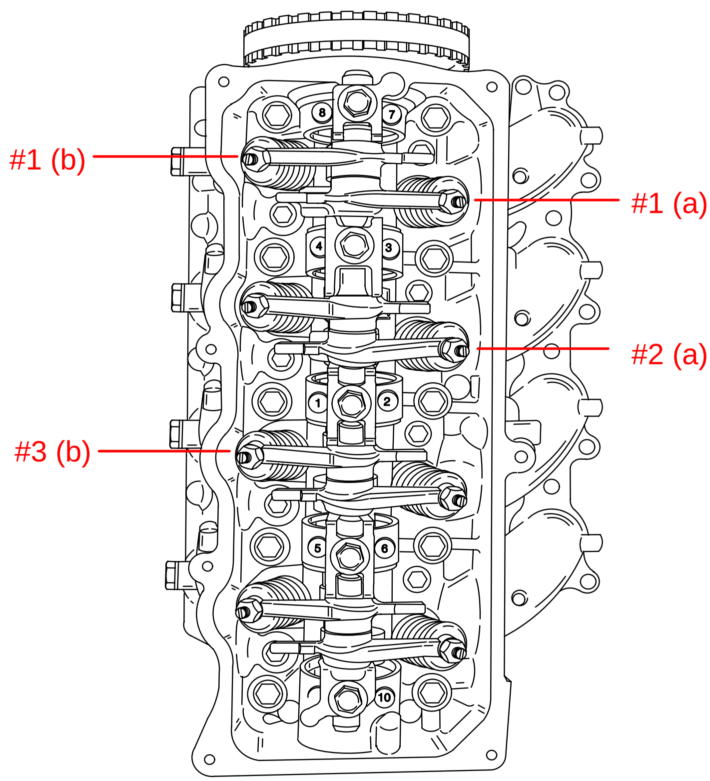
a - Lock nut
b - Adjusting Screw

NO. 1 AND NO. 2 INTAKE VALVES
NO. 1 AND NO. 3 EXHAUST VALVES

1. Turn the driven gear and align the "∆" mark on the gear with the cylinder head mark "∆".
2. Adjust the valve clearance for No. 1 and No. 2 intake valves and No. 1 and No. 3 exhaust valves.



58268

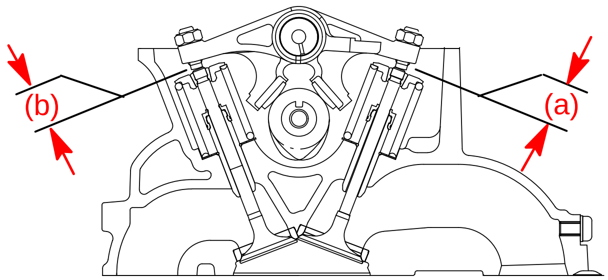


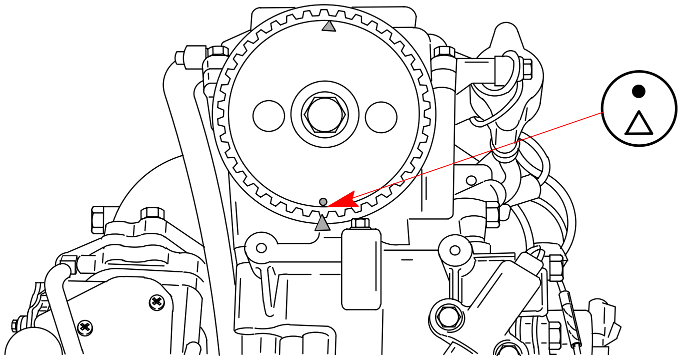
Valve Clearance Specifications (Cold)	
Intake Valve (a)	0.006 - 0.010 in. (0.15 - 0.25 mm)
Exhaust Valve (b)	0.010 - 0.014 in. (0.25 - 0.35 mm)

Valve Adjusting Nut Torque
120 lb-in. (13.5 Nm)

NO. 3 AND NO. 4 INTAKE VALVES
NO. 2 AND NO. 4 EXHAUST VALVES

1. Turn the driven gear and align the "•" mark on the gear with the cylinder head mark "△".
2. Adjust the valve clearance for No. 3 and No. 4 intake valves and No. 2 and No. 4 exhaust valves.





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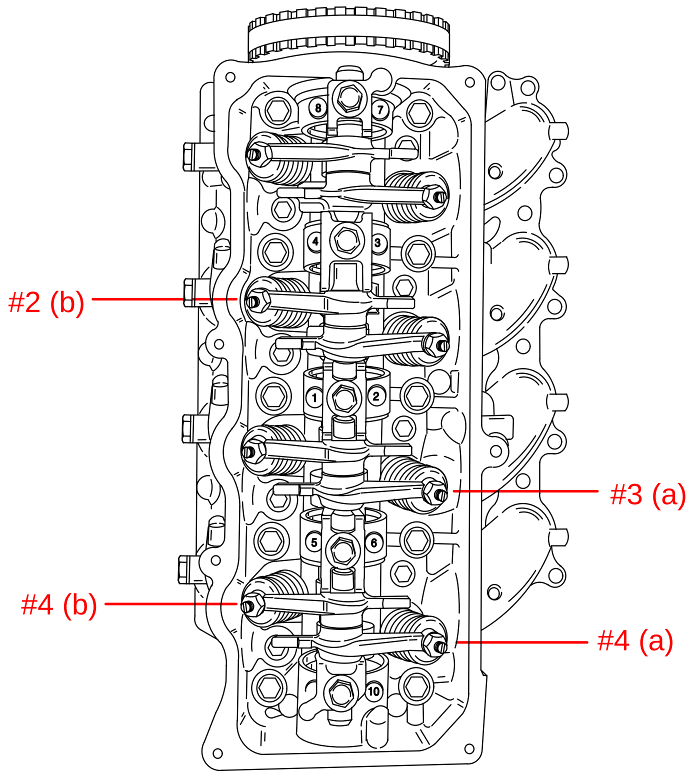


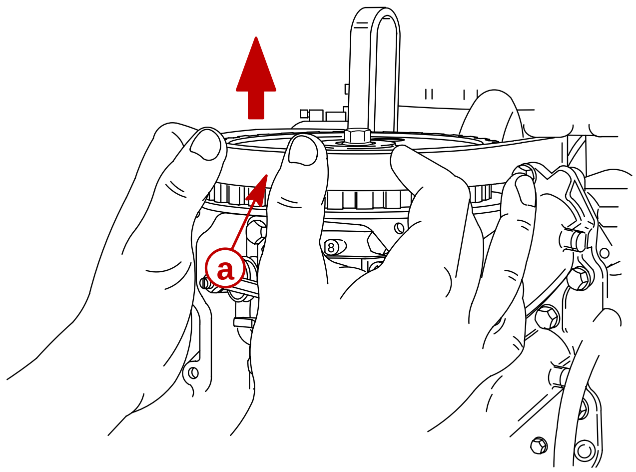
Valve Clearance Specifications (Cold)	
Intake Valve (a)	0.006 - 0.010 in. (0.15 - 0.25 mm)
Exhaust Valve (b)	0.010 - 0.014 in. (0.25 - 0.35 mm)

Valve Adjusting Nut Torque
120 lb-in. (13.5 Nm)

Timing Belt

Removal

1. Remove flywheel and stator. Refer to **section 2B Charging and Starting System**.
2. Remove timing belt from driven gear and drive gear.



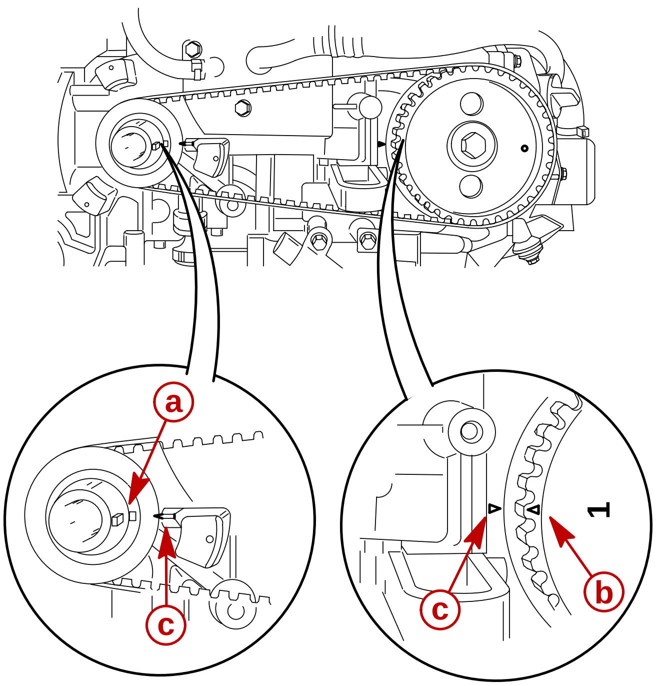
a - Timing Belt

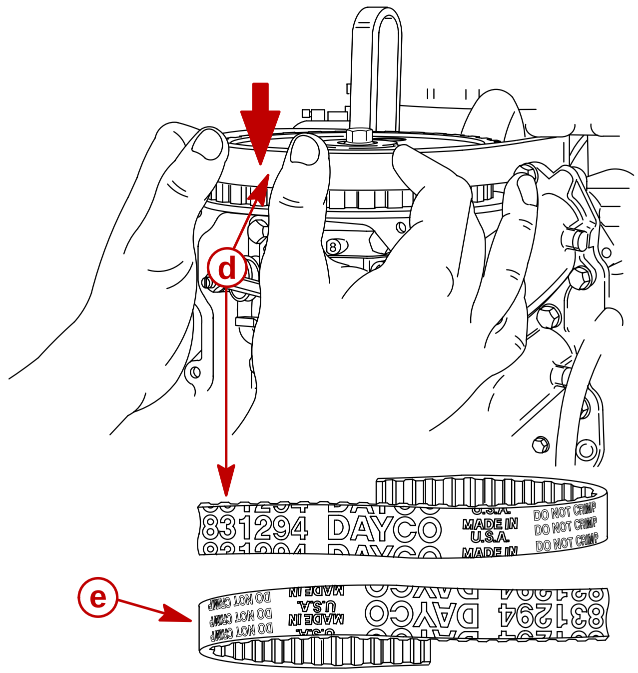
Installation

Timing Belt Installation Notes:

- *Protect the timing belt from water and oil.*
- *Use care not to scratch the belt.*
- *Do not use any metal device to help stretch the belt onto the driven gear.*

1. Align marks on drive and driven gear with marks on cylinder block as shown.
2. Install timing belt onto drive gear as shown. Numbers/letters on belt should be readable once belt is installed.
3. Install stator and flywheel. Refer to **section 2B Charging & Starting System**.



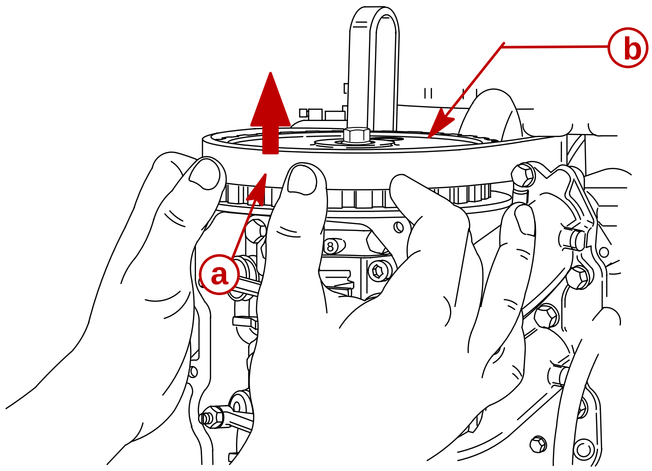


a - Drive Gear Mark
b - Driven Gear Mark
c - Cylinder Block Marks

d - Timing Belt Installed Correctly
e - Timing Belt Installed Incorrectly

Cylinder Head Removal

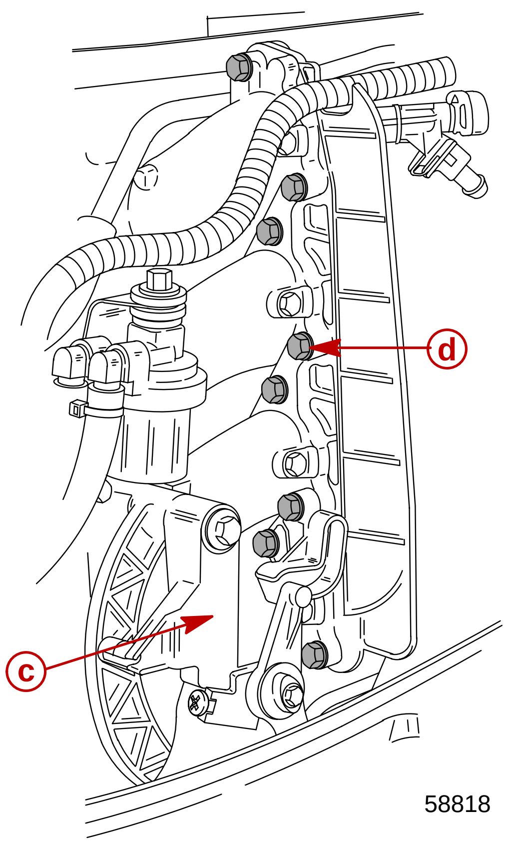
1. Remove valve cover. Refer to **Valve Cover Removal**.
2. Remove timing belt from driven gear.

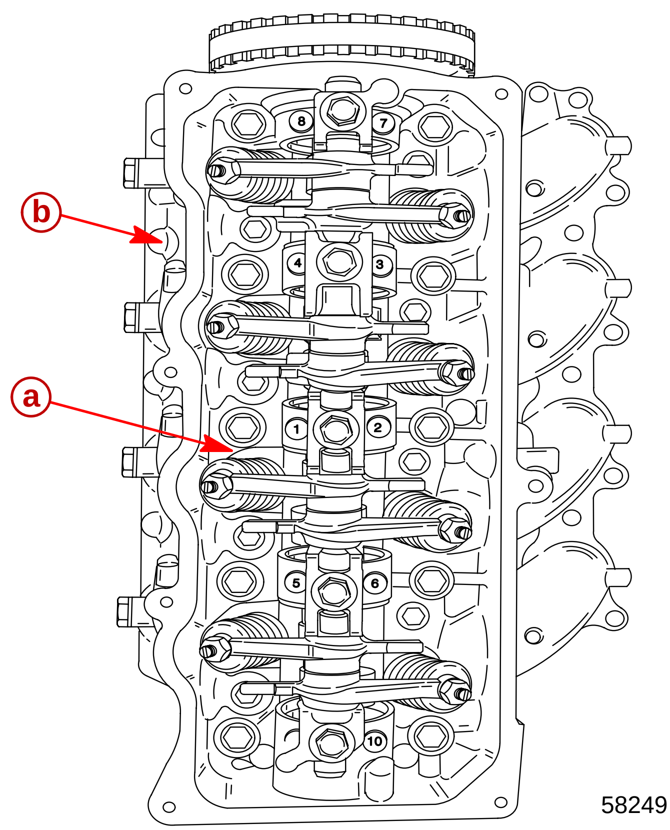


a - Timing Belt
b - Driven Gear

3. Remove the throttle and shift levers from side of cylinder head.
4. Remove the cylinder head and intake manifold assembly mounting bolts.
5. Separate the cylinder head from the block.

NOTE: *Cylinder head gasket is not reusable.*



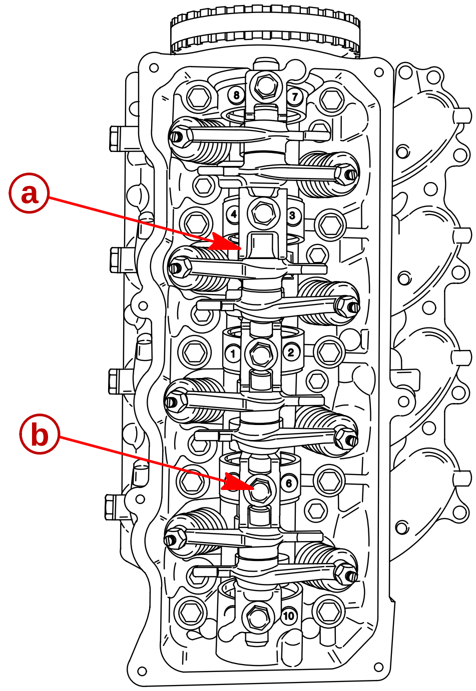


a - Center Bolts (10) M9x95
b - Flange Bolts (5) M6x25
c - Throttle/Shift Levers
d - Intake Manifold Screw (8) M6x25

Cylinder Head Disassembly

Rocker Arm Assembly Removal

1. Remove five screws and the rocker arm shaft.



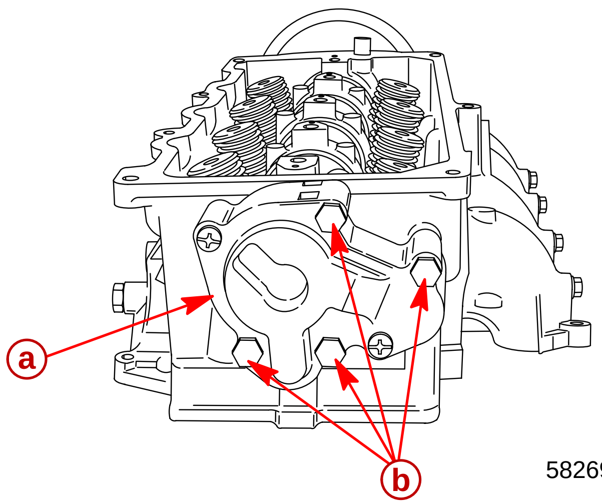
58249

a - Rocker Arm Shaft
b - Screw (5) M8x23

Oil Pump Removal

IMPORTANT: Do not twist/turn oil pump from side to side while removing oil pump from cylinder head as oil pump sealing o-rings will be cut. Pull oil pump away from cylinder head using pry points on oil pump body as needed.

1. Remove four screws and pull out the oil pump assembly.



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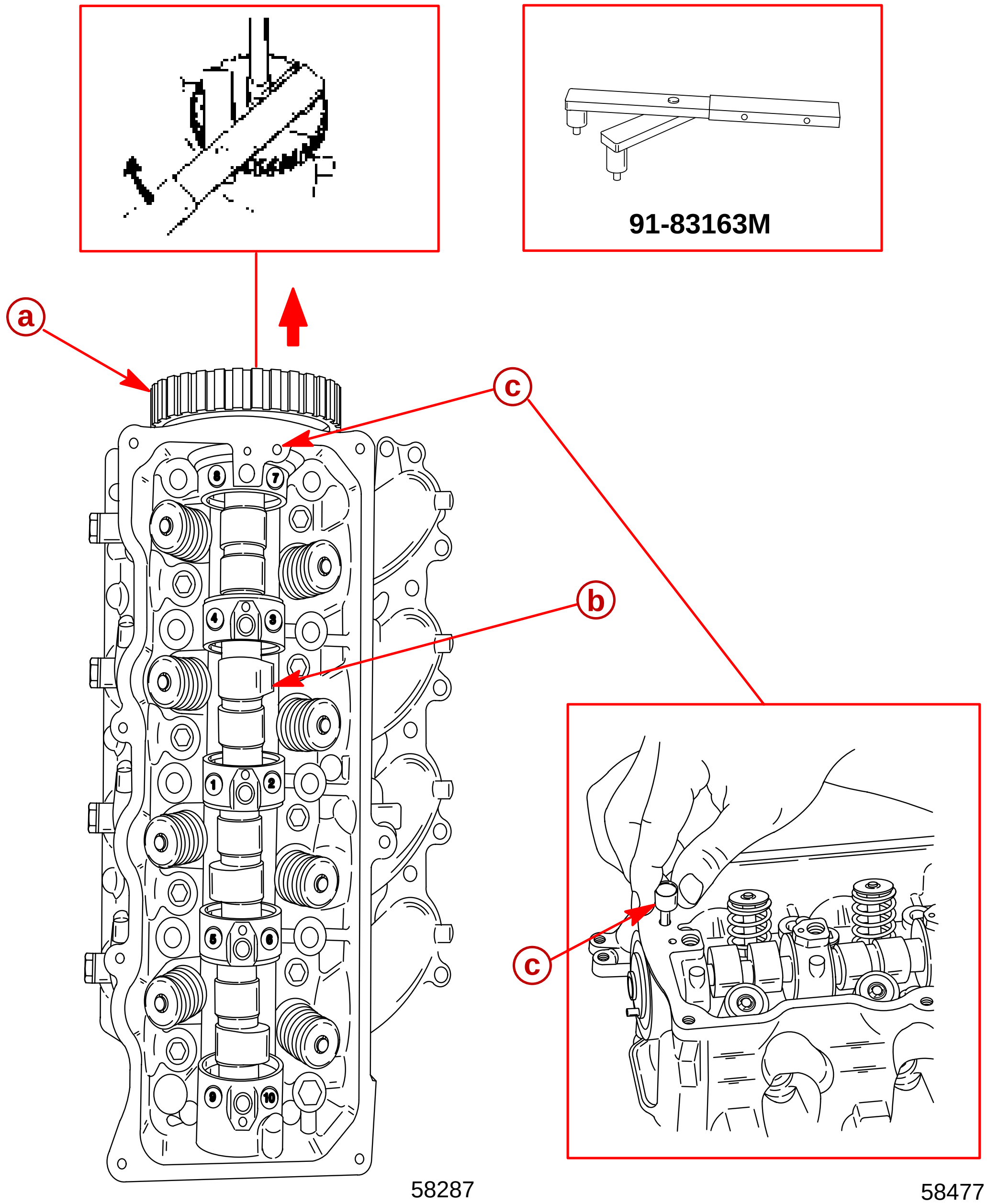
a - Oil Pump Assembly
b - Oil Pump Mounting Screw (4) M6x40

Camshaft Removal

1. Hold driven gear using tool (91-83163M) and remove screw and flat washer. Remove driven gear.
2. Remove camshaft retaining pin. Slide camshaft/oil seal out of cylinder head.

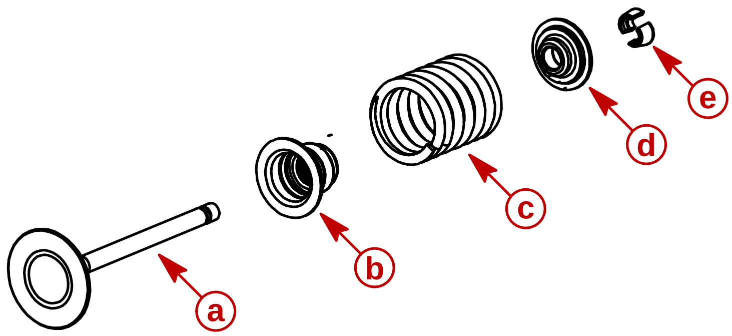
NOTE: *The cam can also be removed from the top without removing the cylinder head from engine.*



a - Driven Gear
b - Camshaft
c - Camshaft Retaining Pin with Seal

Valve Removal

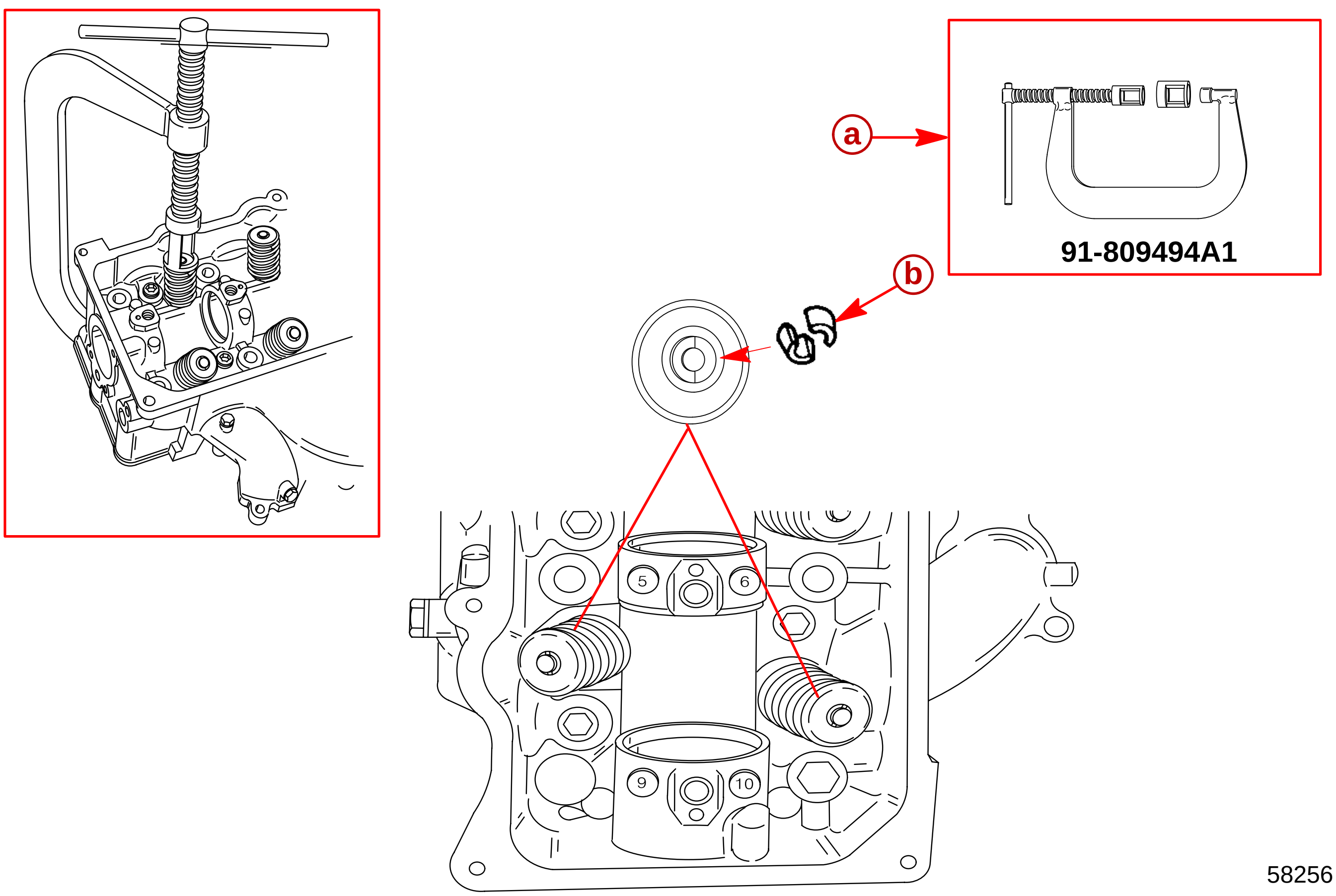
VALVE COMPONENTS



a - Valve
b - Valve Seal
c - Valve Spring
d - Spring Retainer
e - Valve Keepers

REMOVING VALVES

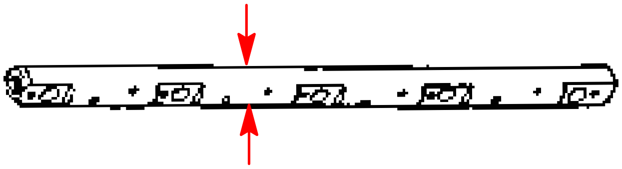
1. Anytime a valve is removed, replace the valve seal.
2. Remove valves as shown.



a - Use Spring Compressor Tool (91-809494A1) to compress the springs for removal
b - Compress the spring and remove the valve keepers

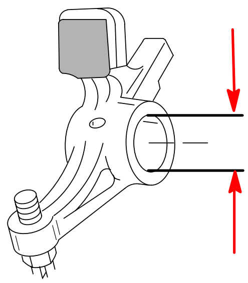
Rocker Shaft and Rocker Arm

1. Measure rocker shaft diameter. Replace shaft if out of specification.



Rocker Shaft Diameter
0.6288 - 0.6296 in. (15.971 -15.991 mm)

2. Measure rocker arm inside diameter. Replace rocker arms if out of specification.



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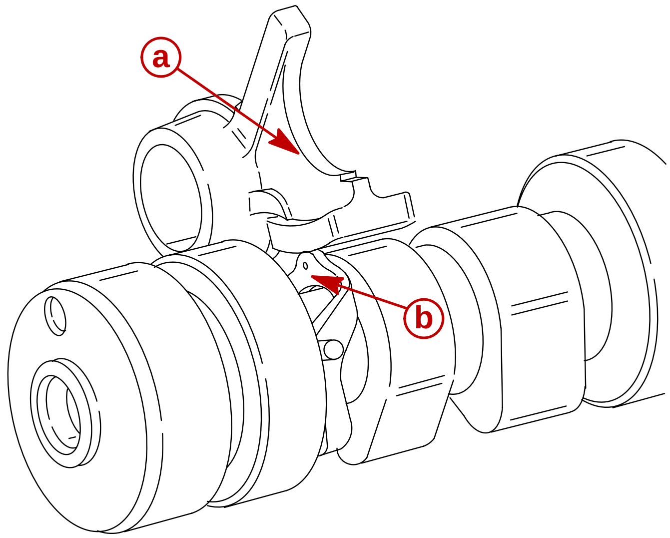
Rocker Arm Inside Diameter
0.6299 - 0.6306 in. (16.000 -16.018 mm)

Camshaft

Manual start models are equipped with a cam shaft featuring a compression release mechanism. The compression relief mechanism releases a percentage of the cylinder compression during engine cranking which lowers the starter rope pull force.

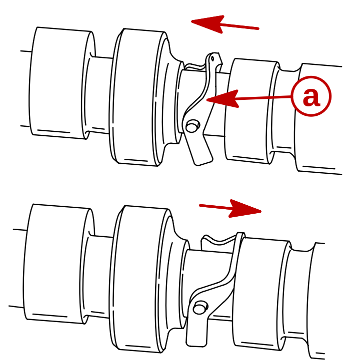
At cranking speeds (RPM) the cam shaft decompression levers rest against the side of the exhaust cam lobes, protruding out from the heal of the lobe. This protrusion contacts the exhaust valve rocker arms during the compression stroke, slightly opening the exhaust valve.

With the increase of centrifugal force at engine running speeds, the decompression levers swing out of contact with the exhaust valve rocker arms, allowing the exhaust valves to operate normally (fully closed) during the compression stroke.



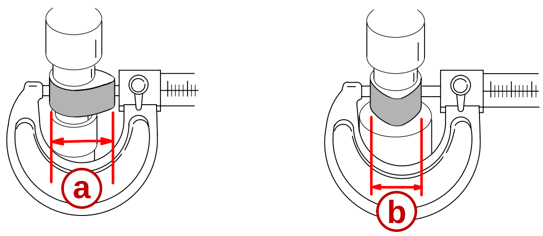
a - Exhaust Valve Rocker Arm
b - Decompression Lever

1. Inspect the camshaft for pitting, heat discoloration, scratches and for the following measurements. Replace camshaft if worn or not within specification.
2. Inspect the compression relief cam lever (if equipped) for free movement. Replace camshaft if necessary.



a - Compression Relief Cam

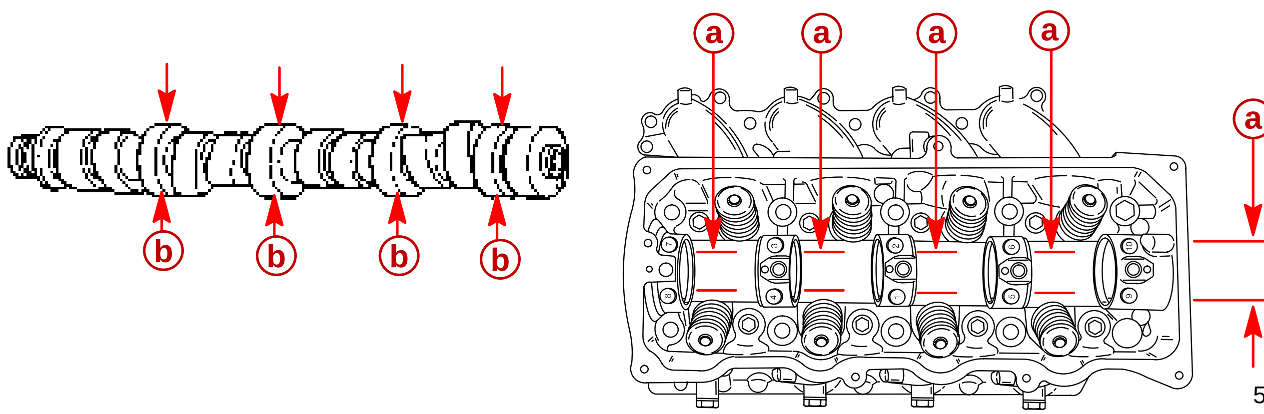
3. Measure the cam lobe length (a) and width (b).



55805

Cam Lobe Specifications		
a	Intake	1.214 - 1.222 in. (30.83 - 31.03 mm)
	Exhaust	1.214 - 1.222 in. (30.83 - 31.03 mm)
b	Intake	1.020 - 1.028 in. (25.90 -26.10 mm)
	Exhaust	1.020 - 1.028 in. (25.90 -26.10 mm)

4. Measure the camshaft bore diameters (a) and camshaft bearing diameters (b).



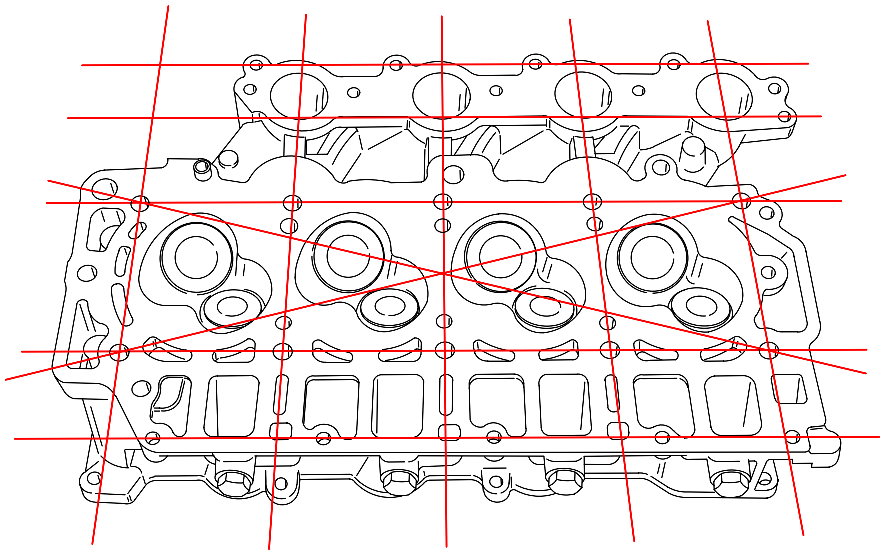
58255

Camshaft Bore Inside Diameter “a”
1.4567 - 1.4577 in. (37.000 - 37.025 mm)

Camshaft Bearing Diameter “b”
1.4541 - 1.4549 in. (36.935 - 36.955 mm)

Cylinder Head

1. Inspect the cylinder head for the following conditions:
   - Mineral deposits/corrosion in water passage ways.
   - Carbon deposits in combustion chamber (use round scraper to clean away deposits). Be careful not to scratch or remove material.
2. Inspect cylinder head for warpage. Replace cylinder head If out of specification.



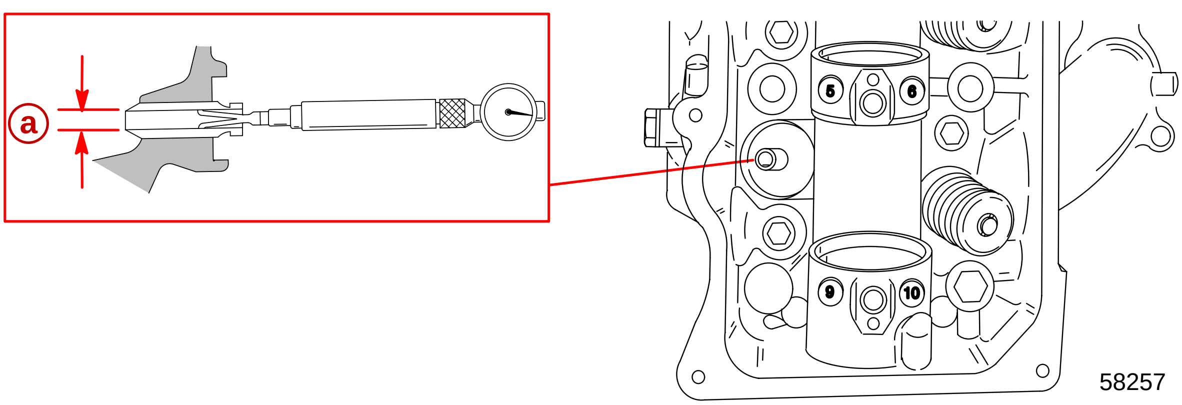
58271

Cylinder Head Warpage Limit
0.004 in. (0.1 mm)

Valve Guides

NOTE: *Inspect the valve guides for wear or damage. If valve guide wear is out of specification, replace the valve guide.*

Measure valve guide bore.

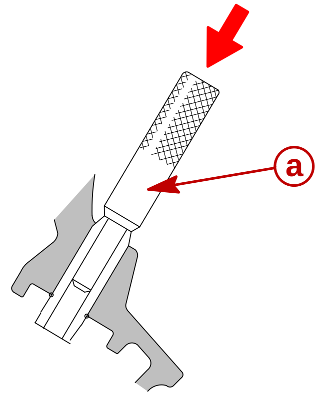


58257

Valve Guide Inside Diameter	
Intake Valve	0.2165 - 0.2170 in. (5.500 - 5.512 mm)
Exhaust Valve	

Valve Guide Replacement

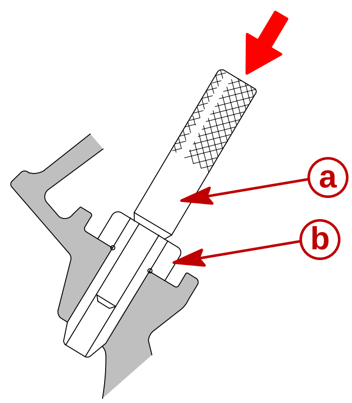
1. Heat the cylinder head in an oven to 390° F (200° C). This will help to ease guide removal and installation and to maintain correct interference fit.
2. Remove the valve guide using a valve guide remover.



55806

a - Valve Guide Remover (91-809495A1)

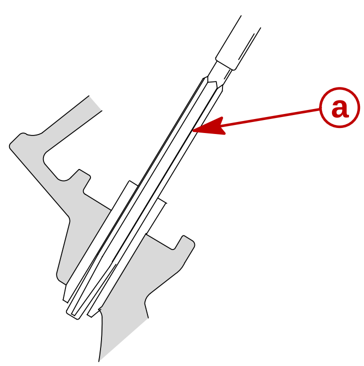
3. Install the new valve guide and circlip using a valve guide installer bushing along with the valve guide remover.



55807

a - Valve Guide Remover (91-809495A1)
b - Valve Guide Installer Bushing (91-809496A1)

4. After installing the valve guide, ream the valve guide using a valve guide reamer to obtain proper stem-to-guide clearance.

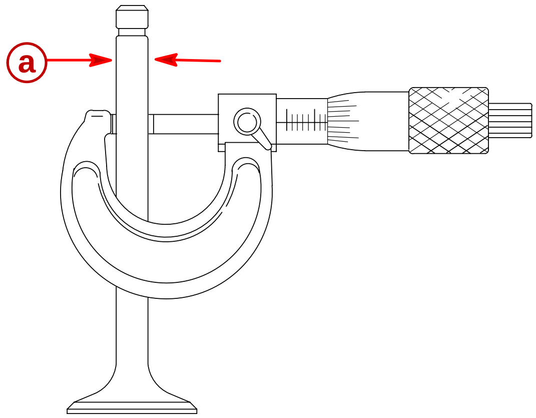


55808

a - Valve Guide Reamer (91-809497A1)

Valves

1. Clean the carbon deposits from the valve. Discard any cracked, warped, or burned valves.
2. Measure the valve stem to check for wear. Replace valves if not in specification.



55810

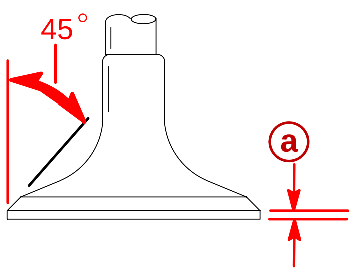
Valve Stem Diameter "a"	
Intake Valve	0.2156 - 0.2161 in. (5.475 - 5.490 mm)
Exhaust Valve	0.2150 - 0.2156 in. (5.460 - 5.475 mm)

3. Check the valve face for pitting. Valves faces that are pitted must be refaced.

NOTE: *Several different types of equipment are available for refacing valves. Follow the equipment manufacturer's instructions.*

NOTE: *After refacing valve seat or replacing the valve and valve guide, the valve seat and valve face should be lapped.*

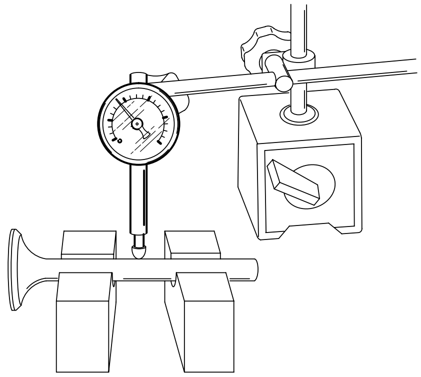
4. Check the margin thickness of the valves after the valves have been ground. Any valve with a margin thickness of less than the specification, should be replaced.



55809

Margin Thickness "a"	
Intake Valve	0.020 - 0.035 in. (0.5 - 0.9 mm)
Exhaust Valve	0.020 - 0.035 in. (0.5 - 0.9 mm)

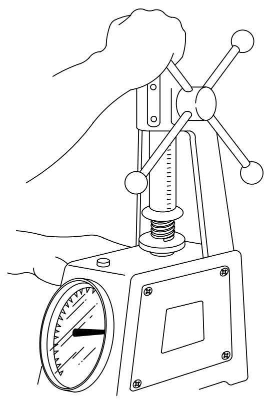
5. Measure valve stem runout, replace if out of specification.



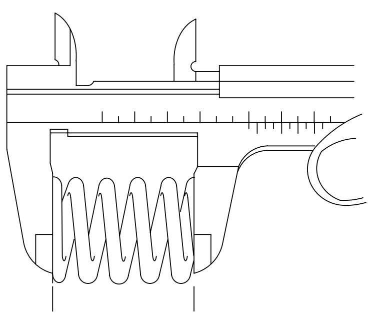
Valve Stem Runout Limit (Max.)	
Intake Valve Exhaust Valve	0.0006 in. (0.016 mm)

Valve Springs

1. Check each spring under load on a spring tester. Replace any weak springs.



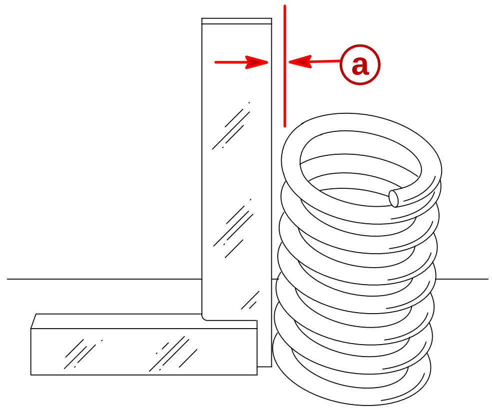
2. Check free length limit of each spring. Replace valve springs if not in specification.



55846

Valve Spring Free Length
1.491 - 1.569 in. (37.85 - 39.85 mm)

3. Check each spring on a flat surface using a square. Rotate spring and check space between the top coil and square. Replace valve springs if not in specification.



55797

Valve Spring Tilt Specification “a”
Less than 0.06 in. (1.7 mm)

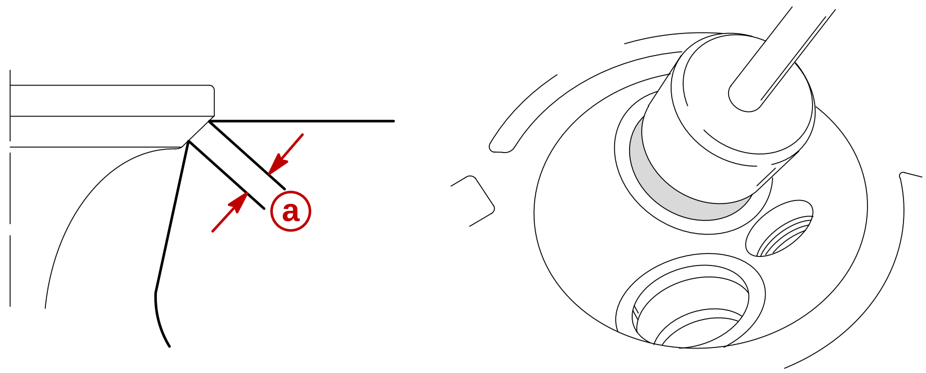
Valve Seat Reconditioning

Clean the carbon deposits from the combustion chambers and valve seats and check for pitting.

Several different types of equipment are available for reseating valve seats. Follow the equipment manufacturer's instructions.

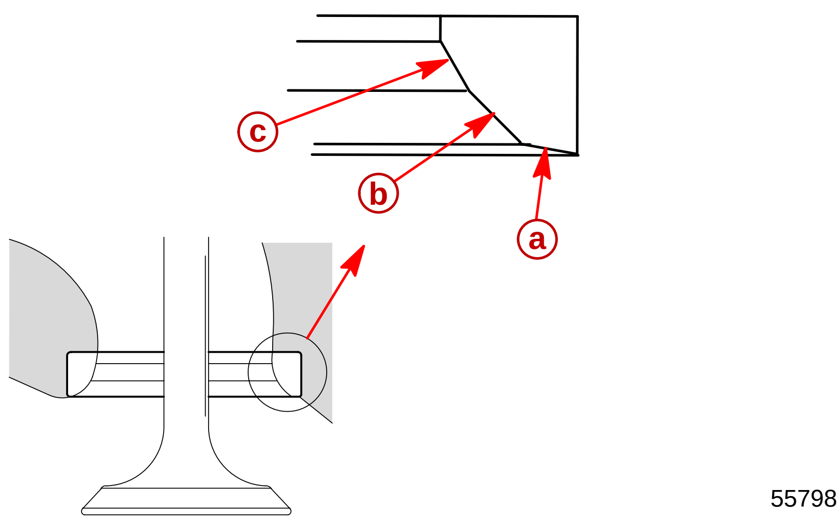
Reface valve seat; use a 60°, 45°, 15° valve seat cutter.

Measure valve seat width (a). Resurface the valve seat If not in specification.



Valve Seat Width Specification "a"	
Intake Valve	0.035 - 0.043 in. (0.9 - 1.1 mm)
Exhaust Valve	

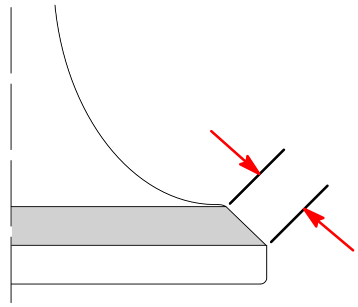
If resurfacing the valve seats is required, resurface the valve seats to the specified angles shown in chart.



Valve Seat Angle Specifications	
a	15°
b	45°
c	60°

Valve Refacing Steps

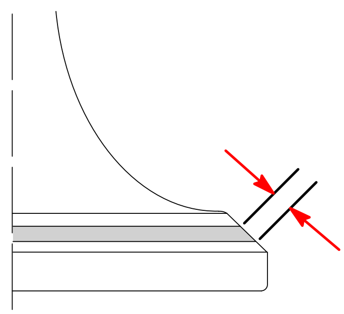
Condition: The valve seat is centered on valve face but it is too wide.



55799

Valve Seat Cutter Set		Desired Results
Use Lightly	15° Cutter	To reduce valve seat width
	60° Cutter	

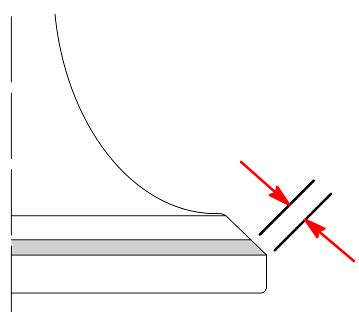
Condition: The valve seat is in the middle of the valve face but it is too narrow.



55800

Valve Seat Cutter Set		Desired Results
Use	45° Cutter	To achieve a uniform valve seat width

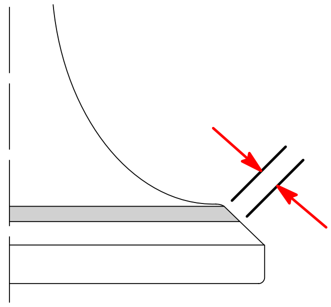
Condition: Valve seat is too narrow and it is near valve margin.



55801

Valve Seat Cutter Set		Desired Results
Use	15° Cutter, First	To center the seat and to achieve its width
	45° Cutter	

Condition: Valve seat is too narrow and is located near the bottom edge of the valve face.

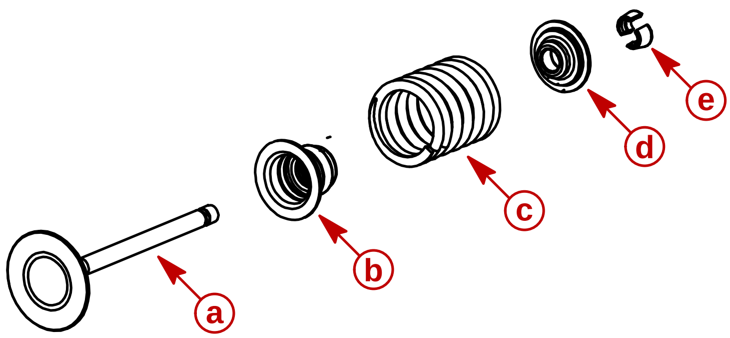


Valve Seat Cutter Set		Desired Results
Use	60° Cutter, First	To center the seat and to increase its Width
	45° Cutter	

Cylinder Head Reassembly

Valve Installation

INTAKE AND EXHAUST VALVE COMPONENTS

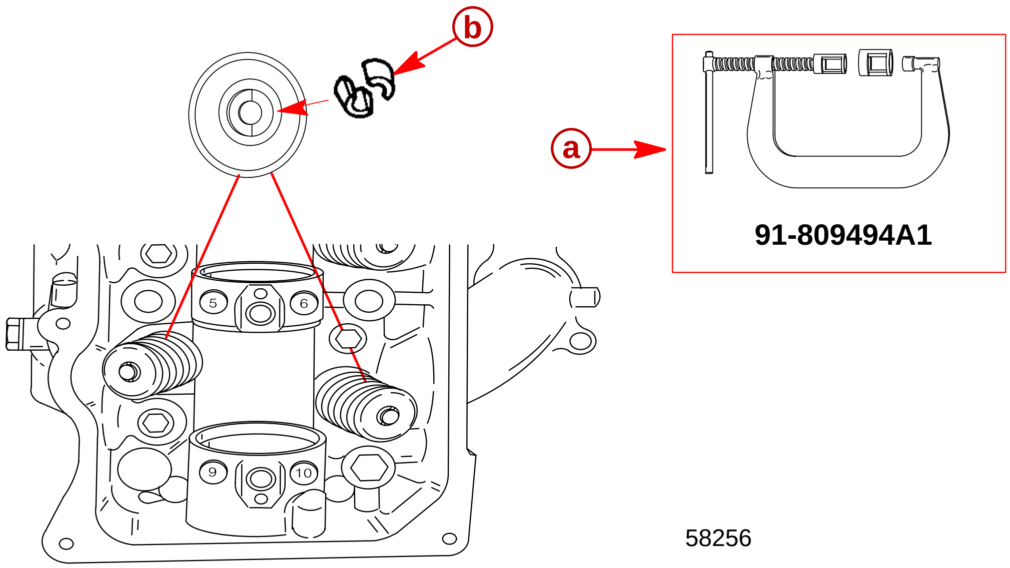


a - Valve
b - Valve Seal
c - Valve Spring
d - Spring Retainer
e - Valve Keepers

INSTALLING VALVES

1. Always use new valve seals.
2. Apply engine oil to the valves and valve seats.
3. Install valves as shown.

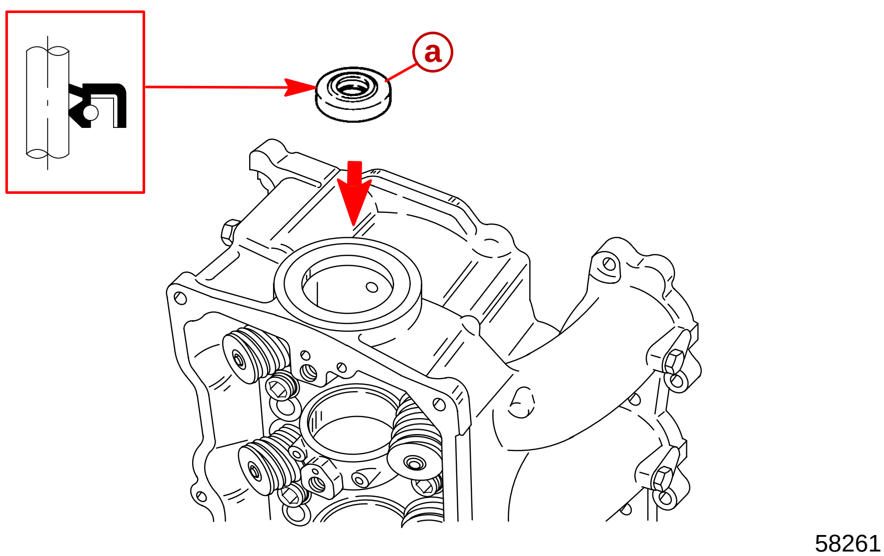
NOTE: *Valve springs are symmetrical and may be installed in either direction.*



a - Use spring compressor tool to compress the springs for installation.
b - Compress the spring and retainer and install the valve keepers around the valve stem. You may have to tap lightly on end of valve to seat the keepers.

Camshaft Oil Seal Installation

1. If removed, install new oil seal. Position seal so part number side is facing outward. Press seal in until it makes contact with the inside flat surface.



a - Upper Camshaft Oil Seal

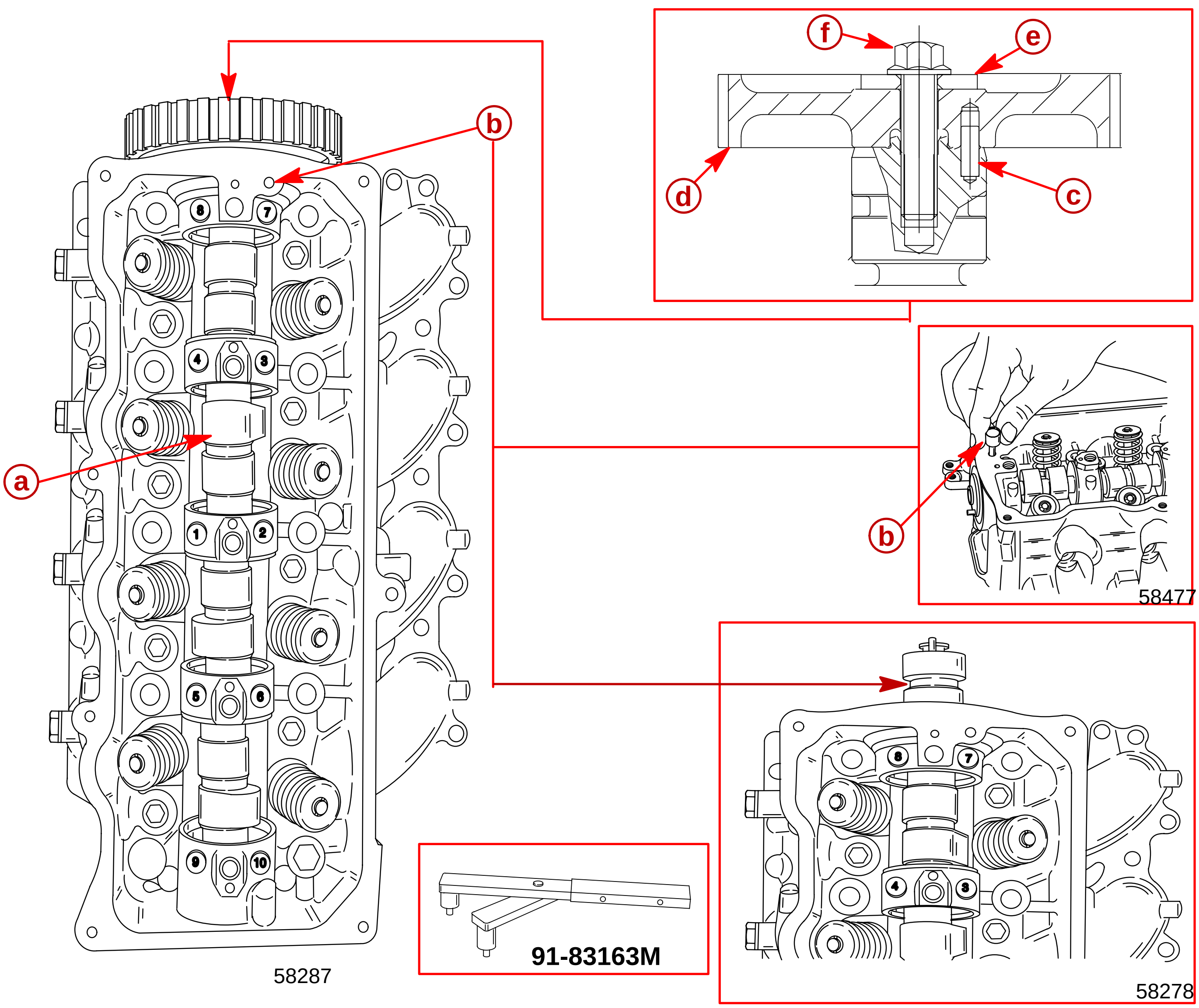
Camshaft Installation

1. Apply engine oil to the main journals (5 places) on the camshaft.
2. Slide camshaft into cylinder head (threaded end towards driven gear).

NOTE: *Camshaft retaining pin groove must align with retaining pin hole in cylinder head.*

3. Install camshaft retaining pin. Install seal over pin.
4. Place driven gear on camshaft so alignment pin is in hole. Hold gear with tool (91-83163M) and fasten with washer and screw. Tighten screw to the specified torque.
5. Remove any oil from the camshaft lobes and apply Moly Grease to the lift portion of the lobes. Obtain Moly Grease from a local source.

NOTE: *Rotate camshaft after assembly to ensure it rotates smoothly.*

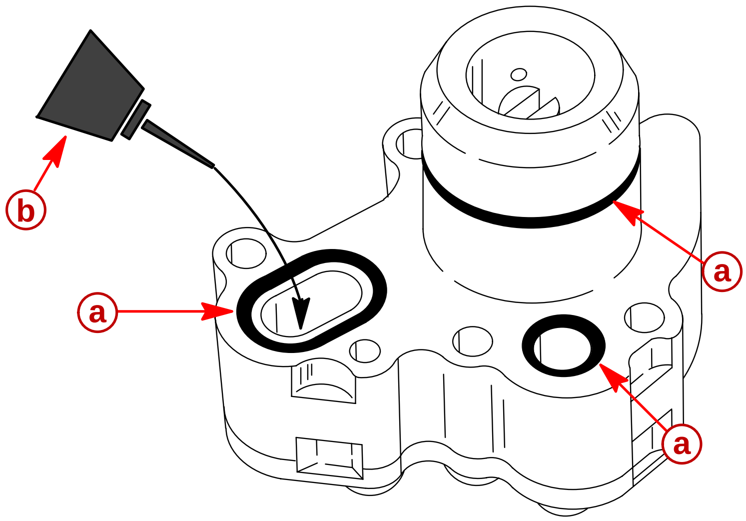


a - Camshaft
b - Camshaft Retaining Pin w/Seal
c - Alignment Pin
d - Driven Gear
e - Washer
f - Screw M10x40

Driven Gear Screw Torque (f)
28 lb-ft (38 Nm)

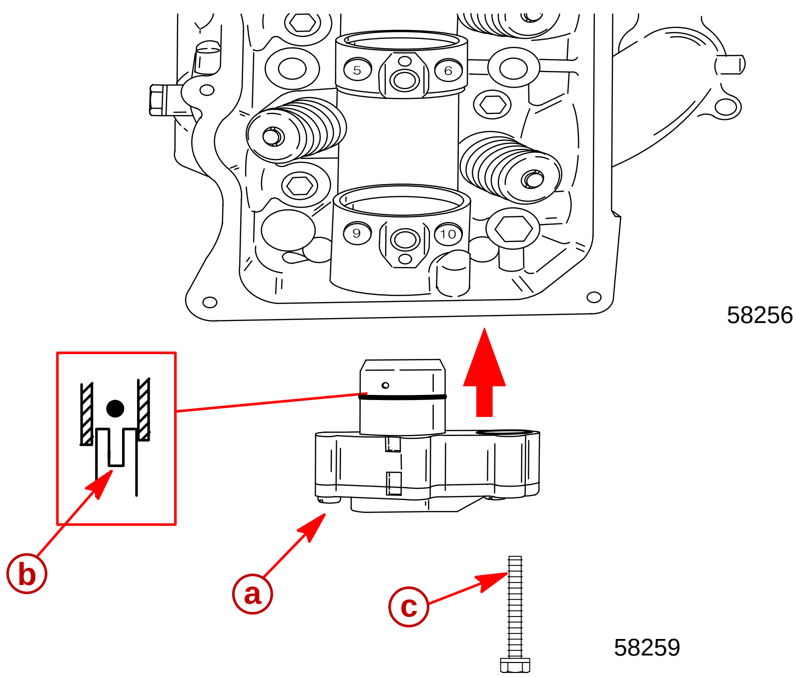
Oil Pump Installation

1. Place O-ring seals on the oil pump. Lubricate the O-rings with oil.
2. Prime the oil pump by pouring approximately 1 fl oz (30 ml) of engine oil into the oil pump body.



a - O-Ring Seals
b - Pour Approximately 1 fl oz (30 ml) of Engine Oil into the Oil Pump Body

3. Align oil pump shaft with the camshaft and install the oil pump.
4. Fasten with 4 screws. Tighten screws to the specified torque.

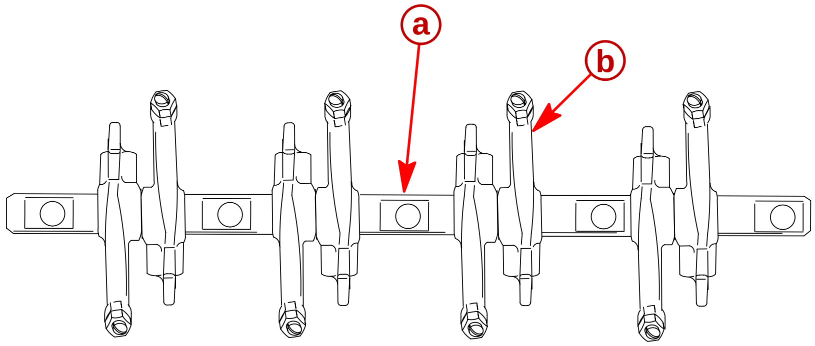


a - Oil Pump Assembly
b - Align Slot with Camshaft Projection
c - Screw (4) M6x40

Oil Pump Mounting Screw Torque
70 lb-in. (8 Nm)

Rocker Arm Shaft Assembly

1. Apply engine oil to the rocker shaft and arms.
2. Locate the end of the rocker shaft that gets installed towards driven gear (oil holes will line-up with the mating oil holes in the cylinder head).
3. Slide the rocker arms onto rocker shaft as shown.



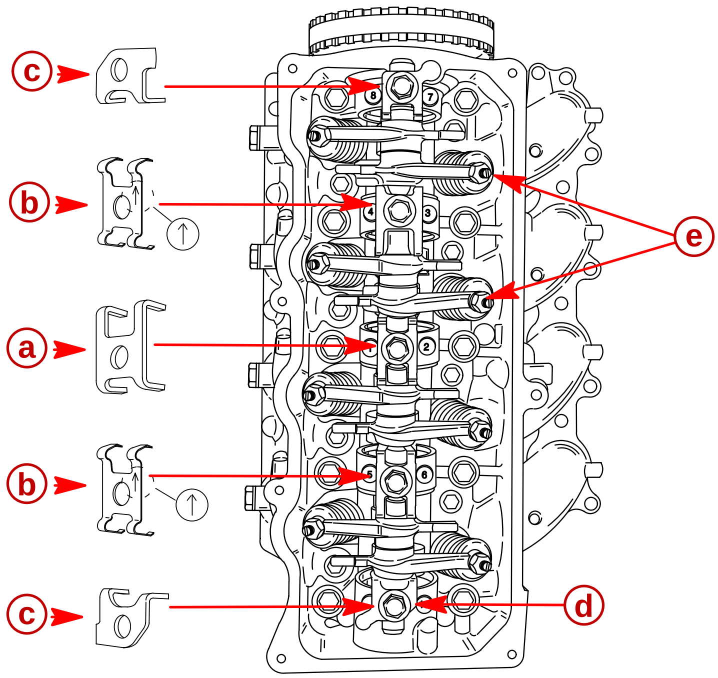
53739

a - Rocker Shaft
b - Rocker Arms

Rocker Arm Shaft Installation

1. Install the rocker arm shaft assembly as shown. Tighten screws to the specified torque.

NOTE: *Leave all adjustment screws loose at this time.*



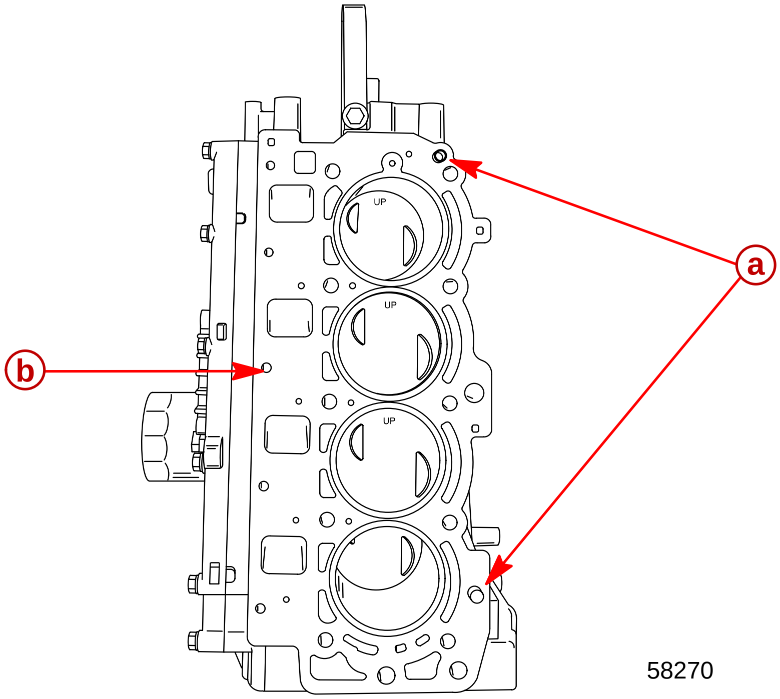
58249

a - Rocker Arm Retainer (1)
b - Rocker Arm Retainer (2) Arrow Must Point Towards Driven Gear
c - Rocker Arm Retainer (2)
d - Mounting Screw (5) M8 x 23
e - Adjustment Screw Loose

Rocker Arm Shaft Mounting Bolt Torque
160 lb-in. (18 Nm)

Cylinder Head Gasket

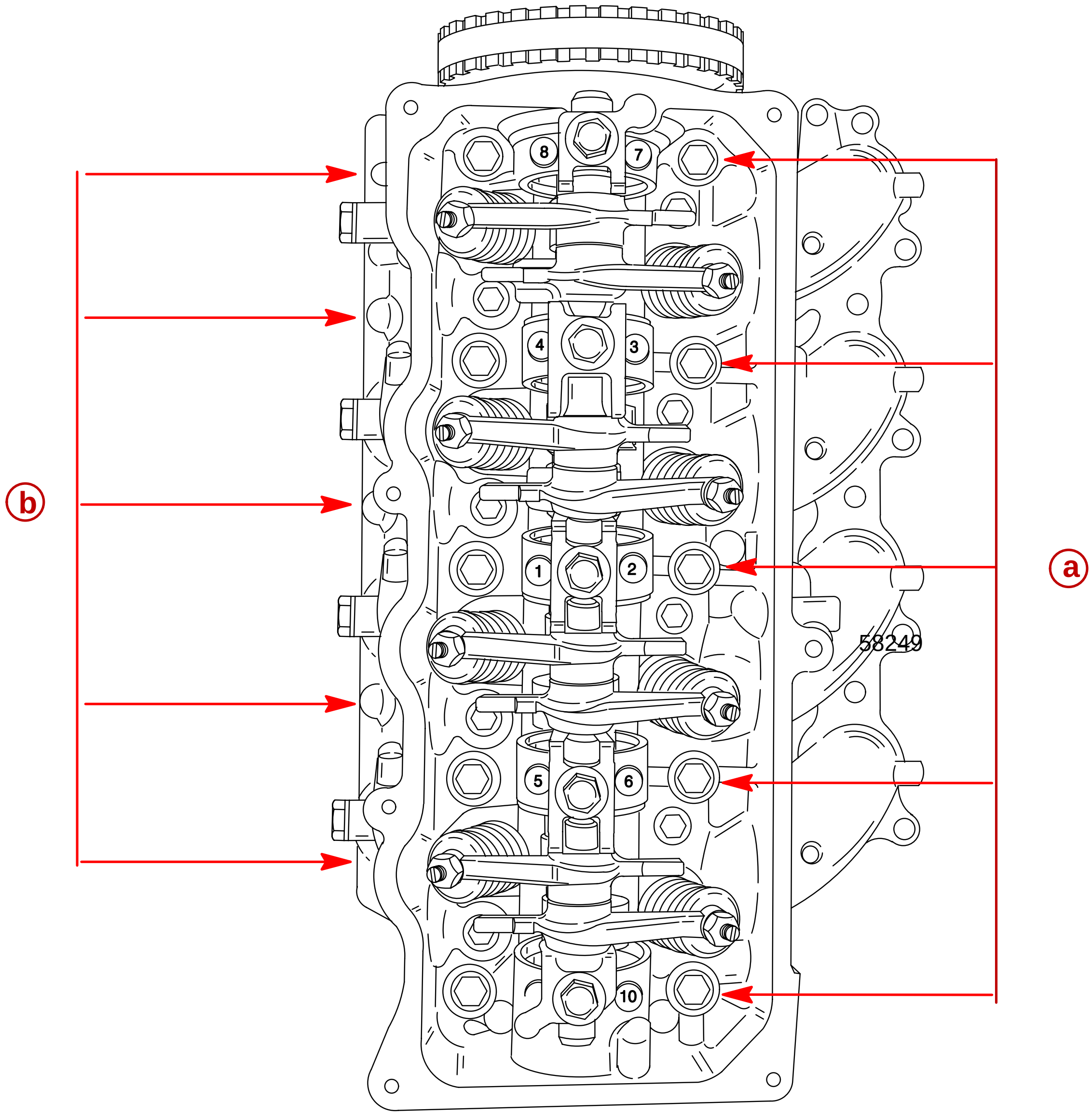
1. Install new cylinder head gasket and dowel pins.



a - Dowel Pin (2)
b - Gasket (new)

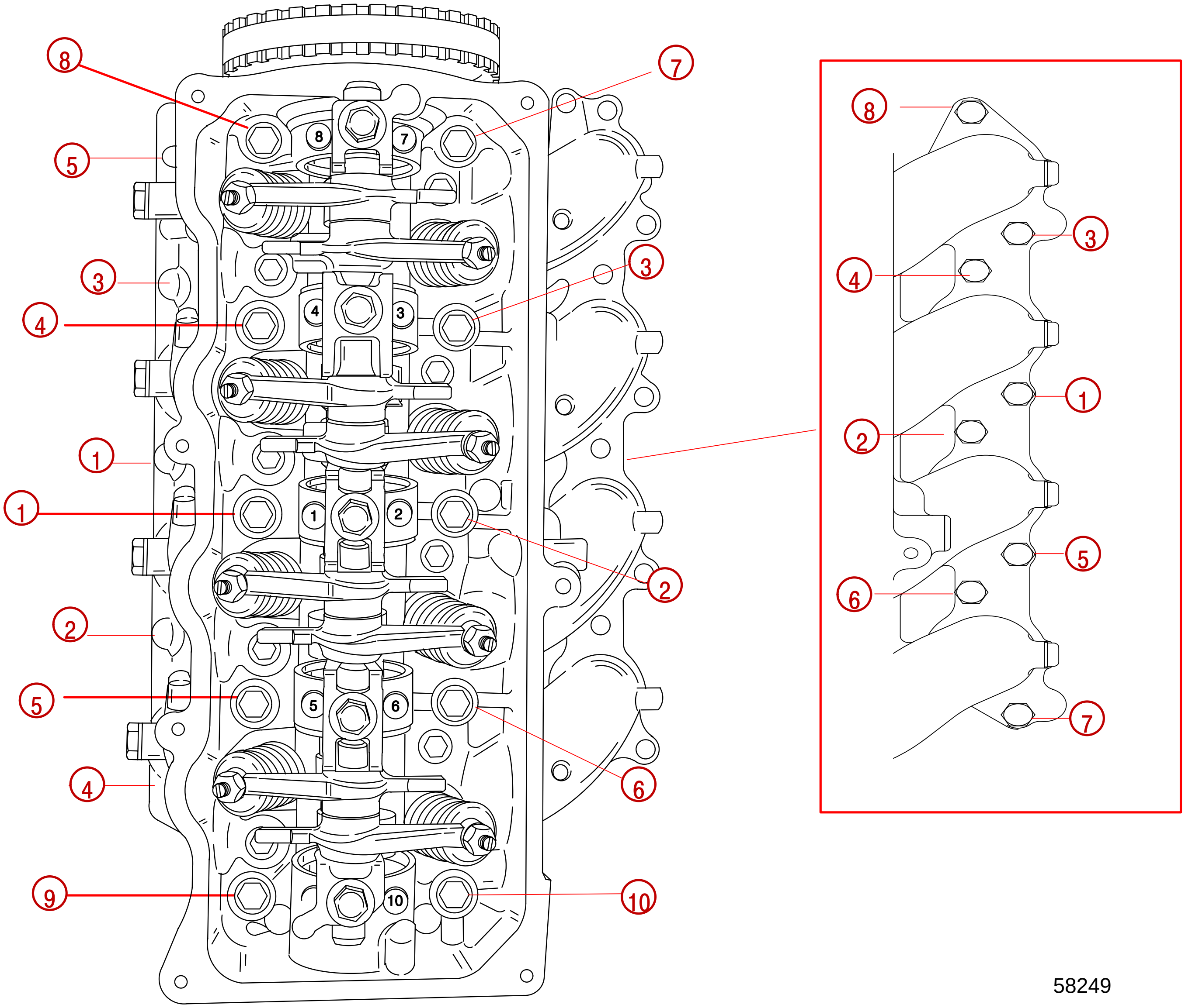
Cylinder Head Installation

1. Apply engine oil to the threads of each bolt and seat surface.
2. Fasten cylinder head with bolts shown.



a - Center Bolts (10) M9x95
b - Flange Bolts (5) M6x25

3. Torque center bolts in sequence and in two steps, then torque the cylinder head and EFI intake manifold screws.
4. Refer to “Timing Belt Installation” preceding, and install timing belt.
5. Refer to “Valve Clearance Adjustment” preceding, to perform valve clearance adjustments.
6. Refer to “Valve Cover Installation” preceding, and install valve cover.



Cylinder Head Bolt Torque
Center Bolts Qty. 10 (Larger Dia. M9) 1st: 17 lb-ft (23 Nm) 2nd: 34.7 lb-ft (47 Nm) Cyl. Head Flange Bolts Qty. 5 (Smaller Dia. M6) 1st: 53 lb-in. (6 Nm) 2nd: 106 lb-in. (12 Nm) Intake Manifold Screws Qty. 8 (Smaller Dia. M6) 70 lb-in. (8 Nm)

POWERHEAD

Section 4B - Cylinder Block/Crankcase

Table of Contents

4
B

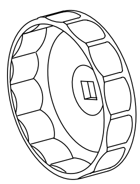
Specifications

CYLINDER BLOCK	**Type** **Displacement** **Number of Cylinders**	4 Stroke Cycle – Over Head Camshaft 60.8 cu. in. (995 cc) 4
STROKE	**Length**	2.953 in. (75 mm)
CYLINDER BORE	**Diameter** **Standard** **Oversize-0.010 in. (0.25 mm)** **Oversize-0.020 in. (0.50 mm)** **Taper/Out of Round Maximum** **Bore Type**	 2.5591 in. (65 mm) 2.5689 in. (65.25 mm) 2.5787 in. (65.5 mm) 0.003 in. (0.08 mm) Cast Iron
PISTON	**Piston Type** **O.D. at Skirt** **Standard** **Oversize-0.010 in. (0.25 mm)** **Oversize-0.020 in. (0.50 mm)**	Aluminum 2.5570 - 2.5578 in. (64.950 - 64.965 mm) 2.5669 - 2.5675 in. (65.2 - 65.215 mm) 2.5768 - 2.5774 in. (65.450 - 65.465 mm)
PISTON CLEARANCE	**Piston to Cylinder Clearance**	0.0014 - .0026 in. (0.035 - 0.065 mm)
RINGS	**Ring End Gap (Installed)** **Top** **Middle** **Bottom (Oil Ring)** **Side Clearance:** **Top** **Middle**	 0.006 - 0.012 in. (0.15 - 0.03 mm) 0.012 - 0.020 in. (0.30 - 0.50 mm) 0.008 - 0.028 in. (0.20 - 0.70 mm) 0.0008 - 0.0024 in. (0.02 - 0.06 mm) 0.0008 - 0.0024 in. (0.02 - 0.06 mm)

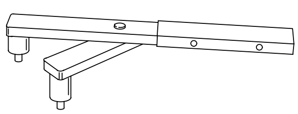
COMPRESSION RATIO	**Compression Ratio** **Cylinder Compression*** **(Electric Models Only, Cold Engine @ W.O.T.)**	9.7:1 180 -210 psi (Peak)
PISTON PIN	**Piston Pin Diameter**	0.6285 - 0.6287 in. (15.965 - 15.970 mm)
CONNECTING ROD	**Oil Clearance (Big End)** **Small End Inside Diameter**	0.0008 - 0.0020 in. (0.020 - 0.052 mm) 0.6293 - 0.6298 in. (15.985 - 15.998 mm)
CRANKSHAFT	**Main Bearing Clearance** **Crankshaft Run-out**	0.0005 - 0.0017 in. (0.012 - 0.044 mm) 0.0018 in. (0.046 mm)

Special Tools

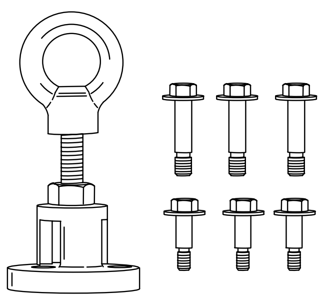
1. Oil Filter Wrench (P/N 91-802653)



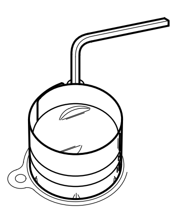
2. Flywheel Holder (P/N 91-83163M)



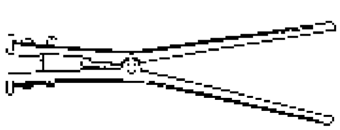
3. Flywheel Puller (P/N 91-83164M)



4. Piston Ring Compressor (P/N FT2997)

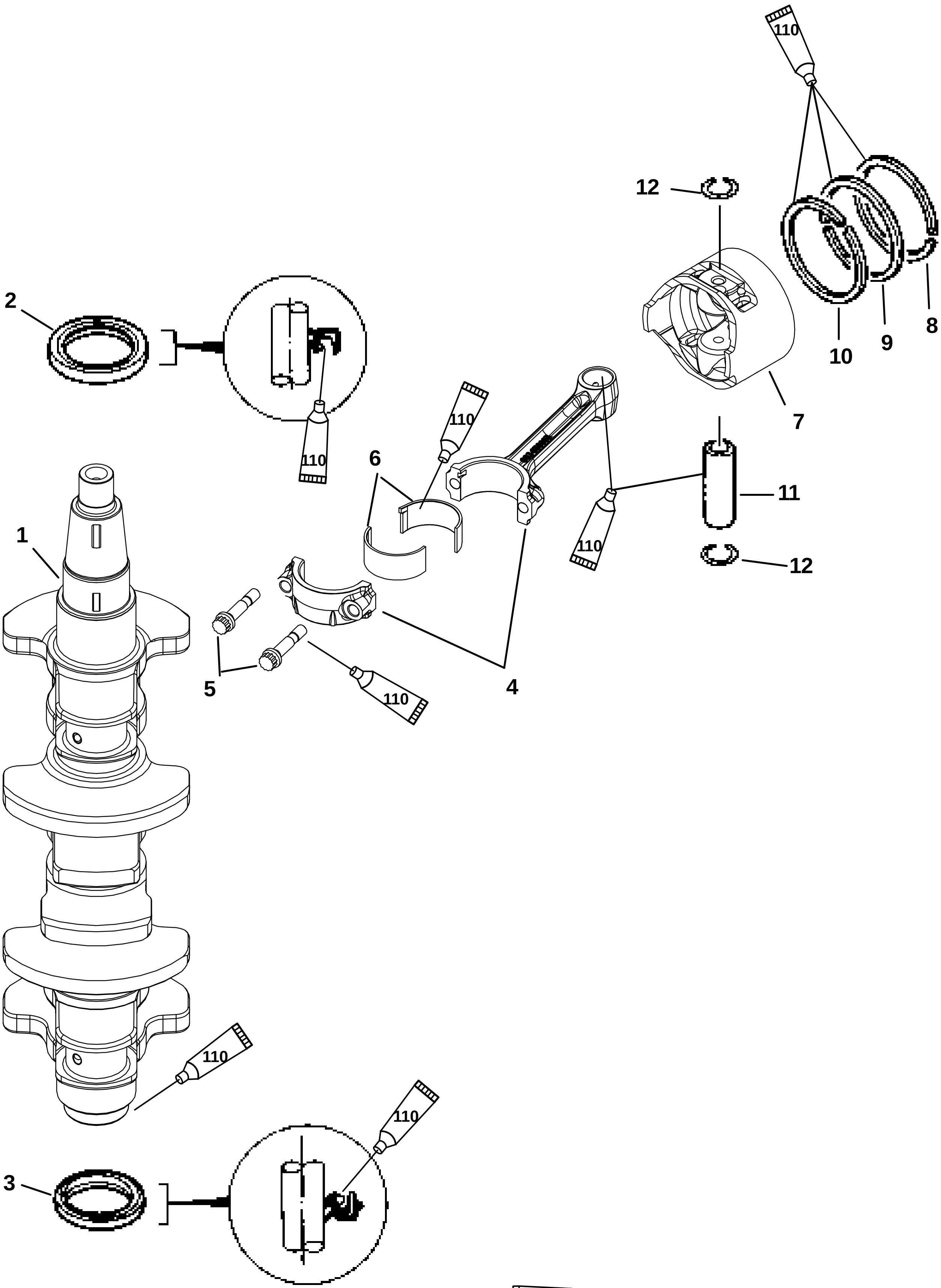


5. Piston Ring Expander (P/N 91-24697)



NOTES:

CRANKSHAFT

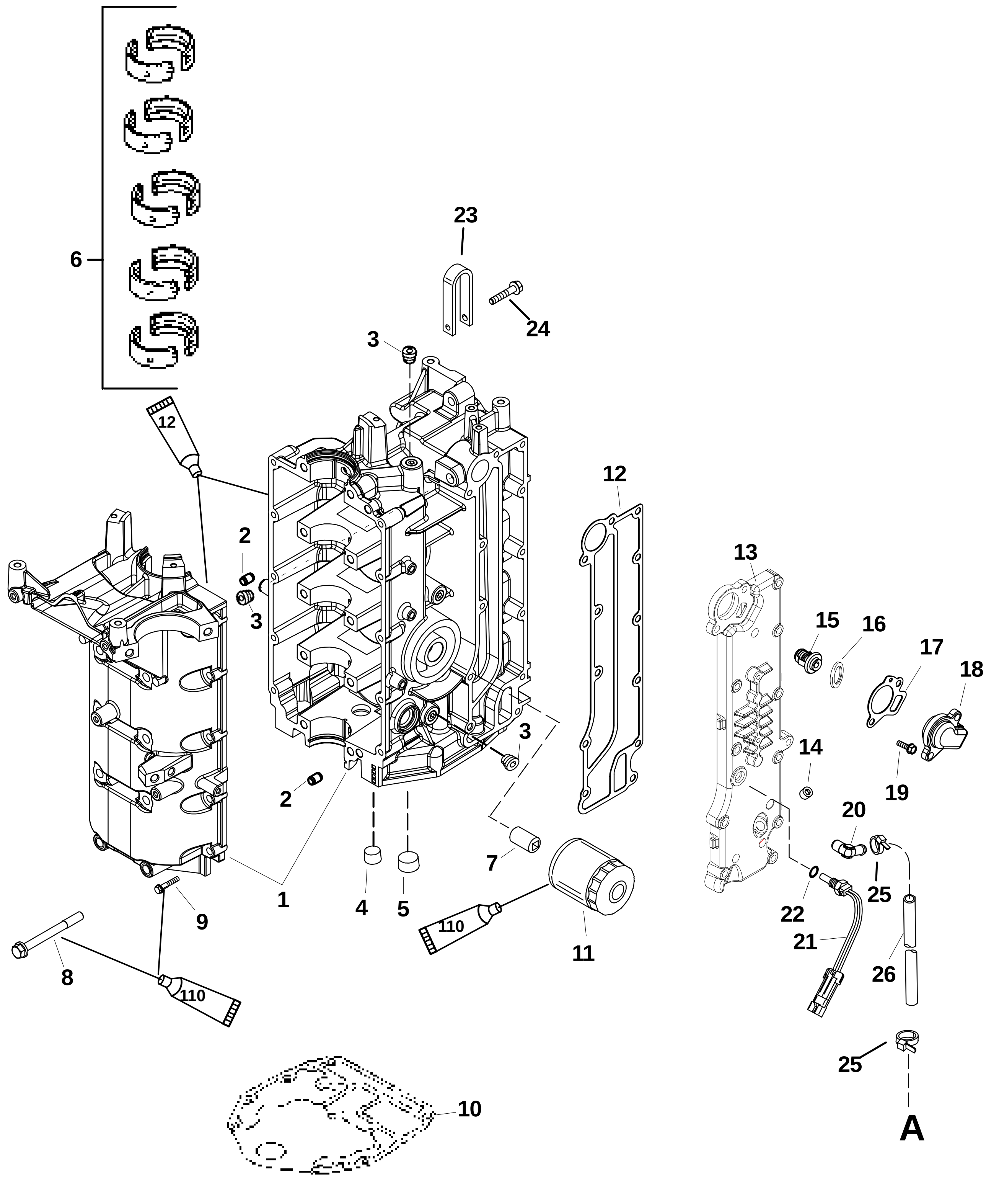


110 4-stroke Outboard Oil (92-828000A12)

CRANKSHAFT

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	CRANKSHAFT			
2	1	OIL SEAL			
3	1	OIL SEAL			
4	4	CONNECTING ROD			
5	8	BOLT	150	12.5	17
6	8	BEARING **(BROWN)**			
	8	BEARING **(BLACK)**			
	8	BEARING **(BLUE)**			
7	4	PISTON			
8	4	PISTON RING (TOP)			
9	4	PISTON RING (SECOND)			
10	4	PISTON OIL RING			
11	4	PISTON PIN			
12	8	RETAINER			

CYLINDER BLOCK AND CRANKCASE



12 Loctite Master Gasket (92-12564-2)

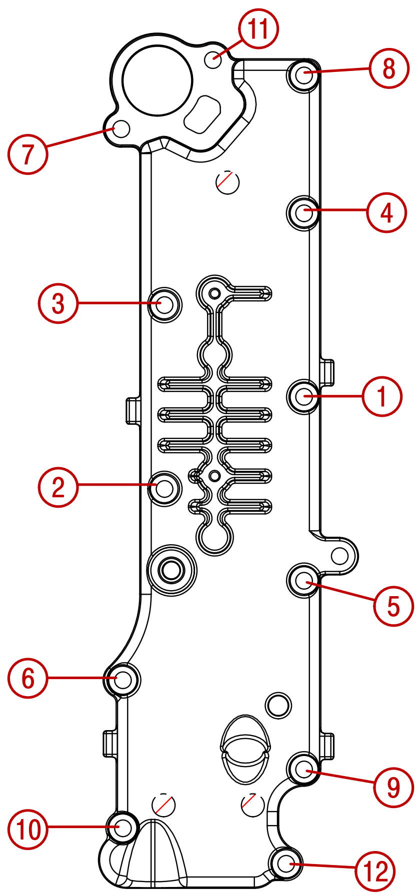
110 4-stroke Outboard Oil (92-828000A12)

A – TO VST COOLER

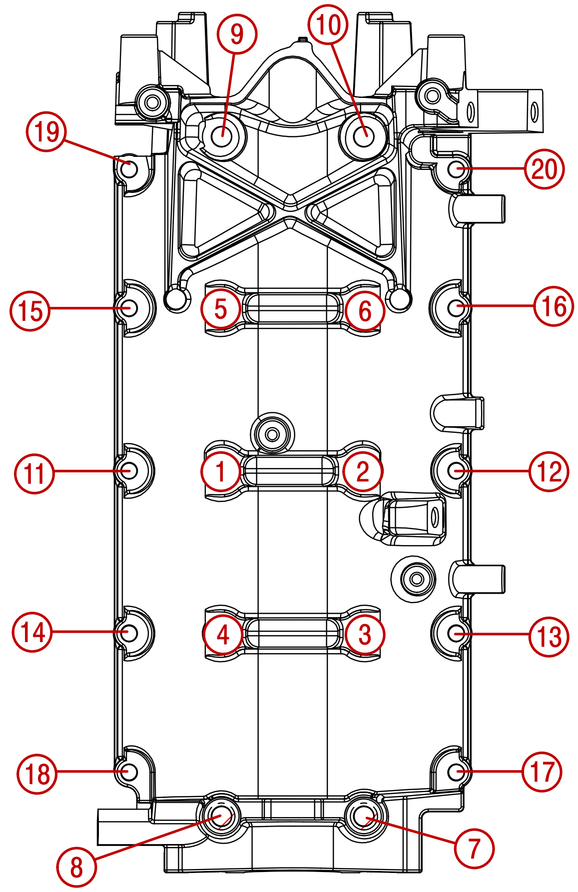
CYLINDER BLOCK AND CRANKCASE

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	CYLINDER BLOCK			
2	2	DOWEL PIN			
3	3	PLUG	79		8.9
4	1	PIPE PLUG (1/2-14)		24.3	33
5	1	PIPE PLUG (3/4-14)		24.3	33
6	10	BEARING **(BROWN)**			
	10	BEARING **(BLACK)**			
	10	BEARING **(BLUE)**			
7	1	NIPPLE		29.5	40
8	10	SCREW (M8 X 82)		22	29.8
9	10	SCREW (M6 X 35)	102		12
10	1	GASKET			
11	1	OIL FILTER	70		7.9
12	1	GASKET			
13	1	EXHAUST COVER			
14	1	PIPE PLUG	Drive Tight		
15	1	THERMOSTAT			
16	1	GASKET			
17	1	GASKET			
18	1	COVER			
19	12	SCREW (M6 X 35)	106		11.9
20	1	ELBOW	Drive Tight		
21	1	ENGINE COOLANT TEMPERATURE (ECT) SENSOR	15		1.7
22	1	O RING			
23	1	LIFTING EYE			
24	1	SCREW (M8 X 35)		29.2	39.6
25	2	STA STRAP			
26	1	TUBING (10 IN.)			

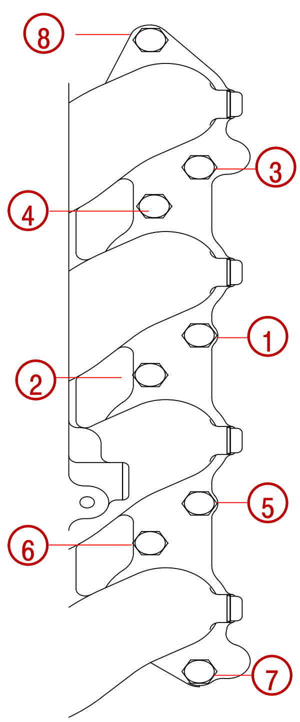
Torque Sequence



Exhaust Cover



Crankcase Cover



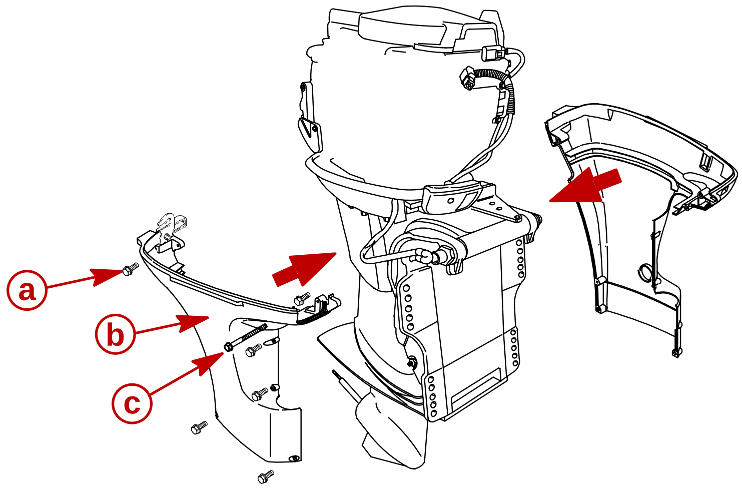
Intake Manifold Flange

Powerhead Removal

⚠ WARNING

The possibility exists that the engine could start when turning the flywheel. To avoid possible serious injury, always disconnect the battery and remove spark plug leads from spark plugs before working on motor.

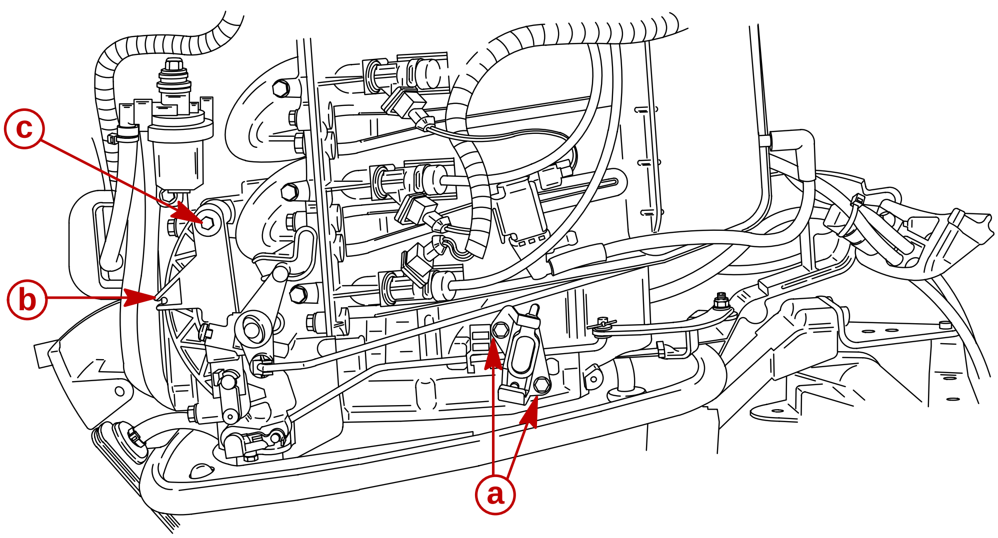
1. On electric start models, disconnect the battery cables from the battery. Remove battery cables from engine.
2. Disconnect the power trim wires (if so equipped).
3. Remove the bottom cowls.



a - Screw (6)-M6x30
b - Lower Cowl
c - Screw-M6x60

4. Drain the engine oil.
5. Remove the control cable anchor bracket screws (remote control models).
6. Remove the throttle/shift lever screw and swing the entire shift linkage to the side.

REMOTE CONTROL MODEL

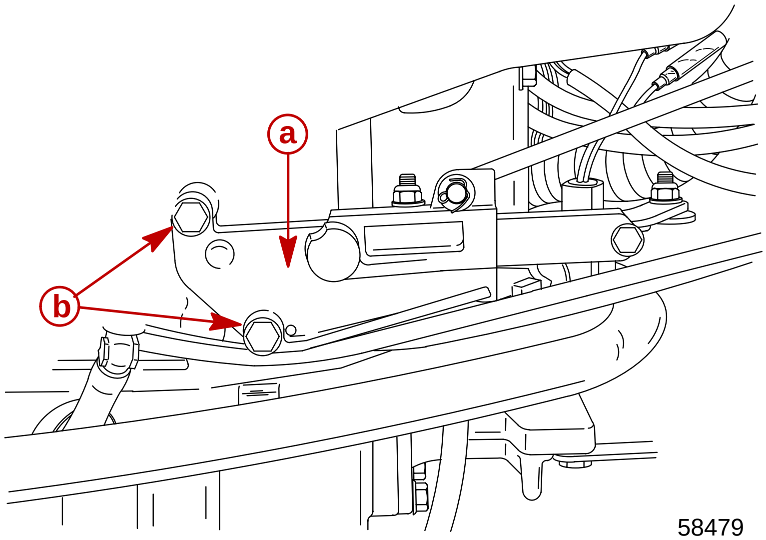


58810

a - Control Cable Anchor Bracket Screw (2) M6 x 16
b - Throttle/Shift Lever
c - Shift Lever Screw (1) M8 x 70

7. Remove the shift guide bracket bolts.

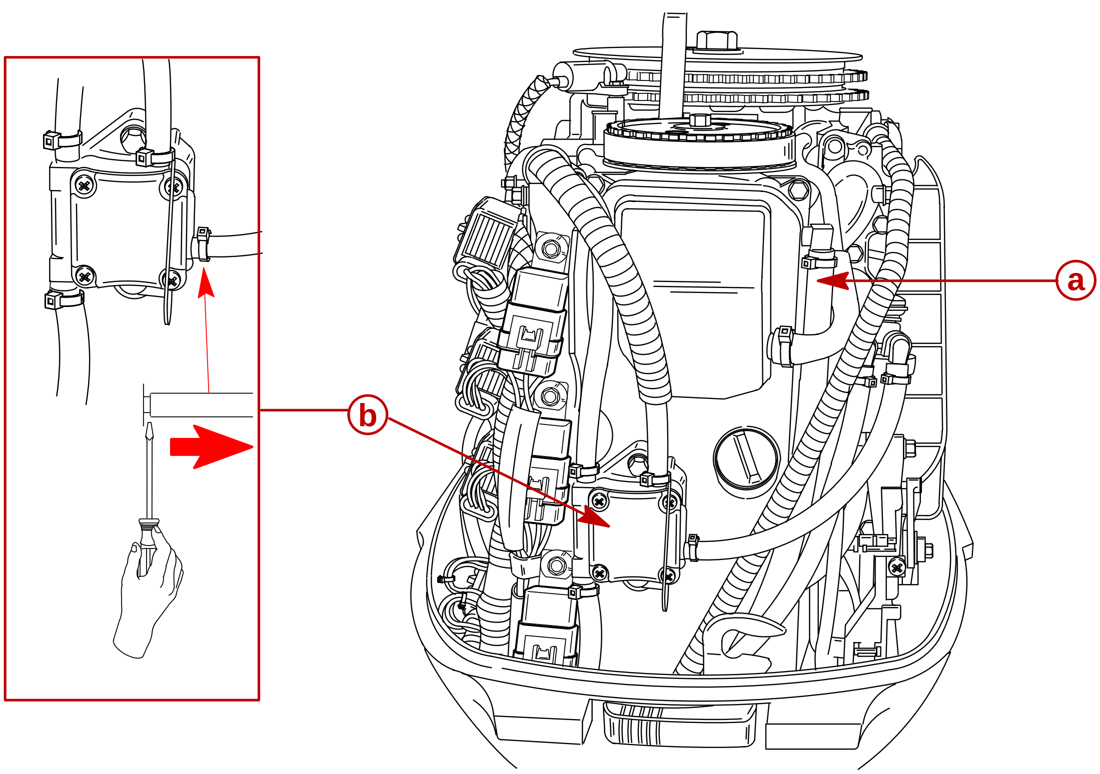
TILLER HANDLE MODEL



a - Shift Guide Bracket
b - Screw (2) M6 x 25

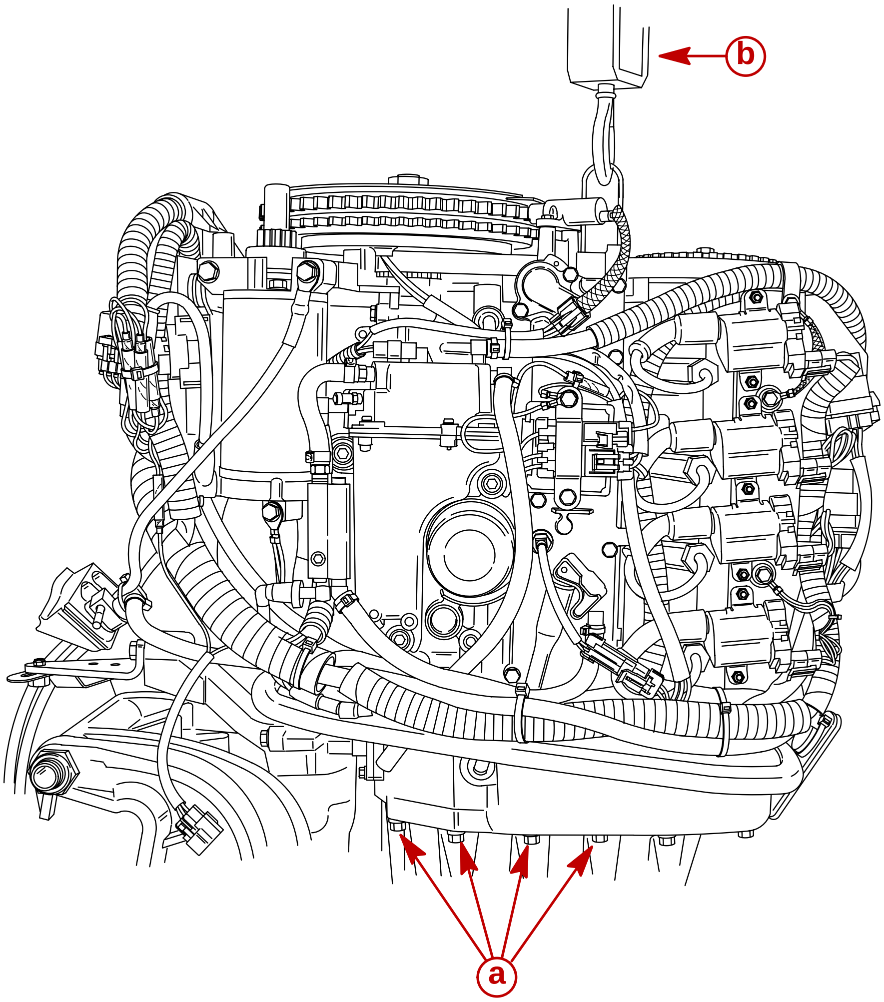
8. Disconnect the crankcase vent hose.
9. Disconnect inlet hose from fuel pump.

IMPORTANT: The hose fittings on the fuel pump can break if you try twisting or pulling off the hoses. Remove hoses by slowly prying off the hoses using a small screwdriver.



a - Crankcase Vent Hose
b - Fuel Pump Inlet hose

10. Remove powerhead mounting bolts.
11. Lift powerhead from driveshaft housing.



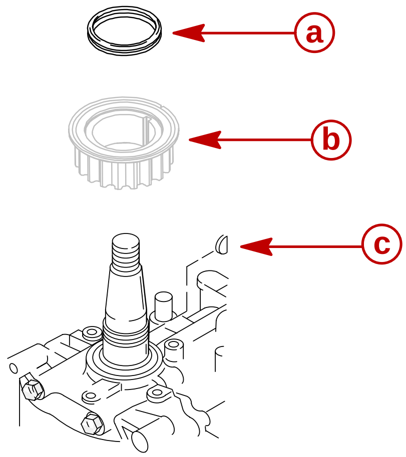
a - Powerhead Mounting Bolts (4 Each Side) M8 x 45
b - Hoist

Removing Powerhead Components

1. Place powerhead on bench.
2. Remove intake assembly. Refer to section **3C Intake Assembly Removal.**
3. Remove Vapor Separator Assembly. Refer to section **3C Vapor Separator Removal.**
4. Remove flywheel, stator and starter. Refer to section **2B Charging & Starting System.**
5. Disconnect/Remove components in the following order: ECM bracket screws(3), main harness ground wire screws (near bottom of starter), starter solenoid mounting screws, oil pressure switch, ECT sensor, regulator/rectifier mounting screws, crank position sensor mounting screws, ignition coil mounting screws.
6. Remove electrical components as an assembly. Disconnect wiring and cut sta-straps as necessary.
7. Remove cylinder head. Refer to section **4A Cylinder Head Removal.**

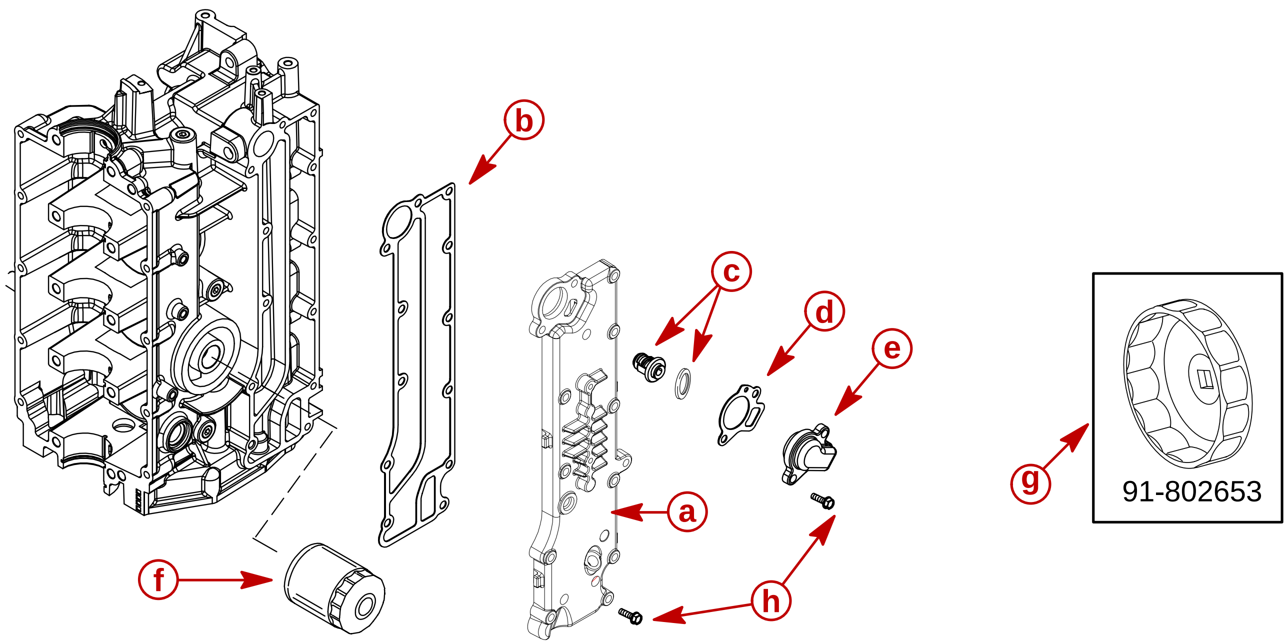
Cylinder Block Disassembly

1. Remove the drive gear components.



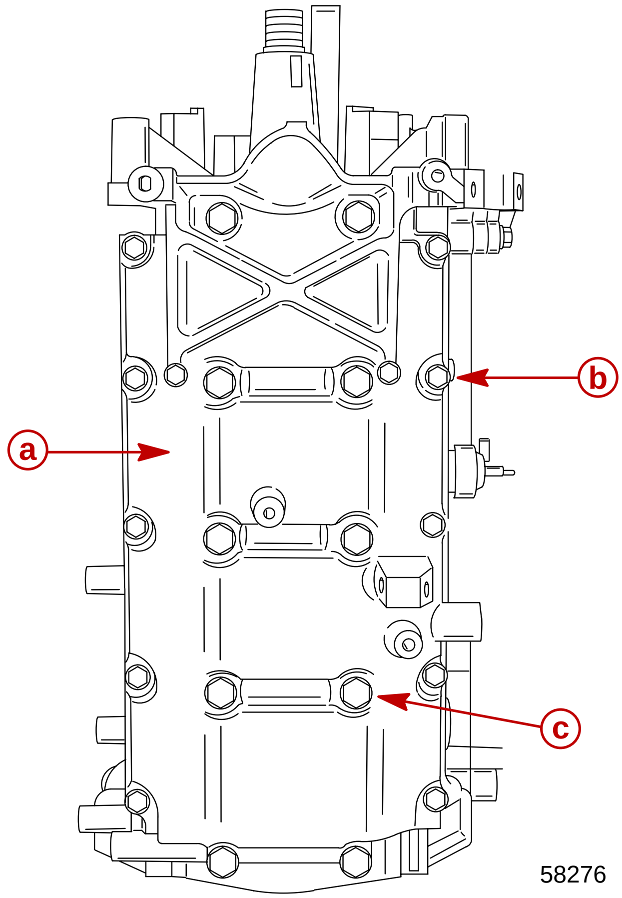
a - Load Ring
b - Drive Gear
c - Woodruff Key

2. Remove exhaust cover and gasket.
3. Remove oil filter.



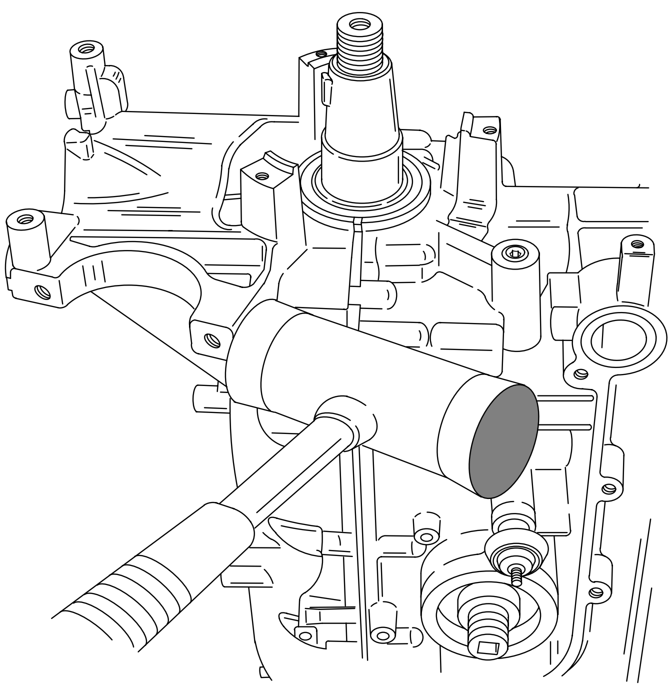
a - Exhaust Cover
b - Gasket
c - Thermostat and Gasket
d - Gasket
e - Thermostat Cover
f - Oil Filter
g - Oil Filter Wrench
h - Exhaust Cover Screw (12) M6 x 35

4. Remove crankcase cover bolts.



a - Crankcase Cover
b - Crankcase Cover Bolts (10) M6 x 35
c - Crankcase Cover Bolts (10) M8 x 82

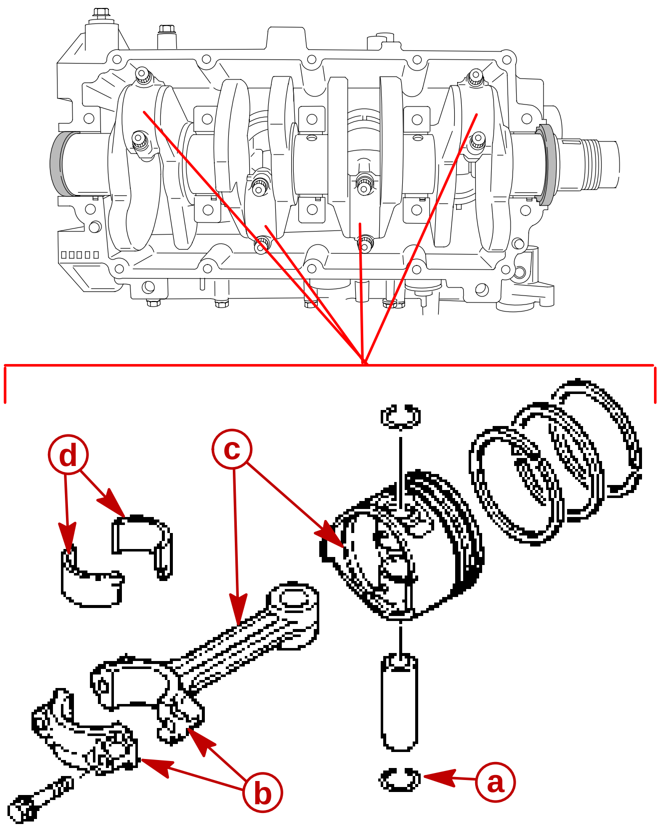
5. With a rubber or plastic hammer, lightly strike the crankcase cover in order to separate it from the block. If the cover will not separate, try prying it off with a screwdriver. Do not damage the split line sealing surface when prying the cover off.

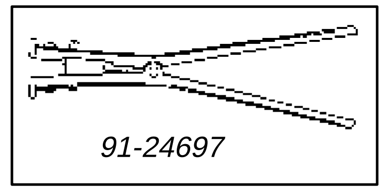


6. Use a 5/16 in. 12 point socket and remove connecting rod bolts.
7. Remove carbon ridge from the cylinder bore using a burr knife. Push out the pistons. Keep each piston, connecting rod, and cap together as an assembly.

NOTE: *Use piston ring expander tool to prevent rings from breaking. If reusing rings, mark their location (piston #1, #2, #3, or #4) for correct installation.*

NOTE: *Each connecting rod and cap are a matched set. They must not be interchanged.*





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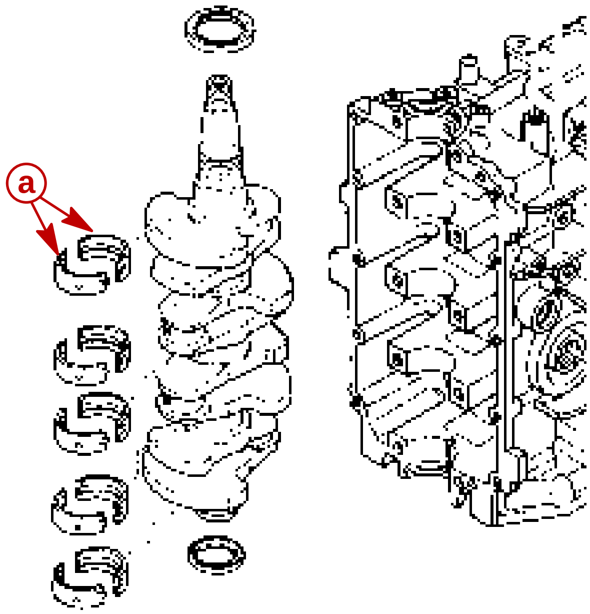
a - Remove Circlips with a Needle Nose Pliers
b - Connecting Rod and Cap are a Matched Set, Don’t Interchange
c - Scribe the Cylinder Number (1 thru 4) on Inside of Each Piston and Connecting Rod so they can be Reinstalled in their Original Location
d - Connecting Rod Bearings – Do Not Interchange. Reinstall in Original Locations

8. Remove crankshaft from block.



a - Main Bearings – Do Not Interchange. Reinstall in Original Locations

Inspection

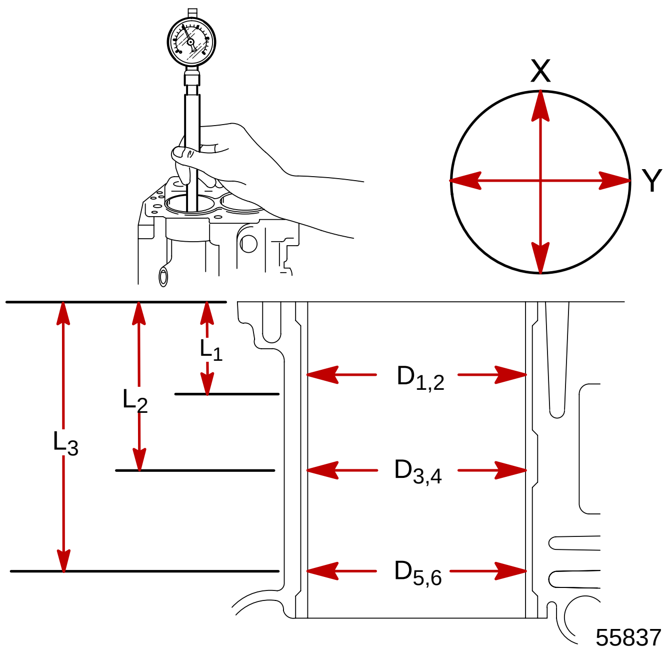
Cylinder Bore

MEASURING CYLINDER BORE

1. Measure the cylinder bore diameter at three locations in both X and Y axis.
2. If the cylinder bore is beyond the standard limits listed in the tables below, it will be necessary to re-bore the cylinder to accept the oversize piston.

NOTE: *Measure at three locations (L_1, L_2, and L_3) in both X and Y axis (D_{1-6}).*
L_1=0.8 in. (20 mm)
L_2=1.6 in. (40 mm)
L_3=2.4 in. (60 mm)

1. Inspect:
   a. Water jacket for mineral deposits/corrosion, clean if necessary.
   b. Inner surface for score marks, repair if necessary.
2. Measure bore diameter with a cylinder gauge, re-bore or replace if necessary.

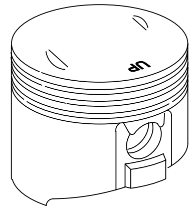


Cylinder Bore Specifications	
Bore Size	**Maximum Taper/Out-of-Round**
Standard Bore 2.5591 in. (65 mm)	0.003 in.(0.08 mm)
Oversize Bore-0.10 in. (0.25 mm) 2.5689 in. (65.25 mm)	0.003 in.(0.08 mm)
Oversize Bore-0.20 in. (0.50 mm) 2.5787 in. (65.5 mm)	0.003 in.(0.08 mm)

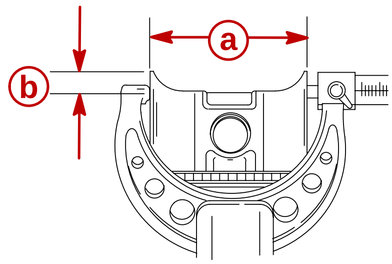
NOTE: *Taper=(Maximum of D_1 or D_2)–(Minimum of D_5 or D_6)*

Piston

1. Inspect piston wall wear/damage, replace if necessary.



2. Measure the piston at a point 0.2 in (5.0 mm) from the bottom, replace if out of specification.



a - Piston Diameter **b** - 0.2 in. (5.0 mm)

Piston Diameter "a"	
Piston Size	**Diameter**
Standard	2.5570 - 2.5578 in. (64.950 - 64.965 mm)
Oversize-0.010 in. (0.50 mm)	2.5669 - 2.5675 in. (65.2 - 65.215 mm)
Oversize -0.020 in. (0.50 mm)	2.5768 - 2.5774 in. (65.450 - 65.465 mm)

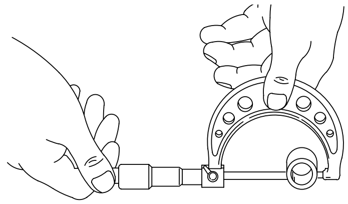
3. Measure piston to cylinder clearance. If out of specification examine piston and cylinder bore further to determine repair/replacement.
   a. Piston to Cylinder Clearance can be defined by:

MBM–MPM=PCC where:
MBM=Minimum Bore Measurement
MPM=Maximum Piston Measurement
PCC=Piston to Cylinder Clearance

Piston to Cylinder Clearance
0.0014 - 0.0026 in. (0.035 - 0.065 mm)

Piston Pin

1. Measure piston pin diameter. Replace piston pin if out of specification.



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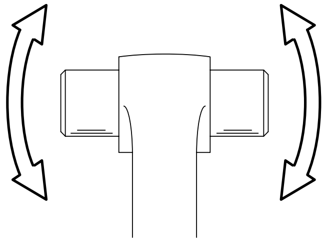
Piston Pin Diameter
0.6285 - 0.6287 in. (15.965 - 15.970 mm)

1. Place the piston pin into the connecting rod and check for free play. There should be no noticeable free play.



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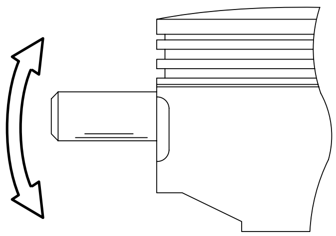
2. Place the piston pin into the piston and check for free play. There should be no noticeable free play.



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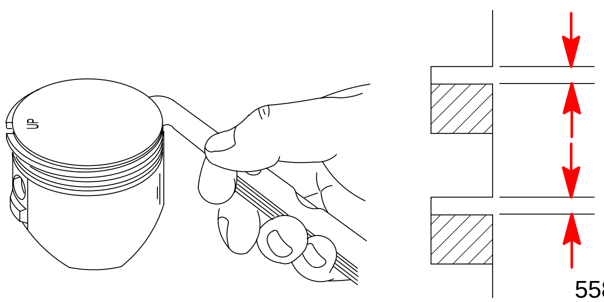
Piston Rings

PISTON RING SIDE CLEARANCE

1. Measure piston ring side clearance. Replace piston and/or piston rings if out of specification.

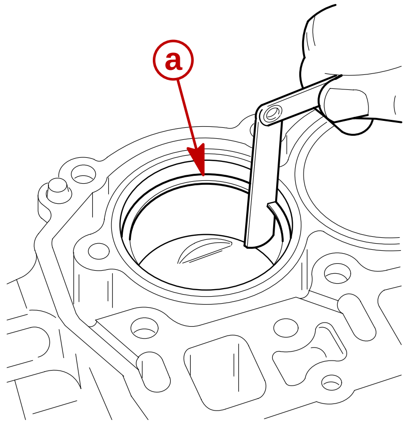


55842

Piston Ring Side Clearance	
Top	0.0008 - 0.0024 in. (0.02 - 0.06 mm)
Middle	0.0008 - 0.0024 in. (0.02 - 0.06 mm)

PISTON RING END GAP CLEARANCE

1. Measure piston ring end gap clearance. Replace piston ring if out of specification.



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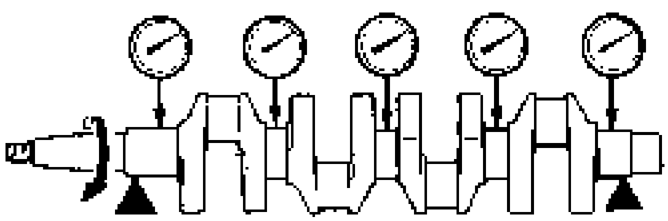
a - Push Piston Rings into Cylinder 0.8 in. (20 mm) Deep. Push in the Rings Using the Piston.

Piston Ring End Gap	
Top	0.006 - 0.012 in. (0.15 - 0.30 mm)
2nd	0.012 - 0.020 in. (0.30 - 0.50 mm)
Oil	0.008 - 0.028 in. (0.20 - 0.70 mm)

Crankshaft

1. Thoroughly clean crankshaft and inspect bearing surfaces. Replace crankshaft if bearing surfaces are pitted, scored, or discolored.
2. Measure Run-out. Replace crankshaft if out of specification.



Crankshaft Run-out
0.0018 in. (0.046 mm)

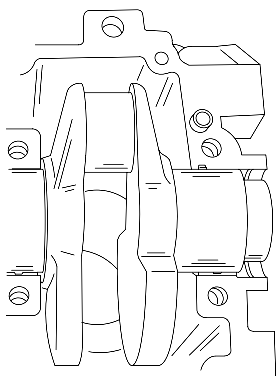
Checking Main Bearing Clearance

IMPORTANT: Do not interchange the main bearings. Reinstall in their original position.

1. Clean all the old sealing material from the split line on the crankcase cover and cylinder block.
2. Clean all the oil from the following areas:
   - Main bearing surfaces on the cylinder block and crankcase cover.
   - Main bearings.
   - Crankshaft bearing surfaces.

NOTE: *Refer to instructions in* *Cylinder Block Reassembly* *for selecting and installing main bearings.*

3. Install main bearings.
4. Place crankshaft into cylinder block.



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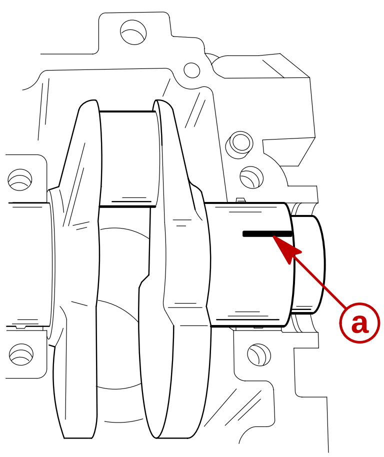
5. Place a piece of plastigauge onto each crankshaft bearing surface.

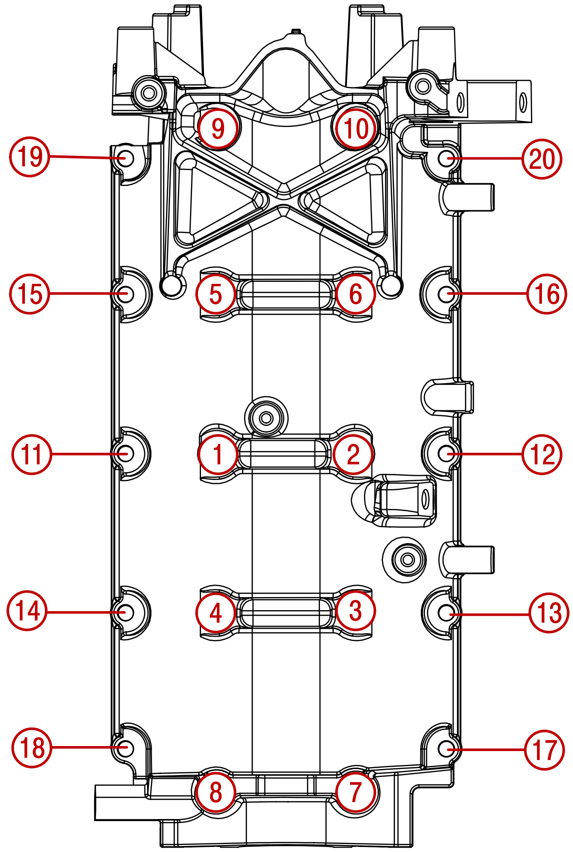


53812

a - Plastigauge

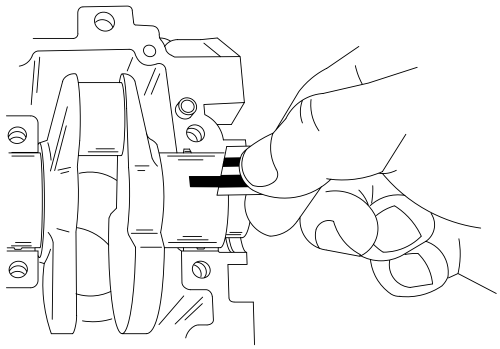
NOTE: *Do not put plastigauge over the oil hole on the bearing surface of the crankshaft.*

6. Install crankcase cover. Apply oil to the cover bolts and torque cover bolts in sequence and in two steps.



Crankcase Cover Bolt Torque		
Center Bolts Qty. 10 (M8x82)	1st Torque:	11 lb-ft. (15 Nm)
	2nd Torque:	22 lb-ft. (30 Nm)
Outer Bolts Qty. 10 (M6x35)	1st Torque:	53 lb-in. (6 Nm)
	2nd Torque:	106 lb-in. (12 Nm)

7. Remove the crankcase cover. Measure the compressed plastigauge to check the main bearing clearance. Replace bearings if clearance is not in specification.



53751

Main Bearing Clearance
0.0005 - 0.0017 in. (0.012 - 0.044 mm)

8. If replacement of the main bearings is required, refer to Main Bearing Selection and Installation in Cylinder Block Reassembly.

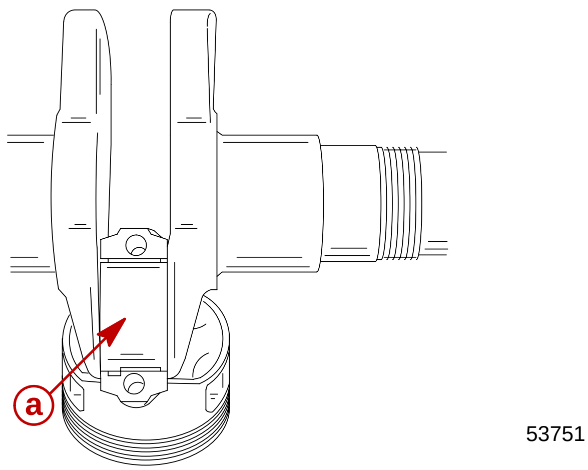
Checking Connecting Rod Bearing Clearance

IMPORTANT: Do not interchange used connecting rod bearings. Reinstall bearings in their original position.

1. Clean all the oil from the connecting rod bearing surfaces and connecting rod journals on the crankshaft.

NOTE: *Refer to instructions in* <u>*Cylinder Block Reassembly*</u> *for selecting and installing connecting rod bearings.*

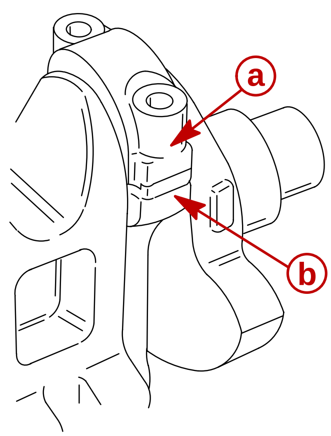
2. Place a piece of plastigauge on the connecting rod journals.

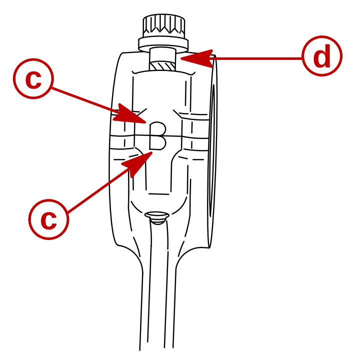


a - Plastigauge

IMPORTANT: Do not rotate connecting rod when checking clearance.

3. Install the connecting rod to the respective journal. Tighten connecting rod bolts in sequence and in two steps to the specified torque.

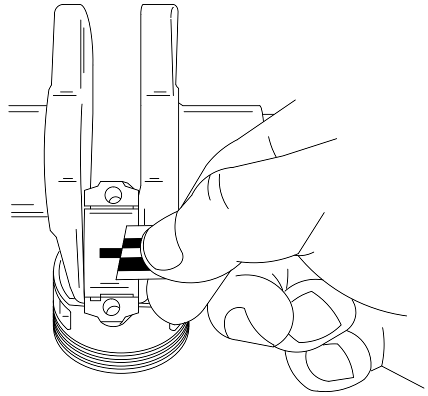




a - Connecting Rod Cap
b - Crankpin
c - Scribe Marks on Cap and Rod
d - Connecting Rod Bolts

Connecting Rod Bolt Torque	
1st Torque:	53 lb-in. (6 Nm)
2nd Torque:	150 lb-in. (17 Nm)

4. Remove the connecting rod cap. Measure the compressed plastigauge to check the connecting rod oil clearance. Replace bearings if oil clearance is not in specification.



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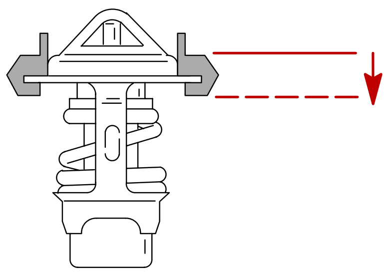
Connecting Rod Oil Clearance
0.0008 – 0.0020 in. (0.020 - 0.052 mm)

Thermostat

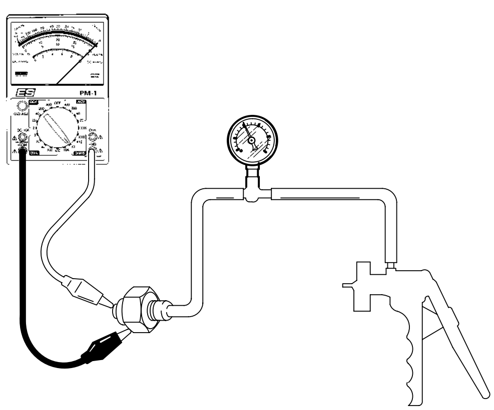
1. Measure the lift of the thermostat at the operating water temperature listed.



Water Temperature	Valve Lift
118 - 123° F (48° - 51° C)	Starts to Open
Above 145° F (63° C)	Minimum 0.12 in. (3 mm)

Oil Pressure Switch

1. Check continuity of switch.



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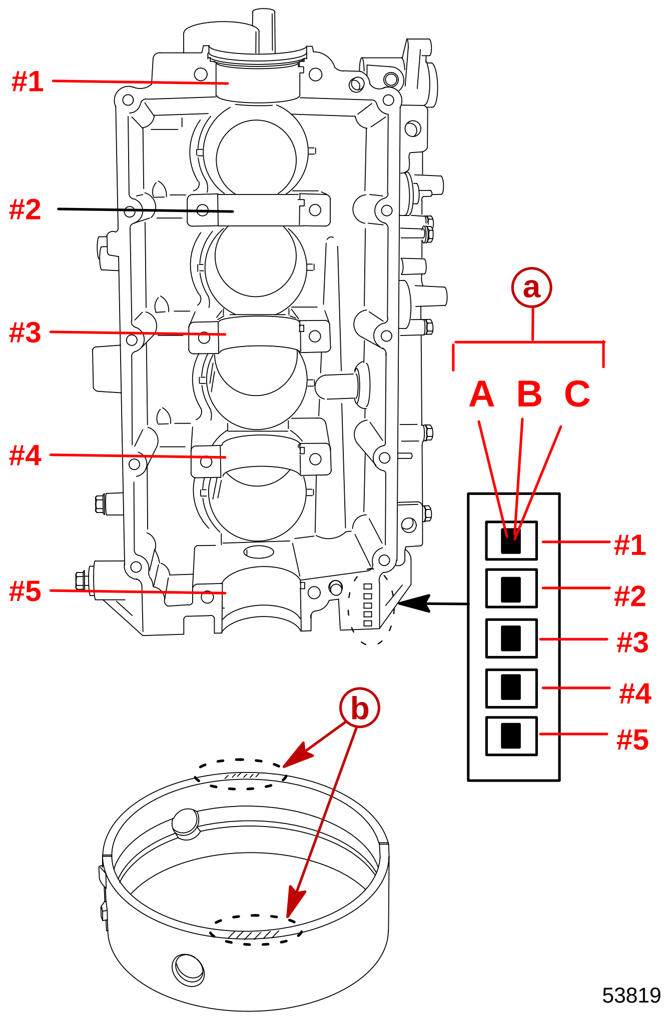
Oil Switch Continuity Check	
Below 2.9 psi (20.0 kPa)	Continuity
Above 2.9 psi (20.0 kPa)	No Continuity

Cylinder Block Reassembly

Selecting New Main Bearings

1. Locate the main bearing code letters on the cylinder block.
2. Refer to the following reference chart to select the correct main bearings.
3. Use the color coded main bearings that match the main bearing code letter.

Main Bearing Code Letter	Main Bearing Color Code
A	Blue
B	Black
C	Brown

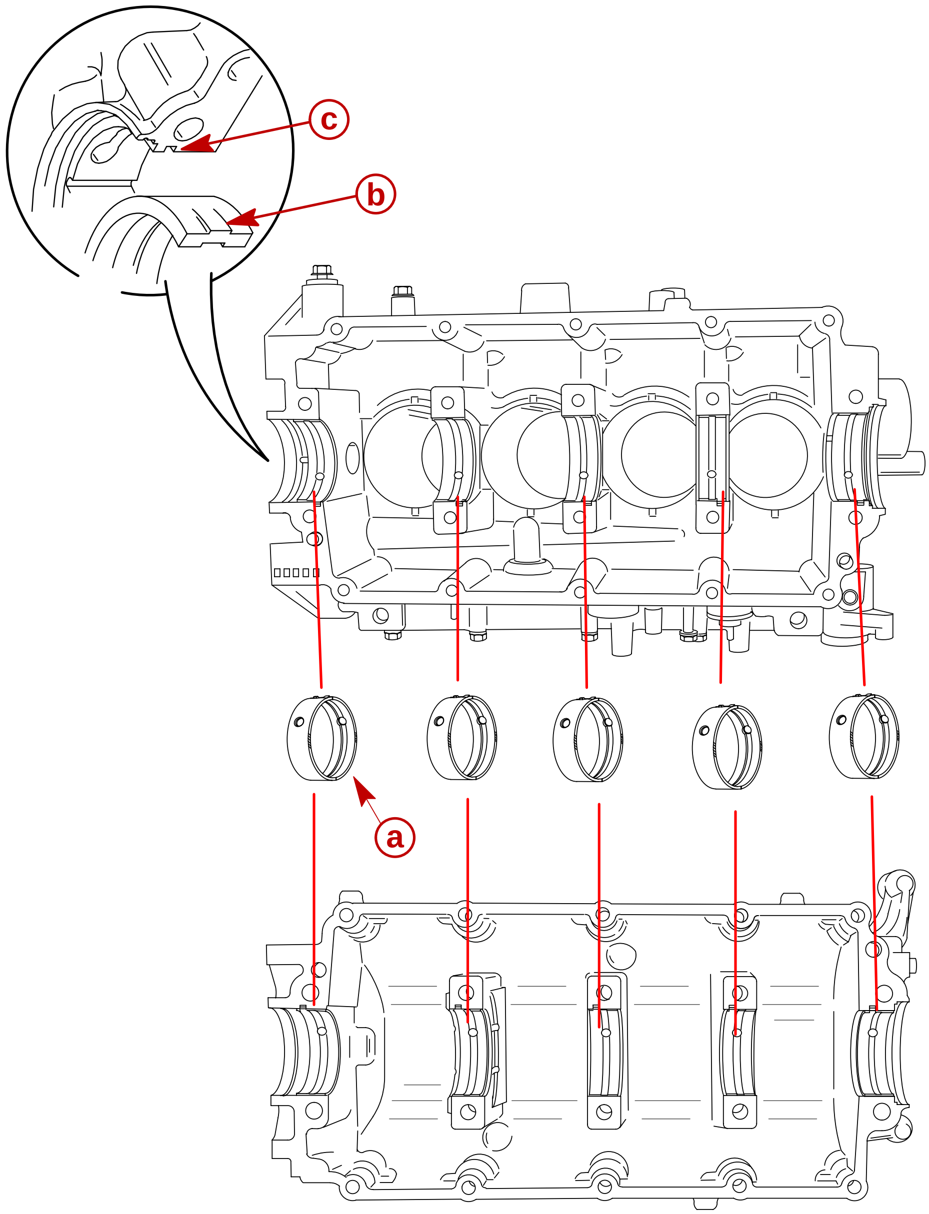


a - Main Bearing Code Letters
b - Main Bearing Identification Color Location

Main Bearing Installation

IMPORTANT: Do not interchange used main bearings. Reinstall in their original position.

1. Check clearance of each bearing, following procedure in Cleaning and Inspection.
2. Clean all the oil from the main bearing surfaces on the cylinder block and crankcase cover.
3. Install main bearings. Make sure the locking tab on each bearing fits into its notch in the cylinder block.

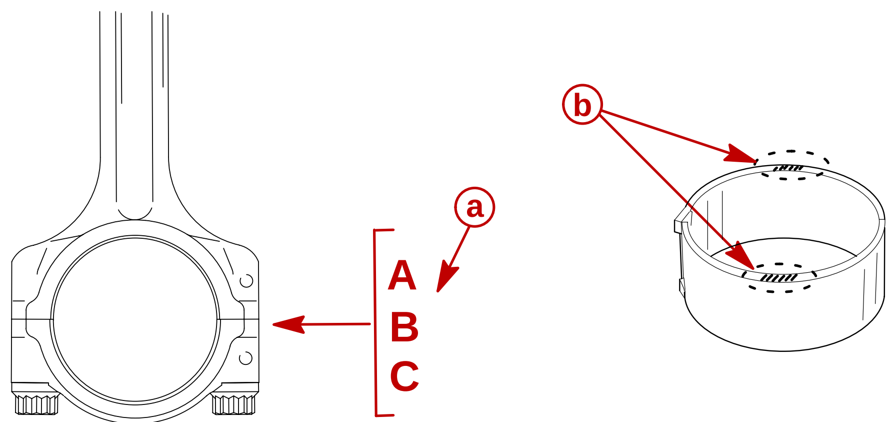


a - Main Bearings
b - Locking Tab
c - Notch in Cylinder Block

Selecting New Connecting Rod Bearings

1. Locate the connecting rod bearing code letter that is scribed on the side of the connecting rod.
2. Refer to the following reference chart to select the correct connecting rod bearings.
3. Use the color coded connecting rod bearings that match the connecting rod bearing code letter.

Connecting Rod Bearing Code Letter	Connecting Rod Bearing Color Code
A	Blue
B	Black
C	Brown



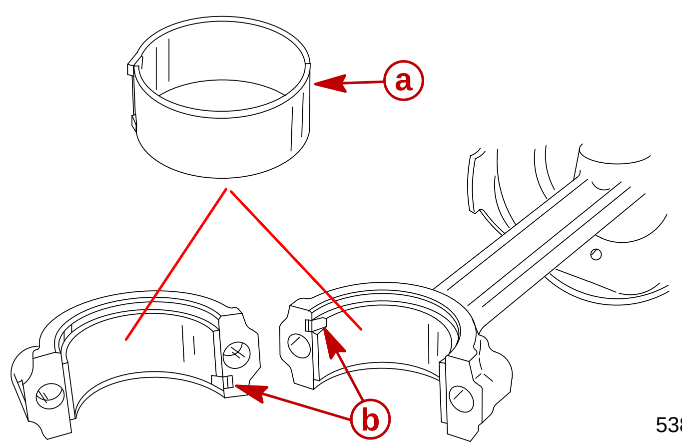
53816

a - Connecting Rod Bearing Code Letters
b - Connecting Rod Bearing Identification Color Location

Installing Connecting Rod Bearings

IMPORTANT: Do not interchange used connecting rod bearings. Reinstall bearings in their original position.

1. Clean all the oil from the bearing surfaces on the connecting rod.
2. Install connecting rod bearings. Make sure the locking lug on each bearing fits into its notch.



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a - Connecting Rod Bearings
b - Fit the Locking Lugs into the Notches

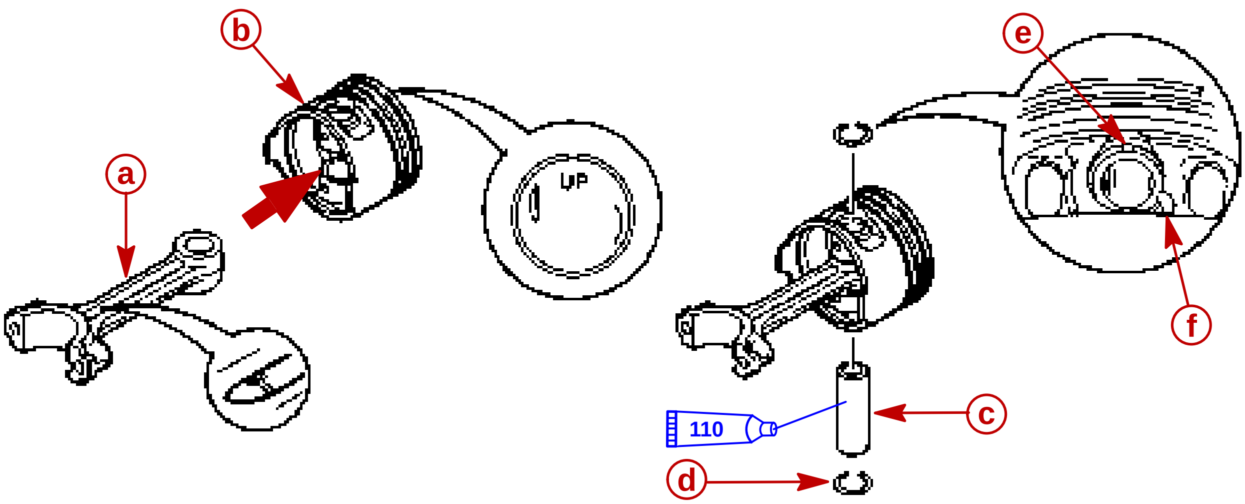
Connecting Rod Installation

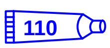
1. Lubricate the piston pin with oil and assemble the piston to the connecting rod. Always use new circlips.

IMPORTANT: Install the split end of the circlip into the groove first, push the other end down until it snaps into the groove. If the shape of the circlip is permanently distorted when attempting installation, discard it and use a new one.

IMPORTANT: Install side of connecting rod marked with a "Y" towards "UP" on piston face.

IMPORTANT: Piston pin clip should be installed with end gap facing opposite of pry point.





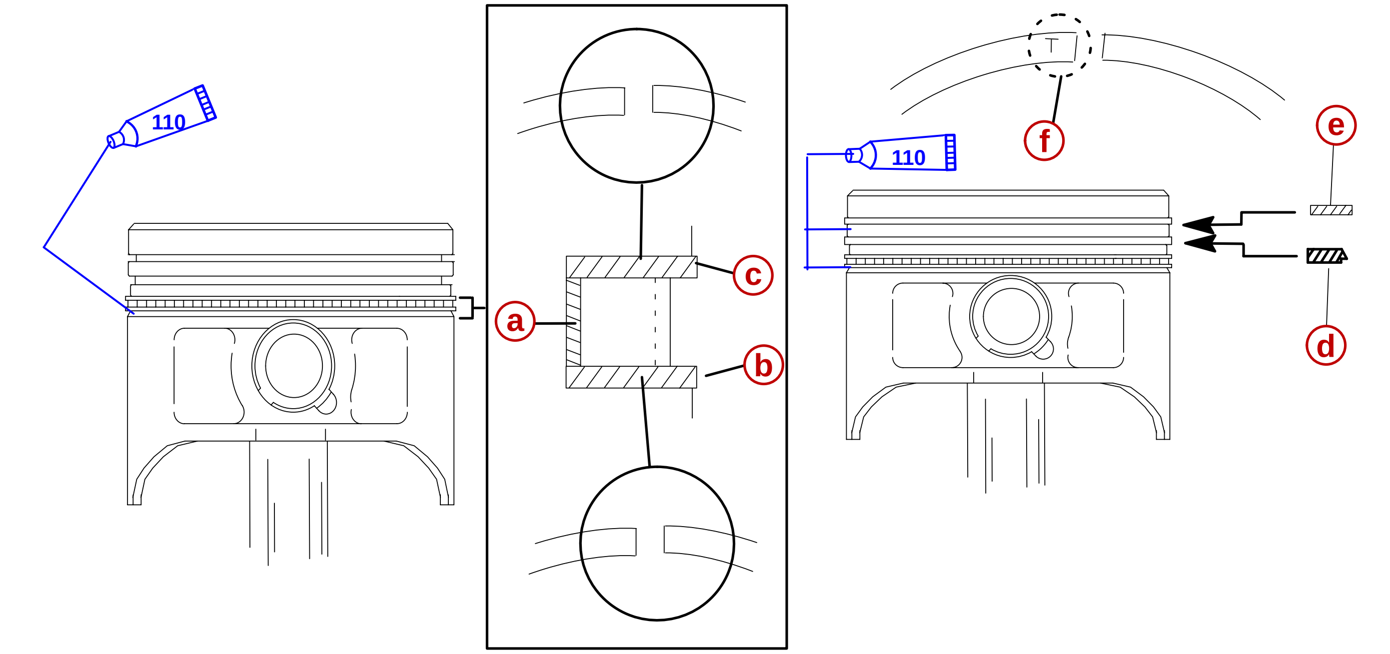
4-stroke Outboard Oil (92-828000A12)

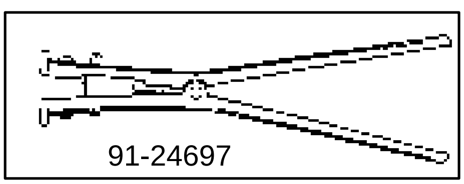
- **a** - Connecting Rod
- **b** - Piston
- **c** - Piston Pin
- **d** - Piston Pin Clip (2)
- **e** - Piston Pin Clip End Gap
- **f** - Pry Point

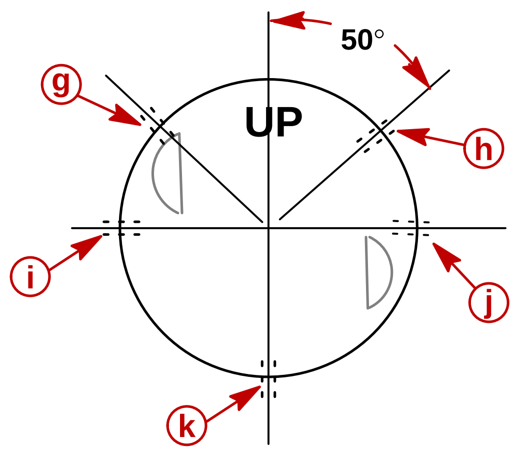
Piston Ring Installation

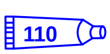
IMPORTANT: Use caution when installing piston rings to avoid scratching piston.

1. Install the oil ring components as shown. Spread rings just enough to slip over piston.
2. Install the second and top compression rings ("T" side up). Spread rings just enough to slip over piston.
3. Offset the piston ring end gaps.









4-stroke Outboard Oil (92-828000A12)

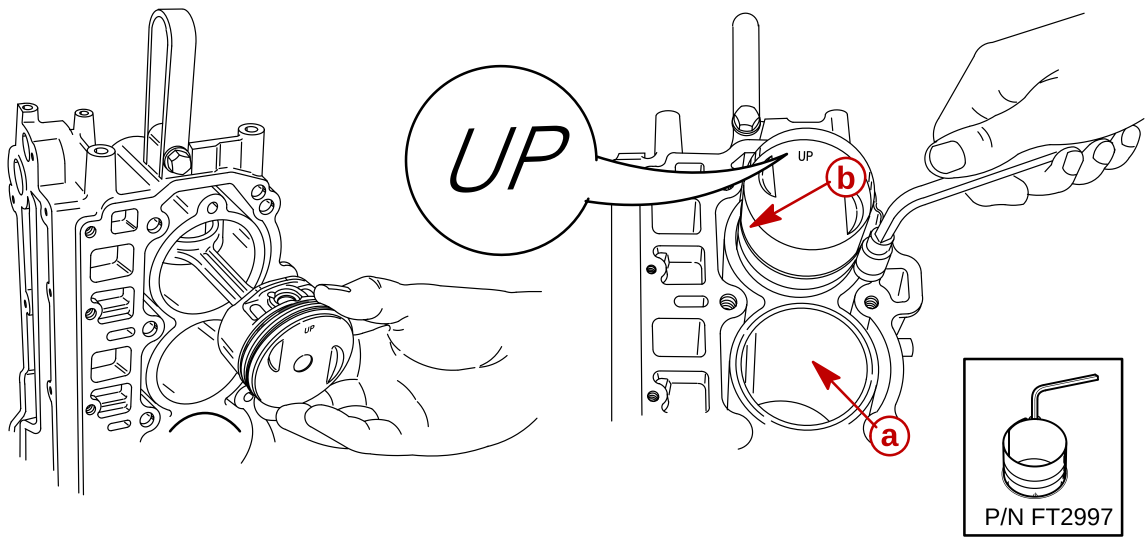
a - Oil Ring Spacer
b - Bottom Rail
c - Top Rail
d - Second Compression Ring ("T" side up)
e - Top Compression Ring ("T" side up)
f - "T" Mark Should Face Piston Crown
g - End Gap – Top Compression Ring
h - End Gap – Second Compression Ring
i - End Gap – Upper Oil Ring Rail
j - End Gap – Lower Oil Ring Rail
k - End Gap – Oil Ring Spacer

Piston Installation

NOTE: *Cylinder bores must be clean before installing pistons. Clean with light honing, as necessary. After honing, clean cylinder bores with water and detergent. After cleaning, swab cylinder bores several times with engine oil and a clean cloth, then wipe with a clean dry cloth.*

1. Lubricate pistons, rings. and cylinder walls with engine oil.
2. Install piston/connecting rod assembly using piston ring compressor tool.

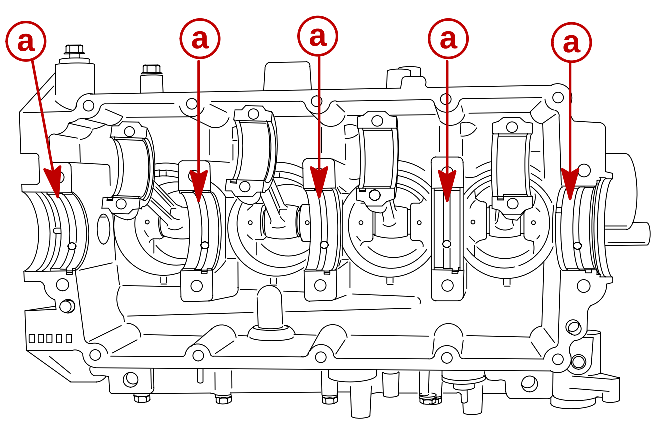
NOTE: *Install used pistons in their original locations(cylinders). Install piston with “UP” mark on piston crown facing toward the flywheel end of block.*



a - Piston Ring Compressor (FT2997)
b - Flywheel End

Crankshaft Installation

1. Lubricate the crankshaft bearing surfaces with engine oil.



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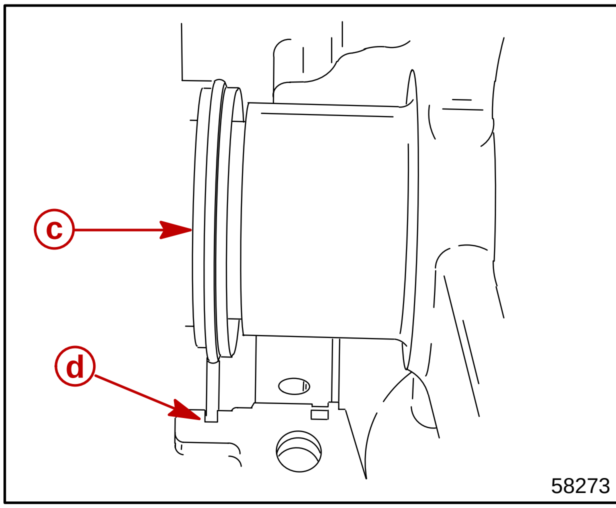
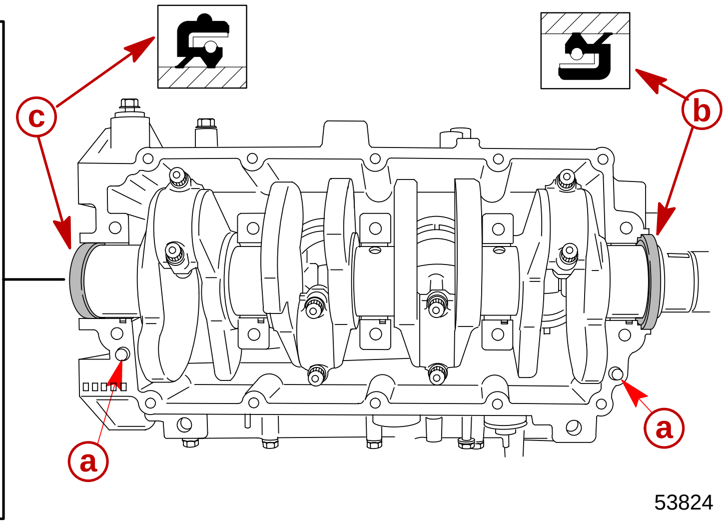
a - Crankshaft Bearing Surface

2. Lubricate the connecting rod journals with engine oil.
3. Lubricate the oil seals lips with oil.

4. Install upper and lower oil seals on crankshaft. Position oil seal lips as shown.
5. If removed, install dowel pins
6. Carefully lower crankshaft into place.

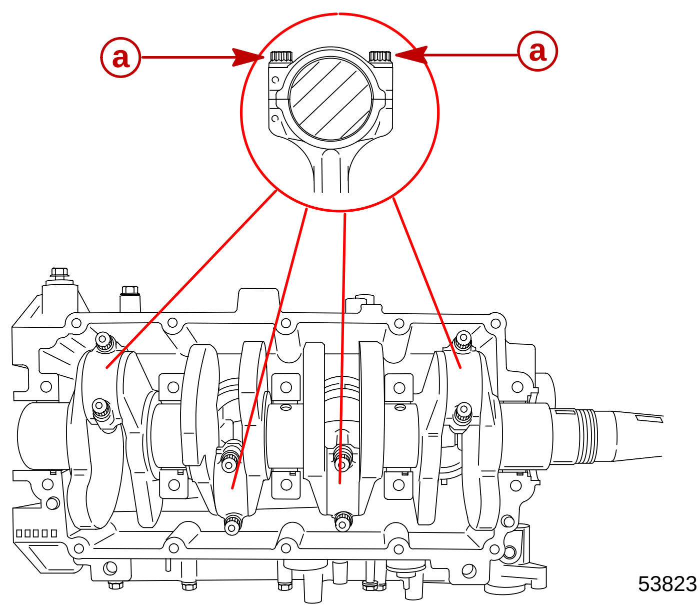
IMPORTANT: Make sure the lower oil seal notch is positioned into the groove in the crankcase.





a - Dowel Pin (2)
b - Upper Oil Seal
c - Lower Oil Seal (Raised Rib)
d - Oil Seal Groove

7. Assemble the connecting rods to the crankshaft. Install the connecting rod caps, aligning the code letter marked on the connecting rod and cap.
8. Apply oil to the connecting rod bolts. Tighten bolts in sequence and in two steps to the specified torque.



a - Apply Oil to Bolt Threads

Connecting Rod Bolt Torque	
1st Torque:	53 lb-in. (6 Nm)
2nd Torque:	150 lb-in. (17 Nm)

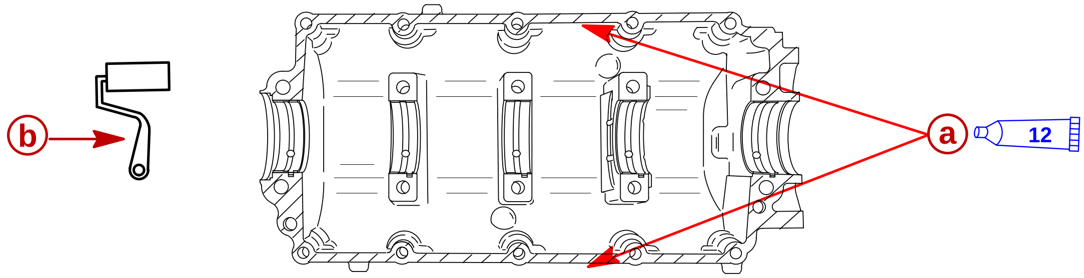
Crankcase Cover Installation

1. Clean off all oil from the contacting surfaces of the crankcase cover and cylinder block.

IMPORTANT: Make sure the contacting surface of the crankcase cover and cylinder block are clean before applying gasket sealant.

2. Apply a smooth even coat of Loctite Master Gasket Sealant to the contacting surfaces on the crankcase cover. Use a small (paint type) roller to spread out the sealant for a smooth even coverage. Instructions in gasket sealant kit must be followed exactly.

NOTE: *Do not apply gasket sealant to the main bearings or the bolt holes.*

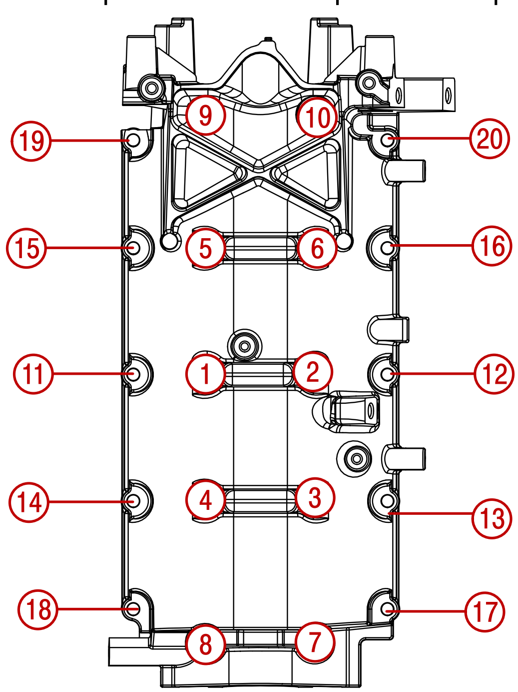


12 Loctite Master Gasket “514” (92-12564-2)

a - Apply Loctite Master Gasket Sealant
b - Use a Roller to Apply a Smooth Even Coat

3. Install crankcase cover on cylinder block. Dowel pins will lineup the two mating surfaces, be sure they are installed.

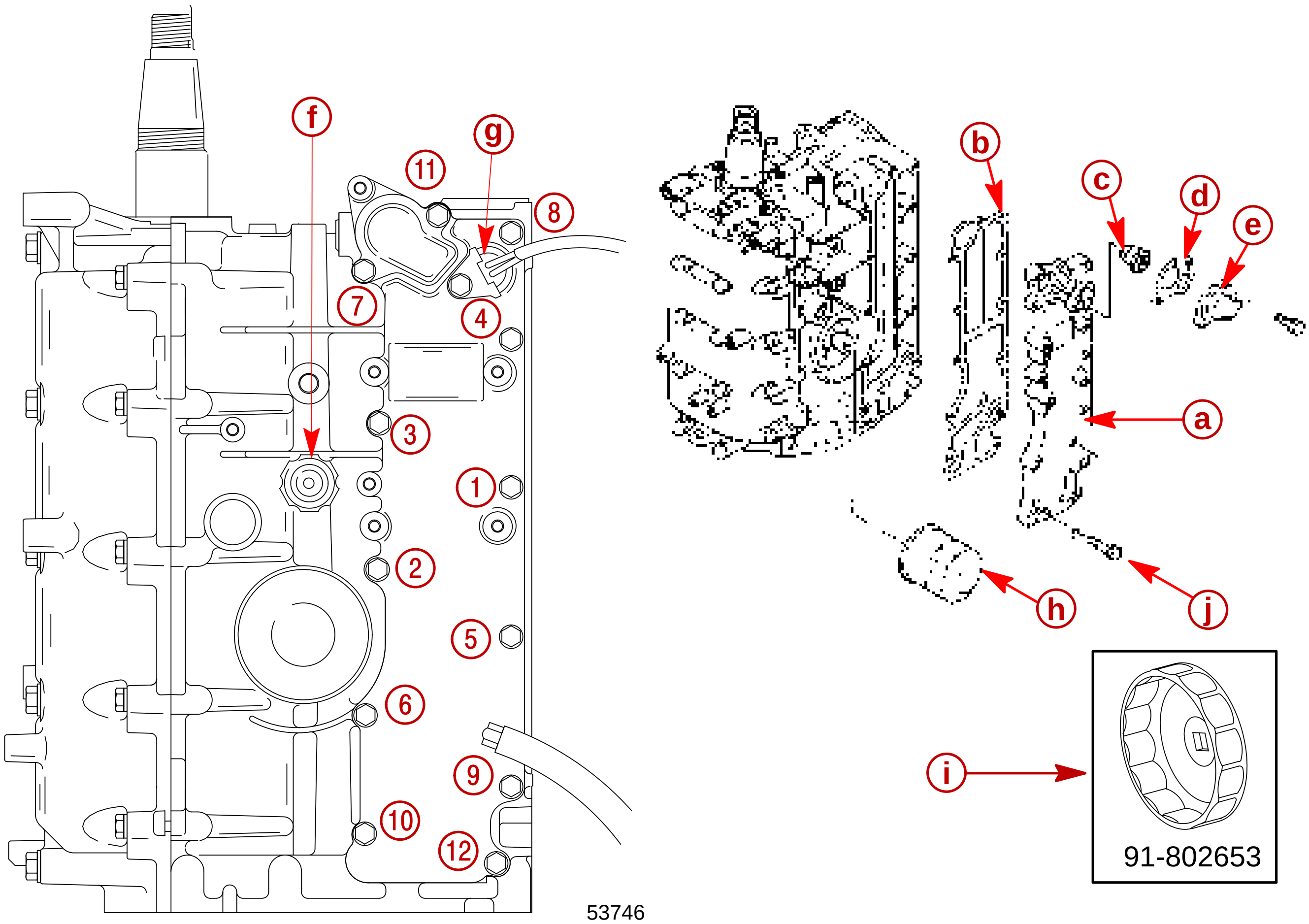
4. Apply oil to bolt threads. Torque the bolts in the sequence shown below. Tighten to the 1st torque value specified below. Repeat this torque sequence for the 2nd torque value.



Crankcase Cover Bolt Torque		
Center Bolts Qty. 10 (M8x82)	1st Torque:	11 lb-ft. (15 Nm)
	2nd Torque:	22 lb-ft. (30 Nm)
Outer Bolts Qty. 10 (M6x35)	1st Torque:	53 lb-in. (6 Nm)
	2nd Torque:	106 lb-in. (12 Nm)

Exhaust Cover Installation

1. Install oil filter. Tighten to specified torque using wrench p/n 91-802653.
2. Install exhaust cover along with the thermostat and thermostat cover. Use new gaskets.
3. Tighten screws to the first torque value in the sequence shown below. Repeat this procedure for the second torque value.
4. Install the oil pressure and temperature switch.



a - Exhaust Cover
b - Gasket
c - Thermostat
d - Gasket
e - Thermostat Cover
f - Oil Pressure Switch
g - Engine Coolant Temperature (ECT) Sensor
h - Oil Filter
i - Oil Filter Wrench
j - Exhaust Cover Screw (12) M6 x 35

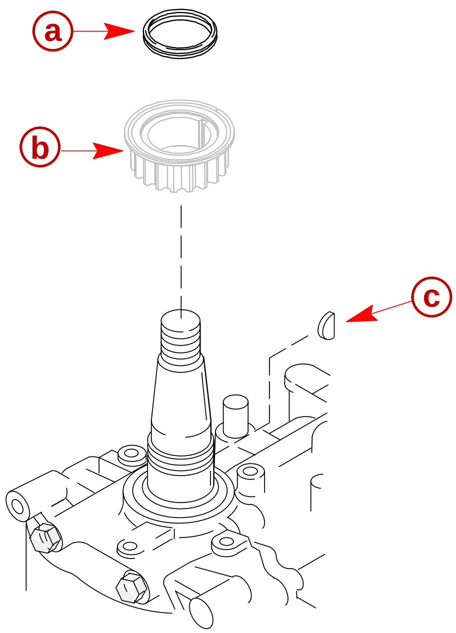
Exhaust and Thermostat Cover Screw Torque	
1st Torque:	53 lb-in. (6 Nm)
2nd Torque:	106 lb-in. (12 Nm)

Oil Filter Torque
70 lb-in. (8 Nm)

Drive Gear Installation

1. Install the drive gear components.

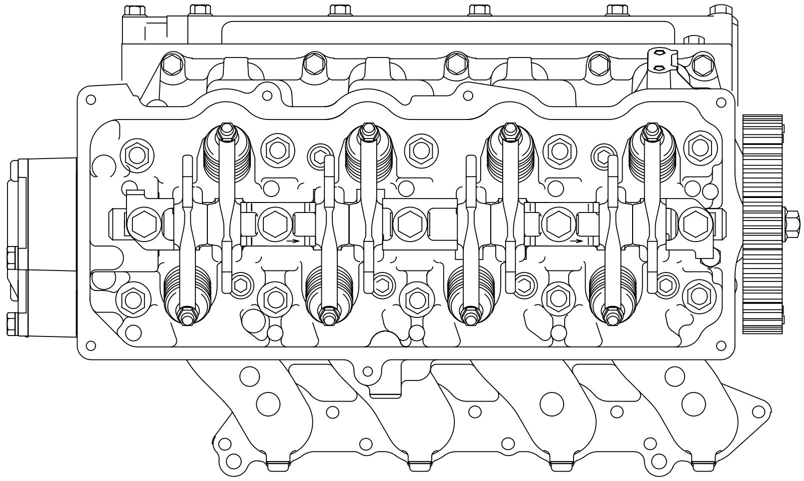
NOTE: *Load Ring is for one time use and must be replaced if flywheel is removed.*



a - Load Ring
b - Drive Gear
c - Drive Key

Installing Powerhead Components

1. Reinstall cylinder head. Refer to Section 4A for installation and torque values.



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Engine Wiring Harness and Ignition/Electrical Component Installation

1. Install the wiring harness assembly to the powerhead in the same order removed. Refer to the appropriate section for each components torque value.

Ignition Components

1. Refer to the appropriate section of the service manual for installation and torque values of the following ignition components.
   a. Timing Belt (Section 4A)
   b. Ignition Coils (section 2A)
   c. ECM (section 3C)
   d. Crank Position Sensor (section 3C)

Charging and Starting System Components

1. Refer to Section 2B for installation and torque values of the following components:
   a. Starter Motor
   b. Voltage Regulator
   c. Stator
   d. Flywheel

Fuel Components

1. Refer to Section 3C for Intake Assembly/Vapor Separator Installation.

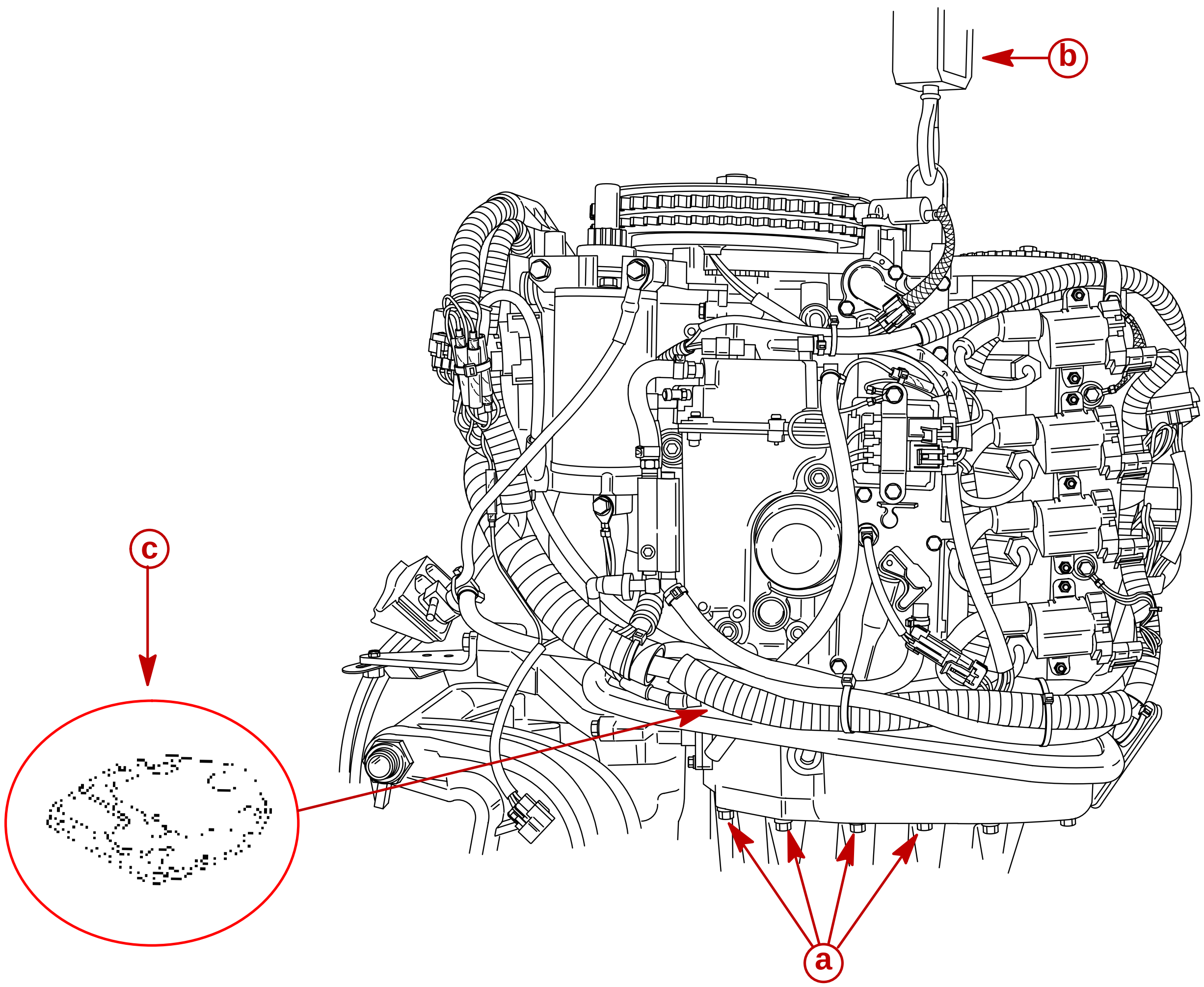
Powerhead Installation

⚠ CAUTION

When lubricating the driveshaft splines do not allow any grease on top of the driveshaft. Grease on top of the driveshaft will force the shaft down when installing the gearcase, causing the pinion gear to bind with the forward gear. This can result in damage or failure of the gears.

1. Install powerhead and new base gasket. Tighten mounting bolts to specified torque.

IMPORTANT: If the crank shaft splines do not line up with the driveshaft splines, shift the gearcase into forward, place a prop on the propshaft and rotate it counterclockwise. This will allow the splines to line up.

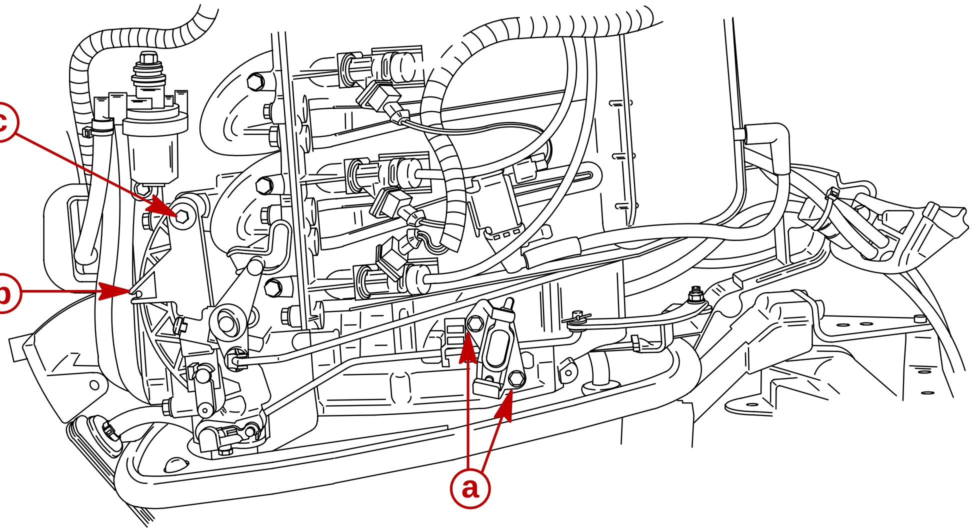


a - Powerhead Mounting Bolts (4 Each Side) M8 x 110
b - Hoist
c - Base Gasket

Powerhead Mounting Bolt Torque
33 lb-ft. (44.7 Nm)

2. Re-connect throttle/shift linkage and control cable anchor bracket. Torque fasteners to specified torque.

Remote Control Model



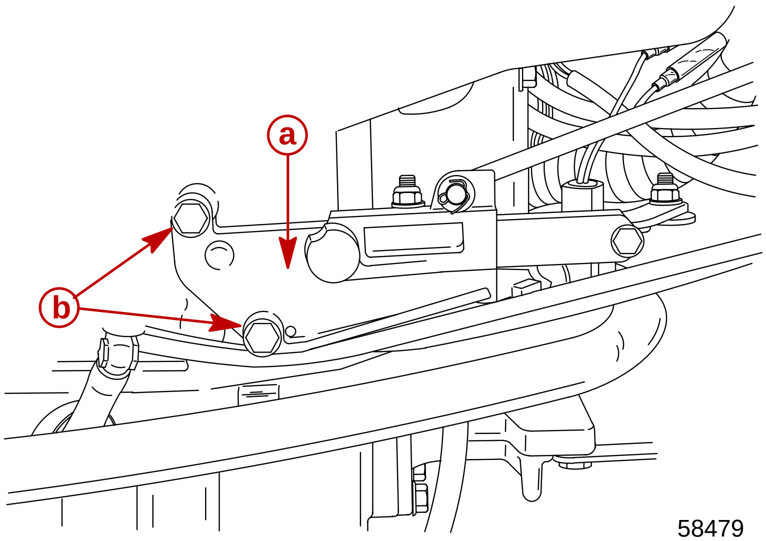
a - Control Cable Anchor Bracket Screw (2) M6 x 16
b - Throttle/Shift Lever
c - Throttle/Shift Lever Screw (1) M8 x 70

Throttle/Shift Lever Mounting Screw Torque
100 lb-in. (11.3 Nm)

Cable Anchor Bracket Mounting Screw Torque
75 lb-in. (8.5 Nm)

3. Install the shift guide bracket screws. Tighten to specified torque.

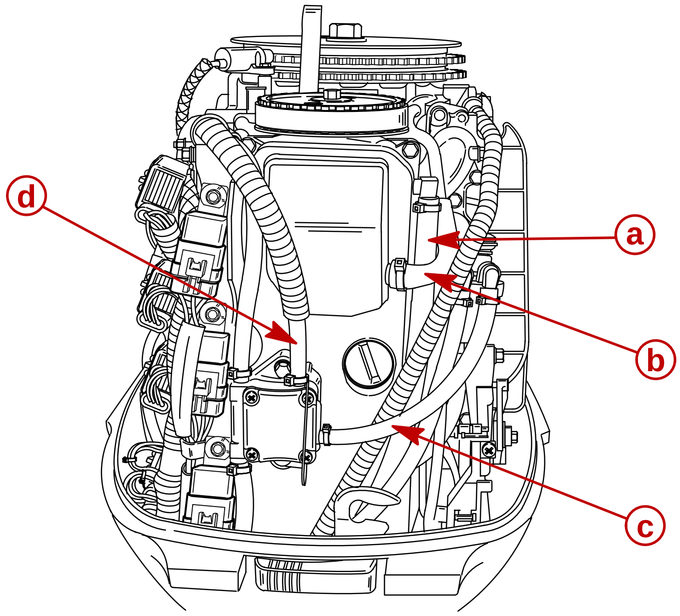
Tiller Handle Model



a - Shift Guide Bracket
b - Screw (2) M6 x 25

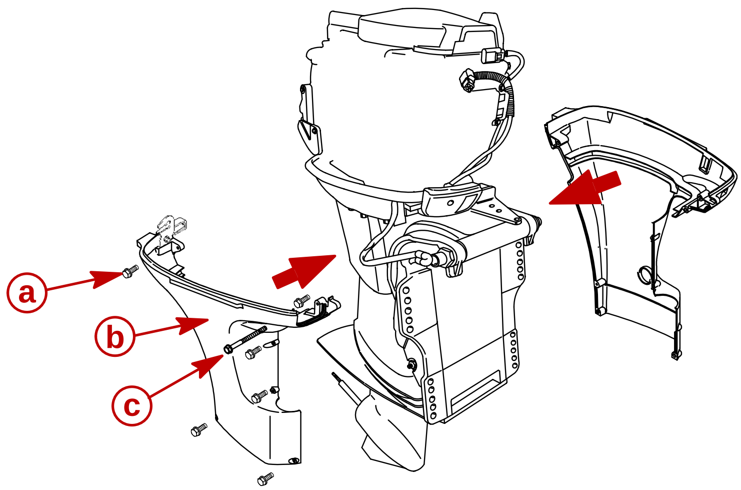
Shift Guide Bracket Mounting Screw Torque
70 lb-in. (8 Nm)

4. Reconnect hoses. Use sta-straps to fasten all hose connections.



a - Crankcase Vent Hose
b - Crankcase Breather Hose
c - Fuel Hose (In)
d - Fuel Hose (Out)

5. Reconnect the power trim harness wires.
6. Install spark plugs
7. Install bottom cowl. Tighten screws to specified torque.



a - Screw (6)-M6x30
b - Lower Cowl
c - Screw-M6x60

Bottom Cowl Screw Torque
60 lb-in. (6.8 Nm)

8. Connect battery cables to battery terminals (red goes to positive terminal).
9. Check engine oil level.

Tiller Handle Models

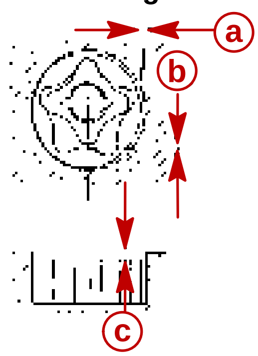
1. Refer to **section 7B** for installation of throttle cables, shift rod and tiller handle wiring.

POWERHEAD

Section 4C - Lubrication

Table of Contents

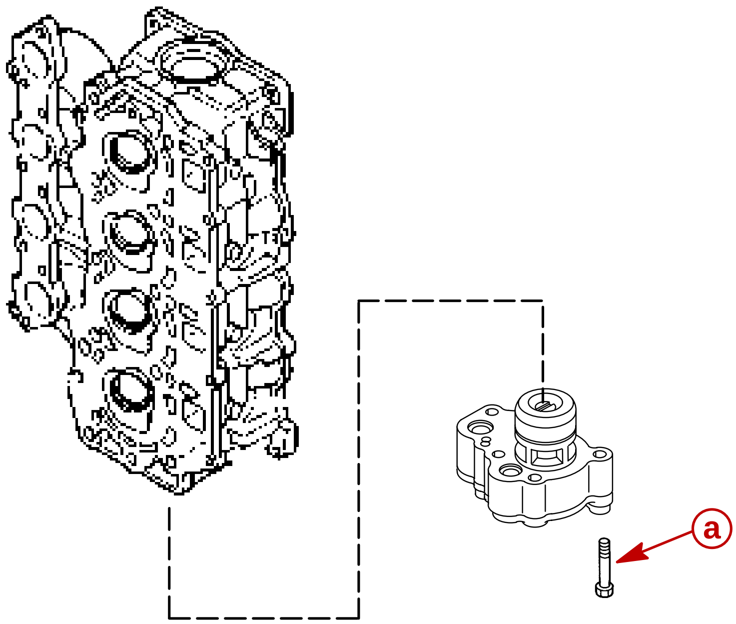
Specifications

LUBRICATION SYSTEM	**Pump Type**	Trochoid
	Engine Oil Pressure (Warm Engine) @ 3000 rpm	30-40 psi (207-278 kPa)
	Engine Oil Pan Capacity	Either 3 Qts. **or** 3 Liters
	Oil Pump:	
	Outer Rotor to Housing "a"	0.0045 - 0.009 in. (0.11 - 0.23 mm)
	Inner Rotor to Outer Rotor "b"	0.005 in. (0.12 mm)
	Rotor to Housing "c"	0.0015 - 0.003 in. (0.04 - 0.08 mm)
		

Oil Pump Removal

IMPORTANT: Do not twist/turn oil pump from side to side while removing it from cylinder head, as oil pump sealing o-rings will be cut. Pull oil pump away from cylinder head by inserting a screwdriver in the pry points on oil pump body.

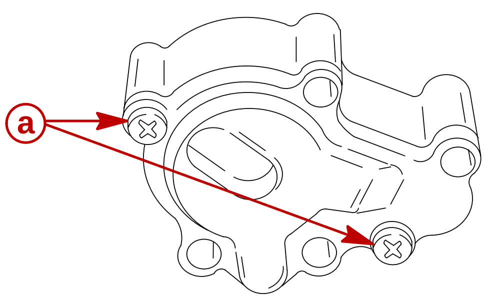
1. Refer to section 4A for Cylinder Head Removal.
2. Remove oil pump mounting screws. Separate oil pump from cylinder head.



a - Mounting Screw (4) M6x40

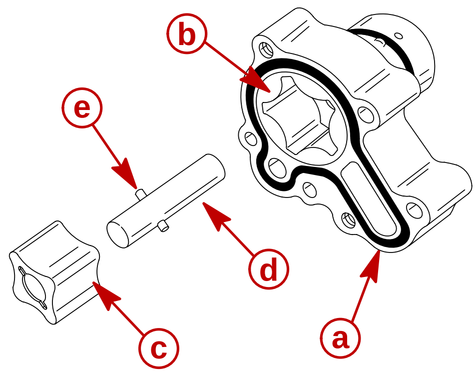
Oil Pump Disassembly

1. If screws cannot be loosened with a screwdriver, heat them with a non-flame type heat source (heat lamp). This will loosen the Loctite sealant on the screw threads. Remove screws.



a - Screw (2)

2. Disassemble Oil Pump.

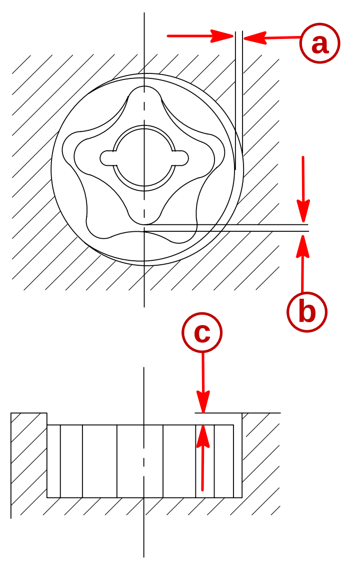


a - Cover Seal
b - Outer Rotor
c - Inner Rotor
d - Shaft
e - Cross Pin

Cleaning and Inspection

Oil Pump

1. Check oil pump components for pitting, scratches, and for the following measurements. Replace oil pump if worn or out of specification.
2. Using a feeler gauge, measure the following oil pump clearances:
   a. Between outer rotor and pump housing (a).
   b. Between the inner rotor and outer rotor (b).
   c. Between the outer rotor and pump housing (c).



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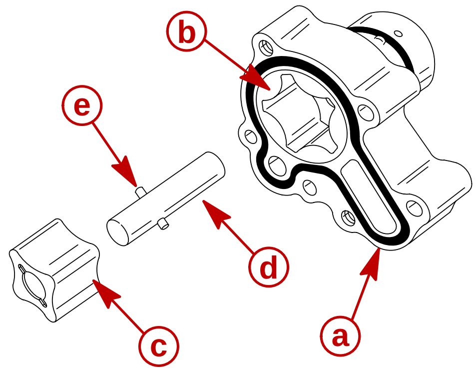
Oil Pump Clearances	
a	0.0045 - 0.009 in. (0.03 - 0.15 mm)
b	0.005 in. (0.12 mm)
c	0.0015 - 0.003 in. (0.03 - 0.08 mm)

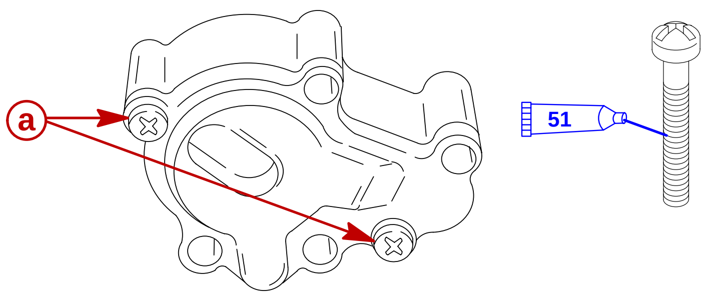
Oil Pump Reassembly

1. Reassemble the oil pump assembly.
2. Lubricate the outer and inner rotors thoroughly with engine oil.



a - Cover Seal
b - Outer Rotor
c - Inner Rotor
d - Shaft
e - Cross Pin

3. Fasten cover with two screws. Apply Loctite 222 to threads. Tighten screws to the specified torque.



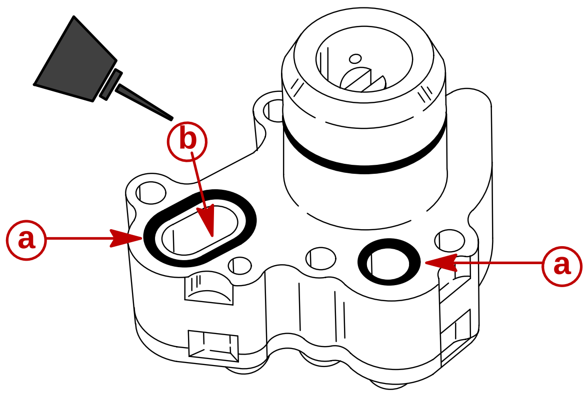
51 Loctite “222” (92-809818)

a - Screw (2) M6 X 16

Oil Pump Cover Screw Torque
70 lb-in. (8 Nm)

Oil Pump Installation

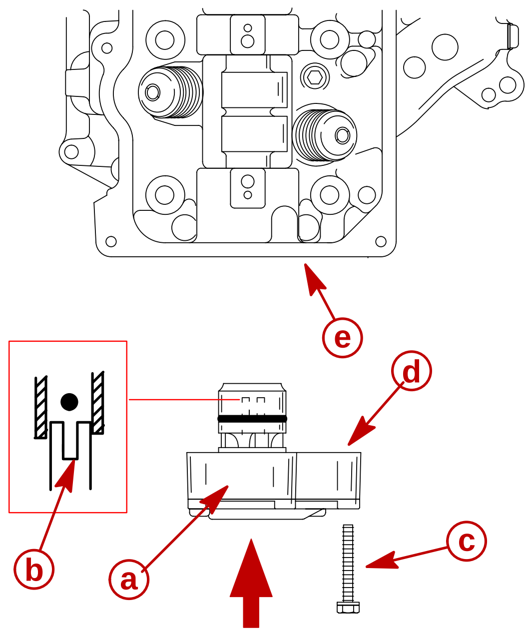
1. Place O-ring seals on the oil pump. Lubricate the O-rings with oil.
2. Prime the oil pump by pouring approximately 1 fl oz (30 ml) of engine oil into the oil pump body.



a - O-Ring Seals
b - 30 ml of Engine Oil

IMPORTANT: When the oil pump mounting surface gets close to the mating surface of the cylinder head, do not twist/turn oil pump from side to side. The sharp edges on the cylinder head will cut the oil pump sealing o-rings.

3. Align oil pump shaft with the camshaft and install the oil pump.
4. Fasten with 4 screws. Tighten screws to the specified torque.



a - Oil Pump Assembly
b - Align Slot with Camshaft Projection
c - Screw (4)-M6x40
d - Oil Pump Mounting Surface
e - Cylinder Head/Oil Pump Mating Surface

Oil Pump Mounting Screw Torque
70 lb-in. (8 Nm)

MID-SECTION

Section 5A - Clamp/Swivel Brackets & Drive Shaft Housing

Table of Contents

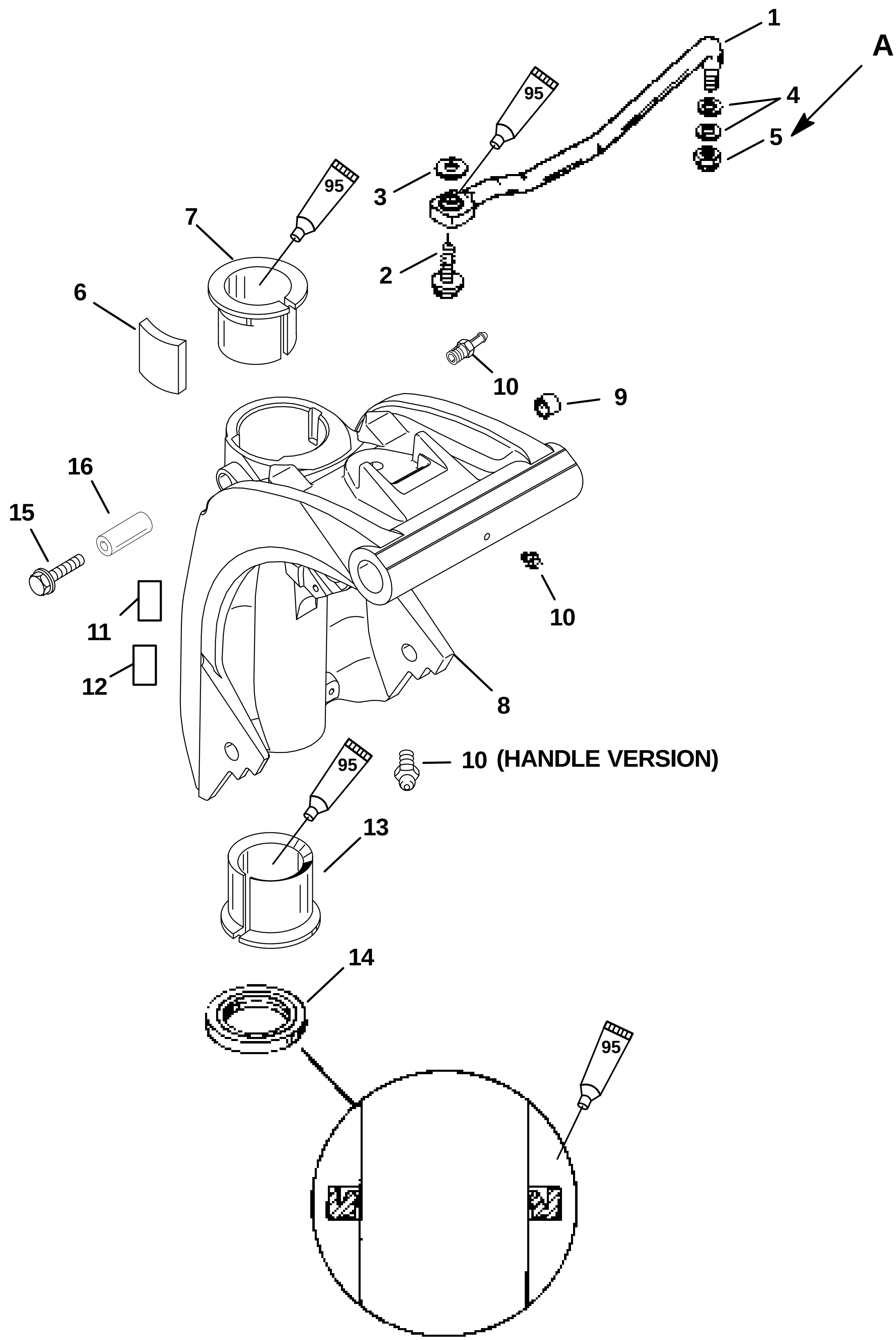
Specifications

MID-SECTION	**Transom Height:**	
	Long Shaft	20 in. (51 cm)
	Steering Pivot Range:	
	Tiller	90°
	Remote	60°
	Full Tilt Up Angle	71°
	Allowable Transom Thickness	2-3/4 in. (69.8 mm)

Part No.	Description
92-809822	Loctite Pipe Sealant w/Teflon
92-850735A1	Anti-Corrosion Grease
92-850736A1	2-4-C w/Teflon
92-828000A12	4-Stroke Outboard Oil

5
A

SWIVEL BRACKET



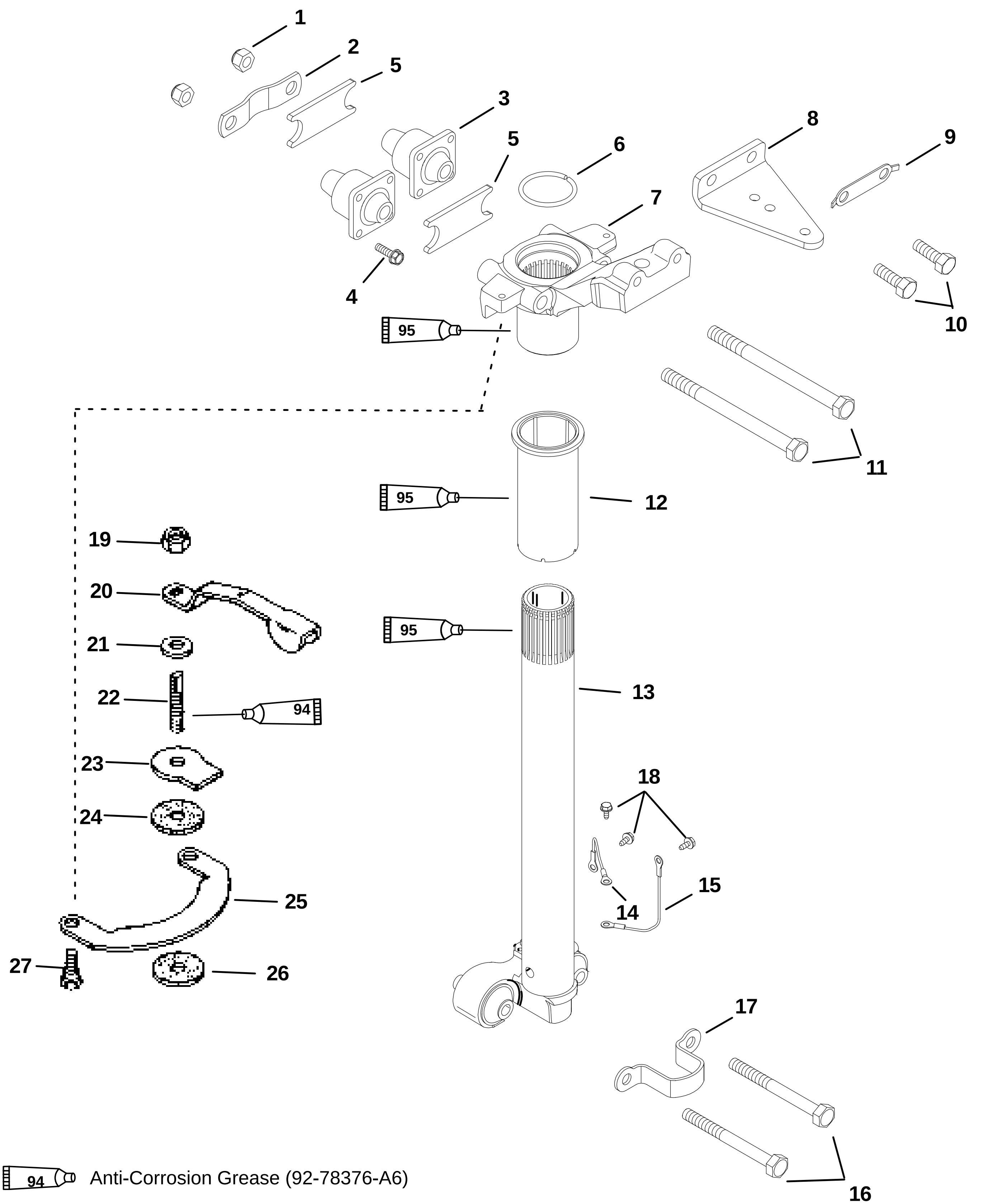
95 2-4-C With Teflon (92-825407A12)

A = TORQUE NUT 120 LB. (13.5 N_M) AND THEN BACK OFF 1/4 TURN.

SWIVEL BRACKET

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	LINK ROD			
2	1	SCREW (1-1/2 IN.)		20	27.0
3	1	WASHER **ELECTRIC NON HANDLE**			
4	2	WASHER			
5	2	NUT (.375-24)	120		13.5
6	1	PUCK			
7	1	BUSHING			
8	1	SWIVEL BRACKET			
9	2	BEARING			
10	2	GREASE FITTING **(Qty. of 3 required on Handle Versions**			
11	1	DECAL-Co-Pilot **(HANDLE)**			
12	1	DECAL-Serial Overlaminate			
13	1	BUSHING (LOWER)			
14	1	SEAL			
15	1	SCREW (M8 x 10) **(HANDLE)**			
	1	SCREW (M8 x 25) **NON-HANDLE**			
16	1	SEAL			

STEERING ARM



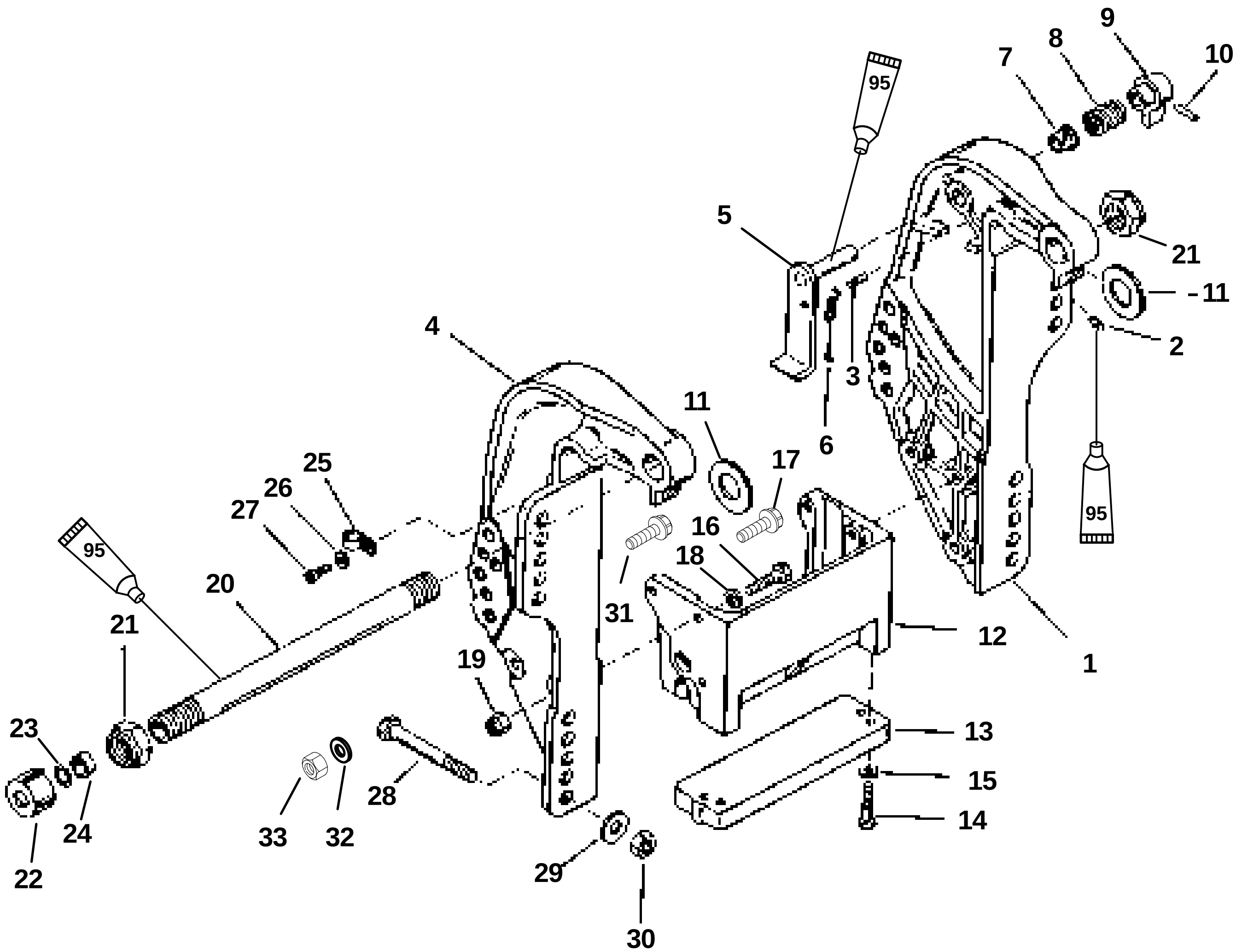
94 Anti-Corrosion Grease (92-78376-A6)

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

STEERING ARM

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	2	NUT	50		5.7
2	1	STRAP			
3	2	MOUNT			
4	8	SCREW (M6 X 20)	130		14.7
5	2	BUMPER			
6	1	RETAINING RING			
7	1	STEERING ARM			
8	1	BRACKET **(NON-HANDLE)**			
9	1	TAB WASHER **(NON-HANDLE)**			
10	2	SCREW (M10 X 30)	32		3.7
11	2	SCREW (M12 X 154)		50	67.8
12	1	SPACER			
13	1	SWIVEL TUBE			
14	1	GROUND STRAP			
15	1	GROUND STRAP			
16	2	SCREW (M10 X 105)		32.5	44
17	1	STRAP - LOWER MOUNT			
18	3	SCREW **(SELF-TAPPING)**	Drive Tight		
19	1	NUT (.375-24) **(HANDLE)**			
20	1	LEVER - CO-PILOT **(HANDLE)**			
21	1	WASHER **(HANDLE)**			
22	1	ROD (THREADED) **(HANDLE)**			
23	1	BRACKET PLATE **(HANDLE)**			
24	1	DISC **(HANDLE)**			
25	1	PLATE **(HANDLE)**			
26	1	DISC **(HANDLE)**			
27	2	SCREW (HEX SHOULDER) **(HANDLE)**	70		7.9

TRANSOM BRACKET

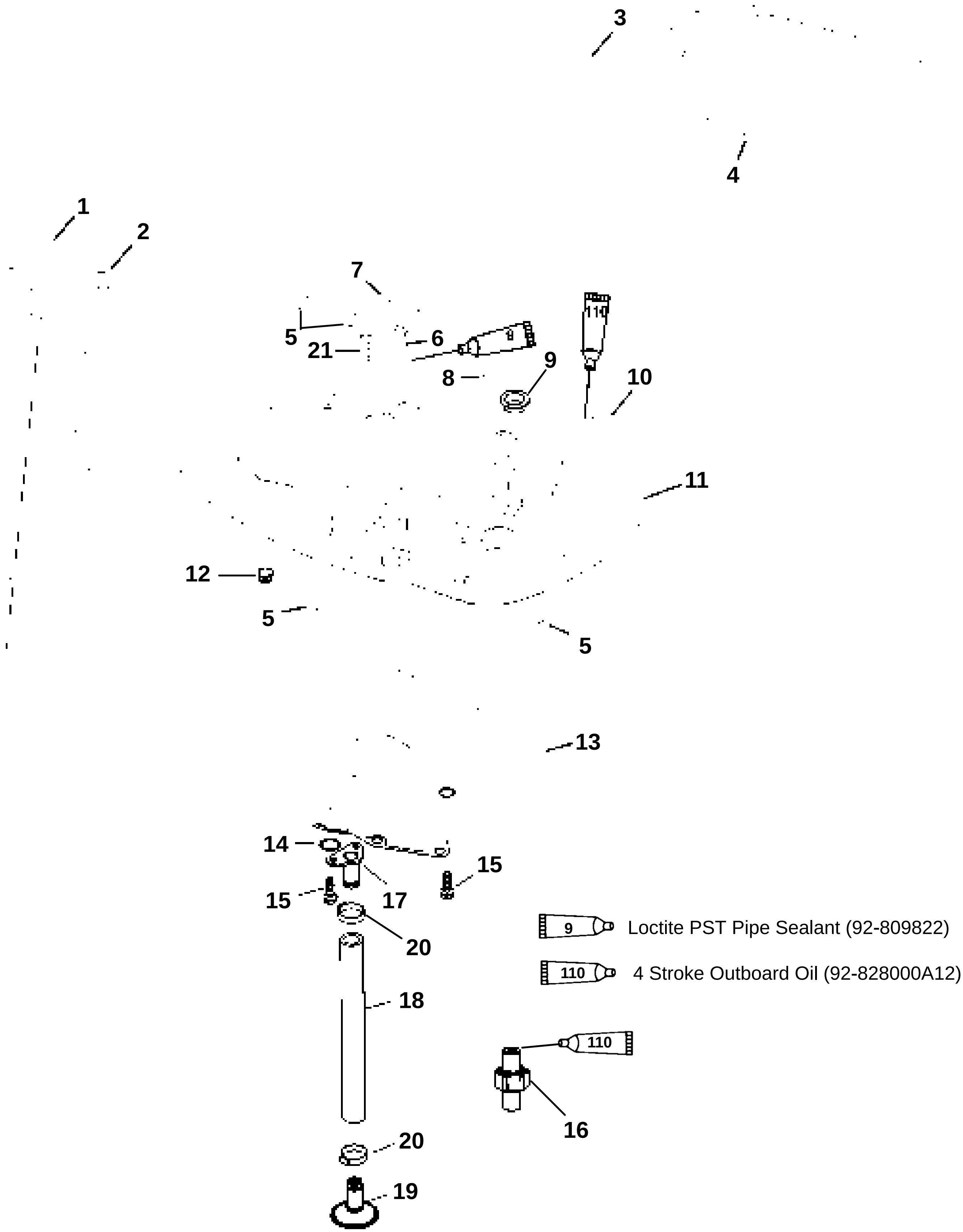


95 2-4-C With Teflon (92-825407A12)

TRANSOM BRACKET

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	lb-ft	Nm.
1	1	TRANSOM BRACKET (PORT)			
2	1	GREASE FITTING			
3	1	GROOVE PIN			
4	1	TRANSOM BRACKET (STARBOARD)			
5	1	TILT LOCK LEVER			
6	1	SPRING			
7	1	NYLINER			
8	1	SPRING			
9	1	KNOB			
10	1	GROOVE PIN			
11	2	WASHER			
12	1	ANCHOR BRACKET			
13	1	ANODE ASSEMBLY			
14	2	SCREW (M6 X 25)	60		6.8
15	2	WASHER			
16	5	SCREW **(30 MM)**		25	33.9
17	1	SCREW **(35 MM)**		32.5	44
18	4	LOCKWASHER			
19	2	NUT			
20	1	TILT TUBE			
21	2	NUT	Tighten nut to 32 lb-ft and then back off 1/4 turn.		
22	1	SEAL KIT **(NON-HANDLE)**			
23	1	O RING **(NON-HANDLE)**			
24	1	SPACER **(NON-HANDLE)**			
25	2	CLIP			
26	1	C-WASHER			
27	1	SCREW (10-16 X 5/8)	Drive Tight		
28	4	SCREW	Drive Tight		
29	4	WASHER	Drive Tight		
30	4	NUT			
31	2	SCREW (M10 X 40)			
32	2	WASHER			
33	2	NUT			

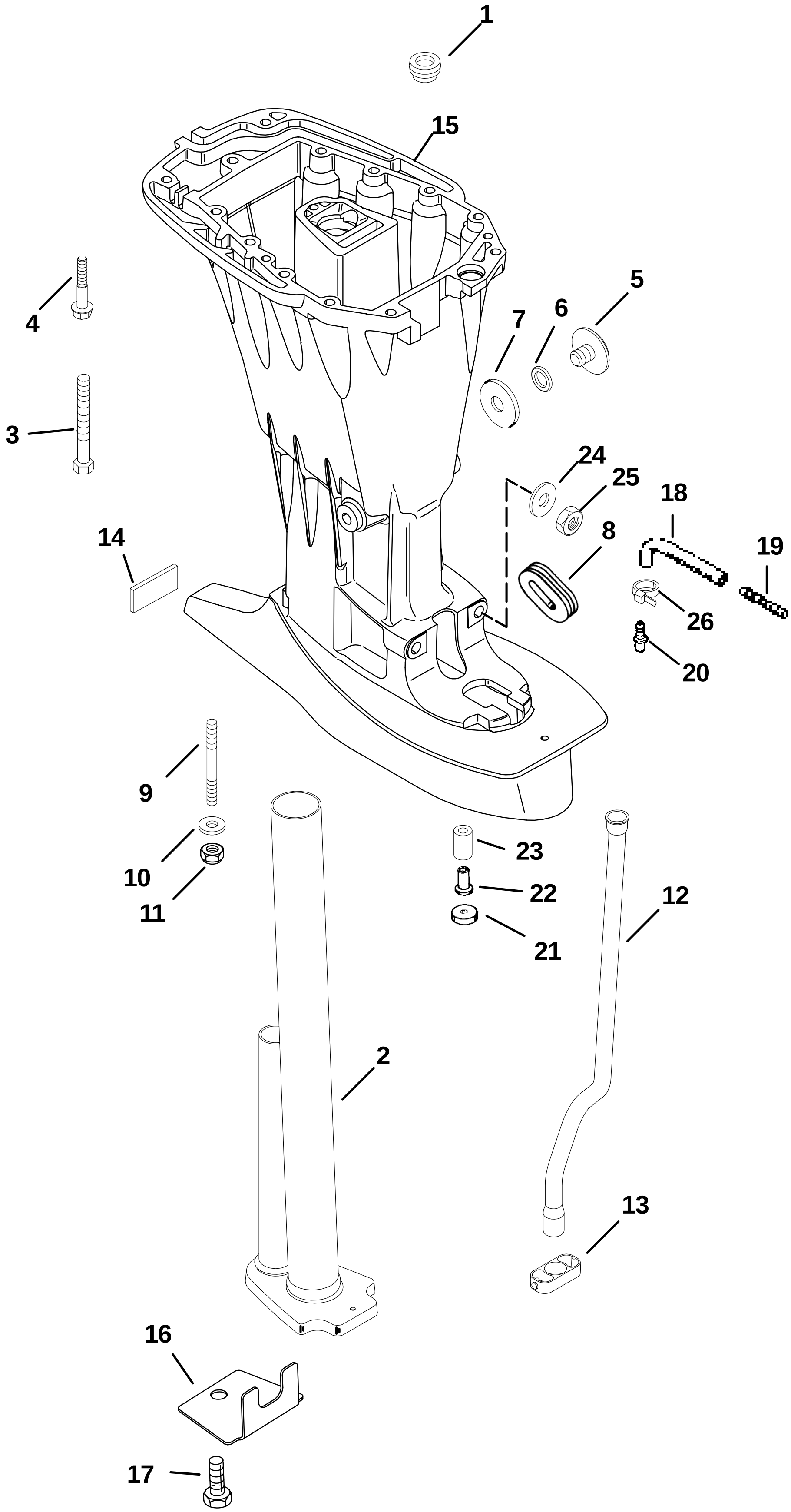
ADAPTOR PLATE



ADAPTOR PLATE

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	DIPSTICK			
2	1	DIPSTICK TUBE			
3	1	SEAL			
4	1	HEAT SHIELD			
5	4	DOWEL PIN			
6	1	ELBOW			
7	2	STA-STRAP			
8	1	SEAL-DRIVESHAFT			
9	1	BUSHING			
10	1	PLUG-OIL PASSAGE		24.3	33
11	1	ADAPTOR PLATE			
12	1	PLUG			
13	1	GASKET			
14	1	O RING			
15	3	SCREW (M6 X 20)	75		8.5
16	1	OIL PRESSURE RELIEF VALVE	34		3.8
17	1	PLATE-TOP OIL PICKUP			
18	1	HOSE-OIL PICKUP			
19	1	BAFFLE			
20	2	CLAMP			
21	1	SCREW (M6 X 55)	150		17

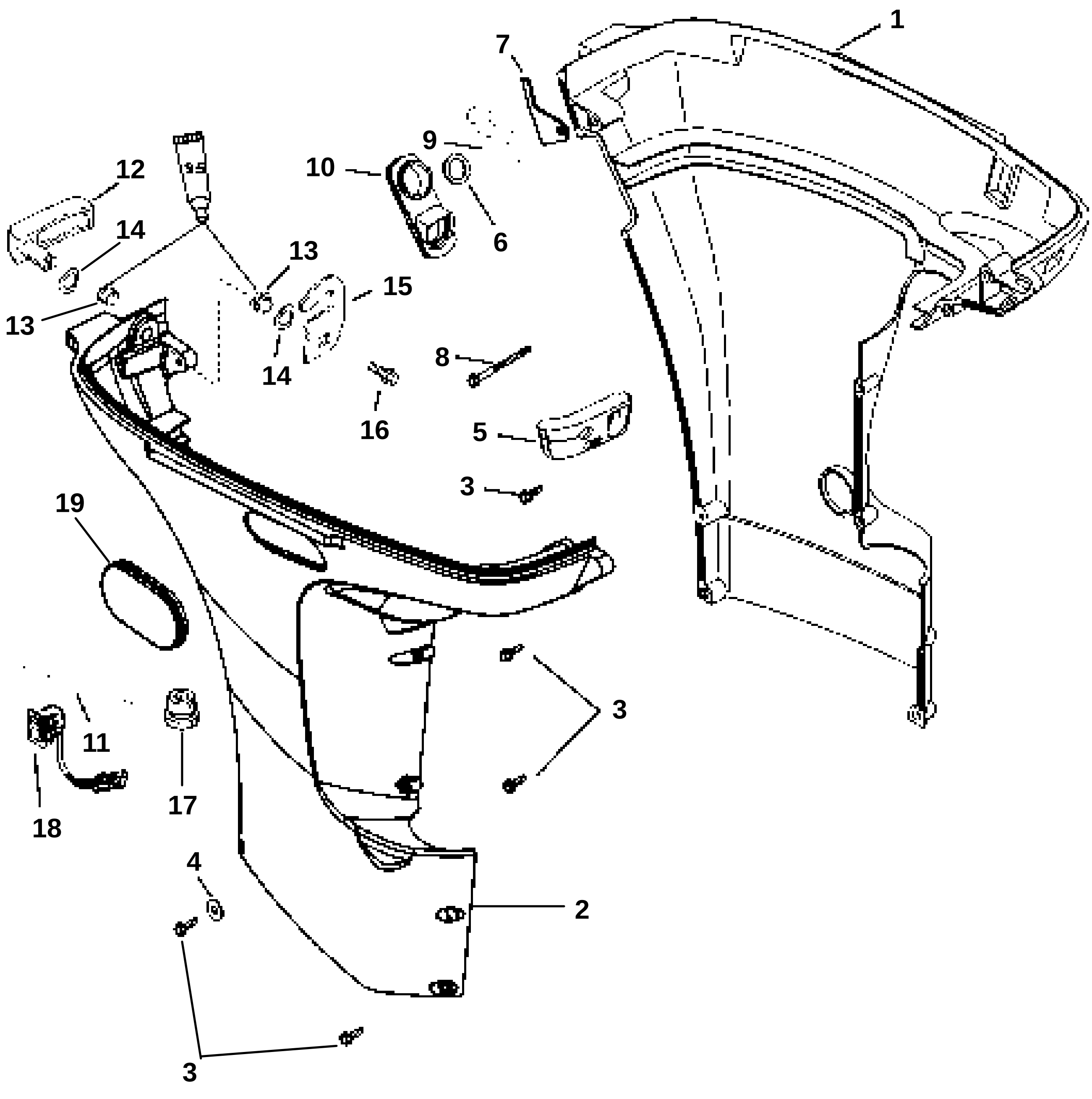
DRIVESHAFT HOUSING



DRIVESHAFT HOUSING

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	SEAL–water tube			
2	1	EXHAUST PIPE			
3	8	SCREW (M8x110)		33	44.7
4	5	SCREW (M8 x 45)		28	38
5	1	DRAIN PLUG	210	17.5	23.5
6	1	GASKET			
7	2	BUMPER			
8	1	GROMMET			
9	1	STUD (M10 x 50) **(NON-BIGFOOT)**		12	16.3
	1	STUD (M10 x 100) **(BIGFOOT)**		12	16.3
10	1	WASHER			
11	1	NUT		40	54.5
12	1	WATER TUBE			
13	1	GUIDE			
14	1	BUMPER **(LONG)**			
15	1	DRIVESHAFT HOUSING			
16	1	PLATE			
17	1	SCREW (M10 X 25)		26	35.3
18	1	SPEEDOMETER PICK UP			
19	1	CONNECTOR			
20	1	FITTING			
21	1	SPACER			
22	1	COUPLING			
23	1	BUSHING			
24	2	WASHER			
25	2	NUT			
26	1	STA-STRAP			

BOTTOM COWL

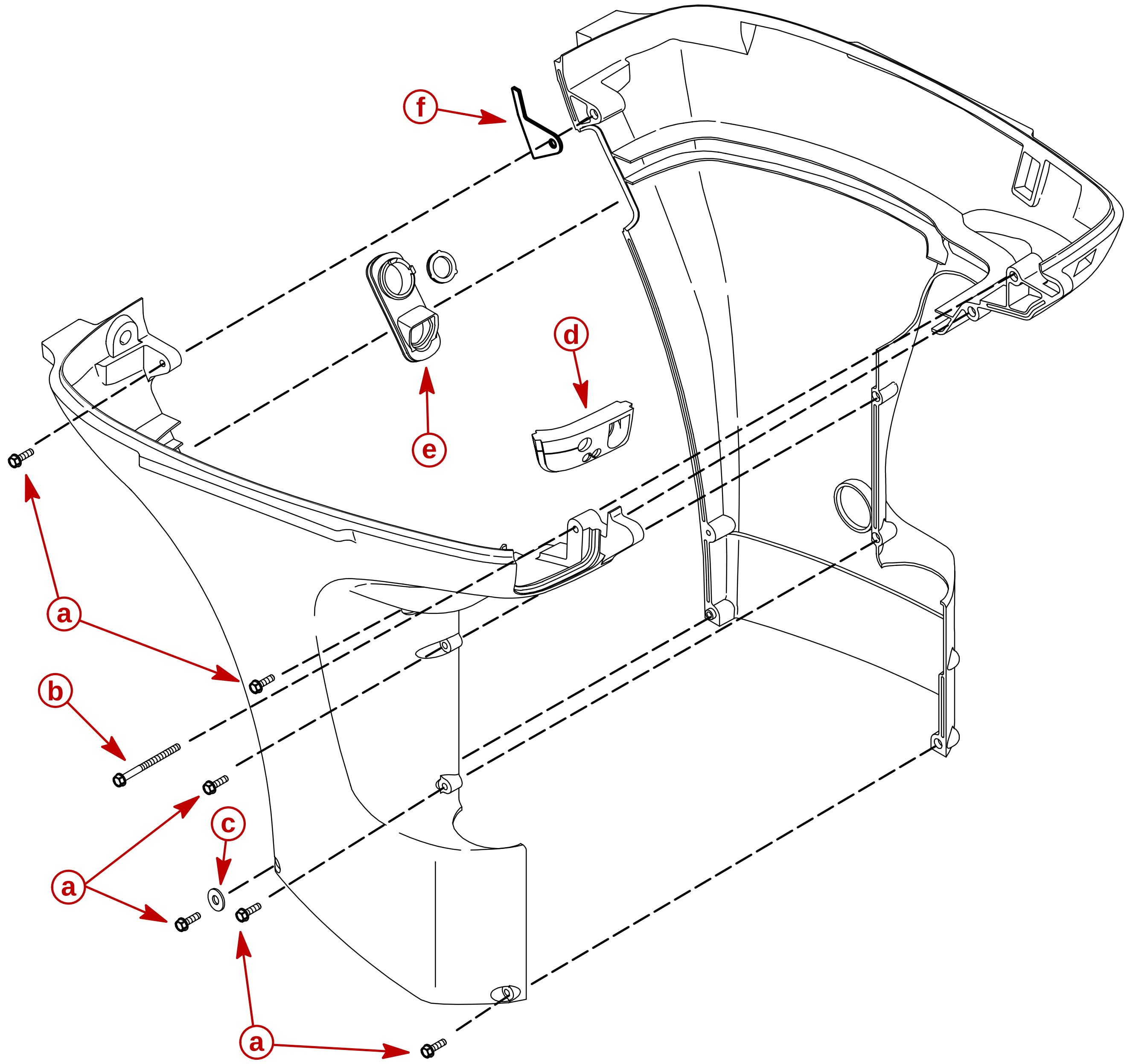


95 2-4-C With Teflon (92-850736A1)

BOTTOM COWL

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	BOTTOM COWL **(LONG-PORT)**			
2	1	BOTTOM COWL **(LONG-STBD.)**			
3	6	SCREW (M6 X 30)	60		6.8
4	1	WASHER			
5	1	SEAL			
6	1	WASHER			
7	1	GASKET			
8	1	SCREW (M6 X 60)	60		6.8
9	1	FITTING-TELLTALE			
10	1	BOOT			
11	1	STA-STRAP			
12	1	LEVER-COWL LATCH			
13	2	BUSHING			
14	2	WAVE WASHER			
15	1	LATCH HOOK			
16	1	SCREW (M6 X 16)	60		6.8
17	1	GROMMET			
18	1	SWITCH			
19	1	GROMMET			

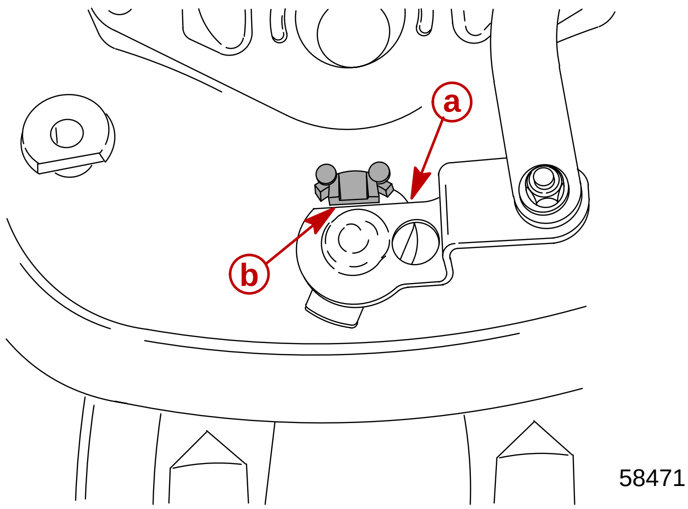
Bottom Cowl Removal/Installation

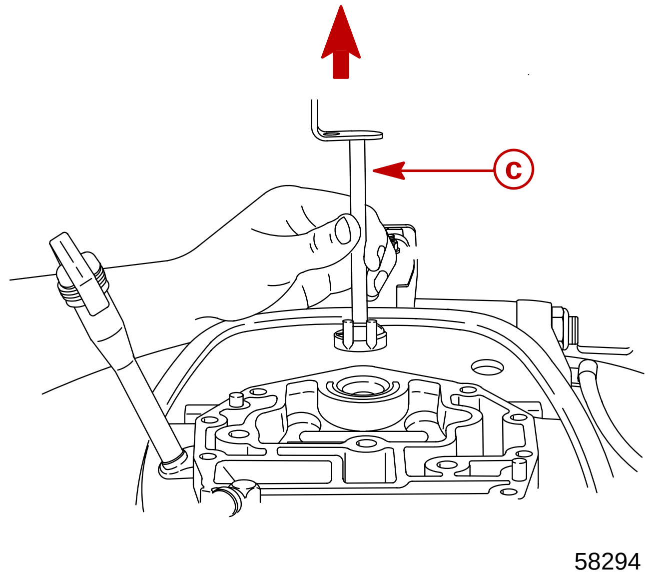


a - Cowl Screws (6) M6 x 30
b - Cowl Screw (1) M6 x 60
c - Washer
d - Grommet
e - Boot
f - Gasket

Adaptor Plate Removal

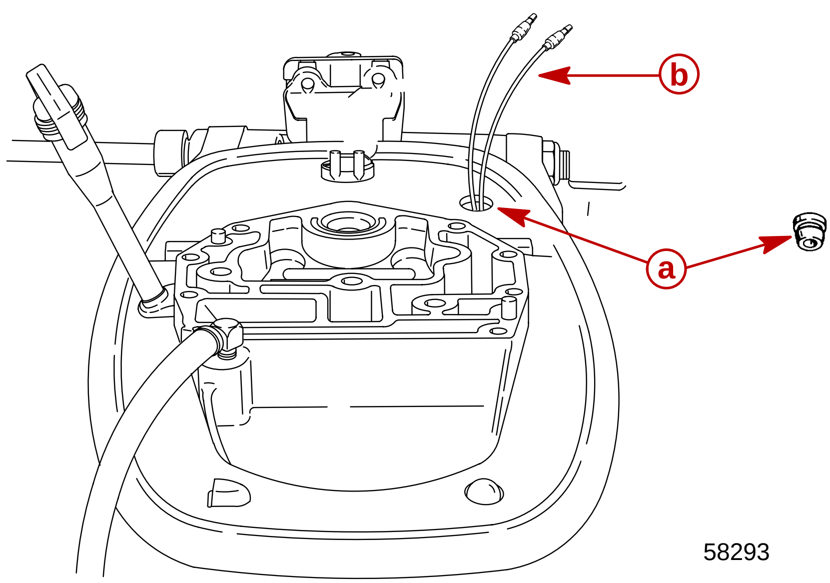
1. Remove powerhead, refer to section 4B.
2. Remove lower unit, refer to section 6.
3. Rotate shift linkage until the flat on the shift shaft bracket lines up with the flat on the bushing. Pull the shift shaft straight up and out.





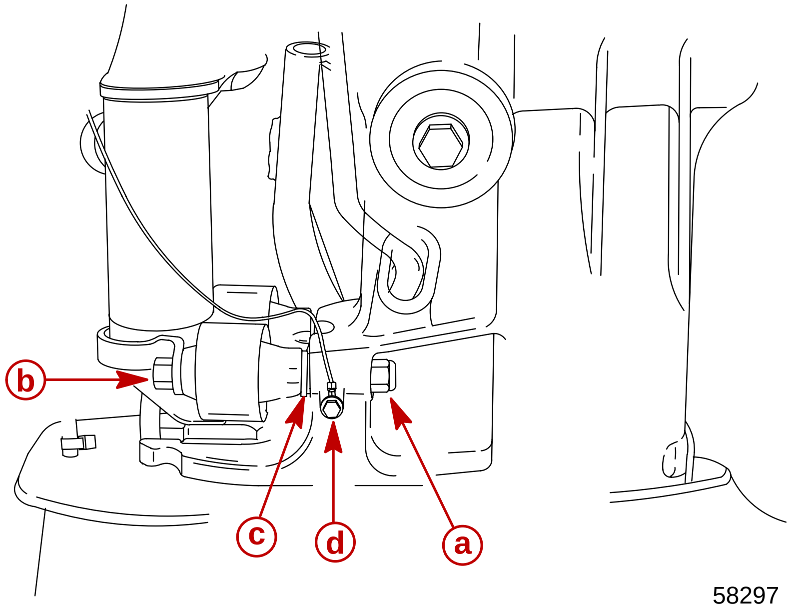
a - Shift Bracket Flat
b - Bushing Flat
c - Shift Shaft

4. Remove wire grommet from adaptor plate. Pull power trim wires out of grommet.



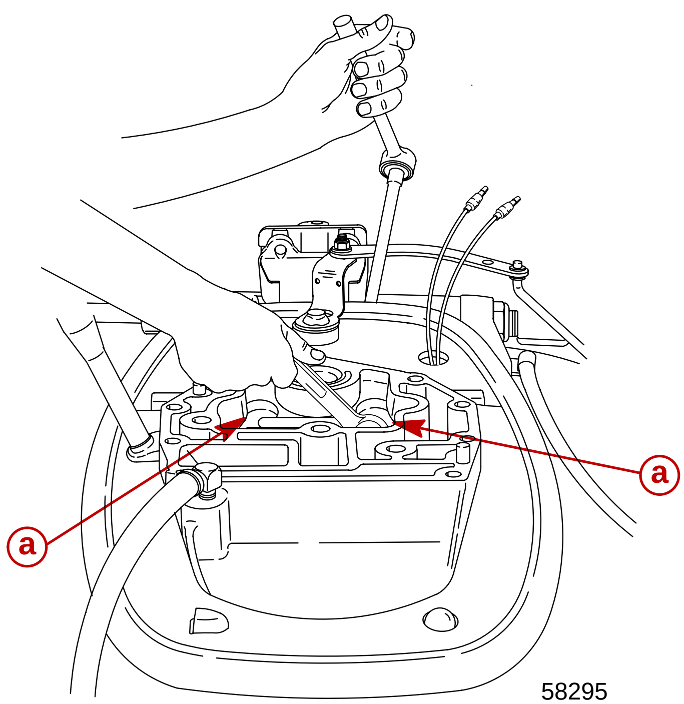
a - Trim Wire Grommet
b - Power Trim Wires

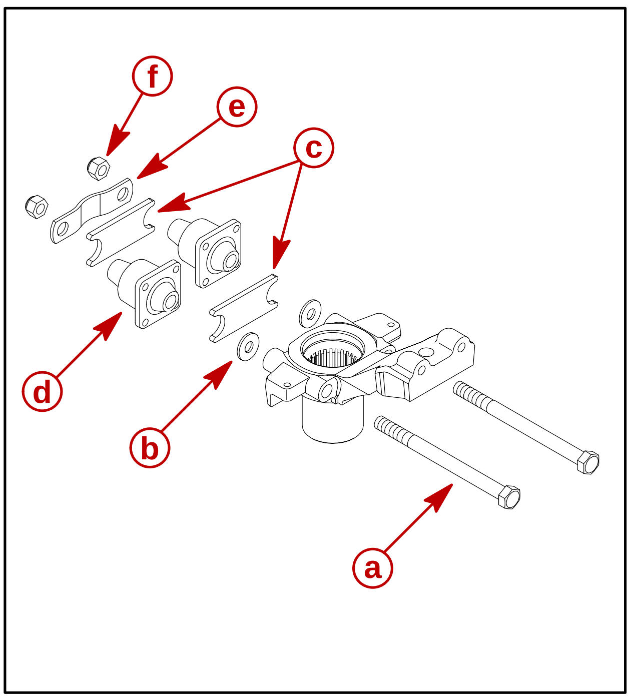
5. Remove nuts and washers from lower mount bolts.
6. Remove ground strap bolt.



a - Nut (2)
b - Lower Mount Bolt (2) M10 x 105
c - Washer (2)
d - Ground Strap Bolt

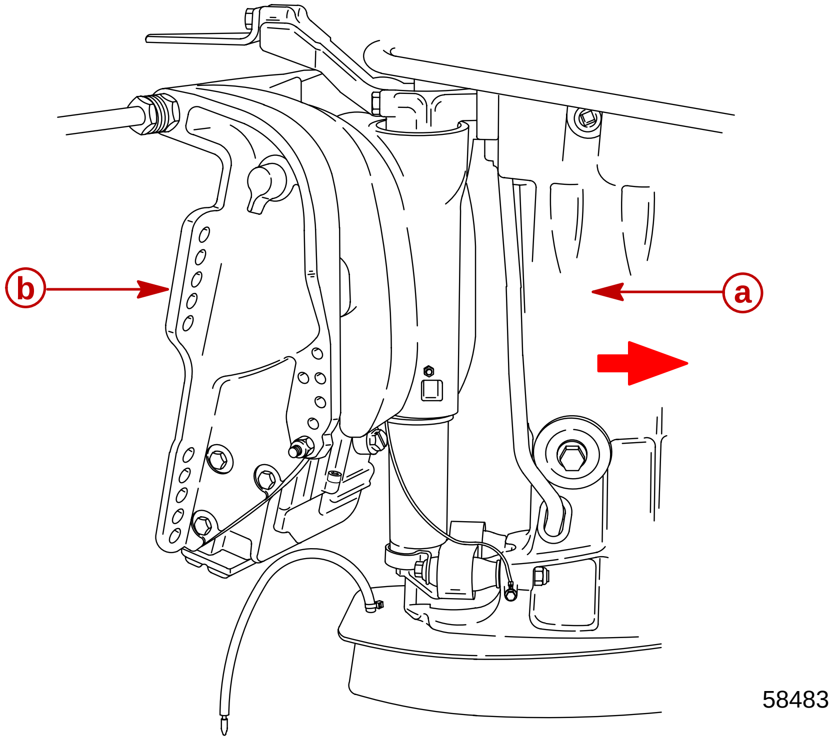
7. Remove nuts and washers from upper mount bolts.





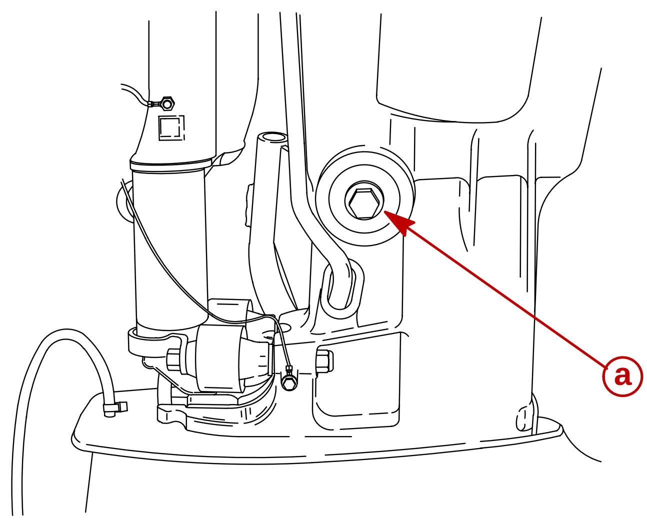
a - Upper Mount Bolt (2) M12 x 154
b - Washer (2)
c - Bumper (2)
d - Mount (2)
e - Strap
f - Nut (2)

8. Separate drive shaft housing from transom bracket mount bolts by pulling backward.



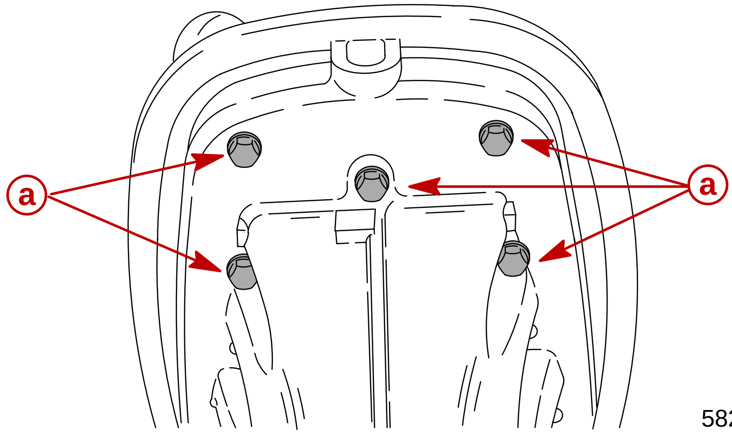
a - Driveshaft Housing
b - Transom Bracket

9. Remove drain plug on port side of driveshaft housing to drain remaining oil from sump.



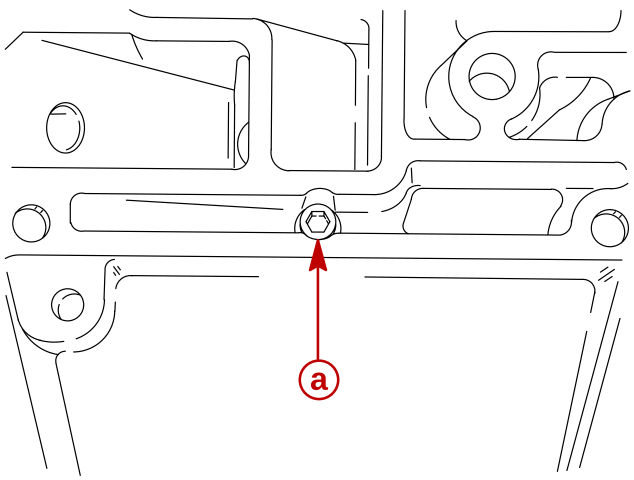
a - Drain Plug

10. Remove five (5) adaptor plate screws from aft/underside of driveshaft housing.



a - Screw (5) M8 x 45

11. Remove allen head screw on top of adaptor plate.



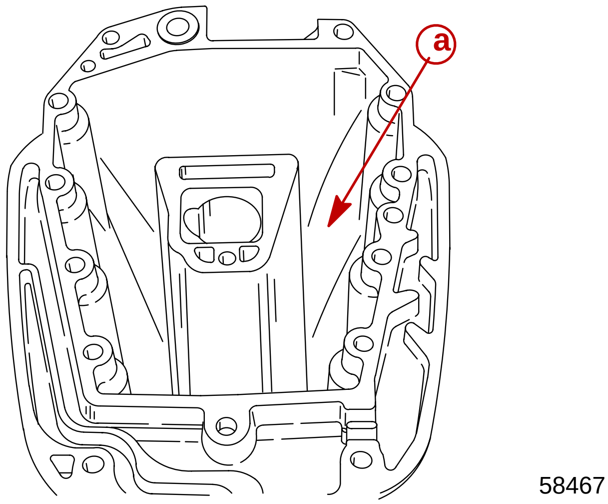
a - Allen Head Screw M6 x 55

12. Remove adaptor plate from driveshaft housing.

13. Inspect powerhead base gasket and adaptor plate gasket before reassembly. Replace if necessary.

Cleaning Oil Sump

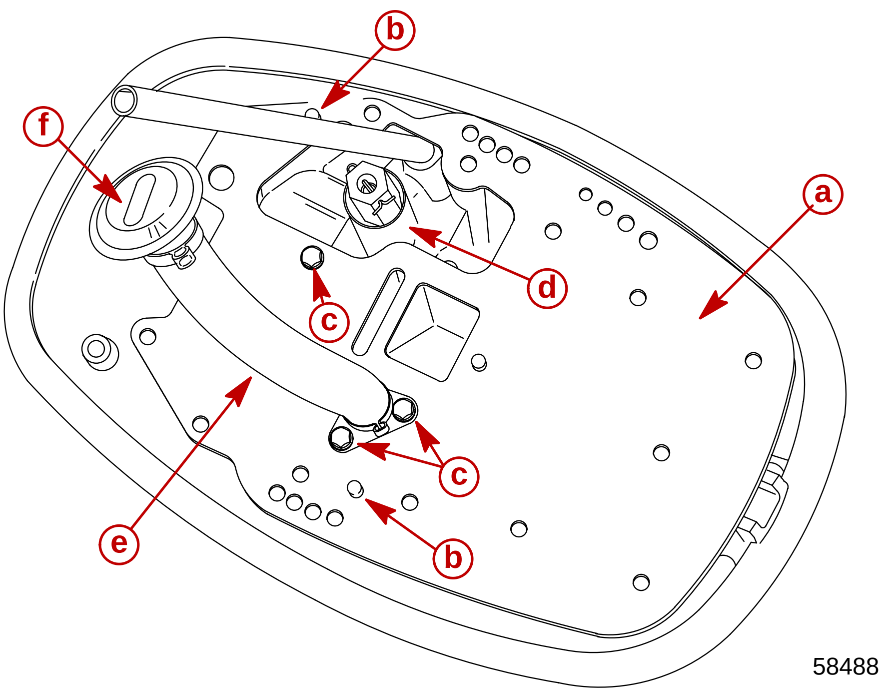
1. Inspect and clean oil sump thoroughly before reassembly.



a - Oil Sump

Adaptor Plate Inspection/Cleaning

1. Disassemble, clean and inspect adaptor plate components as required.
2. Oil pick-up screen in baffle should be clean and free of damage.
3. Oil pick-up hose must be in good condition and clamped securely at either end.
4. Oil pressure relief valve must be clean and free to open and close without sticking.



a - Gasket
b - Dowel Pin (2)
c - Screw (3) M6 x 20
d - Oil Pressure Relief Valve/Deflector Cup Assembly
e - Oil Pick-up Hose
f - Baffle Screen

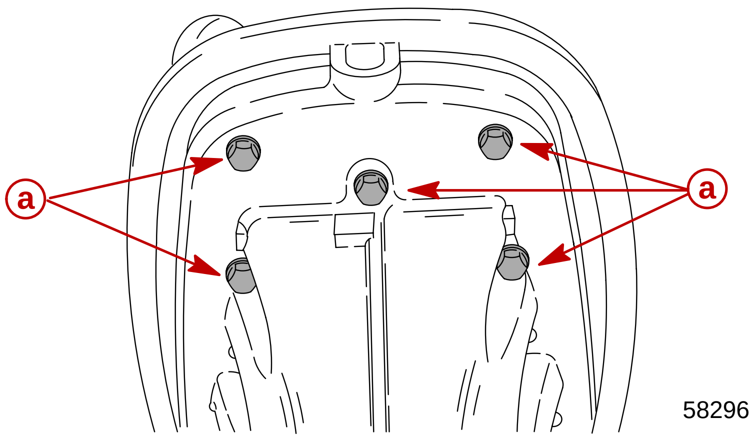
Adaptor Plate Reassembly

1. If removed during cleaning/inspection, install adaptor plate components per the above diagram. Tighten fasteners to specified torque.

Pickup Hose/Gasket Screw Torque
75 lb-in. (8.5 Nm)

Oil Pressure Relief Valve Torque (Oiled)
17 lb-ft. (23 Nm)

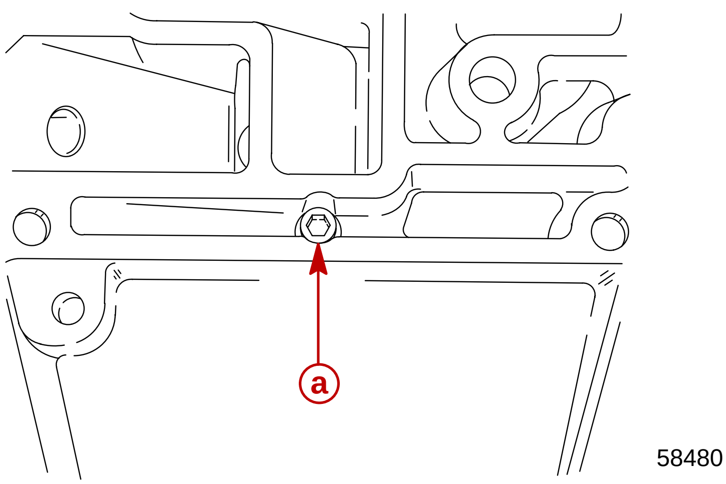
1. Place adaptor plate on to driveshaft housing, install five (5) screws on the aft/underside of the driveshaft housing and tighten to specified torque.



a - Screw (5) M8 x 45

Adaptor Plate Screw Torque
33 lb-ft. (44.7 Nm)

2. Install allen head screw on top side of adaptor plate. Tighten to specified torque.

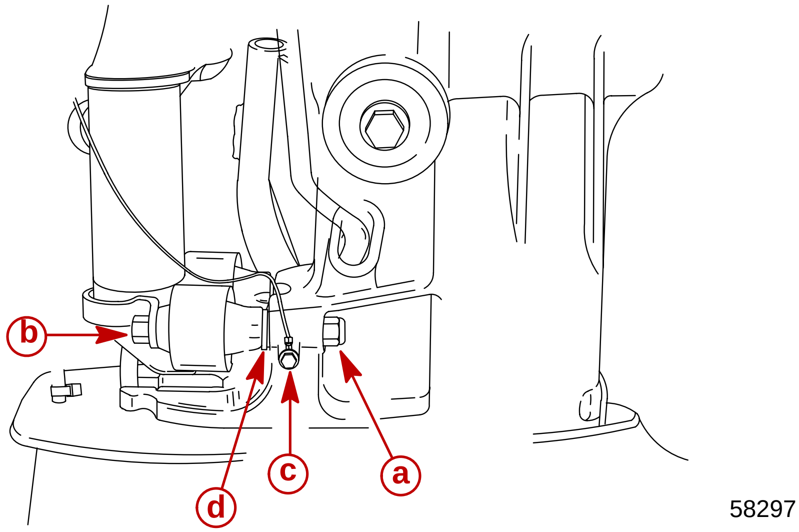


a - Allen Head Screw M6 x 55

Adaptor Plate Screw Torque
150 lb-in. (16.9 Nm)

Driveshaft Housing Reassembly

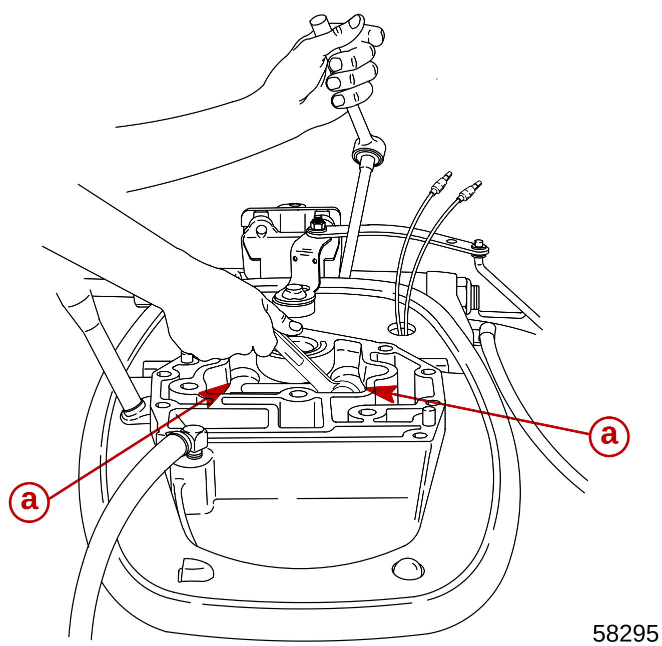
1. Replace driveshaft housing assembly to transom bracket. Two people may be required for this, one to hold the driveshaft housing, the other to install the upper and lower bolts.
2. Tighten lower bolts to specified torque. Make sure washers are in the correct position.
3. Tighten ground strap screw.



a - Nut (2)
b - Lower Mount Bolt (2) M10 x 105
c - Ground Strap Screw
d - Washer (2)

Driveshaft Housing Lower Bolt Torque
32.5 lb-ft. (44 Nm)

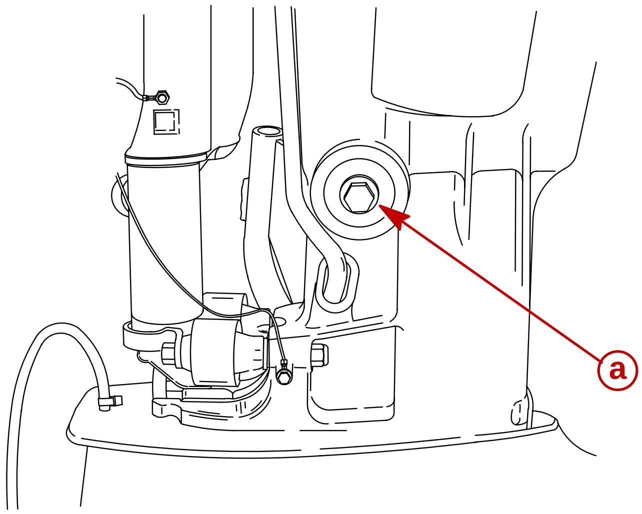
4. Tighten upper mount bolts to specified torque.



a - Upper Mount Bolt(2) M12 x 154

Driveshaft Housing Upper Bolt Torque
50 lb-ft. (68 Nm)

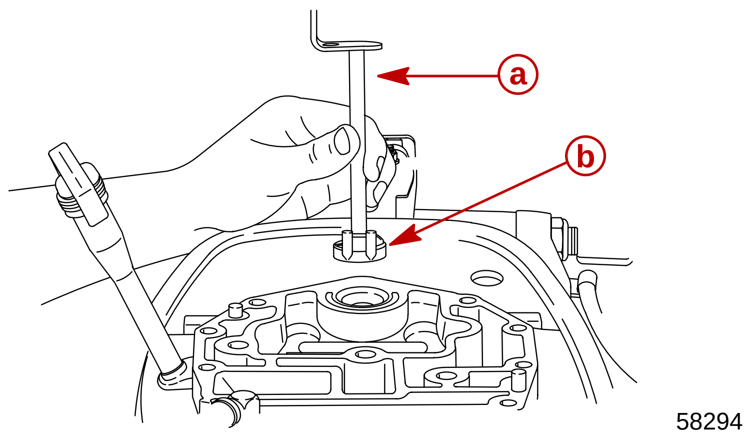
5. Replace drain plug into housing and torque to specified torque.



a - Drain Plug

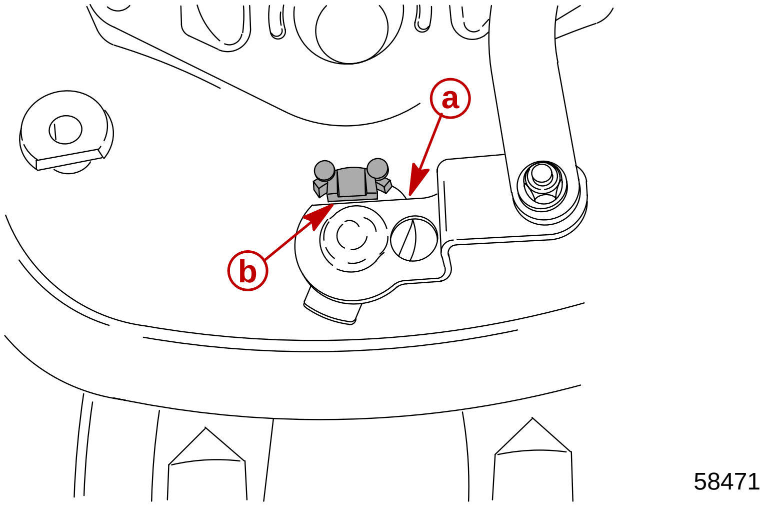
Drain Plug Torque
17.5 lb-ft (24 Nm)

6. Slide the shift shaft through the bushing, into the driveshaft housing.



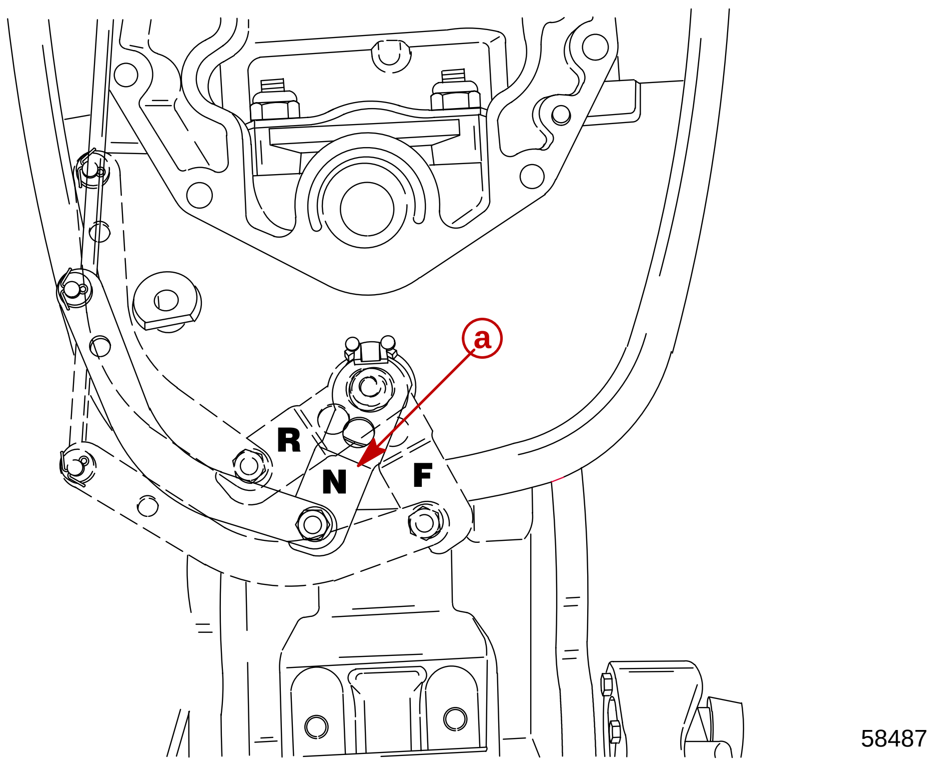
a - Shift Shaft
b - Bushing

7. Rotate shift shaft so the flat on the shift shaft bracket lines up with the flat on the bushing.



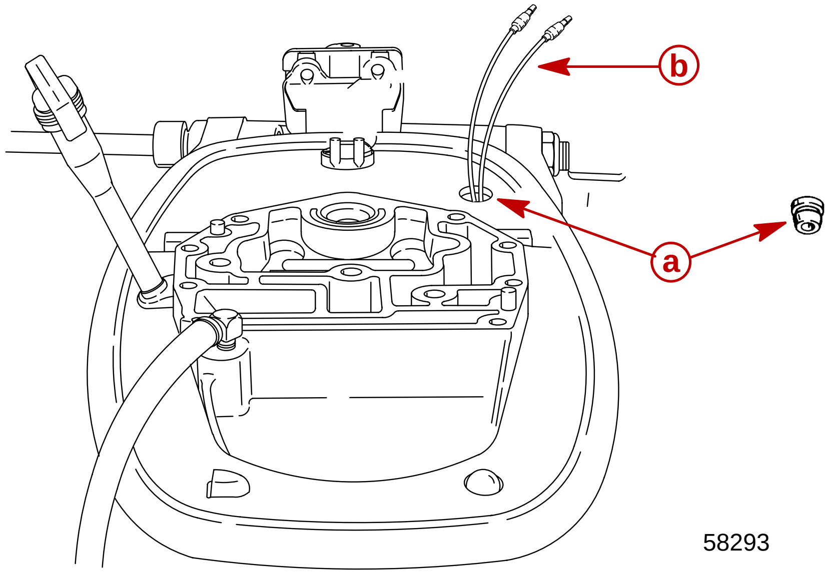
a - Shift Shaft Bracket
b - Bushing Flat

8. Rotate shift shaft and position bracket in the neutral position.



a - Shift Shaft Bracket

9. Install grommet and pull power trim wires up thru adaptor plate grommet.



a - Trim Wire Grommet
b - Power Trim Wires

10. Reinstall the following components:
    - Lower unit, refer to section 6.
    - Powerhead, refer to section 4B.

MID-SECTION

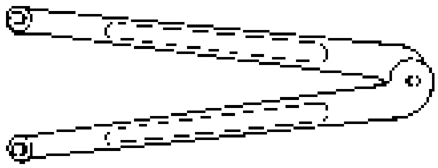
Section 5B - Power Trim

Table of Contents

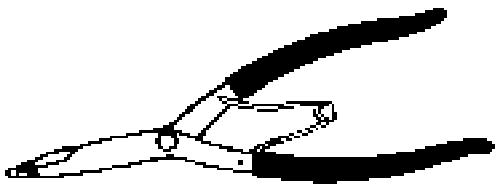
5
B

Special Tools

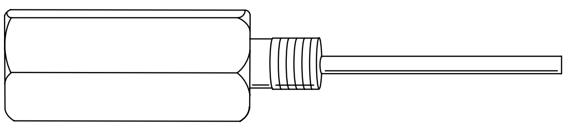
1. Spanner Wrench P/N 91-74951



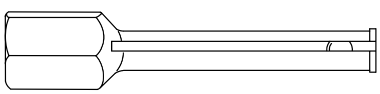
2. Lock-Ring Pliers Snap-On P/N SRP2



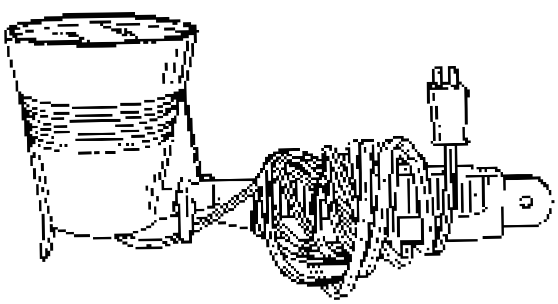
3. Expanding Rod P/N CG 41-11*



4. Collet P/N CG 41-14*



5. Heat Lamp P/N 91-63209

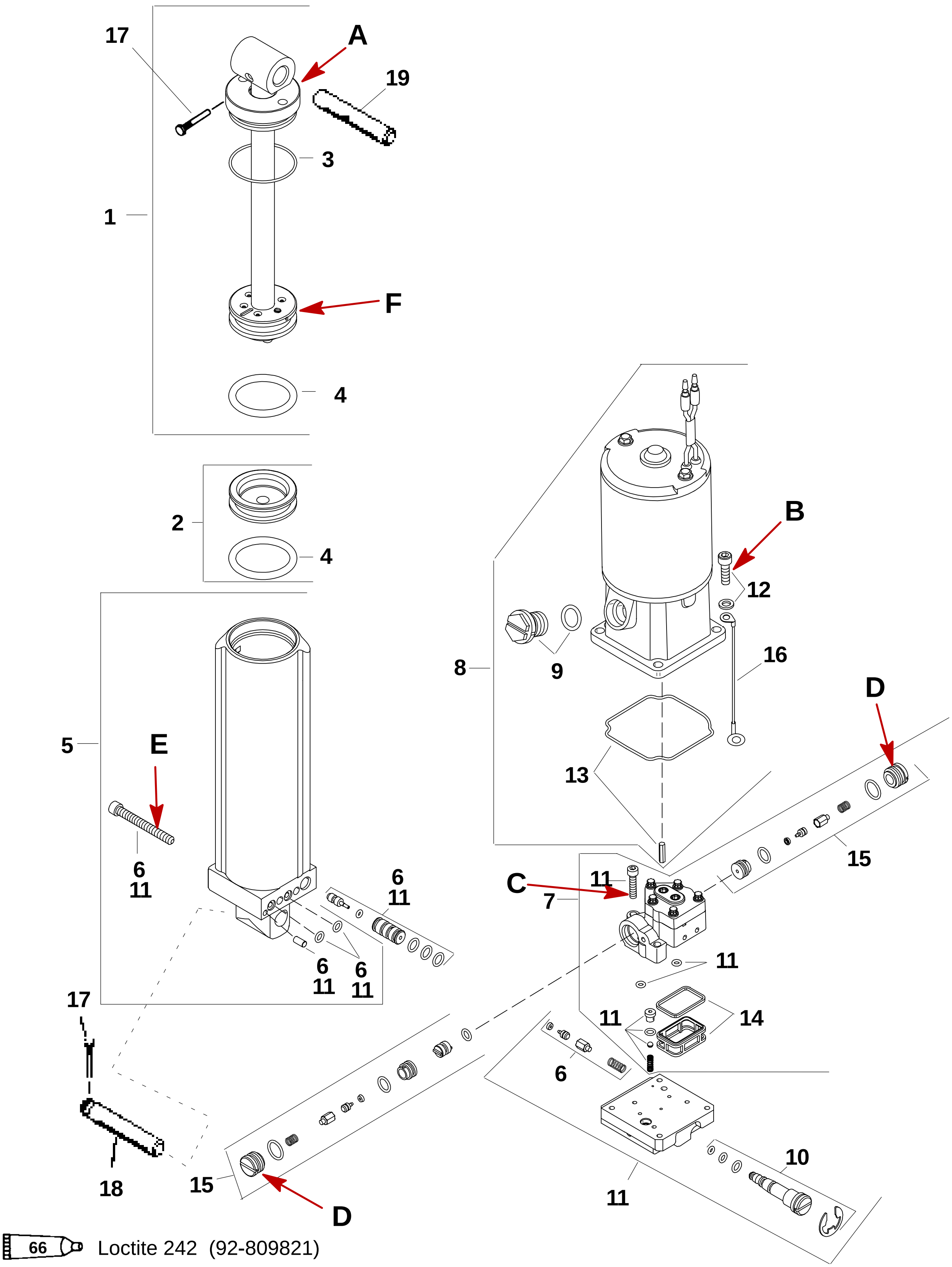


Quicksilver Lubricants and Service Aids

Part No.	Description
92-90100A12	Power Trim Fluid
92-850736A1	2-4-C w/Teflon

Notes:

Power Trim



Loctite 242 (92-809821)

***NOTE:** Lubricate all O-rings using Quicksilver Power Trim and Steering Fluid. If not available, use automotive (ATF) automatic transmission fluid.*

***NOTE:** It is recommended that all O-rings be replaced when servicing tilt system.*

Power Trim

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in.	TORQUE lb-ft	TORQUE Nm
–	1	POWER TRIM PUMP			
1	1	SHOCK ROD KIT			
2	1	MEMORY PISTON ASSEMBLY			
3	1	O RING REBUILD KIT			
4	2	O RING			
5	1	CYLINDER ASSEMBLY			
6	1	TRIM LIMIT VALVE KIT **(NON-BIGFOOT)**			
	1	TRIM LIMIT VALVE KIT **(BIGFOOT)**			
7	1	PUMP ASSEMBLY			
8	1	MOTOR KIT			
9	1	RESERVOIR PLUG			
10	1	MANUAL RELEASE ASSEMBLY			
11	1	MANIFOLD KIT			
12	1	SCREW KIT (MOTOR)			
13	1	DRIVE SHAFT			
14	1	FILTER KIT			
15	1	P.O. CHECK ASSEMBLY KIT			
16	1	CABLE			
–	1	O RING KIT (COMPLETE TRIM)			
17	2	GROOVE PIN			
18	1	ANCHOR PIN			
19	1	PIN			

A - Torque cylinder cap to 45 lb-ft (61 Nm)

B - Torque screws to 80 lb-in. (9.0 Nm)

C - Torque screws to 70 lb-in. (7.9 Nm)

D - Torque plugs to 120 lb-in. (13.5 Nm)

E - Torque screws to 100 lb-in. (11 Nm)

F - Torque shock piston to 90 lb-ft (122 Nm)

Theory Of Operation

The Power Trim system consists of an electric motor, pressurized fluid reservoir, pump and trim cylinder.

The remote control (or trim panel) is equipped with a switch that is used for trimming the outboard “up” and “down”, and for tilting the outboard for shallow water operation (at slow speed) or for “trailering”. The outboard can be trimmed “up” or “down” while engine is under power or when engine is not running.

Adjustments

Trimming Characteristics

NOTE: *Because varying hull designs react differently in various degrees of rough water, it is recommended to experiment with trim positions to determine whether trimming “up” or “down” will improve the ride in rough water.*

When trimming your outboard from a mid-trim position (trim tab in neutral, straight fore-and-aft, position), you can expect the following results:

TRIMMING OUTBOARD “UP” (“OUT”)

⚠ WARNING

Excessive trim “out” may reduce the stability of some high speed hulls. To correct instability at high speed, reduce the power gradually and trim the motor “In” slightly before resuming high speed operation. (Rapid reduction in power will cause a sudden change of steering torque and may cause additional momentary boat instability.)

- Will lift bow of boat, generally increasing top speed.
- Transfers steering torque harder to left on installations below 23 in. transom height.
- Increases clearance over submerged objects.
- In excess, can cause porpoising and/or ventilation.
- In excess, can cause insufficient water supply to water pump resulting in serious water pump and/or powerhead overheating damage.

⚠ WARNING

Excessive engine trim angle will result in insufficient water supply to water pump causing water pump and/or powerhead overheating damage. Make sure that water level is above gear housing water intake holes whenever engine is running.

Operating “Up” circuit will actuate the “up” relay (located under engine cowl) and close the electric motor circuit. The electric motor will drive the pump, thus forcing automatic transmission fluid through internal passageways into the “up” side of the trim cylinder.

The trim cylinder/trim rod will position the engine at the desired trim angle within the 20° maximum trim range. The power trim system is designed so the engine cannot be trimmed beyond the 20° maximum trim angle as long as engine RPM is above approximately 2000 RPM.

The engine can be raised beyond the 20° maximum trim angle for shallow water operation, etc., by keeping the engine RPM below 2000 RPM. If engine RPM increases above 2000 RPM, the thrust created by the propeller (if deep enough in the water) will cause the trim system to automatically lower the engine back to the 20° maximum trim angle.

TRIMMING OUTBOARD “DOWN” (“IN”)

WARNING

Excessive speed at minimum trim “In” may cause undesirable and/or unsafe steering conditions. Each boat should be tested for handling characteristics after any adjustment is made to the tilt angle (tilt pin relocation).

- Will help planing off, particularly with a heavy load.
- Usually improves ride in choppy water.
- In excess, can cause boat to veer to the left or right (bow steer).
- Transfers steering torque harder to right (or less to the left).
- Improves planing speed acceleration (by moving tilt pin one hole closer to transom).

Operating “Down” circuit will actuate the “down” relay (located under engine cowl) and close the electric motor circuit (motor will run in opposite direction of the “Up” circuit). The electric motor will drive the pump, thus forcing automatic transmission fluid through internal passageways into the “down” side of the trim cylinder. The trim rod will move the engine downward to the desired angle.

Trailering Outboard

WARNING

Excessive engine trim angle will result in insufficient water supply to water pump causing water pump and/or powerhead overheating damage. Make sure that water level is above gear housing water intake holes whenever engine is running.

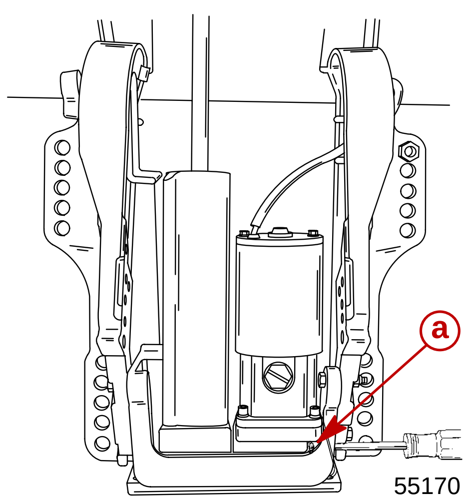
While operating “up” circuit, the cylinder rod will continue to tilt the outboard to a full up position for trailering.

Tilting Outboard Up and Down Manually

WARNING

Before loosening the manual release valve, make sure all persons are clear of engine, as engine will drop to full “down” position when valve is loosened.

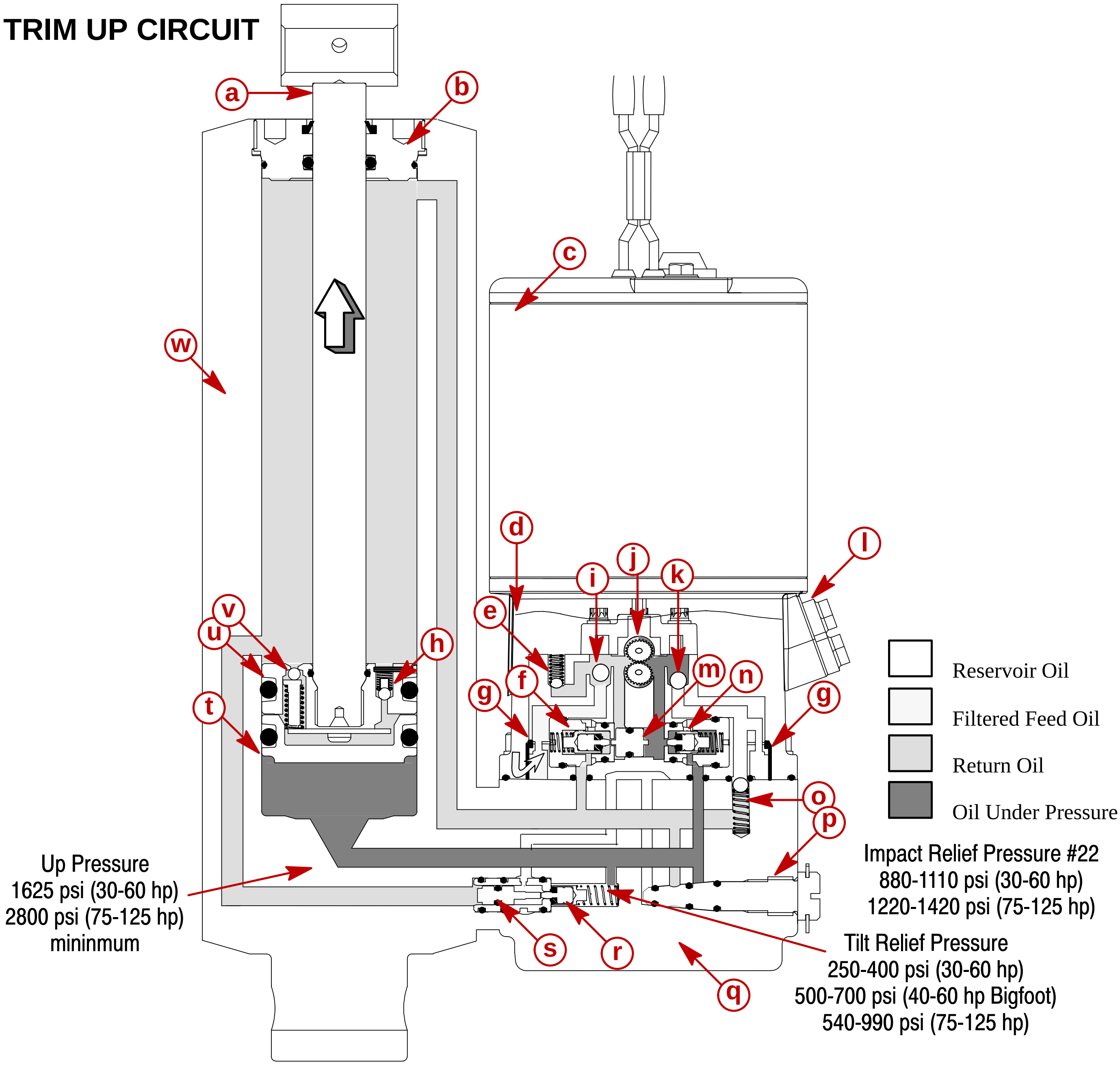
With power trim installed, the outboard can be raised or lowered manually by opening the manual release valve 3 to 4 turns (counterclockwise).



a - Manual Release Valve

Power Trim Flow Diagrams

TRIM UP CIRCUIT

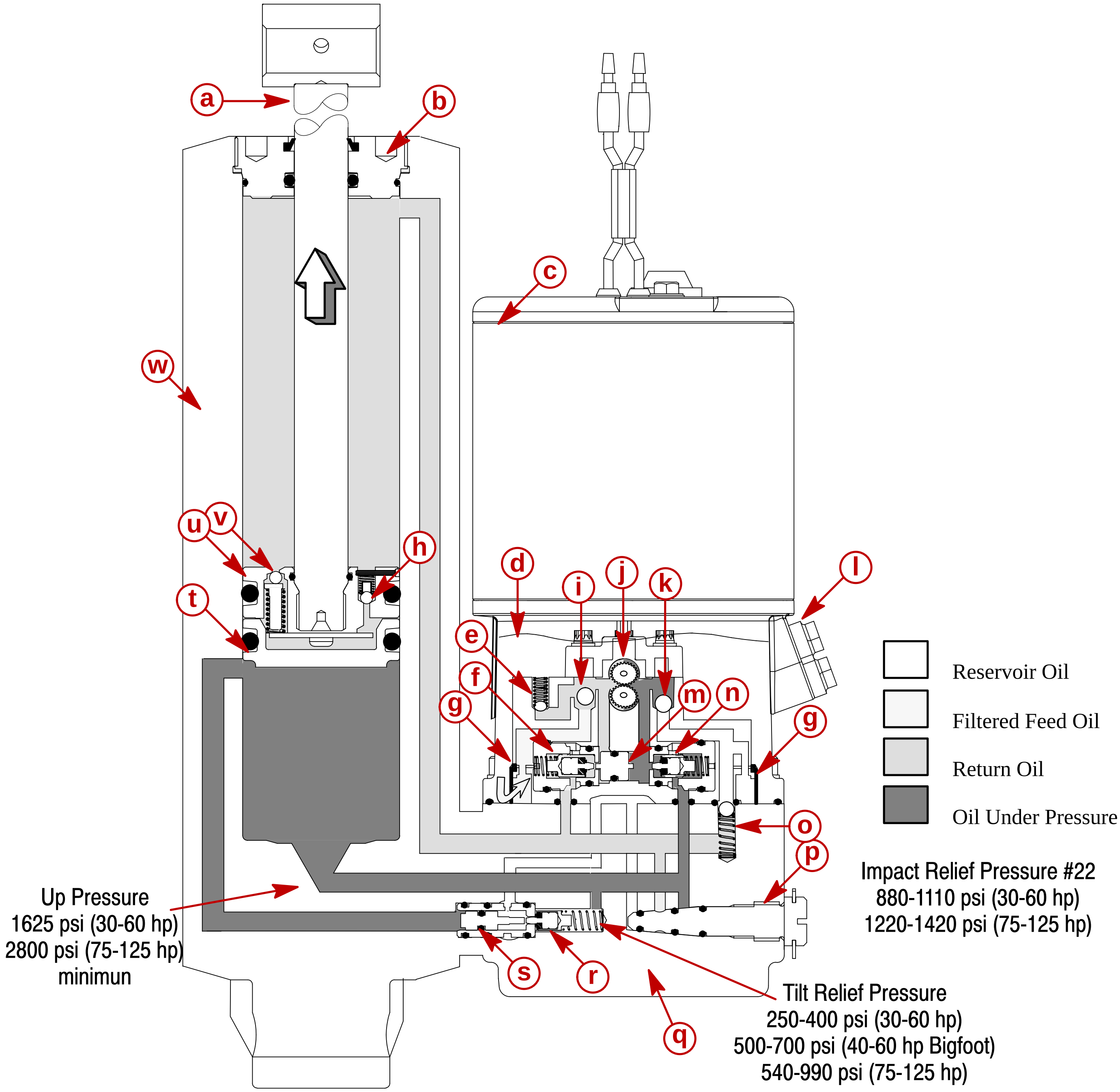


- **a** - Piston Rod
- **b** - End Cap
- **c** - Electric Motor
- **d** - Reservoir Oil
- **e** - Down Circuit Pressure Relief Valve
- **f** - Down Circuit Pressure Operated Valve
- **g** - Filter (2 shown for clarity)
- **h** - Shock Return Valve
- **i** - Up Circuit Suction Port
- **j** - Oil Pump
- **k** - Down Circuit Suction Port
- **l** - Oil Fill Cap
- **m** - Shuttle Valve
- **n** - Up Circuit Pressure Operated Valve
- **o** - Manifold Reverse Suction Valve
- **p** - Manual Release Valve
- **q** - Manifold
- **r** - Tilt Relief Valve
- **s** - Tilt Relief Piston
- **t** - Memory Piston
- **u** - Shock Piston
- **v** - Impact Relief Valve
- **w** - Cylinder

Trim Up

When the trim switch is activated in the up position, the electric motor (c) begins to rotate the oil pump gears (j), the oil pump draws a small amount of oil through the filter (g) and through the up circuit suction port (i). The oil pump gear (j) rotation forces oil into the passages for the up circuit. Oil, under pressure, will slide the shuttle valve (m) against the down circuit pressure operated valve (f). The shuttle valve will mechanically open the down pressure operated valve, allowing oil from the down cavity of the trim cylinder to flow into the oil pump. This returning oil, from the down cavity, will supply most of the oil required for the up circuit. Oil in the up circuit is blocked from returning into the reservoir by the ball inside the down circuit suction port (k). The pressure of the oil will force the up circuit pressure operated valve (n) to open, allowing the oil to enter the passages inside the manifold (q) leading to the trim cylinder (w) up cavity. Oil is blocked from all other passages by the closed manual release valve (p). Oil under pressure will enter the trim cylinder below the memory piston (t). With an increasing amount of oil entering the cylinder, the memory piston contacts the shock piston (u) and forces the piston rod (a) up and out, raising the outboard motor. Oil on the top of the shock piston exits through a passage running down along the side of the cylinder and enters the manifold passages. The oil is drawn back into the pump (j) through the open down circuit pressure operated valve (f) and enters the pump as supply for the up circuit.

Tilt Circuit



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q - Manifold
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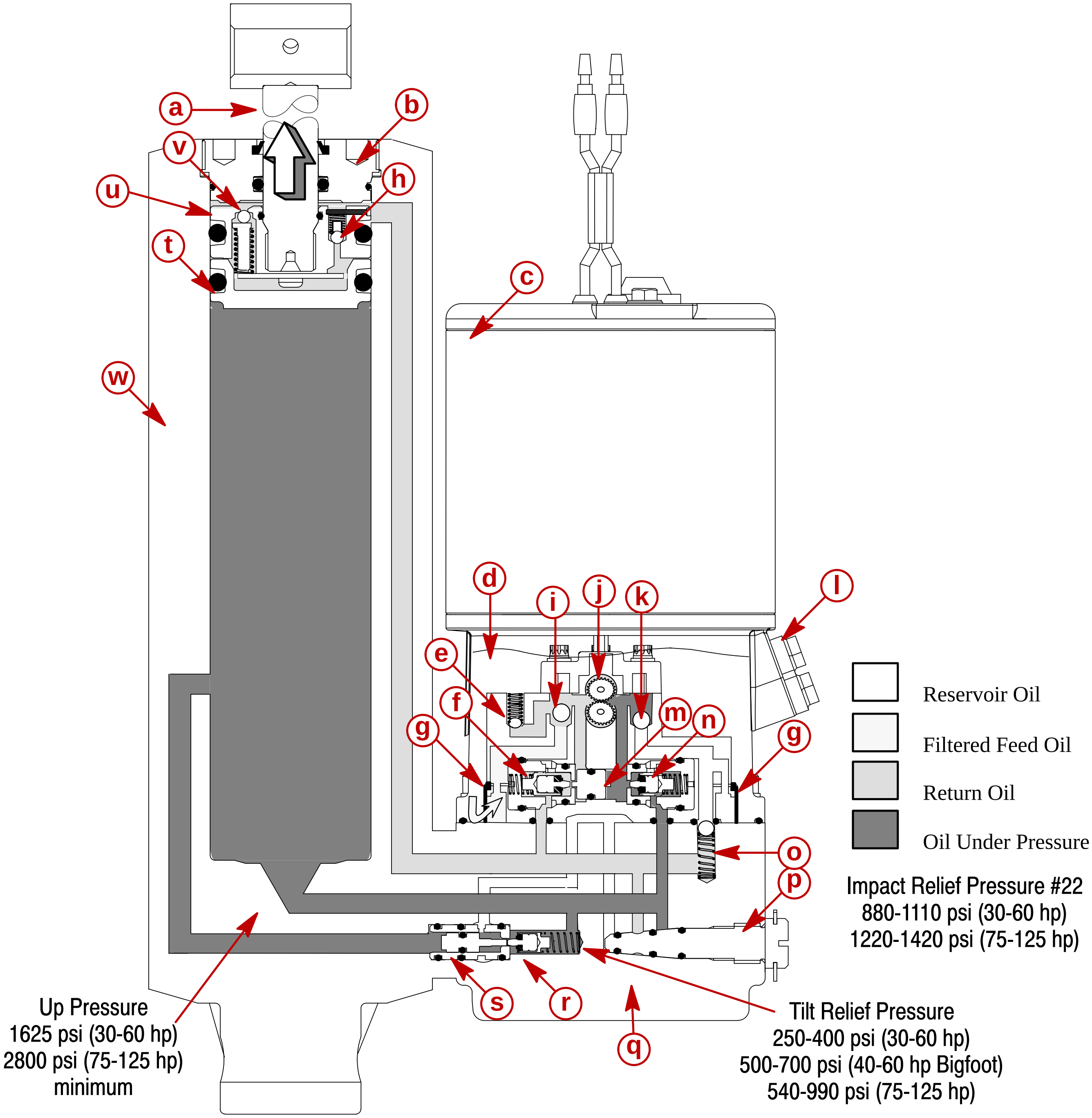
s - Tilt Relief Piston
t - Memory Piston
u - Shock Piston
v - Impact Relief Valve
w - Cylinder

Tilt Up

In the up mode, as the piston rod (a) extends from the cylinder (w), the memory piston (t) clears or uncovers the pressure relief passage. Oil from the up cavity will enter this passage and, if required, causes the tilt relief piston (s) to open the tilt pressure relief valve (r). This valve lowers the amount of pressure available to lift the outboard motor. With the engine in forward gear, and at high engine rpm, the oil pressure available will not be able to overcome the propeller thrust, limiting the trim range to below the pressure relief orifice. When the engine rpm falls or if engine is not in forward gear, the oil pressure is available to extend the piston rod (a) up into the tilt range.

Maximum Tilt



- **a** - Piston Rod
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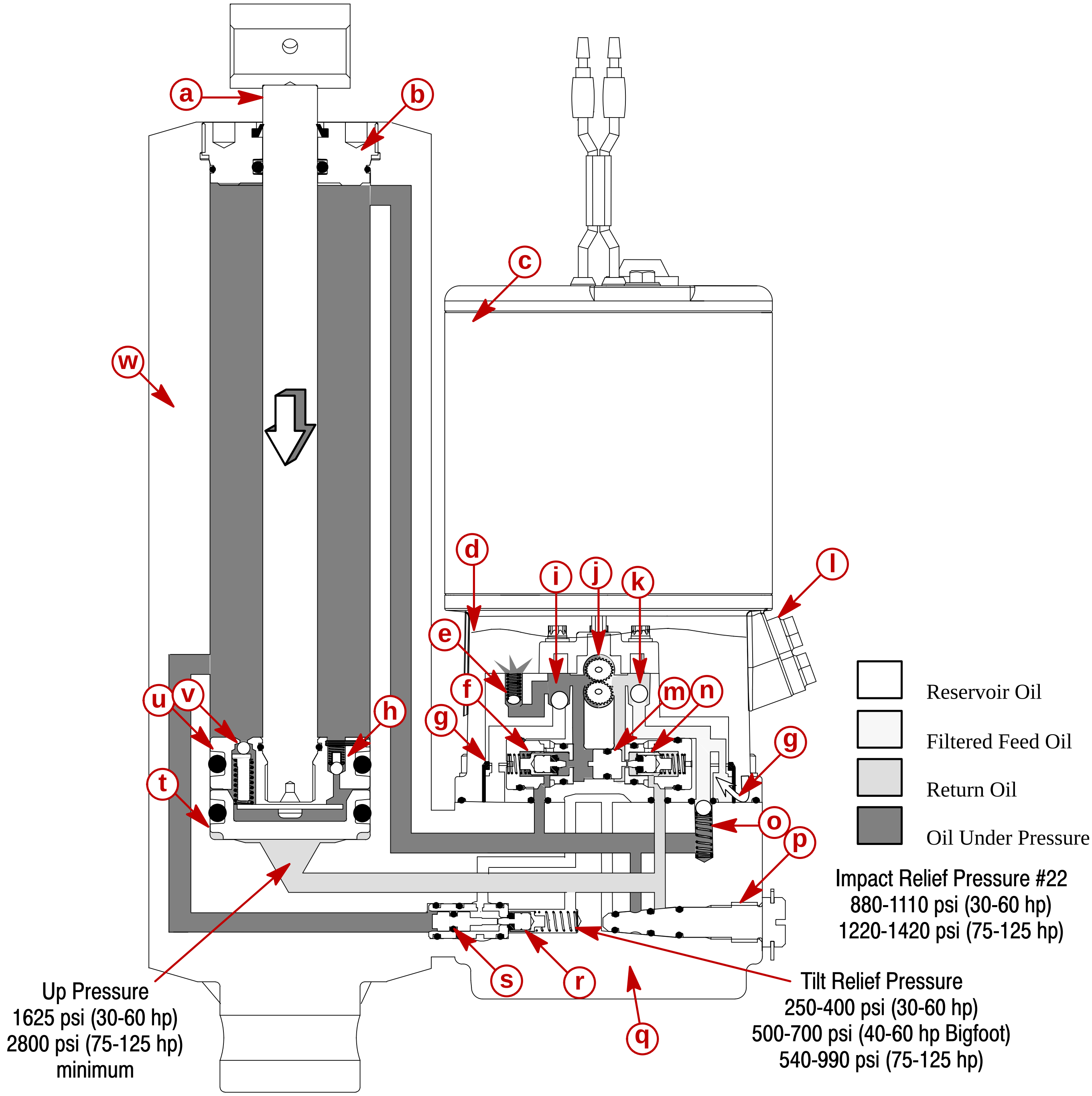
- **u** - Shock Piston
- **v** - Impact Relief Valve
- **w** - Cylinder

Maximum Tilt

With the piston rod at maximum travel, and due to no rod movement, the pressure inside of the trim cylinder (w) will increase to the pressure required to move the tilt relief piston (s). The tilt relief piston’s “pin” opens the tilt relief valve (r). Up pressure flows into the trim relief passage, and returns back into the reservoir.

Down Circuit

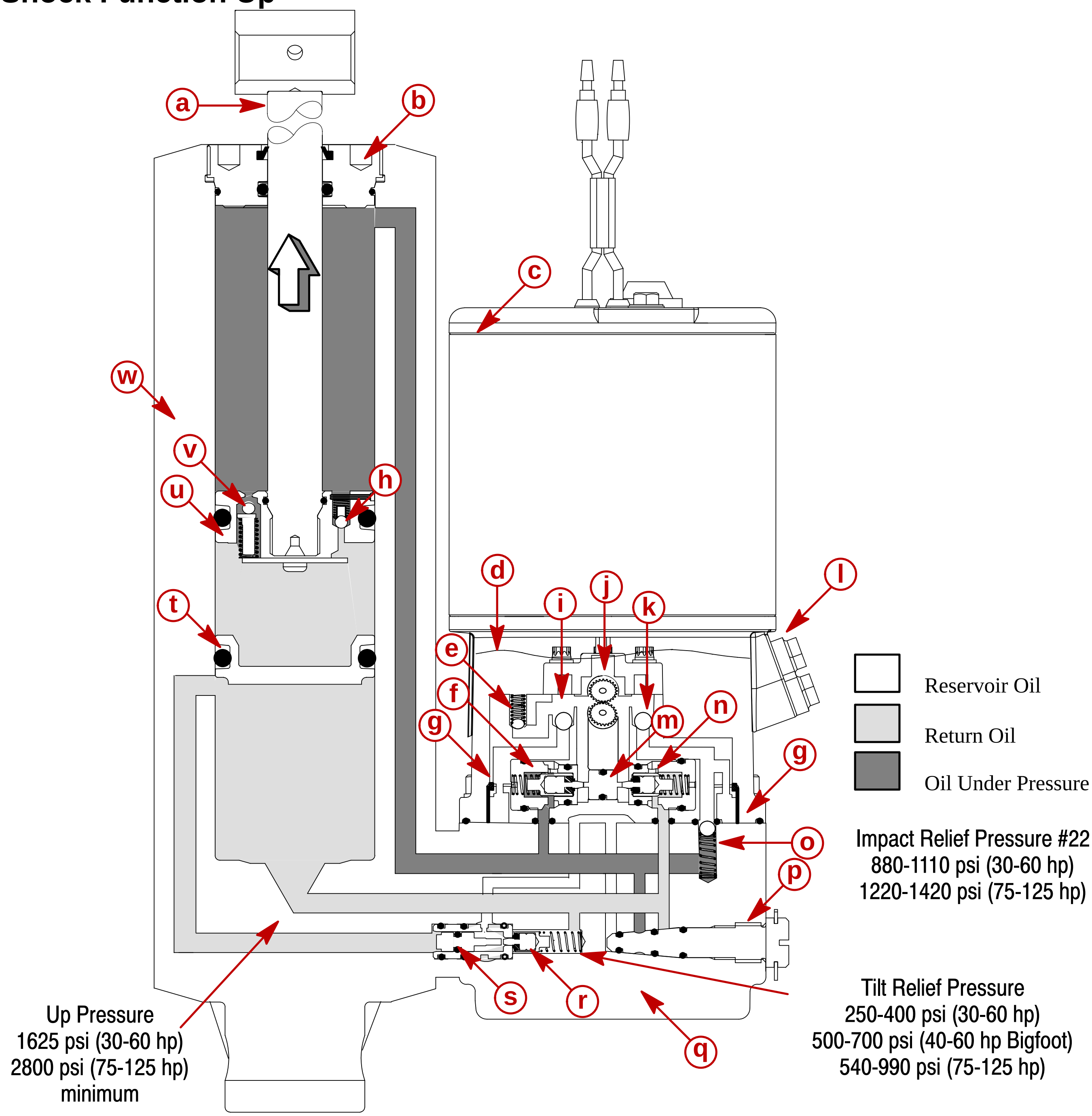


a - Piston Rod
b - End Cap
c - Electric Motor
d - Reservoir Oil
e - Down Circuit Pressure Relief Valve
f - Down Circuit Pressure Operated Valve
g - Filter (2 shown for clarity)
h - Shock Return Valve
i - Up Circuit Suction Port
j - Oil Pump
k - Down Circuit Suction Port
l - Oil Fill Cap
m - Shuttle Valve
n - Up Circuit Pressure Operated Valve
o - Manifold Reverse Suction Valve
p - Manual Release Valve
q - Manifold
r - Tilt Relief Valve
s - Tilt Relief Piston
t - Memory Piston
u - Shock Piston
v - Impact Relief Valve
w - Cylinder

Down Mode

When the trim switch is activated in the down position, the electric motor (c) will rotate the pump (j) in the opposite direction. With the oil pump gears rotating backwards, the flow of oil is reversed. Oil is drawn through the filter (g), through the down circuit suction port (k) and into the oil pump (j). The pump forces pressurized oil into the down passages. Oil will slide the shuttle valve (m) into the up circuit pressure operated valve (n). The shuttle valve will mechanically open the up circuit pressure operated valve and allow oil, from the up cavity of the trim cylinder (w), to return into the oil pump. This returning oil, from the up cavity, will supply the oil required for the down circuit. The oil is blocked from returning into the reservoir by the ball (i) inside the up circuit suction port. Oil, under pressure, opens the down circuit pressure operated valve (f) and enters the down passages inside of the manifold (q). The manifold passage connects into the trim cylinder passage leading to the top of the cylinder. The cavity, inside the cylinder, above the shock piston (u) is the down cavity. As the down cavity fills with oil, the piston rod (a) retracts into the cylinder, lowering the outboard motor. Oil from the up cavity exits the cylinder and is drawn back into the pump through the open up circuit pressure operated valve (n). When the piston rod reached full travel, the oil pressure inside the down circuit will rise until the down pressure regulating valve (e) opens, bypassing oil back into the reservoir. When the trim button is released, and the oil pump stops supplying pressure, both of the pressure operated valves (f & n) will close, and if open, the down pressure relief valve (e) will close. The closed valves will lock the fluid on either side of the shock piston (u) & memory piston (t), holding the outboard motor in position.

Shock Function Up



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e - Down Circuit Pressure Relief Valve
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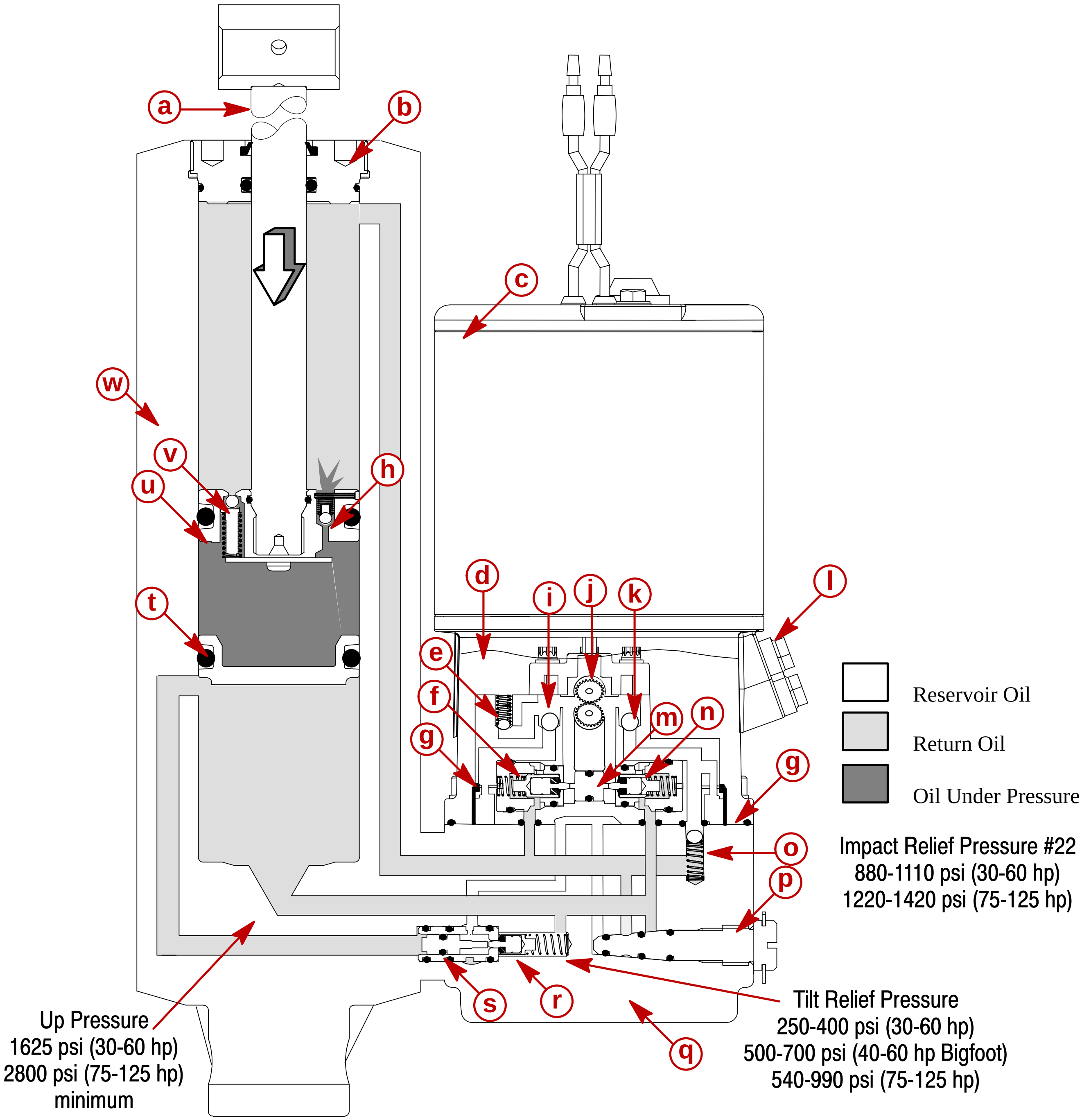
o - Manifold Reverse Suction Valve
p - Manual Release Valve
q - Manifold
r - Tilt Relief Valve
s - Tilt Relief Piston
t - Memory Piston
u - Shock Piston
v - Impact Relief Valve
w - Cylinder

Shock Function Up

Oil inside the down cavity is locked in a static position by the closed down circuit pressure operated valve (f), the manual release valve (p) and the manifold reverse suction valve (o). If the outboard strikes an underwater object while in forward gear, the piston rod (a) will try to rapidly extend from the cylinder (w), and the pressure increases inside the trim cylinder down cavity and connecting passages. When the pressure increases to the level required, the impact relief valves (v), located inside the shock piston (u), will open and allow the fluid to pass through it. As the fluid passes through the piston, the piston rod (a) will extend from the trim cylinder. The memory piston (t) is held in position by vacuum, created by the oil in the up cavity being locked in a static position. Therefore, oil passing through the shock piston is trapped between the memory piston (t) and shock piston (u).

Shock Function Return

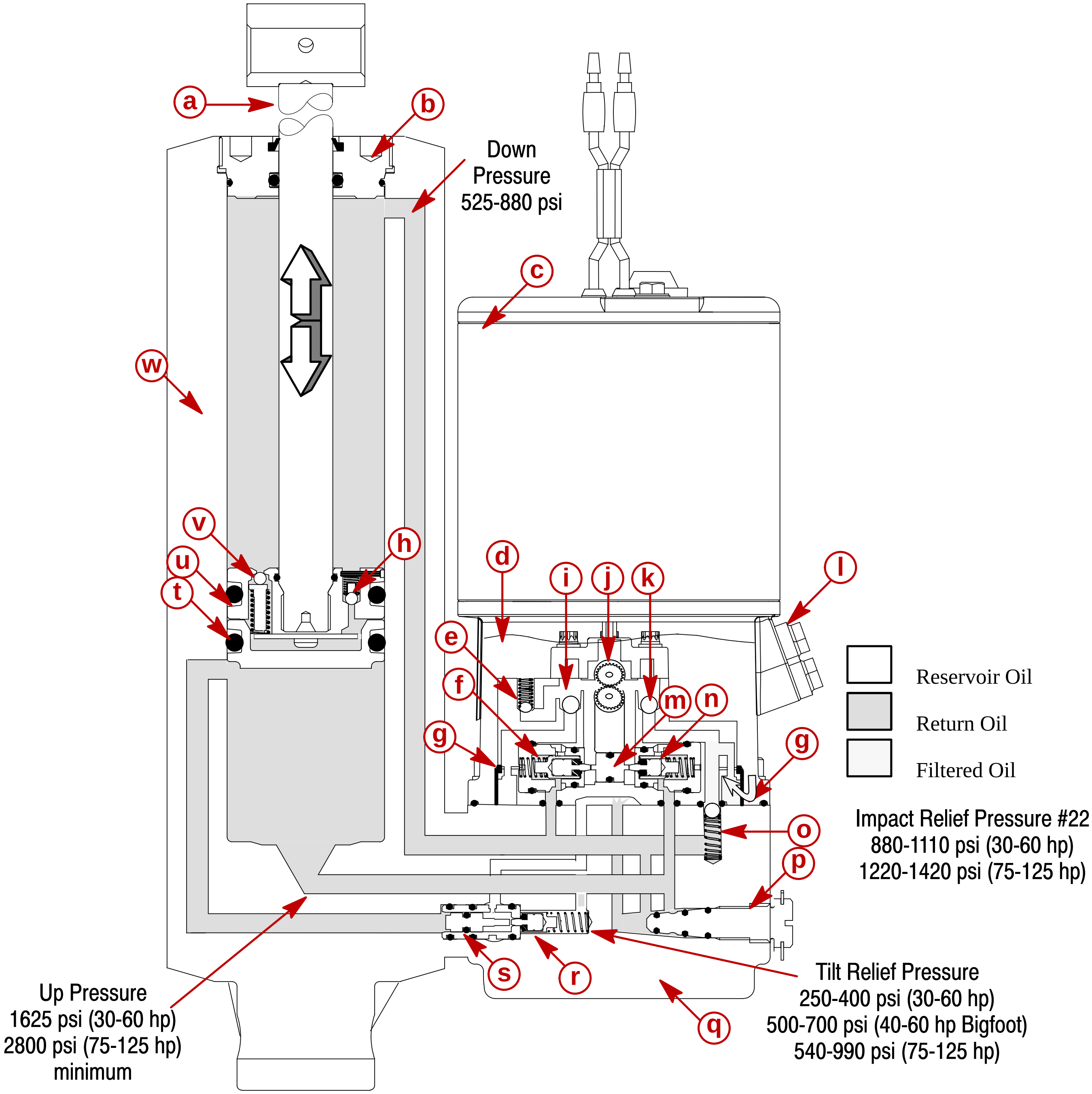


- **a** - Piston Rod
- **b** - End Cap
- **c** - Electric Motor
- **d** - Reservoir Oil
- **e** - Down Circuit Pressure Relief Valve
- **f** - Down Circuit Pressure Operated Valve
- **g** - Filter (2 shown for clarity)
- **h** - Shock Return Valve
- **i** - Up Circuit Suction Port
- **j** - Oil Pump
- **k** - Down Circuit Suction Port
- **l** - Oil Fill Cap
- **m** - Shuttle Valve
- **n** - Up Circuit Pressure Operated Valve
- **o** - Manifold Reverse Suction Valve
- **p** - Manual Release Valve
- **q** - Manifold
- **r** - Tilt Relief Valve
- **s** - Tilt Relief Piston
- **t** - Memory Piston
- **u** - Shock Piston
- **v** - Impact Relief Valve
- **w** - Cylinder

Shock Function Return

After the engine clears the under water object, the weight of the engine will increase the oil pressure between the memory piston (t) and shock piston (u) to the level required to open the shock return valve (h), inside the shock piston, allowing the oil to bleed back through the shock piston into the down cavity. If required, additional oil will enter the down cavity through the manifold reverse suction valve (o). This will return the engine back against the memory piston (t) and into the original running position.

Manual Release



- **a** - Piston Rod
- **b** - End Cap
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- **u** - Shock Piston
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- **w** - Cylinder

Manual Tilt

To manually tilt the outboard engine, the owner will need to back out the manual release valve (p) 3-4 turns. With the valve backed out, the internal passages inside the manifold are connected together. These passages connect both the cylinder down and up cavities together, along with the reservoir, allowing the engine to be raised or lowered. Piston rod (a) movement will continue until the manual release valve (p) is closed, locking the fluid inside of the cylinder and manifold.

Troubleshooting

Support outboard with tilt lock pin when servicing power trim system.

IMPORTANT: After debris or failed components have been found (during troubleshooting procedure), it is recommended that unit be disassembled completely and ALL O-rings be replaced. Check ball valve components and castings must be cleaned using engine cleaner and compressed air or replaced prior to re-assembly.

IMPORTANT: Power trim system is pressurized. Outboard must be in the full “UP” position (trim rod fully extended) prior to fill/drain plug, or manual release valve removal.

Refer to instructions following if disassembly is required when servicing.

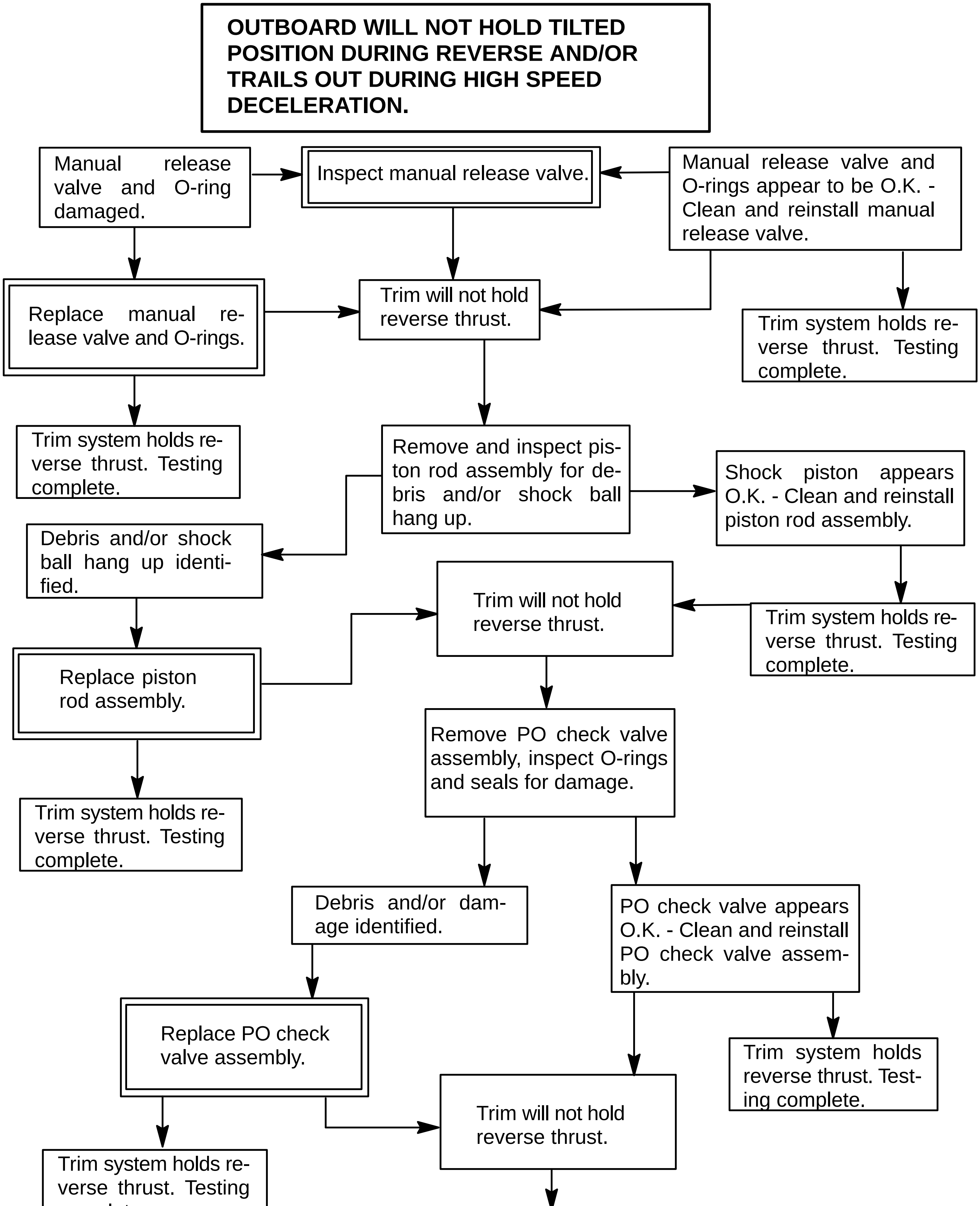
Follow preliminary checks before proceeding to troubleshooting flow diagrams (following).

Preliminary Checks

IMPORTANT: Operate Power Trim system after each check to see if problem has been corrected. If problem has not been corrected proceed to next check.

1. Check that manual release valve is tightened to full right (clockwise) position.
2. Check trim pump fluid level with outboard in full “UP” position and fill if necessary. Refer to “Bleeding Power Trim Unit”.
3. Check for external leaks in Power Trim system. Replace defective part(s) if leak is found.
4. Outboard not holding tilted position (falls down to trim position) indicates debris or defective components in trim assembly. Clean or replace components as required.

Hydraulic System Troubleshooting Flow Chart



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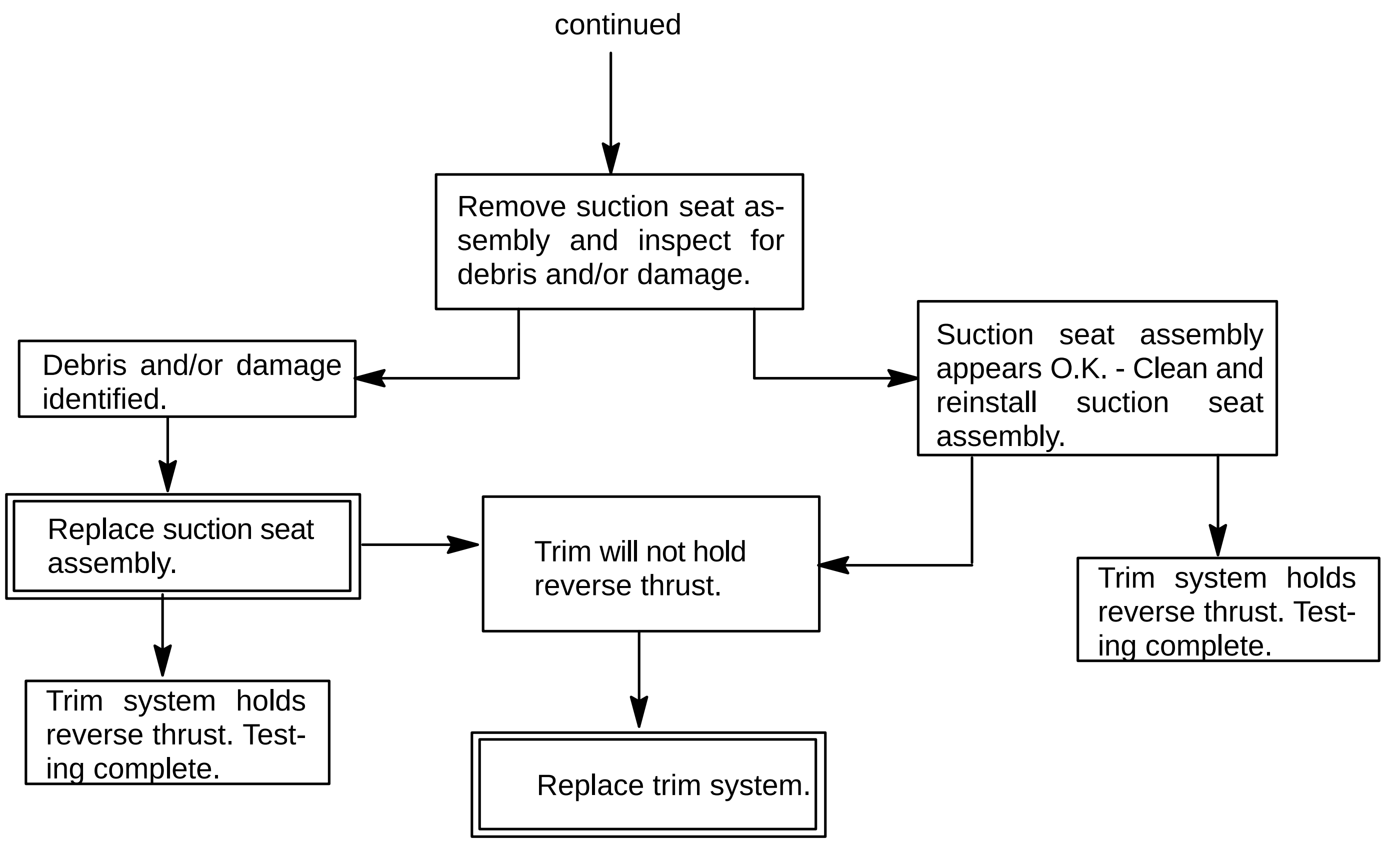
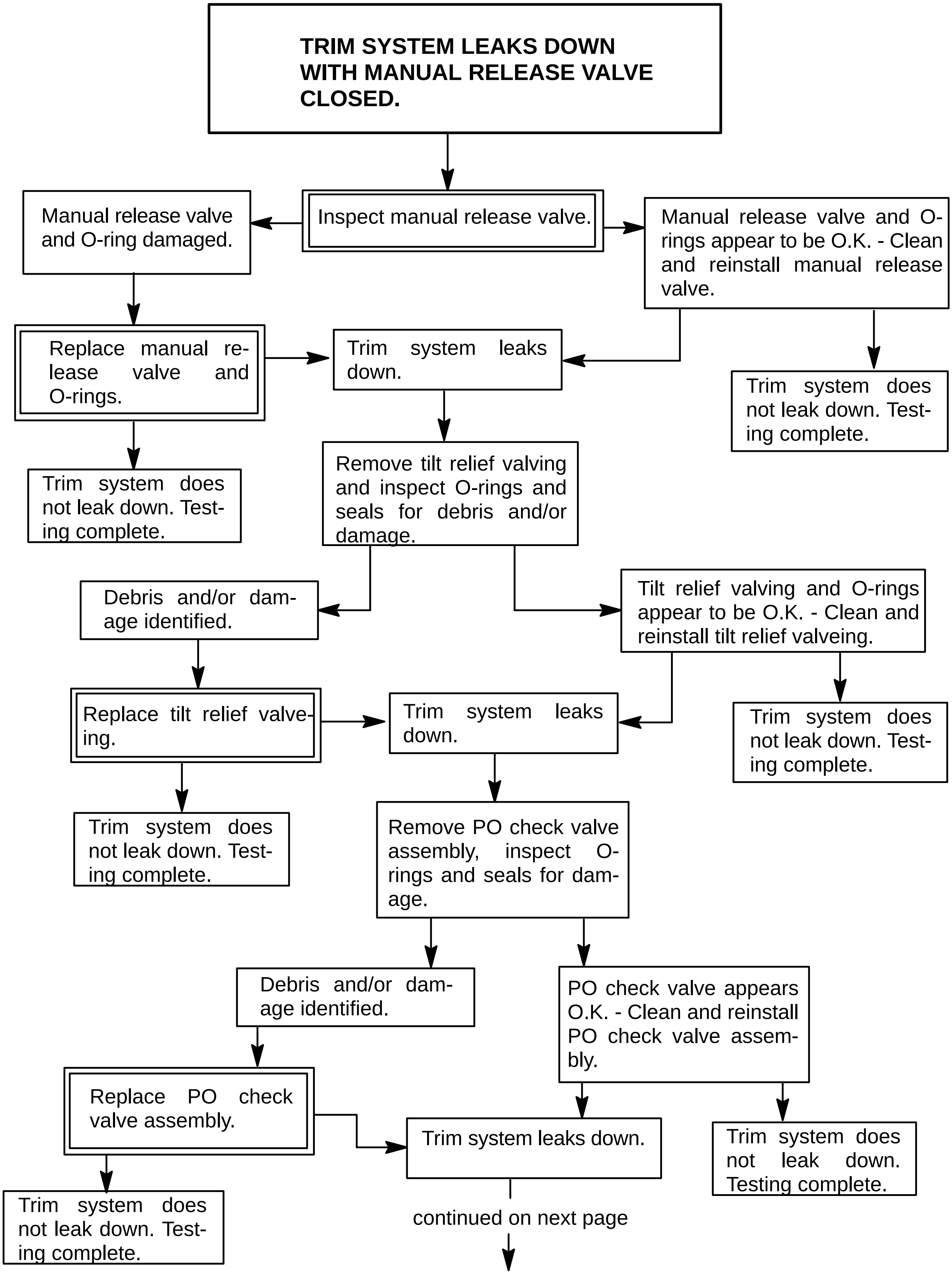
Hydraulic System Troubleshooting Flow Chart



Hydraulic System Troubleshooting Flow Chart



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Hydraulic System Troubleshooting Flow Chart

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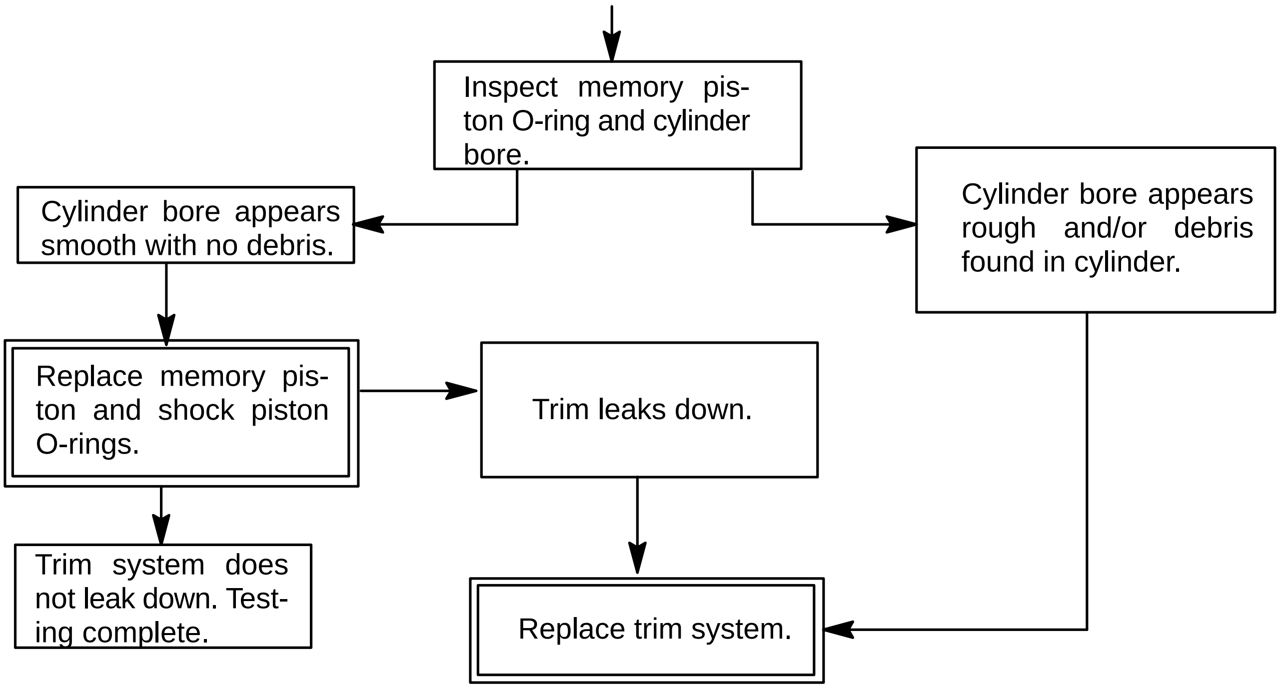
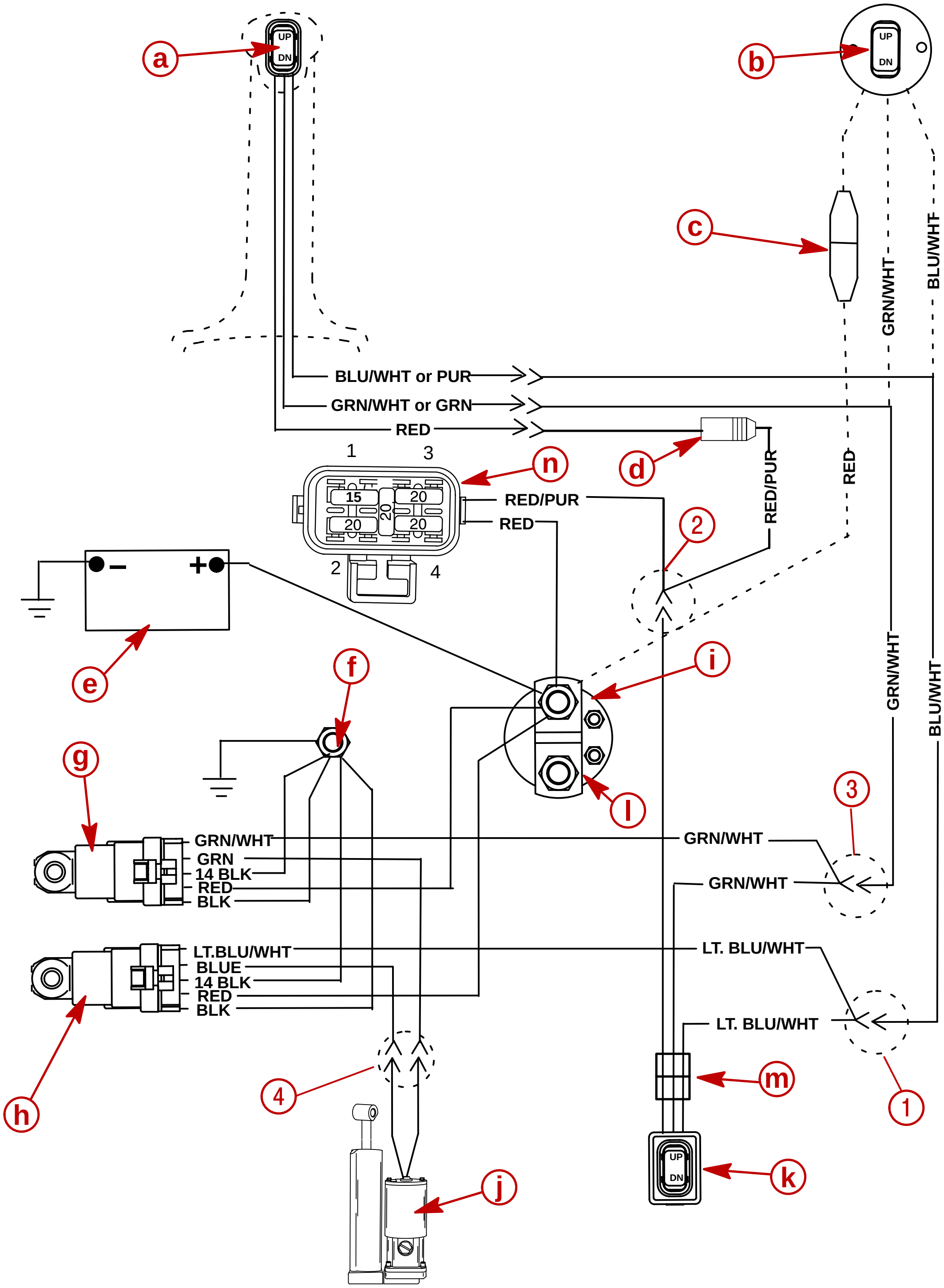


Troubleshooting the Power Trim Electrical System



a - Trim Switch (Remote Control Mounted)
b - Trim Switch (Panel Mounted)
c - Fuse Holder – Accessory
d - Remote Control Wiring Plug Connector
e - Battery
f - Starter Bolt
g - Down Relay
h - Up Relay
i - Solenoid
j - Trim Pump Motor
k - Cowl Switch
l - Solenoid
m - 3-Pin Connector
n - Main Fuse Holder - Fuse #3

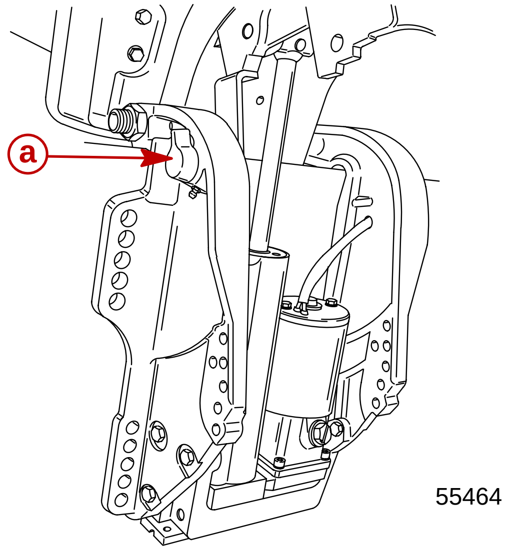
Troubleshooting the Power Trim Electrical System

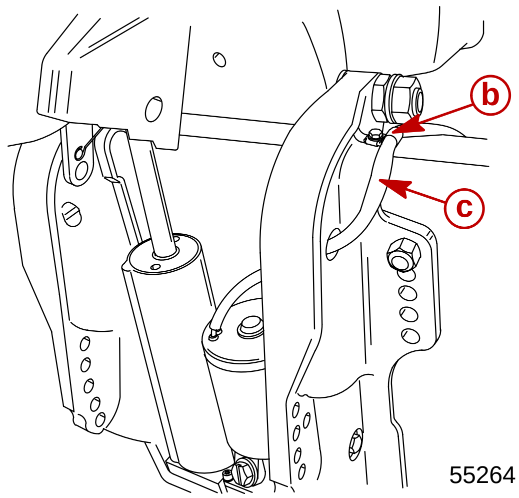
Refer to wiring diagram on preceding page for location of wire connections.

Problem	Possible Cause	Remedy
Trim Switch “UP” is inoperative, but the Cowl Switch “UP” does operate.	1. Open wire between Wire Connection (1) and Trim Switch. 2. Faulty Trim Switch.	1. Check for an open connection or cut wire. 2. Replace.
Cowl Switch “UP” is inoperative, but the Trim Switch “UP” does operate.	1. Open wire between Wire Connection (2) and Solenoid. 2. Faulty Cowl Switch.	1. Check for an open connection or cut wire. 2. Replace.
Trim Switch “UP” and Cowl Switch “UP” are both inoperative.	1. Open wire between Wire Connection (1) and the “Up” Relay. 2. Open BLK wire between ground and “UP” Relay. 3. Open RED wire between Solenoid and “UP” Relay. 4. Faulty “UP” Relay.	1. Check for an open connection. 2. Check for an open connection. 3. Check for an open connection. 4. Replace.
Trim Switch “DOWN” is inoperative, but the Cowl Switch “DOWN” does operate.	1. Open wire between Wire Connection (3) and Trim Switch. 2. Faulty Trim Switch.	1. Check for an open connection or cut wire. 2. Replace.
Cowl Switch “DOWN” is inoperative, but the Trim Switch “DOWN” does operate.	1. Open wire between Wire Connection (2) and Solenoid. 2. Faulty Cowl Switch.	1. Check for a open connection or cut wire. 2. Replace
Trim Switch “DOWN” and Cowl Switch “DOWN” are both inoperative.	1. Open wire between Wire Connection (3) and the “UP” Relay. 2. Open BLK wire between ground and “DOWN” Relay. 3. Open RED wire between Solenoid and “DOWN” Relay. 4. Faulty “DOWN” Relay	1. Check for an open connection. 2. Check for an open connection. 3. Check for an open connection. 4. Replace.
Trim Switch “UP” and “DOWN” are both inoperative, but the Cowl Switch does operate.	1. 20 AMP Fuse blown. 2. Faulty trim switch. 3. Wire is open between fuse holder and solenoid. 4. Wire is open between fuse holder and trim switch.	1. Replace fuse. Locate the cause of the blown fuse. Check electrical wiring for a shorted circuit. 2. Replace. 3. Check for a open connection or cut wire. 4. Check for a loose or corroded connection.
Trim Switch and Cowl Switch are both inoperative.	1. One of the Trim Pump Motor wires is open between the motor and the Relays. 2. Faulty trim pump motor.	1. Check wire connections (4) for loose or corroded condition. 2. If voltage is present at connections (4) when the appropriate trim button is pressed, then motor is faulty. Replace motor.
Trim system operates (motor runs) without pressing the switches.	1. The Trim or Cowl switch is shorted.	1. Replace.

Power Trim System Removal

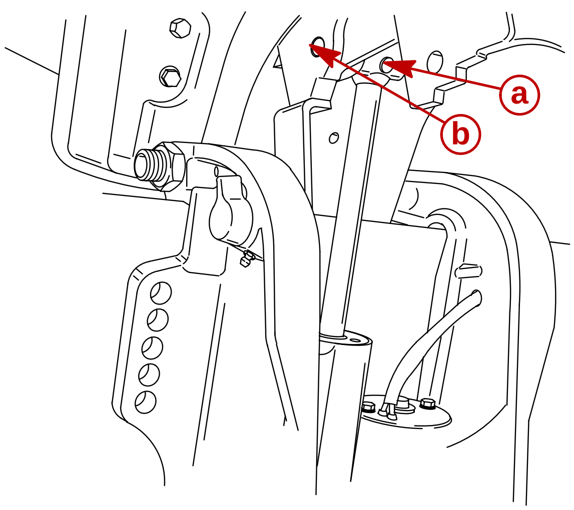
1. Tilt outboard to the full up position and support with tilt lock pin.
2. Disconnect the power trim wire harness and remove clamp.

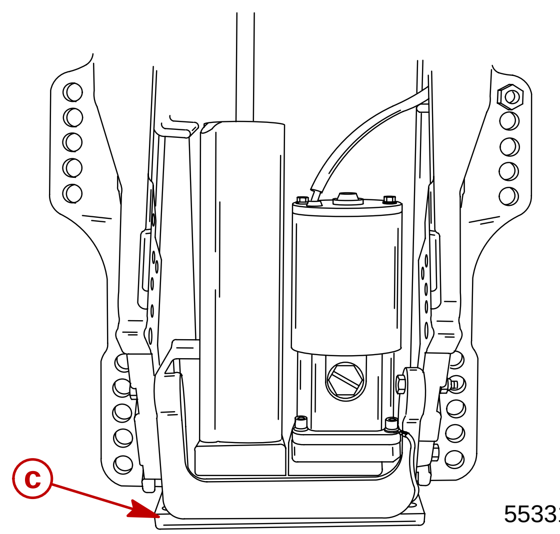




a - Tilt Lock Pin
b - Power Trim Wire Harness Clamp
c - Harness

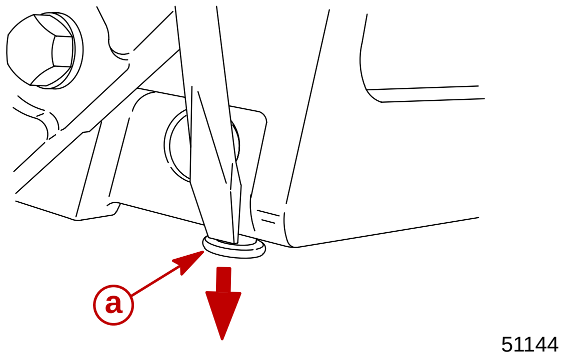
3. Remove the trilobe pin.
4. Drive out the upper pivot pin.
5. Remove the sacrificial anode.

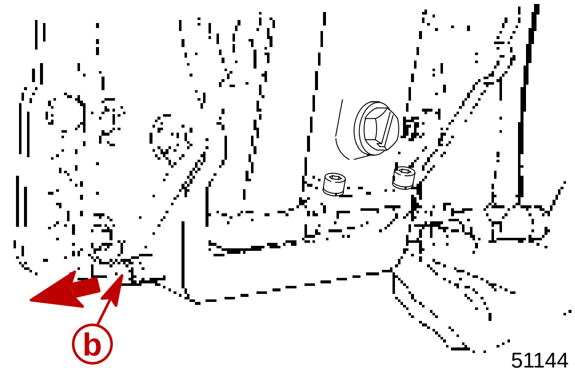




a - Trilobe Pin
b - Upper Pivot Pin
c - Sacrificial Anode

6. Use suitable punch to remove (Drive Down) lower pin. Retain dowel pin.
7. Use suitable punch to drive out lower pivot pin.



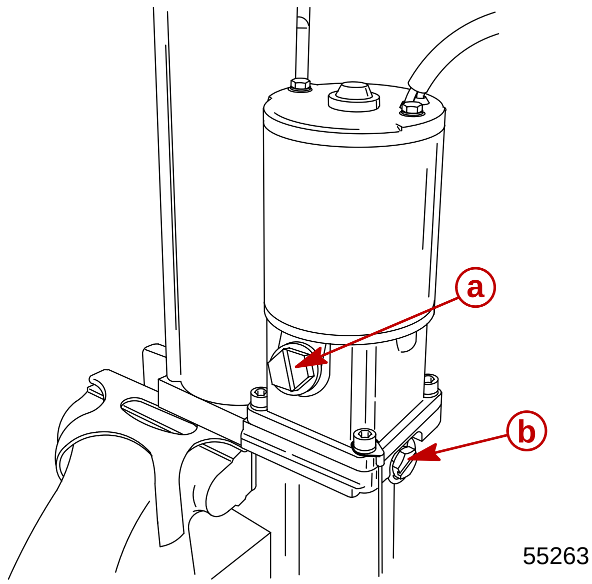


a - Dowel Pin
b - Lower Pivot Pin

Power Trim Disassembly

IMPORTANT: Power trim system is pressurized. Trim rod must be in the full "UP" position (fully extended) prior to fill/drain plug, or manual release valve removal.

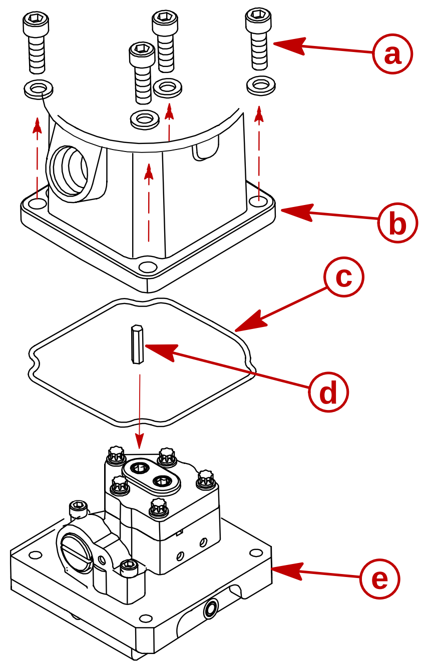
1. Remove reservoir cap.
2. Remove manual release valve assembly to drain oil.



a - Reservoir Cap
b - Manual Release Valve

Trim Motor Removal

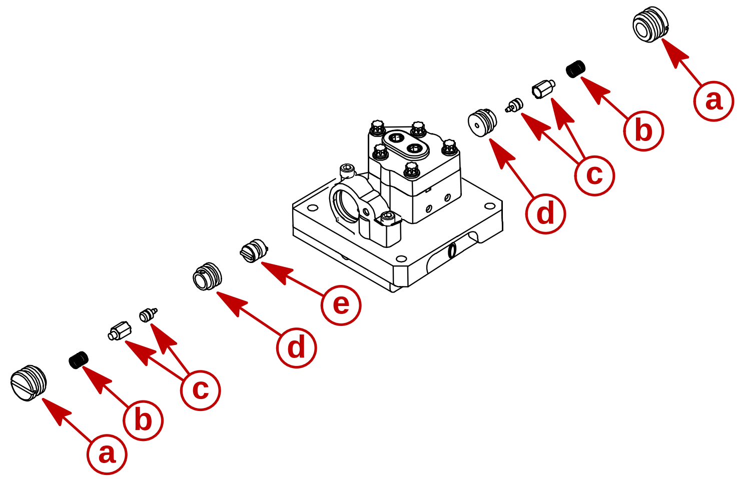
1. Secure power trim assembly in a soft jaw vise.
2. Remove four (4) screws to remove motor/reservoir. Remove reservoir seal and coupler.



a - Screw (4)
b - Reservoir
c - Reservoir Seal
d - Coupler
e - Manifold Assembly

Pump and Components Removal

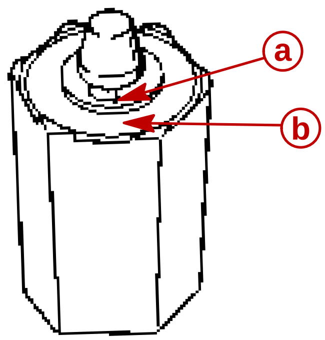
1. Remove pressure operated plugs on pump. Remove spring and check valve/poppet (both sides). Use special tool CG 41-11 and special tool CG 41-14 with 5/16″ end to remove spool.

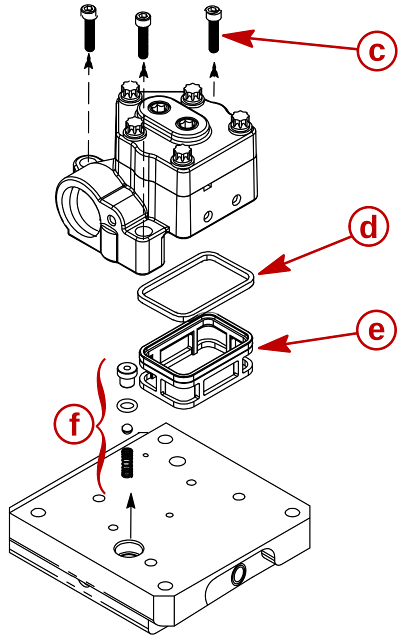


a - Plug (2)
b - Spring (2)
c - Check Valve/Poppet (2)
d - Seat (2)
e - Spool

IMPORTANT: Inspect poppet assembly for debris in the area shown. If debris is found on poppet replace poppet.

2. Remove three (3) screws to remove pump. Remove filter and filter seal under pump. Remove suction seat assembly.

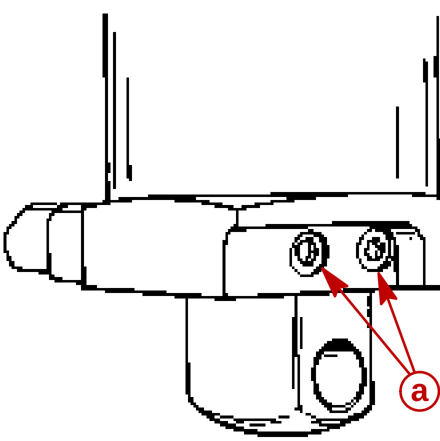




- **a** - Debris Under Valve Tip
- **b** - Rubber Seat
- **c** - Screw (3)
- **d** - Filter Seal
- **e** - Filter
- **f** - Suction Seat Assembly

Manifold Removal

1. Remove two (2) screws to remove manifold from cylinder.
2. Remove tilt relief components.



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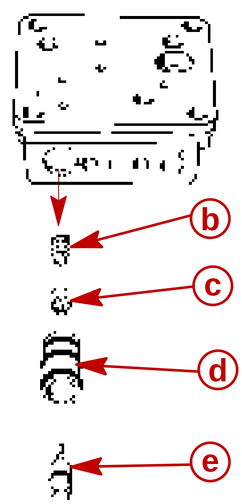

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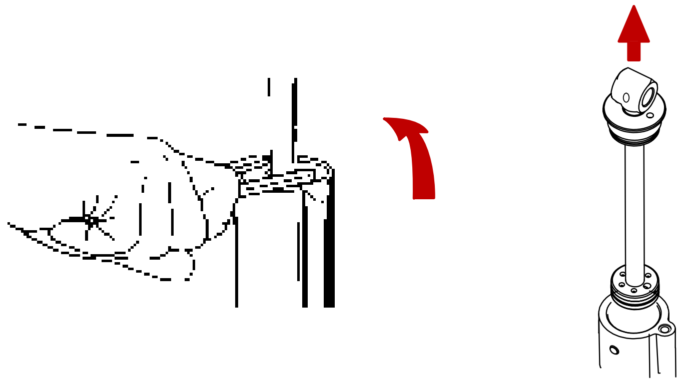
- **a** - Screw (2)
- **b** - Spring
- **c** - Poppet
- **d** - Spool Housing
- **e** - Trim Limit Spool

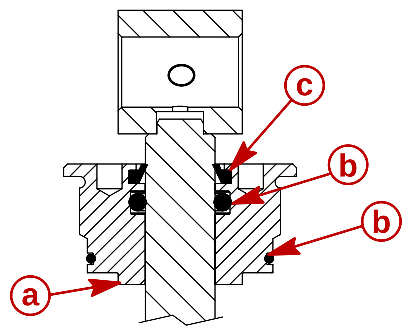
Shock Rod Removal

1. Unscrew end cap assembly from cylinder using spanner wrench [1/4 in. x 5/16 in. (6.4mm x 8mm) long pegs].
2. Remove shock rod assembly from cylinder.



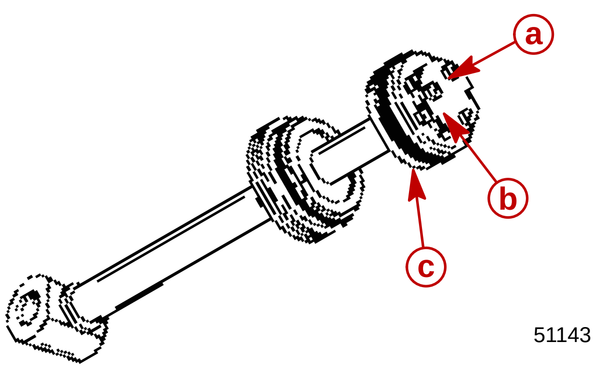
Shock Rod Disassembly

NOTE: *The only serviceable items on the shock rod assembly are the O-rings and wiper ring. If shock rod requires any other repair, replace shock rod assembly.*



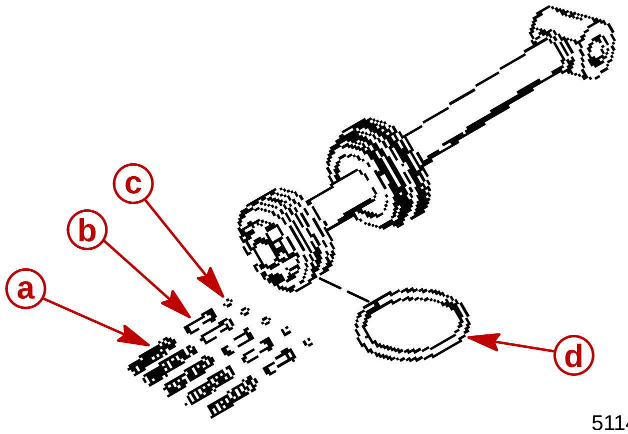
a - End Cap
b - O-ring (2)
c - Wiper Ring

1. Place shock rod assembly on clean work surface.
2. Remove three (3) screws and remove plate from shock rod piston.



a - Screw (3)
b - Plate
c - Shock Rod Piston

3. Remove check ball components from shock rod piston.
4. Remove o-ring from shock rod piston.

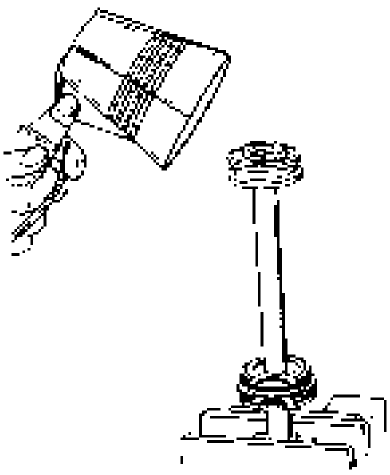


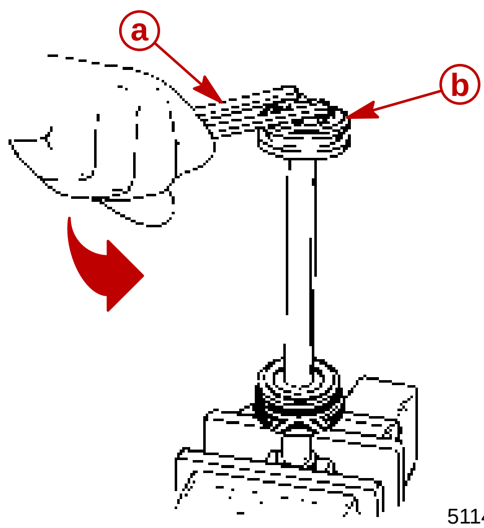
a - Spring (5)
b - Seat (5)
c - Ball (5)
d - O-ring

CAUTION

When removing shock piston, spanner wrench must have 1/4 in. x 5/16 in. long pegs to avoid damage to shock piston.

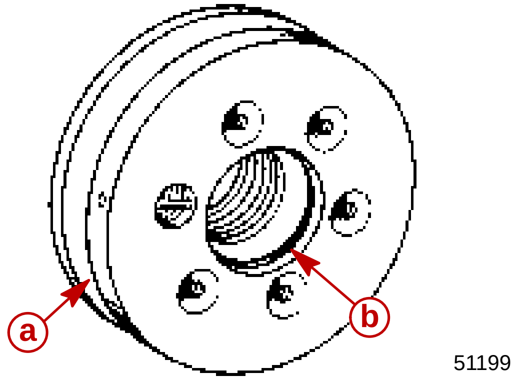
5. Place shock rod into soft jawed vise and apply heat to loosen piston using torch lamp (P/N 91-63209).
6. Loosen shock rod piston using spanner wrench [1/4 in. x 5/16 in. (6.4mm x 8mm) long pegs].
7. Allow shock rod piston to cool. Remove from shock rod.





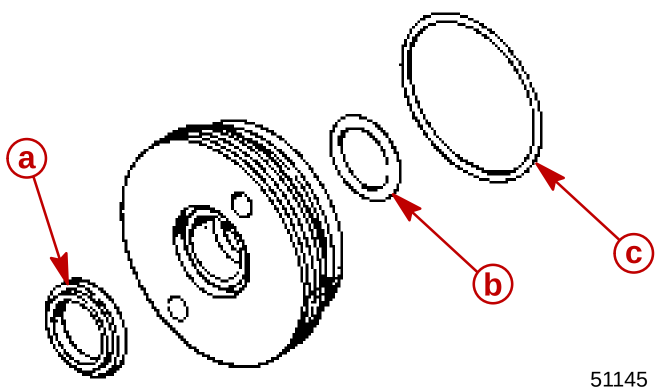
a - Spanner Wrench
b - Shock Rod Piston

8. Inspect check valve for debris; clean debris from check valve if found. If debris cannot be cleaned from check valve, replace shock piston as an assembly.
9. Clean shock and components with compressed air.
10. Remove inner o-ring from shock rod piston.



a - Shock Piston
b - O-ring

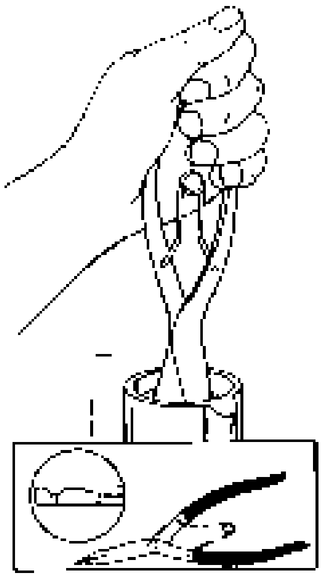
11. Remove cylinder end cap assembly from shock rod.
12. Inspect shock. If wiper (located in cap) has failed to keep rod clean, replace wiper.
13. Place end cap on clean work surface.
14. Remove rod wiper, inner o-ring, and outer o-ring.



a - Rod Wiper
b - Inner O-ring
c - Outer O-ring

Memory Piston Removal

1. Remove memory piston from cylinder using one of two methods:
   a. Using lock ring pliers (P/N 91-822778A3) or suitable tool.



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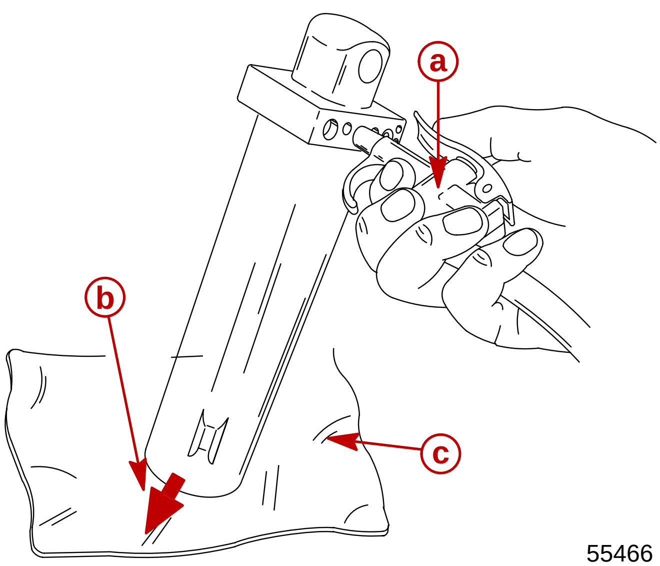
   b. Blowing compressed air into manual release valve hole using air nozzle.

⚠ WARNING

Memory piston cup may be expelled at a high velocity when air pressure is applied. Failure to place cylinder as shown below could result in personal injury.

NOTE: *Point cylinder opening down and away. Use a shop rag or towel to avoid damage to the memory piston.*

2. Remove o-ring from memory piston.



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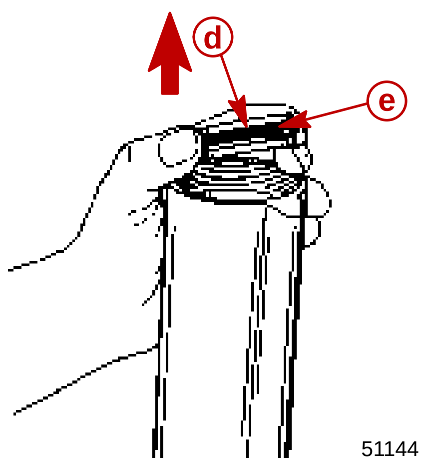

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a - Adaptor/Air Hose
b - Memory Piston Exit
c - Shop Rag
d - O-Ring
e - Memory Piston

Cleaning/Inspection/Repair

IMPORTANT: Components must be dirt and lint free. Slightest amount of debris in Power Trim system could cause system to malfunction.

Clean shock rod and components with parts cleaner and dry with compressed air.

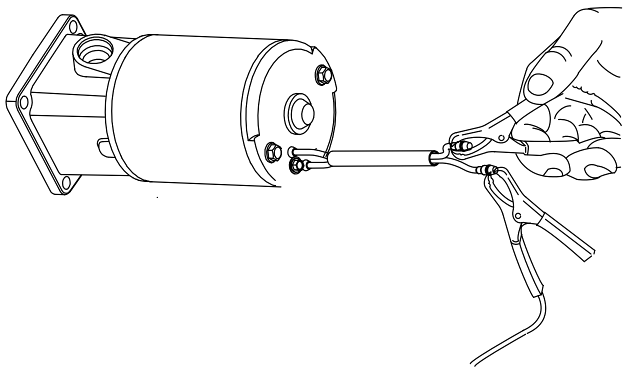
It is recommended that all O-rings in trim system be replaced. Use O-Ring Kit 25-809880A1.

Lubricate all o-rings with Quicksilver Power Trim Fluid (92-90100A12). If not available, use automotive (ATF) automatic transmission fluid.

Trim Motor Electrical Tests

1. Connect a 12 volt supply to motor leads. If motor fails to run, replace pump motor.

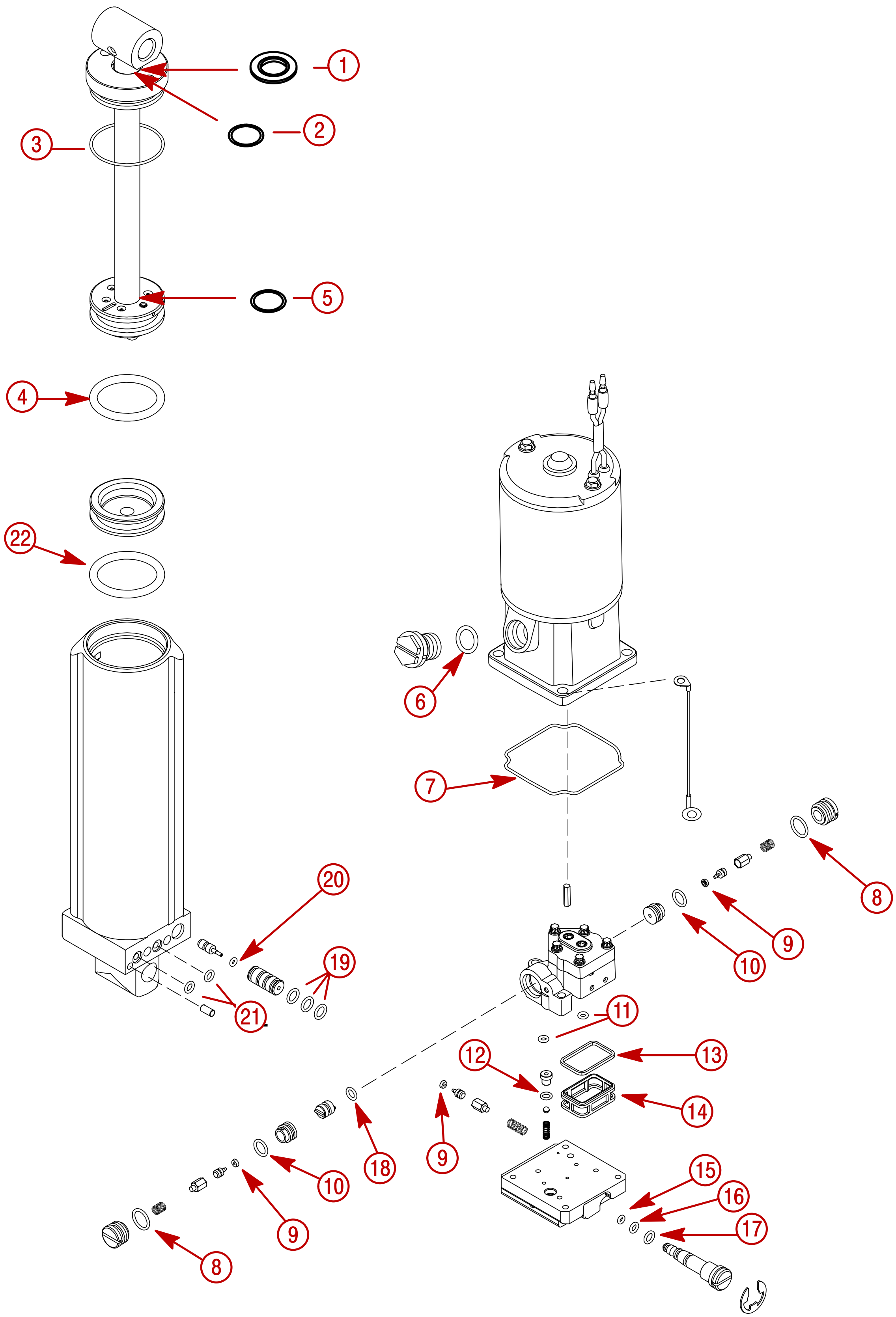
IMPORTANT: Trim Motor is not serviceable. If motor fails to run, replace motor assembly.



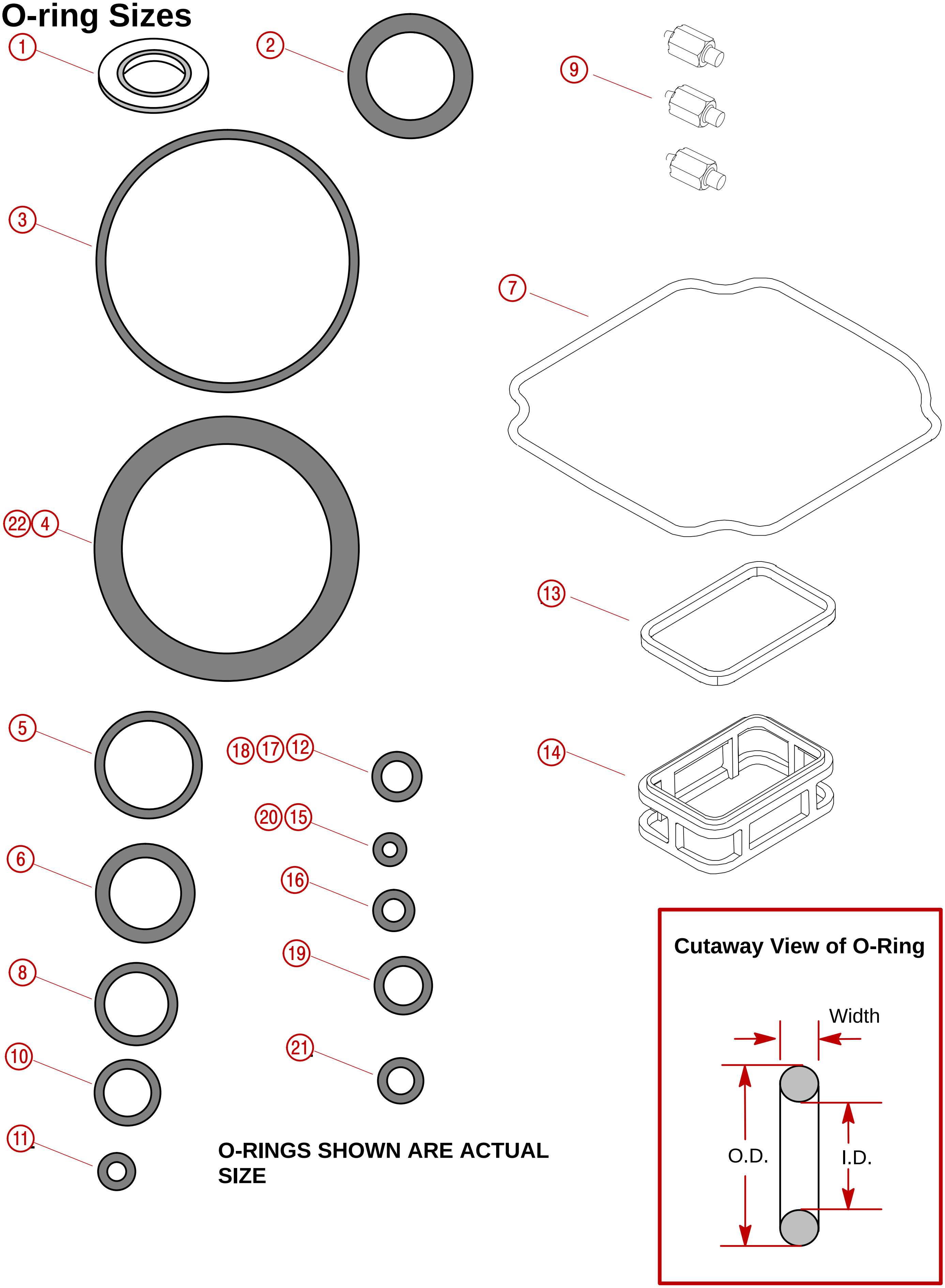
Reassembly

O-Ring and Seal Placement

O-Rings and Seals are part of O-Ring Kit 25-809880A1.



O-ring Sizes



O-RINGS SHOWN ARE ACTUAL SIZE

Cutaway View of O-Ring

O-ring Description and Sizes

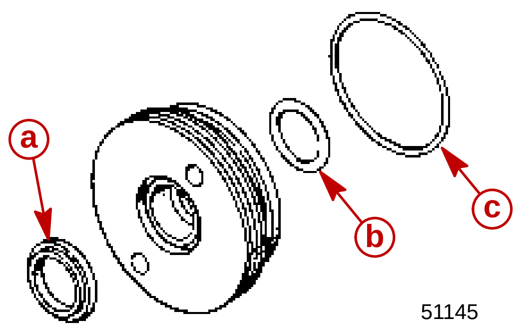
O-Ring	Description	O-Ring I.D.	O-Ring O.D.	O-Ring Width
1	Wiper Ring			
2	Cyl. Cap, Inner	0.671 in. (17.04 mm)	0.949 in. (24.10 mm)	0.139 in. (3.53 mm)
3	Cyl. Cap	1.864 in. (47.34 mm)	2.004 in. (50.90 mm)	0.07 in. (1.78 mm)
4	Shock Piston	1.6 in. (40.64 mm)	2.02 in. (53.086 mm)	0.21 in. (5.334 mm)
5	Piston Bolt	0.676 in. (17.17 mm)	.816 in. (20.726 mm)	0.07 in. (1.78 mm)
6	Reservoir Plug	0.549 in. (13.94 mm)	0.755 in. (19.17 mm)	0.103 in. (2.616 mm)
7	Motor Seal			
8 (2)	P.O. Check Plug	0.489 in. (12.42 mm)	0.629 in. (15.97 mm)	0.07 in. (1.78 mm)
9 (3)	Poppet Assy.			
10 (2)	P.O. Check Seat	0.364 in. (9.25 mm)	0.504 in. (12.80 mm)	0.07 in. (1.78 mm)
11 (2)	Pump Port	0.145 in. (3.683 mm)	0.285 in. (7.239 mm)	0.07 in. (1.78 mm)
12	Suction Seat	0.239 in. (6.07 mm)	0.379 in. (9.626 mm)	0.07 in. (1.78 mm)
13	Filter Seal			
14	Filter			
15	Manual Release	0.114 in. (2.90 mm)	0.254 in. (6.451 mm)	0.07 in. (1.78 mm)
16	Manual Release	0.176 in. (4.47 mm)	0.316 in. (8.026 mm)	0.07 in. (1.78 mm)
17	Manual Release	0.239 in. (6.07 mm)	0.379 in. (9.626 mm)	0.07 in. (1.78 mm)
18	Spool	0.239 in. (6.07 mm)	0.379 in. (9.626 mm)	0.07 in. (1.78 mm)
19 (3)	Spool Housing	0.301 in. (7.645 mm)	0.441 in. (11.20 mm)	0.07 in. (1.78 mm)
20	Trim Limit Spool	0.114 in. (2.895 mm)	0.254 in. (6.451 mm)	0.07 in. (1.78 mm)
21 (2)	Manifold	0.208 in. (5.283 mm)	0.348 in. (8.839 mm)	0.07 in. (1.78 mm)
22	Memory Piston	1.6 in. (40.64 mm)	2.02 in. (53.086 mm)	0.21 in. (5.334 mm)

Power Trim Reassembly

IMPORTANT: Lubricate all o-rings with Quicksilver Power Trim Fluid (92-90100A12). If not available, use automotive (ATF) automatic transmission fluid.

Shock Rod Reassembly

1. Install lubricated o-rings to end cap.
2. Install rod wiper.
3. Install lubricated o-rings to shock piston.



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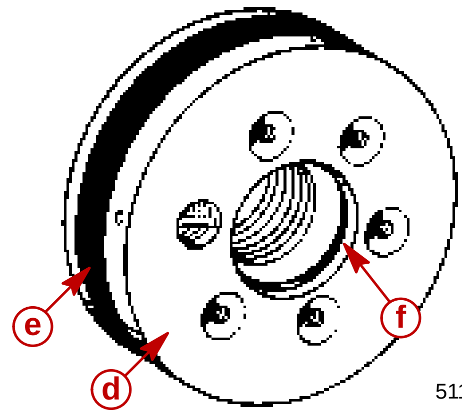

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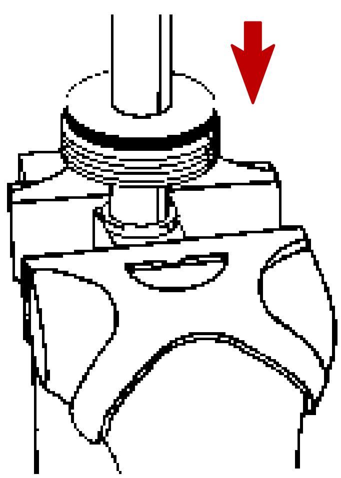
a - Rod Wiper
b - Inner O-ring
c - Outer O-ring
d - Shock Piston
e - O-ring
f - O-ring

4. Clamp shock rod in soft jawed vise.
5. Position cylinder end cap onto rod as shown.



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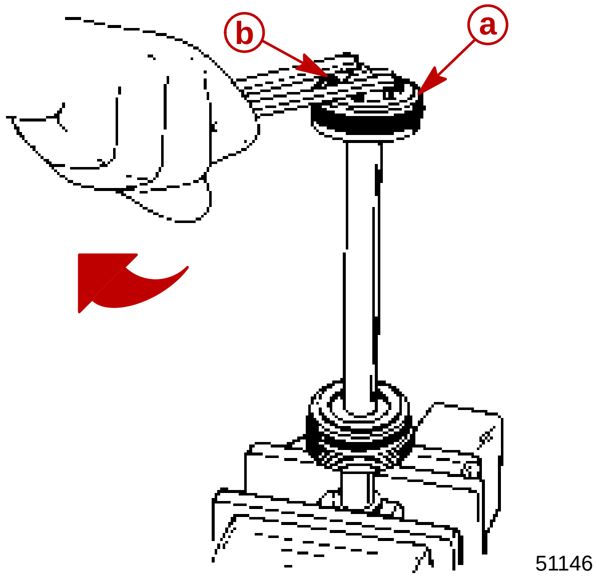
⚠ CAUTION

When installing shock rod piston, spanner wrench must have 1/4 in. x 5/16 in. (6.4mm x 8mm) long pegs to avoid damage to shock rod piston.

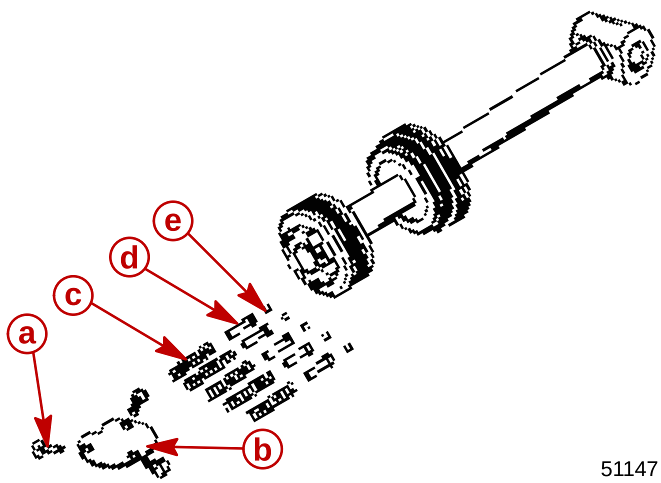
6. Apply Loctite Grade "A" (271) to threads on shock rod.
7. Install shock rod piston.

8. Tighten shock rod piston securely using spanner wrench (1/4 in. x 5/16 in. long pegs). If a torquing type spanner tool is used to tighten shock piston, then torque to 90 lb-ft (122 Nm).



a - Shock Rod Piston - Torque to 90 lb-ft (122 Nm)
b - Spanner Wrench

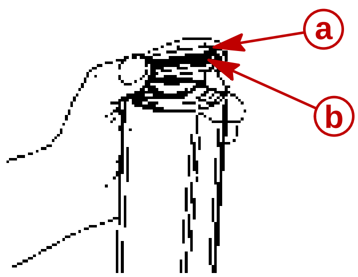
9. Remove shock rod assembly from vise.
10. Install ball, seat, and spring (five sets) to shock rod piston.
11. Secure components with plate. Torque screws to 35 lb-in. (4.0 Nm).

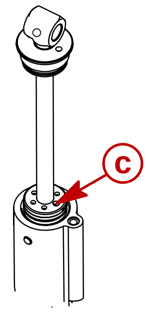


a - Screw (3) Torque to 35 lb-in. (4.0 Nm)
b - Plate
c - Spring (5)
d - Seat (5)
e - Ball (5)

Shock Rod Installation

1. Place trim cylinder in soft jawed vice.
2. Install lubricated o-ring to memory piston and place into cylinder. Push memory piston all the way to bottom.
3. Fill cylinder three inches (76.2 mm) from top of cylinder using Quicksilver Power Trim and Steering Fluid. If not available, use automotive (ATF) automatic transmission fluid.
4. Install shock rod into cylinder until power trim fluid flows through oil blow off ball passage. Fill remaining cylinder to just below the cylinder threads.



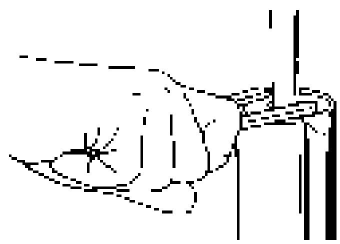


a - Memory Piston
b - O-ring
c - Oil Blow Off Ball Passage

⚠ CAUTION

End cap must not make contact with shock rod piston when tightening. Shock rod piston must be positioned in cylinder deep enough to avoid contact.

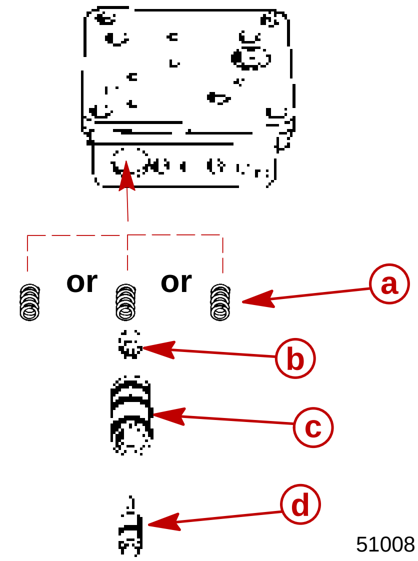
5. Tighten end cap securely using spanner wrench [1/4 in. x 5/16 in. (6.4mm x 8mm) long pegs]. If a torquing type spanner tool is used to tighten end cap, then torque to 45 lb-ft (61.0 Nm).



Trim Limit Assembly Installation

1. Lubricate all O-rings. Install spring, poppet, spool housing and trim limit spool into manifold.

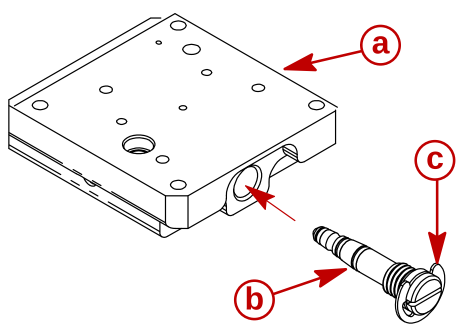
NOTE: *There are three different size springs used in this manifold. The heavy spring is used on 75-125 hp outboards. The medium spring is used on 40-60 hp Bigfoot outboards. The light spring is used on 30-60 hp outboards.*



a - Spring
b - Poppet
c - Spool Housing
d - Trim Limit Spool

Manual Release Valve Installation

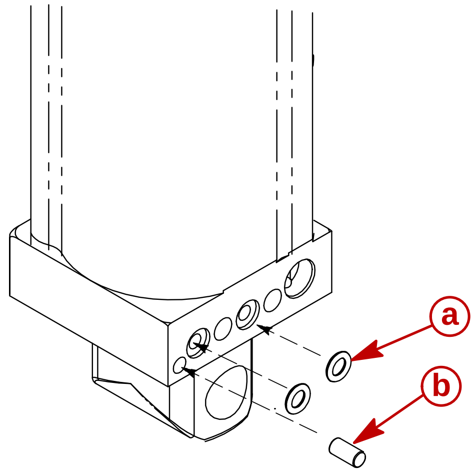
1. Install “E” clip (if removed) and lubricate o-rings to manual release valve.
2. Install manual release valve assembly into manifold.



a - Manifold
b - Manual Release Valve
c - E Clip

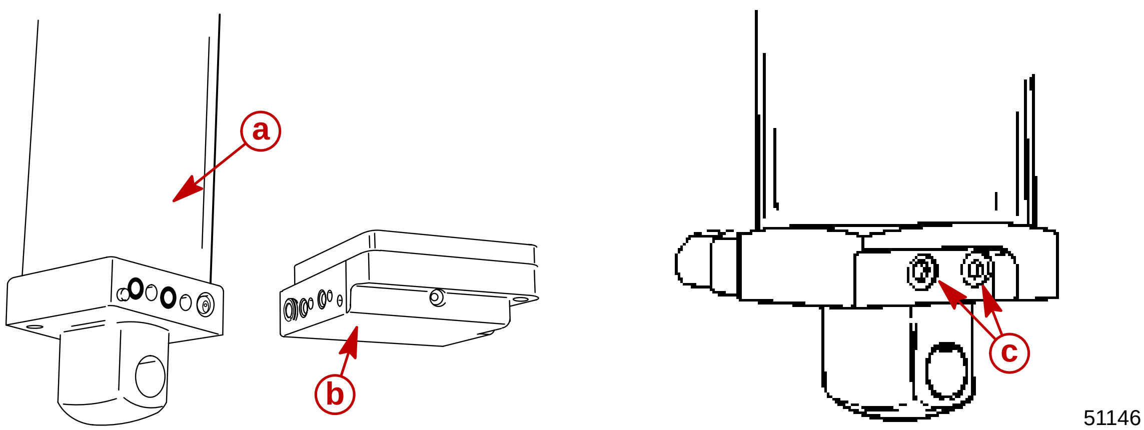
Manifold Installation

1. Install dowel pin and two (2) lubricated o-rings into trim cylinder.



a - O-Ring (2)
b - Dowel Pin

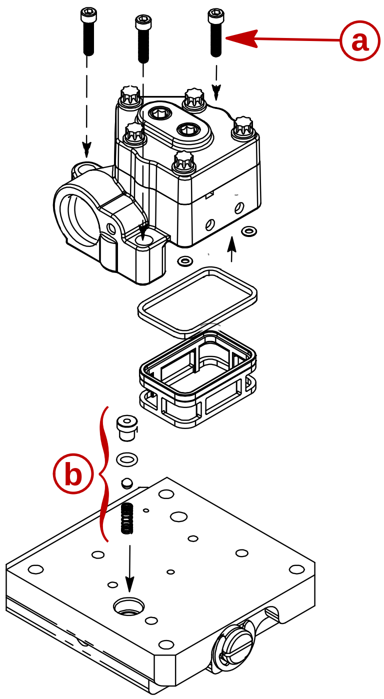
2. Align the trim cylinder and pump/reservoir assembly together.
3. Install the two (2) long screws and torque to 100 lb-in. (11 Nm).



a - Trim Cylinder Assembly
b - Reservoir/Manifold Assembly
c - Screw (2) Torque to 100 lb-in. (11 Nm)

Oil Pump Installation

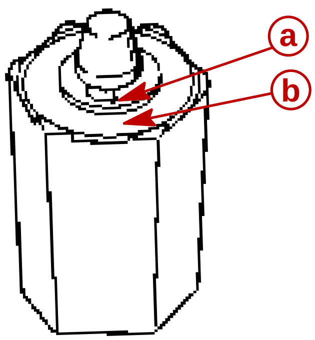
1. Install spring, ball, lubricated o-ring and plastic seat to manifold.
2. Check to see that o-rings are placed on bottom of pump.
3. Install filter and filter seal under pump. Install pump onto manifold. Torque screws to 70 lb-in. (7.7 Nm).



a - Screw (3) Torque to 70 lb-in. (7.7 Nm)
b - Suction Seat Assembly

Pressure Operated Assembly Installation

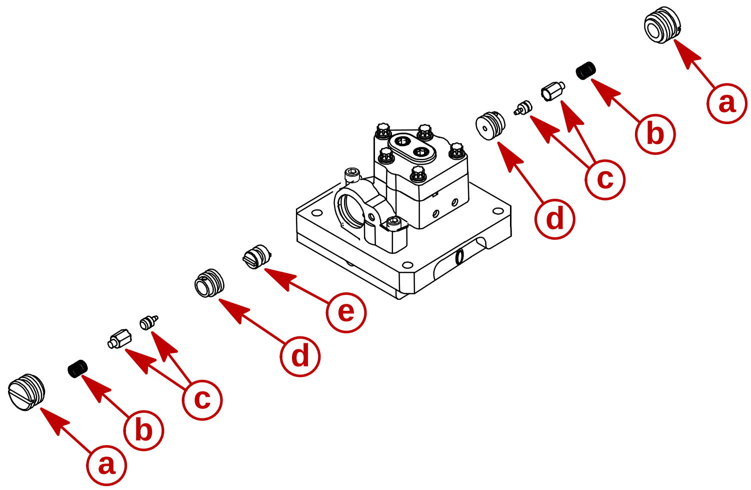
IMPORTANT: Inspect poppet assembly for debris in the area shown. If debris is found on poppet, replace poppet.



a - Debris Under Valve Tip
b - Rubber Seat

1. Lubricate o-rings.

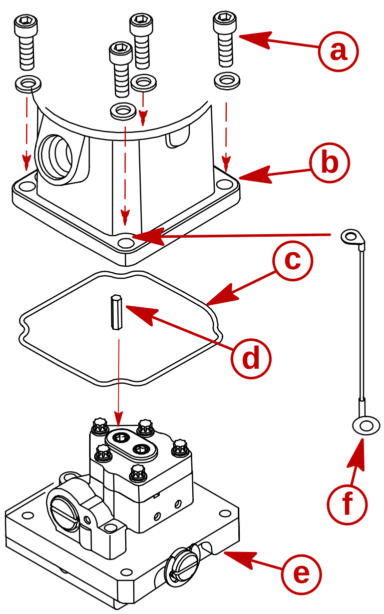
2. Install spool, seat with o-ring, check valve/poppet, spring and plug with o-ring into pump. Repeat for other side. Torque plugs to 120 lb-in. (13.5 Nm).



a - Plug (2) Torque to 120 lb-in. (13.5 Nm)
b - Spring (2)
c - Check Valve/Poppet (2)
d - Seat (2)
e - Spool

Reservoir/Motor Installation

1. Install coupler into top of pump. Make sure reservoir seal is in the reservoir groove and place reservoir onto pump/manifold assembly. Install ground strap under screw shown Torque screws to 80 lb-in. (9 Nm).

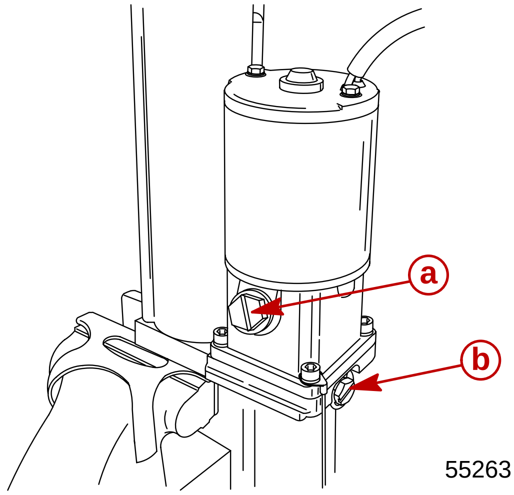


a - Screw (4) Torque to 80 lb-in. (9 Nm)
b - Reservoir
c - Reservoir Seal
d - Coupler
e - Manifold Assembly
f - Ground Strap

2. Fill reservoir to bottom of fill hole using Quicksilver Power Trim Fluid (92-90100A12). If not available, use automotive (ATF) automatic transmission fluid.

Bleeding Power Trim Unit

1. Secure power trim unit in soft jawed vise.
2. Add power trim fluid until it's even with the bottom of the fill hole. Reinstall plug.
3. Close the manual release valve. (Turn full clockwise).

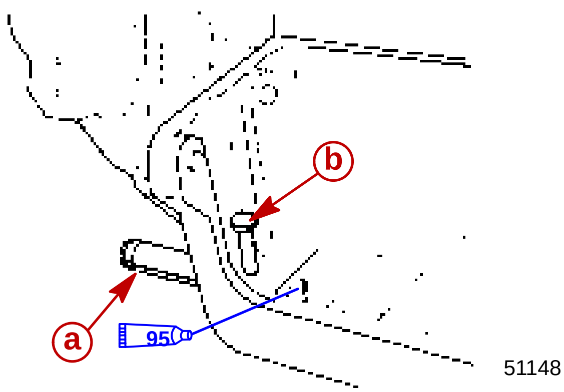


a - Reservoir Plug/Fill Hole
b - Manual Release Valve

4. Using a 12 volt power supply, connect the positive lead to (blue) trim motor wire and negative lead to (green) trim motor wire and drive shock rod to the up position. Repeat three times.
5. Connect the positive lead to the (green) trim motor wire, and the negative lead to the (blue) trim motor wire and drive the shock rod to the down position.
6. Recheck fluid level, add fluid if required and repeat cycle until fluid level stays even with the bottom of the fill hole.

Installation of Power Trim System

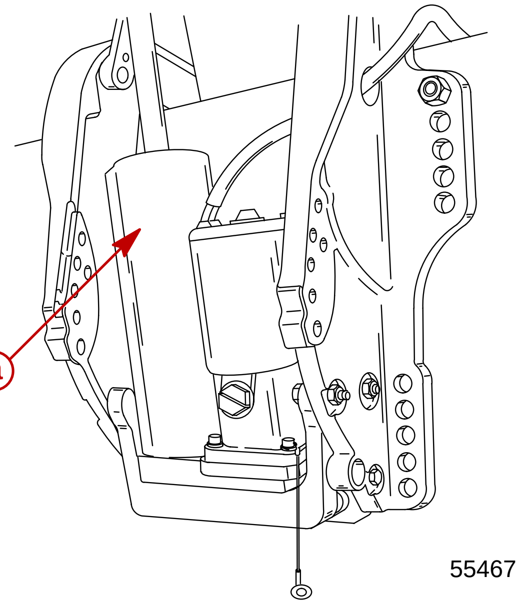
1. Lubricate lower pivot pin, mounting holes with 2-4-C Marine Lubricant.
2. Start lower pivot pin into pivot pin bore and position lower dowel pin (retained) in its respective hole.

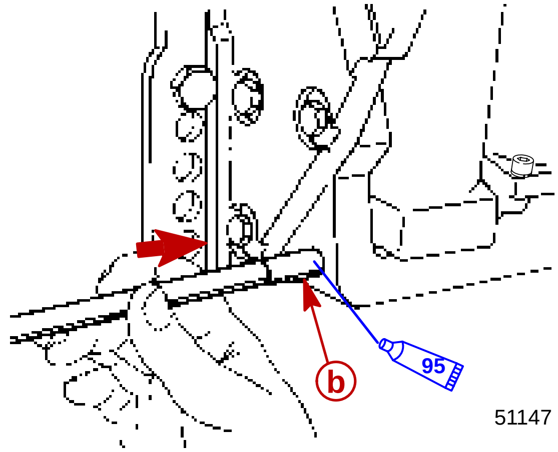


95 2-4-C w/Teflon (92-850736A1)

a - Lower Pivot Pin
b - Lower Dowel Pin

3. Position trim cylinder assembly (bottom first) between clamp brackets.
4. Apply 2-4-C Marine Lubricant to lower pivot pin. Using a suitable punch, drive lower pivot pin into clamp bracket and trim cylinder assembly until pivot pin is flush with outside surface.

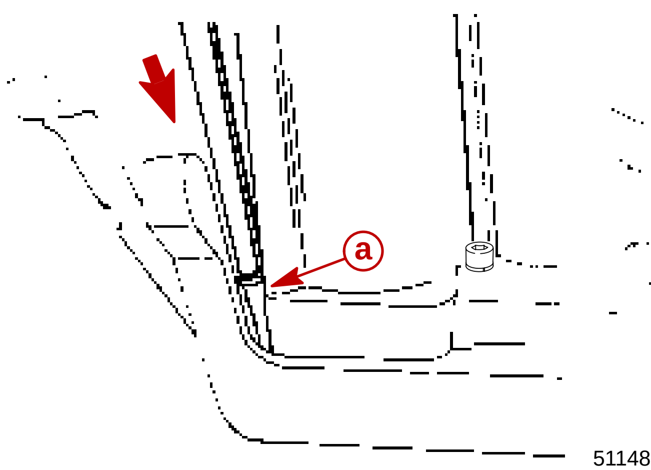


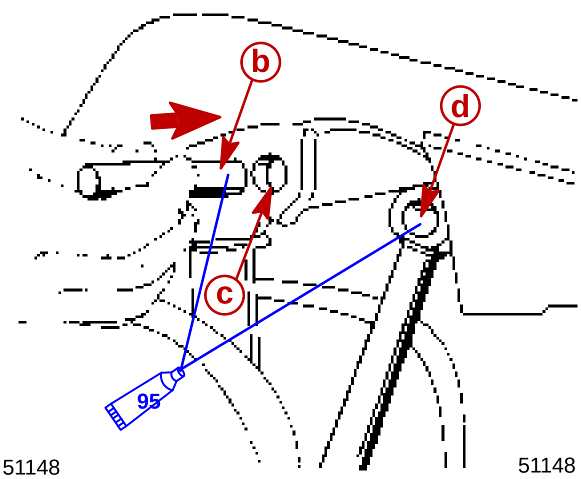


95 2-4-C w/Teflon (92-850736A1)

a - Trim Cylinder Assembly
b - Lower Pivot Pin

5. Using a suitable punch, drive lower dowel pin into its hole until seated.
6. Apply 2-4-C Marine Lubricant to surface of upper pivot pin, pivot pin bore and trim ram bore.

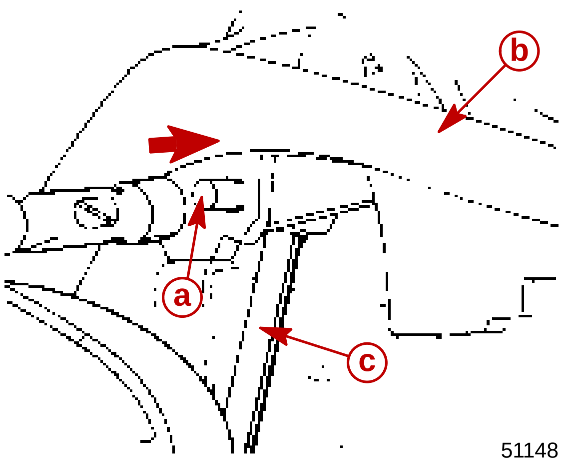


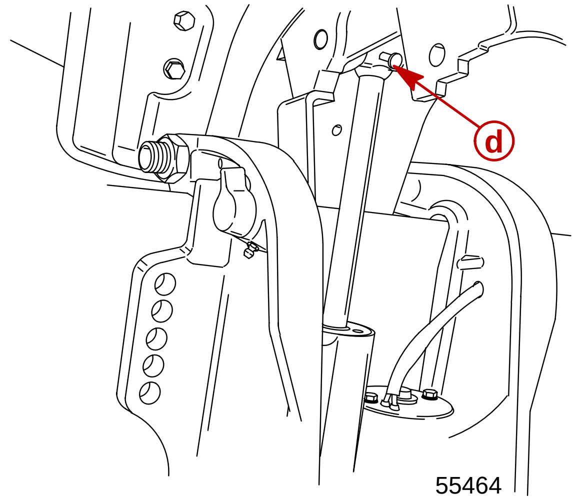


95 2-4-C w/Teflon (92-850736A1)

a - Lower Dowel Pin
b - Pivot Pin
c - Pivot Pin Bore
d - Trim Ram Bore

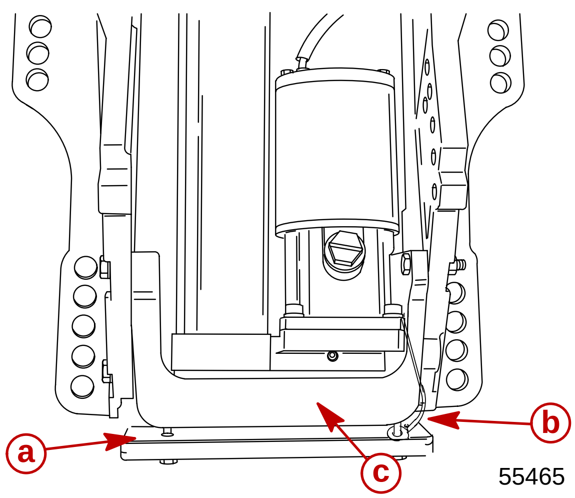
7. Using a suitable mallet, drive upper pivot pin into swivel bracket and through trim ram until pivot pin is flush with swivel bracket.
8. Drive pivot pin into its hole until seated.

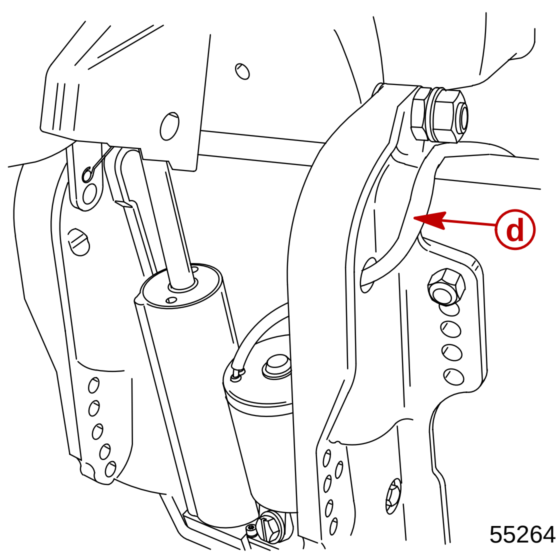




a - Pivot Pin
b - Swivel Bracket
c - Trim Ram
d - Trilobe Pin

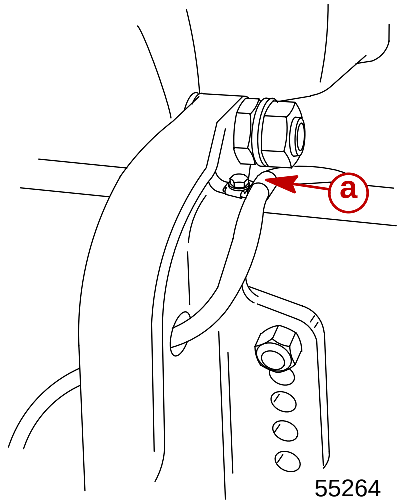
9. Install sacrificial aluminum anode to reservoir bracket placing ground strap between bracket and anode, as shown.
10. Route trim harness through clamp bracket and cowling.





a - Sacrificial Anode
b - Ground Strap
c - Bracket
d - Trim Harness

11. Secure trim harness with clamp, as shown.



a - Clamp

MID-SECTION

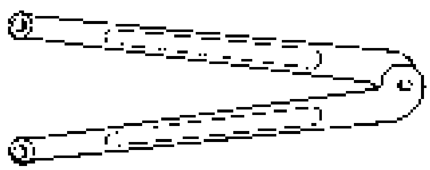
Section 5C - Manual Tilt Assist

Table of Contents

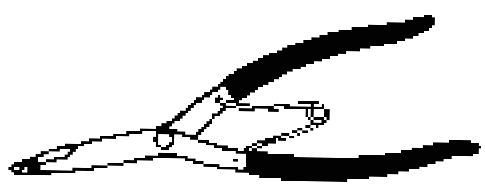
5
C

Special Tools

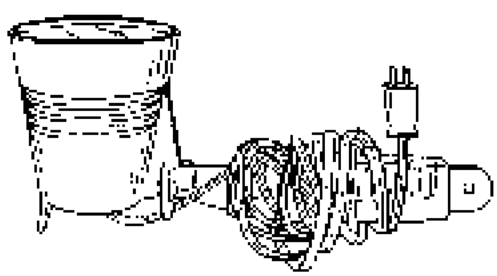
1. Spanner Wrench P/N 91-74951



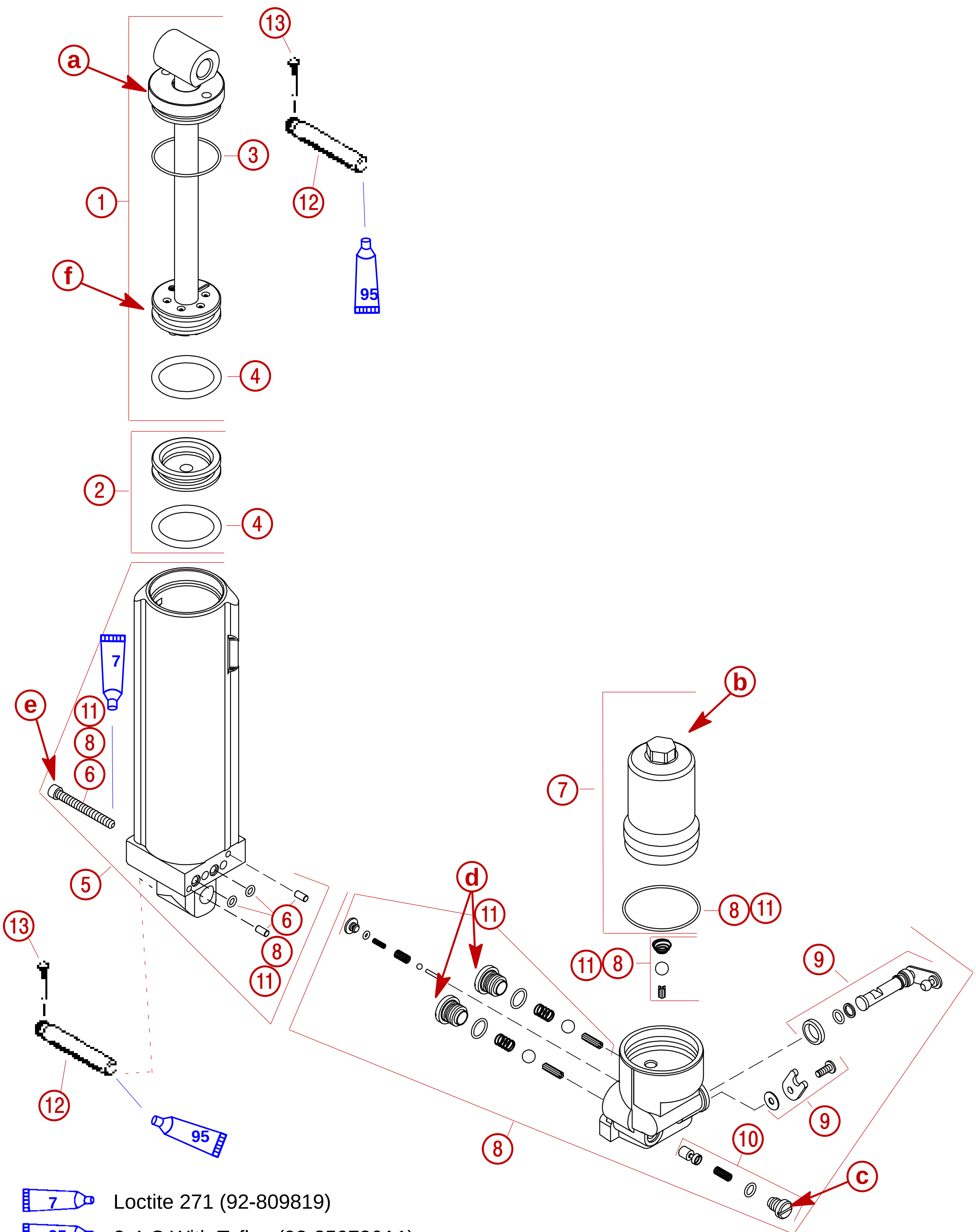
2. Lock-Ring Pliers P/N 91-822778A3



3. Heat Lamp P/N 91-63209



Manual Tilt Components



7 Loctite 271 (92-809819)

95 2-4-C With Teflon (92-850736A1)

NOTE: *Lubricate all O-rings using Quicksilver Power Trim and Steering Fluid. If not available, use automotive (ATF) automatic transmission fluid.*

NOTE: *It is recommended that all o-rings be replaced when servicing tilt system.*

Manual Tilt Components

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in.	TORQUE lb-ft	TORQUE Nm
1	1	SHOCK ROD ASSEMBLY		45	61
	1	SHOCK ROD ASSEMBLY **(BEACHING)**			
2	1	MEMORY PISTON ASSEMBLY			
3	1	O RING REBUILD KIT-Cylinder			
4	2	O RING			
5	1	CYLINDER ASSEMBLY			
6	1	SCREW AND SEAL KIT			
7	1	ACCUMULATOR ASSEMBLY		35	47
8	1	VALVE BODY ASSEMBLY			
9	1	CAM KIT			
10	1	VELOCITY VALVE KIT	75	6.2	8.5
11	1	CHECK SYSTEM REPAIR KIT	75	6.2	8.5
–	1	O RING KIT			
12	2	PIN			
13	2	GROOVE PIN			

a – Torque cylinder cap to 45 lb-ft (61 Nm)

b – Torque Accumulator to 35 lb-ft (47 Nm)

c – Torque Velocity Valve to 75 lb-in. (8.5 Nm)

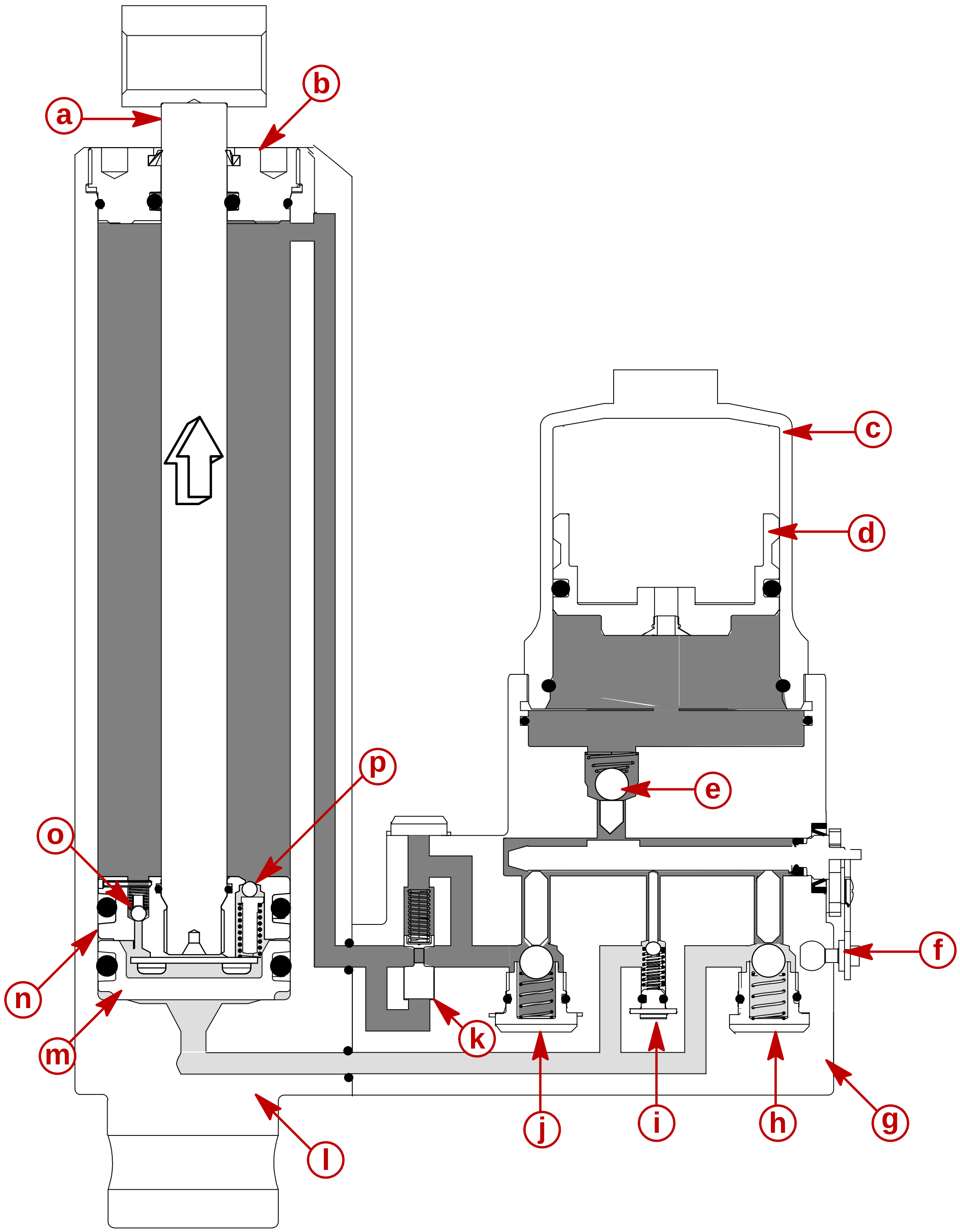
d – Torque Transfer Valve Plug to 75 lb-in. (8.5 Nm)

e – Torque Screw to 100 lb-in. (11 Nm)

f – Torque Shock Piston to 90 lb-ft (122 Nm)

Manual Trim Flow Diagrams

Up Circuit

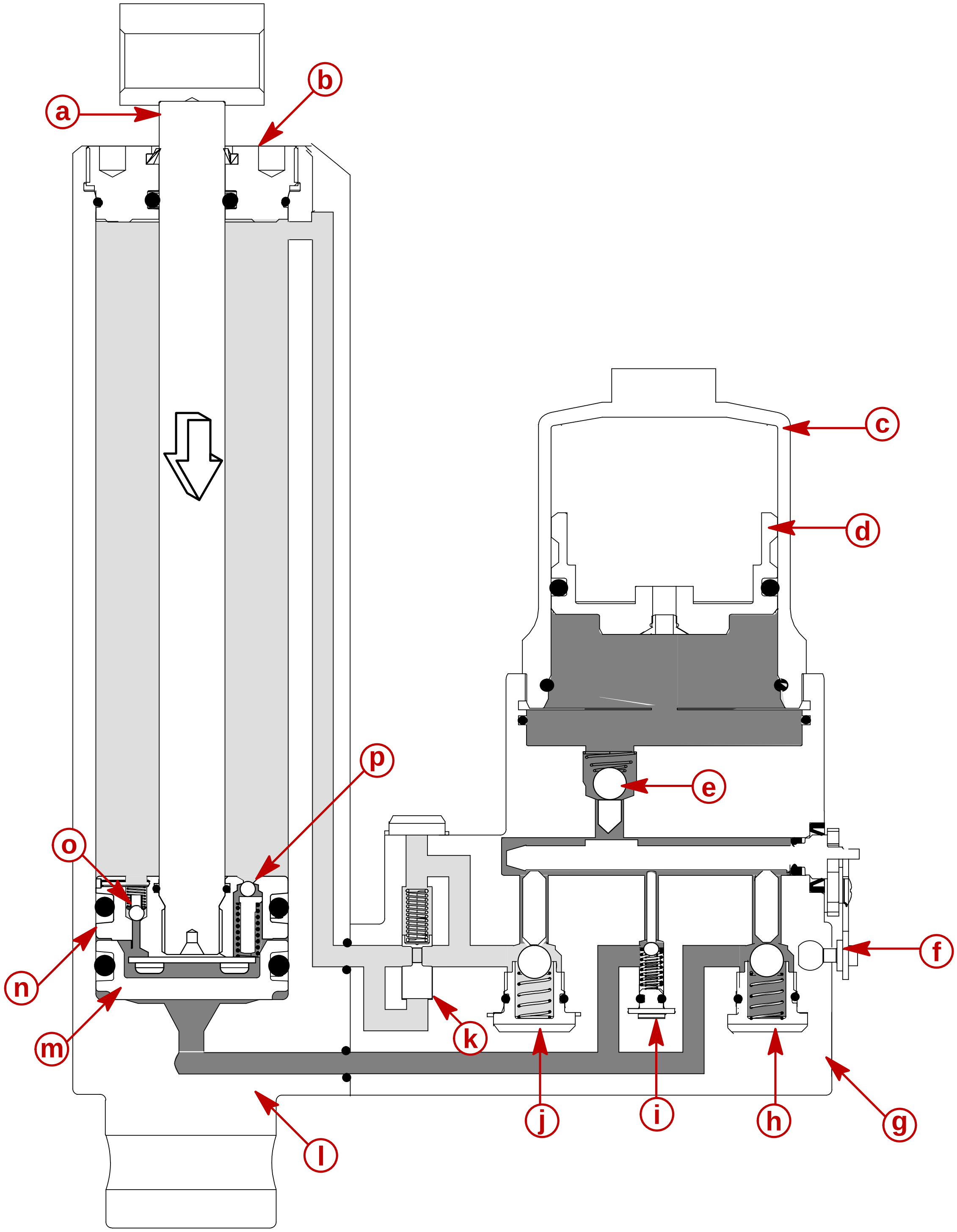


- **a** - Shock Rod
- **b** - End Cap
- **c** - Accumulator
- **d** - Accumulator Piston
- **e** - Accumulator Check Valve
- **f** - Camshaft Lever
- **g** - Manifold
- **h** - Down Circuit Fast Transfer Valve
- **i** - Down Circuit Slow Transfer Valve
- **j** - Up Circuit Fast Transfer Valve
- **k** - Surge Valve
- **l** - Cylinder
- **m** - Memory Piston
- **n** - Shock Piston
- **o** - Shock Return Valve
- **p** - Impact Relief Valve

Up Circuit

With the engine in the down position, the accumulator piston (d) will be at the top of the accumulator (c) with the gas at maximum pressure. To raise the engine, the camshaft lever (f) is rotated all the way down. The internal shaft connected to the camshaft lever will move the push rods, opening the accumulator check valve (e), both fast transfer valves (h & j) and the down circuit slow transfer valve (i). As the operator lifts the engine, oil, under pressure inside the accumulator, will flow around both the slow transfer valve (i) and the down circuit fast transfer valve (h). Oil flows into the bottom of the tilt cylinder forcing the memory piston (m) into the shock piston (n) and then forcing the shock rod up and out. Oil above the shock piston exits the cylinder (l) through an interconnecting passage along side of the cylinder and returns into the manifold (g). Inside the manifold the oil flows past the groove in the surge valve (k), through the up circuit fast transfer valve (j) and mixes with the oil flowing from the accumulator into the up cavity. With the engine in the correct position, the camshaft lever (f) is rotated up and the push rods allow the check valves (e, h, i, & j) to close. The closed check valves prevent the oil from traveling between cavities and locks the engine into position.

Down Circuit



- **a** - Shock Rod
- **b** - End Cap
- **c** - Accumulator
- **d** - Accumulator Piston
- **e** - Accumulator Check Valve
- **f** - Camshaft Lever
- **g** - Manifold
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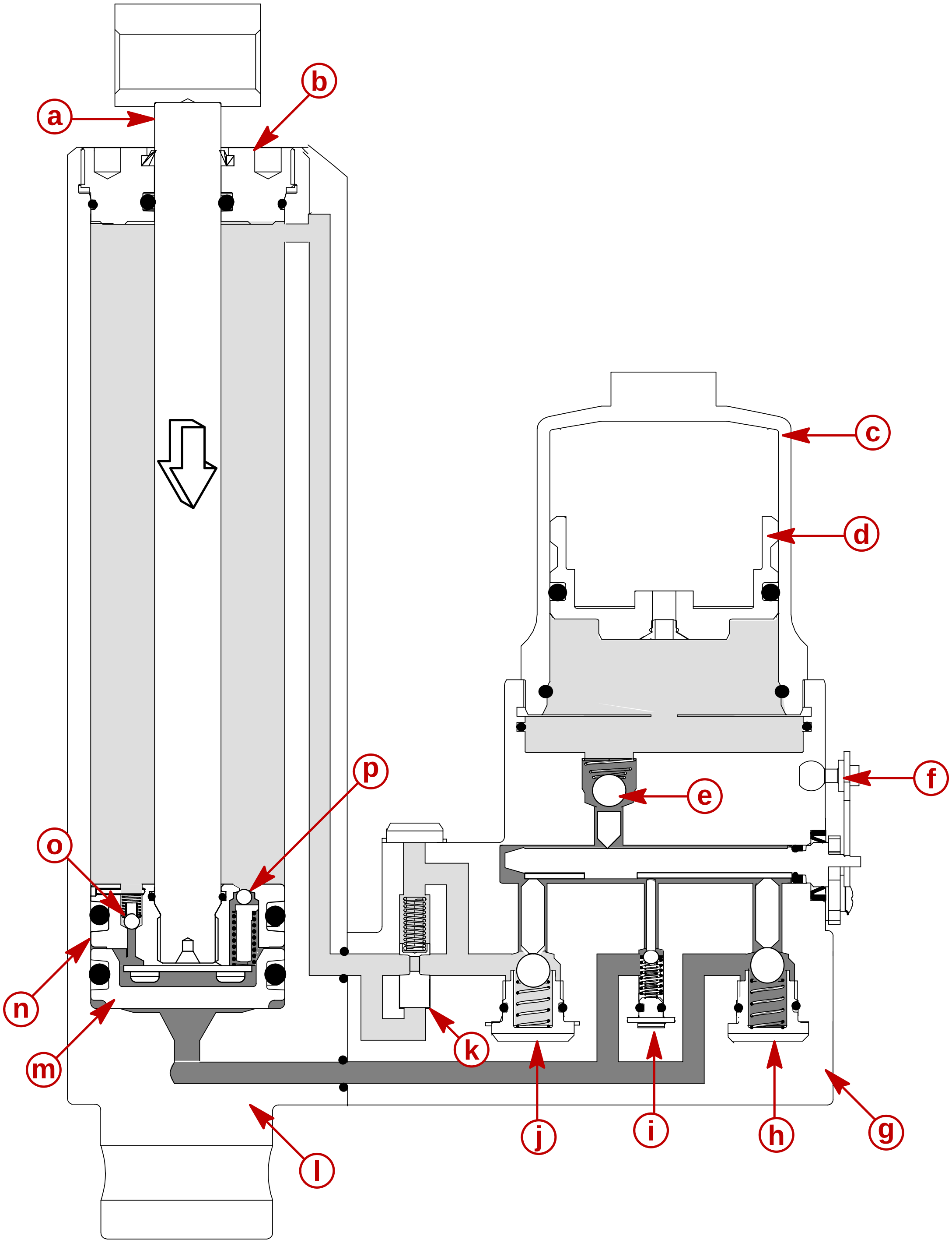
- **i** - Down Circuit Slow Transfer Valve
- **j** - Up Circuit Fast Transfer Valve
- **k** - Surge Valve
- **l** - Cylinder
- **m** - Memory Piston
- **n** - Shock Piston
- **o** - Shock Return Valve
- **p** - Impact Relief Valve

Down Circuit

With the engine tilted up, the piston (inside the accumulator (d)) will be at the bottom of the accumulator, (c) and the gas pressure low. To lower the engine, the camshaft lever (f) is rotated down, the internal cam will cause the push rods to open the accumulator check valve (e), both fast transfer valves (h & j) and the down circuit slow transfer valve (i). The operator will have to press down on the engine cowl to overcome the pressure inside cylinder. Fluid will flow out of the bottom of the cylinder, past both the down circuit fast transfer valve (h) and down circuit slow transfer valve (i). Fluid will flow past the up circuit fast transfer valve (j), surge valve (k) and through the interconnecting passage into the top of the cylinder (l). Due to the shock rod (a), the tilt cylinder cavities differ in volume, the extra fluid from the up cavity [forced into the accumulator (c)] will cause the internal accumulator piston (d) to compress the gas. With the engine in the correct position, the camshaft lever is rotated up and the push rods allow the check valves (e, h, i, & j) to close.

Slow Tilt Down Under High Thrust

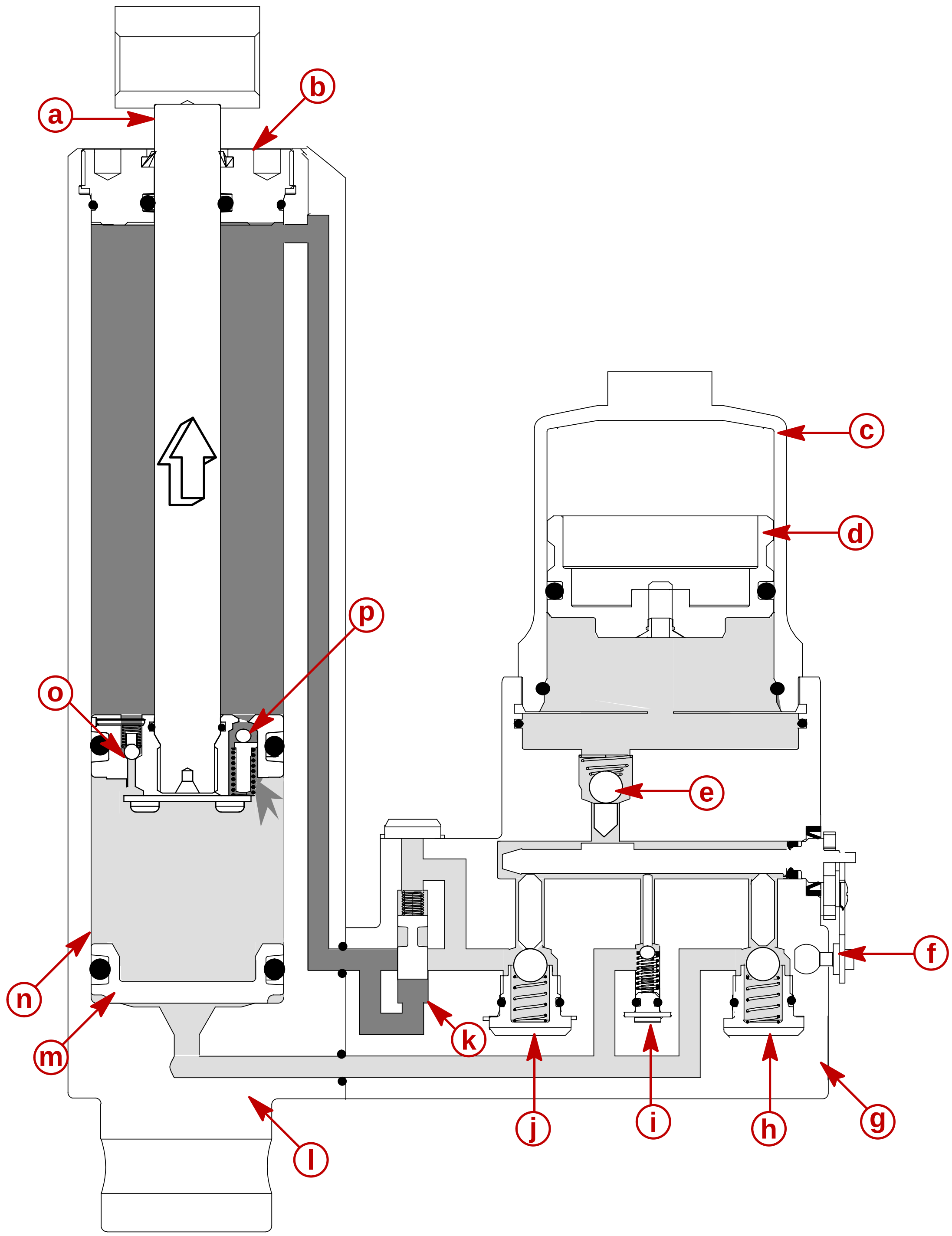


a - Shock Rod
b - End Cap
c - Accumulator
d - Accumulator Piston
e - Accumulator Check Valve
f - Camshaft Lever
g - Manifold
h - Down Circuit Fast Transfer Valve
i - Down Circuit Slow Transfer Valve
j - Up Circuit Fast Transfer Valve
k - Surge Valve
l - Cylinder
m - Memory Piston
n - Shock Piston
o - Shock Return Valve
p - Impact Relief Valve

Slow Tilt Down Under High Thrust

To tilt the engine down under high thrust conditions [where the propeller thrust forces the shock rod down, creating higher pressure below the memory piston (m)], the camshaft lever (f) is rotated slightly downward. The internal shaft connected to the lever will open the down circuit slow transfer valve (i) allowing oil under pressure into the cavity around the shaft. The higher oil pressure will open the up circuit fast transfer valve (j) allowing oil from the bottom of the cylinder to flow above the shock piston (n) while lowering the engine. Additional oil will flow into the accumulator (c) as the internal pressure forces the accumulator check valve (e) to open. Oil flowing into the accumulator moves the accumulator piston (d) and compresses the gas.

Under Water Strike (Valves Open)

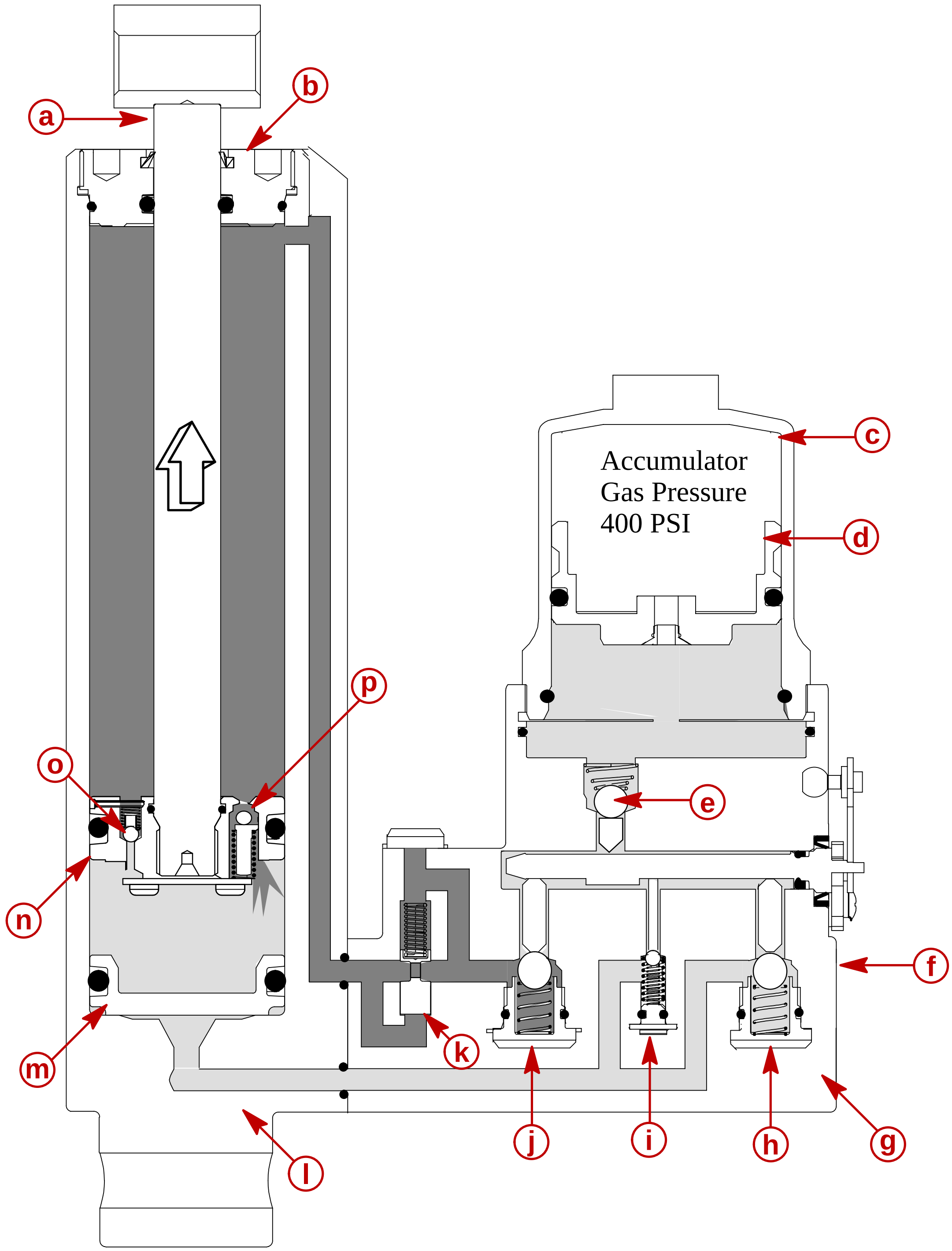


- **a** - Shock Rod
- **b** - End Cap
- **c** - Accumulator
- **d** - Accumulator Piston
- **e** - Accumulator Check Valve
- **f** - Camshaft Lever
- **g** - Manifold
- **h** - Down Circuit Fast Transfer Valve
- **i** - Down Circuit Slow Transfer Valve
- **j** - Up Circuit Fast Transfer Valve
- **k** - Surge Valve
- **l** - Cylinder
- **m** - Memory Piston
- **n** - Shock Piston
- **o** - Shock Return Valve
- **p** - Impact Relief Valve

Under Water Strike (Valves Open)

Should the drive unit strike a submerged object while in forward motion, the shock rod (a) will extend from the tilt cylinder (l). Fluid will attempt to exit the cylinder through the interconnecting passage. The rapid fluid flow will increase the pressure below the surge valve (k), causing the valve to move, closing the oil return passage back into the accumulator (c). Oil inside the up cavity is locked in a static position by the closed surge valve. As the shock rod extends outward, the pressure inside the up cavity will reach sufficient pressure to open the shock valve (p) which opens at 880-1110 PSI. Oil will flow into the cavity created as the shock rod & shock piston (a & n) moves away from the memory piston (m).

Shock Function (Valve Closed)

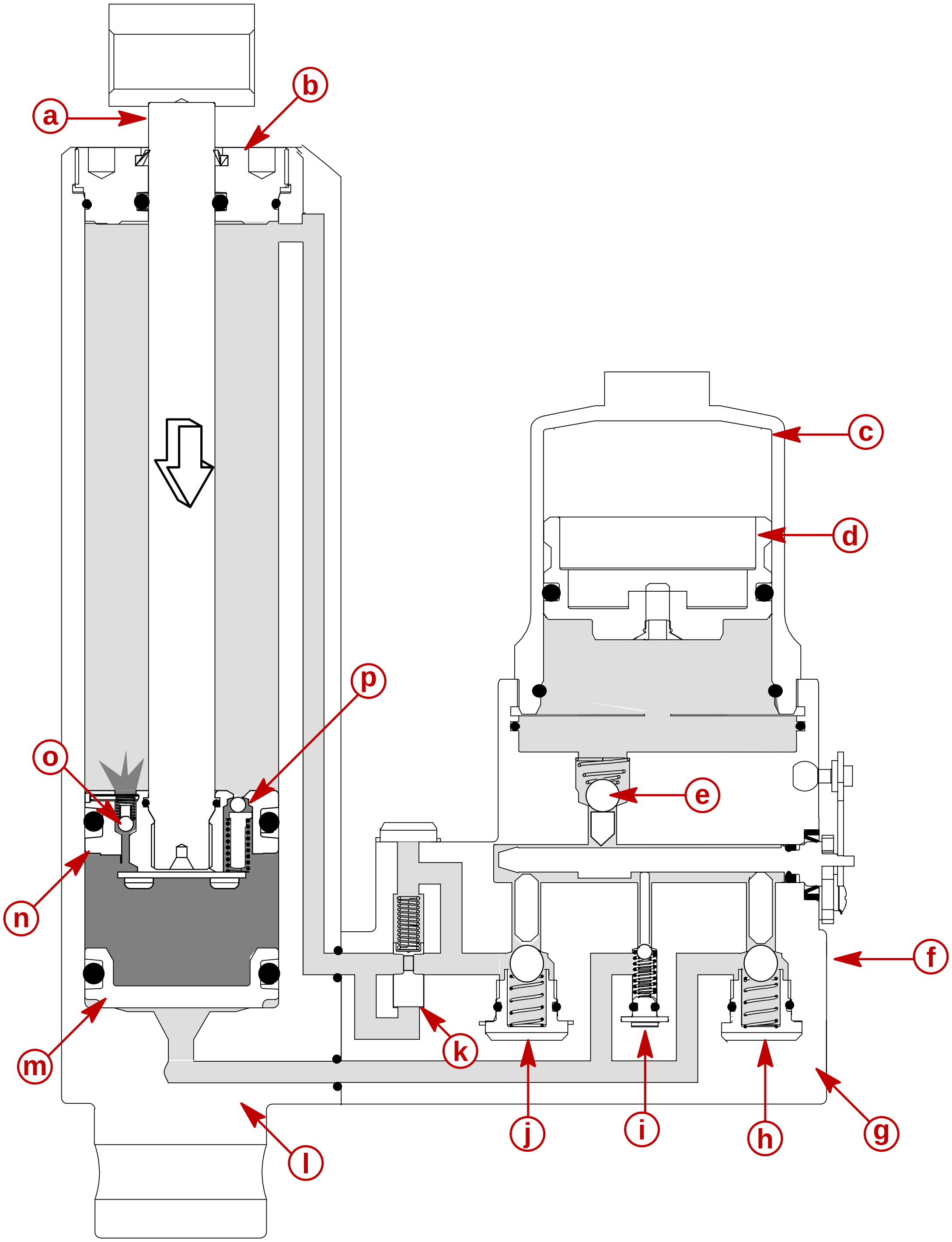


a - Shock Rod
b - End Cap
c - Accumulator
d - Accumulator Piston
e - Accumulator Check Valve
f - Camshaft Lever
g - Manifold
h - Down Circuit Fast Transfer Valve
i - Down Circuit Slow Transfer Valve
j - Up Circuit Fast Transfer Valve
k - Surge Valve
l - Cylinder
m - Memory Piston
n - Shock Piston
o - Shock Return Valve
p - Impact Relief Valve

Shock Function (Valves Closed)

Should the drive unit strike a submerged object while in forward motion, the shock rod (a) will extend from the cylinder (l). Oil inside the up cavity is locked in a static position by the closed up circuit fast transfer valve (j), the closed down circuit slow transfer valve (i) and closed down circuit fast transfer valve (h). Fluid will attempt to exit the cylinder through the interconnecting passage back into the accumulator (c). The closed up circuit fast transfer valve (j) will prevent the fluid return. As the shock rod extends outward, the pressure inside the up cavity will reach sufficient pressure to open the shock valve (p) which opens at 880-1110 PSI. Oil will flow into the cavity created as the shock rod & shock piston (n) moves away from the memory piston (m).

Shock Function Return



a - Shock Rod
b - End Cap
c - Accumulator
d - Accumulator Piston
e - Accumulator Check Valve
f - Camshaft Lever
g - Manifold
h - Down Circuit Fast Transfer Valve
i - Down Circuit Slow Transfer Valve
j - Up Circuit Fast Transfer Valve
k - Surge Valve
l - Cylinder
m - Memory Piston
n - Shock Piston
o - Shock Return Valve
p - Impact Relief Valve

Shock Function Return

After the drive clears the object, the shock return valve (o) will allow the oil to flow from between the shock piston (n) and memory piston (m) onto the down cavity as the drive returns to its original running position.

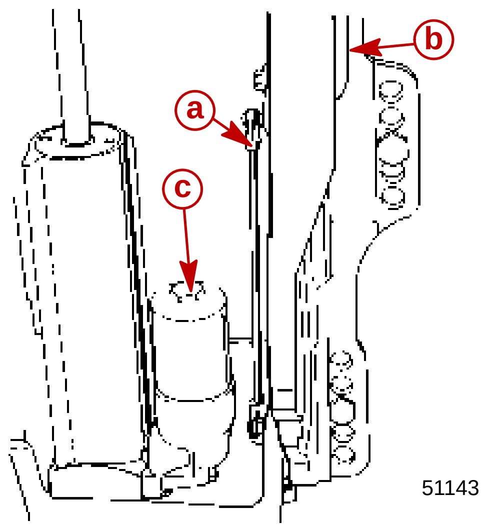
Hydraulic System Troubleshooting

Refer to disassembly/reassembly instructions (following) if disassembly is required when servicing.

IMPORTANT: After debris or failed components have been found (during troubleshooting procedure), it is recommended that unit be disassembled completely and all o-rings be replaced. Check ball components and castings must be cleaned using engine cleaner and compressed air or replaced prior to reassembly.

Support outboard with tilt lock lever when servicing manual tilt system.

1. Check manual release cam adjustment. Cam must open and close freely. Adjust cam link rod as necessary.

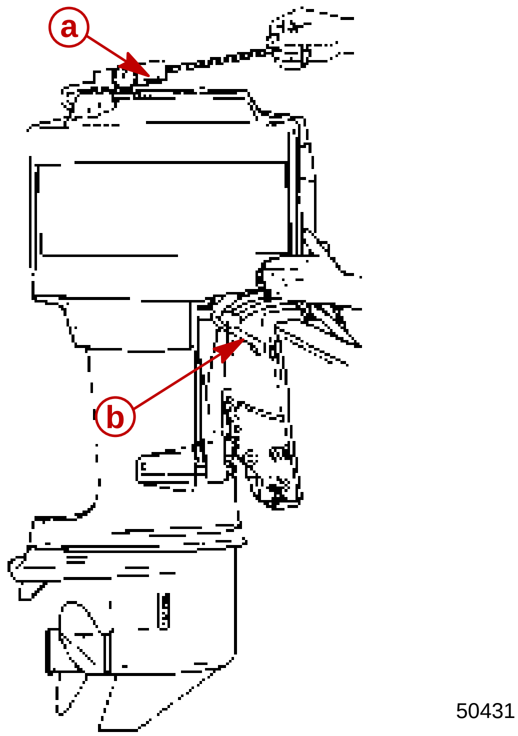


a - Link Rod
b - Manual Release Lever
c - Accumulator

2. Check for external leaks in the manual tilt system. Replace defective part(s) if leak is found.

IMPORTANT: If cut or damaged o-rings are found, inspect machined surfaces for scoring, burrs or debris.

3. Check for discharged accumulator. 35 to 50 lb-ft (47-68 Nm) of pulling force must be attained when tilting outboard from full “down” to full “up” position. If more than 50 lb-ft (68 Nm) of force is required, replace accumulator.



a - Weight Scale
b - Valve Lever (open position)

Manual Tilt System Removal

CAUTION

Remove cowling and remove all spark plug leads from spark plugs to prevent accidental starting while servicing outboard.

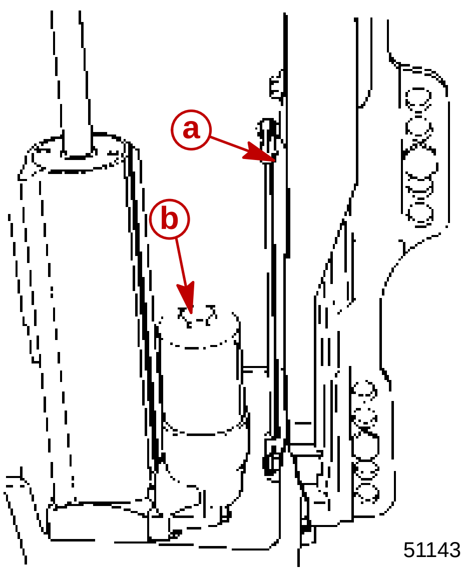
WARNING

Service or installation of the tilt system may result in loss of pressure in the shock cylinder. If the outboard is not in the full down position, such loss of pressure will cause the engine to fall to the full down position with a potential for damaging engine or causing personal injury. To avoid such injury support outboard in the up position using tilt lock lever.

WARNING

Manual tilt system is pressurized. Accumulator must be removed when shock rod is in the full up position, prior to servicing, otherwise oil spray-back may occur.

1. Support outboard in the up position using tilt lock lever.
2. Remove link rod.
3. Position piece of wood under transom bracket instead of tilt lock for access of removing pin. Use suitable punch to remove (DRIVE DOWN) upper dowel pin. Retain dowel pin.



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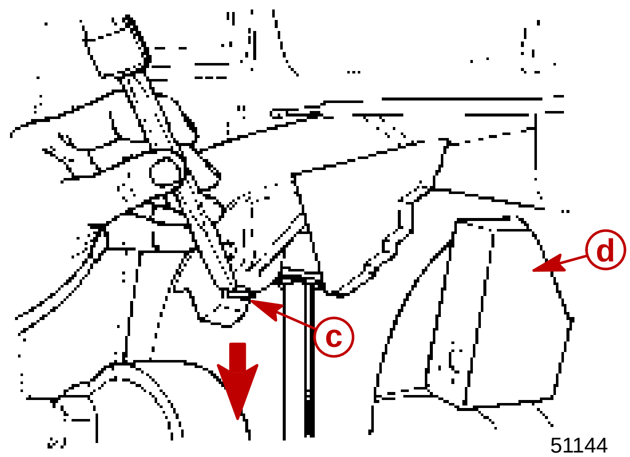

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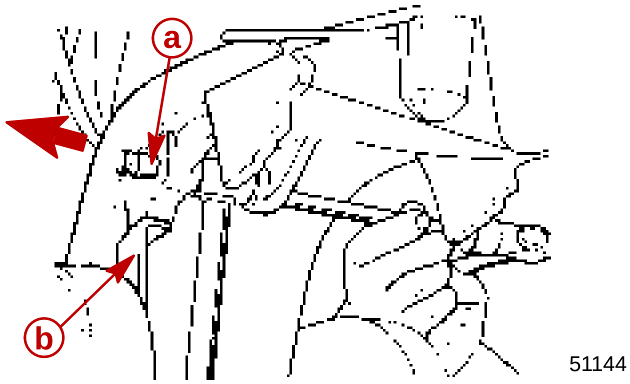
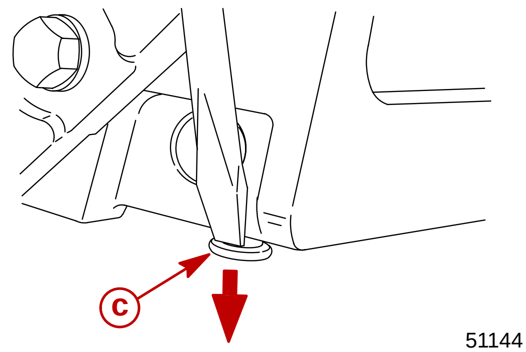
a - Link Rod
b - Accumulator
c - Dowel Pin
d - Wood

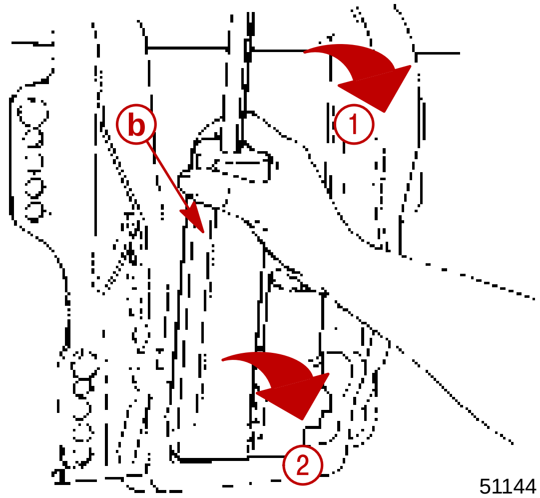
4. Position tilt lock and remove piece of wood. Use suitable punch to drive out upper pivot pin.
5. Use punch to remove (Drive Down) lower dowel pin. Retain dowel pin.





a - Pivot Pin
b - Tilt Lock
c - Dowel Pin

6. Use suitable punch to drive out lower pivot pin.
7. Tilt shock absorber assembly (TOP FIRST) out from clamp bracket and remove assembly.



a - Pivot Pin
b - Manual Tilt System

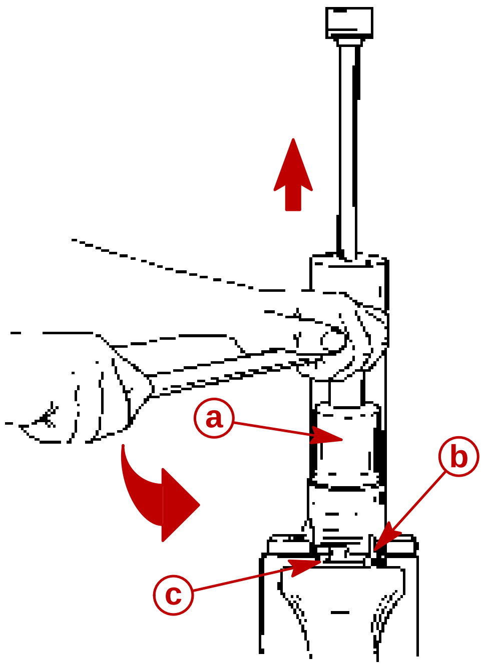
Manual Tilt System Disassembly

NOTE: *Accumulator contains a high pressure nitrogen charge and is NOT SERVICEABLE. Replace if necessary.*

⚠ WARNING
This tilt system is pressurized. Remove accumulator only when shock rod is in full up position.

Accumulator Removal

1. Place manual tilt system in soft jawed vise.
2. Position shock rod to full up position.
3. Open cam shaft valve (Down Position).
4. Loosen velocity valve enough to drip, wait until dripping stops.
5. When fluid stops dripping, loosen and remove accumulator.
6. If plunger can be compressed into accumulator by hand, accumulator is defective. Replace accumulator.



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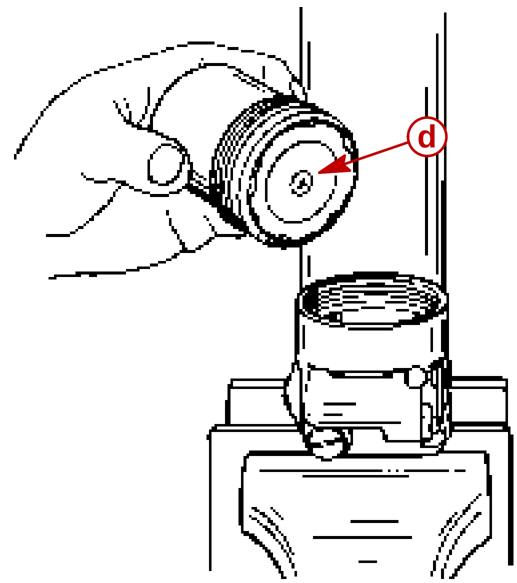

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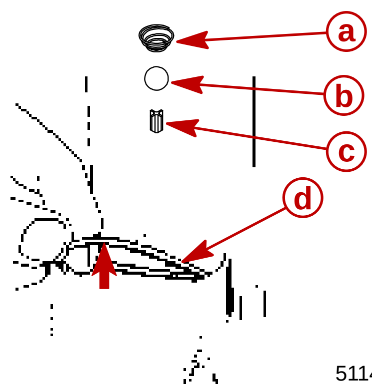
a - Accumulator
b - Cam Lever
c - Velocity Valve
d - Plunger

7. Once accumulator is removed, remove o-ring, conical spring, steel ball and plunger.

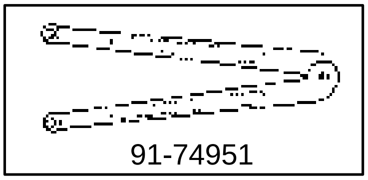


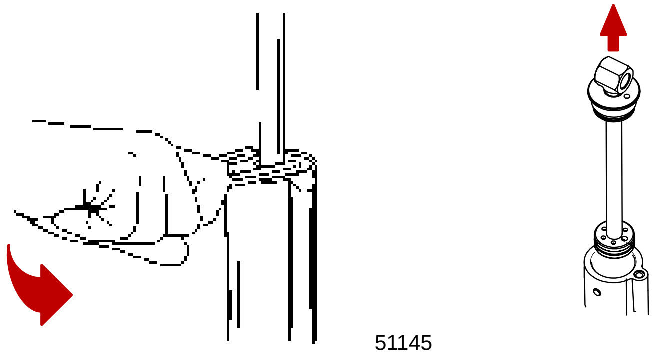
51145

a - Conical Spring
b - Steel Ball
c - Plunger
d - O-ring

Shock Rod Removal

1. Unscrew cylinder end cap assembly using spanner wrench [1/4 in. x 5/16 in. long pegs].
2. Remove shock rod assembly from cylinder.





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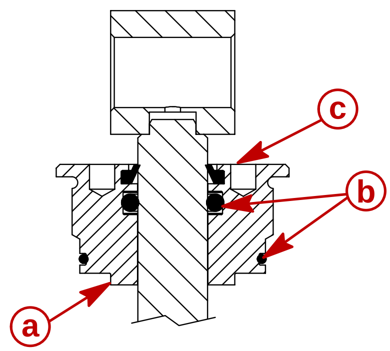
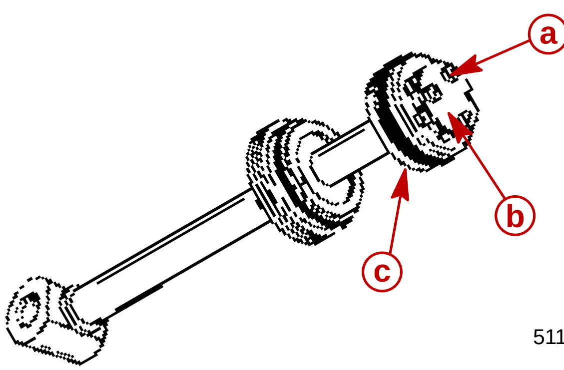
Shock Rod Disassembly

NOTE: *The only serviceable items on the shock rod assembly are the O-rings and wiper ring. If shock rod requires any other repair, replace shock rod assembly.*



a - End Cap
b - O-ring (2)
c - Wiper Ring

1. Place shock rod assembly on clean work surface.
2. Remove three (3) screws and remove plate from shock rod piston.



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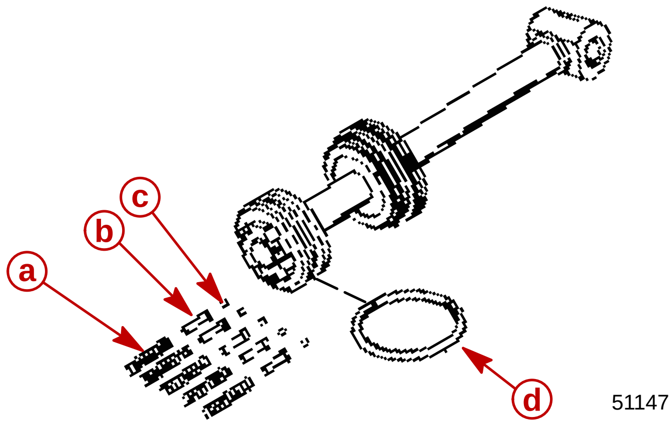
a - Screw (3)
b - Plate
c - Shock Rod Piston

3. Remove check ball components from shock rod piston.
4. Remove o-ring.

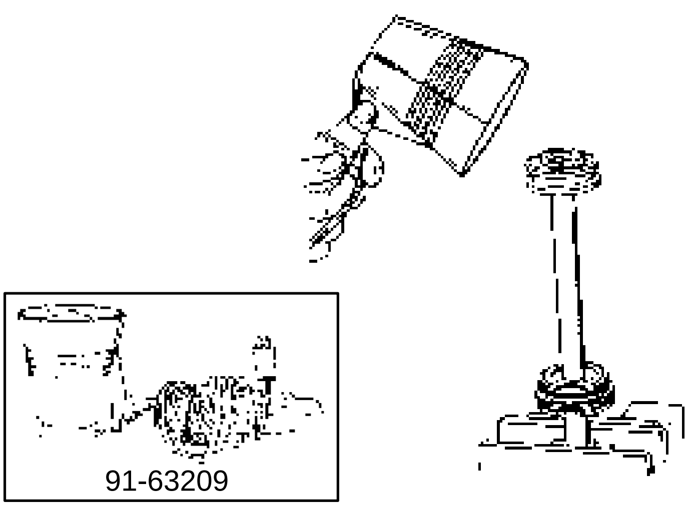


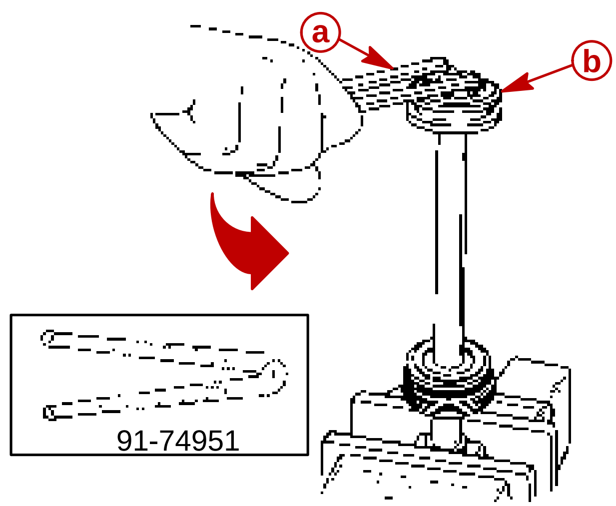
a - Spring (5)
b - Seat (5)
c - Ball (5)
d - O-ring

⚠ CAUTION

When removing shock piston, spanner wrench must have 1/4 in. x 5/16 in. long pegs to avoid damage to shock piston.

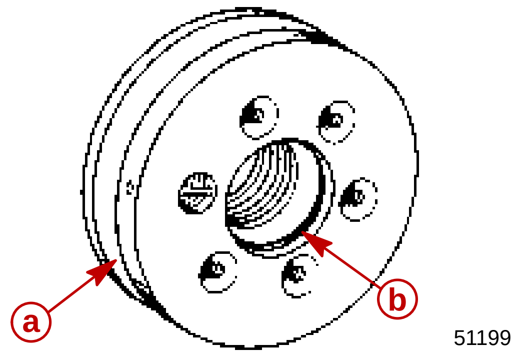
5. Place shock rod into soft jawed vise and apply heat to loosen piston using torch lamp (P/N 91-63209).
6. Loosen shock rod piston using spanner wrench [1/4 in. x 5/16 in. (6.4mm x 8mm) long pegs].
7. Allow shock rod piston to cool. Remove from shock rod.





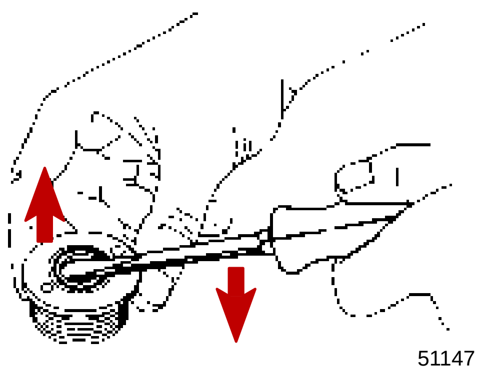
a - Spanner Wrench
b - Shock Rod Piston

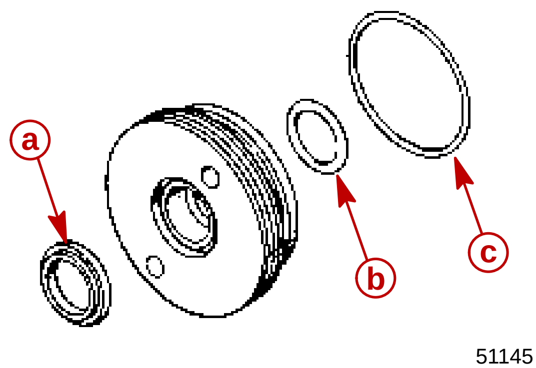
8. Inspect check valve for debris; clean debris from check valve if found. If debris cannot be cleaned from check valve, replace shock piston as an assembly.
9. Clean shock and components with compressed air.
10. Remove inner O-ring.



a - Shock Piston
b - O-ring

11. Remove cylinder end cap assembly from shock rod.
12. Inspect shock. If wiper (located in cap) has failed to keep rod clean, replace wiper.
13. Place end cap on clean work surface.
14. Remove rod wiper, inner o-ring, and outer o-ring.

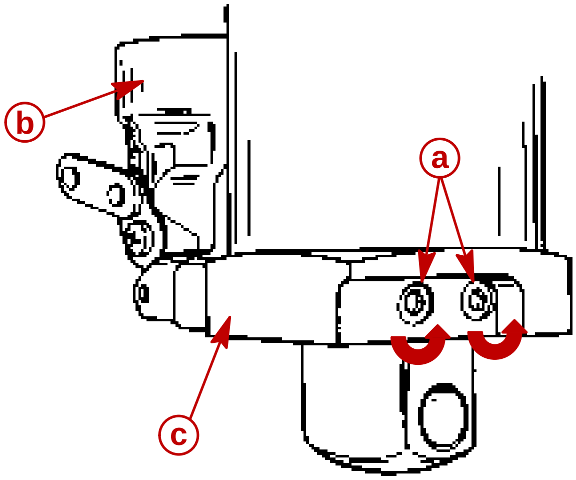




a - Rod Wiper
b - Inner O-ring
c - Outer O-ring

Valve Block Removal

1. Remove two screws from the shock rod cylinder to separate the valve block.
2. Remove o-rings and dowel pins.



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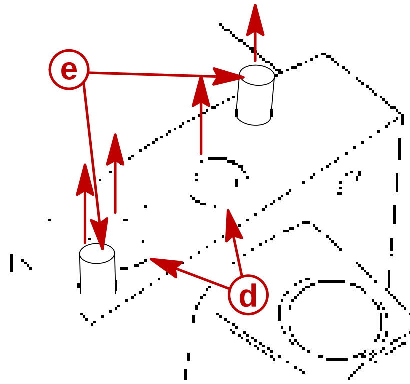

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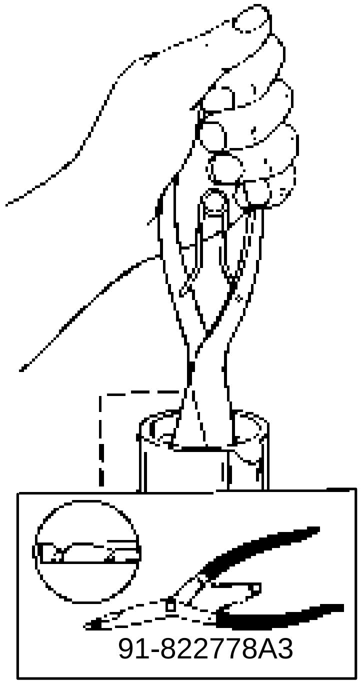
a - Screw
b - Valve Block
c - Shock Rod Cylinder
d - O-ring (2)
e - Dowel Pin (2)

Memory Piston Removal

1. Remove memory piston from cylinder using one of two methods:
   a. Using lock ring pliers.



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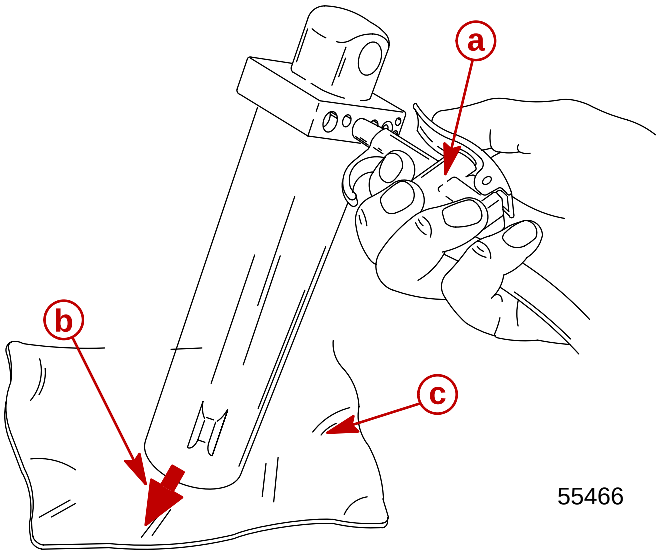
b. Blowing compressed air into center o-ring hole.

⚠ WARNING

Memory piston cup may be expelled at a high velocity when air pressure is applied. Failure to place cylinder as shown below could result in personal injury.

NOTE: *Point cylinder opening down and away. Use a shop rag or towel to avoid damage to the memory piston. Fluid will blow out also.*

2. Remove O-ring from memory piston.



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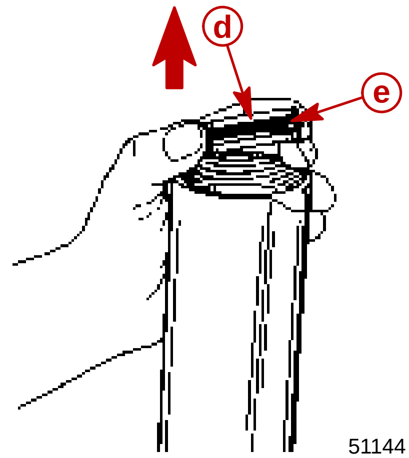

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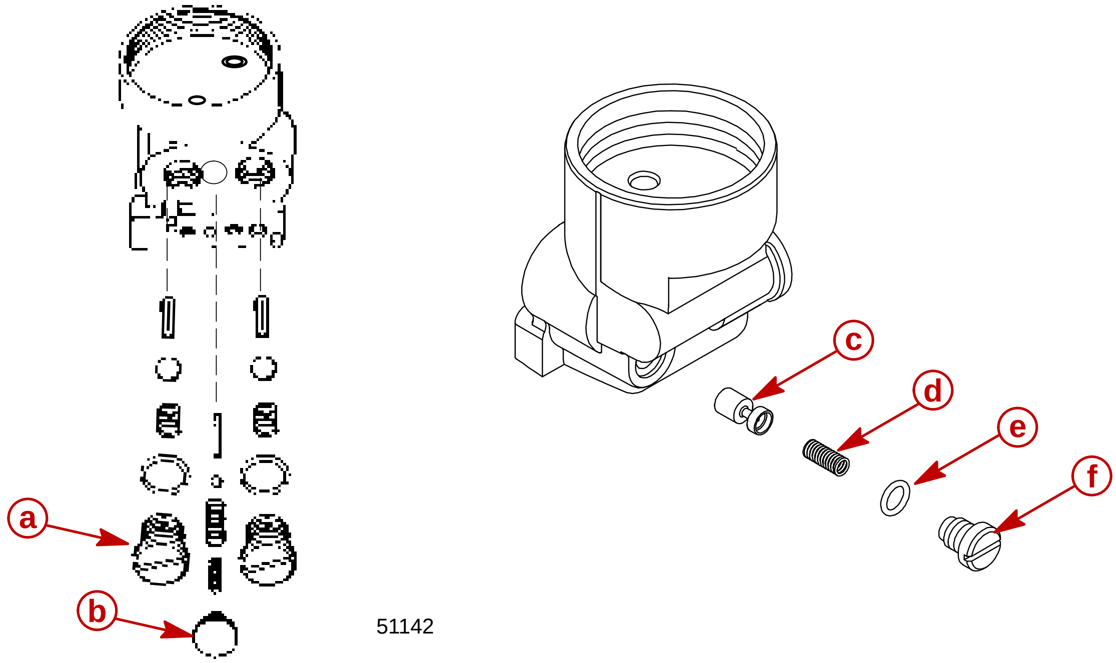
a - Adaptor/Air Hose
b - Memory Piston Exit
c - Shop Rag
d - O-Ring
e - Memory Piston

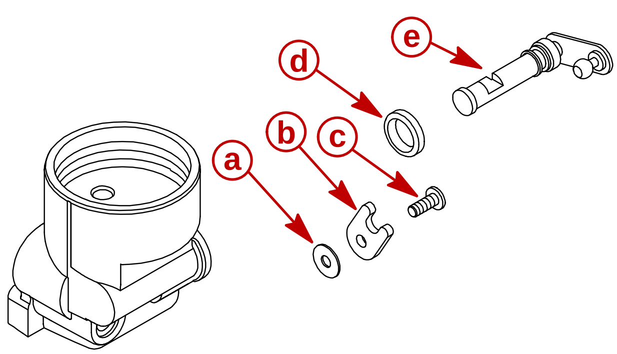
Valve Block Disassembly

1. Remove check retainer plug and components.
2. Remove hydraulic oil transfer valve plugs and components.
3. Remove surge valve assembly.



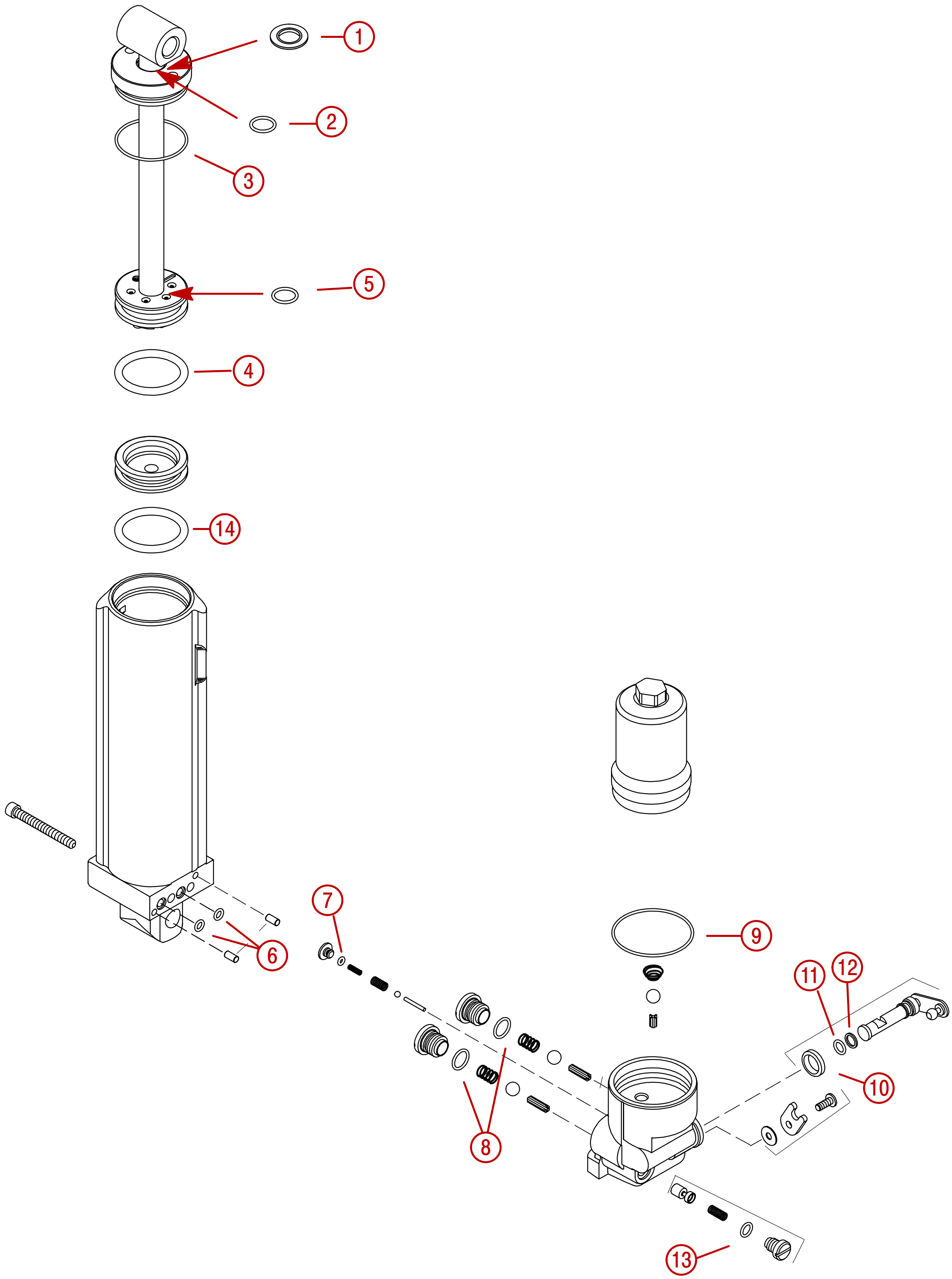
a - Transfer Valve Plug Assembly (2)
b - Check Retainer Plug or Screw Assembly
c - Spool
d - Spring
e - O-ring
f - Velocity Valve

4. Remove screw and remove cam assembly.



a - Spacer Retainer Clip
b - Retainer Clip
c - Screw
d - Shaft Seal
e - Cam

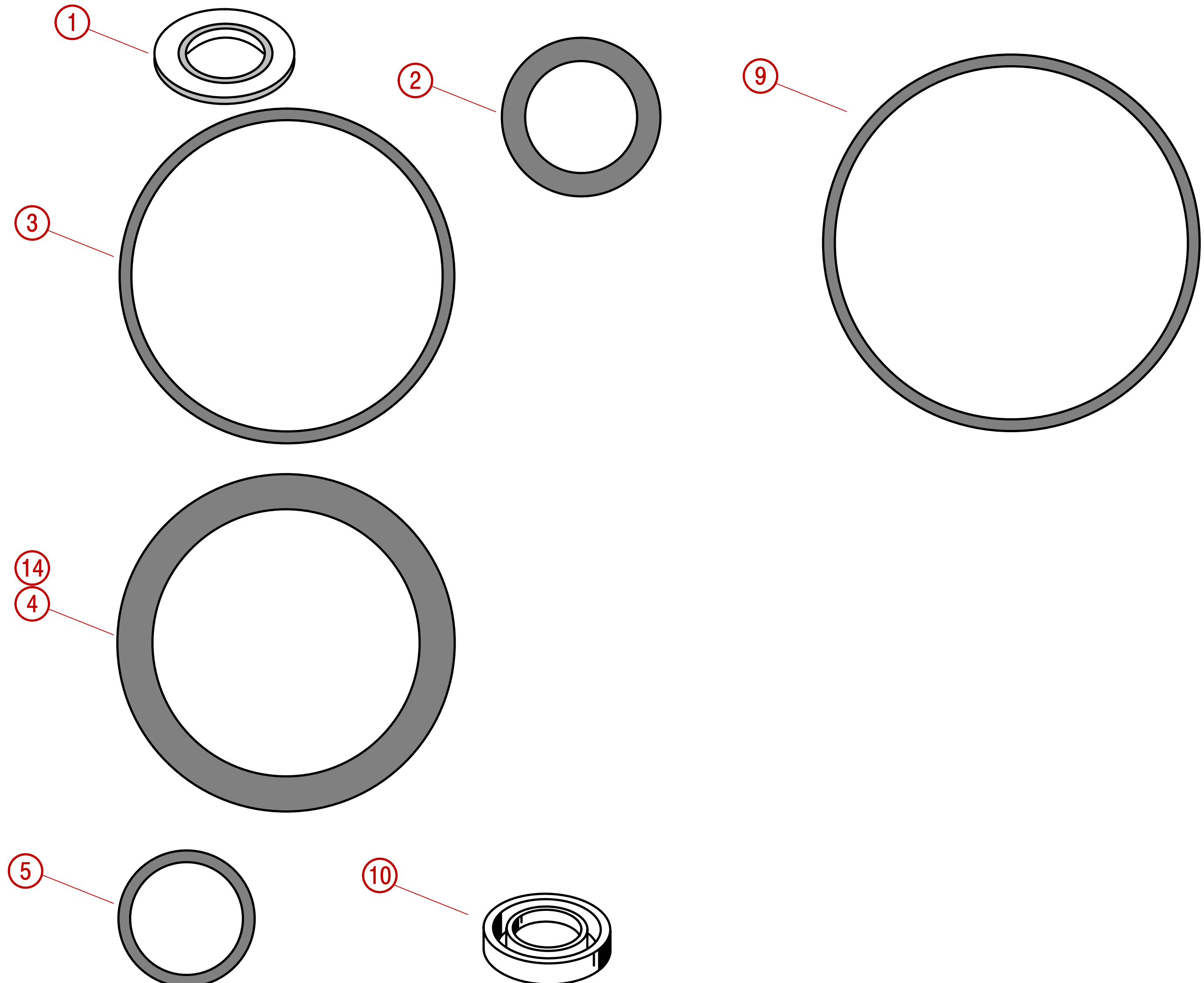
Reassembly - O-Ring and Seal Placement

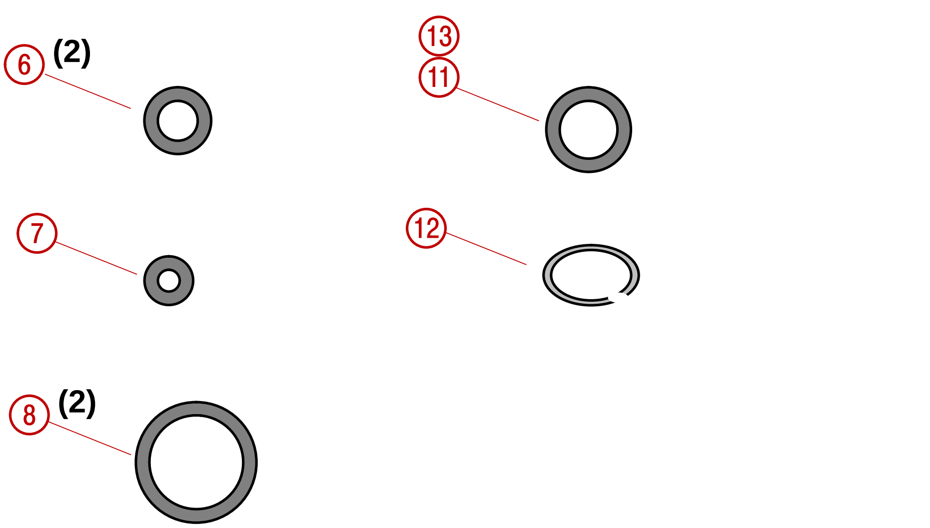


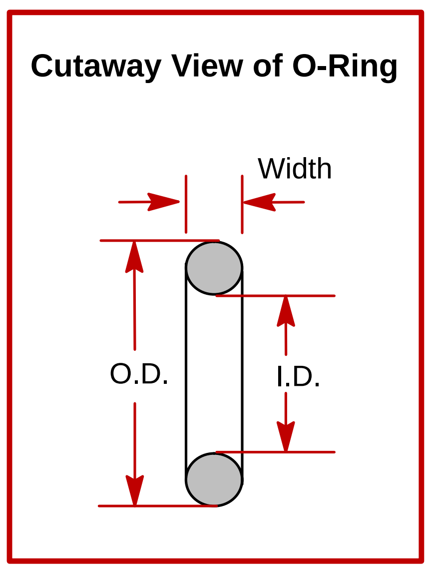
NOTE: *Lubricate all O-rings using Quicksilver Power Trim and Steering Fluid. If not available, use automotive (ATF) automatic transmission fluid.*

NOTE: *It is recommended that all o-rings be replaced when servicing tilt system.*

Actual O-Ring Sizes







O-RINGS SHOWN ARE ACTUAL SIZE

O-Ring Description and Sizes

O-Ring	Description	O-Ring I.D.	O-Ring O.D.	O-Ring Width
1	Wiper Ring			
2	Cyl. Cap, Inner	0.671 in. (17.04 mm)	0.949 in. (24.10 mm)	0.139 in. (3.53 mm)
3	Cyl. Cap	1.864 in. (47.34 mm)	2.004 in. (50.90 mm)	0.07 in. (1.78 mm)
4	Shock Piston	1.6 in. (40.64 mm)	2.02 in. (53.086 mm)	0.21 in. (5.334 mm)
5	Piston Bolt	0.676 in. (17.17 mm)	.816 in. (20.726 mm)	0.07 in. (1.78 mm)
6 (2)	Manifold Split Line	0.208 in. (5.283 mm)	0.348 in. (8.839 mm)	0.07 in. (1.78 mm)
7	Slow Valve	0.114 in. (2.90 mm)	0.254 in. (6.451 mm)	0.07 in. (1.78 mm)
8 (2)	Plug	0.489 in. (12.42 mm)	0.629 in. (15.97 mm)	0.07 in. (1.78 mm)
9	Accumulator	2.114 in. (53.69 mm)	2.254 in. (57.25 mm)	0.07 in. (1.78 mm)
10	Lip Seal			
11	Cam Shaft	0.301 in. (7.645 mm)	0.441 in. (11.20 mm)	0.07 in. (1.78 mm)
12	Back Up Ring			
13	Surge Valve	0.301 in. (7.645 mm)	0.441 in. (11.20 mm)	0.07 in. (1.78 mm)
14	Memory Piston	1.6 in. (40.64 mm)	2.02 in. (53.086 mm)	0.21 in. (5.334 mm)

Manual Tilt System Cleaning and Inspection

1. It is recommended that all o-rings exposed during disassembly be replaced.
2. Clean components, filter, and check valve seats using engine cleaner and compressed air. Do not use cloth rags.
3. Inspect all machined surfaces for burrs or scoring to assure o-ring longevity.
4. Inspect shock rod. If scraper (located in cap) has failed to keep rod clean, replace scraper.

Manual Tilt System Reassembly

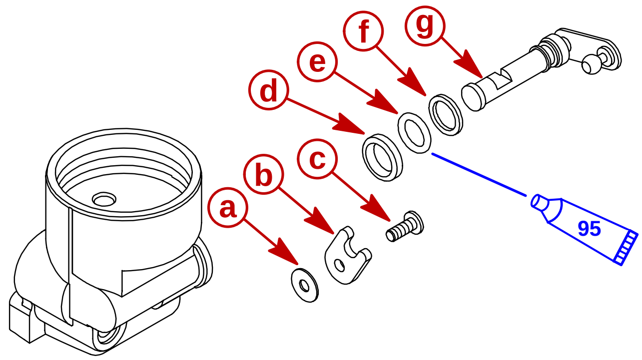
IMPORTANT: Components must be dirt and lint free. Slightest amount of debris in tilt system could cause system to malfunction.

Apply Quicksilver Power Trim and Steering Fluid to all o-rings during reassembly. If not available, use automotive (ATF) automatic transmission fluid.

CAM SHAFT REASSEMBLY

IMPORTANT: Cam shaft O-ring must be lubricated using 2-4-C with Teflon.

1. Install lubricated o-ring and back up seal to cam.
2. Install shaft seal in valve block with lips facing out.
3. Install cam shaft assembly in valve block.
4. Secure cam shaft in place using insulator, retainer plate, and screw. Tighten screw securely.

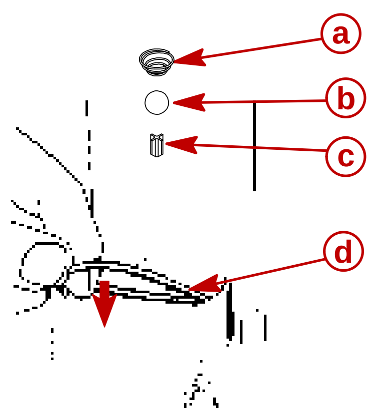


95 2-4-C w/Teflon (92-850736A1)

a - Spacer Retainer Clip
b - Retainer Clip
c - Screw
d - Shaft Seal
e - O-ring
f - Back up Seal
g - Cam

VALVE BODY CHECK REASSEMBLY

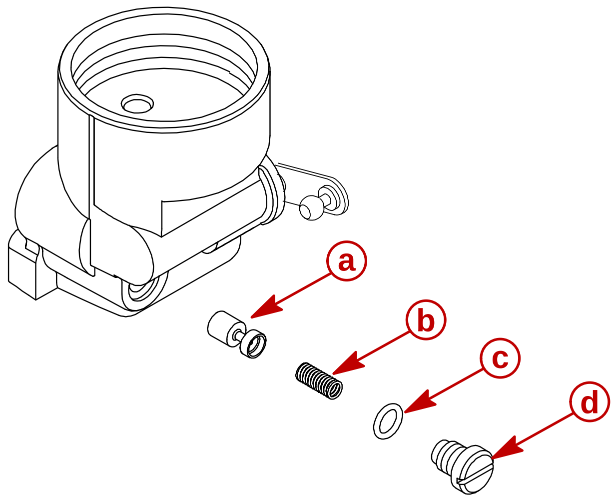
1. Install lubricated o-ring, plunger, steel ball and conical spring to valve block.



a - Conical Spring
b - Steel Ball
c - Plunger
d - O-ring

VELOCITY VALVE REASSEMBLY

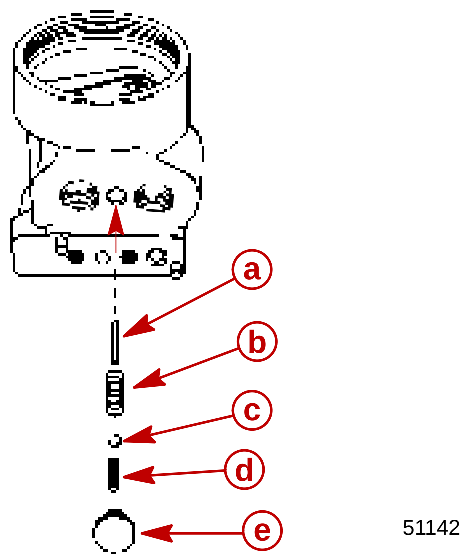
1. Install spool, spring, lubricated o-ring and screw plug (surge valve assembly) into valve block.
2. Torque velocity valve to 75 lb-in. (8.5 Nm).



a - Spool
b - Spring
c - O-ring
d - Velocity Valve - Torque to 75 lb-in. (8.5 Nm)

CHECK RETAINER REASSEMBLY

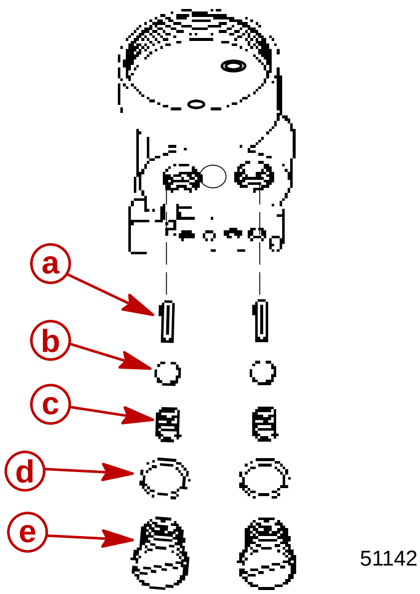
1. Install plunger, spring (large), ball, spring (small), and plug into valve block.



a - Plunger
b - Spring (Large)
c - Ball
d - Spring (Small)
e - Plug

VALVE PLUG REASSEMBLY

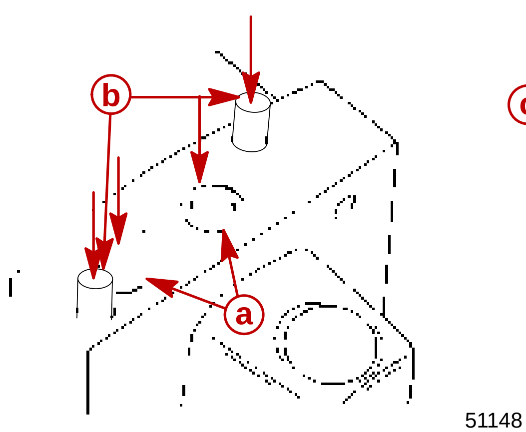
1. Install plunger, steel ball, spring, lubricated o-ring and screw plug. Torque screw plugs to 75 lb-in. (8.5 Nm).

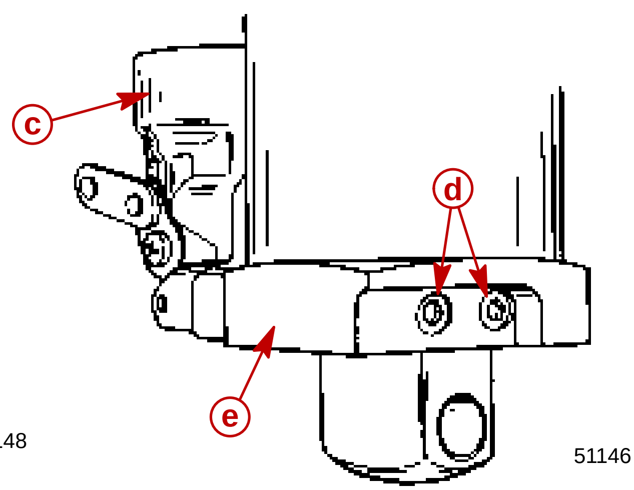


a - Plunger (2)
b - Steel Ball (2)
c - Spring (2)
d - O-ring (2)
e - Screw Plug (2) Torque to 75 lb-in. (8.5 Nm)

Valve Block Installation

1. Install lubricated O-rings and dowel pins.
2. Install valve block to shock rod cylinder. Insert screws to shock rod cylinder and torque to 100 lb-in. (11 Nm).

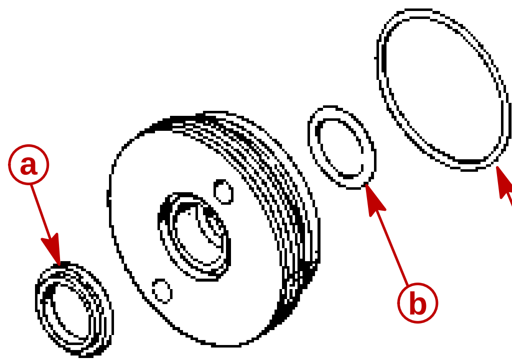




a - O-ring (2)
b - Dowel Pin (2)
c - Valve Block
d - Screw (2) Torque to 100 lb-in. (11 Nm)
e - Shock Rod Cylinder

Shock Rod Reassembly

1. Install lubricated o-rings to end cap.
2. Install rod wiper.
3. Install lubricated o-rings to shock piston.



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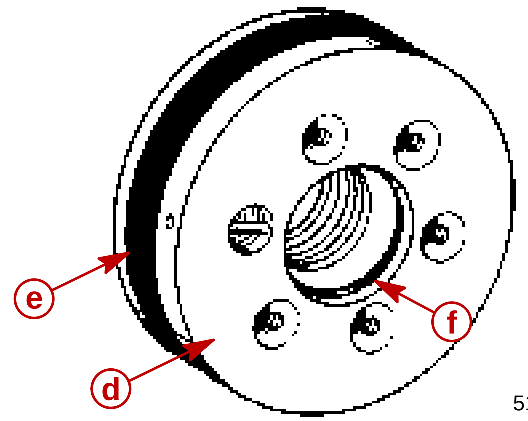

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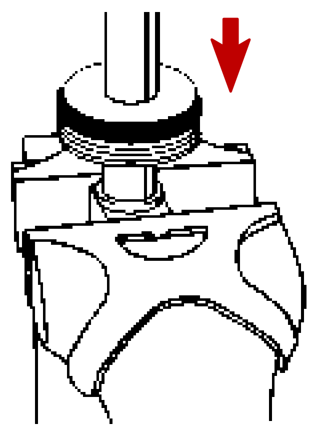
a - Rod Wiper
b - Inner O-ring
c - Outer O-ring
d - Shock Piston
e - O-ring
f - O-ring

4. Clamp shock rod in soft jawed vise.
5. Position cylinder end cap onto rod, as shown.



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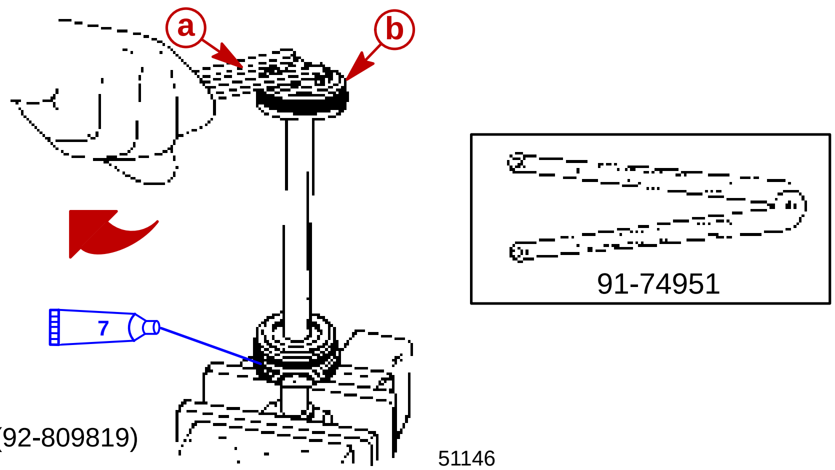
⚠ CAUTION

When installing shock rod piston, spanner wrench must have1/4 in. x 5/16 in. (6.4mm x8mm) long pegs to avoid damage to shock rod piston.

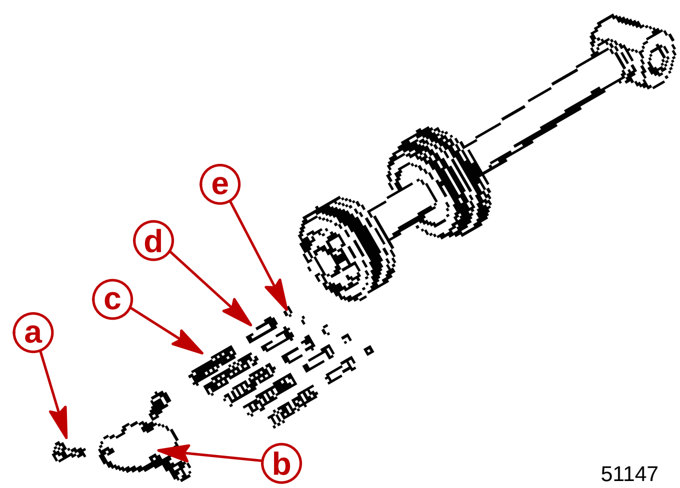
6. Apply Loctite Grade “A” (271) to threads on shock rod.
7. Install shock rod piston.
8. Tighten shock rod piston securely using spanner wrench [1/4 in. x 5/16 in. (6.4mm x 8mm) long pegs]. If a torquing type spanner tool is used to tighten shock piston, then torque to 90 lb-ft (122 Nm).



7 Loctite “271” (92-809819)

a - Spanner Wrench
b - Shock Rod Piston - Torque to 90 lb-ft (122 Nm)

9. Install ball, seat, and spring (five sets) to shock rod piston.
10. Secure components with plate. Torque screws to 35 lb-in. (3.9 Nm).
11. Remove shock rod assembly from vise.



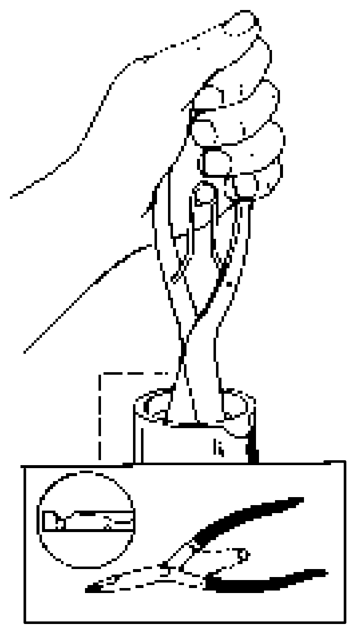
a - Screw (3) Torque to 35 lb-in. (3.9 Nm)
b - Plate
c - Spring (5)
d - Seat (5)
e - Ball (5)

Shock Rod Installation and Fluid Filling Procedure

NOTE: *There are two ways for the filling procedure. The first is the easiest and less time consuming.*

Filling Procedure Option One

1. Place trim cylinder in soft jawed vice.
2. With manifold cam lever closed (Up Position), fill cylinder and manifold to top with Quicksilver Power trim and steering fluid, or (ATF) automatic transmission fluid. Let bubbles disperse.
3. Install lubricated o-ring to memory piston.
4. Using lock ring pliers (P/N 91-822778A3). Set memory piston in top of cylinder then open cam lever (Down Position) and push memory piston down just below cylinder treads. Close cam lever (Up Position).



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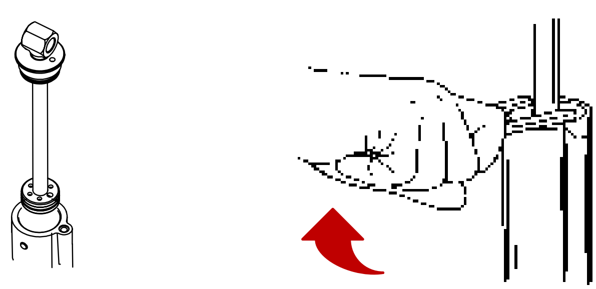
5. Fill top of cylinder again with fluid to top and install shock rod assembly on top memory piston. Open cam lever (Down Position) and push shock rod assembly down to 1/8″ below cylinder threads. Close cam lever (Up Position).
6. Fill top of shock rod assembly with fluid to top of cylinder. Open cam lever (Down Position) and screw cylinder cap down.
7. Tighten end cap securely using spanner wrench [1/4 in. x 5/16 in. (6.4mm x 8mm) long pegs]. If a torquing type spanner tool is used to tighten end cap, then torque the end cap to 45 lb-ft (61.0 Nm). Close cam lever (Up Position).



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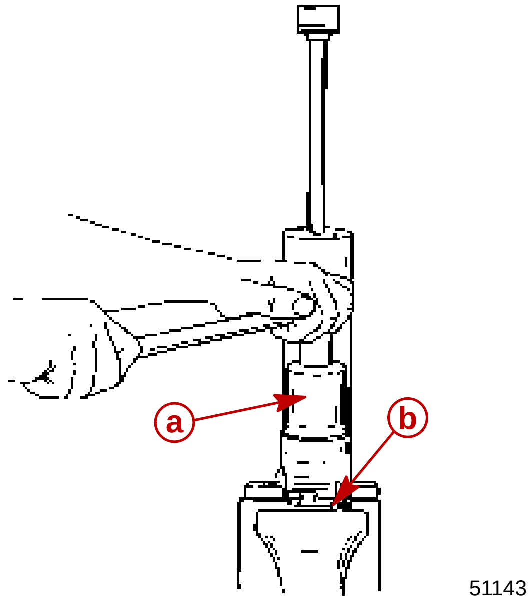
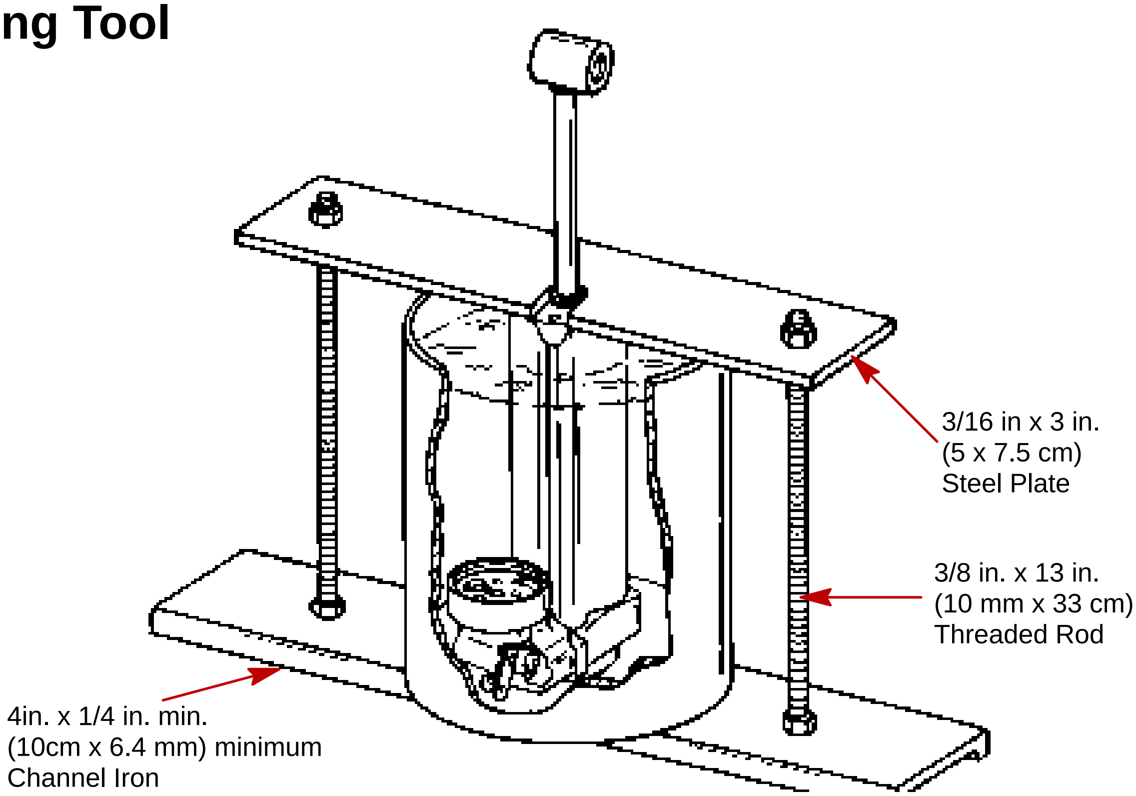
8. Open and close cam lever, watching for bubbles coming from accumulator check ball hole. When bubbles stop, fill accumulator opening to top with fluid. Grease threads on accumulator and opening with 2-4-C with Teflon. Start accumulator in threads and open cam lever (Down Position). Torque accumulator to 35 lb–ft (47 Nm).

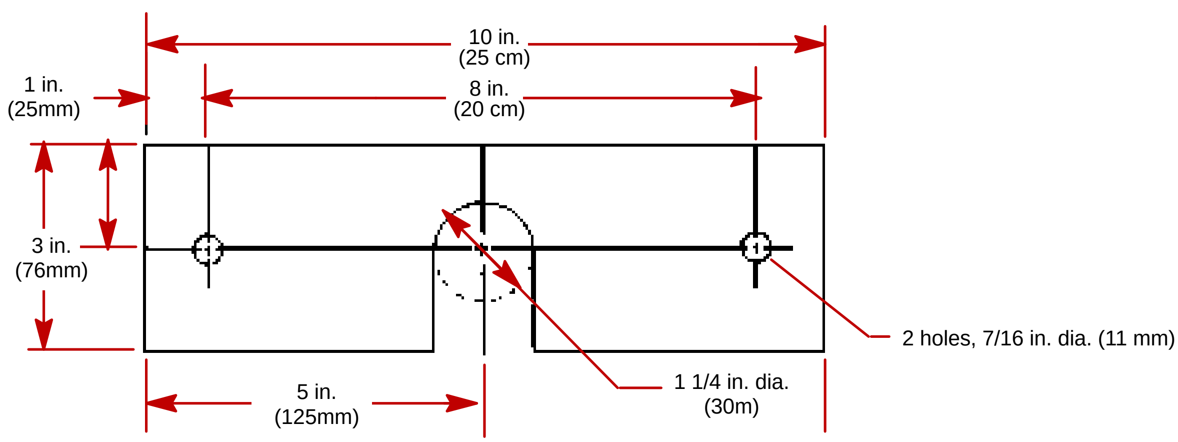


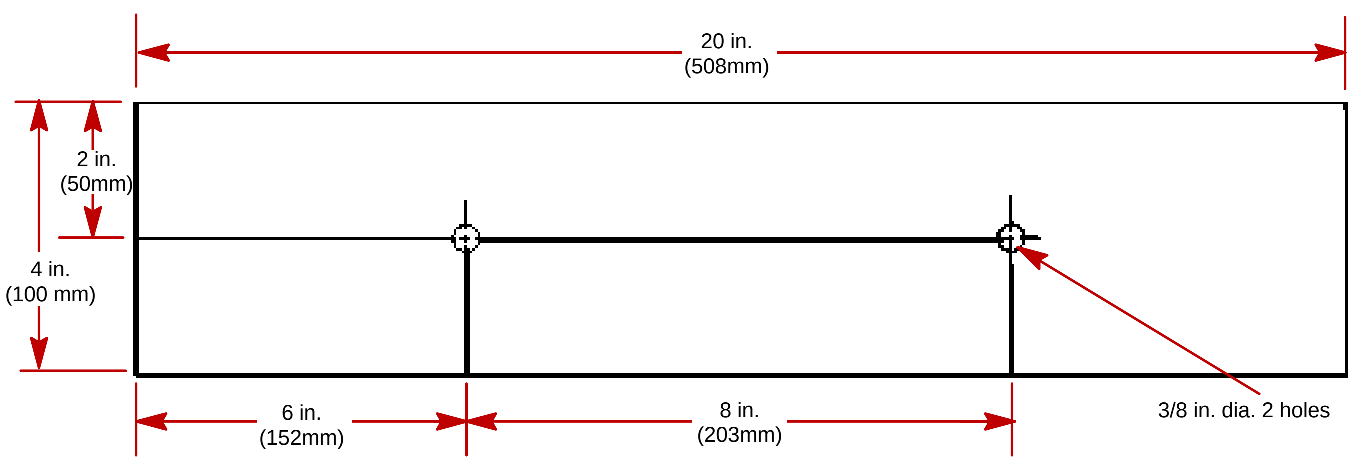
a - Accumulator
b - Cam Lever (Down Position)

NOTE: *If filling procedure is done correctly, it should be hard to turn cylinder rod assembly by hand.*

Filling Procedure Option Two Instructions for Making Retaining Tool





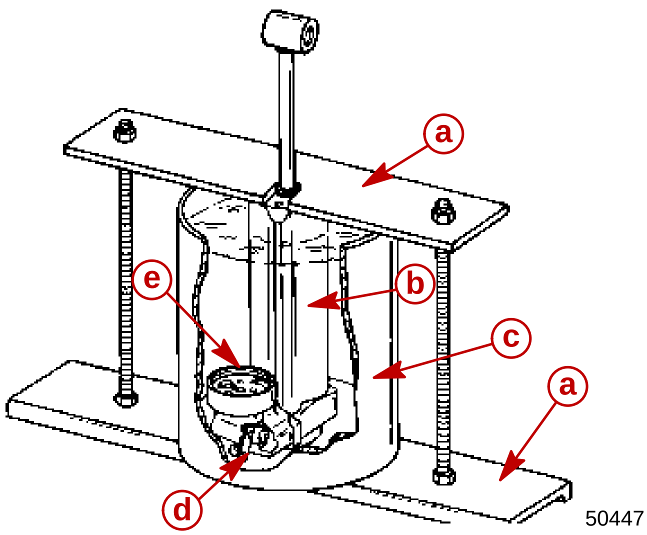


Bleeding Manual Tilt System

IMPORTANT: While bleeding tilt system, time must be allowed between each stroke to allow air bubbles to dissipate.

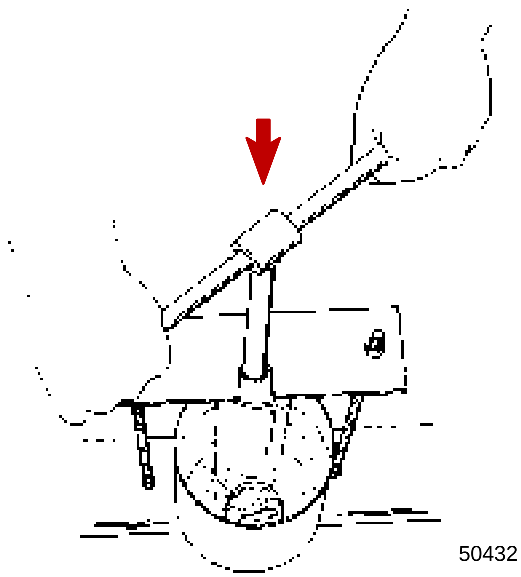
1. With shock rod in the full up position and manifold cam lever open (facing down), secure tilt system to retaining tool and container. (A No. 10 can or 3 lb coffee can could be used.)
2. Fill container to near full level using Quicksilver Power Trim and Steering Fluid. If not available, use automotive (ATF) automatic transmission fluid.

IMPORTANT: Fluid level must remain above accumulator opening during bleeding process.

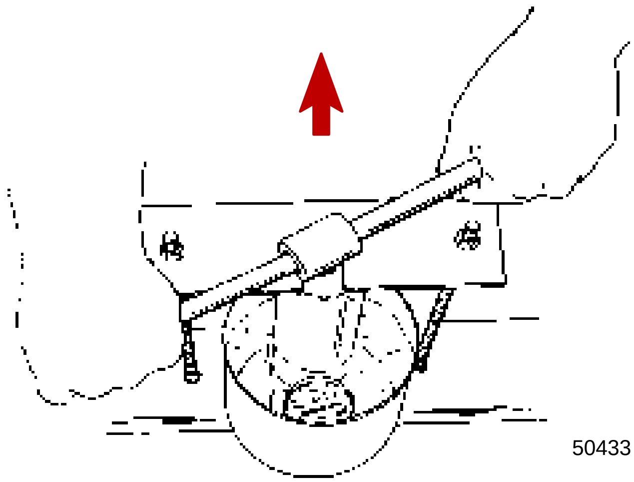


a - Retaining Tool
b - Tilt System
c - Container
d - Cam Lever
e - Accumulator Opening

3. Bleed unit by pushing rod down slowly (18-20 seconds per stroke) until stopped at base. Wait until all air bubbles exit accumulator base.



4. During up stroke, pull up on rod slowly 3 in. (76 mm) from base.
5. Wait until all air bubbles to exit accumulator base.



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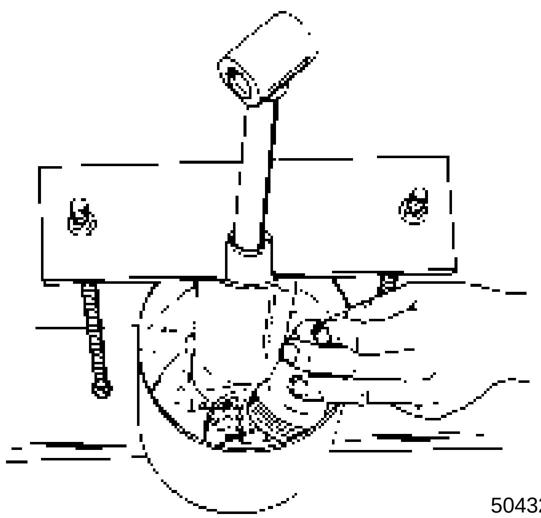
6. Slowly cycle unit 5-8 times (round trip per cycle) using short strokes 3 in. (76 mm) from base allowing bubbles to disappear during each stroke.
7. Allow unit to stand five minutes, then proceed to cycle unit 2-3 more times using short strokes. No air bubbles should appear from accumulator port at this time.
8. With oil level well above accumulator port, slowly pull rod to full up position.
9. Install accumulator making sure air bubbles do not enter system.
10. Tighten accumulator snugly at this time.



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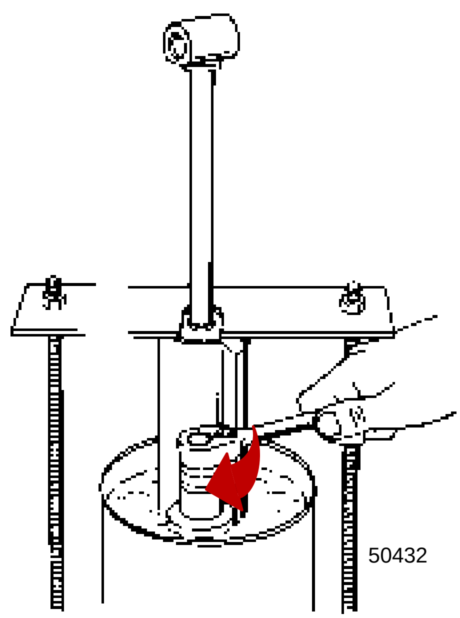

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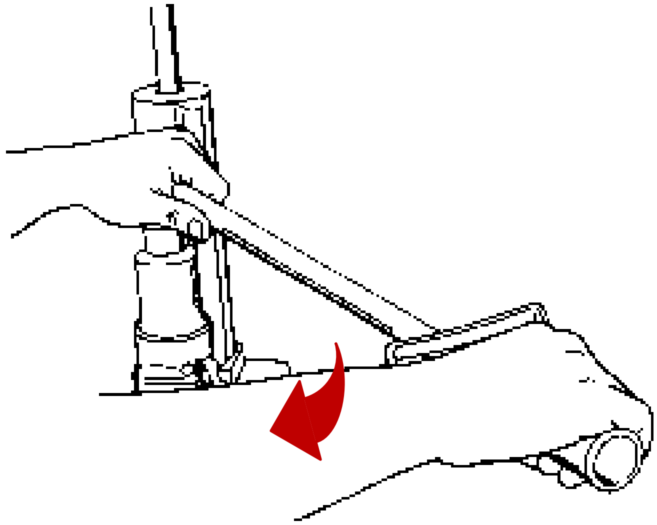
11. With cam lever remaining open (facing down), remove tilt assembly from oil and secure in soft jawed vise. Torque accumulator to 35 lb-ft (47 Nm).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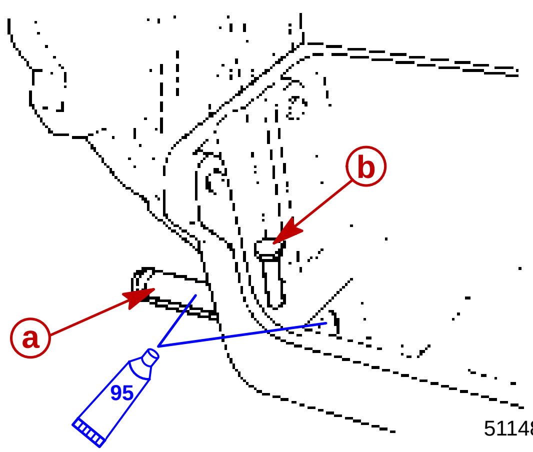
Manual Tilt System Installation

1. Apply 2-4-C Marine Lubricant to lower pivot pin hole and pivot pin surface.
2. Start lower pivot pin into pivot pin hole and position lower dowel pin (retained) in its hole.
3. Reinstall manual tilt system, bottom first. Reconnect release valve link rod.



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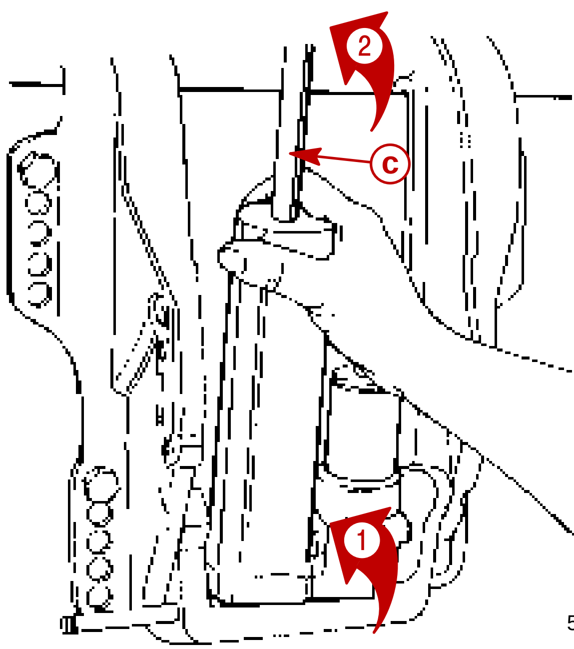

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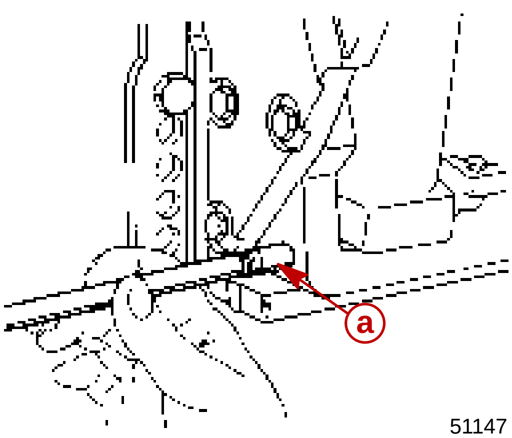
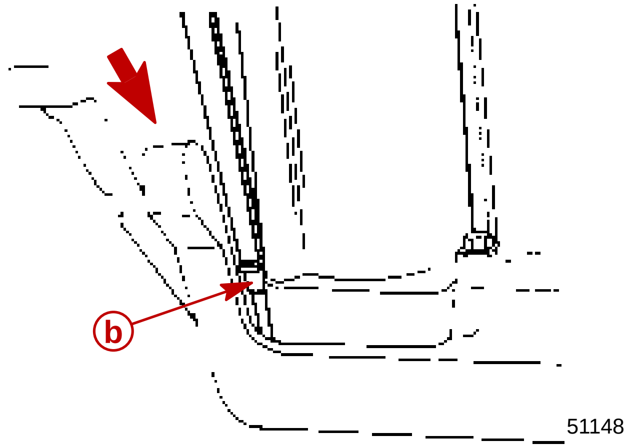
95 2-4-C w/Teflon (92-850736A1)

a - Lower Pivot Pin
b - Lower Dowel Pin
c - Manual Tilt System

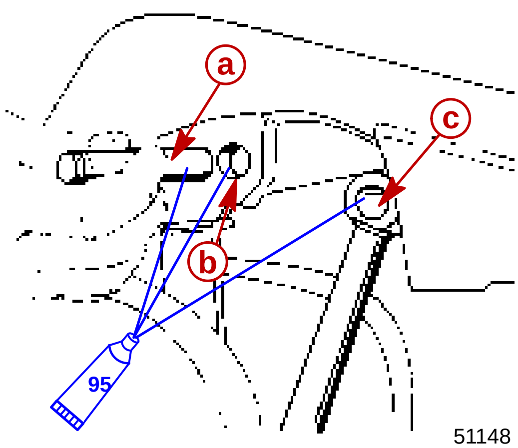
4. Using a suitable punch, drive lower pivot pin into clamp bracket and trim cylinder assembly until pivot pin is flush with outside surface.
5. Using a punch, drive lower dowel pin in until seated.

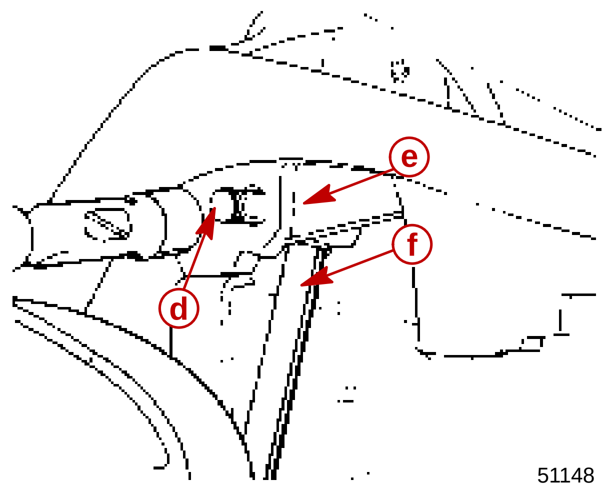




a - Lower Pivot Pin
b - Lower Dowel Pin

6. Apply 2-4-C Marine Lubricant to surface of upper pivot pin, pivot pin hole and shock rod hole.
7. Using a mallet, drive upper pivot pin into swivel bracket and through shock rod until pivot pin is flush with swivel bracket.

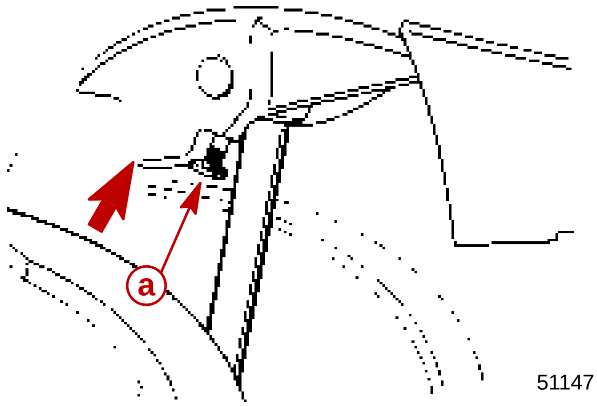




95 2-4-C w/Teflon (92-850736A1)

a - Pivot Pin
b - Pivot Pin Bore
c - Shock Rod Bore
d - Pivot Pin
e - Swivel Bracket
f - Shock Rod

8. Drive upper dowel pin (a) into its hole until seated.

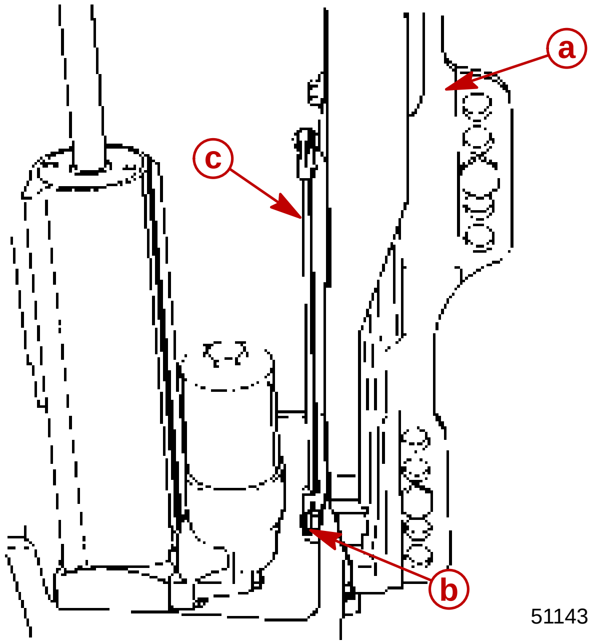


a - Dowel Pin

9. Check manual release cam adjustment. Cam must open and close freely. Adjust link rod as necessary.

Manual Release Valve Adjustment

1. With outboard in full up position, place tilt lock lever forward.
2. Lift cam lever (with link rod) to full up position.



a - Tilt Lock Lever
b - Cam Lever
c - Link Rod

3. Link rod end must snap onto ball of tilt lock lever without moving tilt lock lever or cam lever.

LOWER UNIT

Section 6A - Non-Bigfoot Gear Housing

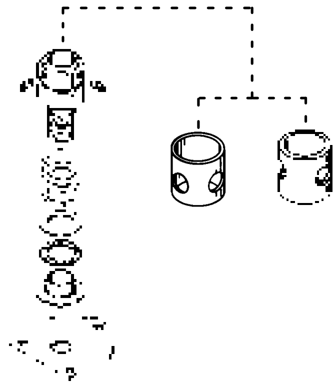
Table of Contents

Specifications

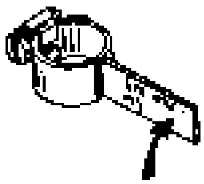
GEAR HOUSING (1.83:1)	**Gear Ratio**	1.83:1
	Gearcase Capacity	11.5 fl oz (340 mL)
	Lubricant Type	Quicksilver Gear Lube-Premium Blend
	Forward Gear	
	Number of Teeth	22 Spiral/Bevel
	Pinion Gear	
	Number of Teeth	12 Spiral/Bevel
	Pinion Height	0.025 in. (0.64 mm) Pinion Gear Locating Tool (91-817008A2)
	Forward Gear Backlash	0.011-0.017 in. (0.28-0.43 mm) Backlash Indicator Tool (91-19660--1) MARK #4 or 0.366 in. (9.3 mm)
	Water Pressure (Warm Engine)	
	@ 800 rpm	1-3 psi (7-21 kPa)
	@ 6000 rpm (WOT)	12-25 psi (83-172 kPa)
	Leak Test Pressure	10-12 psi (68-83 kPa) for 5 Minutes

Special Tools

1. Bearing Preload Tool 91-14311A2

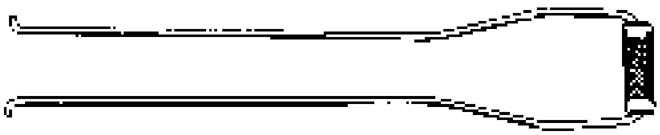


2. Backlash Indicator Tool 91-19660--1

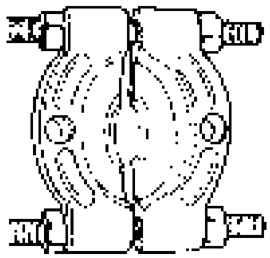


19660-1

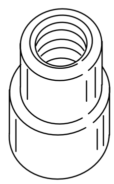
3. Puller 91-27780



4. Universal Puller Plate 91-37241

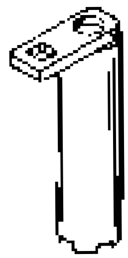


5. Driver Head 91-37312.

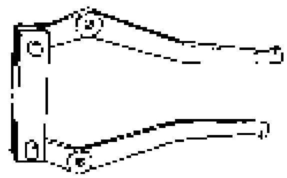


6. Driver Rod (91-37323)

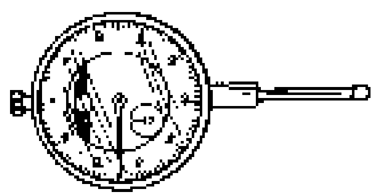
7. Bearing Retaining Tool 91-43506.



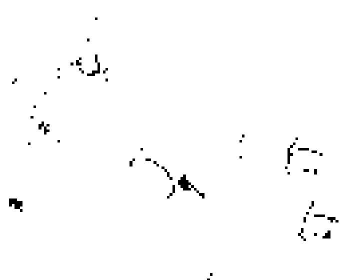
8. Puller Jaws (91-46086A1)



9. Dial Indicator (91-58222A1)



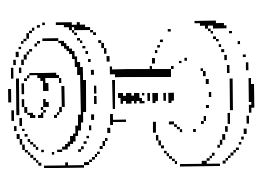
10. Dial Indicator Adaptor Kit (91-83155)



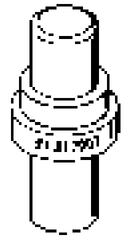
11. Puller Bolt (91-85716)

12. Forward Gear Bearing Installer 91-817005.

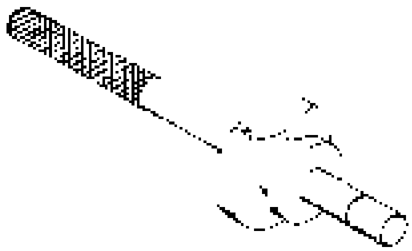
13. Water Pump Base Seal Installer 91-817006.



14. Bearing Carrier Seal Installer 91-817007.



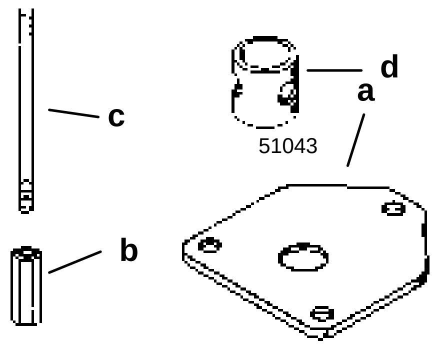
15. Pinion Gear Location Tool 91-817008A2.



16. Forward Gear Bearing Race Driver Cup 91-817009.

17. Needle Bearing Installer 91-817011.

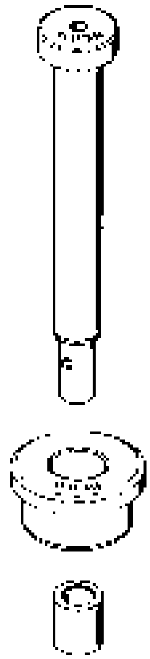
18. Backlash Indicator Tool 91-817057A1.



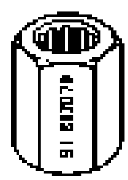
Ref.	Description	Qty.
a	Plate	1
b	Nut	1
c	Stud	1
d	Sleeve	1

91-817057A-1 Update Kit (Converts 91-14311A-1 Bearing Preload Kit Tool to a 91-14311A-2)

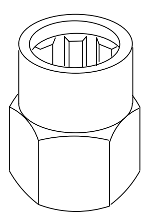
19. Lower Driveshaft Bearing Driver Assembly 91-817058A1.



20. Driveshaft Holding Tool 91-817070 55/60 (2–stroke).



21. Driveshaft Holding Tool 91-877840A1 50/60 (4–stroke).

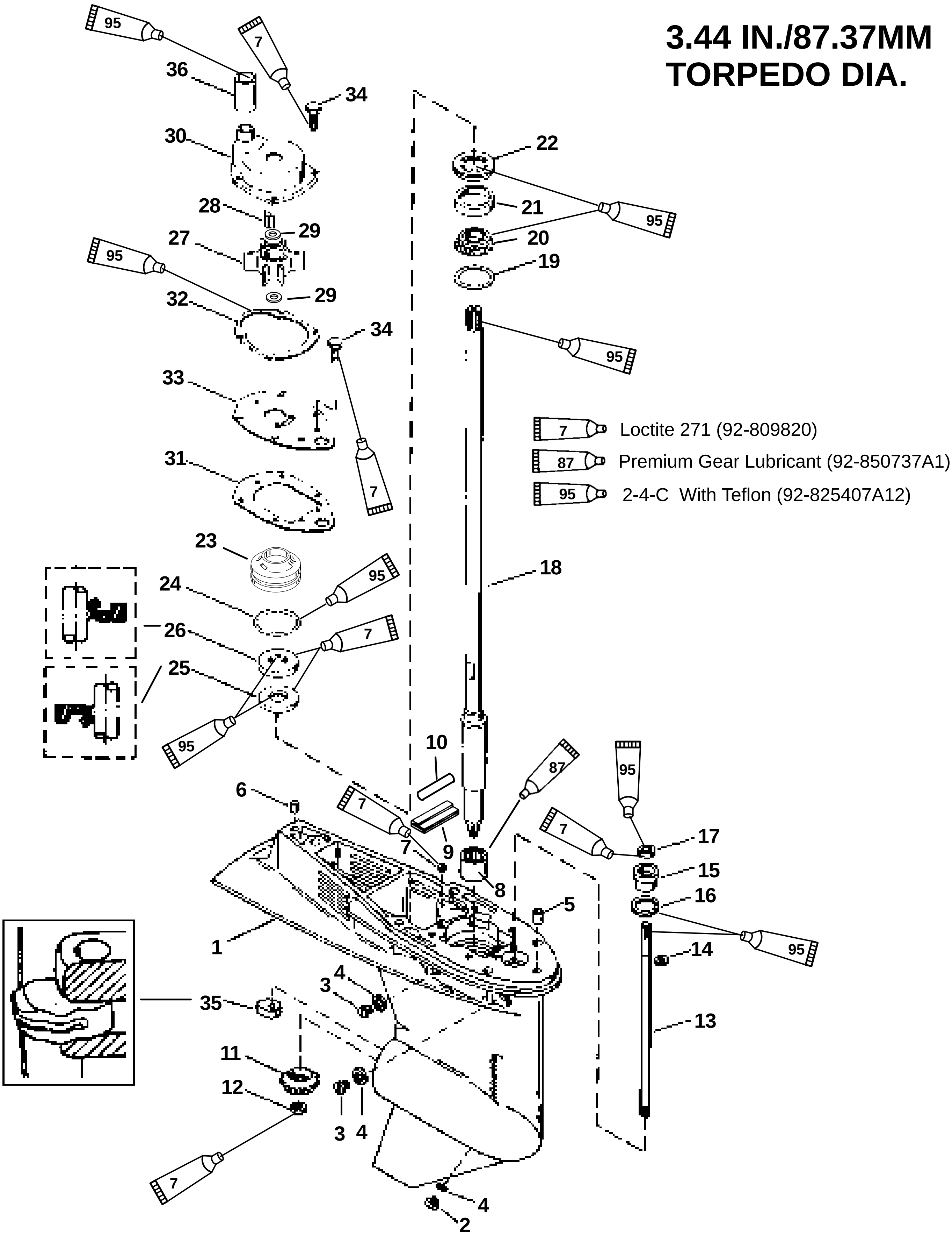


Quicksilver Lubricants and Service Aids

Part No.	Description
92-809820	Loctite “271”
92-90113--2	RTV Silicone Sealer
92-850737A1	Premium Blend Gear Lubricant
92-850735A1	Anti-Corrosion Grease
92-850736A1	2-4-C w/Teflon

GEAR HOUSING (DRIVE SHAFT)(1.83:1 GEAR RATIO)

3.44 IN./87.37MM TORPEDO DIA.



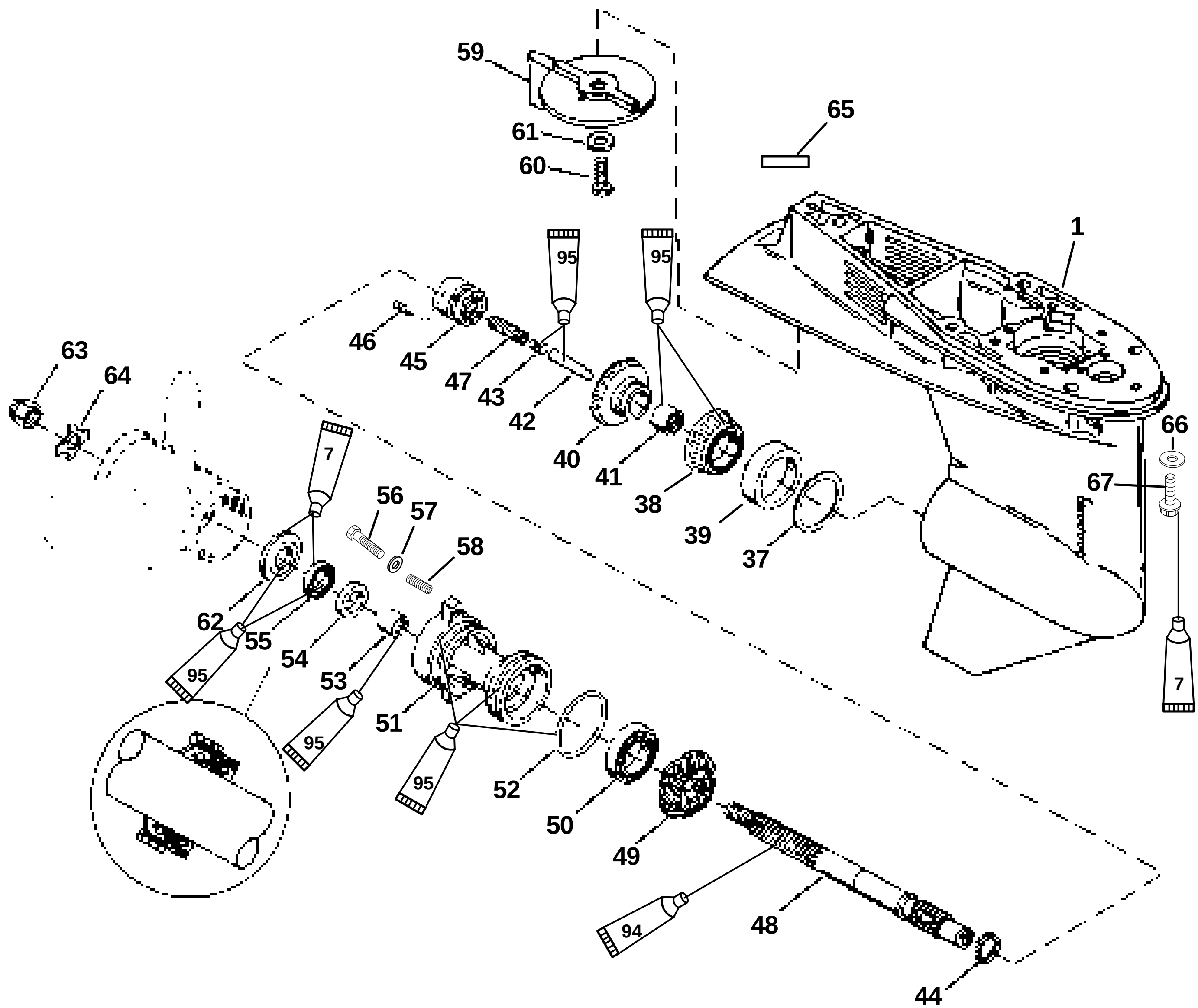
7	Loctite 271 (92-809820)
87	Premium Gear Lubricant (92-850737A1)
95	2-4-C With Teflon (92-825407A12)

GEAR HOUSING (DRIVE SHAFT)(1.83:1 GEAR RATIO)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	GEAR HOUSING			
2	1	DRAIN SCREW	58		6.5
3	2	SCREW	58		6.5
4	3	WASHER-sealing			
5	1	DOWEL PIN			
6	1	DOWEL PIN			
7	1	PIPE PLUG			
8	1	ROLLER BEARING			
9	1	SEAL KIT			
10	1	FILLER PLATE			
11	1	PINION GEAR (14 TEETH)			
12	1	NUT		50	67.8
13	1	SHIFT SHAFT ASSEMBLY			
14	1	RETAINING RING			
15	1	BUSHING ASSEMBLY			
16	1	O-RING			
17	1	OIL SEAL			
18	1	DRIVE SHAFT			
19	AR	SHIM SET **(SIZES 006 THRU 038)**			
20	1	TAPERED ROLLER BEARING			
21	1	CUP			
22	1	NUT		75	101.7
23	1	WATER PUMP BASE			
24	1	O-RING			
25	1	OIL SEAL			
26	1	OIL SEAL			
27	1	IMPELLER			
28	1	KEY			
29	2	WASHER			
30	1	WATER PUMP			
31	1	GASKET **(LOWER)**			
32	1	GASKET **(UPPER)**			
33	1	FACE PLATE			
34	6	SCREW (M6x16)	60		6.8
35	1	SHIFT CAM			
36	1	COUPLER			

GEAR HOUSING (PROP SHAFT)(1.83:1 GEAR RATIO)

3.44 IN./87.37MM TORPEDO DIA.



7 Loctite 271 (92-809820)

94 Anti-Corrosion Grease (92-78376A6)

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

GEAR HOUSING (PROP SHAFT)(1.83:1 GEAR RATIO)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	GEAR HOUSING			
37	AR	SHIM SET **(SIZES 006 THRU 048)**			
38	1	TAPERED ROLLER BEARING			
39	1	CUP			
40	1	FORWARD GEAR (23 TEETH)			
41	1	ROLLER BEARING			
42	1	CAM FOLLOWER			
43	1	SLIDE			
44	1	SPRING			
45	1	CLUTCH			
46	1	CROSS PIN			
47	1	SPRING			
48	1	PROPELLER SHAFT			
49	1	REVERSE GEAR (23 TEETH)			
50	1	BALL BEARING			
51	1	BEARING CARRIER ASSEMBLY			
52	1	O-RING			
53	1	ROLLER BEARING			
54	1	OIL SEAL			
55	1	OIL SEAL			
56	2	SCREW (M8x30)	225	18.8	25.5
57	2	WASHER			
58	2	THREADED INSERT			
59	1	TRIM TAB			
60	1	SCREW (M10 x 30)	186		21.0
61	1	WASHER			
62	1	THRUST HUB			
63	1	PROPELLER NUT		55	74.6
64	1	TAB WASHER			
65	1	DECAL- Gear Ratio			
66	4	WASHER			
67	4	SCREW (M10 x 45)		40	54

General Service Recommendations

There may be more than one way to "disassemble" or "reassemble" a particular part(s), therefore, it is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

In many cases, disassembly of a sub-assembly may not be necessary until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly-reassembly sequence.

Threaded parts are right hand (RH), unless otherwise indicated.

When holding, pressing or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel (one that will contact only the bearing race) when pressing or driving bearings.

Whenever compressed air is used to dry a part, verify that no water is present in air line.

Bearings

⚠ WARNING

To avoid personal injury, wear eye protection and regulate air pressure to not more than 25 p.s.i. (172 kPa) when drying bearings with compressed air. Do not spin bearings with compressed air as this may cause bearings to score from lack of lubrication.

All bearings must be cleaned and inspected. Clean bearings with solvent and dry with compressed air. Air should be directed at the bearing so that it passes through the bearing. Do not spin bearing with compressed air (see above warning). After cleaning, lubricate bearings with Quicksilver Gear Lubricant. DO NOT lubricate tapered bearing cups until after inspection.

Inspect all bearings for roughness, catches and bearing race side wear. Work inner bearing race in-and-out, while holding outer race, to check for side wear. When inspecting tapered bearings, determine condition of rollers and inner bearing race by inspecting bearing cup for pitting, scoring, grooves, uneven wear, imbedded particles and/or discoloration from over-heating. Always replace tapered bearing and race as a set.

Inspect gear housing for bearing races that have spun in their respective bores. If race(s) have spun, gear housing must be replaced.

Roller bearing condition is determined by inspecting the surface of the shaft that the roller bearing supports. Check shaft surface for pitting scoring, grooving, imbedded particles, uneven wear and/or discoloration from overheating. The shaft and bearing must be replaced if such a condition exists.

Seals

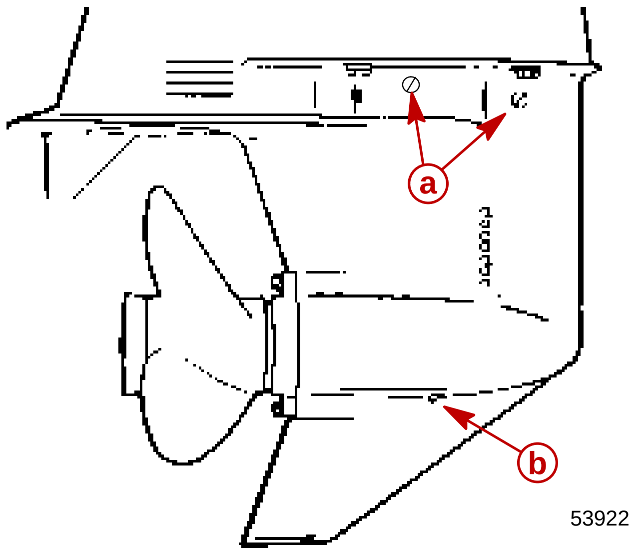
As a normal procedure, all O-rings and oil seals should be replaced without regard to appearance. To prevent leakage around seals, apply Loctite 271 to outer diameter of all seals. When using Loctite on seals or threads, surfaces must be clean and dry. Apply 2-4-C w/Teflon on all O-rings and on I.D. of oil seals. Apply 2-4-C w/Teflon to external surfaces of bearing carrier.

Draining and Inspecting Gear Lubricant

⚠ WARNING

If gear housing is installed on engine, to avoid accidental starting, disconnect (and isolate) spark plug leads from spark plugs before working near the propeller.

1. With gear housing in normal running position, place a clean pan under housing and remove the two vent screws and one fill/drain screw (with gaskets).



a - Vent Plug
b - Fill/Drain Plug

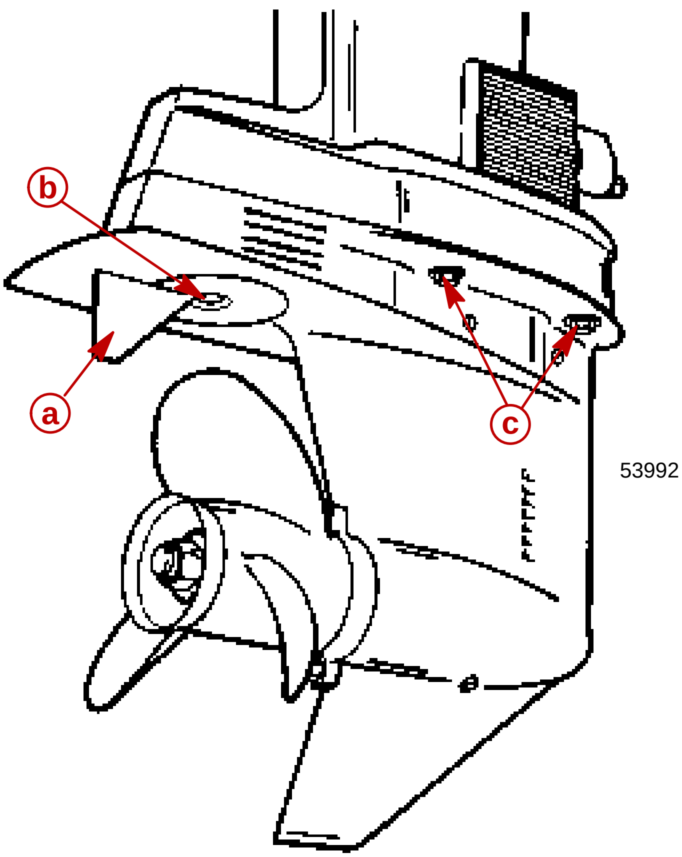
2. Inspect gear lubricant for metal particles (lubricant will have a "metal flake" appearance). Presence of fine metal particles (resembling powder) in the drain pan indicates normal wear. The presence of metal chips in the drain pan indicates the need for gear housing disassembly and component inspection.
3. Note color of gear lubricant. White or cream color MAY indicate presence of water in lubricant. Gear lubricant which has been drained from a gear case recently in operation will have a yellowish color due to lubricant agitation/aeration. Gear lube which is mixed with assembly lubricant (Special Lube 101 or 2-4-C w/Teflon) will also be creamy white in color. This is normal and should not be confused with the presence of water. If water is suspected to be present in gearcase, a pressure check of gearcase should be made (with no lubricant in gearcase). Gearcase should hold 10-12 psi of pressure for 5 minutes without leaking down. Pouring a portion of the gear lubricant into a glass jar and allowing the lubricant to settle will allow any water in the lube to separate and settle to the bottom of the jar.
4. Presence of water in gear lubricant indicates the need for disassembly and inspection of oil seals, seal surfaces, O-rings, water pump gaskets, bearings and bearing surfaces, as well as gear housing components. If gearcase is rebuilt, gearcase should be pressure checked before filling with lubricant.

Removal

WARNING

To prevent accidental engine starting, remove (and isolate) spark plug leads from spark plugs before removing gear housing.

1. Remove (and isolate) spark plug leads from spark plugs.
2. Shift engine into forward gear.
3. Tilt engine to full "Up" position.
4. Remove 4 bolts and washers, two from each side.
5. Remove trim tab.
6. Remove locknut and washer in trim tab recess.
7. Remove gear housing.



a - Trim Tab
b - Locknut and Washer
c - Bolts(4) M10 x 45 and Washers(4)

Disassembly

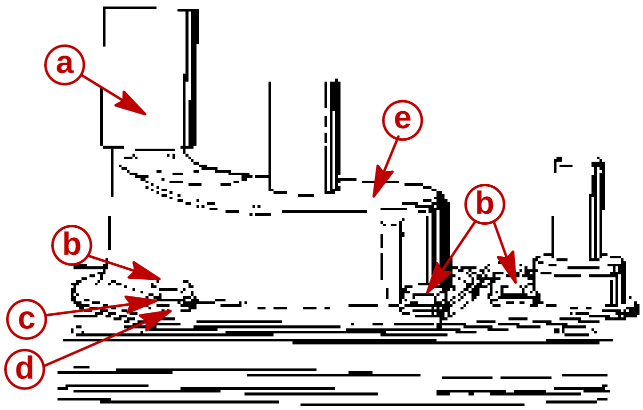
Water Pump

NOTE: *If water tube seal stayed on water tube (inside of drive shaft housing) when gear housing was removed, pull water tube seal from water tube.*

1. Replace water tube seal, if damaged.
2. Remove 6 screws, washers, and isolators (Design 1).
3. Remove cover.

NOTE: *Isolators from forward 2 screws are shorter than the other isolators. Retain these for proper reassembly (Design 1).*

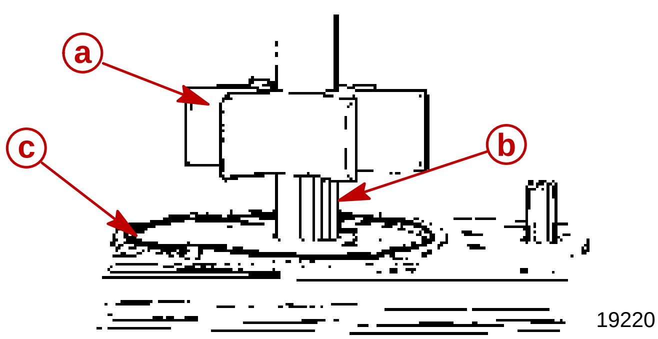
NOTE: *Design 1 included isolators on the water pump housing screws. Newer design versions did not use these isolators.*



a - Water Tube Seal
b - Screw (6) M6x30
c - Washers (6)
d - Isolators (6) If so equipped
e - Cover

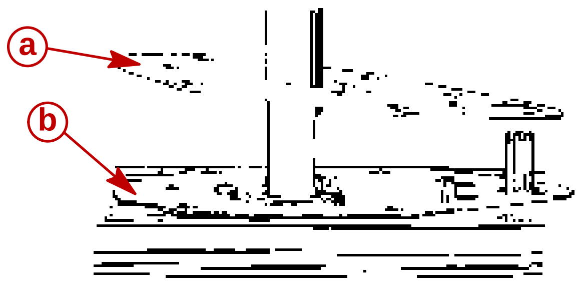
IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting cover and plate, as the depth of the groove will not affect water pump output.

4. Replace cover if thickness of steel at the discharge slots is 0.060 in. (1.524 mm) or less, or if groove(s) (other than impeller sealing bead groove) in cover roof are more than 0.030 in. (0.762 mm) deep.
5. Lift impeller, drive key, and gasket from drive shaft.



a - Impeller
b - Drive Key
c - Gasket

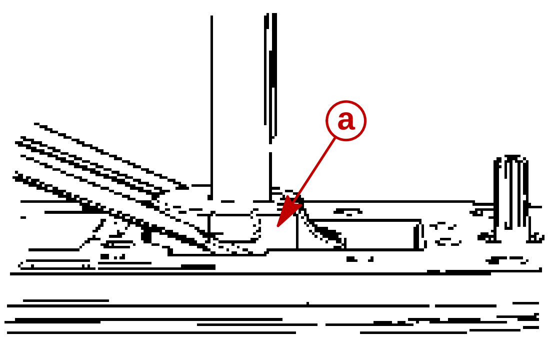
6. Inspect impeller. Replace impeller if any of the following conditions exist:
   - Impeller blade(s) are cracked, torn, or worn.
   - Impeller is glazed or melted (caused by operation without sufficient water supply).
   - Rubber portion of impeller is not bonded to impeller hub.
7. Remove plate and gasket.
8. Replace plate if groove(s) (other than impeller sealing bead groove) in plate are more than 0.030 in. (0.762 mm) deep.



a - Plate
b - Gasket

Old Style Base

9. Remove water pump base by lifting gently as shown. Inspect carefully for cracks.



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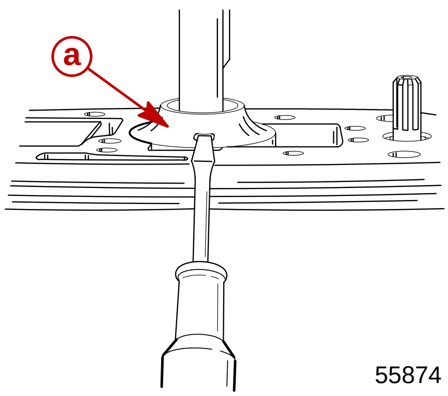
a - Water Pump Base

New Style Base

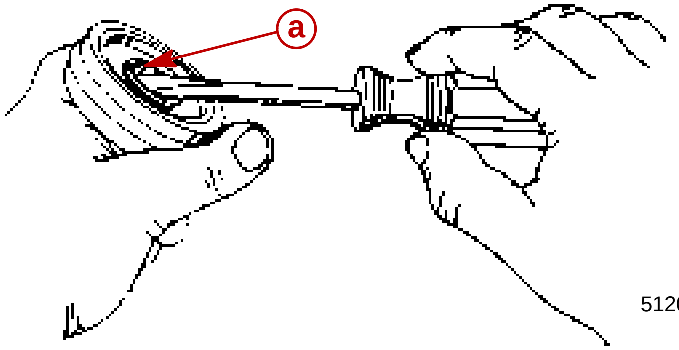
10. Remove water pump base by lifting gently as shown. Inspect carefully for cracks.



55874

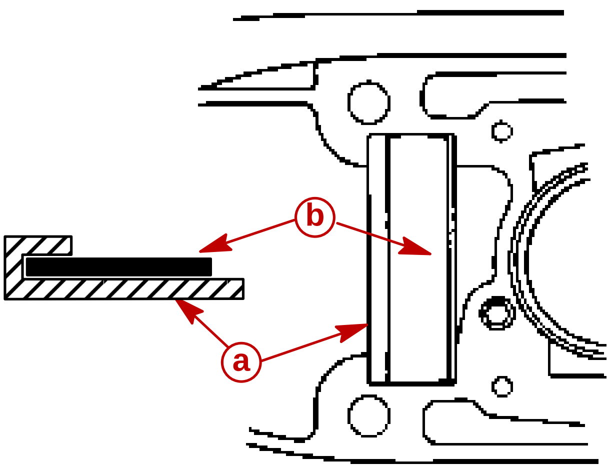
a - Water Pump Base

11. Remove (and discard) seals, if damaged. Secure the base to a bench top or **lightly** clamp base in vise when removing seals.



a - Seals

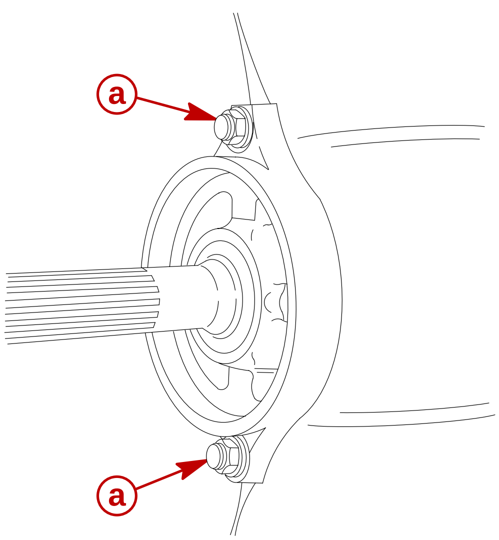
12. Remove seal and plate if damaged or worn.



a - Seal
b - Plate

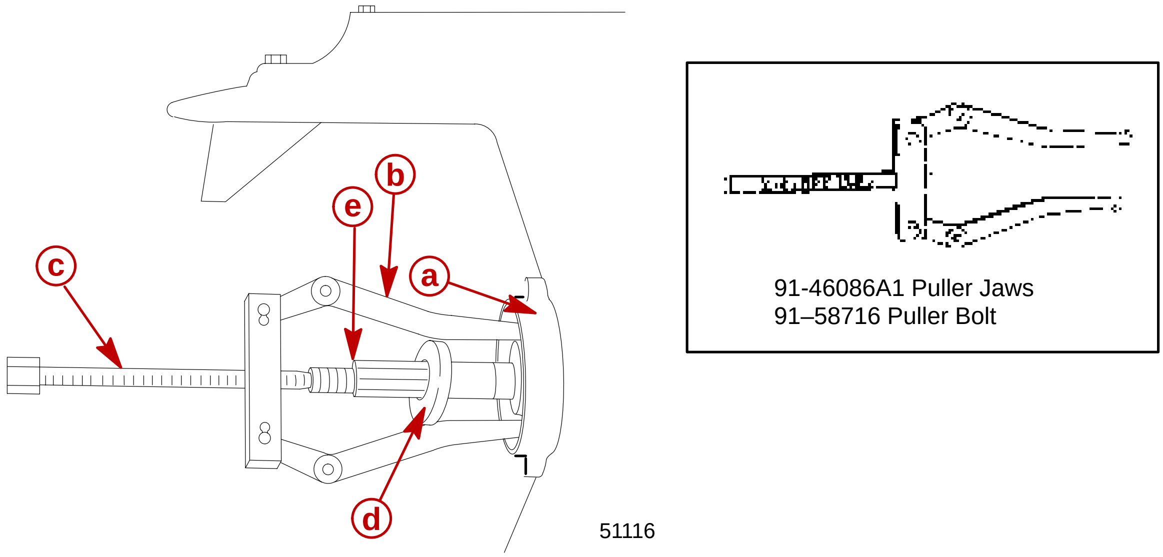
Bearing Carrier and Propeller Shaft

1. Remove fasteners.



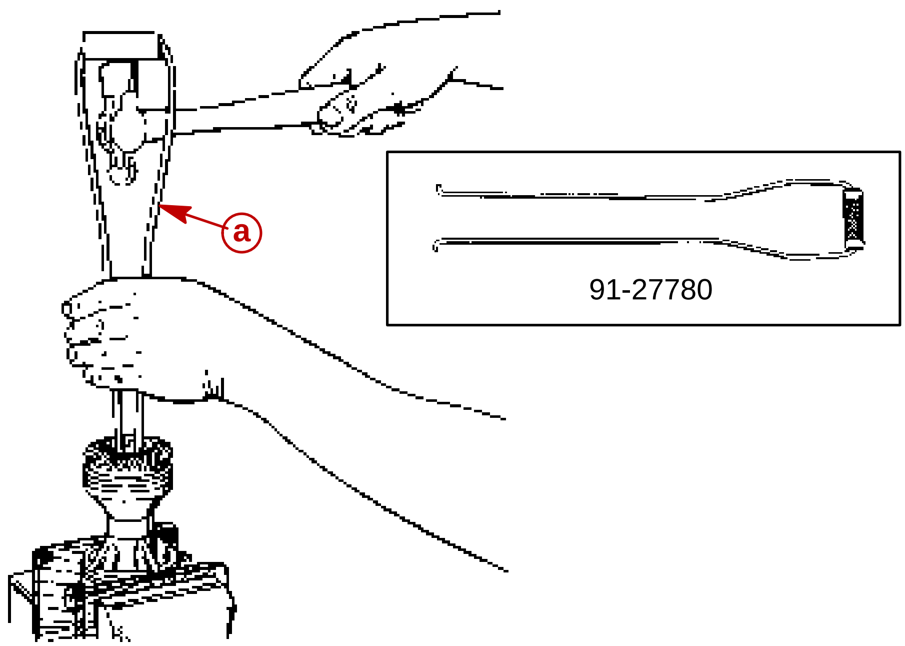
a - Fasteners

2. With propeller shaft horizontal, use bearing puller to remove carrier from gear housing. Remove propeller shaft components as an assembly, taking care not to lose cam follower.



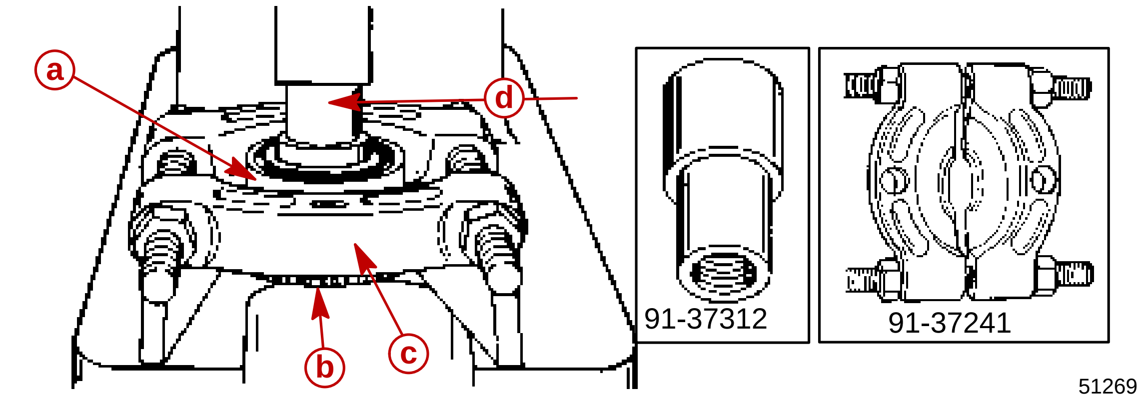
a - Bearing Carrier
b - Puller Jaws (91-46086A1)
c - Puller Bolt (91-85716)
d - Thrust Hub
e - Propeller Shaft

3. Replace reverse gear if gear teeth or clutch teeth on reverse gear are chipped or worn. If reverse gear must be replaced, pinion and sliding clutch should also be inspected for damage.
4. If reverse gear bearing is rusted or does not roll freely, replace bearing. Remove bearing and reverse gear using bearing puller.



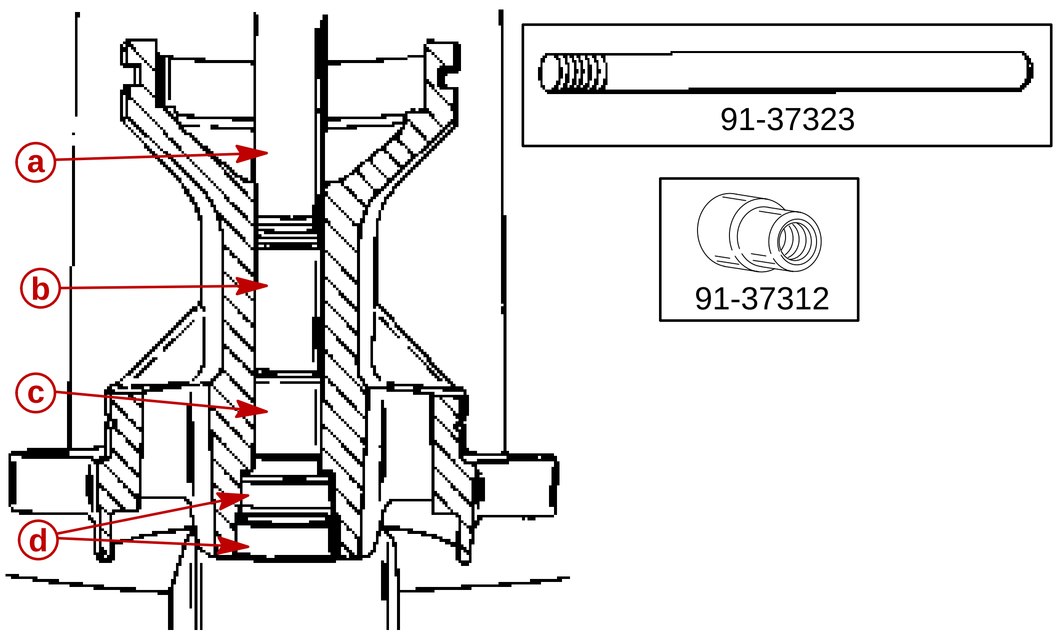
a - Bearing Puller (91-27780)

5. Remove ball bearing from reverse gear using Universal Puller Plate and mandrel.



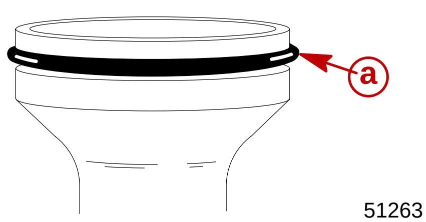
a - Ball Bearing
b - Reverse Gear
c - Universal Puller Plate (91-37241)
d - Driver Head (91-37312)

6. If bearing is rusted or does not roll freely, replace bearing. Remove bearing and oil seals. Discard oil seals.



a - Driver Rod (91-37323)
b - Driver Head (91-37312)
c - Propeller Shaft Needle Bearing
d - Oil Seals (2)

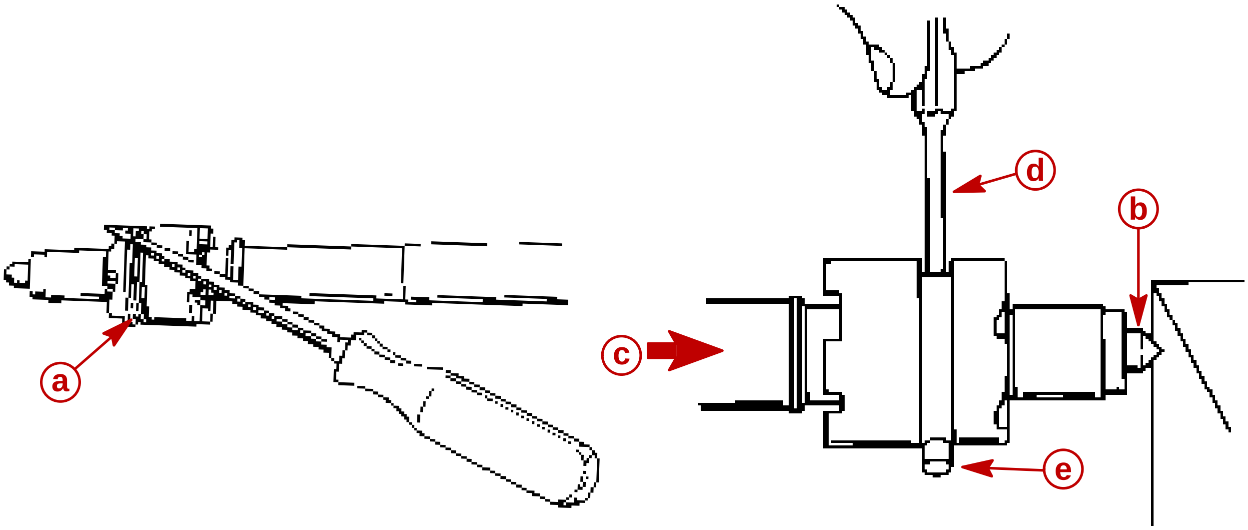
7. Remove propeller shaft seals and bearing carrier O-ring.



a - O-ring

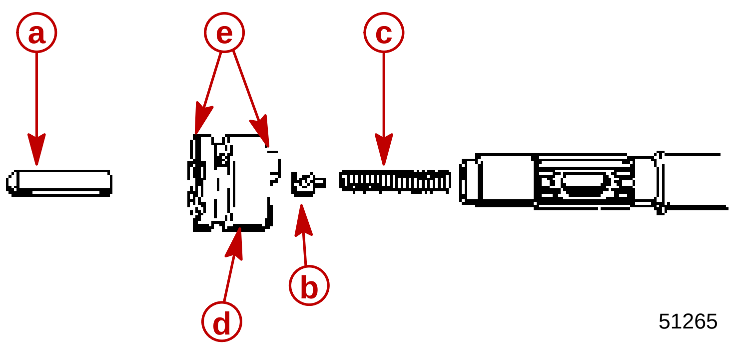
Propeller Shaft Disassembly

1. Remove spring. Push out cross pin.



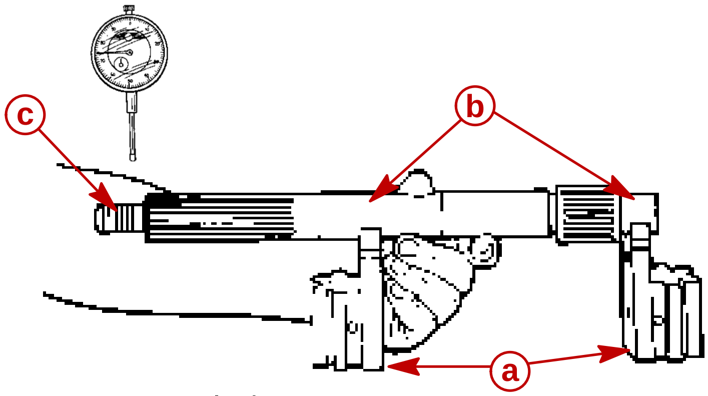
a - Spring
b - Cam Follower
c - Apply Pressure as Shown
d - Punch
e - Cross Pin

2. Replace cam follower if worn or pitted on either end.
3. Replace sliding clutch if jaws are rounded or chipped. Rounded jaws indicate the following:
   - Improper shift cable adjustment.
   - Engine idle speed too high while shifting.
   - Shifting too slowly.



a - Cam Follower
b - Guide Block
c - Spring
d - Sliding Clutch
e - Jaws

4. Check bearing surfaces of propeller shaft. If shaft is worn/pitted, replace shaft and corresponding bearing.
5. Replace propeller shaft if:
   a. Splines are twisted or worn.
   b. Bearing surfaces of propeller shaft are pitted or worn.
   c. Oil seal surface is grooved in excess of 0.005 in. (0.12mm).
   d. Shaft has a noticeable “wobble” or is bent more than 0.006 in. (.152 mm). Check with a dial indicator and V-blocks.



51139

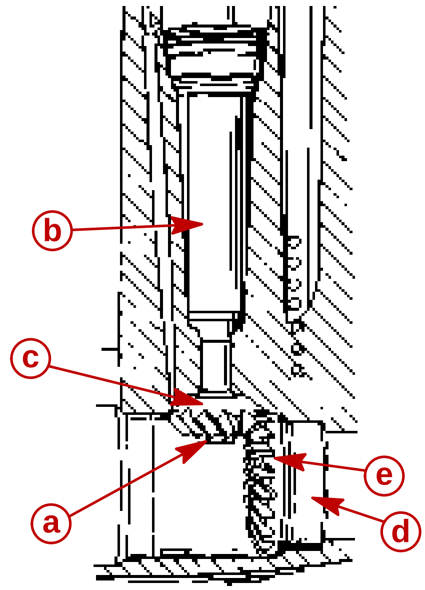
a - V-Blocks
b - Bearing Surfaces
c - Check with Dial Indicator Here

Pinion Gear, Driveshaft and Forward Gear

1. Hold driveshaft using Driveshaft Holding Tool. Remove (and discard) pinion nut.

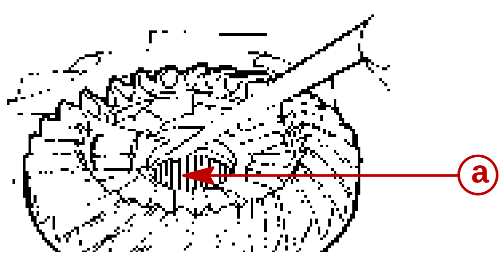
Model	Drive Shaft Holding Tool
40/50/60 (4-Stroke)	91-877840A1
55/60 Bigfoot (2–Stroke)	91-817070

2. Remove driveshaft, pinion gear, and forward gear.
3. Replace pinion gear if chipped or worn.
4. Replace lower driveshaft bearing if rusted or damaged; or does not roll freely. To remove, refer to “Lower Driveshaft Bearing”, following.
5. Replace forward gear if gear teeth are chipped or worn.



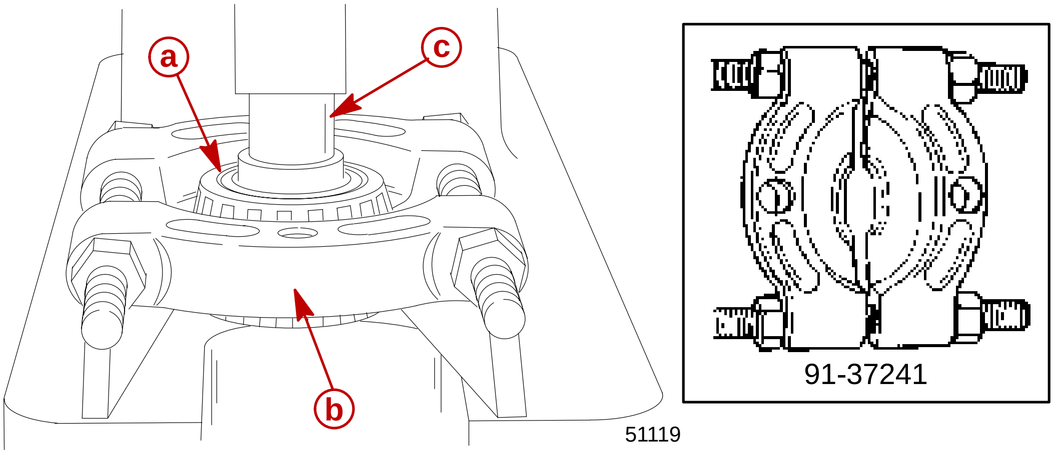
a - Pinion Nut
b - Driveshaft
c - Pinion Gear
d - Bearing
e - Forward Gear

6. Replace forward gear needle bearing if rusted or does not roll freely after cleaning in solvent. Remove as shown.



a - Needle Bearing

7. Replace forward gear tapered roller bearing and race if either bearing or race are rusted or damaged; or if bearing does not roll freely after cleaning in solvent. Remove bearing from gear using Universal Puller Plate and Mandrel. To remove race, refer to “Forward Gear Bearing Race”, following.

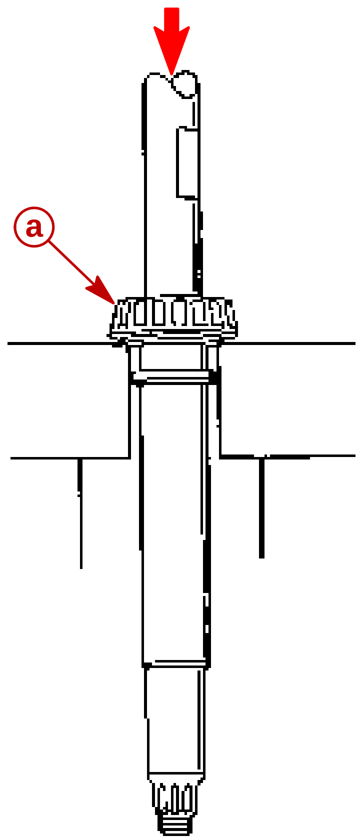


51119

a - Bearing/Race
b - Puller Plate (91-37241)
c - Mandrel

Upper Driveshaft Bearing

1. Replace bearing and race if either bearing or race are rusted or damaged; or if bearing does not roll freely after cleaning in solvent.

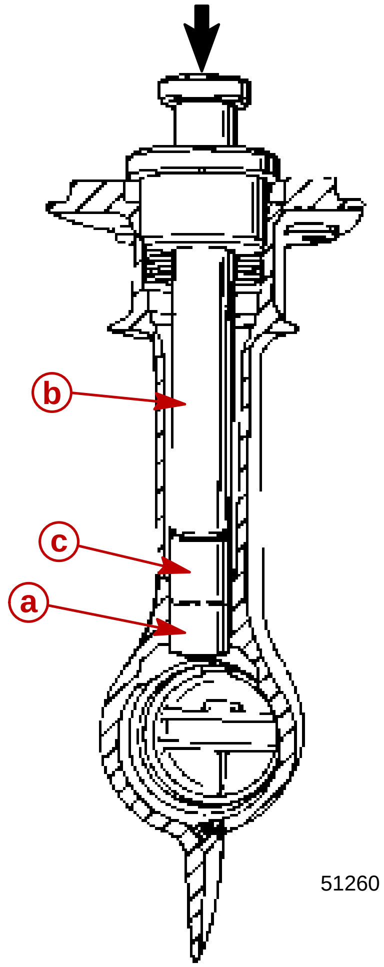


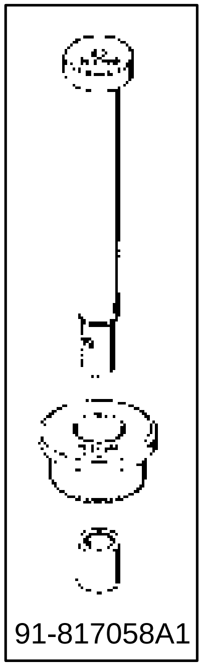
51271

a - Bearing

Lower Driveshaft Bearing

1. Remove lower driveshaft bearing using tool (91-817058A1) with bushing installed.



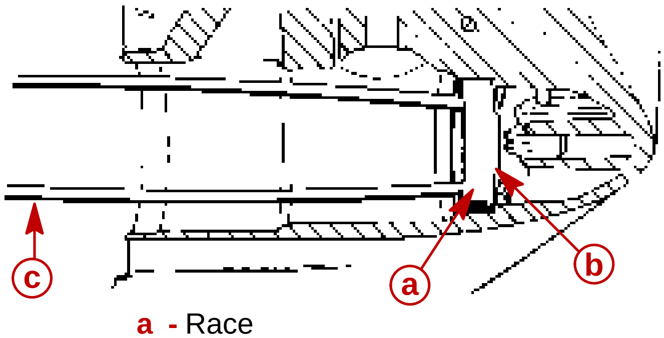


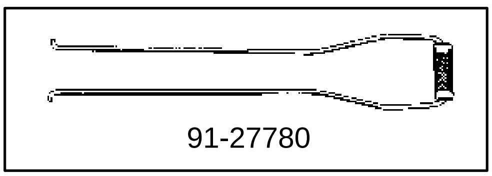
a - Bearing
b - Removal Tool (91-817058A1)
c - Bushing

Forward Gear Bearing Race

IMPORTANT: Retain shim(s) for re-assembly.

1. Remove race and shim(s) using bearing puller.

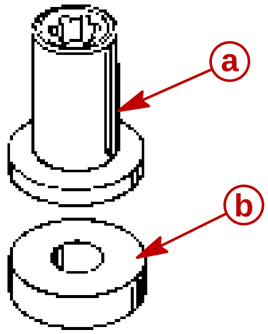




a - Race
b - Shim(s)
c - Bearing Puller (91-27780)

Shift Shaft

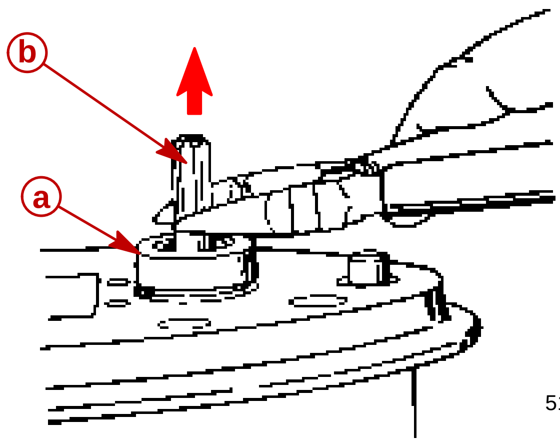
1. Remove shift shaft coupler and spacer.



51271

a - Coupler
b - Spacer

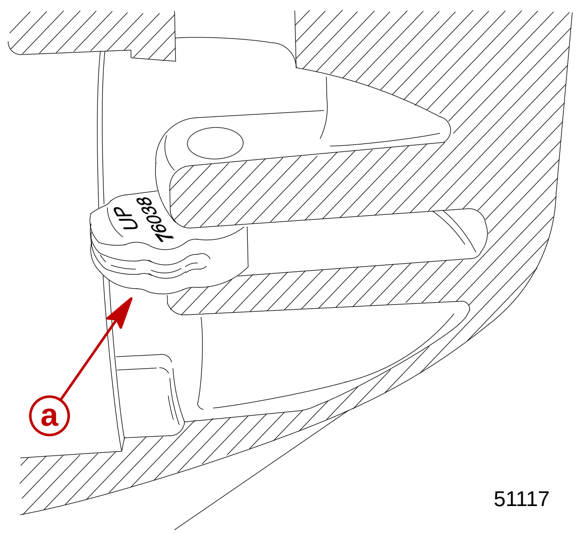
2. Remove shift shaft bushing and shift shaft. Protect shift shaft to prevent spline damage.



51205

a - Shift Shaft Bushing
b - Shift Shaft

3. Remove shift shaft cam, replace if worn.

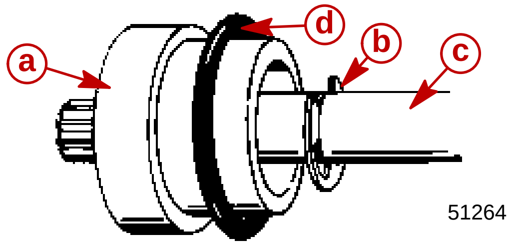


51117

a - Shift Shaft Cam (55/60 2–Stroke shown)

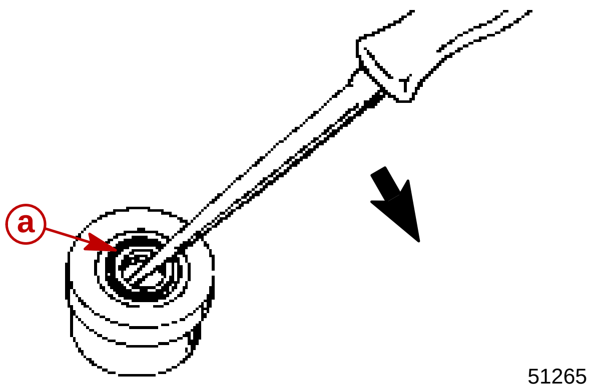
NOTE: *Remove any burrs or sharp edges on the shift shaft splines before removing the shift shaft bushing.*

4. Remove shift shaft bushing and “E” clip from shift shaft. Replace shift shaft if splines are twisted or damaged on either end of shaft. Remove (and discard) O-ring if damaged.



a - Shift Shaft Bushing
b - “E” Clip
c - Shift Shaft
d - O-ring

5. Remove (and discard) seal if damaged.

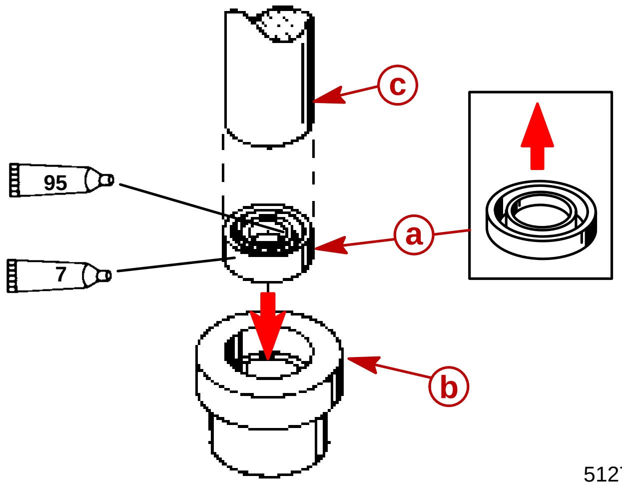


a - Seal

Gear Housing Reassembly

Shift Shaft

1. Apply Loctite 271 on O.D. of new seal. Install with seal lip up, as shown.
2. Press seal into shift shaft bushing until seal bottoms. Use a suitable tool.
3. Apply 2-4-C w/Teflon on O-ring and I.D. of seal.



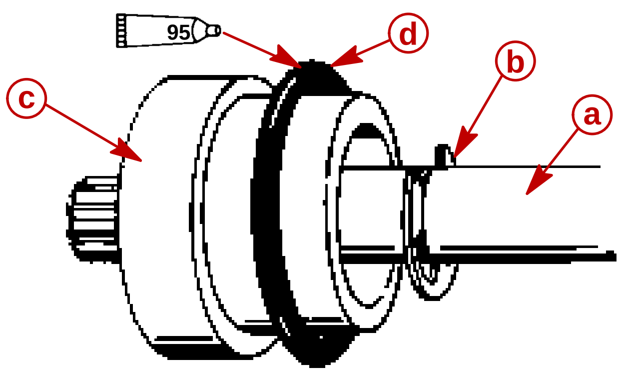
51270

7 Loctite 271 (92-809820)

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

a - Seal Lips Facing Up
b - Shift Shaft Bushing
c - Tool

4. Assemble components.

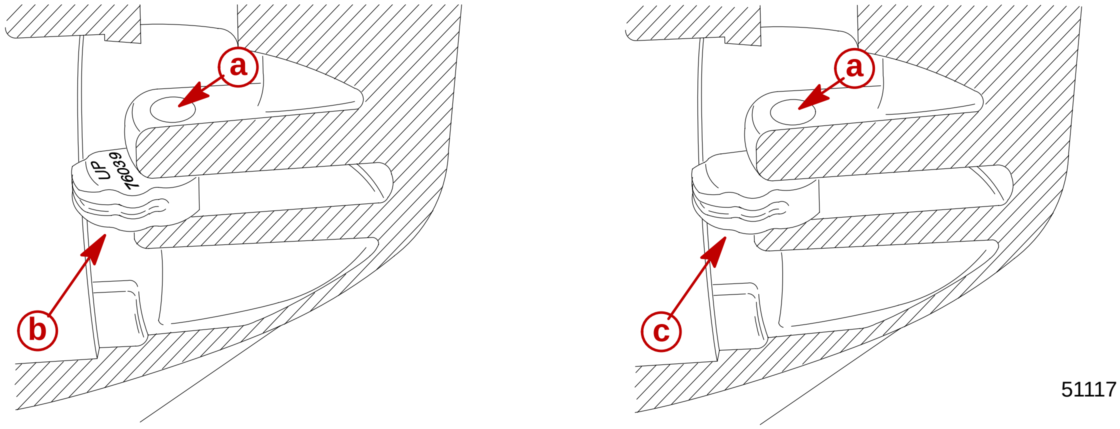


51264

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

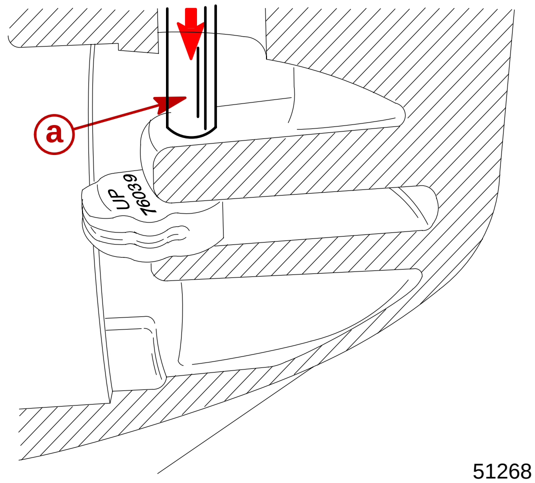
a - Shift Shaft
b - “E” Clip
c - Bushing
d - O-ring

5. Install shift cam; align hole in shift cam with shift shaft pilot bore.



a - Shift Shaft Pilot Bore
b - Shift Cam numbers up (2–Stroke)
c - Shift Shaft numbers down (4–Stroke)

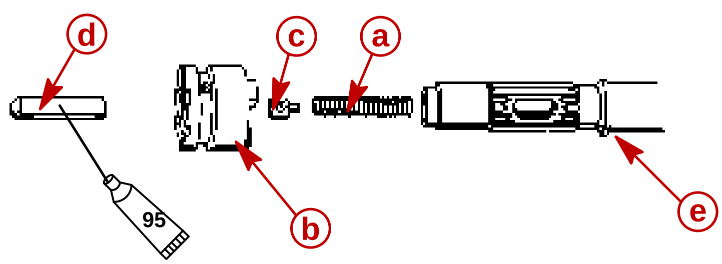
6. Install shift shaft assembly; insert splines into shift cam.



a - Shift Shaft Assembly

Propeller Shaft

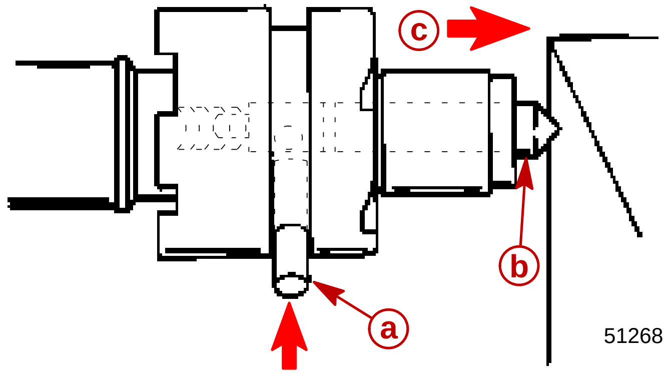
1. Install components. Clutch should be installed with long end (non-ratcheting) toward propshaft reverse shoulder.



95 2-4-C w/Teflon (92-850736A1)

a - Spring
b - Clutch (Align Hole with Slot in Prop Shaft)
c - Guide Block
d - Cam Follower (Hold in Place with 2-4-C w/Teflon)
e - Propshaft Shoulder

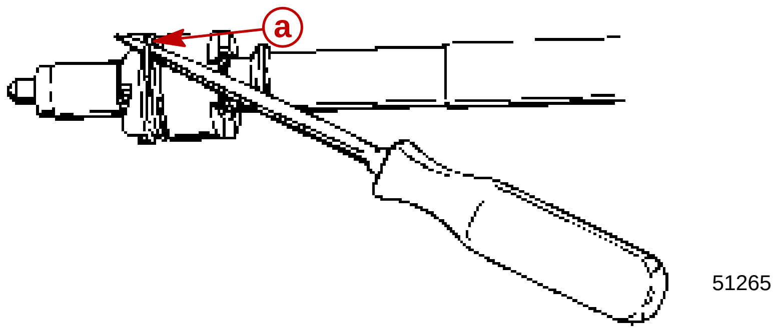
2. Install cross pin.



a - Cross Pin
b - Cam Follower
c - Apply Pressure in This Direction

3. Install spring.

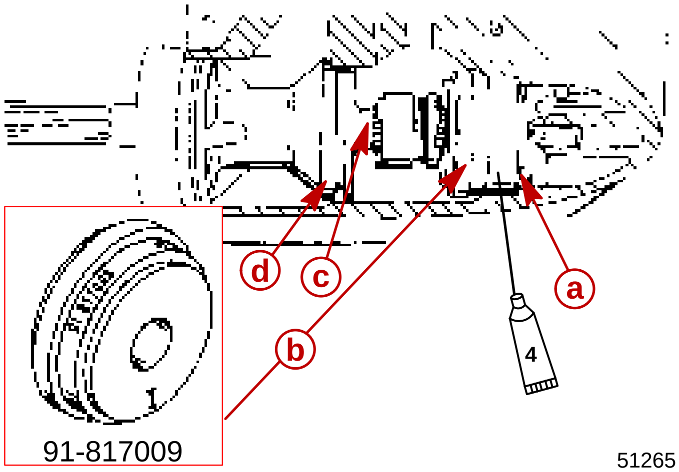
NOTE: *Spring windings must lay flat in clutch groove. DO NOT allow spring coils to overlap each other.*



a - Spring

Forward Gear Bearing Race

1. Place shim(s), retained from disassembly, into housing. If shim(s) were lost or damaged, or a new gearcase is being assembled, start with a .010 in. (.254mm) shim.
2. Drive bearing race into housing. Use a lead hammer to avoid damage to propshaft.



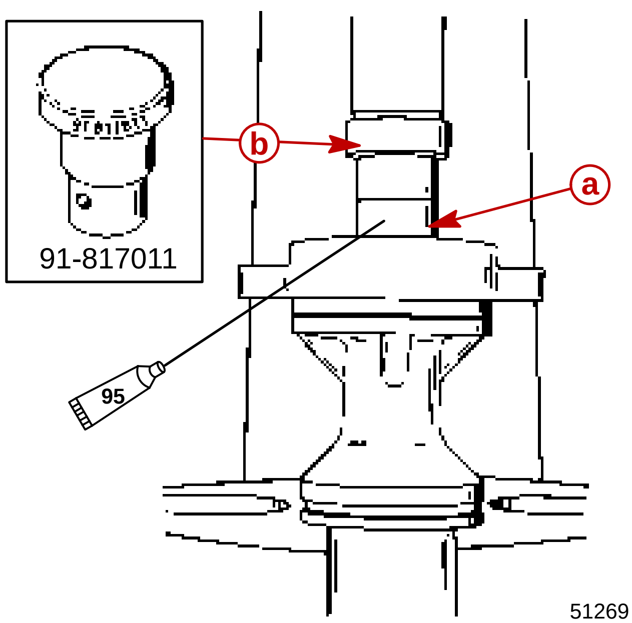
4 Needle Bearing Assy. Lub. (92-825265A1)

a - Shim(s)
b - Driver Cup (91-817009)
c - Propeller Shaft
d - Assembled Bearing Carrier

Bearing Carrier

1. Lubricate O.D. of needle bearing with 2-4-C w/Teflon.
2. Install needle bearing.

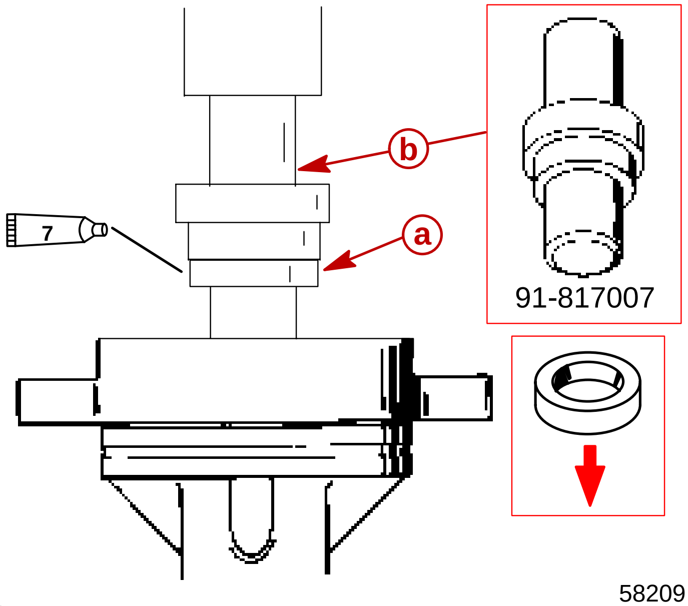
Installation Note: Push against numbered end of bearing.



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

a - Needle Bearing
b - Installer (91-817011)

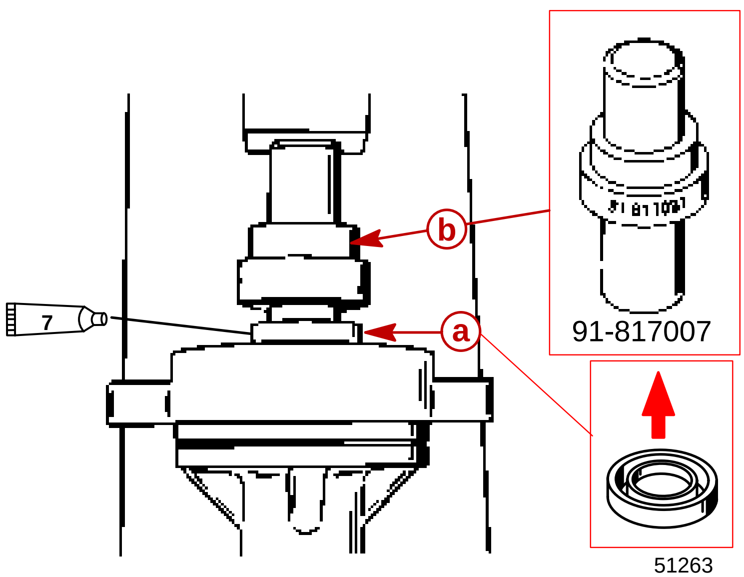
3. Apply Loctite 271 on O.D. of small diameter oil seal. Seal lip should face away from shoulder on Installation Tool. Press seal in until Installer Tool bottoms out.



7 Loctite “271” (92-809819)

a - Small Diameter Seal
b - Installer Tool (91-817007)

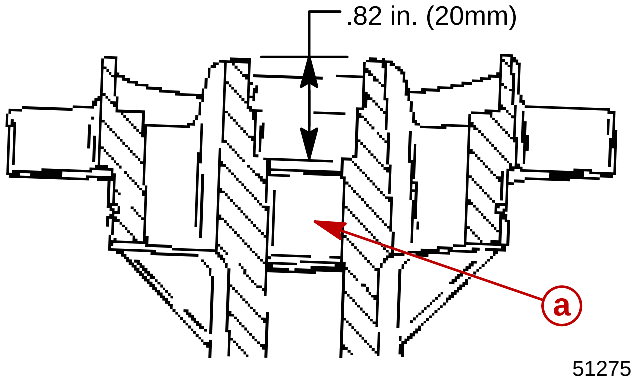
4. Apply Loctite 271 on O.D. of larger diameter oil seal. Seal lip should face towards shoulder on installation tool. Press in until Installer tool bottoms out.



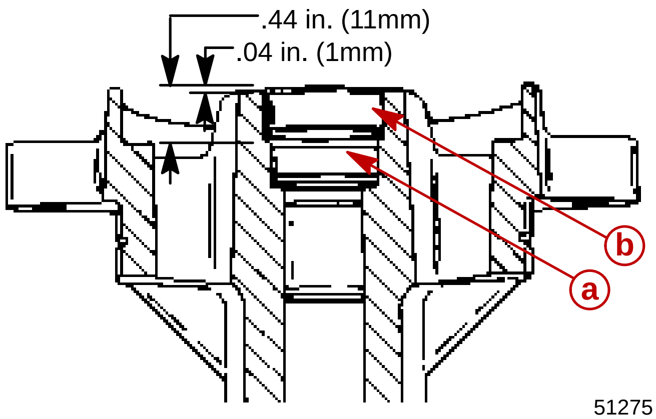
7 Loctite “271” (92-809819)

a - Large Diameter Seal
b - Installer Tool (91-817007)

Installation Note: If service tools are not available, the following reference dimensions apply for installing bearing and seals to proper depths.



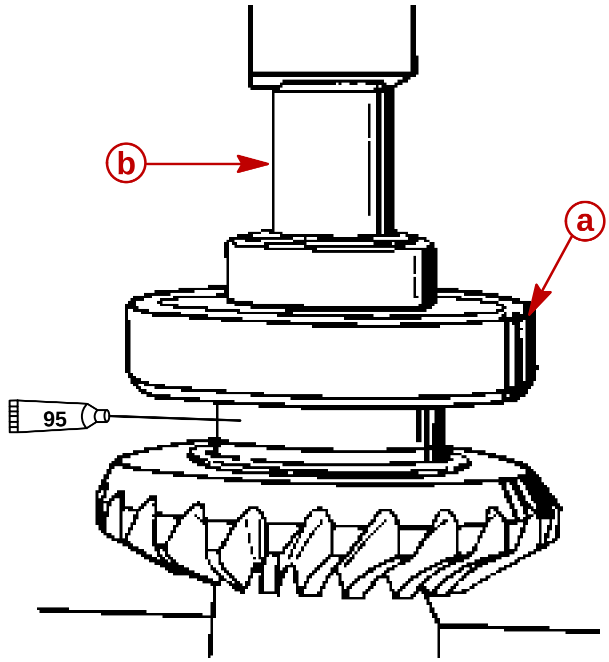
a - Bearing



a - Oil Seal (Install with Lip Down)
b - Oil Seal (Install With Lip Up)

Reverse Gear

1. Lubricate I.D. of bearing with 2-4-C w/Teflon. Use suitable mandrel and press onto gear until bearing bottoms.

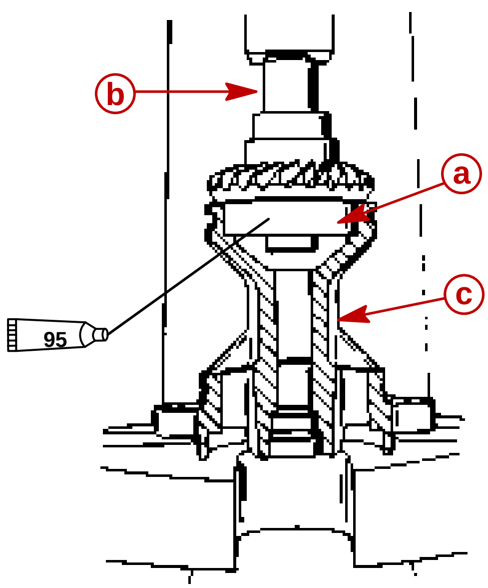


51205

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

a - Bearing
b - Suitable Mandrel

2. Lubricate O.D. of bearing with 2-4-c w/Teflon. Use suitable mandrel and press reverse gear/bearing assembly into bearing carrier until bearing bottoms out.



51264

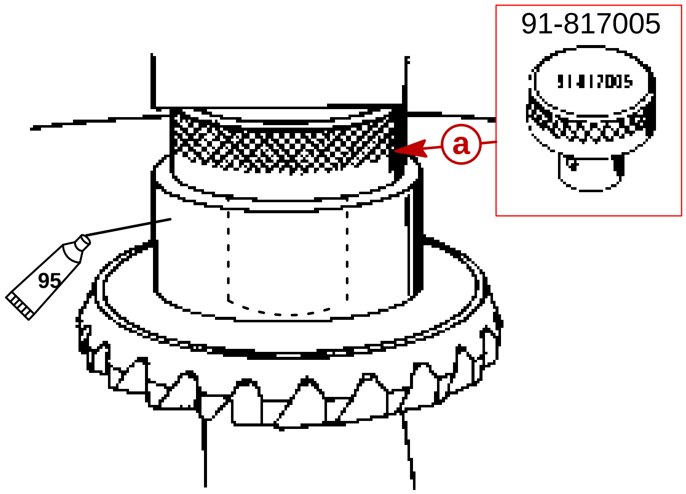
95 2-4-C With Teflon (92-825407A12)

a - Reverse Gear and Bearing Assembly
b - Suitable Mandrel
c - Bearing Carrier

Forward Gear

1. Lubricate O.D. of bearing with 2-4-C w/Teflon. Press new propshaft bearing into gear until Installer Tool bottoms.

Installation Note: Push against numbered end of bearing.

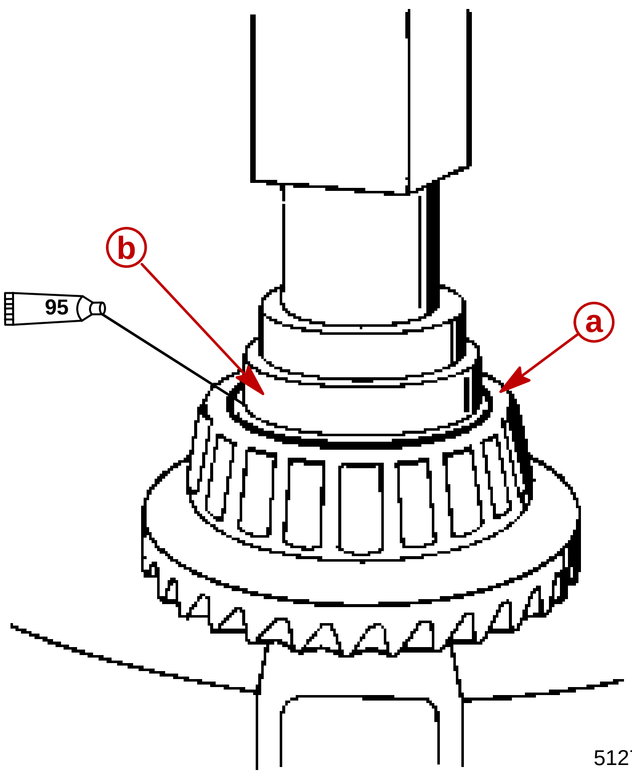


51291

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

a - Installer Tool (91-817005)

2. Lubricate I.D. of bearing with 2-4-C w/Teflon. Use suitable mandrel and press tapered roller bearing onto gear until bearing bottoms on gear.



51272

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

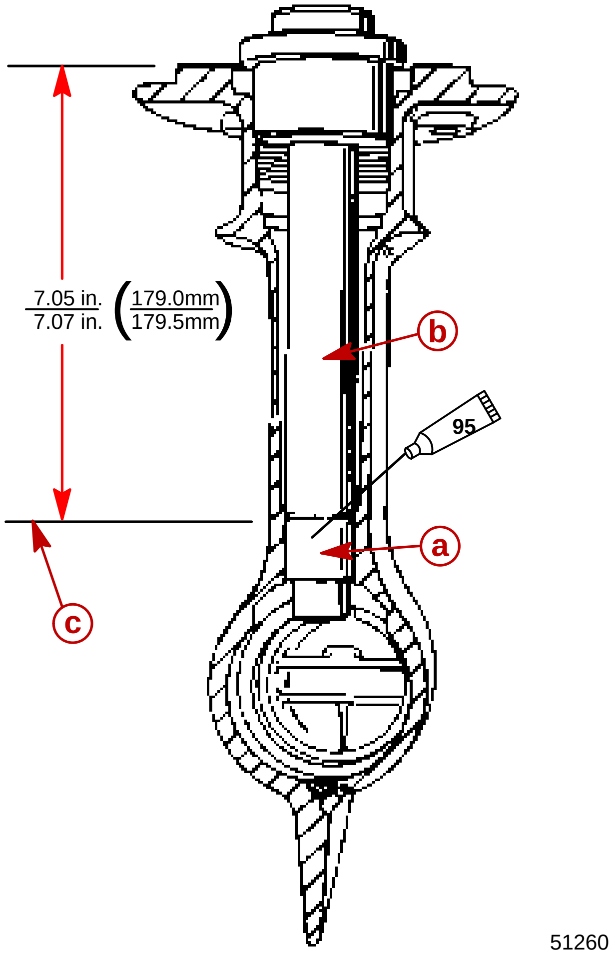
a - Bearing (Lubricate I.D. Before Assembly)

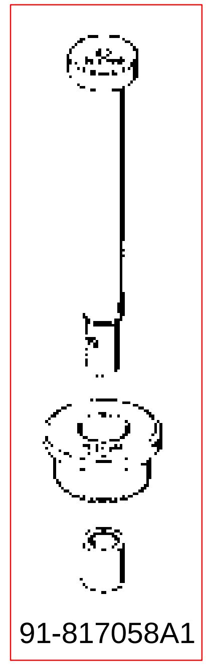
b - Suitable Mandrel

Lower Driveshaft Bearing Installation

1. Lubricate O.D. of bearing with 2-4-C w/Teflon.
2. Install bearing into housing. Press until Installer Tool bottoms out.

Installation Note: Push against numbered end of bearing.



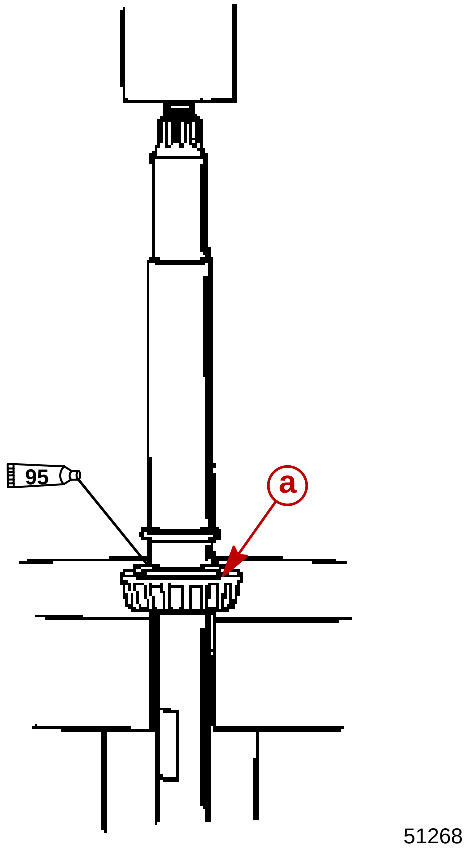


95 2-4-C With Teflon (92-825407A12)

a - Needle Bearing (Lubricate O.D. Before Assembly)
b - Bearing Installer Tool (91-817058A1)
c - Reference (Bearing Depth)

Upper Driveshaft Bearing Installation

1. Lubricate I.D. of bearing with 2-4-C w/Teflon. Using suitable mandrel press upper drive-shaft bearing onto driveshaft until bearing contacts driveshaft shoulder.



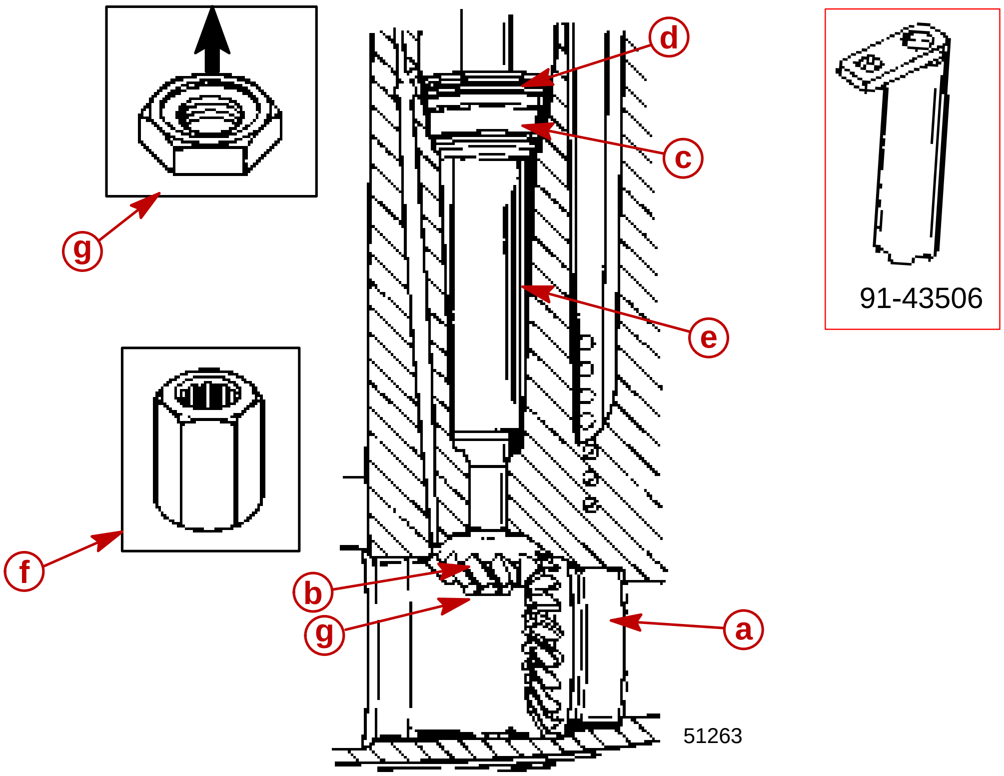
95 2-4-C With Teflon (92-825407A12)

a - Upper Driveshaft Bearing (Lubricate I.D. Before Assembly)

Forward Gear, Pinion Gear, Upper Driveshaft Bearing Race, Retainer and Driveshaft Installation

NOTE: *If shim(s) were lost or are not reusable (damaged), start with approximately .015 in. (0.361mm).*

Install components in sequence shown.



ASSEMBLY SEQUENCE

- **a -** Forward Gear/Bearing: Apply Premium Blend Gear Lube to Bearing Rollers Before Installation
- **b -** Pinion Gear
- **c -** Driveshaft
- **d -** Upper Driveshaft Bearing Race and Shim(s)
- **e -** Upper Driveshaft Bearing Retainer. Tighten to Specified Torque using Tool (91-43506)
- **f -** Driveshaft Holding Tool
- **g -** Pinion Nut (New) (See Note at “Pinion Gear Depth”, Following.) Recess in Nut is Installed Toward Pinion Gear (See Inset).

Model	Drive Shaft Holding Tool
40/50/60 (4-Stroke)	91-877840A1
55/60 (2-Stroke)	91-817070

Upper Driveshaft Bearing Retainer Torque
75 lb-ft (101.7 Nm)

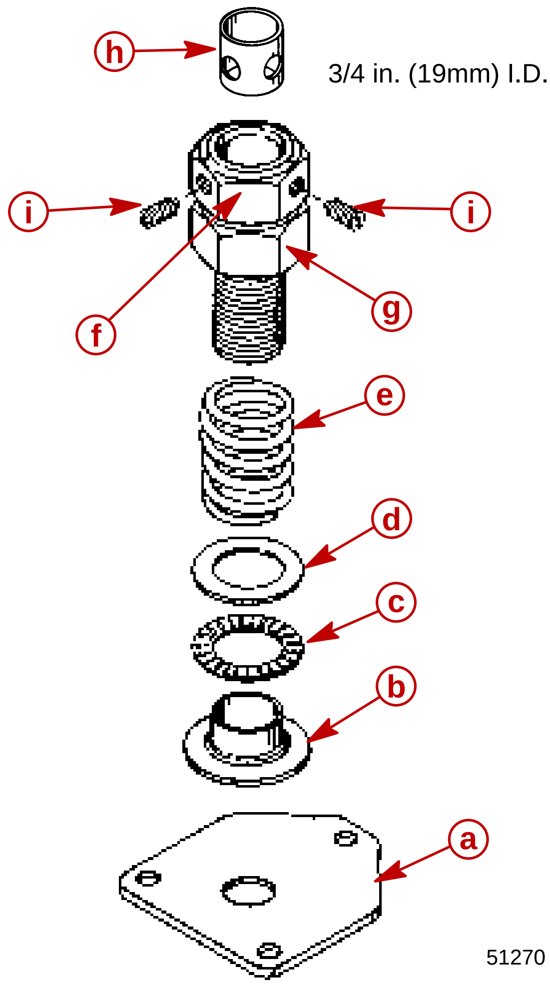
Pinion Gear Location and Forward Gear Backlash

DETERMINING PINION GEAR LOCATION

NOTE: *Read entire procedure before attempting any change in shim thickness.*

IMPORTANT: Forward gear assembly pilots the end of the pinion gage and must be installed in gear housing when checking pinion gear depth. Without it an inaccurate measurement will be obtained.

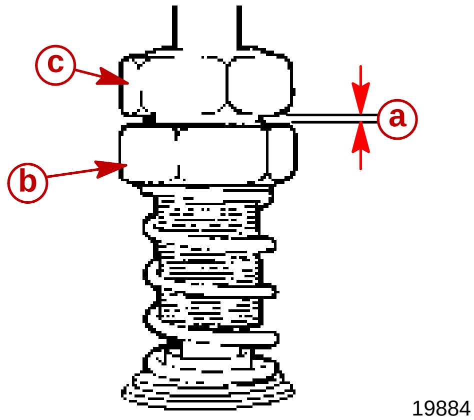
1. Clean the gear housing bearing carrier shoulder and diameter.
2. Position gear housing upright (driveshaft vertical). Install Bearing Preload Tool (91–14311A2) in sequence shown.



INSTALLATION SEQUENCE: Bearing Preload Tool (91–14311A2)

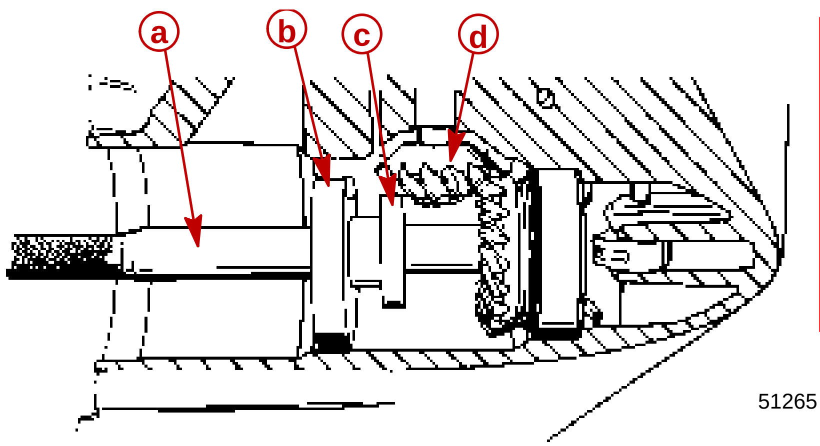
- **a** - Plate
- **b** - Adaptor: Bearing surfaces clean and free of nicks
- **c** - Thrust Bearing: Oiled and able to move freely
- **d** - Thrust Washer: Clean and free of nicks and bends
- **e** - Spring
- **f** - Nut: Threaded all the way onto bolt
- **g** - Bolt: Held snug against spring
- **h** - Sleeve: Holes in sleeve must align with set screws
- **i** - Set Screw (2): Tighten against drive shaft, bolt should not slide on driveshaft

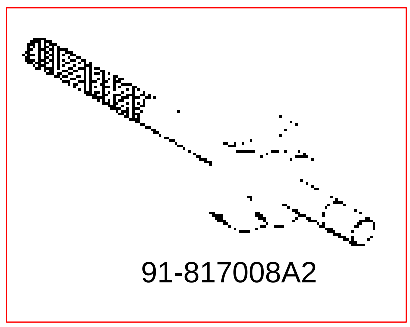
3. Measure distance between top of nut and bottom of bolt head.
4. Increase distance by 1 in. (25.4mm).
5. Rotate driveshaft 10 revolutions. This properly seats upper driveshaft tapered roller bearing.



a - Distance, 1 in. (25.4 mm)
b - Nut
c - Bolt

6. Insert Pinion Location Tool. Position access hole as shown. Insert feeler gauge between gauging surface and pinion gear.

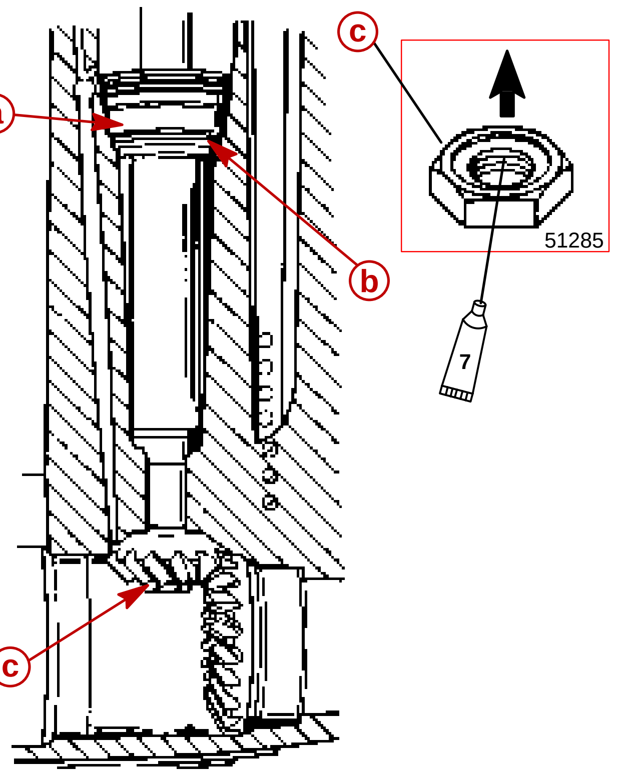




a - Pinion Location Tool (91-817008A2)
b - Access Hole
c - Gauging Surface
d - Pinion Gear

7. The correct clearance between the gauging surface and the pinion gear is .025 in. (0.64mm).
8. If clearance is more than .025 in. (0.64mm) remove shims from under the upper bearing cup. If clearance is less than 0.25 in., add shims under the upper bearing race.
9. After final adjustment to pinion height, **and forward gear backlash has been established,** apply Loctite 271 to threads and torque new pinion nut to specified torque.

NOTE: *Clean driveshaft and pinion nut threads with Loctite Primer of suitable de-greaser before applying Loctite.*



51263

7 Loctite “271” (92-809819)

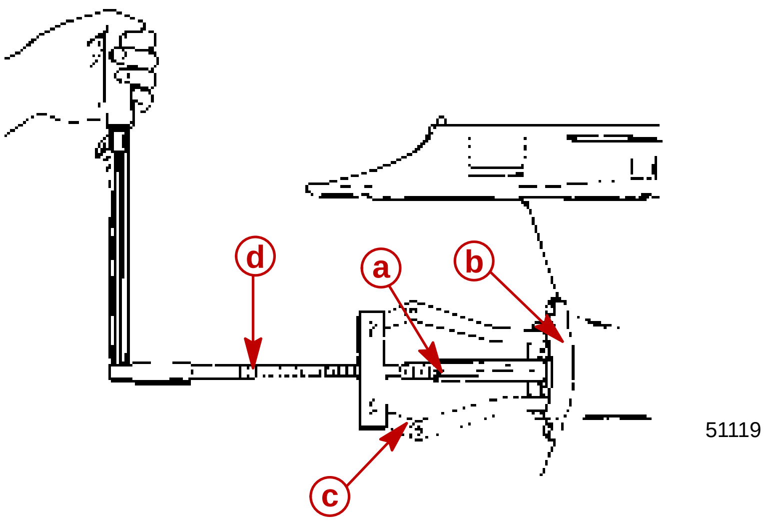
a - Bearing Race
b - Shim(s)
c - Pinion Nut (Recessed Side Toward Pinion)

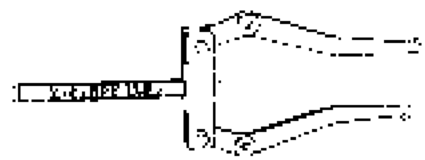
Pinion Nut Torque
50 lb-ft (67 Nm)

Determining Forward Gear Backlash

NOTE: *Read entire procedure before attempting any change in shim thickness.*

1. Obtain correct pinion gear location; refer to “Determining Pinion Gear Location”, preceding.
2. Install Bearing Preload Tool on driveshaft; refer to “Determining Pinion Gear Location”, preceding.
3. Install components as shown.
4. While holding the driveshaft, torque the puller bolt to 45 in-lb.
5. Rotate driveshaft 5-10 revolutions. This should properly seat the forward gear tapered roller bearing. **Repeat step 4.**



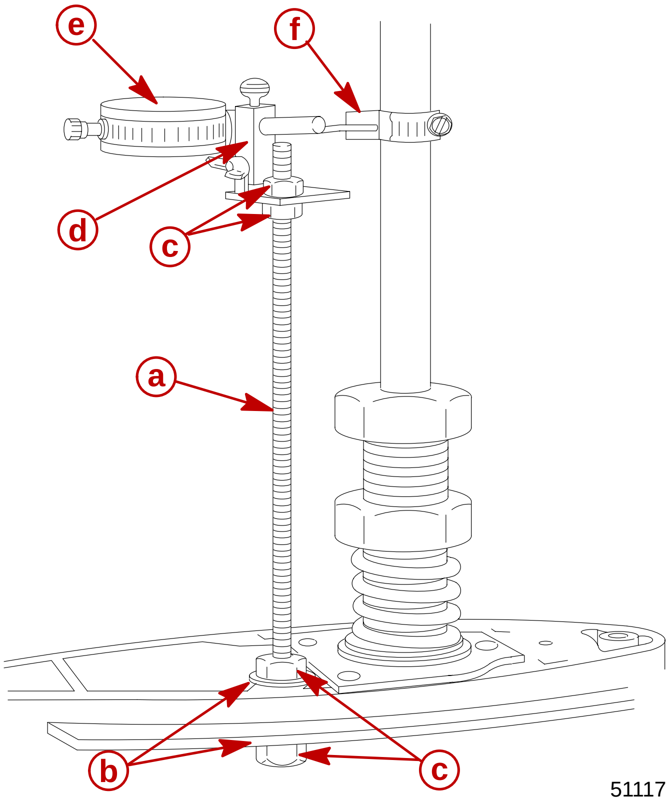


a - Propeller Shaft*
b - Bearing Carrier* (Assembled)
c - Puller Jaws (91-46086A1)
d - Puller Bolt (91-58716)

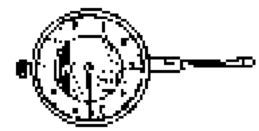
Puller Bolt Torque
45 lb-in. (5.1 Nm)

- *Refer to “Bearing Carrier and Propeller Shaft Installation”, following.

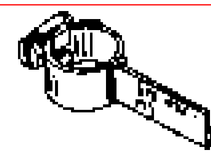
6. Install components as shown.



91–83155 Dial Indicator Adapter Kit



91–58222A1 Dial Indicator



91–19660–1 Backlask Indicator

a - Threaded Rod (Obtain Locally)
b - Washers
c - Nuts
d - Dial Indicator Adaptor Kit (91-83155)
e - Dial Indicator (91-58222A1)
f - Backlash Indicator Tool (91-19660-1)

7. Position Dial Indicator on appropriate line (from chart) marked on Backlash Indicator Tool.

MODEL	BACKLASH INDICATOR TOOL	ALIGN POINTER OF DIAL INDICATOR WITH MARK
40/50/60 (4-Stroke)	91-19660-1	4 OR 0.366 in. (9.3 mm)
55/60 (2-Stroke)	91-19660-1	3

8. Turn driveshaft back-and-forth (check for no rotation at the propeller shaft).

9. Dial Indicator registers amount of backlash, which must be between specifications shown in chart.

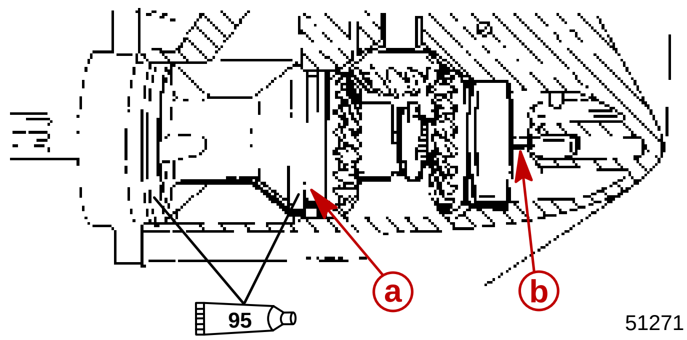
MODEL	DIAL INDICATOR MINIMUM	DIAL INDICATOR MAXIMUM
40/50/60 (4-Stroke)	0.011 in. (0.28 mm)	0.017 in. (.43 mm)
55/60 (2-Stroke)	0.013 in. (0.33 mm)	0.019 in. (.48 mm)

10. If backlash is less than the minimum reading, remove shim(s) from in front of the forward gear bearing race. If backlash is more than the maximum reading, add shim(s) in front of the forward gear bearing race. When final measurement has been made, apply Loctite 271 to threads of pinion nut.

NOTE: By adding or subtracting .001 in. (0.025mm) shim, the backlash will change 0.001 in. (0.032mm).

Bearing Carrier and Propeller Shaft Installation

1. Lubricate O-ring, bearing carrier and related gearcase housing bores, in areas shown, with Quicksilver 2-4-C w/Teflon.
2. Insert propeller shaft assembly into bearing carrier.
3. Install bearing carrier and propeller shaft assembly into gear housing. Use care not to displace cam follower.

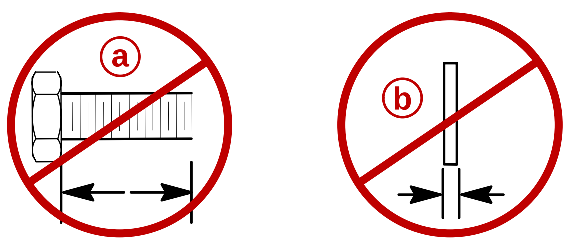


95 2-4-C w/Teflon (92-850736A1)

a - O-ring
b - Cam Follower

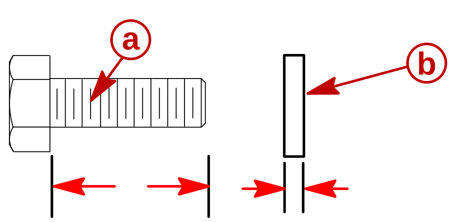
4. Discard the thin 0.063 in. (1.60 mm) flat washers and the 25 mm long bolts on models listed. Install thicker flat washers and longer bolts.

55/60 (3 Cylinder - 2 Stroke) Non Big Foot
USA 0G662097 and below
Belgium NA



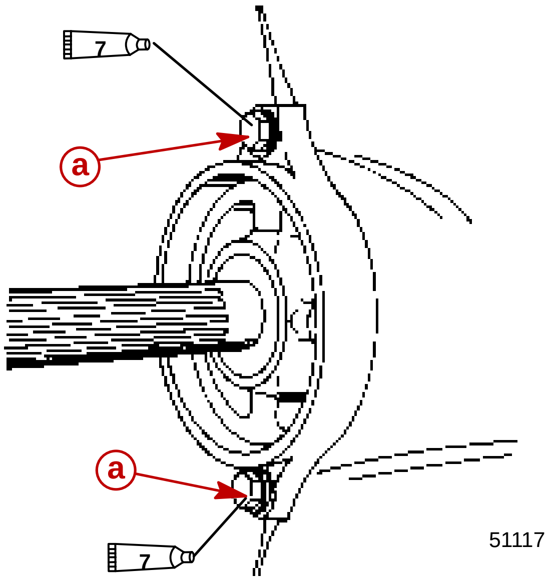
a - Bolt 25 mm Long - Discard
b - Thin Flat Washer 0.063 in. (1.60 mm) thick - Discard

5. Install thicker flat washers and longer bolts.



a - Bolt (10-855940-30) 1.18 in. (30 mm) Long
b - Washer (12-855941) 0.090 in. (2.29 mm)

6. Torque bolts to specified torque.



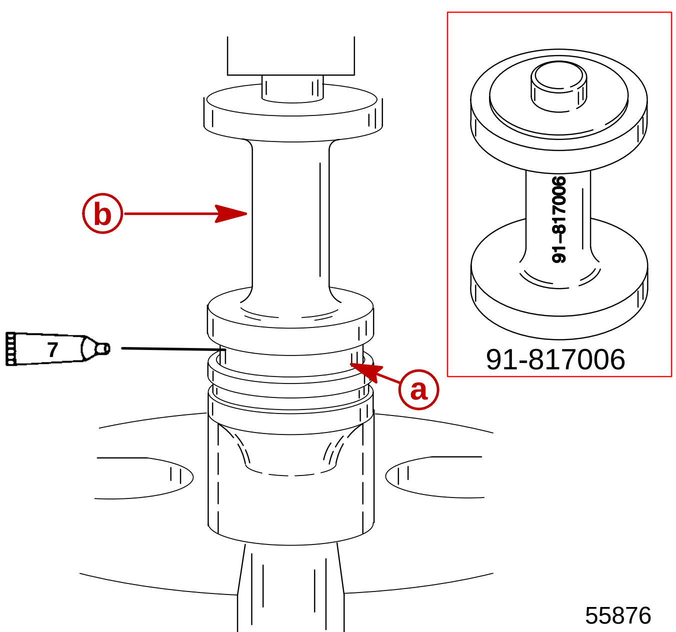
7 Loctite “271” (92-809819)

a - Bolts (2) M8x30

Bearing Carrier Bolt Torque
225 lb-in. / 18.8 lb-ft. (25.5 Nm)

Water Pump Re-Assembly and Installation

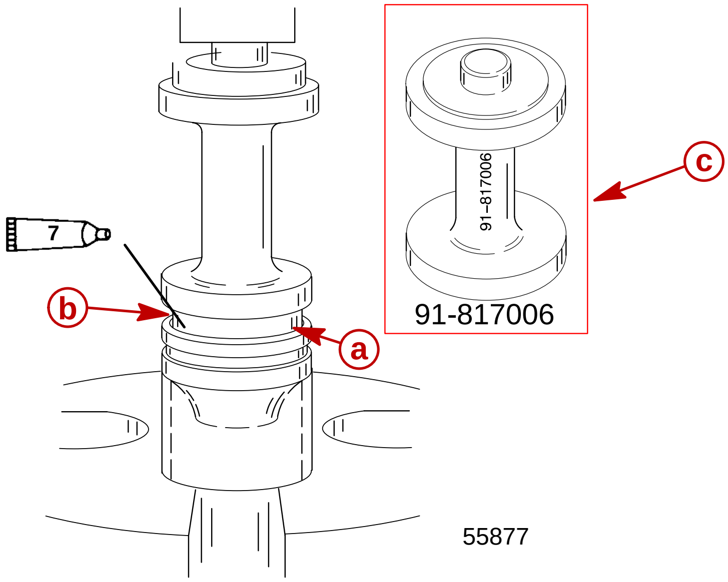
1. Place seal on longer shoulder side of tool. Seal spring should face the shoulder of the tool during installation. Apply Loctite 271 to O.D. of seal.
2. Press into water pump base until tool bottoms.



7 Loctite 271 (92-809820)

a - Seal
b - Seal Installation Tool (91-817006)

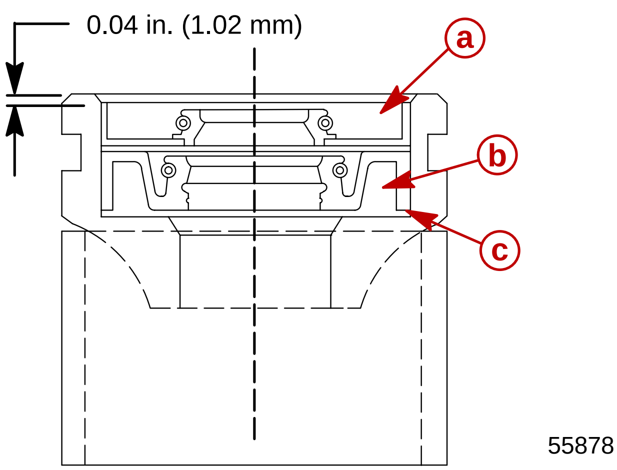
3. Place seal on shorter shoulder side of tool. Seal spring should face the shoulder of the tool during installation. Apply Loctite 271 to O.D. of seal.
4. Press into water pump base until tool bottoms.



7 Loctite 271 (92-809820)

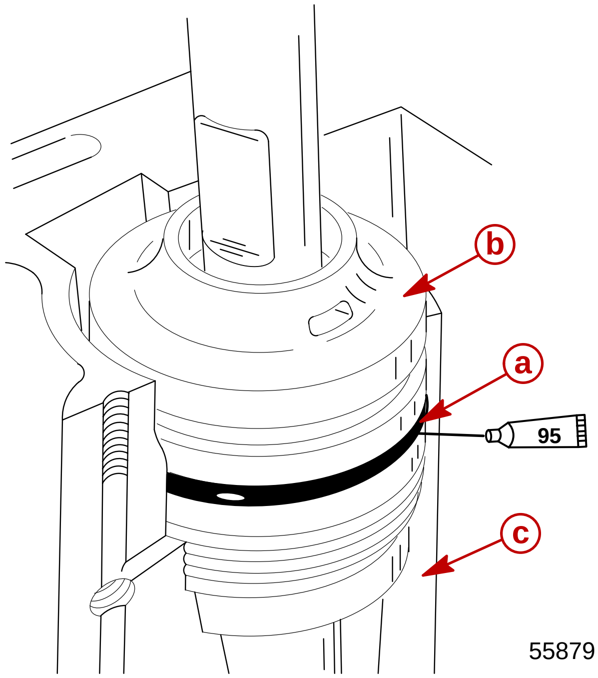
a - Seal
b - Shorter Side of Tool
c - Seal Installation Tool (91-817006)

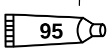
NOTE: *If installation tool is not available, press seals in as shown to depths indicated.*



a - Seal (Install with spring visible when installed.)
b - Seal (Install with spring visible when installed.)
c - Seal Bottom

5. Install O-ring. Apply Quicksilver 2-4-C w/Teflon to o-ring,seal lips and gear housing bore.
6. Install water pump base into gear case.

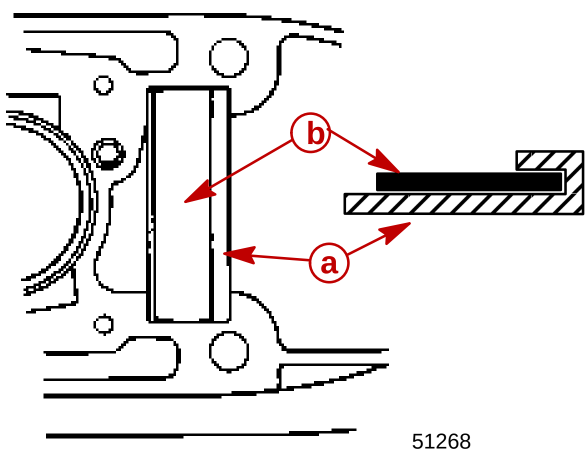




2-4-C w/Teflon (92-850736A1)

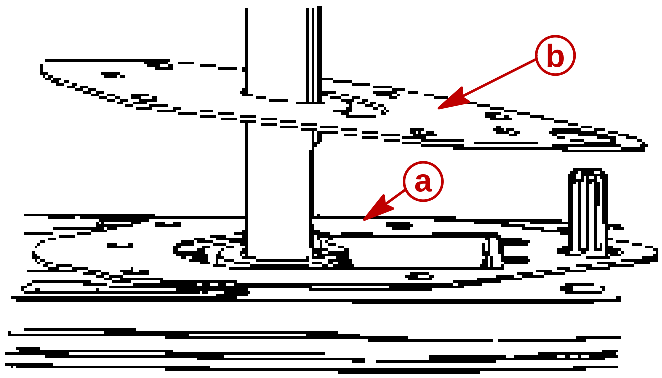
a - O-ring
b - Water Pump Base
c - Gear Case

7. If removed previously, re-install seal and filler plate.



a - Seal
b - Filler Plate

8. Install gasket and face plate.

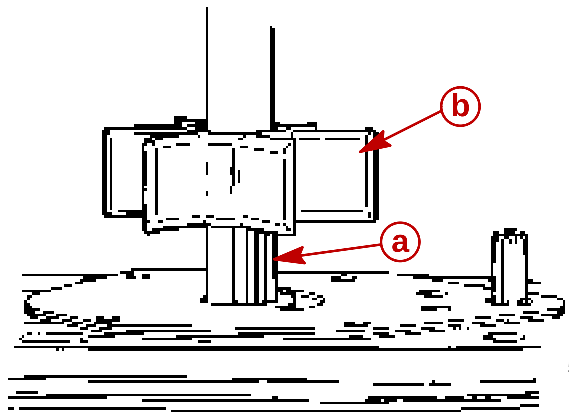


51293

a - Gasket
b - Face Plate

IMPORTANT: If the old impeller is re-used, install in the original (clockwise) direction of rotation.

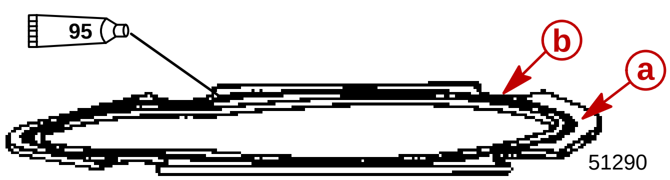
9. Install drive key and impeller.



51292

a - Drive Key
b - Impeller

10. Lubricate I.D. of cover with Quicksilver 2-4-C w/Teflon. Install gasket with bead facing up.



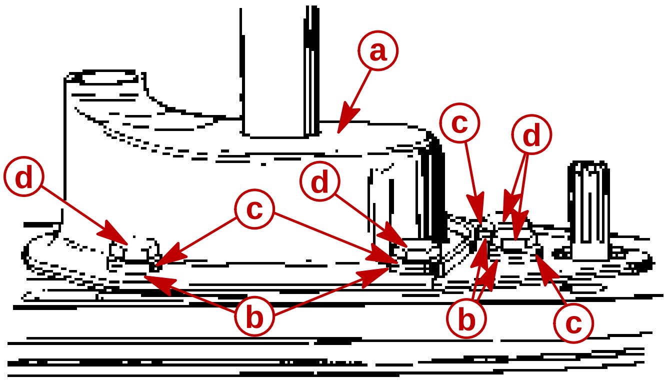
51290

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

a - Gasket
b - Bead Toward Cover

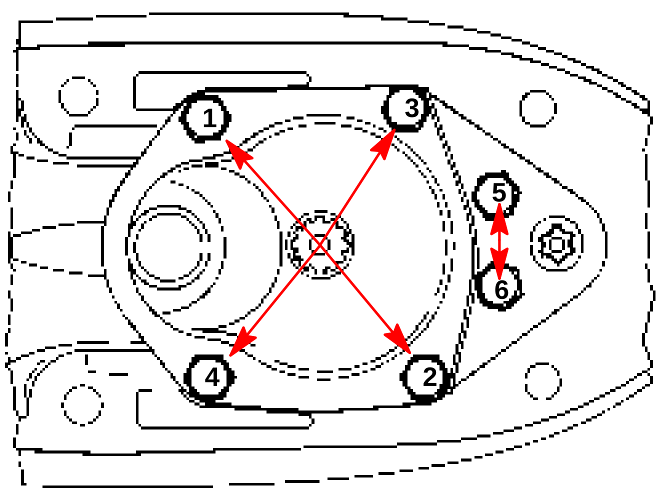
11. Rotate driveshaft clockwise and push water pump housing down.

12. Apply Loctite 271 on threads and tighten screws to specified torque (in sequence shown).



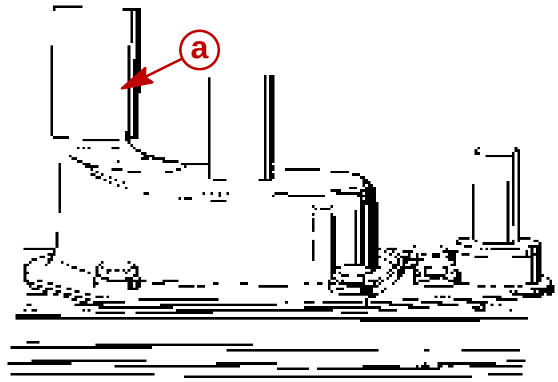
a - Water Pump Housing Assembly
b - Isolators, **(Design 1)** Note: 2 isolators for forward screws are different from remaining 4 isolators
c - Washers (6)
d - Screw (6) M6x16

NOTE: *Torque cover screws as shown.*



Cover Screw Torque
60 lb-in. (6.8 Nm)

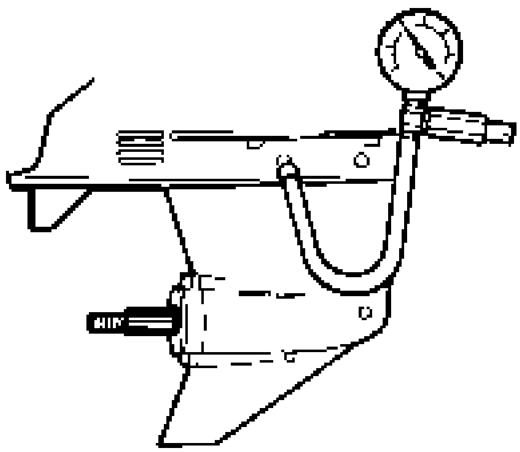
13. If water tube seal stayed on water tube (in driveshaft housing), pull seal from water tube.
14. Lubricate I.D. of water tube seal with Quicksilver 2-4-C w/Teflon and install.



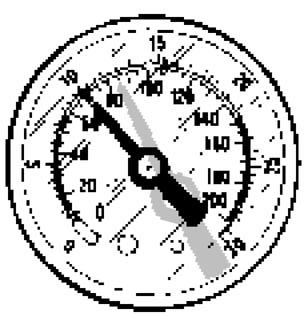
a - Water Tube Seal

Gear Housing Pressure Test

1. Remove vent plug and install pressure test gauge. Tighten securely.



2. Pressurize housing to 10-12 PSI (69-83 kPa) and observe gauge for 5 minutes.
3. Rotate driveshaft, prop shaft and move shift rod while housing is pressurized to check for leaks.



4. If pressure drop is noted, immerse housing in water.
5. Re-pressurize to 10-12 PSI (69-83 kPa) and check for air bubbles.
6. Replace leaking seals as necessary. Retest housing.

NOTE: *Gearcase assembly should hold 10-12 PSI (69-83 kPa) for 5 minutes.*

7. Remove tester from housing. Install vent plug and new sealing washers.

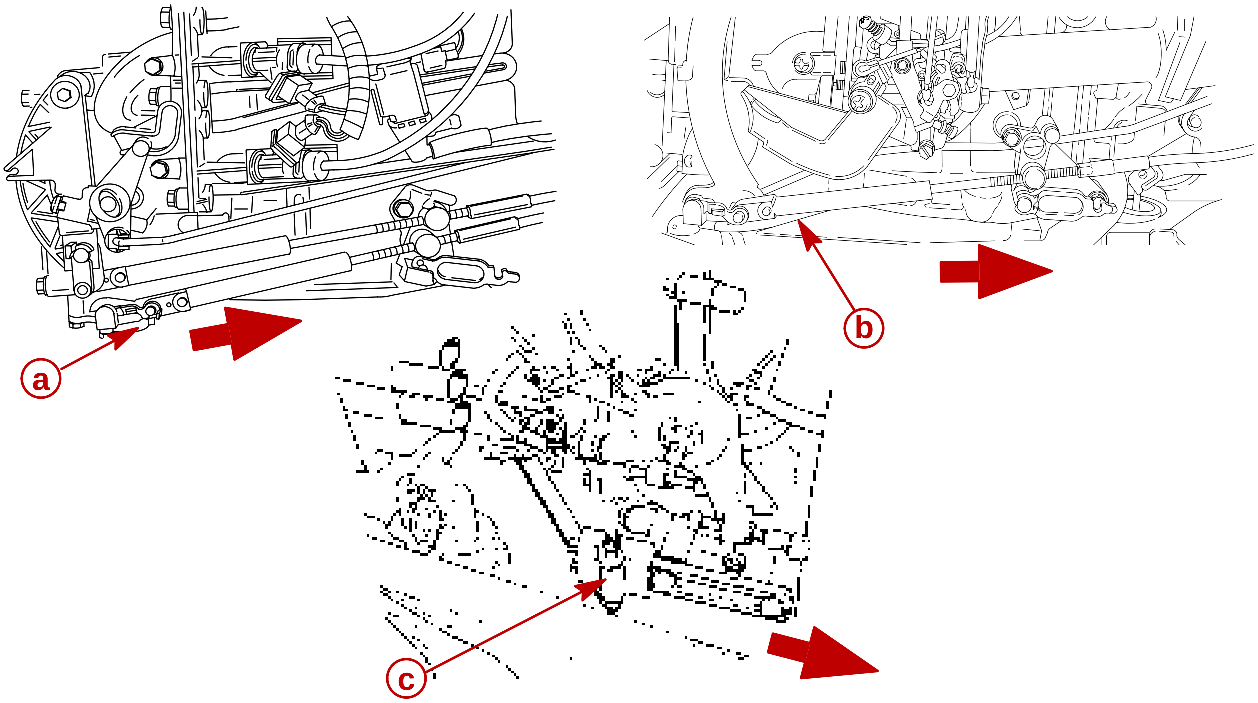
Gear Housing Installation

⚠ WARNING

Disconnect (and isolate) spark plug leads before installing gear housing onto drive-shaft housing.

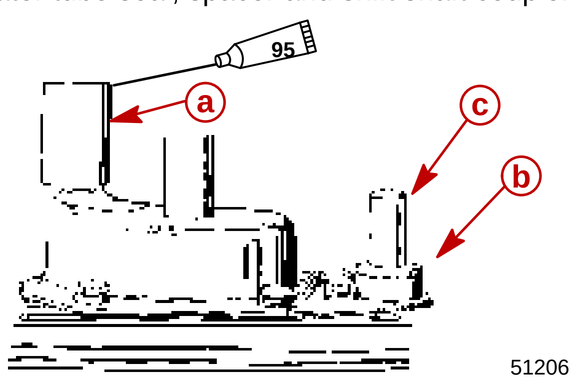
1. Position shift linkage into forward gear position.

   Remote Control Model Shown



a - Shift Lever 40/50/60 EFI (4-Stroke)
b - Shift Lever 40/50/60 Carb (4-Stroke)
c - Shift Lever 60 Carb (2-Stroke)

2. Tilt engine to full “Up” position. Engage tilt lock lever.
3. Shift gear housing into neutral. Propeller shaft will rotate freely in either direction.
4. Install water tube seal, spacer and shift shaft coupler.



51206

95 2-4-C w/Teflon (92-850736A1)

a - Water Tube Seal
b - Spacer
c - Shift Shaft Coupler

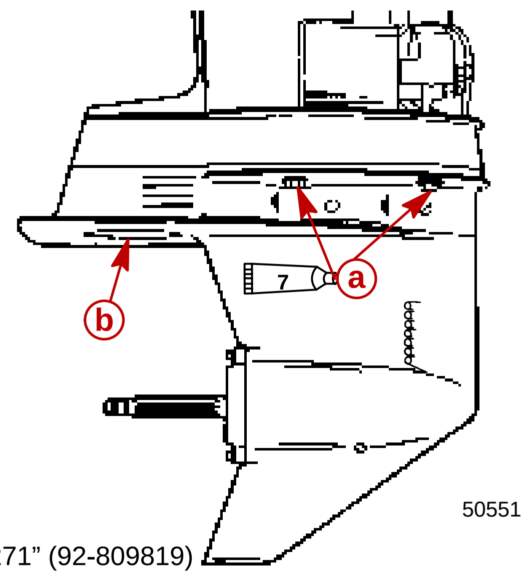
⚠ CAUTION

Do not lubricate top of driveshaft. Excess lubricant will not allow driveshaft to fully engage crankshaft. Tightening the gear housing fasteners (if excess lubricant is on top of driveshaft) will load the driveshaft/crankshaft and may damage either or both powerhead and gear housing. Wipe the top of driveshaft free of lubricant.

5. Lightly apply Quicksilver 2-4-C w/Teflon onto the driveshaft splines.
6. Shift gear housing into forward gear. Gear housing will not engage when propeller shaft is turned clockwise.
7. Position driveshaft into driveshaft housing. Move gear housing towards driveshaft housing while aligning shift shaft coupler, water tube seal and driveshaft splines.

NOTE: *If the driveshaft splines will not align with the crankshaft splines, install a propeller and turn the propeller shaft counterclockwise while pushing gear housing onto driveshaft housing. It may also be necessary to move the shift block (on the powerhead) to align the shift shaft splines for proper re-assembly.*

8. Install 4 bolts and washers, (two each side). Apply Loctite 271 on bottom half of bolt threads prior to installation.
9. Install locknut and washer.
10. Torque bolts and locknut to specified torque.



7 Loctite “271” (92-809819)

a - Bolts and Washers (4) M10x45
b - Locknut and Washer

Bolts and Locknut Torque
40 lb-ft (54 Nm)

11. Check shift operation.
    a. Propeller shaft will not rotate in counterclockwise direction when in forward gear. Clutch will ratchet (clicking noise) when rotated clockwise.
    b. Propeller shaft will rotate freely in either direction when gearcase is in neutral.
    c. Propeller shaft will not rotate in either direction when gearcase is in reverse.

IMPORTANT: If shift operation is not as described, remove the gear housing and correct the shift operation.

Filling Gear Housing with Lubricant

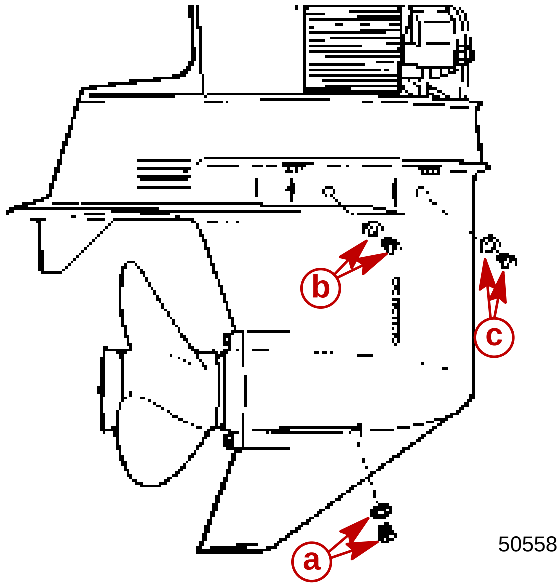
NOTE: *Gear housing lubricant capacity is approximately 11.5 fl. oz. (340 ml).*

⚠ WARNING
If gear housing is installed on outboard, disconnect (and isolate) spark plug leads from spark plugs before working near the propeller.
⚠ CAUTION
Do not use automotive grease in the gear housing. Use only Quicksilver Gear Lube.

1. Remove any gasket material from “Fill/Drain” and “Vent” plugs and gear housing. Install new sealing washers on “Fill/Drain” and “Vent” plugs.

IMPORTANT: Never add lubricant without removing “Vent” plugs. Gear housing cannot be filled because of trapped air. Fill gear housing when driveshaft is in a vertical position.

2. Remove “Fill/Drain” plug and sealing washer.
3. Insert lubricant tube in “Fill/Drain” hole, then remove “Vent” plugs and sealing washer.
4. Fill until excess lubricant flows out of left “Vent” hole.
5. Replace left “Vent” plug and sealing washer and continue to fill until lubricant flows from right “Vent” hole.
6. Replace right “Vent” plug and sealing washer.
7. Install “Fill/Drain” plug and sealing washer.
8. Torque screws to specified torque.



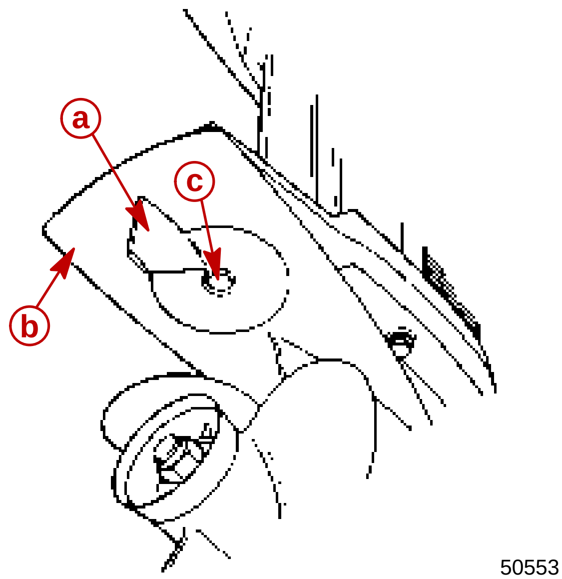
a - “Fill/Drain” Plug
b - “Vent” Plug
c - “Vent” Plug

Screw Torque
58 lb-in. (6.5 Nm)

Trim Tab Adjustment and Replacement

IMPORTANT: The trim tab is made of a special alloy to aid in protecting the drive shaft housing and gear housing from galvanic corrosion (corrosion and pitting of metal surfaces). Do not paint or place protective coating on the trim tab, or trim tab corrosion protection function will be lost.

1. Replace trim tab if 50% (or more) corroded. Mark location of old trim tab on anti-ventilation plate before removal; install new trim tab in same location.
2. The trim tab will offset (balance) some of the “steering load” that is caused by “propeller torque” at higher speeds. If at higher speeds the boat turns more easily to the left, loosen screw, move the trim tab (trailing edge) to the left (when viewed from behind); re-tighten screw. Turn trim tab (trailing edge) to the right if the boat turns more easily to the right.



a - Trim Tab
b - Anti-Ventilation Plate
c - Retaining Screw (M10x30) and Washer

Retaining Screw Torque
22 lb-ft (29.8 Nm)

LOWER UNIT

Section 6B - Bigfoot Gear Housing

Table of Contents

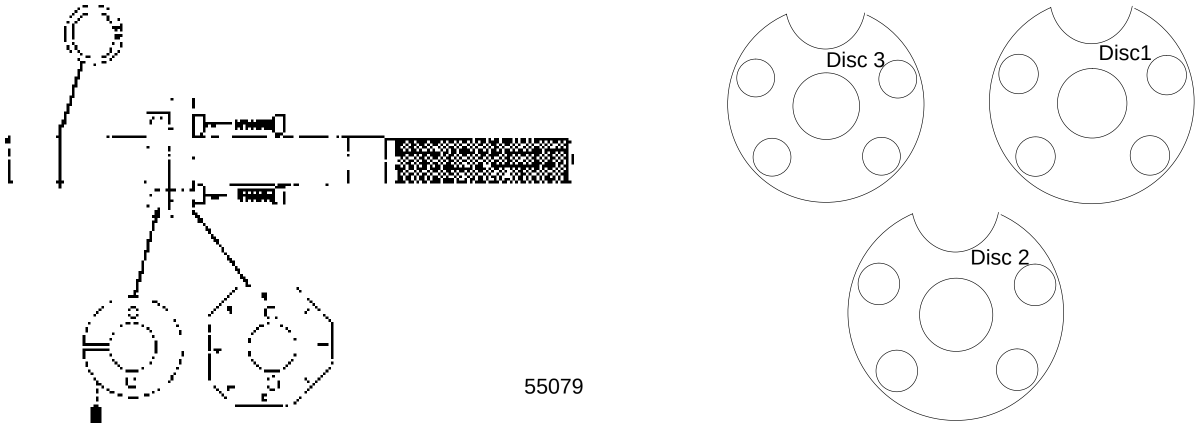
6
B

Specifications

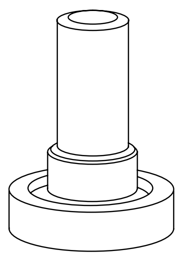
GEAR HOUSING BIGFOOT (2.31:1)	**Gear Ratio**	2.31:1
	Gearcase Capacity	24.0 fl oz (710 mL)
	Lubricant Type	Quicksilver Gear Lube-Premium Blend
	Forward Gear	
	Number of Teeth	30 Spiral/Bevel
	Pinion Gear	
	Number of Teeth	13 Spiral/Bevel
	Pinion Height	0.025 in. (0.64 mm)
	Pinion Gear Locating Tool	91-12349A2
	Flat Number	#8
	Disc Number	#3
	Forward Gear Backlash	0.012 - 0.019 in. (0.30 - 0.48 mm)
	Backlash Indicating Tool	91-78473
	Mark Number	#4
	Water Pressure	
	@ 800 rpm	2-6 psi (14-41 kPa)
	@ 6000 rpm (WOT)	12-25 psi (83-172 kPa)
	Leak Test Pressure	10-12 psi (69-83 kPa) for 5 Minutes

Special Tools

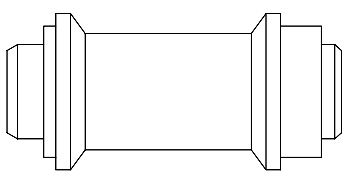
1. Pinion Gear Locating Tool (91-12349A2)



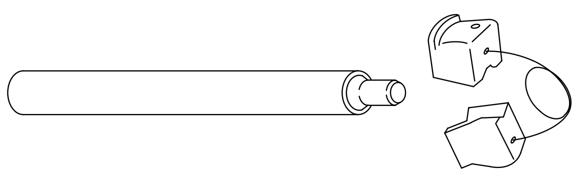
2. Bearing Installation Tool (91-13945)



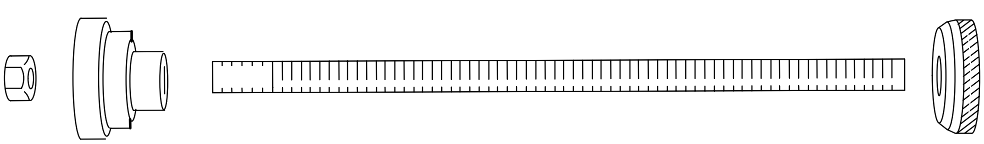
3. Oil Seal Driver (91-13949)



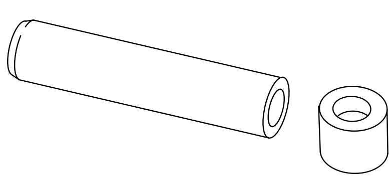
4. Bearing Race Tool (91-14308A1)



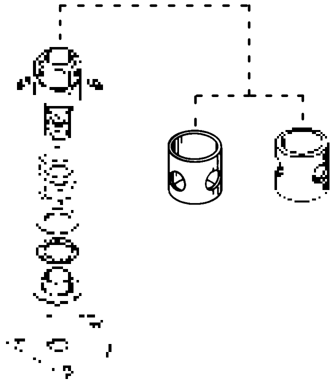
5. Bearing Installation (91-14309A1)



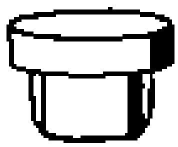
6. Wear Sleeve Installation Tool (91-14310A1)



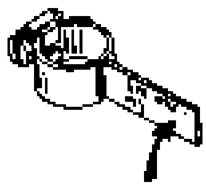
7. Bearing Preload Tool (91-14311A2)



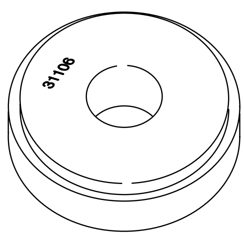
8. Mandrel (91-15755)*



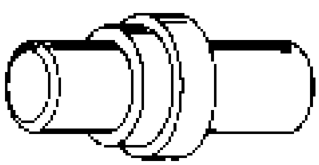
9. Backlash Indicator Tool (91-19660--1) 2.07:1 Gear Ratio (14/29)



10. Mandrel (91-31106)

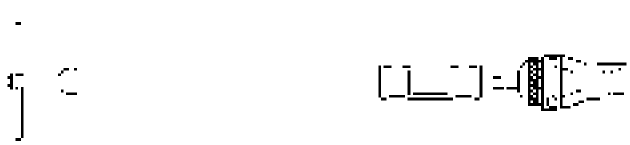


11. Oil Seal Driver (91-31108)

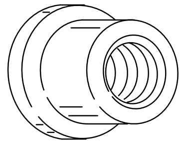


12. Treaded Rod (91-31229) and Nut (91-24156)*

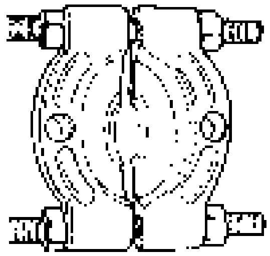
13. Slide Hammer (91-34569A1)



14. Mandrel (91-36569)*



15. Universal Puller Plate (91-37241)

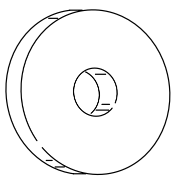


73652

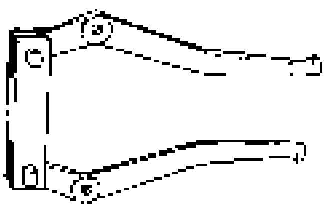
16. Driver Rod (91-37323)*

74184

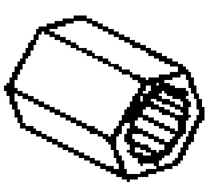
17. Mandrel (91-37350)



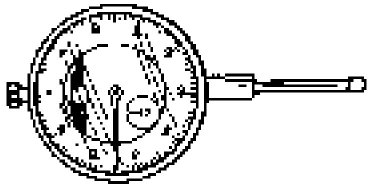
18. Puller Jaws (91-46086A1)



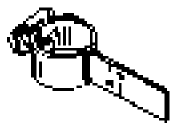
19. Driver Shaft Holding Tool (91-56775, 2-Stroke), (91-56775, 40/50 4-Stroke, 747cc/935cc), (91-877840A1, 40/50/60 4-Stroke, 995cc), (91-804776A1, 75/90 4-Stroke)



20. Dial Indicator (91-58222A1)



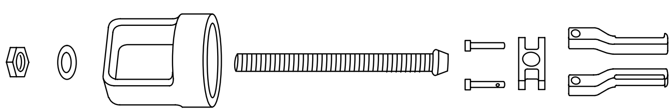
21. Backlash Indicator Tool (91-78473) 2.31:1 Gear Ratio (13/30)



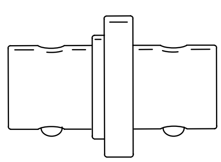
22. Puller Bolt (91-85716)

23. Dial Indicator Adaptor Kit (91-83155)

24. Bearing Puller Assembly (91-83165M)



25. Bearing Installation Tool (91-856875A1)



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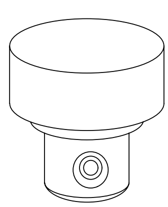
26. Bearing Installation Tool (91-877321A1)

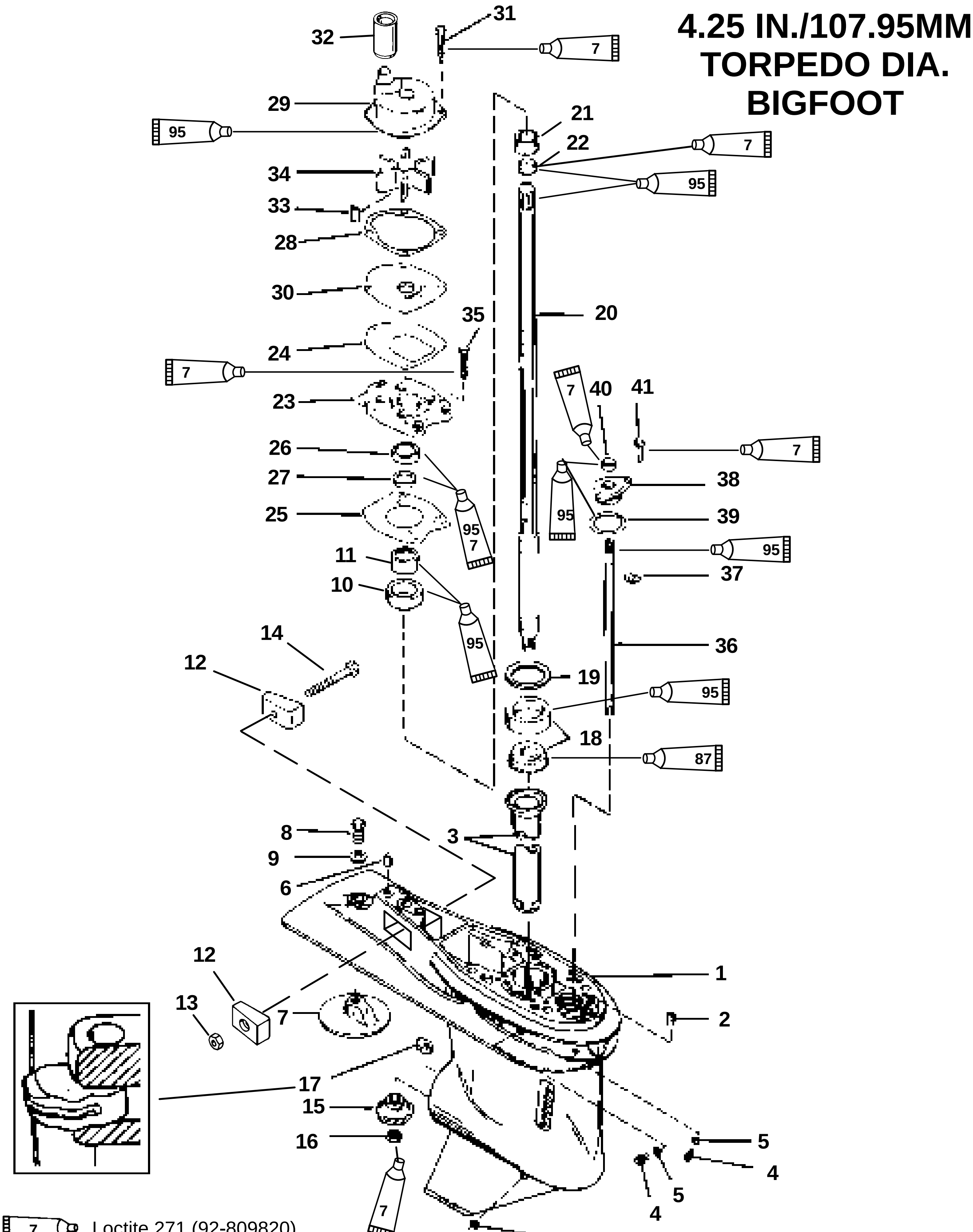


* From Bearing Removal and Installation Kit (91-31229A7)

Quicksilver Lubricants and Service Aids

Part No.	Description
92-809820	Loctite “271”
92-90113--2	RTV Silicone Sealer
92-850737A1	Premium Blend Gear Lube
92-850735A1	Anti-Corrosion Grease
92-850736A1	2-4-C w/Teflon

GEAR HOUSING (DRIVE SHAFT)(2.31:1 GEAR RATIO)



7 Loctite 271 (92-809820)

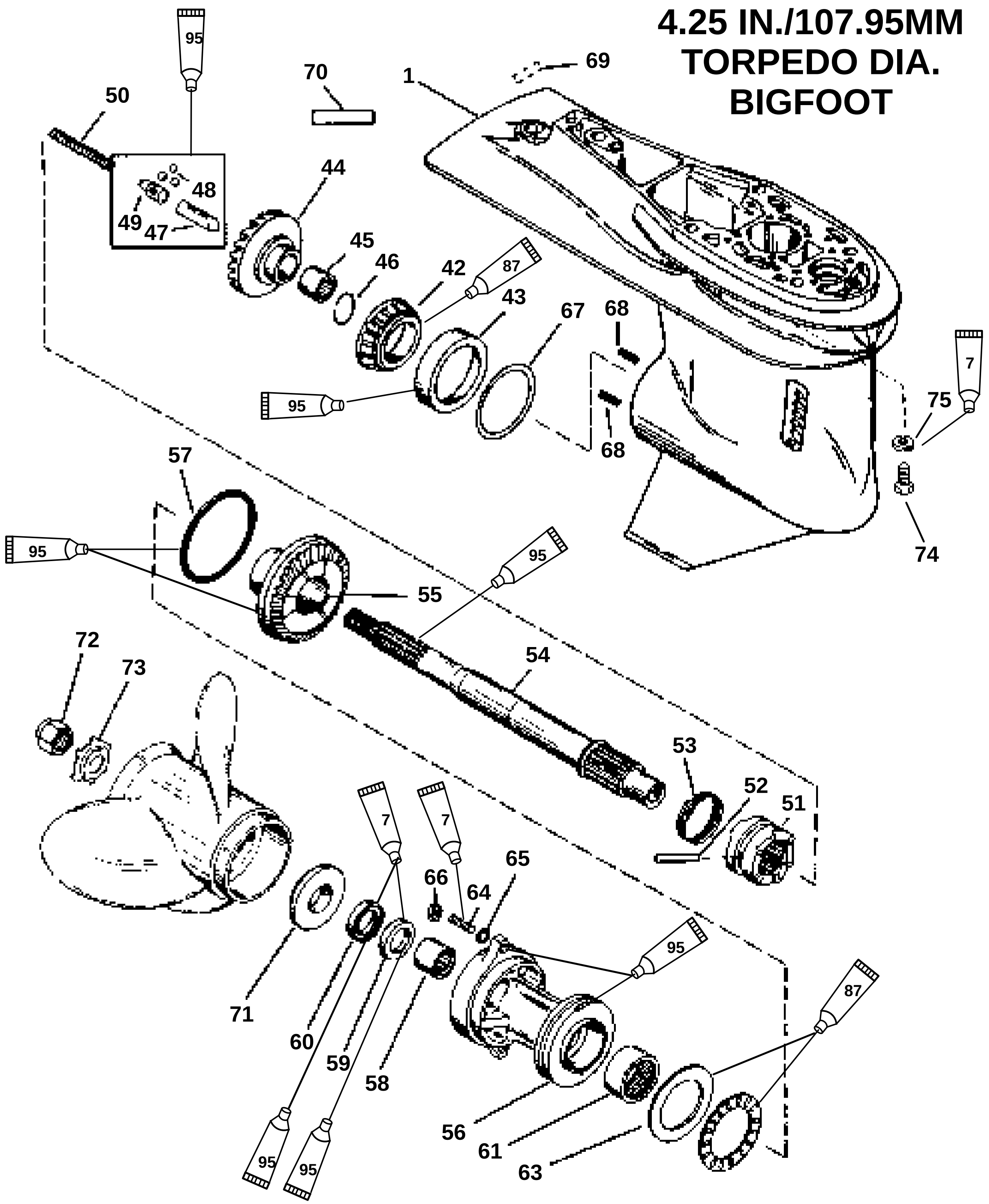
87 Premium Gear Lubricant (92-850737A1)

95 2-4-C With Teflon (92-850736A1)

GEAR HOUSING (DRIVE SHAFT)(2.31:1 GEAR RATIO)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
–	1	GEAR HOUSING			
1	1	GEAR HOUSING ASSEMBLY			
2	1	DOWEL PIN **(FRONT)**			
3	1	OILER TUBE			
4	3	DRAIN SCREW	60		6.8
5	3	WASHER-Sealing			
6	1	DOWEL PIN **(REAR)**			
7	1	TRIM TAB			
8	1	SCREW (.437-14 x 1.25)		22	29.8
9	1	WASHER			
10	1	CARRIER			
11	1	NEEDLE BEARING			
12	2	ANODE			
13	1	NUT			
14	1	SCREW (M6 x 40)	60		6.8
15	1	PINION GEAR (13 TEETH)			
16	1	NUT		70	95
17	1	SHIFT CAM			
18	1	TAPERED ROLLER BEARING			
19	AR	SHIM ASSEMBLY **(SIZES 006 THRU 048)**			
20	1	DRIVE SHAFT ASSEMBLY			
21	1	WEAR SLEEVE ASSEMBLY			
22	1	RING SEAL			
23	1	COVER ASSEMBLY			
24	1	GASKET			
25	1	GASKET			
26	1	OIL SEAL **(LOWER)**			
27	1	OIL SEAL **(UPPER)**			
28	1	GASKET			
29	1	WATER PUMP ASSEMBLY			
30	1	FACE PLATE			
31	4	SCREW (M6x30)	60		6.8
32	1	SEAL			
33	1	KEY			
34	1	IMPELLER			
35	6	SCREW	60		6.8
36	1	SHIFT SHAFT ASSEMBLY			
37	1	E-RING			
38	1	BUSHING ASSEMBLY			
39	1	O-RING			
40	1	OIL SEAL			
41	2	SCREW (M6 x 1)	60		6.8

GEAR HOUSING (PROP SHAFT)(2.31:1 GEAR RATIO)



7 Loctite 271 (92-809820)

87 Premium Gear Lubricant (92-850737A1)

95 2-4-C With Teflon (92-850736A1)

GEAR HOUSING (PROP SHAFT)(2.31:1 GEAR RATIO)

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	GEAR HOUSING ASSEMBLY			
42	1	TAPERED ROLLER BEARING ASSEMBLY			
43	1	CUP			
44	1	FORWARD GEAR (30 TEETH)			
45	1	ROLLER BEARING			
46	1	RETAINING RING			
47	1	CAM FOLLOWER ASSEMBLY			
48	3	BALL			
49	1	SLIDE			
50	1	SPRING			
51	1	CLUTCH			
52	1	CROSS PIN			
53	1	SPRING			
54	1	PROPELLER SHAFT			
55	1	REVERSE GEAR (30 TEETH)			
56	1	BEARING CARRIER ASSEMBLY			
57	1	O-RING			
58	1	ROLLER BEARING			
59	1	OIL SEAL **(INNER)**			
60	1	OIL SEAL **(OUTER)**			
61	1	ROLLER BEARING			
62	1	THRUST WASHER			
63	1	THRUST BEARING			
64	2	STUD		100	135
65	2	WASHER			
66	2	NUT		22	29.8
67	AR	SHIM ASSEMBLY **(SIZES 006 THRU 038)**			
68	2	THREAD INSERT			
69	1	DECAL			
70	1	DECAL-PROP OPERATION			
71	1	THRUST HUB ASSEMBLY			
72	1	PROPELLER NUT ASSEMBLY **SERVICE ITEMS**			
73	1	TAB WASHER			
74	4	SCREW		40	54.2
75	4	WASHER			

General Service Recommendations

There may be more than one way to “disassemble” or “reassemble” a particular part(s), therefore, it is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

In many cases, disassembly of a sub-assembly may not be necessary until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly-reassembly sequence.

Threaded parts are right hand (RH), unless otherwise indicated.

When holding, pressing or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel (one that will contact only the bearing race) when pressing or driving bearings.

When compressed air is used to dry a part, verify that no water is present in air line.

Bearings

All bearings must be cleaned and inspected. Clean bearings with solvent and dry with compressed air. Air should be directed at the bearing so that it passes through the bearing. DO NOT spin bearing with compressed air, as this may cause bearing to score from lack of lubrication. After cleaning, lubricate bearings with Premium Blend Gear Lubricant. DO NOT lubricate tapered bearing cups until after inspection.

Inspect ball bearings for roughness, catches and bearing race side wear. Work inner bearing race in-and-out, while holding outer race, to check for side wear. When inspecting tapered bearings, determine condition of rollers and inner bearing race by inspecting bearing cup for pitting, scoring, grooves, uneven wear, imbedded particles and/or discoloration from over-heating. Always replace tapered bearing and race as a set.

Inspect gear housing for bearing races that have spun in their respective bores. If race(s) have spun, gear housing must be replaced.

Roller bearing condition is determined by inspecting the surface of the shaft that the roller bearing supports. Check shaft surface for pitting, scoring, grooving, imbedded particles, uneven wear and/or discoloration from overheating. The shaft and bearing must be replaced if such a condition exists.

Seals

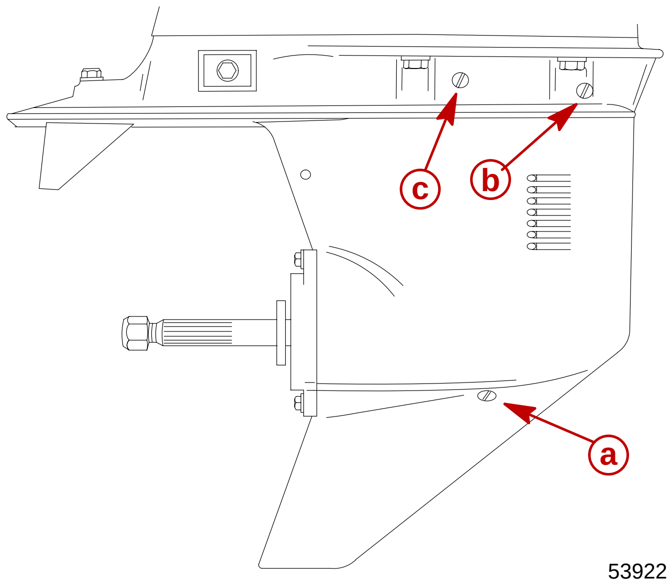
As a normal procedure, all O-rings and oil seals should be replaced without regard to appearance. To prevent leakage around seals, apply Loctite 271 to outer diameter of all metal case seals. When using Loctite on seals or threads, surfaces must be clean and dry. Apply 2-4-C w/Teflon on all O-rings and on I.D. of oil seals. Apply 2-4-C w/Teflon to external surfaces of bearing carrier.

Draining and Inspecting Gear Lubricant

⚠ WARNING

If gear housing is installed on engine, to avoid accidental starting, disconnect (and isolate) spark plug leads from spark plugs before working near the propeller.

1. With gear housing in normal running position, place a clean pan under housing and remove the two vent screws and one fill/drain screw (with gaskets).



a - Fill/Drain Screw
b - Oil Level Screw
c - Vent Screw

2. Inspect gear lubricant for metal particles (lubricant will have a "metal flake" appearance). Drain lube into a clean pan/container. Presence of fine metal particles (resembling powder) in the gear lube indicates normal wear. The presence of metal chips in the gear lube indicates the need for gear housing disassembly and component inspection.
3. Note color of gear lubricant. White or cream color MAY indicate presence of water in lubricant. Gear lubricant which has been drained from a gear case recently in operation will have a yellowish color due to lubricant agitation/aeration. Gear lube which is mixed with assembly lubricant (Special Lube 101 or 2-4-C w/Teflon) will also be creamy white in color. This is normal and should not be confused with the presence of water. If water is suspected to be present in gearcase, a pressure check of gearcase should be made (with no lubricant in gearcase). Gearcase should hold 10 to 12 psi of pressure for 5 minutes without leaking down. Pouring a portion of the gear lubricant into a glass jar and allowing the lubricant to settle will allow any water in the lube to separate and settle to the bottom of the jar.
4. Presence of water in gear lubricant indicates the need for disassembly and inspection of oil seals, seal surfaces, O-rings, water pump gaskets as well as gear housing components for damage. If gearcase is rebuilt, gearcase should be pressure checked before filling with lubricant.

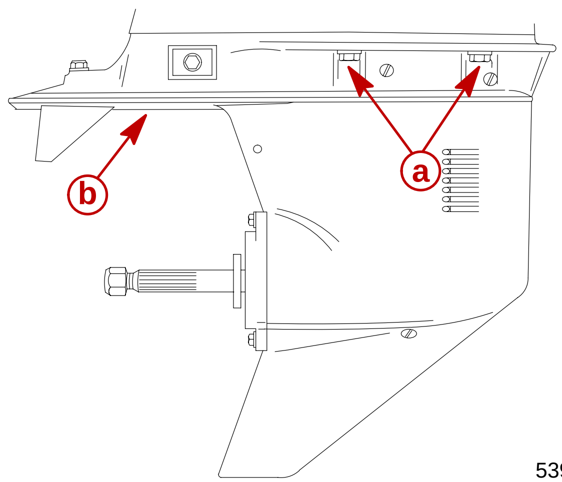
Removal

⚠ WARNING

To prevent accidental engine starting, remove (and isolate) spark plug leads from spark plugs before removing gear housing.

IMPORTANT: 90 hp (4-Stroke) models, when removing or installing gearcase carefully guide driveshaft through drive shaft bushing to avoid scoring bushing surface.

1. Remove (and isolate) spark plug leads from spark plugs.
2. Shift engine into forward gear.
3. Tilt engine to full “Up” position.
4. Remove 4 fasteners.
5. Remove locknut and washer.
6. Remove gear housing.



53992

a - Fasteners (2 Each Side)
b - Locknut and Washer

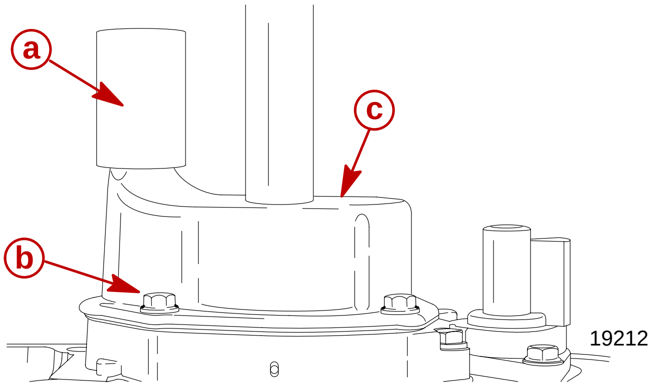
Disassembly

Water Pump

NOTE: *If water tube seal stayed on water tube (inside of drive shaft housing) when gear housing was removed, pull water tube seal from water tube.*

NOTE: *Newer models will not have the isolators installed on the water pump.*

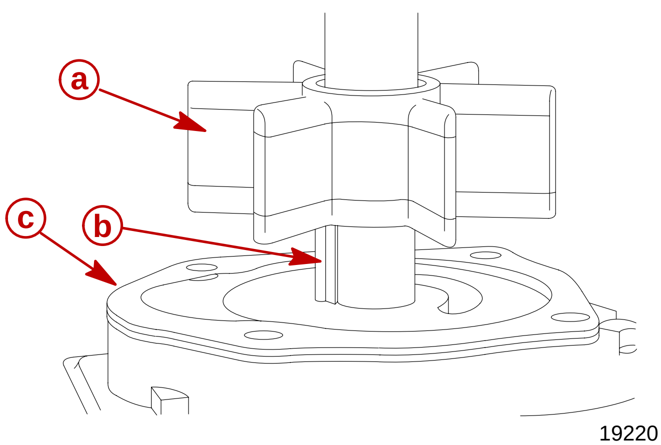
1. Replace water tube seal, if damaged.
2. Remove 4 screws (2 on each side of water pump housing), washers, and isolators.
3. Remove cover.



a - Water Tube Seal
b - Screw, Washer, Isolator (4 each)
c - Cover

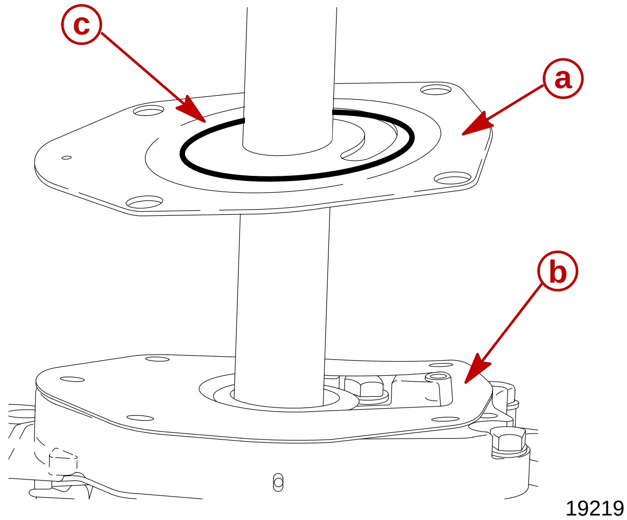
IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting cover (Step 4) and plate (Step 8), as the depth of the groove will not affect water pump output.

4. Replace cover if thickness of steel at the discharge slots is 0.060 in. or less, or if groove(s) (other than impeller sealing bead groove) in cover roof are more than 0.030 in. (0.762 mm) deep.
5. Lift impeller, drive key, and gasket from drive shaft.



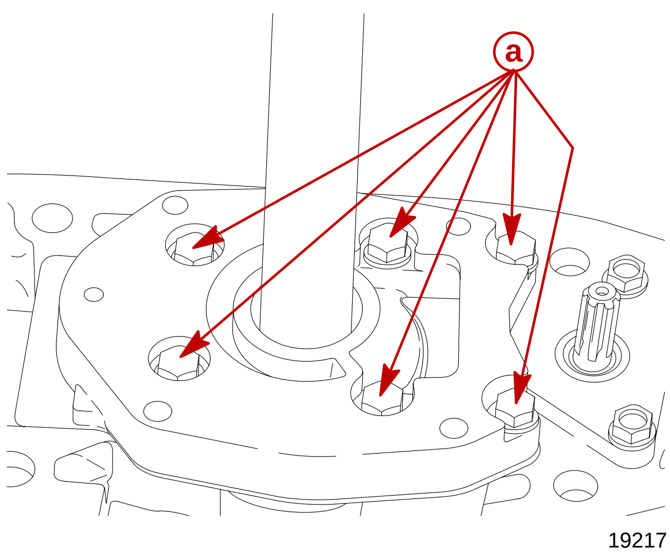
a - Impeller
b - Drive Key
c - Gasket

6. Inspect impeller. Replace impeller if any of the following conditions exist:
   - Impeller blade(s) are cracked, torn, or worn.
   - Impeller is glazed or melted (caused by operation without sufficient water supply).
   - Rubber portion of impeller is not bonded to impeller hub.
7. Remove plate and gasket.
8. Replace plate if groove(s) (other than impeller sealing bead groove) in plate are more than 0.030 in. (0.762 mm) deep.



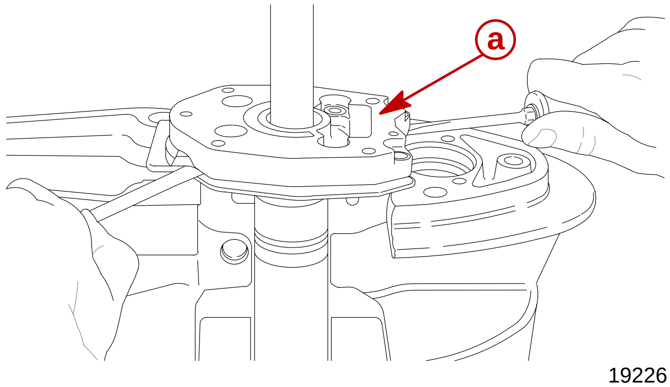
a - Plate
b - Gasket
c - Impeller Sealing Groove

9. Remove screws and washers.



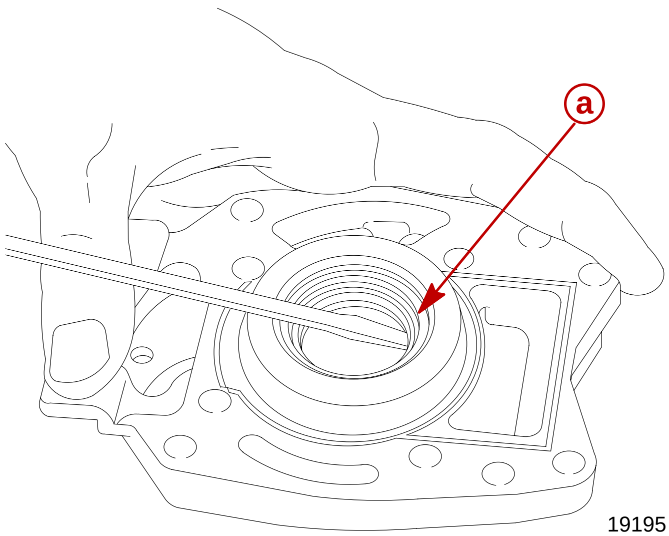
a - Screws and Washers (6 each)

10. Remove water pump base using flat screwdrivers to lightly pry up on base.



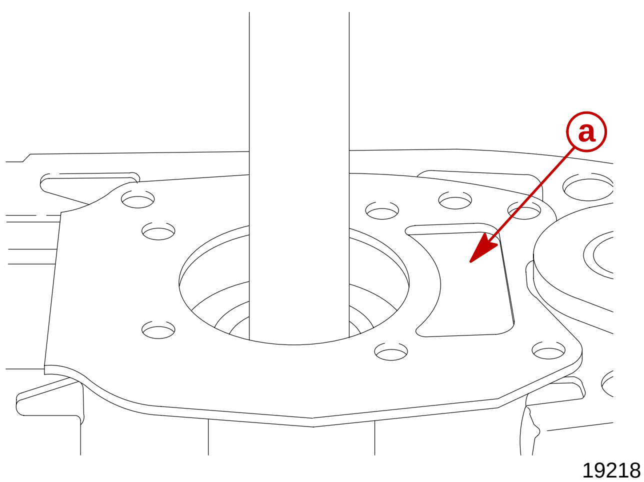
a - Water Pump Base

11. Remove (and discard) seals **(IT MAY BE BENEFICIAL TO CLAMP THE WATER PUMP BASE IN A VISE WHILE REMOVING SEALS).**



a - Seals

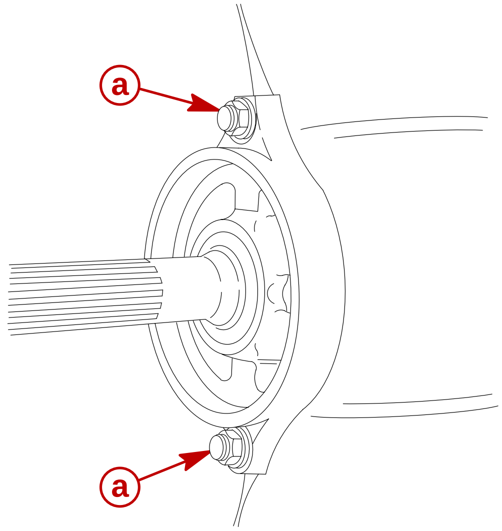
12. Remove gasket.



a - Gasket

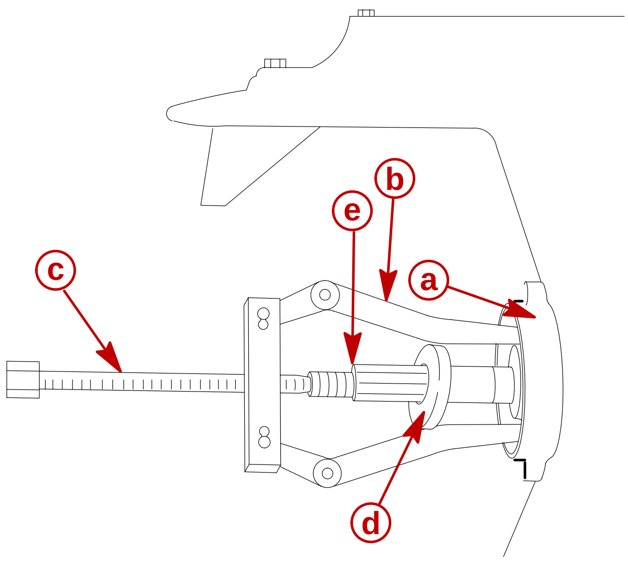
Bearing Carrier and Propeller Shaft

1. Remove fasteners.



a - Fasteners

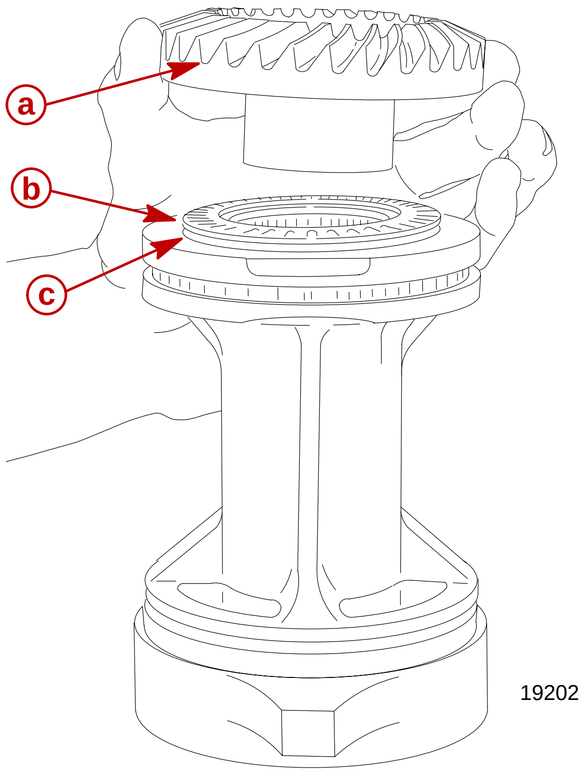
2. With propeller shaft horizontal, pull carrier (using tool shown) to break seal with gear housing.
3. Remove bearing carrier/propeller shaft components as an assembly by pulling back on the propshaft. Take care not to lose cam follower or 3 metal balls in end of propeller shaft.
4. Remove propeller shaft from bearing carrier.



a - Bearing Carrier
b - Puller Jaws (91-46086A1)
c - Puller Bolt (91-85716)
d - Thrust Hub
e - Propeller Shaft

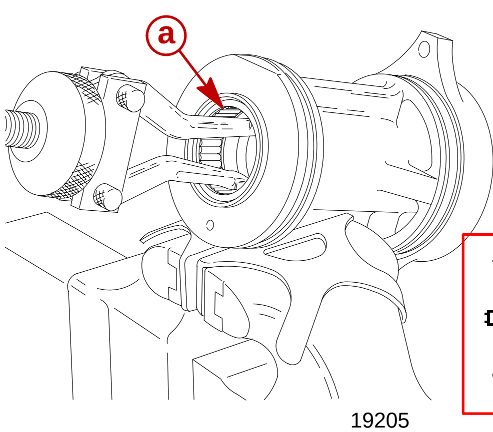
5. Lift reverse gear, thrust bearing and thrust washer from bearing carrier. Replace thrust bearing and thrust washer if rusted or damaged.

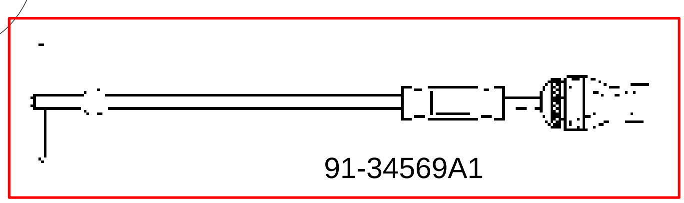
6. Replace reverse gear if gear teeth or clutch teeth on reverse gear are rounded or chipped. If reverse gear must be replaced, pinion gear and sliding clutch should be inspected for damage.



a - Reverse Gear
b - Thrust Bearing
c - Thrust Washer

7. If reverse gear radial bearing is rusted or does not roll freely, replace bearing. If the bearing needs to be replaced remove it using Slide Hammer (91-34569A1).

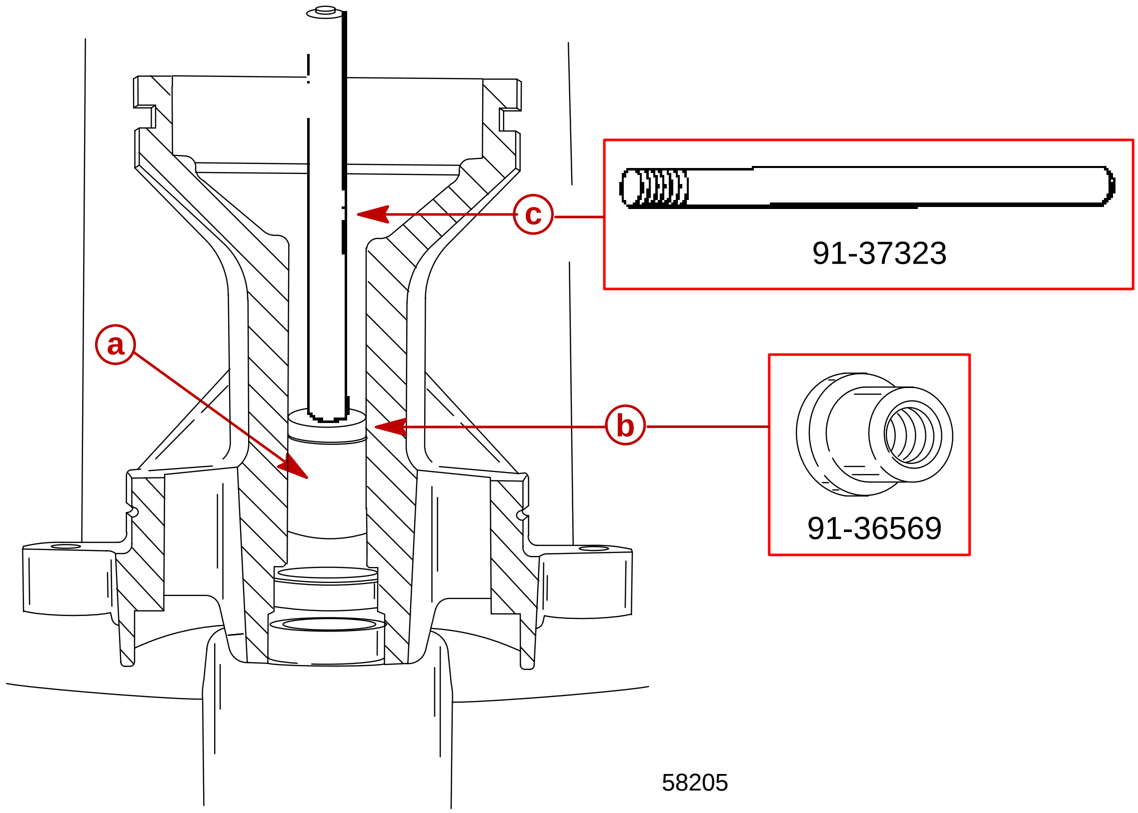




a - Radial Bearing

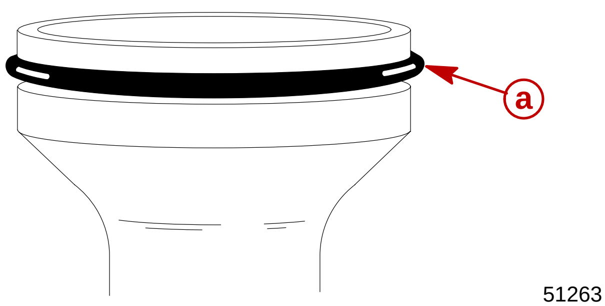
8. If bearing is rusted or does not roll freely, replace bearing. If replacement is necessary, remove bearing and oil seals using Mandrel* (91-36569) and Driver Rod* (91-37323). Discard oil seals.

NOTE: **From Bearing Removal and Installation Kit (91-31229A7).*



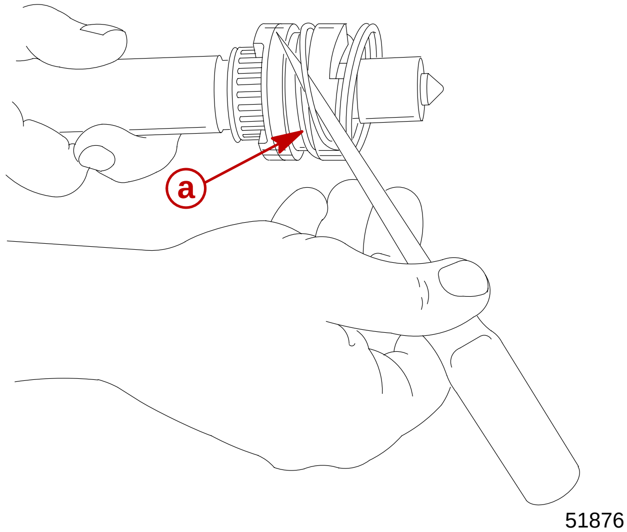
a - Bearing
b - Mandrel (91-36569)
c - Driver Rod (91-37323)

9. Remove propeller shaft seals (if not removed with bearing in Step 9) and bearing carrier O-ring.



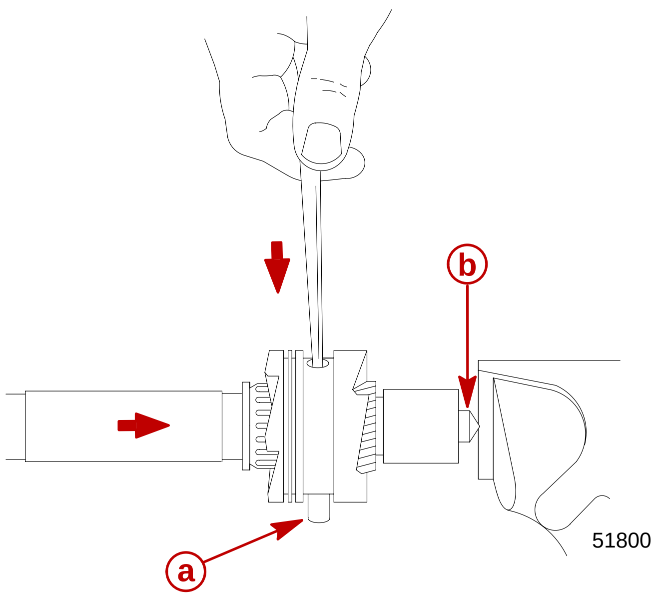
a - O-ring

10. Remove spring.



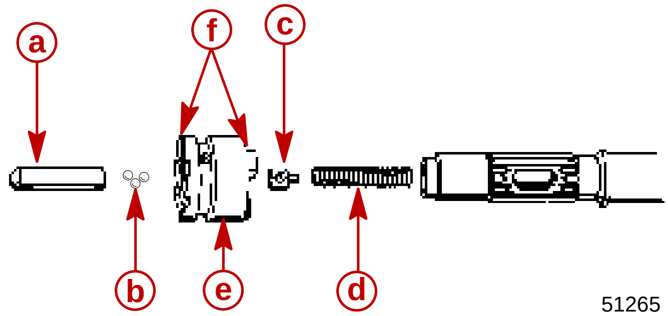
a - Spring

11. Apply constant pressure to cam follower in order to prevent it and internal components from ejecting out of the propeller shaft during removal of the cross pin from the clutch.



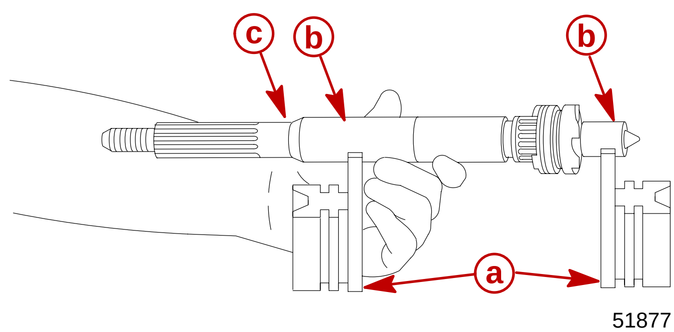
a - Cross Pin
b - Cam Follower

12. Remove components from propeller shaft.
13. Replace cam follower if worn or pitted.
14. Replace sliding clutch if jaws are rounded or chipped. Rounded jaws indicate one or more of the following:
    - Improper shift cable adjustment.
    - Engine idle speed too high while shifting.
    - Shifting from neutral to reverse (or forward) too slowly.



a - Cam Follower
b - Metal Balls (3)
c - Guide Block
d - Spring
e - Sliding Clutch
f - Jaws

15. Replace propeller shaft if any of the following exist:
    - Splines are twisted or worn.
    - Bearing surfaces of propeller shaft are pitted or worn.
    - Oil seal surface is grooved.
    - Shaft has a noticeable “wobble” or is bent more than 0.009 in. (0.228 mm). Prop shaft trueness should be measured with a dial indicator with prop shaft on V-blocks.



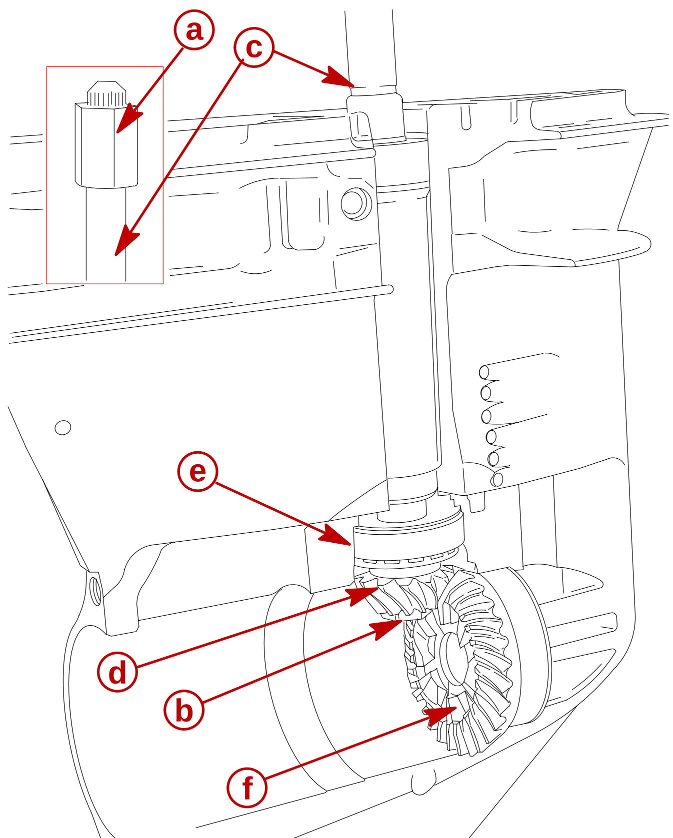
a - V-Blocks
b - Bearing Surfaces
c - Measure with Dial Indicator at This Point

Pinion Gear, Drive Shaft, and Forward Gear

1. Hold drive shaft using Drive Shaft Holding Tool; remove (and discard) pinion nut.

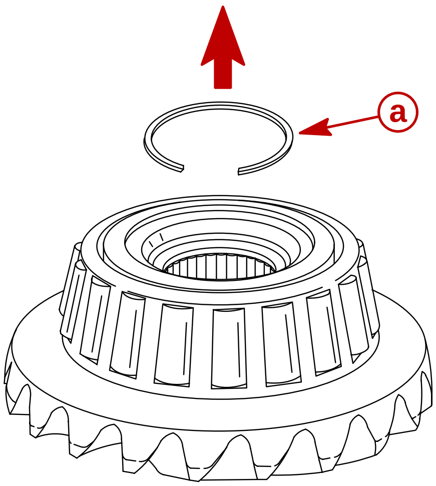
Model	Drive Shaft Holding Tool
40/50 Bigfoot (4-Stroke, 747cc/935cc)	91-56775
40/50/60 Bigfoot (4-Stroke, 995cc)	91-877840A1
75/90/115 EFI (4-Stroke)	91-804776A1
60 Bigfoot (2-Stroke)	91-56775
75/90/100/115/125 (2-Stroke)	91-56775

2. Remove drive shaft, pinion gear, pinion bearing and forward gear.
3. Replace pinion gear if it is chipped or worn.
4. Replace pinion bearing and race if either are rusted, pitted or damaged; or if bearing does not roll freely. To remove race, refer to "Lower Drive Shaft Bearing Race," following.
5. Replace forward gear if gear teeth or clutch teeth are chipped or worn.



a - Drive Shaft Holding Tool
b - Pinion Nut
c - Drive Shaft
d - Pinion Gear
e - Pinion Bearing
f - Forward Gear

6. Replace forward gear needle bearing if it is rusted or does not roll freely.
7. Use suitable tools (screwdriver and awl) to remove retaining ring. Use a punch and hammer to remove bearing.



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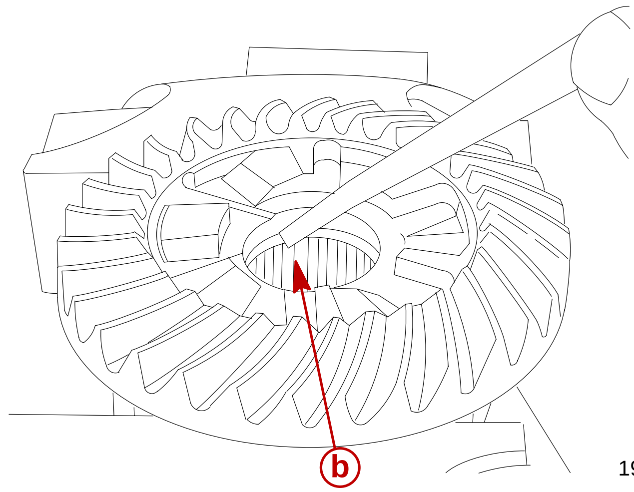
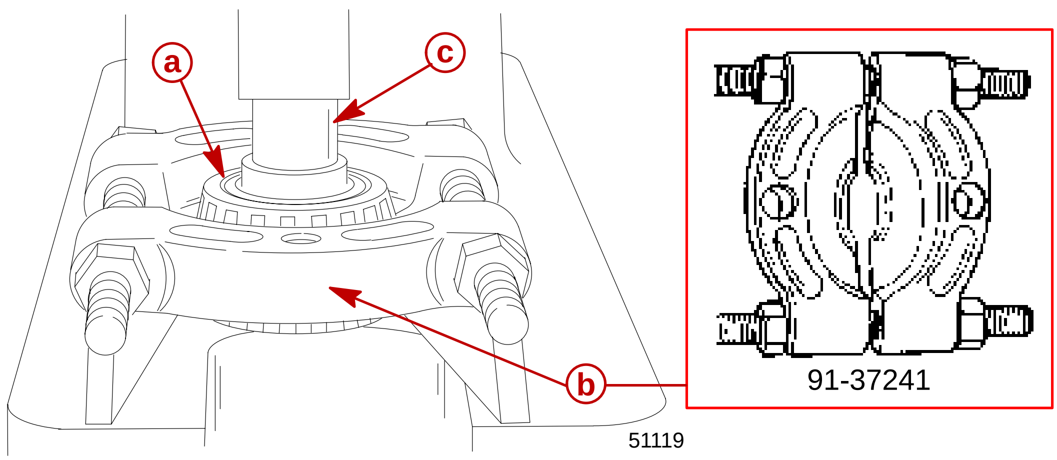


19203

a - Retaining RIng
b - Forward Gear Needle Bearing

8. Replace forward gear bearing and race if either are rusted, pitted or damaged, or if bearing does not roll freely. Remove bearing from gear using Universal Puller Plate (91-37241) and mandrel. To remove race, refer to “Forward Gear Bearing Race,” following.



51119

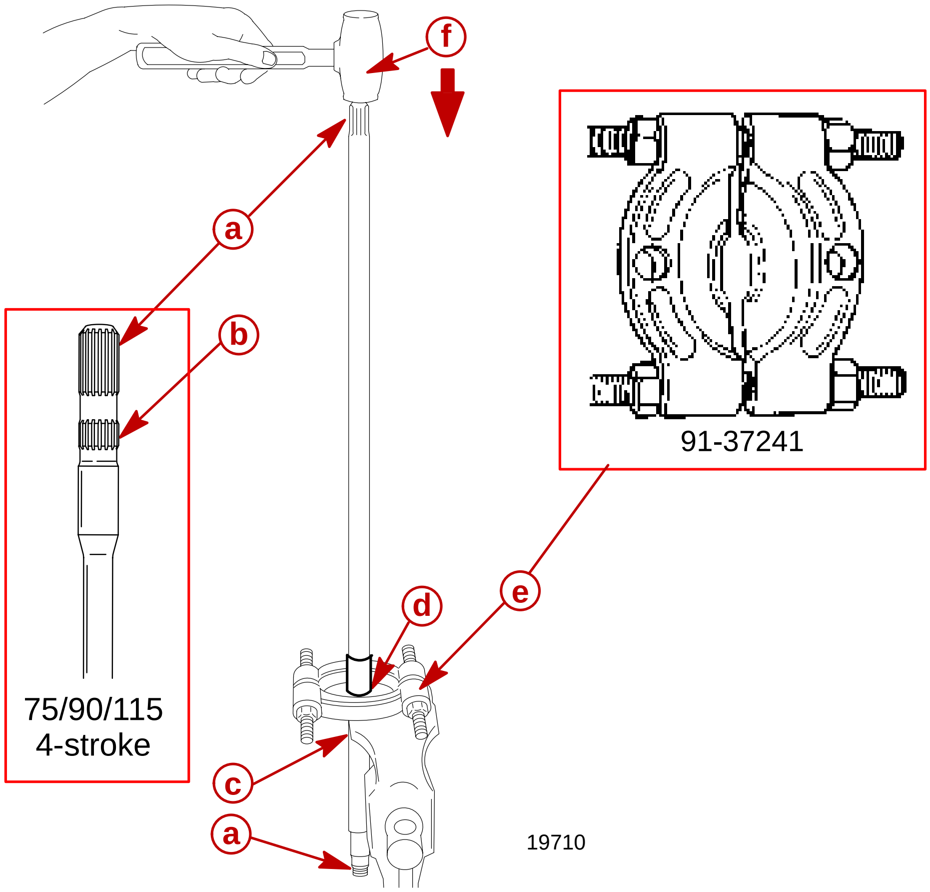
a - Forward Gear Bearing
b - Universal Puller Plate (91-37241)
c - Mandrel

9. Replace drive shaft if splines are worn or twisted.

10. If bearing surface is damaged, replace drive shaft and corresponding bearing.

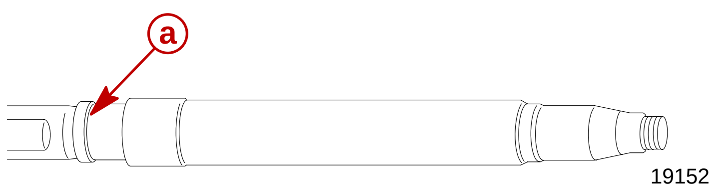
IMPORTANT: Do not tighten vise against drive shaft.

11. If wear sleeve is deeply grooved allowing water to enter gear case, remove (and discard) sleeve using Universal Puller Plate (91-37241) and mallet.



a - Crankshaft/Driveshaft Splines
b - Oil Pump Drive Splines 75/90 4-Stroke Only
c - Bearing Surface
d - Wear Sleeve
e - Universal Puller Plate (91-37241)
f - Mallet

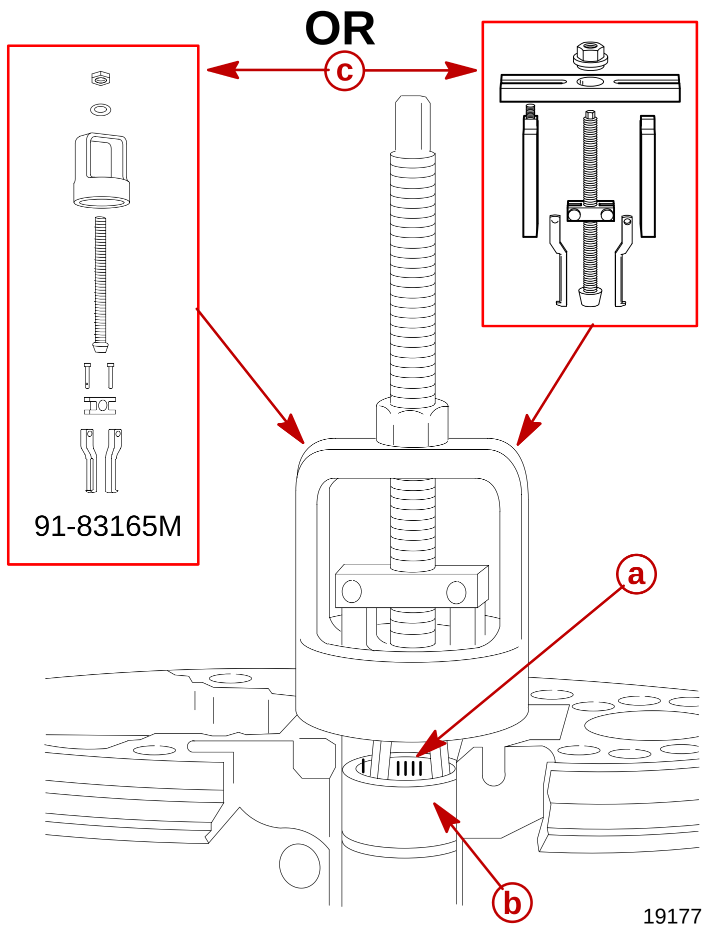
12. Remove (and discard) rubber ring.



a - Rubber Ring

Upper Drive Shaft Bearing

1. Replace upper drive shaft bearing and sleeve if either are rust stained, or if bearing will not roll freely. Remove bearing and then sleeve using Puller Assembly (91-83165M) with suitable jaws.

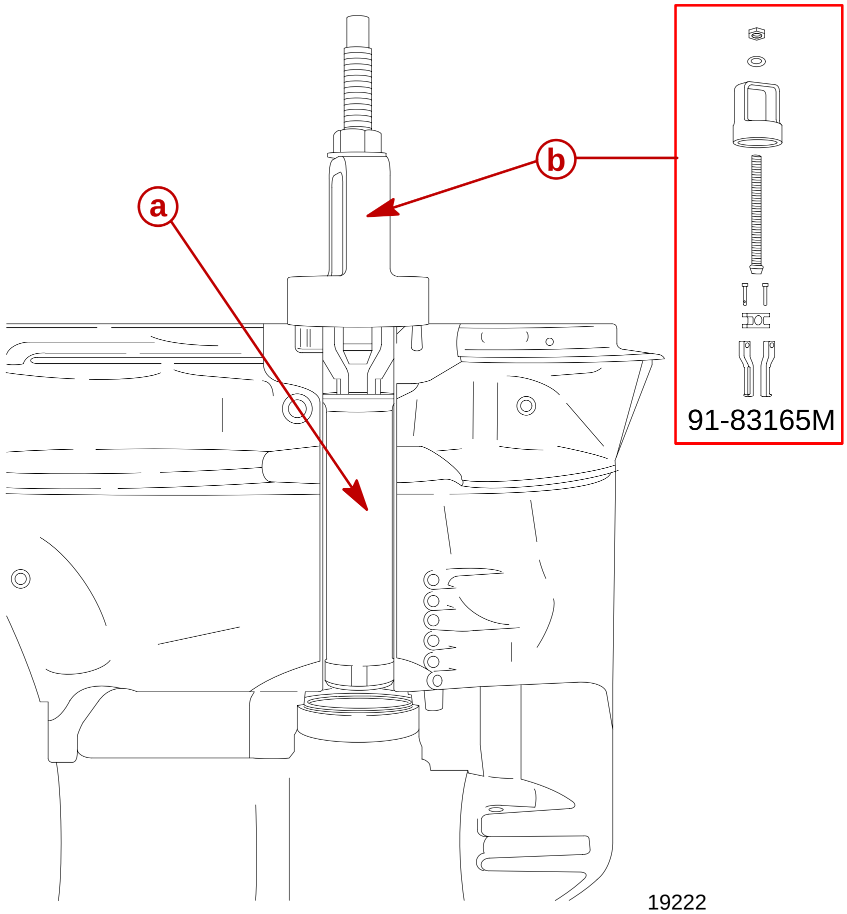


a - Upper Drive Shaft Bearing
b - Sleeve
c - Puller Assembly (91-83165M)

IMPORTANT: Upper drive shaft bearing/sleeve must be removed prior to oil sleeve removal. Refer to “Upper Drive Shaft Bearing,” preceding.

Oil Sleeve

1. Remove oil sleeve (if necessary) using Puller Assembly (91-83165M) with suitable jaws.



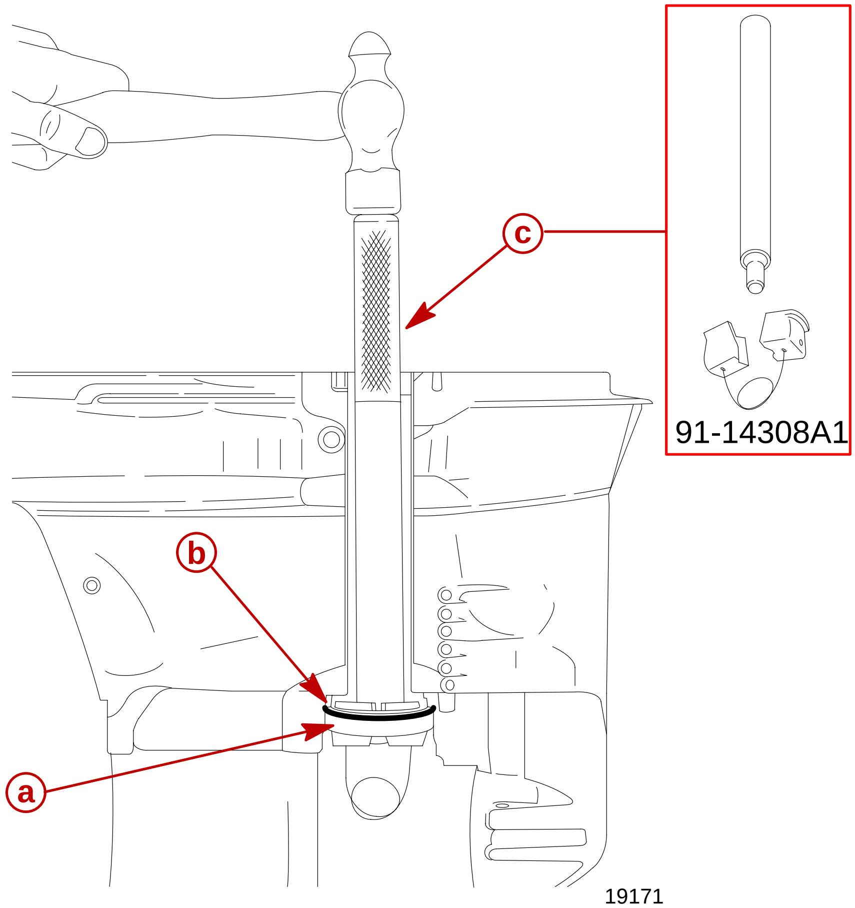
a - Oil Sleeve
b - Puller Assembly (91-83165M)

Lower Drive Shaft Bearing Race

IMPORTANT: Upper drive shaft bearing/sleeve and oil sleeve do not have to be removed for lower drive shaft bearing race removal.

IMPORTANT: Retain shim(s) for reassembly.

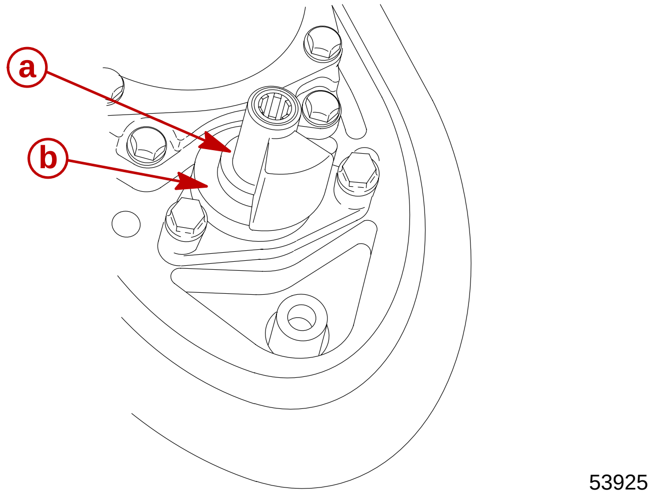
1. Remove bearing race and shim(s) using bearing race tool (91-14308A1).



a - Bearing Race
b - Shim(s)
c - Bearing Race Tool (91-14308A1)

Shift Shaft

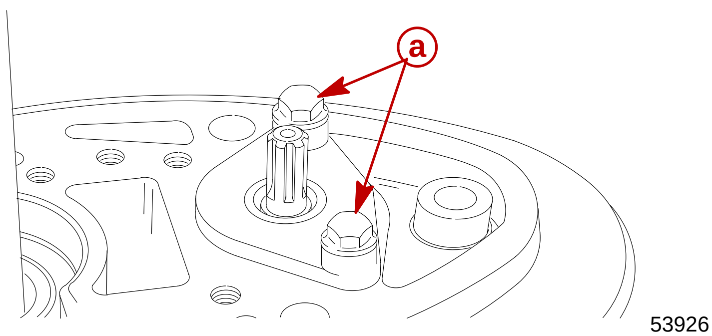
1. Remove shift shaft coupler and nylon spacer.



75 (2-Stroke) Tiller Model Shown

a - Shift Shaft Coupler
b - Spacer

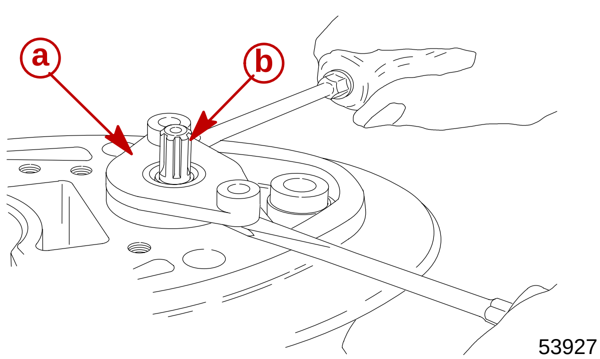
2. Remove bolts.



a - Bolts

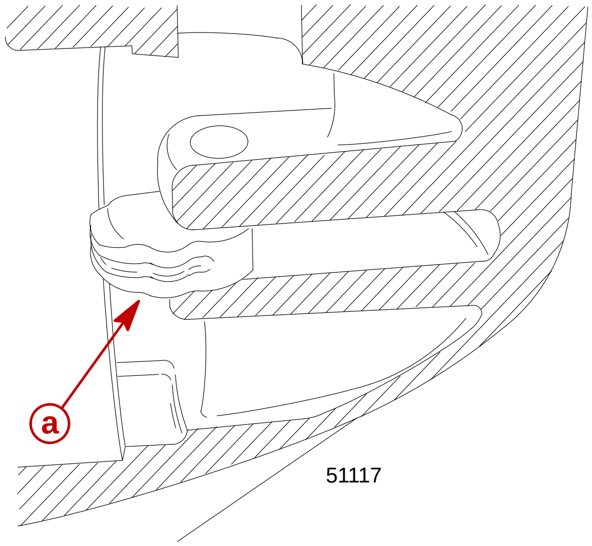
NOTE: *Remove rough edges from shift shaft splines before removing shift shaft bushing.*

3. Remove shift shaft bushing and shift shaft.



a - Bushing
b - Shift Shaft

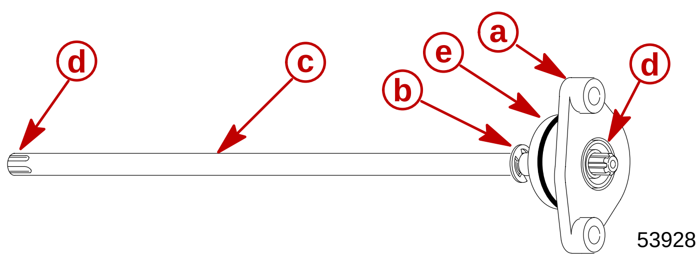
4. Remove shift cam from housing.
5. Replace shift cam if worn.



60 (2-Stroke) Bigfoot Shown

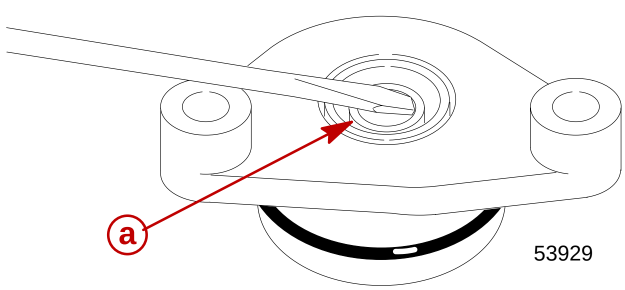
a - Shift Cam

6. Remove shift shaft bushing and clip from shift shaft.
7. Replace shift shaft if splines are worn or shaft is twisted.
8. Remove (and discard) O-ring.



a - Bushing
b - Clip
c - Shift Shaft
d - Splines
e - O-ring

9. Remove (and discard) seal. (Lightly clamp the bushing in a vise when removing seal.)

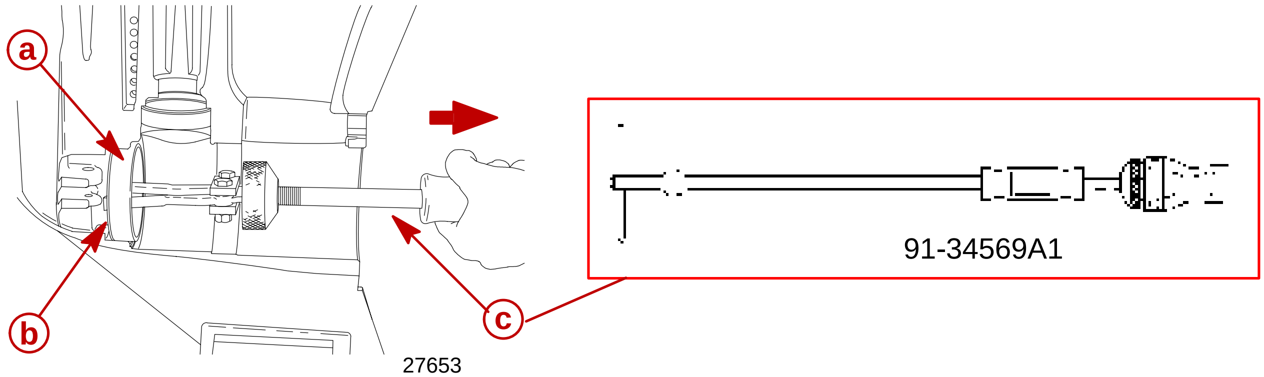


a - Seal

Forward Gear Bearing Race

IMPORTANT: Retain shim(s) for reassembly. If shims are damaged, replace with new shims of equal thickness.

1. Remove race and shim(s) using Slide Hammer (91-34569A1).



a - Race
b - Shim(s)
c - Slide Hammer (91-34569A1)

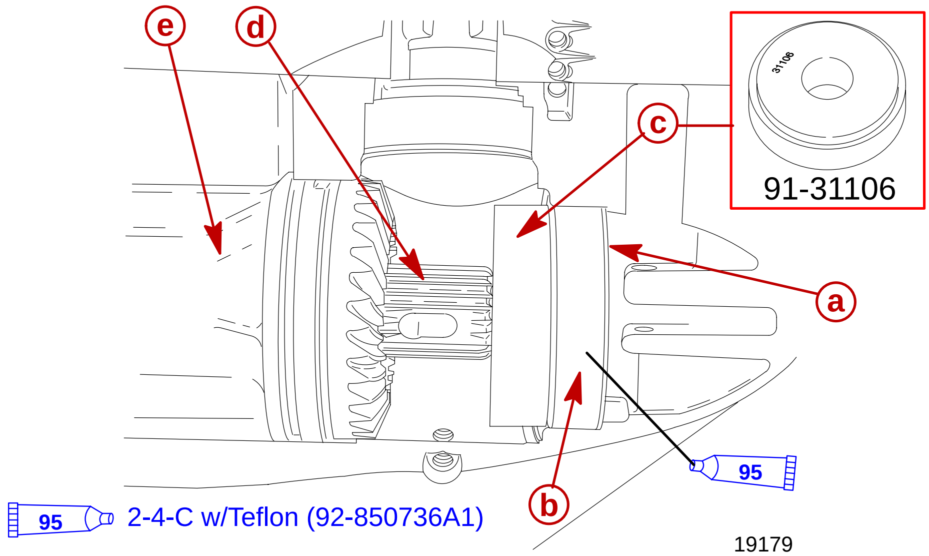
Reassembly

Forward Gear Bearing Race

NOTE: *Propshaft should be vertical when installing bearing race.*

1. Place shim(s) (retained from disassembly) into housing. If shim(s) were lost, or a new gear housing is being assembled, start with 0.010 in. (0.254 mm) shim(s).
2. Assemble components as shown using mandrel (91-31106). Apply 2-4-C w/Teflon to O.D. of race. Drive race into housing by striking propeller shaft end with lead hammer.

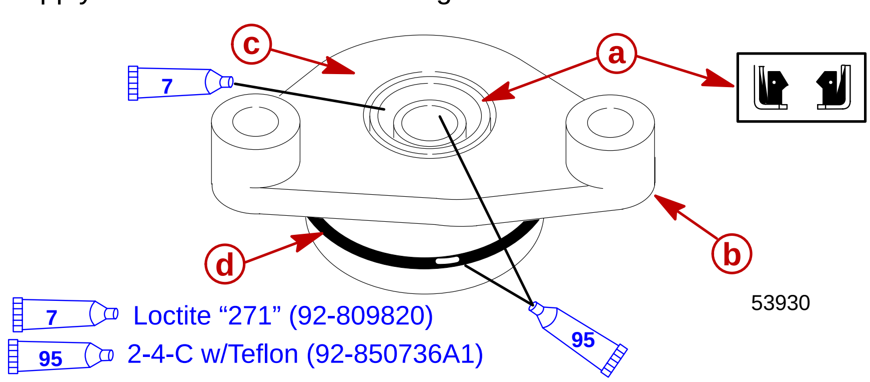
NOTE: *Install a nut on the end of the propshaft to prevent damage to the propshaft threads while performing step 2.*



a - Shim(s)
b - Race
c - Mandrel (91-31106)
d - Disassembled Propeller Shaft
e - Assembled Bearing Carrier

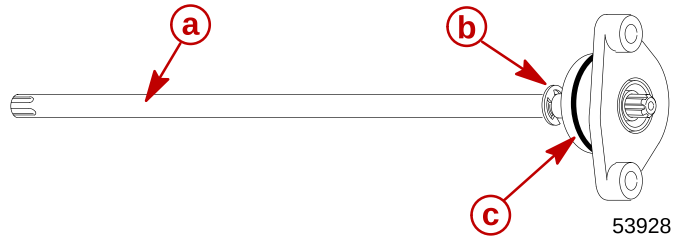
Shift Shaft

1. Apply Loctite 271 on O.D. of new seal.
2. Press seal into shift shaft bushing until seal is seated against shoulder.
3. Install new O-ring.
4. Apply 2-4-C with Teflon on O-ring and I.D. of seal.



a - Seal
b - Bushing
c - Surface
d - O-ring

5. Assemble components as shown.

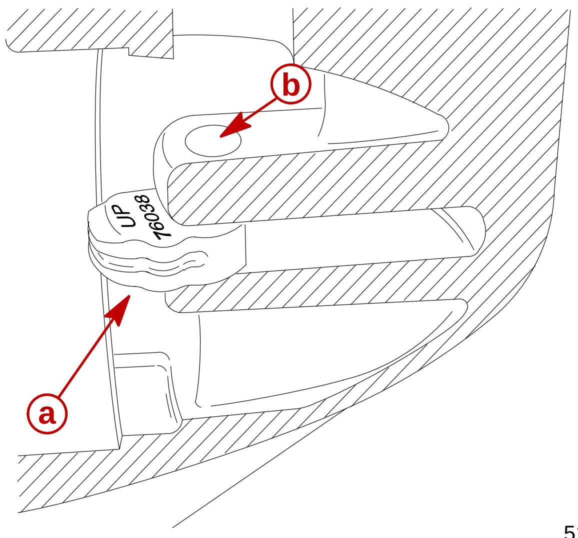


53928

a - Shift Shaft
b - "E" Clip
c - Shift Shaft Bushing

6. Install shift cam; align hole in shift cam with shift shaft pilot bore in gear housing.

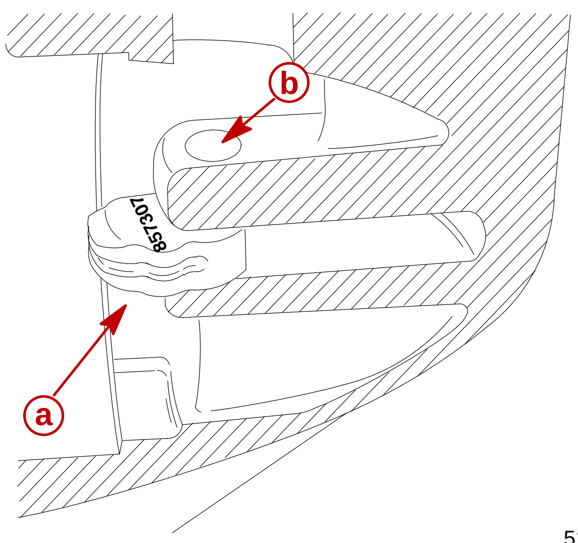
60 Bigfoot, 75/90/100/115/125 (2-Stroke)



51117

a - Shift Cam (marked with "UP" and part number)
b - Shift Shaft Pilot Bore

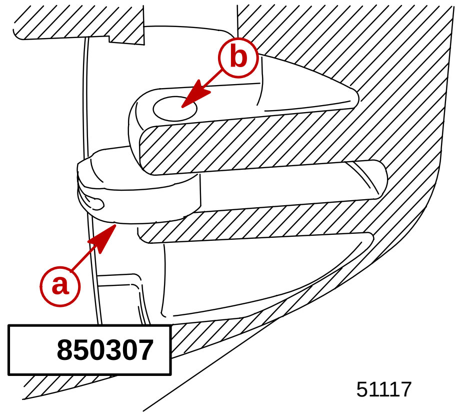
60 Bigfoot, 75/90/100/115/125 (2-Stroke) & 75/90/115EFI (4-Stroke)



51117

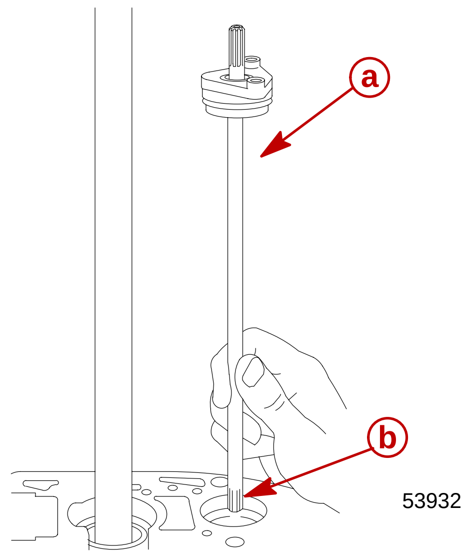
a - Shift Cam (marked with part number **only**)
b - Shift Shaft Pilot Bore

40/50 Bigfoot (4-Stroke,747cc/935cc), 40/50/60 Bigfoot (4-Stroke, 995cc)



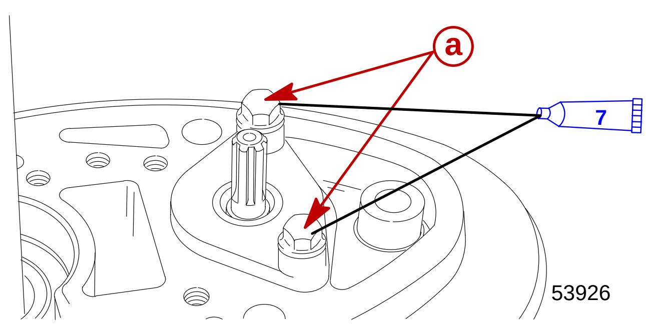
a - Shift Cam (**Numbers Down**)
b - Shift Shaft Pilot Bore

7. Install shift shaft assembly; insert splines into shift cam.



a - Shift Shaft Assembly
b - Splines

8. Apply Loctite 271 to bottom half of threads on each screw. Install screws and tighten to specified torque.



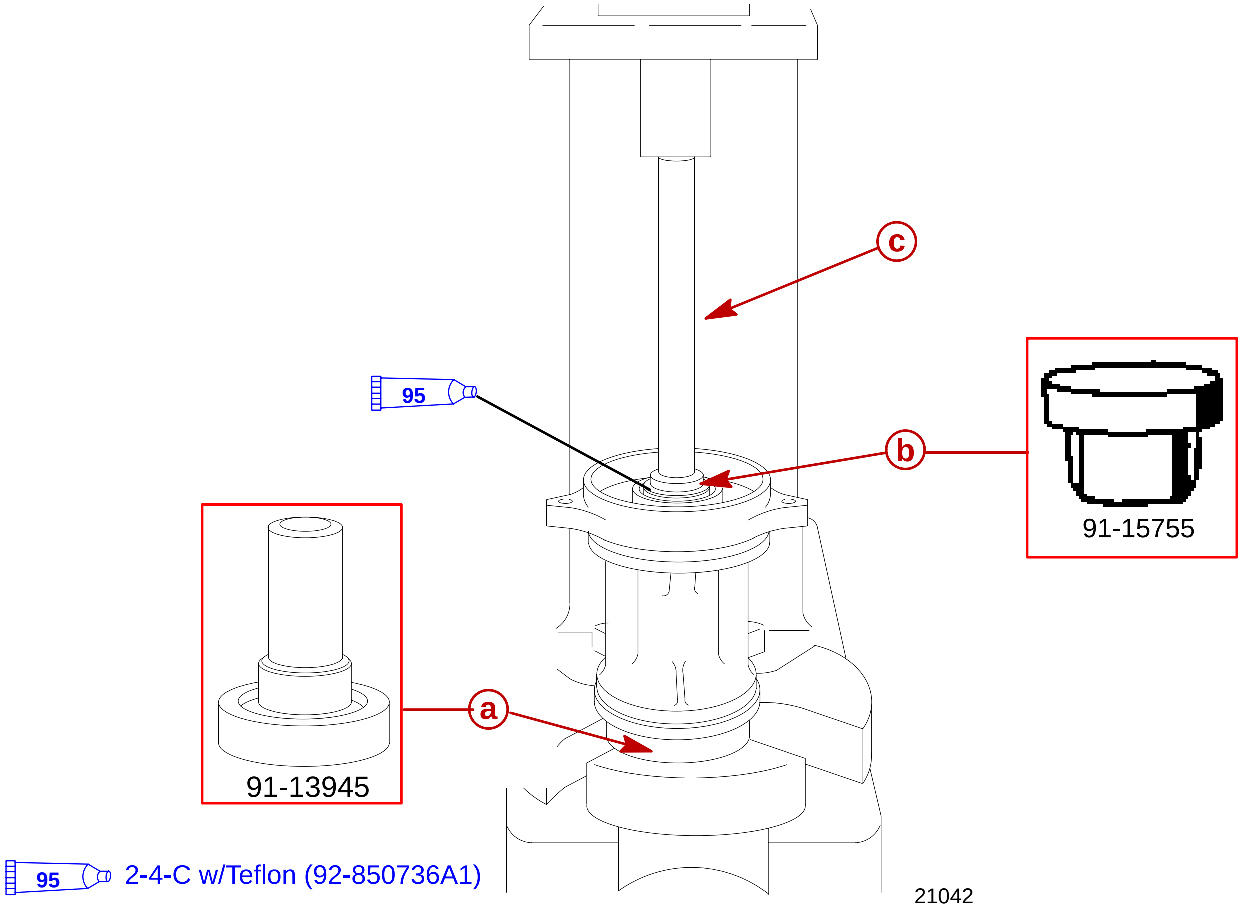
7 Loctite “271” (92-809820)

a - Screw (2)

Screw Torque
60 lb-in. (6.8 Nm)

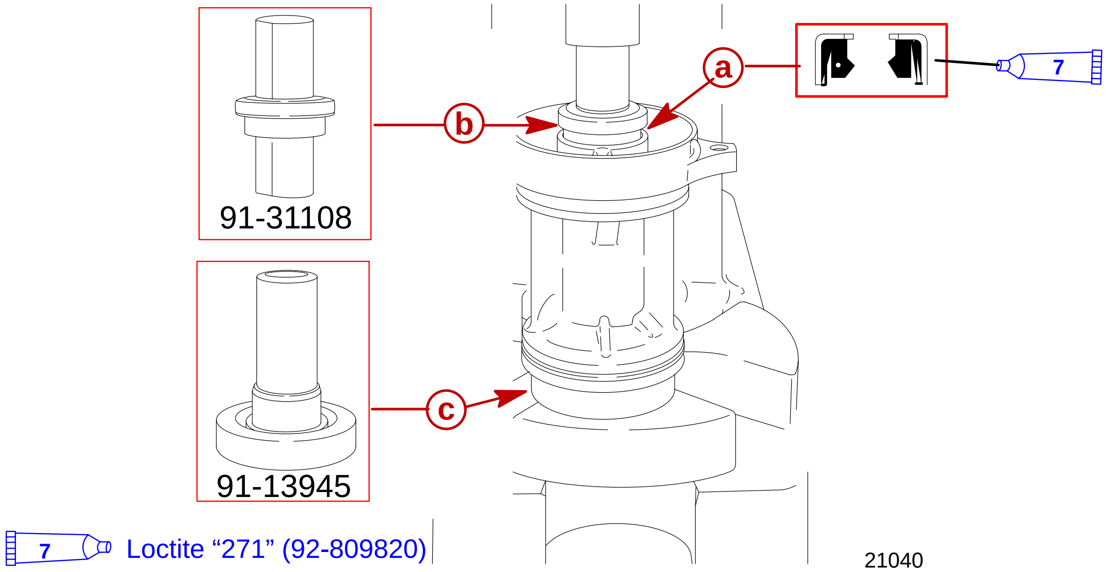
Bearing Carrier Reassembly

1. Lubricate O.D. of bearing and bearing carrier bore with Quicksilver 2-4-C w/Teflon.
2. Protect lip on forward side of bearing carrier, using bearing installation tool (91-13945).
3. Press propeller shaft needle bearing (number side toward mandrel 91-15755) into carrier, until bearing bottoms out.



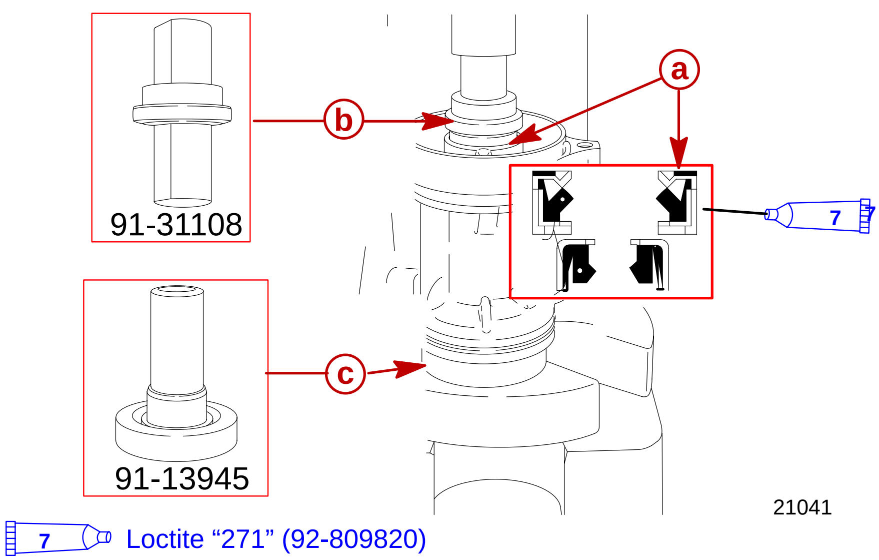
a - Bearing Installation Tool (91-13945)
b - Mandrel (91-15755)
c - Suitable Driver Rod

4. Place smaller diameter seal on longer shoulder of Oil Seal Driver (91-31108) with seal lip away from shoulder.
5. Protect lip on front side of bearing carrier using Bearing Installation Tool (91-13945). Apply Loctite 271 on O.D. of seal. Press seal into carrier until tool bottoms.



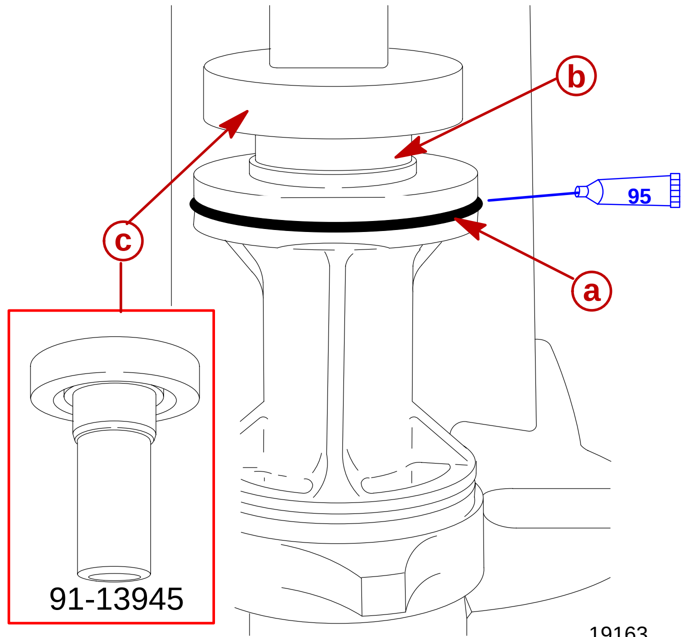
a - Seal
b - Oil Seal Driver (91-31108)
c - Bearing Installation Tool (91-13945)

6. Place larger diameter seal on shorter shoulder of Oil Seal Driver (91-31108) with seal lip toward shoulder.
7. Protect lip on front side of bearing carrier using Bearing Installation Tool (91-13945). Apply Loctite 271 on O.D. of new seal. Press seal into carrier until tool bottoms.



a - Seal
b - Oil Seal Driver (91-31108)
c - Bearing Installation Tool (91-13945)

8. Install O-ring. Lubricate O-ring with 2-4-C w/Teflon. Lubricate seal lips with 2-4-C w/Teflon.
9. Lubricate outside diameter of reverse gear bearing and bearing carrier bore with a light coating of 2-4-C w/Teflon.
10. Press bearing into carrier until tool bottoms.

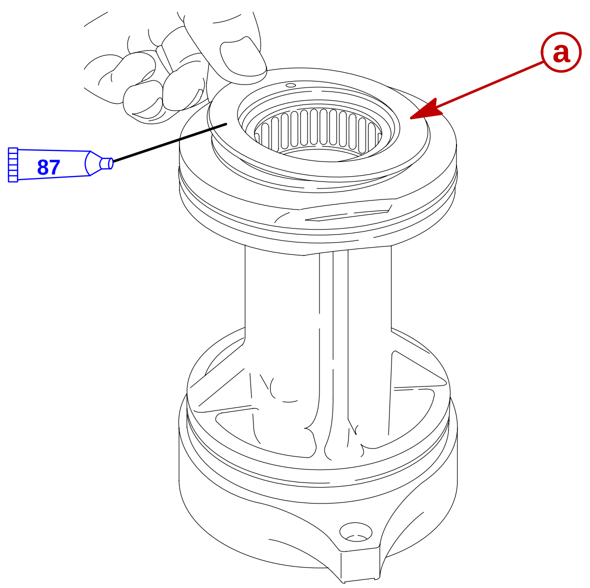


19163

95 2-4-C w/Teflon (92-850736A1)

a - O-ring
b - Bearing, Numbered Side Toward Tool
c - Bearing Installation Tool (91-13945)

11. Install thrust washer. Coat thrust washer with Premium Blend Gear Lubricant.

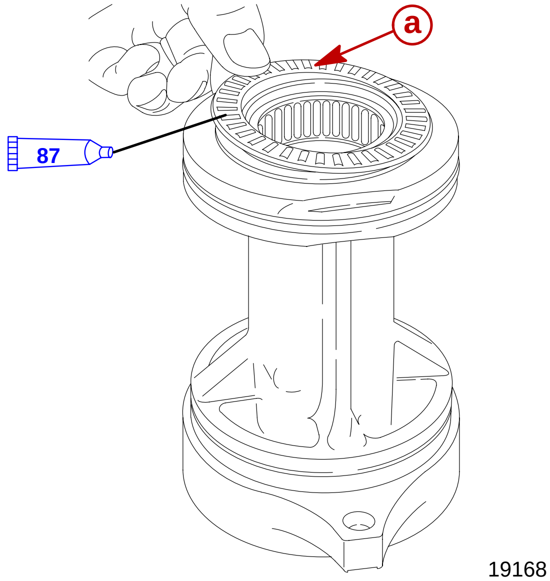


19167

87 Premium Blend Gear Lubricant (92-850737A1)

a - Thrust Washer

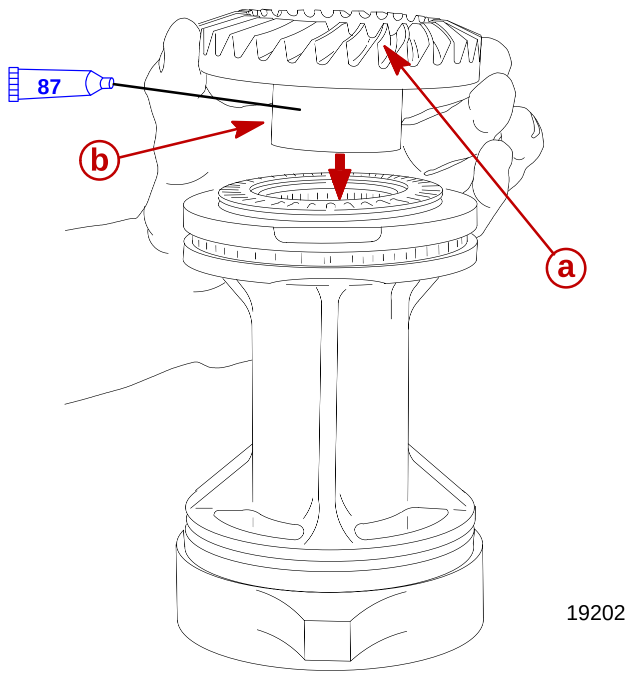
12. Install thrust bearing. Coat thrust bearing with Premium Blend Gear Lubricant.



87 Premium Blend Gear Lubricant (92-850737A1)

a - Thrust Bearing

13. Apply Premium Blend Gear Lubricant to bearing surface of reverse gear and install reverse gear.

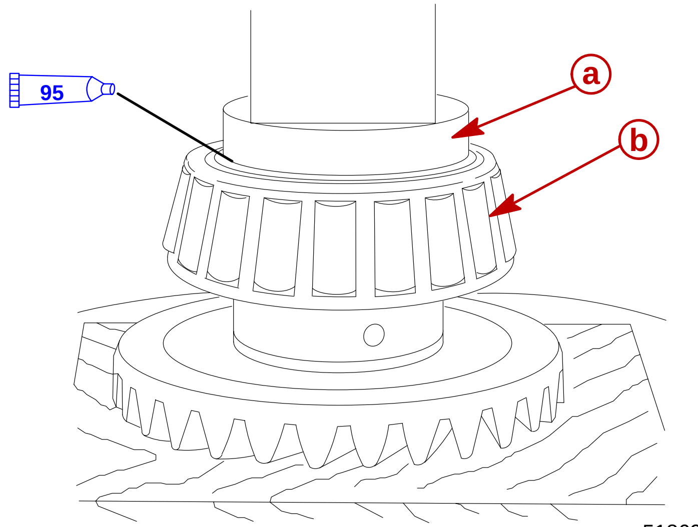


87 Premium Blend Gear Lubricant (92-850737A1)

a - Reverse Gear
b - Bearing Surface

Forward Gear Reassembly

1. Apply Quicksilver 2-4-C w/Teflon grease to the I.D. of the bearing. Press bearing onto gear using suitable mandrel (press only on inner race of bearing). Because the gear hub is longer than the bearing, a tube type mandrel should be used to install the bearing. This will allow the bearing to bottom out on the gear.



95 2-4-C w/Teflon (92-850736A1)

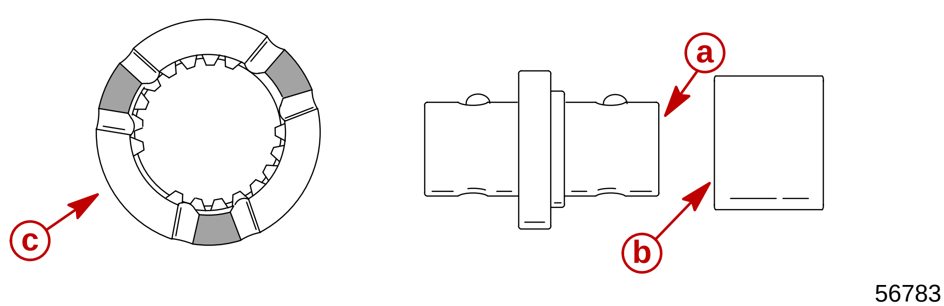
a - Mandrel (91-37350)
b - Bearing; Lubricate I.D. with Quicksilver 2-4-C w/Teflon

2. Inspect reverse gear end of clutch to determine the number of jaws. Refer to chart, following, for tool end selection.

Model	Installation Tool	End Stamped	Bearing Position
3 Jaw Reverse Clutch	91-856875A 1	3	0.155 in. (3.94mm) below surface
6 Jaw Reverse Clutch	91-856875A 1	6	Flush with surface

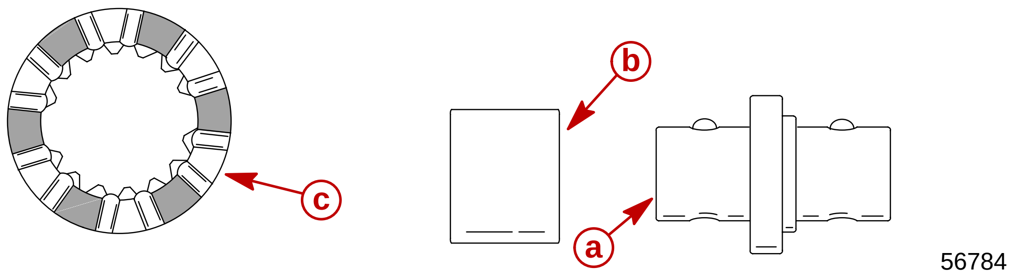
FORWARD GEAR NEEDLE BEARING INSTALLATION

3 Jaw Reverse Clutch



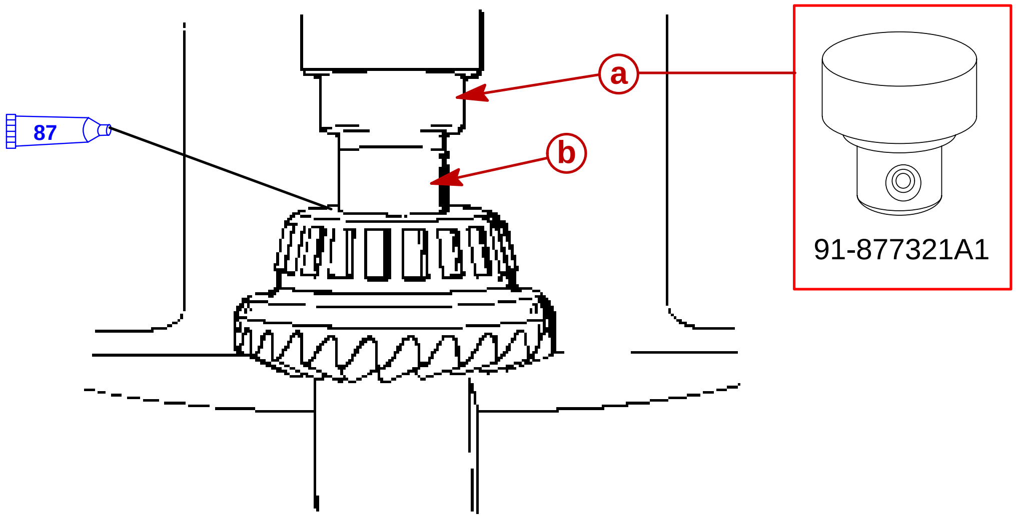
a - Stamped “3”
b - Numbered end of Needle Bearing
c - 3 Jaw Reverse Clutch

6 Jaw Reverse Clutch



a - Stamped “6”
b - Numbered end of Needle Bearing
c - 6 Jaw Reverse Clutch

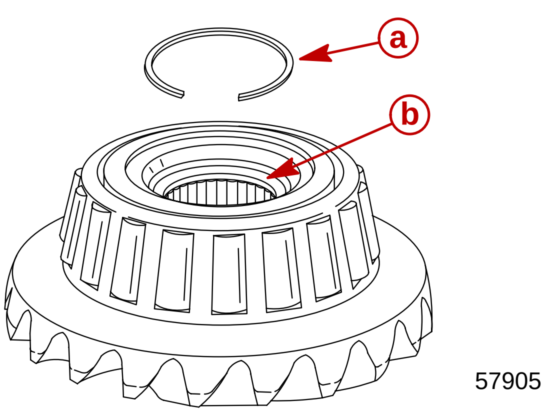
3. Apply Premium Blend Gear Lubricant to I.D. of forward gear, and O.D. of needle bearing. Press needle bearing into forward gear (using forward gear bearing installer tool) until tool bottoms out on gear.



87 Premium Blend Gear Lubricant (92-850737A1)

a - Forward Gear Bearing Installer (91-877321A1)
b - Needle Bearing, Numbered Side Toward Installer Tool

4. Install retaining ring into groove of forward gear by starting at one end of retaining ring and working it around until seated in groove.

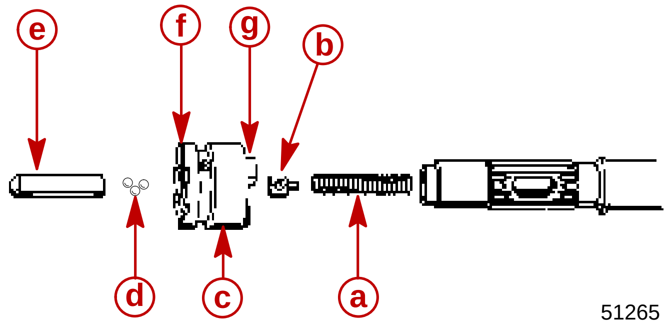


a - Retaining Ring
b - Groove in Forward Gear

Propeller Shaft Reassembly

1. Install components into propeller shaft in sequence shown.

***NOTE:** When installing the clutch make sure the ratcheting clutch teeth (angled) are toward forward gear, and non-ratcheting (square on both sides) are toward reverse gear.*

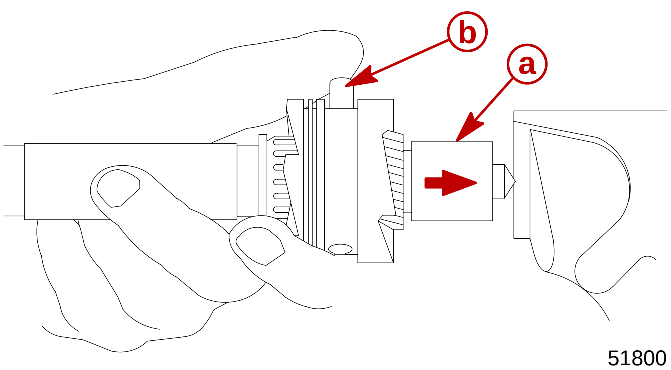


51265

Assembly Sequence

a - Spring
b - Guide Block
c - Clutch
d - 3 Metal Balls
e - Cam Follower
f - Forward Clutch Teeth
g - Reverse Clutch Teeth

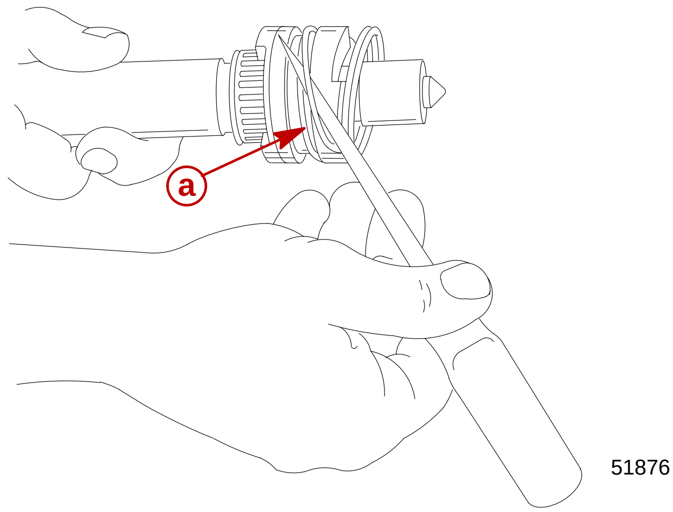
2. Align the hole in the clutch with the hole in the guide block, install cross pin.



51800

a - Apply Pressure in This Direction
b - Cross Pin

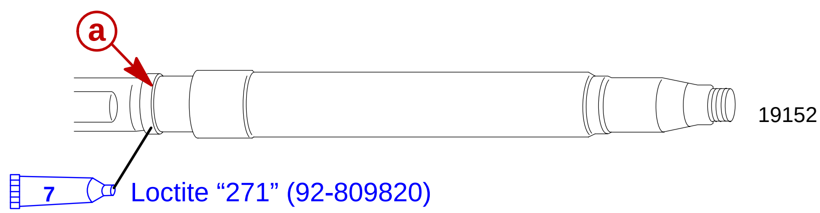
3. Install spring. **DO NOT** allow spring coils to overlap each other.



a - Spring

Drive Shaft Wear Sleeve Installation

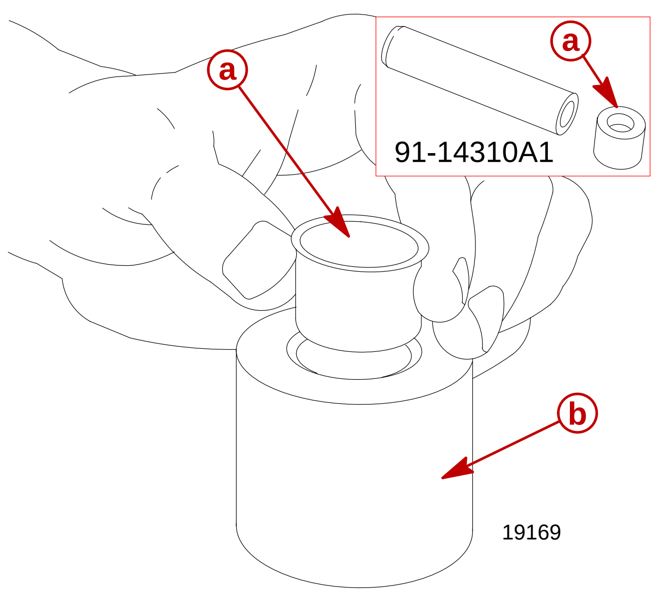
1. Install new rubber ring.
2. Apply a light coat of Loctite 271 on outside diameter of rubber ring.



a - Ring

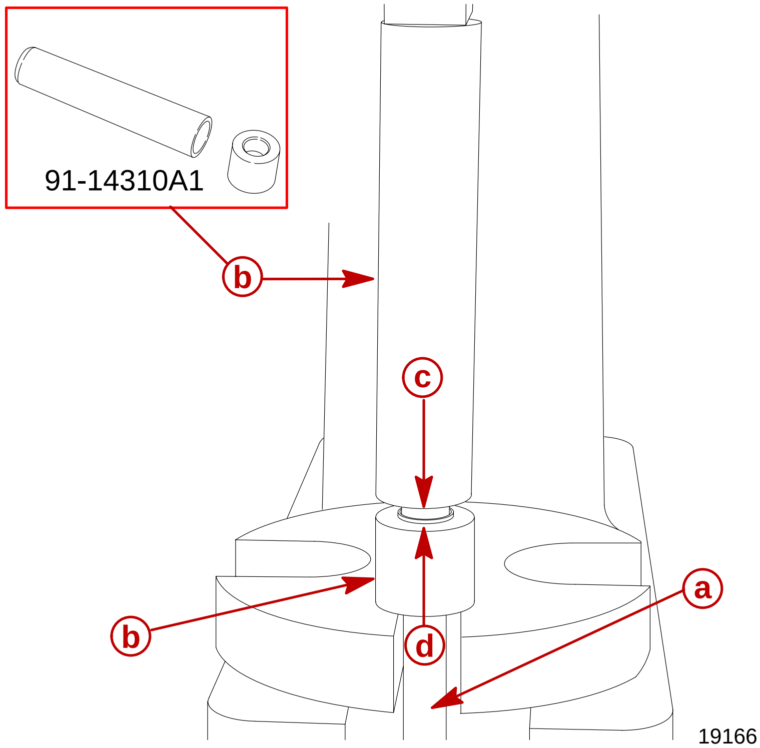
3. Insert sleeve into holder*.

*Component of Wear Sleeve Installation Tool (91-14310A1).



a - Sleeve
b - Holder

4. Press sleeve onto drive shaft using Wear Sleeve Installation Tool (91-14310A1); continue pressing until the upper and lower part of the tool make surface to surface contact.



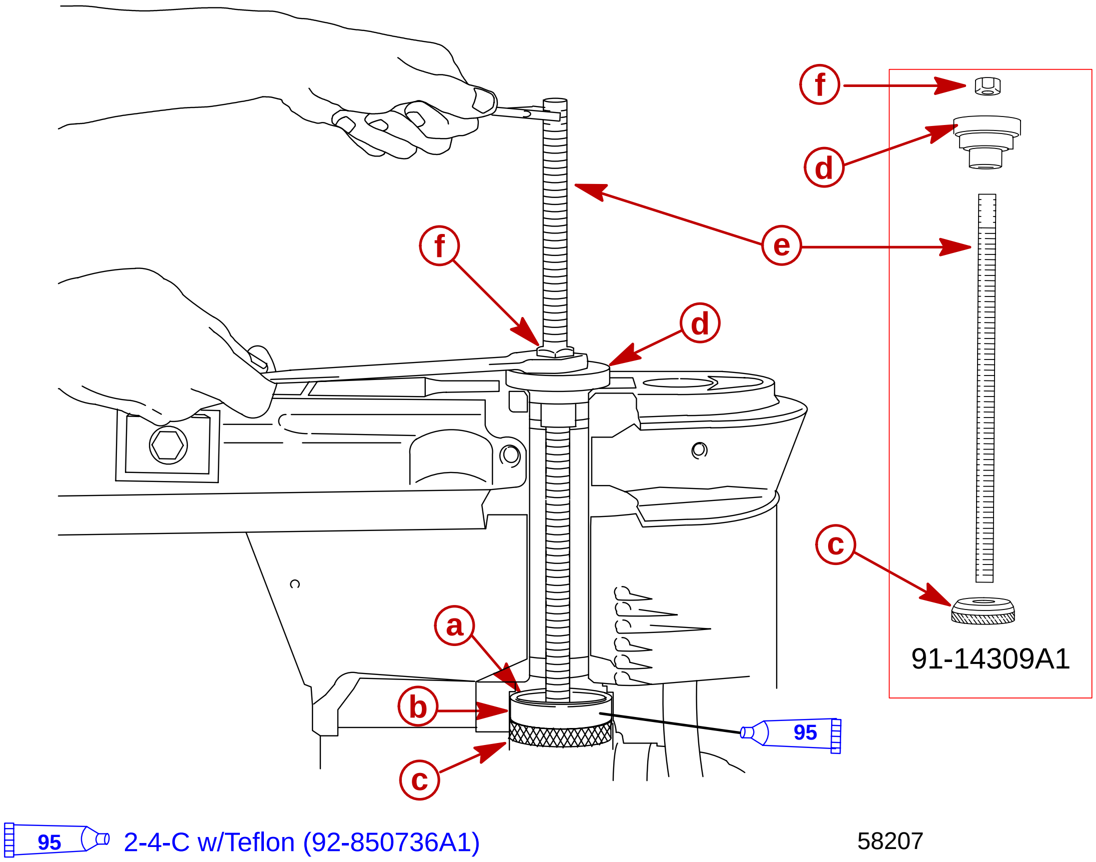
a - Drive Shaft
b - Wear Sleeve Installation Tool (91-14310A1)
c - Upper part of tool (Surface C)
d - Lower part of tool (Surface D)

5. Remove excess Loctite from assembled shaft.

Drive Shaft Lower Bearing Race Installation

1. Lubricate O.D. of bearing race with Quicksilver 2-4-C w/Teflon.
2. Install shim(s) and bearing race into housing. If Shim(s) were lost or a new gear housing is being assembled, start with 0.025 in. (0.635 mm) shim(s).

***NOTE:** Verify shim(s) are not cocked when drawing up race. Once shims and bearing cup are in place, position gearcase assembly so the driveshaft is vertical. This will aid in preventing the bearing cup from becoming cocked in the bore.*



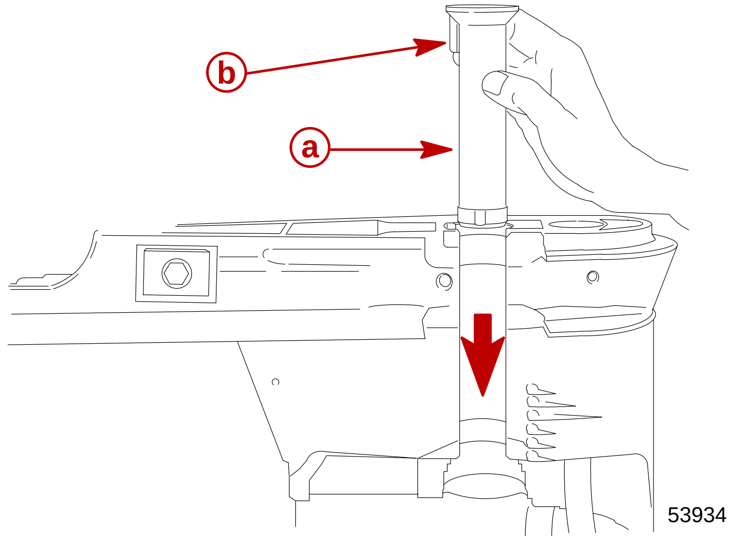
a - Shim(s) (Retained From Disassembly)
b - Bearing Race
c - Mandrel* (13780)
d - Mandrel* (13781)
e - Threaded Rod** (91-31229)
f - Nut** (11-24156)

*From Bearing Installation Tool (91-14309A1)

**From Bearing Removal and Installation Kit (91-31229A7)

Oil Sleeve Installation

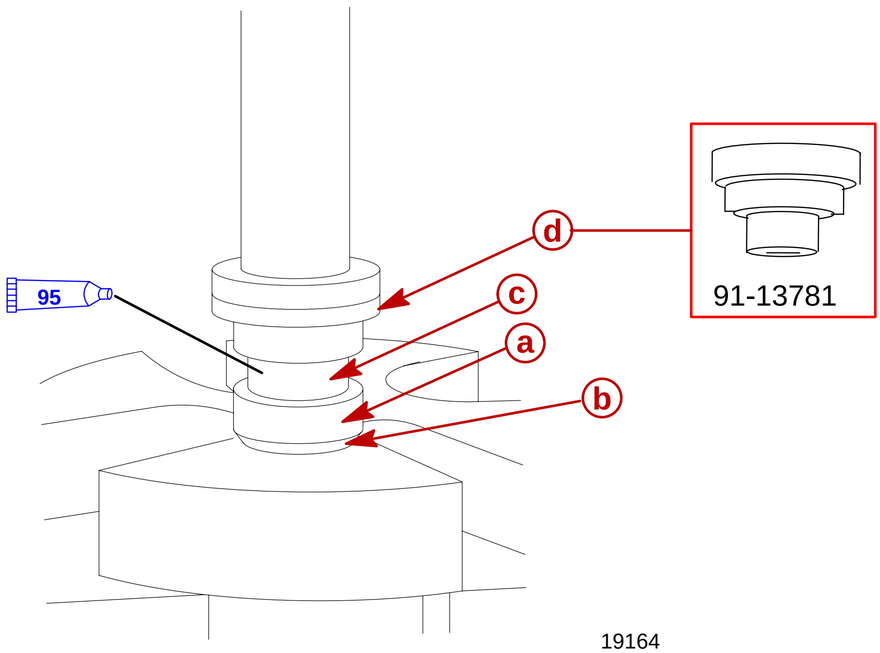
1. Install oil sleeve with tab positioned as shown.



a - Oil Sleeve
b - Tab

Drive Shaft Upper Bearing Installation

1. Lubricate I.D. of bearing sleeve and O.D. of bearing with 2-4-C w/Teflon.
2. Press bearing into sleeve using mandrel from bearing installation tool (91-14309A1).



95 2-4-C w/Teflon (92-850736A1)

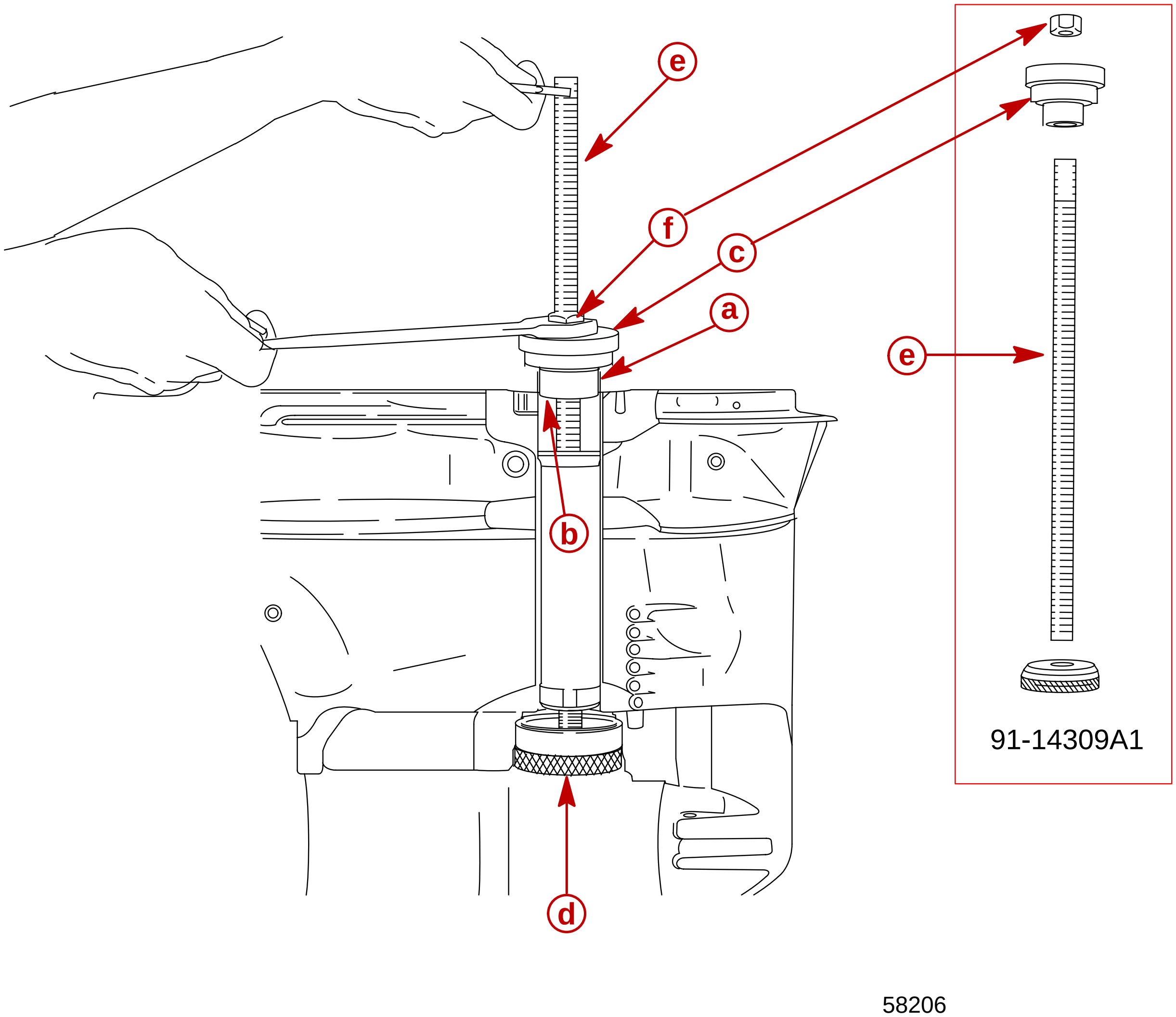
a - Bearing Sleeve
b - Tapered End
c - Bearing; Numbered Side Toward Mandrel
d - Mandrel* (91-13781)

*From Bearing Installation Tool (91-14309A1)

3. Install bearing/sleeve into housing.

IMPORTANT: Oil sleeve must be installed prior to upper driveshaft bearing installation.

IMPORTANT: Lower driveshaft bearing cup pilots the mandrel (13780) during installation of the upper driveshaft bearing/sleeve. Lower bearing cup must be installed prior to installing upper bearing/sleeve.



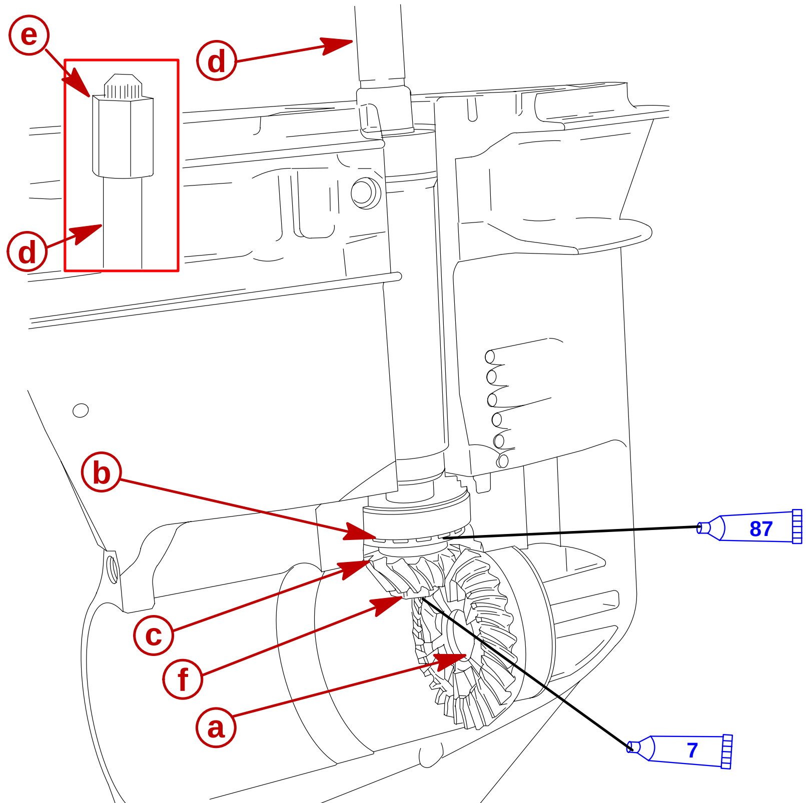
a - Bearing/Sleeve
b - Tapered End Of Sleeve
c - Mandrel* (13781)
d - Mandrel* (13780)
e - Threaded Rod** (91-31229)
f - Nut** (11-24156)

*From Bearing Installation Tool (91-14309A1)

**From Bearing Removal and Installation Kit (91-31229A7)

Forward Gear, Drive Shaft Lower Bearing, Pinion Gear, and Drive Shaft Installation

1. Install components per assembly sequence shown.



19175

7 Loctite “271” (92-809820)

87 Premium Gear Lubricant (92-850737A1)

Assembly Sequence:

- **a -** Forward Gear/Bearing: Apply Premium Blend gear lube to bearing rollers.
- **b -** Drive Shaft Lower Tapered Roller Bearing: Apply Premium Blend Gear Lube to bearing rollers.
- **c -** Pinion Gear
- **d -** Drive Shaft
- **e -** Drive Shaft Holding Tool
- **f -** Pinion Nut (New): Clean nut and driveshaft threads with Loctite Primer or suitable de-greaser. Apply Loctite 271 to threads **(not necessary if using a new nut with drylock patch on threads)** during final assembly (after pinion gear depth and forward gear backlash have been set), tighten to specified torque.

Model	Drive Shaft Holding Tool
40/50 Bigfoot (4-Stroke, 747cc/935cc)	91-56775
40/50/60 Bigfoot (4-Stroke, 995cc)	91-877840A1
75/90/115EFI (4-Stroke)	91-804776A1
60 Bigfoot/75/90/100/115/125 (2-Stroke)	91-56775

Pinion Nut Torque
70 lb-ft (95 Nm)

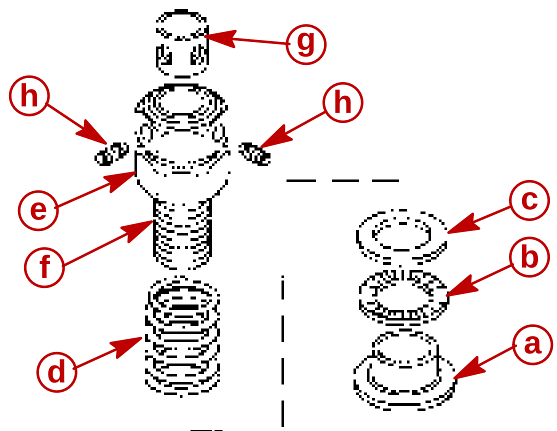
Pinion Gear Depth and Forward Gear Backlash

DETERMINING PINION GEAR DEPTH

NOTE: *Read entire procedure before attempting any change in shim thickness.*

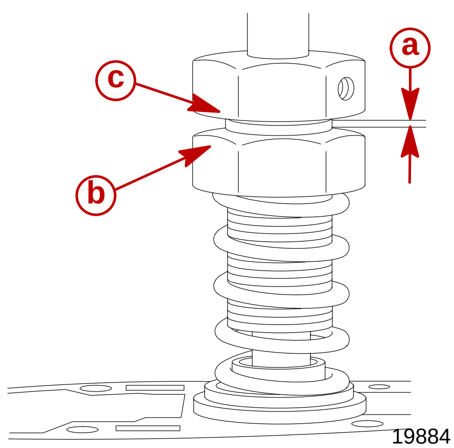
IMPORTANT: Forward gear assembly pilots the end of the pinion gauge and must be installed in gear housing when checking pinion gear depth. Without it an inaccurate measurement will be obtained.

1. Clean the gear housing bearing carrier shoulder and diameter.
2. With gear housing positioned up right (drive shaft vertical), install Bearing Preload Tool (91-14311A2) over drive shaft in sequence shown.



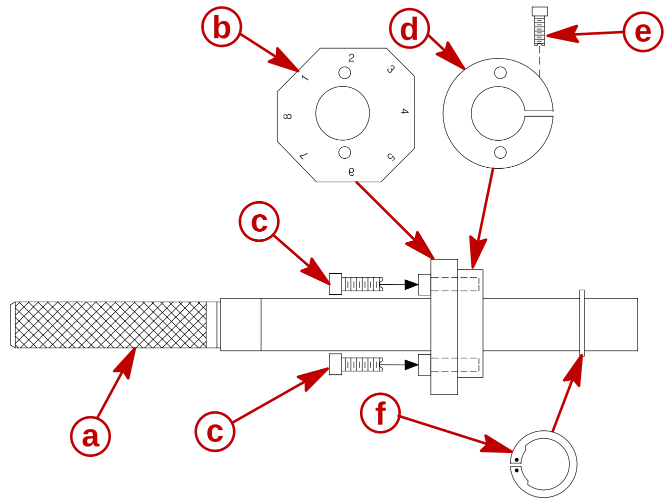
a - Adaptor: Bearing surfaces clean and free of nicks
b - Thrust Bearing: Oiled and able to move freely
c - Thrust Washer: Clean and free of nicks and bends
d - Spring
e - Nut: Threaded all-the-way onto bolt
f - Bolt: Held snug against spring
g - Sleeve: Holes in sleeve must align with set screws
h - Set Screw (2): Tightened against drive shaft, bolt should not slide on drive shaft.

3. Measure distance between top of nut and bottom of bolt head.
4. Increase distance by 1 in. (25.4 mm).
5. Rotate drive shaft 5 to 10 revolutions. This should properly seat drive shaft tapered roller bearing.



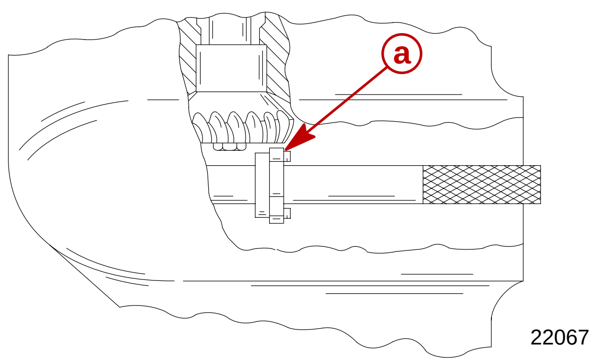
a - 1 in. (25.4 mm)
b - Nut
c - Bolt Head

6. Assemble Pinion Gear Locating Tool (91-12349A2) as shown; do not tighten collar retaining screw at this time. Install gauging block with numbers away from split collar.



a - Arbor
b - Gauging Block
c - Screw (2)
d - Split Collar
e - Collar Retaining Screw
f - Snap Ring

7. Insert tool into forward gear assembly; position gauging block under pinion gear as shown.



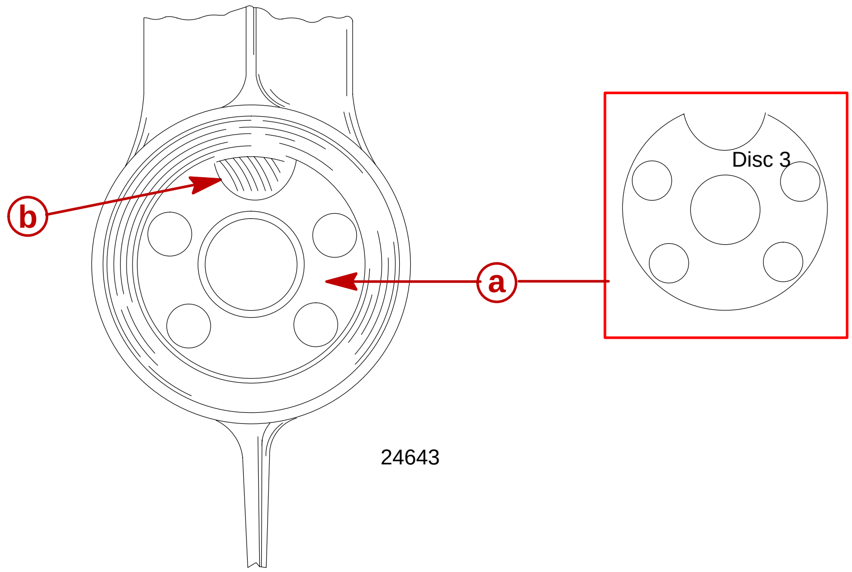
a - Gauging Block

8. Remove tool, taking care not to change gauging block position, and tighten collar retaining bolt.

9. Insert tool into forward gear assembly; position proper numbered flat (from chart) of gauging block – under pinion gear.

MODEL	GEAR RATIO (PINION GEAR TEETH/REVERSE GEAR TEETH)	USE FLAT NO.	LOCATING DISC NO.
40/50 Bigfoot (4-stroke, 747cc/935cc)	2.31:1 (13/30)	8	3
40/50/60 Bigfoot (4-stroke, 995cc)	2.31:1 (13/30)	8	3
75/90/115EFI (4-stroke)	2.07:1 (14/29)	2	3
60 Bigfoot/60 Seapro 60 Marathon	2.31:1 (13/30)	8	3
75-thru-90 (3 Cylinder)	2.31:1 (13/30)	8	3
100/115/125 (4 Cylinder)	2.07:1 (14/29)	2	3

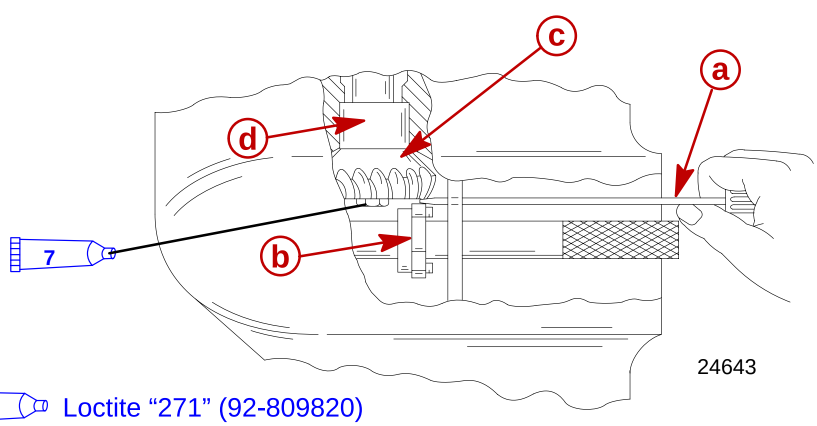
10. Install locating disc against bearing carrier shoulder in gear housing.
11. Position access hole as shown.



a - Locating Disc
b - Access Hole

12. Determine pinion gear depth by inserting a feeler gauge thru access hole in locating disc.
13. The correct clearance between gauging block and pinion gear is 0.025 in. (0.64 mm).
14. If clearance is correct, leave Bearing Preload Tool on drive shaft and proceed to "Determining Forward Gear Backlash," following.
15. If clearance is more than 0.025 in. (.064 mm) add shims behind the bearing race. If clearance is less than 0.025 in. (.064 mm) remove shims from behind the bearing race. When reinstalling pinion nut, apply Loctite 271 on threads of nut.

***NOTE:** Clean driveshaft and pinion nut threads with Loctite Primer or suitable de-greaser before applying Loctite.*



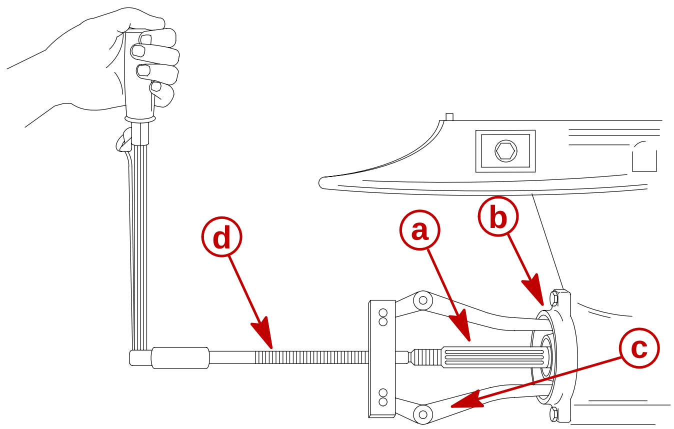
7 Loctite "271" (92-809820)

a - Feeler Gauge
b - Gauging Block
c - Pinion Gear
d - Bearing Race

DETERMINING FORWARD GEAR BACKLASH

NOTE: *Read entire procedure before attempting any change in shim thickness.*

1. Obtain correct pinion gear depth; refer to “Determining Pinion Gear Depth,” preceding.
2. Install Bearing Preload Tool (91-14311A2) on drive shaft; refer to “Determining Pinion Gear Depth,” preceding.
3. Install components as shown.
4. While holding the driveshaft (to prevent from turning), torque the puller bolt to 45 lb-in.
5. Rotate driveshaft 5-10 revolutions. This should properly seat the forward gear tapered roller bearing. **Repeat step 4.**

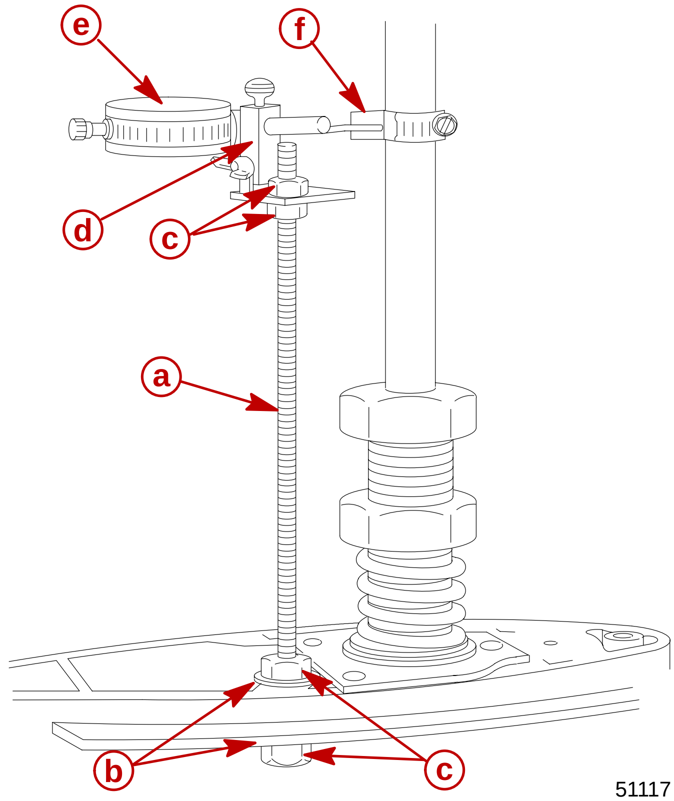


a - Propeller Shaft*
b - Bearing Carrier* (Assembled)
c - Puller Jaws (91-46086A1)
d - Puller Bolt (91-85716)

Puller Bolt Torque
45 lb-in. (5 Nm)

*Refer to **“Bearing Carrier and Propeller Shaft Installation,”** following.

6. Install components as shown.



a - Threaded Rod (Obtain Locally)
b - Washers
c - Nuts
d - Dial Indicator Adaptor Kit (91-83155)
e - Dial Indicator (91-58222A1)
f - Backlash Indicator Tool

7. Position Dial Indicator on appropriate line (from chart below) marked on Backlash Indicator Tool. Make sure the dial indicator is perpendicular (⊥) to the indicator tool or an inaccurate reading will be obtained.

MODEL	BACKLASH INDICATOR TOOL	ALIGN POINTER of DIAL INDICATOR with MARK
40/50 Bigfoot (4-stroke, 747cc/935cc)	91-78473	4
40/50/60 Bigfoot (4-stroke, 995cc)	91-78473	4
75/90/115EFI (4-Stroke)	91-19660--1	1
60 Seapro/60 Marathon 60 Bigfoot	91-78473	4
75-thru-90 (3 Cylinder)	91-78473	4
100/115/125 (4 Cylinder)	91-19660--1	1

8. Grasp the driveshaft pre-load tool bolt head and lightly turn drive shaft back-and-forth (no movement should be noticed at propeller shaft).
9. Dial Indicator registers amount of backlash, which must be between specification shown in chart.

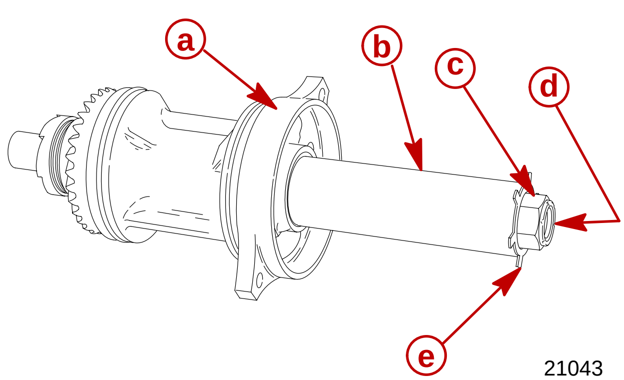
MODEL	DIAL INDICATOR MINIMUM	READING MAXIMUM
40/50 Bigfoot (4-Stroke, 747cc/935cc)	0.012 in. (0.30 mm)	0.019 in. (.48 mm)
40/50/60 Bigfoot (4-Stroke, 995cc)	0.012 in. (0.30 mm)	0.019 in. (.48 mm)
75/90/115EFI (4-Stroke)	0.013 in. (0.38 mm)	0.019 in. (.55 mm)
60 Bigfoot	0.012 in. (0.30 mm)	0.019 in. (.48 mm)
75-thru-90 (3 Cylinder)	0.012 in. (0.30 mm)	0.019 in. (.48 mm)
100/115/125 (4 Cylinder)	0.013 in. (0.38 mm)	0.019 in. (0.55 mm)

10. If backlash is less than the minimum specification, remove shim(s) from in front of forward gear bearing race. If backlash is more than the maximum specification, add shim(s) in front of forward gear bearing race. When reinstalling pinion nut, apply Loctite 271 on threads of nut.

NOTE: By adding or subtracting 0.001 in. (0.025 mm) shim, the backlash will change approximately 0.001 in.

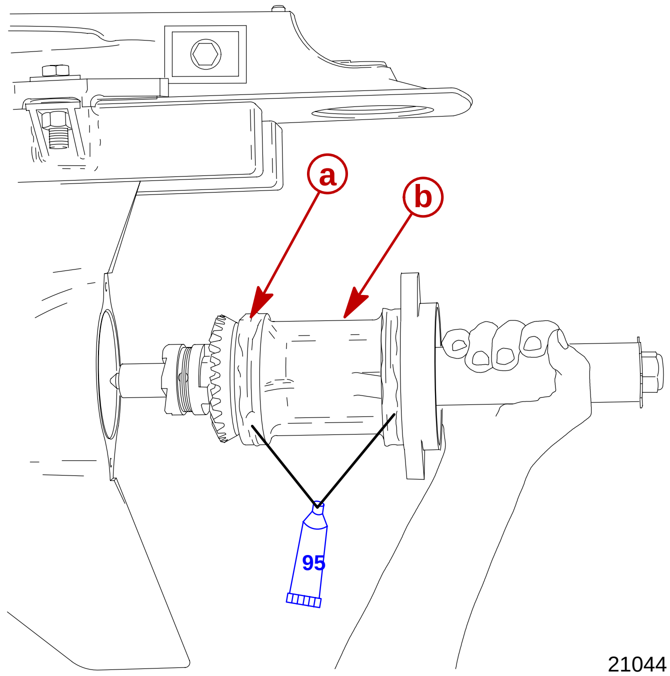
Bearing Carrier and Propeller Shaft Installation

1. Insert propeller shaft assembly into bearing carrier.
2. Before installing bearing carrier assembly into gear housing, obtain locally a 6 in. (152.4 mm) long by 1-1/4 in. – 1-1/2 in. (31.7 – 38.1 mm) diameter piece of PVC pipe. Install the PVC pipe over the prop shaft and secure the pipe against the bearing carrier assembly with the propeller nut and tab washer. This holds the reverse gear and thrust bearing tight against the bearing carrier preventing possible bearing damage during installation.



a - Bearing Carrier Assembly
b - PVC Pipe
c - Propeller Nut
d - Prop Shaft
e - Tab Washer

3. Generously lubricate O-ring, bearing carrier, and gear housing mating surfaces with 2-4-C w/Teflon.
4. Install bearing carrier and propeller shaft into housing with the word **“TOP”** (located on flange) toward top of housing.

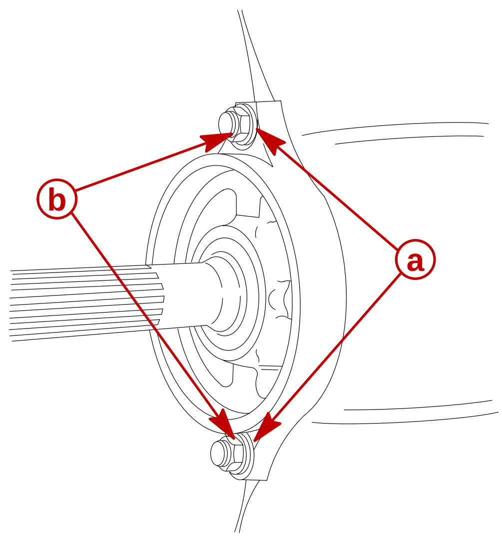


95 2-4-C w/Teflon (92-850736A1)

a - O-ring **b -** TOP

NOTE: *Use thick 0.090 in. (2.29mm) washers (12-855941) under fasteners if not previously installed.*

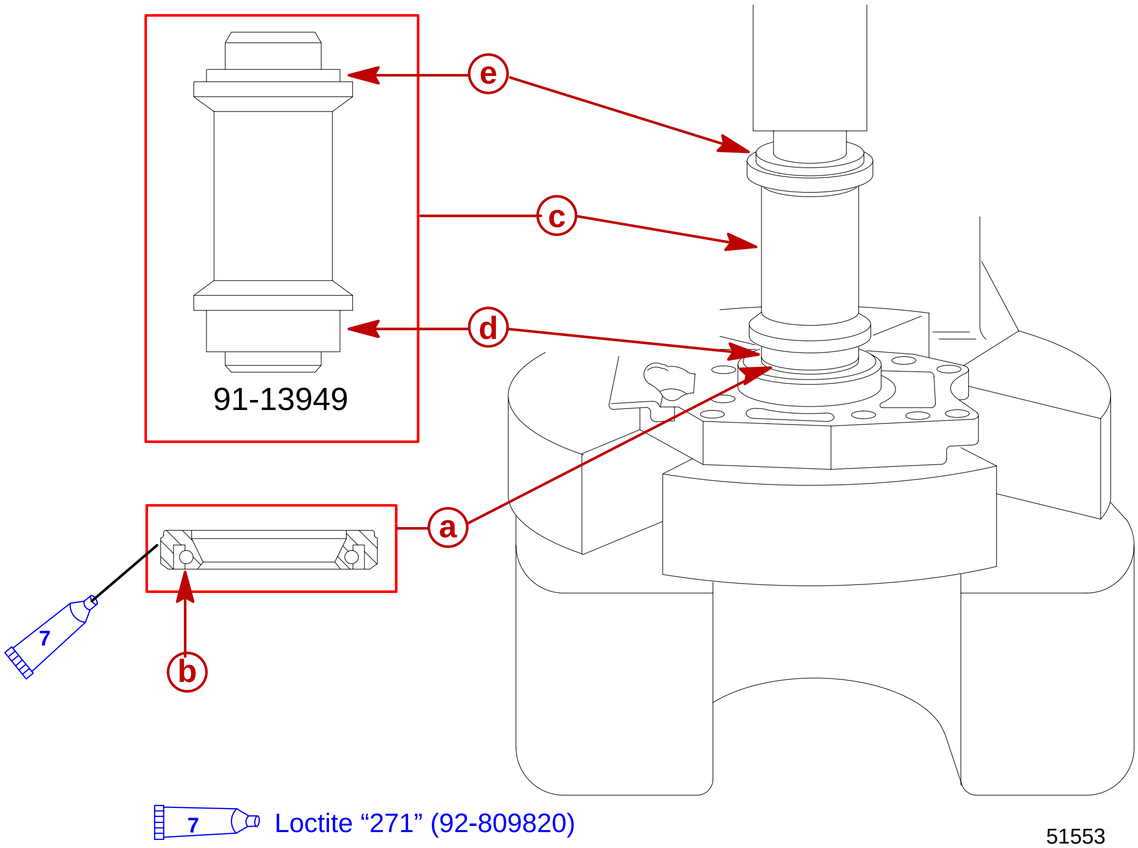
Washer Thickness	Fastener Torque
0.090 in. (2.29mm)	22 lb-ft (29.8 Nm)
0.060 in. (1.53mm)	25 lb-ft (33.9 Nm)



a - Washers
b - Fasteners (If using Screws Apply Loctite 271 on Threads)

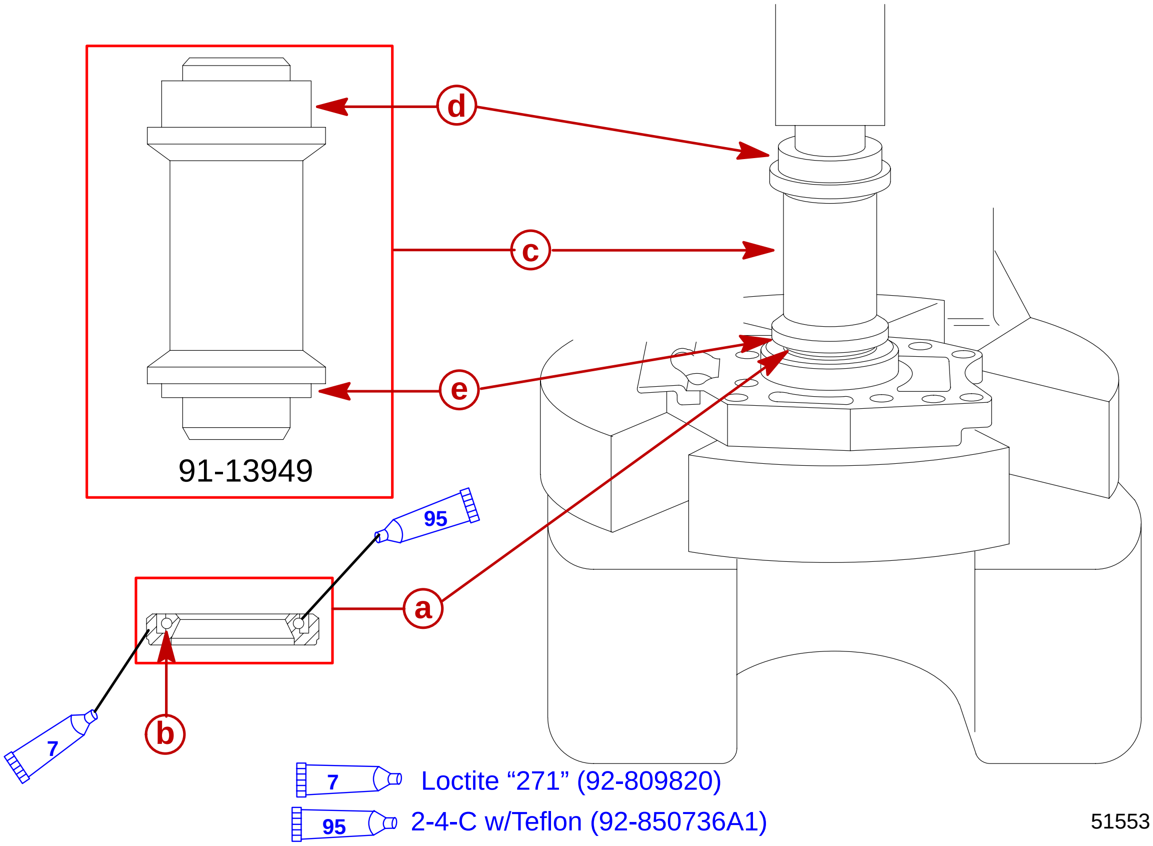
Water Pump Reassembly and Installation

1. Place water pump base upper seal on longer shoulder side of Oil Seal Driver (91-13949) with seal lip away from shoulder.
2. Apply Loctite 271 on O.D. of seal; press seal into water pump base until tool bottoms.



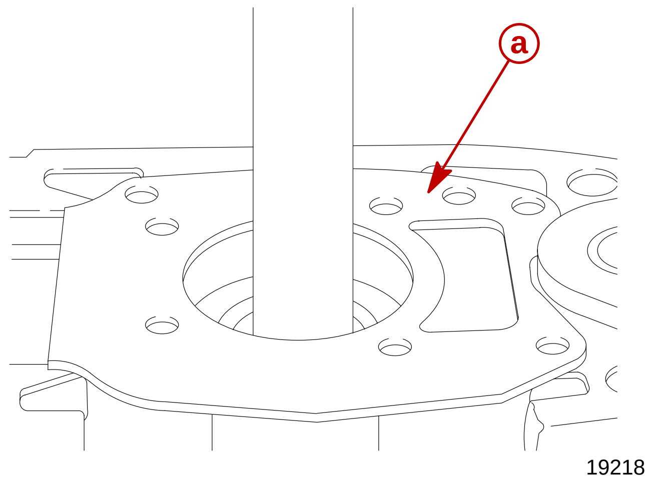
a - Seal - Lip Faces UP (when water pump base is installed on gearcase)
b - Spring - Faces UP (when water pump base is installed on gearcase)
c - Oil Seal Driver (91-13949)
d - Longer Shoulder Side of Oil Seal Driver
e - Shorter Shoulder Side of Oil Seal Driver

3. Place water pump base lower seal on shorter shoulder side of Oil Seal Driver (91-13949) with seal lip toward shoulder.
4. Apply Loctite 271 on O.D. of seal; press seal into water pump base until tool bottoms.
5. Lubricate lip of each seal with Quicksilver 2-4-C w/Teflon (92-850736A1).



a - Seal - Lip Faces DOWN (when water pump base is installed on gearcase)
b - Spring - Faces DOWN (when water pump base is installed on gearcase)
c - Oil Seal Driver (91-13949)
d - Longer Shoulder Side of Oil Seal Driver
e - Shorter Shoulder Side of Oil Seal Driver

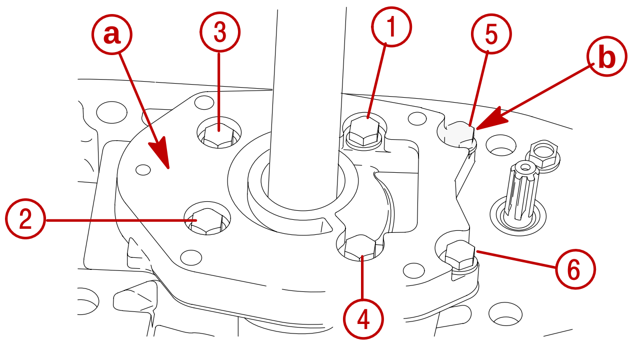
6. Install gasket.



a - Gasket

IMPORTANT: To prevent cutting the seal lips remove any burrs or sharp edges from the driveshaft splines before installing water pump base assembly.

7. Install components as shown. Apply Loctite 271 on bottom half of screw threads and tighten to specified torque (in sequence shown).



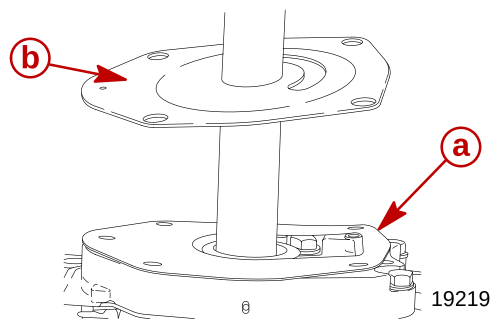
19217

7 Loctite “271” (92-809820)

a - Water Pump Base
b - Screw (6) M6 x 1 and Washers(6)

Screw Torque
60 lb-in. (6.8 Nm)

8. Install gasket and plate.

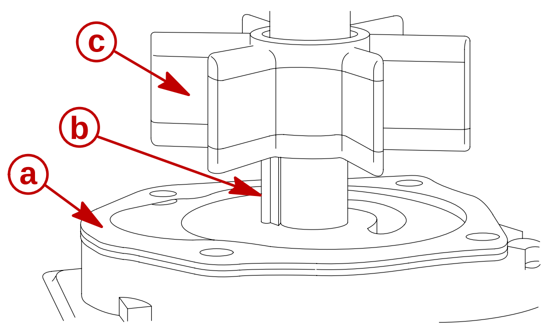


19219

a - Gasket
b - Plate

IMPORTANT: If the old impeller is re-used it must be installed in original (clockwise) direction of rotation.

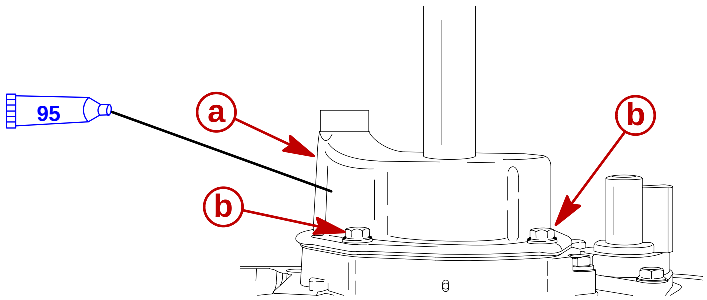
9. Install gasket, drive key and impeller.



19220

a - Gasket
b - Drive Key
c - Impeller

10. Lubricate I.D. of cover with Quicksilver 2-4-C w/Teflon.
11. Rotate drive shaft clockwise and push impeller housing down (over impeller) until it contacts water pump base.
12. Apply Loctite 271 to bottom threads of cover screws. Install cover screws and tighten to specified torque.



95 2-4-C w/Teflon (92-850736A1)

19212

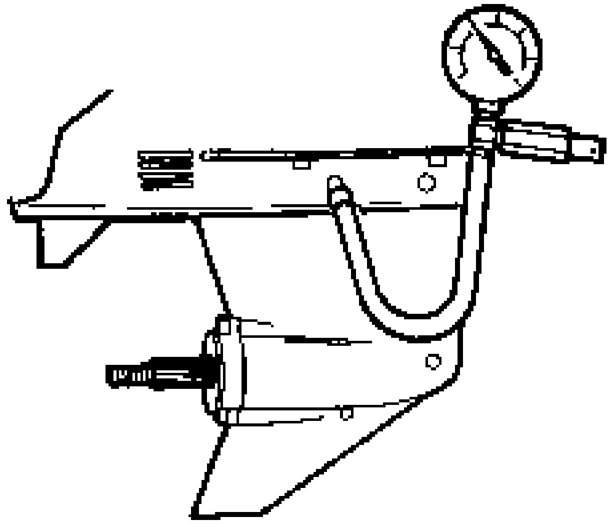
a - Impeller Housing
b - Screw (4) M 6 x 30

Screw Torque
60 lb-in. (6.8 Nm)

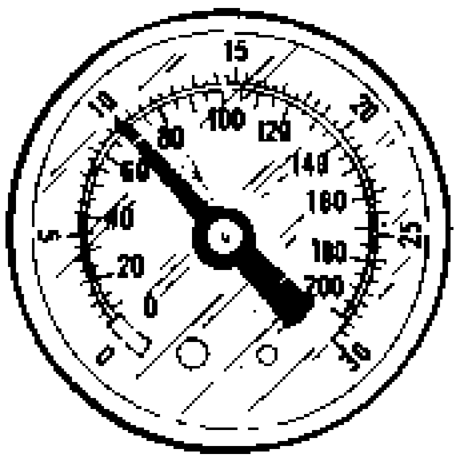
NOTE: *It is recommended that the gearcase be pressure tested for leaks after reassembly and* ***BEFORE*** *gear lube is added. Gearcase should hold 10-12 psi (69-83 kPa) for 5 minutes.*

Gear Housing Pressure Test

1. Remove vent plug and install pressure test gauge.



2. Pressurize housing to 10-12 psi *(69-83 kPa)* and observe gauge for 5 minutes.
3. Rotate drive shaft, prop shaft and shift shaft while housing is pressurized to check for leaks.



4. If pressure drop is noted, immerse housing in water.
5. Re-pressurize to 10-12 psi *(69-83 kPa)* and check for air bubbles.
6. Replace leaking seals as necessary. Retest housing.

NOTE: *Gearcase should hold 10-12 psi (69-83 kPa) for 5 minutes.*

7. Remove tester from housing and install vent plug and sealing washer.

Filling Gear Housing With Lubricant

NOTE: *Gear housing lubricant capacity is 24 fl oz (710 mL).*

⚠ WARNING

If gear housing is installed on engine, to avoid accidental starting, disconnect (and isolate) spark plug leads from spark plugs before working near the propeller.

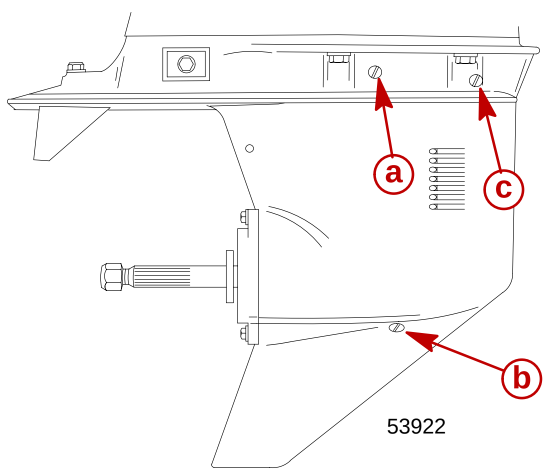
⚠ CAUTION

Do not use automotive grease in the gear housing. Use only Quicksilver Premium Blend Gear Lube.

1. Remove any gasket material from "Fill/Drain" and "Vent" screws and gear housing.
2. Install new sealing washer on "Fill/Drain" and "Vent" screws.

IMPORTANT: Never apply lubricant to gear housing without first removing "Vent" screws or gear housing cannot be filled because of trapped air. Fill gear housing only when driveshaft is in a vertical position.

3. Remove lubricant "Fill/Drain" screw and sealing washer from gear housing.
4. Insert lubricant tube into "Fill" hole, then remove "Vent" screws and sealing washer.
5. Fill gear housing with lubricant until excess starts to flow out of one (first) "Vent" screw hole.
6. Install this "Vent" screw and sealing washer only and continue filling until excess starts to flow out of second "Vent" screw hole.
7. Rotate driveshaft clockwise approximately 10 revolutions. Let gearcase sit for at least one minute to allow any trapped air to settle out, then top off lubricant level.



a - Vent Screw - Torque to 60 lb-in. (6.8 Nm)
b - Fill/Drain Screw - Torque to 60 lb-in. (6.8 Nm)
c - Oil Level Vent Screw - Torque to 60 lb-in. (6.8 Nm)

8. Replace second lubricant "Vent" screw and sealing washer.

IMPORTANT: Do not lose more than one fluid ounce (30cc) of gear lubricant while re-installing "FILL/DRAIN" screw.

9. Remove lubricant tube from Fill/Drain hole; install Fill/Drain screw and sealing washer.

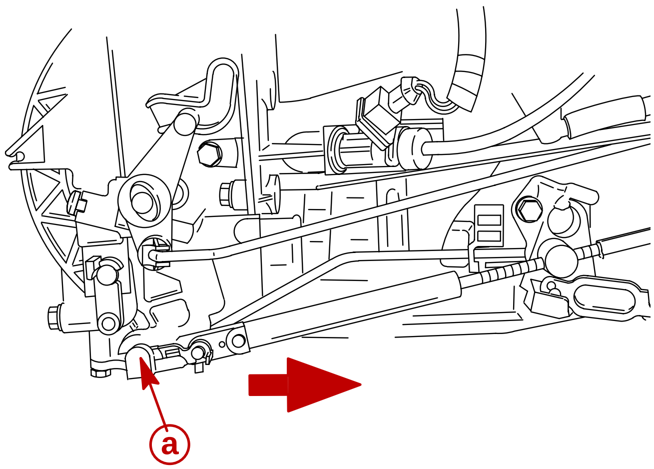
Gearcase Installation

⚠ WARNING

Disconnect (and isolate) spark plug leads from spark plugs before installing gear housing onto drive shaft housing. Failure to follow this warning could result in accidental engine starting and possible injury.

1. Position outboard shift linkage into forward gear position.

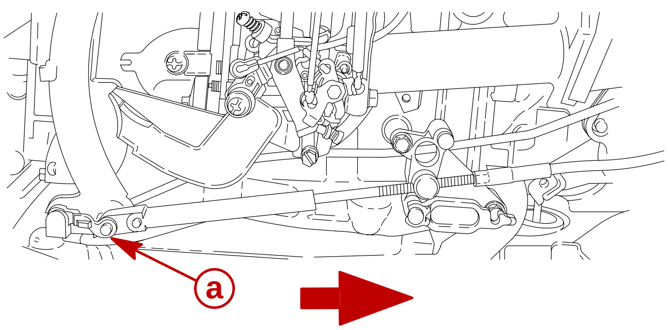
Models 40-60 Bigfoot (4-Stroke EFI)



Remote Control Model Shown

a - Shift Lever

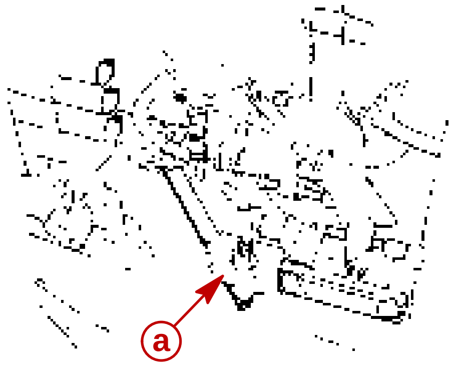
Models 40-60 Bigfoot (4-Stroke Carb)



Remote Control Model Shown

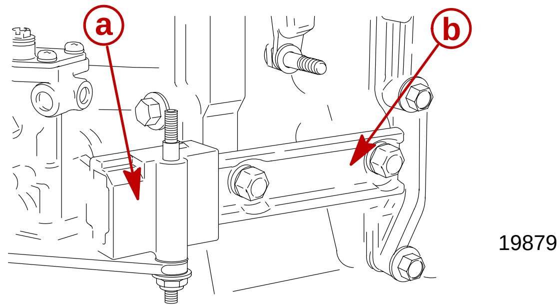
a - Shift Lever

Models 60 Bigfoot (2-Stroke)



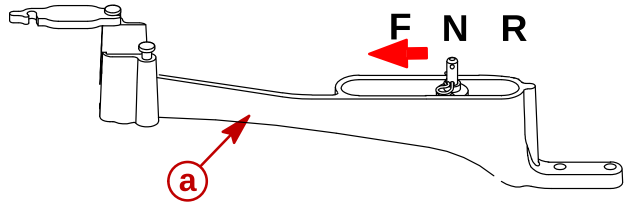
a - Shift Block

Models 75/90/100/115/125 (2-Stroke)



a - Shift Block; Front of Block MUST Extend 1/8 in. (3.2 mm) Past Front of Rail.
b - Rail

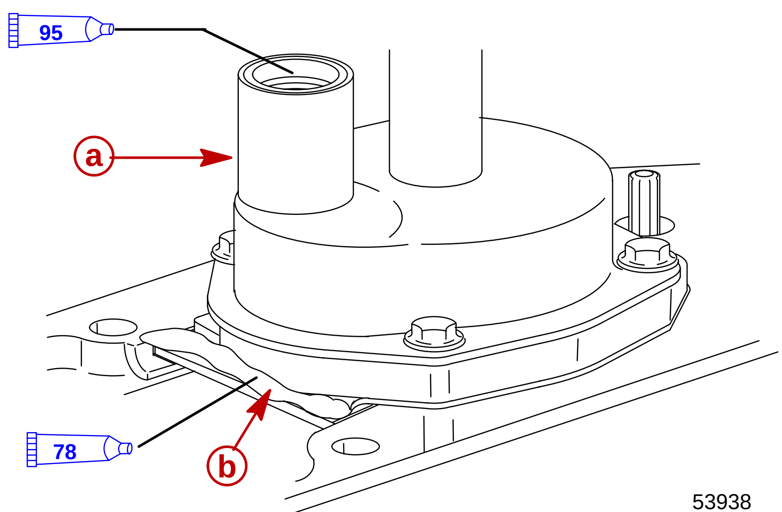
Models 75/90/115EFI (4-Stroke)



a - Shift Block

2. Tilt engine to full up position and engage tilt lock lever.
3. Shift gear housing into neutral position. Propeller shaft will rotate freely in either direction.
4. Install water tube seal; apply 2-4-C w/Teflon to I.D. of seal.
5. Apply a bead of RTV Sealer as shown.

NOTE: *For ease of gear housing installation, install water tube seal (labyrinth end) onto water tube in drive shaft housing. Tapered end of water tube seal goes onto water pump.*



78 G. E. RTV Sealant 92-90113--2

95 2-4-C w/Teflon (92-850736A1)

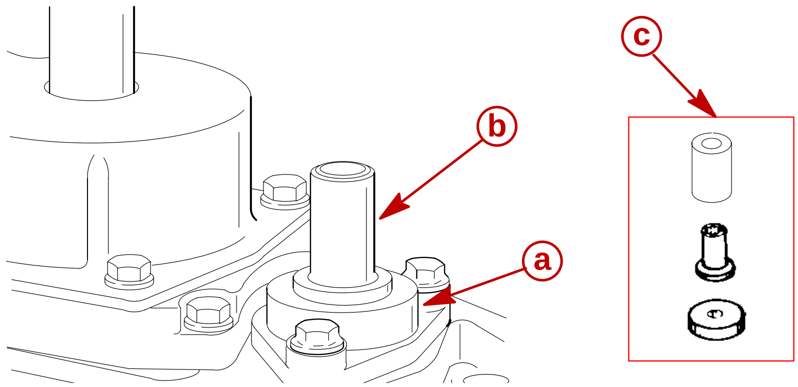
a - Water Tube Seal
b - RTV Sealer

⚠ CAUTION

Do not use lubricant on top of drive shaft. Excess lubricant, that is trapped in clearance space, will not allow drive shaft to fully engage with crankshaft. Subsequently, tightening the gear housing fasteners (while lubricant is on top of drive shaft) will load the drive shaft/crankshaft and damage either or both the power head and gear housing. Top of drive shaft is to be wiped free of lubricant.

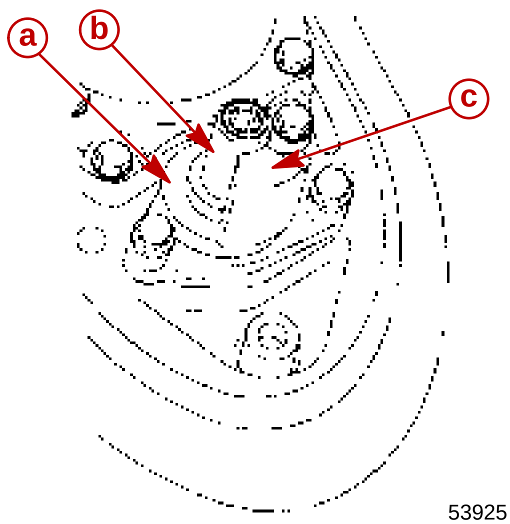
6. Apply a light coat of Quicksilver 2-4-C w/Teflon onto drive shaft splines.
7. Apply a light coat of Quicksilver 2-4-C w/Teflon on gear case shift shaft splines and upper shift shaft splines. Do not use lubricant on ends of shift shafts.
8. Install components as shown in appropriate photo.

ALL MODELS EXCEPT 75 (2-STROKE) W/MECHANICAL REVERSE LOCK



a - Nylon Spacer
b - Shift Shaft Coupler
c - Bushing 40-60 Bigfoot **4–Stroke Only**

75 (2-STROKE) W/MECHANICAL REVERSE LOCK



a - Nylon Spacer
b - Shift Shaft Coupler
c - Flat; MUST BE Positioned Toward Front of Gear Housing

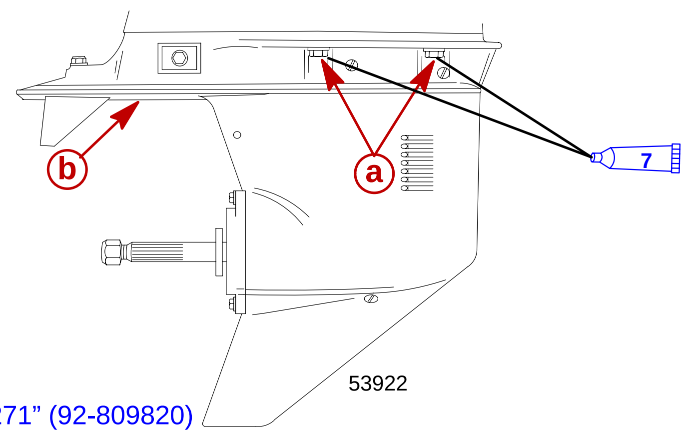
9. Shift gear housing into forward gear position. In forward gear the gear housing will ratchet when propeller shaft is turned clockwise. Resistance will be felt when propeller shaft is rotated counterclockwise.
10. Apply Loctite Grade 271 on threads of gear housing retaining bolts.

NOTE: *During installation of gear housing, it may be necessary to move the shift block (located under cowl) slightly to align upper shift shaft splines with shift shaft coupler splines.*

NOTE: On 75/90 hp (4-Stroke) *models. If, while performing Step 11, the drive shaft splines will not align with the oil pump splines, place a propeller onto propeller shaft and turn it counterclockwise as the gear housing is being pushed toward drive shaft housing. Continue rotating the propshaft until the driveshaft splines align with the crankshaft splines.*

IMPORTANT: 75/90 hp (4-Stroke) models, when removing or installing gearcase, carefully guide driveshaft through driveshaft bushing to avoid scoring bushing surface.

11. Position gear housing so that the driveshaft is protruding into driveshaft housing.
12. Move gear housing up toward driveshaft housing, while aligning upper shift shaft splines with shift shaft coupler splines, water tube with water tube seal, and crankshaft splines with driveshaft splines.
13. Install 4 fasteners and washers (two each side). Install locknut and washer.
14. Torque bolts and locknut (or nuts only if applicable) to specified torque.



Loctite “271” (92-809820)

a - Fasteners and Washers (2 Each Side)
b - Locknut and Washer

Bolt or Nut Torque
40 lb-ft (54 Nm)

15. Check shift operation as follows:
    - Place shift lever in forward gear. Gear housing should ratchet when propeller shaft is turned clockwise. Resistance should be felt when propeller shaft is turned counterclockwise.
    - Place shift lever in neutral. Propeller shaft should rotate freely in either direction.
    - While rotating propeller shaft, place shift lever in reverse gear. Resistance should be felt when propeller shaft is rotated in either direction.

IMPORTANT: If shift operation is not as described above, the gear housing must be removed and the cause of the problem corrected.

Trim Tab Adjustment and Replacement

IMPORTANT: The trim tab is now painted and does NOT aid in protecting the drive shaft housing and gear housing from galvanic corrosion (corrosion and pitting of metal surfaces). Side anodes now provide protection. Do not paint or place protective coating on the side anodes, or corrosion protection function will be lost.

TRIM TAB REPLACEMENT

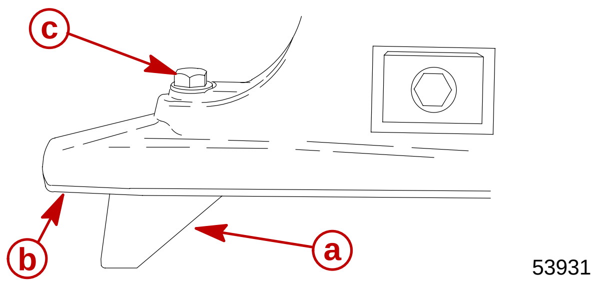
1. Replace trim tab if damaged. Mark location of old trim tab on anti-ventilation plate before removal; install new trim tab in same location.

TRIM TAB ADJUSTMENT

NOTE: The trim tab provides a means to offset (balance) some of the steering load that is caused by propeller torque at higher operating speeds.

NOTE: *Loosen trim tab bolt sufficiently to allow trim tab to disengage from locking ridges in gear case before attempting to move tab. DO NOT strike trim tab with a hard object to make adjustments.*

1. Shift engine control into **NEUTRAL** and turn ignition key to **OFF** position.
2. If at higher speeds the boat turns more easily to the left, loosen screw, move the trim tab (trailing edge) to the left (when viewed from behind). Tighten retaining screw to specified torque.
3. If the boat turns more easily to the right, loosen screw, move the trim tab (trailing edge) to the right (when viewed from behind) turn trim tab (trailing edge) to the right . Tighten retaining screw to specified torque.



a - Trim Tab
b - Anti-Ventilation Plate
c - Retaining Screw and Washer

Retaining Screw Torque
22 lb-ft (29.8 Nm)

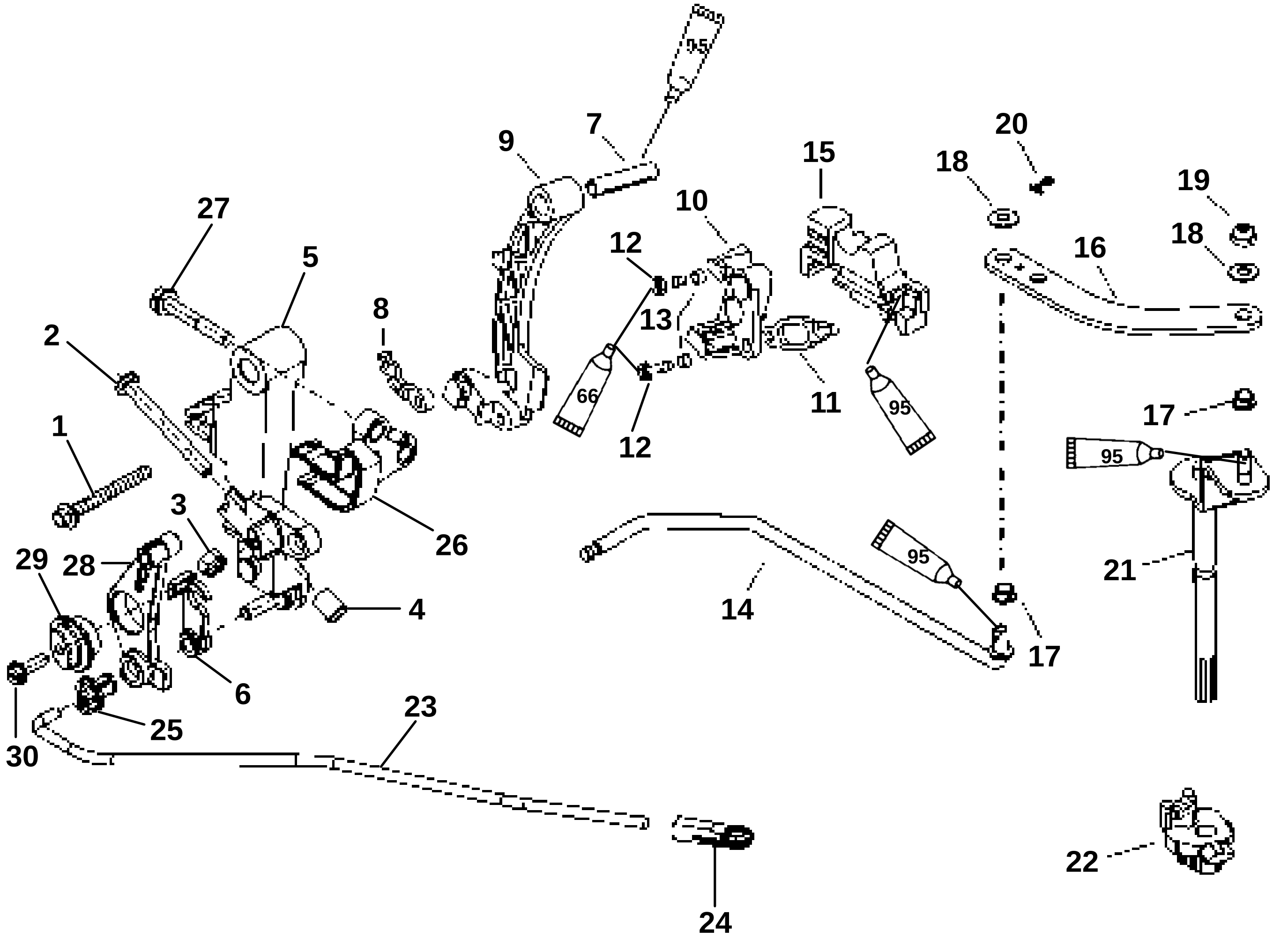
ATTACHMENTS/CONTROL LINKAGE

Section 7A - Throttle/Shift Linkage

Table of Contents

7
A

LINKAGE (REMOTE)



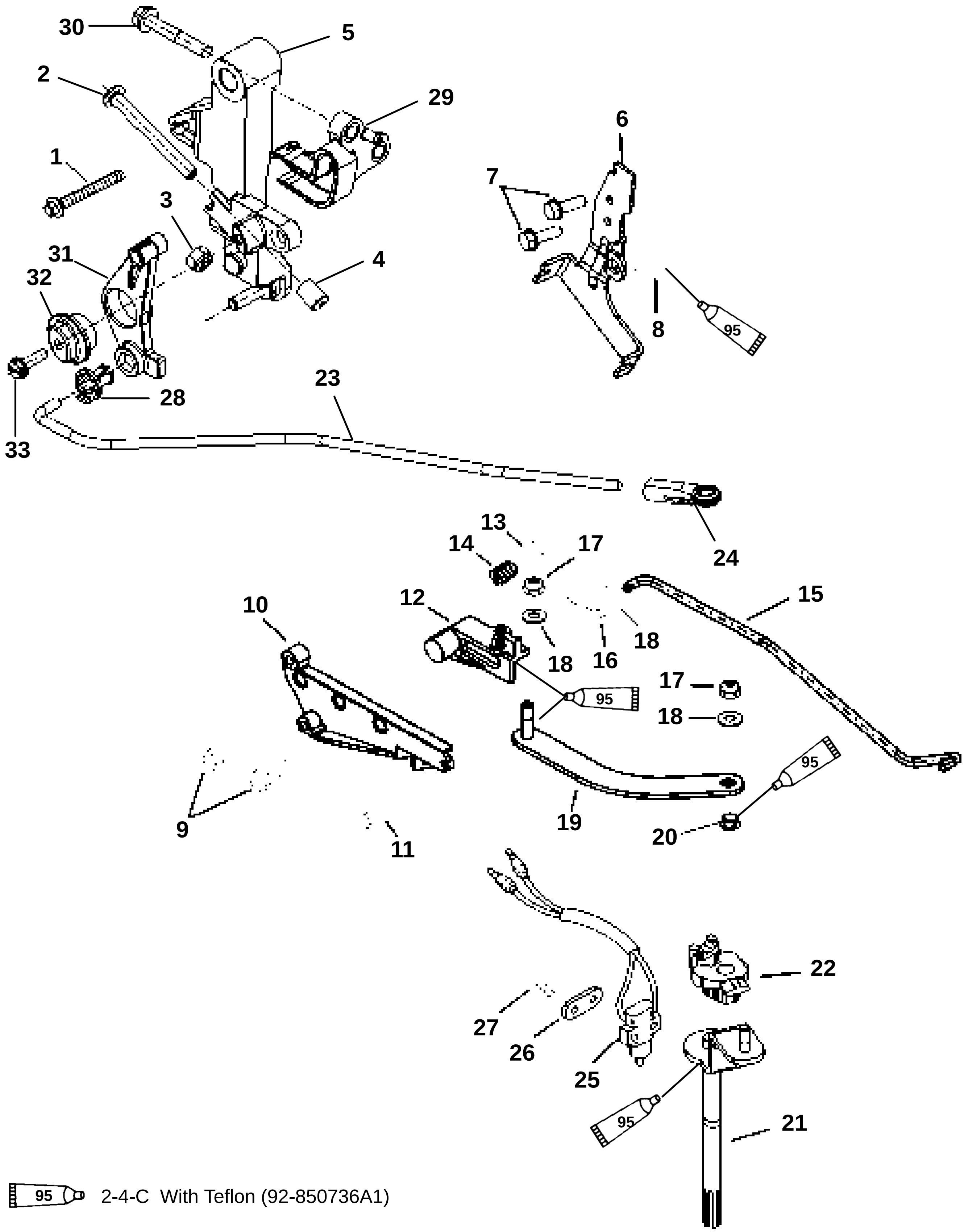
66 Loctite 242 (92-809821)

95 2-4-C With Teflon (92-850736A1)

LINKAGE (REMOTE)

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	SCREW (M8 X 70)	100		11.3
2	1	SCREW (M6 X 55)			
3	1	NUT			
4	1	CAP			
5	1	THROTTLE LEVER			
6	1	RETAINER			
7	1	BUSHING			
8	1	RETAINER			
9	1	SHIFT LEVER			
10	1	BRACKET			
11	1	LATCH			
12	2	SCREW (M6 X 16)	75		8.5
13	2	SLEEVE			
14	1	SHIFT ROD			
15	1	GUIDE - SHIFT ROD			
16	1	SHIFT LINK			
17	2	NYLINER			
18	2	WASHER			
19	1	NUT	75		8.5
20	1	COTTER PIN			
21	1	SHIFT SHAFT LEVER			
22	1	BUSHING			
23	1	LINK			
24	1	SOCKET	75		8.5
25	1	BUSHING			
26	1	THROTTLE CAM			
27	2	SCREW (M6 X 40)	75		8.5
28	1	THROTTLE ARM			
29	1	BUSHING			
30	1	SCREW (10-16 X .625)	Drive Tight		

LINKAGE (HANDLE)



95 2-4-C With Teflon (92-850736A1)

LINKAGE (HANDLE)

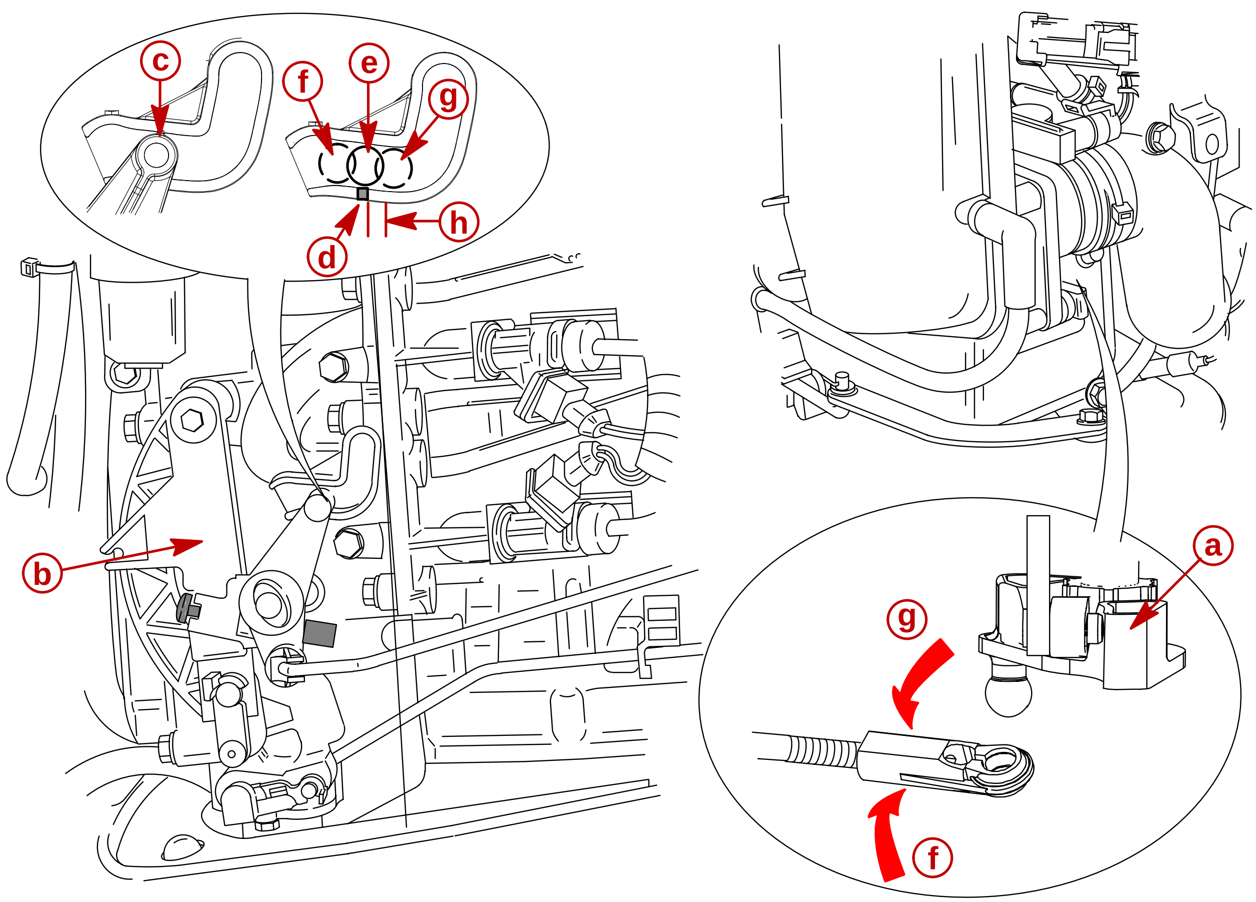
REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	SCREW (M8 X 70)	100		11.3
2	1	SCREW (M6 X 55)			
3	1	NUT			
4	1	CAP			
5	1	THROTTLE LEVER			
6	1	BRACKET **(HANDLE)**			
7	2	SCREW (M6 X 20)	75		8.5
8	1	BUSHING			
9	2	SCREW (M6 X 25)	75		8.5
10	1	SHIFT GUIDE			
11	1	SCREW (M5 X 12)	45		5.1
12	1	SHIFT SLIDE			
13	1	SHIFT DETENT			
14	1	SPRING			
15	1	SHIFT ROD			
16	1	COTTER PIN			
17	2	NUT	75		8.5
18	3	WASHER			
19	1	SHIFT LINK			
20	1	NYLINER			
21	1	SHIFT SHAFT LEVER			
22	1	BUSHING			
23	1	THROTTLE LINK			
24	1	SOCKET	75		8.5
25	1	SWITCH			
26	1	PLATE-SWITCH			
27	2	SCREW (M3 X 20)	20		2.3
28	1	BUSHING			
29	1	THROTTLE CAM			
30	2	SCREW (M6 X 40)	75		8.5
31	1	THROTTLE ARM			
32	1	BUSHING			
33	1	SCREW (10-16 X .625)	Drive Tight		

Throttle Link Adjustment

Adjustment

***NOTE:** For remote control models, remove remote control throttle cable during throttle link adjustment. For tiller handle models, throttle cables remain attached and throttle twist grip should be used to advance throttle during throttle link adjustment.*

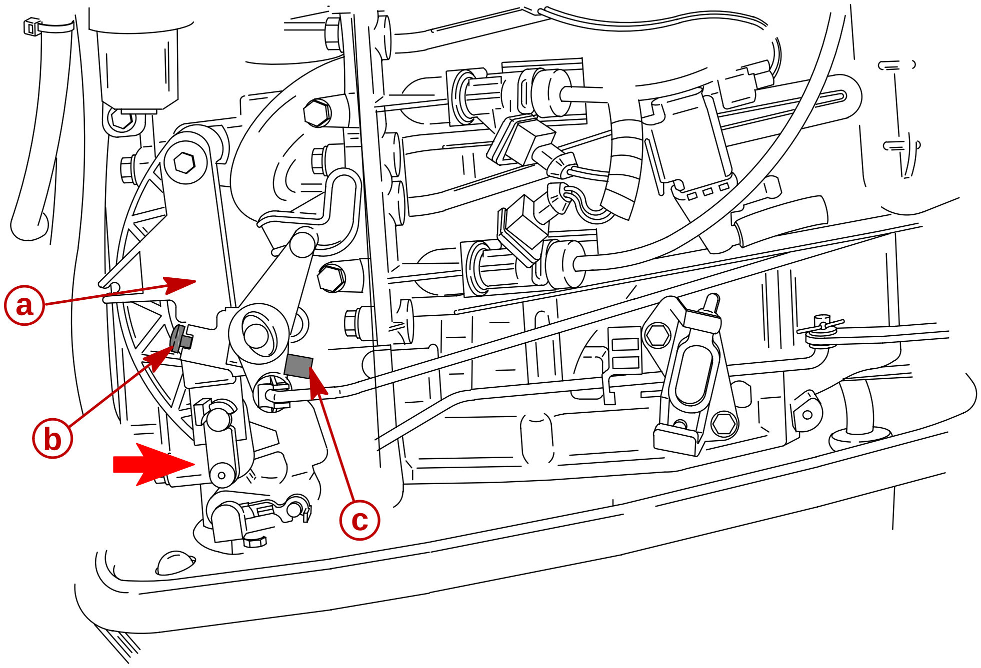
1. Lightly hold throttle body arm against idle stop.
2. Slowly push throttle lever forward until you feel the throttle body start to move. The center of throttle arm roller should line up with the throttle cam alignment mark. If adjustment is needed proceed to next step. Tolerance may range from mark to 1/8 inch (3.2 mm) after mark.
3. Remove lower cowl. Refer to **Cowl Removal** section 5A.
4. Disconnect the throttle link rod from the throttle arm and throttle body arm.
5. If the throttle body arm engages (throttle shutter opens) before the center of the roller aligns with the throttle cam alignment mark, shorten the link rod by turning the socket clockwise. If the throttle body arm engages after the roller aligns with the throttle cam alignment mark, lengthen the link rod by turning the socket counterclockwise.
6. Snap socket onto throttle body arm and push rod end into throttle arm.
7. Repeat steps 1 & 2. Adjust if necessary.



a - Throttle Body Arm
b - Throttle Lever
c - Throttle Arm Roller
d - Throttle Cam Alignment Mark
e - Correct
f - Shorten Link Rod
g - Lengthen Link Rod
h - Alignment Tolerance - 1/8 inch (3.2mm)

Maximum Throttle

1. With throttle cable(s) attached, advance throttle (remote control handle or throttle twist grip) to wide open throttle position.
2. Throttle stop should lightly contact adjoining surface. To ensure the throttle shutter is fully open, back the throttle stop screw out until there is a gap between the throttle stop screw and adjoining surface (at WOT position). Keep turning the throttle stop screw **"in"** until the throttle stop lightly contacts the adjoining surface.



a - Throttle Lever
b - Throttle Stop Screw
c - Throttle Stop

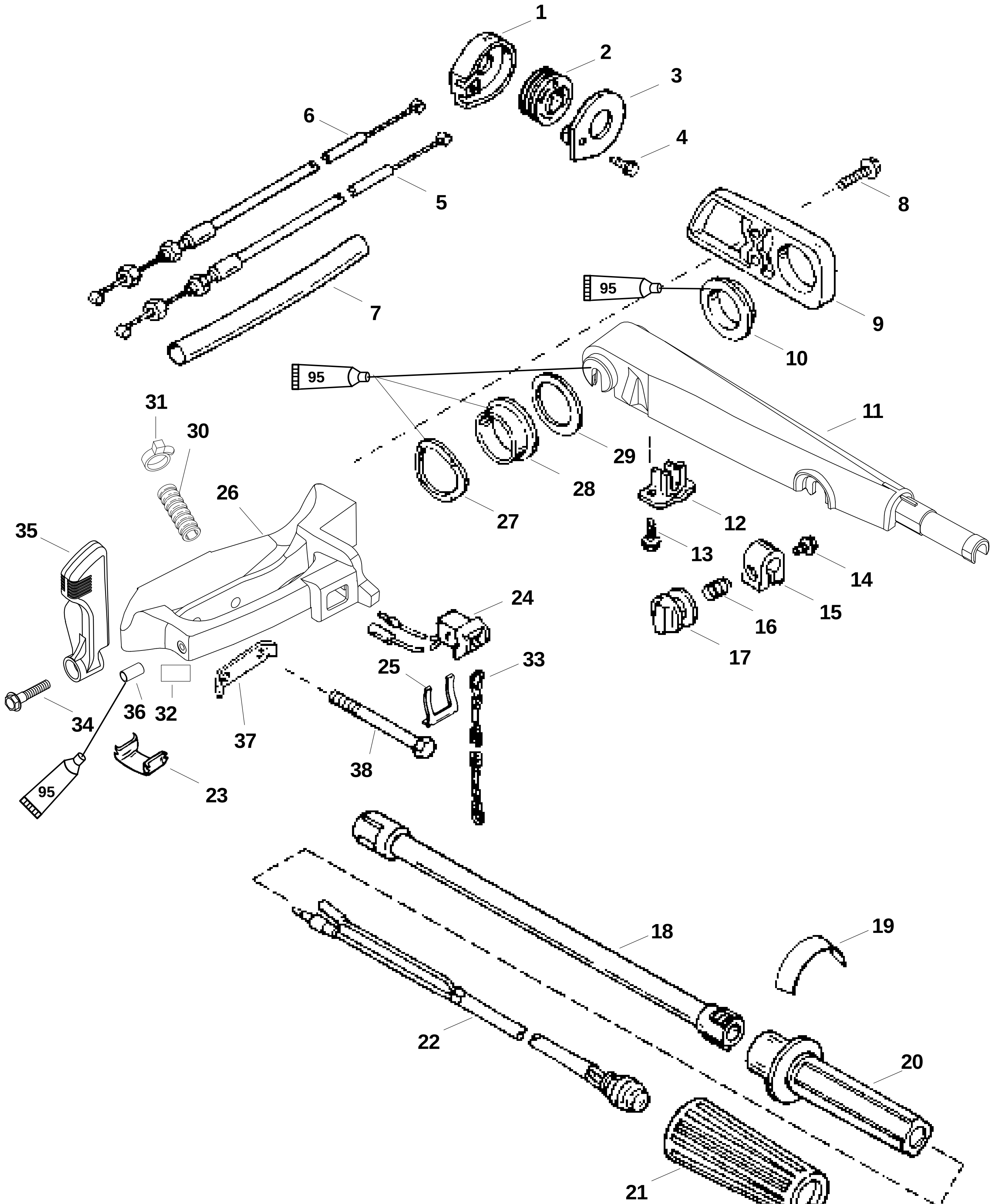
ATTACHMENTS/CONTROL LINKAGE

Section 7B - Tiller Handle

Table of Contents

7
B

TILLER HANDLE



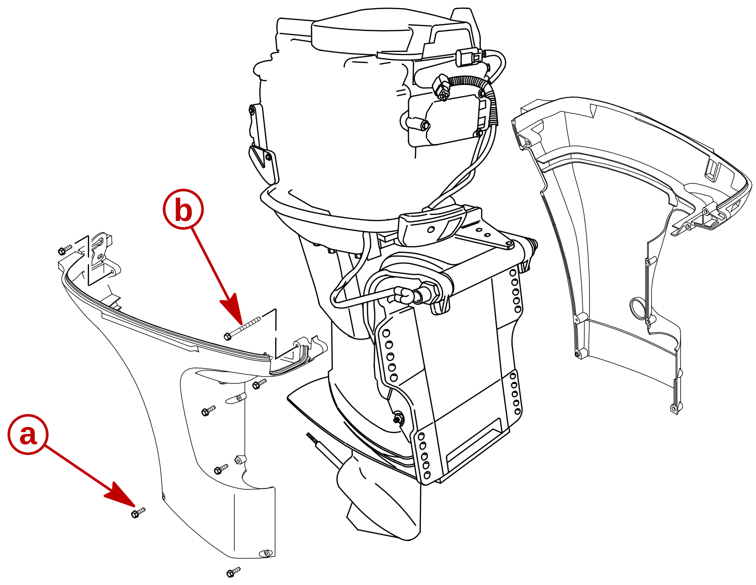
95 2-4-C With Teflon (92-825407A12)

TILLER HANDLE

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	COVER KIT			
2	1	PULLEY			
3	1	CASE			
4	1	SCREW (10-16 x 1/2 IN. Self Tapping)	20		2.3
5	1	THROTTLE CABLE **(30-1/2 IN.)**			
6	1	THROTTLE CABLE **(41-1/2 IN.)**			
7	1	SLEEVE			
8	2	SCREW (M8 x 25)	135		15.3
9	1	COVER			
10	1	BUSHING			
11	1	ARM–Steering Handle			
12	1	RETAINER			
13	1	SCREW (M5 x 16)	35		3.9
14	1	SCREW (M6 x 25)			
15	1	LOCK–Throttle			
16	1	SPRING			
17	1	KNOB–Throttle			
18	1	TILLER TUBE			
19	1	DECAL			
20	1	HANDLE–Throttle			
21	1	GRIP			
22	1	SWITCH **(STOP)**			
23	2	CLIP			
24	1	SWITCH **(STOP)**			
25	1	RETAINER			
26	1	BRACKET–Tiller			
27	1	WAVE WASHER			
28	1	BUSHING			
29	1	WASHER			
30	1	CONDUIT			
31	1	CABLE TIE			
32	1	DECAL-Shift (F-N-R)			
33	1	LANYARD SWITCH			
34	1	SCREW (M8 x 35)	100		11.3
35	1	SHIFT HANDLE			
36	1	BUSHING			
37	1	TAB WASHER			
38	2	SCREW (M10 x 90)		35	47.5

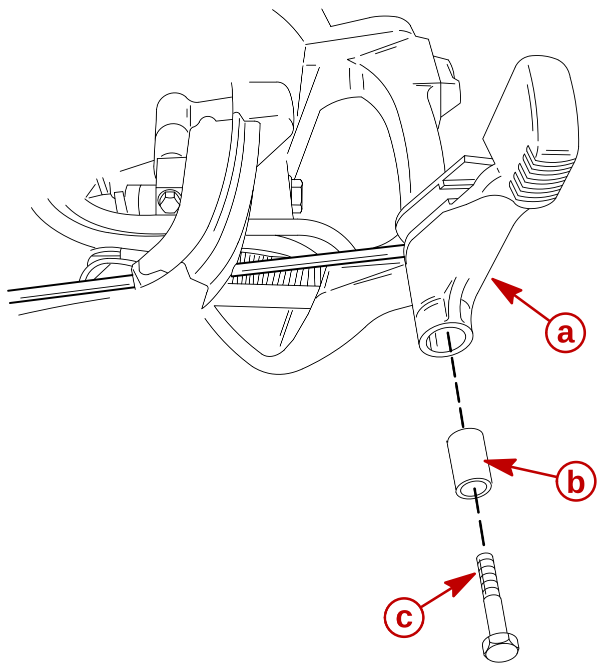
Tiller Handle Assembly Removal

1. Remove lower cowl.



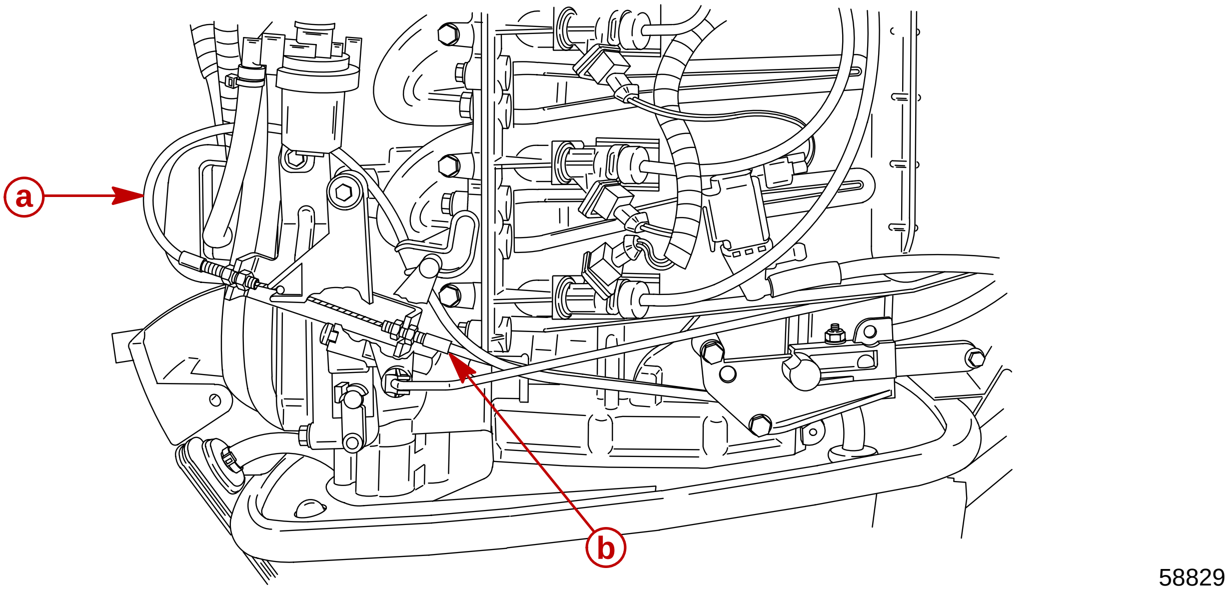
a - Screws-M6x30 (6)
b - Screw-M6x60

2. Remove shift handle.



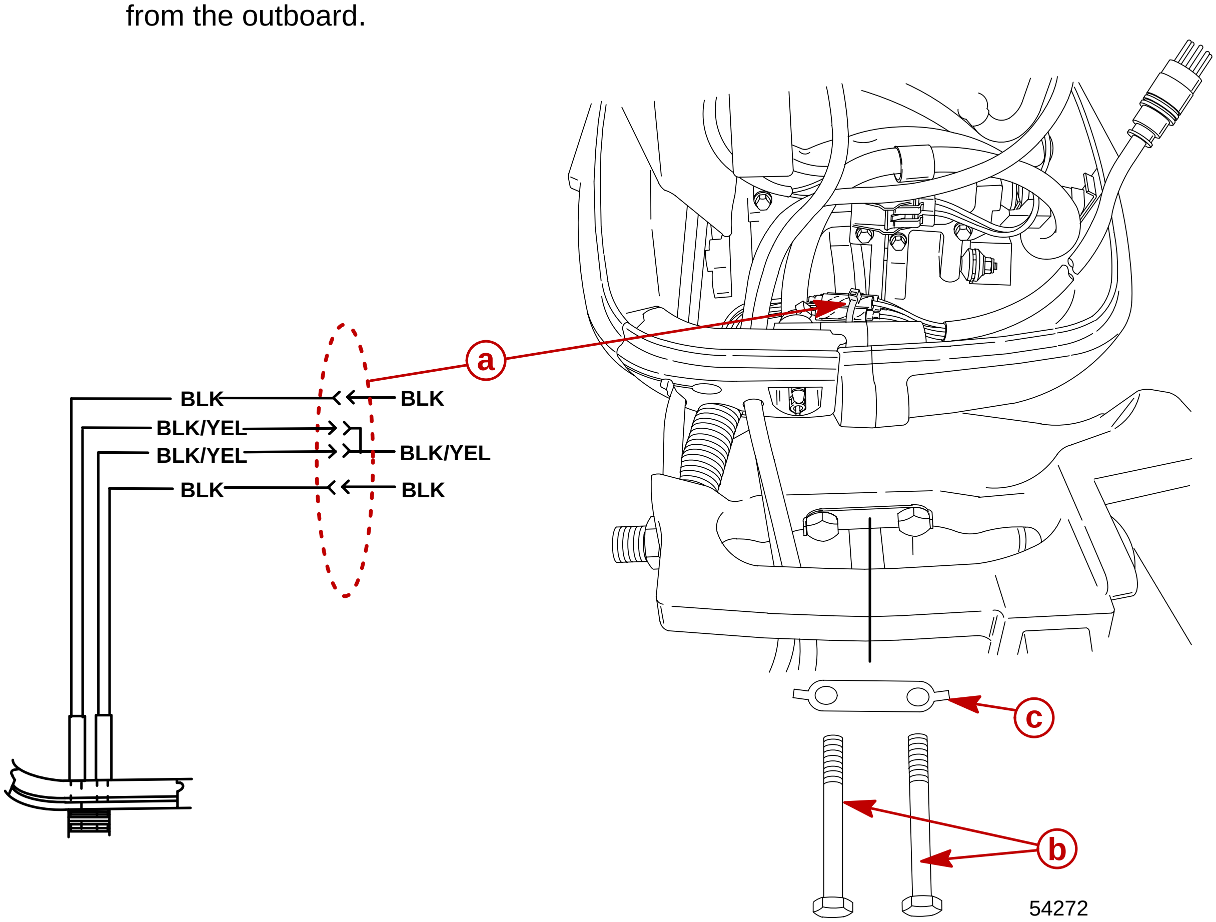
a - Shift Handle
b - Bushing
c - Screw-M8x35

3. Loosen the jam nuts and disconnect the throttle cables from the throttle lever.



a - Throttle Cable (Long)
b - Throttle Cable (Short)

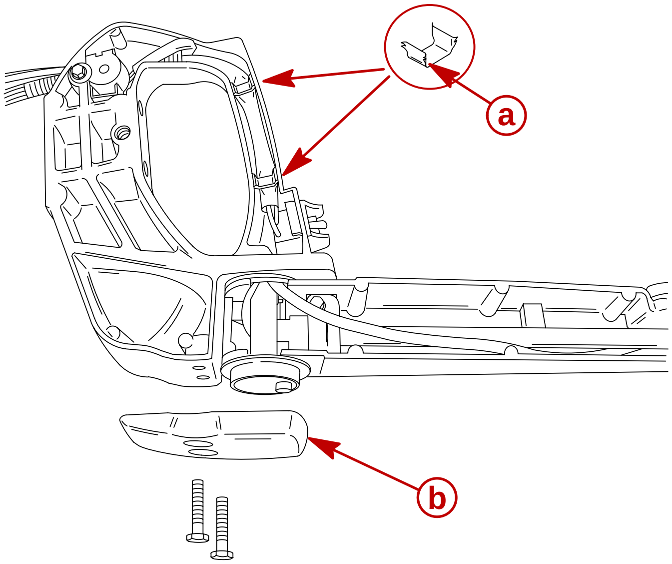
4. Disconnect the tiller handle wiring.
5. Remove two screws (b) securing the tiller handle. Remove the tiller handle assembly from the outboard.



a - Disconnect Tiller Handle Wires
b - Screws-M10x90 (2)
c - Tab Washer

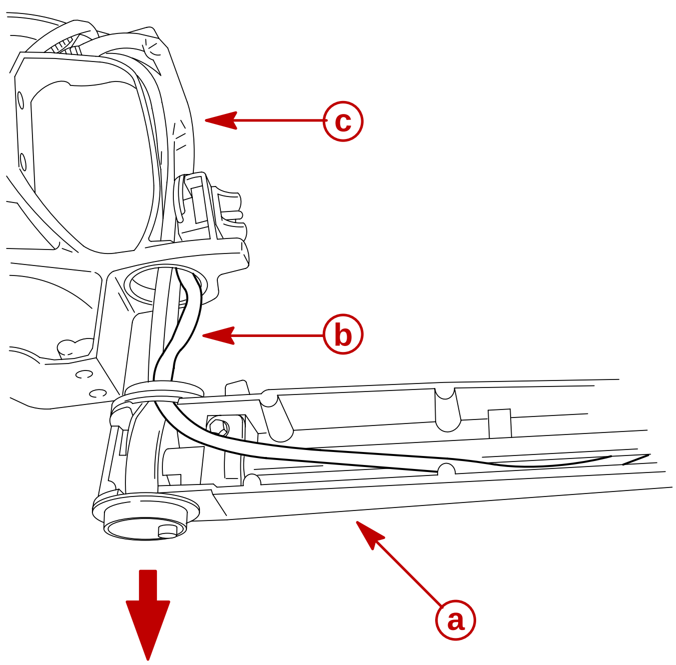
Tiller Handle Disassembly

1. Pry the two clips out of the hand grip.
2. Remove the side cover.



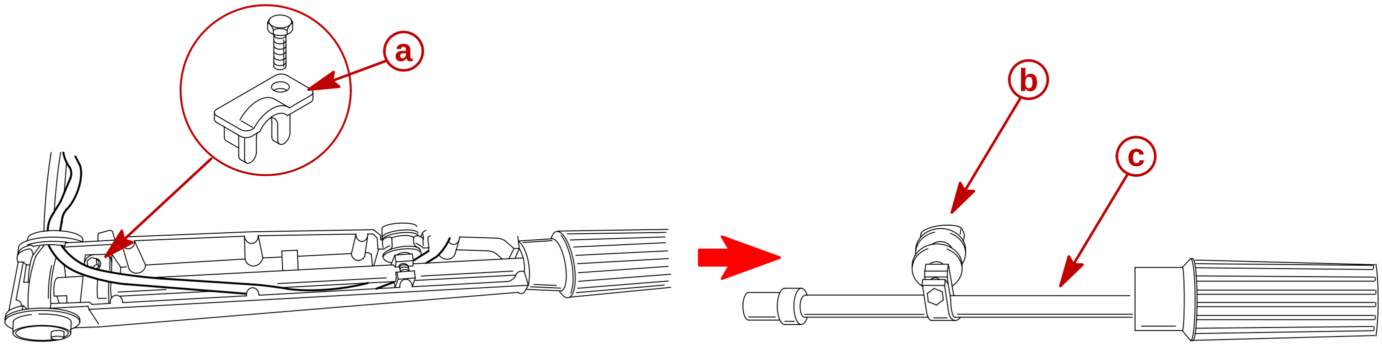
a - Clips (2)
b - Side Cover

3. Pull the tiller arm, along with the throttle cables and wiring, from the tiller bracket.



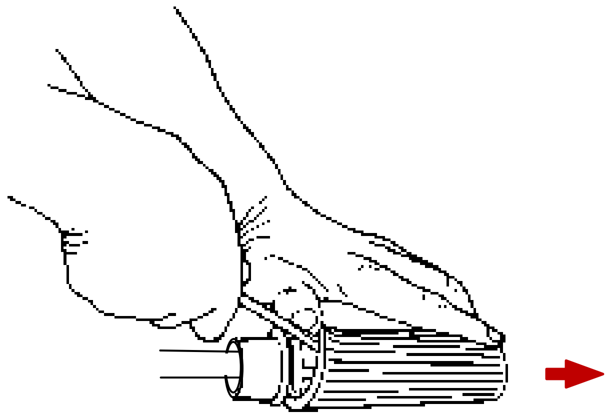
a - Tiller Arm
b - Throttle Cables/Wiring
c - Tiller Bracket

4. Remove retainer and slide out the tiller tube assembly.
5. Remove the throttle friction knob assembly.

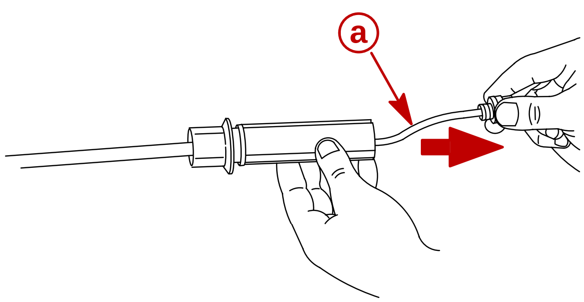


a - Retainer
b - Throttle Friction Knob Assembly
c - Tiller Tube Assembly

6. Use a flat tip screwdriver to pry/push the rubber grip off the handle.

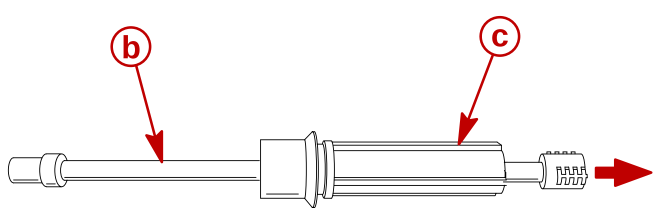


7. Pull out the stop switch harness.



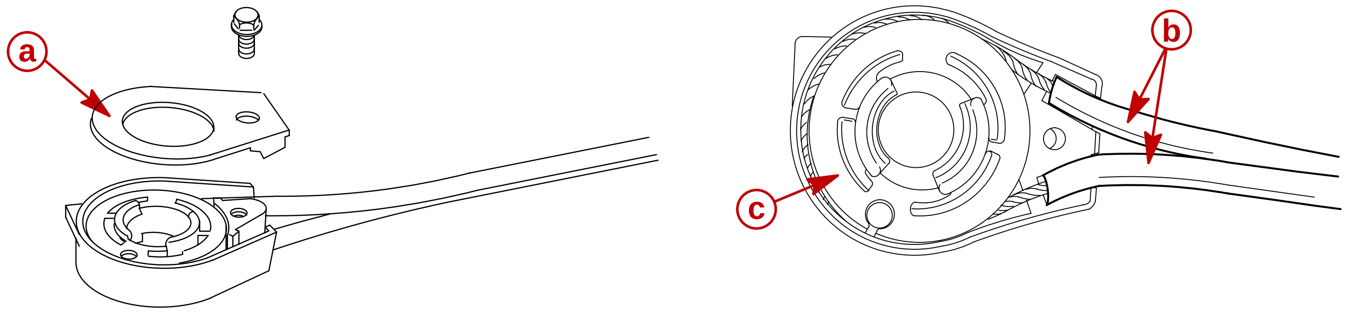
a - Stop Switch Harness

8. Push the tiller tube out of the handle.



b - Tiller Tube
c - Handle

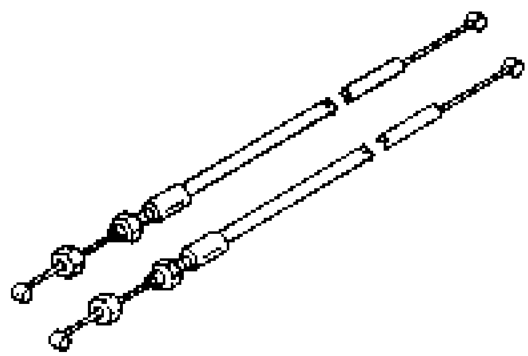
9. Remove cover and disconnect throttle cables from pulley.



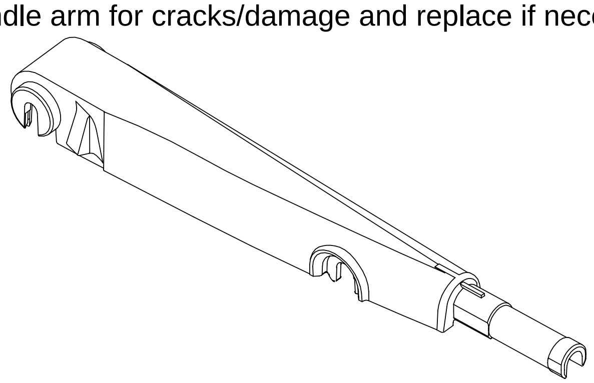
a - Cover
b - Throttle Cables
c - Pulley

Cleaning/Inspection/Repair

1. Inspect throttle cables for bending/damage and replace if necessary.

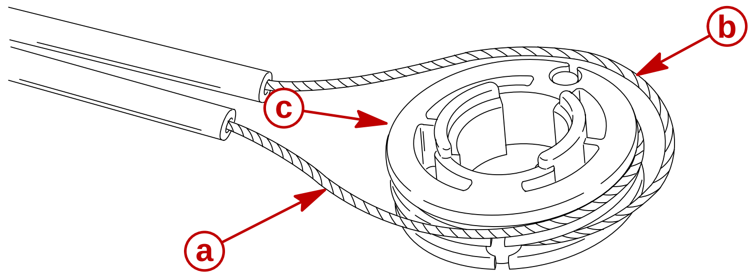


2. Inspect steering handle arm for cracks/damage and replace if necessary.



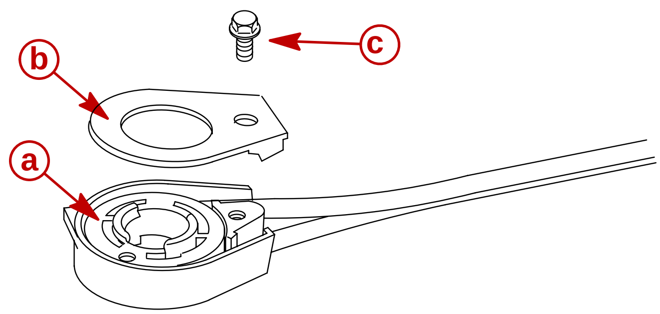
Tiller Handle Reassembly

1. Wrap cables around pulley as shown.



a - Short Throttle Cable (30-1/2 in.) Place in Top Groove
b - Long Throttle Cable (40-1/2 in.) Place in Bottom Groove
c - Pulley

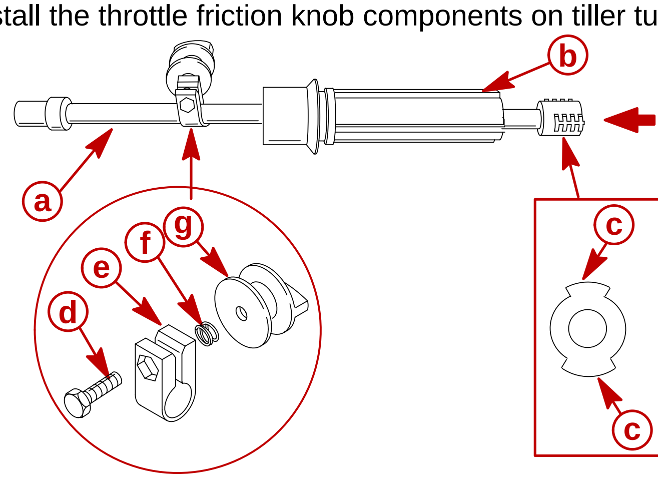
2. Place pulley and cables into case.
3. Install cover with screw.



a - Pulley
b - Cover
c - Screw 10-16x$^1/_2$ in.

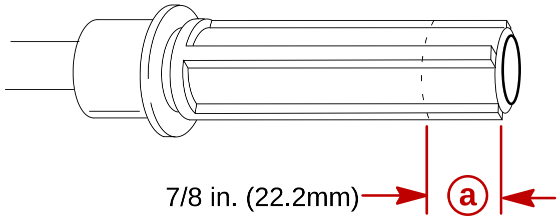
Pulley Cover Screw Torque
20 lb. in. (2.3 N·m)

4. Match tiller tube end with slots in the handle. Pull the tube end into the handle until it bottoms out.
5. Install the throttle friction knob components on tiller tube.



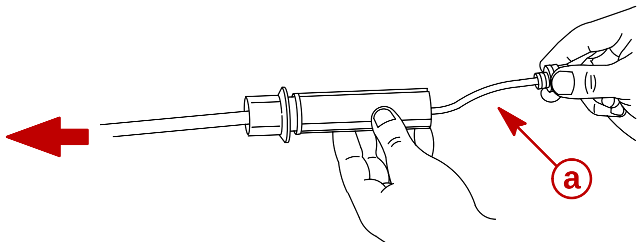
a - Tiller Tube
b - Handle
c - Slots In Handle
d - Screw M6x25
e - Lock
f - Spring
g - Knob

6. Check to make sure tiller tube is recessed in the end of the handle 7/8 in. (22.2mm).



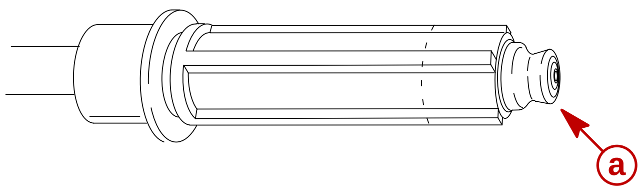
a - 7/8 in. (22.2 mm)

7. Insert the engine stop switch harness through the tiller tube.



a - Engine Stop Switch Harness

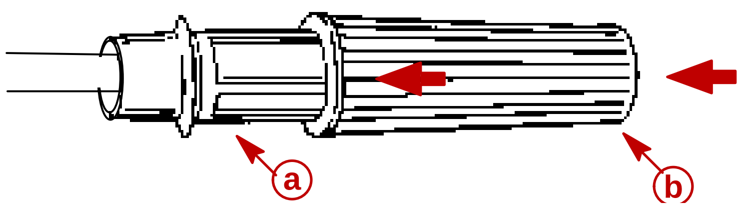
8. Place the stop switch into end on handle.



a - Stop Switch

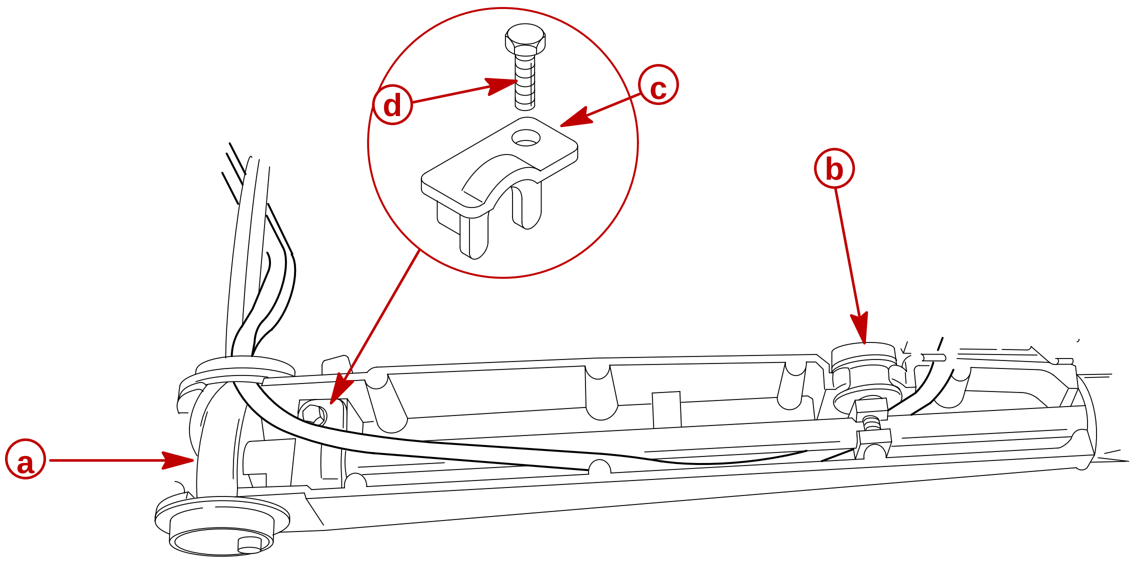
9. Align the grooves inside the rubber grip with the ridges on the handle. Push the rubber grip onto the handle.

NOTE: *Applying a soap/water solution to the inside of the rubber grip will ease installation.*



a - Rubber Grip
b - Handle

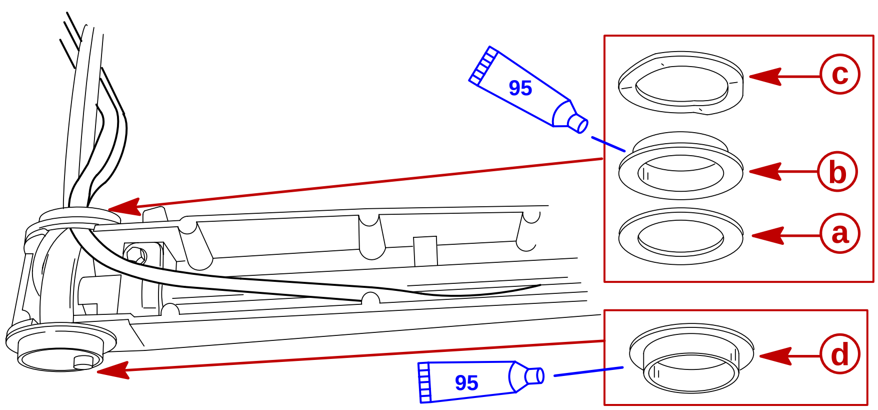
10. Place pulley assembly into arm.
11. Slide the tiller tube into the arm. Position the throttle friction knob into its slot.
12. Match the end of the tiller tube with the slots in the pulley assembly. Insert the tiller tube end into the pulley assembly.
13. Secure tiller tube with retainer.
14. Snap the engine start switch on the tiller tube.



a - Pulley Assembly
b - Throttle Lock Knob
c - Retainer
d - Screw-M5x16

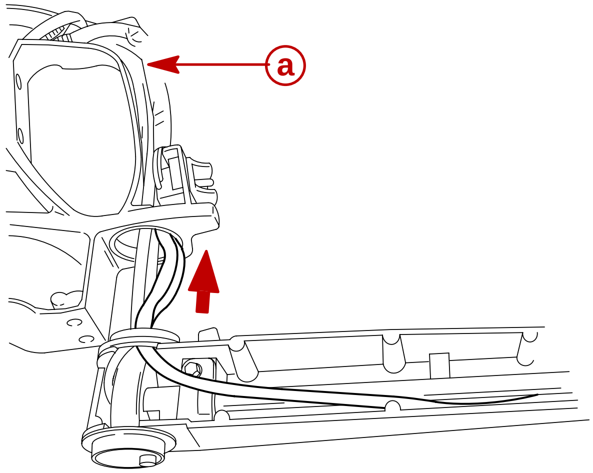
Tiller Tube Retainer Screw Torque
35 lb. in. (3.9 N·m)

15. Place bushing components on the arm mounts.



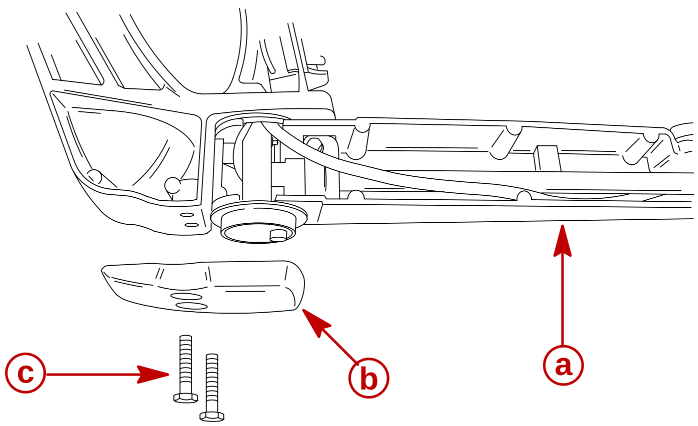
95 2-4-C w/Teflon (92-850736A1)
a - Flat Washer
b - Bushing
c - Wave Washer (1)
d - Bushing

16. Pull the throttle cables and wiring into the bracket.



a - Tiller Bracket

17. Push the arm into the tiller bracket. Secure the arm by installing the cover and screws. Tighten screws to specified torque.



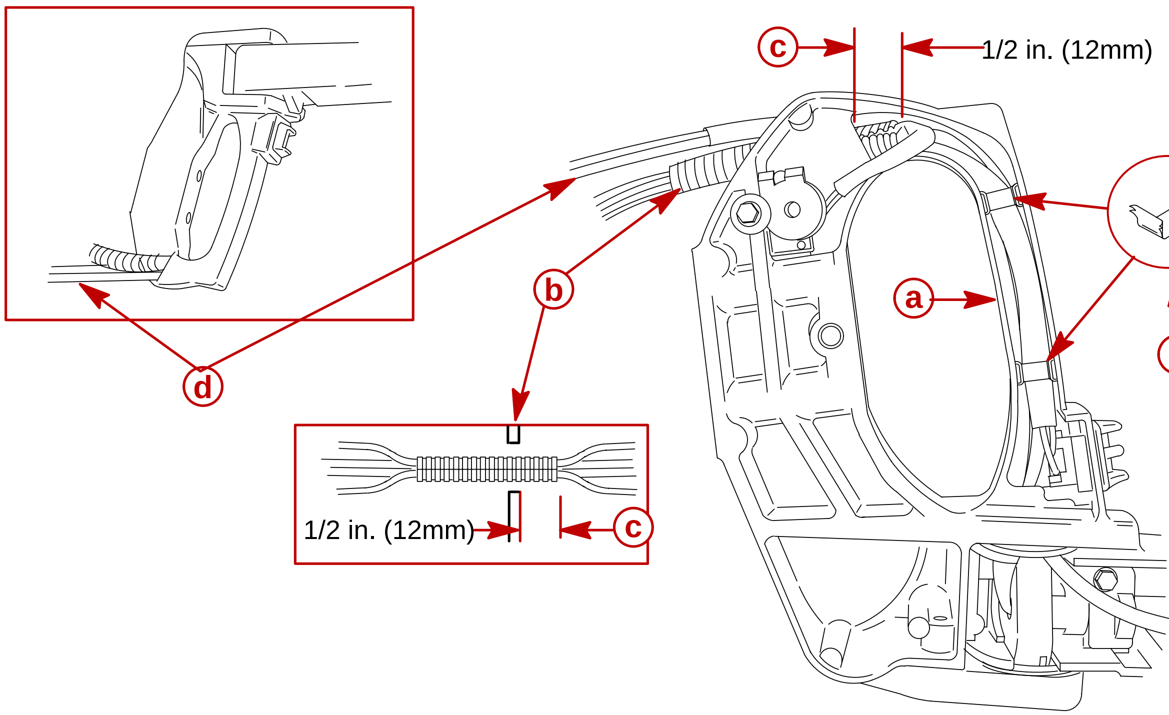
a - Arm
b - Cover
c - Screw (2) M8 x 25

Arm Cover Screw Torque
135 lb. in. (15.3 N·m)

⚠ CAUTION

Wiring passing through the hand grip opening must be protected from chaffing or being cut, by using the wiring conduit described in the following steps. Failure to protect wiring as described could result in electrical system failure.

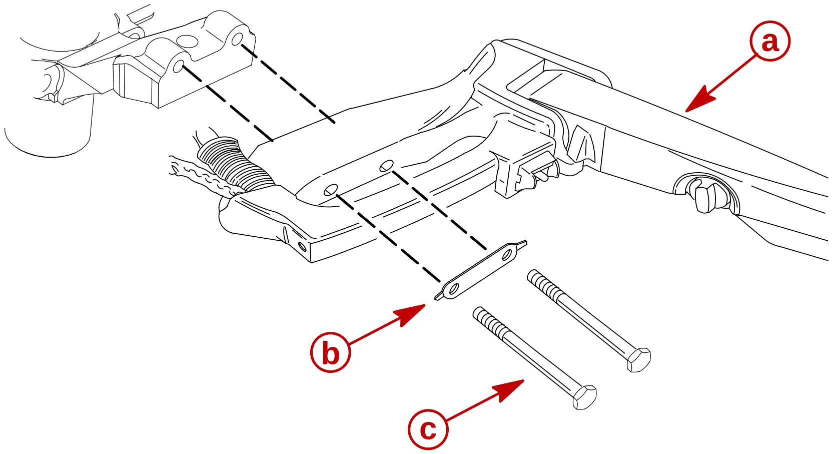
18. Place the throttle cables through the hand grip opening as shown.
19. Place all wiring inside the wiring conduit.
20. Route the wiring through the hand grip opening and position the wiring conduit inside the opening so that at least 1/2 in. (12.7mm) extends past each end of the opening.
21. Push the wiring and throttle cables down into the handle grip and hold in place with two clips.



a - Hand Grip Opening
b - Wiring Conduit (Place all Wiring Inside – See CAUTION above)
c - Wiring Conduit 1/2 in extending past opening
d - Throttle Cables (Position toward outer side)
e - Clips (2)

Tiller Handle Installation

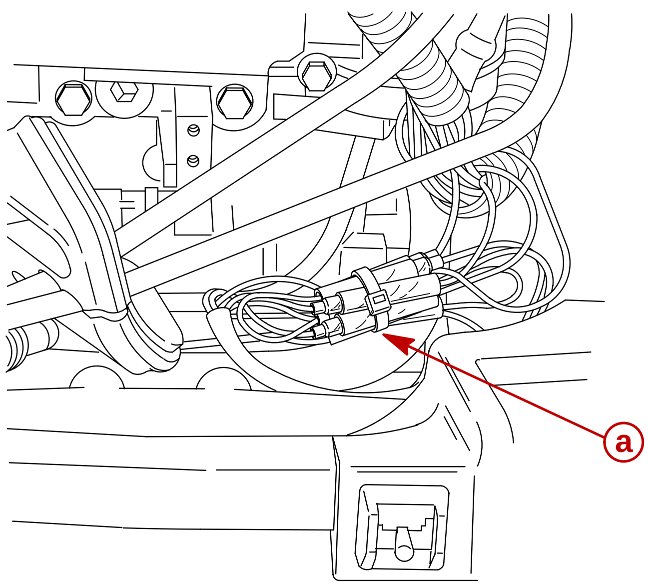
1. Install tiller handle, new tab washer, and screws. Tighten screws to specified torque.
2. Bend tabs onto flats of screws.



a - Tiller Handle
b - Tab Washer
c - Screw (2) M10 x 90

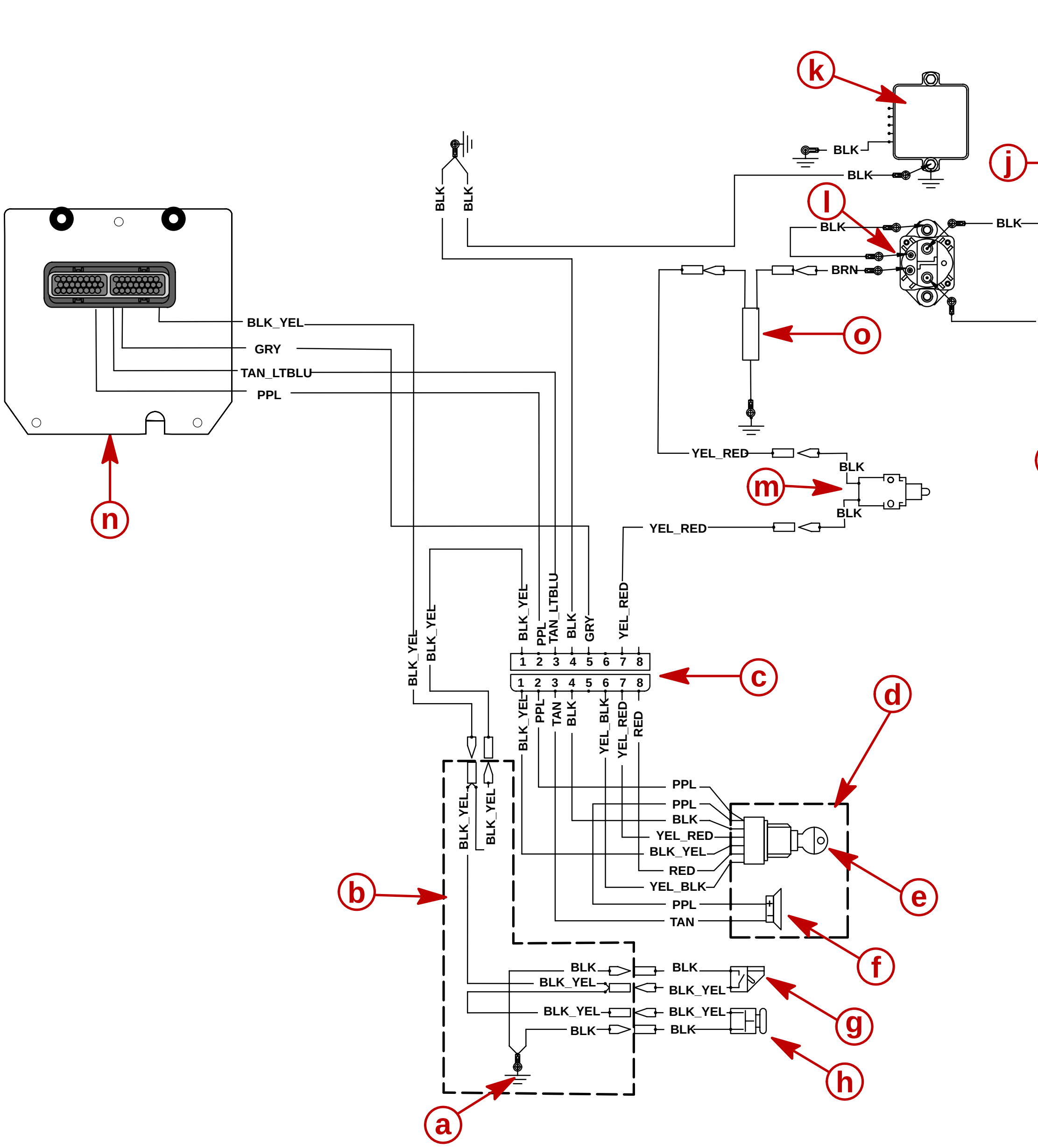
Tiller Handle Mounting Screw Torque
35 lb. ft. (47.5 N·m)

3. Connect wires as shown in wiring diagram (on next page).
4. Secure wires at connectors with cable tie as shown.



a - Cable Tie

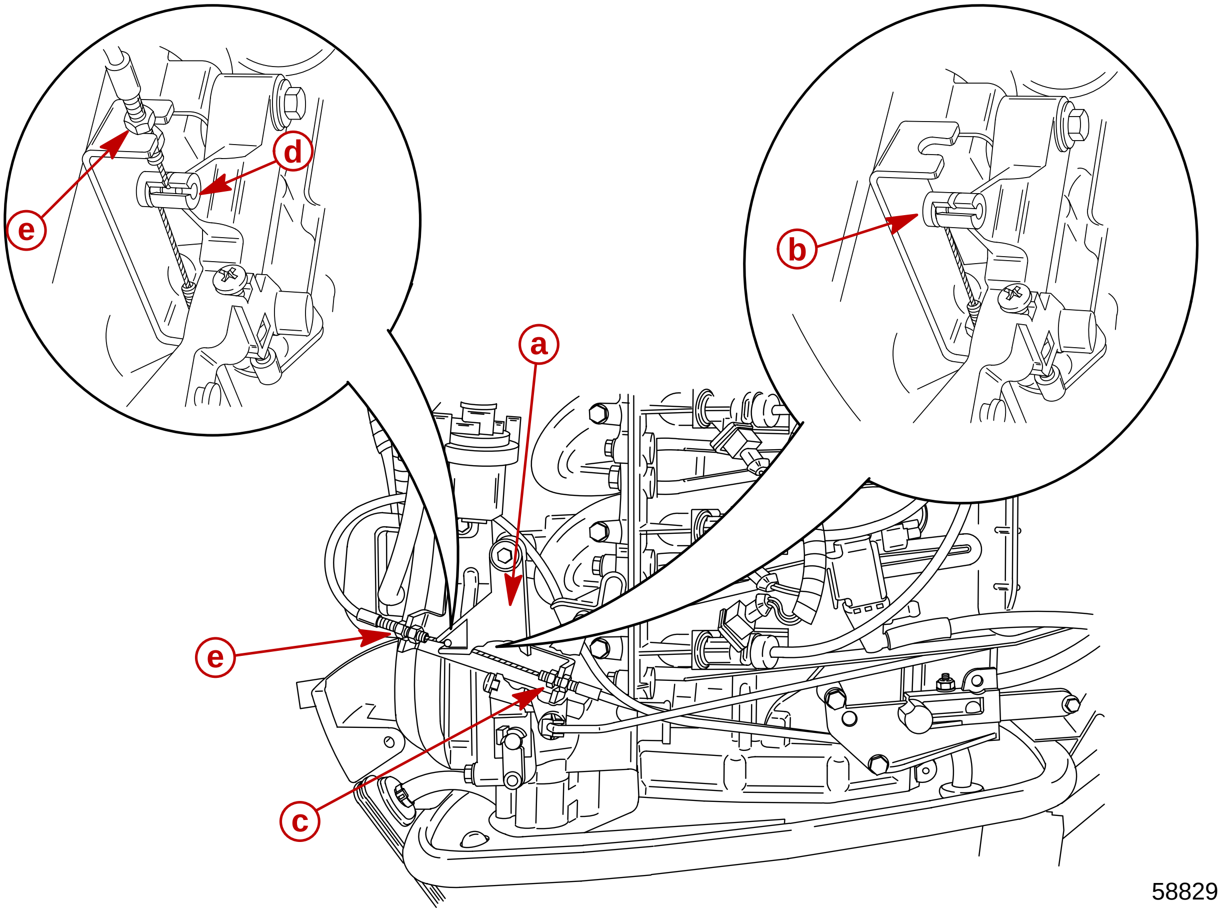
ELECTRIC START TILLER HANDLE WIRING DIAGRAM-40/50/60 (4-STROKE)



BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
TAN = Tan
WHT = White
YEL = Yellow
LIT = Light
DRK = Dark

- **a** - Ground Harness below Starter Motor M6x16 screw
- **b** - Harness Extension
- **c** - Harness Connection
- **d** - Key Switch Assembly Transom Mount
- **e** - Key Switch
- **f** - Horn
- **g** - Lanyard Stop Switch
- **h** - Push Button Stop Switch
- **i** - Battery
- **j** - Starter Motor
- **k** - Voltage Regulator/Rectifier
- **l** - Start Solenoid
- **m** - Neutral Start Switch
- **n** - ECM
- **o** - In-line Diode

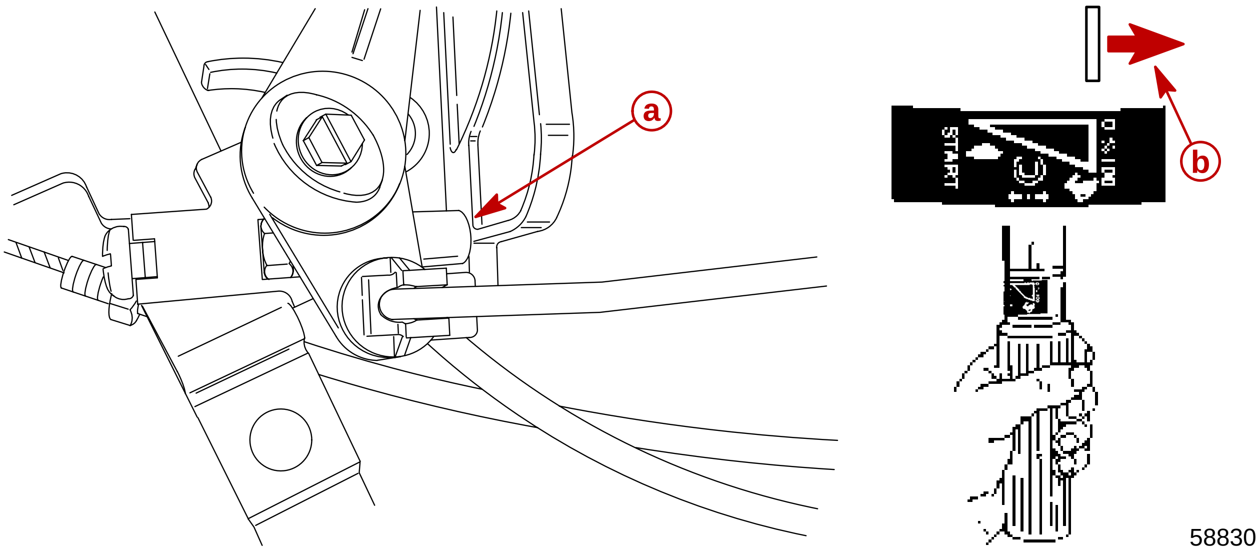
5. Rotate throttle grip to idle position.
6. Insert the anchor on the shorter throttle cable into the anchor slot on the throttle lever.
7. Secure cable in position by tightening jam nuts onto bracket (finger tighten only).
8. Insert anchor on remaining cable into the anchor slot on the throttle lever.
9. Secure cable in position by tightening jam nuts onto bracket (finger tighten only).



a - Throttle Lever
b - Anchor of Shorter Throttle Cable
c - Jam Nut
d - Anchor of Longer Throttle Cable
e - Jam Nut

10. Rotate throttle grip to the wide open throttle position. The throttle stop screw should be contacting the plate. If there is a gap between the throttle stop screw and plate, loosen the jam nut on the shorter throttle cable, turn the adjustment nut clockwise. Tighten the jam nut finger tight, rotate the throttle grip to full throttle. Keep adjusting until the throttle stop screw lightly contacts the plate.

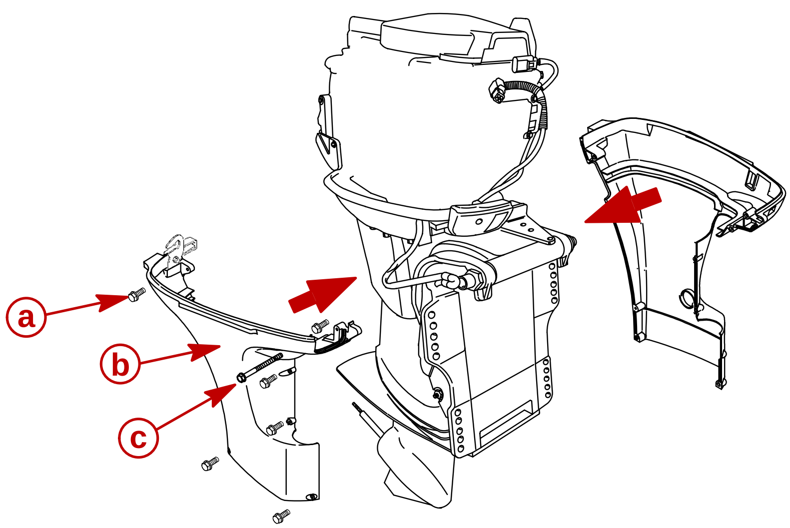
NOTE: *No free-play should exist in throttle grip handle once the throttle stop screw has hit the plate. If this condition exists, re-adjust jam nuts on appropriate throttle cable.*



a - Throttle Stop Screw Hitting Plate
b - No Free play should exist in throttle grip handle past full throttle once throttle stop screw has hit plate. If this condition exists re-adjust jam nuts.

IMPORTANT: After installation, cycle the throttle grip a few times from the idle position to the wide-open-throttle position. Make sure the throttle stop is still contacting the plate. If it is not, re-adjust the jam nuts.

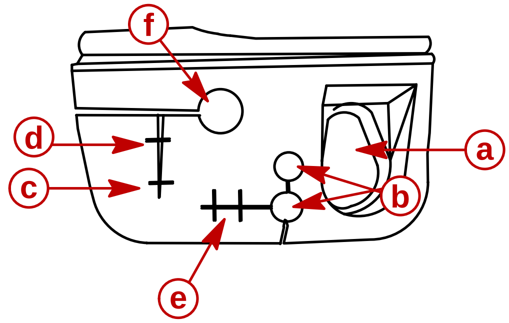
11. Install lower cowl.



a - Screw (6)-M6x30
b - Lower Cowl
c - Screw-M6x60

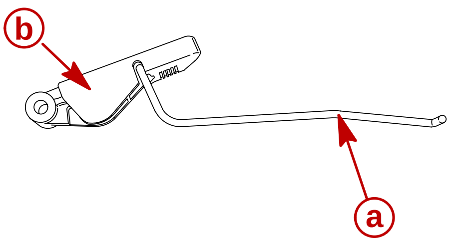
Bottom Cowl Bolt Torque
60 lb. in. (6.8 N·m)

12. Cables, wires, and shift rod should be routed through grommet as shown. Seat grommet between cowl halves.



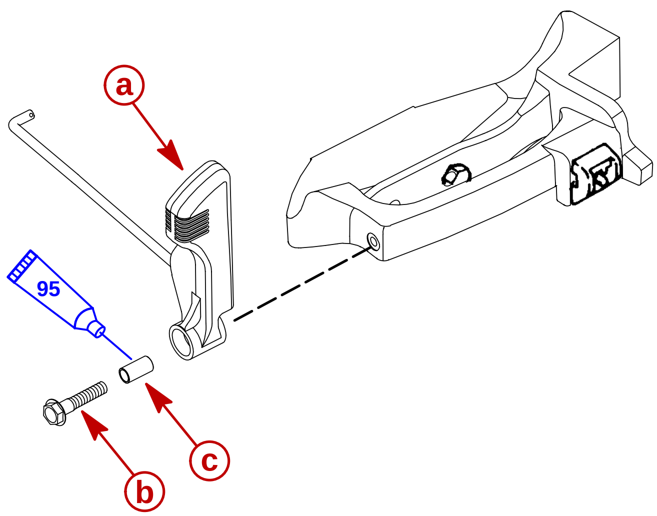
a - Fuel Connector
b - Battery Cables
c - Throttle Cables
d - Shift Rod
e - Tiller Handle Harness Wires
f - Remote Key Harness

13. Assemble the shift rod into the shift handle by sliding the rod into the hole.



a - Shift Rod
b - Shift Handle

14. Install shift handle assembly, bushing, and screw. Tighten screw to specified torque.



95 2-4-C w/Teflon (92-850736A1)

a - Handle Assembly
b - Screw M8 x 35
c - Bushing

Shift Handle Screw Torque
100 lb. in. (11.3 N·m)

COLOR DIAGRAMS

Table of Contents

8

Notes:

40/50/60 EFI (4-STROKE)
TILLER HANDLE ELECTRIC
COLOR WIRING DIAGRAM
2002 MODELS

40/50/60 EFI (4-Stroke) Tiller Handle Electric 2002 Models

1. ECM
2. Starboard ECM Connector
3. Manifold Air Temperature (MAT) Sensor
4. Manifold Absolute Pressure (MAP) Sensor
5. Throttle Position Sensor (TPS)
6. Engine Coolant Temperature (ECT) Sensor
7. Crank Position Sensor (CPS)
8. Oil Pressure Switch
9. Idle Air Control (IAC) Valve
10. Ignition Coil (EST) #1
11. Ignition Coil (EST) #2
12. Ignition Coil (EST) #3
13. Ignition Coil (EST) #4
14. Main Power Relay
15. SmartCraft Data Bus Circuit - 15 amp. fuse
16. Fuel Pump/IAC/Injector Circuit - 20 amp. fuse
17. Main Power Relay/Accessory Circuit - 20 amp. fuse
18. Ignition Coil Circuit - 2 amp. fuse
19. Voltage Regulator/Rectifier
20. Stator
21. Start Solenoid
22. Starter
23. To Trim Motor
24. Trim Down Relay
25. Trim Up Relay
26. To 12 Volt Battery
27. Cowl Mounted Trim Switch
28. To Trim Connections on Remote Control Harness
29. Suppression Diode
30. Vapor Separator Tank
31. Engine Harness Connection
32. Data Bus (10 pin) Control Area Network (CAN)
33. DDT Connection
34. Fuel Injector #1
35. Fuel Injector #2
36. Fuel Injector #3
37. Fuel Injector #4
38. Port ECM Connector
39. Neutral Start Switch
40. 12 Volt Switched Auxiliary Power Source
41. Key Switch
42. Warning Horn
43. Push Button Stop Switch
44. Lanyard Stop Switch
45. Tachometer Signal
46. Tiller Handle Harness Connection


59080

40/50/60 EFI (4-STROKE)
REMOTE CONTROL ELECTRIC
COLOR WIRING DIAGRAM
2002 MODELS

40/50/60 EFI (4-Stroke) Remote Control Electric 2002 Models

1. ECM
2. Starboard ECM Connector
3. Manifold Air Temperature (MAT) Sensor
4. Manifold Absolute Pressure (MAP) Sensor
5. Throttle Position Sensor (TPS)
6. Engine Coolant Temperature (ECT) Sensor
7. Crank Position Sensor (CPS)
8. Oil Pressure Switch
9. Idle Air Control (IAC) Valve
10. Ignition Coil (EST) #1
11. Ignition Coil (EST) #2
12. Ignition Coil (EST) #3
13. Ignition Coil (EST) #4
14. Main Power Relay
15. SmartCraft Data Bus Circuit - 15 amp. fuse
16. Fuel Pump/IAC/Injector Circuit - 20 amp. fuse
17. Main Power Relay/Accessory Circuit - 20 amp. fuse
18. Ignition Coil Circuit - 2 amp. fuse
19. Voltage Regulator/Rectifier
20. Stator
21. Start Solenoid
22. Starter
23. To Trim Motor
24. Trim Down Relay
25. Trim Up Relay
26. To 12 Volt Battery
27. Cowl Mounted Trim Switch
28. To Trim Connections on Remote Control Harness
29. Suppression Diode
30. Vapor Separator Tank
31. Engine Harness Connection
32. Data Bus (10 pin) Control Area Network (CAN)
33. DDT Connection
34. Fuel Injector #1
35. Fuel Injector #2
36. Fuel Injector #3
37. Fuel Injector #4
38. Port ECM Connector

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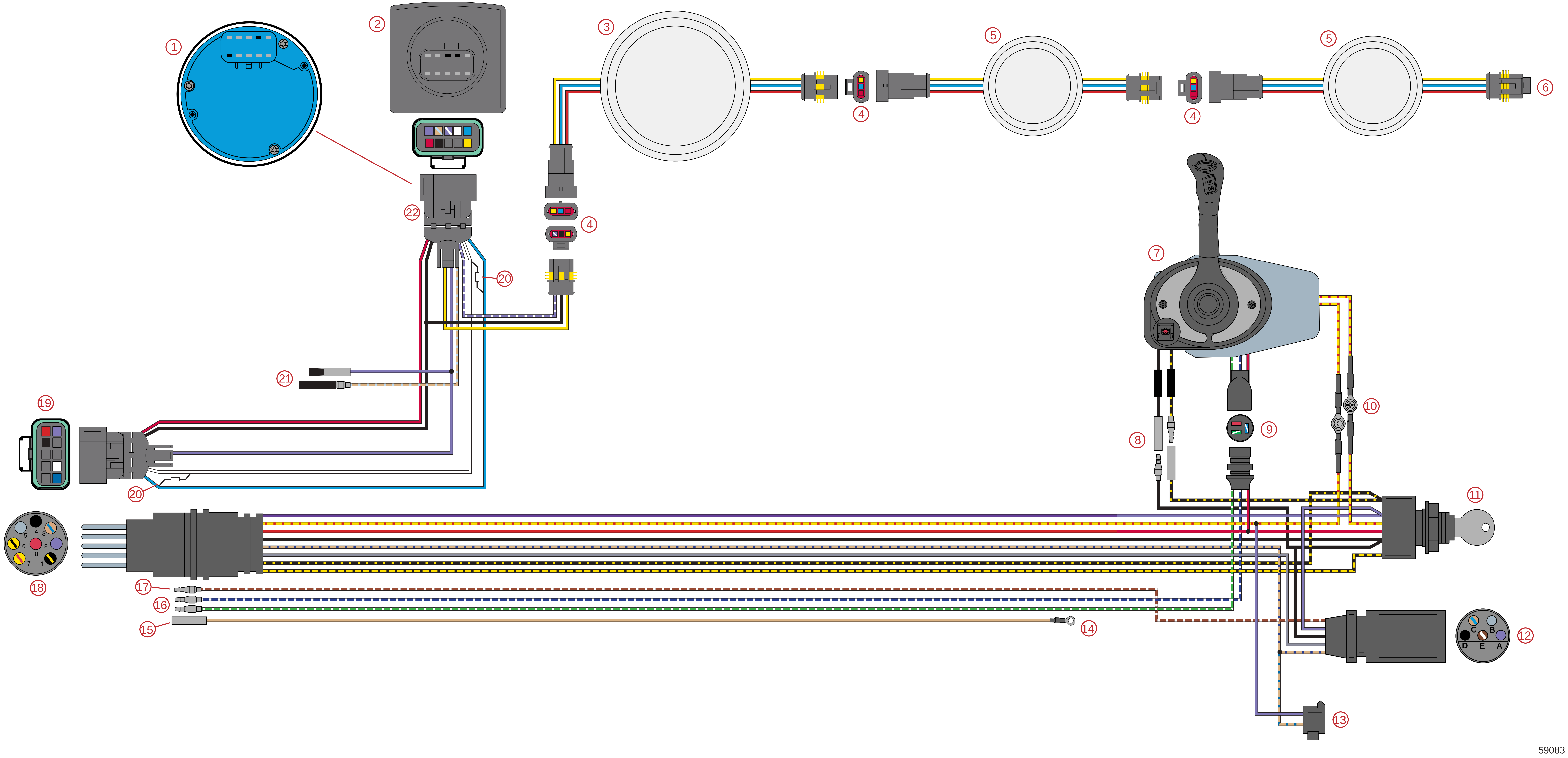
40/50/60 EFI (4-STROKE)
TYPICAL SMARTCRAFT (CAN) INSTALLATION
2002 MODEL YEAR

40/50/60 EFI (4-Stroke) Typical SmartCraft (CAN) Installation 2002 Models

1. System Tachometer (can be used in place of System Monitor and System Link Tachometer
2. System Monitor
3. System Link Tachometer
4. System Link Series Connections
5. 2-1/4 in. System Link Gauges (Engine Temperature and Battery)
6. Series Connection for Additional System Link Gauges
7. 4000 Series Mechanical Panel Control (MPC 4000)
8. Connections for Lanyard Stop Switch
9. Connections for Power Trim Switch
10. Connections for Neutral Start Safety Switch
11. Ignition Key Switch
12. Analog Tachometer Harness (Not Used on CAN Installation)
13. Warning Horn
14. Analog Temperature Gauge Connection
15. Connection for Analog Temperature Sender
16. Connections to Trim Relays
17. Connection for Analog Trim Sender
18. Remote Control Harness Connects to Engine Harness
19. 10-Pin Control Area Network (CAN) Harness, Connect to Data Bus 10-Pin CAN Harness on Engine
20. Resistors within CAN Harness (120 1/4W 5%)
21. Connections for Auxiliary Warning Horn for Depth Sensor
22. 10-Pin Control Area Network (CAN) Connection to System Monitor or System Tachometer



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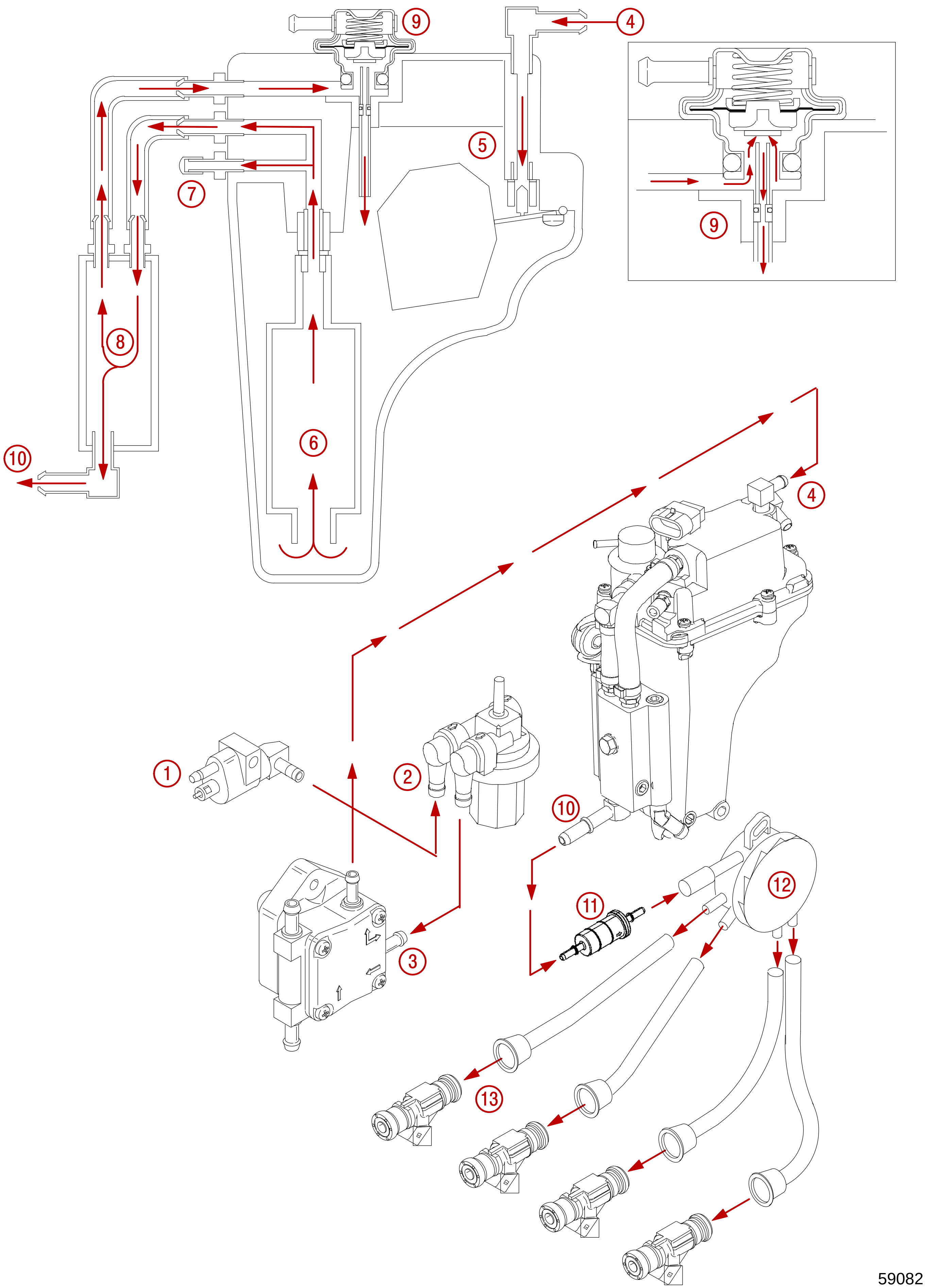
40/50/60 EFI (4-STROKE)
FUEL FLOW DIAGRAM

40/50/60 EFI (4-Stroke) Fuel Flow Diagram

1. From Boat Fuel Tank
2. Fuel Filter Assembly
3. Low Pressure Mechanical Fuel Pump
4. Vapor Separator Tank (VST) “Low-Pressure In”
5. Float Valve
6. High-Pressure Electric Fuel Pump
7. Schrader Valve for Testing Fuel Pressure
8. Fuel Cooler
9. Pressure Regulator
10. Vapor Separator Tank (VST) “High-Pressure Out”
11. High Pressure Fuel Filter
12. Fuel Distribution Manifold
13. Fuel Injectors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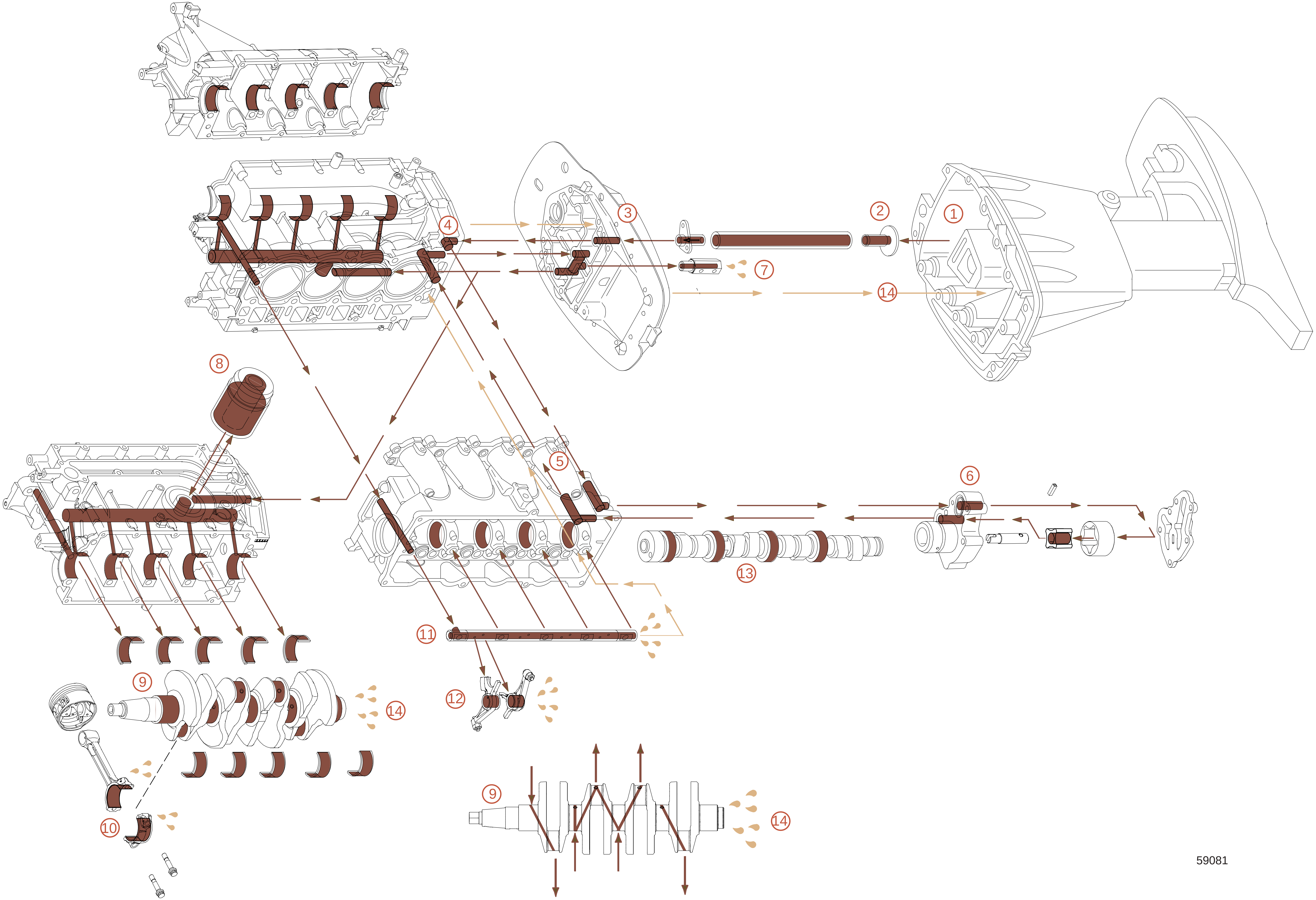
40/50/60 EFI (4-STROKE)
OIL FLOW DIAGRAM

40/50/60 EFI (4-Stroke) Oil Flow Diagram

1. Sump
2. Oil Pick-up
3. Oil Passages in Adapter Plate
4. Oil Passages in Cylinder Block
5. Oil Passages In Cylinder Head
6. Oil Pump
7. Oil Pressure Regulator
8. Oil Filter
9. Crankshaft
10. Piston, Rod, Wrist-Pin
11. Rocker Arm Shaft
12. Rocker Arms
13. Camshaft
14. Return to Sump



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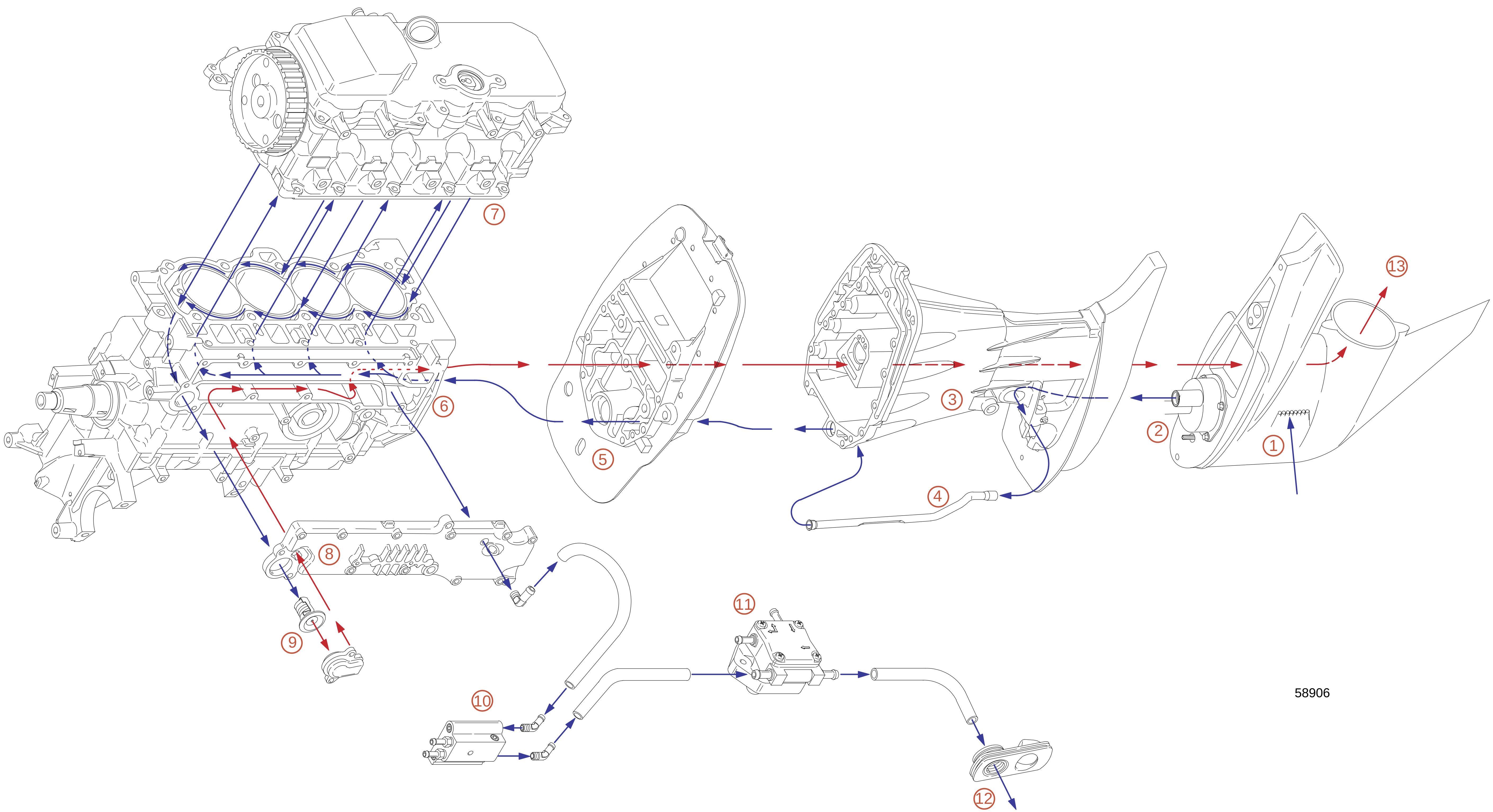
40/50/60 EFI (4-STROKE)
WATER FLOW DIAGRAM

40/50/60 EFI (4-Stroke) Water Flow Diagram

1. Water Inlet
2. Water Pump
3. Driveshaft Housing
4. Water Tube
5. Adapter Plate
6. Cylinder Block
7. Cylinder Head
8. Water Jacket Cover
9. Thermostat
10. Fuel Cooler
11. Fuel Pump
12. Tell-Tale
13. Water Discharged with Exhaust



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