MERCURY

Service Manual

200/225 OptiMax

Direct Fuel Injection

Starting Model Year 2000
Starting Serial Number OG960500

200/225 OptiMax

Starting Model Year 2000
Starting S/N OG960500

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.

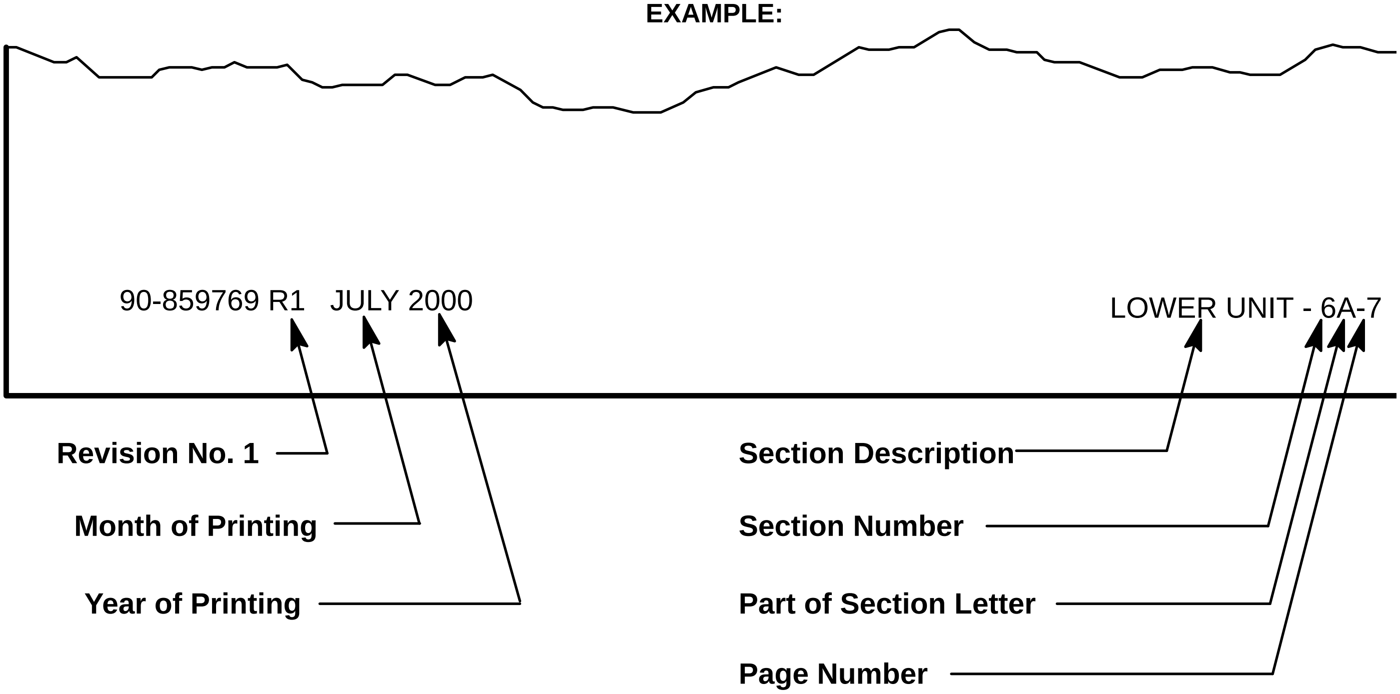
We reserve the right to make changes to this manual without prior notification.

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

Page Numbering

Two number groups appear at the bottom of each page. The example below is self-explanatory.

EXAMPLE:



Service Manual Outline

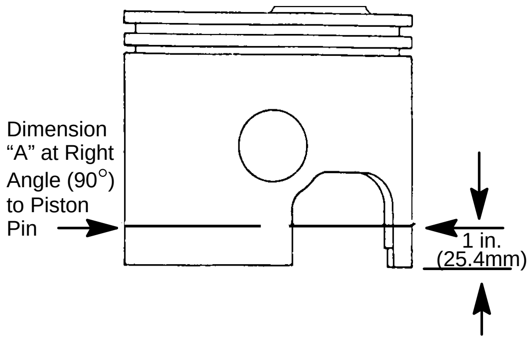
IMPORTANT INFORMATION

Section 1A - Specifications

Table of Contents

Master Specifications

Model 200/225 DFI		
HORSEPOWER (KW)	**Model 200** **Model 225** **Full Throttle RPM (200/225)** **Idle RPM (In Gear) (200/225)** **RPM Limiter** **Model 200/225**	200 (149.2 kw) 225 (167.8 kw) 5000 - 5750 550 5800
OUTBOARD WEIGHT	**Model 200/225** **– 20 in. (50.8cm) Shaft** **– 25 in. (63.5cm) Shaft** **– 30 in. (76.2 cm) Shaft**	 516.0 lbs. (234.0 kg) 528.0 lbs. (239.5 kg) 544.0 lbs. (246.8 kg)
CYLINDER BLOCK	**Type** **Displacement** **Thermostat**	V-6 Cylinder, Two Cycle, Direct Injected 185.9 cu. in. (3047 cc) 60° Vee 120°F (49°C)
STROKE	**Length (All Models)**	3.00 in. (76.2mm)
CYLINDER BORE	**Diameter (Std)** **Diameter 0.015 in. Oversize** **Diameter 0.030 in. Oversize** **Taper/Out of Round/Wear Maximum** **Bore Type**	3.6265 in. (92.1131mm) 3.6415 in. (92.4941 mm) 3.6565 in. (92.875 mm) 0.003 in. (0.076 mm) Cast Iron
CRANKSHAFT	**Maximum Runout**	0.002 in. (0.0508 mm)
PISTON	**Piston Type** **Diameter Standard** **Diameter 0.015 in. Oversize** **Diameter 0.030 in. Oversize**	Aluminum 3.6210 in. ± .0005 in. (91.9734 mm ± 0.0127 mm) 3.6360 in. ± 0.0005 in. (89.0905 mm ± 0.0127 mm) 3.6510 in. ± 0.0005 in. (92.7354 mm ± 0.0127 mm)

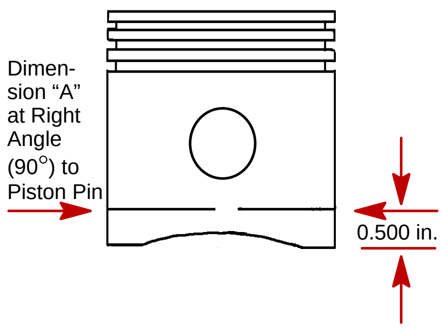
Model 200/225 DFI		
PISTON DIAMETER		3.6210 in. ± .0005 in. (91.9734 mm ± .0127 mm)**Using a micrometer, measure dimension “A” at location shown. Dimension “A” should be 3.6205 in. ± .0005 for a STANDARD size piston (new) Dimension “A” will be 0.001 - 0.0015 less if coating is worn off piston (used)**
REEDS	**Reed Stand 0pen (Max.)**	0.020 in. (0.50 mm)
MID SECTION	**Power Trim (Total Tilt Range)** **Power Trim (Tilt Range)** **Maximum amount of acceptable leak down in 24 hrs.** **Steering Pivot Range** **Tilt Pin Adjustment Positions** **Allowable Transom Thickness**	75° 20° 1 in. (25.4 mm) 60° 5 2-3/8 in. (6.03 cm)

Model 200/225 DFI		
GEAR HOUSING	**Gear Ratio**	
	Standard Ratio All Models	1.75:1 12/21 Teeth
	Optional High Altitude Ratio	1.87:1 15/28 Teeth
	Gearcase Capacity	27.0 fl. oz. (798.0 ml)
	Pinion Height	0.025 in. (0.635 mm)
	Forward Gear Backlash	.
	– 1.75:1/1.87:1	0.017 in. - 0.028 in. (0.431 mm - 0.711 mm)
	Reverse Gear Backlash	
	– Standard Rotation	0.028 in. - 0.052 in. (0.71 mm - 1.32 mm)
	– Counter Rotation	0.040 in. - 0.060 in. (1.0 mm - 1.52 mm)
	Water Pressure @ RPM	8 - 10 psi minimum @ 5000 RPM
	Gear Housing Pressure Check (without gear lubricant)	15 psi minimum
DIRECT INJECTION	**Injectors**	
	– Quantity	6
	– Injectors are Crank Angle Driven by ECM	
	– #2 Cylinder	WHT/RED + RED/WHT Leads
	– #4 Cylinder	WHT/YEL + YEL/WHT Leads
	– #6 Cylinder	WHT/PPL + PPL/WHT Leads
	– #1 Cylinder	WHT/BRN + BRN/WHT Leads
	– #3 Cylinder	WHT/ORG + ORG/WHT Leads
	– #5 Cylinder	WHT/DRK BLU + DRK BLU/WHT Leads
	Fuel Line Pressure @ Injectors	89 ± 2 psi (613.5 ± 13.8 kPa)
	Air Pressure	79 ± 2 psi (544.0 ± 13.8 kPa)
	High Pressure Electric Fuel Pump Amperage Draw	5 - 9 Amperes
	Low Pressure Electric Fuel Pump Amperage Draw	1 - 2 Amperes
	Low Pressure Electric Fuel Pump Output	6 - 9 psi (41.37 - 62.04 kPa)
	Fuel Injector Ohm Resistance	1.8 ± 0.1 Ω
	Direct Injector Ohm Resistance	1.3 ± 0.3 Ω
	Fuel/Air Differential	10 psi (68.5 kPa)

Model 200/225 DFI		
FUEL SYSTEM	**Fuel** **Recommended Gasoline** **Recommended Oil** **Gasoline/Oil Ratio** **– @ Idle** **– @ WOT** **Fuel Pressure** **Crankcase Pump** **– @ Idle** **– @ WOT**	Gasoline w/Oil Injection Unleaded 87 Octane Minimum Quicksilver TC-W3 Premium Plus 2 Cycle Outboard Oil 300 - 400:1 50:1 Normal – 2-3 psi (13.7 - 20.5 kPa) Minimum – 1 psi (6.8 kPa) Normal – 8-10 psi (41.0 - 54.8 kPa) Maximum – 10 psi (68.5 kPa) Minimum – 4 psi (27.4 kPa)
STARTING SYSTEM	**Model Year 2000** **Starter Draw (Under Load)** **Starter Draw (No Load)** **Minimum Brush Length** **Model Year 2001** **Starter Draw (Under Load)** **Starter Draw (No Load)** **Minimum Brush Length** **Battery Rating**	 210 Amperes 30 Amperes 0.25 in. (65.4 mm) 170 Amperes 60 Amperes 0.25 in. (65.4 mm) 1000 (Minimum) Marine Cranking Amps 750 (Minimum) Cold Cranking Amps 105 (Minimum) Ampere Hours
IGNITION SYSTEM	**Type** **Firing Order** **Model Year 2000** **Spark Plug Type** **Spark Plug Gap** **Model Year 2001** **Spark Plug Type** **Spark Plug Gap** **Maximum Timing** **Idle Timing** **Throttle Position Sensor** **Model Year 2000** **@ Idle** **@ W.O.T** **Model Year 2001** **@ Idle** **@ W.O.T** **Crank Position Sensor** **Air Gap**	Digital Inductive 1-2-3-4-5-6 CHAMPION QC12GMC 0.040 in. (1.0 mm) NGK PZFR5F-11 (heavy duty) 0.043 in. (1.1 mm) Not Adjustable; Controlled by ECM Not Adjustable; Controlled by ECM 4.0 - 4.7 vdc 0.4 - 1.3 vdc 0.4 - 1.3 vdc 4.0 - 4.7 vdc 0.025 in. - 0.040 in. (0.635 mm - 1.01 mm)
CHARGING SYSTEM	**Alternator Output (Regulated)** **Brush Length (Exposed)** **Voltage Output** **Regulator Current Draw**	32 - 38 Amps @ 2000 RPM @ Battery* 52 - 60 Amps @ 2000 RPM @ Alternator Std Length: 0.413 in. (10.5 mm) Min. Length: 0.059 in. (1.5 mm) 13.5 to 15.1 Volts 0.15 mA (Ign. Switch Off) 30.0 mA (Ign. Switch On)

*Amperage listed is when battery is in a discharged state. If battery is fully charged, amperage readings will be less.

♦Electric fuel pump pressure, if used in conjunction with engine mechanical fuel pump, must be limited to no more than 4 psi (27.4 kPa).

Model 200/225 DFI		
Air Compressor	Type Compressor Output	Reciprocating Piston (1 to 1 ratio with engine RPM) @ Idle – 80 psi @ W.O.T. – 110 psi
Cylinder Block	Displacement	7.07 cu. in. (116 cc)
Cylinder Bore	Diameter (Standard) Taper/Out-of-Round/Wear Maximum Bore Type	2.5591 in. (65.0 mm) 0.001 in. (0.025 mm) Cast Iron
Stroke	Length	1.374 in. (34.9 mm)
Piston	Piston Type	Aluminum
Piston Diameter		2.5578 ± .0004 in. (64.97 ± 0.010 mm)
Piston Ring	End Gap Top Ring Middle Ring Bottom Ring	 0.0059 - 0.0098 in. (0.15 - 0.25 mm) 0.0059 - 0.0098 in. (0.15 - 0.25 mm) 0.0039 - 0.014 in. (0.10 - 0.35 mm)
Reeds	Reed Stand Open	0.010 in. (0.25 mm)

Propeller Information Charts

Optimax 200

- Wide Open Throttle RPM: 5000-5750
- Gear Reduction: 1.75:1

Diameter	Pitch	No. of Blades	Model	Gross Boat Wgt. (lbs)	Boat Length	Speed (mph)	RH Propeller Part Number	LH Propeller Part Number
14.62″	27	3	Tempest+	Up to 2300	Up to 19′	67-80	48-825868A47	
13.75″	26	4	Trophy+	Up to 2400	Up to 20′	65-77	48-825944A47	
14.62″	26	3	Tempest+	Up to 2400	Up to 20′	65-77	48-825874A47	
13.75″	25	3	Laser II	2100 – 2600	18 – 21′	62-73	48-16550A46	48-16549A46
13.75″	25	4	Trophy+	2100 – 2600	18 – 21′	62-73	48-825942A47	
14.62″	25	3	Tempest+	2100 – 2600	18 – 21′	62-73	48-825866A47	
13.25″	25	5	Hi-Five	2100 – 2600	18 – 21′	62-73	48-816374A46	
13.38″	25	3	Aluminum	2100 – 2600	18 – 21′	62-73	48-78126A45	
13.75″	24	4	Trophy+	2200 – 2700	19 – 21′	60-70	48-825940A47	
14.62″	24	3	Tempest+	2200 – 2700	19 – 21′	60-70	48-825872A47	
13.75″	23	3	Laser II	2300 – 2900	19 – 22′	57-67	48-16548A46	48-16547A46
13.75″	23	4	Trophy+	2300 – 2900	19 – 22′	57-67	48-825938A47	
14.62″	23	3	Tempest+	2300 – 2900	19 – 22′	57-67	48-825864A47	
14.63″	23	3	Mirage+	2300 – 2900	19 – 22′	57-67	48-13704A46	48-13705A46
13.25″	23	5	Hi-Five	2300 – 2900	19 – 22′	57-67	48-815762A46	
13.5″	23	3	Vengeance	2300 – 2900	19 – 22′	57-67	48-16320A46	48-16321A46
14″	23	3	Aluminum	2300 – 2900	19 – 22′	57-67	48-832834A45	
13.88″	21	3	Laser II	2600 – 3100	19 – 23′	52-61	48-16546A46	48-16319A46
13.75″	21	4	Trophy+	2600 – 3100	19 – 23′	52-61	48-825934A47	
14.62″	21	3	Tempest+	2600 – 3100	19 – 23′	52-61	48-825862A47	
14.75″	21	3	Mirage+	2600 – 3100	19 – 23′	52-61	48-13702A46	48-13703A46
13.25″	21	5	Hi-Five	2600 – 3100	19 – 23′	52-61	48-815760A46	
13.75″	21	3	Vengeance	2600 – 3100	19 – 23′	52-61	48-16318A46	48-16319A46
14.25″	21	3	Aluminum	2600 – 3100	19 – 23′	52-61	48-832832A45	
14″	19	3	Laser II	2900 – 3600	20 – 24′	46-55	48-16544A46	48-16543A46
14.62″	19	3	Tempest+	2900 – 3600	20 – 24′	46-55	48-825860A47	
15.25″	19	3	Mirage +	2900 – 3600	20 – 24′	46-55	48-13700A46	48-13701A46
13.25″	19	5	Hi-Five	2900 – 3600	20 – 24′	46-55	48-815758A46	
14″	19	3	Vengeance	2900 – 3600	20 – 24′	46-55	48-16316A46	48-16317A46
14.5″	19	3	Aluminum	2900 – 3600	20 – 24′	46-55	48-832830A45	
15.5″	17	3	Mirage +	3300 – 4300	21 – 25′	39-49	48-18278A46	48-90159A46
13.5″	17	5	Hi-Five	3300 – 4300	21 – 25′	39-49	48-821154A46	
14.5″	17	3	Vengeance	3300 – 4300	21 – 25′	39-49	48-16314A46	48-16315A46
15″	17	3	Aluminum	3300 – 4300	21 – 25′	39-49	48-832828A45	
16″	16	3	Aluminum	3600 – 4700	22 – 26	36-46	48-16440A45	
15.75″	15	3	Mirage +	3900 – 5400	23 – 26′	32-43	48-19838A46	48-19841A46
14.5″	15	3	Vengeance	3900 – 5400	23 – 26′	32-43	48-16312A46	
15.25″	15	3	Aluminum	3900 – 5400	23 – 26′	32-43	48-78116A45	
16″	14	3	Aluminum	4300 – 6000	24 – 27′	29-39	48-16438A45	

Optimax 200 continued

- Wide Open Throttle RPM: 5000-5750
- Gear Reduction: 1.75:1

16″	13	3	Mirage +	5000 +	25 – 30′	25-36	48-826072A46	
16″	13	3	Aluminum	5000+	Pontoon	25-36	48-78114A45	
16″	12	3	Aluminum	7000+	Pontoon/Work	21-33	48-16436A45	
16″	11	3	Aluminum	8500 +	House/Work	1-29	48-78112A45	

Optimax 225

- Wide Open Throttle RPM: 5000-5750
- Gear Reduction: 1.75:1

Diameter	Pitch	No. of Blades	Model	Gross Boat Wgt. (lbs)	Boat Length	Speed (mph)	RH Propeller Part Number	LH Propeller Part Number
14.62″	27	3	Tempest+	Up to 2600	Up to 20′	67-80	48-825868A47	
13.75″	26	4	Trophy+	Up to 2700	Up to 21′	65-77	48-825944A47	
14.62″	26	3	Tempest+	Up to 2700	Up to 21′	65-77	48-825874A47	
13.75″	25	3	Laser II	2400 – 2900	19 – 22′	62-73	48-16550A46	48-16549A46
13.75″	25	4	Trophy+	2400 – 2900	19 – 22′	62-73	48-825942A47	
14.62″	25	3	Tempest+	2400 – 2900	19 – 22′	62-73	48-825866A47	
13.25″	25	5	Hi-Five	2400 – 2900	19 – 22′	62-73	48-816374A46	
13.38″	25	3	Aluminum	2400 – 2900	19 – 22′	62-73	48-78126A45	
13.75″	24	4	Trophy+	2500 – 3000	20 – 23′	60-70	48-825940A47	
14.62″	24	3	Tempest+	2500 – 3000	20 – 23′	60-70	48-825872A47	
13.75″	23	3	Laser II	2600 – 3200	20 – 23′	57-67	48-16548A46	48-16547A46
13.75″	23	4	Trophy+	2600 – 3200	20 – 23′	57-67	48-825938A47	
14.62″	23	3	Tempest+	2600 – 3200	20 – 23′	57-67	48-825864A47	
14.63″	23	3	Mirage+	2600 – 3200	20 – 23′	57-67	48-13704A46	48-13705A46
13.25″	23	5	Hi-Five	2600 – 3200	20 – 23′	57-67	48-815762A46	
13.5″	23	3	Vengeance	2600 – 3200	20 – 23′	57-67	48-16320A46	48-16321A46
14″	23	3	Aluminum	2600 – 3200	20 – 23′	57-67	48-832834A45	
13.88″	21	3	Laser II	2900 – 3500	21 – 24′	52-61	48-16546A46	48-16319A46
13.75″	21	4	Trophy+	2900 – 3500	21 – 24′	52-61	48-825934A47	
14.62″	21	3	Tempest+	2900 – 3500	21 – 24′	52-61	48-825862A47	
14.75″	21	3	Mirage+	2900 – 3500	21 – 24′	52-61	48-13702A46	48-13703A46
13.25″	21	5	Hi-Five	2900 – 3500	21 – 24′	52-61	48-815760A46	
13.75″	21	3	Vengeance	2900 – 3500	21 – 24′	52-61	48-16318A46	48-16319A46
14.25″	21	3	Aluminum	2900 – 3500	21 – 24′	52-61	48-832832A45	
14″	19	3	Laser II	3300 – 4000	21 – 25′	46-55	48-16544A46	48-16543A46
14.62″	19	3	Tempest+	3300 – 4000	21 – 25′	46-55	48-825860A47	
15.25″	19	3	Mirage +	3300 – 4000	21 – 25′	46-55	48-13700A46	48-13701A46
13.25″	19	5	Hi-Five	3300 – 4000	21 – 25′	46-55	48-815758A46	
14″	19	3	Vengeance	3300 – 4000	21 – 25′	46-55	48-16316A46	48-16317A46
14.5″	19	3	Aluminum	3300 – 4000	21 – 25′	46-55	48-832830A45	
15.5″	17	3	Mirage +	3700 – 4800	22 – 26′	39-49	48-18278A46	48-90159A46
13.5″	17	5	Hi-Five	3700 – 4800	22 – 26′	39-49	48-821154A46	
14.5″	17	3	Vengeance	3700 – 4800	22 – 26′	39-49	48-16314A46	48-16315A46
15″	17	3	Aluminum	3700 – 4800	22 – 26′	39-49	48-832828A45	

Optimax 225 continued

- Wide Open Throttle RPM: 5000-5750
- Gear Reduction: 1.75:1

16″	16	3	Aluminum	4000 – 5300	23 – 26	36-46	48-16440A45	
15.75″	15	3	Mirage +	4300 – 6100	23 – 27′	32-43	48-19838A46	48-19841A46
14.5″	15	3	Vengeance	4300 – 6100	23 – 27′	32-43	48-16312A46	
15.25″	15	3	Aluminum	4300 – 6100	23 – 27′	32-43	48-78116A45	
16″	14	3	Aluminum	4800 – 6800	24 – 29′	29-39	48-16438A45	
16″	13	3	Mirage +	6000 +	25 – 30′	25-36	48-826072A46	
16″	13	3	Aluminum	6000+	Pontoon	25-36	48-78114A45	
16″	12	3	Aluminum	8000+	Pontoon/Work	21-33	48-16436A45	
16″	11	3	Aluminum	9500 +	House/Work	1-29	48-78112A45	

1 B

IMPORTANT INFORMATION

Section 1B - Maintenance

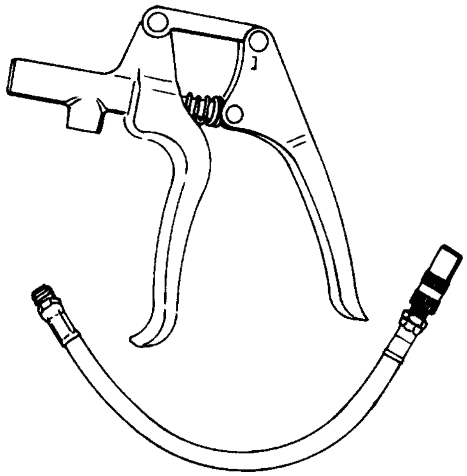
Table of Contents

Specifications

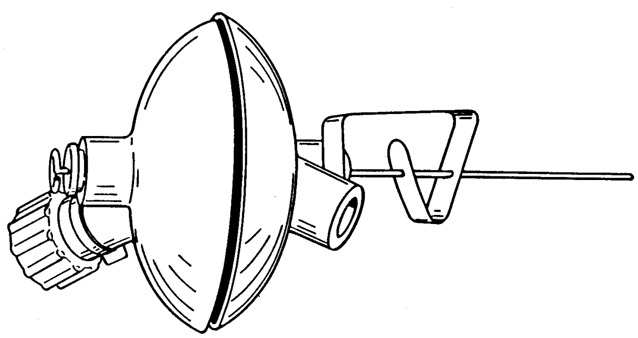
FUEL SYSTEM	**Fuel** **Recommended Gasoline** **Recommended Oil**	Gasoline w/Oil Injection Unleaded 87 Octane Minimum Quicksilver TC-W3 Premium Plus 2 Cycle Outboard Oil
IGNITION SYSTEM	**Model Year 2000** **Spark Plug Type** **Spark Plug Gap** **Model Year 2001** **Spark Plug Type** **Spark Plug Gap**	 Champion QC12GMC 0.040 in. (1.0 mm) NGK PZFR5F-11 0.040 in. (1.0 mm)
STARTING SYSTEM	**Battery Rating**	1000 (Minimum) Marine Cranking Amps 750 (Minimum) Cold Cranking Amps 105 (Minimum) Ampere Hours
GEAR HOUSING	**Gearcase Capacity** **Water Pressure @ RPM**	27.0 fl. oz. (798.0 ml) 8-10 psi minimum @ 5000 RPM

Special Tools

1. Grease Gun 91-37299A1

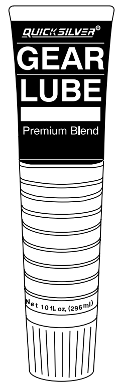


2. Flushing Attachment 44357A2

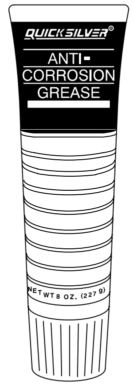


Quicksilver Lubricant/Sealant

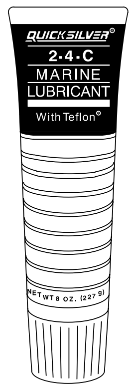
1. Gear Lubricant - Premium Blend 92-850737A1



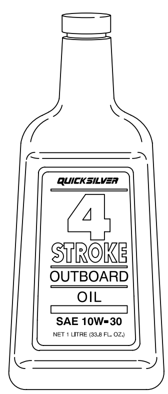
2. Anti-Corrosion Grease 92-850735A1



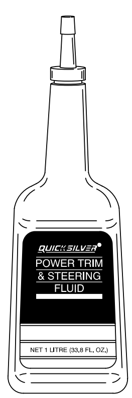
3. 2-4-C Marine Lubricant with Teflon 92-850736A1



4. SAE 30W Motor Oil (Obtain Locally)



5. Quicksilver Power Trim and Steering Fluid 91-90100A12



Inspection and Maintenance Schedule

Before Each Use

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

After Each Use

1. Flush out the outboard cooling system if operating in salt or polluted water.
2. Wash off all salt deposits and flush out the exhaust outlet of the propeller and gear case with fresh water if operating in salt 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. Inspect and clean spark plugs.
3. Replace water separating fuel filter.
4. Replace compressor air intake filter.
5. Check corrosion control anodes. Check more frequently when used in salt water.
6. Drain and replace gear case lubricant.
7. Lubricate splines on the drive shaft and shift shaft.∗
8. Check power trim fluid.
9. Inspect battery.
10. Check control cable adjustments.∗
11. Check tightness of bolts, nuts, and other fasteners.

Every 300 Hours of Use or Every Three Years, Whichever Occurs First

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

∗ *These items should be serviced by an authorized dealer.*

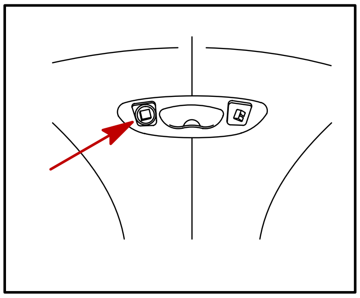
Flushing Engine

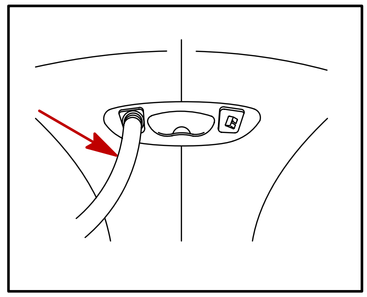
Flushing Cooling System – Using Cowl Flush Plug

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.

NOTE: *Engine can be stopped or running at idle speed when flushing the cooling system. Do not flush engine using a water system that exceeds 45 psi.*

1. Remove the plug from fitting in the bottom cowl.





2. Attach a water hose to the fitting. Turn water on and flush for 3 to 5 minutes.

Flushing Cooling System – Using Flushing Attachment 44357A2

⚠ WARNING

When flushing, verify that area in vicinity of propeller is clear and that no person is standing nearby – to avoid possible injury. It is recommended to remove propeller as a precautionary measure.

IMPORTANT: Front/nose water inlets must be taped closed when running engine on flush to prevent possible overheating.

1. Install Quicksilver Flushing Attachment 44357A2 (or equivalent tool) on the gear housing from the FRONT side, positioning the rubber cups over the water intake openings.
2. Connect hose [1/2 in.(12.7mm) I.D. or larger] between flushing attachment and water tap.

IMPORTANT: To prevent water pump damage, do not start or run engine unless cooling water is flowing.

3. With the outboard in the normal operating position (vertical), partially open water tap (IT IS NOT NECESSARY to use full water pressure) and adjust water flow so that there is a significant water loss around the rubber cups.
4. Start engine and idle in NEUTRAL. Increase engine speed, not to exceed 2500 RPM.
5. Flush or service engine as required. Verify adequate cooling water is provided.
   a. Water must be discharged thru “tell tale.”

IMPORTANT: Prevent engine overheating. If water flow is insufficient, stop engine and determine cause before continuing.

   b. Flush until discharge water is clear. In salt-water areas, run outboard 3 to 5 minutes.
   c. Stop engine before turning off water.
6. Stop engine, turn water off and remove flushing attachment from gear housing.

IMPORTANT: While and after flushing, keep outboard in upright position until all water has drained from drive shaft housing to prevent water from entering the powerhead via drive shaft housing and exhaust ports.

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 sign of fuel leakage.

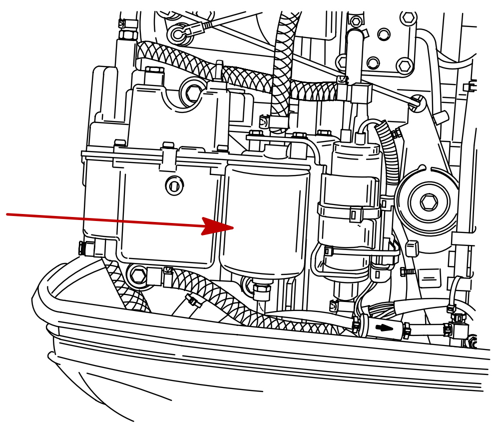
Fuel Line Inspection

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 is found, the fuel line or primer bulb must be replaced.

Water Separating Fuel Filter

NOTE: *The warning system will turn on when water in the fuel filter reaches the full level.*

1. This filter removes moisture and also debris from the fuel. If the filter becomes filled with water, the water can be removed. If the filter becomes plugged with debris, the filter must be replaced with a new filter.



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Remove and replace filter as follows:

a. Turn ignition key switch to OFF position.

b. Disconnect wire at bottom of filter.

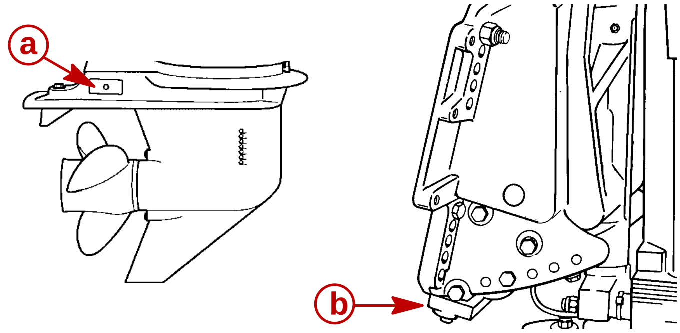
c. Remove filter by turning the filter in the direction of the arrow (clockwise). Tip the filter to drain fluid in a suitable container.

d. Lubricate the sealing ring on the filter with oil. Thread on the filter and tighten securely by hand. Reconnect the wire to the filter.

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

Corrosion Control Anode

The gear case has two corrosion control anodes (a). Another anode (b) is installed on the bottom of the transom bracket assembly. An anode helps protect the outboard against galvanic corrosion by sacrificing its metal to be slowly eroded instead of the outboard metals.

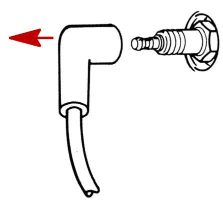


Each anode requires periodic inspection especially in salt water which will accelerate the erosion. To maintain this corrosion protection, always replace the anode before it is completely eroded. Never paint or apply a protective coating on the anode as this will reduce effectiveness of the anode.

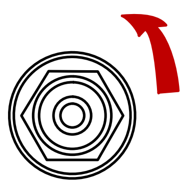
Spark Plug Inspection

Inspect spark plugs at the recommended intervals.

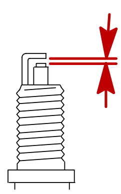
1. Remove the spark plug leads by twisting the rubber boots slightly and pull off. Inspect spark plug boots and replace if cracked.



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 in General Information Section.



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 20 lb. ft. (27 N·m).

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.

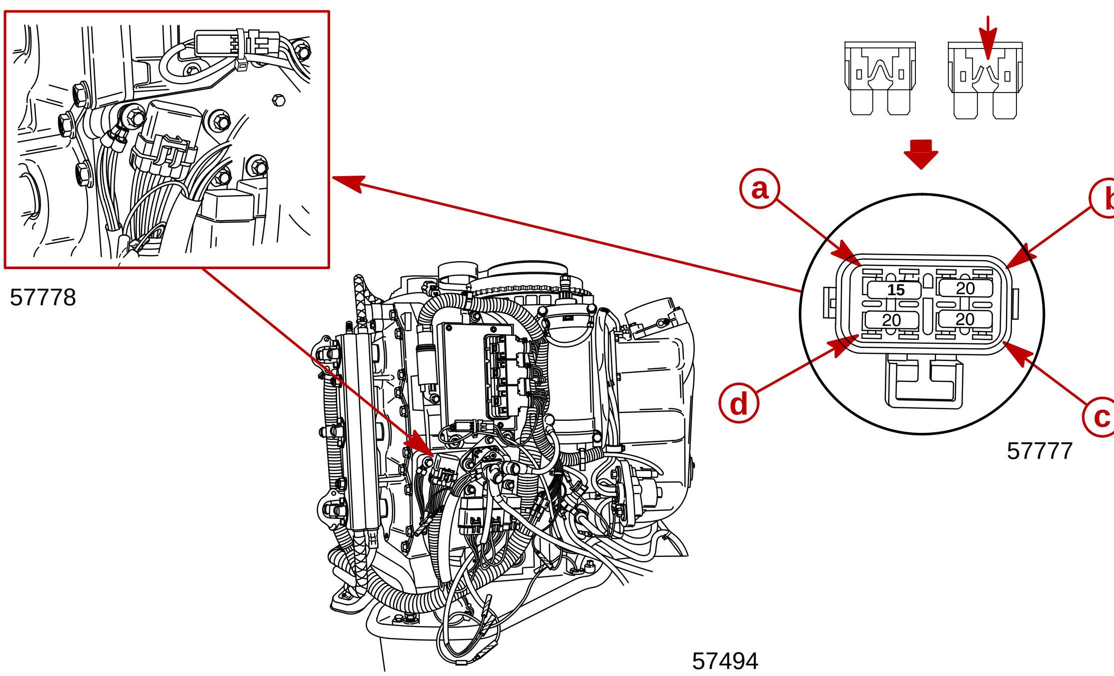
1. Turn off the engine before servicing the battery.
2. Add water as necessary to keep the battery full.
3. Make sure the battery is secure against movement.
4. Battery cable terminals should be clean, tight, and correctly installed. Positive to positive and negative to negative.
5. Make sure the battery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

Fuse Replacement

IMPORTANT: Always carry spare SFE 15 and SFE 20 AMP fuses.

The electrical wiring circuits on the outboard are protected from overload by fuses in the wiring. If a 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 rating.
2. The fuses and circuits are identified as follows:
   a. Smart Craft Data Bus Circuit – SFE 15 AMP Fuse.
   b. Accessories – SFE 20 AMP Fuse.
   c. Ignition Coil Circuit – SFE 20 AMP Fuse.
   d. Electric Fuel Pump/ECM Driver Power/Oil Pump Circuit – SFE 20 AMP Fuse.



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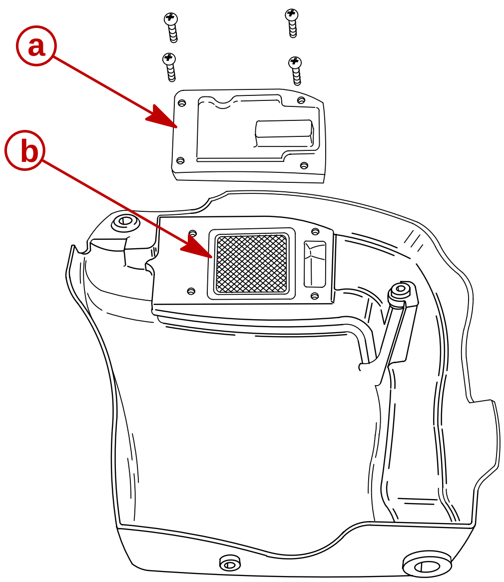
Compressor Air intake Filter

The filter should be changed every 100 hours of operation, or once a season. **Never run the engine without the air filter.**

Removal

1. Remove flywheel cover (a) from the engine. Remove cover and filter.



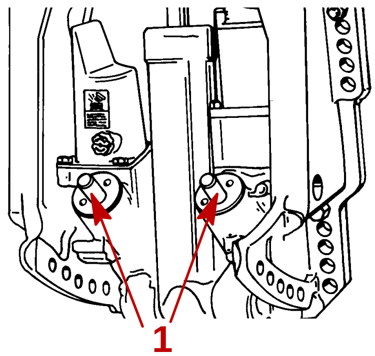
Installation

Install filter (b) into the cover. Fasten cover with 4 screws. Apply Loctite 271 to screw threads.

Lubrication Points

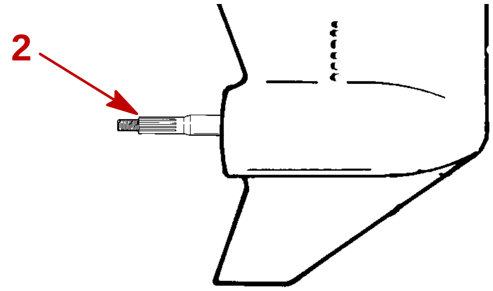
Lubricate Point 1 with Quicksilver Special Lubricant 101.

1. Trim Rod Ball Ends – Turn the ball ends to work the lubricant into the ball sockets.



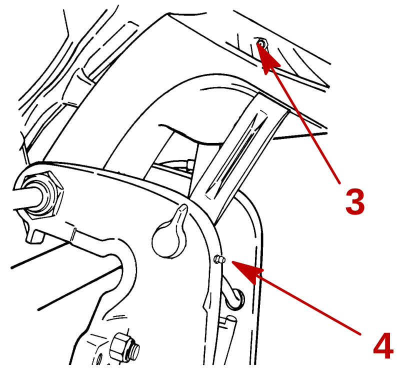
Lubricate Point 2 with Quicksilver Anti-Corrosion Grease or 2-4-C Marine Lubricant with Teflon.

2. 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.

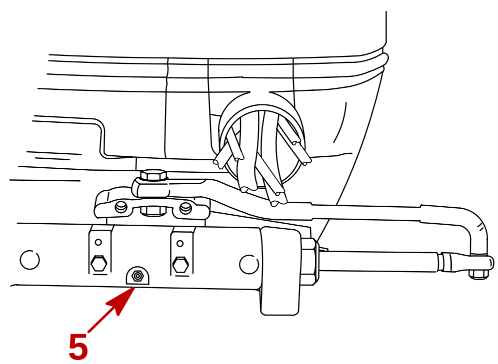


Lubricate Points 3 thru 6 with Quicksilver 2-4-C Marine Lubricant with Teflon or Special Lubricate 101.

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



5. Tilt Tube – Lubricate through fitting.



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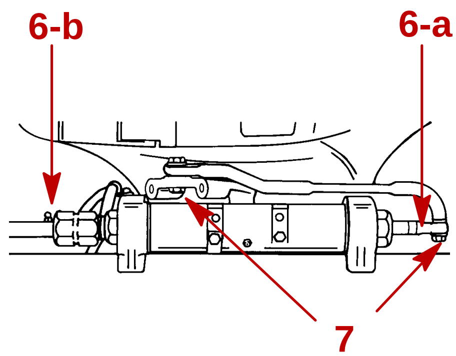
6. Steering Cable Grease Fitting (If Equipped) – Rotate steering wheel to fully retract the steering cable end (a) into the outboard tilt tube. Lubricate through fitting (b).

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.

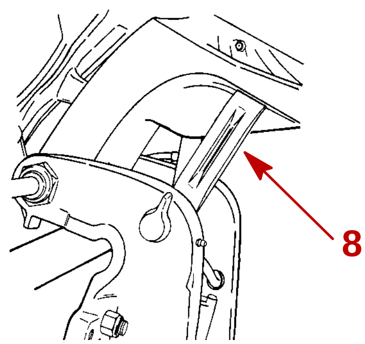
Lubricate Points 7 With Light Weight Oil.

7. Steering Link Rod Pivot Points – Lubricate pivot points.

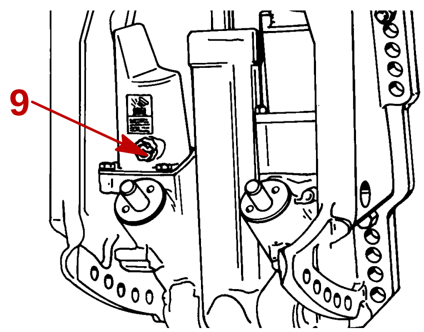


Checking Power Trim Fluid

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



9. 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.



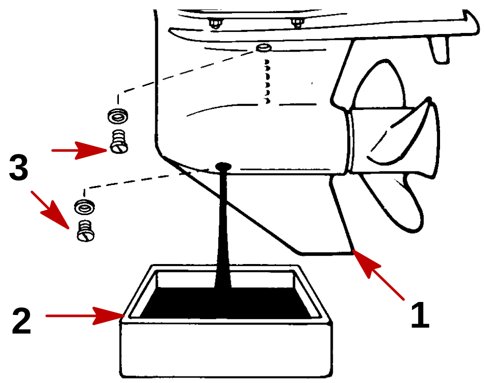
Gear Case Lubrication

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.

DRAINING GEAR CASE

NOTE: *Some models may have the vent and fill/drain plugs on the opposite side.*

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



GEAR CASE LUBRICANT CAPACITY

Gear case lubricant capacity is approximately 27 fl. oz. (798.0 ml).

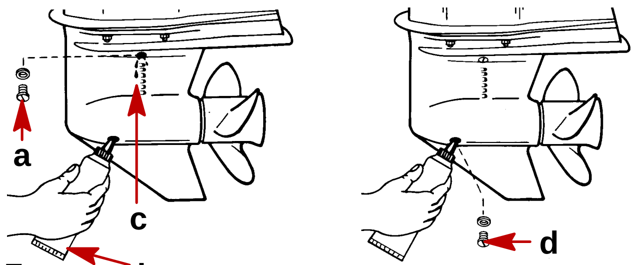
CHECKING GEAR CASE LUBRICANT LEVEL AND REFILLING GEAR CASE

***NOTE:** Some models may have the vent and fill/drain plugs on the opposite side.*

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).



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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 all the cooling water intake holes 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 system (tank, hoses, fuel pumps, and fuel injection systems) 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. Place the outboard in water or connect flushing attachment for circulating cooling water. Run the engine at 2000 rpm for 25 minutes to allow treated fuel to fill the fuel system.

PROTECTING INTERNAL ENGINE COMPONENTS

NOTE: *Make sure the fuel system has been prepared for storage.*

1. Remove the spark plugs and add approximately one ounce (30ml) of engine oil into each spark plug hole. Rotate the flywheel manually several times to distribute the oil in the cylinders. Reinstall spark plugs.
2. Remove the water separating fuel filter and empty contents into a suitable container. Refer to Maintenance Section for removal and installation of filter. Replace fuel filter annually, or every 100 Hours of operation, or if large amount of fuel contamination is present.

PROTECTING EXTERNAL OUTBOARD COMPONENTS

1. Lubricate all outboard components listed in the Inspection and Maintenance Schedule.
2. Touch up any paint nicks. See your dealer for touch-up paint.
3. Spray Quicksilver Corrosion Guard on external metal surfaces (except corrosion control anodes).

GEAR CASE

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 manufacturers 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.

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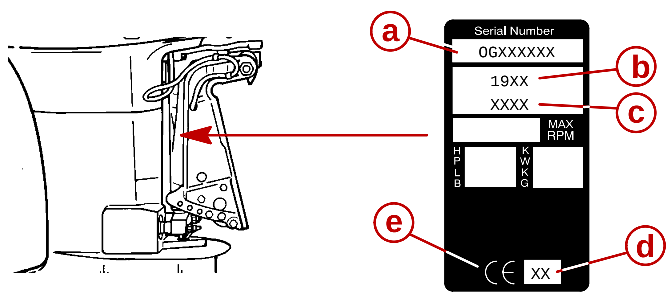
IMPORTANT INFORMATION

Section 1C - General Information

Table of Contents

Serial Number Location

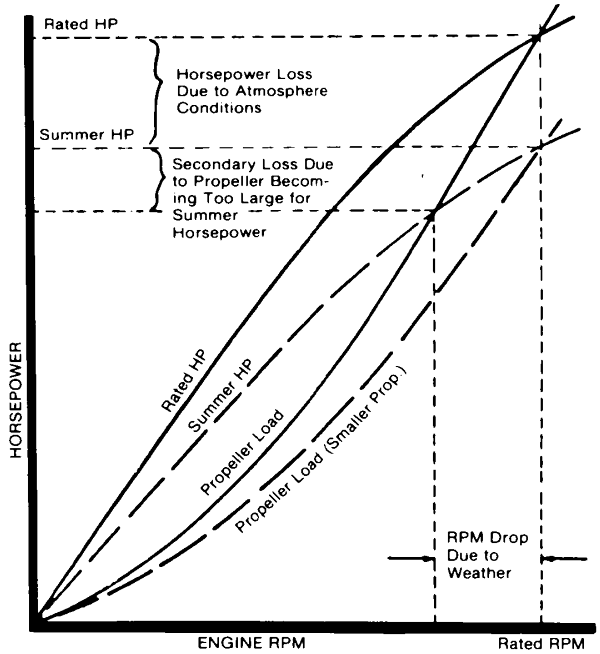
The engine serial number is located on the top of the engine block. A serial number is also located on the starboard side of the swivel bracket.



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

Conditions Affecting Performance

Weather



Weather conditions exert a profound effect on power output of internal combustion engines. 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, correcting all values to the power that the engine will produce at sea level, at 30% relative humidity at 77° F (25°C) temperature 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 engine power. This is reflected in decreased boat speeds – as much as 2 or 3 mph. Nothing will regain this speed for the boater but the coming of cool, dry weather.

In pointing out the consequences of weather effects, an engine – running on a hot, humid summer day – may loose 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 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 run 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 can be regained by switching to a smaller pitch propeller that allows the engine to run again at recommended RPM.

To obtain optimum engine performance under changing weather conditions, the engine MUST be propped 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.

This will allow the engine to develop full power while operating in an RPM range that discourages damaging detonation.

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)
      (1.) Improves ease of planing off.
      (2.) Generally improves rough water ride.
      (3.) If excessive, can make the boat veer back-and-forth (bow steer).

BOTTOM

1. **Boat 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.
   a. **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.
   b. **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.
   c. **Surface Roughness:** Moss, barnacles, etc., on boat or corrosion of motor's gear housing increase skin friction and cause speed loss. Clean surfaces when necessary.
   d. **Gear Housing:** If unit is left in the water, marine vegetation may accumulate over a period of time. This growth MUST be removed from unit before operation, as it may clog the water inlet holes in the gear housing and cause the engine to overheat.

Trim

TRIMMING OUTBOARD "OUT" ("UP")

WARNING

Excessive trim "out" also may reduce the stability of some high speed hulls. To correct instability at high speed, reduce the power GRADUALLY and trim the outboard "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.)

1. Will lift bow of boat, generally increasing top speed.
2. Transfers steering torque harder to left on single outboard installations below 23 in. (584mm) transom height.
3. Increases clearance over submerged objects.
4. In excess, can cause porpoising and/or ventilation.
5. If trimmed out beyond the water pickup, reduced water supply can cause overheating resulting in engine damage.

TRIMMING OUTBOARD "IN" ("DOWN") CHARACTERISTICS

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 angle (trim adjustment bolt relocation.)

1. Will help planing off, particularly with a heavy load.
2. Usually improves ride in choppy water.
3. In excess, can cause boat to veer to the left or right (bow steer).
4. Transfers steering torque harder to right (or less to the left) on single outboard installations.
5. Improves planing speed acceleration (by moving trim adjustment bolt one hole closer to transom).

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 or from an irregularity in the propeller blade itself. 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.

VENTILATION

Ventilation occurs when air is drawn from the water's surface (excessive trim out angle) or from the engine exhaust flow (wrong propeller/propeller hardware installed or gear case labyrinth seal worn) into the propeller blades. These air bubbles strike the propeller blade surface and cause erosion of the blade surface. If allowed to continue, eventual blade failure (breakage) will occur.

Engine

DETONATION

Detonation in a 2-cycle engine resembles the “pinging” heard in an automobile engine. It can be otherwise described as a tin-like “rattling” or “plinking” sound.

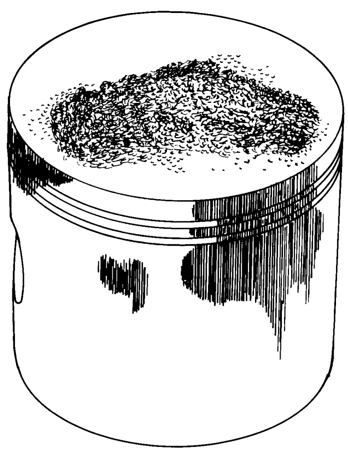
Detonation is an explosion of an unburned portion of the fuel/air charge after the spark plug has fired. Detonation creates severe shock waves in the engine, and these shock waves often find or create a weakness: The dome of a piston, cylinder head/gasket, piston rings or piston ring lands, piston pin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

A few of the most common causes of detonation in a marine 2-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).

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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Engine Compression

Engine compression should be checked with engine block warm, throttle shutter wide open, all spark plugs removed and using a fully charged battery. Normal compression for all cylinders should be 110 to 130 psi (758.5 to 896.4 kPa). Cylinders should not vary more than 15 psi (103.4 kPa) between one another. A variance of more than 15 psi would indicate the need for a power head inspection/disassembly.

Following Complete Submersion

Salt Water Submersion

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.

Submerged While Running

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.

SUBMERGED ENGINE (FRESH WATER)

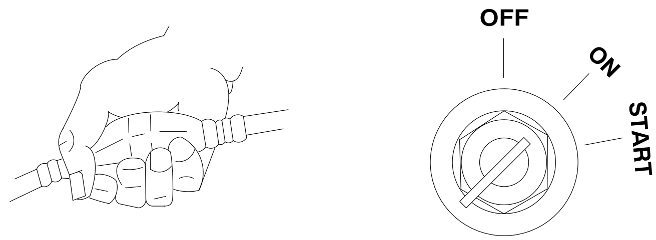
IMPORTANT: Engine should be run within 2 hours after recovery, or serious internal damage may occur. If unable to start engine in this period, disassemble engine and clean all parts. Apply oil as soon as possible.

NOTE: *If sand has entered the air intake on the engine, do not attempt to the start the engine. Sand will cause internal engine damage. disassembly is required to clean all internal engine components of sand.*

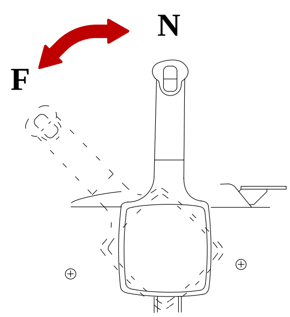
1. Recover engine from water as quickly as possible.
2. Remove cowling.
3. Clean the exterior of the outboard with fresh water.
4. Dry all wiring and electrical components using compressed air.
5. Drain water from fuel system as follows:
    a. Disconnect remote fuel hose from engine.
    b. Remove drain plug from vapor separator and drain fuel/water. Reinstall plug after draining.
    c. Remove the fuel hose from bottom of port side fuel rail and drain fuel/water. Reinstall hose.
    d. Remove the water separating fuel filter and empty contents.
6. Drain water from air compressor system as follows:
    a. Dry or replace the air filter for the compressor.
    b. Remove air outlet hose for the air compressor and drain water from compressor and hose. Reinstall hose.
    c. Remove the air hose from bottom of port side fuel rail and drain water. Reinstall hose.
7. Drain water from engine as follows:
    a. Tilt up the outboard and and allow water to drain from crankcase area into air plenum. Draw water out of air plenum through throttle plate opening using a suitable hose or pump.
    b. Remove spark plugs from engine.
    c. Rotate flywheel manually to blow out any water from the cylinders.

   d. Add approximately one ounce (30ml) of engine oil into each spark plug hole. Rotate the flywheel manually several times to distribute the oil in the cylinders. Reinstall spark plugs.

8. Drain water from the oil injection system as follows:
   a. Remove remote oil hose (black without blue stripe) from pulse fitting on starboard side of engine.
   b. Drain any water from hose and reconnect.
   c. If water was present in hose, check for water in the remote oil tank. Drain tank if water is present.
9. Disassemble the engine starter motor and dry components.
10. Prime the oil injection pump as follows:
    a. Fill the engine fuel system with fuel. Connect fuel hose and squeeze primer bulb until it fells firm.
    b. Turn the ignition key switch to the "ON" position.



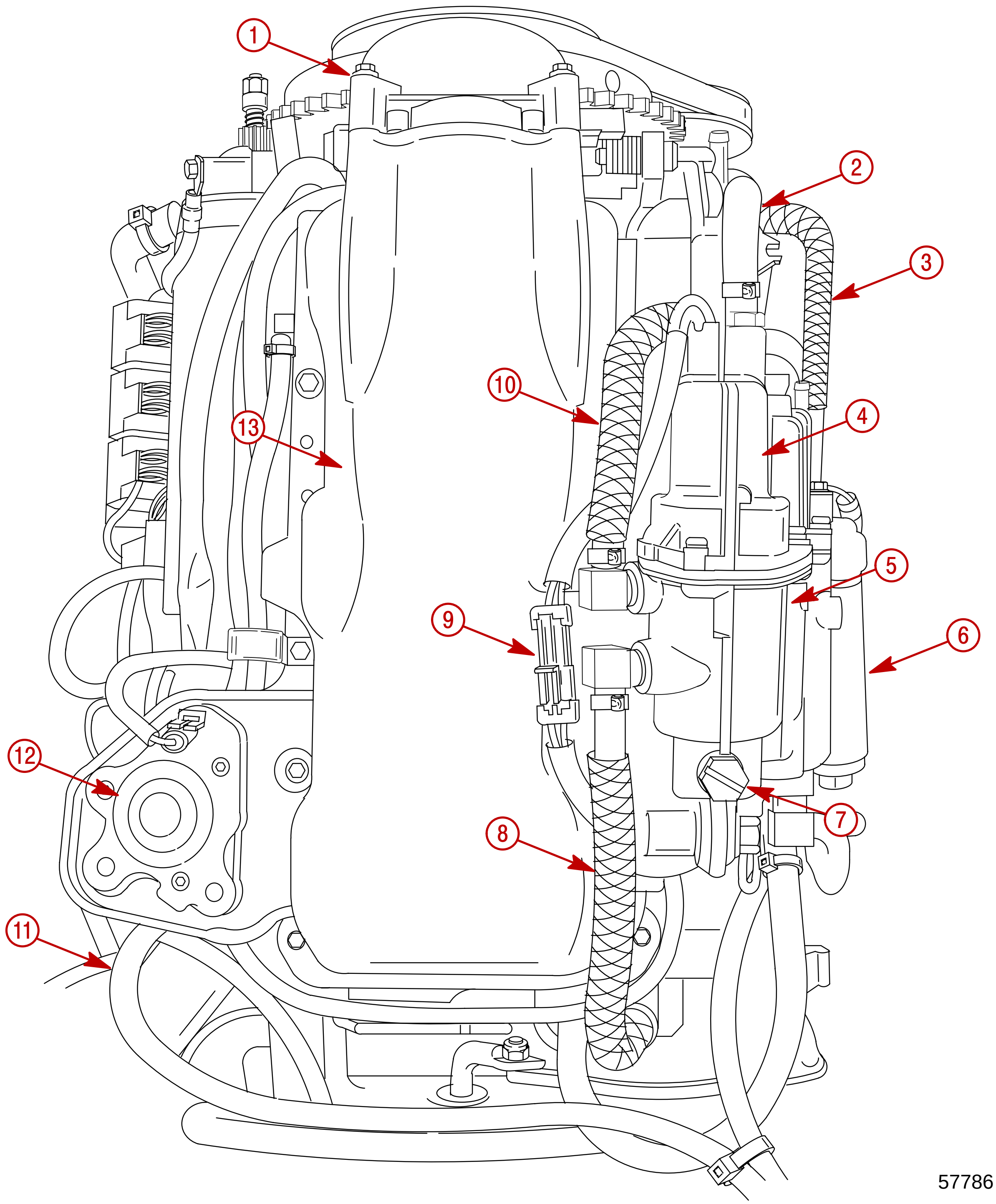
    c. Within the first 10 seconds after the key switch has been turned on, move the remote control handle from neutral into forward gear 3 to 5 times. This will automatically start the priming process.



NOTE: *Audible click from the oil pump will tell you the pump is priming. It may take a few minutes for the pump to complete the priming process.*

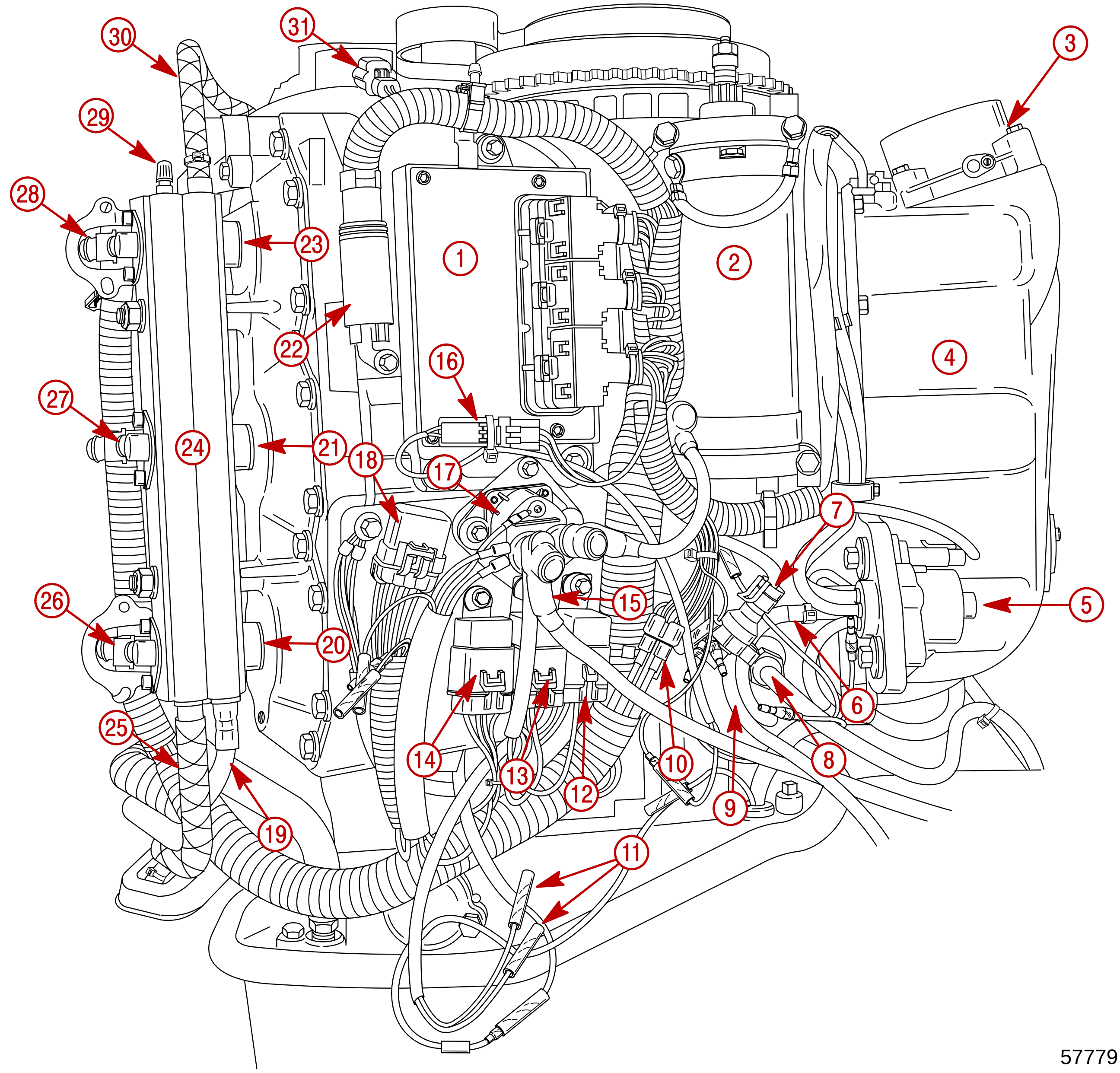
11. Attempt to start engine, using a fresh fuel source.If engine starts, it should be run for at least one hour to eliminate any water in engine.
12. If engine fails to start, determine cause (fuel, electrical or mechanical).

Model Year 2000 200/225 DFI Powerhead Front View



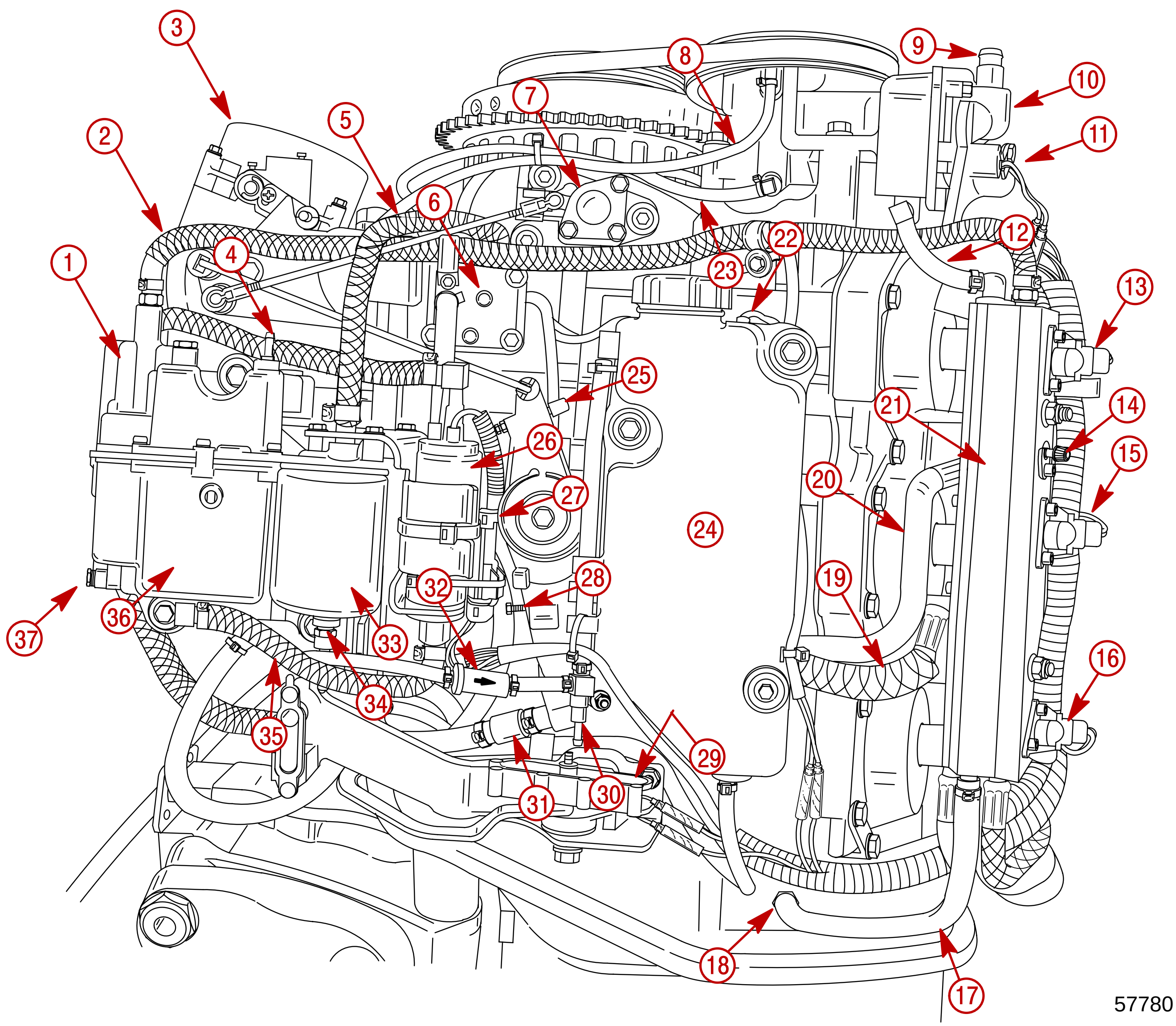
1 - Throttle Plate Assembly
2 - Fuel Hose Out to Fuel Rails (High Pressure)
3 - Fuel Inlet to Fuel/Water Separator
4 - High Pressure Electric Fuel Pump (Inside Vapor Separator)
5 - Vapor Separator
6 - Fuel/Water Separator
7 - Vapor Separator Drain Plug
8 - Fuel Return Hose from Fuel Rail
9 - Fuel Pump Electrical Connector (High Pressure Pump)
10 - Fuel Hose Outlet from Low Pressure Electric Fuel Pump to Vapor Separator
11 - Remote Oil Tank Pressure Hose
12 - Electric Oil Pump
13 - Air Plenum

Model Year 2000 200/225 DFI Powerhead Starboard View



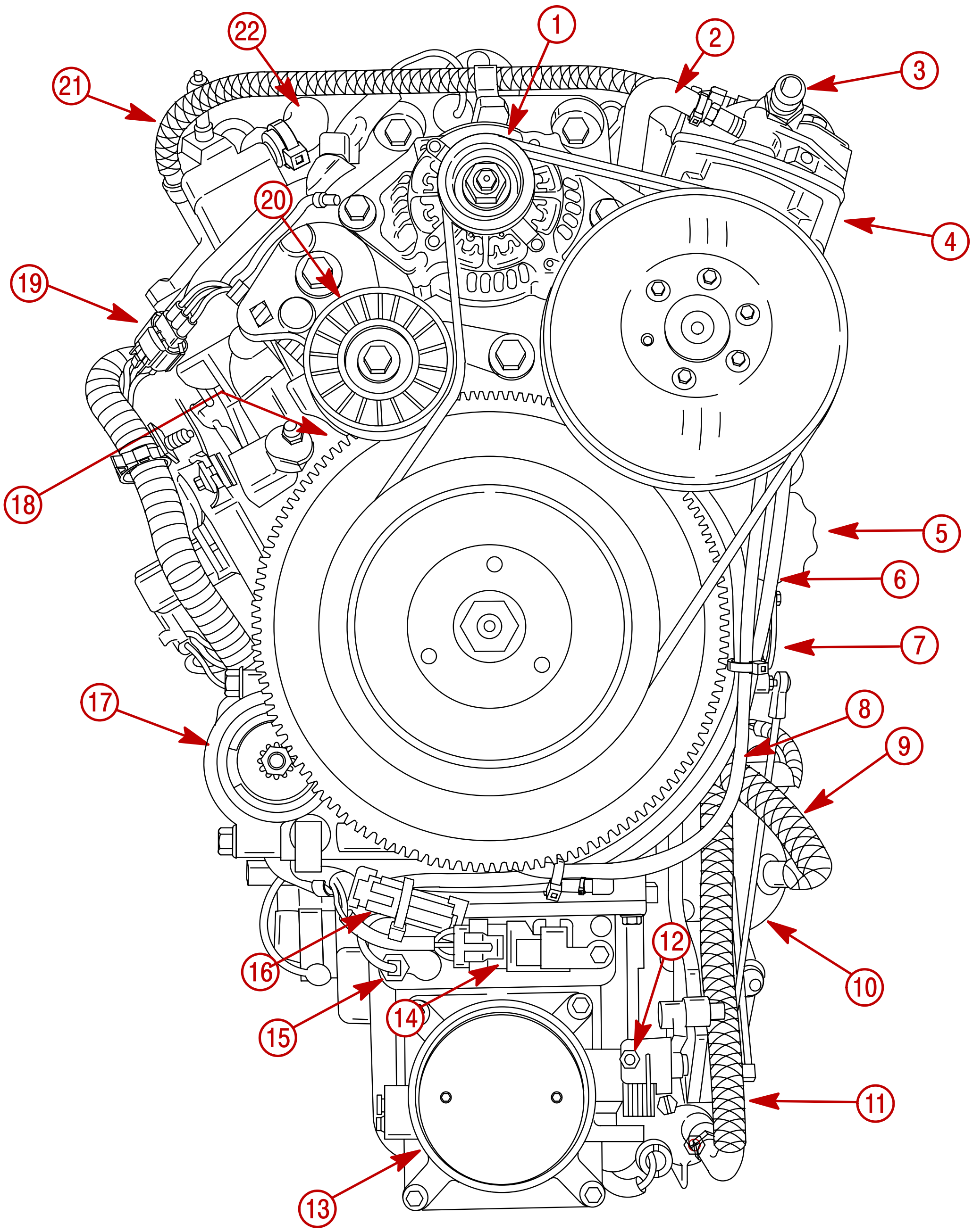
1 - Electronic Control Module
2 - Starter Motor
3 - Throttle Body Assembly
4 - Air Plenum
5 - Oil Pump
6 - Oil Hose from Oil Reservoir to Oil Pump
7 - Digital Speedometer Pressure Sensor
8 - Remote Oil Tank Pressure Hose
9 - Negative Battery Cable
10 - Digital Instrument Connectors
11 - Trim Motor Connectors
12 - Main Power Relay
13 - Trim DOWN Relay
14 - Trim UP Relay
15 - Positive Battery Cable
16 - Digital Diagnostic Terminal Connector
17 - Starter Solenoid
18 - 20 Ampere Fuses (4)
19 - 80 psi Air Hose
20 - #5 Direct Injector
21 - #3 Direct Injector
22 - Engine Harness Connector
23 - #1 Direct Injector
24 - Starboard Fuel Rail
25 - High Pressure (90 psi) Fuel Hose
26 - #5 Fuel Injector
27 - #3 Fuel Injector
28 - #1 Fuel Injector
29 - Fuel Pressure Port (90 psi)
30 - 80 psi Air Hose from Air Compressor
31 - Crank Position Sensor Connector

Model Year 2000 200/225 DFI Powerhead Port View



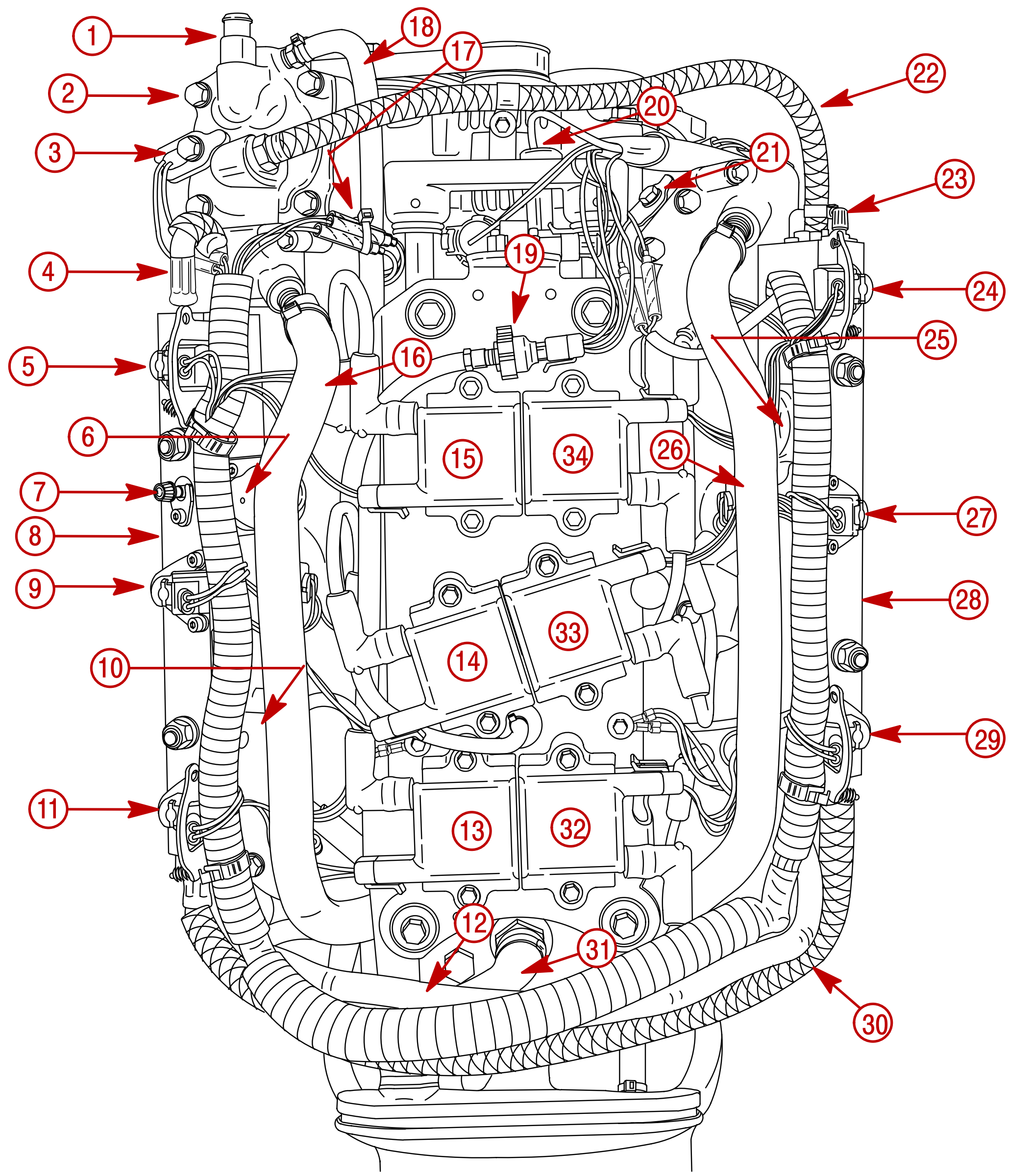
1 - High Pressure Electric Fuel Pump (inside Vapor Separator)
2 - Fuel Out (90 psi)
3 - Throttle Plate Assembly
4 - Low Pressure Fuel Pump Outlet Hose
5 - Fuel Inlet Hose to Fuel/Water Separator
6 - Pulse Fuel Pump
7 - Throttle Position Sensor
8 - Oil Inlet Hose to Air Compressor
9 - Air Inlet to Air Compressor
10 - Air Compressor
11 - Temperature Sensor (Air Compressor)
12 - Water Inlet Hose to Air Compressor
13 - #2 Fuel Injector
14 - Fuel Pressure Test Port
15 - #4 Fuel Injector
16 - #6 Fuel Injector
17 - Water Inlet to Fuel Rail from Adaptor Plate
18 - Cooling Water Strainer Screen
19 - Excess Fuel Return to Vapor Separator
20 - Excess Air Return to Air Plenum
21 - Port Fuel Rail
22 - Low Oil Switch
23 - Excess Oil from Air Compressor
24 - Oil Reservoir
25 - Wide Open Throttle Stop Screw
26 - Low Pressure Electric Fuel Pump
27 - Low Pressure Electric Fuel Pump Connector
28 - Idle Stop Screw
29 - Neutral Shift Interrupt Switch
30 - 2 psi Check Valve
31 - 40 psi Check Valve
32 - Oil Reservoir Oil Filter
33 - Fuel/Water Separator
34 - Fuel/Water Sensor
35 - Low Pressure Electric Fuel Pump Inlet Hose
36 - Vapor Separator
37 - Vapor Separator Drain Plug

Model Year 2000 200/225 DFI Powerhead Top View



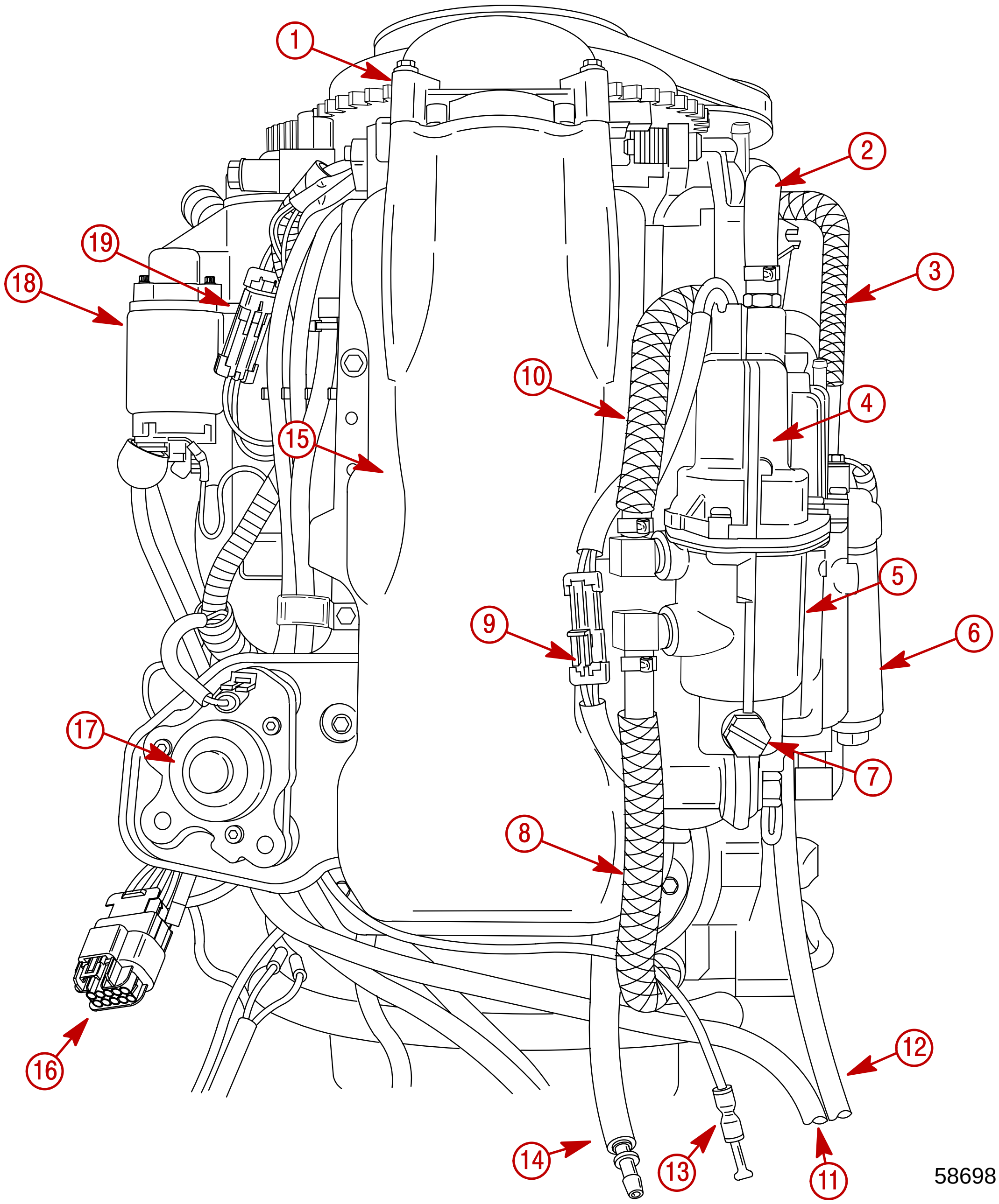
1 - 60 Ampere Alternator
2 - Air Compressor Water Outlet to Tell-Tale
3 - Air Compressor Inlet Nozzle
4 - Air Compressor
5 - Oil Reservoir
6 - Oil Hose to Air Compressor from Oil Pump
7 - Throttle Position Sensor
8 - Oil Return Hose from Air Compressor
9 - Fuel Inlet to Fuel/Water Separator
10 - Fuel Water Separator
11 - Fuel (90 PSI) to Fuel Rails
12 - Throttle Plate Adjustment Screw
13 - Throttle Plate Assembly
14 - MAP Sensor
15 - Air Temperature Sensor
16 - Air Temperature Sensor Connector
17 - Starter Motor
18 - Crank Position Sensor
19 - Crank Position Sensor Connector
20 - Belt Tensioner
21 - Air Hose (80 PSI) to Fuel Rail
22 - Thermostat Outlet Hose to Adaptor Plate

Model Year 2000 200/225 DFI Powerhead Aft View



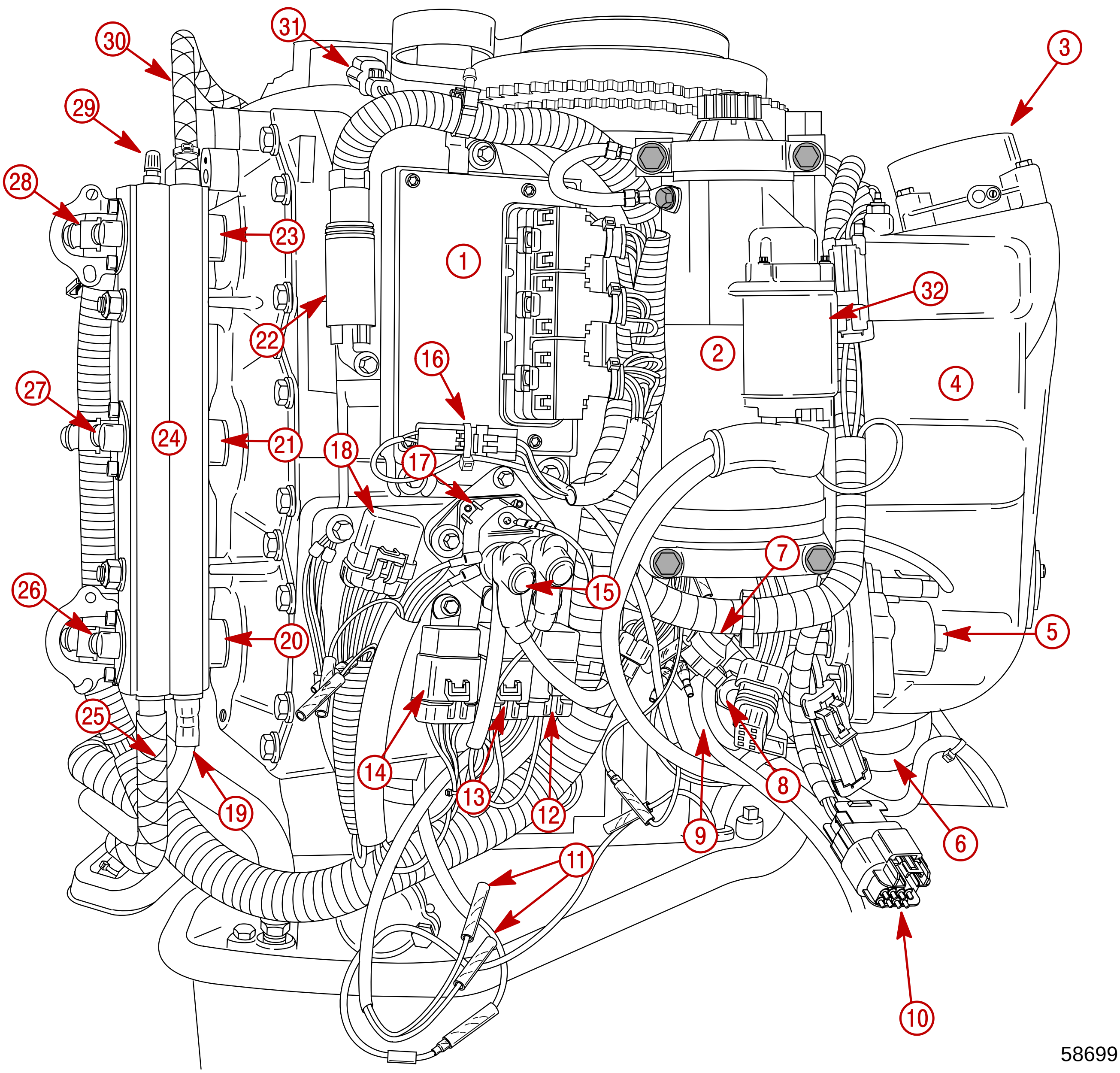
1 - Air Compressor Air Inlet
2 - Air Compressor
3 - Air Compressor Temperature Sensor
4 - High Pressure Fuel Hose (90 psi)
5 - #2 Fuel Injector
6 - Air Regulator
7 - Air Pressure Test Valve
8 - Port Fuel Rail
9 - #4 Fuel Injector
10 - Fuel Regulator
11 - #6 Fuel Injector
12 - Air Pressure (80 psi)
13 - #6 Ignition Coil
14 - #4 Ignition Coil
15 - #2 Ignition Coil
16 - Thermostat Outlet Hose to Adaptor Plate
17 - Port Head Temperature Sensor
18 - Water Out (tell-tale) from Air Compressor
19 - Water Pressure Sensor
20 - 60 Ampere Alternator
21 - Starboard Head Temperature Sensor
22 - Air Pressure (80 psi)
23 - Fuel Pressure Test Valve
24 - #1 Fuel Injector
25 - Tracker Valve
26 - Thermostat Outlet Hose to Adaptor Plate
27 - #3 Fuel Injector
28 - Starboard Fuel Rail
29 - #5 Fuel Injector
30 - High Pressure Fuel Hose (90 psi)
31 - Fresh Water Flush Hose
32 - #5 Ignition Coil
33 - #3 Ignition Coil
34 - #1 Ignition Coil

Model Year 2001 200/225 DFI Powerhead Front View



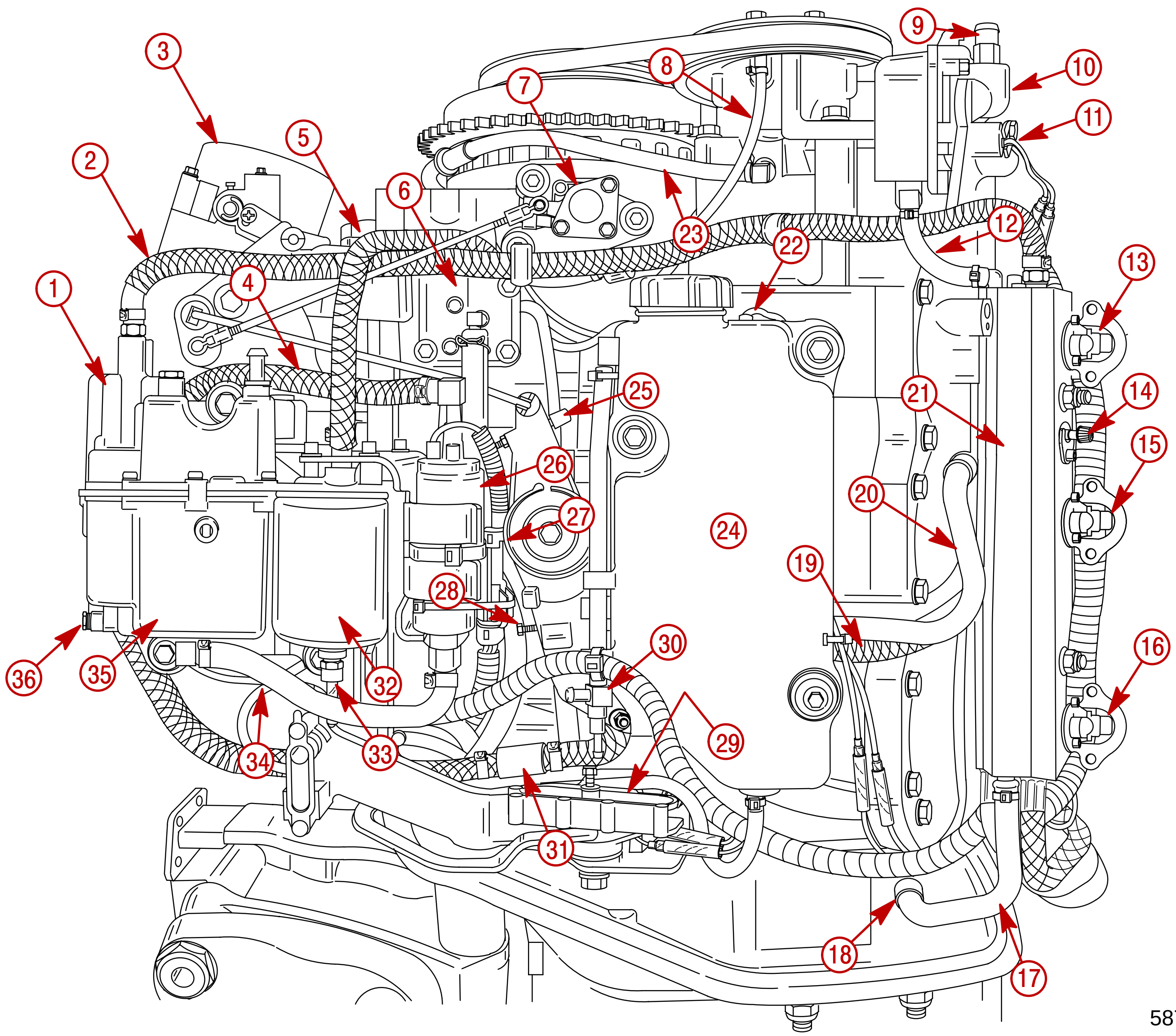
1 - Throttle Plate Assembly
2 - Fuel Hose Out to Fuel Rails (High Pressure)
3 - Fuel Inlet to Fuel/Water Separator
4 - High Pressure Electric Fuel Pump (Inside Vapor Separator)
5 - Vapor Separator
6 - Fuel/Water Separator
7 - Vapor Separator Drain Plug
8 - Fuel Return Hose from Fuel Rail
9 - Fuel Pump Electrical Connector (High Pressure Pump)
10 - Fuel Hose Outlet from Low Pressure Electric Fuel Pump to Vapor Separator
11 - Remote Oil Tank Pressure Hose
12 - Oil Hose to Oil Reservoir (BLUE Stripe)
13 - Water Pressure (GRAY); Speedometer (BLACK)
14 - Fuel Inlet Hose
15 - Air Plenum
16 - Oil Tank/Fuel Tank/ Paddle Wheel for Smart-Craft Sensor Connector
17 - Electric Oil Pump
18 - Starter Solenoid
19 - Air Temperature Sensor Connector

Model Year 2001 200/225 DFI Powerhead Starboard View



1 - Electronic Control Module
2 - Starter Motor
3 - Throttle Body Assembly
4 - Air Plenum
5 - Oil Pump
6 - Oil Hose from Oil Reservoir to Oil Pump
7 - Digital Speedometer Pressure Sensor
8 - Remote Oil Tank Pressure Hose
9 - Negative Battery Cable
10 - Digital Instrument Connectors
11 - Trim Motor Connectors
12 - Trim DOWN Relay
13 - Trim UP Relay
14 - Main Power Relay
15 - Positive Battery Cable
16 - Digital Diagnostic Terminal Connector
17 - Slave Solenoid
18 - Fuses (3 – 20 Amp) (1 – 15 Amp)
19 - 80 psi Air Hose
20 - #5 Direct Injector
21 - #3 Direct Injector
22 - Engine Harness Connector
23 - #1 Direct Injector
24 - Starboard Fuel Rail
25 - High Pressure (90 psi) Fuel Hose
26 - #5 Fuel Injector
27 - #3 Fuel Injector
28 - #1 Fuel Injector
29 - Fuel Pressure Port (90 psi)
30 - 80 psi Air Hose from Air Compressor
31 - Crank Position Sensor Connector
32 - Starter Solenoid

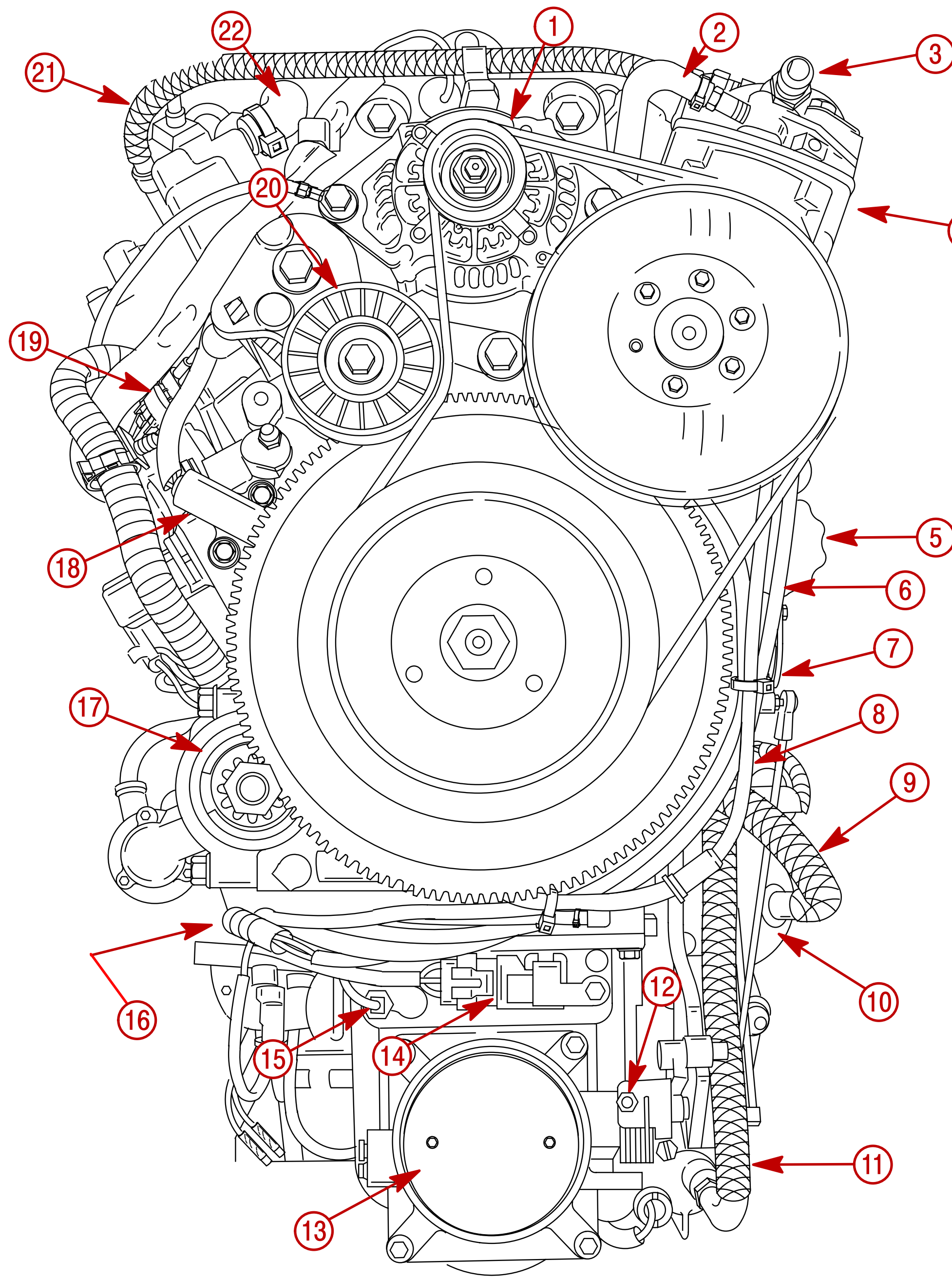
Model Year 2001 200/225 DFI Powerhead Port View



58702

1 - High Pressure Electric Fuel Pump (inside Vapor Separator)
2 - Fuel Out (90 psi)
3 - Throttle Plate Assembly
4 - Low Pressure Fuel Pump Outlet Hose
5 - Fuel Inlet Hose to Fuel/Water Separator
6 - Pulse Fuel Pump
7 - Throttle Position Sensor
8 - Oil Inlet Hose to Air Compressor
9 - Air Inlet to Air Compressor
10 - Air Compressor
11 - Temperature Sensor (Air Compressor)
12 - Water Inlet Hose to Air Compressor
13 - #2 Fuel Injector
14 - Air Pressure Test Port
15 - #4 Fuel Injector
16 - #6 Fuel Injector
17 - Water Inlet to Fuel Rail from Adaptor Plate
18 - Cooling Water Strainer Screen
19 - Excess Fuel Return to Vapor Separator
20 - Excess Air Return to Air Plenum
21 - Port Fuel Rail
22 - Low Oil Switch
23 - Excess Oil from Air Compressor
24 - Oil Reservoir
25 - Wide Open Throttle Stop Screw
26 - Low Pressure Electric Fuel Pump
27 - Low Pressure Electric Fuel Pump Connector
28 - Idle Stop Screw
29 - Neutral Shift Interrupt Switch
30 - 2 psi Check Valve
31 - 40 psi Check Valve
32 - Fuel/Water Separator
33 - Fuel/Water Sensor
34 - Low Pressure Electric Fuel Pump Inlet Hose
35 - Vapor Separator
36 - Vapor Separator Drain Plug

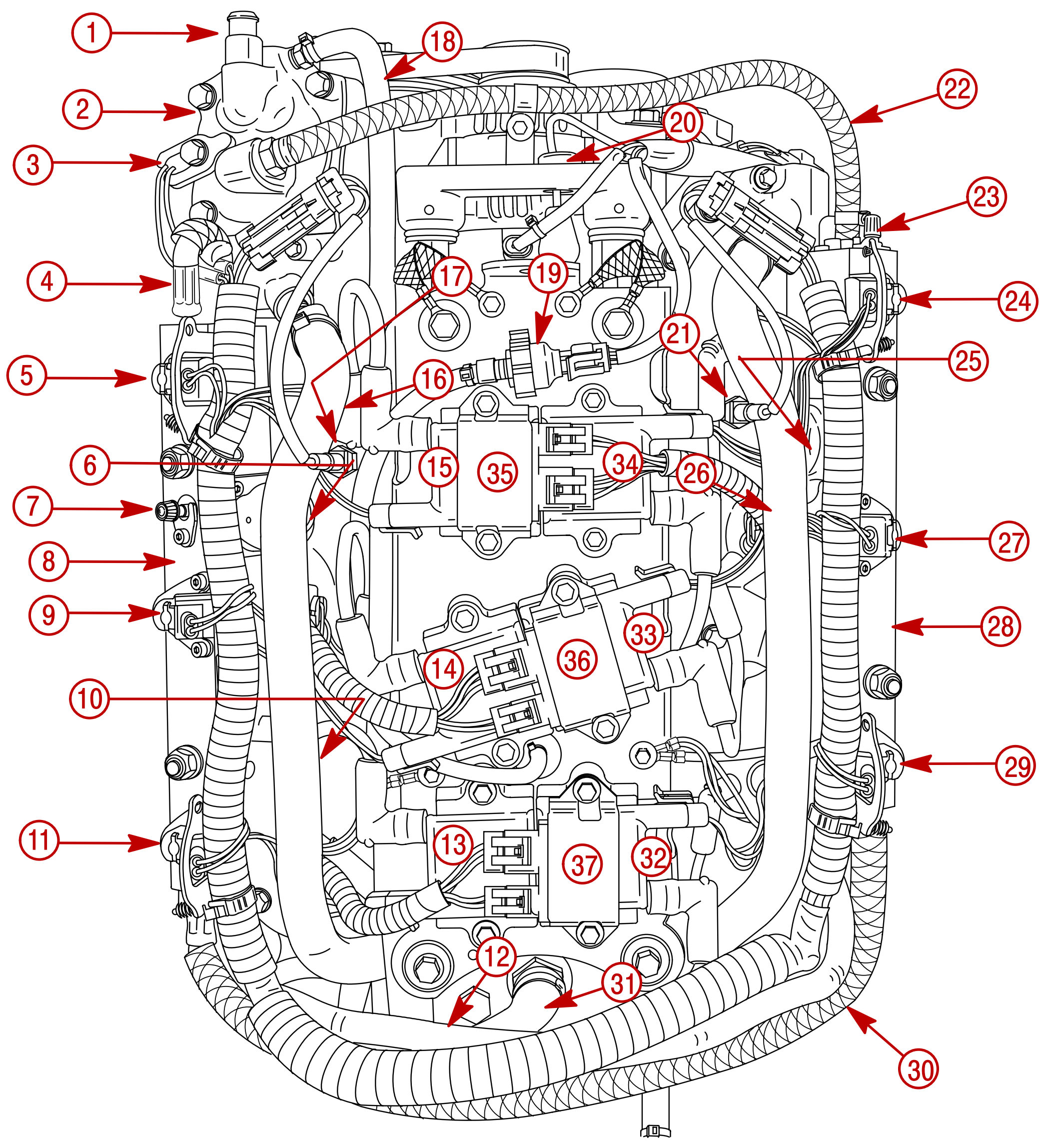
Model Year 2001 200/225 DFI Powerhead Top View



58697

1 - 60 Ampere Alternator
2 - Air Compressor Water Outlet to Tell-Tale
3 - Air Compressor Inlet Nozzle
4 - Air Compressor
5 - Oil Reservoir
6 - Oil Hose to Air Compressor from Oil Pump
7 - Throttle Position Sensor
8 - Oil Return Hose from Air Compressor
9 - Fuel Inlet to Fuel/Water Separator
10 - Fuel Water Separator
11 - Fuel (90 PSI) to Fuel Rails
12 - Throttle Plate Adjustment Screw
13 - Throttle Plate Assembly
14 - MAP Sensor
15 - Air Temperature Sensor
16 - Air Temperature Sensor Connector
17 - Starter Motor
18 - Crank Position Sensor
19 - Crank Position Sensor Connector
20 - Belt Tensioner
21 - Air Hose (80 PSI) to Fuel Rail
22 - Thermostat Outlet Hose to Adaptor Plate

Model Year 2001 200/225 DFI Powerhead Aft View



1 - Air Compressor Air Inlet
2 - Air Compressor
3 - Air Compressor Temperature Sensor
4 - High Pressure Fuel Hose (90 psi)
5 - #2 Fuel Injector
6 - Air Regulator
7 - Air Pressure Test Valve
8 - Port Fuel Rail
9 - #4 Fuel Injector
10 - Fuel Regulator
11 - #6 Fuel Injector
12 - Air Pressure (80 psi)
13 - #6 Ignition Coil
14 - #4 Ignition Coil
15 - #2 Ignition Coil
16 - Thermostat Outlet Hose to Adaptor Plate
17 - Port Head Temperature Sensor
18 - Water Out (tell-tale) from Air Compressor
19 - Water Pressure Sensor
20 - 60 Ampere Alternator
21 - Starboard Head Temperature Sensor
22 - Air Pressure (80 psi)
23 - Fuel Pressure Test Valve
24 - #1 Fuel Injector
25 - Tracker Valve
26 - Thermostat Outlet Hose to Adaptor Plate
27 - #3 Fuel Injector
28 - Starboard Fuel Rail
29 - #5 Fuel Injector
30 - High Pressure Fuel Hose (90 psi)
31 - Fresh Water Flush Hose
32 - #5 Ignition Coil
33 - #3 Ignition Coil
34 - #1 Ignition Coil
35 - #1/#2 Coil Driver
36 - #3/#4 Coil Driver
37 - #5/#6 Coil Driver

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 Application

Decal 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.

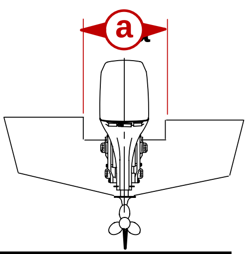
NOTE: *To remove any remaining bubbles, pierce the decal at one end of the bubble with stick pin and press out the entrapped air or wetting solution with your thumb (moving toward the puncture).*

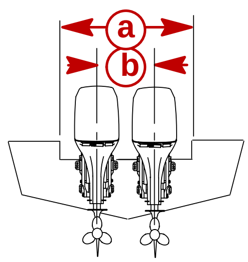
IMPORTANT INFORMATION

Section 1D - Outboard Motor Installation

Table of Contents

Installation Specifications



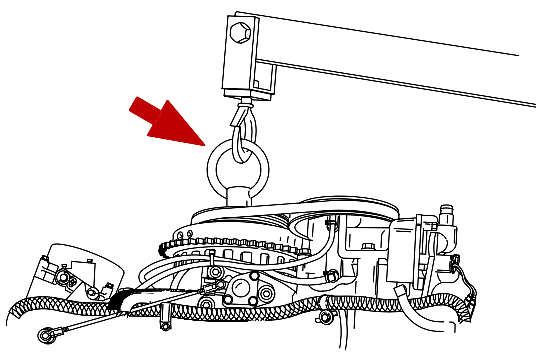


a – Transom Opening – Minimum
Single Engine – 33-3/8 in. (848 mm)
Dual Engines – 59-3/4in. (1518 mm)

b – Engine Center Line For Dual Engine
26 in. (660 mm) Minimum

Lifting Outboard

Electric Start Models – Remove plastic cap from flywheel hub. Thread lifting ring into flywheel a minimum of 5 turns. Replace plastic cap after installation.



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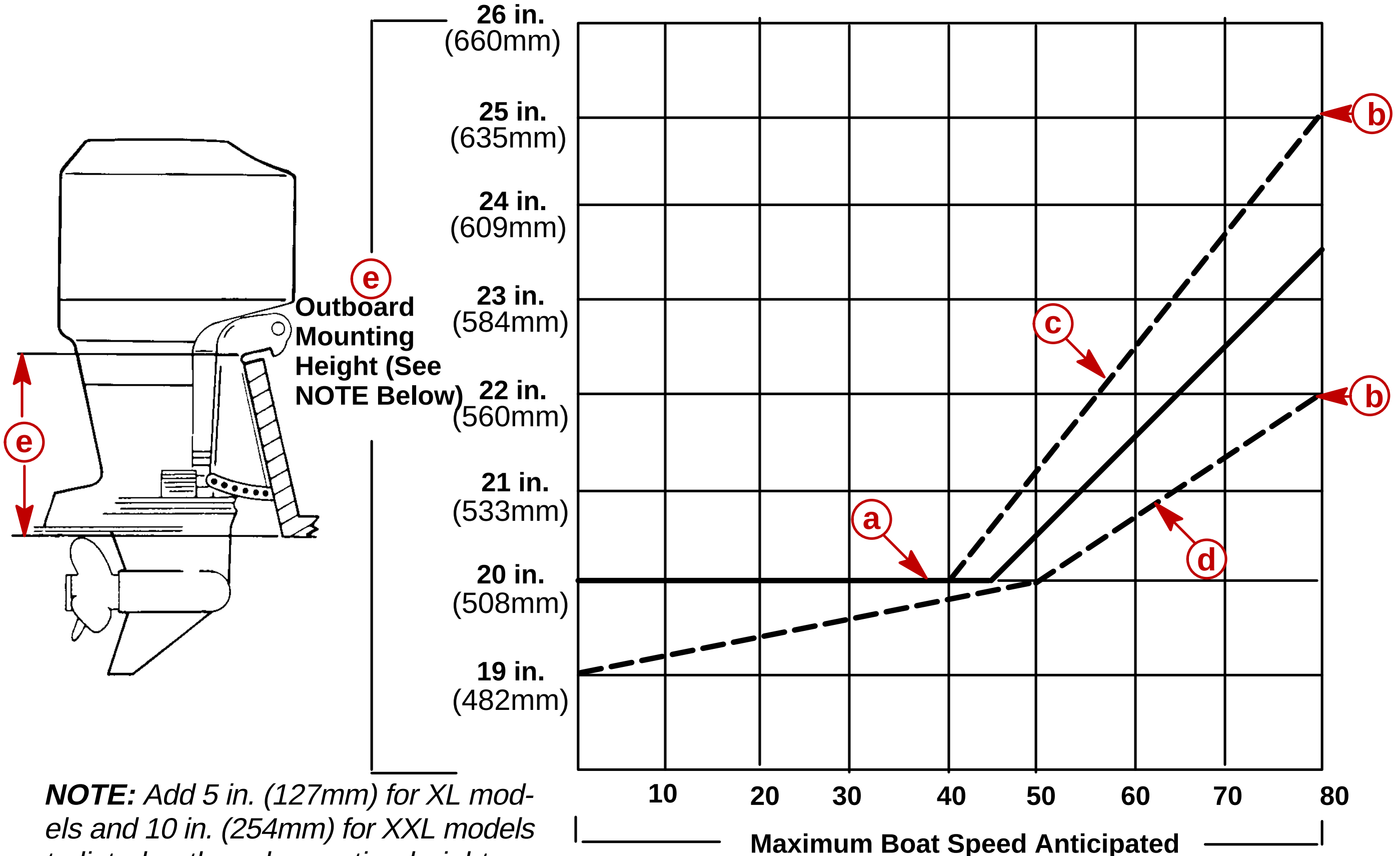
Installing Outboard to Boat Transom

Determining Recommended Outboard Mounting Height



NOTE: *Add 5 in. (127mm) for XL models and 10 in. (254mm) for XXL models to listed outboard mounting height.*

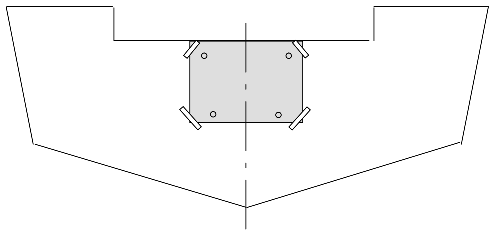
NOTICE TO INSTALLER:

1. The outboard should be mounted high enough on the transom so that the exhaust relief hole will stay at least 1 in. (25.4 mm) above the water line when the engine is running at idle speed. This will prevent exhaust restriction.
2. The mounting height (e) of the outboard must not exceed 25 in. (635 mm) for L models, 30 in. (762 mm) for XL models and 35 in. (889 mm) for XXL models. Mounting the outboard higher may cause damage to the gear case components.
   a. This solid line is recommended to determine the outboard mounting height. Increasing the height of outboard generally will provide the following: 1) Less steering torque, 2) more top speed, 3) greater boat stability, but, 4) will cause more prop “break loose” which may be particularly noticeable when planing off or with heavy load.
   b. These broken lines represent the extremes of known successful outboard mounting height dimensions.
   c. This line may be preferred to determine outboard mounting height dimension, if maximum speed is the only objective.
   d. This line may be preferred to determine outboard mounting height dimension for dual outboard installation.
   e. Outboard mounting height (height of outboard transom brackets from bottom of boat transom). For heights over 22 in. (560 mm), a propeller, that is designed for surfacing operation is usually preferred.

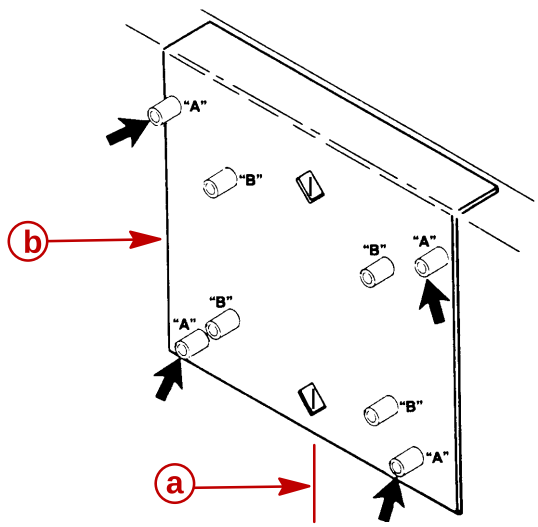
Installing Outboard

Drilling Outboard Mounting Holes

1. Attach (tape) engine mounting template (located with the installation manual) to boat transom.

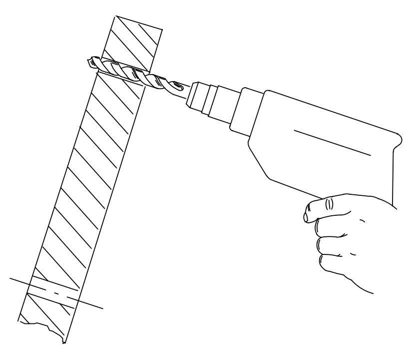


IMPORTANT: If using "Transom Drilling Fixture" (part number 91-98234A2), use drill guide holes marked "A" when drilling outboard mounting holes.



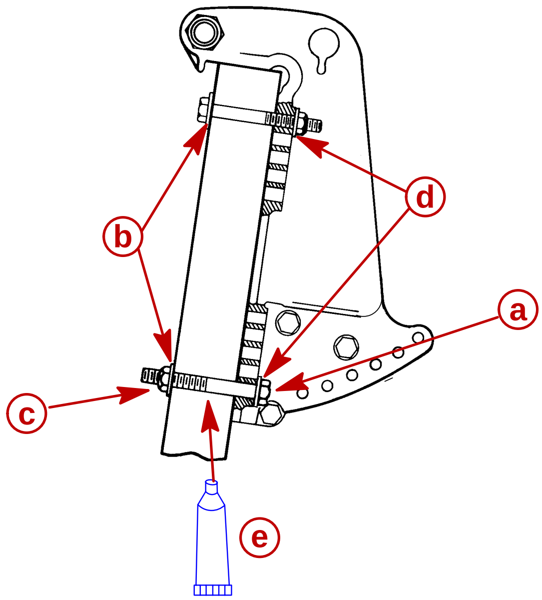
a - Centerline of Transom
b - Transom Drilling Fixture (91-98234A2)

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



Securing Outboard To Boat Transom

1. Refer to "Determining Recommended Outboard Motor Mounting Height", preceding and install outboard to the nearest recommended mounting height.
2. Fasten outboard with provided mounting hardware shown.

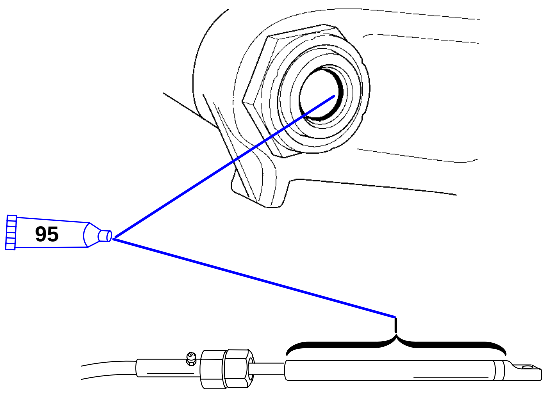


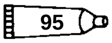
a - 1/2 in. Diameter Bolts (4)
b - Flat Washers(4)
c - Locknuts (4)
d - Flat Washers(4)
e - Marine Sealer - Apply to Shanks of Bolts, Not Threads

Steering Cable

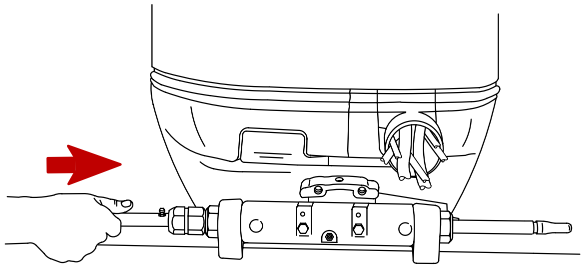
STARBOARD SIDE ROUTED CABLE

1. Lubricate O-ring seal and entire cable end.



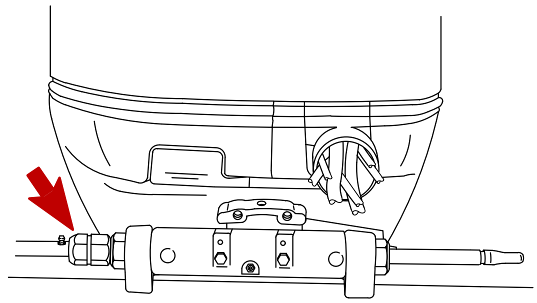
 2-4-C With Teflon (92-825407A12)

2. Insert steering cable into tilt tube.



57832

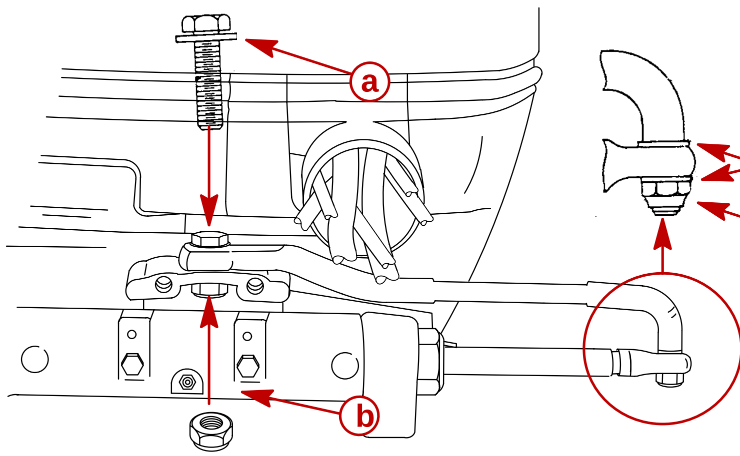
3. Torque nut to 35 lb. ft. (47.5 N·m).



57833

Steering Link Rod

1. Install steering link rod per illustration.



57834

a - Special Bolt (10-90041) Torque to 20 lb-ft (27 Nm)
b - Nylon Insert Locknut (11-34863) Torque to 20 lb-ft (27 Nm)
c - Flat Washer (2)
d - Nylon Insert Locknut (11-34863) Tighten Locknut Until it Seats, Then Back Nut Off 1/4 Turn

IMPORTANT: The steering link rod that connects the steering cable to the engine must be fastened using special washer head bolt (“a” – Part Number 10-14000) and self locking nuts (“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.

⚠ 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.

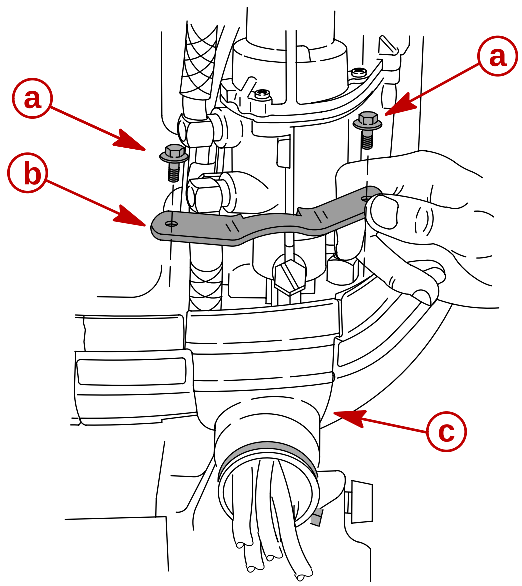
Electrical, Hoses and Control Cables

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.

Front Clamp Assembly

REMOVAL

Remove two screws with retainer and open the front clamp.



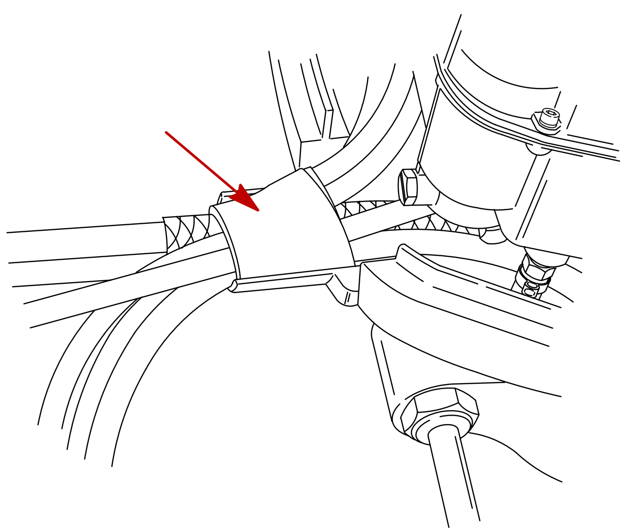
57803

a - Screws (2)
b - Retainer
c - Clamp

INSTALLATION

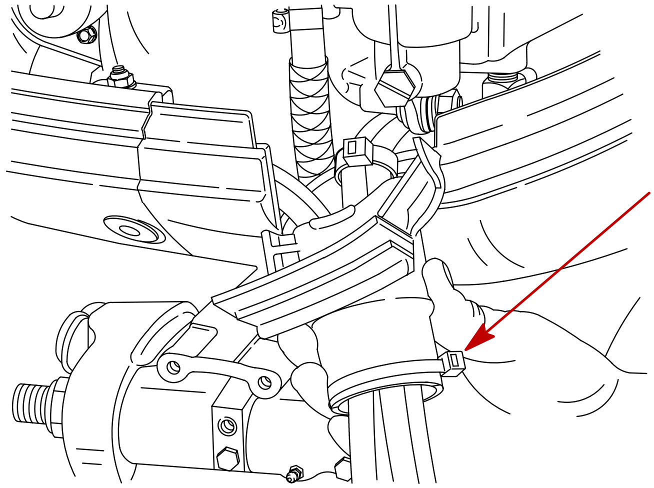
IMPORTANT: Sufficient slack must exist in engine wiring harness, battery cables, fuel hose, and oil hoses routed between clamp and engine attachment point, to relieve stress and prevent hoses from being kinked or pinched.

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



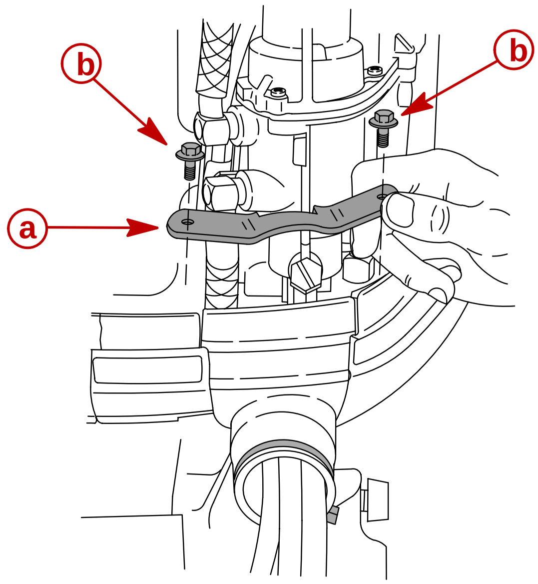
57840

2. Secure both halves of clamp with sta-strap.



57802

3. Secure clamp assembly into bottom cowl with retainer and 2 screws.

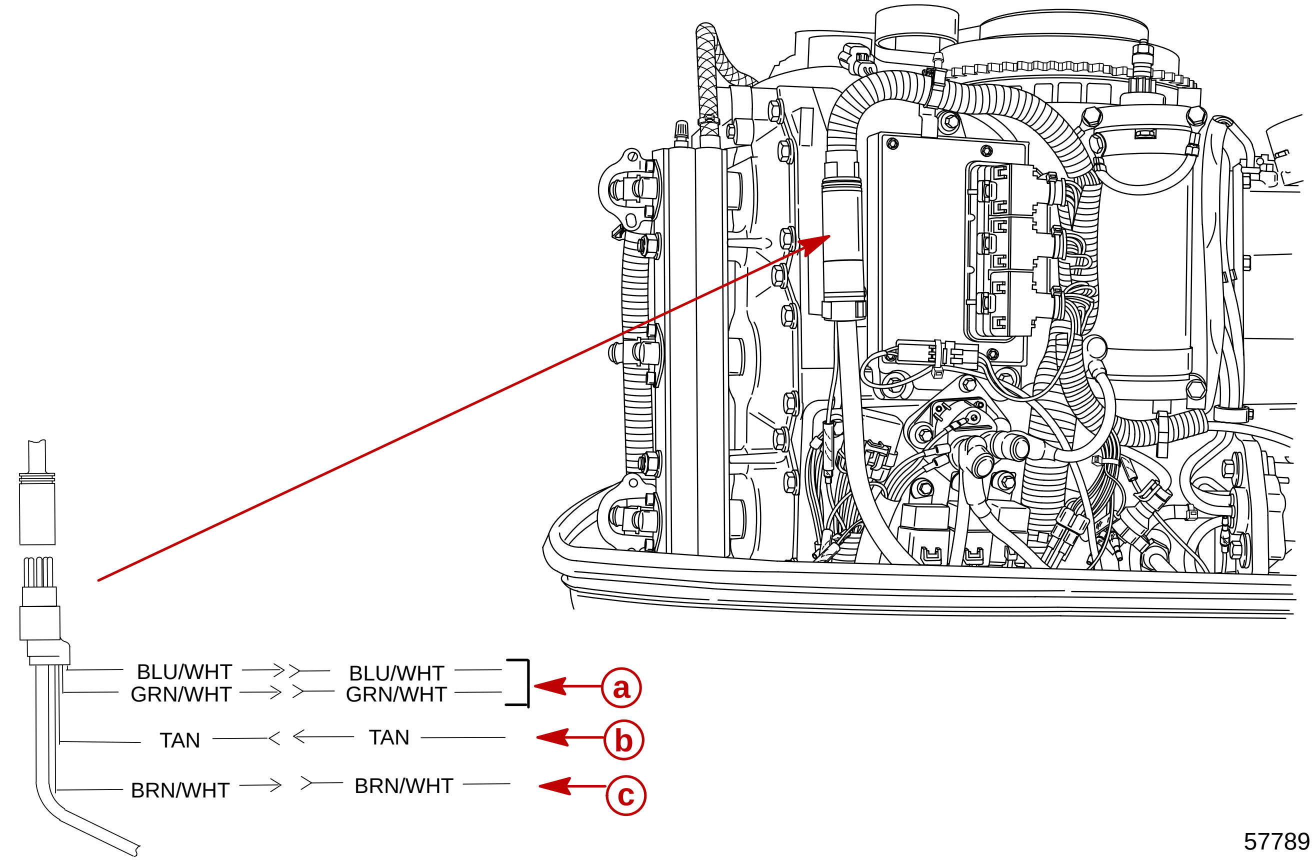


57803

a - Retainer
b - Screws

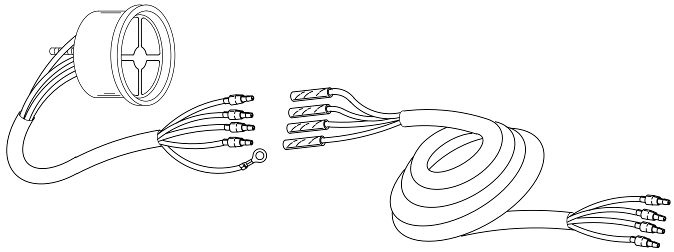
Remote Wiring Harness

1. Connect wiring. Place harness into the holder.



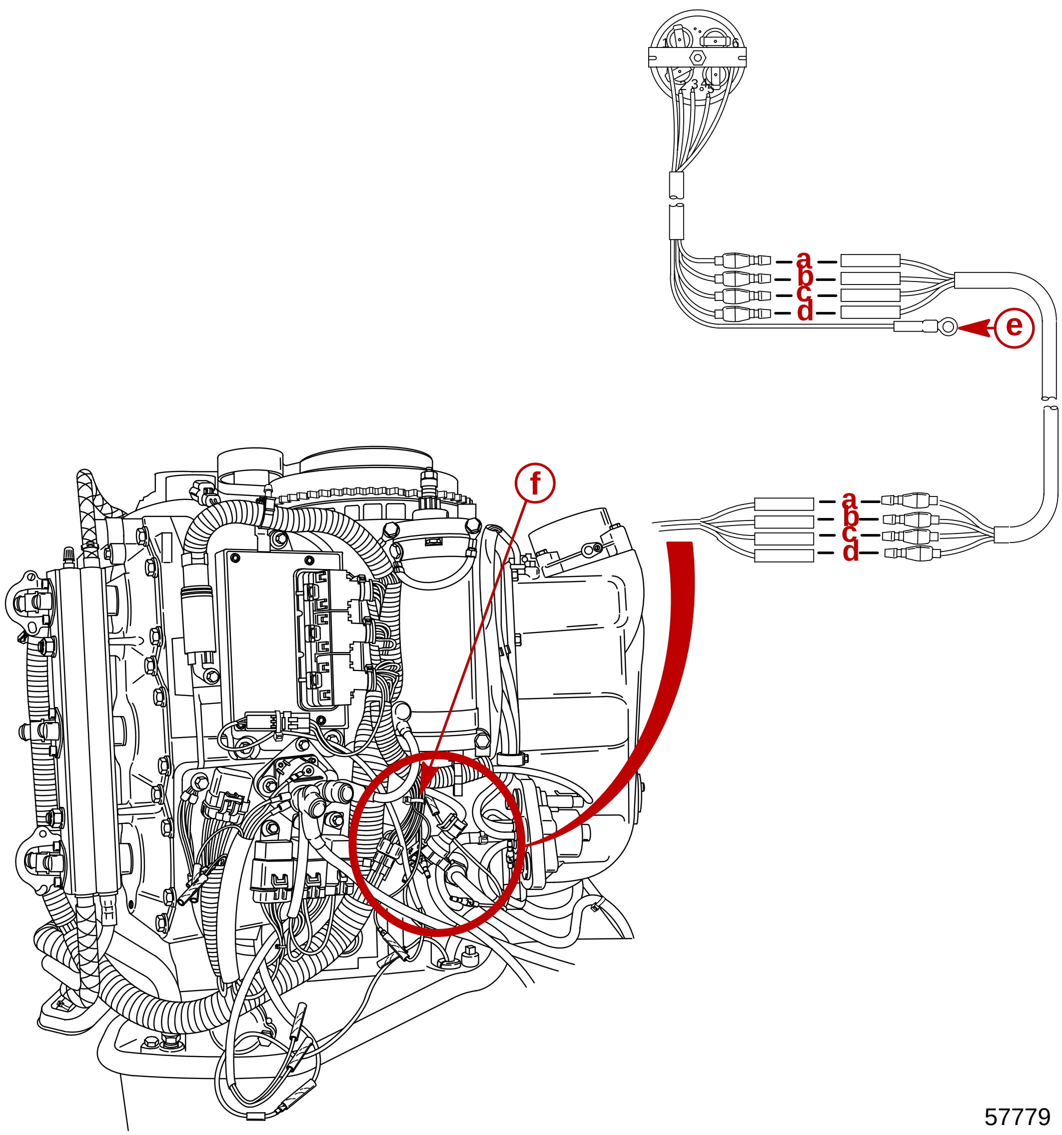
a - Power Trim Connections
b - Connection For Water Temp Gauge (Non Digital Models)
c - Data Communication Link (Digital Models) and Connection For Trim Gauge (Non Digital Models)

Four Light Warning Gauge Harness (Model Year 2000 Only)



NOTE: *The Four Function Warning Gauge can only be used on Model Year 2000 outboards. For Model Year 2001 outboards, refer to SmartCraft Product Applications Manual for visual warning options.*

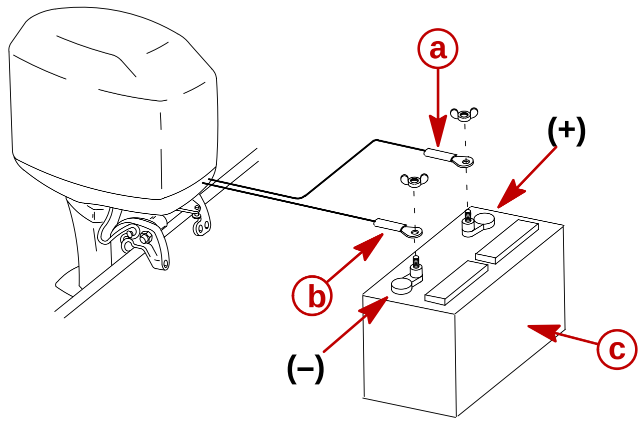
Connect the harness extension to gauge and engine.



a - TAN/BLACK
b - TAN/WHITE
c - PINK/LT. BLUE
d - ORANGE
e - Connect PURPLE to 12 Volt Source or Adjacent Gauge
f - Sta-Strap – Fasten Wiring to Prevent Catching on Cowl

Battery Cables

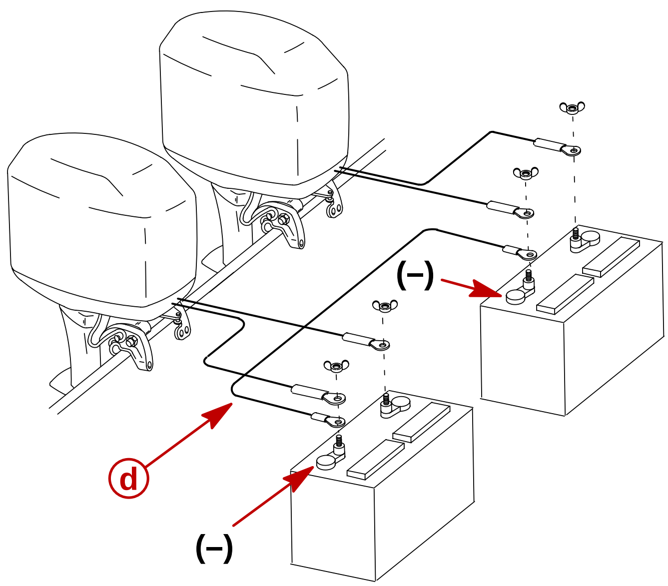
Single Outboard



a - RED Sleeve (Positive)
b - BLACK Sleeve (Negative)
c - Starting Battery

Dual Outboard

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



d - Common Ground Cable

Fuel Hose Connection

Fuel Hose Size – Minimum fuel line inside diameter (I.D.) is 5/16 in. (8 mm), with separate fuel line/fuel tank pickup for each engine.

Fasten remote fuel hose to fitting with hose clamp.

Oil Hose Connections

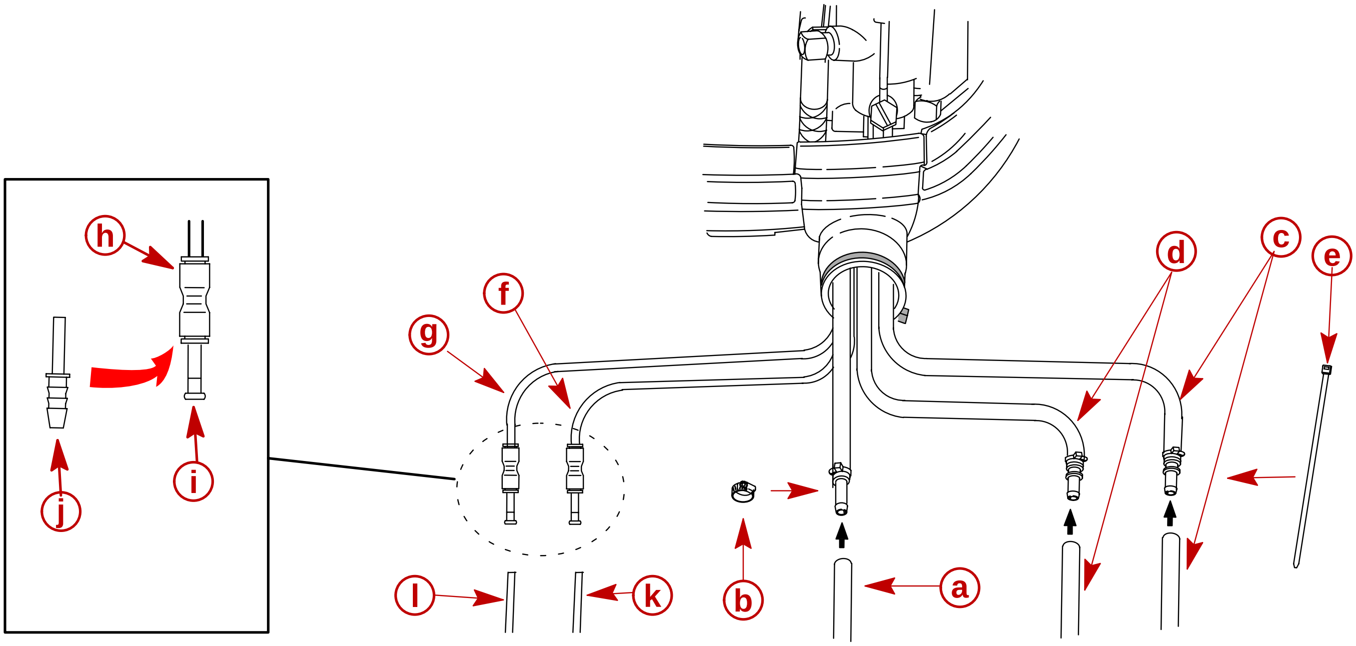
Connect the remote oil hoses to the engine hose connections as shown. Fasten hose connections with sta-straps.

Speedometer Tubing Connection (Models without SmartCraft Gauges)

This outboard has a speedometer water pick-up located in the leading edge of the gear case. If you want to use this water pickup for the speedometer, connect the water tubing as shown.

Water Pressure Tubing Connection (Models without SmartCraft Gauges)

If the boat is equipped with a water pressure gauge, make the water connection to this tubing as shown.



- **a** - Remote Fuel Hose
- **b** - Hose Clamp – Secure Remote Fuel Hose
- **c** - Oil Hoses with Blue Stripe - Secure With Sta-Strap
- **d** - Oil Hoses without Blue Stripe - Secure With Sta-Strap
- **e** - Sta-Strap (2) - Secure Oil Hoses
- **f** - Speedometer Water Pickup Tubing (Black Color)
- **g** - Water Pressure Tubing (Gray Color)
- **h** - Coupler – Push In on End of Coupler to Disconnect Plug or Tubing
- **i** - Plug – Remove when Making Coupler Connection
- **j** - Barb Hose Fitting (2) Provided with Outboard – Install this fitting into Coupler, if a Rubber Hose Connection is Required
- **k** - Speedometer Hose – Insert the barb hose fitting (j) into Coupler and Connect Hose
- **l** - Water Pressure Tube – Insert into Coupler, Pull on Tube to Verify That it is Locked

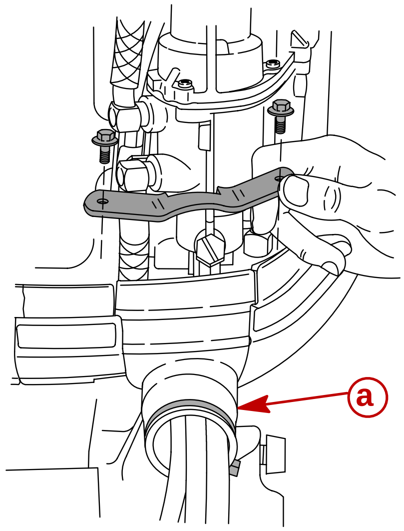
NOTE: *Model 2001 outboards using conventional speedometers (non-SmartCraft) requires that the BLACK speedometer hose be disconnected from speedometer sensor on the back of the engine block. The hose is rerouted out through the bottom cowl with other hoses/cables.*

Shift Cable Installation

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

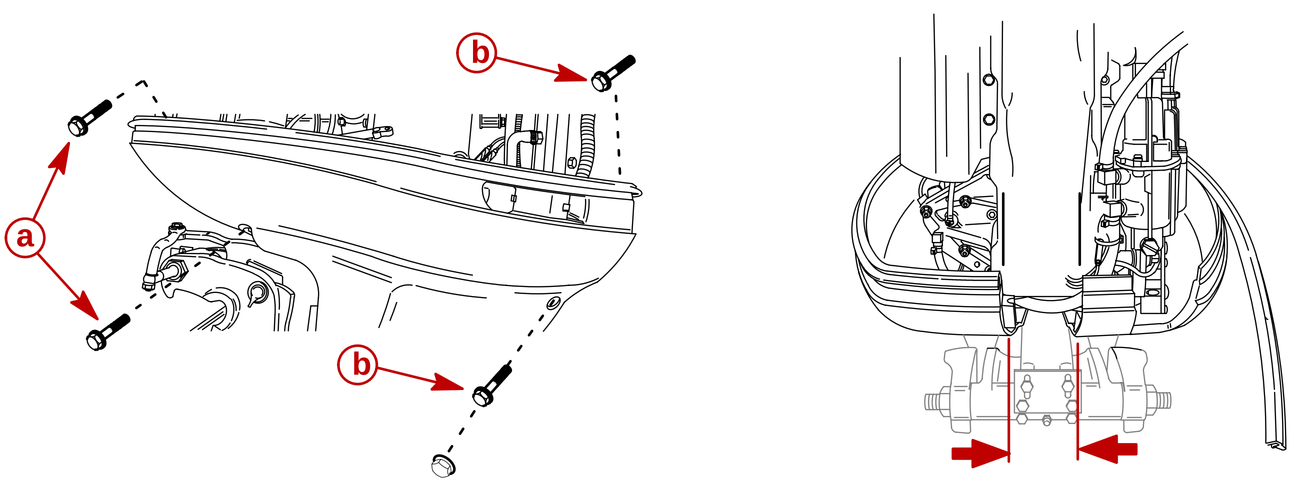
NOTE: *Prior to installing shift and throttle cables on engine, for ease of installation, it is recommended that the bottom cowl be loosened and spread apart to avoid possibly kinking control cables during installation.*

1. Remove the front clamp.



a - Clamp

2. Separate the front end of the bottom cowl as follows:
   a. Remove the 2 front screws (a) and loosen the rear 2 screws (b).
   b. Separate the bottom cowl.



a - Remove Front Screws
b - Loosen Rear Screws - Remove Rubber Plug for Access to Lower Screw

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.*

Counter Rotation Outboards

Counter rotating (left hand) gear cases can be identified by a “L” stamped into the end of the propeller shaft.

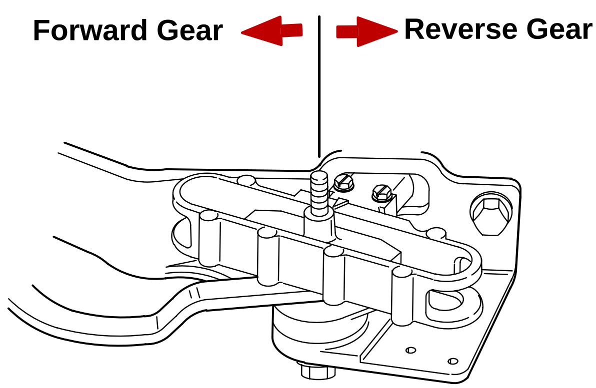
The Quicksilver Dual Engine Console Mount Control, P/N 88688A22 or 88688A52, is required to shift the counter rotation outboard. The installation instructions shipped with the control explain the procedure required to connect this control to a counter rotation outboard.

IMPORTANT: If the counter rotation outboard is rigged similar to a standard rotation outboard OR if a standard rotation outboard is rigged similar to a counter rotation outboard, the reverse gear and bearing in the gear case must function as forward gear. THE REVERSE GEAR/BEARING ARE NOT DESIGNED TO CARRY THE SUSTAINED LOADS THAT ARE GENERATED WHEN RUNNING UNDER CONSTANT HIGH RPM AND THRUST CONDITIONS.

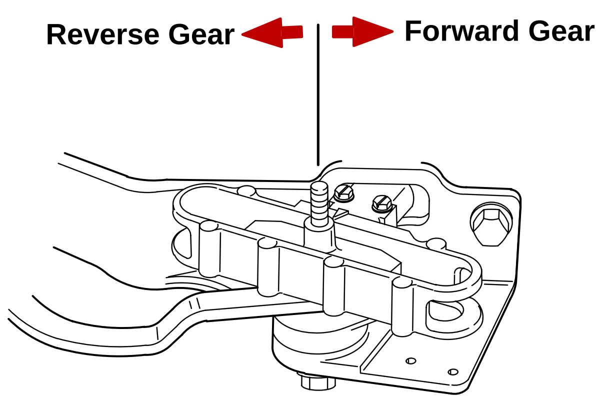
OUTBOARD SHIFTING DIRECTION

On counter rotation outboards, the shift linkage moves in the opposite direction compared to a standard rotation outboard.

STANDARD ROTATION GEAR OUTBOARDS



COUNTER ROTATION OUTBOARDS

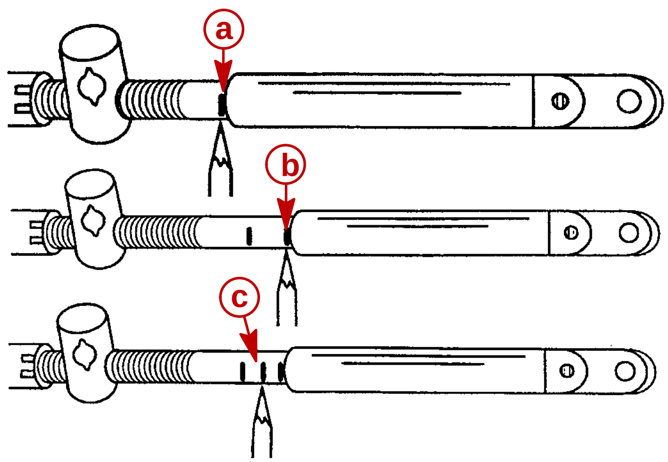


Installation

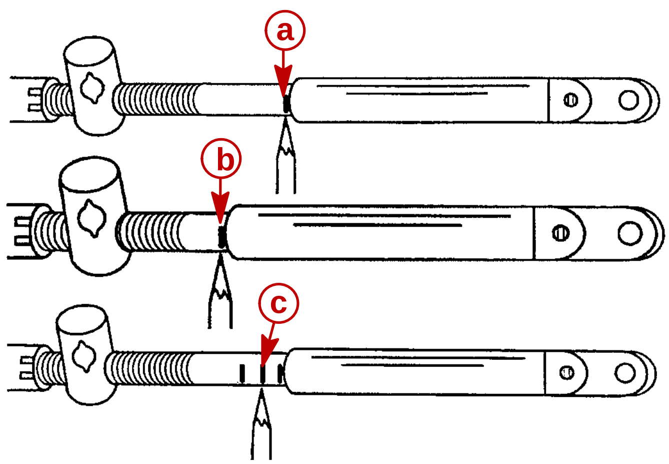
IMPORTANT: Step 1 must be followed for proper adjustment of the shift cable.

1. Locate the center point of the slack or lost motion that exists in the shift cable as follows:
   a. Move the remote control handle from neutral into forward and advance the handle to full speed position. Slowly return the handle back to the neutral. Place a mark (a) on the cable against the cable end guide.
   b. Move the remote control handle from neutral into reverse and advance the handle to full speed position. Slowly return the handle back to the neutral. Place a mark (b) on the cable against the cable end guide.
   c. Make a center mark (c), midway between marks (“a” and “b”). Align the cable end guide against this center mark when installing cable to the engine.

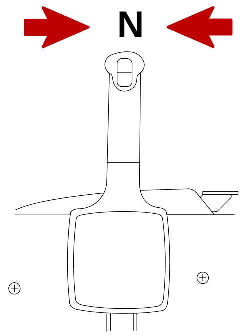
STANDARD ROTATION OUTBOARDS



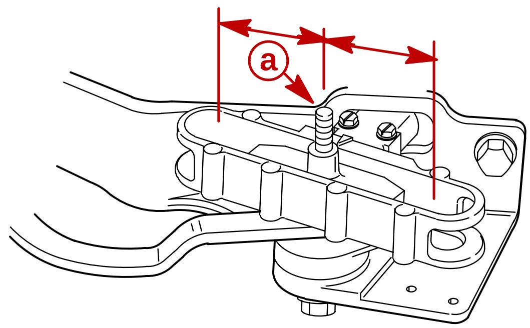
COUNTER ROTATION OUTBOARDS



2. Position remote control and outboard into neutral.

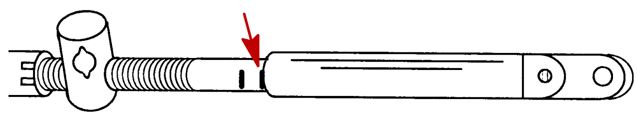


3. Slide the shift cable retainer forward until resistance is felt, then slide cable anchor toward rear until resistance is felt. Center the anchor pin between resistance points.



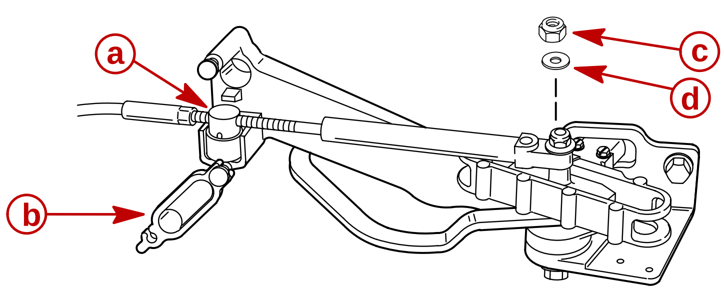
a - Anchor Pin

4. Align the shift cable end guide with the center mark as instructed in Step 1.



5. Place shift cable on anchor pin. Adjust cable barrel so it slips freely into the barrel holder.

6. Secure shift cable with shift cable retainer.



a - Cable Barrel
b - Shift Cable Retainer
c - Locknut – Tighten locknut then back off locknut 1/4 turn
d - Nylon Washer

7. Check shift cable adjustments as follows:
   a. With remote control in forward, the propshaft should lock solidly in gear. If it does not, adjust cable barrel closer to cable end guide.
   b. Shift remote control into neutral. The propshaft should turn freely without drag. If not, adjust barrel away from cable end guide. Repeat steps a and b.

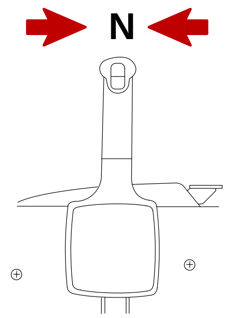
c. Shift remote control into reverse while turning propeller. The propshaft should lock solidly in gear. If not, adjust barrel away from cable end guide. Repeat steps a thru c.

d. Return remote control handle to neutral. The propeller should turn freely without drag. If not, adjust barrel closer to cable end guide. Repeat steps a thru d.

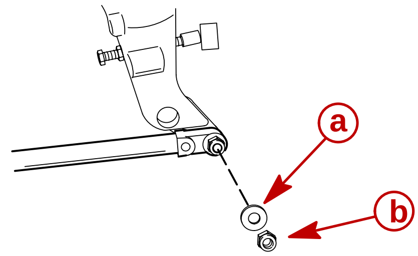
Throttle Cable

INSTALLATION

1. Position remote control into neutral.

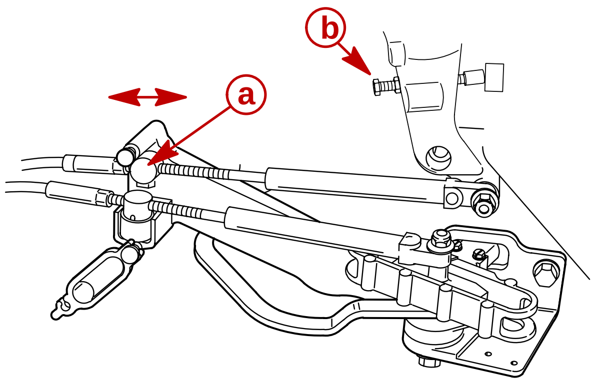


2. Attach throttle cable to the throttle lever. Secure with latch.



a - Nylon Washer
b - Locknut – Tighten locknut then back off locknut 1/4 turn

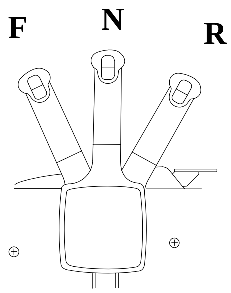
3. Adjust the cable barrel so that the installed throttle cable will hold the idle stop screw against the stop.



a - Cable Barrel – Adjust To Hold Idle Stop Screw Against Stop
b - Idle Stop Screw

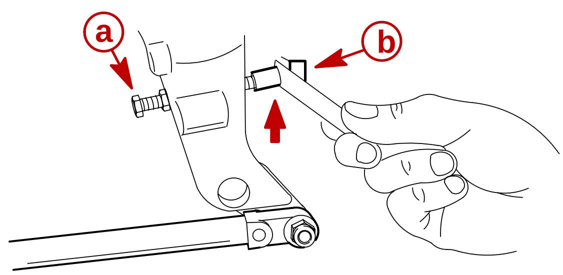
4. Check throttle cable adjustment as follows:

   a. Shift outboard into gear a few times to activate the throttle linkage. Make sure to rotate the propeller shaft while shifting into reverse.



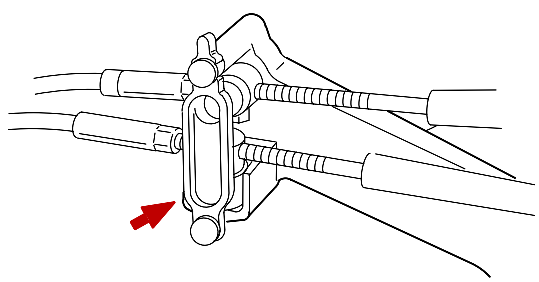
   b. Return remote control to neutral. Place a thin piece of paper between idle adjustment screw and idle stop. Adjustment is correct when the paper can be removed without tearing, but has some drag on it. Readjust cable barrel if necessary.

IMPORTANT: The idle stop screw must be touching the stop.



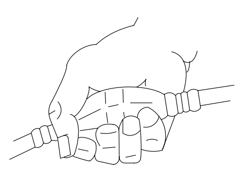
a - Idle Stop Screw
b - Idle Stop

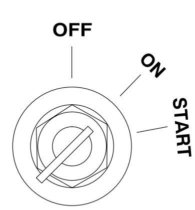
5. Lock the barrel holder in place with the cable latch.



Filling Fuel System

NOTE: *For initial start of a new engine or for an engine that ran out of fuel, or was drained of fuel, the fuel system should to be filled as follows:*



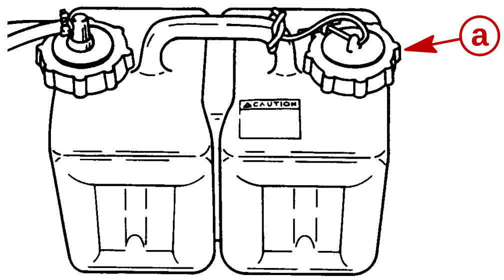


- *Squeeze the fuel line primer bulb until it feels firm.*
- *Turn the ignition key switch to the ON position for three seconds. This operates the electric fuel pump.*

- *Turn the ignition key switch back to the OFF position, and squeeze the primer bulb again until it feels firm. Turn the ignition key switch to the "ON" position again for three seconds. Continue this procedure until the fuel line primer bulb stays firm.*

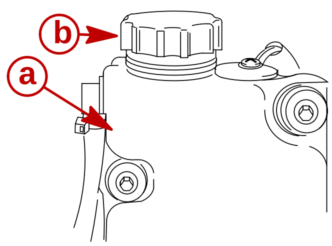
Oil Injection Set-Up

1. Fill remote oil tank with the recommended oil listed in the Operation and Maintenance Manual. Tighten fill cap.



a - Fill Cap

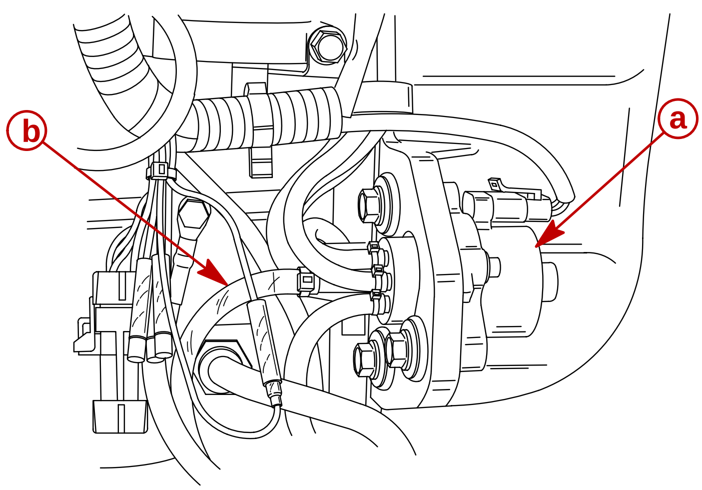
2. Remove cap and fill engine oil tank with oil. Reinstall the fill cap.



a - Engine Oil Tank
b - Fill Cap

Priming the Oil Injection Pump

Before starting engine for the first time, prime the oil injection pump. Priming will remove any air that may be in the pump, oil supply hose, or internal passages.



57916

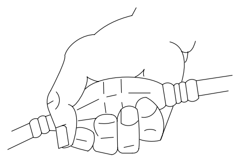
a - Oil Injection Pump
b - Oil Supply Hose

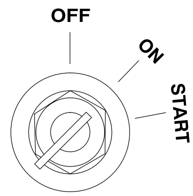
⚠ CAUTION

To prevent damage to the fuel pumps, fill the engine fuel system with fuel. Otherwise the fuel pumps will run without fuel during the priming process.

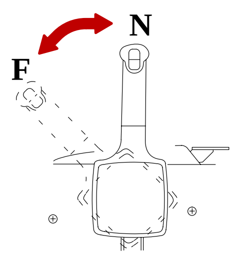
Prime the oil injection pump as follows:

1. Fill the engine fuel system with fuel. Connect fuel hose and squeeze primer bulb until it fells firm.
2. Turn the ignition key switch to the “ON” position.





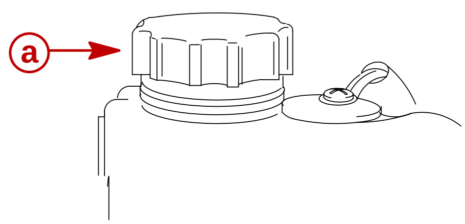
3. Within the first 10 seconds after the key switch has been turned on, move the remote control handle from neutral into forward gear 3 to 5 times. This will automatically start the priming process.



NOTE: *It may take a few minutes for the pump to complete the priming process.*

Purging Air From the Engine Oil Tank

1. Loosen the fill cap on the engine oil tank.
2. Start the engine. Run the engine until the all the air has been vented out of the tank and oil starts to flow out of the tank. Re-tighten fill cap.



a - Fill Cap

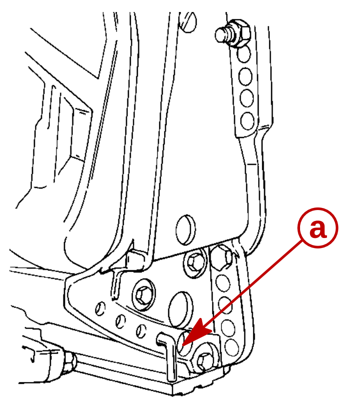
Trim “In” Angle Adjustment

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 spend in a bow high boat attitude 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 under. This can be accomplished by purchasing a stainless steel tilt pin (P/N 17-49930A1) and inserting 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.

⚠ 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 engine is trimmed extremely under or in.



a - Tilt Pin

ELECTRICAL

Section 2A – Ignition

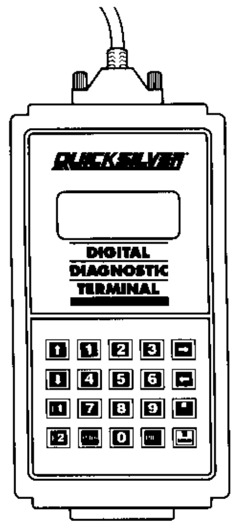
Table of Contents

Specifications

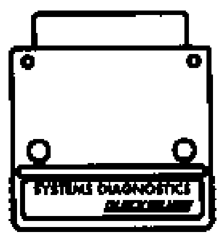
IGNITION SYSTEM	**Type**	Digital Inductive
	Firing Order	1-2-3-4-5-6
	Model Year 2000	
	Spark Plug Type	CHAMPION QC12GMC
	Spark Plug Gap	0.040 in. (1.0 mm)
	Model Year 2001	
	Spark Plug Type	NGK PZFR5F-11 (heavy duty)
	Spark Plug Gap	0.043 in. (1.1 mm)
	Maximum Timing	Not Adjustable; Controlled by ECM
	Idle Timing	Not Adjustable; Controlled by ECM
	Throttle Position Sensor	
	Model Year 2000	
	@ Idle	4.0 - 4.7 vdc
	@ W.O.T	0.4 - 1.3 vdc
	Model Year 2001	
	@ Idle	0.4 - 1.3 vdc
	@ W.O.T	4.0 - 4.7 vdc
	Crank Position Sensor	
	Air Gap	0.025 in. – 0.040 in. (0.635 mm – 1.01 mm)

Special Tools

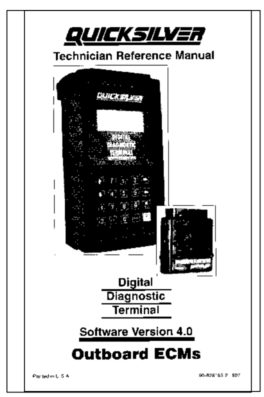
1. Digital Diagnostic Terminal (DDT) 91-823686A2



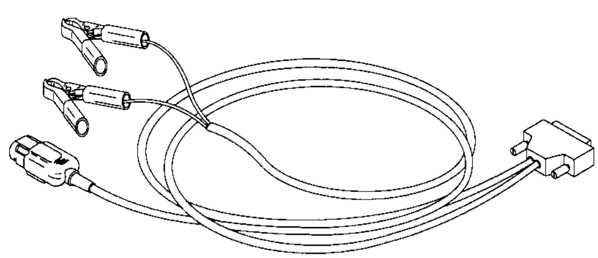
2. Model Year 2000 – Software Cartridge 91-822608--5
   Model Year 2001 – Software Cartridge 91-880118



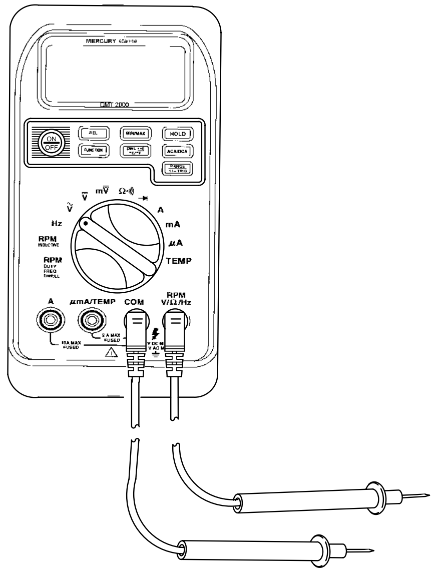
3. Model Year 2000 – DDT Reference Manual 90-825159-3
   Model Year 2001 – DDT Reference Manual 90-881204



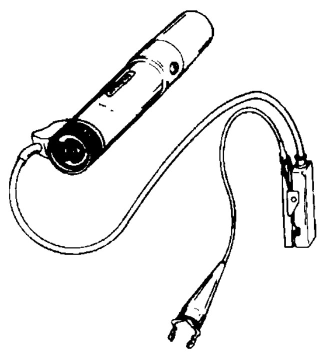
4. Adaptor Harness 84-822560A5



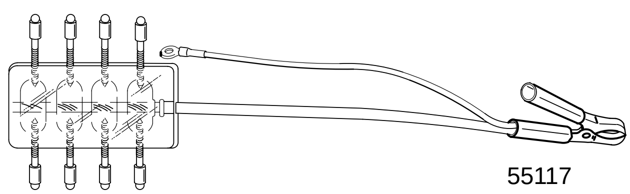
5. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1



6. Inductive Timing Light 91-99379



7. Spark Gap Tester 91-850439T



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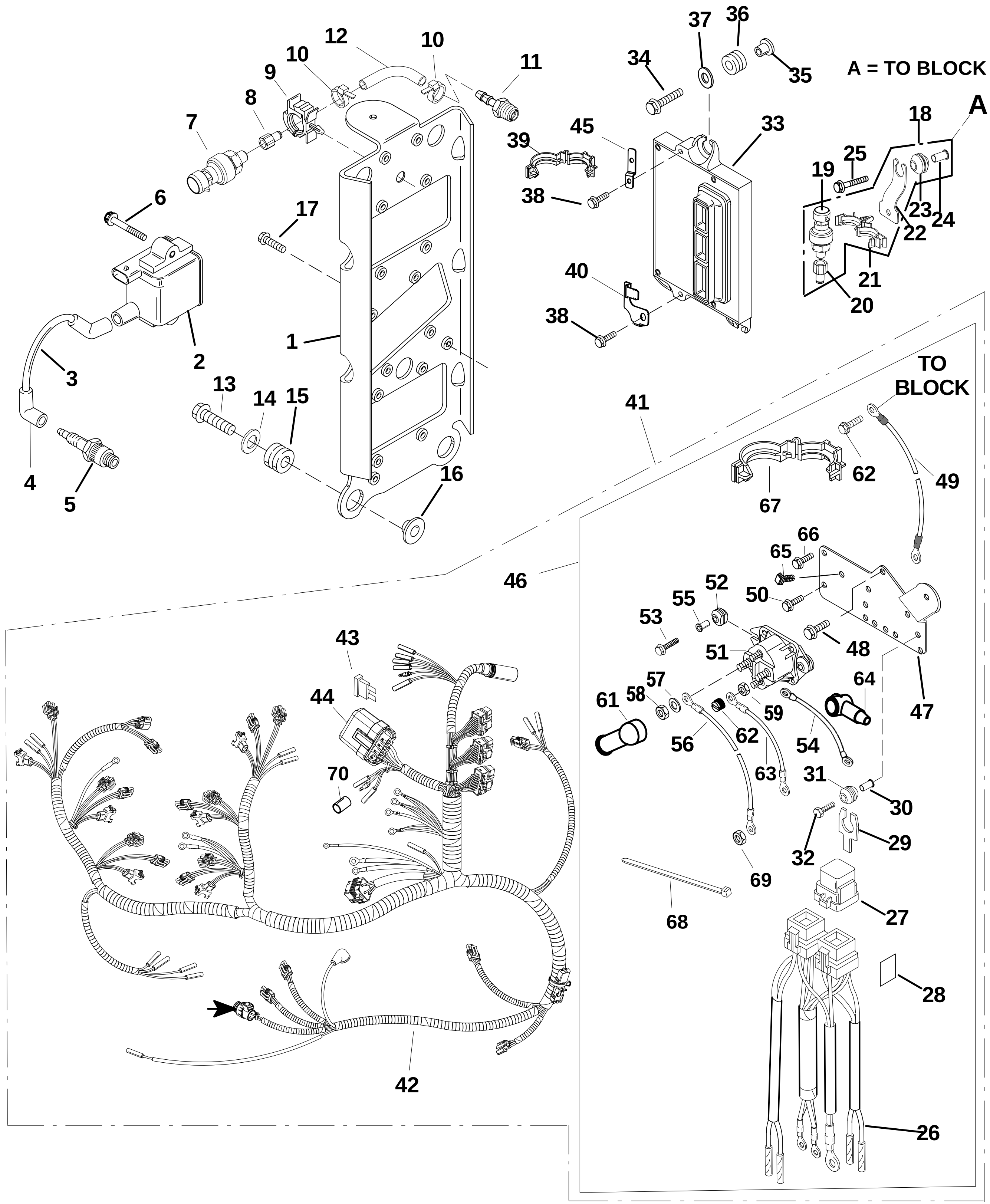
Electrical Components Model Year 2000



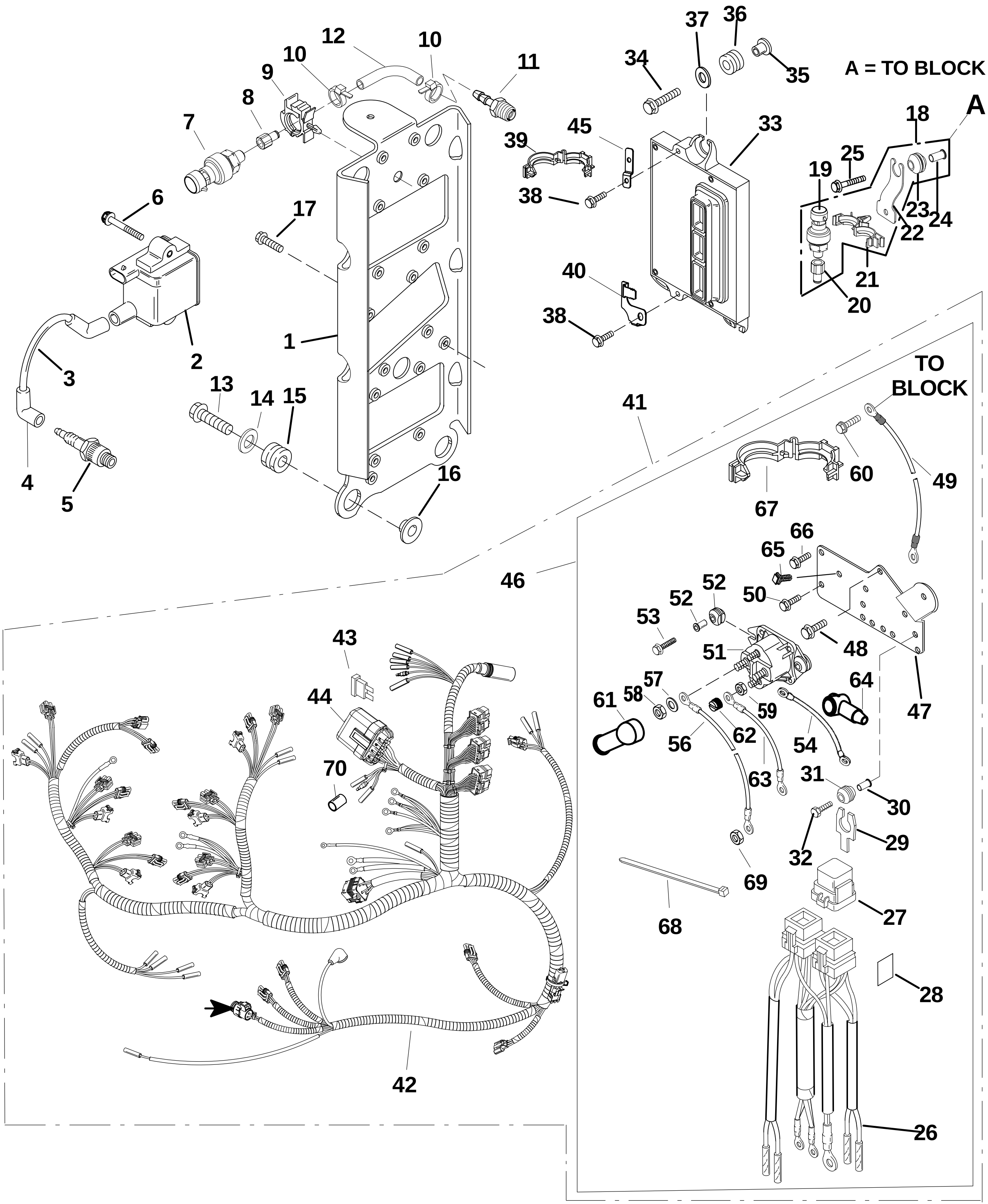
***NOTE:** *Coat all eyelet wiring terminals with #25 GACO N700.*

***NOTE:** *Coat all multi-pin electrical connections (except power trim relay connections) with #6DC-4.*

Electrical Components Model Year 2000

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm
1	1	ELECTRICAL MOUNTING PLATE			
2	6	IGNITION COIL			
3	6	HI-TENSION CABLE			
4	12	BOOT			
5	6	SPARK PLUG		20	27
6	12	SCREW (M6 x 30)			
7	1	SENSOR			
8	1	FITTING			
9	1	CLIP			
10	2	STA-STRAP			
11	1	FITTING			
12	1	TUBING (15 IN.)			
13	4	SCREW (.312-18 x 1-1/4 IN.)	235	19.5	26
14	4	WASHER			
15	4	GROMMET			
16	4	BUSHING			
17	2	SCREW-engine harness ground (M6 x 14)	35		4
18	1	PITOT SENSOR ASSEMBLY			
19	1	SENSOR – FUEL PRESSURE			
20	1	FITTING – STRAIGHT **DIGITAL**			
21	1	CLIP – CONDUIT			
22	1	BRACKET – SPEEDO SENSOR			
23	1	GROMMET			
24	1	BUSHING			
25	1	SCREW (M6 x 25)			
26	1	TRIM HARNESS			
27	3	RELAY			
28	3	DECAL-Trim Relay			
29	3	BRACKET			
30	3	BUSHING			
31	3	GROMMET			
32	3	SCREW (M6 x 25)	35		4
33	1	ECU **(200)**			
	1	ECU **(225)**			
34	3	SCREW (M6 x 25)	100		11.5
35	3	BUSHING			
36	3	GROMMET			
37	3	WASHER			
38	2	SCREW (M6 x 14)	100		11.5
39	1	CLIP			
40	1	CLIP			

Electrical Components



NOTE: COAT ALL EYELET WIRING TERMINALS WITH #25 GACO N700

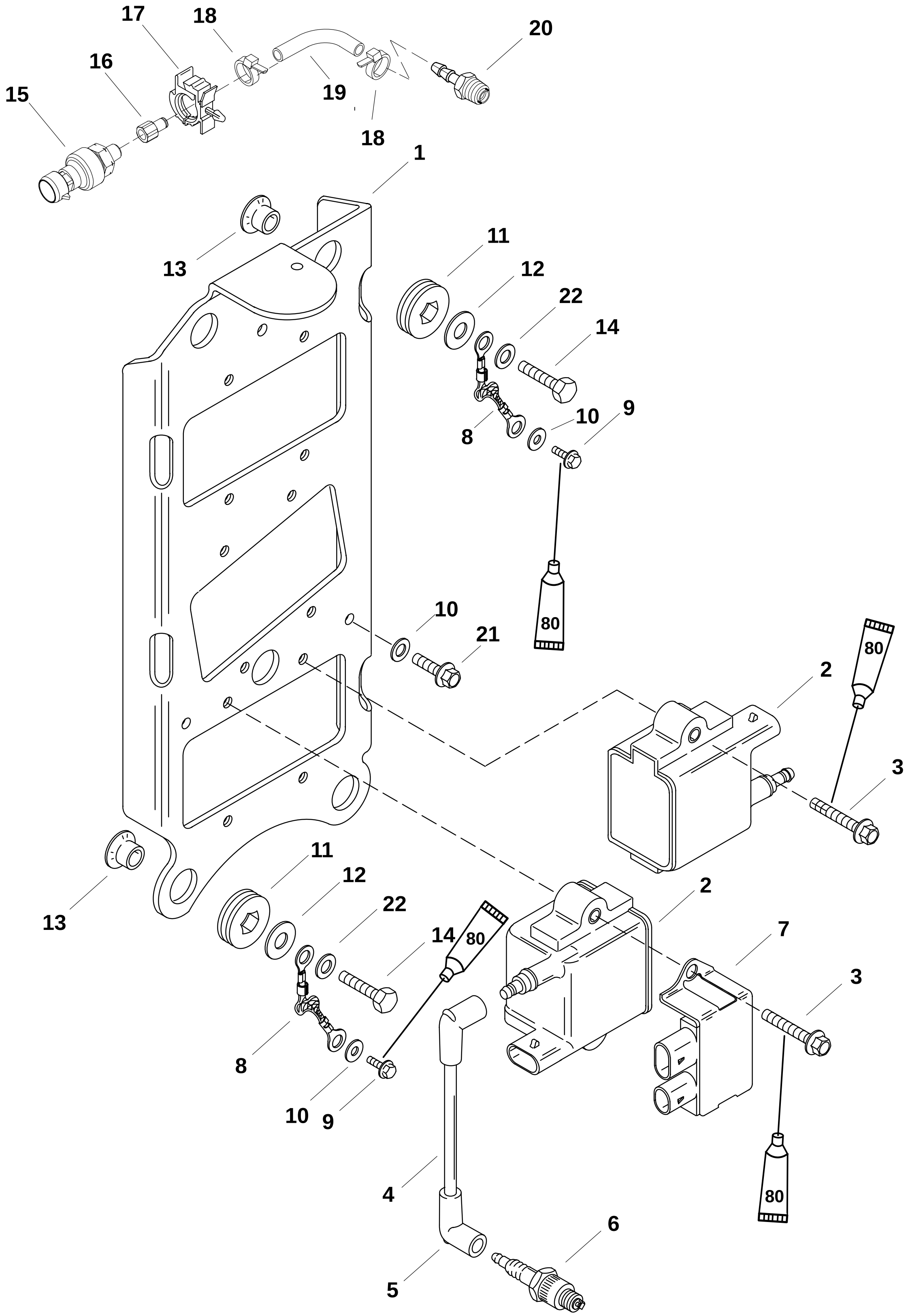
NOTE: COAT ALL MULTI-PIN ELECTRICAL CONNECTIONS (EXCEPT POWER TRIM RELAY CONNECTORS) WITH #6 DC-4

A = TO BLOCK

Electrical Components

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	lb-ft	Nm
41	1	ELECTRICAL PLATE ASSY			
42	1	ENGINE HARNESS			
43	5	FUSE			
44	1	FUSE COVER			
45	1	BRACKET			
46	1	RELAY PLATE ASSEMBLY			
47	1	RELAY PLATE			
48	3	SCREW (M6 x 12)	100		11.5
49	1	BATTERY CABLE **(NEGATIVE)**			
50	2	SCREW (M6 x 14)	35		4
51	1	STARTER SOLENOID			
52	2	GROMMET			
53	2	SCREW (M6 x 25)	35		4
54	1	CABLE **(BLACK)**			
55	2	BUSHING			
56	1	BATTERY CABLE **(POSITIVE)**			
57	2	LOCKWASHER			
58	2	NUT (5/16-18)	50		5.5
59	2	NUT (10-32)	8		0.9
60	1	SCREW (M8 x 20)		18	24.5
61	1	BOOT (RED)			
62	1	CAP NUT			
63	1	CABLE			
64	2	INSULATOR BOOT (YELLOW)			
65	1	CLIP			
66	1	SCREW (M6 x 14)			
67	1	CLIP			
68	1	STA STRAP			
69	1	NUT			
70	1	PLUG (GRAY WIRE) **(DIGITAL)**			

Coil Plate Model Year 2001



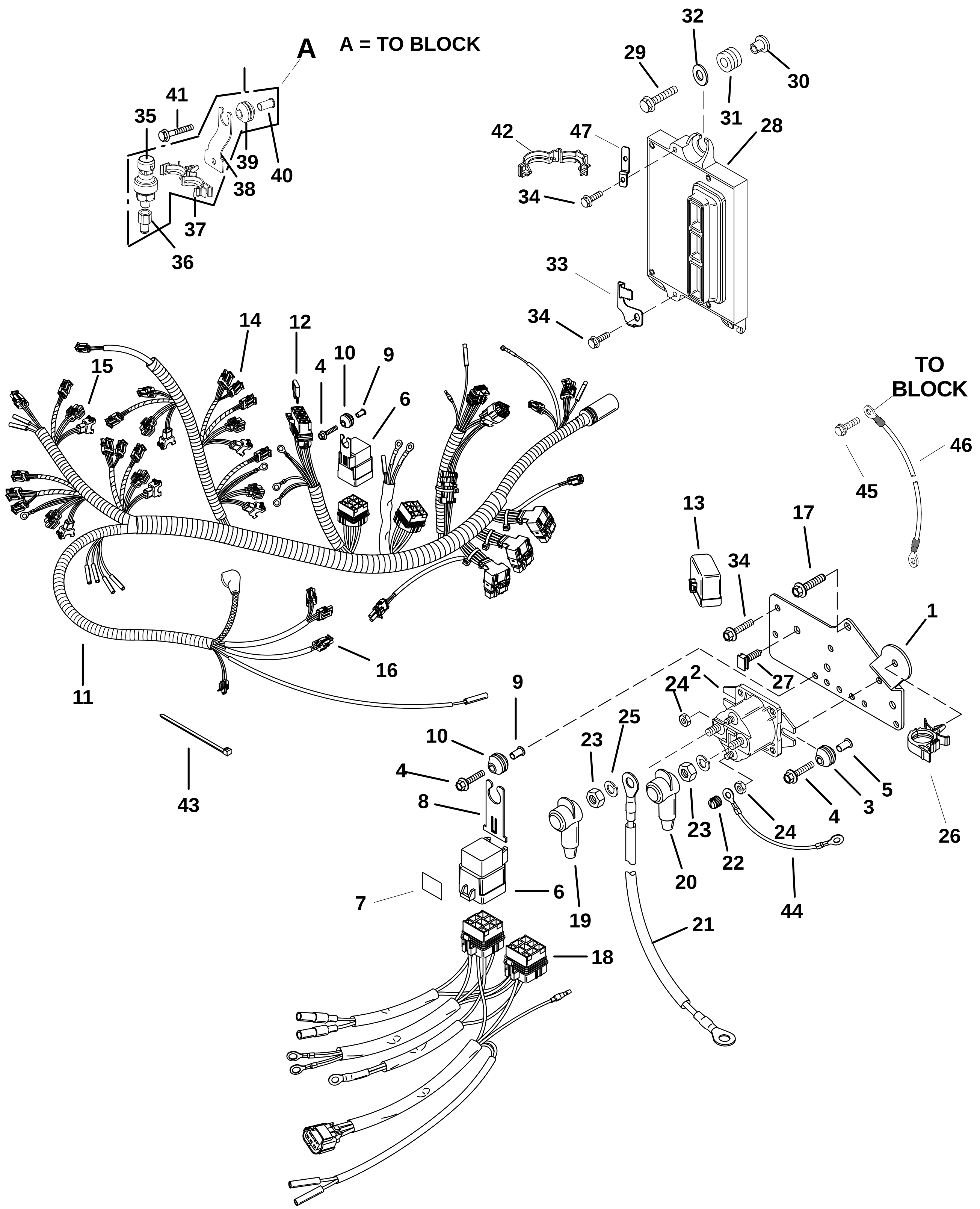
80 30W 4 Cycle Engine Oil (92-97959)

58557

Coil Plate Model Year 2001

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm
1	1	COIL MOUNTING PLATE			
2	6	IGNITION COIL			
3	12	SCREW	60		7
4	6	HIGH TENSION CABLE			
5	12	BOOT			
6	6	SPARK PLUG		20	27
7	3	DUAL COIL DRIVER			
8	2	CABLE			
9	2	SCREW (M6 x 10)	60		7
10	4	WASHER			
11	4	GROMMET			
12	4	WASHER			
13	4	BUSHING			
14	4	SCREW (.312-18 x 1-1/4 IN.)		20	27
15	1	SENSOR			
16	1	FITTING	40		4.5
17	1	CLIP			
18	2	STA STRAP			
19	1	TUBING (15 IN.)			
20	1	FITTING			
21	2	SCREW (M6 x 14)			
22	2	WASHER			

Solenoid Plate Model Year 2001



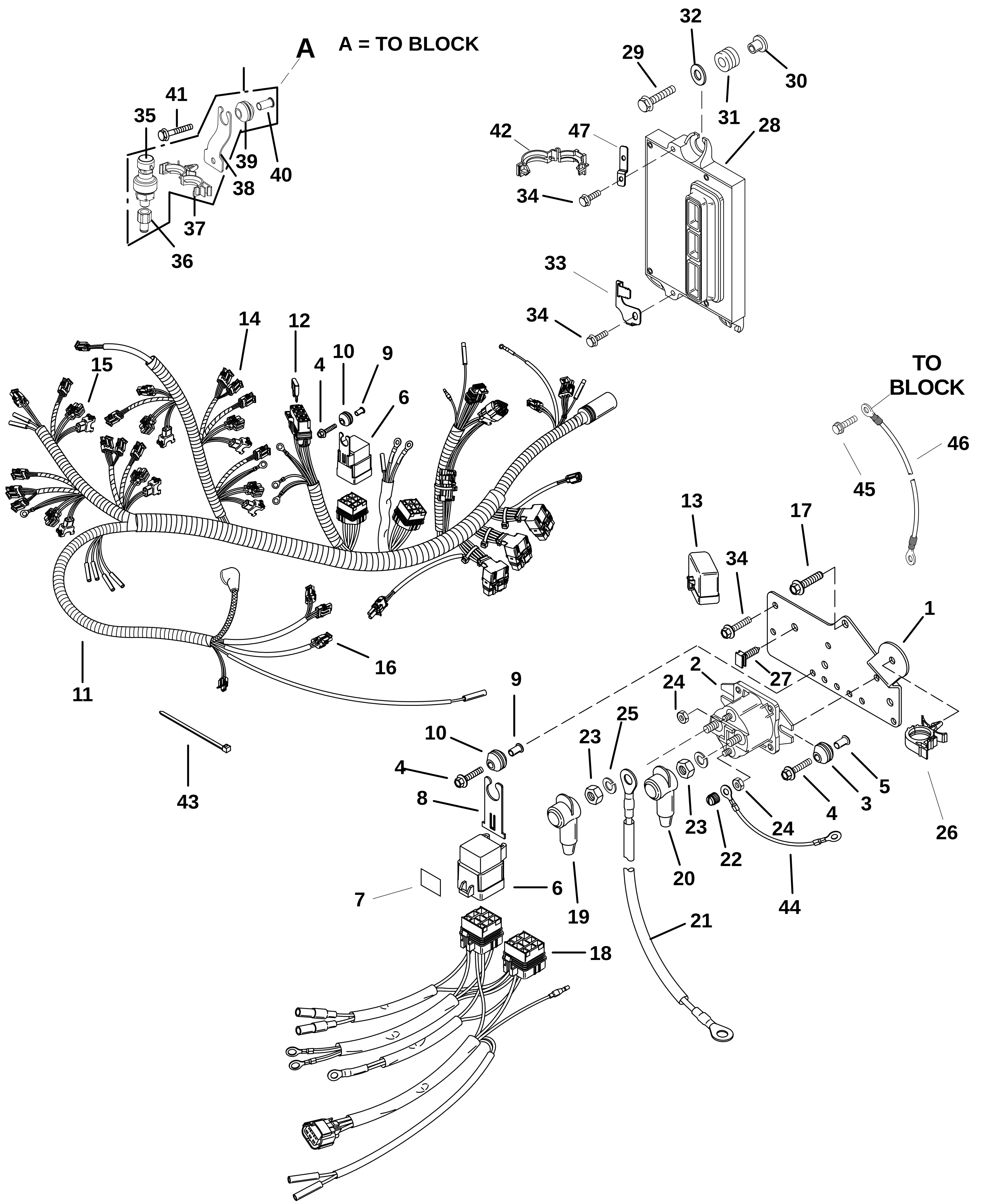
***NOTE:** *Coat all eyelet wiring terminals with #25 GACO N700.*

***NOTE:** *Coat all multi-pin electrical connections (except power trim relay connections) with #6DC-4.*

Solenoid Plate Model Year 2001

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm
1	1	SOLENOID PLATE			
2	1	SOLENOID			
3	2	GROMMET			
4	5	SCREW (M6 x 25)	35		4
5	2	BUSHING			
6	3	RELAY ASSEMBLY			
7	3	DECAL			
8	3	BRACKET			
9	3	BUSHING			
10	3	GROMMET			
11	1	ENGINE HARNESS			
12	5	FUSE (4 – 20 AMP) (1 – 15 AMP)			
13	1	FUSE COVER			
14	1	HARNESS (DIRECT INJECTOR)			
15	1	HARNESS (FUEL INJECTOR)			
16	1	HARNESS (TPS)			
17	3	SCREW-(M6 x 12)	100		11.5
18	1	TRIM HARNESS			
19	1	INSULATOR BOOT (RED)			
20	1	INSULATOR BOOT (YELLOW)			
21	1	CABLE (RED)			
22	1	CAP NUT			
23	2	NUT (5/16-18)	50		5.5
24	2	NUT (10-32) (BRASS)	8		0.9
25	2	LOCKWASHER			
26	1	CLIP			
27	1	CLIP			
28	1	ECU **(200)**			
	1	ECU **(225)**			
29	3	SCREW (M6 x 25)	100		11.5
30	3	BUSHING			
31	3	GROMMET			
32	3	WASHER			
33	1	CLIP			
34	5	SCREW (M6 x 14)	100		11.5
35	1	SENSOR – SPEEDOMETER WATER PRESSURE			
36	1	FITTING	50		5.5
37	1	CLIP			
38	1	BRACKET			
39	1	GROMMET			
40	1	BUSHING			
41	1	SCREW (M6 x 25)	35		4
42	1	CLIP			
43	2	STA–STRAP			

Solenoid Plate Model Year 2001



***NOTE:** *Coat all eyelet wiring terminals with #25 GACO N700.*

***NOTE:** *Coat all multi-pin electrical connections (except power trim relay connections) with #6DC-4.*

Solenoid Plate Model Year 2001

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
44	1	CABLE			
45	1	SCREW (M8 x 20)		18	24.5
46	1	BATTERY CABLE (NEGATIVE)			
47	1	BRACKET			

Theory of Operation

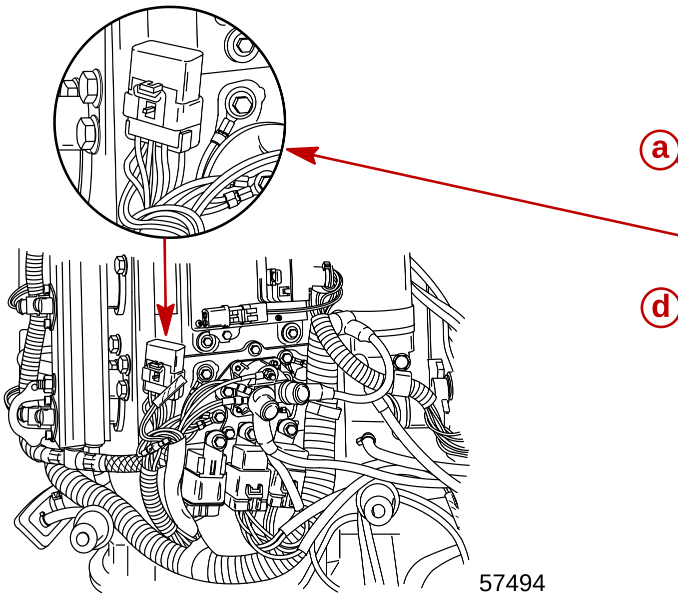
When the ignition key is turned to the RUN position, battery voltage is applied to the main relay through the PURPLE wire. When the Electronic Control Module (ECM) receives a signal from the Crank Position Sensor, the main relay ground circuit is completed through the ECM. The main relay is then closed and D.C. current from the battery or charging system is transferred through the main relay 20 ampere fuse to the positive terminal of all 6 ignition coil primary windings. The negative terminal of the coil primary is connected to engine ground through the ECM. When this circuit is closed, a magnetic field is allowed to be built up in the ignition coil. The Crank Position Sensor senses the location of the 24 teeth (Model 2000) or 54 teeth (Model 2001) on the flywheel and supplies a trigger signal to the ECM. When the ECM receives this signal, the ECM will then open the ground circuit of the coil primary. The magnetic field in the ignition coil primary will then collapse cutting across the coil secondary winding creating a high voltage charge (50,000 volts) that is sent to the spark plug.

Ignition Component Description

Fuses

The electrical wiring circuits on the outboard are protected from overload by fuses in the wiring. If a 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 rating.
2. The fuses and circuits are identified as follows:
   a. **Model Year 2000** – ECM Driver Power/Oil Pump Circuit – SFE 20 AMP Fuse
   Model Year 2001 – Smart Craft Data Bus Circuit – SFE 15 AMP Fuse.
   b. Accessories – SFE 20 AMP Fuse.
   c. Ignition Coil Circuit – SFE 20 AMP Fuse.
   d. **Model Year 2000** – Electric Fuel Pump Circuit – SFE 20 AMP Fuse
   Model Year 2001 – Electric Fuel Pump/ECM Driver Power/Oil Pump Circuit – SFE 20 AMP Fuse.



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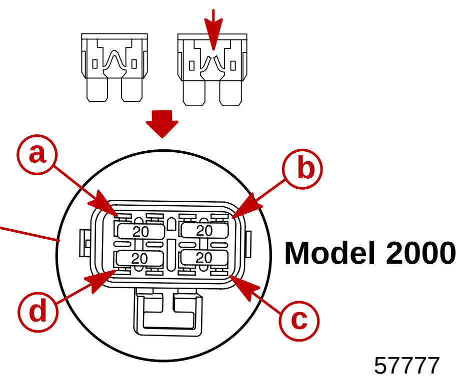

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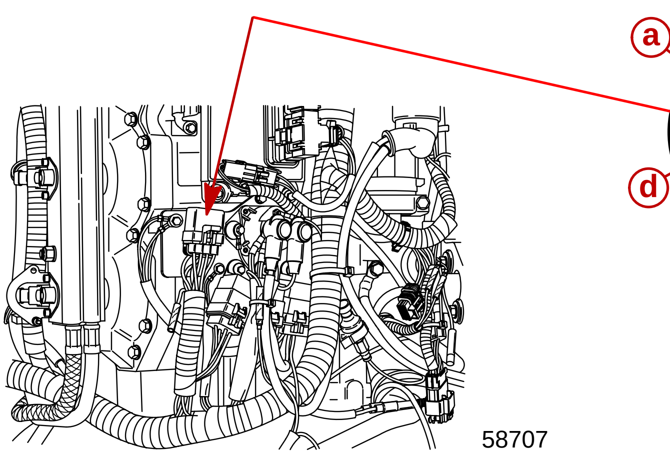

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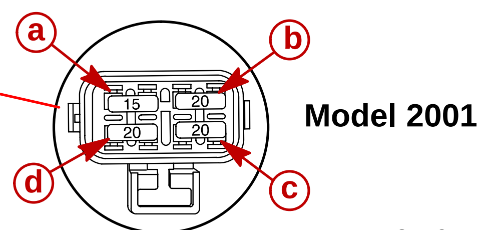


58459

Ignition Component Description

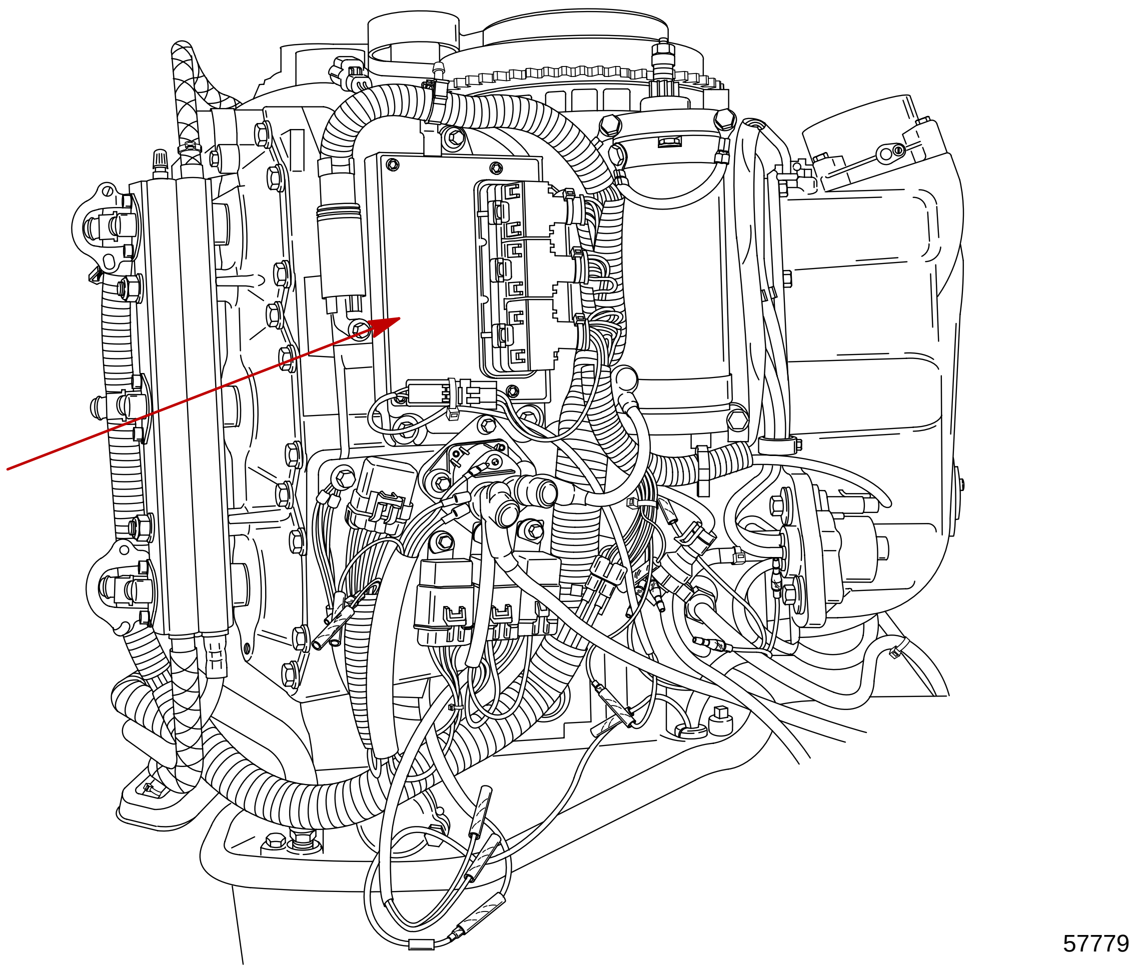
Electronic Control Module (ECM)

The ECM requires 8 VDC minimum 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 91-823686A2 using adaptor harness 84-822560A5.

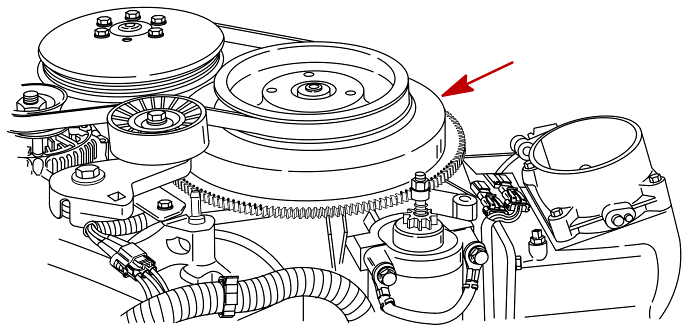
The ECM performs the following functions:

- Calculates the precise fuel and ignition timing requirements based on engine speed, throttle position, manifold pressure and coolant temperature.
- Controls fuel injectors for each cylinder, direct injectors for each cylinder and ignition for each cylinder.
- Controls all alarm horn and warning lamp functions.
- Supplies tachometer signal to gauge.
- Controls RPM limit function.
- Monitors shift interrupt switch.
- Records engine running information.



Flywheel

Model Year 2000 – 24 teeth under the flywheel ring gear
Model Year 2001 – 54 teeth under the flywheel ring gear
Provide engine rpm and crankshaft position information to the ECM through the crank position sensor.

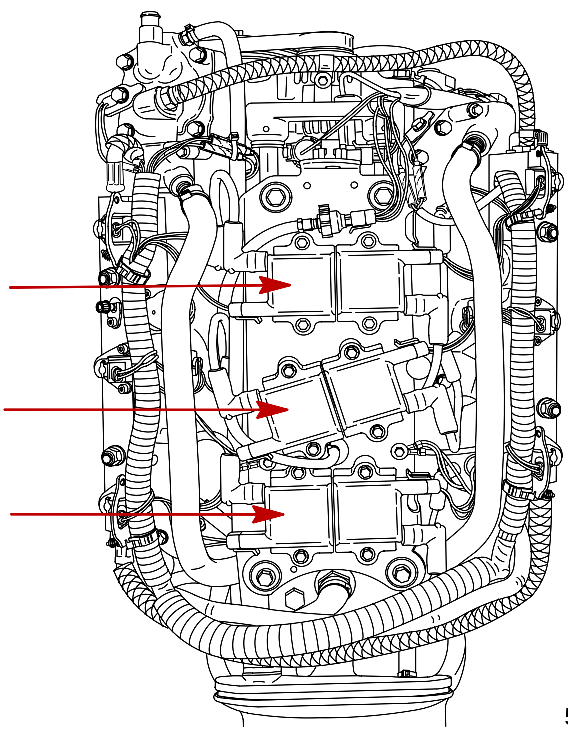


57799

Ignition Coils

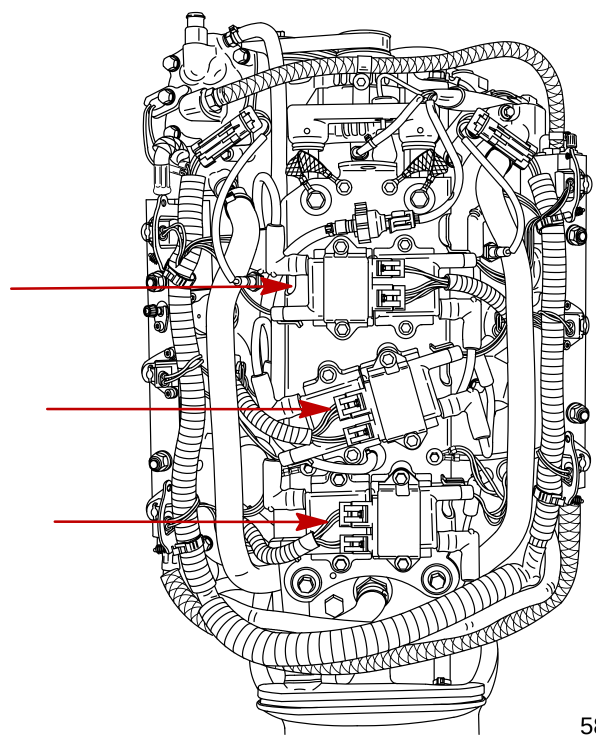
Model Year 2000/2001 – Inductive type ignition coils are used on the DFI engines.

12 volt DC is supplied to the coils at all times from the boat battery. For a predetermined length of time (dwell), the primary circuit of the coil is completed by closing the electrical circuit within the coil driver. When the coil driver circuit opens, the primary field of the coil collapses inducing high voltage in the secondary windings which produces up to 50000 volts at the spark plugs.



57785

MODEL YEAR 2000



58701

MODEL YEAR 2001

Ignition Coil Ohm Test

Connect meter leads between primary terminal (GRN/Striped) and (RED/YELLOW) terminal pin.	0.38 - 0.78 Ω
Connect meter leads between spark plug wire/high voltage tower and ground terminal pin.	8.1 - 8.9 k Ω

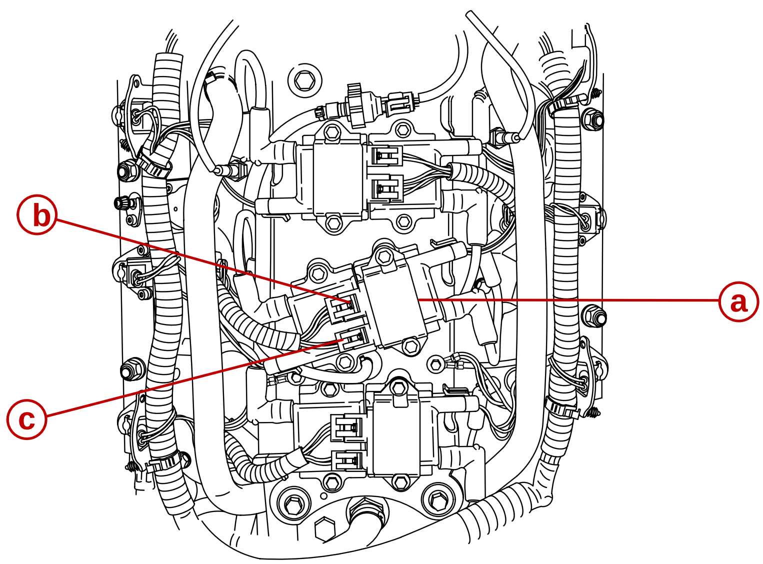
Coil Driver

Model Year 2001 only

The ECM sends a 5 VDC pulse to the coil driver mounted on each ignition coil. Which coil driver receives this pulse is determined by the ECM receiving a signal from the crank position sensor.

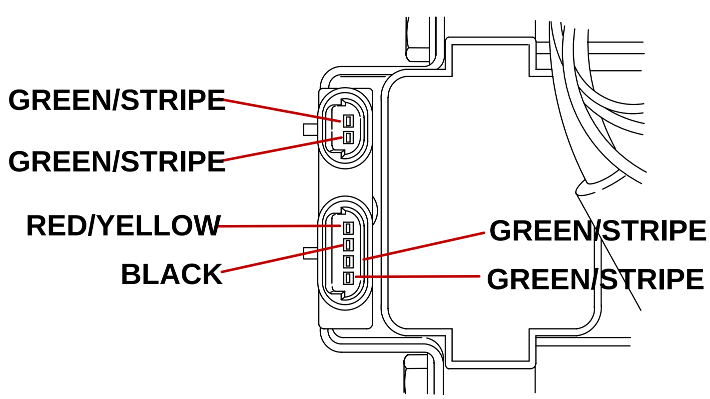
When the coil driver receives its ECM pulse (signal), it closes its circuit which allows the primary side of the ignition coil to build up energy which it initially receives from the boat battery.

When the ECM pulse (signal) to the coil driver drops below 1.3 volts, the coil driver opens its circuit which causes the primary field of the ignition coil to collapse. This field collapse induces a voltage buildup in the secondary winding of the ignition coil resulting in a potential voltage of up to 50000 volts at the spark plug.



a - Coil Driver
b - 4 Pin Connector
c - 2 Pin Connector

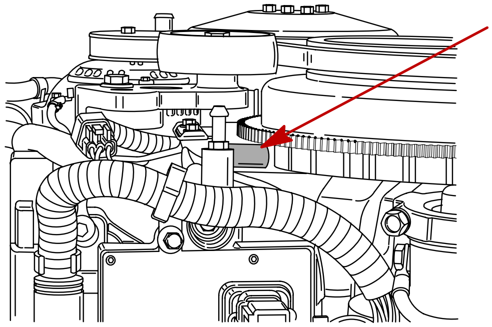
Coil Driver Ohm Test



4 Pin Connector – Connect meter leads between RED/YEL and BLACK male pins.	85 k Ω ± 10%
4 Pin Connector – Connect meter leads between BLACK male pin and each GREEN STRIPED male pin.	10 k Ω ± 10%
Connect meter leads between BLACK male pin on 4 pin connector and each GREEN STRIPED male pin on the 2 pin connector.	OPEN – No Continuity

Crank Position Sensor

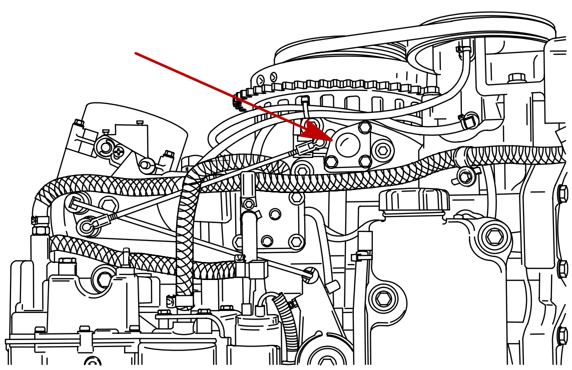
Model Year 2000 – Senses 24 teeth located on flywheel under ring gear.
Model Year 2001 – Senses 54 teeth located on flywheel under ring gear.
Supplies the ECM with crank position information and engine speed. If sensor should fail, the engine will stop running.



Crank Position Sensor Specifications	
Air Gap	0.025 in – 0.040 in (0.635 mm – 1.01 mm)

Throttle Position Sensor (TPS)

The TPS transmits throttle angle information to the ECM which varies the injector pulse width accordingly. Should the sensor fail, the dash mounted CHECK ENGINE light will light and the warning horn will sound. RPM will be reduced by the ECM. TPS settings are not adjustable. TPS settings can be monitored with the Digital Diagnostic Terminal through the ECM. Voltage change should be smooth from idle to wide open throttle. If voltage change is erratic, TPS is defective.



Model Year 2000 Throttle Position Sensor Specifications	
Idle	4.0 – 4.7 VDC
Wide Open Throttle	0.4 – 1.3 VDC

Model Year 2001 Throttle Position Sensor Specifications	
Idle	0.4 – 1.3 VDC
Wide Open Throttle	4.0 – 4.7 VDC

Throttle Position Sensor (TPS) Troubleshooting

If the throttle position sensor(s) are out of the intended operating range when the engine is started, the Electronic Control Module (ECM) will sense that the Throttle Position Sensor (TPS) has failed. The warning horn will sound, check engine light will illuminate DDT will indicate failed TPS and the engine will go into RPM reduction. When the engine is started, the throttle arm on the engine must be against the throttle stop screw.

- Check throttle cable adjustment. The throttle stop screw on the throttle arm must be against the throttle stop on the cylinder block when the engine is started. Pre-load the throttle cable barrel 1 or 2 turns if necessary.
- Verify driver is not pushing on throttle (if foot throttle is used) or advancing the throttle only on the control box.
- Check throttle cam to roller adjustment. If the roller is not down in the pocket/valley area on the cam, there is a tendency for the roller to ride up or down on the cam which causes the TPS link arm to push/pull on the TPS lever resulting changing values.
- Heat or pressure test the TPS.

HEAT TEST

With engine at idle, heat the TPS (with a hot air gun) below the electrical connection until **warm** to the touch. Watch for any one or a combination of the following symptoms:

- RPM change
- Check engine light illumination
- Momentary warning horn signal
- TPS voltage value change (1/2 volt) on DDT

***NOTE:** Excessive heat will damage TPS.*

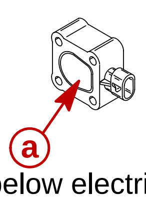
PRESSURE TEST

IMPORTANT: When testing TPS voltage, do not move the drive mechanism (rotor/wiper).

1. Connect DDT and rotate the key to the “ON” position.
2. Set DDT to read TPS voltage; expand the screen to show Now/Min/Max.

***NOTE:** Test accuracy is improved when TPS is at its lowest voltage reading; this may be idle or WOT depending on model year.*

3. Clear the minimum/maximum values on the DDT – press the “0” button.
4. Watch the DDT readings while pressing below the electrical connection point on the TPS cover.



a - Press on cover below electrical connection

5. Voltage reading should change:

- Less than a couple of digits (i.e. 1.90 v to 1.92 v)

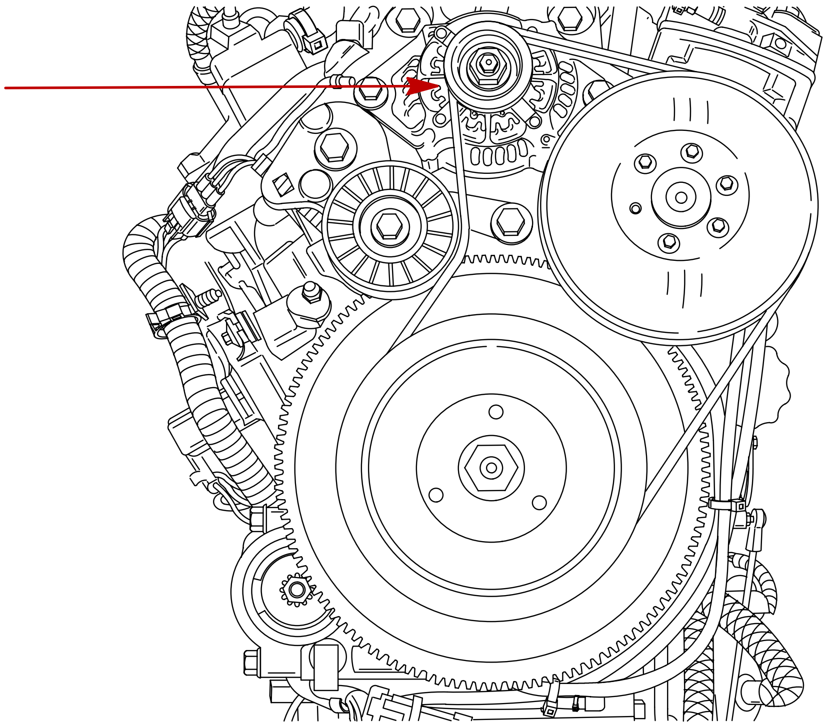
***NOTE:** Version 5.0 cartridge gives 3 decimal point (millivolts) accuracy if below 1 volt.*

- Less than 10 millivolts (i.e. 0.293 v to 0.285 v)

Replace any TPS that fails either test.

Charging System Alternator

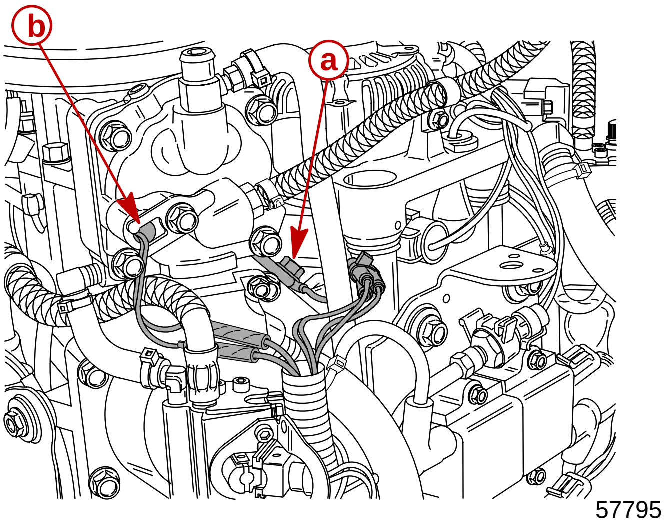
Battery charging system is contained within the belt driven alternator, including the regulator. At cranking speeds, electrical power for the engine is provided by the boat battery – minimum recommended size is 750 CCA, or 1,000 MCA, cold cranking amperes or 105 (Minimum) Ampere Hours. Above 550 RPM, all electrical power is provided by the alternator. Should engine rpm drop below 550 RPM, the alternator is not capable of providing sufficient output and the battery becomes the primary source of electrical power.
Alternator output (when hot) to the battery @ 2000 RPM is approximately 33 - 38 amperes.



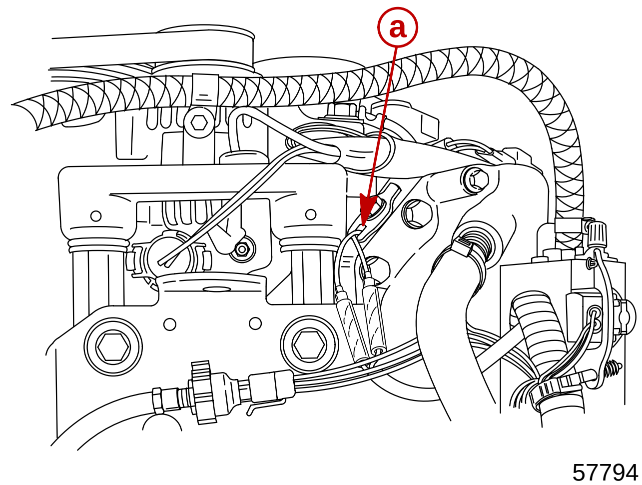
57806

Temperature Sensor

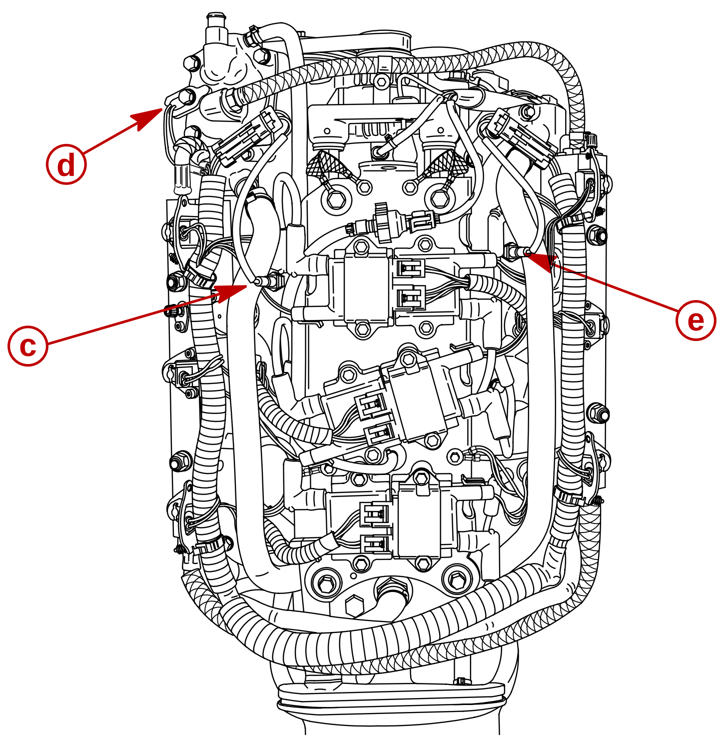
Three (3) temperature sensors are used to provide cylinder head temperature information to the ECM. One sensor is mounted on each cylinder head and one in the air compressor cylinder head. The ECM uses this information to increase injector pulse width for cold starts and to retard timing in the event of an over-heat condition.



MODEL 2000 PORT



MODEL 2000 STARBOARD



MODEL 2001

a - Cylinder Temperature Sensor
b - Air Compressor Temperature Sensor
c - Cylinder Temperature Sensor (PORT
d - Air Compressor Temperature Sensor
e - Cylinder Temperature Sensor (STARBOARD)

An ohms test of the temperature sensor would be as follows:

MODEL YEAR 2000 – Insert digital or analog ohmmeter test leads into both TAN/BLACK sensor leads. With engine at temperature (F°) indicated, ohm readings should be as indicated ±10%. There should be no continuity between BLACK and each TAN/BLACK lead and no continuity between each TAN/BLACK lead and ground.

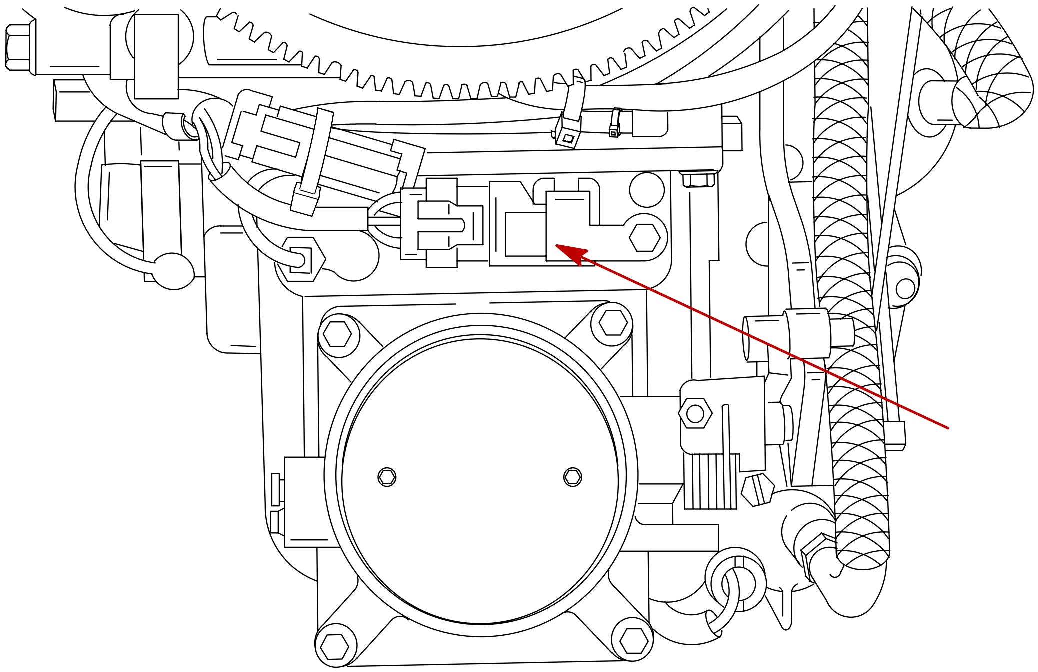
MODEL YEAR 2001 – Disconnect temperature sensor harness and check continuity with digital or analog ohmmeter test leads between both connector pins. With engine at temperature (F°) indicated, ohm readings should be as indicated ±10%. There should be no continuity between each connector pin and ground.

MODEL YEAR 2000		
F	C	OHMS
257	125	34
248	120	38
239	115	44
230	110	51
221	105	59
212	100	68
203	95	79
194	90	92
185	85	107
176	80	126
167	75	148
158	70	175
149	65	208
140	60	248
131	55	298
122	50	360
113	45	436
104	40	532
95	35	653
86	30	805
77	25	1000
68	20	1250
59	15	1573
50	10	1993
41	5	2546
32	0	3277
14	–10	5579
5	–15	7372

MODEL YEAR 2001		
F	C	OHMS
257	125	340
248	120	390
239	115	450
230	110	517
221	105	592
212	100	680
203	95	787
194	90	915
185	85	1070
176	80	1255
167	75	1480
158	70	1752
149	65	2083
140	60	2488
131	55	2986
122	50	3603
113	45	4370
104	40	5327
95	35	6530
86	30	8056
77	25	10000
68	20	12493
59	15	15714
50	10	19903
41	5	25396
32	0	32654
14	–10	55319
5	–15	72940

Manifold Absolute Pressure (MAP) Sensor

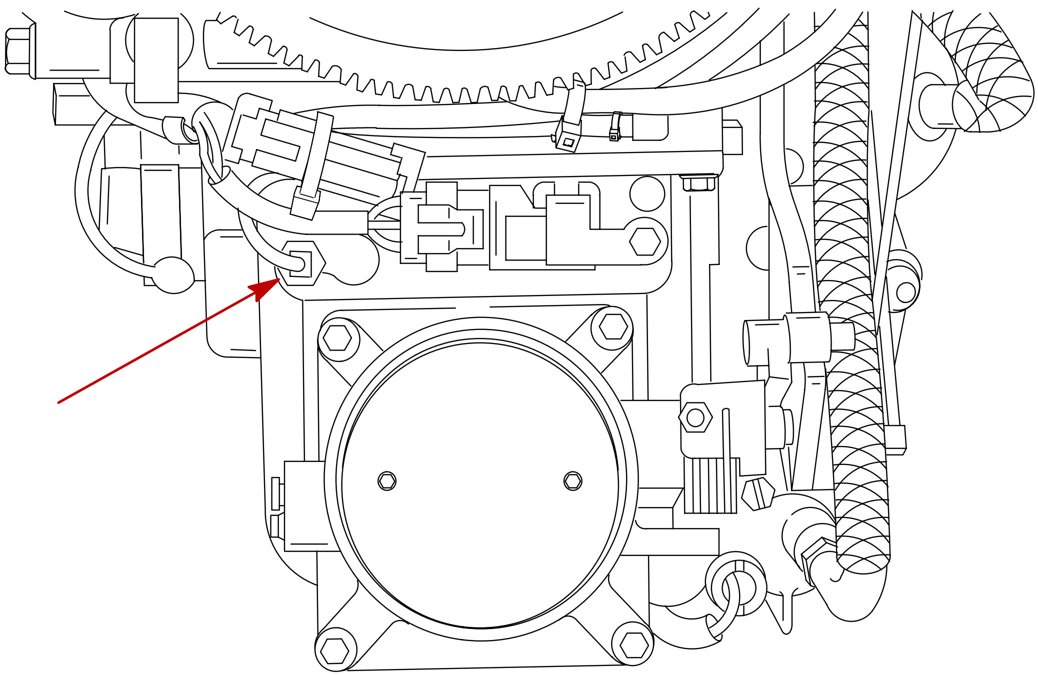
The MAP sensor is mounted on top of the air plenum. The ECM regulates fuel flow, in part, based on manifold absolute pressure.



57793

Air Temperature Sensor

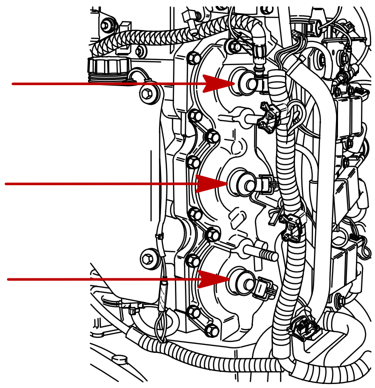
The air temperature sensor is mounted on top of the air plenum. The ECM regulates fuel flow, in part, based on manifold air temperature. As air temperature increases, the ECM decreases fuel flow.



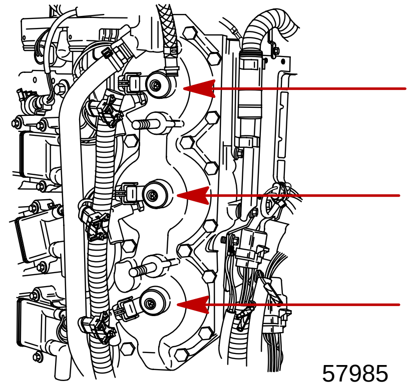
57793

Direct Injectors

6 direct injectors (1 per cylinder) are used to inject a fuel/air mix into cylinders. Injectors are mounted between fuel rails and cylinder heads.



57986

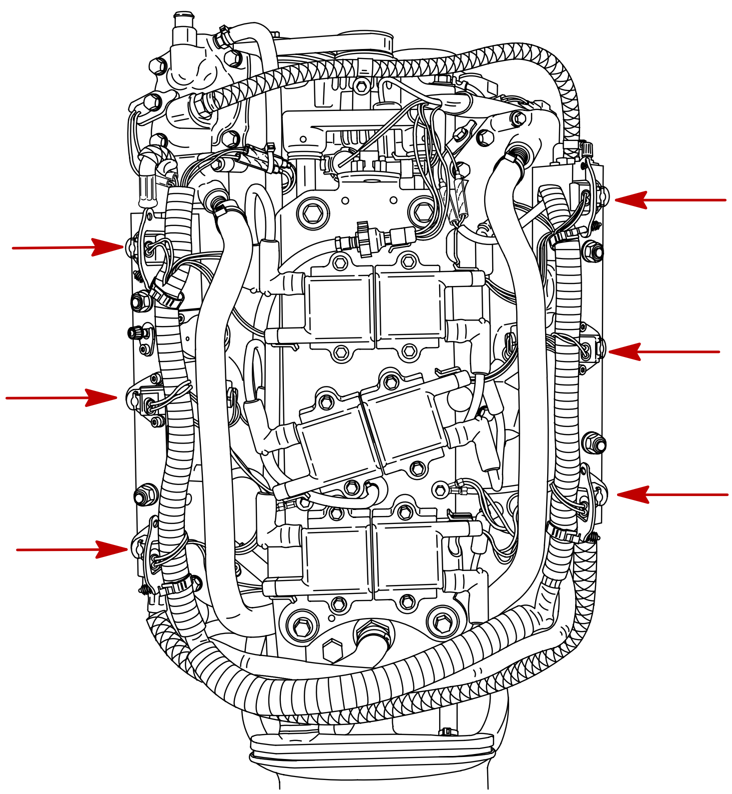


57985

Direct Injector Ohm Test (Injector Lead Disconnected)	
Connect meter leads between each injector terminal pin.	1 - 1.6 Ω
Connect 1 meter lead to either injector pin while touching the other meter lead to the injector metal case.	No continuity

Fuel Injectors

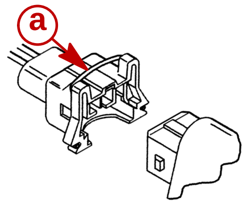
6 fuel injectors (1 per cylinder) are used to provide fuel from the fuel rail to the direct injectors. The fuel injectors are mounted in the fuel rail.



57785

Fuel Injector Ohm Test (Injector Lead Disconnected)	
Connect meter leads between each injector terminal pin.	1.7 - 1.9 Ω

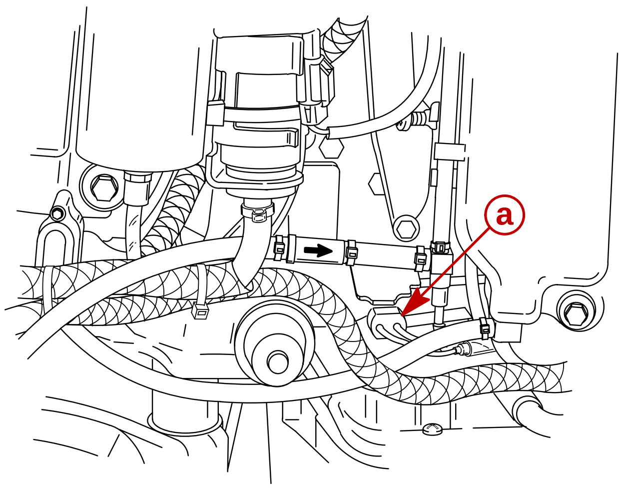
Disconnecting Harness Connectors from Ignition Coils and/or Injectors



54871

a - Wire Clip (push center down to remove)

Shift Interrupt Switch



57737

a - Shift Interrupt Switch

The shift interrupt switch is designed to reduce the torque load on the gear case components to assist in shifting. The switch is monitored by the ECM which will interrupt the fuel flow momentarily to 3 cylinders (#1, #2 and #4) when engine speed exceeds 600 rpm in neutral.

The switch function can be monitored by the DDT. The DDT will display ON when outboard is in neutral and OFF when in gear.

The switch is open (no continuity) when outboard is in gear and closed (continuity) when outboard is in neutral.

If shift operation is difficult, shift interrupt switch function can be checked by the DDT or an ohmmeter – for open or closed operation and for a continuity check of the switch harness for shorts or open wiring.

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.

<u>Disconnecting a sensor for troubleshooting purposes may have no noticeable effect.</u>

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.

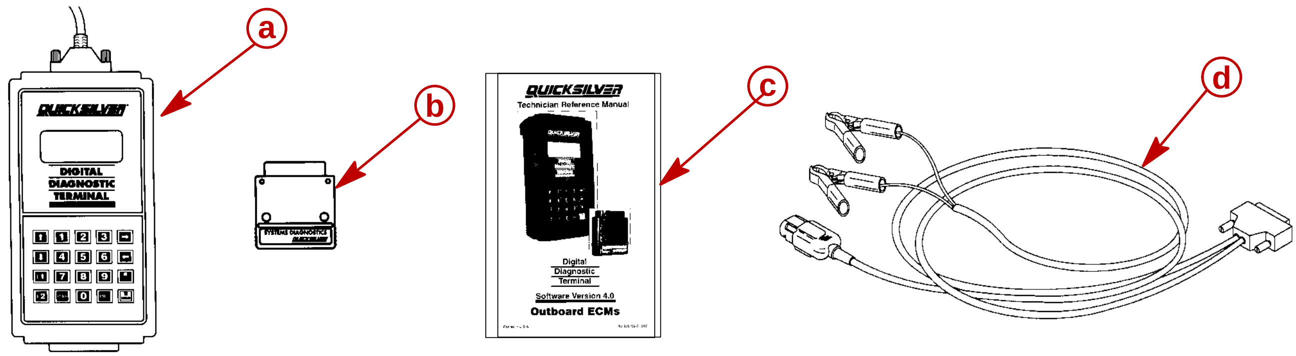
***NOTE:** ECMs are capable of performing a cylinder misfire test to isolate problem cylinders. Once a suspect cylinder is located, an output load test on the ignition coil, fuel injector and direct injector may be initiated through use of the DDT.*

- 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.
- Check air compressor pressure.

Troubleshooting with the Digital Diagnostic Terminal



a - Digital Diagnostic Terminal (91-823686A2)
b - **2000 and Prior –** Software Cartridge (91-822608--4 or --5 or --6)
2001 and Up – Software Cartridge (91-880118)
c - **2000 and Prior –** DDT Reference Manual (90-825159-3)
2001 – DDT Reference Manual (90-881204)
d - Adapter 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.

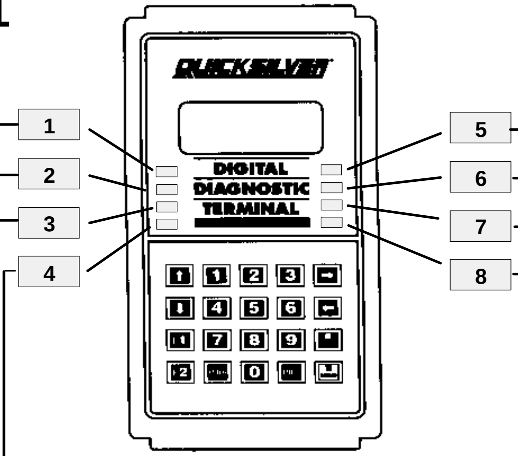
Attach the diagnostic cable to the ECM diagnostic connector and plug in the software cartridge. You will be able to monitor sensors and ECM data values including status switches.

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.

Notes:

DDT Functions – Optimax Models Software Version 4.0 and 4.1



1

MARINE DIAGNOSTICS
1 - Mariner/Mercury
2 - MerCruiser
3 - Injector Test
4 - Tool Setup

5

SELECT ECM
1 - 3.0L Ignition ECM
2 - 3.0L Fuel ECM
3 - 824003 Fuel ECM
4 - 2.5L Hi Perf ECM
5 - DFI ECM
6 - 4 Stroke ECM

1 or 2

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

Select Auto Test:
1 - STATIC TEST — *Engine Not Running During Test*
2 - RUNNING TEST — *Engine Running During Test*

Monitors Engine Functions While Engine is Running

ENGINE RPM
TPI 1 VOLTS
TPI 2 VOLTS
BATTERY VOLTS
PWR 1 VOLTS
PWR 2 VOLTS
COOL TMP STB °F
COOL TMP PRT °F
MAP PSI
AIR TMP °
TRIGGER ERR
TIME TO OIL
OIL INJ CNT
TPI %
AIR COM TMP °F
BLOCK PSI

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

Select Function:
1 - OIL PUMP PRIME
2 - CYLINDER MISFIRE
3 - OUTPUT LOAD TEST
4 - RESET BREAK-IN OIL

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

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

ECM RUN TIME	xx
RPM 0000-0999	xx
RPM 1000-1499	xx
RPM 1500-2999	xx
RPM 3000-3999	xx
RPM 4000-4999	xx
RPM 5000-5999	xx
RPM 6000+	xx
BREAK IN Min	xx
OVER TMP Sec	x
RPM LIMIT CNT	x
RPM LIMIT SEC	x
ACT TEMP SEC	x
BLOCK PSI Sec	x
CTS TMP Sec	x
CTP TMP Sec	x
OIL PMP Sec	x

Select Fault Hist:
1-IGNITION
2-INJECTOR
3-PUMP
4-SENSORS
5-SWITCHES
6-MISCELLANEOUS

Any fault in Select Status functions 1 thru 7 will turn on the matching panel light.
Illuminated panel light 8 Indicates engine is in Break-in.

NOTE:Test data is lost when Key Switch is turned off. Any existing faults from Tests 1 thru 6 are transferred to Fault History.

Select Status:
1 - IGNITION
2 - INJECTOR
3 - PUMP
4 - SENSORS
5 - SWITCHES
6 - MISCELLANEOUS
7 - RPM LIMIT
8 - BREAK-IN

Text Book Data (specs)

98 DI
ECM #
CODE
IGN PRI .38-.78 ohm
SEC 8.1-8.9 Kohm
DINJ 1.0-1.6 ohm
FINJ 1.7-1.9 ohm
TPI1 3.7-4.9v IDLE
0.3-1.8v WOT
TPI2 0.1-1.5v IDLE
3.2-4.9v WOT
TPI1 LtBlu/Red IN
TPI2 LtBlu/Wht OUT
TGAP 0.025-.04in
PWR RLY 81-99 ohm
CTS max 220F
ACT max 150-220F
30-8000 ohm 1K@77F
AIR TMP .540-44
BATV 12.6-15.0
MAP 7-15 psi
FUEL 88-90 psi
AIR 77-81 psi

IGN	ACTIVE	HIST
IGN 1	PASS	PASS
IGN 2	PASS	PASS
IGN 3	PASS	PASS
IGN 4	PASS	PASS
IGN 5	PASS	PASS
IGN 6	PASS	PASS

INJECTOR	ACTIVE	HIST
INJ 1	PASS	PASS
INJ 2	PASS	PASS
INJ 3	PASS	PASS
INJ 4	PASS	PASS
INJ 5	PASS	PASS
INJ 6	PASS	PASS

PUMP	ACTIVE	HIST
OIL PMP	PASS	PASS

SENSOR	ACTIVE	HIST
COOL STB	PASS	PASS
COOL PRT	PASS	PASS
MAP	PASS	PASS
AIR TMP	PASS	PASS
TPI 1	PASS	PASS
TPI 2	PASS	PASS
TRIG SIG	PASS	PASS
COMP TMP	PASS	PASS
BLOCK PSI	PASS	PASS

SWITCH	ACTIVE	HIST
SHIFT SW	ON	NA
H2O FUEL	NO	NO
L OIL	NO	NO

MISC.	ACTIVE	HIST
BATTERY	PASS	PASS
PWR RLY	PASS	PASS
PWR 1 V	PASS	PASS
PWR 2 V	PASS	PASS
HORN	PASS	PASS
LAMP	PASS	PASS

LIMIT	ACTIVE	HIST
CTS LIM	OFF	ON
CTP LIM	OFF	OFF
ACT LIM	OFF	OFF
TP1 LIM	OFF	OFF
TP2 LIM	OFF	OFF
RPM LIM	OFF	OFF
OIL LIM	OFF	ON
BAT LIM	OFF	OFF
BLK LIM	OFF	OFF
PWR LIM	OFF	OFF

STATUS BREAK-IN ENGINE IS IN BREAK-IN MODE. xxx MINUTES TO COMPLETION.
or
STATUS BREAK-IN ENGINE HAS COMPLETED A FACTORY SCHED-ULED BREAK-IN.

DDT Functions – Optimax Models Software Version 1.0

SmartCraft Monitor
1 – Mercury Marine
2 – Tool Setup

THIS ENGINE IS A
xx MY xxx x.xL xxx
PRESS 1 to CONTINUE

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

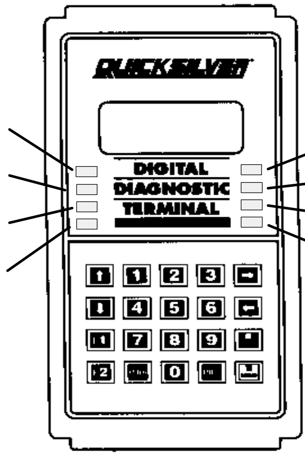
Select Auto Test:
1 – STATIC TEST

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

ENGINE RPM
TPI 1 VOLTS
BATTERY VOLTS
PWR 1 VOLTS
COOL TMP STB °F
COOL TMP PRT °F
MAP PSI
AIR TMP °F
BLOCK PSI
OIL INJ CNT
TPI %
AIR COM TMP °F
OIl LEVEL
FUEL LEVEL
AVAILABLE PWR %
SHIFT
TRIM
PITOT
PADDLE WHEEL
LAKE/SEA TMP °F

01MY DI
ECM #
CODE
IGN PRI .38-.78 ohm
SEC 8.1-8.9 Kohm
DINJ 1.0-1.6 ohm
FINJ 1.7-1.9 ohm
TYPICAL TPI RANGE
TPI 1 0.19-1.0v IDLE
3.45-4.63v WOT
TGAP 0.025-.04in
PWR RLY 81-99 ohm
RPM LIMIT 5850
PROP RPM 5000-5750
AIR COMPRESSOR
1Kohm @ 77F/25C
AIRTEMP/COOLANT
10 Kohm @ 77F/25C
BATV 12.6-15.0
MAP 7-15 psi
FUEL AIR +10 psi
AIR 77-82 psi
OIL PUMP COIL
1.8-2.0 ohms
1 FUSE-INJ/OIL PUMP
2 FUSE-FUEL PUMP
3 FUSE-ACCESSORY
4 FUSE-IGNITION
OVERTEMP/BLOCK
PRESSURE LIMITS ARE
CONTROLLED BY
ENGINE GUARDIAN
SEE SERVICE MANUAL
FOR GUARDIAN INFO

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



Fault Status List

ACT INPUT HI or LO	Air compessor temperature sensor input is high or low
AT INPUT HI or LO	Air tempetratrure (engine) sensor input is high or low
BATT VOLT HI or LOW	Battery voltage is high or low
BLOCK PRESS LOW	Block pressure is low
BPSI INPUT HI or LO	Block Pressure Sensor input is high or low
BREAK-IN	Engine Break-In In Progess
COMP OVERHEAT	Compressor overheat
CTP INPUT HI or LO	Coolant temp port sensor input is high or low
CTS INPUT HI or LO	Coolant temp starboard sensor input is high or low
DINJ 1 thru 6 SHORT or OPEN	Direct injector (1 thru 6) is short or open circuit
EST 1 thru 6 SHORT or OPEN	Electronic spark trigger signal (1 thru 6) is short or open circuit
FINJ 1 thru 6 SHORT or OPEN	Fuel injector (1 thru 6) is short or open circuit
FUEL LVL IN HI or LO	Fuel level sensor input is high or low
GUARDIAN	Guardian system activated
H2O IN FUEL	Water in fuel
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
OIL LVL IN HI or LO	Oil level sensor input is high or low
OIL PUMP	Oil pump electrical failure
OIL RESERVE STR	Oil reserve strategy is active
OVERSPEED	Overspeed is activated
PITOT INPUT HI or LO	Pilot Pressure Sensor input is high or low
PORT OVERHEAT	Port cylinder head overheat
SEA TMP IN HI or LO	Sea or lake temperature sensor input is high or low
STAR OVERHEAT	Starboard cylinder head overheat
TPI1 INPUT HI or LO	TPI #1 sensor input is high or low
TPI1 NO ADAPT	ECM is unable to adapt to the current position of the TPI
TPI1 RANGE HI or LO	TPI #1 is above or below the allowable range
TRIM INPUT HI or LO	Trim sensor input is high or low
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-BREAK-IN
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
COOL TMP STB °F
COOL TMP PRT °F

FAULT SECONDS
BATT VOLT HIGH
BATT VOLT LOW
BLOCK PRESS LOW
COMP OVERHEAT
ETC MOTOR OPEN
ETC MOTOR SHORT
FUEL P INPUT HI
FUEL P INPUT 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 – 749
RPM 750 – 1499
RPM 1500 – 2999
RPM 3000 – 3999
RPM 4000 – 4499
RPM 4500 – 4999
RPM 5000– 5499
RPM 5500 – 6249
RPM 6250 +
BREAK-IN LEFT
RPM LIMIT Sec
GRD LIMIT Sec
ACT TEMP Sec
BLOCK PSI Sec
CTS TMP Sec
CTP TEMP Sec
LOW OIL Sec
OIL PMP 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

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

DFI Troubleshooting Guide		
Symptom	**Cause**	**Action**
1. Engine cranks but won't start	**1.0** Lanyard stop switch in wrong position.	Reset lanyard stop switch.
	1.1 Weak battery or bad starter motor, battery voltage drops below 8 volts while cranking (ECM cuts out below 8 volts) (Fuel pump requires 9 Volts).	Replace/charge battery. Inspect condition of starter motor. Check condition of battery terminals and cables.
	1.2 Low air pressure in rail (less than 70 psi at cranking	Inspect air system for leaks. Inspect air filter for plugging (air pressure measured on port rail). Inspect air compressor reed valves if necessary.
	1.3 No fuel	Check that primer bulb is firm. Key-on engine to verify that fuel pump runs for 2 seconds and then turn off. Measure fuel pressure (valve on starboard rail). Fuel pressure should be 10 ± 1 psi greater than the air pressure.
	1.4 Low fuel pressure	Check fuel pressure from low pressure electric fuel pump (6–10 psi). Check for fuel leaks. If fuel pressure leaks down faster than air pressure, seals on fuel pump may be leaking. Check air system pressure, see **1.2**.
	1.5 Flywheel misaligned during installation	Remove flywheel and inspect.
	1.6 Blown fuse	Replace fuse. Inspect engine harness and electrical components.
	1.7 Main Power Relay not functioning	Listen for relay to "click" when the key switch is turned on.
	1.8 Spark Plugs	Remove fuel pump fuse. Unplug all direct injector connectors. Remove spark plugs from each cylinder. Connect spark plug leads to Spark Gap Tester 91-830230T. Crank engine or use DDT output load test for each ignition coil and observe spark. If no spark is present, replace appropriate ignition coil. If spark is present, replace spark plugs.

DFI Troubleshooting Guide (continued)		
Symptom	**Cause**	**Action**
1. Engine cranks but will not start (continued)	**1.9** ECM not functioning **1.9A** Crank Position Sensor not functioning	Injection System: Listen for injector “ticking” when cranking or connect spare injector to each respective harness. Ticking should start after 2 cranking revolutions. Ignition System: – Check for proper operation by using Inductive Timing Light 91-99379. – Check battery voltage (RED/YEL Lead) @ ignition coils. – Check for blown fuse (C15). – Check battery voltage to fuse from main power relay (PURPLE Lead). – Check for shorted stop wire (BLK/YEL). – Check crank position sensor setting [0.015 in. – 0.040 in. (0.38mm – 1.01mm)] from flywheel or for defective crank position sensor. – Defective ECM. Power Supply: Clean and inspect remote control male and female harness connectors.
2. Engine cranks, starts and stalls	**2.0** Low air pressure in rail	See **1.2**
	2.1 Low fuel pressure in rail	See **1.2** and **1.3**
	2.2 Abnormally high friction in engine	Check for scuffed piston or other sources of high friction.
	2.3 Air in fuel system/lines	See **1.3** Crank and start engine several times to purge.
	2.4 TPS malfunction	Check motion of throttle arm. Stop nuts should contact block at idle and WOT. Check TPS set-up. Must connect DDT with adapter harness (84-822560A5) to ECM.
	2.5 Remote control to engine harness connection is poor	Clean and inspect male and female connectors.
	2.6 Flywheel misaligned during installation	Remove flywheel and inspect.

DFI Troubleshooting Guide (continued)		
Symptom	**Cause**	**Action**
3. Engine idle is rough	**3.1** Low air pressure in rail (less than 79 ± 2 psi while running)	See **1.2**
	3.2 Fouled spark plug	Replace spark plug: –If carbon bridges electrode gap or if it is completely black. –If it is not firing and is wet with fuel. *Note: If spark plug is grey or completely black with aluminum specs, this indicates a scuffed piston.*
	3.3 Failed direct injector	Refer to specifications for ohm test.
	3.4 Failed fuel injector	Refer to specifications for ohm test.
	3.5 Bad coil/weak spark	Refer to specifications for ohm test.
	3.6 Flywheel misaligned during installation	Remove flywheel and inspect.
4. Engine idles fast (rpm >700) or surges	**4.1** Broken fuel pressure regulator or tracker diaphragm	Measure fuel pressure. Remove and inspect diaphragms (a special tool is required for assembly).
	4.2 Fuel leak	Check for fuel entering induction manifold or air compressor inlet. Fuel pump diaphragm leaking and/or Vapor Separator flooding over.
	4.3 Tracker Valve spring missing	Inspect tracker valve for proper assembly.
	4.4 Improper set-up	Check throttle cable & cam roller adjustment.
5. Engine runs rough below 3000 rpm	**5.1** Fouled spark plug	See **3.2**
	5.2 Low air pressure in rail	See **1.2**
	5.3 Throttle misadjusted	Check throttle cam setup on induction manifold. Inspect linkage and roller. If throttle plate stop screws have been tampered with, contact Mercury Marine Service Department for correct adjustment procedures.
	5.4 Bad coil/weak spark	See **3.5**
	5.5 TPS malfunction	See **2.4**
6. Engine runs rough above 3000 rpm	**6.1** Fouled spark plug	See **3.2**
	6.2 Speed Reduction	See **7**
	6.3 Low air pressure in rails	See **1.2**
	6.4 TPS malfunction	See **2.4**

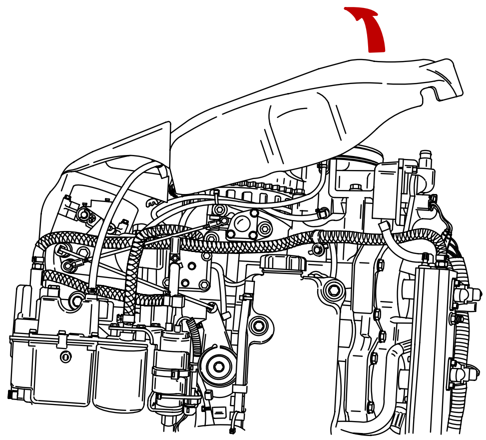
DFI Troubleshooting Guide (continued)		
Symptom	**Cause**	**Action**
7. Speed Reduction (RPM reduced or limited to 3000)	**7.1** Low battery voltage ECM requires 8 volts minimum Fuel Pump requires 9 volts	Check battery and/or alternator. Check electrical connections.
	7.2 Overheat condition (engine and/or air compressor)	Check water pump impeller/cooling system.
	7.3 Oil pump electrical failure	Check electrical connection.
	7.4 TPS failure If TPS fails, rpm is reduced approximately 20% and the ECM refers to the MAP sensor	Check electrical connections.
8. Engine RPM reduced to idle only		Refer to Guardian System Section 2D
9. Loss of spark on 1 cylinder	**9.1** Loose wire or pin in connectors between ECM and coil primary.	Check connectors.
	9.2 Faulty ignition coil.	Replace coil.
	9.3 Faulty spark plug.	Replace spark plug.
	9.4 Faulty spark plug wire	Replace spark plug wire.
	Note: Due to the long spark duration of this ignition system, the DDT may indicate the incorrect cylinder as having an ignition fault. Example: If the DDT indicates an ignition fault on cylinder #4, the problem may be on the prior cylinder in the firing order – I.E. cylinder number #3.	

Ignition Components Removal and Installation

Flywheel Cover Removal and Installation

REMOVAL

Remove flywheel cover by lifting off.



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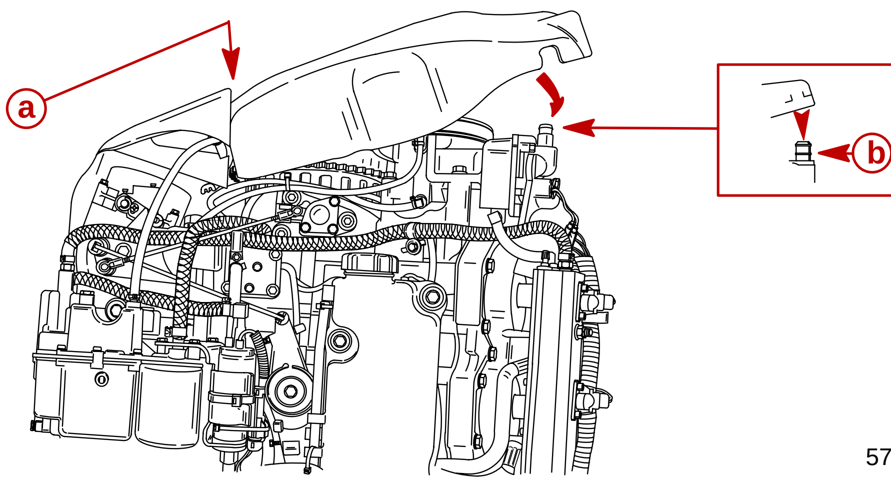
INSTALLATION

Install flywheel cover by inserting the front pin and air tube into the rubber grommets and then pushing the cover down onto the rear pin and air intake tube for the air compressor.



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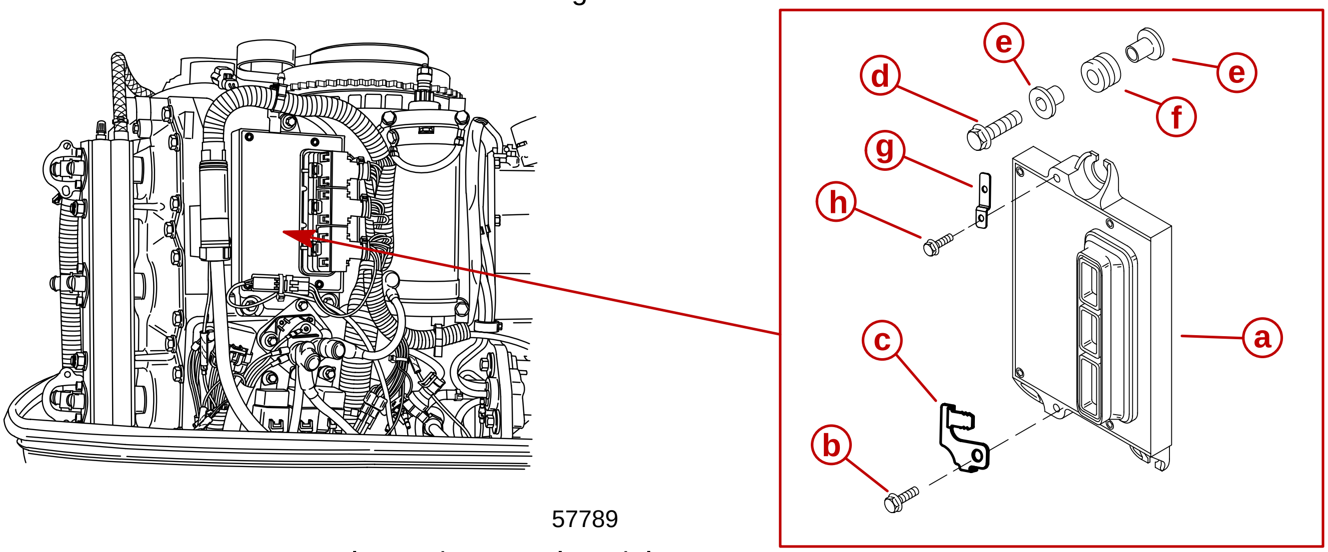
a - Front Pin and Air Tube
b - Air Intake Tube

Electronic Control Module (ECM)

REMOVAL

1. Disconnect ECM harness connectors.
2. Remove 3 bolts securing ECM.



57789

a - Electronic Control Module
b - Screw [Torque to 100 lb in. (11.5 Nm)]
c - Bracket
d - Screw [Torque to 70 lb in. (8.0 Nm)]
e - Bushing
f - Grommet
g - Bracket
h - Screw [Torque to 100 lb. in. (11.5 Nm)]

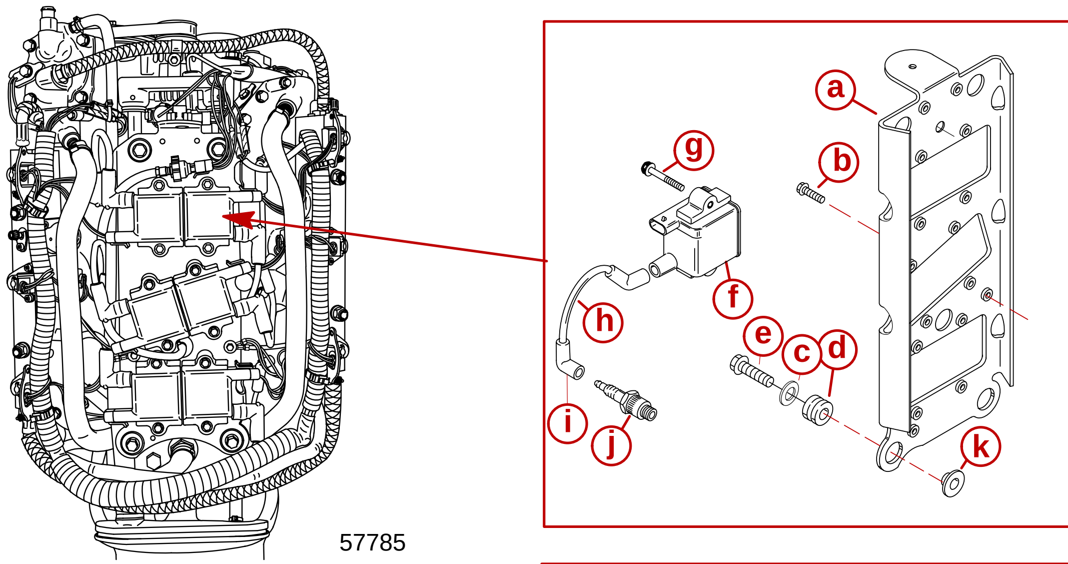
INSTALLATION

1. Secure ECM to powerhead with 3 bolts.
2. Install rubber pad and bracket for the fuse holder.
3. Reconnect harness connectors.

Ignition Module (Coil)

REMOVAL

1. Disconnect coil harness and spark plug lead.
2. Loosen the electrical mounting plate to gain access to the rear locknuts.
3. Remove module attaching bolts.



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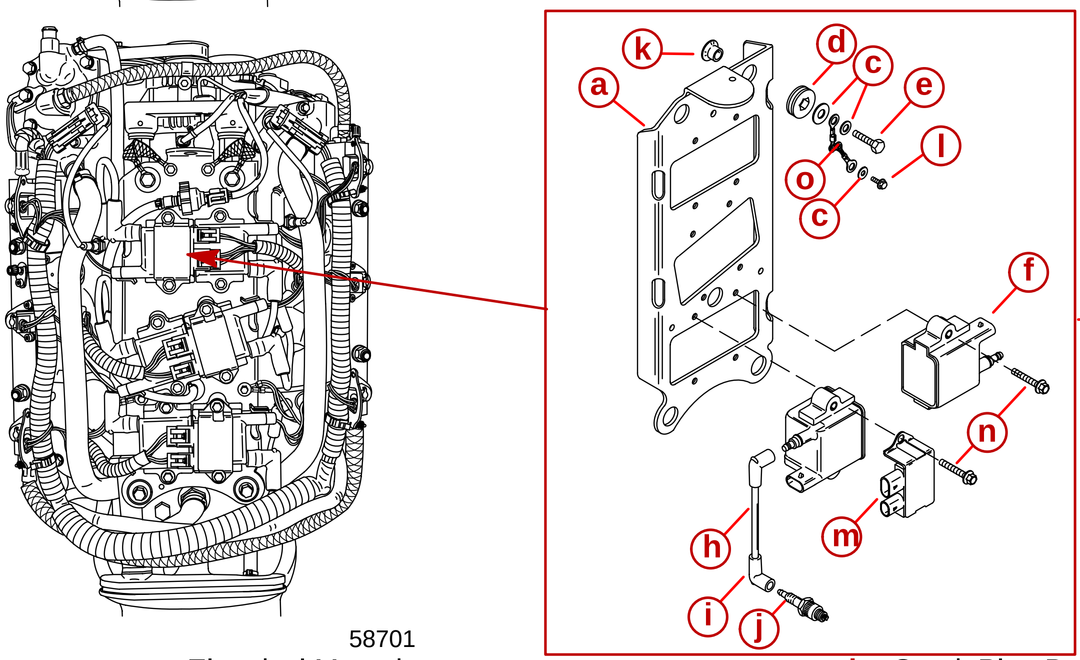


58701

- **a** - Electrical Mounting Plate
- **b** - Screw [Torque to 35 lb. in. (4.0 Nm)]
- **c** - Washer
- **d** - Rubber Grommet
- **e** - Bolts (4) – Torque to 20 lb. ft. (27 N·m).
- **f** - Ignition Coils (6)
- **g** - Screw [Torque to 80 lb. in. (9.0 Nm)]
- **h** - Spark Plug Lead
- **i** - Spark Plug Boot
- **j** - Spark Plug
- **k** - Bushing
- **l** - Screw [Torque to 60 lb. in. (7 N m)]
- **m** - Coil Driver (3)
- **n** - Screw [Torque to 60 lb. in. (7 N m)]
- **o** - Ground Strap
- **p** - Model 2000
- **q** - Model 2001

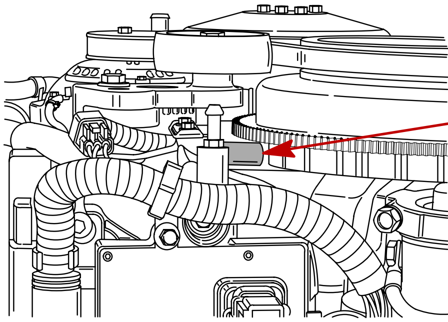
INSTALLATION

1. Fasten coils to electrical mounting plate as shown.
2. Reinstall electrical mounting plate.
3. Reconnect spark plug lead and coil harness.

Crank Position Sensor

REMOVAL

1. Disconnect harness.
2. Remove bolt securing sensor to bracket.



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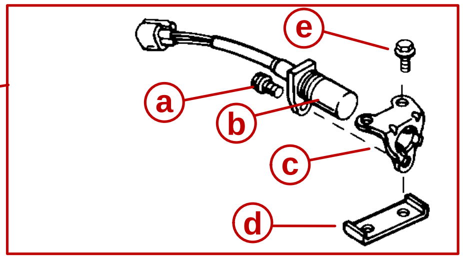


56069

a - Screw [Torque to 50 lb. in. (5.5 Nm)]
b - Crank Position Sensor
c - Bracket
d - Guide Bracket
e - Screw [Torque to 100 lb. in. (11.5 Nm)]

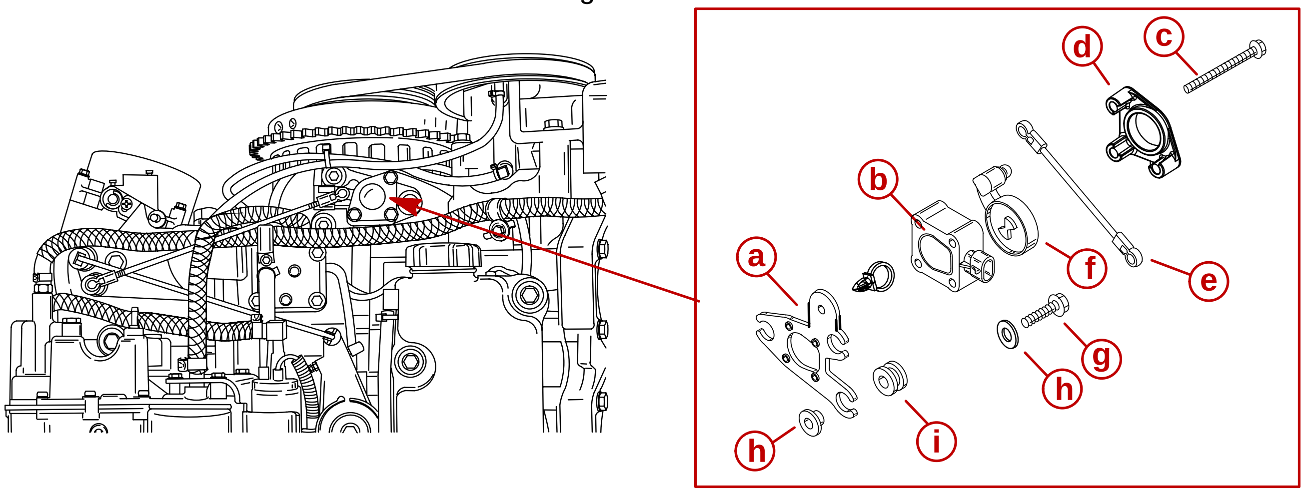
INSTALLATION

1. Fasten sensor to bracket with bolt.
2. Set air gap @ 0.025 in. – 0.040 in. (0.635 mm – 1.01 mm)
3. Reconnect sensor harness.

Throttle Position Sensor (TPS)

REMOVAL

1. Disconnect wiring harness.
2. Remove screws securing sensor to bracket.



a - Bracket
b - Sensor
c - Screw (3) – Torque to 20 lb. in (2.5 Nm)
d - TPS Cover
e - Throttle Link
f - TPS Lever
g - Screw [Torque to 70 lb. in. (8.0 Nm)]
h - Bushing (2)
i - Grommet

INSTALLATION

1. Fasten sensors to bracket as shown.
2. Reconnect wiring harness.

ELECTRICAL

Section 2B – Charging & Starting System

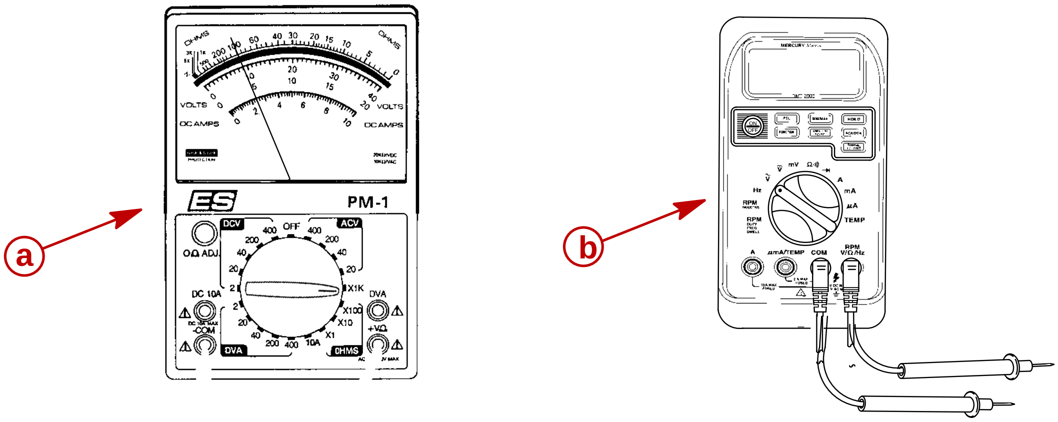
Table of Contents

Specifications

CHARGING SYSTEM	**Alternator Output (Regulated)**	32 - 38 Amperes @ 2000 RPM @ Battery 52 - 60 Amperes @ 2000 RPM @ Alternator
	Brush Length	Std Exposed Length: 0.413 in. (10.5 mm) Min. Exposed Length: 0.059 in. (1.5 mm)
	Voltage Output	13.5 to 15.1 Volts
	Regulator Current Draw	0.15 mA (Ign. Switch Off) 30.0 mA (Ign. Switch On)
STARTING SYSTEM	**Model Year 2000 Electric Start**	
	Starter Draw (Under Load)	210 Amperes
	Starter Draw (No Load)	30 Amperes
	Minimum Brush Length	0.25 in. (65.4 mm)
	Model Year 2001 Electric Start	
	Starter Draw (Under Load)	170 Amperes
	Starter Draw (No Load)	60 Amperes
	Minimum Brush Length	0.25 in. (65.4 mm)
	Battery Rating	1000 (Minimum) Marine Cranking Amps (MCA) 750 (Minimum) Cold Cranking Amps (CCA) 105 Amp Hour

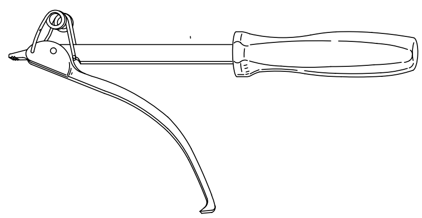
Special Tools

1. Volt/Ohm Meter 91-99750A1or DMT 2000 Digital Tachometer Multimeter 91-854009A1



a - Volt/Ohm Meter 91-99750A1
b - DMT 2000 Digital Tachometer Multimeter 91-854009A1

2. Ammeter (60 Ampere minimum) (Obtain locally)
3. Flywheel Holder 91-52344



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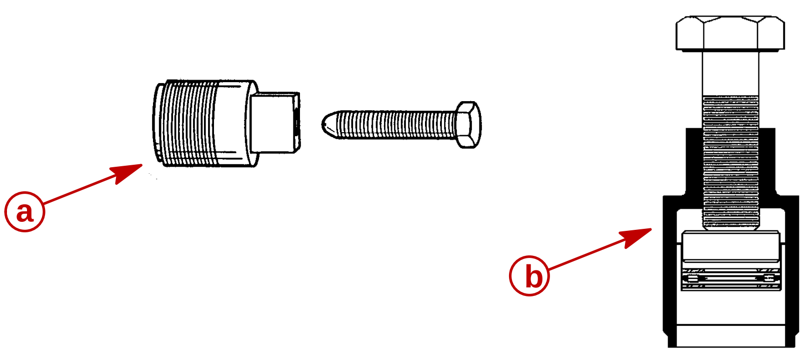
4. Protector Cap 91-24161 (Used with Puller 91-73687A1)

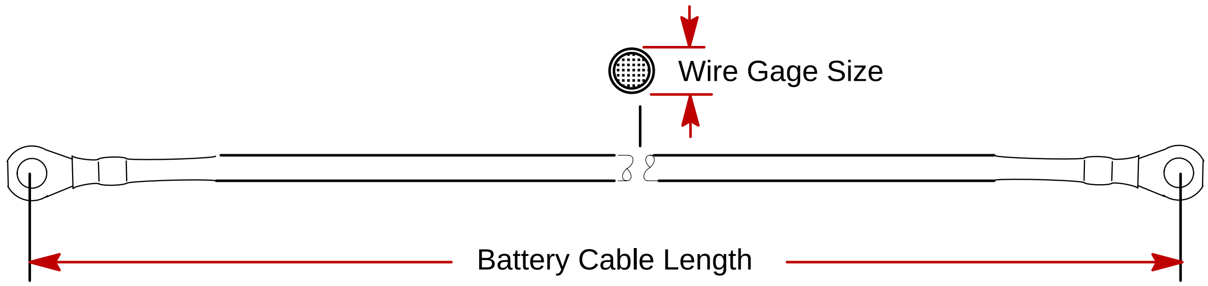
5. Flywheel Puller 91-73687A1 or 91-849154T1



a - Puller 91-73687A1
b - Puller 91-849154T1

Battery Cable Size

If standard (original) battery cables are replaced with longer cables, the wire gauge size must increase. See chart below for correct wire gauge size.



Battery Cable Wire Gage Size Mercury/Mariner Outboards																	
	Battery Cable Length																
	8 ft. 2.4m	9 ft. 2.7m	10ft. 3.0m	11ft. 3.4m	12ft. 3.7m	13ft. 4.0m	14ft. 4.3m	15ft. 4.6m	16ft. 4.9m	17ft. 5.2m	18ft. 5.5m	19ft. 5.8m	20ft. 6.1m	21ft. 6.4m	22ft. 6.7m	23ft. 7.0m	24ft. 7.3m
Models	Wire Gage Size No. SAE																
6-25 Hp	#8*	#8	#6	#6	#6	#6	#4	#4	#4	#4	#4	#4	#4	#4	#2	#2	#2
30-115 Hp	#6*	#4	#4	#4	#4	#4	#2	#2	#2	#2	#2	#2	#2	#2	#0	#0	#0
125-250 Hp (except DFI)			#6*	#6	#4	#4	#4	#4	#4	#4	#2	#2	#2	#2	#2	#2	#2
DFI Models					#4*	#2	#2	#2	#2	#2	#2	#2	#2	#2	#0	#0	#0

* = Standard (original) Cable Length and wire gage size.

Replacement Parts

⚠ WARNING

Electrical, ignition and fuel system components on your Mercury/Mariner outboard are designed and manufactured to comply with U. S. Coast Guard Rules and Regulations to minimize risks of fire and explosions. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Recommended Battery

A 12 volt marine battery with a minimum Cold Cranking amperage rating of 750 amperes or 1000 (minimum) Marine Cranking amperes should be used.

Battery

Precautions

CAUTION

If battery acid comes in contact with skin or eyes, wash skin immediately with a mild soap. Flush eyes with water immediately and see a doctor.

When charging batteries, an explosive gas mixture forms in each cell. Part of this gas escapes through holes in vent plugs and may form an explosive atmosphere around battery if ventilation is poor. This explosive gas may remain in or around battery for several hours after it has been charged. Sparks or flames can ignite this gas and cause an internal explosion which may shatter the battery.

The following precautions should be observed to prevent an explosion.

1. DO NOT smoke near batteries being charged or which have been charged very recently.
2. DO NOT break live circuits at terminals of batteries because a spark usually occurs at the point where a live circuit is broken. Always be careful when connecting or disconnecting cable clamps on chargers. Poor connections are a common cause of electrical arcs which cause explosions.
3. DO NOT reverse polarity of battery terminal to cable connections.

Charging a Discharged Battery

WARNING

Hydrogen and oxygen gases are produced during normal battery operation or charging. Sparks or flame can cause this mixture to ignite and explode, if they are brought near the vent openings. Sulphuric acid in battery can cause serious burns, if spilled on skin or in eyes. Flush or wash away immediately with clear water.

The following basic rule applies to any battery charging situation:

1. Any battery may be charged at any rate (in amperes) or as long as spewing of electrolyte (from violent gassing) does not occur and for as long as electrolyte temperature does not exceed 125° F (52° C). If spewing of electrolyte occurs, or if electrolyte temperature exceeds 125° F, charging rate (in amperes) must be reduced or temporarily halted to avoid damage to the battery.
2. Battery is fully charged when, over a 2-hour period at a low charging rate (in amperes), all cells are gassing freely (not spewing liquid electrolyte), and no change in specific gravity occurs. Full charge specific gravity is 1.260-1.275, corrected for electrolyte temperature with electrolyte level at 3/16 in. (4.8 mm) over plate, unless electrolyte loss has occurred (from age or over-filling) in which case specific gravity reading will be lower. For most satisfactory charging, lower charging rates in amperes are recommended.
3. If, after prolonged charging, specific gravity of at least 1.230 on all cells cannot be reached, battery is not in optimum condition and will not provide optimum performance; however, it may continue to provide additional service, if it has performed satisfactorily in the past.

4. To check battery voltage while cranking engine with electric starting motor, place RED (+) lead of tester on POSITIVE (+) battery terminal and BLACK (–) lead of tester on NEGATIVE (–) battery terminal. If the voltage drops below 9-1/2 volts while cranking, the battery is weak and should be recharged or replaced.

Winter Storage of Batteries

Battery companies are not responsible for battery damage either in winter storage or in dealer stock if the following instructions are not observed:

1. Remove battery from its installation as soon as possible and remove all grease, sulfate and dirt from top surface by running water over top of battery. Be sure, however, that vent caps are tight beforehand, and blow off all excess water thoroughly with compressed air. Check water level, making sure that plates are covered.
2. When adding distilled water to battery, be extremely careful not to fill more than 3/16 in. (4.8 mm) above perforated baffles inside battery. Battery solution or electrolyte expands from heat caused by charging. Overfilling battery will cause electrolyte to overflow (if filled beyond 3/16″ above baffles).
3. Grease terminal bolts well with 2-4-C Marine Lubricant and store battery in a COOL-DRY place. Remove battery from storage every 30-45 days, check water level and put on charge for 5 or 6 hours at 6 amperes. DO NOT FAST CHARGE.
4. If specific gravity drops below 1.240, check battery for reason and recharge. When gravity reaches 1.260, discontinue charging. To check specific gravity, use a hydrometer, which can be purchased locally.
5. Repeat preceding charging procedure every 30-45 days, as long as battery is in storage, for best possible maintenance during inactive periods to ensure a good serviceable battery in spring. When ready to place battery back in service, remove excess grease from terminals (a small amount is desirable on terminals at all times), recharge again as necessary and reinstall battery.

Flywheel Removal and Installation

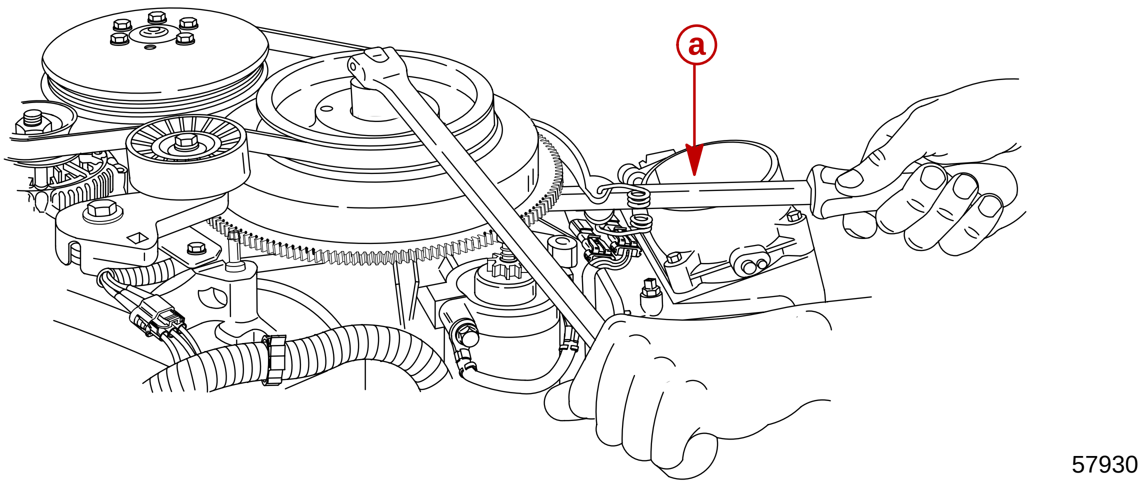
Removal

1. Remove flywheel cover from engine.

⚠ WARNING

Engine could possibly start when turning flywheel during removal and installation; therefore, disconnect (and isolate) spark plug leads from spark plugs to prevent engine from starting.

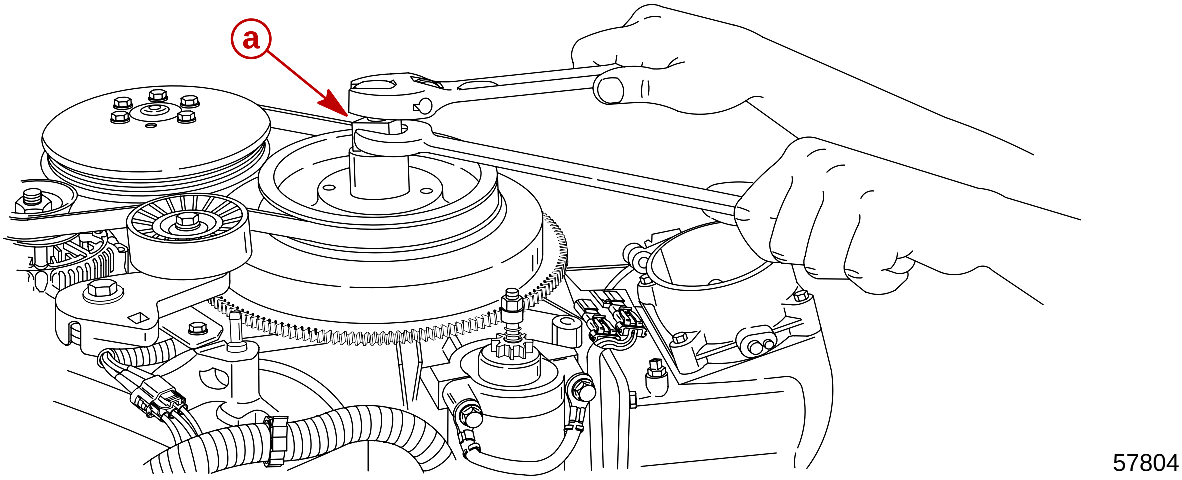
2. Disconnect spark plug leads from spark plugs.
3. While holding flywheel with flywheel holder (91-52344), remove flywheel nut and washer.



a - Flywheel Holder (91-25344)

4. Install a crankshaft Protector Cap (91-24161) on end of crankshaft, then install Flywheel Puller (91-73687A2) into flywheel.

5. Hold flywheel tool with wrench while tightening bolt down on protector cap. Tighten bolt until flywheel comes free.



a - Flywheel Puller (91-73687A2)

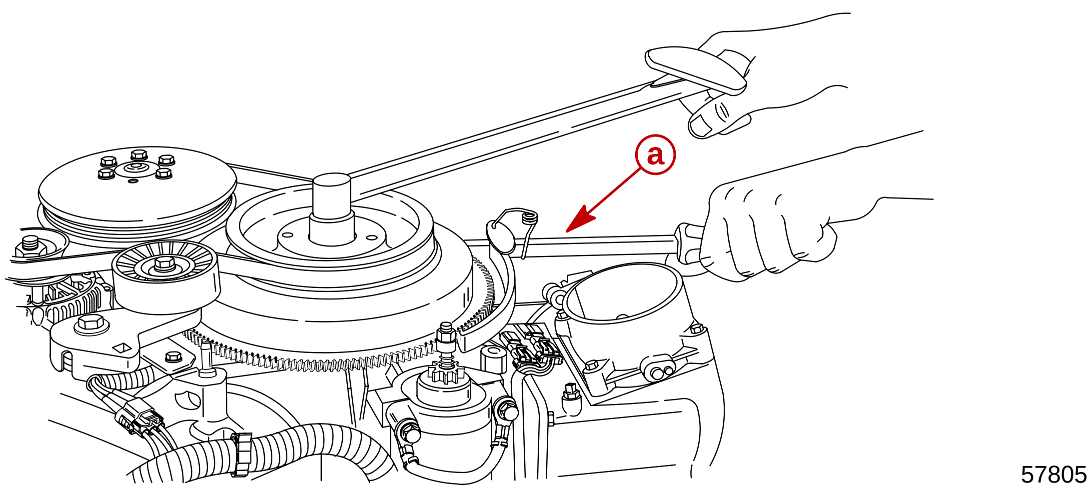
NOTE: *Neither heat or hammer should be used on flywheel to aid in removal as damage to flywheel may result.*

6. Remove flywheel. Inspect flywheel for cracks or damage.

Installation

IMPORTANT: Clean flywheel/crankshaft taper with solvent and assemble dry.

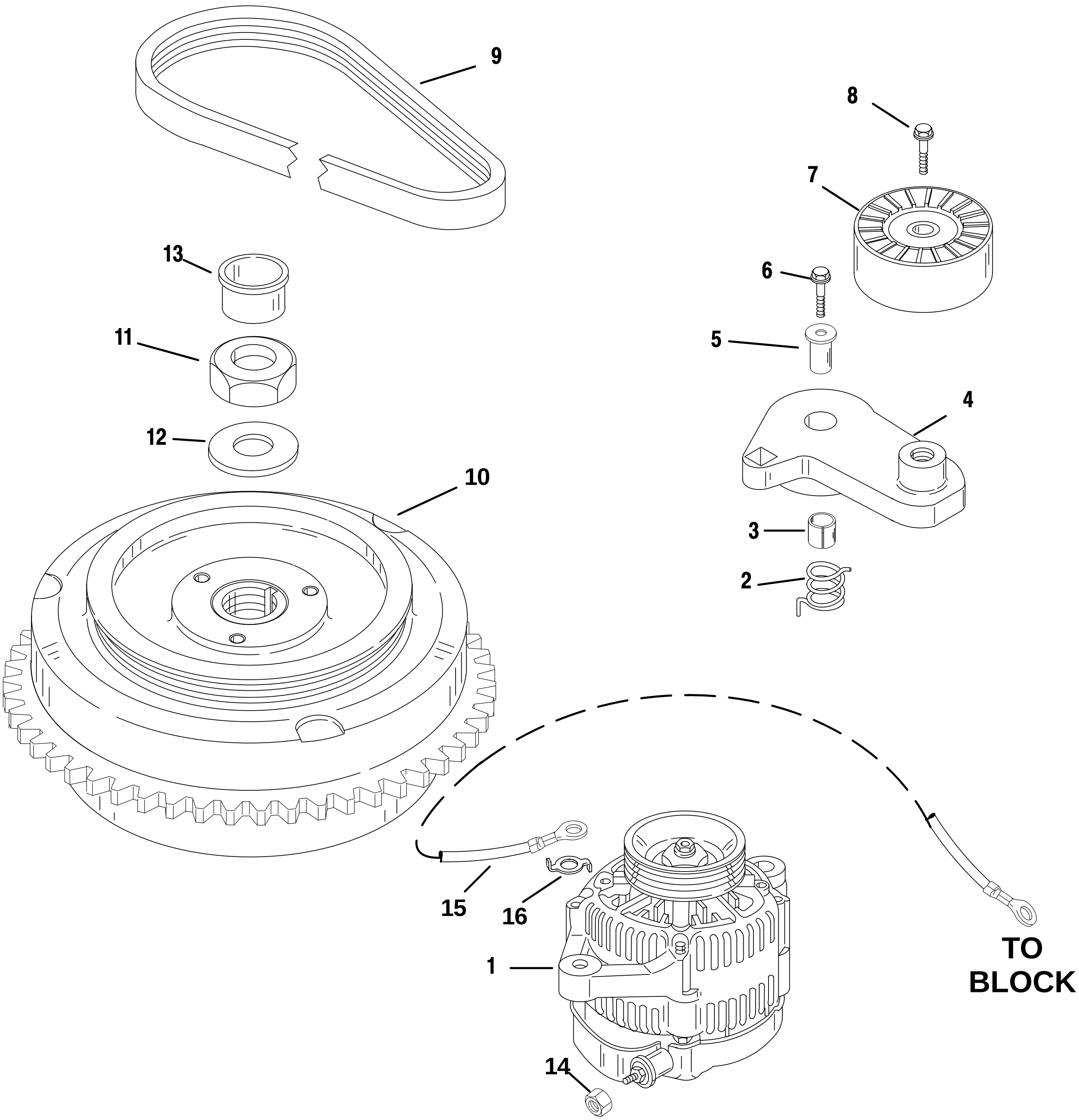
1. Install flywheel.
2. Install flywheel washer and nut.
3. Hold flywheel with Flywheel Holder (91-52344). Torque nut to 125 lb-ft (169.5 Nm).



a - Flywheel Holder (91-52344)

Notes:

Flywheel/Alternator

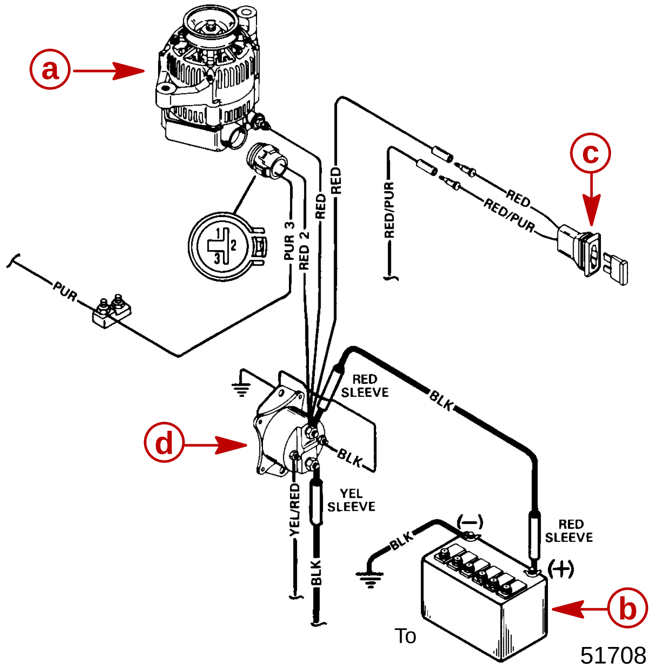


Flywheel/Alternator

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	ALTERNATOR			
2	1	SPRING			
3	1	BEARING			
4	1	BELT TENSIONER			
5	1	BUSHING			
6	1	SCREW (M10 x 45)	200	16.5	22.6
7	1	PULLEY			
8	1	SCREW (M10 x 35)	300	25	34
9	1	BELT			
10	1	FLYWHEEL			
11	1	NUT (.625-18)		125	169
12	1	WASHER			
13	1	PLUG			
14	1	NUT	36		4.0
15	1	CABLE			
16	1	WASHER – ANTI ROTATION			

System Components

The battery charging system consists of the alternator, battery, ignition switch, starter solenoid and the wiring which connects these components.



a - Alternator
b - Battery
c - 20 Ampere Fuse
d - Starter Solenoid

Precautions

The following precautions must be observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator system.

1. Do not attempt to polarize the alternator.
2. Do not short across or ground any of the terminals on the alternator, except as specifically instructed.
3. Never disconnect the alternator output lead, regulator harness or battery cables when the alternator is being driven by the engine.
4. Always remove NEGATIVE (–) battery cable from battery before working on alternator system.
5. When installing battery, be sure to connect the NEGATIVE (–) (GROUNDED) battery cable to NEGATIVE (–) battery terminal and the POSITIVE (+) battery cable to POSITIVE (+) battery terminal.
6. When using a charger or booster battery, connect it in parallel with existing battery (POSITIVE to POSITIVE; NEGATIVE to NEGATIVE).

Alternator Description

The alternator employs a rotor, which is supported in 2 end frames by ball bearings, and is driven at 2.5 times engine speed. The rotor contains a field winding enclosed between 2 multiple-finger pole pieces. The ends of the field winding are connected to 2 brushes which make continuous sliding contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between the 2 end frames. It consists of 3 windings wound 120° electrically out-of-phase on the inside of a laminated core. The windings are connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains 8 diodes which allows current to flow from ground, through the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge changes this alternating current to direct current which appears at the output terminal. A diode trio is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cutout relay in the voltage regulator also is not required, as the rectifier diodes prevent the battery from discharging back through the stator.

A small amount of current is supplied by the excitation circuit in the regulator to the rotor field to initially start the alternator charging. Once the alternator begins to produce output, field current is supplied solely by the diode trio.

The alternator is equipped with 2 fans which induce air flow through the alternator to remove heat created by the rectifier and stator.

Diagnosis of Alternator System on Engine

1. If problem is an undercharged battery, verify condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on.
2. Check physical condition and state of charge of battery. Battery must be at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.

IMPORTANT: RED output lead from alternator must be tight. A darkened RED sleeve indicates lead was loose and becoming hot.

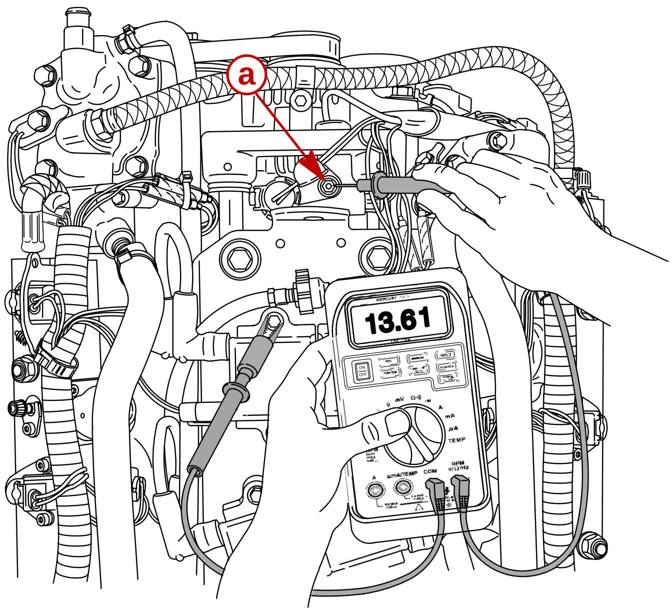
4. Check alternator drive belt for cracks and fraying. Replace if necessary. Check belt tension. Adjust if necessary, as outlined under "**Drive Belt Replacement and Adjustment.**"

Alternator System Circuitry Test

Using a 0-20 volt DC voltmeter, perform the following tests:

Output Circuit

1. Connect POSITIVE (+) voltmeter lead to alternator terminal B (output terminal). Connect NEGATIVE (–) lead to case ground on alternator.
2. Shake alternator wiring harness. Meter should indicate battery voltage and should not vary. If proper reading is not obtained, check for loose or dirty connections or damaged wiring.

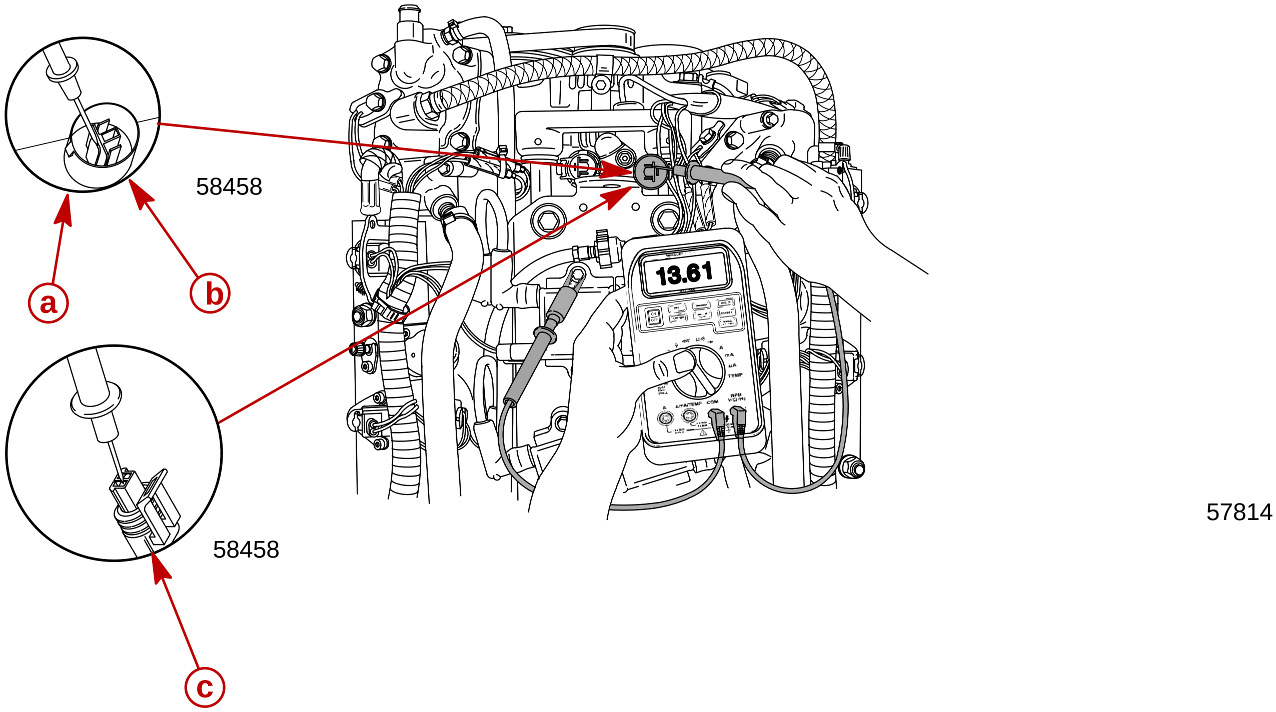


57813

a - Terminal B

Sensing Circuit

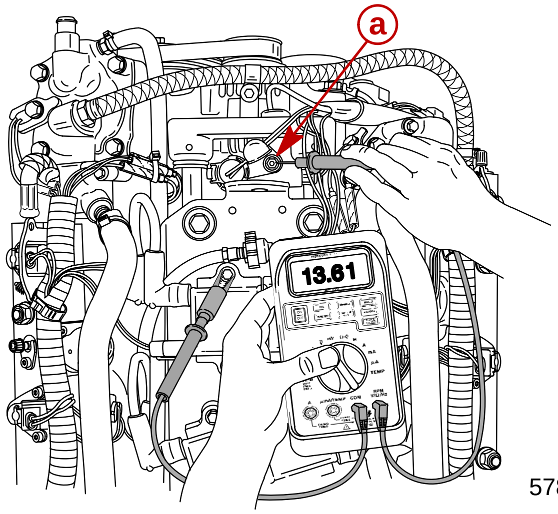
1. Unplug RED and PURPLE lead connector from alternator.
2. Connect POSITIVE (+) voltmeter lead to RED lead and NEGATIVE (–) voltmeter lead to ground.
3. Voltmeter should indicate battery voltage. If correct voltage is not present, check sensing circuit (RED lead) for loose or dirty connections or damaged wiring.



a - Sense Lead (RED)
b - Model Year 2000 Connector
c - Model Year 2001 Connector

Voltage Output

1. Using a 0-20 volt DC voltmeter, connect POSITIVE (+) lead of voltmeter to TERMINAL B of alternator and NEGATIVE (–) lead of voltmeter to engine ground.
2. Start engine and allow to warm up. Increase engine RPM from idle to 2000. Normal voltage output should be 13.5 – 15.1 volts. If voltage reading is greater than normal, replace voltage regulator.
3. If voltage reading is less than normal, fabricate a tool from a piece of stiff wire to the following specifications:



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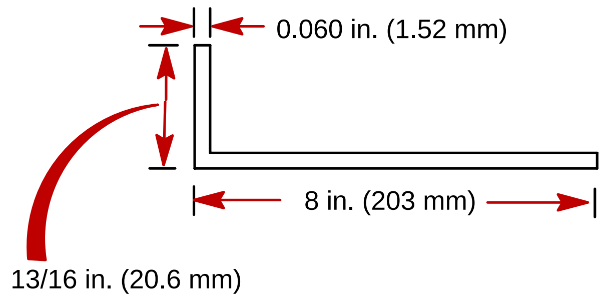
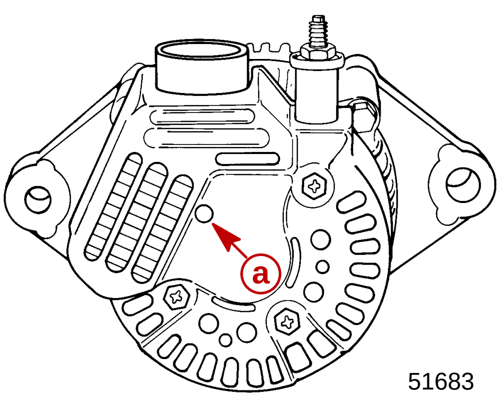


a - Terminal B

4. Insert bent end of tool through end cover and ground TERMINAL F.



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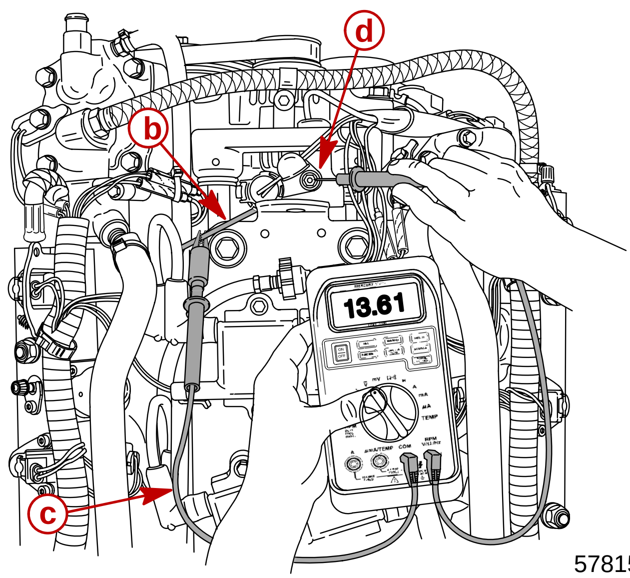


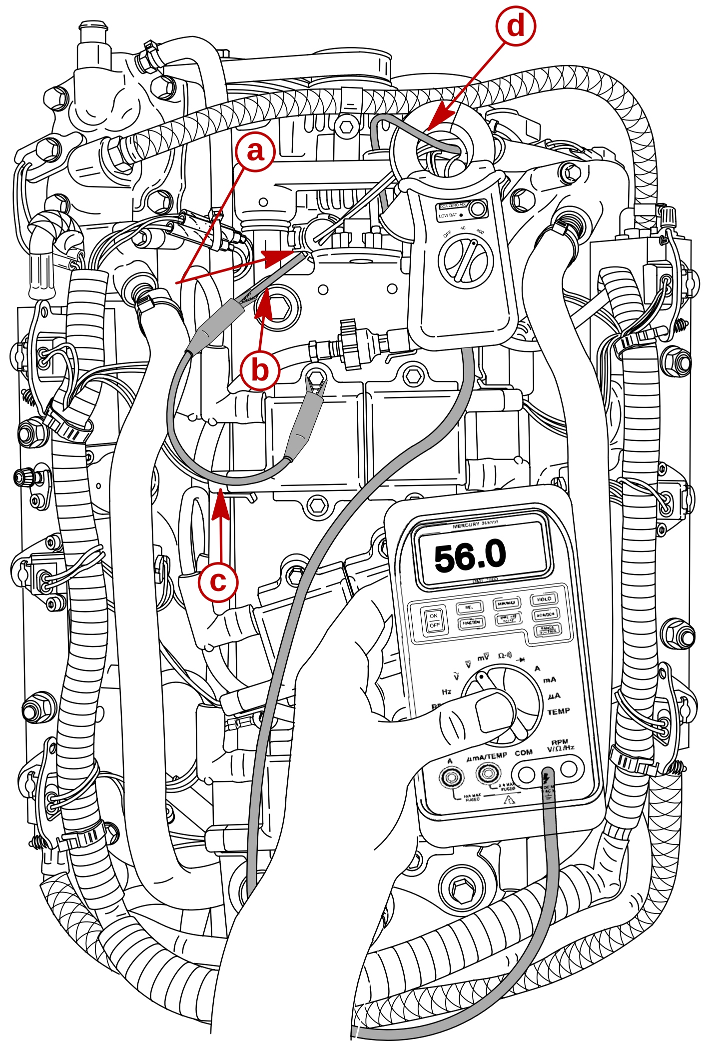
57815

a - Terminal F
b - Tool
c - Jumper Wire to Engine Ground (Attach to end of Tool)
d - Terminal B

5. With TERMINAL F grounded, voltage should rise to within the normal range (13.5 – 15.1). If voltage rises, replace the regulator.
6. If the voltage DOES NOT rise to within the normal range with TERMINAL F grounded, perform "**CURRENT OUTPUT**" test.

Current Output

1. With engine shut off, install ammeter (capable of reading 60+ amperes) in series between TERMINAL B on alternator and POSITIVE (+) terminal of battery, or if using a clamp-on ammeter, place clamp over output lead of alternator.
2. Start engine and allow to warm up. Advance RPM to 2000.
3. Insert tool, previously fabricated for **VOLTAGE OUTPUT**, through end cover and ground TERMINAL F.



57816

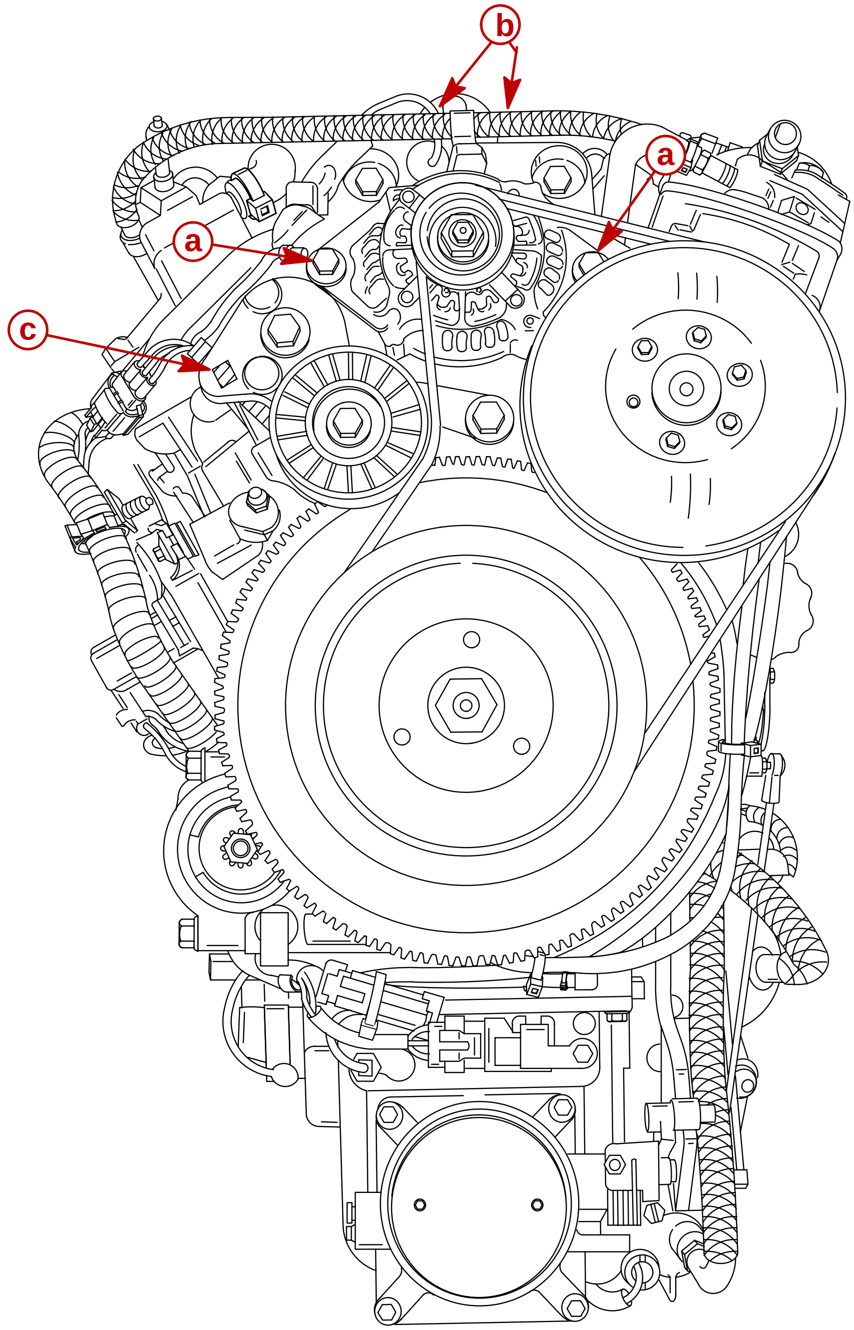
a - Terminal F
b - Tool
c - Jumper Wire to Engine Ground
d - Output Lead

4. Normal output is 52 – 60 amperes @ 2000 RPM @ the alternator. If output is normal, replace regulator. If output is low, a disassembly of the alternator is necessary to inspect and test individual components.

Repair

Removal

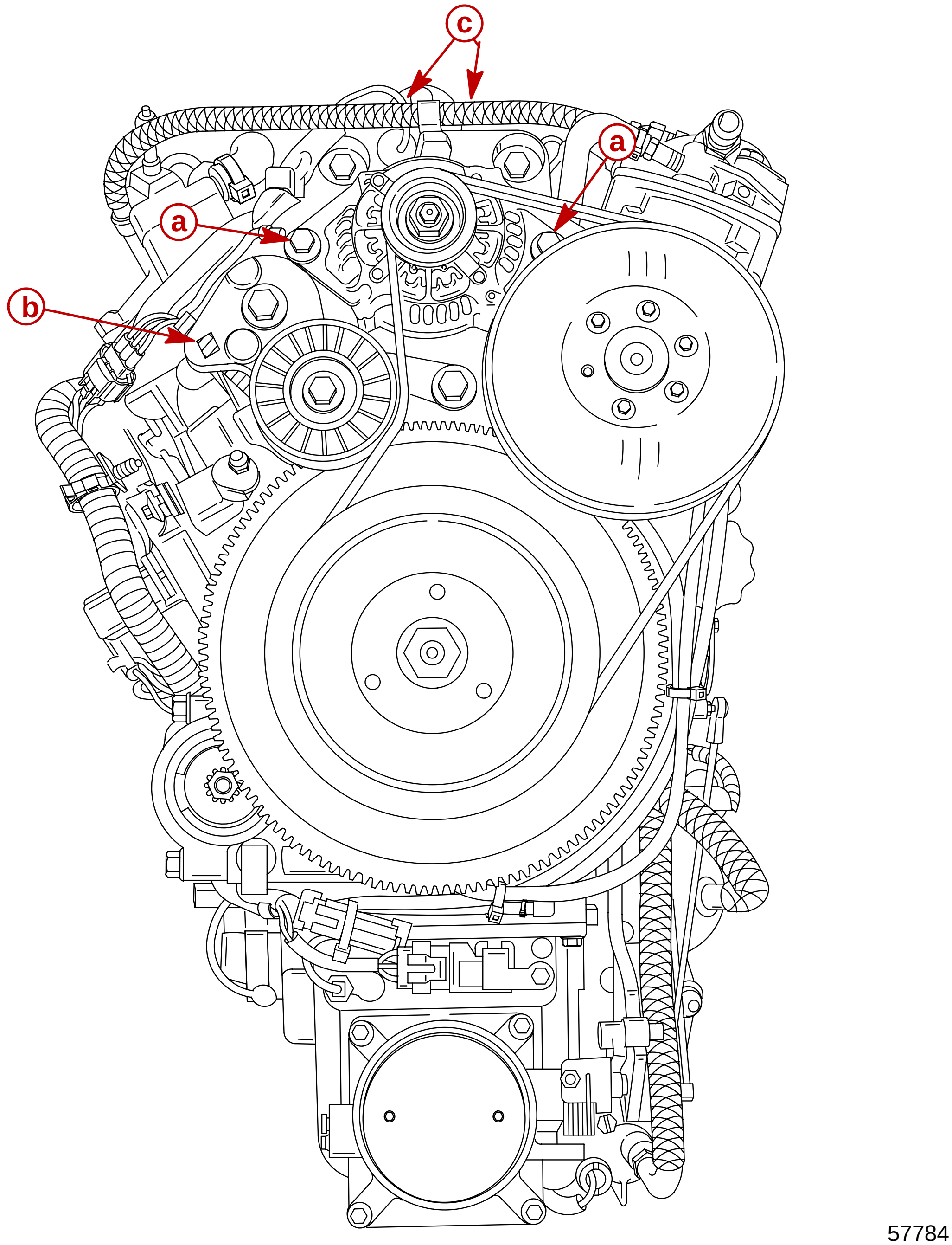
1. Remove top cowling.
2. Disconnect battery cables from battery.
3. Disconnect wiring harness from alternator.
4. Use a breaker bar to release belt tensioner and remove alternator belt.
5. Remove 2 bolts securing alternator.



a - Attaching Bolts
b - Harnesses (hidden)
c - Belt Tensioner

Installation

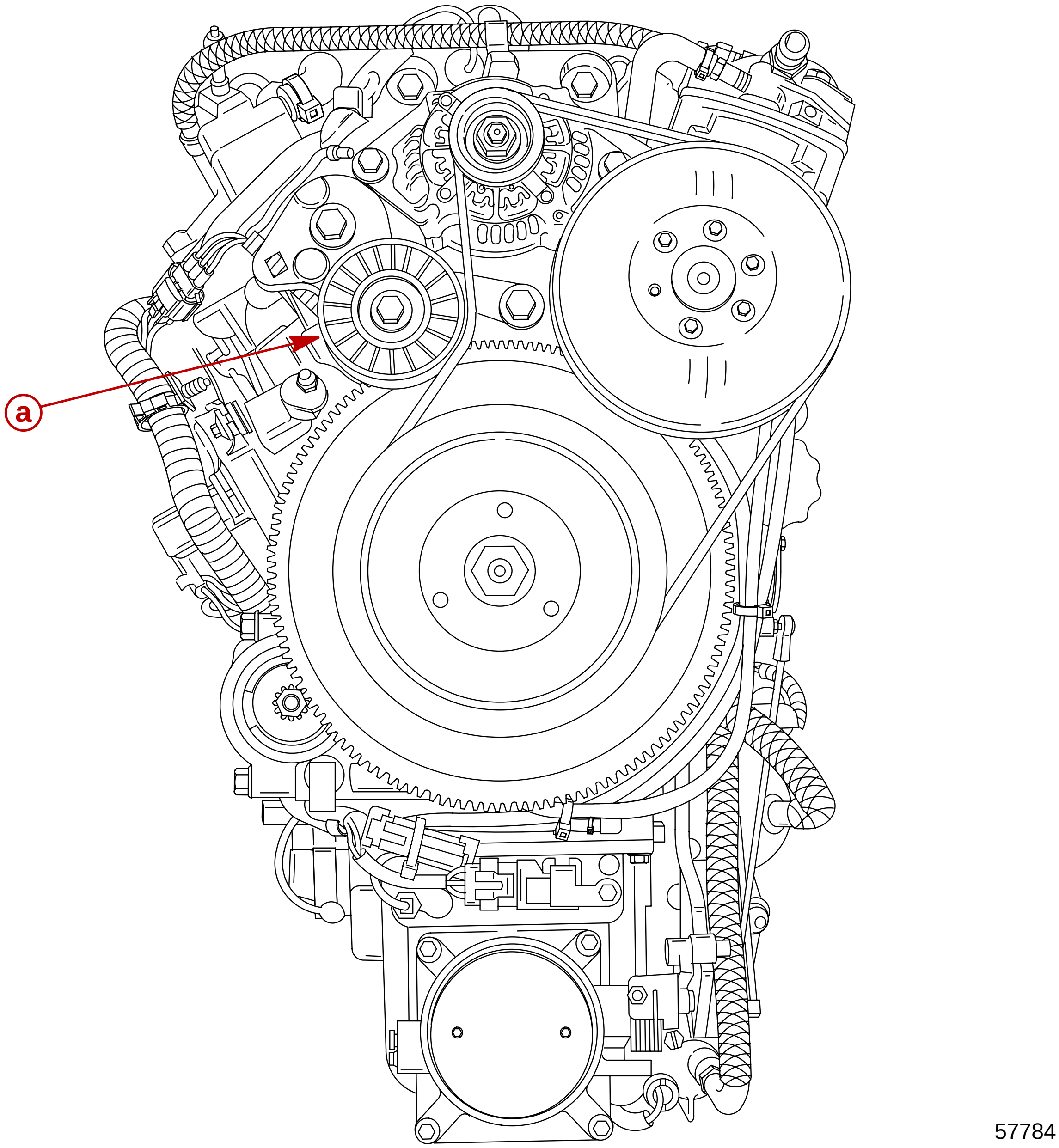
1. Secure alternator to engine block with 2 attaching bolts. Torque bolts to 40 lb-ft (54 Nm).
2. Install alternator belt in V-groove of flywheel, alternator and compressor pulley.
3. Reconnect electrical harness to alternator.



a - Bolts [Torque to 40 lb-ft (54 Nm)]
b - Tensioner
c - Harnesses

Alternator Belt Tension Adjustment

Correct alternator belt tension is maintained by a belt tensioner assembly.



a - Belt Tensioner Assembly

Starter System

Starter Motor Amperes Draw

STARTER MOTOR PART NO.	NO LOAD AMP. DRAW	NORMAL AMP. DRAW
50-833153-1	30 AMPS	210 AMPS
50-853329-1	60 AMPS	170 AMPS

Starter System Components

1. Battery
2. Starter Solenoid
3. Neutral Start Switch
4. Starter Motor
5. Ignition Switch
6. Slave Solenoid (Model Year 2001)

Description

The battery supplies electricity to activate the starter motor. When the ignition is turned to the “START” position, the starter solenoid is energized and completes the starter circuit between the battery and starter.

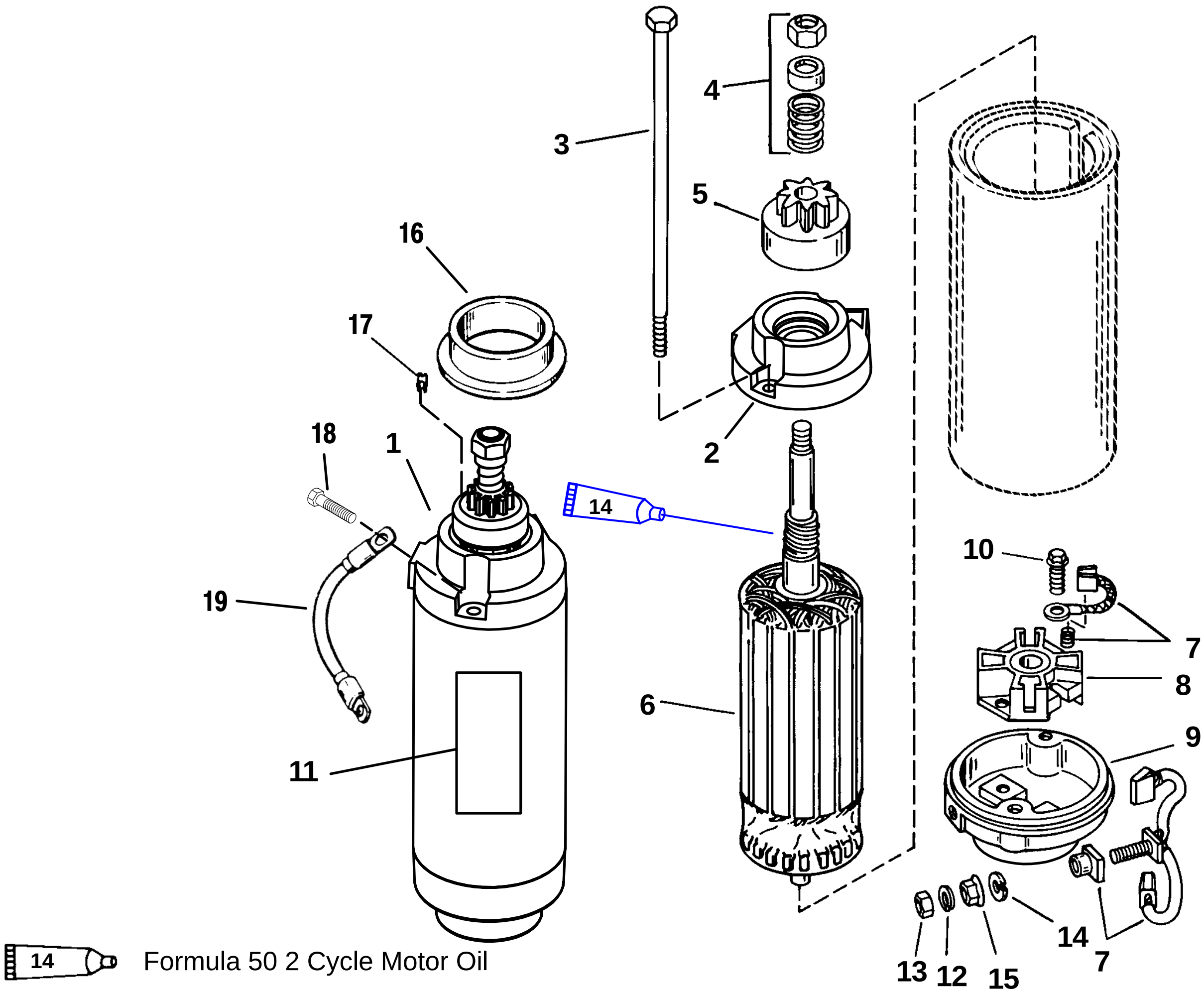
Model Year 2001 engines incorporate a slave solenoid to activate the starter solenoid.

The neutral start switch opens the starter circuit when the shift control lever is not in neutral thus preventing accidental starting when the engine is in gear.

⚠ CAUTION

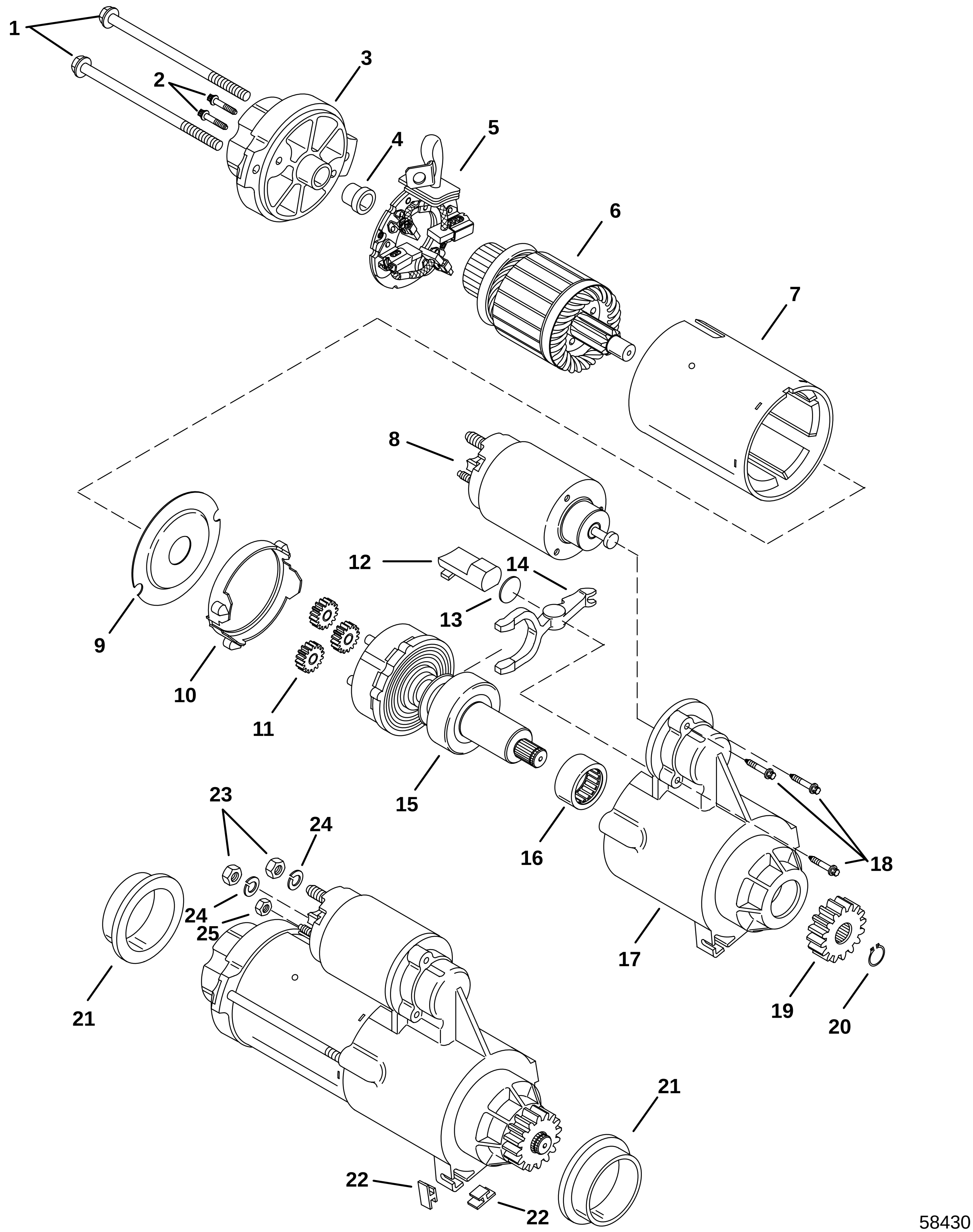
The starter motor may be damaged if operated continuously. DO NOT operate continuously for more than 30 seconds. Allow a 2 minute cooling period between starting attempts.

Starter Motor (Model Year 2000)(Centrifugal Bendix)



REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	STARTER MOTOR			
2	1	DRIVE CAP			
3	2	THRU BOLT	70		8.0
4	1	DRIVE KIT			
5	1	PINION			
6	1	ARMATURE			
7	1	BRUSH/SPRING KIT			
8	1	BRUSH HOLDER			
9	1	COMMUTATOR CAP			
10	2	SCREW	Drive Tight		
11	1	DECAL, Warning-High voltage			
12	1	LOCKWASHER			
13	2	NUT (1/4-20) **(SERVICE ITEM)**	60		7.0
14	2	LOCKWASHER			
15	1	NUT (1/4-20)	60		7.0
16	2	COLLAR			
17	2	RUBBER STOP			
18	1	SCREW (1/4-20 x 5/8)	80		9.0
19	1	WIRE ASSEMBLY (BLACK)			

Starter Motor (Model Year 2001)(Solenoid Driven Bendix)



Starter Motor (Model Year 2001)(Solenoid Driven Bendix)

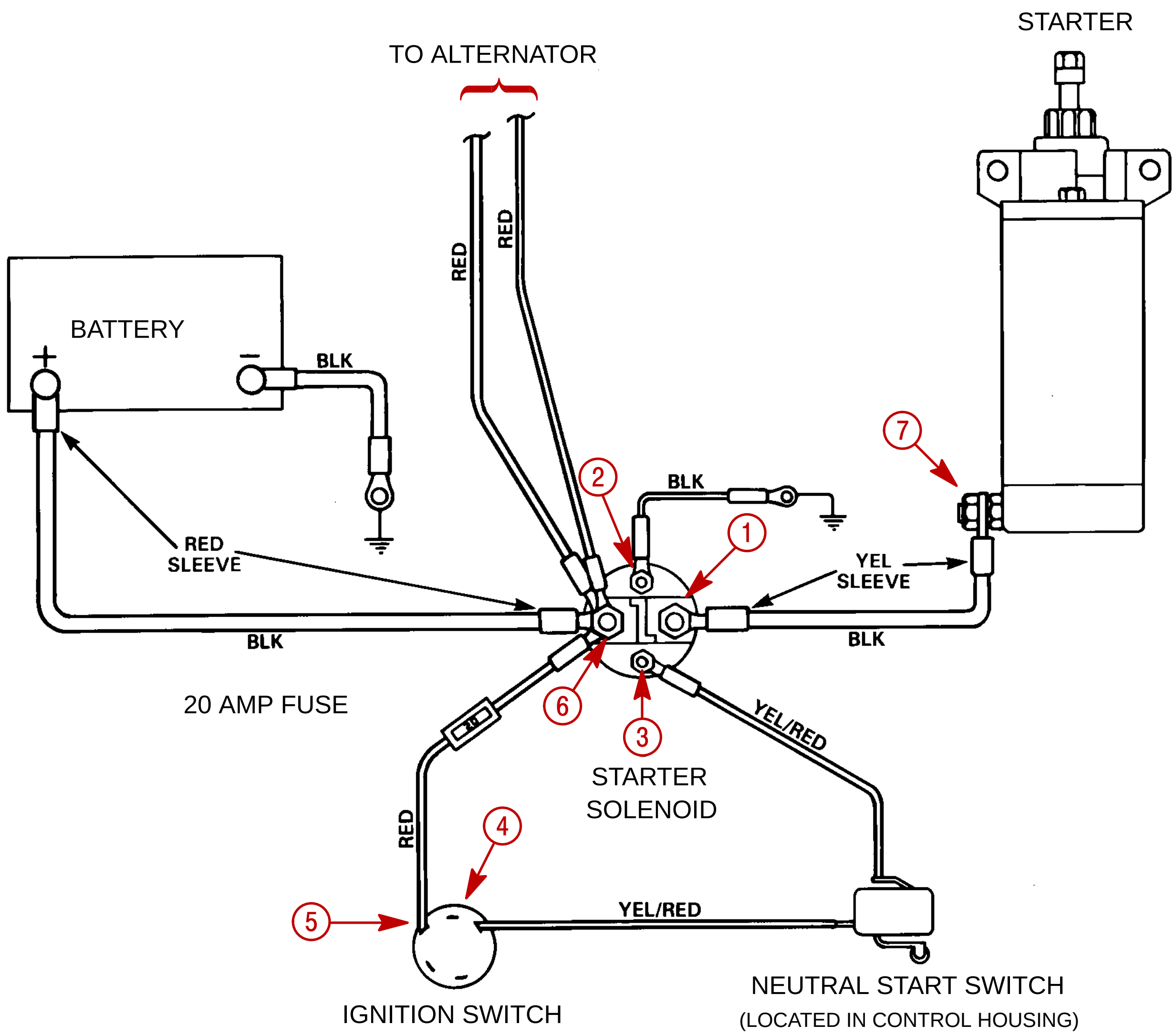
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	2	THRU BOLT	110		12.5
2	2	SCREWS	30		3.4
3	1	END CAP			
4	1	BUSHING			
5	1	BRUSH PLATE ASSEMBLY			
6	1	ARMATURE			
7	1	FIELD FRAME			
8	1	SOLENOID			
9	1	SHIELD			
10	1	CUSHION			
11	3	PLANETARY GEARS			
12	1	PLUG			
13	1	DISC			
14	1	SHIFT FORK			
15	1	GEAR/CLUTCH ASSEMBLY			
16	1	BEARING			
17	1	HOUSING			
18	3	SCREW	40		4.5
19	1	DRIVE GEAR			
20	1	SNAP RING			
21	2	MOUNTING COLLAR			
22	2	STOP			
23	2	NUT	55		6.0
24	2	WASHER			
25	1	NUT	20		2.3

Troubleshooting the Centrifugal Bendix Starter Circuit

Before beginning the troubleshooting flow chart, verify the following conditions:

1. Confirm that battery is fully charged.
2. Check that control lever is in "NEUTRAL" position.
3. Check terminals for corrosion and loose connections.
4. Check cables and wiring for frayed and worn insulation.
5. Check 20 amp fuse.

Location of "Test Points" (called out in flow chart) are numbered below.



Starter Circuit

Starter Circuit Troubleshooting Flow Chart (Centrifugal Bendix)

Starter Motor Does Not Turn

SAFETY WARNING: Disconnect yellow (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 (Rx1 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

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.
b. Connect voltmeter between common engine ground and Test Point 3.
c. Turn ignition key to “Start” position.

No voltage reading: proceed to Step 4

12 Volt Reading
Defective starter solenoid

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 YELLOW/RED wire is open between Test Points 4 and 3.

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
Check for voltage between common engine ground and Test Point 6.

No voltage reading:
Check RED 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 wire between Test Points 5 and 6.

*Battery Voltage

TEST 7

a. Connect voltmeter between common engine and Test Point1.
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 cable (with YELLOW sleeve) 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 cable (with YELLOW sleeve) for poor connection or open circuit.

12 Volt Reading*

If starter motor does not turn, check starter motor.

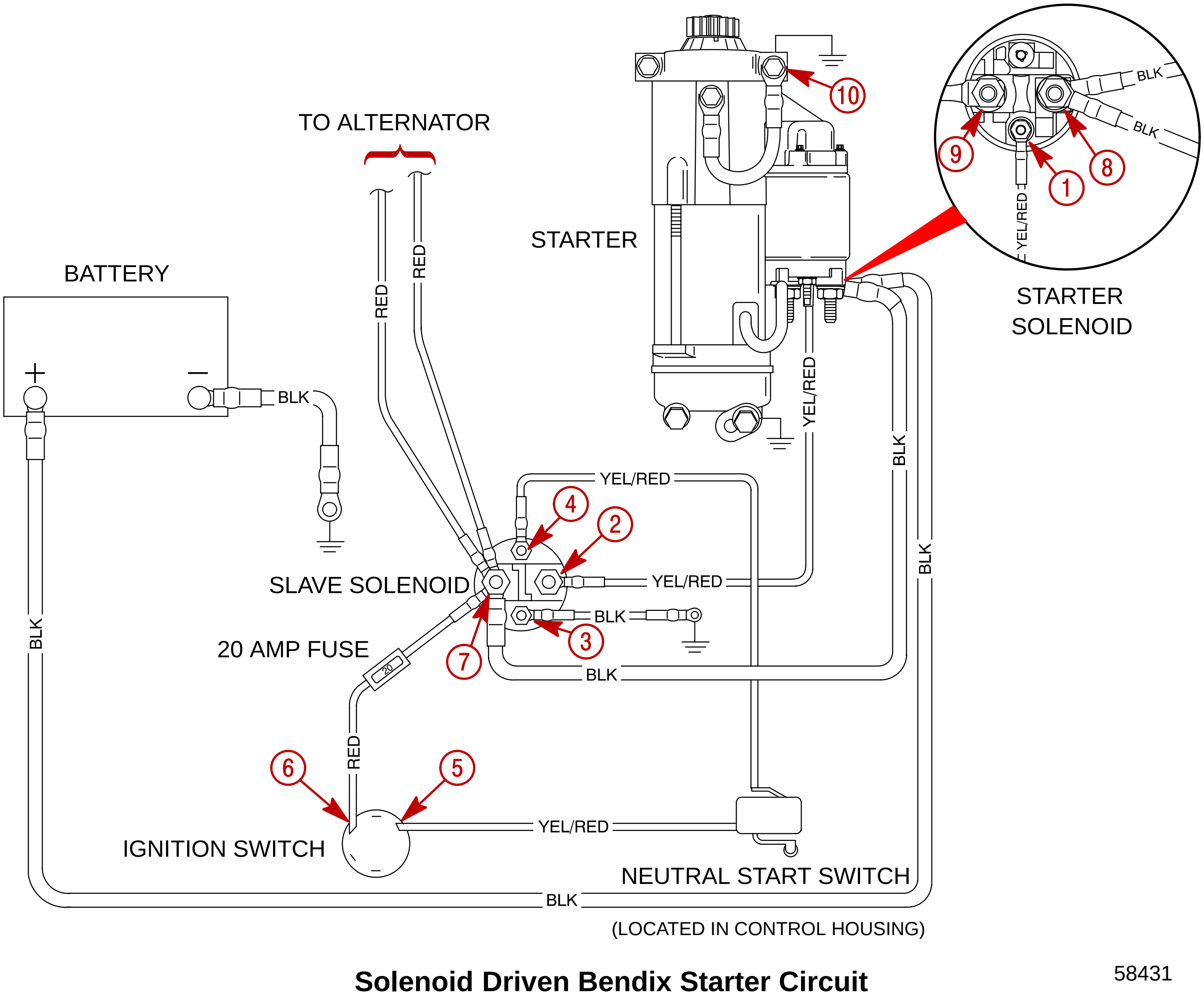
*Battery Voltage

Troubleshooting the Solenoid Driven Bendix Starter Circuit

Before beginning the troubleshooting flow chart, verify the following conditions:

1. Confirm that battery is fully charged.
2. Check that control lever is in “NEUTRAL” position.
3. Check terminals for corrosion and loose connections.
4. Check cables and wiring for frayed and worn insulation.
5. Check 20 amp fuse.

Location of “Test Points” (called out in flow chart) are numbered below.



Solenoid Driven Bendix Starter Circuit

Starter Circuit Troubleshooting Flow Chart (Solenoid Driven Bendix)

Starter Motor Does Not Turn

TEST 1
With ignition key in START position, check for battery voltage at TEST POINT 1.

Voltage indicated and solenoid clicks

Voltage indicated at Test Point 9 is 9.5 volts or greater.

Defective starter motor

Voltage indicated at Test Point 9 is less than 9.5 volts.

Defective starter solenoid

No voltage indicated

Go to TEST 2

Voltage indicated and solenoid does not click

Check for starter motor ground at Test Point 10

Good ground

Defective starter solenoid

Bad ground – clean cable ends or replace ground cable

SAFETY WARNING: Disconnect BLACK with RED sleeve (starter motor) cable from slave solenoid test point 7 BEFORE making tests 1–thru–7 to prevent unexpected engine cranking.

TEST 2
Use an ohmmeter (Rx1 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 3

Test 3
a. Disconnect BLACK ground wire(s) from Test Point 3.
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.

TEST 4
a. Reconnect BLACK ground wire.
b. Connect voltmeter between common engine ground and Test Point 4.
c. Turn ignition key to “Start” position.

12 Volt Reading*
Check BLACK ground wire for poor connection or open circuit.
Reconnect ground wire to starter solenoid.
Proceed to TEST 8.

No voltage reading: proceed to TEST 5

12 Volt Reading
Defective starter solenoid

TEST 5
a. Connect voltmeter between common engine ground and Test Point 5.
b. Turn ignition key to "Start" position.

No voltage reading: proceed to TEST 6

12 Volt Reading*
Neutral start switch is open or YELLOW/RED wire is open between Test Points 5 and 4.

TEST 6
Connect voltmeter between common engine ground and Test Point 6

No voltage reading: proceed to TEST 7

12 Volt Reading*
Defective ignition switch.

TEST 7
Check for voltage between common engine ground and Test Point 7.

No voltage reading:
Check BLACK cable with RED sleeve between battery(+) POSITIVE terminal and Test Point 8 and Test Point 7.

12 Volt Reading*
Check fuse in RED wire between Test Points 6 and 7.
Check for open RED wire between Test Points 6 and 7.

TEST 8
a. Connect voltmeter between common engine ground and Test Point 2.
b. Turn ignition key to "Start" position.

No voltage reading:
Defective slave solenoid

12 Volt Reading*
Should hear solenoid click: proceed to TEST 9

TEST 9
a. Reconnect BLACK cable (with RED sleeve) to slave solenoid Test Point 7.
b. Connect voltmeter between common engine ground and Test Point 7.
c. Turn ignition key to "Start" position.

No voltage reading:
Check BLACK cable (with RED sleeve) for poor connection or open circuit.

*Battery Voltage

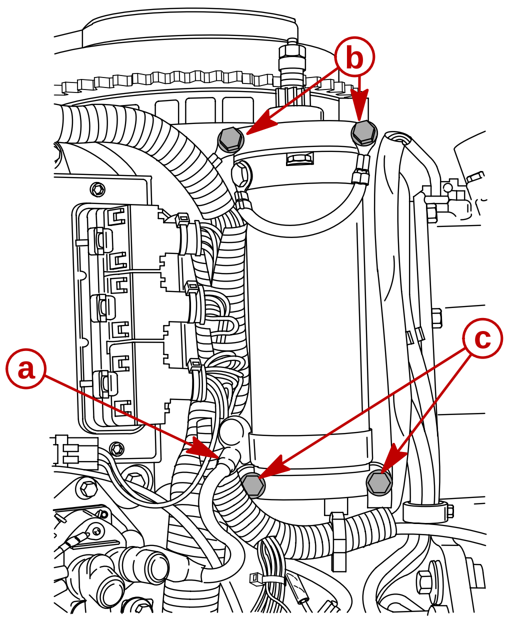
Starter Removal and Installation (2000 Model)(Centrifugal Bendix)

Removal

CAUTION

Disconnect battery leads from battery before removing starter.

1. Disconnect BLACK ground cable from starter.
2. Disconnect BLACK cable (with YELLOW sleeve) from starter.
3. Remove 2 upper bolts and 2 lower bolts securing starter and remove starter.



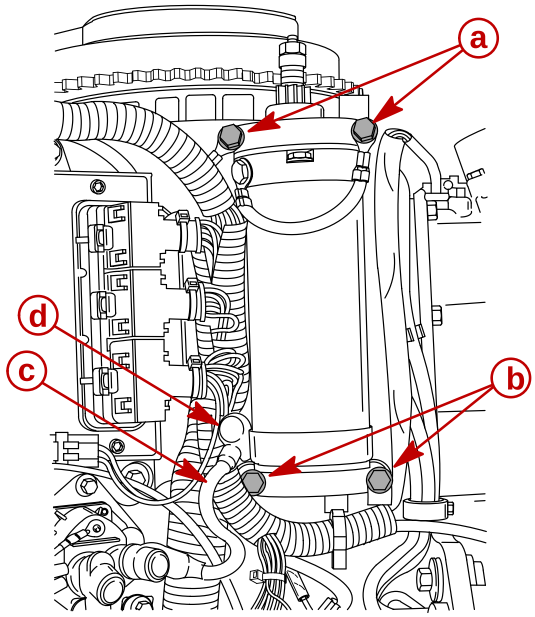
57924

a - BLACK (with YELLOW sleeve) POSITIVE (+) 12-Volt Cable
b - Upper Mounting Bolts
c - Lower Mounting Bolts

Installation

1. Secure starter to engine with 4 bolts. Use Left top bolt to attach BLACK NEGATIVE (–) battery cable.
   Torque top attaching bolts to 23 lb. ft. (31 Nm). Torque bottom attaching bolts to 21 lb. ft. (28.5 Nm).

2. Secure BLACK cable (with YELLOW sleeve) to POSITIVE (+) terminal on starter. Torque nut to 60 lb. in. (7 Nm).

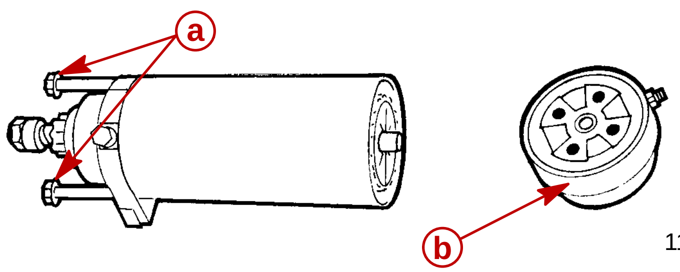


57924

a - Top Bolts [Torque to 23 lb. ft. (31 Nm)]
b - Bottom Bolts [Torque to 21 lb. ft. (28.5 Nm)]
c - BLACK Cable (with YELLOW sleeve)
d - Nut [Torque to 60 lb. in. (7 Nm)]

Disassembly

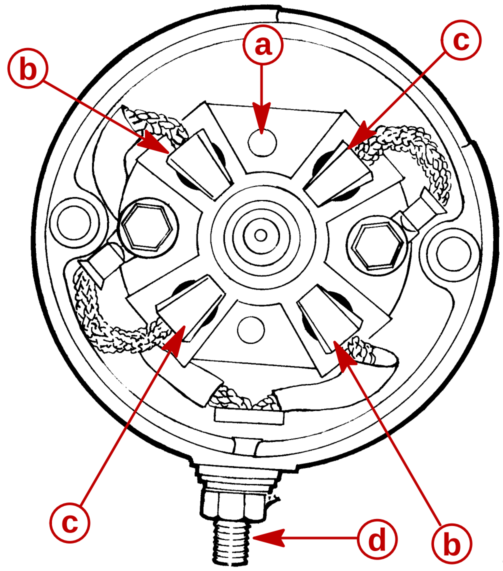
1. Remove starter as outlined in “Starter Removal and Installation,” preceding.
2. Remove 2 through bolts from starter.
3. Tap commutator end cap to loosen and remove from frame. Do not loose brush springs.



11646

a - Through Bolts
b - Commutator End Cap

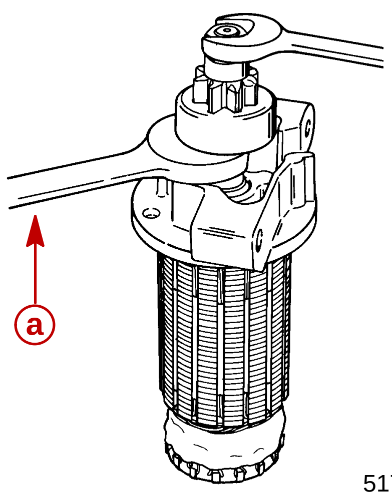
4. Brush replacement is recommended if brushes are pitted, chipped or worn to less than 0.25 in. (6.4 mm). If necessary, remove brushes as follows:
   a. Remove hex nut and washers from POSITIVE (+) terminal and remove POSITIVE brushes and terminal as an assembly.
   b. Remove 2 bolts securing NEGATIVE (–) brushes and brush holder to end cap.



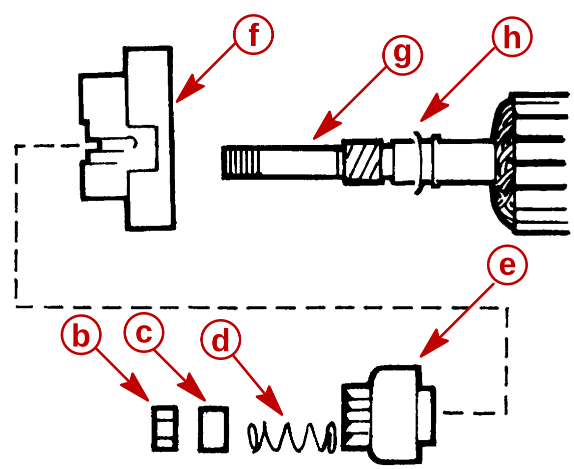
11656

a - Brush Holder
b - Positive Brushes
c - Negative Brushes
d - Positive Terminal

5. Remove armature (with drive end cap) from starter frame.
6. Remove locknut and remove drive assembly from armature shaft.



51711



11658

a - Hold Armature Shaft with Wrench on Hex Portion of Drive Assembly
b - Locknut
c - Spacer
d - Spring
e - Drive Assembly
f - Drive End Cap
g - Armature Shaft
h - Washer

Cleaning and Inspection

1. Clean all starter 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. Inspect brush holder for damage or for failure to hold brushes against commutator.
5. Replace brushes that are pitted or worn to less than 1/4 in. (6.4 mm) in length.
6. Inspect the armature conductor (commutator bar junction) for a tight connection. A loose connection (excessive heat from prolonged cranking melts solder joints) results in a burned commutator bar.
7. Resurface and undercut a rough commutator as follows:

CAUTION

Do not turn down the commutator excessively.

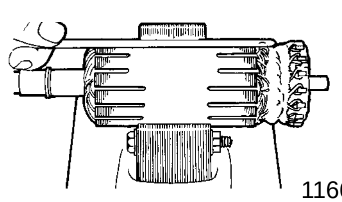
   a. Resurface the commutator and undercut the insulation between the commutator bars 1/32 in. (0.8mm) to the full width of the insulation and so that the undercut is flat.
   b. Clean the commutator slots after undercutting.
   c. Sand the commutator lightly with No. 00 sandpaper to remove burrs, then clean the commutator.
   d. Recheck the armature on a growler for shorts as specified in the following procedure (“Testing”).

8. Open-circuited armatures often can be repaired. The most likely place for an open circuit is at the commutator bars, as a result of long cranking periods. Long cranking periods overheat the starter motor so that solder in the connections melts and is thrown out. The resulting poor connections then cause arcing and burning of the commutator bars.
9. Repair bars, that are not excessively burned, by resoldering the leads in bars (using rosin flux solder) and turning down the commutator in a lathe to remove burned material, then undercut the mica.
10. Clean out the copper or brush dust from slots between the commutator bars.
11. Check the armature for ground. See the following procedure (“Testing”).

Testing (For Centrifugal Bendix and Solenoid Driven Bendix Starters)

Armature Test for Shorts

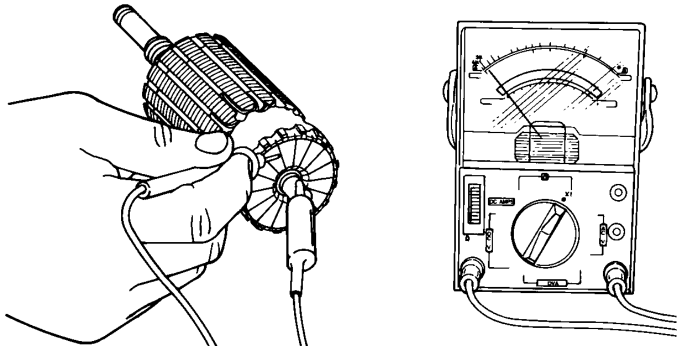
Check armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. If saw blade vibrates, armature is shorted. Recheck after cleaning between commutator bars. If saw blade still vibrates, replace armature.



11669

Armature Test for Ground

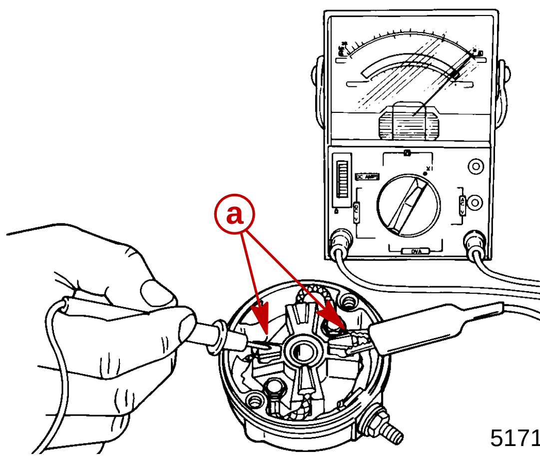
1. Set ohmmeter to (R x 1 scale). Place one lead of ohmmeter on armature core or shaft and other lead on commutator.
2. If meter indicates continuity, armature is grounded and must be replaced.



51711

Checking Positive Brushes and Terminal

Set ohmmeter to (R x 1 scale). Connect meter leads between POSITIVE brushes. Meter must indicate full continuity or zero resistance. If resistance is indicated, inspect lead to brush and lead to POSITIVE terminal solder connection. If connection cannot be repaired, brushes must be replaced.

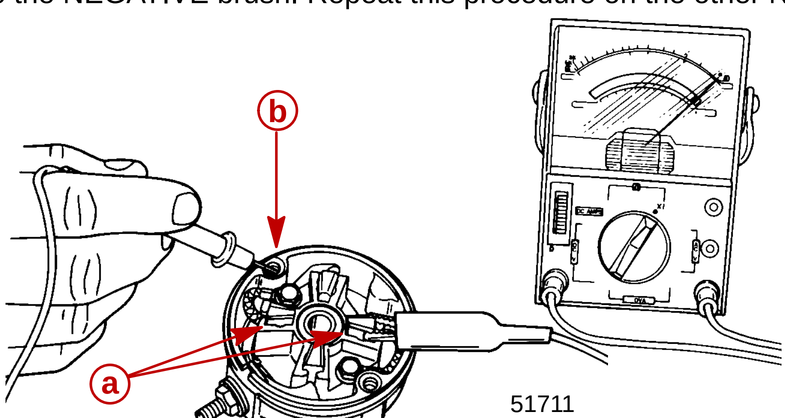


51711

a - POSITIVE (+) Brushes

Testing Negative Brushes for Ground

Set ohmmeter to (R x1 scale). Place one lead of the 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.

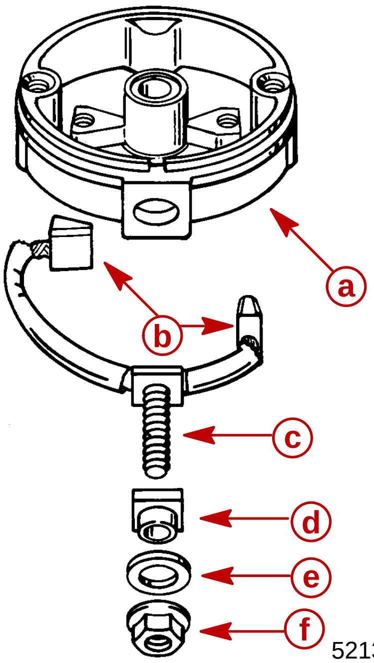


51711

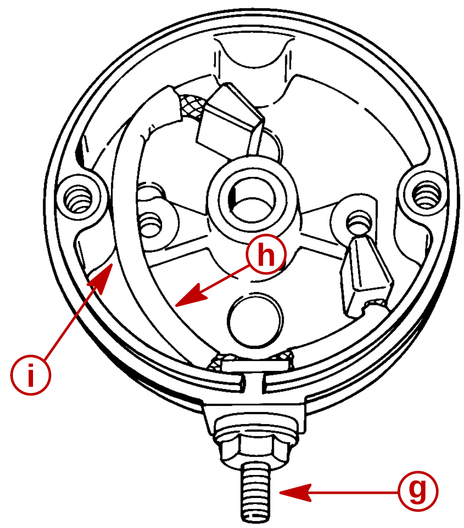
a - NEGATIVE (–) Brushes
b - End Cap

Reassembly

1. If brushes were removed, replace as follows:
   a. Install POSITIVE brushes (along with POSITIVE terminal) into commutator end cap.



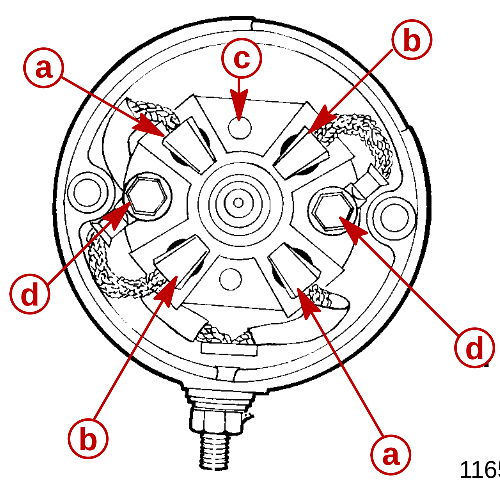
52131



51713

a - End Cap
b - POSITIVE Brushes
c - POSITIVE Terminal
d - Insulating Block
e - Insulating Washer
f - Hex Nut
g - POSITIVE (+) Terminal
h - Long Brush Lead
i - Push Lead into Slot

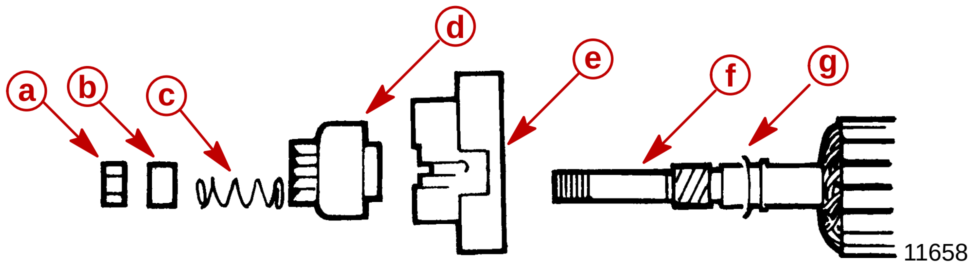
   b. Install NEGATIVE brushes (along with brush holder).



11656

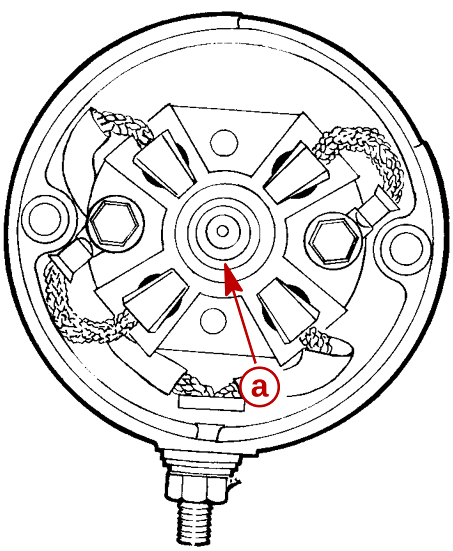
a - POSITIVE (+)Brushes
b - NEGATIVE (–) Brushes
c - Brush Holder
d - Bolts (Fasten NEGATIVE Brushes and Holder)

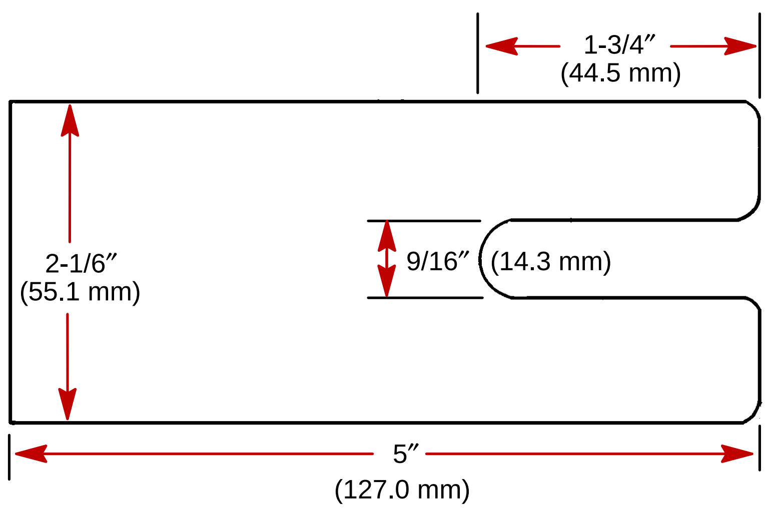
2. If removed, reinstall parts on armature shaft. Use a new locknut and tighten securely on end of shaft.



a - Locknut
b - Spacer
c - Spring
d - Drive Assembly
e - Drive End Cap
f - Armature Shaft
g - Washer

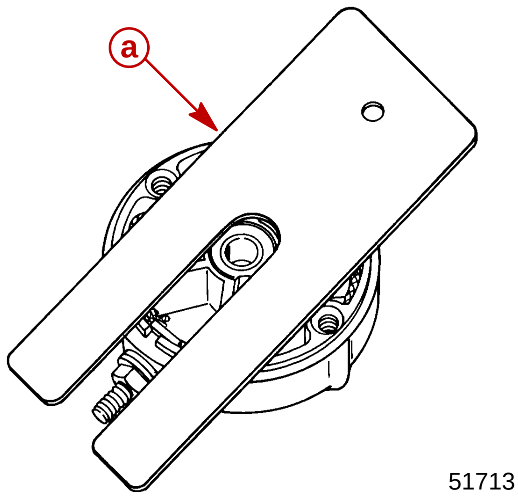
3. Lubricate helix threads on armature shaft with a drop of SAE 10W oil.
4. Lubricate bushing in drive end plate with a drop of SAE 10W oil.
5. Position armature into starter frame.
6. Lubricate bushing (located in commutator end cap) with one drop of SAE 10W oil. DO NOT overlubricate.
7. To prevent damage to brushes and springs when installing commutator end cap, it is recommended that a brush retaining tool be made as shown:

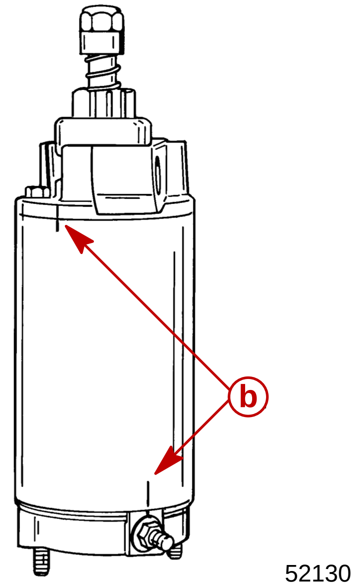




a - Bushing (DO NOT overlubricate)

8. Place springs and brushes into brush holder and hold in place with brush retainer tool.
9. Install commutator end cap onto starter frame. Align marks on frame with alignment marks on end caps. Remove brush retainer tool. Install through bolts and torque to 70 lb. in. (8 Nm).

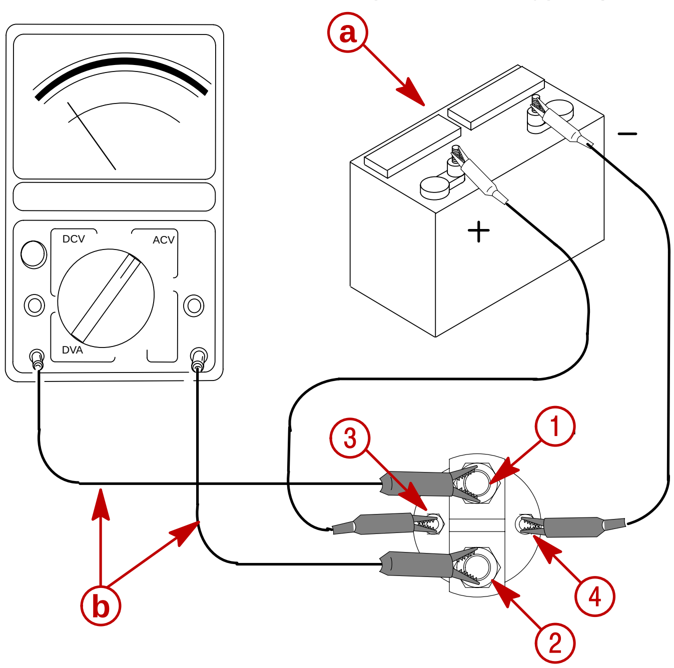




a - Brush Retainer Tool
b - Alignment Marks

Starter Solenoid Test

1. Disconnect all wires from solenoid.
2. Connect ohmmeter (R x1 scale) between terminals 1 and 2.
3. Connect a 12-volt power supply between terminals 3 and 4. Solenoid should click and meter should read 0 ohms (full continuity).
4. If meter does not read 0 ohms (full continuity), replace solenoid.



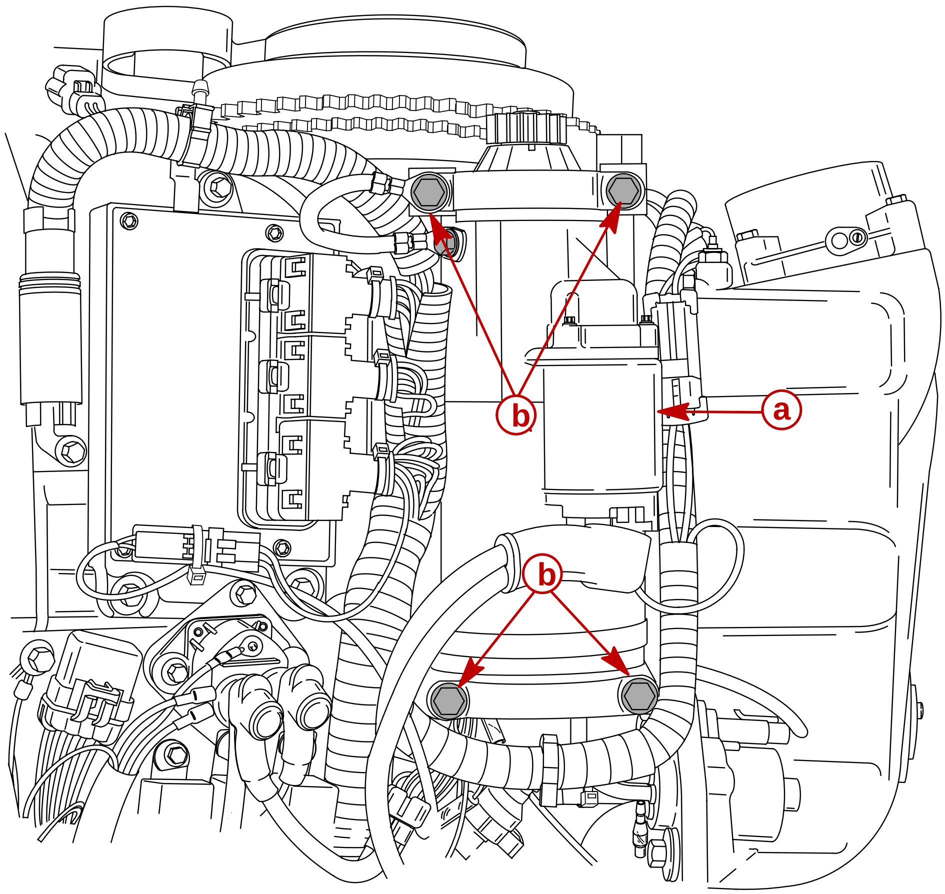
a - 12-VOLT Supply
b - VOA Leads

Starter Removal and Installation (2001 Model) (Solenoid Driven Bendix)

Removal

⚠ CAUTION
Disconnect battery leads from battery before removing starter.

1. Disconnect battery cables from battery.
2. Disconnect wires from starter solenoid terminals.
3. Remove starter trunion mounting bolts and remove starter from engine.

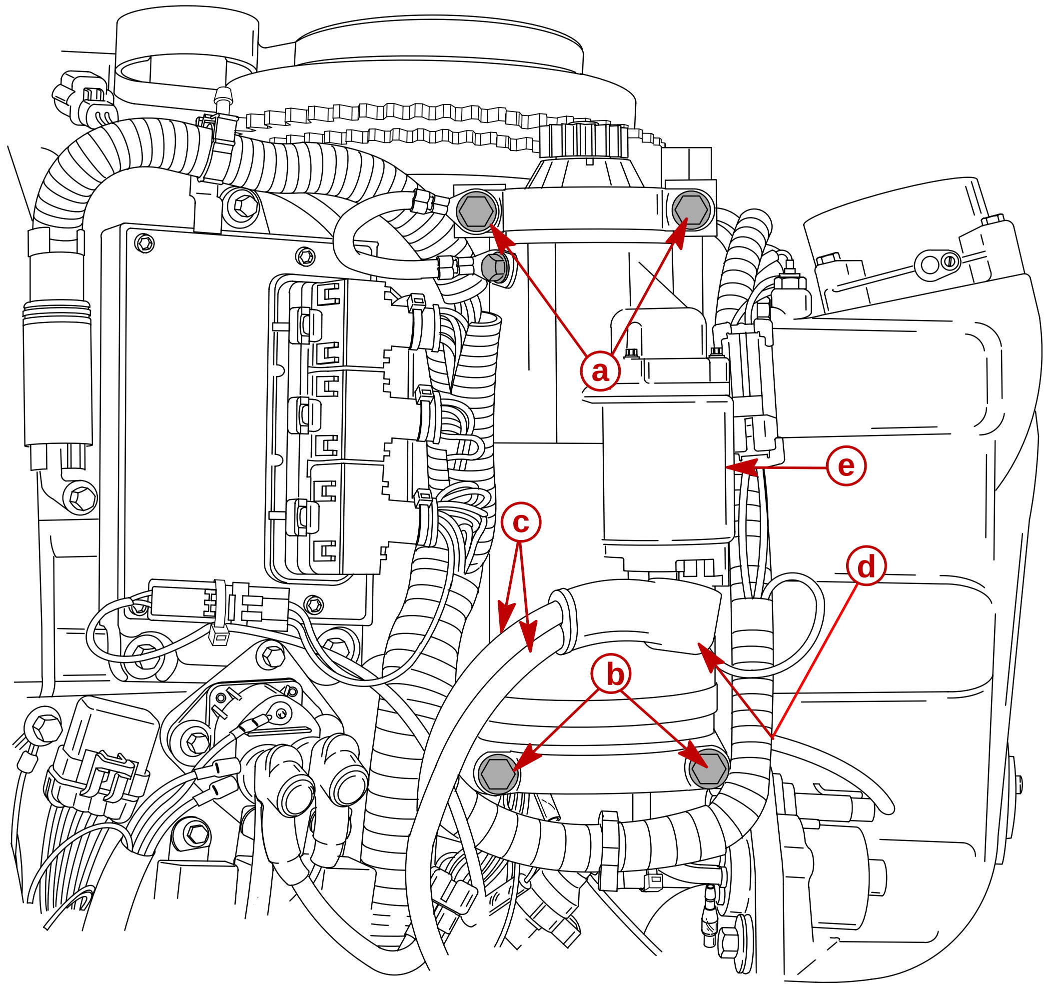


58700

a - Starter Solenoid
b - Mounting Bolts

Installation

1. Secure starter to engine with 4 bolts. Use right top bolt to attach BLACK NEGATIVE. Torque top attaching bolts to 23 lb-ft (31 Nm). Torque bottom attaching bolts to 21 lb-ft. (28.5 Nm).
2. Secure BLACK cables (with RED sleeves) to POSITIVE (+) terminal on starter solenoid. Torque nut to 55 lb-in (6 Nm).

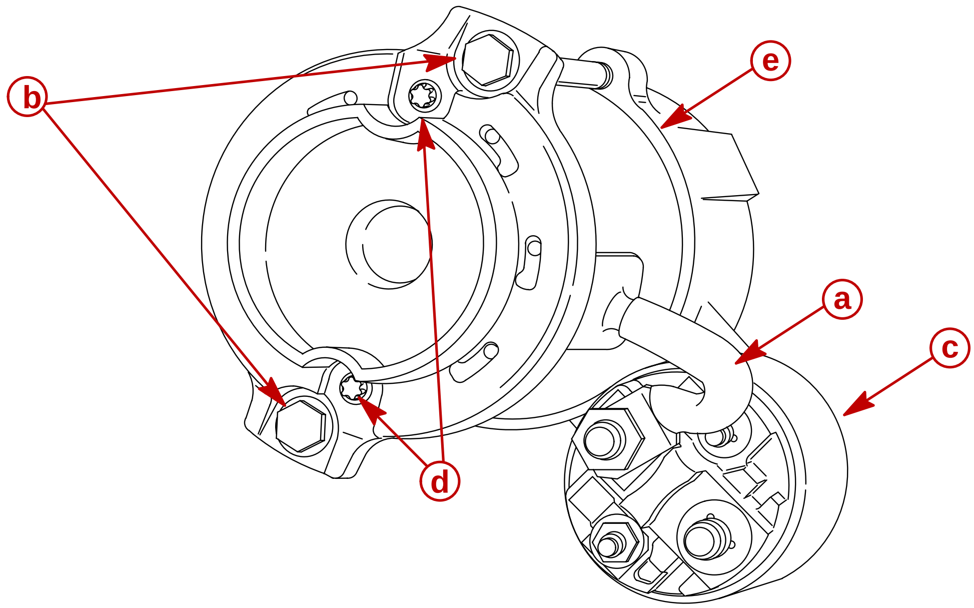


58700

a - Top Bolts [Torque to 23 lb-ft (31 Nm)]
b - Bottom Bolts [Torque to 21 lb-ft (28.5 Nm)]
c - BLACK Cables (with RED sleeves)
d - Nut [Torque to 55 lb-in (6 Nm)]
e - Starter Solenoid

Disassembly (Solenoid Driven Bendix Starter)

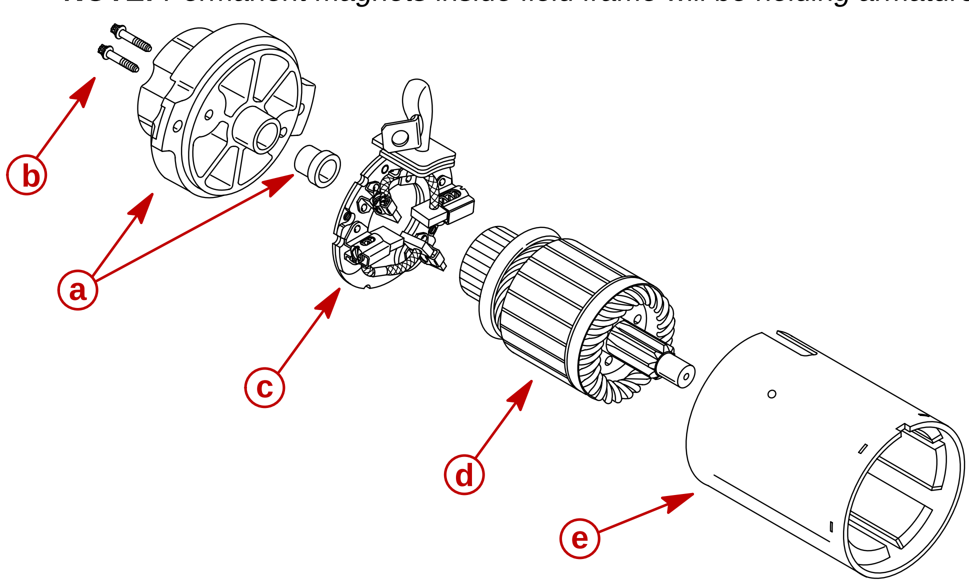
1. Remove brush lead from solenoid and through bolts from end frame.



a - Brush Lead
b - Through Bolts
c - Starter Solenoid
d - Brush Plate Screws
e - End Frame

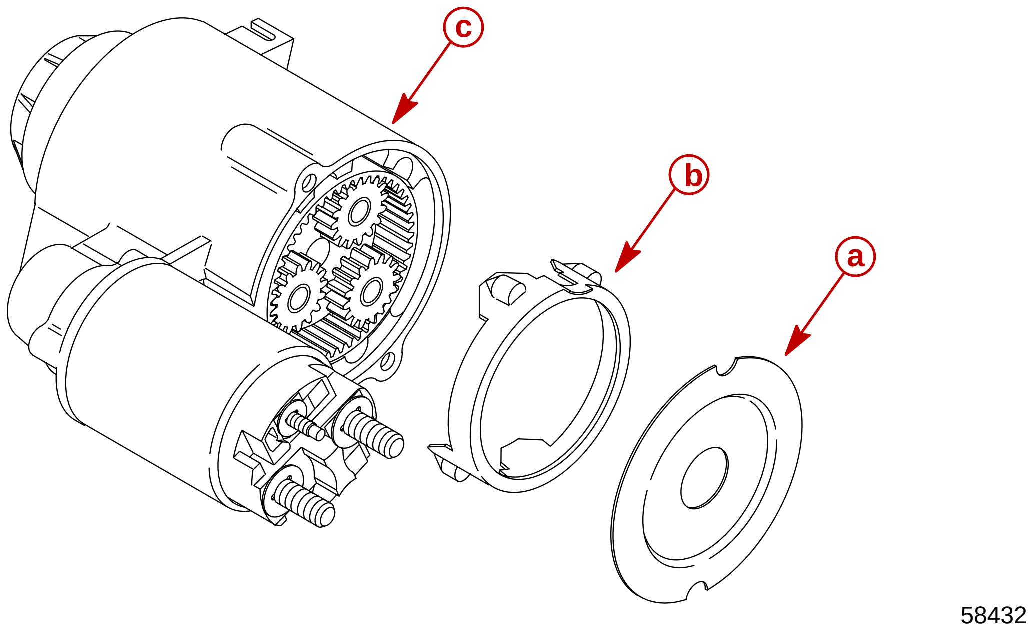
2. Remove armature and field frame from drive housing.

NOTE: *Permanent magnets inside field frame will be holding armature in place.*



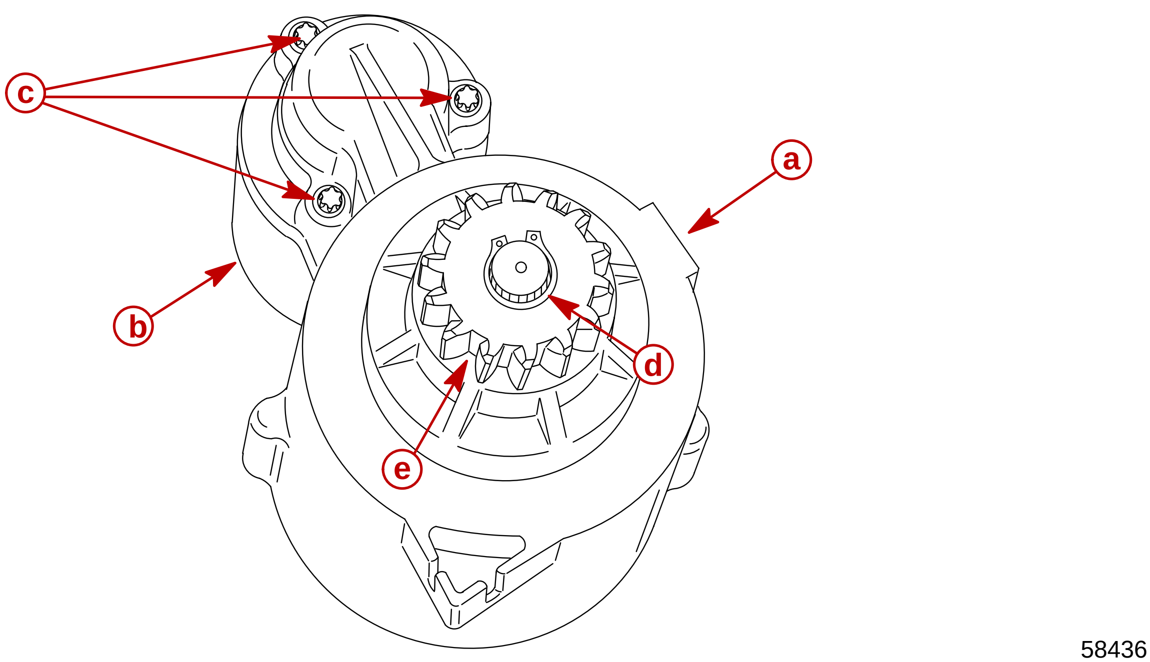
a - End Frame and Bearing
b - Screws (2) [Internal Torx – Snap On E6 Socket]
c - Brush Holder
d - Armature
e - Field Frame

3. Remove shield and cushion from drive housing.



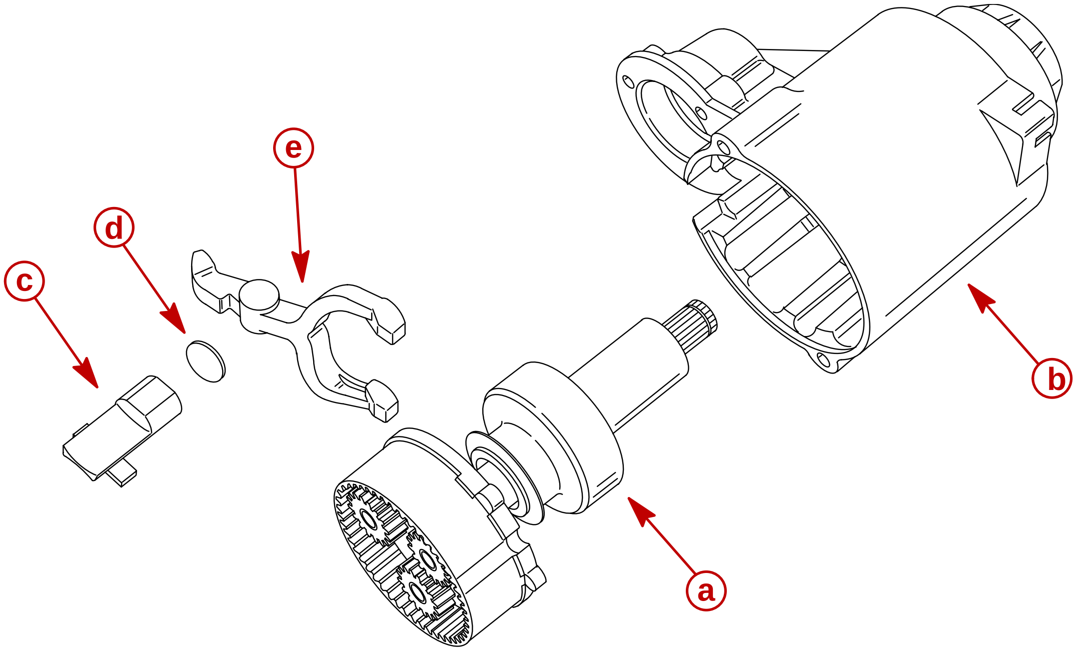
a - Shield
b - Cushion
c - Drive Housing

4. Remove 3 screws retaining starter solenoid. Remove solenoid from drive housing.
5. Remove snap ring and gear from starter shaft.



a - Drive Housing
b - Starter Solenoid
c - Screws (3) [Internal Torx– Snap On E6 Socket]
d - Snap Ring
e - Pinion Gear

6. Remove planetary gear and clutch assembly from drive housing.
7. Remove solenoid arm, metal disc and plug from drive housing.

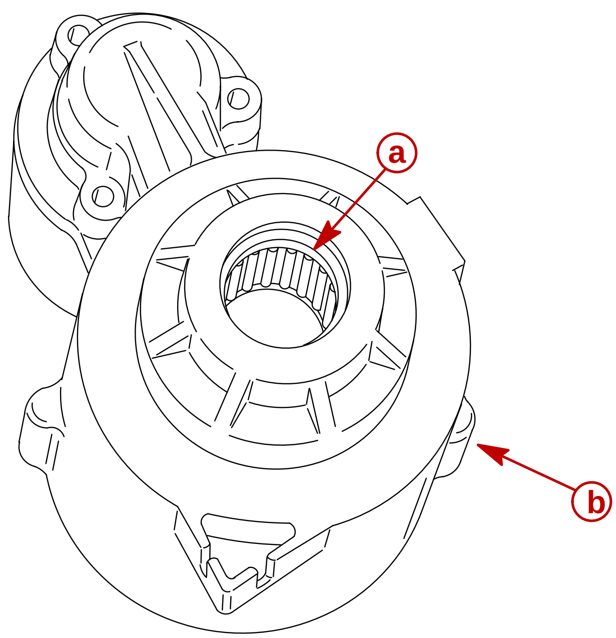


58437

- **a** - Planetary Gear and Clutch Assembly
- **b** - Drive Housing
- **c** - Plug
- **d** - Metal Disc
- **e** - Solenoid Arm

8. Inspect drive housing needle bearing for roughness. If bearing is worn or damaged, bearing can be removed by using an appropriate mandrel to drive/press bearing from drive housing.

NOTE: *If bearing has spun in drive housing bore, drive housing must be replaced.*



58439

- **a** - Needle Bearing
- **b** - Drive Housing

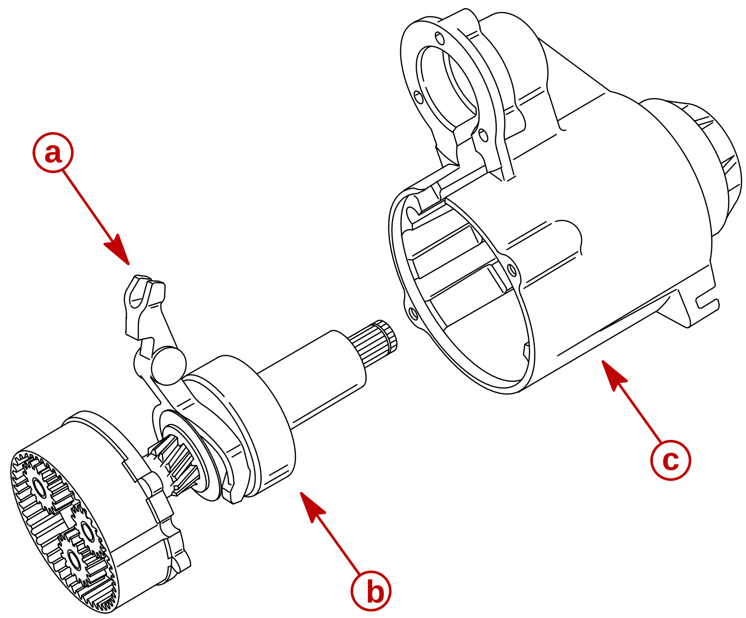
Cleaning and Inspection

IMPORTANT: Do not use grease dissolving solvents to clean electrical components, planetary gears or drive clutch. Solvent will damage insulation and wash the lubricant out of the clutch drive and gears. Use clean rags and compressed air to clean components.

1. Test over-running clutch action of drive. Pinion should turn freely in over-running direction and must not slip in cranking direction.
2. Inspect pinion teeth for wear.
3. Inspect spring for tension and drive collar for wear.
4. Check that bearings roll freely. If any roughness is felt, replace bearing.
5. Inspect planetary gear assembly. Gears must mesh easily and roll freely with no binding.

Reassembly (Solenoid Driven Bendix Starter)

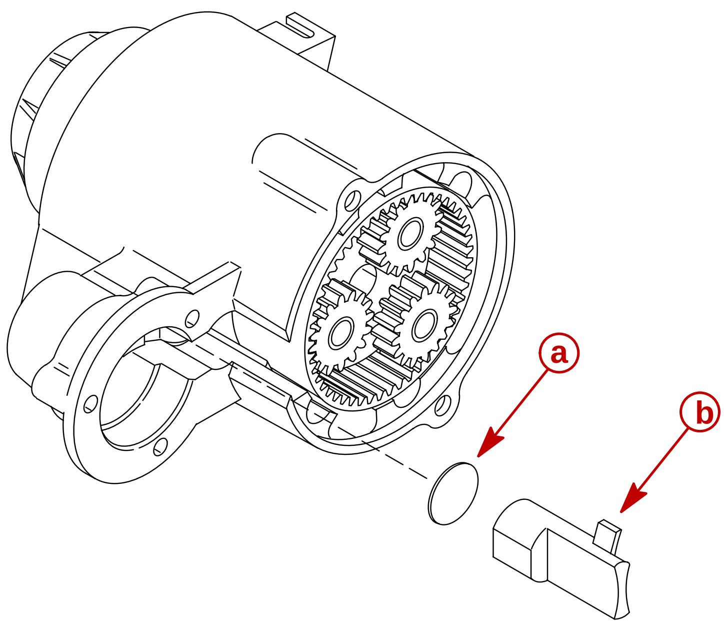
1. Install solenoid arm with planetary gear and clutch assembly into drive housing.



58438

a - Solenoid Arm
b - Planetary Gear and Clutch Assembly
c - Drive Housing

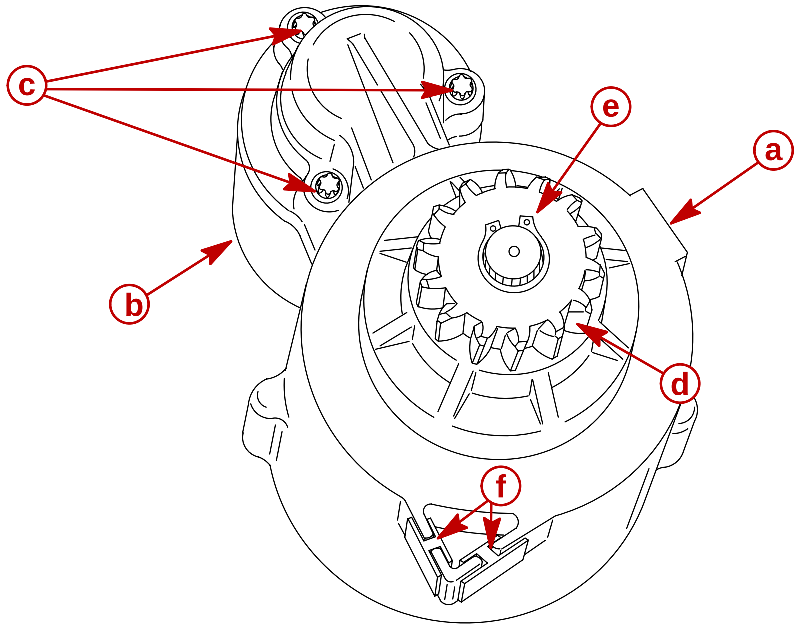
2. Install metal disc and plug into drive housing.



58433

a - Metal Disc
b - Plug

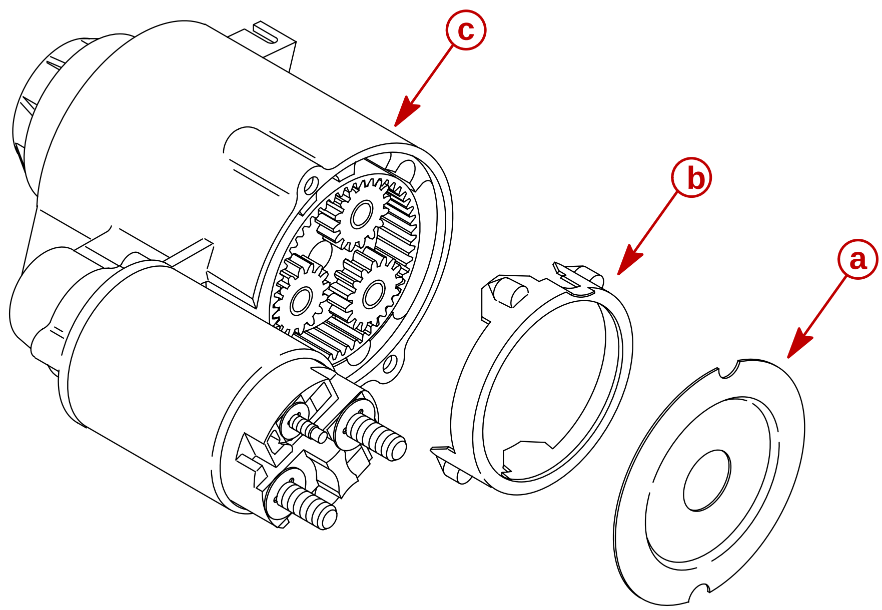
3. Attach solenoid arm to starter solenoid. Install starter solenoid in drive housing and secure with 3 screws. Torque screws to 40 lb-in (4.5 N.m).
4. Install drive gear and secure with snap ring.
5. Reinstall rubber bumpers on housing.



58436

a - Drive Housing
b - Starter Solenoid
c - Screw (3) [Torque to 40 lb-in (4.5 N.m)
d - Drive Gear
e - Snap Ring
f - Bumpers

6. Install cushion and shield in drive housing.

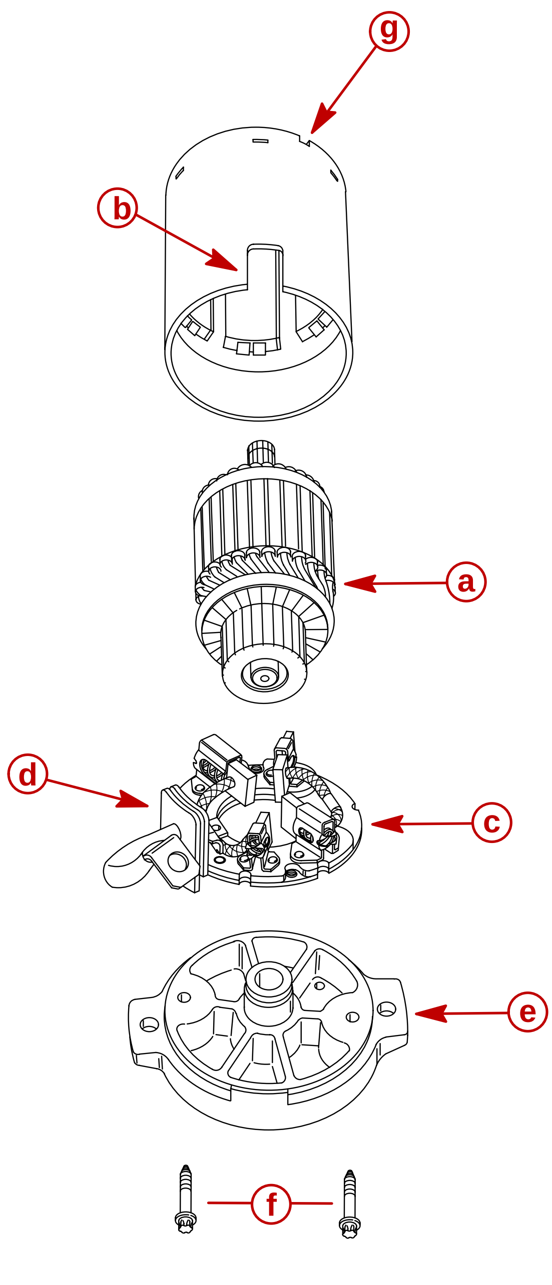


58432

a - Shield
b - Cushion
c - Drive Housing

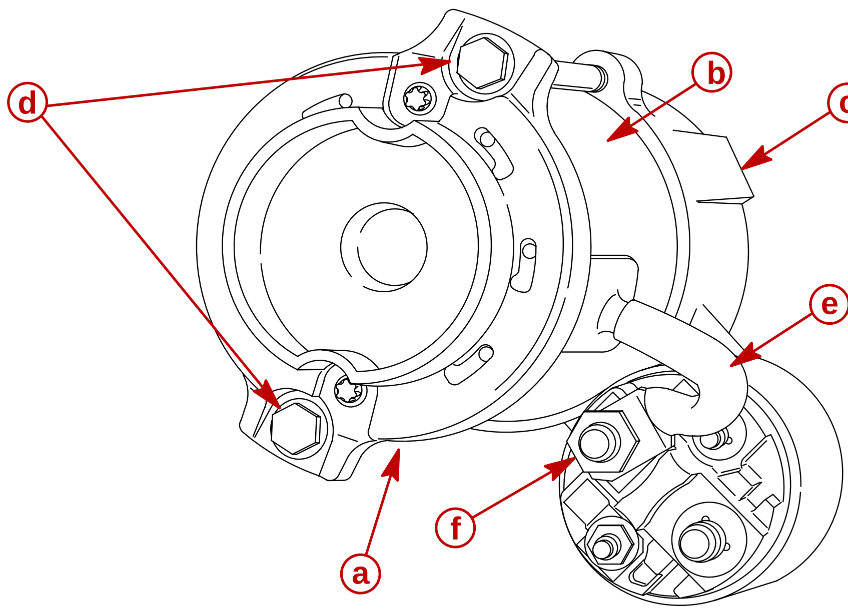
7. Install field frame over armature.
8. While holding brushes back, slide brush plate onto armature while aligning brush lead grommet with slot in field frame.
9. Secure end plate to brush assembly with 2 screws. Torque screws to 30 lb-in (3.4 Nm)

NOTE: *Prior to installing field frame assembly into drive housing, align slot in field frame with plug in drive housing.*



a - Armature
b - Field Frame Grommet Slot
c - Brush Plate
d - Brush Lead Grommet
e - End Plate
f - Screws [Torque to 30 lb-in (3.4 Nm)]
g - Field Frame Plug Slot

10. Install field frame and end frame in drive housing.
11. Install through bolts and brush lead. Torque through bolts to 110 lb-in (12.5 Nm). Torque brush nut to 55 lb-in (6 Nm).



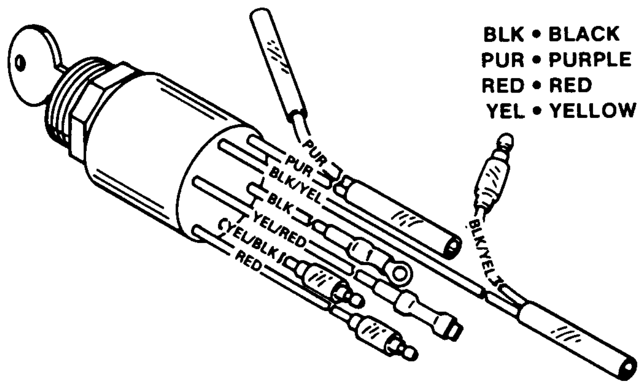
58434

a - End Frame
b - Field Frame
c - Drive Housing
d - Through Bolts [Torque to 110 lb-in (12.5 Nm)]
e - Brush Lead
f - Brush Nut [Torque to 55 lb-in (6 Nm)]

Commander 2000 Key Switch Test

1. Disconnect remote control wiring harness and instrument panel connector.
2. Set ohmmeter on R x 1 scale for the following tests.
3. If meter readings are other than specified in the following tests, verify that switch and not wiring is faulty. If wiring checks ok, replace switch.

IMPORTANT: Key switch must be positioned to “RUN” or “START” and key pushed in to actuate choke for this test.



KEY POSITION	CONTINUITY SHOULD BE INDICATED AT THE FOLLOWING POINTS: BLK	BLK/YEL	RED	YEL/RED	PUR	YEL/BLK
OFF	O	O				
RUN			O		O	
START			O	O		
				O	O	
			O		O	
CHOKE*			O			O
			O		O	
					O	O

ELECTRICAL

Section 2C – Timing, Synchronizing & Adjusting

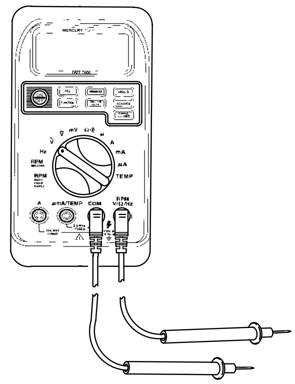
Table of Contents

Specifications

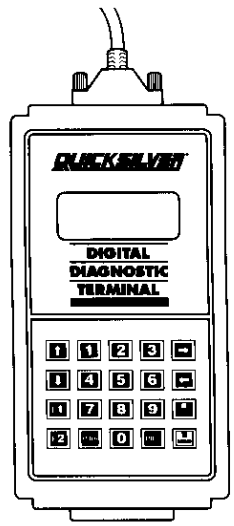
Full Throttle RPM (200/225)	5000 - 5750
Idle RPM (In Gear) (200/225)	550
Maximum Timing	Not Adjustable; Controlled by ECM
Idle Timing	Not Adjustable; Controlled by ECM
Model Year 2000 **Spark Plug Type** **Spark Plug Gap** **Model Year 2000** **Spark Plug Type** **Spark Plug Gap**	 CHAMPION QC12GMC 0.040 IN. (1.0 MM) NGK PZFR5F-11 (HEAVY DUTY) 0.043 IN. (1.1 MM)
Firing Order	1-2-3-4-5-6
Throttle Position Sensor **Model Year 2000** **@ Idle** **@ W.O.T** **Model Year 2001** **@ Idle** **@ W.O.T**	 4.0 - 4.7 VDC 0.4 - 1.3 VDC 0.4 - 1.3 VDC 4.0 - 4.7 VDC

Special Tools

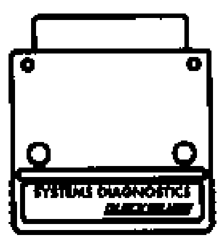
1. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1



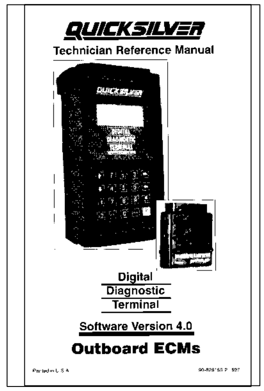
2. Digital Diagnostic Tool (DDT) 91-823686A2



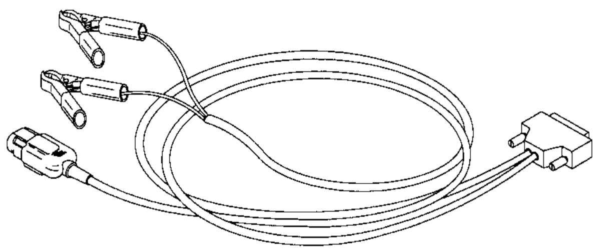
3. Model Year 2000 Software Cartridge 91-822608--6
   Model Year 2001 Software Cartridge 91-880118



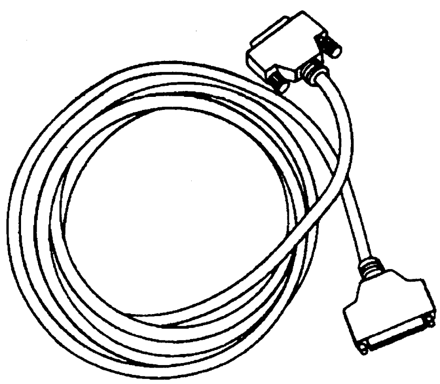
4. Model Year 2000 DDT Reference Manual 90-825159-4
   Model Year 2001 DDT Reference Manual 90-881204



5. ECM Harness 84-822560A5



6. Extension Cable [10 ft. (3.05m)] 84-825003A1



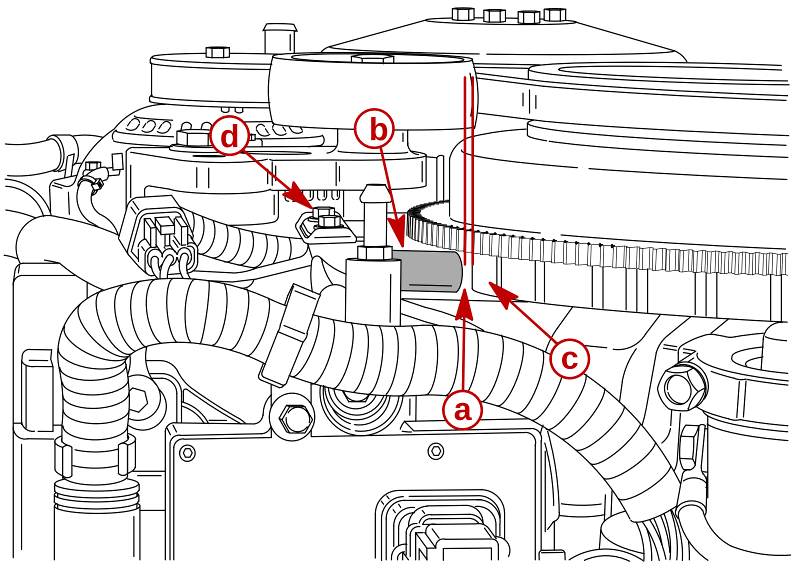
Crank Position Sensor

***NOTE:** Crank Position Sensor is adjustable.*

1. Remove flywheel cover.
2. Using a feeler gauge, measure the air gap between the crank position sensor and a tooth on the flywheel. Gap should be 0.025 in. - 0.040 in. (0.635 mm - 1.02 mm). If necessary, loosen both screws, set gap to specification and tighten screws to 105 lb.in. (12 N·m).

IMPORTANT: Crank Position Sensor must be perpendicular to flywheel tooth.

3. Reinstall flywheel cover.

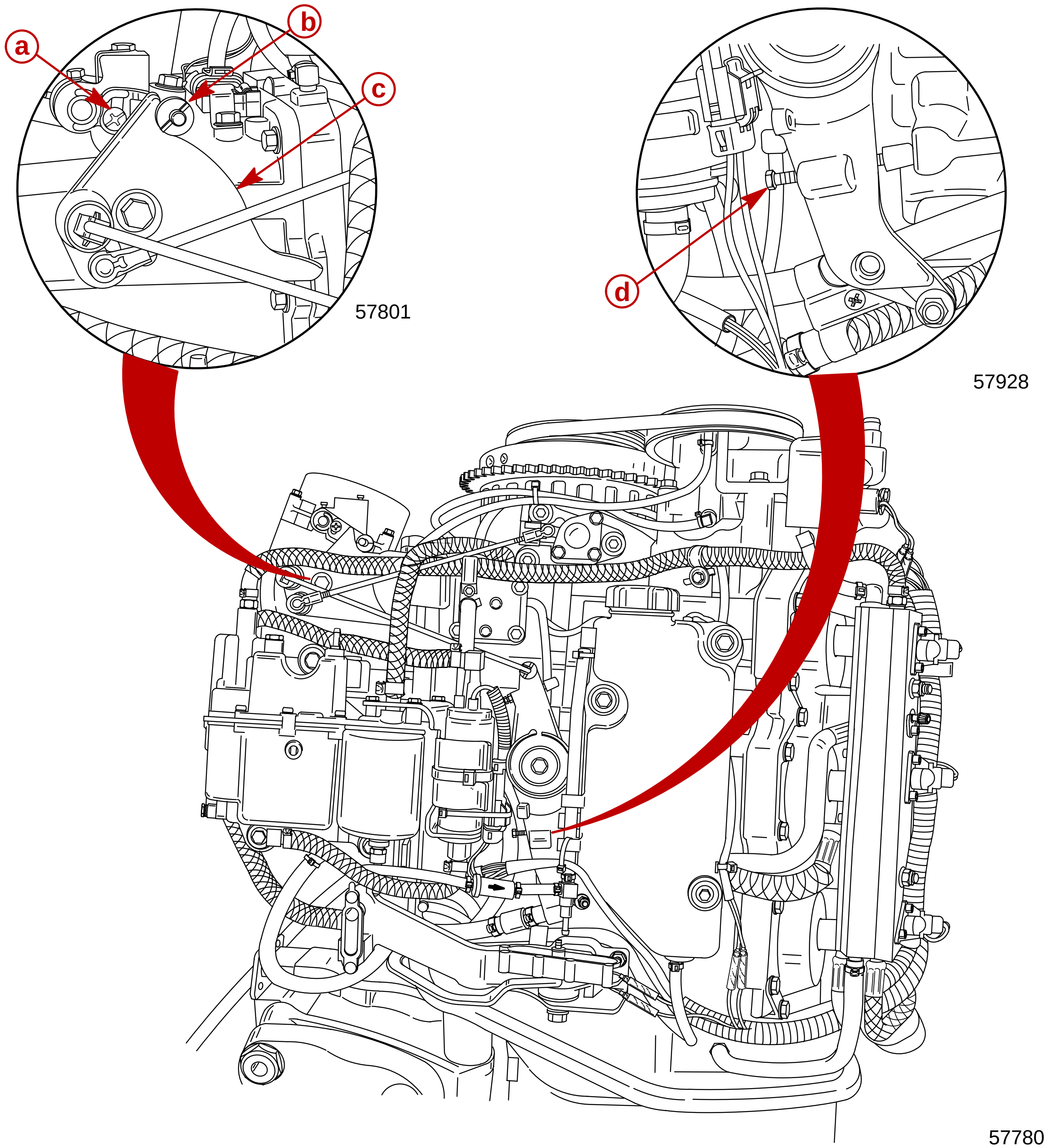


57796

a - Air Gap [0.025 in - 0.040 in. (0.635 mm - 1.02 mm)]
b - Crank Position Sensor
c - Flywheel Tooth
d - Bracket Screws [Torque to 105 lb. in.(12 N·m)]

Throttle Cam Adjustment

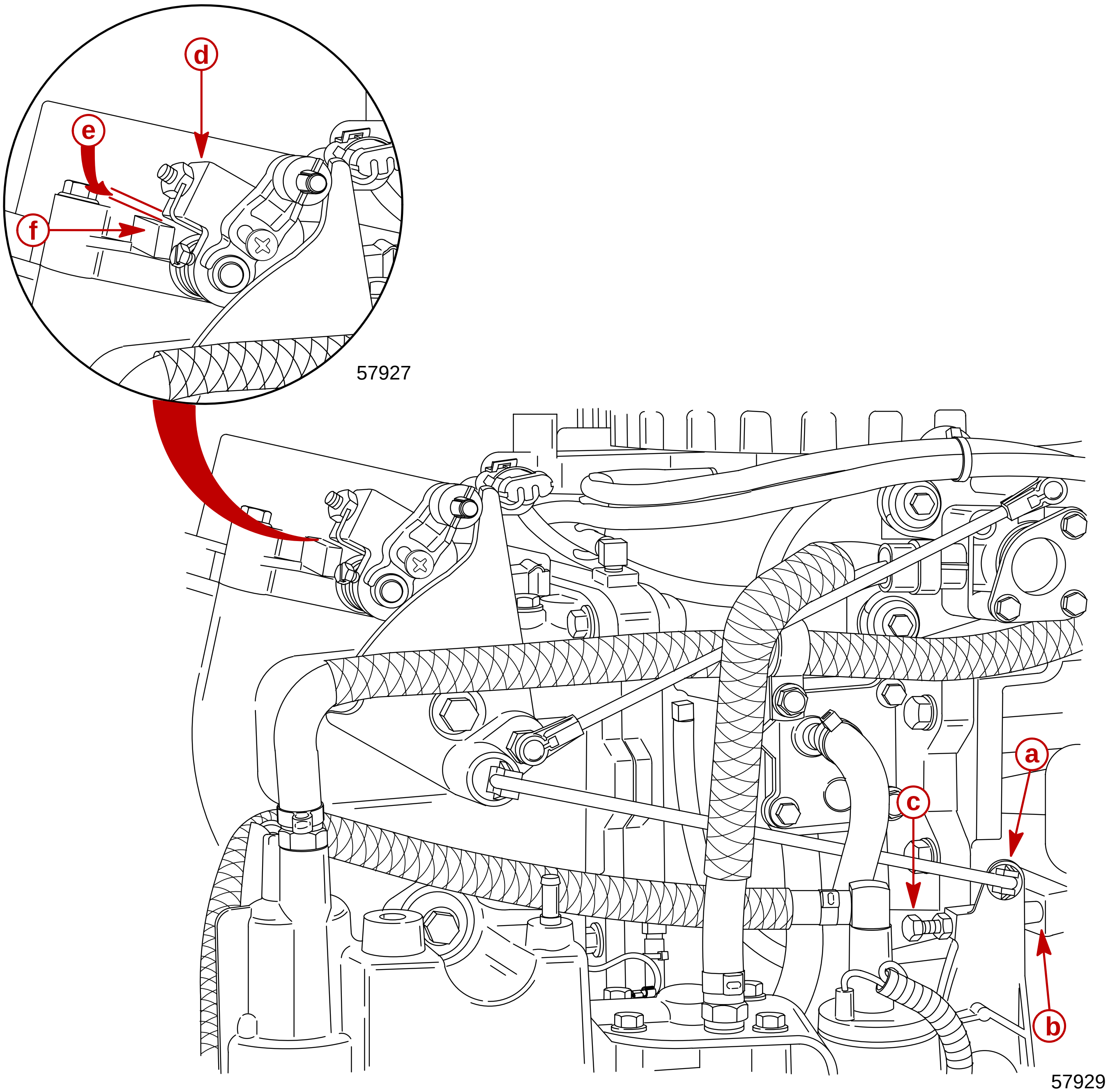
1. Loosen roller arm screw allowing roller to move freely.
2. Allow roller to rest on throttle cam. Adjust idle stop screw on throttle arm to align cam roller in the pocket of the throttle cam.
3. Tighten roller arm screw to provide clearance of 0.005 in. ± 0.005 in. (0.127 mm ± 0.127 mm) between roller and cam.



a - Roller Arm Screw
b - Roller
c - Throttle Cam (200/225)
d - Idle Stop Screw

Maximum Throttle

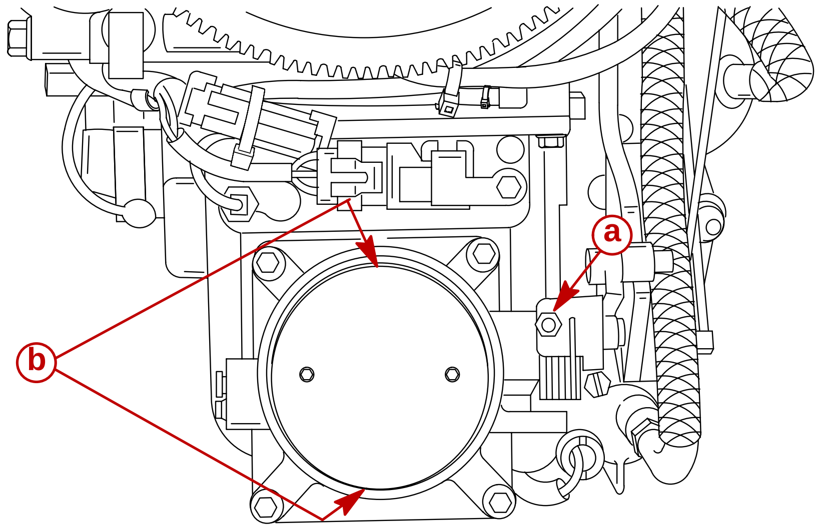
1. Hold throttle arm against full throttle stop.
2. Adjust full throttle stop screw (located behind electric fuel pump) to allow full throttle valve opening while maintaining a 0.010 in. (0.254 mm) clearance between arm of throttle shaft and stop on attenuator box.
3. Tighten jam nut on full throttle stop screw.
4. Check for free play (roller lifts from cam) between roller and cam at full throttle to prevent linkage from binding. Readjust full throttle stop screw, if necessary.



a - Throttle Arm
b - Stop
c - Full Throttle Stop Screw
d - Throttle Shaft Arm
e - 0.010 in. (0.254 mm) Clearance
f - Stop on Attenuator Box

Throttle Plate Screw

IMPORTANT: DO NOT adjust throttle plate stop screw from factory setting. However, should the throttle plate require adjustment, use the throttle plate stop screw to set the total throttle plate clearance @ 0.149 in. (3.78 mm) using suitable drills [so that the combined air gap fore and aft on the throttle plate equals a total of 0.149 in. (3.78 mm)].



57793

a - Throttle Plate Stop Screw
b - Throttle Plate Clearance – Set @ 0.149 in. (3.78 mm)

Throttle Position Sensor (TPS) Adjustment

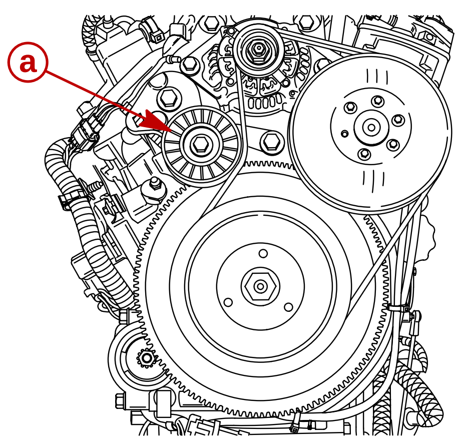
The Throttle Position Sensor is not adjustable. TPS settings can be monitored with the Digital Diagnostic Terminal through the ECM. If TPS settings are not within specifications, refer to Section 2A.

Idle Speed (All Models)

Engine idle speed is not adjustable. The parameters affecting idle speed can be checked and monitored by the DDT. Refer to the DDT Reference Manual for complete details.

Alternator Belt Tension Adjustment (All Models)

Correct alternator belt tension is maintained by a belt tensioner assembly (a).



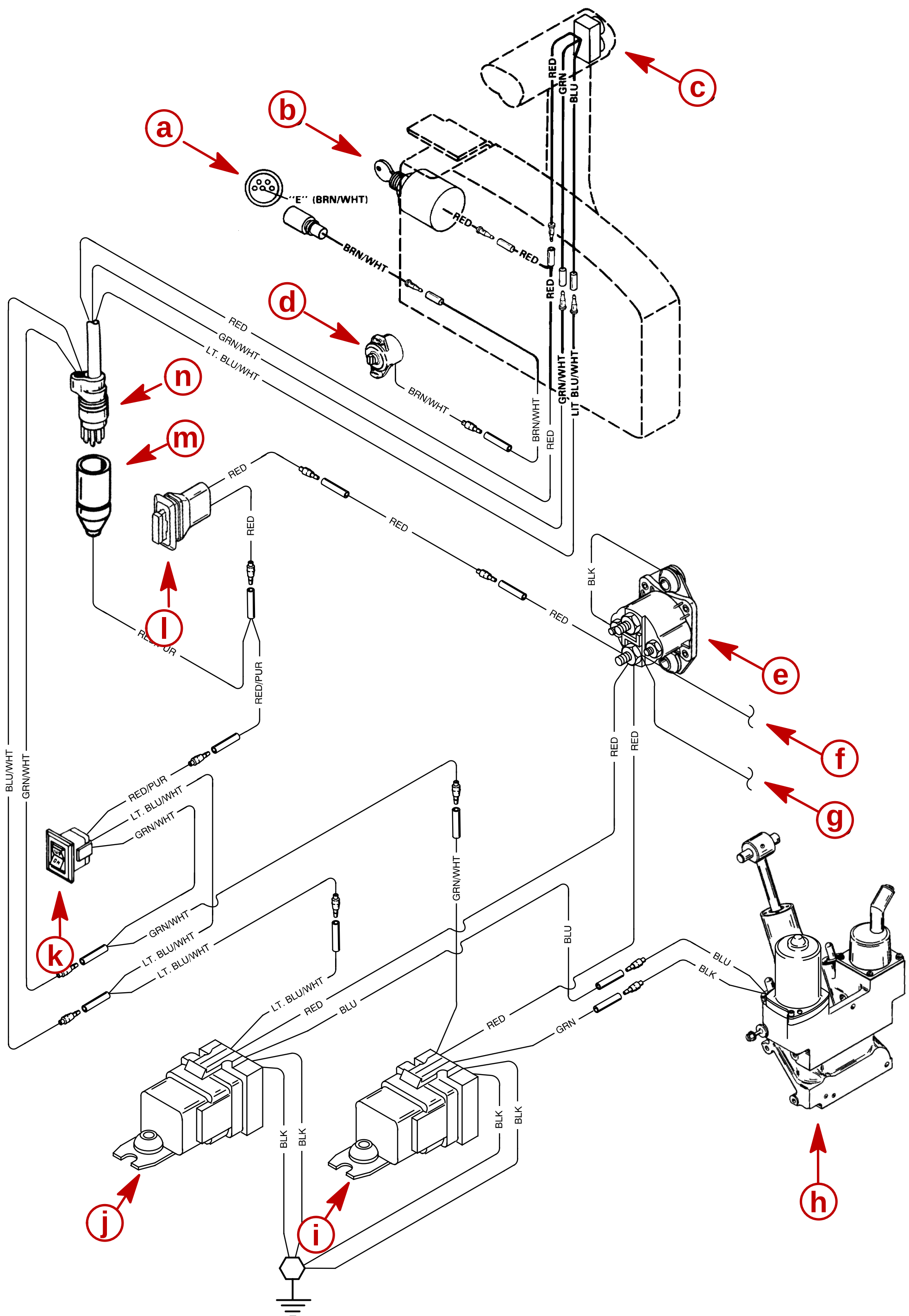
57806

ELECTRICAL

Section 2D – Wiring Diagrams

Table of Contents

Power Trim Wiring Diagram



a - Tach. Connector	**h** - Trim Pump and Motor
b - Key Switch Assembly	**i** - DOWN Solenoid
c - Trim Switch	**j** - UP Solenoid
d - Trim Sender	**k** - Bottom Cowl Switch
e - Start Solenoid	**l** - 20 Ampere Fuse
f - To Battery	**m** - Engine Harness
g - To Alternator	**n** - Remote Control Harness

Instrument Wiring Connections

Wire Color			Where To
BLK	=	BLACK	GROUND
TAN/WHT	=	TAN/WHITE	OIL LIGHT
TAN/BLK	=	TAN/BLACK	TEMPERATURE LIGHT
TAN	=	TAN	TEMPERATURE GAUGE
PUR	=	PURPLE	IGNITION 12 VOLT
GRY	=	GRAY	TACHOMETER
BRN/WHT	=	BROWN/WHITE	TRIM GAUGE
TAN/BLU	=	TAN/BLUE	VISUAL WARNING KIT (OPT.)

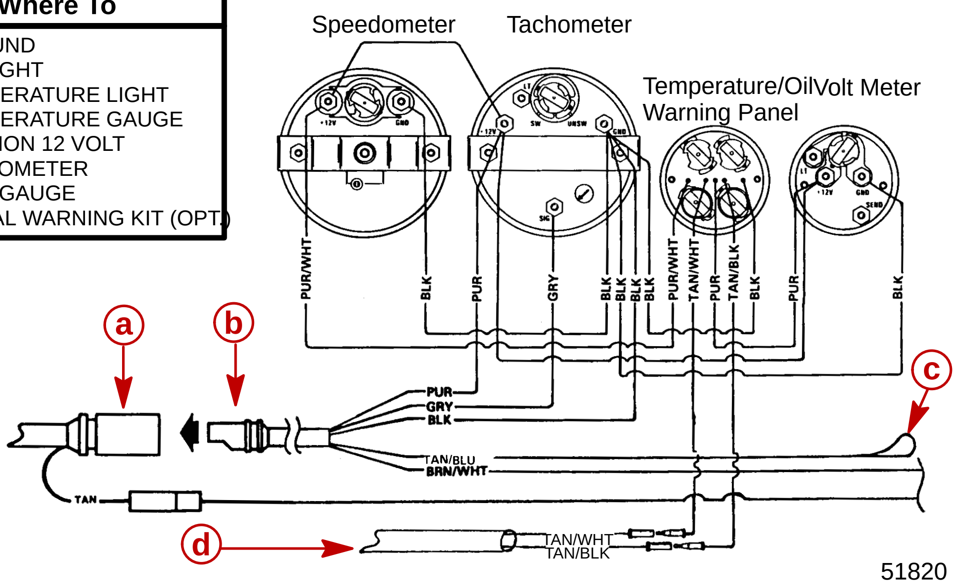


Figure 1 – Without Light Switch

NOTE: *ANY INSTRUMENT WIRING HARNESS LEADS NOT USED MUST BE TAPED BACK TO THE HARNESS.*

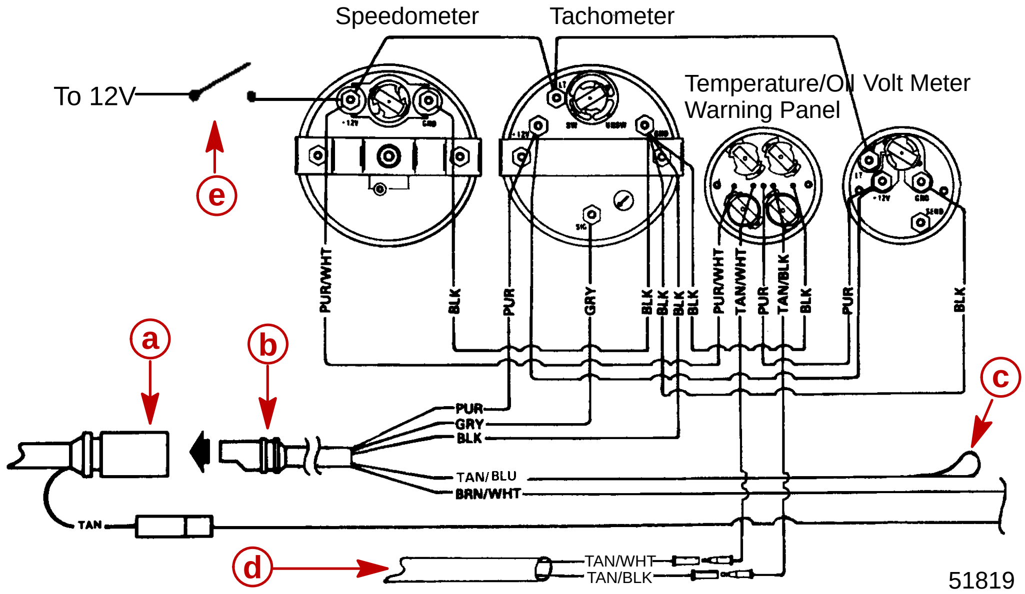
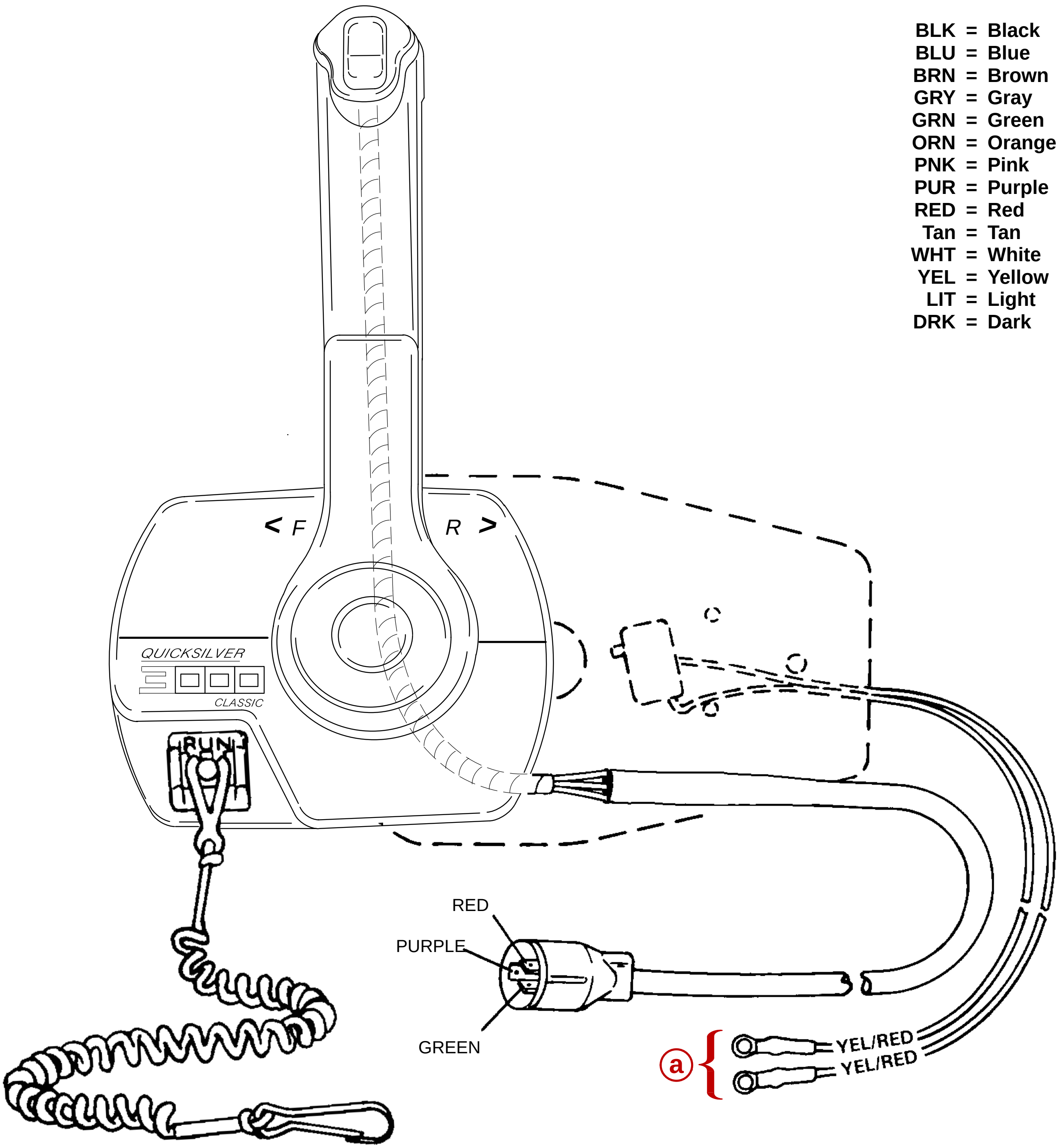


Figure 2 – With Light Switch

- **a** - Tachometer Receptacle - From Control Box or Ignition/Choke Switch
- **b** - Tachometer Wiring Harness
- **c** - Lead to Optional Visual Warning Kit (Taped Back to Harness)
- **d** - Cable Extension (For Two Function Warning Panel)
- **e** - Light Switch

Commander 3000 Classic Panel Remote Control

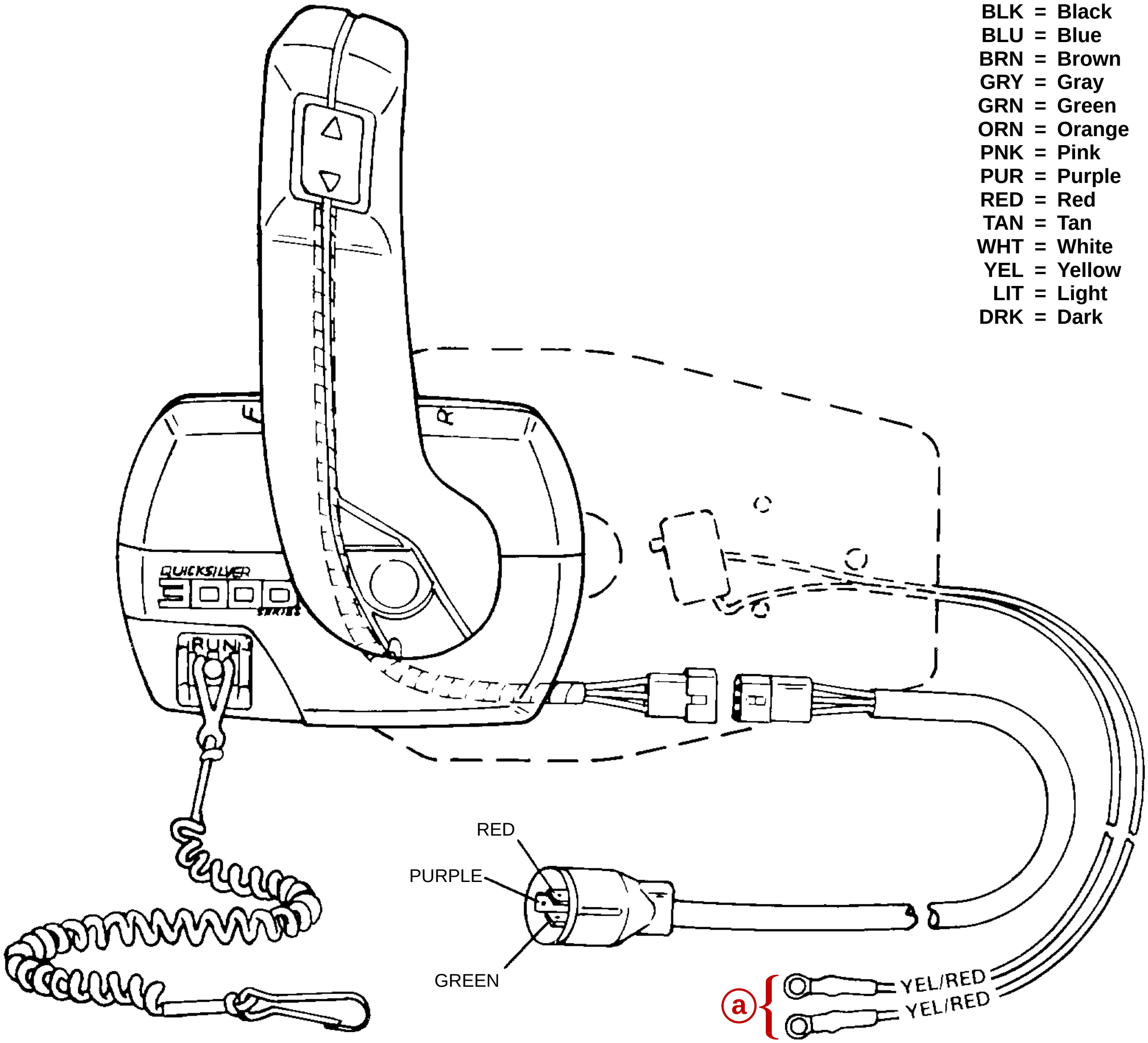


BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
Tan = Tan
WHT = White
YEL = Yellow
LIT = Light
DRK = Dark

a - Neutral Interlock Switch

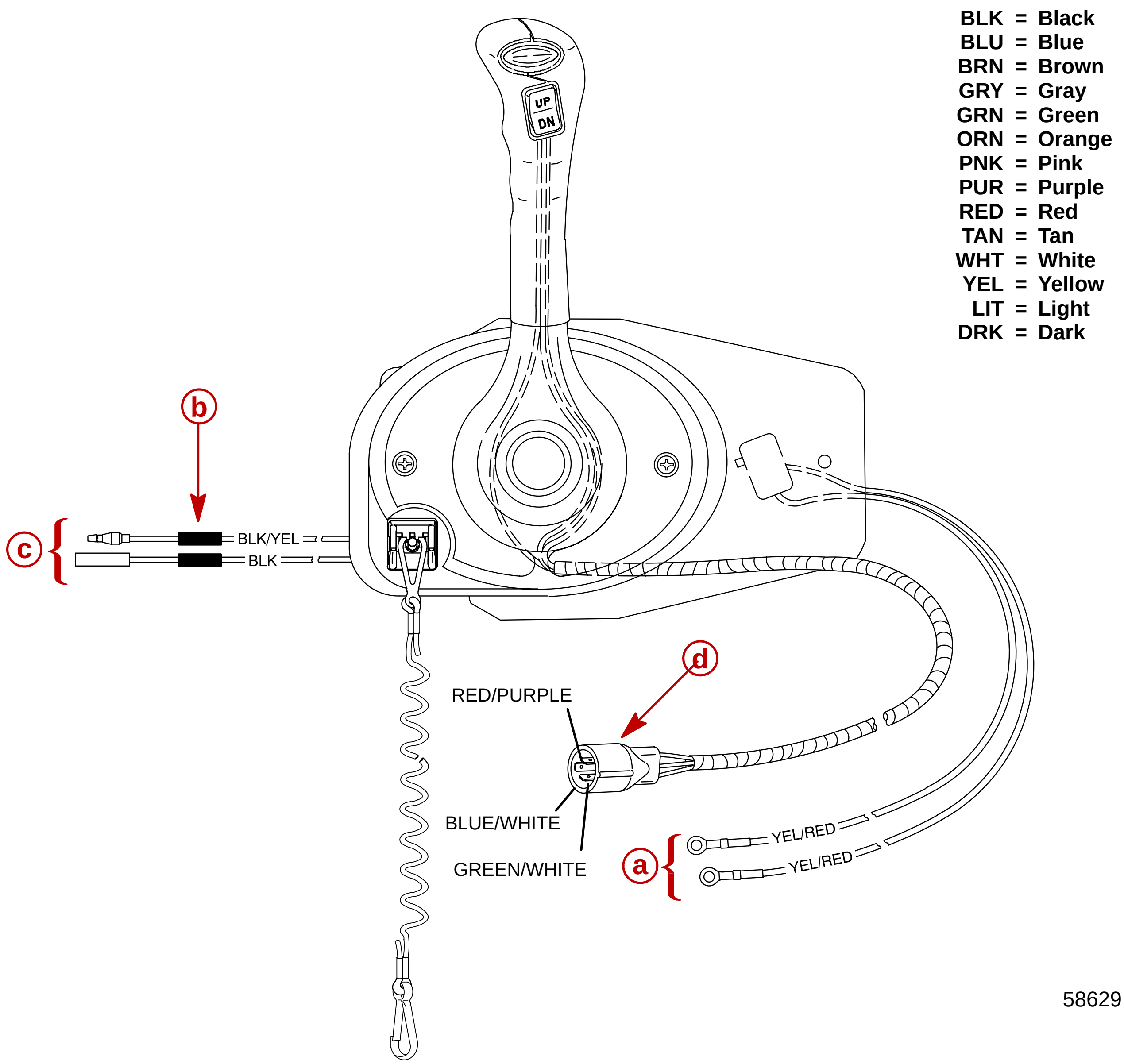
Commander 3000 Panel Remote Control

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 - Neutral Interlock Switch

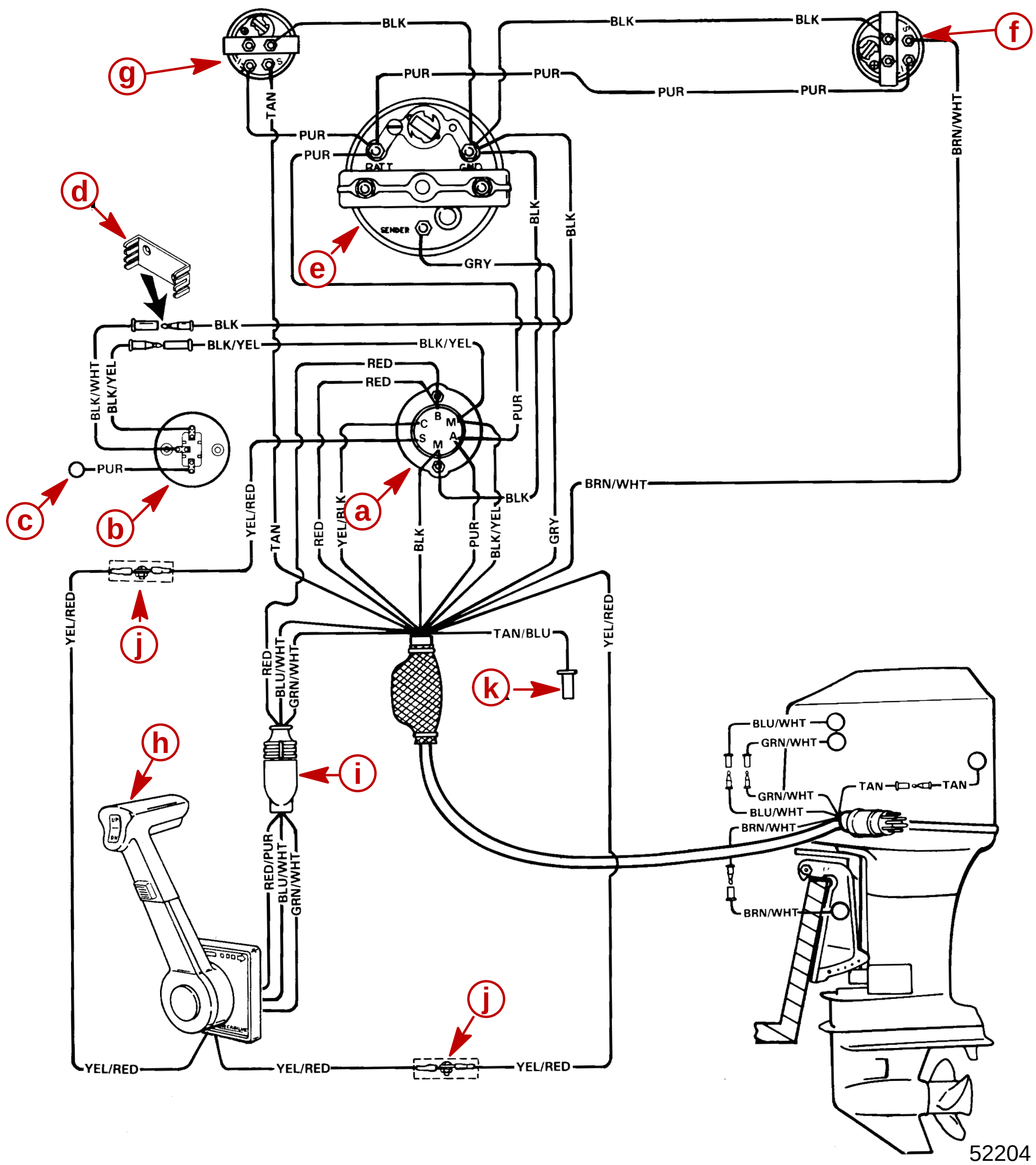
MPC 4000 Mechanical Panel Control



a - Neutral Interlock Switch
b - Solder Connections covered with shrink tube
c - Emergency Stop Switch Harness
d - Trim Harness

Instrument/Lanyard Stop Switch Wiring Diagram

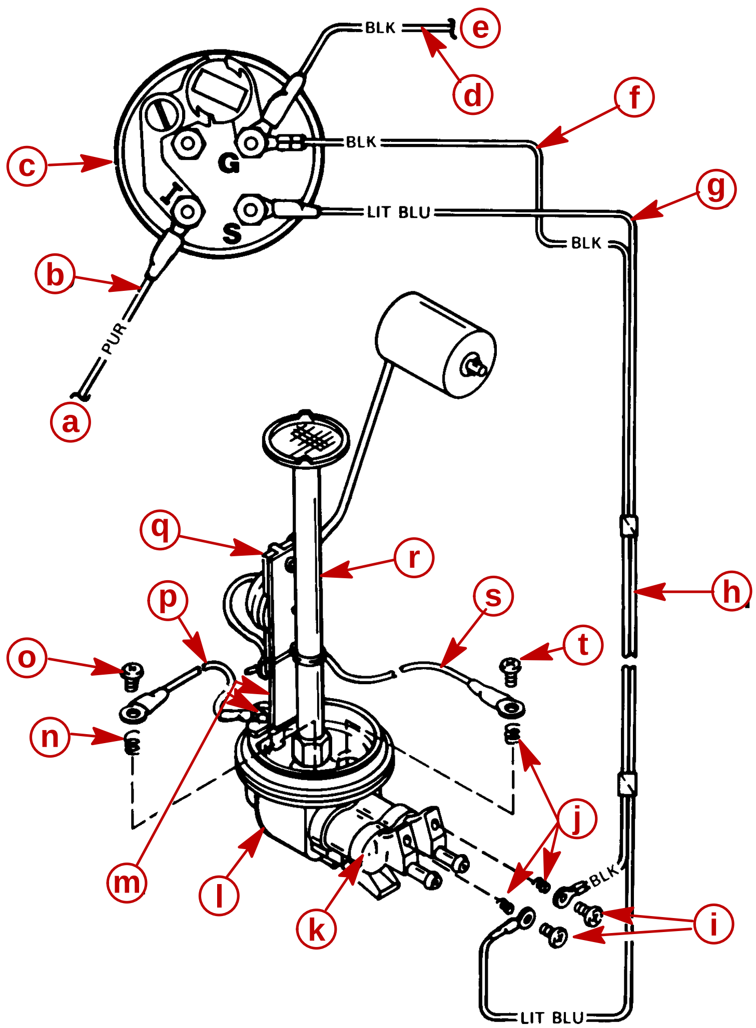
BLK=BLACK
BLU=BLUE
BRN=BROWN
GRN=GREEN
GRY=GRAY
PUR=PURPLE
RED=RED
TAN=TAN
WHT=WHITE
YEL=YELLOW



a - Ignition/Choke Switch
b - Lanyard Stop Switch
c - Lead Not Used on Outboard Installations
d - Retainer
e - Tachometer
f - Trim Indicator Gauge (Optional)
g - Temperature Gauge
h - Remote Control
i - Power Trim Harness Connector
j - Connect Wires Together w/Screw and Nut (2 Places); Apply Liquid Neoprene to Connections and Slide Rubber Sleeve over each Connection.
k - Lead to Optional Visual Warning Kit

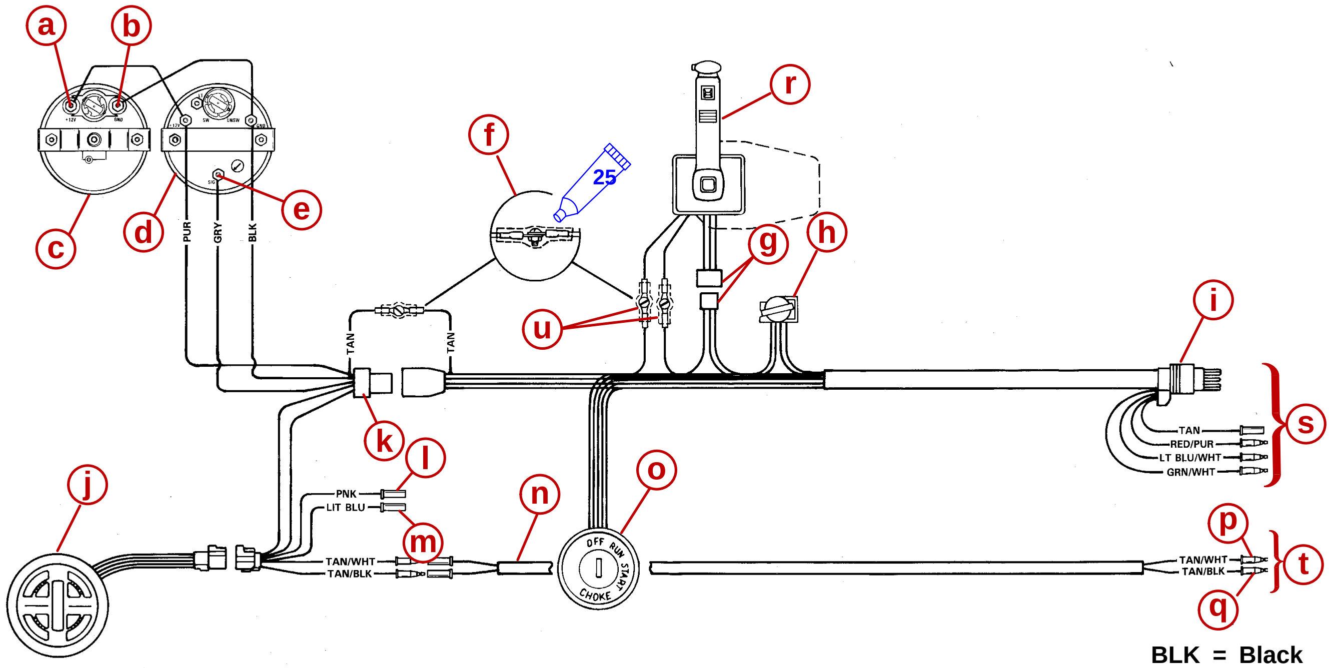
IMPORTANT: On installations where gauge options will not be used, tape back any unused wiring harness leads.

Oil Level Gauge Wiring Diagram



a - To 12 Volt Source
b - PURPLE Wire (Connect to Trim Indicator Gauge “I” [or POSITIVE (+) 12 Volt Source that is Turned “ON” and “OFF” with Ignition Switch])
c - Oil Level Gauge
d - BLACK Wire (Connects to NEGATIVE Ground)
e - To Ground
f - BLACK Wire (From Gauge to Oil Clip Connector)
g - LIGHT BLUE Sender Lead to Gauge
h - Wiring Harness (LT. BLU. and BLACK)
i - Screw (10-16 x 5/8 in.)
j - Spring
k - Oil Clip Connector
l - Adaptor Housing
m - Screw (10-16 x 1/4 in.)
n - Spring
o - Screw (10-16 x 5/8 in.)
p - BLACK Wire
q - Oil Level Sender Unit
r - Oil Pick-Up Tube
s - WHITE Lead (from Oil Level Sender)
t - Screw (10-16 x 5/8 in.)

Panel Mount Remote Control Wiring Installation



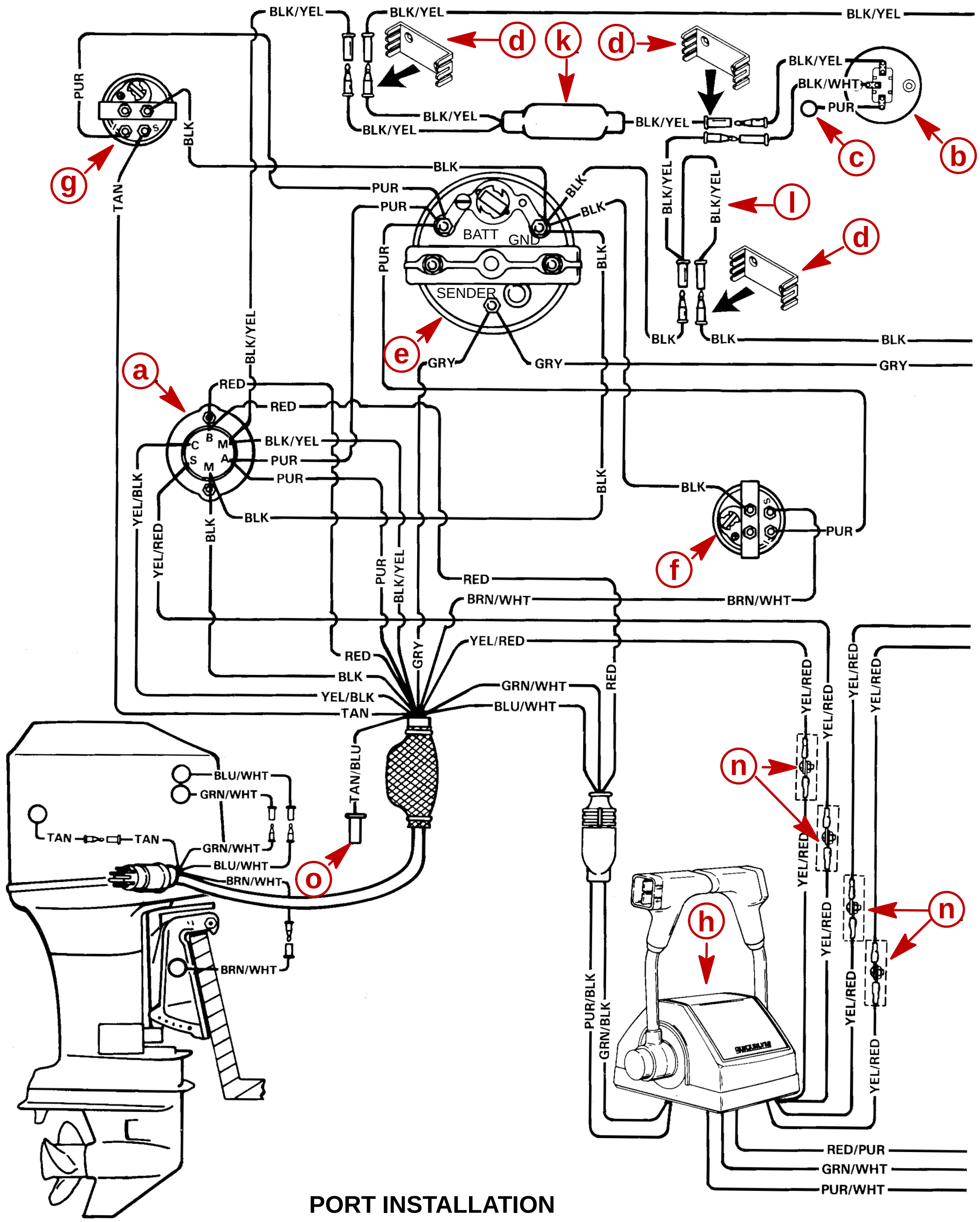
BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
TAN = Tan
WHT = White
YEL = Yellow
LIT = Light
DRK = Dark

25 Liquid Neoprene (92-25711--2)

a - (+) 12 Volt Terminal
b - (–) Ground Terminal
c - Speedometer
d - Tachometer
e - Tachometer Signal Terminal
f - Connect Wires Together with Screw and Hex Nut (3 Places); Apply Quicksilver Liquid Neoprene to Connections and Slide Rubber Sleeve Over Each Connection.
g - Power Trim Connector
h - Horn
i - 8 Pin Harness Connector
j - Multi-Function Gauge
k - Multi-Function Adapter Harness
l - To Fuel Sender (Optional)
m - To Oil Sender (Optional)
n - Two Wire Harness
o - Ignition/Choke Switch
p - Low Oil Sender Lead
q - Over Temperature Switch Lead
r - Panel Mount Remote Control
s - To Engine
t - To Engine
u - Neutral Safety Switch Lead

Instrument/Lanyard Stop Switch Wiring Diagram (Dual Outboard)

BLK=BLACK
BLU=BLUE
BRN=BROWN
GRN=GREEN
GRY=GRAY
PUR=PURPLE
RED=RED
TAN=TAN
WHT=WHITE
YEL=YELLOW

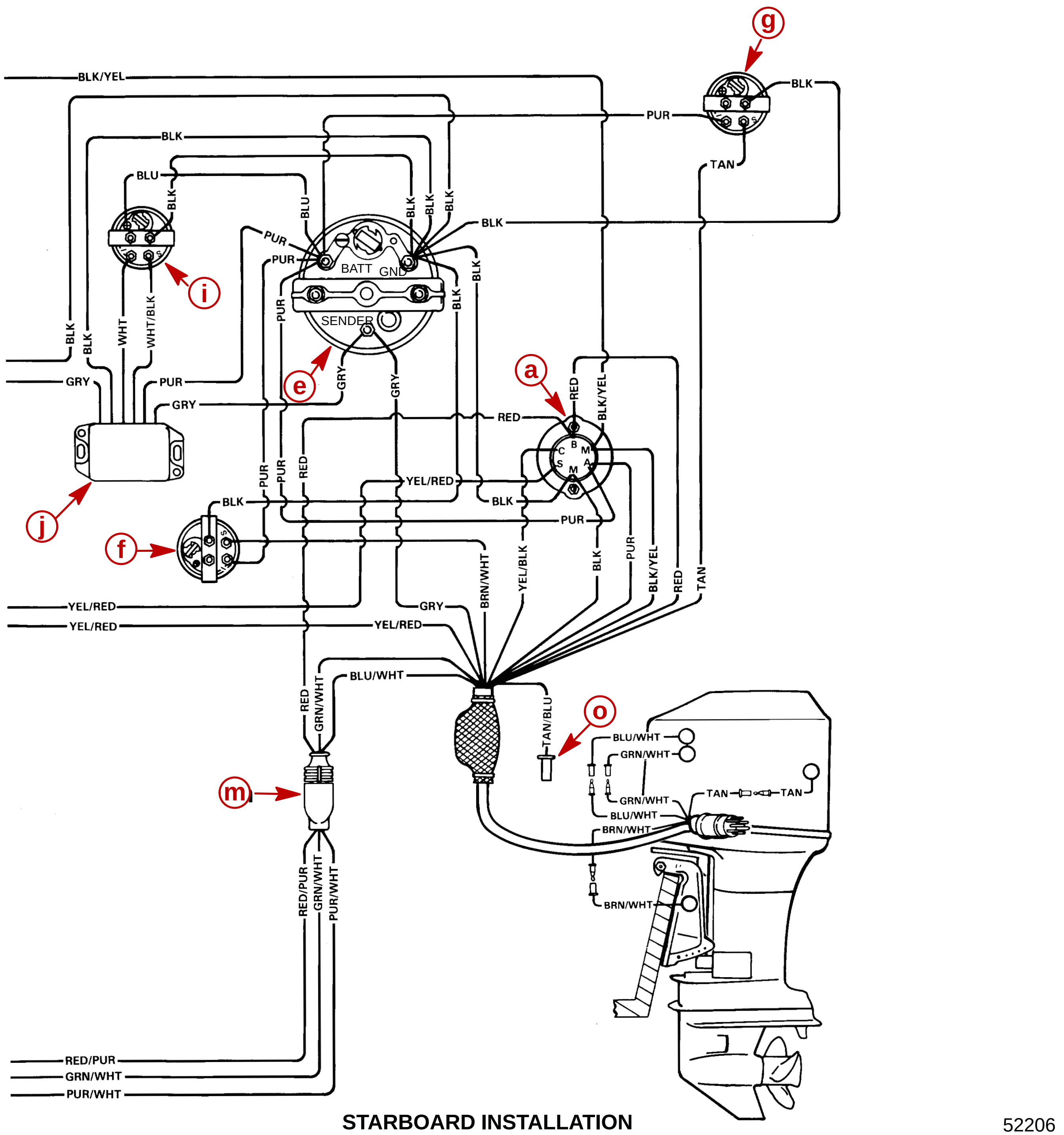


52205

PORT INSTALLATION

- **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

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



STARBOARD INSTALLATION

52206

- **i** - Synchronizer Gauge
- **j** - Synchronizer Module
- **k** - Lanyard Switch (Isolation) Diode
- **l** - Y Harness
- **m** - Power Trim Harness Connector
- **n** - Connect Wires together with Screw and Nut (4 Places); Apply Liquid Neoprene to Connections and slide Rubber Sleeve over each Connection.
- **o** - Lead to Visual Warning Kit

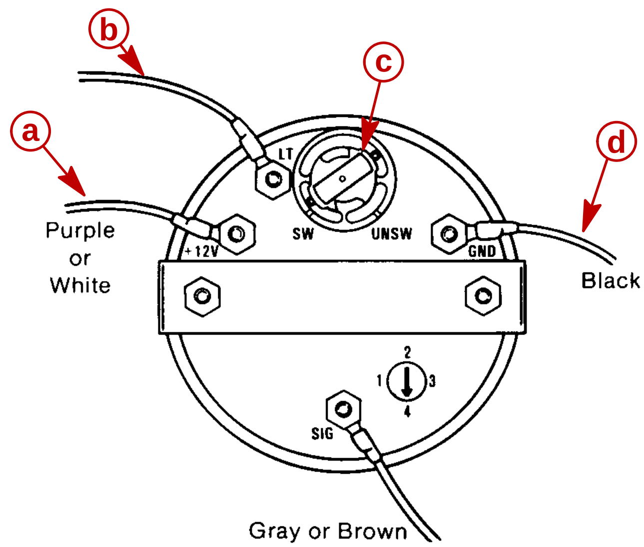
QSI Gauge Wiring Diagrams

Tachometer Wiring Diagram

Tachometer dial on back side of case must be set to position number 4.

WIRING DIAGRAM A

Use this wiring diagram when using a separate light switch for instrument lighting.

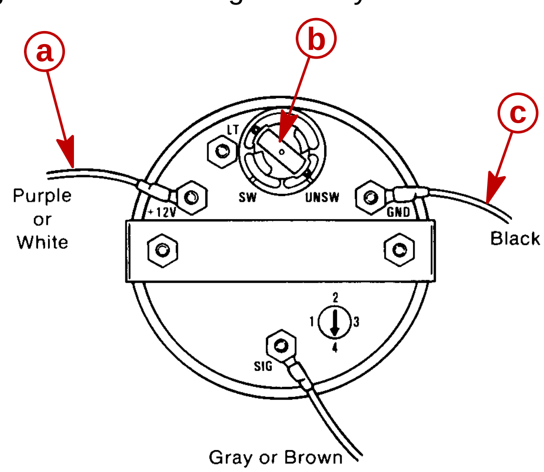


51106

- **a** - Connect to + 12 Volt
- **b** - +12 Volt Light Switch Wire
- **c** - Position Light Bulb to the Switched Position
- **d** - Connect to NEGATIVE (–) Ground

WIRING DIAGRAM B

Use this wiring diagram when instrument lighting is wired directly to the ignition key switch. (Instrument lights are on when ignition key switch is turned on.)



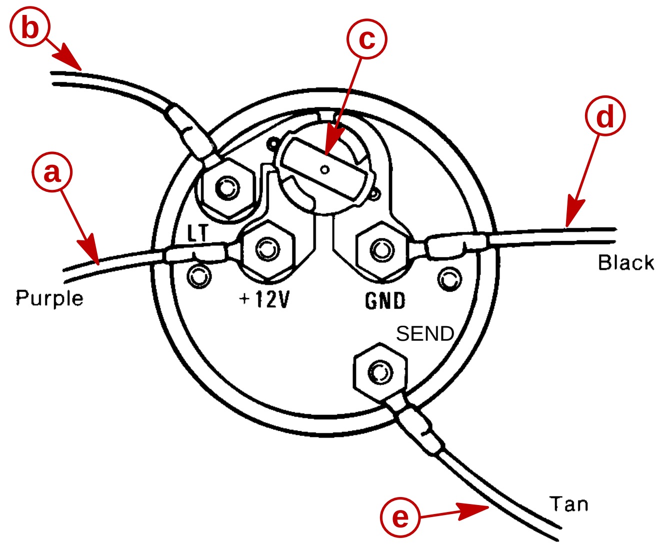
51106

- **a** - Connect to +12 Volt
- **b** - Position Light Bulb to the Unswitched Position
- **c** - Connect to NEGATIVE (–) Ground

Water Temperature Gauge

WIRING DIAGRAM A

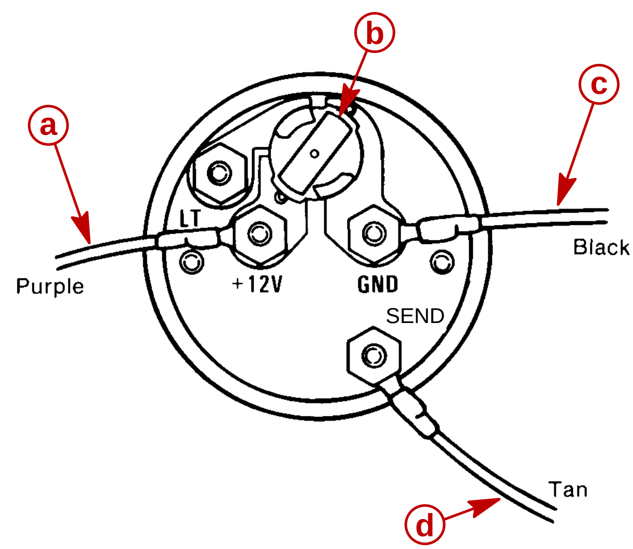
Use this wiring diagram when using a separate light switch for instrument lighting.



a - Connect to + 12 Volt
b - +12 Volt Light Switch Wire
c - Position Light Bulb to the Switched Position
d - Connect to NEGATIVE (–) Ground
e - Connect to TAN Lead located at the Tachometer Receptacle on Commander Side Mount Remote Control or TAN Lead coming from Accessory Ignition/ Choke Assembly.

WIRING DIAGRAM B

Use this wiring diagram when instrument lighting is wired directly to the ignition key switch. (Instrument lights are on when ignition key is turned on.)

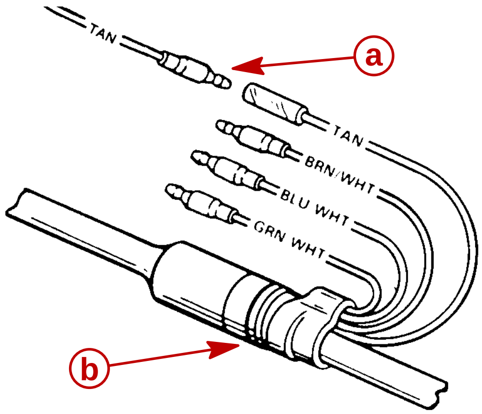


51105

a - Connect to +12 Volt
b - Position Light Bulb to the Unswitched Position
c - Connect to NEGATIVE (–) Ground
d - Connect to TAN Lead located at the Tachometer Receptacle on Commander Side Mount Remote Control or TAN Lead coming from Accessory Ignition/ Choke Assembly

Route TAN lead on starboard side of engine to engine/remote control harness. Connect as shown.

IMPORTANT: Tape back and isolate any unused wiring harness leads.



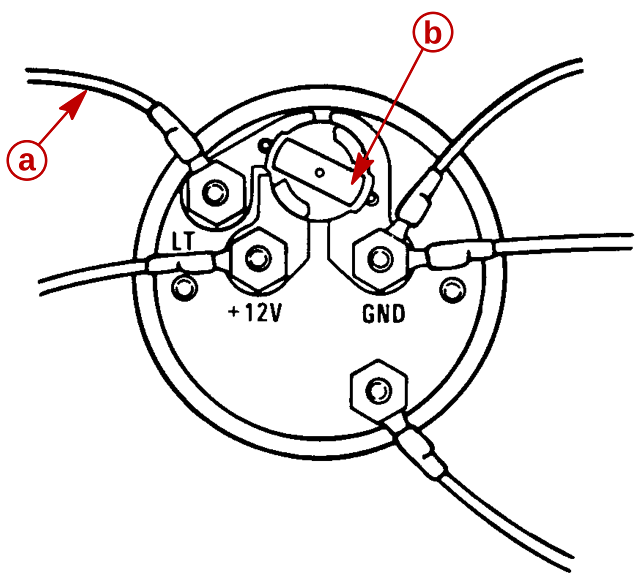
28086

a - Lead from Temperature Sender
b - Engine/Remote Control Harness

Oil Level Gauge Wiring

LIGHT BULB POSITION A

Use this position when using a separate light switch for instrument lighting.

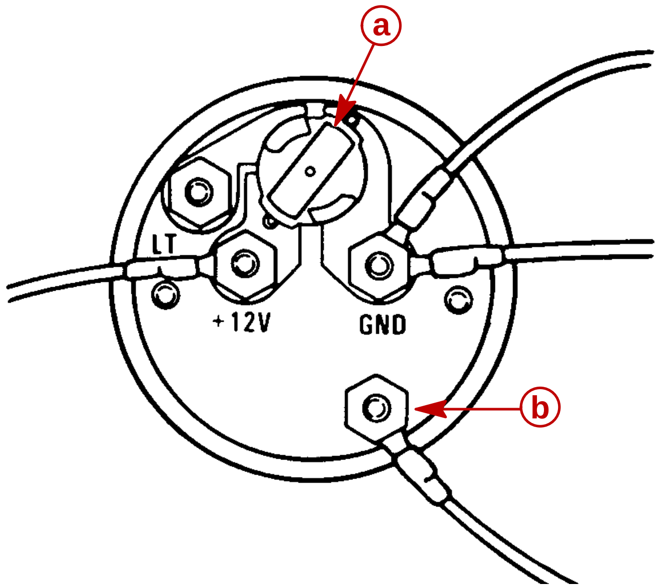


51109

a - +12 Volt Light Switch Wire
b - Position Light Bulb to the Switched Position

LIGHT BULB POSITION B

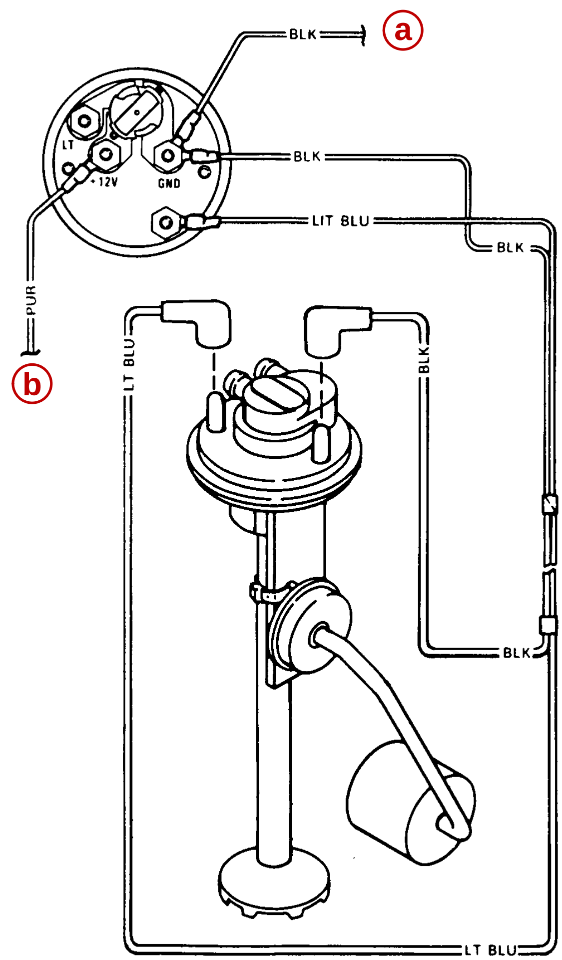
Use this position when instrument lighting is wired directly to the ignition key switch. (Instrument lights are on when ignition key switch is turned on.)



51112

a - Position Light Bulb to the Unswitched Position
b - Sender

SENDER WIRING



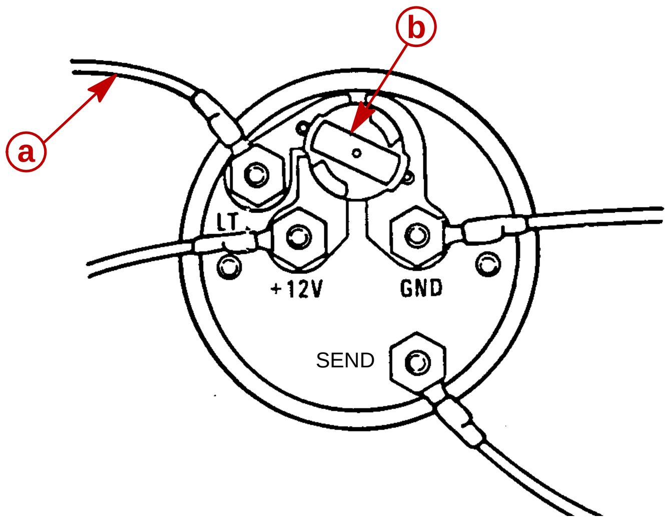
51108

a - Connect to +12 Volt
b - Connect to NEGATIVE (–) Ground

Engine Synchronizer Wiring Diagram

LIGHT BULB POSITION A

Use this position when using a separate light switch for instrument lighting.

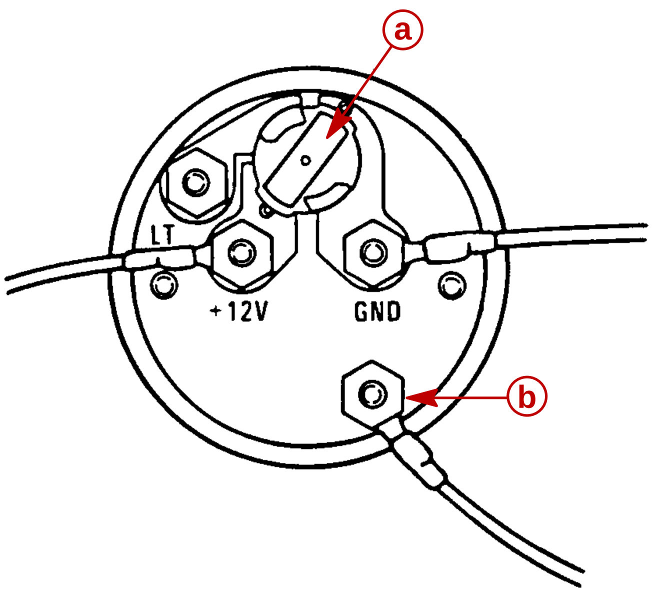


51105

a - +12 Volt Light Switch Wire
b - Position Light Bulb to the Unswitched Position

LIGHT BULB POSITION B

Use this position when instrument lighting is wired directly to the ignition key switch. (Instrument lights are on when ignition key switch is turned on.)

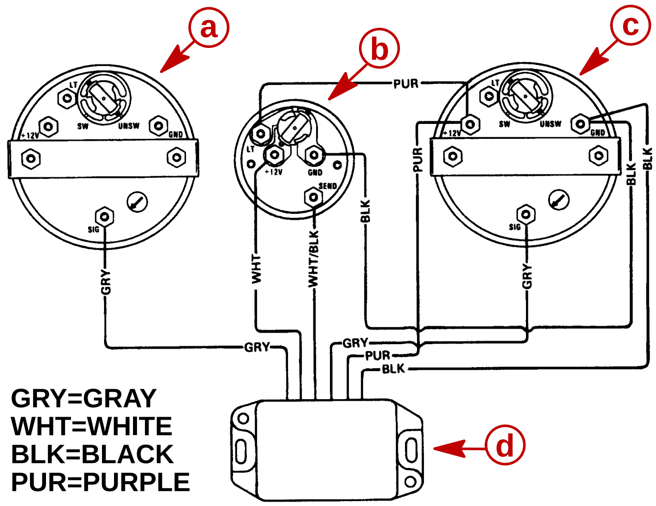


51106

a - Position Light Bulb to the Switched Position
b - Sender

Synchronizer wiring can be accomplished two different ways as an option to the user.

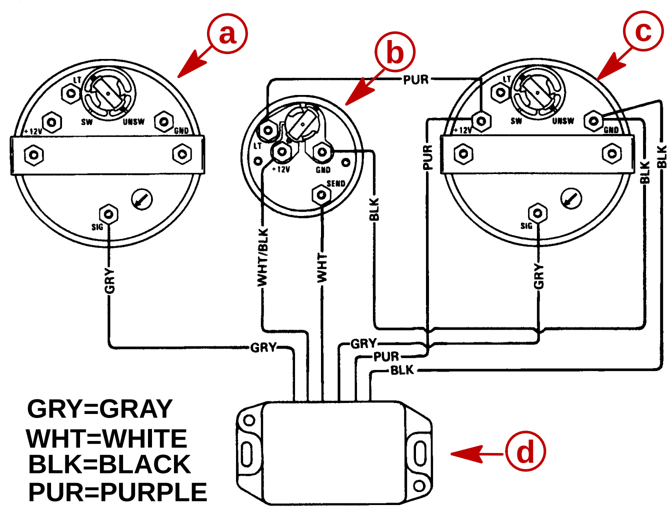
Wiring Diagram – Gauge needle to point toward slow running engine



51107

a - Tachometer Starboard Engine
b - Synchronizer Gauge
c - Tachometer Port Engine
d - Synchronizer Module

Wiring Diagram – Gauge needle to point toward fast running engine



51107

a - Tachometer Starboard Engine
b - Synchronizer Gauge
c - Tachometer Port Engine
d - Synchronizer Module

Maintenance

Clean gauge by washing with fresh water to remove sand and salt deposits. Wipe off with a soft cloth moistened with water. The gauge may be scored or damaged if wiped with abrasive material (sand, saline or detergent compounds, etc.) or washed with solvents such as trichloroethylene, turpentine, etc.

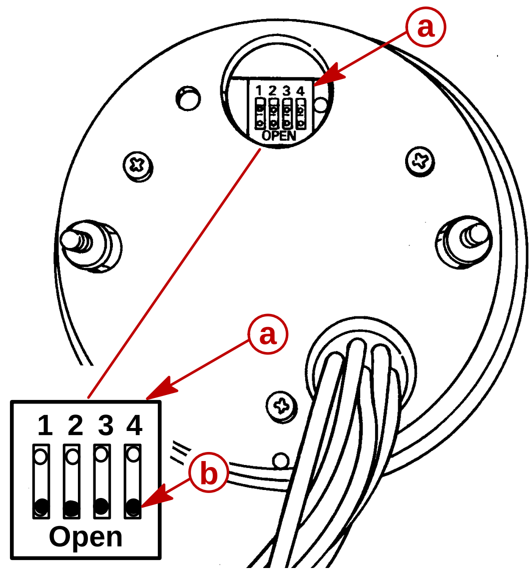
Multi-Function Gauge

Dip Switch Setting/Testing

NOTE: *The multi-function gauge "Dip Switch" must be set on the back of gauge prior to operation. Turn the ignition switch to the "OFF" position before setting dip switch. The gauge will reset to selected settings when the ignition is turned "On".*

IMPORTANT: Test the gauge and related wiring BEFORE making final "Dip Switch" settings and BEFORE securing the gauge to dashboard of boat.

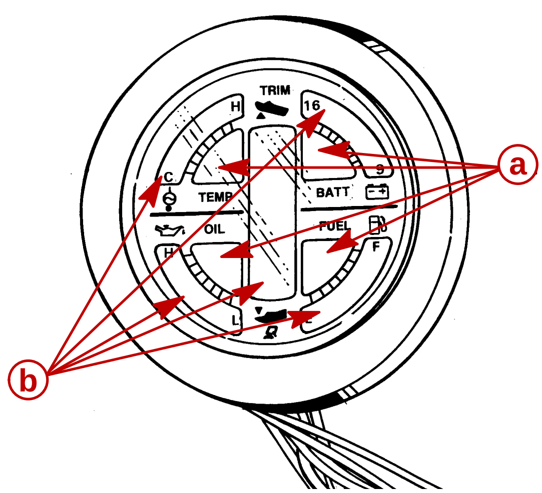
1. With the ignition switch in the "Off" position, set the multi-function gauge "Dip Switch" in (test) position as shown. (BLACK dot indicates switch position).



52095

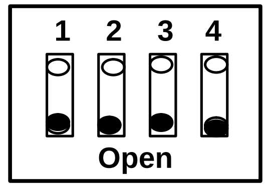
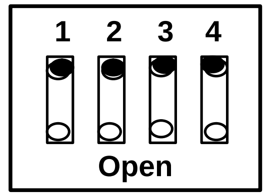
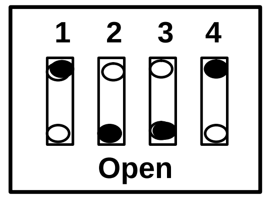
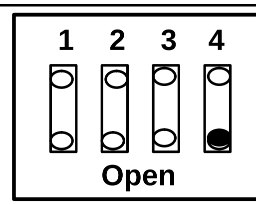
a - "Dip Switch" (shown in test position)
b - Black Dot - Switch in "Open" Position

2. Turn ignition switch to the "Run" position. The multi-function gauge now is in the display test mode. The gauge Temp, Batt, Oil, and Fuel red warning lights should be alternately flashing "On" and "Off"; the BLACK L.C.D. bar graphs should be cycling. (This indicates that all gauge functions are operational).
3. Turn ignition switch to the "Off" position. Reset the gauge "Dip Switch" to the correct operating position for the outboard application.



a - Gauge Lights (Red)
b - Gauge L.C.D. Bar Graph (Black)

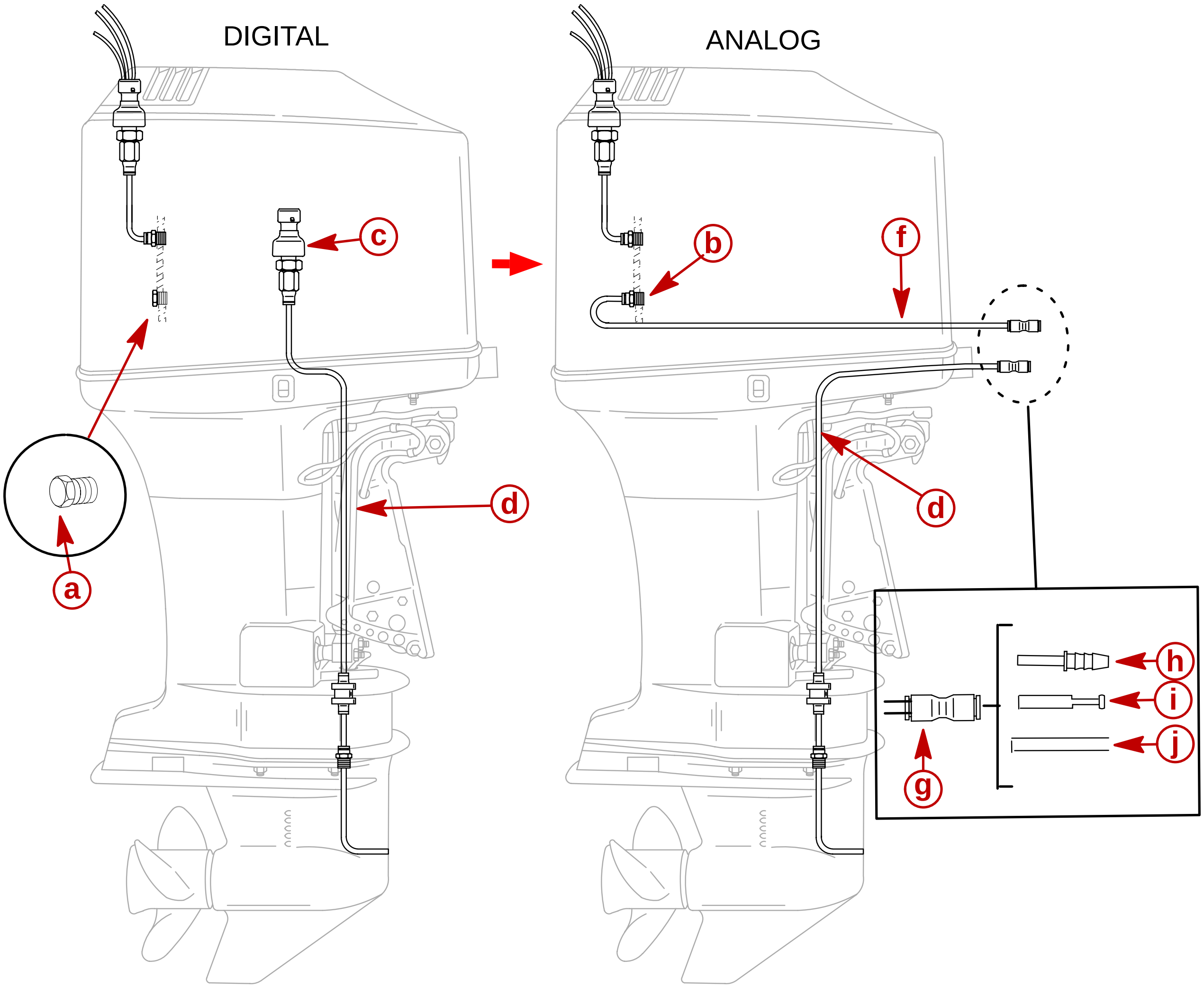
Outboard Multi-Function Gauge Setting

Model	Dip Switch Setting
Test Display (All)	
275 hp (3.4 Litre) Outboards (single engine)	
135-250 hp Outboards (single engine)	
"Note" On Dual Engine/Single Fuel Tank Applications: Position Dip Switch 4 "Open" *	

* Dip Switch (4) in "Open Position" For Dual Engine Single Fuel Tank Applications. Switches 1,2,3 Must Be In Specified Model Position.

Water Pressure Gauge Hose Connection

Model 200/225



ENGINE WATER PRESSURE TUBE

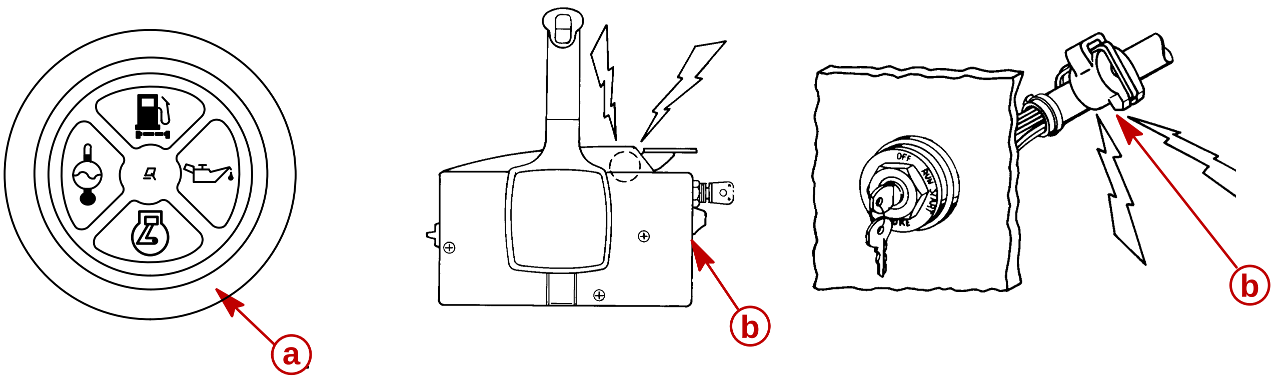
1. Remove and discard plug (a). from the lower corner on back of cylinder block.
2. Install fitting (b) into hole where plug (a) was removed from.
3. Connect the 44 in. long gray tubing (f) to fitting (b). Route the tubing out through the front of the outboard.
4. Install coupler (g) onto end of tube. Insert the plug (i), barb fitting (h), or gauge tubing (j) into the coupler. *NOTE: Barb fitting (h) is used for hose connection.*

NOTE: *An after market water pressure gauge may be connected to the engine, if existing hosing is not appropriate, by removing plug (a) or fitting (b) and installing a suitable barb fitting.*

NOTE: *Digital gauge speedometers use water pressure sensor (c) wired to the ECM. Analog gauge speedometers use BLACK Tubing (d) connected through adaptor fitting to speedometer gauge tubing.*

Warning System

The outboard warning system incorporates warning light gauge and warning horn. The warning horn is located inside the remote control or is part of the ignition key switch wiring harness.



a - Warning Light Gauge (Analog Models Only) – 2000 Model Year
b - Warning Horn

When the key switch is turned to the ON position, the warning lights and horn will turn on for a moment as a test to tell you the system is working.

Warning System Signals

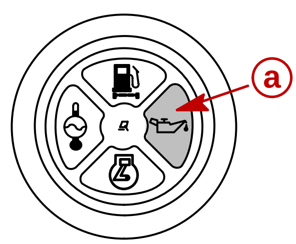
NOTE: *The warning system signals which includes audible and visual indicator involving the horn and lights will identify the potential problems listed in the chart*

Problem	Horn	Check Engine Light	Low Oil Light	Over Heat Light	Water In Fuel Light	Engine Speed Reduction Activated
Power Up/System Check	Single Beep	Yes	Yes	Yes	Yes	No
Low Oil	4 Beep... 2 Minutes Off		Yes			No
Oil Pump Electrical Failure		Yes	Yes			Yes
Over Heat	Continuous Beep			Yes		Yes
Water In Fuel	4 Beep... 2 Minutes Off				Yes	No
Over Speed	Continuous Beep					Yes (Activated at 5800 RPM)
Coolant Sensor Failure	No	Yes				No
MAP Sensor Failure	No	Yes				No
Air Temperature Sensor Fail-ure	No	Yes				No
Ignition Coil Failure	No	Yes				No
Injector Failure	No	Yes				No
Horn Failure	N/A	Yes				No

Problem	Horn	Check Engine Light	Low Oil Light	Over Heat Light	Water In Fuel Light	Engine Speed Reduction Activated
Battery Voltage too high (16V) or too low (11V) or very low (9.5V)	No	Yes				Yes – If battery voltage is less than 10.4 V – RPM is reduced.
Over Heat Cyl. Head/Compressor	Continuous Beep			Yes		Yes
Throttle Sensor Failure	Continuous Intermittant Beeping	Yes				RPM reduced, ECM then refers to MAP Sensor for throttle position
Block Water Pressure	Yes	Yes		Yes		Yes

Warning System Operation (Model Year 2000)

LOW OIL LEVEL

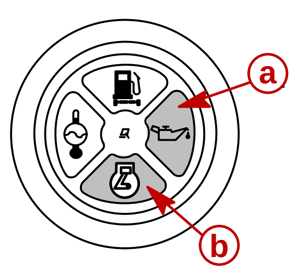


The system is activated when the oil in the engine mounted oil reservoir tank drops below 50 fl. oz. (148 ml) You still have an oil reserve remaining for 30 minutes of full speed operation.

NOTE: *The engine mounted oil reservoir tank (located beneath the top cowl) along with the remote oil tank will have to be refilled.*

The OIL light (a) will come on and the warning horn sounds a series of four short tones. If you continue to operate the outboard, the light will stay on and the horn will sound four short tones every two minutes. The engine has to be shut off to reset the warning system.

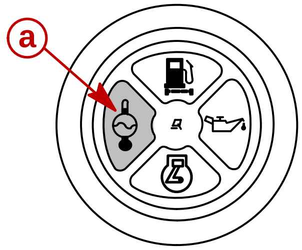
NO OIL FLOW TO THE ELECTRIC OIL PUMP



The system is activated when there is an electrical failure of the oil pump or the oil pump circuit. Stop the engine as soon as possible. Continuing to operate the engine can result in severe engine damage.

The OIL light (a) and CHECK ENGINE light (b) will come on and the warning horn will begin sounding. The warning system will automatically reduce and limit the engine speed. The engine has to be shut off to reset the warning system.

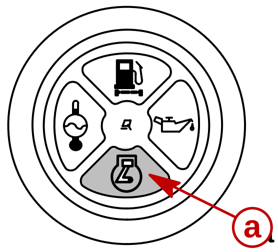
ENGINE OVERHEAT



The system is activated when the engine temperature is too hot.

The TEMP light (a) will come on and the warning horn begins sounding. The warning system will automatically limit the engine speed to 3000 RPM. After the engine has cooled, shift the outboard into neutral to reset the overheat circuit.

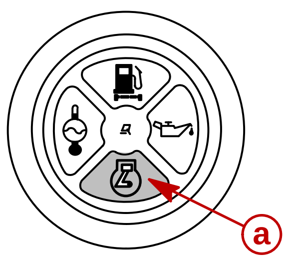
IGNITION COIL, SENSOR, OR INJECTOR NOT FUNCTIONING



The system is activated if an ignition coil, sensor or injector is not functioning correctly.

The CHECK ENGINE light (a) will turn on.

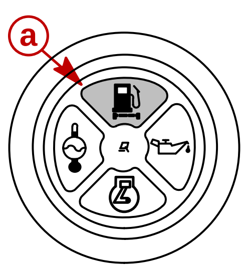
THROTTLE SENSOR NOT FUNCTIONING



The system is activated if the throttle sensor is not functioning correctly.

The CHECK ENGINE light (a) will turn on and the warning horn will begin sounding.

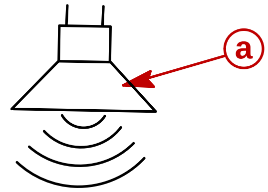
WATER SEPARATING FUEL FILTER IS FULL OF WATER



The water level detection warning is activated when water in the water separating fuel filter reaches the full level. The water can be removed from the filter.

The WATER DETECTION light (a) will come on and the warning horn will begin sounding a series of four beeps. If you continue to operate the outboard, the light will stay on and the horn will sound every two minutes.

ENGINE OVER-SPEED PROTECTION SYSTEM



The system is activated when the engine speed exceeds the maximum allowable RPM.

Anytime the engine over-speed system is activated, the warning horn (a) begins to sound continuously. The system will automatically reduce the engine speed to within the allowable limit.

NOTE: *Engine speed should never reach the maximum limit to activate the system unless the propeller is ventilating, an incorrect propeller is being used, or the propeller is faulty.*

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.

Guardian System Operation with Gauges

4 Function Gauge	System will sound warning horn and illuminate appropriate light on gauge.
SmartCraft Gauge	System will sound warning horn and display the warning message.

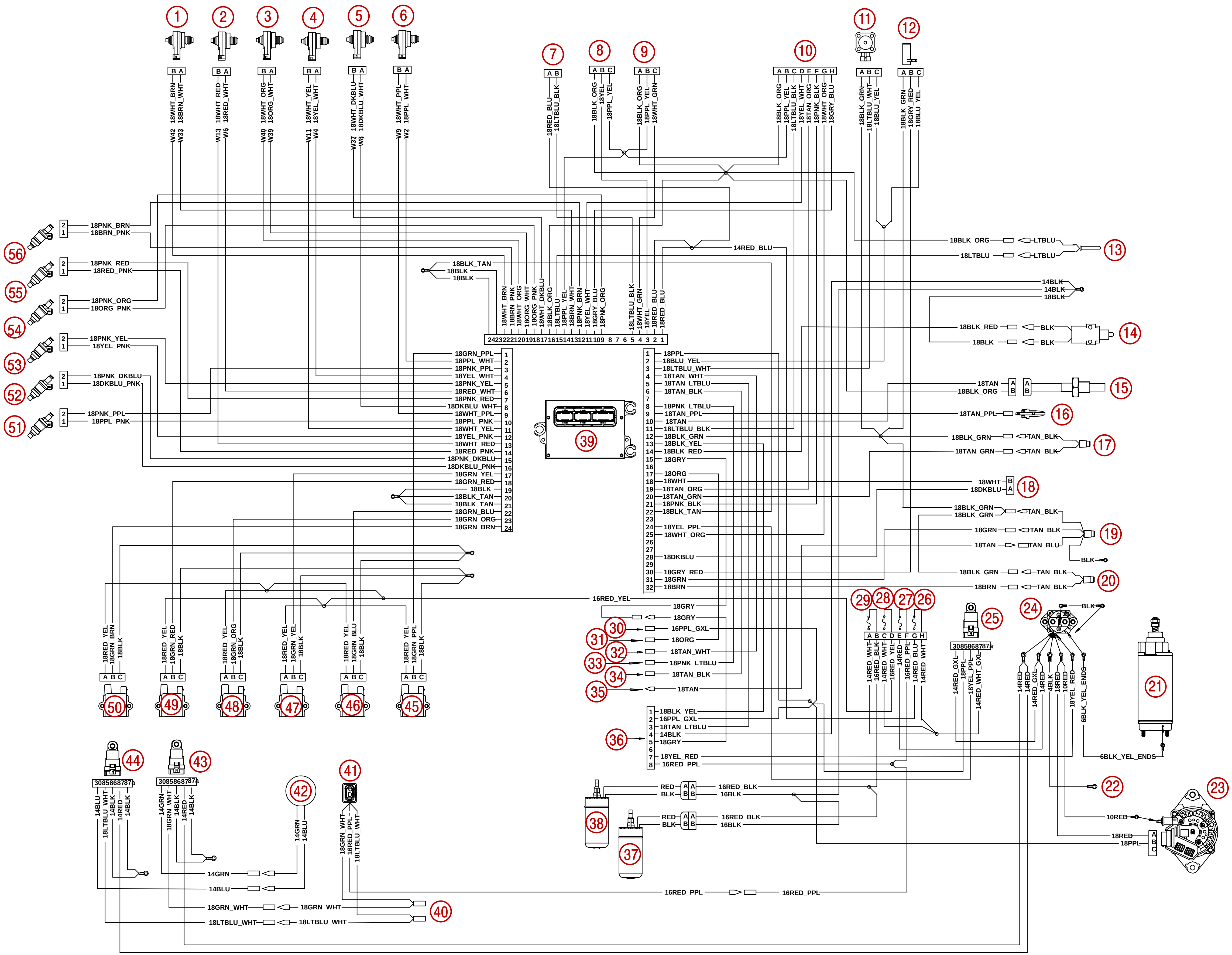
Guardian System Activation

Condition	Result
Engine Overheat	Engine power level can be reduced to any percentage down to an idle speed, if overheat condition persists.
Air Compressor Overheat	2000 Model – engine power level can be reduced to any percentage down to an idle speed, if overheat condition persists. 2001 Model – no power reduced.
Block Water Pressure Low	Engine power level can be reduced to any percentage down to a fast idle, if condition persists.
Throttle Position Sensor Failure	If the throttle position sensor fails or becomes disconnected, power will be limited to a maximum of approximately 4500 rpm. When the TPS is in the fail mode, the ECM will use the MAP sensor for a reference to determine fuel calibration.
Temperature Sensor (cylinder head and air compressor) Failure	If a temperature sensor should fail or become disconnected, power will be reduced by 25%.
Battery Voltage (too high or too low)	Battery voltage greater than 16.5 volts or less than 10.5 volts will result in engine output power being reduced. The higher or lower the voltage is outside of these parameters, the greater the percentage of power reduction. In an extreme case, power could be reduced to idle speed.
Oil Pump Failure	If the oil pump fails or an open circuit occurs between the pump and the ECM, engine power will be reduced to idle.

Notes:

2000 (Analog) Model 200/225 DFI Wiring Diagram

1 - Direct Injector #1
2 - Direct Injector #2
3 - Direct Injector #3
4 - Direct Injector #4
5 - Direct Injector #5
6 - Direct Injector #6
7 - Oil Pump
8 - Map Sensor
9 - Block Pressure Sensor
10 - Smartcraft Gauge Harness
11 - Throttle Position Sensor (TPS)
12 - Crank Position Sensor
13 - Low Oil Switch
14 - Shift Switch
15 - Air Temperature Sensor
16 - Water Sensor
17 - Starboard Head Temperature Switch
18 - Digital Diagnostic Terminal Connector
19 - Port Head Temperature Switch
20 - Compressor Temperature Switch
21 - Starter
22 - To 12 Volt Battery
23 - 60 Ampere Alternator
24 - Starter Solenoid
25 - Main Power Relay
26 - ECM Driver/Oil Pump Circuit 20 Ampere Fuse
27 - Accessories 20 Ampere Fuse
28 - Ignition Coil 20 Ampere Fuse
29 - Electric Fuel Pump 20 Ampere Fuse
30 - Accessory Power
31 - Check Engine Light
32 - Low Oil Light
33 - Water In Fuel Light
34 - Over-Heat Light
35 - To Temperature Gauge
36 - Remote Control
37 - Fuel Pump #2 (Outside Vapor Separator)
38 - Fuel Pump #1 (Inside Vapor Separator)
39 - Electronic Control Module
40 - To Remote Control Trim Switch
41 - Cowl Mounted Trim Switch
42 - Trim Pump
43 - Trim Down Relay
44 - Trim Up Relay
45 - Ignition Coil #6
46 - Ignition Coil #5
47 - Ignition Coil #4
48 - Ignition Coil #3
49 - Ignition Coil #2
50 - Ignition Coil #1
51 - Fuel Injector #6
52 - Fuel Injector #5
53 - Fuel Injector #4
54 - Fuel Injector #3
55 - Fuel Injector #2
56 - Fuel Injector #1



2000 (Digitial) Model 200/225 DFI Wiring Diagram

1 - Direct Injector #1
2 - Direct Injector #2
3 - Direct Injector #3
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5 - Direct Injector #5
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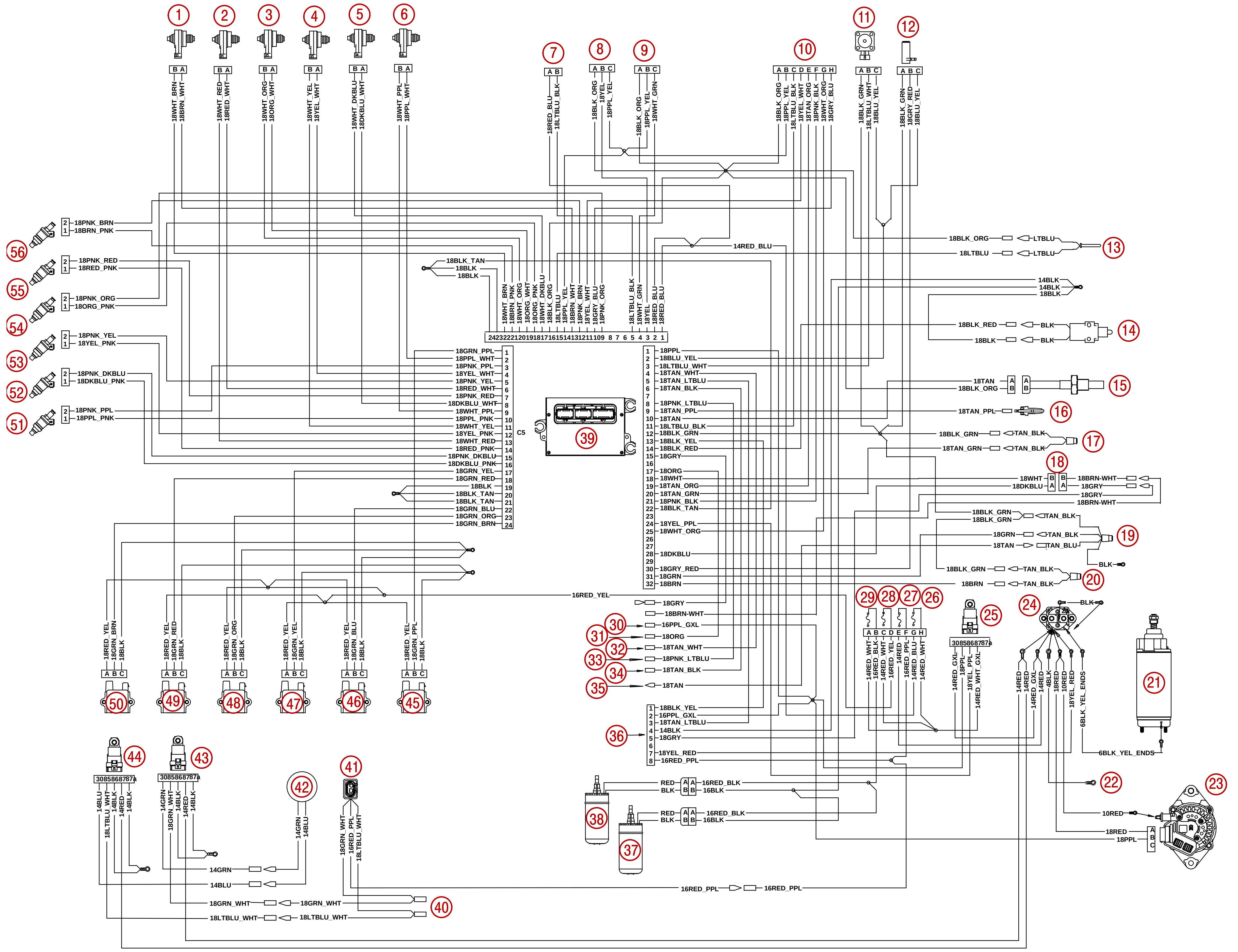
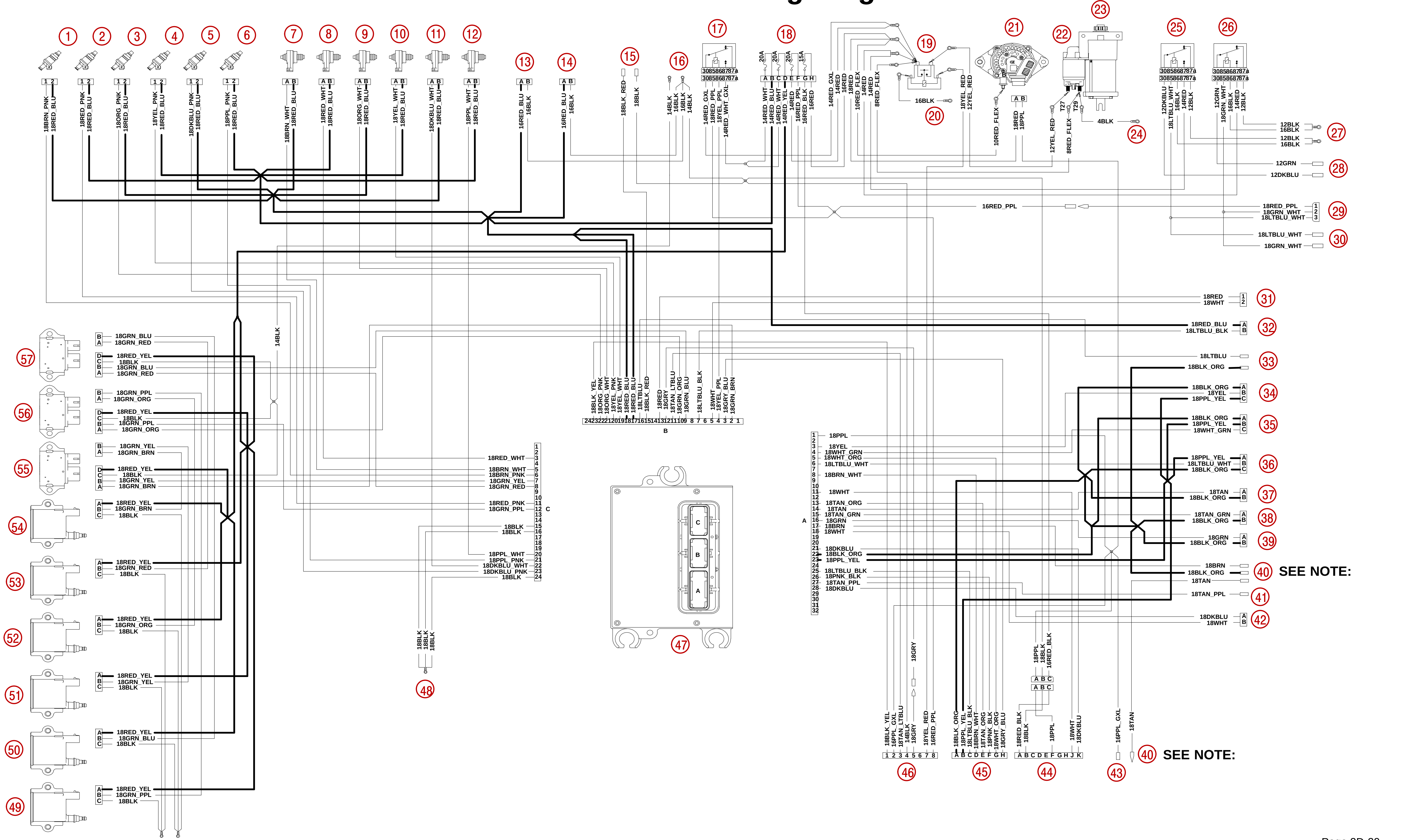
48 - Ignition Coil #3
49 - Ignition Coil #2
50 - Ignition Coil #1
51 - Fuel Injector #6
52 - Fuel Injector #5
53 - Fuel Injector #4
54 - Fuel Injector #3
55 - Fuel Injector #2
56 - Fuel Injector #1



2001 Model 200/225 DFI Wiring Diagram



1 - #1 Fuel Injector
2 - #2 Fuel Injector
3 - #3 Fuel Injector
4 - #4 Fuel Injector
5 - #5 Fuel Injector
6 - #6 Fuel Injector
7 - #1 Direct Injector
8 - #2 Direct Injector
9 - #3 Direct Injector
10 - #4 Direct Injector
11 - #5 Direct Injector
12 - #6 Direct Injector
13 - #1 Fuel Pump
14 - #2 Fuel Pump
15 - Shift Switch
16 - To Ground
17 - Main Power Relay
18 - Fuses (4)
19 - Slave Solenoid
20 - To Ground
21 - 60 Amp Alternator
22 - Starter Solenoid
23 - Starter
24 - To 12 Volt Battery (+ Cable)
25 - Trim UP Relay
26 - Trim DOWN Relay
27 - To Ground
28 - Trim Pump
29 - Cowl Trim Switch
30 - Remote Trim Switch
31 - Crank Sensor
32 - Oil Pump
33 - Low Oil Switch
34 - MAP Sensor
35 - Block Pressure Sensor
36 - Throttle Position Indicator
37 - Air Temperature Sensor
38 - Starboard Head Temp Sensor
39 - Port Head Temp Sensor
40 - Compressor Temp Sensor
41 - Water-in-Fuel Sensor
42 - Diagnostic Connector
43 - Accessory Power
44 - Data Bus (Control Area Network)
45 - Boat Harness (Digital Sensor)
46 - Remote Control
47 - Electronic Control Unit
48 - To Ground
49 - Ignition Coil #5
50 - Ignition Coil #6
51 - Ignition Coil #4
52 - Ignition Coil #3
53 - Ignition Coil #2
54 - Ignition Coil #1
55 - Coil Driver #1 and #4
56 - Coil Driver #3 and #6
57 - Coil Driver #2 and #5

NOTE: TAN lead added to engine harness along with 4-lead Compressor Temperature Sender on 2001 Models S/N 0T280001 and above.

FUEL SYSTEM

Section 3A – Pulse Crankcase Driven Fuel Pump

Table of Contents

3
A

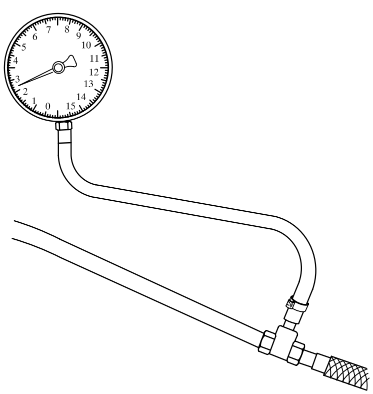
Specifications

Model 200/225 DFI		
FUEL SYSTEM	**Fuel Pressure Crankcase Pump – @ Idle**	Normal – 2-3 psi (13.7 - 20.5 kPa) Minimum – 1 psi (6.8 kPa)
	– @ WOT	Normal – 8-10 psi (41.0 - 54.8 kPa) Maximum – 10 psi (68.5 kPa) Minimum – 4 psi (27.4 kPa)

NOTE: *Electric fuel pump pressure, if used in conjunction with engine mechanical fuel pump, must be limited to no more than 4 psi* (27.4 kPa).

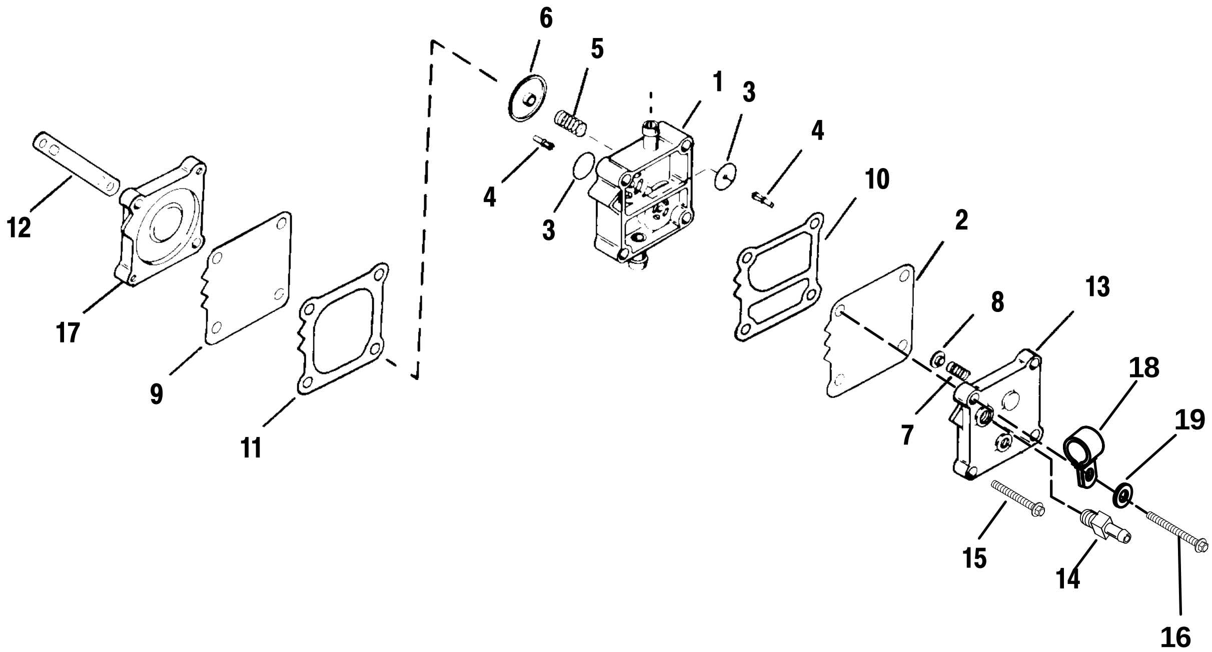
Special Tools

1. Fuel Pressure/Vacuum Gauge (0-15 psi) (Obtain Locally)



57721

Fuel Pump



REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
–	1	FUEL PUMP ASSEMBLY			
1	1	FUEL PUMP			
2	1	DIAPHRAGM KIT			
3	2	DISC CHECK VALVE			
4	2	RETAINER			
5	1	SPRING			
6	1	CAP			
7	1	SPRING			
8	1	CAP			
9	1	DIAPHRAGM			
10	1	GASKET–boost			
11	1	GASKET–pulse			
12	1	GASKET			
13	1	PLATE			
14	1	FITTING			
15	2	SCREW–fuel pump (M5 x 40)	55		6
16	2	SCREW–pump to crankcase (M6 x 50)	55		6
17	1	BASE			
18	1	FUEL HOSE CLIP			
19	1	WASHER			

Fuel Pump Description/Operation

The fuel pump is a crankcase-pressure-operated, diaphragm-type pump. Crankcase pulsating pressure (created by the up-and-down movement of piston) is transferred to fuel pump by way of a passage (hole) between crankcase and fuel pump.

When piston is in an upward motion, a vacuum is created in the crankcase, thus pulling in on the fuel pump diaphragm. The inlet check valve (in fuel pump) is opened and fuel (from fuel tank) is drawn into fuel pump.

Downward motion of the piston forces the mixture out of the crankcase into the cylinder. This motion also forces out on the fuel pump diaphragm, which, in turn, closes the inlet check valve (to keep fuel from returning to fuel tank) and opens the outlet check valve, thus forcing fuel to the VST.

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 power-head 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

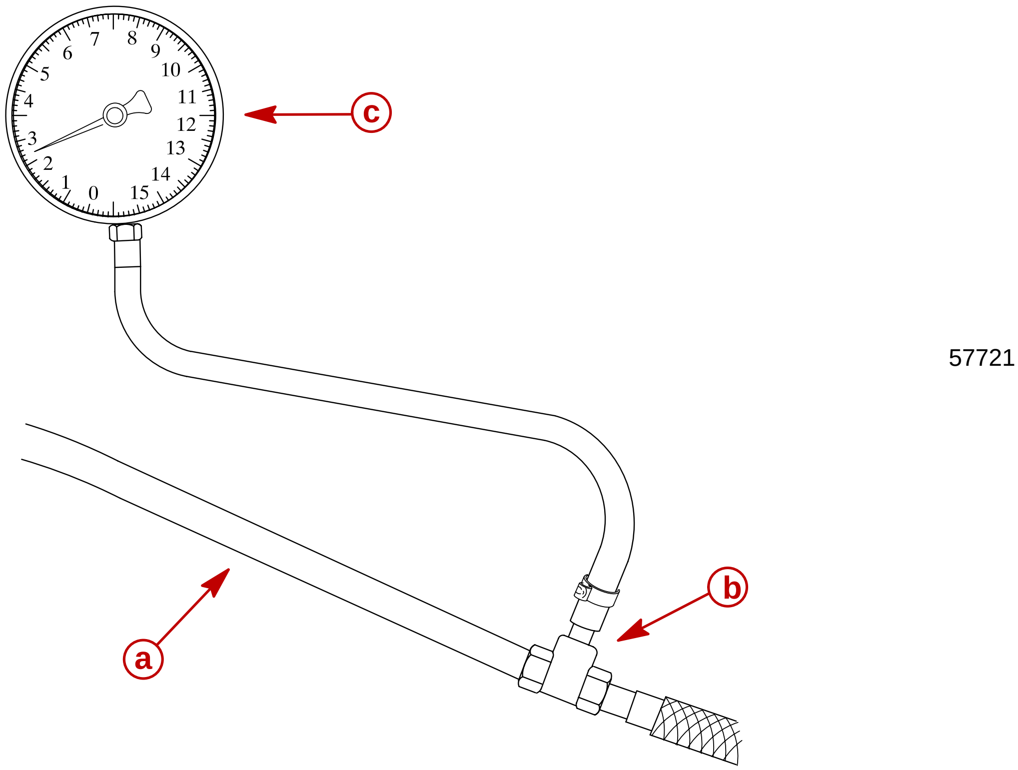
Since any type of anti-siphon device must be located between the outboard fuel inlet and fuel tank outlet, a simple method of checking [if such a device (or bad fuel) is a problem source] is to operate the outboard with a separate fuel supply which is known to be good, such as a remote fuel tank.

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.

Checking Fuel Pump Lift (Vacuum)

The square 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.

Fuel pump vacuum and air bubbles in the fuel supply can be checked with a vacuum gauge, a t-fitting and a clear piece of fuel hose. Connect the clear hose between the inlet fitting on the pulse driven fuel pump and the vacuum gauge t-fitting keeping the t-fitting as close as possible to the pump. Connect the fuel line from the fuel tank to the remaining connection on the t-fitting.



a - Clear Hose
b - T-fitting
c - Vacuum Gauge

Vacuum Test Troubleshooting

This test is normally performed at an idle speed. As engine rpm increases, there will be a slight increase in vacuum. The increase should not exceed specification

Normal Reading	Below 2.5 in. of mercury

Reading above 2.5 in. of mercury	Restriction within the fuel system – • Restricted anti-siphon valve • Restriction within the primer bulb • Kinked or collapsed fuel hose • Plugged water separating fuel filter (in the boat) • Restriction in fuel line thru-hull fitting • Restriction in fuel tank switching valves • Plugged fuel tank pick-up screen

Testing Fuel Pump

Install clear fuel hose(s) between fuel pump and VST. Run engine, and inspect fuel passing thru hose(s) for air bubbles.

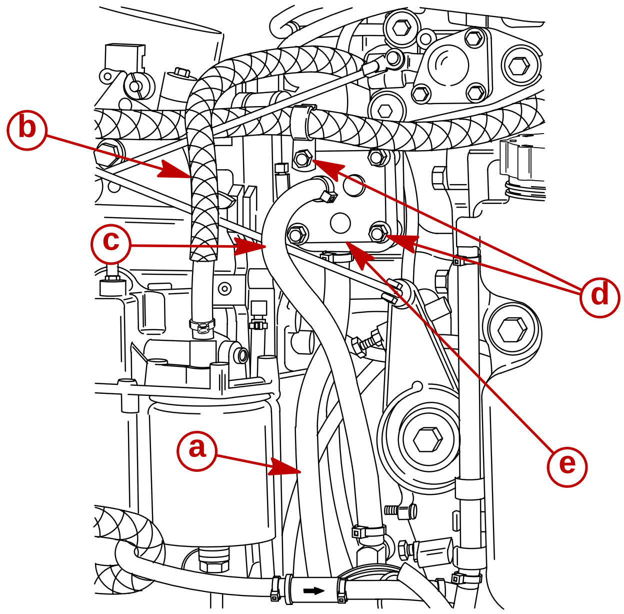
Problem: Air Bubbles in Fuel Line	
Low fuel in tank.	Fill tank with fuel.
Loose fuel line connection.	Check and tighten all connectors.
Fuel pump fitting loose.	Tighten fitting.
A hole or cut in fuel line.	Check condition of all fuel lines and replace.
Fuel Pump anchor screw(s) loose.	Tighten all screws evenly and securely.
Fuel Pump filter cover anchor screw loose.	Tighten screws securely.
Fuel pump filter gasket worn out.	Replace gasket.
Fuel pump gasket(s) worn out.	Rebuild fuel pump.
Fuel vaporizing	Fuel with high reed vapor pressure (winter grade fuel) may vaporize (form bubbles) when used in hot/warm weather. Use fuel with a lower reed vapor pressure (summer grade fuel).
Problem: Lack of Fuel Pump Pressure	
An anti-siphon valve.	See "Checking for Restricted Fuel Flow" preceding.
Air in fuel line.	See "Air Bubbles in Fuel Line", above.
A dirty or clogged fuel filter.	Clean or replace fuel filter.
The fuel pickup in fuel tank is clogged or dirty.	Clean or replace pickup.
Worn out fuel pump diaphragm.	Rebuild fuel pump.
Worn out check valve(s) in fuel pump.	Rebuild fuel pump.
A leaky check valve gasket.	Rebuild fuel pump.
Pulse hole(s) plugged.	Remove fuel pump and clean out holes.
Hole in pulse hose.	Replace pulse hose.
Loose pulse hose.	Tighten connection(s).
Fuel hose internal diameter too small.	Use 5/16 I.D. fuel hose.
Primer bulb check valve not opening.	Replace primer bulb.
Excessive fuel lift required.	Fuel lift exceeds 2.5 in. of vacuum (mercury).

Fuel Pump Removal/Disassembly

IMPORTANT: Fuel pump diaphragm and gaskets should not be re-used once fuel pump is disassembled.

NOTE: *External low pressure electric fuel pump and vapor separator have been removed from illustration to provide improved visual clarity for location of mechanical fuel pump.*

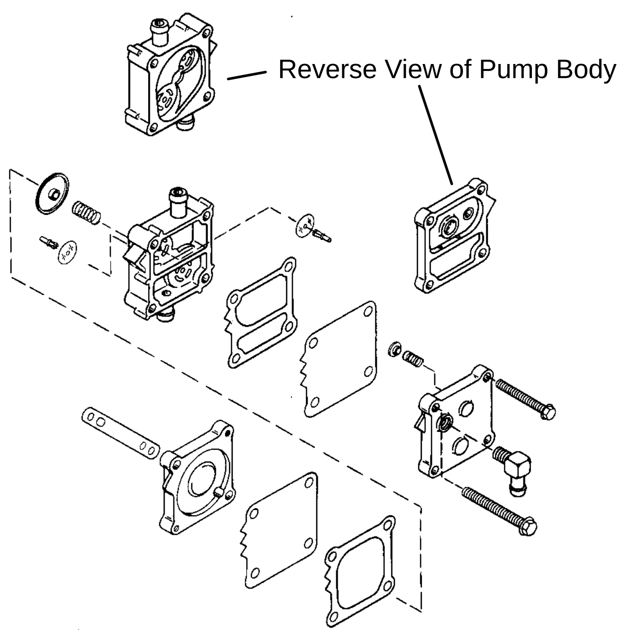
1.



57922

a - Disconnect fuel hose from tank to fuel pump
b - Disconnect fuel hose from fuel pump to water separator
c - Disconnect pulse hose
d - Remove mounting screws
e - Remove fuel pump

2. Disassemble fuel pump.



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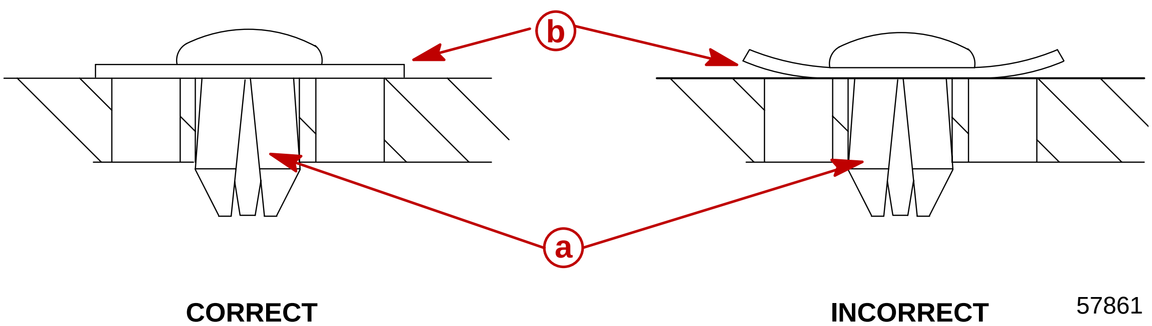
Cleaning/Inspection

1. Clean fuel pump housing, check valves, pulse chamber and pump base in solvent and dry all but check valves with compressed air.
2. Inspect each check valve for splits, chips and for proper sealing against pump housing.
3. Inspect boost springs for weakness or breakage.
4. Inspect fuel pump housing, pulse chamber and base for cracks or rough gasket surface and replace if any are found.
5. Inspect fitting on fuel pump housing for loosening or any signs of fuel or air leaks. Replace or tighten fitting if a leak is found.

Reassembly/Installation

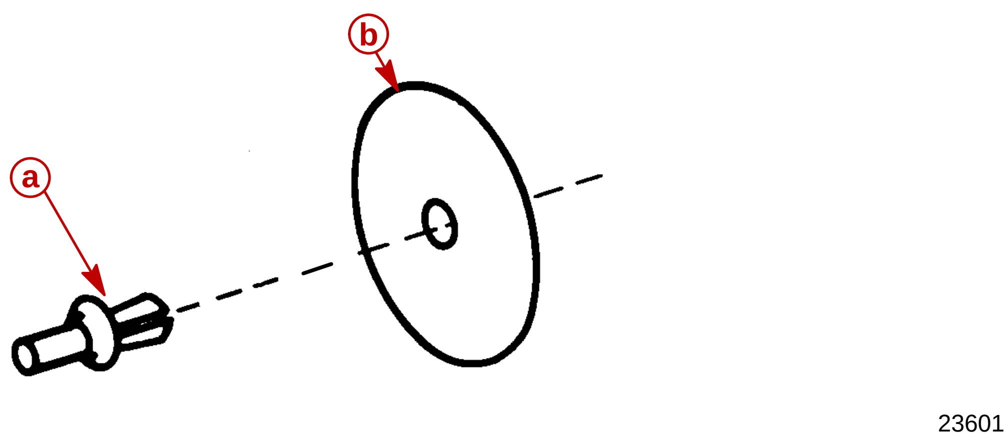
ASSEMBLY

NOTE: *The new repair kits contain check valves made of a plastic material, impervious to damage from additives. When repairing the fuel pump discard old rubber and small plastic check valve disks, and install one new plastic disk under each retainer. Caution must be taken not to push the check valve retainer to tightly against the check valve, this may cause valve to deform.*



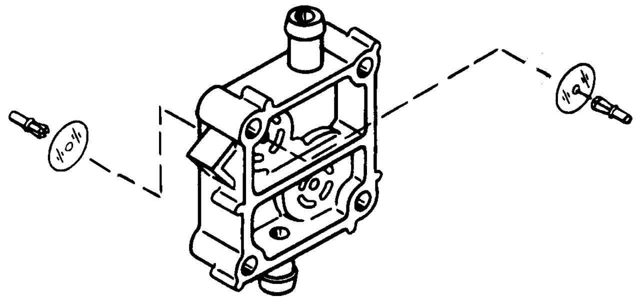
a - Check Valve Retainer
b - Check Valve (Plastic)

1.

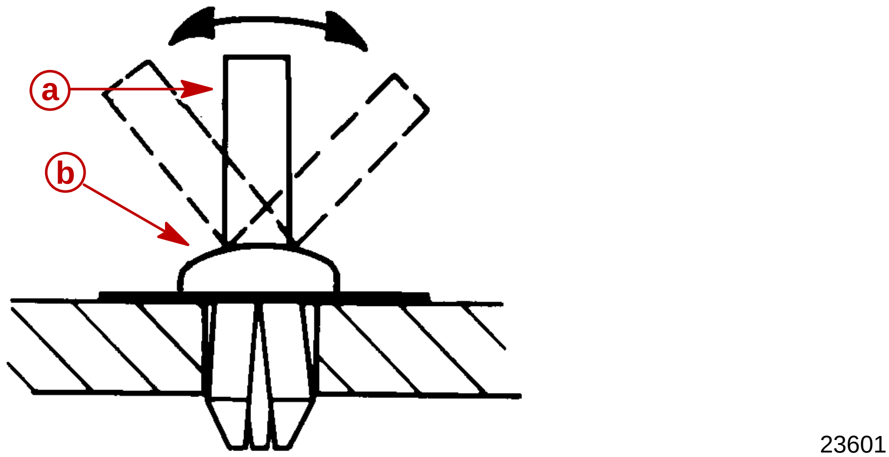


a - Insert Retainer through check valve
b - Plastic Check Valve

2. Install check valves and retainers into fuel pump body.

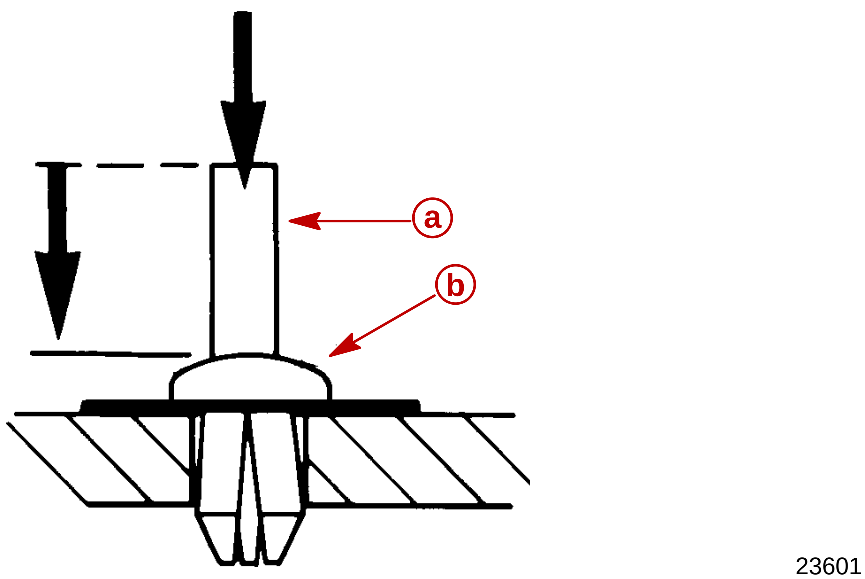


3. With retainer installed in pump body, break retainer rod from retainer by bending sideways.



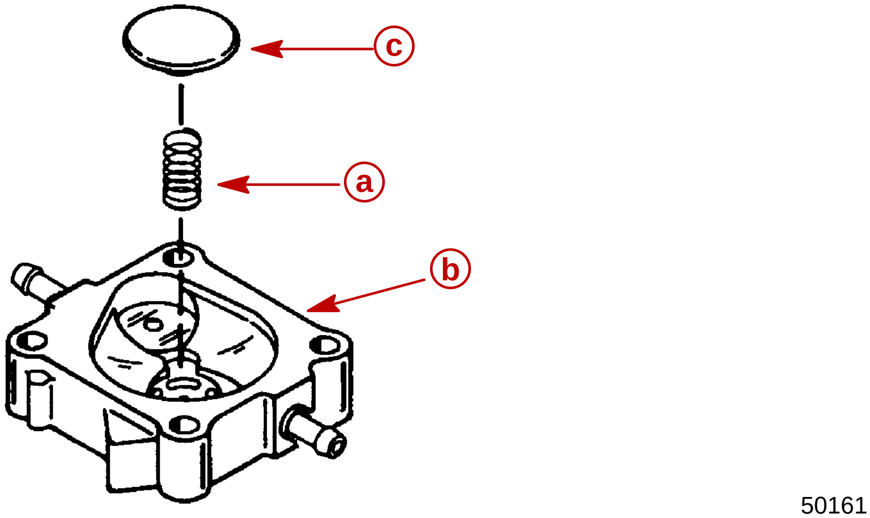
a - Rod
b - Retainer Cap

4. Reinstall rod into retainer cap and, use a small hammer or hammer and punch to tap rod down into retainer until flush with top of retainer.



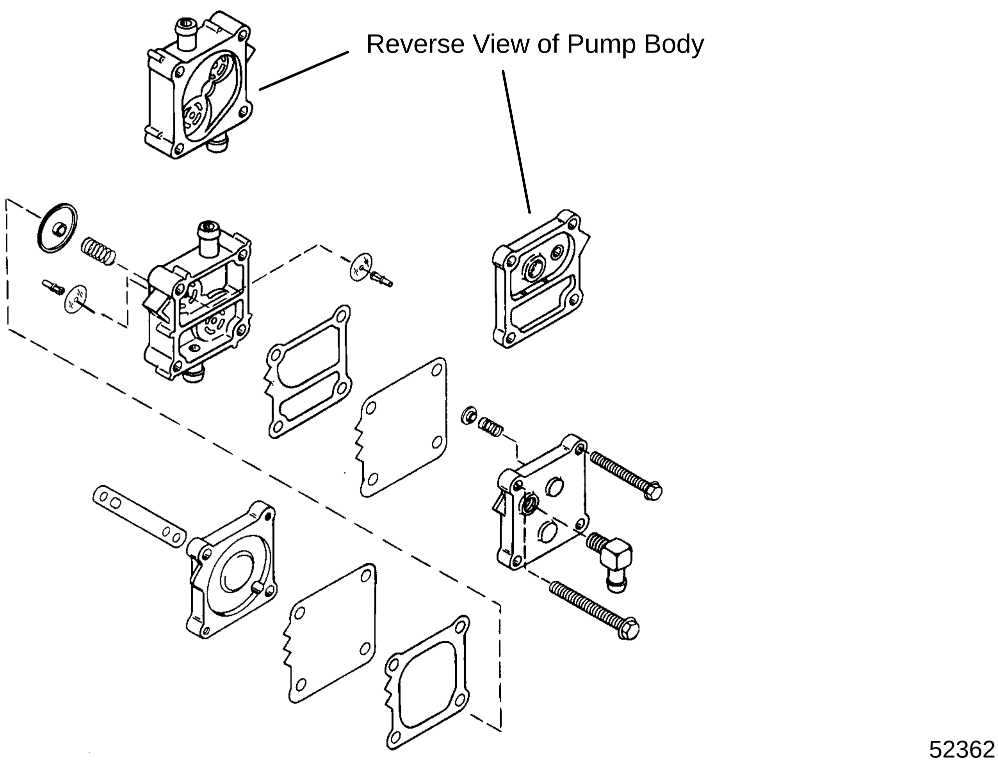
a - Rod
b - Retainer Cap

5. Place boost spring into pump body and place cap onto boost spring.



a - Boost Spring
b - Pump Body
c - Cap

6. Assemble remainder of components as shown and install retaining screws thru to align.



7. Install pump onto engine. Torque to 55 lb. in. (6 N·m).
8. Install hoses onto proper fittings and secure with sta-straps.
9. Run engine and check for leaks.

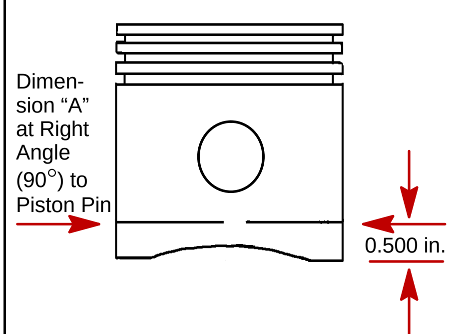
FUEL SYSTEM

Section 3B – Direct Fuel Injection

Table of Contents

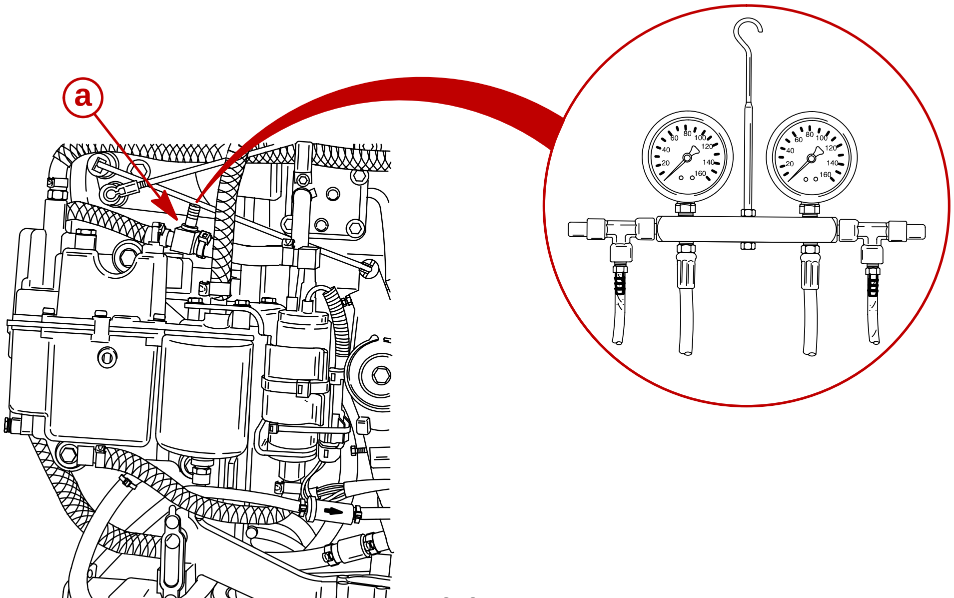
Specifications

Fuel System Specifications	
Fuel Pressure	89 ± 2 psi (613.5 ± 13.8 kPa)
Air Pressure	79 ± 2 psi (544.0 ± 13.8 kPa)
Fuel/Air Differential	10 psi (68.5 kPa)
High Pressure Electric Fuel Pump Amperage Draw	6-9 Amps
Low Pressure Electric Fuel Pump Amperage Draw	1-2 Amps
Low Pressure Electric Fuel Pump Output	6-10 psi (41.37 kPa - 68.5 kPa)
Fuel Injector Ohm Resistance	1.8 ± 0.1Ω
Direct Injector Ohm Resistance	1.3 ± 0.3Ω

Air Compressor Specifications		
Air Compressor	Type Compressor Output	Reciprocating Piston (1 to 1 ratio with engine RPM) @ Idle – 80 psi @ W.O.T. – 110 psi
Cylinder Block	Displacement	7.07 cu. in. (116 cc)
Cylinder Bore	Diameter (Standard) Taper/Out-of-Round/Wear Maximum Bore Type	2.5591 in. (65.0 mm) 0.001 in. (0.025 mm) Cast Iron
Stroke	Length	1.374 in. (34.9 mm)
Piston	Piston Type	Aluminum
Piston Diameter		2.5578 ± .0004 in. (64.97 ± 0.010 mm)
Piston Ring	End Gap Top Ring Middle Ring Bottom Ring	 0.0059 - 0.0098 in. (0.15 - 0.25 mm) 0.0059 - 0.0098 in. (0.15 - 0.25 mm) 0.0039 - 0.014 in. (0.10 - 0.35 mm)
Reeds	Reed Stand Open	0.010 in. (0.25 mm)

Special Tools

1. Duel Fuel/Air Pressure Gauge 160 psi – 91-852087A1/A2/A3

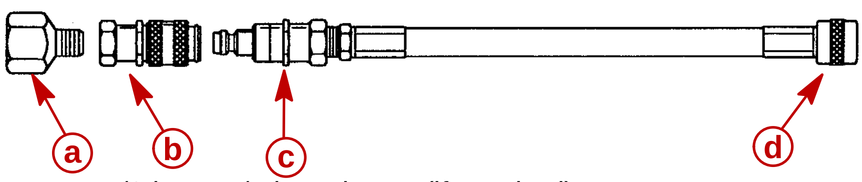


57818

a - Schrader Valve “Tee” (22-849606)

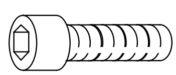
2. Adaptors to convert pressure gauge 91-852087A1/A2 to an A23

***NOTE:** 2 Adaptors 91-803804A2 are required to convert a pressure gauge set.*

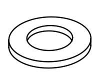


a - 1/2 in. to 1/4 in. Adapter (if required)
b - Female Quick Disconnect
c - Male Quick Disconnect
d - Screw on Schrader

3. Screw (5 mm x 25 mm) (2 each) – 10-40073-25



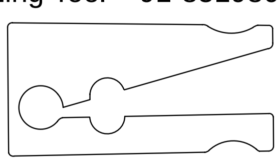
4. Flat Washer (2 each) – 12-30164



5. Seal/Teflon Ring Installation Tool – 91-851980

56015

6. Seal/Teflon Ring Sizing Tool – 91-851980-1



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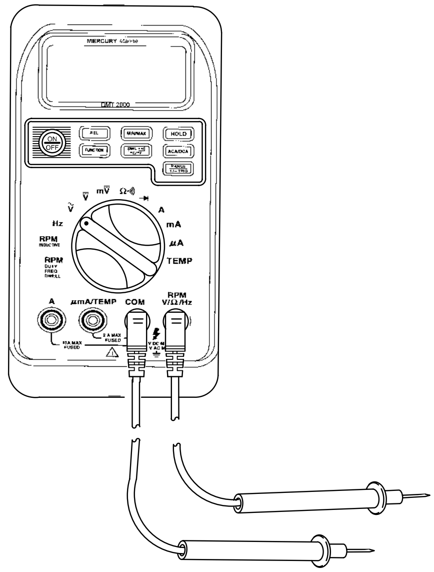
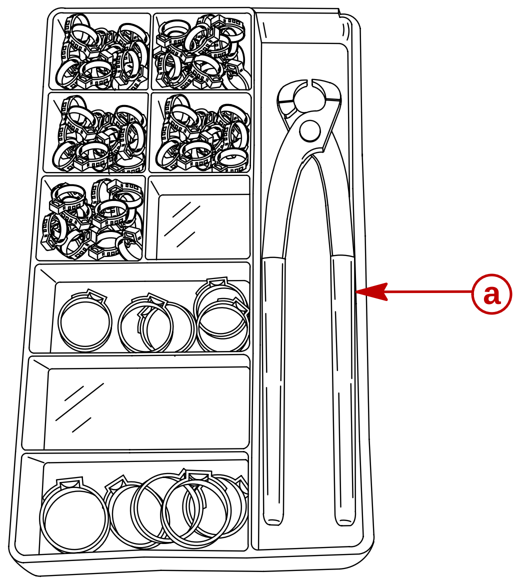
7. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1



8. Clamp Tool Kit 91-803146A2



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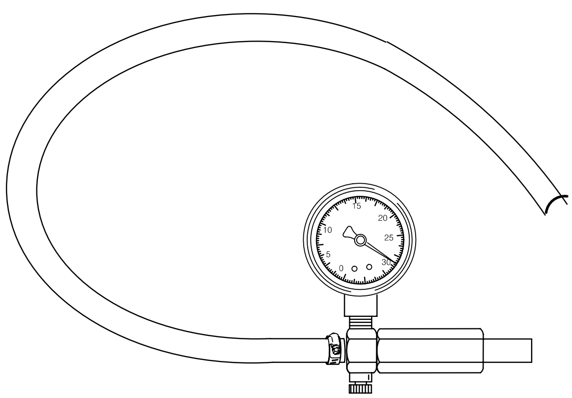
a - Clamp Tool 91-803146T

9. Gearcase Leakage Tester (FT-8950)



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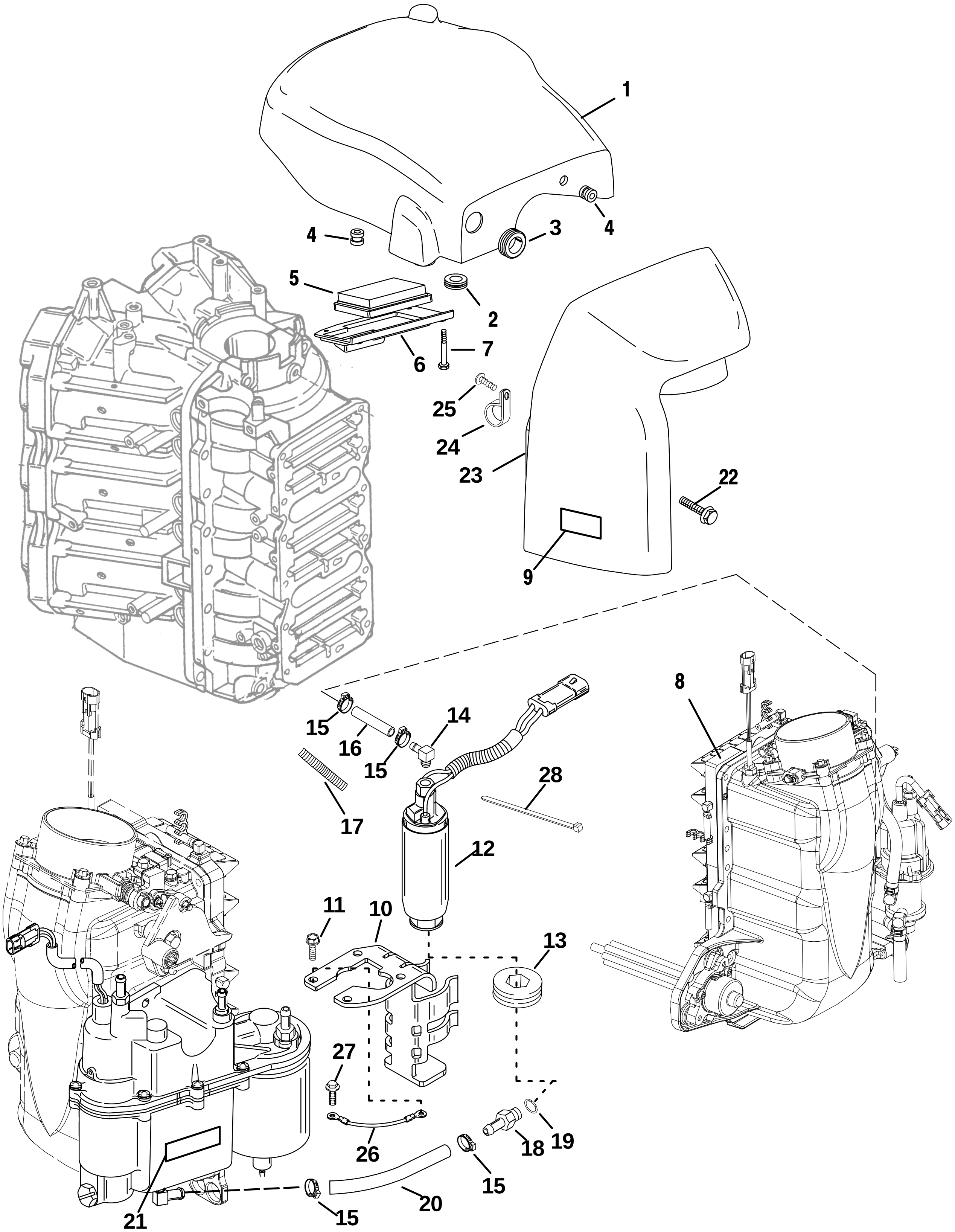
Notes:

Air Handler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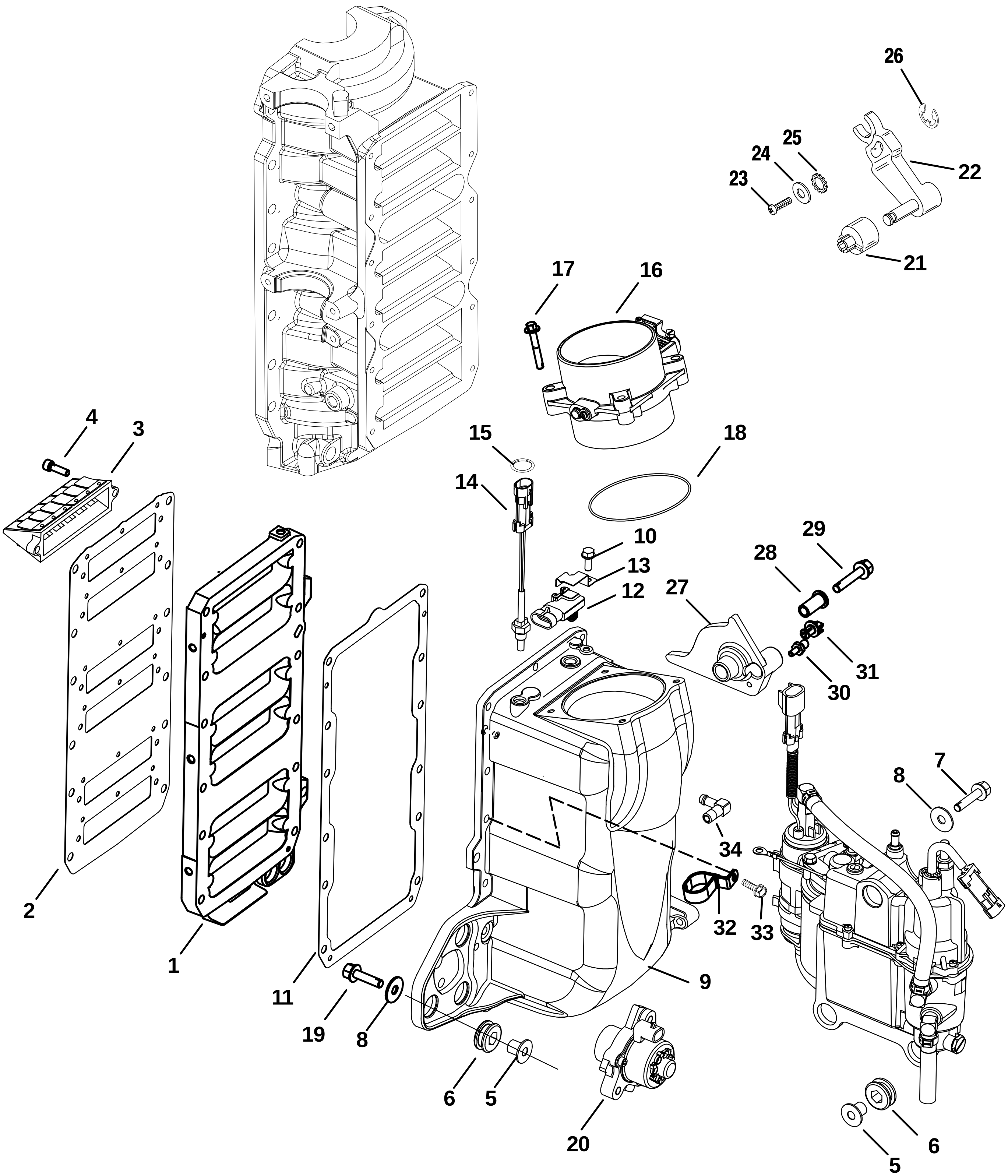
Air Handler

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	COVER			
2	1	GROMMET			
3	1	GROMMET			
4	2	GROMMET			
5	1	AIR FILTER			
6	1	COVER			
7	4	SCREW (M5 x 13)			
8	1	AIR HANDLER ASSEMBLY			
9	1	DECAL-Caution-Start in Gear			
10	1	BRACKET			
11	4	SCREW (M6 x 16)	100		11.5
12	1	FUEL PUMP			
13	1	GROMMET			
14	1	ELBOW			
15	4	CLAMP			
16	1	HOSE			
17	1	INSULATING SLEEVE			
18	1	FITTING			
19	1	O RING			
20	1	HOSE			
21	1	DECAL-EPA Label Information **(SEE NOTE)**			
22	1	SCREW (M6 x 45)	120	10	13.5
23	1	AIR ATTENUATOR			
24	1	CLIP			
25	1	SCREW (10-16 x 3/4 IN.)			
26	1	CABLE			
27	1	SCREW (M6 x 8)			
28	1	CABLE TIE (14 IN.)			

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

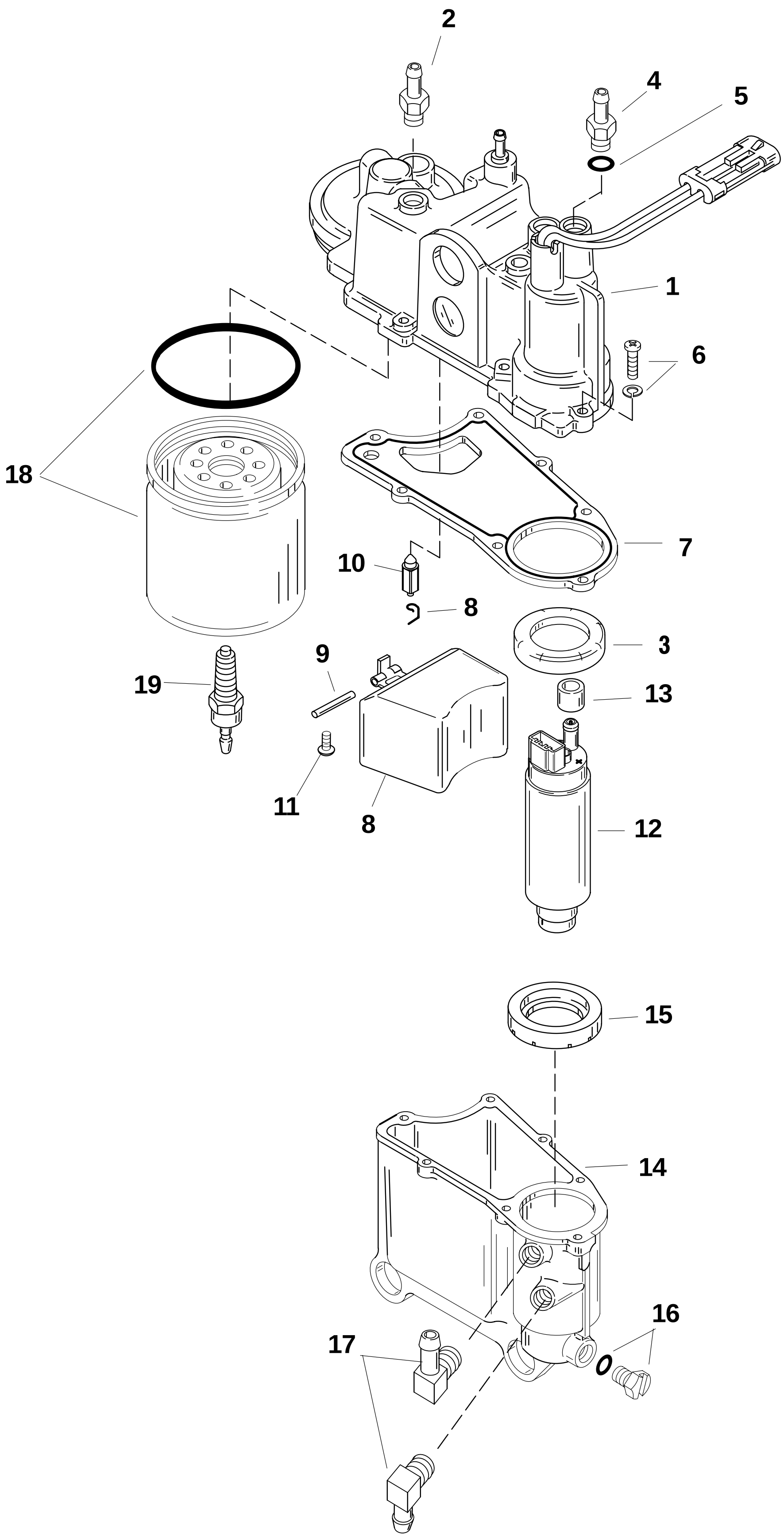
Air Handler Components



Air Handler Components

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
–	1	AIR HANDLER			
1	1	ADAPTOR PLATE			
2	1	GASKET			
3	6	REED BLOCK			
4	12	SCREW (M6 x 1)	90		10
5	6	BUSHING			
6	6	GROMMET			
7	3	SCREW (M8 x 35)	140		16
8	6	WASHER			
9	1	AIR PLENUM KIT			
10	1	SCREW			
11	1	GASKET			
12	1	SENSOR–MAP			
13	1	BRACKET			
14	1	TEMPERATURE SENSOR			
15	1	O RING			
16	1	THROTTLE BODY KIT			
17	4	SCREW	100		11.5
18	1	O RING			
19	3	SCREW		17	23
20	1	OIL PUMP			
21	1	ROLLER			
22	1	THROTTLE ROLLER			
23	1	SCREW (M5 x 16)	Drive Tight		
24	1	WASHER			
25	1	STAR WASHER			
26	1	RETAINING RING			
27	1	CAM ASSEMBLY			
28	1	BUSHING			
29	1	SCREW (M8 X 40)	145	12	16
30	1	THREADED BALL			
31	1	SWIVEL BUSHING			
32	1	CLAMP			
33	11	SCREW (M6 x 40)	100		11.5
34	1	FITTING			

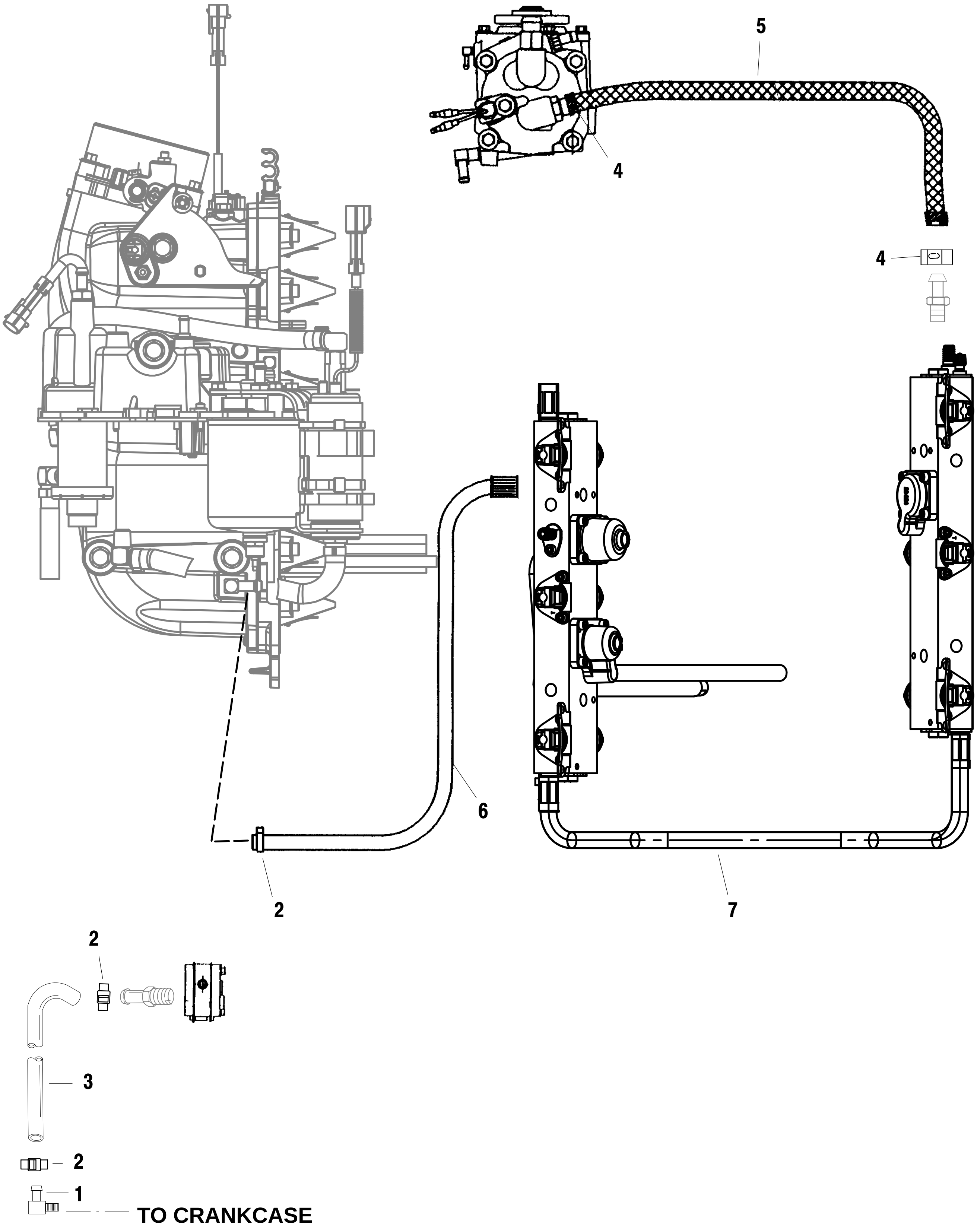
Vapor Separator Components



Vapor Separator Components

REF. NO.	QTY.	DESCRIPTION	TORQUE lb. in.	TORQUE lb. ft.	TORQUE N·m
1	1	COVER KIT			
2	1	ELBOW			
3	1	SEAL			
4	1	FITTING KIT-Pump Outlet			
5	1	O RING			
6	7	SCREW	30		3.5
7	1	GASKET			
8	1	FLOAT KIT			
9	1	FLOAT PIN			
10	1	NEEDLE VALVE			
11	1	SCREW	10		1.0
12	1	FUEL PUMP KIT			
13	1	SLEEVE			
14	1	BOWL KIT			
15	1	SEAL			
16	1	PLUG KIT			
17	2	ELBOW			
18	1	FUEL FILTER ASSEMBLY			
19	1	PROBE			

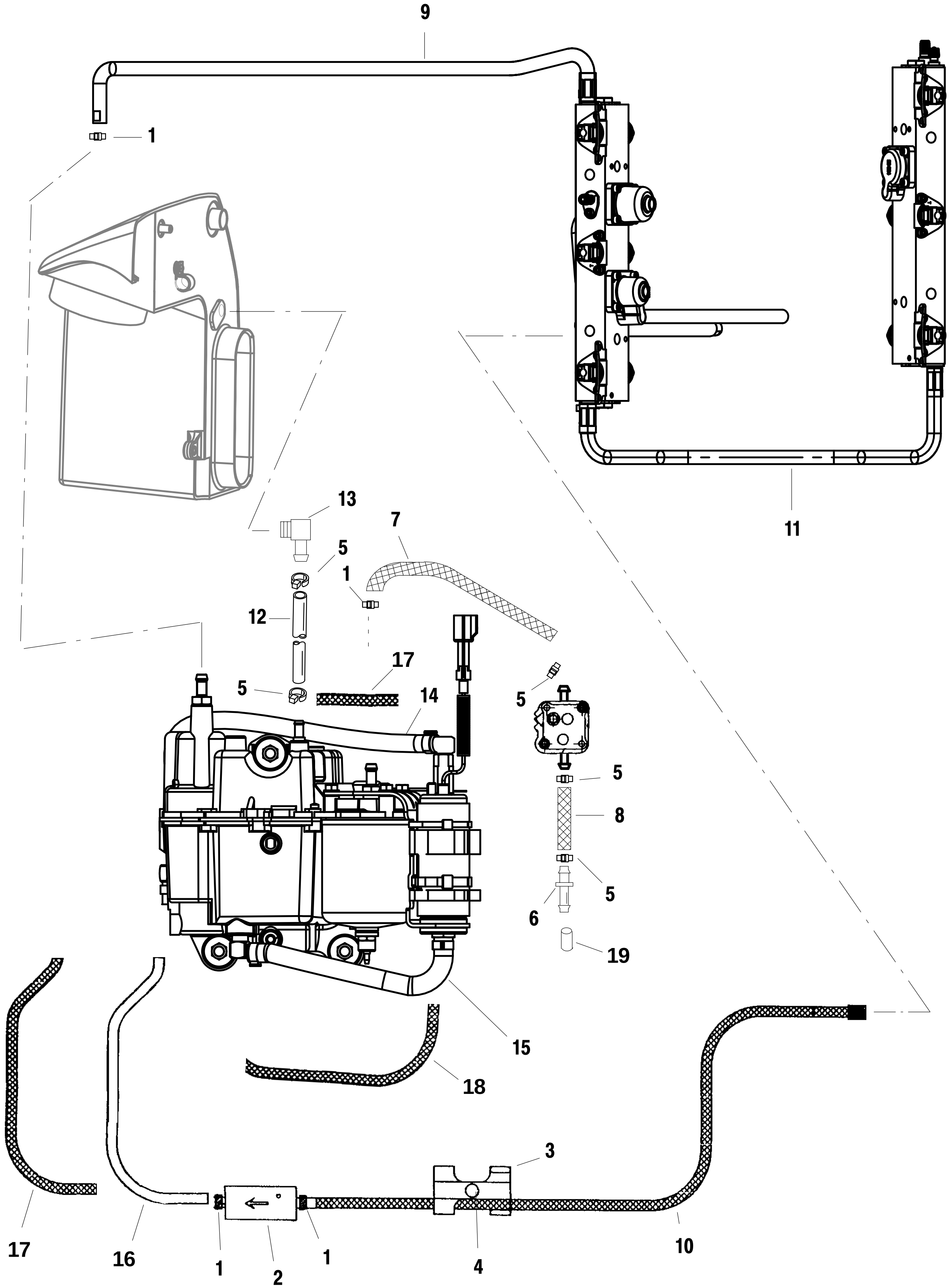
Air Hoses



Air Hoses

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm
1	1	ELBOW			
2	3	STA STRAP			
3	1	HOSE-Pulse Line			
4	2	CLAMP			
5	1	HOSE			
6	1	HOSE			
7	1	HOSE			

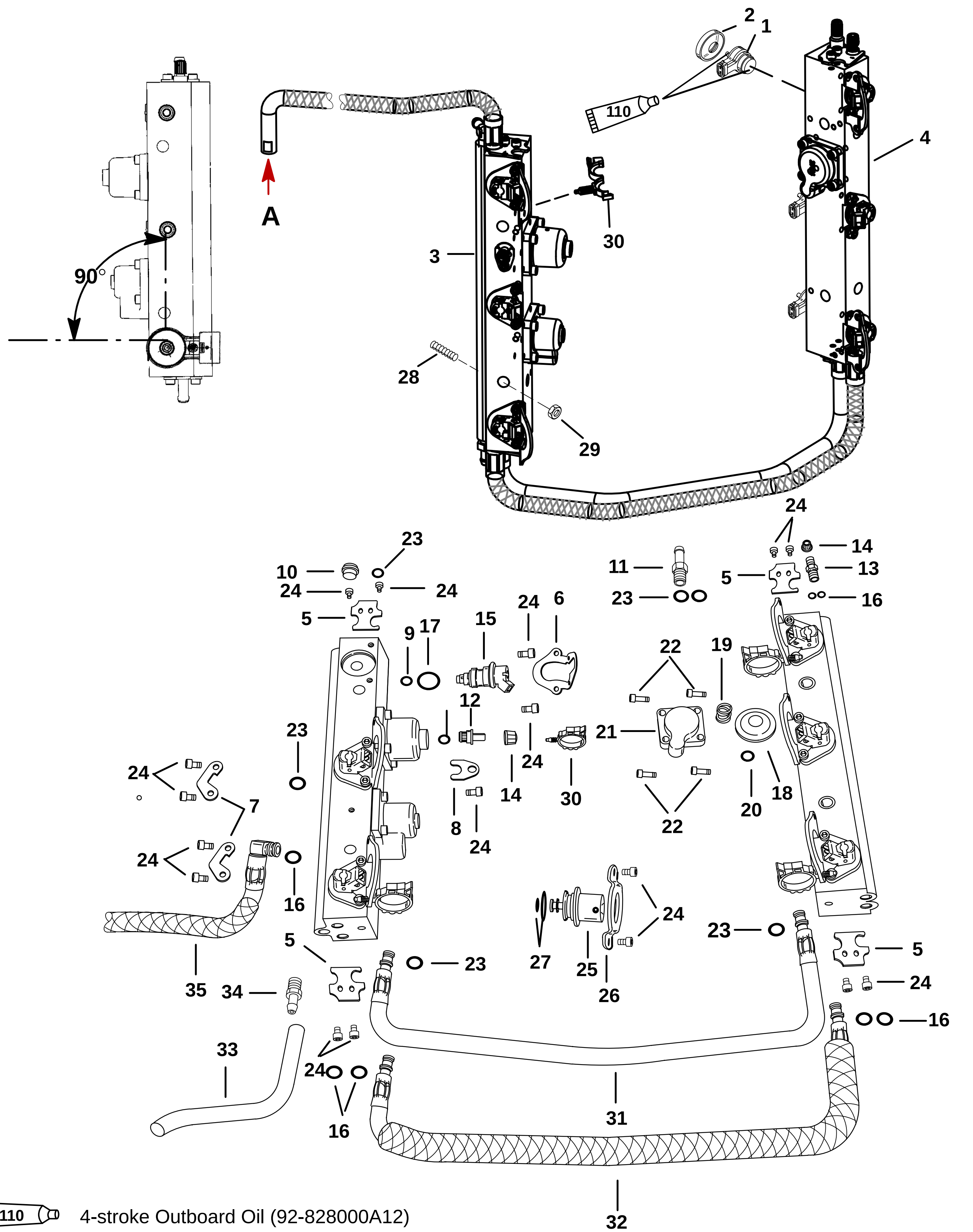
Fuel System



Fuel System

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	4	CLAMP			
2	1	CHECK VALVE			
3	1	T CLAMP			
4	1	SCREW (M5 x 35)			
5	5	STA STRAP			
6	1	CONNECTOR			
7	1	HOSE/SLEEVE			
8	1	HOSE			
9	1	HOSE-Fuel Supply			
10	1	HOSE-Fuel Bypass			
11	1	HOSE-Fuel Balance			
12	1	HOSE (18 IN.)			
13	1	ELBOW			
14	1	HOSE			
15	1	HOSE			
16	1	TUBING			
17	2	SLEEVE (14 IN.)			
18	1	SLEEVE (8 IN.)			
19	1	CAP			

Fuel Rails



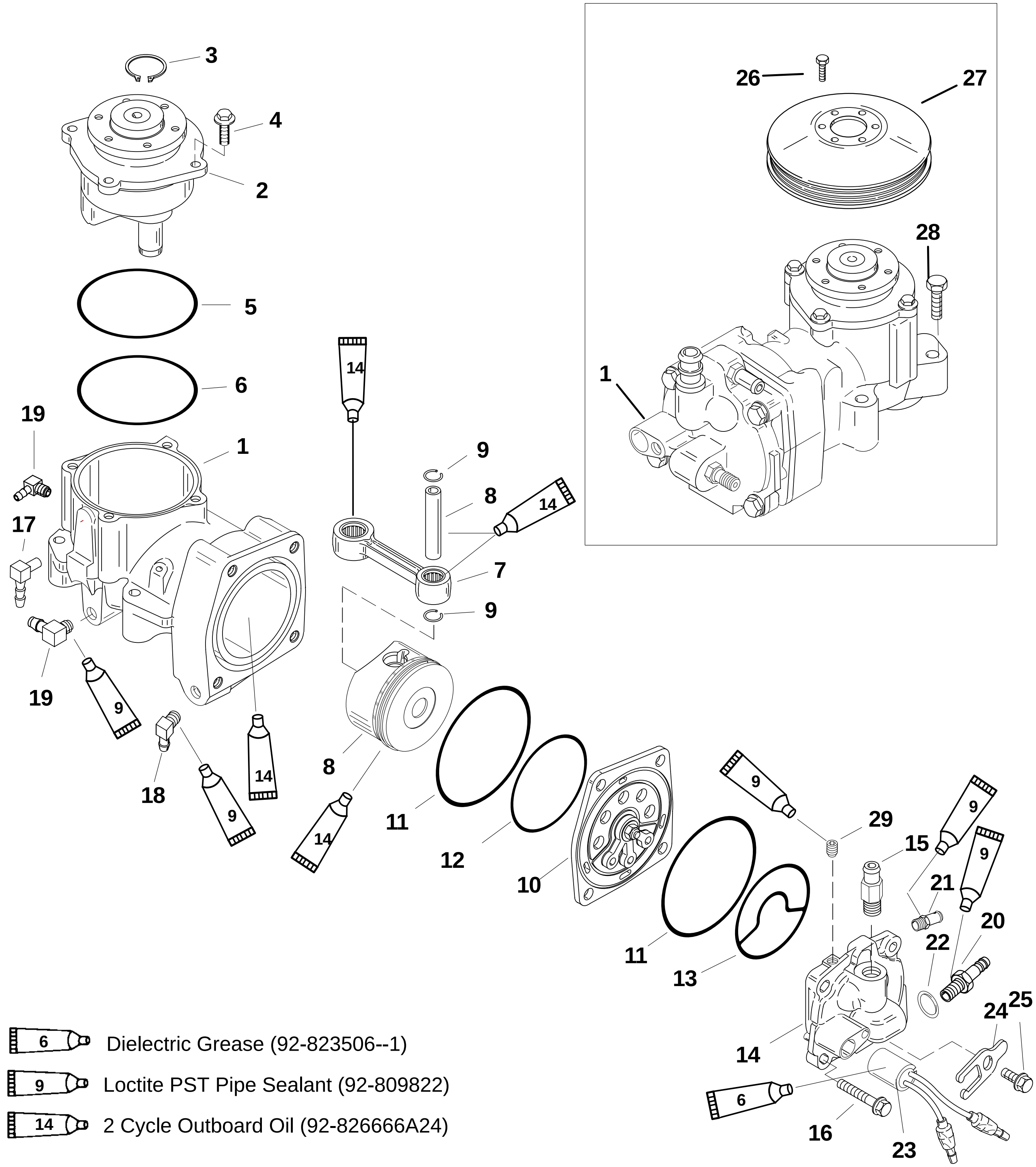
110 4-stroke Outboard Oil (92-828000A12)

A – To Vapor Separator

Fuel Rails

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
–	1	FUEL RAIL ASSEMBLY			
1	6	INJECTOR			
2	6	CUPPED WASHER			
3	1	FUEL RAIL **(PORT)**			
4	1	FUEL RAIL **(STARBOARD)**			
5	4	CLAMP			
6	4	CLAMP			
7	2	CLAMP			
8	2	CLAMP			
9	1	O-RING KIT			
10	1	AIR PLUG			
11	1	FITTING			
12	1	AIR VALVE KIT			
13	1	FUEL VALVE KIT			
14	2	CAP			
15	6	FUEL INJECTOR			
16	1	O-RING KIT			
17	1	O-RING KIT			
18	1	DIAPHRAGM			
19	1	SPRING			
20	1	O-RING			
21	1	COVER			
22	4	SCREW (M5 X 16)	70		8
23	1	O-RING (16 PER KIT)			
24	17	SCREW (M5 X 8)	70		8
25	1	AIR REGULATOR (**MODEL 2001**)			
26	1	CLAMP			
27	1	O-RING KIT			
28	4	STUD (M10 x 91)			
29	4	NUT (M10)		33	45
30	4	CLIP – CONDUIT			
31	1	AIR HOSE (80 PSI)			
32	1	FUEL HOSE (90 PSI)			
33	1	WATER INLET HOSE			
34	1	FITTING			
35	1	FUEL RETURN HOSE TO VAPOR SEPARATOR			

Air Compressor Components



6 Dielectric Grease (92-823506--1)

9 Loctite PST Pipe Sealant (92-809822)

14 2 Cycle Outboard Oil (92-826666A24)

Air Compressor Components

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	AIR COMPRESSOR			
2	1	END CAP			
3	1	SNAP RING			
4	4	SCREW (M6 x 20)	Note*		
5	1	O RING			
6	1	O RING			
7	1	CONNECTING ROD			
8	1	PISTON ASSEMBLY			
9	2	LOCK RING			
10	1	REED PLATE ASSEMBLY			
11	2	O RING			
12	1	O RING			
13	1	SEAL			
14	1	COMPRESSOR HEAD			
15	1	FITTING-Straight			
16	4	SCREW (M8 x 35)	240	20	27
17	1	ELBOW			
18	1	ELBOW			
19	2	ELBOW (CHECK VALVE)			
20	1	CONNECTOR			
21	1	FITTING			
22	1	O RING			
23	1	TEMPERATURE SENSOR			
24	1	RETAINER			
25	1	SCREW (M6 x 12)	240	20	27
26	5	SCREW (M6 x 12)	190		21.5
27	1	PULLEY			
28	4	SCREW (M8 x 50)	240	20	27
29	1	PLUG			

***NOTE:** Model Year 2000 (GOLD colored pulley) – Torque for pulley screws is 190 lb. in. (21.5 Nm)*

***NOTE:** Model Year 2001 (BLACK colored pulley) – Torque for pulley screws is 170 lb. in. (19 Nm)*

DFI Operation

Air Induction Through Crankcase

Combustion air enters the cowl through holes located in the top aft end of the cowl. The cowl liner directs this air to the bottom of the powerhead. This limits the exposure of salt air to the components inside the engine cowl.

Once inside the cowl the air enters the plenum through the throttle shutter which is located in the plenum assembly. The air then continues through the reed valves and into the crankcase. The throttle shutter is actuated by the throttle shaft. Mounted on a separate shaft is a throttle position sensor (TPS). This sensor tells the engine control unit (ECM) the position of the throttle.

If the TPS should fail, the dash mounted CHECK ENGINE light will flash and the warning horn will sound. Engine speed will be reduced.

Air Compressor System

Air from inside the engine cowl is drawn into the compressor through the flywheel cover. This cover acts like a muffler to quiet compressor noise and contains a filter to prevent the ingestion of debris into the compressor. The compressor is driven by a belt from a pulley mounted on the flywheel and is automatically self adjusted using a single idler pulley. This air compressor is a single cylinder unit containing a connecting rod, piston, rings, bearings, reed valves, and a crankshaft. The compressor is water cooled to lower the temperature of the air charge and is lubricated by oil from the engine oil pump assembly. As the compressor piston moves downward inside the cylinder, air is pulled through the filter, reed valves and into the cylinder. After the compressor piston changes direction, the intake reeds close and the exhaust reeds open allowing compressed air into the hose leading to the air/fuel rails.

The air/fuel rails contain two passages; one for fuel, the second is the air passage. The air passage is common between all the cylinders included in the rail. A hose connects the starboard rail air passage to the air compressor. Another hose connects the starboard air rail passage to the port air rail passage. An air pressure regulator will limit the amount of pressure developed inside the air passages to approximately 10 psi below the pressure of the fuel inside the fuel passages (i.e. 80 psi air vs 90 psi fuel). Air exiting the pressure regulator is returned into the air plenum.

Fuel

Fuel for the engine is stored in a typical fuel tank. A primer bulb is installed into the fuel line to allow priming of the fuel system. A crankcase mounted pulse driven diaphragm fuel pump draws fuel through the fuel line, primer bulb, fuel pump assembly and then pushes the fuel thru a water separating fuel filter. This filter removes any contaminates and water before the fuel reaches the vapor separator. Fuel vapors are vented through a hose into the air compressor inlet in the front of the flywheel cover. The electric fuel pump is different than the fuel pump that is utilized on the standard EFI engine (non DFI), and is capable of developing fuel pressures in excess of 90 psi. Fuel inside the rail must remain pressurized at exactly 10 psi over the air rail pressure or the ECM (map) calibrations will be incorrect. Fuel from the vapor separator is supplied to the top of the port fuel rail. A fuel line connects the bottom of the first rail to the opposite fuel rail. Fuel is stored inside the rail until an injector opens. A fuel pressure regulator controls pressure in the fuel rails, and allows excess fuel to return into the vapor separator. The fuel regulator not only regulates fuel pressure but also regulates it at approximately 10 p.s.i. higher than whatever the air rail pressure is. The fuel regulator diaphragm is held closed with a spring that requires 10 p.s.i. to force the diaphragm off the diaphragm seat. The back side of the diaphragm is exposed to air rail pressure. As the air rail pressure increases, the fuel pressure needed to open the regulator will equally increase. Example: If there is 50 p.s.i. of air pressure on the air rail side of the diaphragm, 60 p.s.i. of fuel pressure will be required to open the regulator. The port fuel rail is water cooled.

To equalize the pulses developed by the pumps (both air and fuel) a tracker diaphragm is installed in the starboard rail. The tracker diaphragm is positioned between the fuel and air passages. The tracker diaphragm is a rubber diaphragm which expands and retracts depending upon which side of the diaphragm senses the pressure increase (pulse).

Oil

Oil in this engine is not mixed with the fuel before entering the combustion chamber. Oil is stored inside a standard remote oil reservoir. Crankcase pressure will force oil from the remote oil tank into the oil reservoir on the side of the powerhead. Oil will flow from the oil reservoir into the oil pump. The oil pump is a solenoid design. It is activated by the ECM and includes 7 pistons with corresponding discharge ports. The oil pump is mounted directly onto the powerhead. Each cylinder is lubricated by one of the discharge ports. The oil is discharged into the crankcase. The seventh passage connects to the hose that leads to the air compressor for lubrication. Excess oil from the compressor returns into the plenum and is ingested through the crankcase.

The ECM will change the discharge rate of the oil pump, depending upon engine demand. The ECM will also pulse the pump on initial start up to fill the oil passages eliminating the need to bleed the oil system. The ECM provides additional oil for break in, as determined by its internal clock. The oil ratio varies with engine rpm and load.

Electrical

The electrical system consists of the ECM, crank position sensor (flywheel speed & crankshaft position), throttle position sensor (TPS), MAP sensor, engine temperature sensor, ignition coils and injectors (fuel & direct). The engine requires a battery to start (i.e. the ignition and injection will not occur if the battery is dead). The system will run off of the alternator.

Operation

The operation of the system happens in milliseconds (ms); exact timing is critical for engine performance. As the crankshaft rotates, air is drawn into the crankcase through the throttle shutter, into the plenum and through the reed valves. As the piston nears bottom-dead-center, air from the crankcase is forced through the transfer system into the cylinder. As the crankshaft continues to rotate the exhaust and intake ports close. With these ports closed, fuel can be injected into the cylinder. The ECM will receive a signal from the throttle position sensor (TPS), engine temperature sensor (TS) and the crank position sensor (flywheel speed and position sensor). With this information the ECM refers to the fuel calibration (maps) to determine when to activate (open and close) the injectors and fire the ignition coils. With the piston in the correct position, the ECM opens the fuel injector, 90 psi fuel is discharged into a machined cavity inside the air chamber of the air/fuel rail. This mixes the fuel with the air charge. Next the direct injector will open, discharging the air/fuel mixture into the combustion chamber. The direct injector directs the mixture at the bowl located in top of the piston. The piston's bowl directs the air/fuel mixture into the center of the combustion chamber. This air fuel mixture is then ignited by the spark plug.

Compressor Notes: To aid in starting when the air rail pressure is low and before the compressor has time to build pressure, some direct injectors are held open by the ECM. This allows the compression from inside the cylinders to pressurize the air rail faster (1 or 2 strokes, or 60^0 of crankshaft rotation).

Idle Notes: Idle quality is controlled by fuel volume and fuel timing. The throttle shutter will be open at idle speed. The shift cut-out switch will interrupt the fuel to 3 of the cylinders to assist in shifting.

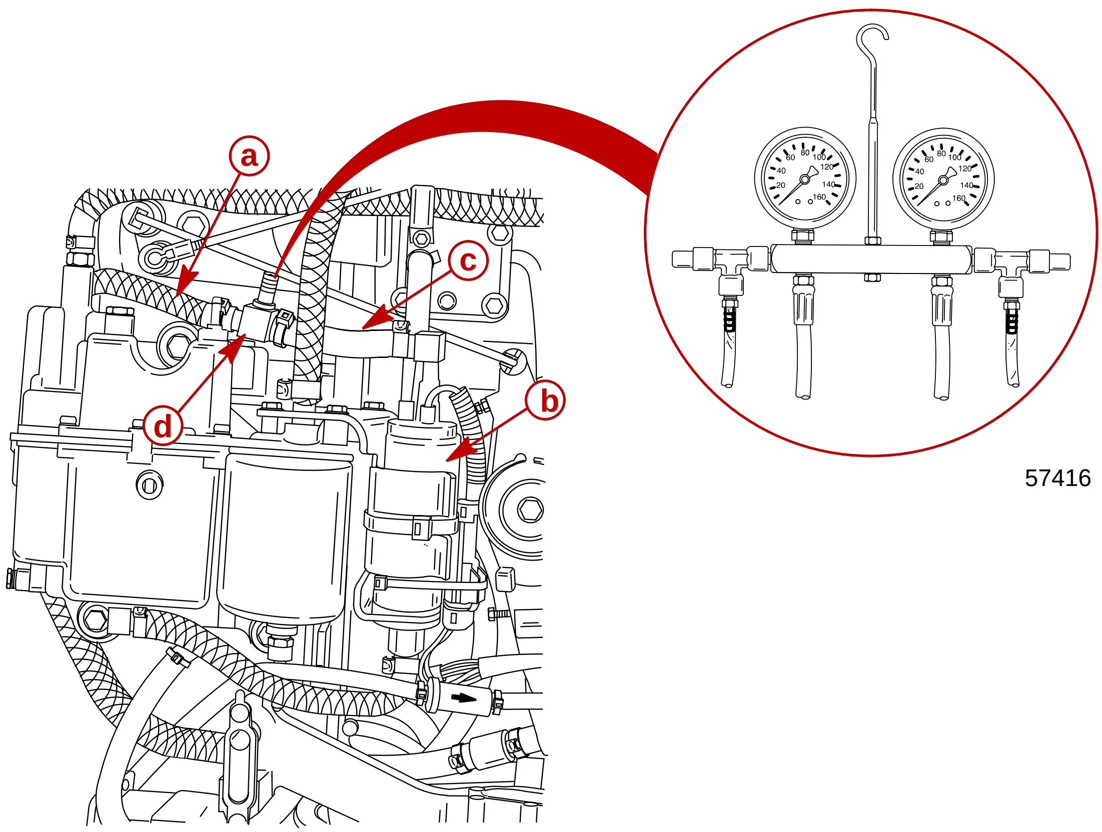
The TPS signals the ECM to change the fuel and spark without movement of the throttle shutters. The throttle cam is manufactured to allow the TPS sensor shaft to move before opening the throttle shutter.

Testing Electric Fuel Pump Pressure Output

Low Pressure Electric Fuel Pump

IMPORTANT: After completing fuel pressure tests, reconnect and secure fuel outlet hose to fuel pump with full circle stainless clamps in Clamp Tool Kit 91-803146A1.

1. Remove outlet fuel hose from low pressure pump. Install a short piece of hose (obtain locally) onto pump outlet fitting. Install Schrader Valve t-fitting (22-849606) between outlet fuel hose (removed from pump) and new fuel hose (installed on pump). Secure hose connections with sta-straps. Due to the low pressure output of this pump, it is recommended that the air gauge of the Dual Fuel/Air Pressure Gauge (91-852087A1/A2/A3) be connected to the Schrader Valve. Gauge should indicate 6-9 psi (41.37 - 62.04 kPa).



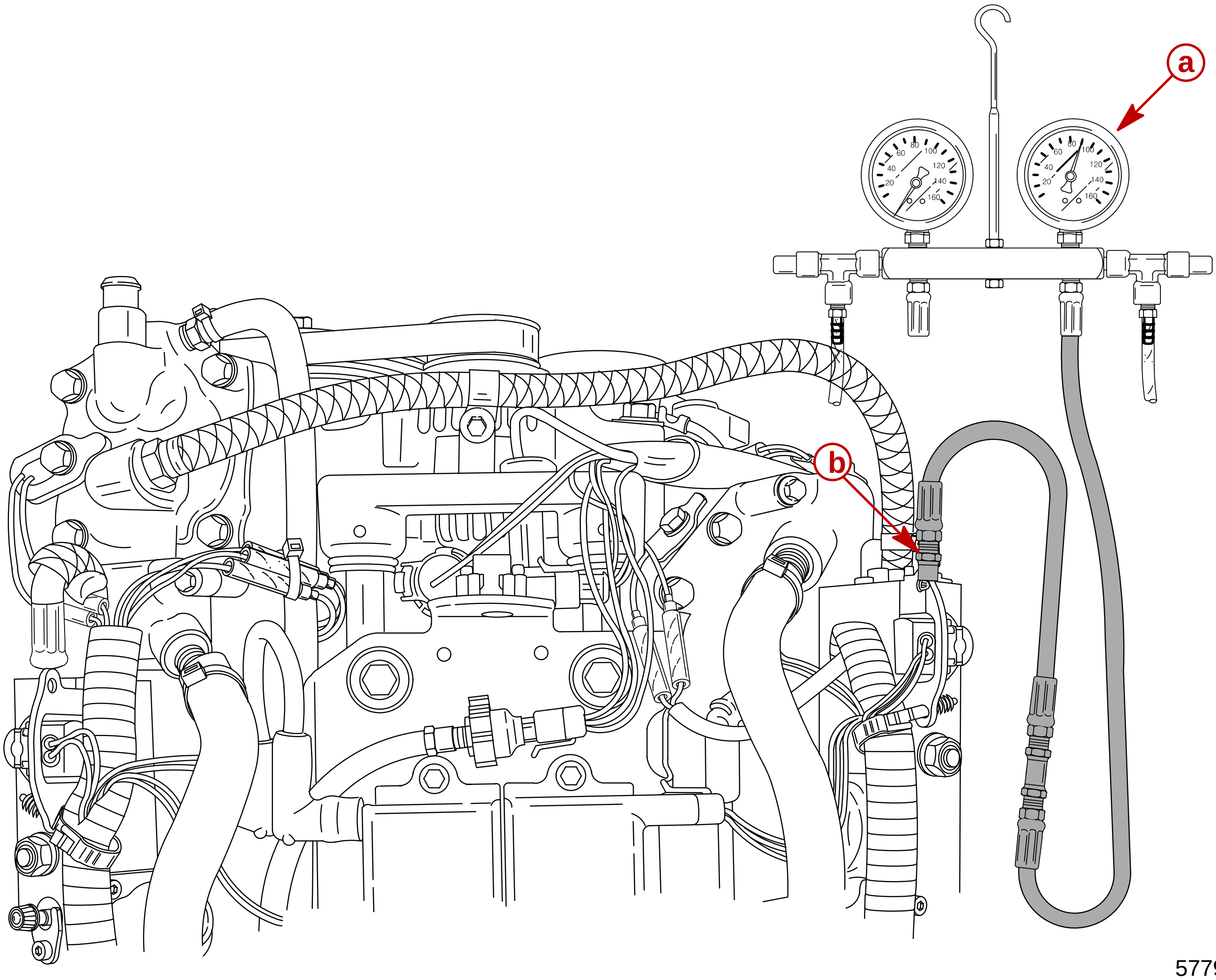
57818

a - Outlet Fuel Hose
b - Low Pressure Electric Fuel Pump
c - Fuel Hose (obtain locally)
d - Schrader Valve (22-849606)

High Pressure Electric Fuel Pump

1. Install Pressure Gauge Assembly 91-852087A1/A2/A3 to starboard fuel rail pressure test valve.

***NOTE:** After 15 seconds of cranking engine with starter motor, fuel pressure gauge should indicate 89 ± 2 psi (613.5 ± 13.8 kPa).*



57798

a - Fuel Pressure Gauge [Should Indicate 89 ± 2 psi (613.5 ± 13.8 kPa)]
b - Fuel Pressure Test Valve

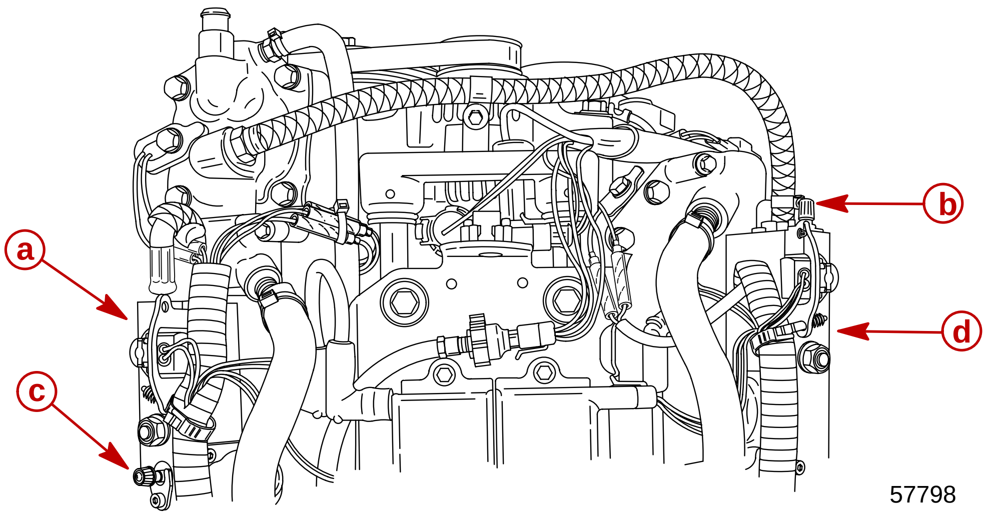
Fuel Management Assembly Removal

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

⚠ WARNING
Drain fuel from vapor separator tank (VST) into a suitable container. Even though VST has been drained, fuel may still remain in fuel rails and hoses. Normal precautionary procedures should be adhered to while working with the fuel system. Avoid sparks, smoking and open flame while in the presence of liquid fuel or fuel vapors.

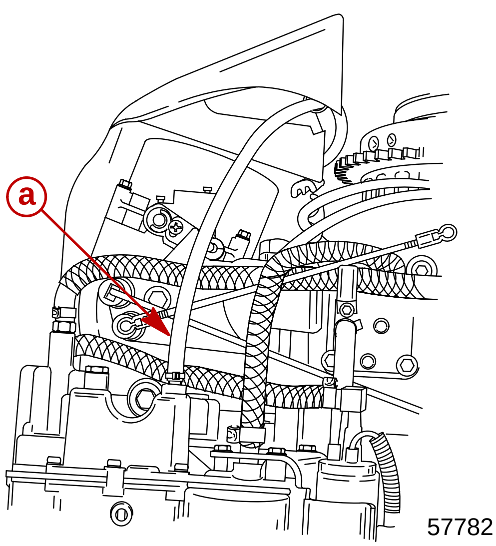
***NOTE:** Use Fuel/Air Pressure Gauge 91-16850--1 or 91-852087A1/A2/A3 to de-pressurize air hose first and then fuel hose.*

1. De-pressurize fuel system.

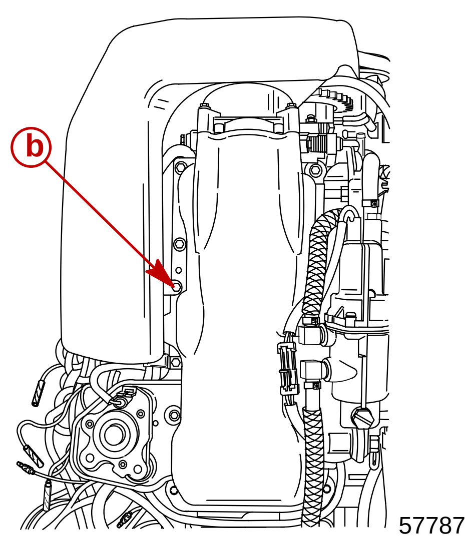


a - Port Fuel Rail
b - Fuel Pressure Port
c - Air Pressure Port
d - Starboard Fuel Rail

2. Remove vapor separator vent hose.
3. Remove bolt securing air management assembly attenuator.

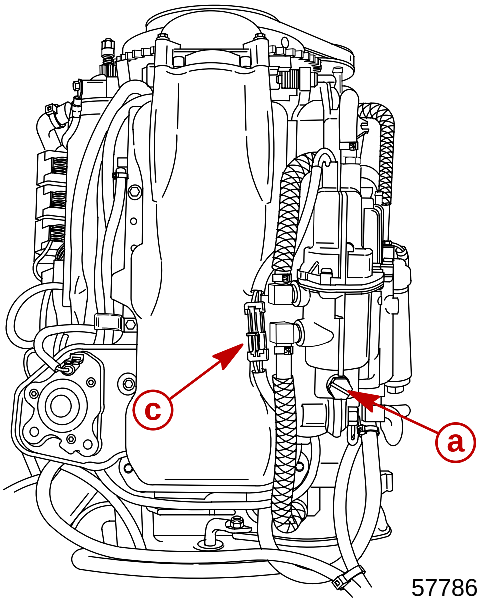


a - Vent Hose



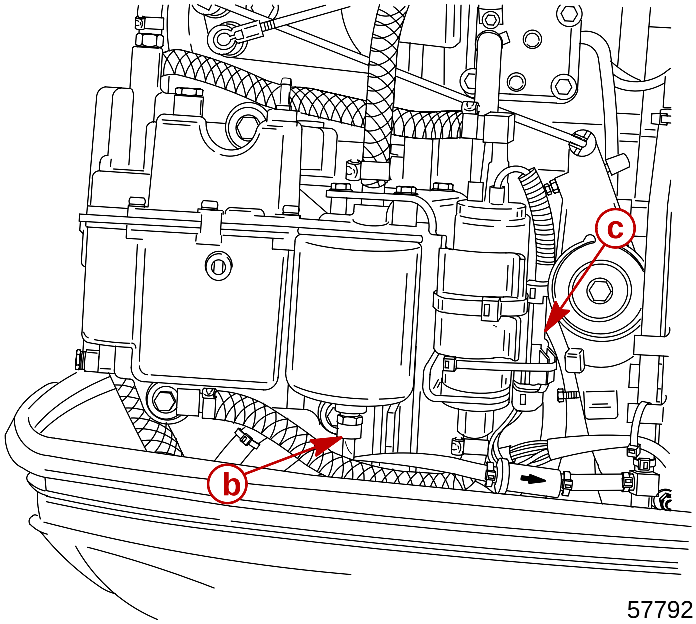
b - Bolt

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



57786

a - Drain Plug

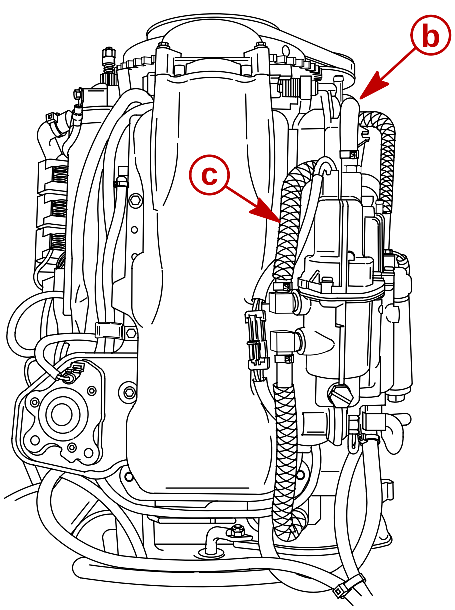


57792

b - Sensor Lead
c - Harness Connectors

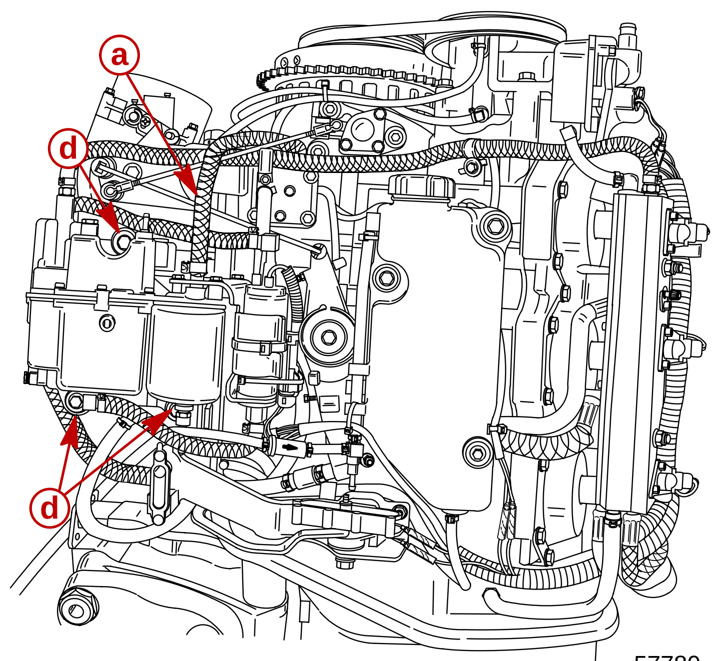
***NOTE:** Lower fuel hose is excess fuel return from fuel rails; upper fuel hose is fuel inlet from electric pump beside fuel/water separator.*

7. Remove the fuel inlet hose from the pulse fuel pump.
8. Remove the fuel outlet hose and fuel return hose from fuel rails.
9. Remove 3 mounting bolts and remove separator.



57786

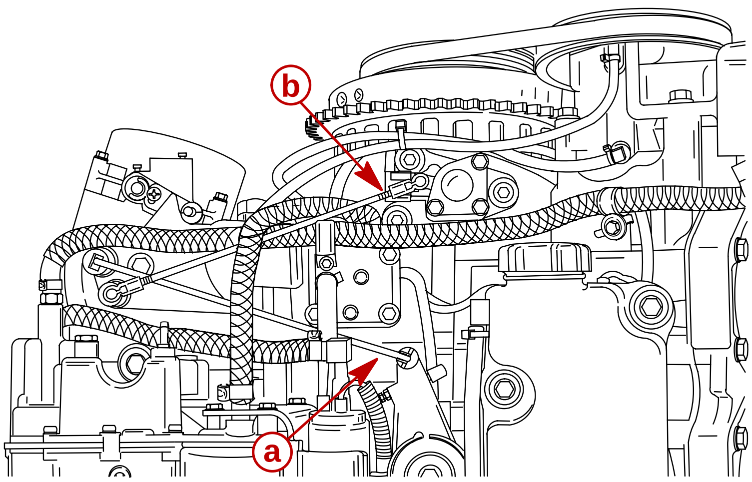
a - Fuel Inlet Hose from Pulse Pump
b - Fuel Outlet Hose



57780

c - Fuel Return Hose
d - Mounting Bolts

10. Disconnect throttle cam link rod and the Throttle Position Sensor link rod.
11. Disconnect MAP Sensor and air temperature sensor from air management assembly.



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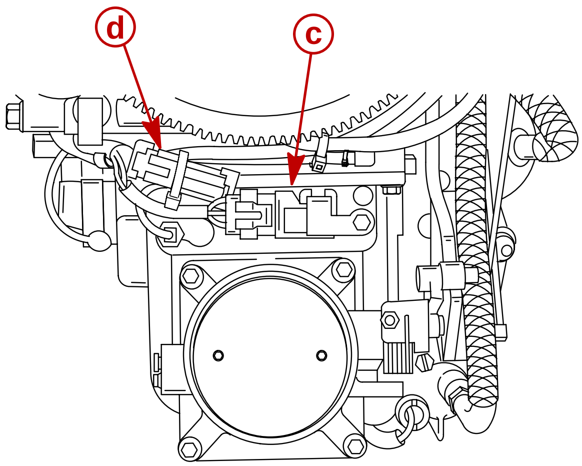
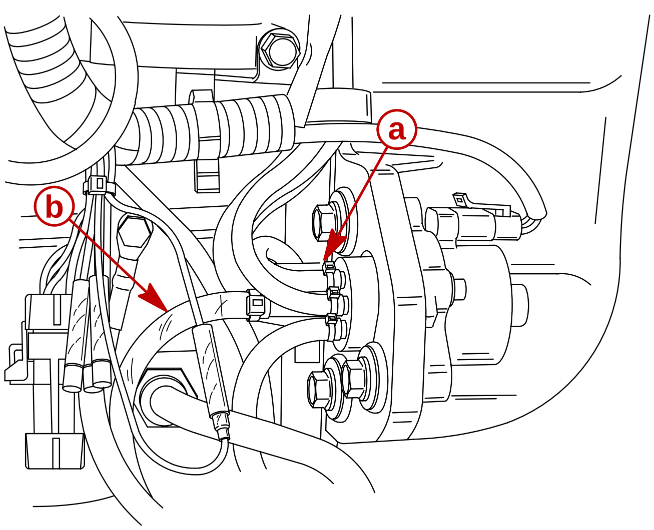


57793

- **a** - Throttle Link Rod
- **b** - Throttle Position Sensor Link Rod
- **c** - MAP Sensor
- **d** - Air Temperature Sensor Connector

12. Disconnect oil hoses from oil pump.
13. Remove and plug oil inlet hose to oil pump.
14. Remove 12 bolts securing air plenum assembly to crankcase and remove assembly.



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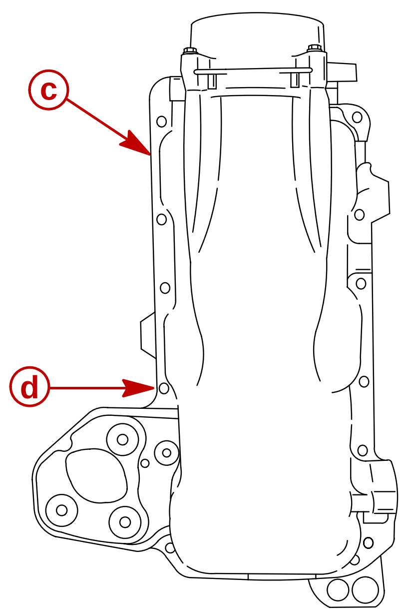
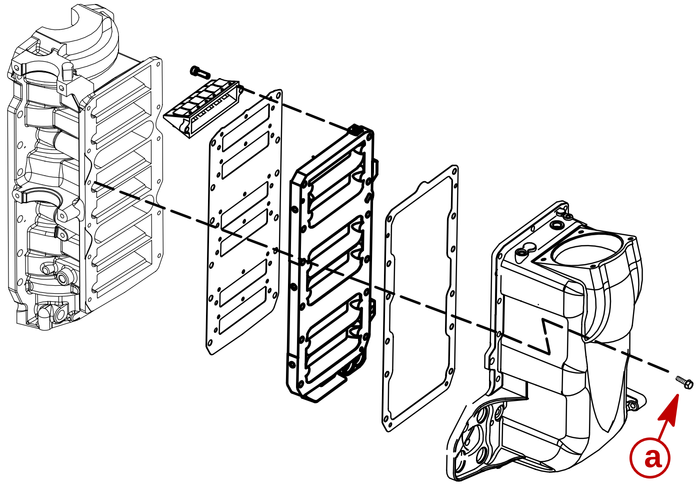


57915

- **a** - Oil Hoses
- **b** - Oil Inlet Hose
- **c** - Air Plenum
- **d** - Bolts (12 each)

Reed Block Assembly Removal

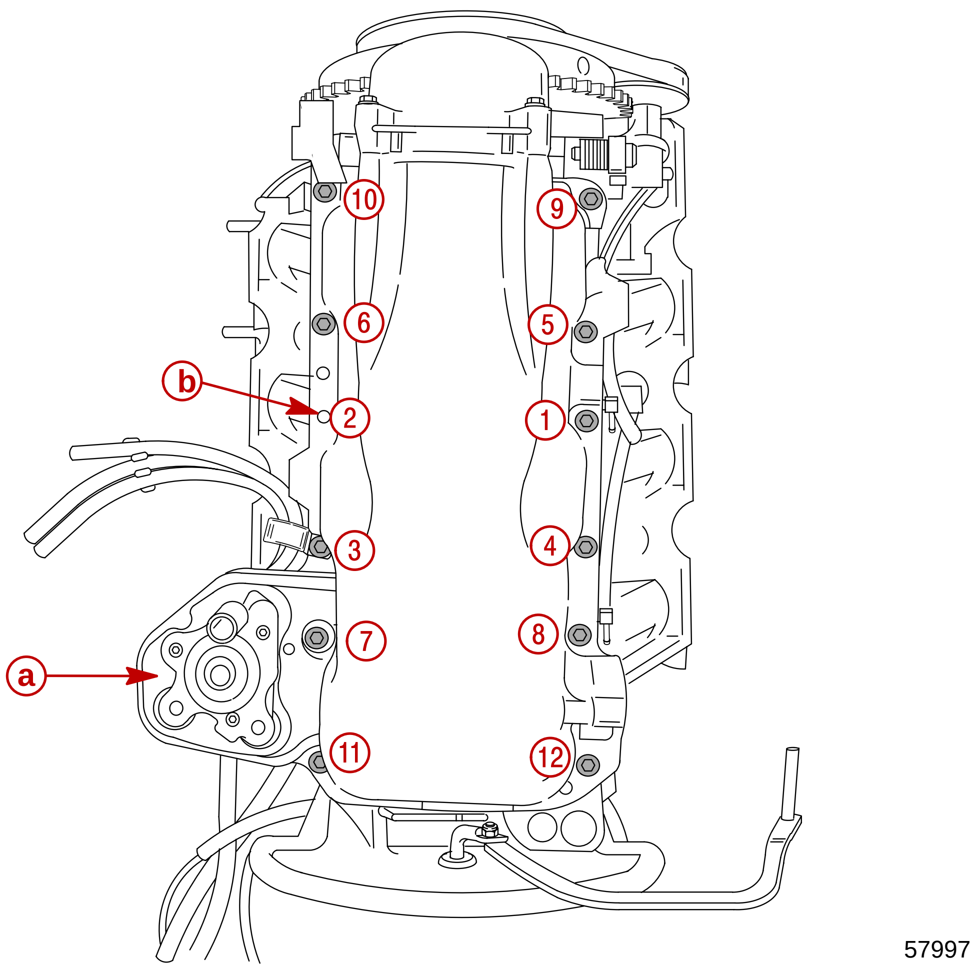
1. Remove 11 screws securing air plenum to crankcase cover.



a - Screws (11 each) (1/4x20x0.88)

Reed Block Assembly Installation

1. Secure oil pump to air plenum with 3 bolts. Torque bolts to 140 lb. in. (16 Nm).
2. Secure air plenum/reed block assembly to crankcase cover with 12 screws. Torque screws in appropriate torque sequence to 100 lb.in. (11.5 Nm).

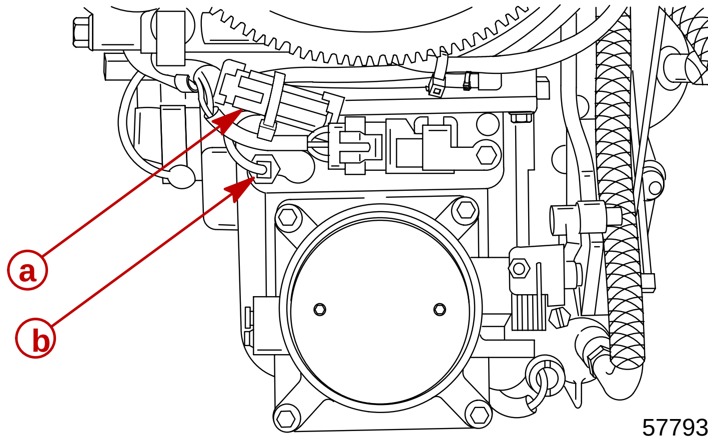


a - Oil Pump

b - This screw must be removed to secure air silencer and then reinstalled

Air Temperature Sensor Removal

Disconnect sensor harness and unscrew sensor.



a - Air Temperature Sensor Harness Connector
b - Air Temperature Sensor

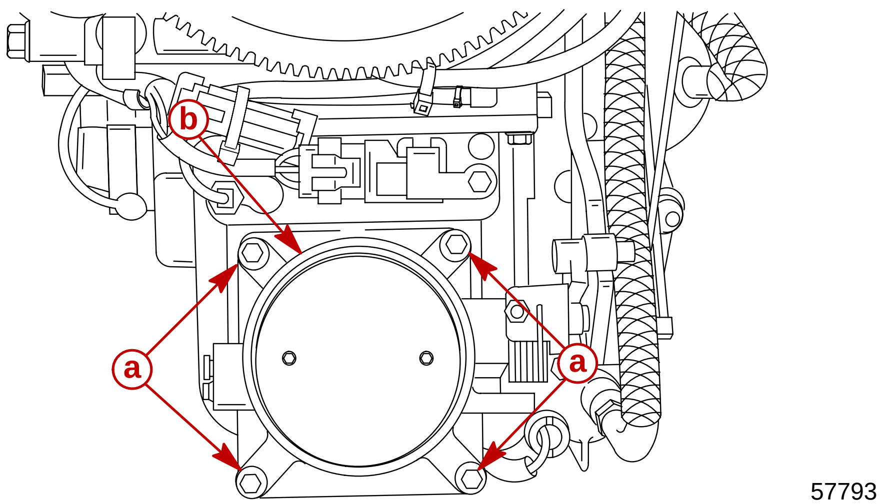
Air Temperature Sensor Installation

Screw sensor into air plenum. Reconnect sensor harness.

Throttle Plate Assembly Removal

***NOTE:** The throttle plate assembly is calibrated and preset for proper running characteristics and emissions at the factory. Other than complete assembly removal from the air plenum, no further disassembly should be made.*

Remove 4 bolts securing throttle plate assembly to air plenum and remove assembly.



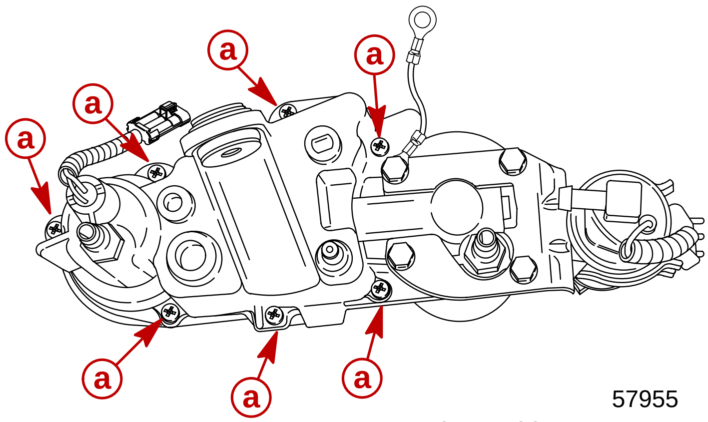
a - Bolts
b - Throttle Plate Assembly

Throttle Plate Assembly Installation

Secure throttle plate assembly to air plenum with 4 bolts. Torque bolts to 100 lb. in. (11.5 Nm).

Vapor Separator Disassembly

1. Remove 7 screws securing separator cover and remove cover.
2. Inspect seal in fuel pump chamber of separator tank for cuts and abraisions. Replace seal if necessary. If seal is serviceable, apply 2-4-C w/Teflon Marine Lubricant (92-825407A12) to seal lips.



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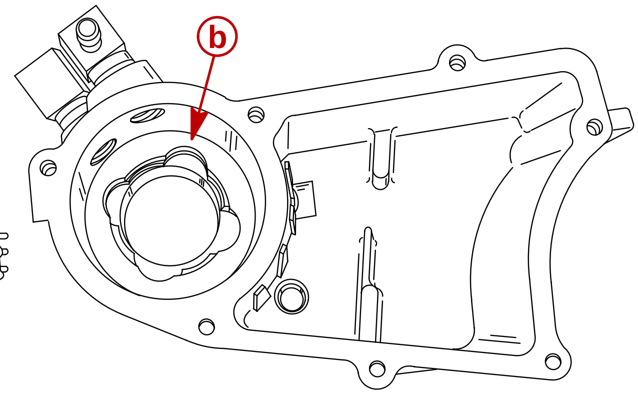


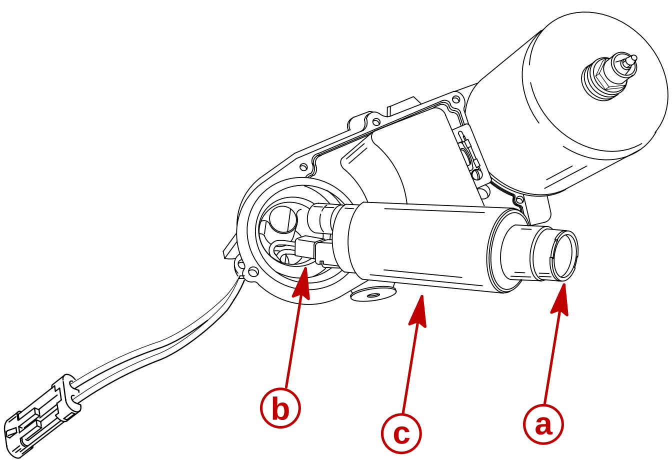
57342

a - Screws (7 each)
b - Seal

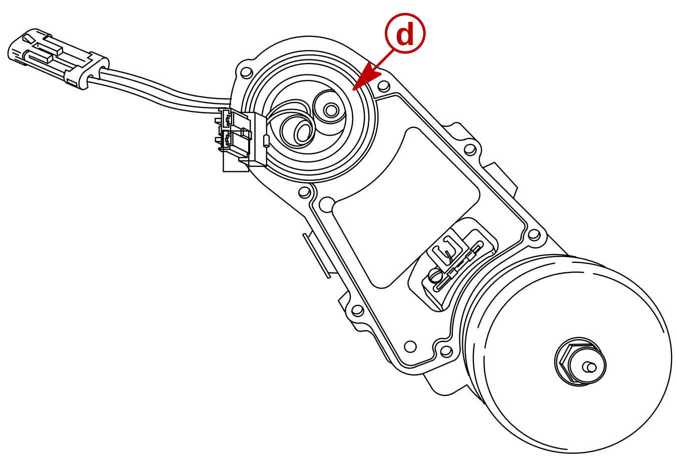
3. Fuel pump may be removed from cover by wiggling slightly while pulling outward.

IMPORTANT: DO NOT twist pump during removal as wire harness may be damaged.

4. Disconnect harness from pump to separate pump from cover. Inspect filter screen for debris. Screen may be pried out of pump and cleaned as required.
5. Inspect seal above fuel pump for cuts or abraisions. Replace seal if necessary. Apply 2-4-C w/Teflon to seal lips.



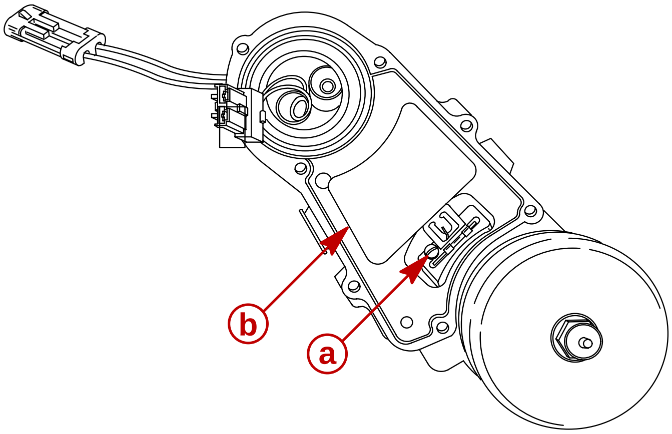
56057



56058

a - Filter Screen
b - Harness Connector
c - Pump
d - Seal (Seal shoulder faces OUT)

6. Loosen screw securing float assembly and remove float. Inspect float for deterioration or fuel retention. Replace float as required.
7. Remove phenolic sealing plate and inspect imbedded neoprene seal on both sides of plate for cuts or abraisions. Replace plate/seal assembly as required.



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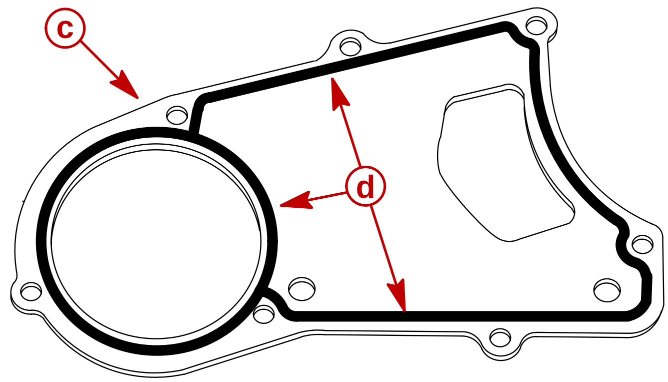
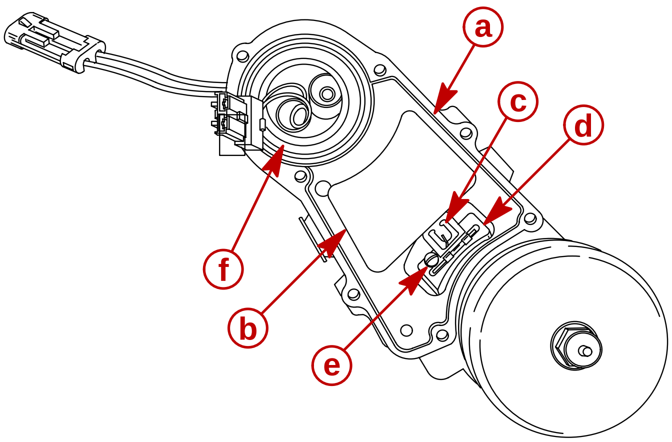


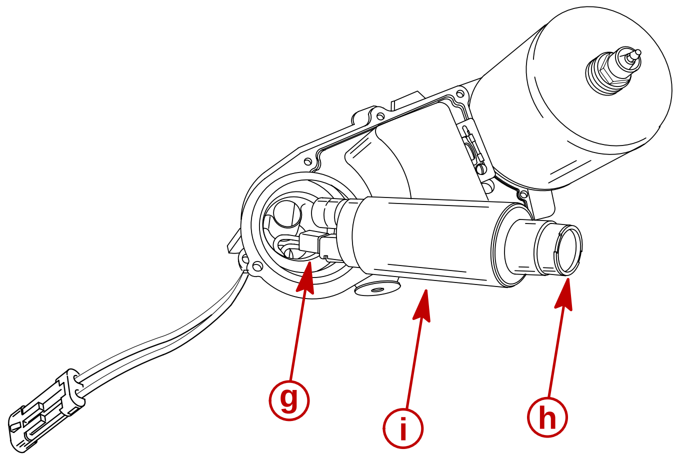
56059

a - Screw
b - Float
c - Plate
d - Seal

Vapor Separator Reassembly

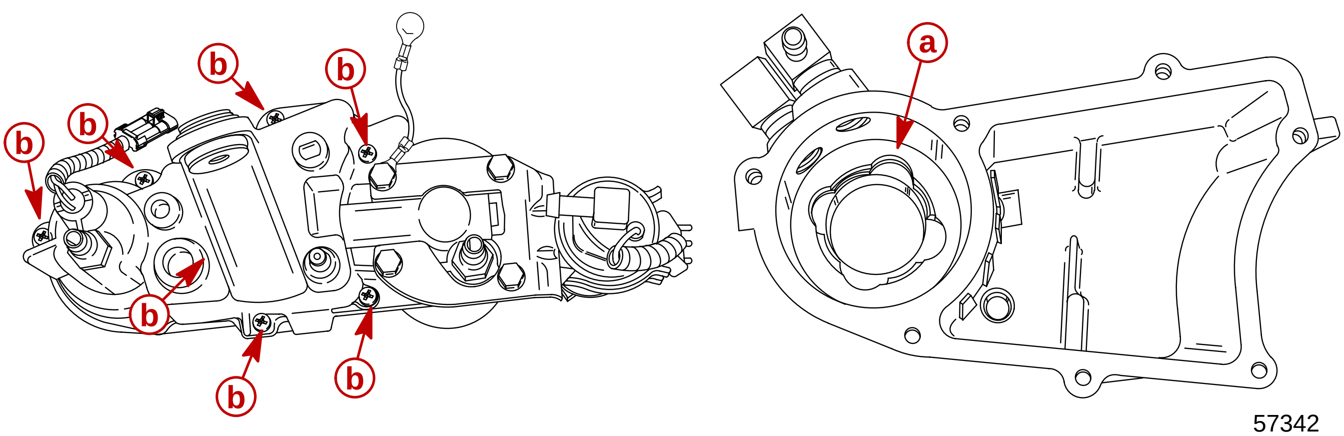
1. Reinstall phenolic sealing plate onto vapor separator cover.
2. Secure float, needle and pivot pin assembly to separator cover with screw. Torque screw to 10 lb. in. (1.0 Nm).
3. Apply 2-4-C w/Teflon to lips of seal in separator cover.
4. Connect electrical harness to fuel pump. Inspect fuel pump filter screen for debris. Remove screen and clean as required.
5. Seat fuel pump and harness into separator cover being careful not to pinch harness.





a - Sealing Plate
b - Float
c - Needle
d - Pivot Pin
e - Screw [Torque to 10 lb. in. (1.0 N·m)
f - Seal (Seal shoulder faces OUT)
g - Harness
h - Filter
i - Fuel Pump

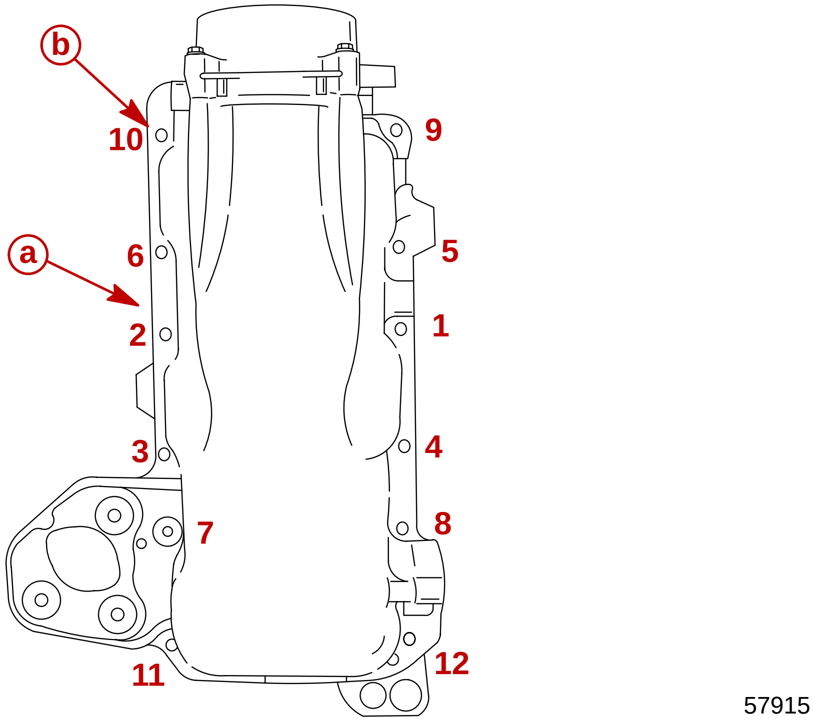
6. Apply 2-4-C w/Teflon to lips of seal in separator tank.
7. Install separator cover with pump onto separator tank.
8. Secure cover to tank with 7 screws. Torque screws to 30 lb. in. (3.5 Nm).



a - Seal
b - Screws [Torque to 30 lb. in. (3.5 Nm)]

Air Plenum Installation

Secure plenum to crankcase with 12 bolts. Torque bolts to 100 lb. in. (11.5 Nm). in sequence shown.

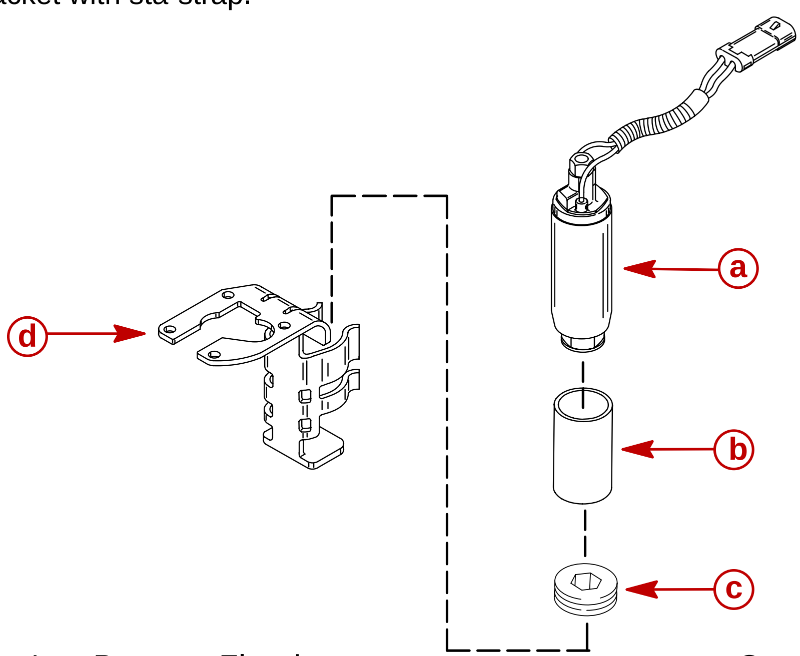


a - Air Plenum
b - Bolts [Torque to 100 lb. in. (11.5 Nm)]

Low Pressure Electric Fuel Pump Installation

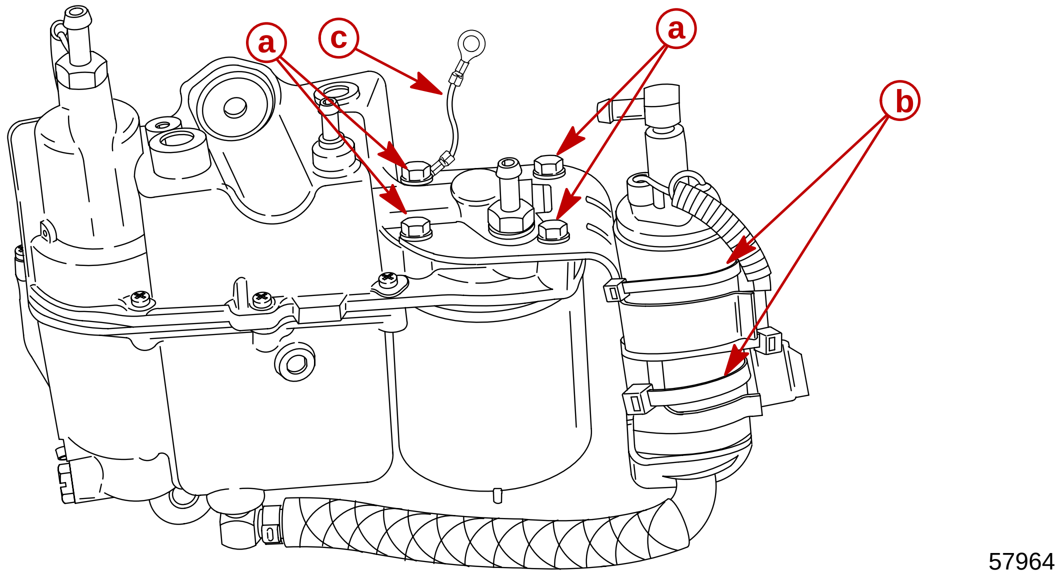
***NOTE:** If pump does not have a sleeve or grommet, refer to Service Bulletin 98-8.*

1. Seat electric fuel pump w/sleeve against grommet in pump bracket. Secure pump to bracket with sta-strap.



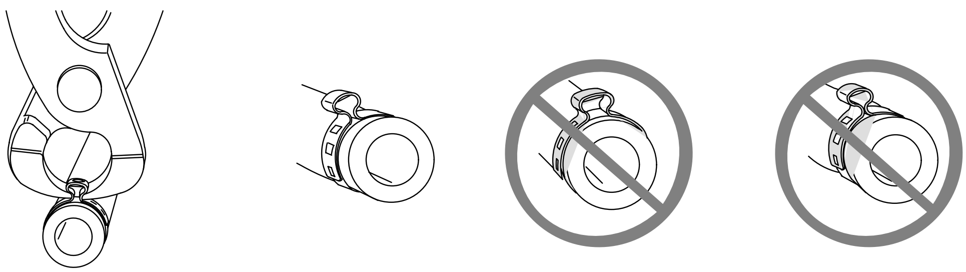
a - Low Pressure Electric Fuel Pump
b - Sleeve
c - Grommet
d - Bracket

2. Secure bracket assembly to vapor separator with 4 screws. Torque screws to 100 lb. in. (11.5 Nm).

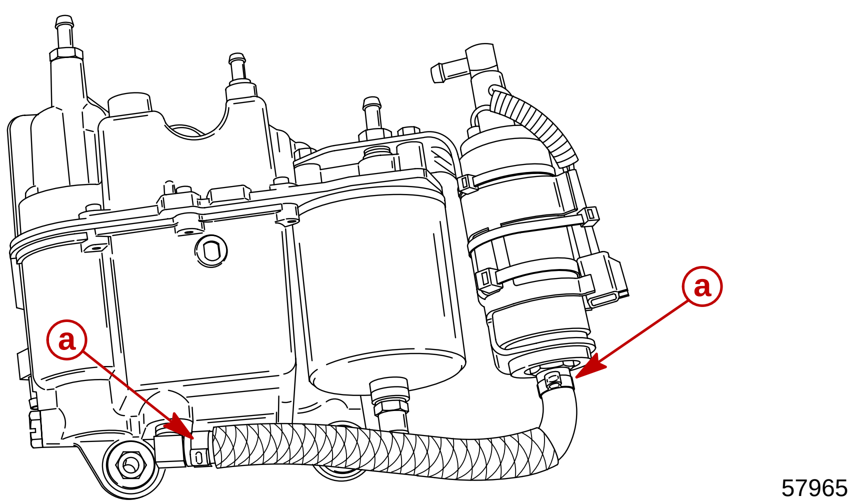


a - Screws – Torque to 100 lb. in. (11.5 Nm)
b - Sta-strap securing pump to bracket
c - Ground lead – attach to air plenum

IMPORTANT: Only use tool 91-803146T (or Snap-On equivalent YA3080) to crimp full circle clamps. Using a different tool could result in a crimp that is too loose, or too tight. Do not use screw type metal hose clamp as it may damage hose.

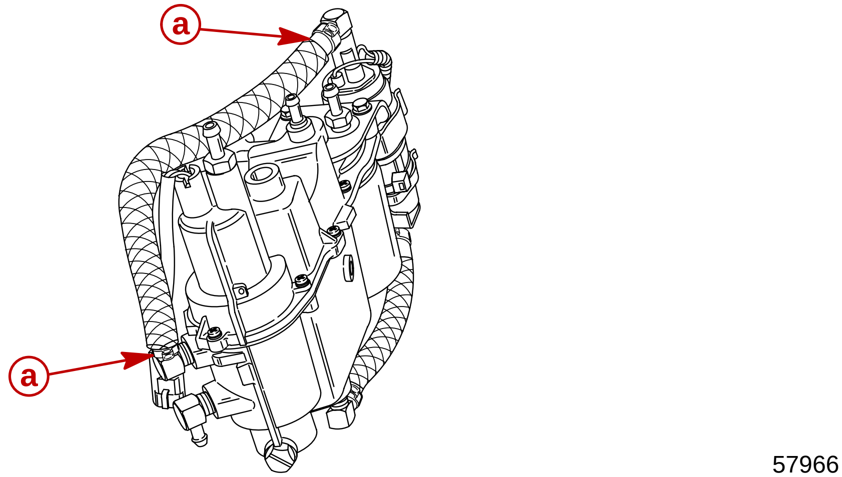


3. Connect fuel hose from bottom of low pressure fuel pump to 90° elbow in bottom of vapor separator. Secure hose with 16.2 mm full circle clamp (54-855697) using crimping tool 91-803146T.



a - Secure Fuel Hose with 16.2 mm Full Circle Clamp (54-855697)

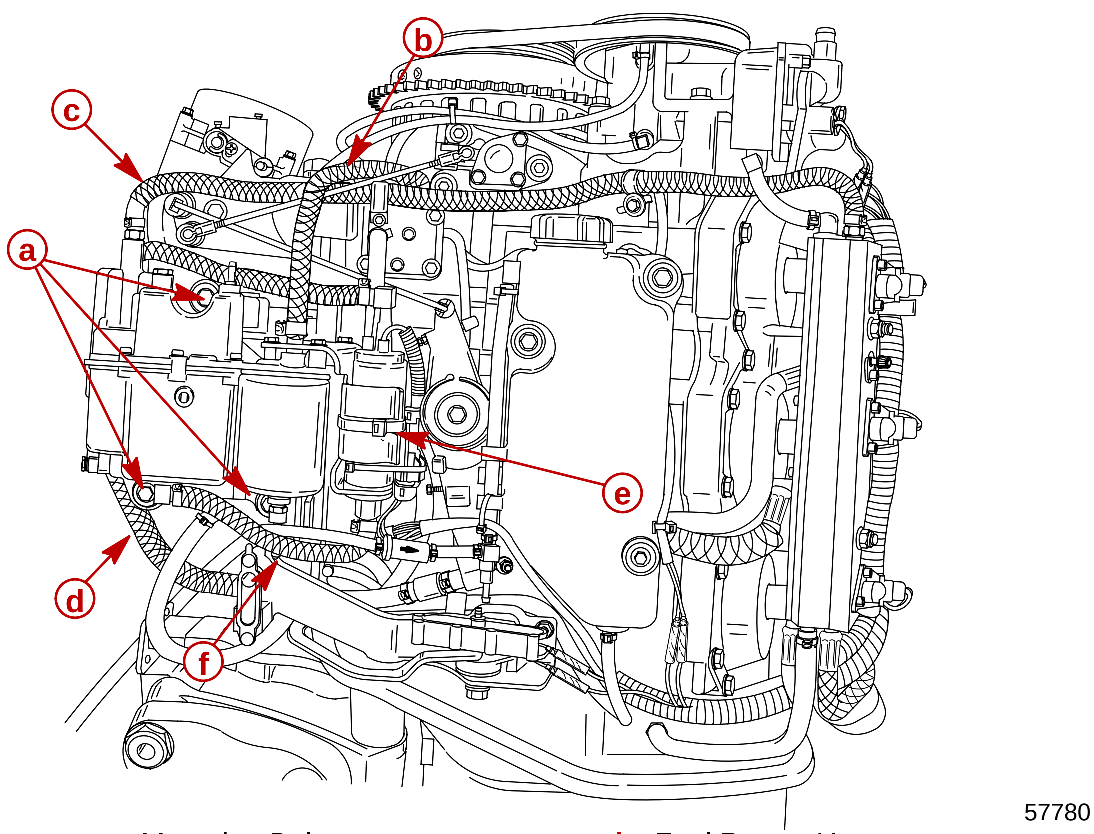
4. Connect fuel hose from top of low pressure fuel pump to 90° elbow on back side of vapor separator. Secure hose with 15.3 mm full circle clamp (54-856880) using crimping tool 91-803146T.



a - Secure Fuel Hose with 15.3 mm Full Circle Clamp (54-856880)

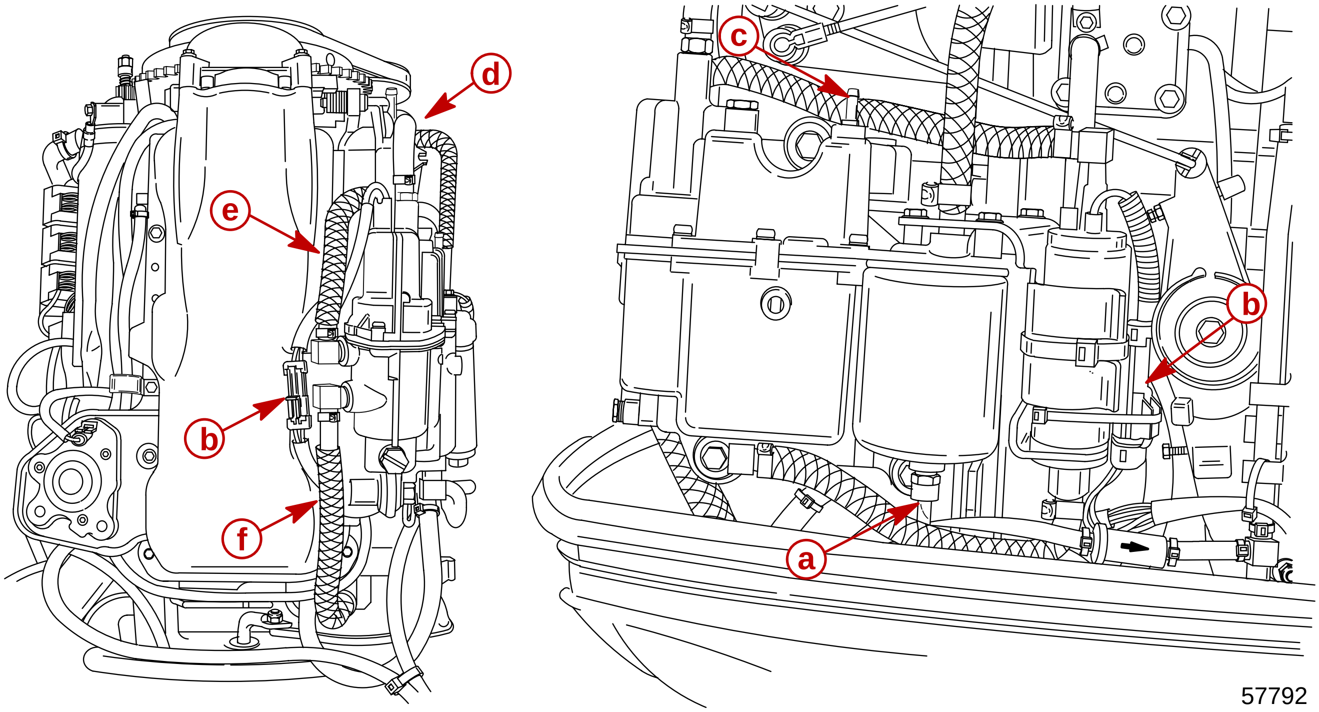
Vapor Separator Installation

1. Secure vapor separator to air plenum with 3 bolts. Torque bolts to 140 lb. in. (16.0 Nm).
2. Connect fuel inlet hose from pulse pump.
3. Connect fuel outlet hose and fuel return hose to vapor separator.



a - Mounting Bolts [Torque to 140 lb. in. (16.0 Nm)]
b - Fuel Inlet Hose
c - Fuel Outlet Hose
d - Fuel Return Hose
e - Low Pressure Electric Fuel Pump (6 - 9 psi)
f - Inlet Fuel Hose to Low Pressure Pump

4. Connect water separator sensor lead to water separator.
5. Connect electric fuel pump harnesses.
6. Connect vent hose from air plenum to vapor separator.



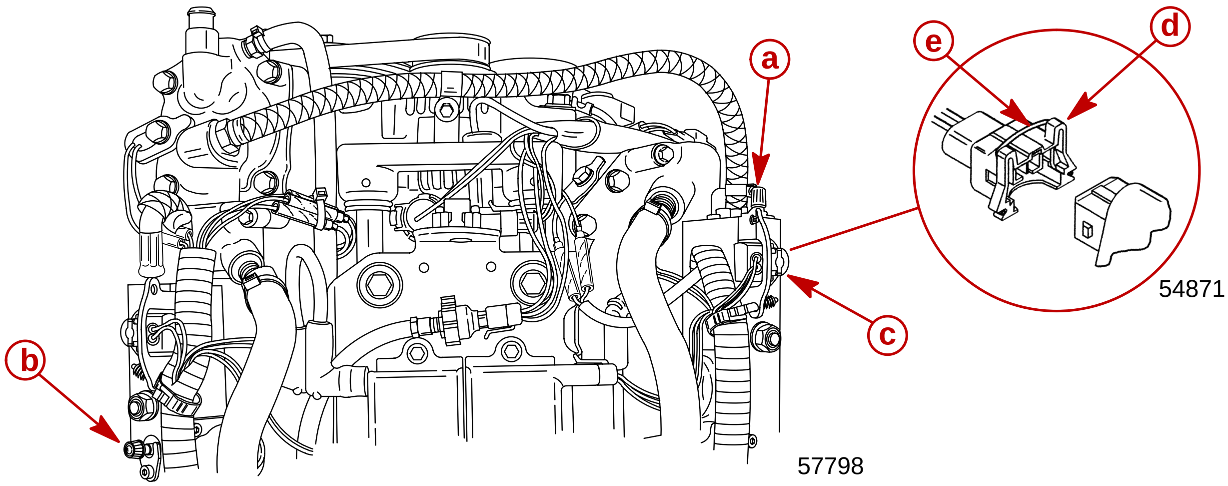
a - Sensor Lead
b - Electric Fuel Pump Harness Connectors
c - Vapor Separator Vent Hose Fitting
d - High Pressure (90 psi) Fuel Outlet Hose
e - Fuel Inlet Hose from Low Pressure Pump (6 - 9 psi)
f - Excess Fuel Return Hose from Fuel Rails

Fuel Rail Removal

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

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

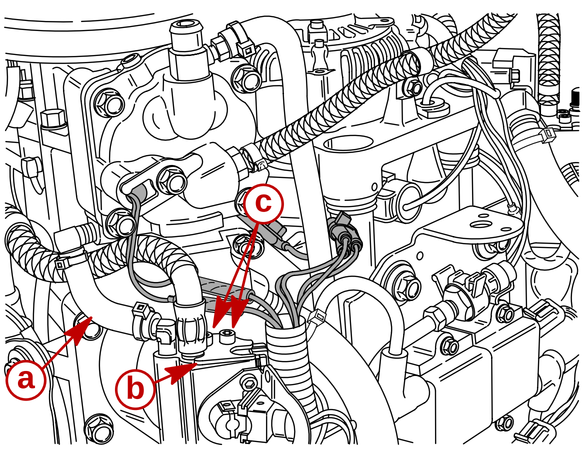
1. De-pressurize fuel system.
2. Remove fuel injector harness from each injector by compressing spring clip with flat tip screw driver while pulling on connector.

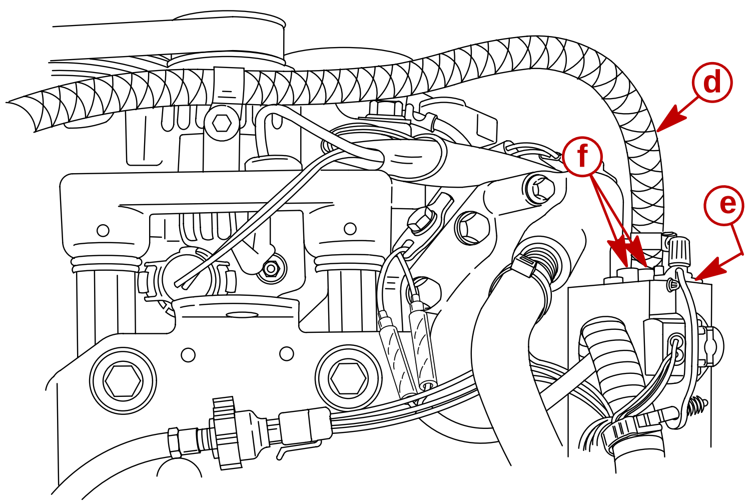


a - Fuel Pressure Port
b - Air Pressure Port
c - Fuel Injector
d - Harness Connector
e - Spring Clip

***NOTE:** Always remove fuel/air hose and fitting together by removing fitting retainer rather cutting clamps.*

3. Remove fuel, water and air hoses from fuel rail.



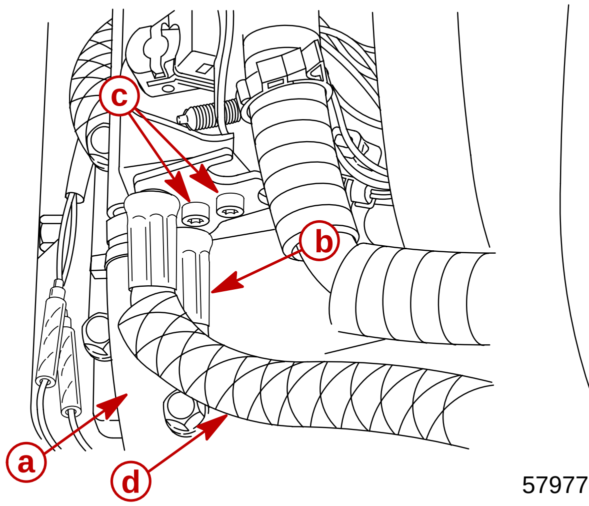


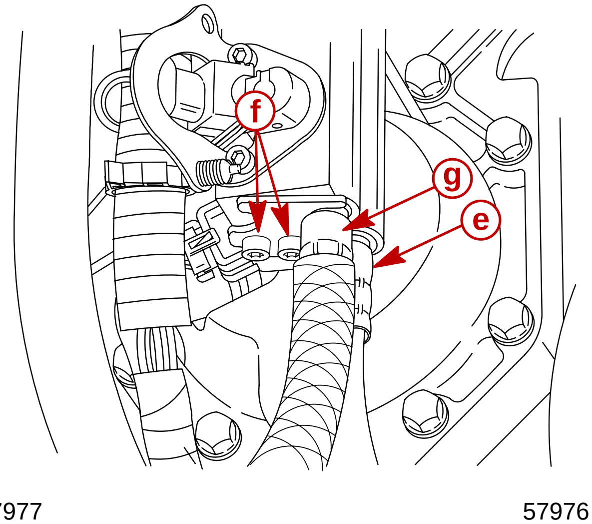
Port Top Fuel Rail Connections

a - Water Inlet Hose to Compressor
b - Retainer
c - Allen Screws (remove)

Starboard Top Fuel Rail Connections

d - Air Hose
e - Retainer
f - Allen Screws





Port Bottom Fuel Rail Connections

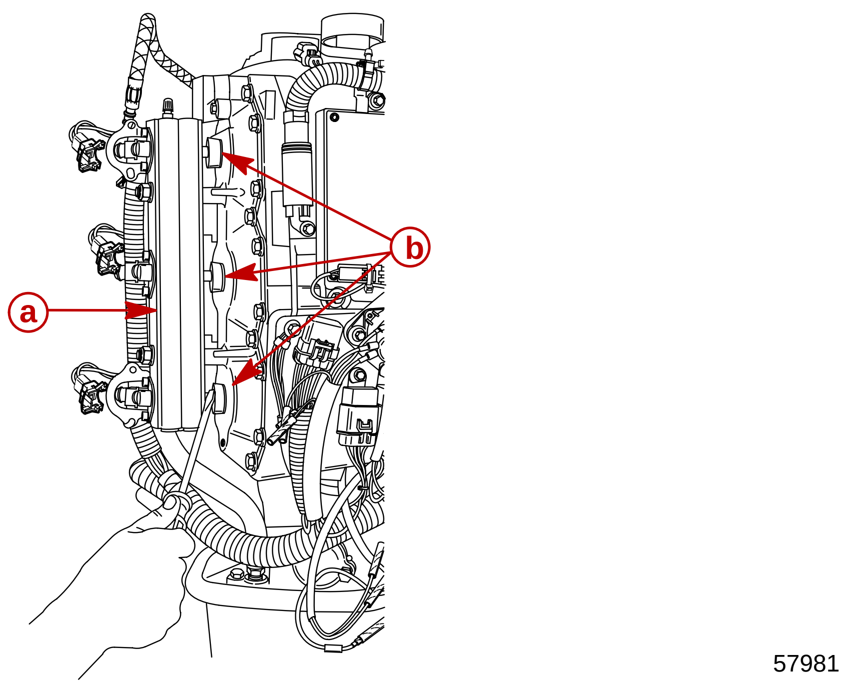
a - Water Inlet Hose to Fuel Rail
b - Air Hose
c - Allen Screws (remove)
d - Fuel Hose

Starboard Bottom Fuel Rail Connections

e - Air Hose
f - Allen Screws
g - Fuel Hose

***NOTE:** It is recommended that direct injectors remain in the cylinder head (if they are not to be replaced) while removing the fuel rail. The direct injectors have a teflon seal which may expand if the injector is removed from the head. This expansion may cause reinstallation difficulty or require the replacement of the seal.*

4. Remove 2 nuts securing fuel rail.
5. As fuel rail is removed, use a flat tip screw driver to hold direct injectors in cylinder head.

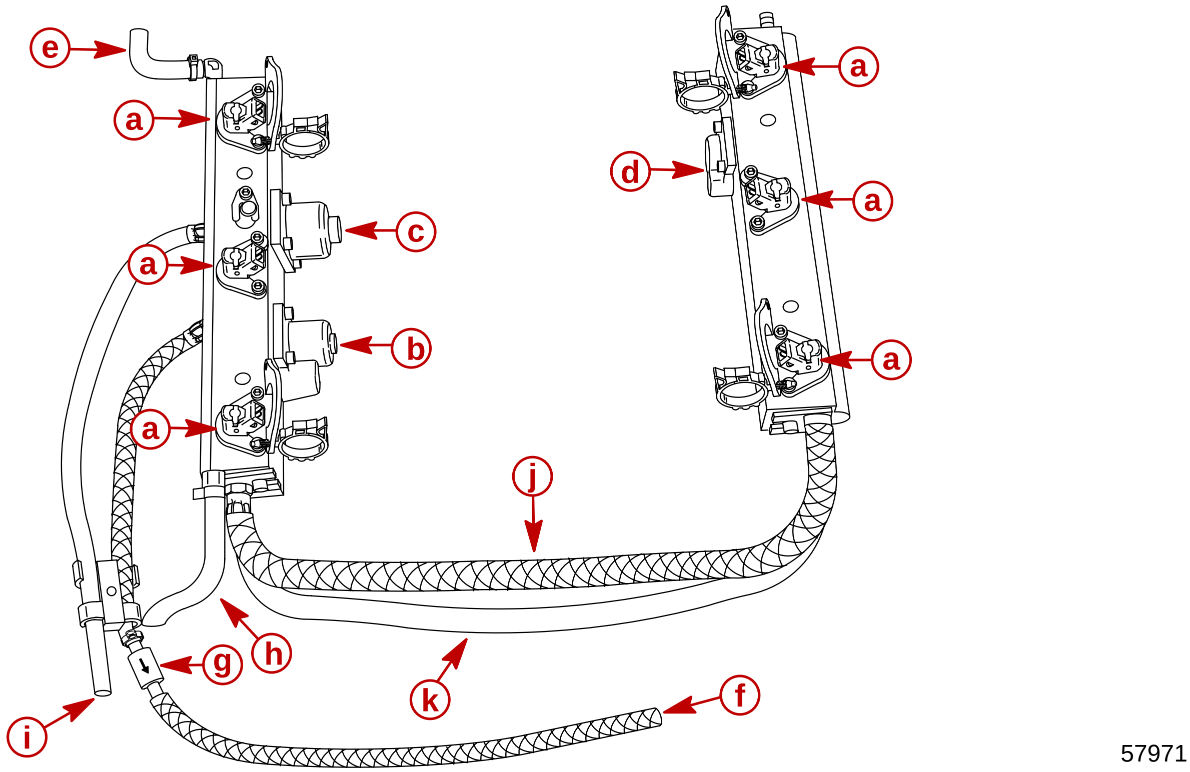


a - Fuel Rail
b - Direct Injectors

The starboard fuel rail contains 3 fuel injectors and a tracker valve.

The port fuel rail contains 3 fuel injectors, 1 fuel fuel regulator, and 1 air regulator.

***NOTE:** Each fuel/air inlet or outlet hose adaptor has 2 o-ring seals. These o-rings should be inspected for cuts or abraisions and replaced as required when fuel rail is disassembled for cleaning.*



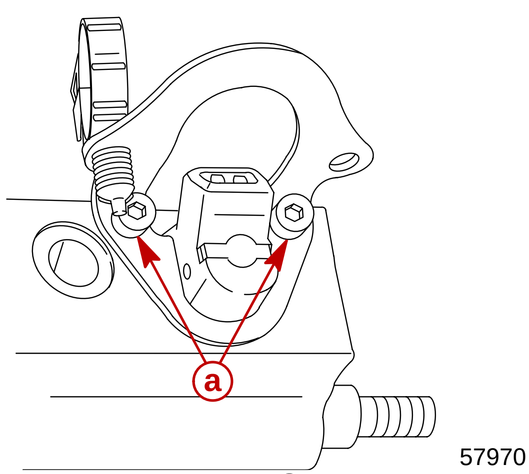
a - Fuel Injector
b - Fuel Regulator
c - Air Regulator
d - Tracker Valve
e - Coolant Inlet to Air Compressor
f - Excess Fuel Return to VST
g - 40 psi Check Valve
h - Water Inlet for Cooling Fuel Rail
i - Excess Air to Air Plenum
j - 90 psi (616 kPa) Fuel
k - 80 psi (547.8 kPa) Air

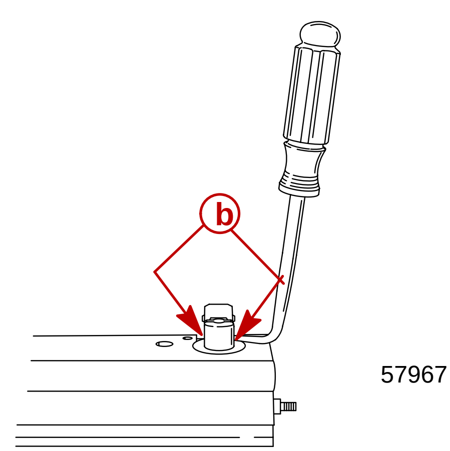
FUEL INJECTOR REMOVAL

1. Remove 2 screws securing injector.

***NOTE:** Use a cotter pin extractor tool in pry holes to remove injectors.*

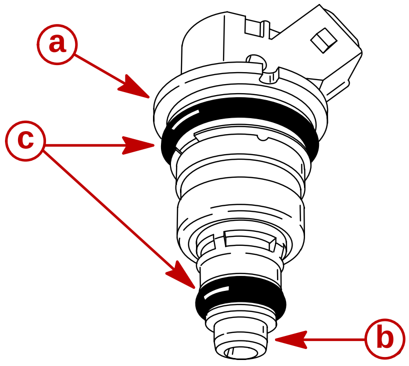
2. Gently pry up on injector to loosen o-ring adhesion and remove injector.



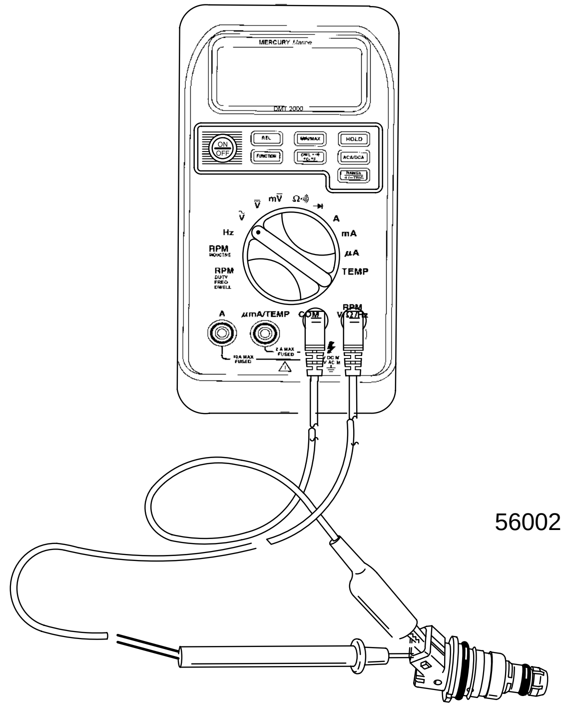


a - Screws
b - Pry Holes

3. Inspect fuel injector orifices for foreign debris; o-rings for cuts or abraisions and plastic components for heat damage. Replace components as required.
4. An ohm test of the fuel injector may be made by connecting test leads to injector terminals. Ohm reading should be 1.8 ± 0.1 ohm.



56124



56002

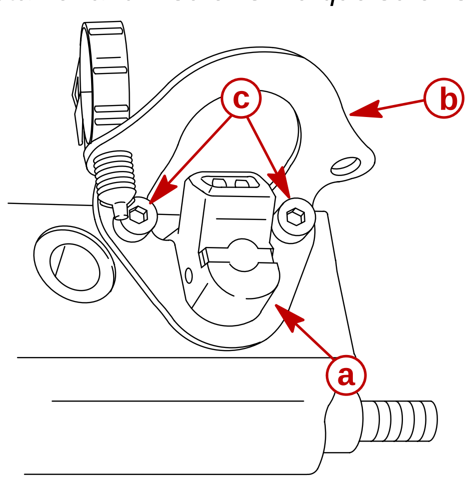
a - Fuel Injector
b - Fuel Nozzle
c - O-Rings

FUEL INJECTOR INSTALLATION

***NOTE:** Apply anti-seize grease (obtain locally) or 2-4-C w/Teflon to fuel injector attaching screw threads.*

1. Insert fuel injector into fuel rail with connector pins facing (inwards) towards center of engine.

***NOTE:** Turn injector back-and-forth slightly to seat injector o-rings in fuel rail while securing injector with retainer and 2 screws. Torque screws to 70 lb. in. (8.0 Nm).*

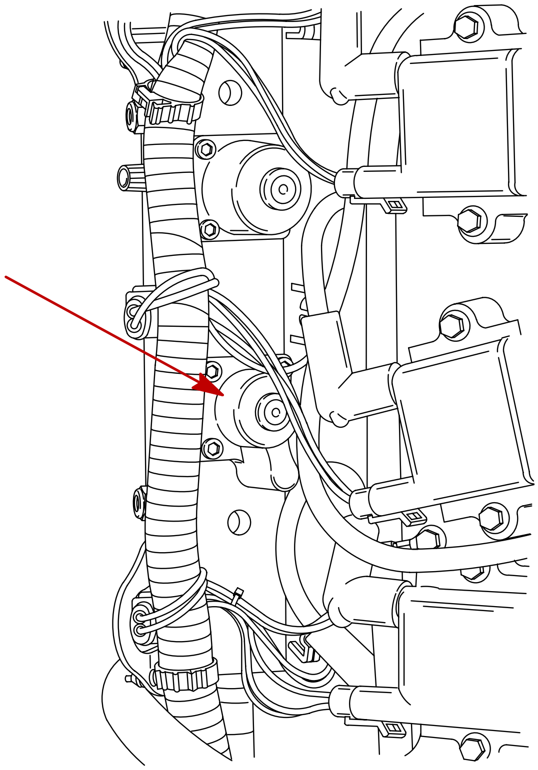


57970

a - Injector
b - Retainer
c - Screws [Torque to 70 lb. in. (8.0 Nm)]

Fuel Pressure Regulator

The fuel regulator is located on the port fuel rail.



57980

The fuel pump is capable of delivering more fuel than the engine can consume. Excess fuel flows through the fuel pressure regulator, interconnecting passages/hoses, fuel cooler, and back to the vapor separator tank. This constant flow of fuel means that the fuel system is always supplied with cool fuel, thereby preventing the formation of fuel vapor bubbles and minimizing the chances of vapor lock.

The fuel pressure regulator is calibrated to raise the fuel pressure to 10 psi above the air pressure.

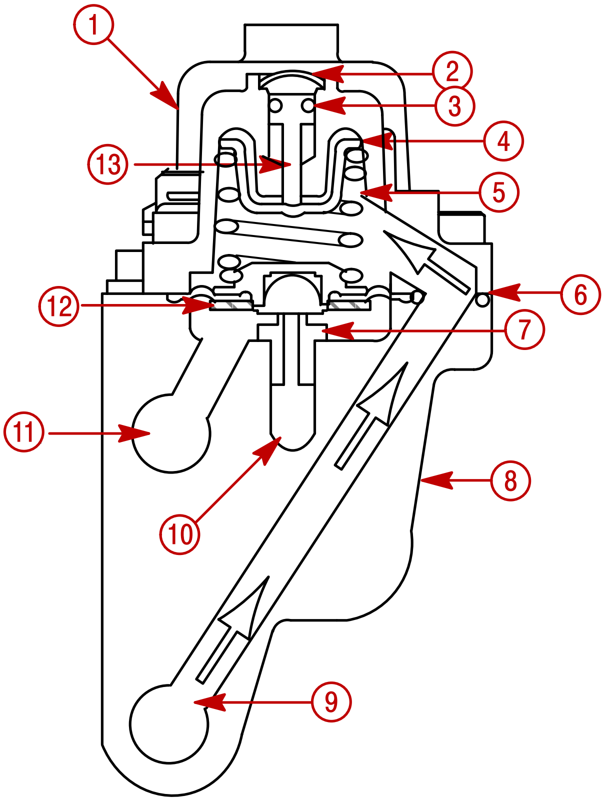
The fuel regulator is mounted on the port fuel rail, near the bottom. This regulator relies on both air and spring pressure to control the fuel pressure. Inside the regulator assembly is a 10 lb. spring, this spring holds the diaphragm against the diaphragm seat. The contact between the diaphragm and diaphragm seat closes the passage between the incoming fuel (from the electric fuel pump) and the fuel return passage.

When the engine is not running (no air pressure on the spring side of the diaphragm) the fuel pressure required to move the diaphragm is 10 psi.

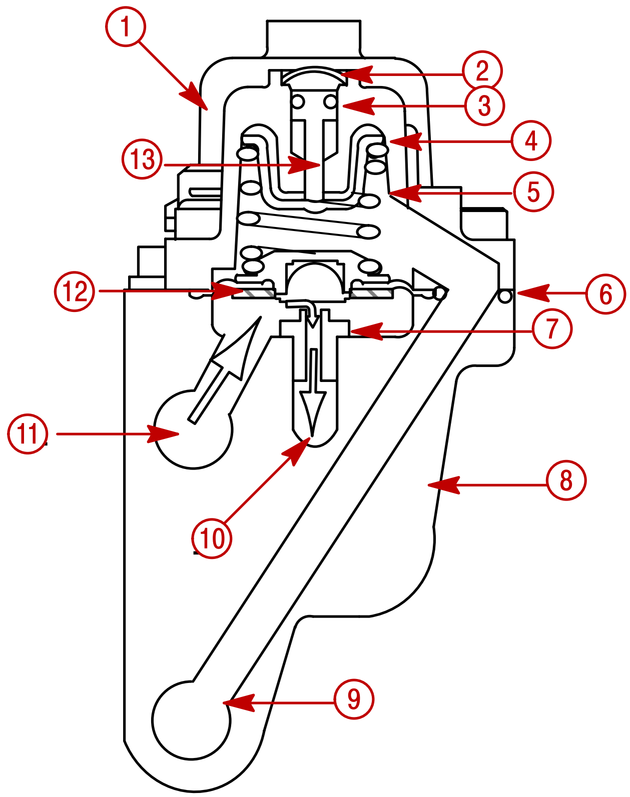
When the engine is running, air pressure from the air compressor (80 psi) is routed through the air passages, to the spring side of the fuel pressure regulator diaphragm.

The air pressure (80 psi) and spring pressure (10 psi) combine to regulate system fuel pressure to 90 psi - or 10 psi higher than the air pressure in the DFI system fuel/air rails.

Regulator Closed



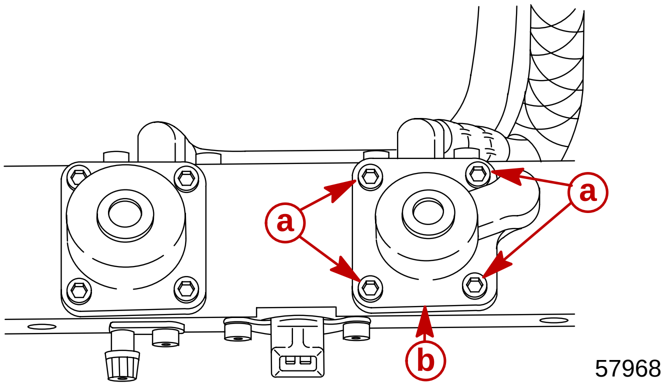
Regulator Open

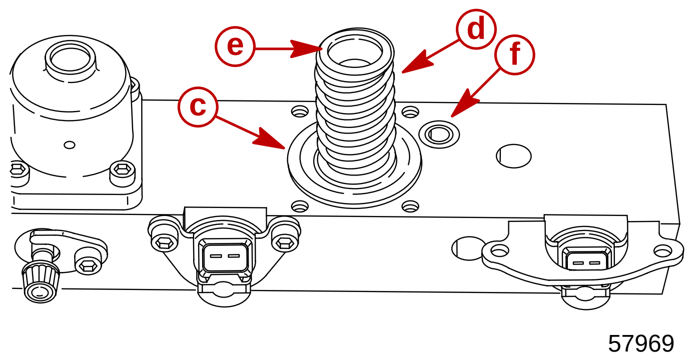


1 - Top Cover
2 - Expansion Plug
3 - O-ring
4 - Spring Retainer
5 - Spring
6 - O-ring
7 - Diaphragm Seat
8 - Air Rail
9 - Air Passage (from Air Compressor)
10 - Fuel Return Passage (to Vapor Separator)
11 - Fuel Inlet Passage (from Electric Fuel Pump)
12 - Diaphragm Assembly
13 - Calibration Screw (Do Not Turn)

FUEL REGULATOR REMOVAL

1. Remove 4 screws securing regulator and remove regulator.
2. Inspect regulator diaphragm for cuts or tears.
3. Inspect regulator housing o-ring for cuts and abraisions. Replace components as required.





a - Screws
b - Fuel Regulator
c - Diaphragm
d - Spring
e - Cup
f - O-Ring

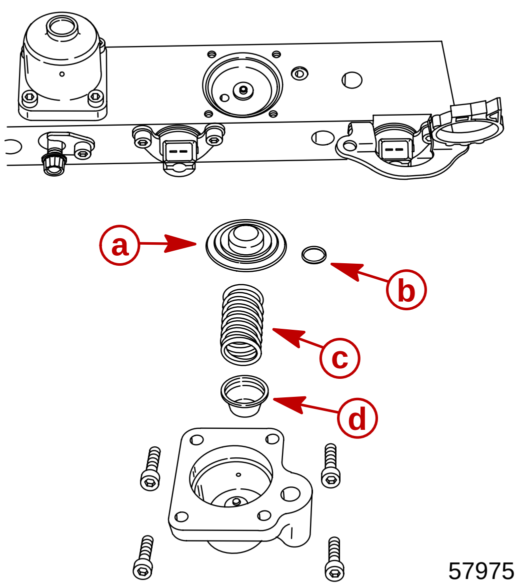
FUEL REGULATOR INSTALLATION

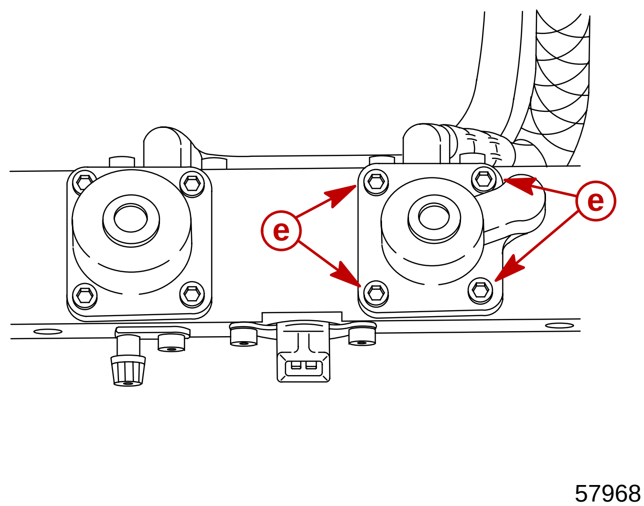
***NOTE:** Apply a light coat of 2-4-C w/Teflon to diaphragm surface and o-ring to aid in the retention of diaphragm and o-ring on fuel rail during reassembly.*

1. Position diaphragm on fuel rail.
2. Position o-ring on fuel rail.
3. Position spring and cup onto diaphragm.

***NOTE:** Apply anti-seize grease (obtain locally) or 2-4-C w/Teflon to regulator attaching screw threads.*

4. Place cover over spring/cup/diaphragm assembly and secure with 4 screws. Torque screws to 70 lb. in. (8.0 Nm).

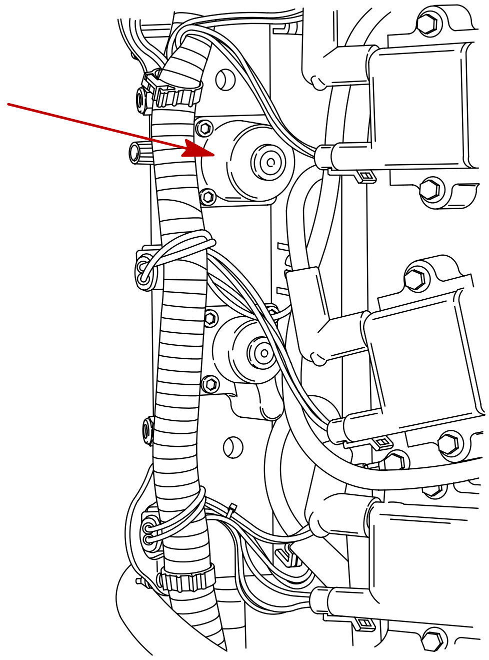




a - Diaphragm
b - O-Ring
c - Spring
d - Cup
e - Screws [Torque to 70 lb. in. (8.0 Nm)]

Air Pressure Regulator

The air pressure regulator is located on the port fuel rail.



57980

The air pressure regulator is designed to limit the air pressure inside the rails to approximately 80 psi.

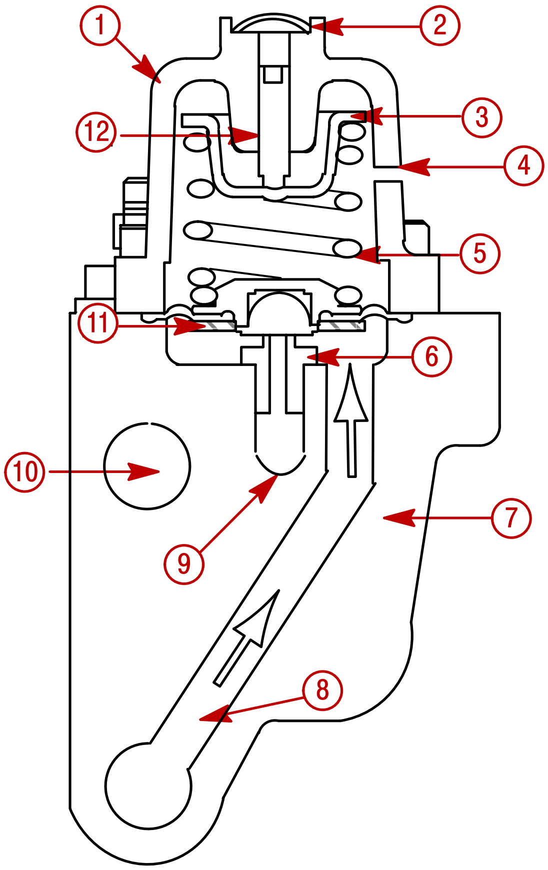
The air regulator uses a spring (pressure) to control the air pressure. This spring (80 psi) holds the diaphragm against the diaphragm seat. The contact area blocks (closes) the air inlet passage from the excess air, return passage. As the air pressure rises (below the diaphragm), it must reach a pressure equal to or greater than the spring pressure holding the diaphragm closed. Once this pressure is achieved, the spring compresses, allowing the diaphragm to move. The diaphragm moves away from the diaphragm seat, allowing air to exit through the diaphragm seat, into the excess air passage leading to the air plenum.

Air Regulator Troubleshooting

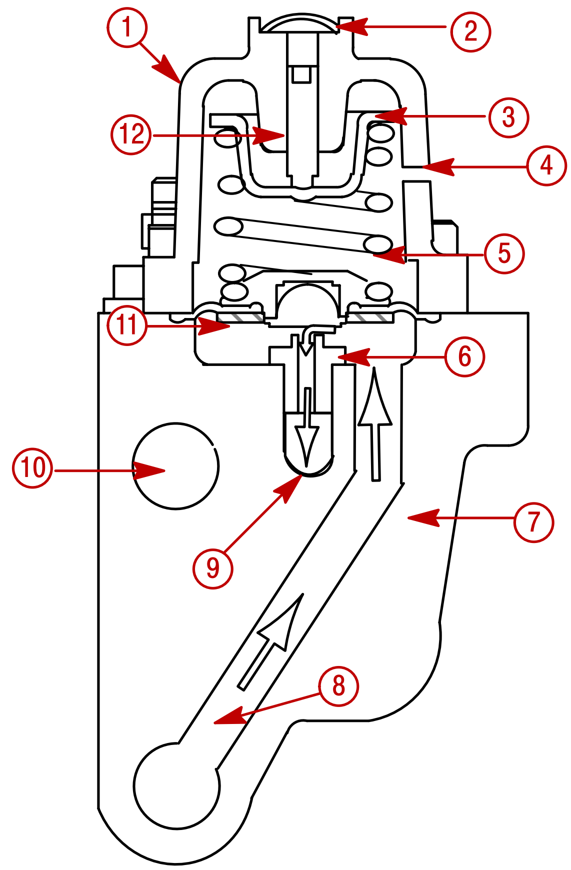
Air pressure should be measured at the air schrader valve located near the middle of the port fuel rail assembly.

- Is air pressure within 78 to 82 psi range at neutral idle psoition?
  - Yes
    - Air regulator is OK
  - No
    - Less than 78 psi?
      - Remove air regulator and clamp. Inspect air regulator o-ring.
        - Air regulator o-ring OK and air pressure is less than 78 psi?
          - Air exiting air bypass?
            - Yes?
              - Failed air regulator.
            - No?
              - Obstruction at compressor inlet or outlet or failed compressor
    - Greater than 82 psi?
      - Remove air bypass hose from exhaust adaptor and measure air pressure at neutral idle condition.
        - Air pressure normal – 78 to 82 psi?
          - Plugged bypass circuit in adaptor plate.
        - Air pressure greater than 82 psi?
          - Failed air regulator.

Regulator Closed



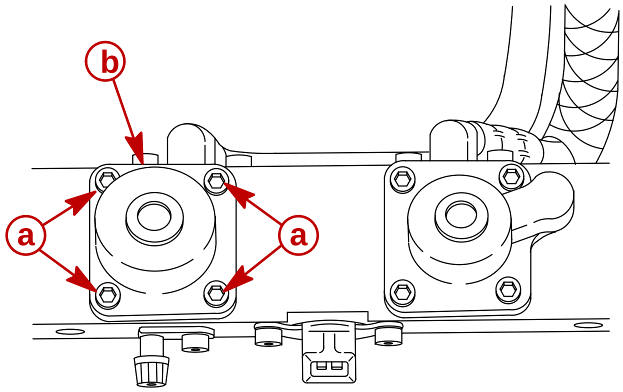
Regulator Open



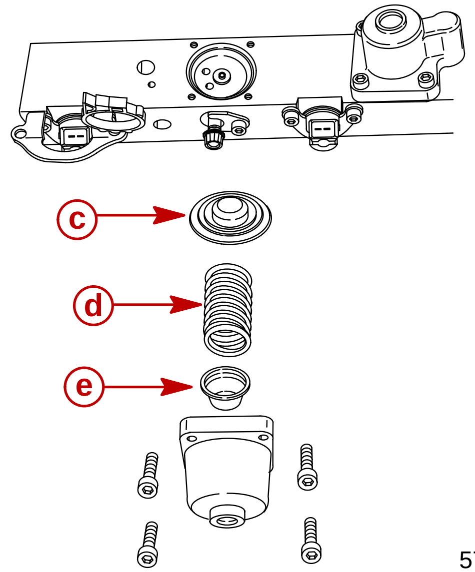
1 - Top Cover
2 - Expansion Plug
3 - Spring Retainer
4 - Vent
5 - Spring
6 - Diaphragm Seat
7 - Air Rail
8 - Air Passage (from Air Compressor)
9 - Excess Air Passage (to Exhaust Adaptor)
10 - Fuel Inlet Passage (from Electric Fuel Pump)
11 - Diaphragm Assembly
12 - Calibration Screw (Do Not Turn)

MODEL YEAR 2000 AIR REGULATOR REMOVAL

1. Remove 4 screws securing regulator and remove regulator.
2. Inspect regulator diaphragm for cuts or tears. Replace as required.



57968



57974

a - Screws
b - Air Regulator
c - Diaphragm
d - Spring
e - Cup

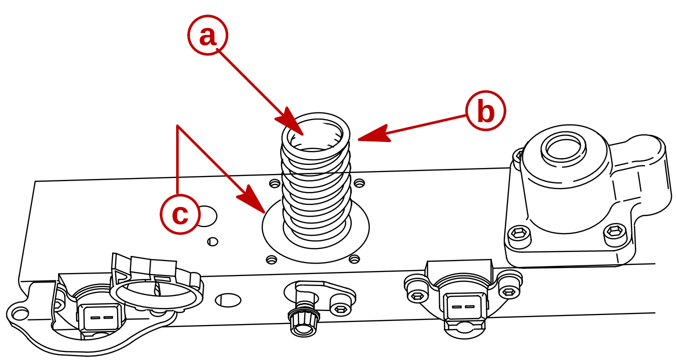
MODEL YEAR 2000 AIR REGULATOR INSTALLATION

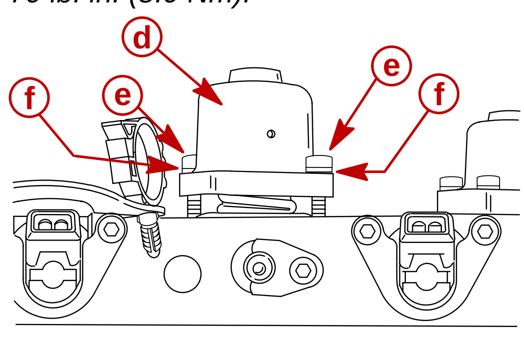
***NOTE:** Apply a light coat of 2-4-C w/Teflon to diaphragm surface to aid in the retention of diaphragm on fuel rail during reassembly.*

1. Position diaphragm, spring and cup onto fuel rail with fuel rail in horizontal position.

***NOTE:** Apply anti-seize grease (obtain locally) or 2-4-C w/Teflon to regulator attaching screw threads.*

***NOTE:** Due to the stiffness of the regulator spring, it is recommended that 2 longer screws (5mm x 25mm long) (10-40073 25) and 2 flat washers (12-30164) be installed through cover first to begin compression. This will allow 2 shorter screws (5mm x 15mm long) to be installed. Remove 2 long screws w/flat washers and install remaining 2 short screws (5mm x 15mm). Torque screws to 70 lb. in. (8.0 Nm).*





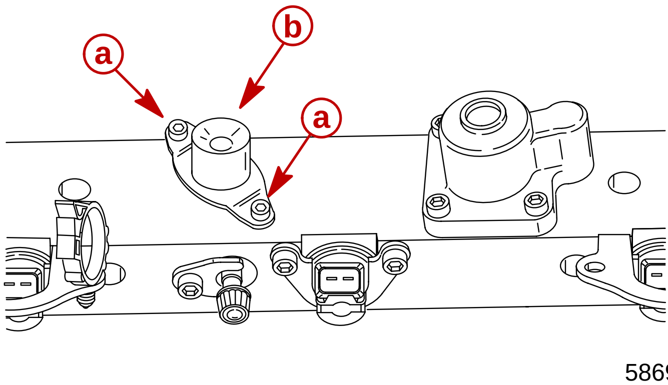
57973

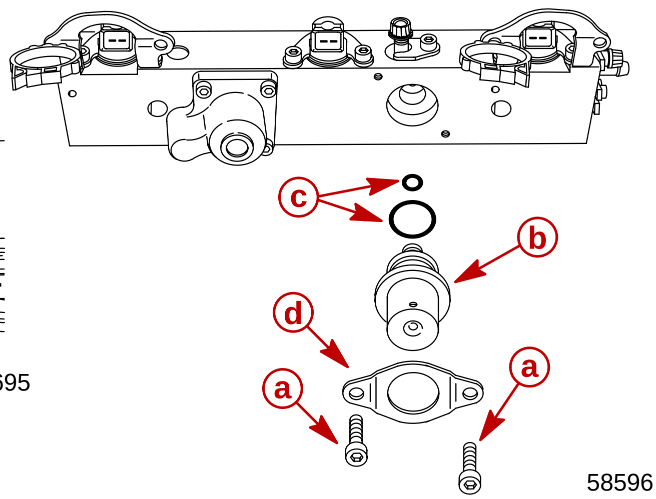
a - Cup
b - Spring
c - Diaphragm
d - Cover
e - Screws (5mm x 25mm) (10-40073 25)
f - Flat Washers (12-30164)

MODEL YEAR 2001 AIR REGULATOR REMOVAL

1. Remove 2 screws securing regulator and remove regulator.
2. Inspect regulator o-rings for cuts and abrasions. Replace as required.

***NOTE:** *Air regulator is not serviceable. If regulator doesn't maintain approximately 80 psi replace it.*





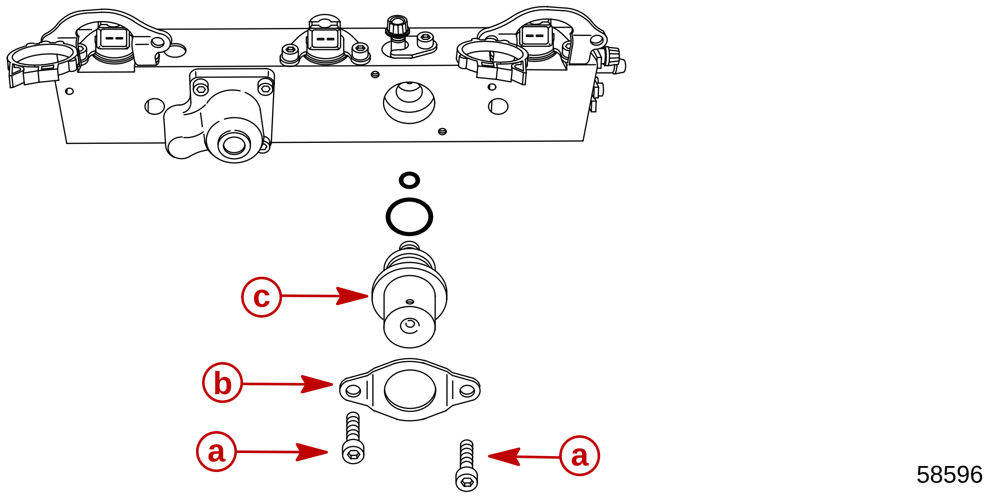
a - Screws
b - Air Regulator
c - O-Rings
d - Retainer

MODEL YEAR 2001 AIR REGULATOR INSTALLATION

1. Position air regulator, retainer and screws onto fuel rail as shown below.

***NOTE:** *Apply anti-seize grease (obtain locally) or 2-4-C w/Teflon to regulator attaching screw threads. Torque screws to 70 lb. in. (8.0 Nm).*

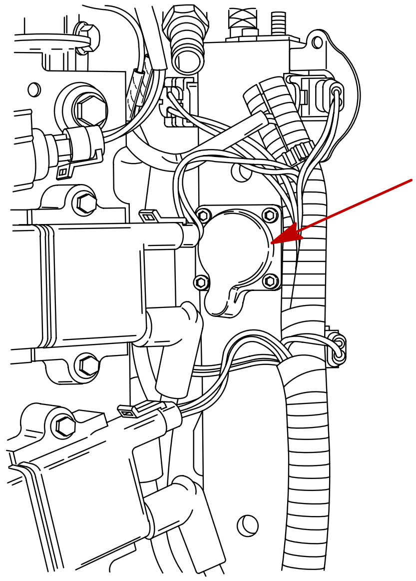
***NOTE:** *Apply a light coat of outboard oil to regulator o-rings to ease installation.*



a - Screws
b - Retainer
c - Air Regulator

Tracker Valve

The tracker valve is located on the starboard fuel/air rail assembly.



57979

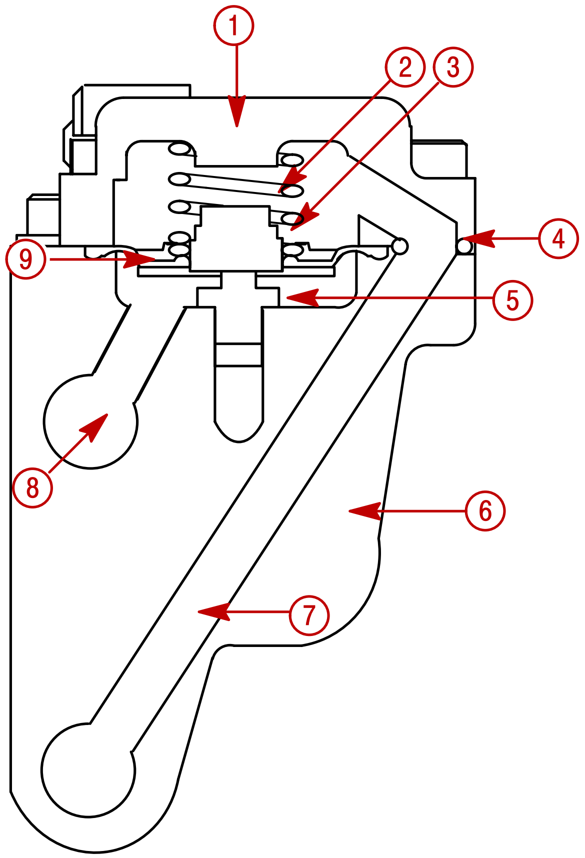
The DFI system must maintain a constant 10 psi pressure difference between the fuel pressure and air pressure in the rails, at all times. The tracker is designed to maintain the 10 psi differential when the air or fuel pressure suddenly raises (i.e. pulses generated by the compressor's piston or by the fuel injectors opening and closing). The tracker contains a spring on the air side of the diaphragm. This spring positions the diaphragm against the diaphragm's seat (when the engine is not running).

After the engine starts, and the fuel and air pressure reach normal operating range, the fuel pressure will compress the spring and the diaphragm will move slightly away from the seat (to a neutral position). At this point the pressure on both sides of the tracker diaphragm is equal (10 psi spring pressure + 80 psi air pressure = 90 psi fuel pressure).

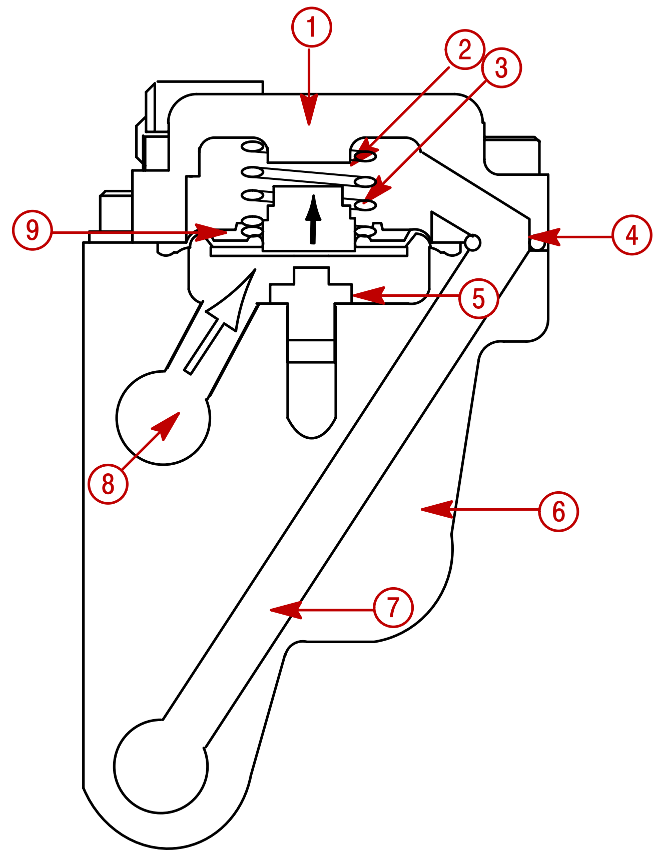
Any air or fuel pressure "spikes" on one side of the diaphragm will transfer this pressure rise to the other system (air or fuel) on the other side of the diaphragm. Both systems will have a momentary increase in pressure so that the 10 psi difference between air and fuel system pressures can be maintained.

***NOTE:** To prevent excessive wear in the seat, the tracker is calibrated to allow the diaphragm to be slightly away from the seat during normal operation.*

Engine Off (No Pressure)



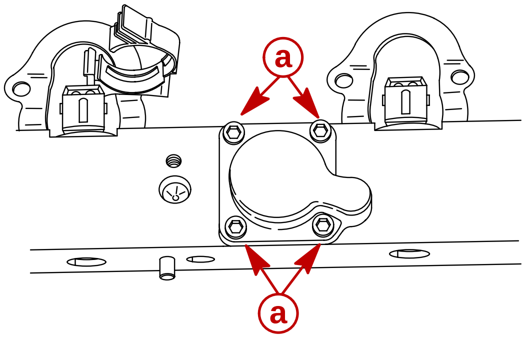
Engine at Operating Pressures



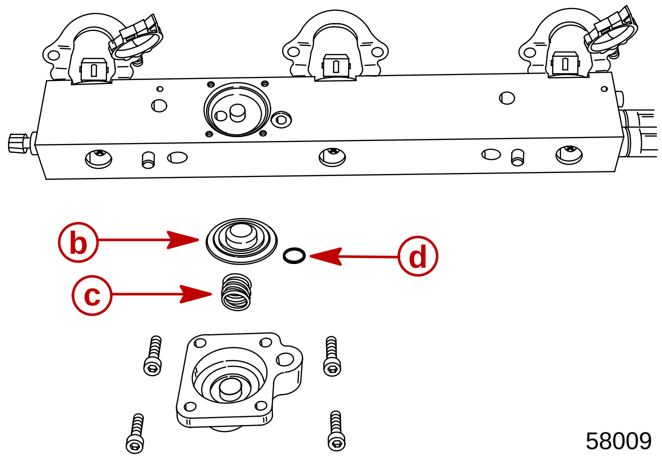
1 - Top Cover
2 - Spring Retainer (not shown)
3 - Spring
4 - O-ring
5 - Diaphragm (at rest) Seat
6 - Air Rail
7 - Air Passage (from Air Compressor)
8 - Fuel Inlet Passage (from Electric Fuel Pump)
9 - Diaphragm Assembly

TRACKER VALVE REMOVAL

1. Remove 4 screws securing tracker valve and remove tracker assembly.
2. Inspect tracker diaphragm for cuts and tears.
3. Inspect tracker cover o-ring for cuts and abraisions. Replace components as required.



57802



58009

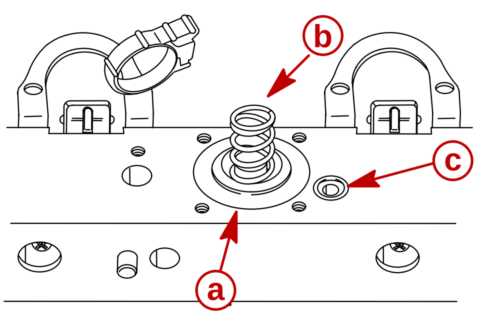
a - Screws
b - Diaphragm
c - Spring
d - O-Ring

TRACKER VALVE INSTALLATION

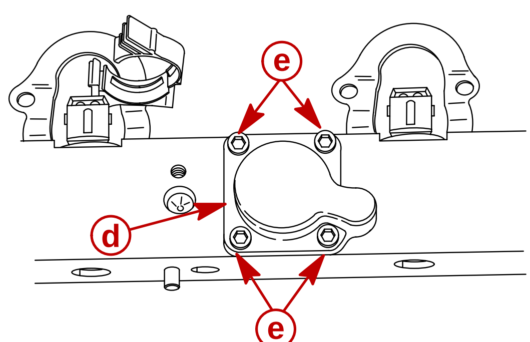
***NOTE:** Apply a light coat of 2-4-C w/Teflon to tracker diaphragm and cover o-ring to aid in their retention on fuel rail while reinstalling tracker valve to fuel rail.*

***NOTE:** Apply anti-seize grease (obtain locally) or 2-4-C w/Teflon to tracker valve attaching screw threads.*

1. Position diaphragm, spring and o-ring onto fuel rail.
2. Place cover over diaphragm/spring/o-ring assembly and secure with 4 screws. Torque screws to 70 lb. in. (8.0 Nm).



57919



57802

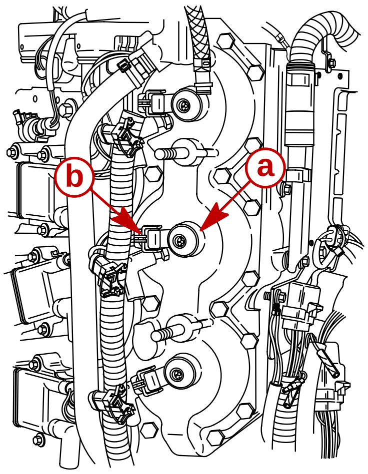
a - Diaphragm
b - Spring
c - O-Ring
d - Cover
e - Screws [Torque to 70 lb. in. (8.0 Nm)]

Fuel Rail Cleaning

After all fuel injectors, air regulator, tracker valve, fuel regulator, inlet hoses and outlet hoses have been removed, the fuel rails may be flushed out with a suitable parts cleaning solvent. Use compressed air to remove any remaining solvent.

Direct Injector Removal

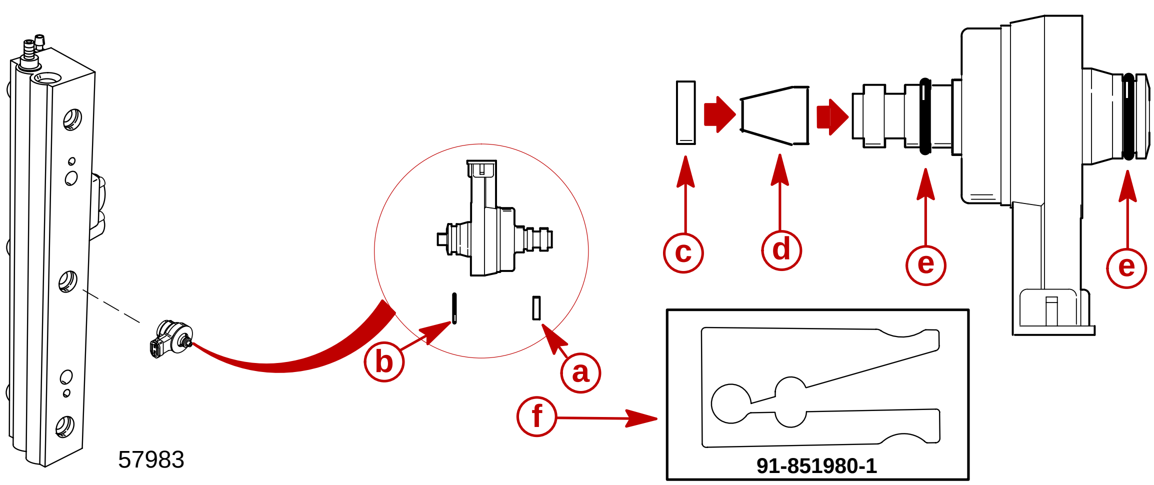
1. Remove harness connectors from direct injectors.
2. Remove direct injector from cylinder head



57985

a - Direct Injector (3 each cylinder head)
b - Harness Connector

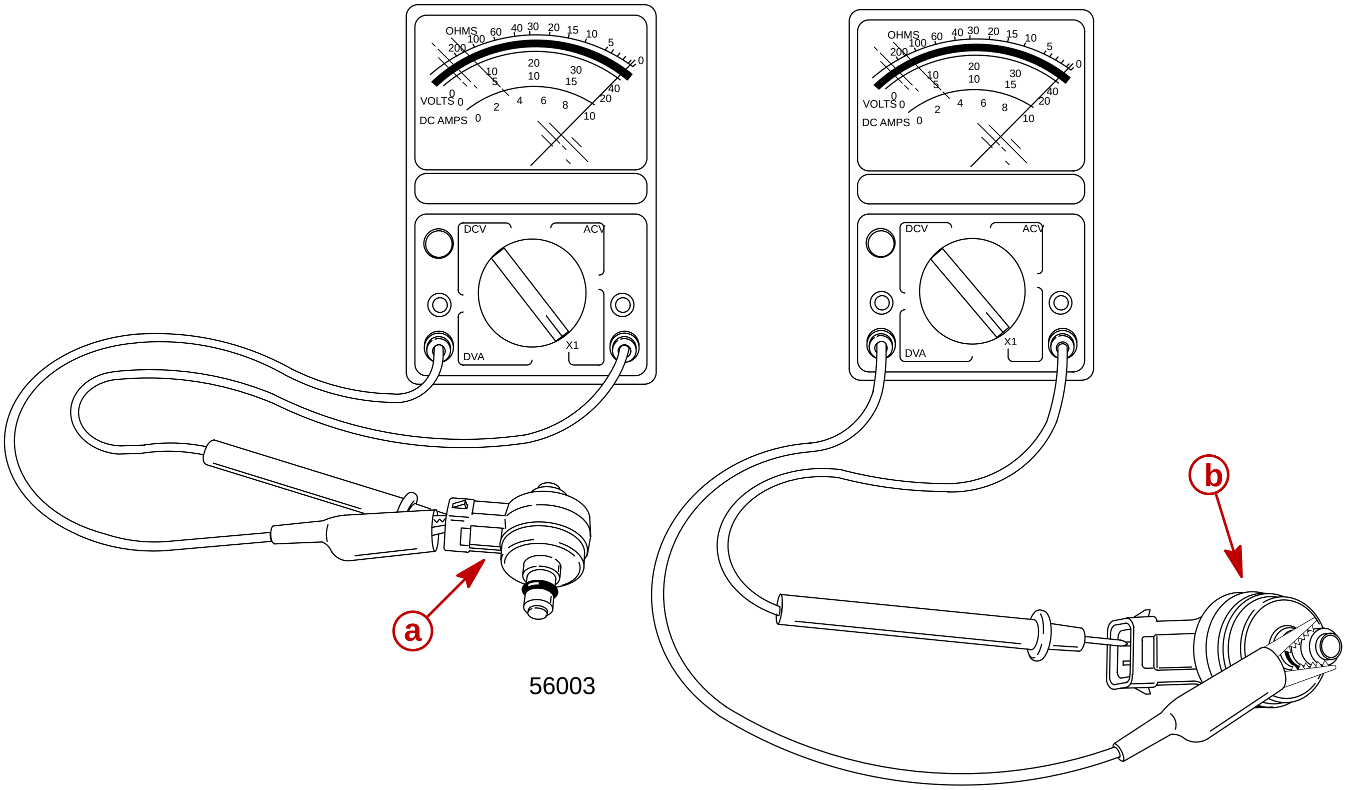
3. Inspect injector teflon sealing ring (white) for signs of combustion blowby (teflon ring will be streaked brownish black). If blowby is present, replace teflon sealing ring. If blowby is not present, sealing ring may be reused.
4. Inspect o-rings and teflon ring for cuts or abraisions. Replace components as required.
5. If teflon seal requires replacement, use teflon ring installation tool 91-851980 to slide new seal onto injector. Following installation of teflon ring, the teflon ring sizing tool (91-851980-1) can be used to compress the teflon seal to aid in the installation of the injector into the cylinder head.



57983

a - Teflon Sealing Ring
b - O-Ring
c - Teflon Seal
d - Seal Installation Tool (91-851980)
e - O-Ring
f - Teflon Ring Sizing Tool (91-851980-1)

6. An ohm test of the direct injector may be made by connecting test leads to injector terminals. Ohm reading should be 1.3 ± 0.3 ohm.
7. An ohm test to determine if direct injector windings are shorted to ground can be made by connecting one ohm lead to either injector pin while touching the other ohm lead to the injector metal case. There should be no continuity. If there is continuity, the internal windings are shorted and the injector must be replaced.



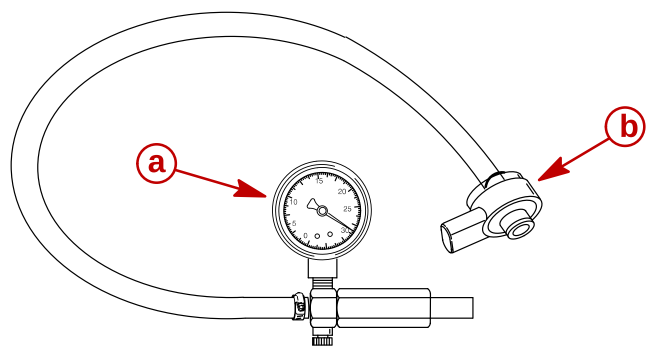
56003

58456

a - Direct Injector Ohm Test (1.3 ± 0.3 ohm)
b - Direct Injector Short to Ground Ohm Test (no continuity)

Direct Injector Leak Test

1. Attach Gearcase Leakage Tool (FT-8950) to discharge side of injector.



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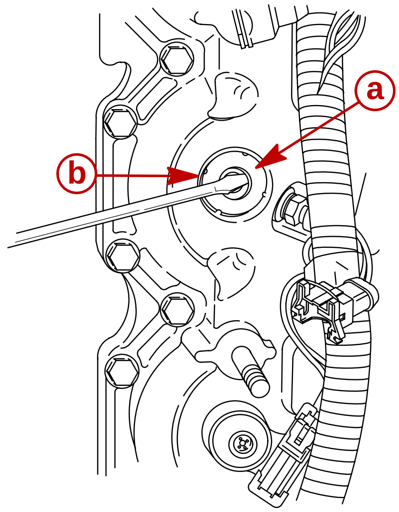
a - Gearcase Leakage Tool (FT-8950)
b - Direct Injector

2. Pump up leakage tool to indicate 25 - 30 psi (172.4 - 206.8 kPa).
3. Direct injector should not leak down more than 1/2 psi (3.5 kPa) in 1 minute.
4. If injector does not meet the above specifications, replace injector.

***NOTE:** If cylinder head is going to be replaced, remove cup washers from each direct injector port by prying out with a flat tip screwdriver. Reinstall washers with retainers into new cylinder head. Washers provide tension between direct injectors, cylinder head and fuel rails.*



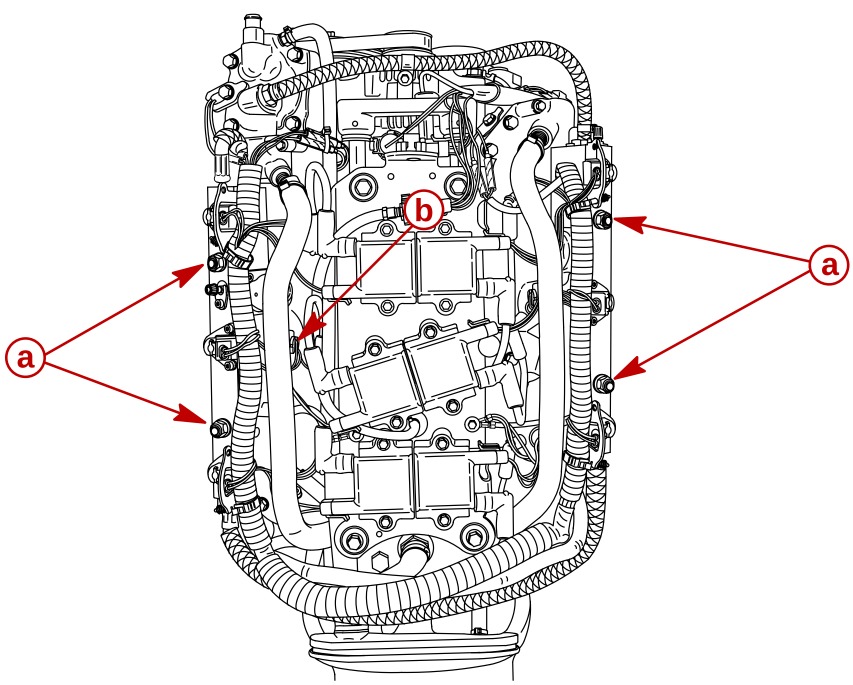
a - Cup Washer
b - Retainer

Fuel Rail and Direct Injector Installation

1. Use Teflon Ring Sizing Tool (91-851980-1) to compress new teflon sealing rings prior to installation of injector into cylinder head.
2. Carefully slide fuel rail over mounting studs and onto direct injectors.

IMPORTANT: ALL fuel and air hoses attached to the fuel rails MUST be secured with stainless steel hose clamps.

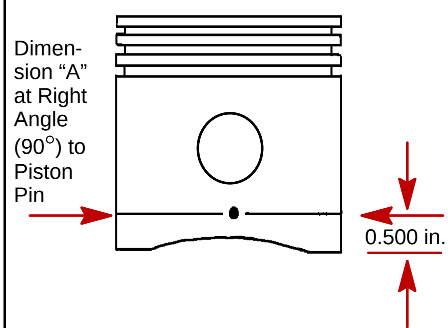
3. Secure each fuel rail with 2 nuts. Torque nuts to 33 lb. ft. (44 Nm).
4. Reinstall direct injector harness connectors.



a - Nuts [Torque to 33 lb.ft. (44 Nm)]
b - Direct Injector Harness Connectors (6) (3 each fuel rail)

Air Compressor

Air compressor is a single cylinder, water cooled and lubricated by the outboard oil pump.

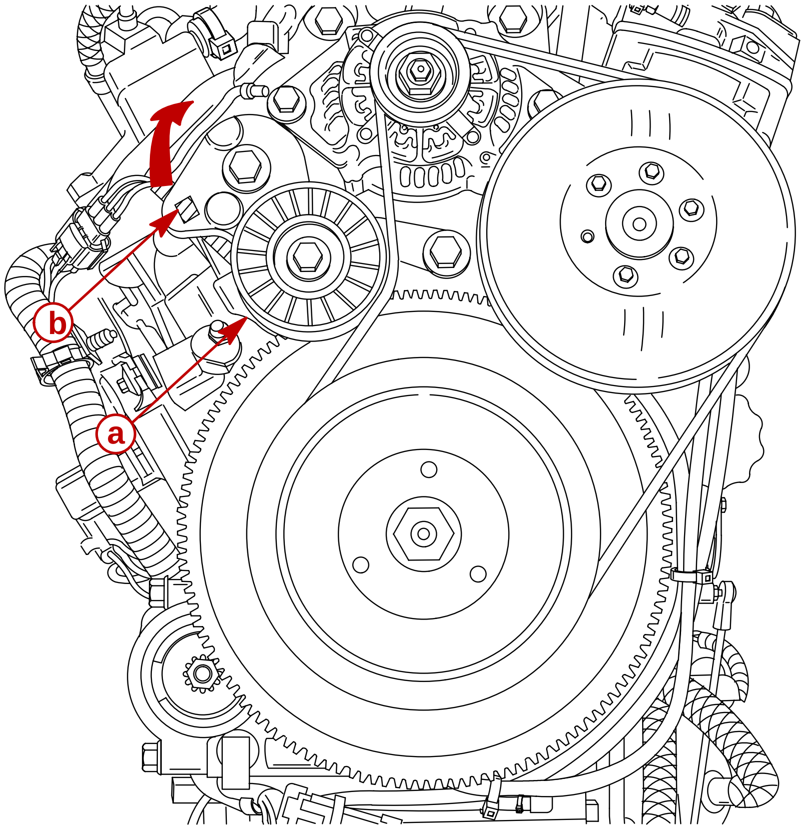
Air Compressor Specifications		
Air Compressor	Type Compressor Output	Reciprocating Piston (1 to 1 ratio with engine RPM) @ Idle – 80 psi @ W.O.T. – 110 psi
Cylinder Block	Displacement	7.07 cu. in. (116 cc)
Cylinder Bore	Diameter (Standard) Taper/Out-of-Round/Wear Maximum Bore Type	2.5591 in. (65.0 mm) 0.001 in. (0.025 mm) Cast Iron
Stroke	Length	1.374 in. (34.9 mm)
Piston	Piston Type	Aluminum
Piston Diameter		2.5578 ± .0004 in. (64.97 ± 0.010 mm)
Piston Ring	End Gap Top Ring Middle Ring Bottom Ring	 0.0059 - 0.0098 in. (0.15 - 0.25 mm) 0.0059 - 0.0098 in. (0.15 - 0.25 mm) 0.0039 - 0.014 in. (0.10 - 0.35 mm)
Reeds	Reed Stand Open	0.010 in. (0.25 mm)

COMPRESSOR REMOVAL

1. Disconnect battery cables from battery terminals.
2. Remove top cowling.

IMPORTANT: Prior to removing flywheel cover, remove vent hose from fitting on flywheel cover.

3. Remove flywheel cover.
4. Use 3/8 inch (9.5 mm) drive on belt tensioner arm to relieve belt tension. Remove belt.



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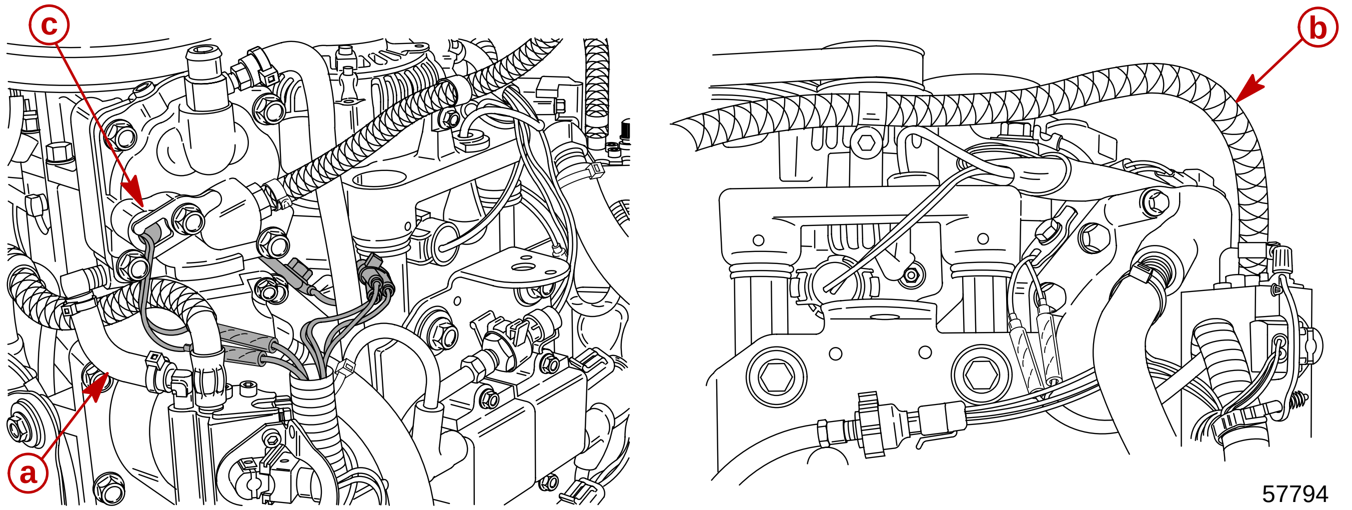
a - Belt Tensioner
b - 3/8 in. (9.5 mm) drive

⚠ CAUTION

If engine has been recently run, air pressure outlet hose fittings may be extremely hot. Allow components to cool off before beginning disassembly.

***NOTE:** Remove 2 screws securing retainer plate to remove air pressure outlet hose. Inspect o-rings on air pressure hose fitting for cuts or abraisions. Replace o-rings as required.*

5. Remove air pressure outlet hose.
6. Disconnect compressor water inlet hose.



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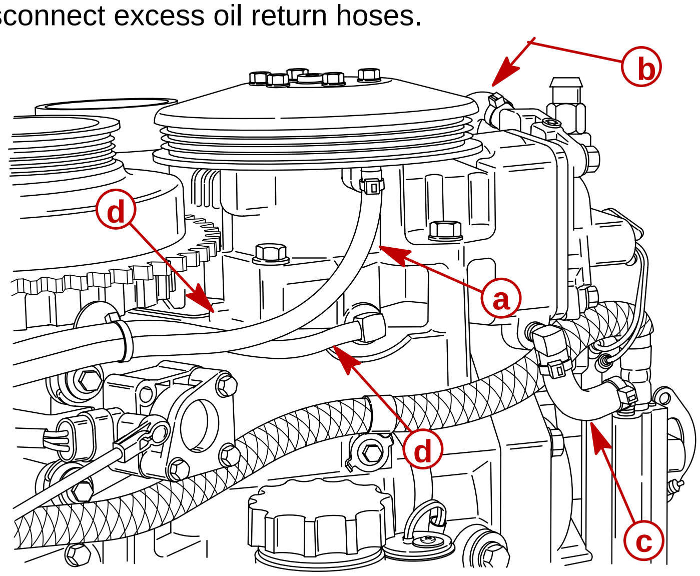
a - Air Pressure Outlet Hose
b - Compressor Water Inlet Hose
c - Compressor Temperature Sensor

7. Disconnect air compressor oil inlet hose.
8. Disconnect water outlet hose (tell-tale).
9. Disconnect excess oil return hoses.



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a - Air Compressor Oil Inlet Hose
b - Water Outlet Hose (tell-tale)
c - Water Inlet Hose
d - Excess Oil Return Hoses

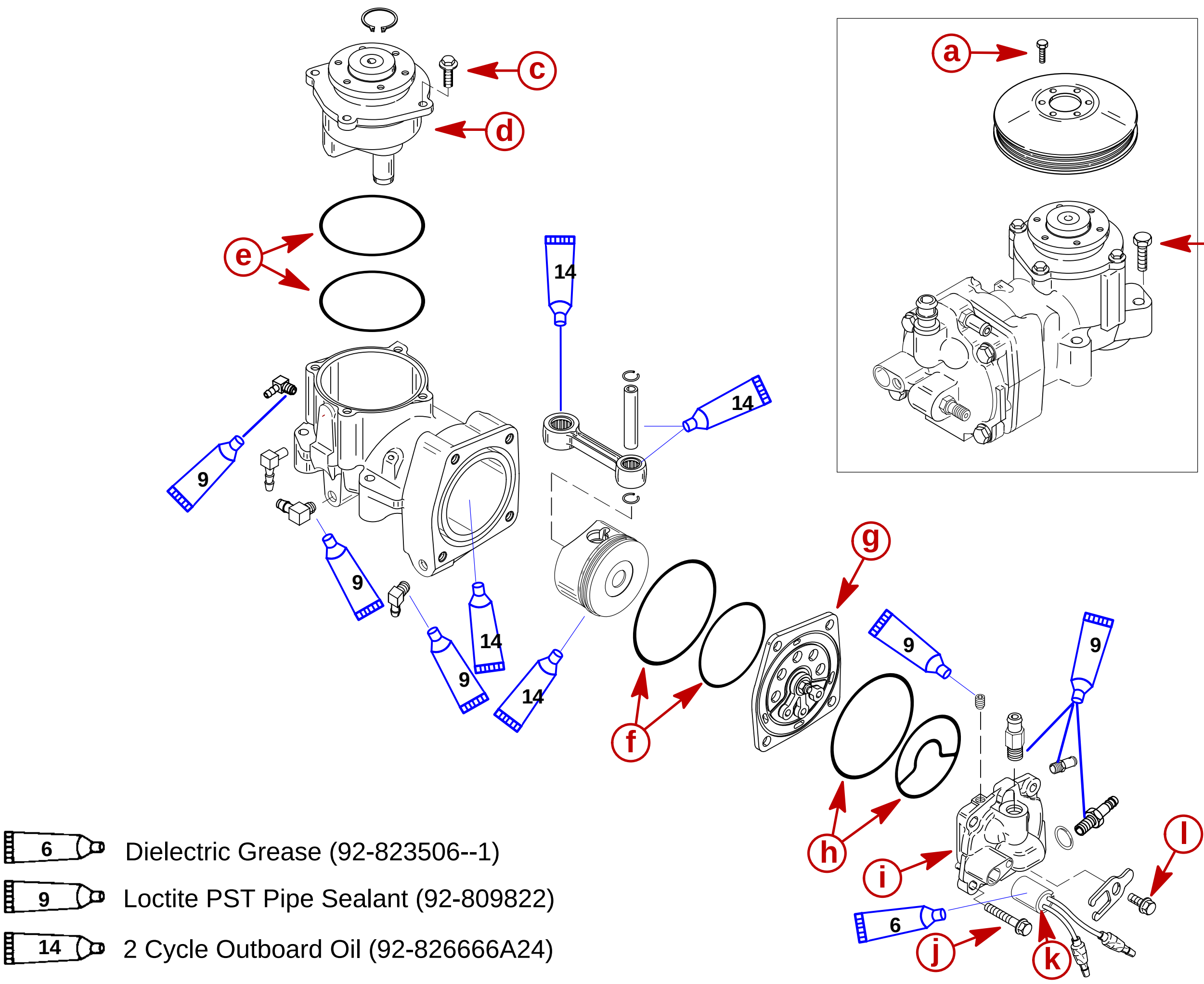
10. Remove 4 bolts securing air compressor to outboard and remove compressor.

Air Compressor Disassembly/Reassembly

IMPORTANT: If an internal failure of the air compressor has occurred, i.e. broken reed, scuffed piston, bearing failure, etc. – all air hoses, fuel rails and injectors should be disassembled and inspected for metal debris. Failure to remove all metal debris will result in poor performance and/or powerhead failure.

***NOTE:** If cylinder bore is scored, air compressor must be replaced as an assembly.*

***NOTE:** The piston and rings are not sold separately. They must be replaced as an assembly. The connecting rod and bearings are not sold separately. They must be replaced as an assembly.*



***NOTE:** End cap bearing and seal are not sold separately. End cap must be replaced as an assembly*

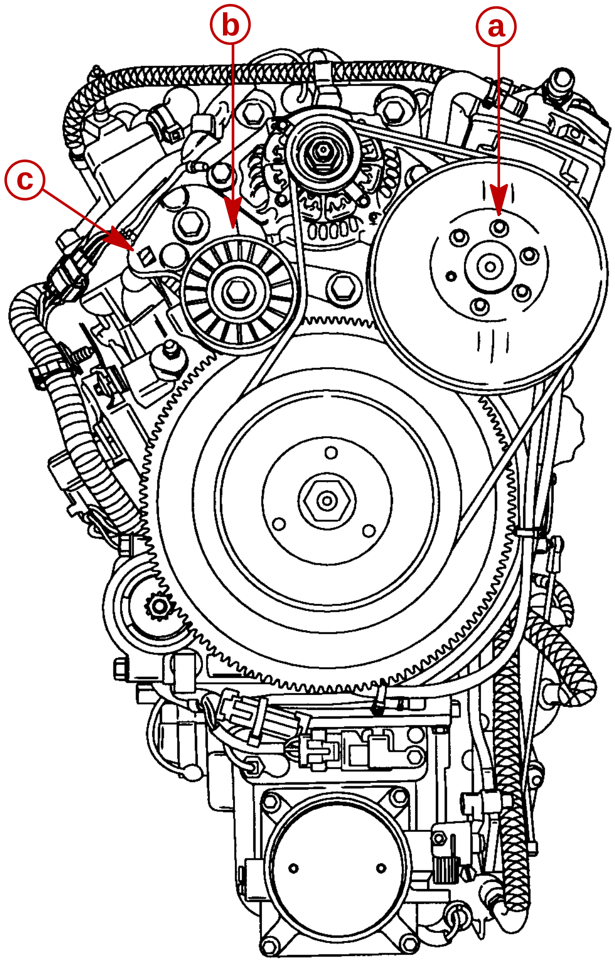
***NOTE:** Piston Installation – use a metal hose clamp for piston ring compressor. Stagger piston ring openings.*

- **a** - Bolt – (GOLD Pulley) – Torque to 190 lb. in. (21.5 Nm)
  (BLACK Pulley) – Torque to 170 lb. in. (19 Nm)
- **b** - Bolt (4 each) (Torque to 20 lb. ft. [27 Nm])
- **c** - Bolt (4 each) (Torque to 100 lb. in. [11.5 Nm])
- **d** - End Cap Assembly (Inspect bearing for roughness)
- **e** - O-Rings (Inspect for cuts or abraisions)
- **f** - O-Rings (Inspect for cuts or abraisions)
- **g** - Reed Plate (Inspect for broken or chipped reeds/stops) Maximum Reed Stand-Open – 0.010 in. (0.254 mm)
- **h** - O-Rings (Inspect for cuts or abraisions)
- **i** - Cylinder Head
- **j** - Bolt (Torque to 20 lb. ft. [27 Nm])
- **k** - Temperature Sensor
- **l** - Bolt (Torque to 20 lb. ft. [27 Nm])

Air Compressor End Cap/Crankshaft Removal and Reassembly

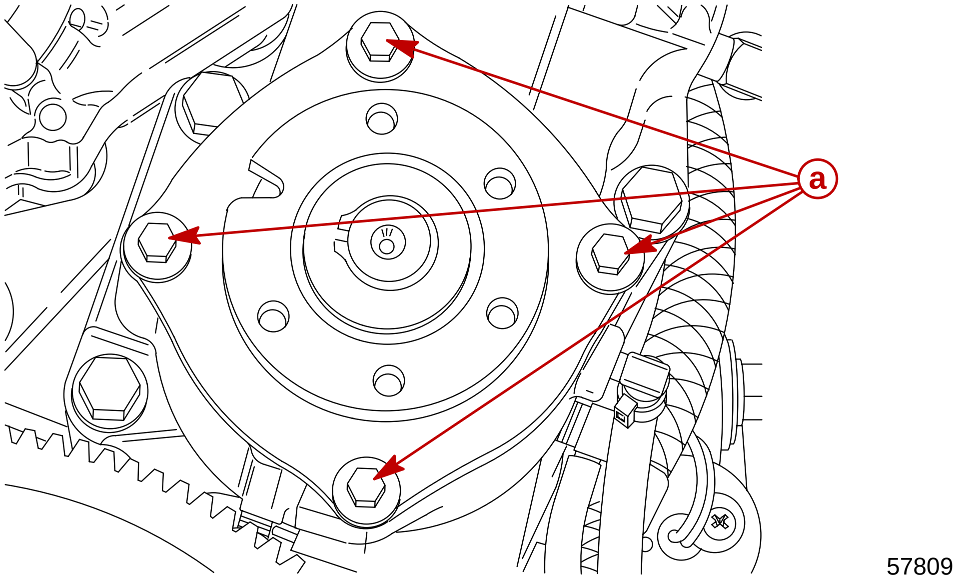
DISASSEMBLY

1. Remove flywheel cover.
2. Use 3/8-inch (9.5 mm) drive on belt tensioner arm to relieve belt tension, and remove belt.
3. Remove the 5 bolts that retain the pulley to the pulley flange.



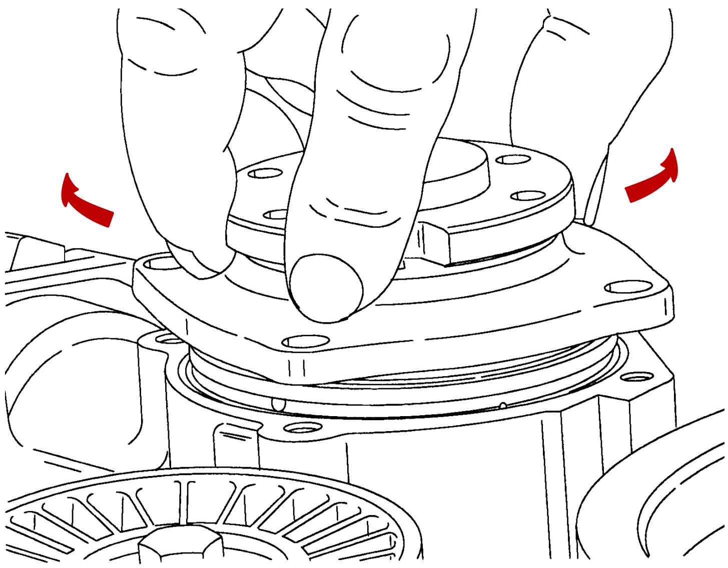
a - Pulley retaining bolts (5)
b - Tensioner
c - 3/8 (9.5 mm) square drive

4. Remove the 4 bolts that retain the end cap to the compressor body.



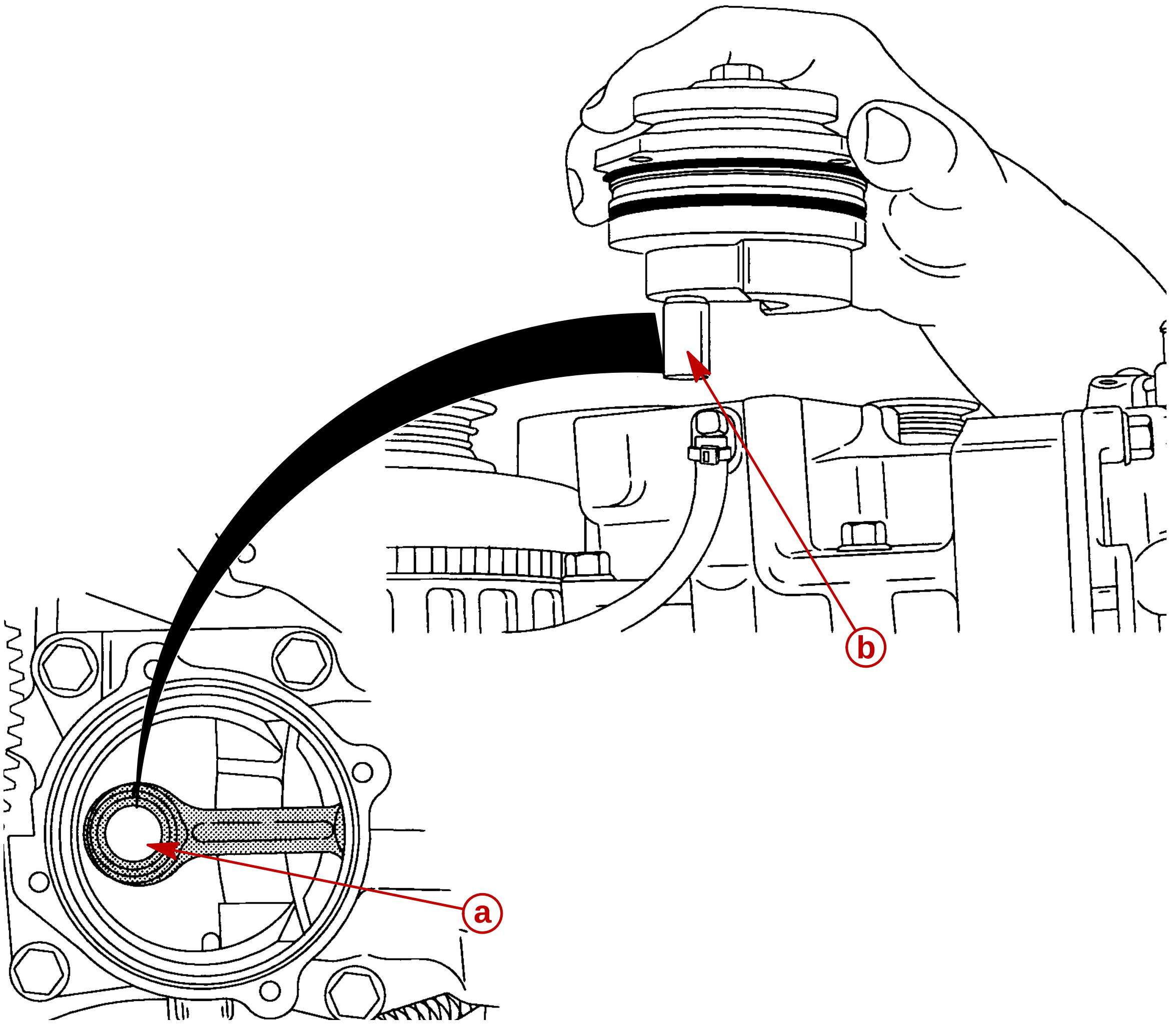
a - End cap retaining bolts (4)

5. While rotating the pulley flange alternately clockwise and counterclockwise about 1/8 to 1/4 turn, pull outward on the pulley flange. Continue rotating until the end cap assembly has been removed from the compressor body.



REASSEMBLY

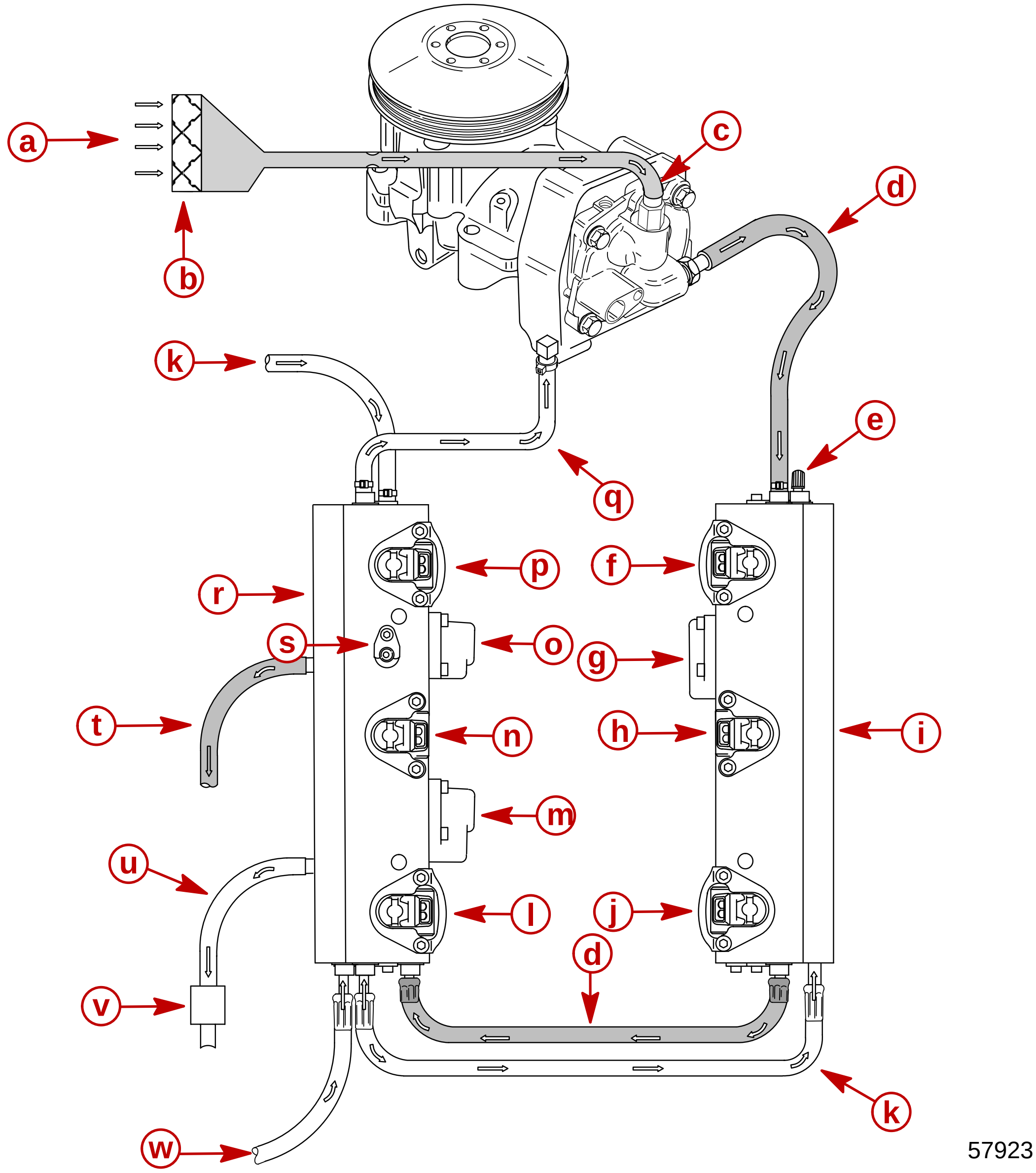
1. Lubricate end cap O-ring and O-ring contact area in compressor body with two cycle oil.
2. Slide the new end cap assembly into the compressor body, keeping the connecting rod journal lined up with the open end of the connecting rod, until the crankshaft just enters the open end of the connecting rod.



a - Connecting rod open end
b - Crankshaft connecting rod Journal

3. While rotating the pulley flange clockwise and counterclockwise, push the end cap into the compressor. Continue rotating the flange until the end cap is all the way down against the compressor body.
4. To confirm that the connecting rod journal has properly engaged with the connecting rod, rotate the flange until you feel resistance from the piston trying to compress air in the cylinder.
5. Apply Loctite 271 (P/N 92-809820) to the threads of the end cap retaining bolts and torque to 100 lb. in. (11.5 Nm).
6. Apply Loctite 271 (P/N 92-809820) to the pulley retaining bolts. Torque to 190 lb. in. (21.5 Nm) for GOLD pulley. Torque to 170 lb. in. (19 Nm) for BLACK pulley.
7. Install compressor/alternator belt.
8. Run engine to confirm that compressor is functioning correctly.

Air Compressor Flow Diagram

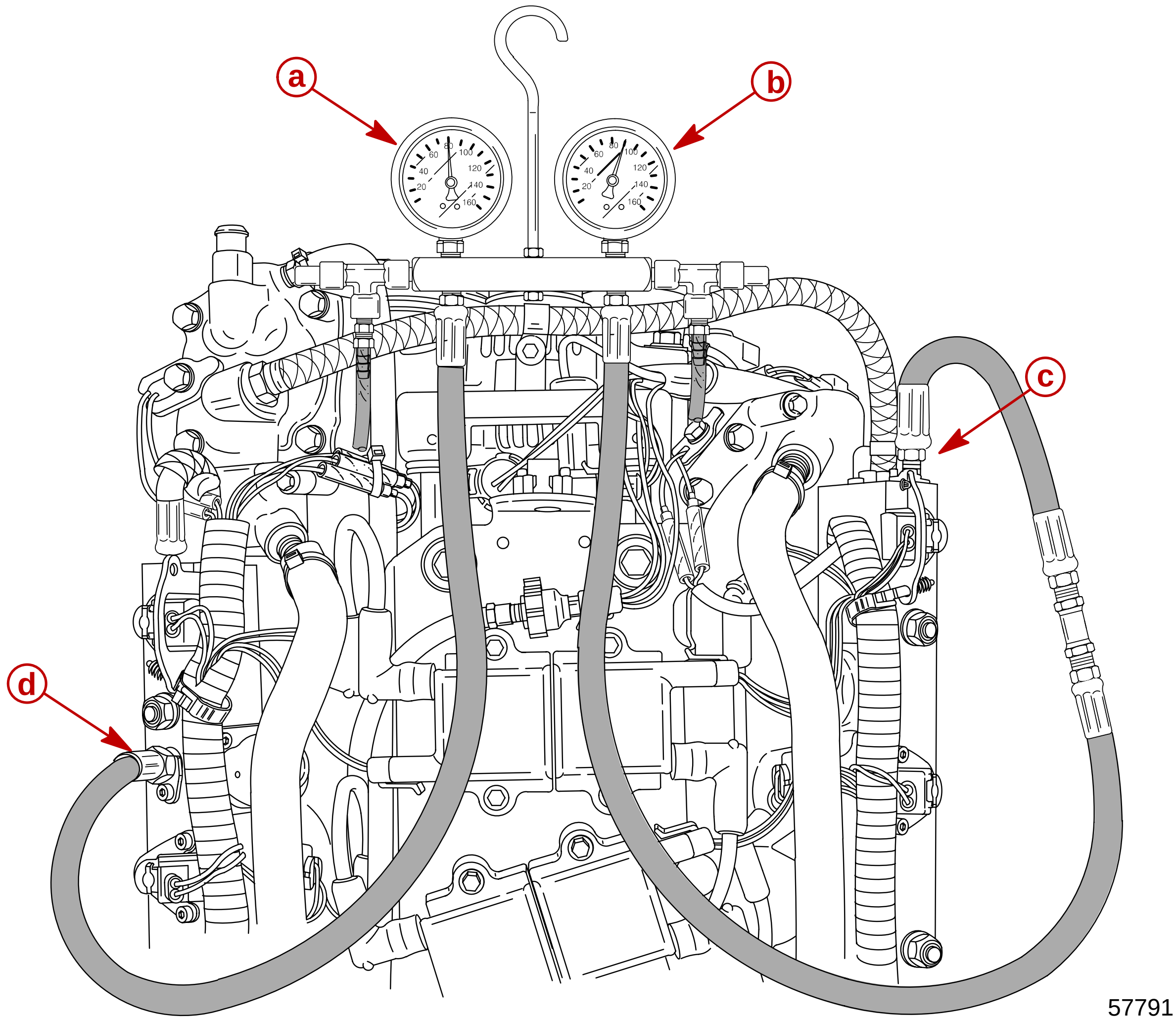


a - Air Inlet
b - Air Filter
c - Compressor Air Inlet
d - Air [79 ± 2 psi (544.0 ± 13.8 kPa)]
e - Fuel System Pressure Test Valve
f - #1 Fuel Injector
g - Tracker Valve
h - #3 Fuel Injector
i - Starboard Fuel Rail
j - #5 Fuel Injector
k - High Pressure Fuel [89 ± 2 psi (613.5 ± 13.8 kPa)]
l - #6 Fuel Injector
m - Fuel Regulator [89 ± 2 psi (613.5 ± 13.8 kPa)]
n - #4 Fuel Injector
o - Air Regulator [79 ± 2 psi (544.0 ± 13.8 kPa)]
p - #2 Fuel Injector
q - Compressor Water Inlet
r - Port Fuel Rail
s - Air Pressure Test Valve
t - Excess Air Return to Air Plenum
u - Excess Fuel Return to VST
v - 40 psi Check Valve
w - Water Inlet to Fuel Rail

Air Compressor Pressure Test

Install Pressure Gauge Assembly 91-852087A1/A2/A3 to fuel rail pressure test valves. Starboard rail has fuel pressure test valve. Port fuel rail has air pressure test valve.

***NOTE:** After 15 seconds of cranking engine with starter motor, air pressure gauge should indicate 79 ± 2 psi (544.0 ± 13.8 kPa) and fuel pressure gauge should indicate 89 ± 2 psi (613.5 ± 13.8 kPa).*



a - Air Pressure Gauge (Should Indicate 79 ± 2 psi (544.0 ± 13.8 kPa)
b - Fuel Pressure Gauge (Should Indicate 89 ± 2 psi (613.5 ± 13.8 kPa)
c - Fuel Pressure Test Valve
d - Air Pressure Test Valve

FUEL PRESSURE AND AIR PRESSURE TROUBLESHOOTING CHART

PROBLEM	CORRECTIVE ACTION
Fuel Pressure and Air Pressure are Both Low	1. Inspect air compressor air intake (air filter in flywheel cover) for blockage. 2. Remove air compressor cylinder head and inspect for scuffing of cylinder wall. Inspect for broken reeds and/or reed stops. 3. Tracker Valve – Remove and inspect diaphragm for cuts or tears and seat damage on diaphragm and rail. 4. Air Regulator – Remove and inspect diaphragm for cuts or tears on diaphragm and rail.
Fuel Pressure Low or Fuel Pressure Drops while Running (Air Pressure Remains Normal)	1. Each time key is turned to the RUN position, both electric pumps should operate for 2 seconds. If it they do not run, check 20 ampere fuse and wire connections. 2. If pumps run but have no fuel output, check vapor separator (remove drain plug) for fuel. 3. If no fuel present in vapor separator, check fuel/water separator for debris. Check crankcase mounted fuel pump for output. 4. Check high pressure pump amperage draw. Normal draw is 6 - 9 amperes; if draw is below 2 amperes, check fuel pump filter (base of pump) for debris. If filter is clean, replace pump. If amperage is above 9 amperes, pump is defective – replace pump. Check low pressure output – 6-9 psi. Check low pressure electric fuel pump amperage draw. Normal draw is 1 - 2 amperes; if draw is below 1 ampere, check for blockage between pump inlet fitting and vapor separator tank. If ampere draw is above 2 amperes, replace pump. 5. Fuel Regulator – Remove and inspect diaphragm for cuts or tears.
Fuel Pressure High and Air Pressure is Normal	1. Stuck check valve in fuel return hose. 2. Debris blocking fuel regulator hole. 3. Faulty pressure gauge
Fuel and Air Pressure Higher than Normal	1. Debris blocking air regulator passage. 2. Air dump hose (rail to air plenum) blocked/plugged.

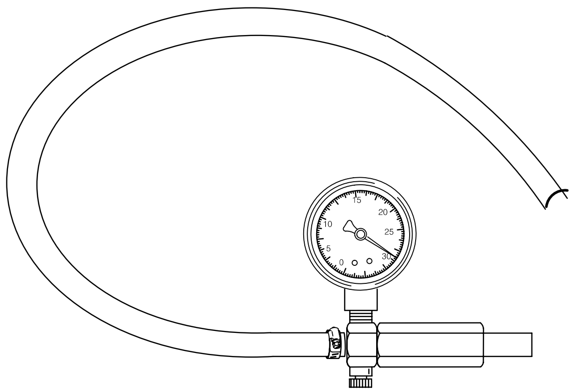
FUEL SYSTEM

Section 3C – Oil Injection

Table of Contents

Special Tools

1. Gearcase Leakage Tester (FT-8950)



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Oil System Operation

Oil in this engine is not mixed with the fuel before entering the combustion chamber. Oil is stored inside the remote oil tank in the boat. Crankcase pressure forces oil from the remote oil tank into the engine oil reservoir. The engine oil reservoir feeds oil to the oil pump. The oil pump is ECM driven and controls oil distribution to the crankcase and air compressor. The oil pump has seven oil discharge ports. Six of the oil discharge ports inject oil into the crankcase through hoses, one hose for each cylinder. The last oil discharge port discharges oil into the air compressor for lubrication. Unused oil from the air compressor returns to the main bearings.

The ECM is programmed to automatically increase the oil supply to the engine during the initial engine break-in period. The oil ratio is doubled during the first 120 minutes of operation whenever engine speed exceeds 2500 RPM and is under load; below 2500 RPM the oil pump provides oil at the normal ratio. After the engine break-in period, the oil ratio will return to normal – 300 - 400:1 at idle to 60:1 at WOT.

NOTE: *On some light boat applications after the break-in is completed and the engine is being run at cruising speed – between 4000 and 5000 RPM – the fuel to oil ratio may be as high as 40:1. This results from a reduced throttle opening with a corresponding reduction in fuel consumption.*

Oil Pump Output

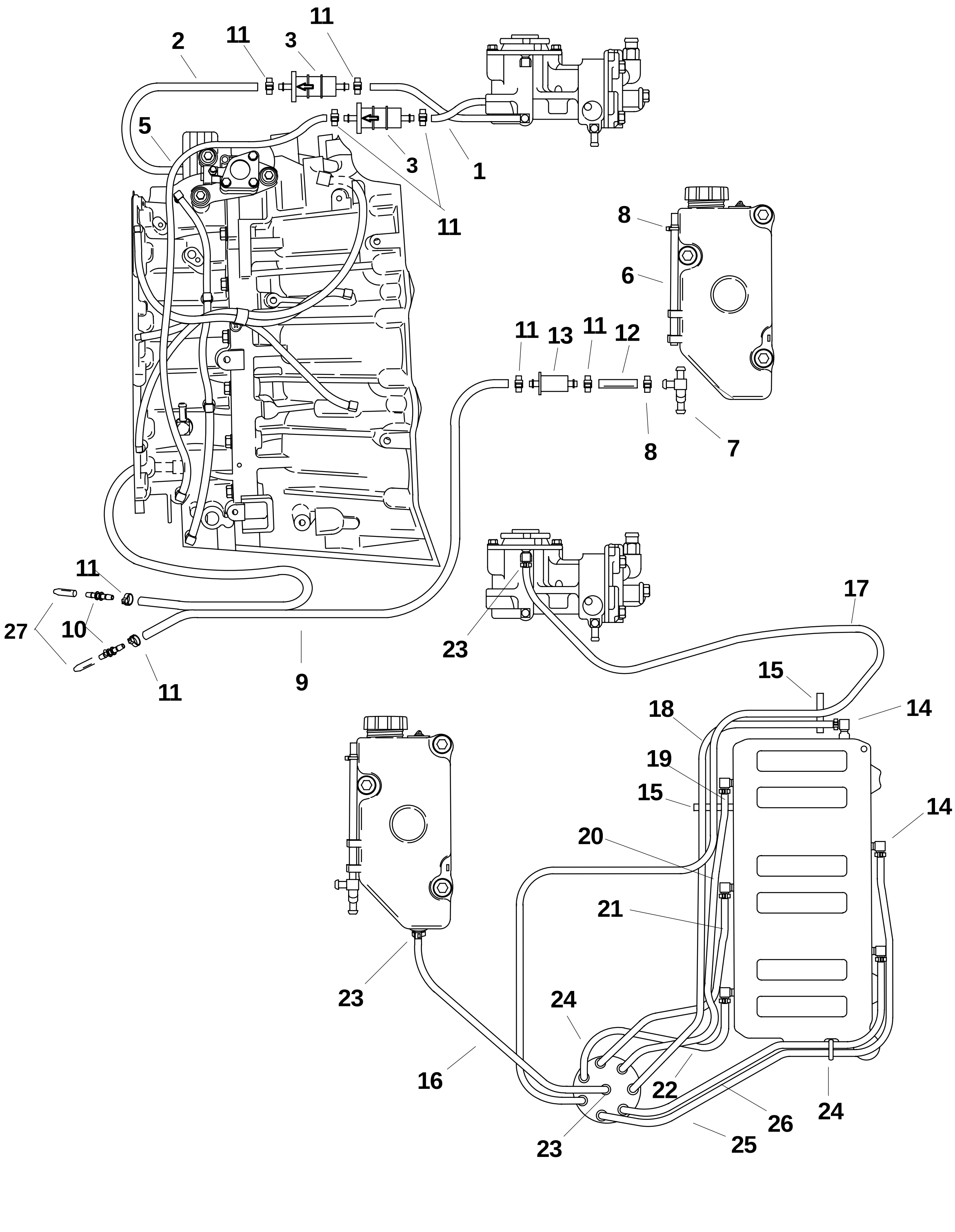
Using the DDT to activate auto prime, the oil pump should discharge 110 ml (cc) ± 8 ml (cc) during the auto prime time period.

To check the oil pump output:

- Verify the on-board oil reservoir is full.
- Release any pressure (loosen cap) from the remote oil tank in the boat.
- With engine not running, use the DDT to activate the auto prime.
- Using a ml or cc graduated container, record the amount of oil needed to refill the on-board oil reservoir.
- Retighten cap on the remote oil tank in the boat.

Notes:

Oiling System



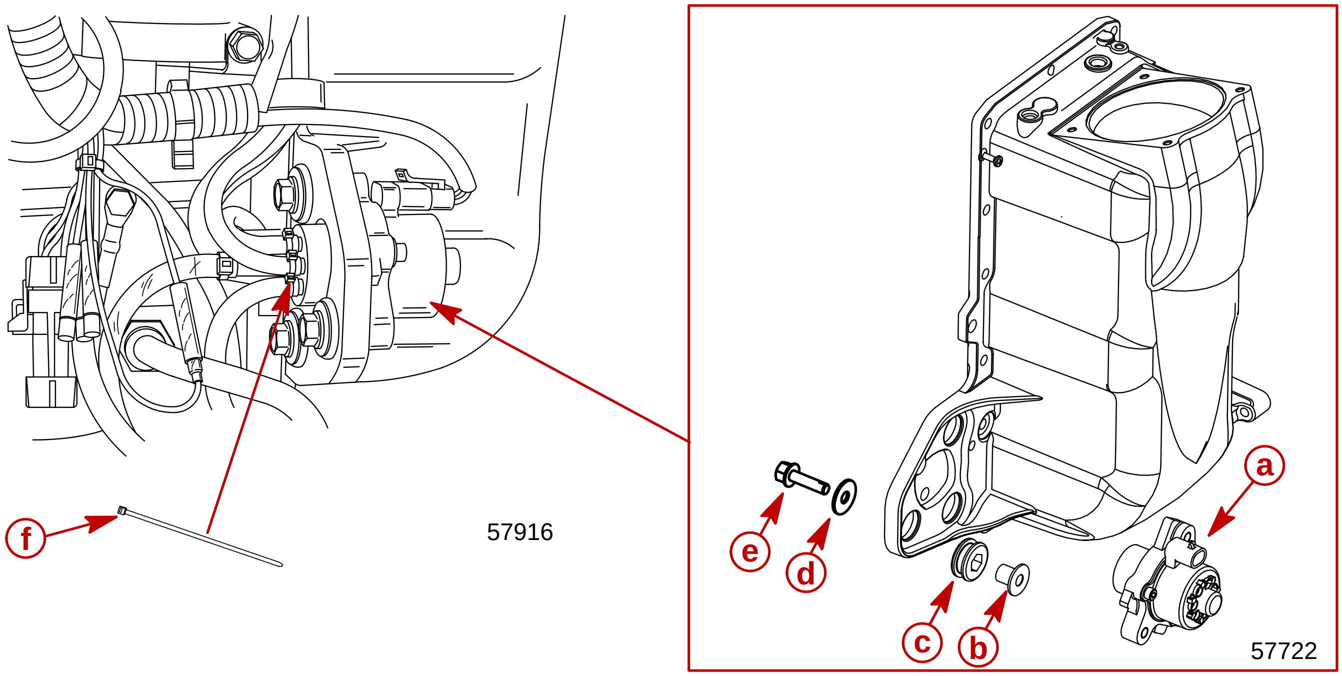
Oiling System

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb. in.	lb.ft.	Nm
1	2	TUBING (11-1/2 IN.)			
2	1	TUBING (5 IN.)			
3	2	INLINE FUEL FILTER			
4	1	TUBING (9 IN.)			
5	1	CONNECTOR			
6	1	TUBING (7 IN.)			
7	1	FITTING			
8	3	STA STRAP			
9	1	HOSE			
10	2	CONNECTOR			
11	4	STA STRAP			
12	1	HOSE			
13	1	FUEL FILTER			
14	6	CHECK VALVE			
15	2	RETAINER			
16	1	TUBING (22 IN.)			
17	1	TUBING (33 IN.)			
18	1	TUBING (19-1/2 IN.)			
19	6	STA STRAP			
20	1	TUBING (11 IN.)			
21	1	TUBING (6 IN.)			
22	1	TUBING (4 IN.)			
23	3	STA STRAP			
24	13	STA STRAP			
25	1	TUBING (20-1/2 IN.)			
26	1	TUBING (15-1/2 IN.)			
27	2	PLUG			

Oil Pump Removal and Installation

REMOVAL

1. Disconnect the wiring harness from the pump.
2. Disconnect the oil hoses.
3. Remove three bolts and remove pump.



a - Oil Pump
b - Bushing (3)
c - Rubber Grommet (3) – Insert into Hole
d - Washer (3)
e - Bolt (3) – Torque to 16 lb. ft. (21.5 Nm)
f - Sta-Straps – Fasten All Hose Ends

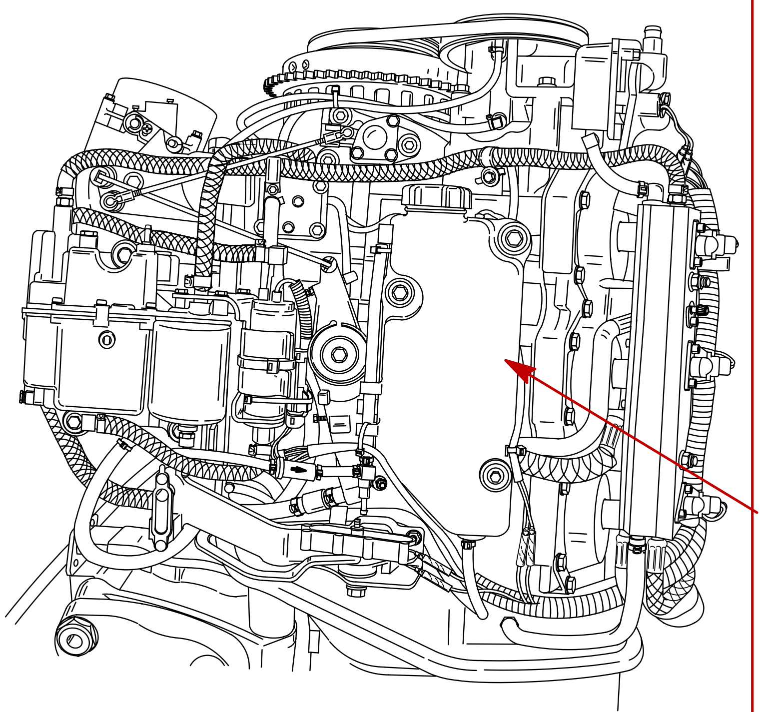
INSTALLATION

1. Install pump as shown.
2. Reconnect the oil hoses. Refer to Oil Injection Hose Installation for correct location. Fasten hoses to pump fittings with sta-straps.
3. Connect the wiring harness.
4. Refill the oil system. Refer to Priming the Oil Pump.

Engine Oil Reservoir Removal and Installation

REMOVAL

1. Disconnect the oil hoses. Plug the hoses to prevent spillage.
2. Disconnect the LIGHT BLUE wire leads.
3. Remove three bolts securing oil tank to powerhead and remove tank.



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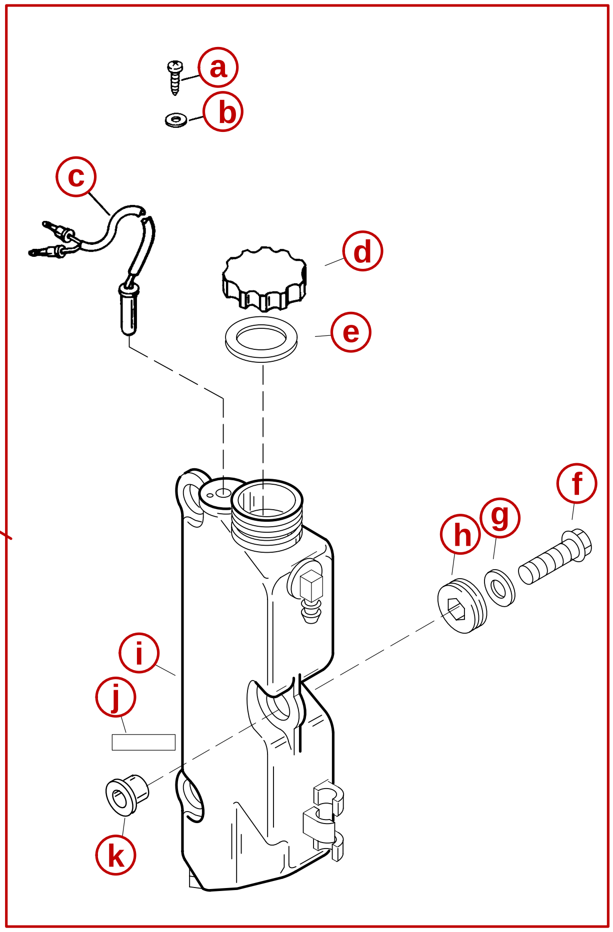


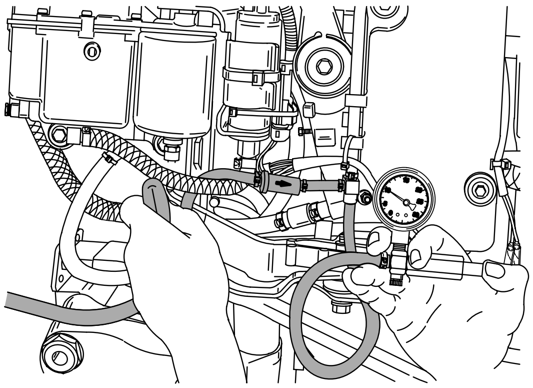
a - Screw (Drive Tight)
b - Washer
c - Low Oil Switch
d - Cap Assembly
e - Gasket
f - Bolt (3) – Torque to 170 lb. in. (19 Nm)
g - Washer (3)
h - Rubber Grommet (3) – Insert into Holes
i - Oil Reservoir
j - Decal
k - Bushing (3)

INSTALLATION

1. Install oil reservoir as shown.
2. Fasten the oil hoses with sta-straps.
3. Connect the LIGHT BLUE wire leads.
4. Refill the oil system. Refer to Priming the Oil Pump.

Priming the Oil Pump

***NOTE:** If a new powerhead is being installed or oil hoses/oil pump has been removed, it is recommended all air be purged from oil pump/oil lines. This can be accomplished by using a gearcase leakage tester (FT-8950). Connect the leakage tester to the inlet t-fitting on the onboard oil reservoir. While clamping off the inlet hose, manually pressurize the reservoir to 10 psi. Using the Digital Diagnostic Terminal 91-823686A2, activate the oil pump prime sequence. Maintain the 10 psi pressure throughout the auto prime sequence. When the auto prime is completed, remove the leakage tester and refill the onboard oil reservoir.*



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Priming the oil pump (filling pump and hoses) is required on new or rebuilt engines and any time maintenance is performed on the oiling system.

There are three methods for priming the oil pump:

METHOD 1 – SHIFT SWITCH ACTIVATION PRIME

This method does three things:

a. Fills the oil pump, oil supply hose feeding pump and oil hoses going to the crankcase and air compressor.

b. Activates break-in oil ratio.

c. Initiates a new 120 minute engine break-in cycle.

Refer to priming procedure following.

METHOD 2 – (DDT) DIGITAL DIAGNOSTIC TERMINAL – RESET BREAK-IN

This method is the same as Method 1, except the run history and fault history are erased from the ECM.

Refer to procedure in the Technician Reference Manual provided with the Digital Diagnostic Software Cartridge Part. No. 91-822608-4 or -5.

METHOD 3 – (DDT) DIGITAL DIAGNOSTIC TERMINAL – OIL PUMP PRIME

This method fills the oil pump, oil supply hose feeding pump, and oil hoses going to the crankcase and air compressor.

Refer to procedure in the Technician Reference Manual provided with the Digital Diagnostic Software Cartridge Part. No. 91-822608-4 or -5.

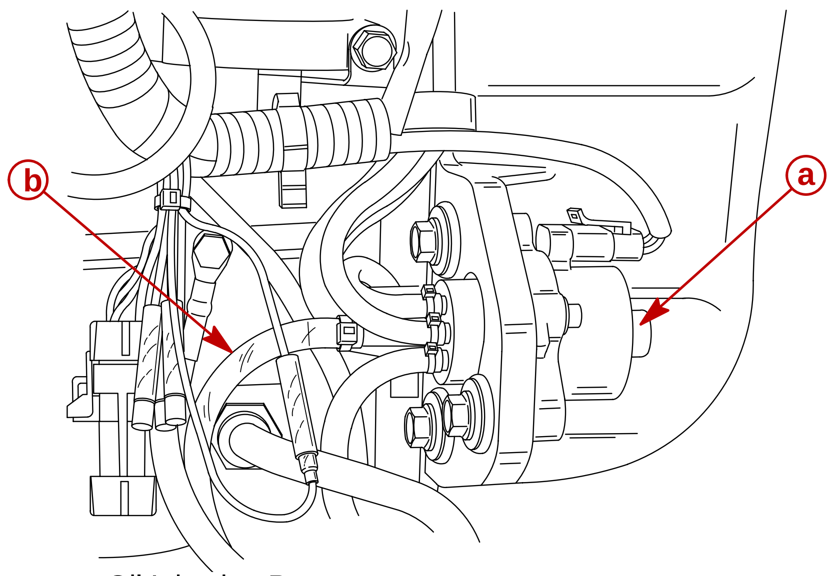
Conditions Requiring Priming the Oil Pump	
Condition	Priming Procedure
New engine	Use Method 1 or 2
Rebuilt Powerhead	Use Method 1 or 2
New Powerhead	Use Method 1 or 2

Oil system ran out of oil	Use Method 3
Oil drained from oil supply hose feeding pump	Use Method 3
Oil pump removed	Use Method 3
Oil injection hoses drained	Use Method 3

Priming Procedure – Method 1

METHOD 1 – SHIFT SWITCH ACTIVATION PRIME PROCEDURE

Before starting engine for the first time, prime the oil pump. Priming will remove any air that may be in the pump, oil supply hose, or internal passages.



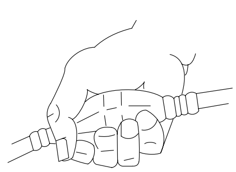
a - Oil Injection Pump
b - Oil Supply Hose

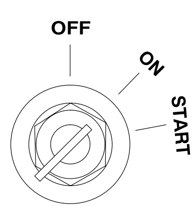
⚠ CAUTION

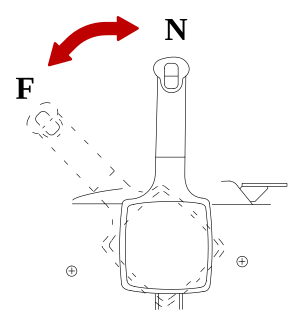
To prevent damage to the fuel pumps, fill the engine fuel system with fuel. Otherwise the fuel pumps will run without fuel during the priming process.

Prime the oil injection pump as follows:

1. Fill the engine fuel system with fuel. Connect fuel hose and squeeze primer bulb until it fells firm.
2. Turn the ignition key switch to the “ON” position.
3. Within the first 10 seconds after the key switch has been turned on, move the remote control handle from neutral into forward gear 3 to 5 times. This will automatically start the priming process.



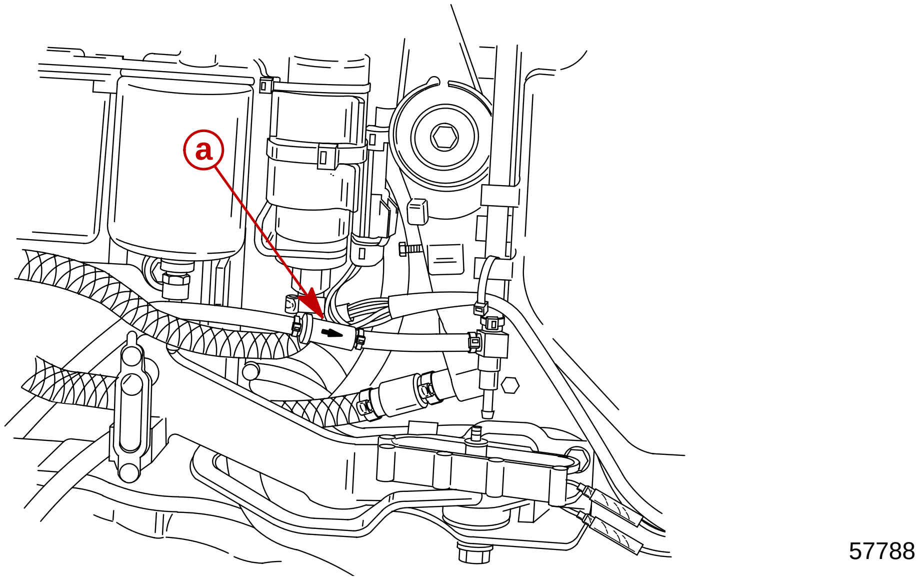




***NOTE:** It may take a few minutes for the pump to complete the priming process.*

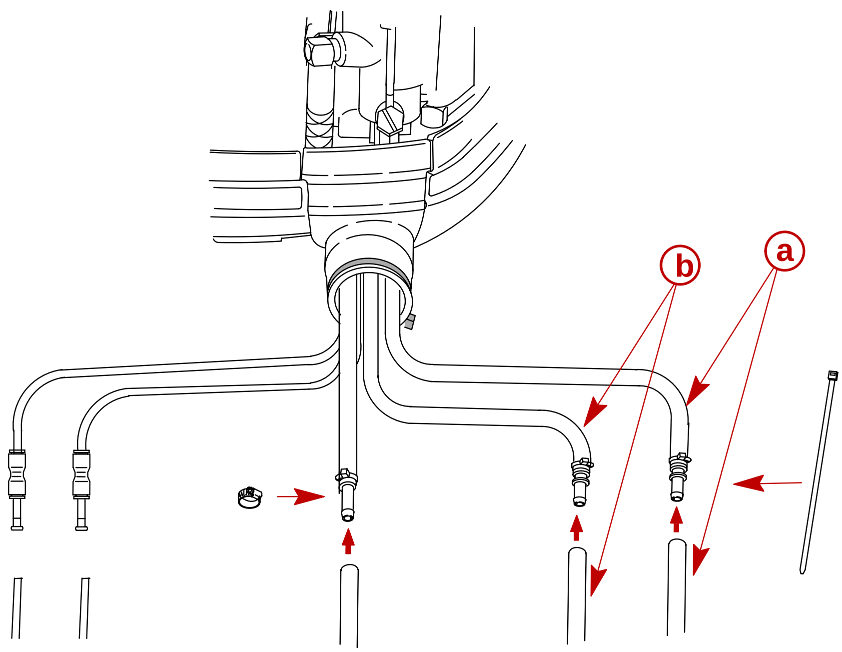
Remote Oil Hose Connections

NOTE: *Oil hose with BLUE stripe contains a directional filter which is designed to trap any debris in the oil before the oil reaches the engine oil reservoir. The filter is marked with an arrow denoting direction of flow of oil and should be installed accordingly. Should engine oil reservoir oil level drop while remote oil tank oil level is normal, oil flow through inline filter has been reduced by debris and filter must be replaced.*



a - Oil Filter

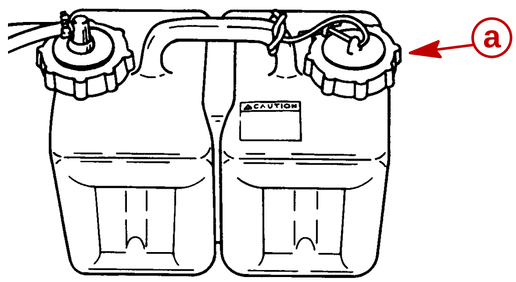
1. Remove shipping cap from fitting and connect oil hose (a). Fasten hose with sta-strap.

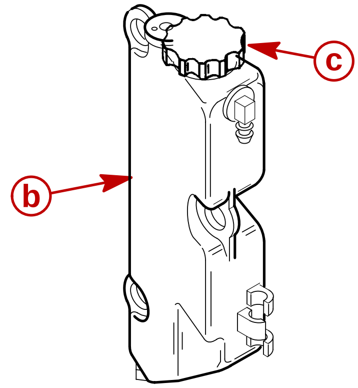


a - Oil Hose with Blue Stripe – Secure with Sta-Strap
b - Oil Hose without Blue Stripe – Secure with Sta-Strap

Filling the Oil Tanks

1. Fill remote oil tank with the recommended oil listed in the Operation and Maintenance Manual. Tighten fill cap.
2. Remove cap and fill engine oil tank with oil. Reinstall the fill cap.
3. Remove air from remote oil hose. Refer to Purging Air from the Engine Oil Reservoir and Remote Oil Hose.



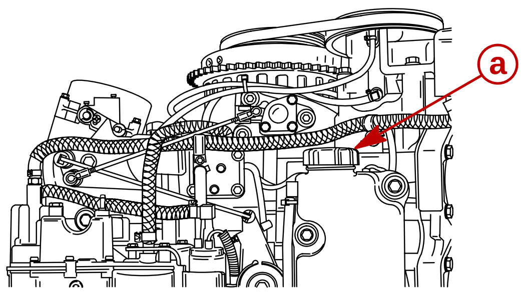


a - Fill Cap
b - Engine Oil Reservoir
c - Fill Cap

Purging Air From the Engine Oil Reservoir and Remote Oil Hose

NOTE: *Before starting engine, make sure the oil pump has been primed.*

1. Start the engine. Run the engine until all the air has been vented out of the reservoir and oil starts to flow out of the reservoir. Re-tighten fill cap.



a - Fill Cap

Oil Warning Systems

LOW OIL LEVEL

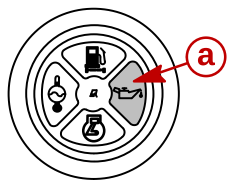
NOTE: *The low oil condition must exist for a minimum of 15 seconds before horn or light is activated.*

The system is activated when the oil in the engine mounted oil reservoir tank drops below 22 fl. oz. (175 ml). You still have an oil reserve remaining for 30 minutes of full speed operation.

NOTE: *The engine mounted oil reservoir (located beneath the top cowl) along with the remote oil tank will have to be refilled (refer to Filling the Oil tanks).*

The warning system works as follows:

The OIL light (a) will come on and the warning horn sounds a series of four short tones. If you continue to operate the outboard, the light will stay on and the horn will sound four short tones every two minutes. The engine has to be shut off to reset the warning system.



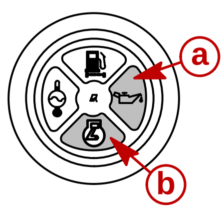
OIL PUMP NOT FUNCTIONING ELECTRICALLY

The system is activated if the oil pump stops functioning electrically. No lubricating oil is being supplied to the engine. Stop the engine as soon as possible. Continuing to operate the engine can result in severe engine damage.

The warning system works as follows:

The OIL light (a) and CHECK ENGINE light (b) will come on and the warning horn will begin sounding. The warning system will automatically reduce and limit the engine speed to 3000 RPM.

The engine has to be shut off to reset the warning system.



Oil System Troubleshooting

Low Oil Warning System is Activated

Problem
Low oil level in engine oil reservoir but not low in remote oil tank
Note: Oil level in engine oil reservoir should be up to the fill cap

Cause	Remedy
Air was never purged from engine oil tank	Purge air from engine oil tank. Refer to procedure
Fill cap is leaking air on remote tank	Caps on remote tank must be sealed and installed tight
Remote oil hoses blocked or punctured	Check hoses for a kink or leakage
Restricted oil outlet filter in remote oil tank	Remove filter and clean
Restricted oil inlet filter in oil hose before engine oil reservoir	Replace oil filter
Air leak in upper portion on the oil pickup tube	Replace tube
Faulty pressure check valve. Located in engine at end of (black without blue stripe) remote oil hose	Replace check valve

Problem
Low oil level in engine oil reservoir and also remote oil tank

Refill both oil tanks. Purge air from engine oil tank. Refer to procedure

Problem
Oil level is not low in either tank

Disconnect blue wires going to the low oil float switch in the engine oil reservoir. Check switch for continuity

No Continuity
Remove engine oil reservoir cap and use wire to pull float to top of travel

- No Continuity
  Oil Float switch is faulty. Replace switch
- Continuity
  Float in oil tank is faulty. Replace oil tank

Continuity
Check for open wire between oil float switch and ECU

Problem
Oil leaks out of exhaust or #6 cylinder

Pulse hose and oil supply hose are reversed

Boat oil tank is mounted higher than pulse hose fitting on engine and oil tank is over-filled

FUEL SYSTEM

Section 3D – Emissions

Table of Contents

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 United States.

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; gasoline 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. However, 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. However, 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.

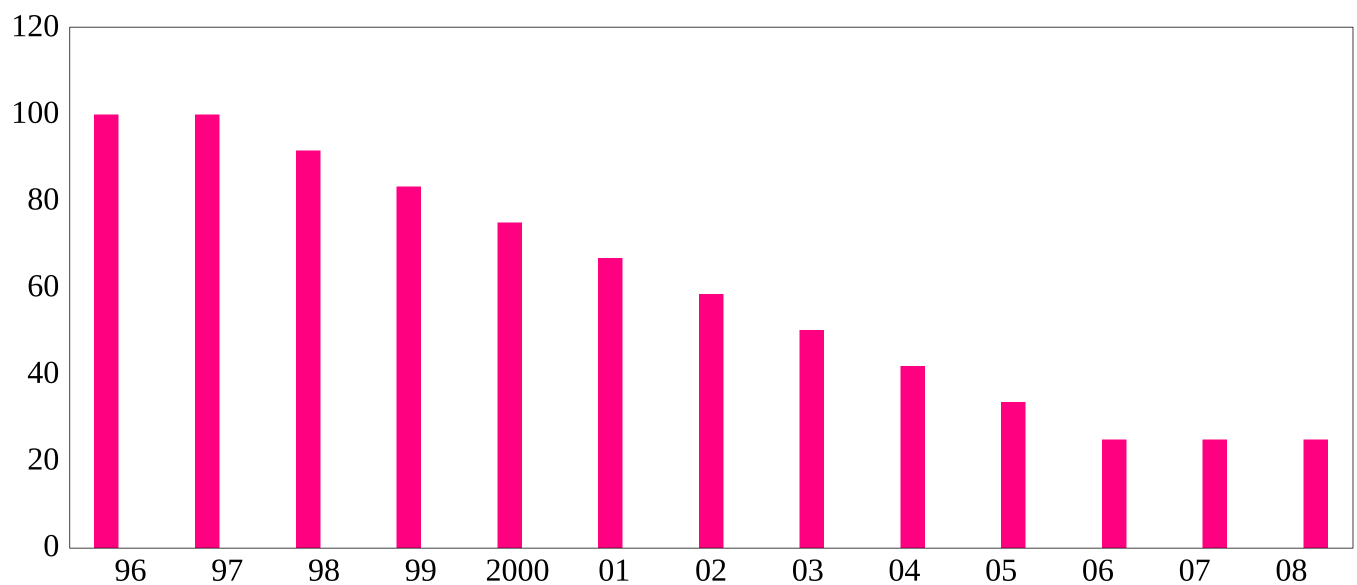
Stoichiometric (14.7:1) Air/Fuel Ratio

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. However, enrichening the air/fuel ratio to decrease combustion temperatures or 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



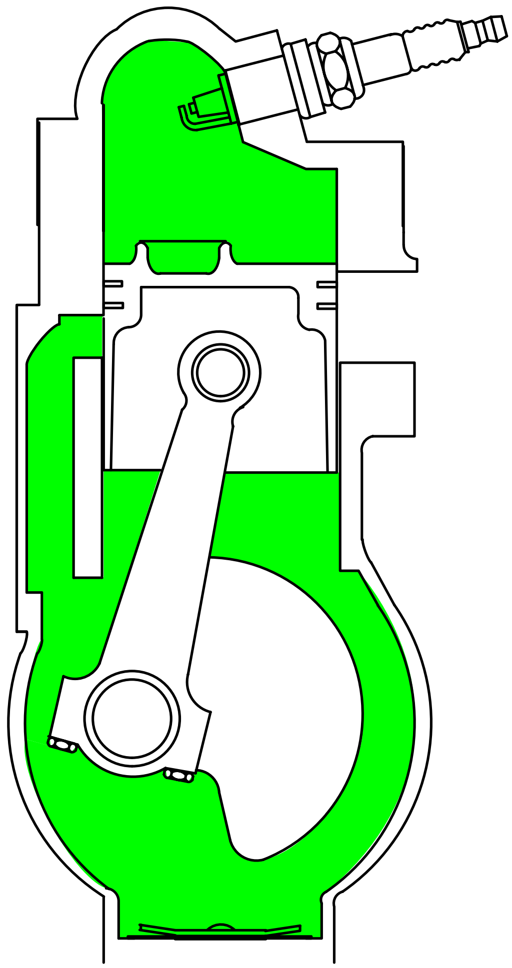
Stratified vs Homogenized Charge

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.

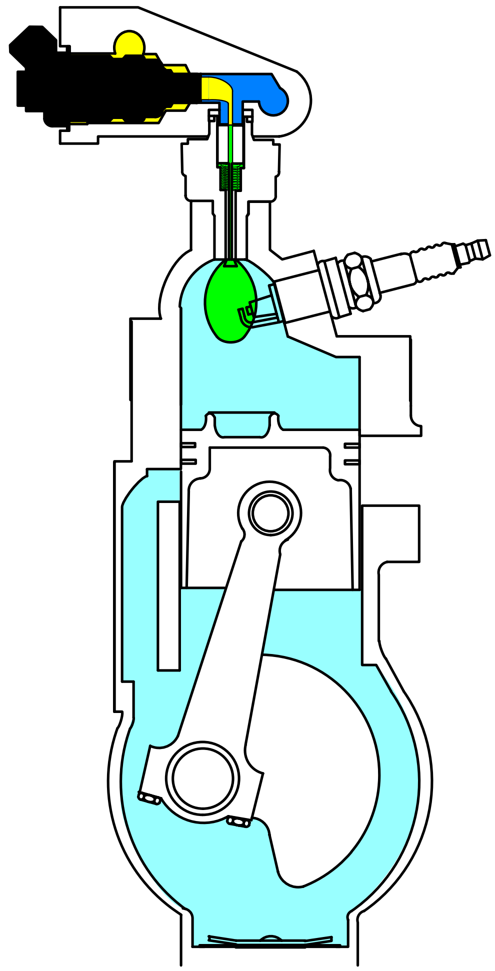
The homogenized charge is easy to ignite when the air/fuel ratio is approximately 14.7:1.



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 is 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. Also included would be factory authorized:

- Installation of performance style gear housings by Mercury Marine.
- Service replacement parts modified, changed or superceded by Mercury Marine.

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.

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:

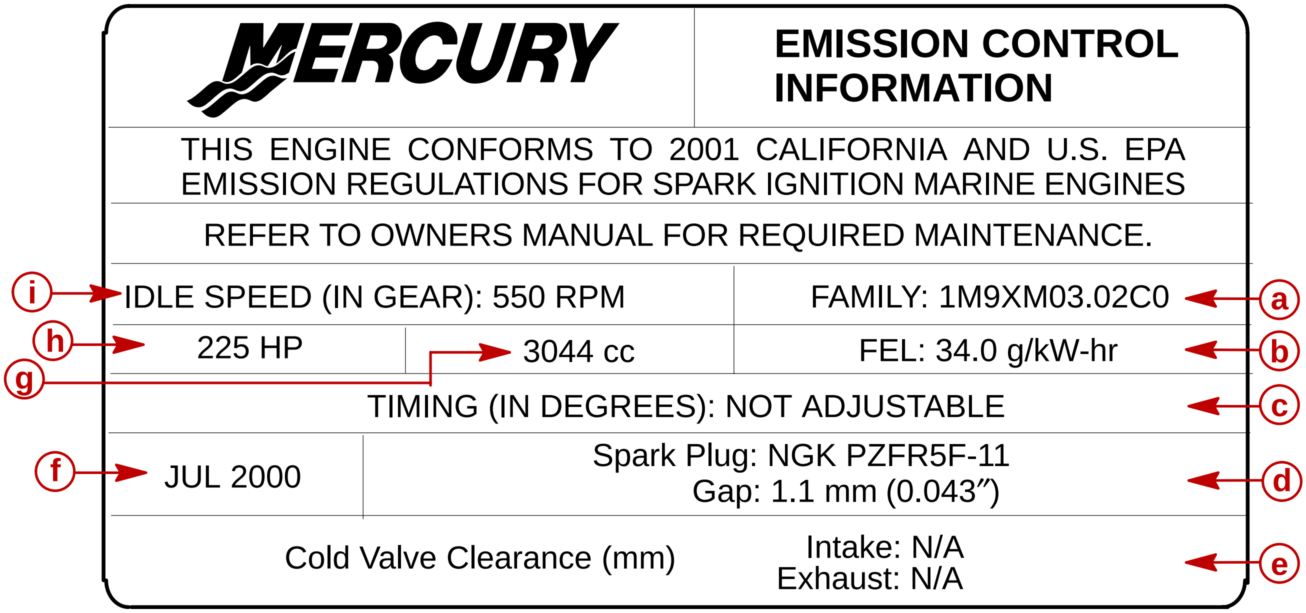
VIA U.S. POSTAL SERVICE:
Office of Mobile Sources
Engine Programs and Compliance Division
Engine Compliance Programs Group (6403J)
401 M St. NW
Washington, DC 20460

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

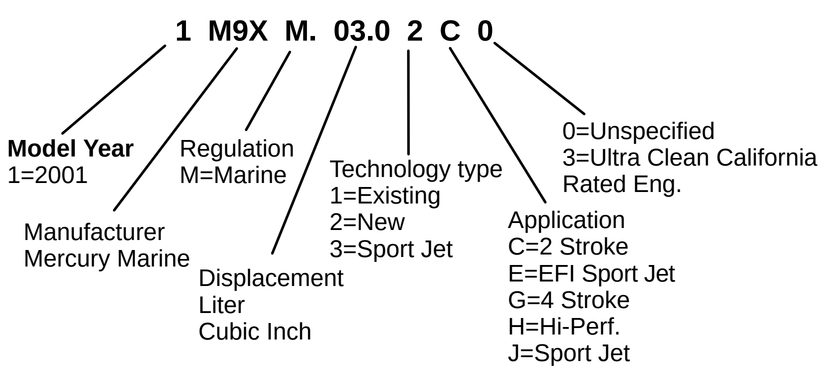
EPA INTERNET WEB SITE:
http:/www.epa.gov/omswww

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
2000 Merc/Mar 3.0 L V6 DFI (200/225 H.P.)	37-804658-00	Intake Plenum
2001 Merc/Mar 3.0 L V6 DFI (200/225 H.P.)	37-804657AO1	Vapor Separator

Service Replacement Certification Label

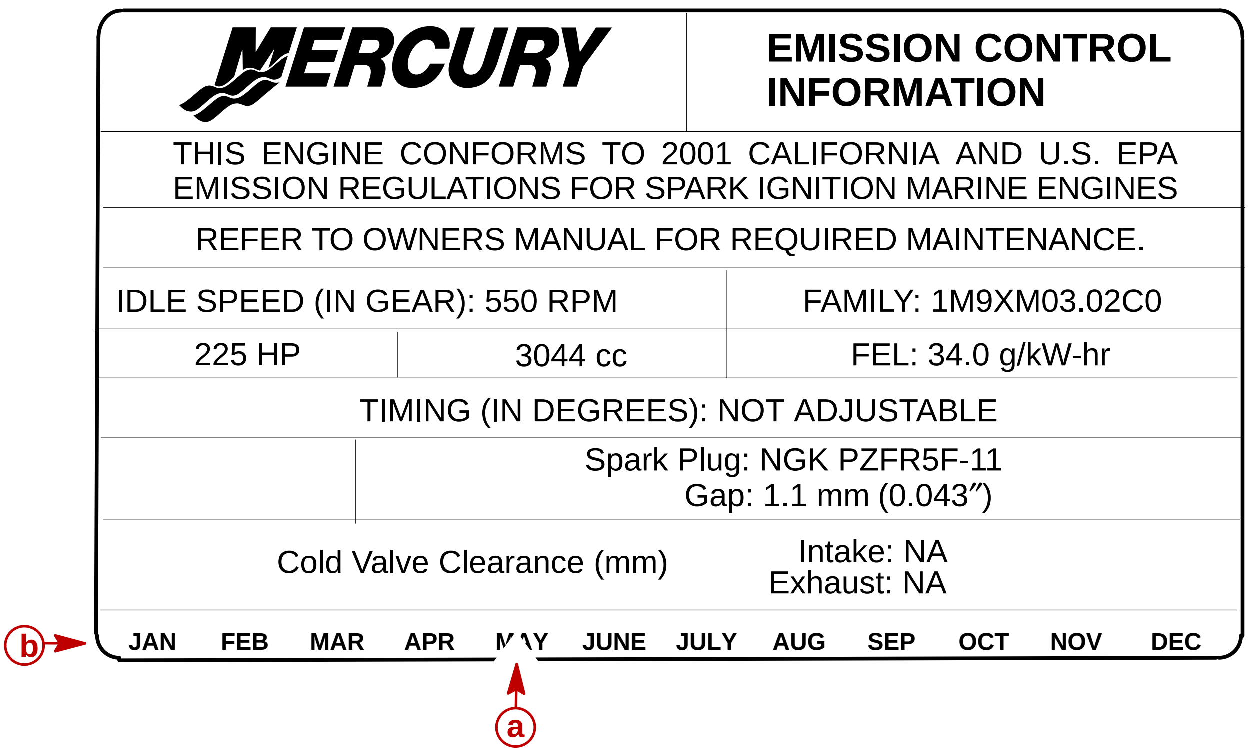
IMPORTANT: By federal law, it is required that all 1998 and newer Mercury Marine outboards have a visible and legible emission certification label. If this label is missing or damaged, contact Mercury Marine Service for replacement if appropriate.

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
2000 Merc/Mar 3.0 L V6 DFI (200/225 H.P.)	37-804658-00	Intake Plenum
2001 Merc/Mar 3.0 L V6 DFI (200/225 H.P.)	37-804658AO1	Vapor Separator

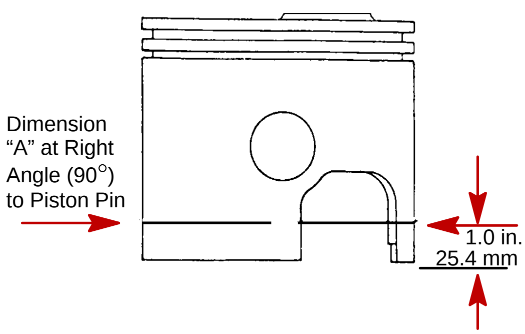
POWERHEAD

Section 4A

Table of Contents

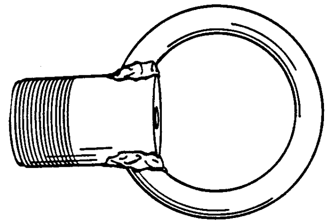
4
A

Powerhead Specifications

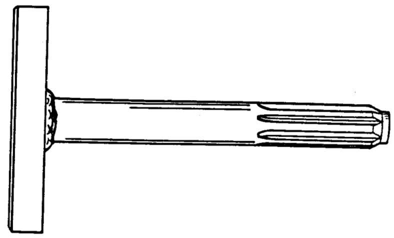
CYLINDER BLOCK	**Type** **Displacement** **Thermostat**	V–6 Cylinder, Two Cycle, Direct Injected 185 cu. in. (3032cc) 60° Vee 120°F (48.9°C)
STROKE	**Length (All Models)**	3.00 in. (76.2mm)
CYLINDER BORE	**Diameter (Std)** **Diameter 0.015 in. Oversize** **Diameter 0.030 in. Oversize** **Taper/Out of Round/Wear Maximum** **Bore Type**	3.6265 in. (92.1131mm) 3.6415 in. (92.4941 mm) 3.6565 in. (92.6751 mm) 0.003 in. (0.076 mm) Cast Iron
PISTON	**Piston Type** **Diameter Standard** **Diameter 0.015 in. Oversize** **Diameter 0.030 in. Oversize**	Aluminum 3.6210 in. ± .0005 in. (91.9734 mm ± 0.0127 mm) 3.6360 in. ± 0.0005 in. (92.3544 mm ± 0.0127 mm) 3.6510 in. ± 0.0005 in. (92.7354 mm ± 0.0127 mm)
CRANKSHAFT	**Maximum Runout**	0.002 in. (0.0508 mm)
PISTON DIAMETER		3.6210 in. ± .0005 in. (91.9734 mm ± .0127 mm) **Using a micrometer, measure dimension "A" at location shown. Dimension "A" should be 3.6210 in. ± .0005 for a STANDARD size piston (new) Dimension "A" will be 0.001 – 0.0015 less if coating is worn off piston (used)**
REEDS	**Reed Stand 0pen (Max.)**	0.020 in. (0.50 mm)

Special Tools

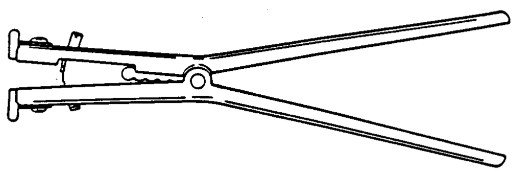
1. Lifting Eye 91-90455



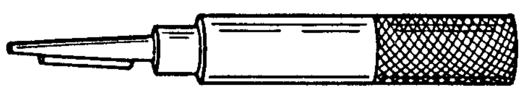
2. Powerhead Stand 91-30591A1



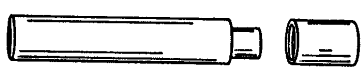
3. Piston Ring Expander 91-24697



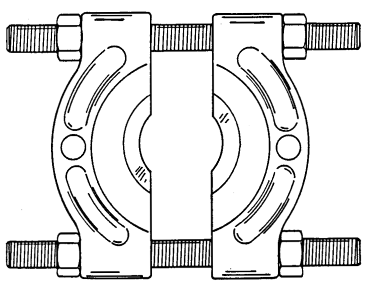
4. Lockring Removal Tool 91-52952A1



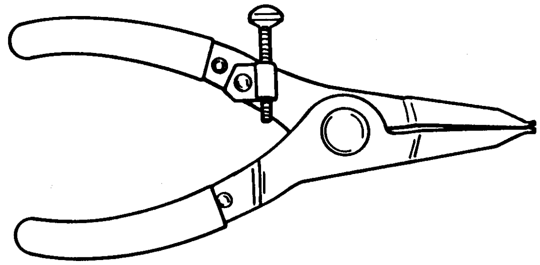
5. Piston Pin Tool 91-92973A1



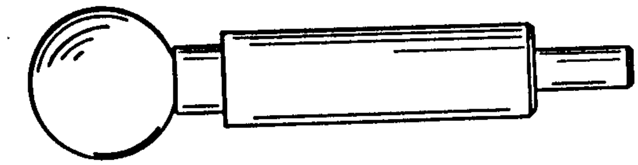
6. Universal Puller Plate 91-37241



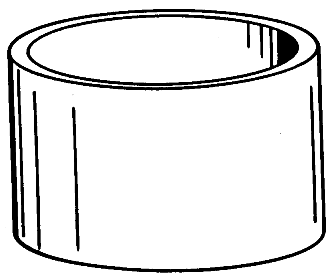
7. Snap Ring Pliers 91-24283



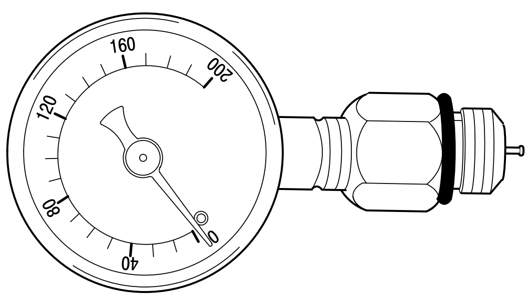
8. Lockring Installation Tool 91-93004A2



9. Piston Ring Compressor 91-823237



10. Compression Tester 91-29287



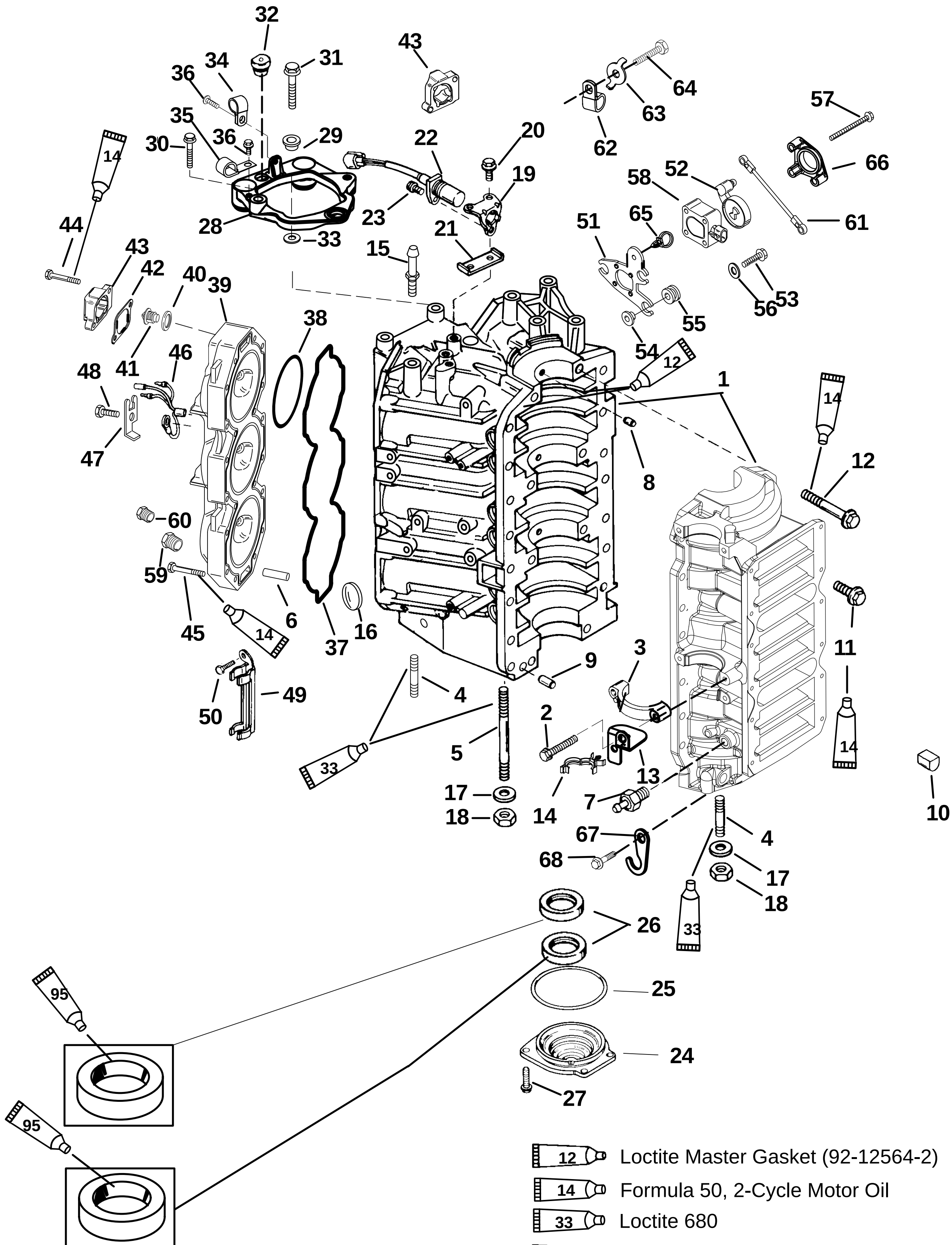
Powerhead Repair Stand

A powerhead repair stand may be purchased from:

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

Notes:

Model Year 2000 Cylinder Block and End Cap



12 Loctite Master Gasket (92-12564-2)

14 Formula 50, 2-Cycle Motor Oil

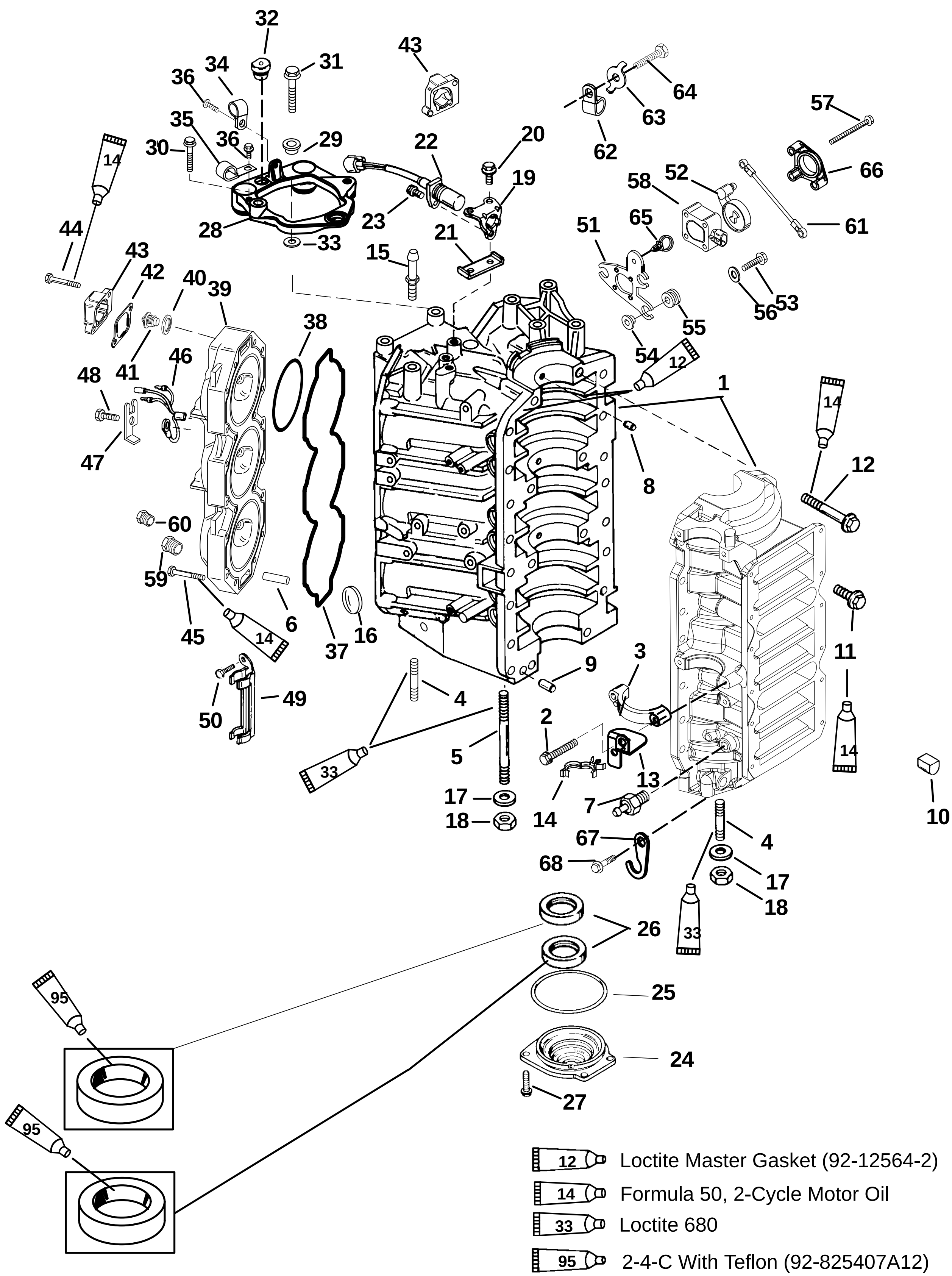
33 Loctite 680

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

Model Year 2000 Cylinder Block and End Cap

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	CYLINDER BLOCK **(225)**			
	1	CYLINDER BLOCK **(200)**			
2	4	SCREW (M8 x 40)		23	31.0
3	2	COVER			
4	4	STUD (M10 x 1.5 x 64)			
5	6	STUD (M10 x 1.5 x 155)			
6	6	WATER DEFLECTOR			
7	1	CHECK VALVE			
8	3	CENTER MAIN PIN			
9	1	DOWEL PIN			
10	6	STOP PLUG			
11	14	SCREW (M8 x 35)		21	28.5
12	8	SCREW (M10 x 1.5)	Torque to 30 lb-ft (40.5 Nm.) and rotate 90 degrees		
13	1	BRACKET			
14	1	CLIP			
15	1	PIN	65		7.5
16	1	PLUG-Serial Number			
17	10	WASHER			
18	10	NUT		50	68
19	1	BRACKET			
20	2	SCREW (M6 x 16)	100		11.5
21	1	GUIDE BRACKET			
22	1	CRANK POSITION SENSOR			
23	1	SCREW (M5 x 10)	50		5.5
24	1	LOWER END CAP			
25	1	O RING			
26	2	OIL SEAL			
27	4	SCREW (M6 x 20)	85		9.5
28	1	PLATE ASSEMBLY			
29	3	MOUNT			
30	3	SCREW (M10 x 45)		40	
31	2	SCREW (M10 x 50)		40	
32	1	GROMMET–SPLIT			
33	6	WASHER			
34	1	CLAMP			
35	1	CLAMP			
36	2	SCREW (M6 x 12)	120	10	13.5

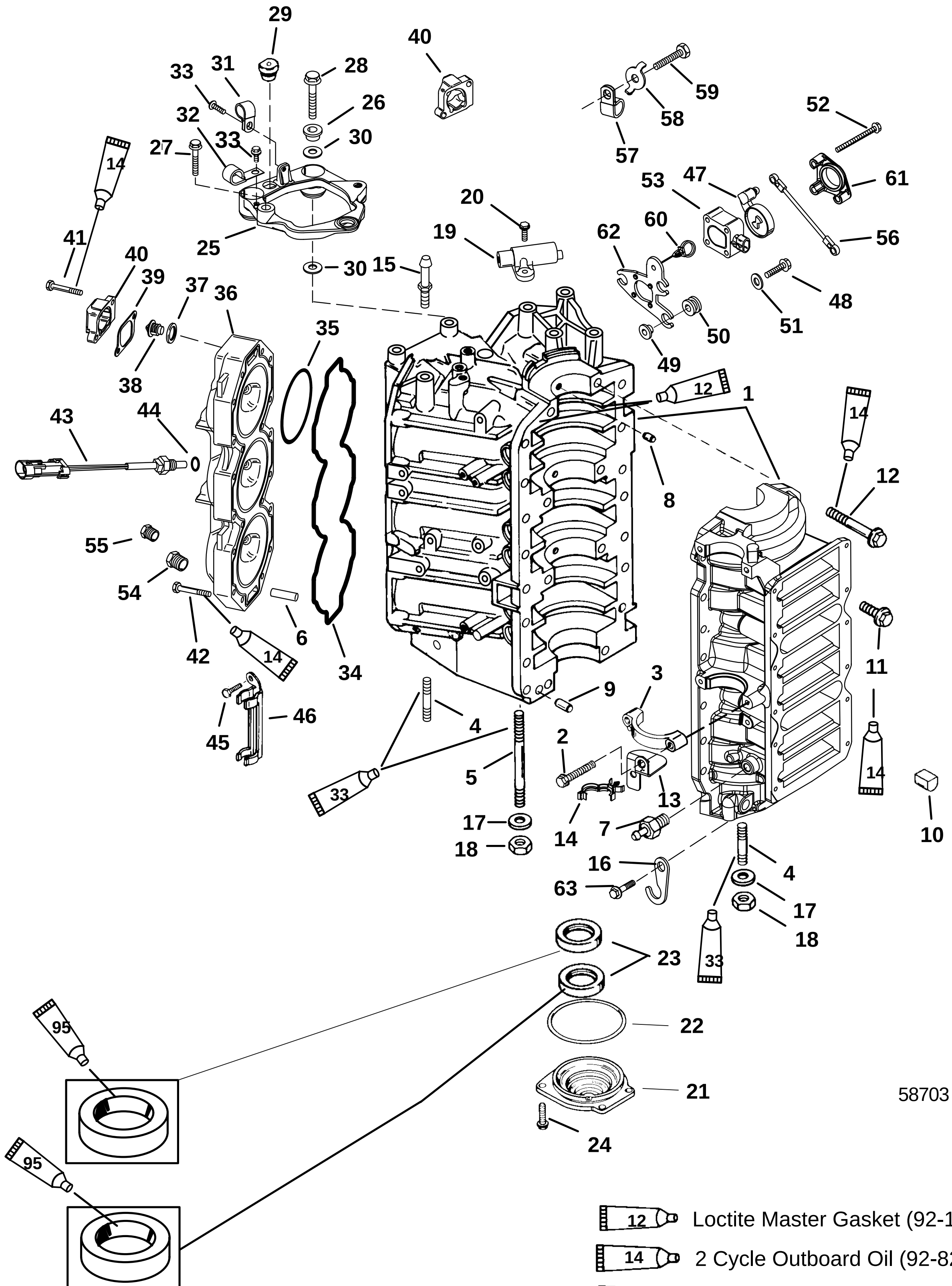
Model Year 2000 Cylinder Block and End Cap



Model Year 2000 Cylinder Block and End Cap

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	lb-ft	Nm.
37	2	SEAL– cylinder head			
38	6	O RING			
39	1	CYLINDER HEAD **(STARBOARD) (200 HP)**			
	1	CYLINDER HEAD **(STARBOARD) (225 HP)**			
	1	CYLINDER HEAD **(PORT) (200 HP)**			
	1	CYLINDER HEAD **(PORT) (225 HP)**			
40	2	SEAL-thermostat			
41	2	THERMOSTAT			
42	2	GASKET– thermostat cover			
43	1	COVER– thermostat **(PORT)**			
	1	COVER– thermostat **(STARBOARD)**			
44	4	SCREW (M6 x 25)	100		11.5
45	40	SCREW (M8 x 50)	20 lb-ft (27 Nm.) and Rotate 90 deg.		
46	1	TEMPERATURE SENSOR **(PORT)**			
	1	TEMPERATURE SENSOR **(STARBOARD)**			
47	2	RETAINER			
48	2	SCREW (M8 x 14)		17	23
49	1	CLAMP			
50	2	SCREW (M6 x 12)	100		11.5
51	1	BRACKET			
52	1	TPI LEVER			
53	3	SCREW-Bracket to Crankcase (M6 x 25)	55		6.0
54	3	BUSHING			
55	3	GROMMET			
56	3	WASHER			
57	3	SCREW TPS to bracket (M5 x 45)			
58	1	THROTTLE POSITION SENSOR			
59	1	PIPE PLUG			
60	1	PIPE PLUG			
61	1	LINK			
62	1	CLIP			
63	1	WASHER			
64	1	SCREW (M6 x 16)			
65	1	CLIP			
66	1	TPS COVER			
67	1	OIL LINE RETAINER			
68	1	SCREW (M8 x 20)			

Model Year 2001 Cylinder Block and End Cap

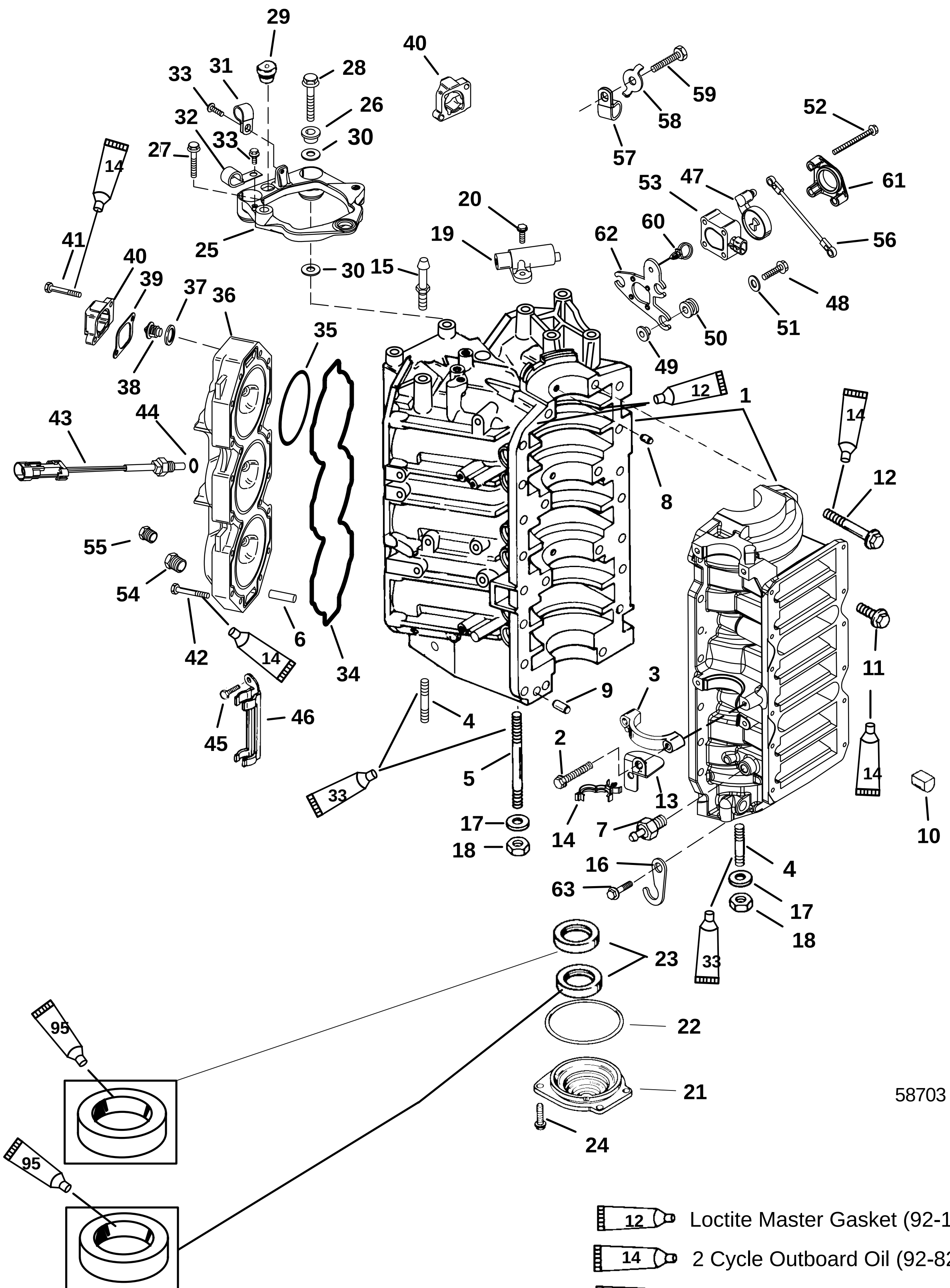


- 12 Loctite Master Gasket (92-12564-2)
- 14 2 Cycle Outboard Oil (92-826666A24)
- 33 Loctite 680 (92-809833)
- 95 2-4-C With Teflon (92-825407A12)

Model Year 2001 Cylinder Block and End Cap

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	CYLINDER BLOCK **(225)**			
	1	CYLINDER BLOCK **(200)**			
2	4	SCREW (M8 x 40)		23	31.0
3	2	COVER			
4	4	STUD (M10 x 1.5 x 64)			
5	6	STUD (M10 x 1.5 x 155)			
6	6	WATER DEFLECTOR			
7	1	CHECK VALVE			
8	3	CENTER MAIN PIN			
9	1	DOWEL PIN			
10	6	STOP PLUG			
11	14	SCREW (M8 x 35)		21	28.5
12	8	SCREW (M10 x 1.5)	Torque to 30 lb-ft (40.5 Nm.) and rotate 90 degrees		
13	1	BRACKET			
14	1	CLIP			
15	1	PIN	65		7.5
16	1	OIL LINE RETAINER			
17	10	WASHER			
18	10	NUT		50	68
19	1	CRANK POSITION SENSOR			
20	2	SCREW (M5 x 16)	100		11.5
21	1	LOWER END CAP			
22	1	O RING			
23	2	OIL SEAL			
24	4	SCREW (M6 x 20)	85		9.5
25	1	PLATE ASSEMBLY			
26	3	MOUNT			
27	3	SCREW (M10 x 45)		40	
28	2	SCREW (M10 x 50)		40	
29	1	GROMMET–SPLIT			
30	6	WASHER			
31	1	CLAMP			
32	1	CLAMP			
33	2	SCREW (M6 x 12)	120	10	13.5

Model Year 2001 Cylinder Block and End Cap



12 Loctite Master Gasket (92-12564-2)

14 2 Cycle Outboard Oil (92-826666A24)

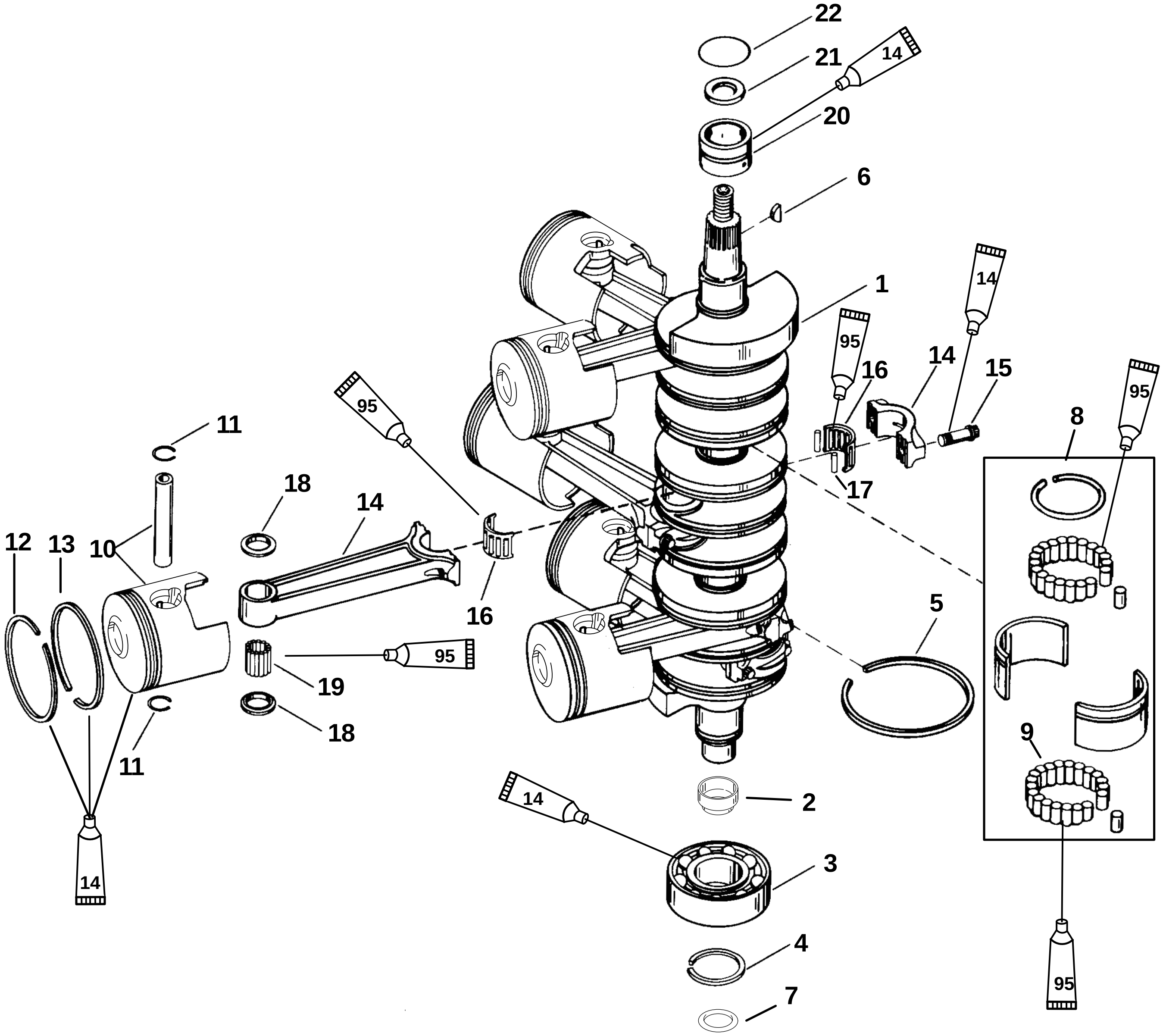
33 Loctite 680 (92-809833)

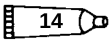
95 2-4-C With Teflon (92-825407A12)

Model Year 2001 Cylinder Block and End Cap

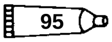
REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
34	2	SEAL– cylinder head			
35	6	SEAL			
36	1	CYLINDER HEAD **(STARBOARD) (200 HP)**			
	1	CYLINDER HEAD **(STARBOARD) (225 HP)**			
	1	CYLINDER HEAD **(PORT) (200 HP)**			
	1	CYLINDER HEAD **(PORT) (225 HP)**			
37	2	SEAL-thermostat			
38	2	THERMOSTAT			
39	2	GASKET– thermostat cover			
40	1	COVER– thermostat **(PORT)**			
	1	COVER– thermostat **(STARBOARD)**			
41	4	SCREW (M6 x 25)	100		11.5
42	40	SCREW (M8 x 50)	20 lb-ft (27 Nm.) and Rotate 90 deg.		
43	1	TEMPERATURE SENSOR **(PORT)**			
	1	TEMPERATURE SENSOR **(STARBOARD)**			
44	2	O-RING			
45	2	SCREW (M6 x 12)	100		11.5
46	1	CLAMP			
47	1	TPI LEVER			
48	3	SCREW-Bracket to Crankcase (M6 x 25)	55		6.0
49	3	BUSHING			
50	3	GROMMET			
51	3	WASHER			
52	3	SCREW TPS to bracket (M5 x 45)			
53	1	THROTTLE POSITION SENSOR			
54	1	PIPE PLUG			
55	1	PIPE PLUG			
56	1	LINK			
57	1	CLIP			
58	1	WASHER			
59	1	SCREW (M6 x 16)			
60	1	CLIP			
61	1	TPS COVER			
62	1	OIL LINE RETAINER			
63	1	SCREW (M8 x 20)			

Crankshaft, Pistons and Connecting Rods





2 Cycle Outboard Oil (92-826666A24)



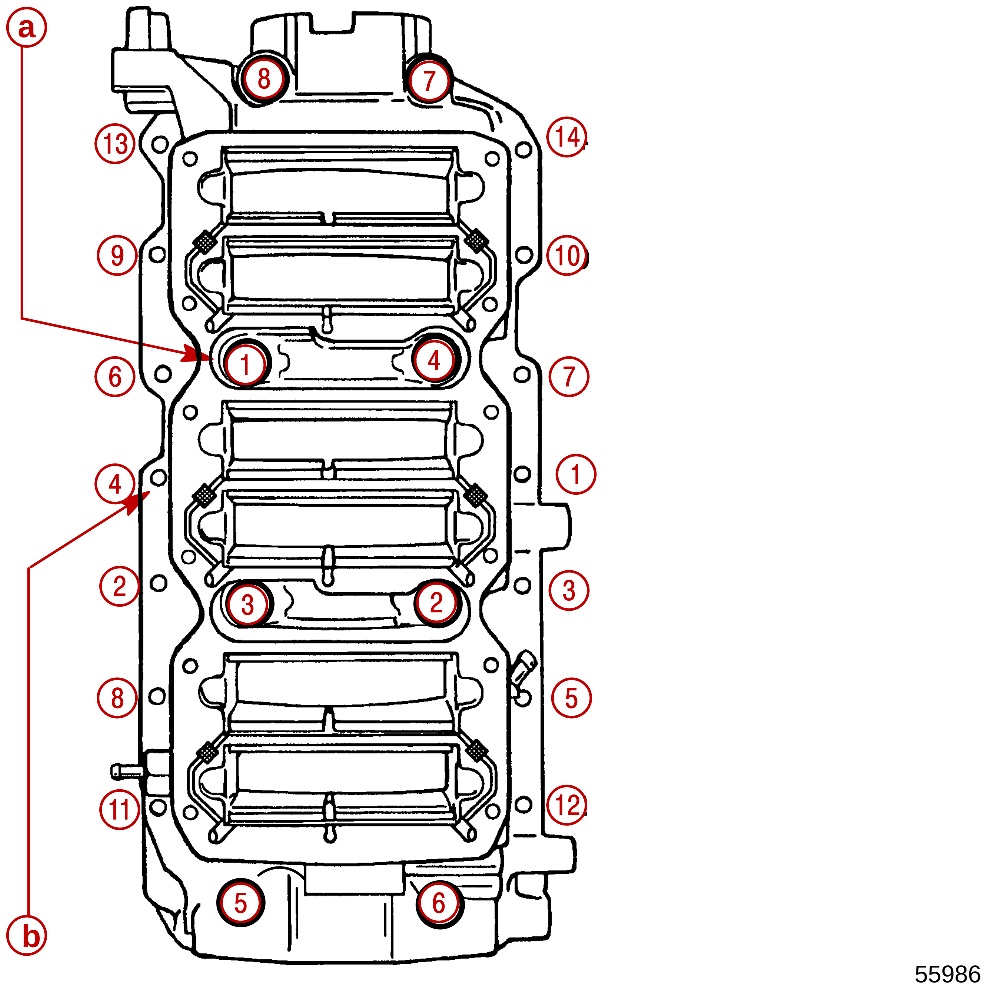
2-4-C With Teflon (92-825407A12)

Crankshaft, Pistons and Connecting Rods

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	CRANKSHAFT			
2	1	WEAR SLEEVE			
3	1	BALL BEARING (LOWER)			
4	1	RETAINING RING			
5	7	SEAL RING			
6	1	WOODRUFF KEY			
7	1	O RING			
8	2	BEARING RACE			
9	88	NEEDLE ROLLER			
10	3	PISTON **(STBD-STANDARD)**			
	3	PISTON **(PORT-STANDARD)**			
11	12	LOCK RING			
12	6	PISTON RING (UPPER)			
13	6	PISTON RING (LOWER)			
14	6	CONNECTING ROD ASSEMBLY			
15	12	SCREW (1-1/4 IN.)	Apply light oil to threads and bolt face: 1st torque - 15 lb-in (1.5 Nm.) 2nd torque - 30 lb-ft (40.5 Nm.) Turn bolt an additional 90 degrees after 2nd torque is attained.		
16	12	BEARING CAGE			
17	96	NEEDLE ROLLER BEARING			
18	12	THRUST WASHER			
19	204	ROLLER BEARING			
20	1	MAIN BEARING (UPPER)			
21	1	OIL SEAL			
22	1	O RING			

Torque Sequence

CRANKCASE COVER BOLTS (AND TORQUE SEQUENCE)

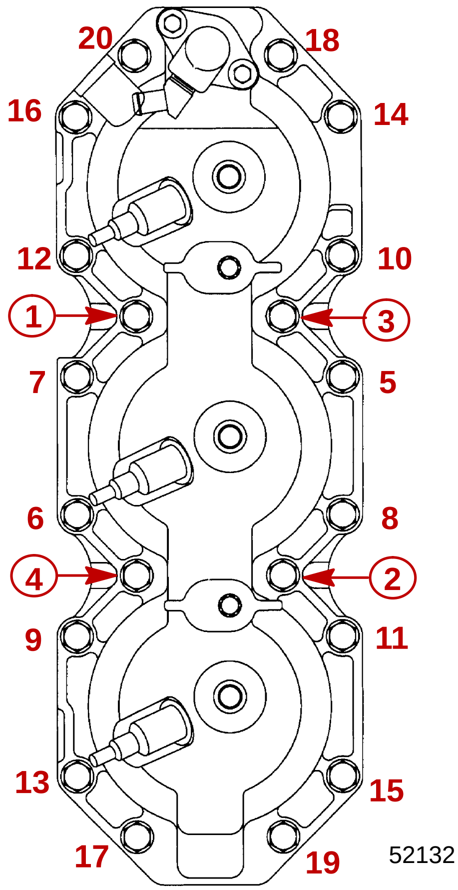


a - Add light oil to threads and bolt face: 8 Bolts (3/8 in. - 16 in.) 38 lb. ft. (51.5 N·m)

b - Bolts (M8 x 1.25 x 35) 28 lb. ft. (38 N·m)

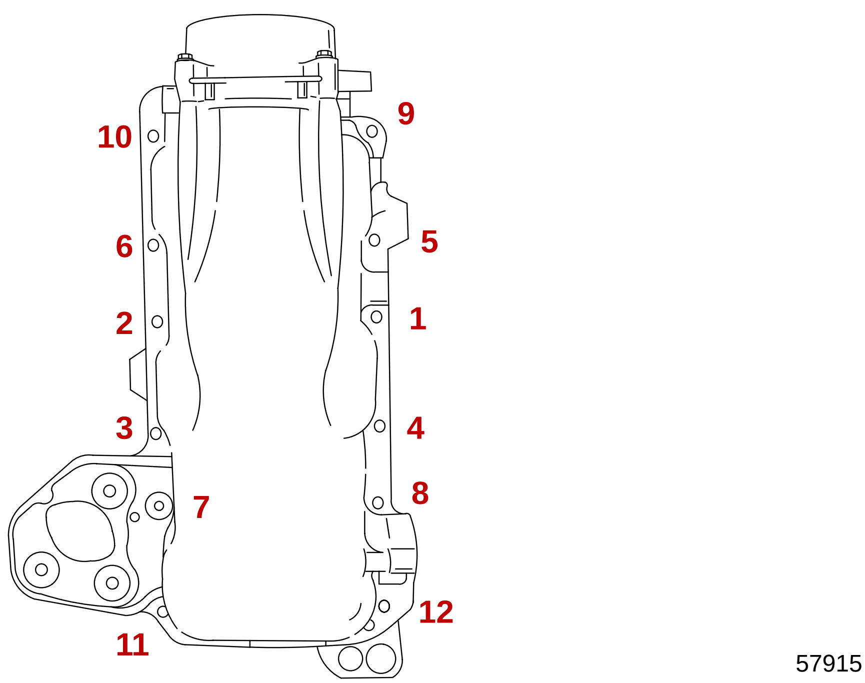
CYLINDER HEAD BOLTS

Add light oil to threads and bolt face: 20 lb. ft. (27 Nm) then turn an additional 90°.



AIR PLENUM/REED BLOCK ASSEMBLY PLATE BOLTS

100 lb. in. (11.5 Nm)



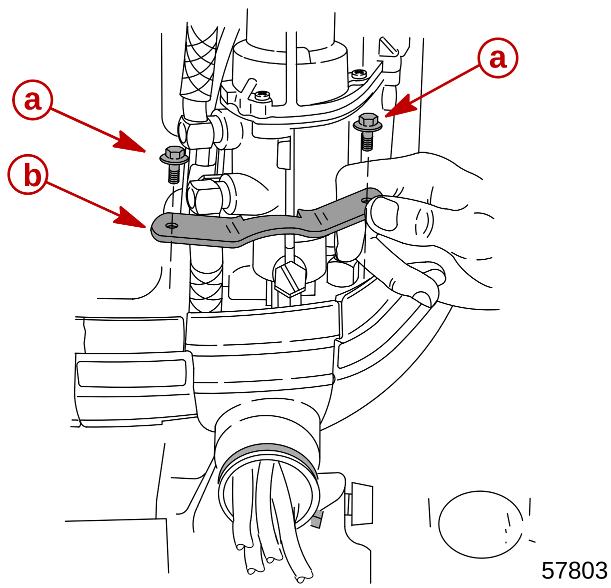
General Information

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

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

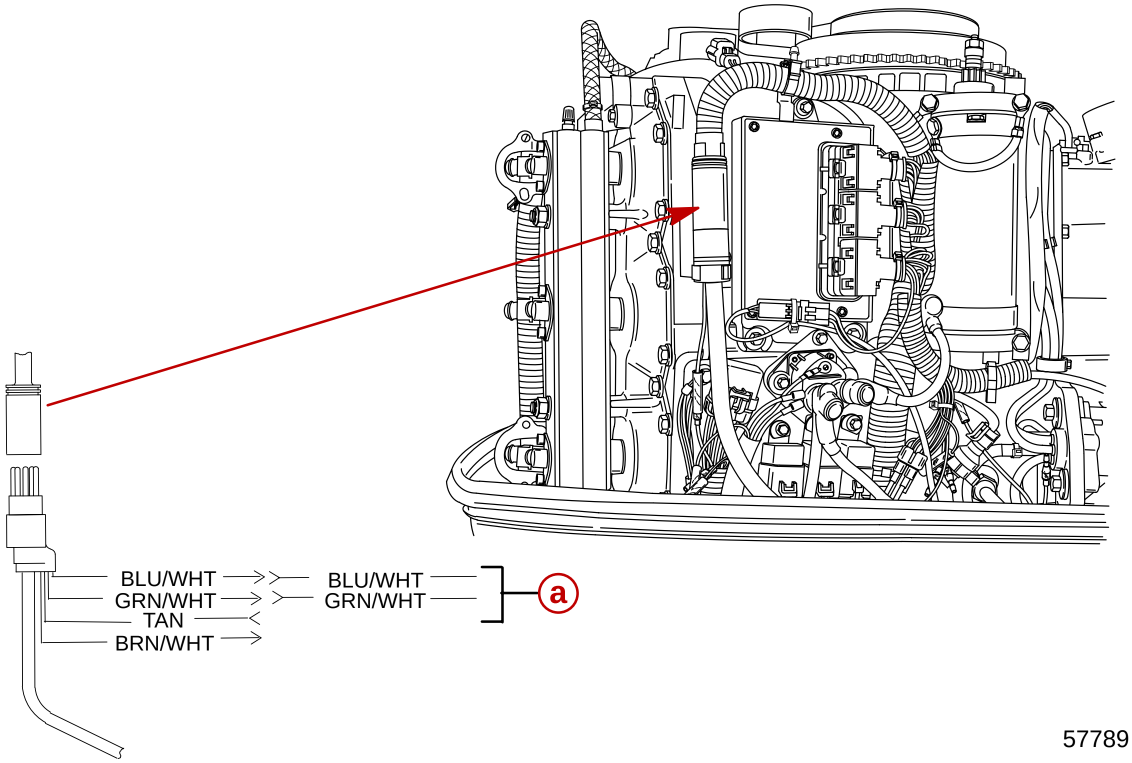
Powerhead Removal from Driveshaft Housing

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



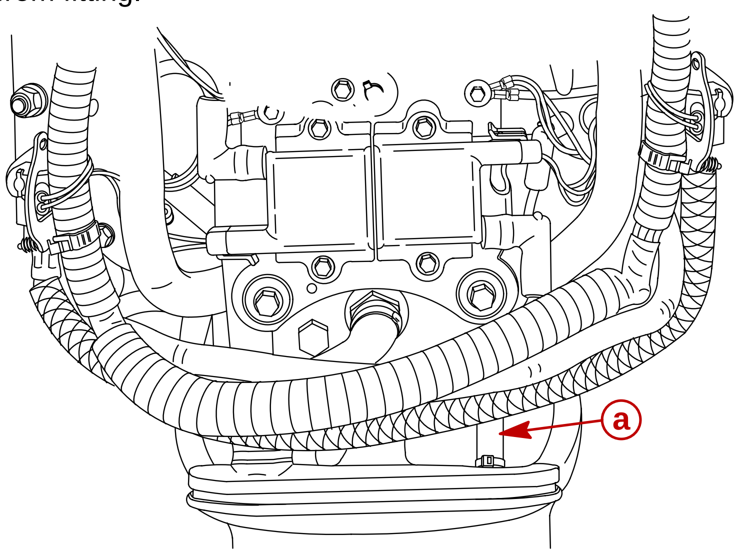
a - Screws
b - Retainer

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



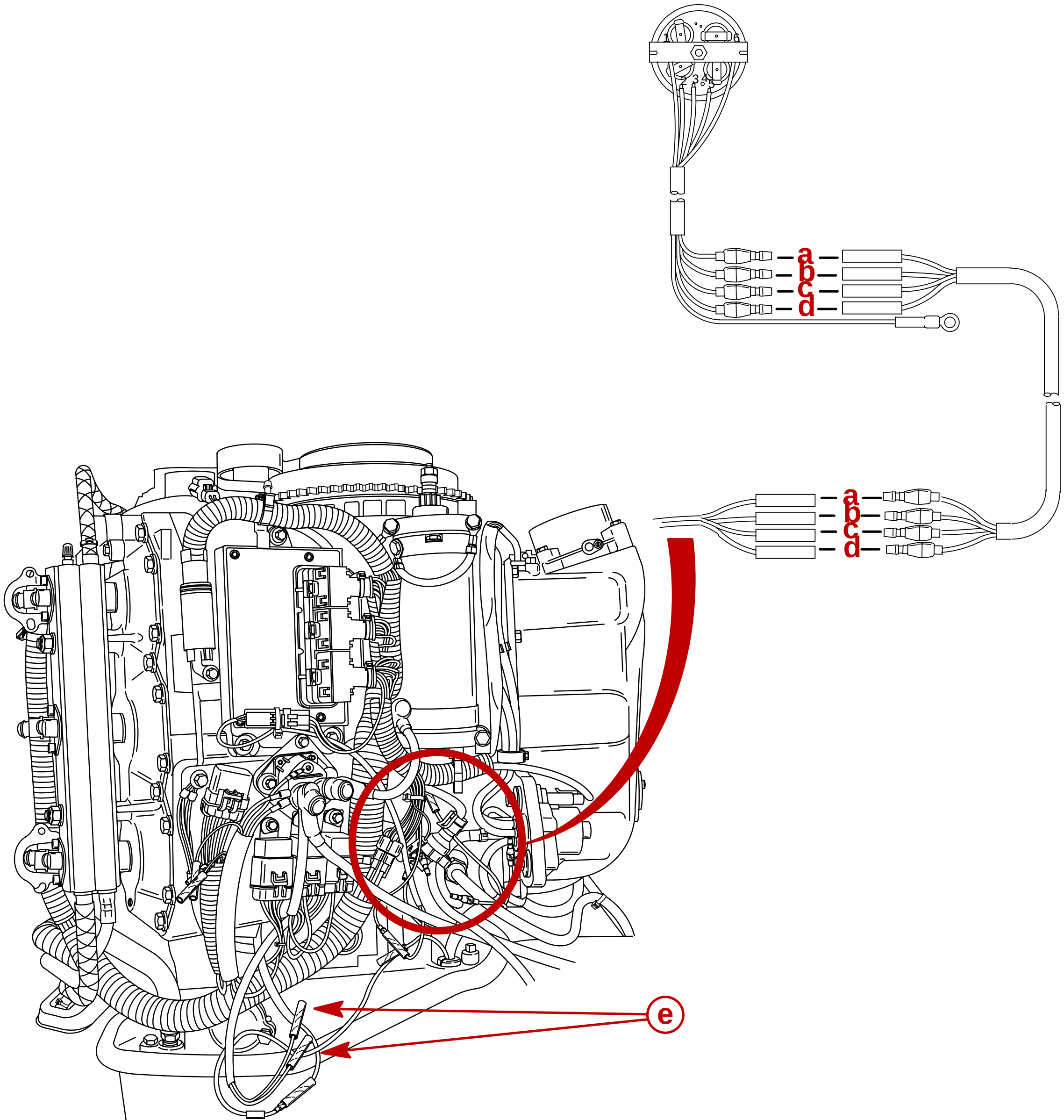
a - Power Trim Connections

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



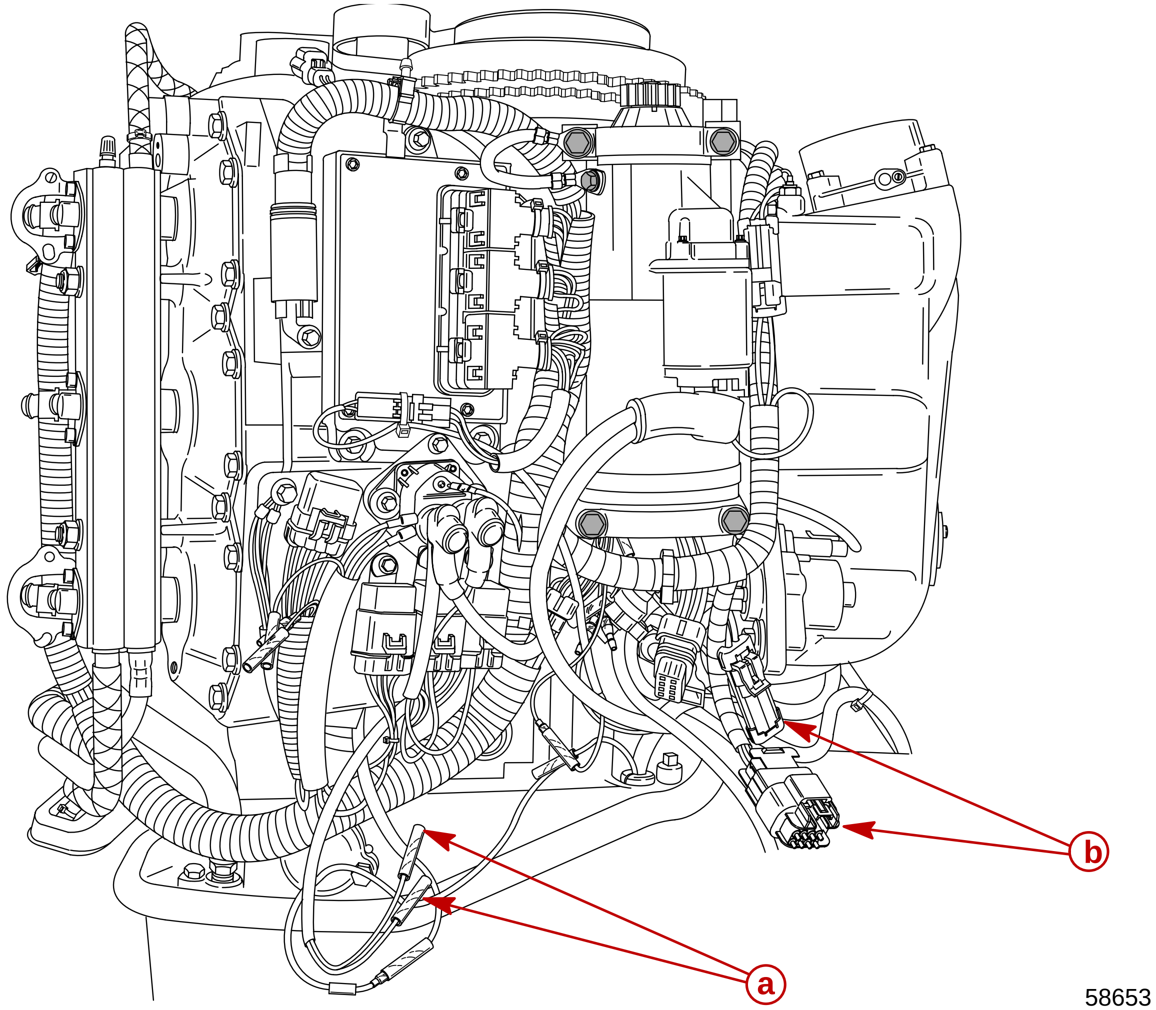
a - Tell-tale Hose

8. **Model Year 2000** – Disconnect warning gauge harness and BLUE and GREEN trim harness leads.



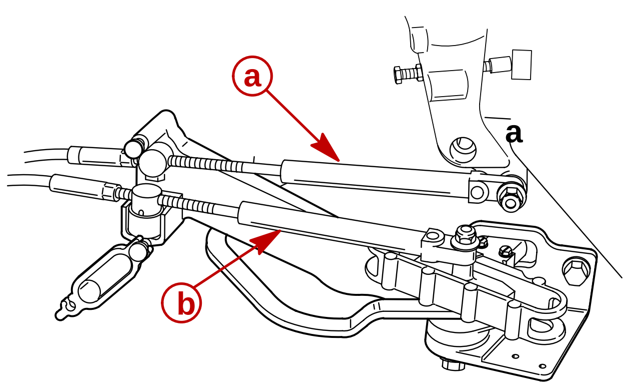
a - TAN/BLACK
b - TAN/WHITE
c - PINK/LT. BLUE to PINK/LT. BLUE
d - ORANGE
e - Trim Harness Leads

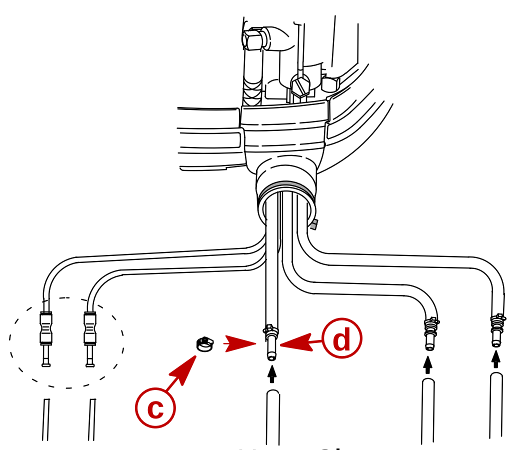
9. **Model Year 2001** – Disconnect Smart Craft harness connectors and BLUE and GREEN trim harness leads.



a - Trim Harness Leads
b - Smart Craft Harness Connectors

10. Slide outboard shift lever into neutral position.
11. Remove throttle cable and shift cable from control cable anchor bracket.
12. Disconnect input fuel line.

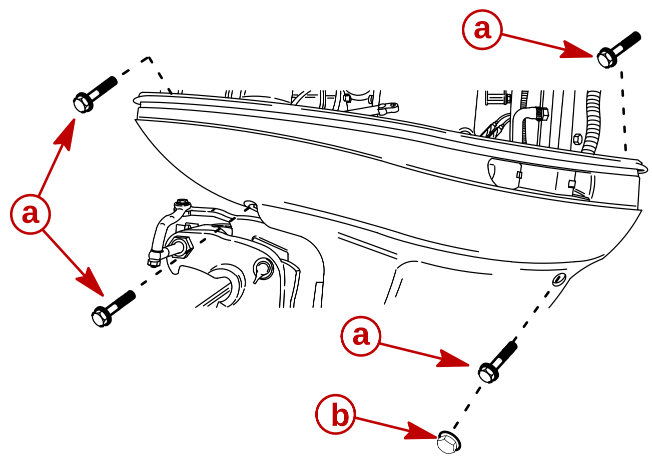




a - Throttle Cable
b - Shift Cable

c - Hose Clamp
d - Fuel Line

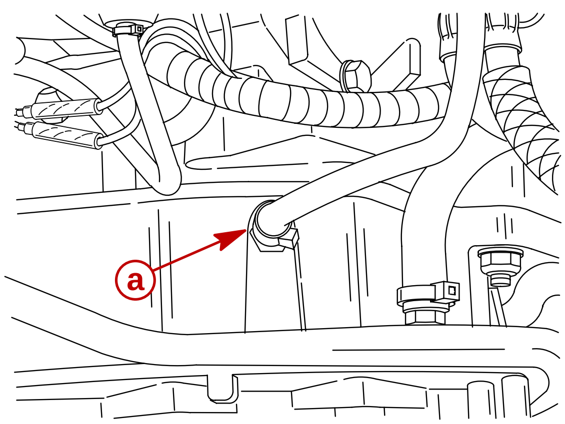
13. Remove 4 bolts securing bottom cowl halves and remove bottom cowling.

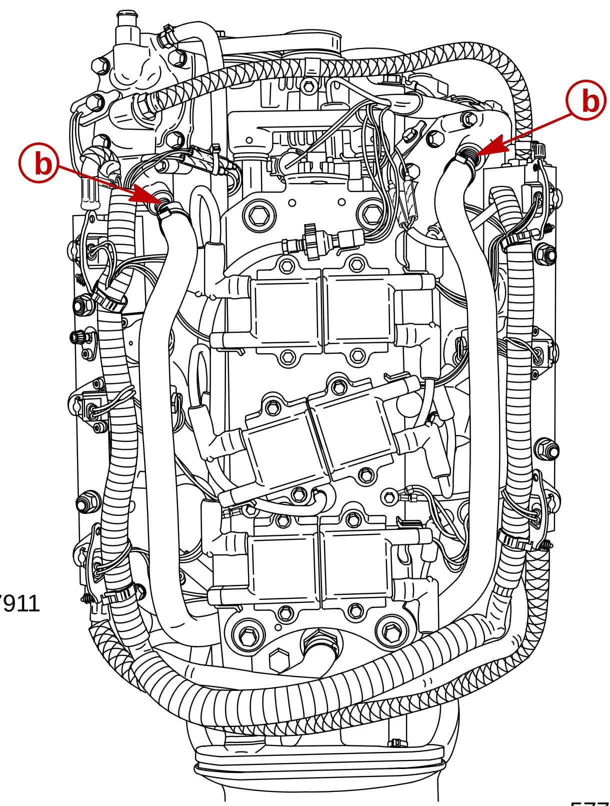


a - Bolt
b - Plug – Remove for access to lower screw

14. Remove fuel rail inlet water hose from fitting on exhaust adaptor plate.

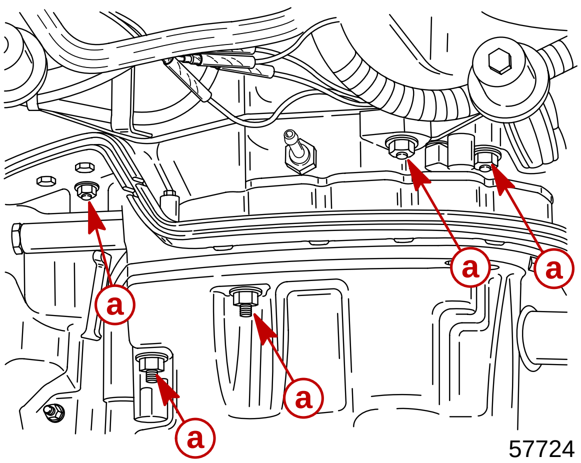
15. Remove thermostat cover hoses from thermostat covers.

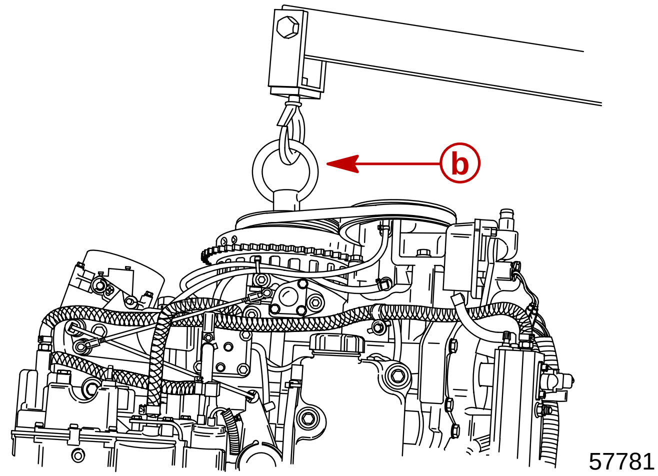




a - Fuel Rail Inlet Water Hose
b - Thermostat Hoses

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





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

Removing Engine Components

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

Removing Engine Components Individually

Section 2 Starter Motor
Starter Motor
*Electronic Control Module
*Ignition Coil
*Starter Solenoid
Alternator
Flywheel

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

Section 4
Throttle/Shift Control Platform
Throttle/Shift Cable Installation and Adjustment

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

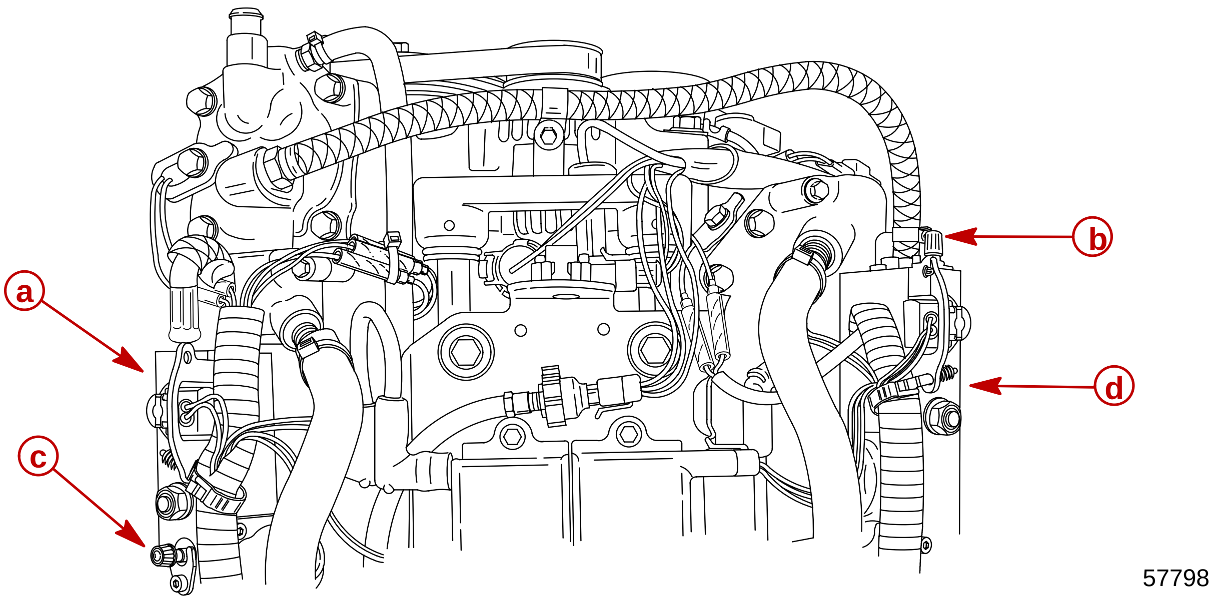
Removing Engine Components as an Assembly

VAPOR SEPARATOR TANK (VST) AND FUEL RAIL REMOVAL

CAUTION

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

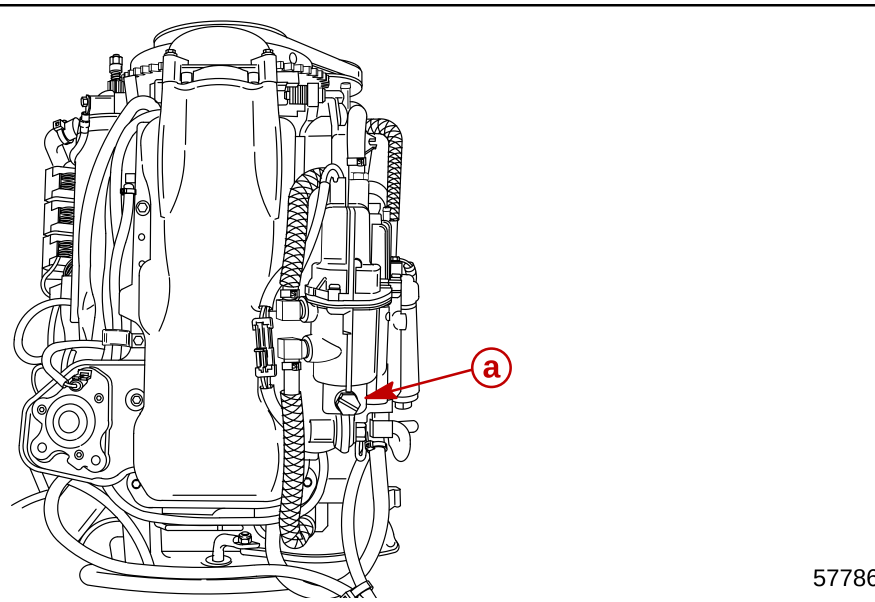
NOTE: *Use Fuel/Air Pressure Gauge 91-16850--1 or 91-852087A1/A2 to de-pressurize air hose first and then fuel hose.*



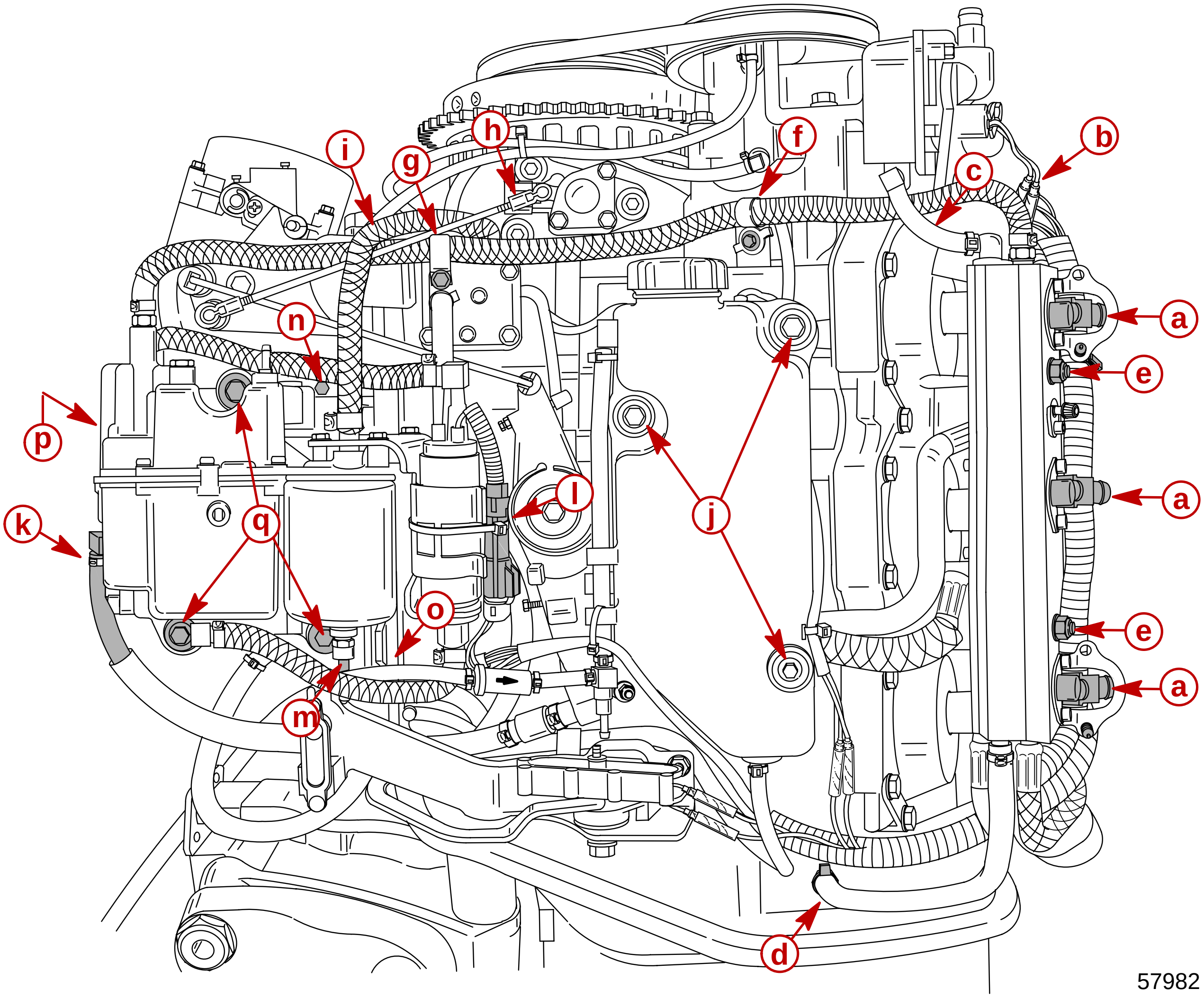
a - Port Fuel Rail
b - Fuel Pressure Port
c - Air Pressure Port
d - Starboard Fuel Rail

WARNING

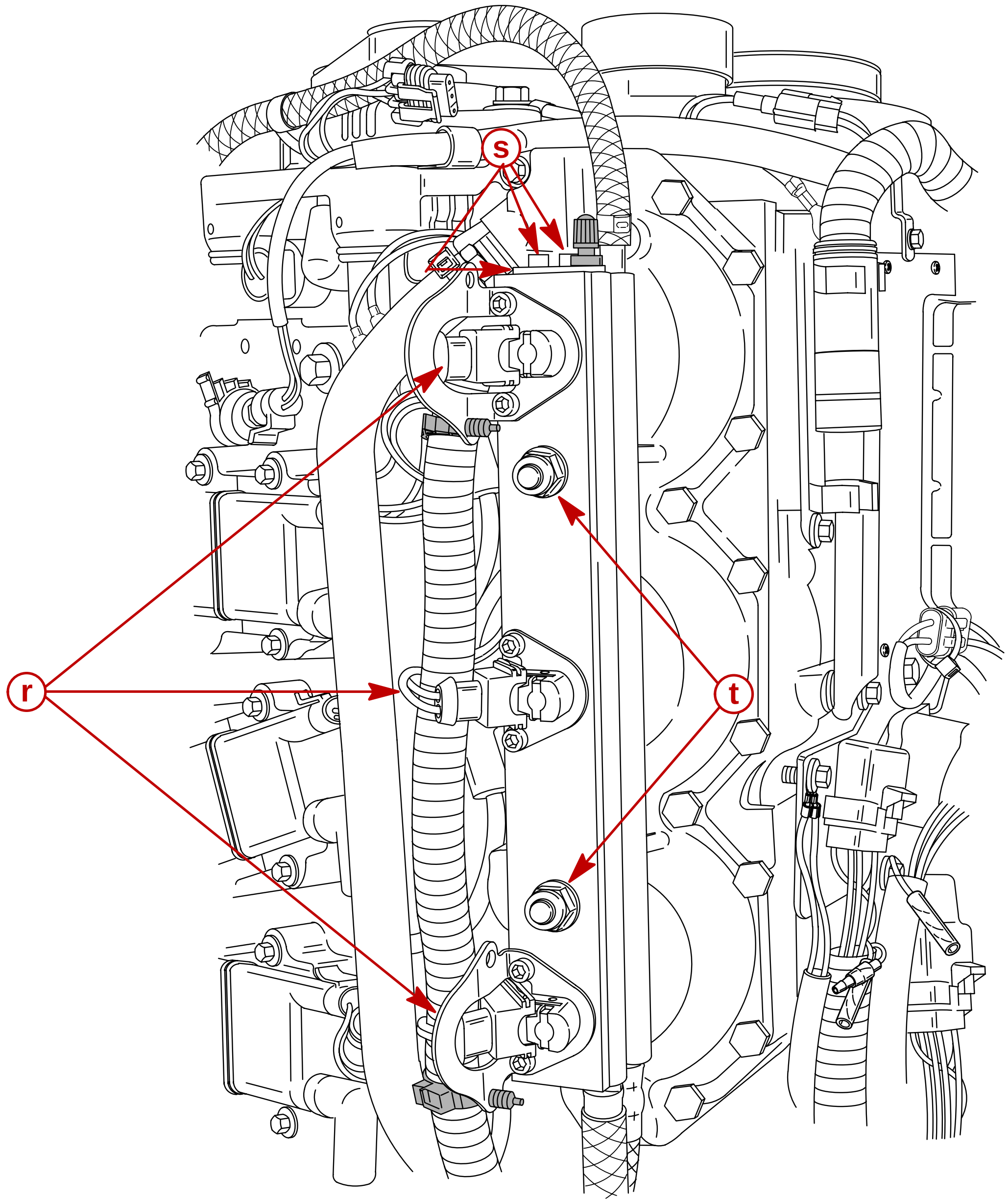
Drain fuel from vapor separator tank (VST) into a suitable container. Even though VST has been drained, fuel may still remain in fuel rails and hoses. Normal precautionary procedures should be adhered to while working with the fuel system. Avoid sparks, smoking and open flame while in the presence of liquid fuel or fuel vapors.



a - VST Drain Plug



a - Disconnect port fuel rail fuel injector harnesses and open harness clamps.
b - Disconnect air compressor temperature sensor leads.
c - Remove air compressor coolant hose.
d - Remove port fuel rail coolant hose.
e - Remove 2 nuts securing port fuel rail.
f - Remove fuel hose clamp above oil reservoir.
g - Remove fuel hose clamp from pulse fuel pump.
h - Remove link arm from throttle position sensor.
i - Remove pulse pump output hose.
j - Remove 3 bolts securing oil reservoir.
k - Remove clamp securing excess fuel return hose and remove hose.
l - Disconnect external electric fuel pump connector.
m - Remove fuel/water separator sensor lead.
n - Remove VST ground lead.
o - Remove excess air return hose (hidden) from air plenum.
p - Disconnect internal electric fuel pump harness (hidden).
q - Remove 3 bolts securing VST.



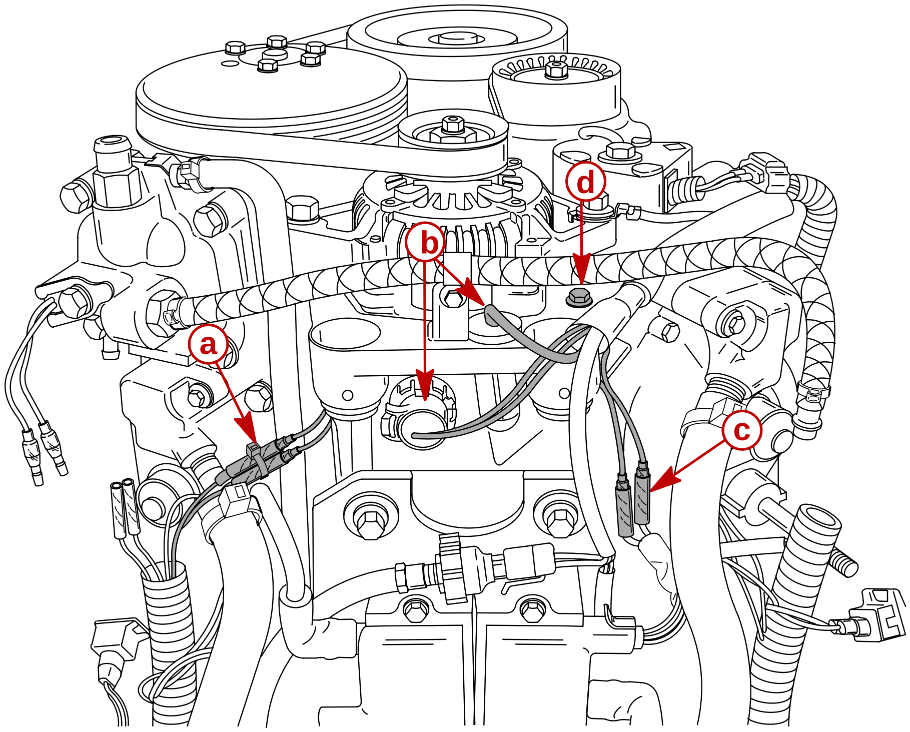
r - Disconnect starboard fuel rail fuel injector harnesses and open harness clamps.

s - Remove 2 screws and retaining plate securing air compressor hose to starboard fuel rail. Remove air hose.

t - Remove 2 nuts securing starboard fuel rail.

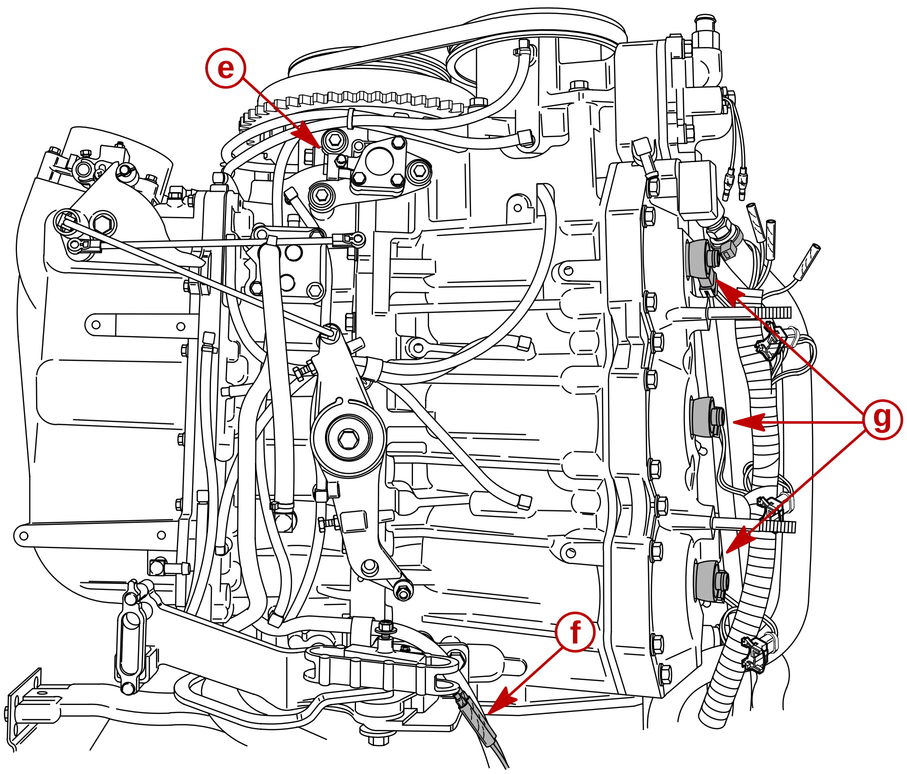
NOTE: *Both fuel rails and VST may now be removed as an assembly.*

ELECTRICAL PLATE AND HARNESS REMOVAL



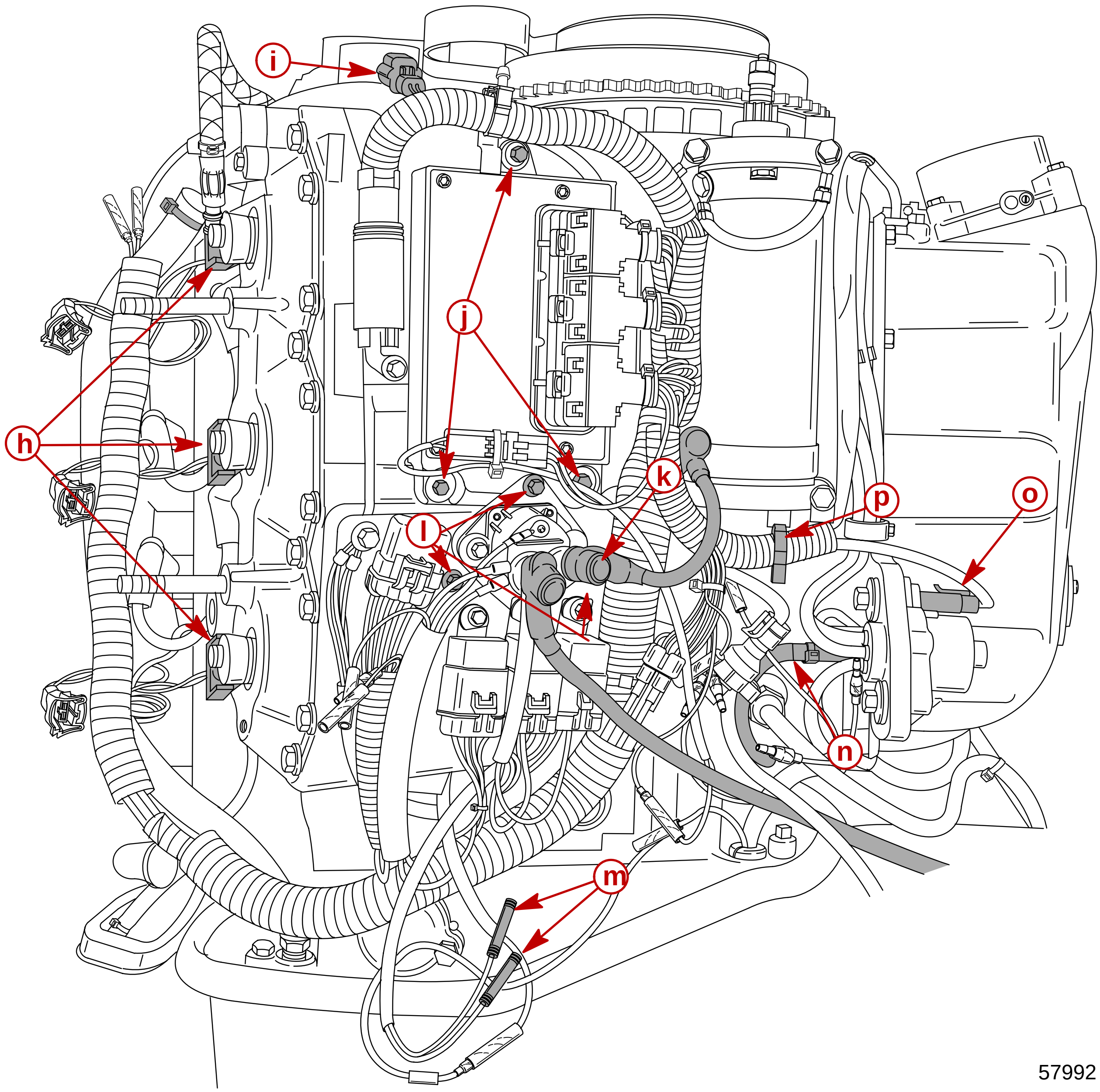
57991

a - Disconnect port cylinder head temperature sensor leads.
b - Disconnect alternator leads.
c - Disconnect starboard cylinder head temperature sensor leads.
d - Remove harness clamp bolt.

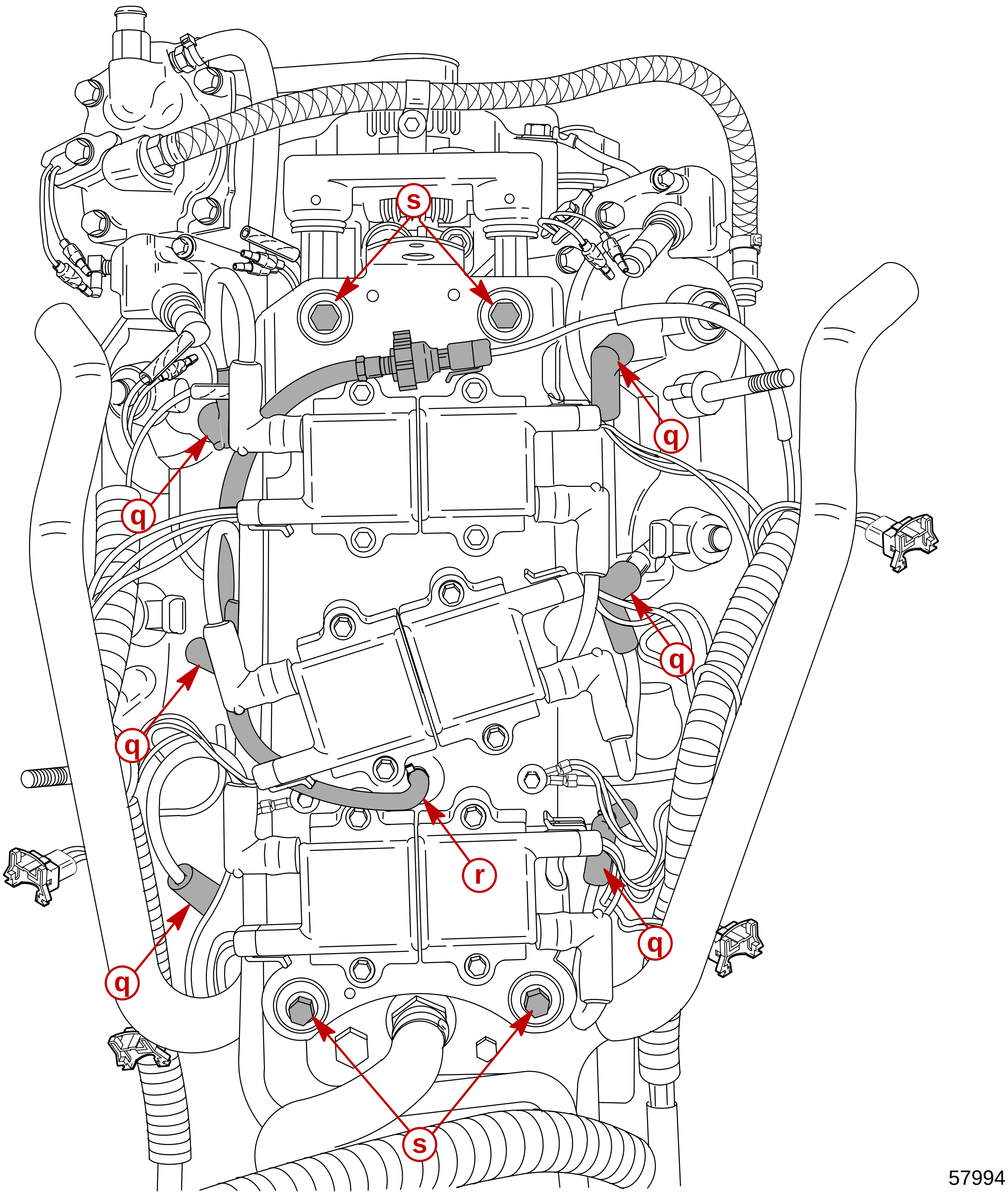


57990

e - Disconnect throttle position sensor connector.
f - Disconnect shift interrupt switch leads.
g - Disconnect #2, #4 and #6 direct injector harnesses.

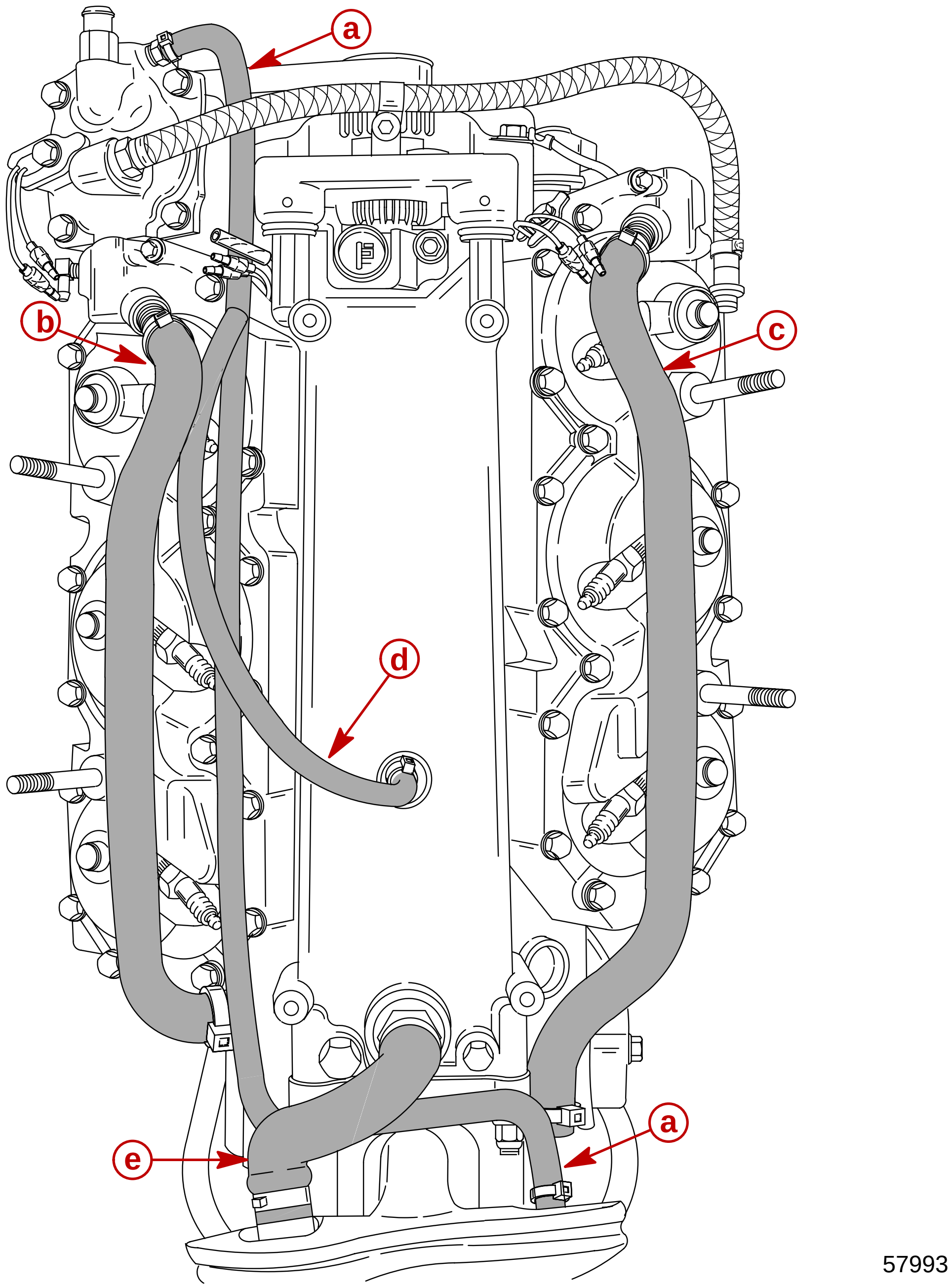


h - Disconnect #1, #3 and #5 direct injector harnesses.
i - Disconnect crank position sensor harness.
j - Remove 3 bolts securing ECM.
k - Remove starter motor cable from starter solenoid.
l - Remove 3 bolts securing electrical plate.
m - Disconnect trim pump leads.
n - Remove oil pump inlet hose and insert plug to prevent leakage.
o - Disconnect oil pump harness.
p - Open harness clamp.



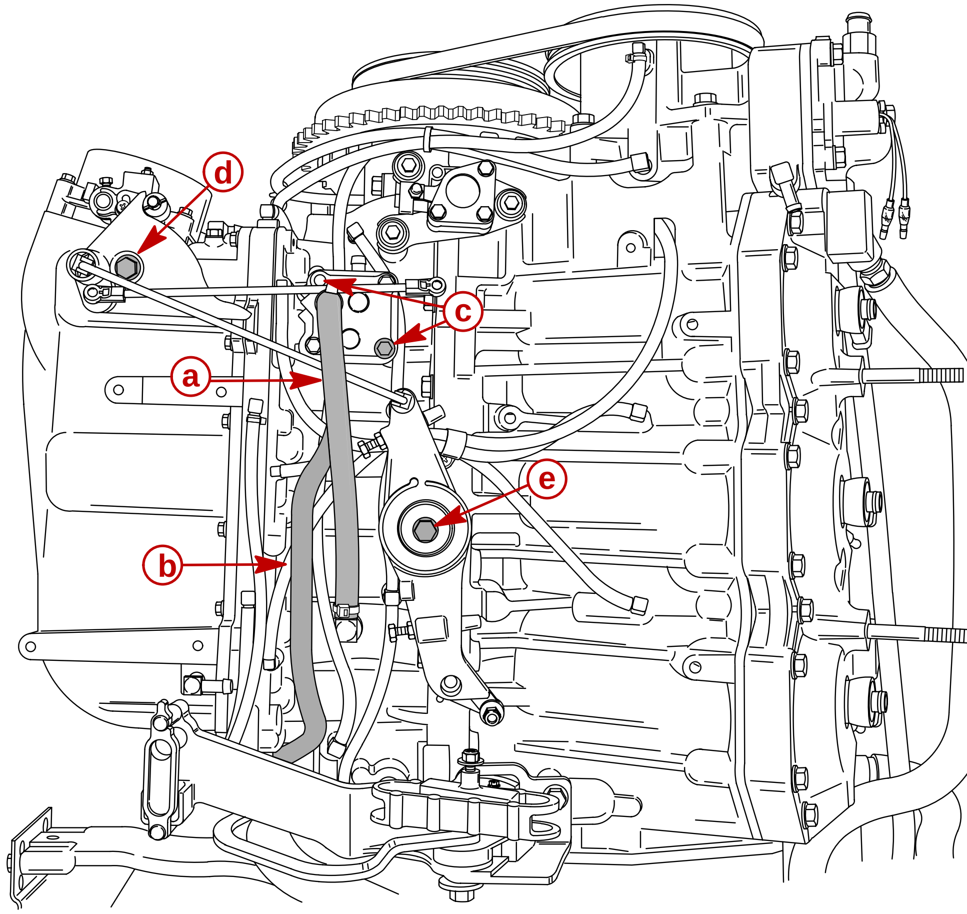
q - Remove 6 spark plug leads.
r - Remove water pressure sensor hose.
s - Remove 4 bolts securing coil plate and remove plate with electrical harness.

WATER HOSE ROUTING



a - Tell-tale Hose
b - Port Thermostat Hose
c - Starboard Thermostat Hose
d - Water Pressure Sensor Hose
e - Engine Flush Hose

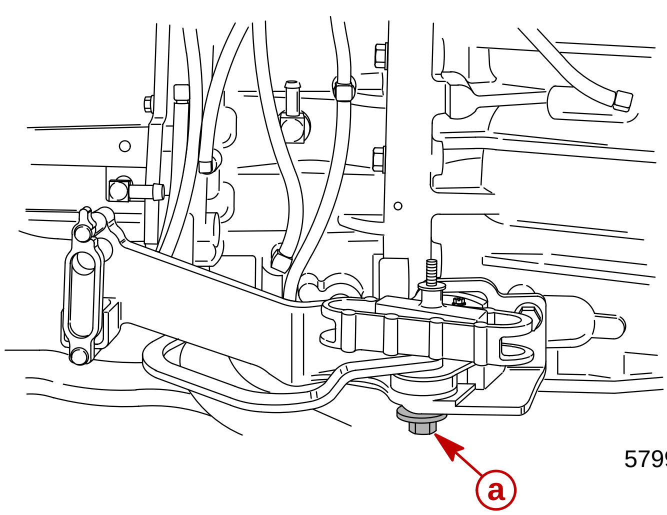
PULSE FUEL PUMP AND THROTTLE LINKAGE REMOVAL



57989

a - Remove fuel pump vacuum hose.
b - Remove fuel pump inlet hose.
c - Remove 2 screws securing fuel pump.
d - Remove bolt securing throttle cam.
e - Remove bolt securing throttle arm.

THROTTLE AND SHIFT PLATFORM REMOVAL



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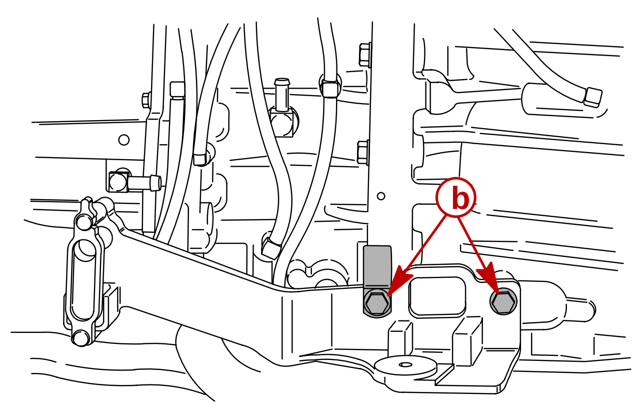
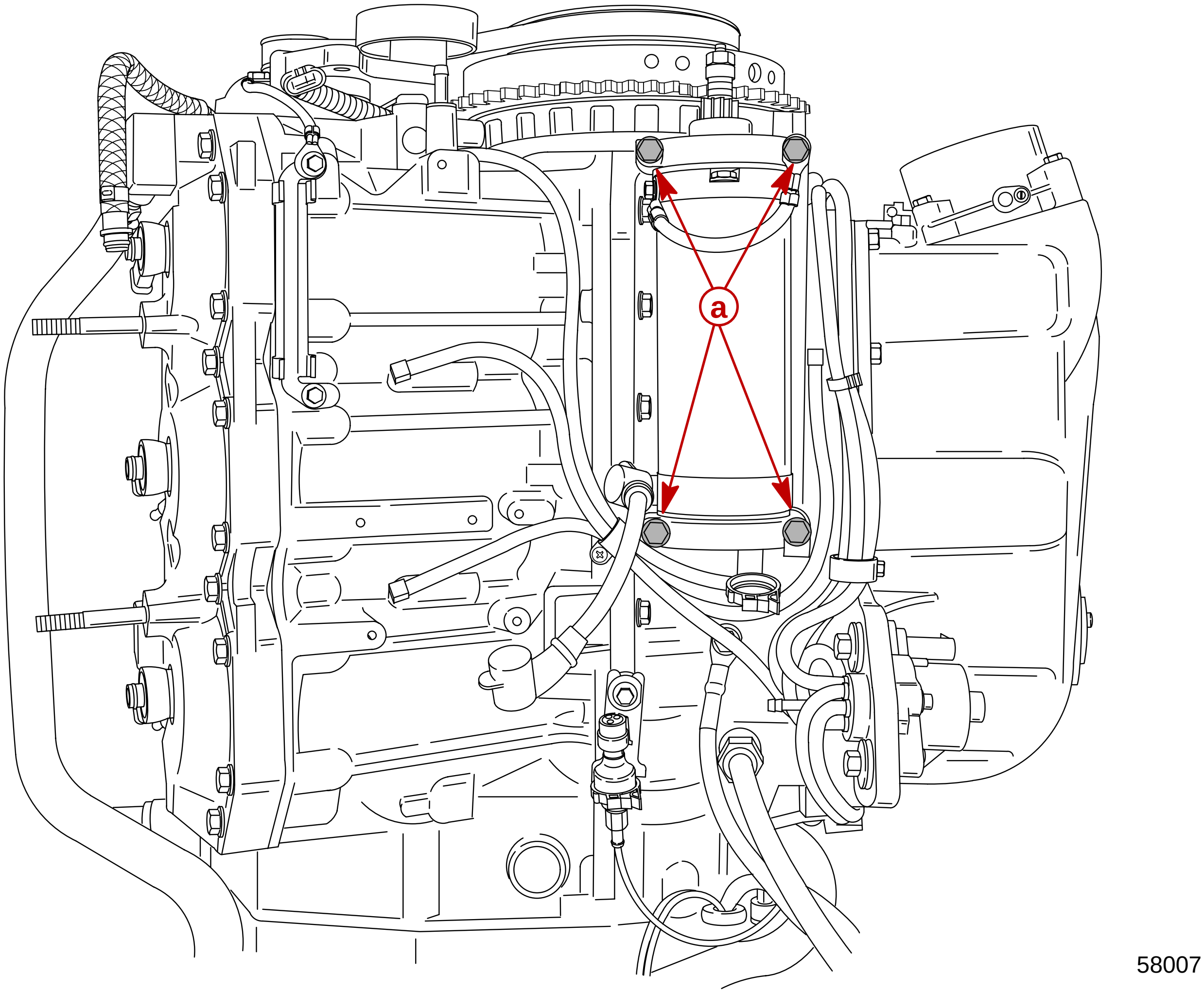


57998

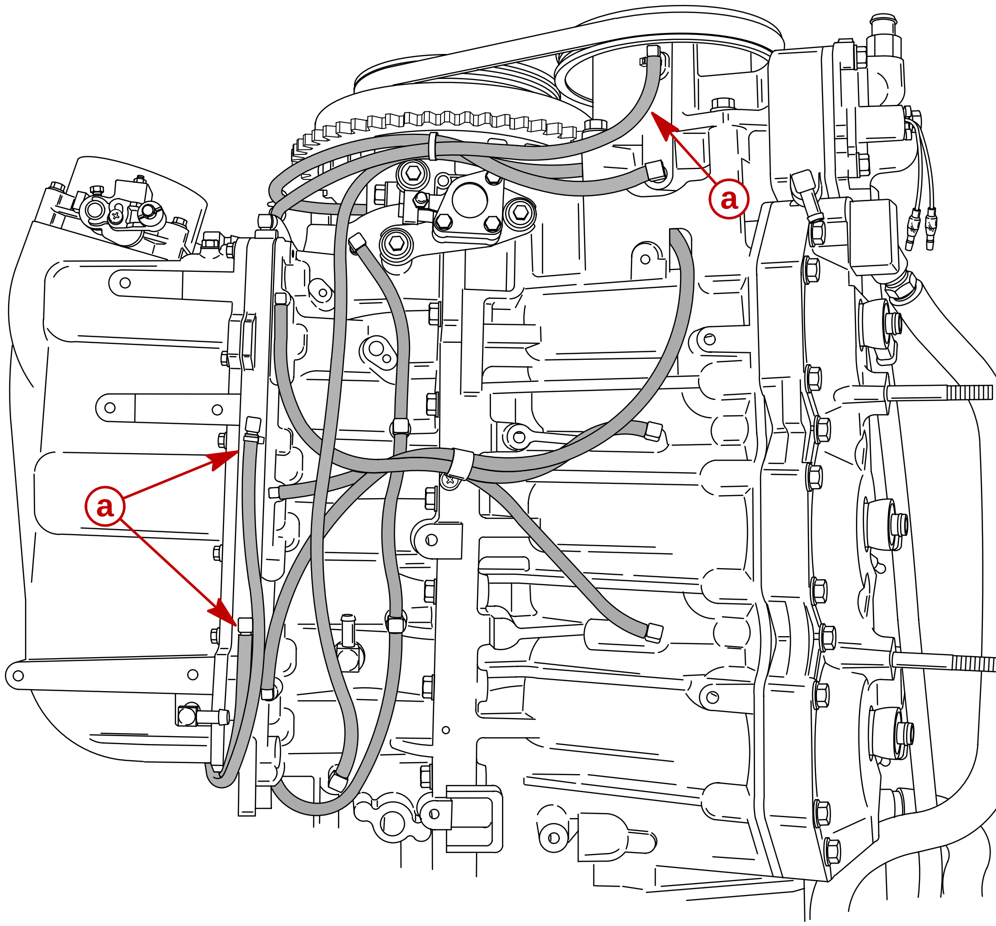
a - Bolt and Flat Washer
b - Bolts

STARTER MOTOR REMOVAL

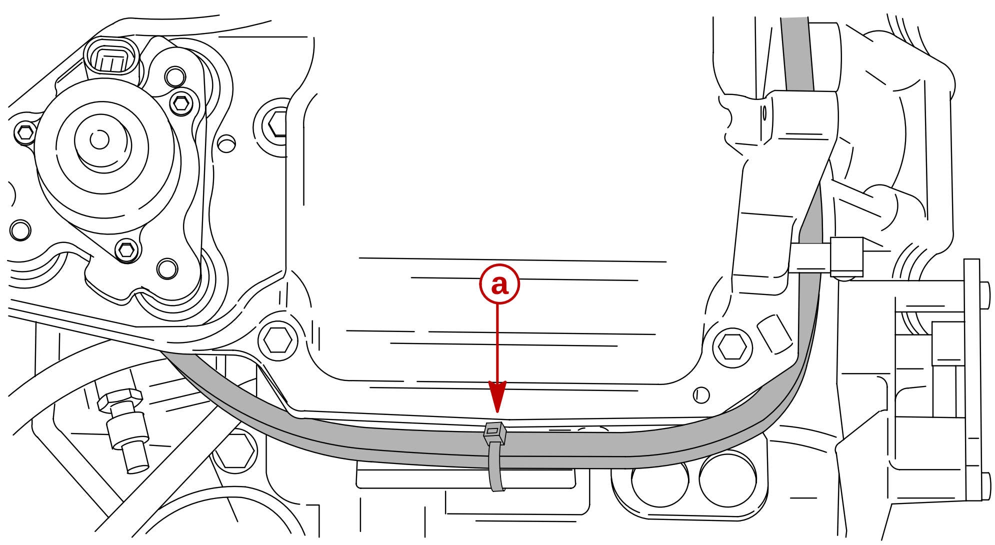


a - Remove 4 bolts

BLEED HOSE AND OIL PUMP HOSE ROUTING PORT SIDE

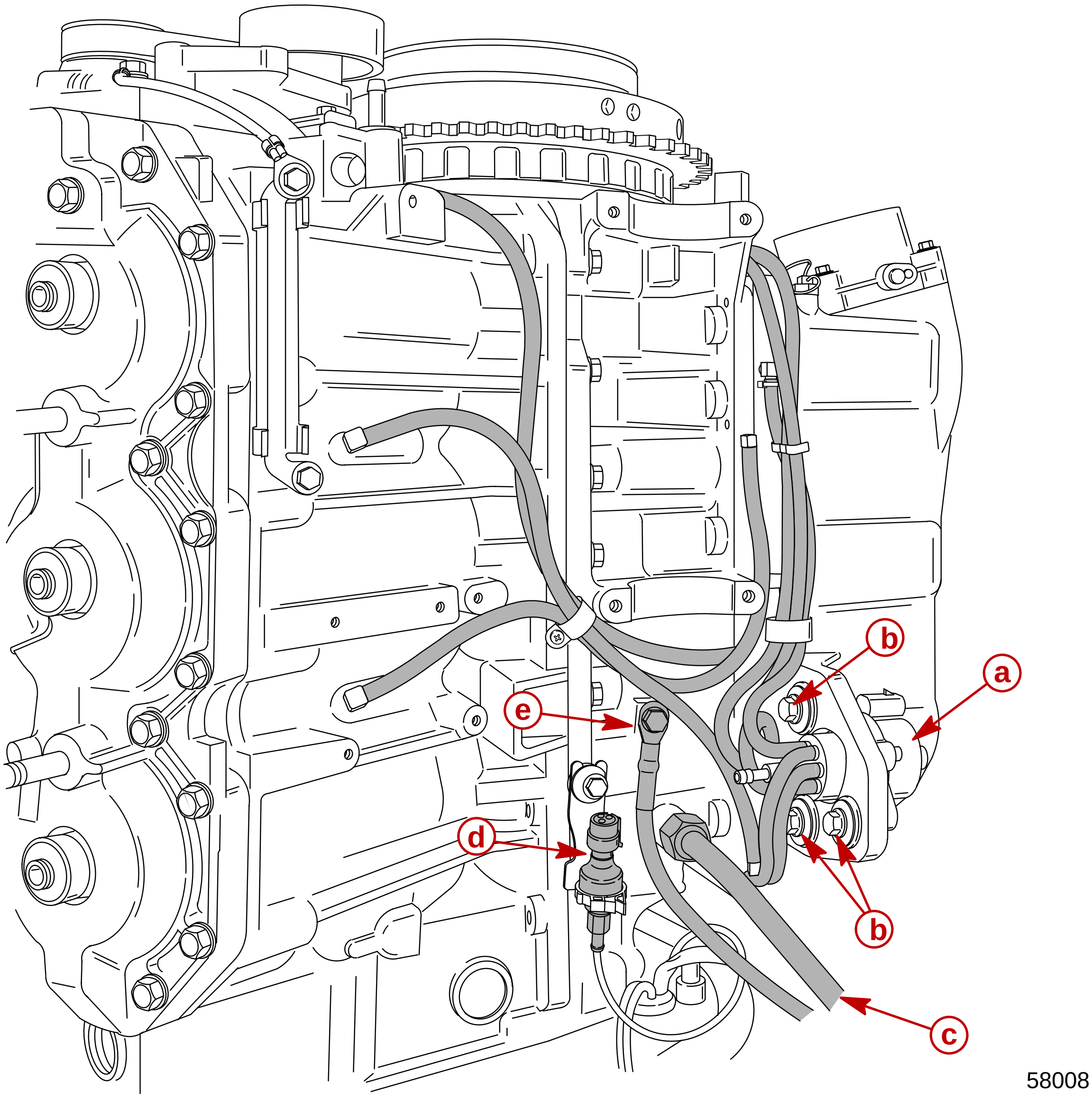


a - Oil Pump Hoses



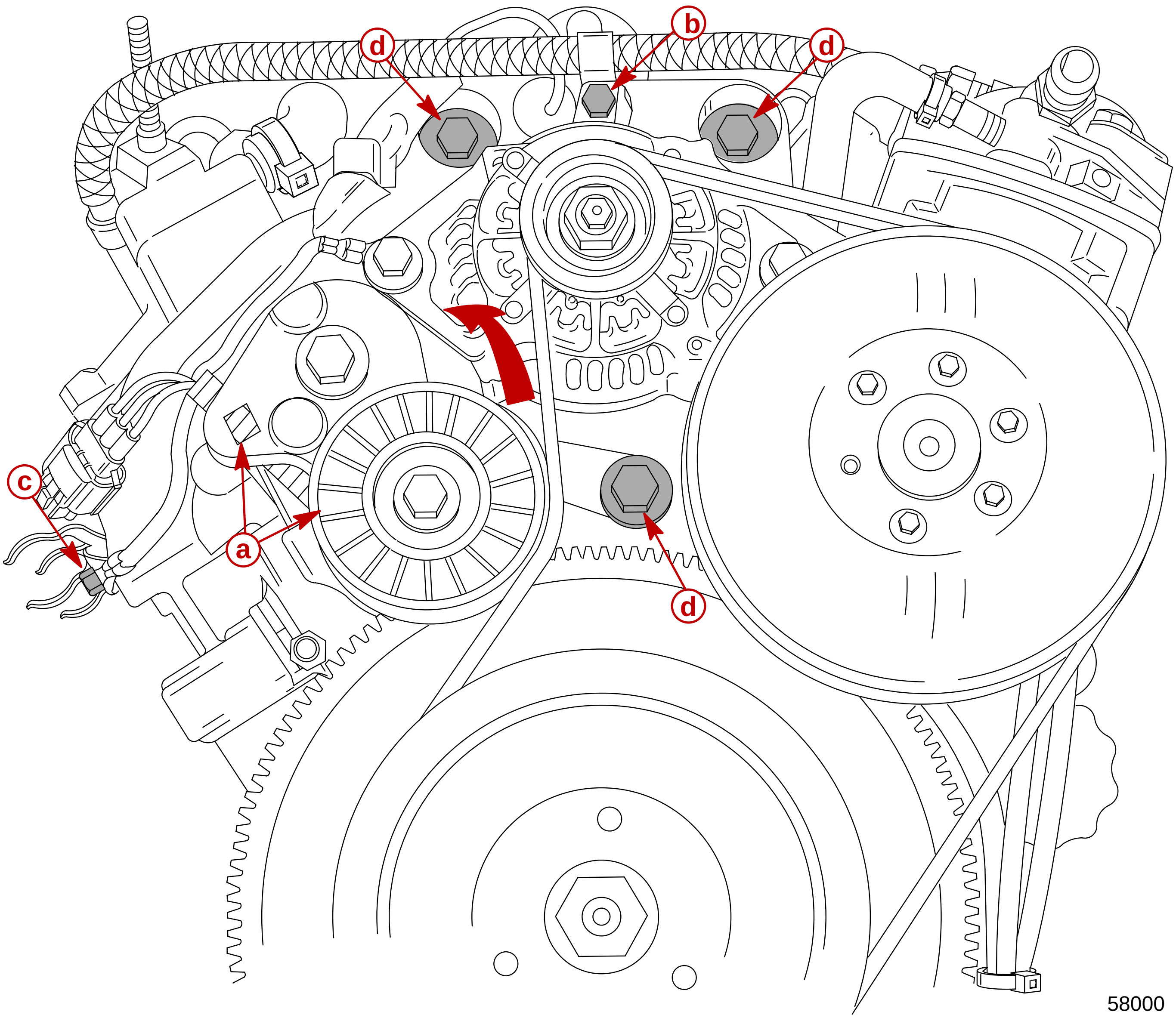
a - Oil hoses from oil pump routed under air plenum and secured by sta-strap

OIL PUMP HOSE AND BLEED HOSE ROUTING STARBOARD SIDE



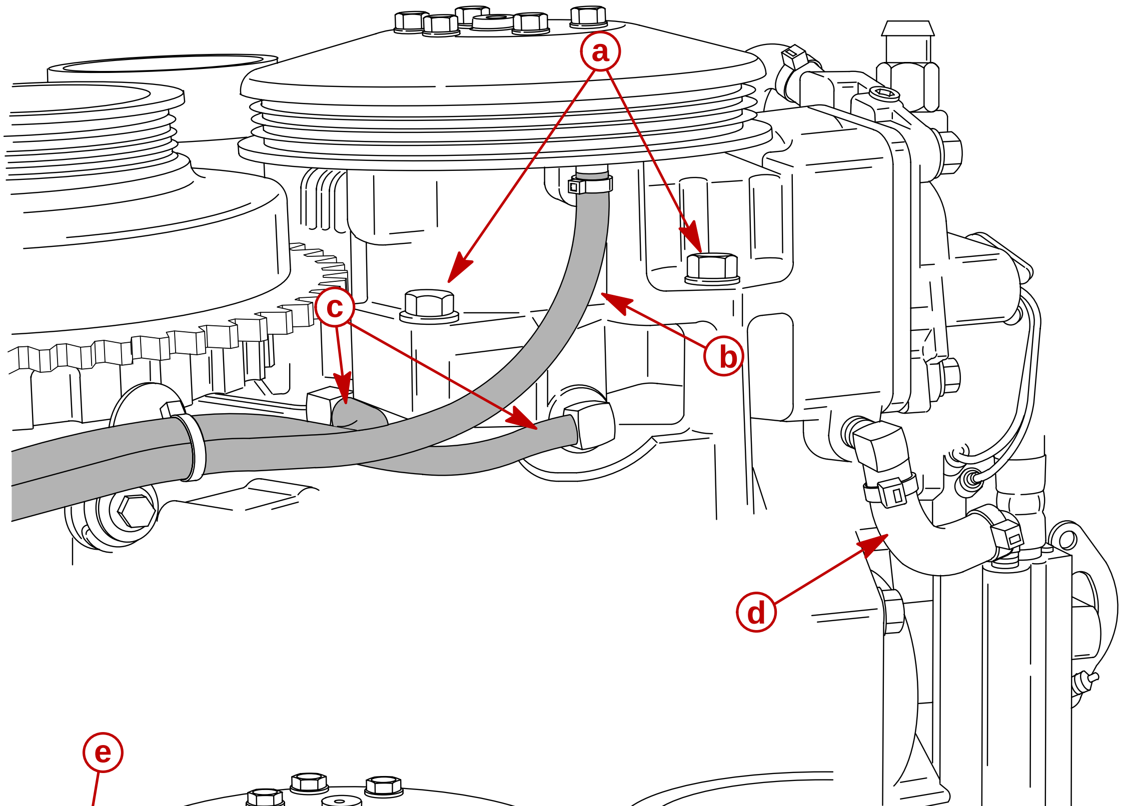
a - Oil Pump
b - Bolts (3)
c - Remote Oil Tank Pressure Hose
d - Smartcraft Speedometer Gauge Pressure Sensor
e - Negative Battery Cable

ALTERNATOR REMOVAL

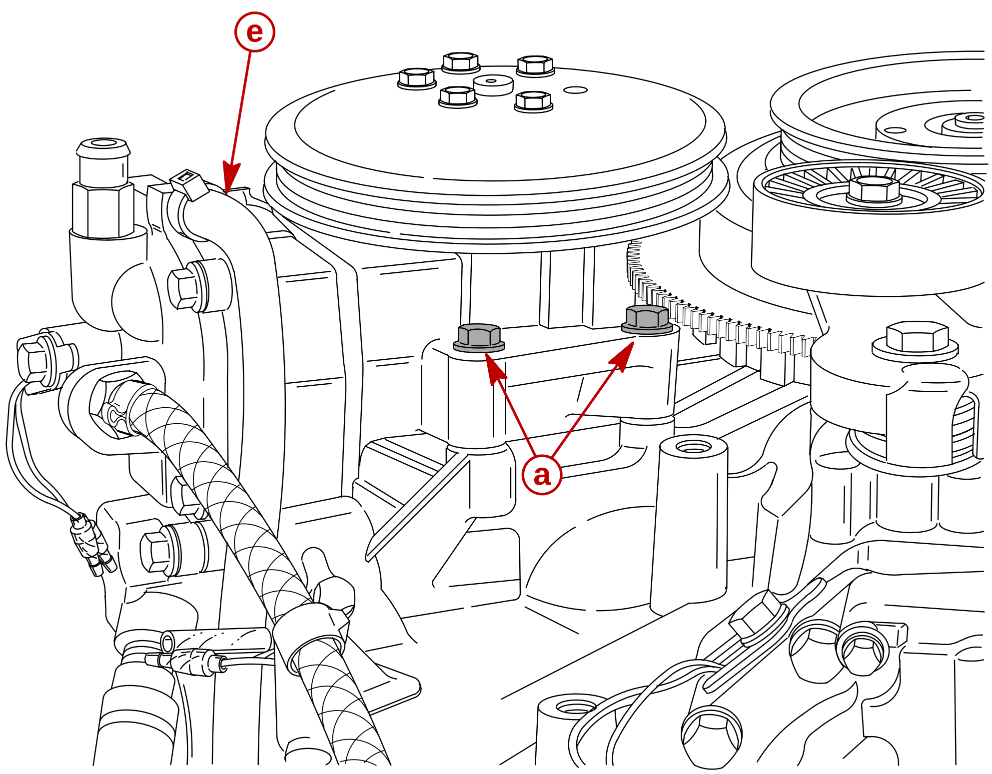


a - Rotate Belt Tensioner with 3/8 in. Drive and Remove Belt
b - Remove J-clamp Bolt
c - Remove Ground Lead Bolt
d - Remove 3 Bolts and Remove Alternator Assembly

AIR COMPRESSOR REMOVAL



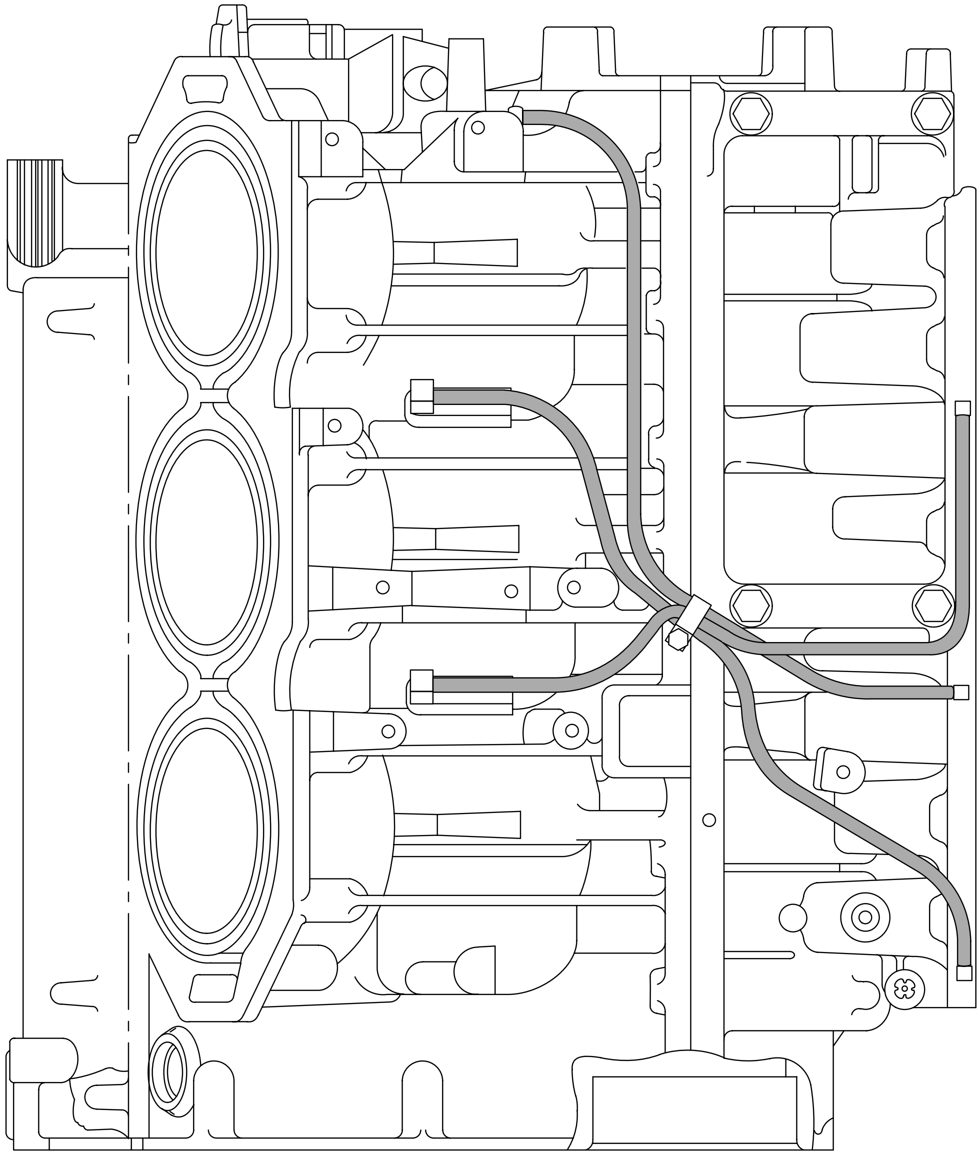
57978



58002

a - Remove 4 Bolts
b - Remove Oil Input Hose
c - Remove Oil Return Hoses
d - Remove Water Inlet Hose
e - Remove Water Out (tell-tale) Hose

STARBOARD SIDE BLEED HOSE ROUTING



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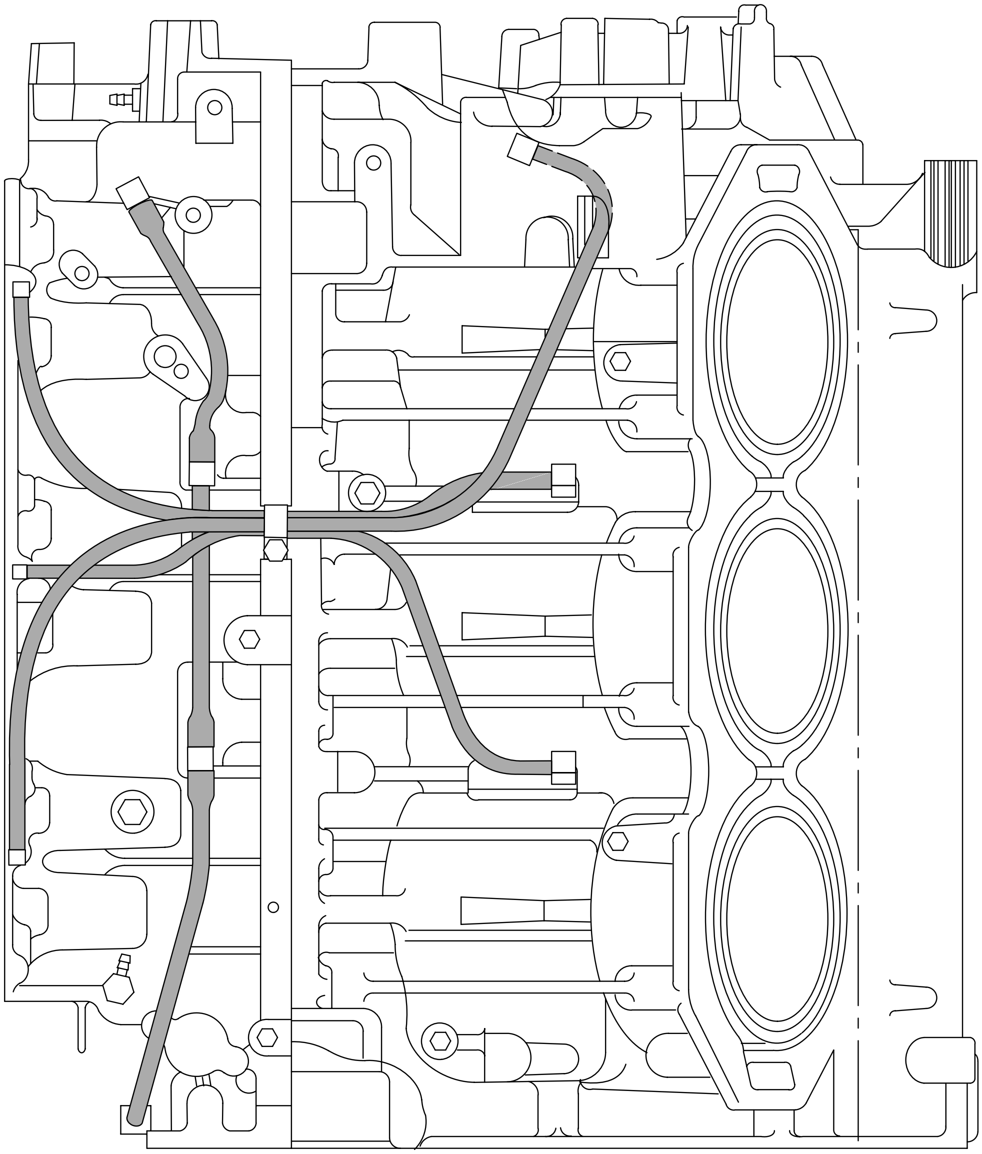
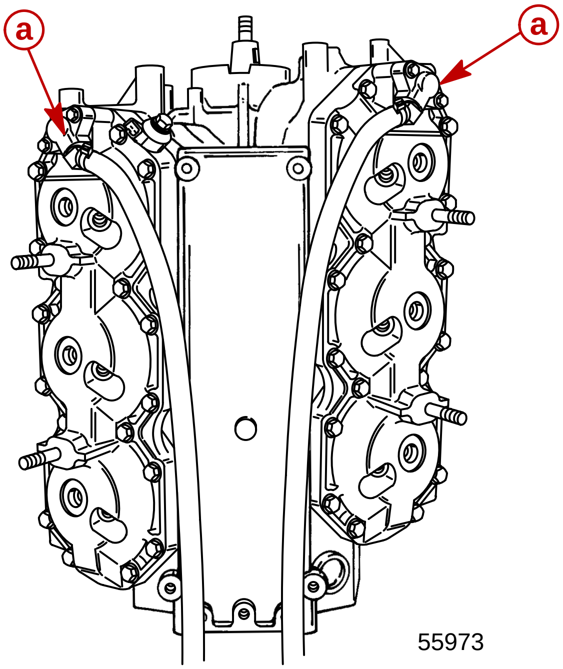
PORT SIDE BLEED HOSE ROUTING

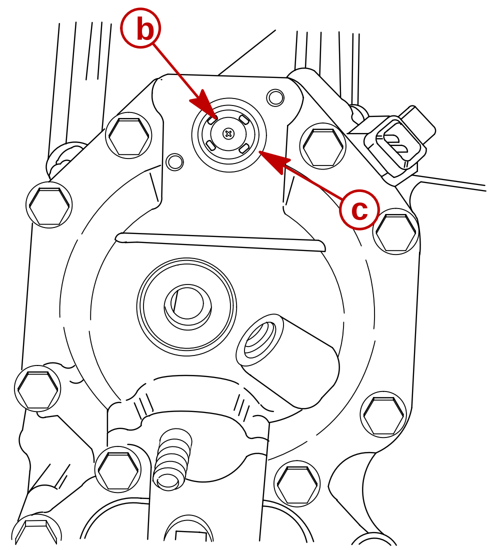


Powerhead Disassembly

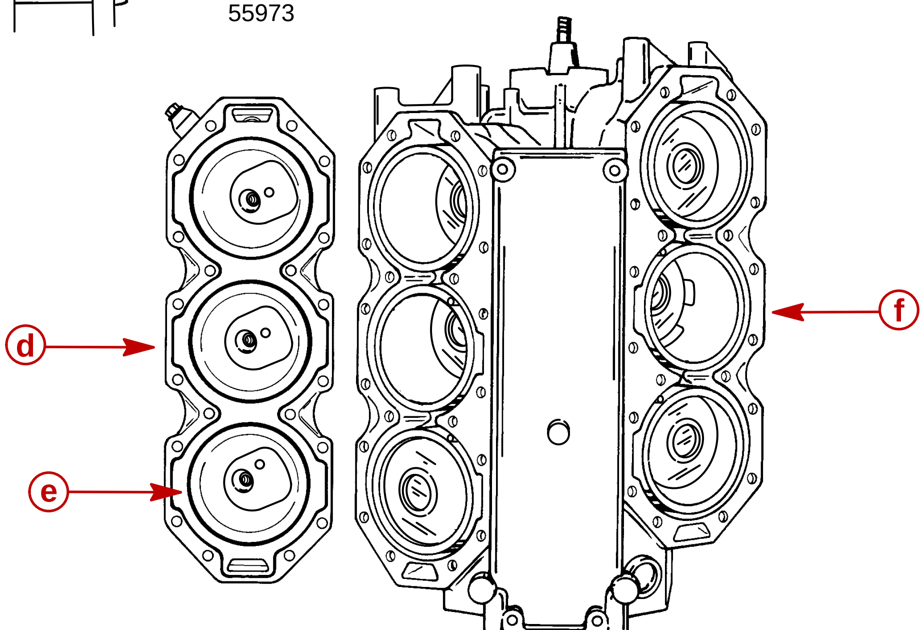
1. Place powerhead in repair stand or on a bench.
2. Remove thermostat covers, thermostats and gaskets.
3. Remove cylinder heads from engine block.



55973



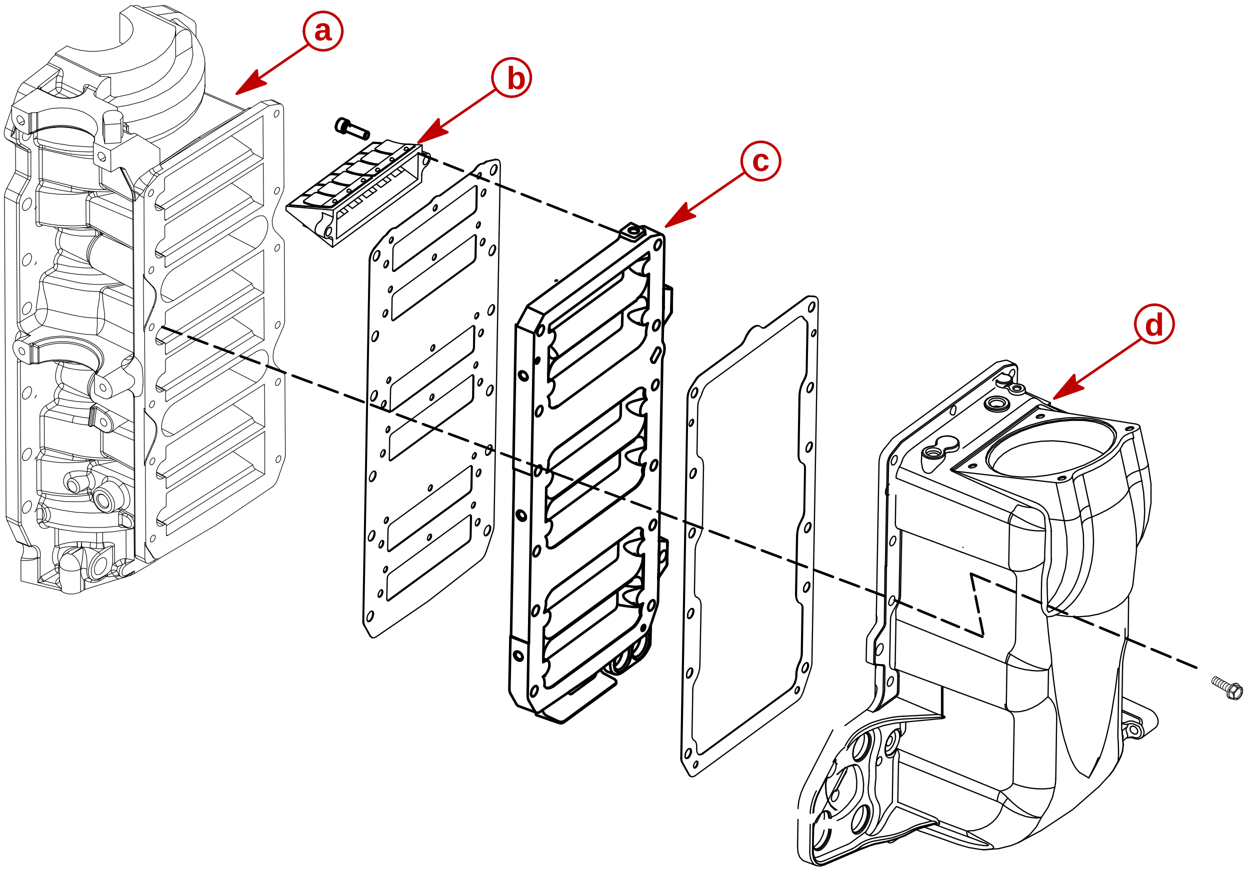
55972



55973

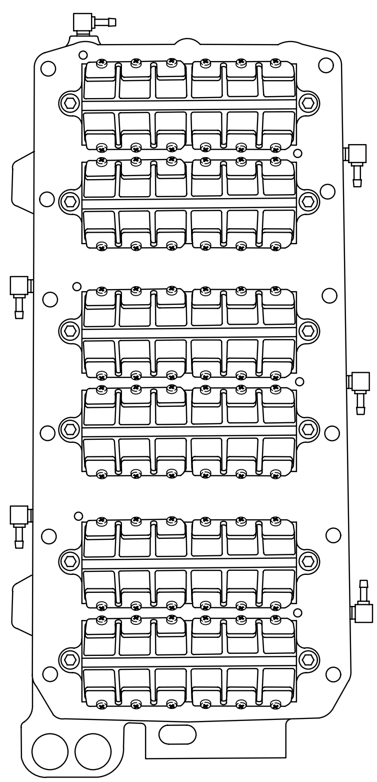
a - Thermostat Cover
b - Thermostat
c - Gasket
d - Cylinder Head
e - Seal/O-Rings
f - Engine Block

4. Remove reed block assembly from crankcase half.



a - Crankcase Half
b - Reed Block (6)
c - Adaptor Plate
d - Air Plenum

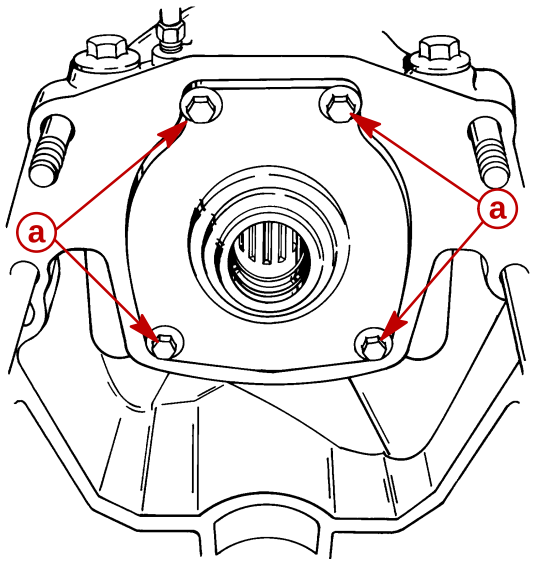
5. Inspect reeds as outlined in "Cleaning and Inspection".



58006

6. Remove bolts from end cap.

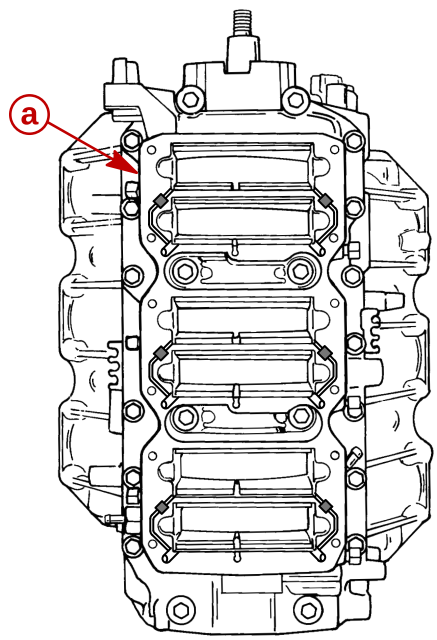
LOWER END CAP



52325

a - Crankcase Attaching End Cap Bolts

7. Remove bolts which secure crankcase cover to cylinder block.

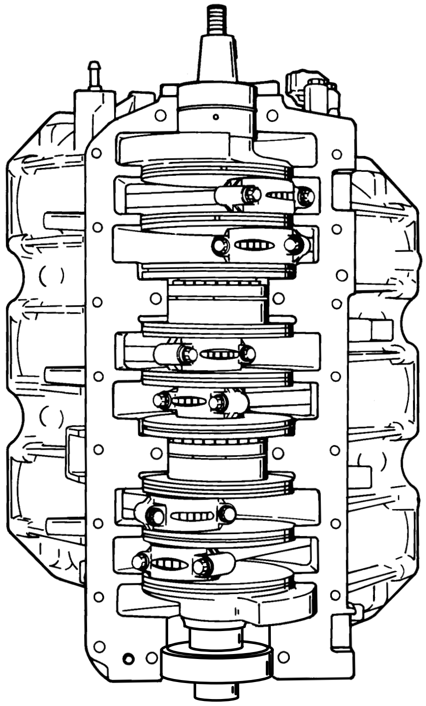


55977

a - Crankcase Cover

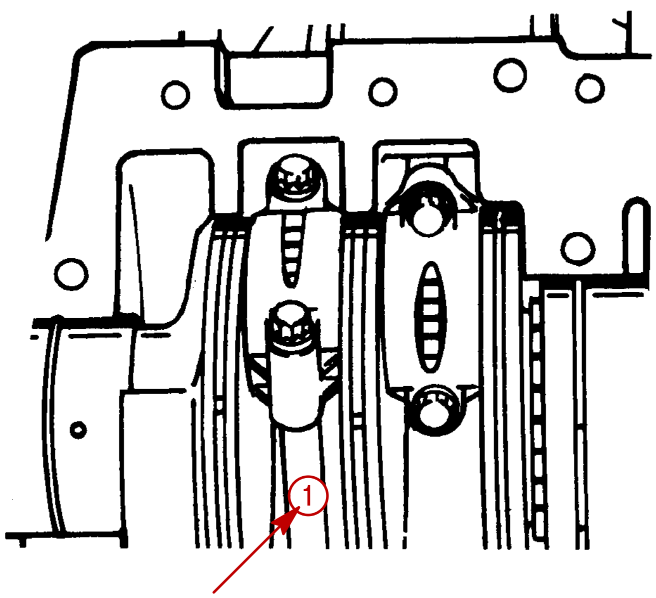
8. Remove crankcase end cap.

CRANKCASE COVER REMOVED



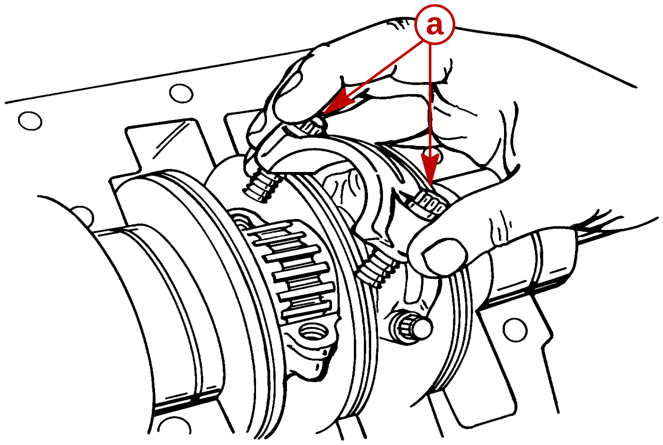
55978

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



52347

11. Use a 3/8 in. 12 point socket to remove connecting rod bolts, then remove rod cap, roller bearings and bearing cage from connecting rod.



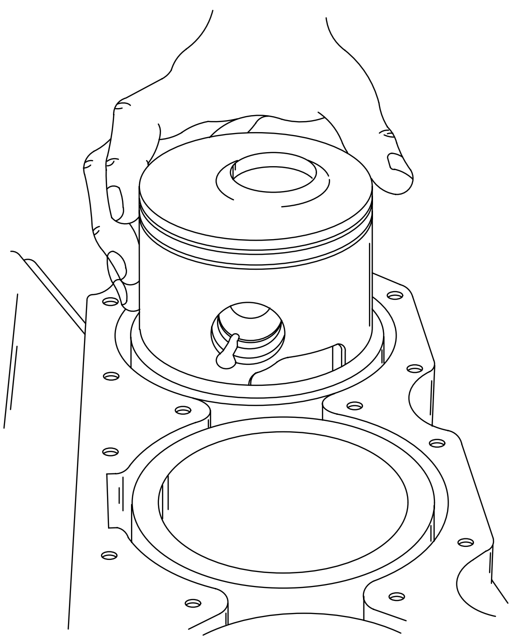
52316

a - Connecting Rod Bolts

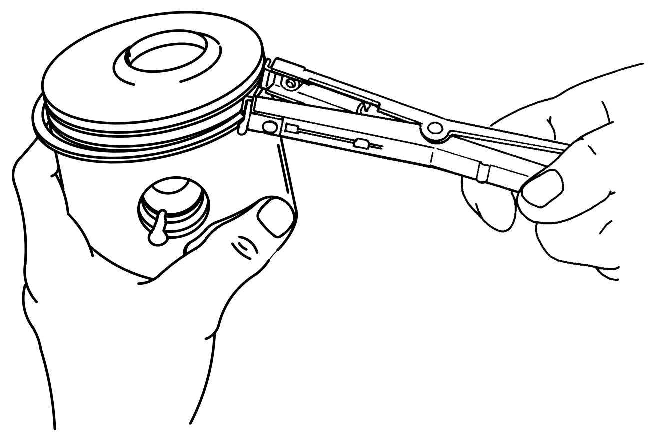
12. Push piston out of cylinder block.
13. After removal, reassemble each piston and connecting rod assembly.

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

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

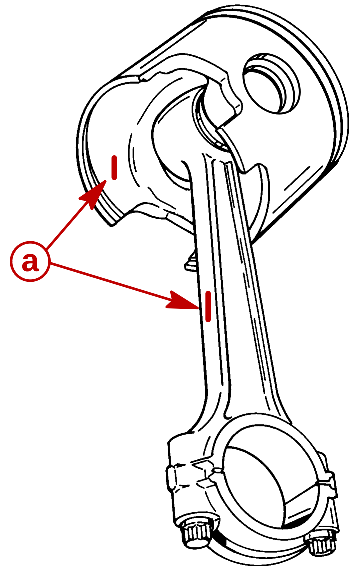


55966



55967

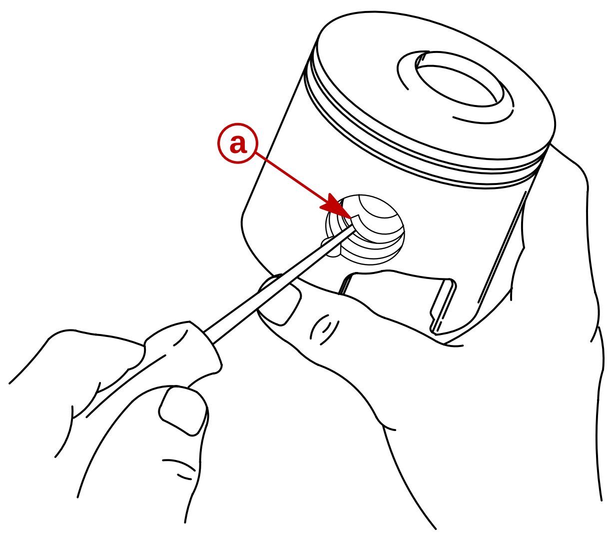
16. Using an awl, scribe identification number of connecting rod on inside of piston (a). Reassemble piston on same connecting rod.



55968

a - Scribe Identification Number

17. Using tool (91-52952A1), remove piston pin lockrings from both ends of piston pin. Never re-use piston pin lockrings.

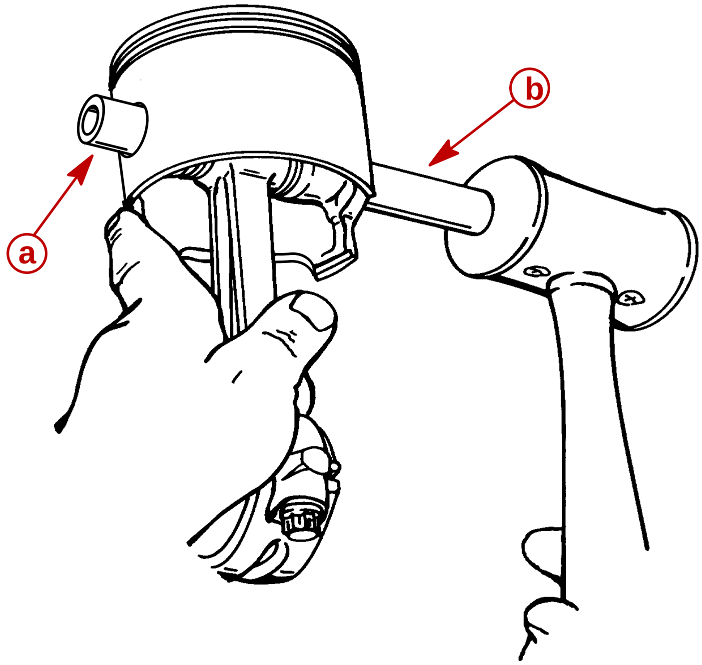


55969

a - Lockring

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

18. Support piston and tap out piston pin using service tool (91-92973A1) as shown.

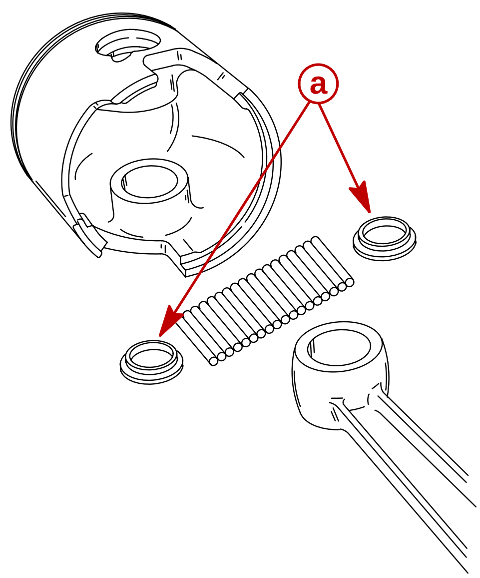


55957

a - Piston Pin
b - Piston Pin Tool (91-92973A1)

19. Remove piston pin needle bearings (34 per piston) and locating washers (2 per piston) as shown.

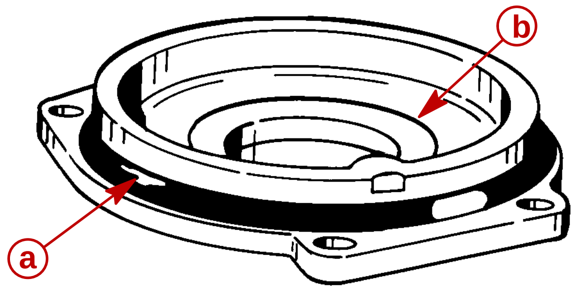
IMPORTANT: It is recommend that new needle bearings be used at reassembly for lasting repair. However, if needle bearings must be re-used, keep each set of bearings identified for reassembly on same connecting rod.



55958

a - Needle Bearing Locating Washers

20. Remove lower end cap from crankshaft.
21. Remove and discard O-ring seal from end cap.
22. Remove oil seals from end cap by driving seals out with a punch and hammer.

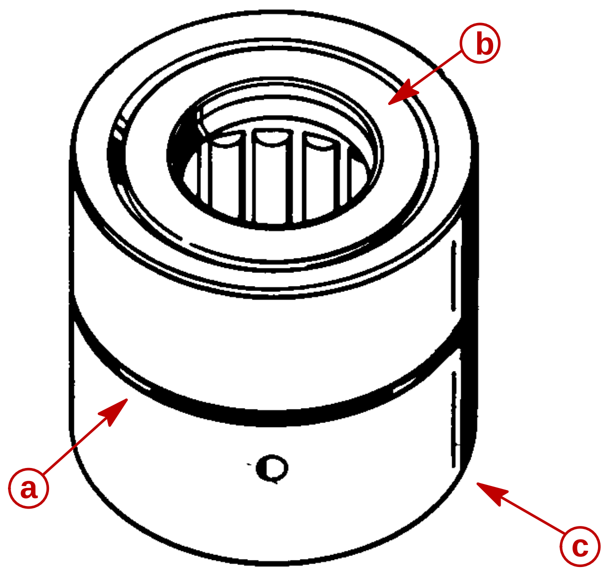


51849

a - O-ring
b - Seal

23. Inspect roller bearing in upper end cap as outlined in “Cleaning and Inspection”.

NOTE: *If roller bearing is damaged, replace roller bearing carrier assembly.*



51473

a - O-Ring
b - Seal
c - Carrier

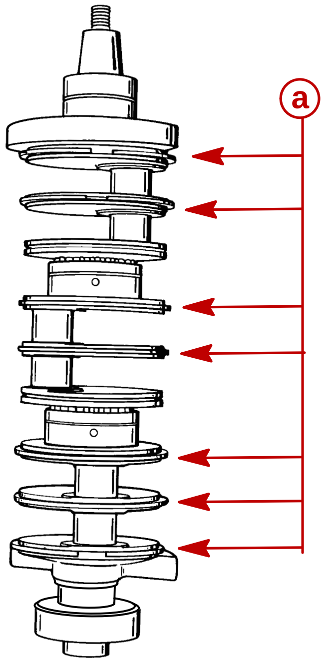
24. Remove crankshaft and place in powerhead stand as shown.

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

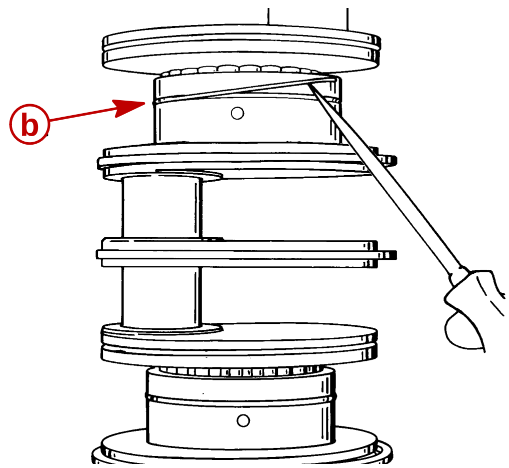
CAUTION

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

25. Remove retaining ring as shown.



55994

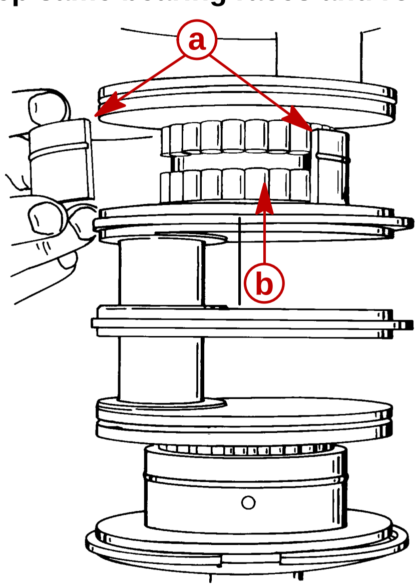


52336

a - Sealing Rings
b - Retaining Ring

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

IMPORTANT: Keep same bearing races and roller bearings together.



52315

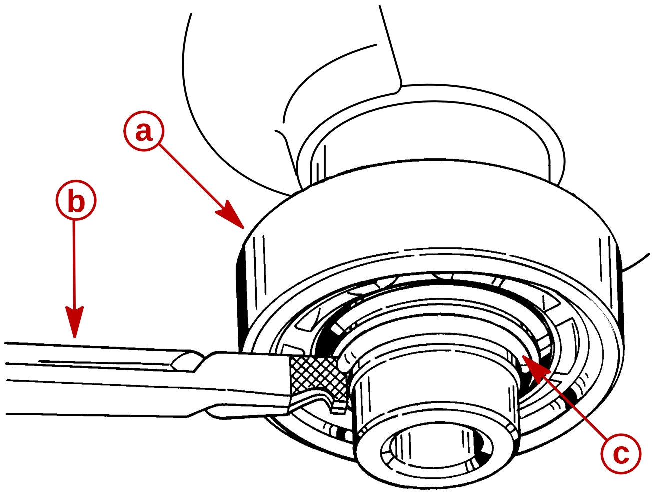
a - Bearing Race Halves
b - Roller Bearings

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

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

27. Remove lower ball bearing from crankshaft as follows:

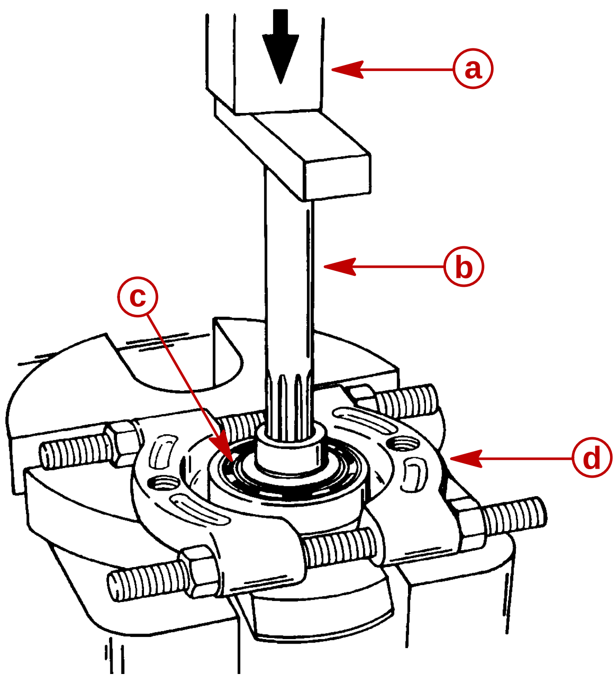
a. Remove retaining ring using a pair of snap ring pliers.



55983

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

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

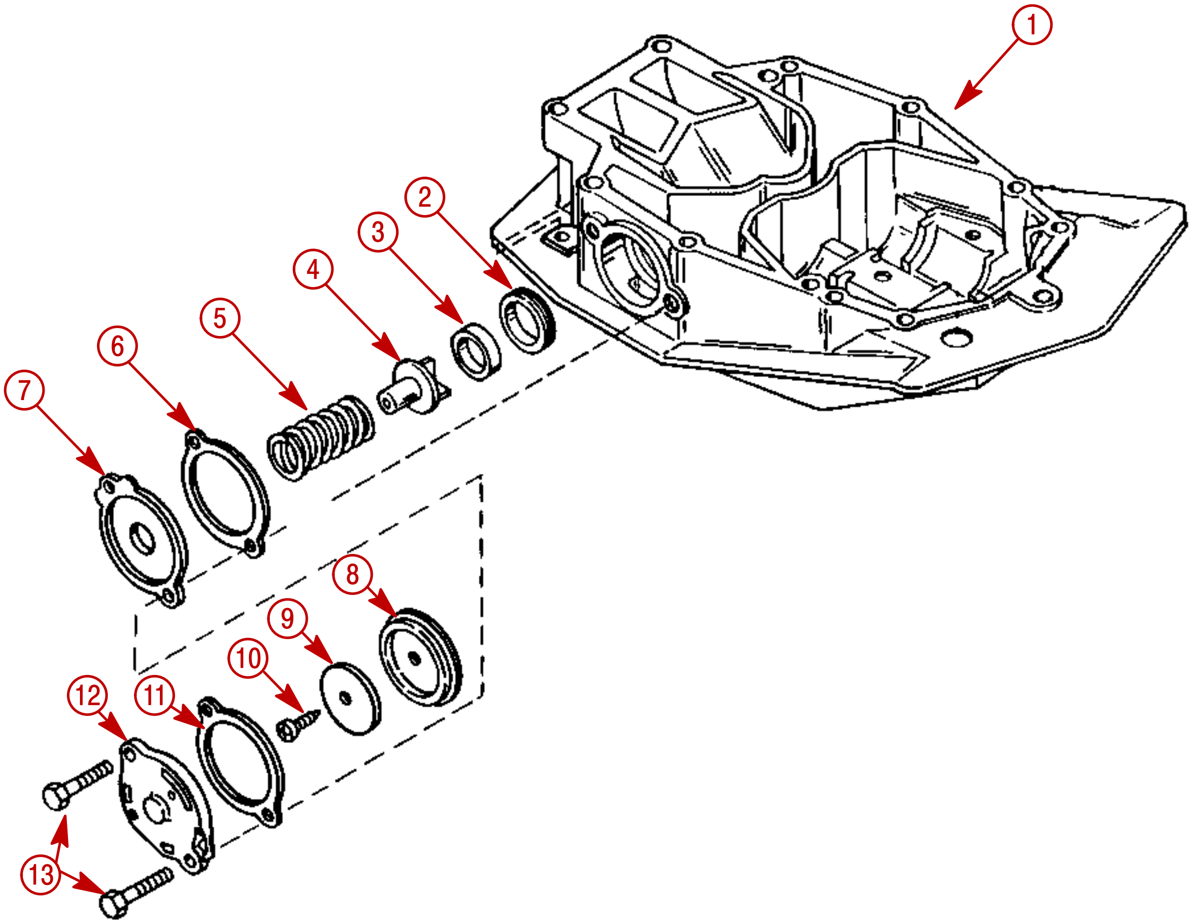


51081

a - Press
b - Powerhead Stand (91-812549A1)
c - Crankshaft Ball Bearing
d - Universal Puller Plate (91-37241)

Water Pressure Relief Valve Components

1. Remove and inspect water pressure relief valve components for debris or damage. Replace components as required.

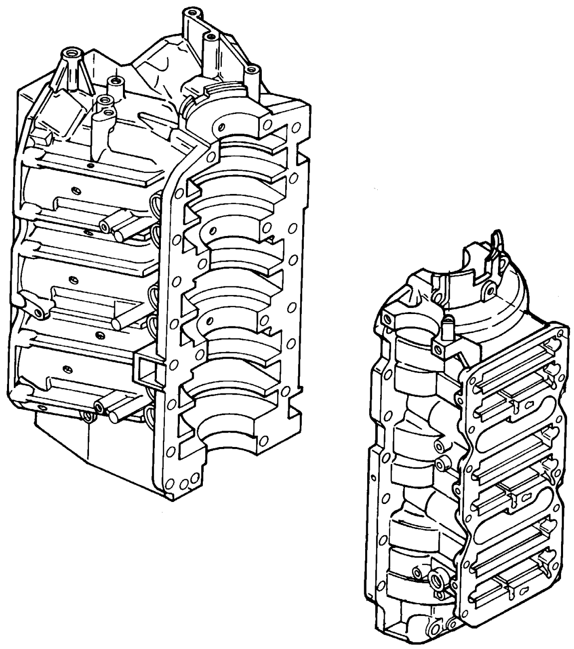


1 - Exhaust Plate
2 - Carrier
3 - Grommet
4 - Poppet/Relief Valve
5 - Spring
6 - Gasket
7 - Inner Plate
8 - Diaphragm
9 - Washer
10 - Screw [Torque to 25 lb. in. (3 Nm)]
11 - Gasket
12 - Outer Cover
13 - Bolts [Torque to 20 lb. ft. (27 Nm)]

Cleaning and Inspection

Cylinder Block and Crankcase Cover

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



CAUTION

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

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

Special Service Information

Grooves in Cylinder Block Caused By Crankshaft Sealing Rings

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

Cylinder Bores

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

HONING PROCEDURE

a. When cylinders are to be honed, follow the hone manufacturer’s recommendations for use of the hone and cleaning and lubrication during honing.

b. For best results, a continuous flow of honing oil should be pumped into the work area. If pumping oil is not practical, use an oil can. Apply oil generously and frequently on both stones and work area.

CAUTION

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

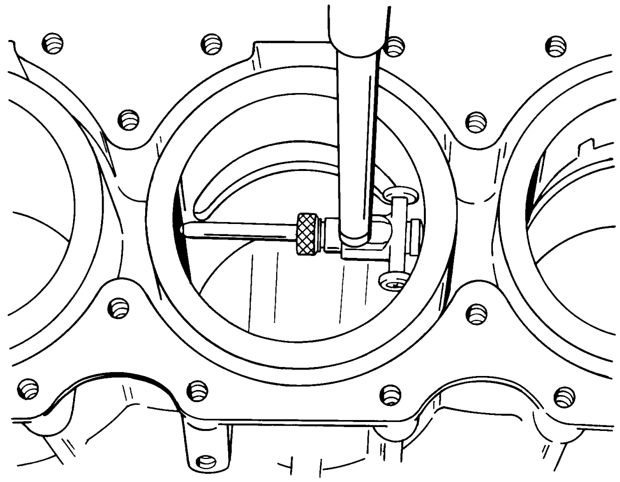
c. Start stroking at smallest diameter. Maintain firm stone pressure against cylinder wall to assure fast stock removal and accurate results.

d. Localize stroking in the smallest diameter until drill speed is constant throughout length of bore. Expand stones, as necessary, to compensate for stock removal and stone wear. Stroke at a rate of 30 complete cycles per minute to produce best cross-hatch pattern. Use honing oil generously.

e. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. A good cleaning is essential. If any of the abrasive material is allowed to remain in the cylinder bore, it will cause rapid wear of new piston rings and cylinder bore in addition to bearings. After cleaning, bores should be swabbed several times with engine oil and a clean cloth, then wiped with a clean, dry cloth. Cylinders **should not** be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

2. Hone all cylinder walls **just enough** to de-glaze walls.

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



52324

225/250 Models

Model	Cylinder Block Finish Hone
200/225	3.6265 in. (92.1131 mm)
0.015 in. (0.38 mm) Oversize	3.6415 in. (92.4941 mm)
0.030 in. (0.76 mm) Oversize	3.6565 in. (92.8751 mm)

4. If a cylinder bore is tapered, out-of-round or worn more than 0.003 in. (0.076 mm) from standard “Cylinder Block Finish Hone” diameter (refer to chart, preceding), it will be necessary to re-bore that cylinder(s) to 0.015 in. (0.381 mm) oversize 0.030 in. (0.762 mm) oversize and install oversize piston(s) and piston rings during reassembly.

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

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

Pistons and Piston Rings

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

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

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

CLEANING PISTON RING GROOVES

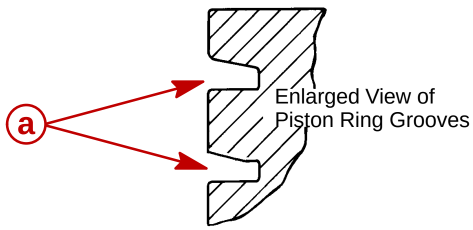
Keystone (tapered) ring grooves

⚠ CAUTION

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

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

Piston with two half keystone (half tapered) rings



a - Ring Grooves

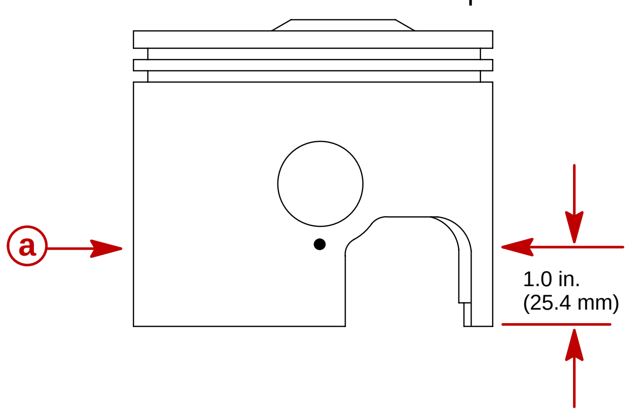
MEASURING PISTON ROUNDNESS

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

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

Piston	Dimension “A”
Standard Piston	3.6210 in. ± .0005 in. (91-9734 mm ± .0127 mm)
0.015 in. Oversize Piston	3.636 in. ± .0005 in. (92.354 mm ± .0127 mm)
0.030 in. Oversize Piston	3.651 in. ± .0005 in. (92.735 mm ± .0127 mm)

2. Using a micrometer, measure dimension “A” at location shown. Dimension “A” should be 3.6210 in. ± 0.0005 in. for a STANDARD size piston.



a - Dimension “A” at RIGHT Angle (90°) to Piston Pin

Cylinder Heads

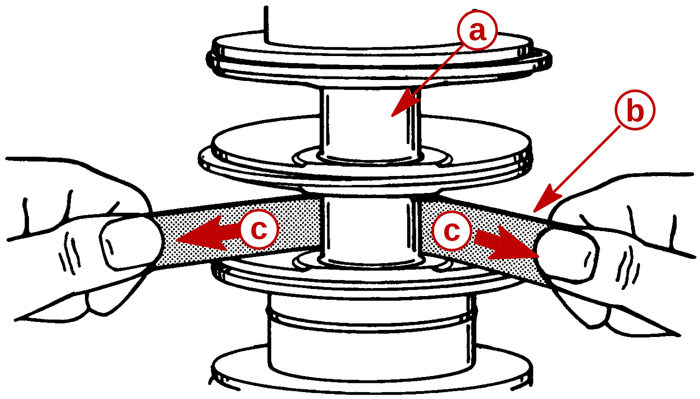
1. Inspect internal surface of cylinder heads for possible damage (as a result of piston or foreign material striking cylinder heads).

IMPORTANT: Cylinder head warpage should not exceed 0.005 in. (0.127 mm) over the ENTIRE length of the cylinder head. If measured warpage, as determined on a surface block, exceeds 0.005 in. (0.127 mm) or a discontinuity of up to 0.005 in. (0.127 mm) exists in a 1.0 in. (25.4 mm) portion of the cylinder head's surface length, then the cylinder head must be replaced.

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

Crankshaft

1. Inspect crankshaft to drive shaft splines for wear. (Replace crankshaft, if necessary.)
2. Check crankshaft for straightness. Maximum runout is 0.002 in. (0.0508 mm). (Replace as necessary.)
3. Inspect crankshaft oil seal surfaces. Sealing surfaces must not be grooved, pitted or scratched. (Replace as necessary.)
4. Check all crankshaft bearing surfaces for rust, water marks, chatter marks, uneven wear and/or overheating. (Refer to "Connecting Rods".)
5. If necessary, clean crankshaft surfaces with crocus cloth.



52323

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

⚠ WARNING

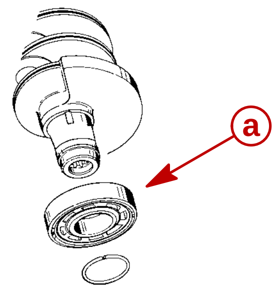
DO NOT spin-dry crankshaft ball bearing with compressed air.

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

Crankshaft (and End Cap) Bearings

IMPORTANT: When overhauling powerhead assembly, it is recommended that all crankshaft bearings – upper/lower, center main, connecting rod and wrist pin bearings – be replaced to ensure optimum powerhead performance and longevity.

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



52326

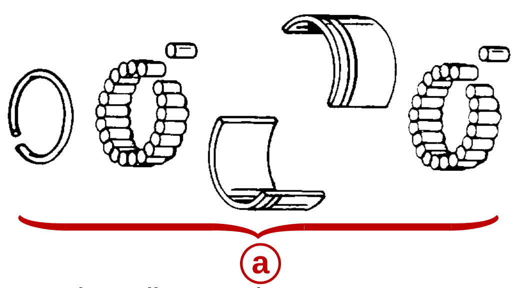
a - Lower Crankshaft Ball Bearing

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

⚠ CAUTION

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

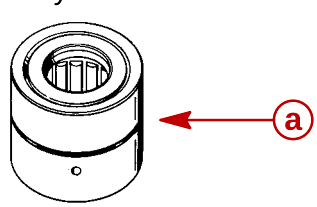
4. Thoroughly inspect center main roller bearings. Replace bearings if they are rusted, fractured, worn, galled or badly discolored.



52153

a - Center Main Roller Bearing

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

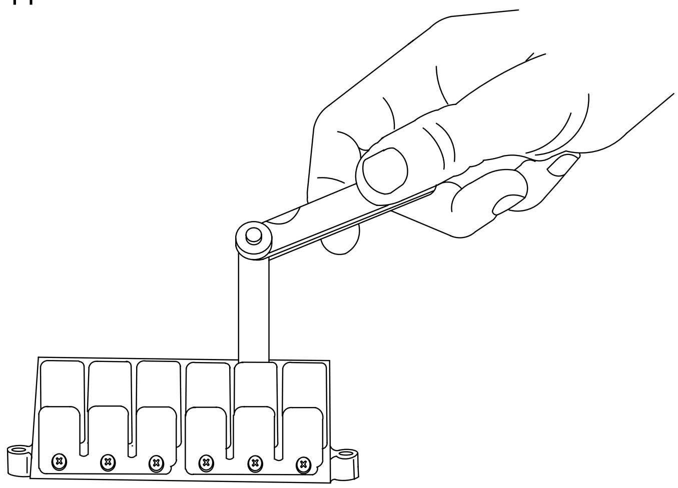


a - Upper Roller Bearing

Reed Block Assembly

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

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



56023

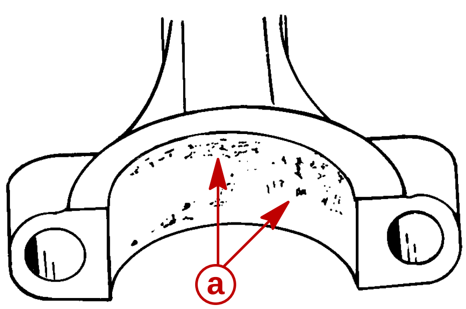
Allowable reed opening is 0.020 in. (0.51 mm) or less. Replace reeds if either reed is standing open more than 0.020 in. (0.51 mm).

End Bearing Bleed System

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

Connecting Rods

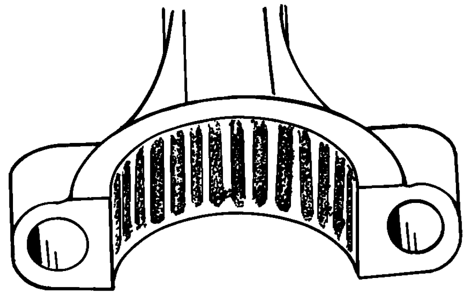
1. Check connecting rods for alignment by placing rods on a surface plate. If light can be seen under any portion of machined surfaces, if rod has a slight wobble on plate, or if a 0.002 in. (0.051 mm) feeler gauge can be inserted between any machined surface and surface plate, rod is bent and must be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



51853

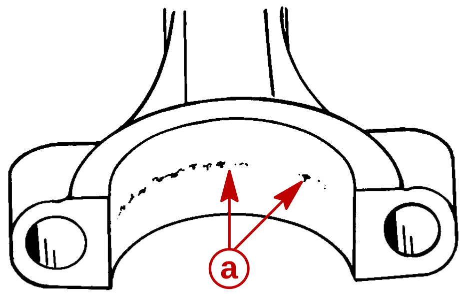
a - Pitting

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



51853

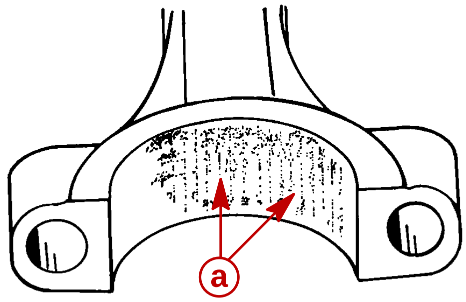
5. **Spalling:** Spalling is the loss of bearing surface, and it resembles flaking or chipping. Spalling will be most evident on the thrust portion of the connecting rod in line with the “I” beam. General bearing surface deterioration could be caused by or accelerated by improper lubrication.



51853

a - Spalling

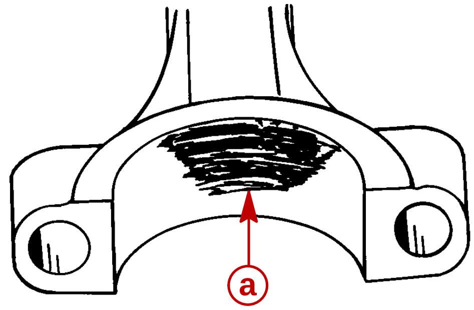
6. **Chatter Marks:** Chatter marks are the result of a combination of low speed - low load - cold water temperature operation, aggravated by inadequate lubrication and/or improper fuel. Under these conditions, the crankshaft journal is hammered by the connecting rod. As ignition occurs in the cylinder,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



51853

a - Chatter Marks Between Arrows

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



51853

a - Uneven Wear Between Arrows

8. If necessary, clean connecting rod bearing surfaces, as follows:

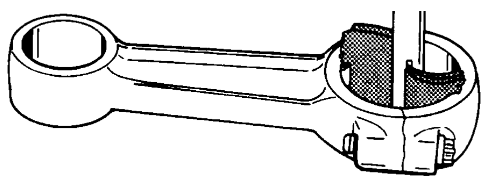
   a. Be sure that "etched" marks on connecting rod (crankshaft end) are perfectly aligned with "etched" marks on connecting rod cap. Tighten connecting rod cap attaching bolts securely.

CAUTION

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

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

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



51083

   c. **Clean PISTON PIN END of connecting rod**, using same method as in Step "b", preceding, but using 320 grit carborundum cloth instead of crocus cloth.

   d. Thoroughly wash connecting rods to remove abrasive grit. Recheck bearing surfaces of connecting rods. Replace any connecting rod(s) that cannot be properly "cleaned up." Lubricate bearing surfaces of connecting rods (which will be re-used) with light oil to prevent rust.

Thermostats (120°F) (49°C)

1. Inspect thermostat covers and cylinder head covers (thermostat opening) for cracks and corrosion damage that could cause leakage. Replace parts as necessary.
2. Remove and discard gasket from each thermostat.
3. Wash thermostats with clean water.
4. Using a thermostat tester, similar to the one shown, test each thermostat as follows:

   a. Open thermostat valve, then insert a thread between valve and thermostat body. Allow valve to close against thread.

   b. Suspend thermostat (from thread) and thermometer inside tester so that neither touches the container. Bottom of thermometer must be even with bottom of thermostat to obtain correct temperature of thermostat opening.

   c. Fill thermostat tester with water to cover thermostat.

d. Plug tester into electrical outlet.

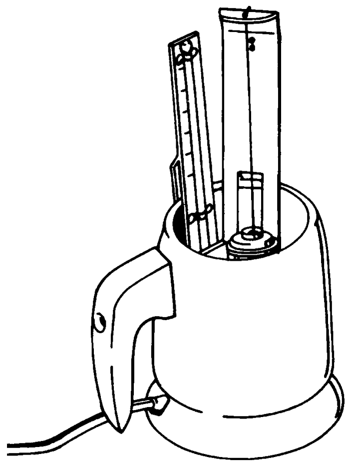
e. Observe temperature at which thermostat begins to open. (Thermostat will drop off thread, that was installed in Step “a”, when it starts to open.) Thermostat must begin to open when temperature reaches 118°-122° F (48°-50° C).

f. Continue to heat water until thermostat is completely open.

g. Unplug thermostat tester.

h. Replace thermostat if it fails to open at the specified temperature, or if it does not fully open.

NOTE: *BE SURE that water in thermostat tester is allowed to cool sufficiently [below 110° F (43° C)] before testing the other thermostat.*



51087

Powerhead Reassembly and Installation

General

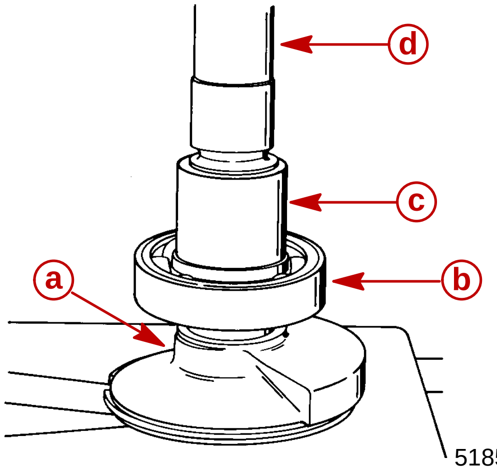
Before proceeding with powerhead reassembly, be sure that all parts to be re-used have been carefully cleaned and thoroughly inspected, as outlined in “Cleaning and Inspection,” preceding. Parts, which have not been properly cleaned (or which are questionable), can severely damage an otherwise perfectly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

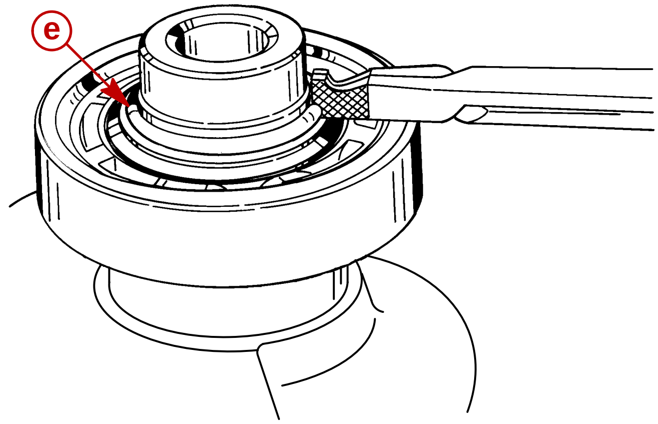
During reassembly, lubricate parts with Quicksilver 2-Cycle Outboard Lubricant whenever “light oil” is specified. Quicksilver part numbers of lubricants, sealers and locking compounds and tools are listed in “Powerhead General Information,” preceding.

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

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

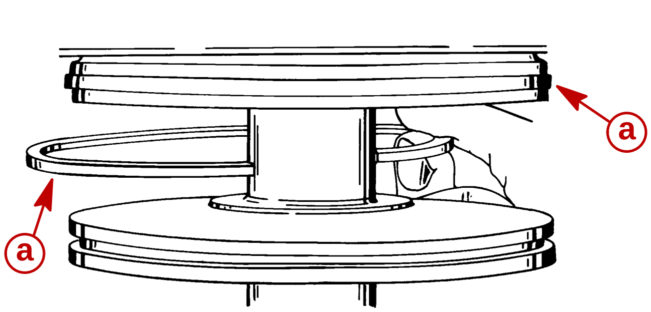
1. If removed, press lower crankshaft ball bearing onto crankshaft as shown. Be sure bearing is pressed firmly against shoulder.
2. Reinstall retaining ring using a suitable pair of Snap Ring Pliers.

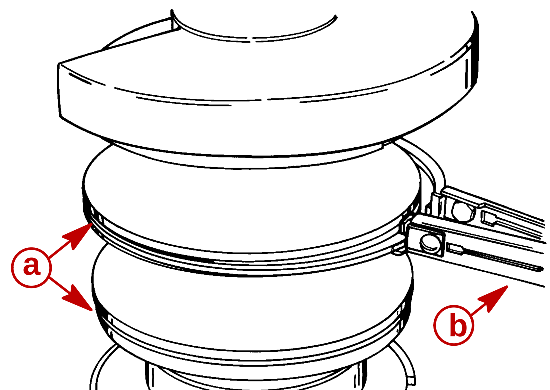




a - Crankshaft
b - Crankshaft Ball Bearing
c - Suitable Mandrel
d - Press
e - Retaining Ring

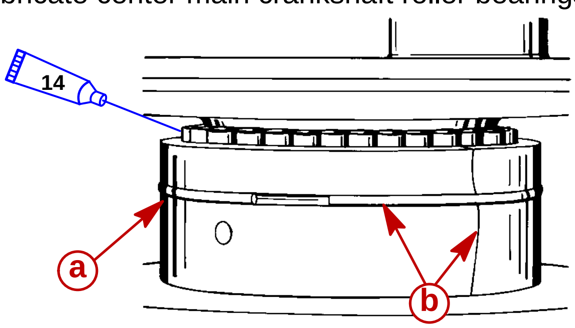
3. If removed, spread new crankshaft sealing rings just enough to slide over crankshaft journal.
4. Use Piston Ring Expander (91-24697) and install crankshaft sealing rings into groove.





a - Crankshaft Sealing Rings
b - Piston Ring Expander (91-24697)

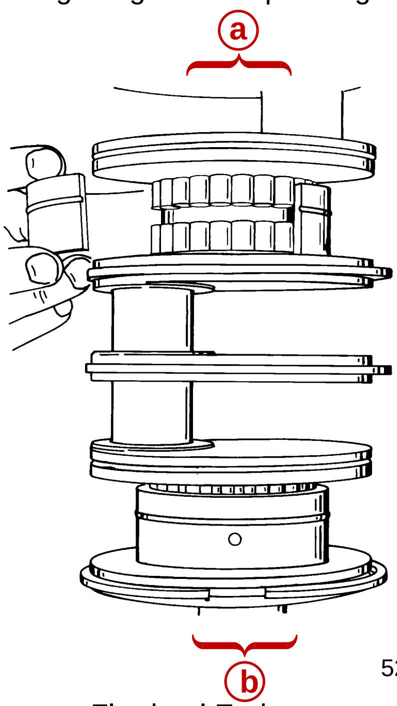
5. Lubricate center main crankshaft roller bearings and races with light oil.



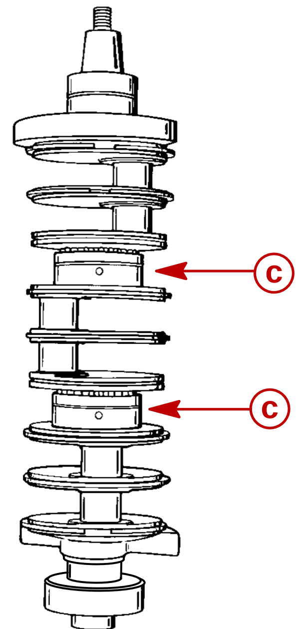
14 2 Cycle Outboard Oil (92-826666A24)

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

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



52315

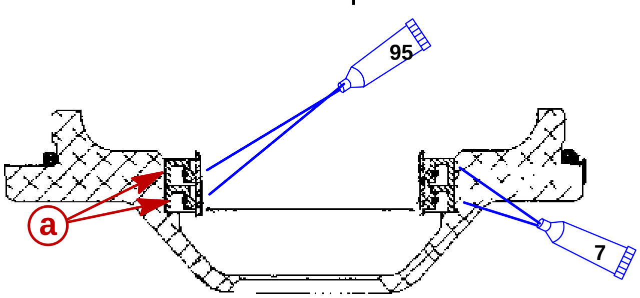


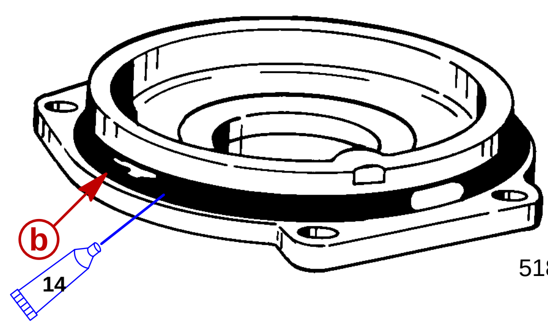
55994

a - Flywheel End
b - Drive Shaft End

c - Center Main Bearing Races

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





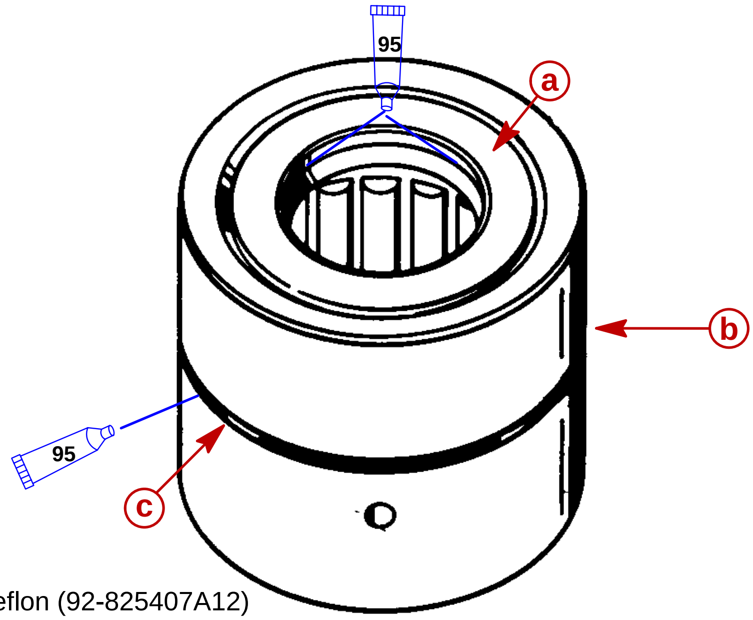
51849

7 Loctite 271 (92-809820)
14 2 Cycle Outboard Oil (92-826666A24)
95 2-4-C With Teflon (92-825407A12)

a - Oil Seal

b - O-ring

10. Install oil seal into upper bearing carrier as follows:
    a. Apply a light film of 2-4-C W/Teflon to outer diameter of upper end cap oil seal; this will ease seal installation into carrier.
    b. Lubricate oil seal lip with 2-4-C w/Teflon.
    c. Use a suitable mandrel, press oil seal into bearing carrier (lip facing down) until bottomed out on shoulder of carrier.
    d. Lubricate O-ring seal surface on end cap with Quicksilver 2-4-C w/Teflon and install on carrier.



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

51473

a - Oil Seal
b - Bearing Carrier
c - O-ring

Crankshaft Installation

SPECIAL INFORMATION

Installing A New Crankshaft Assembly Into Cylinder Block

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

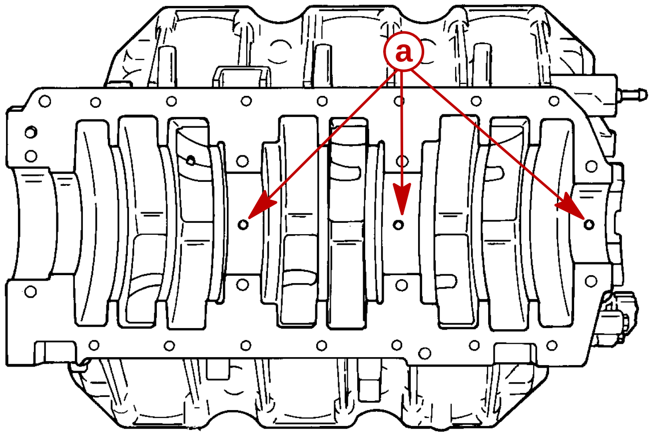
Before installing crankshaft, remove any burrs that may exist on groove edges.

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

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

Install crankshaft as follows:

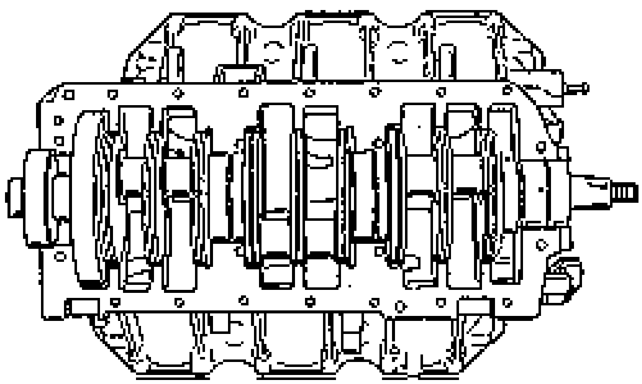
1. Lubricate crankshaft sealing rings with light oil.
2. Check cylinder block to be sure that dowel pins are in place.



55992

a - Dowel Pins

3. Position all crankshaft seal ring gaps straight up.
4. Align hole in each center main bearing race with dowel pin.
5. Gently push crankshaft down into position making sure that the dowel pins are lined up with the holes in center main bearings and crankshaft seal rings are in place.



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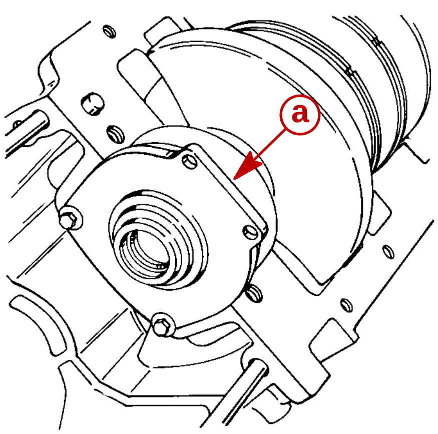
6. Lubricate lower crankshaft end (oil seal area) with light oil, then install lower end cap. Secure end cap to cylinder block with attaching bolts. DO NOT tighten end cap bolts at this time.



52328

a - Lower End Cap

Piston and Connecting Rod Reassembly

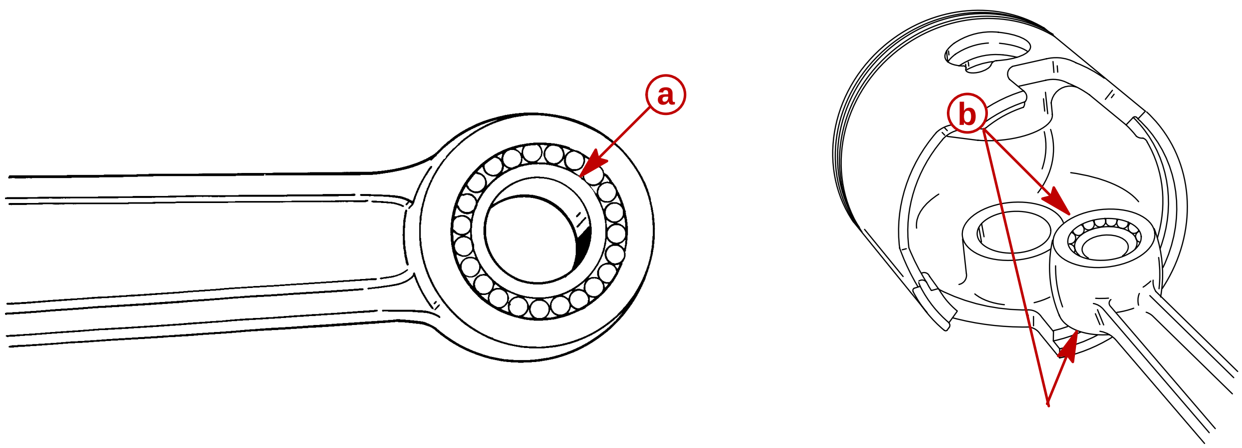
1. Place needle bearings on a clean piece of paper and lubricate with Quicksilver 2-4-C w/Teflon Marine Lubricant.

NOTE: *There are 34 needle bearings per piston.*

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

IMPORTANT: Position connecting rod part number facing towards flywheel.

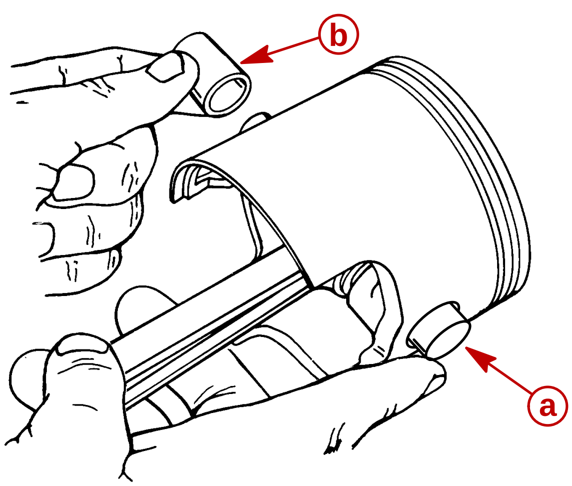
Carefully position piston over end of rod. Make sure locating washers remain in place.



55960

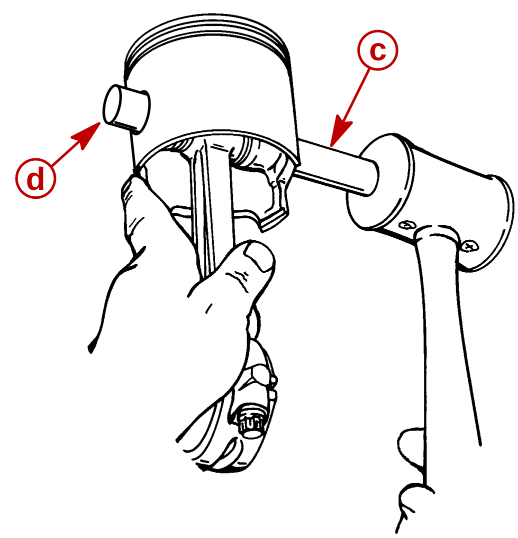
a - Sleeve (Part of Tool Assy. 91-92973A1)
b - Locating Washers

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



55961

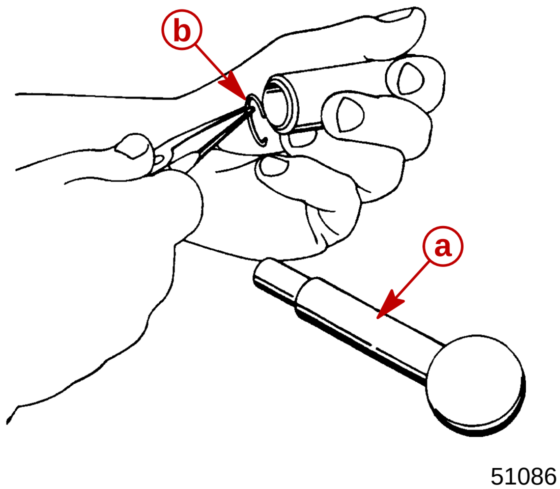
a - Piston Pin Tool (91-74607A1)
b - Sleeve

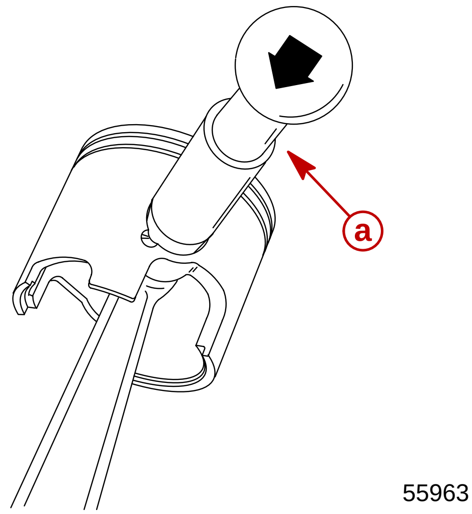


55962

c - Piston Pin
d - Piston Pin Tool

6. Install new piston pin lockrings (one each end of piston pin) with Lockring Installation Tool (91-93004A2).
7. Make sure lockrings are properly seated in piston grooves.

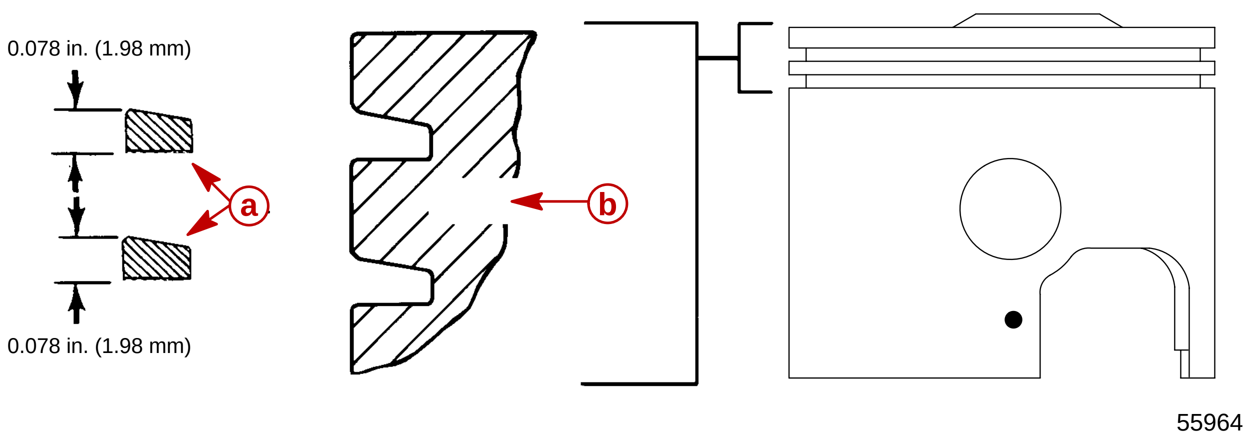




a - Lockring Installation Tool (91-93004A2)
b - Lockring

Piston and Piston Ring Combinations

Pistons with two half keystone (half tapered) rings

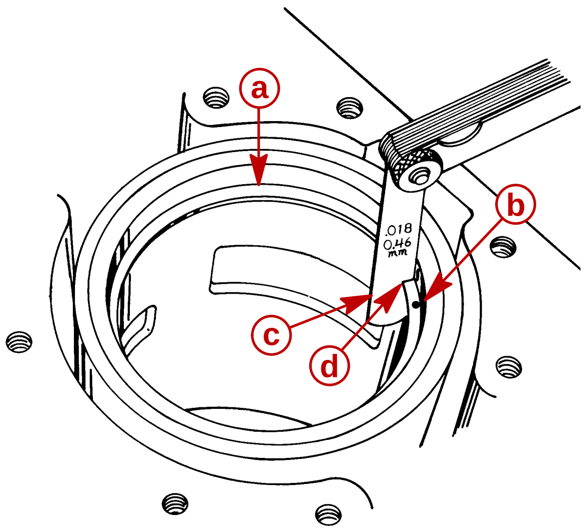


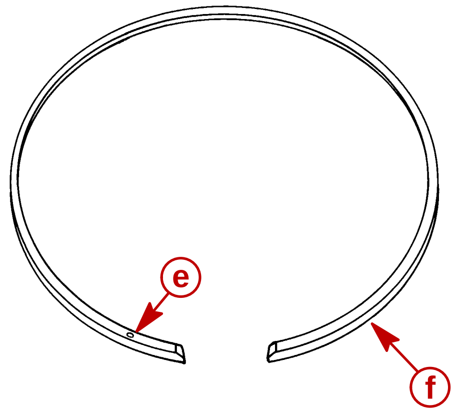
a - Half Keystone (half tapered) Piston Ring
b - Enlarged View of Piston Ring Grooves

Piston Installation

1. Before installing new piston rings, check gap between ring ends by placing each ring in its respective cylinder, then pushing ring about 1/2 in. (12.7 mm) into cylinder using piston to assure proper position.
2. Check end gap of each new piston ring with a feeler gauge. End gap must be within 0.010 in. to 0.018 in. (0.25 mm to 0.46 mm). If end gap is greater, check other piston rings in cylinder bore, until rings (within tolerance) are found.

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



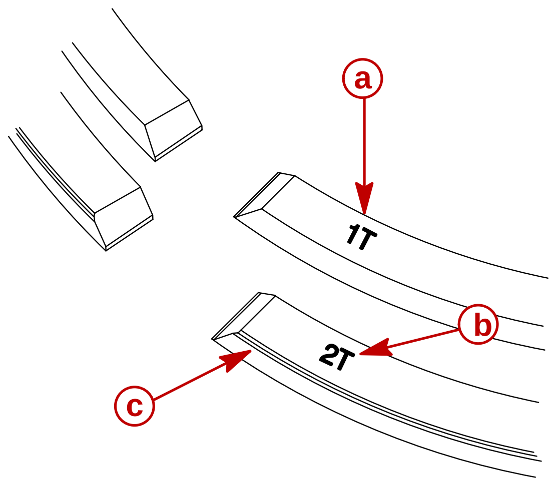


52317

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

e - Dot or Letter
f - Piston Ring

IMPORTANT: Model Year 2001 engines have top and bottom indicated piston rings and should be installed accordingly. The top ring is marked T1 and the bottom ring is marked T2. The "T" represents the top side of of the ring. The bottom ring is stepped to trap oil and bring it into the cylinder bores on the upward stroke.

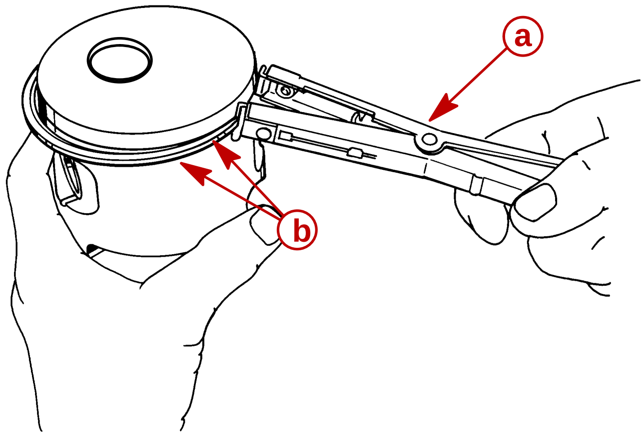


58126

a - T1 top ring
b - T2 bottom ring
c - Step

3. Use Piston Ring Expander (91-24697) and install piston rings (dot side up) on each piston. Spread rings just enough to slip over piston.

4. Check piston rings to be sure that they fit freely in ring groove.
5. Lubricate piston, rings and cylinder wall with 2-Cycle Outboard Oil.



52319

a - Piston Ring Expander (91-24697)
b - Dot Side “Up” on Piston Ring

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

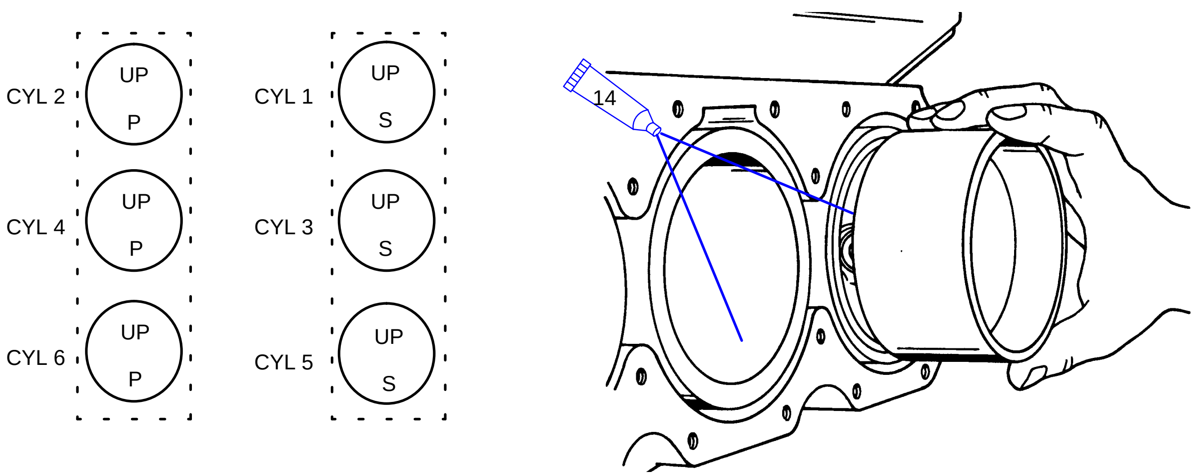
IMPORTANT: Piston must be correctly installed and positioned as shown.

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

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

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

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



52328

14 2 Cycle Outboard Oil (92-826666A24)

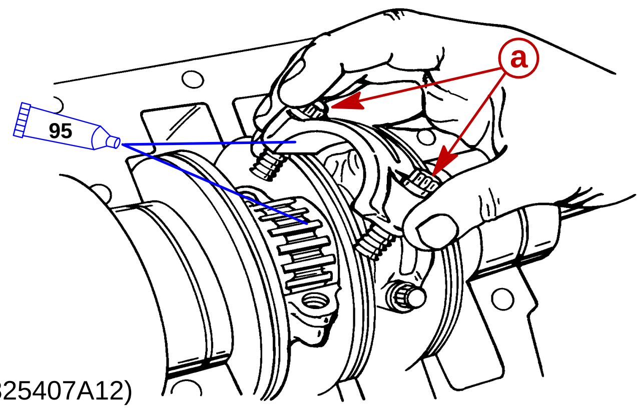
10. Apply Quicksilver 2-4-C w/Teflon to bearing surface of connecting rod and install bearing assembly, as shown.
11. Place connecting rod cap on connecting rod. Apply light oil to threads and face of connecting rod bolts. Thread connecting rod bolts finger-tight while checking for correct alignment of the rod cap as shown.

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

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

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

12. Tighten connecting rod bolts (using a 3/18 in. - 12 point socket). First torque to 15 lb. in. (1.7 N·m) then 30 lb. ft. (41 N·m). Turn each bolt an additional 90° after 2nd torque is attained. Recheck alignment between rod cap and rod as shown.



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

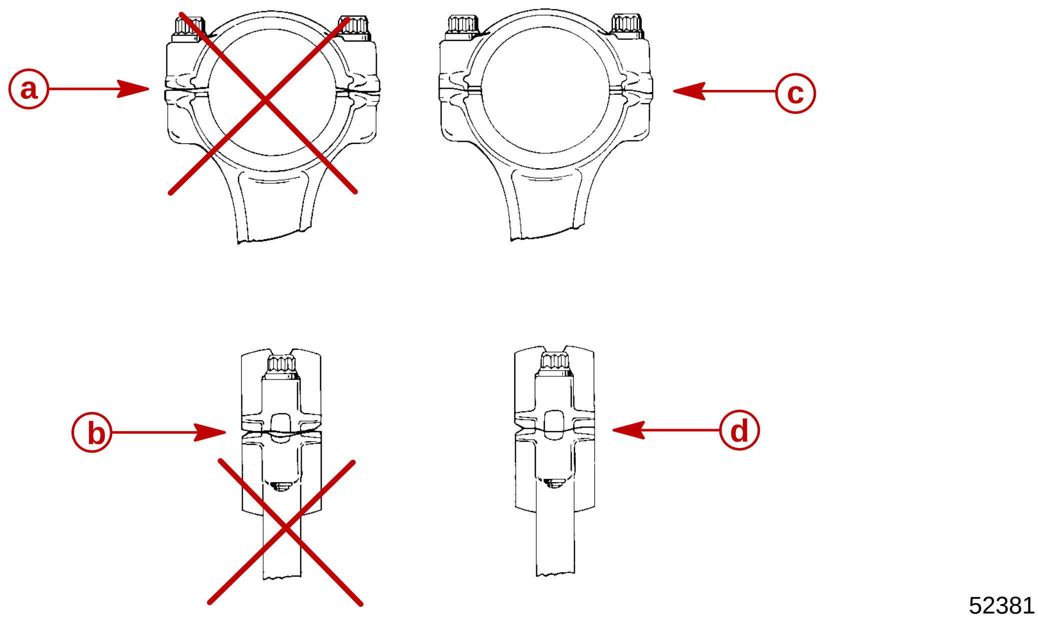
52316

a - Connecting Rod Screws

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

Connecting Rod Cap Alignment

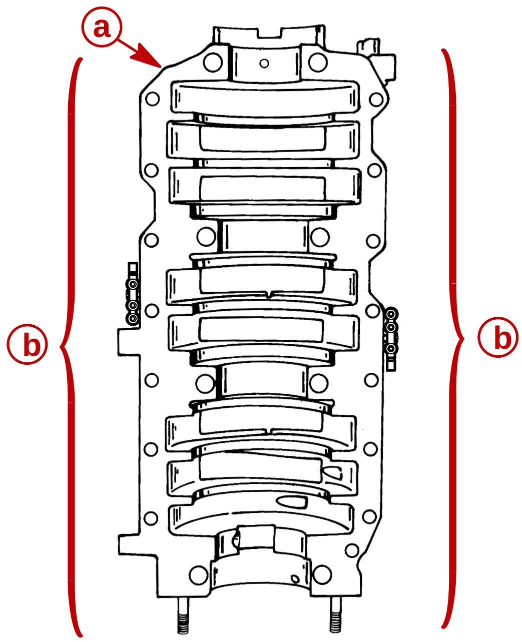
Check each connecting rod cap for correct alignment. If not aligned, a ridge can be seen or felt at the separating line as shown below. Correct any misalignment.



a - Side View Incorrect – Cap on Backwards
b - End View Incorrect – Cap on Backwards
c - Side View Correct
d - End View Correct

Crankcase Cover Installation

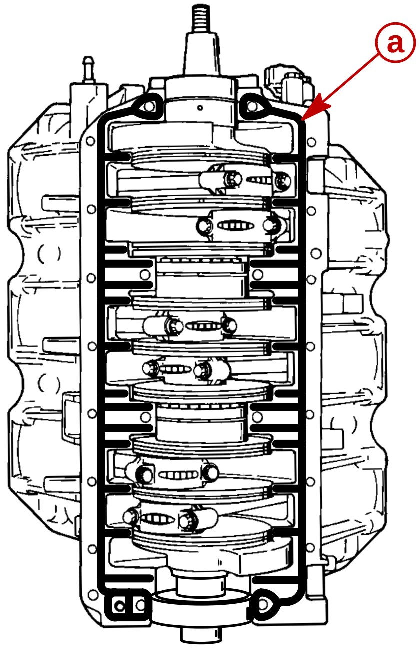
1. Thoroughly remove all oil from mating surfaces of crankcase cover and cylinder block with Loctite Primer 203 included in Master Gasket Kit (92-12564-1).



55984

a - Crankcase Cover
b - Remove all Oil

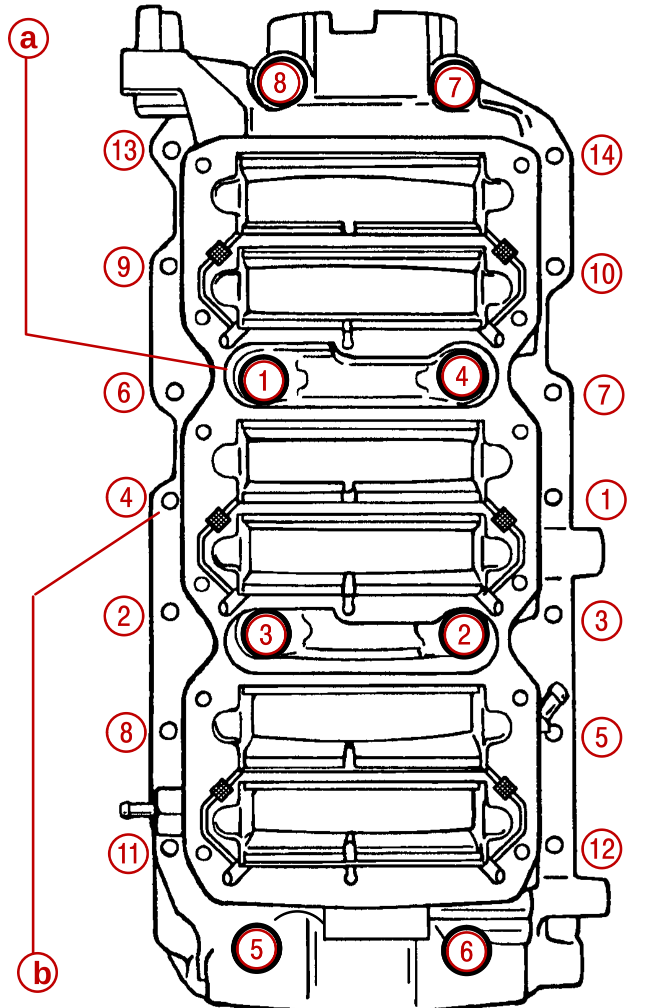
2. Apply a thin, even coat of Loctite Master Gasket on mating surfaces of cylinder block.



55985

a - Loctite Master Gasket (92-12564-1)

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



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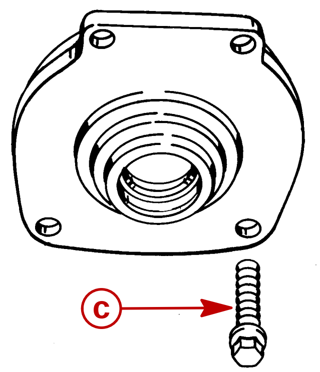
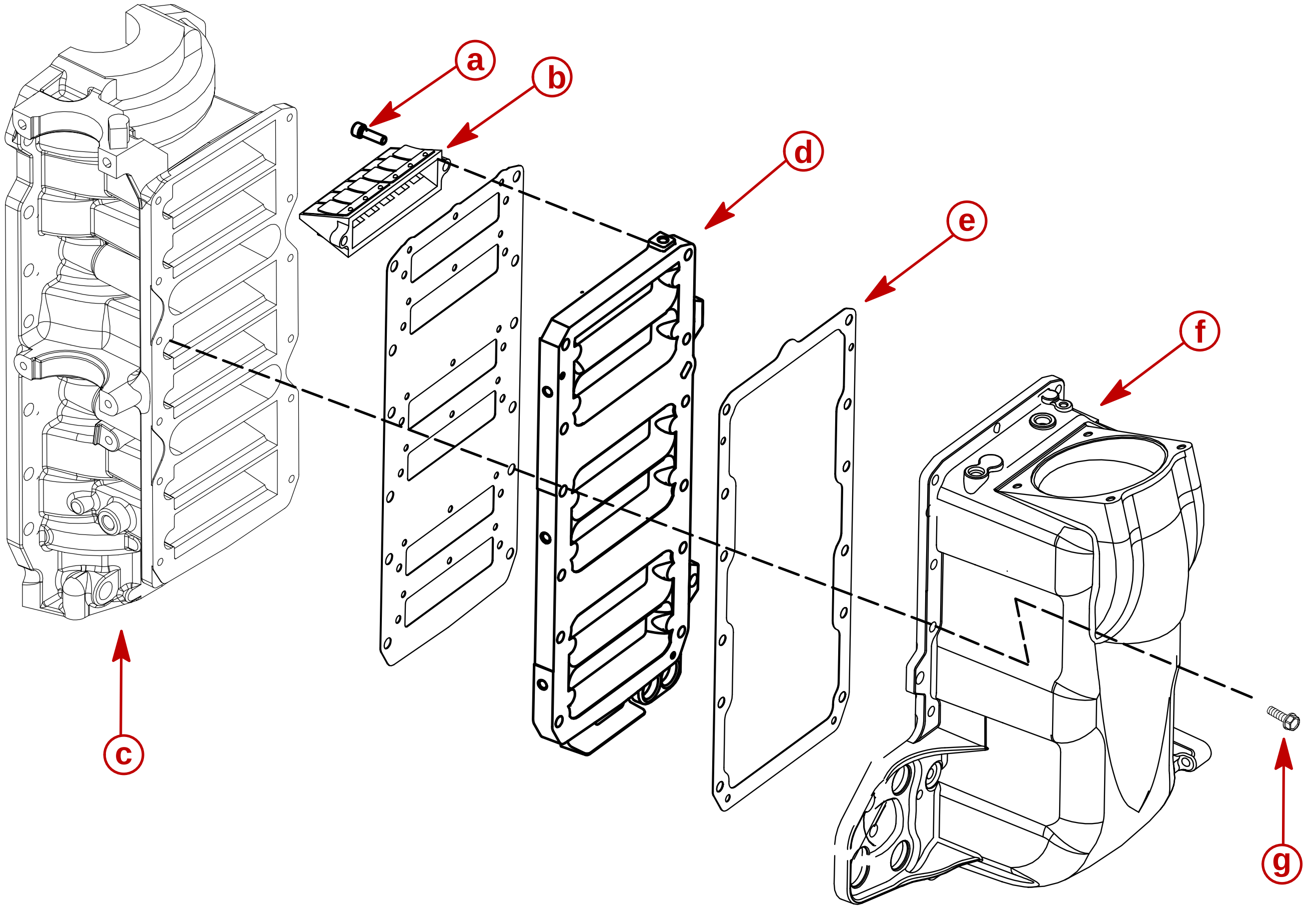


52132

a - Apply Light Oil to Threads of Bolt Face; 8 Bolts (M10 x 1.5 x 80); Torque bolts to 30 lb. ft. (41 Nm) and rotate 90°
b - 14 Bolts; (M8 x 1.25 x 35); Torque bolts to 28 lb. ft. (38 Nm)
c - Lower End Cap Bolts – Torque to 85 lb. in. (9.5 Nm)

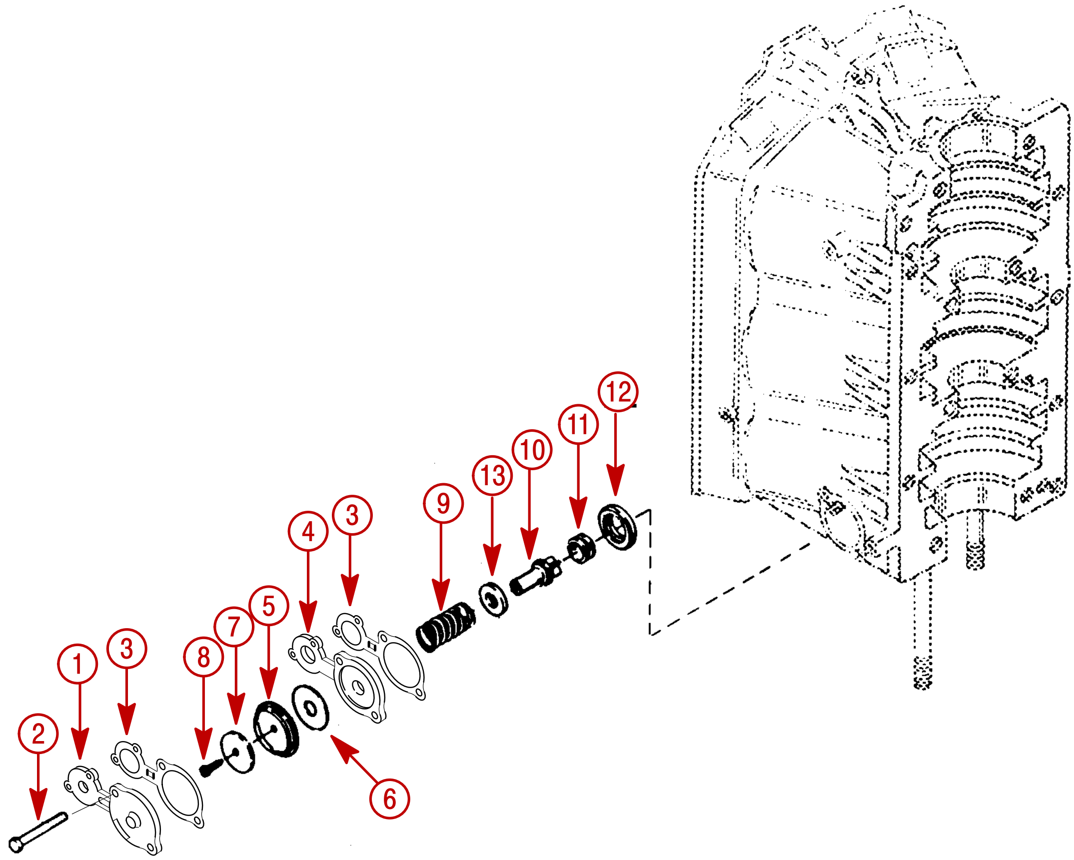
Assembly of Reed Blocks to Reed Block Adaptor Plate



NOTE: *Air plenum gasket is beaded on 1 side. Bead side of the gasket faces the air plenum.*

- **a** - Torque to 90 lb. in. (10 Nm)
- **b** - Reed Block (6)
- **c** - Cylinder Block Cover
- **d** - Adaptor Plate
- **e** - Air Plenum Gasket (bead faces air plenum)
- **f** - Air Plenum
- **g** - Torque to 100 lb. in. (11.5 Nm)

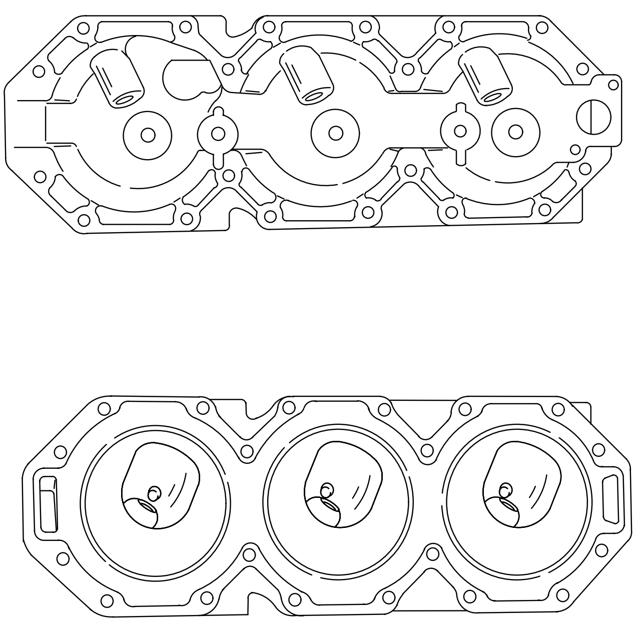
1. If removed, install water pressure relief valve components as shown. Torque bolts to specifications.



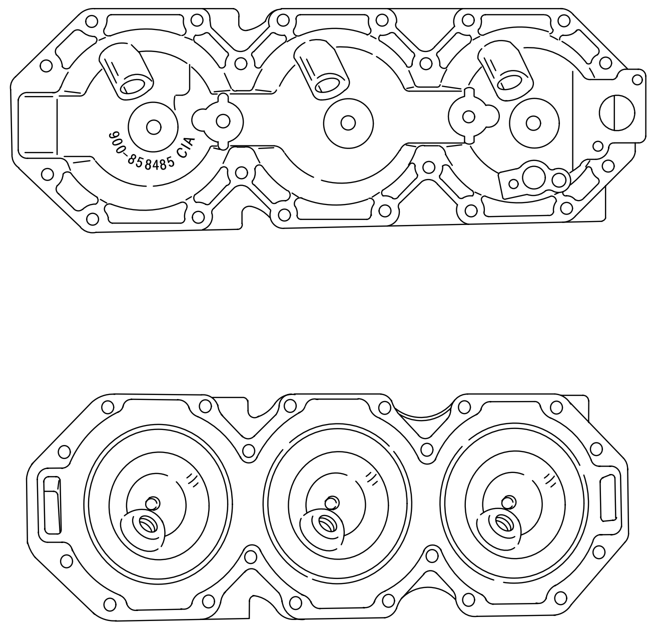
1 - Cover	**7** - Washer
2 - Bolt - 150 lb. in. (17 Nm)	**8** - Screw - 25 lb. in. (3 Nm)
3 - Gasket	**9** - Spring
4 - Relief Valve Plate	**10** - Poppet Valve
5 - Diaphragm	**11** - Grommet
6 - Water Deflector	**12** - Carrier
	13 - Washer

CYLINDER HEAD INSTALLATION

IMPORTANT: Model Year 2000 225 and Model Year 2001 225 cylinder heads are not interchangeable. The combustion chamber configuration has been modified for Model Year 2001 to increase horsepower (3 – 4 hp) and the ECM has been re-calibrated accordingly.

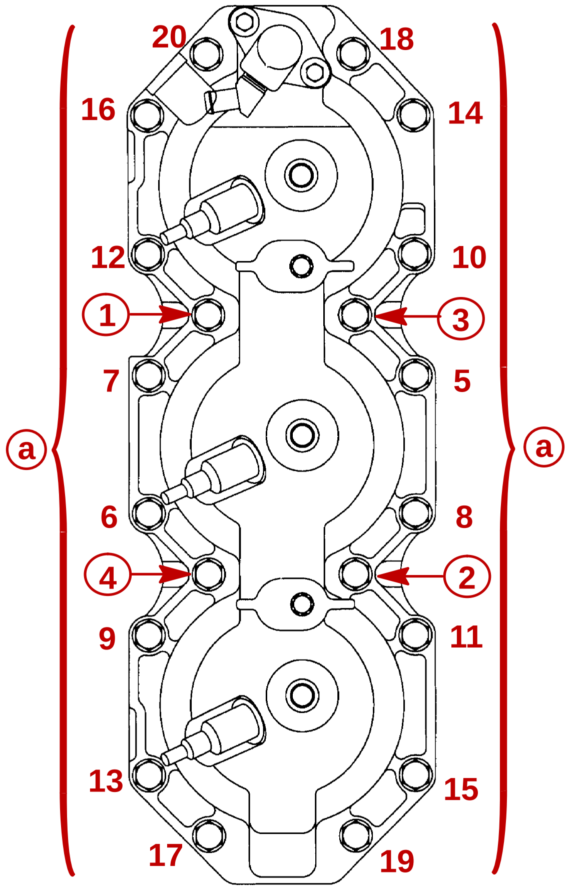


MODEL YEAR 2000



MODEL YEAR 2001

1. Install each cylinder head to engine block with thermostat pocket "UP". Apply light oil to cylinder head bolt threads and torque bolts to 20 lb. ft. (27 Nm) then turn an additional 90°.
2. Install thermostat assembly into each cylinder head.
3. Install overheat temperature sensors into STARBOARD and PORT cylinder heads.



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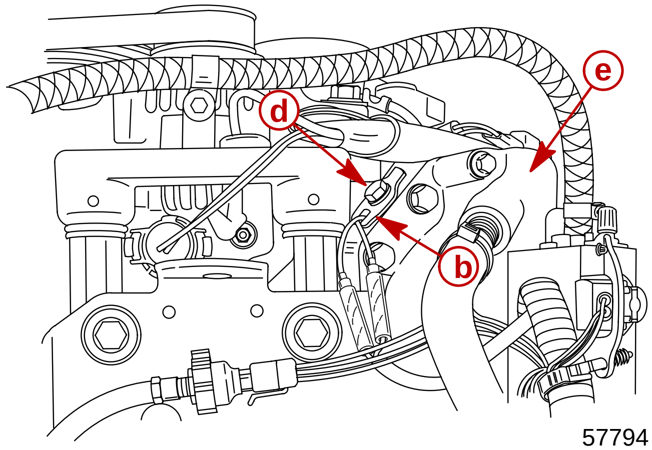

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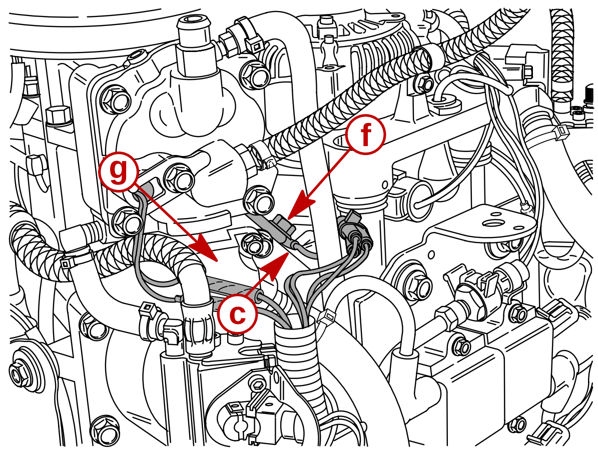


57795

a - Bolt [Torque to 20 lb. ft. (27 Nm) and then turn 90°]
b - Temperature Sensor (Starboard)
c - Temperature Sensor (Port)
d - Bolt [Torque to 17 lb. ft. (23. Nm)]
e - Starboard Thermostat
f - Bolt [Torque to 17 lb. ft. (23 Nm)]
g - Port Thermostat

NOTE: *The temperature senders provide continuous temperature information to the ECM while the engine is running. Should temperature reach approximately 180° F 82° C), the ECM will activate a warning horn and warning light.*

Notes:

Reinstalling Engine Components

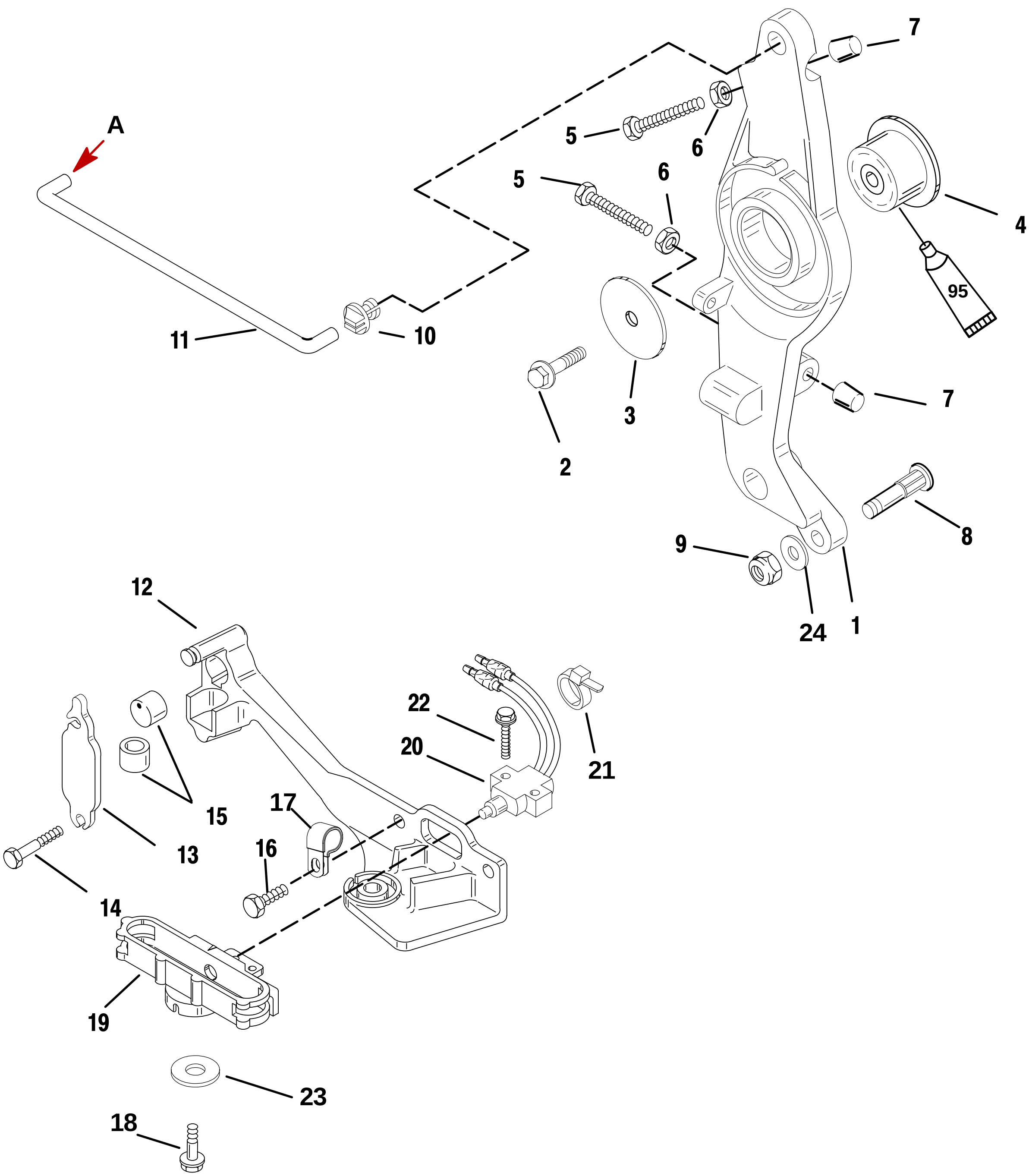
NOTE: *Components can be reinstalled individually or as an assembly. If reinstalling components individually, refer to the following sections. If reinstalling components as an assembly, refer to* ***Removing Engine Components as an Assembly****, page 4A-24, and reinstall in reverse sequence.*

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

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

Section 4
Throttle/Shift Control Platform
Throttle/Shift Cable Installation and Adjustment

Throttle Lever and Shift Shaft



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

A = TO CAM

Throttle Lever and Shift Shaft

REF. NO.	QTY.	DESCRIPTION	TORQUE lb. in.	TORQUE lb. ft.	TORQUE Nm
1	1	THROTTLE CONTROL LEVER			
2	1	SCREW (M8 x 35)	250	21	28
3	1	WASHER			
4	1	BUSHING			
5	2	SCREW (M6 x 55)			
6	2	NUT			
7	2	CAP			
8	1	PIN INSERT			
9	1	NUT	50		5.5
10	1	SWIVEL BUSHING			
11	1	LINK			
12	1	ANCHOR BRACKET			
13	1	LATCH			
14	2	SCREW-Drive			
15	2	CUP			
16	2	SCREW (M8 x 25)		18	24
17	1	CLAMP			
18	1	SCREW (M8 x 25)		20	27
19	1	ROLLER GUIDE			
20	1	SWITCH			
21	1	STA-STRAP			
22	2	SCREW (M3.5 x 20)			
23	1	WASHER			
24	1	WASHER			

Powerhead Installation on Driveshaft Housing

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

WARNING

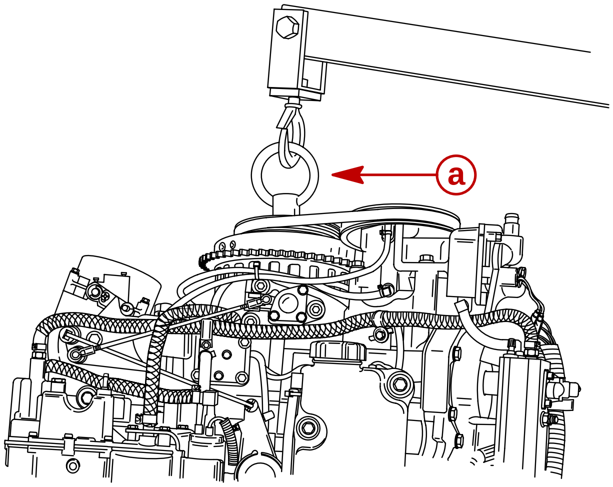
BE SURE that Lifting Eye is threaded into flywheel as far as possible BEFORE lifting powerhead.

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

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

4. Apply a small amount of 2-4-Cw/Teflon Marine Lubricant (92-90018A12) onto driveshaft splines.
5. Use hoist to lower powerhead onto driveshaft housing. It may be necessary to turn flywheel (aligning crankshaft splines with driveshaft splines) so that powerhead will be fully installed.

6. Install 10 flat washers and10 locknuts which secure powerhead to exhaust extension plate/driveshaft housing. Torque locknuts in 3 progressive steps until secured.
7. Disconnect hoist from Lifting Eye and remove Lifting Eye from flywheel.
8. Reinstall plastic cap into center of flywheel cover.



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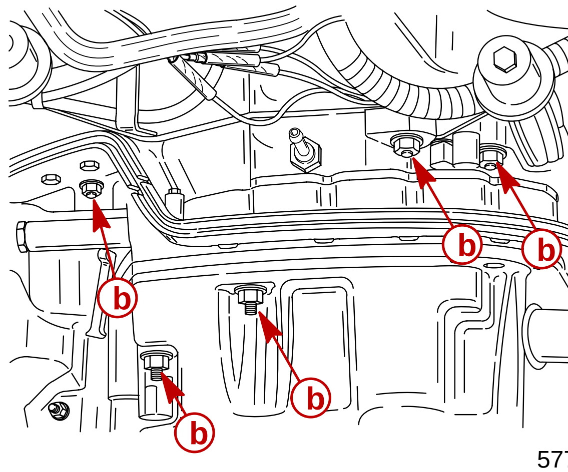
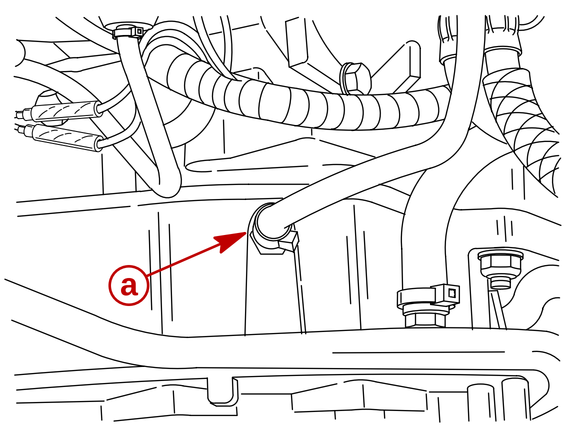


57724

a - Lifting Eye (91-90455)
b - Powerhead Attaching Locknuts and Flat Washers – Torque Nuts to 20 lb. ft. (27 Nm)

9. Install fuel rail inlet water hose to fitting on exhaust adaptor plate. Secure all hoses with sta-straps.
10. Install thermostat cover hoses. Secure hoses with sta-straps.



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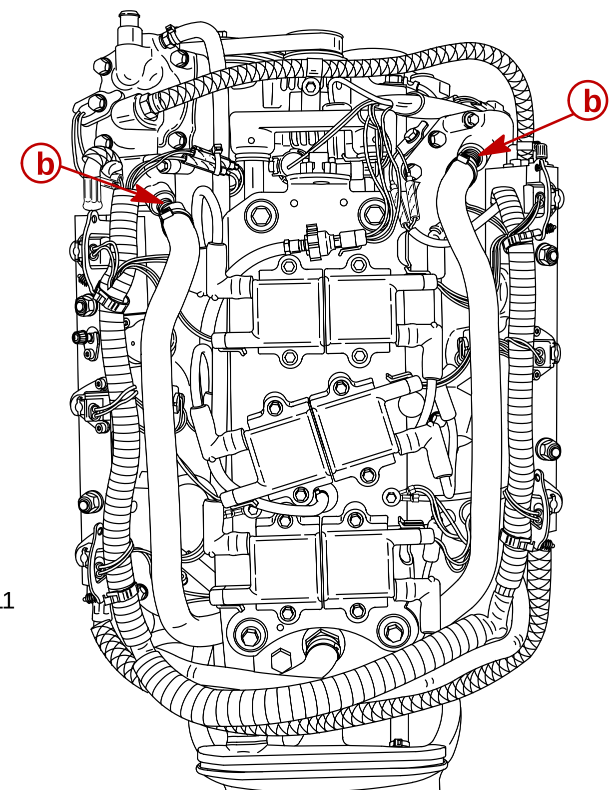

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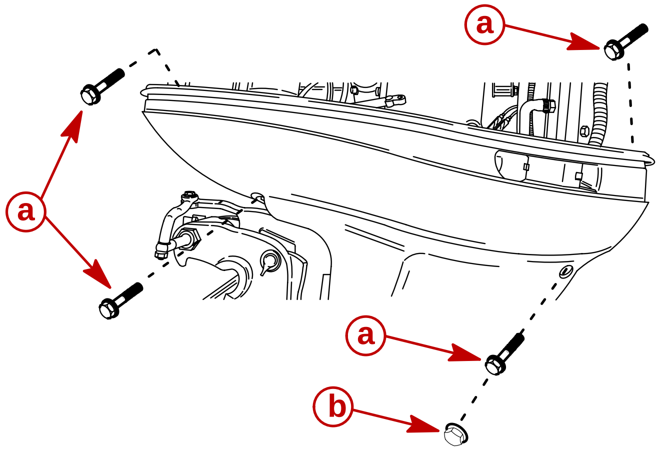
a - Fuel Rail Inlet Water Hose
b - Thermostat Cover Hoses

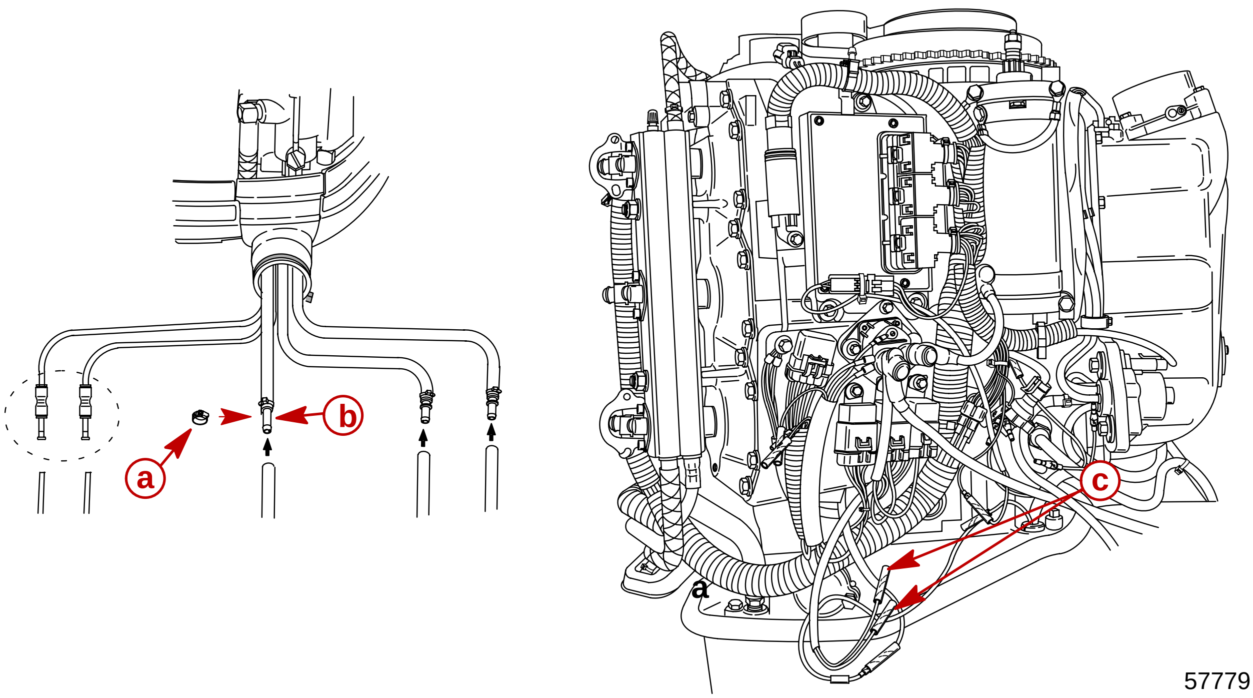
11. Install 4 bolts securing bottom cowl halves and install bottom cowling.



a - Bolts
b - Plug – Remove to gain access to bottom screw

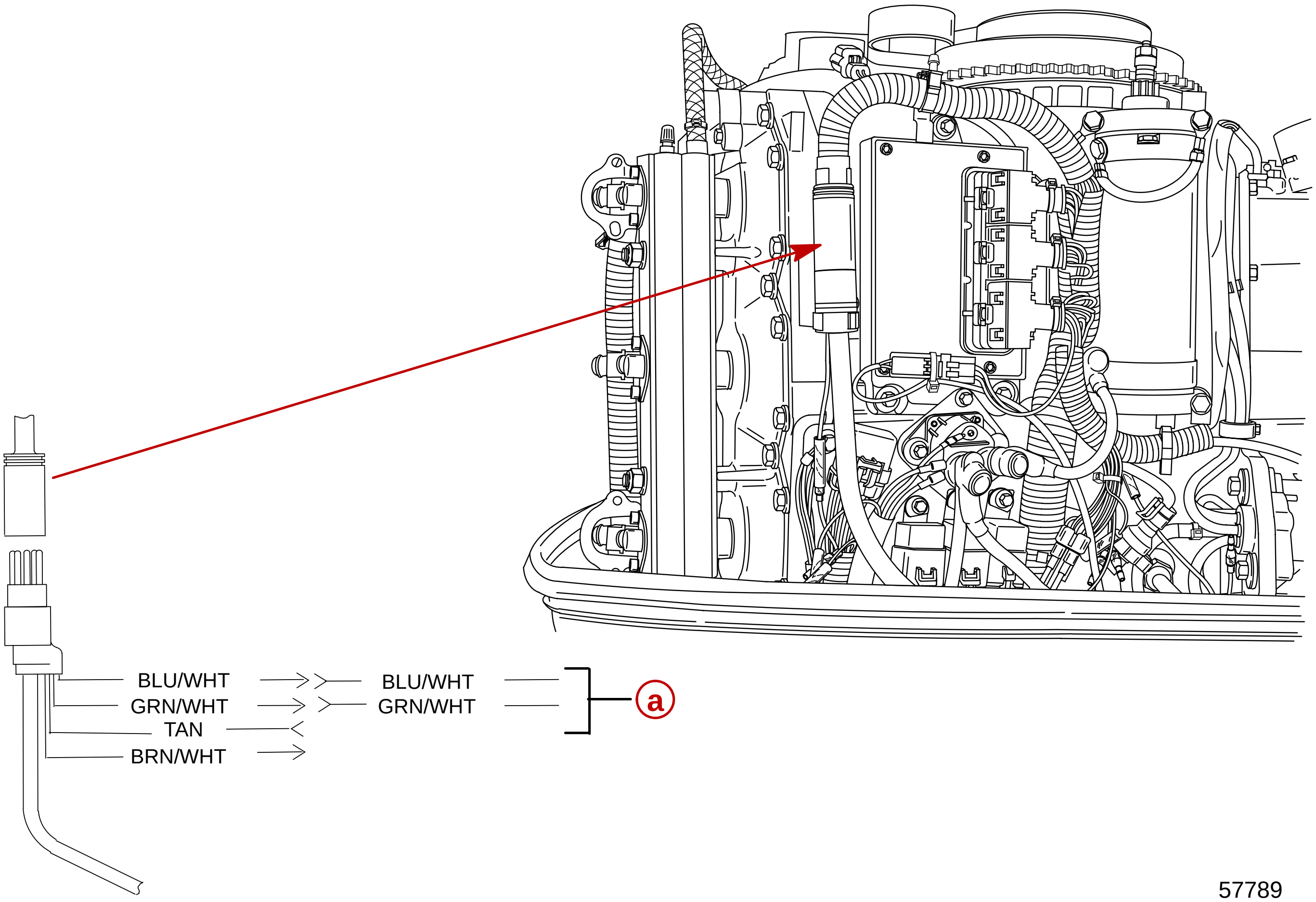
12. Reconnect input fuel line.

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



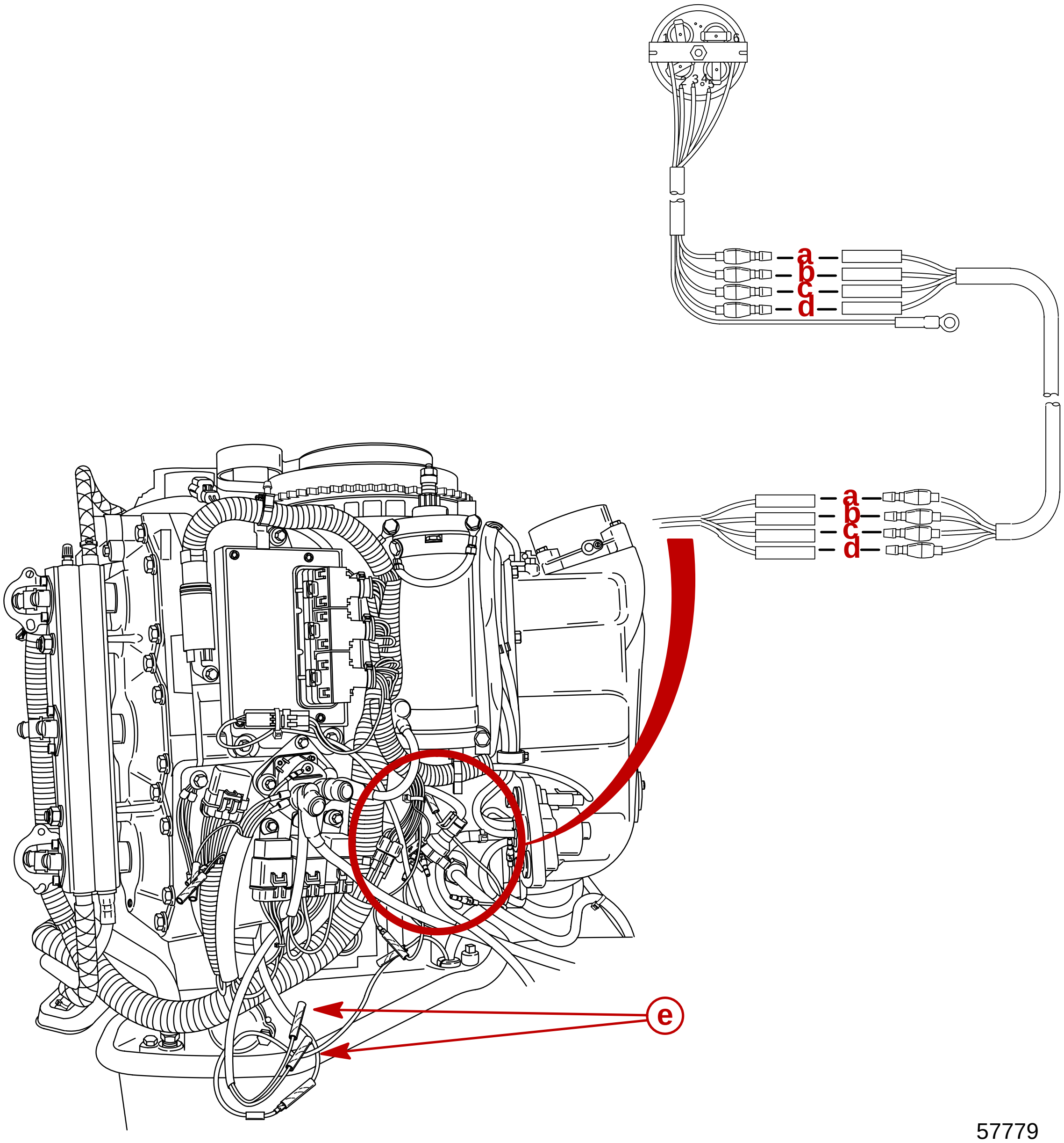
a - Hose Clamp
b - Fuel Line
c - Trim Solenoid Harness Leads

14. Connect wiring. Place harness into holder.



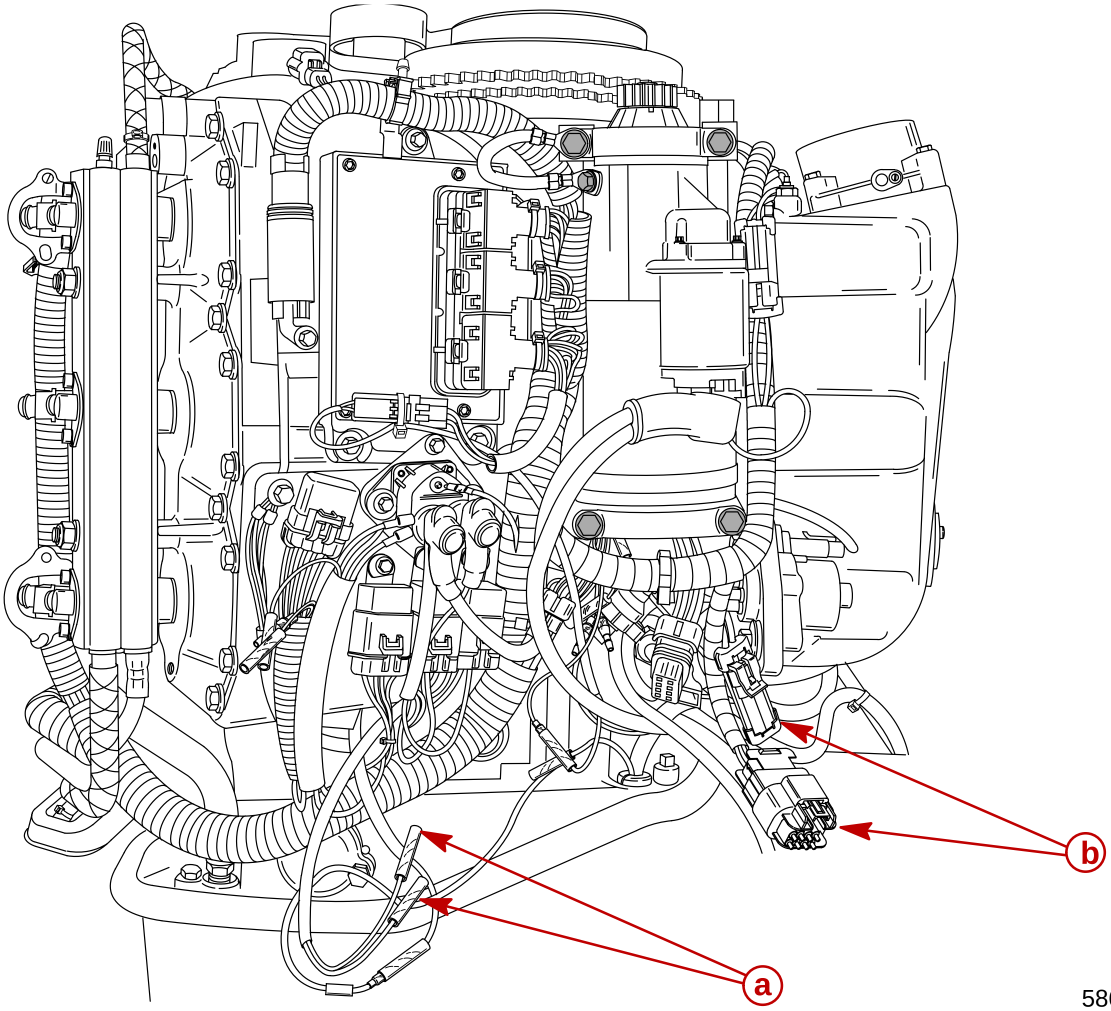
a - Power Trim Connections

15. **Model Year 2000** – Reconnect warning gauge harness and BLUE and GREEN trim harness leads.



a - TAN/BLACK
b - TAN/WHITE
c - PINK/LT. BLUE to PINK/LT. BLUE
d - ORANGE
e - Trim Harness Leads

16. **Model Year 2001** – Reconnect Smart Craft harness connectors and BLUE and GREEN trim harness leads.

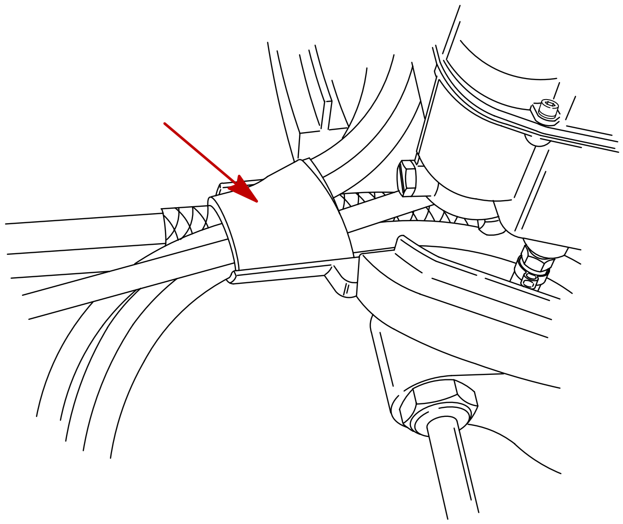


a - Trim Harness Leads
b - Smart Craft Harness Connectors

Front Clamp Reassembly

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

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



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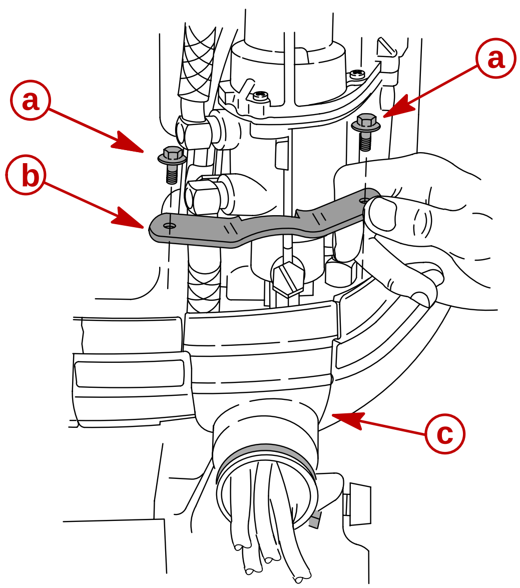
2. Fasten clamp together with two screws and retainer.



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a - Screws (2)
b - Retainer
c - Clamp

Shift Cable Installation

IMPORTANT: Step 1 must be followed for proper adjustment of the shift cable.

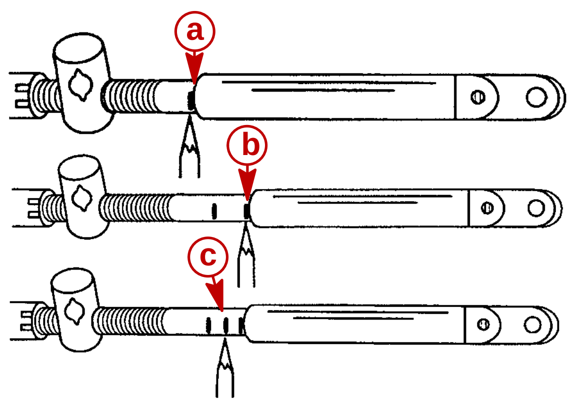
1. Locate the center point of the slack or lost motion that exists in the shift cable as follows:

   a. Move the remote control handle from neutral into forward and advance the handle to full speed position. Slowly return the handle back to the neutral. Place a mark (a) on the cable against the cable end guide.

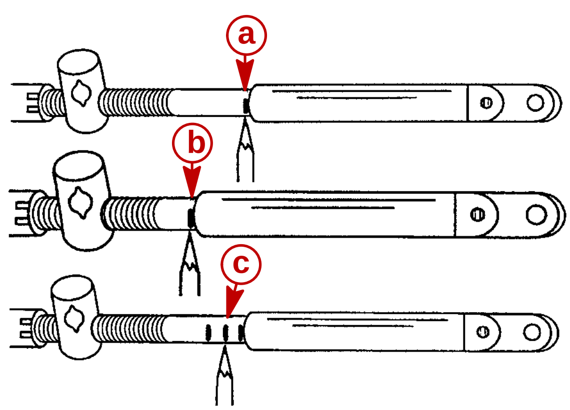
   b. Move the remote control handle from neutral into reverse and advance the handle to full speed position. Slowly return the handle back to the neutral. Place a mark (b) on the cable against the cable end guide.

   c. Make a center mark (c), midway between marks (“a” and “b”). Align the cable end guide against this center mark when installing cable to the engine.

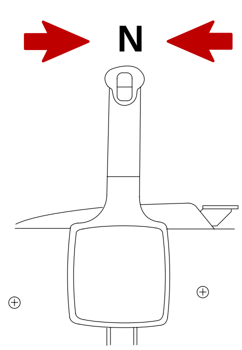
STANDARD ROTATION OUTBOARDS



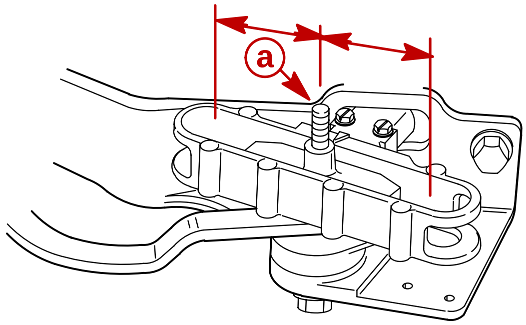
COUNTER ROTATION OUTBOARDS



2. Position remote control and outboard into neutral.

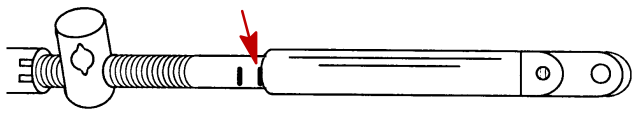


3. Slide the shift cable retainer forward until resistance is felt, then slide cable anchor toward rear until resistance is felt. Center the anchor pin between resistance points.

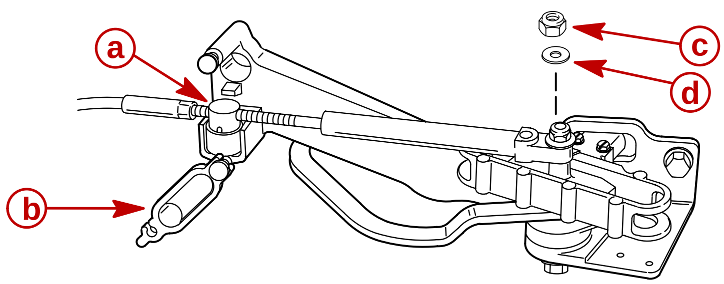


a - Anchor Pin

4. Align the shift cable end guide with the center mark as instructed in Step 1.



5. Place shift cable on anchor pin. Adjust cable barrel so it slips freely into the barrel holder.
6. Secure shift cable with shift cable retainer.



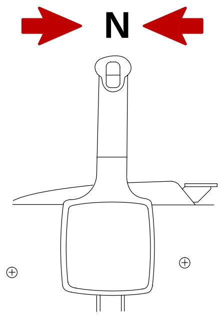
a - Cable Barrel
b - Shift Cable Retainer
c - Locknut – Tighten locknut then back off locknut 1/4 turn
d - Nylon Washer

7. Check shift cable adjustments as follows:
   a. With remote control in forward, the propshaft should lock solidly in gear. If it does not, adjust cable barrel closer to cable end guide.
   b. Shift remote control into neutral. The propshaft should turn freely without drag. If not, adjust barrel away from cable end guide. Repeat steps a and b.
   c. Shift remote control into reverse while turning propeller. The propshaft should lock solidly in gear. If not, adjust barrel away from cable end guide. Repeat steps a thru c.
   d. Return remote control handle to neutral. The propeller should turn freely without drag. If not, adjust barrel closer to cable end guide. Repeat steps a thru d.

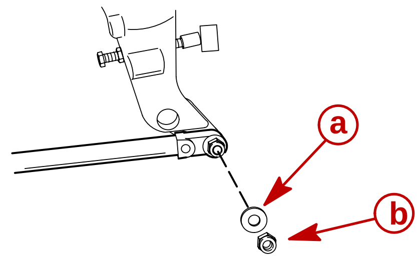
Throttle Cable

INSTALLATION

1. Position remote control into neutral.

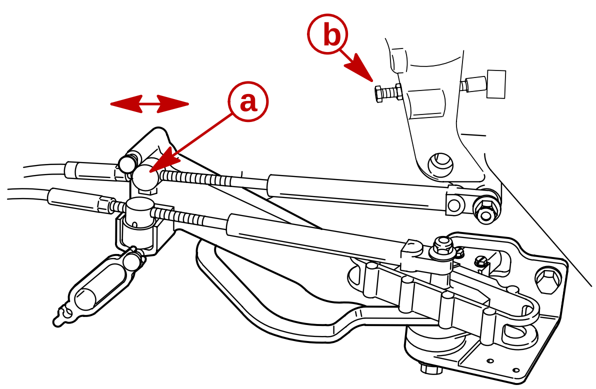


2. Attach throttle cable to the throttle lever. Secure with latch.



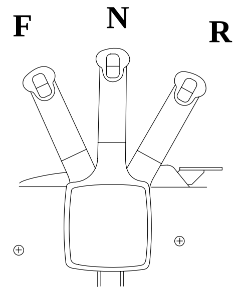
a - Nylon Washer
b - Locknut – Tighten locknut then back off locknut 1/4 turn

3. Adjust the cable barrel so that the installed throttle cable will hold the idle stop screw against the stop.



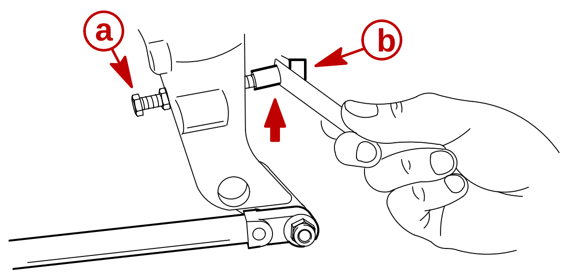
a - Cable Barrel – Adjust To Hold Idle Stop Screw Against Stop
b - Idle Stop Screw

4. Check throttle cable adjustment as follows:
   a. Shift outboard into gear a few times to activate the throttle linkage. Make sure to rotate the propeller shaft while shifting into reverse.



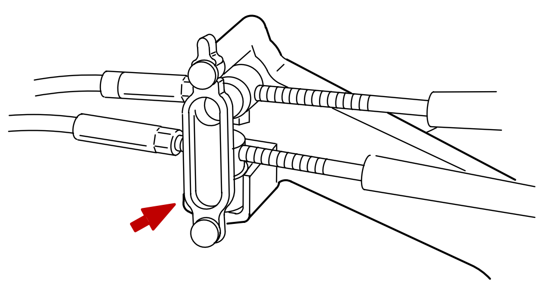
   b. Return remote control to neutral. Place a thin piece of paper between idle adjustment screw and idle stop. Adjustment is correct when the paper can be removed without tearing, but has some drag on it. Readjust cable barrel if necessary.

IMPORTANT: The idle stop screw must be touching the stop.



a - Idle Stop Screw
b - Idle Stop

5. Lock the barrel holder in place with the cable latch.



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

Break-In Procedure

⚠ CAUTION

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

FUEL REQUIREMENTS

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

INITIATING ENGINE BREAK-IN SEQUENCE (PRIMING OIL PUMP)

Refer to Section 3C for proper procedures.

Engine Break-in Procedure (All Models)

FIRST HOUR

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

NEXT 3 HOURS

- Change engine speed every 10 minutes.

POWERHEAD

Section 4B - Cooling

Table of Contents

4
B

Specifications

Water Pressure

Idle	1.5 - 4.5 psi (10.3 - 31.0 kPa)
Poppet Valve Opening	6 - 7 psi (41.4 - 48.3 kPa)
W.O.T.	8 - 23* psi (55.2 - 158.6 kPa)

NOTE: 23 psi water pressure would only be achieved on high performance (70+ mph) boats.

Thermostat . . . . 120°F (49°C)

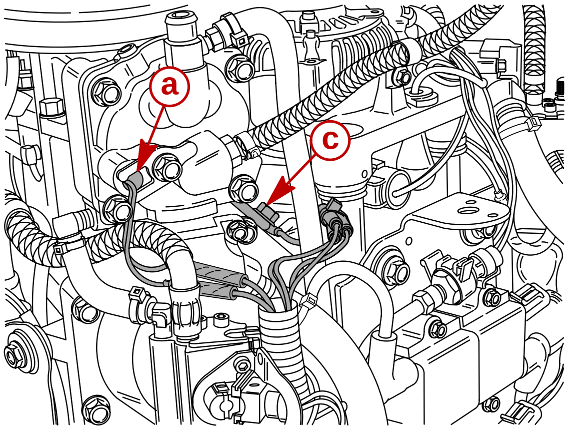
Temperature Sensor

Temperature Sensor(s)	
Between Black and each TAN/BLK wire.	No Continuity
Between each lead and ground	No Continuity

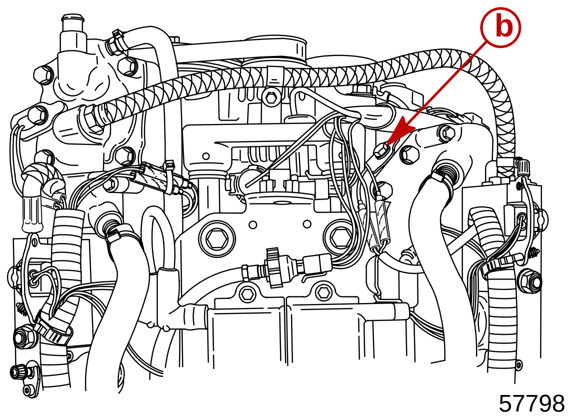
Temperature Sensor Specifications

Starboard and Port Cylinder Heads Horn Activation Speed Reduction – refer to Guardian System in Section 2D	 180°F (82°C) 185°F (85°C)
Air Compressor Horn Activation	 221°F (105°C)

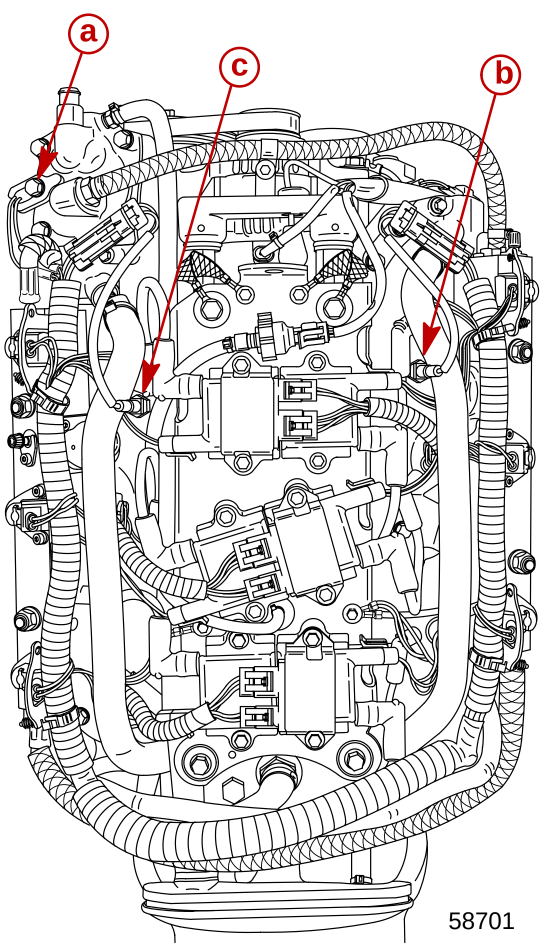
Temperature Sensor Location



MODEL YEAR 2000 PORT



MODEL YEAR 2000 STARBOARD

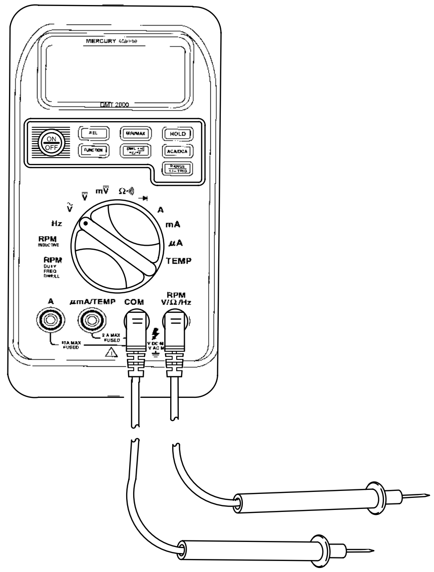


MODEL YEAR 2001

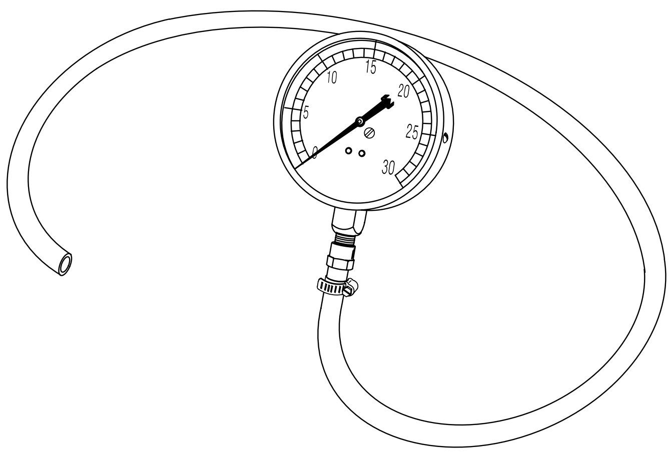
a - Air Compressor Temperature Sensor
b - Starboard Cylinder Head Temperature Sensor
c - Port Cylinder Head Temperature Sensor

Special Tools

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



2. Water Pressure Gauge 91-79250A2



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Temperature Sensor

Three temperature sensors are used to provide cylinder head temperature information to the ECM. A sensor is mounted in the starboard cylinder head and port cylinder head. One sensor is also mounted in the air compressor cylinder head. The ECM uses this information to increase injector pulse width for cold starts and to retard timing in the event of an over-heat condition.

An ohms test of the temperature sensor would be as follows:

MODEL YEAR 2000 – Insert digital or analog ohmmeter test leads into both TAN/BLACK sensor leads. With engine at temperature (F°) indicated, ohm readings should be as indicated ±10%. There should be no continuity between BLACK and each TAN/BLACK lead and no continuity between each TAN/BLACK lead and ground.

MODEL YEAR 2001 – Disconnect temperature sensor harness and check continuity with digital or analog ohmmeter test leads between both connector pins. With engine at temperature (F°) indicated, ohm readings should be as indicated ±10%. There should be no continuity between each connector pin and ground.

***NOTE: Model Year 2000** – The air compressor temperature sensor and cylinder head temperature sensors are the same part number. The ECM has been programmed to activate a warning circuit at different temperatures depending upon sensor location.*

***NOTE:** The Digital Diagnostic Terminal (DDT) can be used to monitor temperature readings from both temperature sensors.*

MODEL YEAR 2000		
F	C	
257	125	34
248	120	38
239	115	44
230	110	51
221	105	59
212	100	68
203	95	79
194	90	92
185	85	107
176	80	126
167	75	148
158	70	175
149	65	208
140	60	248
131	55	298
122	50	360
113	45	436
104	40	532
95	35	653
86	30	805
77	25	1000
68	20	1250
59	15	1573
50	10	1993
41	5	2546
32	0	3277
14	–10	5579
5	–15	7372

MODEL YEAR 2001		
F	C	
257	125	340
248	120	390
239	115	450
230	110	517
221	105	592
212	100	680
203	95	787
194	90	915
185	85	1070
176	80	1255
167	75	1480
158	70	1752
149	65	2083
140	60	2488
131	55	2986
122	50	3603
113	45	4370
104	40	5327
95	35	6530
86	30	8056
77	25	10000
68	20	12493
59	15	15714
50	10	19903
41	5	25396
32	0	32654
14	–10	55319
5	–15	72940

3 Liter Optimax/DFI Water Flow

Description

Cooling water enters the cooling system through the lower unit water inlets. The pump assembly forces water through the water tube and exhaust adapter plate passages filling the power head central water chamber (located behind the exhaust cavity). Water enters the exhaust cover cavity through 6 holes (3 each side) and 1 slot (top) that connects the central chamber to the exhaust cover cavity.

Water exits the exhaust cover cavity through 2 slots near the lower cylinders filling the water passages around the cylinders. Water flow is directed around each cylinder sleeve by 6 water dams.

Water flow exiting the cylinder block is controlled by the thermostats (1 in each cylinder head) and the poppet valve (located in the exhaust adaptor plate). At low RPM (below 1500 RPM) the thermostats control water flow depending upon engine temperature. When the thermostats are open, water passes through the cylinder heads and exits to the drive shaft housing. At higher RPM (above 1500 RPM) the poppet valve will control the water flow.

Water that passes through the poppet valve enters water passages in the exhaust tube to help cool the exhaust tube. Water will exit the exhaust tube through 2 slots at the top of the exhaust relief holes area (helping keep the holes clear of carbon and salt buildup) and through 2 holes at lower rear of exhaust tube into the drive shaft housing.

Water dumped into the drive shaft housing builds up a wall of water around the exhaust tube. This performs 2 functions:

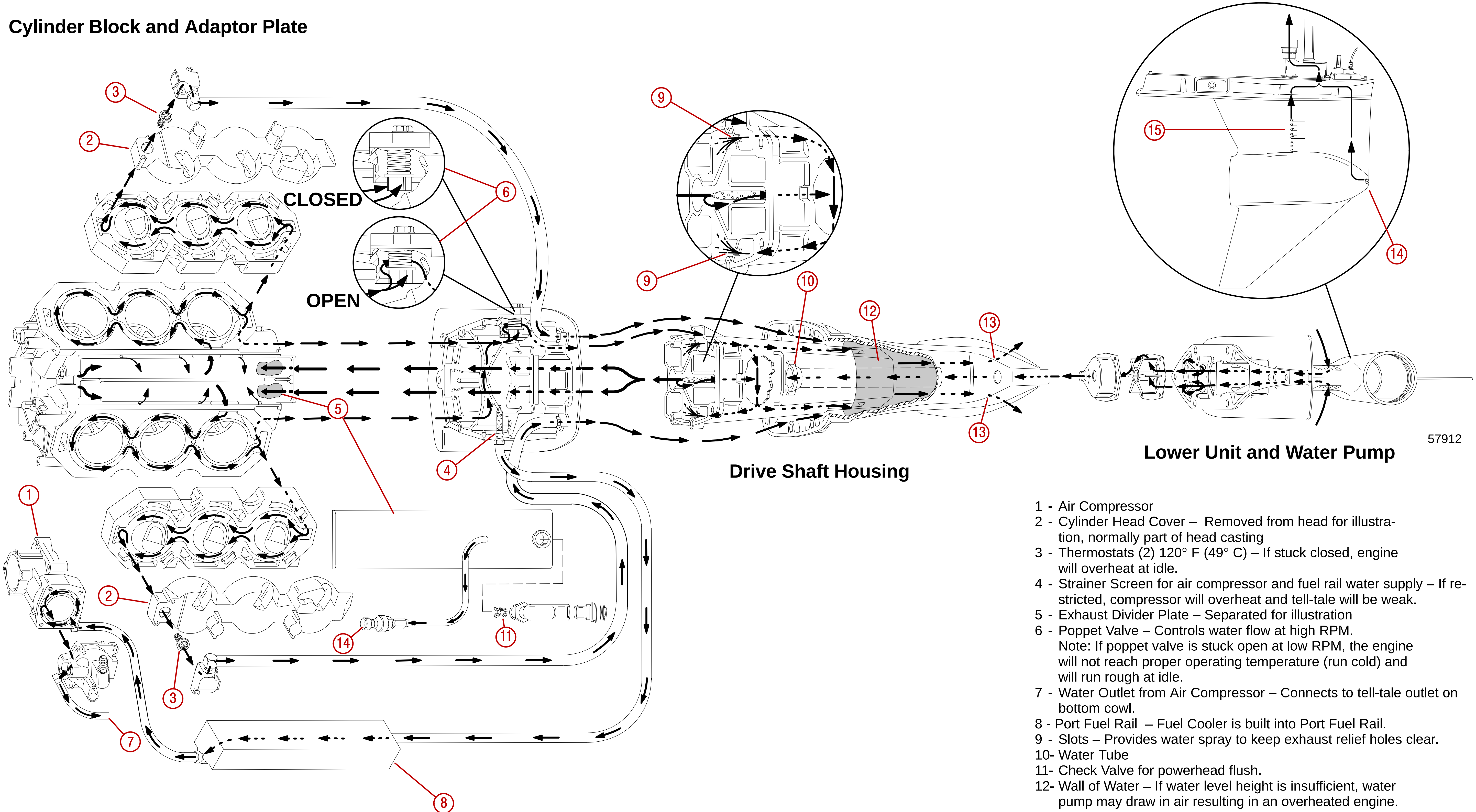
- Helps silence the exhaust
- Prevents air from being drawn into the pump

Water exits the engine in 3 locations:

- Excess water from the wall of water exits through the bottom aft area of the drive shaft housing.
- Water that passes through the air compressor exits out the tell tail.
- Water exits through a strainer screen in the exhaust adaptor plate into the exhaust tube, mixing with the exhaust gases.

To allow complete passage filling and to prevent steam pockets, all cooling passages are interconnected. Small passages are incorporated to allow the cooling system to drain.

Notes:



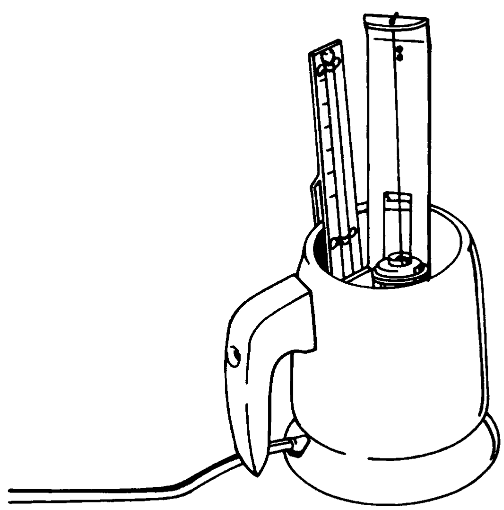
1 - Air Compressor
2 - Cylinder Head Cover – Removed from head for illustration, normally part of head casting
3 - Thermostats (2) 120° F (49° C) – If stuck closed, engine will overheat at idle.
4 - Strainer Screen for air compressor and fuel rail water supply – If restricted, compressor will overheat and tell-tale will be weak.
5 - Exhaust Divider Plate – Separated for illustration
6 - Poppet Valve – Controls water flow at high RPM.
Note: If poppet valve is stuck open at low RPM, the engine will not reach proper operating temperature (run cold) and will run rough at idle.
7 - Water Outlet from Air Compressor – Connects to tell-tale outlet on bottom cowl.
8 - Port Fuel Rail – Fuel Cooler is built into Port Fuel Rail.
9 - Slots – Provides water spray to keep exhaust relief holes clear.
10- Water Tube
11- Check Valve for powerhead flush.
12- Wall of Water – If water level height is insufficient, water pump may draw in air resulting in an overheated engine.
13- Excess water from wall of water around exhaust bucket exits around anodes.
14- Block Water Pressure Sensor
15- Low Water Pickup – 4 Holes
16- Side Water Pickup

Troubleshooting

Thermostat Test (120°F) (49°C)

1. Inspect thermostat covers and cylinder head covers (thermostat opening) for cracks and corrosion damage that could cause leakage. Replace parts as necessary.
2. Remove and discard gasket from each thermostat.
3. Wash thermostats with clean water.
4. Using a thermostat tester, similar to the one shown, test each thermostat as follows:
    a. Open thermostat valve, then insert a thread between valve and thermostat body. Allow valve to close against thread.
    b. Suspend thermostat (from thread) and thermometer inside tester so that neither touches the container. Bottom of thermometer must be even with bottom of thermostat to obtain correct temperature of thermostat opening.
    c. Fill thermostat tester with water to cover thermostat.
    d. Plug tester into electrical outlet.
    e. Observe temperature at which thermostat begins to open. (Thermostat will drop off thread, that was installed in Step “a”, when it starts to open.) Thermostat must begin to open when temperature reaches 118°-122° F (48°-50° C).
    f. Continue to heat water until thermostat is completely open.
    g. Unplug thermostat tester.
    h. Replace thermostat if it fails to open at the specified temperature, or if it does not fully open.

NOTE: *BE SURE that water in thermostat tester is allowed to cool sufficiently [below 110° F (43.3° C)] before testing the other thermostat.*



51087

IMPORTANT: DO NOT operate engine without thermostats installed.

Water Pressure Check

Water pressure may be checked by one of three methods;

- Use a Digital Diagnostic Terminal (DDT) [91-823686A2]
- On engines equipped with SmartCraft gauges, water pressure is an available readout.
- On engines not equipped with SmartCraft gauges, a water pressure line is provided that exits at the front of the lower cowl. A dash style gauge may be connected to this line to register water pressure.

WARNING

Shut off engine and refer to troubleshooting chart if water pressure is not within specification. DO NOT exceed 3000 RPM in neutral.

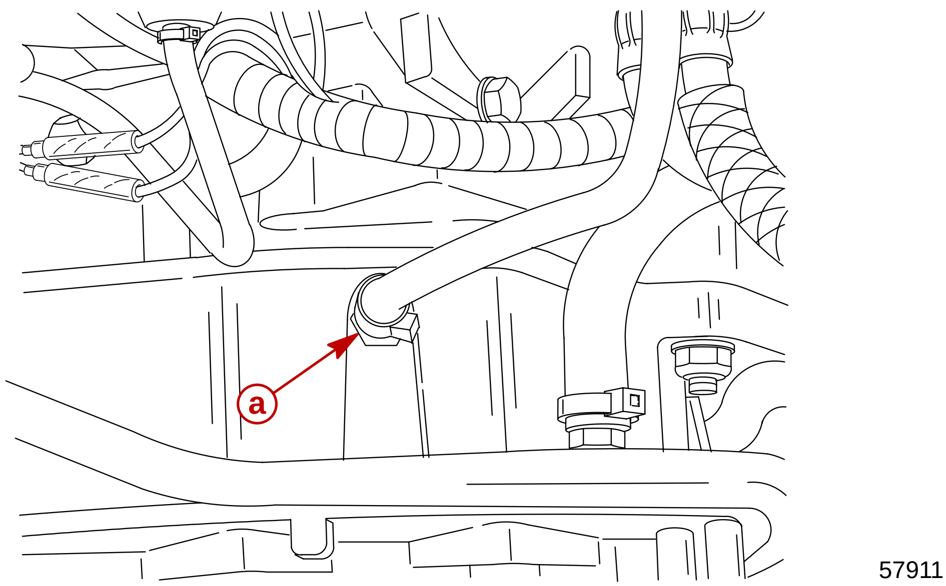
Idle	1.5 - 4.5 psi (10.3 - 31.0 kPa)
Poppet Valve Opening	6 - 7 psi (41.4 - 48.3 kPa)
W.O.T.	8 - 23* psi (55.2 - 158.6 kPa)

NOTE: *23 psi water pressure would only be achieved on high performance (70+ mph) boats.*

Cooling Water Strainer

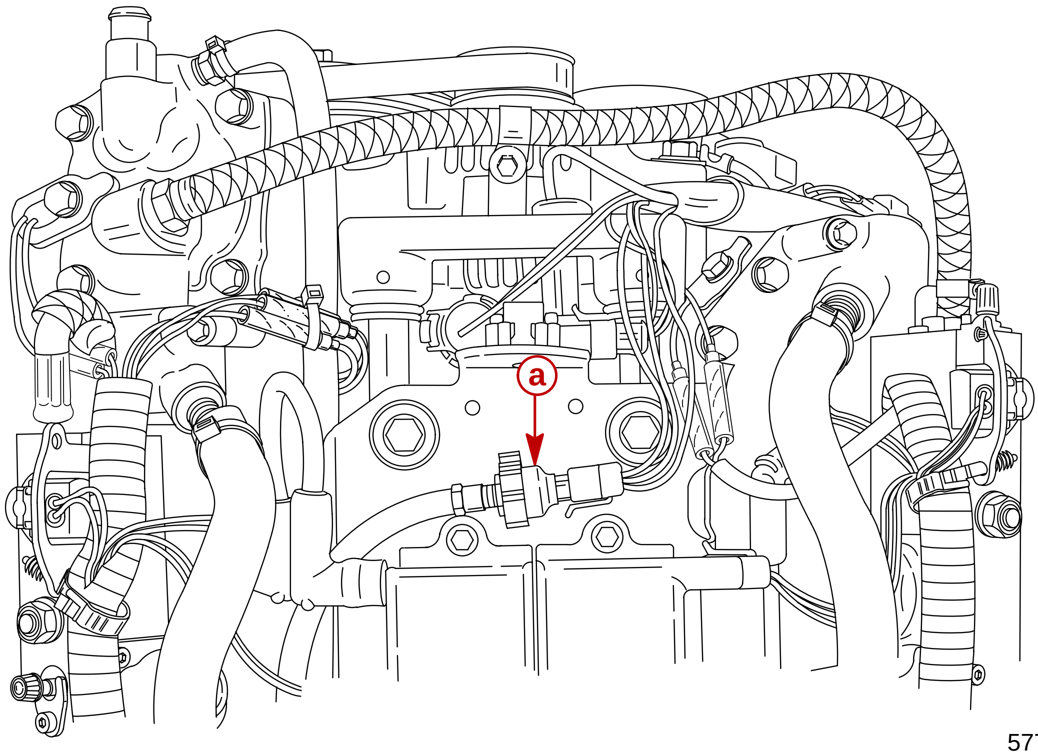
The cooling water strainer filters cooling water flowing to the port fuel rail and air compressor.

1. Remove bottom cowl. Disconnect water hose from the strainer plug.
2. Remove and clean strainer.
3. Apply Loctite Pipe Sealant w/Teflon (92-88504) to strainer threads and reinstall strainer. Reconnect water hose and secure with sta-strap.



a - Water Strainer

Water Pressure Sensor



a - Water Pressure Sensor

The water pressure sensor is monitored by the ECM at 1200 rpm and above. Should the low water pressure continue for more than 5 seconds, a speed reduction circuit* within the ECM will be activated.

*The Guardian System will limit rpm if temperatures are high regardless of system pressure.

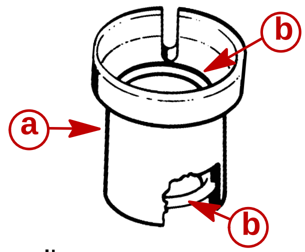
Water Pressure Low for more than 2 seconds	Warning horn activated Warning light illuminated
Water Pressure Low for more than 5 seconds	Warning horn activated Warning light illuminated Maximum engine rpm limited

Minimum block/water pressure requirements:

rpm	2000	2200	2750	3300	3850	4400	4950	5500	6050
kPa	4	6	12	18	24	30	36	42	48
psi	0.59	0.87	1.74	2.6	3.5	4.4	5.2	6.1	7.0

Water Pump Cleaning and Inspection

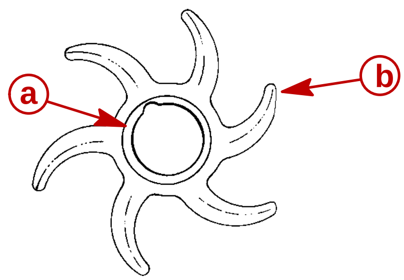
1. Inspect the water tube coupling for wear or damage. If necessary replace the worn or damaged components especially the two O-rings on the inside, one at the top and one at the bottom.



70613

a - Water Tube Coupling
b - O-rings

2. Inspect the water pump impeller for wear on the end, top and bottom of the impeller blades. Replace the impeller if this condition is found.
3. Inspect for proper bonding between the hub and the impeller. Replace the impeller if improper bonding is found.



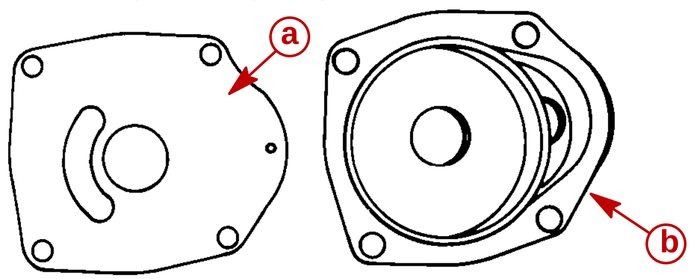
70500

a - Hub
b - Impeller

4. Inspect the impeller blades to see if they are cracked, burnt, hard or deformed. Replace the impeller if the blades are in this condition.

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting cover and plate. The depth of the groove will not affect water pump output.

5. Replace cover and/or face plate if grooves (other than impeller sealing bead groove) are more than 0.030 in. (0.76 mm) deep.



70609

a - Water Pump Face Plate
b - Water Pump Cover

IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

IMPORTANT: It is recommended that the water pump impeller be replaced whenever the gearcase is removed for maintenance. However, if it is necessary to re-use the impeller, DO NOT install in reverse to original rotation as premature impeller failure will occur.

Problem Diagnosis

NOTE: *The Guardian System will limit power if temperatures are high regardless of system pressures.*

Condition	Recommended Range	Possible Cause
Pressure below specification @ idle	1-1/2 - 4-1/2 psi (10.3 - 30.8 kPa)	•Poppet valve spring defective (weak, broken, missing) •Defective poppet valve seal •Severe internal leak •Thermostat stuck open •Low output water pump •Inlet restriction •Strainer screen for air compressor water supply is restricted
Pressure above 5 psi (34.2kPa) @ idle	1-1/2 - 4-1/2 psi (10.3 - 30.8 kPa)	•Plugged poppet by-pass passage or tell-tale
Pressure does not drop between 1200 - 1800 RPM indicating poppet valve has opened	6 - 7 psi (41.1 - 47.9 kPa) between 1200 - 1800 RPM	•Wrong poppet valve spring •Low output water pump •Inlet restriction •Poppet valve vent hole plugged or restricted •Severe internal leak
Poppet valve flutter/water pressure drop does not start prior to 1500 RPM	6 - 7 psi (41.1 - 47.9 kPa) between 1200 - 1800 RPM	•Poppet valve spring defective (weak, broken, strong, missing) •Broken diaphragm in poppet valve •Severe internal leak •Low output water pump •Defective poppet valve seal
Poppet valve flutter/water pressure drop does not stop prior to 1800 RPM	6 - 7 psi (41.1 - 47.9 kPa) between 1200 - 1800 RPM	•Wrong poppet valve spring •Low output water pump •Inlet restriction •Broken diaphragm in poppet valve •Severe internal leak •Defective valve seal
Pressure exceeds specification @ W.O.T.	8 - 10 psi (54.9 - 68.5 kPa) Note: A modified propeller or low pitch propeller is required to check water pressure @ W.O.T. if boat is stationary. Boat must be in the water and secured to a dock or trailer and run in forward gear. DO NOT perform check using a flush device.	•Restriction on discharge side of cooling system •Engine mounted too high on transom or trimmed too far out resulting in formation of steam pockets in cooling system •If boat is not stationary but is being run on open water, ram effect of water on coolant inlets @ high speeds may increase water pressure above specifications
Pressure is below specification @ W.O.T.	8 - 10 psi (54.9 - 68.5 kPa)	•Inlet restriction •Engine mounted too high on transom •Engine trimmed out too far •Configuration of boat bottom interfering with adequate flow of water to coolant inlets •Severe internal leak •Low output water pump
Pressure higher than normal @ W.O.T., but engine still indicates overheat condition	Maximum pressure – 23 psi (157.4 kPa)	•Outlet water passages restricted. •Steam pocket has formed at top of powerhead due to lack of cooling water

MID-SECTION

Section 5A – Clamp/Swivel Brackets & Drive Shaft Housing

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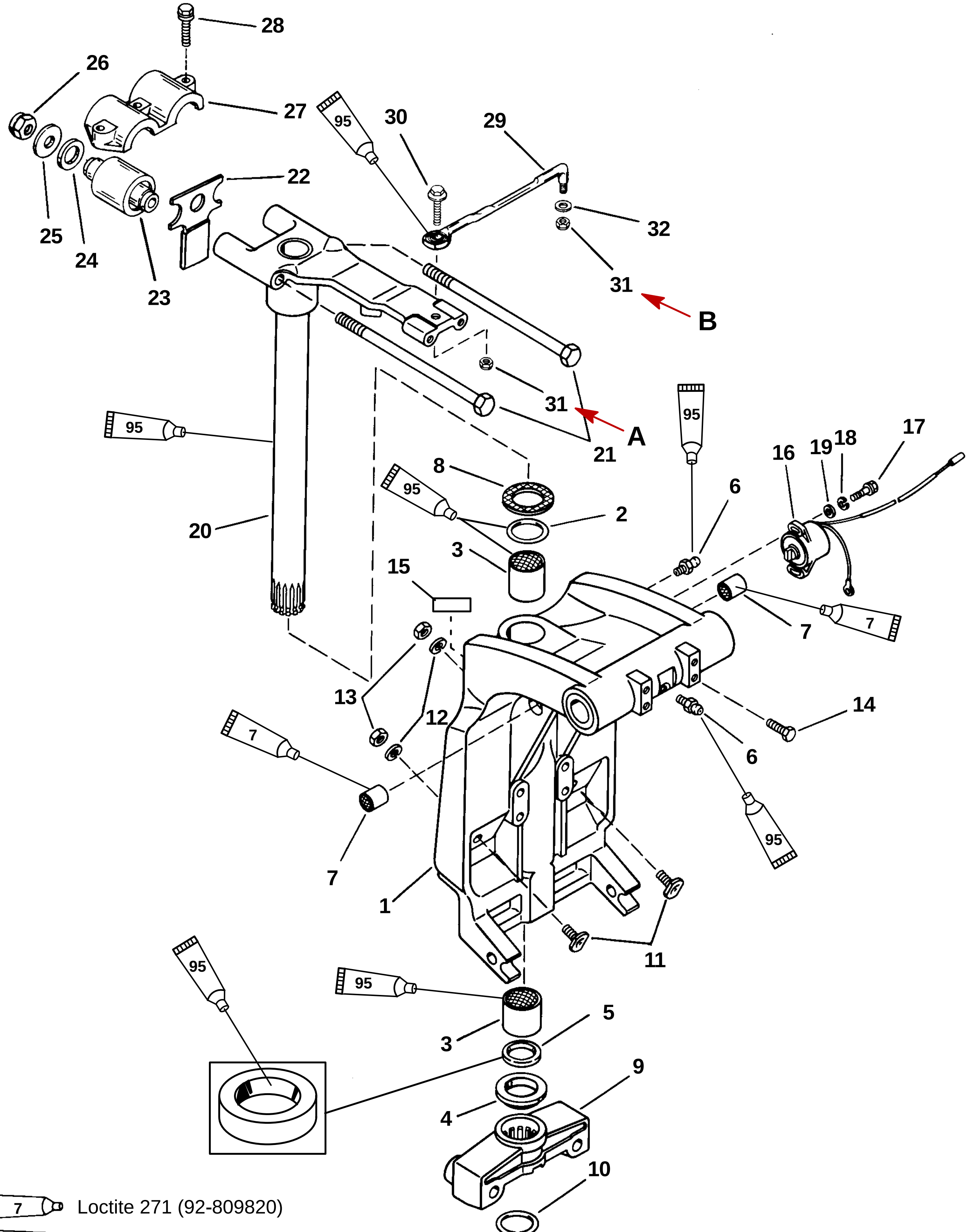
5
A

Swivel Bracket and Steering Arm



7 Loctite 271 (92-809820)

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

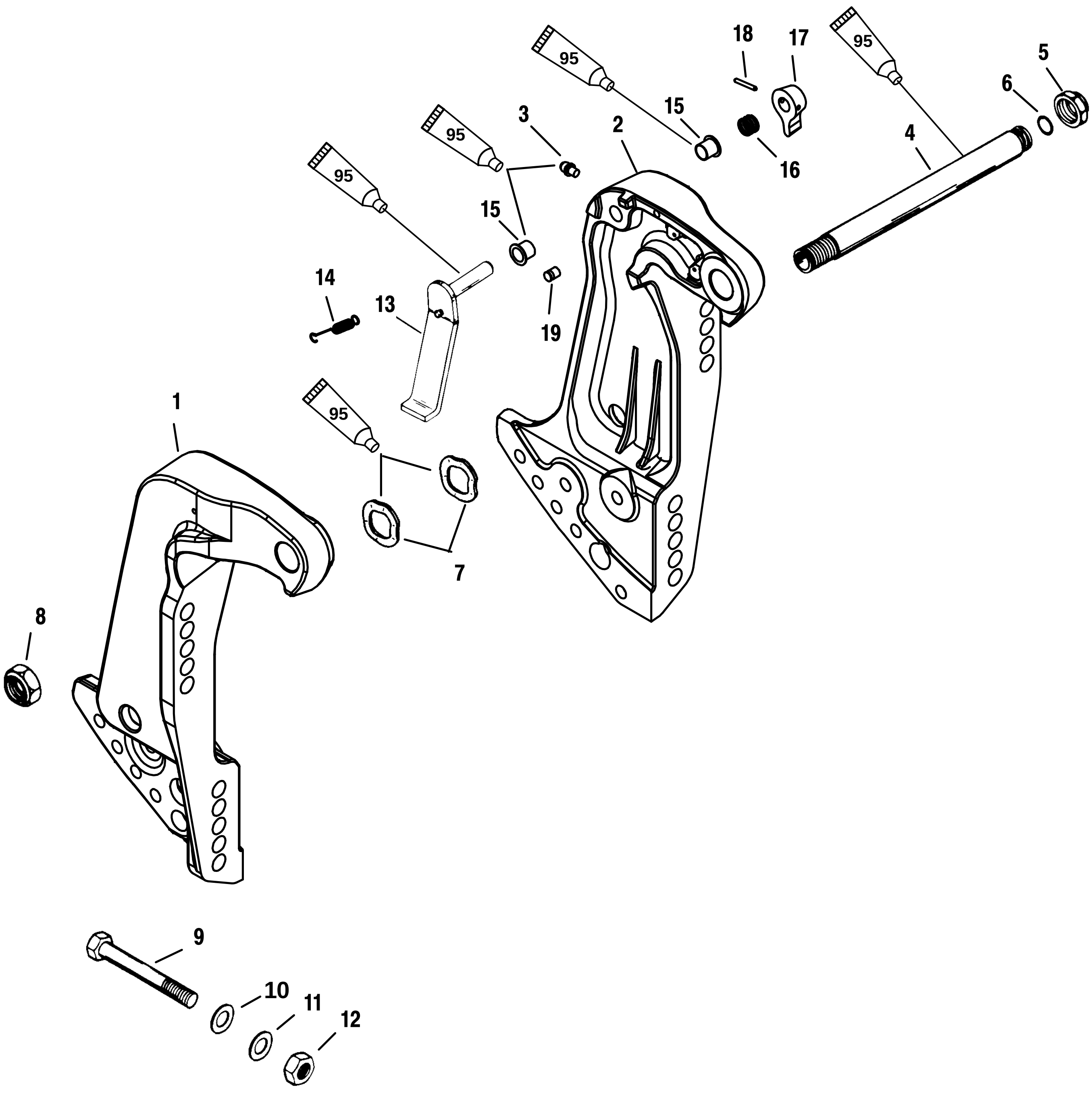
Swivel Bracket and Steering Arm

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb. in.	**lb. ft.**	**N·m**
1	1	SWIVEL BRACKET			
2	1	O RING			
3	2	BUSHING			
4	1	SPACER			
5	1	OIL SEAL (LOWER)			
6	2	GREASE FITTING	85		9.5
7	2	BUSHING			
8	1	THRUST WASHER			
9	1	BOTTOM YOKE **(LONG – CARBON STEEL)**			
	1	BOTTOM YOKE **(XL–STAINLESS STEEL)**			
10	1	RETAINING RING			
11	2	STRIKER PLATE			
12	2	LOCKWASHER			
13	2	NUT		25	34
14	2	SCREW (1/4-28 x 1/2 IN.)	100		11.5
15	1	DECAL-Serial Overlaminate			
16	1	TRIM SENDER			
17	2	SCREW (10-24 x 3/4 IN.)	15		1.7
18	2	LOCKWASHER			
19	2	WASHER			
20	1	SWIVEL PIN/STEERING ARM **(LONG – CARBON STEEL)**			
	1	SWIVEL PIN/STEERING ARM**(XL–STAINLESS STEEL)**			
21	2	SCREW (M12 x 1.75 x 190)			
22	1	BUMPER			
23	2	UPPER MOUNT			
24	2	WASHER			
25	2	WASHER			
26	2	NUT		50	68
27	1	CLAMP			
28	3	SCREW (M8 x 35)		20	27
29	1	STEERING LINK ASSEMBLY			
30	1	SCREW		20	27
31	2	NUT (.375-24)			
32	2	WASHER			

NOTE: *A – Torque nut to 120 lb. in. (13.5 Nm) and then back off 1/4 turn.*

NOTE: *B – Torque nut to 20 lb. ft. (27 Nm)*

Transom Brackets



95 2-4-C w/Teflon (92-825407A12)

Transom Brackets

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	lb-ft	Nm.
1	1	TRANSOM BRACKET **(STARBOARD)**			
2	1	TRANSOM BRACKET **(PORT)**			
3	1	GREASE FITTING **(PORT)**	80		9
4	1	TILT TUBE			
5	1	NUT (1 IN.-14)		45	61
6	1	O-RING			
7	2	WAVE WASHER			
8	1	NUT (7/8-14)		45	61
9	4	BOLT			
10	4	WASHER			
11	4	WASHER			
12	4	NUT			
13	1	TILT LOCK LEVER ASSEMBLY			
14	1	SPRING			
15	2	BUSHING			
16	1	SPRING			
17	1	KNOB			
18	1	GROOVE PIN			
19	1	PIN			

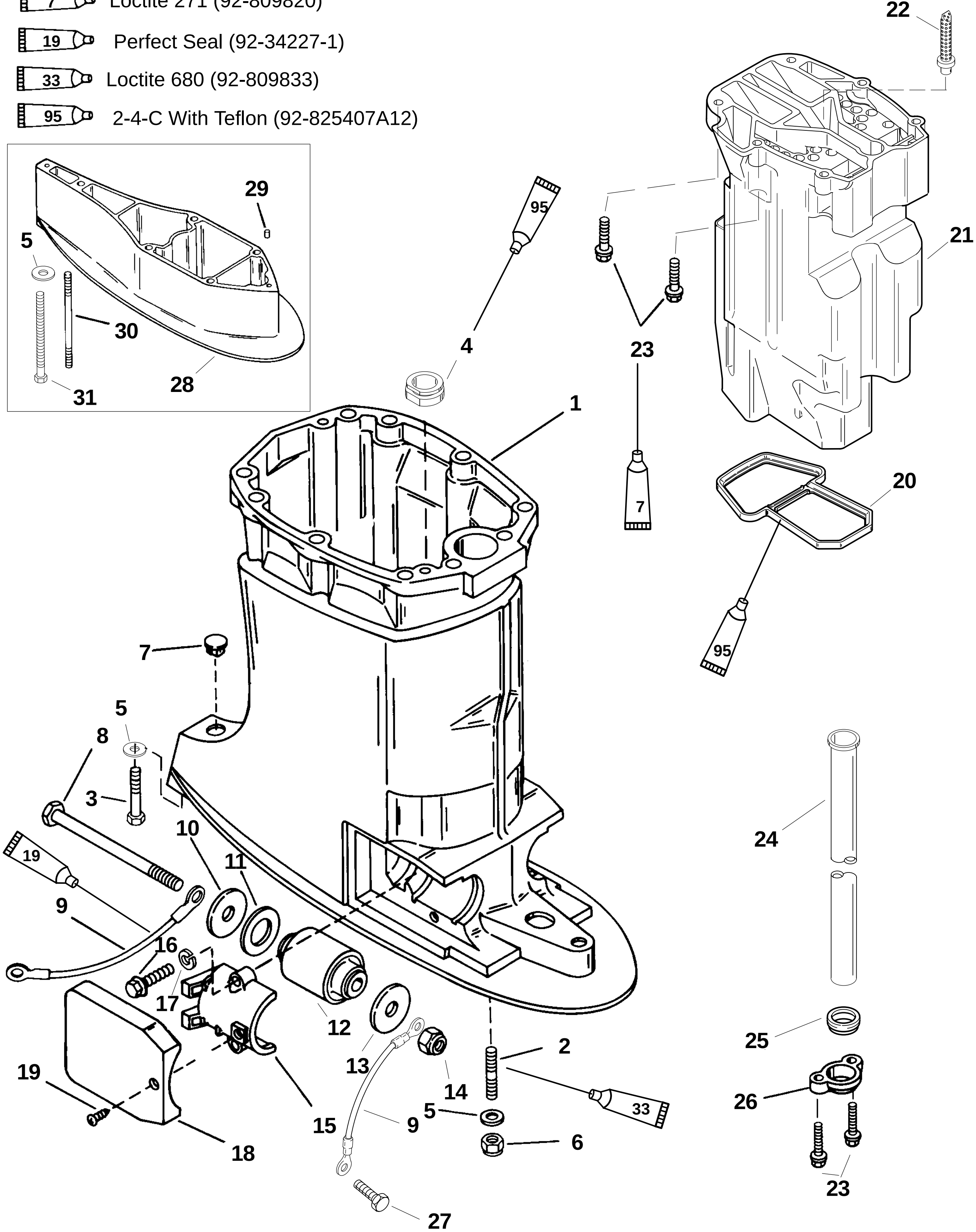
Drive Shaft Housing and Exhaust Tube

7 Loctite 271 (92-809820)

19 Perfect Seal (92-34227-1)

33 Loctite 680 (92-809833)

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



Drive Shaft Housing and Exhaust Tube

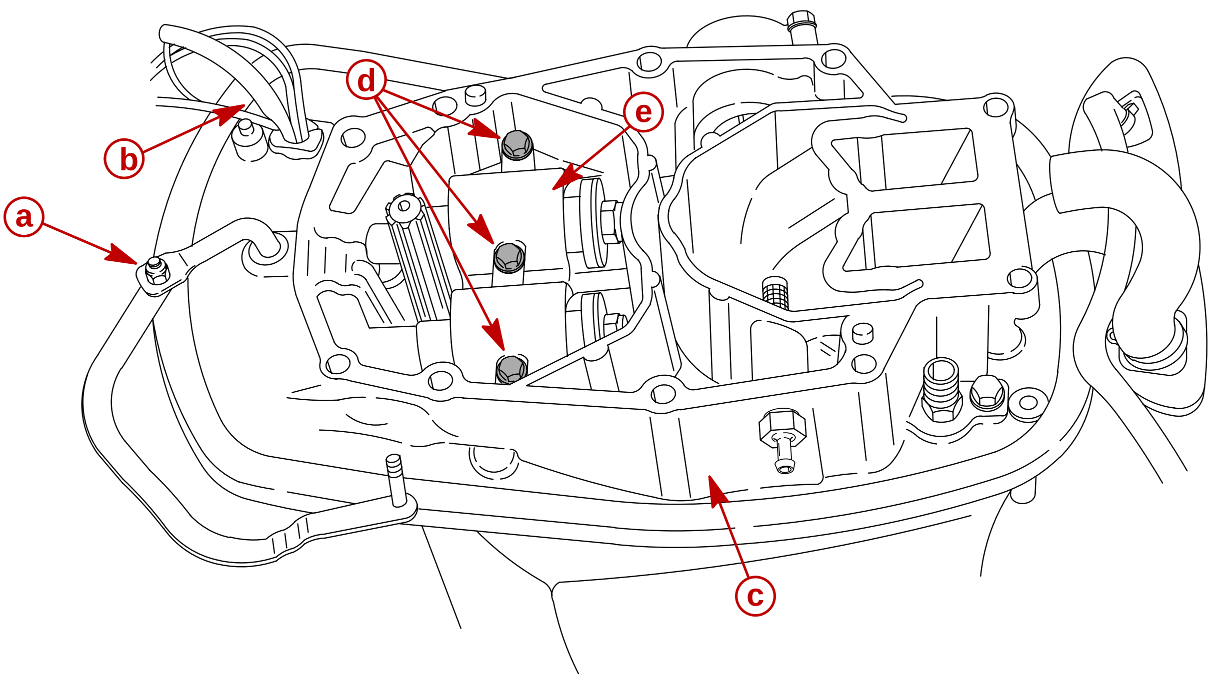
REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	DRIVE SHAFT HOUSING **(LONG)**			
	1	DRIVE SHAFT HOUSING **(X/XX–LONG)**			
2	4	STUD (M12 x 1.75 x 54) **LONG/X-LONG**			
3	1	SCREW (M12 x 35)		45	61.0
4	1	GROMMET			
5	5	WASHER			
6	4	NUT (M12 x 1.75)		55	74.5
7	1	PLUG			
8	2	SCREW (M14 x 2 x 178)			
9	2	GROUND WIRE			
10	2	WASHER			
11	2	WASHER			
12	2	MOUNT			
13	2	WASHER			
14	2	NUT		90	122
15	2	CLAMP			
16	4	SCREW (M8 x 35)		20	27.0
17	1	LOCKWASHER			
18	2	COVER			
19	2	SCREW (10-16 x 7/16 IN.)	Drive Tight		
20	1	SEAL			
21	1	EXHAUST TUBE			
22	1	STRAINER			
23	6	SCREW (M8 x 35)		16.5	22.5
24	1	WATER TUBE **(LONG)**			
	1	WATER TUBE **(X-LONG)**			
	1	WATER TUBE **(XX-LONG)**			
25	1	SEAL			
26	1	CLAMP			
27	1	SCREW (1/4-20 x .375)			
28	1	SPACER			
29	2	DOWEL PIN **XX-LONG**			
30	4	STUD (M12 x 179)			
31	1	SCREW (M12 x 160)			

Drive Shaft Housing and Dyna-Float Suspension

Refer to "Powerhead Removal" section to remove powerhead. Refer to "Lower Unit Removal" in this section to remove lower unit.

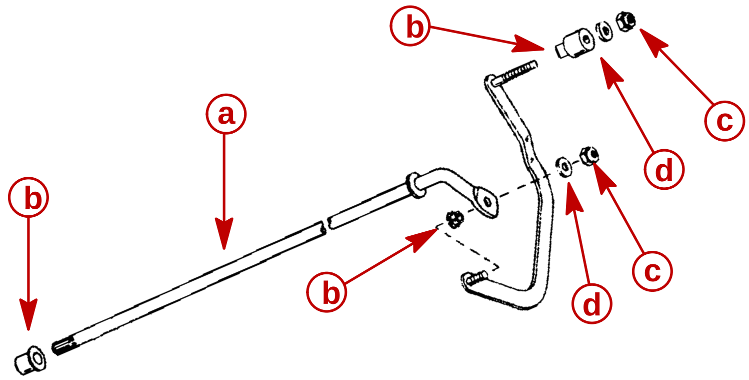
Removal and Disassembly

1. Remove shift shaft from driveshaft housing by pulling straight up on shaft.
2. Remove power trim wiring harness from exhaust adaptor plate.
3. Remove 3 bolts which secure upper mount cover to adaptor plate. Remove cover.



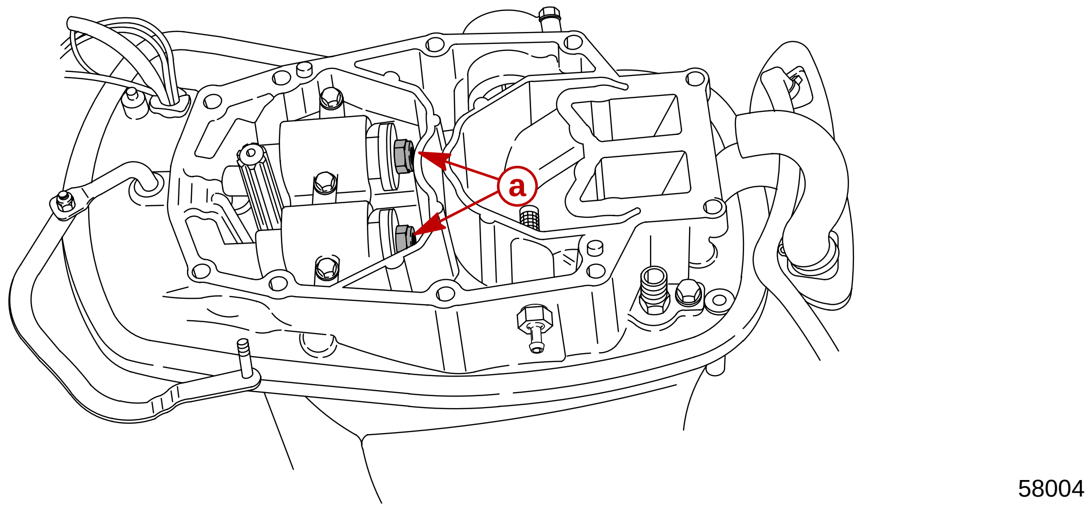
a - Shift Shaft Linkage
b - Wiring Harness
c - Adaptor Plate
d - Bolts
e - Upper Mount Cover

SHIFT LINKAGE ASSEMBLY



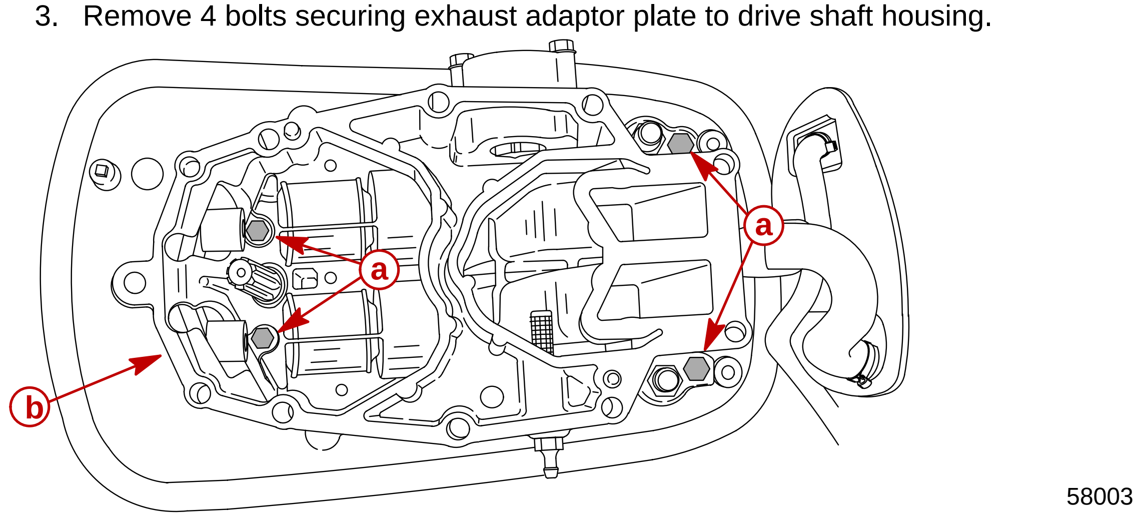
a - Shift Shaft Assembly
b - Bushing (3)
c - Lock Nut (2)
d - Washer (2)

1. Remove upper mount nuts and flat washers.
2. Pull mount bolts through mounts and remove mounts.



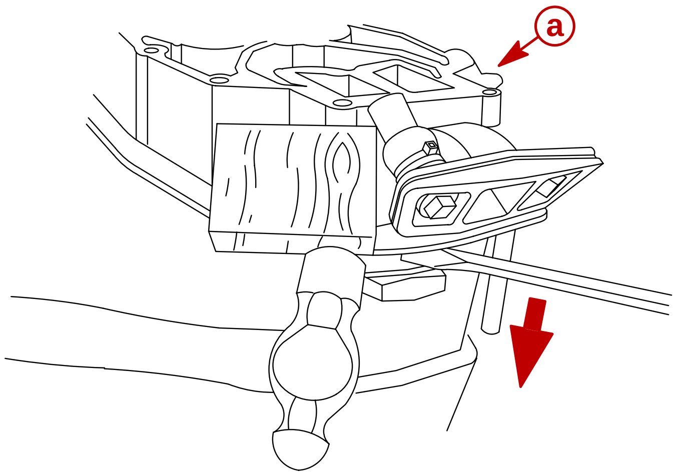
a - Upper Mount Nuts

3. Remove 4 bolts securing exhaust adaptor plate to drive shaft housing.



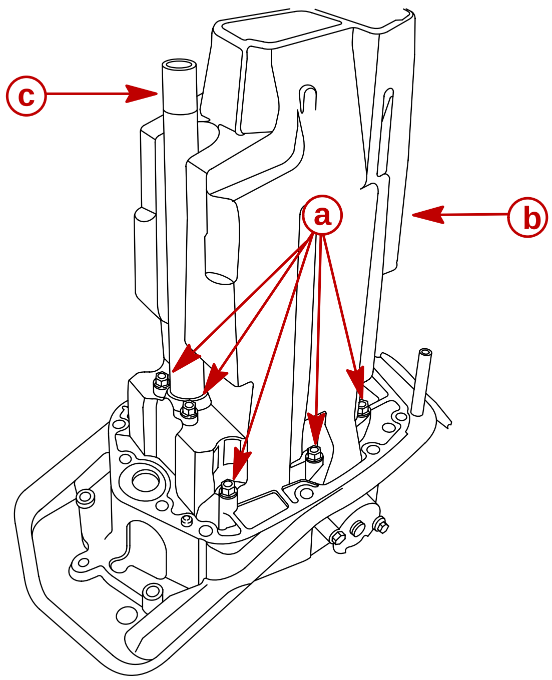
a - Bolts
b - Adaptor Plate

4. While applying upward pressure on rear of adaptor plate, use a mallet and a piece of hardwood against the adaptor plate to loosen gasket adhesion.



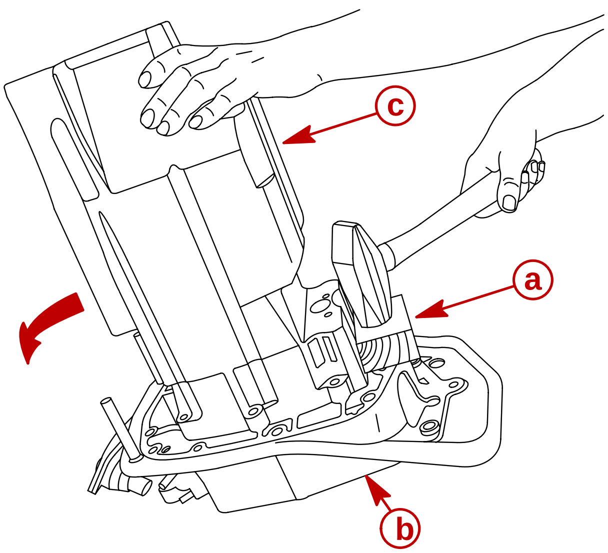
a - Adaptor Plate

5. Remove 2 bolts securing water tube to adaptor plate and remove tube. Remove 6 bolts securing exhaust tube to adaptor plate.



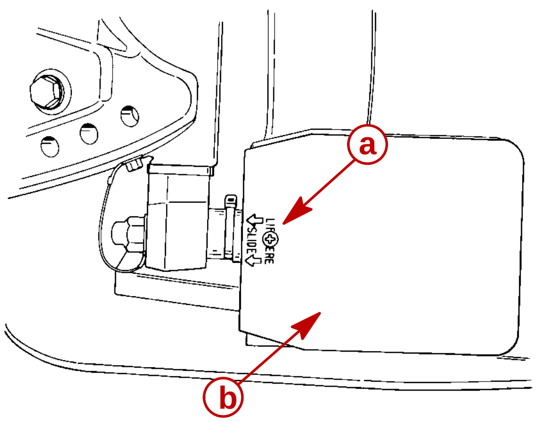
a - Bolts
b - Exhaust Tube
c - Water Tube

6. While tilting adaptor plate/exhaust tube assembly, use a piece of hardwood and a mallet to loosen gasket adhesion. Remove exhaust tube.



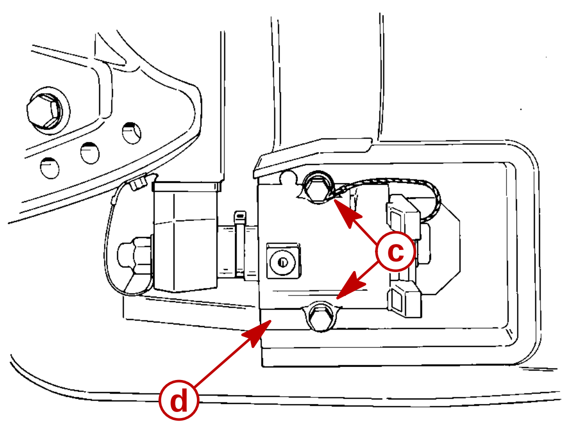
a - Hardwood
b - Adaptor Plate
c - Exhaust Tube

7. Remove all gasket material from driveshaft housing and related components.
8. Remove screw, which secure lower mount cover to drive shaft housing, and remove cover.
9. Remove bolts securing lower mount retainers to drive shaft housing. Remove retainers.



52307

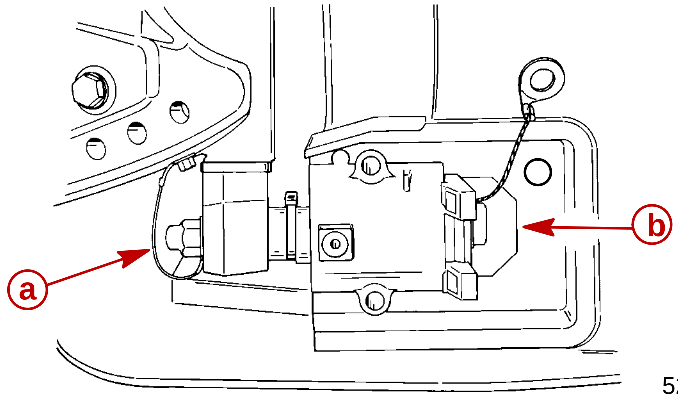
a - Screw
b - Cover



52308

c - Bolts
d - Lower Mount Retainer (1 each side)

10. Remove lower mount nuts and rubber caps.

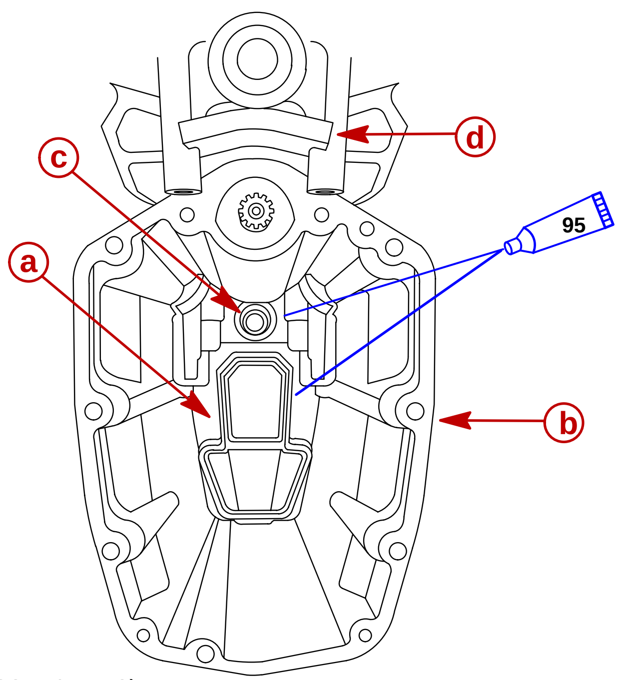


a - Lower Mount Nuts
b - Rubber Caps

11. Remove drive shaft housing from swivel bracket by pulling alternately from top to bottom on housing.
12. Remove upper and lower mounts by lifting them out of drive shaft housing.

Reassembly and Installation

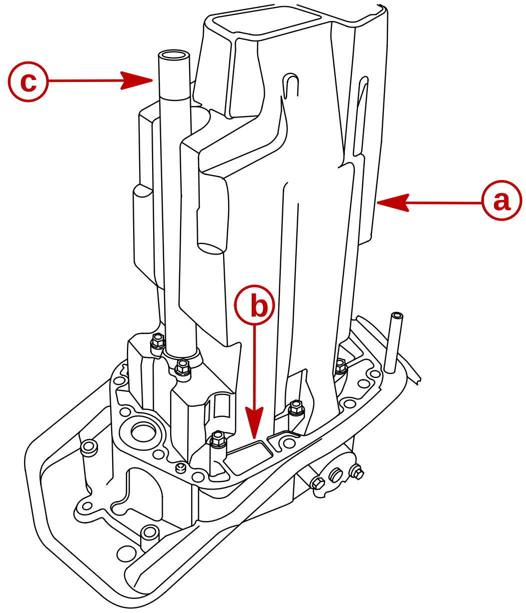
1. Apply a thin coat of 2-4-C Marine Lubricant onto inside portion of exhaust tube seal and water tube grommet.
2. Install exhaust tube seal into driveshaft housing with tapered side of seal facing up.



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

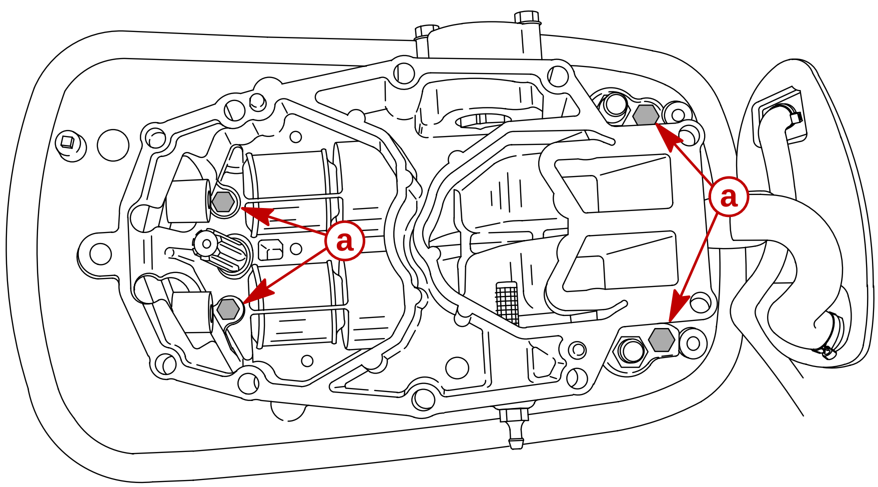
a - Exhaust Tube Seal
b - Driveshaft Housing
c - Water Tube Grommet
d - Leather Bumper

3. Position exhaust tube and gasket on adaptor plate. Secure both to plate with 6 bolts. Torque bolts to 21 lb. ft. (28.5 Nm).
4. Secure tube to adaptor plate with 2 bolts. Torque bolts to 80 lb. in. (9 Nm).



a - Exhaust Tube
b - Gasket
c - Water Tube

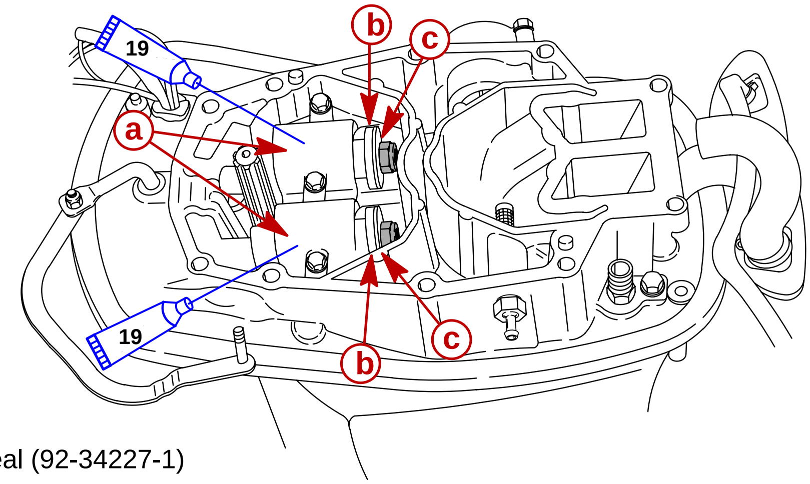
5. Position adaptor plate on top of housing.
6. Secure adaptor plate to drive shaft with 4 bolts. Torque bolts to 25 lb. ft. (34 Nm).



58003

a - Bolts [Torque to 25 lb. ft. (34 Nm)]

7. Apply a small amount of Perfect Seal onto metal portion of upper dyna-float mounts.
8. Position mounts on drive shaft housing plate.
9. Install a rubber washer onto each upper mount, followed by a metal washer.
10. Push bolts thru mounts.



19 Perfect Seal (92-34227-1)

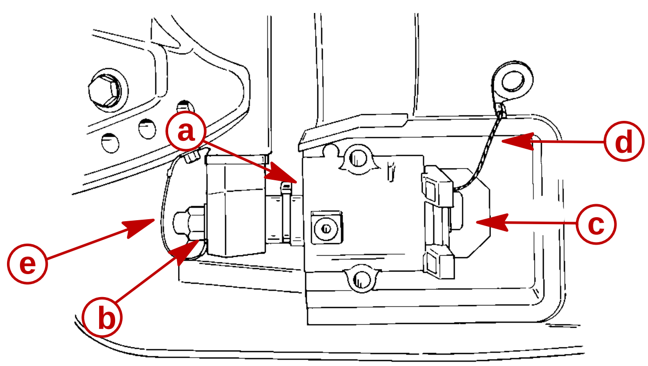
58004

a - Dyna-Float Mounts
b - Rubber Washers
c - Metal Washer

11. Install a ground strap onto port lower mount bolt.

NOTE: *Apply Perfect Seal along length of lower mount bolts.*

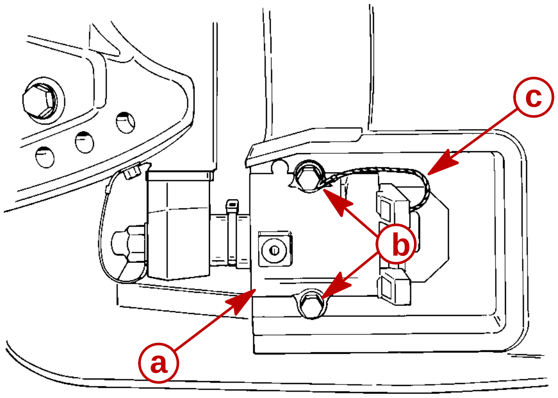
12. Insert a mounting bolt thru the short end of each lower mount.
13. Position a mount on each lower side of drive shaft housing.
14. Install a flat washer over each lower mounting bolt.
15. Start upper mounting bolts in upper mounts and align lower mounting bolts with holes in swivel pin yoke. Slide drive shaft housing up against yoke and bumper.
16. Secure upper mounts to steering arm with flat washers and self-locking nuts. Torque nuts to 50 lb. ft. (68 Nm).
17. Install ground strap between port lower mount bolt and swivel bracket.
18. Secure lower mounts to swivel pin yoke with self-locking nuts. Torque nuts to 90 lb. ft. (122 Nm). Place a rubber cap over each lower mounting bolt head.



52308

a - Lower Mount
b - Nut [Torque to 90 lb. ft. (122 Nm)]
c - Rubber Cap
d - Ground Strap (only 1 side)
e - Ground Strap (to swivel bracket)

19. Install lower mount retainers and secure each retainer with 2 bolts. Secure ground strap with the nearest retainer bolt and flat washer. Torque bolts to 20 lb. ft. (27 Nm).
20. Install lower mount covers and secure each cover with a screw.



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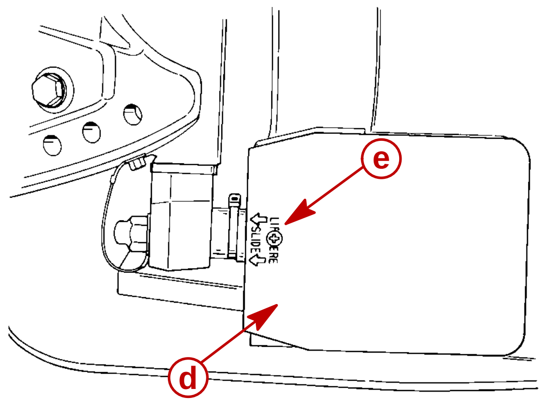
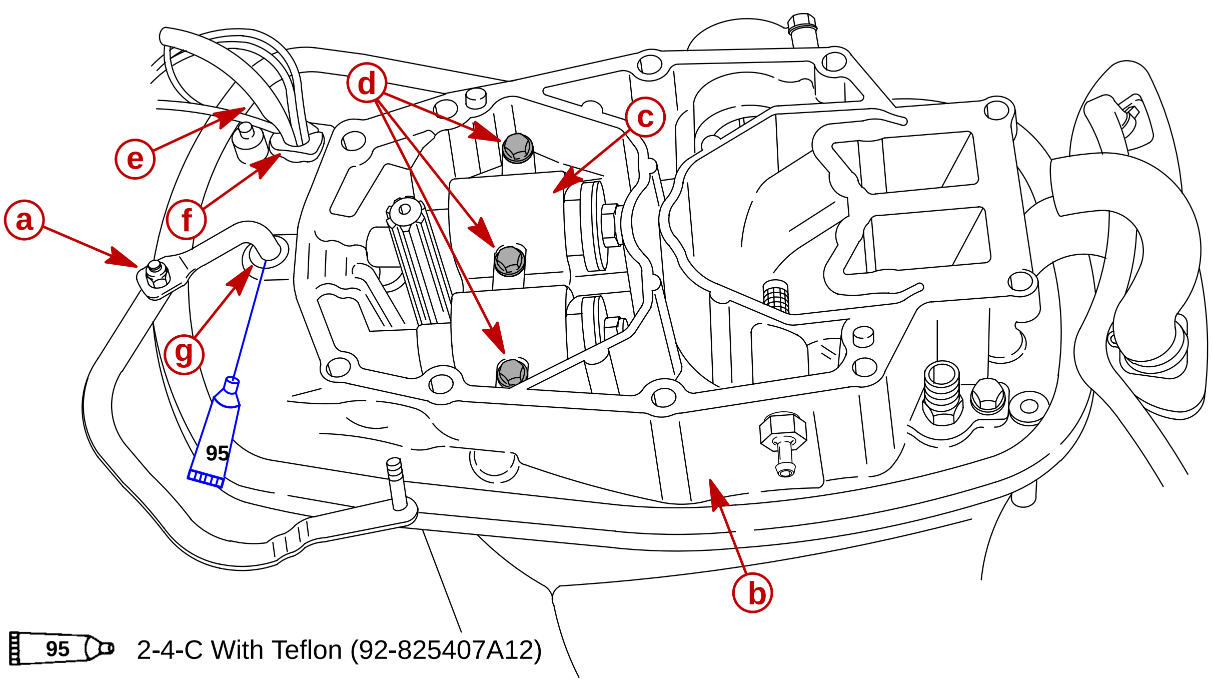


52307

- **a** - Lower Mount Retainer
- **b** - Bolts [Torque to 20 lb. ft. (27 Nm)]
- **c** - Ground Strap
- **d** - Cover
- **e** - Screw (1 for each cover)

21. Install upper mount cover on adaptor plate. Secure cover with 3 bolts. Torque bolts to 20 lb. ft. (27 Nm).
22. Route power trim harness thru grommet in adaptor plate.
23. Reinstall shift shaft with bushing into adaptor plate. Apply 2-4-C w/Teflon to bushing.



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

58005

- **a** - Shift Shaft Linkage
- **b** - Exhaust Adaptor Plate
- **c** - Upper Mount Cover
- **d** - Bolts [Torque to 20 lb. ft. (27 Nm)]
- **e** - Power Trim Harness
- **f** - Grommet
- **g** - Bushing

MID-SECTION

Section 5B – Power Trim - Design I (Showa)

Table of Contents

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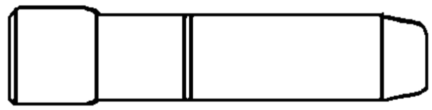
B

Power Trim Specifications

POWER TRIM	Design I (Showa)	
	Trim “UP”	1300 PSI (91kg/cm^2) Maximum Pressure
	Trim “DOWN”	500 PSI (35kg/cm^2) Minimum Pressure
	Leak Down Design I & II	Maximum Acceptable Amount of Leak Down in 24 hours is 1 in. (25.4 mm)

Special Tools

1. Alignment Tool 91-11230



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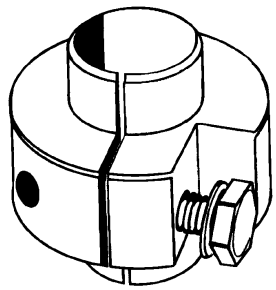
2. Trim Rod Removal Tool 91-44486A1



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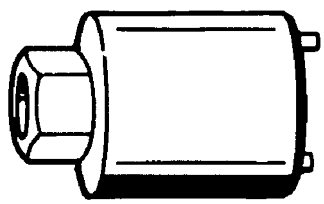
3. Trim Rod Guide Removal Tool 91-44487A1



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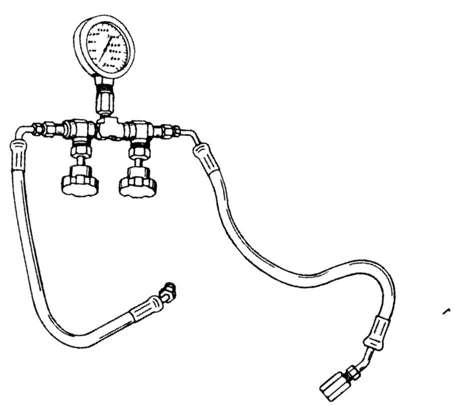
4. Power Trim Test Gauge Kit 91-52915A6



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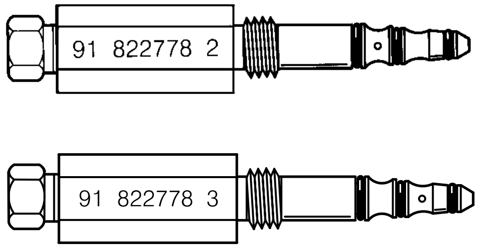
5. Adaptor Fitting 91-82278A2 and 91-82278A3



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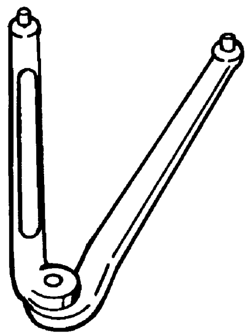
6. Spanner Wrench 91-74951



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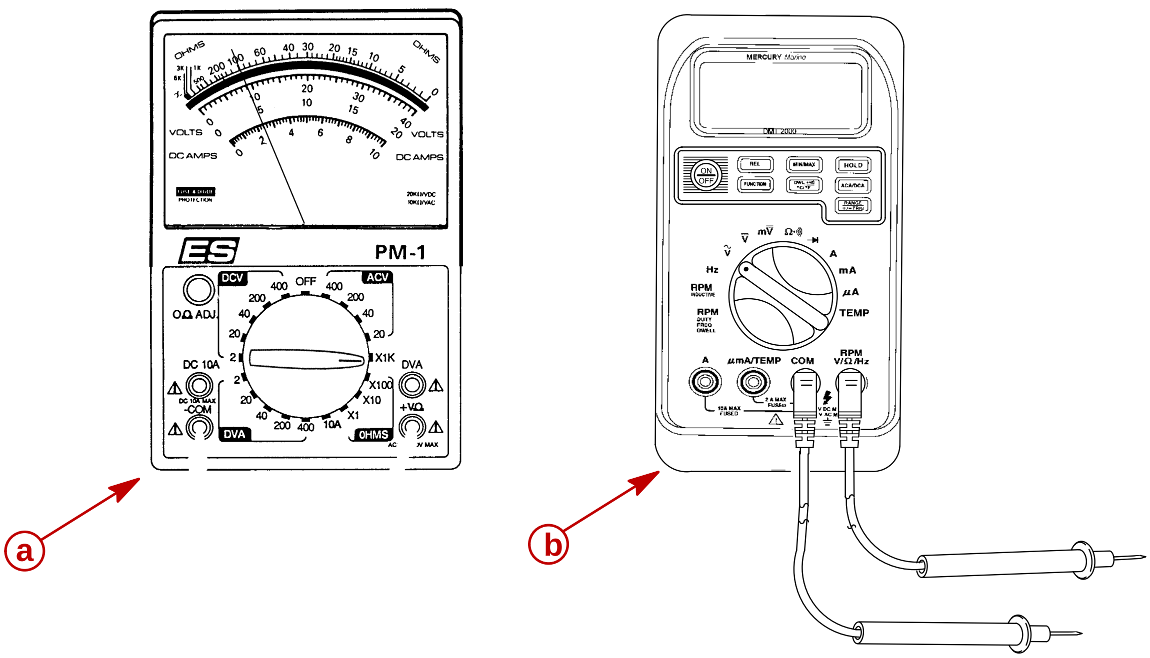
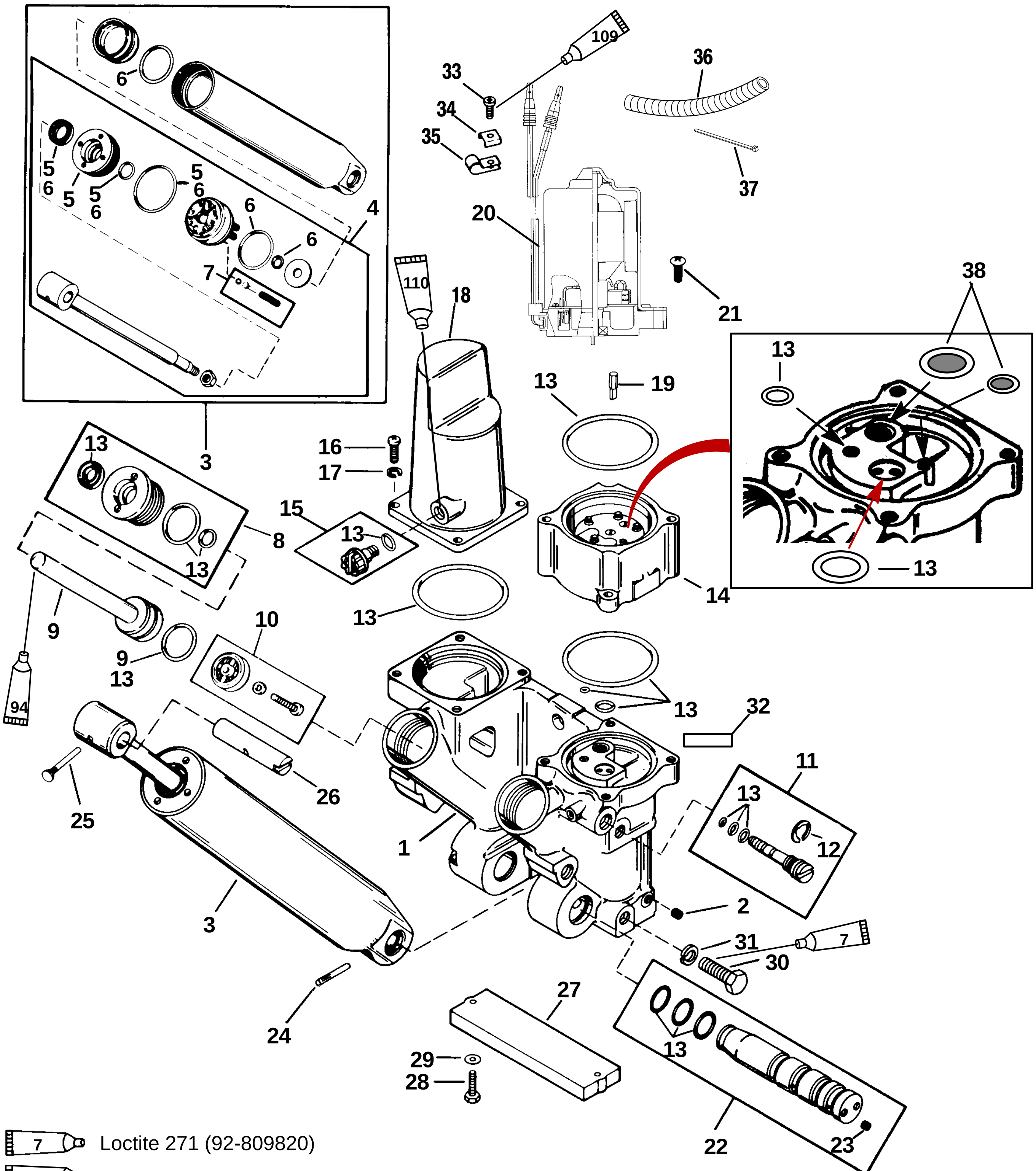
7. Multi-Meter DVA Tester 91-99750A1 or DMT 2000 Digital Tachometer Multi-meter 91-854009A1



a - Multi-Meter DVA Tester 91-99750A1
b - DMT 2000 Digital Tachometer Multi-meter 91-854009A1

Power Trim Components



7 Loctite 271 (92-809820)

94 Anti-Corrosion Grease (92-78376A6)

109 GM Silicone Sealer (92-91600-1)

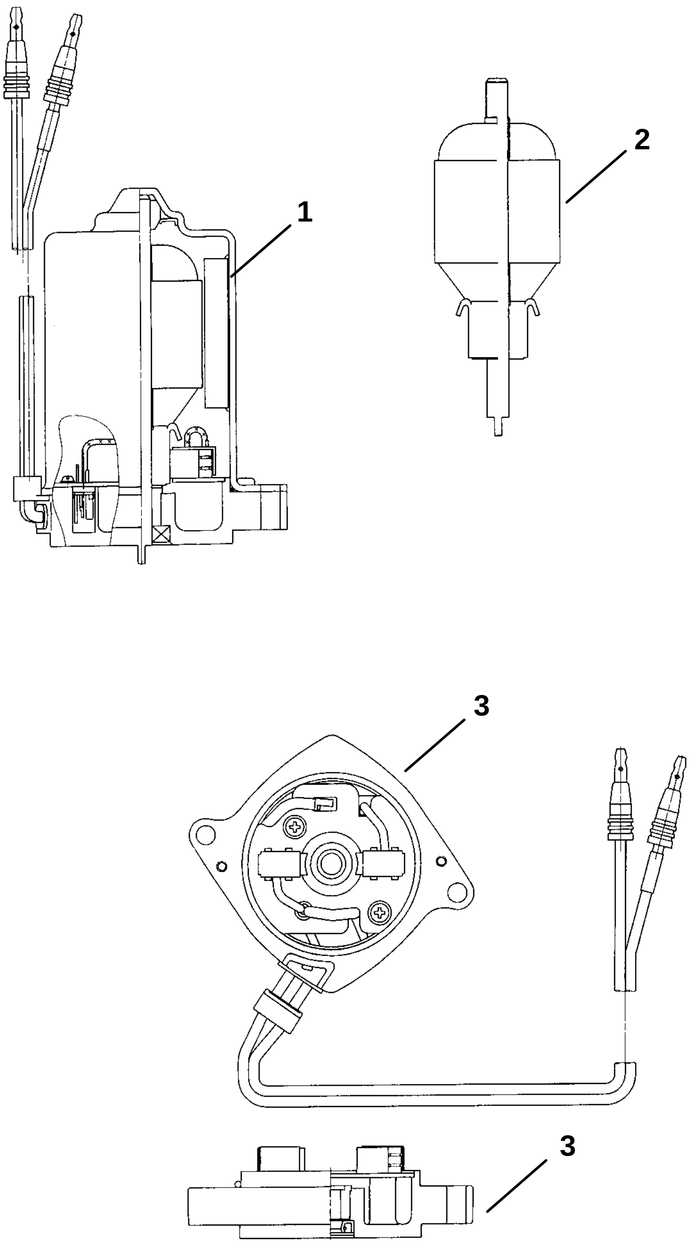
110 Power Trim & Steering Fluid (92-90100A12)

Power Trim Components

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
–	1	POWER TRIM ASSEMBLY–Complete			
1	1	MANIFOLD ASSEMBLY			
2	9	PIPE PLUG			
3	1	TILT CYLINDER ASSEMBLY			
4	1	PISTON ROD			
5	1	GUIDE KIT			
6	1	REPAIR KIT			
7	1	CHECK VALVE KIT			
8	2	GUIDE ASSEMBLY			
9	1	PISTON/ROD ASSEMBLY **(PORT)**			
	1	PISTON/ROD ASSEMBLY **(STBD.)**			
10	1	TRIM FILTER ASSEMBLY			
11	1	VALVE ASSEMBLY			
12	1	E RING			
13	1	O RING KIT			
14	1	PUMP			
15	1	PLUG ASSEMBLY			
16	4	SCREW			
17	4	WASHER			
18	1	COVER			
19	1	DRIVE SHAFT			
20	1	TRIM MOTOR (Breakdown on Power Trim Motor)			
21	2	SCREW **(LONG)**	80		9
	2	SCREW **(SHORT)**	80		9
22	1	SHAFT ASSEMBLY			
23	2	PIPE PLUG			
24	1	GROOVE PIN			
25	1	GROOVE PIN			
26	1	SHAFT			
27	1	ANODE ASSEMBLY			
28	2	SCREW (M6 x 1 x 25)	70		8
29	2	WASHER			
30	6	SCREW (M10 x 1.5 x 30)		45	61
31	6	WASHER			
32	1	DECAL-Caution power trim			
33	1	SCREW (10-16 x 3/5 IN.)			
34	1	C WASHER			
35	2	CLAMP			
36	1	TUBING			
37	1	STA-STRAP			
38	2	FILTER SCREENS			

NOTE: *Lubricate all O-rings with Power Trim and Steering Fluid.*

Power Trim Motor



REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb.in.	lb.ft.	N·m
–	1	POWER TRIM MOTOR			
1	1	BRUSH AND SEAL KIT			
2	1	ARMATURE KIT			
3	1	END FRAME **(Complete)**			

Power Trim - General Information

Description

The Power Trim System consists of an electric motor, pressurized fluid reservoir, pump, tilt cylinder, and two trim rams.

The remote control (or trim panel) has switches that trim the outboard “Up” or “Down” and tilt the engine for “Trailering”. The outboard can be trimmed and tilted under power or when the outboard is not running.

Trimming Characteristics

NOTE: *Because hull designs react differently in varying water conditions, varying the trim position will often improve the ride and boat handling. When trimming from a mid-trim position (with outboard trim tab in a straight fore and aft position), expect the following:*

TRIMMING OUTBOARD “UP” (OUT):

WARNING

Excessive trim “Out” may reduce the stability of some high speed hulls. To correct instability, reduce the power gradually and trim the outboard “In” slightly before resuming high speed operation. A rapid reduction in power will result in a sudden change of steering torque and may cause additional boat instability.

Will lift boat bow, increasing top speed.

Transfers steering torque harder to port (left) on installations below 23 in. (584.2 mm) transom height.

Increases gearcase clearance over submerged objects.

Excess trim can cause “porpoising” and/or ventilation.

WARNING

Excessive outboard trim angle will result in insufficient water supply causing water pump and/or powerhead overheating damage. Insure water level is above water intake holes whenever outboard is running.

The “Up” circuit actuates the up solenoid (under outboard cowl) and closes the motor circuit. The electric motor drives the pump, forcing fluid thru passageways into the up side of the trim cylinders.

The trim cylinders position the outboard at the desired trim angle in the 20 degree maximum trim range. The system will not allow the outboard to be trimmed above the 20 degree trim range as long as the engine RPM is above approximately 2000 RPM.

The outboard can be trimmed above the 20 degree maximum trim angle (for shallow water operation, etc.), by keeping the engine RPM below 2000. If the RPM increases over 2000, propeller thrust (if propeller is deep enough) will cause the trim system to return the outboard to the 20 degree maximum trim position.

TRIMMING OUTBOARD "DOWN" (IN):

> **⚠ WARNING**
>
> **Excessive speed at minimum trim "In" may result in undesirable and/or unsafe steering conditions. Test for handling characteristics after any adjustment is made to the trim angle (and tilt pin location).**

Aids planing, particularly with heavy loads.

Improves ride in choppy water conditions.

Excess trim "In" can cause "bow steer" (boat veers to left or right).

Transfers steering torque to starboard (right).

Improves acceleration to planing speed.

The "Down" circuit actuates the down solenoid (under engine cowl) and closes the motor circuit. The electric motor drives the pump in the opposite direction as the up circuit, forcing fluid thru passageways into the "down" side of the tilt ram. The tilt ram moves the engine down to the desired position.

Trailering Outboard

The "Up" circuit first moves the trim cylinders; when the trim cylinders extend fully, the tilt ram extends to tilt the outboard to the full up position for trailering.

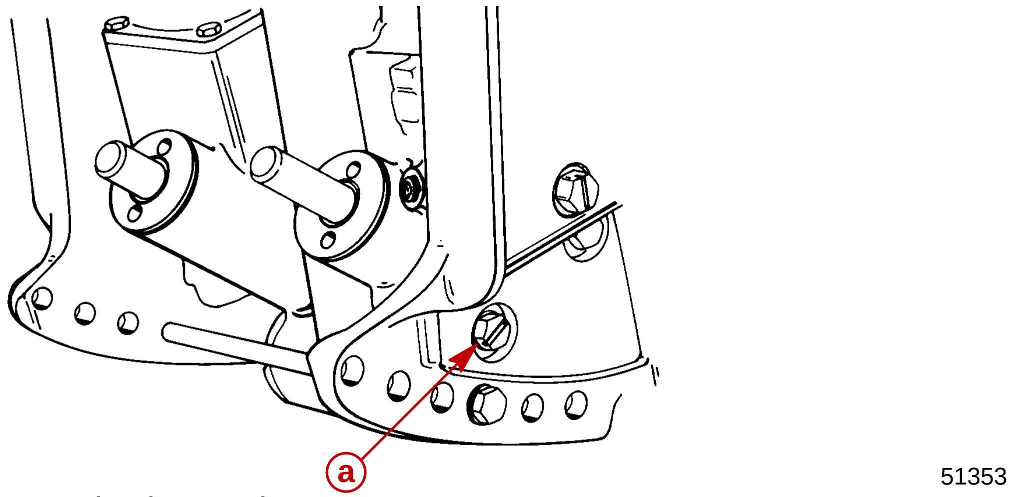
Before the boat is trailered, the operator should check for clearance between the outboard skeg and pavement to prevent damage to skeg from striking pavement.

If the outboard must be tilted for clearance between skeg and pavement, a device such as a "Transom Saver" should be installed to prevent stress to boat transom from outboard weight while the boat/outboard are being trailered.

Tilting Outboard Manually

> **⚠ WARNING**
>
> **Before opening the manual release valve knob, insure all persons are clear of outboard as outboard will drop to full "Down" when valve is opened.**

The outboard can be raised or lowered manually by opening the manual release valve 3 to 4 turns counterclockwise. Close manual release valve to hold outboard at the desired tilt position.



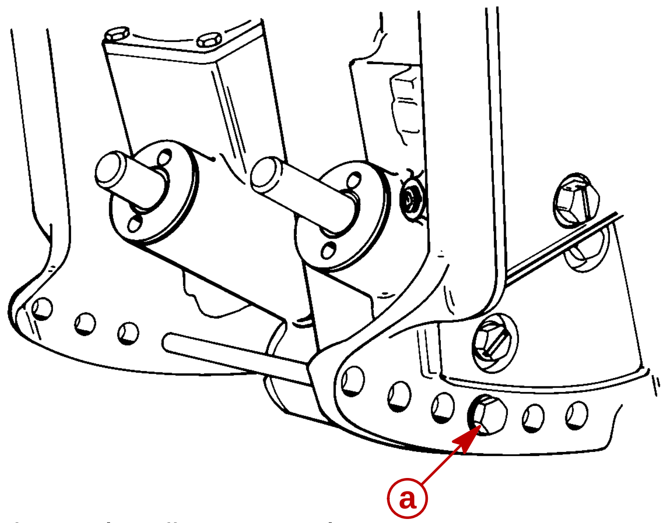
a - Manual Release Valve

Trim "In" Angle Adjustment

⚠ WARNING

Boat operation with outboard trimmed to the full "In" trim angle [not using the trim angle adjustment bolt (a)] at planing speed may result in undesirable and/or unsafe steering conditions. A water test for handling/steering conditions is required after any trim angle adjustments.

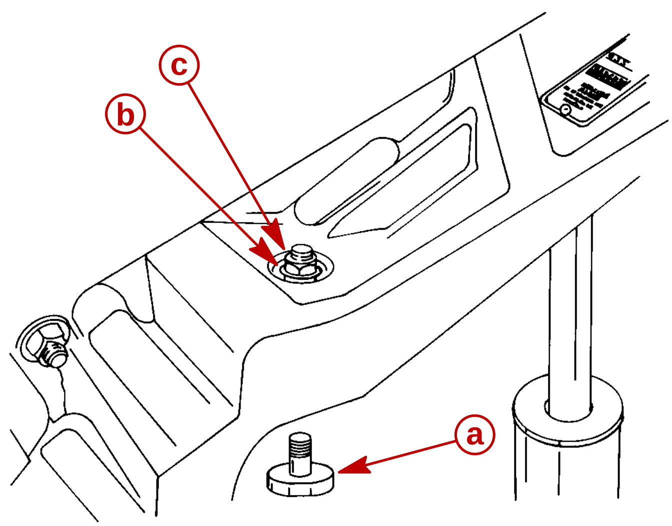
IMPORTANT: Some boat/motor combinations not using the trim angle adjustment pin (a) and trimmed to the full "In" trim angle position may not exhibit any undesirable and/or unsafe handling and/or steering characteristics at planing speed. If so, not using the trim angle adjustment bolt (a) may be advantageous to acceleration and planing. A water test is required to determine if these characteristics apply to a particular boat/motor combination.



a - Trim Angle Adjustment Bolt

Striker Plate Replacement

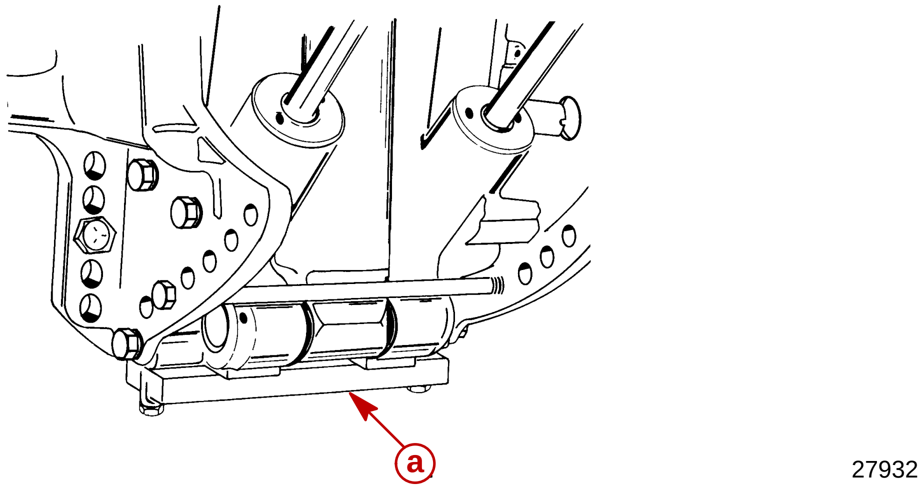
Visually inspect striker plates (a) and replace if worn excessively.



a - Striker Plate (2)
b - Lockwasher
c - Locknut. Torque to 80 lb. in. (9.0 Nm)

Anode Plate

Anode plate (a) is a self-sacrificing alloy plate that is consumed gradually by corrosion while providing protection to the midsection and power trim from galvanic corrosion. Replace anode plate when it is 50% consumed.



a - Anode Plate

IMPORTANT: Do not paint or place protective coating on anode plate, or corrosion protection function will be lost.

Trim Indicator Gauge

A Quicksilver Trim Indicator Gauge accessory kit is available for the power trim sender (if not previously installed).

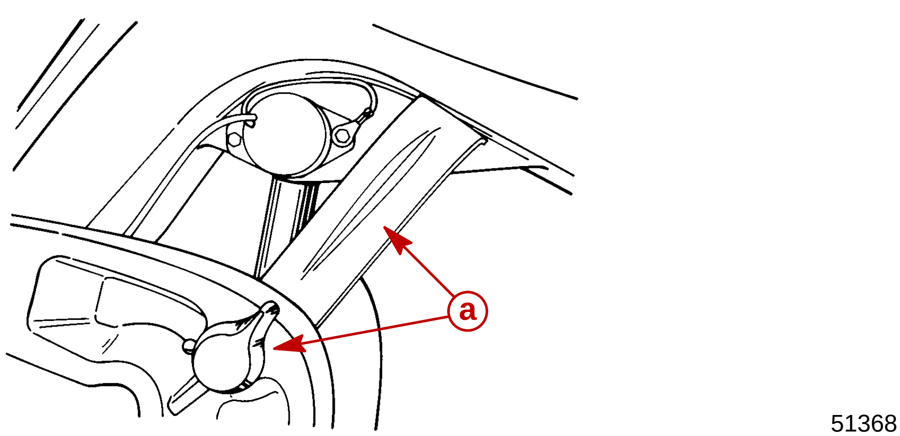
Check, Fill and Purge - Power Trim System

TO CHECK:

> **⚠ CAUTION**
>
> **Tilt outboard to full “Up” position and engage tilt lock lever before checking fluid level. System is pressurized. Extend trim and tilt rams fully to depressurize system.**

Remove fill plug and O-ring. System is full when oil level is present at filler hole. Tighten fill plug securely.

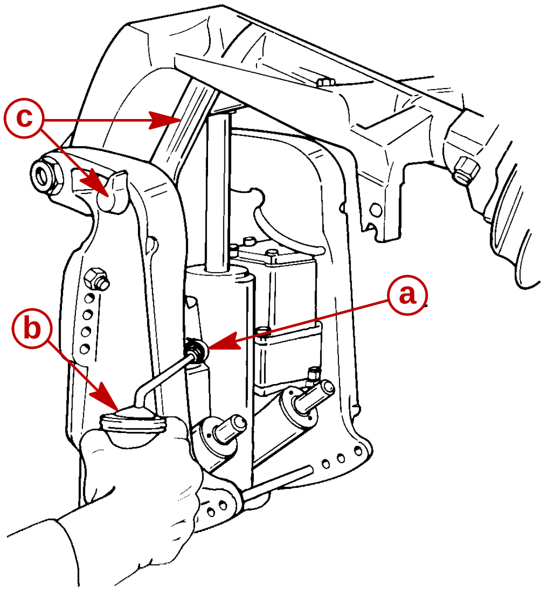
NOTE: *Automatic Transmission Fluid (ATF) Type F, FA, Dexron II or Dexron III may be used.*



a - Tilt Lock Lever

TO FILL:

IMPORTANT: This trim system is pressurized. Remove "Fill" plug only when outboard is tilted to the full "Up" position or the trim/tilt rams are fully extended. Retighten "Fill" plug before tilting outboard down or retracting tilt/trim rams. Remove "Fill" plug and O-ring. System is full when oil level is present at fill hole. Tighten "Fill" plug securely.



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- **a** - Fill Plug and O-ring (remove to fill system, tighten securely)
- **b** - Oil Can (fill system with Quicksilver Power Trim and Steering Fluid)
- **c** - Tilt Lock Lever (engage to support engine in "Up" position)

TO PURGE:

IMPORTANT: Fill plug and O-ring must be tightened securely before purging system.

IMPORTANT: Run Trim System in short "jogs" until pump is primed and trim system moves. If trim motor is run without priming pump, driveshaft failure could result.

Cycle outboard through entire trim/tilt range 4 times. Check fluid level after purging system.

Push down on outboard when trim rams are slightly extended. If rams retract more than 1/8 in. (3.2 mm), air is present in system. Cycle system again and check fluid level.

Troubleshooting

IMPORTANT: Determine if Electrical or Hydraulic problem exists.

IMPORTANT: Acceptable power trim leak down should not exceed 1 in. (25.4 mm) (when measured at the tilt ram) in a 24 hour period.

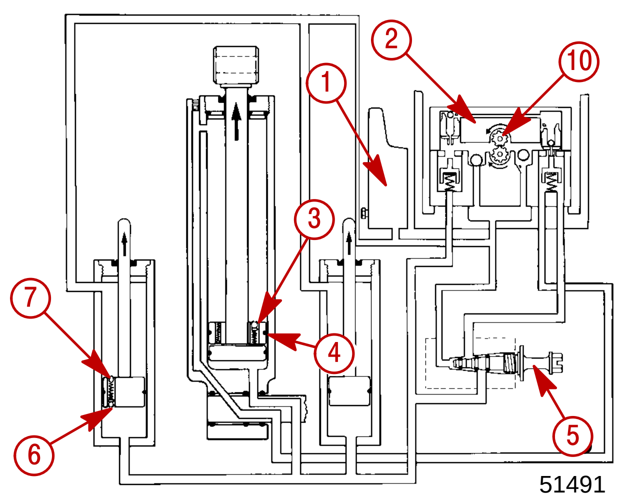
HYDRAULIC SYSTEM TROUBLESHOOTING

IMPORTANT: Make one correction at a time. Check operation of trim system before proceeding to the next check.

CONDITION OF TRIM SYSTEM	PROBLEM
A. Trim motor runs; trim system does not move up or down.	1, 2, 5, 10
B. Does not trim full down. Up trim OK.	2, 3, 4
C. Does not trim full up. Down trim OK.	1, 6
D. Partial or “Jerky” down/up.	1, 3
E. “Thump” noise when shifting.	2, 3, 6, 7
F. Does not trim under load.	5,8, 9,10
G. Does not hold trim position under load.	2, 5, 6
H. Trail out when backing off from high speed.	3, 4
I. Leaks down and does not hold trim.	2, 5, 7
J. Trim motor working hard and trims slow up and down.	8, 9
K. Trims up very slow.	1, 2, 8, 9
L. Starts to trim up from full down position when “IN” trim button is depressed.	3, 4
M. Trim position will not hold in reverse.	3, 4

PROBLEM

1. Low oil level.
2. Pump assembly faulty.
3. Tilt ram piston ball not seated (displaced, dirt, nickel seat).
4. Tilt ram piston O-ring leaking or cut.
5. Manual release valve leaking (check condition of O-rings) (Valve not fully closed).
6. Lower check valve not seating in port side trim ram.
7. Upper check valve not seating in port side trim ram.
8. Check condition of battery.
9. Replace motor assembly.
10. Broken motor/pump drive shaft.



External Mounted Hydraulic System

ELECTRICAL SYSTEM TROUBLESHOOTING

CONDITION OF TRIM SYSTEM	PROBLEM
A. Trim motor does not run when trim button is depressed.	1, 2, 4, 5, 6, 7, 8
B. Trim system trims opposite of buttons.	3
C. Cowl mounted trim buttons do not activate trim system.	2, 4, 5, 6, 7

PROBLEM

1. Battery low or discharged.
2. Open circuit in trim wiring.
3. Wiring reversed in remote control.
4. Wire harness corroded through.
5. Internal motor problem (brushes, shorted armature).
6. Blown fuse(s).
7. Trim switch failure.
8. Verify relays are functioning correctly.

POWER TRIM RELAY TEST PROCEDURE

The trim motor relay system used on permanent magnet trim systems connect each of the two wires from the trim motor to either ground or positive in order to allow the motor to run in both directions.

If the motor will not run in the UP direction, it could be either the UP relay is not making contact to 12 volts **OR** the DOWN relay is not making contact to ground. The opposite is true if the system will not run DOWN. When the system is not energized, both relays should connect the heavy motor leads to ground.

To test which relay is faulty if the trim system does not operate in one direction:

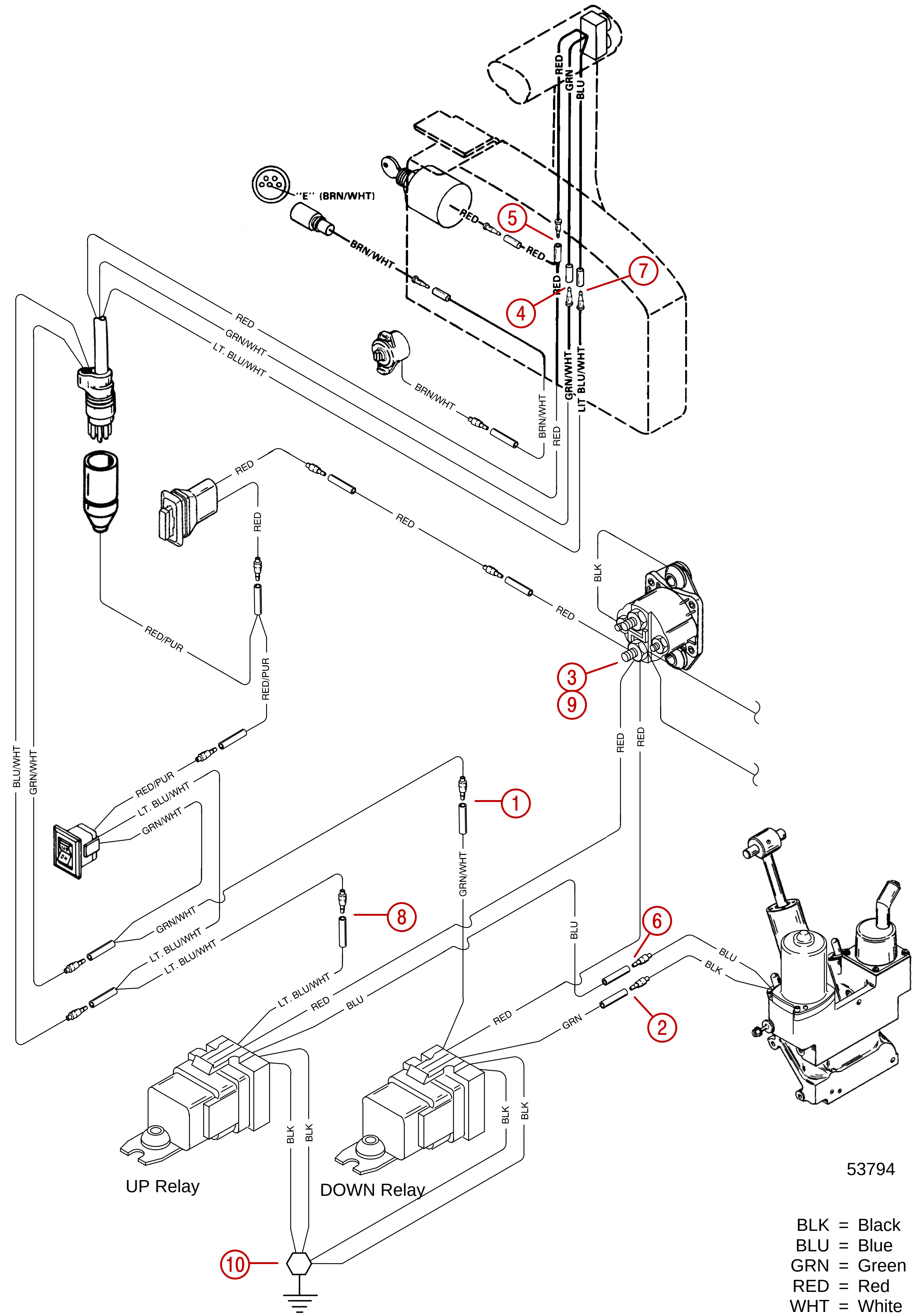
1. Disconnect the heavy gauge pump wires from the trim control relay.
2. Check for continuity between the heavy leads from the trim relays to ground.

Ohmmeter Leads Between	Resistance (Ohms)	Scale Reading* (x__________)
GREEN and Ground	0	Full Continuity (Rx1)
BLUE and Ground	0	Full Continuity (Rx1)

Replace the relay that does not have continuity.

3. Connect a voltmeter to the heavy BLUE lead and to ground. You should have 12 volts on the BLUE lead when the UP switch is pushed. You should should also have 12 volts on the GREEN lead when the DOWN switch is pushed. Replace the relay that does not switch the lead to positive.

Power Trim System with Relays and 2 Wire Trim Motor



BLK = Black
BLU = Blue
GRN = Green
RED = Red
WHT = White

Electrical System Troubleshooting

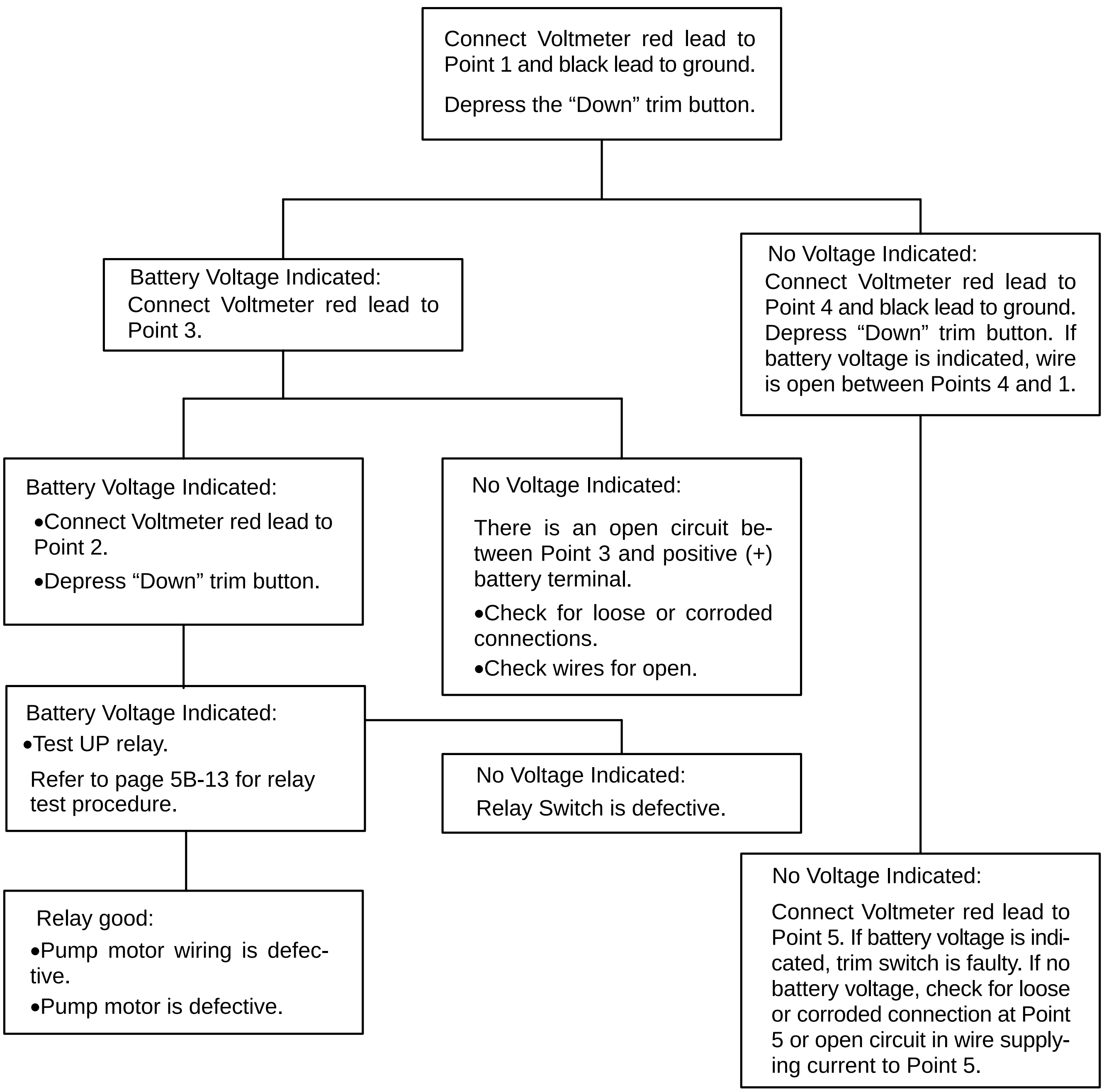
General Checks

Before troubleshooting the Power Trim electrical system, check the following:

1. Check for disconnected wires.
2. Make certain all connections are tight and corrosion free.
3. Check that plug-in connectors are fully engaged.
4. Make certain battery is fully charged.

Refer to the preceding four wiring diagrams for connection points when troubleshooting the electrical systems (Connection points are specified by number.)

Troubleshooting the “Down Circuit”



Troubleshooting the “Up” Circuit

Connect Voltmeter red lead to Point 8 and black lead to ground.

Depress the “Up” trim button.

Battery Voltage Indicated:
Connect Voltmeter red lead to Point 9.

No Voltage Indicated:
Connect Voltmeter red lead to Point 7 and black lead to ground. Depress “Up” trim button. If battery voltage is indicated, wire is open between Points 7 and 8.

Battery Voltage Indicated:
- Connect Voltmeter red lead to Point 6.
- Depress “Up” trim button.

No Voltage Indicated:

There is an open circuit between Point 9 and positive (+) battery terminal.
- Check for loose or corroded connections.
- Check wires for open.

Battery Voltage Indicated:
- Test DOWN relay.

Refer to page 5B-13 for relay test procedure.

No Voltage Indicated:

Relay Switch is defective.

Relay good:
- Pump motor wiring is defective.
- Pump motor is defective.

No Voltage Indicated:

Connect Voltmeter red lead to Point 5. If battery voltage is indicated, trim switch is faulty. If no battery voltage, check for loose or corroded connection at Point 5 or open circuit in wire supplying current to Point 5.

Troubleshooting the “Down” and “Up” Circuits (All Circuits Inoperative)

Check in-line fuse (under cowl) to see if fuse is blown.

Blown Fuse:

•Correct problem that caused fuse to blow.

•Replace fuse.

Fuse Not Blown:

Connect Voltmeter red lead to Point 3 and black lead to ground. Battery voltage should be indicated.

No Voltage Indicated:

•Check battery leads for poor connections or open circuits.

•Check battery charge.

Battery Voltage Indicated:

•Connect Voltmeter red lead to Point 8 and black lead to ground.

•Depress “Up” trim button and check for battery voltage.

No Voltage Indicated:

Connect red Voltmeter lead to Point 5, and black lead to ground.

Battery Voltage Indicated:

•Check black ground wires for poor connection or poor ground, Point 10.

•Pump motor is faulty. Refer to “Motor and Electrical Tests/ Repair”, following.

No Voltage Indicated:

Check that voltage is being supplied to control by performing the following checks:

•DO NOT start engine.

•Turn ignition switch to “Run” position.

•Check for voltage at any instrument, using a Voltmeter.

Battery Voltage Indicated:

Trim switch is faulty or there is an open circuit in wires (green-white, blue-white) between trim buttons and trim pump.

•Check trim switch.

•Check all trim harness connectors for loose or corroded connections.

•Check for pinched or severed wires.

No Voltage Indicated:

Red wire is open between Point 3 and red terminal on back of the ignition switch.

•Check for loose or corroded connections.

•Check for open in wire.

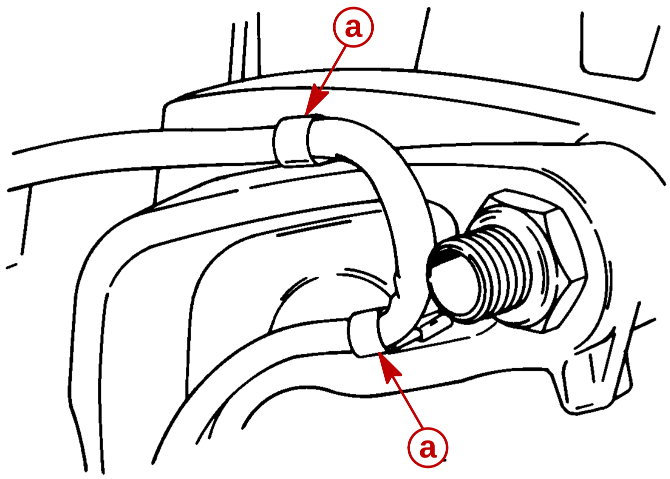
Battery Voltage Indicated:

There is an open circuit in wire between Point 5 and Red terminal on the back of the ignition switch.

Power Trim Assembly Removal and Installation

Removal

1. Remove clamps on transom bracket to free power trim wiring.
2. Raise outboard to full “Up” position and engage tilt lock lever.



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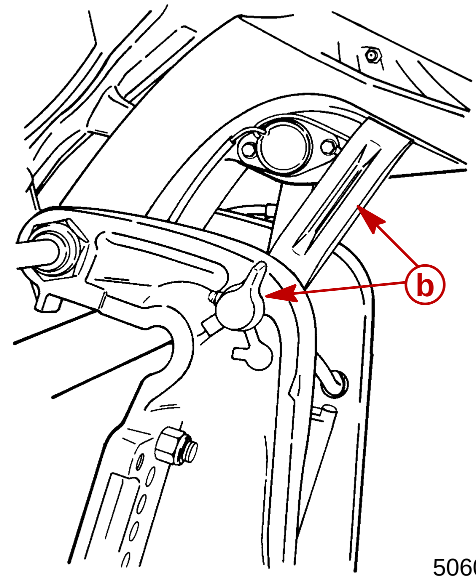

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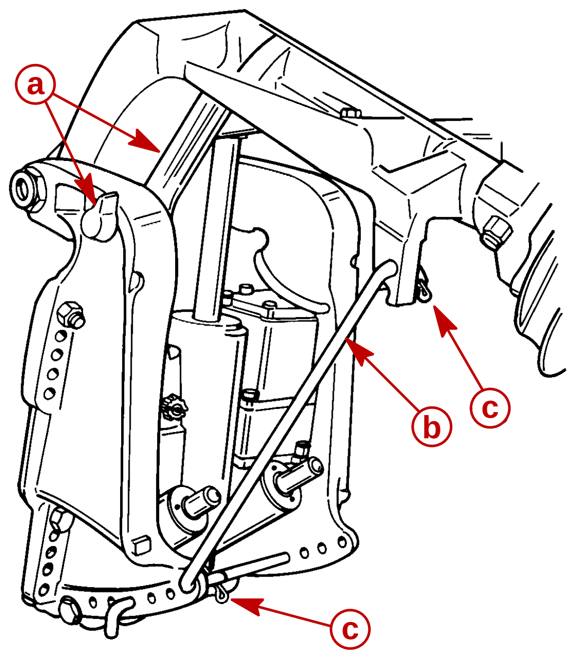
a - Clamps
b - Tilt Lock Lever

⚠ WARNING

Failure to support outboard as shown could result in personal injury and/or damage to outboard or boat.



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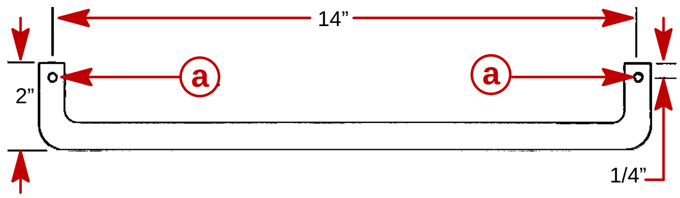
a - Tilt Lock Lever
b - Support Tool
c - Retaining Clips

IMPORTANT: Support outboard as shown above to prevent engine from tipping when power trim retaining pin is removed.

SUPPORT TOOL

3/8 in. diameter metal rod (a used shift shaft works well)



a - Drill holes for retaining clips

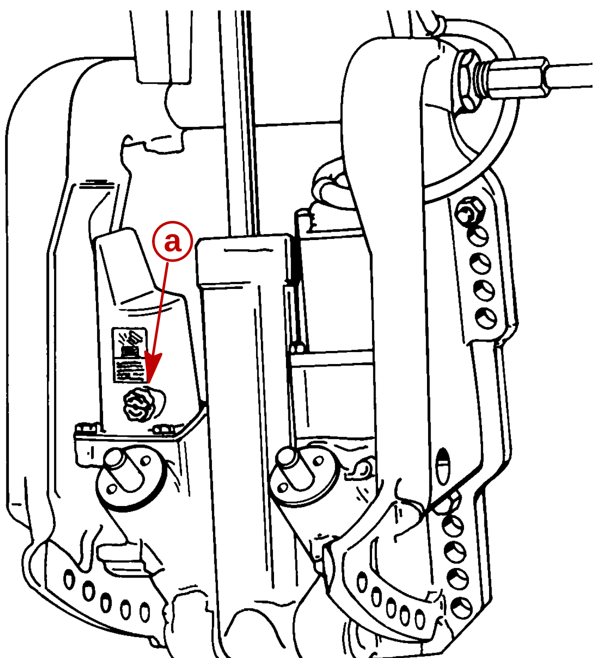
METRIC CONVERSION

14 in. = 35.56 cm.	2 in. = 50.8 mm
3/8 in. = 9.5 mm.	1/4 in. = 6.35 mm.

> **⚠ CAUTION**
>
> **Disconnect battery cables at battery before removing power trim wires from solenoids.**

3. Disconnect power trim wires at solenoids (BLUE, GREEN, and BLACK) or if relay style, disconnect (BLUE and GREEN) bullet connector harness.
4. Open filler cap and release any remaining pressure in the system.

IMPORTANT: Outboards equipped with thru-the-tilt-tube steering - remove steering link arm from end of steering cable and cable retaining nut from tilt tube.



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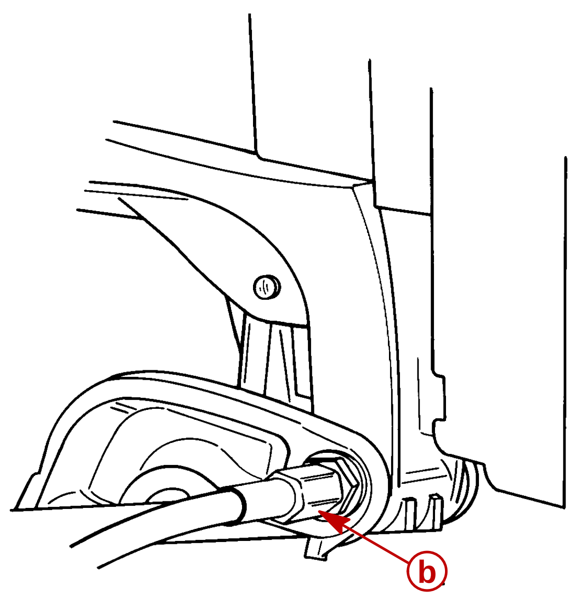

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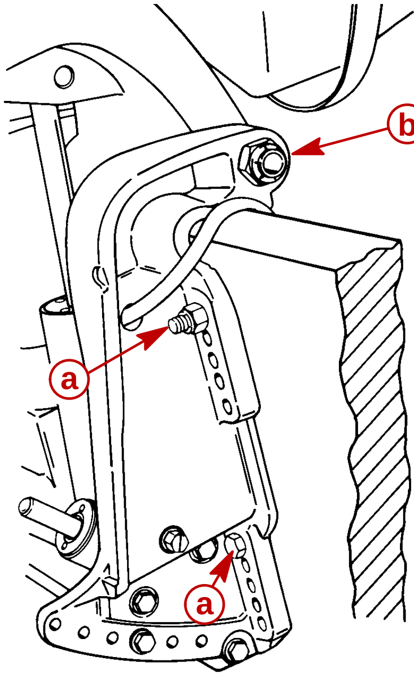
a - Filler Cap
b - Retaining Nut

5. Remove outboard transom mounting bolts, and loosen tilt tube nut until nut is flush with end of tilt tube thread.
6. Remove 3 screws and washers and move starboard transom bracket.



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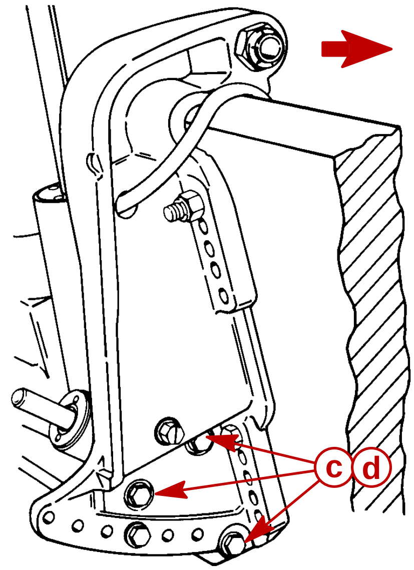

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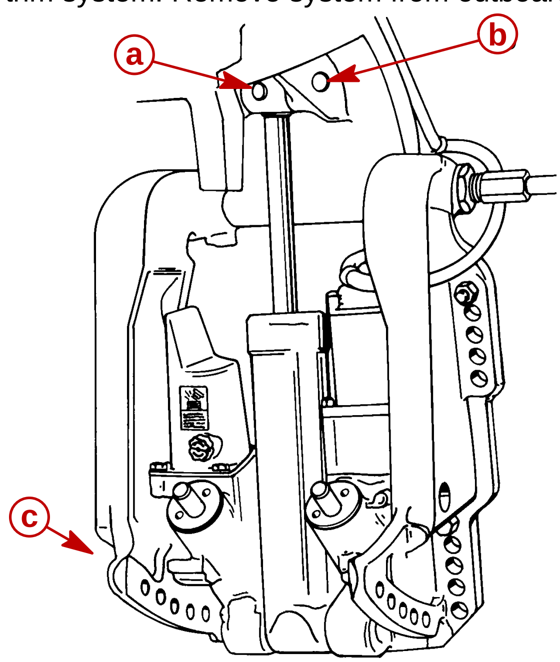
a - Transom Mount Bolts (2)
b - Tilt Tube Nut (flush with end of thread)
c - Screws (3)
d - Washers (3)

IMPORTANT: Cross pin (a) should not be reused. Replace with new cross pin.

7. Drive out cross pin, push out upper swivel pin, and remove 3 screws and washers retaining trim system. Remove system from outboard.

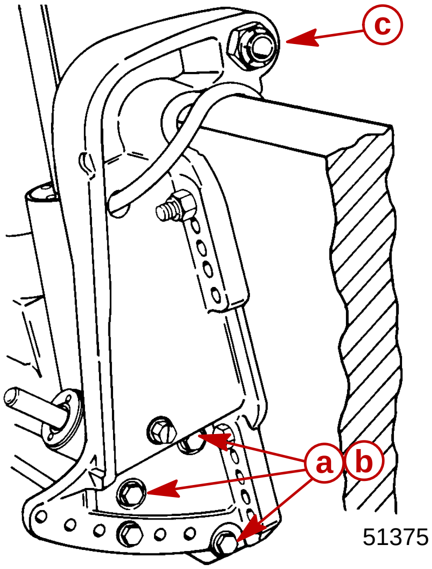


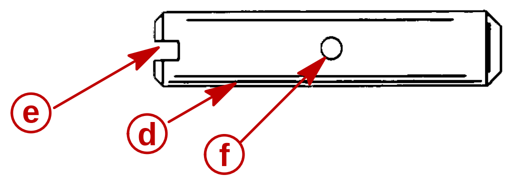
51339

a - Cross Pin
b - Upper Swivel Pin
c - Port Transom Bracket Screws and Washers (3). Remove to Release Trim System from Outboard.

Installation

1. Paint any exposed metal surfaces to prevent corrosion.
2. Apply Loctite 271 to screws. Install trim system, starboard transom bracket, and tilt tube nut.
3. Use a 12 volt power source to extend tilt ram up to align upper swivel shaft hole and end of ram. Connect trim motor wires [BLUE wire to POSITIVE (+), BLACK wire to NEGATIVE (–)]. If ram extends too far, retract ram by connecting GREEN wire to POSITIVE (+).
4. Install Upper Swivel Pin with slotted end to left (port) side of engine.

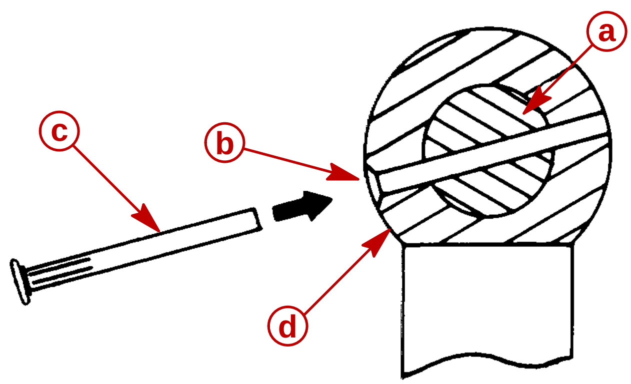




a - Screw (6) Torque to 40 lb. ft. (54.0 N·m)
b - Lockwasher (6) Install one per screw
c - Tilt Tube Nut
d - Upper Swivel Pin
e - Slotted end
f - Cross hole (in line with slotted end)

IMPORTANT: Cross pin should not be reused. Install a new pin.

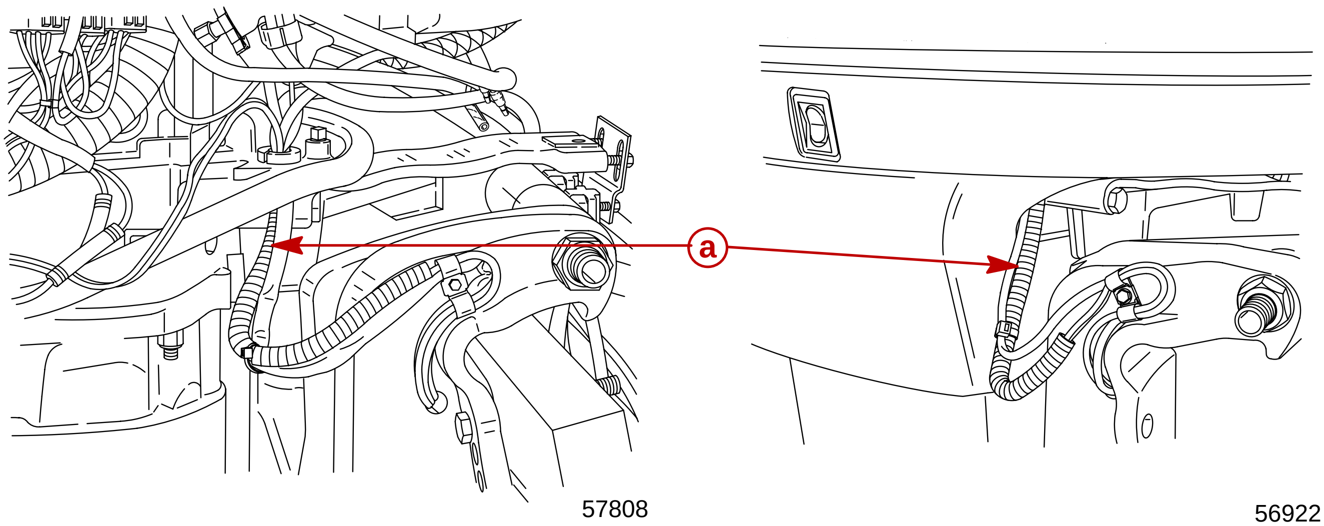
5. Position slot on end of swivel shaft in line with hole in tilt ram end. Insert a punch into tilt ram hole to align cross hole in upper swivel shaft. Tap new cross pin in until flush.



a - Upper Swivel Shaft (Slot is in line with cross hole)
b - Chamfered End of Hole (Faces away from transom)
c - Retaining Pin
d - Tilt Ram End

6. Connect trim motor wires to solenoids. Refer to Wiring Diagrams in this manual. Route trim wires as specified in this manual.

NOTE: *The 2 power leads going to the trim motor should be encapsulated with conduit tubing. If tubing has not been previously installed, order 32-828547-353 and cut to appropriate length.*



a - Conduit Tubing

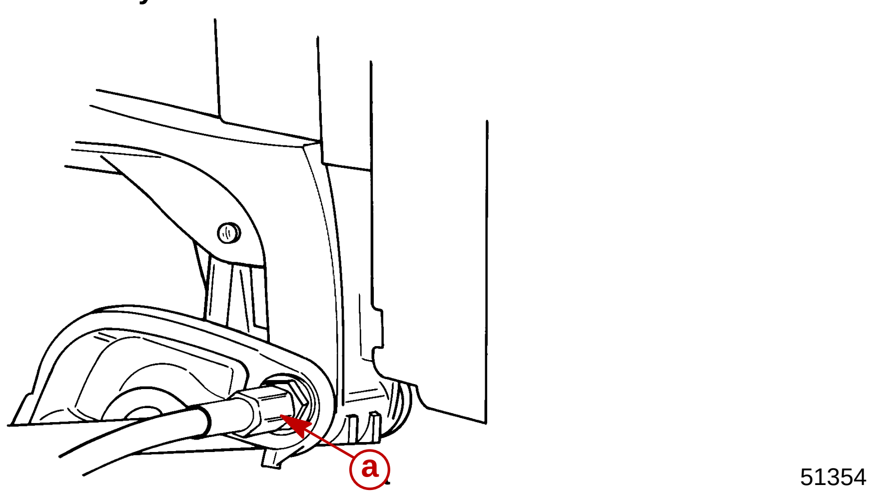
7. Apply marine sealer to shanks of mount bolts and install transom mount bolts.

IMPORTANT: Do not use an impact driver to tighten transom mount bolts.

Apply marine sealer to threads of mount bolts. Secure with flat washers and locknuts. Be sure installation is watertight.

8. Tighten tilt tube nut securely.

IMPORTANT: Outboards equipped with thru-the-tilt-tube steering: Tighten steering cable retaining nut securely to tilt tube.



a - Steering Cable Retaining Nut

9. Apply Quicksilver Liquid Neoprene (91-25511--2) on all electrical connections.

⚠ WARNING

Electrical wires passing through cowl openings must be protected from chafing or being cut. Follow the recommended procedures outlined in Section 1D of this Manual. Failure to protect wires as described could result in electrical system failure and/or injury to occupants of boat.

Testing Power Trim System With Test Gauge Kit (91-52915A6)

IMPORTANT: This test will not locate problems in the trim system. The test will show if the system is correct after a repair. If minimum pressures are not obtainable, the trim system requires additional repair.

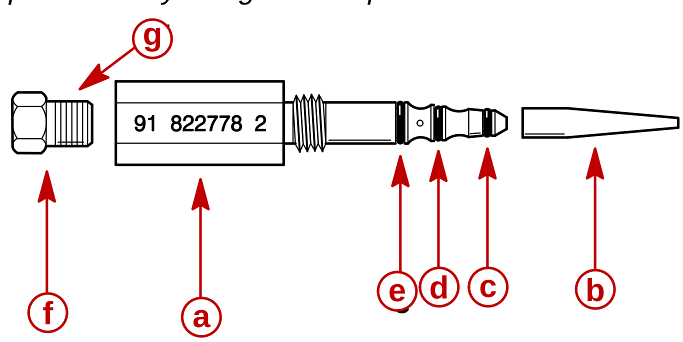
"UP" Pressure Check

IMPORTANT: Insure battery is fully charged before performing tests.

1. Tilt outboard to full "Up" position and engage tilt lock lever.
2. Slowly remove "Fill" plug to bleed pressure from reservoir.
3. Remove circlip securing manual release valve and unscrew release valve from trim assembly.

NOTE: *A small amount of trim fluid may drip from manual release valve hole. Place a suitable container under trim assembly to collect any leakage.*

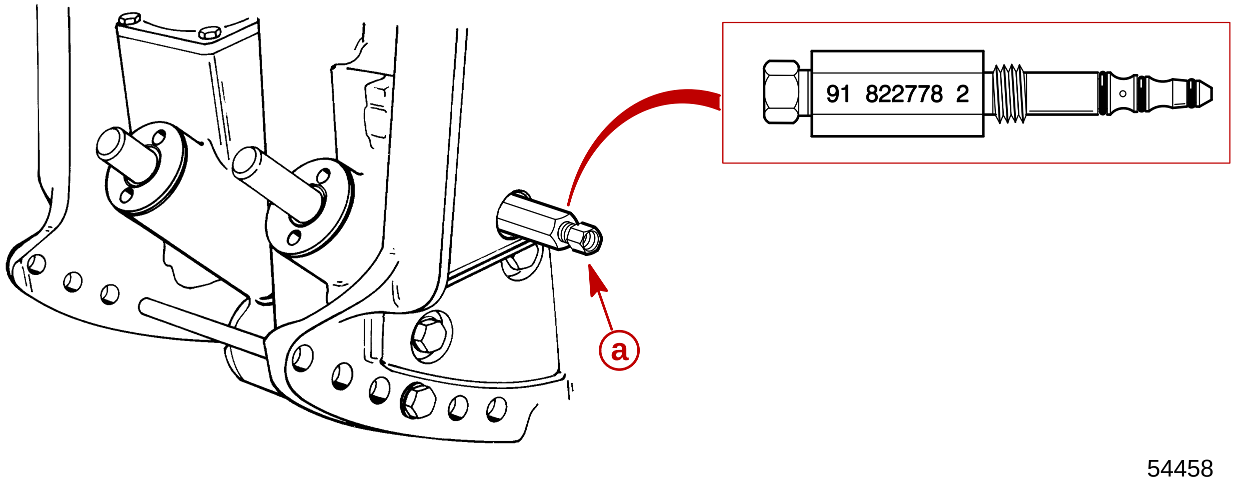
NOTE: *Assemble test adaptor by using O-ring installation tool to position small O-ring onto adaptor 1st, then install medium O-ring and lastly large O-ring. Thread brass fitting into test adaptor securely using teflon tape on threads.*



54457

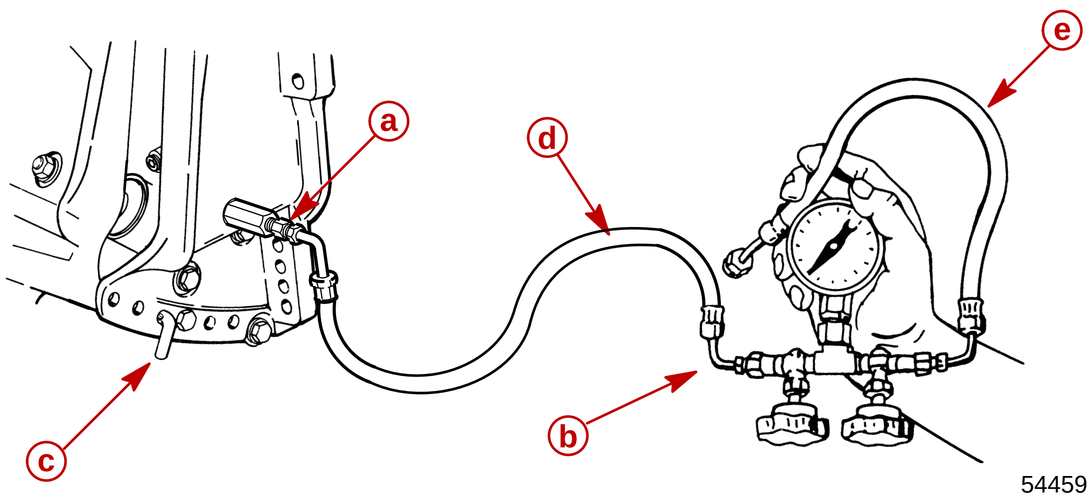
a - Test Adaptor (91-822778A2)
b - O-ring Installation Tool
c - Small O-ring (Install 1st)
d - Medium O-ring (Install 2nd)
e - Large O-ring (Install Last)
f - Brass Fitting
g - Apply Teflon Tape

4. Install test adaptor 91-822778A2 into manual release valve hole.



a - Test Adaptor (91-822778A2)

5. Thread hose from Test Gauge Kit (91-52915A6) into brass fitting on adaptor.



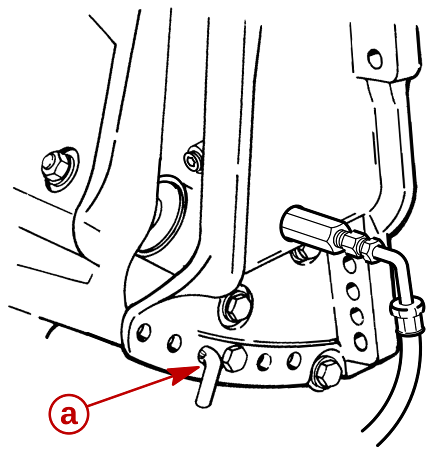
a - Brass Fitting
b - Test Gauge Assembly
c - Tilt Pin (Position in Hole Shown)
d - Hose
e - Hose (Not Used)

6. Reinstall fill plug.
7. Disengage tilt lock lever.

⚠ CAUTION

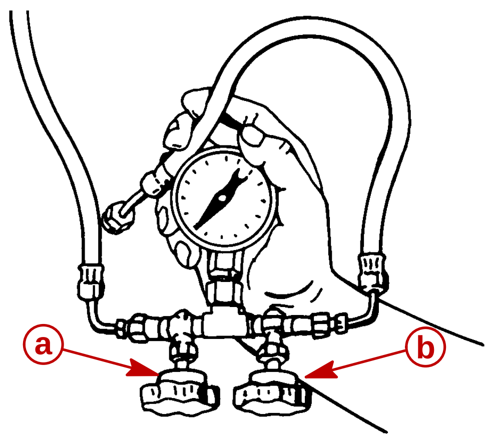
Failure to install spare tilt pin (or hardened bolts and nuts) in hole shown could result in transom bracket failure and possible injury.

8. Move outboard “IN” until hole in swivel bracket “ear” aligns with the 3rd tilt hole in transom bracket. Lock engine in trim range by installing a 3/8 in. (9.5 mm) diameter tilt pin or two 3/8 in. (9.5 mm) hardened bolts and nuts thru the transom brackets and swivel bracket in the hole shown.



a - Tilt Pin Hole (Install Spare Tilt Pin or Hardened Bolts and Nuts)

9. Open valve (a) and close valve (b).



10. Run trim “UP”. The minimum pressure should be 1300 P.S.I. (91 kg/cm^2).
11. Run trim “DOWN” to release pressure and remove spare tilt pin or bolts and nuts.
12. Tilt outboard full “UP” and engage tilt lock lever.
13. Slowly remove “Fill” plug to bleed pressure.
14. Remove test gauge hose and adapter.
15. Reinstall Manual Release Valve and secure valve with circlip.
16. Retighten “Fill” plug.

NOTE: *If pressure is less than 1300 PSI (91 kg/cm^2), troubleshoot system per instructions* *on page 5B-16.*

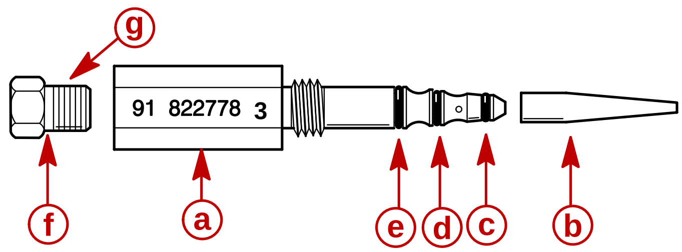
"DOWN" Pressure Check

IMPORTANT: Insure battery is fully charged before performing tests.

1. Tilt outboard to full "Up" position and engage tilt lock lever.
2. Slowly remove "Fill" plug to bleed pressure from reservoir.
3. Remove circlip securing manual release valve and unscrew release valve from trim assembly.

NOTE: *A small amount of trim fluid may drip from manual release valve hole. Place a suitable container under trim assembly to collect any leakage.*

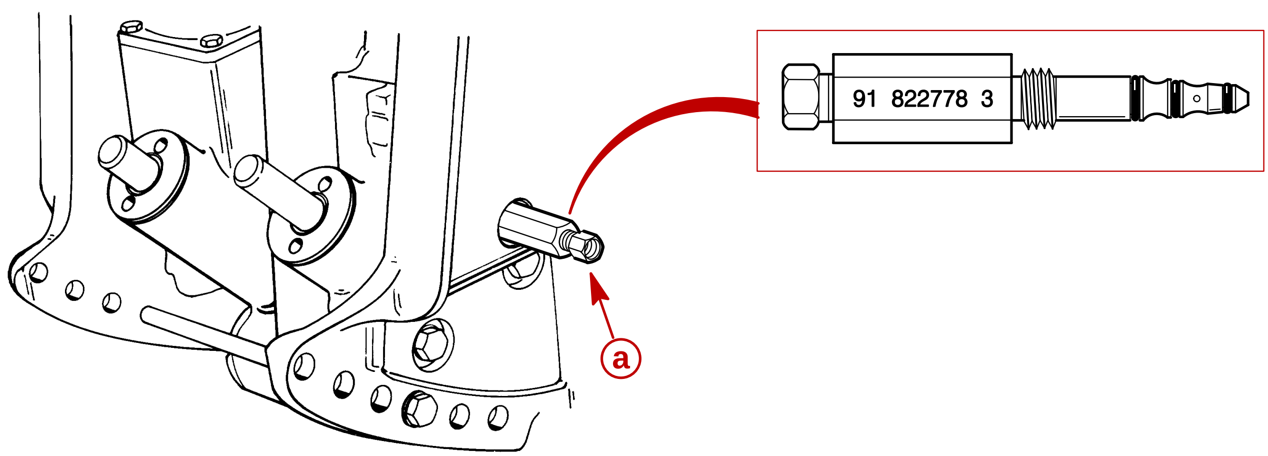
NOTE: *Assemble test adaptor by using O-ring installation tool to position small O-ring onto adaptor 1st, then install medium O-ring and lastly large O-ring. Thread brass fitting into test adaptor securely using teflon tape on threads.*



54457

a - Test Adaptor (91-822778A3)
b - O-ring Installation Tool
c - Small O-ring (Install 1st)
d - Medium O-ring (Install 2nd)
e - Large O-ring (Install Last)
f - Brass Fitting
g - Apply Teflon Tape

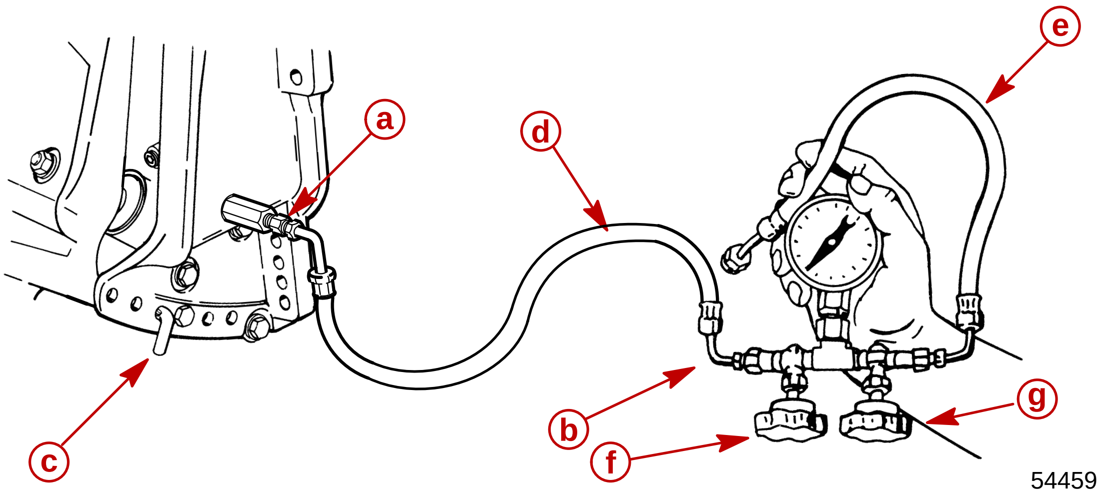
4. Install test adaptor 91-822778A3 into manual release valve hole.



54458

a - Test Adaptor (91-822778A3)

5. Thread hose from Test Gauge Kit (91-52915A6) into brass fitting on adaptor.



a - Brass Fitting
b - Test Gauge Assembly
c - Tilt Pin (Position in Hole Shown)
d - Hose
e - Hose (Not Used)
f - OPEN Valve
g - CLOSE Valve

6. Reinstall fill plug.
7. Disengage tilt lock lever.
8. Open valve (f) and close valve (g).
9. Run trim “DOWN”. Minimum pressure should be 500 P.S.I. (35 kg/cm^2).
10. Tilt outboard full “UP” and engage tilt lock lever.
11. Slowly remove “Fill” plug to bleed pressure.
12. Remove test gauge hose and adaptor.
13. Reinstall manual release valve and secure valve with circlip.
14. Retighten “Fill” plug.

NOTE: *If pressure is less than 500 PSI (35 kg/cm^2), troubleshoot system per instructions on Page 5B-15.*

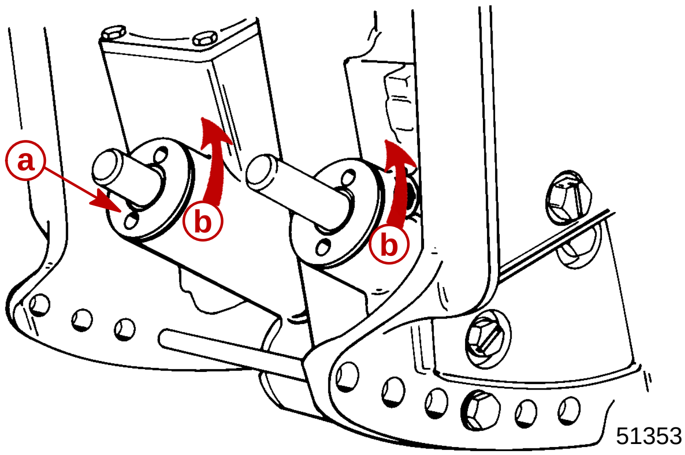
Hydraulic Repair

TRIM ROD REMOVAL AND REPAIR

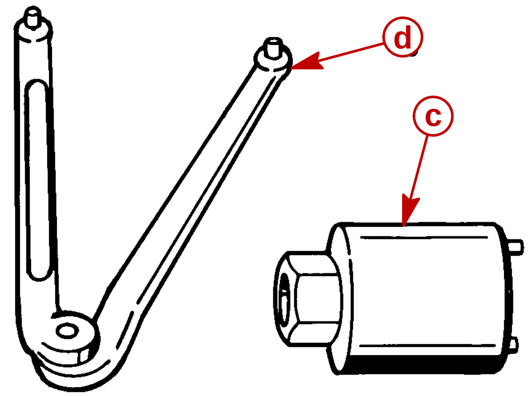
NOTE: *Power Trim does not have to be removed from outboard to remove trim rods.*

1. Tilt outboard to full “UP” position and engage tilt lock lever.
2. Slowly remove “Fill” plug to bleed reservoir pressure.
3. Turn Manual Release Valve 3 to 4 turns (counterclockwise) to bleed remaining pressure.
4. Remove trim rod cylinder caps.

NOTE: *Place a clean pan under trim system to catch fluid.*



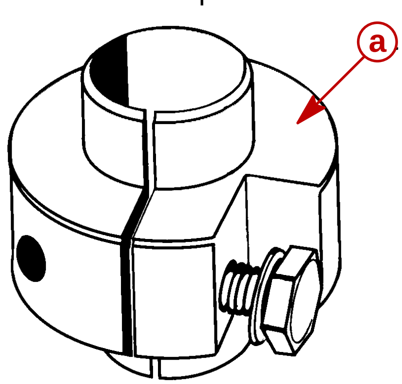
51353



51337

a - Trim Rod Cylinder Cap
b - Turn Counterclockwise to Remove
c - Removal Tool (91-44487A1)
d - Spanner Wrench (91-74951)

5. Install trim rod removal tool and pull trim rod from cylinder.



27933

a - Trim Rod Removal Tool (91-44486A1)

CLEANING AND INSPECTION - TRIM RODS AND CAPS

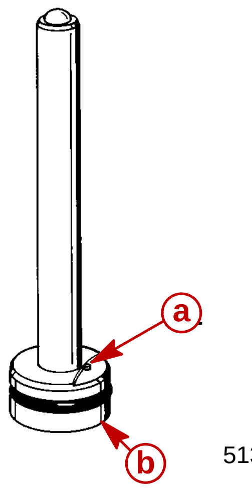
⚠ CAUTION

Do not remove check valve (a). Check valve is preset to operate at a specific pressure. Removal and installation of check valve could result in improper operating pressure and possible system damage.

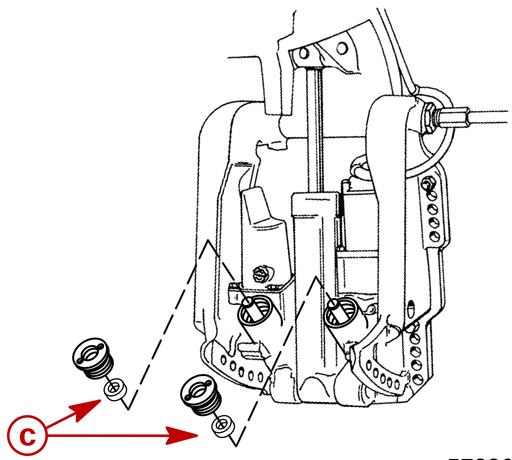
NOTE: *Check valve is in port side trim rod only.*

NOTE: *Certain models may have trim limit reducers installed on the trim rod to limit trim out angle. Each reducer limits the amount of total trim by 2°. A maximum of 5 reducers may be installed on each trim rod.*

1. Inspect check valve and check valve screen for debris; if debris cannot be removed, replace trim rod assembly. Clean trim rod with parts cleaner and dry with compressed air.



51352

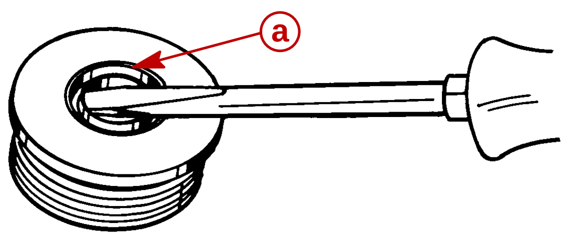


57886

a - Check Valve
b - Check Valve Screen
c - Trim Limit Reducers

Trim Rod End Cap Seal

1. Inspect trim cap end seal and replace if damaged or if seal does not keep trim rod clean.



51343

a - Seal (remove as shown)

2. Install new seal with seal lip up.

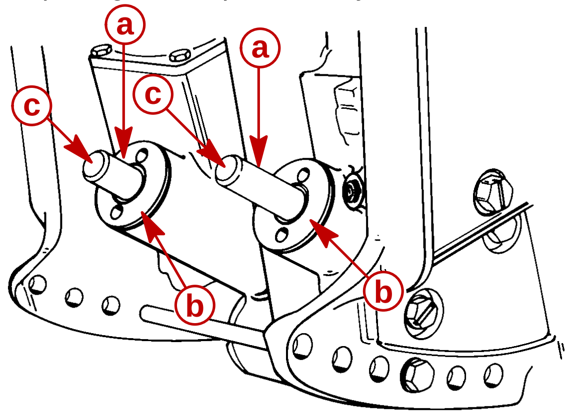
TRIM ROD INSTALLATION

IMPORTANT: Components must be free of dirt and lint. Any debris in the system can cause system to malfunction.

NOTE: *Install trim rod with check valve in the port (left) cylinder.*

1. Apply Quicksilver Power Trim and Steering Fluid on all O-rings and seals before installation.

2. Install trim rods and caps. Use installation tool (91-44487A1) or spanner wrench (91-74951) to tighten caps securely.



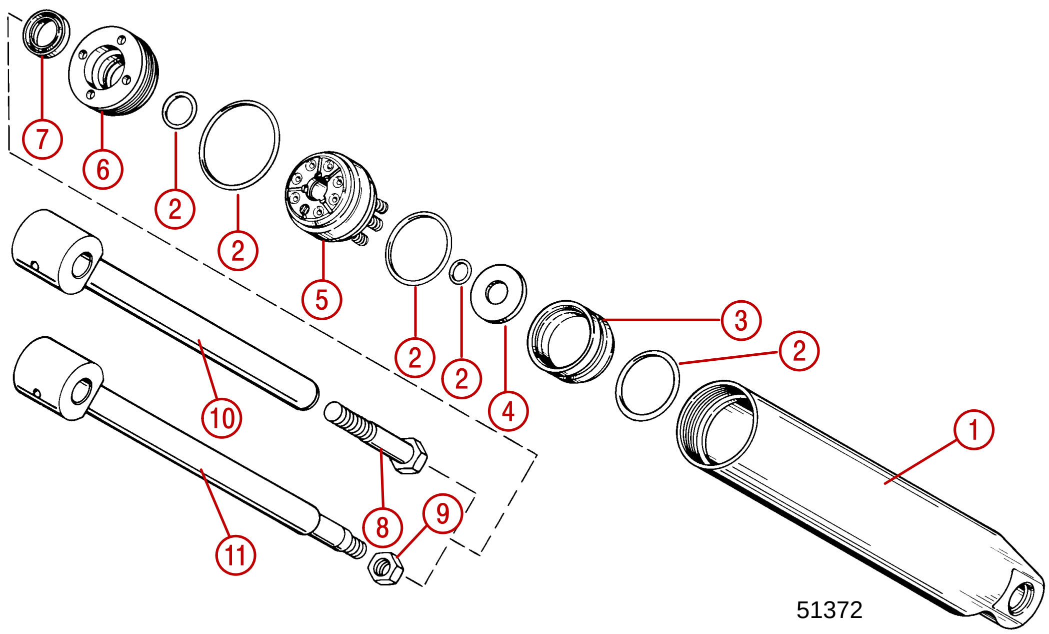
a - Trim Rods
b - Cylinder End Caps
c - Rod End Rollers (lubricate with Quicksilver Anti-Corrosion Grease or Special Lubricant 101)

Tilt Ram

REMOVAL - TILT ROD ASSEMBLY ONLY

NOTE: *Tilt Rod Assembly can be removed from cylinder without removing entire power trim system from outboard.*

TILT RAM COMPONENTS



1 - Housing - Tilt Ram
2 - O-ring* (5)
3 - Memory Piston**
4 - Washer
5 - Piston Assembly
6 - End Cap
7 - Oil Seal
8 - Bolt (Design 1)
9 - Nut (Design 2)
10 - Tilt Rod (Design 1)
11 - Tilt Rod (Design 2)

*O-ring Repair Kit Available, P.N. 811607A1 (Includes item 7, Oil Seal)

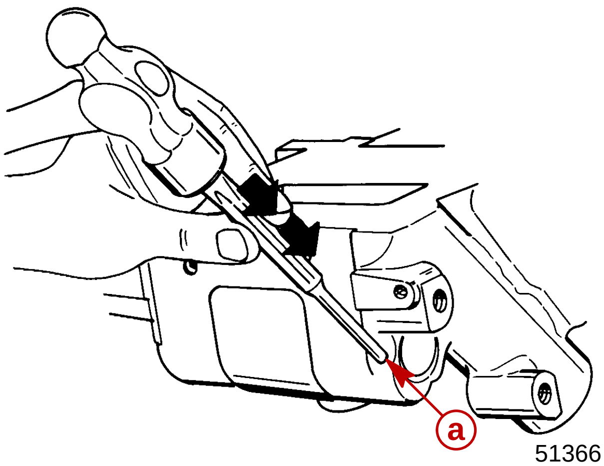
**Memory piston (3) for tilt rods (10 and 11) are different and must be used with correct tilt rod/cylinder assembly. Memory piston for Design 1 tilt rod is flat, Design 2 is dished to clear nut and thread.

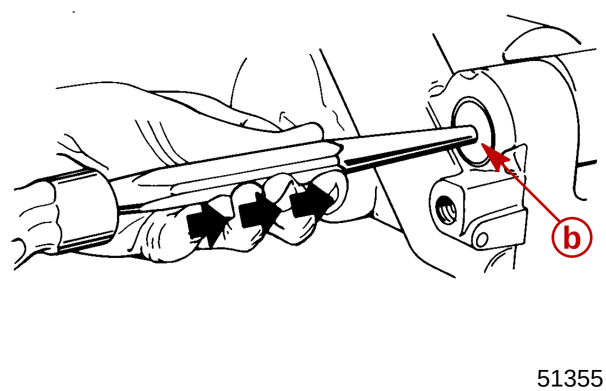
TILT RAM REMOVAL - POWER TRIM SYSTEM REMOVED FROM OUTBOARD

⚠ CAUTION

Insure trim system is depressurized prior to tilt ram removal.

1. Remove cross pin.
2. Remove lower swivel pin.

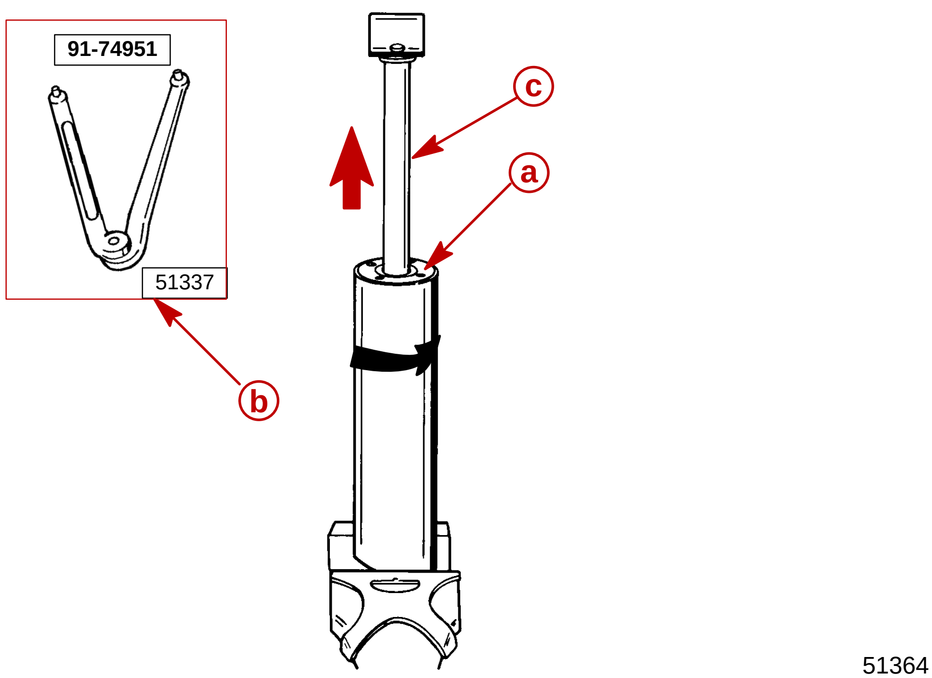




a - Cross Pin (Remove as shown)
b - Lower Swivel Pin (Remove as shown)

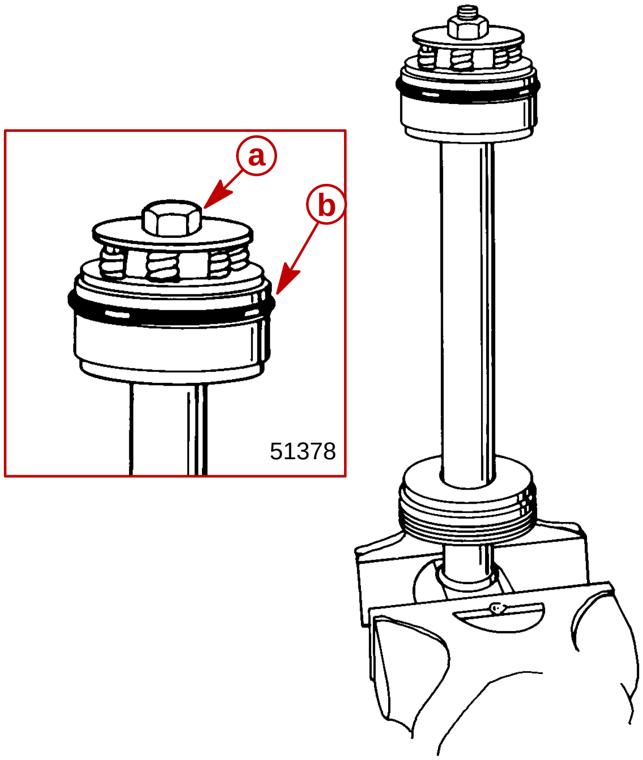
Disassembly

1. Secure tilt ram in a soft jawed vise. Remove tilt rod and cap.



a - Cap (Turn Counterclockwise to Remove)
b - Spanner Wrench (91-74951)
c - Tilt Rod - Pull to Remove

2. Clamp tilt rod in a soft jawed vise. Remove bolt or nut as applicable to disassemble rod assembly. Remove O-ring.



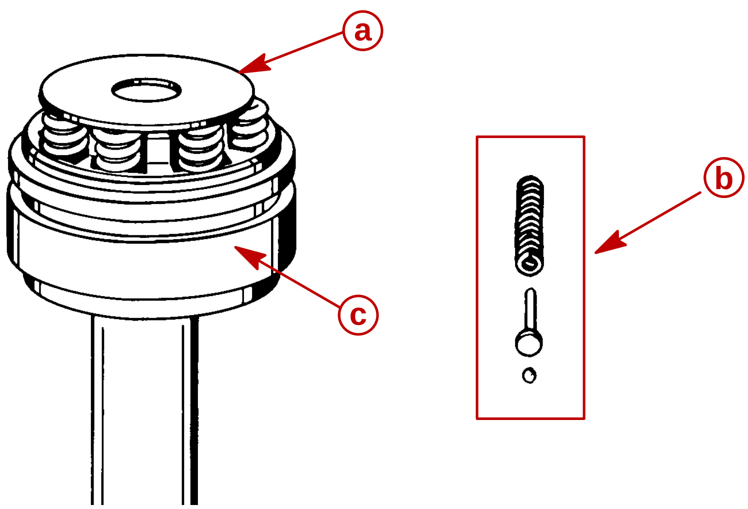
51340

a - Bolt (Design 1) or Stud/Nut (Design 2)
b - O-Ring

IMPORTANT: Design 1 tilt rod assembly can be used to replace a Design 2 tilt rod assembly. Design 1 or Design 2 cylinder assemblies (complete) can be used as replacements.
Design 2 will NOT fit a cylinder originally using a Design 1 tilt rod assembly.
Memory Pistons for Design 1 and 2 differ also and must be used only on the cylinder the piston was removed from.

3. Remove washer, check valve assemblies, and piston.

NOTE: *Check valve held in by roll pin can be cleaned but not removed.*

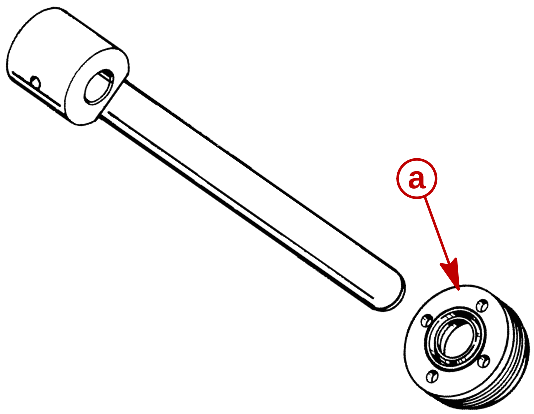


51363

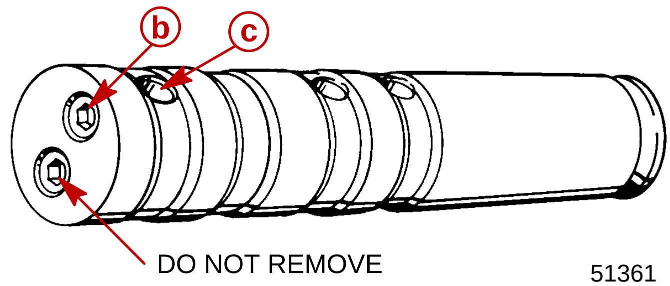
a - Washer
b - Check Valve Assembly (7)
c - Piston

4. Remove end cap from tilt rod.
5. Remove allen plug.

IMPORTANT: Remove plug from same side as holes in shaft.



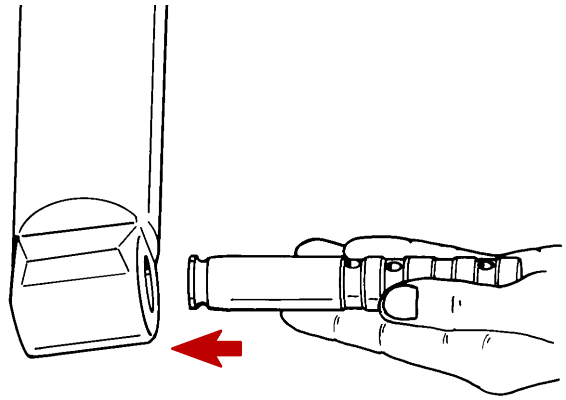
51376



51361

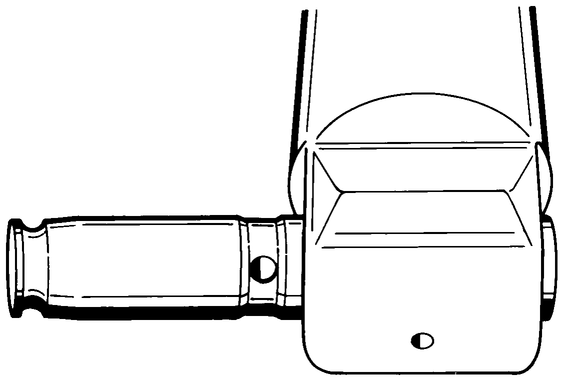
a - End Cap
b - Allen Plug
c - Hole In Shaft

6. Lubricate shaft with Quicksilver Power Trim and Steering Fluid. Insert shaft into cylinder.



51342

7. Tap shaft into cylinder until shaft is positioned as shown.

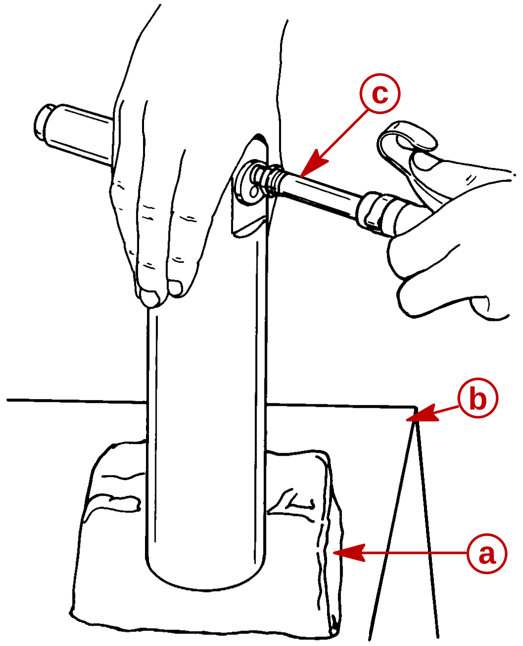


51365

⚠ 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.

8. Place cylinder as shown. Hold down on cylinder and inject air into shaft opening.



a - Shop Cloth
b - Solid Surface
c - Air Nozzle

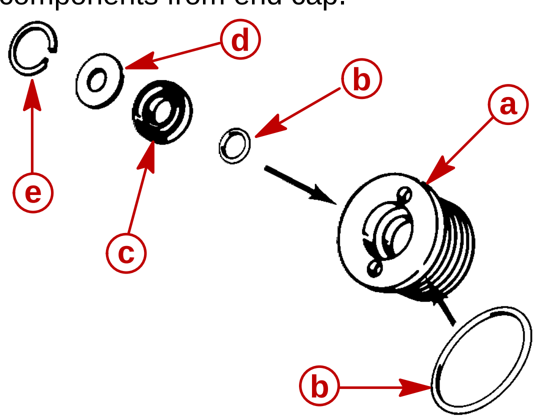
9. Remove shaft after Memory Piston Cup has been expelled. Replace allen plug removed in Step 5 and tighten securely.

CLEANING AND INSPECTION

1. Inspect all internal parts for damage or wear. Clean and replace parts as necessary.
2. Inspect tilt rod for scratches. Replace scraper seal in rod end cap if tilt rod is scratched or worn.
3. Slight scratches or tool marks less than 0.005 in. (0.1 mm) deep in cylinder are acceptable.

Scraper Seal Replacement

1. Remove components from end cap.



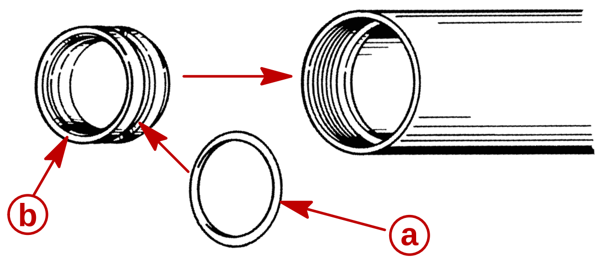
a - Cap
b - O-ring (2)
c - Scraper Seal
d - Washer
e - Retaining Ring

REASSEMBLY

IMPORTANT: Components must be clean for reassembly. Any debris in the system can cause the system to malfunction.

NOTE: *Refer to "Tilt Ram Components" for proper O-ring sizes.*

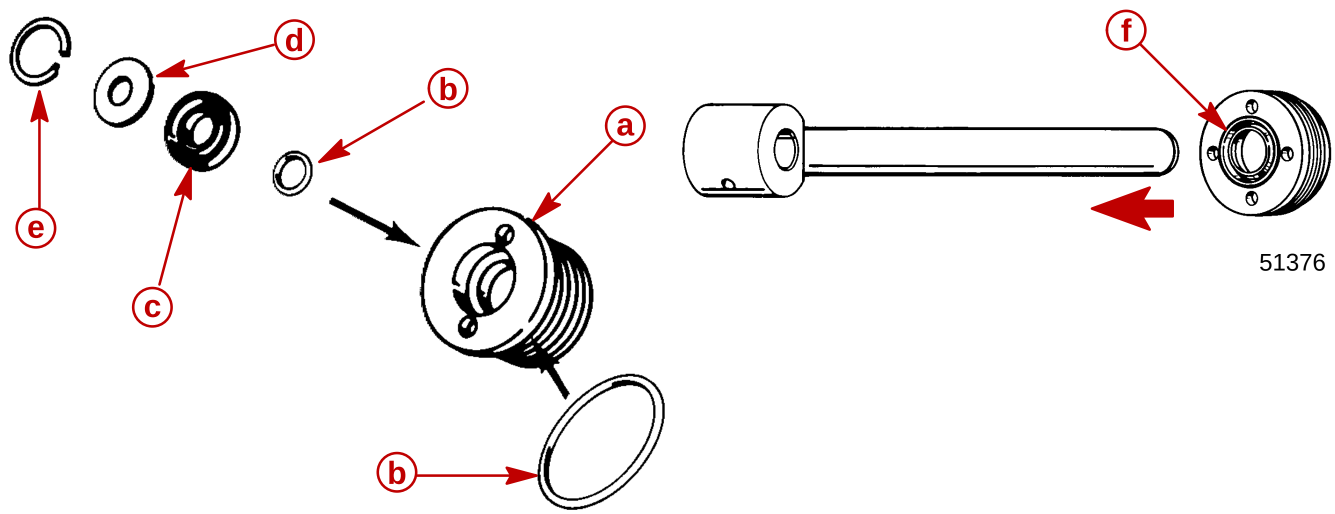
1. Apply Quicksilver Power Trim and Steering Fluid on O-rings prior to reassembly.
2. Install O-ring on Memory Piston Cup and install in cylinder.



51372

a - O-ring
b - Memory Piston Cup (Design 1 shown)

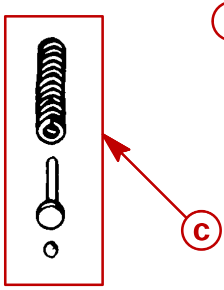
3. Assemble end cap.
4. Install end cap.

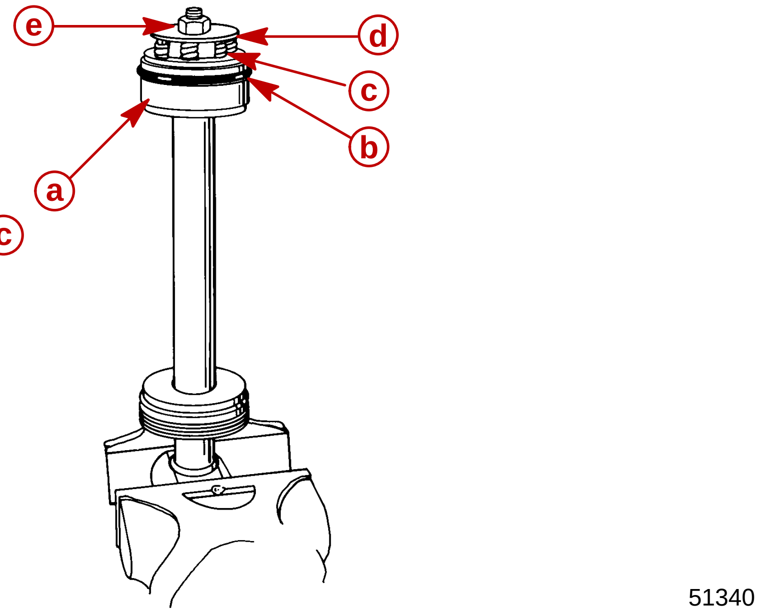


51376

a - End Cap
b - O-ring (2)
c - Scraper seal
d - Washer
e - Retaining Ring
f - End Cap

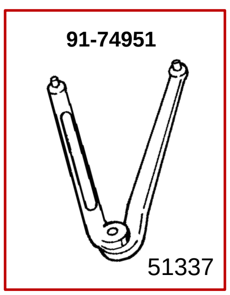
5. Install components on rod.

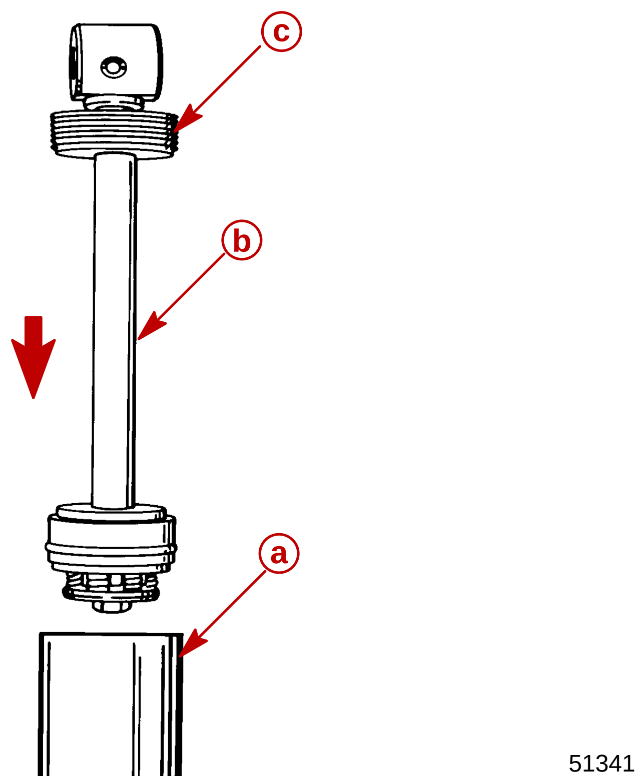




a - Piston
b - O-ring
c - Check Valve Assembly (7)
d - Washer
e - Bolt or Locknut. (Tighten securely)

6. Clamp cylinder in a soft jawed vise and install tilt rod assembly. Use spanner wrench and tighten end cap securely.

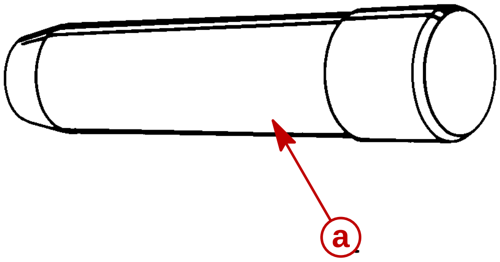


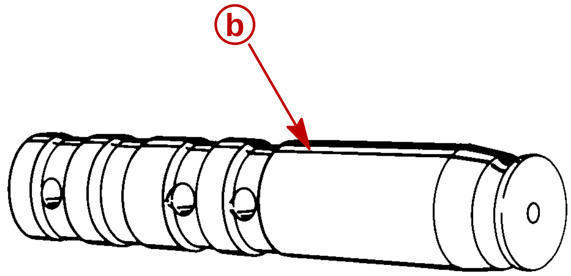


a - Cylinder
b - Tilt Rod Assembly
c - End Cap (Tighten Securely.) Use Spanner Wrench.

TILT RAM ASSEMBLY INSTALLATION

1. Lubricate alignment tool (91-11230) and shaft. Use Quicksilver Power Trim and Steering Fluid.



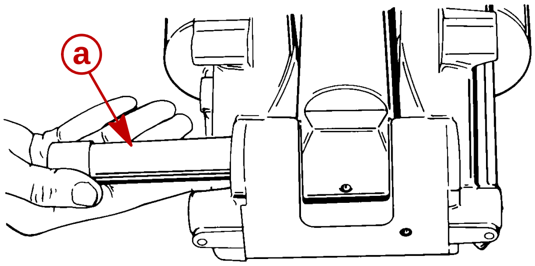


51369

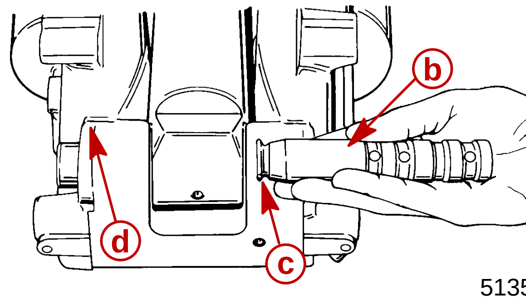
a - Alignment Tool (91-11230)
b - Shaft

2. Align tilt ram and housing using alignment tool.

3. Install shaft.



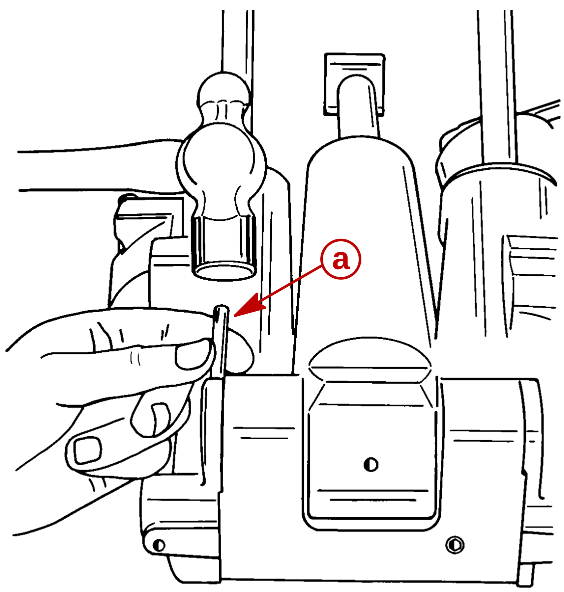
51348



51352

a - Alignment Tool (91-11230)
b - Shaft
c - Groove
d - Hole [Groove (c) will Align with this Hole]

4. Drive pin in until flush.



51356

a - Pin (Drive Against Knurled End)

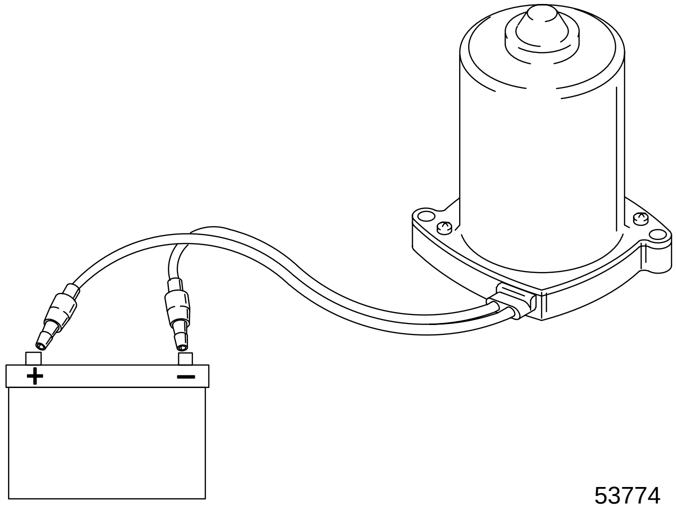
Motor and Electrical Tests/Repair

Trim Pump Motor Test

⚠ WARNING

Do not perform this test near flammable materials, as a spark may occur while making electrical connections.

1. Connect a 12 volt power supply to motor wires; one motor lead to POSITIVE (+) battery terminal and the other motor lead to the NEGATIVE (–) battery terminal. Motor should run. Reverse motor leads between battery terminals. Motor should run.

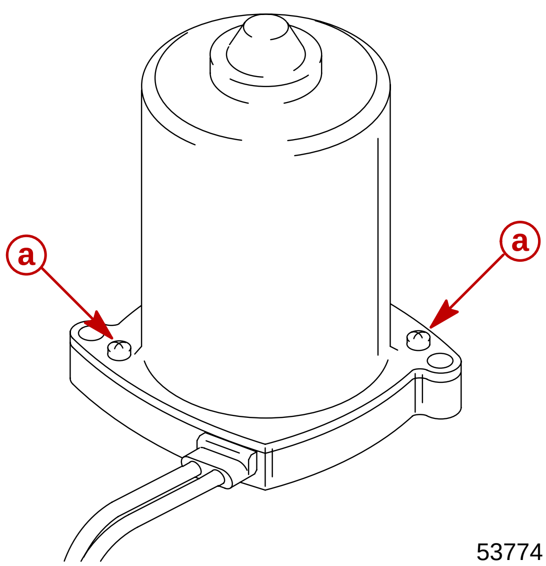


53774

2. If motor does not run, disassemble and check components.

Motor Disassembly

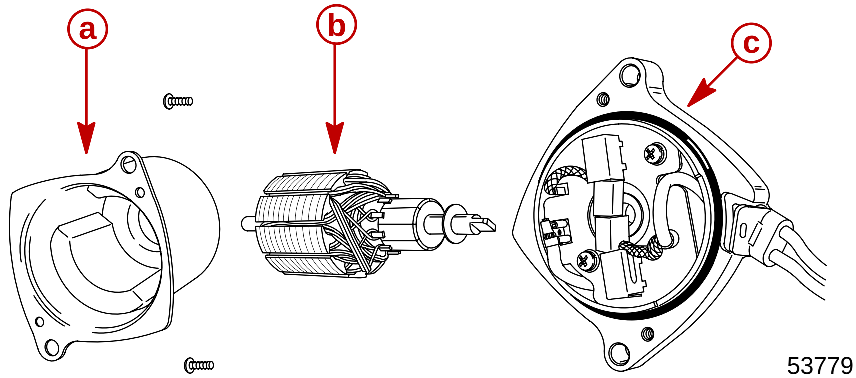
1. Remove 2 screws.



53774

a - Screw (2)

2. Remove frame and armature from end cap. Use care not to drop armature.



a - Frame
b - Armature
c - End Cap

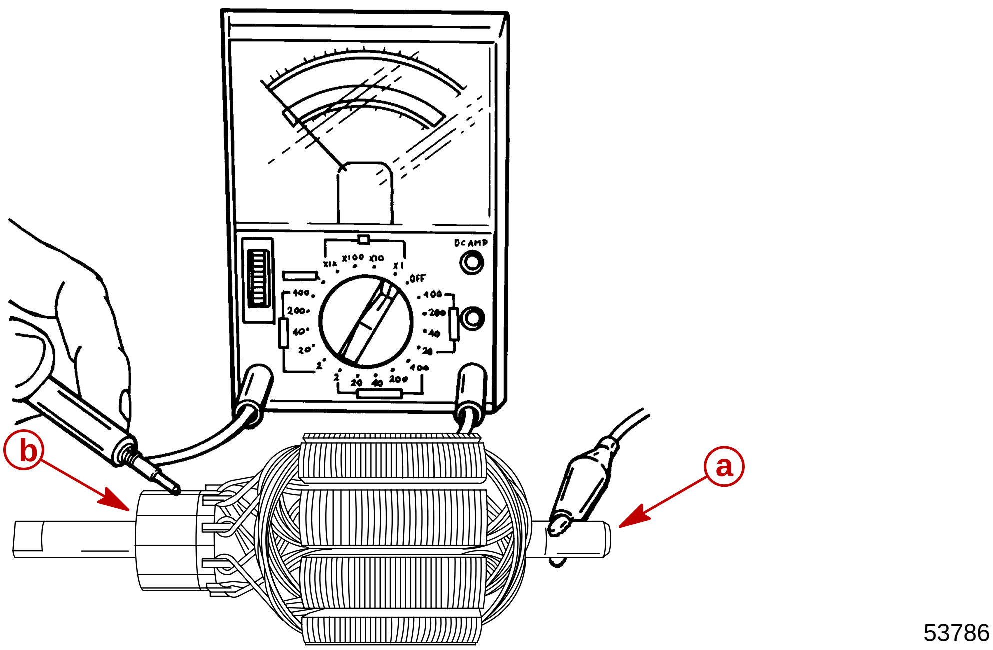
Armature Tests

TEST FOR SHORTS

Check armature on a growler per the growler manufacturer's instructions. Replace armature if a short is indicated.

TEST FOR GROUND

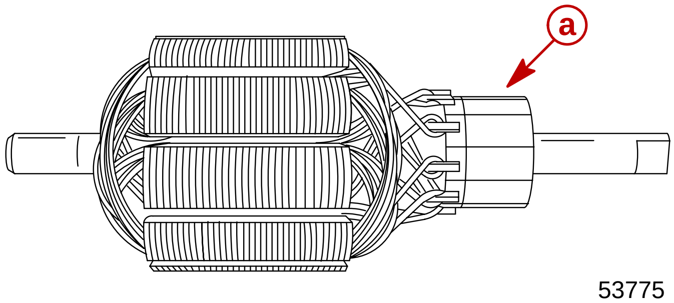
1. Use an Ohmmeter (Rx1 scale). Connect one lead on armature shaft and other lead on commutator. If continuity is indicated, armature is grounded. Replace armature.



a - Armature Shaft
b - Commutator

CHECKING AND CLEANING COMMUTATOR

1. If commutator is worn it may be turned on an armature conditioner or a lathe.
2. Clean commutator with “OO” sandpaper.



a - Commutator

FIELD TESTS

IMPORTANT: Commutator end of armature must be installed in brushes when performing the following tests.

Ohmmeter Leads Between	Resistance (Ohms)	Scale Reading* (x__________)
BLUE and BLACK Motor Wires	0	(Rx1)
BLACK Motor Wire, and Frame (Motor Housing)	No Continuity	(Rx1)
BLUE Motor Wire and Frame	No Continuity	(Rx1)

*If specified readings are not obtained, check for:

- defective armature
- dirty or worn brushes
- dirty or worn commutator

If defective components are found, repair or replace component(s) and retest.

Motor Repair

REMOVAL

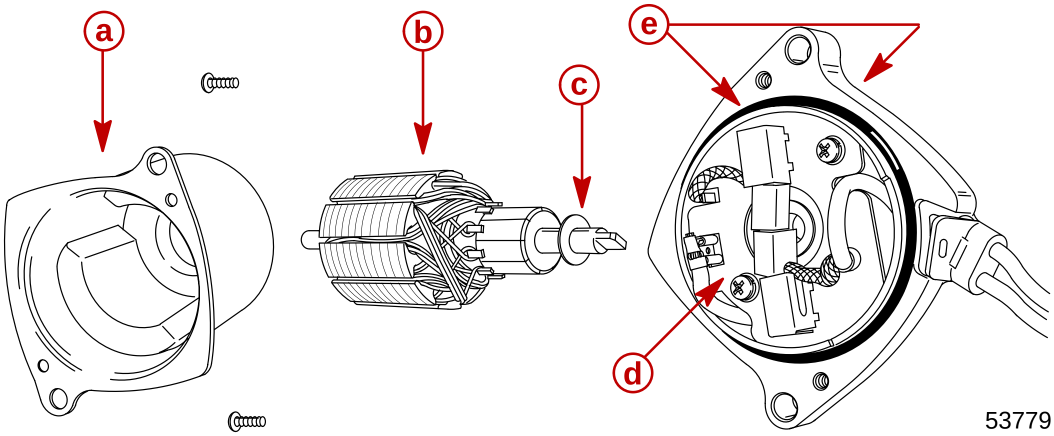
NOTE: *Power Trim System does not have to be removed from outboard to repair/replace motor.*

DISASSEMBLY

Refer to **“Motor Disassembly”** on page 5B-38 to disassemble motor from pump.

CLEANING AND INSPECTION

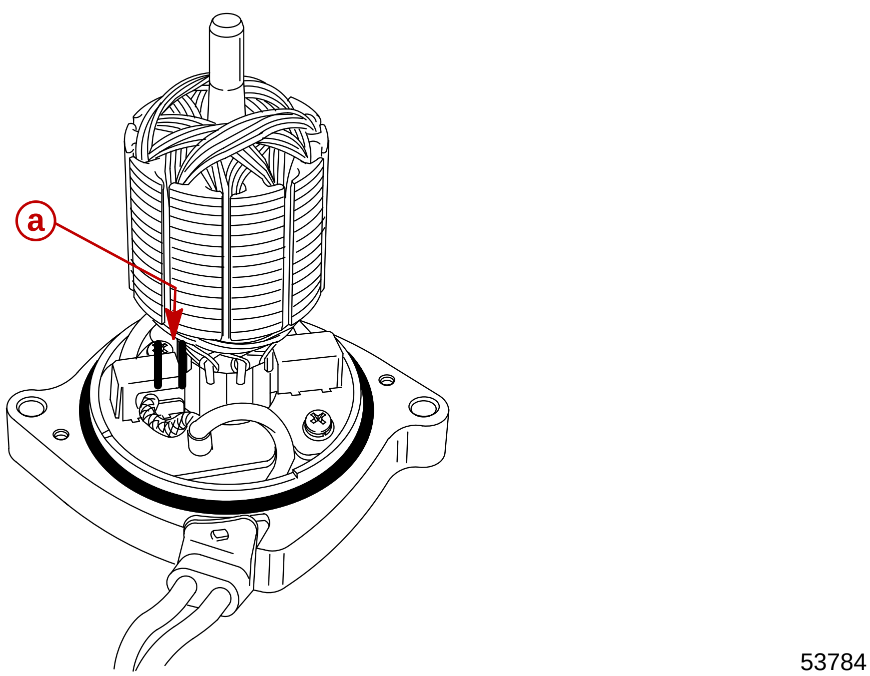
Inspect O-rings and replace if necessary. Carefully inspect power cord for cuts or tears which will allow water to enter motor. Replace cord if cut or torn. Clean, inspect, and test motor components. Refer to **"Brush Replacement"**, **"Armature Test"**, and **"Field Tests"** for inspection and test procedures.



a - Frame
b - Armature
c - Shim
d - Brush Card Assembly
e - O-rings

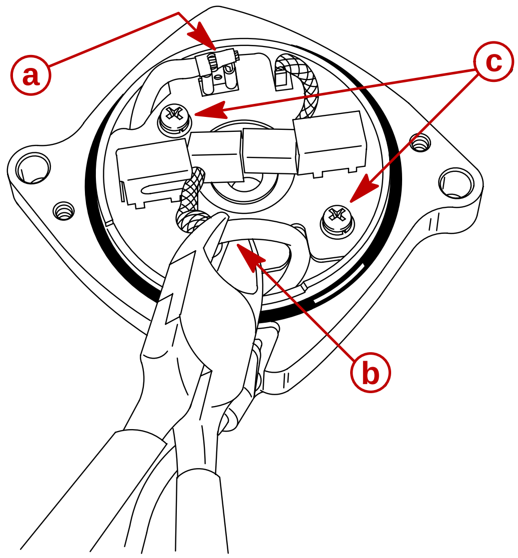
BRUSH REPLACEMENT

1. Brush replacement is required if brushes are pitted, chipped, or if distance (a) between the brush pigtail and end of brush holder slot is 1/16 in. or less. Check distance with armature installed.



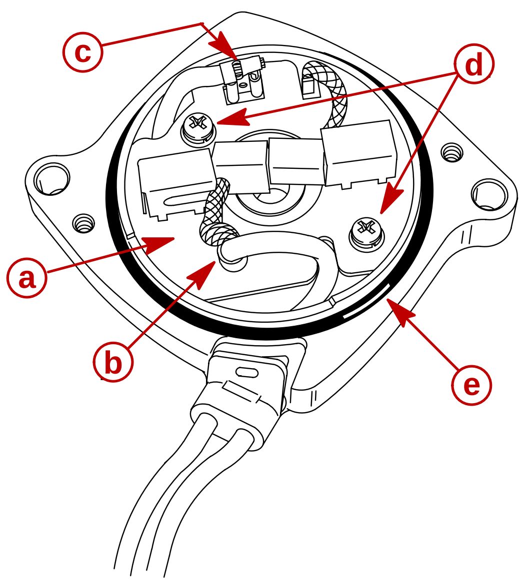
a - 1/16 in.

2. To replace brush card, disconnect spade terminal.
3. Cut crimped brush lead.
4. Remove 2 screws securing brush card to end cap.



a - Spade Terminal
b - Crimped Brush Lead
c - Screws

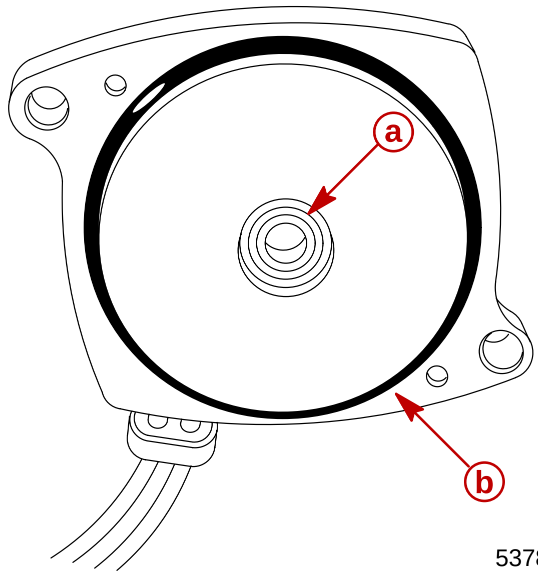
5. Install new brush card (BRUSH and SEAL KIT 828714A1).
6. Crimp metal connector onto motor lead and new brush lead.
7. Connect spade connector motor lead to brush card connector.
8. Secure brush card to end cap with 2 screws and lockwashers.
9. Inspect O-ring for cuts and abraisions. Replace O-ring as required (BRUSH and SEAL KIT 828714A1).



a - Brush Card
b - Metal Connector
c - Spade Connector
d - Screws and Lockwashers
e - O-ring

END CAP INSPECTION

1. Inspect seal and O-ring for cuts and abraisions. If replacement is required, install BRUSH and SEAL KIT 828714A1.
2. Inspect bushing for wear. If bushing appears to be excessively worn – grooves, scratches, etc. – install END FRAME ASSEMBLY (COMPLETE) 828715A1.



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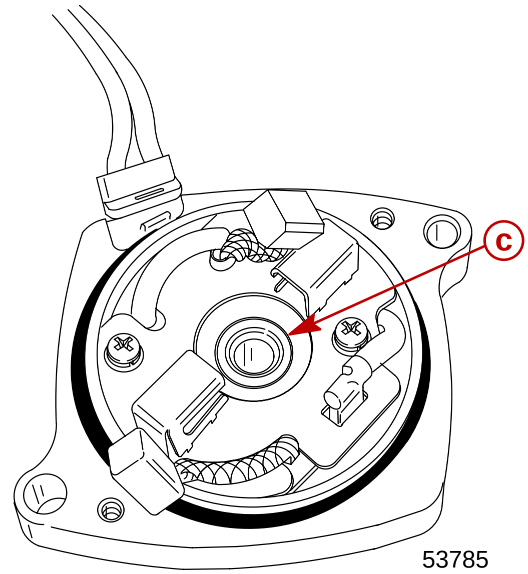
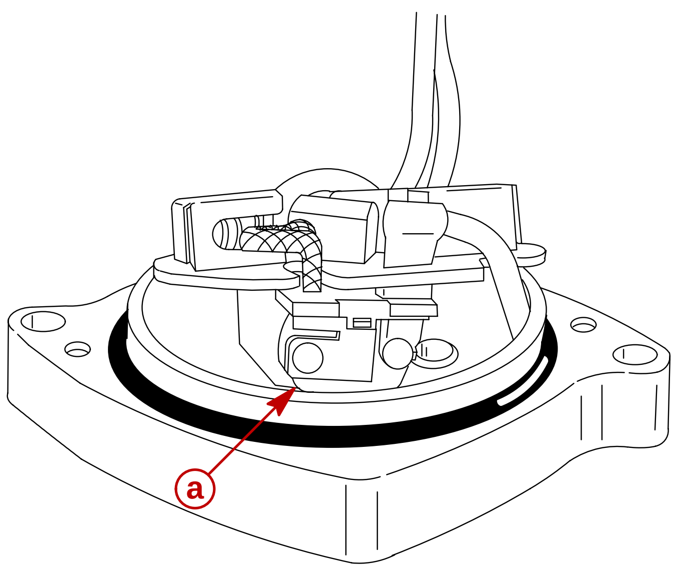


53785

a - Seal (Apply 2-4-C w/Teflon to seal lips)
b - O-ring
c - Bushing

3. If trim motor is overheated, a thermoswitch located under brush card will open. Normally, this switch will reset itself within 1 minute.



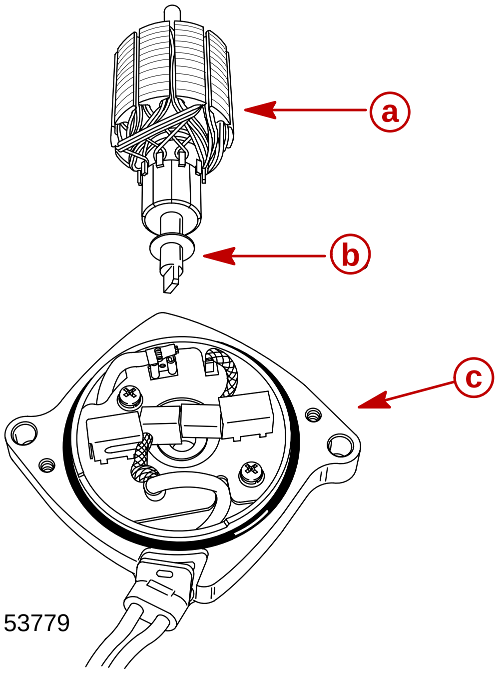
53781

a - Thermoswitch

Reassembly

IMPORTANT: Components must be clean. Any debris in power trim system can cause system to malfunction.

1. Install armature into end cap/brush card assembly.



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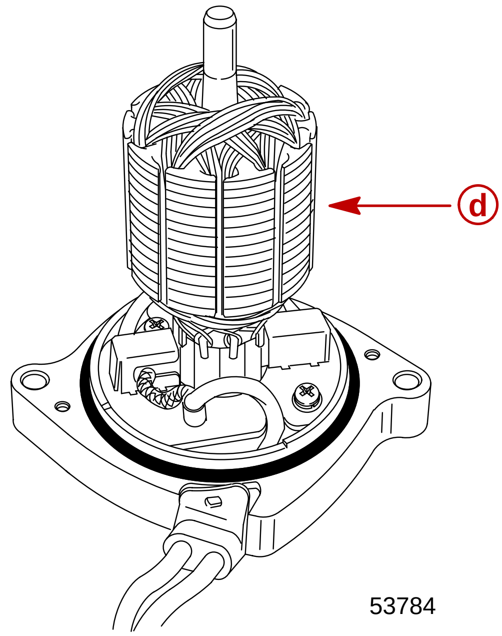
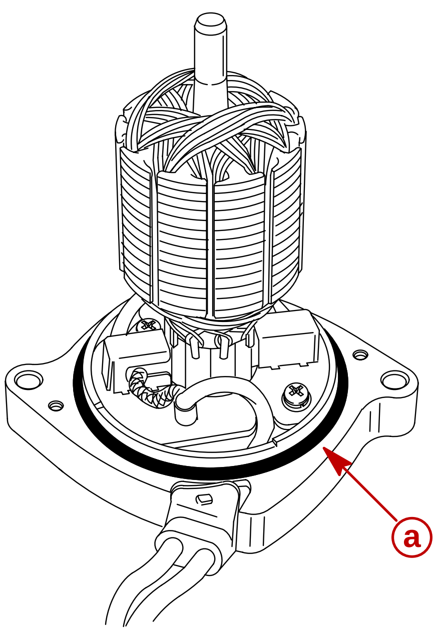


53784

a - Armature
b - Shim
c - End Cap Assembly
d - Armature (Spread brushes to install armature into end cap)

2. Install O-rings in end cap.



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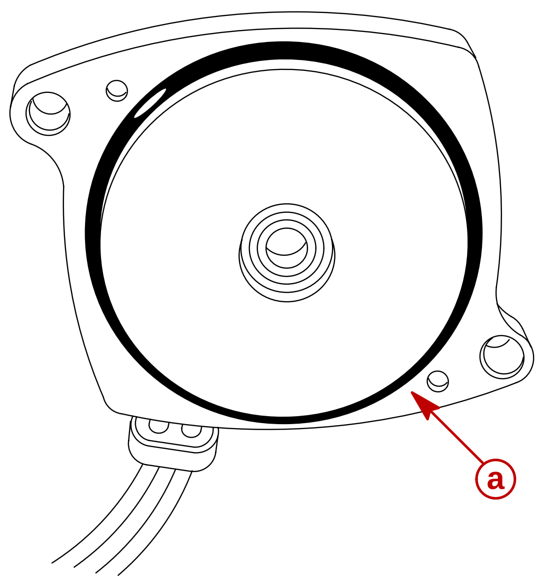
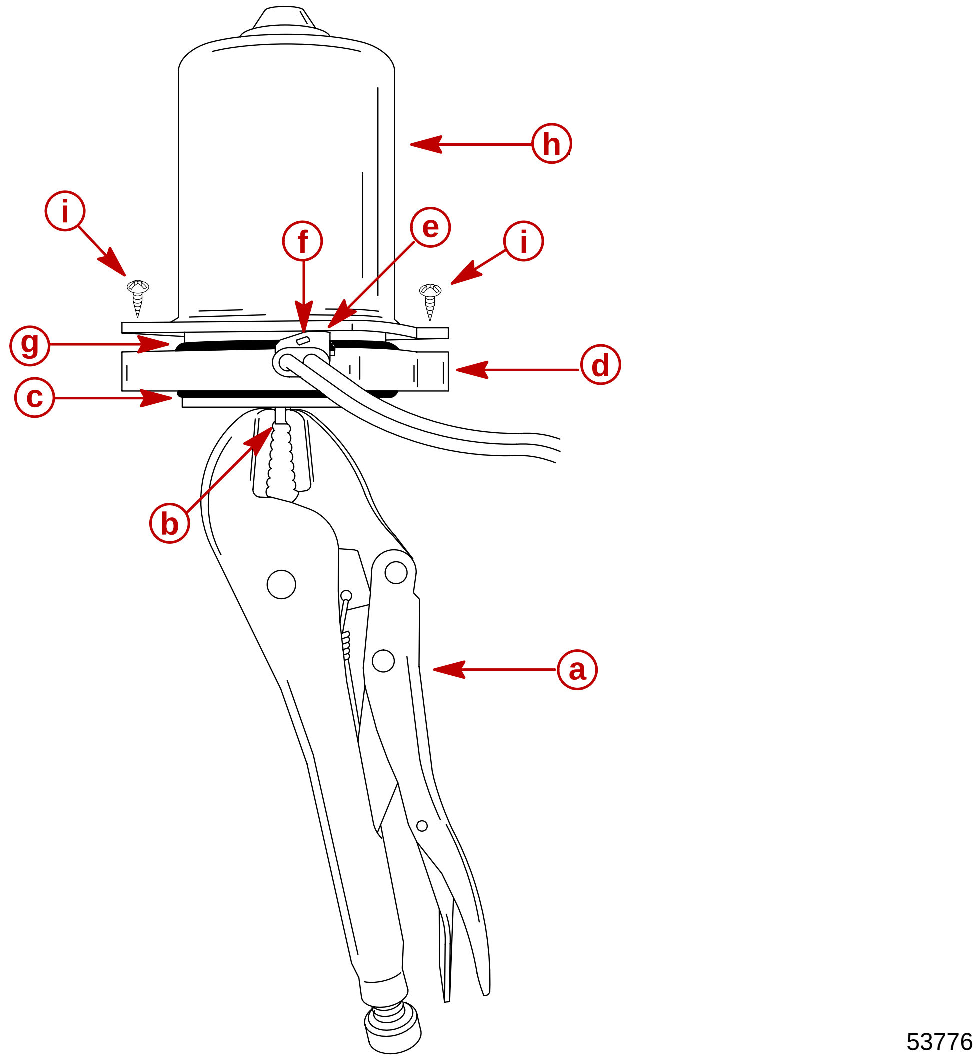


53783

a - O-rings

IMPORTANT: Attach Vise Grip® pliers to armature shaft before installing frame assembly. The Vise Grip® pliers will prevent the armature from being drawn out of the brush card assembly by the frame magnets while installing the frame assembly.

3. Install Vise Grip® pliers on armature shaft.
4. Carefully install frame assembly over armature.
5. Position harness retainer hole over tab in end cap.
6. Secure frame assembly to end cap with 2 screws.



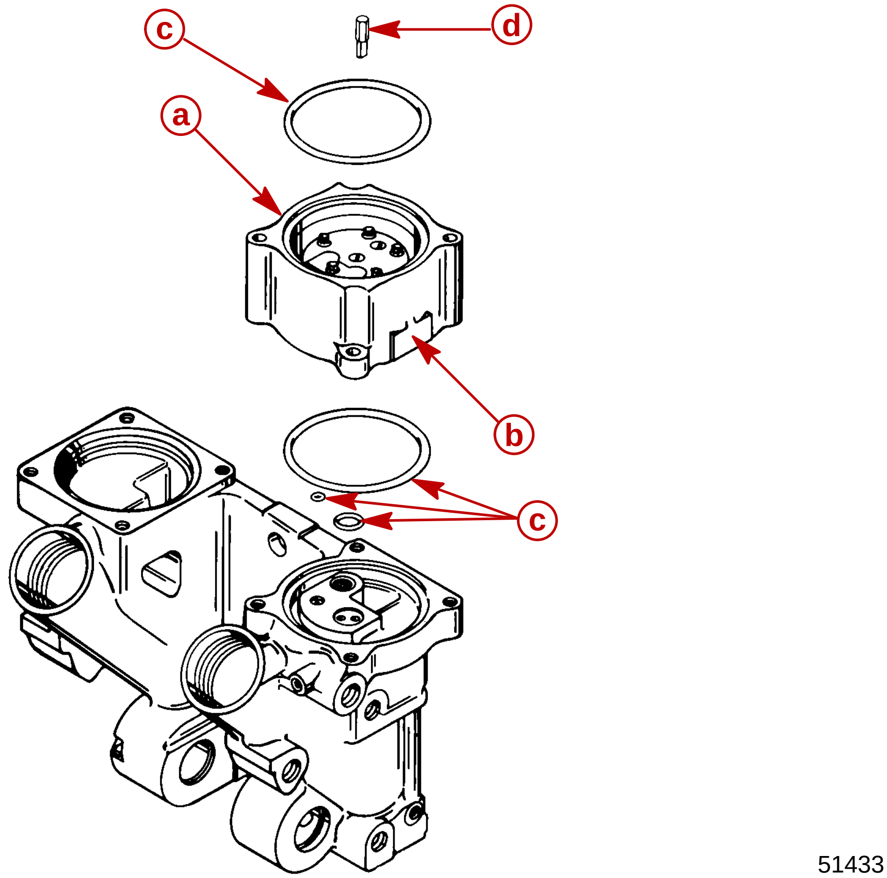
a - Vise Grip® Pliers
b - Armature Shaft
c - O-ring
d - End Cap
e - Harness Retainer
f - Retainer Hole
g - O-ring
h - Frame Assembly
i - Screws

Reassembly - Motor and Pump

NOTE: *Drive shaft is a loose part and may fall out of position.*

1. Install pump onto power trim manifold. Insure O-rings are in proper locations. Secure with two (2) screws. Torque screws to 80 lb. in. (9 Nm).

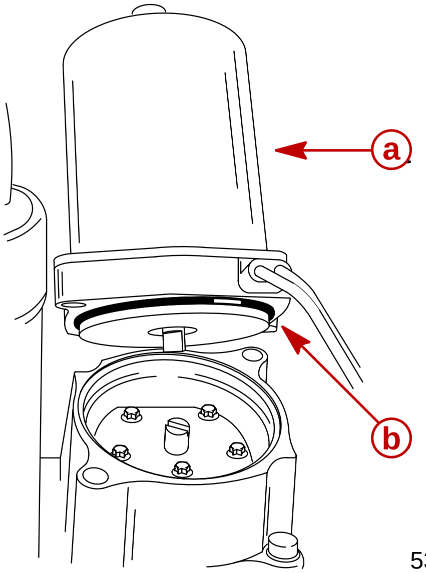
IMPORTANT: Install pump with location flat facing towards starboard transom bracket.



a - Pump (Flat Towards Starboard Transom Bracket)
b - Flat - Faces Starboard Transom Bracket)
c - O-rings (4)
d - Drive Shaft (Install in **Center** Hole in Pump)

2. Fill pump with Quicksilver Power Trim and Steering Fluid prior to installing motor.
3. Install motor, secure with two (2) screws. Route wiring; refer to Wiring Diagrams in this service manual.

NOTE: *Verify motor and drive shaft are aligned.*



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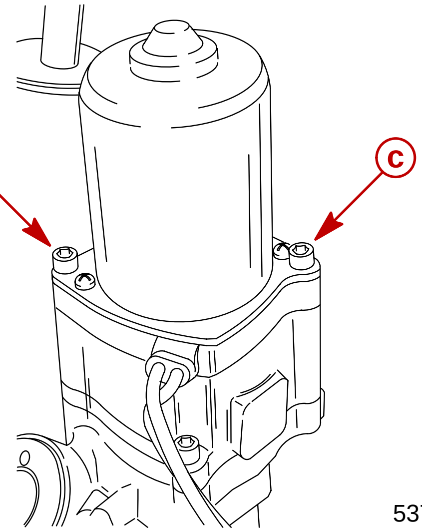


53777

a - Motor
b - O-ring
c - Screw (2) Tighten securely

4. Complete reassembly of Power Trim System as outlined in **“Installation”** on page 5B-21.

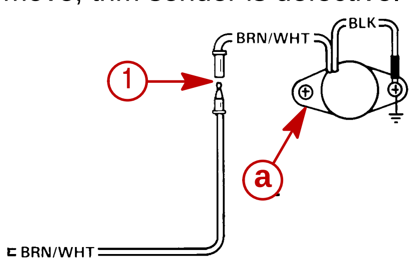
Priming Power Trim System

1. Fill system with Quicksilver Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) Type F, FA, Dexron II or Dexron III. Refer to **“Fill, Check, and Purge”** on page 5B-10.

IMPORTANT: Run Trim System in short “jogs” until pump motor primes and trim system moves. If trim motor is run without priming pump, drive shaft failure could result.

Trim Sender Test

1. Check trim sender black lead for proper ground.
2. Trim outboard to full “DOWN” position.
3. Place ignition switch to “ON” position.
4. Disconnect BRN/WHT trim sender wire from trim sender harness.
5. Connect Ohmmeter (Rx1 scale) leads between outboard ground and Point 1 (trim sender end).
6. Depress “UP” button. Ohmmeter needle should move as the outboard is trimmed up. If needle does not move, trim sender is defective.



22908

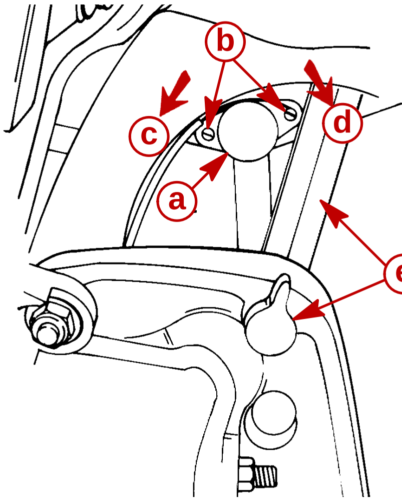
a - Trim Sender

NOTE: *On three wire trim sender, refer to Section 2D, Guardian System, for test.*

Trim Indicator Gauge Needle Adjustment

ANALOG MODEL ENGINES

1. Turn ignition key to "RUN" position.
2. Tilt outboard to full "IN" position. Needle of trim indicator gauge should be in full "IN" position.
3. If not, tilt outboard to full "OUT" position to gain access to trim sender and engage tilt lock lever.
4. Loosen trim sender screws and reposition trim sender.
5. Tighten trim sender screws.

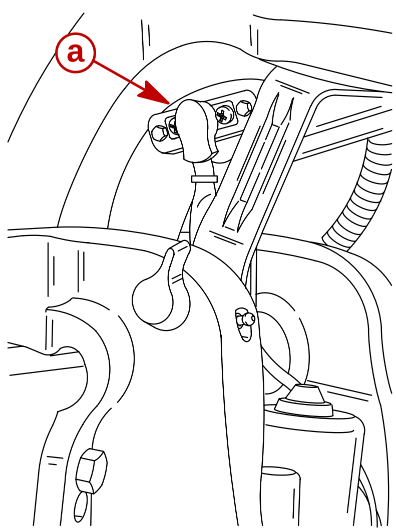


22744

a - Analog Trim Sender
b - Screws, Loosen to Rotate Sender
c - Turn Sender **Counterclockwise** to raise needle reading
d - Turn Sender **Clockwise** to Lower Needle Reading
e - Tilt Lock Lever

DIGITAL MODEL ENGINES

Digital model engines do not have adjustable trim senders. Faulty reading digital trim indicator will require troubleshooting the gauge, wiring or trim sender with replacement of the sender or gauge as required. (See Smartcraft Gauge Test Specifications, Section 2D).

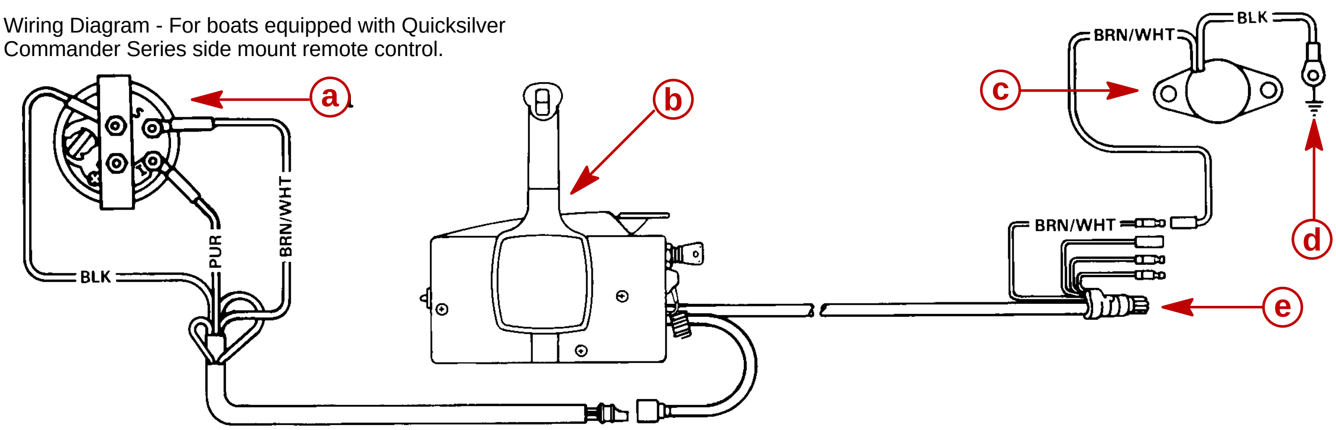


57972

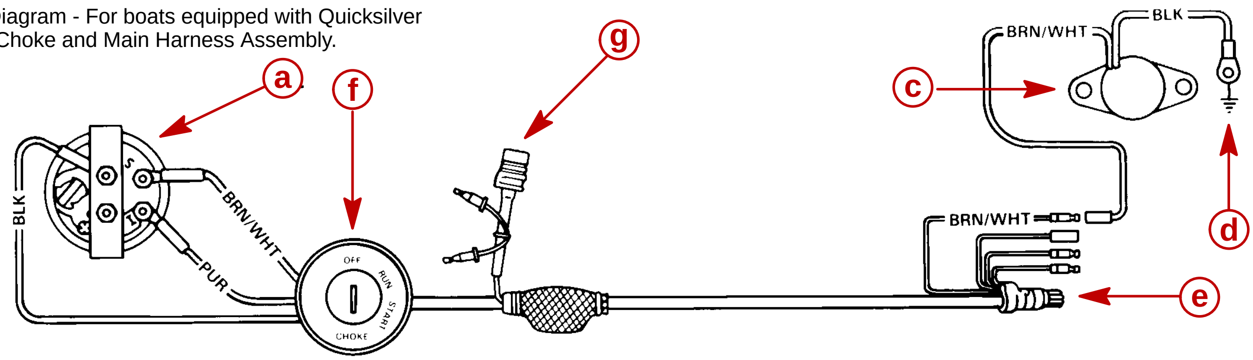
a - Digital Trim Sender (Non-adjustable)

Trim Indicator Wiring Diagrams

Wiring Diagram - For boats equipped with Quicksilver Commander Series side mount remote control.



Wiring Diagram - For boats equipped with Quicksilver Ignition/Choke and Main Harness Assembly.



22908

- **a** - Trim Indicator
- **b** - Remote Control
- **c** - Trim Sender
- **d** - Engine Ground
- **e** - To Engine
- **f** - Ignition Switch
- **g** - Power Trim Harness

MID-SECTION

Section 5C – Power Trim - Design II (Oildyne)

Table of Contents

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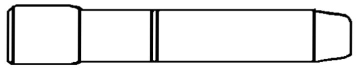
C

Power Trim Specifications

POWER TRIM	Design II (Oildyne)	
	Trim ”UP”	2000 PSI (91kg/cm^2) Maximum Pressure
	Trim “DOWN”	600 PSI (35kg/cm^2) Minimum Pressure
	Leak Down Design I & II	Maximum Acceptable Amount of Leak Down in 24 hours is 1 in. (25.4 mm)

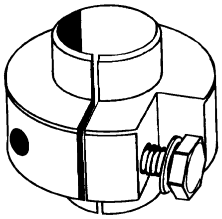
Special Tools

1. Alignment Tool 91-11230



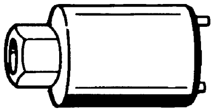
17238

2. Trim Rod Removal Tool 91-44486A1



51337

3. Trim Rod Guide Removal Tool 91-44487A1



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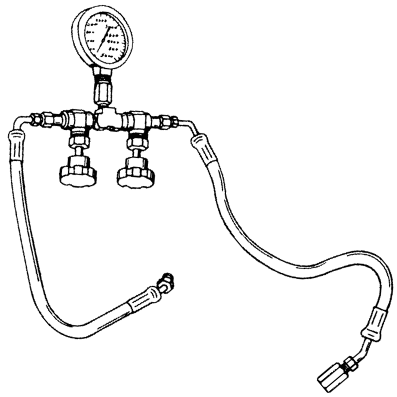
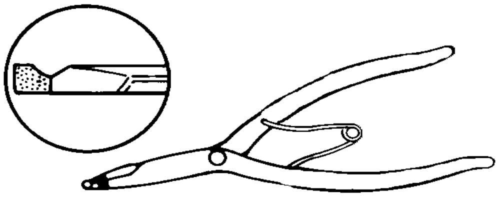
4. Power Trim Test Gauge Kit 91-52915A6

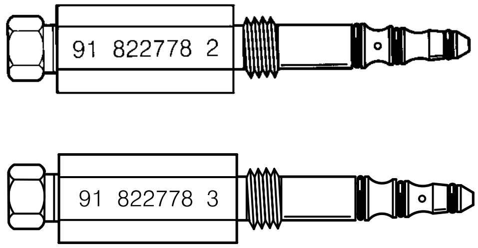


73835

5. Lock-Ring Pliers P/N SRP-4 (Snap-On)

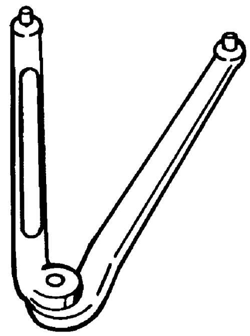


6. Adaptor Fitting 91-82278A2 and 91-82278A3



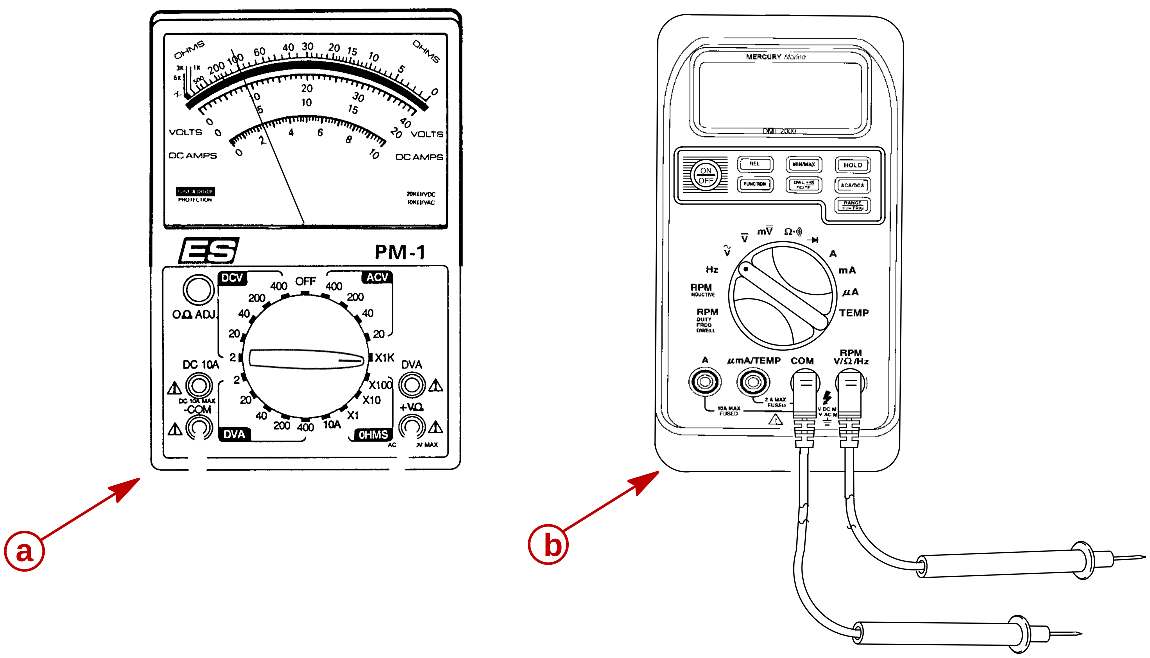
54458

7. Spanner Wrench 91-74951



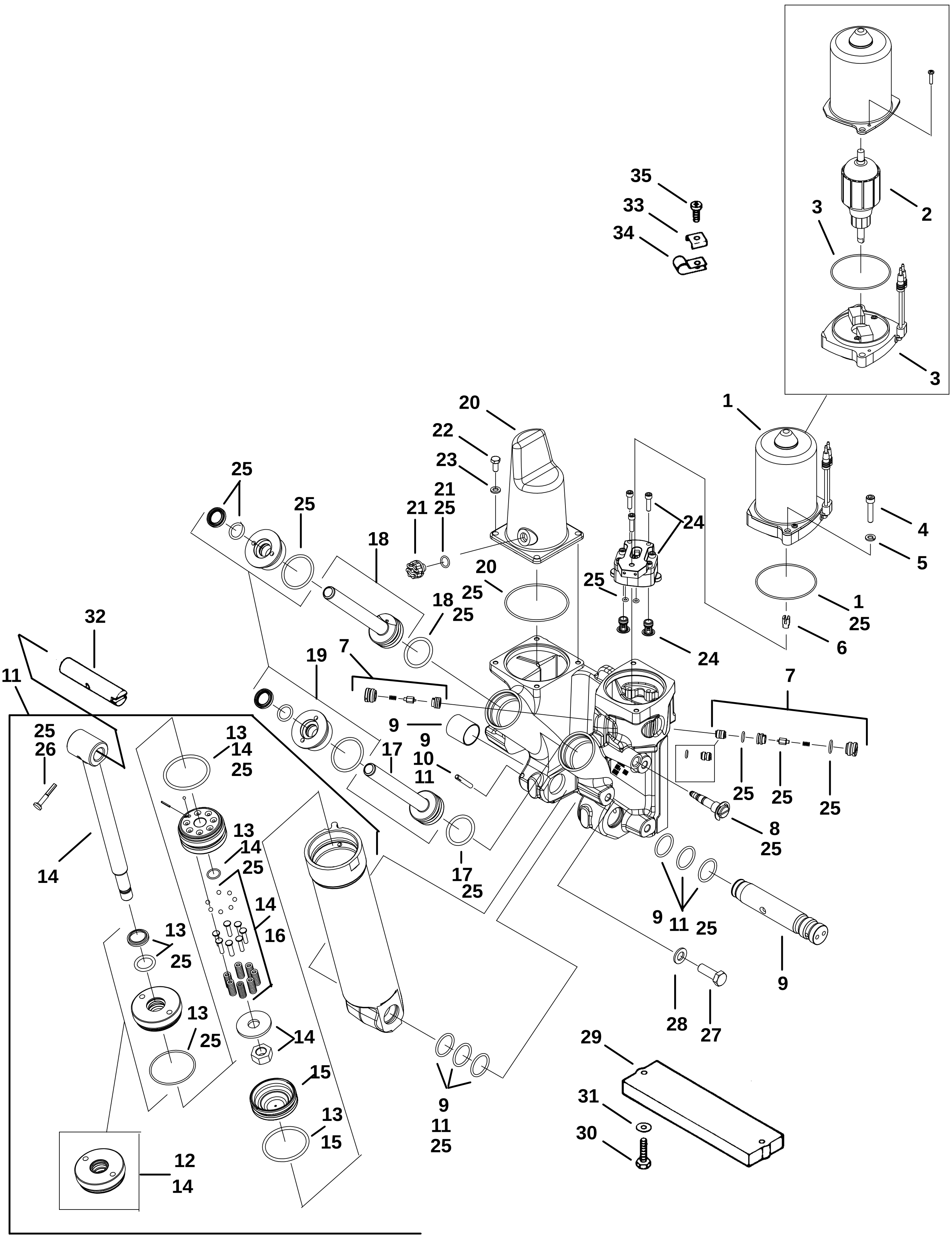
51337

8. Multi-Meter DVA Tester 91-99750A1 or DMT 2000 Digital Tachometer Multi-meter 91-854009A1



a - Multi-Meter DVA Tester 91-99750A1
b - DMT 2000 Digital Tachometer Multi-meter 91-854009A1

Power Trim Components

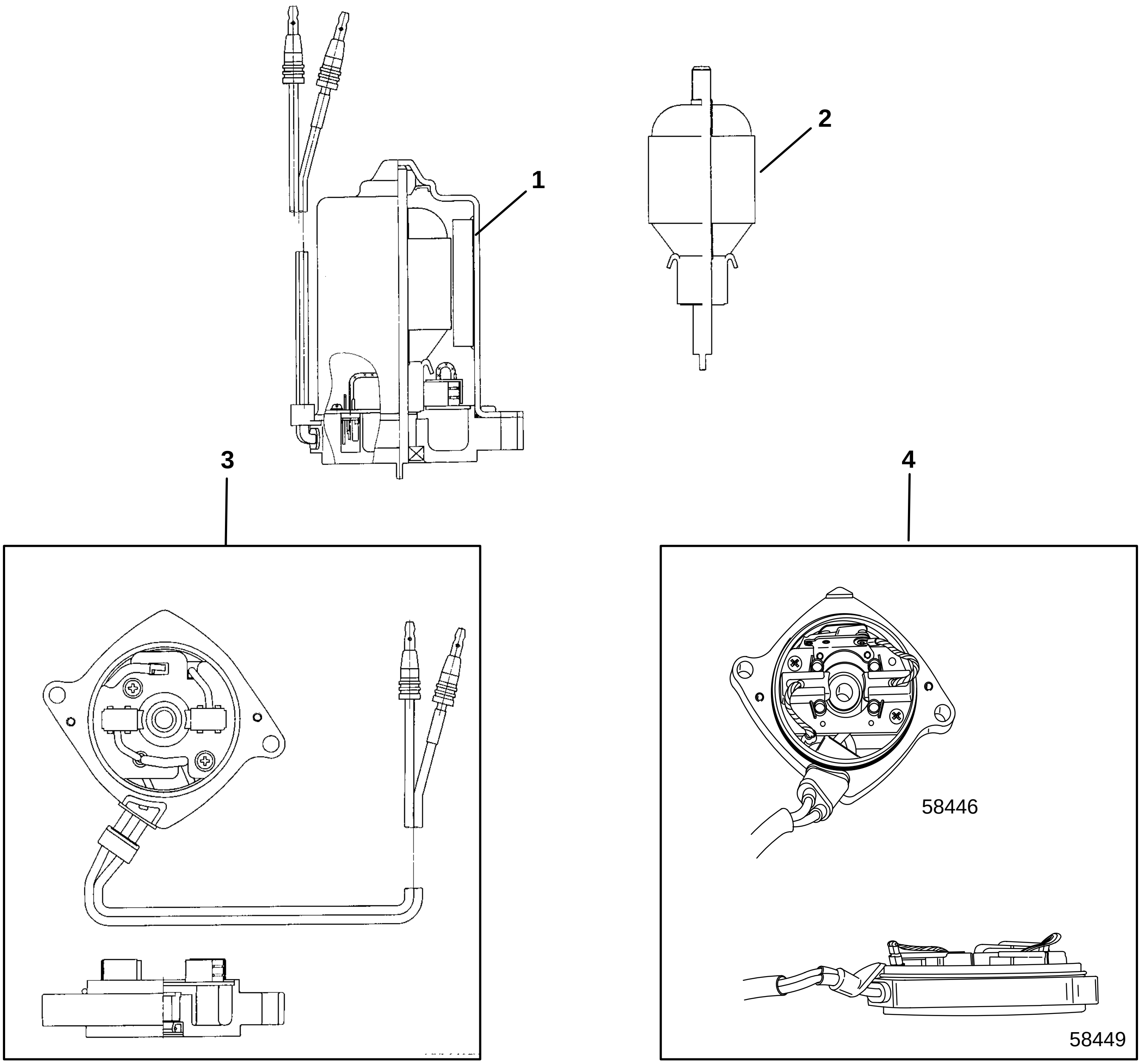


Power Trim Components

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
–	1	POWER TRIM ASSEMBLY–Complete			
1	1	TRIM MOTOR			
2	1	ARMATURE			
3	1	END FRAME			
4	2	SCREW (M6 x 30)	80		9
5	2	LOCKWASHER			
6	1	DRIVE SHAFT			
7	1	CHECK VALVE KIT	120		13.5
8	1	RELIEF VALVE ASSEMBLY	22		2.5
9	1	SHAFT KIT (Includes. Ref. #26)			
10	1	GROOVE PIN			
11	1	TILT CYLINDER ASSEMBLY			
12	1	END CAP (Includes. Ref. #26)		45	61
13	1	O RING KIT (Includes. Ref. #26)			
14	1	SHOCK ROD KIT		95	129
15	1	MEMORY PISTON			
16	1	CHECK VALVE REPAIR KIT (Includes. Ref. #26)			
17	1	STARBOARD TRIM ROD			
18	1	PORT TRIM ROD			
19	2	END CAP TRIM ROD		70	95
20	1	RESERVOIR KIT			
21	1	PLUG KIT	22		2.5
22	4	SCREW (M6 x 14)	60		7
23	4	WASHER			
24	1	PUMP KIT			
25	1	POWER TRIM REPAIR KIT			
26	1	GROOVE PIN			
27	6	SCREW (M10 x 30)		45	61
28	6	WASHER			
29	1	ANODE			
30	2	SCREW (M6 x 25)	70		8
31	2	WASHER			
32	1	SHAFT			
33	1	C WASHER			
34	2	CLIP			
35	2	SCREW (10-16 x 5/8)	Drive Tight		

NOTE: *Lubricate all o-rings with ATF Dexron III or Power Trim and Steering Fluid.*

Power Trim Motor



REF. NO.	QTY.	DESCRIPTION	TORQUE lb.in.	lb.ft.	N·m
–	1	POWER TRIM MOTOR			
1	1	BRUSH AND SEAL KIT			
2	1	ARMATURE KIT			
3	1	END FRAME **(Complete)(MODEL YEAR 2000)**			
4	1	END FRAME **(Complete)(MODEL YEAR 2001)**			

Power Trim - General Information

Description

The Power Trim System consists of an electric motor, pressurized fluid reservoir, pump, tilt cylinder, and two trim rams.

The remote control (or trim panel) has switches that trim the outboard “Up” or “Down” and tilt the engine for “Trailering”. The outboard can be trimmed and tilted under power or when the outboard is not running.

Trimming Characteristics

NOTE: *Because hull designs react differently in varying water conditions, varying the trim position will often improve the ride and boat handling. When trimming from a mid-trim position (with outboard trim tab in a straight fore and aft position), expect the following:*

TRIMMING OUTBOARD “UP” (OUT):

WARNING

Excessive trim “Out” may reduce the stability of some high speed hulls. To correct instability, reduce the power gradually and trim the outboard “In” slightly before resuming high speed operation. A rapid reduction in power will result in a sudden change of steering torque and may cause additional boat instability.

Will lift boat bow, increasing top speed.

Transfers steering torque harder to port (left) on installations below 23 in. (584.2 mm) transom height.

Increases gearcase clearance over submerged objects.

Excess trim can cause “porpoising” and/or ventilation.

WARNING

Excessive outboard trim angle will result in insufficient water supply causing water pump and/or powerhead overheating damage. Insure water level is above water intake holes whenever outboard is running.

The “Up” circuit actuates the up relay (under outboard cowl) and closes the motor circuit. The electric motor drives the pump, forcing fluid thru passageways into the up side of the trim cylinders.

The trim cylinders position the outboard at the desired trim angle in the 20 degree maximum trim range. The system will not allow the outboard to be trimmed above the 20 degree trim range as long as the engine RPM is above approximately 2000 RPM.

The outboard can be trimmed above the 20 degree maximum trim angle (for shallow water operation, etc.), by keeping the engine RPM below 2000. If the RPM increases over 2000, propeller thrust (if propeller is deep enough) will cause the trim system to return the outboard to the 20 degree maximum trim position.

TRIMMING OUTBOARD "DOWN" (IN):

⚠ WARNING

Excessive speed at minimum trim "In" may result in undesirable and/or unsafe steering conditions. Test for handling characteristics after any adjustment is made to the trim angle (and tilt pin location).

Aids planing, particularly with heavy loads.

Improves ride in choppy water conditions.

Excess trim "In" can cause "bow steer" (boat veers to left or right).

Transfers steering torque to starboard (right).

Improves acceleration to planing speed.

The "Down" circuit actuates the down relay (under engine cowl) and closes the motor circuit. The electric motor drives the pump in the opposite direction as the up circuit, forcing fluid thru passageways into the "down" side of the tilt ram. The tilt ram moves the engine down to the desired position.

Trailering Outboard

The "Up" circuit first moves the trim cylinders; when the trim cylinders extend fully, the tilt ram extends to tilt the outboard to the full up position for trailering.

Before the boat is trailered, the operator should check for clearance between the outboard skeg and pavement to prevent damage to skeg from striking pavement.

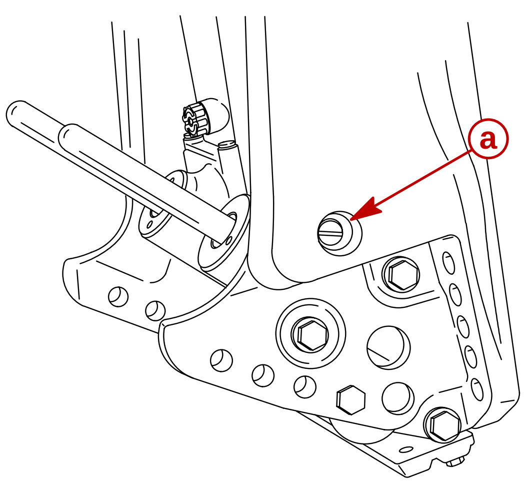
If the outboard must be tilted for clearance between skeg and pavement, a device such as a "Transom Saver" should be installed to prevent stress to boat transom from outboard weight while the boat/outboard are being trailered.

Tilting Outboard Manually

⚠ WARNING

Before opening the manual release valve, insure all persons are clear of outboard as outboard will drop to full "Down" when valve is opened.

The outboard can be raised or lowered manually by opening the manual release valve 3 to 4 turns counterclockwise. Close manual release valve to hold outboard at the desired tilt position.



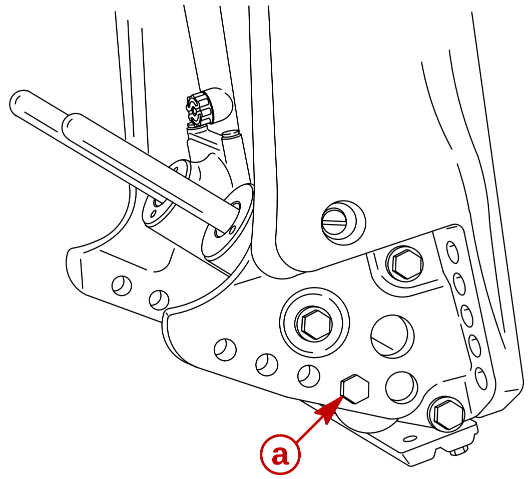
a - Manual Release Valve

Trim "In" Angle Adjustment

⚠ WARNING

Boat operation with outboard trimmed to the full "In" trim angle [not using the trim angle adjustment bolt (a)] at planing speed may result in undesirable and/or unsafe steering conditions. A water test for handling/steering conditions is required after any trim angle adjustments.

IMPORTANT: Some boat/motor combinations not using the trim angle adjustment pin (a) and trimmed to the full "In" trim angle position may not exhibit any undesirable and/or unsafe handling and/or steering characteristics at planing speed. If so, not using the trim angle adjustment bolt may be advantageous to acceleration and planing. A water test is required to determine if these characteristics apply to a particular boat/motor combination.



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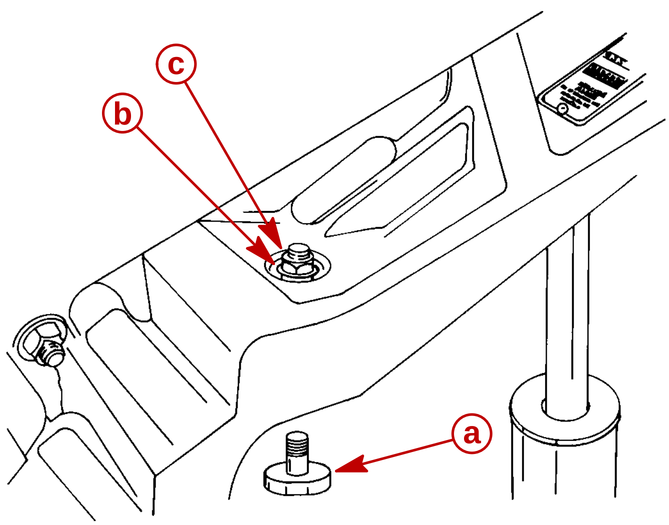
a - Trim Angle Adjustment Bolt

Striker Plate Replacement

Visually inspect striker plates and replace if worn excessively.

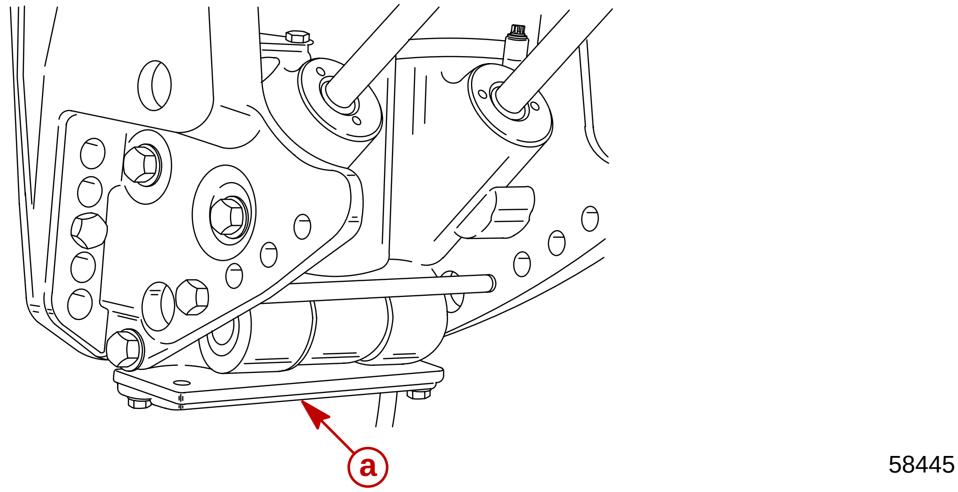


27930

a - Striker Plate (2)
b - Lockwasher
c - Locknut. Torque to 80 lb. in. (9 Nm)

Anode Plate

Anode plate is a self-sacrificing alloy plate that is consumed gradually by corrosion while providing protection to the midsection and power trim from galvanic corrosion. Replace anode plate when it is 50% consumed.



a - Anode Plate

IMPORTANT: Do not paint or place protective coating on anode plate, or corrosion protection function will be lost.

Trim Indicator Gauge

A Quicksilver Trim Indicator Gauge accessory kit is available for the power trim sender (if not previously installed).

Check, Fill and Purge - Power Trim System

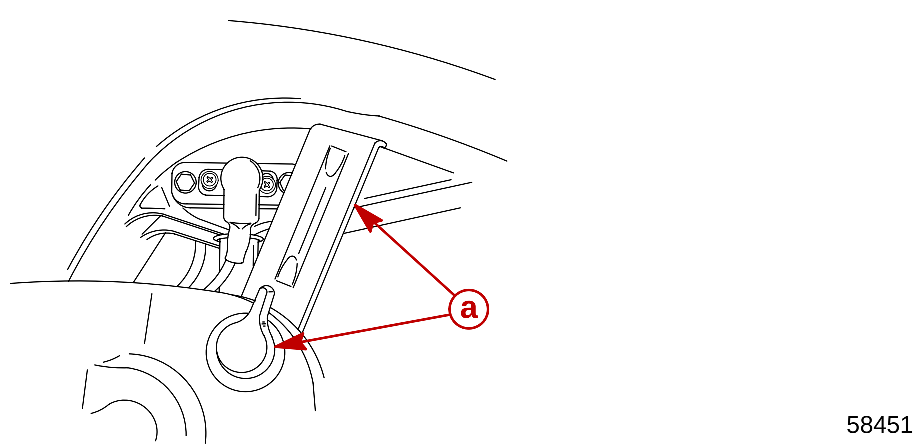
TO CHECK:

CAUTION

Tilt outboard to full "Up" position and engage tilt lock lever before checking fluid level. System is pressurized. Extend trim and tilt rams fully to depressurize system.

Remove fill plug and O-ring. System is full when oil level is present at filler hole. Tighten fill plug securely.

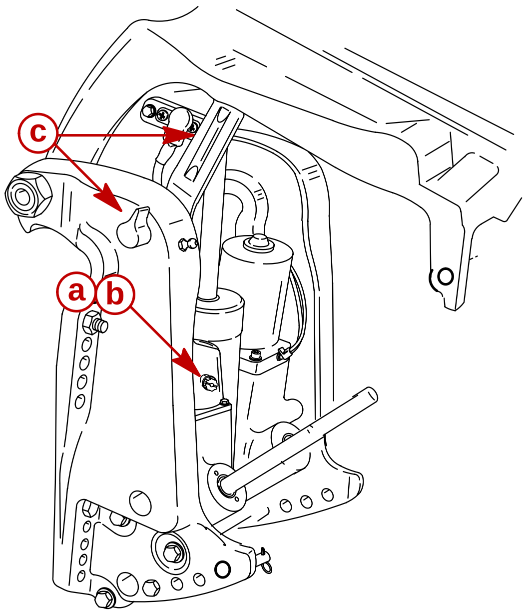
NOTE: *Automatic Transmission Fluid (ATF) Type F, FA, Dexron II or Dexron III may be used.*



a - Tilt Lock Lever

TO FILL:

IMPORTANT: This trim system is pressurized. Remove "Fill" plug only when outboard is tilted to the full "Up" position or the trim/tilt rams are fully extended. Retighten "Fill" plug before tilting outboard down or retracting tilt/trim rams. Remove "Fill" plug and O-ring. System is full when oil level is present at fill hole. Tighten "Fill" plug securely.



58612

a - Fill Plug and O-ring (remove to fill system, tighten securely)
b - Fill system with Quicksilver Power Trim and Steering Fluid
c - Tilt Lock Lever (engage to support engine in "Up" position)

TO PURGE:

IMPORTANT: Fill plug and O-ring must be tightened securely before purging system.

IMPORTANT: Run Trim System in short "jogs" until pump is primed and trim system moves. If trim motor is run without priming pump, driveshaft failure could result.

Cycle outboard through entire trim/tilt range 4 times. Check fluid level after purging system.

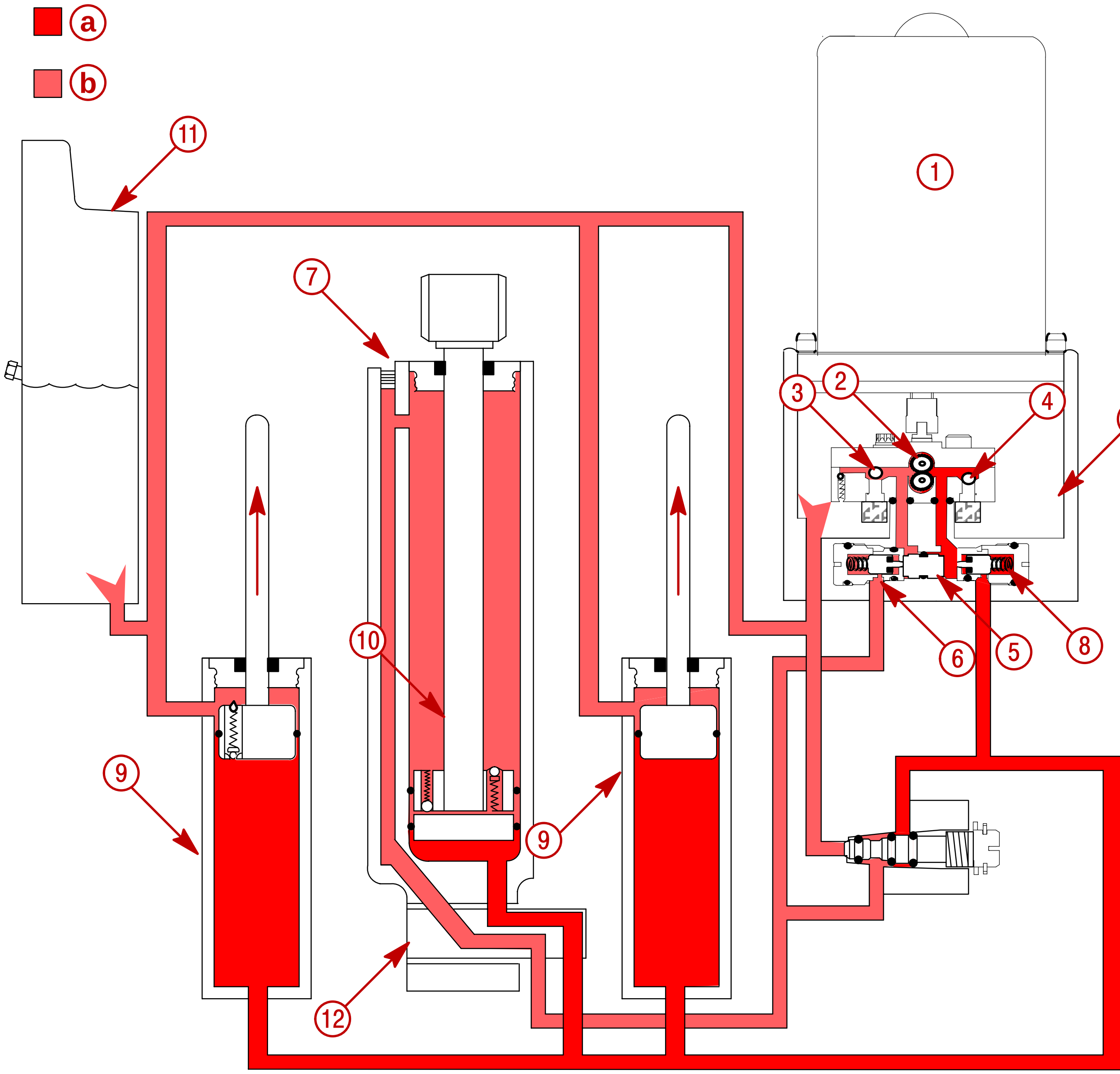
Push down on outboard when trim rams are slightly extended. If rams retract more than 1/8 in. (3.2 mm), air is present in system. Cycle system again and check fluid level.

Trim Circuit

When the up button is activated the electric motor (1) will rotate the oil pump gears (2). As the oil pump gears begin to rotate, oil is drawn through the up circuit suction check valve (3) and into the pump, supplying flow for the up circuit. Oil under pressure opens the up circuit pressure operated valve (8), allowing oil enter the up pressure passages inside the manifold casting. The oil continues on through the up passages into the bottom of the cylinders below the pistons, pushing the trim (9) and tilt (10) rams up and out. Oil, from the pump, is blocked from returning into the reservoir by the closed down suction check valve (4). Oil, under pressure slides the shuttle spool (5) to the left, against the down circuit pressure operated valve (6). The shuttle spool will mechanically open the down pressure operated valve, allowing oil to return into the pump from top of the tilt cylinder (7). Oil returning from the top side of the tilt cylinder piston flows through an interconnecting passage on the side of the tilt cylinder, through the lower pivot pin (12), past the open down pressure operated valve, and into the pump, supplying some of the oil required for the up circuit. Oil returns into the reservoir (11), from the trim rams, through passages cast inside of the manifold.

Up pressure varies from 850 psi to 1150 psi unloaded to approximately 3000 psi against full engine thrust.

Trim Circuit



a - High Pressure
b - Low Pressure
1 - Electric Motor
2 - Oil Pump/Gears
3 - Up Circuit Suction Check Valve
4 - Down Circuit Suction Check Valve
5 - Shuttle Spool
6 - Down Circuit Pressure Operated Valve
7 - Tilt Cylinder
8 - Up Circuit Pressure Operated Valve
9 - Trim Cylinders
10 - Tilt Cylinder Piston
11 - Reservoir
12 - Lower Pivot Pin

Tilt Circuit

In the up mode, as the trim rams (1) reach the limit of their travel, the mechanical check valve (2) of the trim relief valve, in the port trim ram piston (3), contacts the cylinder cap. The “pin” contact with the cover mechanically opens the shut off valve, allowing the trim relief valve to bypass oil and perform the following functions.

- Trim Limit

While the engine is running under thrust (at high engine RPM), the high pressure develops below the pistons. The high pressure will open the check ball on the bottom of the trim relief valve (850-1150 psi), allowing oil to flow through the port trim ram piston. If the operator continues to depress the “up” button, the up pressure will not be sufficient to overcome the propeller thrust, so the trim range is limited to the length of the trim rams. When the engine thrust falls (low engine rpms), the check ball in the trim relief valve closes, allowing oil flow to extend the tilt cylinder ram into the tilt range.

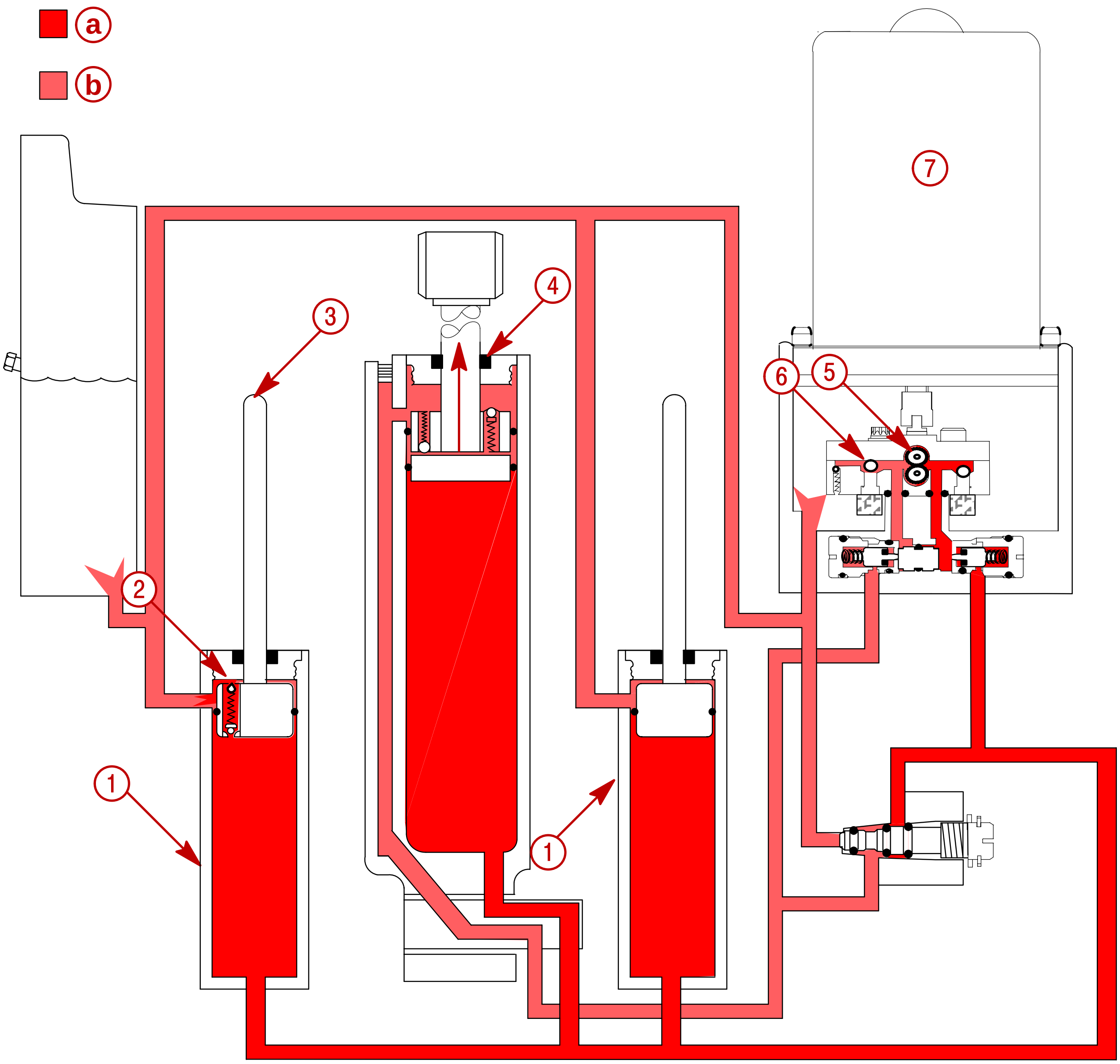
- Over Trim At High Thrust

As the operator increases the engine rpms when the engine is raised beyond the trim range, the pressure below the pistons begin to rise. When the pressure is sufficient, the high pressure will open the check ball on the bottom of the trim relief valve (850-1150 psi), allowing oil to flow through the port trim ram piston. Oil will continue to flow through the valve until either the engine contacts the trim rams and the mechanical shut off valve closes or the engine rpm’s are reduced.

- Maximum Up Pressure Reduction

As the tilt ram extends to its limit, the up pressure below the pistons will increase and open the trim relief check valve to relief the up pressure. If the up button is not released, the up flow will continue to dump over relief causing the electric motor to heat up. The thermal overload switch inside the motor will open, stopping the motor.

Tilt Circuit

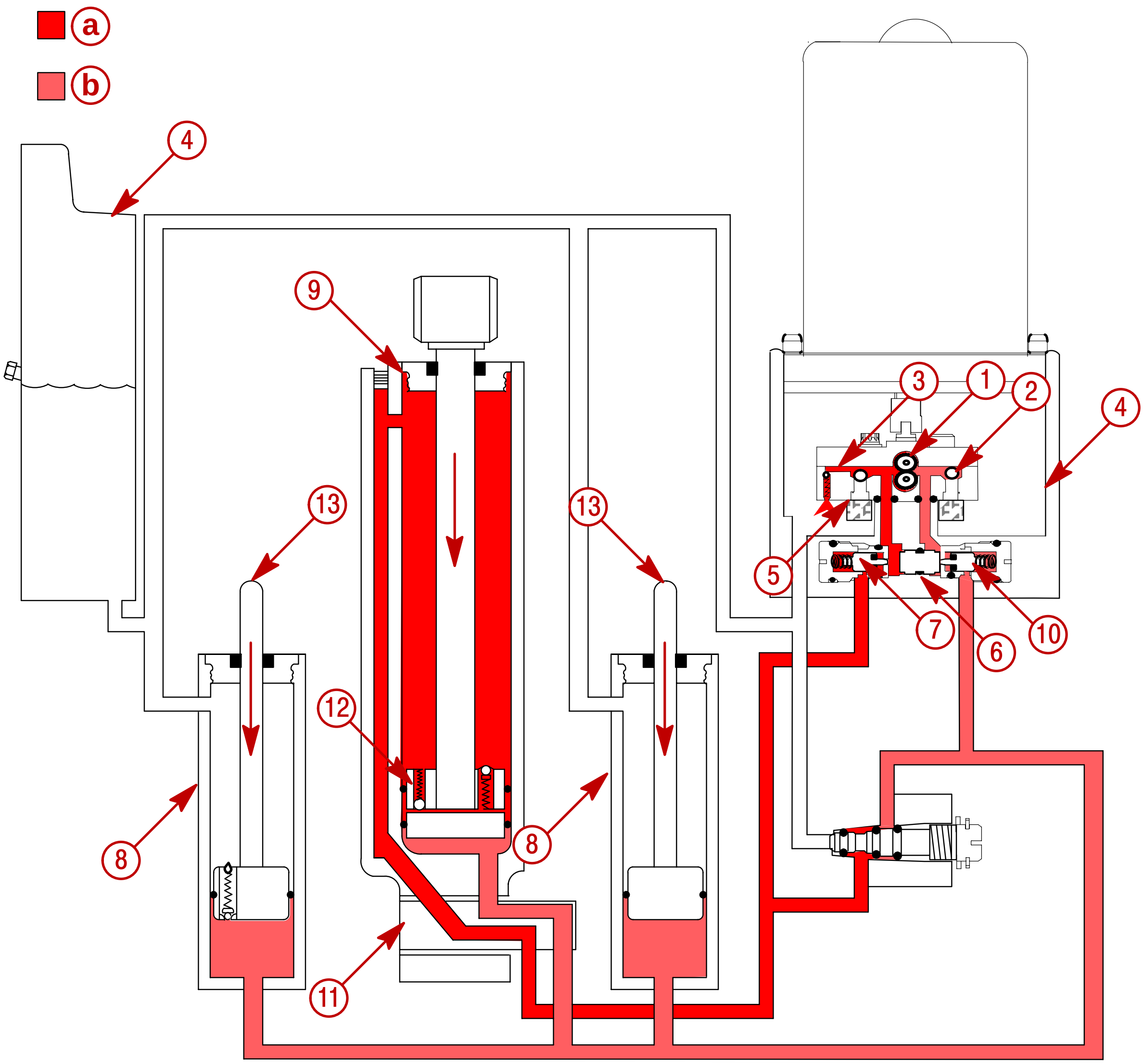


- **a** - High Pressure
- **b** - Low Pressure
- **1** - Trim Cylinders
- **2** - Trim Relief Valve
- **3** - Port Trim ram
- **4** - Tilt Cylinder
- **5** - Pump/Gears
- **6** - Up Circuit Suction Check Valve
- **7** - Electric Motor

Down Circuit

When you depress the down button, the power trim pump (1) is activated in the opposite direction. As the oil pump gears begin to rotate, oil is drawn through the down circuit suction check valve (2) and into the pump, suppling flow for the down circuit. Down circuit oil pressure is lowered by the down pressure regulating valve (3) (640 psi to 1050 psi) allowing excess oil to return into the reservoir (4). Oil is blocked from returning into the reservoir by the closed up circuit suction check valve (5). Oil under pressure then moves the shuttle spool (6) to the right, mechanically opening the “up” pressure operated valve (7), allowing oil from the bottom of the trim (8) and tilt cylinders (9) to supply oil to the trim pump for the down circuit. At this same time, oil under pressure opens the down circuit pressure operated valve (10) allowing oil to exit through the down pressure port. The oil then continues through the down pressure passage, through the pivot pin (11), and into the interconnecting passage of the tilt cylinder leading to the cavity above the shock piston (12), and pushes the piston and ram assembly in (down). As the outboard engine contacts the extended trim rams (13), the weight of the motor, propeller thrust and pump down pressure will force the trim rams to retract.

Down Circuit



- **a** - High Pressure
- **b** - Low Pressure
- **1** - Pump/Gears
- **2** - Down Circuit Suction Check Valve
- **3** - Down Pressure Regulating valve
- **4** - Reservoir
- **5** - Up Circuit Suction Check Valve
- **6** - Shuttle Spool
- **7** - Up Circuit Pressure Operated Valve
- **8** - Trim Cylinders
- **9** - Tilt Cylinder
- **10** - Down Circuit Pressure Operated Valve
- **11** - Pivot Pin
- **12** - Shock Piston
- **13** - Trim Ram

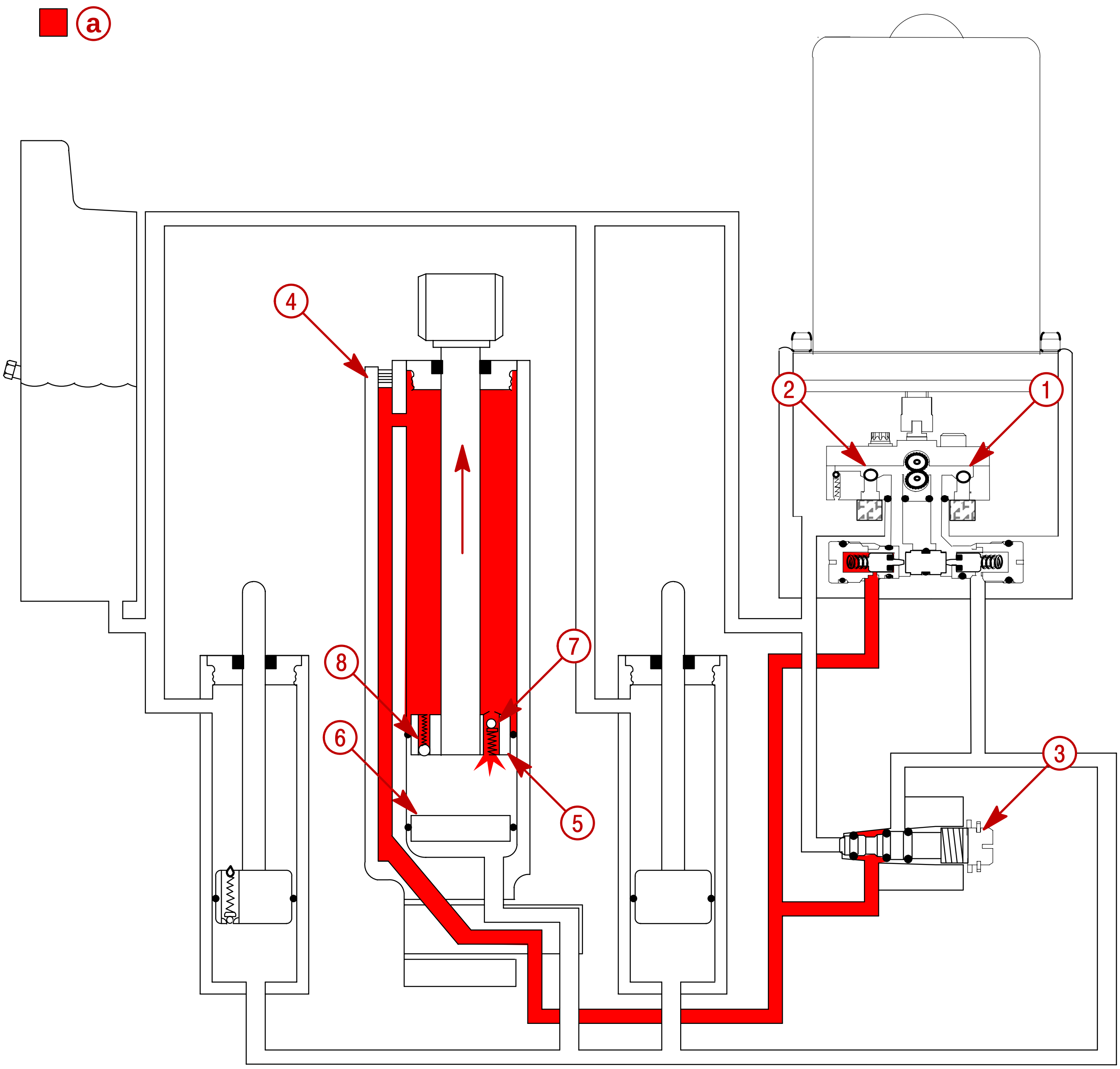
Trail Over System

Should the outboard motor strike a submerged object with light steady pressure, while in forward motion, oil will build up sufficient pressure in the top of the tilt cylinder (4) to open the piston trail over relief valve (7) (600 psi). Oil on the bottom side of the cylinder is locked in by the up circuit pressure operated valve (1) and manual tilt valve (3). Therefore, the piston trail over relief valve allows the oil from the down side cavity of the trim cylinder to pass through the piston trail over relief valve, into the area between the tilt ram piston (5) and the memory piston (6). The return valve (8) allows the oil to return through the piston, back to the down side cavity as the outboard returns to its normal running position. Propeller thrust and the weight of the outboard provides the return motion for the engine.

Shock System

When a submerged object is hit with great force, oil will build up sufficient pressure in the top of the tilt cylinder (4) to open both the trail over valve and the piston impact relief valves (7) (3200 psi). Oil on the bottom side of the cylinder is locked in by the up circuit pressure operated valve (1) and manual tilt valve (3). Therefore, the piston impact relief valve allows the oil from the down side cavity of the trim cylinder to pass through the piston impact relief valve, into the area between the tilt ram piston (5) and the memory piston (6). The return valve (8) allows the oil to return through the piston, back to the down side cavity as the outboard returns to its normal running position. Propeller thrust and the weight of the outboard provides the return motion for the engine.

Trail Over and Shock Absorber



a - High Pressure
1 - Up Circuit Pressure Operated Valve
2 - Down Circuit Pressure Operated Valve
3 - Manual Tilt Valve
4 - Tilt Cylinder
5 - Shock Piston
6 - Memory Piston
7 - Impact Relief & Trail over Valves
8 - Return Valve

Manual Tilt System

If the outboard motor is to be raised or lowered manually, turn the manual release (tilt) valve (1) counterclockwise approximately 3 turns to the full out position. When in the full (out) position, oil in the tilt cylinder (2) can flow freely from the up side to the down side or from the down side to the up side. The oil return line into the reservoir (3) is also open, allowing free oil flow to either side of the tilt cylinder to accommodate the differential oil capacities between the tilt cylinder up side and down side cavities.

When trimming the outboard in either the up or down position, with the manual tilt valve open or leaking, little or no movement will occur. Oil pressure from the pump (4) will move to both, the up cavity and through the manual tilt valve into the down cavity, each cavity would have equal pressure resulting in little or no movement.

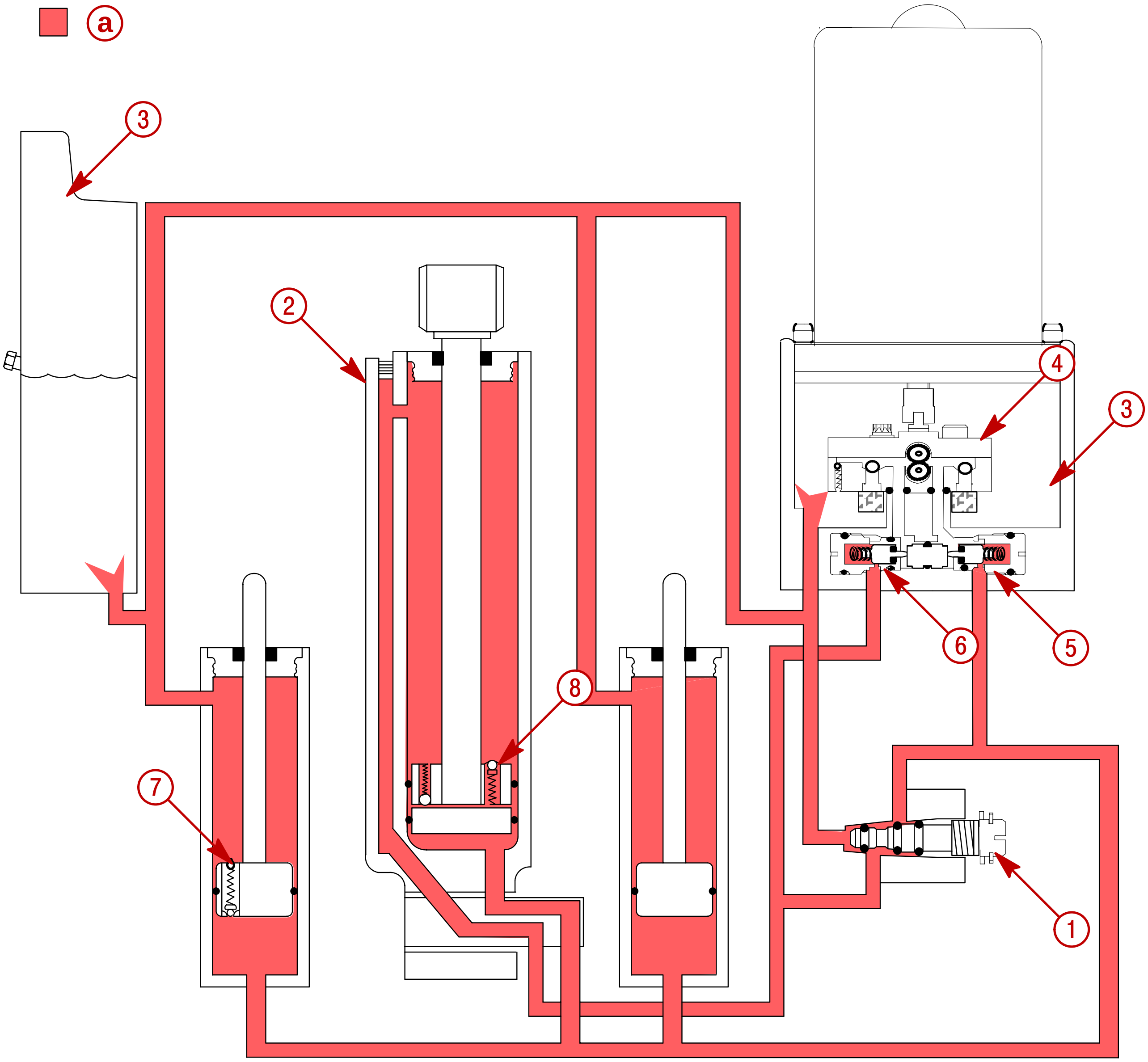
Reverse Operation

To prevent the outboard from coming up or trailing out, when shifted into reverse and/or throttling back rapidly, oil in the trim system must be locked in a static position. This is accomplished by closing the:

- up (5) pressure operated valve
- down (6) pressure operated valves
- trim relief valve (7)
- trail over valve (8)
- impact relief valves (8)
- manual release valve (1)

Thus, not allowing oil in the system to move in either direction.

Manual Tilt



a - Low Pressure
1 - Manual Release Valve
2 - Tilt Cylinder
3 - Reservoir
4 - Pump
5 - Up Pressure Operated Valve
6 - Down Pressure Operated Valve
7 - Trim Relief Valve
8 - Impact Relief Valves

Troubleshooting

IMPORTANT: Determine if Electrical or Hydraulic problem exists.

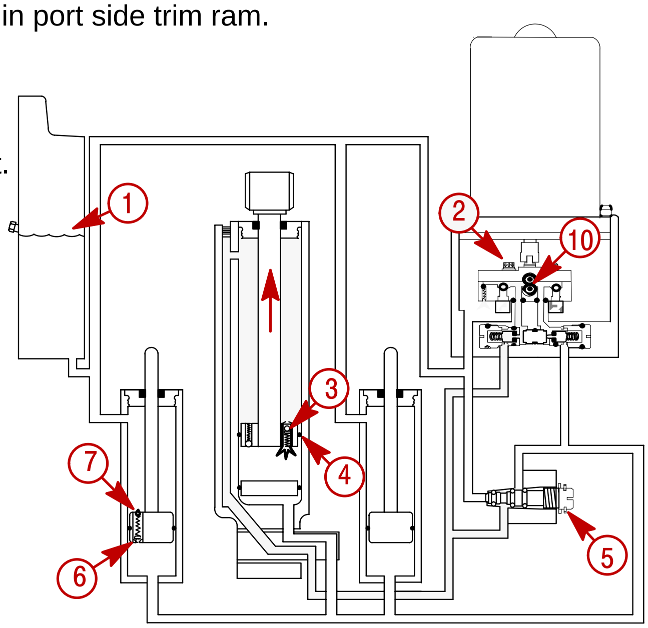
IMPORTANT: Acceptable power trim leak down should not exceed 1 in. (25.4 mm) (when measured at the tilt ram) in a 24 hour period.

HYDRAULIC SYSTEM TROUBLESHOOTING

CONDITION OF TRIM SYSTEM	PROBLEM
A. Trim motor runs; trim system does not move up or down.	1, 5, 10, 11
B. Does not trim full down. Up trim OK.	3, 4, 5
C. Does not trim full up. Down trim OK.	1, 5
D. Partial or “Jerky” down/up.	1, 3
E. “Thump” noise when shifting.	3
F. Does not trim under load.	5, 8, 9
G. Does not hold trim position under load.	5, 6, 7
H. Trail out when backing off from high speed.	3, 4
I. Leaks down and does not hold trim.	5, 6, 7
J. Trim motor working hard and trims slow up and down.	8, 9
K. Trims up very slow.	1, 2, 5, 6, 8, 9
L. Starts to trim up from full down position when “IN” trim button is depressed.	3, 4
M. Trim position will not hold in reverse.	3, 4

PROBLEM

1. Low oil level.
2. Pump assembly faulty.
3. Tilt ram piston ball not seated (displaced, dirt).
4. Tilt ram piston O-ring leaking or cut.
5. Manual release valve leaking (check condition of O-rings) (Valve not fully closed).
6. Lower check valve not seating in port side trim ram.
7. Upper check valve not seating in port side trim ram.
8. Check condition of battery.
9. Replace motor assembly.
10. Broken motor/pump drive shaft.
11. Air pocket under pump.



External Mounted Hydraulic System

ELECTRICAL SYSTEM TROUBLESHOOTING

CONDITION OF TRIM SYSTEM	PROBLEM
A. Trim motor does not run when trim button is depressed.	1, 2, 4, 5, 6, 7, 8
B. Trim system trims opposite of buttons.	3
C. Cowl mounted trim buttons do not activate trim system.	2, 4, 5, 6, 7

PROBLEM

1. Battery low or discharged.
2. Open circuit in trim wiring.
3. Wiring reversed in remote control, cowl switch or trim leads.
4. Wire harness corroded through.
5. Internal motor problem (brushes, shorted armature).
6. Blown fuse(s).
7. Trim switch failure.
8. Verify relays are functioning correctly.

POWER TRIM RELAY TEST PROCEDURE

The trim motor relay system used on permanent magnet trim systems connect each of the two wires from the trim motor to either ground or positive in order to allow the motor to run in both directions.

If the motor will not run in the UP direction, it could be either the UP relay is not making contact to 12 volts **OR** the DOWN relay is not making contact to ground. The opposite is true if the system will not run DOWN. When the system is not energized, both relays should connect the heavy motor leads to ground.

To test which relay is faulty if the trim system does not operate in one direction:

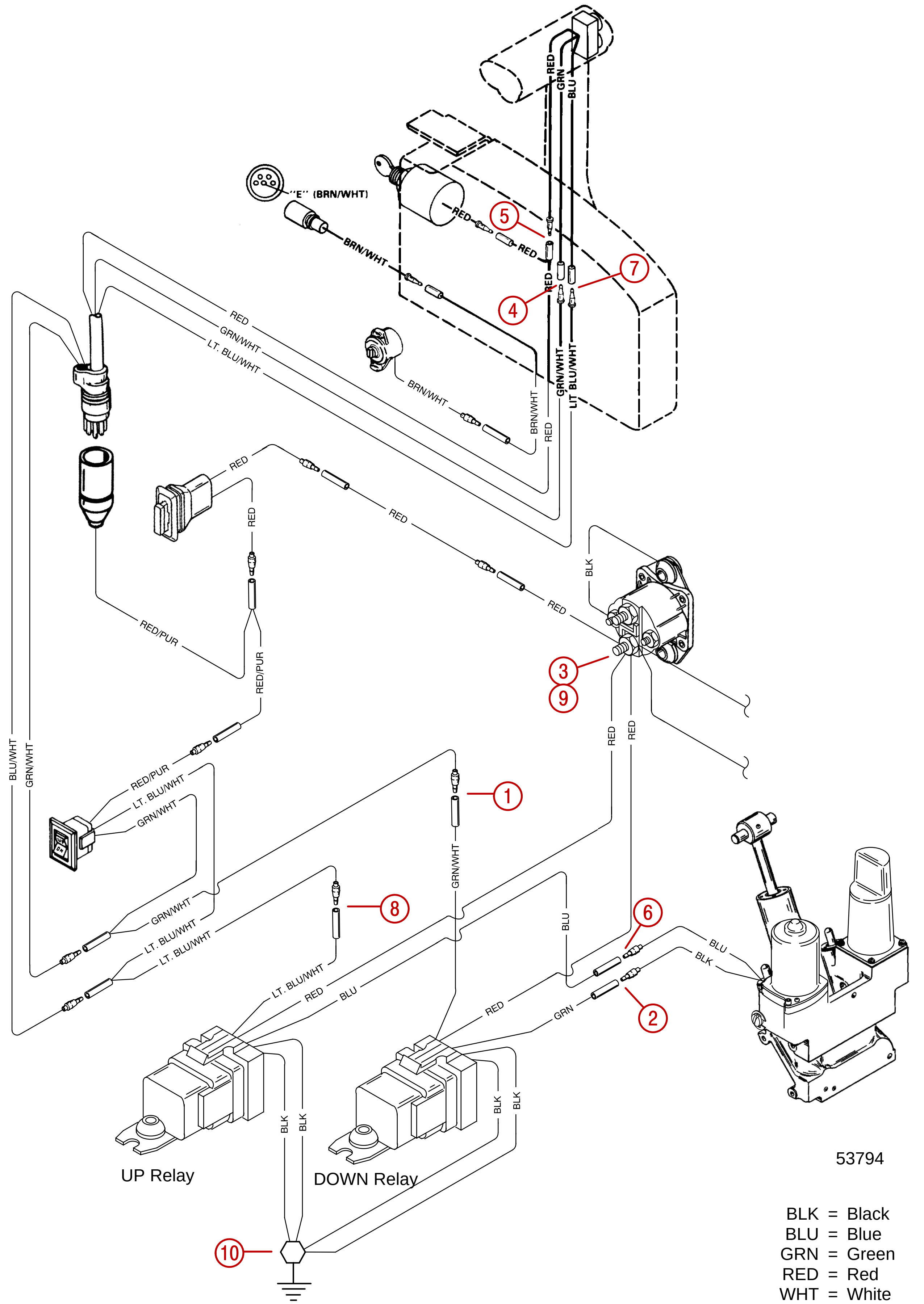
1. Disconnect the heavy gauge pump wires from the trim control relay.
2. Check for continuity between the heavy leads from the trim relays to ground.

Ohmmeter Leads Between	Resistance (Ohms)	Scale Reading* (x__________)
GREEN and Ground	0	Full Continuity (Rx1)
BLUE and Ground	0	Full Continuity (Rx1)

Replace the relay that does not have continuity.

3. Connect a voltmeter to the heavy BLUE lead and to ground. You should have 12 volts on the BLUE lead when the UP switch is pushed. You should should also have 12 volts on the GREEN lead when the DOWN switch is pushed. Replace the relay that does not switch the lead to positive.

Power Trim System with Relays and 2 Wire Trim Motor



BLK = Black
BLU = Blue
GRN = Green
RED = Red
WHT = White

Electrical System Troubleshooting

General Checks

Before troubleshooting the Power Trim electrical system, check the following:

1. Check for disconnected wires.
2. Make certain all connections are tight and corrosion free.
3. Check that plug-in connectors are fully engaged.
4. Make certain battery is fully charged.

Refer to the preceding four wiring diagrams for connection points when troubleshooting the electrical systems (Connection points are specified by number.)

Troubleshooting the “Down Circuit”

Connect Voltmeter red lead to Point 1 and black lead to ground.

Depress the “Down” trim button.

Battery Voltage Indicated:
Connect Voltmeter red lead to Point 3.

No Voltage Indicated:
Connect Voltmeter red lead to Point 4 and black lead to ground. Depress “Down” trim button. If battery voltage is indicated, wire is open between Points 4 and 1.

Battery Voltage Indicated:

- Connect Voltmeter red lead to Point 2.
- Depress “Down” trim button.

No Voltage Indicated:

There is an open circuit between Point 3 and positive (+) battery terminal.

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

Battery Voltage Indicated:

- Test UP relay.

Refer to page 5B-13 for relay test procedure.

No Voltage Indicated:
Relay Switch is defective.

Relay good:

- Pump motor wiring is defective.
- Pump motor is defective.

No Voltage Indicated:

Connect Voltmeter red lead to Point 5. If battery voltage is indicated, trim switch is faulty. If no battery voltage, check for loose or corroded connection at Point 5 or open circuit in wire supplying current to Point 5.

Troubleshooting the "Up" Circuit

Connect Voltmeter red lead to Point 8 and black lead to ground.

Depress the "Up" trim button.

Battery Voltage Indicated:
Connect Voltmeter red lead to Point 9.

Battery Voltage Indicated:

- Connect Voltmeter red lead to Point 6.
- Depress "Up" trim button.

Battery Voltage Indicated:

- Test DOWN relay.

Refer to page 5B-13 for relay test procedure.

Relay good:

- Pump motor wiring is defective.
- Pump motor is defective.

No Voltage Indicated:

Relay Switch is defective.

No Voltage Indicated:

There is an open circuit between Point 9 and positive (+) battery terminal.

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

No Voltage Indicated:

Connect Voltmeter red lead to Point 7 and black lead to ground. Depress "Up" trim button. If battery voltage is indicated, wire is open between Points 7 and 8.

No Voltage Indicated:

Connect Voltmeter red lead to Point 5. If battery voltage is indicated, trim switch is faulty. If no battery voltage, check for loose or corroded connection at Point 5 or open circuit in wire supplying current to Point 5.

Troubleshooting the “Down” and “Up” Circuits (All Circuits Inoperative)

Check in-line fuse (under cowl) to see if fuse is blown.

Blown Fuse:

- Correct problem that caused fuse to blow.
- Replace fuse.

Fuse Not Blown:

Connect Voltmeter red lead to Point 3 and black lead to ground. Battery voltage should be indicated.

No Voltage Indicated:

- Check battery leads for poor connections or open circuits.
- Check battery charge.

Battery Voltage Indicated:

- Connect Voltmeter red lead to Point 8 and black lead to ground.
- Depress “Up” trim button and check for battery voltage.

No Voltage Indicated:

Connect red Voltmeter lead to Point 5, and black lead to ground.

Battery Voltage Indicated:

- Check black ground wires for poor connection or poor ground, Point 10.
- Pump motor is faulty. Refer to “Motor and Electrical Tests/ Repair”, following.

No Voltage Indicated:

Check that voltage is being supplied to control by performing the following checks:

- DO NOT start engine.
- Turn ignition switch to “Run” position.
- Check for voltage at any instrument, using a Voltmeter.

Battery Voltage Indicated:

Trim switch is faulty or there is an open circuit in wires (green-white, blue-white) between trim buttons and trim pump.

- Check trim switch.
- Check all trim harness connectors for loose or corroded connections.
- Check for pinched or severed wires.

No Voltage Indicated:

Red wire is open between Point 3 and red terminal on back of the ignition switch.

- Check for loose or corroded connections.
- Check for open in wire.

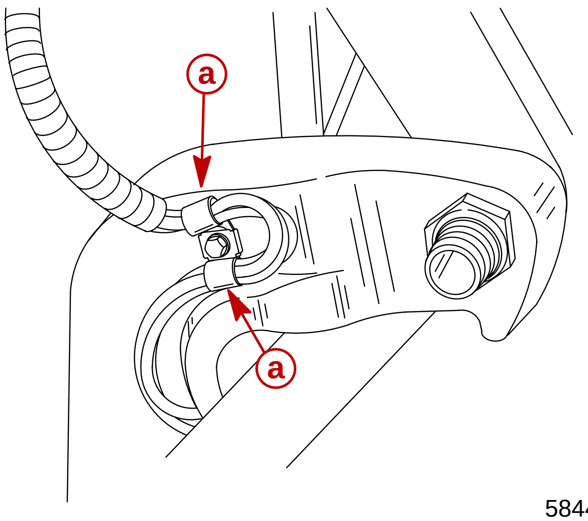
Battery Voltage Indicated:

There is an open circuit in wire between Point 5 and Red terminal on the back of the ignition switch.

Power Trim Assembly Removal and Installation

Removal

1. Remove clamps on transom bracket to free power trim wiring.
2. Raise outboard to full “Up” position and engage tilt lock lever.
3. Remove trim indicator.



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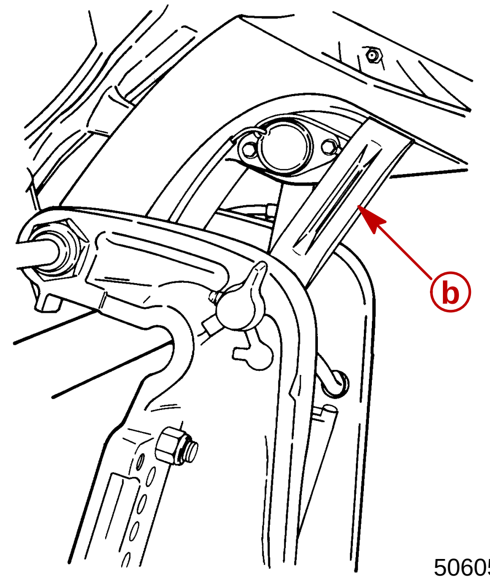
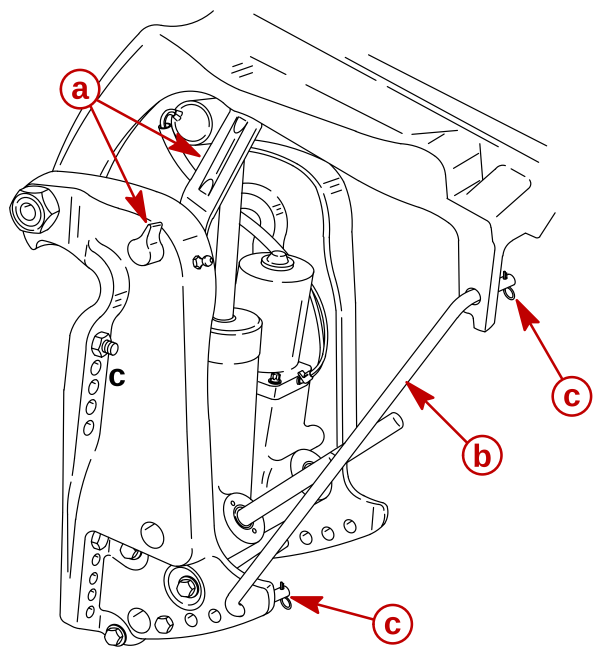


50605

a - Clamps
b - Tilt Lock Lever

⚠ WARNING
Failure to support outboard as shown could result in personal injury and/or damage to outboard or boat.



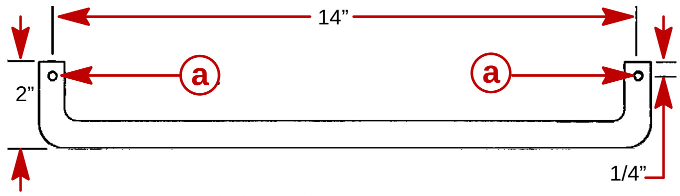
58447

a - Tilt Lock Lever
b - Support Tool
c - Retaining Clips

IMPORTANT: Support outboard as shown above to prevent engine from tipping when power trim retaining pin is removed.

SUPPORT TOOL

3/8 in. diameter metal rod (a used shift shaft works well)



a - Drill holes for retaining clips

METRIC CONVERSION

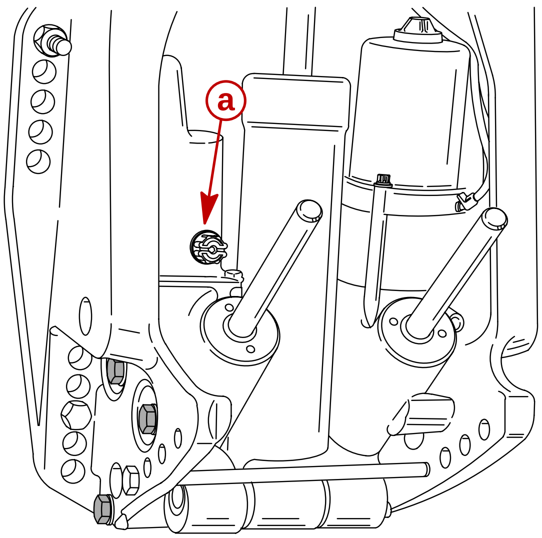
14 in. = 35.56 cm.	2 in. = 50.8 mm
3/8 in. = 9.5 mm.	1/4 in. = 6.35 mm.

⚠ CAUTION

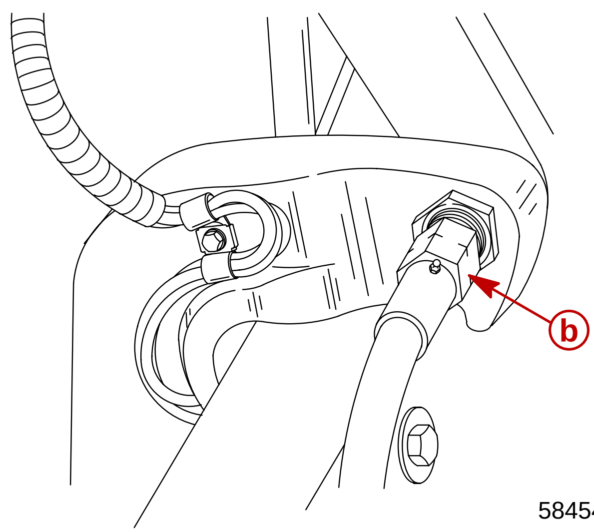
Disconnect battery cables at battery before removing power trim wires from solenoids.

4. Disconnect (BLUE and GREEN) bullet connector harness.
5. Open filler cap and release any remaining pressure in the system.

IMPORTANT: Outboards equipped with thru-the-tilt-tube steering - remove steering link arm from end of steering cable and cable retaining nut from tilt tube.



58444



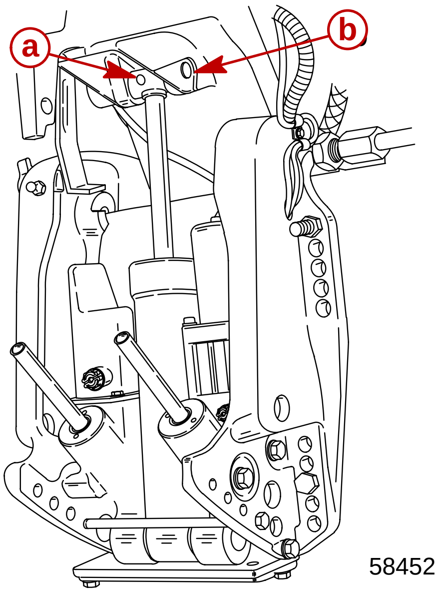
58454

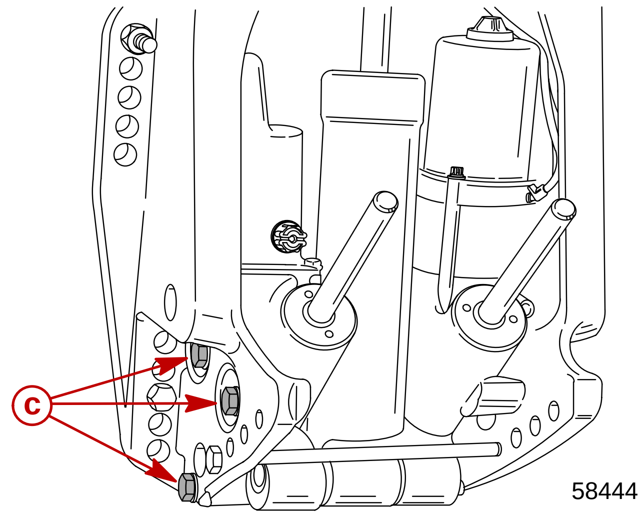
a - Filler Cap
b - Retaining Nut

IMPORTANT: Cross pin (a) should not be reused. Replace with new cross pin.

NOTE: *6 trim mounting bolts should not be reused. Replace with new patch lock bolts.*

6. Drive out cross pin, push out upper swivel pin, and remove 3 bolts and washers in port clamp bracket.

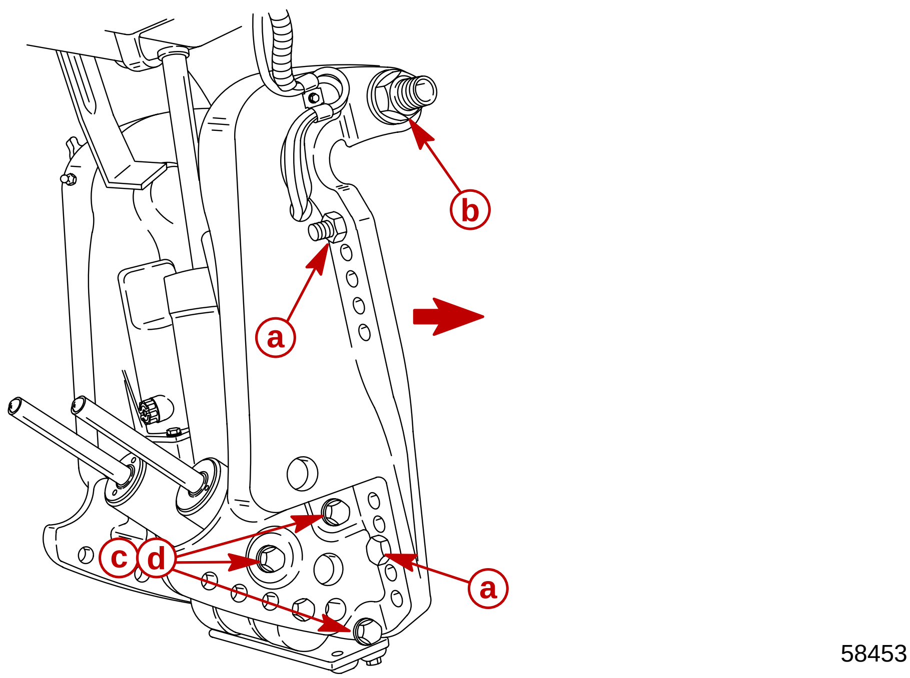




a - Cross Pin
b - Upper Swivel Pin

c - Port Transom Bracket Bolts and Washers (3). Remove to Release Trim System from Outboard.

7. Remove 3 bolts and washers and in starboard transom bracket.



a - Transom Mount Bolts (2)
b - Tilt Tube Nut (flush with end of thread)

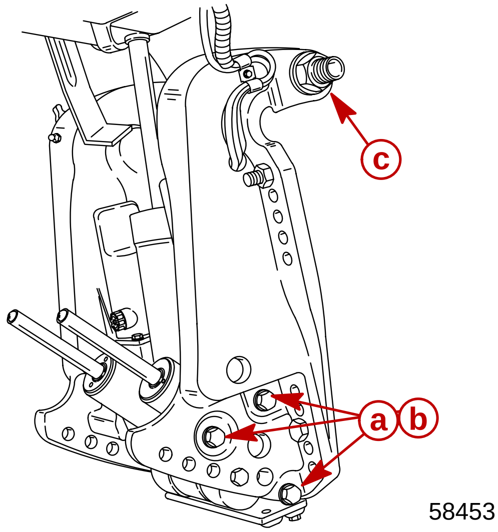
c - Screws (3)
d - Washers (3)

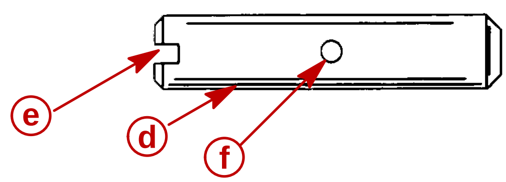
8. Remove outboard transom mounting bolts and loosen tilt tube nut until nut is flush with end of tilt tube thread. Remove system from outboard.

Installation

***NOTE:** Upper swivel pin bushings in swivel bracket should be inspected for wear and replaced as required. The trim rod shoes in the swivel bracket should also be replaced.*

1. Paint any exposed metal surfaces to prevent corrosion.
2. Install trim system, starboard transom bracket, and tilt tube nut.
3. Use a 12 volt power source to extend tilt ram up to align upper swivel shaft hole and end of ram. Connect trim motor wires [BLUE wire to POSITIVE (+), GREEN wire to NEGATIVE (–)]. If ram extends too far, retract ram by connecting GREEN wire to POSITIVE (+) and BLUE wire to NEGATIVE (–).
4. Install Upper Swivel Pin with slotted end to left (port) side of engine.



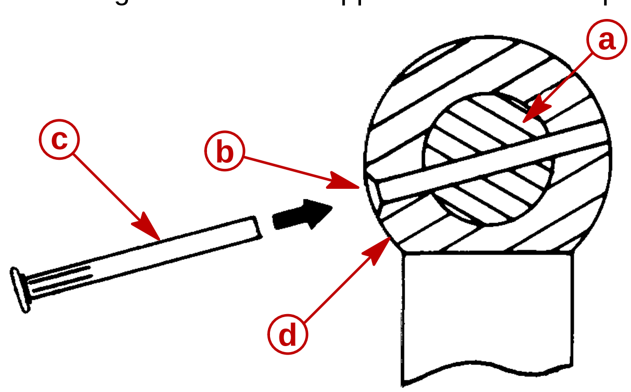


a - Screw (6) Torque to 45 lb. ft. (61.0 N·m)
b - Flat washer (6) Install one per screw
c - Tilt Tube Nut

d - Upper Swivel Pin
e - Slotted end
f - Cross hole (in line with slotted end)

IMPORTANT: Cross pin should not be reused. Install a new pin.

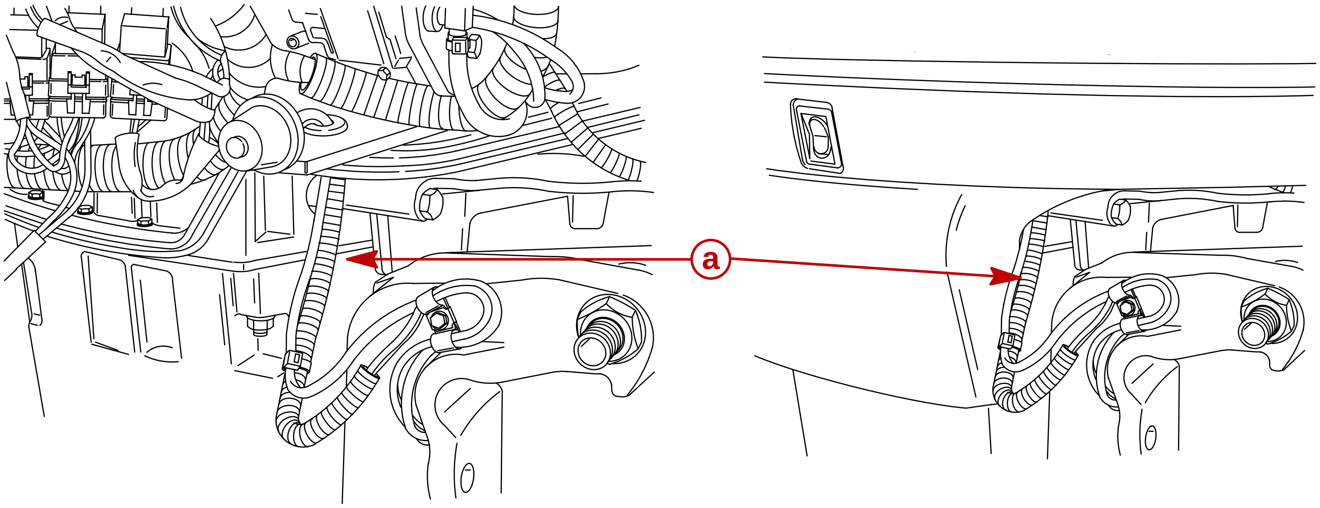
5. Position slot on end of swivel shaft in line with hole in tilt ram end. Insert a punch into tilt ram hole to align cross hole in upper swivel shaft. Tap new cross pin in until flush.



a - Upper Swivel Shaft (Slot is in line with cross hole)
b - Chamfered End of Hole (Faces away from transom)
c - Retaining Pin
d - Tilt Ram End

6. Connect trim motor wires to relays. Refer to Wiring Diagrams in this manual. Route trim wires as specified in this manual.

NOTE: *The 2 power leads going to the trim motor should be encapsulated with conduit tubing.*



56921

56922

a - Conduit Tubing

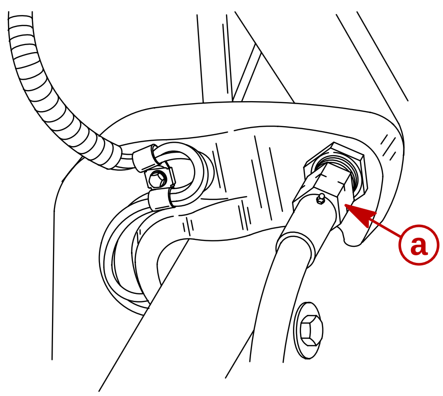
7. Apply marine sealer to shanks of mount bolts and install transom mount bolts.

IMPORTANT: Do not use an impact driver to tighten transom mount bolts.

Apply marine sealer to threads of mount bolts. Secure with flat washers and locknuts. Be sure installation is watertight.

8. Tighten tilt tube nut securely.

IMPORTANT: Outboards equipped with thru-the-tilt-tube steering: Tighten steering cable retaining nut securely to tilt tube.



58454

a - Steering Cable Retaining Nut

⚠ WARNING

Electrical wires passing through cowl openings must be protected from chafing or being cut. Follow the recommended procedures outlined in Section 1D of this Manual. Failure to protect wires as described could result in electrical system failure and/or injury to occupants of boat.

Testing Power Trim System With Test Gauge Kit (91-52915A6)

IMPORTANT: This test will not locate problems in the trim system. The test will show if the system is correct after a repair. If minimum pressures are not obtainable, the trim system requires additional repair.

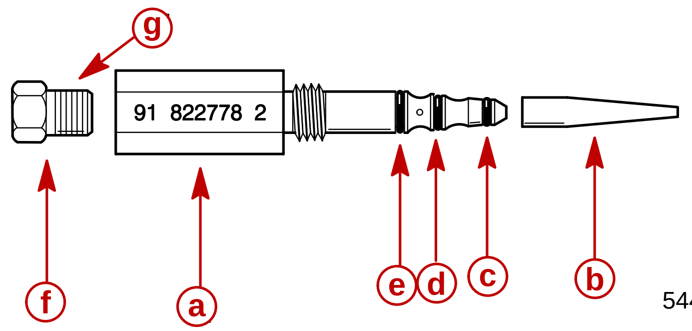
"UP" Pressure Check

IMPORTANT: Insure battery is fully charged before performing tests.

1. Tilt outboard to full "Up" position and engage tilt lock lever.
2. Slowly remove "Fill" plug to bleed pressure from reservoir.
3. Remove circlip securing manual release valve and unscrew release valve from trim assembly.

NOTE: *A small amount of trim fluid may drip from manual release valve hole. Place a suitable container under trim assembly to collect any leakage.*

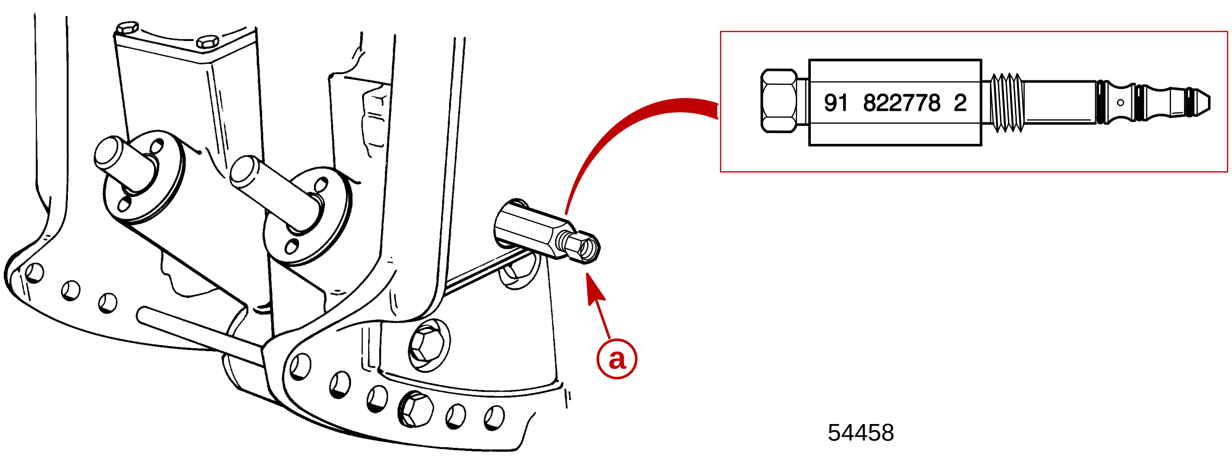
NOTE: *Assemble test adaptor by using O-ring installation tool to position small O-ring onto adaptor 1st, then install medium O-ring and lastly large O-ring. Thread brass fitting into test adaptor securely using teflon tape on threads.*



54457

a - Test Adaptor (91-822778A2)
b - O-ring Installation Tool
c - Small O-ring (Install 1st)
d - Medium O-ring (Install 2nd)
e - Large O-ring (Install Last)
f - Brass Fitting
g - Apply Teflon Tape

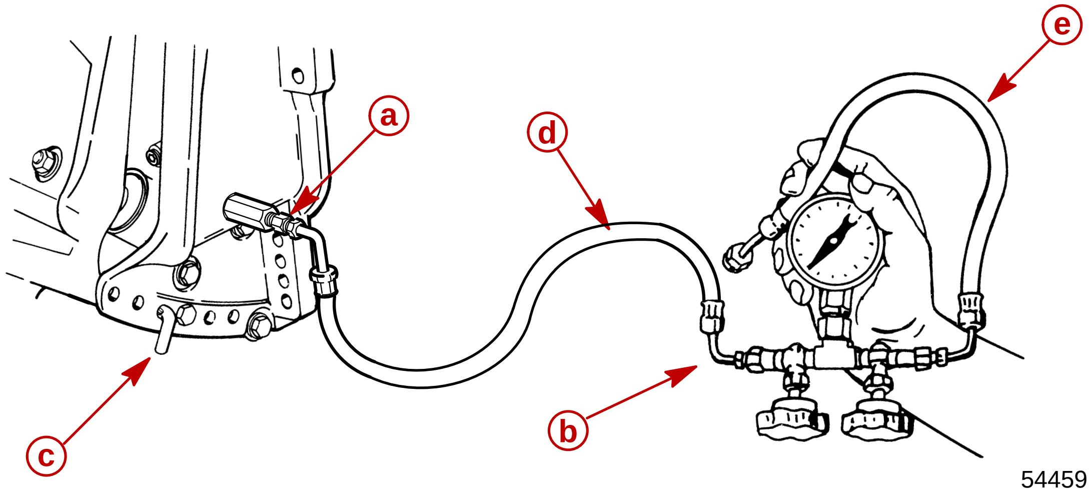
4. Install test adaptor 91-822778A2 into manual release valve hole.



54458

a - Test Adaptor (91-822778A2)

5. Thread hose from Test Gauge Kit (91-52915A6) into brass fitting on adaptor.



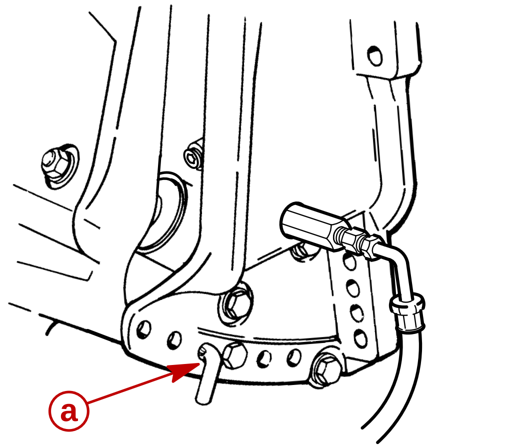
a - Brass Fitting
b - Test Gauge Assembly
c - Tilt Pin (Position in Hole Shown)
d - Hose
e - Hose (Not Used)

6. Reinstall fill plug.
7. Run trim “UP”.
8. Disengage tilt lock lever.

⚠ CAUTION

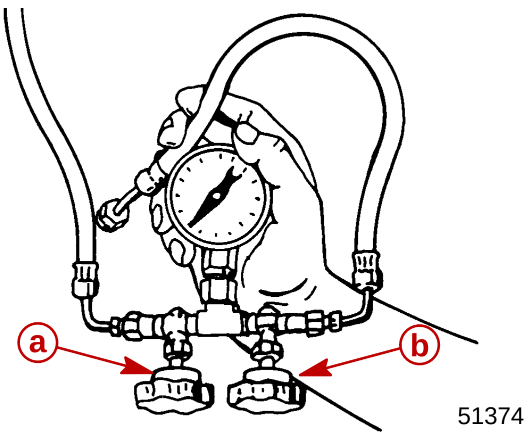
Failure to install spare tilt pin (or hardened bolts and nuts) in hole shown could result in transom bracket failure and possible injury.

9. Move outboard "IN" until hole in swivel bracket "ear" aligns with the 3rd tilt hole in transom bracket. Lock engine in trim range by installing a 3/8 in. (9.5 mm) diameter tilt pin or two 3/8 in. (9.5 mm) hardened bolts and nuts thru the transom brackets and swivel bracket in the hole shown.



a - Tilt Pin Hole (Install Spare Tilt Pin or Hardened Bolts and Nuts)

10. Open valve (a) and close valve (b).



11. Run trim "UP". The minimum pressure should be 2000 P.S.I. (140.6 kg/cm^2).
12. Run trim "DOWN" to release pressure and remove spare tilt pin or bolts and nuts.
13. Tilt outboard full "UP" and engage tilt lock lever.
14. Slowly remove "Fill" plug to bleed pressure.
15. Remove test gauge hose and adapter.
16. Reinstall Manual Release Valve and secure valve with circlip.
17. Retighten "Fill" plug.

NOTE: *If pressure is less than 2000 PSI (140.6 kg/cm^2), troubleshoot system per instructions on page 5B-16.*

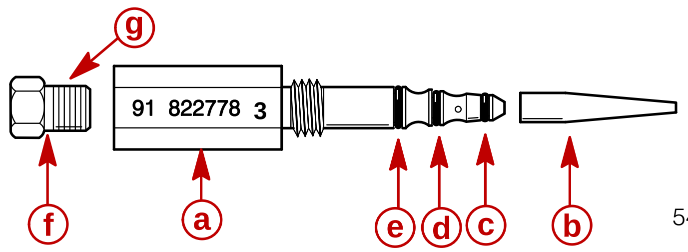
“DOWN” Pressure Check

IMPORTANT: Insure battery is fully charged before performing tests.

1. Tilt outboard to full “Up” position and engage tilt lock lever.
2. Slowly remove “Fill” plug to bleed pressure from reservoir.
3. Remove circlip securing manual release valve and unscrew release valve from trim assembly.

NOTE: *A small amount of trim fluid may drip from manual release valve hole. Place a suitable container under trim assembly to collect any leakage.*

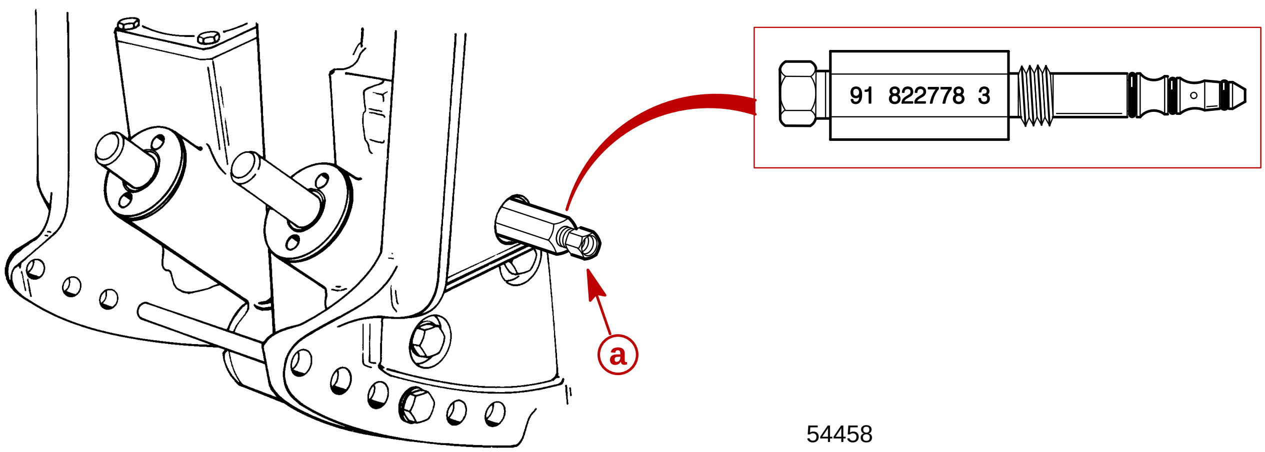
NOTE: *Assemble test adaptor by using O-ring installation tool to position small O-ring onto adaptor 1st, then install medium O-ring and lastly large O-ring. Thread brass fitting into test adaptor securely using teflon tape on threads.*



54457

a - Test Adaptor (91-822778A3)
b - O-ring Installation Tool
c - Small O-ring (Install 1st)
d - Medium O-ring (Install 2nd)
e - Large O-ring (Install Last)
f - Brass Fitting
g - Apply Teflon Tape

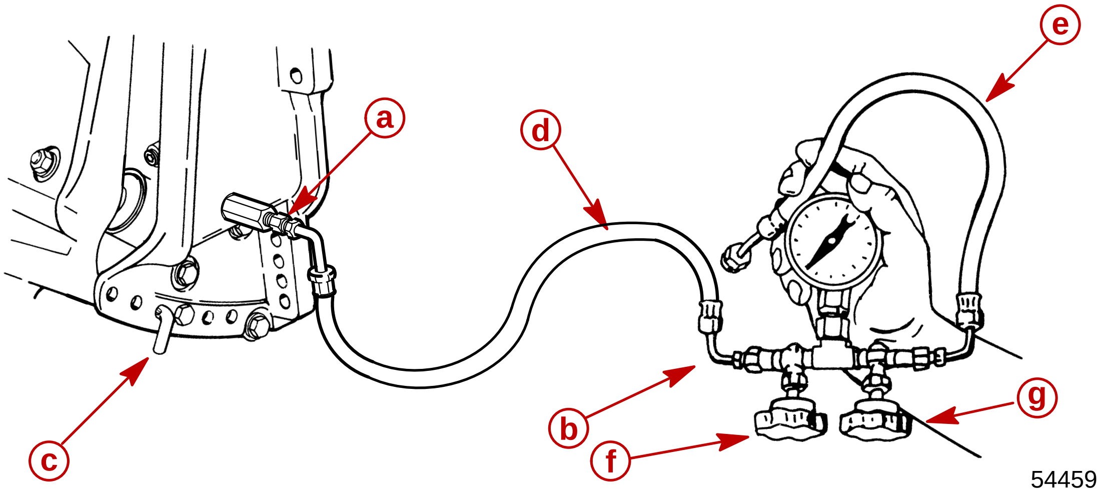
4. Install test adaptor 91-822778A3 into manual release valve hole.



54458

a - Test Adaptor (91-822778A3)

5. Thread hose from Test Gauge Kit (91-52915A6) into brass fitting on adaptor.



a - Brass Fitting
b - Test Gauge Assembly
c - Tilt Pin (Position in Hole Shown)
d - Hose
e - Hose (Not Used)
f - OPEN Valve
g - CLOSE Valve

6. Reinstall fill plug.
7. Run trim "UP".
8. Disengage tilt lock lever.
9. Open valve (f) and close valve (g).
10. Run trim "DOWN". Minimum pressure should be 600 P.S.I. (42 kg/cm^2).
11. Tilt outboard full "UP" and engage tilt lock lever.
12. Slowly remove "Fill" plug to bleed pressure.
13. Remove test gauge hose and adaptor.
14. Reinstall manual release valve and secure valve with circlip.
15. Retighten "Fill" plug.

NOTE: *If pressure is less than 600 PSI (42 kg/cm^2), troubleshoot system per instructions on Page 5B-15.*

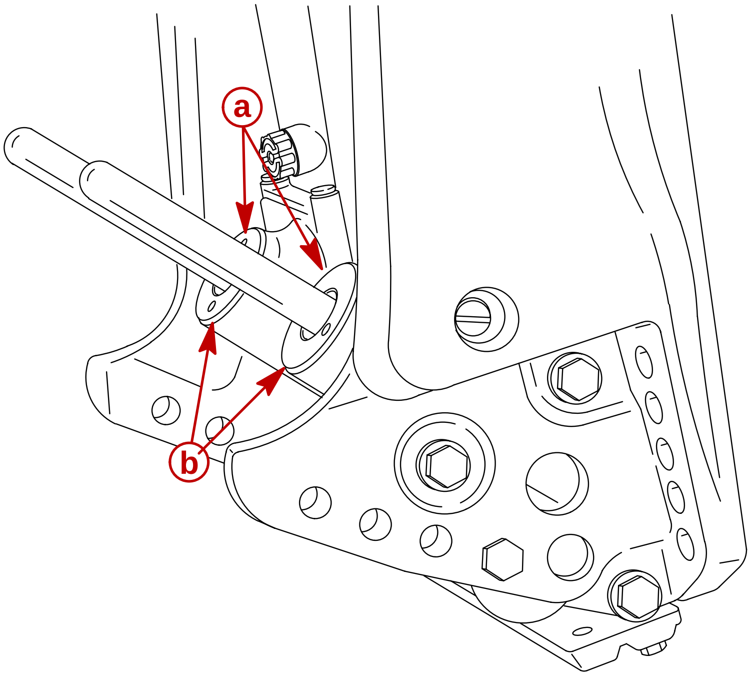
Hydraulic Repair

TRIM ROD REMOVAL AND REPAIR

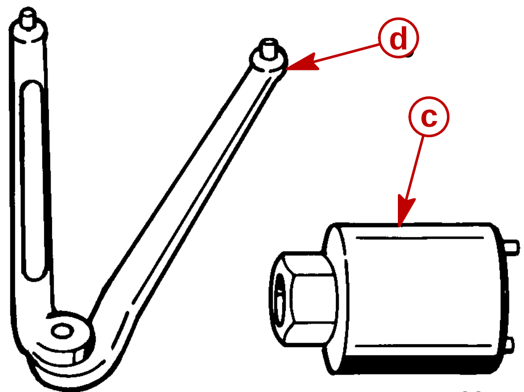
NOTE: *Power Trim does not have to be removed from outboard to remove trim rods.*

1. Tilt outboard to full “UP” position and engage tilt lock lever.
2. Slowly remove “Fill” plug to bleed reservoir pressure.
3. Turn Manual Release Valve 3 to 4 turns (counterclockwise) to bleed remaining pressure.
4. Remove trim rod cylinder caps.

NOTE: *Place a clean pan under trim system to catch fluid.*



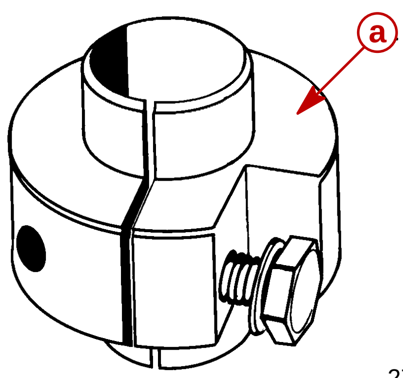
58450



51337

a - Trim Rod Cylinder Cap
b - Turn Counterclockwise to Remove
c - Removal Tool (91-44487A1)
d - Spanner Wrench (91-74951)

5. Install trim rod removal tool and pull trim rod from cylinder.



27933

a - Trim Rod Removal Tool (91-44486A1)

CLEANING AND INSPECTION - TRIM RODS AND CAPS

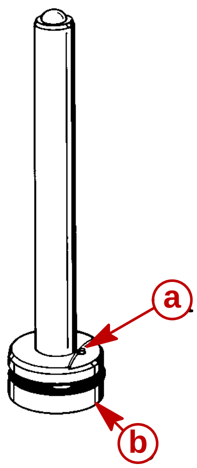
CAUTION

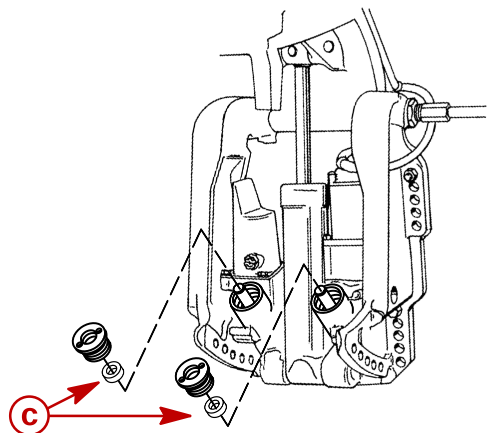
Do not remove check valve (a). Check valve is preset to operate at a specific pressure. Removal and installation of check valve could result in improper operating pressure and possible system damage.

NOTE: *Check valve is in port side trim rod only.*

NOTE: *Certain models may have trim limit reducers installed on the trim rod to limit trim out angle. Each reducer limits the amount of total trim by 2°. A maximum of 5 reducers may be installed on each trim rod.*

1. Inspect check valve and check valve screen for debris; if debris cannot be removed, replace trim rod assembly. Clean trim rod with parts cleaner and dry with compressed air.

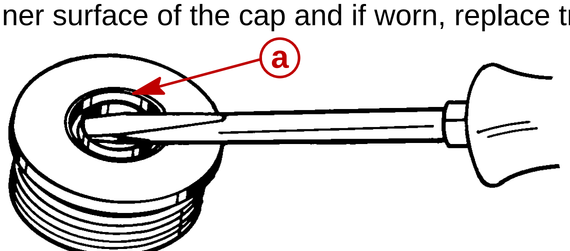




a - Check Valve
b - Check Valve Screen
c - Trim Limit Reducers

Trim Rod End Cap Seal

1. Inspect trim cap end seal and replace if damaged or if seal does not keep trim rod clean.
2. Inspect trim cap internal o-ring and replace if damaged or worn.
3. Inspect inner surface of the cap and if worn, replace trim cap.



a - Seal (remove as shown)

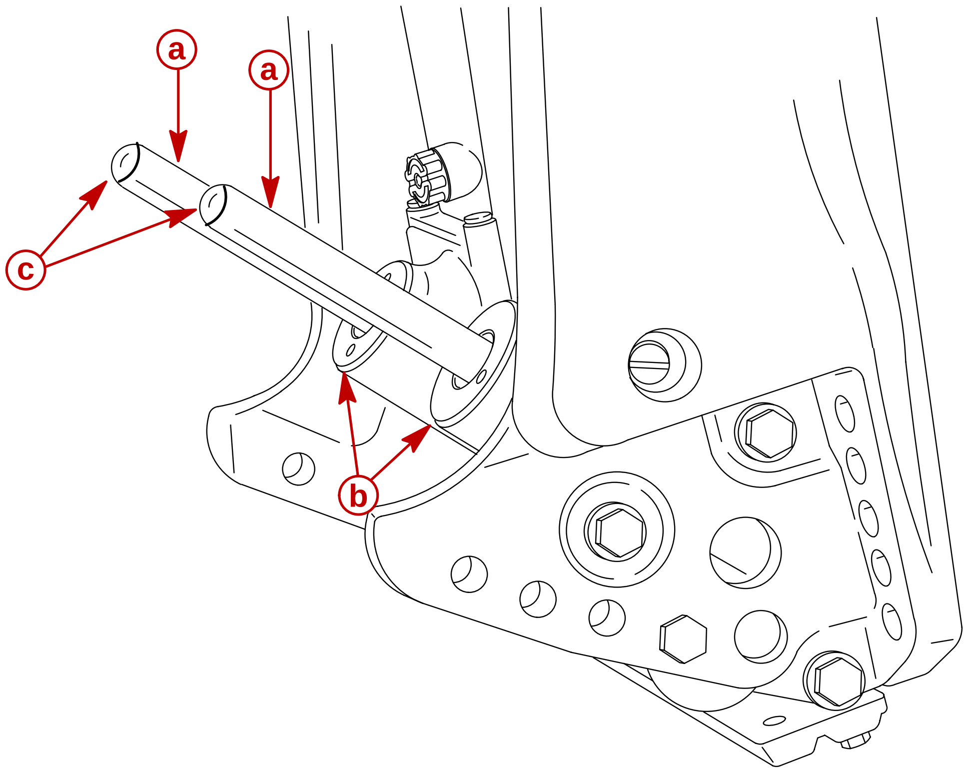
4. Install new seal with seal lip up.

TRIM ROD INSTALLATION

IMPORTANT: Components must be free of dirt and lint. Any debris in the system can cause system to malfunction.

NOTE: *Install trim rod with check valve in the port (left) cylinder.*

1. Apply ATF Dexron III or Quicksilver Power Trim and Steering Fluid on all O-rings and seals before installation.
2. Install trim rods and caps. Use installation tool (91-44487A1) or spanner wrench (91-74951) to tighten caps securely – 70 lb. ft. (95 N m).



58450

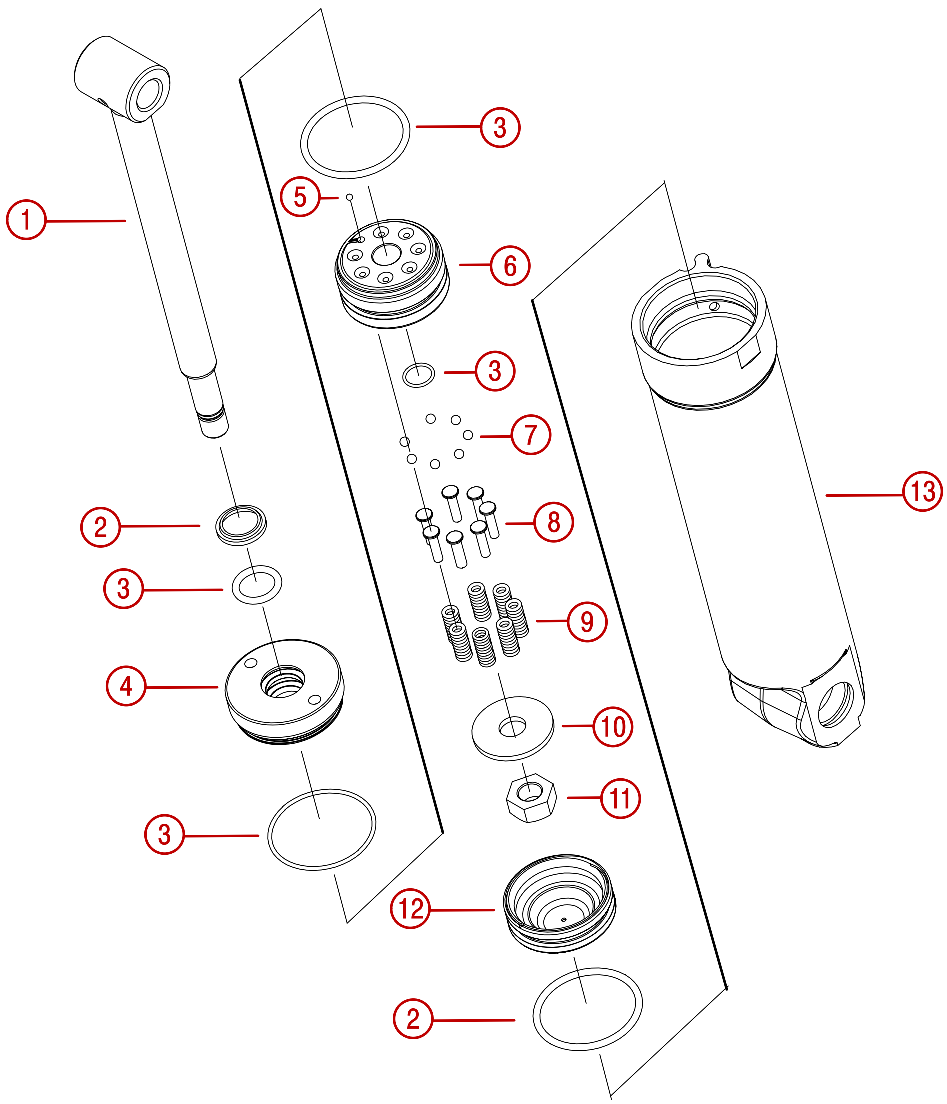
a - Trim Rods
b - Cylinder End Caps
c - Rod End Rollers (lubricate with Quicksilver Anti-Corrosion Grease or Special Lubricant 101)

Tilt Ram

REMOVAL - TILT ROD ASSEMBLY ONLY

NOTE: *Tilt Rod Assembly can be removed from cylinder without removing entire power trim system from outboard.*

TILT RAM COMPONENTS



1 - Tilt Cylinder Rod
2 - Scraper Seal
3 - O-ring*
4 - Cylinder Cap
5 - Return Ball
6 - Shock Piston
7 - Shock Balls
8 - Spring Keepers – (1 is RED)
9 - Shock Springs – (1 is RED for low speed trail over)
10 - Washer
11 - Nut
12 - Memory Piston
13 - Housing

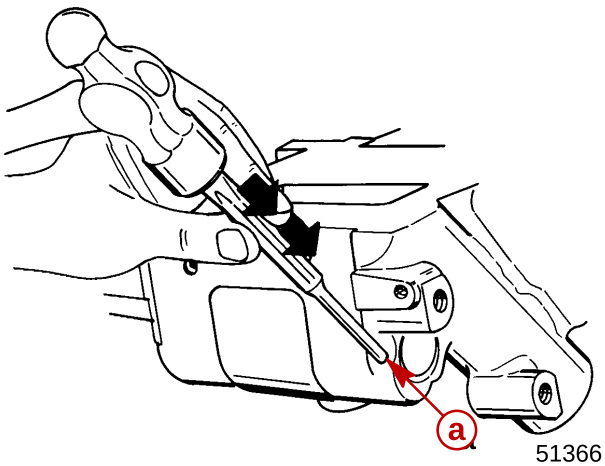
*O-ring Repair Kit Available, P.N. 811607A1 (Includes item 2, Scraper Seal)

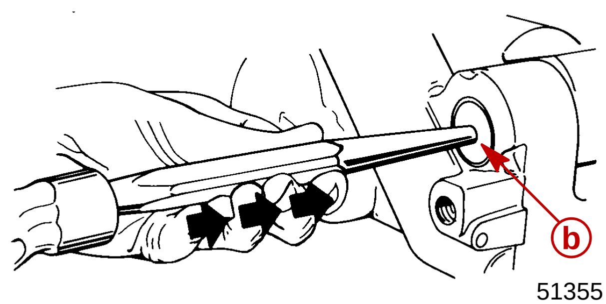
TILT RAM REMOVAL - POWER TRIM SYSTEM REMOVED FROM OUTBOARD

CAUTION

Insure trim system is depressurized prior to tilt ram removal.

1. Remove cross pin.
2. Remove lower swivel pin.

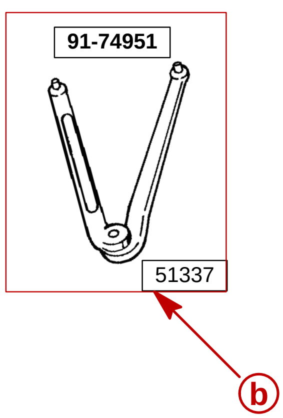


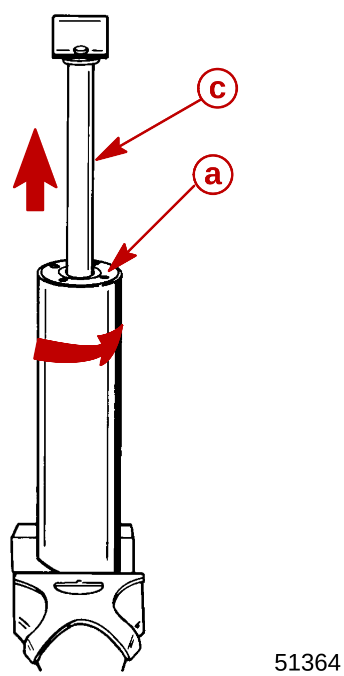


a - Cross Pin (Remove as shown)
b - Lower Swivel Pin (Remove as shown)

Disassembly

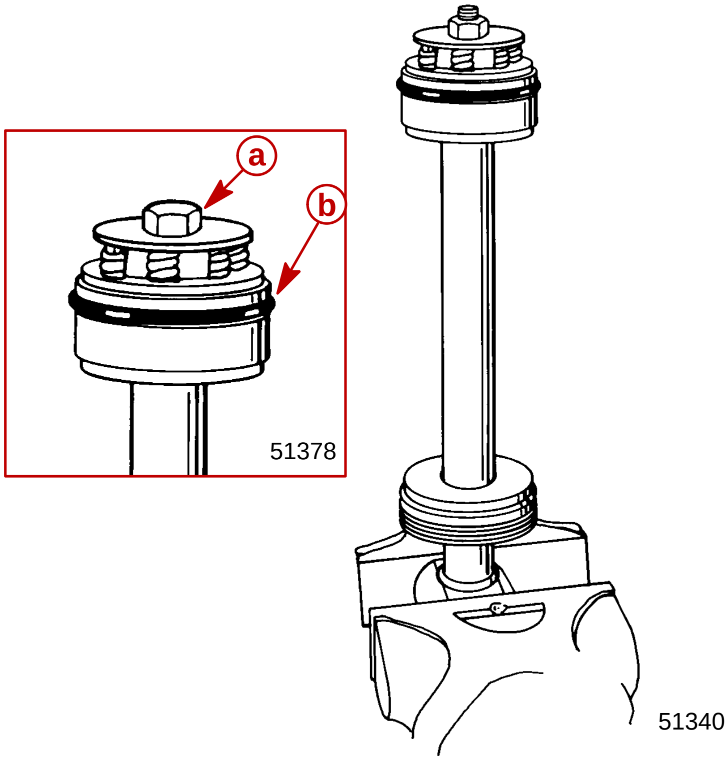
1. Secure tilt ram in a soft jawed vise. Remove tilt rod and cap.





a - Cap (Turn Counterclockwise to Remove)
b - Spanner Wrench (91-74951)
c - Tilt Rod - Pull to Remove

2. Clamp tilt rod in a soft jawed vise. Remove bolt or nut as applicable to disassemble rod assembly. Remove O-ring.

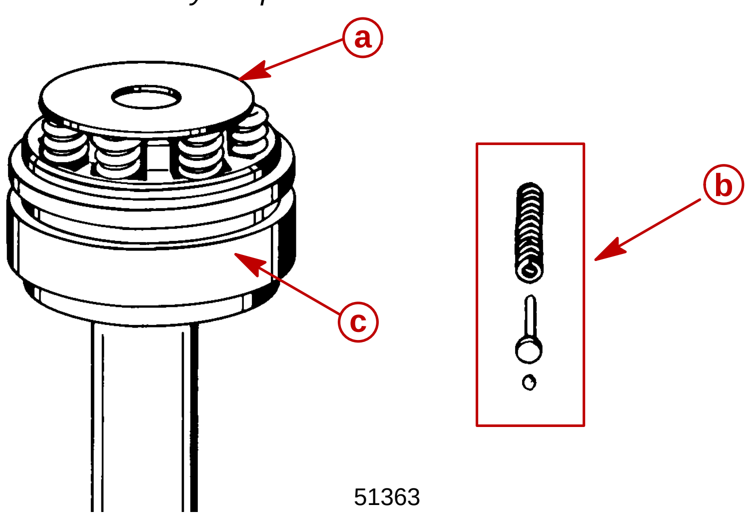


a - Stud/Nut
b - O-Ring

IMPORTANT: Design 1 tilt rod assembly can be used to replace a Design 2 tilt rod assembly. Design 1 or Design 2 cylinder assemblies (complete) can be used as replacements.
Design 2 will NOT fit a cylinder originally using a Design 1 tilt rod assembly.
Memory Pistons for Design 1 and 2 differ also and must be used only on the cylinder the piston was removed from.

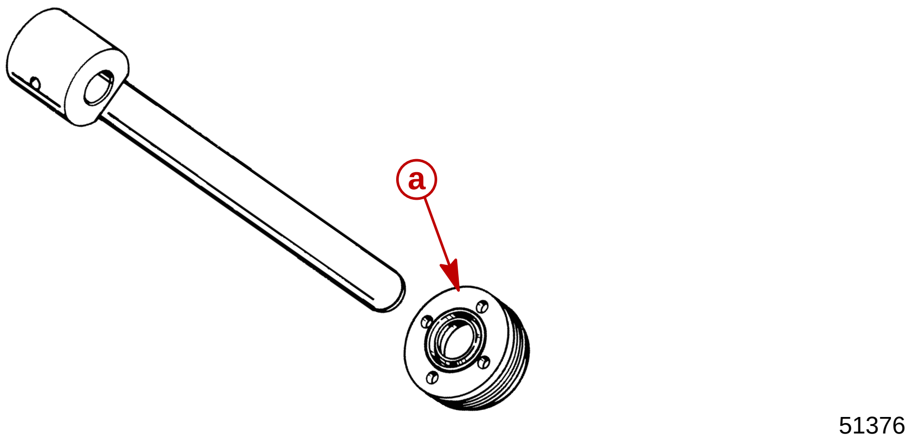
3. Remove washer, check valve assemblies, and piston.

NOTE: *Check valve held in by roll pin can be cleaned but not removed.*



a - Washer
b - Check Valve Assembly (7)
c - Piston

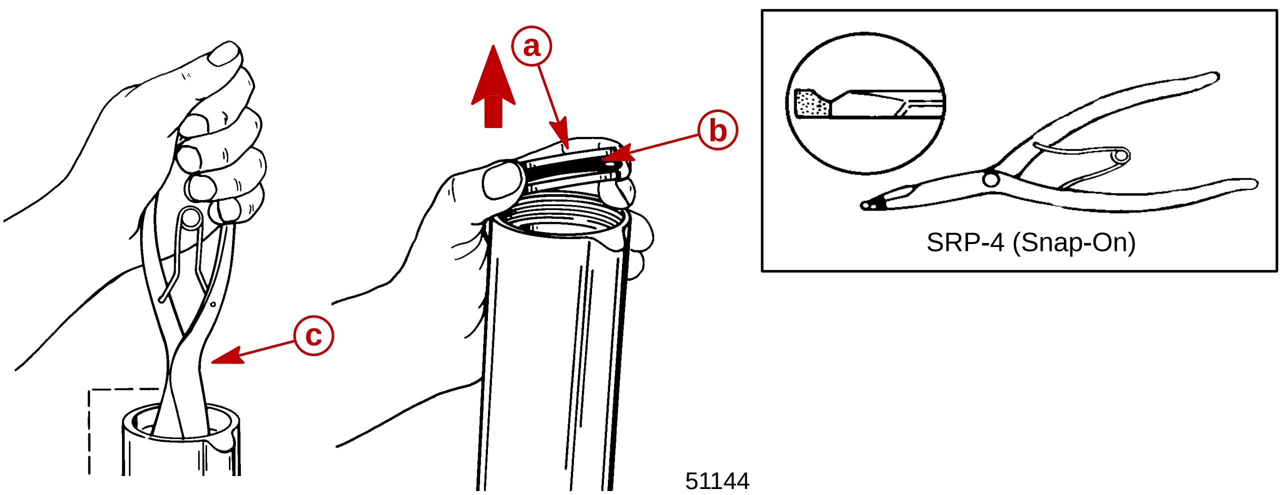
4. Remove end cap from tilt rod.



a - End Cap

Memory Piston Removal

1. Remove memory piston from cylinder using Snap-On lock ring pliers SRP-4 or similar tool.
2. Remove o-ring from memory piston.



a - Memory Piston
b - O-Ring
c - Snap-On Pliers SRP-4

Cleaning/Inspection/Repair

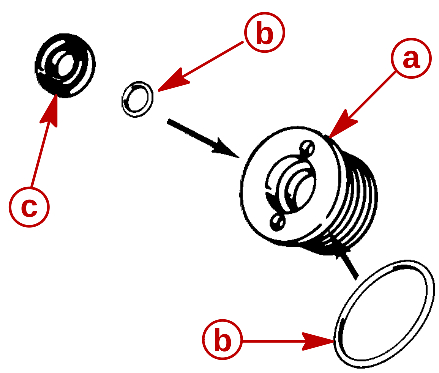
1. Inspect all internal parts for damage or wear. Clean and replace parts as necessary.
2. Inspect tilt rod for scratches. Replace scraper seal in rod end cap if tilt rod is scratched or worn.
3. Slight scratches or tool marks less than 0.005 in. (0.1 mm) deep in cylinder are acceptable.

IMPORTANT: Components must be dirt and lint free. Slightest amount of debris in Power Trim system could cause system to malfunction.

4. Clean shock rod and components with parts cleaner and dry with compressed air.
5. It is recommended that all O-rings in trim system be replaced.
6. Lubricate all o-rings with Quicksilver Power Trim Fluid (92-90100A12). If not available, use automotive (ATF) automatic transmission fluid.

Scraper Seal Replacement

1. Remove components from end cap.



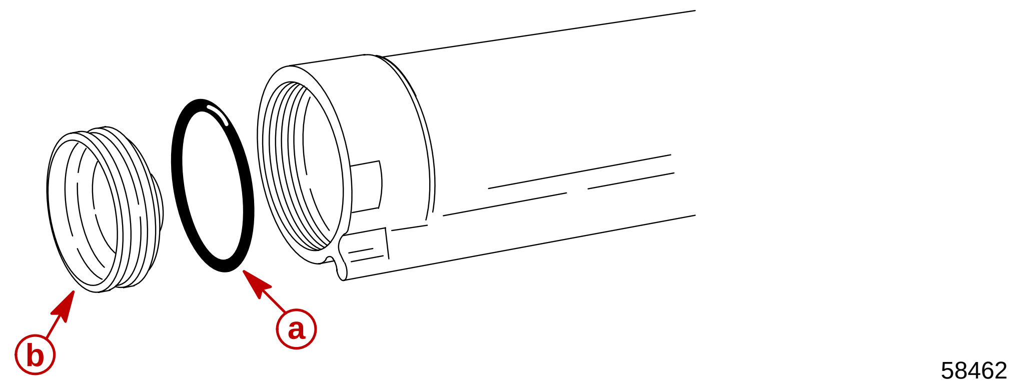
a - Cap
b - O-ring (2)
c - Scraper Seal

REASSEMBLY

IMPORTANT: Components must be clean for reassembly. Any debris in the system can cause the system to malfunction.

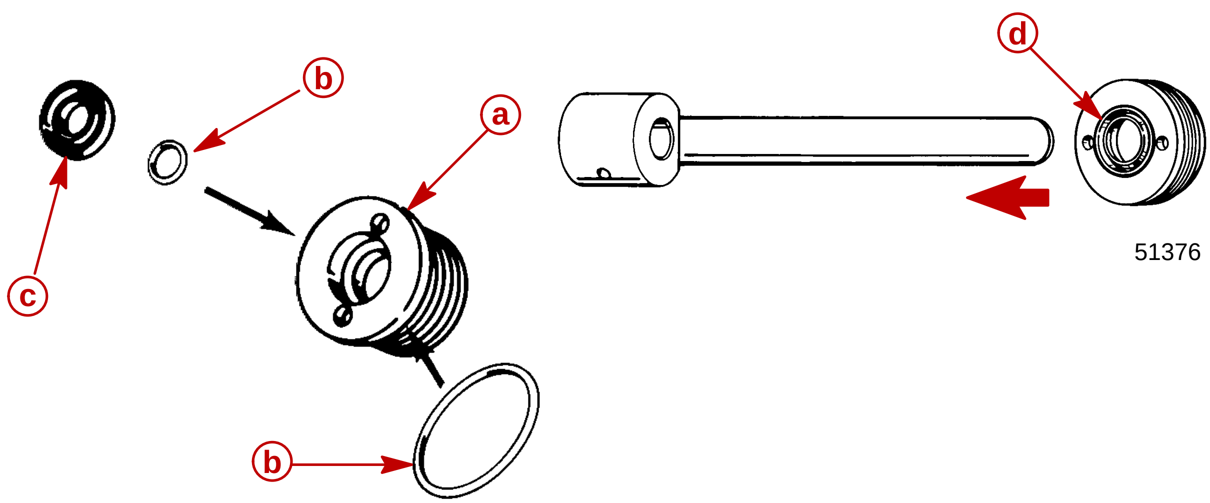
NOTE: *Refer to “Tilt Ram Components” for proper O-ring sizes.*

1. Apply ATF Dexron III or Quicksilver Power Trim and Steering Fluid on O-rings prior to reassembly.
2. Install O-ring on Memory Piston Cup and install in cylinder.
3. Inspect and replace as required 3 o-rings in the bottom of the tilt cylinder.
4. Inspect and replace as required 3 pivot pin o-rings in the manifold.



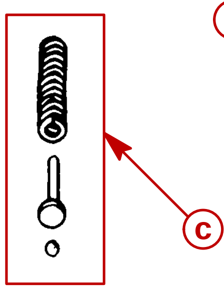
a - O-ring
b - Memory Piston Cup

5. Assemble end cap.
6. Install end cap.



a - End Cap
b - O-ring (2)
c - Scraper seal
d - End Cap

7. Install components on rod.



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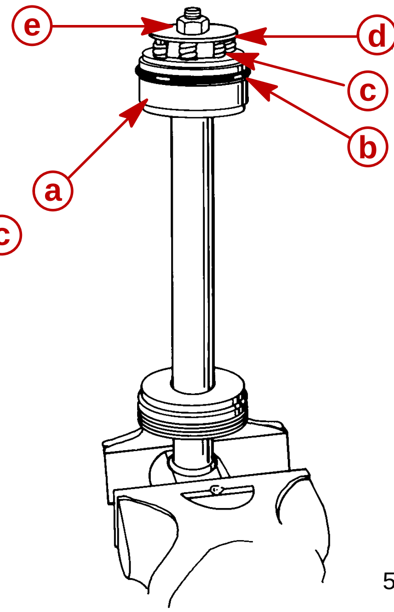
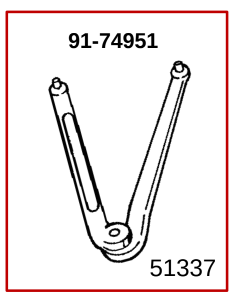


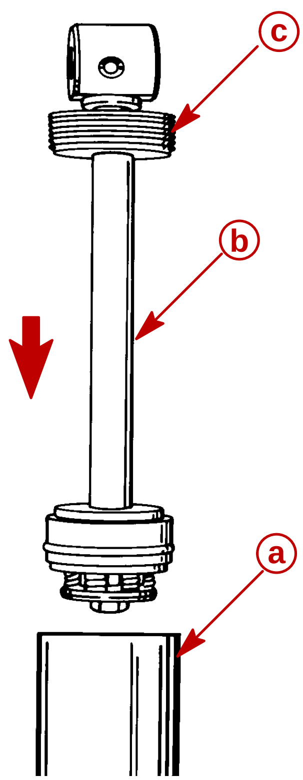
51340

a - Piston
b - O-ring
c - Check Valve Assembly (7)
d - Washer
e - Locknut [Torque to 95 lb. ft. (129 N m)]

8. Clamp cylinder in a soft jawed vise and install tilt rod assembly. Use spanner wrench and tighten end cap securely. Torque end cap to 45 lb. ft. (61 N m).



51337

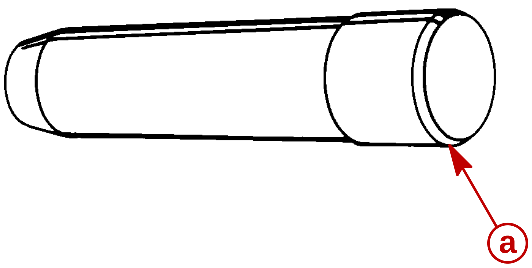


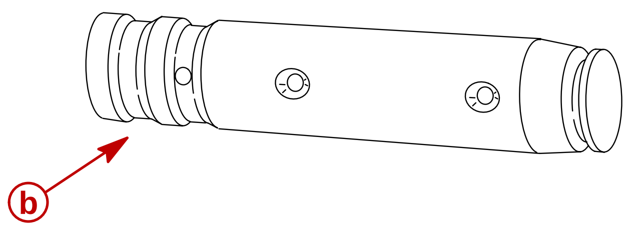
51341

a - Cylinder
b - Tilt Rod Assembly
c - End Cap (Tighten Securely.) Use Spanner Wrench.

TILT RAM ASSEMBLY INSTALLATION

1. Lubricate alignment tool (91-11230) and shaft. Use ATF Dexron III or Quicksilver Power Trim and Steering Fluid.

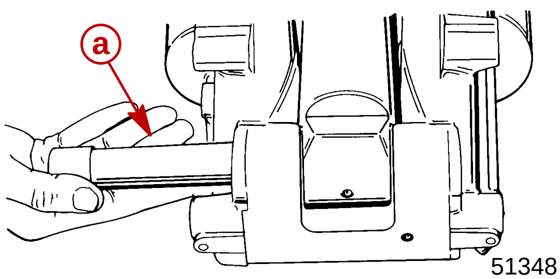


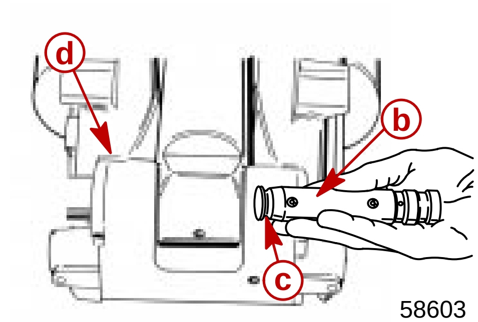


a - Alignment Tool (91-11230)
b - Shaft

2. Align tilt ram and housing using alignment tool.

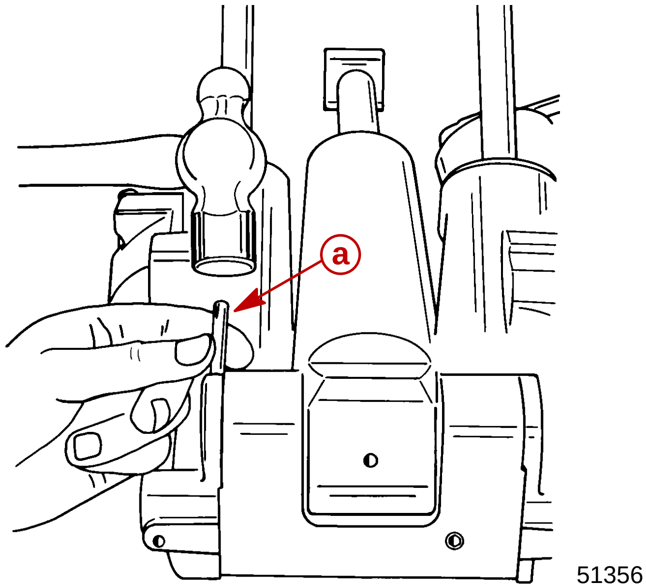
3. Install shaft.





a - Alignment Tool (91-11230)
b - Shaft
c - Groove
d - Hole [Groove (c) will Align with this Hole]

4. Drive pin in until flush.

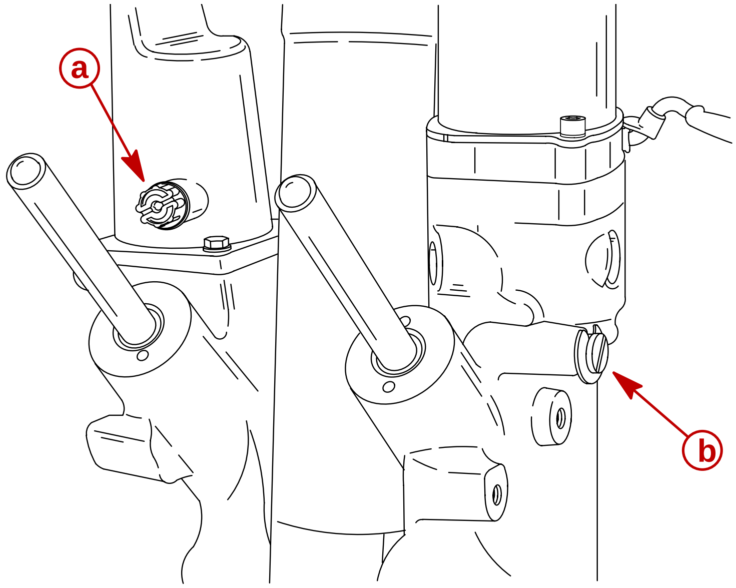


a - Pin (Drive Against Knurled End)

Power Trim Disassembly

IMPORTANT: Power trim is pressurized. Trim rams must be in the full up position (fully extended) prior to fill/drain plug or manual release valve removal.

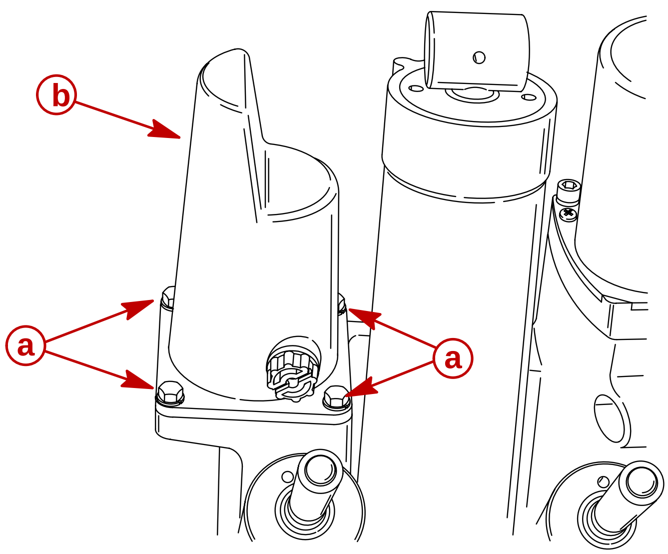
1. Remove reservoir cap to drain oil.
2. Remove manual release valve to drain any remaining oil.



58604

a - Reservoir Cap
b - Manual Release Valve

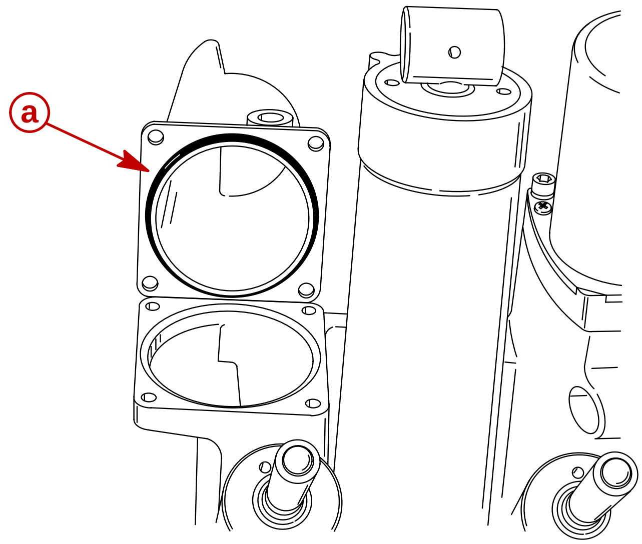
3. Remove 4 screws securing reservoir cover and remove cover.



58606

a - Screws (4)
b - Reservoir Cover

4. Inspect reservoir cover o-ring for cuts or abraisions. Replace o-ring as required.

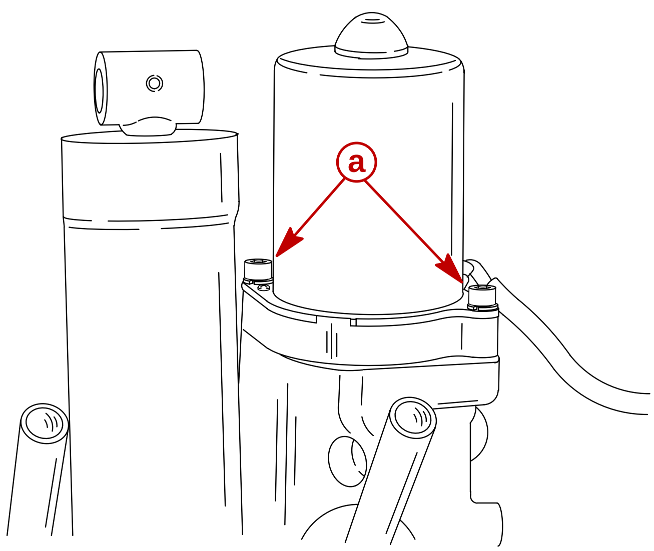


58605

a - O-Ring

Trim Motor Removal

1. Secure power trim assembly in a soft jaw vise.
2. Remove 2 screws securing motor and remove motor. Remove motor o-ring (yellow) and coupler.
3. Inspect o-ring for cuts and abraisions. Replace o-ring as required.



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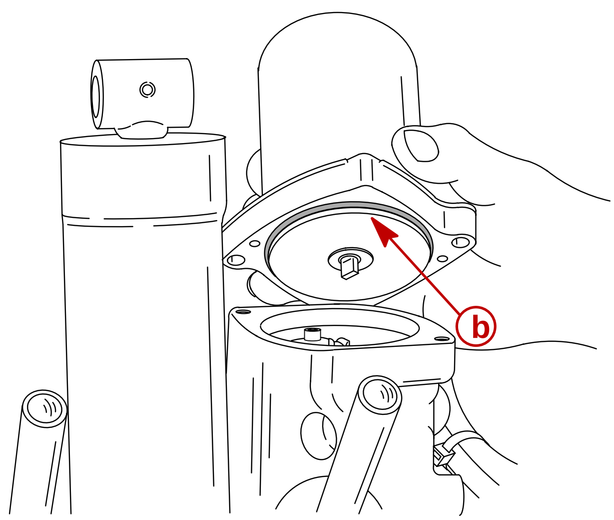


58610

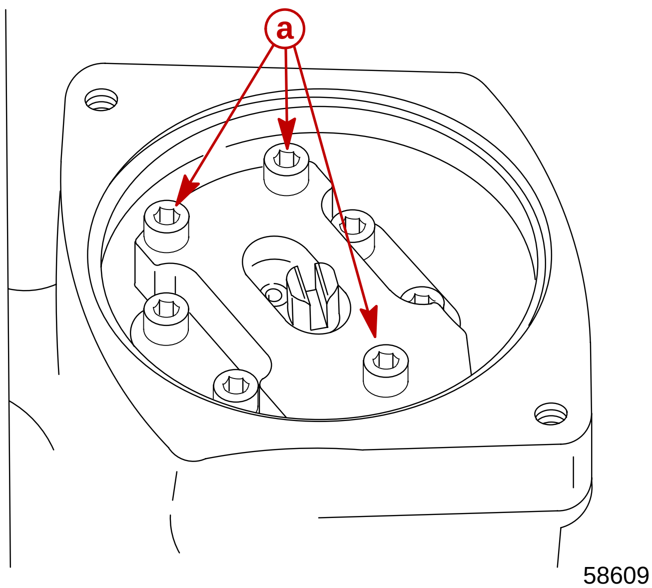
a - Screws and Washers
b - O-Ring (YELLOW)

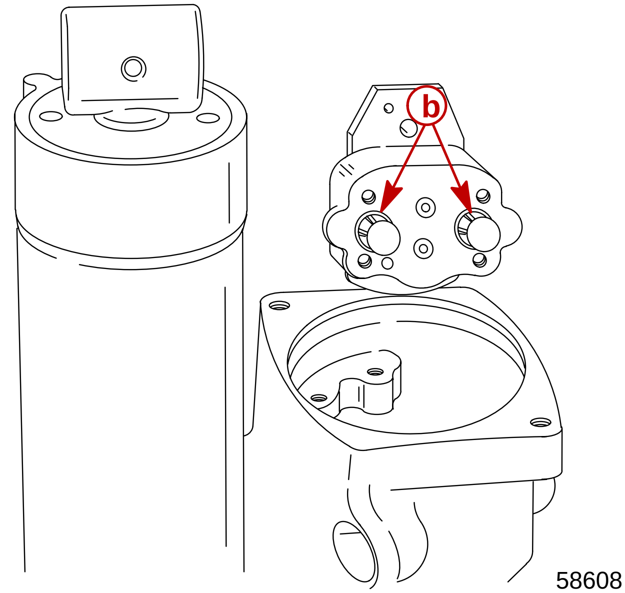
Pump and Component Removal

1. Remove 3 screws securing oil pump.

NOTE: *There are no serviceable parts within the oil pump. Failure of or damage to internal components of the pump requires pump assembly replacement.*

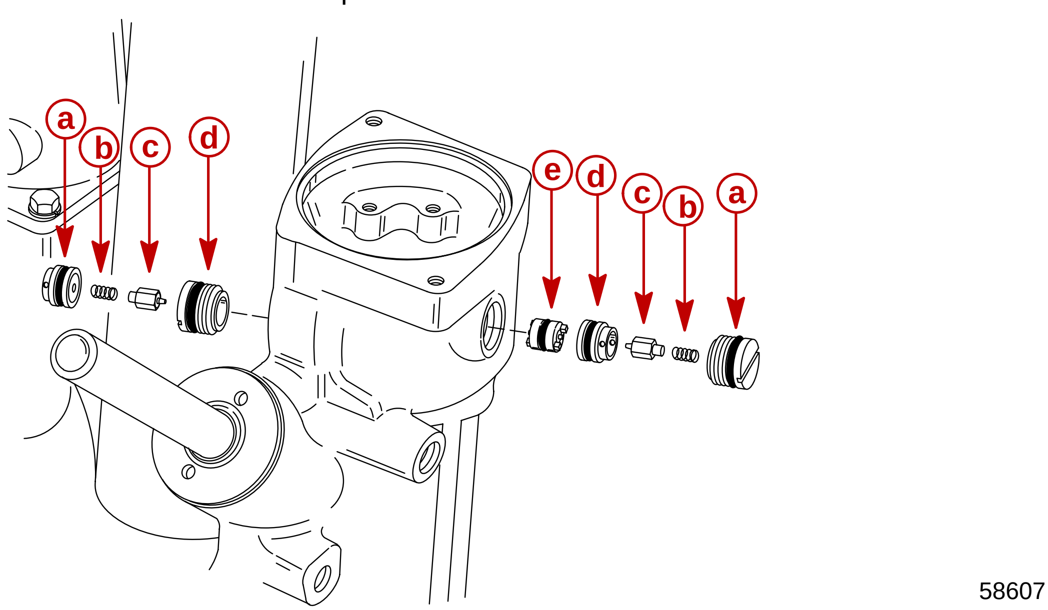
2. Inspect filter/o-ring assemblies on bottom of oil pump. Replace as required.





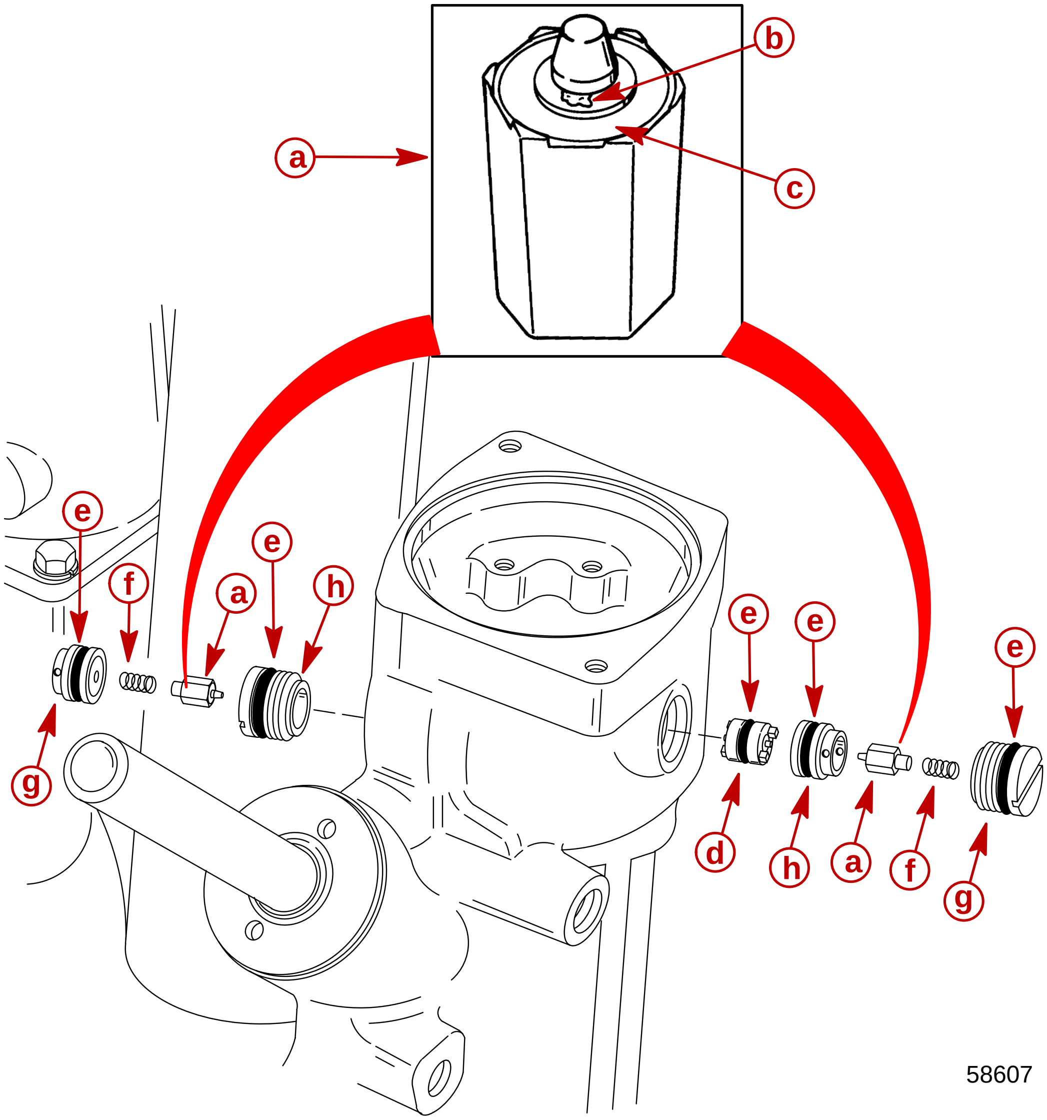
a - Screws
b - Filter/O-ring Assemblies

3. Remove both plugs in manifold. Remove springs, poppet/check valves and seats from both sides. Remove spool.



a - Plugs
b - Springs (2)
c - Poppet/Check Valves (2)
d - Seats (2)
e - Spool

IMPORTANT: Inspect poppet assembly for debris in the area shown. If debris is found on poppet, replace poppet. Inspect o-rings on both seats and spool for cuts or abraisions. Replace o-rings as required.



a - Poppet Assembly
b - Debris on Rubber Seat
c - Neoprene Seat
d - Spool
e - O-Rings
f - Spring
g - Cap
h - Seat

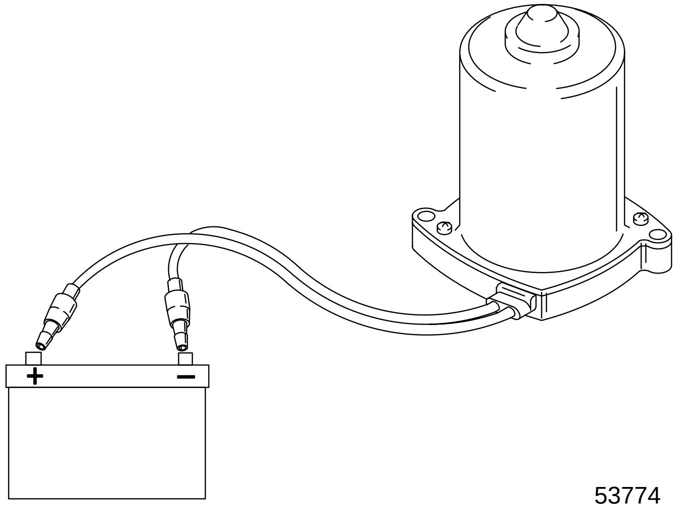
Motor and Electrical Tests/Repair

Trim Pump Motor Test

WARNING

Do not perform this test near flammable materials, as a spark may occur while making electrical connections.

1. Connect a 12 volt power supply to motor wires; one motor lead to POSITIVE (+) battery terminal and the other motor lead to the NEGATIVE (–) battery terminal. Motor should run. Reverse motor leads between battery terminals. Motor should run.

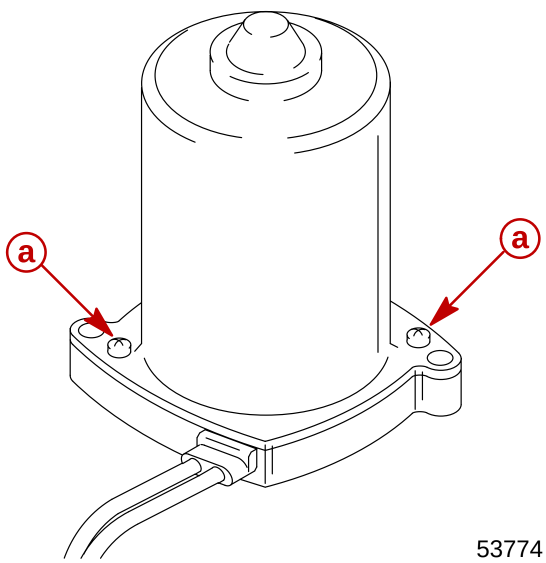


53774

2. If motor does not run, disassemble and check components.

Motor Disassembly

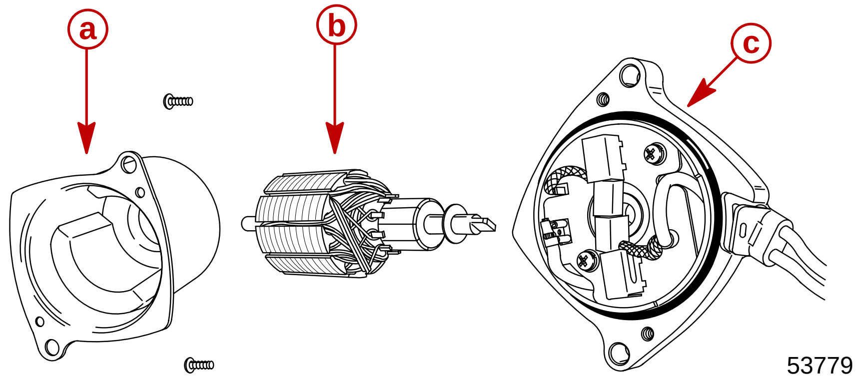
1. Remove 2 screws.



53774

a - Screw (2)

2. Remove frame and armature from end cap. Use care not to drop armature.



a - Can
b - Armature
c - End Cap

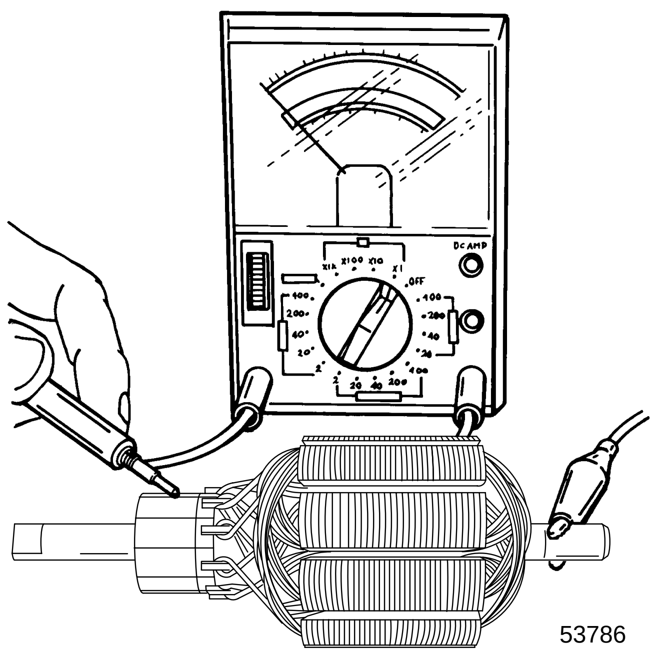
Armature Tests

TEST FOR SHORTS

Check armature on a Growler per the Growler manufacturer's instructions. Replace armature if a short is indicated.

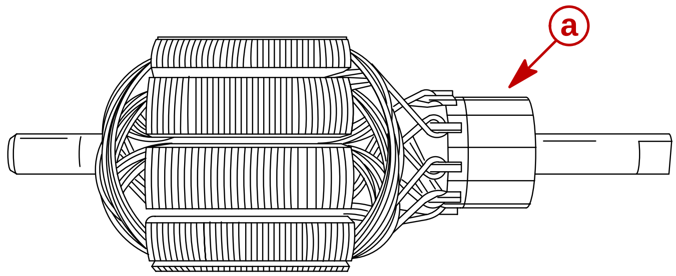
TEST FOR GROUND

1. Use an Ohmmeter (Rx1 scale). Connect one lead on armature shaft and other lead on commutator. If continuity is indicated, armature is grounded. Replace armature.



CHECKING AND CLEANING COMMUTATOR

1. If commutator is worn, replace armature.



a - Commutator

FIELD TESTS

IMPORTANT: Commutator end of armature must be installed in brushes when performing the following tests.

Ohmmeter Leads Between	Resistance (Ohms)	Scale Reading* (x____________)
BLUE and GREEN Motor Wires	0	(Rx1)
GREEN Motor Wire, and Frame (Motor Housing)	No Continuity	(Rx1)
BLUE Motor Wire and Frame	No Continuity	(Rx1)

*If specified readings are not obtained, check for:

- defective armature
- dirty or worn brushes
- dirty or worn commutator

If defective components are found, repair or replace component(s) and retest.

Motor Repair

REMOVAL

NOTE: *Power Trim System does not have to be removed from outboard to repair/replace motor.*

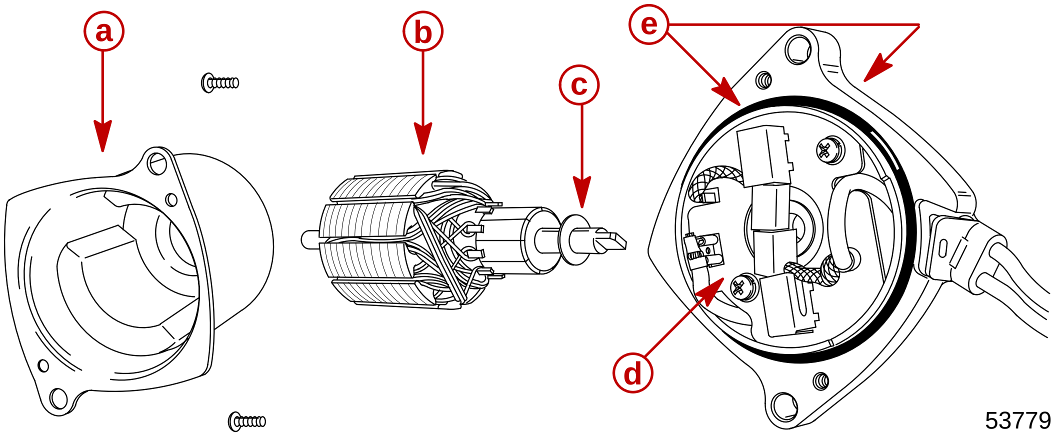
DISASSEMBLY

Trim outboard to the full "UP" position and engage tilt lock lever. Open reservoir plug to relieve pressure, then retighten. Use a SNAP ON [5 mm (FABLM5)] ball end allen bolt driver to remove the 2 motor mounting bolts.

Refer to **"Motor Disassembly"** on page 5B-39 to disassemble motor from pump.

CLEANING AND INSPECTION

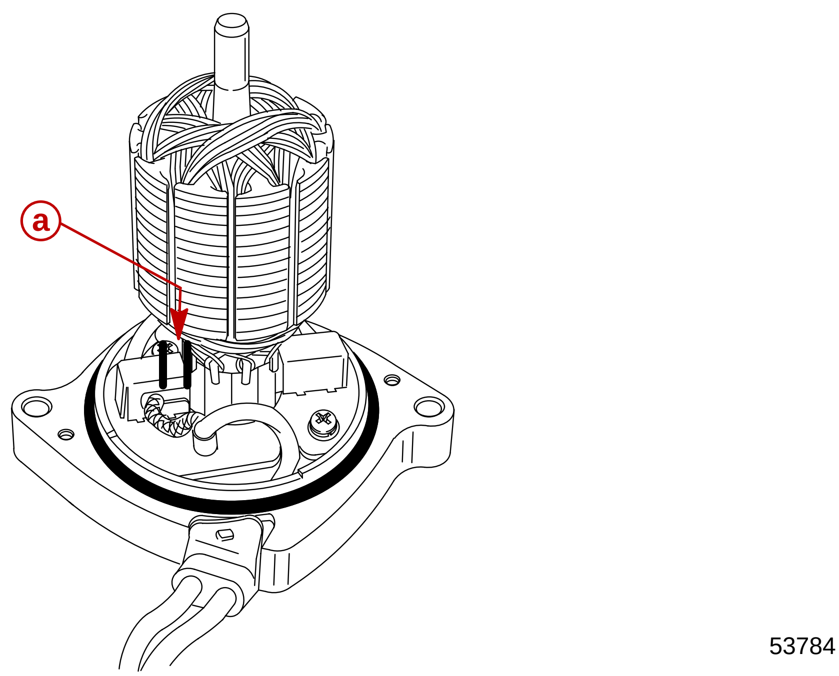
Inspect O-rings and replace if necessary. Carefully inspect power cord for cuts or tears which will allow water to enter motor. If cord is cut or torn, replace motor and power cord as an assembly. Clean, inspect, and test motor components. Refer to **"Brush Replacement"**, **"Armature Test"**, and **"Field Tests"** for inspection and test procedures.



a - Can
b - Armature
c - Shim
d - Motor End Frame Assembly
e - O-rings

BRUSH REPLACEMENT

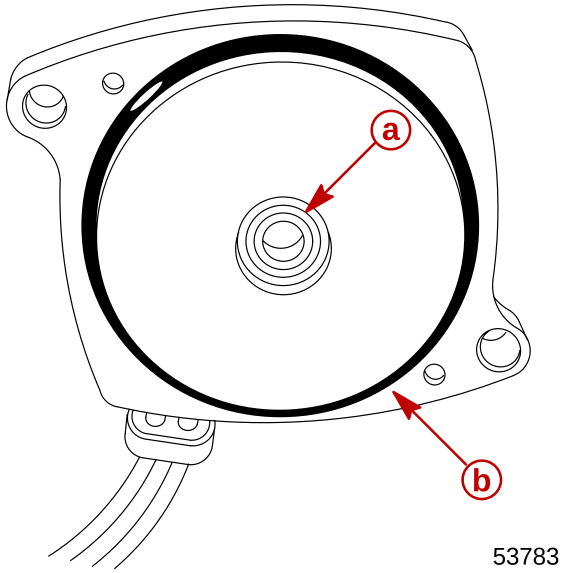
If brushes are pitted, chipped, or if distance (a) between the brush pigtail and end of brush holder slot is 1/16 in. or less, complete motor end must be replaced (brushes are not available separately). Check brush distance with armature installed.

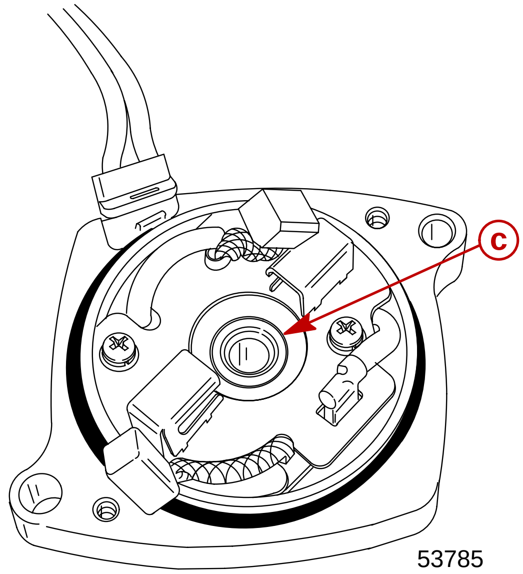


a - 1/16 in.

END CAP INSPECTION

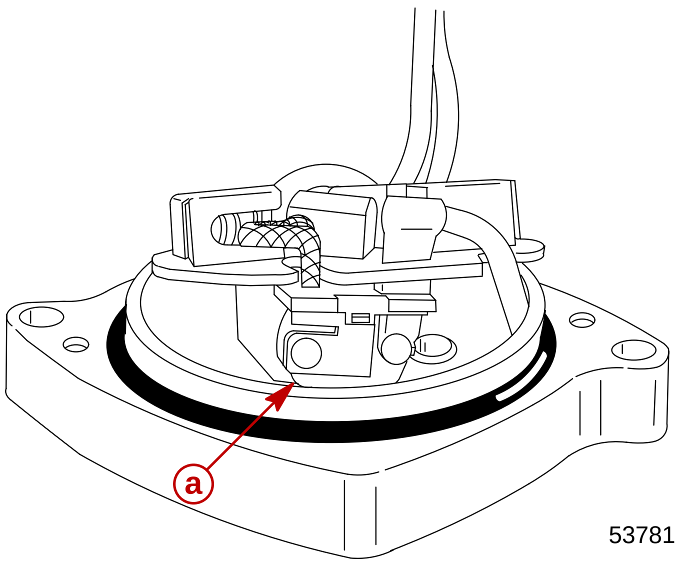
1. Inspect seal and O-ring for cuts and abraisions.
2. Inspect bushing for wear. If bushing appears to be excessively worn – grooves, scratches, etc. – install END FRAME ASSEMBLY (COMPLETE).





a - Seal (Apply 2-4-C w/Teflon to seal lips)
b - O-ring
c - Bushing

3. If trim motor is overheated, a thermoswitch located on the brush card will open. Normally, this switch will reset itself within 1 minute.

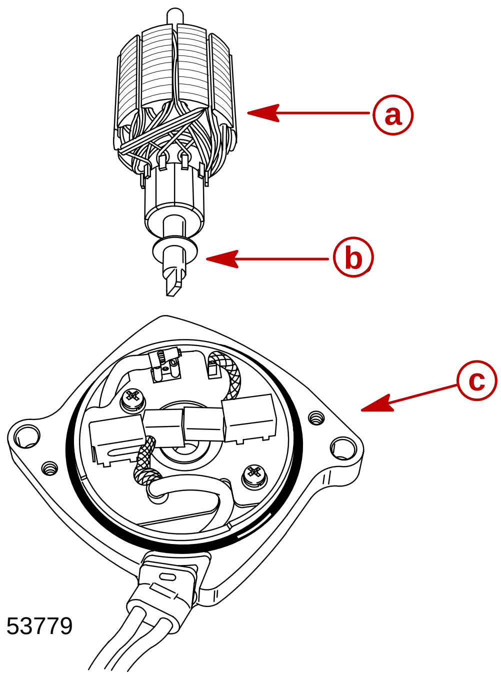


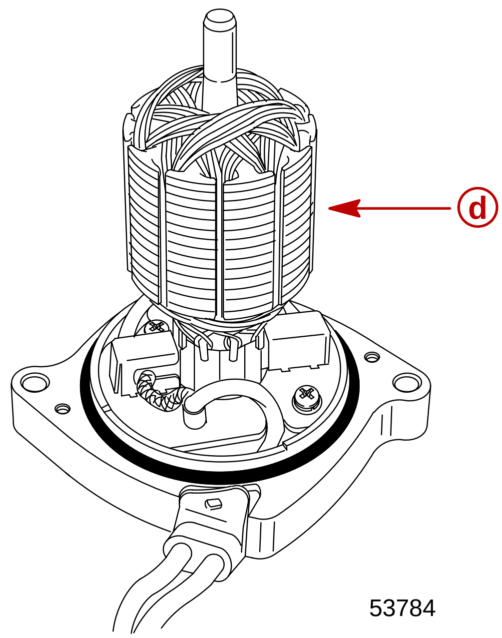
a - Thermoswitch

Reassembly

IMPORTANT: Components must be clean. Any debris in power trim system can cause system to malfunction.

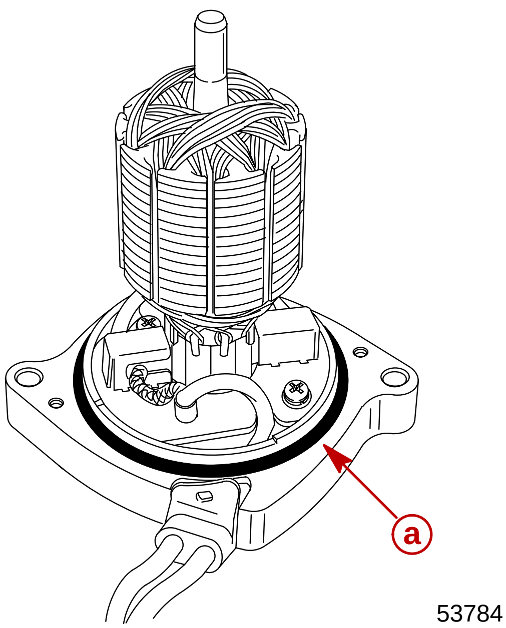
1. Install armature into end cap/brush card assembly.

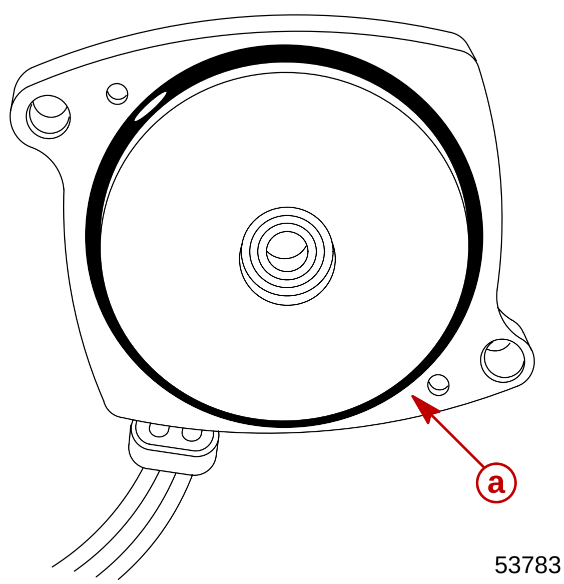




a - Armature
b - Shim
c - End Cap Assembly
d - Armature (Spread brushes to install armature into end cap)

2. Install O-rings in end cap.

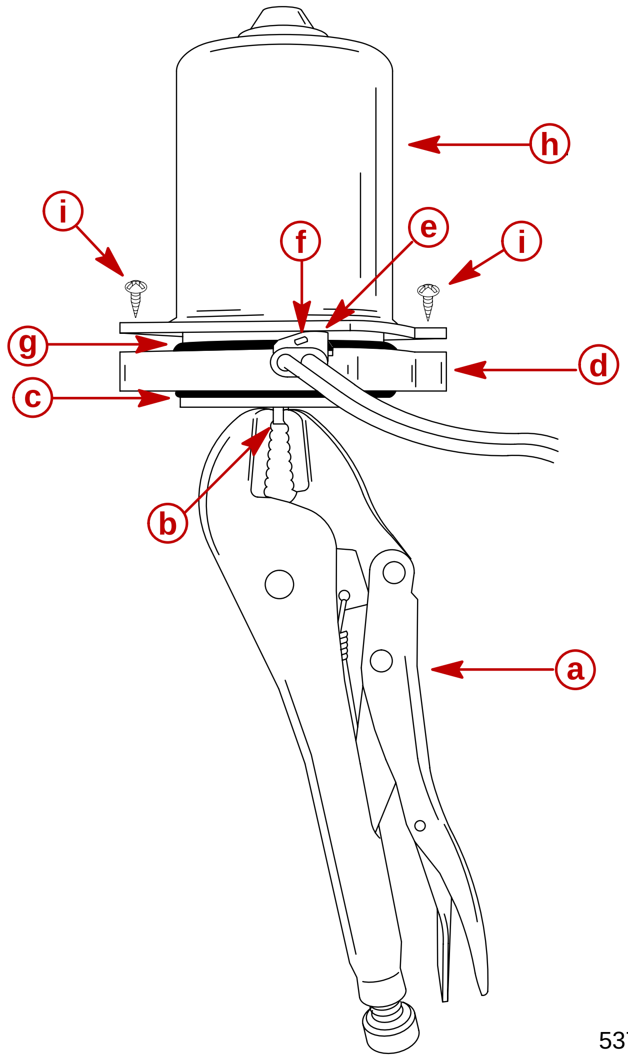




a - O-rings

IMPORTANT: Attach Vise Grip® pliers to armature shaft before installing frame assembly. The Vise Grip® pliers will prevent the armature from being drawn out of the brush card assembly by the frame magnets while installing the frame assembly.

3. Install Vise Grip® pliers on armature shaft.
4. Carefully install can over armature.
5. Position harness retainer hole over tab in end cap.
6. Secure frame assembly to end cap with 2 screws.



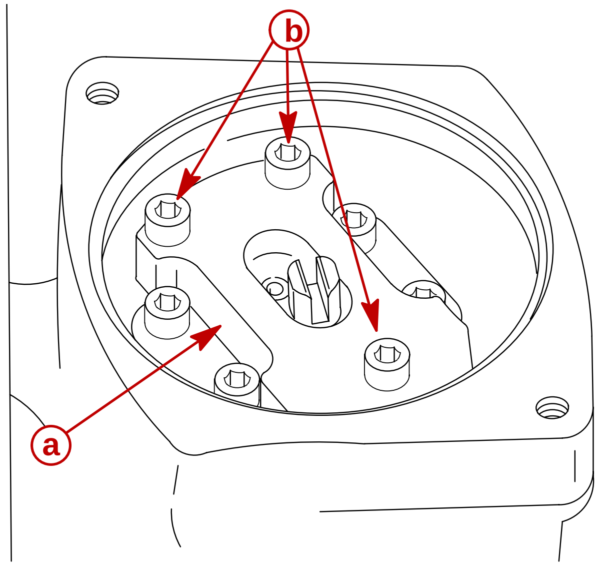
53776

- **a** - Vise Grip® Pliers
- **b** - Armature Shaft
- **c** - O-ring
- **d** - End Cap
- **e** - Harness Retainer
- **f** - Retainer Hole
- **g** - O-ring
- **h** - Can
- **i** - Screws (Drive Tight)

Reassembly - Motor and Pump

NOTE: *Drive shaft is a loose part and may fall out of position.*

1. Install pump into power trim manifold. Insure O-rings are in proper locations. Secure with 3 screws. Torque screws to 60 lb. in. (7 N·m).



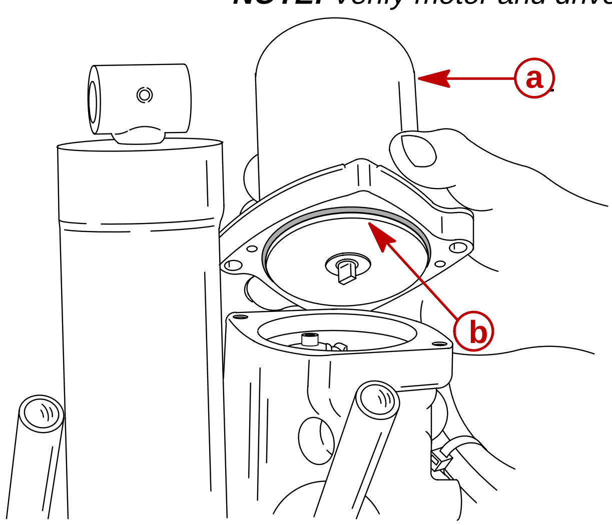
58609

a - Oil Pump
b - Screws (3) Torque to 60 lb. in. (7 N m)]

IMPORTANT: Install pump with location flat facing towards starboard transom bracket.

2. Fill pump with ATF Dexron III or Quicksilver Power Trim and Steering Fluid prior to installing motor.
3. Install motor, secure with 2 screws. Torque screw to 80 lb. in. (9 N m). Route wiring; refer to Wiring Diagrams in this service manual.

NOTE: *Verify motor and drive shaft are aligned.*



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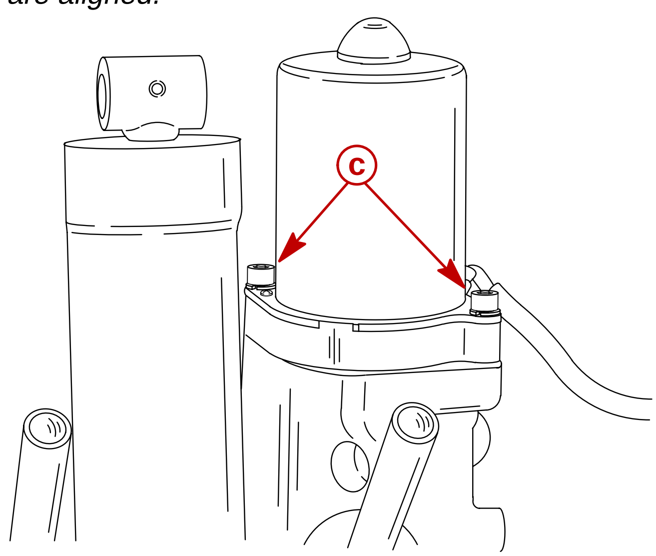
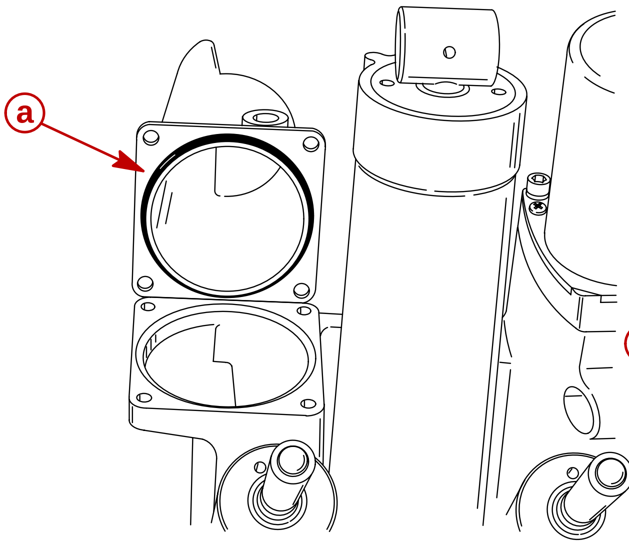


58611

a - Motor
b - O-ring
c - Screw (2) Torque to 80 lb. in. (9 N m).

4. Reinstall reservoir cover. Verify cover o-ring is in place and in serviceable condition. Secure cover with 4 screws. Torque screws to 60 lb. in. (7 Nm).



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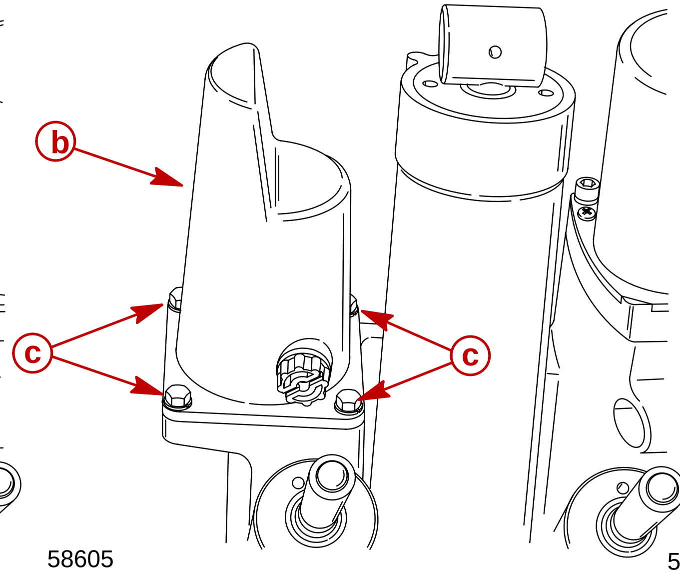


58606

a - O-Ring
b - Reservoir Cover
c - Screws [Torque to 60 lb. in. (7 Nm)]

5. Complete reassembly of Power Trim System as outlined in **"Installation"** on page 5C-31.

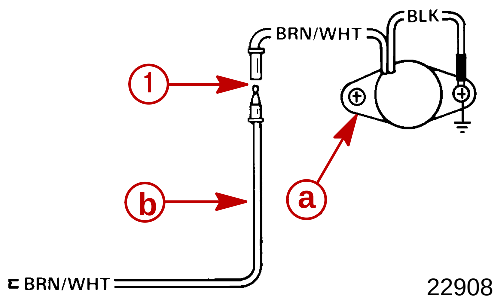
Priming Power Trim System

1. Fill system with Quicksilver Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) Dexron III. Refer to **"Fill, Check, and Purge"** on page 5B-10.

IMPORTANT: Run Trim System in short "jogs" until pump motor primes and trim system moves. If trim motor is run without priming pump, drive shaft failure could result.

Analog Trim Sender Test

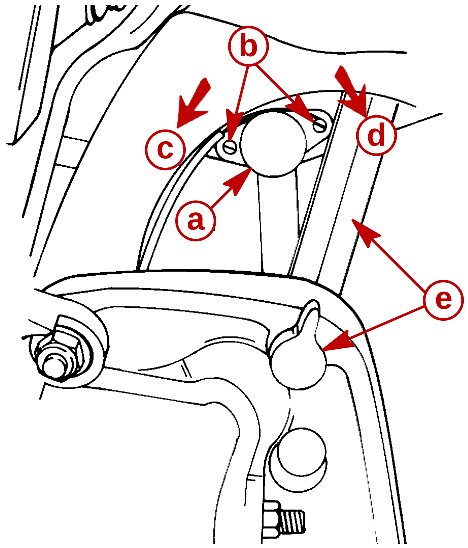
1. Check trim sender black lead for proper ground.
2. Trim outboard to full "DOWN" position.
3. Place ignition switch to "ON" position.
4. Disconnect BRN/WHT trim sender wire from trim sender harness.
5. Connect Ohmmeter (Rx1 scale) leads between outboard ground and Point 1 (trim sender end).
6. Depress "UP" button. Ohmmeter needle should move as the outboard is trimmed up. If needle does not move, trim sender is defective.



a - Trim sender

Trim Indicator Gauge Needle Adjustment

1. Turn ignition key to "RUN" position.
2. Tilt outboard to full "IN" position. Needle of trim indicator gauge should be in full "IN" position.
3. If not, tilt outboard to full "OUT" position to gain access to trim sender and engage tilt lock lever.
4. Loosen trim sender screws and reposition trim sender.
5. Tighten trim sender screws.

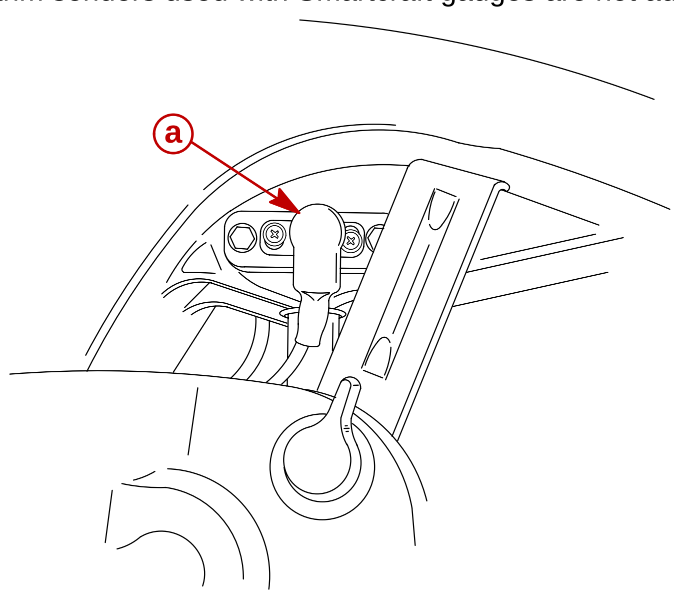


22744

a - Trim Sender
b - Screws, Loosen to Rotate Sender
c - Turn Sender **Counterclockwise** to raise needle reading
d - Turn Sender **Clockwise** to Lower Needle Reading
e - Tilt lock lever

Digital Trim Sender

Digital trim senders used with Smartcraft gauges are not adjustable.



58451

a - Digital Trim Sender

Troubleshooting Digital Trim Sender

Trim sender requires a 5 vdc reference signal from ECU. With the ignition switch in the RUN position and using an appropriate probe (paper clip, etc.) inserted in parallel at the trim sender bullet connectors, this voltage can be checked as follows:

Voltmeter	Sender Harness	Voltage
RED	BLUE	4 – 5 vdc
BLACK	BLACK	

NOTE: *5vdc reference voltage at the ECU can be monitored by the Digital Diagnostic Terminal. Voltage should be 5 vdc ± 0.1 v. Any other voltage indicates a defective ECU. If ECU reference voltage is correct, but voltage at trim sender is low or not existent, inspect sender wiring and connections.*

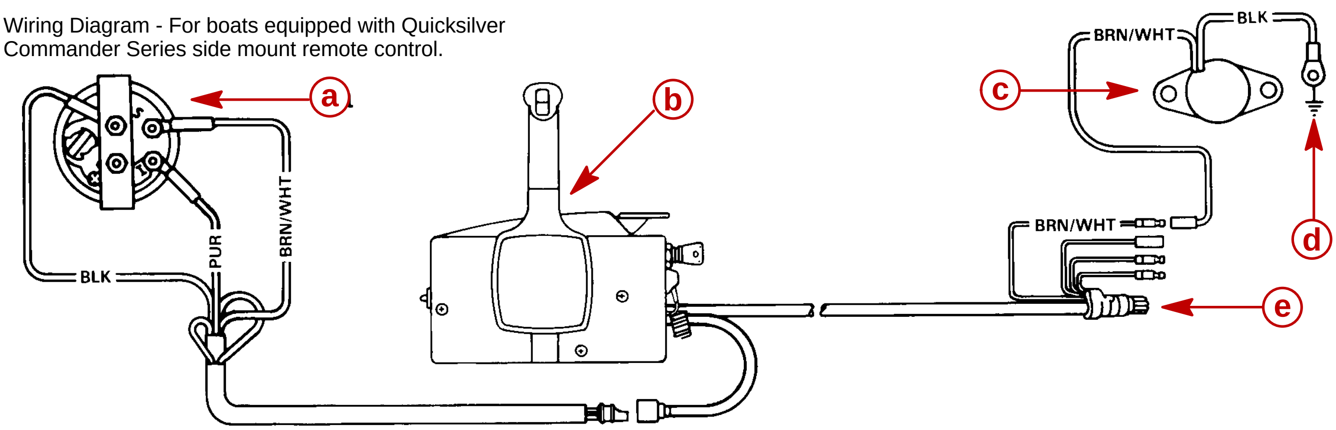
Voltage at trim sender should rise and fall smoothly as outboard is raised or lowered. Voltage at the full UP position should be 4 vdc ± 0.5v. Voltage at the full DOWN position should be 1.5 vdc ± 0.5 v. With the ignition switch in the RUN position and using an appropriate probe (paper clip, etc.) inserted in parallel at the trim sender bullet connectors, this voltage can be checked as follows:

Voltmeter	Sender Harness	FULL UP	FULL DOWN
RED	YELLOW	4 vdc ± 0.5v	1.5 vdc ± 0.5v
BLACK	BLACK		

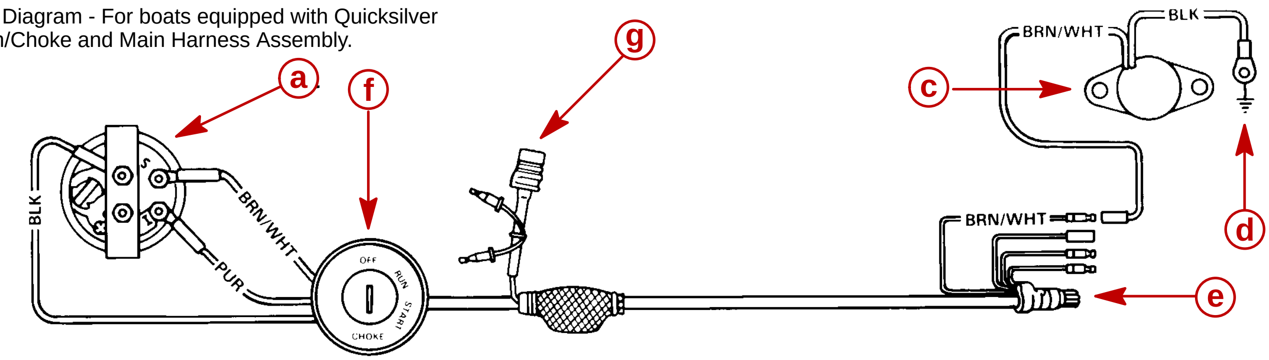
If voltage is not as indicated or voltage rise and fall is erratic, trim sender is defective.

Trim Indicator Wiring Diagrams

Wiring Diagram - For boats equipped with Quicksilver Commander Series side mount remote control.



Wiring Diagram - For boats equipped with Quicksilver Ignition/Choke and Main Harness Assembly.



22908

- **a** - Trim Indicator
- **b** - Remote Control
- **c** - Trim Sender
- **d** - Engine Ground
- **e** - To Engine
- **f** - Ignition Switch
- **g** - Power Trim Harness

LOWER UNIT

Section 6A – Right Hand Non-Ratcheting

Table of Contents

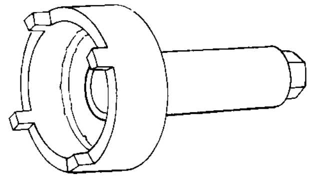
Gear Housing Specifications (Standard Rotation)

Ratio	Pinion Depth	Forward Gear Backlash	Reverse Gear Backlash
1.75:1 1.87:1	0.025 in. (0.635 mm) With Tool 91-12349A2 using Disc #2 and Flat #4	0.017 in. to 0.028 in. (0.431 mm to 0.711 mm) Pointer on line mark #1	0.030 in. to 0.050 in. (0.762 mm to 1.27 mm)
Gearcase Lubricant Capacity			
All Ratios	27.0 fl. oz. (798.0 ml)		
Gearcase Pressure Check			
Gearcase without Oil	Gearcase should hold 15 psi for 5 minutes without leakage		

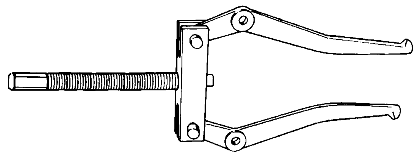
Gear Ratio	Teeth on Pinion Gear	Teeth on Forward and Reverse Gear
1.75:1	12	21
1.87:1	15	28

Special Tools

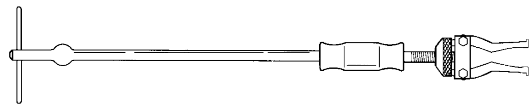
1. Gear Housing Cover Nut Tool 91-61069



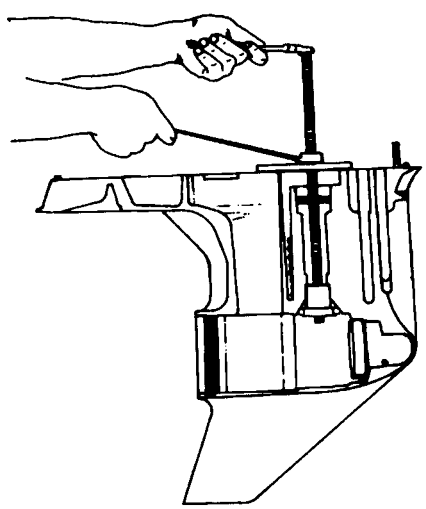
2. Bearing Carrier Removal Tool 91-46086A1 and Puller Bolt 91-85716



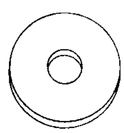
3. Slide Hammer Puller 91-34569A1



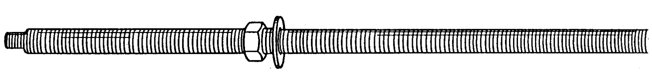
4. Bearing Removal and Installation Kit 91-31229A5. This kit contains the following tools: Pilot 91-36571; Puller Rod 91-31229; Nut 11-24156; Puller Plate 91-29310; Mandrel 91-38628; and Driver Rod 91-37323.



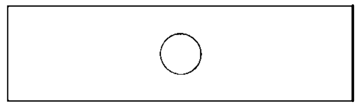
5. Pilot 91-36571



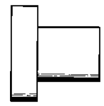
6. Puller Rod 91-31229 and Nut 91-24156



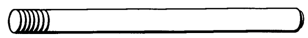
7. Puller Plate 91-29310



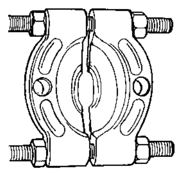
8. Mandrel 91-38628



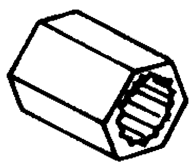
9. Driver Rod 91-37323



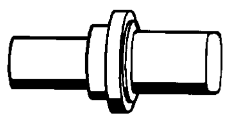
10. Universal Puller Plate 91-37241



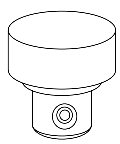
11. Driveshaft Holding Tool 91-56775



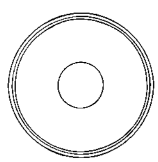
12. Oil Seal Driver 91-31108



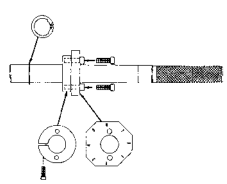
13. Forward Gear Bearing Tool 91-877321A1

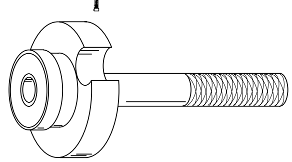


14. Bearing Driver Cup 91-31106

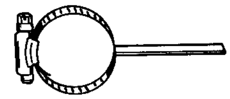


15. Pinion Locating Gear Tool 91-12349A2 or 91-74776

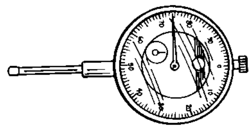




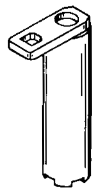
16. Backlash Indicator Rod 91-53459 for (1.75:1 ratio) and 91-78473 for (1.87:1 ratio)



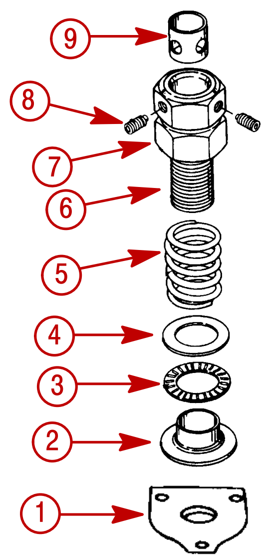
17. Dial Indicator 91-58222A1



18. Bearing Retainer Tool 91-43506

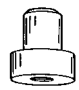


19. Bearing Preload Tool 91-14311A2



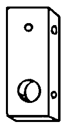
1 - Plate (44307)
2 - Adaptor (N.S.S.)
3 - Bearing (N.S.S.)
4 - Washer (N.S.S.)
5 - Spring (24-14111)
6 - Bolt (10-12580)
7 - Nut (11-13953)
8 - Set Screw (10-12575)
9 - Sleeve (23-13946)

20. Mandrel 91-92788

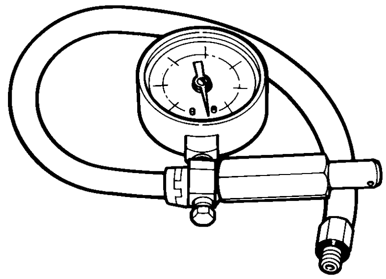


21. Mandrel 91-15755

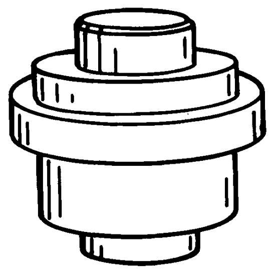
22. Dial Indicator Holder 91-89897



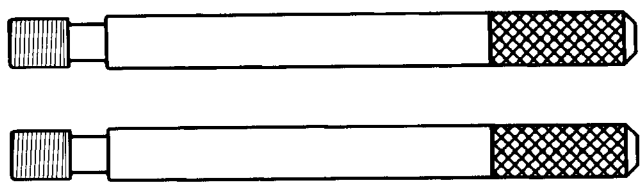
23. Leakage Tester FT8950



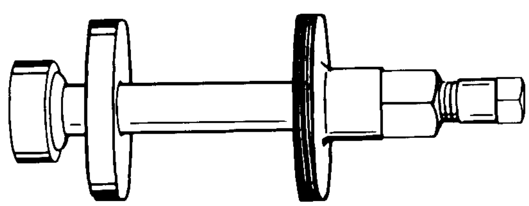
24. Oil Seal Driver 91-817569



25. Water Pump Alignment Pins 91-821571A1



26. Bearing Adaptor Installation Tool 91-18605A2



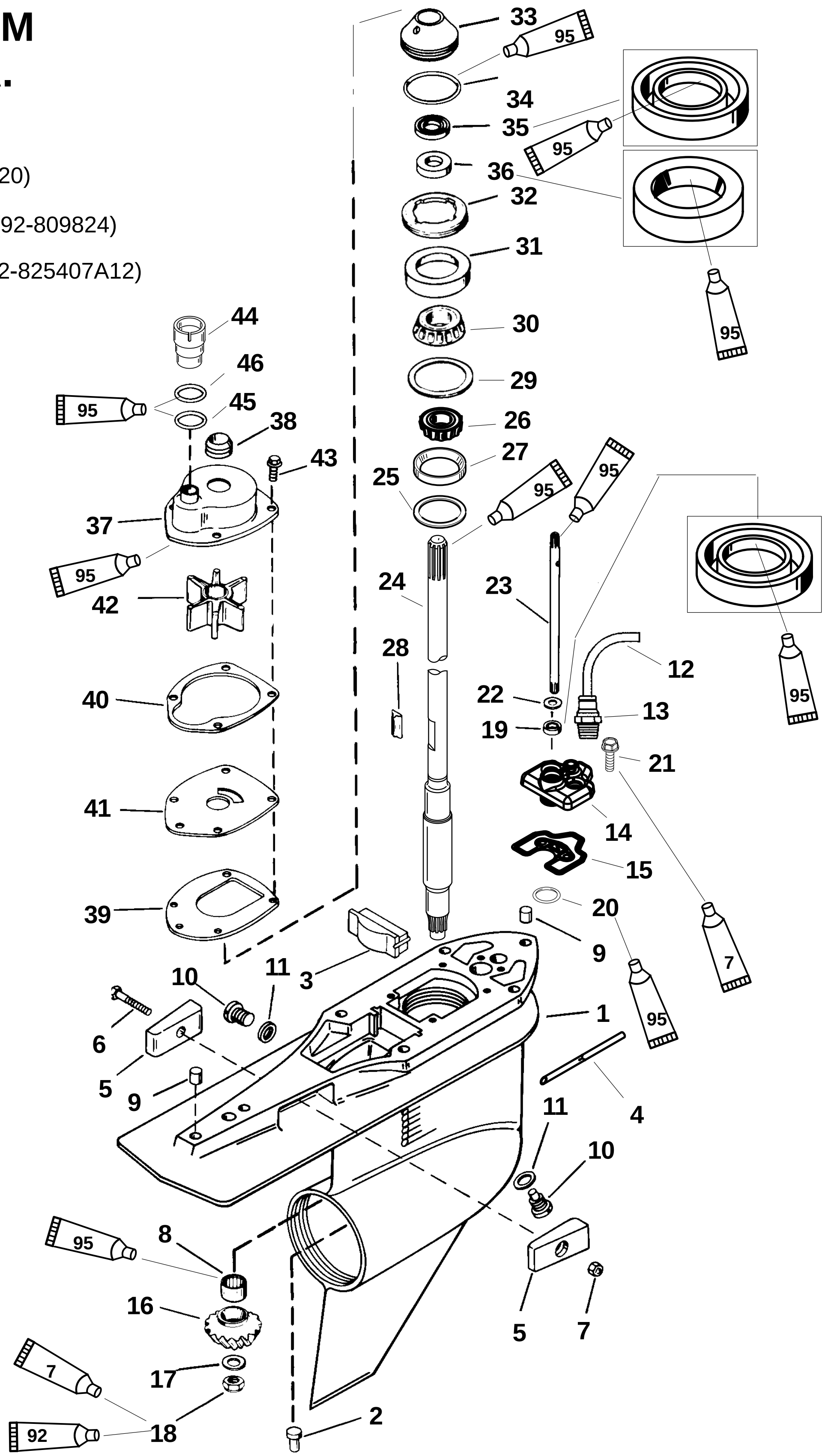
Gear Housing (Drive Shaft)(Standard Rotation)

4.75 IN/120.65MM TORPEDO DIA.

7 Loctite 271 (92-809820)

92 Loctite 7649 Primer (92-809824)

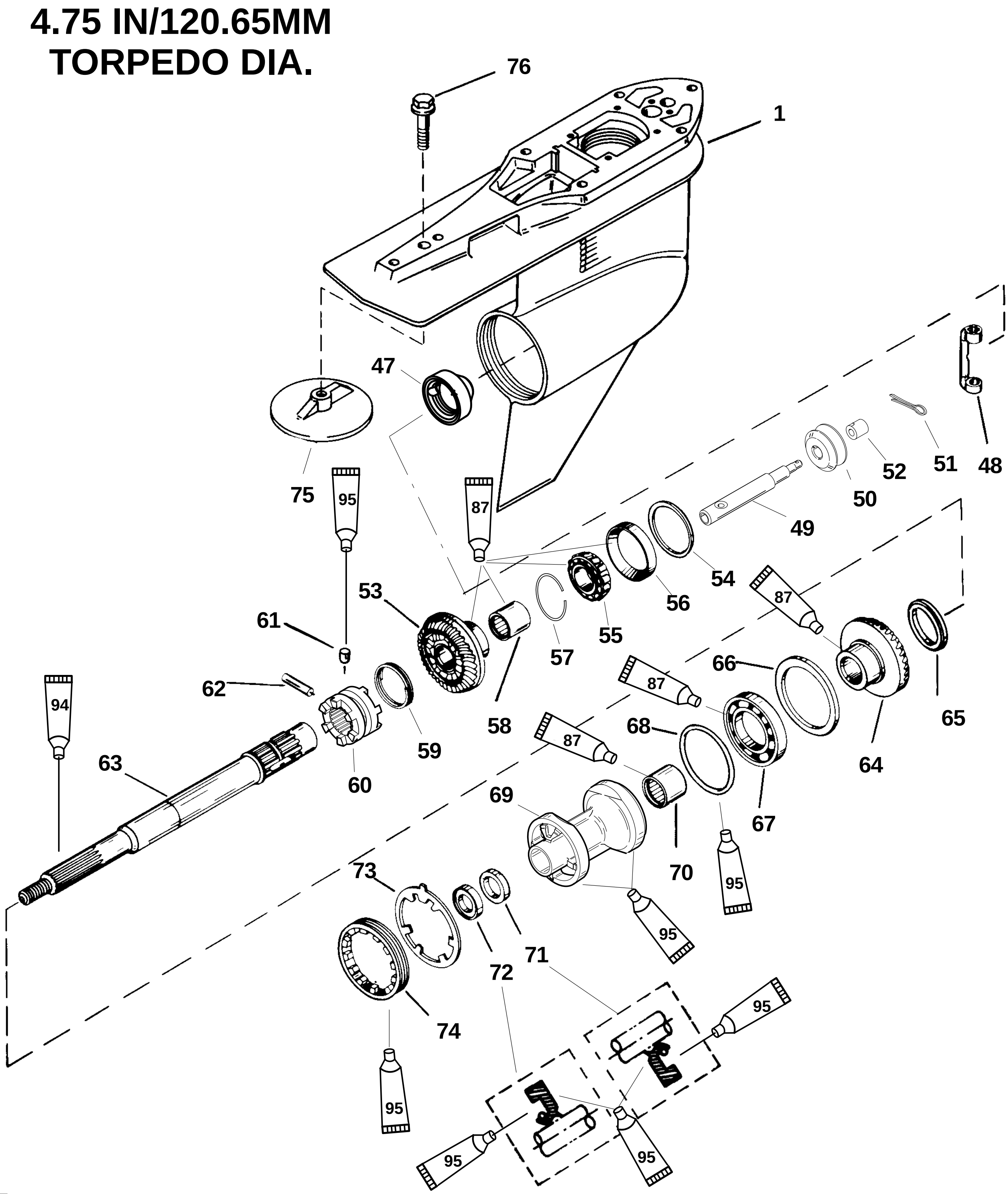
95 2-4-C With Teflon (92-825407A12)



Gear Housing (Drive Shaft)(Standard Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	GEAR HOUSING **(BASIC)**			
2	1	PIN			
3	1	FILLER BLOCK			
4	1	PITOT TUBE			
5	2	ANODE			
6	1	SCREW	60		7
7	1	NUT			
8	1	ROLLER BEARING			
9	2	DOWEL PIN			
10	2	SCREW ASSEMBLY	60		7
11	2	SEALING WASHER			
12	1	HOSE**(LONG - 7 IN)**			
	1	HOSE **(X-LONG - 12 IN)**			
	1	HOSE**(XX-LONG - 17 IN)**			
13	1	CONNECTOR			
14	1	COVER			
15	1	GASKET			
16	1	PINION GEAR **(1.75:1 - 12/21) (Part of 43-859321A3)**			
17	1	WASHER			
18	1	NUT		70	95
19	1	OIL SEAL			
20	1	O RING			
21	2	SCREW (M6 x 16)	60		7
22	1	RUBBER WASHER			
23	1	SHIFT SHAFT (LOWER)			
24	1	DRIVE SHAFT **(LONG)**			
	1	DRIVE SHAFT **(X-LONG)**			
	1	DRIVE SHAFT **(XX-LONG)**			
25	AR	SHIM SET			
26	1	TAPERED ROLLER BEARING			
27	1	CUP			
28	1	KEY			
29	AR	SHIM SET			
30	1	TAPERED ROLLER BEARING			
31	1	CUP			
32	1	RETAINER		100	135
33	1	CARRIER ASSEMBLY			
34	1	O RING			
35	1	OIL SEAL			
36	1	OIL SEAL			
37	1	WATER PUMP ASSEMBLY			
38	1	SEAL			
39	1	GASKET			
40	1	GASKET			
41	1	FACE PLATE			
42	1	IMPELLER			
43	4	SCREW (M6 x 16)	60		7
44	1	COUPLING ASSEMBLY			
45	1	O RING			
46	1	O RING			

Gear Housing (Prop Shaft)(Standard Rotation)



87 Quicksilver Gear Lubricant (92-19007A24)

94 Anti-Corrosion Grease (92-78376-A6)

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

Gear Housing (Prop Shaft)(Standard Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	GEAR HOUSING **(BASIC)**			
47	1	PLUG			
48	1	SHIFT CRANK			
49	1	SHAFT			
50	1	SHIFT SPOOL			
51	1	COTTER PIN			
52	1	SLEEVE			
53	1	FORWARD/PINION GEAR SET **(1.75:1 - 12/21)**			
54	AR	SHIM SET			
55	1	TAPERED ROLLER BEARING			
56	1	CUP			
57	1	RETAINING RING			
58	1	ROLLER BEARING			
59	1	SPRING			
60	1	SLIDING CLUTCH			
61	1	DETENT PIN			
62	1	CROSS PIN			
63	1	PROPELLER SHAFT			
64	1	REVERSE GEAR **(1.75:1 - 12/21)**			
65	1	THRUST SPACER			
66	1	THRUST RING			
67	1	BALL BEARING			
68	1	O RING			
69	1	BEARING CARRIER			
70	1	ROLLER BEARING			
71	1	OIL SEAL (INSIDE)			
72	1	OIL SEAL (OUTSIDE)			
73	1	TAB WASHER			
74	1	COVER		210	285
75	1	ANODIC PLATE			
76	1	SCREW		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. It is suggested that the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to "reassembly and installation" of that component in the reassembly part of this section. Use the "Table of Contents" (on back of section divider) to find correct page number.

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, be sure that no water is present in air line.

BEARINGS

Upon disassembly of gear housing, 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 thru 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 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 overheating. Always replace tapered bearing and race as a set.

Roller bearing condition is determined by inspecting the bearing 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 the conditions described are found.

SHIMS

Keep a record of all shim amounts and location during disassembly to aid in reassembly. Be sure to follow shimming instructions during reassembly, as gears must be installed to correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

SEALS

As a normal procedure, all O-rings and oil seals SHOULD BE REPLACED without regard to appearance. To prevent leakage around oil seals, apply Loctite 271 to outer diameter of all metal case oil seals. When using Loctite on seals or threads, surfaces must be clean and dry. To ease installation, apply Quicksilver 2-4-C w/Teflon Marine Lubricant on all O-rings. To prevent wear, apply Quicksilver 2-4-C w/Teflon Marine Lubricant on I.D. of oil seals.

To prevent corrosion damage after reassembly, apply Quicksilver 2-4-C w/Teflon Marine Lubricant to external surfaces of bearing carrier and cover nut threads prior to installation.

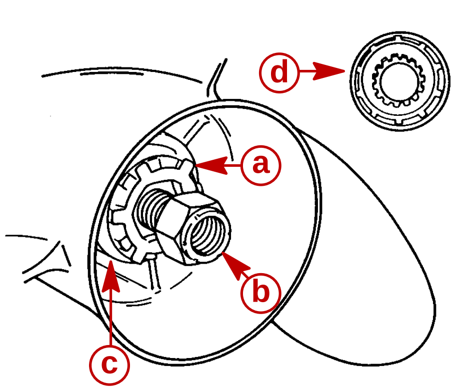
Removal, Disassembly, Cleaning and Inspection – Standard Rotation

Removal

⚠ WARNING

Disconnect high tension leads from spark plugs and remove spark plugs from engine before removing gear housing from driveshaft housing.

1. Disconnect high tension leads from spark plugs and remove spark plugs from engine.
2. Shift engine into NEUTRAL position.
3. Tilt engine to full up position and engage tilt lock lever.
4. Bend tabs of propeller tab washer away from thrust hub (rear), then remove propeller locknut, tab washer, thrust hub (rear), propeller and thrust hub (forward) from propeller shaft.
5. Mark gear housing and trim tab so that trim tab can be reinstalled in the same position. Remove plastic cap at rear edge of driveshaft housing. Remove bolt that secures trim tab and remove tab from gear housing.
6. Once trim tab is removed, remove bolt from inside of trim tab cavity.



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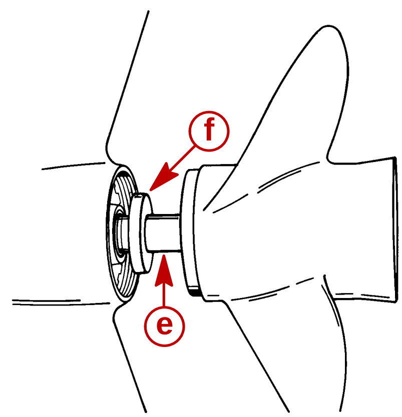

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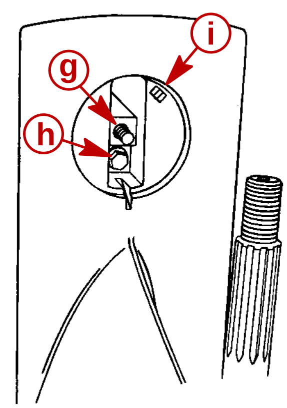

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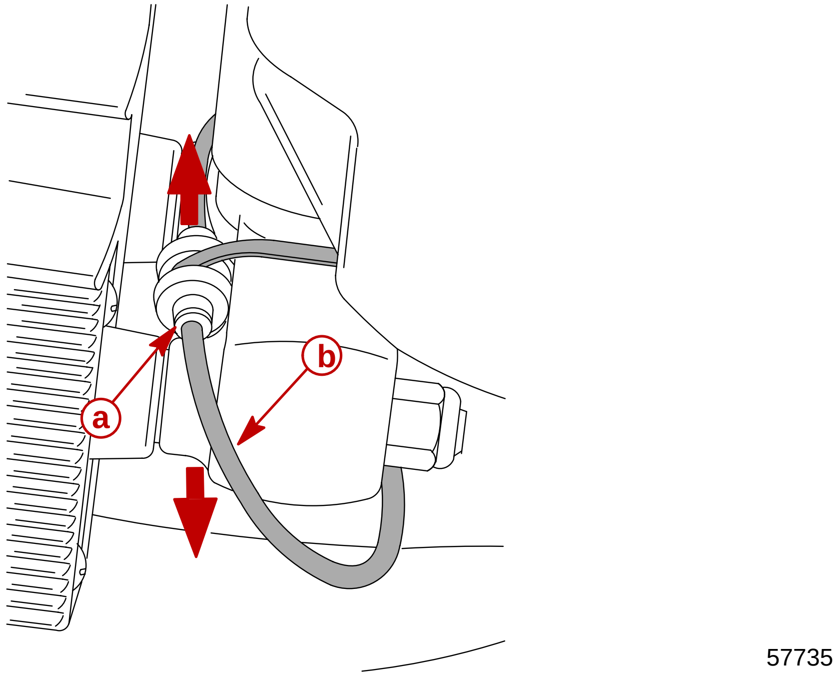
a - Tab Washer
b - Propeller Nut
c - Rear Thrust Hub
d - Continuity Washer (if equipped)
e - Propeller Shaft

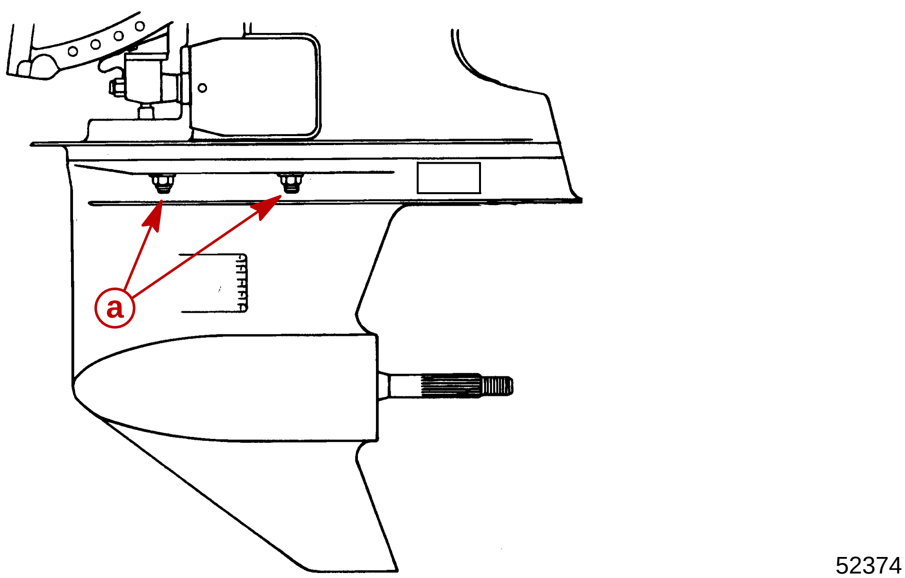
f - Thrust Hub (forward)
g - Bolt (secures trim tab)
h - Bolt (inside trim tab cavity)
i - Ribs – Align Carefully with Trim Tab while Securing Tab

7. While pressing in on speedometer hose junction, pull out on hose to disconnect.



a - Press in on Junction
b - Pull out on Hose

8. Loosen the side mounting locknuts. (Do not attempt to remove one nut before opposite side is loosened sufficiently, or gear housing could be damaged.)



a - Side Mounting Locknuts (2 each side)

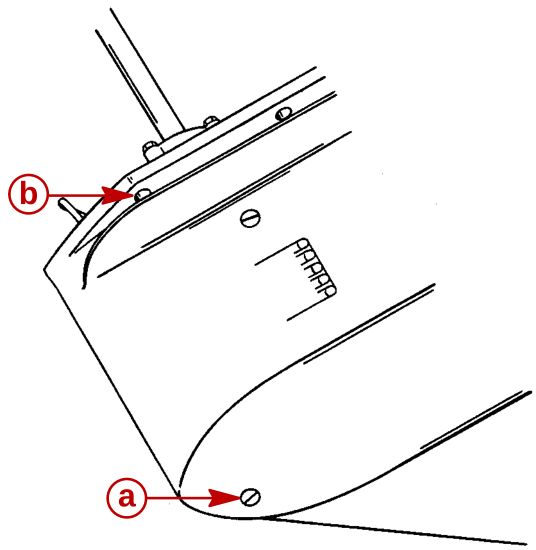
9. Pull gear housing away from driveshaft housing as far as the loosened nuts (in Step 8) will allow, then remove loosened nuts. (DO NOT allow gear housing to fall, as it now is free.)
10. Pull gear housing from driveshaft housing.

Draining and Inspecting Gear Housing Lubricant

1. Place gear housing in a suitable holding fixture or vise with the driveshaft in a vertical position.

NOTE: *Drain and Fill screws may be located on the starboard side of gearcase on later models.*

2. Position a clean drain pan under gear housing and remove “Fill” and “Vent” screws from gear housing.



a - “Fill” Screw
b - “Vent” Screw

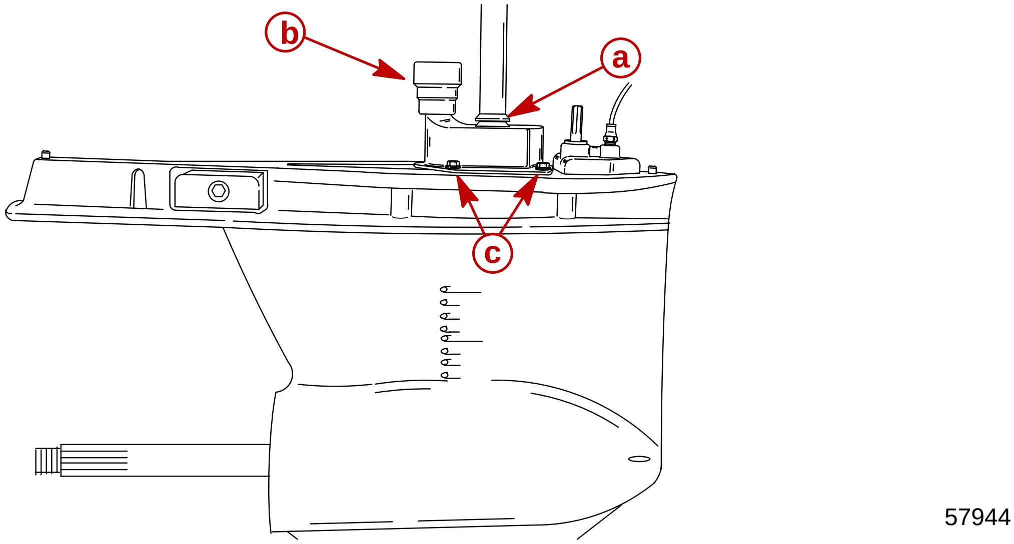
3. Inspect gear lubricant for metal particles. Presence of a small amount of fine metal particles (resembling powder) indicates normal wear. Presence of larger particles (or a large quantity of fine particles) indicates need for gear housing disassembly, and component inspection.
4. Note the color of gear lubricant. White or cream color indicates presence of water in lubricant. Check drain pan for water separation from lubricant. Presence of water in gear lubricant indicates the need for disassembly, and inspection of oil seals, seal surfaces, O-rings and gear housing components.

NOTE: *Gear lubricant drained from a recently run gear case will be a light chocolate brown in color due to agitation/aeration. Oil which is stabilized will be a clear yellow brown in color.*

Water Pump

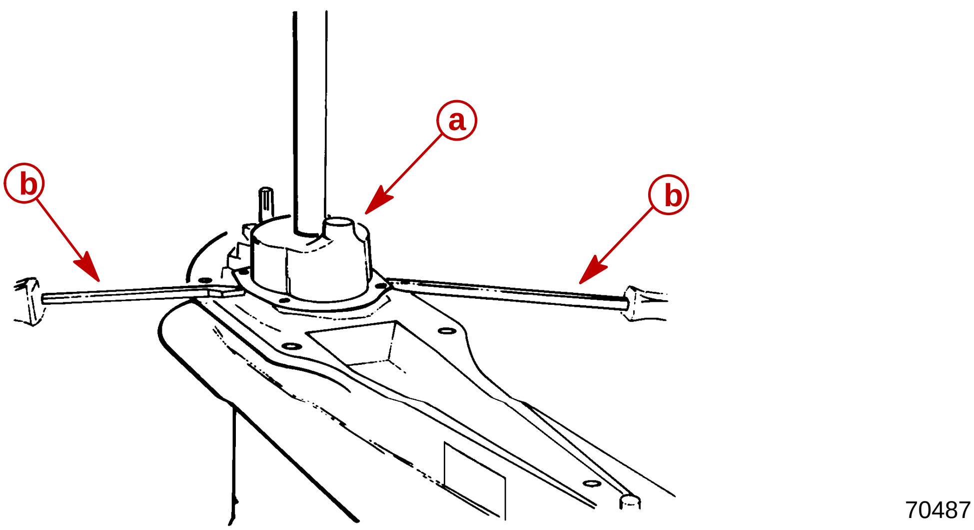
REMOVAL AND DISASSEMBLY

1. Remove the water seal, water tube coupling assembly, and the water pump screws.



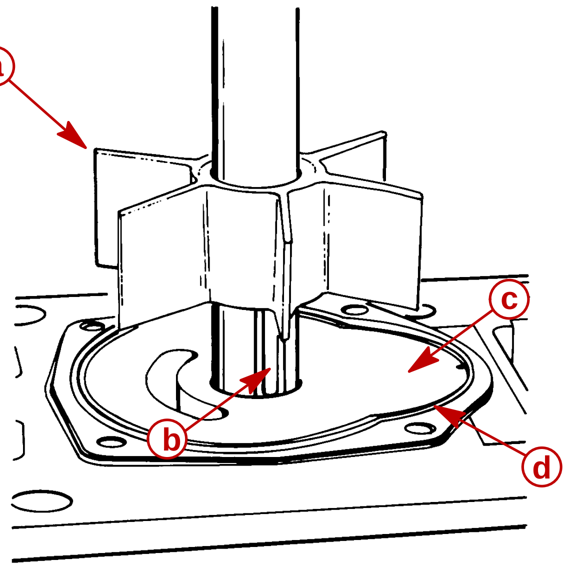
a - Water Seal
b - Water Tube Coupling
c - Water Pump Screws (4)

2. Carefully slide the water pump straight up off of the drive shaft. It may be necessary to encourage the water pump up by gently prying up on its mounting flanges with a couple of screwdrivers.



a - Water Pump Body
b - Screwdrivers

3. Remove the impeller, impeller key, the face plate and gaskets, (discard the gaskets).



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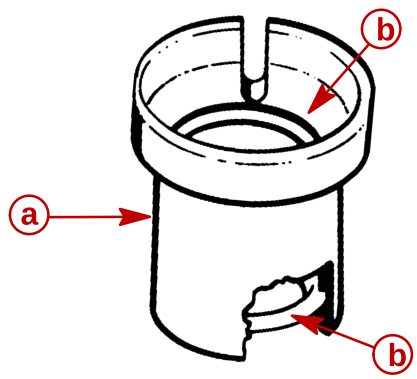
a - Impeller
b - Impeller Key
c - Water Pump Face Plate
d - Gasket (1 each side of face plate)

CLEANING AND INSPECTION

1. Inspect the water tube coupling assembly for wear or damage. If necessary replace the worn or damaged components especially the two O-rings on the inside, one at the top and one at the bottom.



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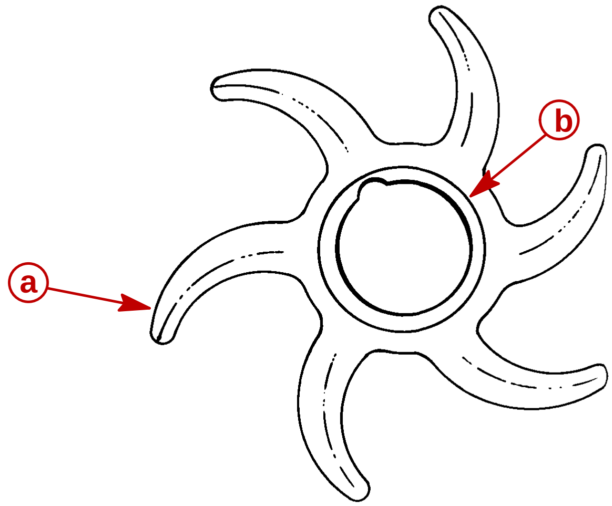
a - Water Tube Adaptor
b - O-rings (2)

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting cover and plate. The depth of the groove will not affect water pump output.

2. Inspect face plate and water pump cover for grooves and/or rough surfaces.
3. Replace cover and /or face plate if grooves (other than sealing grooves) are more than 0.030 in. (0.762 mm) deep.

4. Inspect impeller side seal surfaces and ends of impeller blades for cracks, tears and wear. Replace impeller if any of these conditions are found.
5. Inspect impeller bonding to impeller hub.
6. Inspect impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace impeller if any of these conditions exist.



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a - Impeller
b - Hub

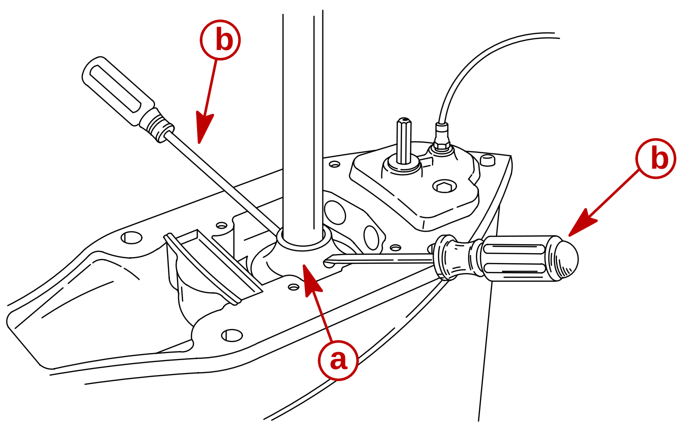
IMPORTANT: When completing gear housing repairs, that require removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to re-use impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur.

IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

Oil Seal Carrier Assembly

REMOVAL

1. Remove the oil seal carrier from the gear housing. It may be necessary to gently pry up on it with two screwdrivers.



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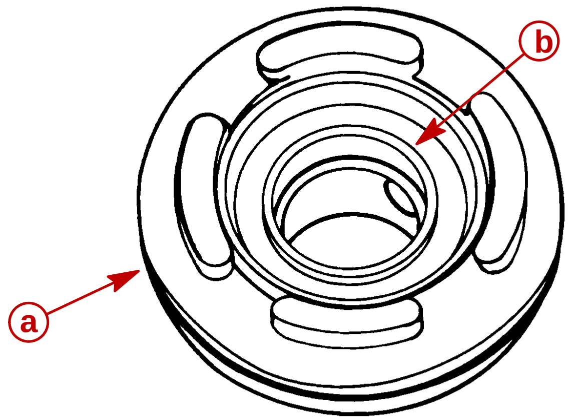
a - Oil Seal Carrier
b - Screwdrivers

OIL SEAL CARRIER ASSEMBLY - COMPONENT DISASSEMBLY

NOTE: *Complete the instructions in this section only if the assembly components have been found to be defective and are in need of repair or replacement.*

1. Remove the o-ring.



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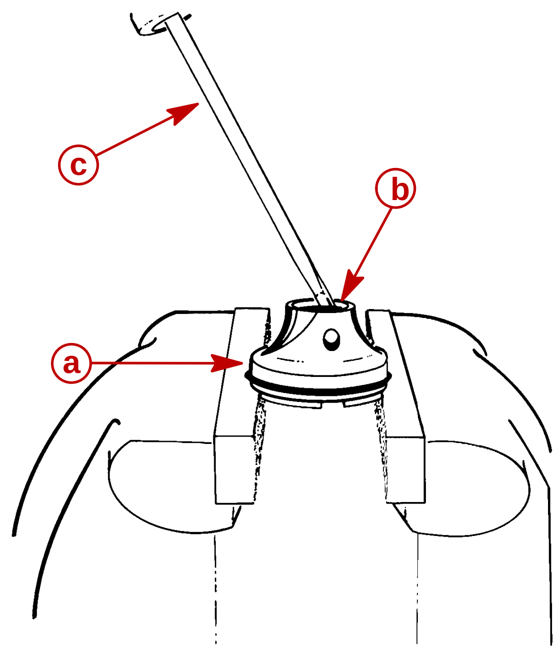
a **-** O-ring
b **-** Oil Seals (2)

2. Remove oil seals.

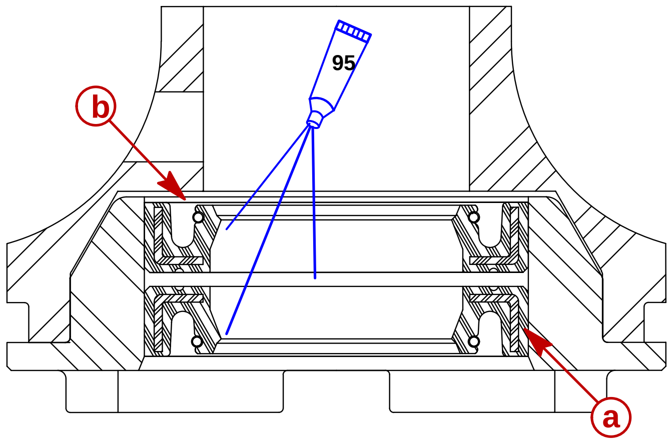


70610

a **-** Oil Seal Carrier
b **-** Oil Seals
c **-** Screwdriver

OIL SEAL CARRIER ASSEMBLY – COMPONENT REASSEMBLY

The oil seals in the carrier assembly are the same diameter. The bottom (first) seal lip faces down; the top (second) seal lip faces up. Apply 2-4-C w/Teflon Marine Lubricant to seal lips and between seals. Press seal into carrier with suitable mandrel. Second seal should be pressed in flush with carrier surface.

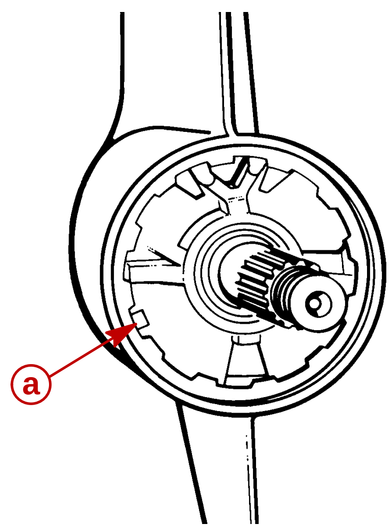


95 2-4-C With Teflon (92-825407A12)

a - Bottom Seal (lip faces down)
b - Top Seal (lip faces up)

Bearing Carrier and Propeller Shaft Removal

1. Straighten the tab on the tab washer.



70490

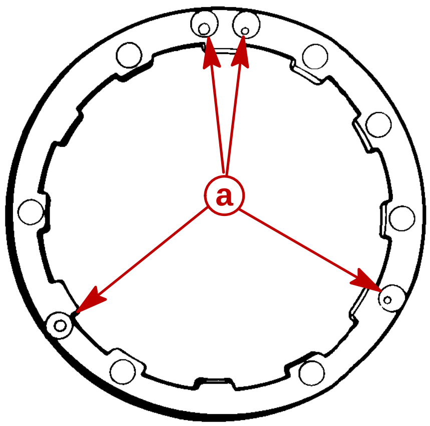
a - Tab on Tab Washer

2. Remove the bearing carrier retainer following step a or b as follows:

CAUTION

DO NOT drill into the gear housing retainer threads when using the following procedure for removing the retainer

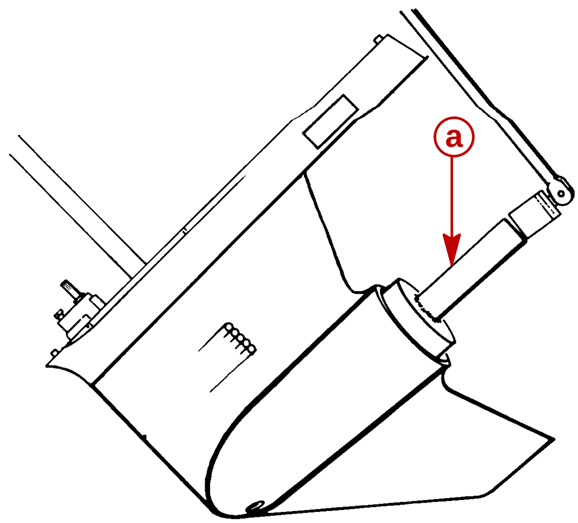
a. If the retainer is corroded in place, drill 4 holes in the retainer and fracture the retainer with a chisel. Pry the remaining segments out.



23356

a - Drilled Holes

b. Remove the bearing carrier retainer using the Bearing Carrier Retainer Wrench (91-61069).

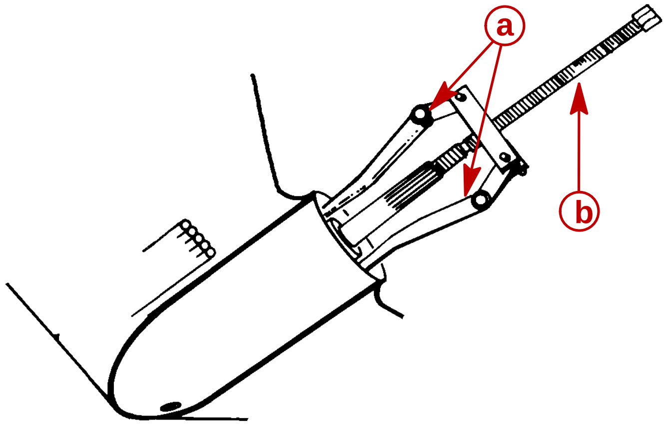


70491

a - Bearing Carrier Retainer Wrench

3. Pull the bearing carrier from the gear housing by pulling on the outer ring of the bearing carrier. POSITION PULLER JAWS CLOSE TO BOSSES IN CARRIER.

NOTE: *If the bearing carrier is seized in the gear housing, it may be necessary to use heat to loosen the carrier.*



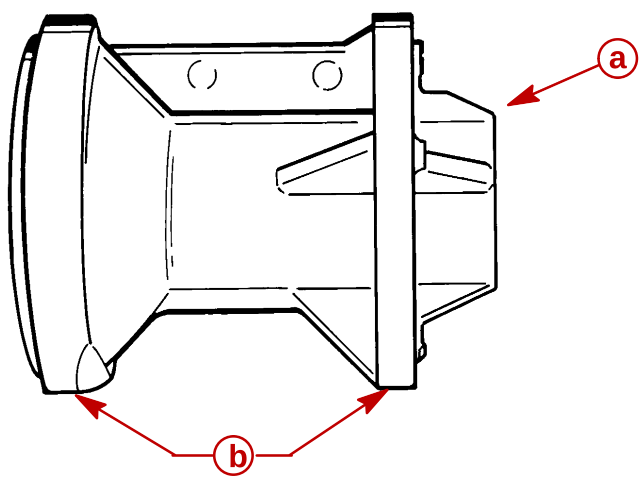
70492

a - Puller Jaws (91-46086A1)
b - Puller Bolt (91-85716)

CLEANING/INSPECTION - BEARING CARRIER

IMPORTANT: It is recommended that all seals and O-rings be replaced (as a normal repair procedure) to assure effective repair.

1. Clean bearing carrier with solvent and dry with compressed air.
2. Inspect the bearing carrier for signs of excessive corrosion especially in the area where the bearing carrier touches the gear housing. If excessive corrosion is evident replace the carrier.



50314

a - Bearing Carrier
b - Inspect for Corrosion

⚠ CAUTION
DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

3. Bearing carrier propeller shaft needle bearing condition is determined by propeller shaft bearing surface condition. (See "Propeller Shaft Inspection.")

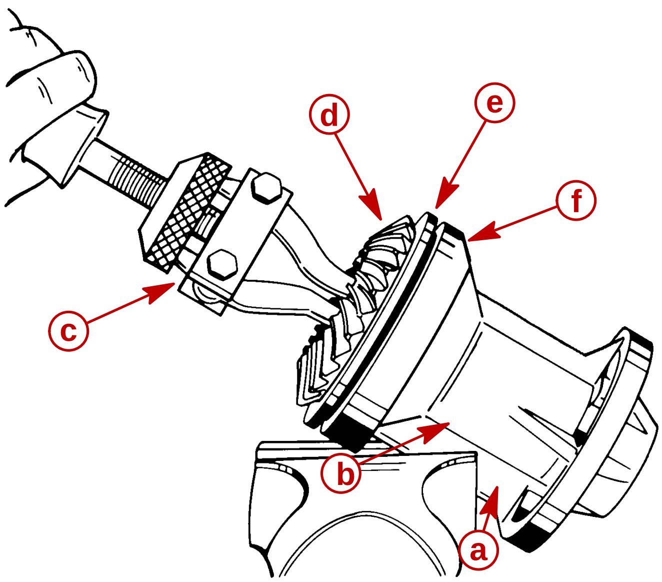
4. Inspect reverse gear to pinion gear wear pattern (should be even and smooth). If not, replace reverse gear and pinion gear.
5. Check clutch jaws on reverse gear for damage. Replace reverse gear, if damage is found on clutch jaws.
6. Apply light oil to reverse gear bearing. Rotate reverse gear bearing while checking bearing for rough spots and/or catches. Push in and pull out on reverse gear to check for bearing side wear. Replace bearing if any of the listed conditions exist.

DISASSEMBLY - BEARING CARRIER

1. Remove and discard O-ring from between bearing carrier and thrust washer.
2. If inspection of reverse gear or reverse gear bearing determines that replacement of gear or bearing is required, remove gear and bearing as follows:

CAUTION
Clamp onto the reinforcing rib of the bearing carrier ONLY, or damage to the carrier may result.

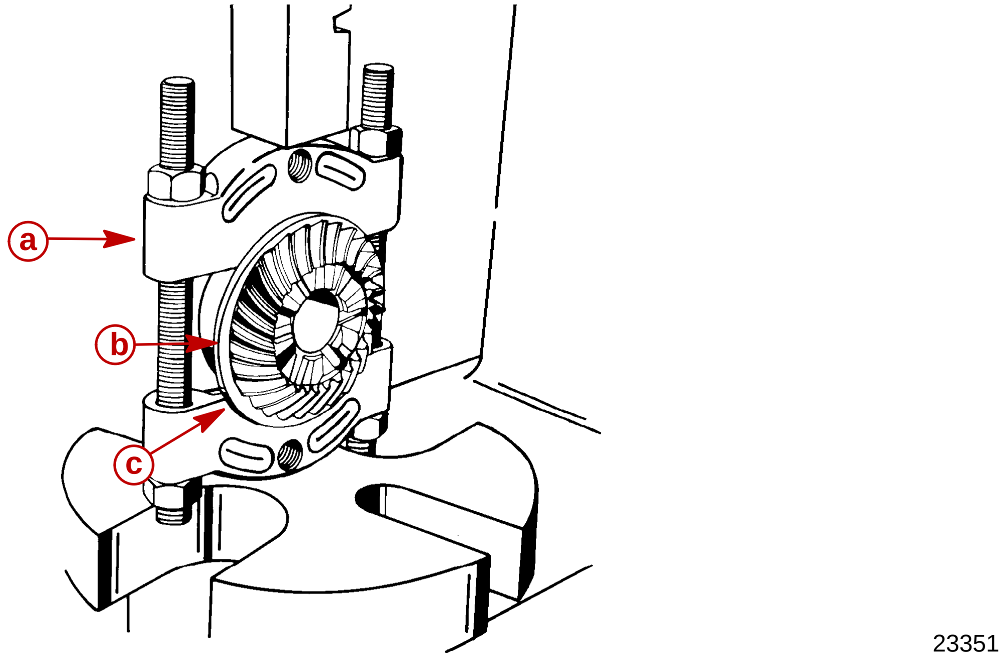
3. Place the bearing carrier in a vise, clamping on the reinforcing rib.
4. Remove the reverse gear, thrust ring, and bearing as an assembly, using a slide hammer puller



a - Bearing Carrier Reinforcing Rib
b - Bearing Carrier
c - Slide Hammer Puller (91-34569A1)
d - Reverse Gear
e - Thrust Hub
f - Bearing (not seen) - Located in the Carrier

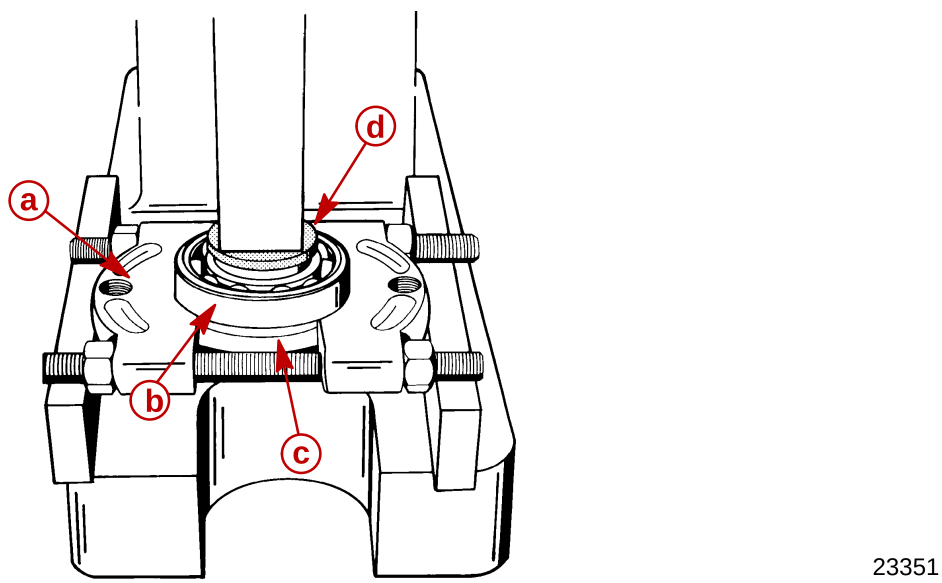
IMPORTANT: The bearing MUST BE replaced if removed from gear.

5. Place the universal puller plate between the thrust washer and bearing as shown and press on the plate until it bottoms.



a - Universal Puller Plate (91-37241)
b - Thrust Washer
c - Bearing

6. Using a suitable mandrel and the universal puller plate to support the bearing, press the bearing from the reverse gear as shown.



a - Universal Puller Plate (91-37241)
b - Bearing
c - Gear
d - Mandrel

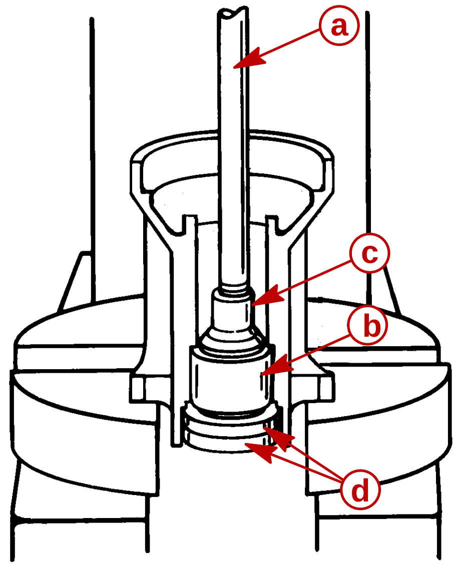
a. **Discard the bearing.**

b. Inspect the gear, and thrust washer for excessive wear, cracks, or damage. Replace the appropriate components if any of these conditions are found.

NOTE: *Inspection of the bearing surfaces on the propeller shaft where the needles of the bearing carrier needle bearing rolls, gives an indication of the condition of the needle bearing inside the bearing carrier. Replace needle bearing in the bearing carrier if the prop shaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.*

7. Perform the following step a. or b. as necessary.

   a. **If Replacing the Needle Bearing <u>and</u> Seals:** Remove the needle bearing and seals with the tools as shown.

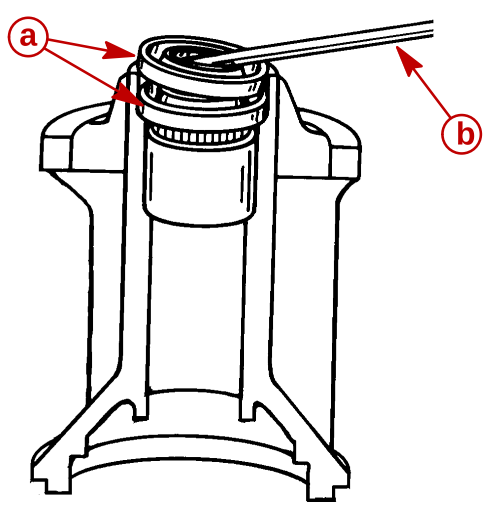


23140

a - Bearing Driver Rod (91-37323)
b - Needle Bearing
c - Driver Head (91-36569)
d - Oil Seals

(1.) **<u>Discard the needle bearing and both seals.</u>**

   b. **If Replacing the Seal <u>Only</u>:** Remove the oil seals with a suitable pry bar, being careful not to damage the bore of the bearing carrier.



23140

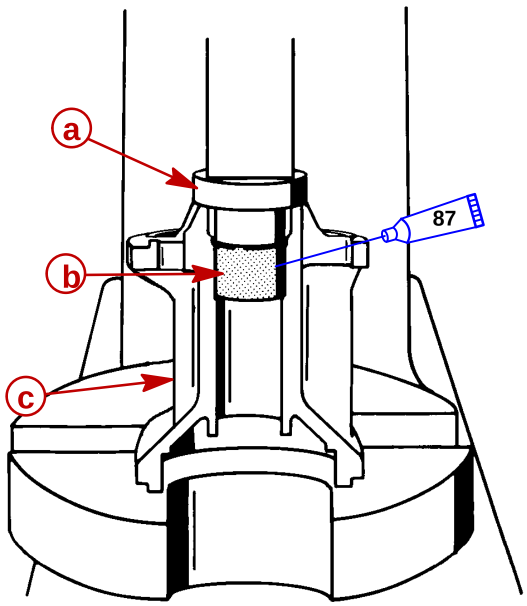
a - Oil Seals
b - Pry Bar

(1.) **<u>Discard both of the seals.</u>**

BEARING CARRIER ASSEMBLY Component Reassembly

NOTE: *Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.*

1. Clean all of the components with a suitable solvent and dry the parts thoroughly using compressed air. Be careful not to spin the bearing.
2. Lubricate the bore that the needle bearing is pressed into with Quicksilver Gear Lubricant (92-13783A24).
3. Assemble the needle bearing (with the numbered end of the bearing towards the driver shoulder), onto the driver.
4. Press the needle bearing into the bearing carrier until the driver bottoms out on the bearing carrier. Ensure that the numbered side of the needle bearing faces the seal end (aft end) of the carrier.

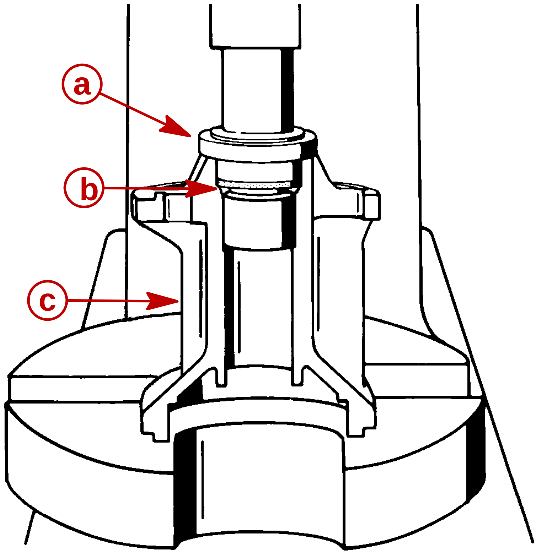


87 Quicksilver Gear Lubricant (92-19007A24)

50315

a - Needle Bearing Driver (P/N 91-15755)
b - Needle Bearing
c - Bearing Carrier

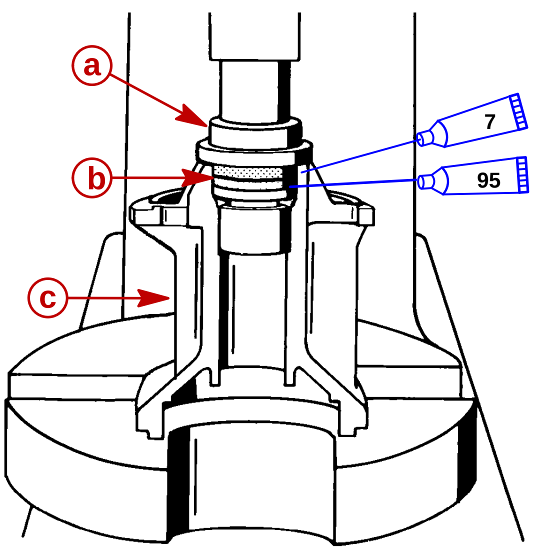
5. **Thoroughly clean** the bore in which the first seal is to be pressed.
6. Assemble the first seal (with the lips of the seal facing away from the driver shoulder) onto the long end of the oil seal driver.
7. Press on the oil seal driver until the driver bottoms on the bearing carrier.



50315

a - Oil Seal Driver (91-31108)
b - Oil Seal
c - Bearing Carrier

8. Apply a thin film of Loctite 271 (92-809820) to the outer diameter of the second seal.
9. Assemble the second seal (with the lips of the seal facing the driver shoulder) onto the short end of the driver.
10. Press the oil seal with the driver until the driver bottoms out on the bearing carrier.



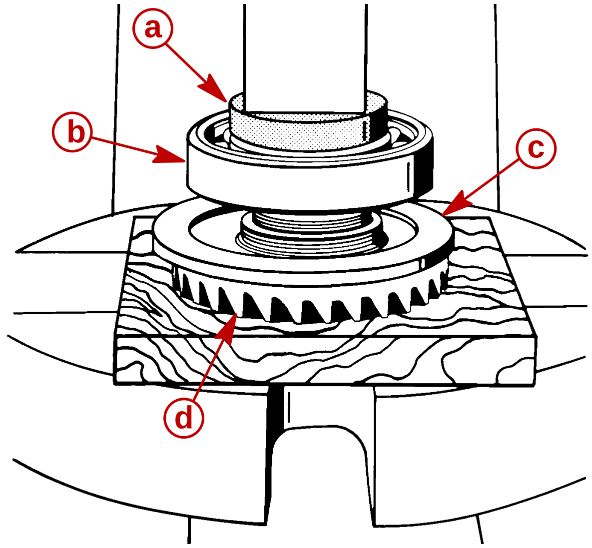
7 Loctite 271 (92-809820)
95 2-4-C With Teflon (92-825407A12)

50315

a - Driver (short end)
b - Oil Seal (lips toward driver shoulder)
c - Bearing Carrier

11. Wipe up all of the excess Loctite. Do not allow any of the excess Loctite to spread to other parts of the assembly.
12. Lubricate the seal lips and fill the area between the seals with 2-4-C w/Teflon (92-825407A12).

13. Install the thrust washer and **a new ball bearing** onto the reverse gear. Press on the inner race of the ball bearing using the pilot washer until the bearing bottoms out on the gear.

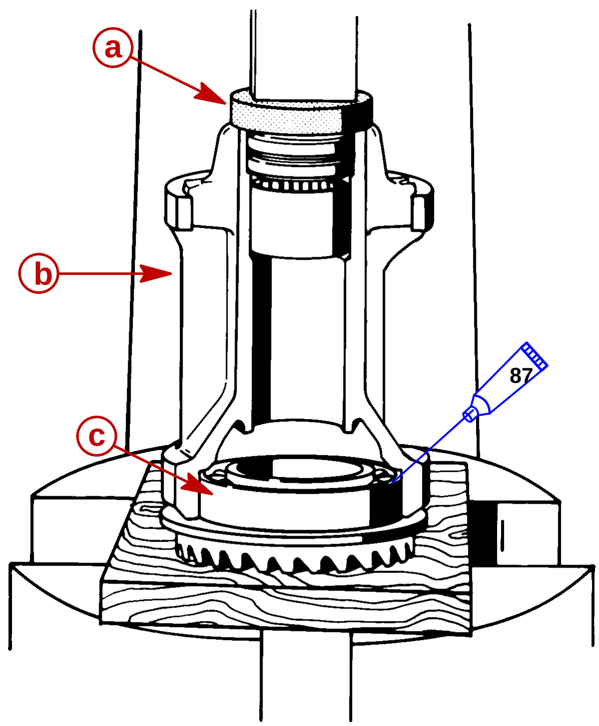


23346

a - Pilot Washer (P/N 91-36571)
b - Ball Bearing
c - Thrust Hub
d - Reverse Gear

14. Lubricate the bore that the bearing is pressed into with Quicksilver Gear Lubricant (92-13783A24).

15. Press the bearing carrier onto the reverse gear and bearing until the bearing bottoms out in bearing carrier, using the pilot washer to press against the carrier.

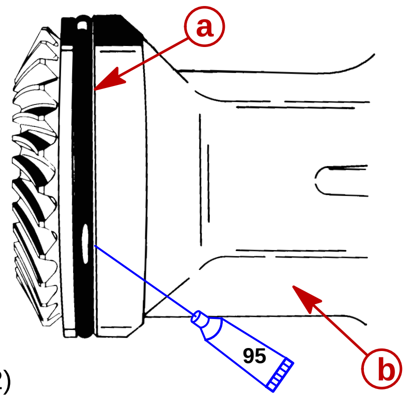


23349

87 Quicksilver Gear Lubricant (92-19007A24)

a - Pilot Washer (91-36571)
b - Bearing Carrier
c - Reverse Gear and Bearing Assembly

16. Lubricate the O-ring with 2-4-C w/Teflon and install the O-ring onto the bearing carrier.



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

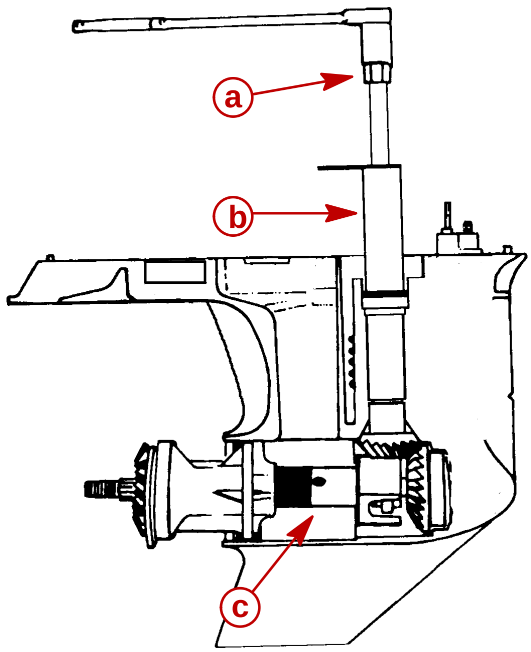
23354

a - O-ring
b - Bearing Carrier

Drive Shaft Assembly

REMOVAL

1. Remove the drive shaft pinion nut as follows:
   a. Place the drive shaft nut wrench onto the drive shaft. Do not loosen the retainer at this time.
   b. Insert the pinion nut adapter with the MR slot facing the pinion gear into the gear housing. It may be necessary to slightly lift and rotate the drive shaft to align the pinion gear nut into the pinion nut adapter slot.
   c. Install the bearing carrier into the gear housing backwards to support the prop shaft and to keep the pinion nut adapter aligned.
   d. Place the drive shaft nut wrench over the drive shaft splines and **loosen**, (but do not fully unscrew), the pinion nut by rotating the drive shaft counterclockwise.

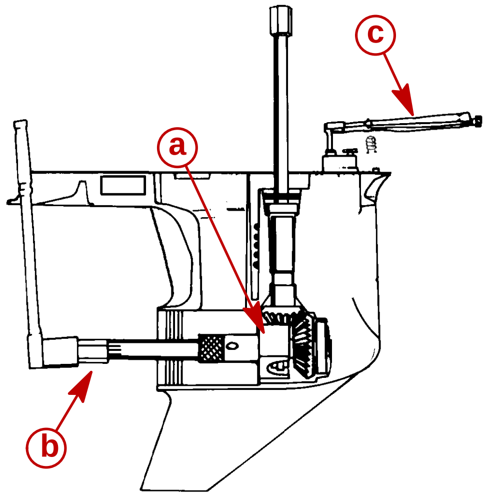


70887

a - Drive Shaft Nut Wrench (91-56775)
b - Drive Shaft Bearing Retainer Wrench (91-43506)
c - Pinion Nut adapter (MR Slot) (91-61067A2)

e. **If the drive shaft is broken,** place propeller shaft nut wrench onto the propeller shaft splines, hold shift shaft in forward gear and **loosen**, (but do not fully unscrew), the pinion nut by rotating prop shaft counterclockwise to turn gears, thus loosening the pinion nut.

NOTE: *The propeller shaft nut wrench is included with the pinion nut adapter kit*



70607

a - Pinion Nut Adaptor (MR slot) (91-61067A2)
b - Propeller Shaft Nut Wrench (91-61067)
c - Shift Shaft (Turn Clockwise) (Protect shaft splines with soft material)

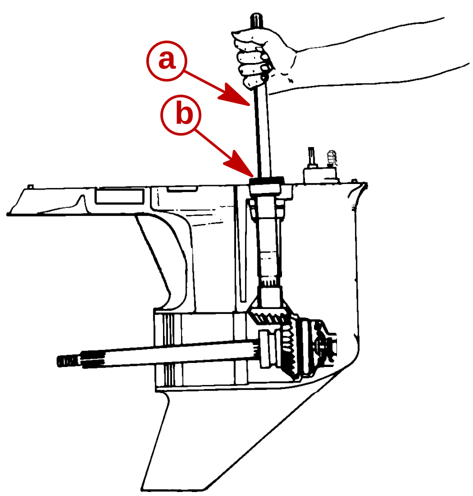
f. Completely unscrew the drive shaft bearing retainer.

g. Completely unscrew the pinion nut by rotating the drive shaft (or the propeller shaft) in a counterclockwise direction.

h. Remove all tools.

IMPORTANT: The pinion bearing rollers are free to fall out of the pinion bearing once the drive shaft is removed. Be careful not to loose the (18) rollers.

2. Remove the drive shaft and all components by pulling the drive shaft straight out of the gear housing as shown.



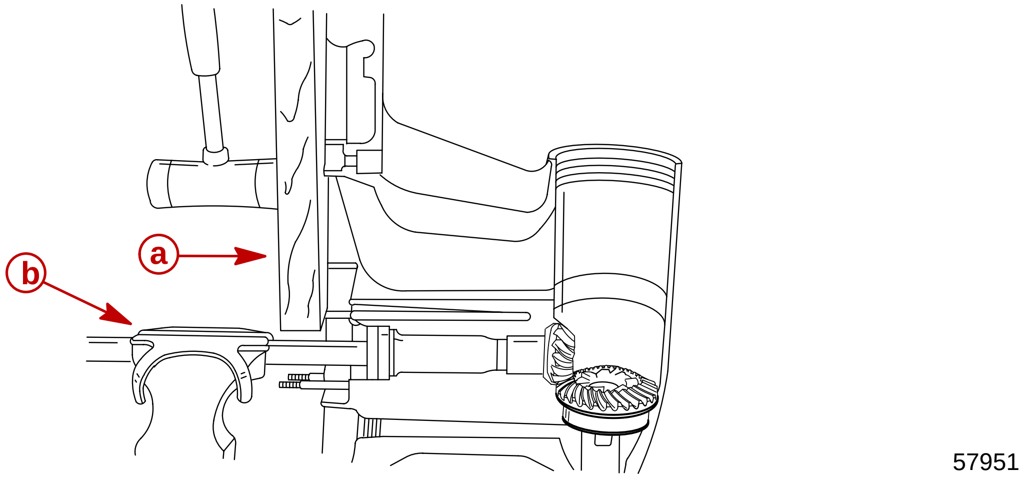
70608

a - Drive Shaft
b - Drive Shaft Retainer, Bearing Cup, Bearing, and Shims

3. Move the prop shaft downward and to the PORT side of the gear case.
4. Retrieve the pinion gear, the washer and the nut from the inside of the gear housing.

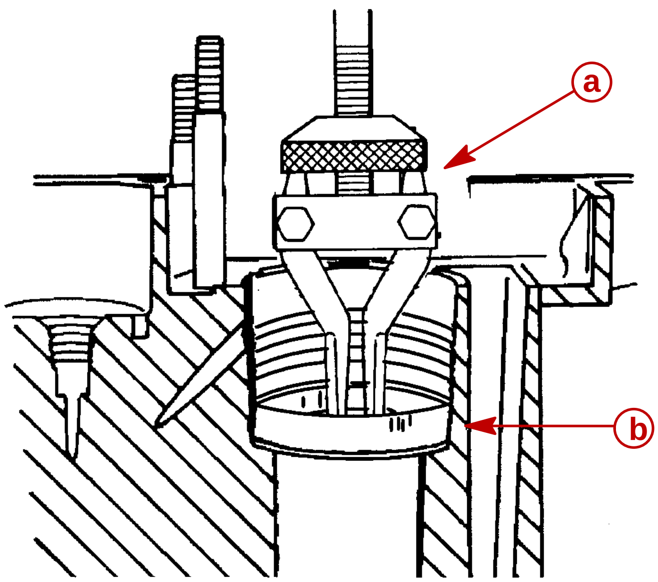
NOTE: *If pinion gear is seized onto the driveshaft, place gearcase in vise using soft jaw vise covers. Place a block of wood on gear housing mating surface. Use a mallet and carefully tap gear housing away from drive shaft.*

CAUTION
Do not strike gear housing hard with mallet or allow gear housing to fall.



a - Wood Block
b - Drive Shaft in Soft Jaw Vise

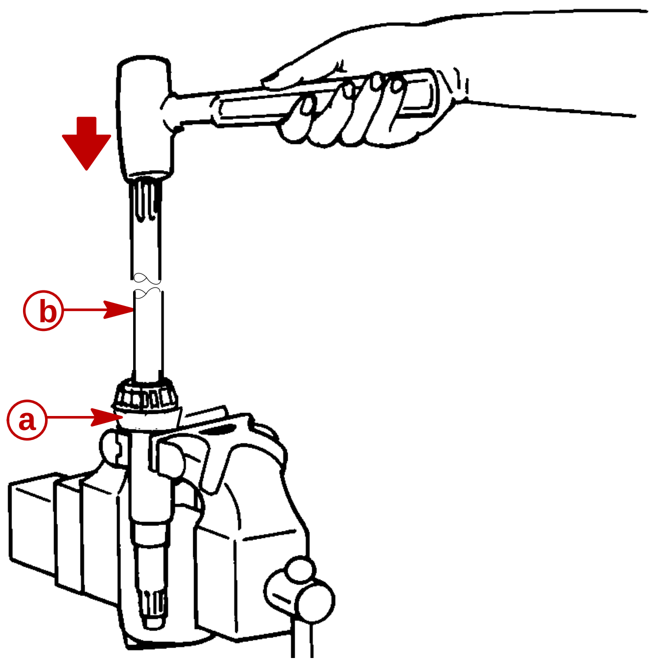
5. Remove lower drive shaft bearing cup and shims using slide hammer puller (34569A1) (retain shims for re-installation).



a - Slide Hammer Puller (91-34569A1)
b - Lower Drive Shaft Bearing Cup

DISASSEMBLY

1. Both upper and lower tapered roller bearings can be removed from the drive shaft in one operation. Using the bottom bearing cup removed from the gearcase, place the cup on top of a vise leaving the vise jaws open enough to allow the drive shaft to slide through.
2. Place the driveshaft through the cup and vise until the bottom bearing is resting in the cup. While holding the driveshaft, tap on the top of the shaft with a lead hammer until the bearings are free. **Do not drop the shaft when performing this operation.**



a - Lower Bearing Cup Removed from Gear Case
b - Drive Shaft With Both Upper and Lower Bearings

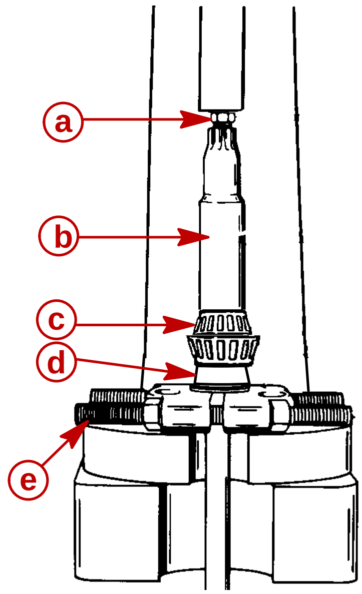
DRIVE SHAFT ASSEMBLY - Inspection

1. Clean all parts with a suitable solvent and dry the parts thoroughly using compressed air, being careful not to spin the bearings.
2. The condition of the drive shaft bearing cup is an indication of the condition of the tapered roller bearing on the drive shaft. Replace the bearing and bearing cup if the cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
3. Inspect the bearing surface on the drive shaft where the needles of the lower pinion bearing roll. Replace the drive shaft if it is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
4. Inspect the splines at both ends of the drive shaft for a worn or twisted condition. Replace the drive shaft if either condition exists.
5. Inspect the gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. **Replace the pinion gear and the forward gear as a set** if any defects are found.
6. Inspect driveshaft for groove(s) where water pump base oil seals contact shaft. Replace driveshaft if groove(s) are found.

REASSEMBLY

NOTE: *Complete the instructions in this section only if the components have been disassembled*

1. Apply a light coat of Quicksilver Heavy Duty Gear Lubricant on I.D. of drive shaft tapered bearing. Apply High Pressure Grease (such as Chicago Manufacturing and Distributing Lube #3) to the O.D. of both bearings.
2. Assemble a new tapered roller bearing to the drive shaft with the large O.D. of the bearing facing the pinion gear end of the drive shaft.
3. Thread a used pinion nut onto end of drive shaft. Leave approximately 1/16″ (2mm) of nut threads exposed. Drive shaft threads MUST NOT extend beyond nut or thread damage could result while pressing.
4. Press the tapered roller bearing onto the drive shaft using the universal puller plate and a suitable mandrel, (an old tapered roller bearing inner race).

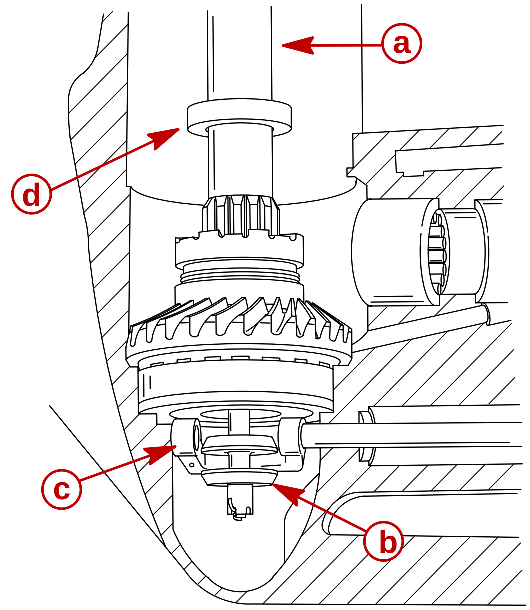


a - Used Pinion Nut
b - Drive Shaft
c - Tapered Bearing(s)
d - Old Bearing Inner Race
e - Universal Puller Plate

Propeller Shaft Assembly and Forward Gear Bearing Cup

REMOVAL

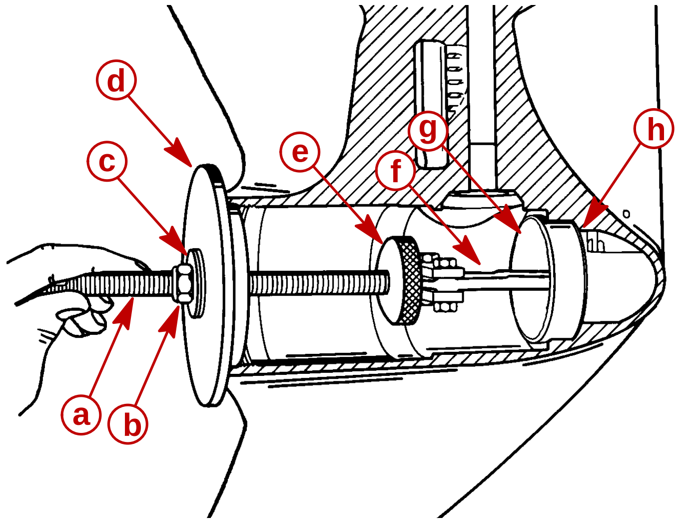
1. Tilt the propeller shaft to the port side of the gear housing and remove the shaft by pulling it straight up and out.



58016

a - Propeller Shaft Assembly
b - Shift Spool
c - Shift Crank
d - Thrust Washer (Reverse Gear)

2. Remove the forward gear bearing cup and shims. Measure and make note of the shim thickness. If the shims are not damaged, they may be reused.



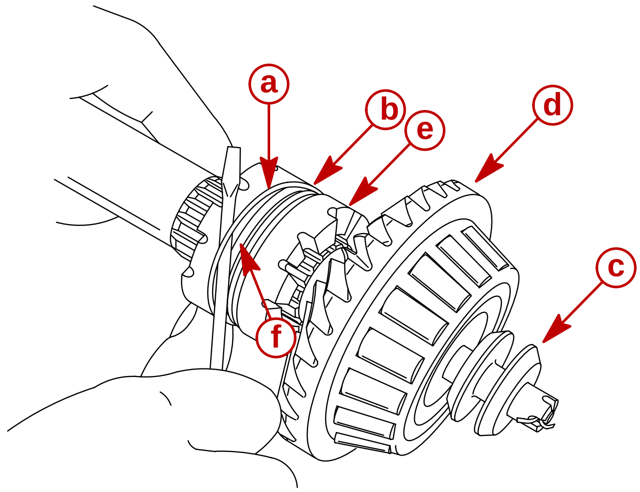
50780

a - Puller Shaft (91-31229)
b - Nut (11-24156)
c - Washer (91-34961)
d - Guide Plate (91-816243)
e - Puller Head (from Slide Hammer Puller Kit 91-34569A1)
f - Jaws (from Slide Hammer Puller Kit)
g - Bearing Cup
h - Shims

PROPELLER SHAFT ASSEMBLY - Component Disassembly

NOTE: *When accomplishing the next step, all of the parts are free to come apart. Work closely over a work bench to ensure that the parts are not dropped or damaged and to avoid personal injury*

1. Remove the spring around the clutch being careful not to over-stretch it during removal. If the spring does not coil back to its normal position once it has been removed, it must be replaced.
2. Remove detent pin.
3. Remove the cross pin that goes through the clutch.
4. Remove the remainder of the components

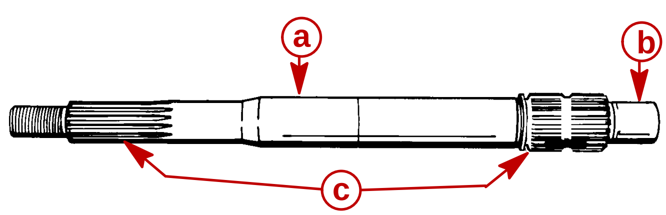


58017

- **a** - Spring
- **b** - Cross Pin
- **c** - Shift Spool Assembly
- **d** - Forward Gear Assembly
- **e** - Sliding Clutch
- **f** - Detent Pin (hidden)

PROPELLER SHAFT ASSEMBLY - Component Inspection

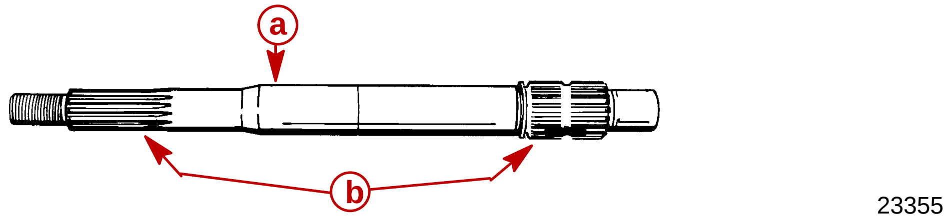
1. Clean all the parts with a suitable solvent and dry the parts thoroughly using compressed air, being careful not to spin bearings
2. Inspect the sliding clutch jaws for damage. Jaws must not be chipped or rounded off. Replace the clutch if they are.
3. Inspect the bearing surfaces on the propeller shaft where the needles of the bearing carrier needle bearing and the needles of the forward gear needle bearing roll. Replace the propeller shaft if it is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.



23355

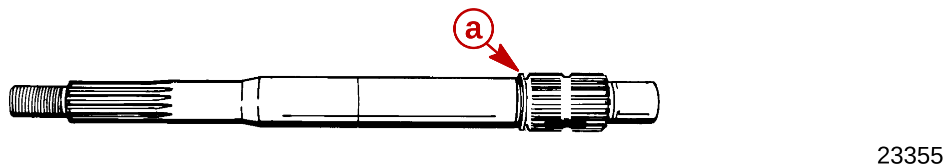
- **a** - Bearing Carrier Needle Bearing Contact Area
- **b** - Forward Gear Needle Bearing Contact Area
- **c** - Splines

4. Inspect the propeller shaft splines at both ends for a broken, worn, or twisted condition. Replace the propeller shaft if any of these conditions exists.
5. Inspect the surface of the propeller shaft where the bearing carrier seal lips contact the shaft. If the oil seals have made grooves, replace the propeller shaft and oil seals.



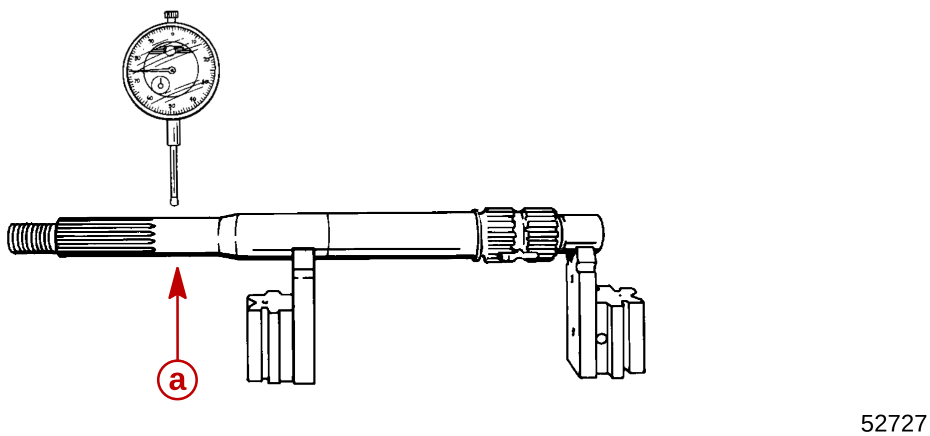
a - Bearing Carrier Seal Contact Area
b - Splines

6. Inspect reverse gear thrust washer surface for wear or taper. If surface is worn or tapered, propeller shaft must be replaced.



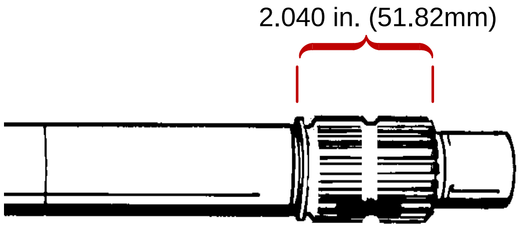
a - Thrust Washer Surface

7. Inspect the propeller shaft for a bent condition.
   a. **V-Blocks and Dial Indicator**
      (1.) Position the propeller shaft bearing surfaces on V-blocks.
      (2.) Adjust the height of V-blocks to level the propeller shaft.
      (3.) Position the dial indicator tip just forward of the propeller shaft splines.
8. Rotate the propeller shaft and observe the dial indicator movement, If the indicator in the dial moves more than 0.009 in. (0.23mm), replace the propeller shaft.



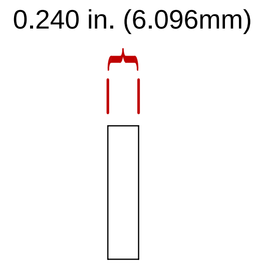
a - Check Movement with Dial Indicator (P/N 91-58222A1) Here

9. Measure propeller shaft FORWARD to REVERSE shoulder length. If measurement is under 2.040 in. (51.82mm), replace propeller shaft.



23355

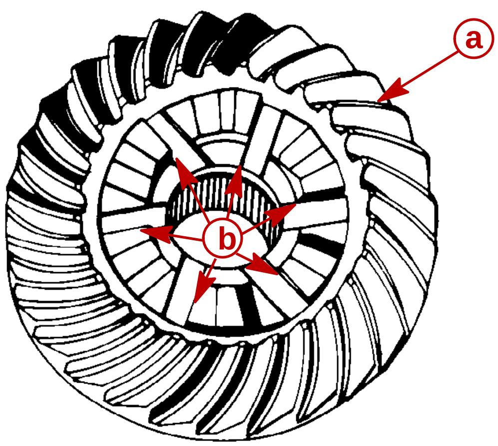
10. Inspect REVERSE thrust washer for wear or taper. Measure thickness of washer. If thickness is LESS than 0.240 in. (6.1mm), replace washer



Forward Gear Assembly

COMPONENT INSPECTION

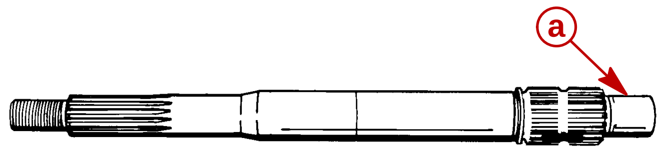
1. Clean the forward gear assembly and the forward gear bearing cup with a suitable solvent and dry with compressed air. Be careful not to spin the bearings.
2. Inspect the gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. **Replace the forward gear and the pinion gear as a set** if any defects are found.
3. Inspect the clutch jaws of the gear for damage. The surfaces must not be chipped or rounded off. **Replace both the forward and pinion gear as a set** if any of these conditions exist.



23351

a - Forward Gear Teeth
b - Clutch Jaws

4. Inspect the needle bearings on the inside of the forward gear and the bearing surface on the propeller shaft. If either the needle bearing or the bearing surface of the propeller shaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, replace the propeller shaft and remove and replace the needle bearing in the forward gear as outlined in the next section.



23355

a - Forward Gear Needle Bearing Contact Area

5. Inspect the tapered roller bearings on the forward gear and the bearing surface on the forward gear bearing cup. If either the roller bearings or the bearing surface of the forward gear bearing cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, replace the forward gear bearing cup and remove and replace the tapered roller bearings as outlined in the next section.

FORWARD GEAR ASSEMBLY - Component Disassembly

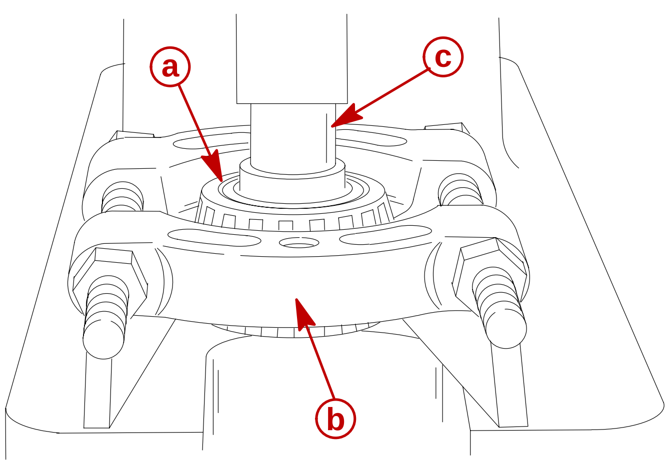
NOTE: *Forward gear can only be removed from gear housing after drive shaft and pinion gear have been removed.*

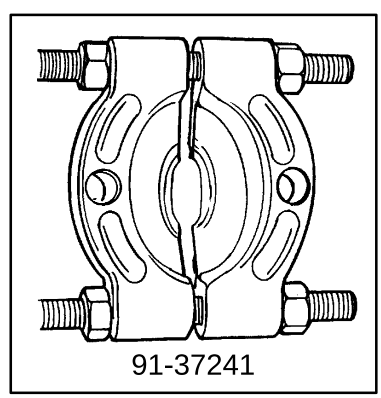
1. Reach into gear housing and lift out forward gear.

IMPORTANT: DO NOT remove tapered bearing or needle bearings from forward gear unless replacement of bearings is required. (Bearings cannot be reused after they have been removed.)

2. If inspection determines that replacement of forward gear tapered bearing is required, separate gear from bearing as follows:
   a. Press Universal Puller Plate (91-37241) between forward gear and tapered bearing.
   b. Place assembly on press and press gear out of bearing with suitable mandrel.

NOTE: *Tapered bearing and race MUST BE replaced as a set.*

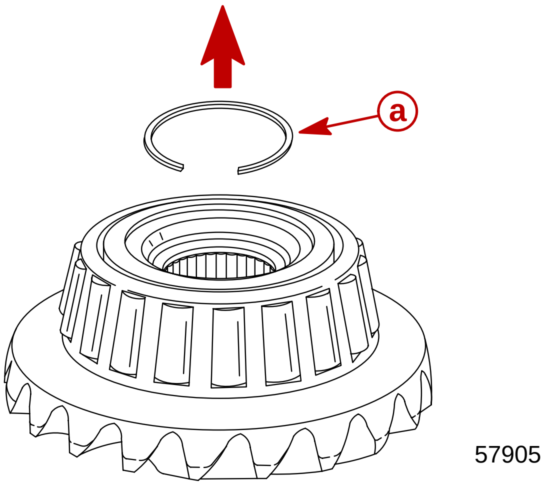


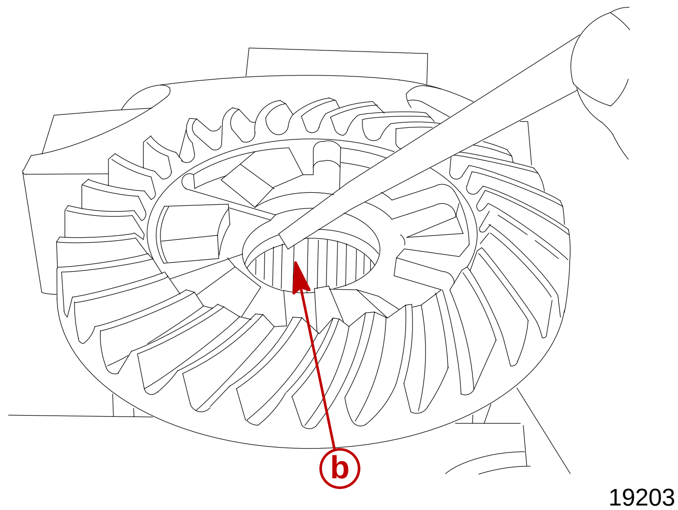


51119

a - Forward Gear Bearing
b - Universal Puller Plate (91-37241)
c - Mandrel

3. If inspection determines that replacement of propeller shaft needle bearings is required, remove bearing as follows:
   a. Clamp forward gear in a soft jaw vise securely.
   b. Use suitable tools (screwdriver and awl) to remove retaining ring. Use a punch and hammer to remove bearing.



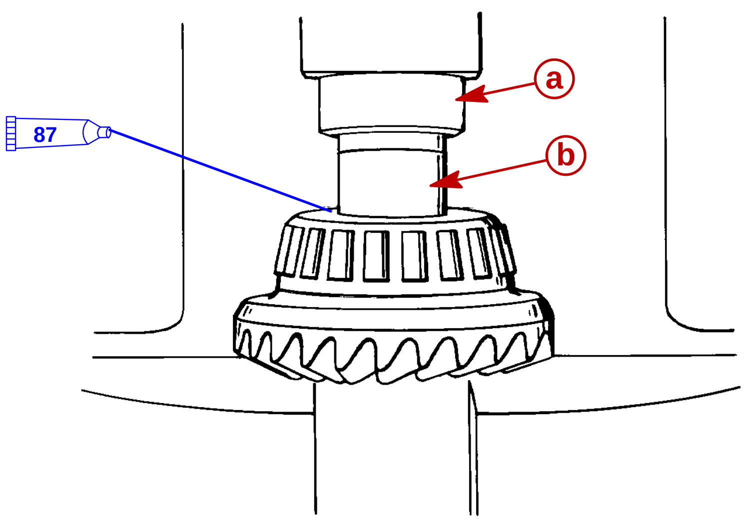


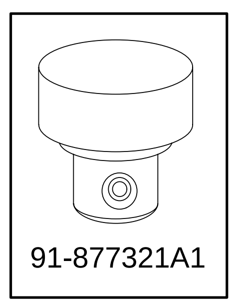
a - Retaining RIng
b - Bearing

FORWARD GEAR ASSEMBLY - Component Reassembly

NOTE: *Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.*

1. Apply Quicksilver gear lubricant to I.D. of forward gear. Press bearing into forward gear using Forward Gear Bearing Installer Tool until tool contacts gear.

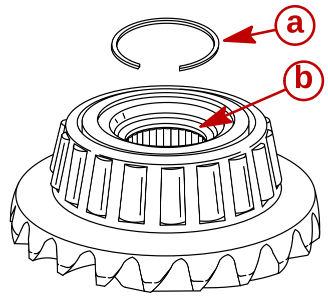




87 Super Duty Gear Lubricant (92-850737A1)

a - Forward Gear Bearing Installer (91-877321A1)
b - Needle Bearing, Numbered Side Toward Installer Tool

2. Install retaining ring into groove of forward gear by starting at one end of retaining ring and working it around until seated in groove.

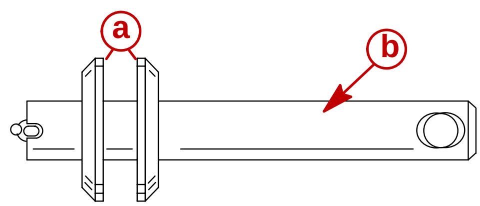


a - Retaining Ring
b - Groove in Forward Gear

Shift Spool Assembly

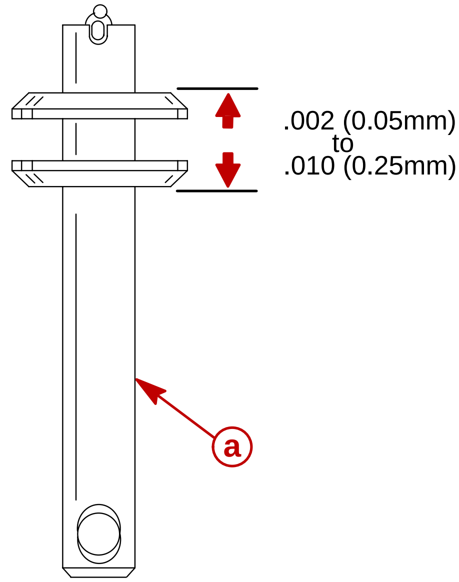
INSPECTION

1. Clean the assembly with a suitable solvent and dry the parts using compressed air.
2. Inspect the shift spool assembly for damage. Small nicks and burrs may be smoothed. If any parts are damaged or worn excessively, it will be necessary to replace the complete shift spool assembly. Individual parts are not available for the assembly.
3. Inspect the shift spool for wear in the area where the shift crank comes into contact.



a - Contact Area
b - Non-Ratcheting Shift Spool

4. Inspect to insure that the spool spins freely (it may be helpful to lightly tap the castle nut end of the shift spool against a firm surface to align the internal parts).
5. Inspect to insure that the spool has 0.002 - 0.010 (0.05 mm - 0.25 mm) end play. This end play may be achieved by turning the castle nut clockwise down until it is snug and then backing off the nut counterclockwise to the first cotter pin slot.



NOTE: *If the spool spins freely and has the proper clearance, it will not be necessary to disassemble and reassemble the spool. If the spool does not function properly, proceed with the following disassembly procedures.*

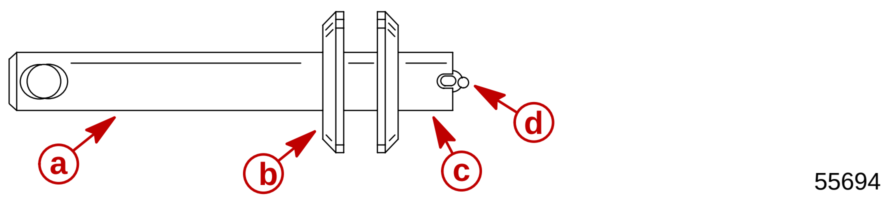
SHIFT SPOOL DISASSEMBLY

NOTE: *Disassembly of the shift spool is for cleaning and inspection of the internal parts due to an improperly functioning shift spool assembly or debris in the gear housing and/or shift spool assembly. Individual components for the shift spool are not available as replacement parts. If the shift spool does not function properly and the following cleaning and adjustment procedures do not correct the problem, it will be necessary to order a new shift spool assembly.*

1. Remove and discard the cotter pin.
2. Remove the castle nut and spool.
3. Clamp the spool in a vice being careful not to damage the spool.
4. Unscrew the retainer.

SHIFT SPOOL REASSEMBLY

1. Place the shift spool onto the shift spool shaft.
2. Screw the castle nut down until it touches the washer and a slight resistance is felt.
3. Loosen the castle nut until the cotter pin slot of the nut is aligned with the hole in the shaft. If, when the castle nut is screwed down, the cotter pin slot is already aligned at the hole in the shaft, back the castle nut off until the next available slot in the nut is aligned with the hole in the shaft.
4. Insert a new cotter pin and bend ends of the cotter pin in opposite directions.
5. Verify the spool has 0.002 - 0.010 in. (0.05 mm - 0.25 mm) end play. If it does not, readjust the castle nut again.



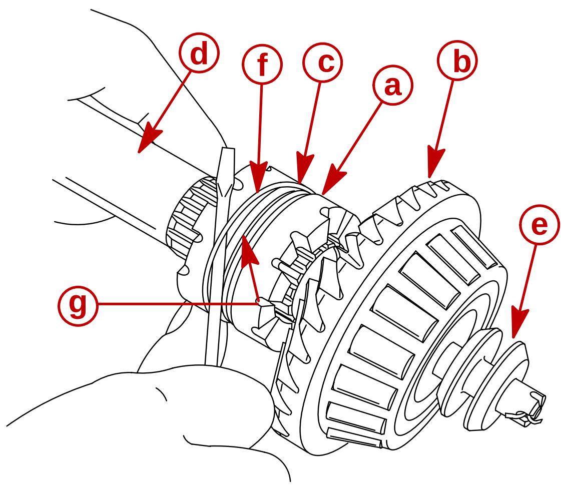
a - Shift Shaft
b - Spool
c - Castle Nut
d - Cotter Pin

6. If this adjustment did not produce the desired results it will be necessary to disassemble, clean, and reassemble the shift spool assembly. If the spool assembly has already been disassembled and cleaned it will be necessary to replace the shift spool assembly.

Propeller Shaft Assembly

COMPONENT REASSEMBLY

1. Install the sliding clutch on the propeller shaft. Align cross pin holes in the clutch with the slot in the propeller shaft.
2. Assemble the forward gear assembly to the propeller shaft.
3. Assemble the shift spool assembly to the propeller shaft being sure to align the cross pin hole of the shift spool shaft with the clutch.
4. Assemble the cross pin through the sliding clutch, through the propeller shaft and through the shift spool shaft hole.
5. Install detent pin in 3rd hole in clutch.
6. Assemble the cross pin retaining spring over the propeller end of the propeller shaft and wind it around the clutch over the cross pin hole. Be careful not to distort the spring while assembling it. **Make sure that the spring is wound on so that it does not cross over on itself and that it lies flat against the clutch once it is assembled. If it does not lie flat against the clutch, a new spring must be installed.**



58017

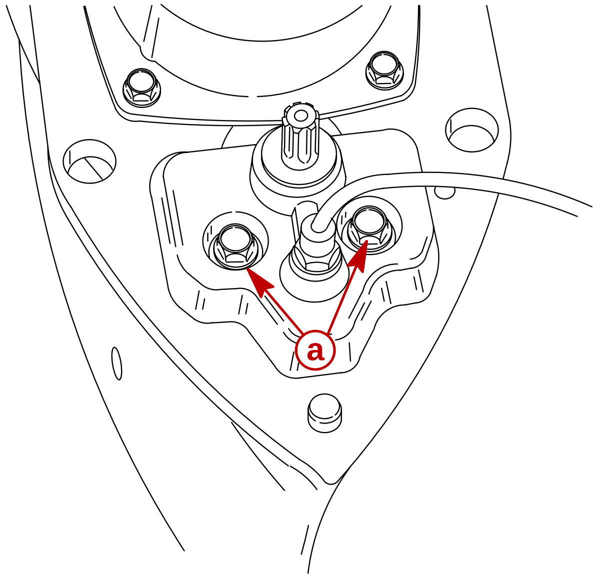
a - Sliding Clutch
b - Forward Gear Assembly
c - Cross Pin (hidden)
d - Propeller Shaft
e - Spool and Actuating Shaft Assembly
f - Cross Pin Retaining Spring
g - Detent Pin (hidden)

Shift Shaft Assembly

REMOVAL

NOTE: *It is possible to remove and service the shift shaft assembly (but not the shift crank inside the gear case) without removing any of the internal components of the gear housing.*

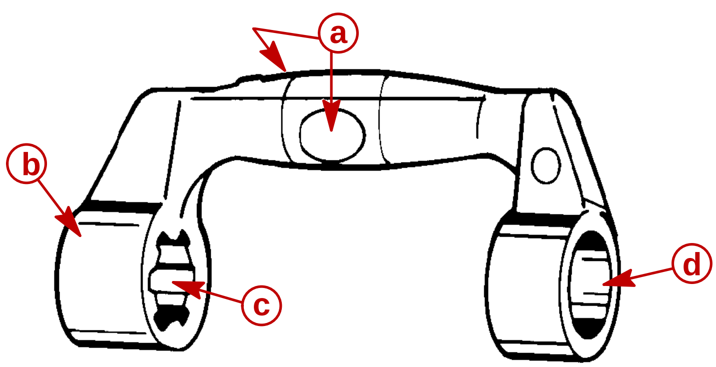
1. Remove the shift shaft bushing screws, and remove the shift shaft and bushing by pulling both straight out of gear housing.



57934

a - Shift Shaft Bushing Screws

2. Remove the shift crank from the inside of the gear housing. Clean it with a suitable solvent and dry it thoroughly. Inspect it for wear in the areas that contact the shift spool and inspect the splines and the diameter that goes over the locating pin for damage or wear.

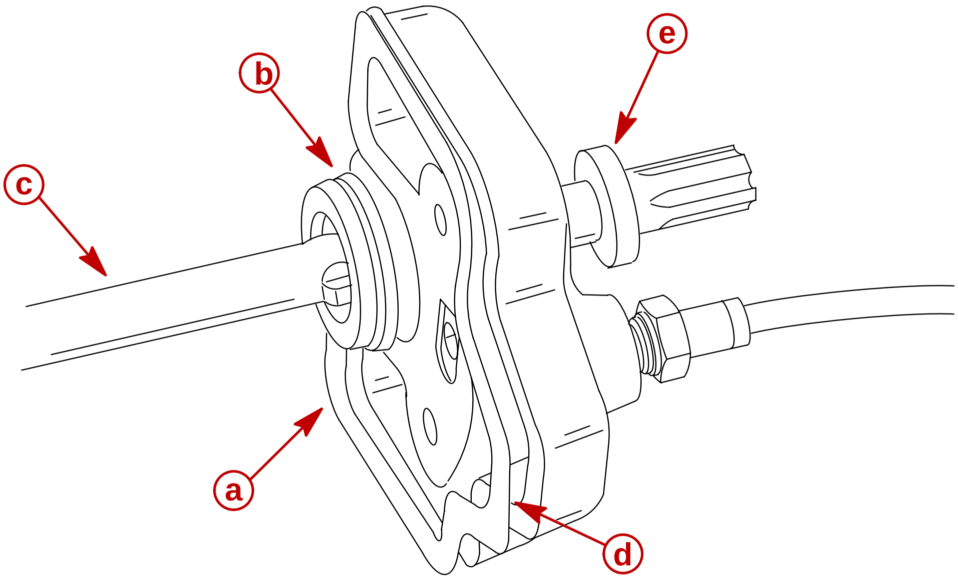


23350

a - Contact Area
b - Shift Crank
c - Splines
d - Diameter for Locating Pin

SHIFT SHAFT ASSEMBLY - Component Disassembly and Inspection

1. Slide the bushing assembly off the shift shaft. Remove the coupler from the shaft.

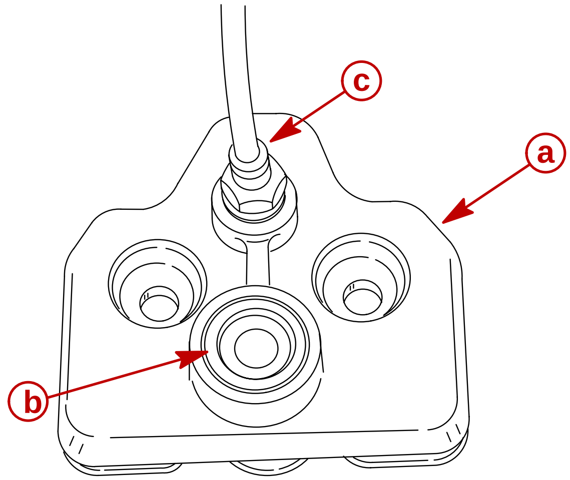


57954

a - Shift Shaft Bushing Assembly
b - O-ring
c - Shift Shaft
d - Gasket
e - Rubber Washer

2. Clean all components with a suitable solvent and dry thoroughly with compressed air.
   a. Inspect the shift shaft bushing for cracking, damage, or excessive wear.
   b. Inspect the oil seal inside the bushing, the sleeve, and the O-rings on the outside of the bushing for damage or excessive wear.
   c. Inspect the speedometer connector for damage or blockage.

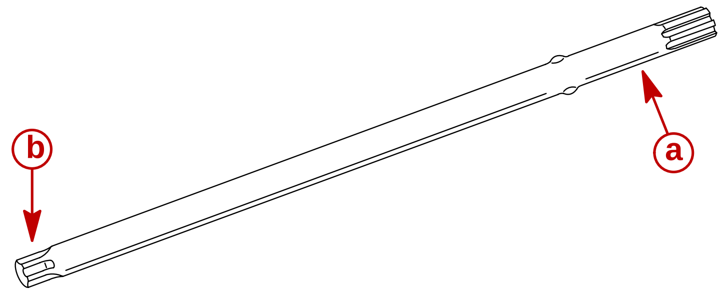
If any of these conditions exist, replace the appropriate components.



57932

a - Shift Shaft Bushing
b - Oil Seal (Oil Seal is Replaceable)
c - Speedometer Tube Connector

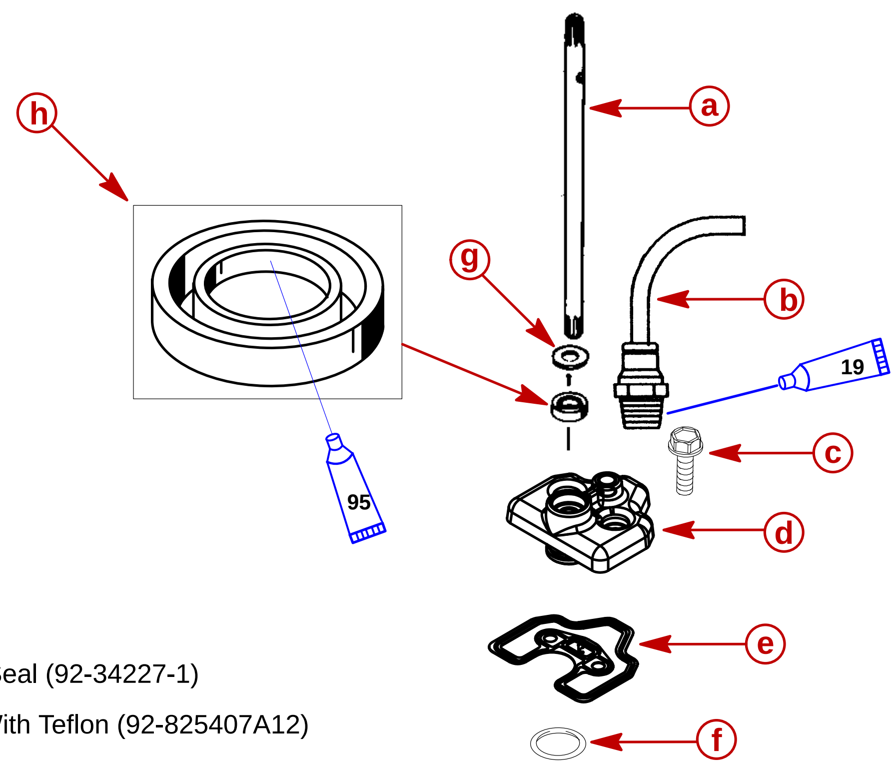
3. Inspect the shift shaft splines and oil seal surface for corrosion and/or excessive wear. Replace the shift shaft if either if these conditions are found.



a - Oil Seal Surface
b - Spline

SHIFT SHAFT ASSEMBLY - Component Reassembly

1. Lightly lubricate the seat of the O-ring diameter on the bushing and the lip of the oil seal with 2-4-C w/Teflon (92-825407A12).
2. If the speedometer connector was removed and/or replaced, lightly coat the **threads of the connector** with Quicksilver Perfect Seal (91-34277-1). Assemble the speed-ometer connector to the bushing and torque the connector to 4.5 lb. in. (0.5 Nm).
3. Assemble all components as shown below.



19 Perfect Seal (92-34227-1)
95 2-4-C With Teflon (92-825407A12)

a - Shift Shaft
b - Speedometer Pressure Hose
c - Bolt (2) [Torque to 60 lb. in. (7 Nm)]
d - Bushing
e - Gasket
f - O-ring
g - Rubber Washer
h - Seal (Lip Faces Up)

Pinion Bearing

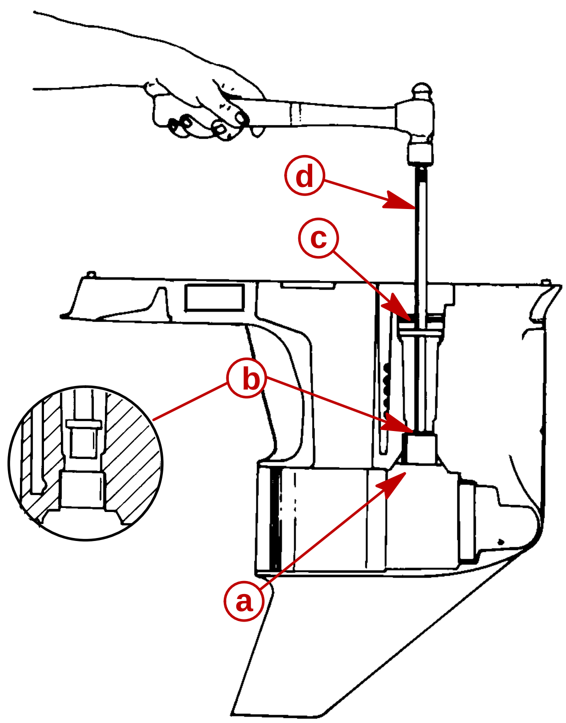
REMOVAL

NOTE: *Inspect the bearing surface on the drive shaft where the needles of the lower pinion bearing roll. The condition of the drive shaft at this location gives an indication of the condition of the needle bearing. Replace lower pinion bearing (needles and race as a set) if the drive shaft is pitted, grooved scored, worn unevenly, discolored from overheating, or has embedded particles.*

IMPORTANT: All the needle bearings (18) MUST BE in place inside bearing race while driving the pinion bearing from the gear housing.

IMPORTANT: Do not reuse the bearing (race or rollers) once it has been removed.

1. Remove and discard the pinion bearing (race and rollers) using tools as shown.



70614

a - Pinion Bearing
b - Bearing Driver (91-36569)
c - Pilot Washer (91-36571)
d - Driver Rod (91-37323)

Gear Housing Reassembly

Gear Housing Inspection

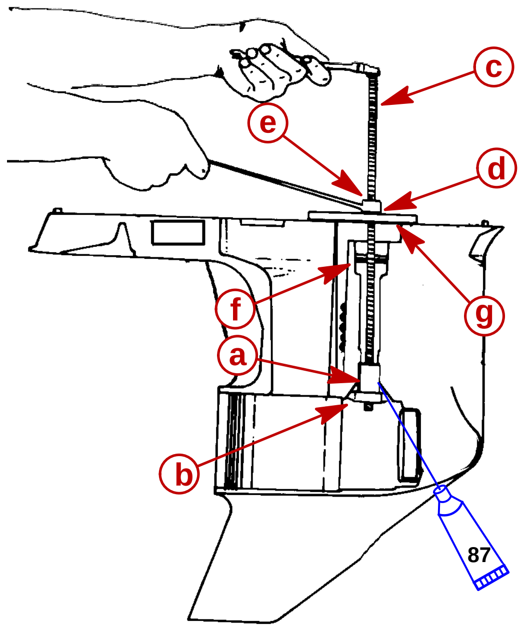
1. Clean the gear housing thoroughly with a suitable solvent and a hard bristle brush. Dry the gear housing thoroughly using compressed air. Insure that all sealants, locking agents and debris are removed.
2. Verify the 2 oil circulation holes in the drive shaft bore and the shift shaft hole are clear and free of debris.
3. Inspect the gear housing for excessive corrosion, impact or any other damage. Excessive damage and/or corrosion requires replacement of the gear housing.
4. Inspect the bearing carrier retainer threads in the gear housing for corrosion and/or stripped threads. Damage or corrosion to the threads requires replacement of the gear housing.
5. Inspect bearing race/cup contact areas for evidence of bearing cup spinning. Check that bearing cups are not loose in bearing bores. Any one bearing bore in which the race/cup is loose will require replacement of the gear housing.
6. Inspect for blockage in water inlet holes and the speedometer hole, clean as necessary. Be careful not to enlarge the speedometer hole as this could cause erroneous speedometer readings.
7. Verify that the locating pins are in place in the gear housing and that the corresponding holes in the drive shaft housing are not elongated. The drive shaft may break if the housings are not aligned properly due to missing locating pins or elongated holes.

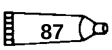
Pinion Bearing

INSTALLATION

IMPORTANT: Install only a new pinion bearing. Do not reinstall a pinion bearing that has been previously removed from a gear housing.

1. Lubricate the bore into which the pinion bearing is to be installed with Quicksilver Gear Lubricant (92-19007A24).
2. Position the new pinion bearing (with the cardboard shipping sleeve in place) onto the driver head, with the lettered and numbered side of the bearing oriented upward.
3. Insert the driver with the bearing assembly, into position (by way of the propeller shaft bore) at the drive shaft bore as shown.





Quicksilver Gear Lubricant (92-19007A24)

70615

a - Drive Shaft Pinion Bearing (With Cardboard Shipping Sleeve)
b - Driver Head (91-38628)
c - Puller Shaft (91-31229)
d - Washer (12-34961)
e - Nut (11-24156)
f - Pilot Washer (91-36571)
g - Puller Plate (91-29310)

4. Install the bearing by screwing down the nut until the bearing is fully seated against the bore shoulder.

Forward Gear Bearing Cup

INSTALLATION

Forward Gear Backlash – .017 in. to .028 in. (0.43mm to 0.71mm)

NOTE: *If the forward gear, forward gear bearing and cup, or gear housing were not replaced, install the same quantity of shims that were taken out when cup was removed. If the forward gear, forward gear bearing/cup, or gear housing were replaced, install 0.020 in. (0.51mm) of shims.*

NOTE: *If backlash has already been checked and it was determined that it needs to be adjusted, (see Checking Forward Gear Backlash), adding or subtracting 0.001 in. (0.03mm) shims will* ***change*** *the gear backlash by the same amount.*

Example 1 (if backlash is too high)

If Forward Backlash Checks:	.040 in.	(1.02 mm)
(Subtract):	.018 in.	(0.46 mm)
Add This Quantity of Shims:	.022 in.	(0.56 mm)
Provides Backlash of 0.018		(0.46 mm)

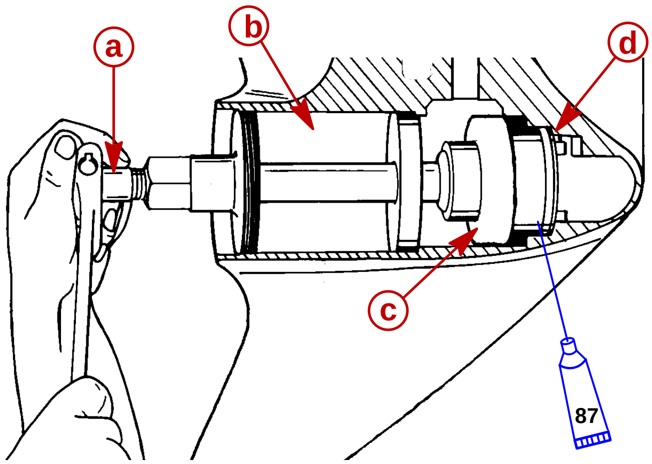
Example 2 (if backlash is too low)

Backlash Checks:	.010 in.	(0.25 mm)
Subtract this Quantity of Shims:	.008 in.	(0.30 mm)
Provides Backlash of 0.018		(0.46 mm)

1. Lubricate the bore into which the forward gear bearing cup is to be installed with Quicksilver Gear Lubricant (92-19007A24).
2. Place the shim(s) into forward bore of gear housing.

3. Press the bearing cup into the gear housing using the installation tool as follows:

IMPORTANT: Verify that the bearing cup is positioned as straight as possible to avoid cocking it in the bore while pressing it in.



87 Quicksilver Gear Lubricant (92-19007A24)

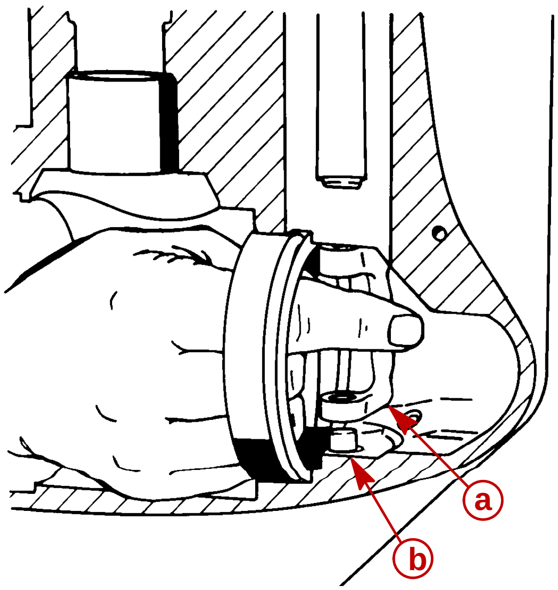
50791

a - Hex-Head Screw
b - Bearing Cup Installation Tool (91-18605A1)
c - Driver Cup (91-31106)
d - Shims

Shift Shaft Assembly

INSTALLATION

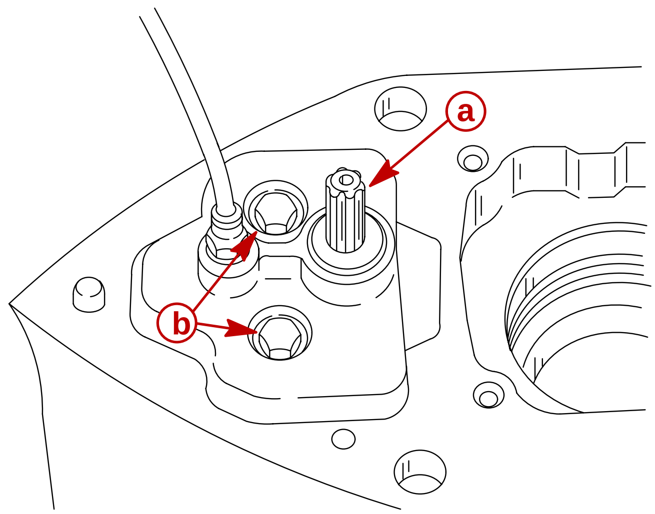
1. Place the shift crank onto the locating pin in the forward section of the gear housing. Ensure that the shift crank faces towards the left (port) side of the gear housing.



50314

a - Shift Crank
b - Locating Pin

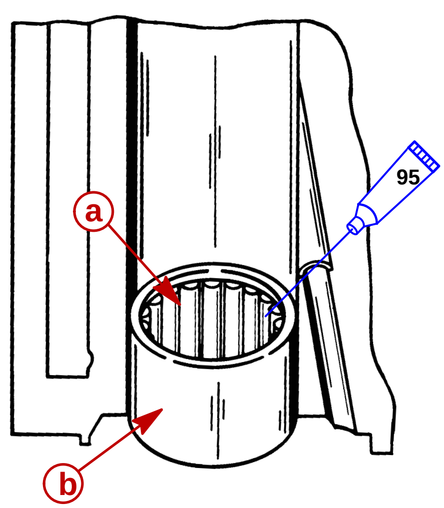
2. Install the shift shaft assembly into the gear housing as shown. Engage the splined end of the shift shaft with the shift crank. Verify O-ring is positioned properly and lubricated with 2-4-C w/Teflon. Secure shift shaft bushing with 2 screws. Torque screws to 60 lb. in. (7 Nm).



57933

a - Shift Shaft Assembly
b - Screws [Torque to 60 lb. in. (7 Nm)]

NOTE: *If the pinion bearing needle bearings have fallen out, install 18 needles into needle bearing outer race. Use 2-4-C w/Teflon (92-825407A12), to help hold needles in place.*



23142

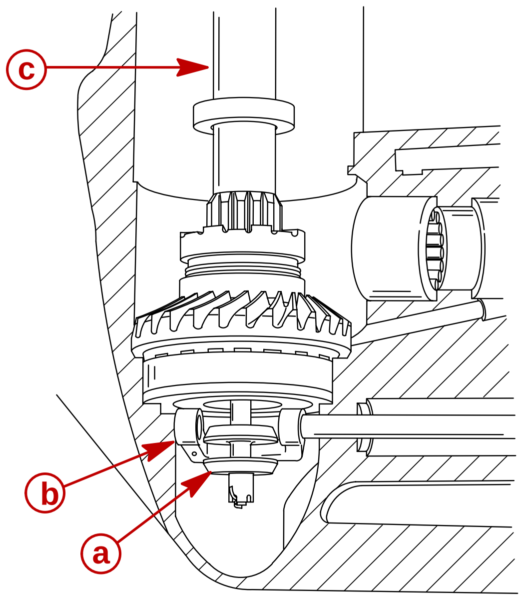
95 2-4-C With Teflon (92-825407A12)

a - Rollers (18)
b - Roller Bearing Outer Race

Propeller Shaft Assembly

INSTALLATION

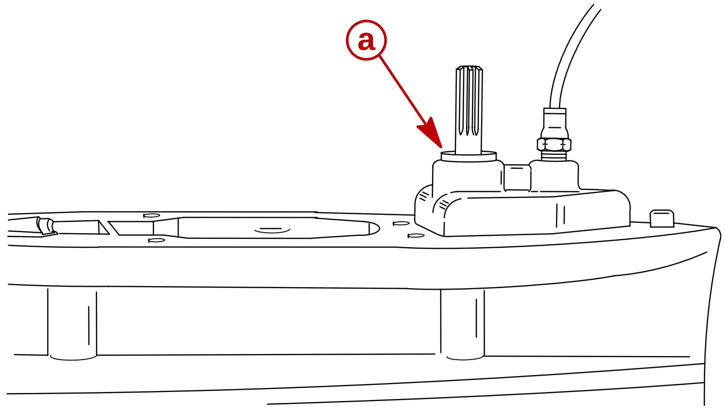
1. To allow for the engagement of the shift spool with the shift crank, tilt the propeller end of the propeller shaft assembly to the left (port) side of gear housing and rotate the shift shaft from reverse to neutral while installing shaft.



58016

a - Shift Actuating Spool
b - Shift Crank
c - Propeller Shaft Assembly

2. Operate the shift shaft to ensure that it has been properly installed. The sliding clutch should move forward when the shift shaft is turned clockwise, and should move aft when the shift shaft is turned counterclockwise.
3. Slide the rubber washer at top end of shift shaft down so that it just touches the oil seal in the bushing.



57947

a - Rubber Washer

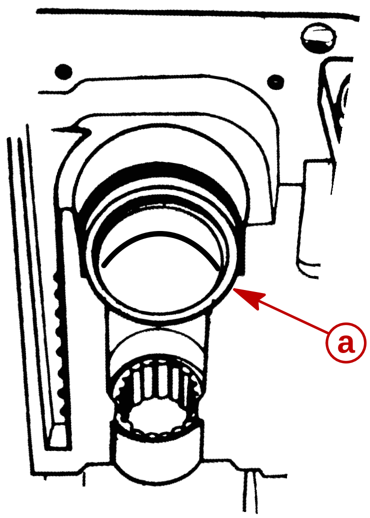
Drive Shaft and Pinion Gear

INSTALLATION

NOTE: *If the original shims were not retained or if pinion gear, drive shaft, drive shaft upper tapered roller bearing and cup, or gear housing were replaced, start off by installing a 0.038 in. (0.96 mm) shim(s), for the upper tapered roller bearing.*

NOTE: *If the original shims were retained (or measurement known) and none of the above listed parts were replaced, reinstall the same shims or same amount of shims.*

1. Place the upper tapered bearing shim(s) into the drive shaft housing bore.



70620

a - Shim(s)

NOTE: *For ease of installation, glue the washer to the pinion gear, using 3M Adhesive (92-25234), or Quicksilver Bellows Adhesive (92-86166), or equivalent.*

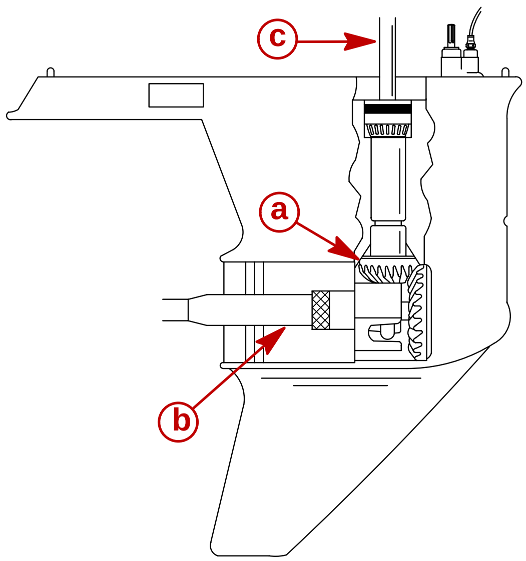
NOTE: *If the backlash may have to be changed, it is recommended that Loctite 271 NOT be applied to the pinion nut UNTIL the backlash setting is finalized. DO NOT reuse the old pinion nut. Install a NEW pinion nut after backlash is finalized.*

NOTE: *Do not install the lower tapered bearing cup or shim(s) at this time.*

2. Apply Loctite 271 (92-809820) to the threads of the pinion gear nut and place the pinion gear nut into the MR slot of the pinion nut adapter.

NOTE: *Install the pinion gear nut with the flat side of the nut away from the pinion gear.*

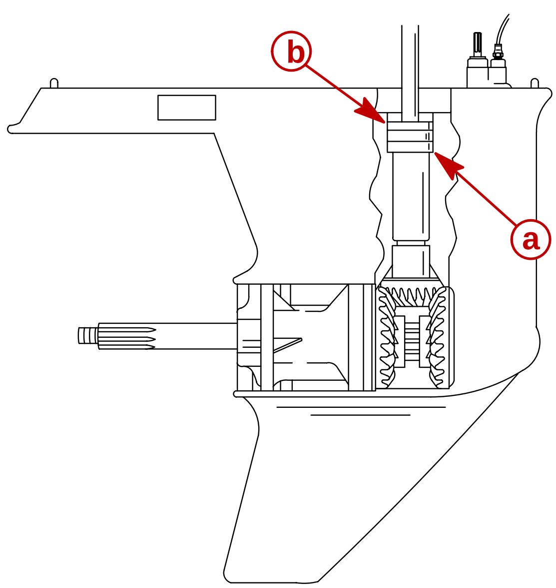
3. Place the pinion gear and washer into the gear housing.
4. Insert the pinion nut adapter (with the nut) into the gear housing.
5. Insert the drive shaft into the gear housing drive shaft bore. It may be necessary to rotate the drive shaft to engage the drive shaft splines into the pinion gear splines.
6. Start the pinion nut onto the drive shaft threads by rotating the drive shaft until the nut is snug.



57952

a - Pinion Gear (with the washer glued to it)
b - Pinion Nut Adaptor (91-61067A2)
c - Drive Shaft

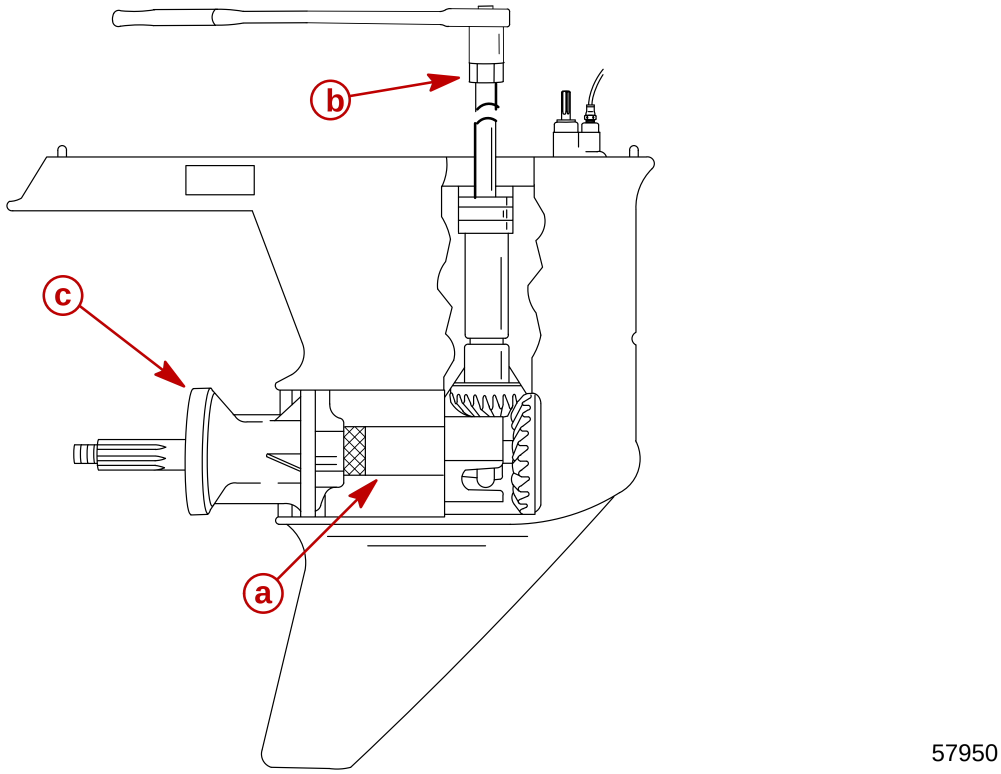
7. Install the upper drive shaft tapered roller bearing cup. Apply 2-4-C w/Teflon to the retainer threads and install the retainer.



57953

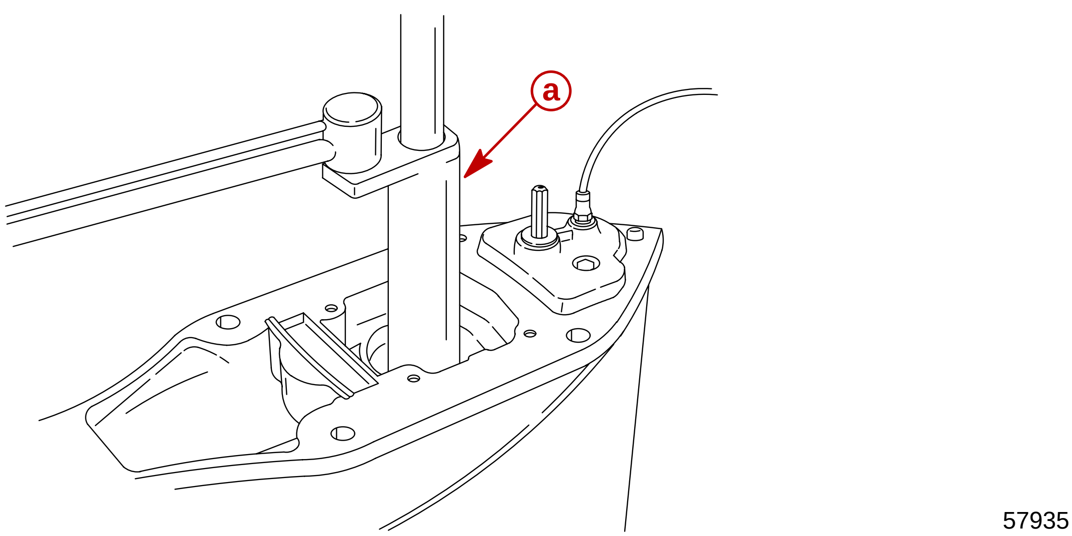
a - Tapered Roller Bearing Cup
b - Drive Shaft Retainer

8. Install the bearing carrier into the gear housing backwards to hold the propeller shaft and the pinion nut adaptor in position.
9. Torque the pinion nut to 75 lb. ft. (102 Nm) by turning the drive shaft using the drive shaft nut wrench and torque wrench.



a - Pinion Nut Adapter (91-61067A2)
b - Drive Shaft Nut Wrench (91-56775)
c - Bearing Carrier (installed backwards)

10. Remove the bearing carrier, pinion nut adapter and drive shaft nut wrench.
11. Torque the retainer to 100 lb. ft. (135 N·m).



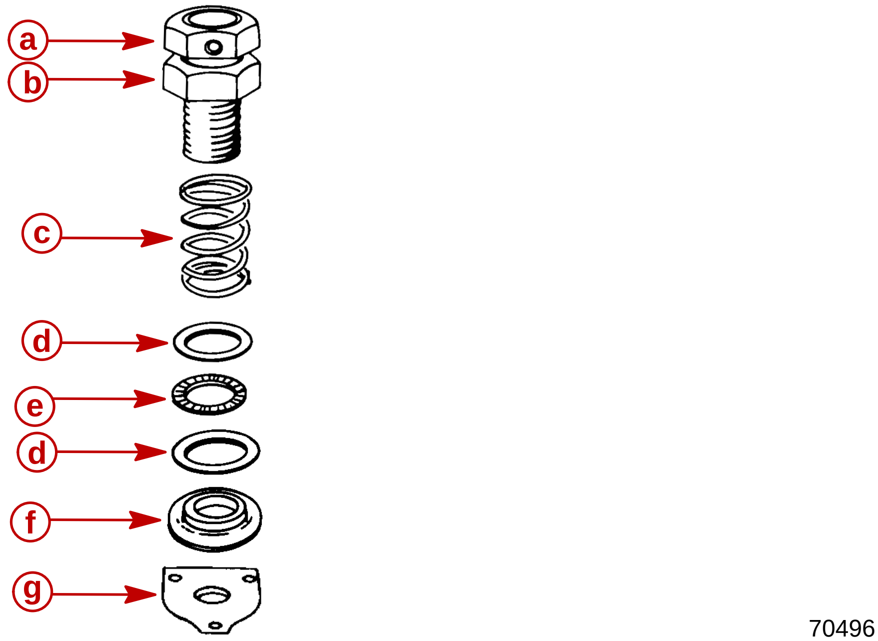
a - Drive Shaft Bearing Retainer Wrench (91-43506)

Gear Location/Backlashes/Checking and Adjustment

Drive Shaft - Bearing Preload Tool

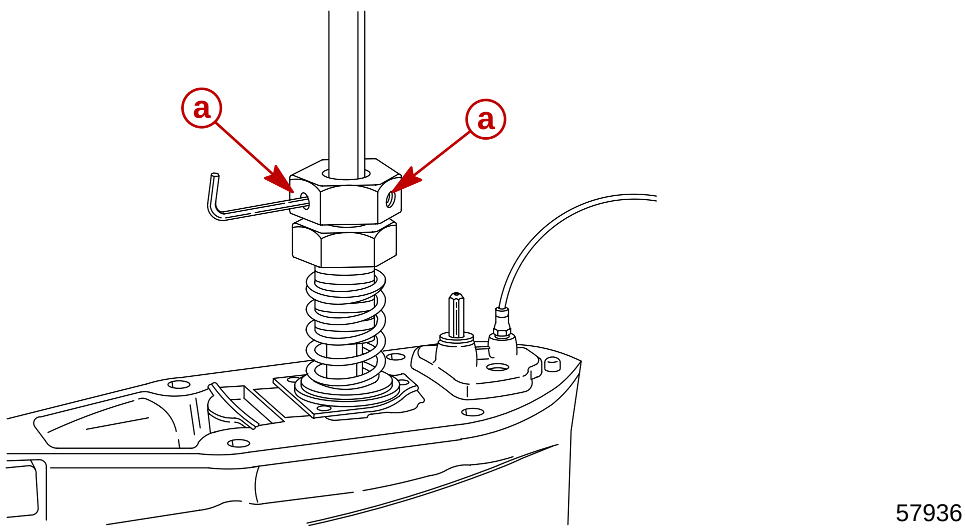
INSTALLATION

1. Install the components from the Bearing Preload Tool Kit (91-14311A2), over the drive shaft in the order shown.



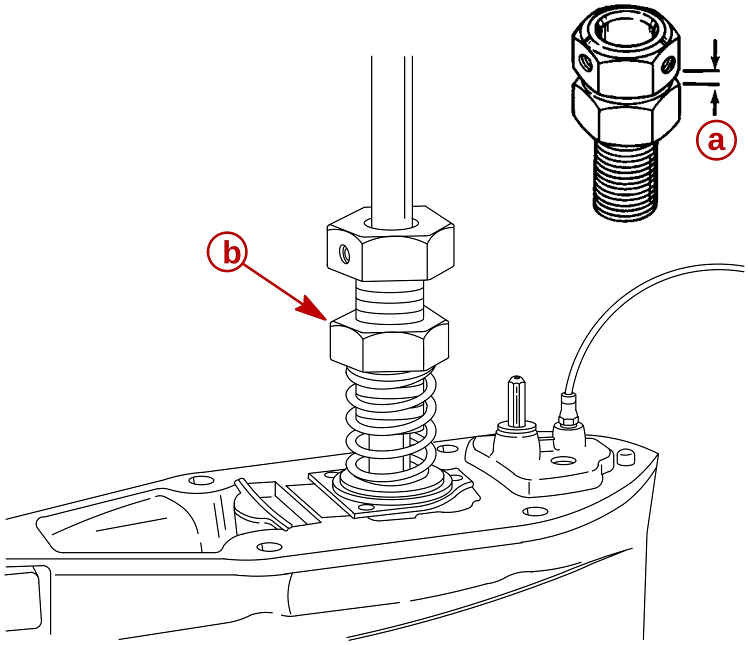
a - Top Nut with Threaded Pipe
b - Nut
c - Spring
d - Thrust Washer (2 Required) (12-18448)
e - Thrust Bearing
f - Thrust Washer
g - Plate

2. Pull up on the drive shaft and tighten the two (2) allen screws in the top nut of the bearing preload tool.



a - Allen Screws

3. Measure distance (a) and increase that distance by 1 in. (25.4mm) by turning bottom nut away from top nut.



a - Distance 1 in. (25.4mm)
b - Bottom nut [screwed down approximately 1 in. (25.4mm)]

Pinion Gear Location

CHECKING AND ADJUSTING

Pinion Depth – 0.025 in. (0.64mm)

NOTE: *If the bearing preload tool has not already been set up, refer to "Drive Shaft - Bearing Preload Tool", 'Installation' section first.*

NOTE: *The prop shaft and forward gear can be installed when checking pinion height IF Pinion Height Tool 91-56048 is used.*

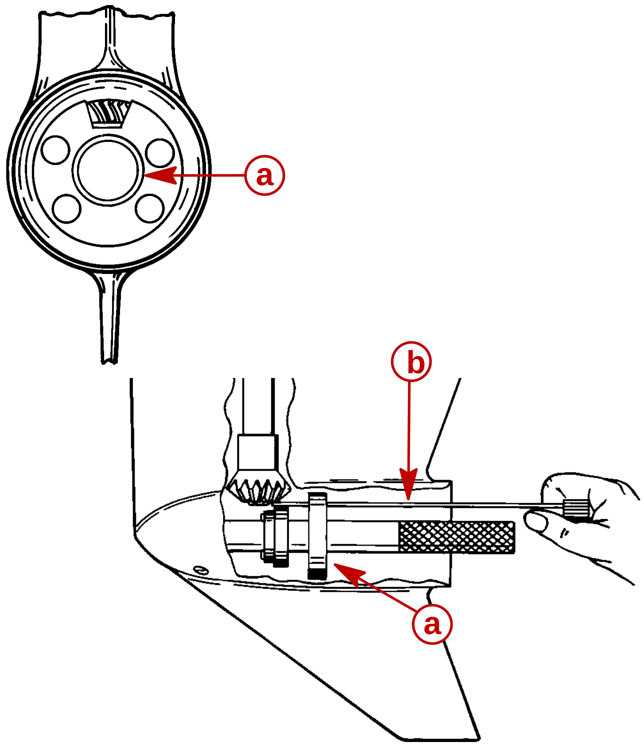
1. Place the pinion gear shimming tool into the gear housing.

NOTE: *Take the following measurements at 3 locations, rotating the drive shaft 120 degrees between each reading (always rotate the drive shaft in a clockwise direction).*

2. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and high point of the shimming tool.
3. Rotate the drive shaft 120 degrees in a clockwise direction and take another reading.
4. Repeat this process until 3 readings have been taken.
5. Add the three readings together and divide the sum by 3 to get the average pinion gear height. Make note of this average measurement.

The average pinion gear height should be 0.025 in. (0.64mm).

6. If the average pinion gear height is not correct, remove the bearing preload tool, the drive shaft retainer and the drive shaft tapered roller bearing cup. (The cup can be removed by wiggling the drive shaft back and forth or by turning gear housing and shaking it.) Add or subtract shims beneath the cup to obtain the proper average pinion gear height. Reinstall the cup and retainer. Retorque retainer to 100 lb. ft. (135 Nm). Reinstall the bearing preload tool and rotate the drive shaft at least 3 full turns in a clockwise direction. Recheck the pinion gear height as in step 5 above. Repeat this process until the average pinion gear height is within specification.



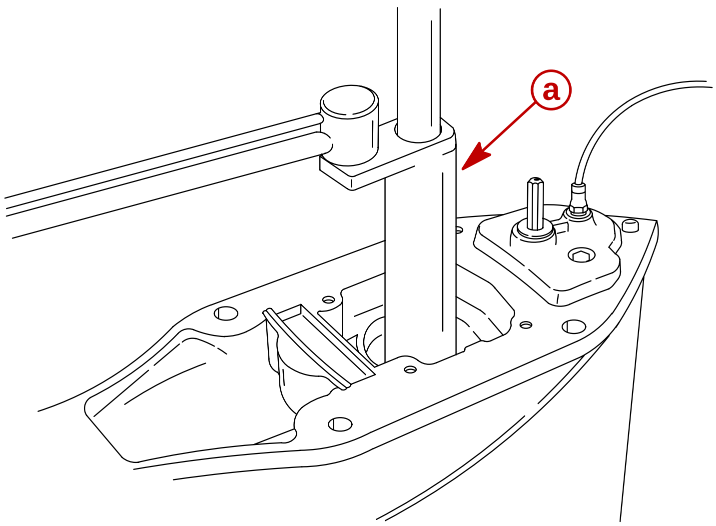
24643

a - Pinion Gear Shimming Tool (91-12349A2) Using Disc #2 and Flat #4

b - 0.025 in. (0.64mm) Feeler Gauge

UPPER DRIVESHAFT BEARING CLEARANCE

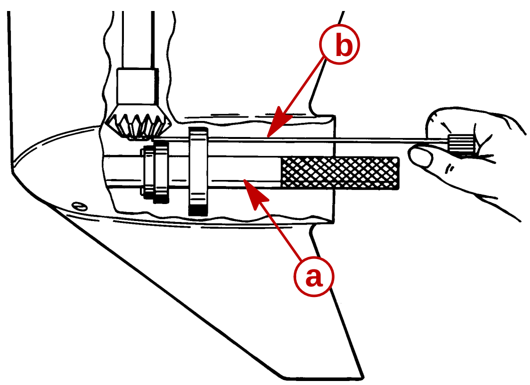
1. When the correct pinion gear height is achieved, remove pinion nut, upper retainer and driveshaft.
2. Apply Quicksilver gear lubricant to O.D. of the driveshaft lower bearing cup and install cup into the gear case.
3. Reinstall driveshaft and pinion gear into gear case.
4. Install the upper drive shaft bearing cup and install and torque the upper bearing retainer to 100 lb. ft. (135 Nm).
5. Torque pinion nut to 70 lb. ft. (95 Nm).



57935

a - Bearing Retainer Tool (91-43506)

6. Push down on drive shaft and check clearance between pinion gear and pinion gear shimming tool shoulder. Clearance should be 0.020 in - 0.024 in. (0.51 mm - 0.61 mm).



a - Pinion Gear Shimming Tool (91-12349A2) Using Disc #2 and Flat #4
b - Feeler Gauge

NOTE: *Do not change shims under upper bearing cup or pinion height will be changed.*

7. Maintain the shims as previously set under the upper drive shaft bearing cup.
8. If clearance is not within specifications, remove the upper bearing cup retainer with tool 91-43506 and remove cup. Leave upper cup shim(s) in place.

NOTE: *A 0.001 in. (25.4 mm) change of shims under the lower bearing cup will result in a 0.001 in. (25.4 mm) change in drive shaft end play.*

9. With new shim(s) under lower bearing cup, reinstall upper bearing cup and torque cup retainer to 100 lb. ft. (135.5 Nm). Recheck drive shaft clearance.

NOTE: *Install a NEW pinion nut with Loctite 271 AFTER all clearances are correct.*

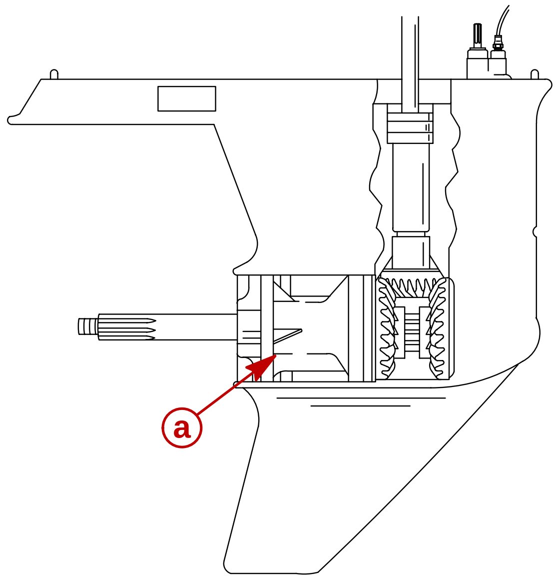
10. If clearance is correct, clean drive shaft threads and apply Loctite 271 and install a new pinion nut. Torque nut to 75 lb. ft. (102 Nm).

Bearing Carrier Assembly

INSTALLATION - (FOR CHECKING BACKLASHES)

NOTE: *If backlashes have already been checked and they are to specification proceed with "Bearing Carrier Assembly", 'Final Installation' section*

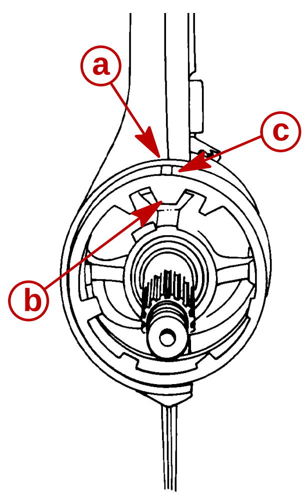
1. Place the bearing carrier assembly into the gear housing. It may be necessary to turn the drive shaft to align the teeth of the pinion and the reverse gears.



57953

a - Bearing Carrier Assembly

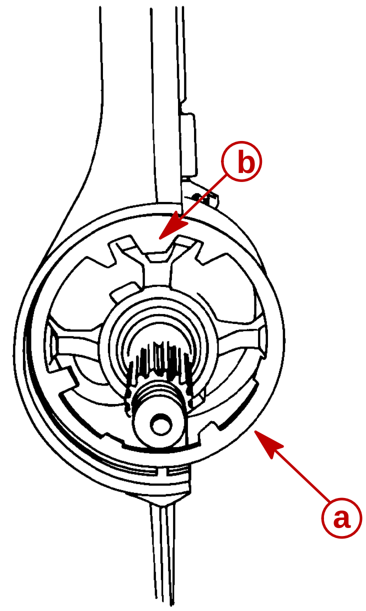
2. Align the bearing carrier "V" shaped notch with the alignment hole in the gear housing and then install the tab washer with the external tab inserted into the hole in the gear housing.



70713

a - Gear Housing Tab Washer Alignment Hole (not seen)
b - "V" Shaped Notch in Bearing Carrier
c - Alignment Tab of Tab Washer

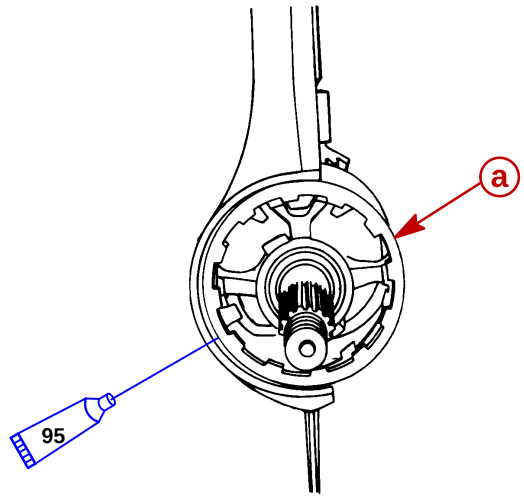
3. Verify that the “V” shaped tab aligns with the “V” notch in bearing carrier.



70714

a - Tab Washer
b - “V” Tab

4. Lubricate the bearing carrier retainer threads with 2-4-C w/Teflon (92-825407A12). Start the retainer into the gear housing threads and screw it down fully by hand.



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

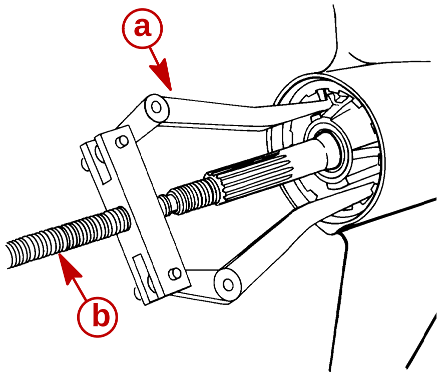
70715

a - Bearing Carrier Retainer

Forward Gear Backlash

CHECKING

1. Apply forward pressure to propeller shaft as follows:
   a. Attach puller jaws and puller bolt onto bearing carrier bosses and propeller shaft.

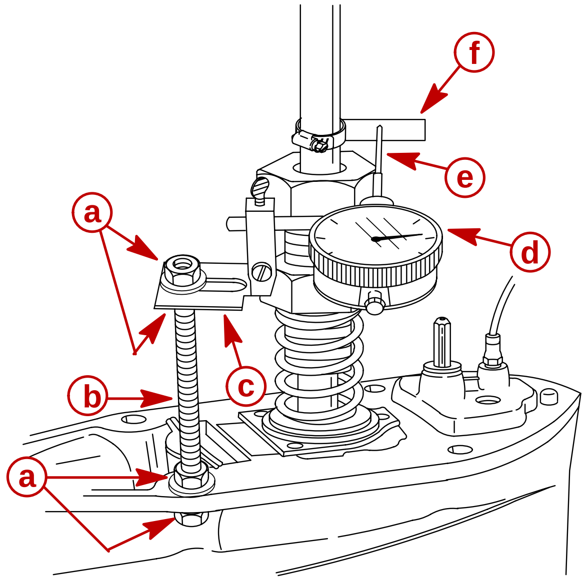


a - Puller Jaws (91-46086A1)
b - Puller Bolt (91-85716)

   b. Torque the puller bolt to 45 lb. in. (5 Nm). Rotate drive shaft three full turns clockwise and retorque the bolt to 45 lb. in. (5 Nm).

NOTE: *If the bearing preload tool has not already been set up, see "Drive Shaft - Bearing Preload Tool", 'Installation' section.*

2. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the "I" mark on the dial indicator tool. Tighten the indicator tool onto the drive shaft and rotate the drive shaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.



a - Nuts (4) (Obtain Locally)
b - Threaded Rod [3/8 in. (9.5mm) obtain locally]
c - Dial Indicator Holding Tool (91-83155)
d - Dial Indicator (91-58222A1)
e - Indicator Pointer
f - Backlash Indicator Rod (91-53459) (for 1.75:1)
Backlash Indicator Rod (91-78473) (for 1.87:1 ratio)

3. Take the backlash readings by lightly turning the drive shaft back and forth, (no movement should be noticed at the propeller shaft).
   a. Observe the dial indicator and record the reading.
   b. Loosen the indicator tool and rotate the drive shaft 90 degrees in a clockwise direction.
   c. Repeat step 2 above and take and record another reading. Repeat step 3 until a total of 4 backlash readings have been taken.
4. Add the four readings together and divide the sum by four. This is your average backlash, which should be 0.017 in. - 0.028 in. (0.431 mm - 0.711 mm) (for 1.64:1; 1.75:1 and 1.87 ratios).
5. If backlash is LESS than the specified minimum, REMOVE shim(s) from in front of forward gear bearing race to obtain correct backlash. When reinstalling pinion nut, apply Loctite 271 to threads of nut.
6. If backlash is MORE than the specified MAXIMUM, add shim(s) in front of forward gear bearing race to obtain correct backlash. When reinstalling pinion nut, apply Loctite 271 to threads of nut.

NOTE: *By adding or subtracting 0.001 in. (0.025 mm) shim, the backlash will change approximately 0.001 in. (0.025 mm).*

Reverse Gear Backlash

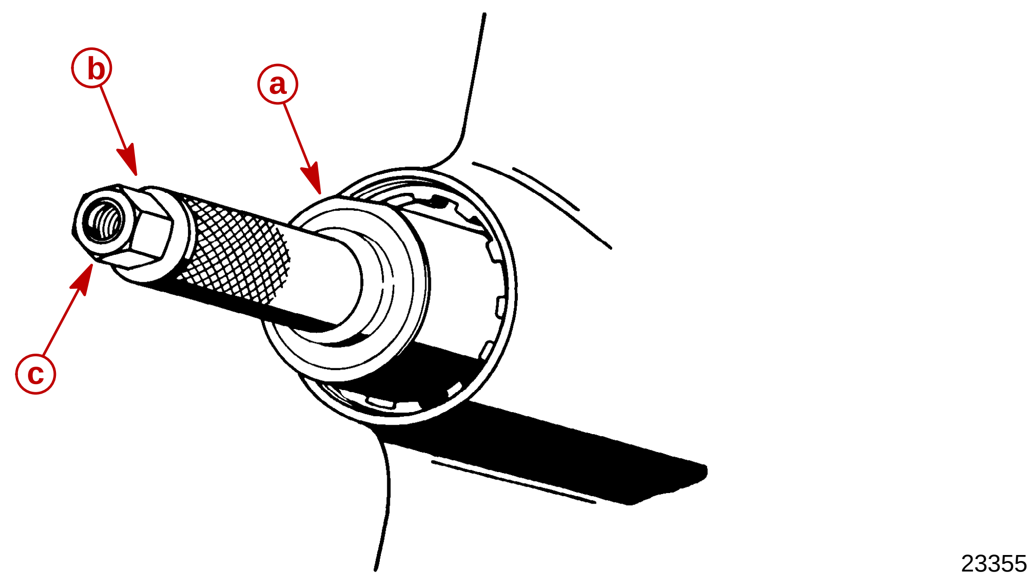
CHECKING

Reverse Gear Backlash – 0.030 in. to 0.050 in. (0.76mm to 1.27mm)

Although reverse gear backlash is not adjustable, it may be checked as follows:

NOTE: *Torque cover nut to 210 lb. ft. (285 Nm).*

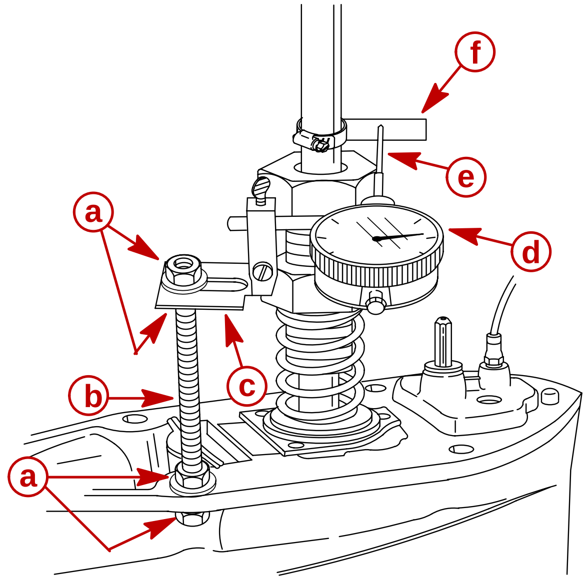
1. Apply backward pressure on the propeller shaft as follows:
   a. Install the pinion nut adaptor, washer and propeller nut as shown.



a - Pinion Nut Adaptor (91-61067A2)
b - Washer (12-54048)
c - Prop Nut

   b. Torque the propeller nut to 45 lb. in. (5 Nm). Rotate the drive shaft 3 full turns in a clockwise direction and retorque the propeller nut to 45 lb. in. (5 Nm).

2. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the “I” mark on the dial indicator tool. Tighten the indicator tool onto the drive shaft and rotate the drive shaft so that the needle in the dial makes at least one full revolution and comes to “0” on the dial indicator scale.



57939

a - Nuts (4) (Obtain Locally)
b - Threaded Rod [3/8 in. (9.5mm) obtain locally]
c - Dial Indicator Holding Tool (91-83155)
d - Dial Indicator (91-58222A1)
e - Indicator Pointer
f - Backlash Indicator Rod (91-53459) (for 1.75:1)
Backlash Indicator Rod (91-78473) (for 1.87:1 ratio)

3. Take the backlash readings by lightly turning the drive shaft back and forth, so as to feel the backlash between the gears, (no movement should be noticed at the propeller shaft).
   a. Observe the dial indicator and record the reading.
   b. Loosen the indicator tool and rotate the drive shaft 90 degrees in a clockwise direction.
   c. Repeat step 2 above and take and record another reading. Repeat step 3 until a total of 4 backlash readings have been taken.
4. Add the four readings together and divide the sum by four. This is your average backlash and it should be 0.030 in. - 0.050 in. (0.76mm - 1.27mm) (for 1.75:1 and 1.87:1 ratios). If backlash is not as indicated, gear case is not properly assembled or parts are excessively worn and must be replaced before returning gear case to service.
5. Loosen the backlash indicator tool and remove the propeller nut, washer and pinion nut adaptor. Remove the dial indicator and all its mounting components. **Do not remove the bearing preload tool. The following instructions give specific instructions for its removal.**

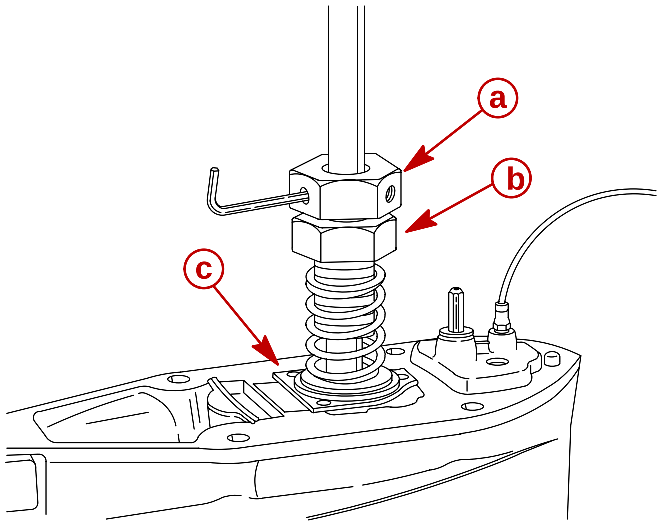
Drive Shaft - Bearing Preload Tool

REMOVAL

CAUTION

Before loosening the top nut allen screws of the bearing preload tool, screw the bottom nut up as close as possible to the top nut.

1. Remove the dial indicator and its supporting tooling.
2. Screw the bottom nut of the bearing preload tool until it is as close as possible to top nut.
3. Loosen the allen screws in the top nut.
4. Remove all components including the water pump face plate.



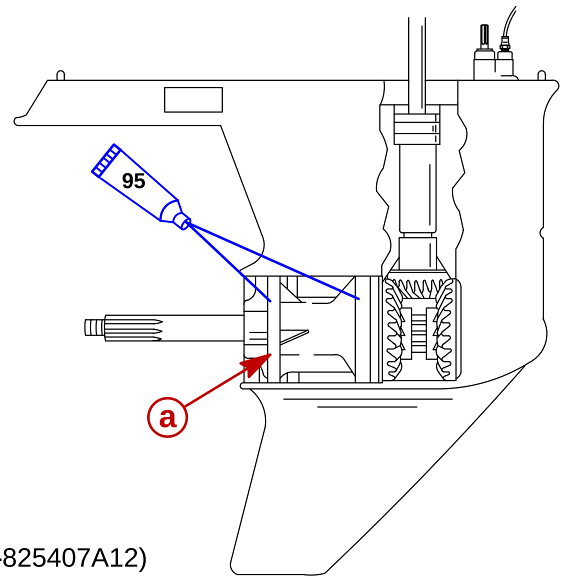
57936

a - Top Nut (with allen screws)
b - Bottom Nut
c - Water Pump Face Plate

Bearing Carrier Assembly

Final Installation

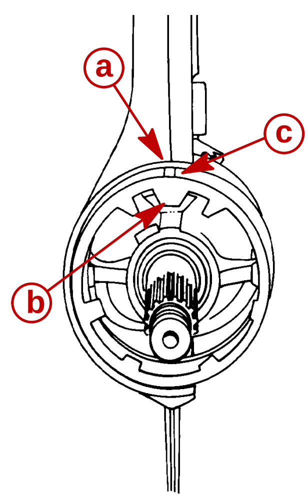
1. Remove the Bearing Carrier and lubricate the following as specified:
   a. Lubricate the carrier O-ring with 2-4-C w/Teflon (92-825407A12).
   b. Lubricate both the forward and aft outer diameters of the bearing carrier and gear case area where carrier will seat with 2-4-C w/Teflon.
   c. Fill the space between the carrier oil seals with 2-4-C w/Teflon.
2. Place the bearing carrier assembly into the gear housing. It may be necessary to turn the drive shaft to align the teeth of the pinion and the reverse gears.



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

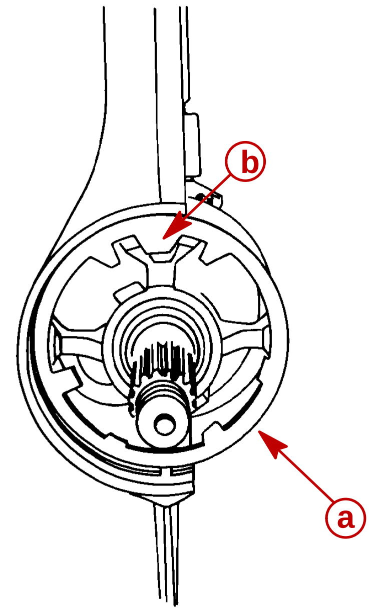
a - Bearing Carrier Assembly

3. Align the bearing carrier "V" shaped notch with the alignment hole in the gear housing and then install the tab washer with the external tab inserted into the hole in the gear housing.



a - Gear Case Alignment Hole
b - "V" Shaped Notch in Bearing Carrier
c - Alignment Tab of Tab Washer

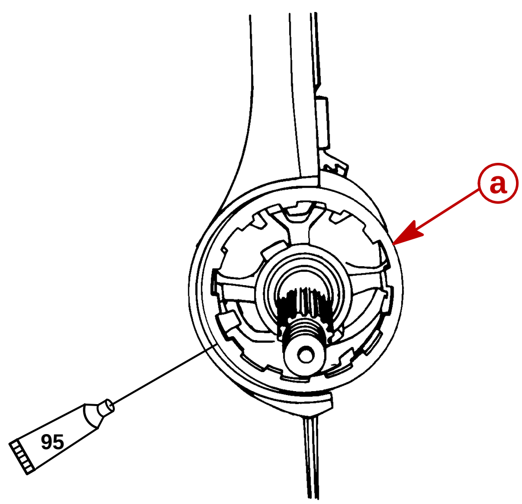
4. Verify the "V" shaped tab aligns with the "V" notch in bearing carrier.



70714

a - Tab Washer
b - "V" Tab

5. Fill the bearing carrier retainer nut threads and corresponding gear housing threads with 2-4-C w/Teflon (92-825407A12). Start the retainer into the gear housing threads and screw it down fully by hand.



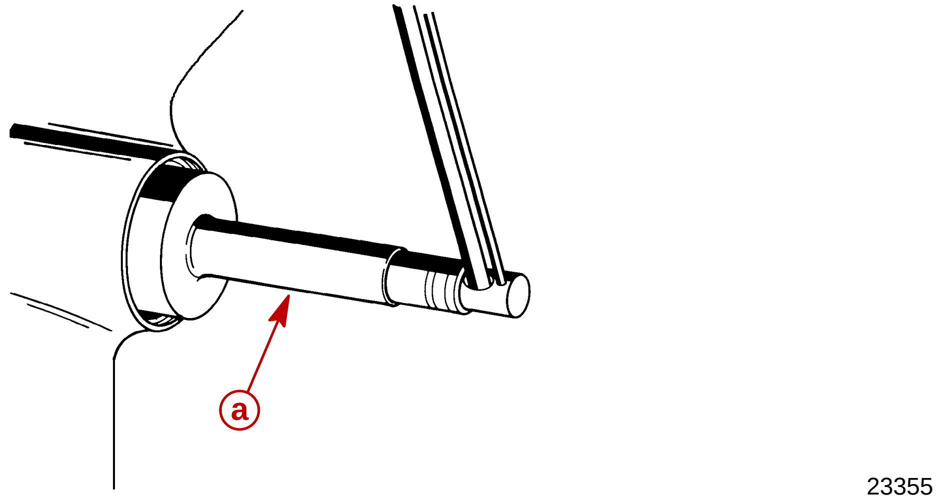
95 2-4-C With Teflon (92-825407A12)

70715

a - Bearing Carrier Retainer

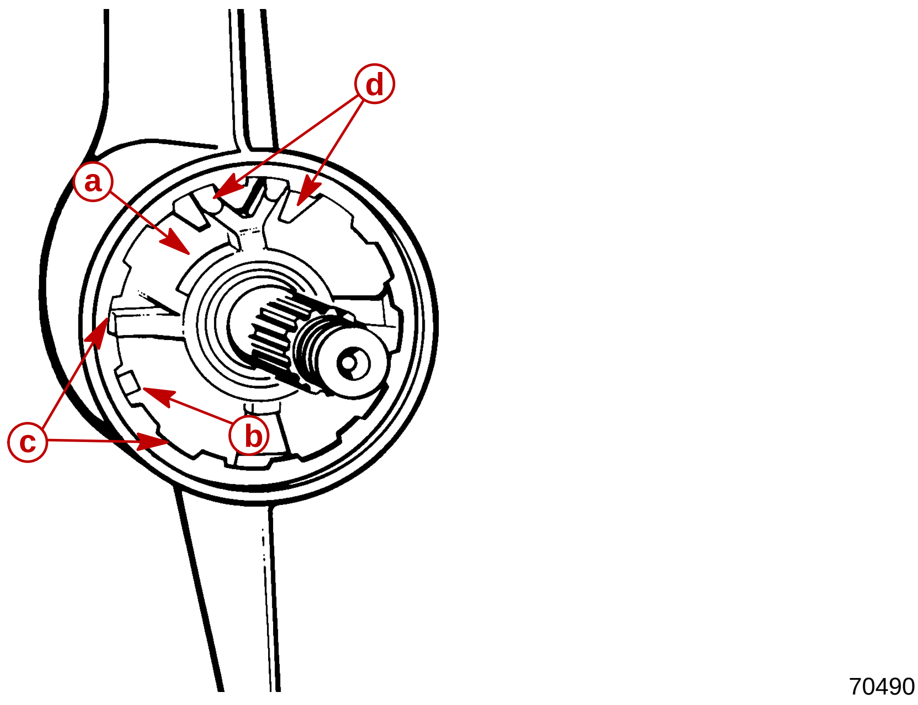
IMPORTANT: Before torquing bearing carrier retainer, gear case must be bolted to drive shaft housing or securely fastened in a gear case holding fixture to avoid possible damage to gear housing.

6. Torque the bearing carrier retainer to 210 lb. ft. (285 Nm). If one tab does not align up in space between two of the notches, continue to tighten retainer until alignment is achieved. DO NOT loosen retainer to achieve alignment.



a - Bearing Carrier Retainer Wrench (91-61069)

7. Bend one tab aft (outward) into a space between two of the notches of the retainer. Bend all the remaining tabs forward (inward).



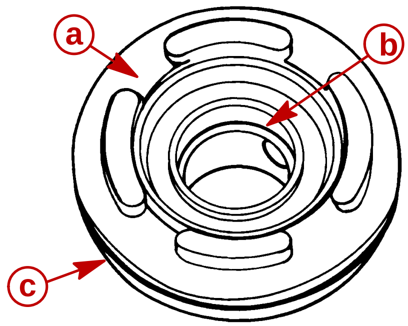
a - Bearing Carrier
b - Tab
c - Retainer Notches
d - Alignment Tabs (Bend Inward)

Oil Seal Carrier Assembly

Installation

NOTE: *Apply hand pressure only to install the oil seal carrier into position. Do not hammer it into position.*

1. Lubricate the oil seal carrier oil seal lips, space between seals and O-ring with 2-4-C w/Teflon and install the oil seal carrier over the drive shaft and into the gear case.



70501

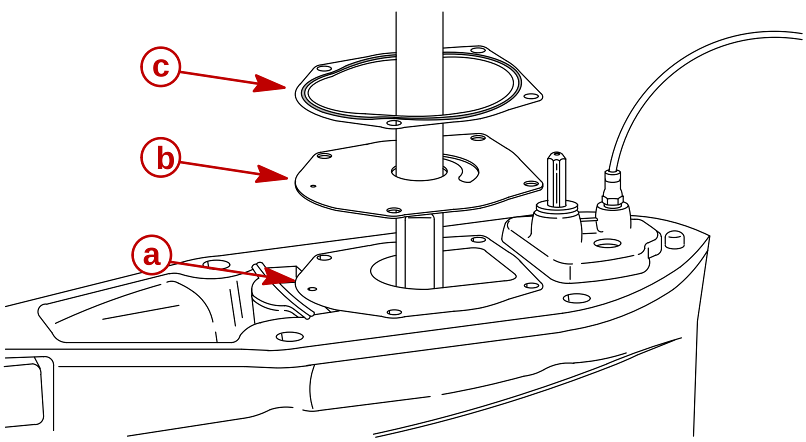
a - Oil Seal Carrier
b - Oil Seal Lips
c - O-ring

Water Pump Assembly

Installation

NOTE: *The gaskets/face plate hole pattern is not symmetrical. If the holes of the gaskets/face plate do not align with the screw holes of the gear case and/or each other, one or more of the parts is upside down. Determine which part(s) is (are) upside down and turn the appropriate part(s) over.*

1. Install the small hole gasket then the face plate followed by the large hole gasket onto the gear case.



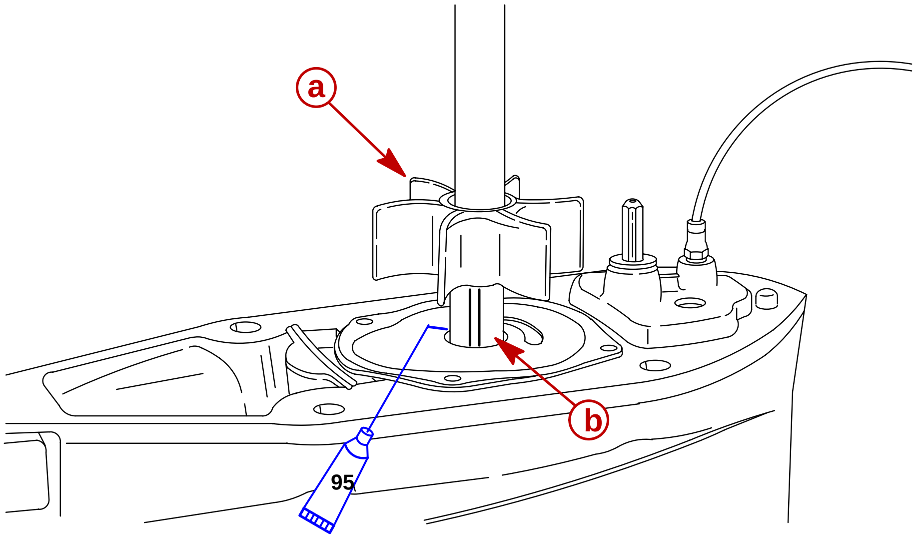
58011

a - Small Hole gasket
b - Face Plate
c - Large Hole Gasket (GRAY sealing ring faces up)

2. Place a small amount of 2-4-C w/Teflon on the flat surface of the impeller key and install the key onto the drive shaft keyway.

IMPORTANT: When using an impeller whose blades have taken a set, face the curl of the blades in a counterclockwise direction. Do not install the impeller with its blades oriented in a reversed direction from original rotation, or premature impeller failure will occur.

3. Assemble the water pump impeller onto the drive shaft and down over the key.

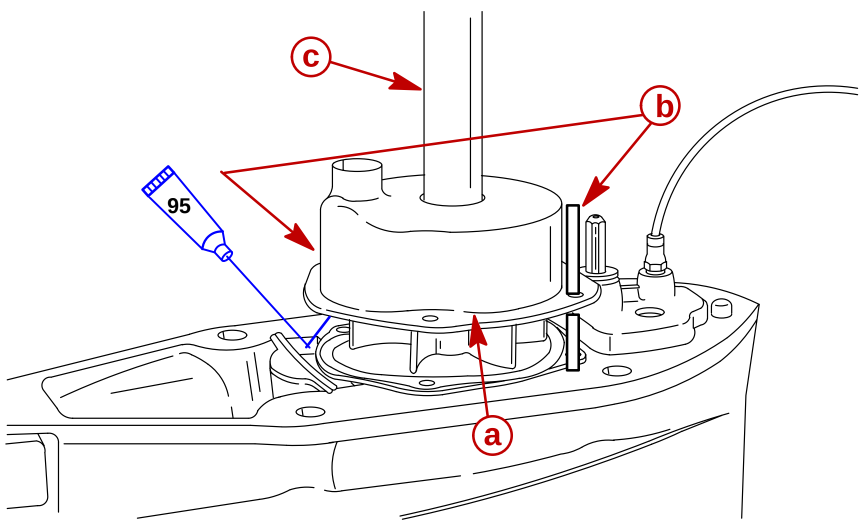


95 2-4-C With Teflon (92-825407A12)

a - Water Pump Impeller
b - Water Pump Impeller Key

4. Install the 2 water pump locating pins through the gaskets and face plate.

5. Apply a light coat of 2-4-C w/Teflon to the inside of the pump cover. Position the water pump body over the drive shaft and water pump locating pins. Rotate the drive shaft in a clockwise direction, while pushing down on the water pump body to ease the water pump over the impeller blades.



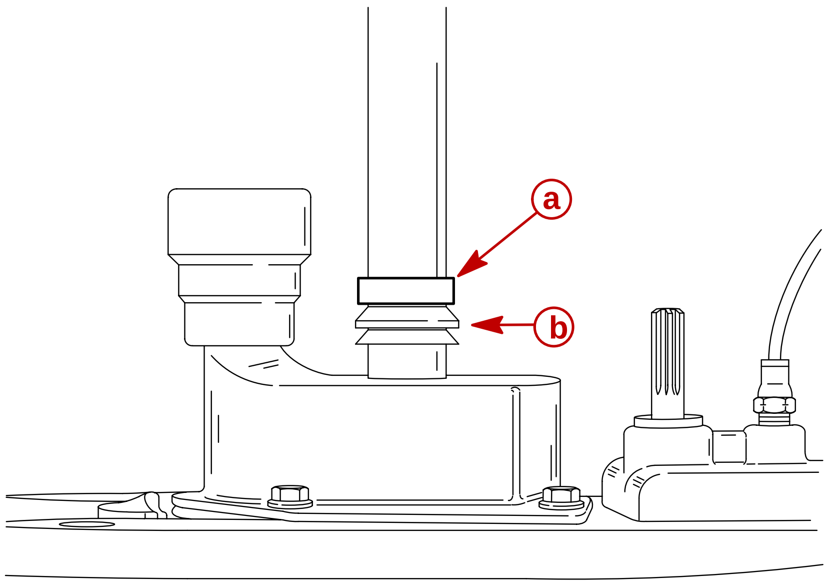
95 2-4-C With Teflon (92-825407A12)

a - Water Pump Body
b - Water Pump Alignment Pins (91-821571A1)
c - Drive Shaft (turn clockwise while installing water pump body)

6. Hand start two (2) fasteners into the water pump assembly and remove the water pump locating pins. Install the remaining 2 fasteners. Run all fasteners down and torque to 60 lb. in. (7 Nm).
7. Lightly lubricate the O-rings in the water tube coupling with 2-4-C w/Teflon (92-825407A12).
8. Install the water tube coupling assembly to the water pump ensuring that the O-rings are not damaged during assembly.

IMPORTANT: If seal installed above pump housing is not at the proper height, air will be drawn into the pump resulting in overheating of the engine.

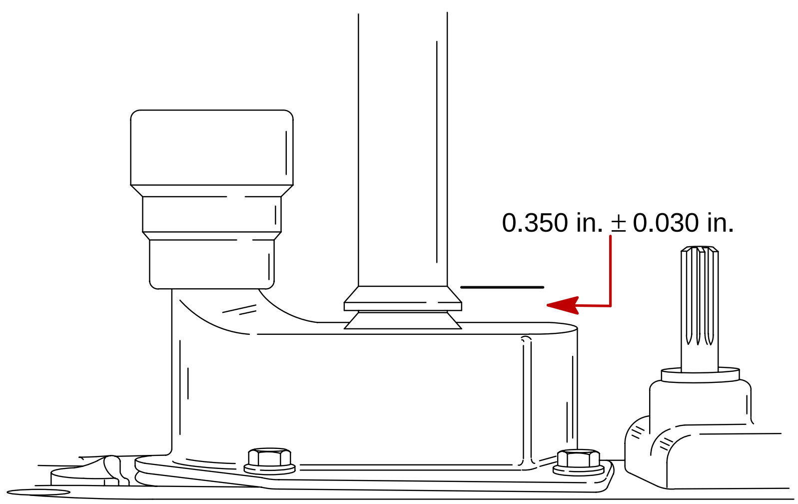
9. Using tool (a) provided in seal kit (26-816575A2) or water pump kit (817275A3), press seal (b) down over drive shaft (DO NOT GREASE DRIVE SHAFT) until tool seats against pump housing.



57945

a - Tool
b - Seal

If tool is not available, lightly press seal against housing until a height of 0.350 in. ± 0.030 in. (8.9mm ± 0.76mm) is obtained.



57946

Gear Lubricant Filling Instructions

1. Inspect “Fill” and “Vent” sealing washers for cuts or abrasions. Replace washers if necessary.
2. Clean any metal debris from magnet on “Fill” plug.

IMPORTANT: Never apply lubricant to gear housing without first removing Vent screw, or gear housing cannot be filled because of trapped air. Fill gear housing ONLY when housing is in a vertical position.

3. Slowly fill housing thru Fill hole with Quicksilver Super Duty Lower Unit Lubricant until lubricant flows out of “Vent” hole and no air bubbles are visible.
4. Install Vent screw into Vent hole.

IMPORTANT: DO NOT lose more than one fluid ounce (30cc) of gear lubricant while reinstalling Fill screw.

5. Remove grease tube (or hose) from Fill hole and quickly install Fill screw into Fill hole.

Installing Gear Housing to Driveshaft Housing

WARNING

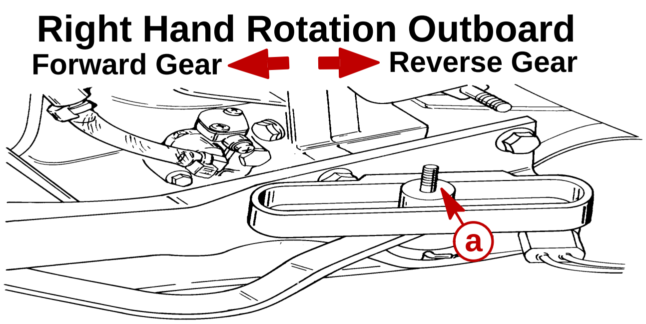
Disconnect high tension leads from spark plugs and remove spark plugs from engine before installing gear housing onto driveshaft housing.

1. Tilt engine to full up position and engage the tilt lock lever.
2. Apply a light coat of Quicksilver 2-4-C w/Teflon Marine Lubricant onto driveshaft splines.

CAUTION

DO NOT allow lubricant on top of driveshaft. Excess lubricant, that is trapped in clearance space, will not allow driveshaft to fully engage with crankshaft. Subsequently, tightening the gear housing nuts (while excess lubricant is on top of driveshaft) will load the driveshaft/crankshaft and damage either or both the powerhead and gear housing. Top of driveshaft is to be wiped free of lubricant.

3. Apply a light coat of Quicksilver 2-4-C w/Teflon Marine Lubricant onto shift shaft splines. (DO NOT allow lubricant on top of shift shaft.)
4. Apply a thin bead of G.E. Silicone Sealer (92-91600-1) against the top of divider block.
5. Insert trim tab bolt into hole in rear of gear housing to driveshaft housing machined surface.
6. Shift gear housing into NEUTRAL and place guide block anchor pin into NEUTRAL position



a - Guide Block Anchor Pin

7. Position gear housing so that the driveshaft is protruding into driveshaft housing.

***NOTE:** If, while performing Step 8, the driveshaft splines will not align with crankshaft splines, place a propeller onto propeller shaft. Shift gearcase into FORWARD and turn propeller counterclockwise as the gear housing is being pushed toward driveshaft housing.*

8. Move gear housing up toward driveshaft housing while aligning shift shaft splines and water tube with water tube guide (in water pump cover).
9. Place flat washers onto studs (located on either side of driveshaft housing). Start a nut on these studs and tighten finger-tight.
10. Start bolt at rear of gear housing inside trim tab recess. DO NOT tighten bolt at this time.
11. Recheck shift shaft spline engagement and correct if necessary.

***NOTE:** Guide block anchor pin should be in FORWARD when gearcase is in FORWARD.*

IMPORTANT: Do not force gear case up into place with attaching nuts.

12. Evenly tighten 2 nuts which were started in Step 9. Torque to 55 lb. ft. (75 Nm).
13. After 2 nuts (located on either side of driveshaft housing) are tightened, check shift operation as follows:
    a. Place guide block anchor pin into forward gear position while turning prop shaft. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate clockwise.
    b. Place guide block anchor pin into NEUTRAL position. Propeller shaft should rotate freely clockwise/counterclockwise.
    c. Place guide block anchor pin into REVERSE gear position. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate counterclockwise.

IMPORTANT: If shifting operation is not as described, preceding, the gear housing must be removed and the cause corrected.

14. Install remaining washers and nuts onto drive shaft studs. Torque to 55 lb. ft. (75 Nm).
15. Torque bolt (started in Step 10) to 45 lb. ft. (61 Nm).
16. Position trim tab or anodic plate in gear housing. Align grooves of trim tab with ribs in trim tab pocket. Adjust to position in which it had previously been installed, and while holding trim tab, torque bolt to 40 lb. ft. (54 Nm)
17. Install plastic cap into trim tab bolt opening at rear edge of driveshaft housing.

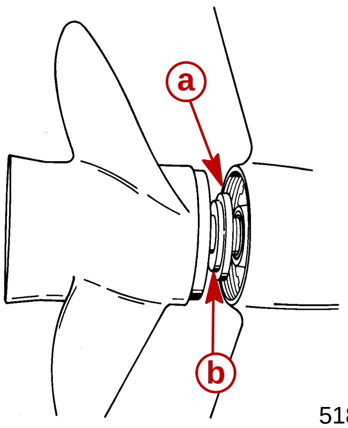
Propeller Installation

⚠ WARNING

When installing or removing propeller, because of the engine's ease in starting, be sure that the remote control is in neutral position and that the key switch is "OFF." Place a block of wood between the anti-cavitation plate and propeller to prevent accidental starting and to protect hands from propeller blades while removing or installing nut.

1. To aid in future removal of the propeller, liberally coat the propeller shaft splines with one of the following Quicksilver products:
   -- Anti-Corrosion Grease (92-78376A6)
   -- Special Lubricant 101 (92-13872A1)
   -- 2-4-C Marine Lubricant (92-90018A12)
   -- Perfect Seal (92-34227--1)

2. Place forward thrust hub over propeller shaft with shoulder side toward propeller.
3. Place propeller on propeller shaft and slide it up against thrust hub.
4. Place continuity washer (if equipped) onto shoulder of rear thrust hub.
5. Place rear thrust hub, tab washer and propeller nut on propeller shaft.
6. Thread propeller nut onto propeller shaft until nut is recessed into tab washer.
7. After propeller nut is recessed into tab washer, tighten nut securely [minimum of 55 lb. ft. (75 Nm) torque].
8. Bend 3 of the tabs of tab washer down in grooves of rear thrust hub to secure propeller nut. (If tab washer tabs do not align with slots, continue to tighten propeller nut to obtain alignment. DO NOT loosen nut to align tabs.)



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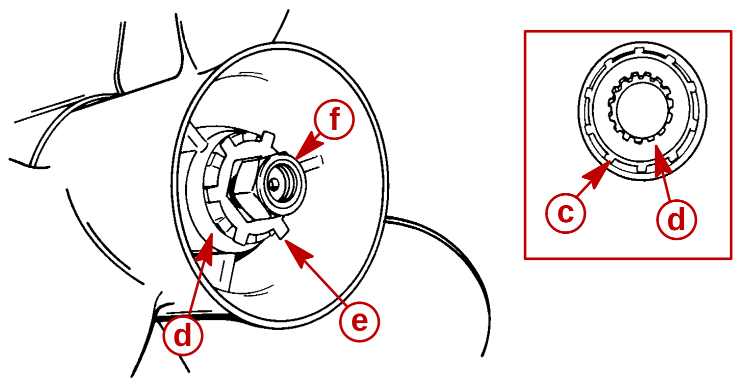

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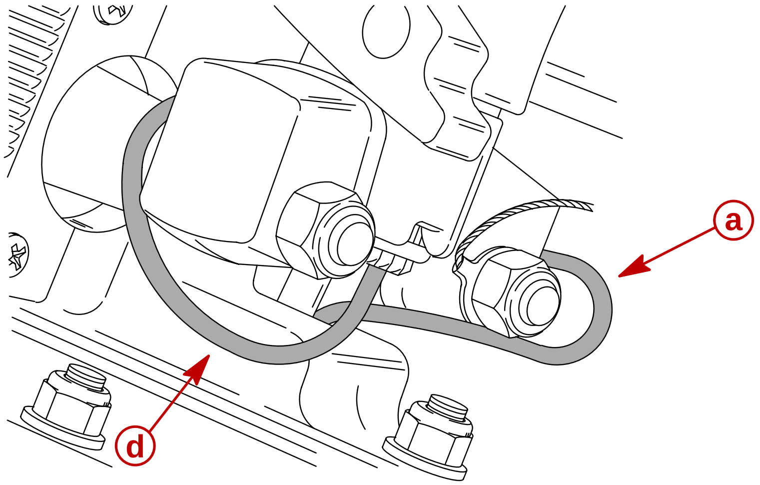
a - Forward Thrust Hub
b - Propeller Shaft
c - Continuity Washer (if Equipped)
d - Rear Thrust Hub
e - Tab Washer
f - Propeller Nut

> **⚠ CAUTION**
>
> **DO NOT misinterpret propeller shaft movement with propeller movement. If propeller and propeller shaft together move forward-and-aft, this is normal; however, propeller should not move forward-and-aft on propeller shaft.**

9. After first use, retighten propeller nut and again secure with tab washer (Steps 7 and 8, preceding). Propeller should be checked periodically for tightness, particularly if a stainless steel propeller is used.

Speedometer Tube Installation

1. Route speedometer tube from gearcase around lower yoke and push into junction. Junction should be secured to yoke with sta-strap.
2. Route speedometer tube from swivel tube around lower yoke and push into junction. After insertion of speedometer tubes into junction, pull on each tube to verify that they are locked into junction. If tube pulls out, reinsert into junction.



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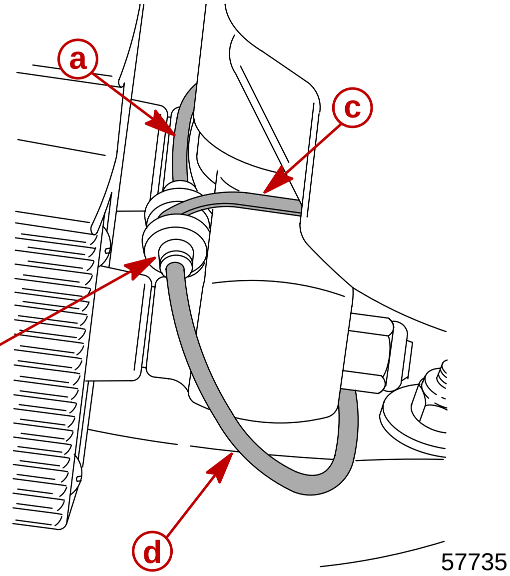

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- **a** - Speedometer Tube from Gearcase
- **b** - Junction
- **c** - Sta-strap
- **d** - Speedometer Tube from Swivel Tube

LOWER UNIT

Section 6B – Left Hand Non-Ratcheting

Table of Contents

6
B

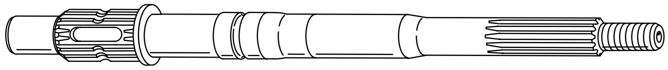
Gear Housing Specifications (Counter Rotation)

Ratio	Pinion Depth	Forward Gear Backlash	Reverse Gear Backlash
1.75:1 1.87:1	0.025 in. (0.635 mm) With Tool 91-12349A2 using Disc #2 and Flat #4	0.017 in. to 0.028 in. (0.431 mm to 0.711 mm) Pointer on line mark #1	0.040 in. to 0.060 in. (1.01 mm to 1.52 mm)
Gearcase Lubricant Capacity			
All Ratios		27.0 fl. oz. (798.0 ml)	
Gearcase Pressure Check			
Gearcase without Oil		Gearcase should hold 15 psi for 5 minutes without leakage	

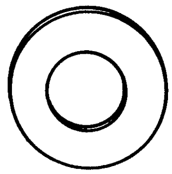
Gear Ratio	Pinion Gear Teeth	Forward and Reverse Gear Teeth
1.75:1	12	21
1.87:1	15	28

Special Tools

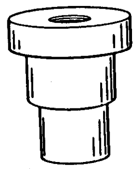
1. Propeller Shaft 44-93003 and Load Washer 12-37429



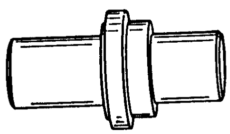
2. Bellville Washer 12-54048



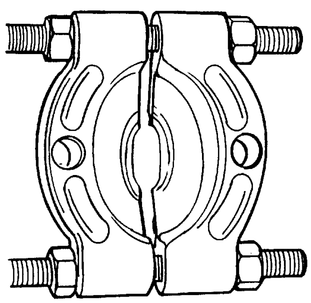
3. Needle Bearing Driver 91-15755



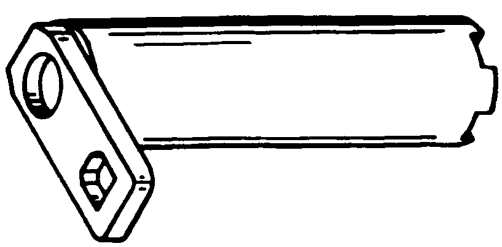
4. Oil Seal Driver 91-31108



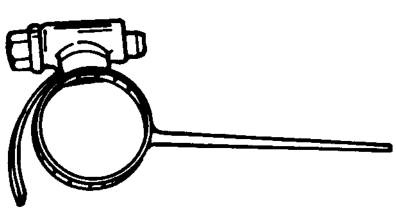
5. Universal Puller Plate 91-37241



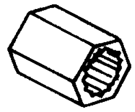
6. Bearing Retainer Tool 91-43506



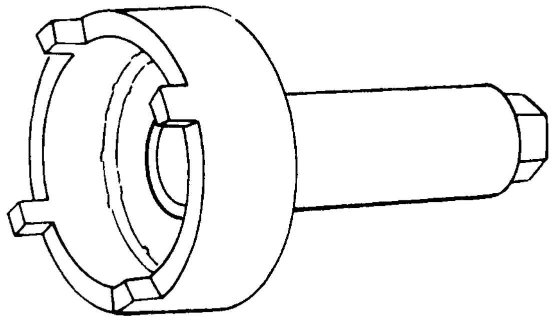
7. Backlash Indicator Rod 91-53459



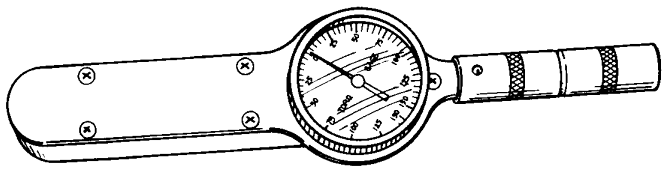
8. Drive Shaft Nut Wrench 91-56775



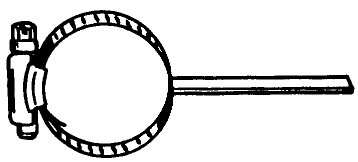
9. Bearing Carrier Retainer Wrench 91-61069



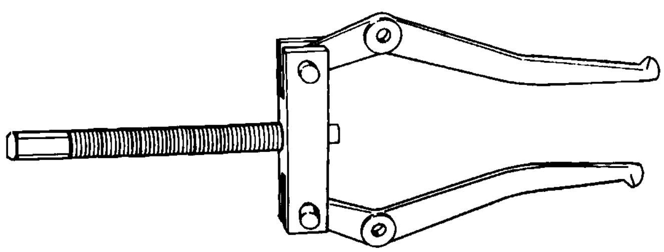
10. Torque Wrench (lb. in.) 91-66274



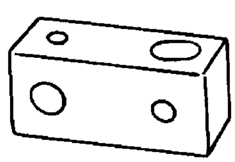
11. Backlash Indicator Rod 91-78473



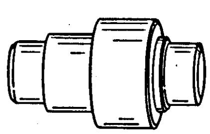
12. Puller Bolt 91-85716 and Puller Jaws 91-46086A1



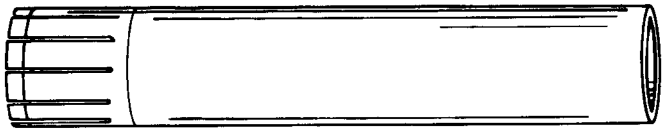
13. Dial Indicator Holding Tool 91-89897



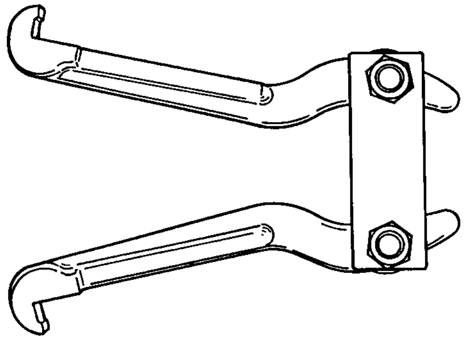
14. Forward Gear Bearing Tool 91-86943



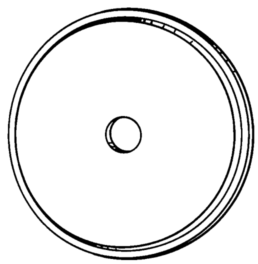
15. Forward Gear Installation Tool 91-815850



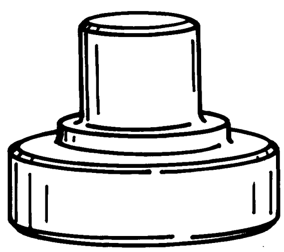
16. Puller Jaws 91-816242



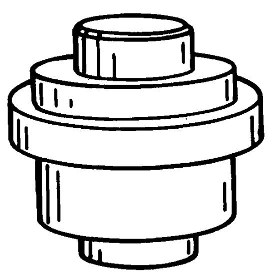
17. Guide Plate 91-816243



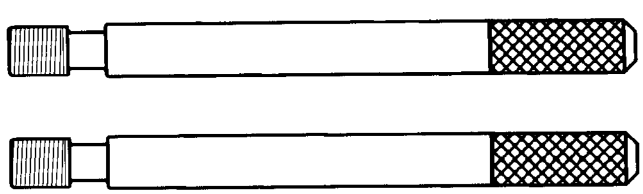
18. Bearing Driver 91-816244



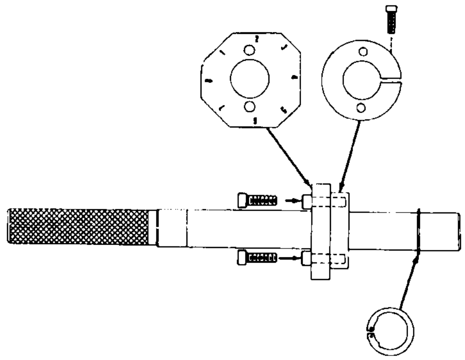
19. Oil Seal Driver 91-817569



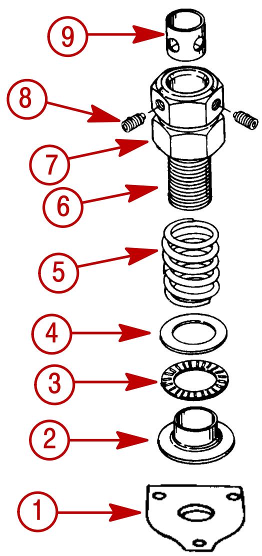
20. Water Pump Alignment Pins 91-821571A1



21. Pinion Gear Shimming Tool 91-12349A2

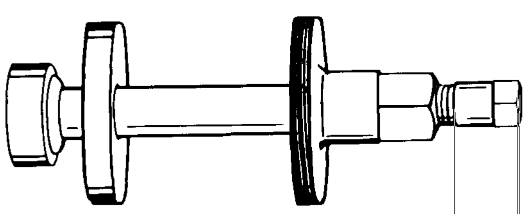


22. Bearing Preload Tool 91-14311A2

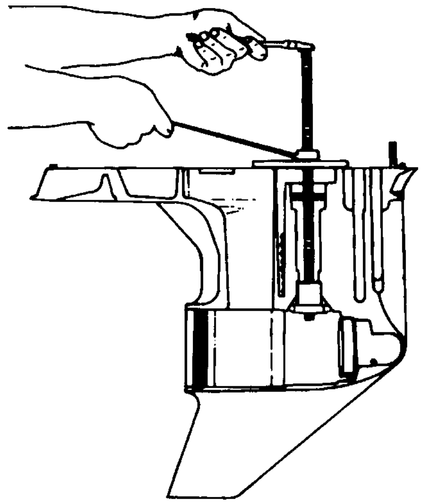


1 - Plate (44307)
2 - Adaptor (N.S.S.)
3 - Bearing (N.S.S.)
4 - Washer (N.S.S.)
5 - Spring (24-14111)
6 - Bolt (10-12580)
7 - Nut (11-13953)
8 - Set Screw (10-12575)
9 - Sleeve (23-13946)

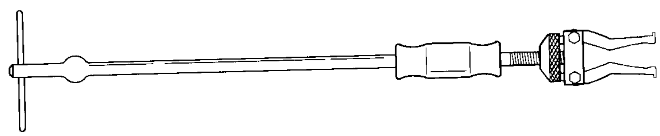
23. Bearing Adaptor Installation Tool 91-18605A2



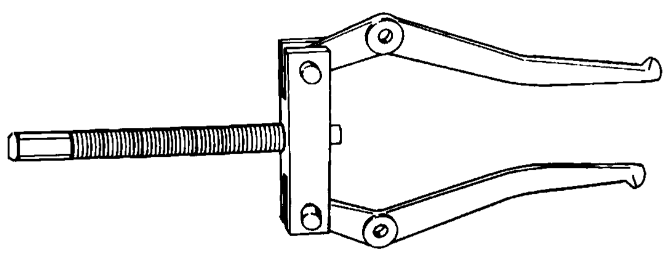
24. Bearing Removal and Installation Tool 91-31229A7 – Includes Driver Head 91-36569: Driver Head Rod 91-37323; Nut 11-24156; Pilot Washer 91-36571; Pilot Plate 91-29310; Puller/Driver Head 91-38628; Mandrel 91-30366; Plate 91-29310; Driver Head 91-32325; Puller Shaft 91-31229; Washer 91-34961.



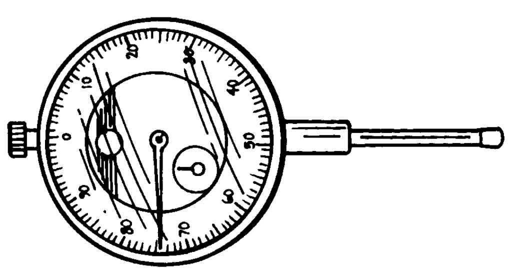
25. Slide Hammer Puller 91-34569A1



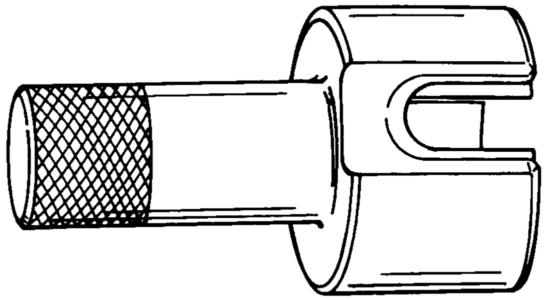
26. Puller Bolt 91-85716 and Puller Jaws 91-46086A1



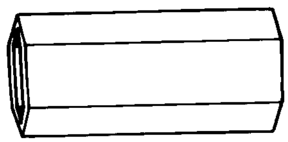
27. Dial Indicator 91-58222A1



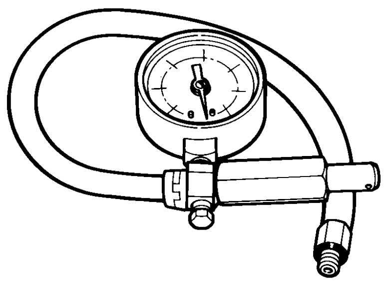
28. Pinion Nut Adaptor 91-61067A3



29. Drive Shaft Adaptor 91-61077



30. Leakage Tester FT8950



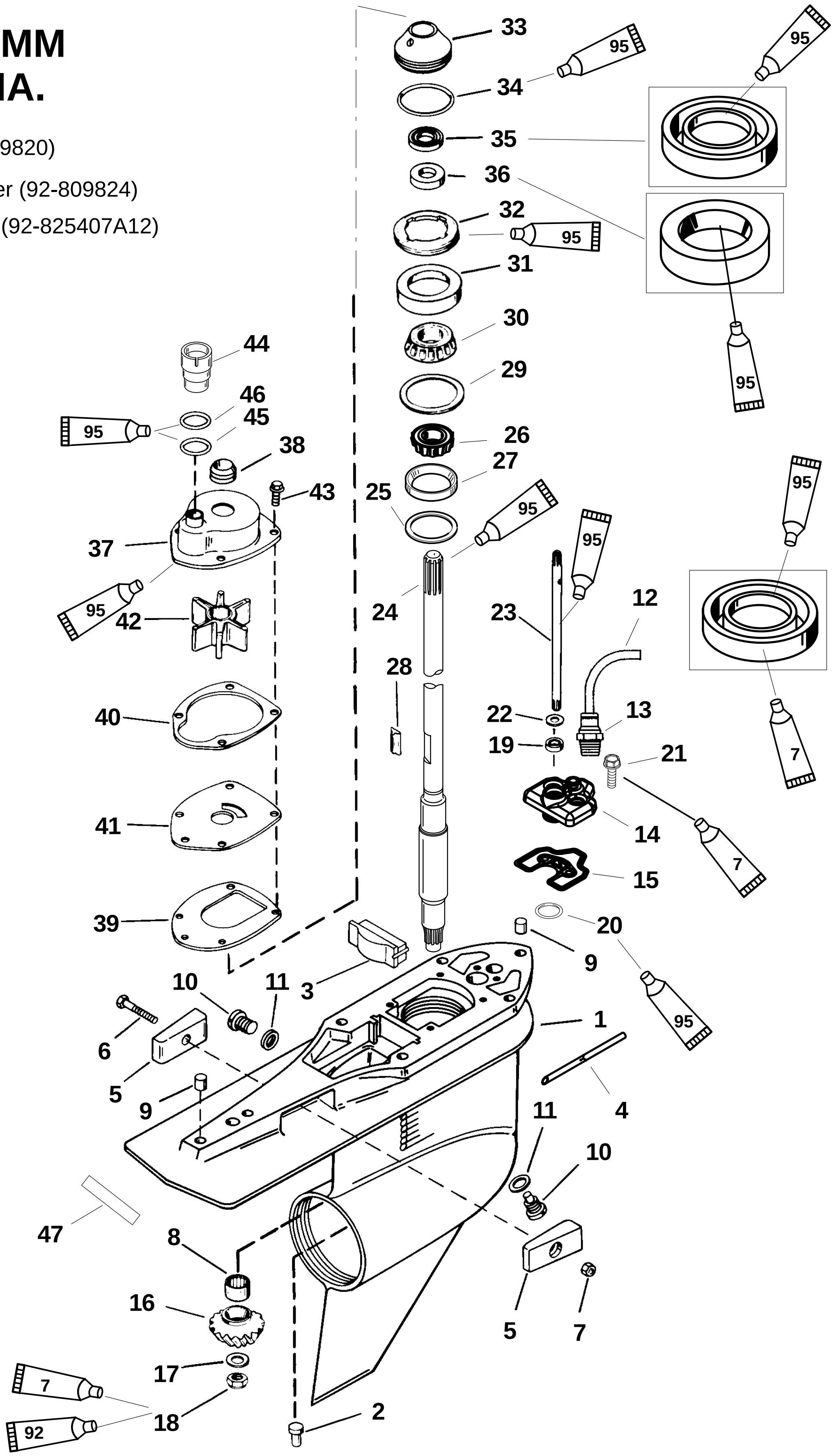
Gear Housing (Drive Shaft)(Counter Rotation)

4.75 IN/120.65MM TORPEDO DIA.

7 Loctite 271 (92-809820)

92 Loctite 7649 Primer (92-809824)

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

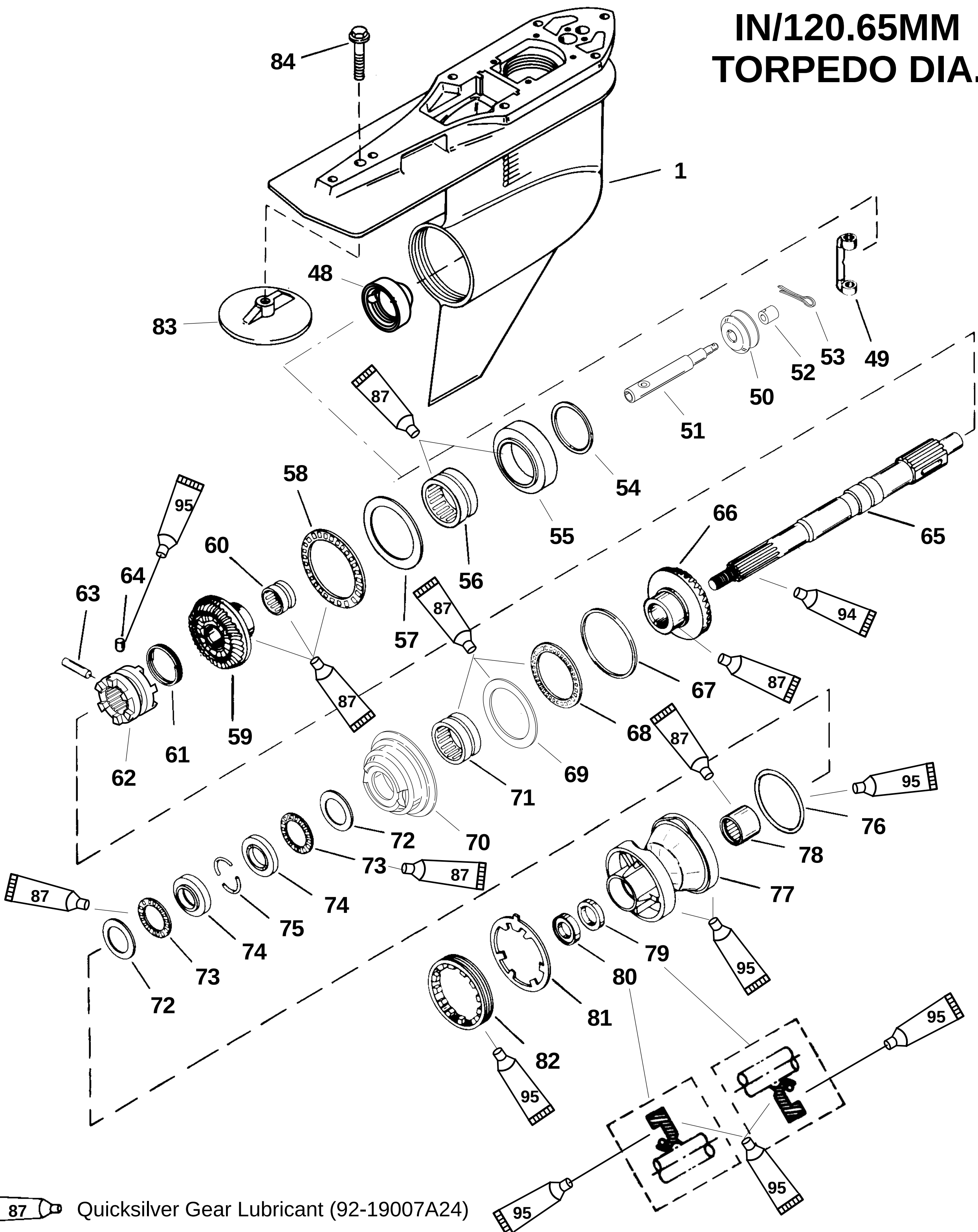


Gear Housing (Drive Shaft)(Counter Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	GEAR HOUSING			
2	1	PIN			
3	1	FILLER BLOCK			
4	1	PITOT TUBE			
5	2	ANODE			
6	1	SCREW	60		7
7	1	NUT			
8	1	ROLLER BEARING			
9	2	DOWEL PIN			
10	2	SCREW ASSEMBLY	60		7
11	2	SEALING WASHER			
12	1	CONNECTOR **(X-LONG - 12 IN.)**			
12	1	CONNECTOR **(XX-LONG - 17 IN)**			
13	1	CONNECTOR			
14	1	COVER			
15	1	GASKET			
16	1	PINION GEAR **(1.75:1 - 12/21) (PART OF 43-828695A1)**			
17	1	WASHER			
18	1	NUT		70	95
19	1	OIL SEAL			
20	1	O RING			
21	2	SCREW (M6 x 16)	60		7
22	1	RUBBER WASHER			
23	1	SHIFT SHAFT (LOWER)			
24	1	DRIVE SHAFT **(X-LONG)**			
24	1	DRIVE SHAFT **(XX-LONG)**			
25	AR	SHIM SET			
26	1	TAPERED ROLLER BEARING			
27	1	CUP			
28	1	KEY			
29	AR	SHIM			
30	1	TAPERED ROLLER BEARING			
31	1	CUP			
32	1	RETAINER		100	135
33	1	CARRIER ASSEMBLY			
34	1	O RING			
35	1	OIL SEAL			
36	1	OIL SEAL			
37	1	WATER PUMP ASSEMBLY			
38	1	SEAL			
39	1	GASKET			
40	1	GASKET			
41	1	FACE PLATE			
42	1	IMPELLER			
43	4	SCREW (M6 x 16)	60		7
44	1	COUPLING ASSEMBLY			
45	1	O RING			
46	1	O RING			
47	1	DECAL-Counter Rotation			

Gear Housing (Prop Shaft)(Counter Rotation)

4.75 IN/120.65MM TORPEDO DIA.



87 Quicksilver Gear Lubricant (92-19007A24)

94 Anti-Corrosion Grease (92-78376A6)

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

Gear Housing (Prop Shaft)(Counter Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	GEAR HOUSING			
48	1	PLUG			
49	1	SHIFT CRANK			
50	1	SHIFT SPOOL			
51	1	SPOOL			
52	1	SLEEVE			
53	1	COTTER PIN			
54	AR	SHIM SET			
55	1	BEARING ADAPTOR ASSEMBLY			
56	1	ROLLER BEARING			
57	1	THRUST WASHER			
58	1	THRUST BEARING			
59	1	REVERSE GEAR **(1.75:1 - 12/21)**			
60	1	ROLLER BEARING			
61	1	SPRING			
62	1	SLIDING CLUTCH			
63	1	CROSS PIN			
64	1	DETENT PIN			
65	1	PROPELLER SHAFT			
66	1	FORWARD GEAR **(1.75:1 - 12/21)**			
67	AR	SPACER SHIM .206 IN.			
	AR	SPACER SHIM .208 IN.			
	AR	SPACER SHIM .210 IN.			
	AR	SPACER SHIM .212 IN.			
	AR	SPACER SHIM .214 IN.			
	AR	SPACER SHIM .216 IN.			
	AR	SPACER SHIM .218 IN.			
	AR	SPACER SHIM .220 IN.			
	AR	SPACER SHIM .222 IN.			
	AR	SPACER SHIM .224 IN.			
	AR	SPACER SHIM .226 IN.			
	AR	SPACER SHIM .228 IN.			
	AR	SPACER SHIM .230 IN.			
68	1	ROLLER BEARING			
69	1	THRUST RING			
70	1	BEARING ADAPTOR ASSEMBLY			
71	1	ROLLER BEARING			
72	2	THRUST WASHER			
73	2	THRUST BEARING			
74	2	THRUST RACE			
75	2	KEEPER			
76	1	O RING			
77	1	BEARING CARRIER ASSEMBLY			
78	1	ROLLER BEARING			
79	1	OIL SEAL (INSIDE)			
80	1	OIL SEAL (OUTSIDE)			
81	1	TAB WASHER			
82	1	COVER		210	285
83	1	ANODIC PLATE			
84	1	SCREW		40	54.0

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. It is suggested that the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to “reassembly and installation” of that component in the reassembly part of this section. Use the “Index” (on back of section divider) to find correct page number.

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

Upon disassembly of gear housing, 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 thru 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 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.

Roller bearing condition is determined by inspecting the bearing 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 the conditions described are found.

SHIMS

Keep a record of all shim amounts and location during disassembly to aid in reassembly. Be sure to follow shimming instructions during reassembly, as gears must be installed to correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

SEALS

As a normal procedure, all O-rings and oil seals SHOULD BE REPLACED without regard to appearance. To prevent leakage around oil seals, apply Loctite 271 to outer diameter of all metal case oil seals. When using Loctite on seals or threads, surfaces must be clean and dry. To ease installation, apply 2-4-C w/Teflon Marine Lubricant on all O-rings. To prevent wear, apply 2-4-C w/Teflon Marine Lubricant on I.D. of oil seals. To prevent corrosion damage after reassembly, apply Quicksilver 2-4-C w/Teflon to external surfaces of bearing carrier and cover nut threads prior to installation.

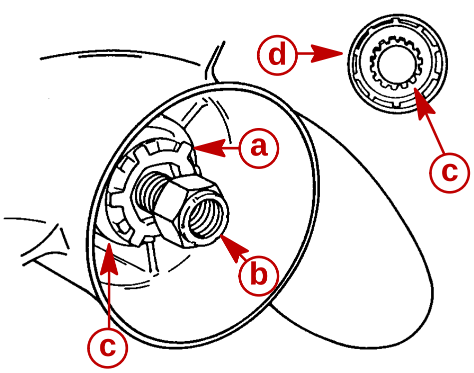
Removal, Disassembly, Cleaning and Inspection of Counter Rotation (Left Hand) Gear Housing

REMOVAL

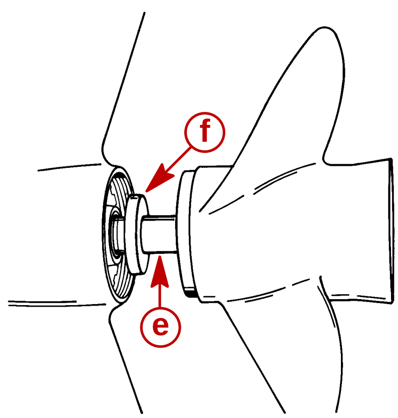
⚠ WARNING

Disconnect high tension leads from spark plugs and remove spark plugs from engine before removing gear housing from driveshaft housing.

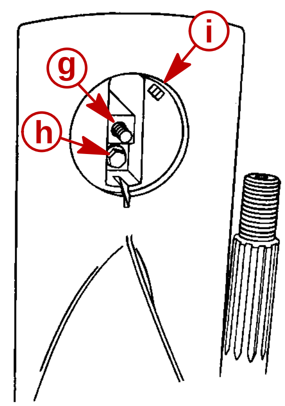
1. Disconnect high tension leads from spark plugs and remove spark plugs from engine.
2. Shift engine into NEUTRAL position.
3. Tilt engine to full up position and engage tilt lock lever.
4. Bend tabs of propeller tab washer away from thrust hub (rear), then remove propeller locknut, tab washer, thrust hub (rear), propeller and thrust hub (forward) from propeller shaft.
5. Mark gear housing and trim tab so that trim tab can be reinstalled in the same position. Remove plastic cap at rear edge of driveshaft housing. Remove bolt that secures trim tab and remove tab from gear housing.
6. Once trim tab is removed, remove bolt from inside of trim tab cavity.



51916



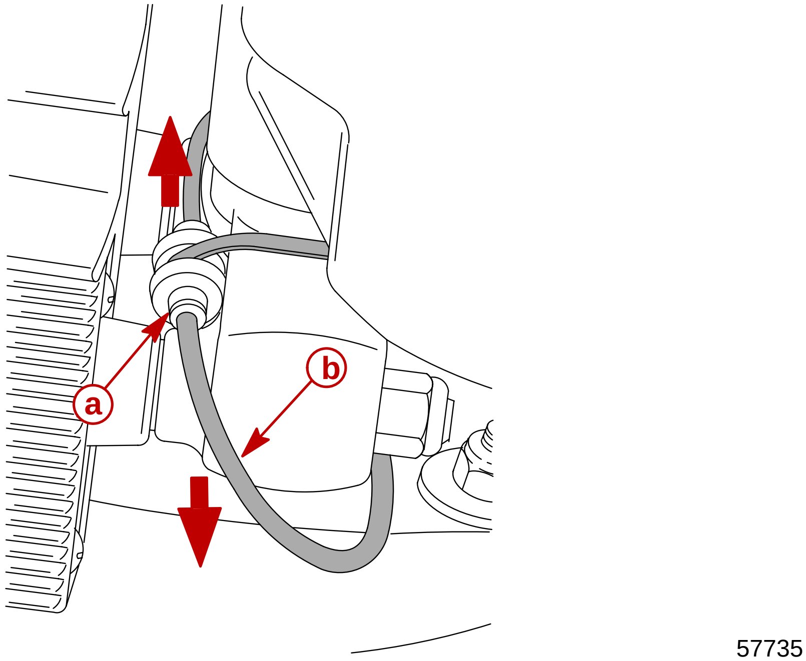
51912



52375

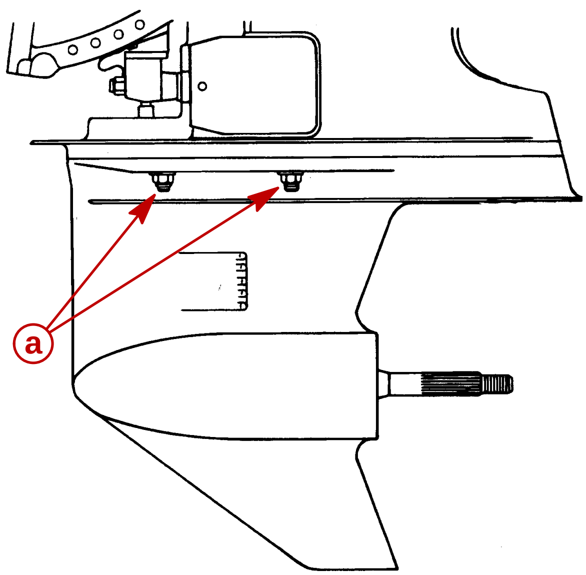
a - Tab Washer
b - Propeller Nut
c - Rear Thrust Hub
d - Continuity Washer (if equipped)
e - Propeller Shaft
f - Thrust Hub (forward)
g - Bolt (secures trim tab)
h - Bolt (inside trim tab cavity)
i - Ribs – Align Carefully with Trim Tab while Securing Tab

7. While pressing in on speedometer hose junction, pull out on hose to disconnect.



a - Press in on Junction
b - Pull out on Hose

8. Loosen the side mounting locknuts. (DO NOT attempt to remove one nut before opposite side is loosened sufficiently, or gear housing could be damaged.)



a - Side Mounting Locknuts

9. Pull gear housing away from drive shaft housing as far as the loosened nuts (in Step 8) will allow, then remove loosened nuts. (DO NOT allow gear housing to fall, as it now is free.)
10. Pull gear housing from drive shaft housing.

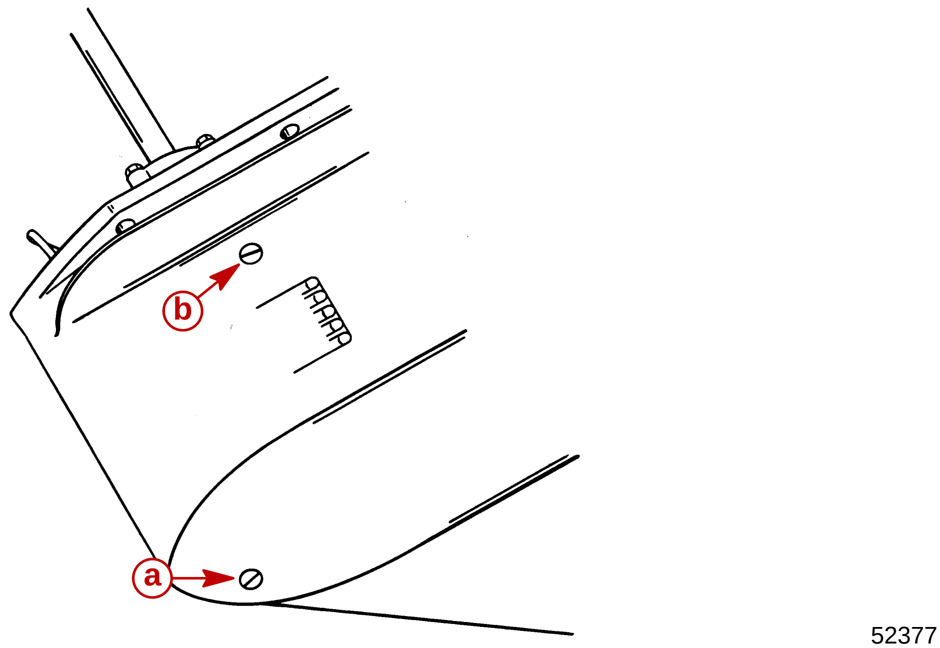
DRAINING AND INSPECTING GEAR HOUSING LUBRICANT

1. Place gear housing in a suitable holding fixture or vise with the driveshaft in a vertical position, as shown.

NOTE: *Drain and Fill screws may be located on the starboard side of gearcase on later models.*

2. Position a clean drain pan under gear housing and remove “Fill” and “Vent” screws from gear housing.
3. Inspect gear lubricant for metal particles. Presence of a small amount of fine metal particles (resembling powder) indicates normal wear. Presence of larger particles (or a large quantity of fine particles) indicates need for gear housing disassembly, and component inspection.
4. Note the color of gear lubricant. White or cream color indicates presence of water in lubricant. Check drain pan for water separation from lubricant. Presence of water in gear lubricant indicates the need for disassembly, and inspection of oil seals, seal surfaces, O-rings and gear housing components.

IMPORTANT: Gear lubricant drained from a recently run gear case will be a light chocolate brown in color due to agitation/aeration. Oil which is stabilized will be a clear yellow brown in color.



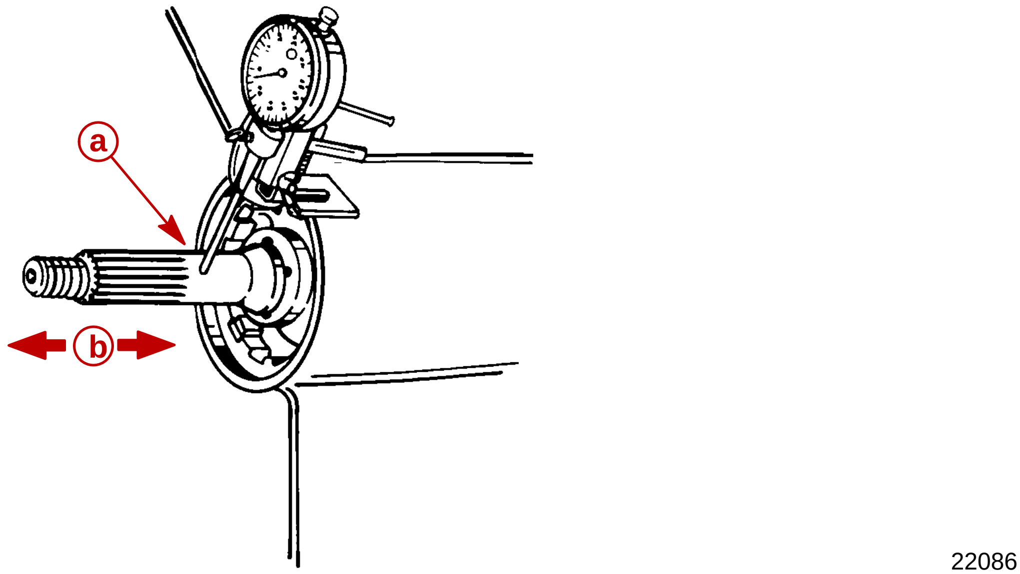
a **-** Fill Screw
b **-** Vent Screw

Pre-Disassembly Inspection

Propeller Shaft

INSPECTION

1. Check for a bent propeller shaft as follows:
   a. Rotate the propeller shaft while observing the dial indicator. If the deflection is more than 0.009 in. (0.23 mm), a bent propeller shaft is indicated.
2. Measure propeller shaft endplay. If it is in excess of 0.093 in. (2.36mm), disassemble gear case and check condition of the reverse shoulder of the propeller shaft, reverse gear and thrust washer. Replace components as required.

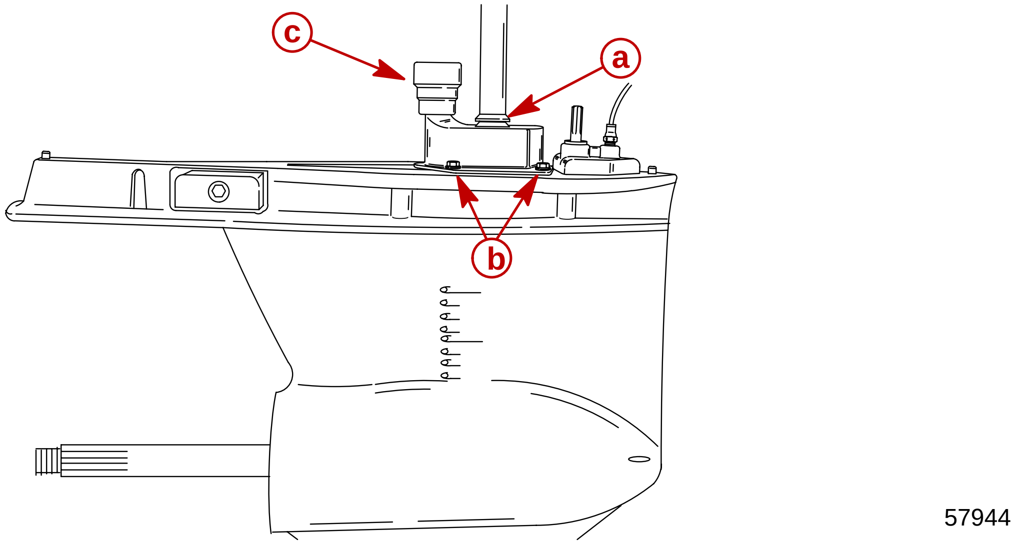


a - Prop Shaft Runout
b - Prop Shaft Endplay

Water Pump

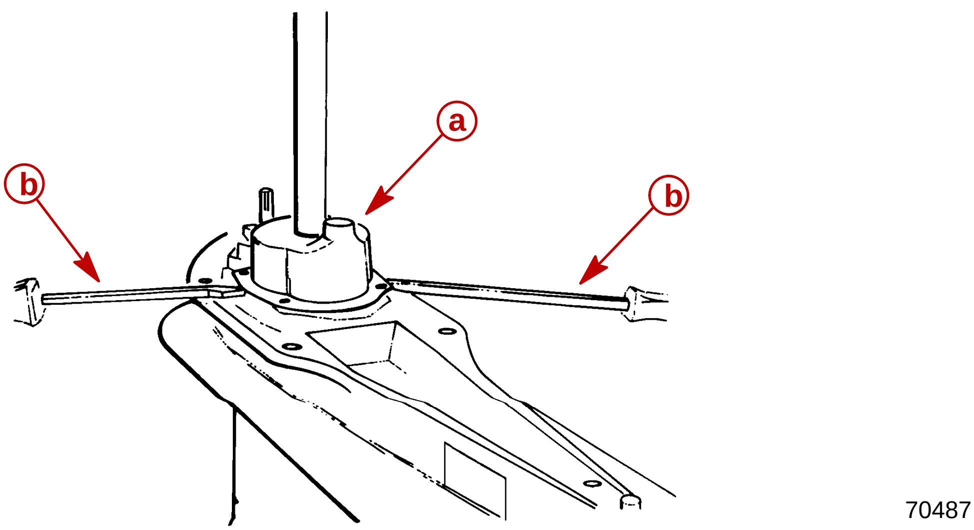
REMOVAL AND DISASSEMBLY

1. Remove the water seal, water tube coupling assembly, and the water pump screws.



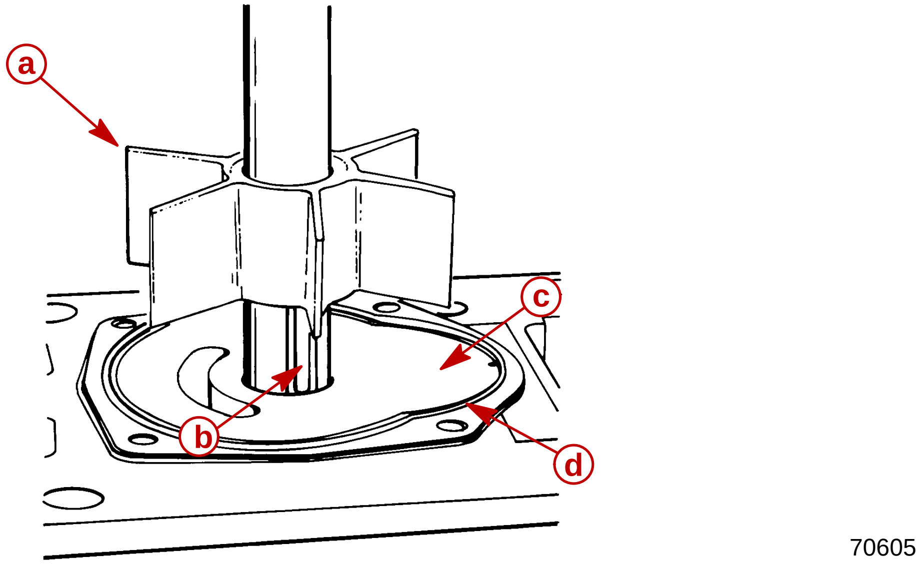
a - Water Seal
b - Water Tube Coupling
c - Water Pump Screws (4)

2. Carefully slide the water pump straight up off of the drive shaft. It may be necessary to encourage the water pump up by gently prying up on its mounting flanges with a couple of screwdrivers.



a - Water Pump Body
b - Screwdrivers

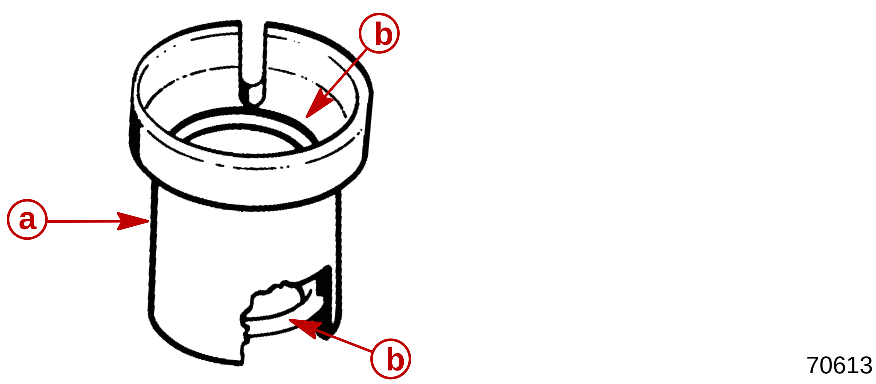
3. Remove the impeller, impeller key, the face plate and gaskets, (discard the gaskets).



a **-** Impeller
b **-** Impeller Key
c **-** Water Pump Face Plate
d **-** Gasket (1 each side of face plate)

CLEANING AND INSPECTION

1. Inspect the water tube coupling assembly for wear or damage. If necessary replace the worn or damaged components especially the two O-rings on the inside, one at the top and one at the bottom.

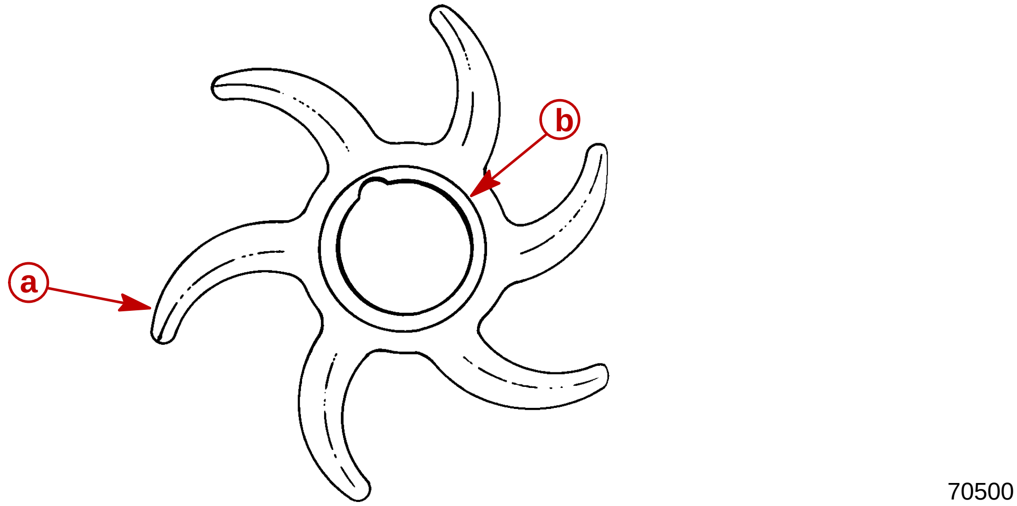


a **-** Water Tube Adaptor
b **-** O-rings (2)

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting cover and plate. The depth of the groove will not affect water pump output.

2. Inspect face plate and water pump cover for grooves and/or rough surfaces.
3. Replace cover and /or face plate if grooves (other than sealing grooves) are more than 0.030 in. (0.762 mm) deep.

4. Inspect impeller side seal surfaces and ends of impeller blades for cracks, tears and wear. Replace impeller if any of these conditions are found.
5. Inspect impeller bonding to impeller hub.
6. Inspect impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace impeller if any of these conditions exist.



a - Impeller
b - Hub

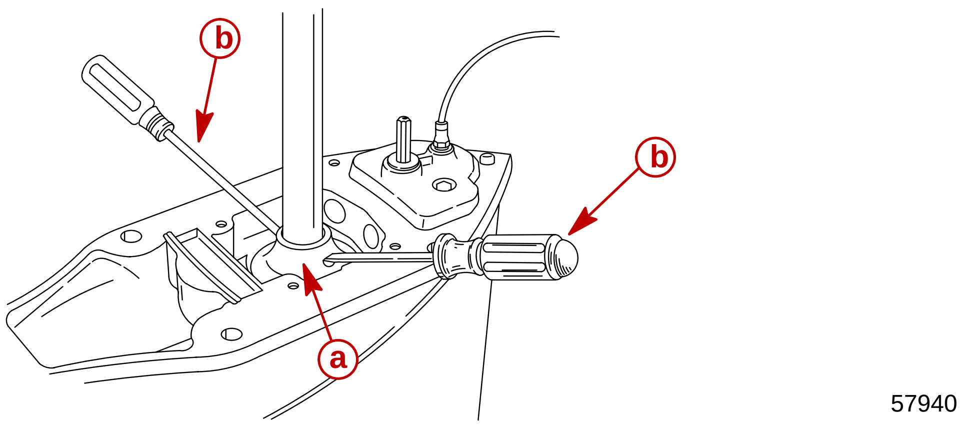
IMPORTANT: When completing gear housing repairs, that require removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to re-use impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur.

IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

Oil Seal Carrier Assembly

REMOVAL

1. Remove the oil seal carrier from the gear housing. It may be necessary to gently pry up on it with two screwdrivers.

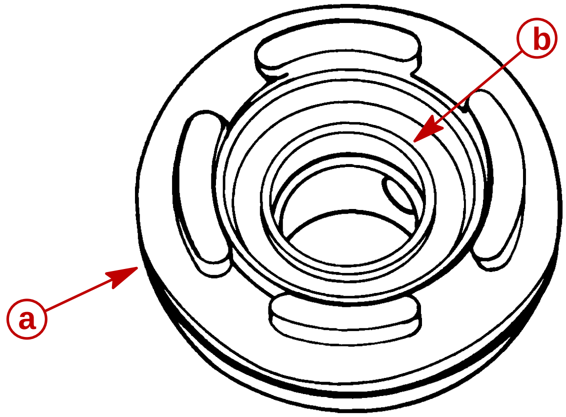


a - Oil Seal Carrier
b - Screwdrivers

OIL SEAL CARRIER ASSEMBLY - COMPONENT DISASSEMBLY

NOTE: *Complete the instructions in this section only if the assembly components have been found to be defective and are in need of repair or replacement.*

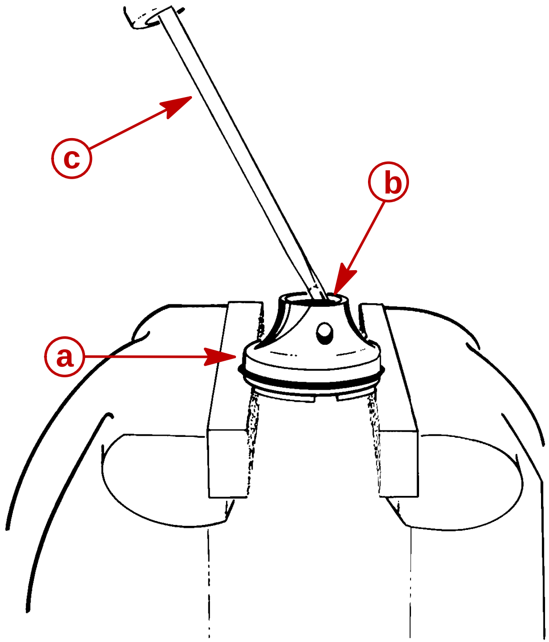
1. Remove the o-ring.



70501

a - O-ring
b - Oil Seals (2)

2. Remove oil seals.

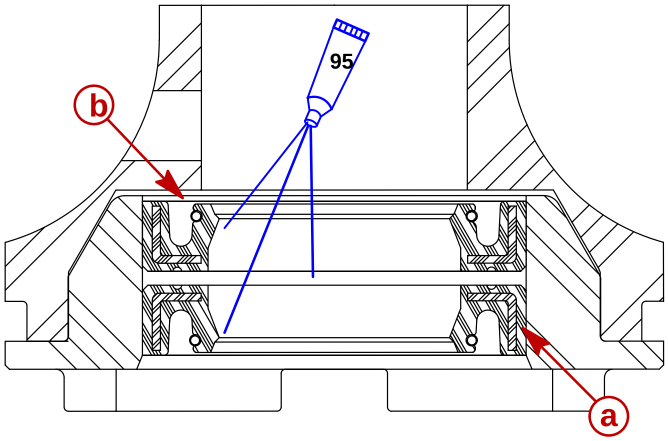


70610

a - Oil Seal Carrier
b - Oil Seals
c - Screwdriver

OIL SEAL CARRIER ASSEMBLY – COMPONENT REASSEMBLY

The oil seals in the carrier assembly are the same diameter. The bottom (first) seal lip faces down; the top (second) seal lip faces up. Apply 2-4-C w/Teflon Marine Lubricant to seal lips and between seals. Press seal into carrier with suitable mandrel. Second seal should be pressed in flush with carrier surface.

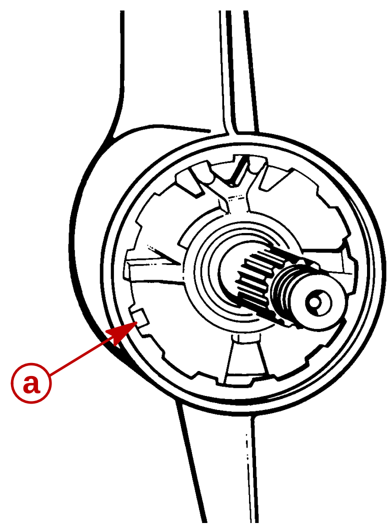


95 2-4-C With Teflon (92-825407A12)

a - Bottom Seal (lip faces down)
b - Top Seal (lip faces up)

Bearing Carrier and Propeller Shaft Removal

1. Straighten the tab on the tab washer.



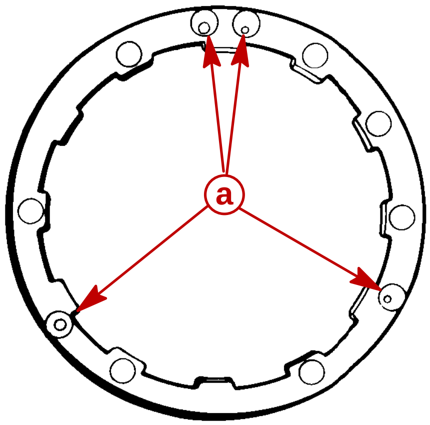
a - Tab on Tab Washer

2. Remove the bearing carrier retainer following step a or b as follows:

CAUTION

DO NOT drill into the gear housing retainer threads when using the following procedure for removing the retainer

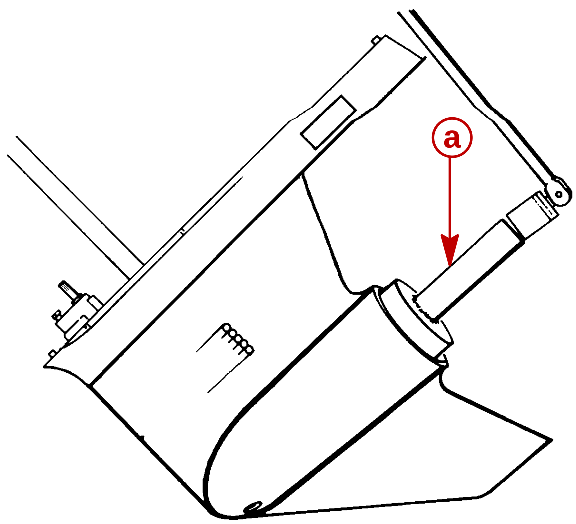
a. If the retainer is corroded in place, drill 4 holes in the retainer and fracture the retainer with a chisel. Pry the remaining segments out.



23356

a - Drilled Holes

b. Remove the bearing carrier retainer using the Bearing Carrier Retainer Wrench (91-61069).

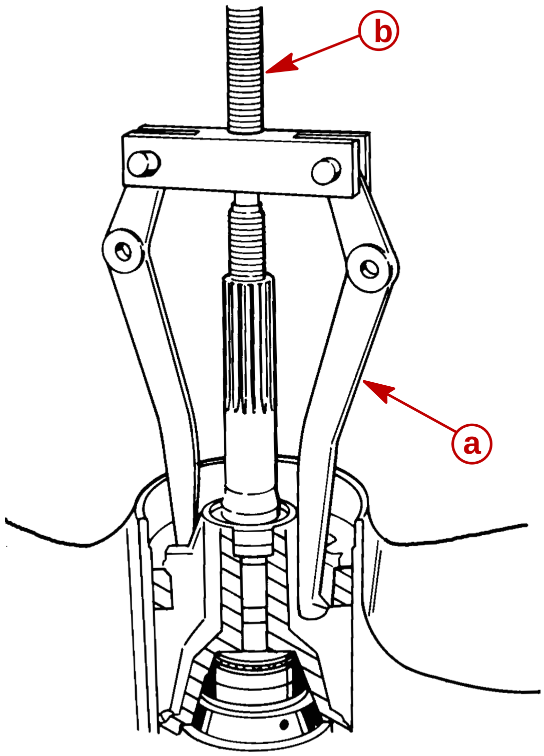


70491

a - Bearing Carrier Retainer Wrench

3. Pull the bearing carrier from the gear housing by pulling on the outer ring of the bearing carrier. POSITION PULLER JAWS CLOSE TO BOSSES IN CARRIER.

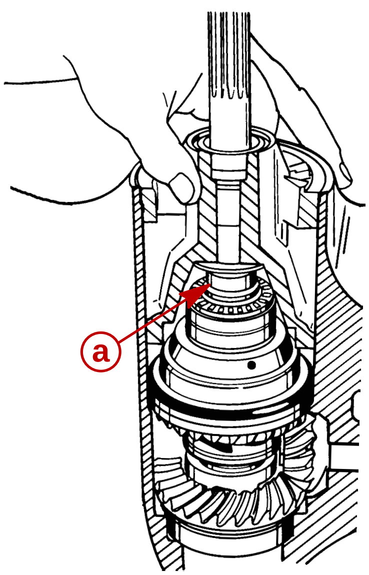
NOTE: *If the bearing carrier is seized in the gear housing, it may be necessary to use heat to loosen the carrier.*



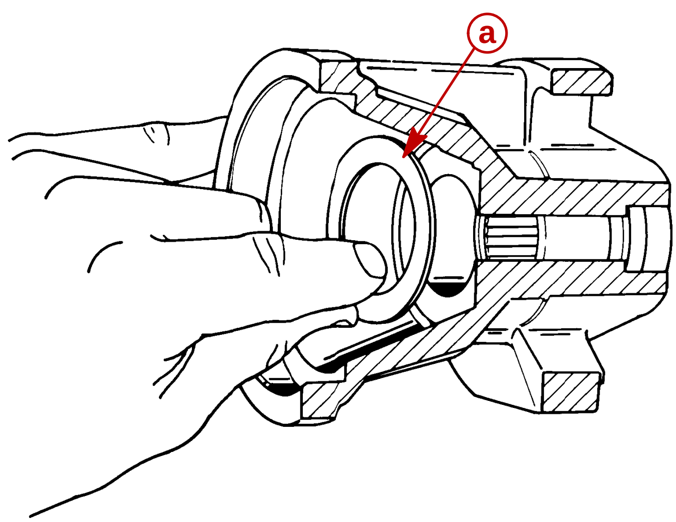
50786

a - Puller Jaws (91-46086A1)
b - Puller Bolt (91-85716)

4. Lift the bearing carrier out of the gear housing. Locate and retain the thrust washer that may be stuck to the inside surface of the bearing carrier.



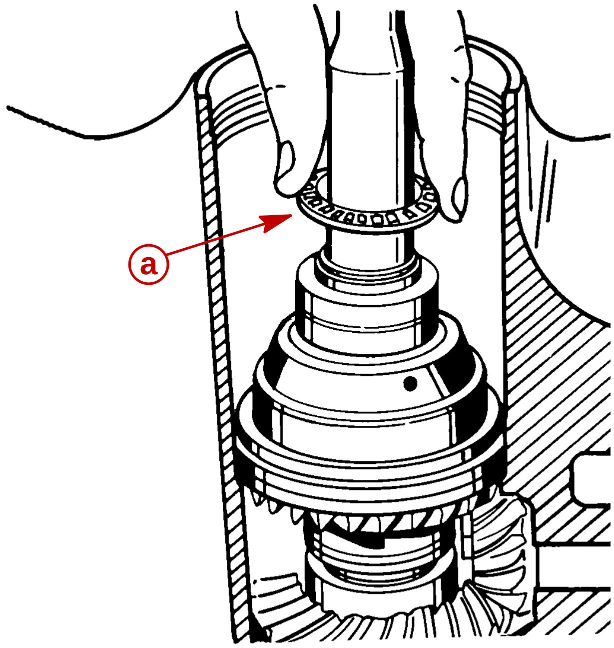
50826



50779

a - Thrust Washer

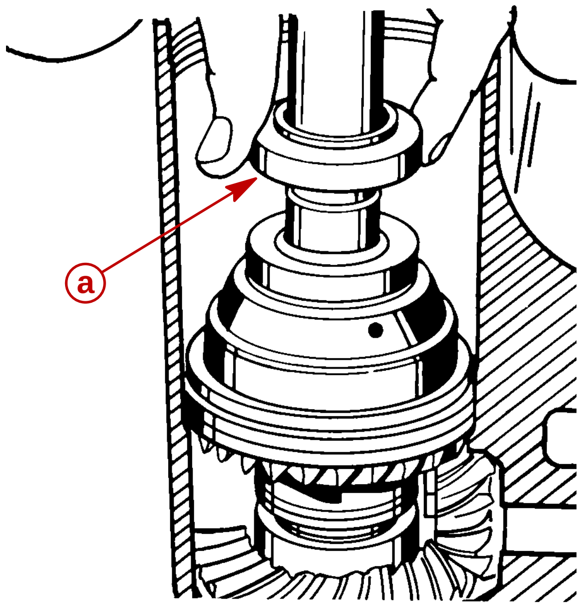
5. Remove the aft thrust bearing.



50786

a - Thrust Bearing

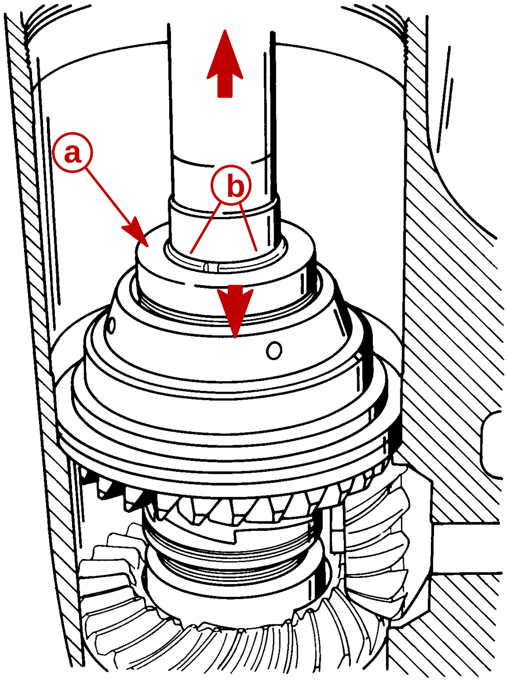
6. Remove the aft thrust collar.



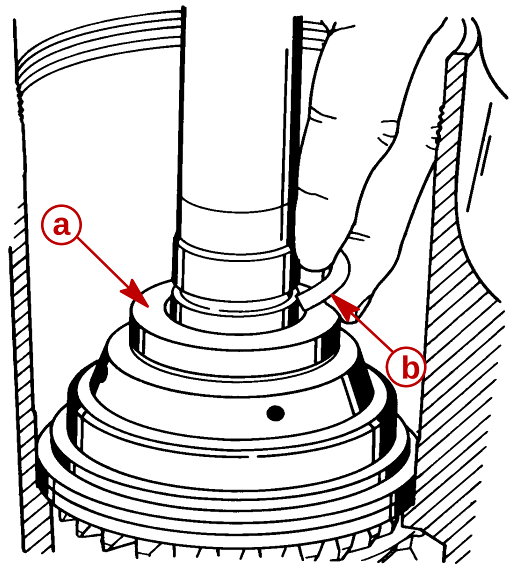
50787

a - Thrust Collar

7. Lift up on the propeller shaft and push down on the forward thrust collar to remove the two keepers.



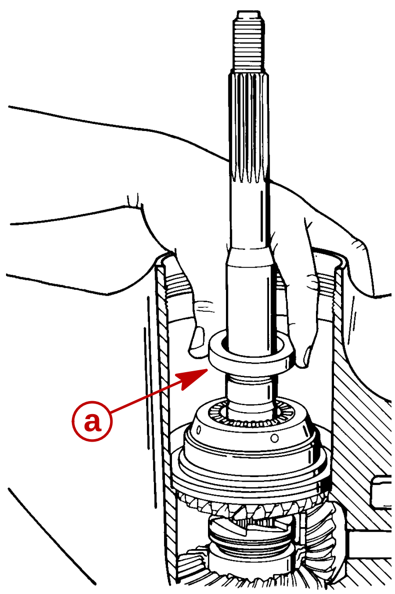
50778



50826

a - Thrust Collar
b - Keepers (2)

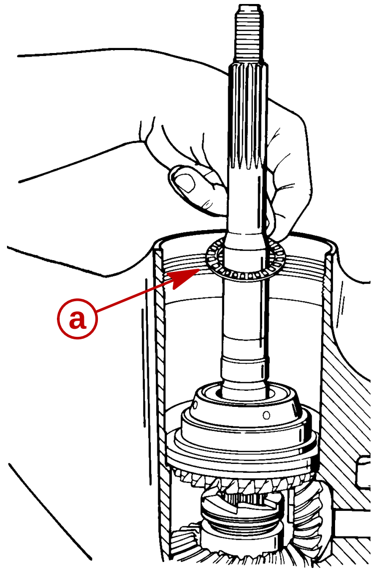
8. Remove the forward thrust collar.



50784

a - Thrust Collar

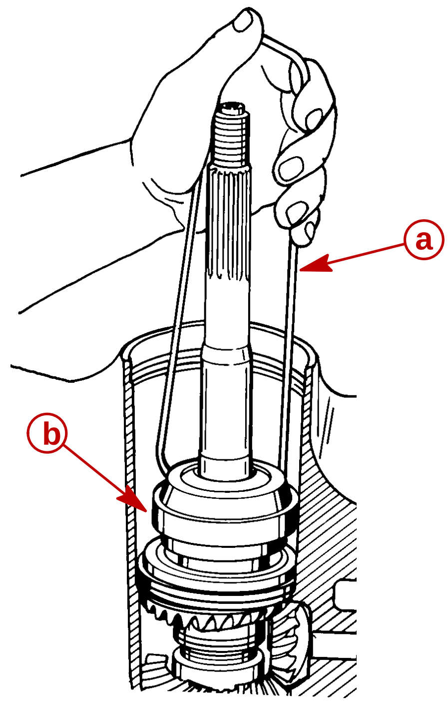
9. Remove the forward thrust bearing.



50783

a - Thrust Bearing

10. Form a tool using a 1/8 in. (3 mm) wire as shown in the following figure and remove the forward gear bearing adaptor.



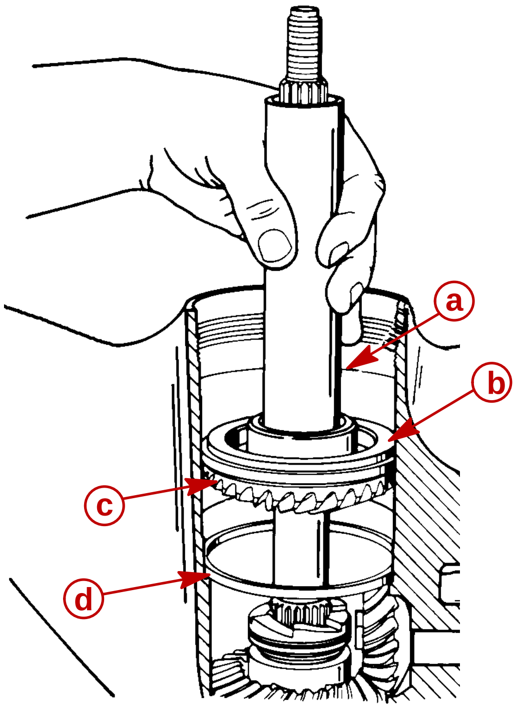
50786

a - Wire Tool
b - Forward Gear Bearing Adaptor

11. Shift gear case into forward gear.

NOTE: *The thrust race has a tight fit in the gear housing bore. Use the Forward Gear Installation Tool (91-815850) to remove the thrust race and the forward gear together. If this attempt fails, form a small hook on the end of a stiff piece of wire and while applying heat to the outside of gear case, pull the thrust race up and out of the gear housing.*

12. Remove the O-ring from inside the gear housing.
13. Remove the forward gear, thrust race, and the thrust bearing (between the gear and the race).
14. Remove the forward gear shim.



50783

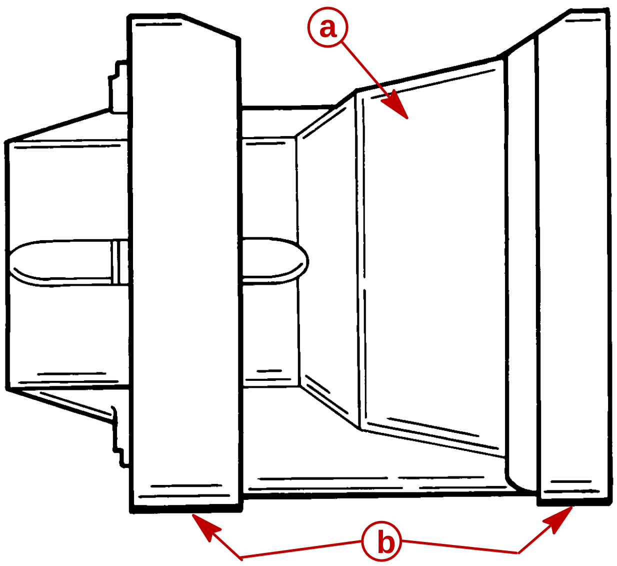
a - Forward Gear Installation Tool (91-815850)
b - Thrust Race
c - Forward Gear
d - Shim

BEARING CARRIER ASSEMBLY - INSPECTION

1. Clean the assembly and all components with a suitable solvent and dry the parts thoroughly using compressed air.

NOTE: *If any of the following items are found to be defective complete the appropriate instruction(s) in "Bearing Carrier Assembly", 'Component Disassembly and Inspection' section.*

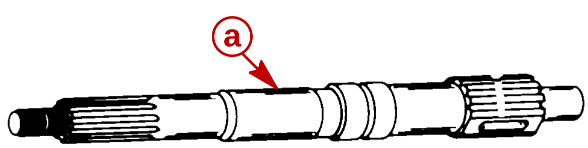
2. Inspect the bearing carrier for signs of excessive corrosion especially in the area where the bearing carrier touches the gear housing. If excessive corrosion is evident replace the carrier.



50818

a - Bearing Carrier
b - Mating Surfaces

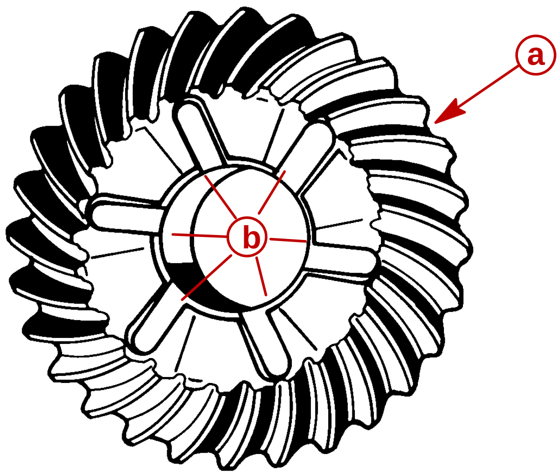
3. The condition of the bearing surface on the propeller shaft in the area that the needle bearing (in the bearing carrier) rides is an indication of the condition of the needle bearing in the bearing carrier. Replace the bearing if the surface of the shaft is pitted, grooved, scored, worn unevenly, discolored from overheating or has embedded metal particles.



50698

a - Propeller Shaft Bearing Contact Area

4. Inspect the forward gear for pitted, chipped, broken teeth, hairline fractures, and excessive or uneven wear. Replace the forward gear and the pinion gear if any defects are found.
5. Inspect the outer hub of the forward gear for excessive wear or damage. Replace the forward and the pinion gear if either of these conditions exist.
6. Inspect the clutch jaws of the gear for damage. Surfaces must not be chipped or rounded off. Replace the forward and the pinion gear if any are found.



23355

a - Reverse Gear Teeth
b - Clutch Jaws

7. Inspect the thrust bearings, collars and forward gear bearing adaptor for excessive wear in the areas where the thrust bearings come into contact with them. Replace the appropriate components if they are found to be defective.
8. Inspect the bearing carrier retainer for cracks and/or broken or corroded threads. Replace it if any are found.
9. Inspect the large O-ring for damage and/or deterioration. Replace it if either condition is found.

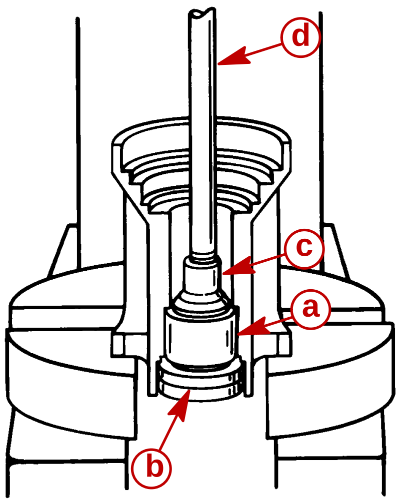
BEARING CARRIER ASSEMBLY - COMPONENT DISASSEMBLY AND INSPECTION

NOTE: *Complete the instructions in this section only if the assembly components have been found to be defective.*

NOTE: *Inspection of the bearing surfaces on the propeller shaft where the needles of the bearing carrier needle bearing rolls, gives an indication of the condition of the needle bearing inside the bearing carrier. Replace needle bearing in the bearing carrier if the prop shaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.*

1. Perform the following step a. or b. as necessary.

   a. **If Replacing the Needle Bearing and Seals:** Remove the needle bearing and seals with the tools as shown.

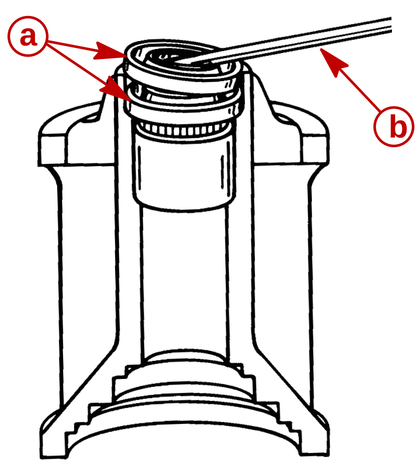


23140

a - Needle Bearing
b - Oil Seals
c - Driver Head (91-36569)
d - Bearing Driver Rod (91-37323)

(1.) **Discard the needle bearing and both seals.**

   b. **If Replacing the Seal Only:** Remove the oil seals with a suitable pry bar, being careful not to damage the bore of the bearing carrier.



23140

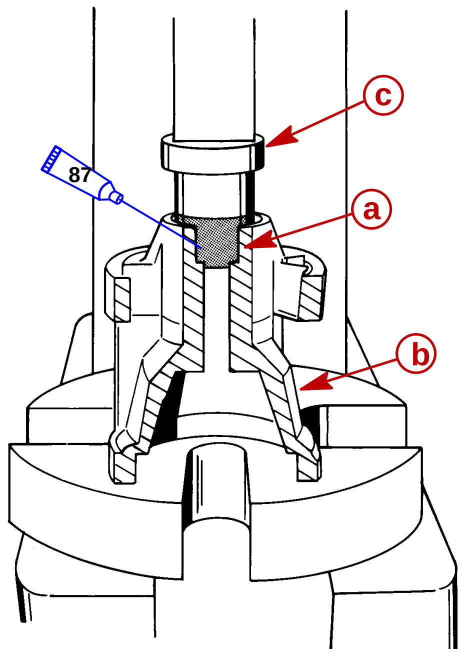
a - Oil Seals
b - Pry Bar

(1.) **Discard both of the seals.**

BEARING CARRIER ASSEMBLY - COMPONENT REASSEMBLY

NOTE: *Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.*

1. Clean all of the components with a suitable solvent and dry the parts thoroughly using compressed air. Be careful not to spin the bearing.
2. Lubricate the bore that the needle bearing is pressed into with Quicksilver Gear Lubricant (92-13783A24).
3. Assemble the needle bearing (with the numbered end of the bearing towards the driver shoulder), onto the driver.
4. Press the needle bearing into the bearing carrier until the driver bottoms out on the bearing carrier. Ensure that the numbered side of the needle bearing faces the seal end (aft end) of the carrier.



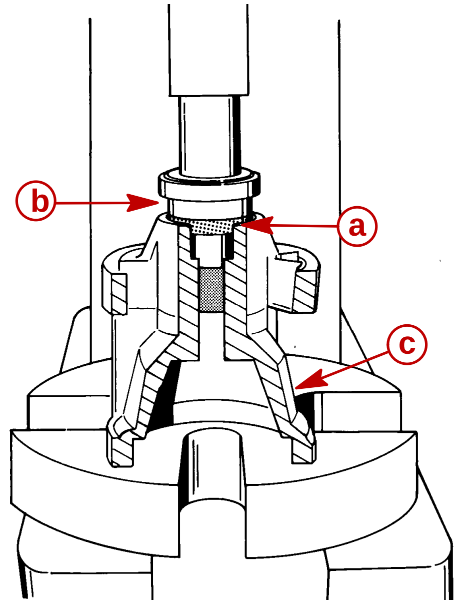
87 Quicksilver Gear Lubricant (92-19007A24)

50788

a - Needle Bearing
b - Bearing Carrier
c - Needle Bearing Driver (91-15755)

5. **Thoroughly clean** the bore to which the first seal is to be pressed.
6. Assemble the first seal (with the lips of the seal facing away from the driver shoulder) onto the long end of the oil seal driver.

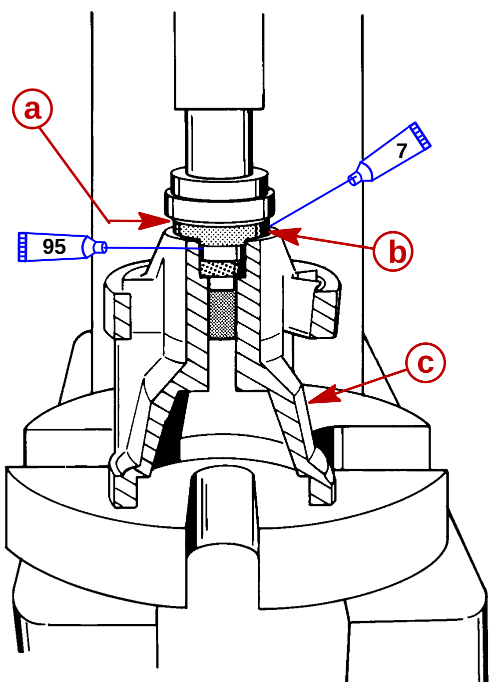
7. Press on the oil seal driver until the driver bottoms onto the aft face of the bearing carrier.



50788

a - Oil Seal
b - Oil Seal Driver (91-31108) (long end)
c - Bearing Carrier

8. Apply a thin film of Loctite 271 (92-809820) to the outer diameter of the second seal.
9. Assemble the second seal (with the lips seal facing the driver shoulder) onto the short end of the driver.
10. Press the oil seal with the driver until the driver bottoms out on the bearing carrier.



7 Loctite 271 (92-809820)

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

50788

a - Driver
b - Oil Seal (lips toward driver shoulder)
c - Bearing Carrier

11. Wipe up all of the excess Loctite. Do not allow any of the excess Loctite to spread to other parts of the assembly.
12. Lubricate the seal lips and fill the area between the seals with 2-4-C w/Teflon (92-825407A12).

Forward Gear Bearing Adaptor Assembly

INSPECTION

1. Thoroughly clean the forward gear bearing adaptor with a suitable solvent and dry it using compressed air.

NOTE: *The condition of the bearing surfaces on the forward gear in the areas that the bearings of the bearing adaptor and the thrust bearing rides, is an indication of the condition of the respective bearings. Replace the bearing(s) if the surface of the gear and/or the thrust washer is pitted, grooved, scored, worn unevenly, discolored from overheating or has embedded metal particles.*

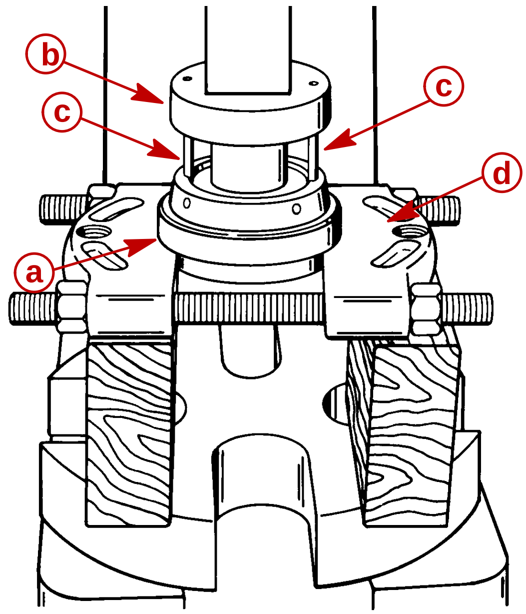
2. Assemble the forward gear to the bearing adaptor. Inspect them for excessive movement or roughness by rotating the gear in the adaptor. Replace the bearing in the adaptor if either of these conditions exist.
3. Inspect the adaptor for other signs of excessive wear or damage. Replace the adaptor if any are found.

FORWARD GEAR BEARING ADAPTOR ASSEMBLY - COMPONENT DISASSEMBLY AND REASSEMBLY

NOTE: *Complete the instructions in this section only if the needle bearing in the bearing adaptor is defective and the adaptor is to be reused.*

1. Disassemble the adaptor as follows:

    a. Remove the bearing from the adaptor using the bearing removal tool. Align the pins of the tool with the holes of the adaptor and apply pressure to the center of the tool so that the pressure is equal on both of the pins. **Discard the bearing.**



50874

a - Forward Gear Bearing Adaptor
b - Bearing Removal Tool (91-816245)
c - Pins
d - Universal Puller Plate

2. Assemble the adaptor as follows:

    a. Lubricate the bore that the needle bearing is pressed into with 2-4-C w/Teflon (92-825407A12).

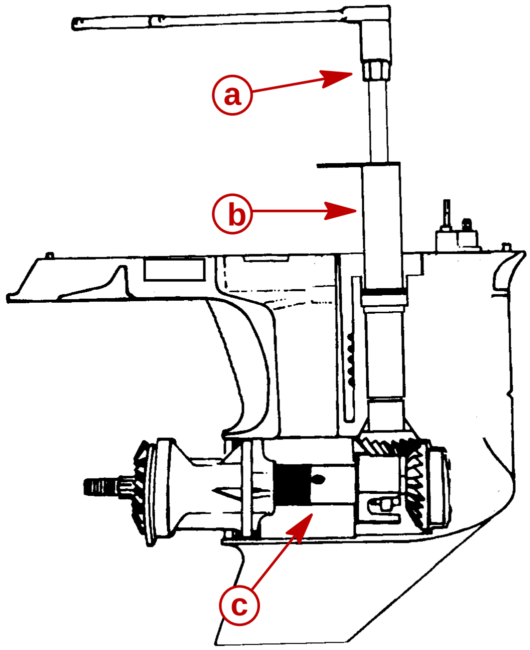
    b. Assemble the needle bearing to the adaptor with the numbered end of the bearing facing the driver shoulder.

    c. Press the needle bearing into the bearing adaptor using a suitable mandrel until the bearing bottoms in the adaptor.

Drive Shaft Assembly

REMOVAL

1. Remove the drive shaft pinion nut as follows:
   a. Place the drive shaft bearing retainer wrench onto the drive shaft. Do not loosen the retainer at this time.
   b. Insert the pinion nut adapter, with the MR slot facing the pinion gear, into the gear housing. It may be necessary to slightly lift and rotate the drive shaft to align the pinion gear nut into the pinion nut adapter slot.
   c. Install the bearing carrier into the gear housing backwards to support the prop shaft and to keep the pinion nut adapter aligned.
   d. Place the drive shaft nut wrench over the drive shaft splines and **loosen**, (but do not fully unscrew), the pinion nut by rotating the drive shaft counterclockwise.

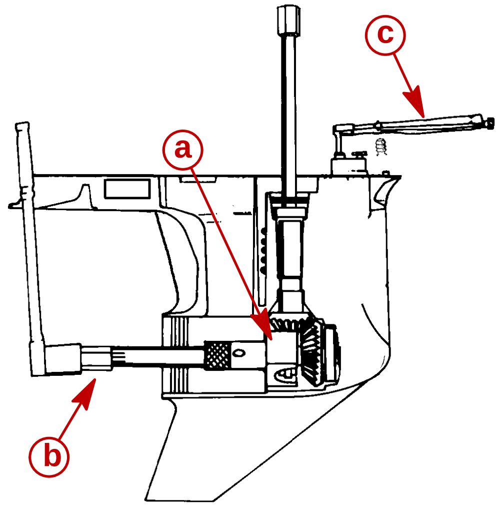


70887

a - Drive Shaft Nut Wrench (91-56775)
b - Drive Shaft Bearing Retainer Wrench (91-43506)
c - Pinion Nut adapter (MR Slot) (91-61067A2)

e. **If the drive shaft is broken,** place propeller shaft nut wrench onto the propeller shaft splines, hold shift shaft in forward gear and **loosen**, (but do not fully unscrew), the pinion nut by rotating prop shaft counterclockwise to turn gears, thus loosening the pinion nut.

NOTE: *The propeller shaft nut wrench is included with the pinion nut adapter kit.*



70607

a - Pinion Nut Adaptor (MR slot) (91-61067A2)
b - Propeller Shaft Nut Wrench (91-61067)
c - Shift Shaft (Turn Clockwise) (Protect shaft splines with soft material)

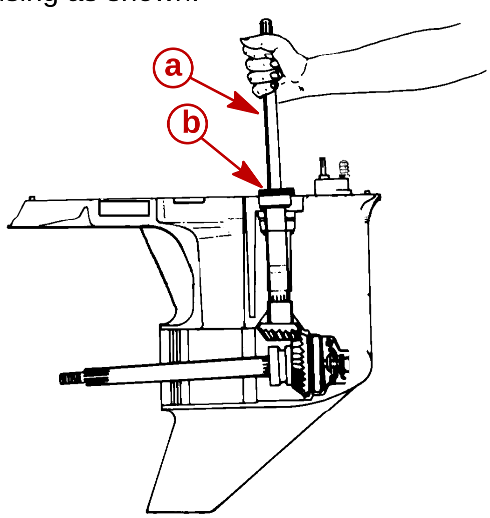
f. Completely unscrew the drive shaft bearing retainer.

g. Completely unscrew the pinion nut by rotating the drive shaft (or the propeller shaft) in a counterclockwise direction.

h. Remove all tools.

IMPORTANT: The pinion bearing rollers are free to fall out of the pinion bearing once the drive shaft is removed. Be careful not to loose the (18) rollers.

2. Remove the drive shaft and all components by pulling the drive shaft straight out of the gear housing as shown.

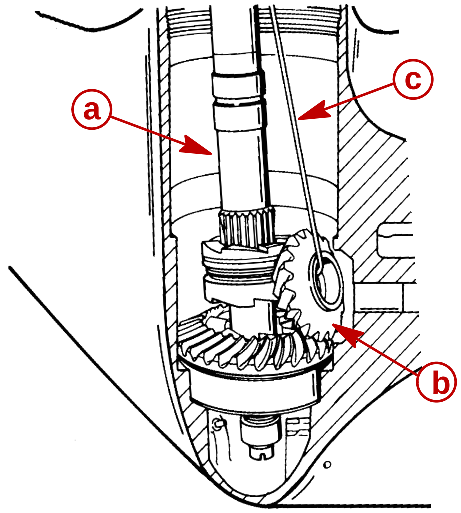


70608

a - Drive Shaft
b - Drive Shaft Retainer, Bearing Cup, Bearing, and Shims

3. With propeller shaft facing straight up, rotate shift lever into forward. Pull propeller shaft up and over towards port side of gear case.

4. Form a small hook on a stiff piece of wire and attempt to hook onto the top side of the gear and pull it out. It may be necessary to slightly move the propeller shaft from side-to-side to dislodge the pinion gear.

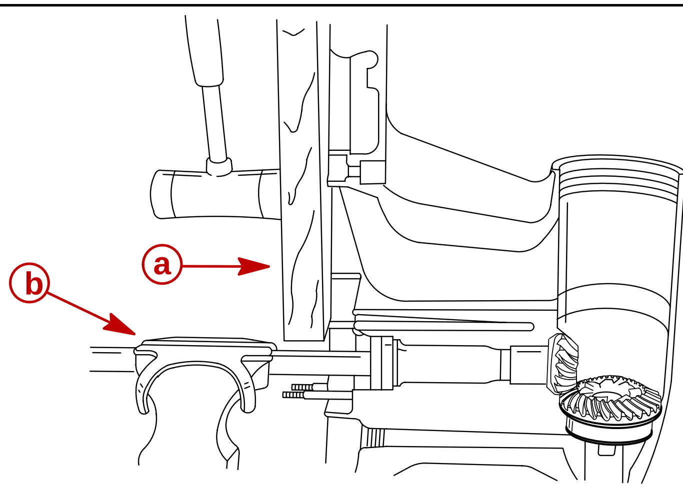


50884

a - Propeller Shaft
b - Pinion Gear
c - Wire Tool

NOTE: *If pinion gear is seized onto the driveshaft, place gearcase in vise using soft jaw vise covers. Place a block of wood on gear housing mating surface. Use a mallet and carefully tap gear housing away from drive shaft.*

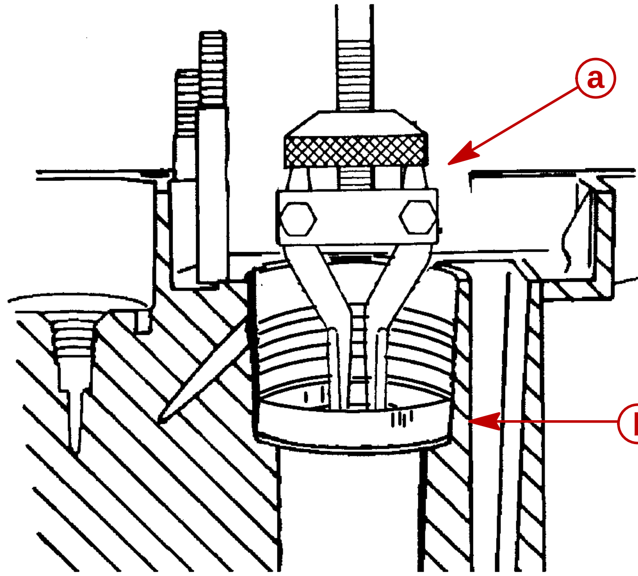
⚠ CAUTION
Do not strike gear housing hard with mallet or allow gear housing to fall.



57951

a - Wood Block
b - Drive Shaft in Soft Jaw Vise

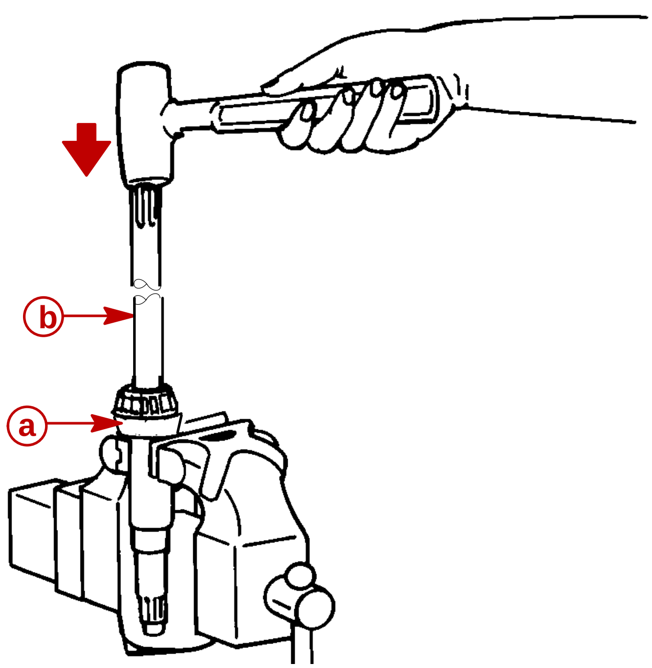
5. Remove lower drive shaft bearing cup and shims using slide hammer puller (34569A1) (retain shims for re-installation).



a - Slide Hammer Puller (91-34569A1)
b - Lower Drive Shaft Bearing Cup

DISASSEMBLY

1. Both upper and lower tapered roller bearings can be removed from the drive shaft in one operation. Using the bottom bearing cup removed from the gearcase, place the cup on top of a vise leaving the vise jaws open enough to allow the drive shaft to slide through.
2. Place the driveshaft through the cup and vise until the bottom bearing is resting in the cup. While holding the driveshaft, tap on the top of the shaft with a lead hammer until the bearings are free. **Do not drop the shaft when performing this operation.**



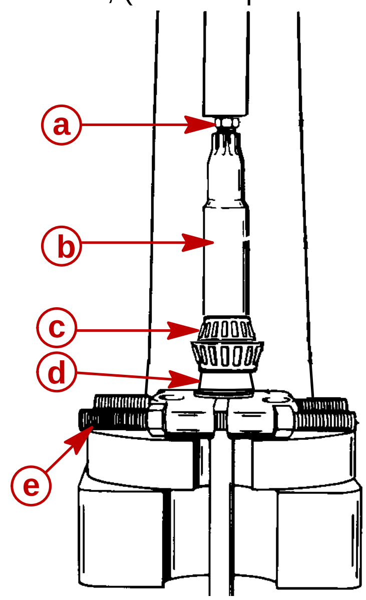
a - Lower Bearing Cup Removed from Gear Case
b - Drive Shaft With Both Upper and Lower Bearings

DRIVE SHAFT ASSEMBLY - INSPECTION

1. Clean all parts with a suitable solvent and dry the parts using compressed air. DO NOT spin the bearings.
2. The condition of the drive shaft bearing cup is an indication of the condition of the tapered roller bearing on the drive shaft. Replace the bearing and bearing cup if the cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
3. Inspect the bearing surface on the drive shaft where the needles of the lower pinion bearing roll. Replace the drive shaft if it is pitted, grooved, scored, worn unevenly, discolored form overheating, or has embedded particles.
4. Inspect the splines at both ends of the drive shaft for a worn or twisted condition. Replace the drive shaft if either condition exists.
5. Inspect the gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. **Replace the pinion gear and the forward gear** if any defects are found.
6. Inspect driveshaft for groove(s) where water pump base oil seals contact shaft. Replace driveshaft if groove(s) are found.

REASSEMBLY

1. Apply a light coat of Quicksilver Heavy Duty Gear Lubricant on I.D. of drive shaft tapered bearing. Apply High Pressure Grease (such as Chicago Manufacturing and Distributing Lube #3) to the O.D. of both bearings.
2. Assemble a new tapered roller bearing to the drive shaft with the large O.D. of the bearing facing the pinion gear end of the drive shaft.
3. Thread a used pinion nut onto end of drive shaft. Leave approximately 1/16″ (2mm) of nut threads exposed. Drive shaft threads MUST NOT extend beyond nut or thread damage could result while pressing.
4. Press the tapered roller bearing onto the drive shaft using the universal puller plate and a suitable mandrel, (an old tapered roller bearing inner race).



a - Used Pinion Nut
b - Drive Shaft
c - Tapered Bearing(s)
d - Old Bearing Inner Race
e - Universal Puller Plate

Propeller Shaft Assembly

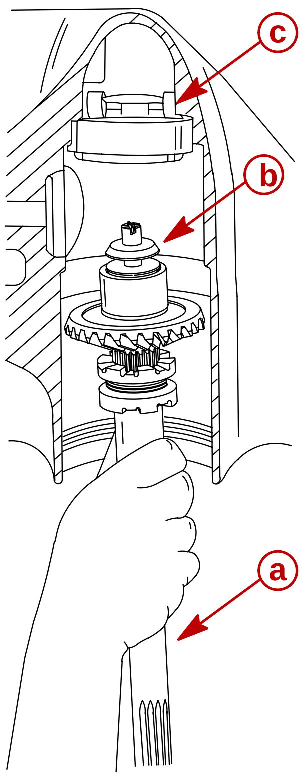
REMOVAL

⚠ CAUTION

Hold onto the propeller shaft assembly in the following step to avoid personal injury and/or dropping components when turning the gear housing over.

1. While holding onto the propeller shaft, turn the gear housing over so that the bore opening is facing down.
2. While moving the propeller shaft to the left (port) side of the gear housing, to allow the shift spool to disengage from the shift crank, lower the propeller shaft out of the gear housing.

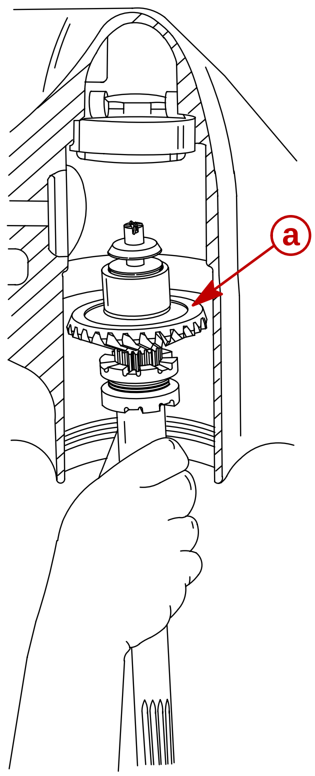
NOTE: *The rollers of the reverse gear bearing adaptor may become dislodged while removing the propeller shaft assembly. If this occurs, inspect the bearing cage to see if it has been damaged. If it has not been damaged simply snap the rollers back into position. If it has been damaged it will be necessary to remove and replace the bearing as outlined in the "Reverse Gear Bearing Adaptor Assembly", 'Component Disassembly and Reassembly' section.*



58014

a - Propeller Shaft Assembly
b - Shift Spool
c - Shift Crank

3. Locate and retain the thrust race and thrust bearing which could be on top of the reverse gear (if not, they may be stuck to the reverse gear bearing adaptor).



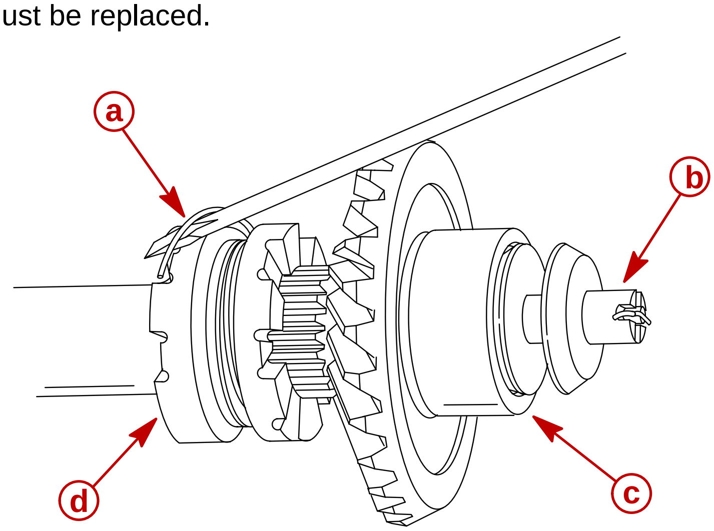
58014

a - Thrust Bearing and Race

PROPELLER SHAFT ASSEMBLY - COMPONENT DISASSEMBLY

IMPORTANT: When accomplishing the next step, all of the parts are free to come apart. Work closely over a work bench to ensure that the parts are not dropped or damaged, and to avoid personal injury.

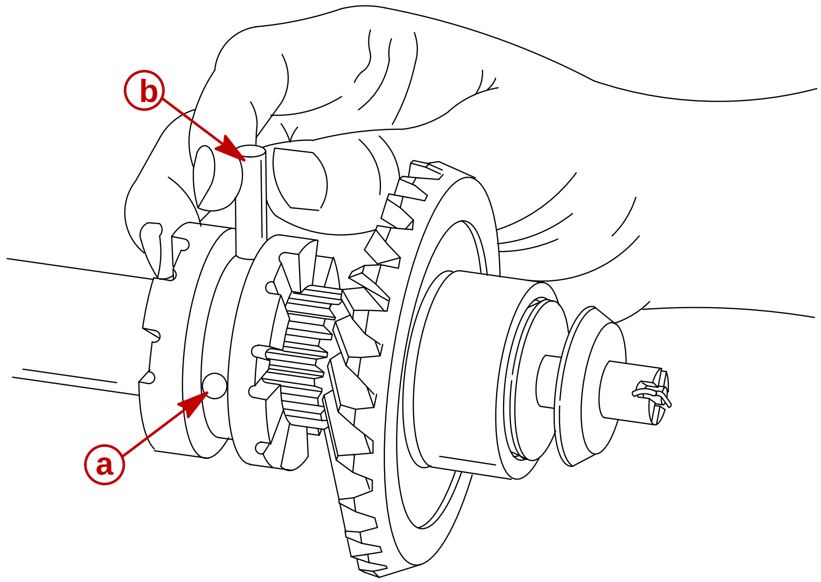
1. Remove the spring around the clutch being careful not to overstretch it during removal. If the spring does not coil back to its normal position once it has been removed, it must be replaced.



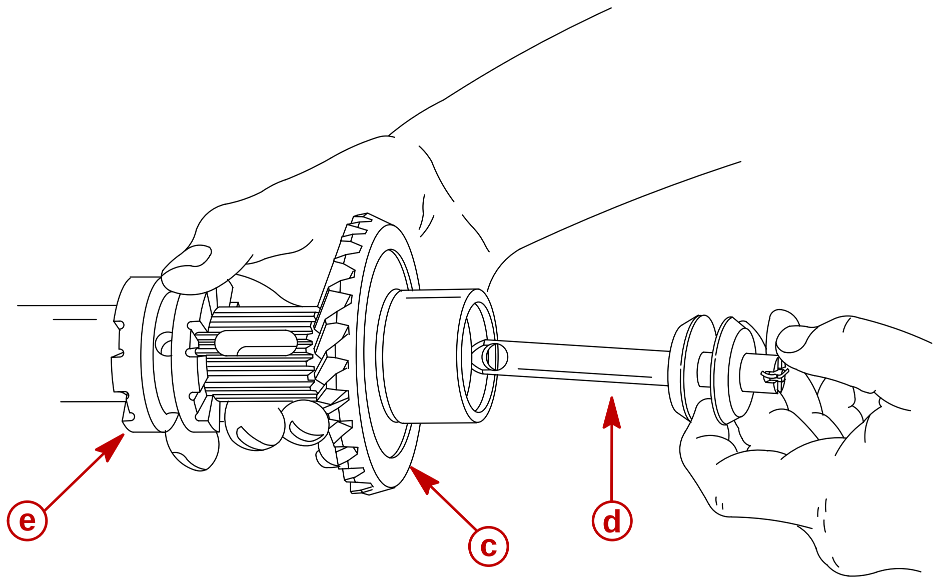
58015

a - Spring
b - Shift Spool Assembly
c - Reverse Gear Assembly
d - Sliding Clutch

2. Remove detent pin.
3. Remove the cross pin that goes through the clutch dog. Remove the reverse gear and slide the clutch off of the propeller shaft.



58012

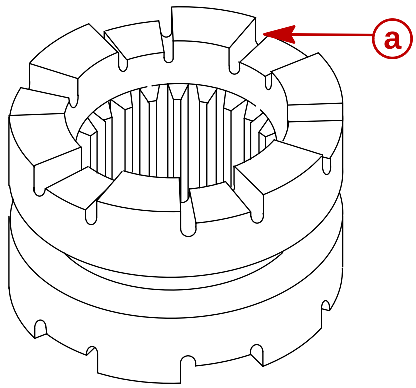


58018

a - Detent Pin
b - Cross Pin
c - Reverse Gear Assembly
d - Spool
e - Clutch

PROPELLER SHAFT ASSEMBLY - COMPONENT INSPECTION

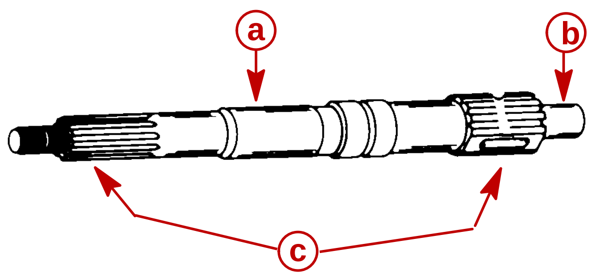
1. Clean all the parts with a suitable solvent and dry the parts thoroughly using compressed air, being careful not to spin bearings.
2. Inspect the sliding clutch jaws for damage. Jaws must not be chipped or rounded off. Replace the clutch if they are.



58013

a - Jaws

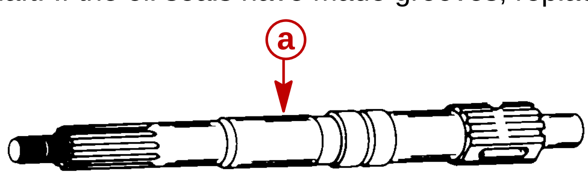
3. Inspect the bearing surfaces on the propeller shaft where the needles of the bearing carrier needle bearing and the needles of the forward gear needle bearing roll. Replace the propeller shaft if it is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.



50698

a - Bearing Carrier Needle Bearing Contact Area
b - Reverse Gear Needle Bearing Contact Area
c - Splines

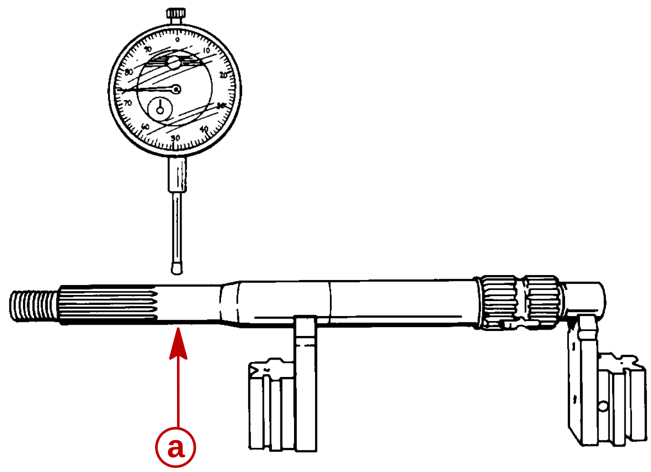
4. Inspect the propeller shaft splines at both ends for a broken, worn, or twisted condition. Replace the propeller shaft if any of these conditions exists.
5. Inspect the surface of the propeller shaft where the bearing carrier seal lips contact the shaft. If the oil seals have made grooves, replace propeller shaft and seals.



50698

a - Bearing Carrier Seal Contact Area

6. Inspect the propeller shaft for a bent condition.
   a. **V-Blocks and Dial Indicator**
      (1.) Position the propeller shaft bearing surfaces on V-blocks.
      (2.) Adjust the height of V-blocks to level the propeller shaft.
      (3.) Position the dial indicator tip just forward of the propeller shaft splines.



52727

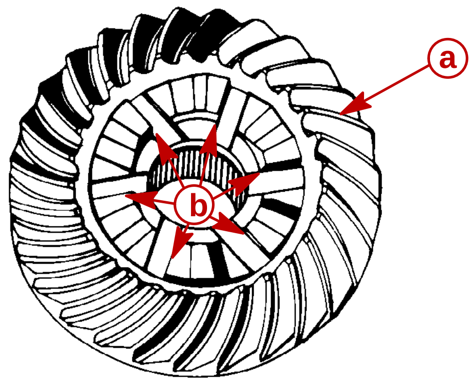
a - Check Movement with Dial Indicator (91-58222A1) Here

7. Rotate the propeller shaft and observe the dial indicator movement. If the indicator in the dial moves more than 0.009 in. (0.23mm), replace the propeller shaft.

Reverse Gear Assembly

COMPONENT INSPECTION

1. Clean the reverse gear assembly with a suitable solvent and dry thoroughly with compressed air. Be careful not to spin the bearings.
2. Inspect the gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. **Replace the reverse gear** if any defects are found.
3. Inspect the clutch jaws of the gear for damage. The surfaces must not be chipped or rounded off. **Replace the reverse gear** if any of these conditions exist.

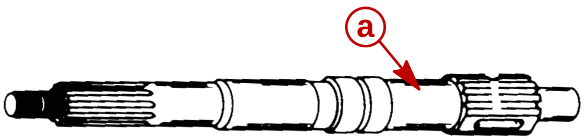


23351

a - Reverse Gear Teeth
b - Clutch Jaws

NOTE: *The needle bearing in the reverse gear should not be removed unless damage has been found. Inspect to ensure that all of the needles are present and in position. The needles may have become dislodged while removing the gear from the propeller shaft (and/or while removing the propeller shaft assembly from the gear housing). They may be snapped back into place as long as no damage has occurred to the bearing cage.*

4. Inspect the needle bearings on the inside of the reverse gear and the bearing surface on the propeller shaft. If either the needle bearings, or the bearing surface of the propeller shaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, replace the propeller shaft and remove and replace the needle bearing in the reverse gear as outlined in the next section.



50698

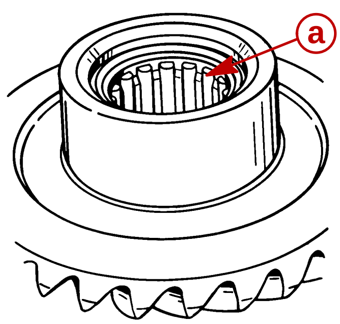
a - Forward Gear Needle Bearing Contact Area

REVERSE GEAR ASSEMBLY - COMPONENT DISASSEMBLY

NOTE: *Reverse gear can only be removed from gear housing after drive shaft and pinion gear have been removed.*

NOTE: *Complete the instructions in this section only if the needle bearing in the gear has been found to be defective and the reverse gear is to be reused. Bearings that have become dislodged may be snapped back into position. If this is the only problem that exists it is not necessary to replace the needle bearing.*

1. Replace bearing if it is rusted or does not roll freely.
2. Press the reverse gear needle bearing out using a suitable mandrel.



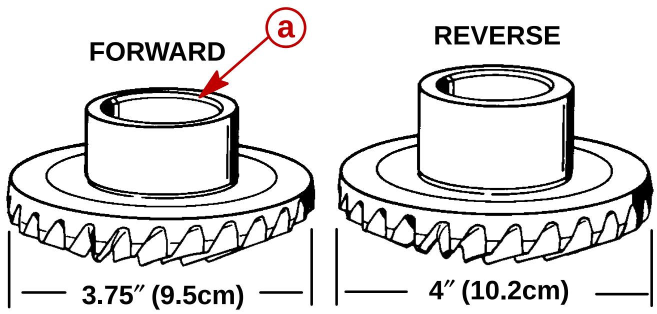
50778

a - Reverse Gear Needle Bearing

REVERSE GEAR ASSEMBLY - COMPONENT REASSEMBLY

NOTE: *Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.*

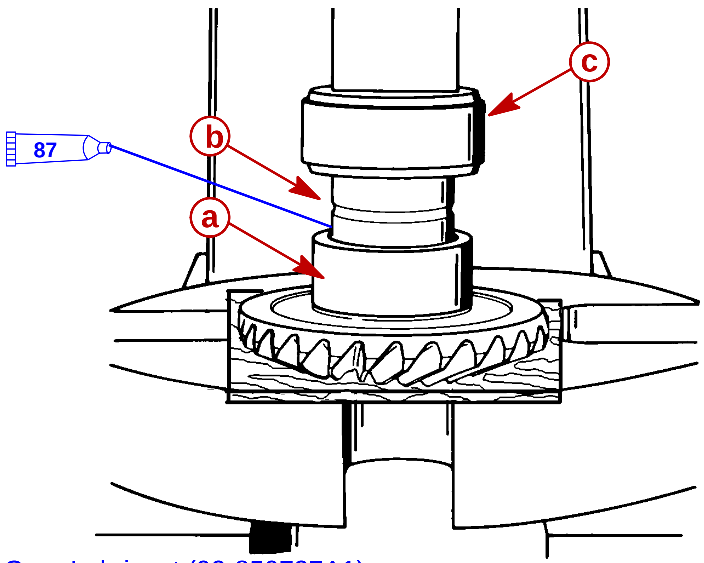
IMPORTANT: The appearance of the forward and reverse gear is almost identical. The forward gear has a shorter hub and is slightly smaller in diameter.



50885

a - Shorter Hub

1. Apply Quicksilver gear lubricant to I.D. of forward gear. Press the needle bearing into the reverse gear until tool contacts gear.



87 Super Duty Gear Lubricant (92-850737A1)

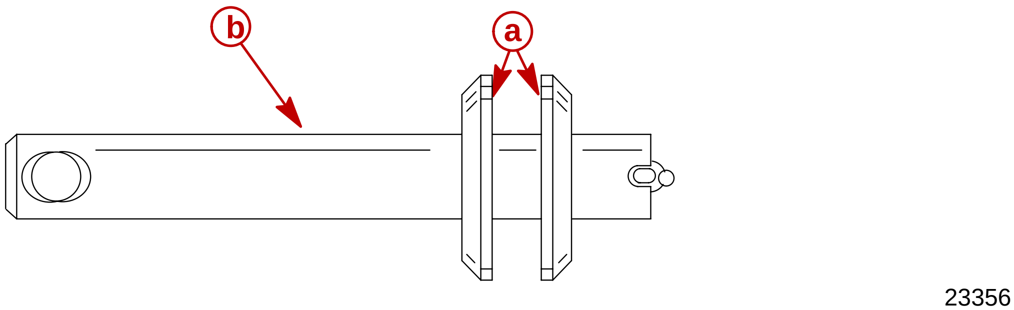
50789

a - Reverse Gear
b - Needle Bearing
c - Bearing Driver (91-86943)

Shift Spool Assembly

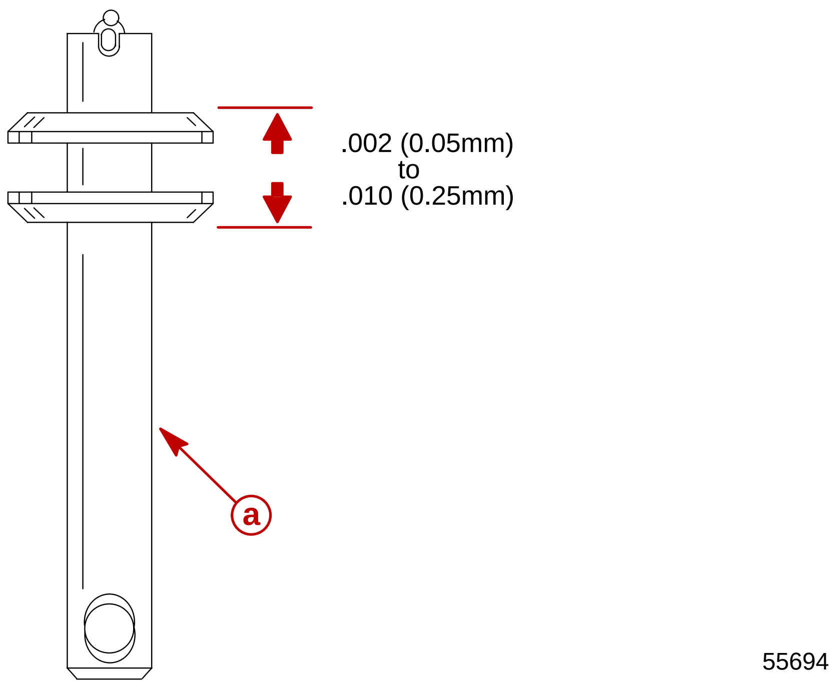
INSPECTION

1. Clean the assembly with a suitable solvent and dry the parts using compressed air.
2. Inspect the shift spool assembly for damage. Small nicks and burrs may be smoothed. If any parts are damaged or worn beyond repair it will be necessary to replace the complete shift spool assembly. Individual parts are not available for the assembly.
3. Inspect the shift spool for wear in the area where the shift crank comes into contact.



a - Contact Area
b - Shift Spool

4. Inspect to insure that the spool spins freely (it may be helpful to lightly tap the forward [castle nut] end of the shift spool shaft against a firm surface to align the internal parts).
5. Inspect to insure that the spool has no more than 0.002-0.010 (0.05-0.25 mm) end play.



a - Spool

SHIFT SPOOL ASSEMBLY - COMPONENT DISASSEMBLY

NOTE: *Disassembly of the shift spool is for cleaning and inspection of the internal parts of the assembly due to an improperly functioning shift spool assembly or debris in the gear housing and/or shift spool assembly. Individual components for the shift spool are not available as replacement parts. If the shift spool does not function properly (see the preceding "Shift Spool Assembly - Inspection" section) and the following cleaning and adjustment procedures do not produce the desired results, it will be necessary to order a new shift spool assembly.*

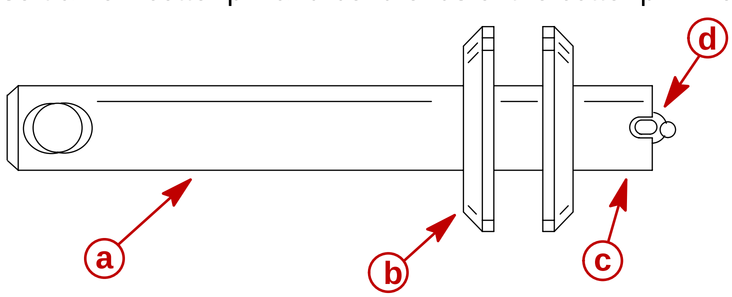
1. Disassemble the shift spool assembly as follows:
   a. Remove and discard the cotter pin.
   b. Remove the castle nut and the spool.

SHIFT SPOOL ASSEMBLY - COMPONENT INSPECTION

1. Clean all components with a suitable solvent and dry them with compressed air.
2. Inspect each component for wear or damage. If any components are worn beyond repair, damaged, or broken it will be necessary to replace the complete shift spool assembly. Small nicks or burrs may be smoothed and the parts reused.

SHIFT SPOOL ASSEMBLY - COMPONENT REASSEMBLY

1. Assemble the shift spool and shift spool shaft as follows:
   a. Place the shift spool onto the shift spool shaft.
   b. Assemble the castle nut and screw it down until it touches the washer and a slight resistance is felt.
   c. Loosen the castle nut until the cotter pin slot of the castle nut is aligned with the hole in the shaft. If, when the castle nut is screwed down, the cotter pin slot is already aligned at the hole in the shaft, back the castle nut off until the next available slot in the nut is aligned with the hole in the shaft.
   d. Insert a new cotter pin and bend ends of the cotter pin in opposite directions.



55694

a - Shift Spool Shaft
b - Shift Spool
c - Castle Nut
d - Cotter Pin

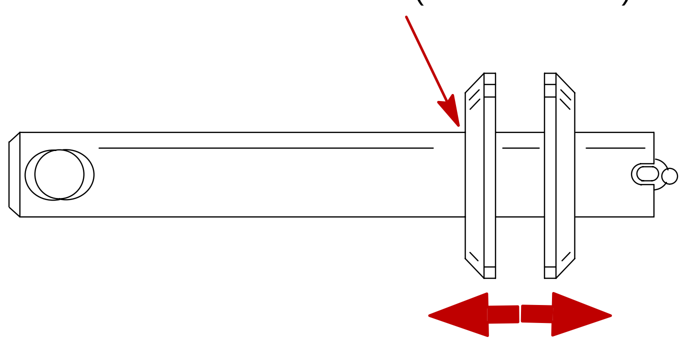
SHIFT SPOOL ASSEMBLY - ADJUSTMENT

NOTE: *If the shift spool assembly has been disassembled and reassembled (as in the previous two sections) skip the following instructions, (1 through 4).*

NOTE: *If the shift spool assembly has not been disassembled and reassembled, do all of the following steps.*

1. Remove and discard the cotter pin.
2. Screw the castle nut down until it touches the washer and a slight resistance is felt.
3. Loosen the castle nut until the cotter pin slot of the castle nut is aligned with the hole in the shaft. If, when the castle nut is screwed down, the cotter pin slot is not aligned at the hole in the shaft, back off the castle nut until the next available slot in the nut is aligned with the hole in the shaft.
4. Insert a new cotter pin and bend ends in opposite directions.
5. Inspect to insure that the spool spins freely (it may be helpful to lightly tap the forward [castle nut] end of the shift spool shaft against a firm surface to align the internal parts).
6. Inspect to insure that the spool has no more than 0.002-0.010 (0.05-0.25 mm) end play, if it does adjust the castle nut once again as outlined previously.

0.002 - 0.010 in. (0.05 - 0.25 mm)

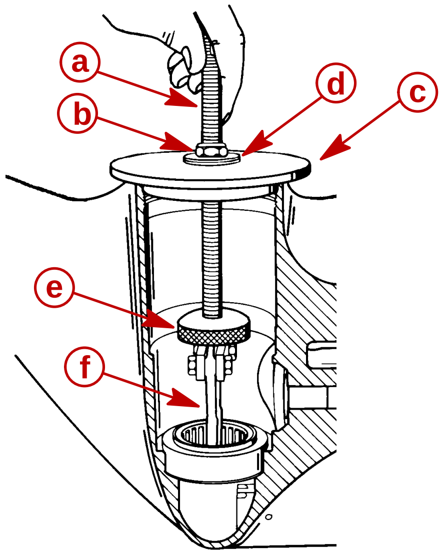


7. If this adjustment did not produce the desired results it will be necessary to disassemble, clean, and reassemble the shift spool assembly. If the spool assembly has already been disassembled and cleaned it will be necessary to replace the shift spool assembly.

Reverse Gear Bearing Adaptor Assembly

REMOVAL

1. Remove the reverse gear bearing adaptor using the tools as shown in the next figure. Remove, measure and make note of the shim thickness. If the shims are not damaged, they may be reused.



50780

a - Bolt (91-31229)
b - Nut (11-24156)
c - Guide Plate (91-816243)
d - Washer (91-34961)
e - Puller Head (from Slide Hammer Puller Kit 90-34569A1)
f - Jaws (91-816242)

REVERSE GEAR BEARING ADAPTOR ASSEMBLY - INSPECTION

1. Thoroughly clean the reverse gear bearing adaptor with a suitable solvent and dry it using compressed air.

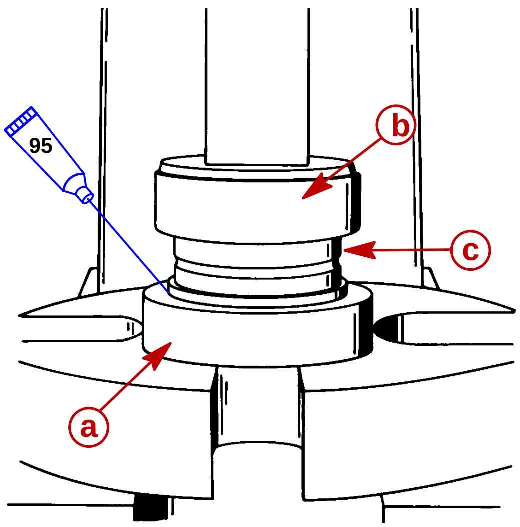
NOTE: *The condition of the bearing surfaces on the reverse gear in the areas that the bearings of the bearing adaptor and the thrust bearing rides, is an indication of the condition of the respective bearings. Replace the bearing(s) if the surface of the gear and/or the thrust washer is pitted, grooved, scored, worn unevenly, discolored from overheating or has embedded metal particles.*

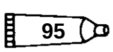
2. Assemble the reverse gear, the thrust bearing, and the thrust race, to the bearing adaptor. Inspect them for excessive movement or roughness by rotating the gear in the adaptor. Replace the bearing in the adaptor and/or the thrust bearing if either of these conditions exist.
3. Inspect the adaptor for other signs of excessive wear or damage. Replace the adaptor if any are found.

REVERSE GEAR BEARING ADAPTOR ASSEMBLY - COMPONENT DISASSEMBLY AND REASSEMBLY

NOTE: *Complete the instructions in this section only if the needle bearing in the bearing adaptor is defective and the adaptor is to be reused.*

1. Disassemble the adaptor as follows:
   a. Remove the bearing from the adaptor using a suitable mandrel.
   b. **Discard the bearing.**
2. Assemble the adaptor as follows:
   a. Lubricate the bore that the needle bearing is to be pressed into with 2-4-C w/Teflon (92-825407A12).
   b. Position the needle bearing on the adaptor with the numbered end of the bearing facing the driver shoulder.
   c. Press the needle bearing into the bearing adaptor using a suitable mandrel until the bearing is flush with the face of the adaptor.



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

50790

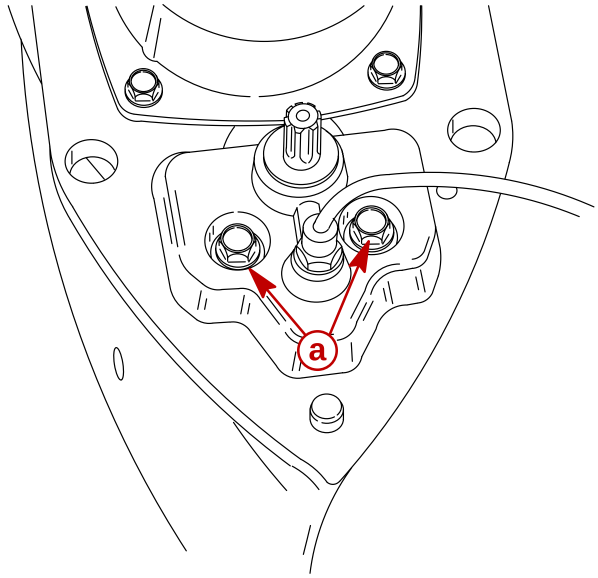
a - Reverse Gear Bearing Adaptor
b - Suitable Mandrel
c - Bearing

Shift Shaft Assembly

REMOVAL

NOTE: *It is possible to remove and service the shift shaft assembly (but not the shift crank inside the gear case) without removing any of the internal components of the gear housing.*

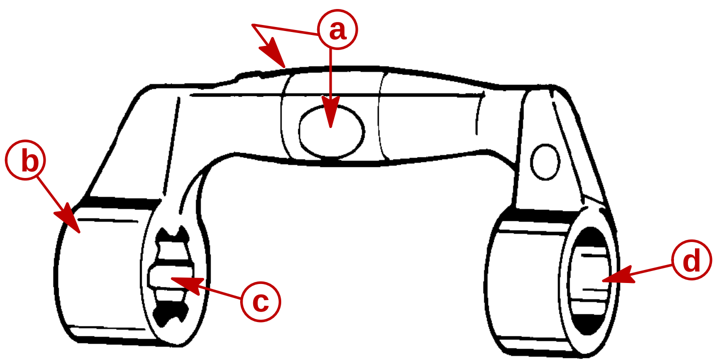
1. Remove the shift shaft bushing screws, and remove the shift shaft and bushing by pulling them straight out of gear housing.



57934

a - Shift Shaft Bushing Screws

2. Remove the shift crank from the inside of the gear housing. Clean it with a suitable solvent and dry it thoroughly. Inspect it for wear in the areas that contact the shift spool and inspect the splines and the diameter that goes over the locating pin for damage or wear.

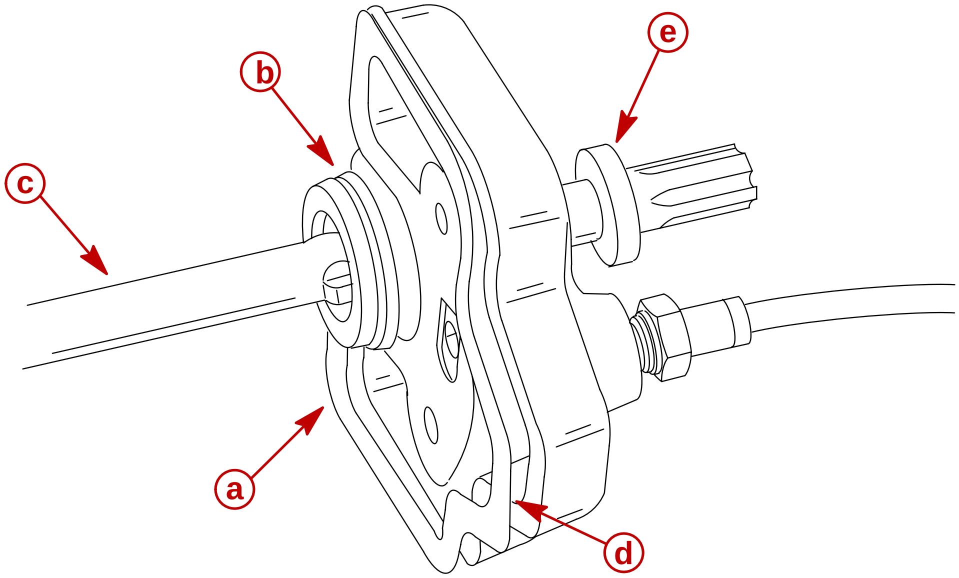


23350

a - Contact Area
b - Shift Crank
c - Splines
d - Diameter for Locating Pin

SHIFT SHAFT ASSEMBLY - Component Disassembly and Inspection

1. Slide the bushing assembly off the shift shaft. Remove the coupler from the shaft.

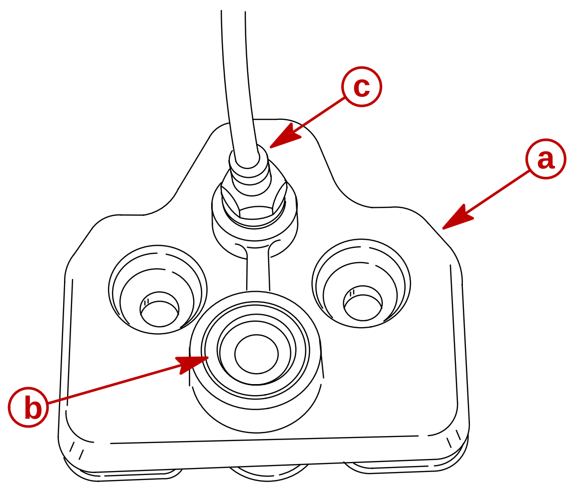


57954

a - Shift Shaft Bushing Assembly
b - O-ring
c - Shift Shaft
d - Gasket
e - Rubber Washer

2. Clean all components with a suitable solvent and dry thoroughly with compressed air.
   a. Inspect the shift shaft bushing for cracking, damage, or excessive wear.
   b. Inspect the oil seal inside the bushing, the sleeve, and the O-rings on the outside of the bushing for damage or excessive wear.
   c. Inspect the speedometer connector for damage or blockage.

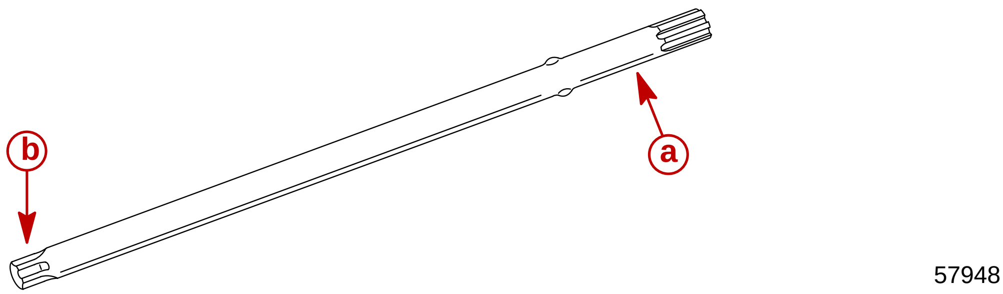
If any of these conditions exist, replace the appropriate components.



57932

a - Shift Shaft Bushing
b - Oil Seal (Oil Seal is Replaceable)
c - Speedometer Tube Connector

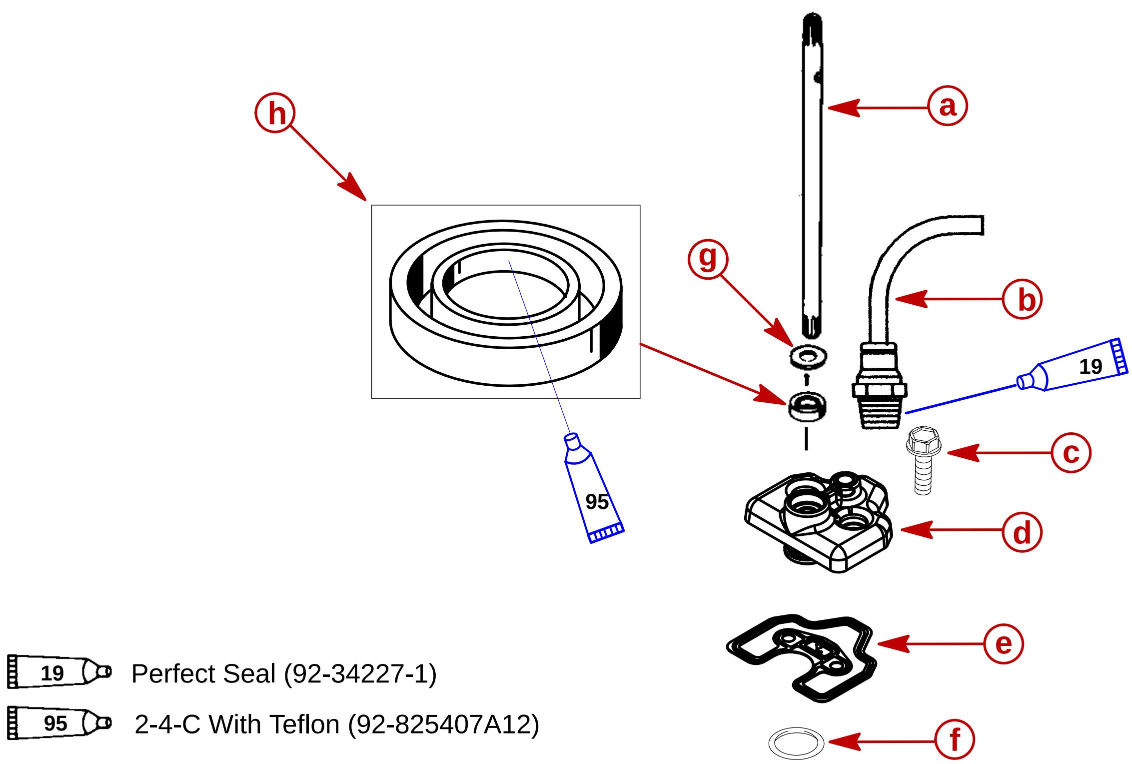
3. Inspect the shift shaft splines and oil seal surface for corrosion and/or excessive wear. Replace the shift shaft if either if these conditions are found.



a - Oil Seal Surface
b - Spline

SHIFT SHAFT ASSEMBLY - Component Reassembly

1. Lightly lubricate the seat of the O-ring diameter on the bushing and the lip of the oil seal with 2-4-C w/Teflon (92-825407A12).
2. If the speedometer connector was removed and/or replaced, lightly coat the **threads of the connector** with Quicksilver Perfect Seal (91-34277-1). Assemble the speedometer connector to the bushing and torque the connector to 4.5 lb. in. (0.5 Nm).
3. Assemble all components as shown below.



a - Shift Shaft
b - Speedometer Pressure Hose
c - Bolt (2) [Torque to 60 lb. in. (7 Nm)]
d - Bushing
e - Gasket
f - O-ring
g - Rubber Washer
h - Seal (Lip Faces Up)

Pinion Bearing

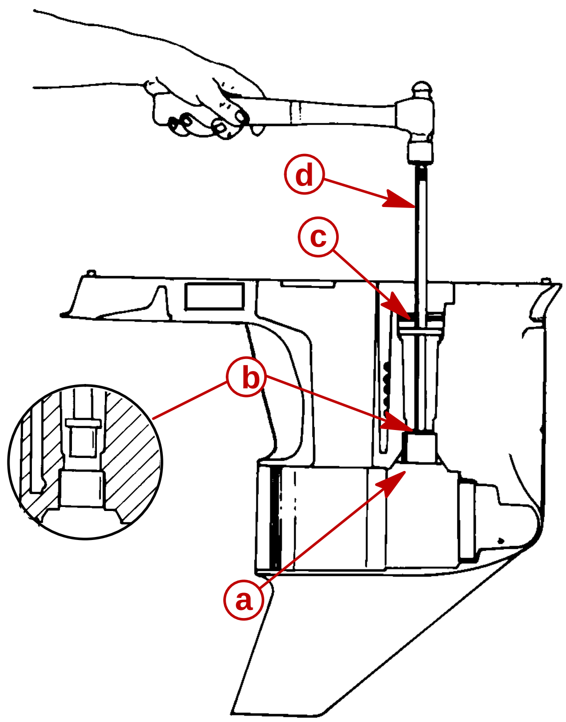
REMOVAL

NOTE: *Inspect the bearing surface on the drive shaft where the needles of the lower pinion bearing roll. The condition of the drive shaft at this location gives an indication of the condition of the needle bearing. Replace lower pinion bearing (needles and race as a set) if the drive shaft is pitted, grooved scored, worn unevenly, discolored from overheating, or has embedded particles.*

IMPORTANT: All the needle bearings (18) MUST BE in place inside bearing race while driving the pinion bearing from the gear housing.

IMPORTANT: Do not reuse the bearing (race or rollers) once it has been removed.

1. Remove and discard the pinion bearing (race and rollers) using tools as shown.



70614

a - Pinion Bearing
b - Bearing Driver (91-36569)
c - Pilot Washer (91-36571)
d - Driver Rod (91-37323)

Gear Housing Reassembly

Gear Housing Inspection

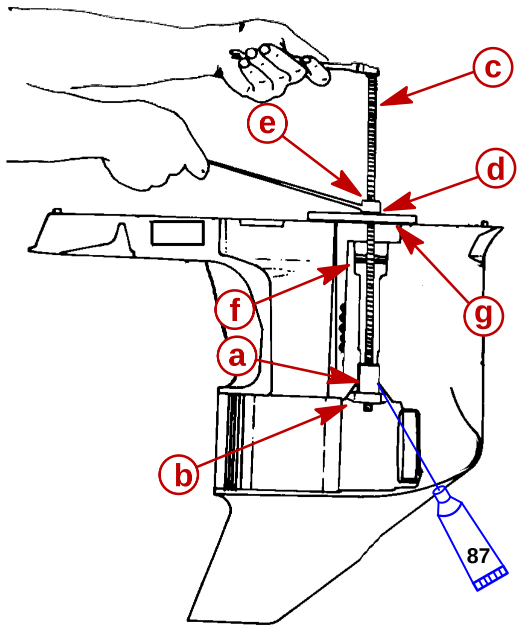
1. Clean the gear housing thoroughly with a suitable solvent and a hard bristle brush. Dry the gear housing thoroughly using compressed air. Insure that all sealants, locking agents and debris are removed.
2. Verify the 2 oil circulation holes in the drive shaft bore and the shift shaft hole are clear and free of debris.
3. Inspect the gear housing for excessive corrosion, impact or any other damage. Excessive damage and/or corrosion requires replacement of the gear housing.
4. Inspect the bearing carrier retainer threads in the gear housing for corrosion and/or stripped threads. Damage or corrosion to the threads requires replacement of the gear housing.
5. Inspect bearing race/cup contact areas for evidence of bearing cup spinning. Check that bearing cups are not loose in bearing bores. Any one bearing bore in which the race/cup is loose will require replacement of the gear housing.
6. Inspect for blockage in water inlet holes and the speedometer hole, clean as necessary. Be careful not to enlarge the speedometer hole as this could cause erroneous speedometer readings.
7. Verify that the locating pins are in place in the gear housing and that the corresponding holes in the drive shaft housing are not elongated. The drive shaft may break if the housings are not aligned properly due to missing locating pins or elongated holes.

Pinion Bearing

INSTALLATION

IMPORTANT: Install only a new pinion bearing. Do not reinstall a pinion bearing that has been previously removed from a gear housing.

1. Lubricate the bore into which the pinion bearing is to be installed with Quicksilver Gear Lubricant (92-19007A24).
2. Position the new pinion bearing (with the cardboard shipping sleeve in place) onto the driver head, with the lettered and numbered side of the bearing oriented upward.
3. Insert the driver with the bearing assembly, into position (by way of the propeller shaft bore) at the drive shaft bore as shown.



70615

87 Quicksilver Gear Lubricant (92-19007A24)

a - Drive Shaft Pinion Bearing (With Cardboard Shipping Sleeve)
b - Driver Head (91-38628)
c - Puller Shaft (91-31229)
d - Washer (12-34961)
e - Nut (11-24156)
f - Pilot Washer (91-36571)
g - Puller Plate (91-29310)

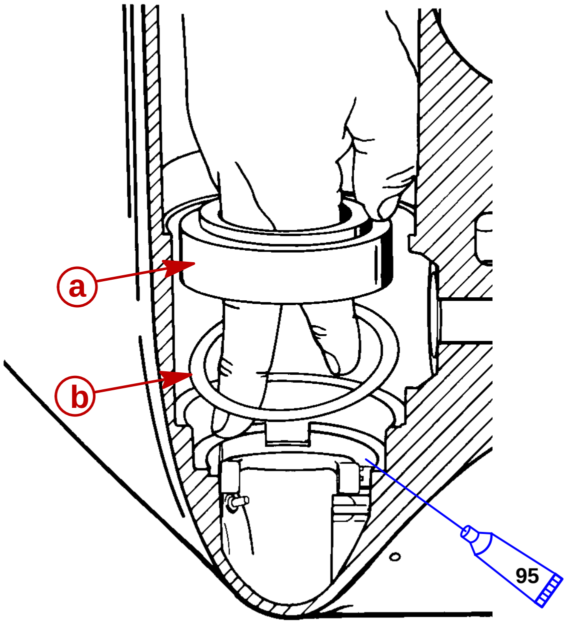
4. Install the bearing by screwing down the nut until the bearing is fully seated against the bore shoulder.

Reverse Gear Bearing Adaptor Assembly

INSTALLATION

NOTE: *If the reverse gear, reverse gear adaptor, large thrust bearing, or bearing race in the gear housing were not replaced, install the same shim(s) (or the same thickness of shim(s) that were taken out when adaptor was removed. If the reverse gear, reverse gear adaptor, large thrust bearing, bearing race, or gear housing were replaced, install 0.008 in. (0.51 mm) of shims.*

1. Lubricate the bore into which the reverse gear bearing adaptor is to be installed with 2-4-C w/Teflon (92-825407A12).
2. Place the shim(s) into reverse bore of gear housing.
3. Position the bearing adaptor in the gear housing.

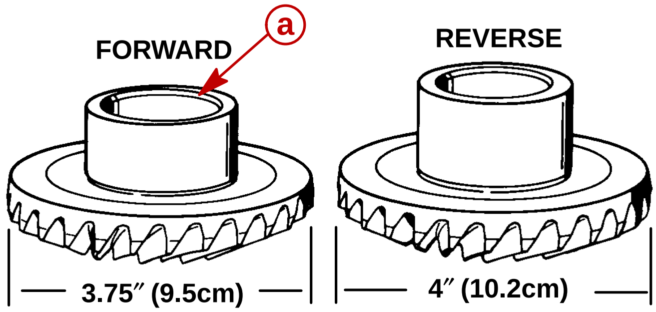


95 2-4-C With Teflon (92-825407A12)

50781

a - Bearing Adaptor
b - Shims

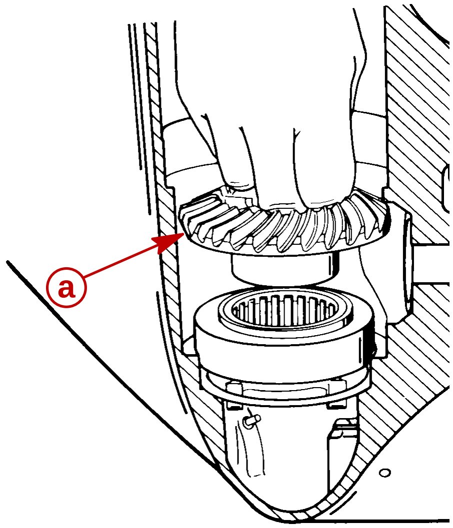
IMPORTANT: The appearance of the forward and reverse gear is almost identical. The forward gear has a shorter hub and is slightly smaller in diameter.



50885

a - Shorter Hub

4. Position the reverse gear (without the thrust race or thrust bearing) into the gear housing and into the adaptor.



50781

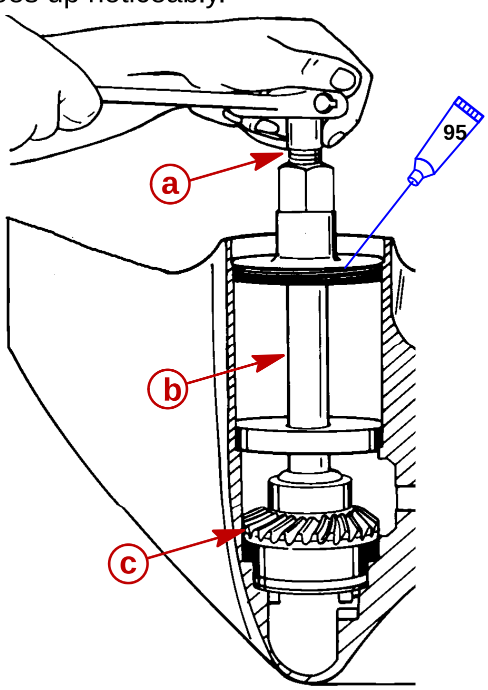
a **-** Reverse Gear

5. Press the bearing adaptor into the gear housing using the installation tool as follows:

IMPORTANT: Be sure that the bearing adaptor is positioned as straight as possible to avoid cocking it in the bore while pressing it in.

a. Lubricate the threads of the installation tool with 2-4-C w/Teflon (92-825407A12).

b. Turn the hex-head screw of the installation tool until the bearing adaptor bottoms out on the gear housing shoulder. DO NOT continue to turn the tool once the screw resistance goes up noticeably.



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

50791

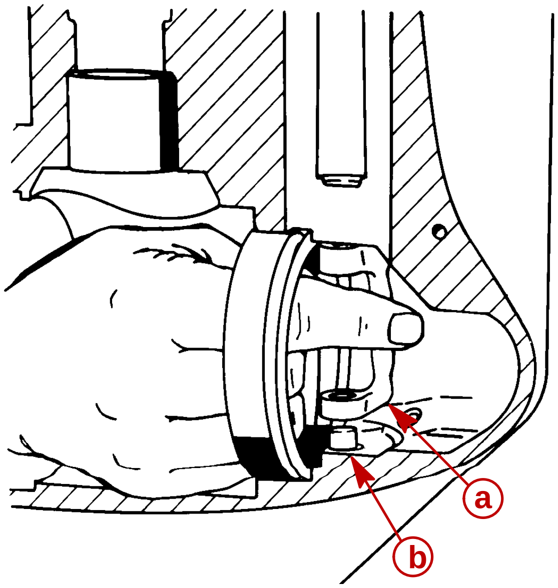
a **-** Hex-Head Screw
b **-** Bearing Adaptor Installation Tool (91-18605A1)
c **-** Reverse Gear

c. Remove the installation tool **and the reverse gear.**

Shift Shaft Assembly

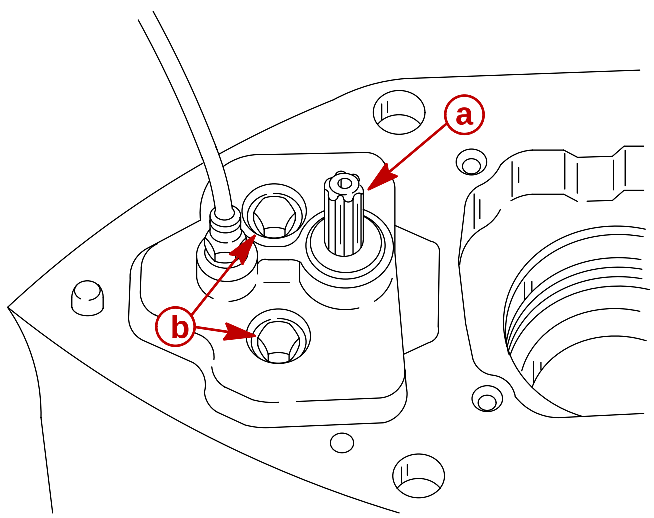
INSTALLATION

1. Place the shift crank onto the locating pin in the forward section of the gear housing. Ensure that the shift crank faces towards the left (port) side of the gear housing.



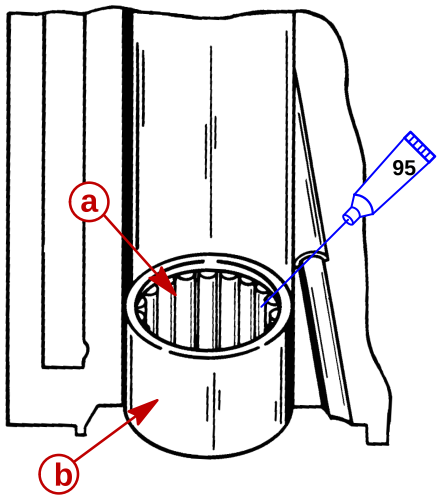
a - Shift Crank
b - Locating Pin

2. Install the shift shaft assembly into the gear housing as shown. Engage the splined end of the shift shaft with the shift crank. Verify O-ring is positioned properly and lubricated with 2-4-C w/Teflon. Secure shift shaft bushing with 2 screws. Torque screws to 60 lb. in. (7 Nm).



a - Shift Shaft Assembly
b - Screws [Torque to 60 lb. in. (7 Nm)]

NOTE: *If the pinion bearing needle bearings have fallen out, install 18 needles into needle bearing outer race. Use 2-4-C w/Teflon (92-825407A12), to help hold needles in place.*



23142

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

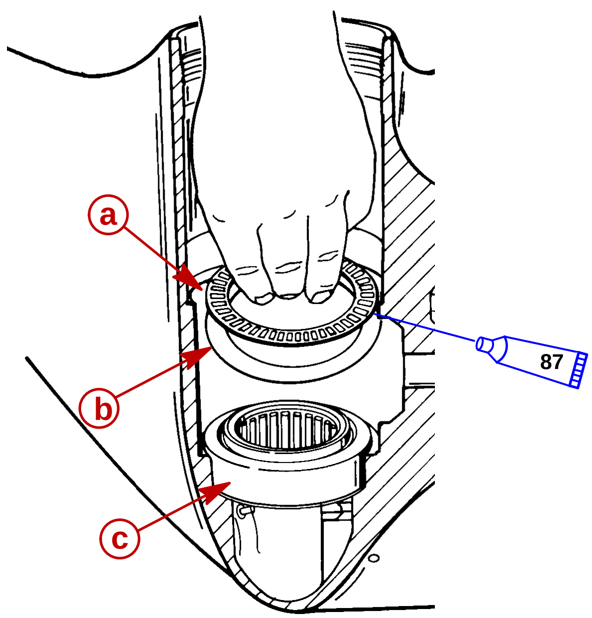
a - Rollers (18)
b - Roller Bearing Outer Race

Gear Location/Backlashes Checking and Adjustment

Reverse Gear

INSTALLATION (FOR CHECKING BACKLASH ONLY)

1. Lubricate the large reverse gear thrust bearing with Quicksilver Gear Lubricant (92-13783A24) and position first the thrust race, then the bearing into the gear housing and onto the reverse gear bearing adaptor.

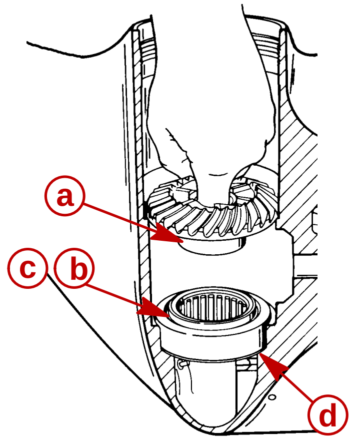


50882

87 Quicksilver Gear Lubricant (92-19007A24)

a - Thrust Bearing
b - Thrust Race
c - Reverse Gear Bearing Adaptor

2. Install the reverse gear into the gear housing and into the reverse gear bearing adaptor.



50884

a - Reverse Gear
b - Thrust Bearing
c - Thrust Race (under Bearing)
d - Reverse Gear Bearing Adaptor

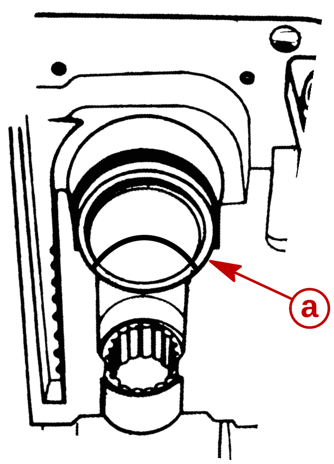
Drive Shaft and Pinion Gear

INSTALLATION

NOTE: *If the original shims were not retained or if pinion gear, drive shaft, drive shaft upper tapered roller bearing and cup, or gear housing were replaced, start off by installing a 0.038 in. (0.96 mm) shim(s), for the upper tapered roller bearing.*

NOTE: *If the original shims were retained (or measurement known) and none of the above listed parts were replaced, reinstall the same shims or same amount of shims.*

1. Place the upper tapered bearing shim(s) into the drive shaft housing bore.



70620

a - Shim(s)

NOTE: *For ease of installation, glue the washer to the pinion gear, using 3M Adhesive (92-25234), or Quicksilver Bellows Adhesive (92-86166), or equivalent.*

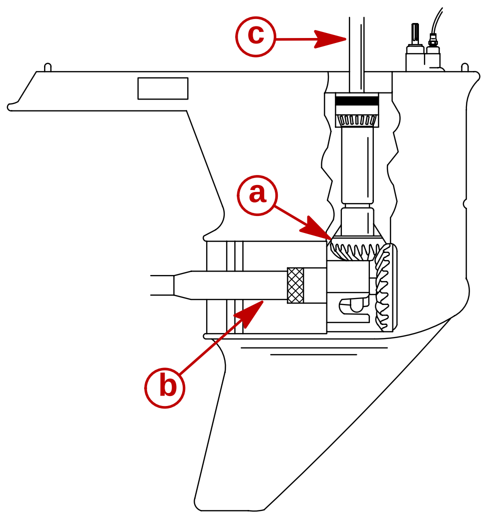
NOTE: *If the backlash may have to be changed, it is recommended that Loctite 271 NOT be applied to the pinion nut UNTIL the backlash setting is finalized. DO NOT reuse the old pinion nut. Install a NEW pinion nut after backlash is finalized.*

NOTE: *Do not install the lower tapered bearing cup or shim(s) at this time.*

2. Apply Loctite 271 (92-809820) to the threads of the pinion gear nut and place the pinion gear nut into the MR slot of the pinion nut adapter.

NOTE: *Install the pinion gear nut with the flat side of the nut away from the pinion gear.*

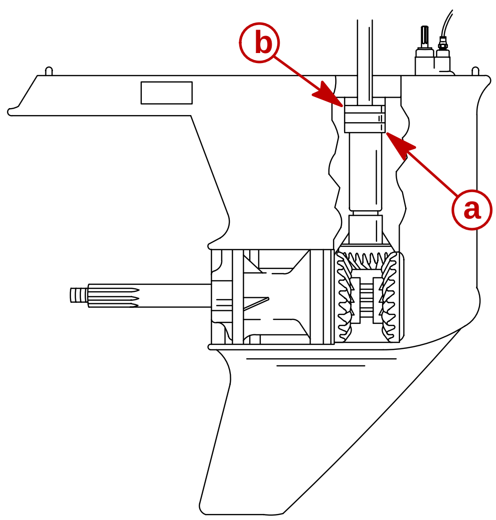
3. Place the pinion gear (with the washer glued to it) into the gear housing.
4. Insert the drive shaft into the gear housing drive shaft bore. It may be necessary to rotate the drive shaft to engage the drive shaft splines into the pinion gear splines.
5. Temporarily install the propeller shaft (without the sliding clutch installed) into reverse gear.
6. Insert the pinion nut adaptor (with the nut) into the gear housing. It may be necessary to raise the drive shaft slightly to clear the tool.
7. Start the pinion nut onto the drive shaft threads by rotating the drive shaft until the nut is snug.



57952

a - Pinion Gear (with the washer glued to it)
b - Pinion Nut Adaptor (91-61067A2)
c - Drive Shaft

8. Install the upper drive shaft tapered roller bearing cup. Apply 2-4-C w/Teflon to the retainer threads and install the retainer.

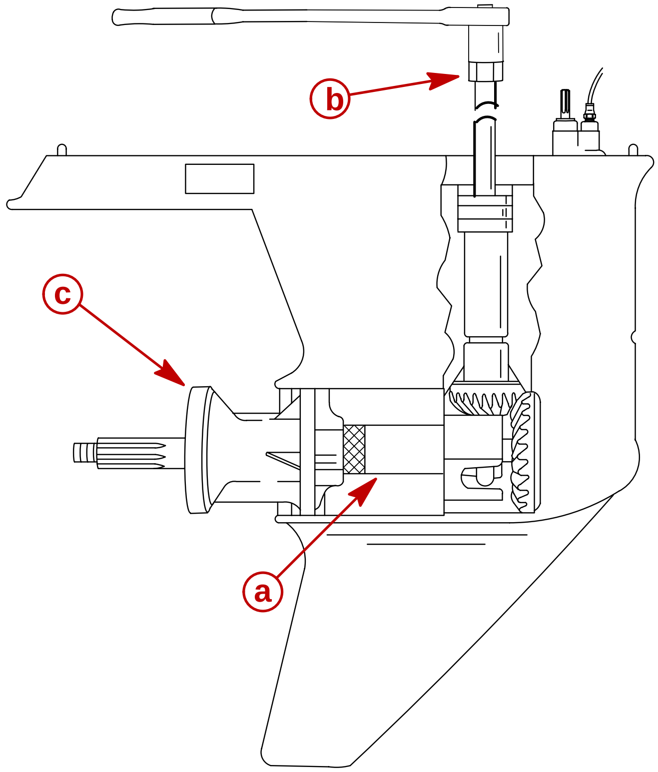


57953

a - Upper Tapered Roller Bearing Cup
b - Drive Shaft Retainer

9. Install the bearing carrier into the gear housing backwards to hold the propeller shaft and the pinion nut adaptor in position.

10. Torque the pinion nut to 70 lb. ft. (95 Nm) by turning the drive shaft using the drive shaft nut wrench and torque wrench.

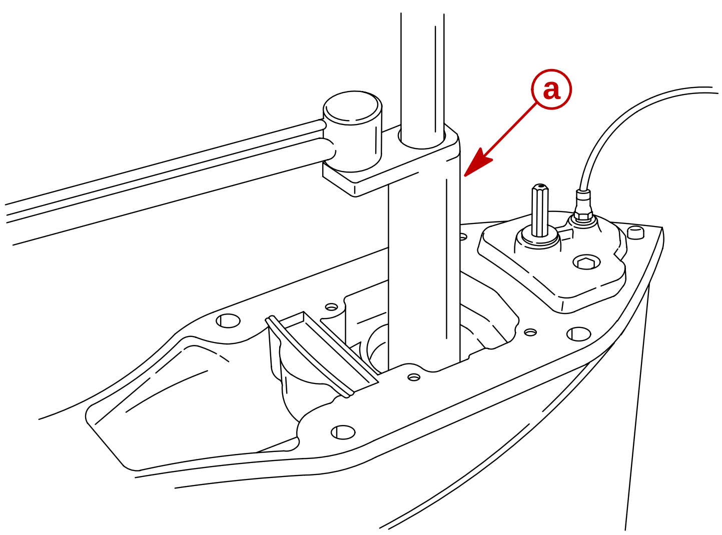


57950

a - Pinion Nut Adapter (91-61067A2)
b - Drive Shaft Nut Wrench (91-56775)
c - Bearing Carrier (installed backwards)

11. Remove the bearing carrier, pinion nut adapter and drive shaft nut wrench.

12. Torque the retainer to 100 lb. ft. (135 N·m).



57935

a - Drive Shaft Bearing Retainer Wrench (91-43506)

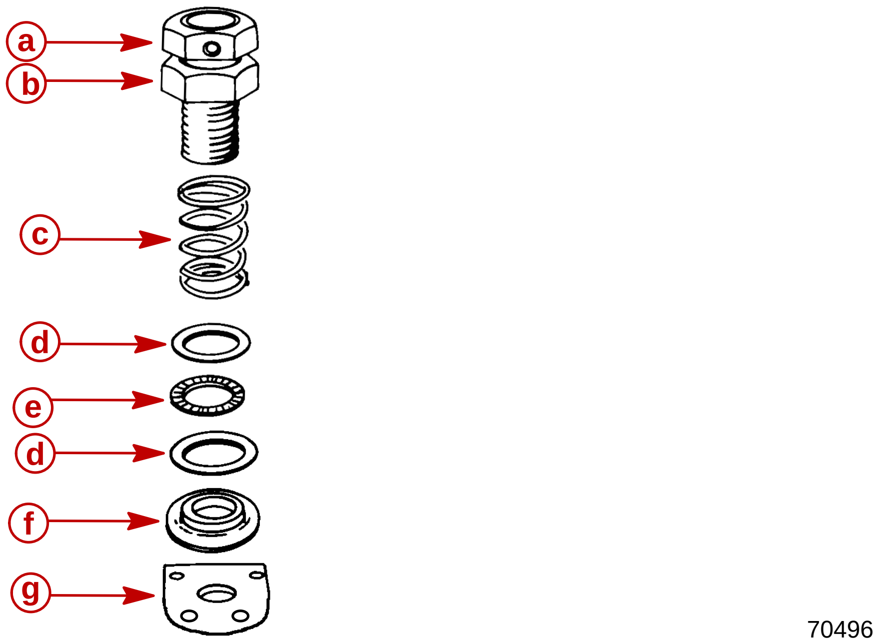
13. Remove retainer wrench.

Gear Location/Backlashes/Checking and Adjustment

Drive Shaft - Bearing Preload Tool

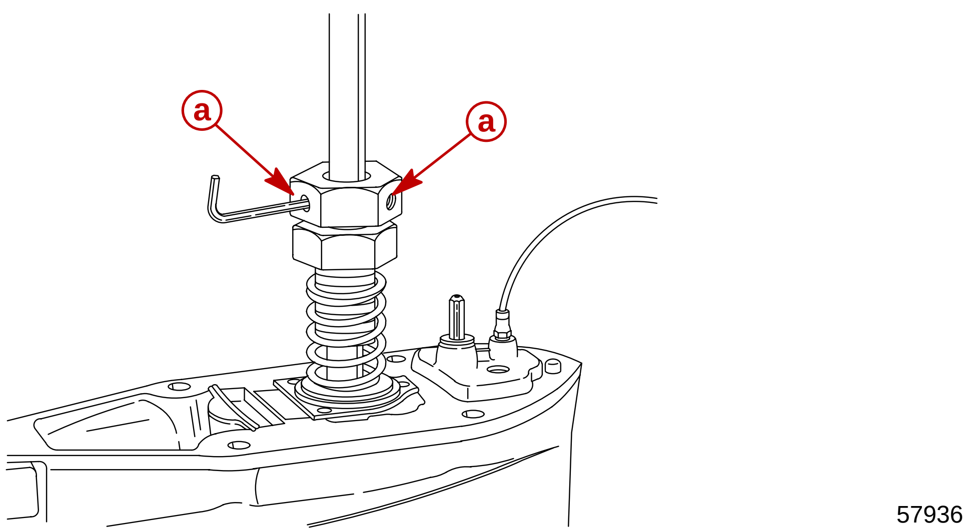
INSTALLATION

1. Install the components from the Bearing Preload Tool Kit (91-14311A1), over the drive shaft in the order shown.



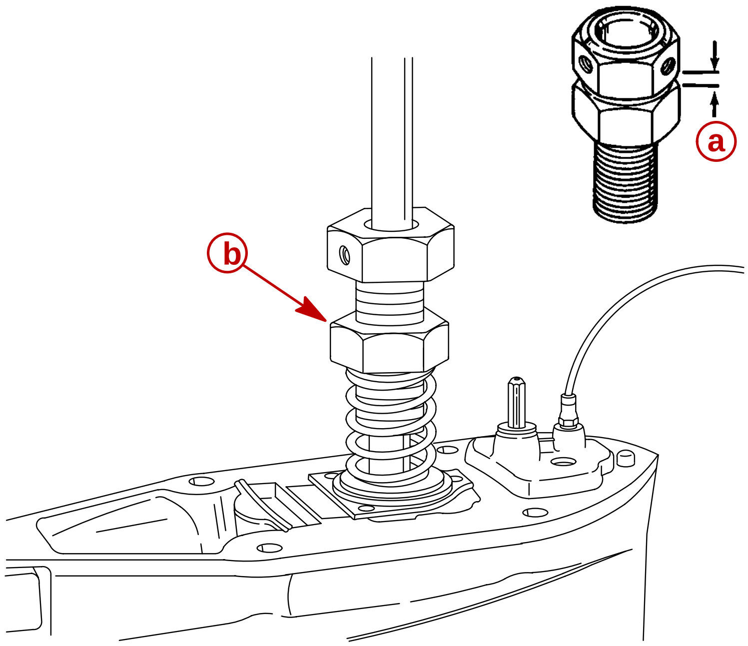
a - Top Nut with Threaded Pipe
b - Nut
c - Spring
d - Thrust Washer (2 Required) (12-18448)
e - Thrust Bearing
f - Thrust Washer
g - Water Pump Face Plate (from your gear housing)

2. Pull up on the drive shaft and tighten the two (2) allen screws in the top nut of the bearing preload tool.



a - Allen Screws

3. Measure distance (a) and increase that distance by 1 in. (25.4mm) by turning bottom nut away from top nut.



a - Distance 1 in. (25.4mm)
b - Bottom nut [screwed down approximately 1 in. (25.4mm)]

Pinion Gear Location

CHECKING AND ADJUSTING

Pinion Depth – 0.025 in. (0.64mm)

NOTE: *If the bearing preload tool has not already been set up, refer to "Drive Shaft - Bearing Preload Tool", 'Installation' section first.*

NOTE: *The prop shaft and reverse gear can be installed when checking pinion height IF Pinion Height Tool 91-56048 is used.*

1. Place the pinion gear shimming tool into the gear housing.

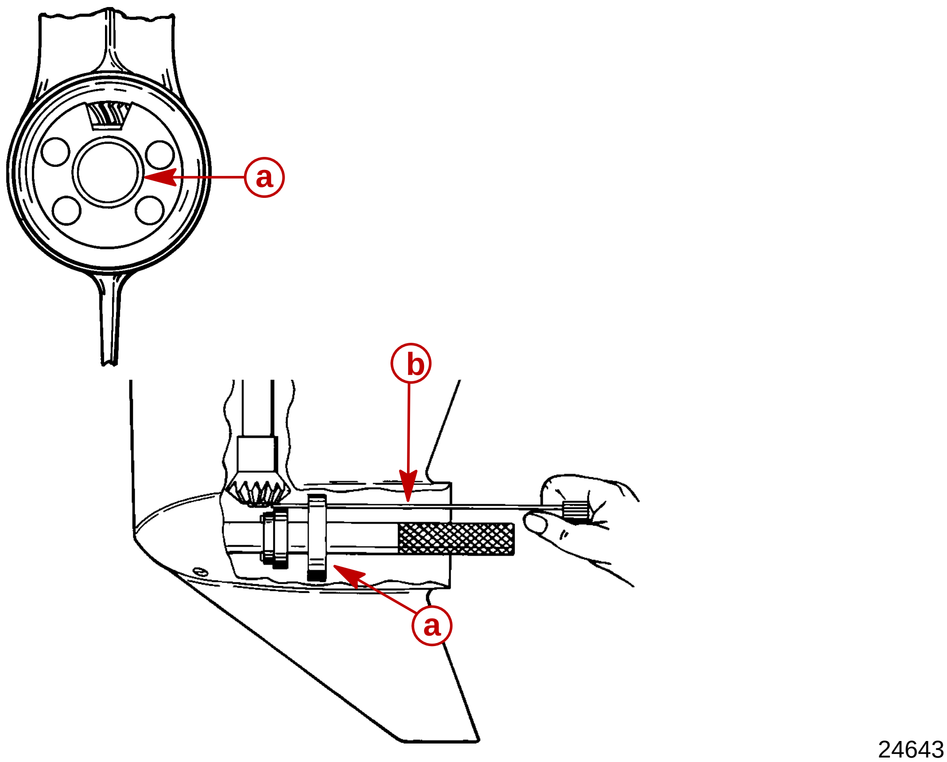
NOTE: *Take the following measurements at 3 locations, rotating the drive shaft 120 degrees between each reading (always rotate the drive shaft in a clockwise direction).*

2. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and high point of the shimming tool.
3. Rotate the drive shaft 120 degrees in a clockwise direction and take another reading.
4. Repeat this process until 3 readings have been taken.
5. Add the three readings together and divide the sum by 3 to get the average pinion gear height. Make note of this average measurement.

The average pinion gear height should be 0.025 in. (0.64mm).

6. **A.** If the (average) pinion gear location does not meet the specification of 0.025 in. (0.64 mm) continue with the instructions on the following section.
   B. If the (average) pinion gear location meets specification, skip the following section and go on to the "Reverse Gear Backlash", 'Checking' section.

7. If the average pinion gear height is not correct, remove the bearing preload tool, the drive shaft retainer and the drive shaft tapered roller bearing cup. (The cup can be removed by wiggling the drive shaft back and forth or by turning gear housing and shaking it.) Add or subtract shims beneath the cup to obtain the proper average pinion gear height. Reinstall the cup and retainer. Retorque retainer to 100 lb. ft. (135 Nm). Reinstall the bearing preload tool and rotate the drive shaft at least 3 full turns in a clockwise direction. Recheck the pinion gear height as in step 5 above. Repeat this process until the average pinion gear height is within specification.



a - Pinion Gear Shimming Tool (91-12349A2) Using Disc #2 and Flat #4
b - 0.025 in. (0.64mm) Feeler Gauge

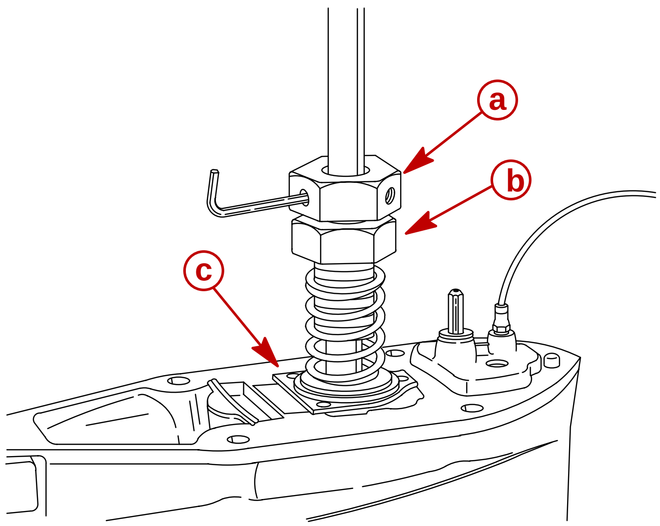
Drive Shaft - Bearing Preload Tool

REMOVAL

CAUTION

Before loosening the top nut allen screws of the bearing preload tool, screw the bottom nut up as close as possible to the top nut.

1. Remove the dial indicator and its supporting tooling.
2. Screw the bottom nut of the bearing preload tool until it is as close as possible to top nut.
3. Loosen the allen screws in the top nut.
4. Remove all components.

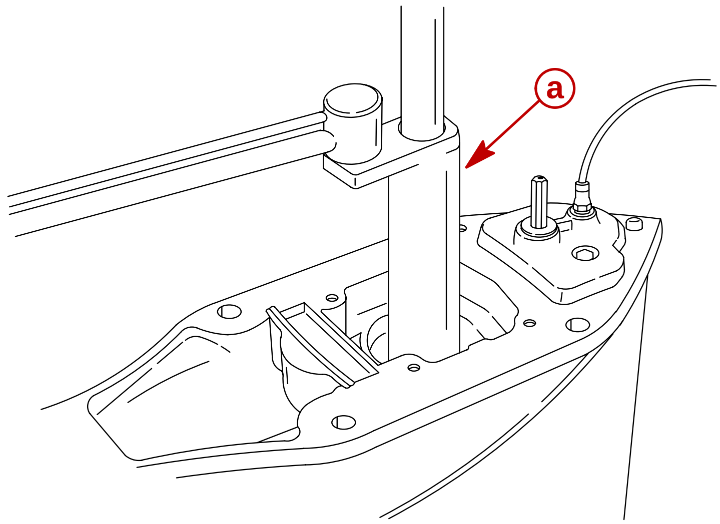


57936

a - Top Nut (with allen screws)
b - Bottom Nut
c - Plate

UPPER DRIVESHAFT BEARING CLEARANCE

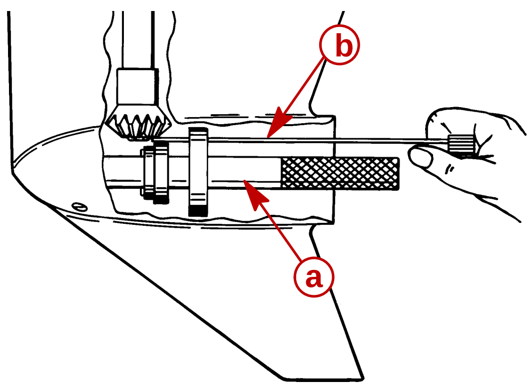
1. When the correct pinion gear height is achieved, remove pinion nut, upper retainer and driveshaft.
2. Apply Quicksilver gear lubricant to O.D. of the driveshaft lower bearing cup and install cup into the gear case.
3. Reinstall driveshaft and pinion gear into gear case.
4. Install the upper drive shaft bearing cup and install and torque the upper bearing retainer to 100 lb. ft. (135 Nm).
5. Torque pinion nut to 70 lb. ft. (95 Nm).



57935

a - Bearing Retainer Tool (91-43506)

6. Push down on drive shaft and check clearance between pinion gear and pinion gear shimming tool shoulder. Clearance should be 0.020 in - 0.024 in. (0.51 mm - 0.61 mm).



a - Pinion Gear Shimming Tool (91-12349A2) Using Disc #2 and Flat #4
b - Feeler Gauge

NOTE: *Do not change shims under upper bearing cup or pinion height will be changed.*

7. Maintain the shims as previously set under the upper drive shaft bearing cup.
8. If clearance is not within specifications, remove the upper bearing cup retainer with tool 91-43506 and remove cup. Leave upper cup shim(s) in place.

NOTE: *A 0.001 in. (25.4 mm) change of shims under the lower bearing cup will result in a 0.001 in. (25.4 mm) change in drive shaft end play.*

9. With new shim(s) under lower bearing cup, reinstall upper bearing cup and torque cup retainer to 100 lb. ft. (135.5 Nm). Recheck drive shaft clearance.

NOTE: *Install a NEW pinion nut with Loctite 271 AFTER all clearances are correct.*

10. If clearance is correct, clean drive shaft threads and apply Loctite 271 and install a new pinion nut. Torque nut to 70 lb. ft. (95 Nm).

Reverse Gear Backlash

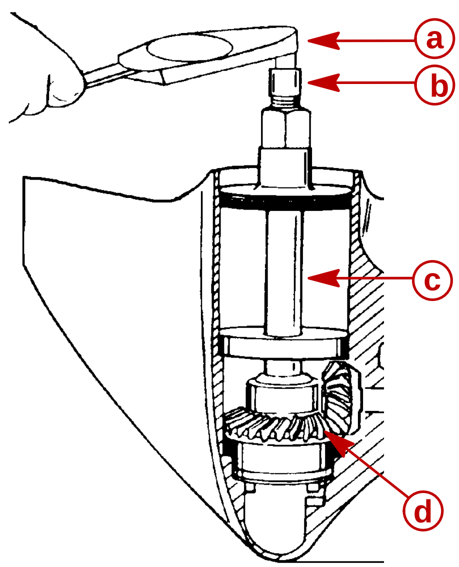
CHECKING

Reverse Gear Backlash Specification: 0.040-0.060 in. (1.01mm-1.5 mm).

NOTE: *If the bearing preload tool has not already been set up see "Drive Shaft - Bearing Preload Tool", 'Installation' section first.*

NOTE: *The reverse gear bearing adaptor installation tool is used to apply a light preload to the reverse gear in the following steps.*

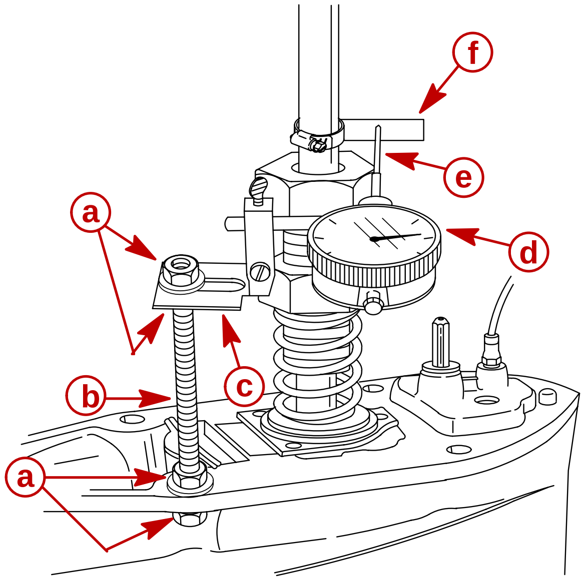
1. Install the reverse gear bearing adaptor installation tool into the gear housing to hold the reverse gear against the thrust bearing as follows:
   a. Assemble the reverse gear bearing adaptor installation tool into the gear housing and tighten it by hand until a slight resistance is felt.
   b. Torque the adaptor's driver bolt to 45 lb. in. (5 Nm).



70973

a - Torque Wrench (91-66274)
b - Driver Bolt
c - Bearing Adaptor Installation Tool (91-18605A1)
d - Reverse Gear

2. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the “I” mark on the dial indicator tool. Tighten the indicator tool onto the drive shaft and rotate the drive shaft so that the needle in the dial makes at least one full revolution and comes to “0” on the dial indicator scale.



57939

- **a** - Nuts (4) (Obtain Locally)
- **b** - Threaded Rod [3/8 in. (9.5mm) obtain locally]
- **c** - Dial Indicator Holding Tool (91-83155)
- **d** - Dial Indicator (91-58222A1)
- **e** - Indicator Pointer
- **f** - Backlash Indicator Rod (91-53459) (for 1.75:1 ratio)
  Backlash Indicator Rod (91-78473) (for 1.87:1 ratio)

3. Take the backlash readings by lightly turning the drive shaft back and forth, so as to feel the backlash between the gears, (no movement should be noticed at the propeller shaft).
   a. Observe the dial indicator and record the reading.
   b. Loosen the indicator tool and rotate the drive shaft 90 degrees in a clockwise direction.
   c. Repeat step 2 above and take and record another reading. Repeat step 3 until a total of 4 backlash readings have been taken.
4. Add the four readings together and divide the sum by four. This is your average backlash and it should be 0.040 in. - 0.060 in. (1.0 mm - 1.5 mm) (for 1.75:1 and 1.87:1 ratios).

***NOTE:** If backlash needs to be adjusted, (see Checking Reverse Gear Backlash), adding 0.001 in. (0.03 mm) shims will **reduce** the gear backlash by approximately 0.001 in. (0.03mm). Subtracting 0.001 in. (0.03mm) shims will **increase** backlash by approximately the same amount.*

Example 1 (if backlash is too high)

Backlash checks:	.070 in.	(1.79 mm)
(subtract) middle of specification:	.050 in.	(1.27 mm)
You get:	.020 in.	(0.50 mm)

add this quantity of shims

Example 2 (if backlash is too low)

middle of specification:	.050 in.	(1.27 mm)
Backlash checks:	.020 in.	(0.50 mm)
(subtract) You get:	.030 in.	(0.76 mm)

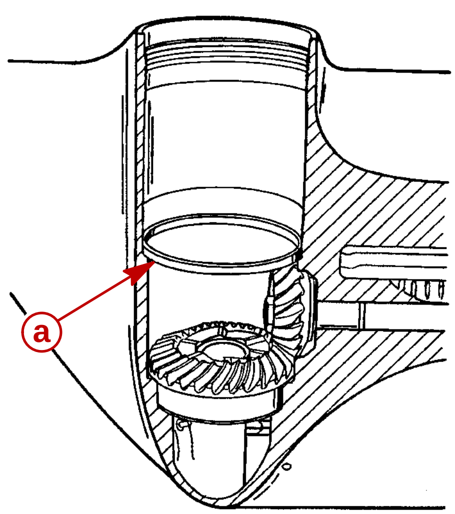
subtract this quantity of shims

5. Loosen the backlash indicator tool and remove the propeller nut, washer and pinion nut adaptor. Remove the dial indicator and all its mounting components. **Do not remove the bearing preload tool. The following instructions give specific instructions for its removal.**

Forward Gear/Bearing Carrier Assembly

CHECKING FORWARD GEAR BACKLASH

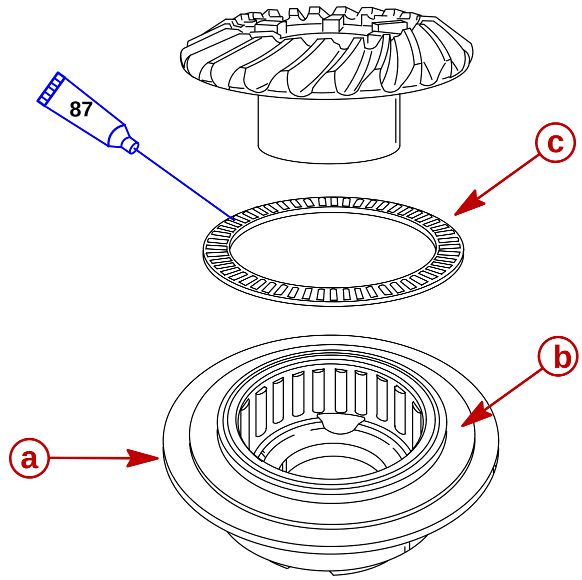
1. Install the appropriate spacer shim into the gear housing.



55428

a - Shim

2. Apply Quicksilver Gear Lubricant to thrust bearing and install thrust bearing and thrust race onto forward gear bearing adaptor.

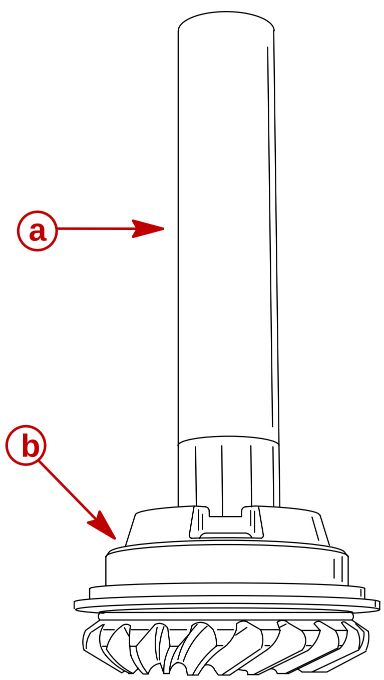


87 Quicksilver Gear Lubricant (92-19007A24)

55220

a - Bearing Adaptor
b - Thrust Washer
c - Thrust Bearing

3. Insert Forward Gear Installation Tool (91-815850) into forward gear/bearing adaptor assembly.

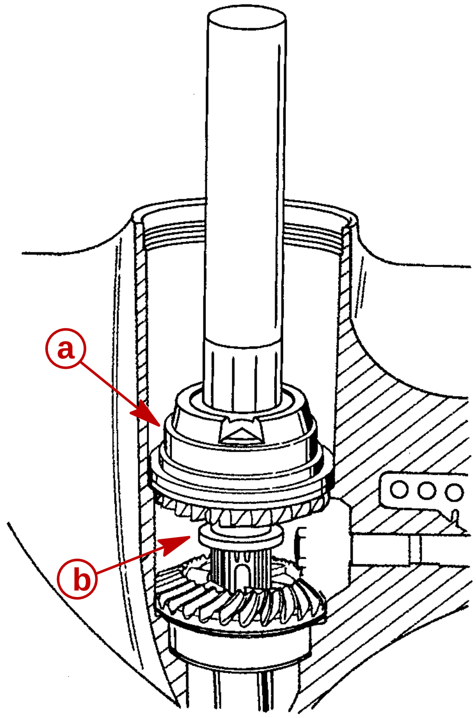


55221

a - Forward Gear Installation Tool (91-815850)
b - Forward Gear/Bearing Adaptor Assembly

NOTE: *Verify load washer is installed on propeller shaft prior to installing forward gear assembly*

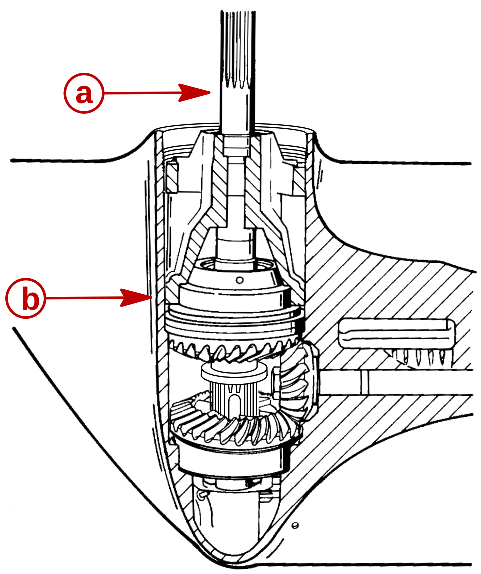
4. Install tool with adaptor assembly over propeller shaft and into gear housing. Applying downward pressure to bearing adaptor, remove installation tool from assembly.



55431

a - Forward Gear Bearing Adaptor
b - Load Washer

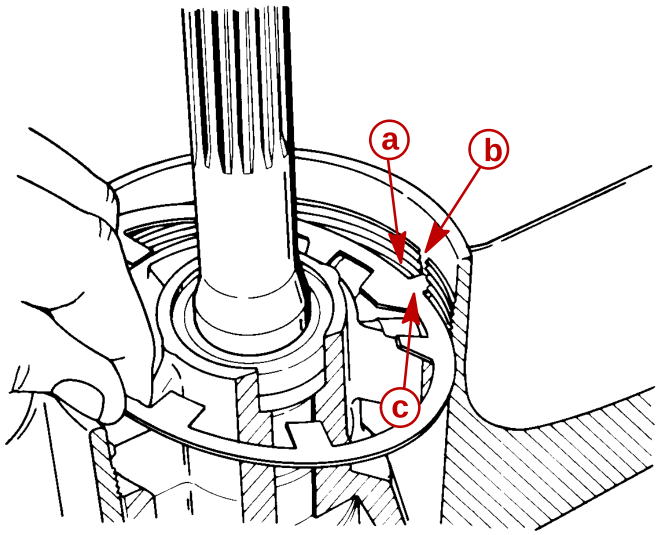
5. Install the bearing carrier over the propeller shaft pushing bearing carrier down until it is fully seated.



55429

a - Propeller Shaft
b - Bearing Carrier

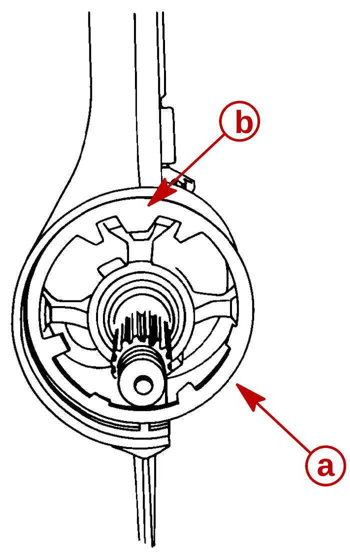
6. Align the bearing carrier “V” shaped notch with the alignment hole in the gear housing. Install the tab washer with the external tab inserted into the hole in the gear housing.



50779

a - Gear Housing Tab Washer Alignment Hole (not seen)
b - “V” Shaped Notch in Bearing Carrier
c - Alignment Tab of Tab Washer

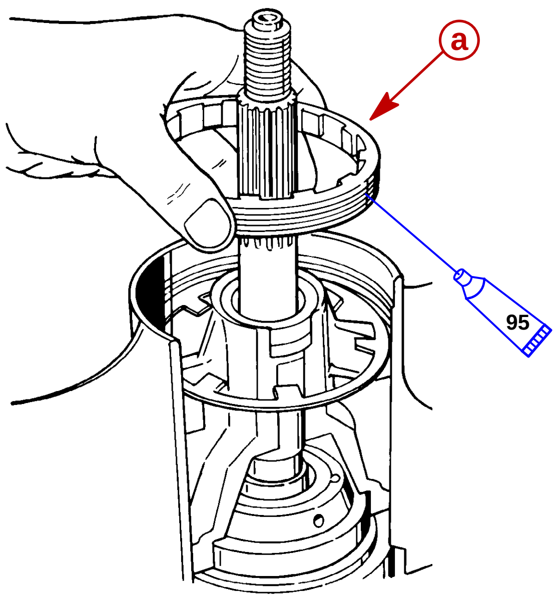
7. Insure that the “V” shaped tab aligns with the “V” notch in bearing carrier.



70714

a - Tab Washer
b - “V” Tab

8. Lubricate the bearing carrier retainer threads with 2-4-C w/Teflon (92-825407A12). Start the retainer into the gear housing threads and screw it down fully by hand.

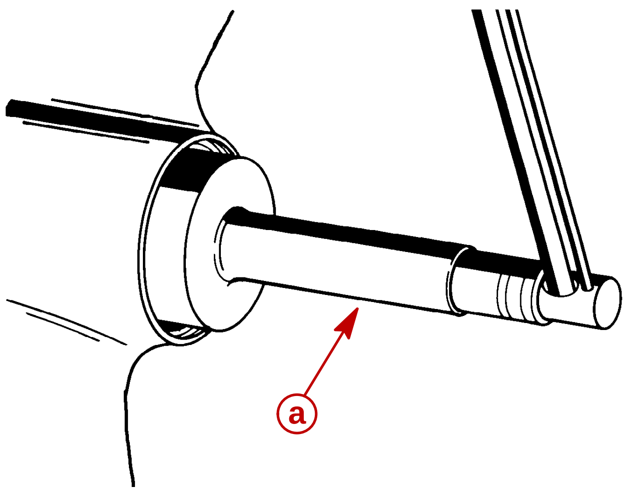


95 2-4-C With Teflon (92-825407A12)

50881

a - Bearing Carrier Retainer

9. Torque the bearing carrier retainer to 210 lb. ft. (285 Nm) to seat forward gear assembly in gear case.

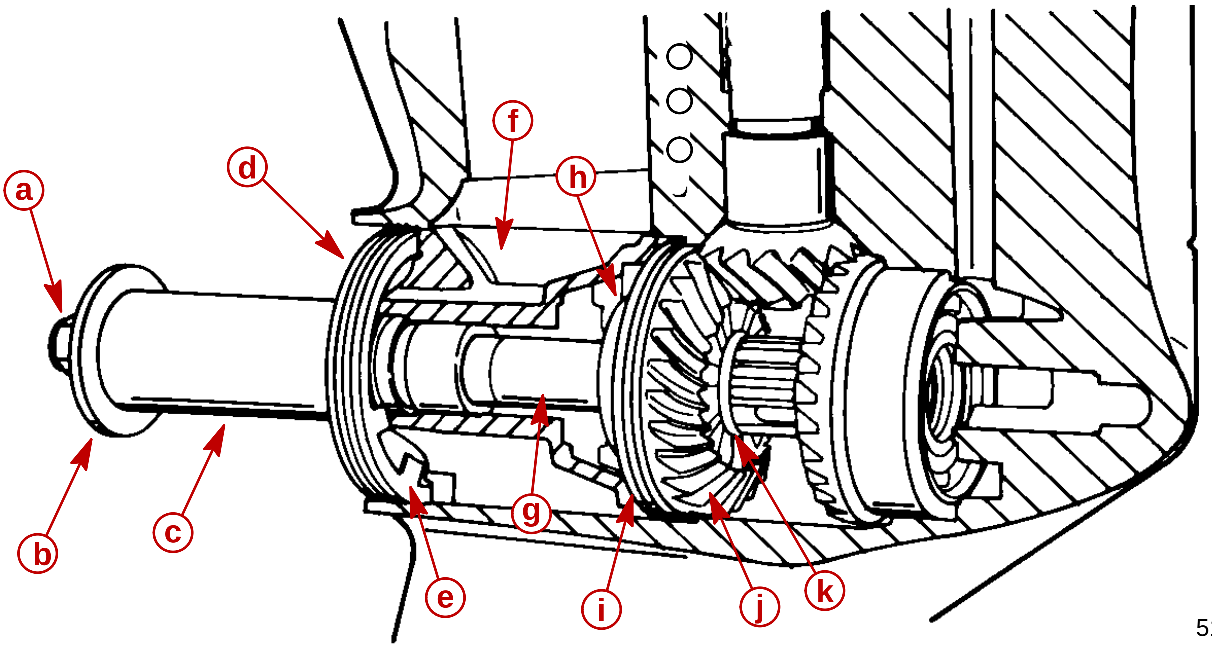


23355

a - Bearing Carrier Retainer Wrench (91-61069)

NOTE: *Drill a 3/8″ (22.2mm) diameter hole through the side (PROPELLER NUT END) of a 5″ x 2″ (127mm x 50.8mm) long piece of PVC pipe. A screwdriver may be inserted thru pipe into propeller shaft splines to prevent PVC pipe from turning while tightening retaining nut.*

10. Install a 5″ x 2″ (127mm x 50.8mm) long piece of PVC pipe (obtain locally) over propeller shaft and secure it against the bearing carrier with a flat washer and nut.



a - Prop Nut
b - Flat Washer
c - PVC Pipe [5″ x 2″ (127mm x 50.8mm)]
d - Retainer
e - Tab Washer
f - Bearing Carrier
g - Prop Shaft
h - Bearing Adaptor
i - Shim
j - Forward Gear
k - Load Washer

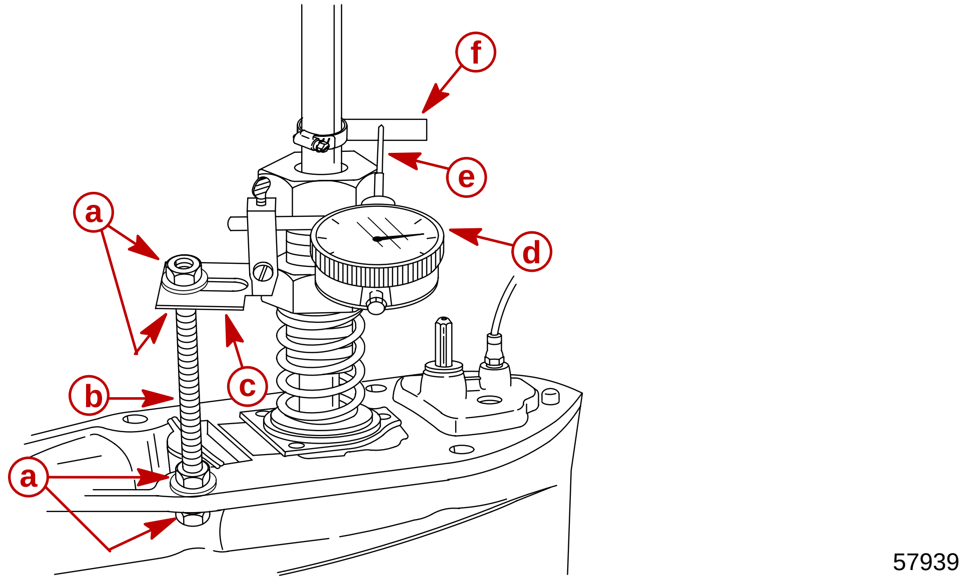
11. Tighten nut to 45 lb. in. (5 Nm). This will seat the forward gear against the forward thrust bearing and tends to hold the propeller shaft from moving when measuring backlash.

Forward Gear Backlash

CHECKING

NOTE: *If the bearing preload tool has not already been set up, see "Drive Shaft - Bearing Preload Tool", 'Installation' section first.*

1. Install a dial indicator as shown in the following figure.



a - Nuts (4) (Obtain Locally)
b - Threaded Rod [3/8 in. (9.5mm) obtain locally]
c - Dial Indicator Holding Tool (91-83155)
d - Dial Indicator (91-58222A1)
e - Indicator Pointer
f - Backlash Indicator Rod (91-53459) (for 1.75:1)
Backlash Indicator Rod (91-78473) (for 1.87:1 ratio)

2. Align the dial indicator pointer so that it is perpendicular to and touching the "I" mark on the dial indicator tool. Tighten the indicator tool onto the drive shaft and rotate the drive shaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.
3. Take the backlash readings by lightly turning the drive shaft back and forth.
   a. Observe the dial indicator and record the reading.
   b. Loosen the indicator tool and rotate the drive shaft 90 degrees in a clockwise direction.
   c. Repeat step 4 above and take and record another reading. Repeat step 4 until a total of 4 backlash readings have been taken.
4. Add the four readings together and divide the sum by 4. This is your average backlash, which should be 0.017 in. - 0.028 in. (0.431mm - 0.711mm) (for 1.75:1 and 1.87:1 ratios).
5. If backlash is MORE than the specified MAXIMUM, REMOVE shim(s) from in front of forward gear bearing race to obtain correct backlash. When reinstalling pinion nut, apply Loctite 271 to threads of nut.
6. If backlash is LESS than the specified MINIMUM, add shim(s) in front of forward gear bearing race to obtain correct backlash. When reinstalling pinion nut, apply Loctite 271 to threads of nut.

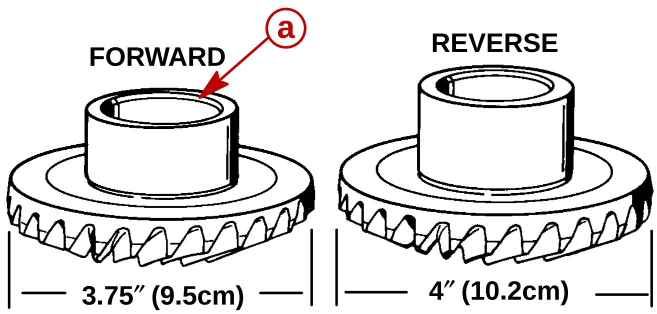
***NOTE:** By adding or subtracting 0.001 in. (0.03mm) shim, the backlash will change approximately 0.001 in. (0.03mm).*

7. Remove the propeller nut, washer, and the pinion nut adaptor.
   a. **If the Backlash is to Specification,** skip the next step (7b), and go on to step 8 following.
   b. **If the Backlash is not to Specification,** complete the following instructions to install a different size spacer shim under the forward gear thrust race.
      (1.) Remove the bearing carrier retainer, tab washer, and the bearing carrier.
      (2.) Using the hook tool, remove the forward gear bearing adaptor.
      (3.) Insert the forward gear installation tool into the forward gear and remove the forward gear, thrust bearing and thrust race.
      (4.) Remove the spacer shim.
      (5.) Complete the instruction found in section “Forward Gear/Bearing Carrier Assembly”, ‘Installation - (For Checking Forward Gear Backlash)’ section.
      (6.) Recheck backlash as outlined in the “Forward Gear Backlash”, ‘Checking’ section.
8. Remove the following items as outlined below:
   a. Remove the bearing carrier retainer, tab washer, and the bearing carrier.
   b. Using the hook tool remove the forward gear bearing adaptor.
   c. Insert the forward gear installation tool into the forward gear and remove the forward gear, thrust bearing and thrust race.
   d. Remove the propeller shaft.
   e. Remove the spacer shim.
   f. “Drive Shaft - Bearing Preload Tool”, ‘Removal’ section.
   g. “Drive Shaft Assembly”, ‘Removal’ section.
   h. Remove the reverse gear.

Propeller Shaft Assembly

Component Reassembly

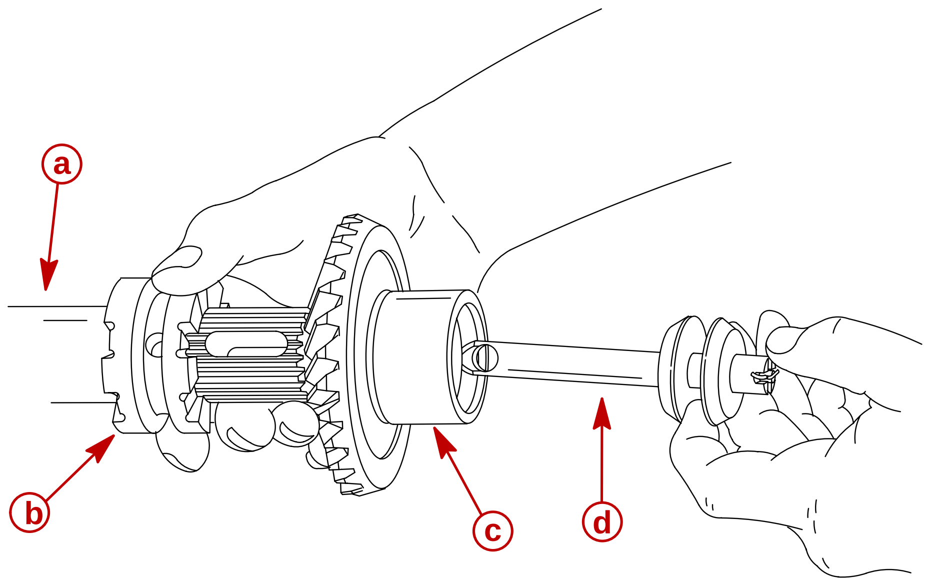
IMPORTANT: The appearance of the forward and reverse gear is almost identical. The forward gear has a shorter hub and is slightly smaller in diameter.



50885

a - Shorter Hub

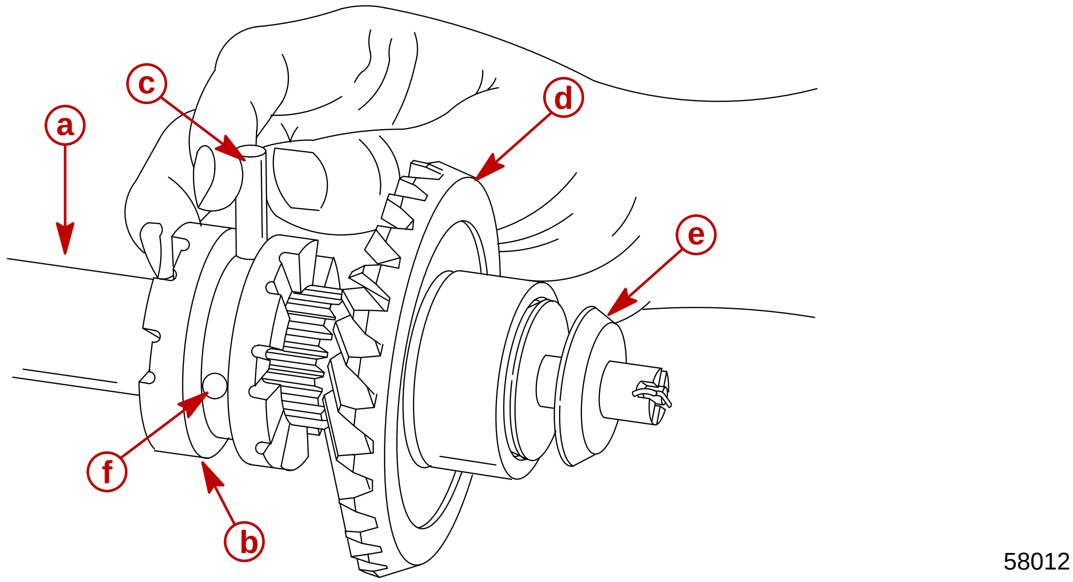
1. Assemble the sliding clutch on the propeller shaft, being sure to align cross pin holes in the clutch with the slot in the propeller shaft. Make sure that the sliding clutch is placed on the propeller shaft with the grooved end of the clutch facing the propeller end of the shaft.
2. Assemble the reverse gear onto the propeller shaft.
3. Assemble the shift spool assembly to the propeller shaft being sure to align the cross pin hole of the shift spool shaft with the clutch slot.



58018

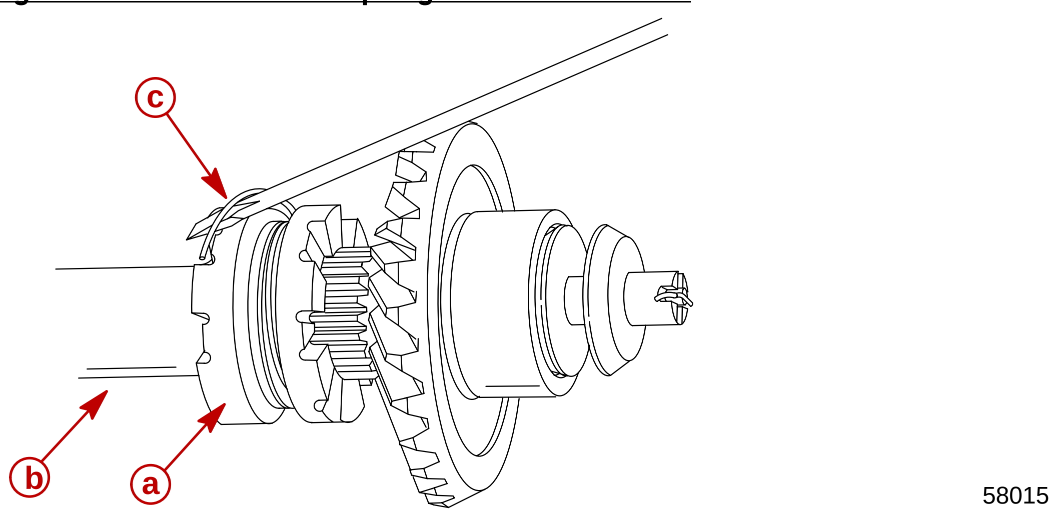
a - Propeller Shaft
b - Sliding Clutch
c - Reverse Gear
d - Shift Spool Assembly

4. Assemble the cross pin through the sliding clutch, through the propeller shaft and through the shift spool shaft hole.
5. Install detent pin in third hole in clutch.



a - Propeller Shaft
b - Sliding Clutch
c - Cross Pin
d - Reverse Gear
e - Shift Spool Assembly
f - Detent Pin

6. Assemble the cross pin retaining spring over the propeller shaft and wind it around the clutch over the cross pin hole. Be careful not to distort the spring while assembling it. **Make sure that the spring is wound on so that it does not cross over on itself and that it lies flat against the clutch once it is assembled. If it does not lie flat against the clutch a new spring must be installed.**

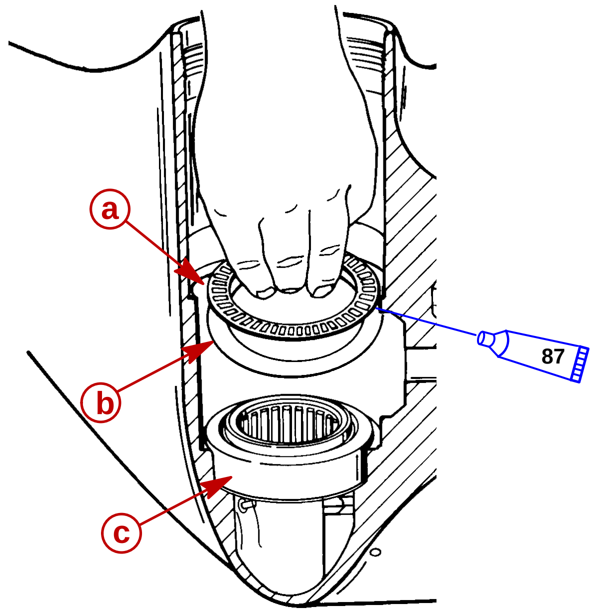


a - Sliding Clutch
b - Propeller Shaft
c - Cross Pin Retaining Spring

Propeller Shaft Assembly

Installation

1. Lubricate the large thrust bearing with Quicksilver Gear Lubricant (92-13783A24) and position first the thrust race then the bearing into the gear housing onto the reverse gear bearing adaptor.

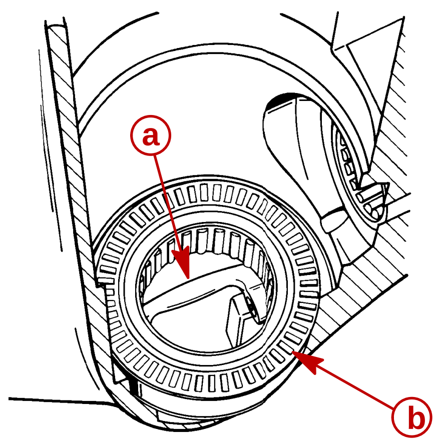


87 Quicksilver Gear Lubricant (92-19007A24)

50882

a - Thrust Bearing
b - Thrust Race
c - Reverse Gear Bearing Adaptor

2. Rotate the shift crank toward the aft end of the gear housing until it touches against the bearing adaptor and hold it in this position.

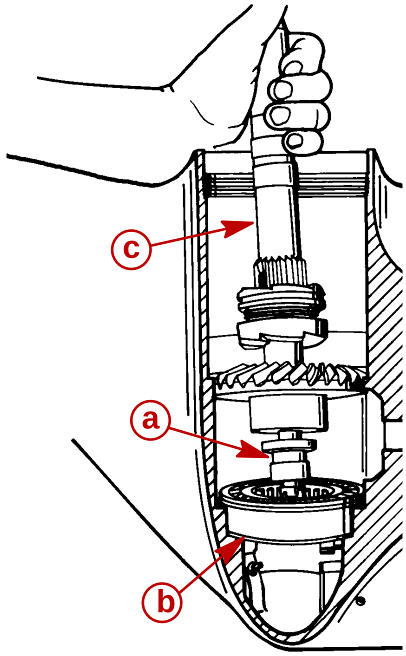


50885

a - Shift Crank
b - Bearing Adaptor

IMPORTANT: Be careful when inserting the propeller shaft assembly into the gear housing as the needle bearings in the reverse gear bearing adaptor can become dislodged. If it is suspected that a needle has become dislodged, remove the propeller shaft assembly and inspect the needle bearing cages for damage. If the cages have not been damaged and a needle bearing is mispositioned, it can be snapped back into place.

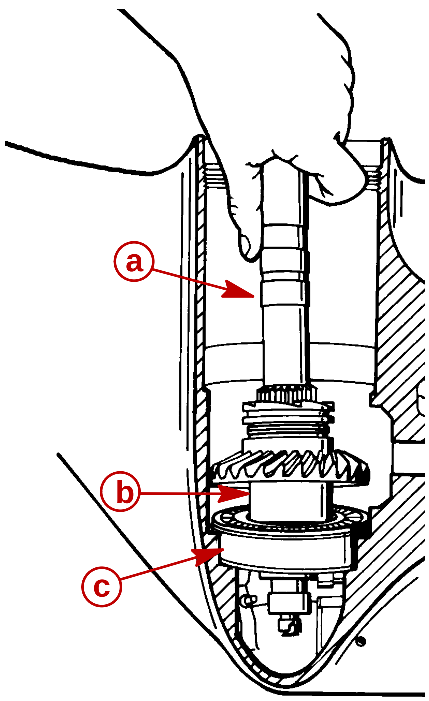
3. To allow for the engagement of the shift spool with the shift crank, tilt the propeller end of the propeller shaft assembly to the left (port) side of gear housing and begin to lower it into the gear housing.



50888

a - Shift Actuating Spool
b - Shift Crank
c - Propeller Shaft Assembly

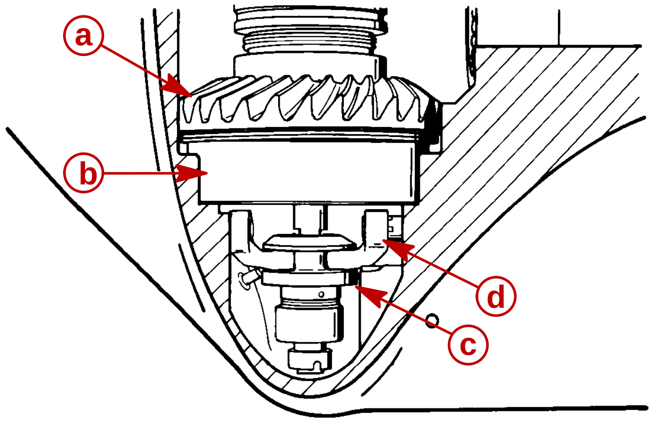
4. With the propeller shaft assembly tilted to the port side of the gear housing, continue to lower the assembly until the reverse gear hub comes into contact with the reverse gear bearing adaptor and the propeller shaft is fully inserted into the reverse gear.



50888

a - Propeller Shaft
b - Reverse Gear Hub
c - Bearing Adaptor

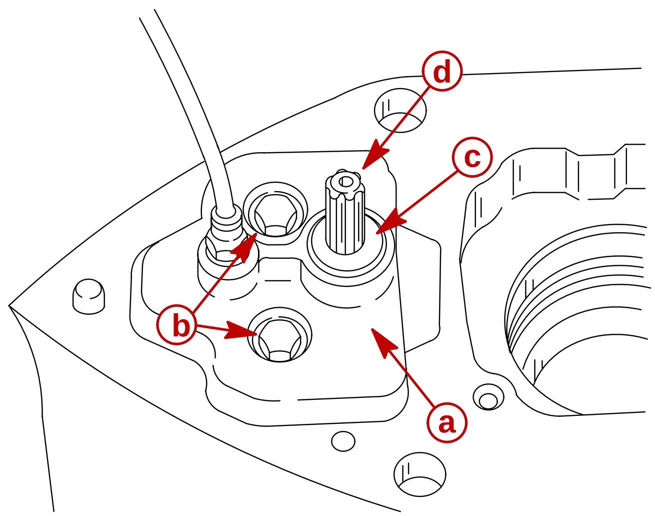
5. Slowly move the propeller shaft to the center of the housing and lower the reverse gear into the bearing adaptor. The shift spool should engage with the shift crank as the propeller shaft centers itself.



50885

a - Reverse Gear
b - Bearing Adaptor
c - Shift Spool
d - Shift Crank

6. Operate the shift shaft to ensure that it has been properly installed. The sliding clutch should move forward when the shift shaft is turned clockwise, and should move aft when the shift shaft is turned counterclockwise.
7. Make sure that the O-rings are present and positioned correctly. Install the screws that secure the shift shaft bushing and torque them to 60 lb. in. (7 Nm).
8. Slide the rubber sleeve at top end of shift shaft down so that it just touches the oil seal in the bushing.



57933

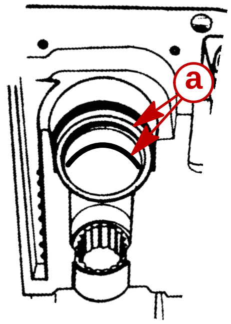
a - Screws [Torque to 60 lb. in. (7 Nm)]
b - Shift Shaft Bushing
c - Rubber Sleeve
d - Shift Shaft

Drive Shaft and Pinion Gear

Final Installation

NOTE: *Verify upper and lower driveshaft bearing shims are installed*

1. Place the shim(s) into the drive shaft housing bore at the location shown.



70620

a - Shims

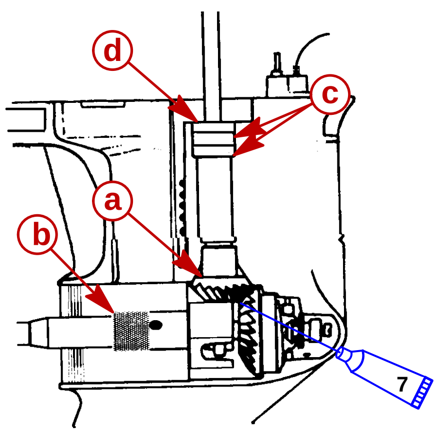
2. Install lower tapered bearing cup.

NOTE: *For ease of installation, glue the washer to the pinion gear, using 3M Adhesive (92-25234), or Quicksilver Bellows Adhesive (92-86166), or equivalent.*

3. Apply Loctite Type 271 (92-809820) to the threads of the **NEW** pinion gear **NUT** and assemble the pinion gear nut into the MR slot of the pinion nut adaptor.

NOTE: *Install the pinion gear nut with the flat side of the nut away from the pinion gear.*

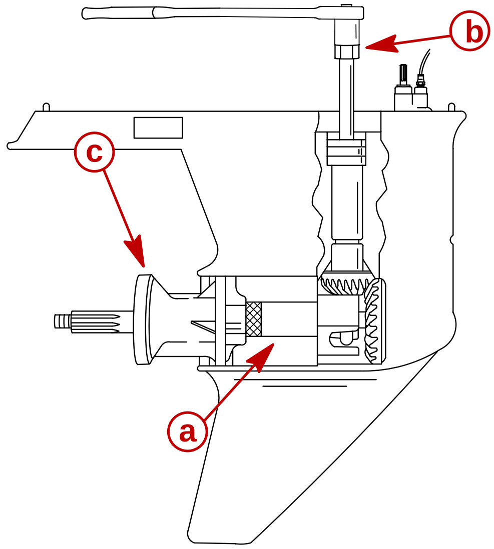
4. Place the pinion gear (with the washer glued to it) into the gear housing.
5. Insert the drive shaft into the gear housing drive shaft bore. It may be necessary to rotate the drive shaft to engage the drive shaft splines into the pinion gear splines.
6. Install upper tapered bearing cup and the retainer
7. Insert the pinion nut adaptor (with the nut assembled to it) into the gear housing. It may be necessary to raise the drive shaft slightly to clear the tool.
8. Start the pinion nut onto the drive shaft threads by rotating the drive shaft until the nut is snug.



7 Loctite 271 (92-809820)

a - Pinion Gear (with the washer glued to it)
b - Pinion Nut Adaptor (91-61067A3)
c - Tapered Roller Bearing Cups
d - Retainer

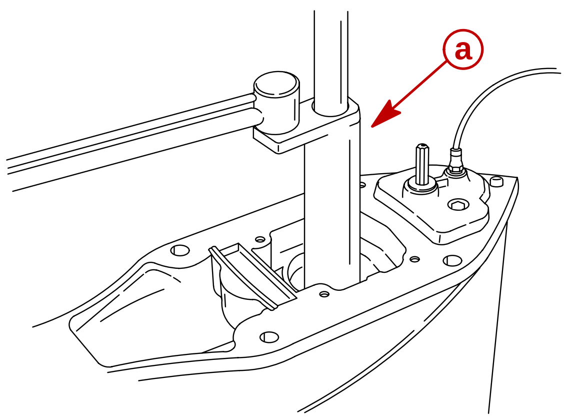
9. Install the bearing carrier into the gear housing backwards to hold the propeller shaft and the pinion nut adaptor in position.
10. Torque the pinion nut by turning the drive shaft using the drive shaft nut wrench and torque wrench with the appropriate socket to 70 lb. ft. (95 Nm).



57950

a - Pinion Nut Adaptor (91-61067A2)
b - Drive Shaft Nut Wrench (91-56775)
c - Bearing Carrier (installed backwards)

11. Remove the bearing carrier, pinion nut adaptor and drive shaft nut wrench.
12. Torque the retainer to 100 lb. ft. (135 Nm).



57935

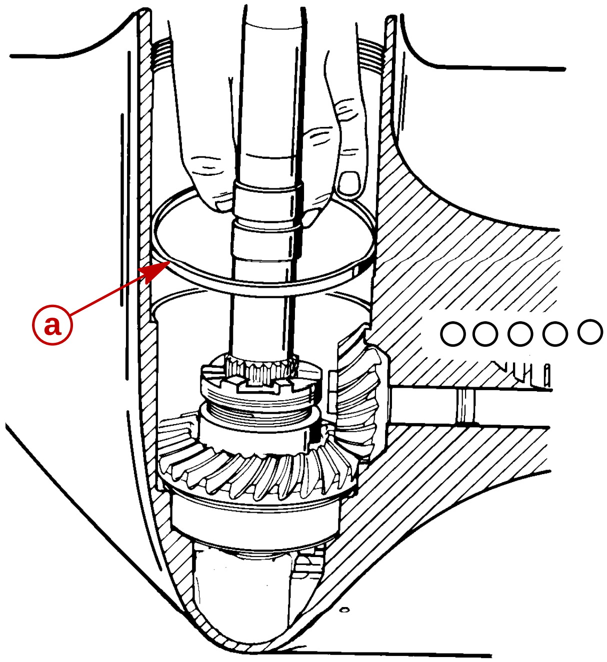
a - Drive Shaft Bearing Retainer Wrench (91-43506)

13. Remove the retainer wrench.

Bearing Carrier Assembly

Final Installation

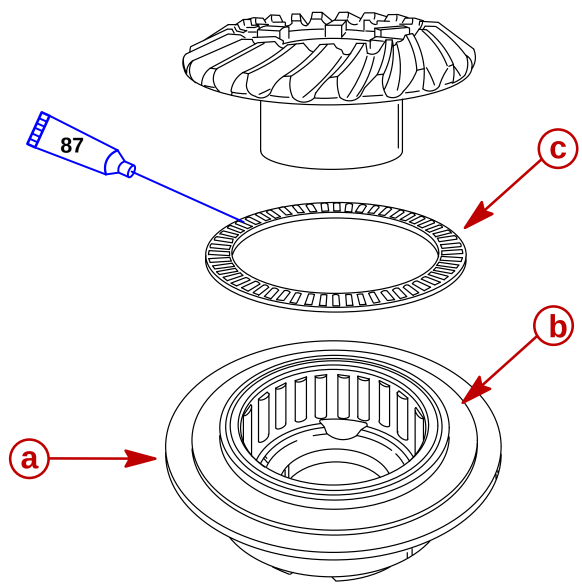
1. Install appropriate spacer shim into the gear housing.



50782

a - Shim

2. Apply Quicksilver Gear Lubricant to thrust bearing and install thrust bearing and thrust race onto forward gear bearing adaptor.

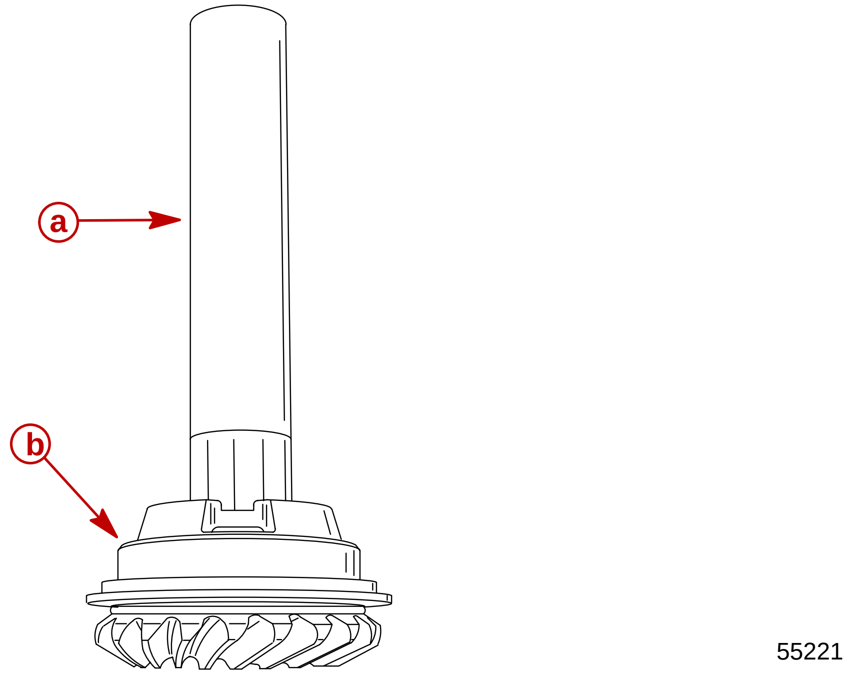


87 Quicksilver Gear Lubricant (92-19007A24)

55220

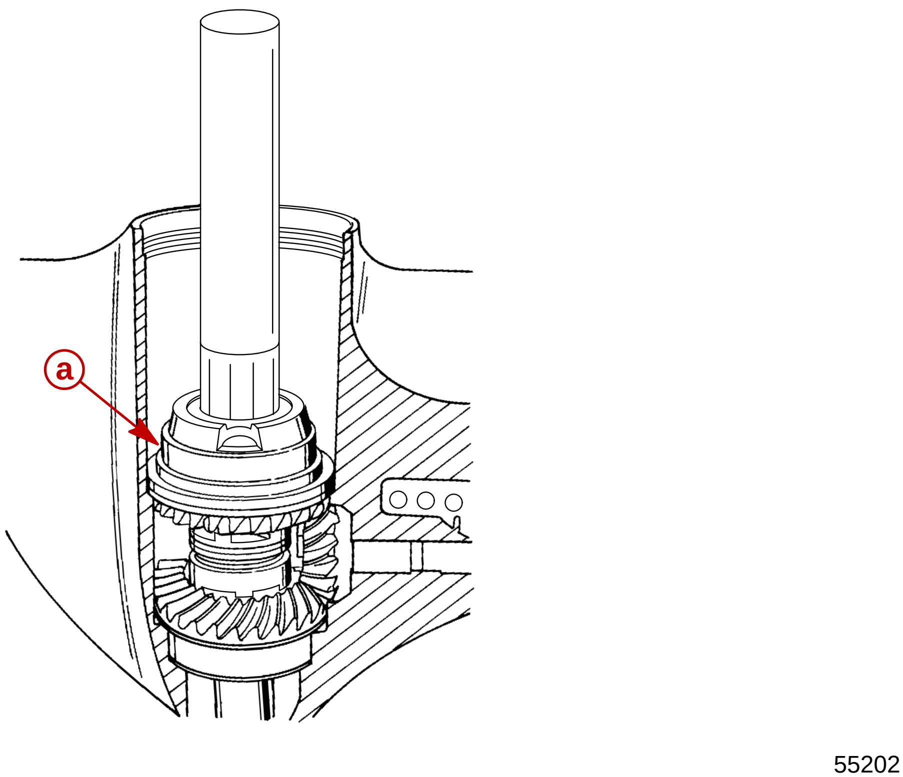
a - Bearing Adaptor
b - Thrust Washer
c - Thrust Bearing

3. Insert Forward Gear Installation Tool (91-815850) into forward gear/bearing adaptor assembly.



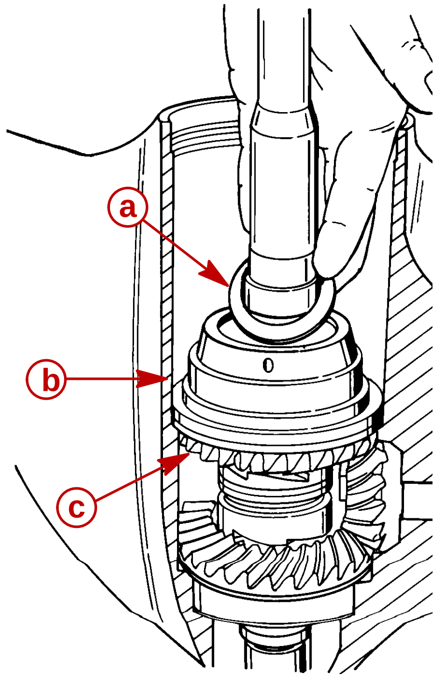
a - Forward Gear Installation Tool (91-815850)
b - Forward Gear/Bearing Adaptor Assembly

4. Install tool with adaptor assembly over propeller shaft and into gear housing. Applying downward pressure to bearing adaptor, remove installation tool from assembly.



a - Forward Gear Bearing Adaptor

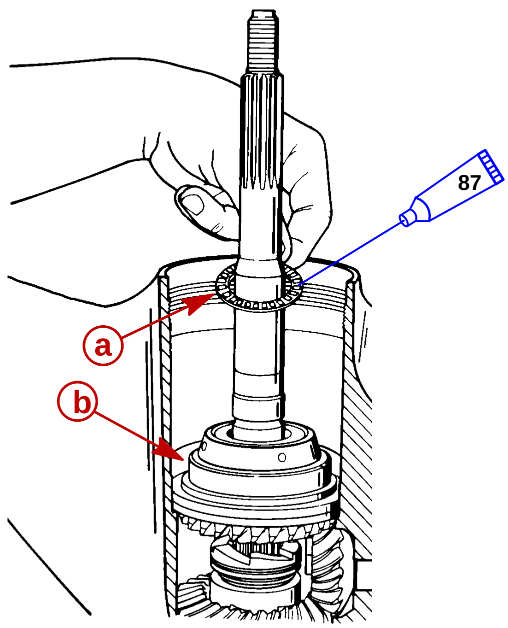
5. Ensure that the top of the bearing adaptor is clean and install the small thrust race on top of the bearing adaptor.

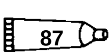


50880

a - Thrust Race
b - Forward Gear Bearing Adaptor
c - Forward Gear

6. Lubricate the small thrust bearing with Quicksilver Gear Lubricant (92-13783A24) and install it on top of the thrust race.



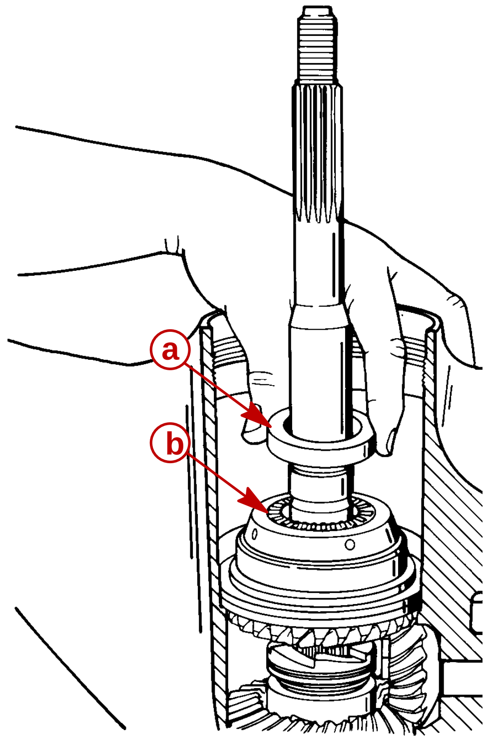


Quicksilver Gear Lubricant (92-19007A24)

50783

a - Small Thrust Bearing
b - Forward Gear Bearing Adaptor

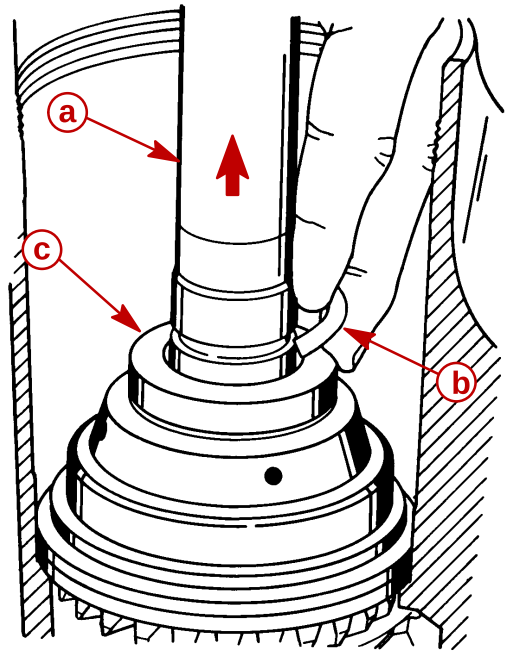
7. Assemble the thrust collar with its STEPPED SIDE DOWN toward the small thrust bearing.



50784

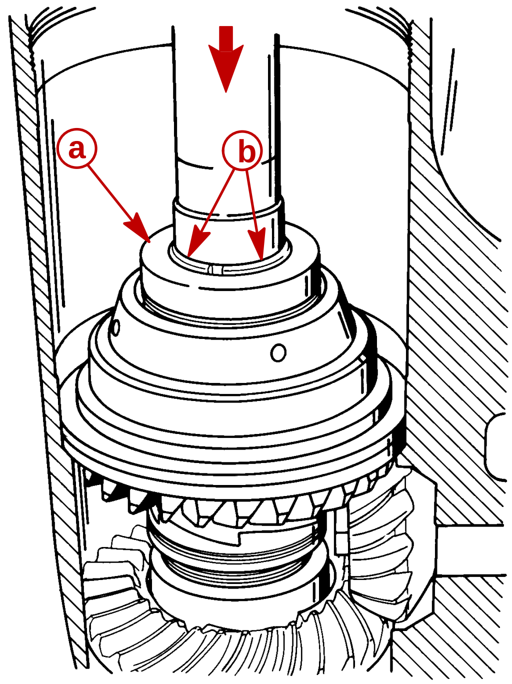
a - Thrust Collar
b - Small Thrust Bearing

8. Pull up slightly on the propeller shaft to gain access to the groove on the shaft for the keepers. Assemble the two keepers into the groove and lower the propeller shaft.



50826

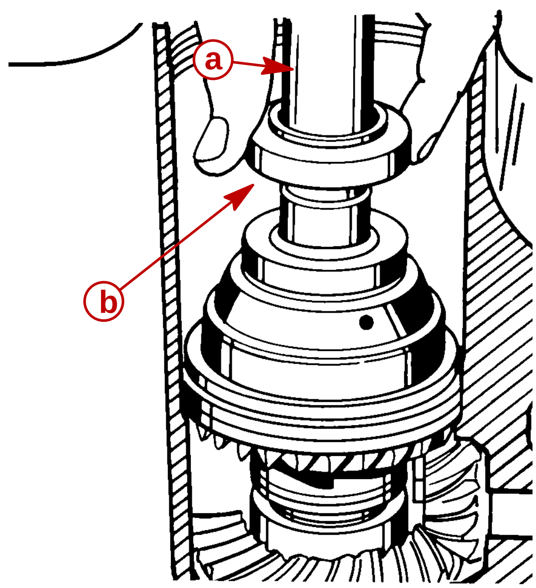
a - Propeller Shaft (slightly lifted)
b - Keepers (2)
c - Thrust Collar



50778

a - Thrust Collar
b - Keepers

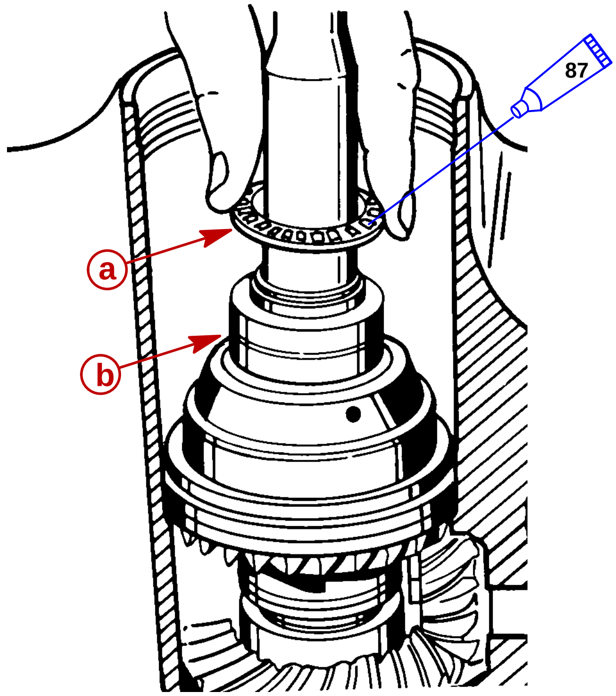
9. Install the second thrust collar with its STEPPED SIDE UP.



50787

a - Propeller Shaft
b - Thrust Collar

10. Lubricate the second thrust bearing with Quicksilver Gear Lubricant (92-13783A24) and install it to the top of the thrust collar.

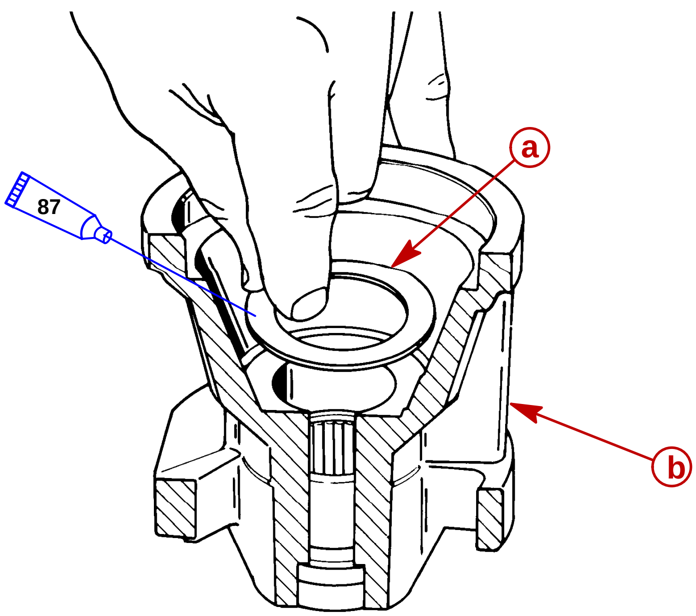


87 Quicksilver Gear Lubricant (92-19007A24)

50786

a - Thrust Bearing
b - Thrust Collar

11. Lubricate the second small thrust bearing race with Quicksilver Gear Lubricant (92-13783A24). Assemble it to the surface inside of the bearing carrier as shown.

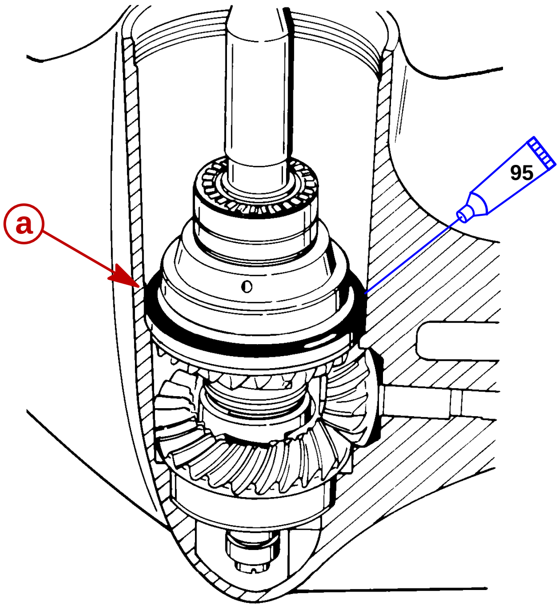


87 Quicksilver Gear Lubricant (92-19007A24)

50779

a - Thrust Race
b - Bearing Carrier

12. Lubricate the large O-ring with 2-4-C w/Teflon (92-825407A12) and assemble into the gear housing as shown following.

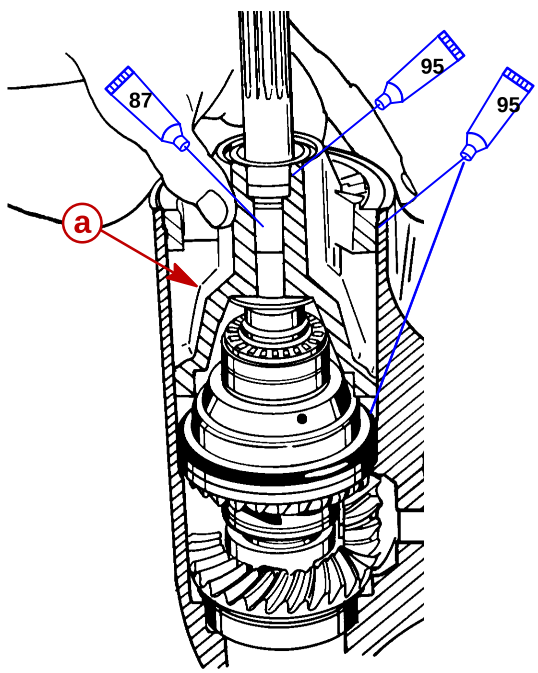


95 2-4-C With Teflon (92-825407A12)

50886

a - O-ring

13. Prepare the bearing carrier for installation as follows:
    a. Lubricate the outer diameter of the bearing carrier with 2-4-C w/Teflon (92-825407A12).
    b. Fill the space between the carrier oil seals with 2-4-C w/Teflon.
    c. Lubricate the needle bearing with Quicksilver Gear Lubricant (92-13783A24).
14. Install the bearing carrier assembly into the gear housing.



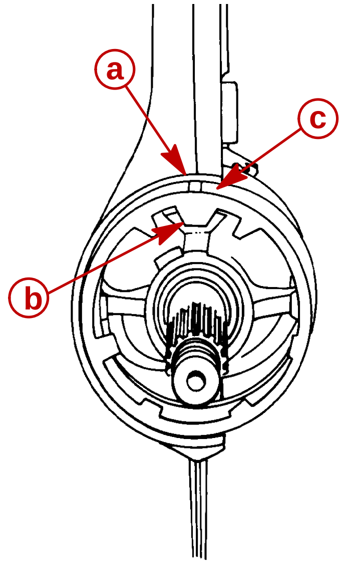
87 Quicksilver Gear Lubricant (92-19007A24)

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

50826

a - Bearing Carrier Assembly

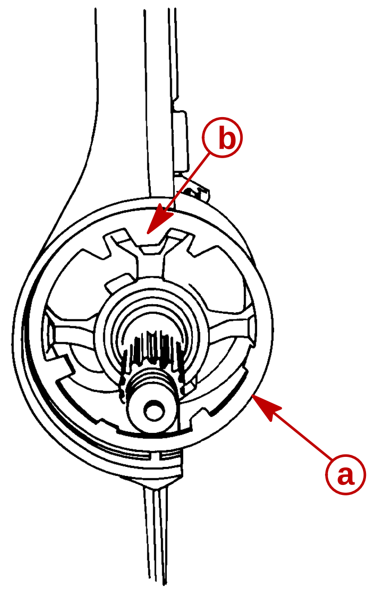
15. Align the bearing carrier "V" shaped notch with the alignment hole in the gear housing and then install the tab washer with the external tab inserted into the hole in the gear housing.



70713

a - Gear Case Alignment Hole
b - "V" Shaped Notch in Bearing Carrier
c - Alignment Tab of Tab Washer

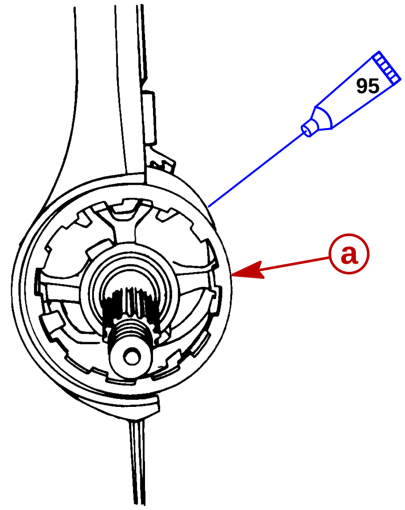
16. Insure that the "V" shaped tab aligns with the "V" notch in bearing carrier.



70714

a - Tab Washer
b - "V" Tab

17. Fill the bearing carrier retainer nut threads and corresponding gear housing threads (360°) with 2-4-C w/Teflon (92-825407A12). Start the retainer into the gear housing threads and screw it down fully by hand.



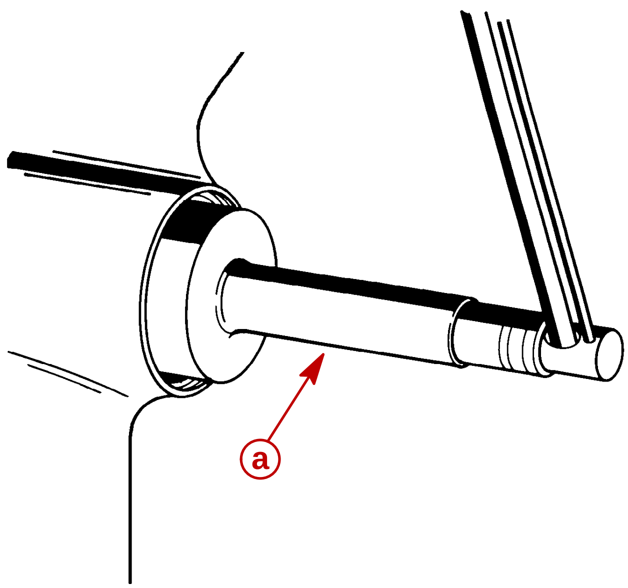
95 2-4-C With Teflon (92-825407A12)

70715

a - Bearing Carrier Retainer

IMPORTANT: Before torquing bearing carrier retainer, gear case must be bolted to drive shaft housing or securely fastened in a gear case holding fixture to avoid possible damage to gear housing.

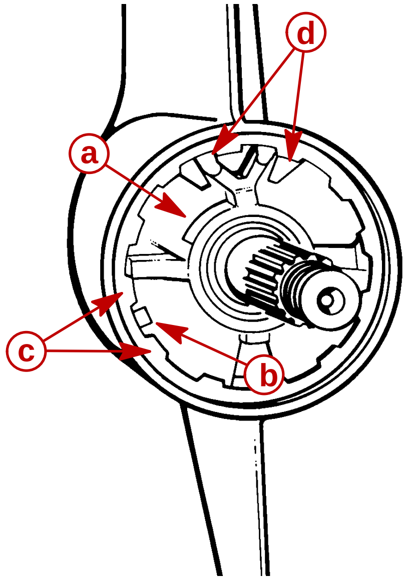
18. Torque the bearing carrier retainer to 210 lb. ft. (284.7 N·m). If one tab does not align up in space between two of the notches, continue to tighten retainer until alignment is achieved. DO NOT loosen retainer to achieve alignment.



23355

a - Bearing Carrier Retainer Wrench (91-61069)

19. Bend one tab aft (outward) into a space between two of the notches of the retainer. Bend all the remaining tabs forward (inward).



70490

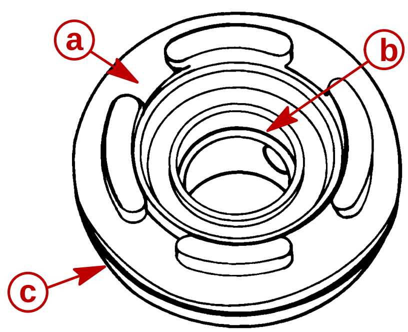
a - Bearing Carrier
b - Tab
c - Retainer Notches
d - Alignment Tabs (Bend Inward)

Oil Seal Carrier Assembly

Installation

NOTE: *Apply hand pressure only to install the oil seal carrier into position. Do not hammer it into position.*

1. Lubricate the oil seal carrier, oil seal lips, space between seals and O-ring with 2-4-C w/Teflon and install the oil seal carrier over the drive shaft and into the gear case.



70501

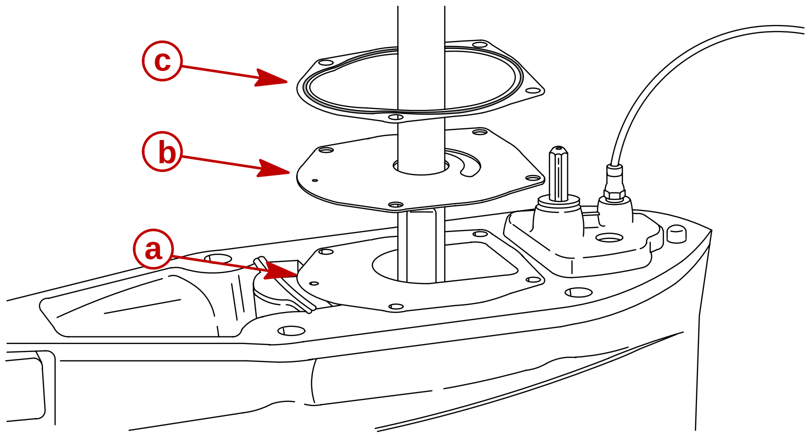
a - Oil Seal Carrier
b - Oil Seal Lips
c - O-ring

Water Pump Assembly

Installation

NOTE: *The gaskets/face plate hole pattern is not symmetrical. If the holes of the gaskets/face plate do not align with the screw holes of the gear case and/or each other, one or more of the parts is upside down. Determine which part(s) is (are) upside down and turn the appropriate part(s) over.*

1. Install the small hole gasket then the face plate followed by the large hole gasket onto the gear case.



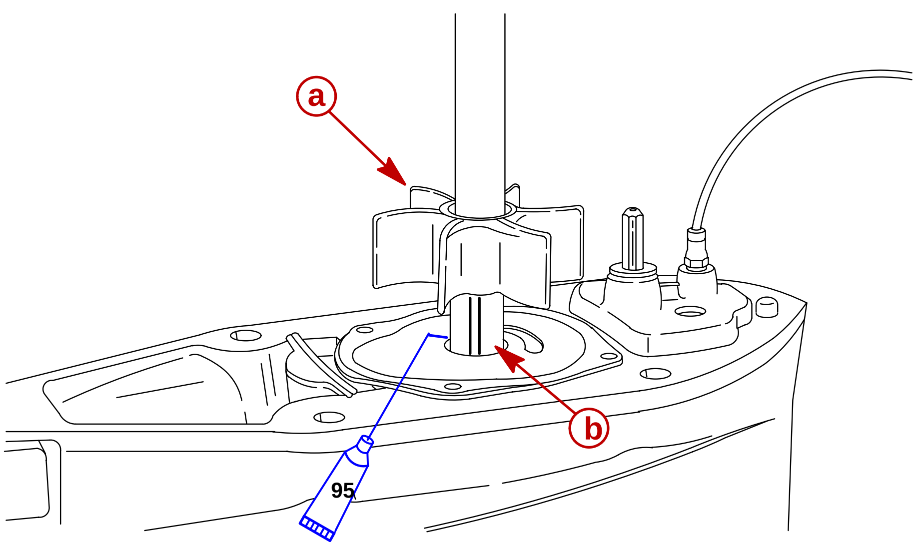
58011

a - Small Hole gasket
b - Face Plate
c - Large Hole Gasket (GRAY sealing ring faces up)

2. Place a small amount of 2-4-C w/Teflon on the flat surface of the impeller key and install the key onto the drive shaft keyway.

IMPORTANT: When using an impeller whose blades have taken a set, face the curl of the blades in a counterclockwise direction. Do not install the impeller with its blades oriented in a reversed direction from original rotation, or premature impeller failure <u>will</u> occur.

3. Assemble the water pump impeller onto the drive shaft and down over the key.

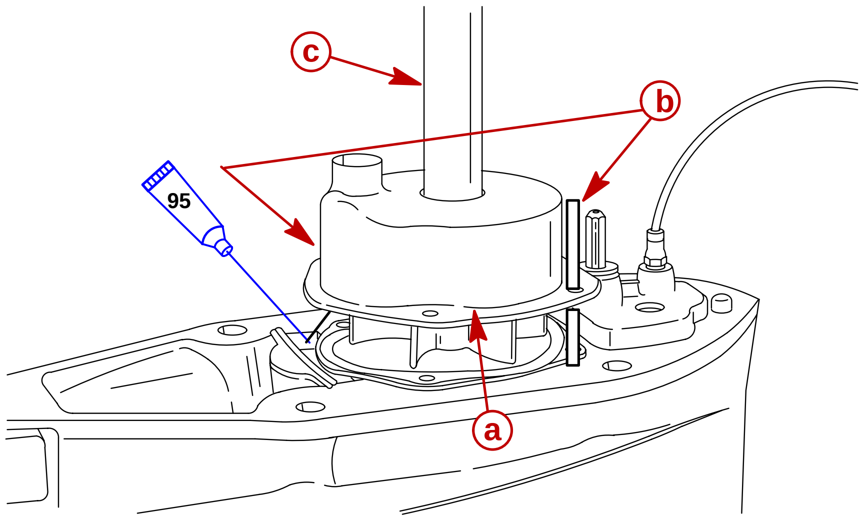


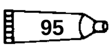
95 2-4-C With Teflon (92-825407A12)

57938

a - Water Pump Impeller
b - Water Pump Impeller Key

4. Install the 2 water pump locating pins through the gaskets and face plate.
5. Apply a light coat of 2-4-C w/Teflon to the inside of the pump cover. Position the water pump body over the drive shaft and water pump locating pins. Rotate the drive shaft in a clockwise direction, while pushing down on the water pump body to ease the water pump over the impeller blades.





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

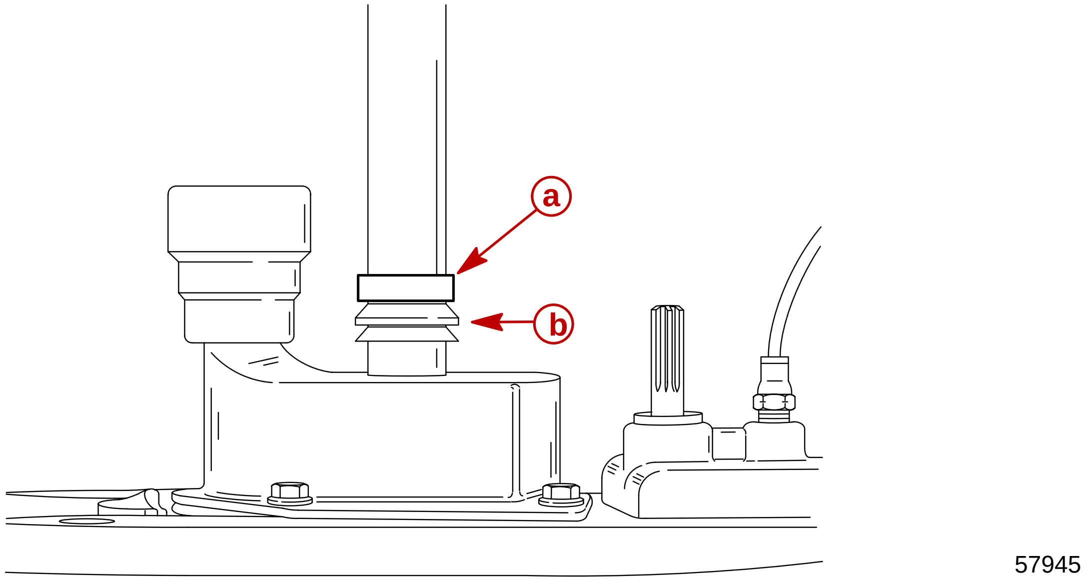
57942

a - Water Pump Body
b - Water Pump Alignment Pins (91-821571A1)
c - Drive Shaft (turn clockwise while installing water pump body)

6. Hand start two (2) fasteners into the water pump assembly and remove the water pump locating pins. Install the remaining 2 fasteners. Run all fasteners down and torque to 60 lb. in. (7 Nm).
7. Lightly lubricate the O-rings in the water tube coupling with 2-4-C w/Teflon (92-825407A12).
8. Install the water tube coupling assembly to the water pump ensuring that the O-rings are not damaged during assembly.

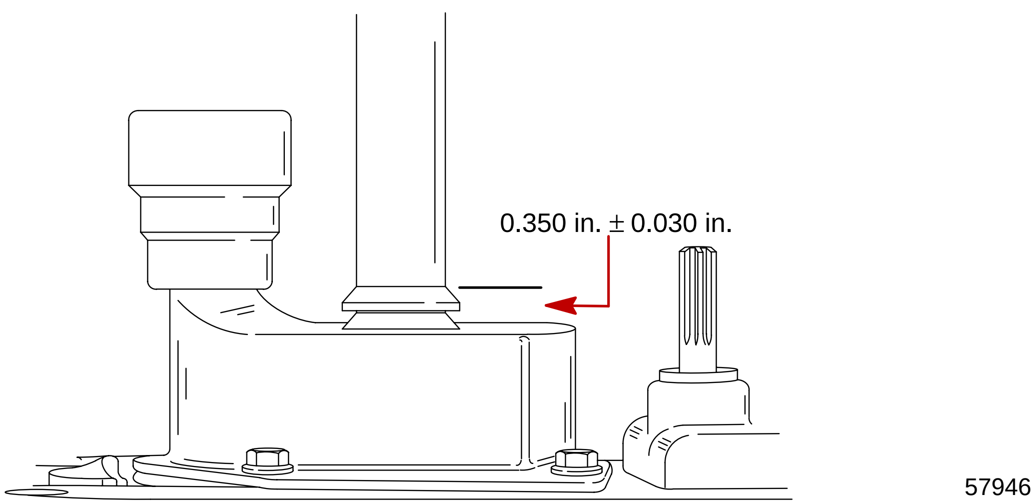
IMPORTANT: If seal installed above pump housing is not at the proper height, air will be drawn into the pump resulting in overheating of the engine.

9. Using tool (a) provided in seal kit (26-816575A2) or water pump kit (817275A3), press seal (b) down over drive shaft (DO NOT GREASE DRIVE SHAFT) until tool seats against pump housing.



a - Tool
b - Seal

If tool is not available, lightly press seal against housing until a height of 0.350 in. ± 0.030 in. (8.9mm ± 0.76mm) is obtained.



Gear Lubricant Filling Instructions

1. Inspect “Fill” and “Vent” sealing washers for cuts or abrasions. Replace washers if necessary.
2. Clean any metal debris from magnet on “Fill” plug.

IMPORTANT: Never apply lubricant to gear housing without first removing Vent screw, or gear housing cannot be filled because of trapped air. Fill gear housing ONLY when housing is in a vertical position.

3. Slowly fill housing thru Fill hole with Quicksilver Super Duty Lower Unit Lubricant until lubricant flows out of “Vent” hole and no air bubbles are visible.
4. Install Vent screw into Vent hole.

IMPORTANT: DO NOT lose more than one fluid ounce (30cc) of gear lubricant while reinstalling Fill screw.

5. Remove grease tube (or hose) from Fill hole and quickly install Fill screw into Fill hole.

Installing Gear Housing to Driveshaft Housing

⚠ WARNING

Disconnect high tension leads from spark plugs and remove spark plugs from engine before installing gear housing onto driveshaft housing.

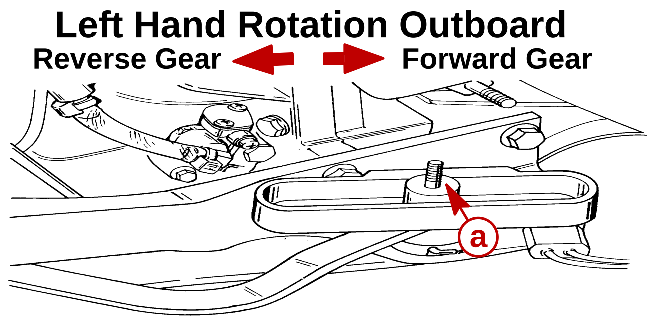
1. Tilt engine to full up position and engage the tilt lock lever.
2. Apply a light coat of Quicksilver 2-4-C w/Teflon Marine Lubricant onto driveshaft splines.

⚠ CAUTION

DO NOT allow lubricant on top of driveshaft. Excess lubricant, that is trapped in clearance space, will not allow driveshaft to fully engage with crankshaft. Subsequently, tightening the gear housing nuts (while excess lubricant is on top of driveshaft) will load the driveshaft/crankshaft and damage either or both the powerhead and gear housing. Top of driveshaft is to be wiped free of lubricant.

3. Apply a light coat of Quicksilver 2-4-C w/Teflon Marine Lubricant onto shift shaft splines. (DO NOT allow lubricant on top of shift shaft.)
4. Apply a thin bead of G.E. Silicone Sealer (92-91600-1) against the top of divider block.
5. Insert trim tab bolt into hole in rear of gear housing to driveshaft housing machined surface.

6. Shift gear housing into NEUTRAL and place guide block anchor pin into NEUTRAL position



a - Guide Block Anchor Pin

7. Position gear housing so that the driveshaft is protruding into driveshaft housing.

NOTE: *If, while performing Step 8, the driveshaft splines will not align with crankshaft splines, place a propeller onto propeller shaft. Shift gearcase into FORWARD and turn propeller counterclockwise as the gear housing is being pushed toward driveshaft housing.*

8. Move gear housing up toward driveshaft housing while aligning shift shaft splines and water tube with water tube guide (in water pump cover).
9. Place flat washers onto studs (located on either side of driveshaft housing). Start a nut on these studs and tighten finger-tight.
10. Start bolt at rear of gear housing inside trim tab recess. DO NOT tighten bolt at this time.
11. Recheck shift shaft spline engagement and correct if necessary.

NOTE: *Guide block anchor pin should be in FORWARD when gearcase is in FORWARD.*

IMPORTANT: Do not force gear case up into place with attaching nuts.

12. Evenly tighten 2 nuts which were started in Step 9. Torque to 55 lb. ft. (75 Nm).
13. After 2 nuts (located on either side of driveshaft housing) are tightened, check shift operation as follows:
    a. Place guide block anchor pin into forward gear position while turning prop shaft. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate counterclockwise.
    b. Place guide block anchor pin into NEUTRAL position. Propeller shaft should rotate freely clockwise/counterclockwise.
    c. Place guide block anchor pin into REVERSE gear position. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate clockwise.

IMPORTANT: If shifting operation is not as described, preceding, the gear housing must be removed and the cause corrected.

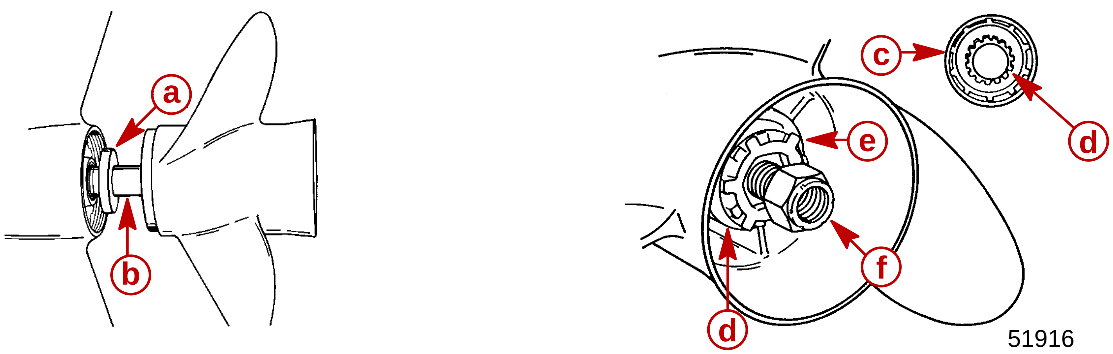
14. Install remaining washers and nuts onto drive shaft studs. Torque to 55 lb. ft. (75 Nm).
15. Torque bolt (started in Step 10) to 45 lb. ft. (61 Nm).
16. Position trim tab or anodic plate in gear housing. Align grooves of trim tab with ribs in trim tab pocket. Adjust to position in which it had previously been installed, and while holding trim tab, torque bolt to 40 lb. ft. (54 Nm)
17. Install plastic cap into trim tab bolt opening at rear edge of driveshaft housing.

Propeller Installation

⚠ WARNING

When installing or removing propeller, because of the engine's ease in starting, VERIFY that the remote control is in NEUTRAL position and that the key switch is "OFF." Place a block of wood between the anti-cavitation plate and propeller to prevent accidental starting and to protect hands from propeller blades while removing or installing nut.

1. To aid in future removal of the propeller, liberally coat the propeller shaft splines with one of the following Quicksilver products:
   -- Anti-Corrosion Grease (92-78376A6)
   -- Special Lubricant 101 (92-13872A1)
   -- 2-4-C Marine Lubricant (92-90018A12)
   -- Perfect Seal (92-34227--1)
2. Place forward thrust hub over propeller shaft with shoulder side toward propeller.
3. Place propeller on propeller shaft and slide it up against thrust hub.
4. Place continuity washer (if equipped) onto shoulder of rear thrust hub.
5. Place rear thrust hub, tab washer and propeller nut on propeller shaft.
6. Thread propeller nut onto propeller shaft until nut is recessed into tab washer.
7. After propeller nut is recessed into tab washer, tighten nut securely [minimum of 55 lb. ft. (74.5 Nm) torque].
8. Bend 3 of the tabs of tab washer down in grooves of rear thrust hub to secure propeller nut. (If tab washer tabs do not align with slots, continue to tighten propeller nut to obtain alignment. DO NOT loosen nut to align tabs.)



a - Forward Thrust Hub
b - Propeller Shaft
c - Continuity Washer (If Equipped)
d - Rear Thrust Hub
e - Tab Washer
f - Propeller Nut

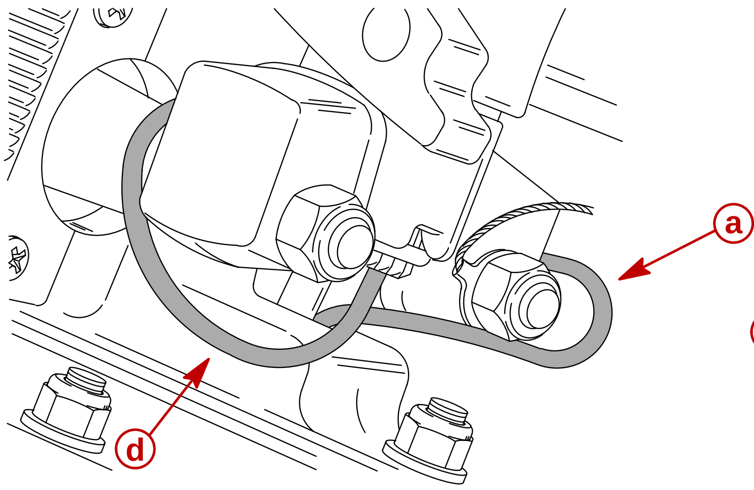
⚠ CAUTION

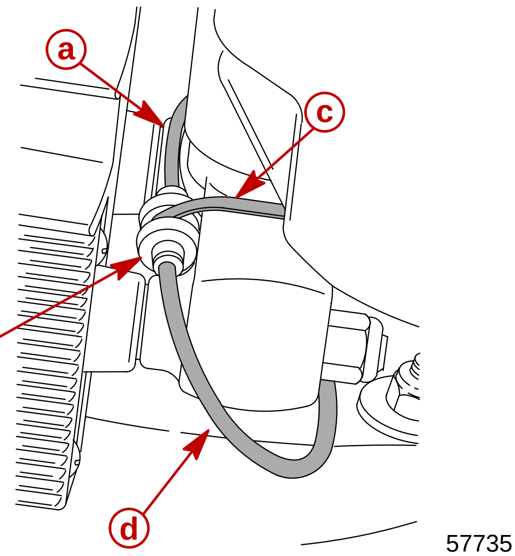
DO NOT misinterpret propeller shaft movement with propeller movement. If propeller and propeller shaft together move forward-and-aft, this is normal; however, propeller should not move forward-and-aft on propeller shaft.

9. After first use, retighten propeller nut and again secure with tab washer (Steps 7 and 8, preceding). Propeller should be checked periodically for tightness, particularly if a stainless steel propeller is used.

Speedometer Tube Installation

1. Route speedometer tube from gearcase around lower yoke and push into junction. Junction should be secured to yoke with sta-strap.
2. Route speedometer tube from swivel tube around lower yoke and push into junction. After insertion of speedometer tubes into junction, pull on each tube to verify that they are locked into junction. If tube pulls out, reinsert into junction.





a - Speedometer Tube from Gearcase
b - Junction
c - Sta-strap
d - Speedometer Tube from Swivel Tube

ATTACHMENTS / CONTROL LINKAGE

Section 7

Table of Contents

Ride Guide Steering Cable/Attaching Kit Installation (92876A1)

Single Cable

Refer to **"Quicksilver Accessories Guide"** to determine correct length of steering cable and remote control cables.

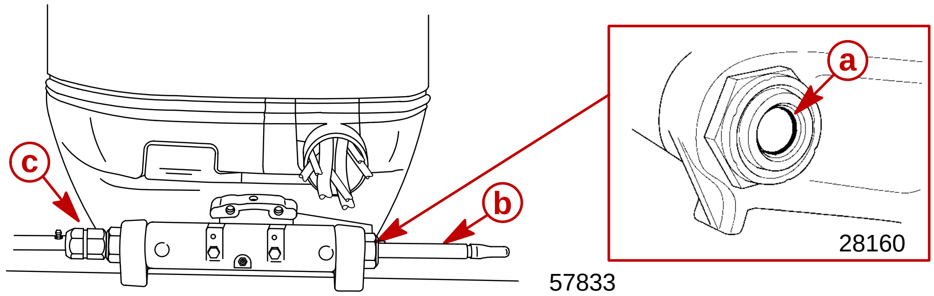
IMPORTANT: Steering cable and remote control cables must be the correct length, sharp bends on too-short cables result in "kinks"; too-long cables require unnecessary bends and/or loops. Both conditions place extra stress on the cables and will reduce the performance of the steering system.

INSTALLING RIDE GUIDE CABLE TO OUTBOARD TILT TUBE

IMPORTANT: Before installing steering cable in tilt tube, lubricate entire cable end with Quicksilver 2-4-C w/Teflon.

***NOTE:** Ride Guide steering cable is lubricated at the factory and requires no additional lubrication at initial installation.*

1. Lubricate seal (a) inside of outboard tilt tube and entire cable end (b) with Quicksilver 2-4-C w/Teflon.
2. Insert steering cable end thru outboard tilt tube and secure steering cable to tilt tube with steering cable attaching nut (c), as shown. Torque nut to 35 lb. ft. (47.5 N·m).



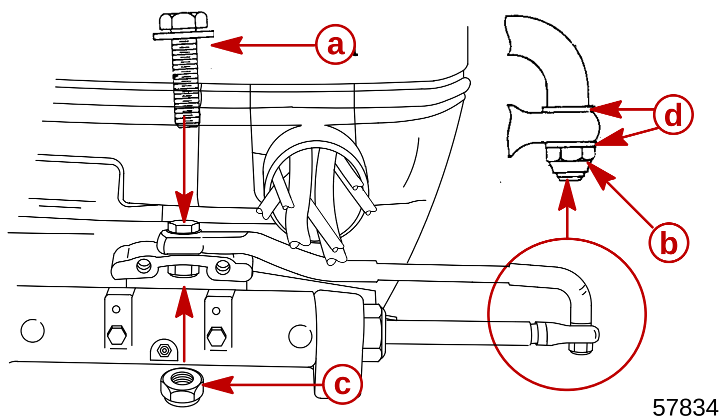
STEERING LINK ROD INSTALLATION

IMPORTANT: The steering link rod that connects the steering cable to the engine must be fastened using special washer head bolt ("a" - Part Number 10-14000) and self locking nuts ("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.

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.

3. 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.
4. **Production Outboards -** Assemble steering link rod to engine with special washer head bolt ("a" - Part Number 10-14000) and nylon insert locknut ("c" - Part Number 11-34863). First torque bolt (a) to 20 lb. ft. (27 Nm), then torque locknut (c) to 20 lb. ft. (27 N·m).
   High Performance Outboards - An access hole is provided through the bottom cowl to ease installation of the link rod connecting bolt. Remove the **BACK** plug for installation and reinstall after installation.



WARNING

After installation is complete (and before operating outboard), check that boat will turn right when steering wheel is turned right and that boat will turn left when steering wheel is turned left. Check steering thru full range (left and right) and at all tilt angles to assure interference-free movement.

Maintenance Instructions

Maintenance inspection is owner's responsibility and must be performed at intervals specified, following:

Normal Service - Every 50 hrs. of operation or 60 days (whichever comes first)

***Severe Service -** Every 25 hrs. of operation or 30 days (whichever comes first)

*Operation in a salt water area is considered **"Severe Service."**

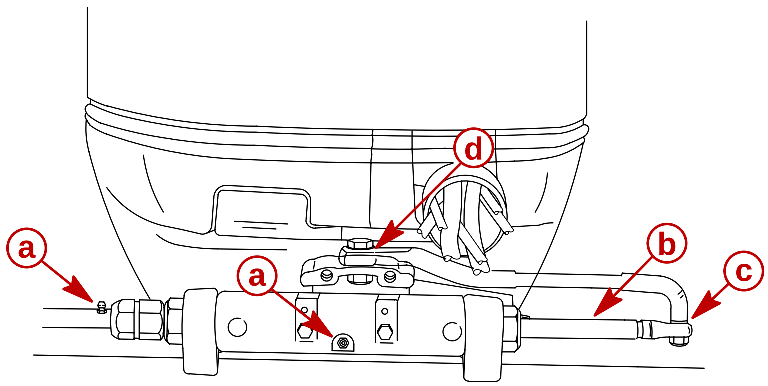
1. Carefully check steering system components for wear. Replace worn parts.
2. Check steering system fasteners to be sure that they are torqued to correct specifications.

NOTE: *Ride-Guide Steering Cables are lubricated at the factory and require no additional lubrication at initial installation.*

WARNING

Core of each steering cable (transom end) must be fully retracted into cable housing before lubricating cable. If cable is lubricated while extended, hydraulic lock of cable could occur.

3. With core of Ride-Guide Steering Cable (transom end) fully retracted, lubricate transom end of steering cables thru grease fittings (a) with 2-4-C w/Teflon (92-825407A12). Lubricate exposed portion of cable end (b) with 2-4-C w/Teflon.
4. Lubricate pivot point (c) of steering link rod and ball joint (d) of link rod with SAE 30 Weight Oil.
5. Inspection and lubrication of steering head assembly (rotary or straight rack) should be performed once each year (by your Authorized Dealer) or whenever steering mount and/or steering head are disassembled, or if steering effort has increased. Lubricate with 2-4-C w/Teflon.



57834
57833

Ride Guide Steering Cable/Attaching Kit Installation (92876A3)

Dual Cable - Single Outboard

WARNING

Quicksilver Super Ride-Guide Steering (dual cables) MUST BE USED with this attaching kit. Failure to adhere to this requirement could result in steering system failure.

Refer to **"Quicksilver Accessories Guide"** to determine correct length of steering cables and remote control cables.

IMPORTANT: Steering cables and remote control cables MUST BE THE CORRECT LENGTH, sharp bends on too-short cables result in "kinks"; too-long cables require unnecessary bends and/or loops. Both conditions place extra stress on the cables and will reduce the performance of the steering system.

CAUTION

With this kit installed, the upper (outboard) mounting bolts MUST BE installed so that hex head end of bolts is on the inside of boat transom, as illustrated. Failure to install upper mounting bolts, as shown in illustration, could result in interference between steering cable nut and ends of mounting bolts when outboard is tilted up.

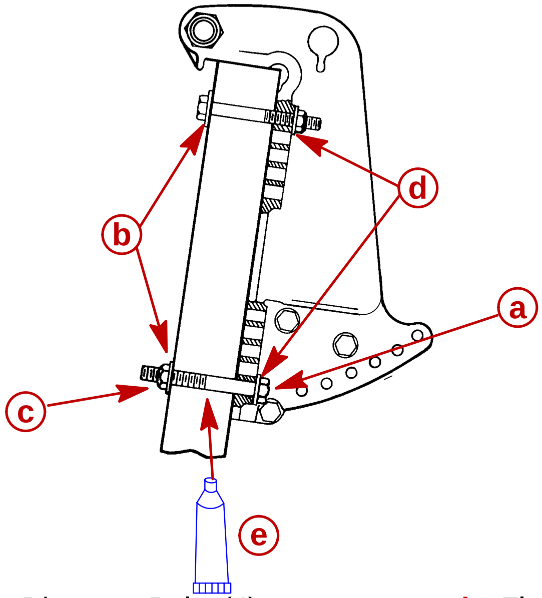
⚠ CAUTION

Marine sealer must be used on shanks bolts to make a water-tight installation.

IMPORTANT: DO NOT use an impact driver when tightening transom bolts.

Apply marine sealer to shanks of mounting bolts (not threads) and secure outboard to transom with 4 bolts, flat washers and locknuts, as shown. Be sure that installation is water-tight.

Install upper bolts so that hex head end of bolts is on the inside of boat transom.

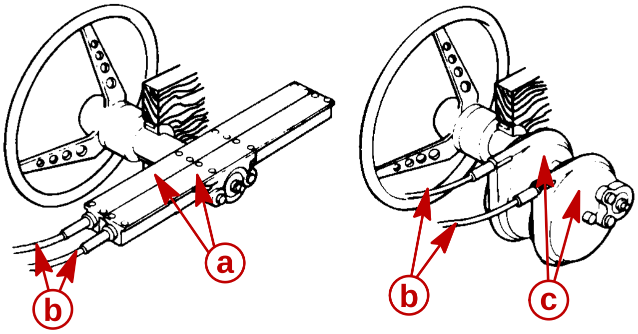


a - 1/2 in. Diameter Bolts (4)
b - Flat Washers(4)
c - Locknuts (4)
d - Flat Washers(4)
e - Marine Sealer - Apply to Shanks of Bolts, Not Threads

Super Ride-Guide Steering Kit Installation

IMPORTANT: Both gear racks or rotary steering heads must be installed so that both steering cables will be routed together on the same side of the boat and will push-and-pull together.

1. Install Super Ride-Guide Steering Kit in accordance with instructions included with Super Ride-Guide Kit.
2. Make sure that both gear racks or rotary steering heads are installed so that both steering cables are routed together down starboard side of boat and will push-and-pull together.

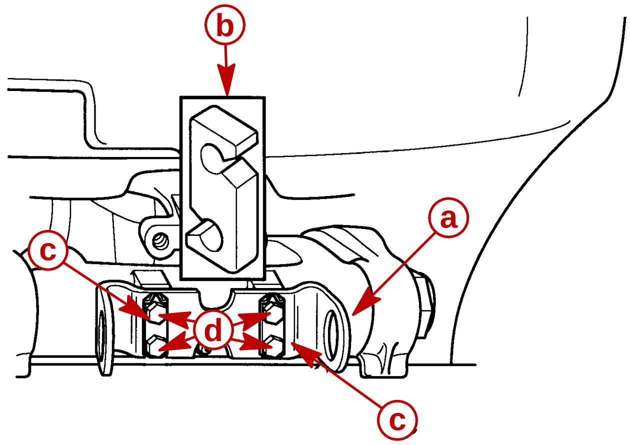


a - Gear Rack
b - Steering Cables
c - Rotary Steering Heads

Steering Cable Mounting Tube Installation

IMPORTANT: Spacers (b) must be installed between outboard swivel bracket and mounting bracket for steering cable mounting tube to provide proper spacing between steering cables.

Secure mounting bracket for steering cable mounting tube on to swivel bracket of outboard.



28163

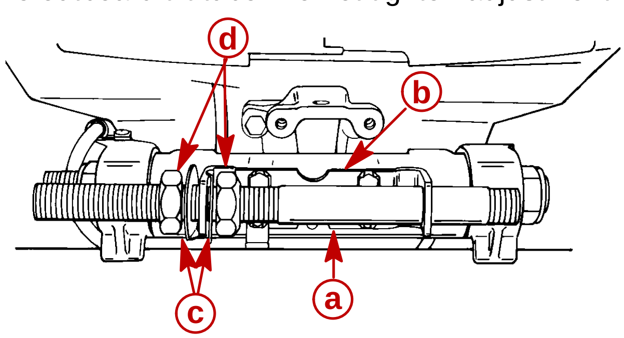
- **a** - Mounting Bracket for Steering Cable Mounting Tube
- **b** - Spacer (2)
- **c** - Locking Retainer (2)
- **d** - Bolts (4) - 7/8 in. (22 mm) Long - Torque to 100 lb. in. (11.5 Nm), then Bend Corner Tabs of Locking Retainers Up and Against Flats on Each Bolt

WARNING

Locking retainer corner tabs, MUST BE bent up and against flats on each bolt that secures mounting bracket for steering cable mounting tube to outboard swivel bracket to prevent bolts from turning out.

Install steering cable mounting tube into mounting bracket with 2 adjusting nuts and 2 locking tab washers. Verify longer threaded end of tube is toward starboard side of boat.

Temporarily adjust tube so that longer threaded end of tube extends out the same distance as the outboard tilt tube. Do not tighten adjustment nuts at this time.



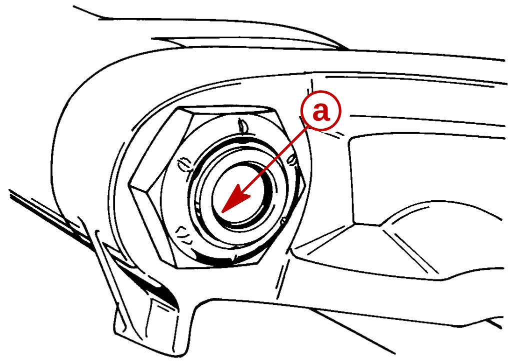
51891

- **a** - Steering Cable Mounting Tube (End of Tube with Longer Threads Toward Starboard Side of Boat)
- **b** - Mounting Bracket
- **c** - Locking Tab Washers (2)
- **d** - Adjustment Nuts (Flats of Nuts Facing Toward Locking Tab Washer)

Installing Steering Cables

IMPORTANT: Lubricate inside of outboard tilt tube, inside of steering cable mounting tube and rubber O-ring seal (located in outboard tilt tube) with Quicksilver 2-4-C w/Teflon before installing steering cables.

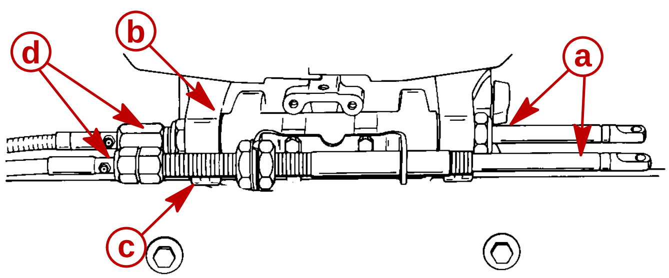
Lubricate inside of outboard tilt tube and inside of steering cable mounting tube with Quicksilver 2-4-C w/Teflon. Verify rubber O-ring seal (a) (located in outboard tilt tube) is lubricated.



51890

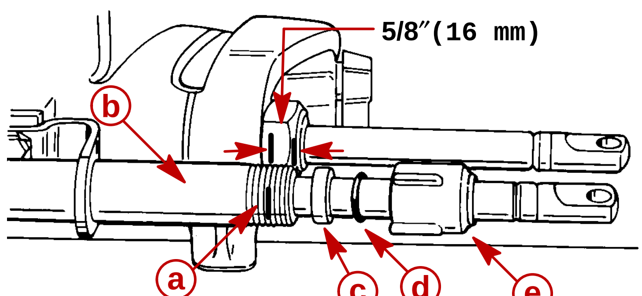
Insert steering cable ends (a) thru outboard tilt tube (b) and cable mounting tube (c). Thread steering cable attaching nuts (d) on to tubes hand tight.

NOTE: *Torque steering cable attaching nuts only after final steering adjustments have been made.*



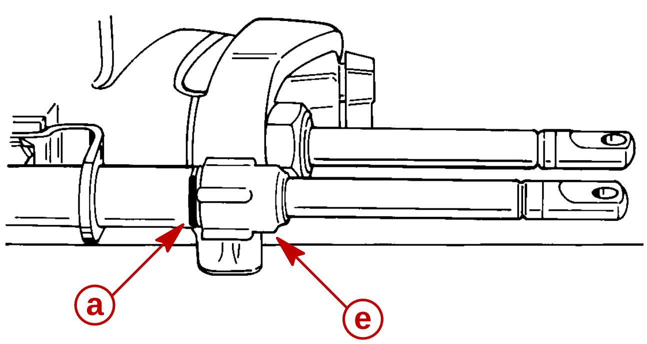
51891

Place a mark (a) on steering cable mounting tube (b) 5/8 in. (16 mm) from end of mounting tube. Slide plastic spacer (c), O-ring (d) and cap (e) over steering cable.



51890

Thread cap (e) onto steering cable mounting tube, up to mark (a).



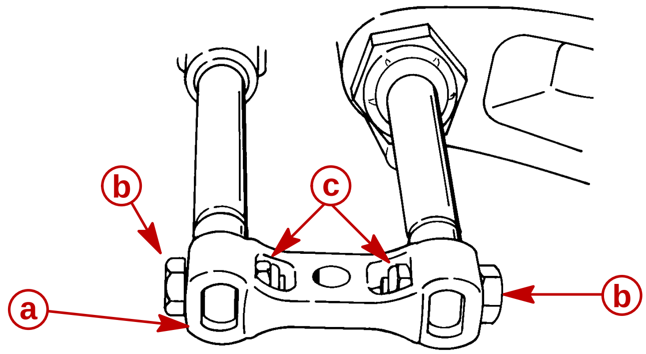
51890

Coupler Installation

⚠ WARNING

Locknuts must be used with bolts to secure steering cables to coupler. Failure to adhere to this requirement could result in steering system failure.

Slide coupler (a) onto steering cable ends and secure each steering cable to coupler with bolt (b) and locknut (c) as shown. Tighten to a torque of 20 lb. ft. (27 Nm).



51888

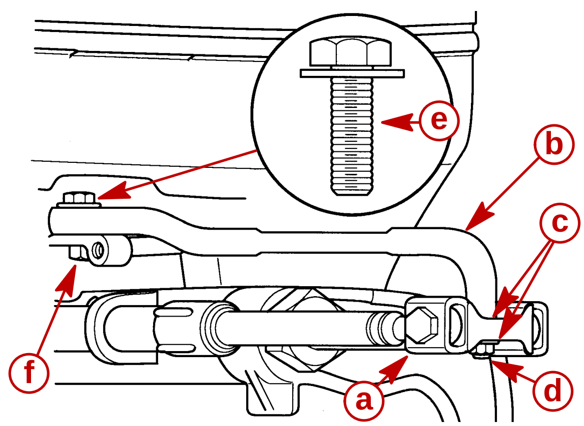
Installing Link Rod

⚠ WARNING

Steering link rod MUST BE secured between outboard steering arm and steering coupler, using special washer head bolt (10-14000) and two nylon insert locknuts (11-34863), as shown. Both special washer head bolt and nylon insert locknuts MUST BE tightened as specified.

Lubricate hole in steering coupler, with Quicksilver 2-4-C w/Teflon. Assemble steering link rod to steering coupler, using 2 flat washers (one each side of coupler) and nylon insert locknut. Tighten locknut until it seats [DO NOT exceed 120 lb. in. (13.5 Nm) of torque], then back nut off 1/4 turn.

Lubricate ball joint in steering link rod with SAE 30W Motor Oil. Secure link rod to outboard steering arm, using special washer head bolt (10-14000) provided and nylon insert lock-nut as shown. Torque special bolt to 20 lb. ft. (27 Nm), then torque locknut to 20 lb. ft. (27 Nm).



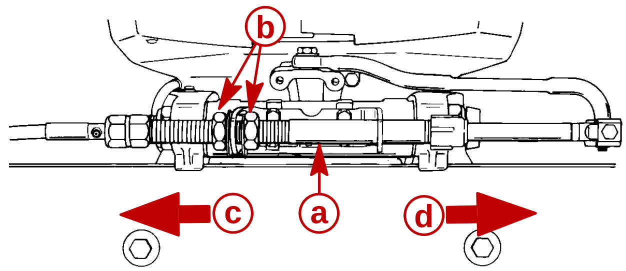
28172

- **a** - Steering Coupler
- **b** - Steering Link Rod
- **c** - Flat Washer (2)
- **d** - Nylon Insert Locknut - Torque until it seats [DO NOT exceed 120 lb. in. (13.5 Nm) of torque], then back nut off 1/4 turn
- **e** - Special Washer Head Bolt (10-14000) - Torque to 20 lb. ft. (27 Nm)
- **f** - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)

STEERING SYSTEM TENSION ADJUSTMENT

IMPORTANT: After this dual steering cable attachment kit is installed, there must be proper tension in forward mounted steering cable tor this attachment kit to operate properly. Not enough tension will cause slack (or play) in steering system. Too much tension will cause steering cables to bind. Perform the following steps to adjust for correct tension.

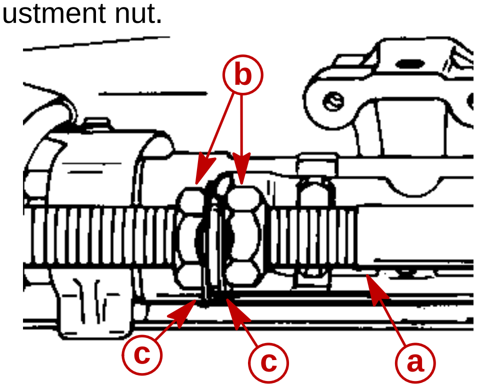
Loosen adjustment nuts and pull steering cable mounting tube (by hand) away from end of steering cable (to remove slack in steering system). Tighten adjustment nuts against mounting bracket and check system for slack (play.) If steering system is too tight, readjust tube toward end of steering cable or, if too much slack (play) exists in system, readjust tube away from end of steering cable. Tighten nuts against mounting bracket and readjust, if necessary.



51887

- **a** - Steering Cable Mounting Tube
- **b** - Adjustment Nuts
- **c** - Adjust Tube in This Direction to Remove Slack from Steering System
- **d** - Adjust Tube in This Direction to Reduce Tension from Steering System

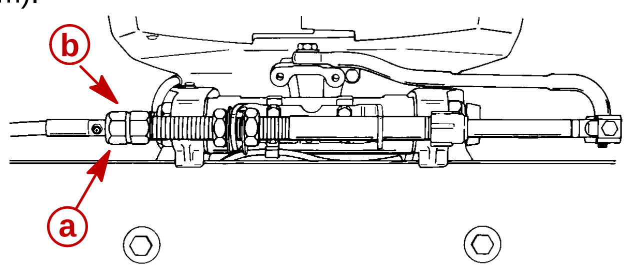
After steering system tension is adjusted correctly, tighten adjustment nuts against mounting bracket, to a torque of 35 lb. ft. (47.5 Nm) and bend a tab lock washer against flat on each adjustment nut.



51887

- **a** - Steering Cable Mounting Tube
- **b** - Adjustment Nuts; Torque to 35 lb. ft. (47.5 Nm)
- **c** - Tab Lock Washer (Bend Against Flat on Each Adjustment Nut)

Tighten steering cable attaching nuts on each steering cable to a torque of 35 lb. ft. (47.5 Nm).



51889

- **a** - Cable Attaching Nut
- **b** - “V” Groove

NOTE: *Cable attaching nuts with a "V" groove around the outer circumference of the nut are self locking and do not require locking sleeves.*

⚠ WARNING

After installation is complete [and before operating outboard(s)], check that boat will turn right when steering wheel is turned right and that boat will turn left when steering wheel is turned left. Check steering thru full range (left and right) at all tilt angles to assure interference-free movement.

Maintenance Instructions

Maintenance inspection is owner's responsibility and must be performed at intervals specified, following:

Normal Service - Every 50 hrs. of operation or 60 days (whichever comes first)
***Severe Service -** Every 25 hrs. of operation or 30 days (whichever comes first)

*Operation in a salt water area is considered "Severe Service."

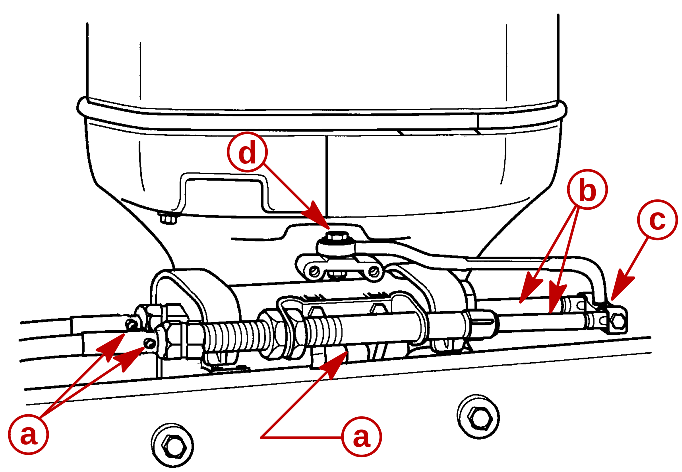
1. Carefully check steering system components for wear. Replace worn parts.
2. Check steering system fasteners to be sure that they are torqued to correct specifications.

NOTE: *Ride-Guide Steering Cables are lubricated at the factory and require no additional lubrication at initial installation.*

⚠ WARNING

Core of each steering cable (transom end) must be fully retracted into cable housing before lubricating cable. If cable is lubricated while extended, hydraulic lock could occur.

3. With core of Ride-Guide Steering Cable (transom end) fully retracted, lubricate transom end of steering cables thru grease fittings (a) with 2-4-C w/Teflon (92-825407A2). Lubricate exposed portion of cable ends (b) with 2-4-C w/Teflon.
4. Lubricate pivot point (c) of steering link rod and ball joint (d) of link rod/steering coupler with SAE 30W Motor Oil.
5. Inspection and lubrication of steering head assembly (rotary or straight rack) should be performed once each year (by your Authorized Dealer) or whenever steering mount and/or steering head are disassembled, or if steering effort has increased. Lubricate with 2-4-C w/Teflon.



28170

Ride Guide Steering Cable/Attaching Kit Installation (92876A6)

Dual Cable - Dual Outboard

WARNING

Quicksilver Super Ride-Guide Steering (dual cables) MUST BE USED with this attaching kit. Failure to adhere to this requirement could result in steering system failure.

Refer to **"Quicksilver Accessories Guide"** to determine correct length of steering cable and remote control cables.

IMPORTANT: Steering cable and remote control cables MUST BE THE CORRECT LENGTH, sharp bends on too-short cables result in "kinks"; too-long cables require unnecessary bends and/or loops. Both conditions place extra stress on the cables and reduce the performance of the steering system.

Installation Requirements

IMPORTANT: The distance from each outboard's centerline to the side of transom opening MUST BE a minimum of 16 in. (406 mm).

This kit contains all necessary parts to connect both outboards to Ride-Guide Steering Cables for 23-1/2 in. thru 27-1/2 in. (597 mm thru 699 mm) outboard centerline spacing. If outboard centerline distance is other then specified, refer to end of this instruction manual for optional extension couplers.

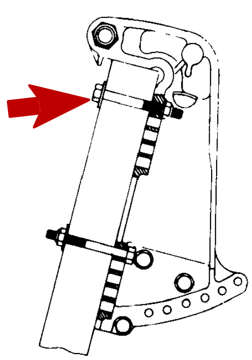
DETERMINE ROUTING OF STEERING CABLES

Use "1" or "2", following, to route steering cables:

1. **Parallel cable routing:** Cables routed together down starboard side of boat Refer to **"Parallel Routed Steering Cables and Attaching Kit Installation,"** immediately following.
2. **Opposite side cable routing:** One cable routed down starboard side of boat and one cable routed down port side of boat. Refer to **"Opposite Side Routed Steering Cables and Attaching Kit Installation,"** located on page 20 of this instruction manual.

CAUTION

With this kit installed, the upper (outboard) mounting bolts MUST BE installed so that hex head end of bolts is on the inside of boat transom, as illustrated. Failure to install upper mounting bolts, as shown in illustration, could result in interference between steering cable nut and ends of mounting bolts when outboard is tilted up.



Install upper bolts so that hex head end of bolts is on the inside of boat transom.

Parallel Routed Steering Cables and Attaching Kit Installation

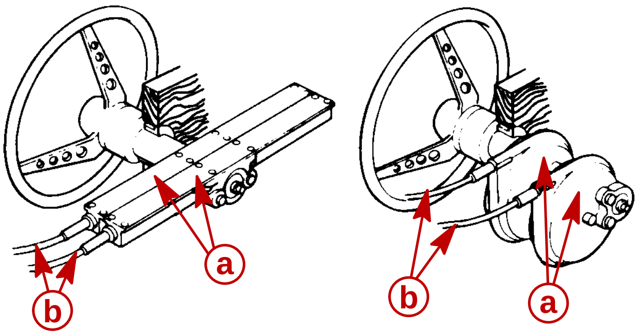
(Both Steering Cables Routed Together Down Starboard Side of Boat)

SUPER RIDE-GUIDE STEERING KIT INSTALLATION

IMPORTANT: Steering cable must be installed into tilt tube of port outboard before outboard is mounted on boat transom.

Both gear racks or rotary steering heads must be installed so that both steering cables will be routed together on the same side of the boat and will push- and-pull together.

1. Install Super Ride-Guide Steering Kit in accordance with instructions included with Super Ride-Guide Kit.
2. Make sure that both gear racks or rotary steering heads are installed so that both steering cables are routed together and will push-and-pull together.

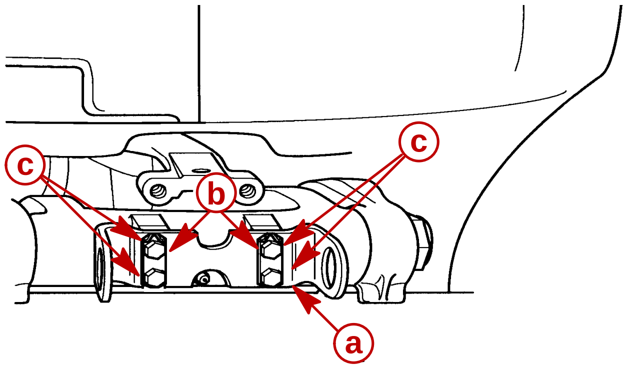


a - Straight Rack (Left); Rotary Steering (Right)
b - Steering Cables (Install so that Both Cables Will Push and Pull Together)

STEERING CABLE INSTALLATION STARBOARD OUTBOARD

IMPORTANT: Mounting bracket for steering cable mounting tube MUST BE secured to outboard swivel bracket, using 5/8 in. (16 mm) long bolts supplied with this dual cable - dual outboard attaching kit.

Secure mounting bracket for steering cable mounting tube, onto swivel bracket of starboard outboard.



28164

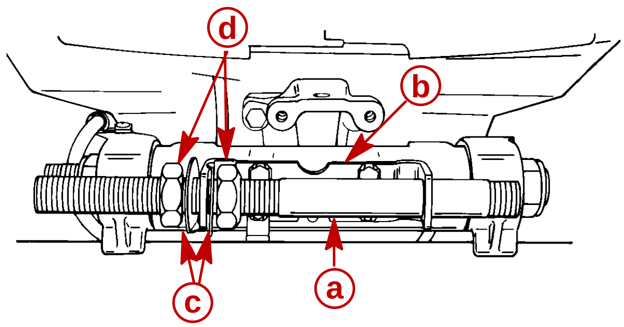
a - Mounting Bracket for Steering Cable Mounting Tube
b - Locking Retainers (2)
c - Bolts (4) - 5/8 in. (16 mm) Long - Torque to 100 lb. in. (11.5 Nm), then Bend Corner Tabs of Locking Retainers Up and Against Flats on Each Bolt

⚠ WARNING

Locking retainer corner tabs, MUST BE bent up and against flats on each bolt that secures mounting bracket for steering cable mounting tube to outboard swivel bracket, to prevent bolts from turning out.

Install steering cable mounting tube into mounting bracket with 2 adjusting nuts and 2 locking tab washers. Be sure longer threaded end of tube is toward starboard side of boat.

Temporarily adjust tube, so that longer threaded end of tube extends out the same distance as the outboard tilt tube. Do not tighten adjustment nuts at this time.



51891

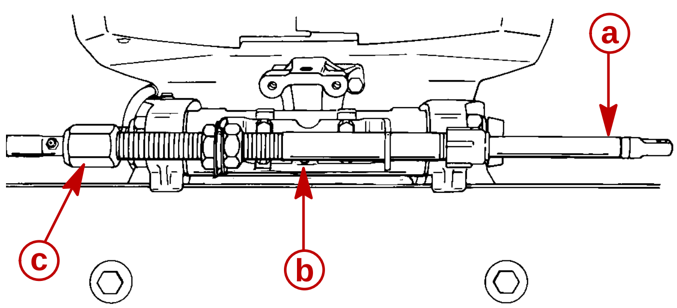
- **a** - Steering Cable Mounting Tube (End of Tube with Longer Threads Toward Starboard Side of Boat)
- **b** - Mounting Bracket
- **c** - Locking Tab Washers (2)
- **d** - Adjustment Nuts (Flats of Nuts Facing Toward Locking Tab Washer)

IMPORTANT: Lubricate inside of steering cable mounting tube with 2-4-C w/Teflon before installing steering cable.

Lubricate inside of steering cable mounting tube (starboard outboard) with 2-4-C w/Teflon.

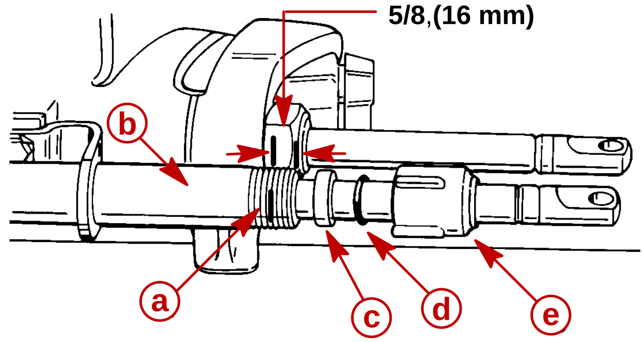
Insert steering cable end (a) thru cable mounting tube (b) and thread steering cable attaching nut (c) onto tube hand tight.

NOTE: *Torque steering cable attaching nut only after final steering adjustments have been made.*



51887

Place a mark (a) on steering cable mounting tube (b) 5/8 in. (16 mm) from end of mounting tube. Slide plastic spacer (c), O-ring (d) and cap (e) over steering cable.



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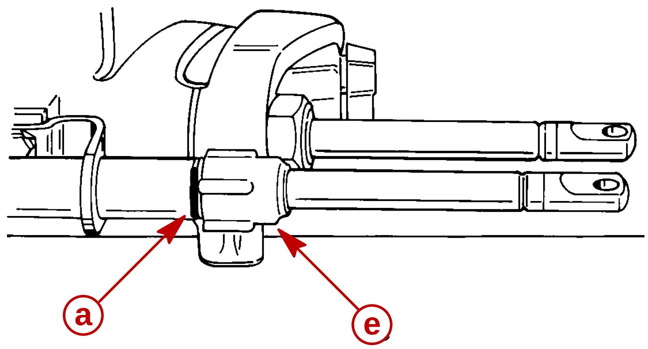
Thread cap (e) onto steering cable mounting tube, up to mark (a).

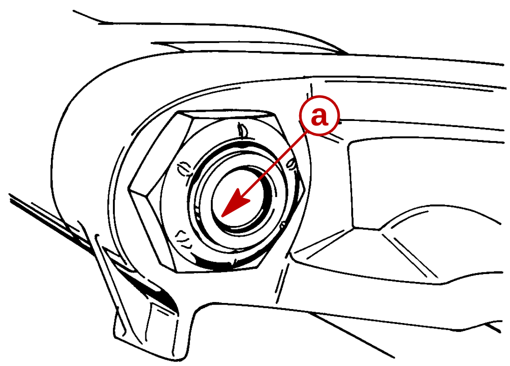


51890

STEERING CABLE INSTALLATION - PORT OUTBOARD

IMPORTANT: Lubricate inside of port outboard's tilt tube and rubber O-ring seal located inside tilt tube with 2-4-C w/Teflon, before installing steering cable.

Lubricate inside of port outboard's tilt tube and rubber O-ring seal (a) with 2-4-C w/Teflon.



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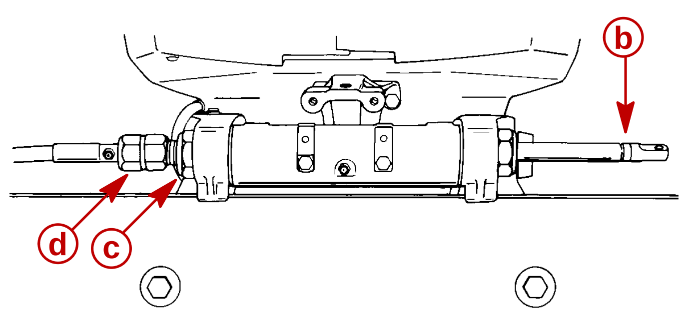
Insert steering cable end (b) thru tilt tube (c) of port outboard and thread steering cable attaching nut (d) onto tilt tube hand tight.

NOTE: *Torque steering cable attaching nuts only after final steering adjustments have been made.*

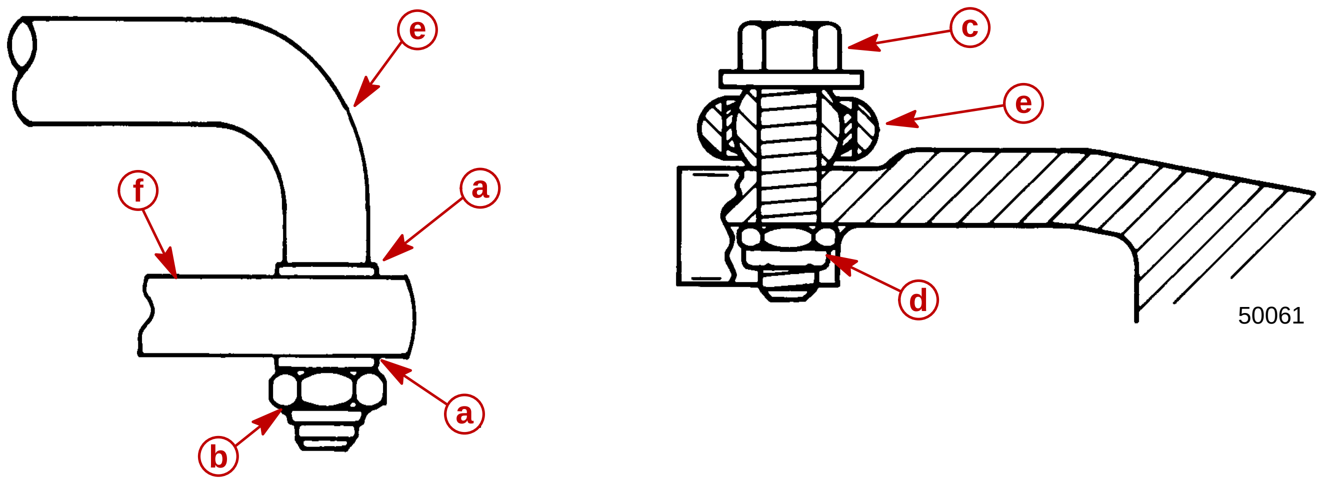


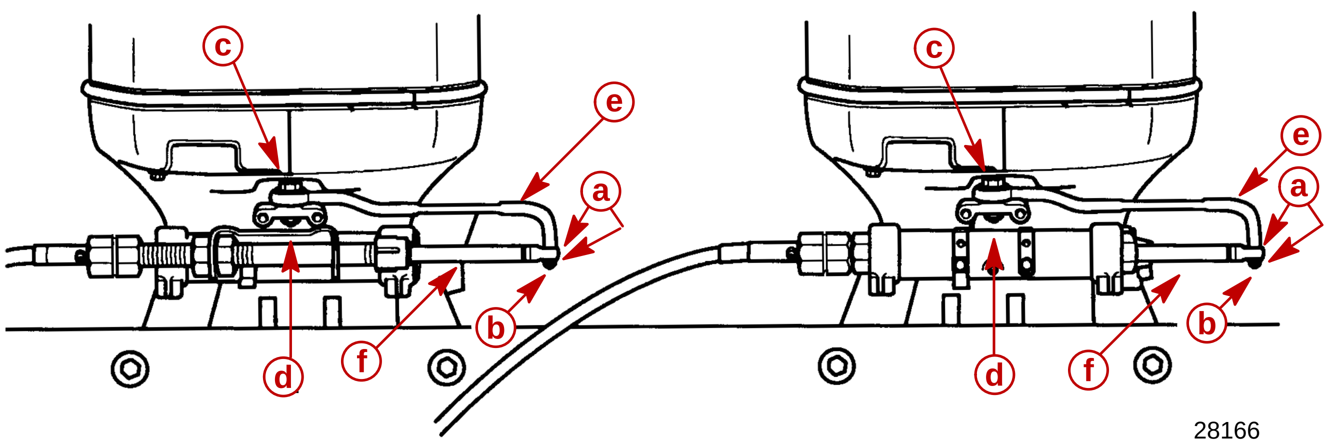
51887

STEERING LINK ROD INSTALLATION

⚠ WARNING

Steering link rods MUST BE secured between outboard steering arm and steering cable end, using special washer head bolt (10-14000) and two nylon insert locknuts (11-34863), as shown. Both special washer head bolt and nylon insert locknuts MUST BE tightened as specified.





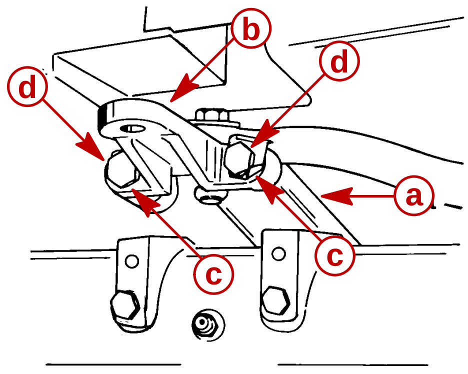
- **a** - Flat Washer (2 Each Link Rod)
- **b** - Nylon Insert Locknut - Torque Until it Seats [DO NOT Exceed 120 lb. in. (13.5 Nm) of Torque], Then Back Off 1/4 Turn
- **c** - Special Washer Head Bolt (10-14000) - Torque to 20 lb. ft. (27 Nm)
- **d** - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)
- **e** - Steering Link Rod
- **f** - Steering Cable End

Lubricate holes in ends of steering cables, with Quicksilver 2-4-C w/Teflon Marine Lubricant. Assemble steering link rods to steering cable ends of each outboard, using flat washers and nylon insert locknuts. Tighten locknuts until they seat [DO NOT exceed 120 lb. in. (13.5 Nm) of torque], then back nut off 1/4 turn.

Lubricate ball joints in steering link rods with SAE 30W Motor Oil. Secure link rods to outboard steering arms, using special washer head bolts (10-14000) provided and nylon insert locknuts as shown. Torque special bolts to 20 lb. ft. (27 Nm) then torque locknuts to 20 lb. ft. (27 Nm).

STEERING ARM EXTENSION BRACKET INSTALLATION

Secure a steering arm extension bracket to each outboard's steering arm.



51889

- **a** - Steering Arm (Port Outboard Shown)
- **b** - Extension Bracket
- **c** - Locking Retainer (2 Each Bracket)
- **d** - Bolts (2 Each Bracket) 1-1/4 in. (31.8 mm) Long - Torque to 23 lb. ft. (31 Nm), Then Bend Corner Tabs of Locking Retainers Up Against Flats on Each Bolt

⚠ WARNING

Locking retainer corner tabs MUST BE bent up and against flats on each bolt that secures extension bracket to outboard steering arm to prevent bolts from turning out.

STEERING COUPLER ASSEMBLY AND INSTALLATION

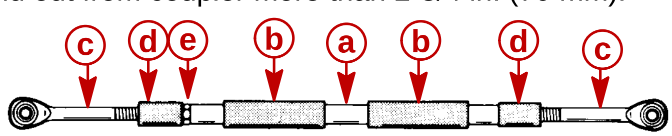
Position outboards so that they are facing straight forward. (Distance between threaded hole centers of steering arm extensions MUST BE equal to distance between propeller shaft centerlines.)

Lubricate inside of rubber sleeves with 2-4-C w/Teflon and slide sleeves on steering coupler.

Work rubber bushings onto threaded ends of steering eyes.

Thread jam nut on starboard steering eye.

Thread steering eyes equally into coupler, so that distance between hole centers of steering eye ball joints is equal to distance between threaded hole centers of steering arm extensions. Exposed threads of steering eyes MUST BE of equal length and threads MUST NOT extend out from coupler more than 2-3/4 in. (70 mm).



50061

- **a** - Coupler
- **b** - Rubber Sleeve
- **c** - Steering Eye
- **d** - Rubber Bushing
- **e** - Jam Nut

⚠ WARNING

Both steering eyes must be threaded into coupler 3/4 in. (19 mm) minimum. Thread length of steering eye is 3-1/2 in. (89 mm), so exposed thread must not extend out of coupler more than 2-3/4 in. (70 mm). Failure to adhere to this requirement could result in steering system failure.

Lubricate ball joint in steering eyes, with SAE 30W Motor Oil.

Assemble steering coupler between outboard steering arm extension brackets, using special washer head bolts (10-14000) provided and nylon insert locknuts as shown.

IMPORTANT: With assembled steering coupler installed and before tightening special washer head bolts/locknuts, check outboard alignment. Distance between centers of special washer head bolts MUST BE equal to distance between propeller shaft center lines, for proper steering. If adjustment is necessary, temporarily remove special washer head bolt/locknut from one steering eye and turn eye in or out to correct alignment.

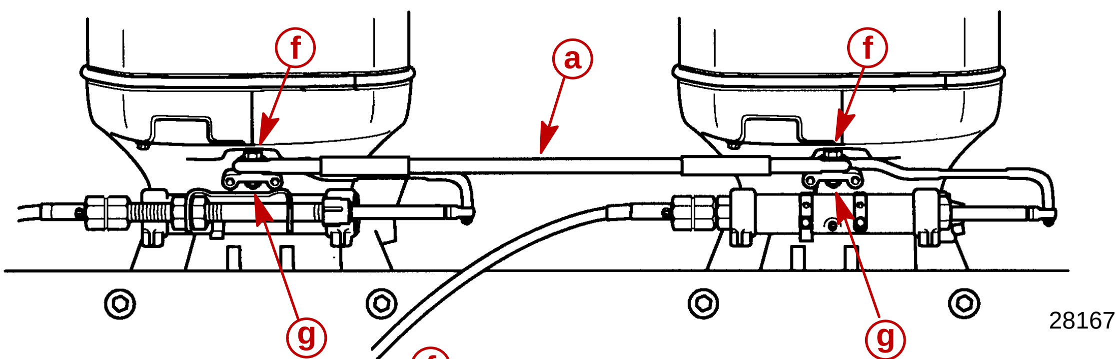
Torque special washer head bolts to 20 Ib. ft. (27 Nm), then torque locknuts to 20 Ib. ft. (27 Nm).

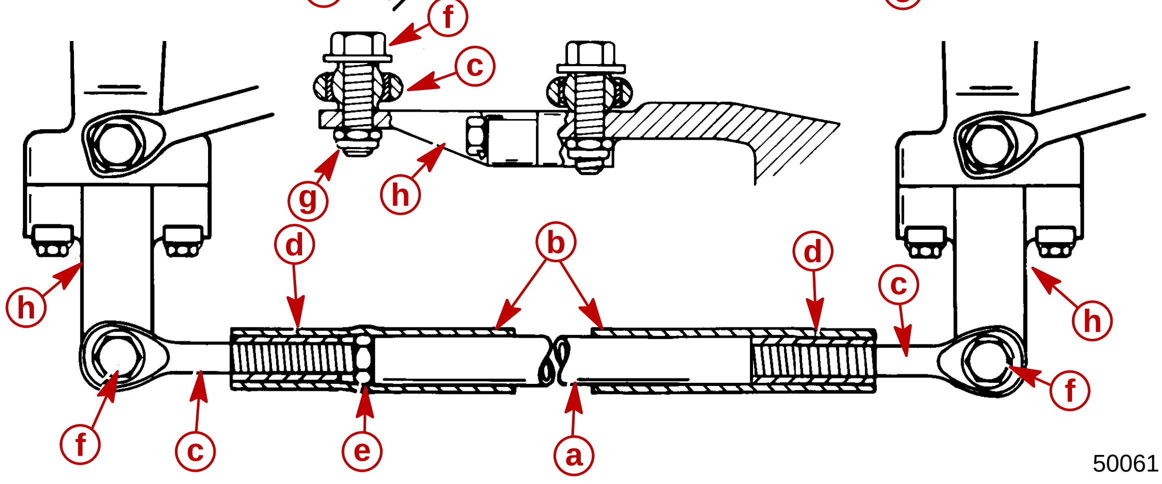
⚠ WARNING

Both steering eyes MUST BE threaded into coupler 3/4 in. (19 mm) minimum, and jam nut must be tightened against coupler to prevent coupler from turning. Torque "jam" nut to 20 Ib. ft. (27 N·m).

Tighten "jam" nut against coupler. Torque "jam" nut to 20 Ib. ft. (27 Nm).

Spray Quicksilver Corrosion Guard on exposed threads of steering eyes and position rubber bushings and rubber sleeves to cover exposed threads of steering eyes.



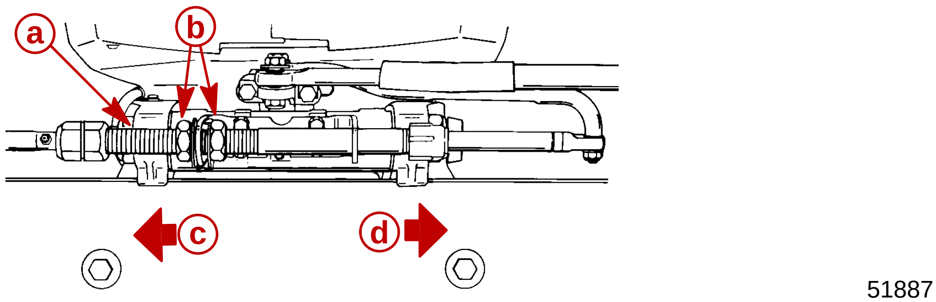


a - Coupler
b - Rubber Sleeve
c - Steering Eye
d - Rubber Bushing
e - Jam Nut - Torque (Against Coupler) to 20 Ib. ft. (27 Nm)
f - Special Washer Head Bolt (10-14000) - Torque to 20 Ib. ft. (27 Nm)
g - Nylon Insert Locknut - Torque to 20 Ib. ft. (27 Nm)
h - Steering Arm Extension Bracket

STEERING SYSTEM TENSION ADJUSTMENT (PARALLEL ROUTED STEERING CABLES)

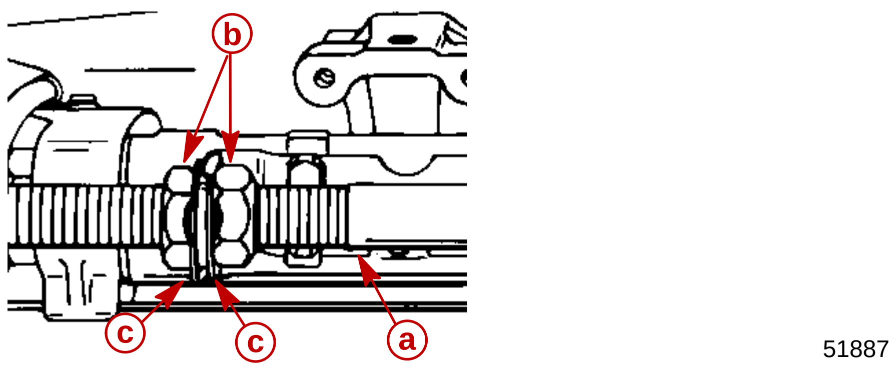
IMPORTANT: For proper operation of this dual cable - dual outboard steering installation, there MUST BE proper tension in the steering system. NOT ENOUGH tension will cause slack (play) in steering system. TOO MUCH tension will cause steering cables to bind. Perform the following steps to correctly adjust tension.

Loosen adjustment nuts and pull steering cable mounting tube (by hand) away from end of steering cable (to remove slack in steering system). Tighten adjustment nuts against mounting bracket and check system for slack (play). If steering system is too tight, readjust tube toward end of steering cable or, if too much slack (play) exists in system, readjust tube away from end of steering cable. Tighten nuts against mounting bracket and readjust, if necessary.



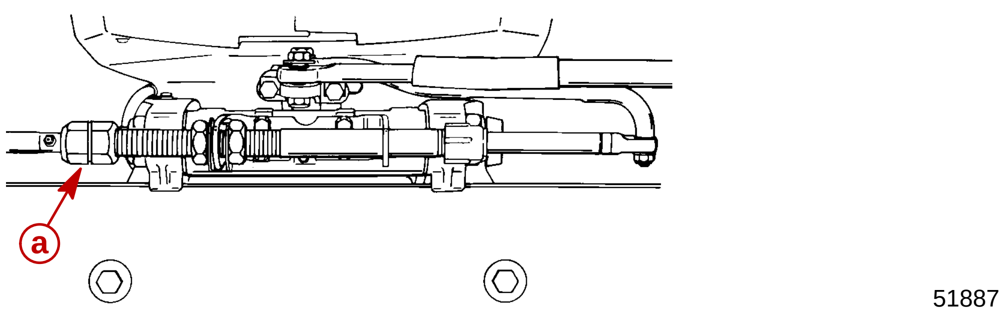
a - Steering Cable Mounting Tube
b - Adjustment Nuts
c - Adjust Tube in This Direction to Remove Slack from Steering System
d - Adjust Tube in This Direction to Reduce Tension from Steering System

After steering system tension is adjusted correctly, tighten adjustment nuts against mounting bracket, to a torque of 35 lb. ft. (47.5 Nm) and bend a tab lock washer against a flat on each nut.



a - Steering Cable Mounting Tube
b - Adjustment Nuts Torque to 35 lb. ft. (47.5 Nm)
c - Tab Lock Washer (Bend Against Flat on Each Adjustment Nut)

Tighten steering cable attaching nuts of each steering cable to a torque of 35 lb. ft. (47.5 Nm).



a - Cable Attaching Nut

⚠ WARNING

After installation is complete (and before operating outboard(s)), check that boat will turn right when steering wheel is turned right and that boat will turn left when steering wheel is turned left. Check steering thru full range (left and right) at all tilt angles to assure interference-free movement.

Adjust trim tabs of both outboards, as outlined in **"Trim Tab Adjustment"**, following.

Opposite Side Routed Steering Cables and Attaching Kit Installation

(One Cable Routed down Starboard Side of Boat and One Cable Routed down Port Side of Boat)

SUPER RIDE-GUIDE STEERING KIT INSTALLATION

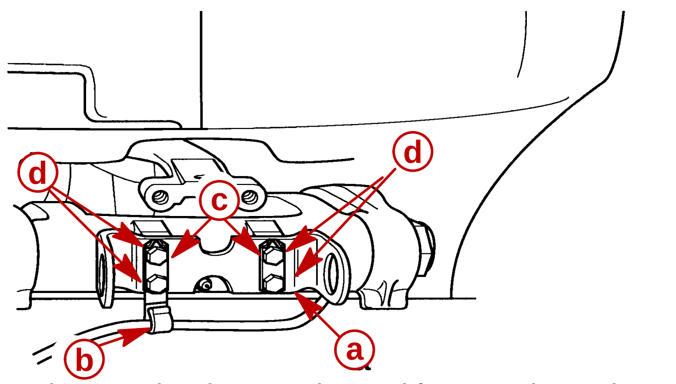
IMPORTANT: Steering cable must be installed into tilt tube of port outboard before outboard is mounted on boat transom.

Install Super Ride-Guide Steering Kit in accordance with instructions included with Super Ride-Guide Kit.

STEERING CABLE INSTALLATION - STARBOARD OUTBOARD

IMPORTANT: Mounting bracket for steering cable mounting tube MUST BE secured to outboard swivel bracket, using 5/8 in. (16 mm) long bolts supplied with this dual cable - dual outboard attaching kit.

Secure mounting bracket for steering cable mounting tube, onto swivel bracket of starboard outboard.



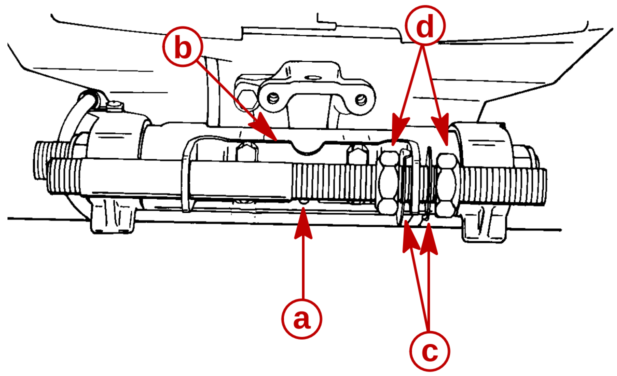
a - Mounting Bracket for Steering Cable Mounting Tube
b - "J" Clip - Supplied with Outboard
c - Locking Retainers (2)
d - Bolts (4) - 5/8 in. (16 mm) Long - Torque to 100 lb. in. (11.5 Nm), Then Bend Corner Tabs of Locking Retainers Up and Against Flats on Each Bolt.

⚠ WARNING

Locking retainer corner tabs MUST BE bent up and against flats on each bolt that secures mounting bracket for steering cable mounting tube, to prevent bolts from turning out.

Install Steering Cable mounting tube into mounting bracket with 2 adjusting nuts and 2 locking tab washers. Verify longer threaded end of tube is toward center of boat transom.

Temporarily adjust tube, so that longer threaded end of tube extends out the same distance as the outboard tilt tube. Do not tighten adjustment nuts at this time.



51891

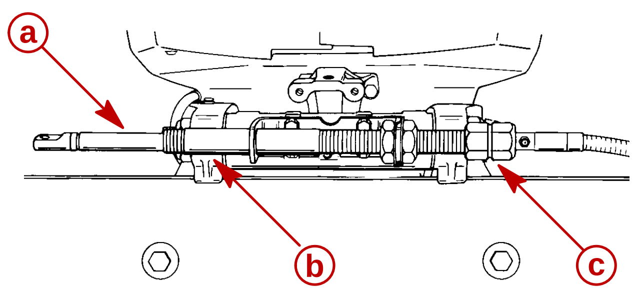
- **a** - Steering Cable Mounting Tube (End of Tube with Longer Threads Toward Center of Boat Transom)
- **b** - Mounting Bracket
- **c** - Locking Tab Washers (2)
- **d** - Adjustment Nuts (Flats of Nuts Facing Toward Locking Tab Washer)

IMPORTANT: Lubricate inside of steering mounting tube with 2-4-C w/Teflon (92-825407A12) before installing steering cable.

Lubricate inside of steering cable mounting tube (starboard outboard) with 2-4-C w/Teflon.

Insert steering cable end (a) (steering cable routed down port side of boat) thru cable mounting tube (b) and thread steering cable attaching nut (c) onto tube hand tight.

NOTE: *Torque steering cable attaching nut only after final steering adjustments have been made.*



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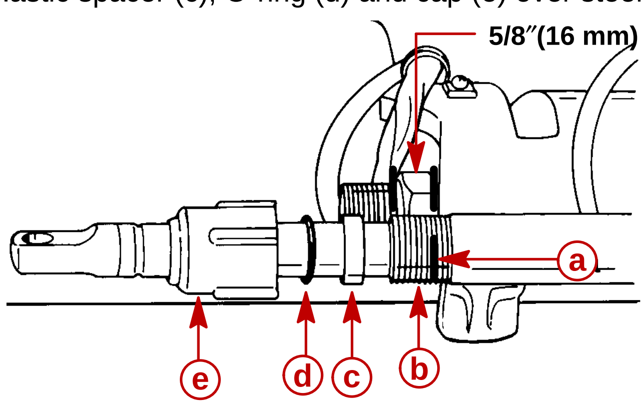
Place a mark (a) on steering cable mounting tube (b) 5/8 in (16 mm) from end of mounting tube. Slide plastic spacer (c), O-ring (d) and cap (e) over steering cable.



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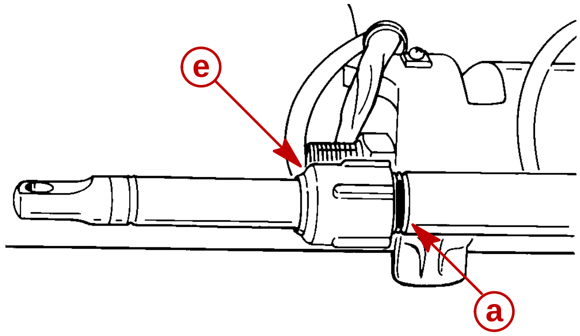
Thread cap (e) onto steering cable mounting tube, up to mark (a).



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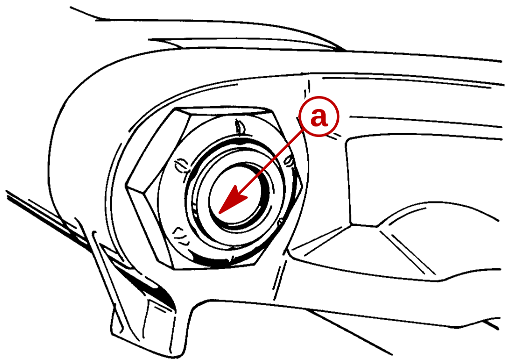
STEERING CABLE INSTALLATION - PORT OUTBOARD

IMPORTANT: Lubricate inside of port outboard's tilt tube and rubber O-ring seal located inside tilt tube with 2-4-C w/Teflon, before installing steering cable.

Lubricate inside of port outboard's tilt tube and rubber O-ring seal (a) with 2-4-C w/Teflon.



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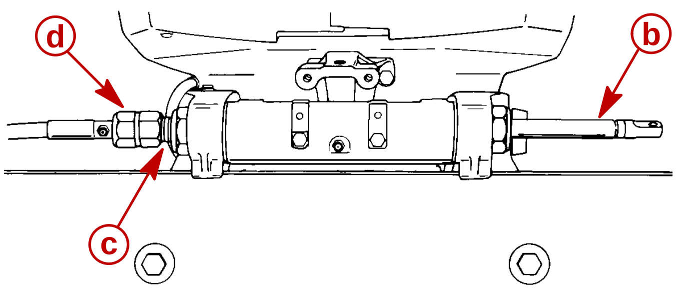
Insert steering cable end (b) (steering cable routed down starboard side of boat) thru tilt tube (c) of port outboard and thread steering cable attaching nut (d) onto tilt tube hand tight.

NOTE: *Torque steering cable attaching nut only after final steering adjustments have been made.*



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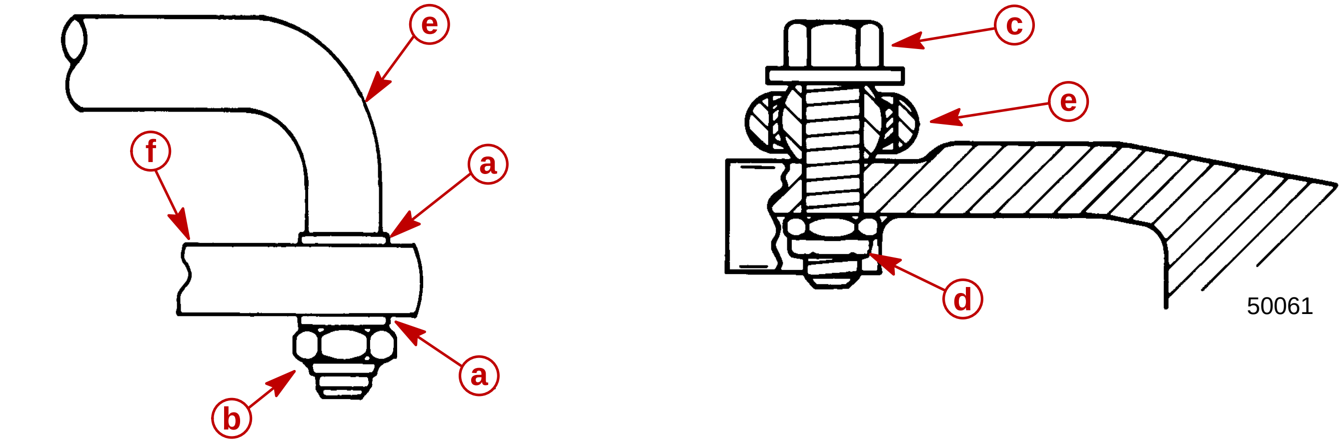
STEERING LINK ROD INSTALLATION

⚠ WARNING

Steering link rods MUST BE secured between outboard steering arm and steering cable end, using special washer head bolt (10-14000) and two nylon insert locknuts (11-34863), as shown. Both special washer head bolt and nylon insert locknuts MUST BE tightened as specified.

Lubricate holes in ends of steering cables, with Quicksilver 2-4-C w/Teflon (92-825407A12). Assemble steering link rods to steering cable ends of each outboard, using flat washers and nylon insert locknuts. Tighten locknuts until they seat [DO NOT exceed 120 lb. in. (13.5 Nm) of torque], then back nut off 1/4 turn.

Lubricate ball joints in steering link rods with SAE 30W Motor Oil. Secure link rods to outboard steering arms, using special washer head bolts (10-14000) provided and nylon insert locknuts as shown. Torque special bolts to 20 lb. ft. (27 Nm) then torque locknuts to 20 lb. ft. (27 Nm).



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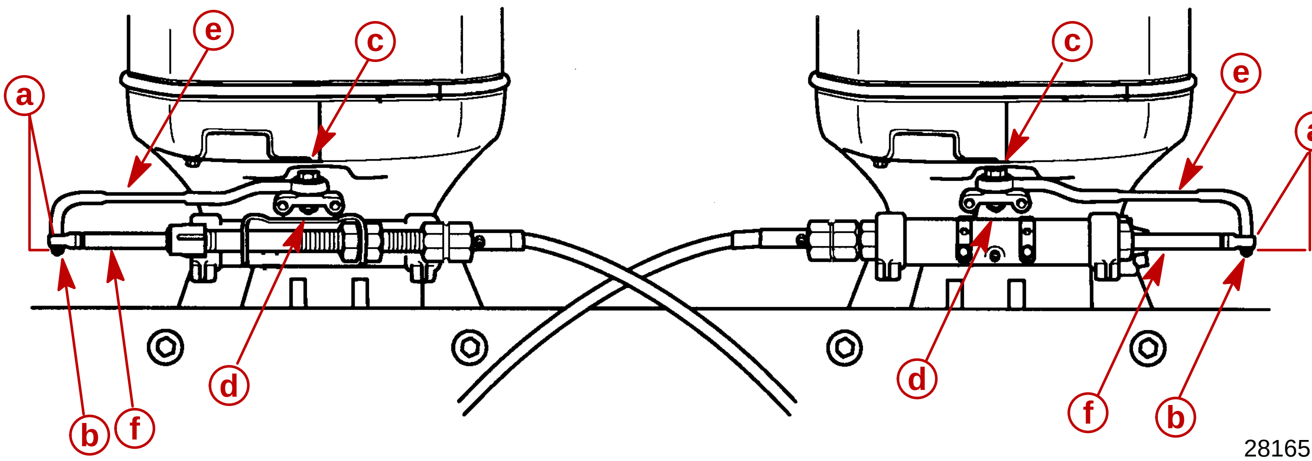
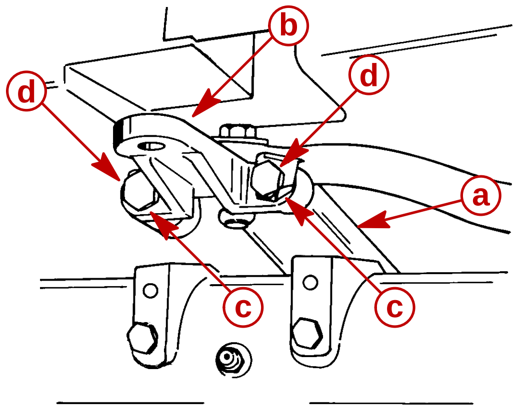


28165

a - Flat Washer (2 Each Link Rod)
b - Nylon Insert Locknut - Torque Until it Seats [DO NOT Exceed 120 lb. in. (13.5 Nm) of Torque], Then Back Off 1/4 Turn
c - Special Washer Head Bolt (10-14000) - Torque to 20 lb.ft. (27 Nm)
d - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)
e - Steering Link Rod
f - Steering Cable End

STEERING ARM EXTENSION BRACKET INSTALLATION

Secure a steering arm extension bracket to each out- board's steering arm.



51889

- **a** - Steering Arm (Port Outboard Shown)
- **b** - Extension Bracket
- **c** - Locking Retainer (2 Each Bracket)
- **d** - Bolts (2 Each Bracket) 1-1/4 in. (31.8 mm) Long - Torque to 23 lb. ft. (31 Nm), Then Bend Corner Tabs of Locking Retainers Up Against Flats on Each Bolt

WARNING

Locking retainer corner tabs, MUST BE bent up and against flats on each bolt that secures extension bracket to outboard steering arm, to prevent bolts from turning out.

STEERING COUPLER ASSEMBLY AND INSTALLATION

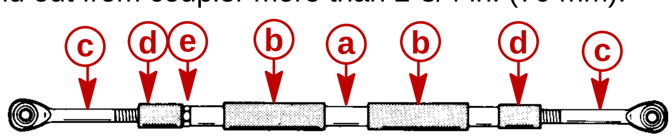
Position outboards so that they are facing straight forward. (Distance between threaded hole centers of steering arm extensions MUST BE equal to distance between propeller shaft centerlines.)

Lubricate inside of rubber sleeves with 2-4-C w/Teflon and slide sleeves on steering coupler.

Work rubber bushings onto threaded ends of steering eyes.

Thread jam nut on starboard steering eye.

Thread steering eyes equally into coupler, so that distance between hole centers of steering eye ball joints is equal to distance between threaded hole centers of steering arm extensions. Exposed threads of steering eyes MUST BE of equal length and threads MUST NOT extend out from coupler more than 2-3/4 in. (70 mm).



50061

- **a** - Coupler
- **b** - Rubber Sleeve
- **c** - Steering Eye
- **d** - Rubber Bushing
- **e** - Jam Nut

WARNING

Both steering eyes must be threaded into coupler 3/4 in. (19 mm) minimum. Thread length of steering eye is 3-1/2 in. (89 mm), so exposed thread must not extend out of coupler more than 2-3/4 in. (70 mm). Failure to adhere to this requirement could result in steering system failure.

Lubricate ball joint in steering eyes with SAE 30W Motor Oil.

Assemble steering coupler between outboard steering arm extension brackets, using special washer head bolts (10-14000) provided and nylon insert locknuts, as shown.

IMPORTANT: With assembled steering coupler installed and before tightening special washer head bolts/locknuts, check outboard alignment. Distance between centers of special washer head bolts MUST BE equal to distance between propeller shaft center lines, for proper steering. If adjustment is necessary, temporarily remove special washer head bolt/locknut from one steering eye and turn eye in or out to correct alignment.

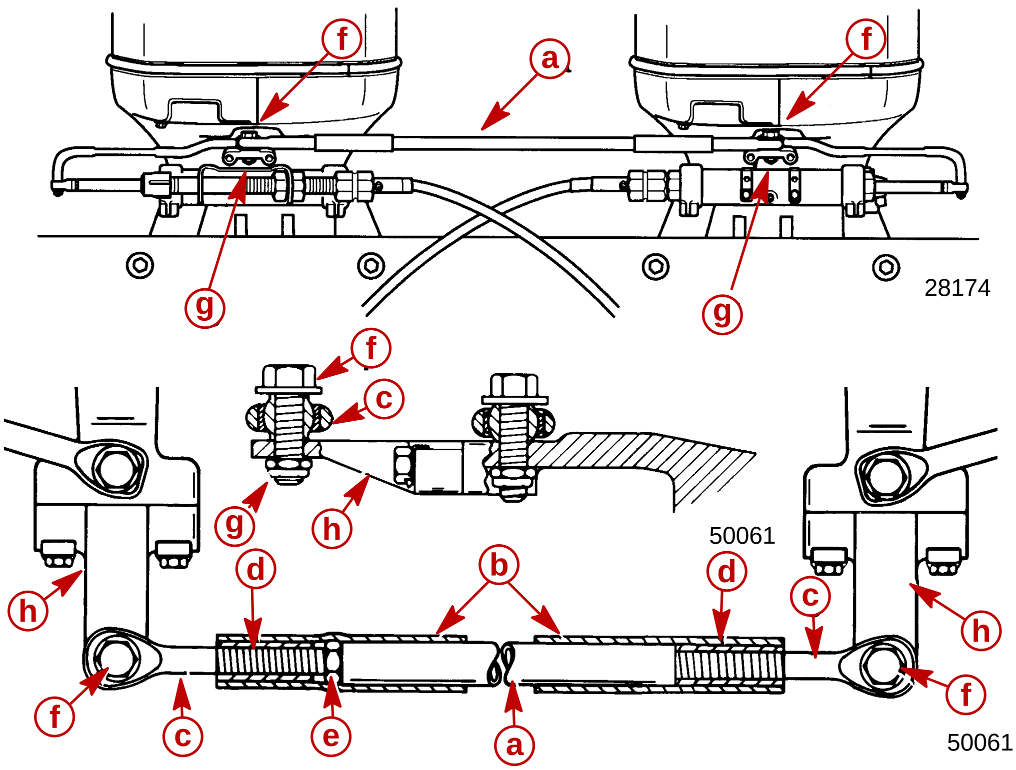
Torque special washer head bolts to 20 lb. ft. (27 Nm), then torque locknuts to 20 lb. ft. (27 Nm).

WARNING

Both steering eyes MUST BE threaded into coupler 3/4 in. (19 mm) minimum, and jam nut must be tightened against coupler to prevent coupler from turning. Torque "jam" nut to 20 lb. ft. (27 Nm).

Tighten "jam" nut against coupler. Torque "jam" nut to 20 lb. ft. (27 Nm).

Spray Quicksilver Corrosion Guard on exposed threads of steering eyes and position rubber bushings and rubber sleeves to cover exposed threads of steering eyes.

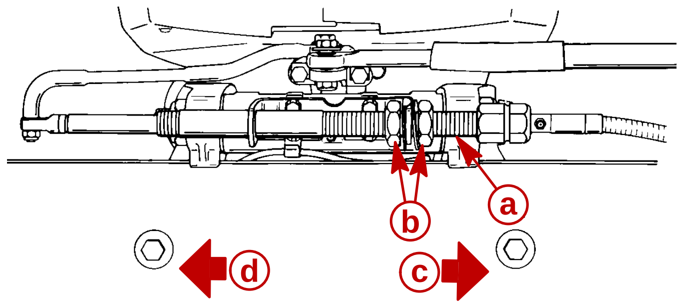


a - Coupler
b - Rubber Sleeve
c - Steering Eye
d - Rubber Bushing
e - Jam Nut - Torque (Against Coupler) to 20 lb. ft. (27 Nm)
f - Special Washer Head Bolt (10-14000) - Torque to 20 lb.ft. (27 Nm)
g - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)
h - Steering Arm Extension Bracket

STEERING SYSTEM TENSION ADJUSTMENT (PARALLEL ROUTED STEERING CABLES)

IMPORTANT: For proper operation of this dual cable - dual outboard steering installation, there MUST BE proper tension in the steering system. NOT ENOUGH tension will cause slack (play) in steering system. TOO MUCH tension will cause steering cables to bind. Perform the following steps to correctly adjust tension.

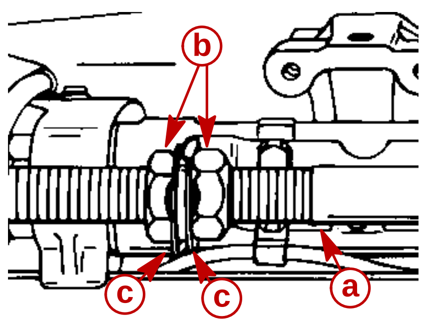
Loosen adjustment nuts and pull steering cable mounting tube (by hand) away from end of steering cable (to remove slack in steering system). Tighten adjustment nuts against mounting bracket and check system for slack (play). If steering system is too tight, readjust tube toward end of steering cable or, if too much slack (play) exists in system, readjust tube away from end of steering cable. Tighten nuts against mounting bracket and readjust, if necessary.



51887

a - Steering Cable Mounting Tube
b - Adjustment Nuts
c - Adjust Tube in This Direction to Remove Slack from Steering System
d - Adjust Tube in This Direction to Reduce Tension from

After steering system tension is adjusted correctly, tighten adjustment nuts against mounting bracket to a torque of 35 lb. ft. (47.5 Nm) and bend a tab lock washer against a flat on each nut.



51887

a - Steering Cable Mounting Tube
b - Adjustment Nuts; Torque to 35 lb. ft. (47.5 Nm)
c - Tab Lock Washer (Bend Against Flat on Each Adjustment Nut)

Tighten steering cable attaching nuts on each steering cable to a torque of 35 lb. ft. (47.5 Nm).

***NOTE:** Cable attaching nuts with a "V" groove around outer circumference are self locking and do not require locking sleeves.*

WARNING
After installation is complete [and before operating outboard(s)], check that boat will turn right when steering wheel is turned right and that boat will turn left when steering wheel is turned left. Check steering thru full range (left and right) at all tilt angles to assure interference-free movement.

Adjust trim tabs of both outboards, as outlined in **"Trim Tab Adjustment,"** following.

Trim Tab Adjustment

DUAL OUTBOARD - COUNTER ROTATION INSTALLATION

1. Shift outboard into neutral and make sure ignition key is at “OFF” position.
2. Remove plastic cap from rear of driveshaft housing and loosen bolt and trim tab.
3. Position trim tabs of both outboards straight to rear of outboard, so that tabs are aligned with gear housing centerline.
4. Tighten both trim tab bolts securely and replace plastic caps. No further adjustment will be required.

DUAL OUTBOARD - NON COUNTER ROTATION INSTALLATION

1. Check trim tab position as follows:

IMPORTANT: Initial trim tab setting for both outboards should be straight to rear of outboard, so that tabs are aligned with gear housing center line. Refer to “If necessary, adjust trim tab as follows,” following.

   a. Operate boat at normal cruise throttle setting and adjust trim to optimum setting.
   b. If boat pulls to the right (starboard), trailing edge of trim tab must be moved to the right (when viewing outboard from behind). If boat pulls to the left (port), trailing edge of trim tab must be moved to the left.

2. If necessary, adjust trim tab as follows:
   a. Shift outboard into NEUTRAL and make sure ignition key is at “OFF” position.
   b. Remove plastic cap from rear of driveshaft housing and loosen bolt and trim tab.

IMPORTANT: Trim tabs MUST BE set in the same position on both outboards.

   c. If boat pulls to the right, adjust trailing edges of both trim tabs to the right. If boat pulls to the left, adjust trailing edges of both trim tabs to the left.
   d. Tighten both trim tab bolts securely and replace plastic caps.
   e. Operate boat per **“Check trim tab position as follows,”** preceding, to check trim tab setting. Readjust trim tabs, if necessary.

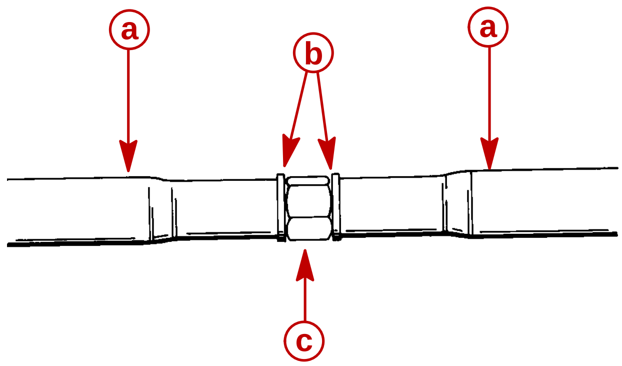
Ride Guide Steering Attachment Extension Couplers

Listed below are typical couplers available. Refer to the current Quicksilver Accessory Guide for specific coupler lengths and part numbers.

Outboard Center Line Distance	Required Coupler(s) Between Steering Eyes
22-1/2 in. thru 24-1/2 in. (572 mm thru 622 mm)	12″ (305 mm) Coupler
23-1/2 in. thru 27-1/2 in. (597 mm thru 699 mm)	15″ (381 mm) Coupler (Supplied with this kit)
26-1/2 in. thru 30-1/2 in. (673 mm thru 755 mm)	18″ (457 mm) Coupler
30 in. thru 34 in. (763 mm thru 864 mm)	9″ (229 mm) Coupler and 12″ (305 mm) Coupler (Connected together with coupler link rod)
33 in. thru 37 in. (838 mm thru 940 mm)	12″ (305 mm) Coupler and 12″ (305 mm) Coupler (Connected together with coupler link rod)

⚠ WARNING

When 2 couplers are connected together with coupler link rod, a lock washer must be used on each side of coupler link rod, and link rod must be torqued to 20 lb. ft. (27 N·m) into end of each coupler.



51890

a - Couplers Connected Together
b - Lock washers
c - Coupler Link Rod [Torque to 20 lb. ft. (27 Nm) into End of Each Coupler]

Maintenance Instructions

Maintenance inspection is owner’s responsibility and must be performed at intervals specified, following:

Normal Service - Every 50 hrs. of operation or 60 days (whichever comes first)

***Severe Service** - Every 25 hrs. of operation or 30 days (whichever comes first)

*Operation in a salt water area is considered **“Severe Service.”**

1. Carefully check steering system components for wear. Replace worn parts.
2. Check steering system fasteners to be sure that they are torqued to correct specifications.

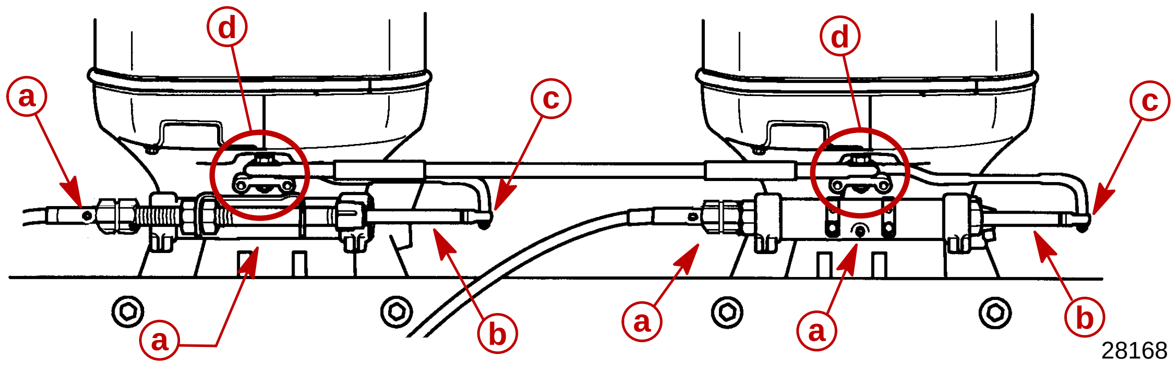
***NOTE:** Ride-Guide Steering Cables are lubricated at the factory and require no additional lubrication at initial installation.*

⚠ WARNING

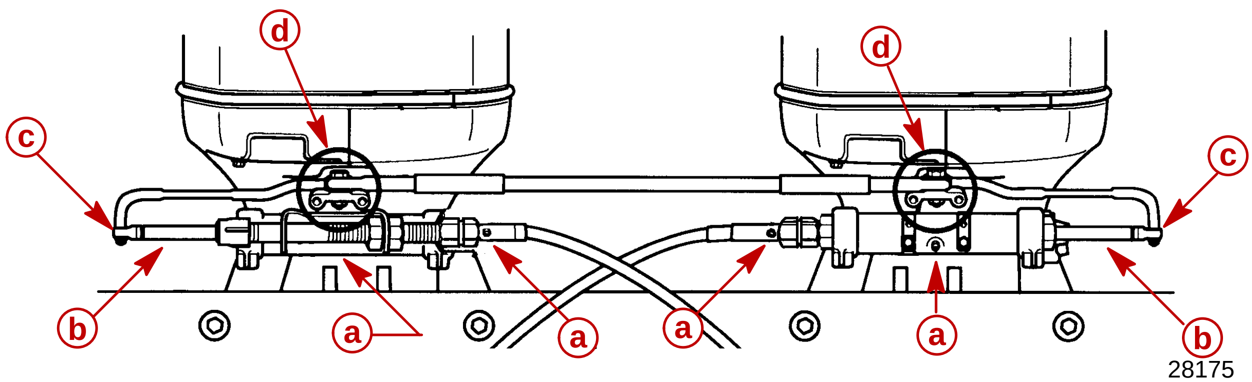
Core of each steering cable (transom end) must be fully retracted into cable housing before lubricating cable. If cable is lubricated while extended, hydraulic lock of cable could occur.

3. With core of Ride-Guide Steering Cable (transom end) fully retracted, lubricate transom end of steering cables thru grease fittings (a) with 2-4-C w/Teflon (92-825407A12). Lubricate exposed portion of cable ends (b) with 2-4-C w/Teflon.
4. Lubricate pivot points (c) of steering link rods and ball joints (d) of link rods/steering coupler with SAE 30W Motor Oil.

5. Inspection and lubrication of steering head assembly (rotary or straight rack) should be performed once each year (by your Authorized Dealer) or whenever steering mount and/or steering head are disassembled, or if steering effort has increased. Lubricate with 2-4-C w/Teflon.



Lubrication Points for Parallel Cable Routing Installations



Lubrication Points for Opposite Side Cable Routing Installations

a - Grease Fitting
b - Cable Ends
c - Pivot Points
d - Ball Joints

Transom Mounted Ride Guide Attaching Kit Installation (73770A1)

Attaching Kit Installation

1. Lubricate both holes in pivot block (Figure 1) with Quicksilver 2-4-C w/Teflon.
2. Place pivot block on pivot spacer and secure to transom bracket with 3/8 in. x 2-1/2 in. (9.5 mm x 63.5 mm) bolt, flat washer and locknut, as shown in Figure 1. Torque locknut to 20 lb. ft. (27 Nm).

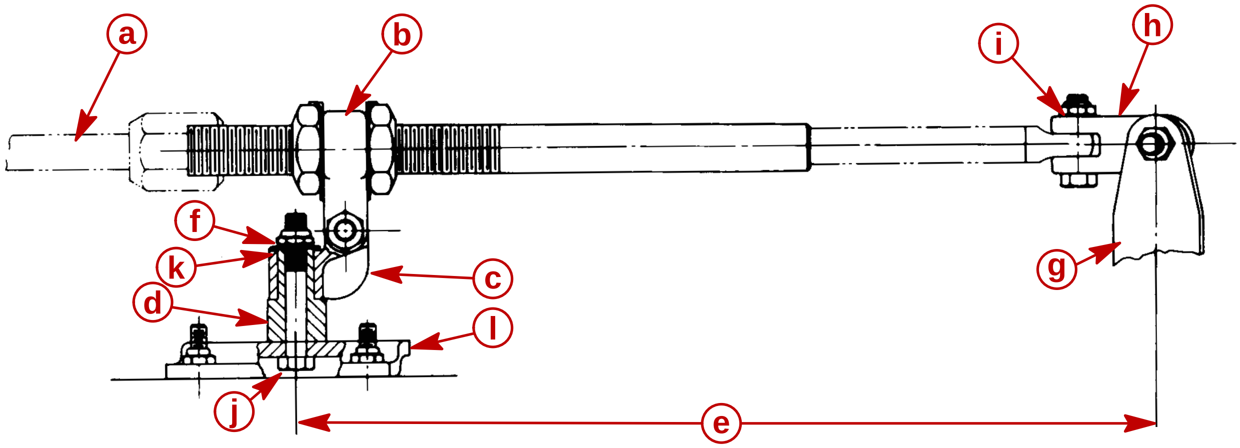


Figure 1

- **a** - Ride-Guide Cable
- **b** - Ride-Guide Yoke
- **c** - Pivot Block
- **d** - Pivot Spacer
- **e** - 15 in. (381 mm) (Centerline of Attaching Kit Pivot to Centerline of Outboard)
- **f** - Pivot Attaching Locknut [Torque to 20 lb. ft. (27 Nm)]
- **g** - Outboard Steering Arm
- **h** - “Clevis Kit”
- **i** - Ride-Guide Cable Attaching Locknut [Torque to 10 lb. ft. (13.5 Nm)]
- **j** - Bolt [3/8 in. x 2-1/2 in. (9.5 mm x 63.5 mm)]
- **k** - Flat Washer
- **l** - Transom Bracket

3. Place Ride-Guide yoke on pivot block and secure with 7/16 in. x 1-3/4 in. (11.1 mm x 44.5 mm) bolt and locknut, as shown in Figures 1 and 2. Torque locknut to 10 lb. ft. (13.5 Nm), **then back off 1/4-turn.**

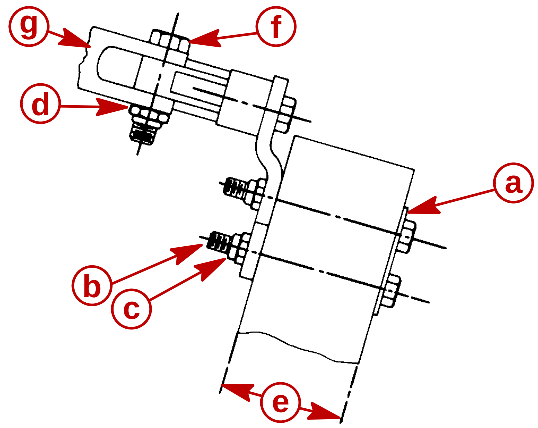


Figure 2

- **a** - Transom Backing Plate
- **b** - Bolt [5/16 in. x 3-1/4 in. (7.9 mm x 82.5 mm)]
- **c** - Locknut [Torque to 10 lb. ft. (13.5 Nm)]
- **d** - Ride-Guide Yoke Attaching Locknut [Torque to 10 lb. ft. (13.5 Nm)] **Then Back Off 1/4-Turn**
- **e** - 2-3/8 in. (60.3 mm) Maximum Transom Thickness
- **f** - Bolt [7/16 in. x 1-3/4 in. (11.1 mm x 44.5 mm)]
- **g** - Ride-Guide Yoke

4. Install one cable tube jam nut onto steering cable tube. Place tab washer over Ride-Guide yoke, then insert cable tube thru tab washer and yoke. Install second cable tube jam nut onto cable tube but do not tighten at this time. (Figure 3)

5. Position transom attaching kit on transom as shown:

   a. Determine centerline of outboard, then measure 15 in. (38.1 cm) over from this centerline and draw a vertical line on transom. (Figure 1)

b. Position attaching kit on transom so that **transom bracket is centered on the 15 in. (38.1 mm) measure** (Figure 1), at the height where the **center of the Ride-Guide yoke is even with, or not more than 1/2 in. (12.7 mm)** above top edge of transom. (Figure 3)

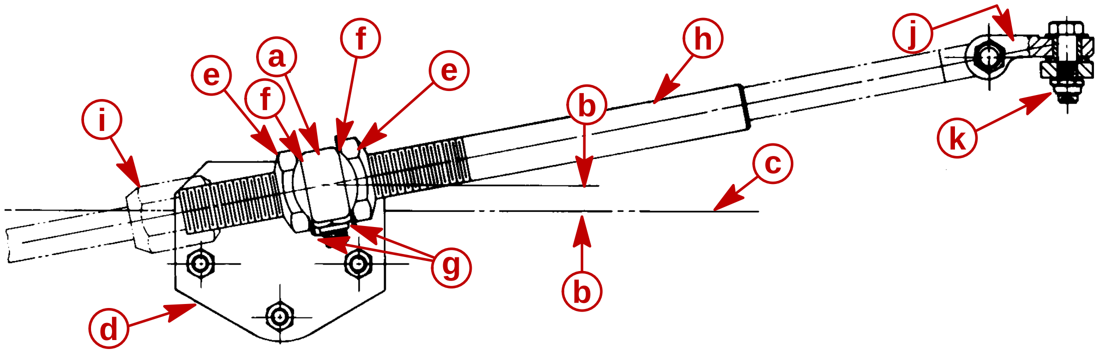


Figure 3

- **a** - Ride-Guide Yoke
- **b** - 0 in. to 1/2 in. (0 mm to 12.8 mm) (Center of Ride-Guide Yoke to Top of Transom
- **c** - Top of Transom
- **d** - Transom Bracket
- **e** - Cable Tube Jam Nuts [Torque to 35 lb. ft. (47.5 Nm)]
- **f** - Tab Washer
- **g** - After Jam Nuts Are Torqued to Specification, Bend Locking Tabs against Nuts
- **h** - Cable Guide Tube
- **i** - Ride-Guide Cable Attaching Nut [Torque to 35 lb. ft. (47.5 Nm)]
- **j** - "Clevis Kit"
- **k** - Clevis Attaching Locknut [Torque to 20 lb. ft. (27 Nm)]

NOTE: *When drilling thru transom, be sure that holes are drilled perpendicular to transom.*

6. With attaching kit positioned as outlined preceding, use 3 holes in transom bracket as a guide and drill three 11/32 in. (8.7 mm) holes thru transom.
7. Use a marine-type sealer on three 5/16 in. x 3-1/4in. (7.9mm x 82.6mm) bolts. Secure attaching kit to transom, using transom backing plate, 3 bolts (with sealer) and 3 locknuts, installed as shown in Figure 2. Torque lock nuts to 10 lb. ft. (13.5 Nm).

STEERING CABLE INSTALLATION

1. Lubricate steering cable end with Quicksilver 2-4-C w/Teflon (92-825407A12).
2. Install steering cable thru steering cable tube, and secure with cable attaching nut. (Figure 3) Do not tighten cable attaching nut at this time.
3. Attach Ride-Guide cable to outboard steering arm, using the proper "Clevis Kit." Installation instructions for clevis are with "Clevis Kit."
4. Adjust 2 large jam nuts on cable tube of attaching kit, so that **steering wheel** is in normal straight-driving position with outboard in straight-running position. Torque each jam nut to 35 lb. ft. (47.5 Nm), then bend a side of tab washer against flat of each jam nut. (Figure 3)
5. Torque Ride-Guide cable attaching nut (which secures cable to guide tube) to 35 lb. ft. (47.5 Nm). (Figure 3)

WARNING

After installation is completed (and before operating outboard), check that boat will turn right when steering wheel is turned right and that boat will turn left when steering wheel is turned left. Check steering thru full range (left and right) at all tilt angles to assure interference-free movement.

Maintenance Instructions

Lubrication and maintenance inspection is owner's responsibility and must be performed at intervals specified, following:

Normal Service - Every 50 hrs. of operation or 60 days (whichever comes first)

***Severe Service -** Every 25 hrs. of operation or 30 days (whichever comes first)

*Operation in a salt water area is considered **"Severe Service."**

CAUTION

Core of steering cable must be fully retracted into cable housing when lubricating cable. If cable is lubricated while extended, hydraulic lock of cable could occur.

1. Lubricate outboard end of Ride-Guide steering cable (thru grease fitting - if equipped - next to cable attaching nut) with Quicksilver 2-4-C w/Teflon.

NOTE: *Ride-Guide steering cable is lubricated at the factory and requires no additional lubrication at initial installation.*

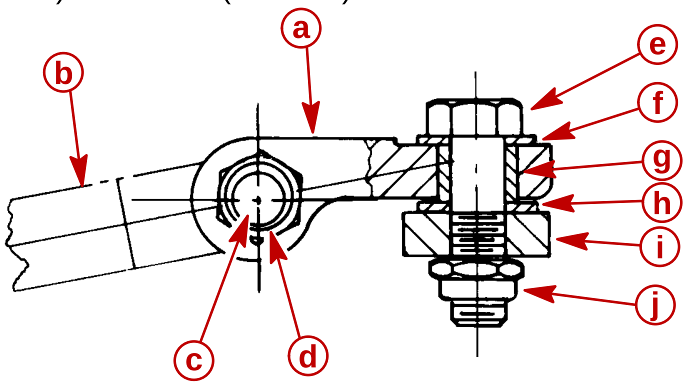
2. Lubricate all steering system pivot points (and exposed portion of steering cable core) with Quicksilver 2-4-C w/Teflon. Lubricate at intervals specified preceding.
3. Carefully check steering system components for wear (at intervals specified, preceding). Replace worn parts.
4. Check steering system fasteners (at intervals specified, preceding) to be sure that they are torqued to correct specifications. (Figures 1, 2 and 3)

Clevis Attaching Kit Installation (A-70599A5)

NOTE: *This kit is used to attach Ride-Guide cable to outboard steering arm ONLY when* ***"Transom Mounted Ride-Guide Attaching Kit"*** *is being used. If Ride-Guide cable is installed thru outboard tilt tube, then "Steering Link Rod" must be used.*

Installation Instructions

1. Install clevis to steering cable as shown.
2. Lubricate 3/8 in. x 1-3/8 in. (9.5 mm x 34.9 mm) bolt (area without threads) with 2-4-C w/Teflon, then secure clevis to steering cable with this bolt and a locknut. Torque locknut (item "d") to 10 lb. ft. (13.5 Nm).



a - Clevis
b - Steering Cable
c - Bolt [3/8 in. x 1-3/8 in. (9.5 mm x 34.9 mm)]
d - Clevis to Steering Cable Locknut [Torque to 10 lb. ft. (13.5 Nm)]
e - Bolt [3/8 in. x 1-1/4 in. (9.5 mm x 31.8 mm)] [Torque to 20 lb. ft. (27 Nm)]
f - Thin Washer [1/16 in. (1.6 mm) Thick]
g - Spacer
h - Thick Washer [1/8 in. (3.2 mm) Thick]
i - Engine Steering Arm
j - Clevis to Engine Locknut [Torque to 20 lb. ft. (27 Nm)]

3. Lubricate spacer (supplied with this kit) with 2-4-C w/Teflon.
4. Attach clevis to top of outboard steering arm with a 3/8 in. x 1-1/4 in. (9.5 mm x 31.8 mm) bolt, thin washer, spacer, thick washer (thick washer must be installed between clevis and steering arm) and locknut, as shown. Torque bolt (item "e") to 20 lb. ft. (27 Nm), then torque locknut (item "j") to 20 lb. ft. (27 Nm).

Maintenance Instructions

Lubrication and maintenance inspection is owner's responsibility and must be performed at intervals specified, following:

Normal Service - Every 50 hrs. of operation or 60 days (whichever comes first)

***Severe Service -** Every 25 hrs. of operation or 30 days (whichever comes first)

*Operation in a salt water area is considered **"Severe Service."**

1. Carefully check steering system components (at intervals specified, preceding) for wear. Replace worn parts.
2. Check steering system fasteners (at intervals specified, preceding) to be sure that they are torqued to correct specifications.
3. Lubricate clevis pivot points with a drop of light oil. Lubricate at intervals specified, preceding.

COLOR DIAGRAMS

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3.0 LITRE OPTIMAX
2000 MODEL YEAR
ANALOG WIRING DIAGRAM

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2. Ignition Coils
3. Fuel Injectors
4. Direct Injectors
5. Oil Pump
6. MAP Sensor
7. Block Pressure Sensor
8. Water Sensor
9. Shift Switch
10. Air Temperature Sensor
11. Throttle Position Sensor (TPS)
12. Crank Position Sensor
13. ECM Driver/Oil Pump Circuit 20 Ampere Fuse
14. Electric Fuel Pump 20 Ampere Fuse
15. Ignition Coil 20 Ampere Fuse
16. Accessories 20 Ampere Fuse
17. Low Oil Switch
18. Compressor Temperature Switch
19. Starter Solenoid
20. Starter Motor
21. 60 Ampere Alternator
22. Main Power Relay
23. Starboard Head Temperature Switch
24. To Remote Control Trim Switch
25. Cowl Mounted Trim Switch
26. Trim Down Relay
27. Trim Up Relay
28. To Trim Pump
29. To 12 Volt Battery
30. Trim Sender
31. Fuel Pump #1 (Inside Vapor Separator)
32. Fuel Pump #2 (Outside Vapor Separator)
33. Engine Harness
34. To Temperature Gauge
35. Low Oil Light
36. Over Heat Light
37. Water in Fuel Light
38. Accessory Power
39. Check Engine Light
40. DDT Test Port
41. SmartCraft Harness (8 pin)

3.0 Litre OptiMax 2000 Model Year Analog

3.0 LITRE OPTIMAX
2000 MODEL YEAR
DIGITAL WIRING DIAGRAM

1. ECM
2. Ignition Coils
3. Fuel Injectors
4. Direct Injectors
5. Oil Pump
6. MAP Sensor
7. Block Pressure Sensor
8. Water Sensor
9. Shift Switch
10. Air Temperature Sensor
11. Throttle Position Sensor (TPS)
12. Crank Position Sensor
13. ECM Driver/Oil Pump Circuit 20 Ampere Fuse
14. Electric Fuel Pump 20 Ampere Fuse
15. Ignition Coil 20 Ampere Fuse
16. Accessories 20 Ampere Fuse
17. Low Oil Switch
18. Starter Solenoid
19. Starter Motor
20. 60 Ampere Alternator
21. Main Power Relay
22. Compressor Temperature Switch
23. Port Head Temperature Switch
24. Starboard Head Temperature Switch
25. To Remote Control Trim Switch
26. Cowl Mounted Trim Switch
27. Trim Down Relay
28. Trim Up Relay
29. To Trim Pump
30. To 12 Volt Battery
31. Fuel Pump #1 (Inside Vapor Separator)
32. Fuel Pump #2 (Outside Vapor Separator)
33. Engine Harness
34. To Temperature Gauge
35. Low Oil Light
36. Over Heat Light
37. Water in Fuel Light
38. Accessory Power
39. Optional Analog Tachometer Signal Wire
40. Check Engine Light
41. To Boat Harness, Brown/White Connection to SmartCraft Data Link (ECM)
42. DDT Test Port
43. SmartCraft Data Link Connection
44. SmartCraft Harness (8 pin)

3.0 Litre OptiMax 2000 Model Year Digital

3.0 LITRE OPTIMAX
2001 MODEL YEAR
WIRING DIAGRAM

1. ECM
2. Ignition Coils
3. Coil Drivers
4. Fuel Injectors
5. Direct Injectors
6. Oil Pump
7. MAP Sensor
8. Block Pressure Sensor
9. Water Sensor
10. Shift Switch
11. Starboard Head Temperature Switch
12. Port Head Temperature Switch
13. Throttle Position Sensor (TPS)
14. Crank Position Sensor
15. SmartCraft Data Bus Circuit - 15 Ampere Fuse
16. ECM Driver, Oil Pump, and Injectors 20 Ampere Fuse
17. Power Trim and Electric Fuel Pumps 20 Ampere Fuse
18. Ignition Coils - 20 Ampere Fuse
19. Low Oil Switch
20. Compressor Temperature Switch S/N OT280000 and below
21. Compressor Temperature Switch S/N OT280001 and above. Tan Lead to Analog Temperature Gauge
22. Slave Solenoid
23. Starter Solenoid
24. Starter Motor
25. 60 Ampere Alternator
26. Air Temperature Sensor
27. Main Power Relay
28. To Remote Control Trim Switch
29. Cowl Mounted Trim Switch
30. Trim Down Relay
31. Trim Up Relay
32. To Trim Pump
33. To 12 Volt Battery
34. Fuel Pump #1 (Inside Vapor Separator)
35. Fuel Pump #2 (Outside Vapor Separator)
36. Accessory Power
37. Engine Harness
38. Data Buss (10 Pin) Control Area Network (CAN)
39. DDT Test Port
40. SmartCraft Data Link Connection
41. SmartCraft Harness (8 pin)
42. Optional Analog Tachometer Signal Wire
43. To Boat Harness, Brown/White Connection to SmartCraft Data Link (ECM)

3.0 Litre OptiMax 2001 Model Year

TYPICAL
SMARTCRAFT (NON CAN)
INSTALLATION
2000 MODEL YEAR

1. 8-Pin Digital Sensor Harness Extension Connection to Engine Wiring Harness
2. Digital Speedometer Sensor
3. Digital Trim Sender
4. 6-Pin Digital Sensor Harness
5. Connection for Analog Temperature Sender
6. Connections to Trim Relays
7. Connection to SmartCraft Data Link (ECM) Two Wire Harness
8. Remote Control Harness Connects to Engine Harness
9. Digital Connections for Fuel Sender
10. Digital Connections to Oil Sender
11. 4-Pin Digital Sensor Harness Connection to Paddle Wheel
12. Paddle Wheel/Lake/Sea Water Temperature Sender
13. Analog Temperature Gauge Connection
14. Warning Horn
15. Tachometer Harness
16. SmartCraft Tachometer Harness
17. Ignition Key Switch
18. Connections for Neutral Start Switch
19. Connections for Power Trim Switch
20. Connections for Lanyard Stop Switch
21. Mechanical Panel Control (MPC) 4000
22. Connection to 12 Volt Power Supply of Engine being Monitored
23. Connection for Optional Visual Warning Light
24. SmartCraft Tachometer
25. Connection Between SmartCraft Tachometer Harness and SmartCraft Tachometer
26. Connection Between SmartCraft Tachometer Harness and SmartCraft Speedometer Harness
27. Connection for Optional GPS
28. Connection Between SmartCraft Speedometer Harness and SmartCraft Speedometer
29. SmartCraft Speedometer
30. Connection for Ambient Air Temperature Sensor
31. Ambient Air Temperature Sensor
32. Connection for Second SmartCraft Tachometer (Dual Outboard Application)
33. SmartCraft Tachometer Harness (Dual Outboard Application)
34. SmartCraft Tachometer (Dual Outboard Application)
35. Connection for Optional Visual Warning Light (Dual Outboard Application)
36. Connection to 12 Volt Power Supply of Second Engine being Monitored (Dual Outboard Application)
37. Connection to Second Remote Control Tachometer Harness (Dual Outboard Application)

Typical SmartCraft (Non CAN) Installation 2000 Model Year

TYPICAL SMARTCRAFT (CAN) INSTALLATION 2001 MODEL YEAR

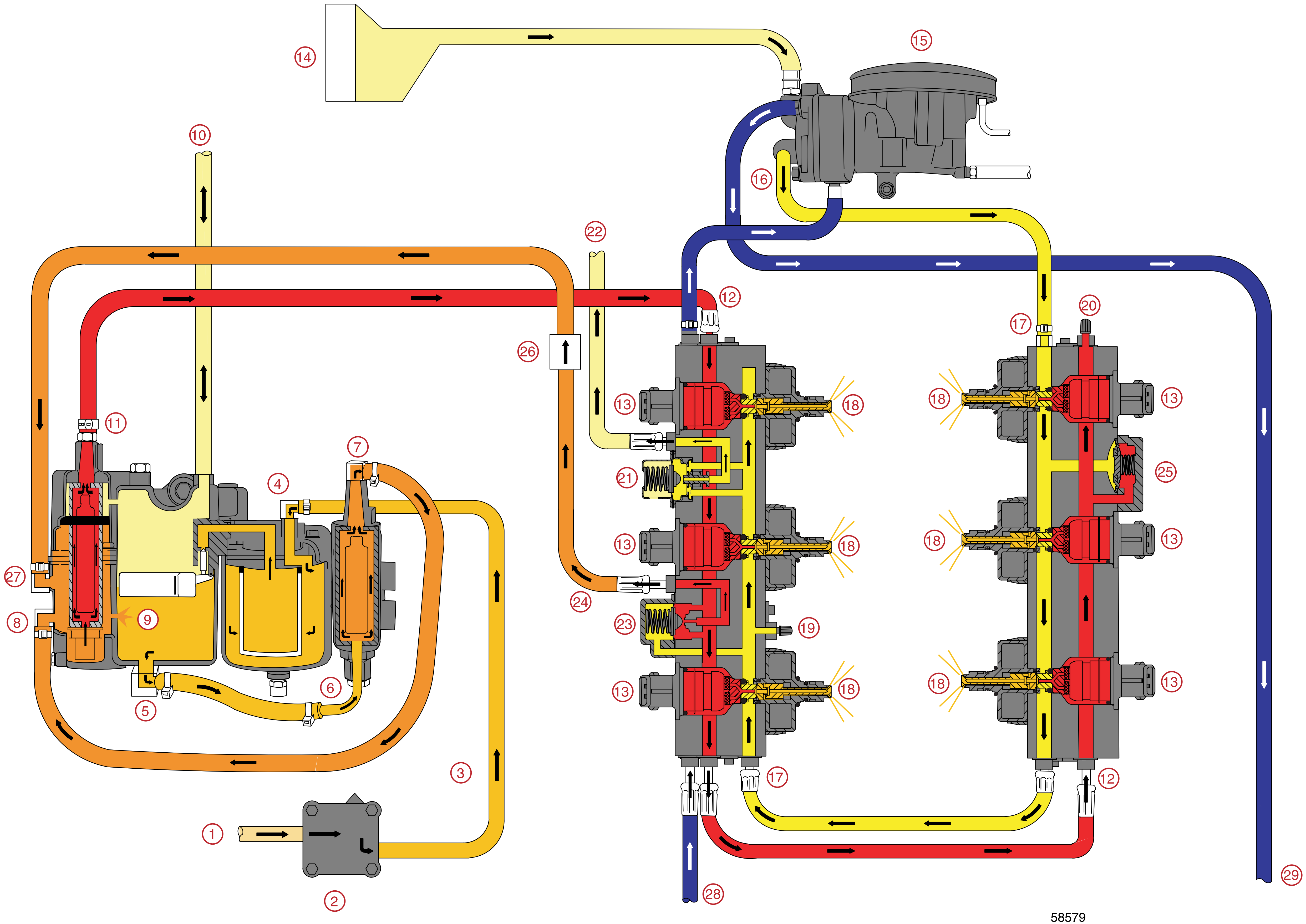
1. 8-Pin Digital Sensor Harness Extension, Connect to 8-Pin SmartCraft Harness on Engine
2. Digital Speedometer Sensor
3. Digital Trim Sender
4. 6-Pin Digital Sensor Harness
5. Connection for Analog Temperature Sender
6. Connections to Trim Relays
7. Connection for Analog Trim Sender
8. Remote Control Harness Connects to Engine Harness
9. 10-Pin Control Area Network (CAN) Harness, Connect to Data Buss 10-Pin CAN Harness on Engine
10. Resistors within CAN Harness (120Ω 1/4W 5%)
11. Connections for Auxiliary Warning Horn for Depth Sensor
12. 10-Pin Control Area Network (CAN) Connection to System Monitor
13. System Monitor
14. System Link Series Connections
15. 3-1/4 in. System Link Gauges (Tachometer and Speedometer)
16. 2-1/4 in. Dia. System Link Gauges (Fuel, Temperature, Trim, etc.)
17. Series Connection for Additional System Link Gauges
18. 4000 Series Mechanical Panel Control (MPC 4000)
19. Connections for Lanyard Stop Switch
20. Connections for Power Trim Switch
21. Connections for Neutral Start Safety Switch
22. Ignition Key Switch
23. Analog Tachometer Harness (Not Used on CAN Installation)
24. Warning Horn
25. Analog Temperature Gauge Connection
26. Paddle Wheel/Lake/Sea Water Temperature Sender
27. 4-Pin Digital Sensor Harness Connection to Paddle Wheel
28. Digital Connections to Oil Sender
29. Digital Connections for Fuel Sender

Typical SmartCraft (CAN) Installation 2001 Model Year

3.0 LITRE OPTIMAX
2000 & 2001 MODEL YEAR
FUEL & AIR FLOW DIAGRAM

1. Fuel inlet from primer bulb
2. Engine Pulse Fuel Pump
3. Fuel line to Water Separating Fuel Filter – 2-8 psi (14-55 kPa)
4. Water Separating Fuel Filter attached to Vapor Separator Tank (VST) Assembly
5. Fuel outlet from VST
6. Fuel Inlet to Low Pressure Electric Fuel Pump
7. Fuel outlet from Low Pressure Electric Fuel Pump – 7-9 psi (48-62 kPa)
8. Fuel inlet to High Pressure Electric Fuel Pump.
9. Relief Passage – Unused fuel returning to VST
10. Air Vent to VST
11. Fuel outlet from High Pressure Electric Fuel Pump – 90 psi (620 kPa)
12. High pressure fuel Inlet to Air/Fuel Rails – 90 psi (620 kPa)
13. Fuel Injector is opened by the ECM, 90 psi (620 kPa) fuel is discharged into a machined cavity inside the air chamber of the air/fuel rail. This mixes the fuel with the air charge.
14. Air Inlet to Air Compressor
15. Air Compressor
16. High Pressure Air Outlet – 80 psi (551 kPa)
17. High Pressure Air Inlet to Air/Fuel Rails – 80 psi (551 kPa)
18. Direct Injector discharges the air/fuel mixture into the combustion chamber
19. Schrader Valve for Testing Air Pressure
20. Schrader Valve for Testing Fuel Pressure
21. Air Pressure Regulator will limit the amount of pressure developed inside the air passages to approximately 10 psi (69 kPa) below the pressure of the fuel inside the fuel passages (i.e. 80 psi [551 kPa] air vs 90 psi [620 kPa] fuel)
22. Bleed Off from Air Pressure Regulator, Routed to the Exhaust Adaptor and Exits thru the Propeller
23. Fuel Pressure Regulator not only regulates fuel pressure but also regulates it at approximately 10 p.s.i. (69 kPa) higher than whatever the air rail pressure is. The fuel regulator diaphragm is held closed with a spring that requires 10 p.s.i. (69 kPa) to force the diaphragm off the diaphragm seat. The back side of the diaphragm is exposed to air rail pressure. As the air rail pressure increases, the fuel pressure needed to open the regulator will equally increase.
24. Bleed off from Fuel Pressure Regulator, Routed Back to VST
25. Tracker Valve has a rubber diaphragm which expands and retracts to equalize the pulses developed by the pumps (both air and fuel).
26. Check Valve – 40 psi (276 kPa)
27. Fuel return inlet from Fuel Regulator
28. Water Inlet to cool port air/fuel rail and air compressor
29. Cooling water from Compressor routed to Tell-Tale

3.0 Litre OptiMax Fuel & Air Flow
2000 & 2001 Model Year



3.0 LITRE OPTIMAX
2000 & 2001 MODEL YEAR
WATER FLOW DIAGRAM

1. Water Inlet
2. Water Pump
3. Wall of Water – If water level height is insufficient, water pump may draw in air resulting in an overheated engine
4. Stainer, Exhaust Cooling Water
5. Main Water Feed to Powerhead from Water Tube
6. Rubber Water Dams (6) – If missing may result in uneven cooling of cylinders and scuffed pistons.
7. Cylinder Head Cover – Removed from head for illustration, normally part of head casting
8. Thermostats (2) 143° F (61.7° C) – If stuck closed, engine will overheat at idle. If stuck open, engine will run cold at idle.
9. Main Water Dump from Powerhead – Fills chamber in Adaptor Plate which feeds Port Fuel Rail, Air Compressor, and Poppet Valve.
10. Strainer Screen for Port Fuel Rail and Air Compressor Water Supply – If restricted, compressor will overheat and tell-tale will be weak
11. Port Fuel Rail – Fuel Cooler is built into Port Fuel Rail
12. Air Compressor – Water Outlet from Air Compressor connects to Tell-Tale outlet on bottom cowl
13. Tell-Tale outlet on bottom cowl
14. Powerhead Flush Inlet Plug
15. Check Valve for Powerhead Flush
16. Block Water Pressure Sensor
17. Rear Exhaust Divider Plate – Separated for illustration. normally part of engine block
18. Poppet Valve – Controls water flow at high RPM. If poppet valve is stuck open at low RPM, the engine will not reach proper operating temperature (run cold) and will run rough at idle
19. Poppet Valve in Closed Position
20. Poppet Valve in Open Position
21. Main Water Dump from Thermostats and Poppet Valve
22. Poppet Valve, when open, fills chamber in Exhaust Tube and Slots provide water spray to keep exhaust relief holes clear
23. Some Water from Water Tube Strainer is diverted through Exhaust Tube and Propeller Hub with Exhaust Discharge
24. Excess Water from Wall of Water around exhaust tube exits around anodes

3.0 Litre OptiMax 2000 & 2001 Model Year Water Flow