MERCURY

Service Manual

150/175/200

Electronic Fuel Injection

Starting Model Year 2002
Starting Serial Number 0T409000

150/175/200 EFI

Starting Model Year 2002
Starting S/N 0T409000

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.

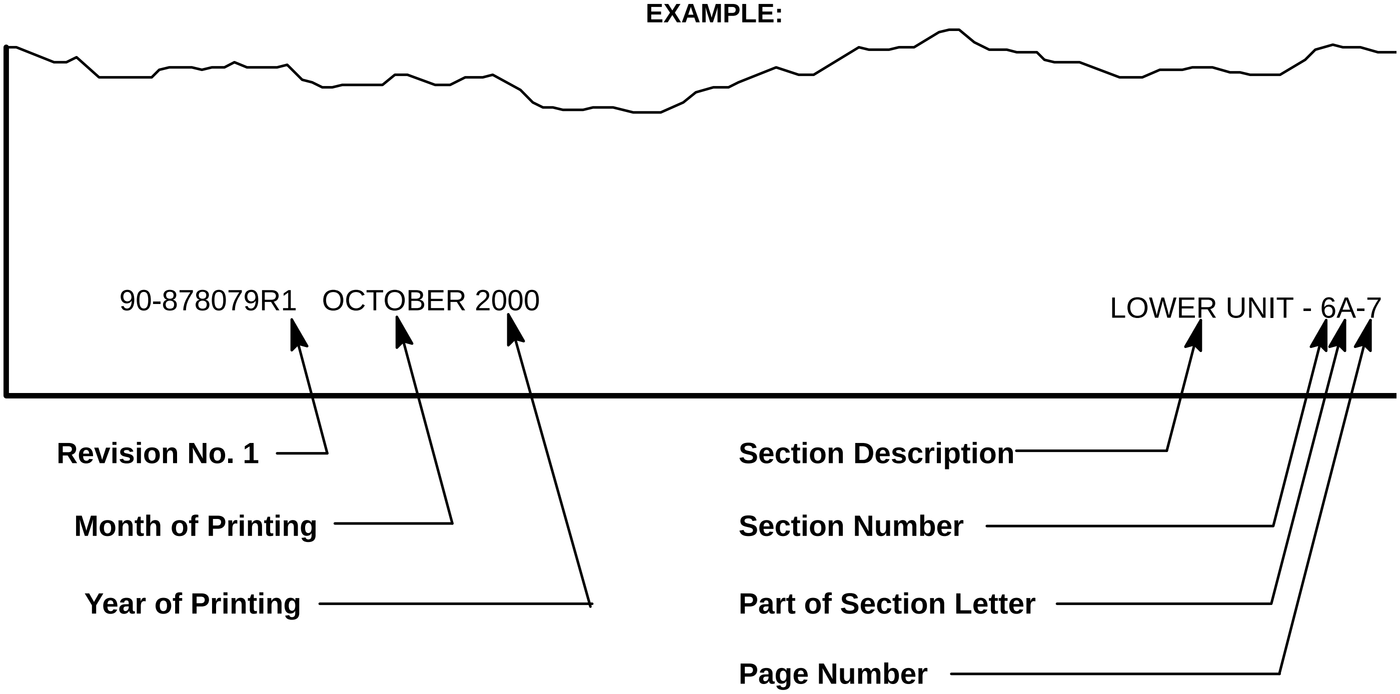
We reserve the right to make changes to this manual without prior notification.

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

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A

IMPORTANT INFORMATION

Section 1A - Specifications

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Specifications

Model 150XRI/175XRI/200XRI		
HORSEPOWER (KW)	**Model 150XRI** **Model 175XRI** **Model 200XRI** **Full Throttle RPM (150/175/200)** **Idle RPM (In Gear) (150/175/200)** **RPM Limiter** **All Models**	150 (111.8) 175 (130.5) 200 (149.1) 5250 – 5750 650 ± 50 Refer to System Information in the Digital Diagnostic Terminal (DDT) for latest information
OUTBOARD WEIGHT	**Model 150XRI/175XRI/200XRI** **Long Shaft** **X-Long Shaft**	 425.0 lb (192.8 kg) 434.0 lb. (196.8 kg)
CYLINDER BLOCK	**Model 150XRI/175XRI/200XRI** **Type** **Displacement** **Thermostat**	 V–6 Cylinder, Two Cycle, Loop Charged 153.0 cu. in. (2507cc) 143°F (61.7°C)
STROKE	**Length (All Models)**	2.650 in. (67.31 mm)
CYLINDER BORE	**Diameter (Std)** **Models 150XRI/175XRI/200XRI** **Taper/Out of Round/Maximum Wear** **Bore Type**	 3.501 in. (88.925 mm) 0.003 in. (0.076 mm) Cast Iron
CRANKSHAFT	**Maximum Runout**	0.006 (0.152 mm)
PISTON	**Piston Type** **Models 150XRI/175XRI/200XRI** **Standard** **0.015 in. (0.381 mm) Oversize**	Aluminum 3.494 in. ± 0.001 in. (88.748 mm ± 0.025 mm) 3.509 in. ± 0.001 in. (89.129 mm ± 0.025 mm)
COMPRESSION	**All Models – Using a fully charged battery, throttle shutters wide open and cylinder block warm**	110 – 135 psi (753.3 – 924.5 kPa) Variance between cylinders should not exceed 15 psi (102.7 kPa)
REEDS	**Model 150XRI/175XRI/200XRI** **Reed Type** **Reed Stand 0pen (Max.)** **Reed Stop (Max.)**	 Steel 0.020 in. (0.50 mm) Not Adjustable

MID SECTION	**Power Trim (Total Tilt Range)** **Power Trim (Tilt Range)** **Maximum Allowable Leak down in 24 hrs.** **Tilt Pin Adjustment Positions** **Steering Pivot Range** **Allowable Transom Thickness**	75° 20° 1 in. (25.4 mm) 5 60° 2-3/8 in. (6.03 cm) Maximum
FUEL SYSTEM	**Fuel** **Recommended Gasoline** **Recommended Oil** **Gasoline/Oil Ratio**	Gasoline w/Oil Injection Unleaded 87 Octane Minimum Quicksilver or Mercury Precision Lubricants NMMA/BIA Certified TC-W3 2 Cycle Outboard Oil 50:1 (25:1 Break-In) ECM Controlled – no premix
STARTING SYSTEM	**Electric Start – All Models** **Centrifugal Bendix** **Starter Draw (Under Load)** **Starter Load (No Load)** **Minimum Brush Length** **Solenoid Driven Bendix** **Starter Draw (Under Load)** **Starter Load (No Load)** **Minimum Brush Length** **Battery Rating**	 165 Amperes 30 Amperes 0.25 in. (25.4 mm) 175 Amperes 60 Amperes 0.25 in. (25.4 mm) Min. 630 Marine Cranking Amps (MCA) or 490 Cold Cranking Amps (CCA)
IGNITION SYSTEM	**Type** **Spark Plug Type** **Spark Plug Gap** **Firing Order** **Idle Timing** **Maximum Timing** **Throttle Position Sensor**	Digital Inductive NGK BPZ8HS-10 0.040 in. (1.0 mm) 1-2-3-4-5-6 Not Adjustable; Controlled by ECM Not Adjustable; Controlled by ECM Not Adjustable; Controlled by ECM
CHARGING SYSTEM	**Alternator Output (Regulated)** **Brush Length** **Voltage Output** **Regulator Current Draw**	42 – 48 Amperes @ 2000 rpm @ Battery 52 – 60 Amperes @ 2000 rpm @ Alternator Std. Exposed Length: 0.413 in. (10.5 mm) Min. Exposed 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)

GEAR HOUSING	**Gear Ratio** **– Models 150XRI** **– Models 175XRI/200XRI** **Gear Ratio – High Altitude** **– Models 150XRI/175XRI/200XRI** **Gearcase Capacity** **– 1.87:1/2.00:1** **Pinion Height** **– All Models** **Forward Gear Backlash** **– 1.87:1 Ratio** **– 2.00:1 Ratio** **Water Pressure @ rpm**	 2.00:1 (14/28 teeth) 1.87:1 (15/28 teeth) 2.00:1 (14/28 teeth) 22.5 fl oz (665.4 ml) 0.025 in. (0.64 mm) 0.018 in. – 0.027 in. (0.460 mm – 0.686 mm) 0.015 in. – 0.022 in. (0.381 mm – 0.558 mm) 12 psi Minimum @ 5500 rpm
OIL INJECTION	**Recommended Oil** **Oil Tank Capacity** **Approx. Time** **– Model 150XRI/175XRI/200XRI** **Reserve Capacity/Approx. Time** **Oil Pump Output** **– Model 150XRI/175XRI/200XRI**	Quicksilver or Mercury Precision Lubricants NMMA/BIA Certified TC-W3 2 Cycle Outboard Oil 3 gal. (11.4 Liter) 6.6 hrs. Approx. 0.74 qt. (0.70 Liter) 20 – 25 min. 26cc during auto prime time period
FUEL INJECTION	**Idle RPM** **– All Models** **Wide Open Throttle (WOT) RPM** **– Model 150XRI/175XRI/200XRI** **Float Adjustment (Vapor Separator)** **Float Level** **Injectors** **– All Models (Quantity)** **– Injectors are Crank Angle Driven by ECM** **– #1 Cylinder** **– #2 Cylinder** **– #3 Cylinder** **– #4 Cylinder** **– #5 Cylinder** **– #6 Cylinder** **Line Pressure @ Injectors** **Injector Resistance** **Electric Fuel Pump Resistance** **Electric Fuel Pump Amperage Draw**	 625 ± 50 5250 – 5750 Preset @ Factory 6 RED + BRN Leads RED + WHT Leads RED + ORG Leads RED + YEL Leads RED + LT BLUE Leads RED + PUR Leads 41 psi – 45 psi (283 kPa – 310 kPa) 12.3 ohms ± 0.5 ohms 0.7 ± 0.3 ohms 4 amperes ± 0.5 amperes

Mercury/Quicksilver Lubricants and Sealants

Description	Mercury Part Number	Quicksilver Part Number
Needle Bearing Assy. Lubricant [8 oz. (226.8 grams)] tube	92-802868A1	N/A
Dielectric Grease [8 oz. (226.8 grams)] can	92-823506-1	92-823506-1
Loctite 271 – Thread Locker (10 ml) tube	92-809819	92-809819
Loctite 567 PST Pipe Sealant (50 ml) tube	92-809822	92-809822
Loctite Master Gasket Kit	92-12564-2	92-12564-2
2 Cycle Premium Outboard Oil [1 Gallon (3.7 liter)]	92-802815A1	92-802815Q1
Perfect Seal [16 oz. (0.45 kg)] can	92-34227-1	92-34227-1
Liquid Neoprene [8 oz. (226.8 grams)] can	92-25711-3	92-25711-3
Cyanacrylate Adhesive	Obtain Locally	Obtain Locally
Bellows Adhesive	N/A	92-86166Q1
Loctite 680 Retaining Compound (10 ml) tube	92-809833	92-809833
Loctite 222 Thread Locker (10 ml) tube	92-809818	92-809818
3M Permabond #3M08155	Obtain Locally	Obtain Locally
Loctite 242 Thread Locker (10 ml) tube	92-809821	92-809821
Loctite 609	Obtain Locally	Obtain Locally
Loctite 405	Obtain Locally	Obtain Locally

Description	Mercury Part Number	Quicksilver Part Number
RTV 587 Silcone Sealer [3 oz. (85.05 grams)]	92-809825	92-809825
Loctite 262	Obtain Locally	Obtain Locally
Premium Gear Lubricant [1 Quart (0.94 liter)]	92-802846A1	92-802846Q1
Loctite 7649 Primer [4.5 oz (127.57 grams)]	92-809824	92-809824
Anti-Corrosion Grease [8 oz. (226.8 grams)] tube	92-802867A1	92-802867Q1
2-4-C with Teflon [8 oz. (226.8 grams)] tube	92-802859A1	92-802859Q1
Loctite Quick Tite	Obtain Locally	Obtain Locally
Isopropyl Alcohol	Obtain Locally	Obtain Locally
Hot Glue	Obtain Locally	Obtain Locally
Special Lubricant 101 [8 oz. (226.8 grams)] tube	92-802865A1	92-802865Q1
4 Stroke 10W30 Outboard Oil [1 Quart (0.94 liter)]	92-802833A1	92-802833Q1
4 Cycle 25W40 Engine Oil [1 Quart (0.94 liter)]	92-802837A1	92-802837Q1
Power Trim & Steering Fluid [8 oz. (226.8 grams)]	92-802880A1	92-802880Q1
Engine Coupler Spline Grease [14 oz. (0.39 kg)] cartridge	92-802869A1	92-802869Q1

IMPORTANT INFORMATION

Section 1B - Maintenance

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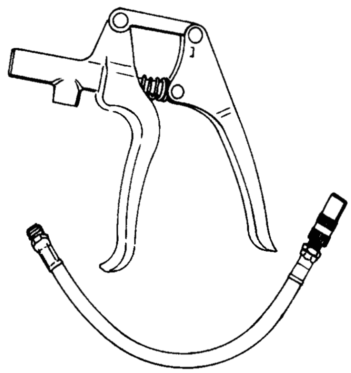
Specifications

Gear Case Lubricant Capacity

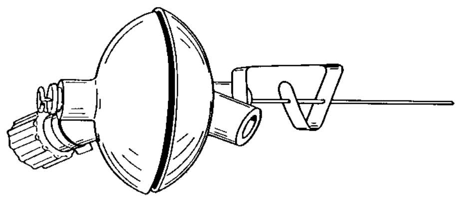
Gear Case Ratio	Capacity
1.87:1	22.5 fl. oz. (717 ml)
2.00:1	22.5 fl. oz. (717 ml)

Special Tools

1. Grease Gun 91-37299A1



2. Flushing Attachment 44357A2



Mercury/Quicksilver Lubricants and Sealants

NOTE: *See section 1A for lubricants and sealants chart.*

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 – EFI models.
4. Check corrosion control anodes. Check more frequently when used in salt water.
5. Drain and replace gear case lubricant.
6. Lubricate splines on the drive shaft and shift shaft.∗
7. Check power trim fluid.
8. Inspect battery.
9. Check control cable adjustments.∗
10. Check tightness of bolts, nuts, and other fasteners.
11. Replace water pump impeller (more often if overheating occurs or reduced water pressure is noted).∗

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

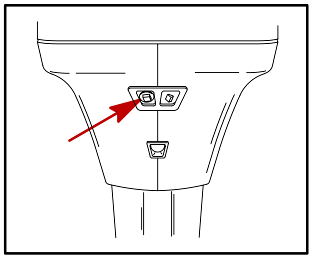
Flushing Engine

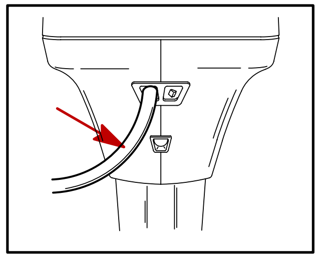
Flushing Cooling System – Using Cowl Flush Plug

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.

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. (12.7 mm) 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.
6. Water must be discharged thru “tell tale.”

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

7. Flush until discharge water is clear. In saltwater areas, run outboard 3 to 5 minutes.
8. Stop engine before turning off water.
9. 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

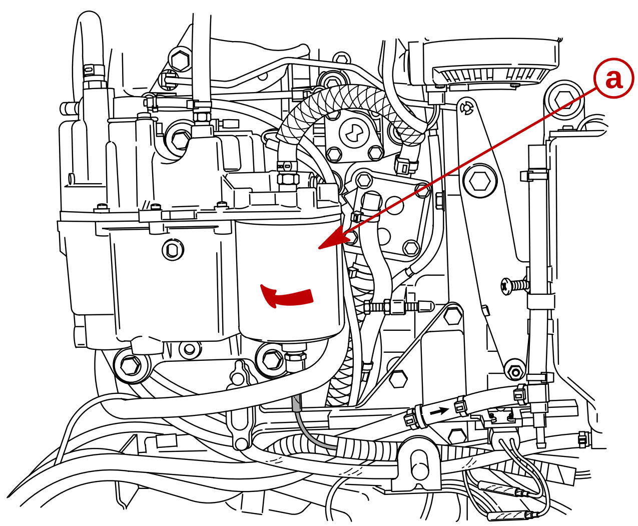
Visually inspect the fuel line and primer bulb for cracks, swelling, leaks, hardness, or other signs of deterioration or damage. If any of these conditions is found, the fuel line or primer bulb must be replaced.

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

Water Separating Fuel Filter – EFI Models

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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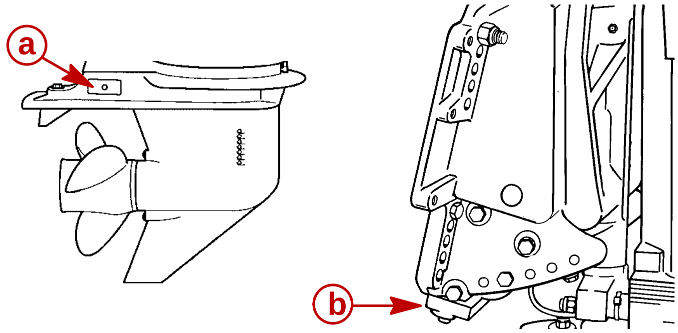
a - Fuel/Water Separator Filter

Remove and replace filter as follows:

2. Turn ignition key switch to OFF position.
3. Disconnect wire at bottom of filter.
4. Remove filter by turning the filter in the direction of the arrow (clockwise). Tip the filter to drain fluid in a suitable container.
5. Lubricate the sealing ring on the filter with oil. Thread on the filter and tighten securely by hand. Reconnect the wire to 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.

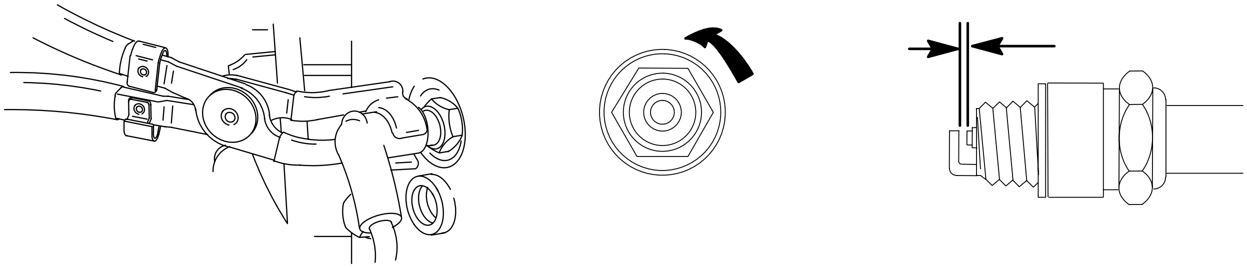
Spark Plug Inspection and Replacement

Inspect spark plugs at the recommended intervals.

⚠ WARNING

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

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



3. Set the spark plug gap. See Specification Chart.
4. Before reinstalling spark plugs, clean away dirt on the spark plug seats. Install plugs finger tight, and tighten 1/4 turn or torque to 20 lb-ft (27 Nm).

Battery Inspection

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

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

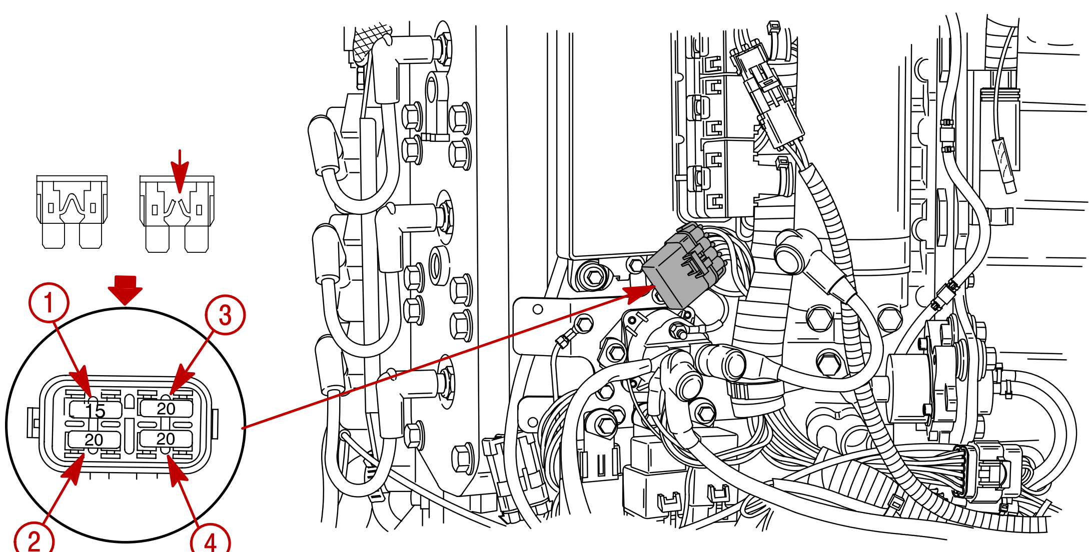
1. Turn off the engine before servicing the battery.
2. Add water as necessary to keep the battery full.
3. Make sure the battery is secure against movement.
4. Battery cable terminals should be clean, tight, and correctly installed. Positive to positive and negative to negative.
5. Make sure the battery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

Fuse Replacement

IMPORTANT: Always carry spare SFE 15 and 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:
    1. Smart Craft Data Bus Circuit – SFE 15 Ampere Fuse
    2. Fuel Injector Harness, Electric Fuel Pump and Oil Pump
    3. Main Power Relay, Remote Control Harness and Power Trim
    4. Ignition Coils



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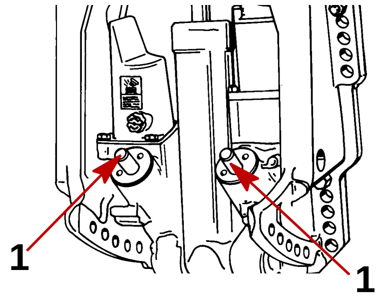
Lubrication Points

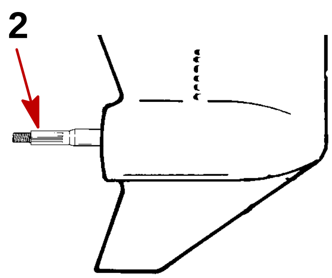
Lubricate Point 1 with Quicksilver Special Lubricant 101.

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



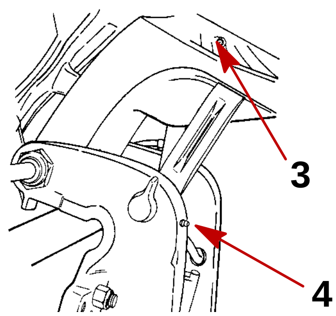
Lubricate Point 2 with Quicksilver Anti-Corrosion Grease or 2-4-C Marine Lubricant with Teflon.

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.

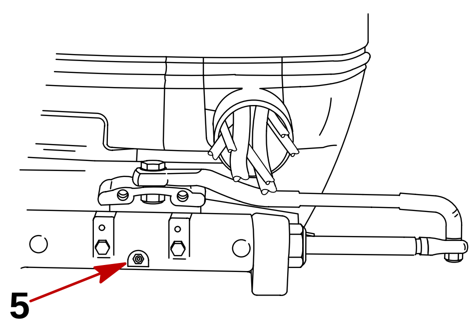


Lubricate Points 3 thru 6 with Quicksilver 2-4-C Marine Lubricant with Teflon or Special Lubricate 101.

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



5. Tilt Tube – Lubricate through fitting.



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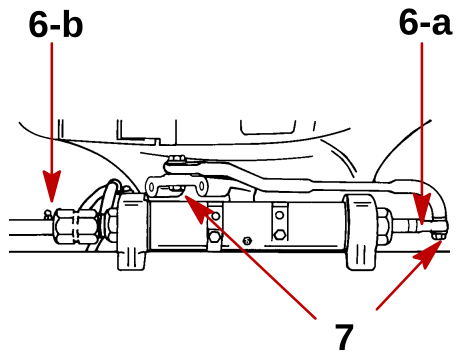
6. Steering Cable Grease Fitting (If Equipped) – Rotate steering wheel to fully retract the steering cable end (a) into the outboard tilt tube. Lubricate through fitting (b).

⚠ 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.

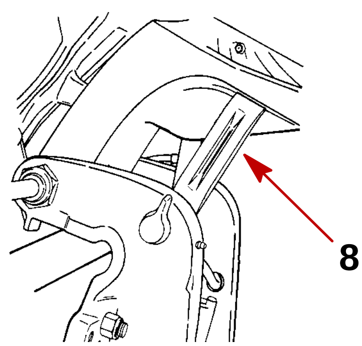
Lubricate Points 7 With Light Weight Oil.

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

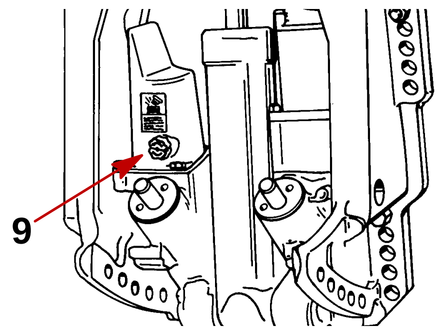


Checking Power Trim Fluid

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.



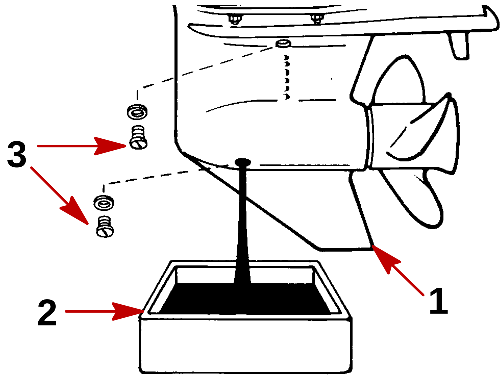
Gear Case Lubrication

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 22.5 fl. oz. (665 ml).

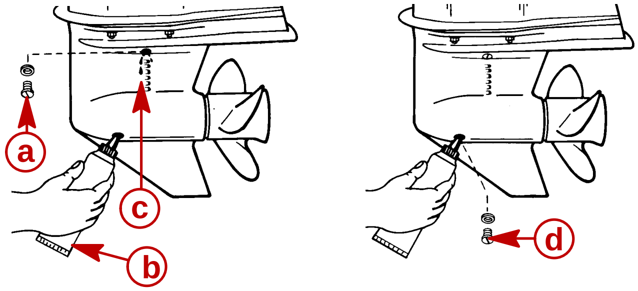
CHECKING GEAR CASE LUBRICANT LEVEL AND REFILLING GEAR CASE

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).



1-5

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 10 minutes to allow treated fuel to fill the fuel system.

PROTECTING INTERNAL ENGINE COMPONENTS

Electronic Fuel Injection (EFI) Models

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.

IMPORTANT INFORMATION

Section 1C - General Information

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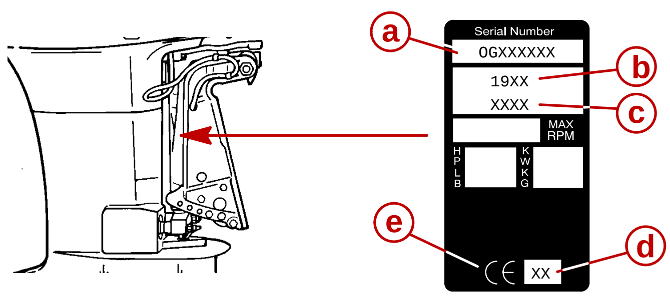
Serial Number Location

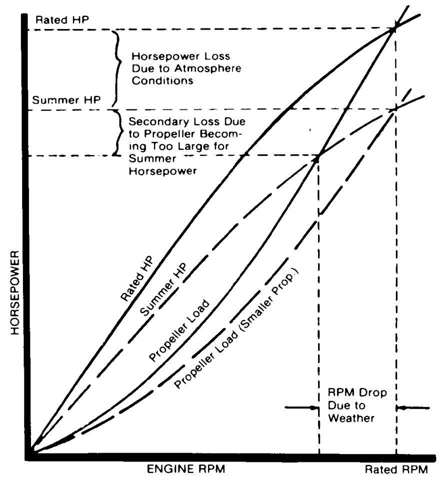
The engine serial number is located on the top of the engine block. A serial number is also located on the starboard side of the swivel bracket.



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. All values are corrected 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.

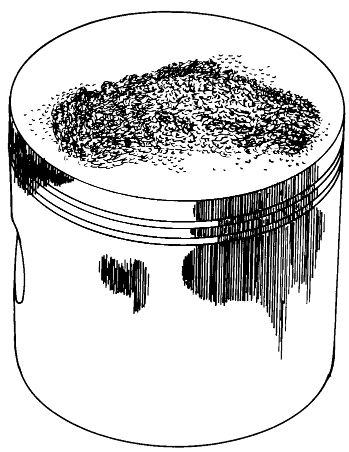
Detonation is an explosion of an unburned portion of the fuel/air charge after the spark plug has fired. Detonation creates severe shock waves in the engine, and these shock waves often find or create a weakness: The dome of a piston, cylinder head/gasket, piston rings or piston ring lands, piston pin 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. EFI Models – Remove drain plug from vapor separator and drain fuel/water. Reinstall plug after draining.
   c. EFI Models – Remove the water separating fuel filter and empty contents.
6. Remove spark plugs and get as much water as possible out of powerhead. Most water can be eliminated by placing engine in a horizontal position (with spark plug holes down) and rotating flywheel.
7. Pour alcohol into intake through air plenum (alcohol will absorbed water). Again rotate flywheel.
8. Turn engine over (place spark plug openings down) and pour engine oil into throat of carburetors while rotating flywheel to distribute oil throughout crankcase.
9. Again turn engine over and pour approximately one teaspoon of engine oil into each spark plug opening. Again rotate flywheel to distribute oil in cylinders.
10. Remove and clean fuel pump assembly.
11. Dry all wiring and electrical components using compressed air.
12. Disassemble the engine starter motor and dry the brush contacts, armature and other corrodible parts.
13. Reinstall spark plugs and fuel pump.
14. 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.

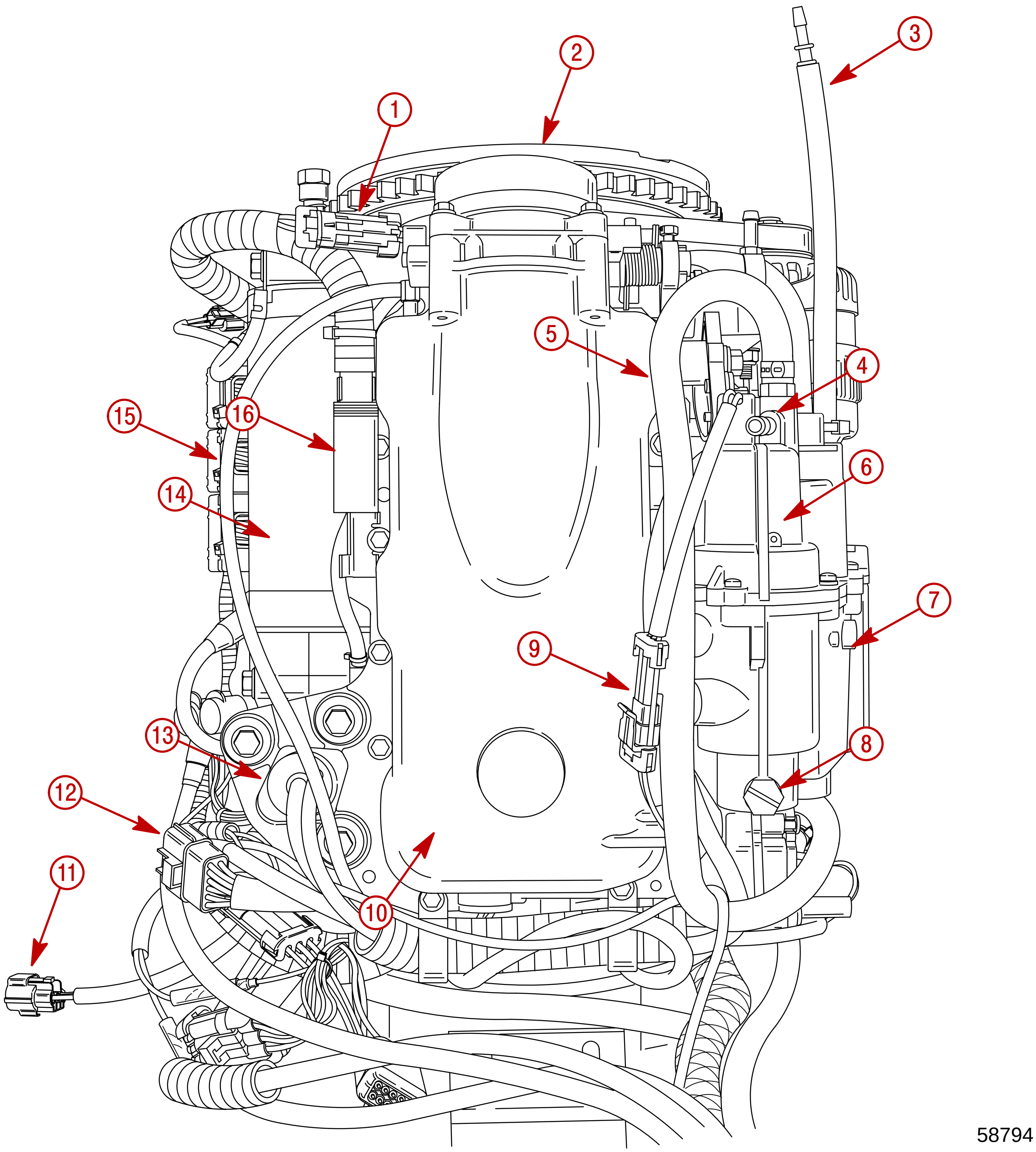
b. Drain any water from hose and reconnect.

c. If water was present in hose, check for water in the remote oil tank. Drain tank if water is present.

15. Attempt to start engine, using a fresh fuel source. If engine starts, it should be run for at least one hour to eliminate any water in engine.

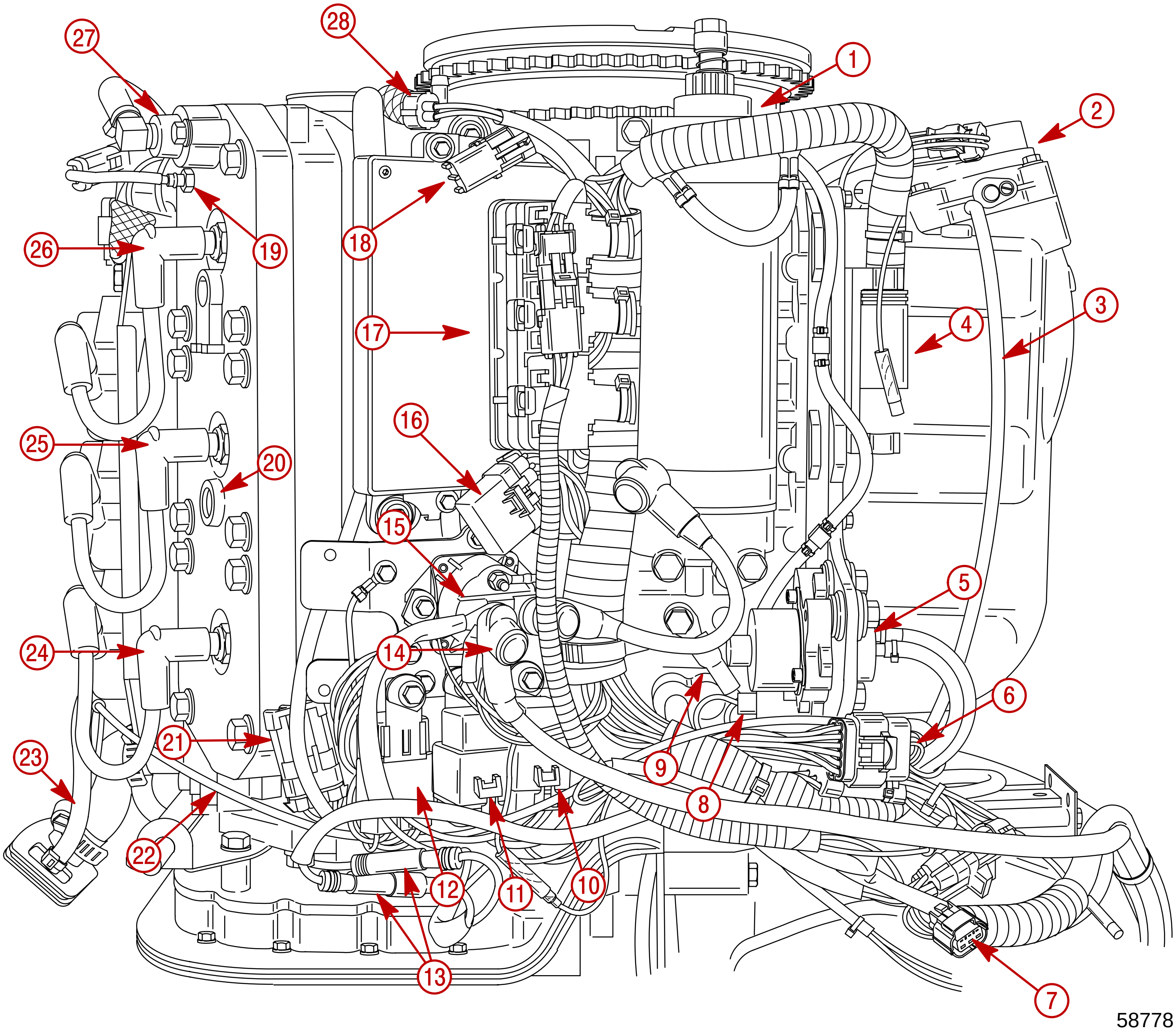
16. If engine fails to start, determine cause (fuel, electrical or mechanical). Engine should be run within 2 hours after recovery of outboard from water, or serious internal damage may occur. If unable to start engine in this period, disassemble engine and clean all parts. Apply oil as soon as possible.

Model 150 XRI/175 XRI/200 XRI Powerhead Front View



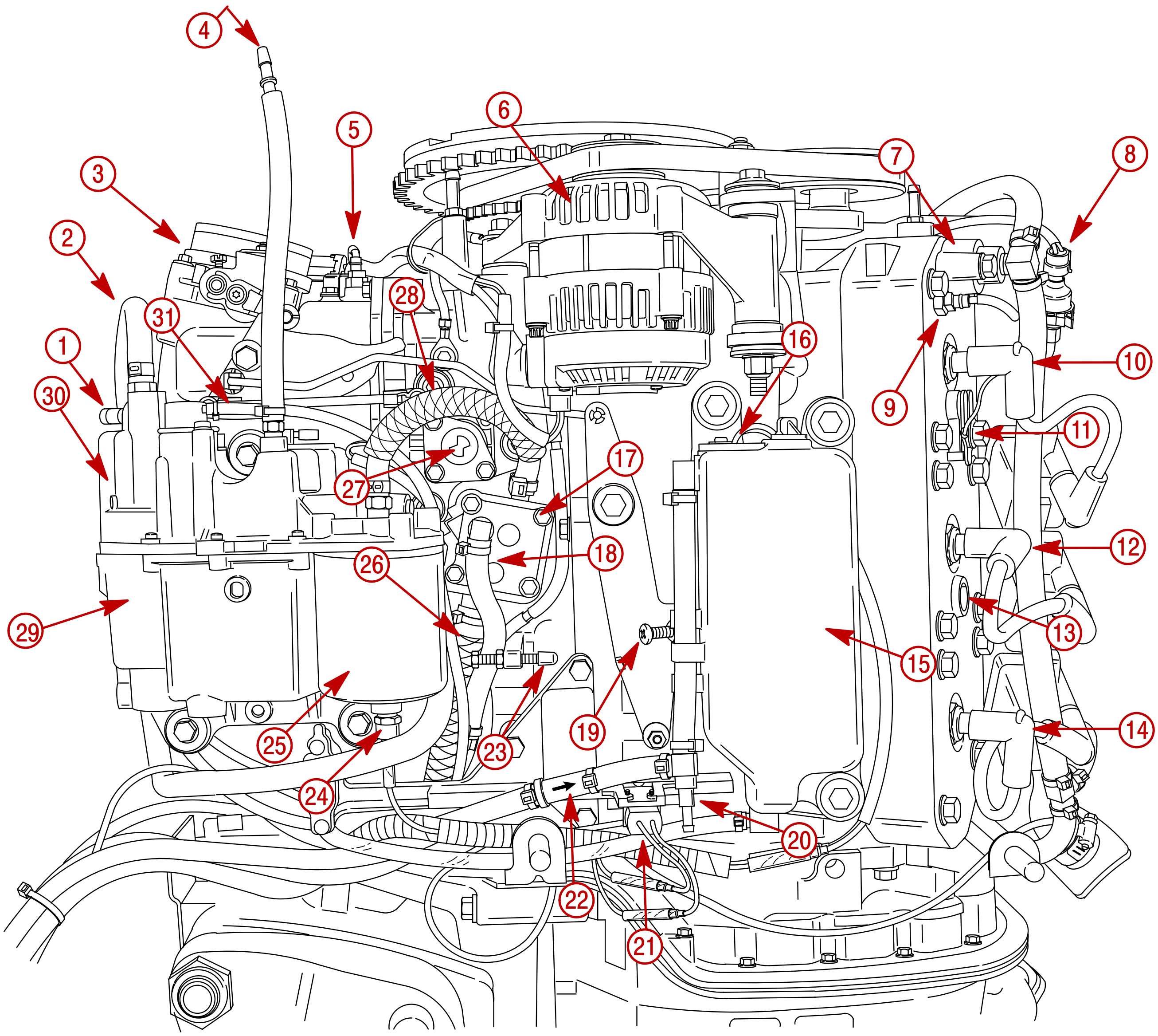
1 - Manifold Absolute Pressure (MAP) Sensor Connector
2 - Throttle Plate Assembly
3 - Vapor Separator Tank (VST) Vent Hose to Flywheel Cover
4 - Fuel Pressure Test Point
5 - Fuel Hose [43 psi ± 2 psi (296 kPa ± 14 kPa)] to Fuel Rail
6 - Electric Fuel Pump (inside VST)
7 - Vapor Separator Tank (VST)
8 - VST Drain Plug
9 - Electric Fuel Pump Harness Connector
10 - Air Plenum
11 - Cowl Trim Connector
12 - Fuel Injector Harness Connector
13 - Oil Pump
14 - Starter Motor
15 - Fuel Regulator Vacuum Hose
16 - Engine Harness Connector

Model 150 XRI/175 XRI/200 XRI Powerhead Starboard View



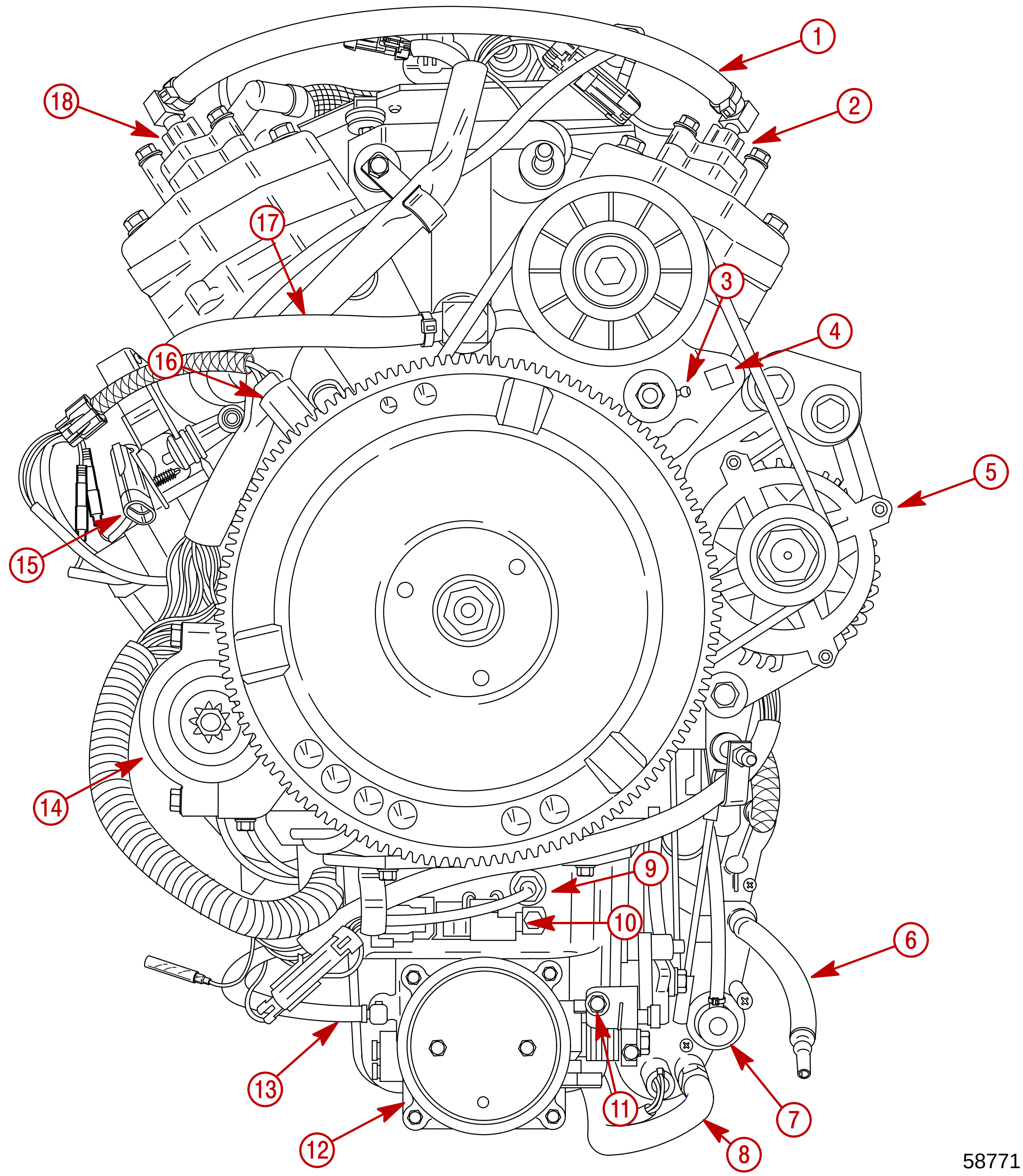
1 - Starter Motor
2 - Throttle Plate Assembly
3 - Fuel Regulator Vacuum Hose
4 - Engine Harness Connector
5 - Oil Pump
6 - Fuel Injector Harness Connector
7 - Cowl Trim Connector
8 - Oil Pump Harness Connector
9 - Negative Battery Cable
10 - Trim DOWN Relay
11 - Trim UP Relay
12 - Main Power Relay
13 - Trim Motor Bullet Connectors
14 - Positive Battery Cable
15 - Starter Solenoid
16 - 20 Ampere Fuses (3); 15 Ampere Fuse (1)
17 - Electronic Control Module (ECM)
18 - Digital Diagnostic Connector
19 - Temperature Sensor (Engine Overheat)
20 - Detonation Sensor (200 EFI Only)
21 - Detonation Sensor Connector (200 EFI Only)
22 - Water Pressure Gauge Hose
23 - Tell-Tale Hose
24 - #5 Cylinder
25 - #3 Cylinder
26 - #1 Cylinder
27 - Starboard Thermostat [143°F (61.7°C)]
28 - Crank Position Sensor Connector

Model 150 XRI/175 XRI/200 XRI Powerhead Port View



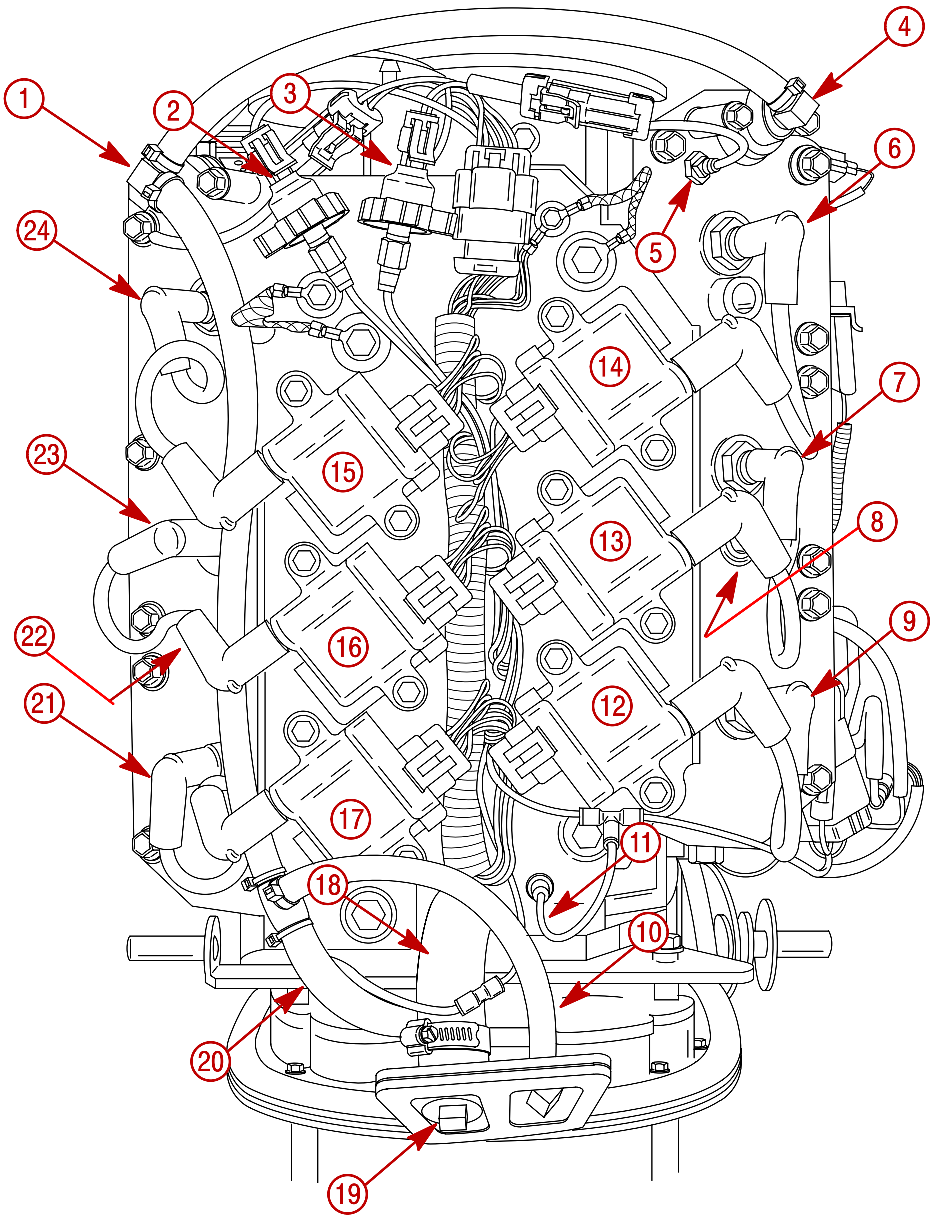
1 - Fuel Pressure Test Point
2 - Fuel Out to Fuel Rail
3 - Throttle Plate Assembly
4 - Vapor Separator Vent Hose
5 - Air Temperature Sensor
6 - 60 Ampere Alternator
7 - Port Thermostat [143°F (61.7°C)]
8 - Speedometer Sensor (BLACK)
9 - Temperature Sensor (Port Head)
10 - #2 Cylinder
11 - Temperature Sender (Analog Gauge)
12 - #4 Cylinder
13 - Detonation Sensor (200 EFI Only)
14 - #6 Cylinder
15 - Oil Reservoir [0.74 qt. (0.70 Liter)]
16 - Low Oil Sensor
17 - Pulse Fuel Pump
18 - Pulse Pump Vacuum Hose
19 - Idle Stop Screw
20 - 4 psi (27 kPa) Check Valve
21 - Shift Interrupt Switch
22 - Filter
23 - Wide Open Throttle Stop Screw
24 - Water Sensor
25 - Fuel/Water Separator
26 - Fuel Inlet Hose to Pulse Pump
27 - Throttle Position Sensor
28 - Fuel Outlet to Fuel /Water Separator
29 - Vapor Separator Tank (VST)
30 - Electric Fuel Pump (inside Vapor Separator)
31 - Fuel Pressure Regulator

Model 150 XRI/175 XRI/200 XRI Powerhead Top View



1 - Thermostat By-Pass Hose
2 - Port Thermostat [143°F (61.7°C)]
3 - Belt Tensioner Grease Fitting
4 - Belt Tensioner
5 - 60 Ampere Alternator
6 - Vapor Separator Vent Hose
7 - Fuel Regulator
8 - Fuel Hose to Fuel Rail [43 psi ± 2 psi (296 kPa ± 14 kPa)]
9 - Air Temperature Sensor
10 - Manifold Air Pressure (MAP) Sensor
11 - Throttle Plate Adjustment Screw (Sealed at Factory)
12 - Throttle Plate Assembly
13 - Pressure Regulator Vacuum Hose
14 - Starter Motor
15 - Digital Diagnostic Tool (DDT) Connector
16 - Crank Position Sensor
17 - Water By-Pass Hose
18 - Starboard Thermostat (143°F (61.7°C)

Model 150 XRI/175 XRI/200 XRI Powerhead Aft View



1 - Port Thermostat [143°F (61.7°C)]
2 - Speedometer Sensor (BLACK)
3 - Water Pressure Sensor
4 - Starboard Thermostat [143°F (61.7°C)]
5 - Temperature Sensor (Engine Overheat)
6 - #1 Cylinder
7 - #3 Cylinder
8 - Starboard Detonation Sensor (200 EFI Only)
9 - #5 Cylinder
10 - Tell–Tale Hose
11 - Water Pressure Gauge Hose
12 - #5 Ignition Coil
13 - #3 Ignition Coil
14 - #1 Ignition Coil
15 - #2 Ignition Coil
16 - #4 Ignition Coil
17 - #6 Ignition Coil
18 - Cylinder Block Flush Hose
19 - Flush Adaptor Plug
20 - Thermostat Outlet Hose to Adaptor Plate
21 - #6 Cylinder
22 - Port Detonation Sensor (200 EFI Only)
23 - #4 Cylinder
24 - #2 Cylinder

Painting Procedures

Color Impregnated Top Cowls

The Model Year 2002 3 Liter V-6 EFI, 2.5 Liter Optimax and 3 Liter Optimax top cowls are constructed of a new material in which the exterior color is impregnated to a depth of approximately 1/16 in. (1.58 mm).

MAINTENANCE

The cowl can be cleaned using a mild non-abrasive soap. The surface luster can be preserved by using a non-abrasive automotive polish (polish designed for clear coat finishes) and buffing with a terry cloth type towel. Abrasive type polishes or cleaners should not be used as they will damage the cowl finish.

REPAIR

Light scratches should be removed by using a non-abrasive automotive polish (polish designed for clear coat finishes) and buffing with a terry cloth type towel. Abrasive type polishes should not be used as they will damage the cowl finish.

Medium scratches can be removed by using 600 to 1000 grit sandpaper. The surface luster can then be restored by using a non-abrasive automotive polish (polish designed for clear coat finishes) and buffing with a terry cloth type towel. Abrasive type polishes should not be used as they will damage the cowl finish.

For deep scratches or for those that penetrate through the exterior finish, automotive body filler can be used to fill the damaged area. 600 to 1000 grit sand paper should be used to smooth the surface area. It is then recommended that the entire cowl then be painted, to achieve an even luster, using normal Mercury Marine approved paint and 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

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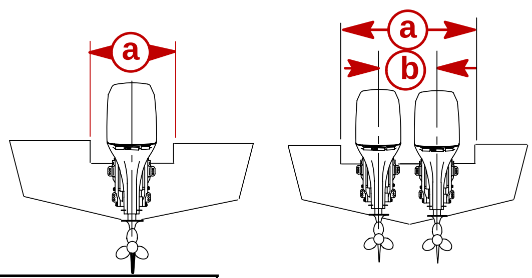
Installation Specifications

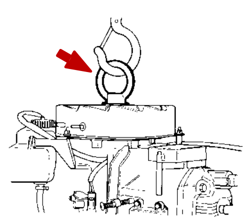


a – Transom Opening – Minimum
Single Engine – 33-3/8 in. (848 mm)
Dual Engines – 59-3/4 in. (1518 mm)

b – Engine Center Line For Dual Engine
26 in. (660mm) 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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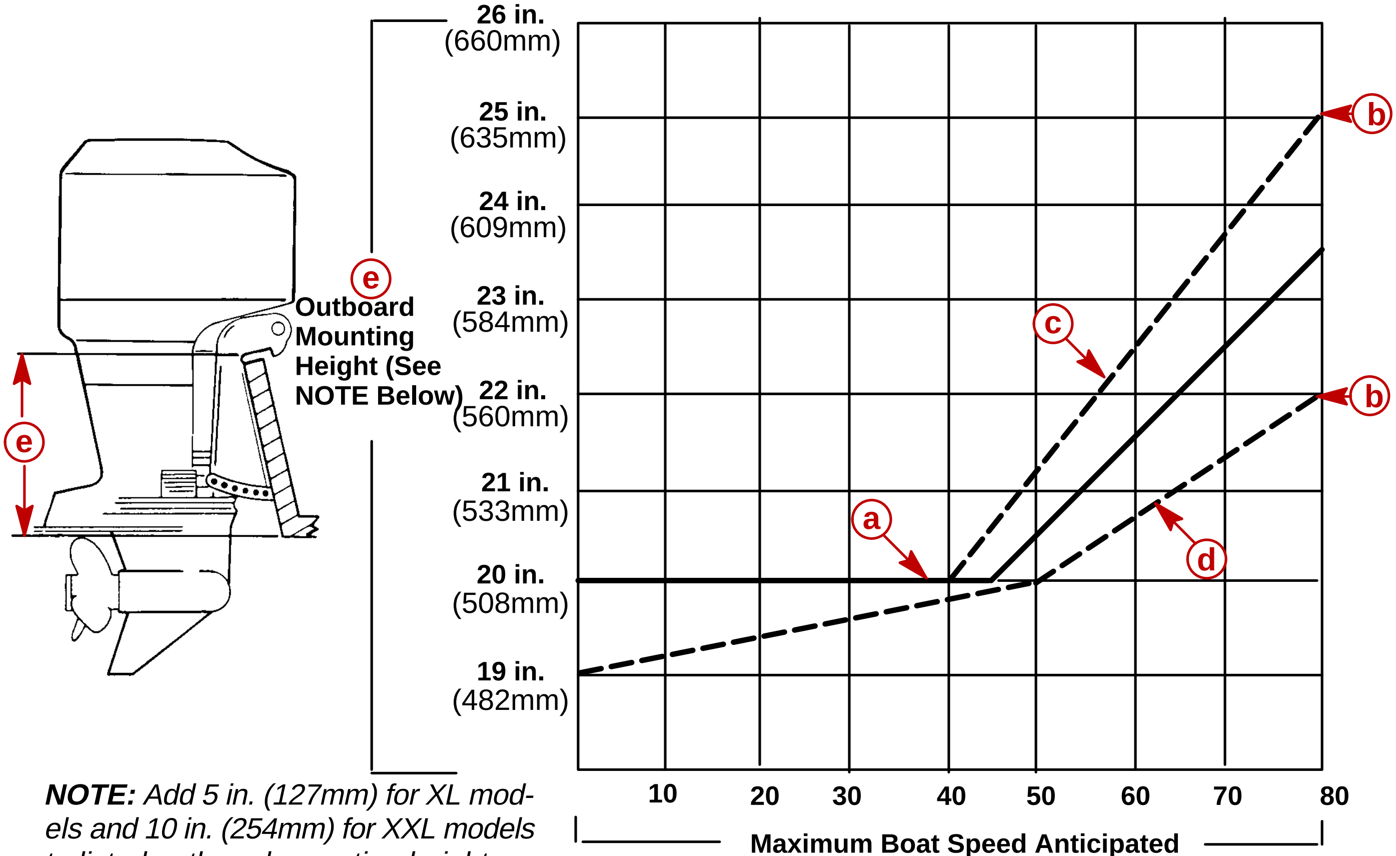
Installing Outboard to Boat Transom

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.*

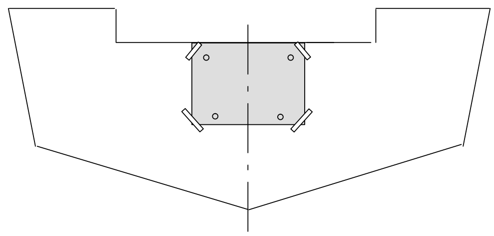
NOTICE TO INSTALLER:

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. (560mm), a propeller, that is designed for surfacing operation is usually preferred.

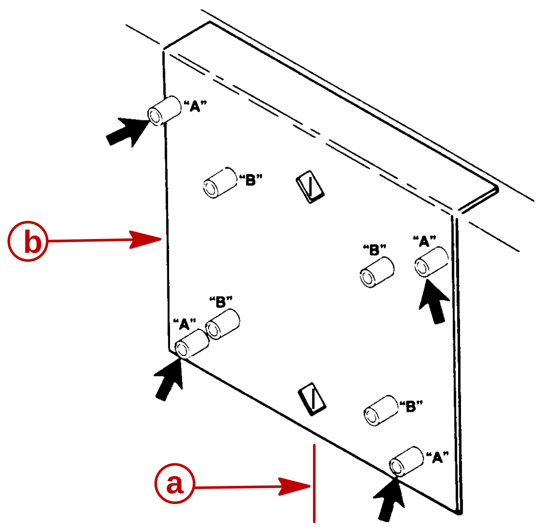
Installing Outboard

Drilling Outboard Mounting Holes

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

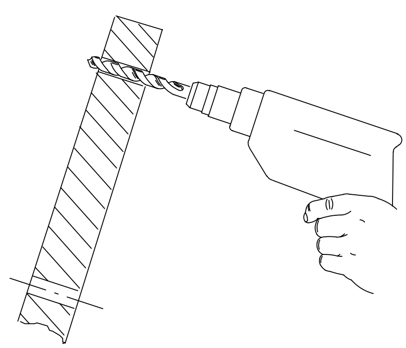


IMPORTANT: If using "Transom Drilling Fixture" (91-98234A2), use drill guide holes marked "A" when drilling outboard mounting holes.



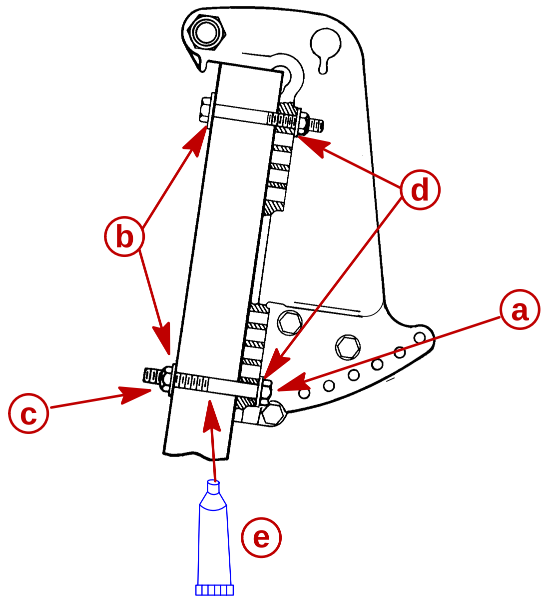
a - Centerline of Transom
b - Transom Drilling Fixture (91-98234A2)

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

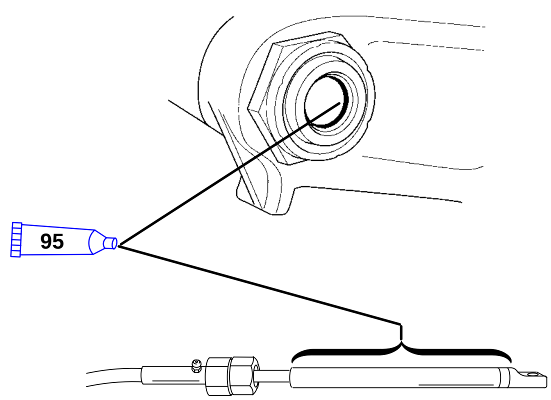


a - 1/2 in. Diameter Bolts (4)
b - Flat Washers(4)
c - Locknuts (4)
d - Flat Washers(4)
e - Marine Sealer - Apply to Shanks of Bolts, Not Threads

Steering Cable

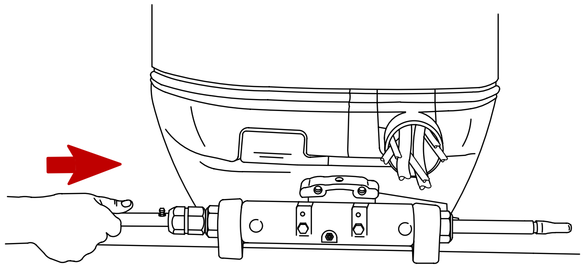
STARBOARD SIDE ROUTED CABLE

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



95 2-4-C with Teflon

2. Insert steering cable into tilt tube.



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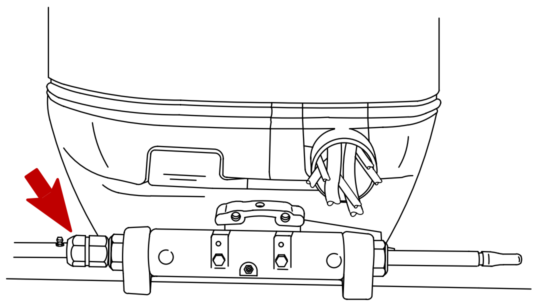
3. Torque nut to 35 lb. ft. (47.5 N·m).



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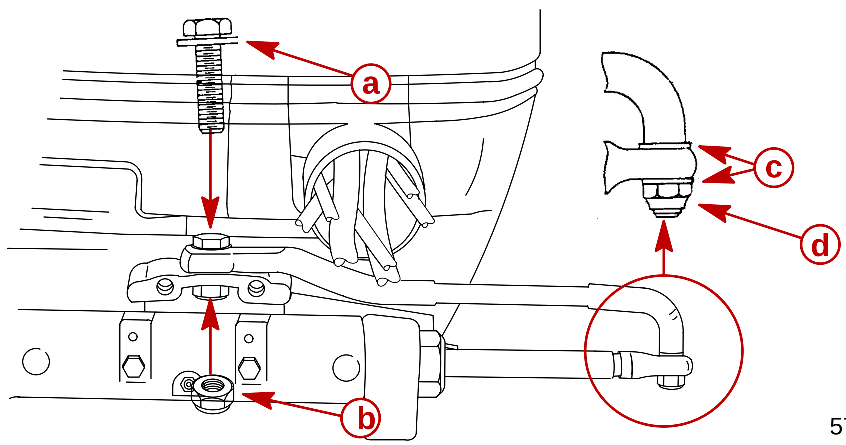
Steering Link Rod

1. Install steering link rod per illustration.



57834

- **a** - Special Bolt (10-90041) Torque to 20 lb-ft (27 N·m)
- **b** - Nylon Insert Locknut (11-34863) Torque to 20 lb-ft (27 N·m)
- **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

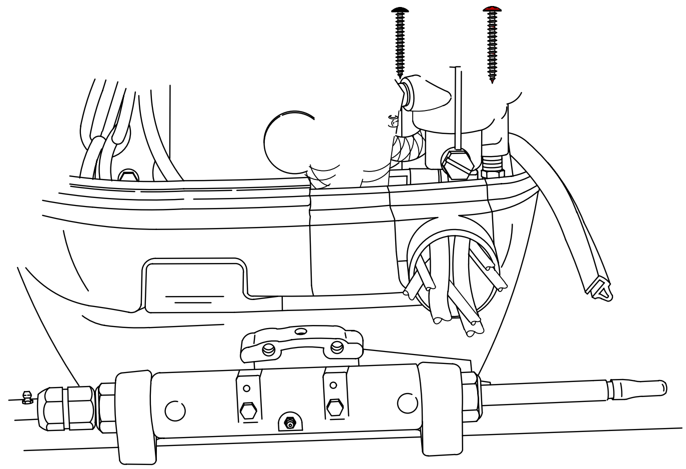
⚠ WARNING
Disengagement of a steering link rod can result in the boat taking a full, sudden, sharp turn. This potentially violent action can cause occupants to be thrown overboard exposing them to serious injury or death.

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.

Installation Note

Open the front clamp assembly.



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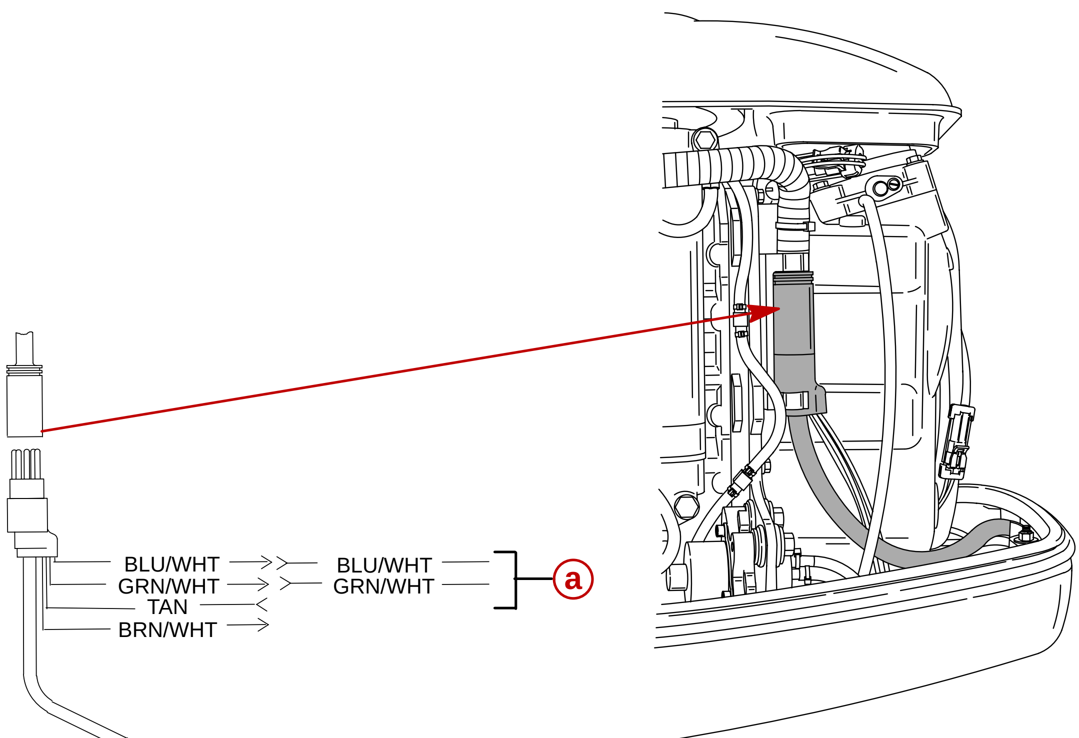
Remote Wiring Harness

1. Connect wiring. Place harness into the holder.

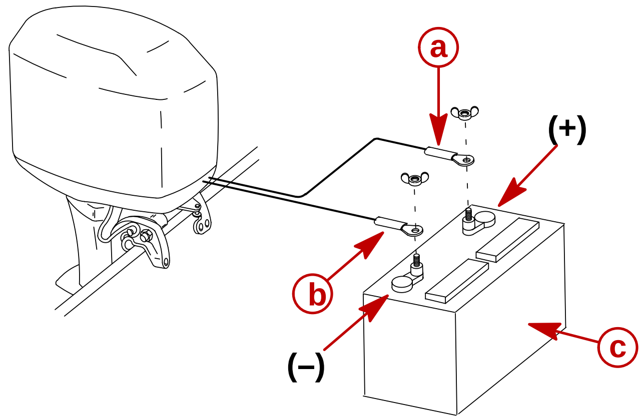


58804

a - Power Trim Connections

Battery Cables

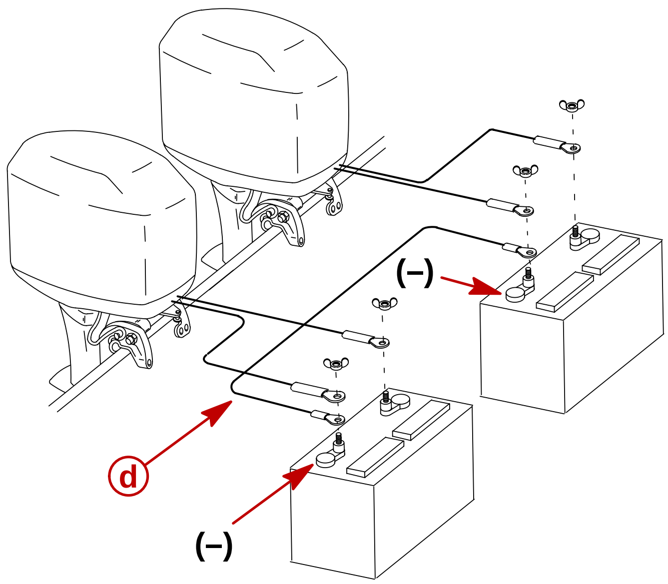
SINGLE OUTBOARD



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. (8mm), with separate fuel line/fuel tank pickup for each engine.

Fasten remote fuel hose to fitting with hose clamp.

Oil Hose Connections

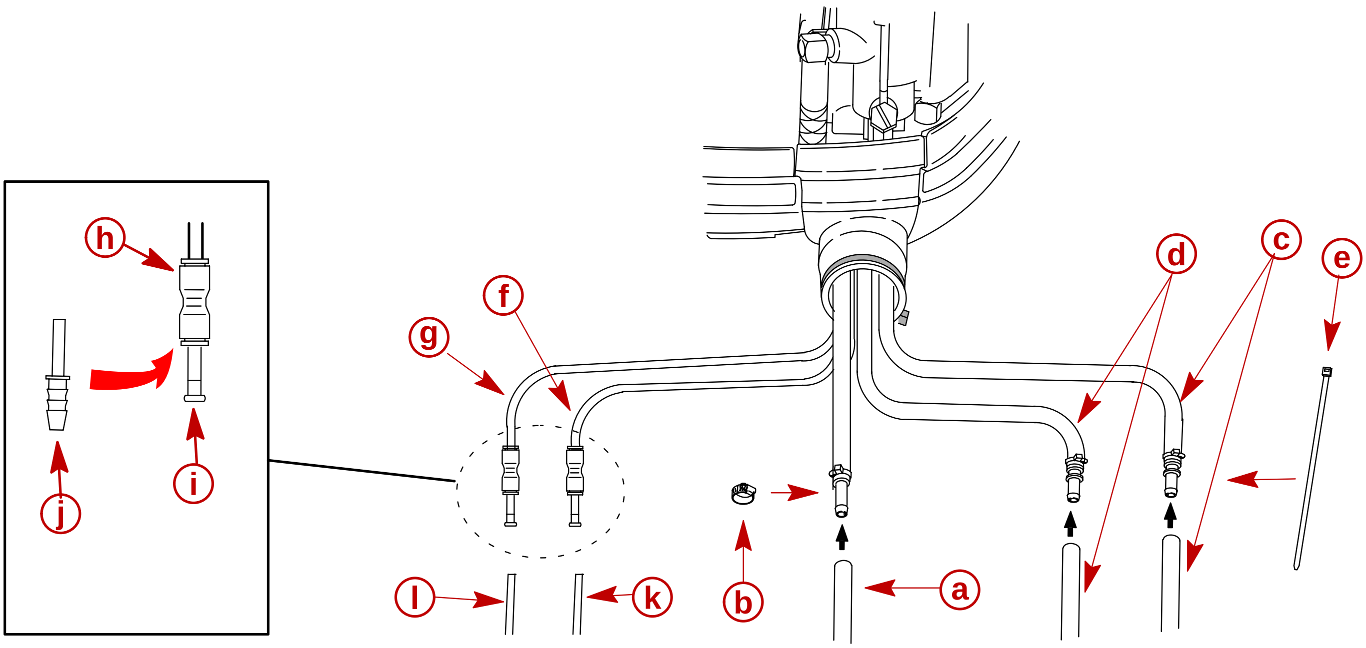
Connect the remote oil hoses to the engine hose connections as shown. Fasten hose connections with sta-straps.

Speedometer Tubing Connection

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

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

Shift Cable

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

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

COUNTER ROTATION OUTBOARDS

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

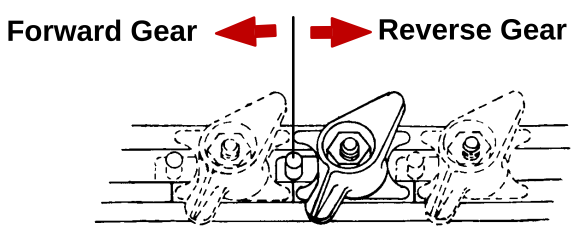
The Quicksilver Dual Engine Console Mount Control, P/N 88688A22 or 88688A52, is required to shift the counter rotation outboard. The installation instructions shipped with the control explain the procedure required to connect this control to a counter rotation outboard.

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.

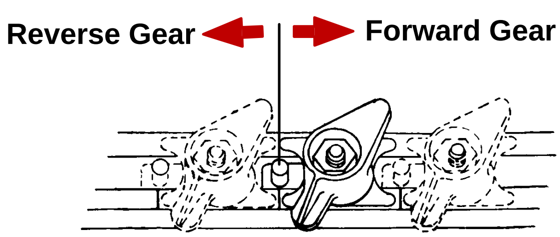
OUTBOARD SHIFTING DIRECTION

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.

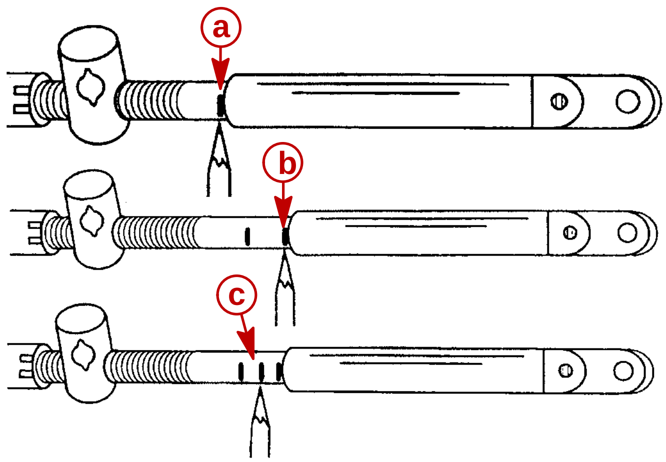
1. Locate the center point of the slack or lost motion that exists in the shift cable as follows:

   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.

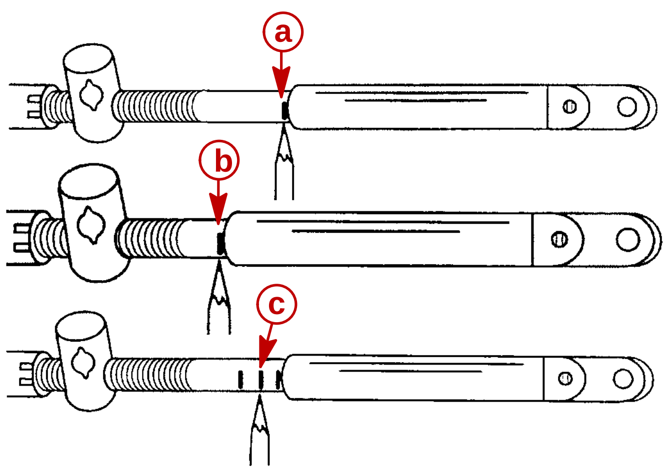
   b. Move the remote control handle from neutral into reverse and advance the handle to full speed position. Slowly return the handle back to the neutral. Place a mark (b) on the cable against the cable end guide.

   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.

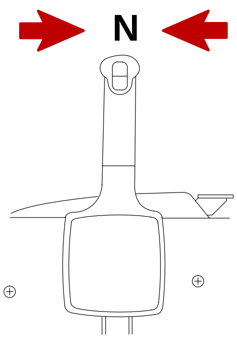
STANDARD ROTATION OUTBOARDS



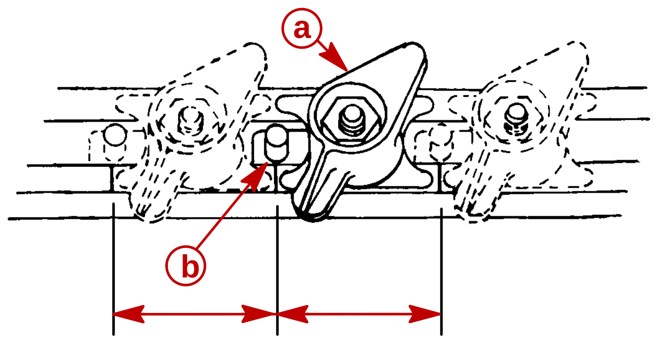
COUNTER ROTATION OUTBOARDS



2. Position remote control and outboard into neutral.

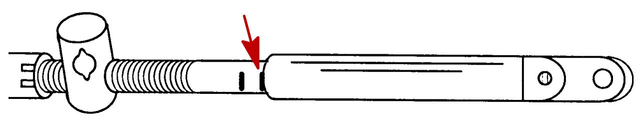


3. Slide the shift cable retainer forward until resistance is felt, then slide cable anchor toward rear until resistance is felt. Center the anchor pin between resistance points.

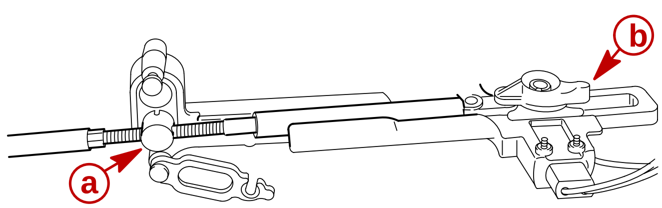


a - Shift Cable Retainer
b - Anchor Pin

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

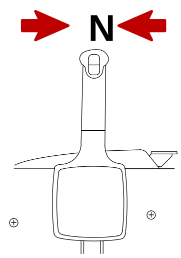
7. Check shift cable adjustments as follows:
   a. With remote control in forward, the propshaft should lock solidly in gear. If it does not, adjust cable barrel closer to cable end guide.
   b. Shift remote control into neutral. The propshaft should turn freely without drag. If not, adjust barrel away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

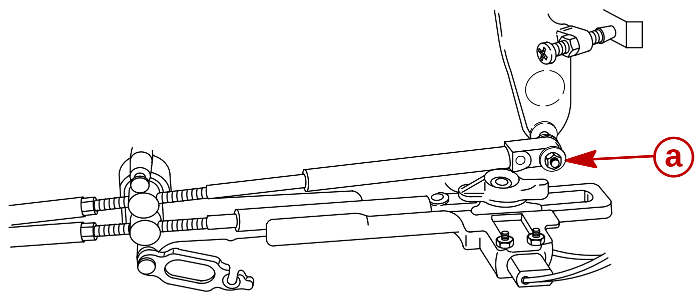
Throttle Cable

INSTALLATION

1. Position remote control into neutral.

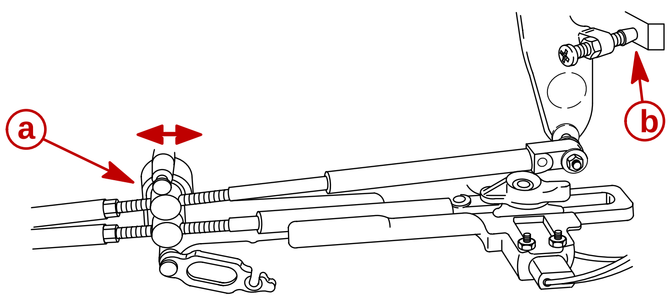


2. Attach throttle cable to the throttle lever. Secure with washer and locknut.



a - Washer and Locknut

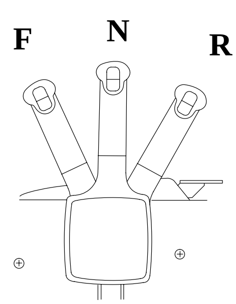
3. Adjust the cable barrel so that the installed throttle cable will hold the idle stop screw against the stop.



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

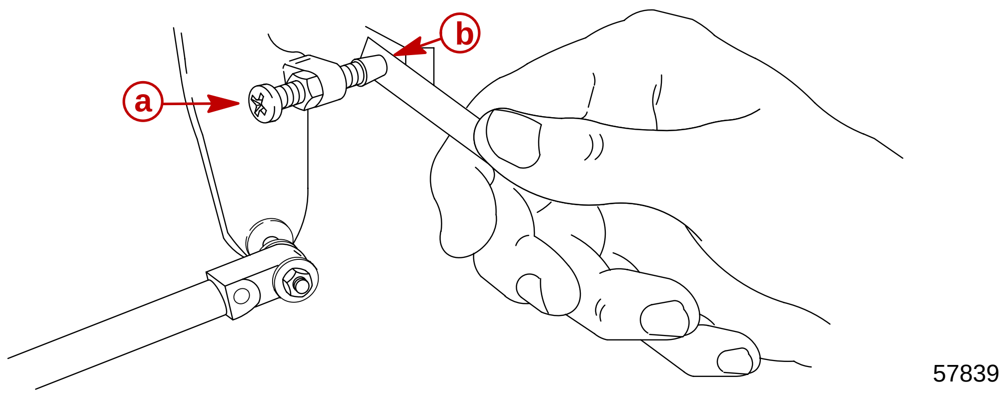
4. Check throttle cable adjustment as follows:

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



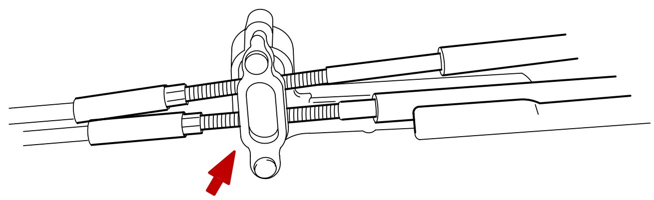
b. Return remote control to neutral. Place a thin piece of paper between idle adjustment screw and idle stop. Adjustment is correct when the paper can be removed without tearing, but has some drag on it. Readjust cable barrel if necessary.

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



a - Idle Stop Screw
b - Idle Stop

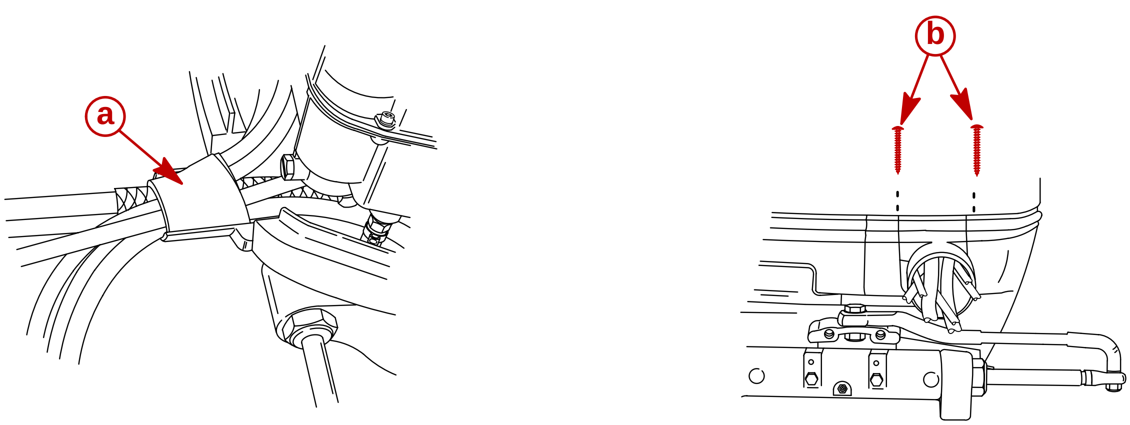
5. Lock the barrel holder in place with the cable latch.



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.
2. Fasten clamp together with two screws.



a - Neoprene Wrap
b - Screw (2)

Oil Injection Set-Up

CAUTION

Be careful not to get dirt or other contamination in tanks, hoses or other components of the oil injection system during installation.

Installing Remote Oil Tank

1. The remote oil tank should be installed in an area in the boat where there is access for refilling.

The tank should be restrained to keep it from moving around, causing possible damage.

An acceptable means of restraining the tank would be the use of eye bolts and an elastic retaining strap about the mid-section of the tank taking care that any metal hooks do not puncture the tank.

Keep in mind, when installing in tight areas, that this tank will be under pressure when the engine is operating and will expand slightly.

2. Oil hoses when routed thru engine well, must be able to extend to the hose fittings on engine.
3. Oil hoses must be arranged so they cannot become pinched, kinked, sharply bent or stretched during operation of the engine.

Installing Oil Hoses To Engine

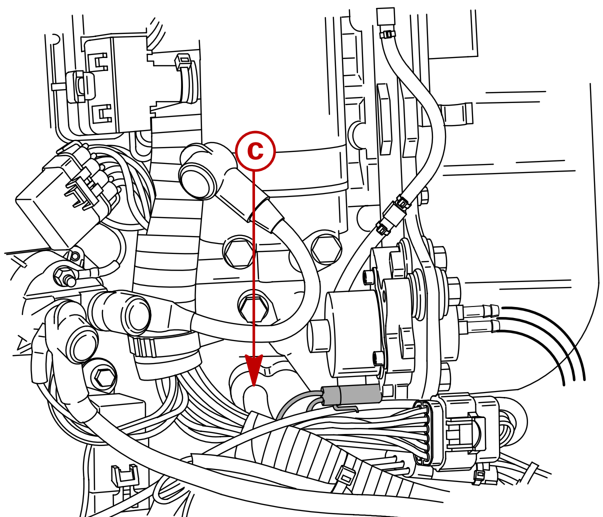
***NOTE:** Oil hose with BLUE stripe contains a directional filter which is designed to trap any debris in the oil before the oil reaches the engine oil reservoir. The filter is marked with an arrow denoting direction of flow of oil and should be installed accordingly. Should engine oil reservoir oil 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.*

Route remote oil tank pulse hoses to starboard side of engine. Route hose with BLUE stripe to port side of engine.

4. Remove (and discard) the shipping cap from hose fitting (a).
5. Connect oil hose from remote oil tank (hose with blue stripe) to fitting (a). Secure with sta-strap.

***NOTE:** Fitting barb (b) is a vent and does not get connected to a hose.*

6. Remove (and discard) shipping cap from pulse fitting (c).
7. Connect the second oil hose from remote oil tank to pulse fitting. Secure with sta-strap.



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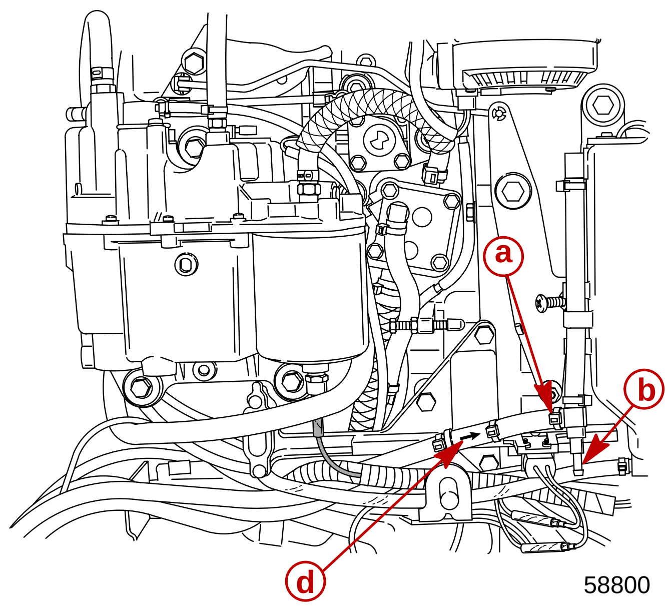

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a - Hose Fitting (Hose with BLUE Stripe)
b - Vent
c - Pulse Fitting
d - Filter

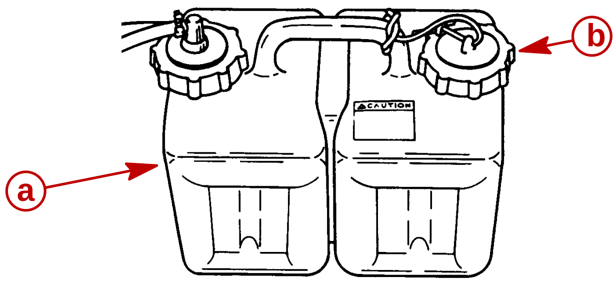
Filling

Mercury Marine recommends the use of "Mercury Precision Premium *Plus* "or "Quicksilver Premium *Plus"* 2-Cycle Oil NMMA Certified TC-W3.

The Premium *Plus* Oil is specially formulated and tested to not only maintain a high level of performance but also increase the durability of the engine. This special blend, developed by Mercury Marine, contains more than twice the additives used in standard blends and ensures the greatest protection for your engine.

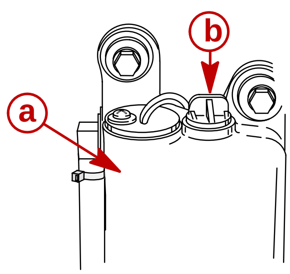
Periodically consult with your dealer to get the latest gasoline and oil recommendations. If "Mercury Precision Premium *Plus"* or "Quicksilver Premium *Plus"* Outboard Oil is not available, you may substitute another brand of 2-Cycle outboard oil that is NMMA Certified TC-W3. Nationally recognized brands are recommended. Continued use of inferior 2-Cycle outboard oil can dramatically reduce engine life. Damage from use of inferior oils that are not NMMA Certified TC-W3 will not be covered under the limited warranty.

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



a - Remote Oil Tank　　**b** - Fill Cap

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

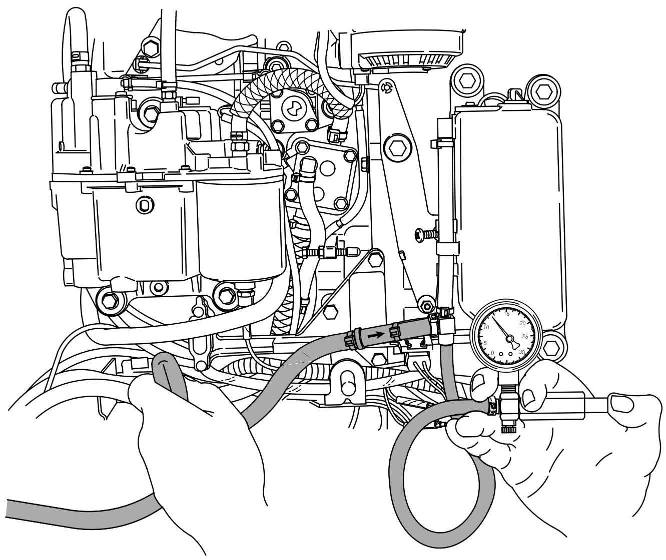


a - Engine Oil Reservoir　　**b** - Fill Cap

Priming the Oil Pump

IMPORTANT: 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.

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 using 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 using pressure) is required on new or rebuilt power heads and any time maintenance is performed on the oiling system that allows air into the oil 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. 91-880118A1.

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

This method fills the oil pump, oil supply hose feeding pump, and oil hose going to vapor separator.

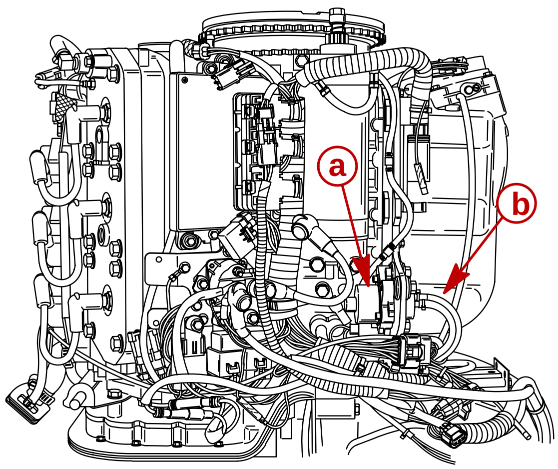
Refer to procedure in the Technician Reference Manual provided with the Digital Diagnostic Software Cartridge Part. No. 91-880118A1.

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.



58778

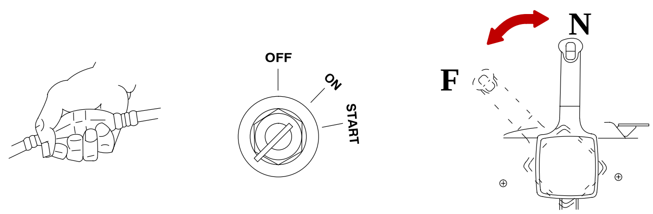
a - Oil Injection Pump **b** - Oil Supply Hose

⚠ CAUTION

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

Prime the oil injection pump as follows:

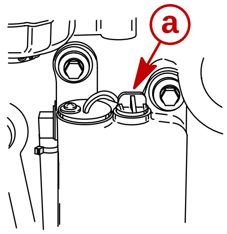
1. Fill the engine fuel system with fuel. Connect fuel hose and squeeze primer bulb until it feels firm.
2. Turn the ignition key switch to the “ON” position.
3. Within the first 10 seconds after the key switch has been turned on, move the remote control handle from neutral into forward gear 3 to 5 times.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

1. Loosen the fill cap on the engine oil reservoir.
2. 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

Trim In Stop Adjustment

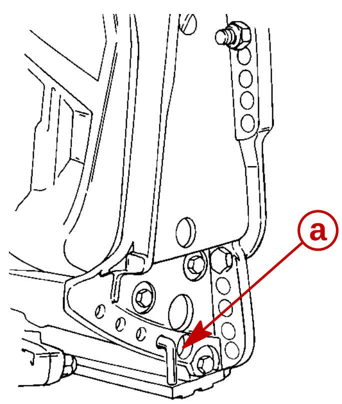
Some outboard boats, particularly some bass boats, are built with a greater than normal transom angle which will allow the outboard to be trimmed further “in” or “under”. This greater trim “under” capability improves acceleration, reduces the angle and time spend in a bow high boat attitude during planing 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 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

Trim Tab Adjustment

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

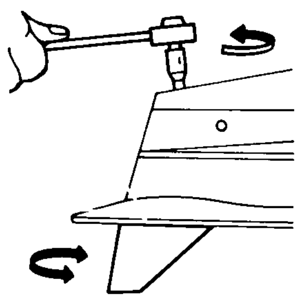
Models Without Power Steering

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

If adjustment is necessary, loosen trim tab bolt until trim tab moves freely (does not rub against locking ridges). DO NOT strike tab to make adjustments. Make small adjustments at a time. If the boat turns more easily to the left, move the trailing edge of trim tab to the left. If the boat turns more easily to the right move the trailing edge of trim tab to the right. Position trim tab in one of the locating grooves BEFORE tightening bolt to prevent damage to holding mechanism. Torque bolt to 40 lb-ft (54 Nm) and retest.

Models With Power Steering

Trim tab adjustment is not required. The trailing edge of the trim tab should be set straight back.



ELECTRICAL

Section 2A - Ignition

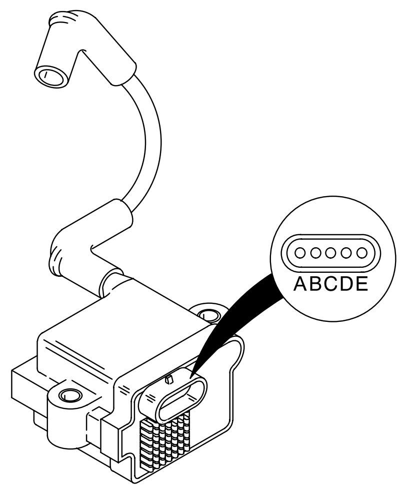
2
A

Table of Contents

Specifications

IGNITION SYSTEM	**Type** **Spark Plug Type** **Spark Plug Gap**	Digital Inductive NGK BPZ8HS-10 0.040 in. (1.0 mm)

Ignition Coil Ohms Test

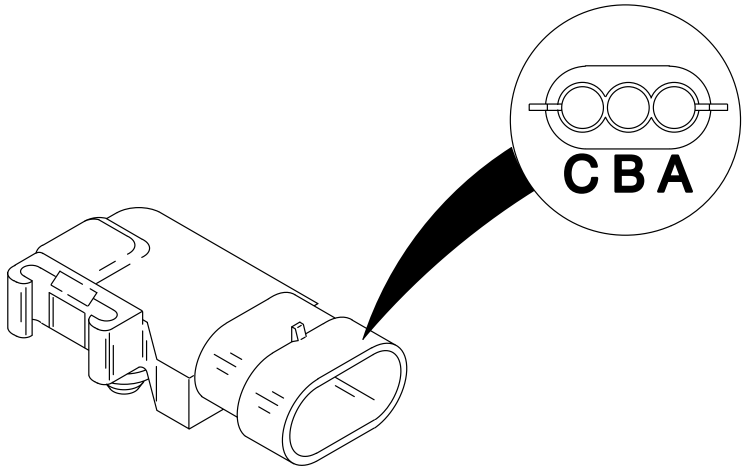


58903

	BLACK METER LEAD						
		Secondary Tower	EST **PIN A**	EST Low **PIN B**	Secondary Low **Pin C**	Primary Ground **Pin D**	Battery + **Pin E**
RED METER LEAD	Secondary Tower	X	No Continuity	No Continuity	850 – 1200 ohm	No Continuity	No Continuity
	EST **PIN A**	No Continuity	X	8500 – 12000 ohm	No Continuity	29000 – 39000 ohm	11000 – 21000 ohm
	EST Low **PIN B**	No Continuity	8500 – 12000 ohm	X	No Continuity	39000 – 49000 ohm	21000 – 31000 ohm
	Secondary Low **Pin C**	850 – 1200 ohm	No Continuity	No Continuity	X	No Continuity	No Continuity
	Primary Ground **Pin D**	No Continuity	20000 – 30000 ohm	31000 – 41000 ohm	No Continuity	X	13000 – 23000 ohm
	Battery + **Pin E**	No Continuity	11000 – 21000 ohm	21000 – 31000 ohm	No Continuity	13000 – 23000 ohm	X

EST = Electronic Spark Trigger
EST Low = Return ground path for the trigger signal to the ECM

Manifold Absolute Pressure (MAP) Sensor Ohms Test



58904

BLACK METER LEAD				
RED METER LEAD		BLK/ORG PIN A	YEL PIN B	PPL/YEL PIN C
	BLK/ORG PIN A	X	95000 – 105000 ohm	3900 – 4100 ohm
	YEL PIN B	95000 – 105000 ohm	X	95000 – 105000 ohm
	PPL/YEL PIN C	3900 – 4100 ohm	95000 – 105000 ohm	X

Crank Position Sensor Resistance Test	
Between 2 pins of Crank Position Sensor Connector	300 – 350 ohms

Throttle Position Sensor Specifications	
Idle	0.19 – 1.0 VDC
Wide Open Throttle	3.45 – 4.63 VDC

Port and Starboard Temperature Sensors; Air Temperature Sensor

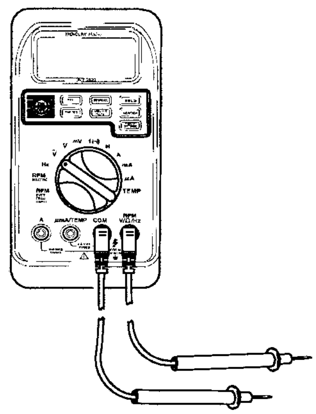
An ohms test of the temperature sensors would be as follows:

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.

Temperature Sensor Specifications		
Fahrenheit	**Centigrade**	**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

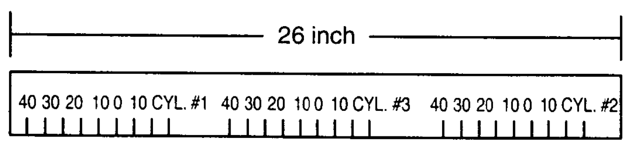
Special Tools

1. DMT 2000 Digital Tachometer Multimeter 91-854009A1

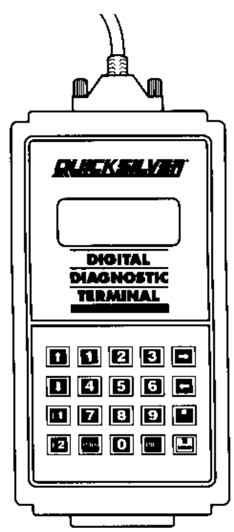


2. Cylinder Timing Decal 91-853883-1

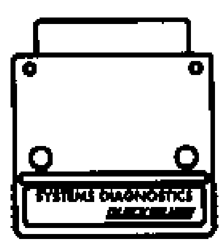
NOTE: *Decal can be used to help troubleshoot ignition timing by determining the timing of individual cylinders.*



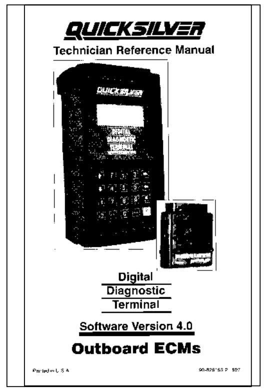
3. Digital Diagnostic Terminal (DDT) 91-823686A2



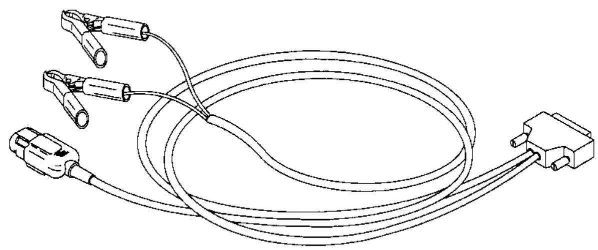
4. Software Cartridge 91-880118--1



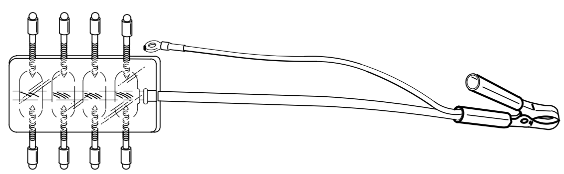
5. DDT Reference Manual 90-881204--1



6. Adaptor Harness 84-822560A5

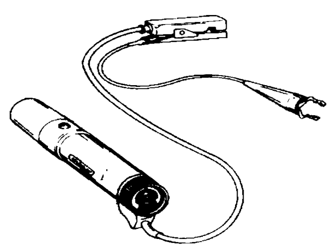


7. Spark Gap Tester 91-850439



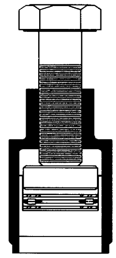
55117

8. Timing Light 91-99379



9. Crank Shaft Protector Cap 91-24161

10. Flywheel Puller 91-849154T1



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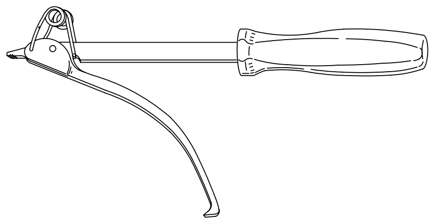
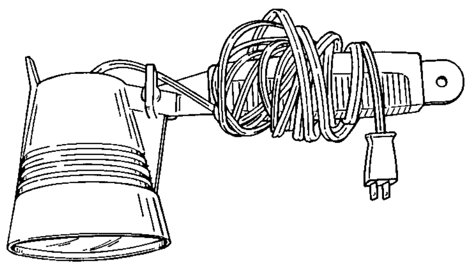
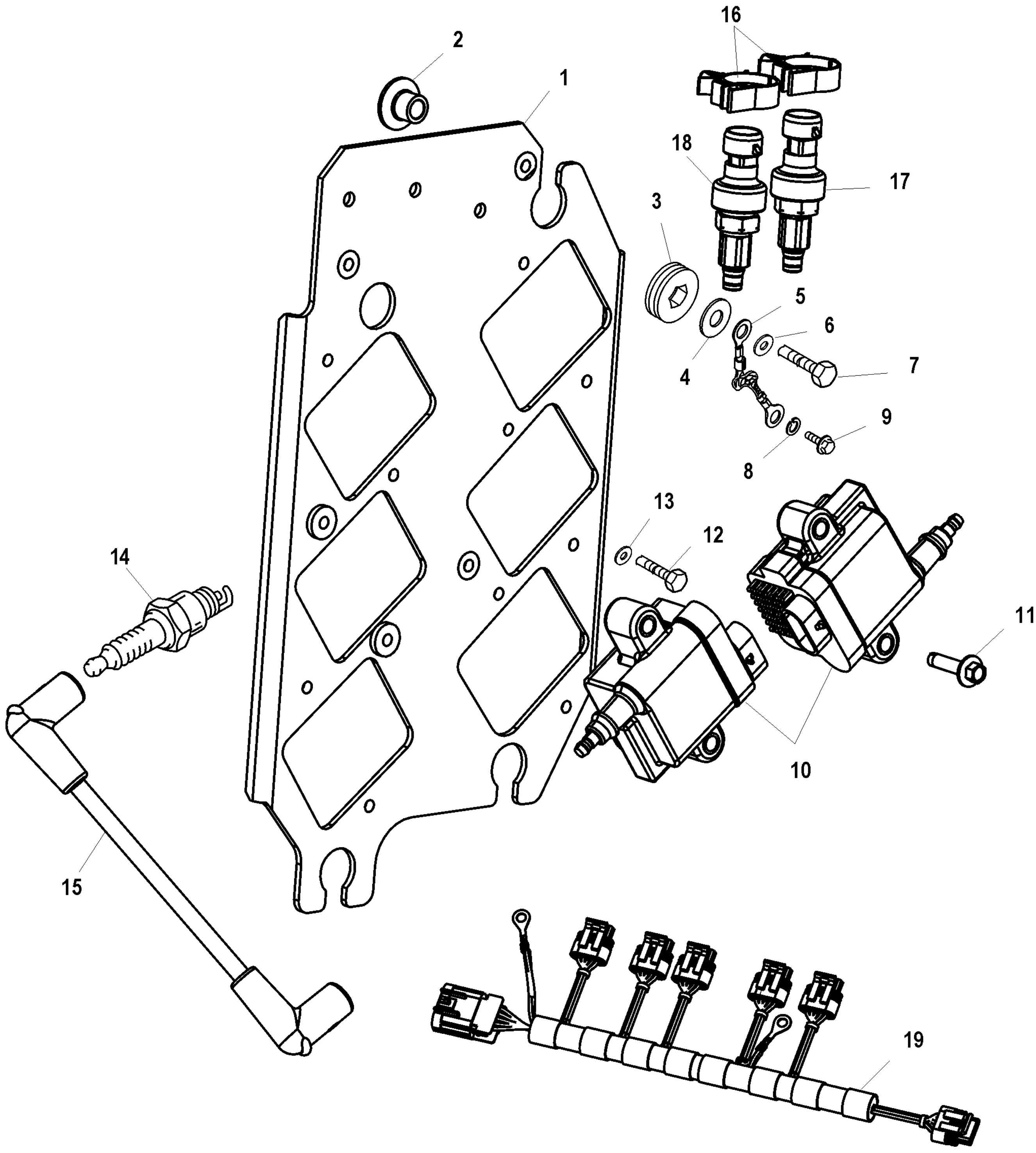
11. Flywheel Holder 91-52344



12. Heat Lamp 91-63209



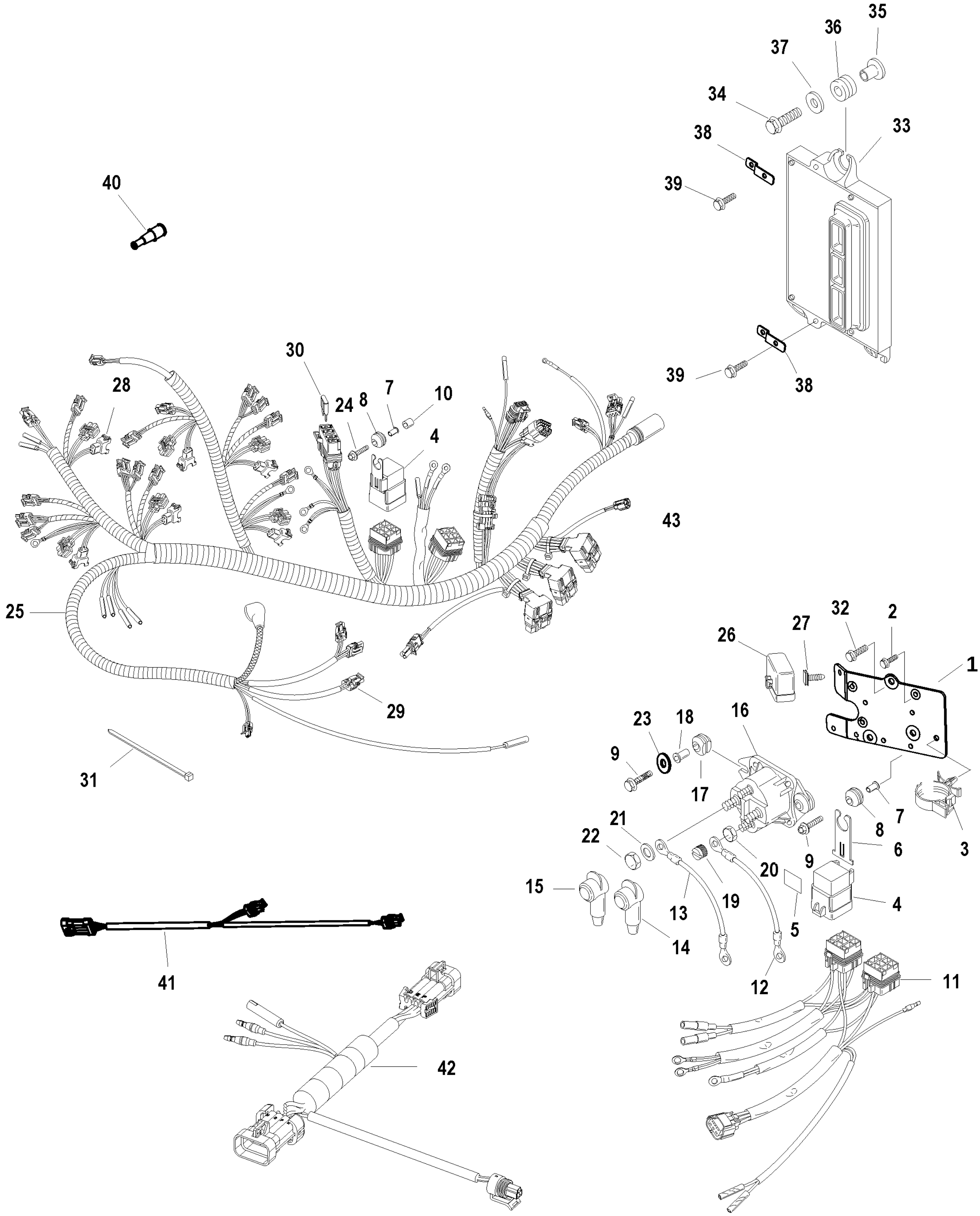
Coil Plate Assembly



Coil Plate Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	COIL PLATE			
2	4	BUSHING			
3	4	GROMMET			
4	4	WASHER			
5	2	CABLE			
6	2	WASHER			
7	4	SCREW (.312-18 x 1-1/4)		20	27
8	3	WASHER			
9	3	SCREW (M6 x 10)	60		7
10	6	IGNITION COIL			
11	12	SCREW (M6 x 25)	100		11.3
12	2	SCREW (M6 x 10)	35		4
13	6	WASHER			
14	6	SPARK PLUG **(NGK#BPZ8HS10)**		20	27
15	6	HI-TENSION CABLE			
16	2	CLIP			
17	1	SENSOR-BLOCK PRESSURE [0-50 psi (0-345 kPa)]			
18	1	SENSOR-SPEEDO [0-100 psi (0-689 kPa)]			
19	1	COIL HARNESS			

Electrical Plate Assembly



Electrical Plate Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	SOLENOID MOUNTING PLATE			
2	3	SCREW (M6 x 10)	100		11.3
3	1	CLIP			
4	3	RELAY			
5	3	DECAL-TRIM RELAY			
6	3	BRACKET			
7	3	BUSHING			
8	3	GROMMET			
9	5	SCREW (M6 x 25)	35		4
10	1	BUSHING			
11	1	TRIM HARNESS			
12	1	CABLE (YELLOW/BLACK)			
13	1	GROUND WIRE (BLACK)			
14	2	BOOT (YELLOW)			
15	1	INSULATOR BOOT (RED)			
16	1	SOLENOID			
17	2	GROMMET			
18	2	BUSHING			
19	1	CAP NUT			
20	2	NUT (10-32)(BRASS)	8		0.9
21	2	LOCKWASHER			
22	2	NUT (5/16-18)	50		5.5
23	1	WASHER			
24	1	SCREW (M6 x 35)	35		4
25	1	ENGINE HARNESS			
26	1	FUSE COVER			
27	2	CLIP			
28	1	HARNESS (FUEL INJECTOR)			
29	1	HARNESS (TPS)			
30		FUSE (4 – 20 AMP) (1 – 15 AMP)			
31	AR	STA-STRAP			
32	3	SCREW (M6 x 12)	30		3.5
33	1	ECM			
34	3	SCREW (M6 x 25)	70		8
35	3	BUSHING			
36	3	GROMMET			
37	3	WASHER			
38	2	CLIP			
39	2	SCREW (M6 x 14)			
40	1	PLUG (MALE)			
41	1	HARNESS-KNOCK SENSOR (200)			
42	1	HARNESS-SMARTCRAFT			

Theory of Operation

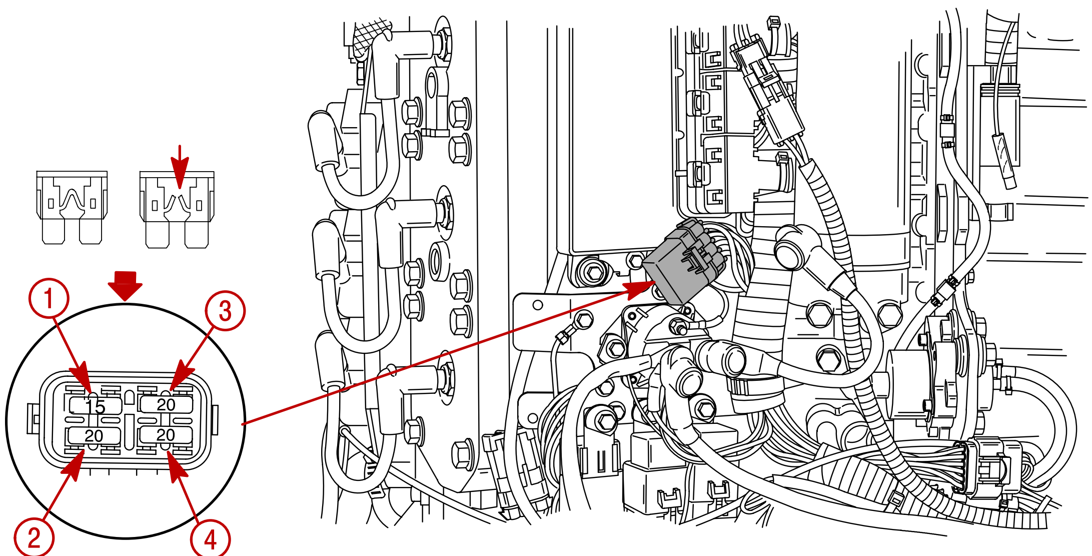
When the ignition key switch is turned to the “RUN” position, battery voltage is applied to both the Electronic Control Module (ECM) through the purple wire and the main power relay through the red/purple wire. As the ECM receives the “RUN” signal, it internally completes the ground circuit of the main relay, for a short period of time, energizing the fuel pump for start-up. As the engine is cranked with the starter motor, the ECM receives the run signal from the Crank Position Sensor (CPS) and completes the ground circuit to the main relay for engine operation. With the main relay closed (completed circuit), D.C. current from the battery/charging system is transferred through the 20 ampere main relay fuse to the positive terminal of all ignition coil primary windings. The negative terminals of the ignition coil primaries are connected to engine ground through the coils’ internal driver, which is triggered by the ECM. With the coil drivers closed, a electric magnetic field is allowed to build up within the ignition coil. As the flywheel rotates, the CPS senses the location of the 54 teeth on the flywheel and supplies the trigger signal information to the ECM. The ECM utilizes the CPS information and determines when to remove the trigger signal from the coil driver of each ignition coil. The coil driver then opens the coil primary ground circuit, allowing it’s magnetic field to rapidly collapse across the coil secondary winding, which induces a high voltage charge (50,000 volts) that fires the spark plug.

Ignition Component Description

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 Ampere Fuse
    b. Fuel Injector Harness, Electric Fuel Pump and Oil Pump
    c. Main Power Relay, Remote Control Harness and Power Trim
    d. Ignition Coils



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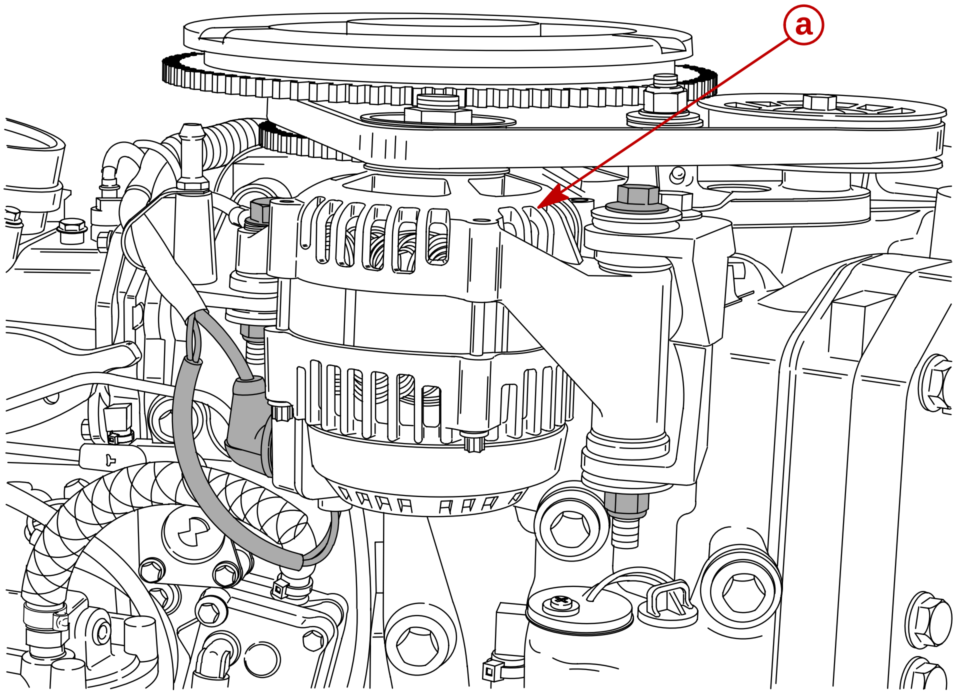
Charging System Alternator

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, 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 35 - 41 amperes.

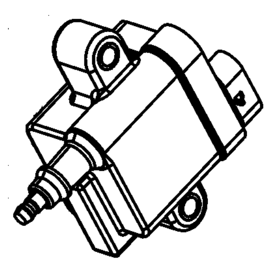


58782

a - Alternator

Ignition Coil

Each module contains an ignition coil and amplifier circuitry which produces approximately 50,000 volts at the spark plugs.



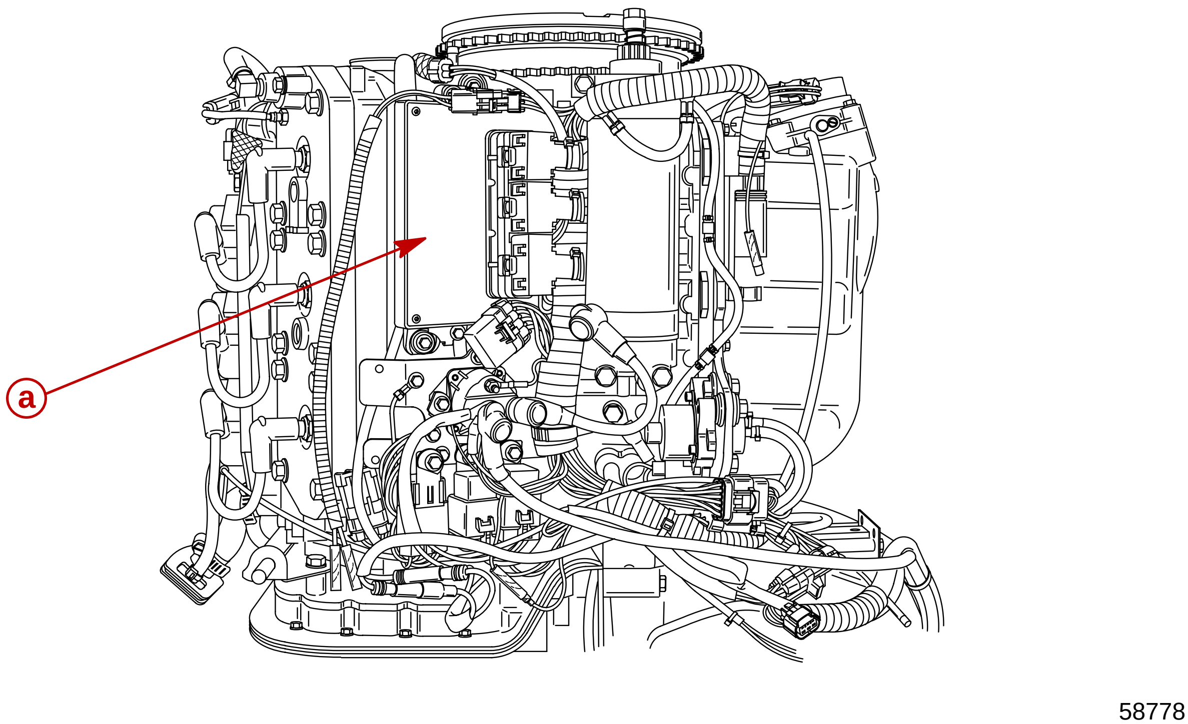
Electronic Control Module

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:

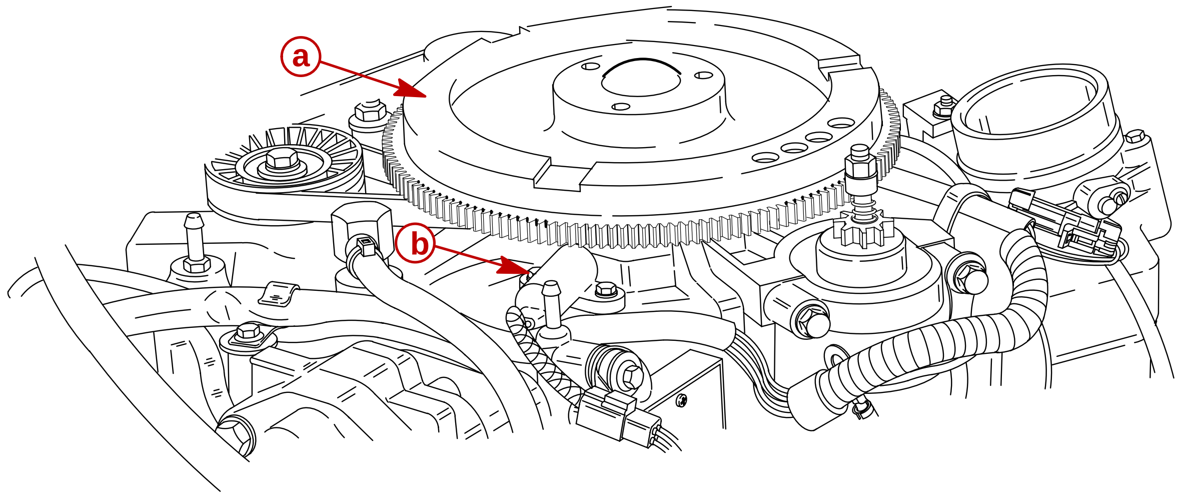
- Calculates the precise fuel and ignition timing requirements based on engine speed, throttle position, manifold pressure and coolant temperature.
- Controls fuel injectors for each cylinder and ignition for each cylinder.
- Controls all alarm horn functions.
- Supplies tachometer signal to gauge.
- Controls RPM limit function.
- Contains detonation control circuitry (200 Model only)
- Records engine running information.



a - Electronic Control Module (ECM)

Flywheel

Flywheel has 54 teeth under the flywheel ring gear which the crank position sensor uses to provide engine rpm and crankshaft position information the ECM.

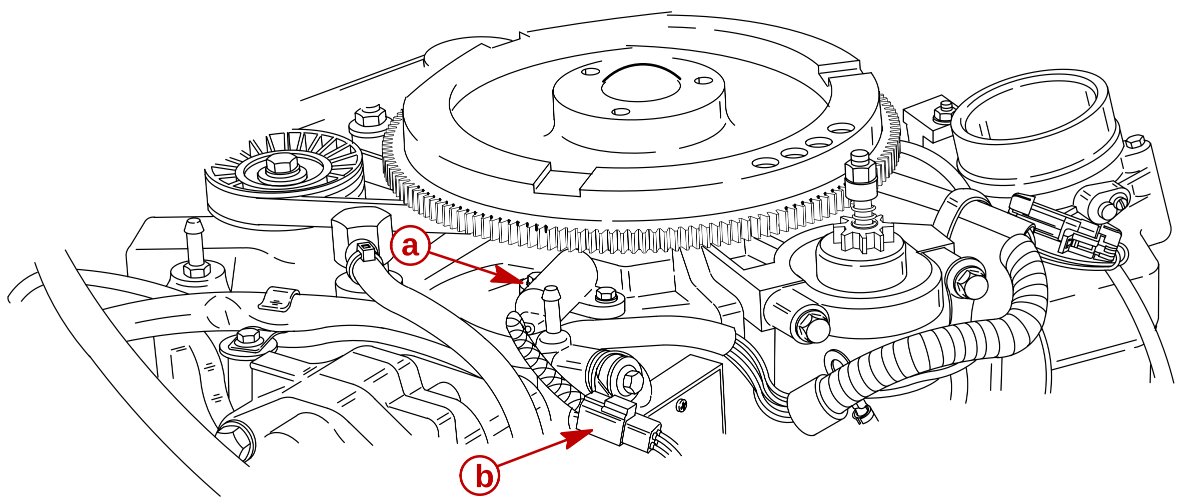


58775

a - Flywheel **b** - Crank Position Sensor

Crank Position Sensor

Monitors 54 teeth on flywheel thus determining crankshaft position and sends crankshaft position angle and engine speed signals to ECM. If crank position sensor should fail, engine will stop running.



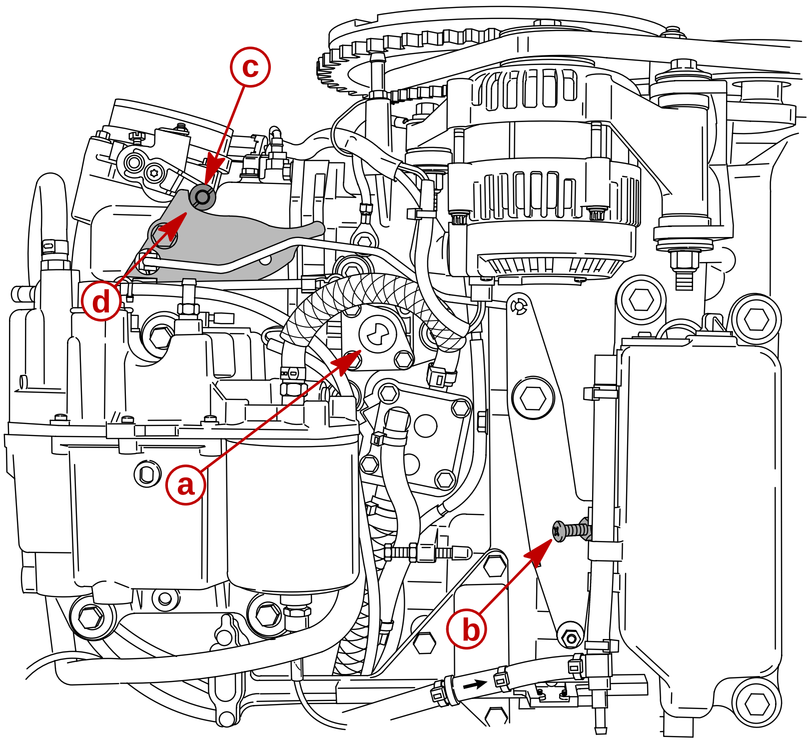
58775

a - Crank Position Sensor **b** - Crank Position Sensor Connector

Crank Position Sensor Resistance Test	
Between 2 pins of Crank Position Sensor Connector	300 – 350 ohms

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 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.



58899

a - Throttle Position Sensor (TPS)
b - Throttle Stop Screw
c - Roller
d - Pocket

Throttle Position Sensor Specifications	
Idle	0.19 – 1.0 VDC
Wide Open Throttle	3.45 – 4.63 VDC

Throttle Position Sensor (TPS) Troubleshooting

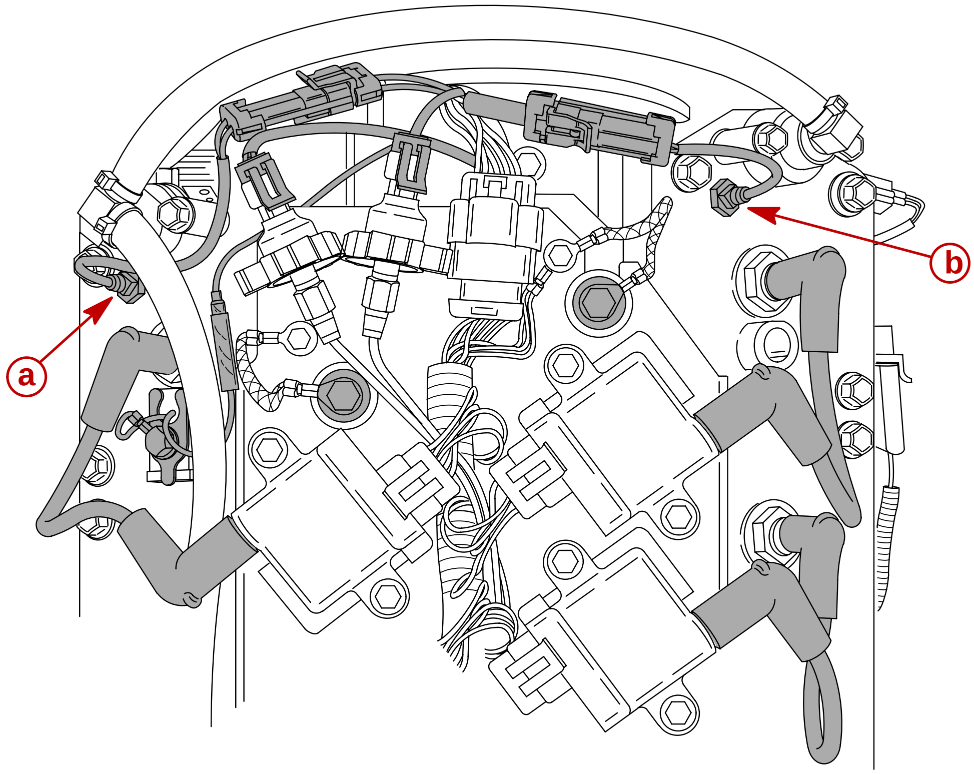
If the throttle position sensor is out of the intended operating range when the engine is started, the Electronic Control Module (ECM) will sense that the Throttle Position Sensor (TPS) has failed. The warning horn will sound, check engine light will illuminate, DDT will indicate failed TPS and the engine will go into RPM reduction. When the engine is started, the throttle arm on the engine must be against the throttle stop screw. Do not move throttle or fast idle control lever forward.

- 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 in changing values.

Cylinder Head Temperature Sensor

Two (2) temperature sensors are used to provide temperature information to the ECM. One sensor is mounted in each 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. Should a temperature sensor fail, the ECM will default to a temperature value of 32 ° F (0 ° C).

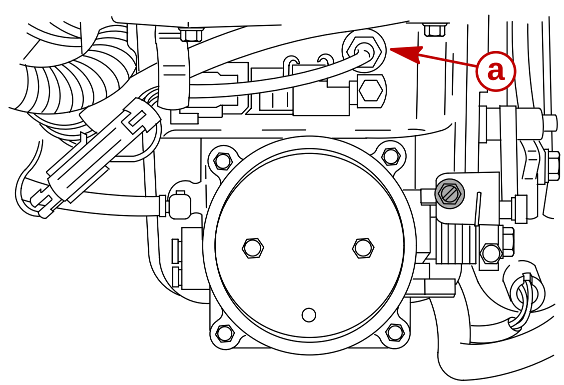


58893

a - Cylinder Temperature Sensor (PORT)
b - Cylinder Temperature Sensor (STARBOARD)

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. Should the air temperature sensor fail, the ECM will default to a temperature value of 32 ° F (0 ° C).



58898

a - Air Temperature Sensor

Port and Starboard Temperature Sensors; Air Temperature Sensor

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

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.

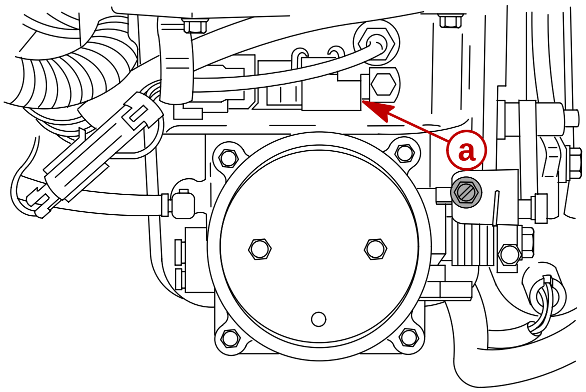
Temperature Sensor Specifications		
Fahrenheit	**Centigrade**	**OHMS**
257	125	340
248	120	390
239	115	450
230	110	517
221	105	592
212	100	680
203	95	787
194	90	915
185	85	1070
176	80	1255
167	75	1480
158	70	1752
149	65	2083
140	60	2488
131	55	2986
122	50	3603
113	45	4370
104	40	5327
95	35	6530
86	30	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 located on top of the air plenum. The ECM regulates fuel flow, in part, based on manifold absolute pressure. The MAP sensor becomes more critical in engine running quality as the engine is operated at higher altitudes (i.e. mountain lakes). Should the MAP sensor fail, the ECM will default to a value of approximately 14.7 psi.

The Digital Diagnostic Terminal (DDT) can be used to determined whether the MAP sensor is functioning properly. As throttle is advanced, numerical value on DDT display should increase. As throttle is retarded, numerical value should decrease indicating MAP sensor is functioning. If numerical value does not change as throttle setting varies, MAP sensor is defective.

NOTE: *If MAP sensor is not functioning, #4 LED indicator light on DDT will be illuminated.*



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a - Manifold Absolute Pressure (MAP) Sensor

Ignition Troubleshooting and Fault Chart

CAUTION

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

- **DO NOT reverse battery cable connections. The battery negative cable is (–) ground.**
- **DO NOT “spark” battery terminals with battery cable connections to check polarity.**
- **DO NOT disconnect battery cables while engine is running.**

Before troubleshooting the ignition system, check the following:

1. Make sure that electrical harness and ignition switch are not the source of the problem.
2. Check that plug-in connectors are fully engaged and terminals are free of corrosion.
3. Make sure that wire connections are tight and free of corrosion.
4. Check all electrical components, that are grounded directly to engine, and all ground wires to see that they are grounded to engine.
5. Check for disconnected wires and short and open circuits.

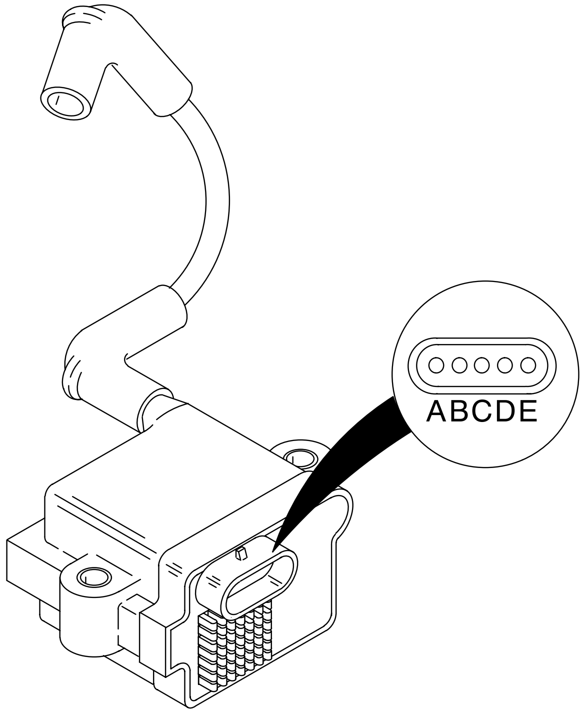
Symptom	Cause	Action
1. Engine cranks but won’t start	**1.0** Lanyard stop switch in wrong position.	Reset lanyard stop switch.
	1.1 Weak battery or bad starter motor, battery voltage drops below 8 volts while cranking (ECM cuts out below 8volts) (Fuel pump requires 9volts)	Replace/charge battery. Inspect condition of starter motor. Check condition of battery terminals and cables.
	1.2 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
	1.3 Flywheel misaligned during installation	Remove flywheel and inspect.
	1.4 Blown fuse	Replace fuse. Inspect engine harness and electrical components.
	1.5 Main Power Relay not functioning	Listen for relay to “click” when the key switch is turned on.
	1.6 Spark Plugs	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.

Symptom	Cause	Action
1. Engine cranks but will not start (continued)	**1.7** ECM not functioning	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 [0.025 in. – 0.040 in. (0.64 mm – 1.02 mm)] from flywheel or for defective crank position sensor. Defective ECM. Power Supply: Clean and inspect remote control male and female harness connectors.
	1.8 Crank Position Sensor not functioning	– Sensor faulty. – Bad connection – Air gap incorrect
2. Engine cranks, starts and stalls	**2.0** Abnormally high friction in engine	Check for scuffed piston or other sources of high friction.
	2.1 Air in fuel system/lines	Crank and start engine several times to purge.
	2.2 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.
	2.3 Remote control to engine harness connection is poor	Clean and inspect male and female connectors.

Symptom	Cause	Action
3. Engine idle is rough	**3.1** 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.*
	3.2 Failed fuel injector	Refer to specifications for ohm test.
	3.3 Bad coil/weak spark	Refer to specifications for ohm test.
	3.4 Flywheel misaligned during installation	Remove flywheel and inspect.
4. Engine idles fast (rpm >700) or surges	**4.1** Fuel leak	Check for fuel entering induction manifold. Fuel pump diaphragm leaking and/or Vapor Separator flooding over.
	4.2 Improper set-up	Check throttle cable & cam roller adjustment.
5. Engine runs rough below 3000 rpm	**5.1** Fouled spark plug	See **3.1**
	5.2 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.
	5.3 Bad coil/weak spark	See **3.3**
	5.4 TPS malfunction	See **2.2**
6. Engine runs rough above 3000 rpm	**6.1** Fouled spark plug	See **3.1**
	6.2 Speed Reduction	See **7**
	6.4 TPS malfunction	See **2.2**

Symptom	Cause	Action
7. Speed Reduction (RPM reduced)	**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	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 to idle	See **2.2**
8. Engine RPM reduced to idle only	**8.1** TPS failed	See **2.2**
	8.2 Battery voltage below 9.5 volts	Use DDT to monitor system
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: If spark plug is partially fouled or the plug gap is too small, 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.	

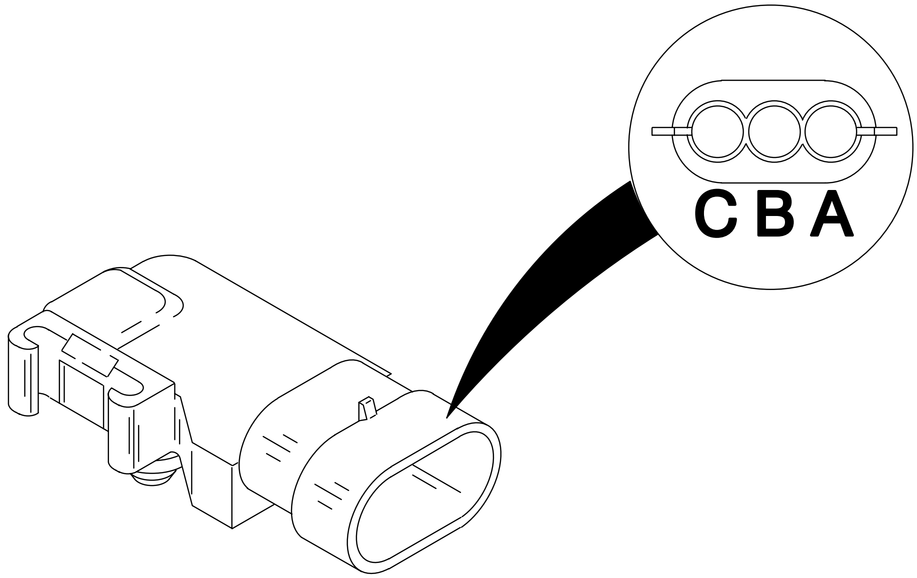
Ignition Coil Ohms Test



BLACK METER LEAD							
		Secondary Tower	EST **PIN A**	EST Low **PIN B**	Secondary Low **Pin C**	Primary Ground **Pin D**	Battery + **Pin E**
RED METER LEAD	Secondary Tower	X	No Continuity	No Continuity	850 – 1200 ohm	No Continuity	No Continuity
	EST **PIN A**	No Continuity	X	8500 – 12000 ohm	No Continuity	29000 – 39000 ohm	11000 – 21000 ohm
	EST Low **PIN B**	No Continuity	8500 – 12000 ohm	X	No Continuity	39000 – 49000 ohm	21000 – 31000 ohm
	Secondary Low **Pin C**	850 – 1200 ohm	No Continuity	No Continuity	X	No Continuity	No Continuity
	Primary Ground **Pin D**	No Continuity	20000 – 30000 ohm	31000 – 41000 ohm	No Continuity	X	13000 – 23000 ohm
	Battery + **Pin E**	No Continuity	11000 – 21000 ohm	21000 – 31000 ohm	No Continuity	13000 – 23000 ohm	X

EST = Electronic Spark Trigger
EST Low = Return ground path for the trigger signal to the ECM

Manifold Absolute Pressure (MAP) Sensor Ohms Test



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BLACK METER LEAD				
RED METER LEAD		BLK/ORG PIN A	YEL PIN B	PPL/YEL PIN C
	BLK/ORG PIN A	X	95000 – 105000 ohm	3900 – 4100 ohm
	YEL PIN B	95000 – 105000 ohm	X	95000 – 105000 ohm
	PPL/YEL PIN C	3900 – 4100 ohm	95000 – 105000 ohm	X

Idle Speed Control

The ECM varies the timing and the fuel flow based on the throttle opening to maintain an idle speed of 650 rpm ± 50 rpm.

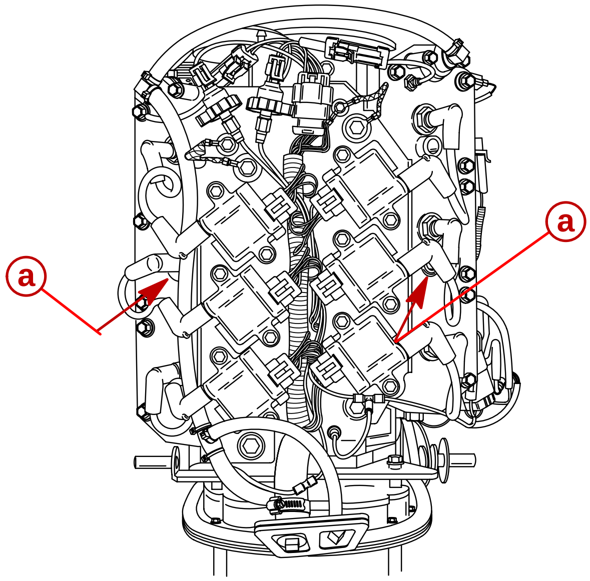
RPM-Limit Circuit

The rpm limit circuitry is contained within the ECM. When the rpm limit point is reached (this point will vary between engine models), a warning horn will sound. If the rpm continues to increase, ignition spark will be cut to cylinders #1, #3 and #5. If the rpm still continues to rise, fuel and ignition spark will be cut to all cylinders.

EFI Detonation Control System (200 Model only)

The detonation control circuit is located in the ECM. This circuit monitors 2 detonation (knock) sensors; 1 each located in each cylinder head. When detonation is initially detected, timing is retarded. If detonation continues, fuel mixture is richened.

Use DDT to monitor Knock Volts (Press Keys 1, 3, 1)



a - Detonation Sensor (hidden) (1 per cylinder head)

Detonation Circuit Test

1. Turn key switch to RUN position (do not start engine). With Digital Diagnostic Terminal connected to engine, DDT should indicate over 6 volts for knock voltage output.
2. Start engine and run at idle. DDT indicated knock voltage output should drop below 1.0 volt. If voltage does not drop below 1.0 volt, knock circuit within ECM is defective.

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.

Disconnecting a sensor for troubleshooting purposes may have no noticeable effect.

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 in) into 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.

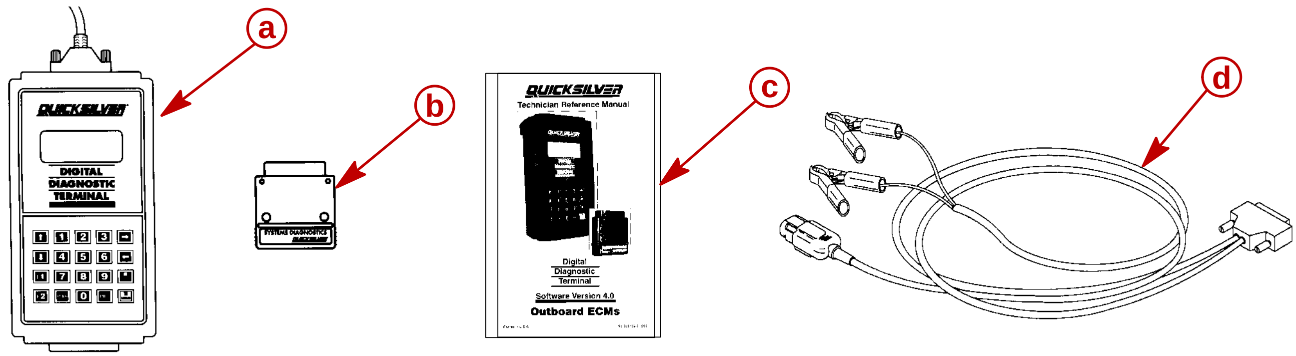
NOTE: *ECMs are capable of performing a cylinder misfire test to isolate problem cylinders. Once a suspect cylinder is located, an output load test on the ignition coil, fuel injector and direct injector may be initiated through use of the DDT.*

- 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.

Troubleshooting with the Digital Diagnostic Terminal



a - Digital Diagnostic Terminal (91-823686A2)
b - Software Cartridge (91-880118-2)
c - 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 – EFI Models
Software Version 1.2 (P/N 880118A2)

SmartCraft Monitor
1 – Mercury Marine
2 – Tool Setup

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

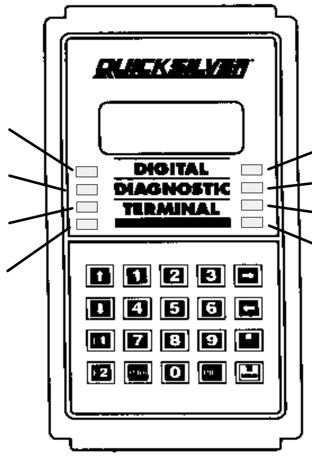
Select Function:
1 - AUTO SELF TEST
2 - MANUAL TEST

Select Auto Test:
1 – STATIC TEST

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

02MY EFI
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 5250-5750
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



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

Fault Status List

ACT INPUT HI or LO	Air compessor temperature sensor input is high or low
AT INPUT HI or LO	Air temperatrure (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
KNOCK SENSOR 1	Knock Sensor #1
KNOCK SENSOR 2	Knock Sensor #2

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

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

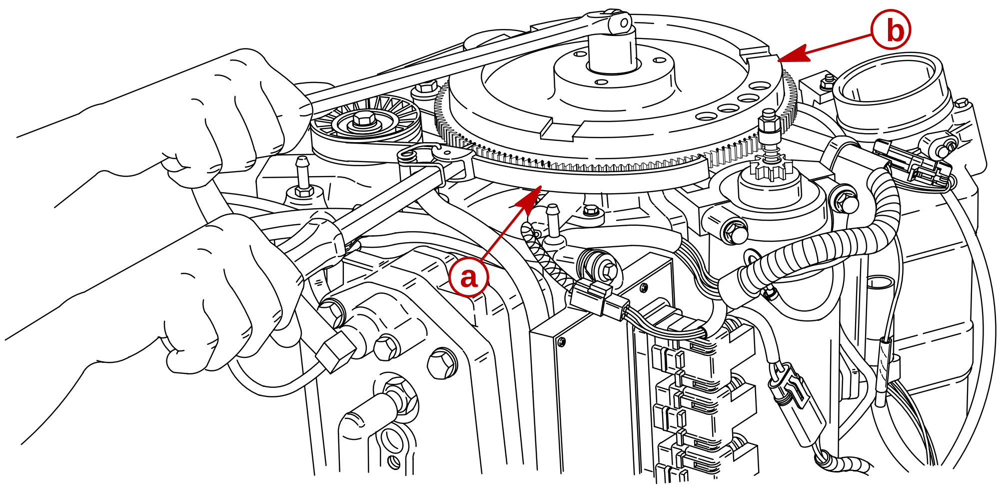
Select Load Test:
1 - IGNITION
2 - FUEL INJECTOR
3 - DIRECT INJECTOR
4 - OIL PUMP
5 - FUEL PUMP
6 - HORN
7 - RESERVE
8 - TACHOMETER
9 - MAIN POWER RELAY

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

Ignition Component Removal and Installation

Flywheel Removal

1. Remove flywheel cover off engine.
2. Remove alternator belt.
3. While holding flywheel with Flywheel Holder (91-52344), remove flywheel nut and washer.



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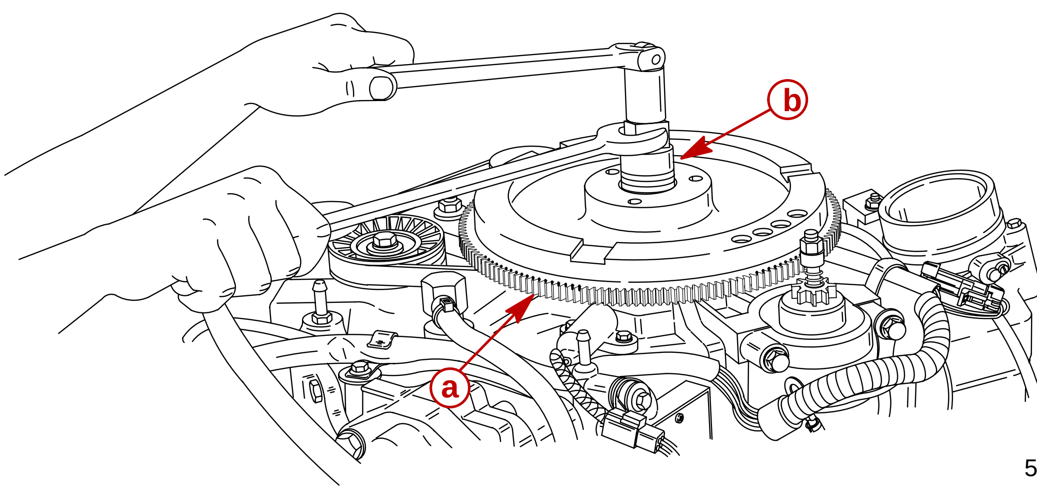
a - Flywheel Holder (91-52344)
b - Flywheel

4. Install Flywheel Puller (91-849154T1) into flywheel.

> **⚠ CAUTION**
>
> **Do not hammer on end of puller center bolt to remove flywheel, or damage may result to crankshaft or bearings. Do not use heat to aid flywheel removal as flywheel and electrical components under flywheel may be damaged.**



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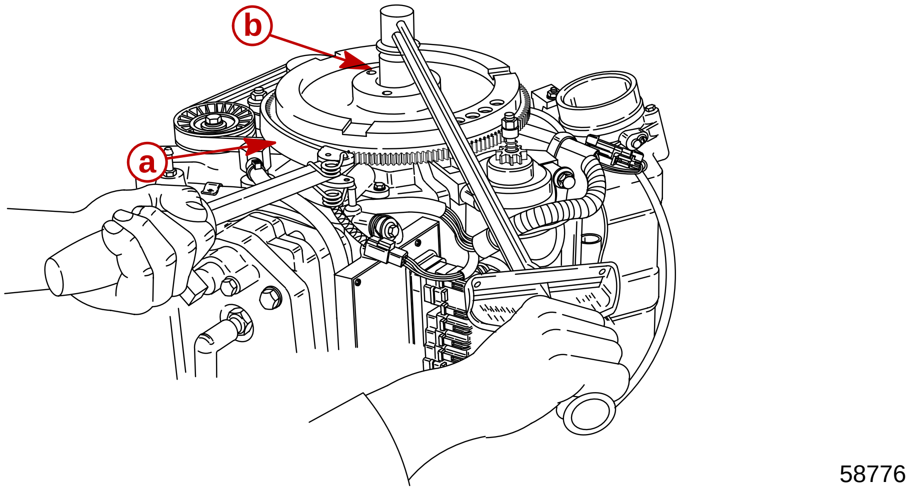
a - Flywheel
b - Flywheel Puller (91-849154T1)

Flywheel Installation

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

1. Reinstall flywheel on crankshaft. Secure flywheel with flat washer and locknut. While holding flywheel with Flywheel Holder (91-52344), torque flywheel nut to 120 lb. ft. (163.0 N m).



a - Flywheel Holder (91-52344)
b - Torque Nut to 120 lb. ft. (163 Nm)

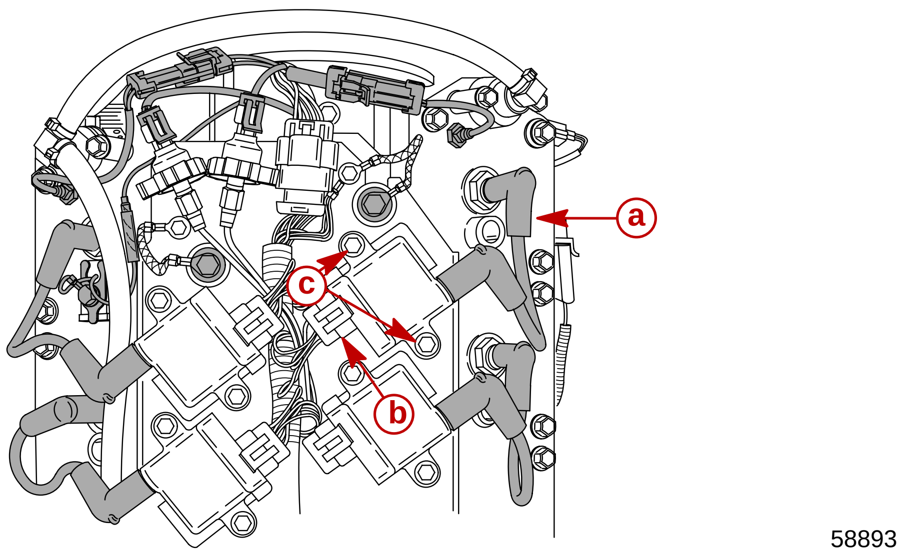
2. Reinstall flywheel cover on engine.

Ignition Coil Removal

⚠ WARNING

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

1. Disconnect spark plug lead from spark plug.
2. Disconnect coil harness connector.
3. Remove 2 bolts securing ignition coil and remove coil.



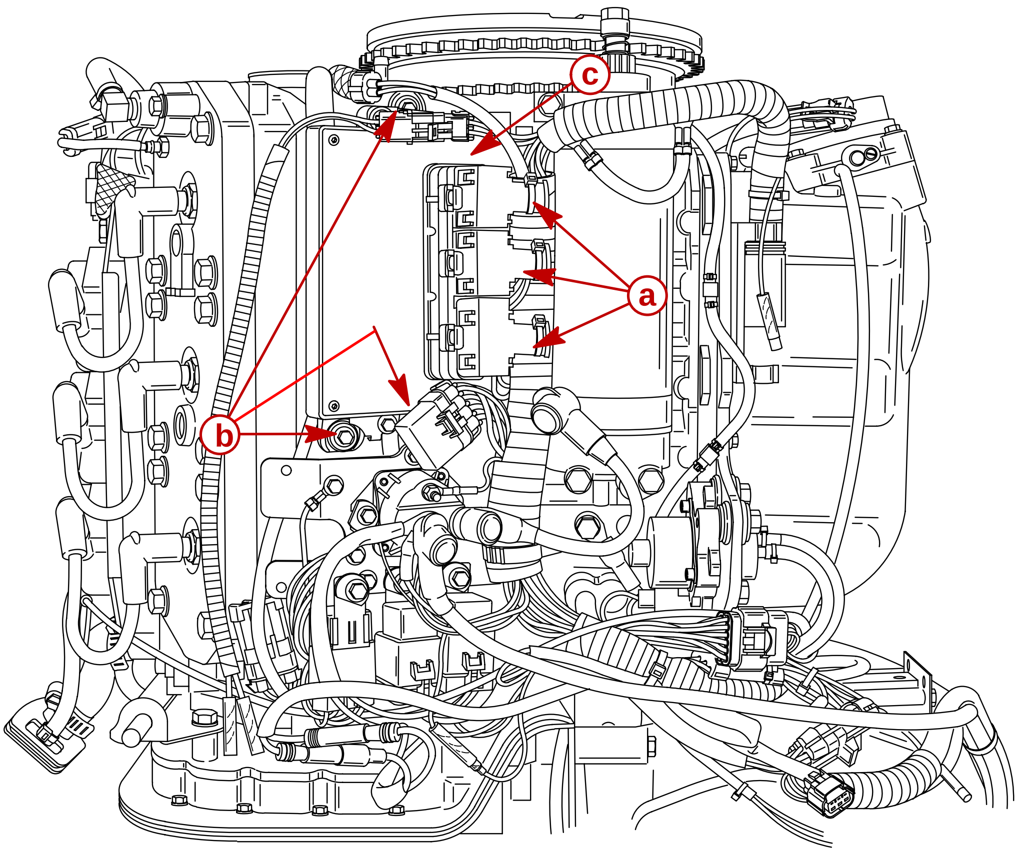
a - Spark Plug Lead
b - Harness Connector
c - Bolts

Ignition Coil Installation

1. Secure coil with 2 bolts. Torque bolts to 70 lb. in. (8 Nm).
2. Reconnect coil harness.
3. Reconnect spark plug lead to spark plug.

Electronic Control Module Removal

1. Disconnect 3 Control Module harness connectors.
2. Remove 3 bolts securing module and remove module.



a - Harness Connectors
b - Bolts (3)
c - Control Module

Electronic Control Module Installation

1. Secure module with 3 bolts. Torque bolts to 70 lb. in. (8 Nm).
2. Reconnect 3 module harness connectors.

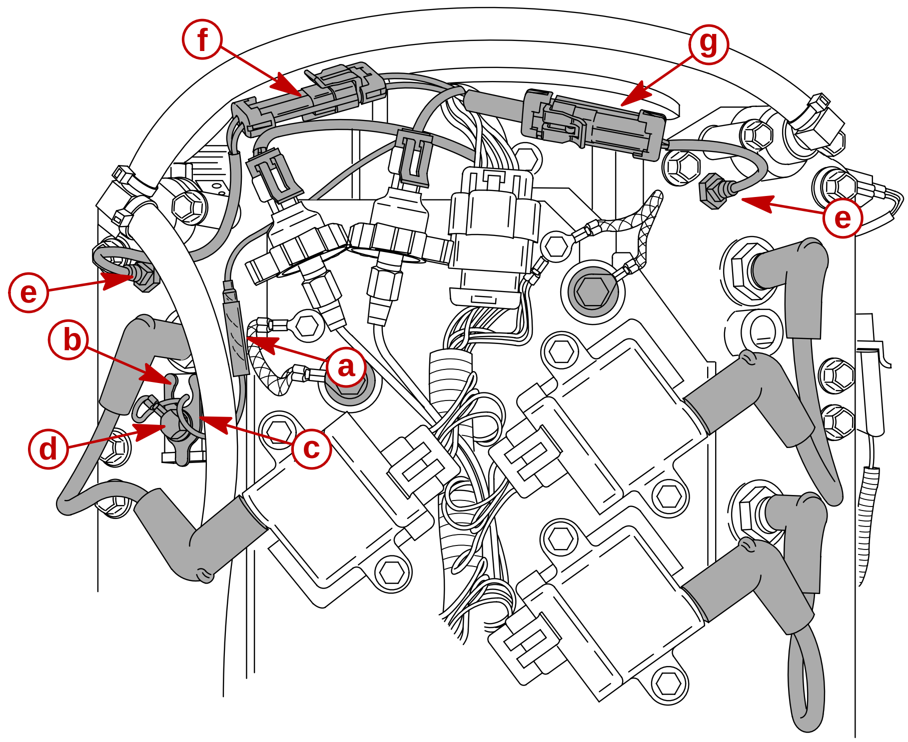
Temperature Sensor Removal

ANALOG TEMPERATURE SENSOR

1. Remove screw and retaining plate.
2. Disconnect bullet connector and remove sensor.

DIGITAL TEMPERATURE SENSOR

1. Disconnect wire harness for PORT and STARBOARD sensors.
2. Unscrew sensor from cylinder head.



a - Bullet Connector
b - Analog Temperature Sensor
c - Retainer
d - Retainer Screw
e - Digital Temperature Sensor
f - Port Sensor Harness
g - Starboard Sensor Harness

Engine Head Temperature Sensor Installation

ANALOG TEMPERATURE SENSOR

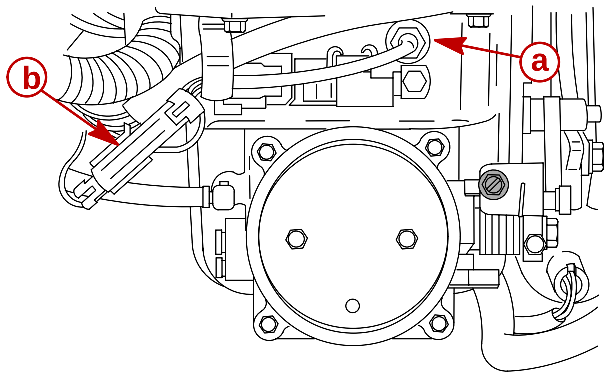
1. Install sensor into pocket.
2. Secure sensor with retainer and screw. Ground (BLACK) lead of sensor is secured with retainer screw. Torque retainer screw to 16.5 lb. ft. (22.4 Nm).
3. Reconnect sensor bullet connector.

DIGITAL TEMPERATURE SENSOR

1. Install sensors into cylinder heads. Torque sensors to 14 lb. in. (1.6 Nm).
2. Reconnect sensor harness connectors.

Air Temperature Sensor Removal

1. Disconnect sensor harness connector.
2. Unscrew sensor from air plenum.



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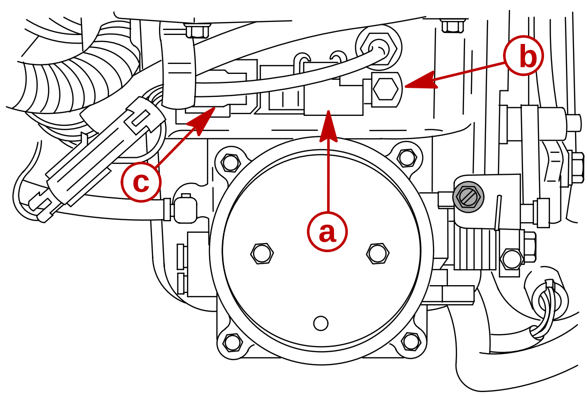
a - Air Temperature Sensor
b - Harness Connector

Air Temperature Sensor Installation

1. Install sensor into air plenum. Torque sensor to 14 lb. in. (1.6 Nm).
2. Reconnect sensor harness.

Manifold Absolute Pressure (MAP) Sensor Removal

1. Disconnect MAP harness.
2. Remove bolt securing MAP retainer.
3. Remove MAP sensor.



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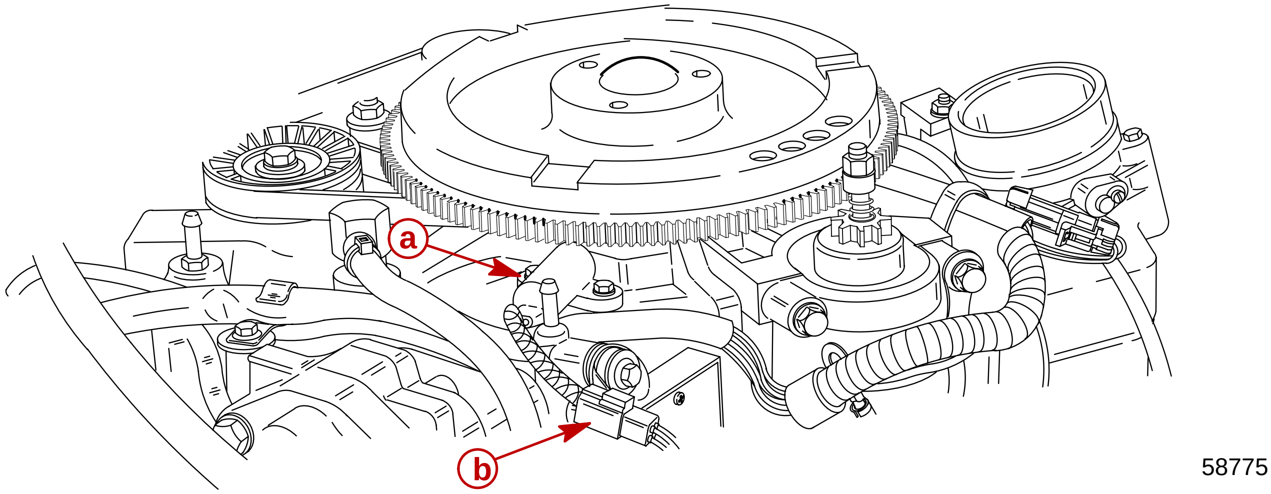
a - Manifold Absolute Pressure (MAP) Sensor
b - Bolt
c - Harness Connector

Manifold Absolute Pressure (MAP) Sensor Installation

1. Install sensor into air plenum.
2. Secure sensor with retainer and bolt. Torque bolt to 35 lb. in. (3.9 Nm).
3. Reconnect MAP harness.

Crank Position Sensor Removal

1. Disconnect sensor harness.
2. Remove screws securing sensor to engine.



a - Crank Position Sensor **b -** Harness Connector

Crank Position Sensor Installation

1. Secure sensor to engine with 2 screws. Torque screws to 45 lb. in. (5 Nm).
2. Reconnect sensor harness.

ELECTRICAL

Section 2B – Charging & Starting System

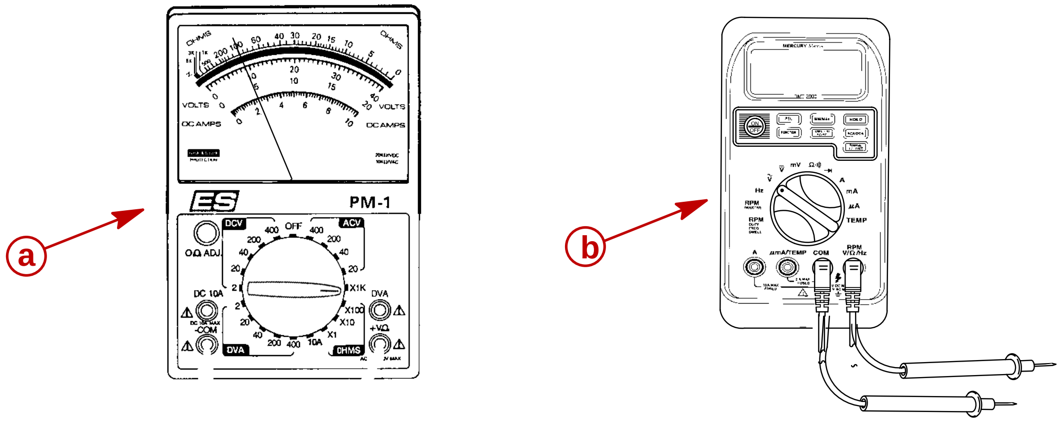
Table of Contents

Specifications

CHARGING SYSTEM	**Alternator Output (Regulated)** **Brush Length** **Voltage Output** **Regulator Current Draw**	35 - 41 Amperes @ 2000 RPM @ Battery 36 - 44 Amperes @ 2000 RPM @ Alternator Std Exposed Length: 0.413 in. (10.5 mm) Min. Exposed 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)
STARTING SYSTEM	**Electric Start – All Models** **Centrifugal Bendix** **Starter Draw (Under Load)** **Starter Draw (No Load)** **Minimum Brush Length** **Solenoid Driven Bendix** **Starter Draw (Under Load)** **Starter Draw (No Load)** **Minimum Brush Length** **Battery Rating**	 165 Amperes 30 Amperes 0.25 in. (25.4 mm) 175 Amperes 60 Amperes 0.25 in. (25.4 mm) Min. 630 Marine Cranking Amps (MCA) or 490 Cold Cranking Amps (CCA)

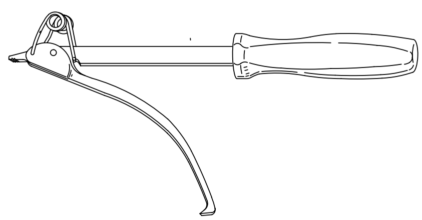
Special Tools

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



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

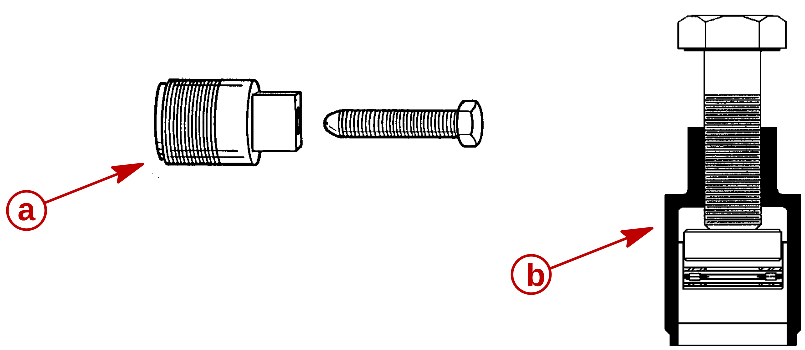
2. Ammeter (60 Ampere minimum) (Obtain locally)
3. Flywheel Holder 91-52344



54964

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

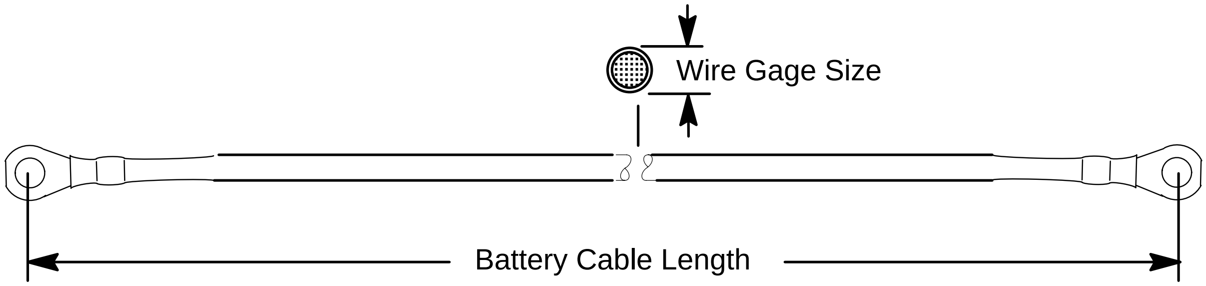
5. Flywheel Puller 91-73687A1 or 91-849154T1



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 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 490 amperes or 630 (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

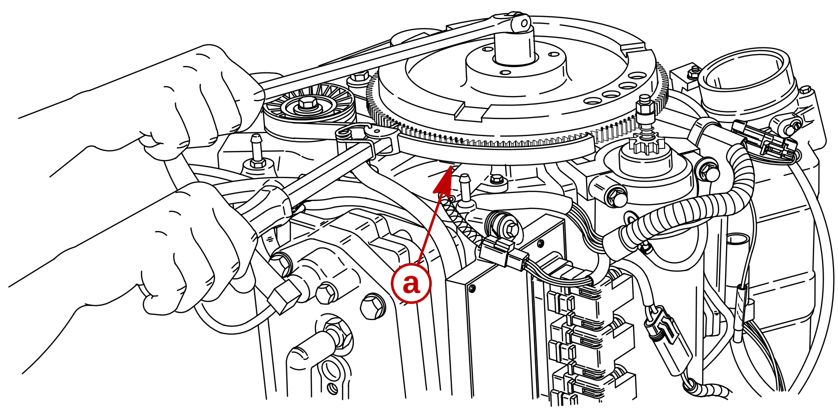
Removal

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.

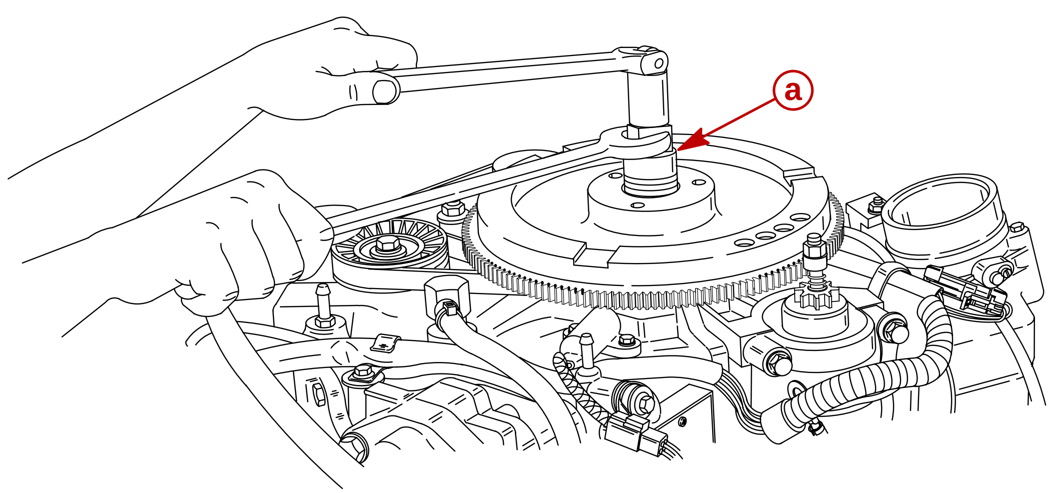
2. Disconnect spark plug leads from spark plugs.
3. While holding flywheel with flywheel holder (91-52344), remove flywheel nut and washer.



58777

a - Flywheel Holder (91-25344)

4. Install a crankshaft Protector Cap (91-24161) on end of crankshaft, then install Flywheel Puller (91-849154T1) into flywheel.
5. Hold flywheel tool with wrench while tightening bolt down on protector cap. Tighten bolt until flywheel comes free.



58775

a - Flywheel Puller (91-849154T1)

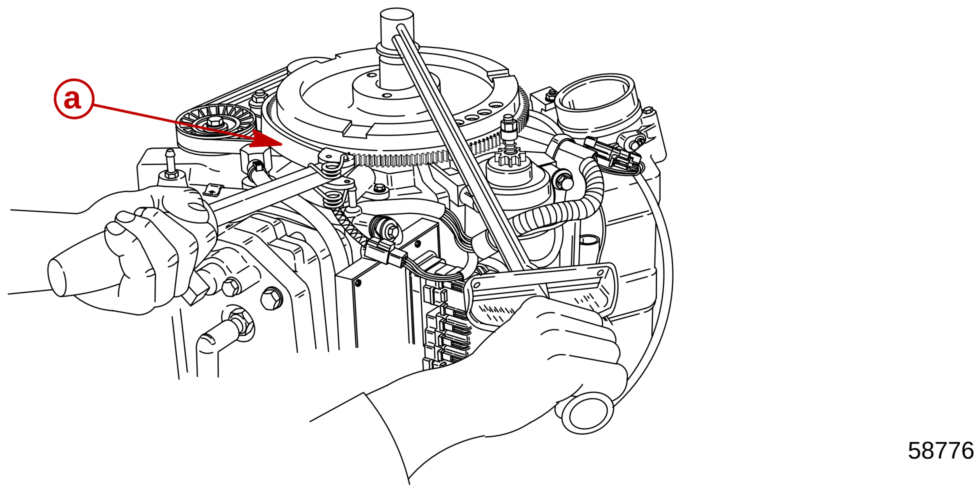
NOTE: *Neither heat or hammer should be used on flywheel to aid in removal as damage to flywheel or electrical components under flywheel may result.*

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

Installation

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

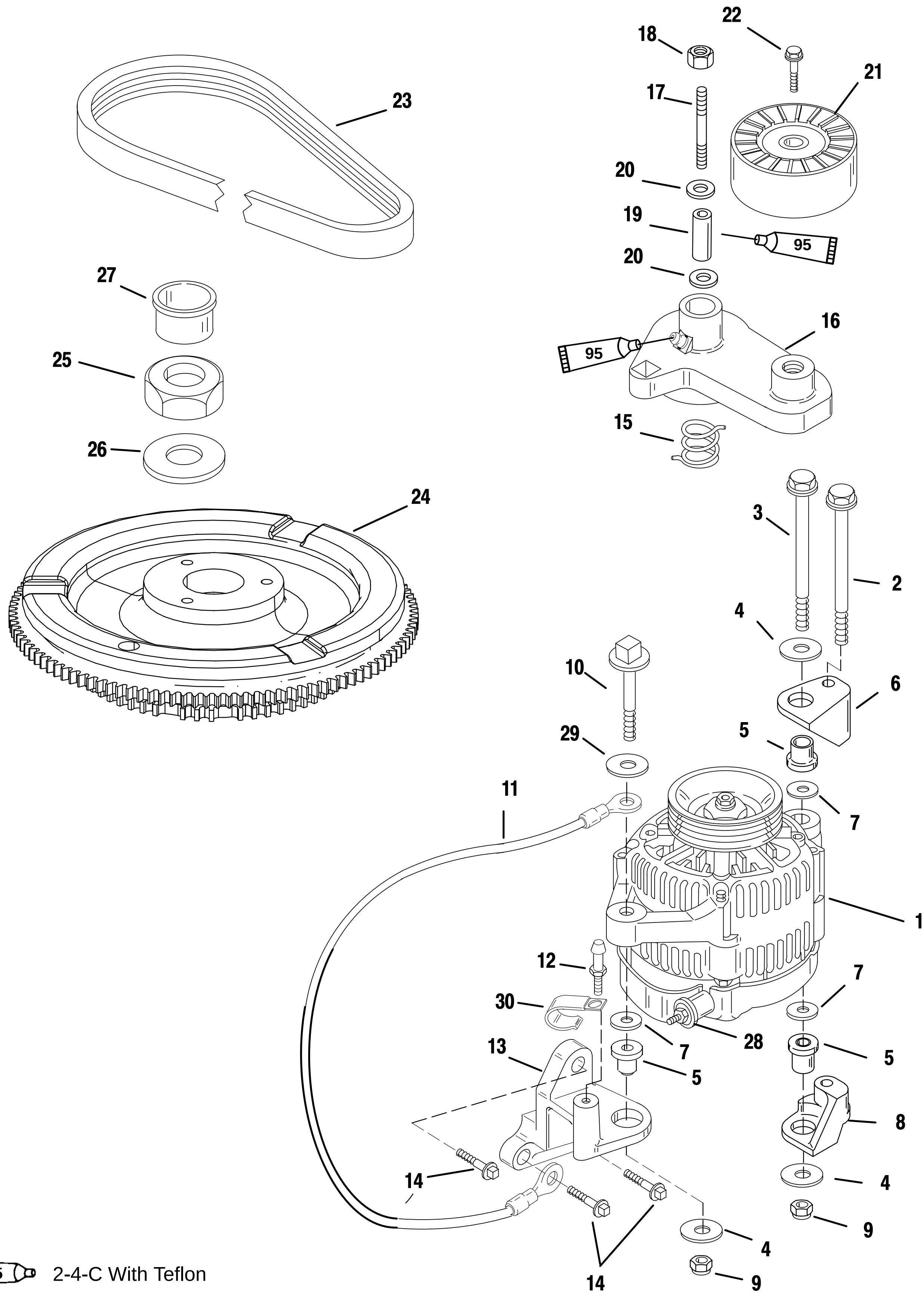
1. Install flywheel.
2. Install flywheel washer and nut.
3. Hold flywheel with Flywheel Holder (91-52344). Torque nut to 125 lb-ft (169.5 Nm).



a - Flywheel Holder (91-52344)

Notes:

Flywheel/Alternator



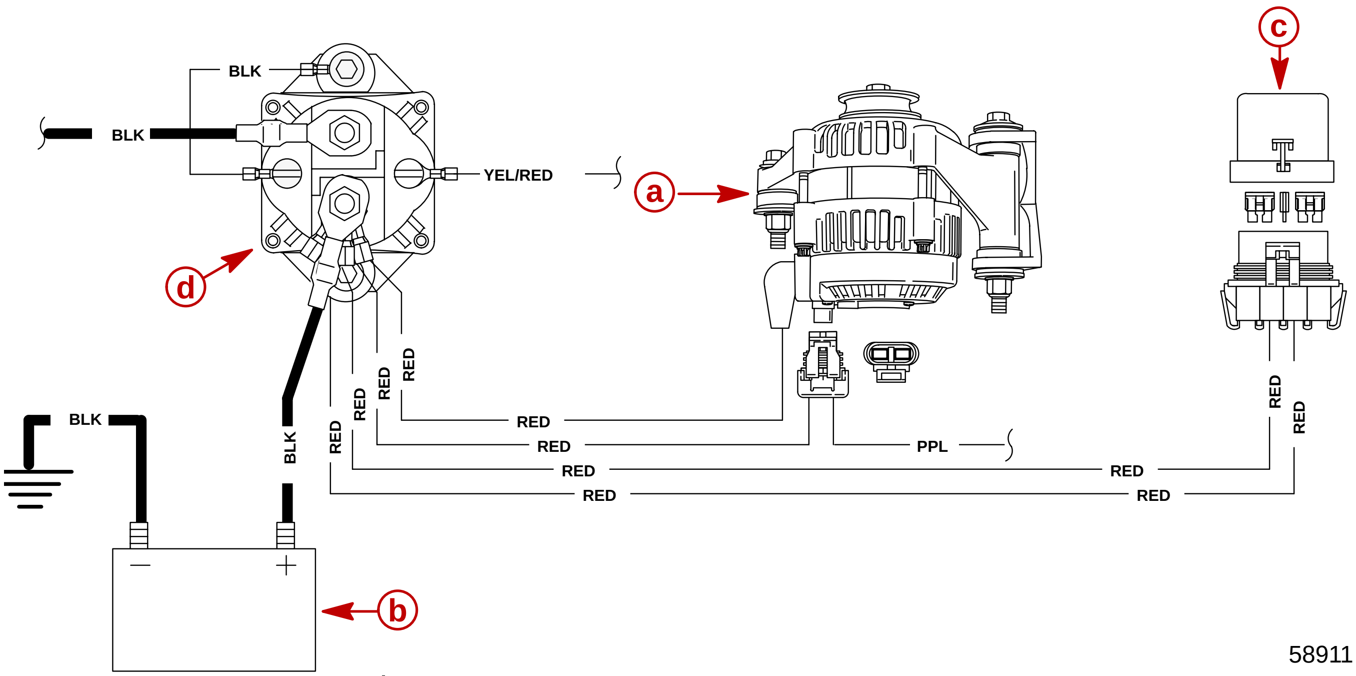
95 2-4-C With Teflon

Flywheel/Alternator

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb. in.	lb. ft.	Nm
1	1	ALTERNATOR			
2	1	SCREW (M10 x 100)		40	54
3	1	SCREW (M10 x120)		40	54
4	3	WASHER			
5	3	MOUNT			
6	1	BRACKET			
7	3	WASHER			
8	1	BRACKET			
9	2	NUT		40	54
10	1	SCREW (M10 x 55)		40	54
11	1	CABLE			
12	1	PIN			
13	1	BRACKET			
14	3	SCREW (5/16-18 x 1 IN.)		15.5	21
15	1	SPRING			
16	1	BELT TENSIONER ARM ASSY			
17	1	STUD (M10 x 85)			
18	1	NUT		15	20
19	1	BUSHING			
20	2	WASHER			
21	1	PULLEY			
22	1	SCREW (M10 x 35)		25	34
23	1	BELT			
24	1	FLYWHEEL			
25	1	NUT (M16X1.5)		125	170
26	1	WASHER			
27	1	PLUG			
28	1	NUT	110	9	12
29	1	WASHER			
30	1	J CLAMP			

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.

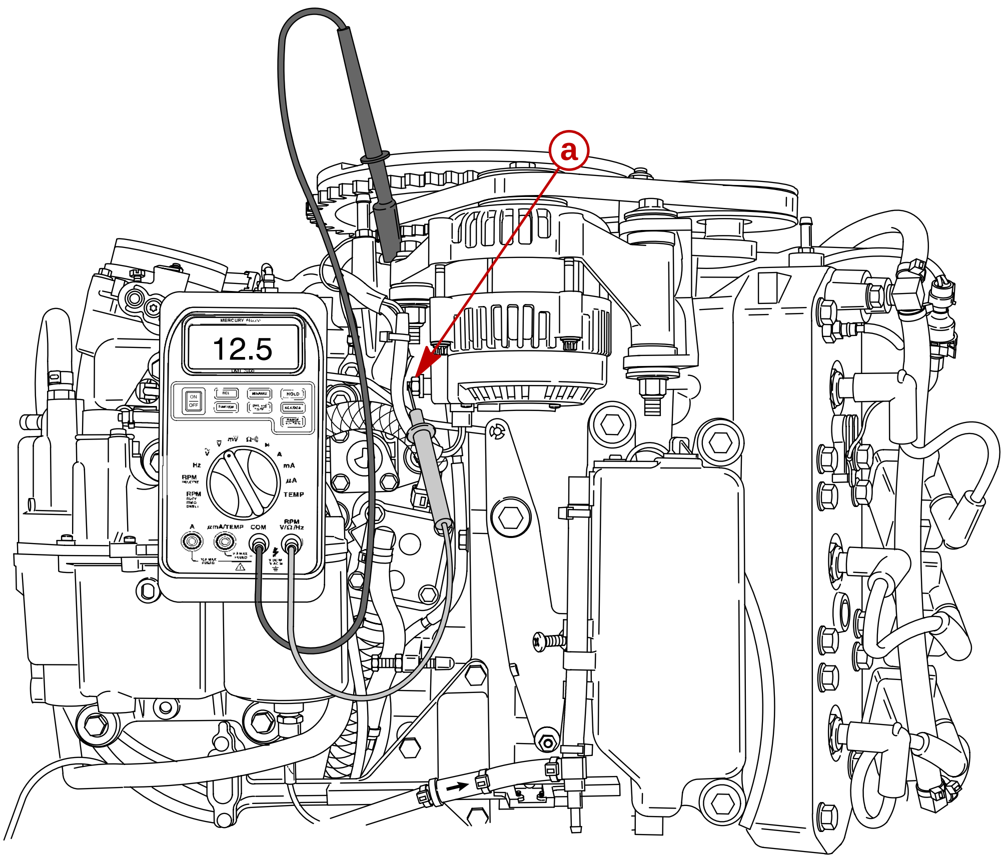
4. Check alternator drive belt for cracks and fraying. Replace if necessary. Check belt tension.

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.

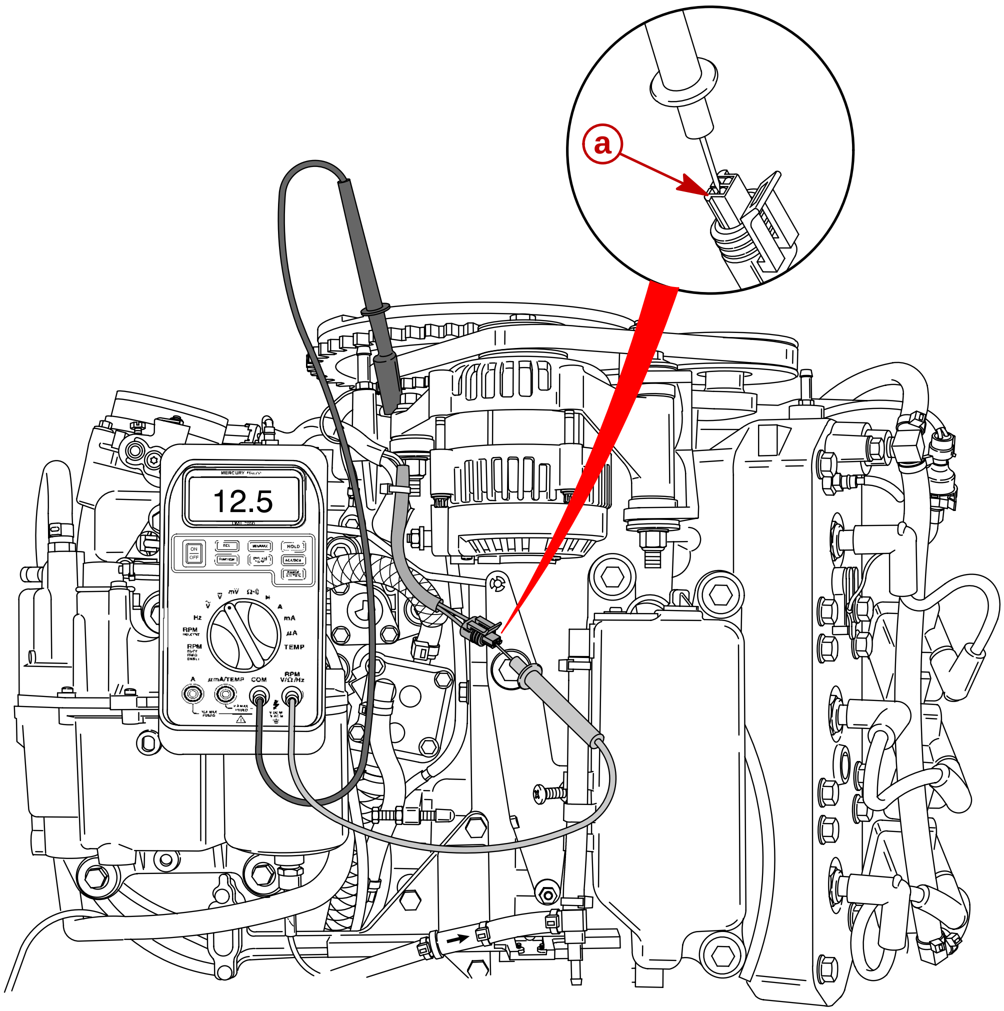


58883

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.



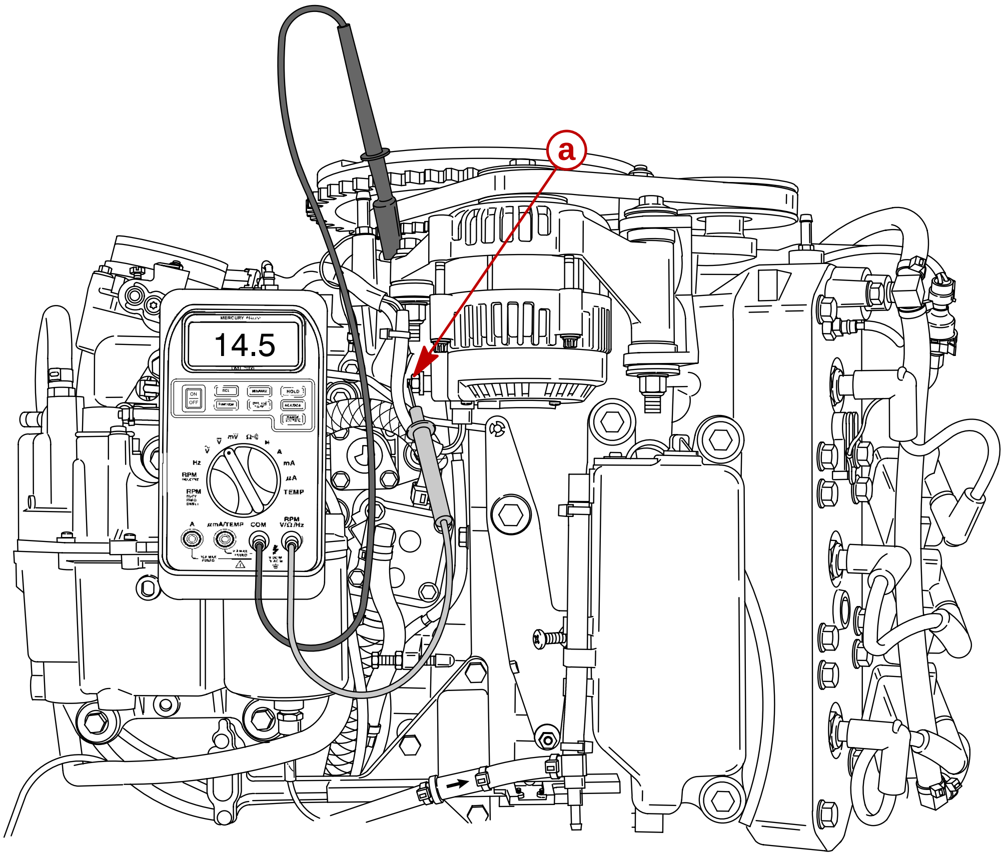
58726

a - Sense Lead (RED)

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 14.1 – 15.0 volts.

NOTE: *If alternator is under-charging, check connections. If alternator is over-charging, replace alternator.*



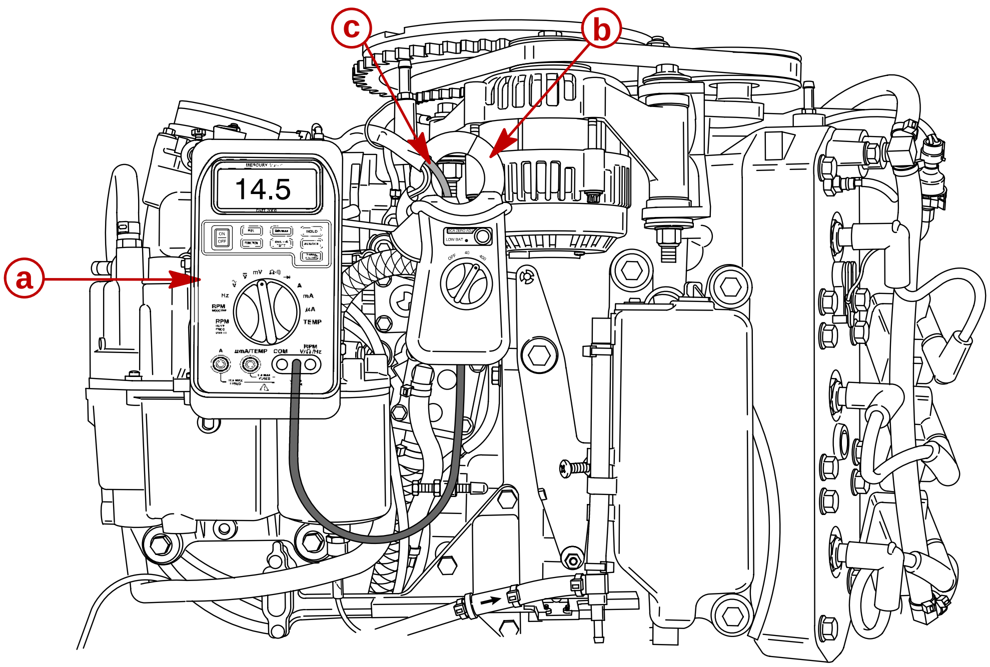
a - Terminal B

Current Output

***NOTE:** Before conducting current output test, assure that all boat electrical accessories are turned **OFF**.*

1. With engine shut off, install ammeter with clamp-on current probe (capable of reading 60+ amperes) onto alternator charging conductor (10 AWG Red Wire).
2. Start engine and allow to warm up.
3. Battery voltage should be between 14.2 and 15.0 VDC for all engine RPMs.

Alternator output current should correspond with graph below.



58882

a - Ammeter (DMT 2000 Digital Tachometer Multimeter 91-854009A1)
b - Clamp-On Current Probe (91-802650)
c - Alternator Charging Conductor (10 AWG Red Wire)

***NOTE:** Alternator amperage output can vary by as much as 10% due to heat buildup from the numbers listed below. Alternator output listed below was with a battery loaded at 12.6 volts.*

RPM	AMPS @ ALTERNATOR	AMPS @ BATTERY	ENGINE DRAW AMPS
600	21	16	5
1000	37	31	6
1500	44	36	8
2000	48	39	9
2500	50	40	10
3000	51	41	10
3500	51	41	10
4000	52	42	10
4500	52	42	10
5000	52	42	10
5500	52	42	10
5750	52	42	10

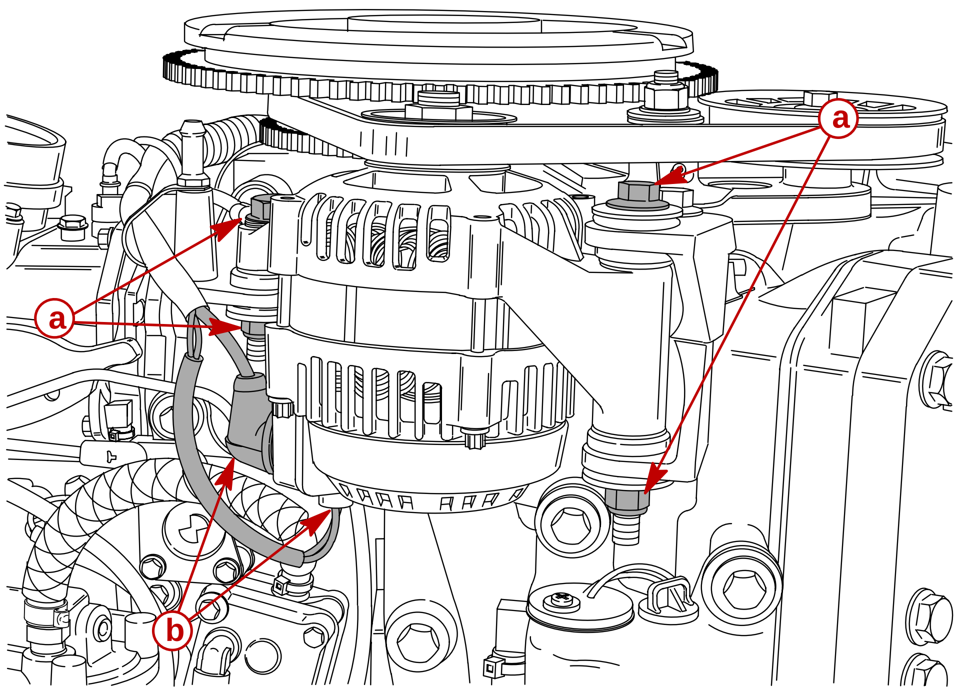
Current Output Troubleshooting

Current Output is Low	Battery Cables are loose or corroded Defective Battery (Open Circuit) Defective Alternator
Current Output is High	Accessories turned on Defective Battery (Internal Short) Defective Alternator

Repair

Removal

1. Remove top cowling.
2. Disconnect battery cables from battery.
3. Disconnect wiring harness from alternator.
4. Remove belt from alternator.
5. Remove attaching bolts.

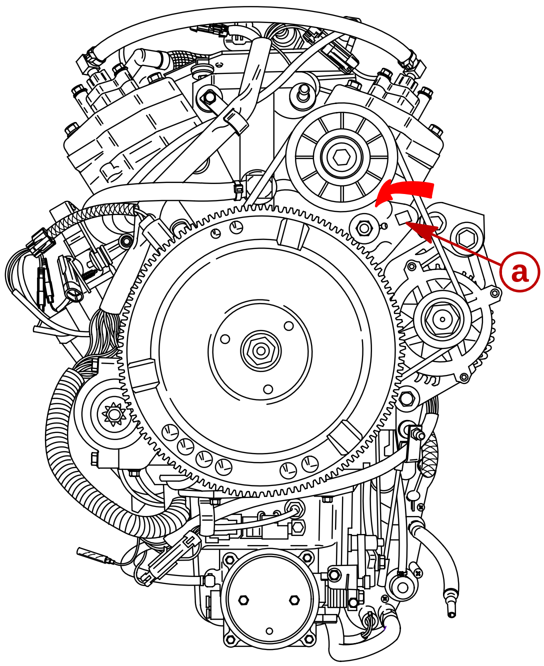


58782

a - Attaching Bolt   b - Harnesses

Installation

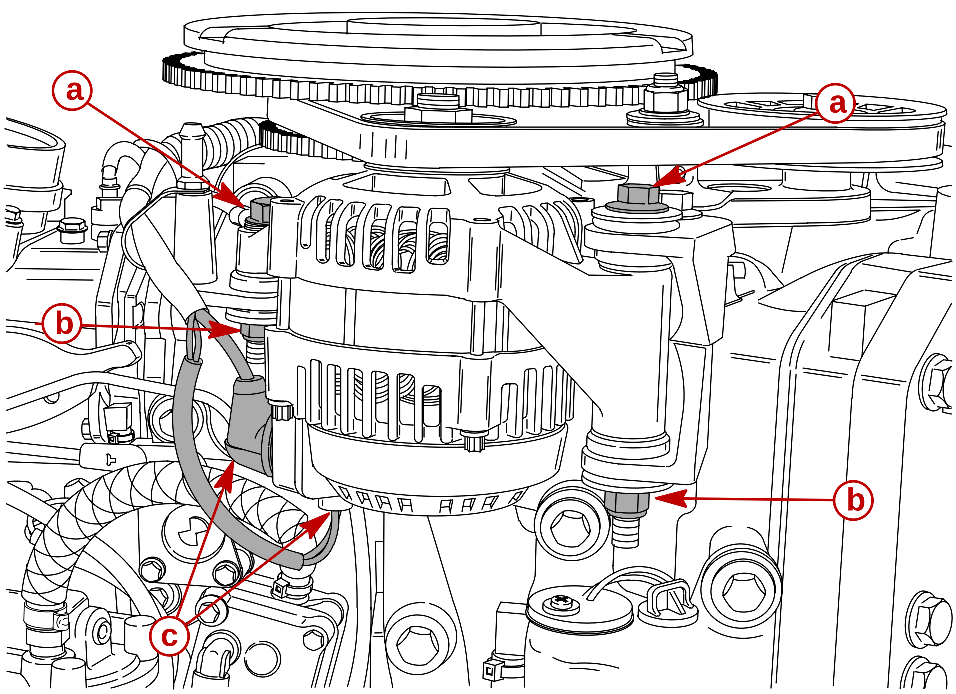
1. Secure alternator to engine block with attaching bolts. Torque top bolt to 40 lb-ft (54 Nm). Torque bottom nut to 35 lb-ft (47.5 Nm).
2. Rotate belt tensioner and install alternator belt in groove of flywheel and alternator pulley.



58771

a - Belt Tensioner (Rotate Counterclockwise)

3. Reconnect electrical harness to alternator.

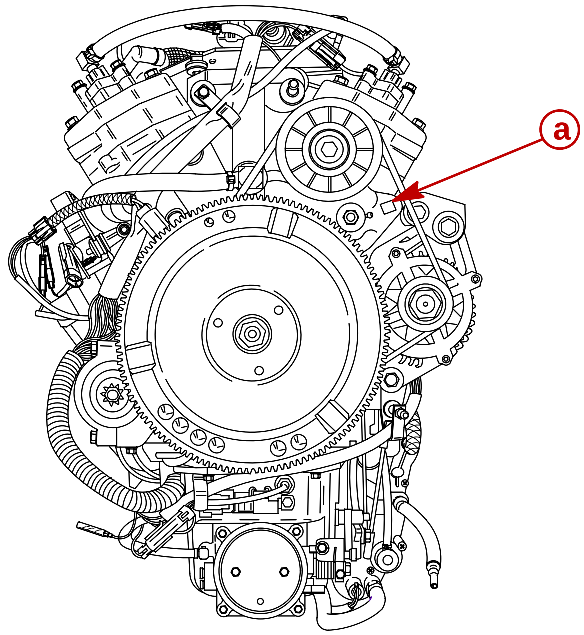


58782

a - Top Bolt [Torque to 40 lb-ft (54 Nm)]
b - Bottom Nut [Torque to 35 lb-ft. (47.5 Nm)
c - Harnesses

Alternator Belt Tension Adjustment

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



58771

a - Belt Tensioner Assembly

Starter System

NOTE: *Early production engines will be equipped with centrifugal bendix type starter motors. Later production engines will be equipped with solenoid driven bendix type starter motors.*

Starter Motor Amperes Draw

STARTING SYSTEM	**Electric Start – All Models**	
	Centrifugal Bendix	
	Starter Draw (Under Load)	165 Amperes
	Starter Load (No Load)	30 Amperes
	Minimum Brush Length	0.25 in. (25.4 mm)
	Solenoid Driven Bendix	
	Starter Draw (Under Load)	175 Amperes
	Starter Load (No Load)	60 Amperes
	Minimum Brush Length	0.25 in. (25.4 mm)
	Battery Rating	Min. 630 Marine Cranking Amps (MCA) or 490 Cold Cranking Amps (CCA)

Starter System Components

Battery

Starter Solenoid

Neutral Start Switch

Starter Motor

Ignition Switch

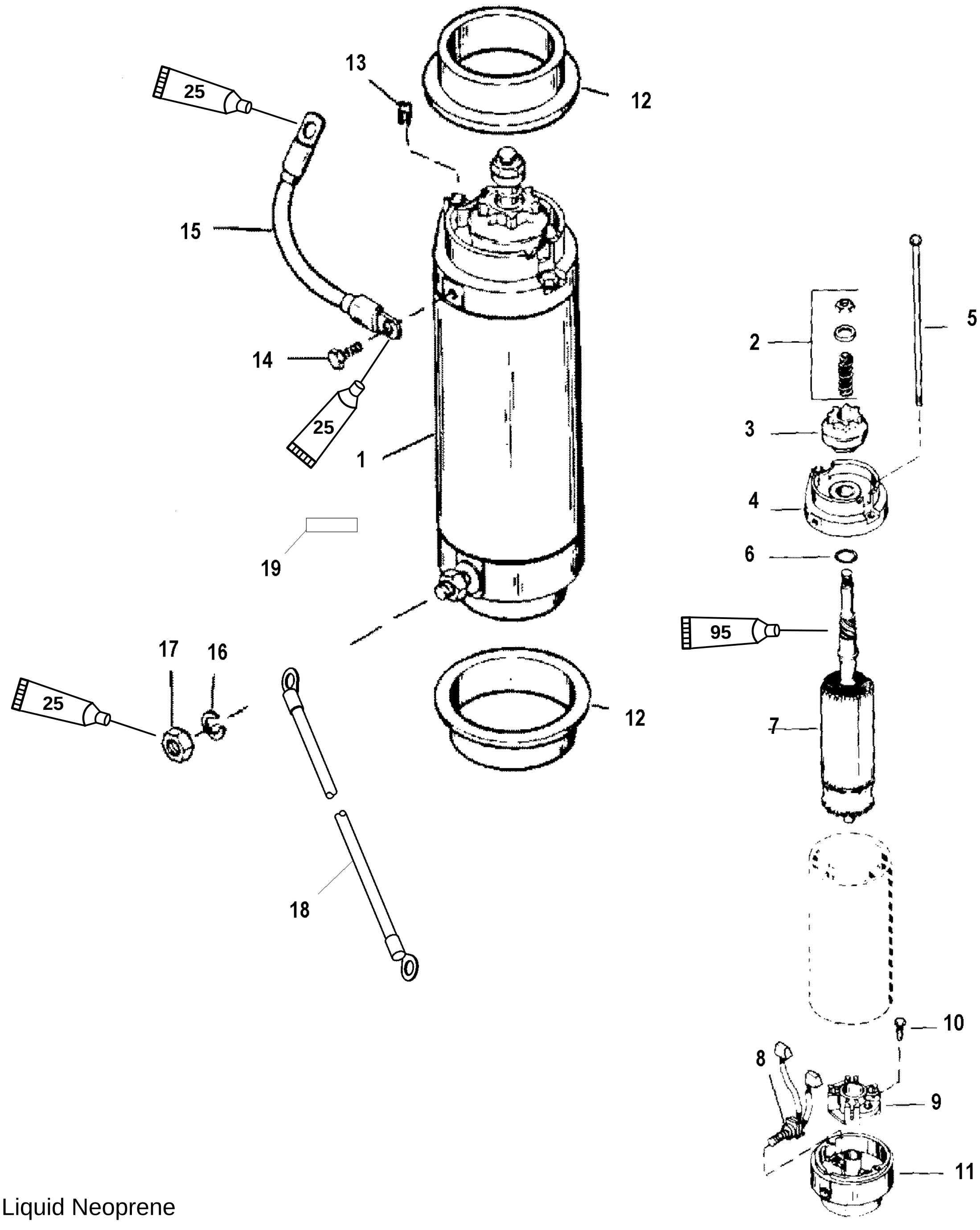
Description

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

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 (Centrifugal Bendix)



25 Liquid Neoprene

95 2-4-C With Teflon

(Centrifugal Bendix) Starter Motor

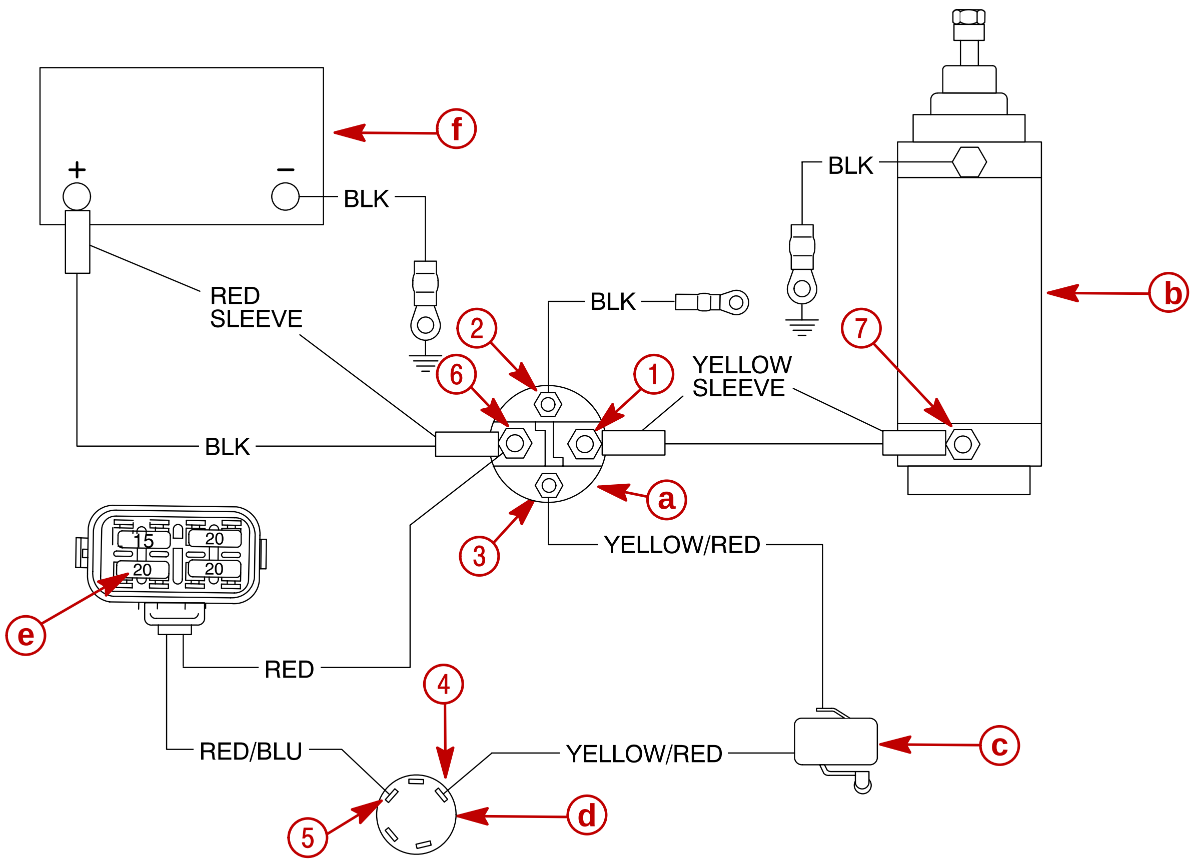
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	STARTER MOTOR			
2	1	DRIVE KIT			
3	1	DRIVE			
4	1	DRIVE END PLATE			
5	2	THRU BOLT	70		8
6	1	WASHER			
7	1	ARMATURE			
8	1	BRUSH SET			
9	2	BRUSH HOLDER			
10	2	SCREW			
11	1	END CAP			
12	2	COLLAR			
13	2	RUBBER STOP			
14	1	SCREW (1/4-20 x 5/8)			
15	1	WIRE ASSEMBLY (BLACK)			
16	1	LOCKWASHER			
17	1	NUT			
18	1	BATTERY CABLE (POSITIVE)			
19	1	DECAL-Warning-High Voltage			

Troubleshooting the Starter Circuit (Centrifugal Bendix)

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

1. Battery is fully charged.
2. 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.

NOTE: *Location of test points (called out in flow chart) are numbered below.*



58064

a - Starter Solenoid
b - Starter
c - Neutral Start Switch
d - Ignition Switch
e - 20 Ampere Fuse
f - Battery

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 TEST 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

Flow Chart (continued)

Y

TEST 7
a. Connect voltmeter between common engine and Test Point 1.
b. Turn ignition key to “Start” position.

No voltage reading:
Defective starter solenoid

12 Volt Reading*
Should hear solenoid click: proceed to TEST 8

TEST 8
a. Reconnect BLACK 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.

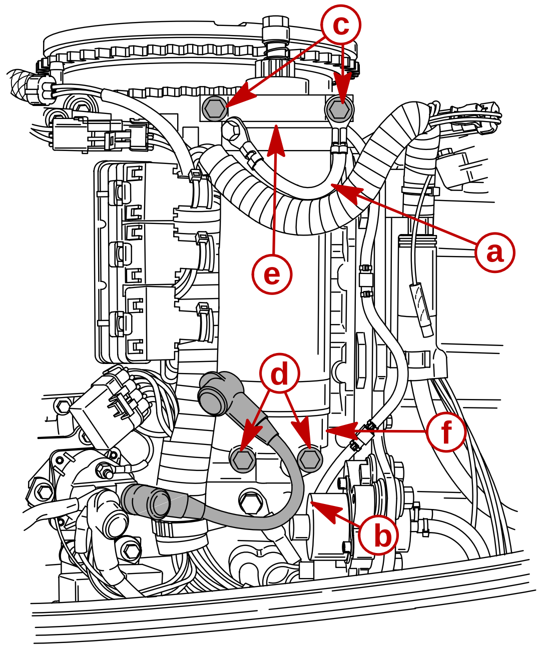
*Battery Voltage

Starter Removal (Centrifugal Bendix)

⚠ CAUTION

Disconnect battery leads from battery before removing starter.

1. Disconnect BLACK ground cable from starter.
2. Disconnect BLACK (with YELLOW sleeve) cable from starter.
3. Remove 4 bolts and upper and lower starter clamps. Lift starter from engine.

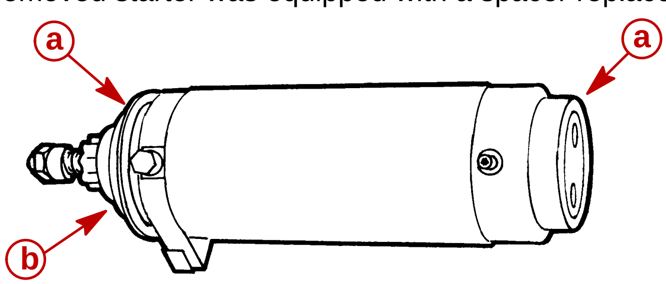


58803

a - BLACK ground cable
b - BLACK (with YELLOW sleeve) + 12 volt cable
c - Upper Mount Bolts
d - Lower Mount Bolts
e - Upper Clamp
f - Lower Clamp

Starter Installation (Centrifugal Bendix)

1. Slide rubber collars on starter.
2. If the removed starter was equipped with a spacer replace spacer on upper collar.



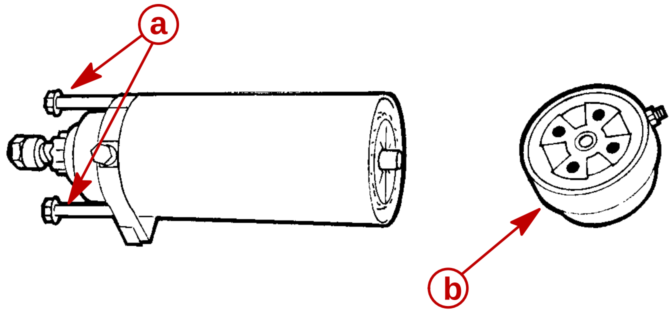
11645

a - Rubber Collar
b - Spacer (If Equipped)

3. Install starter to engine with starter clamps. Make sure that BLACK ground cable is fastened, along with lower mounting bolts. Torque bolts to 210 lb. in. (23.5 N·m).
4. Reconnect yellow cable to positive (+) terminal on starter.
5. Reconnect BLACK ground cable to terminal on starter.

Starter Disassembly (Centrifugal Bendix)

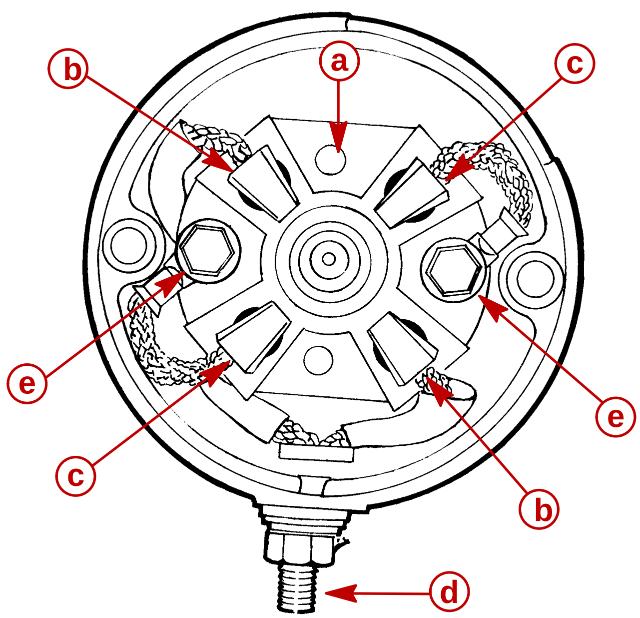
1. Remove starter as outlined in **Starter Removal.**
2. Remove 2 through bolts from starter.



11646

a - Through Bolts
b - Commutator End Cap

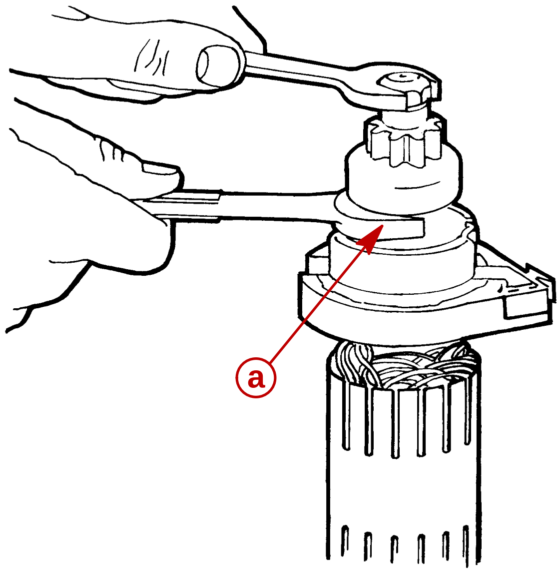
3. Tap commutator end cap to loosen and remove from frame. Do not lose brush springs.
4. Brush replacement is recommended if brushes are pitted, chipped or worn to less than 0.25 in. (6.4 mm). If necessary, remove brushes as follows:
   a. Remove hex nut and washers from POSITIVE (+) terminal and remove POSITIVE brushes and terminal as an assembly.
   b. Remove 2 bolts securing NEGATIVE (–) brushes and brush holder to end cap.



11656

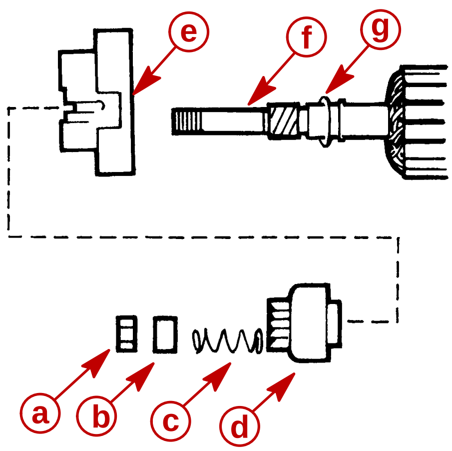
a - Brush Holder
b - Positive Brushes
c - Negative Brushes
d - Positive Terminal
e - Bolts (fasten negative brushes and holder)

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



a - Hold armature shaft with wrench on hex portion of drive assembly

7. Remove parts from shaft.



11658

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

Starter Cleaning, Inspection and Testing

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. (6.4mm) 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.

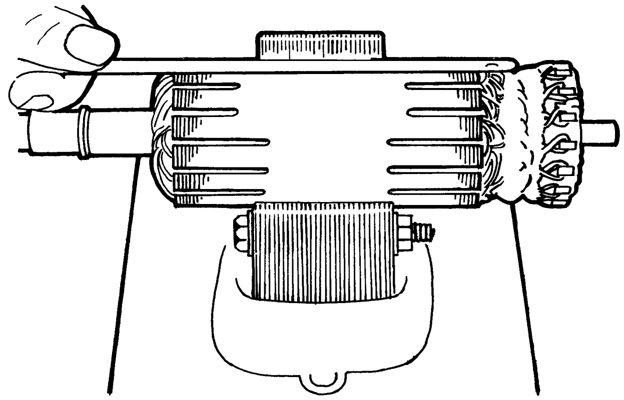
   a. Resurface the commutator and undercut the insulation between the commutator bars 1/32 in. (0.8mm) to the full width of the insulation and so that the undercut is flat.
   b. Clean the commutator slots after undercutting.
   c. Sand the commutator lightly with No. 00 sandpaper to remove burrs, then 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

Armature Test for Shorts

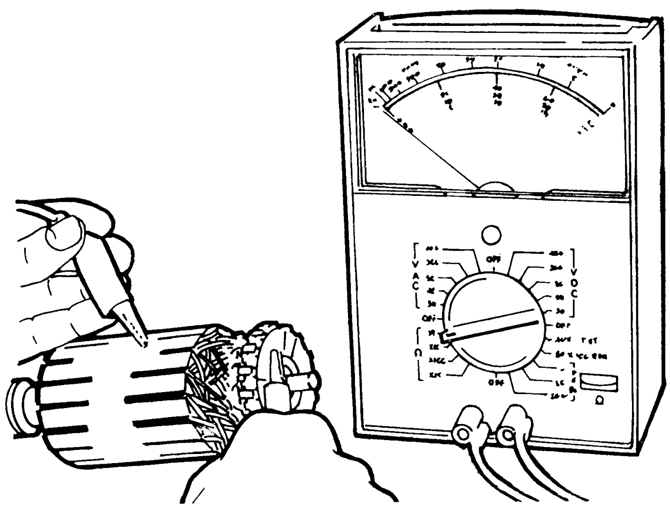
Check armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. If saw blade vibrates, armature is shorted. Recheck after cleaning between commutator bars. If saw blade still vibrates, replace armature.



11669

Armature Test for Ground

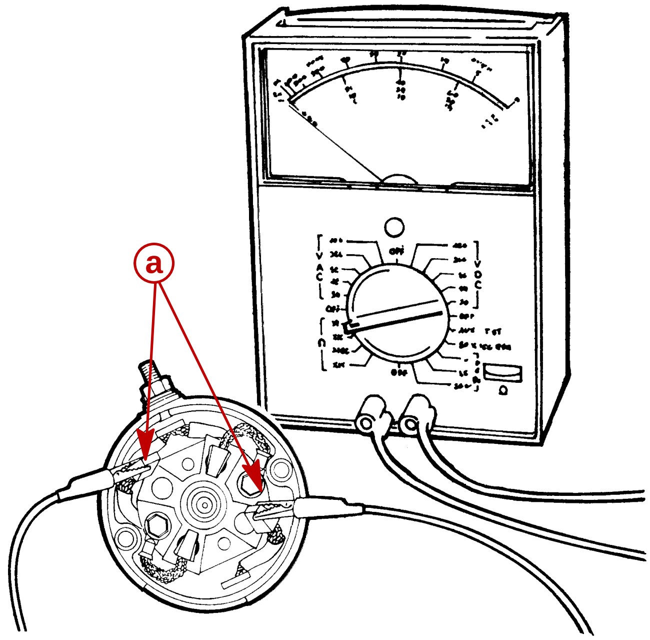
1. Set ohmmeter to (R x 1 scale). Place one lead of ohmmeter on armature core or shaft and other lead on commutator.
2. If meter indicates continuity, armature is grounded and must be replaced.



11675

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.

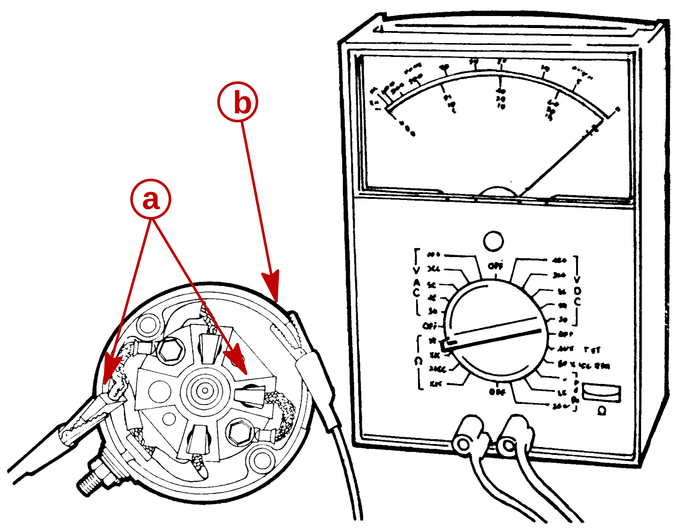


11673

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.



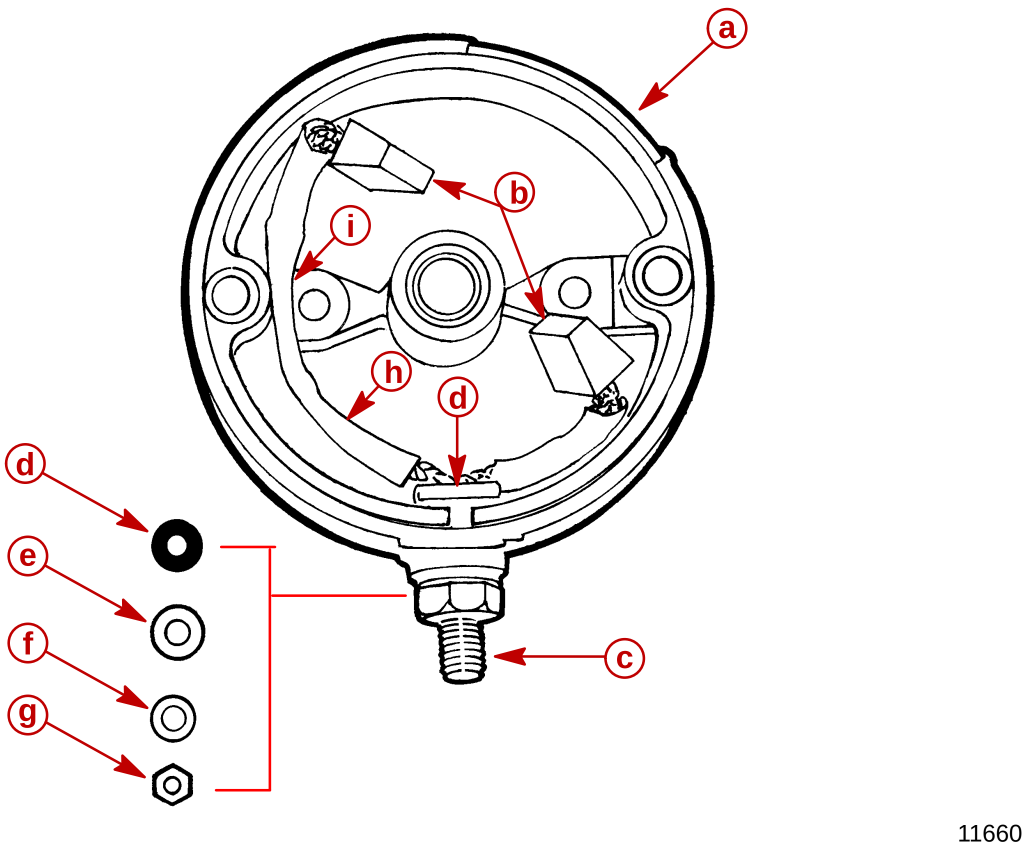
11674

a - Negative (–) Brushes
b - End Cap

Starter Reassembly

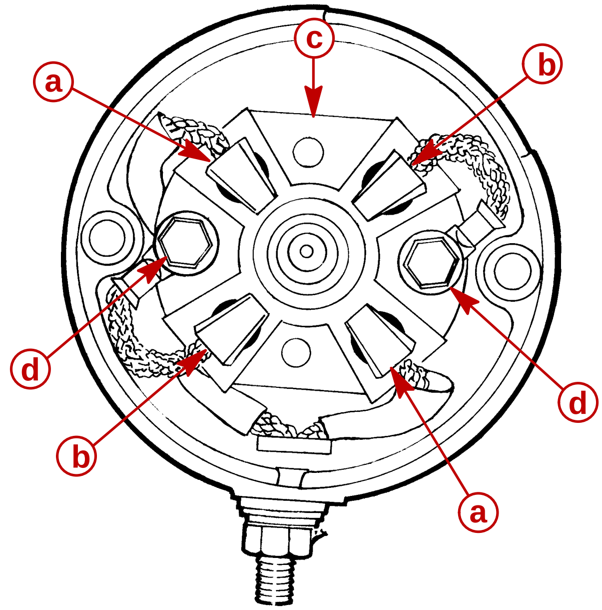
1. If brushes were removed, replace as follows:

   a. Install POSITIVE brushes (along with POSITIVE terminal) into commutator end cap.



- **a** - End Cap
- **b** - Positive Brushes
- **c** - Positive Terminal
- **d** - Insulating Bushing
- **e** - Washer
- **f** - Split Washer
- **g** - Hex Nut
- **h** - Long Brush Lead
- **i** - Push Lead into Slot

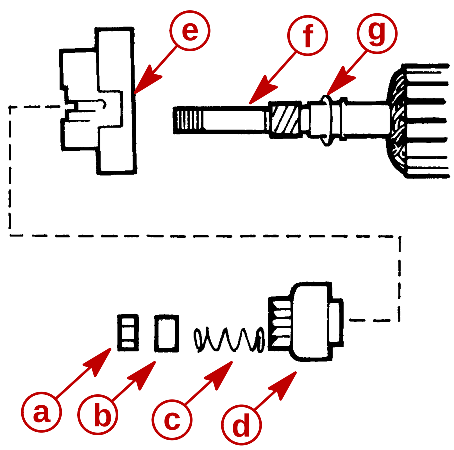
b. Install NEGATIVE brushes (along with brush holder).



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.

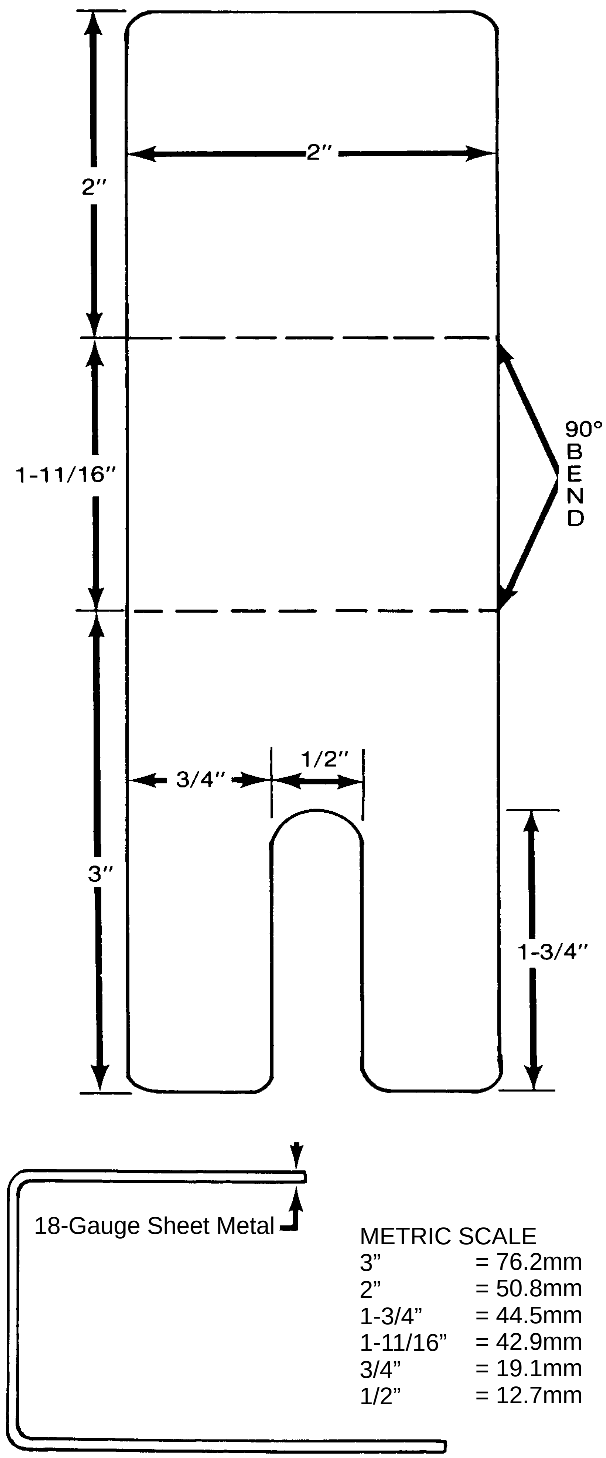


11658

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. To prevent damage to brushes and springs when installing commutator end cap, it is recommended that a brush retaining tool be made as shown:

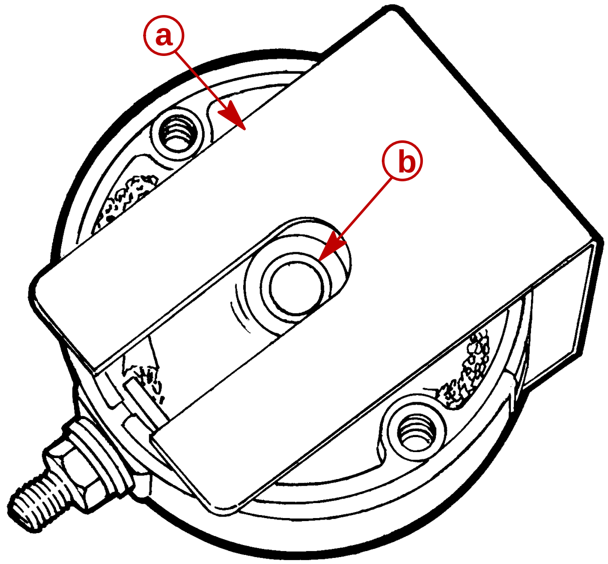


METRIC SCALE

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

7. Lubricate bushing (located in commutator end cap) with one drop of SAE 10W oil. DO NOT over lubricate.

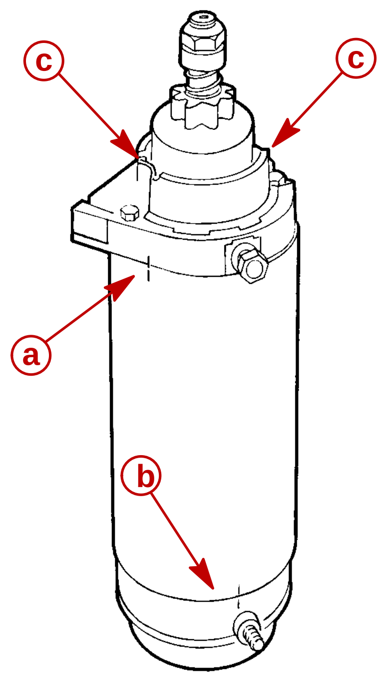
8. Place springs and brushes into brush holder and hold in place with brush retainer tool.



11661

a - Bushing Retainer Tool
b - Bushing (do not over lubricate)

9. Install armature into starter frame and align match marks (a). Install commutator end cap onto starter frame and align match marks (b). Remove brush retainer tool. Install through bolts (c) and torque to 70 lb. in. (8.0 N·m).

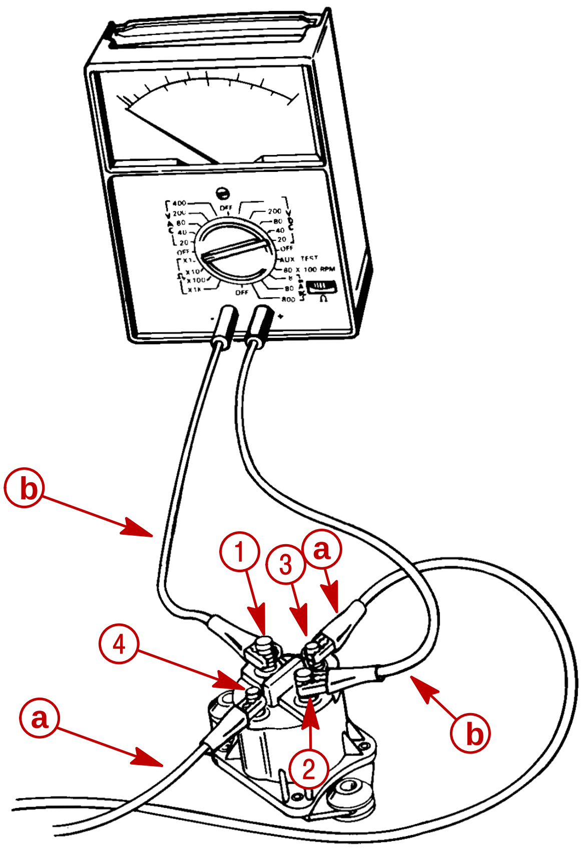


11648

a - Alignment Marks
b - Alignment Marks
c - Bolts [Torque to 70 lb. in. (8 N m)]

STARTER SOLENOID TEST

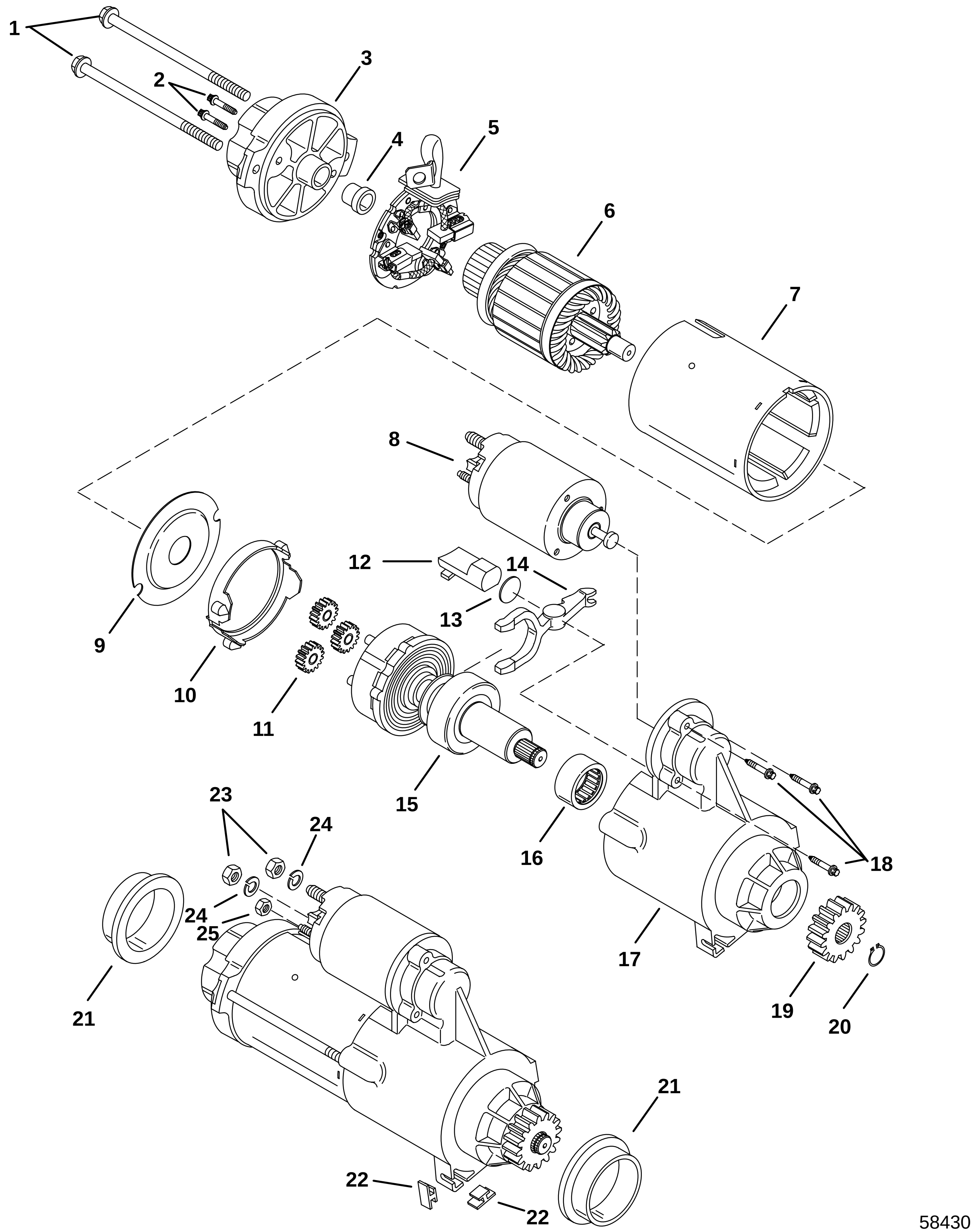
1. Disconnect all wires from solenoid.
2. Use an ohmmeter (R x1 scale) and connect meter leads between solenoid terminals 1 and 2.
3. Connect a 12-volt power supply between solenoid terminals 3 and 4. Solenoid should click and meter should read 0 ohms (full continuity).
4. If meter does not read 0 ohms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



51809

a - 12 Volt Supply
b - VOA Leads

Starter Motor (Solenoid Driven Bendix)



Starter Motor (Solenoid Driven Bendix)

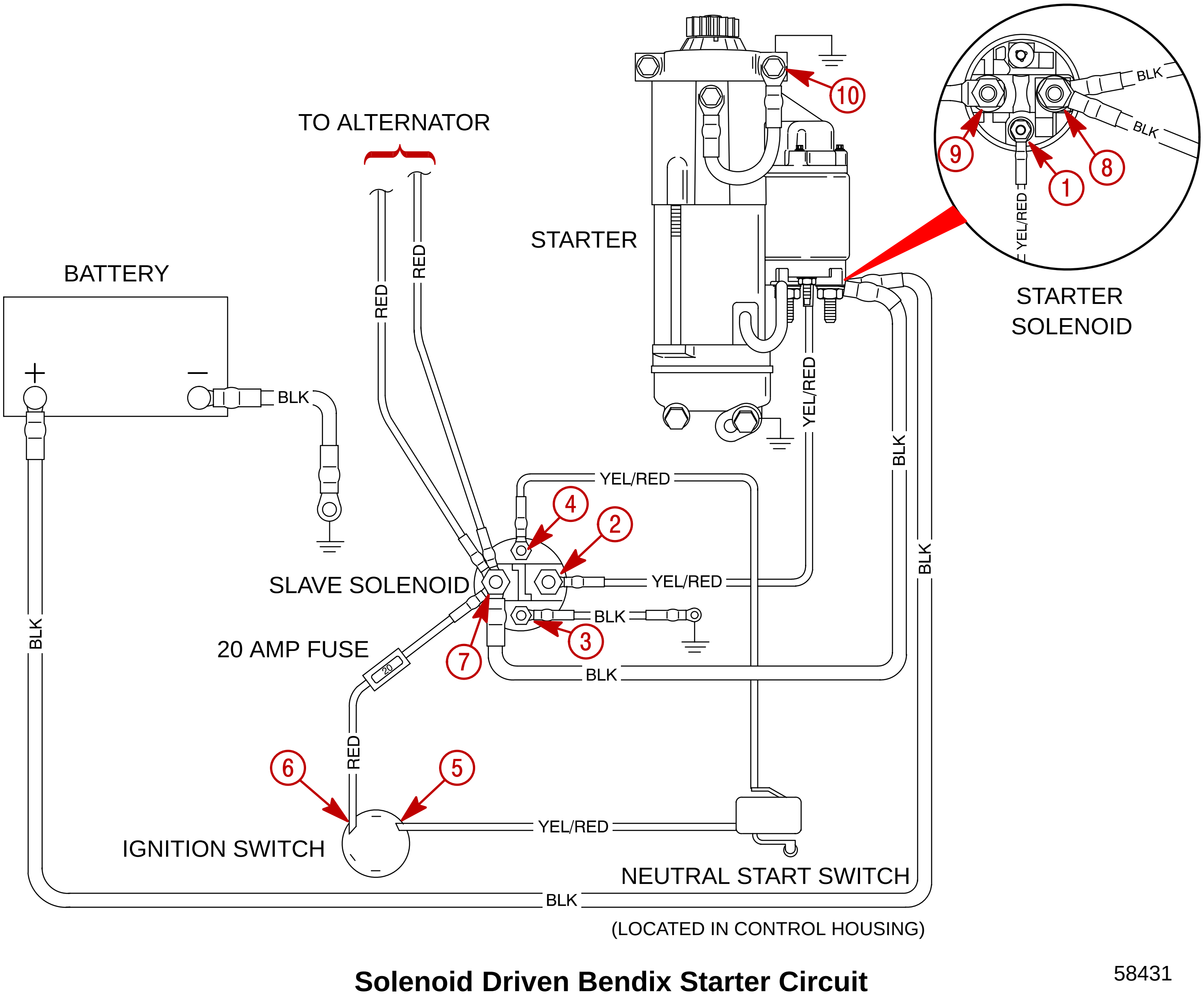
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	2	THRU BOLT	110		12.5
2	2	SCREWS	30		3.4
3	1	END CAP			
4	1	BUSHING			
5	1	BRUSH PLATE ASSEMBLY			
6	1	ARMATURE			
7	1	FIELD FRAME			
8	1	SOLENOID			
9	1	SHIELD			
10	1	CUSHION			
11	3	PLANETARY GEARS			
12	1	PLUG			
13	1	DISC			
14	1	SHIFT FORK			
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 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.

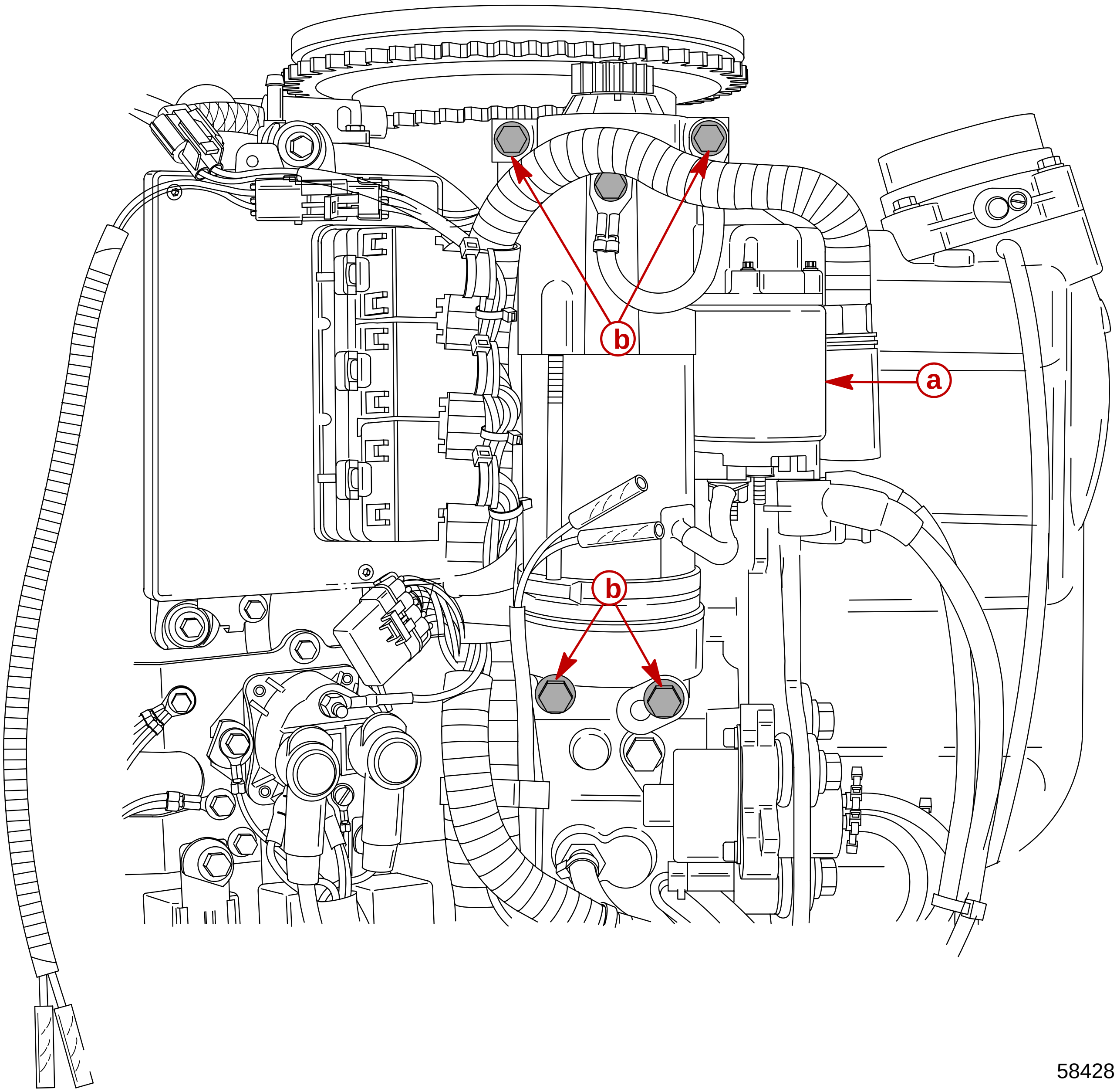
*Battery Voltage

Starter Removal (Solenoid Driven Bendix)

CAUTION

Disconnect battery leads from battery before removing starter.

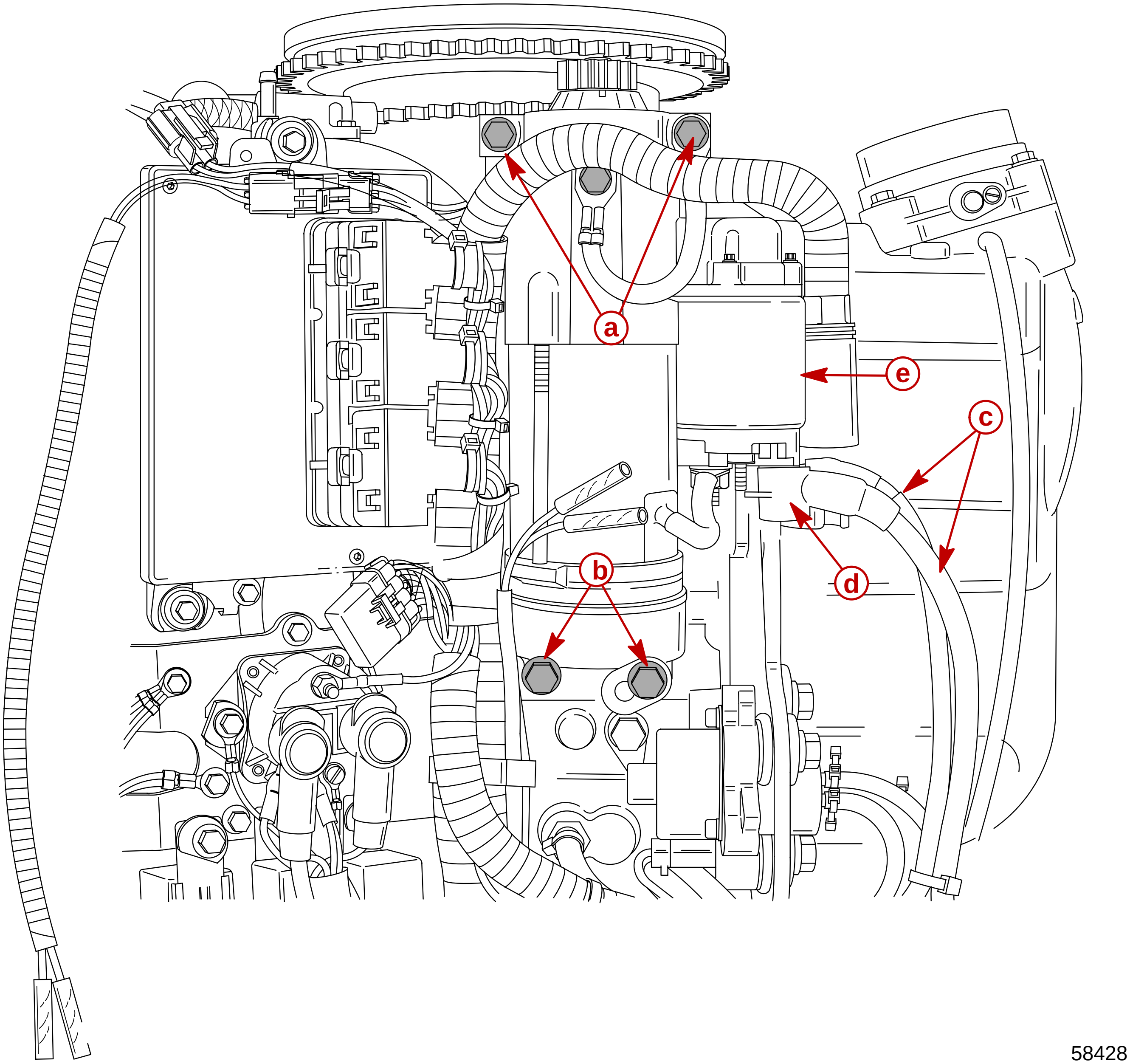
1. Disconnect battery cables from battery.
2. Disconnect wires from starter solenoid terminals.
3. Remove starter trunion mounting bolts and remove starter from engine.



a - Starter Solenoid
b - Mounting Bolts

Starter Installation (Solenoid Driven Bendix)

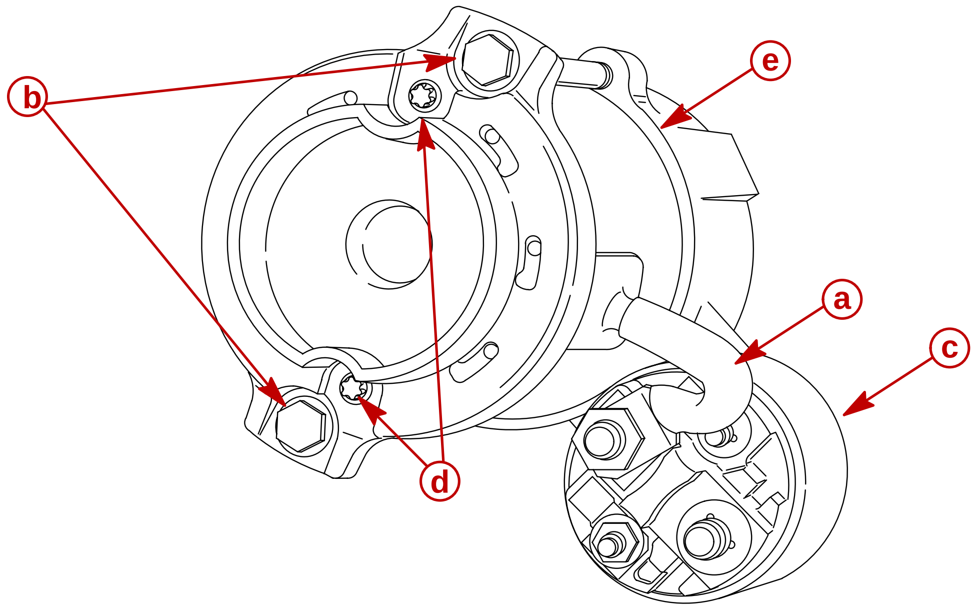
1. Secure starter to engine with 4 bolts. Use right top bolt to attach BLACK NEGATIVE. Torque top attaching bolts to 23 lb-ft (31 Nm). Torque bottom attaching bolts to 21 lb-ft. (28.5 Nm).
2. Secure BLACK cables (with RED sleeves) to POSITIVE (+) terminal on starter solenoid. Torque nut to 55 lb-in (6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



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)

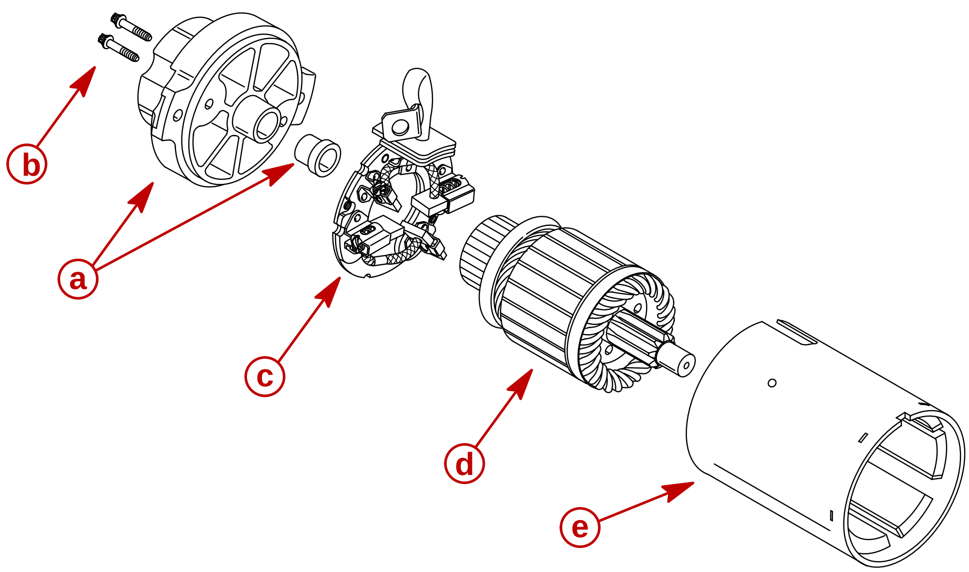
1. Remove brush lead from solenoid and through bolts from end frame.



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

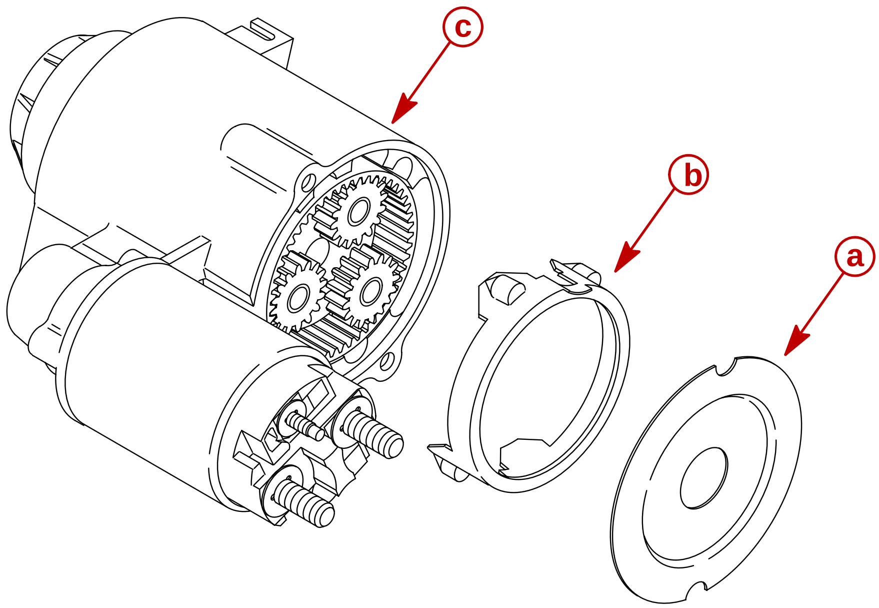
2. Remove armature and field frame from drive housing.

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

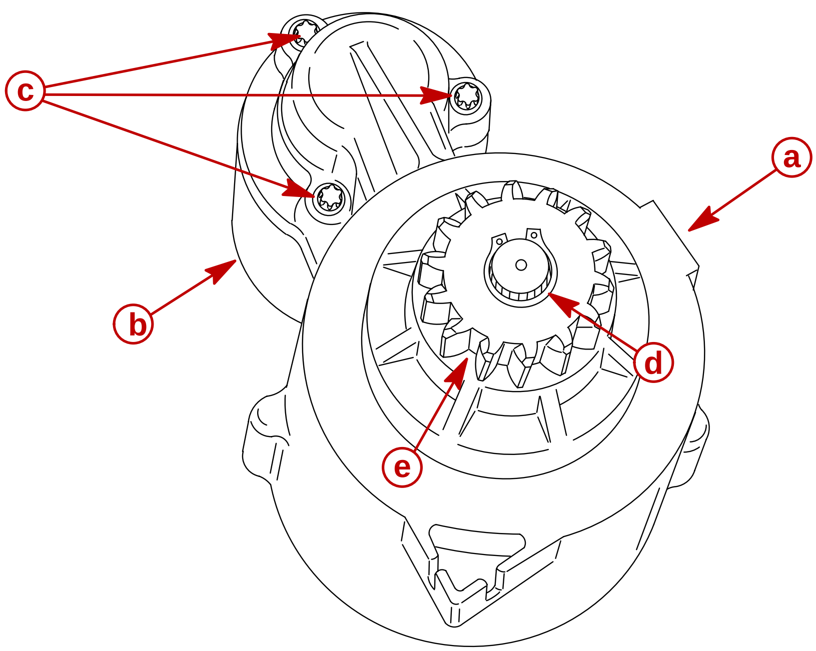
3. Remove shield and cushion from drive housing.



a - Shield
b - Cushion
c - Drive Housing

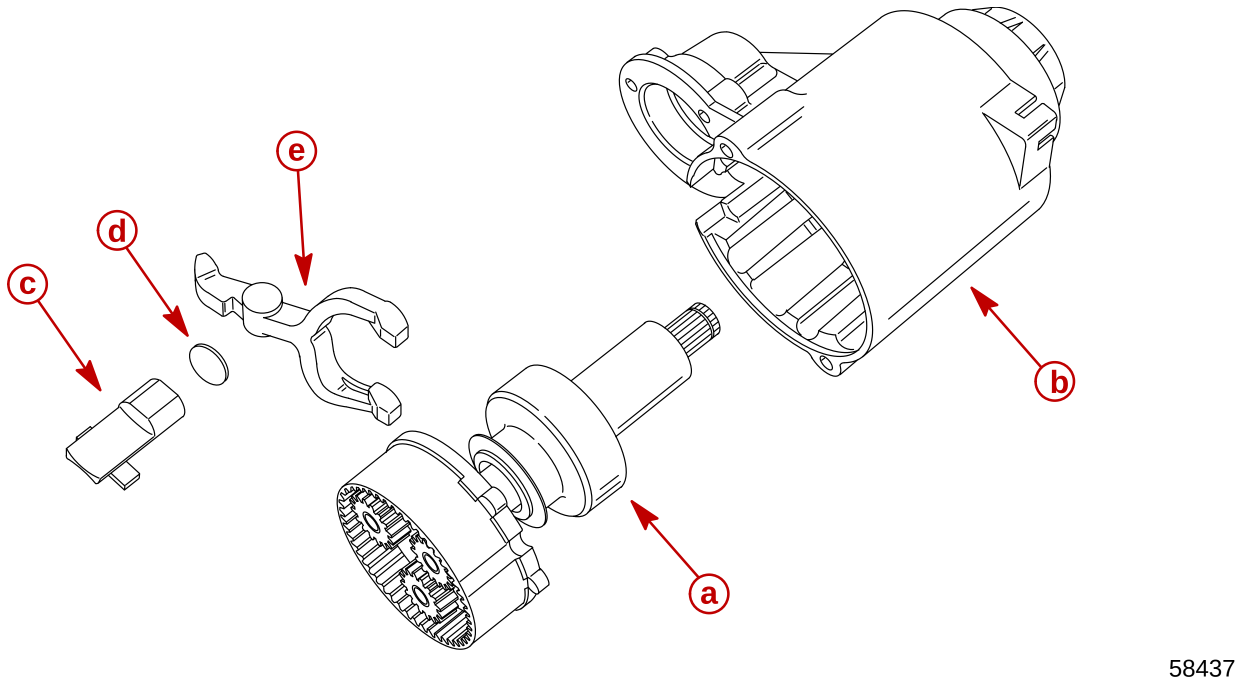
4. Remove 3 screws retaining starter solenoid. Remove solenoid from drive housing.

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

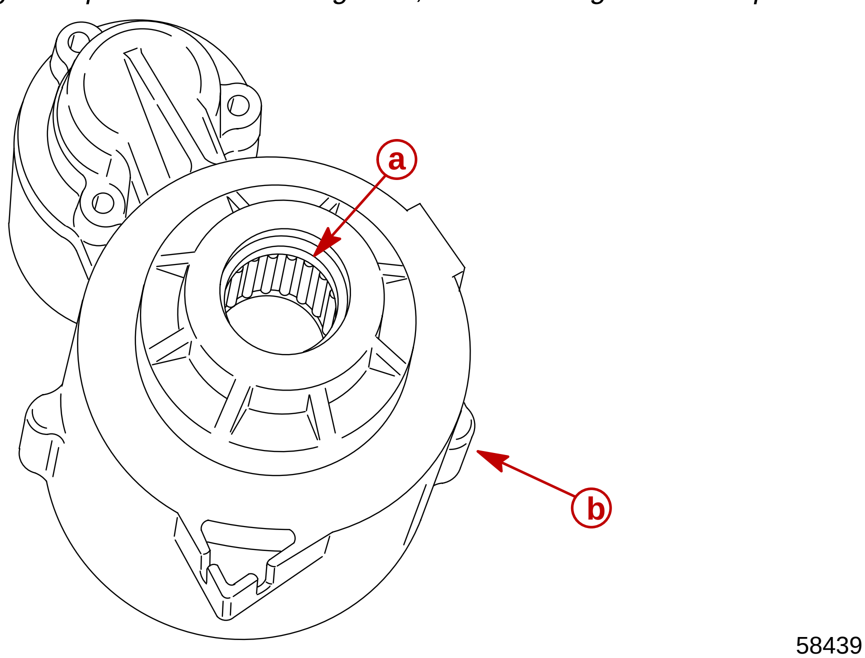
6. Remove planetary gear and clutch assembly from drive housing.
7. Remove solenoid arm, metal disc and plug from drive housing.



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.*



a - Needle Bearing
b - Drive Housing

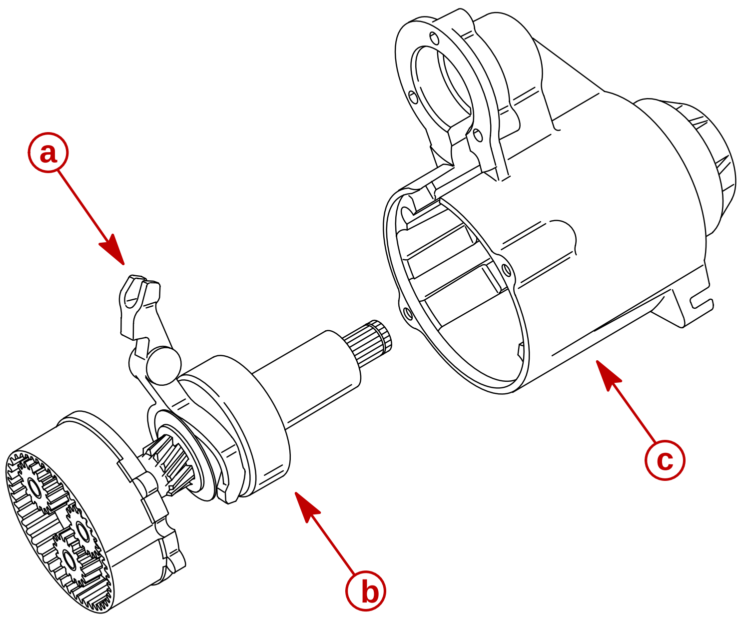
Cleaning and Inspection

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)

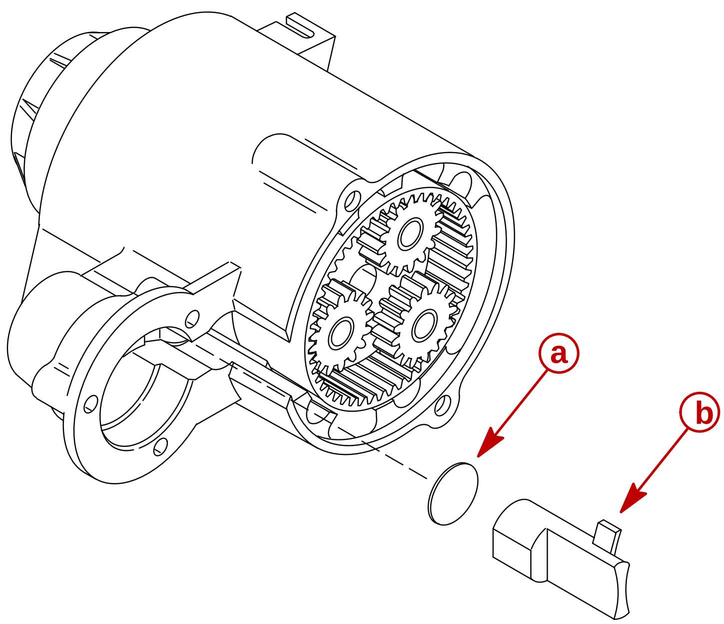
1. Install solenoid arm with planetary gear and clutch assembly into drive housing.



58438

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

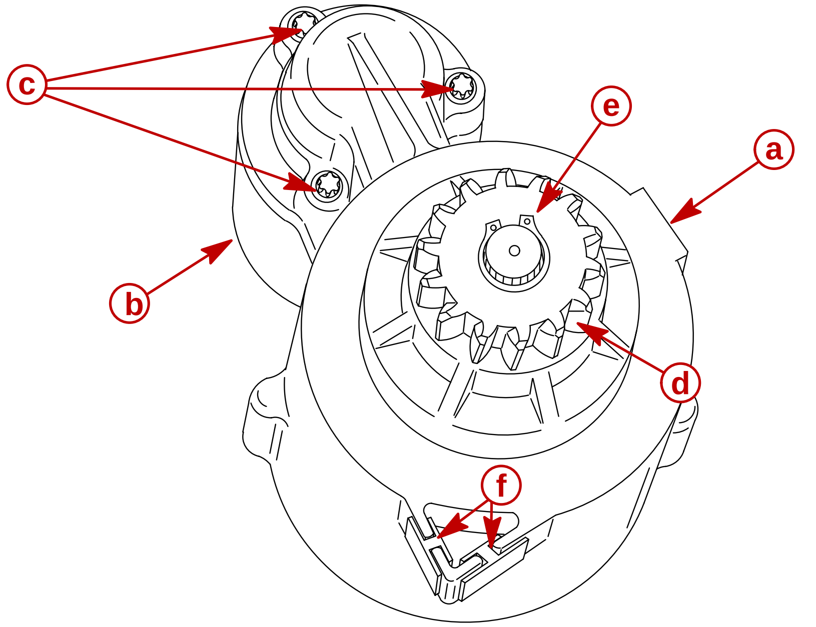
2. Install metal disc and plug into drive housing.



58433

a - Metal Disc
b - Plug

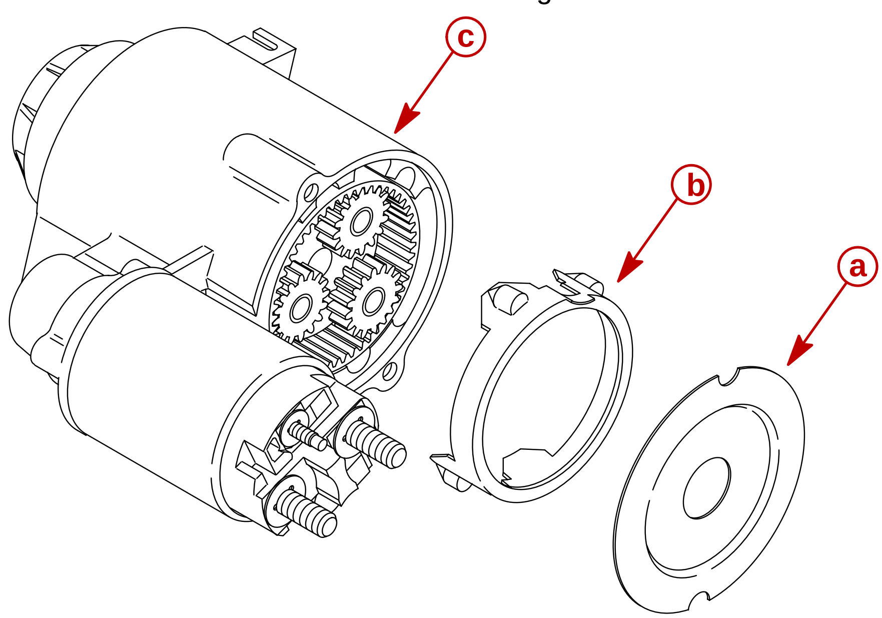
3. Attach solenoid arm to starter solenoid. Install starter solenoid in drive housing and secure with 3 screws. Torque screws to 40 lb-in (4.5 N.m).
4. Install drive gear and secure with snap ring.
5. Reinstall rubber bumpers on housing.



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.

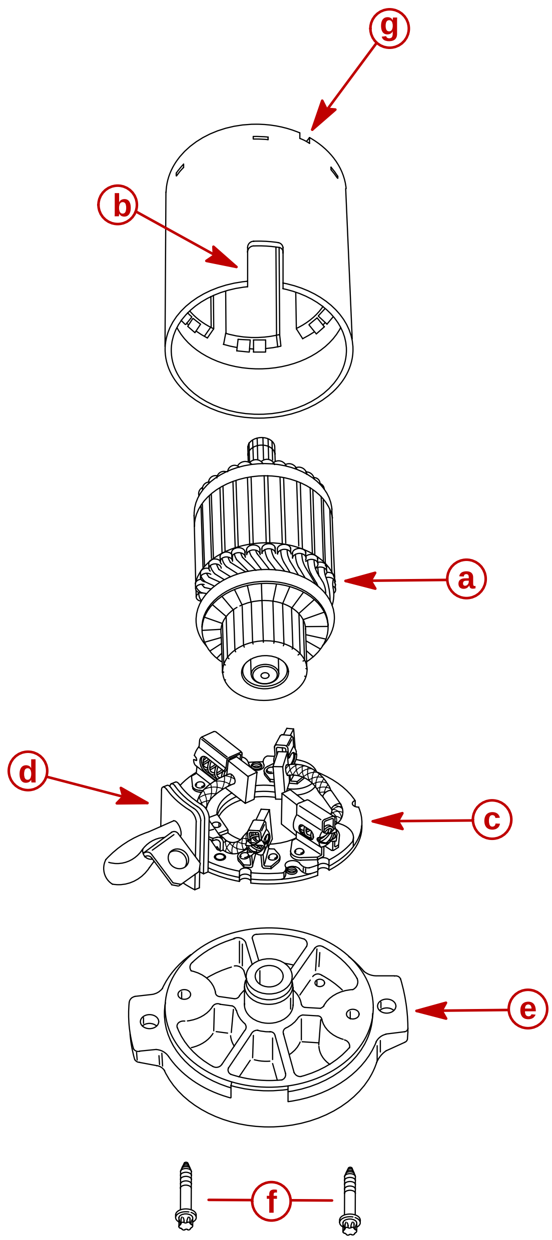


58432

- **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)

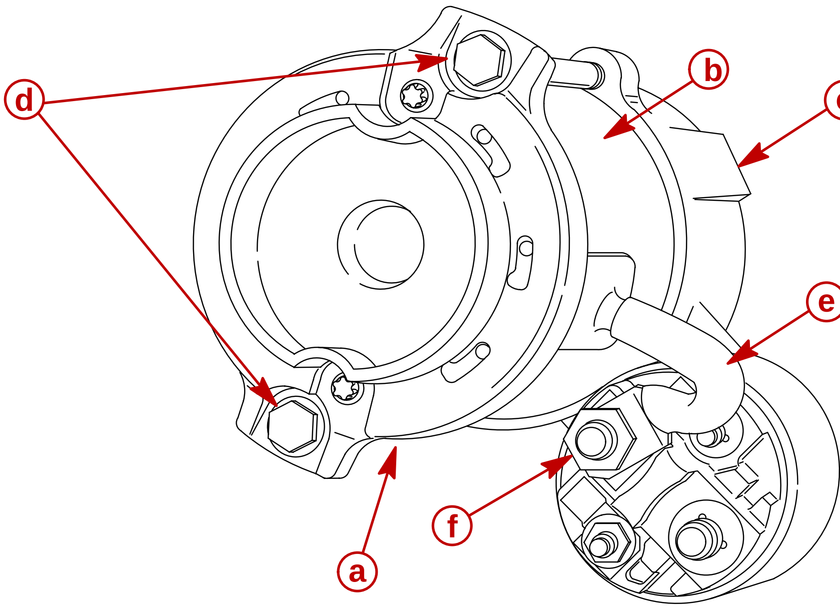
NOTE: *Prior to installing field frame assembly into drive housing, align slot in field frame with plug in drive housing.*



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).



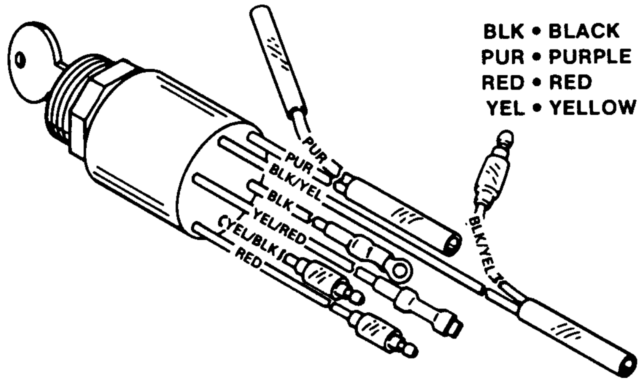
58434

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	BLK	BLK/YEL	RED	YEL/RED	PUR	YEL/BLK
OFF	○	○				
RUN			○		○	
START			○	○		
				○	○	
			○		○	
CHOKE*			○			○
			○		○	
					○	○

ELECTRICAL

Section 2C - Timing, Synchronizing & Adjusting

2C

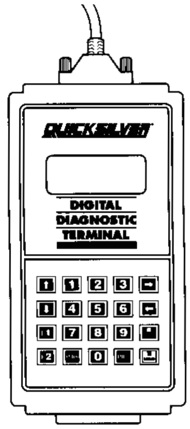
Table of Contents

Specifications

EFI MODELS	**Idle RPM** **– All Models** **Wide Open Throttle (WOT) RPM** **– All Models** **Float Adjustment (Vapor Separator)** **Float Level**	 650 ± 50 5250 – 5750 Preset @ Factory
IGNITION SYSTEM	**Type** **Spark Plug Type** **Spark Plug Gap** **Firing Order** **Throttle Position Sensor** **@ Idle** **@ W.O.T.**	Digital Inductive NGK BPZ8HS-10 0.040 in. (1.0 mm) 1-2-3-4-5-6 0.19 – 1.0 vdc 3.45 – 4.63 vdc
TIMING	**Idle Timing** **– 150XRI/175/200 XRI Models** **– 175 XRI** **@ WOT RPM** **– Model 150 XRI** **@ WOT RPM** **– Model 200XRI** **@ WOT RPM**	 1° – 7° ATDC 18° BTDC 18° BTDC 20° BTDC

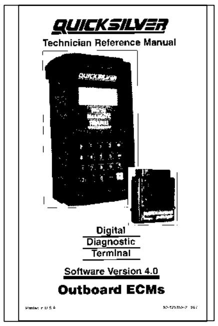
Special Tools

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

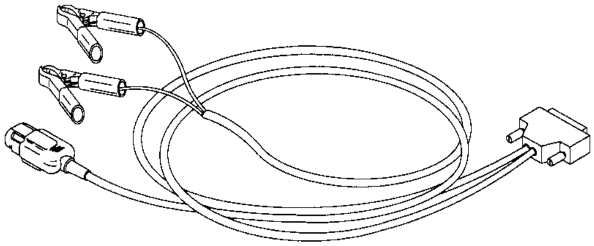


2. Software Cartridge 91-880118A2

3. DDT Reference Manual 90-881204-1



4. Adaptor Harness 84-822560A5 (use with DDT)

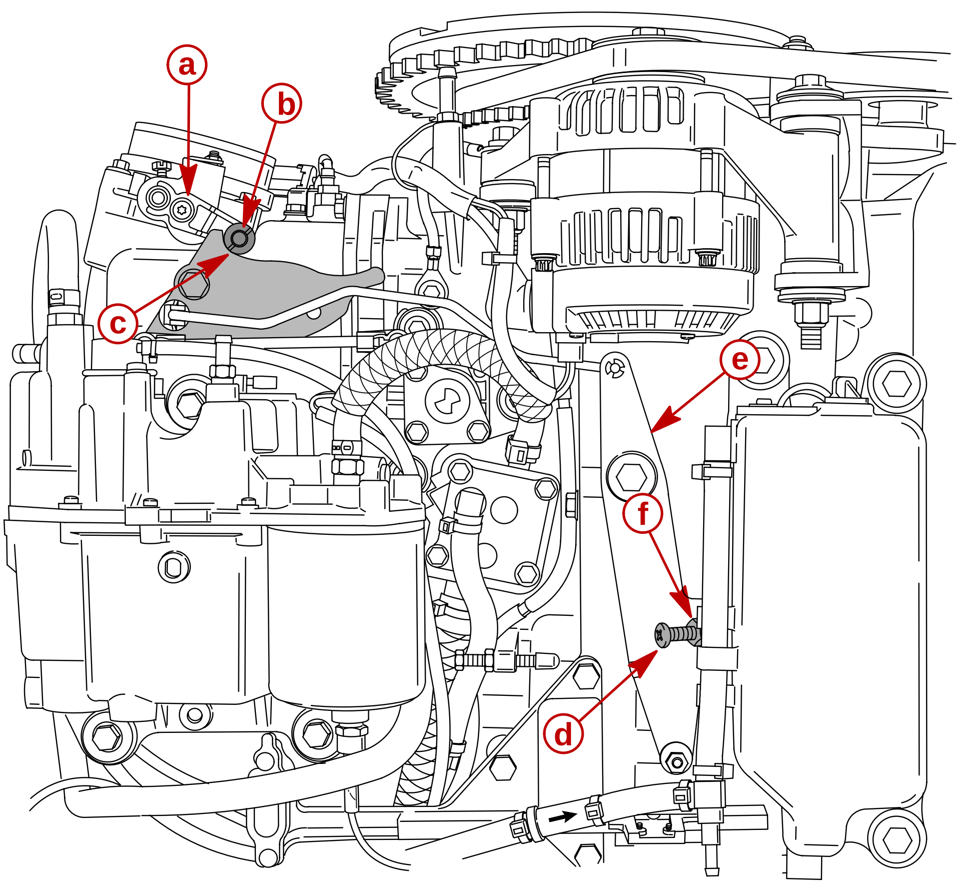


Adjustments

IMPORTANT: All throttle linkage adjustments have been set at factory and appropriately secured to prevent unnecececessary readjustment. These factory settings enable this engine to meet federally mandated emission standards and should not be tampered with. However, should certain components fail, it may be necessary to reset throttle linkage to approximate factory settings.

Throttle Cam Adjustment

1. Loosen cam follower screw (a), using Snap-On Tool TTXR25E, allowing cam follower to move freely.
2. Allow roller (b) to rest on throttle cam (c). Adjust idle stop screw (d) on throttle arm (e) to align curved radius on throttle cam (c) with center of roller (b). Tighten jam nut (f).
3. While holding throttle arm against idle stop, move cam follower arm until a 0.005 in. to 0.020 in. (0.13 mm to 0.51 mm) clearance exists between roller and throttle cam. Tighten cam follower screw (a).



58899

a - Cam Follower Screw
b - Roller
c - Throttle Cam
d - Idle Stop Screw
e - Throttle Arm
f - Jam Nut

Timing

All timing adjustments are controlled by the Electronic Control Module (ECM). No external mechanical timing adjustments can be made.

Actual engine timing can be monitored by using a Digital Diagnostic Terminal (DDT).

Ignition timing at idle, whether in gear or in neutral, will vary.

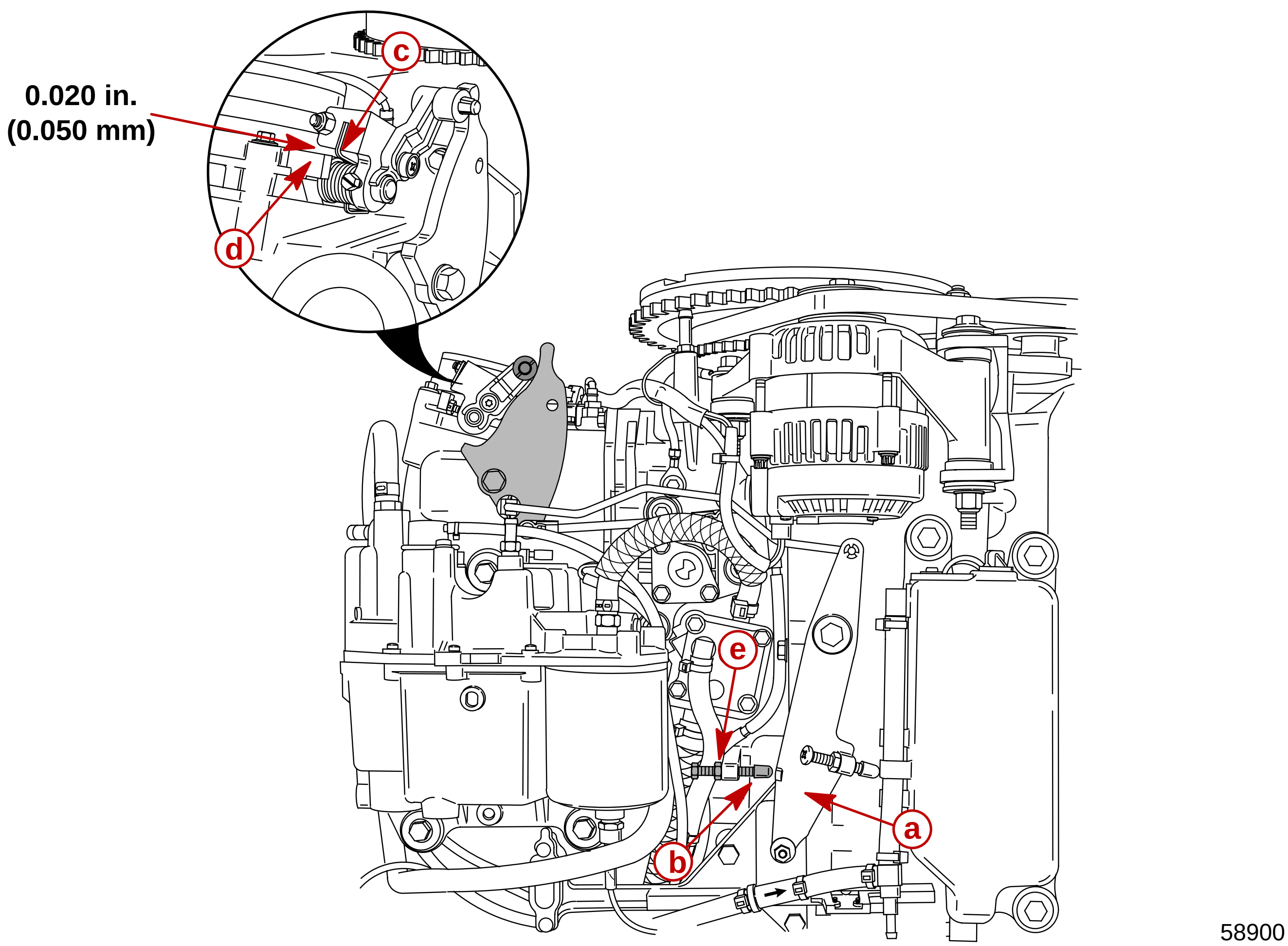
The ECM will use ignition timing to maintain an rpm of approximately 700 in neutral and 625 in forward gear. An engine that is cold will require more timing advance than an engine that is at normal operating temperature.

Engine timing at idle should be between 1° to 7° ATDC with the engine at normal operating temperature.

Engine timing at 5000 rpm should be approximately 18° to 20° BTDC for all models.

Maximum Throttle Adjustment

1. Hold throttle arm (a) against full throttle stop screw (b). Adjust full throttle stop screw to allow full throttle valve opening, while maintaining a clearance of 0.020 in. (0.50 mm) between arm (c) of throttle shaft and stop (d) on throttle assembly. Tighten locknut (e).
2. Check for slight free play (roller lifter 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 - Full Throttle Stop Screw
c - Throttle Shaft Arm
d - Stop
e - Locknut

Throttle Position Sensor

The Throttle Position Sensor (TPS) is not adjustable. The Throttle Position Sensor function can be monitored by using the DDT. All voltages should be within specifications listed. Voltage progression from idle to wide open throttle should be smooth. If voltage is out of specification or progression is erratic, TPS should be replaced.

IGNITION SYSTEM	**Throttle Position Sensor** **@ Idle** **@ W.O.T.**	 0.19 – 1.0 vdc 3.45 – 4.63 vdc

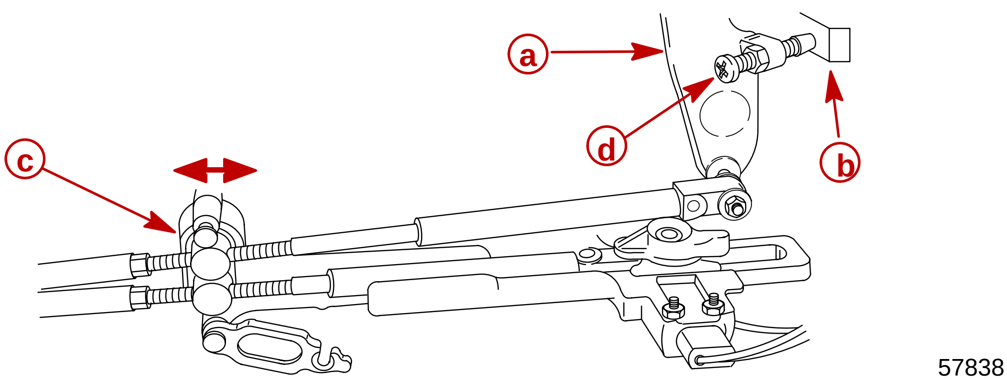
Idle Speed

The idle speed is not adjustable. Idle speed is controlled by the ECM by advancing or retarding the ignition timing to maintain an idle rpm of approximately 700 in neutral and 625 in gear.

Throttle Cable Installation

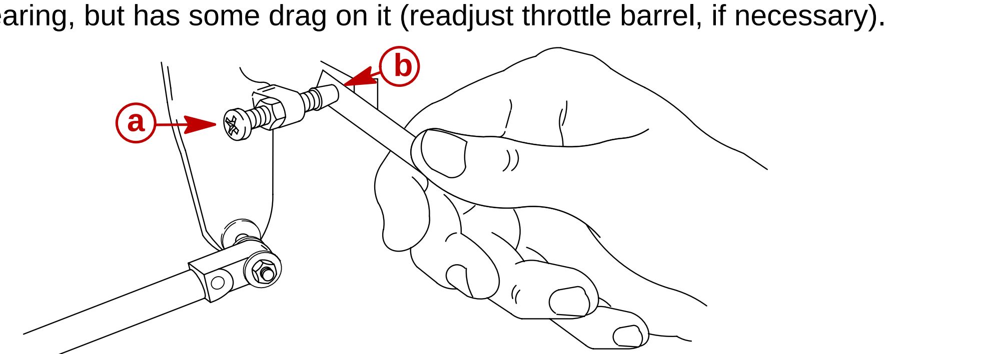
1. With end of throttle cable connected to throttle lever, hold throttle lever (a) against idle stop (b). Adjust throttle cable barrel to slip into barrel recess of control cable anchor bracket, with a light preload of throttle lever against idle stop. Lock barrel in place.

IMPORTANT: Excessive preload on throttle cable will cause difficulty when shifting from "FORWARD" to "NEUTRAL" (readjust throttle cable barrel, if necessary).



a - Throttle Lever
b - Idle Stop
c - Cable Barrel – Adjust To Hold Idle Stop Screw Against Stop
d - Idle Stop Screw

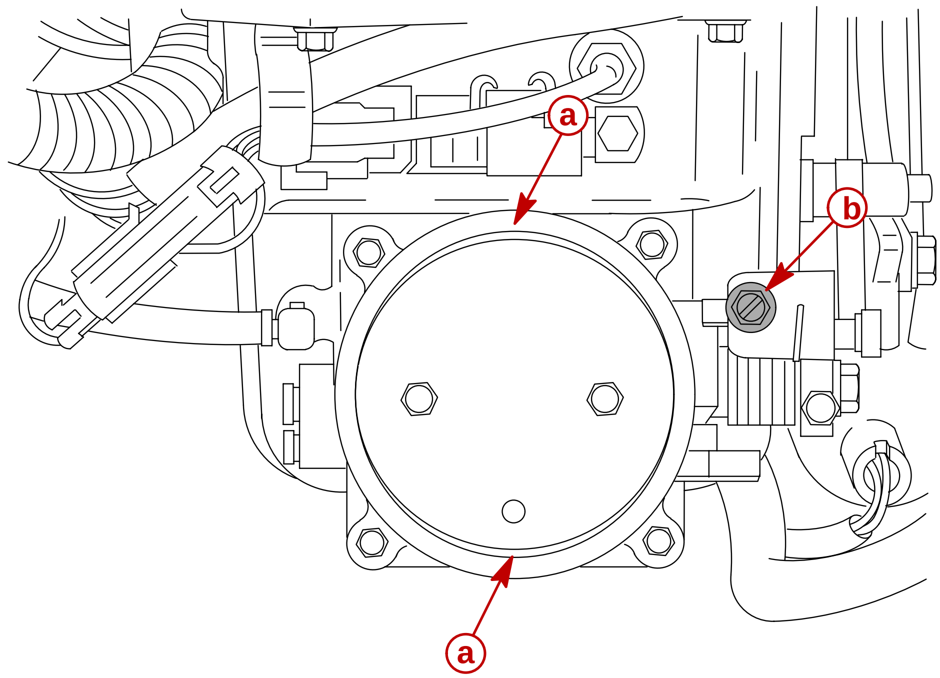
2. Check preload on throttle cable by placing a thin piece of paper between idle stop screw (a) and idle stop (b). Preload is correct when paper can be removed without tearing, but has some drag on it (readjust throttle barrel, if necessary).



a - Idle Stop Screw
b - Idle Stop

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 @ 0.040 in. (1.0 mm) or 0.020 in. (0.50 mm) each side.



58898

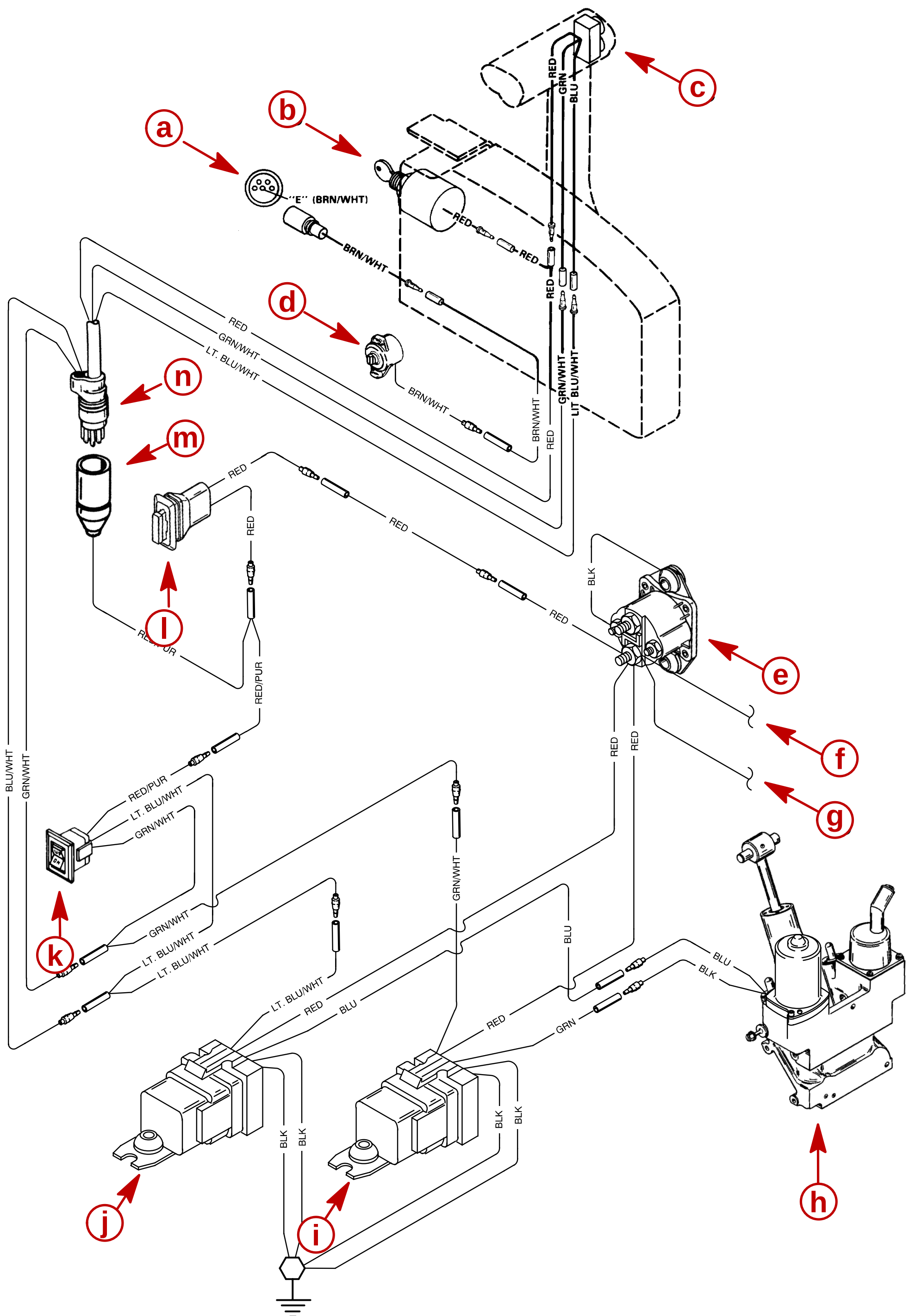
a - 0.020 in. (0.50 mm) each side
b - Throttle Plate Stop Screw

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.)

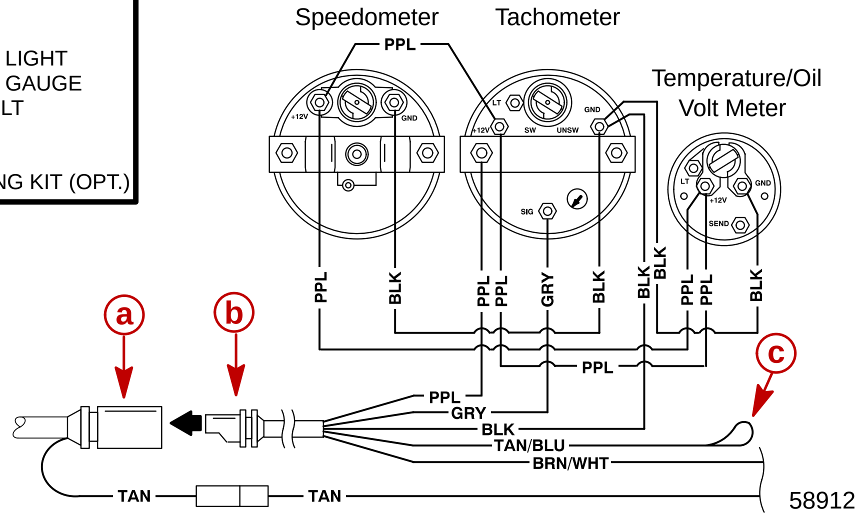


Figure 1 – Without Light Switch

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

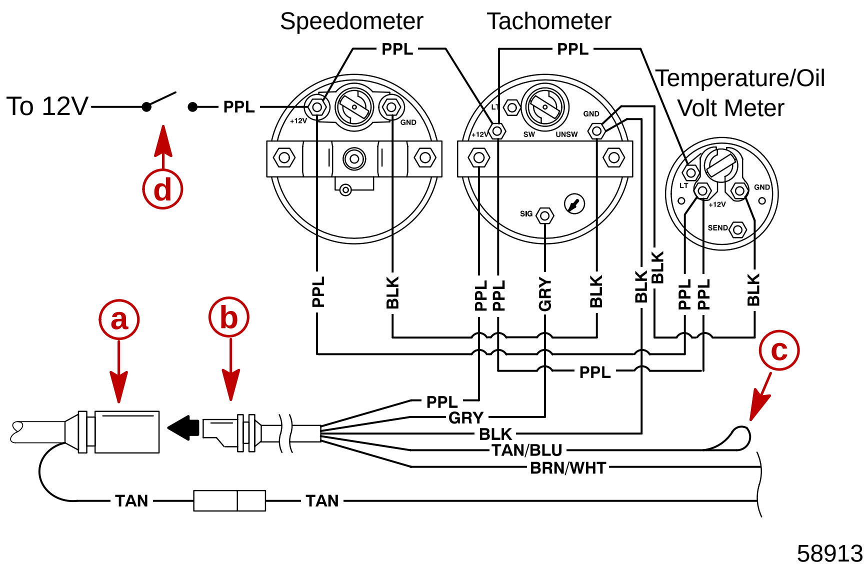
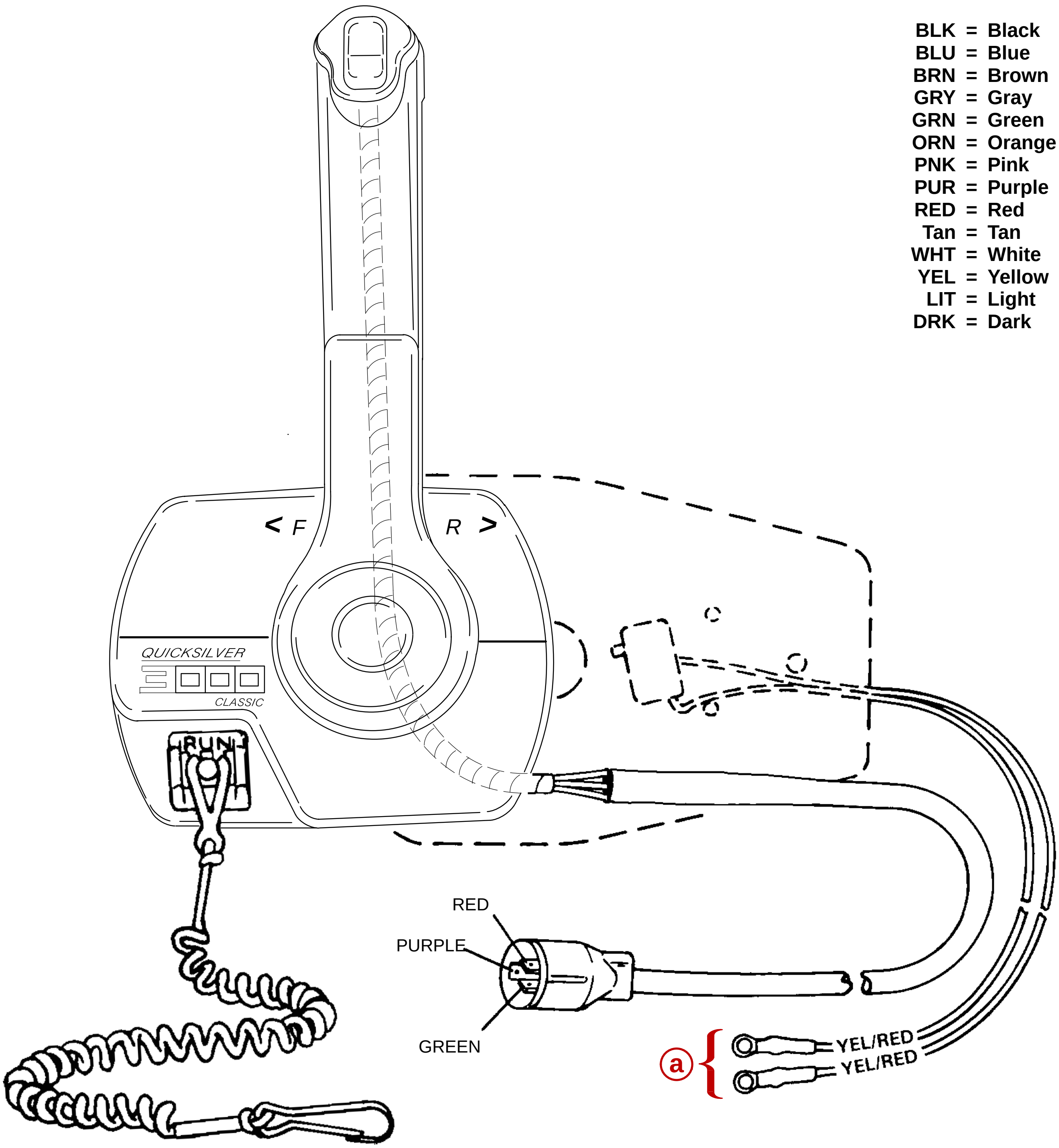


Figure 2 – With Light Switch

- **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** - Light Switch

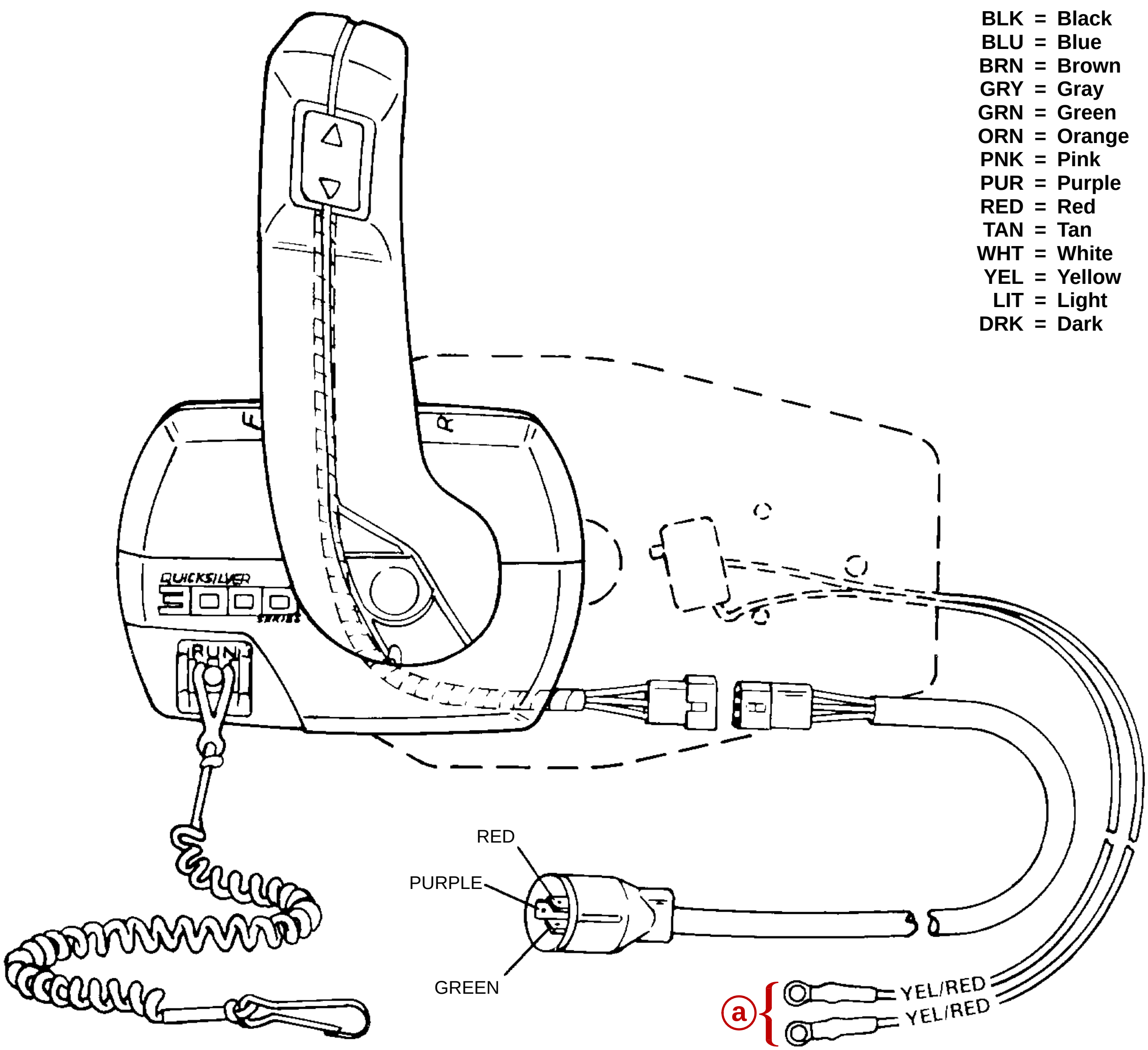
Commander 3000 Classic Panel Remote Control

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



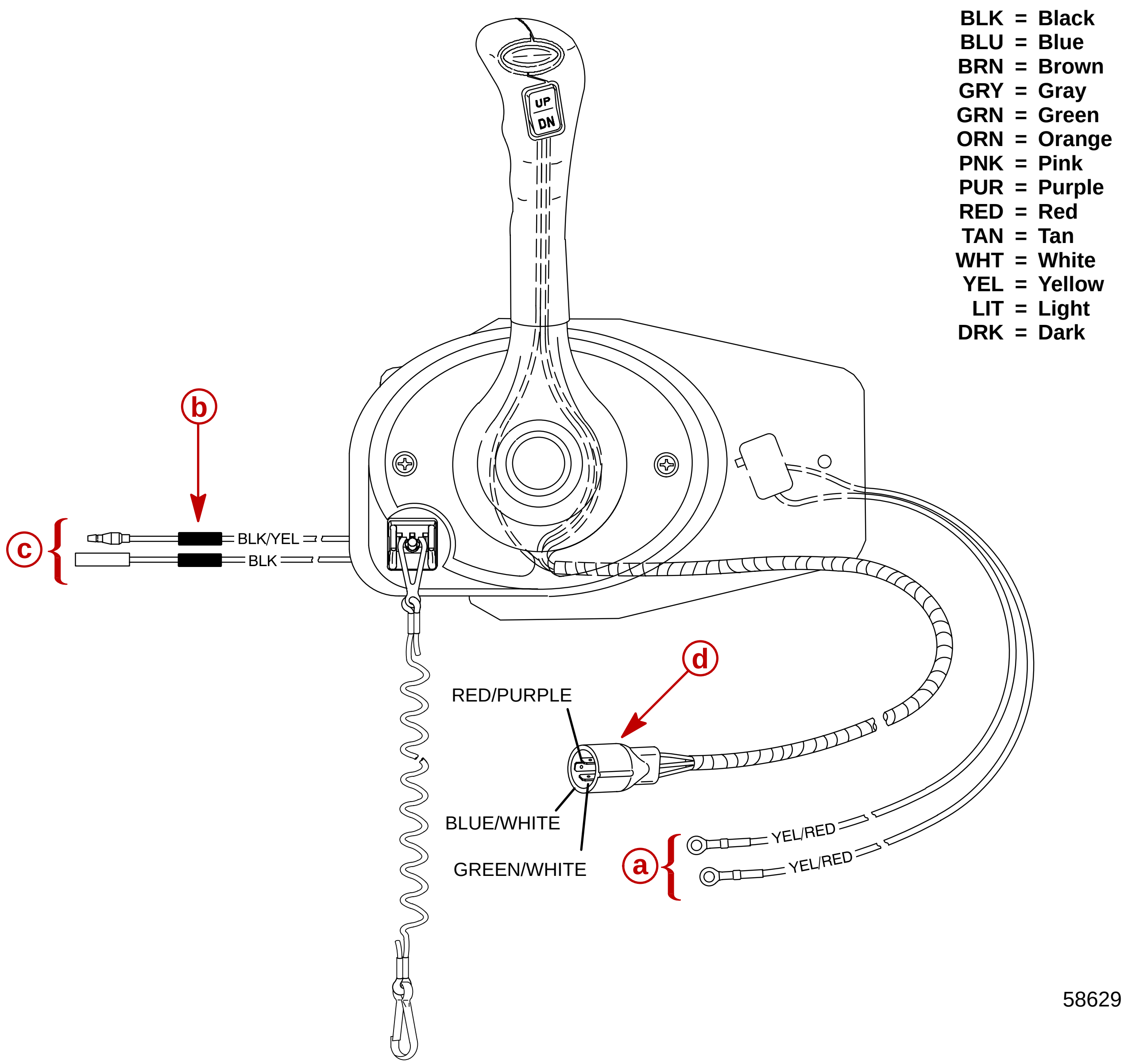
a - Neutral Interlock Switch

Commander 3000 Panel Remote Control



a - Neutral Interlock Switch

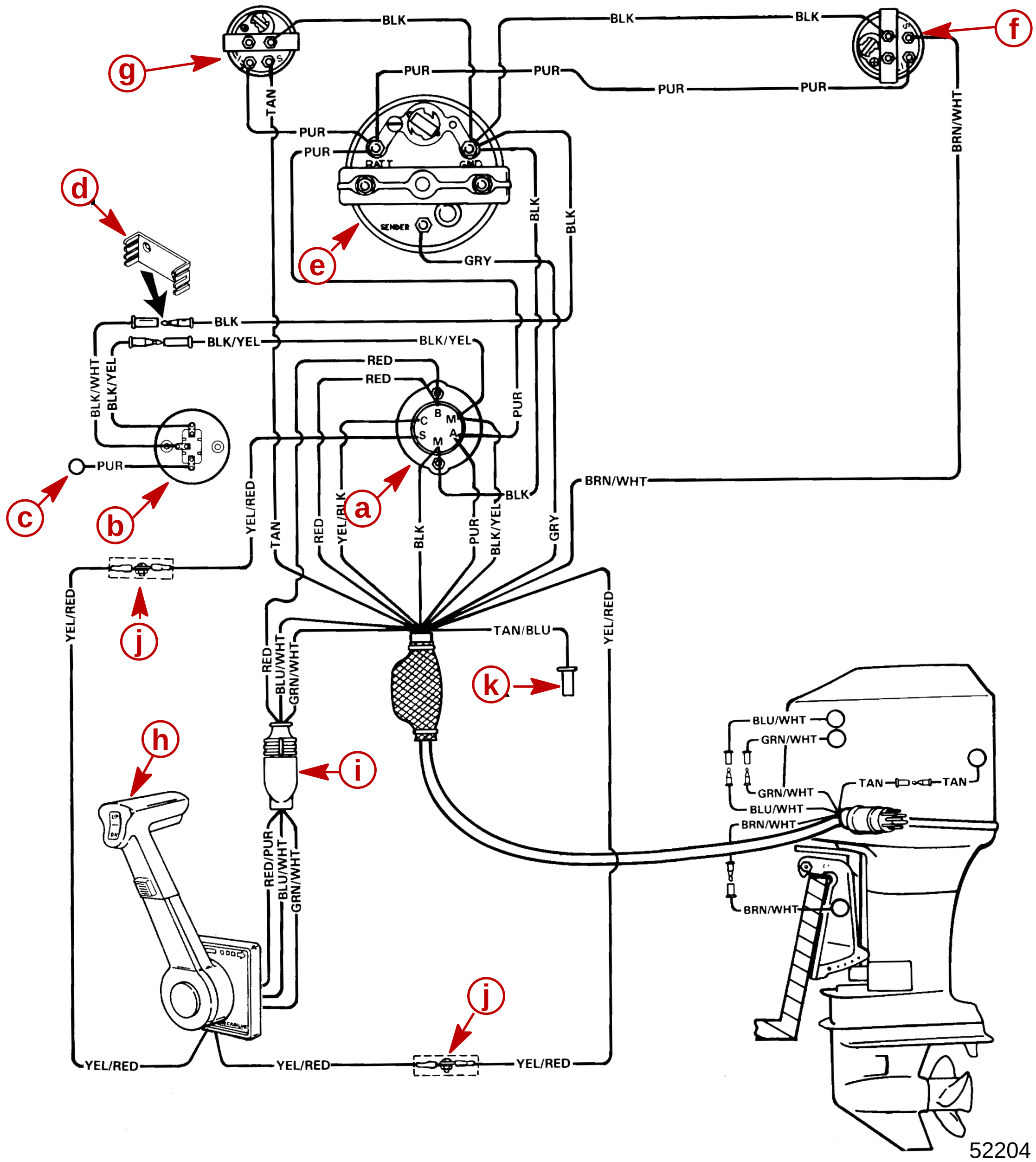
4000 Series Mechanical Panel Control



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

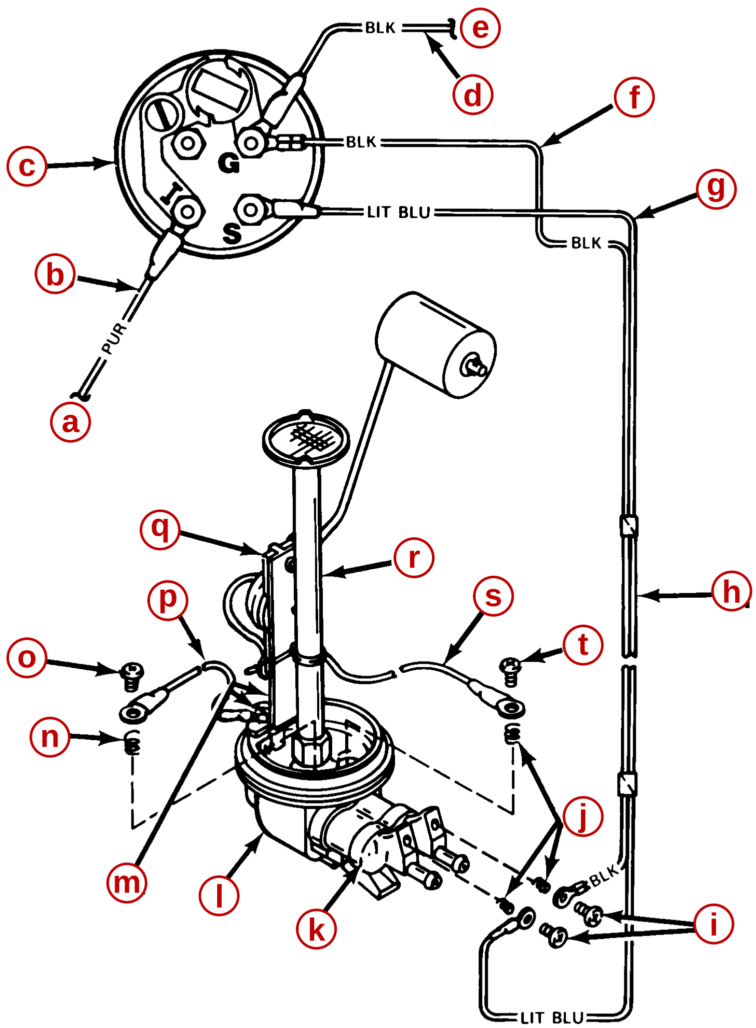
BLK=BLACK
BLU=BLUE
BRN=BROWN
GRN=GREEN
GRY=GRAY
PUR=PURPLE
RED=RED
TAN=TAN
WHT=WHITE
YEL=YELLOW



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

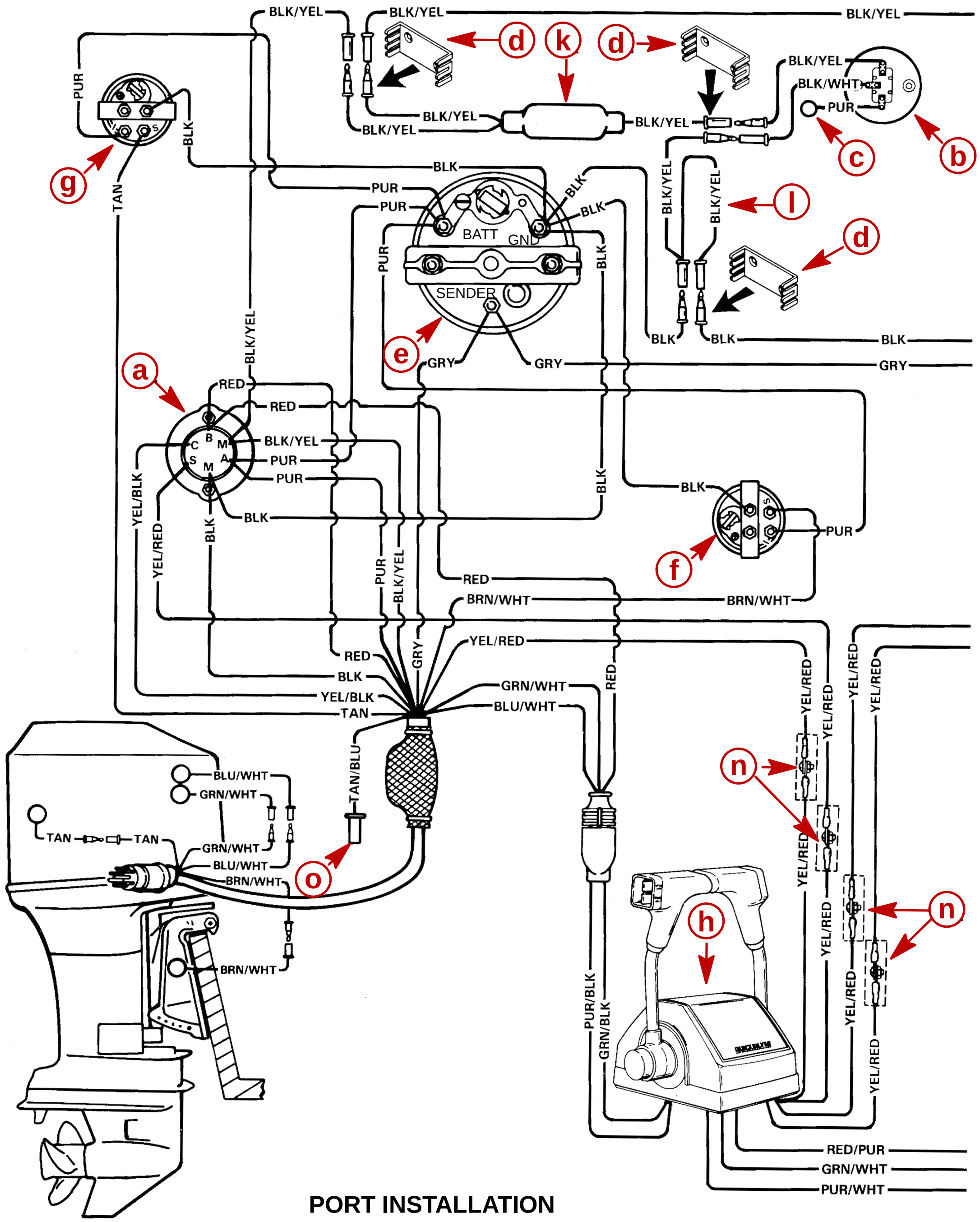


a - To 12 Volt Source
b - PURPLE Wire (Connect to Trim Indicator Gauge “I” [or POSITIVE (+) 12 Volt Source that is Turned “ON” and “OFF” with Ignition Switch])
c - Oil Level Gauge
d - BLACK Wire (Connects to NEGATIVE Ground)
e - To Ground
f - BLACK Wire (From Gauge to Oil Clip Connector)
g - LIGHT BLUE 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.)

Notes:

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

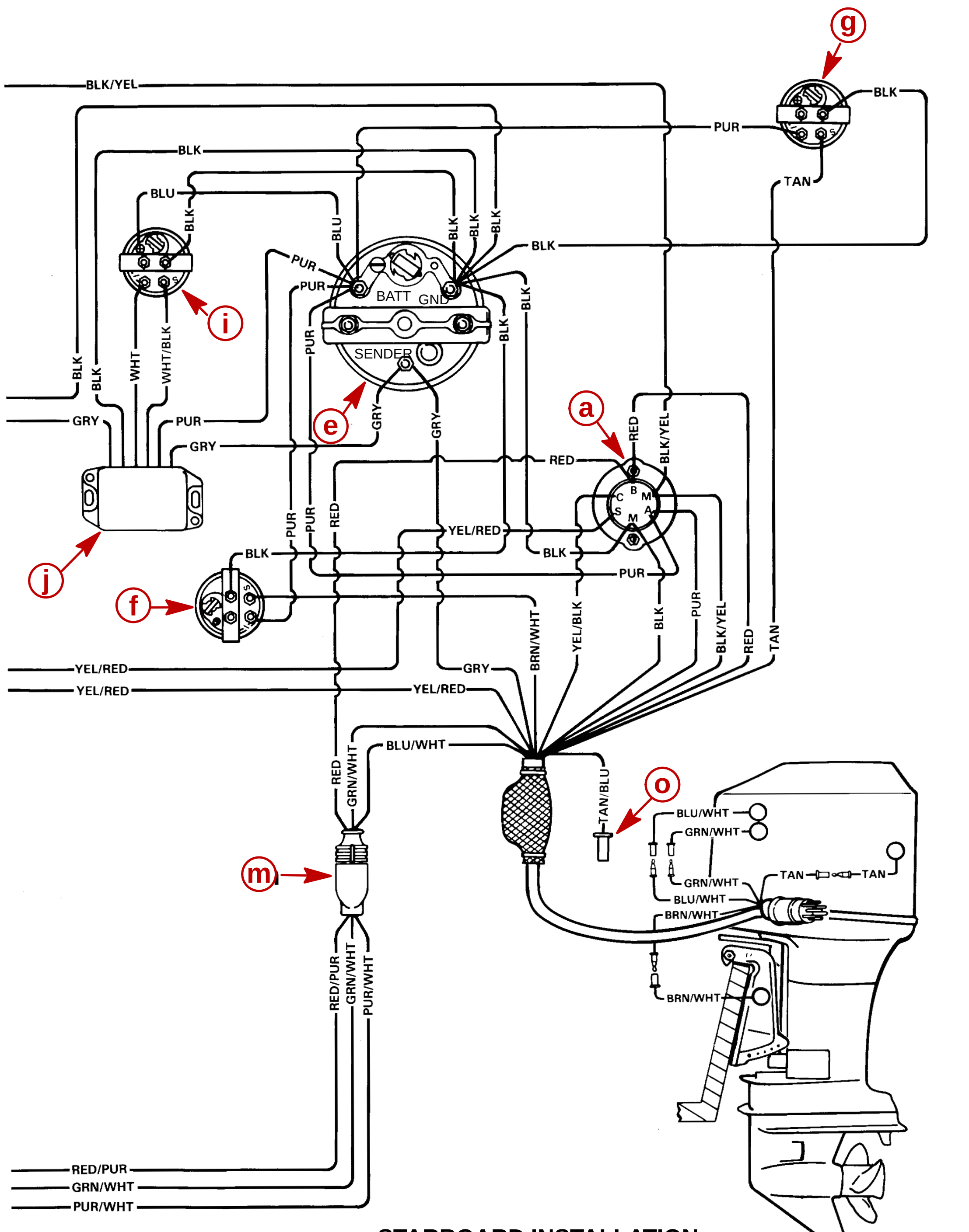


52205

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

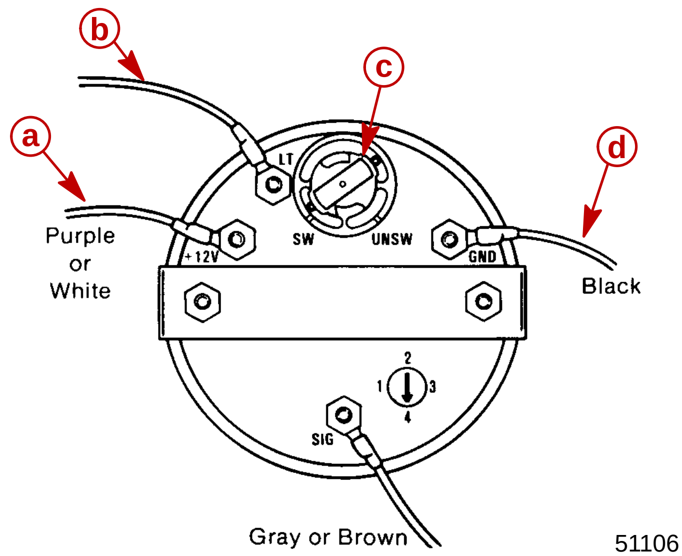
QSI Gauge Wiring Diagrams

Tachometer Wiring Diagram

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

WIRING DIAGRAM A

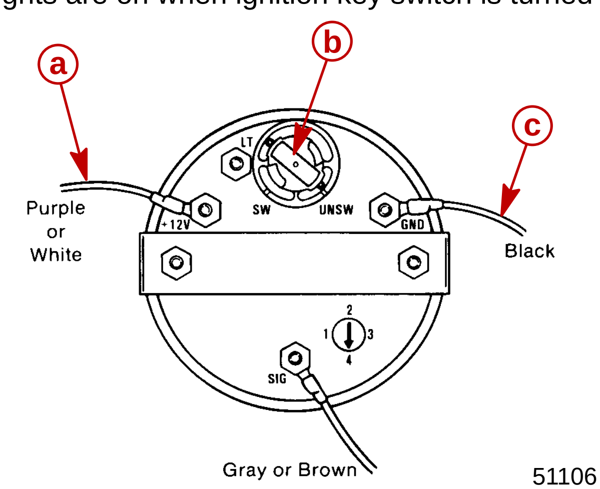
Use this wiring diagram when using a separate light switch for instrument lighting.



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.)

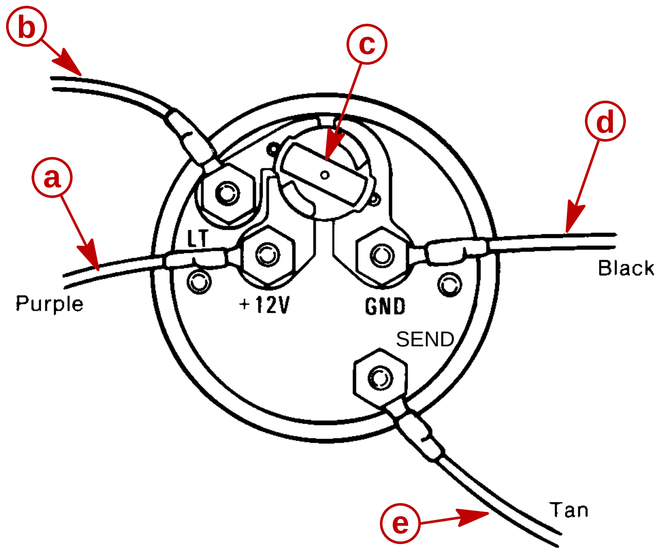


a - Connect to +12 Volt
b - Position Light Bulb to the Unswitched Position
c - Connect to NEGATIVE (–) Ground

Water Temperature Gauge

WIRING DIAGRAM A

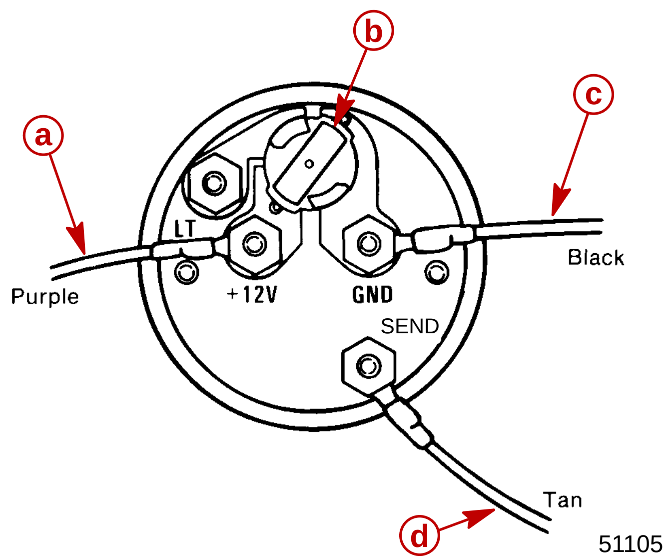
Use this wiring diagram when using a separate light switch for instrument lighting.



- **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

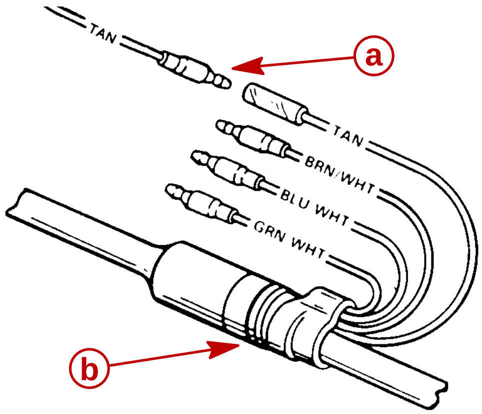
Use this wiring diagram when instrument lighting is wired directly to the ignition key switch. (Instrument lights are on when ignition key is turned on.)



- **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.



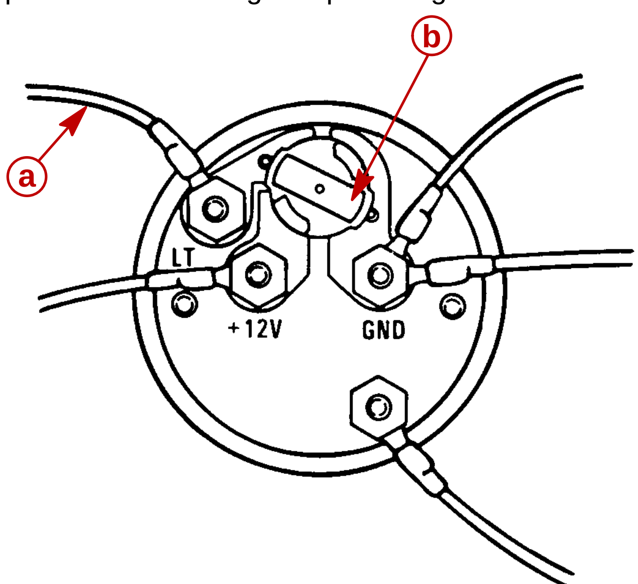
28086

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.

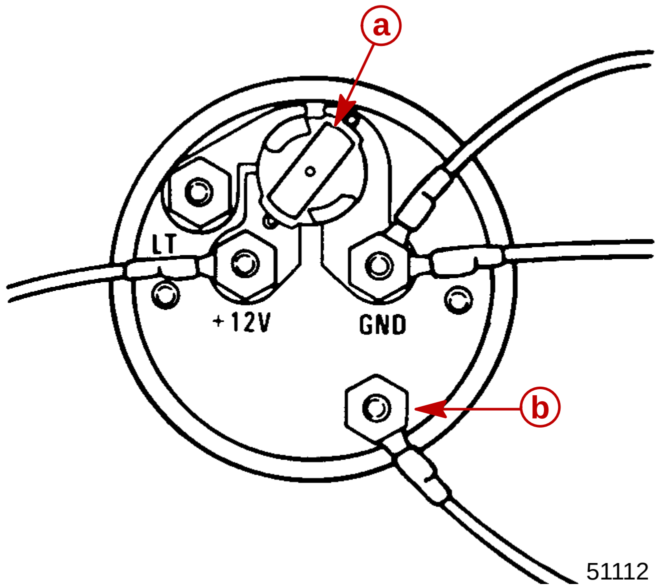


51109

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

LIGHT BULB POSITION B

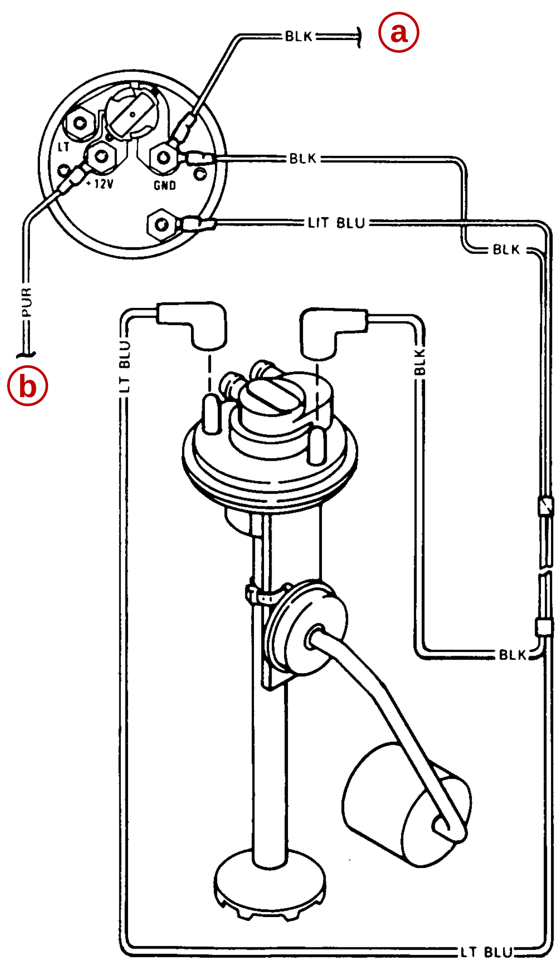
Use this position when instrument lighting is wired directly to the ignition key switch. (Instrument lights are on when ignition key switch is turned on.)



51112

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

SENDER WIRING



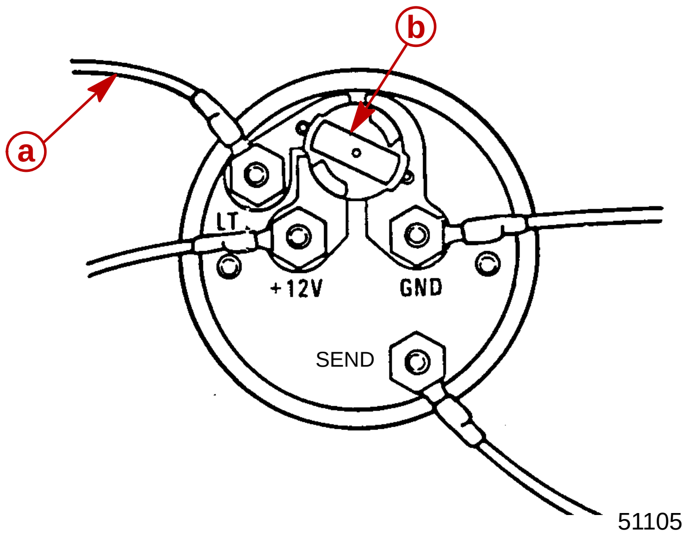
51108

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

Engine Synchronizer Wiring Diagram

LIGHT BULB POSITION A

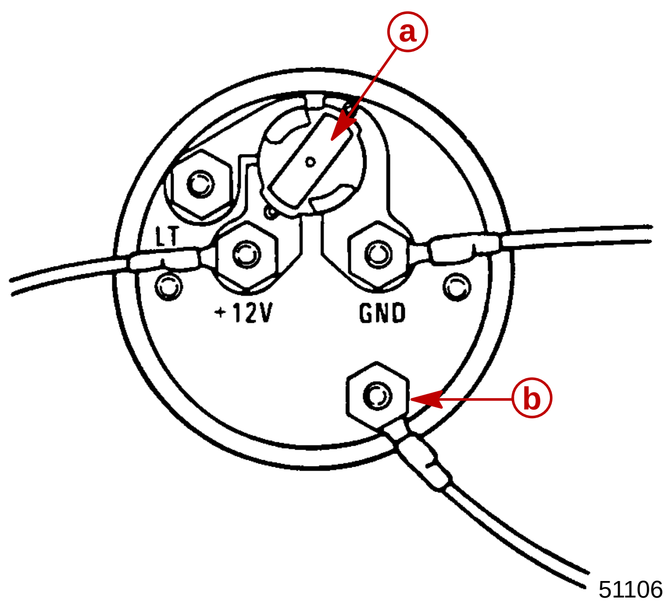
Use this position when using a separate light switch for instrument lighting.



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

LIGHT BULB POSITION B

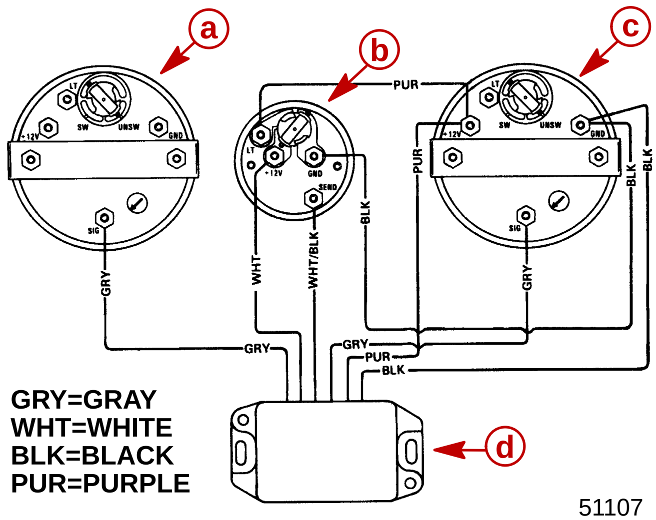
Use this position when instrument lighting is wired directly to the ignition key switch. (Instrument lights are on when ignition key switch is turned on.)



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

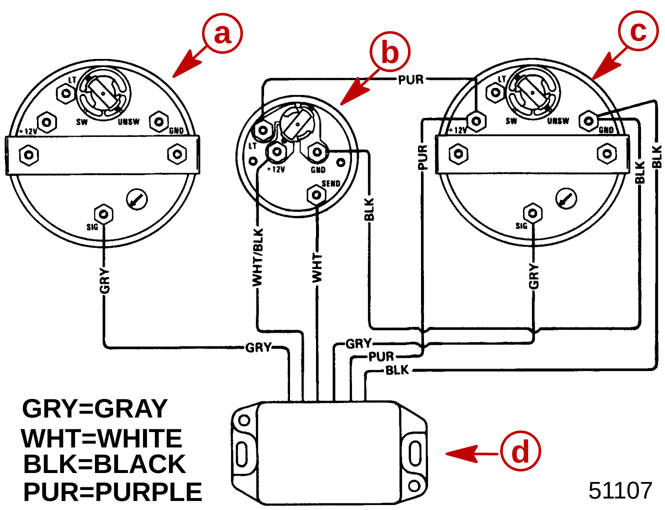
Synchronizer wiring can be accomplished two different ways as an option to the user.

Wiring Diagram – Gauge needle to point toward slow running engine



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

Wiring Diagram – Gauge needle to point toward fast running engine



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.

Warning System Signals

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

Problem	Horn	Monitor Display	Guardian Activated	Engine Speed Reduction Activated
Power Up/System Check	Single Beep	Yes	N/A	No
Low Oil	4 Beep... 2 Minutes Off	Yes	No	No
Oil Pump Electrical Failure		Yes	Yes	Yes (See Guardian System)
Over Heat	Continuous Beep	Yes	Yes	Yes (See Guardian System)
Water In Fuel	4 Beep... 2 Minutes Off	Yes	No	
Over Speed	Continuous Beep	Yes	Yes	Yes (See Guardian System)
Coolant Sensor Failure	No	Yes	No	No
MAP Sensor Failure	No	Yes	No	No
Air Temperature Sensor Failure	No	Yes	No	No
Ignition Coil Failure	No	Yes	No	No
Injector Failure	No	Yes	No	No
Horn Failure	N/A	Yes		No
Battery Voltage too high (16V) or too low (11V) or very low (9.5V)	No	Yes	Yes	Yes (See Guardian System)
Throttle Sensor Failure	Continuous Intermittant Beeping	Yes	Yes	Yes (See Guardian System)
Block Water Pressure	Yes	Yes	Yes	Yes (See Guardian System)
Calculated Oil Level Critical	Yes	Yes	Yes	Yes

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

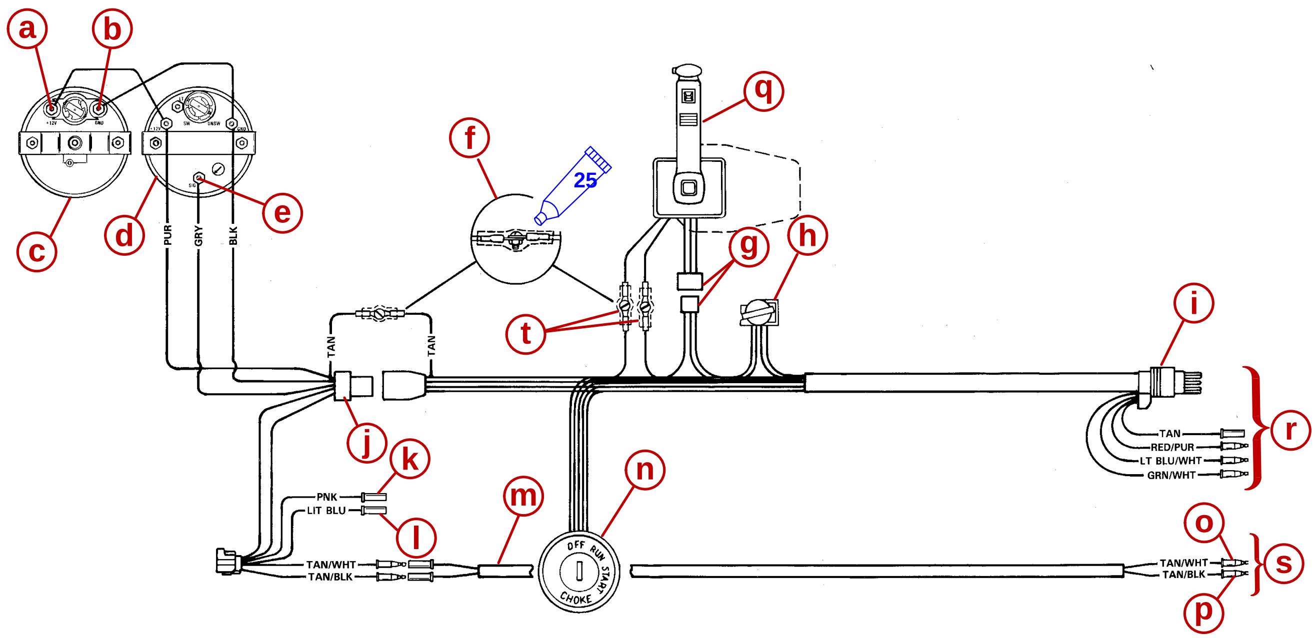
Smartcraft Gauge/Monitor	System will sound warning horn and display the warning message.

Guardian System Activation

Warning Horn		
Function	**Sound**	**Description**
Cooling System Problem	Continuous	Engine Guardian System is activated. Power limit will very with level of overheat. Shift outboard into neutral and check for a steady stream of water coming out of the water pump indicator hole. If no water is coming out of the water pump indicator hole or flow is intermittent, stop engine and check water intake holes for obstruction. The Guardian system must be RESET before engine will operate at higher speeds. Moving throttle lever back to idle resets the system.
Oil Level Is Critically Low	Continuous	Engine Guardian System is activated. Power limit will limit engine speed. The oil level is critically low in the engine mounted oil reservoir tank. Refill the engine mounted oil reservoir tank along with the remote oil tank.
Oil Pump Failure	Continuous	Engine Guardian System is activated. Power limit will limit engine speed. The warning horn is activated if the oil pump should ever stop functioning electrically. No lubricating oil is being supplied to the engine.

Engine Overspeed	Continuous	The warning horn is activated any time engine speed exceeds the maximum allowable RPM. The system will limit the engine speed to within the allowable range. If the overspeed condition continues, the Engine Guardian System will place the engine in power reduction. The Guardian system must be RESET before engine can resume full power. Moving throttle lever back to idle resets the system. Engine overspeed indicates a condition that should be corrected. Overspeed could be caused by incorrect propeller pitch, engine height, trim angle, etc.
Sensor out of Range	Continuous	Engine Guardian System is activated. Power limit may activate at full throttle speed.
	Intermittent Beep	Engine Guardian System is activated. Power limit may restrict engine speed to idle.

Analog Gauge Panel Mount Remote Control Wiring Installation

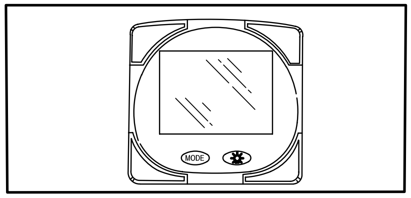


BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
TAN = Tan
WHT = White
YEL = Yellow
LIT = Light
DRK = Dark

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 Adapter Harness
k - To Fuel Sender (Optional)
l - To Oil Sender (Optional)
m - Two Wire Harness
n - Ignition/Choke Switch
o - Low Oil Sender Lead
p - Over Temperature Switch Lead
q - Panel Mount Remote Control
r - To Engine
s - To Engine
t - Neutral Safety Switch Lead

System Monitor V2.0



Basic Operation

The System Monitor is an LCD multi-function display gauge. A variety of displays can be activated using the MODE button.

Pressing the MODE button scrolls the following displays: fuel used, tachometer (RPM), fuel flow, power trim position, engine temp, water pressure, battery voltage, traveling range (if calibrated), and water depth (if equipped with transducer).

The System Monitor will power up when the ignition is turned on.

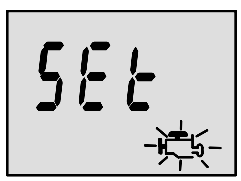
The display includes a backlight which allows you to read it at night. The backlight brightness is adjustable using button.

In the event of a warning alarm, the warning icon(s) will be displayed.

The System Monitor can be calibrated to display both the English or the Metric system. The System Monitor can also be calibrated so that the trim position is displayed whenever the propulsion unit is trimmed. Refer to *Cal1* Calibration Section for details.

Initial Power Up (Or After Master Reset)

Unit will display software level then flash the word **"SEt"** in conjunction with engine icon.



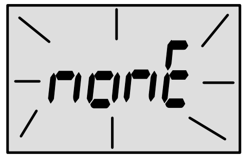
Press the MODE button.

The unit will begin it's **"Auto–detection"** of engine type procedure. In this procedure System Monitor checks with the engine control module (ECM) to see what type of engine you have and presets the data monitoring screens accordingly, (e.g., If System Monitor detects an inboard engine connected to the data network it will turn off all engine/drive TRIM functions as these functions are not used in an inboard engine installation). The intention is to make initial setup easier.

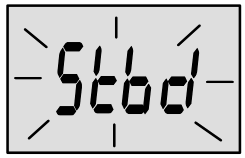
NOTE: *If "2001" comes up during auto detect the gauge has detected that your engine is a pre 2002 model. You will need to manually select your engine type. Use the button to scroll through the choices. Stnd = Stern Drive, Inbd = Inboard, JEtd = Jet Drive, Out2 = Outboard 2 Stroke, Out4 = Outboard 4 Stroke. Press* MODE *to continue.*

NOTE: *If you see the flashing message,* ***(A) "nonE"*** *after the Auto–detection occurs, the gauge can not find an engine. Please check wiring for correct connection. If you receive one of the following other flashing messages:* ***(B) "Stbd"*** *or,* ***(C) "noSt"*** *refer to the "Set–Up Errors Section".*

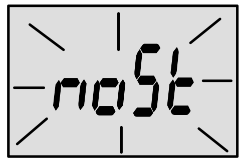
A)



B)



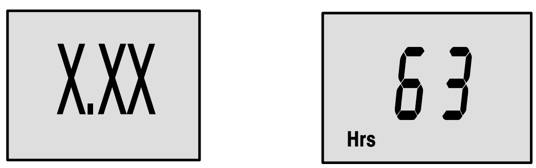
C)



Standard Information Display Screens

START UP SCREEN

At power up, a momentary (1 second) screen displays the current System Monitor software version, followed by a 4 second display showing hours of engine use.



NOTE: *NOT ALL SCREENS MAY APPLY TO YOUR ENGINE TYPE.*

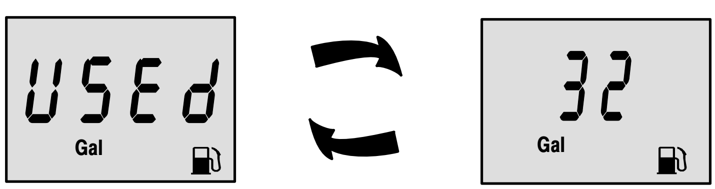
NOTE: *Screens can be turned on/off in Cal1. Refer to the Cal1 calibration section for details.*

RPM SCREEN

Tachometer – Displays engine speed in Revolutions Per Minute (RPM).

FUEL USED SCREEN

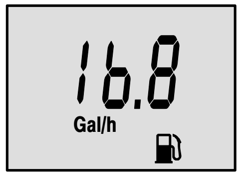
The System Monitor displays approximate fuel used since the last reset.



Fuel Used Reset will return display back to 0. You can preform a **Fuel Used Reset** any-time by pressing MODE and buttons together momentarily.

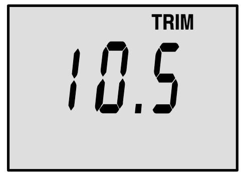
FUEL FLOW SCREEN

The System Monitor displays current estimated individual engine fuel consumption in Gallons per hour (Gal/hr) or Liters per hour (Ltr/hr).



TRIM POSITION SCREEN

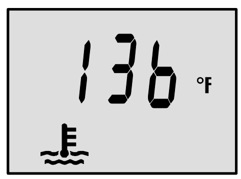
Displays trim position of the propulsion unit up to the maximum trim position, and then displays trailer position. 0 = down, 10 = maximum trim, and 25 = full trailer.



NOTE: *The System Monitor may be calibrated so that trim is displayed whenever the trim switch is used. Refer to the Cal1 Calibrations Section for details.*

ENGINE TEMPERATURE SCREEN

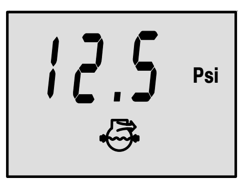
Displays the engine temperature in degrees Fahrenheit (°F) or Celsius (°C).



NOTE: *You can change the units of measure within Cal1. Refer to the Cal1 Calibration Section for details.*

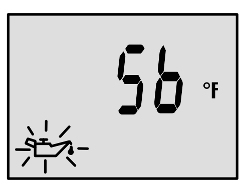
WATER PRESSURE SCREEN

Displays cooling system water pressure of the engine in Psi or Bar.



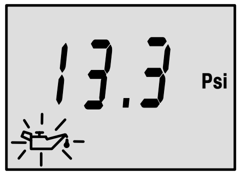
OIL TEMPERATURE SCREEN

Displays the engine oil temperature in degrees Fahrenheit (°F) or Celsius (°C).



OIL PRESSURE SCREEN

Displays engine oil pressure in Psi or Bar.



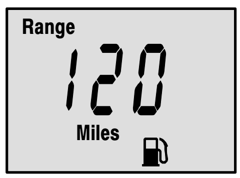
BATTERY VOLTAGE SCREEN

Displays voltage level (condition) of battery.

Display of Range and Depth Information

RANGE SCREEN

Displays estimated traveling range based on current fuel consumption and fuel remaining in the tank that is connected to the system. The number displayed is an estimate of the distance you can travel on the remaining fuel at current boat speed.

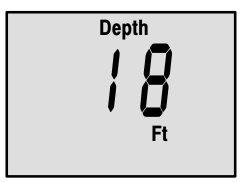


NOTE: *To activate this screen, you must perform the fuel tank calibration in Cal2. Refer to the Cal2 Calibration Section for details.*

NOTE: *You must have a speed input device connected to the system (paddle wheel or pitot pressure transducer).*

WATER DEPTH SCREEN

Displays the depth of water under the transducer if connected.

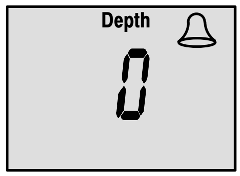


SHALLOW WATER ALARM FEATURE

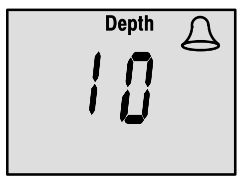
You can set an alarm to trigger whenever the boat moves into water shallower than the alarm level.

Setting Shallow Water Alarm.

1. The water depth screen must be displayed. Be sure Depth is turned on in *Cal2*. Refer to *Cal2* Calibration Section for details.
2. Press both MODE and buttons together for 3 seconds.
3. The alarm on or off menu will appear.
4. Press the button to toggle to ON.



5. Push MODE button to save.
6. The depth number will be flashing. Press the button to set the flashing number to desired alarm depth. 100 ft. maximum depth and 2 ft. minimum depth.



7. Push MODE button to save.

Warning System

NOTE: *Alarm warnings may vary depending on your engine type. Some warnings listed may not apply to your engine. Please consult your engines owners manual for a complete list of engine warnings.*

The System Monitor warning system incorporates the display screen, the warning horn and the Guardian Protection system. The warning horn is located inside the remote control or is part of the ignition key switch wiring harness.

- **Alarms Warnings –** When a problem is detected, the warning horn sounds and the offending icon appears on the display.
  If problem can cause immediate engine damage – The horn will sound continuously and the Engine Guardian System will respond to the problem by limiting engine power. Immediately reduce throttle speed to idle and refer to the warning messages on the following pages that tell you what to do about it.
  If problem will not cause immediate engine damage – The horn will sound but not continuously. Refer to the warning messages on the following pages that tell you what to do about it.
- **Engine Guardian System –** Monitors the critical sensors on the engine for any early indications of problems. The system will respond to a problem by reducing engine power in order to maintain a safe operating condition.

NOTE: *If the mode button is pressed to a different screen, the flashing alarm signal will remain flashing to indicate there still is a problem.*

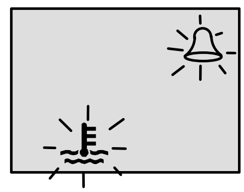
Warning Display Screens

The engine has an **"Engine Guardian System"**. The ECM Engine control module monitors the critical sensors on the engine for any early indications of problems. The Guardian System will respond to a problem by reducing engine speed in order to maintain a safe operating condition. The System Monitor will display the alarm.

The warning system will alert the operator to the potential problems. Refer to the pages following for explanation of the problem and the correct action to take.

ALARM – OVERHEAT

The Bell and Temperature icons are displayed and the warning horn begins sounding continuously to inform the driver that there is insufficient water pressure in the cooling system. The Engine Guardian System will start limiting engine power.



If the engine overheats, immediately reduce throttle speed to idle. Shift into neutral. If outboard: check for a steady stream of water coming out of the water pump indicator hole.

NOTE: *The throttle will have to be returned to idle to reset the system.*

If no water is coming out of the water pump indicator hole or flow is intermittent, stop engine and check cooling water intake holes for obstruction. If no obstruction is found, this may indicate a blockage in the cooling system or a water pump problem. Operating the engine while overheated will cause engine damage.

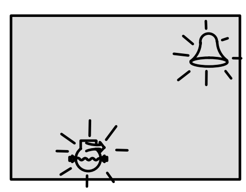
If a steady stream of water is coming out of the water pump indicator hole and the warning horn continues to sound, there still may be insufficient cooling water or an engine problem. Stop engine. Operating the engine while overheated will cause engine damage.

The overheat problem must be corrected before you can resume normal operation.

NOTE: *If you are in a stranded situation, stopping the engine and allowing it to cool back down will usually allow some additional low speed (idle) running time before the engine starts to overheat again.*

ALARM – LOW WATER PRESSURE

The Bell and Water Pressure icons are displayed and the warning horn begins sounding continuously to inform the driver that there is insufficient water pressure in the cooling system. The Engine Guardian System will start limiting engine power.



Some causes of insufficient cooling water pressure are (1) obstructed cooling water intake holes (2) blockage in the cooling system or a water pump problem. Running the engine with the cooling water intake holes out of the water.

NOTE: *The throttle will have to be returned to idle to reset the system.*

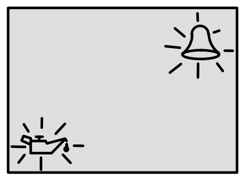
If the warning system is activated, immediately reduce throttle speed to idle. Shift engine into neutral. and check for a steady stream of water coming out of the water pump indicator hole.

If no water is coming out of the water pump indicator hole, or flow is intermittent, stop engine and check cooling water intake holes for obstruction. If no obstruction is found, this may indicate a blockage in the cooling system or a water pump problem. Have the outboard checked by your dealer. Operating the engine without adequate cooling water pressure will overheat the engine.

If the warning signals stop and a steady stream of water is coming out of the water pump indicator hole, return engine to normal operation. If the warning system is activated repeatedly, have the outboard checked by your dealer.

ALARM – LOW OIL RESERVE – OUTBOARD 2 STROKE

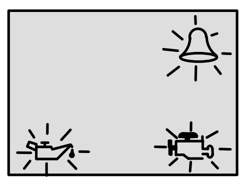
The bell and oil icons are displayed and the warning horn begins sounding a series of four beeps every two minutes to inform the driver that the oil level is critically low in the engine mounted oil reservoir tank. When the oil level gets close to empty, the horn begins sounding continuously and the Engine Guardian System will start limiting engine power.



The engine mounted oil reservoir tank along with the remote oil tank will have to be refilled (refer to Fuel & Oil Section).

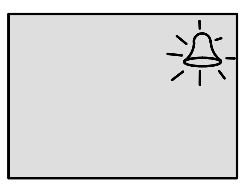
ALARM – OIL PUMP FAULT

The Bell, Engine and oil icons are displayed and the warning horn begins sounding continuously to inform the driver that the oil pump has stopped functioning electrically. No lubricating oil is being supplied to the engine. Stop the engine as soon as possible. The Engine Guardian system will start limiting the engine power. Consult your dealer for assistance.



ALARM – ENGINE OVERSPEED

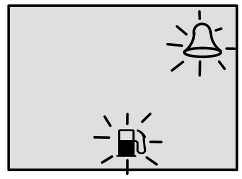
The Bell icon is displayed and the warning horn begins sounding continuously to inform the driver that the engine speed exceeded the maximum allowable RPM. The system will automatically reduce the engine speed to within the allowable limit.



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.*

ALARM – WATER IN FUEL

The Bell and Fuel Icon will appear and the warning horn will begin sounding a series of four beeps every two minutes when water in the water-separating fuel filter reaches the full level. On some engines water can be removed from the filter. Refer to Maintenance Section for filter removal.

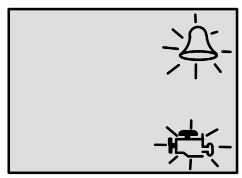


ALARM – LOW FUEL

The Bell and Fuel Icon will appear and the warning horn will sound a series of four beeps. This alarm occurs when there is less than 1/8 of the total fuel capacity left. Once the four beeps have sounded, this alarm will not reoccur unless the condition still exists after next key up.

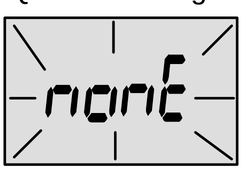
ALARM – ENGINE MALFUNCTION

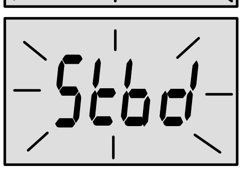
The Bell and Engine Icon will appear to inform the driver that an engine problem has occurred. If the warning system senses that the problem could cause permanent engine damage, the Engine Guardian System will start limiting engine power.

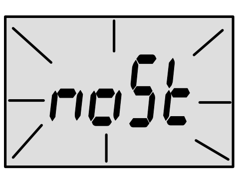


INSTALLATION ERROR DETECTION

1. System Monitor flashes a **“nonE”** message when there is no communication between System Monitor and an ECM. Check for loose wiring. Preform master reset and try auto detecting again. (Refer to Page 45 for Master Reset.)
2. System Monitor flashes a **“Stbd”** message when there is more than one Stbd ECM present on the SmartCraft network. Need to configure ECM’s to proper engine location using DDT or Quicksilver Diagnostics Tool.
3. System Monitor flashes a **“noSt”** message when there are no Stbd ECM’s present on the SmartCraft network. Need to configure ECM’s to proper engine location using DDT or Quicksilver Diagnostics Tool.

A)


B)


C)


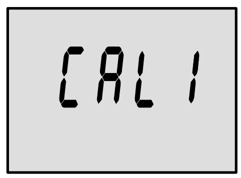
CAL1 Calibration

Cal1 Display Calibrations:
•Trim Pop up Screen (On or Off) •Trim Calibration •English or Metric Units Selection •Range Units Selection •(On or Off) Depth, Trim, Engine Temperature, Oil Pressure, Oil Temperature, Water Pressure, Volts, Engine Hours, and Data Simulator pages.

NOTE: NOT ALL SCREENS MAY APPLY TO YOUR ENGINE TYPE.

CAL1 HEADER SCREEN

1. Turn ignition key to the on position.
2. Press and hold MODE and for 3 seconds to bring up the *Cal1* calibration screen. Release the buttons to enter *Cal1*.
3. Press the MODE button to advance through the *Cal1* calibration functions.
4. Press and hold MODE and for 3 seconds to save changes and exit the *Cal1* calibration screen.

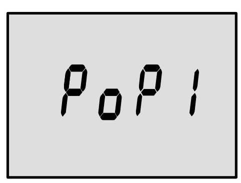


Press the MODE button to move to the next calibration screen.

NOTE: *Pressing the button while in this header screen, will "transfer" you straight into Cal2.*

TRIM POP UP SCREEN (ON OR OFF)

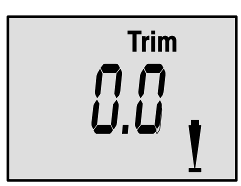
If you want the power trim display screen to pop up as you trim the propulsion unit, calibrate as follows: With the pop up screen displayed and the number "flashing", press the button to select 1=ON or 0=off.



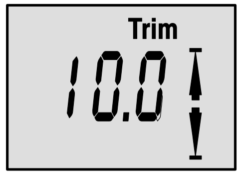
Press the MODE button to save and move to the next function.

Set the trim sensor as follows:

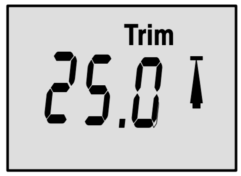
Calibration 0.0 – The word "Trim" and down arrow should be blinking. Use the trim switch and trim the unit to the full Down/In position. Press the button to save. Press the MODE button to advance to the Calibration 10.0 setting.



Calibration 10.0 – The word "Trim" and the down and up arrows should be blinking. Trim the unit out to the maximum trim **(not trailer)** position. Press the button to save. Press the MODE button to advance to the Calibration 25.0 setting.



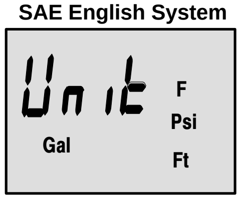
Calibration 25.0 – The word "Trim" and up arrow should be blinking. Use the trim switch and trim the unit out to the maximum trailer position. Press the button to save. Press the MODE button to move to the next function.



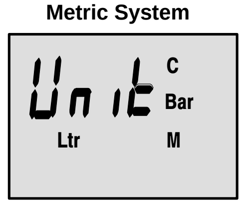
ENGLISH OR METRIC READINGS SELECTION

The System Monitor allows you to display reading in the SAE (standard) English system or the Metric system. Press the button to toggle between units.

SAE English System



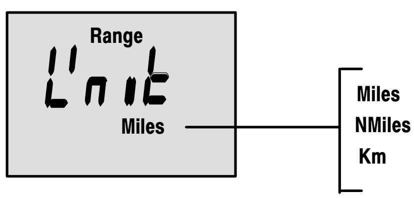
Metric System



Press the MODE button to save and move to the next function.

RANGE READINGS SELECTION

The System Monitor allows you to display reading in Miles, Nautical Miles or Kilometers. Press the button to toggle between units.



Press the MODE button to save and move to the next function.

DATA PAGE SELECTIONS

Select if you would like to display Depth, Trim, Engine Temperature, Oil Pressure, Oil Temperature, Water Pressure, Volts, Engine Hours, and Data Simulator pages or not.

NOTE: *The engine connected may not support all screen functions.*

Press the button to toggle between units.

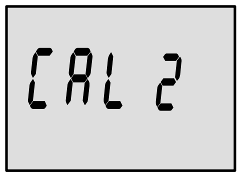
Press the MODE button to save and move to the next function.

CAL2 Calibration

CAL2 Display Calibrations:
•Paddle Wheel Speed Sensor Frequency Setting •Pitot Water Pressure Speed Sensor Input Setting •Pitot Water Pressure Speed Sensor Multiplier •Fuel Tank Calibration

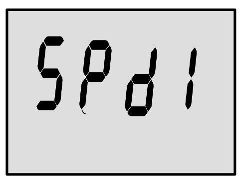
CAL2 HEADER SCREEN

1. Turn ignition key to the on position.
2. Press and hold MODE and , System Monitor will first display *Cal1*,and then after 6 seconds will display *Cal2*. Release the buttons to enter the *Cal2* calibration screen.
3. Press the MODE button to advance through the *Cal2* calibration functions.
4. Press and hold MODE and for 3 seconds to get out of the *Cal2* calibration screen.



PITOT WATER PRESSURE SENSOR INPUT SETTING (SPD1 OR SPD2)

Select the PSI input of the Pitot water pressure sensor on the engine. Press the button to select 1 = 100 PSI or 2 = 200 PSI. The standard PSI input on production Mercury product is 100 PSI. Certain High Performance applications may require a 200 Psi input.



Press the MODE button to save and move to the next function.

PITOT WATER PRESSURE SENSOR MULTIPLIER (1.XX)

This multiplier can be used to adjust the pitot speed to match speed as measured on GPS or radar gun. Press the button to select change.

Press the MODE button to save and move to the next function.

Frequency can be changed to match requirements of different sensors. 4.9 (hz/Mile) is the frequency of the paddle wheel speed sensor provided by Mercury Marine.

Press the MODE button to save and move to the next function.

FUEL TANK CALIBRATION:

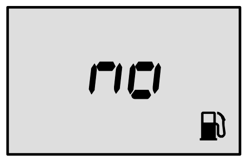
NOTE: *There are three methods to set up fuel tank level monitoring feature:*

First: Do nothing. Linear readout based on raw sensor values. This mode does not factor in irregular tank shapes.

Second: By following the tank calibration procedure described on pages 33–35, but without actually adding fuel. System Monitor will supply an estimated range value based on linear interpolation of the sensor range values. This mode does not factor in irregular tank shapes.

Third: By following the tank calibration procedure described on pages 33–35 completely System Monitor will display an estimated range value that factors in the tank shape.

1. Scroll using the MODE key until you see **"t1"**. This tells you that you have entered tank 1 calibration.
2. Press MODE once more.
3. You will see the word **"no"** and the gas tank icon. Enter the capacity of tank 1 in gallons using the key.



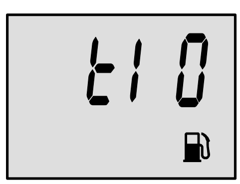
NOTE: *The word **"no"** will not go away unless the gauge sees a tank connected to the system. With no tank connected you will not be able to enter a capacity.*

4. Press MODE once more.
5. You will see **"t2"**. This tells you that you have entered tank 2 calibration.
6. Press MODE once more.
7. You will see the word **"no"** and the gas tank icon. Enter the capacity of tank 2 in gallons using the key.

NOTE: *The word **"no"** will not go away unless the gauge sees a tank connected to the system. With no tank connected you will not be able to enter a capacity.*

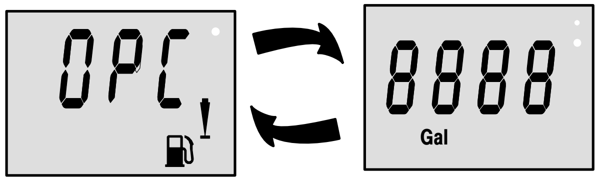
NOTE: *Tank 2 does not have to be a fuel tank. It could represent an oil tank for example. See page 35 for tank 2 selection.*

Select whether you want to calibrate the fuel tank **"t1"**. (The gauge will not let you calibrate the fuel tank until the capacity had been entered). Press the button to select 0= off or 1= on.

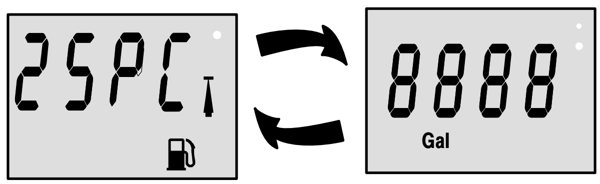


Selecting **"1"** will bring up the following calibration screens.

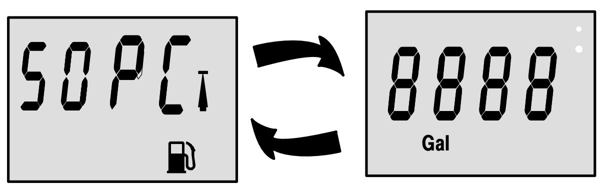
Calibration 0% – The "0 percent" display alternates between percent of tank capacity and quantity of fuel to add based on total capacity entered in *Cal2.* Add fuel to total quantity displayed and push the button to save. Press the MODE button to advance to the Calibration 25% setting.



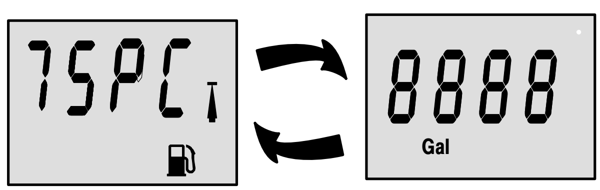
Calibration 25% – The "25 percent" display alternates between percent of tank capacity and quantity of fuel to add based on total capacity entered in *Cal2.* Add fuel to total quantity displayed and press the button to save. Press the MODE button to advance to the Calibration 50% setting.



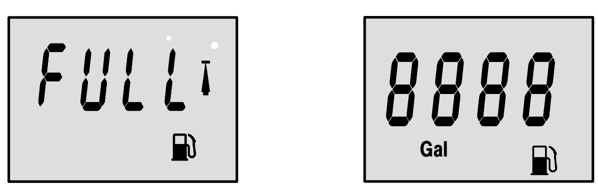
Calibration 50% – The "50 percent" display alternates between percent of tank capacity and quantity of fuel to add based on total capacity entered in *Cal2.* Add fuel to total quantity displayed and press the button to save. Press the MODE button to advance to the Calibration 75% setting.



Calibration 75% – The "75 percent" display alternates between percent of tank capacity and quantity of fuel to add based on total capacity entered in *Cal2.* Add fuel to total quantity displayed and press the button to save. Press the MODE button to advance to the Calibration FULL setting.

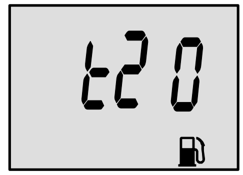


Calibration FULL – The "FULL percent" display alternates between percent of tank capacity and quantity of fuel to add based on total capacity entered in *Cal2.*

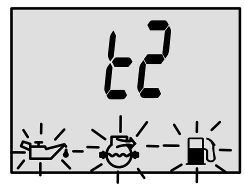


Add fuel to fill tank and press the button to save. Press the MODE button to move to the next function.

At this point you have completed tank 1 calibration and you will see **"t2"**.



Change **"t20"** to a 1 (on). Press the button, you will see a blinking tank icon. Using the button, select which tank you want tank 2 to be, (oil, fuel or water/waste). Press the MODE button to continue.



NOTE: *If you choose oil or water/waste, no further cal will be needed.*

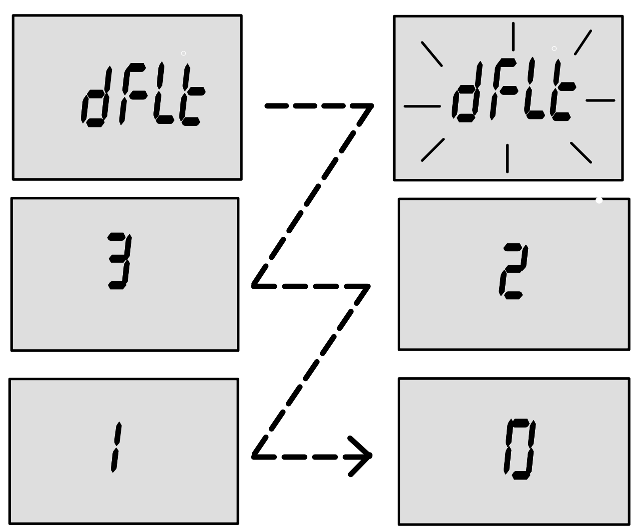
Repeat tank calibration procedure described on page 34 and 35 if calibration of the second tank is desired.

Master Reset Command

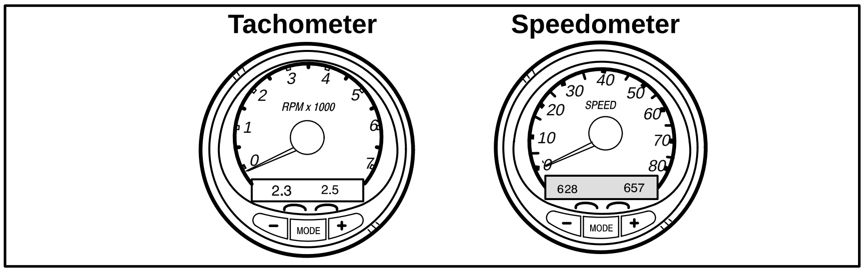
Master Reset: You can return the gauge back to factory presets through the Master Reset command.

IMPORTANT: Performing a master reset will reset the unit back to all factory defaults, thus eliminating any installation calibrations performed during set up of product.

1. Hold in MODE and for approximately 12 seconds. You will see the word **"dFLt"** let go of the buttons.
2. Immediately press and hold in MODE and again until the unit counts down to zero **"0"**.
3. The **"SEt"** message flashing on the screen indicates that the unit has been reset to factory defaults.



System Tach & Speed



Basic Operation and Features

Power up: Each gauge will power up when the ignition is turned on. Gauges will stay on as long as the ignition is on.

On first time power up of gauge or after a “Master Reset”, gauge will show “**Auto detect**”. Upon pressing the mode button, gauge will automatically determine engine type. This will preset the data monitoring screens accordingly. The intention is to make initial setup easier. If gauge shows a warning of “No Starboard Engine” or “Multiple Starboard Engines”, engine will need to be properly selected (Port and Stbd) using a Mercury engine diagnostic tool. “Master Reset” and “Auto detect” again. (See page 45 for “Master Reset”).

Lights: The brightness and contrast are adjustable.

Buttons: The MODE button is used for selecting information screens. The **“+”** and **“–”** buttons are used for setting engine speed during troll control and setting gauge calibrations.

Troll Control: Allows the operator to set and control the idle speed of the engine for trolling without using the throttle.

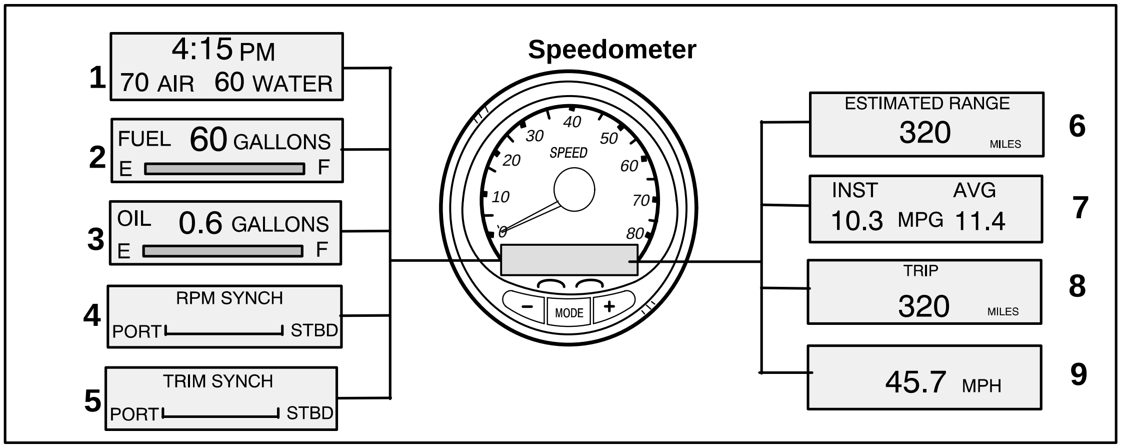
Engine Guardian System: Monitors the critical sensors on the engine for any early indications of problems. The system will respond to a problem by reducing engine speed in order to maintain a safe operating condition.

Warning System: The system will sound the warning horn and display the warning message.

Digital Display Screen: Displays the following engine information.

Tachometer Display Screen:	Speedometer Display Screen:
DEPENDING ON ENGINE TYPE	***DEPENDING ON ENGINE TYPE*** Speed
Engine Break–in	Fuel Used
Engine Temperature	COG/SOG – If GPS Input
Oil Psi	Distance and fuel to way point –
Trim and RPM	*if way point programmed into optional GPS*
Trim and Water Pressure	Clock – Air/Sea Temp
Water Pressure	Inst. and Ave. Fuel Economy
Battery Voltage and Engine Hours	Trip Odometer
Fuel Flow and Fuel Used	Fuel Tank Levels
RPM	Oil Tank Levels
	Fresh Water Tank2 or Level(s)
	Waste Water Level(s) or
	Dual Engine
	Trim and RPM Synchronizer –
	Fuel Range
	Fuel Economy
	Trip Odometer

Speedometer Display Screens



NOTE: NOT ALL SCREENS MAY APPLY TO YOUR ENGINE TYPE.

When the ignition is turned on, the speedometer will show the last screen that was displayed before the ignition was turned off.

Press MODE to change display screens. You can revert back to the previous screen by pressing and holding MODE for 2 seconds. This will reverse the display rotation.

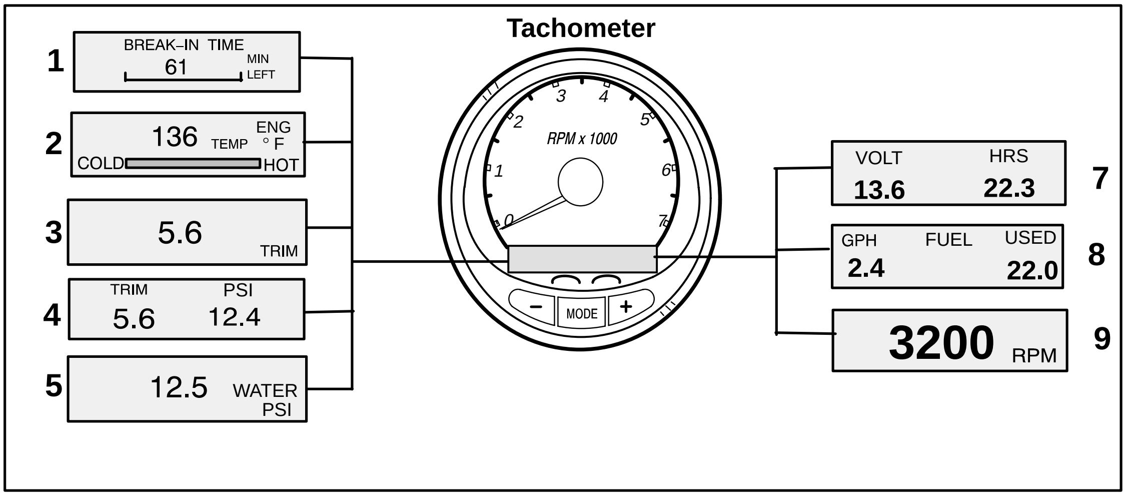
NOTE: *Readings can be displayed in English (U.S.) or Metric. Refer to Calibrations.*

NOTE: *Descriptions are necessarily in order on the gauge. Order changes depending on engine type.*

1. **Clock - Temp –** Clock, air temperature and water temperature. The air and water temperature sensors will have to be connected to obtain display readings.
2. **Fuel Level –** Displays the amount of fuel remaining.
3. **Oil Level –** Displays the amount of engine oil remaining, or water/waste tank level (if attached).
4. **RPM Synchronizer –** Dual Engines Only – Monitors the revolutions of both engines.
5. **Trim Synchronizer –** Dual Engines Only – Displays the trim position of both engines. Simplifies keeping trim levels equal.
6. **Traveling Range –** The estimated traveling range is based on boat speed, fuel consumption and fuel remaining in the tank. The numbers displayed indicates an estimate of the distance you can travel with the remaining fuel. Speed input required (Paddle Wheel, Pitot Pressure or GPS).
7. **Fuel Economy –** The display shows average **"AVG"** fuel consumption as well as Instantaneous **"INST"** fuel economy. The numbers displayed indicate miles per gallon "**MPG"** or kilometer per liter **"KM/L"**.

   Fuel Reset – To reset, select the display screen and press MODE and TROLL – buttons.
8. **Trip Odometer –** Tells how far you've gone since you last reset the gauge to zero. **Trip Reset** – To reset, select the display screen and press MODE and TROLL – buttons.
9. **Digital Speedometer –** Can display boat speed in miles per hour, kilometer per hour, or nautical miles per hour. The (LCD) digital speedometer will continue to increase even if **"StEt"** is at maximum. The speedometer will use the paddle wheel for its low speed readings but will switch to the speedo or GPS (if connected) for high speed readings. (Transition point setting described in Cal2, page 51.)

Tachometer Display Screens



NOTE: NOT ALL SCREENS MAY APPLY TO YOUR ENGINE TYPE.

When the ignition is turned on, the tachometer will display the last screen that was displayed before the ignition was turned off.

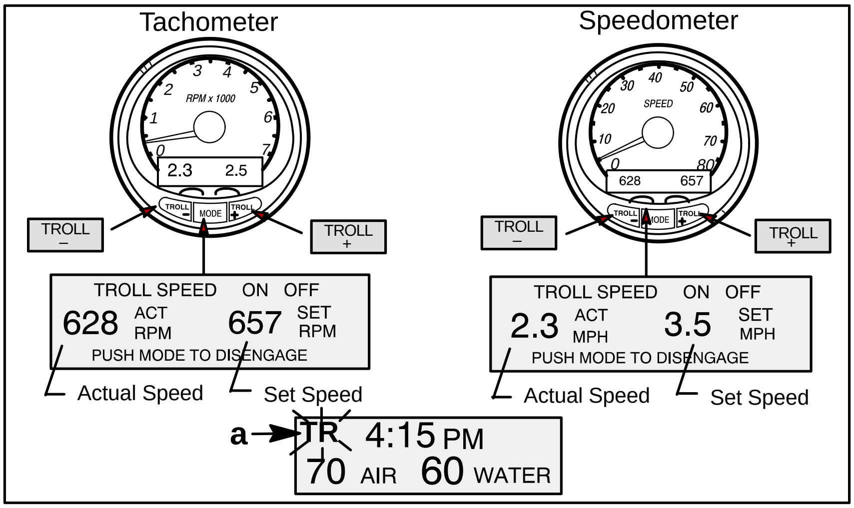
Press MODE to change display screens. You can revert back to the previous screen by pressing and holding MODE for 2 seconds. This will reverse the display rotation.

***NOTE:** Readings can be displayed in English (U.S.) or Metric. Refer to Calibration.*

1. **Engine Break-in –** Displays time remaining on the break-in period of a new engine. This screen will automatically disappear after the break-in period is complete.
2. **Temperature –** Displays engine coolant temperature from Cold to Hot.
3. **Power Trim Angle:** Displays trim angle of the outboard or sterndrive up to the maximum trim angle, and then displays the trailer angle. 0 = down, 10 = maximum trim, and 25 = full trailer.
4. **Power Trim Angle - Water Pressure –** Displays trim angle of the engine and cooling system water pressure.
5. **Water Pressure:** Displays cooling system water pressure at the engine.
6. **Oil Pressure (Not Shown Above) –** Displays engine oil pressure in units of Psi or Bar.
7. **Battery Voltage –** Displays voltage level (condition) of battery. Also records the running time of engine.
8. **Fuel Flow –** Displays engine fuel use in gallons per hour or liters per hours.
9. **Digital Tachometer:** Displays engine speed in Revolutions Per Minute (RPM).

Troll Control

BASIC OPERATION



With troll control you can maintain a trolling speed of 550 to1000 rpm without using the throttle.

NOTE: *Troll control may not be available on all engine models.*

NOTE: *Troll control min/max range may change depending on engine type.*

You can set the troll control by using either the tachometer or speedometer. Tachometer will set the speed in RPM and speedometer will set the speed in MPH, Kph or KN.

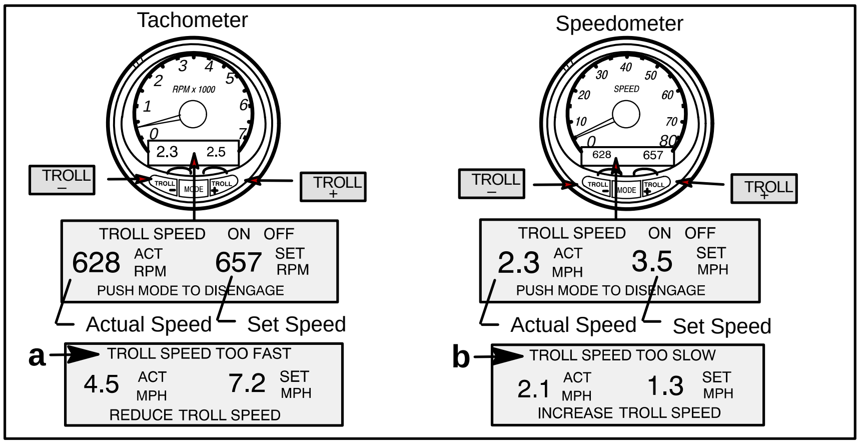
You can shut off troll control anytime by pushing the MODE button when in the troll display screen or by moving the throttle.

If you have troll control set at a desired speed and then you shut off the troll control, the system remembers the set speed and will return to that speed when re-engaged.

The display screen will revert back to the previous screen after 10 seconds of no activity. Push the TROLL + or TROLL – button to reactivate the display screen.

When the troll control is engaged and you are out of the troll control screen, a flashing signal **"TR"** (a) will appear in the upper left corner of the display to indicate troll control is still running.

SETTING TROLL CONTROL



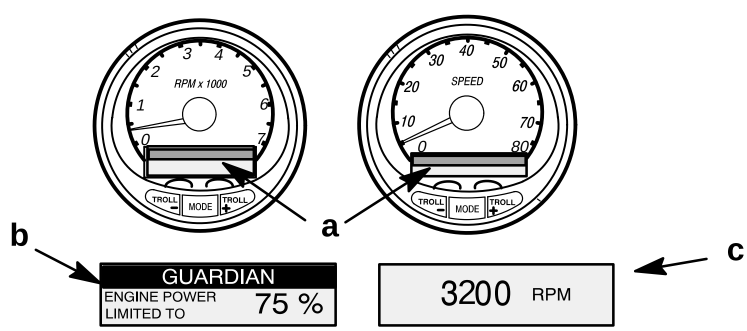
1. With the engine running, shift engine into gear. Set engine speed at idle.
2. Push in the [TROLL +] or [TROLL –] button to bring up the troll control display screen.
3. Press [MODE] to engage (turn on) the troll control.
4. Use the [TROLL +] [TROLL –] buttons to set the desired speed. Use **(+)** to increase speed and **(–)** to decrease speed.
5. If you set troll control to a higher speed than the troll rpm can bring the boat to, the **TARGET SPEED TOO FAST** (a) message will appear. Reduce troll speed.
6. If you set troll control to a slower speed than the troll rpm can bring the boat to, the **TARGET SPEED TOO SLOW** (b) message will appear. Increase troll speed.

EXITING TROLL CONTROL

There are three ways to turn off the troll control:

- Press the [MODE] button when in the troll display screen.
- Move the throttle to a different speed.
- Shift engine into neutral.

Warning System



NOTE: *Warnings may be different depending on engine type. Please consult your engines owners manual for a complete list of failures.*

The SmartCraft warning system incorporates the display screens (a) the warning horn and the Guardian Protection system. The warning horn is located inside the remote control or is part of the ignition key switch wiring harness.

- **Alarms Warnings –** When a problem is detected, the warning horn sounds and the name of the offending alarm appears on the display.
  If problem can cause immediate engine damage – the horn will sound continuously and the Engine Guardian System (b) will respond to the problem by limiting engine power. Immediately reduce throttle speed to idle and refer to the warning messages on the following pages that tell what to do.
  If problem will not cause immediate engine damage – The horn will sound but not continuously. Refer to the warning messages on the following pages that tell what to do.

  The alarm message will stay displayed until the mode button is pressed. If there are multiple alarms, these will cycle on the display at five-second intervals.
  If the mode button is pressed to a different screen, the flashing alarm signal **"AL"** (c) will appear in the upper right corner to indicate there still is a problem.
- **Engine Guardian System –** Monitors the critical sensors on the engine for any early indications of problems. The system will respond to a problem by reducing engine power in order to maintain a safe operating condition. The display screen will show the percent of power available.

Alarm Messages

These messages will appear and the horn will sound if there is a problem detected in one of the engine systems.

NOTE: *The warning system will alert the operator to the potential problems listed in the chart. Refer to the page listed for explanation of the problem and the correct action to take.*

PROBLEM	TACHOMETER DISPLAY	SPEEDOMETER DISPLAY	ENGINE GUARDIAN SYSTEM ACTIVATED	HORN ONLY
BATTERY *	●		●	
ENGINE DATA BUS	●			
FAULT – HORN	●			
FAULT – IGNITION	●			
FAULT – INJECTOR	●			
FAULT – OIL PUMP	●		●	
FAULT – SENSOR	●		●*	
FAULT – WATER TEMP	●			
LOW FUEL		●		
LOW OIL		●		
OIL TEMP	●			
OIL PSI	●			
OVERHEAT	●		●	
OVER SPEED	●			
PRESSURE	●		●	
RESERVE OIL	●		●	
WATER IN FUEL	●			
FLASH CHECK SUM				●
MAP				●
MAT				●
TPS				●

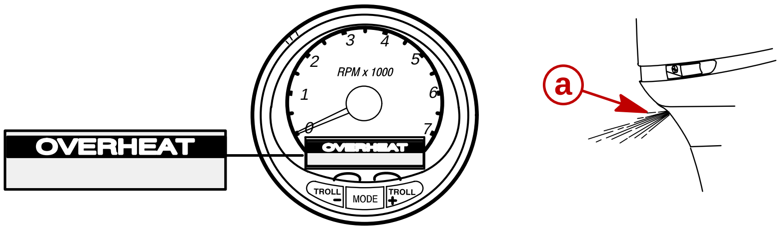
* Throttle and manifold pressure sensors only

OVERHEAT

The overheat alarm message appears and the warning horn begins sounding continuously. The Engine Guardian System will start limiting engine power.

If the engine overheats, immediately reduce throttle speed to idle. Shift engine into neutral. Check for an obstruction covering the water intake holes on the engine.

NOTE: *The throttle will have to be returned to idle to reset the system.*



a - Water Pump Indicator Hole

If no water is coming out of the water pump indicator hole or flow is intermittent, stop engine and check cooling water intake holes for obstruction. If no obstruction is found, this may indicate a blockage in the cooling system or a water pump problem. Operating the engine while overheated will cause engine damage.

If a steady stream of water is coming out of the water pump indicator hole and the warning horn continues to sound, there still may be insufficient cooling water or an engine problem. Operating the engine while overheated will cause engine damage.

NOTE: *If you are in a stranded situation, stopping the engine and allowing it to cool back down will usually allow some additional low speed (idle) running time before the engine starts to overheat again.*

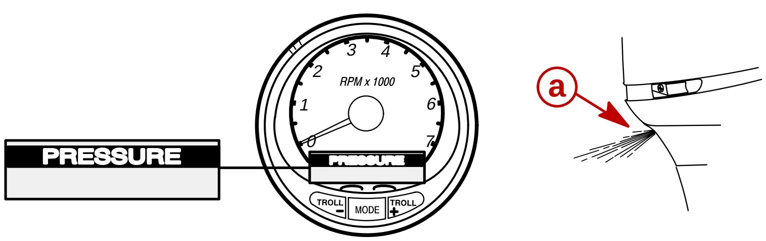
The overheat problem must be corrected before you can resume normal operation.

PRESSURE

This alarm message is displayed and the warning horn begins sounding continuously to inform the driver that there is insufficient water pressure in the cooling system. The Engine Guardian System will start limiting engine power.

Some causes of insufficient cooling water pressure are (1) obstructed cooling water intake holes (2) blockage in the cooling system or a water pump problem (3) running the engine with the cooling water intake holes out of the water.

NOTE: *The throttle will have to be returned to idle to reset the system.*



a - Water Pump Indicator Hole

If the warning system is activated, immediately reduce throttle speed to idle. Shift engine into neutral and check for a steady stream of water coming out of the water pump indicator hole.

If no water is coming out of the water pump indicator hole or flow is intermittent, stop engine and check cooling water intake holes for obstruction. If no obstruction is found, this may indicate a blockage in the cooling system or a water pump problem. Operating the engine without adequate cooling water pressure will overheat the engine.

If the warning signals stop and a steady stream of water is coming out of the water pump indicator hole, return engine to normal operation. If the warning system is activated repeatedly, have the outboard checked by your dealer.

OVERSPEED (a)

This message is displayed and the warning horn begins sounding continuously to inform the driver that the engine speed exceeded the maximum allowable RPM. The system will automatically reduce the engine speed to within the allowable limit.

NOTE: *Your 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*

WATER IN FUEL (b)

This message will appear and the warning horn will begin sounding a series of four beeps every two minutes when water in the water-separating fuel filter reaches the full level. Water can be removed from the filter. Refer to Maintenance Section for filter removal.

FAULT-HORN (c)

This message informs you that the warning horn is not functioning correctly.

RESERVE OIL LOW – 2 STROKE OUTBOARD ONLY (d)

This message is displayed and the warning horn begins sounding a series of four beeps every two minutes to inform the driver that the oil level is critically low in the engine mounted oil reservoir tank. When the oil level gets close to empty, the horn begins sounding continuously and the Engine Guardian System will start limiting engine power. The display shows percent of reserve oil that's remaining.

The engine mounted oil reservoir tank along with the remote oil tank will have to be refilled (Refer to Fuel & Oil Section).

FAULT-OIL PUMP (e)

This message is displayed and the warning horn begins sounding continuously to inform the driver that the oil pump has stopped functioning electrically. No lubricating oil is being supplied to the engine. Stop the engine as soon as possible. The Engine Guardian system will start limiting the engine power.

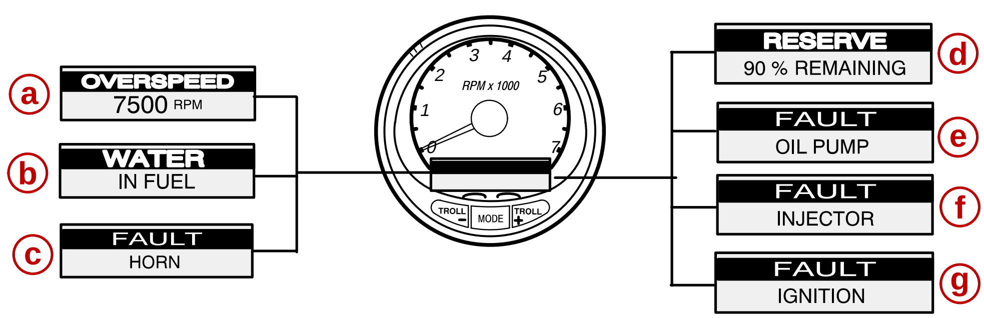
NOTE: *The throttle will have to be returned to idle to reset the system.*

FAULT-INJECTOR (f)

This alarm informs you if one or more of the fuel injectors have stop functioning electrically.

FAULT-IGNITION (g)

This alarm informs you that a problem has developed in the ignition system.



BATTERY (a)

When the electrical system is not charging, or the battery charge is low, the warning message is designed to come on and the Engine Guardian System will start limiting engine power. If the message appears immediately after starting, it is possible that the engine alternator can recharge the battery after operating awhile. If this message appears while driving or comes on after starting and continues to be displayed, check engine to determine the cause of the problem and to avoid being stranded with a dead battery. To help the alternator recharge the battery quickly, reduce the load on the electrical system by turning off any unneeded accessories.

NOTE: *The throttle will have to be returned to idle to reset the system.*

ENGINE DATA BUS (b)

This message tells you that the data communication link between the tachometer and engine is not connected.

LOW FUEL LEVEL (c)

This message serves as a warning that the fuel level in the fuel tank is critically low. You should stop for fuel immediately to avoid running out.

LOW OIL LEVEL – OUTBOARD 2 STROKE ONLY (d)

This message serves as a warning that the oil level in the remote oil tank is low. You should stop and refill the oil tank immediately to avoid running out.

FAULT-SENSOR (e)

This message informs you if one of the sensors is not functioning correctly

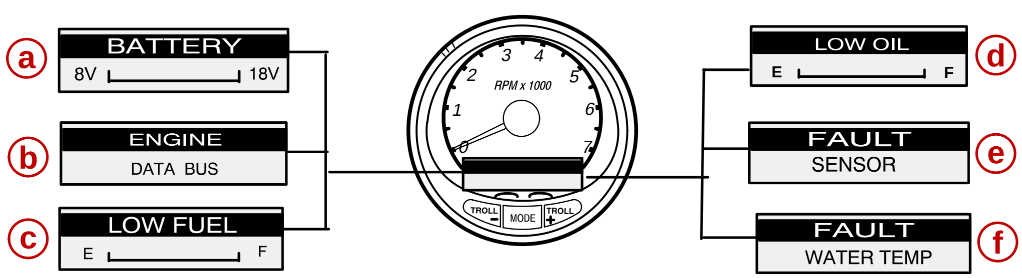
If the throttle sensor has failed, the warning horn will sound a continuous beeping and the engine will not reach its full power.

If the throttle sensor and manifold pressure sensor both fail, the warning horn will sound a continuous beeping and the engine speed will stay at idle.

If the temperature or block pressure sensor should fail, the Engine Guardian System will limit the maximum engine power to 75 percent.

FAULT-WATER TEMP (f)

This message informs you that the sensor for measuring outside lake/sea water temperature is not functioning correctly.



WARNING NO STARBOARD ENGINE (a)

Informs you that the Instrument does not see the starboard engine computer. Usually indicates that no data is being transferred from the engine's computer to the gauge. (Check wiring, also make sure both terminator resistors are installed in the bus). Make sure both ECM's are not configured for port location using a DDT or Quicksilver Diagnostic Tool.

WARNING MULTIPLE STARBOARD ENGINE (b)

Informs you that the instruments are recognizing multiple engines as starboard.

In multiple engine applications, each engine must first be assigned a position (starboard, port, starboard2 or port2) with a Quicksilver Diagnostic Tool before the system will function properly.

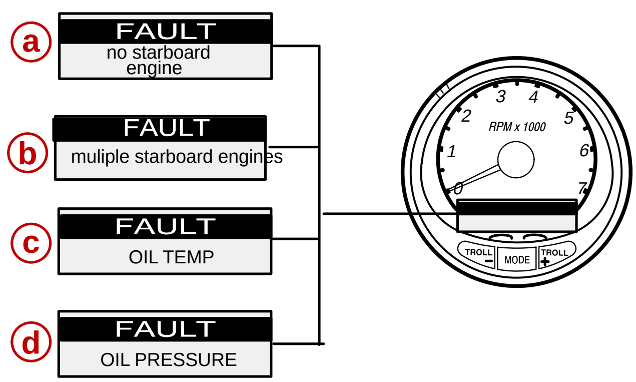
If you have a dual engine application, you must first program the port engine with a Quicksilver Diagnostic Tool.

OIL TEMPERATURE (c)

This overheat alarm message appears and the warning horn begins sounding continuously. The Engine Guardian System will start limiting engine power.

OIL PRESSURE (d)

This alarm message is displayed and the warning horn begins sounding continuously to inform the driver that there is insufficient oil pressure.



Auto-Detection Engine Function

AUTO–DETECTION ENGINE FUNCTION – System tach and speed come standard with the **"Engine Auto–detection Screen"** this screen lets the gauge on its initial power up automatically detect which engine type you are using and preconfigure the gauge to match that vessel type.

Master Reset Command

MASTER RESET – By pressing [TROLL –] and [TROLL +] simultaneously for approximately 10 seconds (Until the graphic bars "collide"). You will be able to restore the unit back to factory presets.

WARNING: After a master reset all previously saved data will be lost (example: calibrations, clock settings, and trip logs).

Tachometer Calibration

Quick Cal – This calibration for setting lighting and contrast.

1. Press in the MODE and TROLL + buttons for up to 2 seconds to get to Quick Cal screen.
2. Press MODE to advance through the lighting and contrast sections.

Cal1 – This calibration level lets you turn on and off the system screens. You may configure the system to display as little or as much information as you prefer.

1. Press in the MODE and TROLL + buttons and hold for approximately 7 seconds until you see the calibration1 (*Cal1*) screen.
2. Press MODE to advance through the calibration selections.

Cal2 – This calibration level lets you configure the system sensor inputs.

1. Press in the MODE and TROLL + buttons and hold for approximately 10 seconds for calibration2 (*Cal2*) screen.
2. Press MODE to advance through the calibration selections.

TACH CALIBRATION – CAL 1 LEVEL

1. Press in the MODE and TROLL + buttons and hold for approximately 7 seconds until you see the calibration1 (*Cal1*) screen.
2. Press MODE to advance through the calibration selections.

REMOTE SCREENS? [NO] [SAVE] [YES]	If yes is selected, then screen changes made on this SC1000 tach will effect any other SC1000 tach in the system. ***NOTE:*** *all tach will need to have this screen turned to “Yes” for this function to work.*
REMOTE LCD LIGHT? [NO] [SAVE] [YES]	If yes is selected, then lighting levels made on this SC1000 tach will effect any other SC1000 tach in the system. ***NOTE:*** *all tach will need to have this screen turned to “Yes” for this function to work.*
REMOTE LCD CONTRAST? [NO] [SAVE] [YES]	If yes is selected, then contrast levels made on this SC1000 tach will effect any other SC1000 tach in the system. ***NOTE:*** *all tach will need to have this screen turned to “Yes” for this function to work.*
TRIM POPUP? [NO] [SAVE] [YES]	Do you want power trim display screen to pop up momentarily when you trim the engine?

CALIBRATION TRIM CALIBRATION [SKIP] [EDIT] TRIM FULL DOWN THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE] TRIM FULL UP THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE] TRIM TO TRAILER POINT THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE]	Choosing edit allows you to calibrate the gauge to the standard 0–10 unit trim and 11–25 trailer position scale.
DISPLAY UNITS [DOWN] [SAVE] [UP]	Lets you change units of measure between English (standard) or Metric.
SPEED UNITS [DOWN] [SAVE] [UP]	Lets you select speed units. You can choose from MPH (Miles Per Hour), KN (Nautical Miles Per Hour) or KMH (Kilometers Per Hour).
DEPTH SCREEN? [NO] [SAVE] [YES]	Do you want to turn on the depth screen? (Remember: You must have a Smart Craft depth transducer connected to the system for this screen to operate)
ENGINE TEMP SCREEN? [NO] [SAVE] [YES]	Do you want to turn on the engine temp screen?
OIL TEMP SCREEN? [NO] [SAVE] [YES]	Do you want to turn on the oil temp screen?
OIL PRESS SCREEN? [NO] [SAVE] [YES]	Do you want to turn on the oil pressure screen?
TRIM AND PSI SCREEN? [NO] [SAVE] [YES]	Do you want to turn on the trim and water pressure split screen?

WATER PSI SCREEN? [NO] [SAVE] [YES]	Do you want to turn on the water pressure screen?
TRIM AND RPM SCREEN? [NO] [SAVE] [YES]	Do you want to turn on the trim and RPM split screen?
RPM SCREEN? [NO] [SAVE] [YES]	Do you want to turn on the digital RPM screen?
SIMULATOR MODE? [NO] [SAVE] [YES]	Do you want to turn on a simulation mode? (used for demonstration purposes).
EXIT? [NO] [SAVE] [CAL2]	Do you want to exit calibration? Or jump straight into calibration level 2?
EXTERNAL SENSORS [SKIP] [EDIT]	This section lets you enable or disable the following external sensor inputs.
PITOT SENSOR? [NO] [SAVE] [YES]	Is the boat equipped with a pitot sensor to measure boat speed?
PADDLE SENSOR? [NO] [SAVE] [YES]	Is the boat equipped with a paddle wheel to measure boat speed?
TRIM SENSOR? [NO] [SAVE] [YES]	Is the boat equipped with a trim sensor?
SEA TEMP? [NO] [SAVE] [YES]	Is the boat equipped with a water temperature sensor?
INVERT STEERING [NO] [SAVE] [YES]	Is steering angle showing up on the link gauge opposite the direction that it should be? If it is then this feature will reverse the signal so it is displayed properly.

TACH CALIBRATION – CAL 2 LEVEL

SPEED OPTION [SKIP] [EDIT]	This section lets you configure the following speed sensors.
PITOT SENSOR? [NO] [SAVE] [YES]	Select pitot transducer type. You can choose 100 or 200 PSI. (100 PSI is the most common)
PITOT SENSOR MULTIPLIER [DOWN] [SAVE] [UP]	Adjust the pitot pressure sensor for correcting display readings that are to high/low.
PADDLE SENSOR PULSE FACTOR [DOWN] [SAVE] [UP]	Adjust paddle wheel frequency for display readings that are to high/low.
PADDLE TO PITOT TRANSITION [DOWN] [SAVE] [UP]	Set the speed at which the gauge stops looking at the paddle wheel and starts using pitot to measure boat speed.

There are three methods for calibrating System Tach fuel tank level monitoring feature:

First: Do nothing. Linear readout based on raw sensor values. This mode does not factor in irregular tank shapes.

Second: By following the tank calibration procedure described on pages 33–35, but without actually adding fuel. Calibrate fuel tank by pressing the **”dEFLt”** button. System Tach will supply an estimated range value based on linear interpolation of the sensor range values. This mode does not factor in irregular tank shapes.

Third: By following the tank calibration procedure described on pages 33–35 completely System Tach will display an estimated range value that factors in the tank shape.

FUEL TANK CAPACITY [DOWN] [SAVE] [UP]	Lets you enter the capacity of your boats fuel tank. This option is the same for tank 1 as it is for tank 2.
CALIBRATION FUEL TANK [SKIP] [EDIT]	Lets you enter the mode where you can calibrate your fuel tank. Fuel tank calibration procedure is the same for tank 1 as it is for tank 2.
FILL TO 1/4 THEN PRESS PLUS BUTTON [DFLT] [SKIP] [SAVE]	You can choose to have tank at 1/4 and hit SAVE, or hit DFLT and a default value will be entered based on the capacity of the tank.

FILL TO 1/2 THEN PRESS PLUS BUTTON [DFLT] [SKIP] [SAVE]	You can choose to have tank at 1/2 and hit SAVE, or hit DFLT and a default value will be entered based on the capacity of the tank.
FILL TO 3/4 THEN PRESS PLUS BUTTON [DFLT] [SKIP] [SAVE]	You can choose to have tank at 3/4 and hit SAVE, or hit DFLT and a default value will be entered based on the capacity of the tank.
FILL TO FULL THEN PRESS PLUS BUTTON [DFLT] [SKIP] [SAVE]	You can choose to have tank at full and hit SAVE, or hit DFLT and a default value will be entered based on the capacity of the tank.
DEPTH SENSOR OFFSET [DOWN] [SAVE] [UP]	Lets you electronically configure a depth offset. Entering a negative number gives you a water line offset. A positive number gives you a keel offset.
DEPTH ALARM [DOWN] [SAVE] [UP]	Lets you enter a depth value. When the depth transducer reads that value or below, the shallow water alarm will sound.
EMPTY TANK THEN PRESS PLUS BUTTON [DFLT] [SKIP] [SAVE]	You can choose to have an empty tank and hit SAVE, or hit DFLT and a default value will be entered based on the capacity of the tank.

Speedometer Calibration

Quick Cal – This calibration for setting lighting and contrast.

1. Press in the MODE and TROLL + buttons for up to 2 seconds to get to Quick Cal screen.
2. Press MODE to advance through the lighting and contrast sections.

Cal1 – This calibration level lets you turn on and off the system screens. You may configure the system to display as little or as much information as you prefer.

1. Press in the MODE and TROLL + buttons and hold for approximately 7 seconds until you see the calibration1 (*Cal1*) screen.
2. Press MODE to advance through the calibration selections.

Cal2 – This calibration level lets you configure the system sensor inputs.

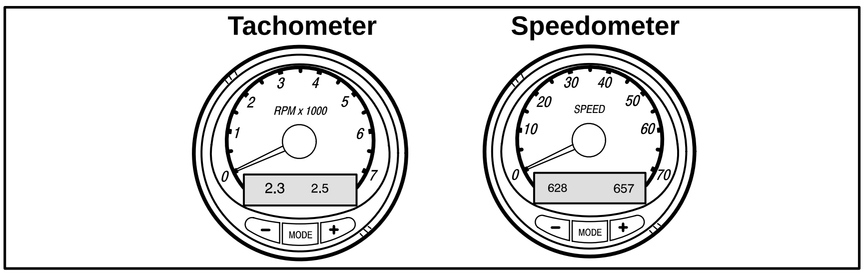
1. Press in the MODE and TROLL + buttons and hold for approximately 10 seconds for calibration2 (*Cal2*) screen.
2. Press MODE to advance through the calibration selections.

SPEEDOMETER CALIBRATION CAL 1 LEVEL

Display	Description
REMOTE LCD LIGHT? [NO] [SAVE] [YES]	Enables you to set the lighting levels on all the SC1000 simultaneously from this gauge.
REMOTE LCD CONTRAST? [NO] [SAVE] [YES]	Enables you to control the contrast from another System TACH/ Speed simultaneously from this gauge.
TIME [NO] [SKIP] [EDIT]	Allows you to set the time.
TIME FORMAT [DOWN] [SAVE] [UP]	Choose between a 12 hour and 24 hour format.
USE GPS TIME? [DOWN] [SAVE] [UP]	If you have a GPS connected this feature enables the gauge to let the GPS update the gauges internal clock.
CALIBRATION HOUR 12:00 AM [DOWN] [SAVE] [UP]	Adjust the gauges internal clock to match your local time. First set the hours then press MODE button to set the minutes.
DISPLAY UNITS [DOWN] [SAVE] [UP]	Lets you change units of measurement between English (standard) or Metric.
SPEED UNITS [DOWN] [SAVE] [UP]	Lets you select the units at which speed is displayed. You can choose from MPH (Miles Per Hour), KTS (Knots), or KMH (Kilometers Per Hour).
TO WAY POINT SCREEN? [NO] [SAVE] [YES]	If you have a GPS connected you can turn on the screen that shows your distance and fuel to a way point.
SIMULATOR MODE? [NO] [SAVE] [YES]	Do you want to turn on a simulation mode? (Used for demonstration purposes).
EXIT? [NO] [YES] [CAL2]	Do you want to exit calibration? Or jump straight into calibration level 2?
EXTERNAL SENSORS [SKIP] [EDIT]	This lets you enable or disable external sensor inputs.

AIR TEMP? [NO] [SAVE] [YES]	Are you using a air temp. sensor?
GPS? [NO] [SAVE] [YES]	Do you have a GPS sensor installed?
USE GPS SPEED? [NO] [SAVE] [YES]	Use the GPS input to drive the speed display?
WATER TEMPERATURE ADJUST [DOWN] [SAVE] [UP]	Adjust water temp. transducer to match actual sea water temperature.

SmartCraft Gauge Operation



Basic Operation and Features

Power up: Each gauge will power up when the ignition is turned on. Gauges will stay on as long as the ignition is on.

Lights: The brightness and contrast are adjustable. Refer to Gauge Calibration following.

Buttons: The MODE button is used for selecting information screens. The + and – buttons are used for setting engine speed during troll control and setting gauge calibrations.

Troll Control: Allows the operator to set and control the idle speed of the engine for trolling without using the throttle.

Engine Guardian System: Monitors the critical sensors on the engine for any early indications of problems. The system will respond to a problem by reducing engine speed in order to maintain a safe operating condition.

Warning System – System will sound the warning horn and display warning message.

Gauge Calibrations

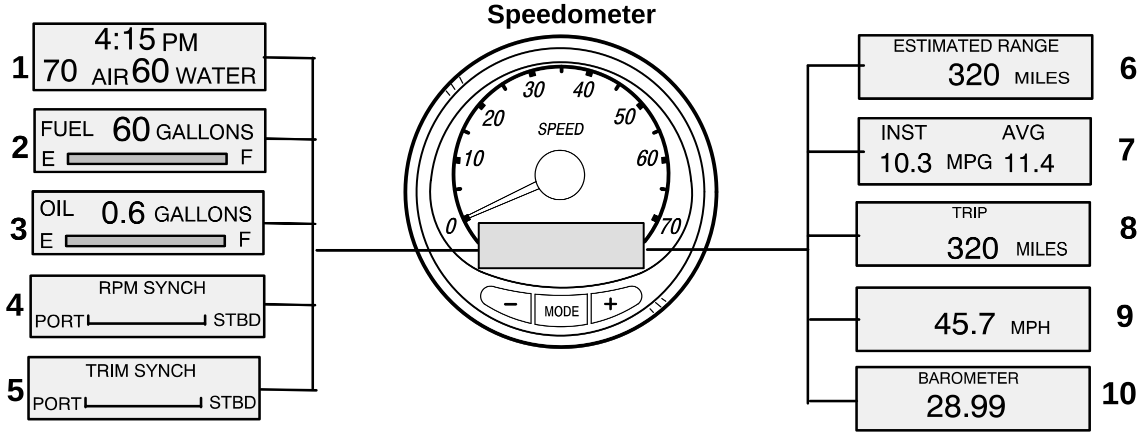
Digital Display Screen: Displays the following engine information.

Tachometer Display Screen:
Digital Tachometer
Hour Meter
Power Trim Angle
Fuel Flow
Engine Temperature
Battery Voltage
Water Pressure

Speedometer Display Screen:
Clock and Temperature
Fuel Tank Level(s)
Oil Tank Level(s)
Fuel Economy
Fuel Range
Trip Odometer
Digital Speedometer
Barometer Reading

Speedometer Display Screen

Speedometer



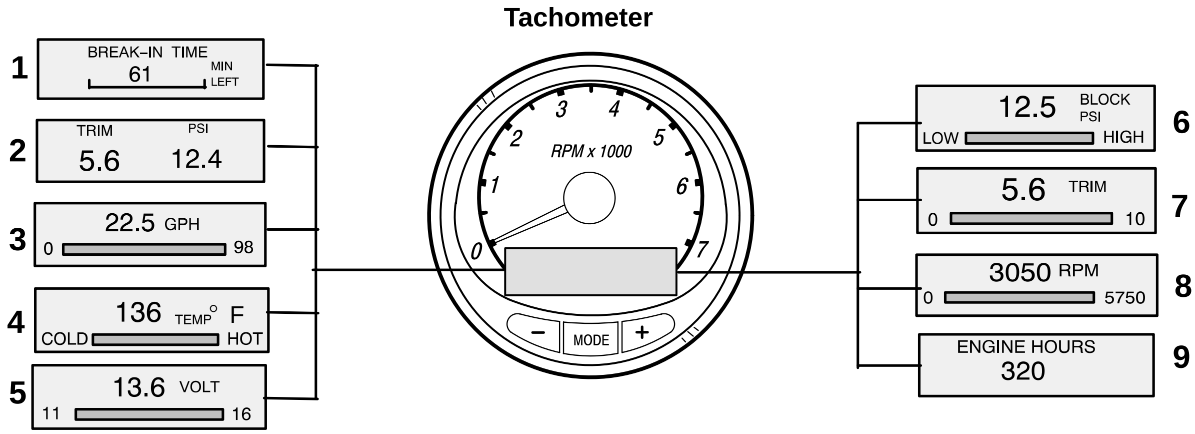
When the ignition is turned on, the speedometer will show the last screen that was displayed before the ignition was turned off.

NOTE: *Readings can be displayed in English or Metric. Refer to Calibration.*

Press MODE to change display screens. You can revert back to the previous screen by pressing and holding MODE for 2 seconds. This will reverse the display rotation.

1. **Clock - Temp** – Clock, air temperature and water temperature. The air and water temperature sensors will have to be connected to obtain display readings.
2. **Fuel Level –** Displays the amount of fuel remaining.
3. **Oil Level –** Displays the amount of engine oil remaining.
4. **RPM Synchronizer –** Dual Engines – Monitors the revolutions of both engines. Allows throttle adjustments to keep each running uniformly.
5. **Trim Synchronizer –** Dual Engines – Displays the trim position of both engines. Simplifies keeping trim levels equal.
6. **Traveling Range:** The estimated traveling range is based on current fuel consumption and fuel remaining in the tank .The numbers displayed indicates an estimate of the distance you can travel with the remaining fuel.
7. **Fuel Economy –** The display shows average **"AVG"** fuel consumption as well as instantaneous **"INST"** fuel economy. The numbers displayed indicate miles per gallon "**MPG"** or kilometer per liter **"KM/L"**. **Reset** – To reset, select the display screen and press MODE and TROLL – buttons.
8. **Trip Odometer:** Tells how far you've gone since you last set the gauge to zero. **Trip Reset** – To reset, select the display screen and press MODE and TROLL – buttons.
9. **Digital Speedometer:** Can display boat speed in miles per hours, Kilometers per hour, or knots. The digital speedometer will continue to increase even if needle is at maximum. The speedometer will use the paddle wheel for its low speed readings but will switch to the speedo or GPS (if connected) for high speed readings.
10. **Barometer:** Shows the barometer pressure reading only at the time the ignition was turned on.

Tachometer Display Screens



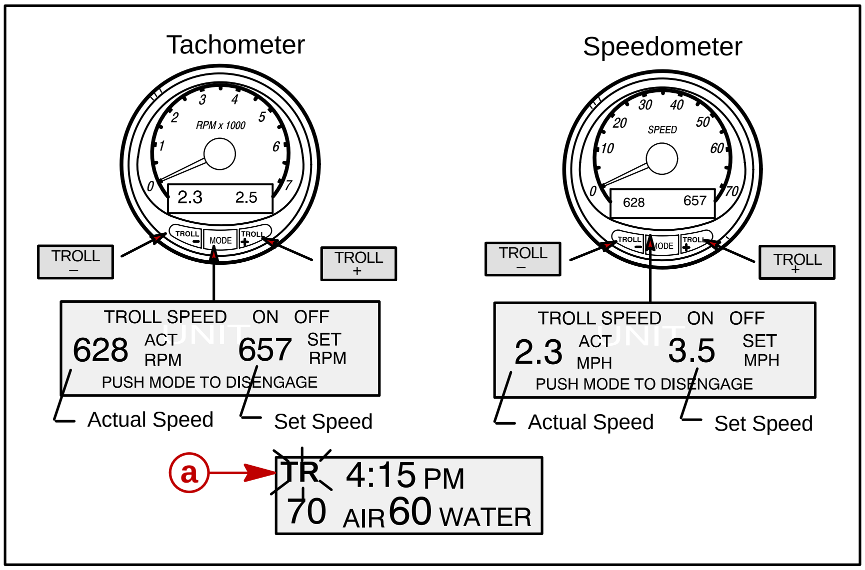
When the ignition is turned on, the tachometer will display the last screen that was displayed before the ignition was turned off.

Press MODE to change display screens. You can revert back to the previous screen by pressing and holding MODE for 2 seconds. This will reverse the display rotation.

NOTE: *Readings can be displayed in English or Metric. Refer to Calibration.*

1. **Engine Break in –** Displays time remaining on the break-in period of a new engine. This screen will automatically disappear after the break-in period is complete.
2. **Power Trim Angle - Water Pressure –** Displays trim angle of the outboard and cooling system water pressure.
3. **Fuel Flow –** Displays engine fuel use.
4. **Temperature –** Displays engine coolant temperature from Cold to Hot
5. **Battery Voltage –** Displays voltage level (condition) of battery
6. **Water Pressure:** Displays cooling system water pressure at the engine.
7. **Power Trim Angle:** Displays trim angle of the outboard up to the maximum trim angle, and than displays the trailer angle. 0 = DOWN; 10 = FULL TRIM; and 25 = FULL TRAILER.
8. **Digital Tachometer:** Displays engine speed in Revolutions Per Minute (RPM)
9. **Hour Meter:** Records the running time of the engine

Troll Control



BASIC OPERATION

With Troll control you can maintain a trolling speed of 450 to1000 rpm without using the throttle.

You can set the trolling control by using either the tachometer or speedometer. Tachometer will set the speed in RPM and speedometer will set the speed in MPH.

You can shut off troll control anytime by pushing the MODE button when in the troll display screen or moving the throttle.

If you have troll control set at a desired speed and then you shut off the troll control, the system remembers the set speed and will return to that speed when re-engaged.

The display screen will revert back to the previous screen after 10 seconds of no activity. Push the TROLL + or TROLL – button to reactivate the display screen.

When the troll control is engaged and you are out of the troll control screen, a flashing signal “TR” (a) will appear in the upper left corner of the display to tell you troll control is still running.

TO SET TROLL CONTROL

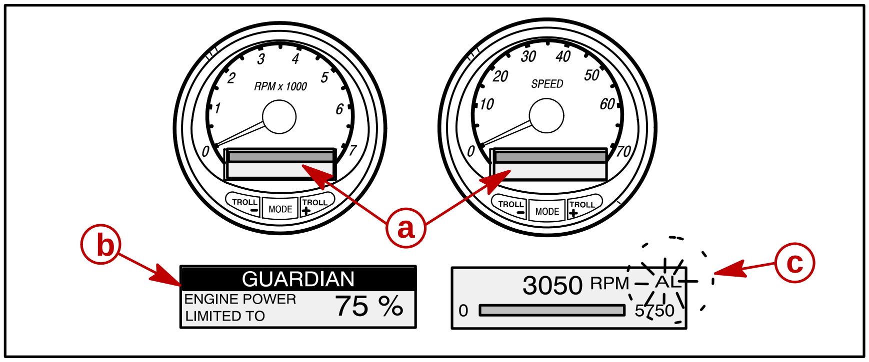
1. With the engine running, shift outboard into gear. Set engine speed at idle.
2. Push in the TROLL + or TROLL – button to bring up the troll control display screen.
3. Press MODE to engage (turn on) the troll control.
4. Use the TROLL + TROLL – buttons to set the desired speed. Use **(+)** to increase speed and **(–)** to decrease speed.
5. If you set troll control to a higher speed than the troll rpm can bring the boat to, the **TARGET SPEED TOO FAST** message will appear. Reduce troll speed.
6. If you set troll control to a slower speed than the troll rpm can bring the boat to, the **TARGET SPEED TOO SLOW** message will appear. Increase troll speed.

EXITING TROLL CONTROL

There are three ways to turn off the troll control:

- Press the MODE button when in the troll display screen.
- Move the throttle to a different speed.
- Shift outboard into neutral.

Warning System



The SmartCraft warning system incorporates the display screens (a) the warning horn and the Guardian Protection system. The warning horn is located inside the remote control or is part of the ignition key switch wiring harness.

- **Alarms Warnings –** When a problem is detected, the warning horn sounds and the name of the offending alarm appears on the display.
  If problem can cause immediate engine damage – the horn will sound continuously and the Engine Guardian System (b) will respond to the problem by limiting engine power. Immediately reduce throttle speed to idle and refer to the warning messages on the following pages that will tells you what to do about it.
  If problem will not cause immediate engine damage – The horn will sound but not continuous.
  The alarm message will stay displayed until the mode button is pressed. If there are multiple alarms, these will cycle on the display at five second intervals.
  If the mode button is pressed to a different screen, the flashing alarm signal “AL” (c) will appear in the upper right corner to indicate there still a problem.
- **Engine Guardian System –** Monitors the critical sensors on the engine for any early indications of problems. The system will respond to a problem by reducing engine power in order to maintain a safe operating condition. The display screen will show the percent of power loss.

Alarm Messages

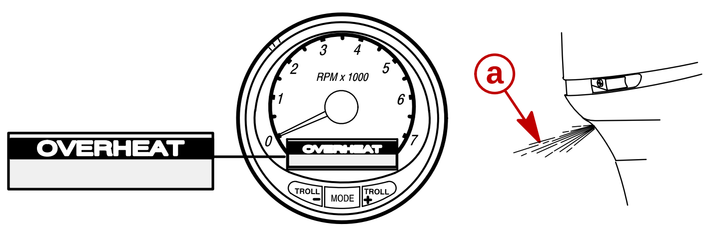
These messages will appear and the horn will sound if there is a problem detected in one of the outboard systems.

NOTE: *The warning system will alert the operator to the potential problems listed in the chart. Refer to explanations following.*

PROBLEM	TACHOMETER DISPLAY	SPEEDOMETER DISPLAY	ENGINE GUARDIAN SYSTEM ACTIVATED
BATTERY *	●		●
ENGINE DATA BUS		●	
FAULT – HORN	●		
FAULT – IGNITION	●		
FAULT – INJECTOR	●		
FAULT – OIL PUMP	●		●
FAULT – SENSOR	●		●*
FAULT – SPEEDO	●		
FAULT – WATER TEMP	●		
LOW FUEL		●	
LOW OIL		●	
OVERHEAT	●		●
OVER SPEED	●		
PRESSURE	●		●
RESERVE OIL	●		●
UNIT MISMATCH (MULTI ENGINE)	●		
WATER IN FUEL	●		

* Throttle and manifold pressure sensors only

OVERHEAT



a - Water Pump Indicator Hole

The overheat alarm message appears and the warning horn begins sounding continuously. The Engine Guardian System will start limiting engine power.

If the engine overheats, immediately reduce throttle speed to idle. Shift outboard into neutral and check for a steady stream of water coming out of the water pump indicator hole.

NOTE: *The throttle will have to be returned to idle to reset the system.*

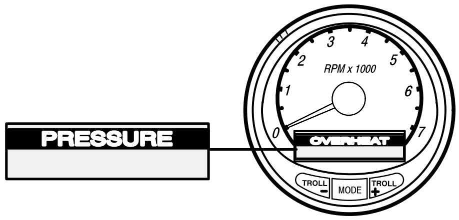
If no water is coming out of the water pump indicator hole or flow is intermittent, stop engine and check cooling water intake holes for obstruction. If no obstruction is found, this may indicate a blockage in the cooling system or a water pump problem. Operating the engine while overheated will cause engine damage.

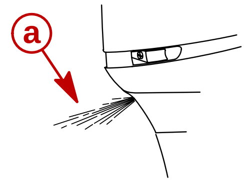
If a steady stream of water is coming out of the water pump indicator hole and the warning horn continues to sound, there still may be insufficient cooling water or an engine problem. Stop engine. Operating the engine while overheated will cause engine damage.

NOTE: *If you are in a stranded situation, stopping the engine and allowing it to cool back down will usually allow some additional low speed (idle) running time before the engine starts to overheat again.*

The overheat problem must be corrected before you can resume normal operation.

PRESSURE





a - Water Pump Indicator Hole

This alarm message is displayed and the warning horn begins sounding continuously to inform the driver that there is insufficient water pressure in the cooling system. The Engine Guardian System will start limiting engine power.

Some causes of insufficient cooling water pressure are (1) obstructed cooling water intake holes (2) blockage in the cooling system or a water pump problem (3) running the outboard with the cooling water intake holes out of the water.

NOTE: *The throttle will have to be returned to idle to reset the system.*

If the warning system is activated, immediately reduce throttle speed to idle. Shift outboard into neutral and check for a steady stream of water coming out of the water pump indicator hole.

If no water is coming out of the water pump indicator hole or flow is intermittent, stop engine and check cooling water intake holes for obstruction. If no obstruction is found, this may indicate a blockage in the cooling system or a water pump problem. Stop engine. Operating the engine without adequate cooling water pressure will overheat the engine.

If the warning signals stop and a steady stream of water is coming out of the water pump indicator hole, return engine to normal operation.

OVERSPEED (a)

This message is displayed and the warning horn begins sounding continuously to inform the driver that the engine speed has exceeded the maximum allowable RPM. The system will automatically reduce the engine speed to within the allowable limit.

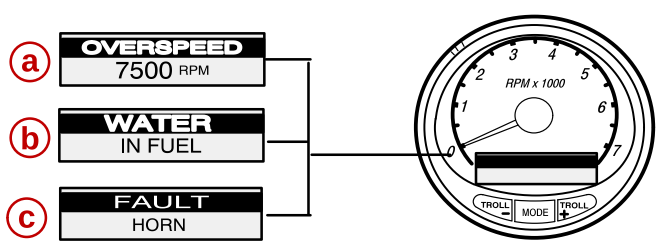
NOTE: *Your engine speed should never reach the maximum limit to activate the system unless the propeller is ventilating, an incorrect propeller is being used, or the propeller is faulty.*

WATER IN FUEL (b)

This message will appear and the warning horn will begin sounding a series of four beeps every two minutes when water in the water separating fuel filter reaches the full level. The water can be removed from the filter.

FAULT-HORN (c)

This message informs you that warning horn is not functioning correctly.



RESERVE OIL LOW (a)

This message will appear and the warning horn will begin sounding a series of four beeps every two minutes to inform the driver that the oil level is critically low in the engine mounted oil reservoir tank. When the oil level gets close to empty, the horn begins sounding continuously and the Engine Guardian System will start limiting engine power. The display shows percent of reserve oil that's remaining.

The engine mounted oil reservoir tank along with the remote oil tank will have to be refilled.

FAULT-OIL PUMP (b)

This message is displayed and the warning horn begins sounding continuously to inform the driver that the oil pump has stopped functioning electrically. No lubricating oil is being supplied to the engine. Stop the engine as soon as possible. The Engine Guardian system will start limiting the engine power.

NOTE: *The throttle will have to be returned to idle to reset the system.*

FAULT-INJECTOR (c)

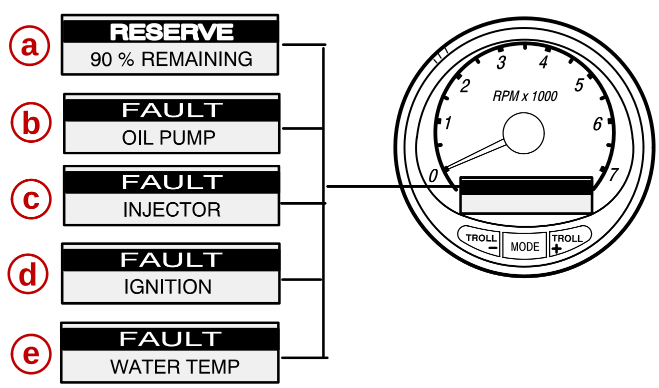
This alarm informs you if one or more of the fuel injectors have stopped functioning electrically.

FAULT-IGNITION (d)

This alarm informs you that a problem has developed in the ignition system.

FAULT-WATER TEMP (e)

This message informs you that the sensor (located in the paddle wheel) for measuring outside lake/sea water temperature is not functioning. Two possible things to check for are 1, Check the wiring going to the paddle wheel. 2, If the paddle wheel is not being used or If only one paddle wheel is used for duel engine setup, edit the corresponding tachometer calibration to delete the water temp sensor.



BATTERY (a)

The warning message is designed to come on and the Engine Guardian System will start limiting engine power when the electrical system is not charging or the battery charge is low. If the message appears immediately after starting, it is possible that the engine alternator can recharge the battery after operating awhile. If this message appears while driving or comes on after starting and continued to be displayed, the electrical system must be checked to determine the cause of the problem to avoid being stranded with a dead battery. To help the alternator recharge the battery quickly, you can reduce the load on the electrical system by turning off any unneeded accessories.

NOTE: *The throttle will have to be returned to idle to reset the system.*

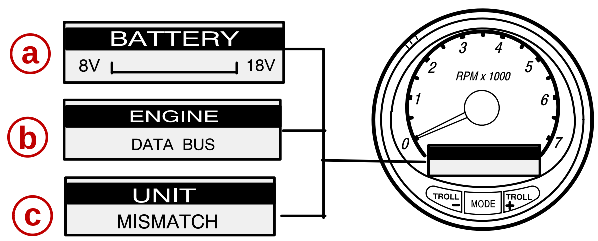
ENGINE DATA BUS (b)

This message tells you the data communication link between the tachometer and engine is not connected. Check for disconnected wires. Be sure the gray and brown/white wires are connected to the diagnostic port plug on the engine. See SmartCraft Gauge Wiring.

UNIT MISMATCH (c)

(Multi Engines) This message tells you that the tachometers are not calibrated alike. (For example, this could happen if one tachometer readings are in English and the another is in Metric. Re-calibrate the tachometers.

NOTE: *When calibrating multi tachometers, have all the tachometers powered up at the same time while calibrating.*



LOW FUEL LEVEL (d)

This message tells you that the fuel level in the fuel tank is critically low. Stop for fuel immediately to avoid running out. The engine must be shut off to reset the warning system.

LOW OIL LEVEL (e)

This message tells you that the oil level in the remote oil tank is low. Stop and refill the oil tank immediately to avoid running out. The engine must be shut off to reset the warning system.

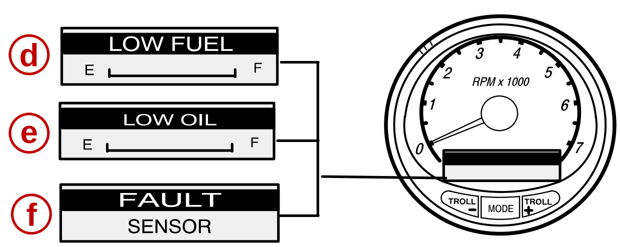
FAULT-SENSOR (f)

This message informs you if one of the sensors is not functioning correctly.

If the throttle sensor has failed, the warning horn will sound a continuous beeping and the engine will not reach its full power.

If the throttle sensor and manifold pressure sensor both fail, the warning horn will sound a continuous beeping and the engine speed will stay at idle.

If the temperature or block pressure sensor should fail, the Engine Guardian System will limit the maximum engine power by 25 percent.



Tachometer Calibration

NOTE: *When calibrating multi tachometers (multi engines) turn ignition on for all the tachometers.*

Simple Calibration – This calibration for setting lighting and a few other common screens can be made while engine is running.

1. Press in the MODE and TROLL + buttons for calibration screen.
2. Press MODE to advance through the calibration selections.

Advanced Calibration – This calibration goes through the entire mode selections.

1. Turn ignition key to the off position.
2. Hold TROLL + TROLL – and turn ignition on.
3. Press and hold MODE for 2 seconds to bring up the calibration screen.
4. Press MODE to advance through the calibration selections.

CALIBRATION BRIGHTNESS [DOWN] [SAVE] [UP]	**Press – or +** to adjust level. **Press MODE** to save setting
CALIBRATION BRIGHTNESS SET ALL INSTRUMENTS? [NO] [YES]	Do you want the same brightness level for all SmartCraft gauges? **Press +** for yes. **Press MODE** for no.
CALIBRATION CONTRAST [DOWN] [SAVE] [UP]	**Press – or +** to adjust level. **Press MODE** to save setting
CALIBRATION CONTRAST SET ALL INSTRUMENTS? [NO] [YES]	Do you want the same contrast level for all SmartCraft gauges? **Press +** for yes. **Press MODE** for no.
CALIBRATION CONTROL OPTIONS REMOTE SCREEN ? YES – NO [DOWN] [SAVE] [UP]	Multi Engine – Do you want tachometer display screens to advance together? **Press + or –** to select. **Press MODE** to save.
CALIBRATION CONTROL OPTIONS TRIM POP UP ? YES – NO [DOWN] [SAVE] [UP]	Do you want power trim angle display screen to pop up whenever you trim the outboard ? **Press + or –** to select. **Press MODE** to save.
CALIBRATION ENGINE POSITION SINGLE-PORT-CENTER-STARBOARD [DOWN] [SAVE] [UP]	Match tachometer to the correct engine. **Press +** to select engine. **Press MODE** to save.
CALIBRATION DISPLAY UNITS ENGLISH - METRIC [DOWN] [SAVE] [UP]	Select display readings in English or Metric. **Press + or –** to select **Press MODE** to save.

Display	Description
CALIBRATION SPEED UNITS KN - KPH - MPH [DOWN] [SAVE] [UP]	Display boat speed in KN (knots), KPH (kilometers per hour), MPH (miles per hour). **Press + or –** to select setting. **Press MODE** to save.
CALIBRATION EXTERNAL SENSORS [SKIP] [EDIT] CALIBRATION EXTERNAL SENSORS SPEEDO SENSOR ? YES/NO [DOWN] [SAVE] [UP] CALIBRATION EXTERNAL SENSORS PADDLE WHEEL SENSOR ? YES/NO [DOWN] [SAVE] [UP] CALIBRATION EXTERNAL SENSORS WATER TEMP SENSOR ? YES/NO [DOWN] [SAVE] [UP]	**Press MODE** to skip to the next display. **Press +** (edit) if your adding or deleting any external sensor to the SmartCraft System. *Editing External Sensors* Add <u>Yes or No</u> for each sensor No = not used Yes = in use **Press + or –** for correct setting **Press MODE** to save and advance to next sensor
CALIBRATION FUEL TANK CAPACITY CAPACITY = XX.XX [DOWN] [SAVE] [UP]	Add the capacity of the fuel tank. **Press + or –** to select. **Press MODE** to save.
CALIBRATION FUEL TANK CALIBRATION [SKIP] [EDIT] CALIBRATING EMPTY TANK THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE] CALIBRATING 1/4 VALUE FILL TO X.X G. THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE] CALIBRATING 1/2 VALUE FILL TO X.X G. THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE] CALIBRATING 3/4 VALUE FILL TO X.X G. THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE] CALIBRATING FULL FILL TANK TO FULL THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE]	This calibration sets the fuel level of the tank. *NOTE: If the fuel tank is not calibrated, fuel range cannot be displayed* **Press MODE** to skip to the next display. **Press +** (edit) to calibrate the fuel tank. *Pressing DFLT (default) during edit will return to original value setting* Calibrate the fuel tank as follows: 1. Empty the fuel tank, **Press +** to save 2. Fill tank to 1/4 full, **Press +** to save. 3. Fill tank to 1/2 full, **Press +** to save 4. Fill tank to 3/4 full, **Press +** to save. 5. Fill tank to full, **Press +** to save. The fuel tank is now calibrated

CALIBRATION OIL TANK CAPACITY CAPACITY = XX.XX [DOWN] [SAVE] [UP]	Add the capacity of the oil tank. **Press + or –** to select. **Press MODE** to save.
CALIBRATION OIL TANK CALIBRATION [SKIP] [EDIT] CALIBRATING EMPTY TANK THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE] CALIBRATING 1/4 VALUE FILL TO X.X G. THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE] CALIBRATING 1/2 VALUE FILL TO X.X G. THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE] CALIBRATING 3/4 VALUE FILL TO X.X G. THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE] CALIBRATING FULL FILL TANK TO FULL THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE]	This calibration accurately adjusts the oil level sending unit in the oil tank. **Press MODE** to skip to the next display. **Press +** (edit) to calibrate the oil tank. *Pressing DFLT (default) during edit will return to original value setting* Calibrate the oil tank as follows: 1. Empty the oil tank, **Press +** to save 2. Fill tank to 1/4 full, **Press +** to save. 3. Fill tank to 1/2 full, **Press +** to save 4. Fill tank to 3/4 full, **Press +** to save. 5. Fill tank to full, **Press +** to save. The oil tank is now calibrated
CALIBRATION SPEED SENSORS [SKIP] [EDIT] CALIBRATION PITOT SENSOR MULTIPLIER 1.00 [DOWN] [SAVE] [UP] CALIBRATION PADDLE WHEEL SENSOR MULTIPLIER 1.00 [DOWN] [SAVE] [UP]	If the speedometer is not reading correctly, the speed sensors can be re-calibrated to correct the setting. **Press MODE** to skip to the next display. **Press +** (edit) to calibrate the sensors. Increasing or decreasing the multiplier will increase or decrease the speed reading **Press – or +** for changing setting. **Press MODE** to save.

CALIBRATION TRIM CALIBRATION [SKIP] [EDIT] CALIBRATION TRIM FULL UP THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE] CALIBRATION TRIM TO TRAILER POINT THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE] CALIBRATION TRIM FULL UP THEN PRESS PLUS (+) BUTTON [DFLT] [SKIP] [SAVE]	If the trim setting is not reading correctly, the trim sensor can be re-calibrated to correct the setting. *Pressing DFLT (default) during edit will return to original value setting* **Press MODE** to skip to the next display. **Press +** (edit) to calibrate the sensor. 1. Trim outboard full up, than **Press +** to save. 2. Trim outboard to the point where the trim cylinders takes over, than **Press +** to save. 3. Trim outboard full down, than **Press +** to save.
CALIBRATION EXIT ? [NO] [YES]	Do you want to exit the calibration mode? **Press +** for yes. **Press MODE** for no.

Speedometer Calibration

Simple Calibration – This calibration for setting lighting and setting the clock can be made while engine is running.

1. Press in the MODE and TROLL + buttons for calibration screen.
2. Press MODE to advance through the calibration selections.

Advanced Calibration – This calibration goes through the entire mode selections.

1. Turn ignition key to the off position.
2. Hold TROLL + TROLL – and turn ignition key to the on position.
3. Press and hold MODE for 2 seconds to bring up the calibration screen.
4. Press MODE to advance through the calibration selections.

CALIBRATION BRIGHTNESS [DOWN] [SAVE] [UP]	**Press – or +** to adjust level. **Press MODE** to save setting
CALIBRATION BRIGHTNESS SET ALL INSTRUMENTS? [NO] [YES]	Do you want the same brightness level for all SmartCraft gauges? **Press +** for yes. **Press MODE** for no.
CALIBRATION CONTRAST [DOWN] [SAVE] [UP]	**Press – or +** to adjust level. **Press MODE** to save setting
CALIBRATION CONTRAST SET ALL INSTRUMENTS? [NO] [YES]	Do you want the same contrast level for all SmartCraft gauges? **Press +** for yes. **Press MODE** for no.

CALIBRATION
TIME
[SKIP] [EDIT]

If the clock display is correct , press **MODE** to skip.
To set or reset the clock **Press +**

CALIBRATION
TIME FORMAT
12H – M,D,Y, or 24H – D,M,Y
[DOWN] [SAVE] [UP]

Select 12 hour or 24 hour clock set.
Press – or + to select. Press **MODE** to save.

CALIBRATION
NMEA
ENABLE or DISABLE
[DOWN] [SAVE] [UP]

Press – or + to enable or disable GPS time calibration. If a GPS navigation receiver is connected to the gauges, NMEA data will set the time automatically. **Press MODE** to save.

CALIBRATION
UTC ZONE
UTC CORRECTION = X H
[DOWN] [SAVE] [UP]

Press – or + to add UTC correction. **MODE** to save. (Hour off-set from universal time constant)

CALIBRATION HOUR
4:15 PM
[DOWN] [SAVE] [UP]

Press **–** or **+** to set the hour
Press **MODE** to save.

CALIBRATION MINUTE
4:15 PM
[DOWN] [SAVE] [UP]

Press **–** or **+** to set the minute
Press **MODE** to save.

CALIBRATION
EXTERNAL SENSORS
[SKIP] [EDIT]

Press MODE to skip to the next display. **Press +** (edit) if your adding or deleting any external sensor to the SmartCraft Sys-tem.

Editing External Sensors
Chose Yes or No for each sensor
No = not used Yes = in use
Press + or – for correct setting
Press MODE to save and advance to next sensor

CALIBRATION
EXTERNAL SENSORS
AIR SENSOR SENSOR ? YES/NO
[DOWN] [SAVE] [UP]

CALIBRATION
EXTERNAL SENSORS
GPS CONNECTED ? YES/NO
[DOWN] [SAVE] [UP]

If YES was saved

CALIBRATION
EXTERNAL SENSORS
USE GPS SPEED ? YES/NO
[DOWN] [SAVE] [UP]

Chose Yes or No if you want the speedometer to read GPS speed

---

CALIBRATION
EXIT ?
[NO] [YES]

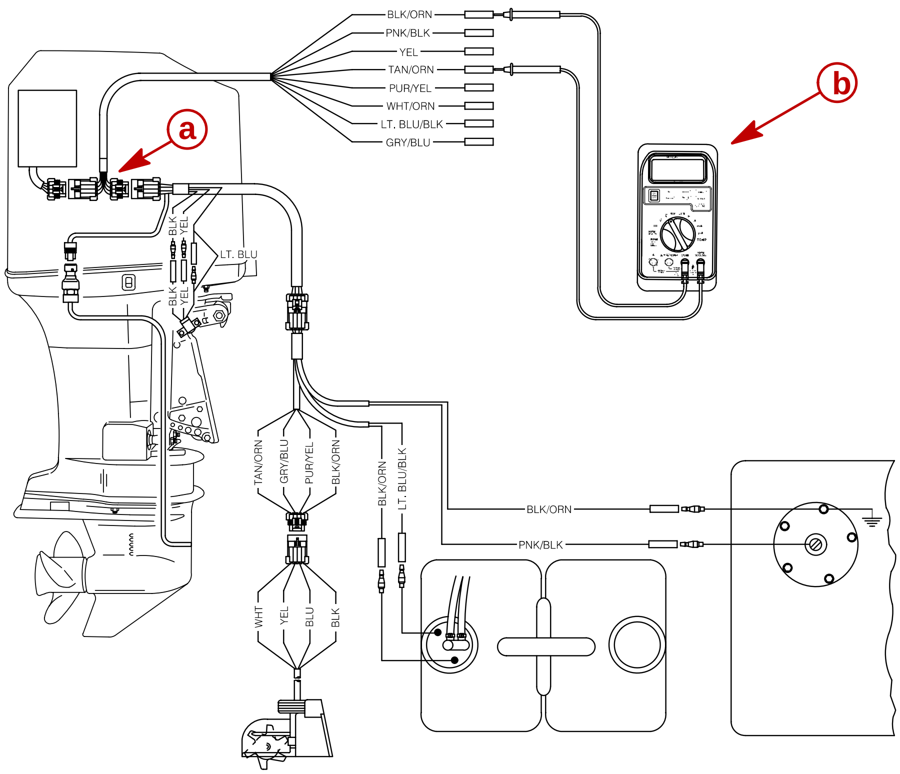
Do you want to exit the calibration mode? **Press +** for yes.
Press MODE for no.

SmartCraft Gauge Test Specifications

Test Equipment Required:

1. Test Harness 84-875233A2 (a).
2. DMT 2000 Digital Tachometer Multimeter 91-854009A1 (b).

***NOTE:** Connect negative DMT lead to BLACK/ORANGE lead on test harness 84-875233A2 for all tests. Use positive DMT lead on all other test harness leads to determine if individual sensors are within specifications.*



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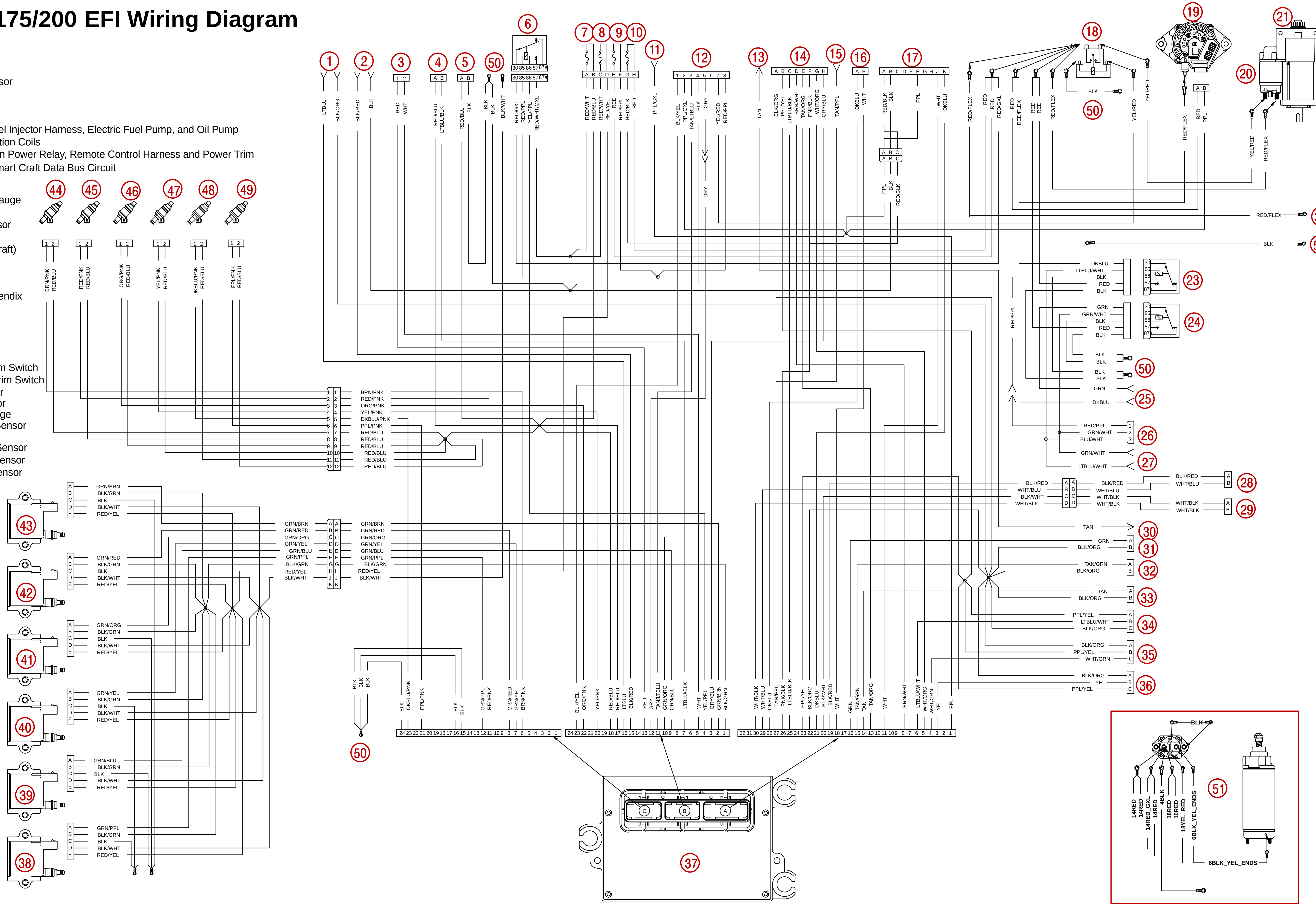
SENSOR	RED TEST LEAD	BLACK TEST LEAD	RANGE
Trim	Yellow	Black/Orange	2.7 vdc UP – 0.6 vdc DOWN
Fuel Sender	Pink/Black	Black/Orange	0.65 vdc FULL – 2.92 vdc EMPTY
Lake Temperature	Tan/Orange	Black/Orange	2.5 vdc @ room temp. (Voltage decreases as temperature increases)
+5 vdc Sensor Power	Purple/Yellow	Black/Orange	4.9 vdc – 5.1 vdc
Pitot Pressure	White/Orange	Black/Orange	0.5 vdc static (voltage increases with pressure)
Oil Sender	Light Blue/Black	Black/Orange	0.63 vdc FULL – 2.89 vdc EMPTY
Paddle Wheel Frequency	Gray/Blue	Black/Orange	Set meter to Hz and spin paddle wheel or set meter to AC volts and spin paddle wheel. Hz or AC volts should increase as wheel spins faster.

150/175/200 EFI Wiring Diagram

1 - Low Oil Switch
2 - Shift Switch
3 - Crank Position Sensor
4 - Oil Pump
5 - Fuel Pump
6 - Main Power Relay
7 - 20 Amp Fuse – Fuel Injector Harness, Electric Fuel Pump, and Oil Pump
8 - 20 Amp Fuse – Ignition Coils
9 - 20 Amp Fuse – Main Power Relay, Remote Control Harness and Power Trim
10 - 15 Amp Fuse – Smart Craft Data Bus Circuit
11 - Accessory Power
12 - Remote Control
13 - To Temp Analog Gauge
14 - Boat Harness
15 - Water In Fuel Sensor
16 - DDT Terminal
17 - Data Bus (SmartCraft)
18 - Slave Solenoid
19 - 60 Amp Alternator
20 - Starter Solenoid
21 - Solenoid Driven Bendix Starter
22 - To 12V Battery
23 - Trim Up Relay
24 - Trim Down Relay
25 - Trim Pump
26 - Cowl Mounted Trim Switch
27 - Remote Control Trim Switch
28 - Port Knock Sensor
29 - Stbd Knock Sensor
30 - Temp Sensor Gauge
31 - Port Head Temp Sensor
32 - Air Temp Sensor
33 - Stbd Head Temp Sensor
34 - Throttle Position Sensor
35 - Block Pressure Sensor
36 - MAP Sensor
37 - ECM
38 - #6 Ignition Coil
39 - #5 Ignition Coil
40 - #4 Ignition Coil
41 - #3 Ignition Coil
42 - #2 Ignition Coil
43 - #1 Ignition Coil
44 - #1 Fuel Injector
45 - #2 Fuel Injector
46 - #3 Fuel Injector
47 - #4 Fuel Injector
48 - #5 Fuel Injector
49 - #6 Fuel Injector
50 - To Ground
51 - Early Production Centrifugal Bendix Starter
52 - 12V Battery Negative Lead



FUEL SYSTEM

Section 3A - Fuel Pump

Table of Contents

3
A

Specifications

Fuel Pump Pressure @ W.O.T.

Maximum – 10 psi (68.5 kPa)
Normal – 8-10 psi (41.0 – 54.8 kPa)
Minimum – 3 psi (20.5 kPa)

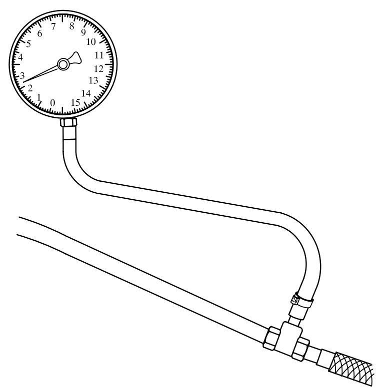
Fuel Pump Pressure @ Idle

Normal – 2-3 psi (13.7 – 20.5 kPa)
Minimum – 1 psi (6.8 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 Gauge (0–15 psi) (Obtain Locally)



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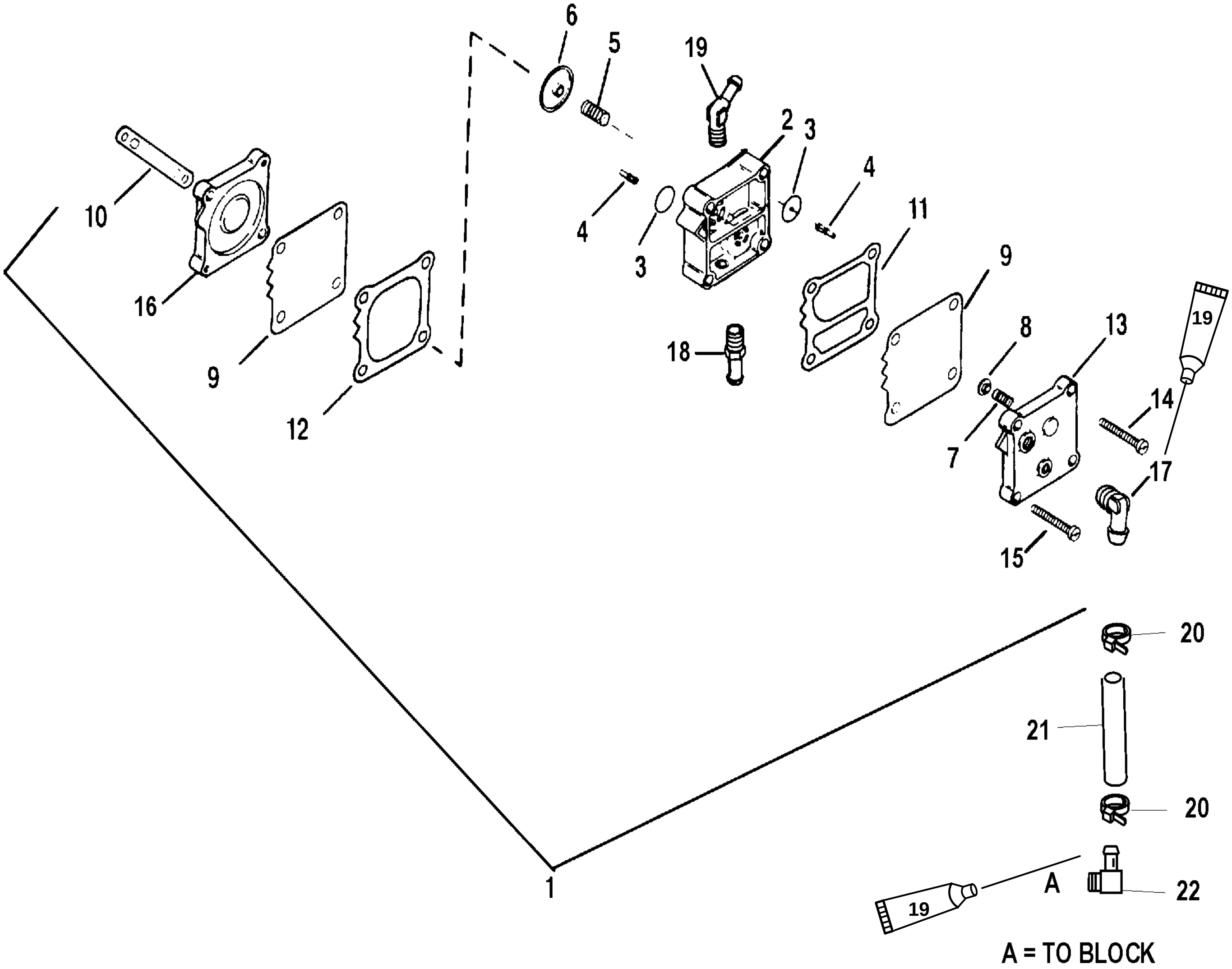
2. Vacuum Gauge (0 – 10 inches of vacuum mercury). Obtain Locally

Notes:

Fuel Pump Assembly



19 Perfect Seal (92-34227-1)

Fuel Pump Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	FUEL PUMP ASSEMBLY			
2	1	BODY–FUEL PUMP			
3	2	CHECK VALVE			
4	2	RETAINER			
5	1	SPRING			
6	1	CAP			
7	1	SPRING			
8	1	CAP			
9	2	DIAPHRAGM			
10	1	GASKET			
11	1	GASKET-BOOST			
12	1	GASKET-PULSE			
13	1	PLATE			
14	2	SCREW–FUEL PUMP (M5 x 40)	55		6.0
15	2	SCREW–PUMP TO CRANKCASE (M6 x 50)	55		6.0
16	1	BASE			
17	1	ELBOW			
18	1	FITTING			
19	1	ELBOW (45 DEGREE)			
20	2	STA STRAP			
21	1	TUBING (6 IN.)			
22	1	ELBOW			

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 air 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(EFI models) or carburetors.

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

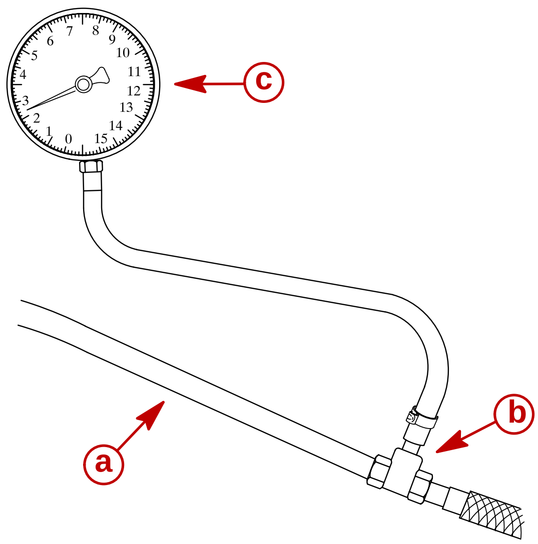
Since any type of anti-siphon device must be located between the outboard fuel inlet and fuel tank outlet, a simple method of checking [if such a device (or bad fuel) is a problem source] is to operate the outboard with a separate fuel supply which is known to be good, such as a remote fuel tank.

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.



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

Vacuum Test Troubleshooting

Before proceeding with the system vacuum test, confirm that the pulse fuel pump is capable of supplying the required vacuum. To do this, start the engine, pinch off/restrict the fuel supply hose between the vacuum gauge and fuel tank. The vacuum gauge should rise to or exceed the maximum normal reading of 2.5 inches vacuum (mercury). If it fails to reach this minimum number, the pump needs servicing or there is a lack of crankcase pressure to operate the pump.

Normal Reading	Below 2.5 in. of vacuum (mercury)

Reading above 2.5 in. of vacuum (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

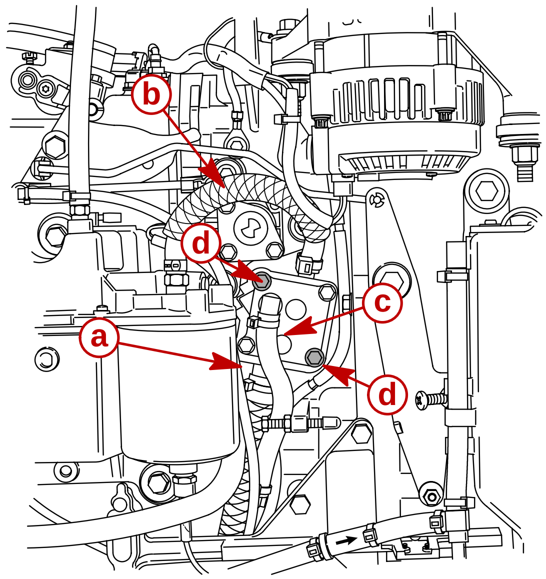
Testing Fuel Pump

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.

1. Disconnect fuel hoses from fuel pump.
2. Disconnect pulse hose.
3. Remove two mounting screws.
4. Remove fuel pump from engine.



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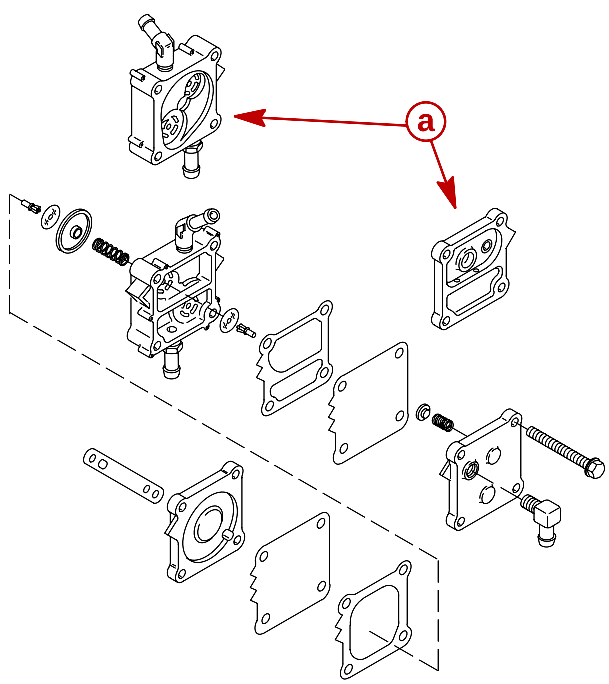
a - Fuel Inlet
b - Fuel hose from fuel pump to Fuel/Water Separator
c - Pulse hose
d - Mounting screws

5. Disassemble fuel pump.



58876

a - Reverse View of Pump Body

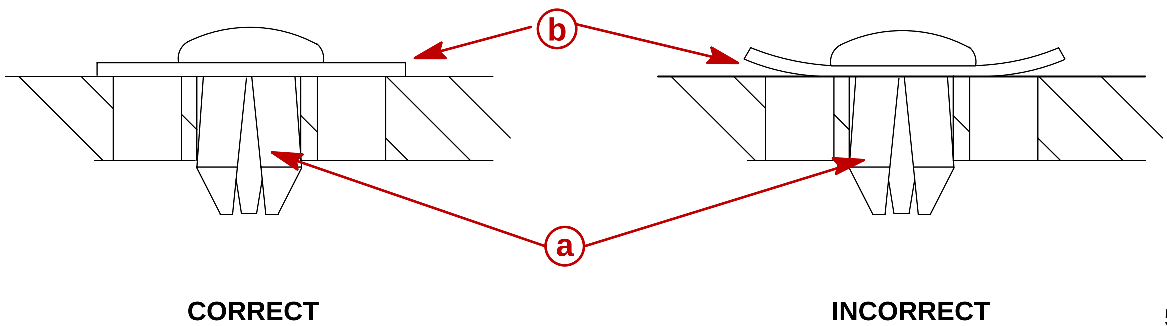
Cleaning/Inspection

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 or chips.
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

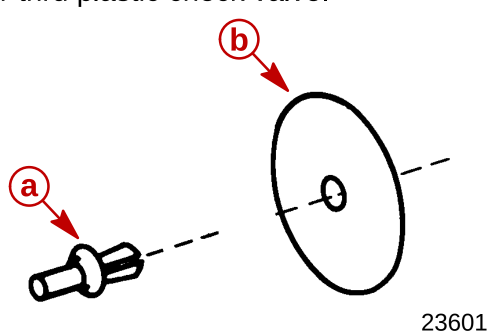
ASSEMBLY

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.*



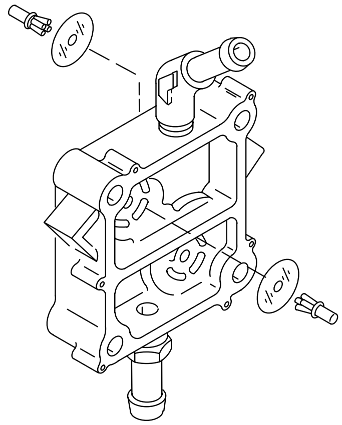
a - Check Valve Retainer
b - Check Valve (Plastic)

1. Insert retainer thru plastic check valve.



a - Retainer
b - Plastic Check Valve

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



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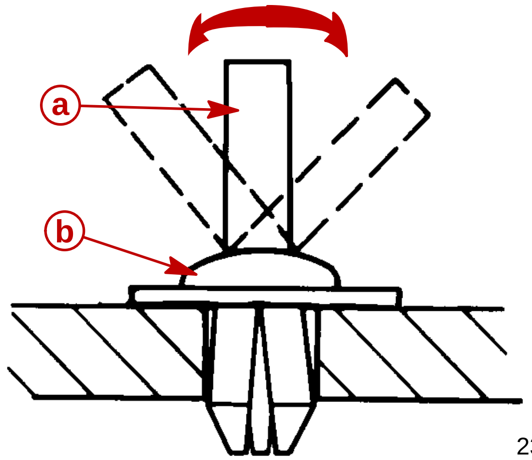
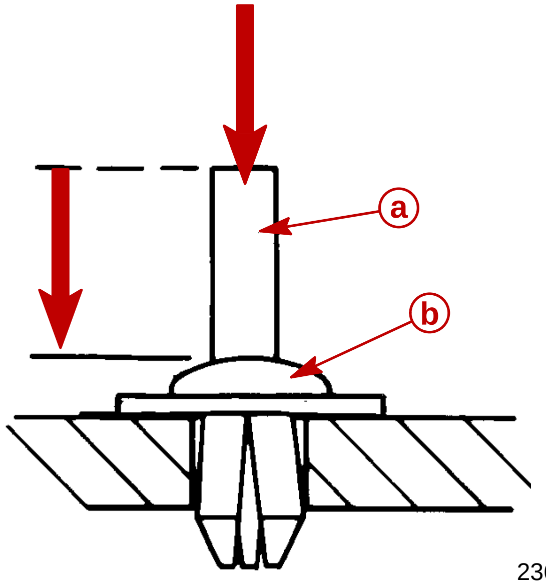
3. With retainer installed in pump body, break retainer rod from retainer by bending sideways.



23601

a - Rod
b - Retainer Cap

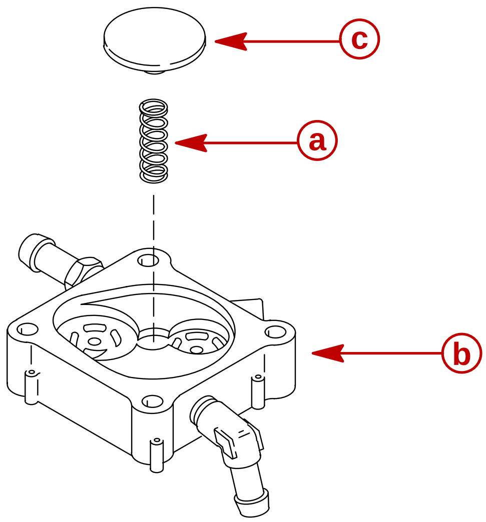
4. Reinstall rod into retainer cap and, use a small hammer or hammer and punch to tap rod down into retainer until flush with top of retainer.



23601

a - Rod
b - Retainer Cap

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



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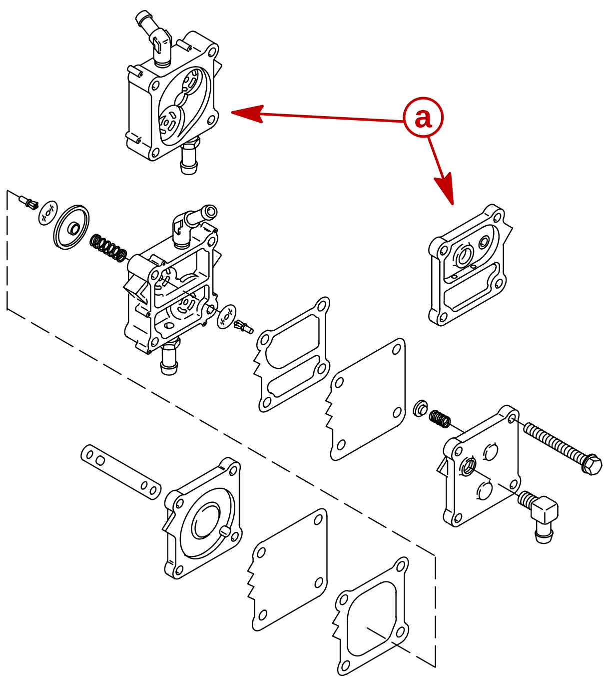
a - Boost Spring
b - Pump Body
c - Cap

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



58876

a - Reverse View of Pump Body

INSTALLATION

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

FUEL SYSTEM

Section 3B - Fuel Injection

3B

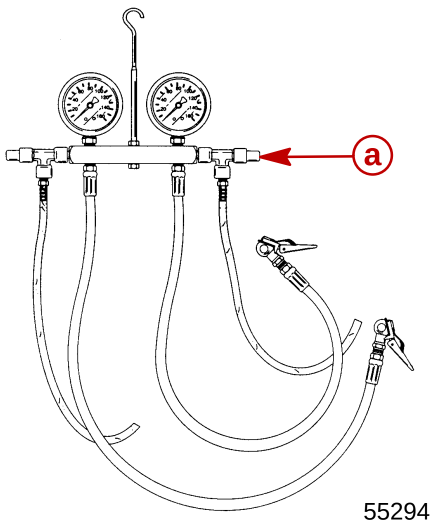
Table of Contents

Specifications

FUEL INJECTION	**Idle RPM**	
	– All Models	625 ± 50
	Wide Open Throttle (WOT) RPM	
	– Model 150XRI/175XRI/200XRI	5250 – 5750
	Float Adjustment (Vapor Separator)	
	Float Level	Preset @ Factory
	Injectors	
	– All Models (Quantity)	6
	– Injectors are Crank Angle Driven by ECM	
	– #1 Cylinder	RED + BRN Leads
	– #2 Cylinder	RED + WHT Leads
	– #3 Cylinder	RED + ORG Leads
	– #4 Cylinder	RED + YEL Leads
	– #5 Cylinder	RED + LT. BLUE Leads
	– #6 Cylinder	RED + PUR Leads
	Line Pressure @ Injectors	41 psi – 45 psi (283 kPa – 310 kPa)
	Injector Resistance	12.3 ohms ± 0.5 ohms
	Electric Fuel Pump Resistance	0.7 ± 0.3 ohms
	Electric Fuel Pump Amperage Draw	4 amperes ± 0.5 amperes

Special Tools

1. Fuel Pressure Gauge 91-852087A3(a) or Fuel Pressure Gauge 91-881834A1(b).



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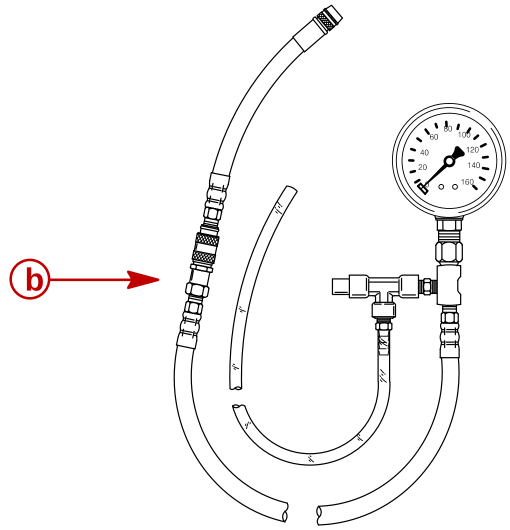

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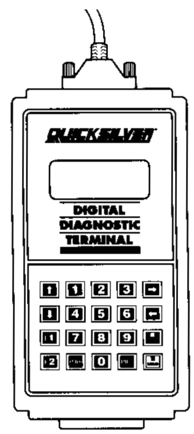
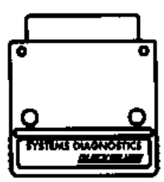
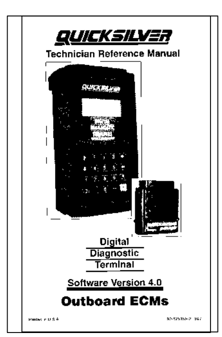
2. Digital Diagnostic Terminal (DDT) 91-823686T2



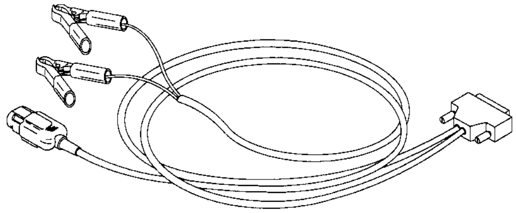
3. Software Cartridge 91-880118A2



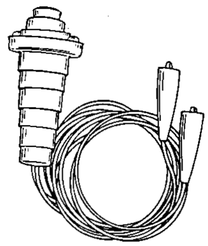
4. DDT Reference Manual 90-881204-1



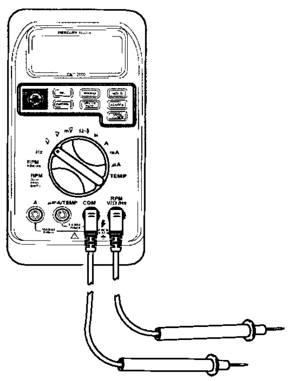
5. Adaptor Harness 84-822560A5 (use with DDT)



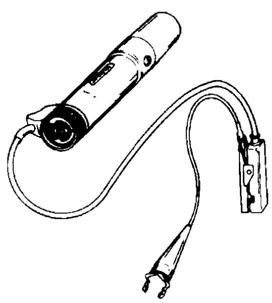
6. Remote Starter Switch 91-52024A1



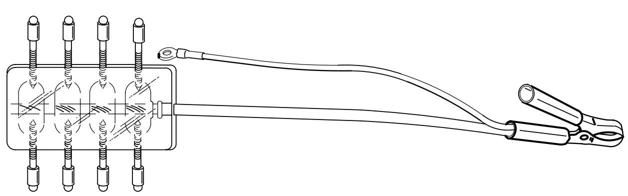
7. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1



8. Inductive Timing Light 91-99379



9. Spark Gap Tester 91-850439T



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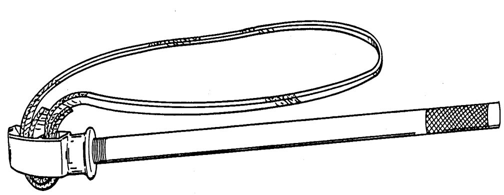
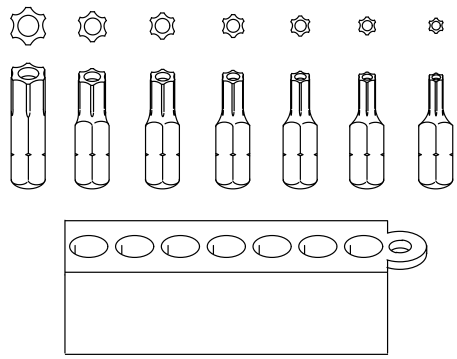
10. Strap Wrench 91-24937A1



11. Tamper Proof Torx Screw Set 91-881828



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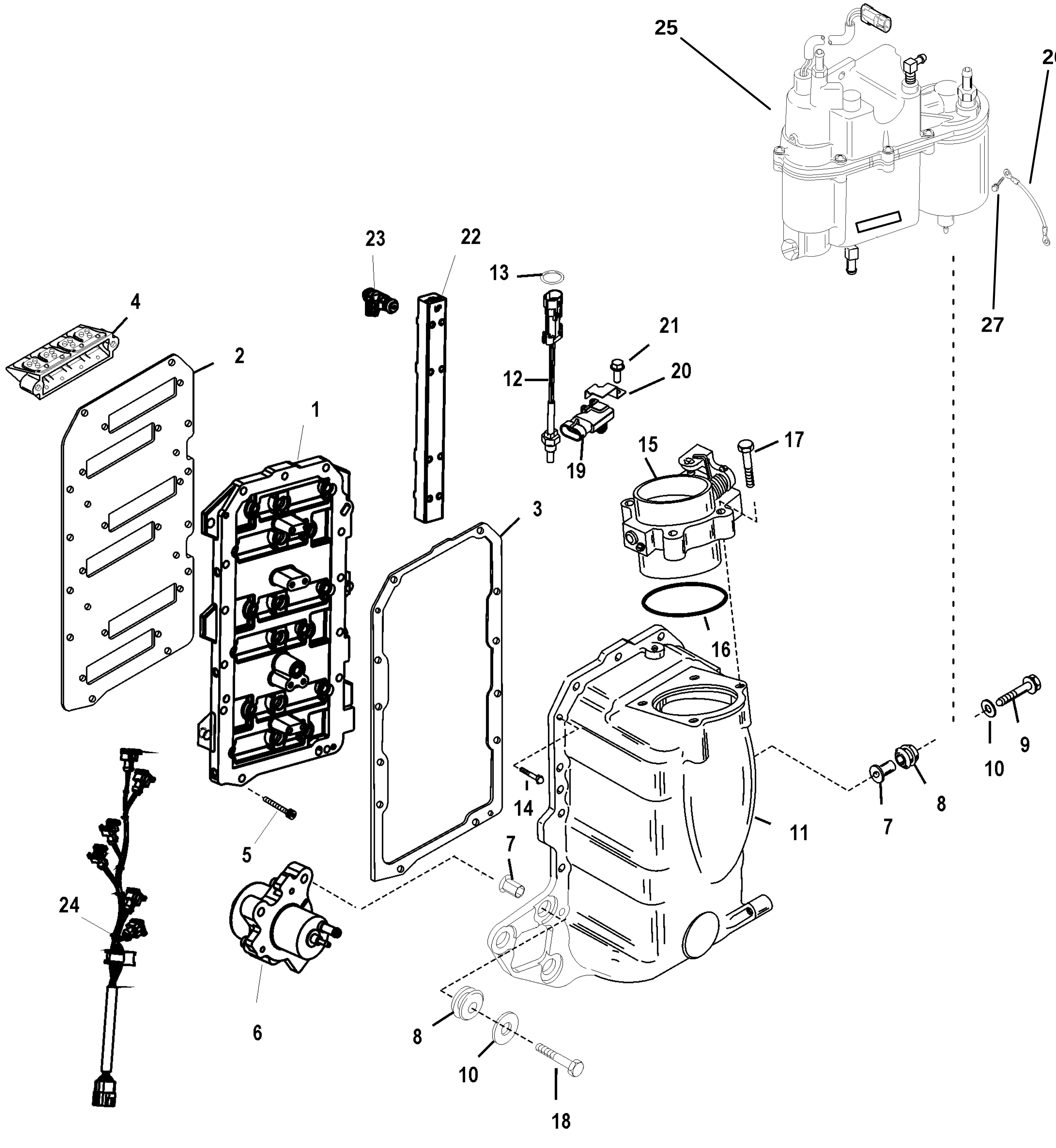
Notes:

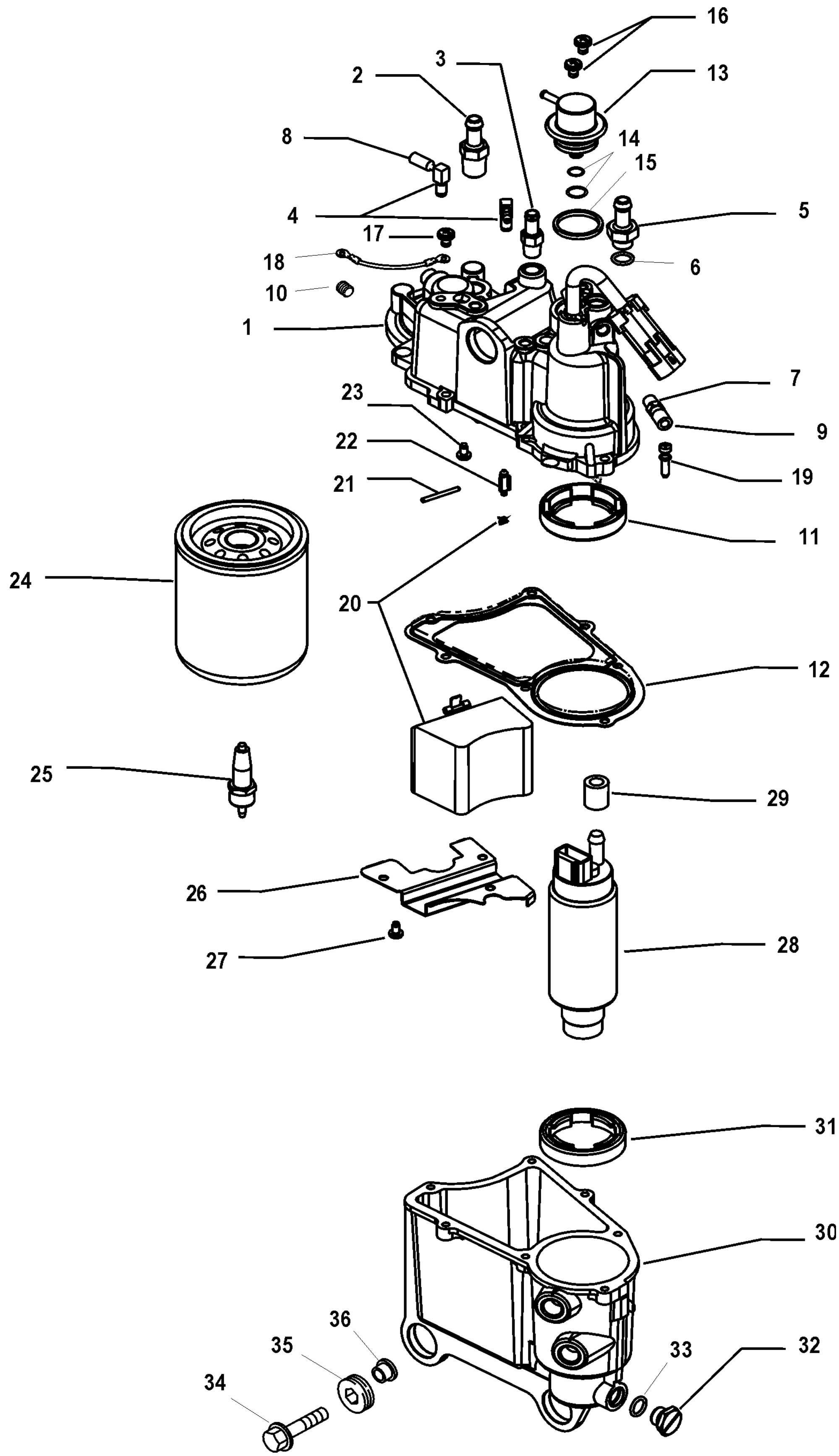
Fuel Management System



Fuel Management System

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
–	1	FUEL MANAGEMENT ASSEMBLY			
1	1	ADAPTOR PLATE KIT			
2	1	GASKET			
3	1	GASKET			
4	6	REED BLOCK			
5	12	SCREW (1/4-20 x 0.88)	100		11.3
6	1	OIL PUMP			
7	6	BUSHING			
8	6	GROMMET			
9	3	SCREW (M8 x 35)	140		16
10	6	WASHER			
11	1	AIR PLENUM KIT			
12	1	TEMPERATURE SENSOR	14		1.6
13	3	O-RING			
14	2	SCREW (M4 x 16)	Drive Tight		
15	1	THROTTLE BODY KIT			
16	1	O-RING			
17	4	SCREW	100		11.5
18	3	SCREW	140		16
19	1	MAP SENSOR			
20	1	BRACKET			
21	1	SCREW (M6 x 16)	80		9
22	1	FUEL RAIL			
23	6	FUEL INJECTOR			
24	1	INJECTOR HARNESS			
25	1	VAPOR SEPARATOR TANK			
26	1	GROUND CABLE			
27	1	SCREW (M6 x 10)	Drive Tight		

Vapor Separator Components



Vapor Separator Components

REF. NO.	QTY.	DESCRIPTION	TORQUE lb. in.	lb. ft.	N·m
–	1	VAPOR SEPARATOR ASSEMBLY			
1	1	COVER KIT			
2	1	FITTING - STRAIGHT			
3	1	FITTING - STRAIGHT			
4	2	ELBOW			
5	1	FITTING - STRAIGHT			
6	1	O-RING			
7	1	VALVE			
8	1	CAP			
9	1	CAP			
10	1	PLUG			
11	1	SEAL			
12	1	GASKET			
13	1	PRESSURE REGULATOR KIT			
14	1	O-RING KIT			
15	1	WASHER - RUBBER			
16	2	SCREW	22		2.5
17	1	SCREW	22		2.5
18	1	GROUND WIRE			
19	7	SCREW	30		3.5
20	1	FLOAT KIT			
21	1	FLOAT PIN			
22	1	INLET VALVE			
23	1	SCREW	40		4.5
24	1	FUEL FILTER			
25	1	PROBE			
26	1	FUEL BAFFLE			
27	3	SCREW	40		4.5
28	1	FUEL PUMP KIT			
29	1	SLEEVE			
30	1	BOWL KIT			
31	1	SEAL			
32	1	PLUG KIT			
33	1	O-RING			
34	3	SCREW (M8 x 30)		15	20
35	3	BUSHING			
36	3	GROMMET			

Electronic Fuel Injection (EFI) System

Introduction

The troubleshooting information provided here consists of preliminary checks (checks to be followed before proceeding with EFI tests), diagrams (fuel flow and electrical wiring), component description (from diagrams), flow charts (low pressure fuel delivery, high pressure fuel delivery, fuel delivery vs. electrical delivery), problem diagnosis, and a series of test and check procedures that will help isolate problems associated with the fuel injection system. Each test/check (listed) can be completed without major fuel system disassembly.

Using the Test Procedures

Read the entire test before beginning to perform outlined procedures. Study the RESULTS material prior to testing. This will help in determining that each test is providing desired results.

EFI System Tests

- EFI Electrical System and ECM Check
- Fuel Gauge Connection/Pressure Test
- Vapor Separator Fuel Delivery Test
- Vapor Separator Float Test
- Water Separating Filter Flow Test
- Pulse Fuel Pump Delivery Test
- Final Filter Check
- Fuel Pressure Regulator Test
- Electric Fuel Pump Test
- Injector Electrical Test
- Injector Fuel Delivery Test
- Injector Operating Test
- Induction Manifold Leak Check
- Sensor Tests

Safety Precautions

⚠ CAUTION
Always use approved safety glasses or goggles when working on pressurized fuel systems.
⚠ DANGER
Motor fuels are extremely flammable. Do not show open sparks or flames when working near fuel systems.
⚠ WARNING
To avoid potential fire hazards, use extreme caution when connecting and disconnecting fuel line connections and test adaptors. Do not allow fuel to spill on hot engine parts or on live electrical connections.

⚠ CAUTION
Wipe up fuel spills immediately.

⚠ CAUTION
Depressurize fuel system prior to opening line connections or removing fuel system components.

⚠ DANGER
Perform the tests in this section in a well ventilated area to avoid being overcome by fuel vapors or poisonous exhaust gases.

Fuel Injection System Function

Fuel is delivered directly to the engine by way of fuel injectors. These injectors are provided with a constant supply of fuel (41 to 45 psi; 283 to 310 kPa) delivered to the fuel rail. The injectors are opened and closed electronically by the Electronic Control Module (ECM). The ECM receives input signals from various sensors in the EFI system which in turn transmits controlling outputs (open/close) to the injectors. The length of time the injectors stay open is considered pulse width. The pulse width will widen (richer) or narrow (leaner) depending on signals ECM receives from sensors, to allow efficient operation at all speeds and conditions.

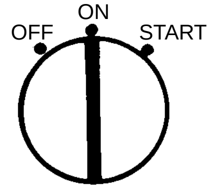
IMPORTANT: The following preliminary steps MUST BE FOLLOWED before attempting EFI problem diagnosis.

Preliminary Checks

Ignition Spark Check

Purpose: This test determines if the ignition system is delivering usable spark to the spark plugs. By performing this test, the probable cause can be isolated to either the ignition system or fuel system.

1. Disconnect all spark plug wires from spark plugs.
2. Connect spark gap tester Quicksilver (91-850439T) to a good ground on engine. Connect Spark Plug Extensions (91-877870A1) between tester and spark plug leads.
3. Connect Remote Starter Switch Quicksilver (91-52024A1) to starter solenoid.
   a. Connect RED lead from switch to large positive (+) terminal with RED banded cable attached [(+) cable from battery].
   b. Connect BLACK lead from switch to small terminal with YELLOW/RED lead attached.
4. Turn ignition key switch to the "ON" position.



5. Look at spark gap tester viewing port for presence of good quality spark.

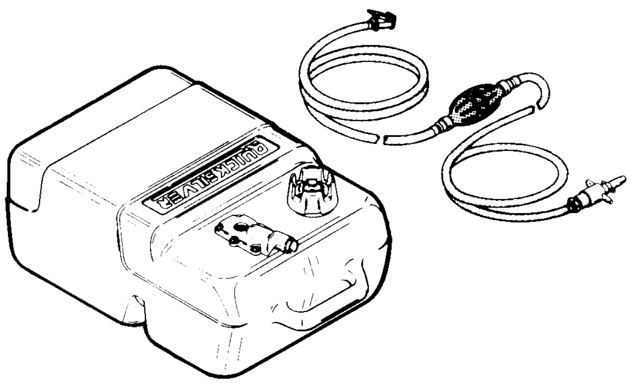
A steady, blue spark should be present at each spark plug wire. If a good spark is present, problem may not be ignition related. If good spark is not present, problem may be ignition related. Troubleshoot ignition system. Refer to appropriate ignition section in this service manual.

Electronic Fuel Injection Set Up

IMPORTANT: Follow EFI Synchronizing/Adjustment section 2C before attempting tests on EFI system.

EFI set up procedures must be followed before tests on system are performed (refer to Section 2C). Improper set up can result in poor engine performance (i.e. uncontrollable idle speeds, lean sneezing, low power during acceleration or engine will simply not run.) Failure to properly set up the EFI system can lead to misdirections in solving simple problems in the EFI system.

Fresh Quality Fuel



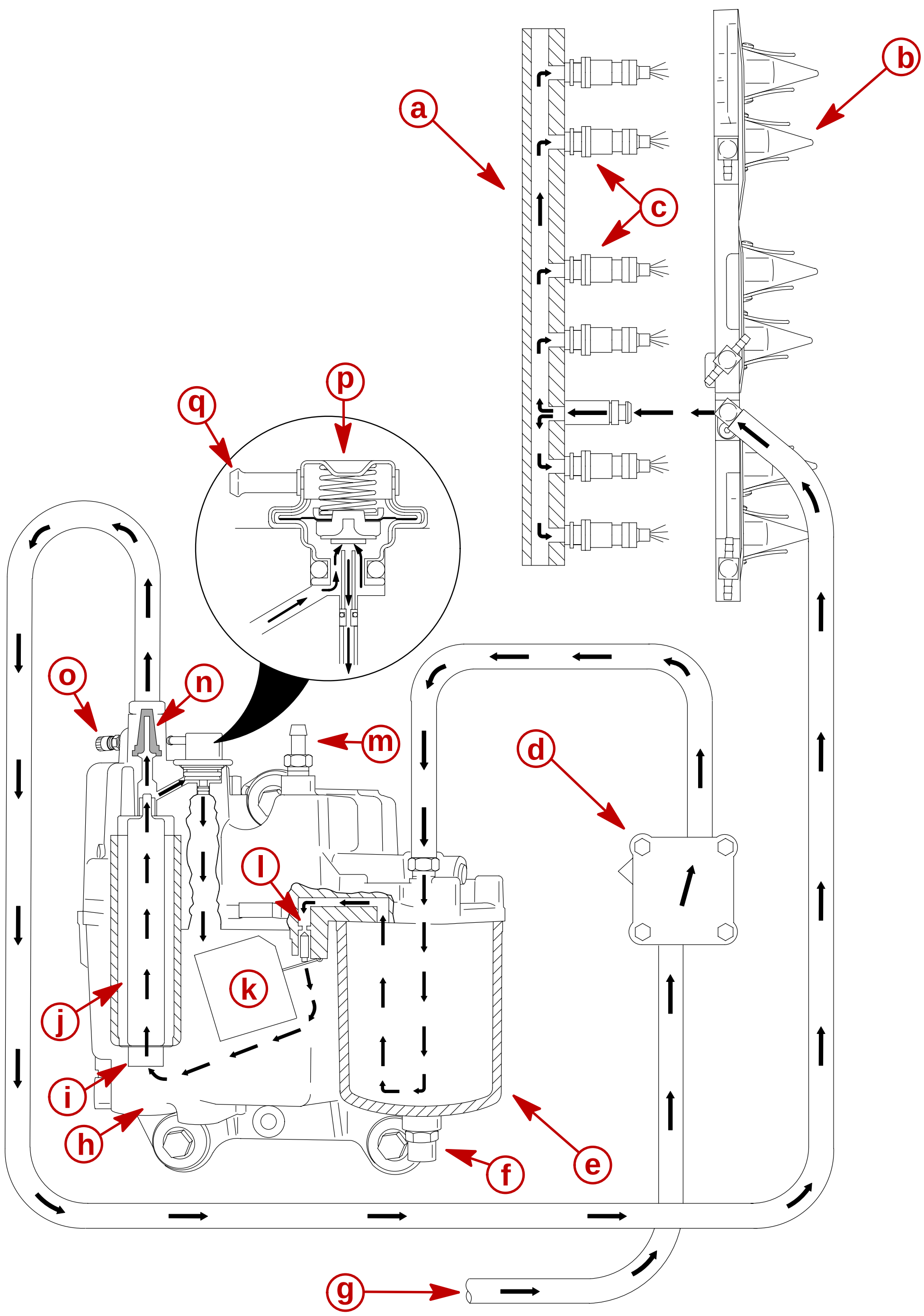
Using a remote fuel tank containing a major brand of premium unleaded gasoline, test run the outboard to eliminate any problems related to restricted fuel supply (clogged lines, malfunctioning anti-siphon valve, etc.) and/or marginal gasoline.

Low Battery Voltage

Low battery voltage can cause EFI system to deliver fuel in an inconsistent manner.

Inspect battery connections and charging system, refer to Section 2B. The EFI system requires a substantial amount of voltage to function properly. Operating engine at a low RPM for an extended period of time while operating numerous electrical accessories can cause low voltage.

Fuel Flow Diagram



a - Fuel Rail	**j** - Electric Fuel Pump
b - Reed Block Plate Assembly	**k** - Vapor Separator Float
c - Fuel Injectors (6)	**l** - Needle and Seat
d - Pulse Fuel Pump	**m** - Vapor Separator to Flywheel Cover Vent Hose
e - Fuel/Water Separator	**n** - Final Filter
f - Water Sensor	**o** - Fuel Rail Pressure Port
g - From Fuel Tank	**p** - Fuel Pressure Regulator
h - Vapor Separator	**q** - Fuel Pressure Regulator Vent Hose
i - Electric Fuel Pump Filter	

Fuel Flow Component Description

Pulse Fuel Pump (d)

The pulse fuel pump operates through alternating crankcase pressure to deliver fuel through the water separating filter to the vapor separator.
Fuel pressure @ Idle: 2 – 3 psi (13.8 – 20.7 kPa) [Minimum – 1 psi (6.9 kPa)].
Fuel Pressure @ Wide-Open-Throttle: 6 – 8 psi (41.4 – 55.2) [Minimum: 4 psi (27.6 kPa)].

Water Separating Filter (e)

The water separating filter protects the fuel injectors from water and debris. The filter contains a sensor probe which monitors water level in the filter. If water is above the sensor probe, the warning horn will begin a series of beeps.

Vapor Separator (h)

The vapor separator is a fuel reservoir which continuously blends and circulates fresh fuel and oil.

a. Fuel Inlet – Fresh fuel delivered from the water separator by the crankcase mounted pulse fuel pump. The amount of fuel allowed to enter the vapor separator is controlled by a needle/seat and float assembly mounted in the cover of the vapor separator.

b. Oil Inlet – Oil delivered by ECM controlled oil pump.

c. Fuel Pressure Regulator Inlet – Unused fuel/oil mixture being recirculated from the pump back into the vapor separator.

Final Filter (n)

The final filter is located above the electric fuel pump in the brass fuel fitting. The filter collects debris and prevents them from flowing into the fuel rail and injectors.

Electric Fuel Pump (Inside Vapor Separator) (j)

The electric fuel pump runs continuously while providing fuel in excess of engine demands. The excess fuel is circulated through the fuel rail to the fuel pressure regulator and back to the vapor separator. Normal fuel pressure is 41 – 45 psi (283 to 310 kPa).

Fuel Injectors (c)

The fuel injectors are located on the fuel rail. The injector valve body consists of a solenoid actuated needle and seat assembly. The injector receives signals from the EFI Electronic Control Module. These signals determine how long the needle is lifted from the seat (pulse width) allowing a measured fuel flow. The pulse width will widen (richer) or narrow (leaner) depending on various signals received from sensors connected to the EFI ECM. The ECM receives a signal from the crank position sensor to fire each injector accordingly.

A 12 wire harness connects the fuel injectors to the ECM. The RED wire is at 12 volts and connects to all injectors. The BLUE, YELLOW, WHITE, BROWN, PURPLE and ORANGE wires each go to individual injectors and are normally at 12 volts for a zero differential. To fire the injectors this voltage is brought down to near ground creating a potential across the injectors.

Fuel Pressure Regulator (p)

The fuel pressure regulator is located on top of the vapor separator and is continuously regulating fuel pressure produced by the electric fuel pump. The electric pump is capable of producing 90 psi (621 kPa) of fuel pressure. The pressure regulator limits fuel pressure at the injectors to 41 to 45 psi (283 to 310 kPa).

EFI Electrical Components

ELECTRONIC CONTROL MODULE (ECM)

The ECM is continually monitoring various engine conditions (engine temperature, engine detonation control (Model 200 only), engine throttle opening and climate conditions (induction air temperature, barometric pressure and altitude level) needed to calculate fuel delivery (pulse width length) of injectors. The pulse width is constantly adjusted (rich/lean conditions) to compensate for operating conditions, such as cranking, cold starting, climate conditions, altitude, acceleration and deceleration, allowing the outboard to operate efficiently at all engine speeds.

12 Volt Battery - The 12 volt battery provides power to the ECM through the main power relay.

IMPORTANT: When disassembling EFI System DISCONNECT BATTERY CABLES.

In the "start" position, injector pulse widths are increased as engine head temperature is reduced to provide adequate fuel for quick start up.

Fuel Injectors - A 12 wire harness connects the fuel injectors to the ECM. The red wire is at 12 volts and connects to all injectors. The BLUE, YELLOW, WHITE, BROWN, PURPLE and ORANGE wires each go to individual injectors and are normally at 12 volts for a zero differential. To fire the injectors this voltage is brought down to near ground creating a potential across the injectors.

Electric Fuel Pump - The ECM contains a fuel pump driver circuit that provides power to the electric fuel pump. The fuel pump does not have its negative terminal (–) "BLACK/RED wire" grounded to the pump housing. The fuel pump positive terminal (+) "RED wire" and the negative terminal (–) are at 12 volts with the ignition switch in the off position for a zero differential. When the pump is on, the negative terminal is brought down to near ground (i.e. 1.5 volts).

SENSOR INTERACTION WITH THE ECM

IMPORTANT: DO NOT run engine for extended periods of time with sensors disconnected or bypassed (shorted). Serious engine damage may result.

AIR TEMPERATURE SENSOR

The air temperature sensor transmits manifold absolute air temperature, through full RPM range, to the ECM. As air temperature increases "sensor" resistance decreases causing the ECM to decrease fuel flow (leaner mixture). Disconnecting the air temperature sensor or temperature sensor failure will cause the ECM to revert to a default temperature source of 32° F (0° C).

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The map sensor is a non-serviceable sensor mounted on top of the air plenum. The MAP sensor is used to sense changes in manifold absolute pressure. The MAP sensor is functioning through the full RPM range and is continually signaling induction manifold pressure readings to the ECM. The ECM in turn determines fuel flow as signals are received. The MAP sensor's operation can be monitored using the DDT. With the engine running, as the throttle is increased or decreased, the MAP sensor's DDT display should change. If no change occurs, MAP sensor is not functioning properly.

ENGINE HEAD TEMPERATURE SENSOR (PORT AND STARBOARD CYLINDER HEAD)

The Engine Head Temperature Sensors provide the ECM signals related to engine temperature to determine level of fuel enrichment during engine warm up. The ECM is receiving information at all engine temperatures. Disconnecting the temperature sensors or temperature sensor failure will cause the ECM to revert to a default temperature source of 32° F (0° C). The temperature sensors can be monitored with the DDT.

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 illuminate and the warning horn will sound. RPM will be reduced by the ECM. The TPS is not adjustable. TPS settings can be monitored with the Digital Diagnostic Terminal. Voltage change should be smooth from idle to wide open throttle. If voltage change is erratic, the TPS is defective.

IGNITION SYSTEM	**Throttle Position Sensor** @ **Idle** @ **W.O.T.**	 0.19 – 1.0 vdc 3.45 – 4.63 vdc

WATER SENSING SYSTEM

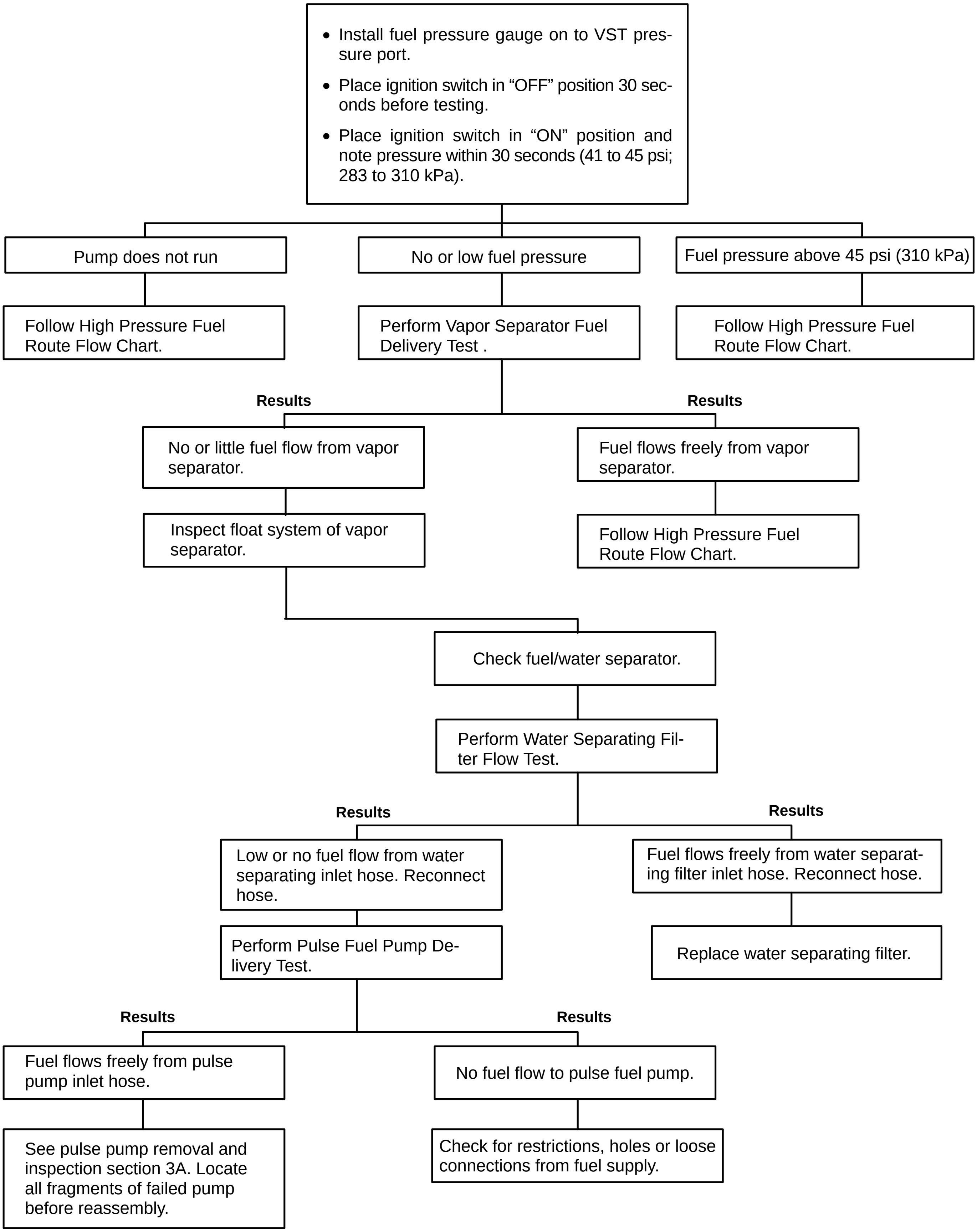
The system consists of a water separating fuel filter (port side powerhead) and a sensing probe (bottom of filter).

WATER SENSING SYSTEM FUNCTION

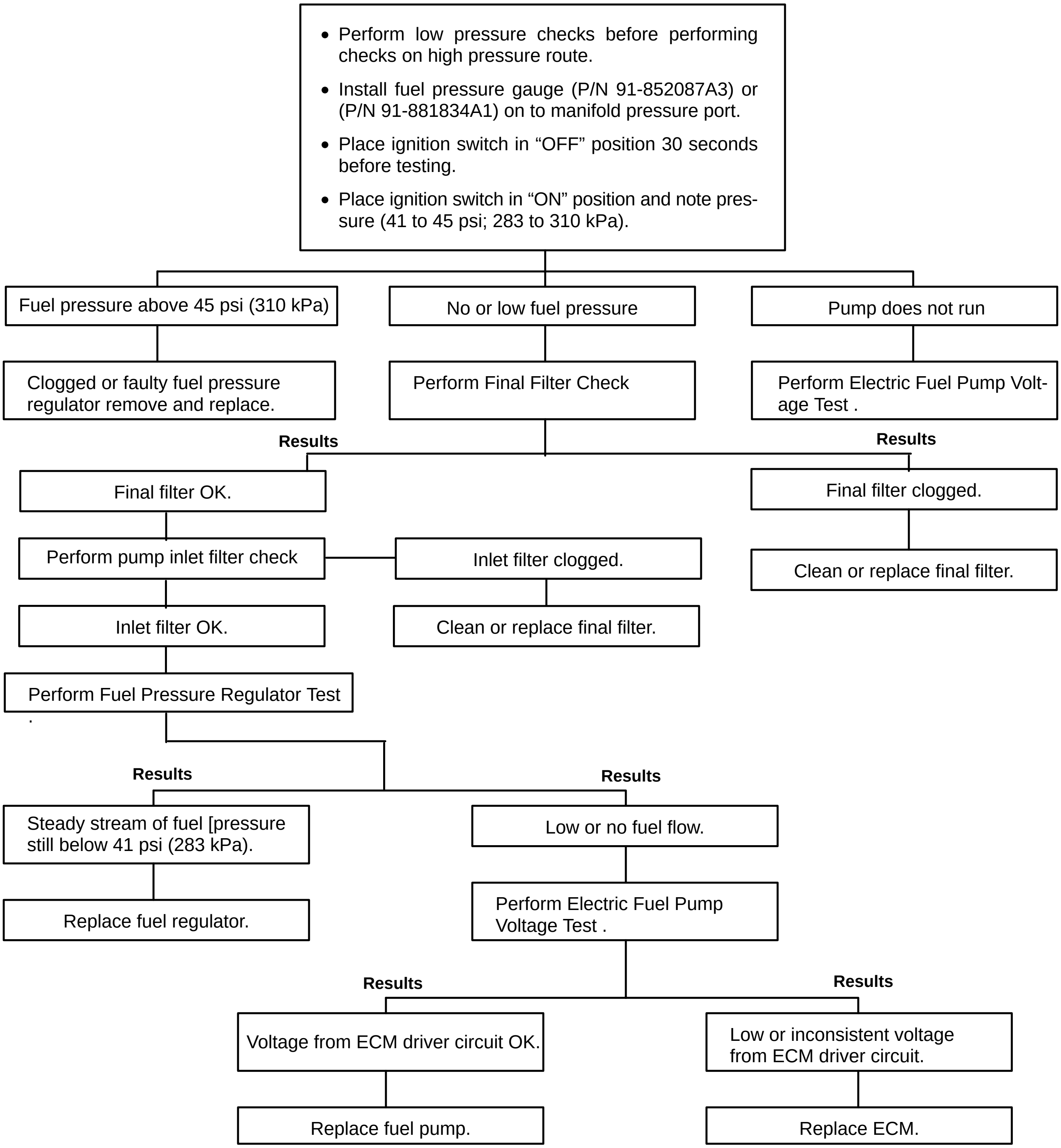
1. The filter separates the accumulated water from the fuel.
2. A voltage is always present at sensing probe. When water reaches top of probe it completes the circuit to ground.
3. The completed circuit activates the warning horn which intermittantly sounds.

The system can be tested by disconnecting the TAN wire from sensor probe and holding to a good engine ground connection for 10 seconds.

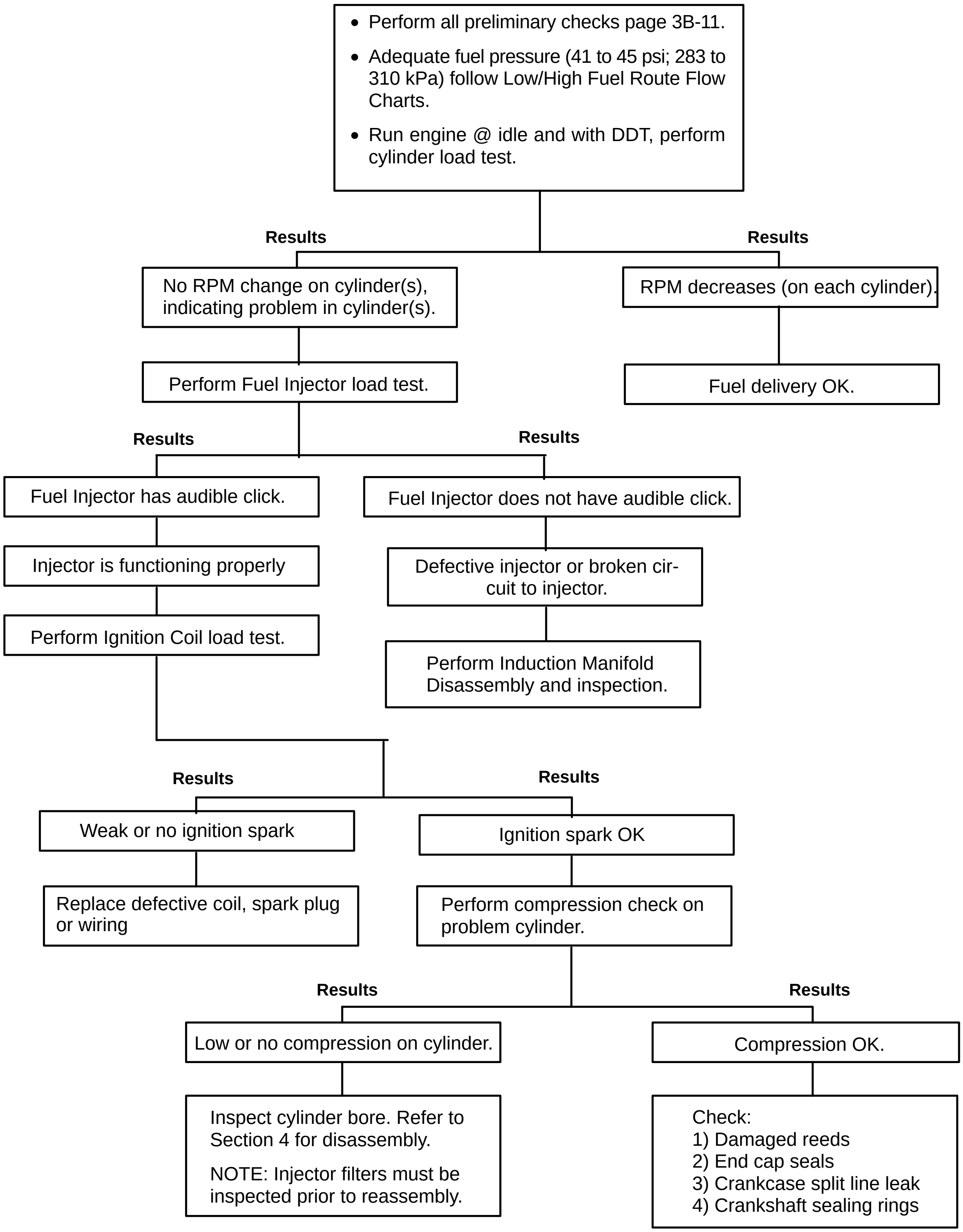
EFI Fuel Management (Low Pressure Fuel Route)



EFI Fuel Management (High Pressure Fuel Route)

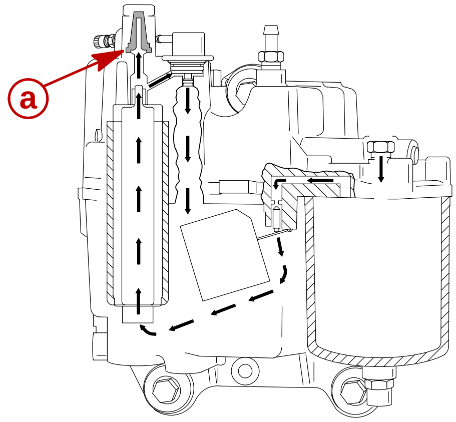


Fuel Rail Electrical/Fuel Determination



EFI System Test Procedures

NOTE: *A clogged final filter located in fitting above fuel pump will cause low fuel pressure readings at the fuel pressure port. Remove fuel fitting and inspect final filter. Clean and/or replace final filter as necessary.*



a - Final Filter

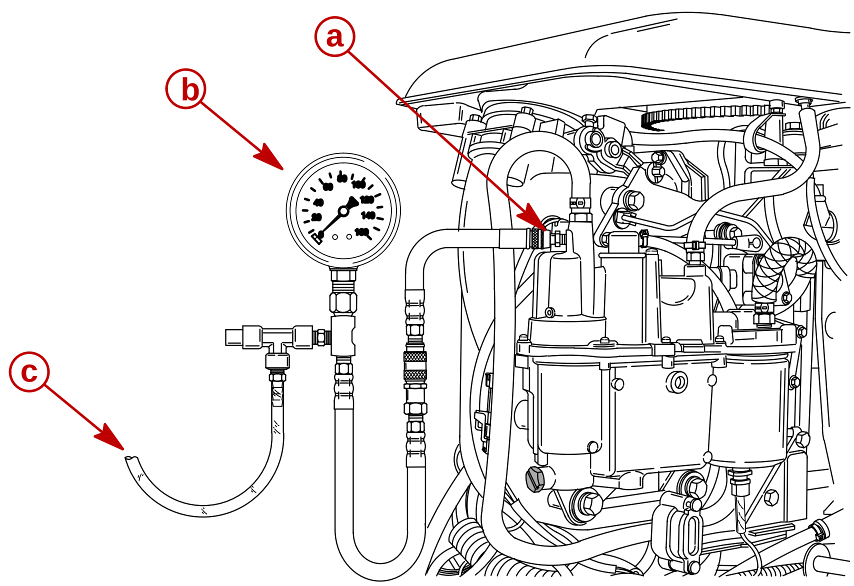
Fuel Gauge Connection/Pressure Test

IMPORTANT: When checking fuel pressure while engine is running, fuel pressure may fluctuate. Fuel pressure fluctuation [i.e. 41 to 45 psi (283 to 310 kPa)] is common, as the regulated pressure is a differential between fuel rail and manifold vacuum.

Purpose: Checking fuel manifold pressure ensures that fuel under usable pressure is available to the fuel injectors. This test isolates the probable cause as either a fuel delivery or EFI electrical system failure.

IMPORTANT: Fuel pressure should be monitored through full RPM range to determine fuel supply problems at high engine speeds.

1. Connect fuel pressure gauge to VST pressure port.



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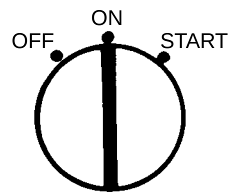
a - Pressure Port
b - Fuel Pressure Gauge (91-881834A1)
c - Direct fuel into suitable container

2. Turn ignition key switch to “ON” position.



3. Operate electric fuel pump (ignition key on).

NOTE: *Fuel pump will only operate for approximately 2-4 seconds. By turning the key switch to “OFF” and then back to “ON” the pump will operate for 2-4 seconds more.*

4. Take reading on fuel pressure gauge.

Results: If pressure reading is 41 to 45 psi (283 to 310 kPa), the electric fuel pump is providing fuel with enough pressure to be used by the injectors. Pump malfunction is not the cause of EFI trouble.

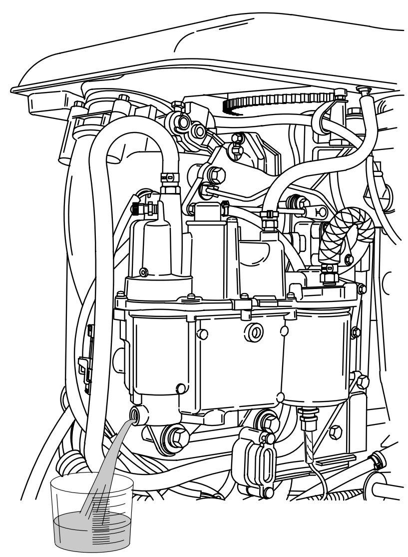
If fuel pressure is well below 41 psi (283 kPa), fuel delivery to electric fuel pump, fuel pump failure or other related problem exists. Inspect final filter for debris.

If fuel pressure is above 45 psi (310 kPa) go to fuel pressure regulator test.

Vapor Separator Fuel Delivery Test

Purpose: Verifying there is adequate fuel flow to the electric fuel pump (through full RPM range) will determine components in low pressure fuel system are functioning correctly.

1. Remove vapor separator drain plug and place a clean container under drain.
2. Prime fuel line primer bulb.



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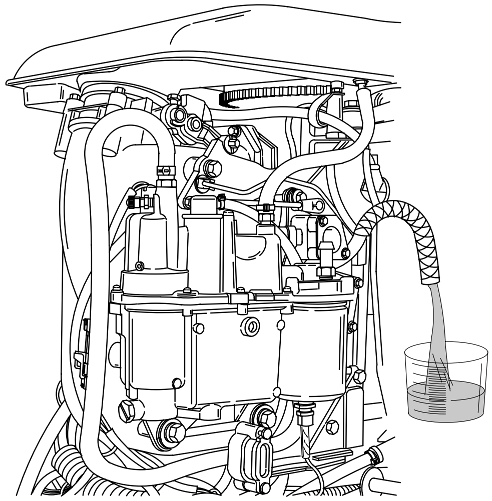
Results: Fuel should flow when plug is removed and continue to flow as primer bulb is pumped. If fuel flow is not present, inspect pulse fuel pump, water separator filter or VST float and needle valve.
If fuel flow is present, go to **High Pressure Flow Chart**.

Pulse Fuel Pump Delivery Test

Purpose: This test will indicate pulse fuel pump is capable of supplying the low pressure fuel route with adequate fuel supply.

1. Place emergency stop switch in OFF position to prevent engine from starting.
2. Remove fuel inlet hose from fuel/water separator.



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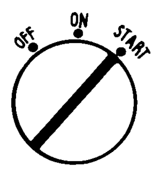
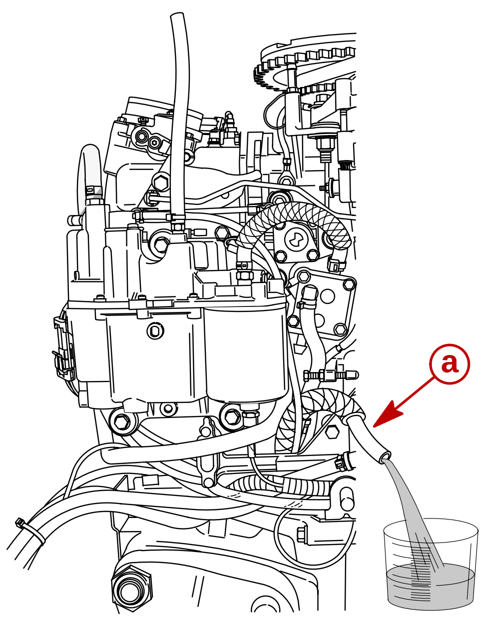
3. Turn ignition key switch to “START” and operate starter motor for 10 to 20 seconds.



Results: Fuel should flow freely from hose. Refer to **Fuel/Water Separator Inspection** and/or **Vapor Separator Float Test.**
If fuel does not flow from hose:

4. Remove inlet hose to pulse fuel pump and put end into clean container.
5. Squeeze primer bulb several times.



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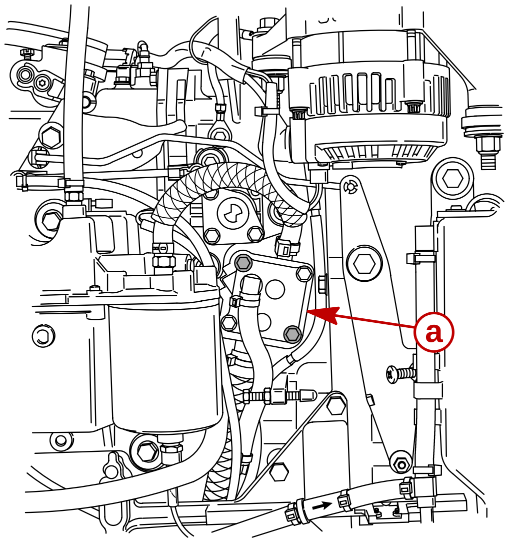
a - Inlet Fuel Hose

Results: If low or no fuel flow is present, inspect fuel hose for restrictions. Inspect anti-siphon valve and boat fuel tank for proper fuel delivery. If fuel flow is present, remove, disassemble and inspect pulse fuel pump. All fragments of failed pump must be located before reassembly.



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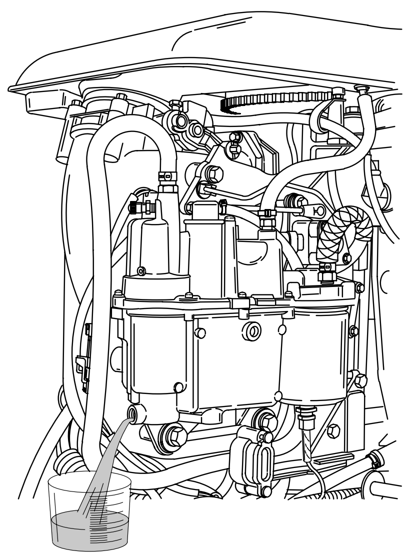
a - Pulse Fuel Pump

Water Separating Filter Inspection

Remove fuel/water separator filter. Inspect filter for debris. Replace filter as required.

1. Place emergency stop switch in OFF position to prevent engine from starting.
2. Remove vapor separator drain plug and place a clean container under drain.
3. Crank engine over with starter.



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Results: If fuel flow is present, fuel is being delivered to electric fuel pump. If fuel is not present, refer to **Vapor Separator Float Test**.

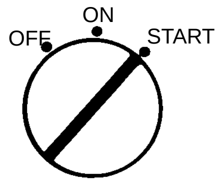
Vapor Separator Float Test

***NOTE:** If squeezing the primer bulb in the **Vapor Separator Fuel Delivery Test** previous provides adequate fuel to the vapor separator, the vapor separator float, needle and seat is functioning properly and the following test does not need to be performed.*

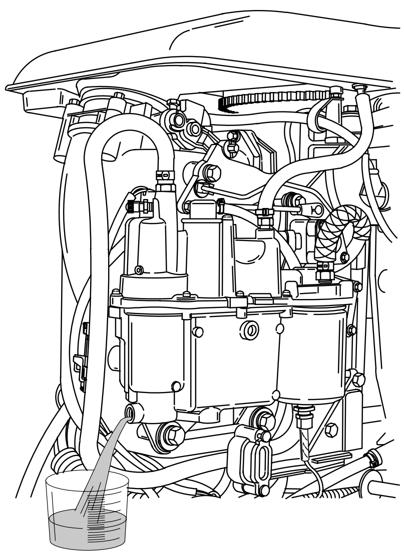
Purpose: This test will indicate if float is stuck in the up (closed) position.

***NOTE:** If float is stuck down, vapor separator will over flow causing a rich condition.*

1. Place emergency stop switch in OFF position to prevent engine from starting.
2. Turn ignition key switch to "START" position and operate starter motor for 15 to 20 seconds.



3. Remove vapor separator drain plug and place a clean container under drain.



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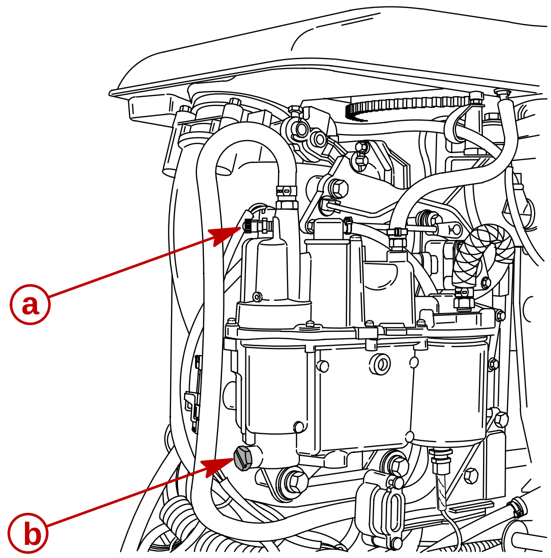
Results: If fuel flow is low or not present, remove, disassemble and inspect float assembly. See vapor separator disassembly.

Electric Fuel Pump Inlet Filter Check and De-Pressurizing EFI System Procedures

Purpose: Checking the inlet filter for obstructions, damage etc. eliminates this component as a possible source of restriction in the system.

1. De-pressurize EFI fuel system by wrapping a clean cloth around pressure port valve and inserting tip of screwdriver into valve, depressing valve core. Let fuel drain from valve.



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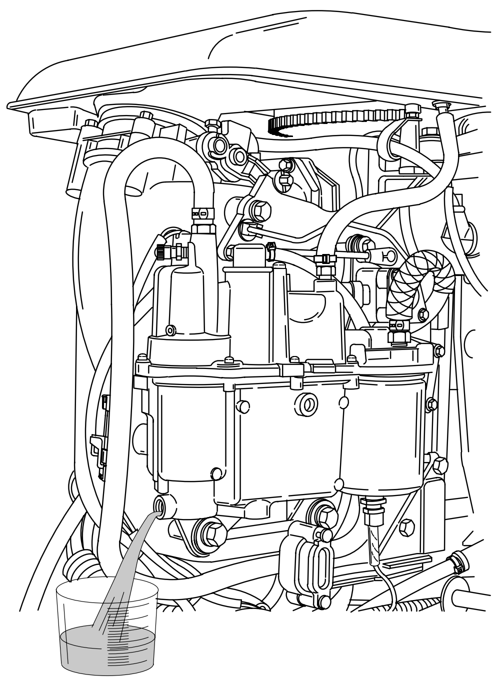
a - Pressure Port **b** - Drain Plug

2. Remove drain plug from vapor separator and allow fuel to drain into suitable container.



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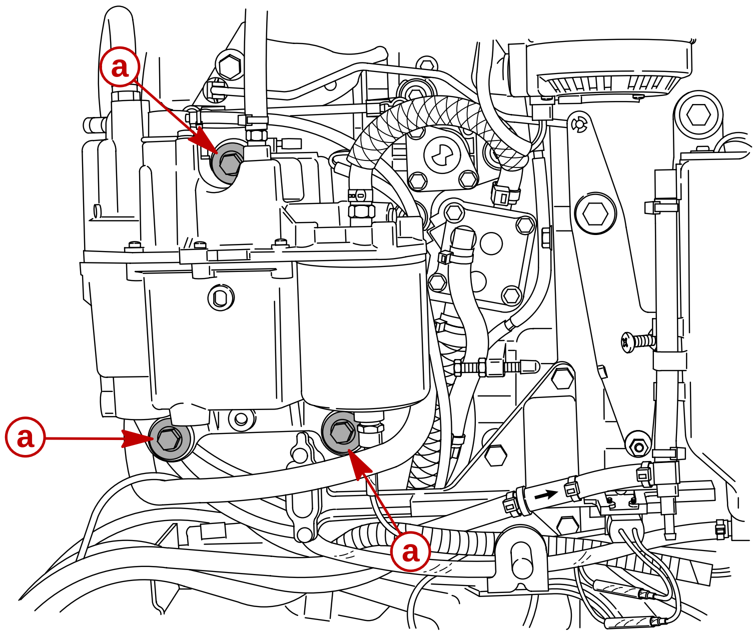
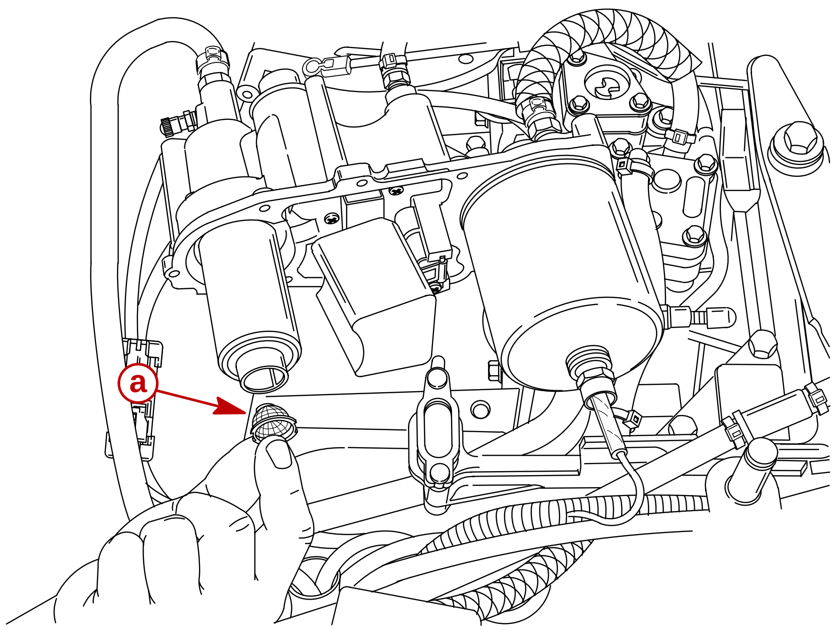
3. Remove 3 bolts securing vapor separator assembly to manifold.



a - Bolts

4. Tilt vapor separator assembly out from manifold and remove 9 screws securing cover.
5. Remove vapor separator tank from cover.
6. Pull downward to remove filter from fuel pump.



a - Inlet Filter

7. Inspect filter for debris or damage.

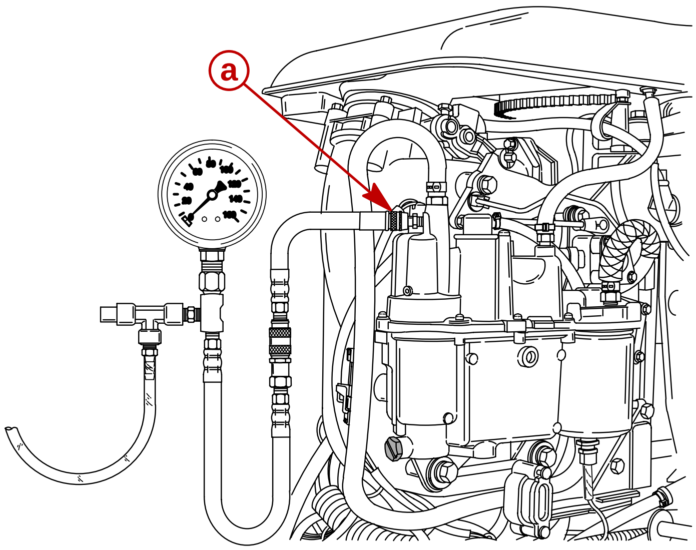
Results: If filter is clogged with debris, clean filter with solvent and compressed air or replace filter. Reassemble vapor separator to manifold and recheck fuel pressure. If pressure is still below 41 psi (283 kPa), perform fuel **Pressure Regulator Test**.

Pressure Regulator Test

NOTE: *Low fuel pressure can be caused by inadequate fuel supply, a defective electric fuel pump or fuel pressure regulator. Verify adequate fuel is being supplied to the vapor separator. If fuel supply is proper, inspect final filter inside outlet fuel fitting on vapor separator for debris. If filter is clean, perform amperage draw test on electric fuel pump. If amperage draw is within specifications, replace fuel pressure regulator.*

Purpose: This test will determine if a weak, plugged or open pressure regulator is causing inadequate fuel pressure in the system.

1. Connect pressure gauge 91-881834A1 to EFI test port.



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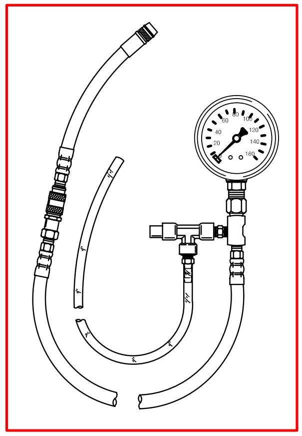
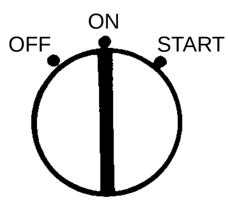


91-881834A1

a - Test Port

2. Turn ignition key switch to “ON” position and check fuel pressure reading on gauge. If pressure reading is below 41 psi (283 kPa) replace regulator.

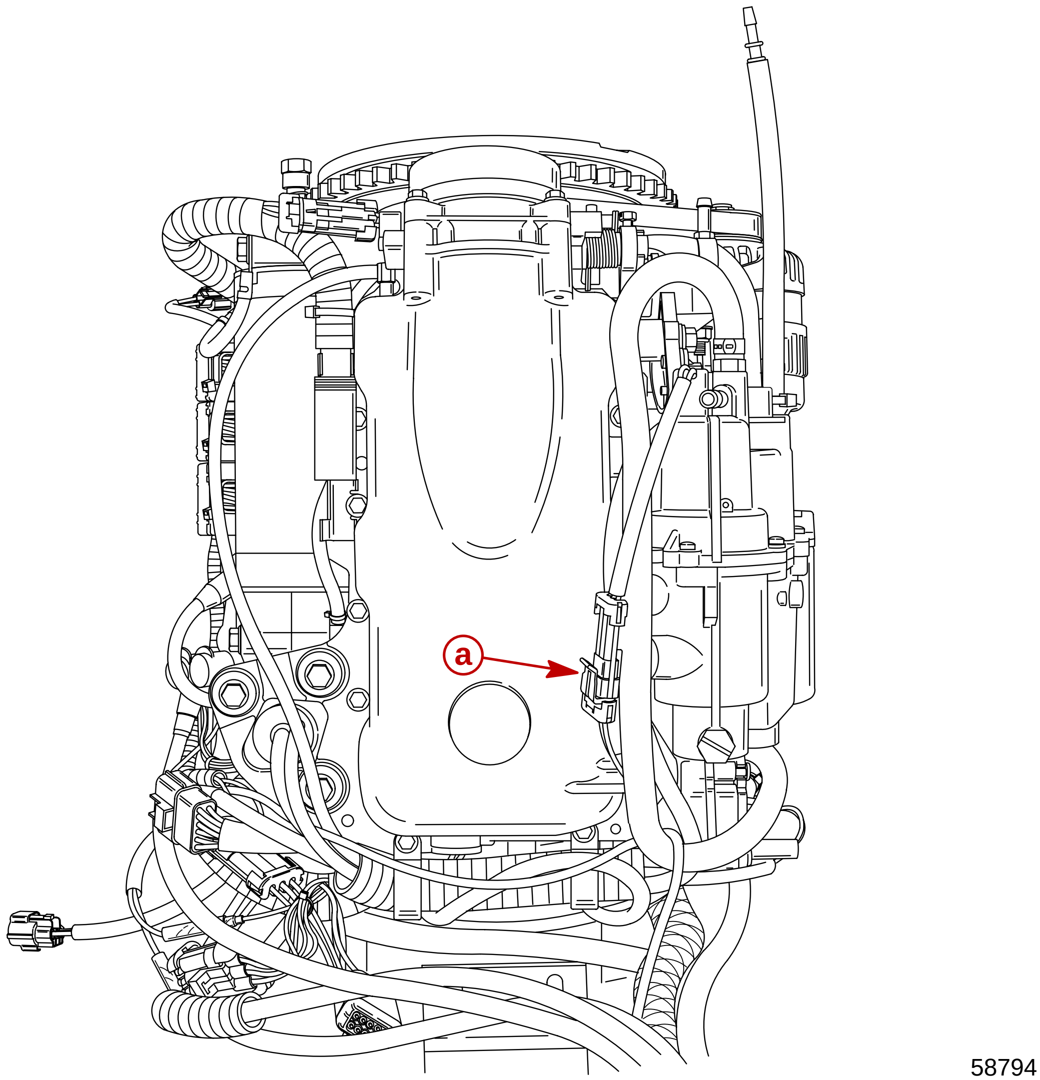


Electric Fuel Pump Voltage/Pressure Test

NOTE: *The Digital Diagnostic Terminal (DDT) can implement a load test for the electric fuel pump. If the electric fuel pump does not appear to run, it is recommended that the DDT load test be performed first before performing the following voltage test.*

Purpose: If insufficient electrical power is available at the pump, no or low fuel pressure will be developed.

1. Disconnect electric fuel pump harness connector.
2. Set volt meter to read battery voltage and connect black test lead to BLACK wire in the fuel pump connector, positive test lead to positive wire (RED/BLUE) of fuel pump connector (engine harness end).



a - Fuel Pump Harness Connector – Positive test lead to RED/BLUE wire and Negative test lead to BLACK wire (engine harness end)

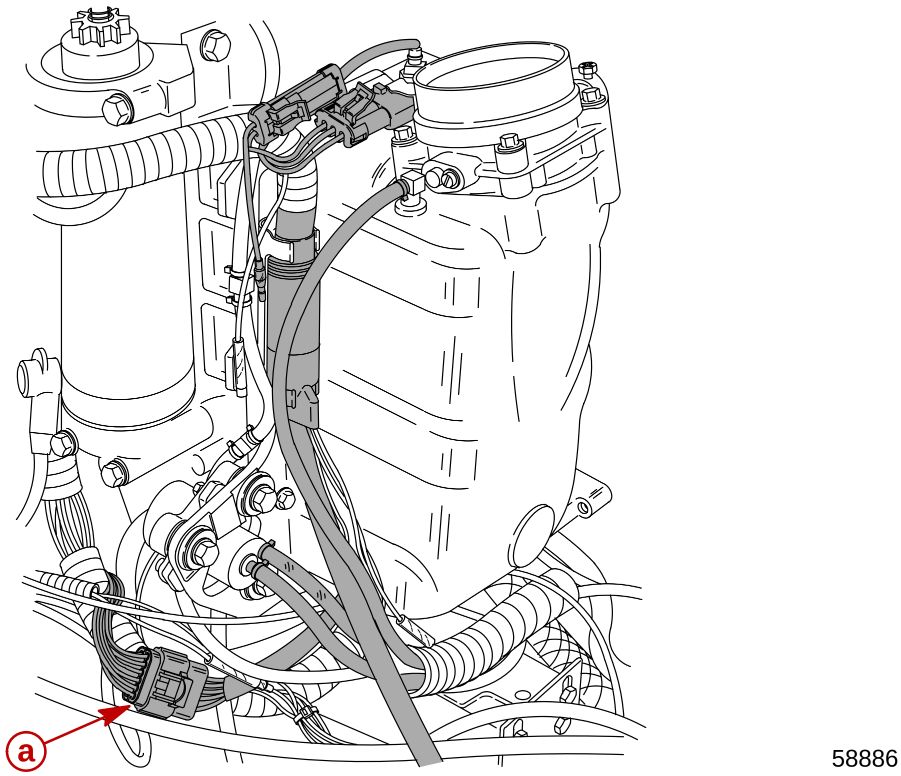
3. Turn key to RUN position. Battery voltage will be applied to the RED/BLUE lead for about 2 seconds.

Results: If battery voltage is not present, inspect battery, battery connections and harness for corrosion, damage or loose connections. If correct battery voltage is present, replace electric pump.

NOTE: *If electric fuel pump runs but fuel pressure is low, perform amperage draw test on electric pump. Amperage draw should be 4 amperes ± 0.5 amperes. If amperage draw is high, replace pump.*

Injector Electrical Harness Test

An injector load test can be performed using the Digital Diagnostic Terminal (DDT). An audible click will be heard each time an injector is activated. If an injector does not respond to the load test, an ohm test can be made on the harness and the injector(s).



a - Injector Harness

Injector Resistance	
#1 Cylinder – RED + BRN Leads #2 Cylinder – RED + WHT Leads #3 Cylinder – RED + ORG Leads #4 Cylinder – RED + YEL Leads #5 Cylinder – RED + LT. BLUE Leads #6 Cylinder – RED + PUR Leads	12.3 ohms ± 0.5 ohms

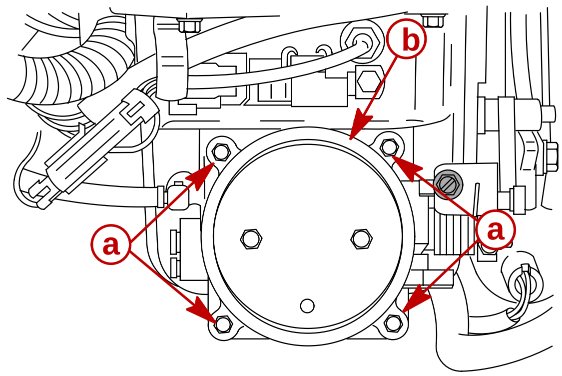
Injector Load Test

An injector load test can be performed using the Digital Diagnostic Terminal (DDT). An audible click will be heard each time an injector is activated. This test will verify that each injector is operating mechanically, not that each injector is allowing the proper amount of fuel to enter each cylinder. Refer to DDT Reference Manual 90-881204–1 for test procedures.

Fuel Rail Assembly Leakage Test

Purpose: This test will determine if the supply tube or injector o-rings are leaking or if an injector is stuck open.

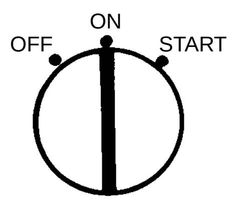
1. Remove 4 screws securing throttle plate assembly to air plenum and remove assembly.



58898

a - Screws   b - Throttle Plate Assembly

2. Put ignition key switch in "ON" position. Electric fuel pump should run for approximately 2 seconds.



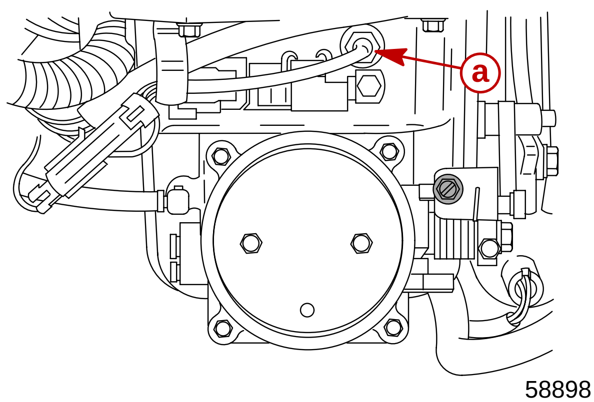
3. While pump is running, observe fuel rail.

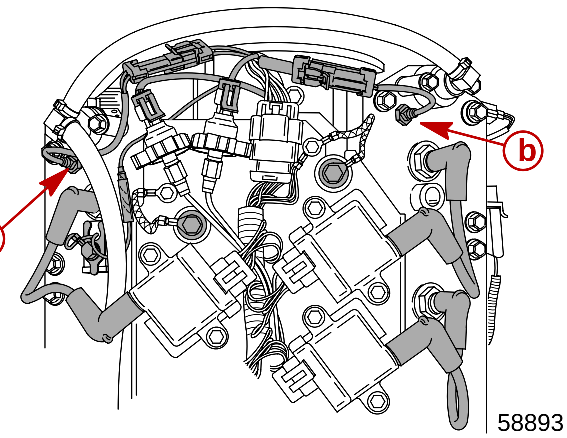
Results: If leakage is observed, refer to **Fuel Rail Removal**. Replace o-rings and/or injectors as required.

Air Temperature Sensor and Head Temperature Sensor Test

Purpose: This test eliminates possibilities of improper fuel delivery related to air/head temperature sensors.

NOTE: *Air/Head Temperature Sensor functioning can be monitored using the Digital Diagnostic Terminal (DDT). The Air Temperature sensor should indicate ambient air temperature. The Head Temperature sensor should indicate cylinder head water temperature. The ECM will revert to a default temperature of 32° F (0° C) if it should lose either air or head temperature sensor signal. The sensors can also be tested using a DMT2000 Digital Multimeter 91-854009A1.*





a - Air Temperature Sensor

b - Head Temperature Sensor

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.

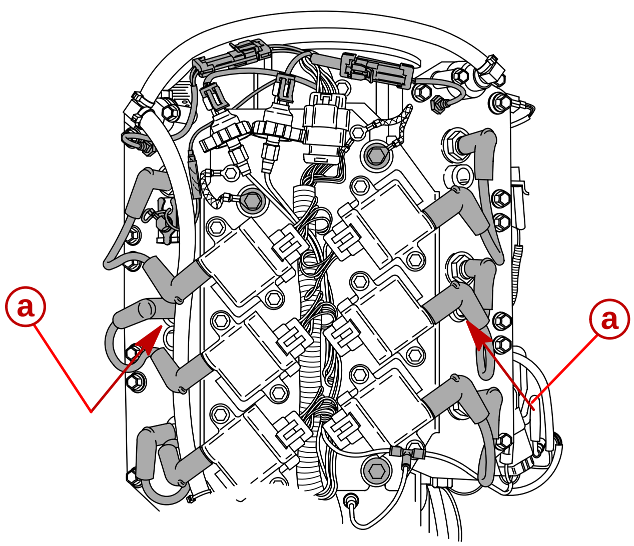
1. Disconnect and remove temperature sensors from engine.
2. Connect DMT (91-854009A1) to leads of sensor.
3. Place sensor in ice water while monitoring meter reading. Use chart (below) for reference.

Results: Resistance does not change inversely with temperature change. Replace defective temperature sensor. Resistance changes inversely with temperature change. Temperature sensor OK.

Temperature Sensor Specifications		
Fahrenheit	**Centigrade**	**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

Detonation Control System Test (200 Models Only)



a - Knock Sensor

Purpose: Determines whether the detonation sensor and circuit located in the ECM is functioning.

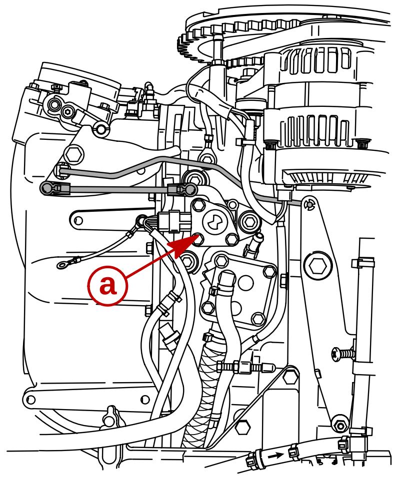
1. Place outboard in water, connect Digital Diagnostic Terminal (DDT) to engine.

NOTE: *If either knock sensor is not functioning, #4 LED indicator light on DDT will be illuminated.*

2. Start engine, allow to warm up. Using SPECIAL FUNCTIONS portion of DDT, access KNOCK OUTPUT LOAD TEST.

Results: As throttle is advanced and engine is under load (in gear), numerical value on DDT display should increase. As throttle is retarded, numerical value should decrease indicating knock sensor/circuit is functioning. If numerical value does not change as throttle setting and load on engine varies, knock sensor or knock circuit in ECM is defective.

Throttle Position Sensor Test



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a - Throttle Position Sensor

Purpose: Determines whether Throttle Position Sensor is functioning properly through the use of the Digital Diagnostic Terminal (DDT). The Throttle Position Sensor is not adjustable.

1. Place outboard in water, connect Digital Diagnostic Terminal (DDT) to engine.

NOTE: *If throttle position sensor is not functioning, #4 LED indicator light on DDT will be illuminated.*

2. Start engine, allow to warm up. Using DATA MONITOR portion of DDT, access TPI VOLTS.

Results: As throttle is advanced, numerical value on DDT display should increase. As throttle is retarded, numerical value should decrease.

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.*

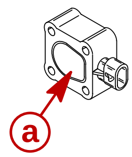
PRESSURE TEST

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:

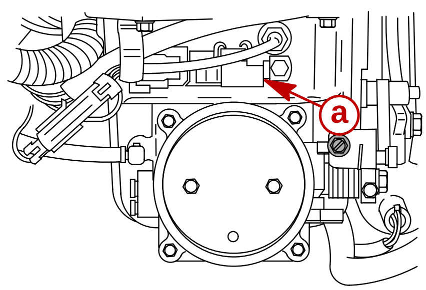
- Less than a couple of digits (i.e. 1.90 v to 1.92 v)

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.

MAP Sensor Test



58898

a - MAP Sensor

Purpose: Determines whether the Manifold Absolute Pressure (MAP) Sensor is functioning properly through the use of the Digital Diagnostic Terminal (DDT).

1. Place outboard in water, connect Digital Diagnostic Terminal (DDT) to engine.

NOTE: *If MAP sensor is not functioning, #4 LED indicator light on DDT will be illuminated.*

2. Start engine, allow to warm up. Using DATA MONITOR portion of DDT, access MAP PSI.

Results: As throttle is advanced, numerical value on DDT display should increase. As throttle is retarded, numerical value should decrease indicating MAP sensor is functioning. If numerical value does not change as throttle setting varies, MAP sensor is defective. The ECM would revert to a default of approximately 14.7 PSI (near sea level) should it not receive a signal from the MAP sensor.

Problem Diagnosis

Condition	Possible Source	Action
Engine Down On Power Or RPM	– Failed Ignition Coil	Refer to Section 2 Electrical and Ignition Tests.
	– Low Compression	Refer to Section 4 Power Head.
	– Broken Reed	Inspect Reeds.
	– Fuel Delivery Problem	Follow Low/High Pressure Fuel Route Flow Charts and Fuel Rail Electrical/Fuel Determination Flow Chart.
	– Fuel Rail Leak	Perform Fuel Rail Leak Test.
	– Vapor Separator Flooding Over, Engine Running Rich.	Check for fuel coming out of vapor separator vent hose.
	– Cylinder Head Temperature Sensor Circuit Failed.	Check cylinder head temperature sensor.
Poor Acceleration – Idles Ok, Top Speed Ok	– Improper EFI Set Up.	Refer to Section 2 Electrical and Ignition for proper EFI set up procedures.
	– Water Covering Idle Relief Exhaust Ports.	Boats with extended transoms or low engine mount can cause engine to load up on acceleration.
	– T.P.S. Failure.	Refer to page 3B-33.
	– MAP Sensor Failure	Refer to page 3B-34.
	– R.F.I. Problem*	Install BPZ8HS-10 Spark Plugs.

Condition	Possible Source	Action
Poor Acceleration – Idles Ok, Top Speed Ok (Continued)	– Timing Not Advancing.	Check Timing Advance with DDT.
Engine Surges Between 4000 And 5000 RPM	– Intermittant Ignition Coil Failure. – Final Filter Clogging. – T.P.S. – Injector Connector Problem. – Vapor Separator Flooding Over. – Injector Filter Clogged.	Refer to Section 2A Electrical and Ignition for tests. Perform Final Filter Check. Check TPS Operation with DDT Perform DDT Load Test and Ohms Test. Check for fuel coming out of vapor separator vent hose. Must be determined by elimination; mechanical, electrical and load tests
Engine Idles Ok But Stumbles At Off Idle Speeds	– Improper EFI Setup. – Failed Ignition Coil. – Failed Or Disconnected EFI Sensors. – Fuel Delivery Problem. – Manifold Fuel Leak. – R.F.I.* Problem. – Induction Manifold Air Leak. – MAP Sensor Failure.	Refer to Section 2C Electrical and Ignition for proper EFI set up procedures. Refer to Section 2A Electrical and Ignition Tests. Perform EFI sensor tests. Follow Low/High Pressure Fuel Route Flow Charts and Fuel Rail Electrical/Fuel Determination Flow Chart. Perform Induction Manifold Leak Check. Install BPZ8HS-10 Spark Plugs. Check manifold cover gasket, manifold to reed block housing gasket and reed block housing to crankcase gasket. Refer to page 3B-34.
Engine Idles Rough (May Lean Sneeze) – Acceleration Ok; Full Throttle Ok	– Improper EFI Setup. – MAP Sensor Failure.	Refer to Section 2C Electrical and Ignition for proper EFI set up procedures. Refer to page 3B-34.

Condition	Possible Source	Action
Engine Idles Rough (May Lean Sneeze) – Acceleration OK; Full Throttle Ok. (continued)	– Ignition Coil Failure. – Broken Reed.	Refer to Section 2A Electrical and Ignition Tests. Inspect Reed Assembly
Engine Runs but Slowly Drops RPM then Dies.	– Restrictions in Fuel System between Tank and Engine. – Clogged Final Filter. – Pulse Fuel Pump Failure. – Electric Fuel Pump Delivery Failure.	Install remote gas tank with fresh, high quality fuel. Perform Final Filter Check. Follow Low Pressure Fuel Route Flow Chart. Follow High Pressure Fuel Route Flow Chart.
Engine Stops for No Apparent Reason or Does Not Start.	– Battery Undercharged. – EFI Harness Connections. – Ignition System Failure. – Pulse Fuel Pump Failure. – Electric Fuel Pump Failure. – ECM Failure.	Check battery connections, under charged battery or worn out battery. Check EFI harness connector for improper connection. Refer to Section 2A Electrical and Ignition Tests. Follow Low Pressure Fuel Route Flow Chart. Follow High Pressure Fuel Route Flow Chart. The DDT (91-823686T2) will monitor information coming from sensors or switches to the ECM and will indicate if the sensor or switch is defective. For a more thorough analysis of the ECM, refer to EFI Tester Manual 91-11001A2.
Engine Stops for No Apparent Reason, but will Restart.	– Restriction in Fuel System	Check fuel pressure on fuel rail at the RPM that failure occurs.

*R.F.I. Radio Frequency Interference. High voltage can alter signals ECM receives from sensors causing improper fuel delivery. Route all sensor wires away from high voltage leads (i.e. spark plug leads)

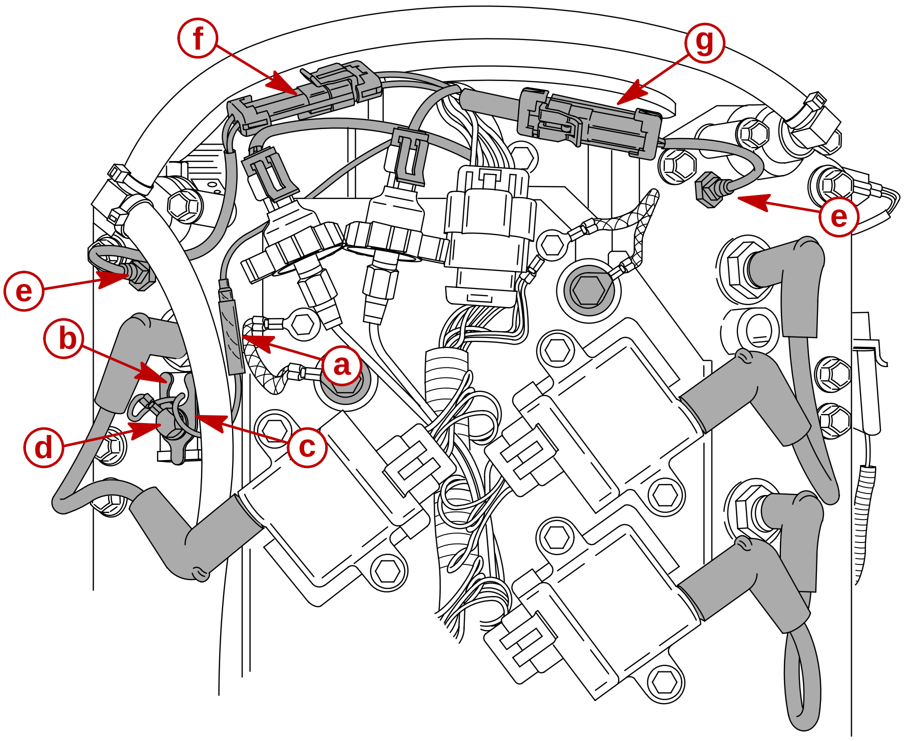
Engine Head Temperature Sensor Removal

ANALOG TEMPERATURE SENSOR

1. Remove screw and retaining plate.
2. Disconnect bullet connector and remove sensor.

DIGITAL TEMPERATURE SENSOR

1. Disconnect wire harness for PORT and STARBOARD sensors



a - Bullet Connector
b - Analog Temperature Sensor
c - Retainer
d - Retainer Screw
e - Digital Temperature Sensor
f - Port Sensor Harness
g - Starboard Sensor Harness

Engine Head Temperature Sensor Installation

ANALOG TEMPERATURE SENSOR

1. Install sensor into pocket.
2. Secure sensor with retainer and screw. Ground (BLACK) lead of sensor is secured with retainer screw. Torque retainer screw to 16.5 lb. ft. (22.4 Nm).
3. Reconnect sensor bullet connector.

DIGITAL TEMPERATURE SENSOR

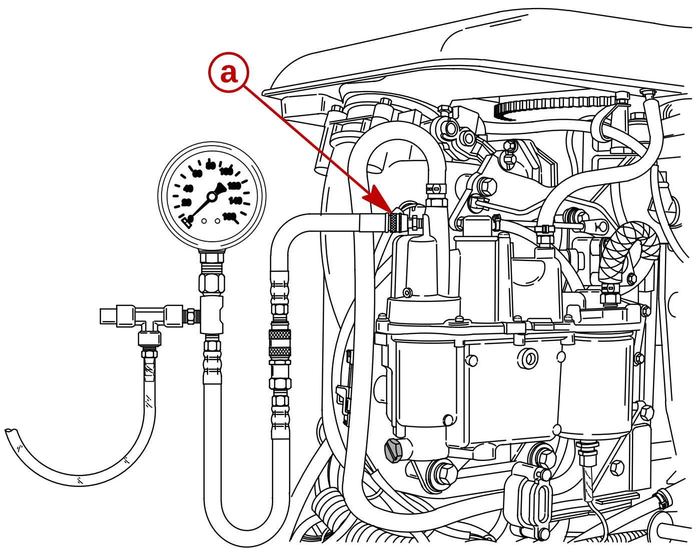
1. Install sensors into cylinder heads. Torque sensors to 14 lb. in. (1.6 Nm).
2. Reconnect sensor harness connectors.

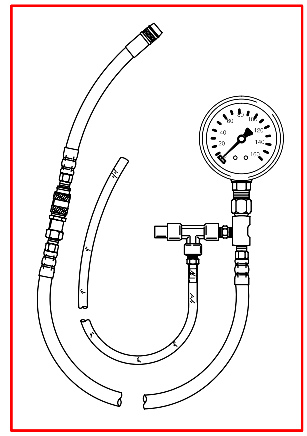
Fuel Management Assembly Removal

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

NOTE: *Use Fuel/Air Pressure Gauge 91-881834A1 to de-pressurize fuel system.*

1. De-pressurize fuel system.





91-881834A1

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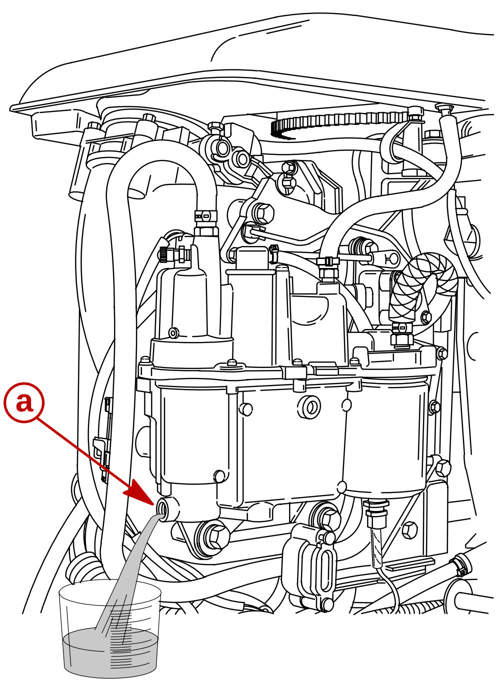
a - Fuel Pressure Port **b** - Fuel Pressure Gauge 91-881834A1

2. Place suitable container underneath vapor separator drain plug and remove plug.



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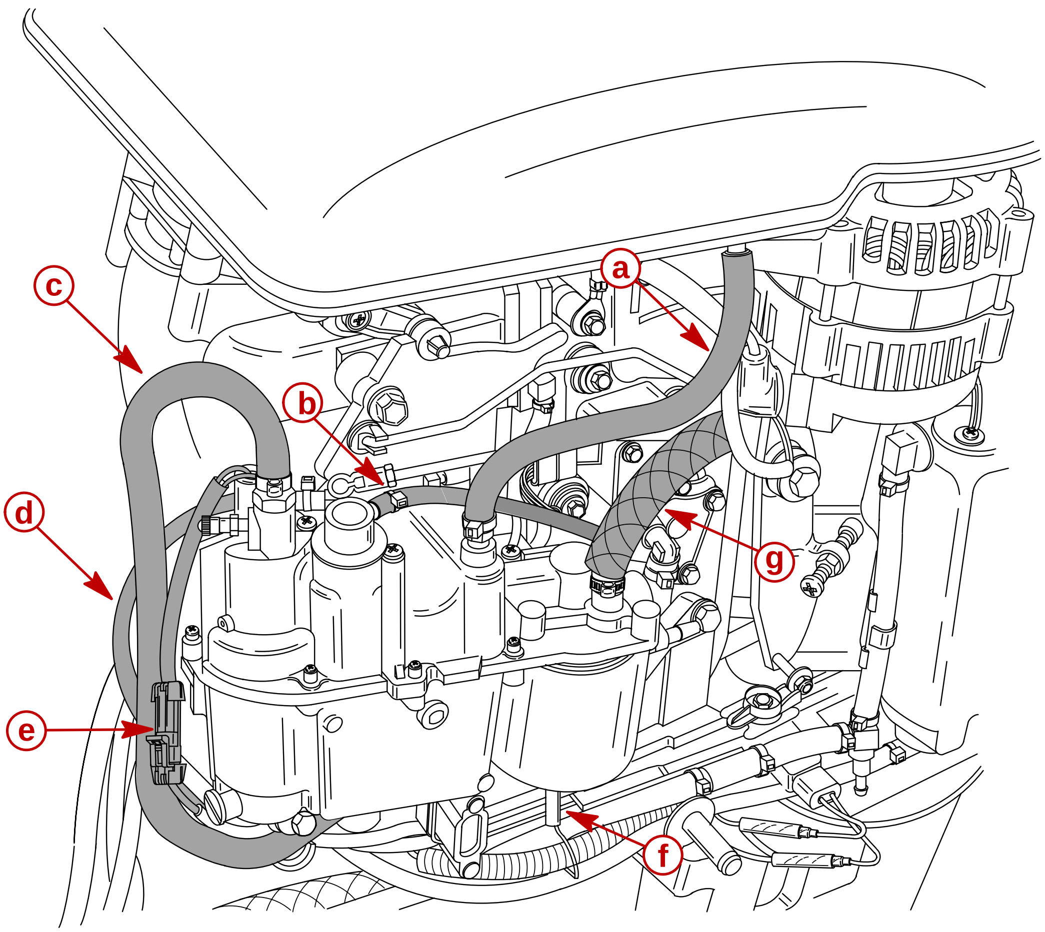
a - Drain Plug

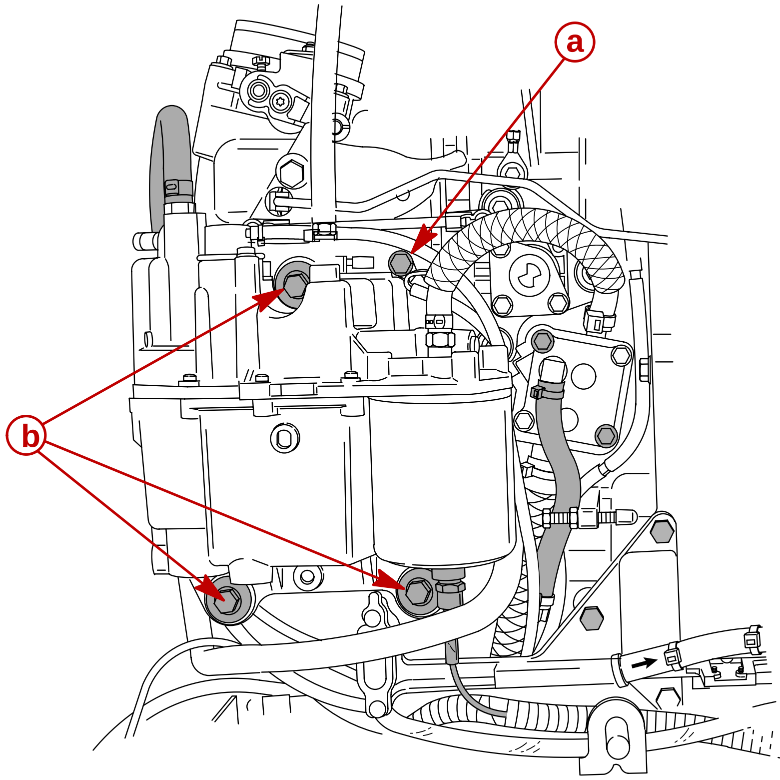
3. Disconnect the following hoses and connectors:



58878

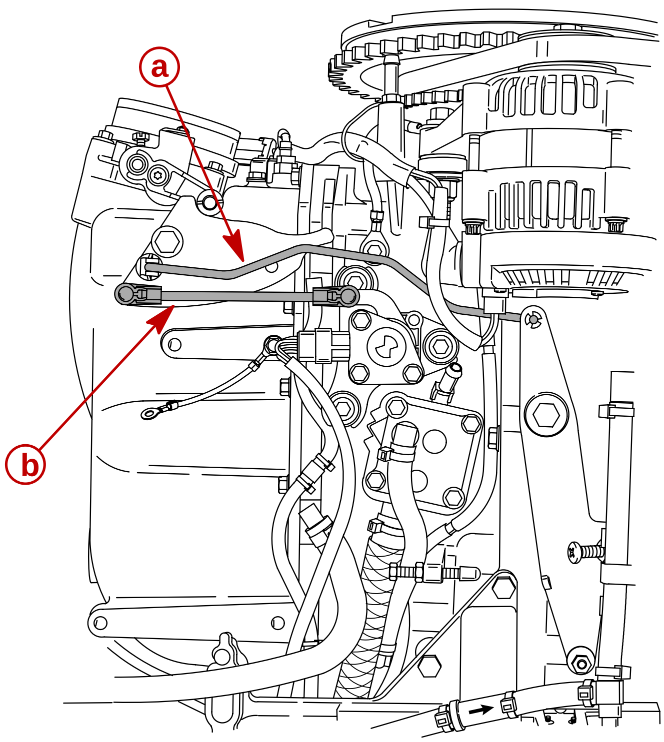
a - VST Vent Hose
b - Fuel Pressure Regulator Vent Hose
c - VST Output Fuel Hose
d - VST Oil Input Hose
e - VST Electric Fuel Pump Harness Connector
f - Water Sensor Bullet Connector
g - Fuel/Water Separator Input Fuel Hose

4. Remove ground lead between VST and air plenum.
5. Remove 3 bolts securing VST to air plenum and remove VST.



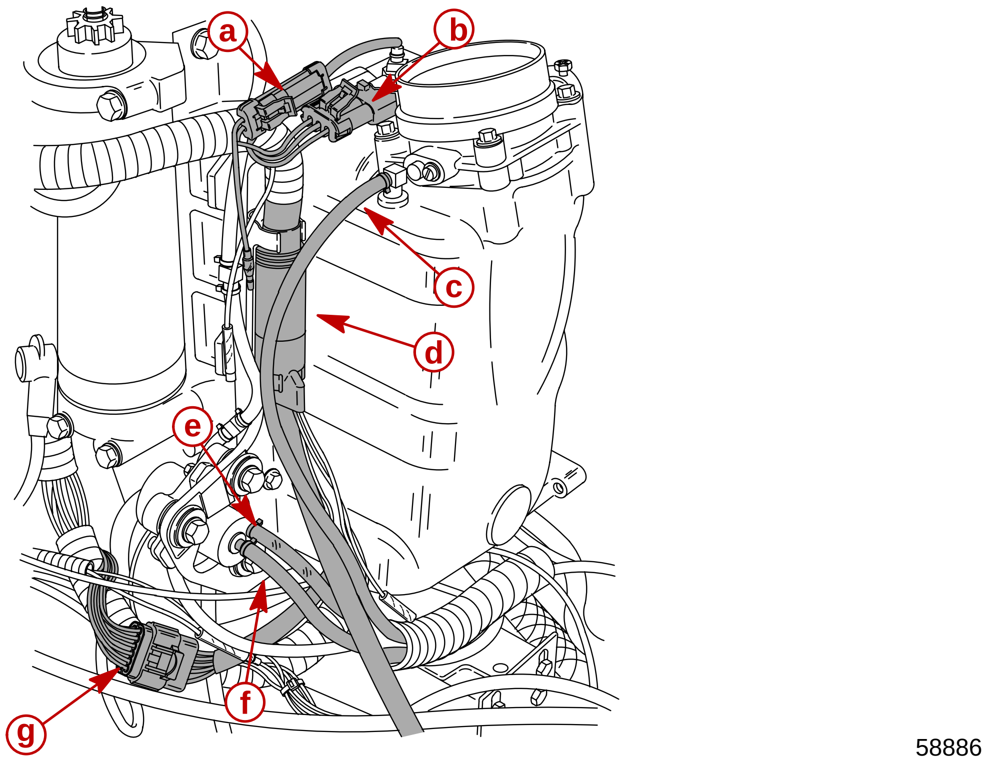
a - VST Ground Lead
b - VST Attaching Bolts

6. Disconnect throttle cam link rod and the Throttle Position Sensor link rod.



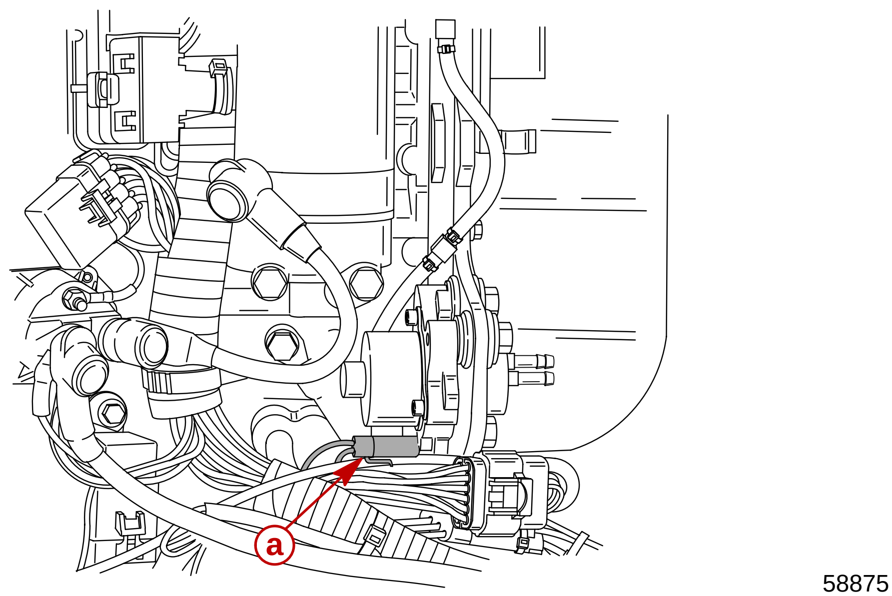
a - Throttle Cam Link Rod
b - Throttle Position Sensor Link Rod

7. Disconnect the following hoses and connectors:



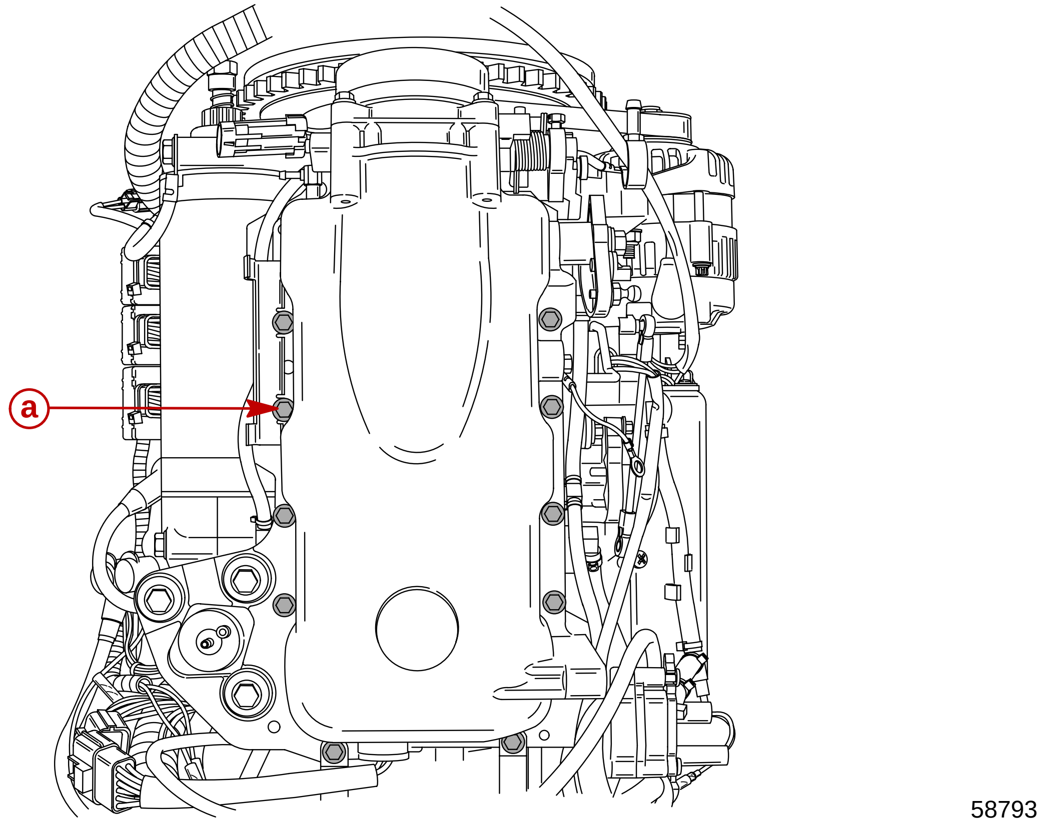
a - Air Temperature Sensor
b - MAP Sensor
c - Fuel Regulator Hose
d - Engine Harness
e - Oil Inlet Hose (plug to prevent leakage)
f - Oil Output Hose
g - Fuel Injector Harness Connector

8. Disconnect oil pump electrical harness.



a - Electrical Harness

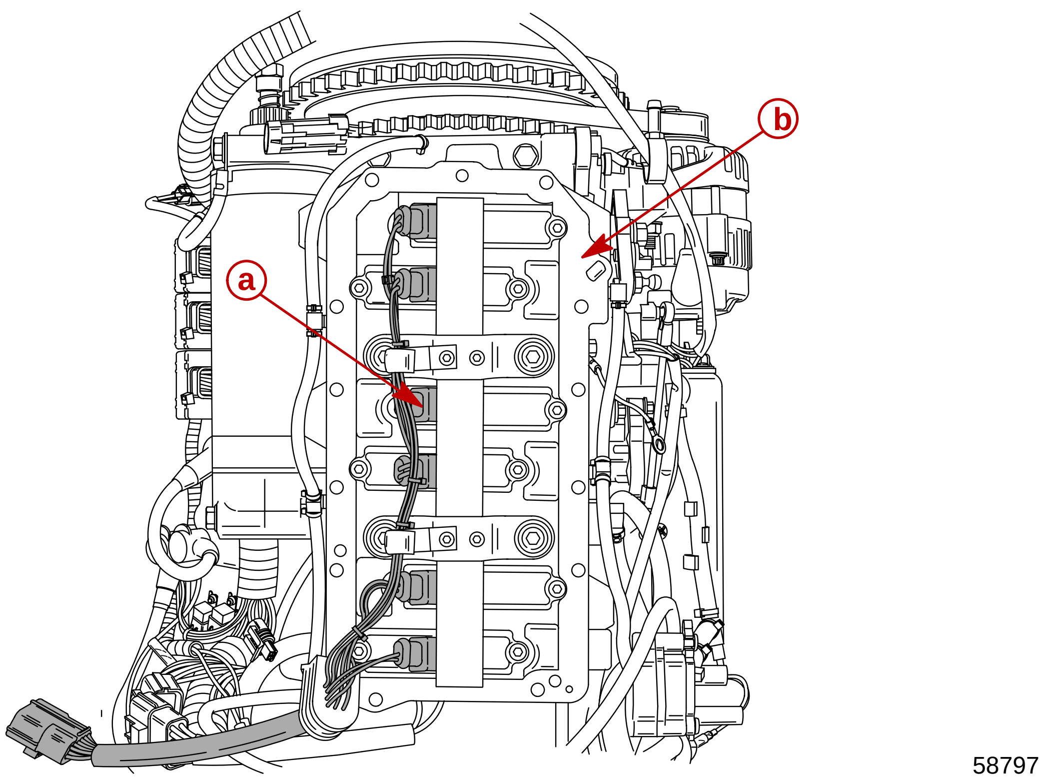
9. Remove 12 bolts securing air management assembly to crankcase and remove assembly.



a - Bolts (12 each)

Fuel Rail Removal

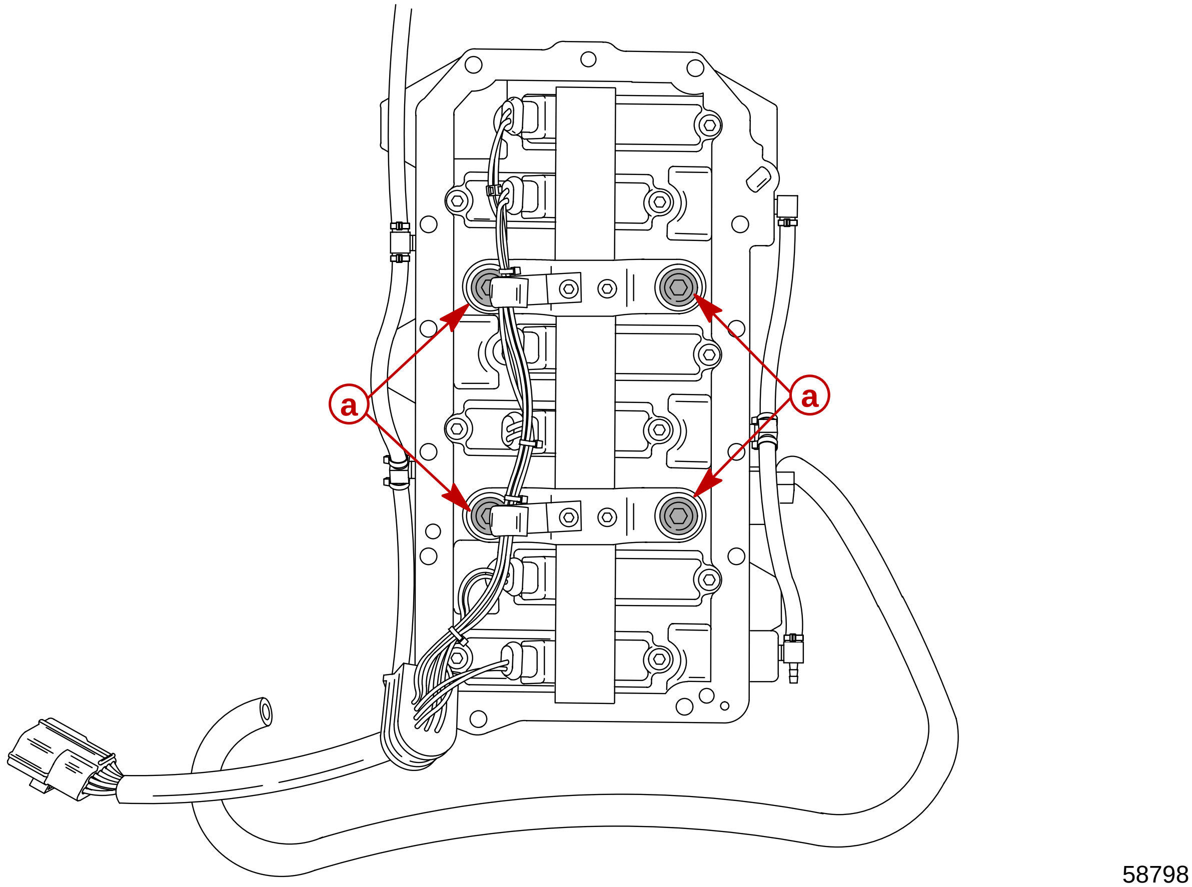
The fuel rail/injector assembly is attached to the reed block assembly plate by 4 screws.



a - Fuel Rail/Injector Assembly

b - Reed Block Assembly

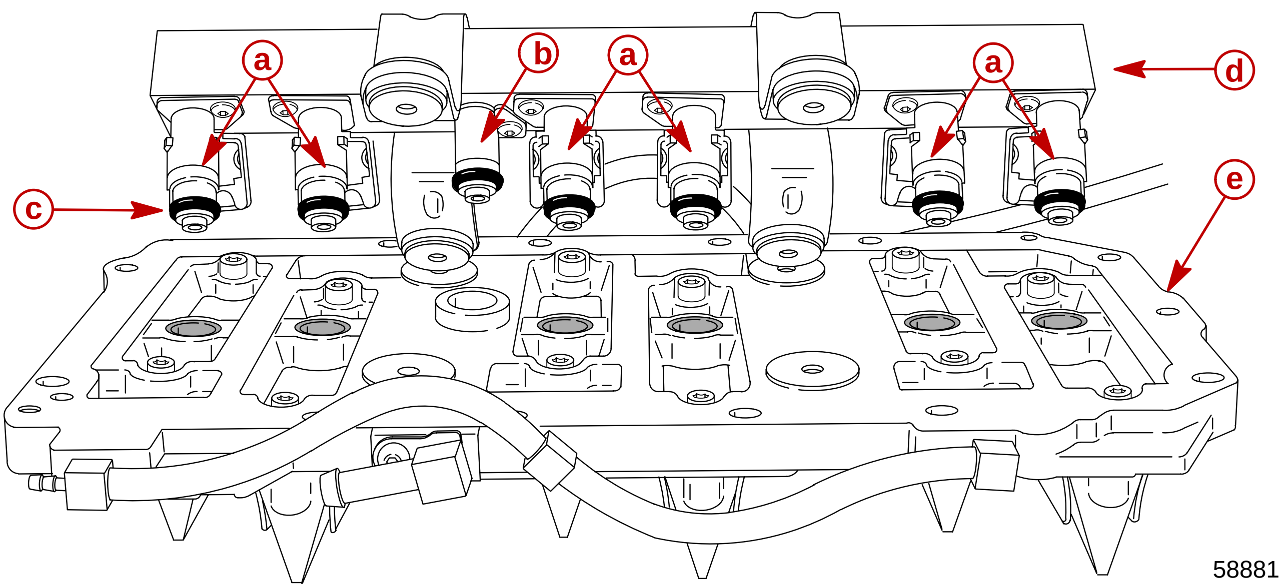
1. Remove 4 screws to securing fuel rail/injector assembly to reed block assembly.



a - Screws

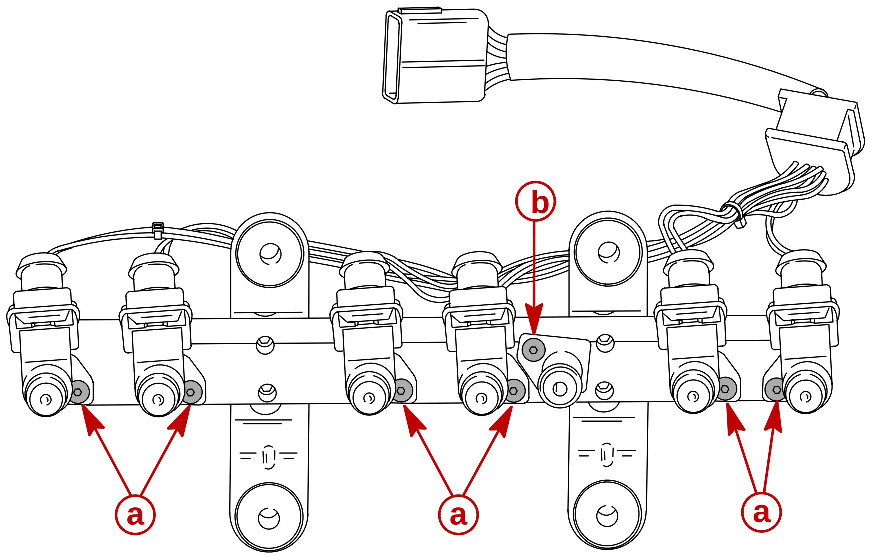
2. Lift fuel rail assembly from reed block assembly.

3. Inspect o-rings for cuts and abrasions. Replace if necessary.



a - Fuel Injectors (6)
b - Fuel Rail Fuel Inlet Pipe
c - O-Rings
d - Fuel Rail
e - Reed Block Assembly

4. Individual fuel injectors and fuel inlet pipe can be removed from fuel rail by removing attaching screws. Use Tamper Proof Torx Screw Set 91-881828 to remove screws.

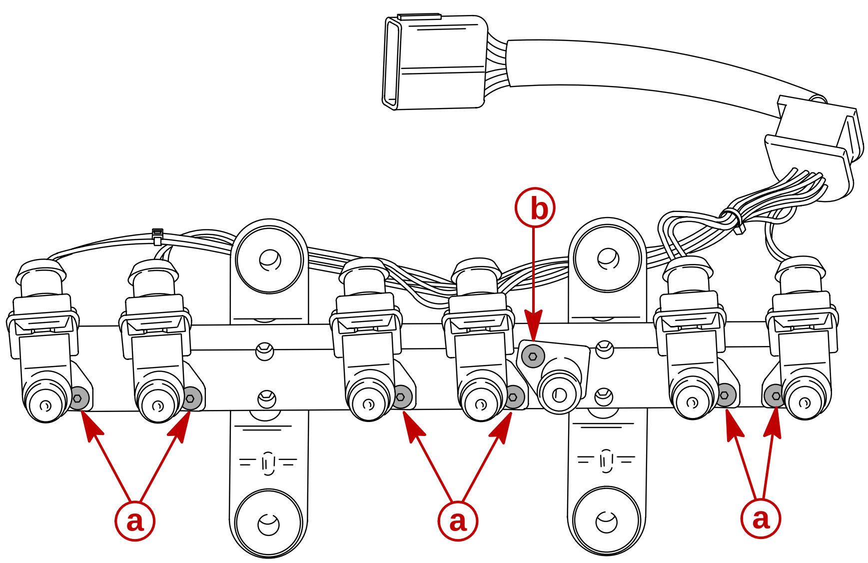


a - Fuel Injector Attaching Screws
b - Fuel Inlet Pipe Attaching Screw

Fuel Rail Installation

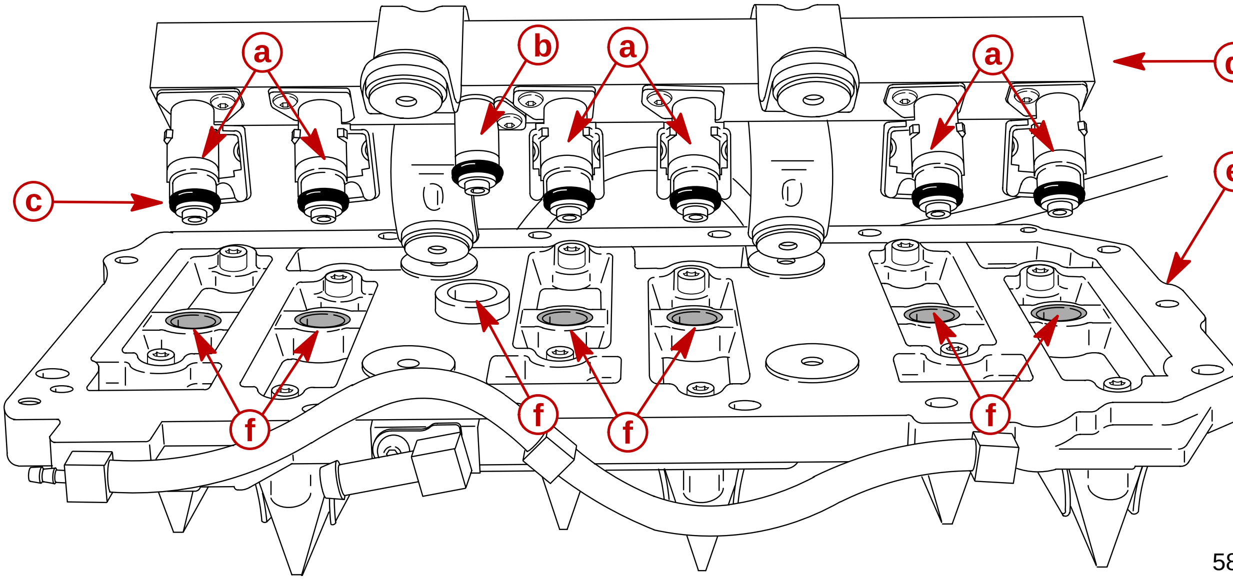
NOTE: *Inspect all o-rings for cuts and abrasions. Applying light oil to all o-rings and o-ring contact surfaces on reed block assembly plate will ease installation of fuel rail assembly.*

1. Secure fuel injectors to fuel rail with tamper proof screws. Torque screws to 27 lb. in. [3.0 Nm].
2. Secure fuel inlet pipe to fuel rail with tamper proof screw. Torque screw to 65 lb. in. [7.0 Nm].



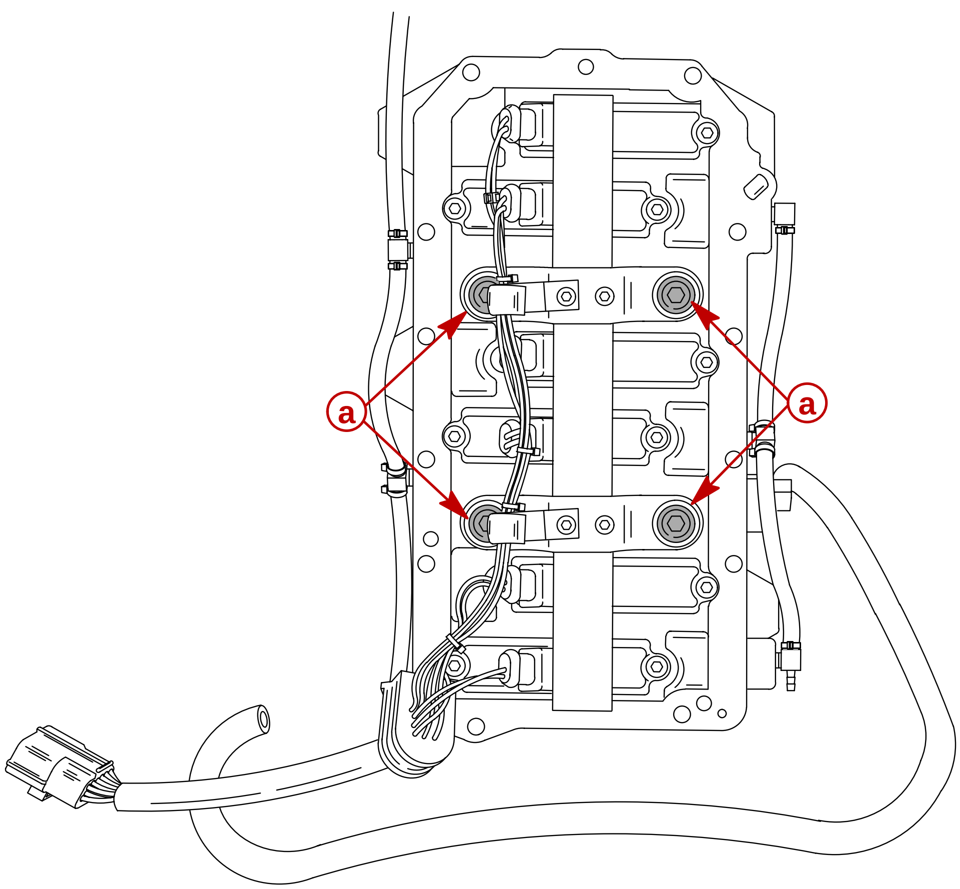
a - Fuel Injector Attaching Screws [Torque to 27 lb. in. (3.0 Nm)]
b - Fuel Inlet Pipe Attaching Screw [Torque to 65 lb. in. (7.0 Nm)]

3. Apply light oil to all o-rings and o-ring contact surfaces on reed block assembly plate to ease installation of fuel rail assembly.



a - Fuel Injectors (6)
b - Fuel Rail Fuel Inlet Pipe
c - O-Rings
d - Fuel Rail
e - Reed Block Assembly
f - O-Ring Contact Surface

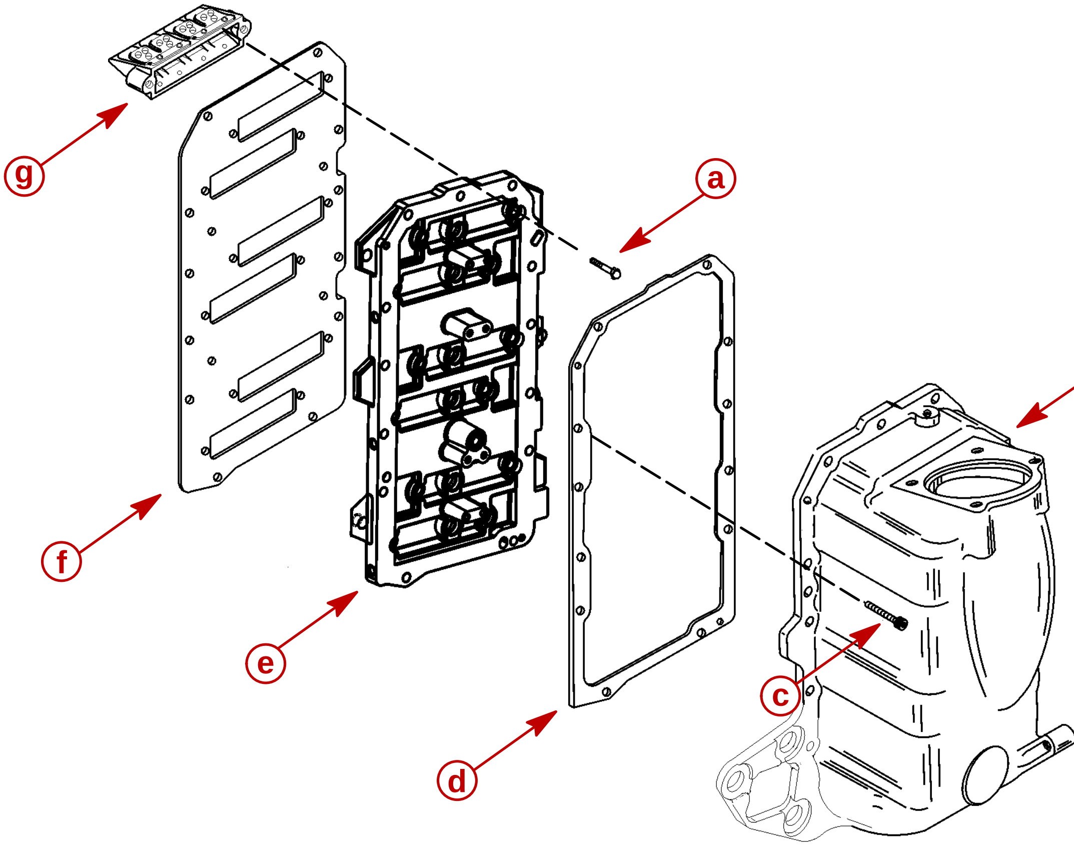
4. Secure fuel rail assembly to reed block assembly plate with 4 screws. Torque screws to 65 lb. in. [7.0 Nm].



a - Screws [Torque to 65 lb. in. (7.0 Nm)]

Reed Block Assembly Removal

1. Remove 12 screws securing air plenum to reed plate assembly.
2. Remove 12 screws securing reed blocks to reed plate assembly.



a - Screws (2 each per reed block) (M4x16)
b - Air Plenum
c - Screws (12 each) (1/4x20x0.88)
d - Gasket
e - Adaptor Plate
f - Gasket
g - Reed Block (6 each)

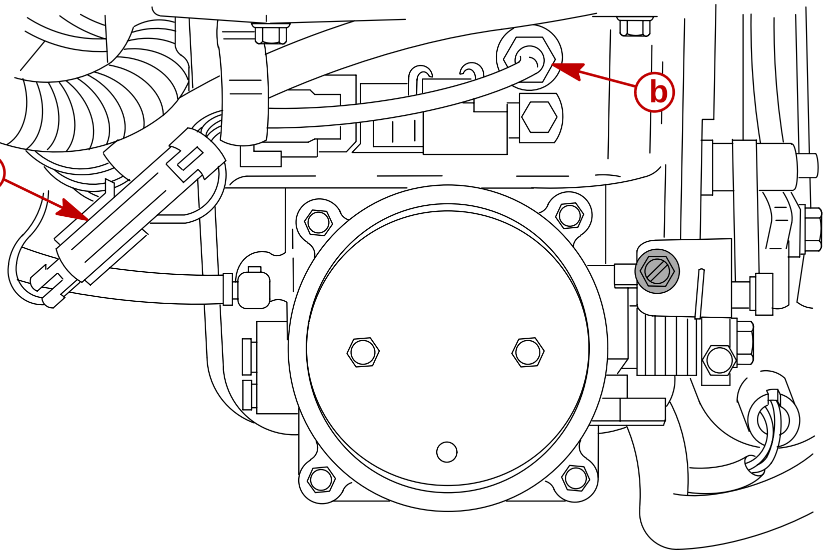
Reed Block Assembly Installation

NOTE: *The gasket between the air plenum and the adaptor plate has a sealing bead which faces toward the air plenum during assembly. Gaskets may be reused if they do not show signs of tears, abrasions or oil saturation. Replace gaskets if necessary.*

1. Secure reed block assembly to adaptor plate with 2 screws. Torque screws to 105 lb. in. (11.8 Nm).
2. Secure air plenum and adaptor plate/reed block assembly to cylinder block crankcase with 12 screws. Torque screws to 15 lb. ft. (20 Nm).

Air Temperature Sensor Removal

Disconnect sensor harness and unscrew sensor.



58898

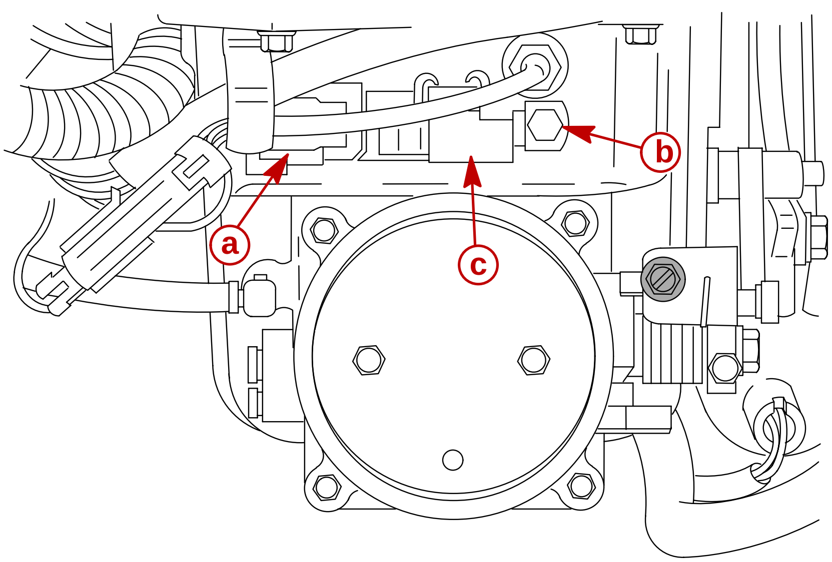
a - Temperature Sensor Harness **b** - Air Temperature Sensor

Air Temperature Sensor Installation

1. Carefully thread sensor into air plenum. Torque sensor to 14 lb. in. (1.6 Nm).
2. Reconnect sensor harness.

Manifold Absolute Pressure (MAP) Sensor Removal

1. Disconnect MAP sensor harness connector.
2. Remove sensor retaining screw.



58898

a - MAP Harness Connector
b - Retaining Screw
c - MAP Sensor

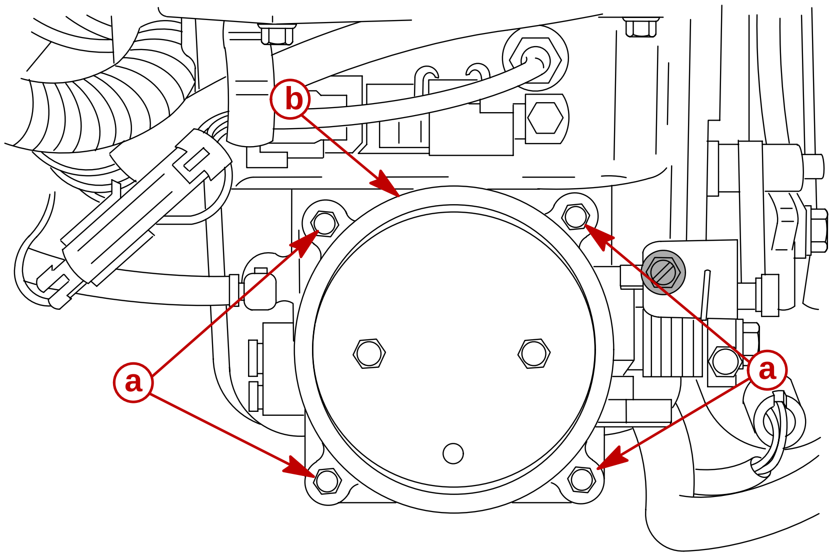
Manifold Absolute Pressure (MAP) Sensor Installation

1. Secure MAP sensor with screw. Torque screw to 80 lb. in. (9.0 Nm).
2. 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.



58898

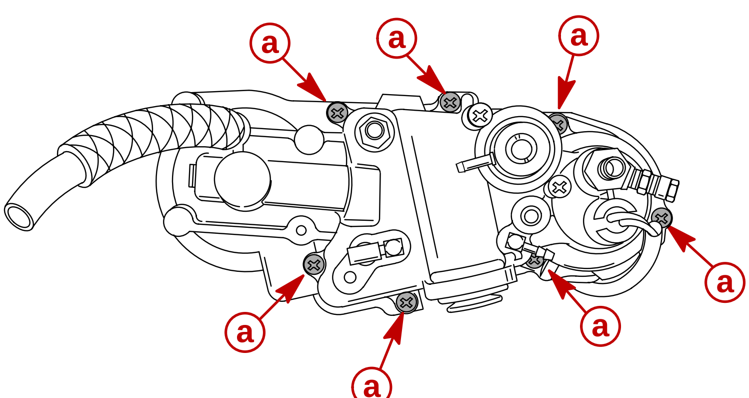
a - Bolts
b - Throttle Plate Assembly

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 with Teflon Marine Lubricant (92-825407A12) to seal lips.



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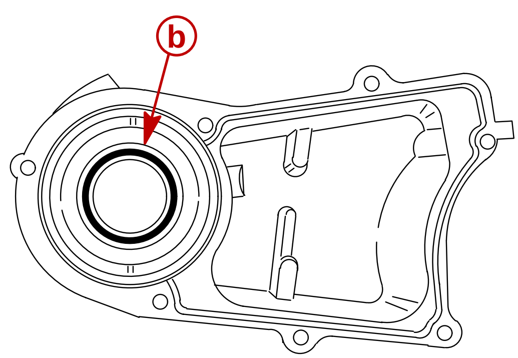


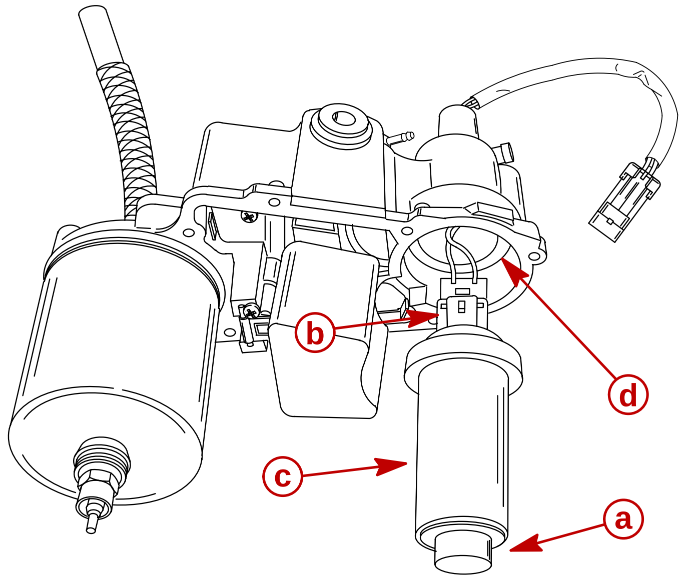
58783

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.

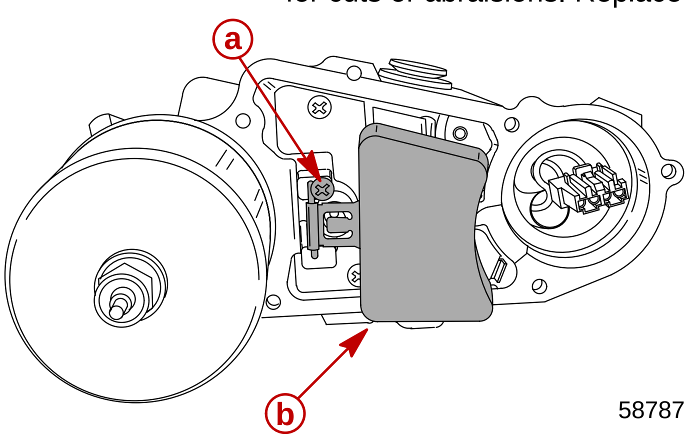
4. Disconnect harness from pump to separate pump from cover. Inspect filter screen for debris. Screen may be pried out of pump and cleaned as required.
5. Inspect seal above fuel pump for cuts or abraisions. Replace seal if necessary. Apply 2-4-C w/Teflon to seal lips.



58786

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 gasket and inspect imbedded neoprene sealing bead on both sides of gasket for cuts or abraisions. Replace gasket/seal assembly as required.



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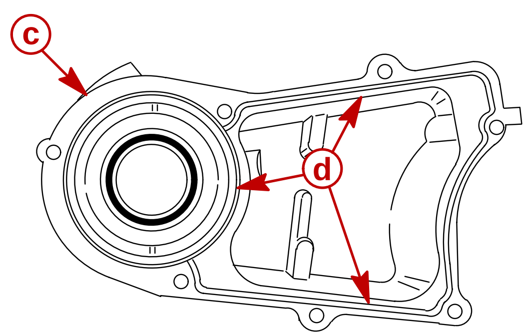


58783

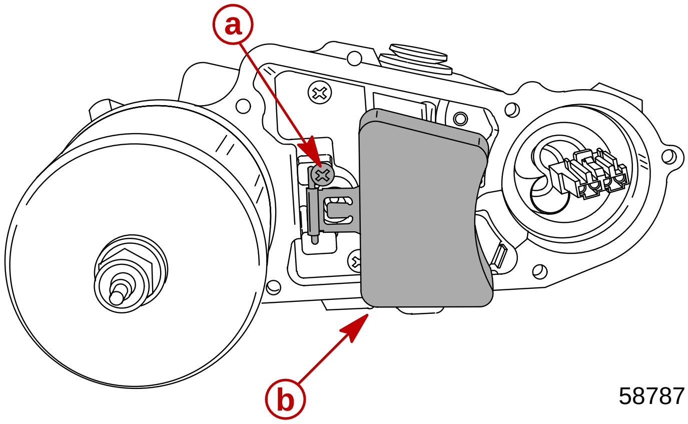
a - Screw
b - Float
c - Gasket
d - Sealing bead

Vapor Separator Reassembly

NOTE: *Inspect VST cover gasket with sealing bead for cuts or abrasions. Replace if necessary. Inspect fuel pump seal in VST cover for cuts or abrasions. Replace if necessary.*

1. Install gasket w/sealing bead 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 with Teflon to lips of seal in separator cover.



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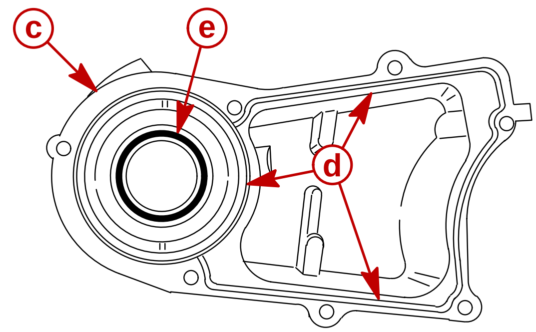
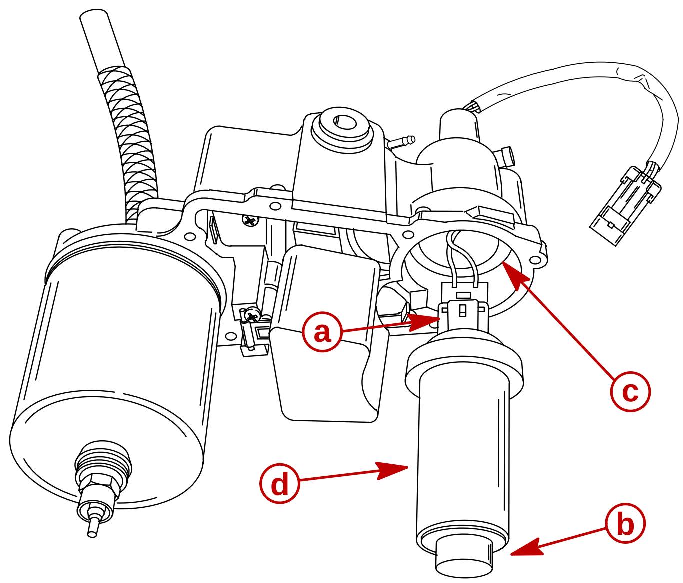


58783

- **a** - Screw [Torque to 10 lb. in. (1.0 Nm)]
- **b** - Float
- **c** - Gasket
- **d** - Sealing Bead
- **e** - Seal (Seal shoulder faces OUT)

4. Connect electrical harness to fuel pump. Inspect fuel pump filter screen for debris. Remove screen and clean as required.

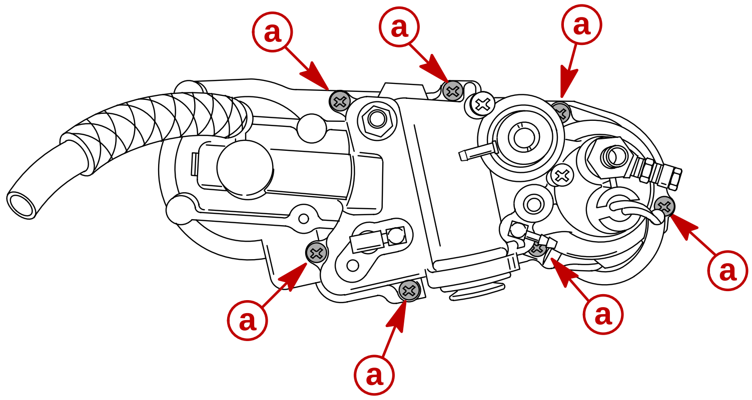
5. Seat fuel pump and harness into separator cover being careful not to pinch harness.



58786

- **a** - Harness
- **b** - Filter
- **c** - Seal
- **d** - Fuel Pump

6. Install separator cover with pump onto separator tank.
7. Secure cover to tank with 7 screws. Torque screws to 30 lb. in. (3.5 Nm).

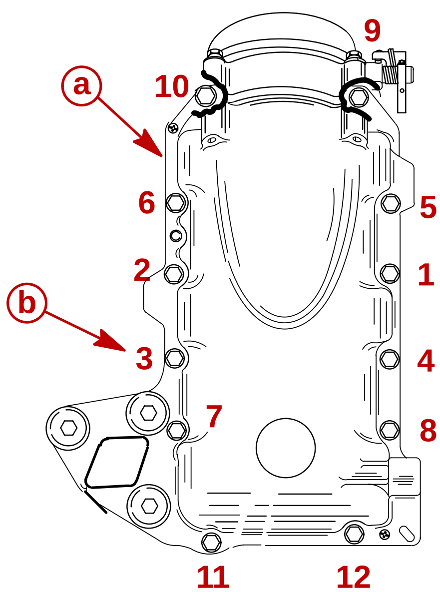


58784

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

Air Plenum Installation

Secure plenum to crankcase with 12 bolts. Torque bolts to 125 lb. in. (14 Nm). in sequence shown

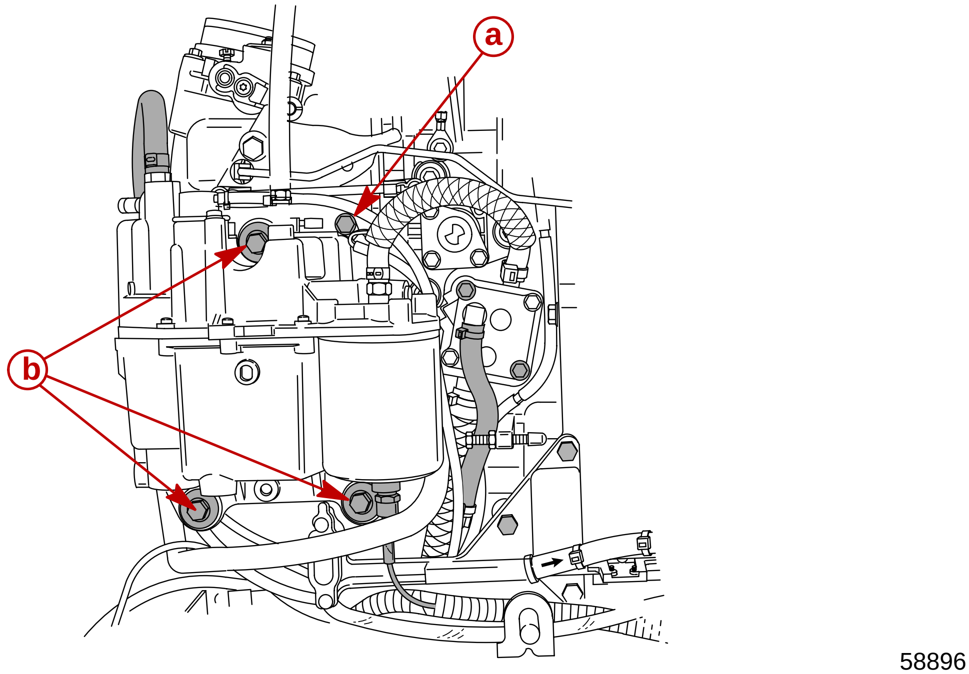


56144

a - Air Plenum
b - Bolts [Torque to 125 lb. in. (14 Nm)]

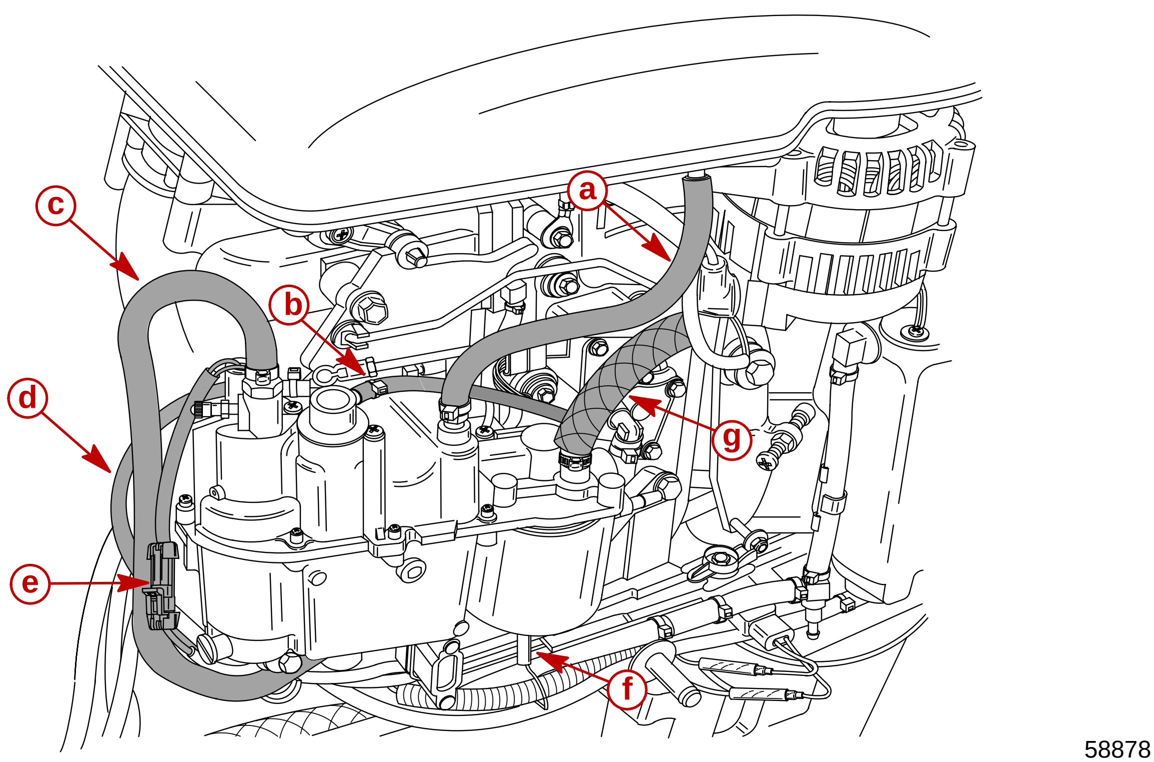
Vapor Separator (VST) Installation

1. Install ground lead between VST and air plenum.
2. Install 3 bolts securing VST to air plenum. Torque bolts to 140 lb. in. (16 Nm).



a - VST Ground Lead
b - Bolts [Torque to 140 lb. in. (16 Nm)]

3. Reconnect the following hoses and connectors:

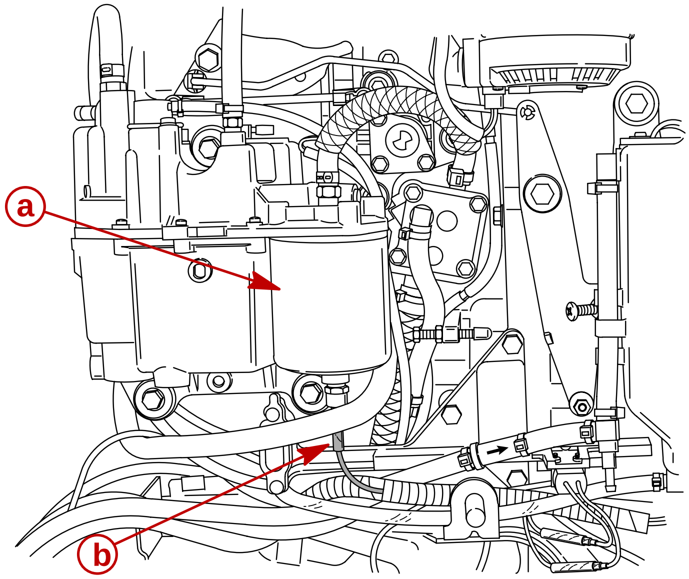


a - VST Vent Hose
b - Fuel Pressure Regulator Vent Hose
c - VST Output Fuel Hose
d - VST Oil Input Hose
e - VST Electric Fuel Pump Harness Connector
f - Water Sensor Bullet Connector
g - Fuel/Water Separator Input Fuel Hose

Water Separating Filter Assembly Removal

NOTE: *To inspect or replace water separator, it is not necessary to remove inlet fuel line.*

1. Remove water sensor lead from bottom of separator.
2. With wipe towels available, use Strap Wrench (91-24937A1) to remove water separator.



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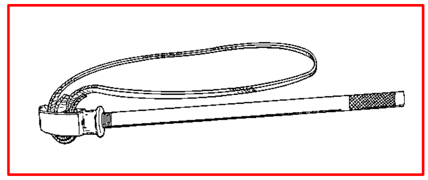


91-24937A1

a - Water Separator
b - Water Sensor Lead

Water Separating Filter Assembly Installation

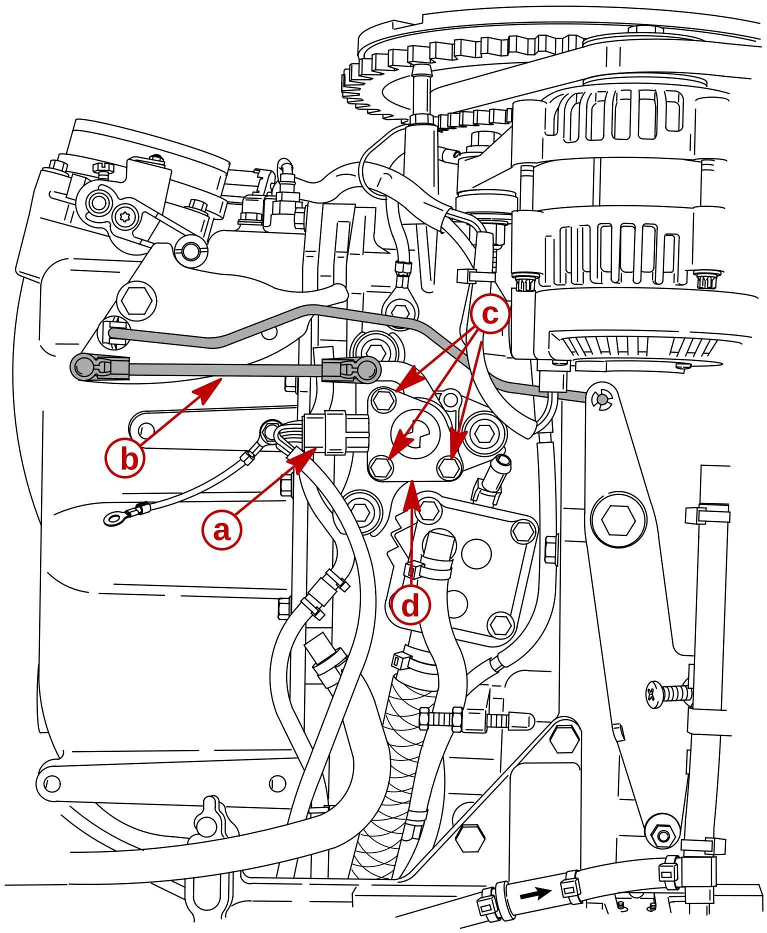
IMPORTANT: Apply a light coat of outboard oil to the rectangular sealing ring on the water separator before installation.

1. After applying oil to sealing ring of water separator, install separator onto bracket.
2. HAND TIGHTEN SEPARATOR. DO NOT use strap wrench or other tool to tighten separator.
3. Reconnect water sensor lead to bottom of separator.

Throttle Position Sensor Removal

NOTE: *Vapor Separator has been removed for visual clarity.*

1. Remove throttle position sensor (TPS) harness connector.
2. Remove sensor link rod.
3. Remove 3 screws securing sensor.



58871

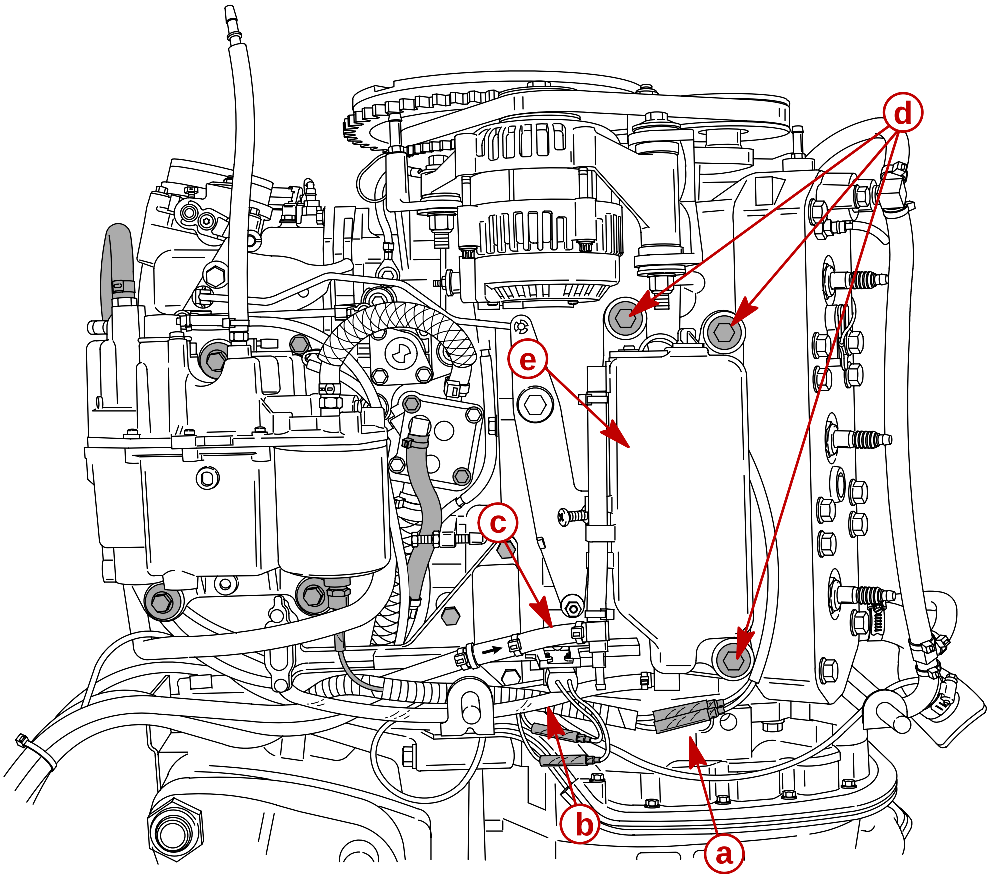
a - Sensor Harness Connector
b - Sensor Link Rod
c - Retaining Screws
d - Throttle Position Sensor

Throttle Position Sensor Installation

1. Secure sensor with 3 screws. Torque screws to 70 lb. in. (8.0 Nm).
2. Reconnect sensor harness.
3. Reconnect sensor link rod.

Oil Reservoir Removal

1. Disconnect low oil sensor bullet connectors (BLUE leads).
2. Remove sta-strap securing reservoir hose to oil pump and remove hose. Plug hose to prevent leakage.
3. Remove oil input hose to oil reservoir from check valve.
4. Remove 3 screws and remove reservoir.



58896

a - Bullet Connectors
b - Reservoir Hose
c - Oil Input Hose
d - Screws
e - Oil Reservoir

Oil Reservoir Installation

1. Secure oil reservoir to engine with 3 screws. Torque screws to 14 lb. ft. (19 Nm).
2. Secure oil reservoir hose to oil pump with sta-strap.
3. Secure oil input hose to check valve with sta-strap.
4. Reconnect low sensor bullet connectors.

Fuel Pressure Regulator Removal

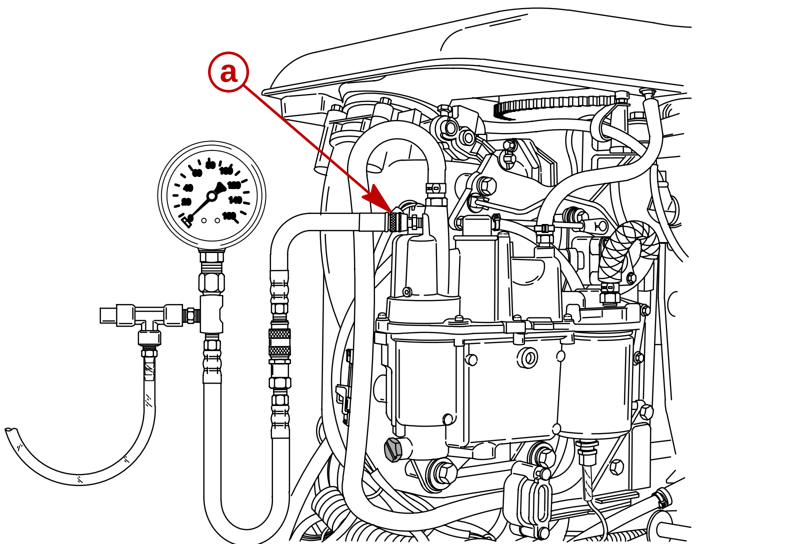
1. Disconnect boat battery from engine harness.

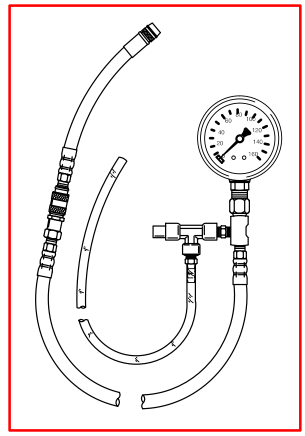
⚠ CAUTION

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

NOTE: *Use Fuel/Air Pressure Gauge 91-881834A1 to de-pressurize fuel system.*

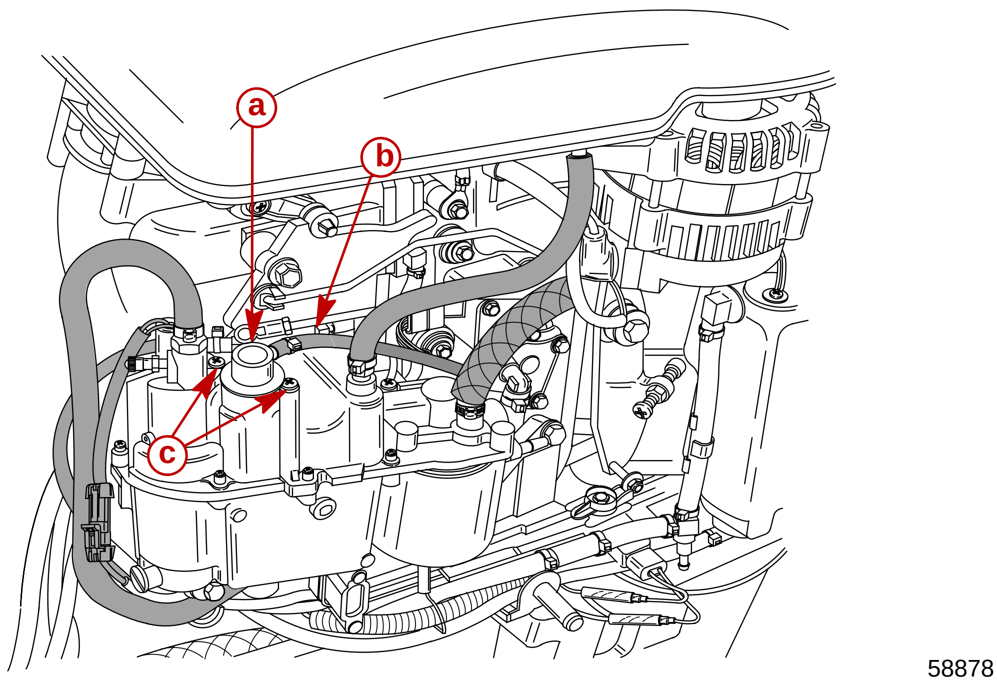
1. De-pressurize fuel system.





a - Fuel Pressure Port

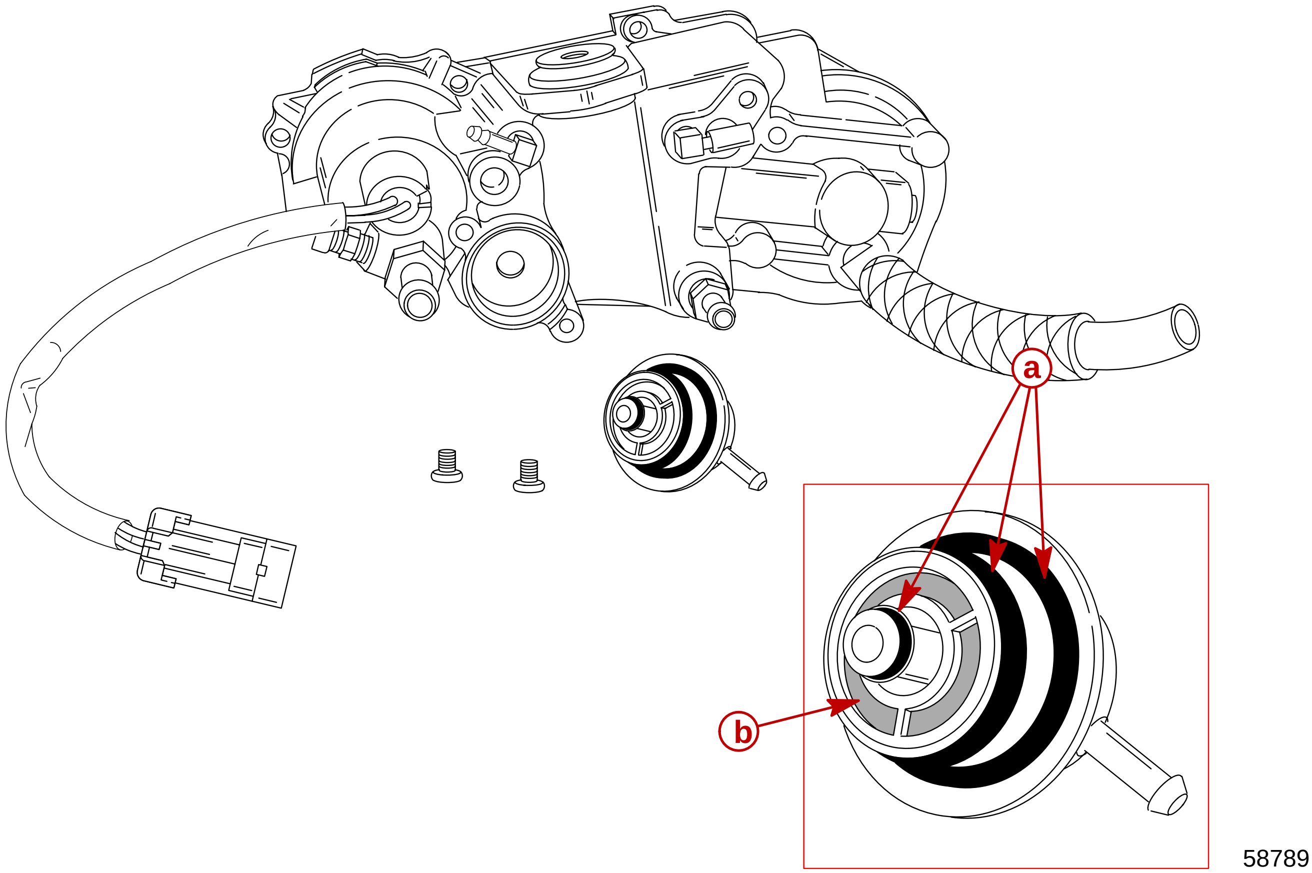
2. Remove fuel regulator vent hose from pressure regulator.
3. Remove 2 screws securing regulator to separator and remove regulator.



a - Fuel Pressure Regulator
b - Regulator Vent Hose
c - Screws

Fuel Pressure Regulator Disassembly

1. Inspect O-rings for cuts and abraisions. Replace as required.
2. Inspect fuel filter for debris. Clean with solvent as required.



a - O-Rings
b - Filter

Fuel Pressure Regulator Reassembly

1. Reinstall fuel regulator into vapor separator.
2. Secure regulator with 2 screws. Drive screws tight.
3. Reconnect regulator vent hose.

EFI System Cleaning and Inspection

Cleaning

1. Clean all non-electrical metal parts using a good grade solvent.
2. Use a soft bristle brush for removing large accumulations of dirt or grease and oil.
3. Varnish type coating of induction manifold parts may be removed using carburetor cleaner.
4. Wiring harnesses can be wiped down with a slightly solvent dampened rag.
5. Clean all fuel passages in induction manifold.
6. Dry all components using clean lint free cloths that are free of abrasives such as metal shavings or dirt.
7. Compressed air may be used to dry parts if the air used is free of moisture and unlubricated.

Inspection

1. Look at entire system for signs of an obvious problem such as poor condition of wire insulation, leaking fitting, cracked or loose hoses and lines.
2. Look for fuel or oil leaks wherever these fluids are used (i.e. fuel filter cap, fuel pump, vapor separator cap, etc.).
3. Check for signs of tampering or abuse such as modifications to wiring or hose routing.
4. Look at main connector between engine harness and ECM box for missing, corroded or bent contact pins and socket. Check for dislodged grommet in ECM where harness enters box.
5. Look at all sensors (throttle position, air temperature and water temperature) connectors and harnesses for bad connections or poor insulation conditions such as fraying, stripping, cracks or signs of abrasion wear.
6. Look for loose, missing or damaged mounting hardware such as stripped threads on screws.
7. Look at sensors for signs of wear or damage such as cracks, chips, etc.
8. Look at filter housing for cracks, holes or other damage. Check for secure mounting.
9. Look at vapor separator for leaks, cracks, pitting or other damage.
10. Check all rubber mounting grommets for swelling tears, cracks or other conditions that would render parts unserviceable.
11. Check vapor separator float for signs of fuel entry in the float. Look at needle for wear of point.
12. Look at injectors for signs of plugging or looseness in fit with induction manifold.
13. Look at throttle linkage for bends, kinking or binding. Check spring for kinks.
14. Inspect all rubber seals and gaskets for swelling, cracks or slices that would cause improper sealing.

FUEL SYSTEM

Section 3C - Oil Injection

Table of Contents

3
C

Specifications

OIL INJECTION	**Recommended Oil** **Oil Tank Capacity** **Approx. Time** **– Model 150XRI/175XRI/200XRI** **Reserve Capacity/Approx. Time** **Oil Pump Output** **– Model 150XRI/175XRI/200XRI**	Quicksilver TC-W3 3 gal. (11.4 Liter) 6.6 hrs. Approx. 0.74 qt. (0.70 Liter) 20–25 min. 26cc during auto prime time period

CAUTION

Be careful not to get dirt or other contamination in tanks, hoses or other components of the oil injection system during installation.

Operation of the Oil Injection System

The oil injection system delivers oil mixture on engine demand, from 120:1 at idle to 50:1 at wide open throttle.

Oil is stored inside a remote oil tank in the boat. This tank holds enough oil for approximately 150 gallons of fuel at wide open throttle.

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 engine oil reservoir contains enough oil for 20–25 minutes of full throttle running after the remote oil tank is empty. The warning horn will sound if the oil level in the engine oil reservoir is low.

The oil pump is ECM driven and pumps oil to the vapor separator tank where it mixes with fuel supplied by the engine mounted pulse pump.

The ECM is programmed to automatically increased the oil supply to the engine during the initial engine break-in period. The oil ratio during the first 120 minutes is 100:1 @ idle and 40:1 @ wide open throttle. After the first 120 minutes, the oil ratio changes to 120:1 @ idle and 50:1 @ wide open throttle.

Final Checks Before Operation of Engine

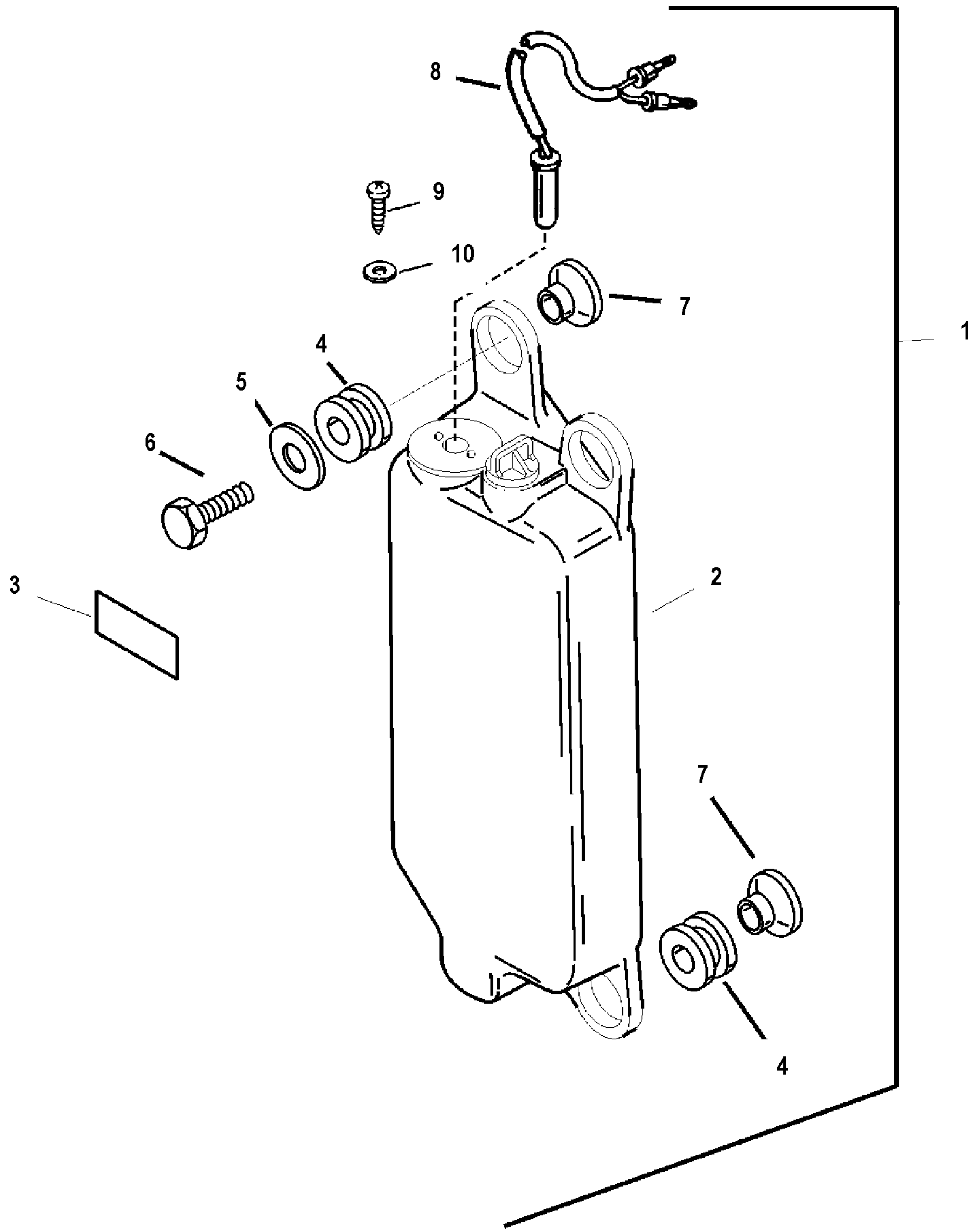
- Make sure fill cap gaskets are in place and caps are tight on engine oil reservoir and remote oil tank.
- Be certain the warning horn is installed and is operational. Refer to Instrument and Warning Horn Installation.
- Each time the key switch is turned from the “OFF” to “ON” position (engine not running); the warning horn will sound momentarily. This tells you the warning system for the oil injection system is functional and the warning horn is operational. If warning horn does not sound or horn stays on when key is turned to the “ON” position, refer to oil injection system troubleshooting chart following to correct the problem.

Checking Operation of the Oil Injection System (Engine Running)

1. Operate engine following the break-in procedure outlined in the Operation and Maintenance Manual. If warning horn should sound an intermittent “beep,” “beep,” “beep” during operation, this indicates low oil level in the engine mounted oil reservoir. Refer to troubleshooting following, to correct the problem.
2. After engine has been run for a short time, check that no oil is leaking out of engine oil reservoir fill cap.

Notes:

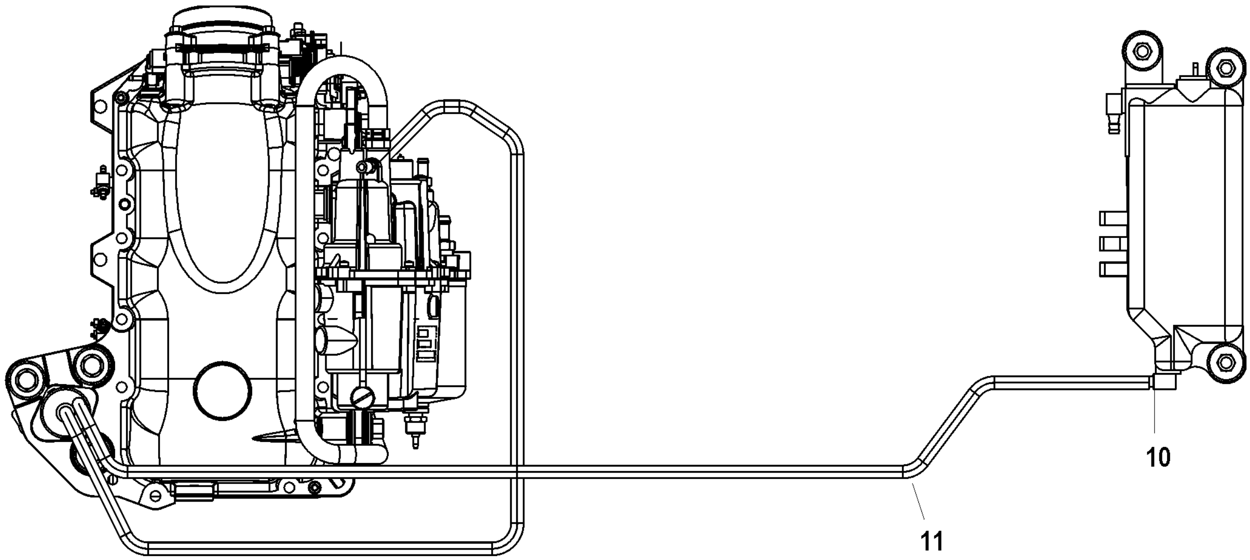
Oil Injection Components

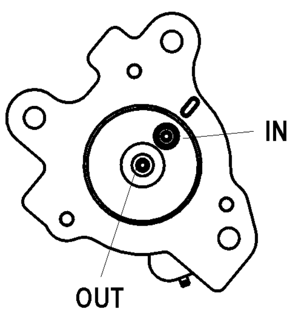


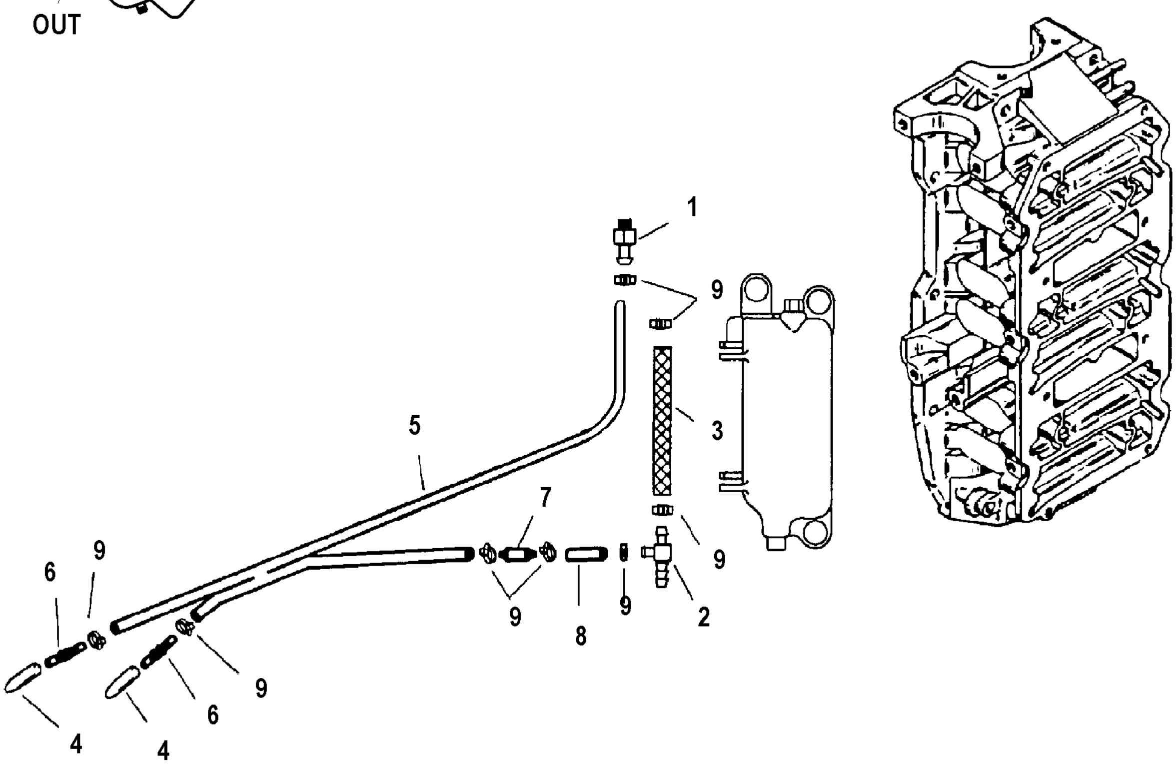
Oil Injection Components

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	OIL RESERVOIR ASSEMBLY			
2	1	OIL RESERVOIR			
3	1	DECAL-RESERVOIR			
4	3	GROMMET			
5	3	WASHER			
6	3	SCREW [5/16-18 x 1-1/4 IN)		15	20
7	3	BUSHING			
8	1	SWITCH			
9	1	SCREW [0.164-18 x 1-1/4 IN)	Drive Tight		
10	1	WASHER			

Oil Lines



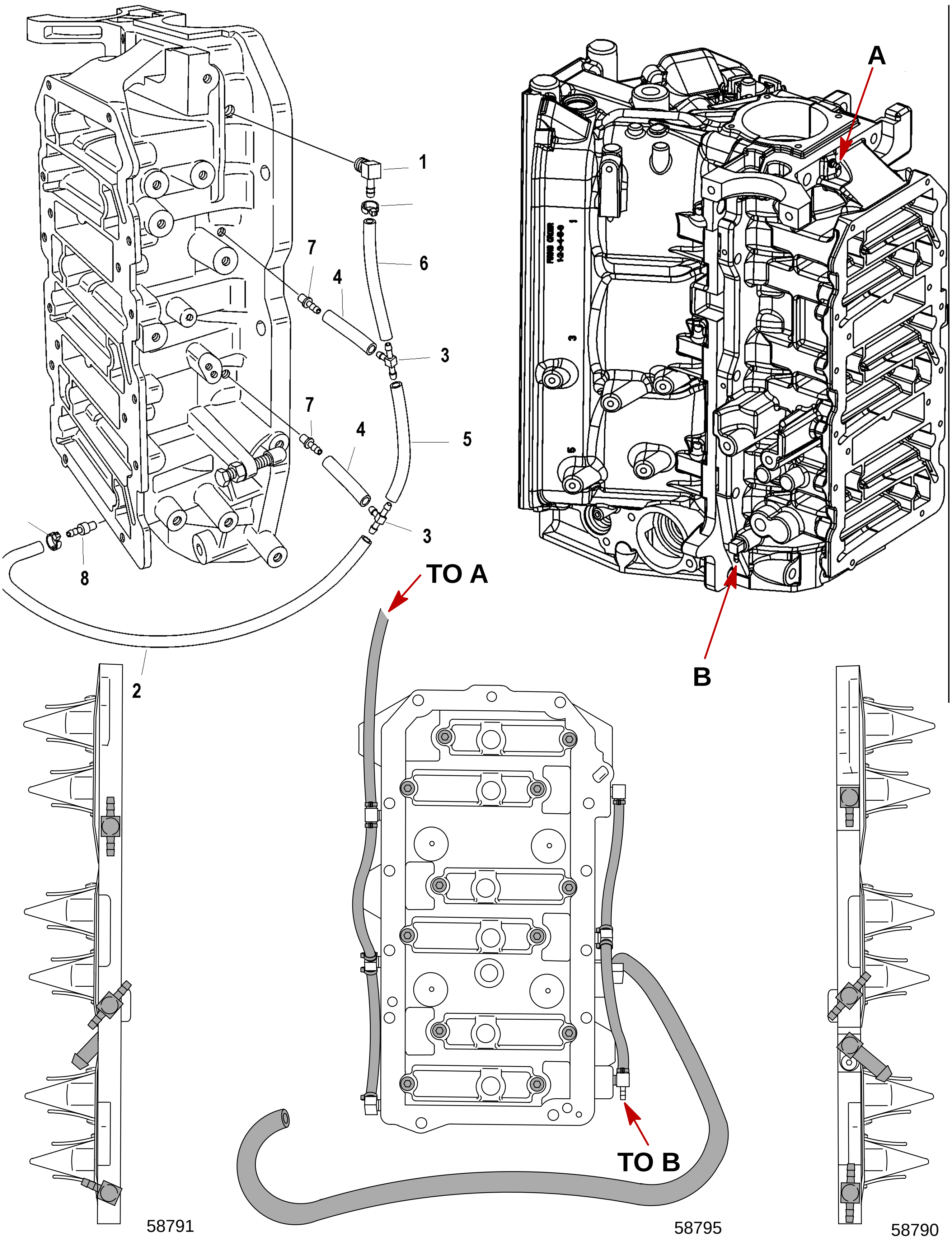




Oil Lines

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	FITTING			
2	1	TEE FITTING			
3	3	TUBING [6 IN (15.2 CM)]			
4	2	CAP			
5	1	HOSE ASSEMBLY			
6	2	FITTING			
7	1	FUEL FILTER			
8	1	HOSE			
9	AR	STA-STRAP [8 IN (20.3 CM)]			
10	AR	STA-STRAP [5-1/2 IN (14 CM)]			
11	1	TUBING [24 IN (60.9 CM)]			

Oil Lines



Oil Lines

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	FITTING			
2	1	TUBING [22 IN (55.8 CM)]			
3	2	TEE FITTING			
4	2	TUBING [1-1/2 IN (3.8 CM)]			
5	1	TUBING [4-3/4 IN (12 CM)]			
6	1	TUBING [3-1/2 IN (8.9 CM)]			
7	3	CHECK VALVE			
8	1	CHECK VALVE			

Oil Injection Components

REMOTE OIL TANK a

Holds 3 gallons (11.5 liters) of oil.

NOTE: *Some boats may be equipped with optional 1.8 gallon (7.0 liters) oil tank.*

The tank is pressurized by air from crankcase pressure thus forcing oil up the outlet hose to the oil reservoir on engine.

OIL PICK UP TUBE b

A filter screen is located in end of tube to prevent dirt or other particles from entering the system.

FILTER c

Directional filter designed to prevent impurities from entering oil reservoir.

4 PSI CHECK VALVE d

If oil flow to reservoir is obstructed and injection pump continues to pump oil, the 4 PSI valve will open to allow air to enter reservoir to prevent a vacuum.

OIL RESERVOIR e

The oil reservoir feeds the oil pump and contains enough oil for 20–25 minutes of full throttle running after the remote tank is empty. The warning horn will sound if the oil level in oil reservoir is low.

LOW OIL (FLOAT) SENSOR f

If oil level drops in oil reservoir, the sensor will signal the Electronic Control Module (ECM) to sound the warning horn.

VAPOR SEPARATOR TANK (VST) g

Contains electric fuel pump which pumps fuel @ 43 psi ± 2 psi (296.5 kPa ±13.8 kPa) to the fuel rail. Oil supplied by the electric oil pump is mixed with fuel supplied by the engine pulse pump in the VST.

OIL INLET HOSE h

Hose that carries oil from oil reservoir to electric oil pump.

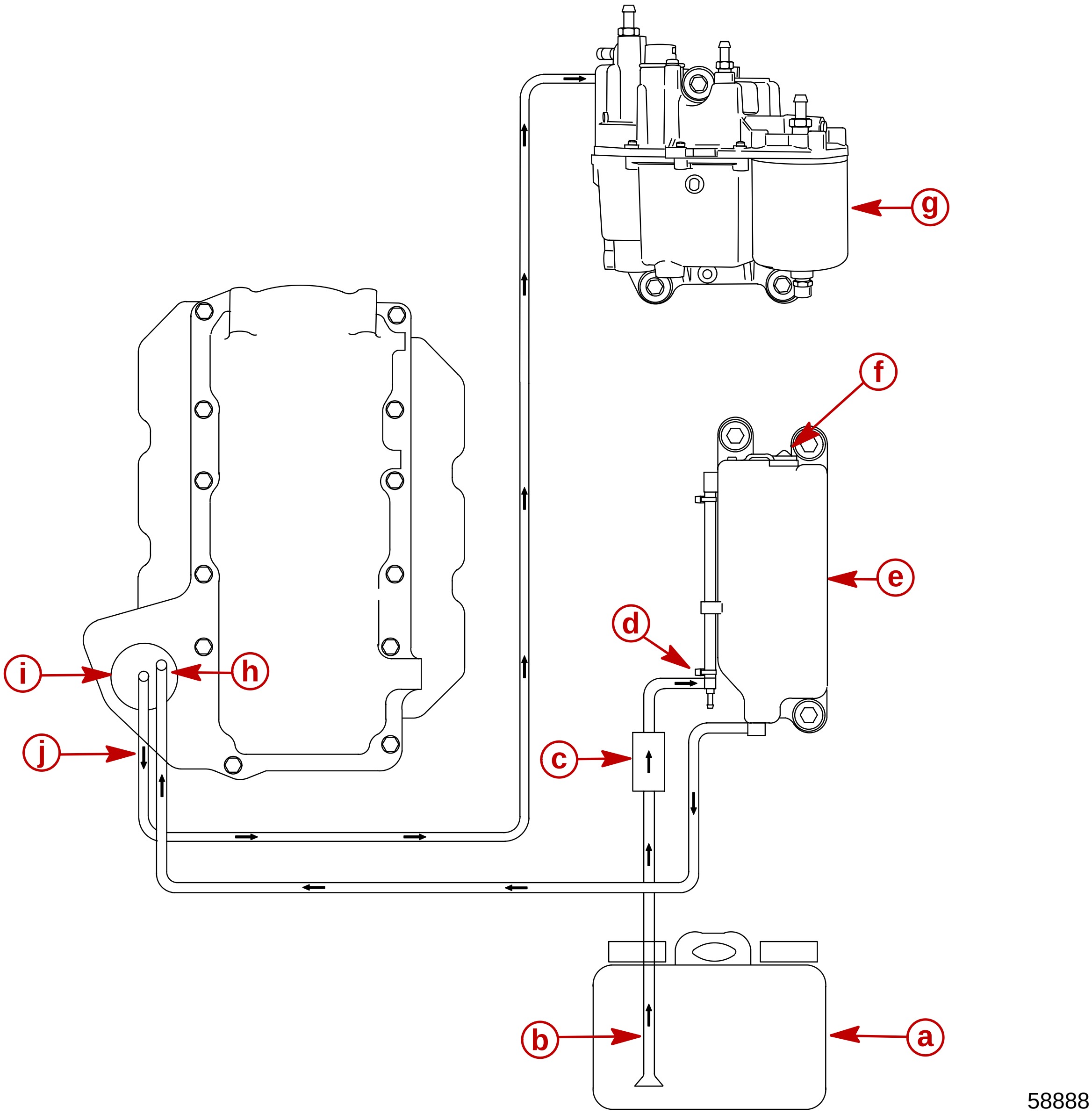
OIL INJECTION PUMP i

Injection pump is electrically operated and controlled by the ECM. Pump varies oil ratio from 120:1 at idle to 50:1 at wide open throttle.

OIL OUTLET HOSE j

Hose that carries oil from electric fuel pump to mix with fuel in vapor separator.

Oil Injection Flow System



a - Remote Oil Tank
b - Oil Pick-up Tube
c - Filter
d - 4 PSI Check Valve
e - Oil Reservoir
f - Low Oil (Float) Sensor (Inside Reservoir)
g - Vapor Separator Tank
h - Oil Inlet to Oil Pump
i - Oil Injection Pump
j - Oil Outlet Hose to Vapor Separator Tank

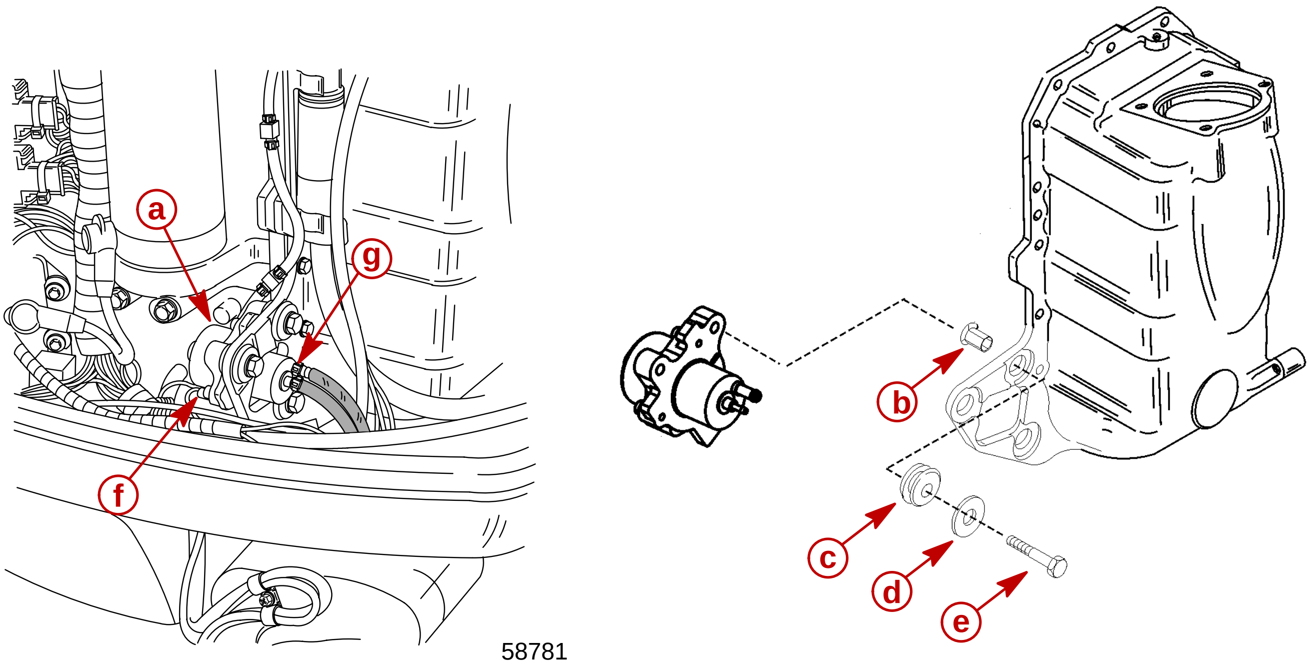
Oil Pump Removal and Installation

REMOVAL

1. Disconnect the wiring harness from the pump.
2. Disconnect the oil hoses.

NOTE: *Plug oil supply hose from oil reservoir to prevent spillage.*

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 140 lb. in. (16 Nm)
- **f** - Wiring Harness
- **g** - Sta-Straps

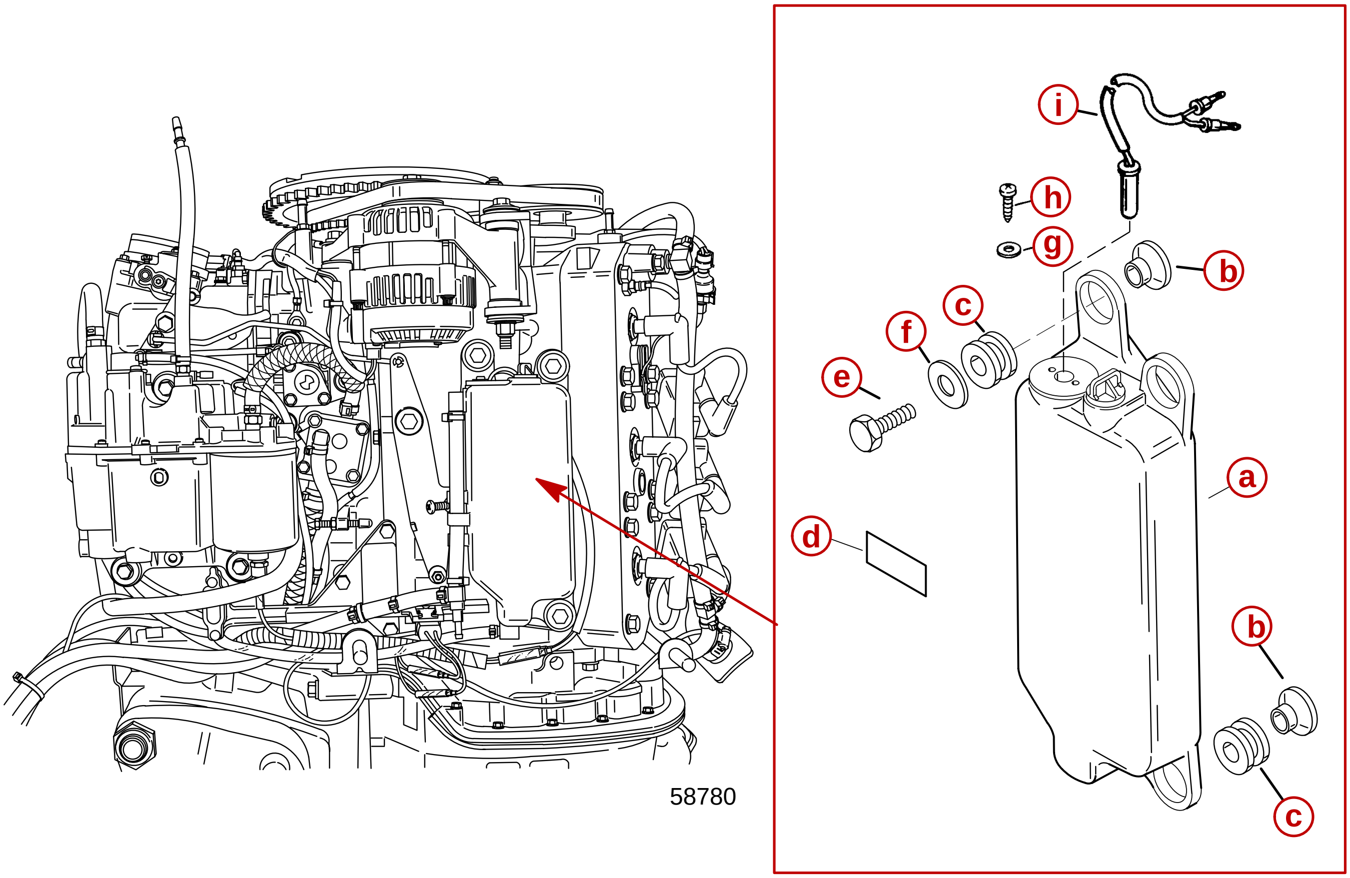
INSTALLATION

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 BLUE with BLACK STRIPE wire leads.
3. Remove three bolts securing oil tank to powerhead and remove tank.



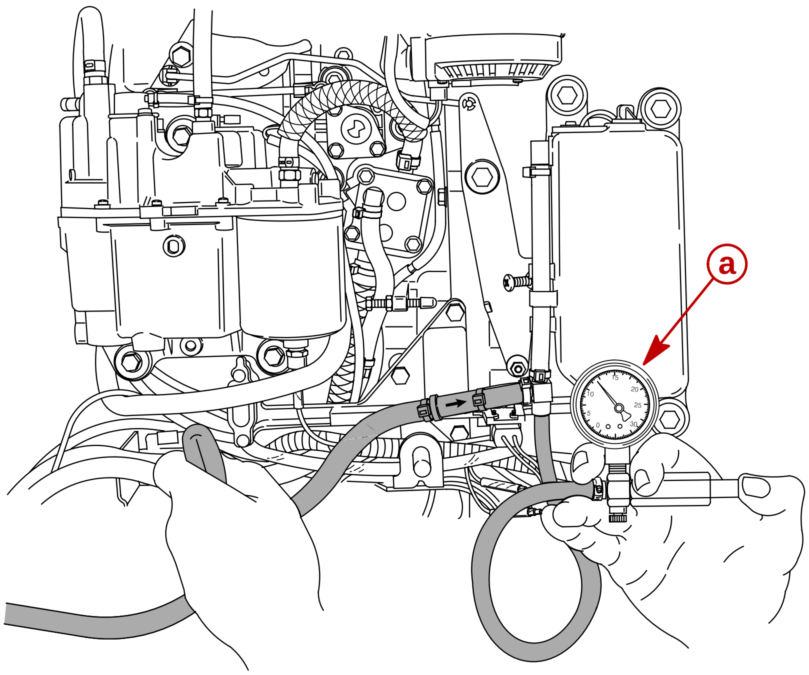
a - Oil Reservoir
b - Bushing (3)
c - Rubber Grommet (3) – Insert into Holes
d - Decal
e - Bolt (3) – Torque to 170 lb. in. (19 Nm)
f - Washer (3)
g - Washer
h - Screw (Drive Tight)
i - Low Oil Switch (Normally Closed Circuit)

INSTALLATION

1. Install oil reservoir as shown.
2. Fasten the oil hoses with sta-straps.
3. Connect the BLUE with BLACK STRIPE 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 using gearcase leakage tester (FT-8950)(a). 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 using pressure) is required on new or rebuilt power heads and any time maintenance is performed on the oiling system that allows air into the oil 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 91-880118A2.

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.

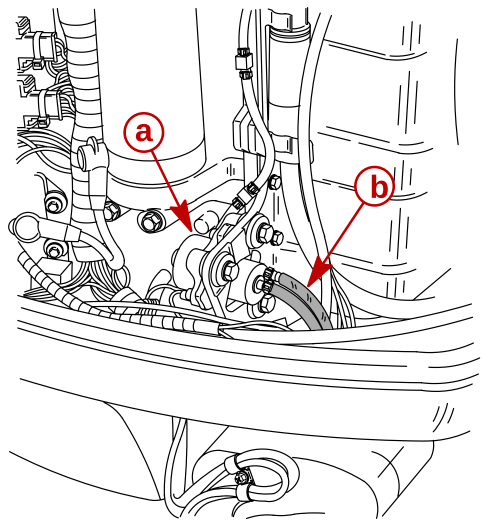
Refer to procedure in the Technician Reference Manual provided with the Digital Diagnostic Software Cartridge Part. No. 91-880118--1.

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.



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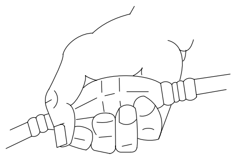
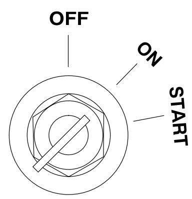
a - Oil Injection Pump
b - Oil Supply Hose

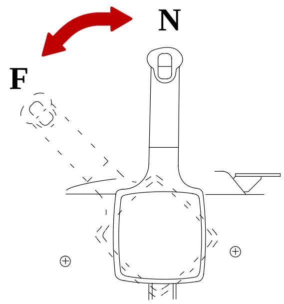
CAUTION
To prevent damage to the fuel pump, fill the engine fuel system with fuel. Otherwise the fuel pump will run without fuel during the priming process.

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.







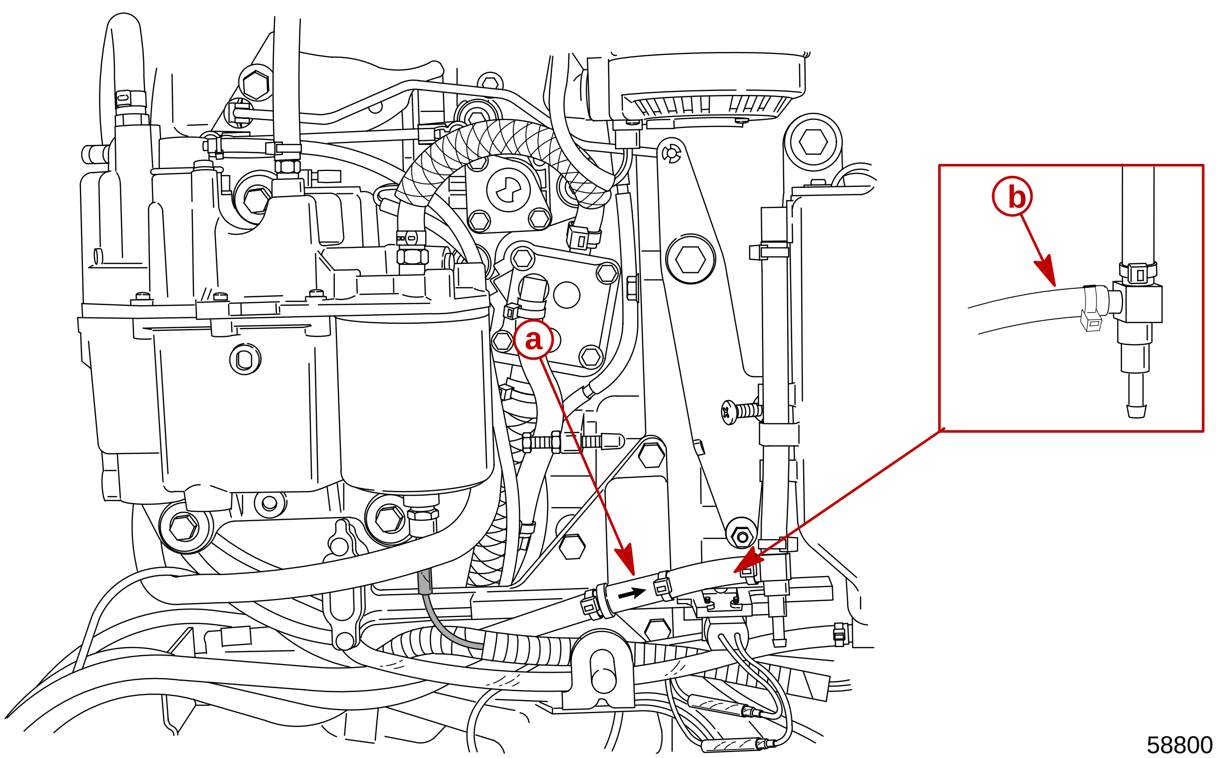
NOTE: *It may take a few minutes for the pump to complete the priming process.*

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.*

CONNECTING OIL HOSE WITH BLUE STRIPE

1. Remove shipping cap from fitting and connect oil hose (b). Fasten hose with sta-strap.

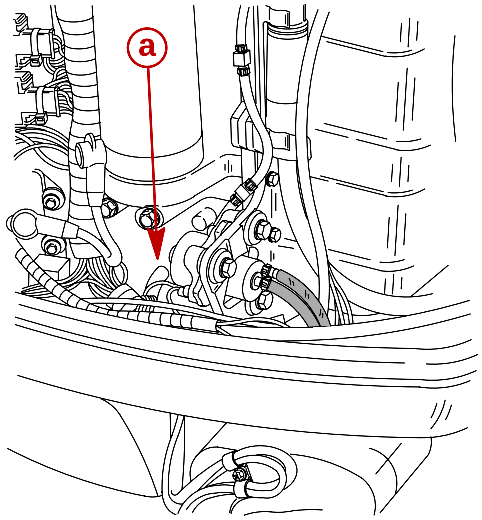


a - Directional Oil Filter

b - Oil Hose with Blue Stripe

CONNECTING OIL HOSE WITHOUT BLUE STRIPE

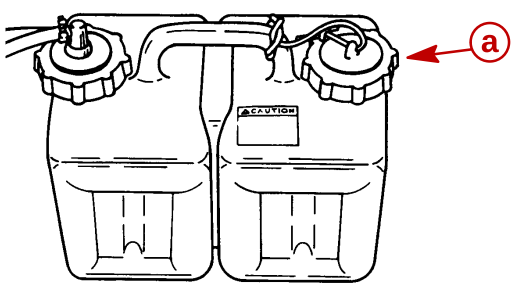
1. Remove shipping cap from fitting and connect hose (a). Fasten hose with sta-strap.

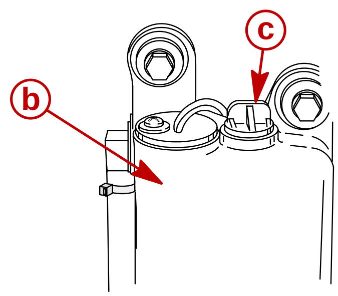


a - Oil Hose Without Blue Stripe

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.





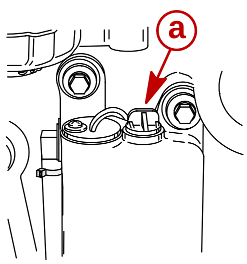
a - Fill Cap
b - Engine Oil Reservoir

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

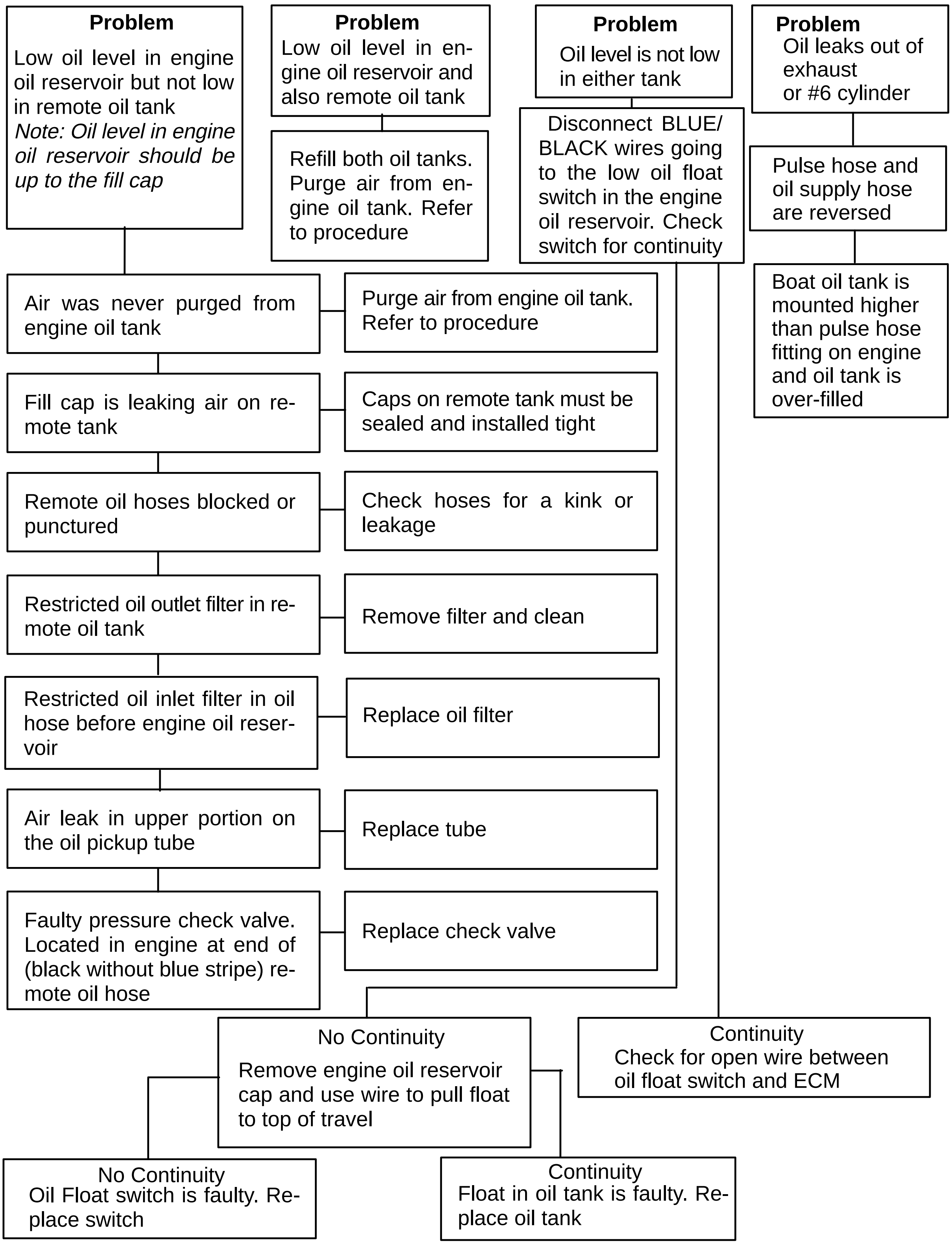
Oil Warning Systems

Warning Horn		
Function	**Sound**	**Description**
Start Up	One Beep	Normal System Test
Low Oil Reserve	Four Beeps every 2 Minutes	Oil level is low in the engine mounted oil reservoir tank. Refill the engine mounted oil reservoir tank along with the remote oil tank. Refer to Fuel & Oil Section.
Oil Level is Critically Low	Continuous	Engine Guardian System is activated. Power limit will allow a fast idle. The oil level is critically low in the engine mounted oil reservoir tank. Refill the engine mounted oil reservoir tank along with the remote oil tank. Refer to Fuel and Oil Section.
Oil Pump Failure	Continuous	Engine Guardian System is activated. Power limit will allow a fast idle. The warning horn is activated if the oil pump should ever stop functioning electrically. No lubricating oil is being supplied to the engine.

NOTE: *As an option, Mercury Monitor or SmartCraft Gauges may be used to provide low oil information or oil pump operation information.*

Oil System Troubleshooting

Low Oil Warning System is Activated



FUEL SYSTEM

Section 3D – Emissions

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D

Exhaust Emissions Standards

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

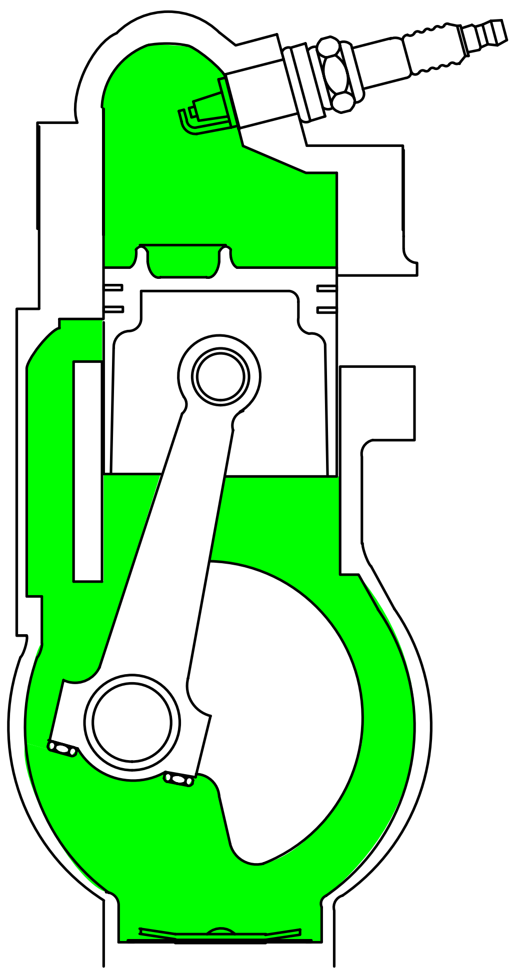
Stratified vs Homogenized Charge

At certain operating conditions, DFI engines use a stratified charge inside the combustion chamber to aid in reducing emissions. All other models exclusively 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, crankcase and/or combustion chamber. Additional mixing occurs as the fuel is forced through the transfer system into the cylinder.

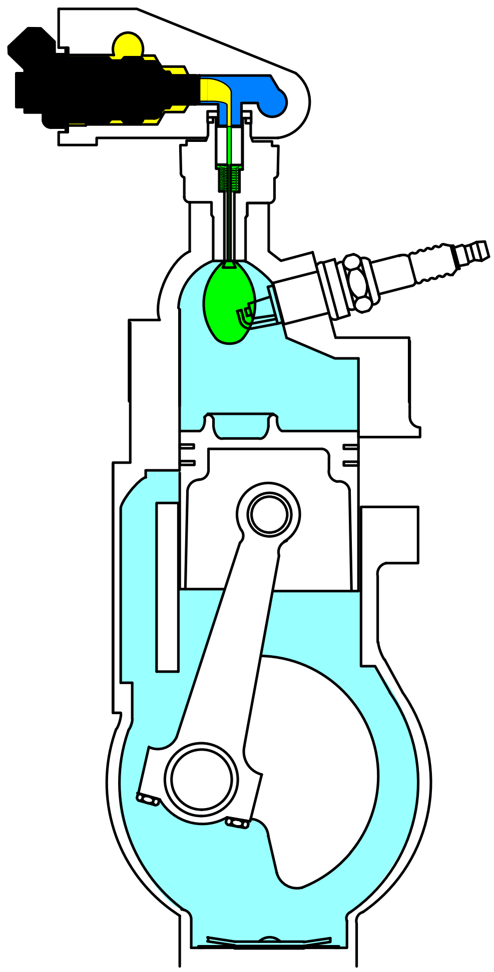
The homogenized charge has an air/fuel ratio of approximately 14.7:1 and is uniform throughout the cylinder.



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 fuel cloud into the cylinder. Surrounding this cloud is air supplied by the transfer system. As the cloud is ignited and burns, the surrounding air provides almost complete combustion before the exhaust port opens.

A stratified charge engine concentrates a rich mixture in the vicinity of the spark plug (air/fuel ratio is less than 14.7:1). Elsewhere, the mixture is very lean or is comprised of air only.



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:

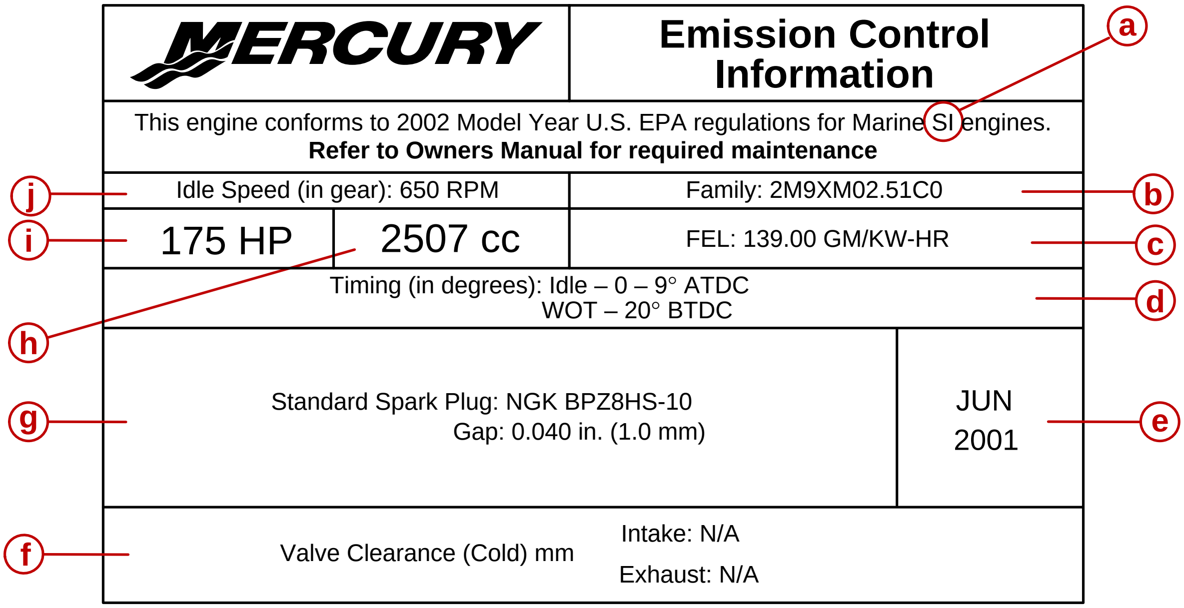
VIA U.S. POSTAL SERVICE:
Office of Mobile Sources
Engine Programs and Compliance Division
Engine Compliance Programs Group (6403J)
401 M St. NW
Washington, DC 20460

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

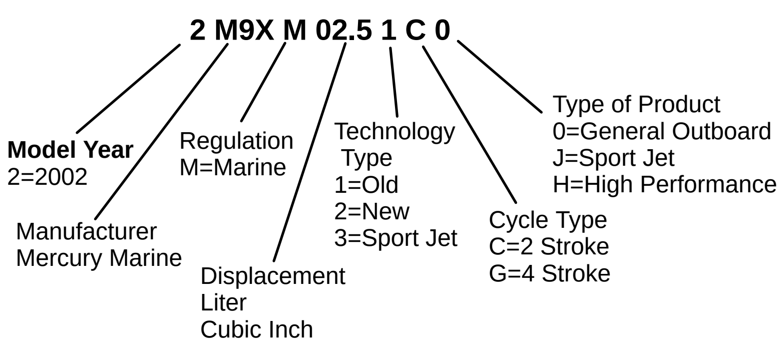
EPA INTERNET WEB SITE:
http:/www.epa.gov/omswww

Manufacturer's 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** - Spark Ignition (SI)
- **b** - Family example
- **c** - FEL: Represents (Mercury Marine) statement of the maximum emissions output for the engine family
- **d** - Timing specifications when adjustable
- **e** - Month and Year of Production
- **f** - Valve Clearance (Four Stroke engines only)
- **g** - Recommended spark plug for best engine performance
- **h** - Cubic Centimeter
- **i** - Engine Horsepower rating
- **j** - Idle Speed (In Gear)



Service Replacement Certification Label

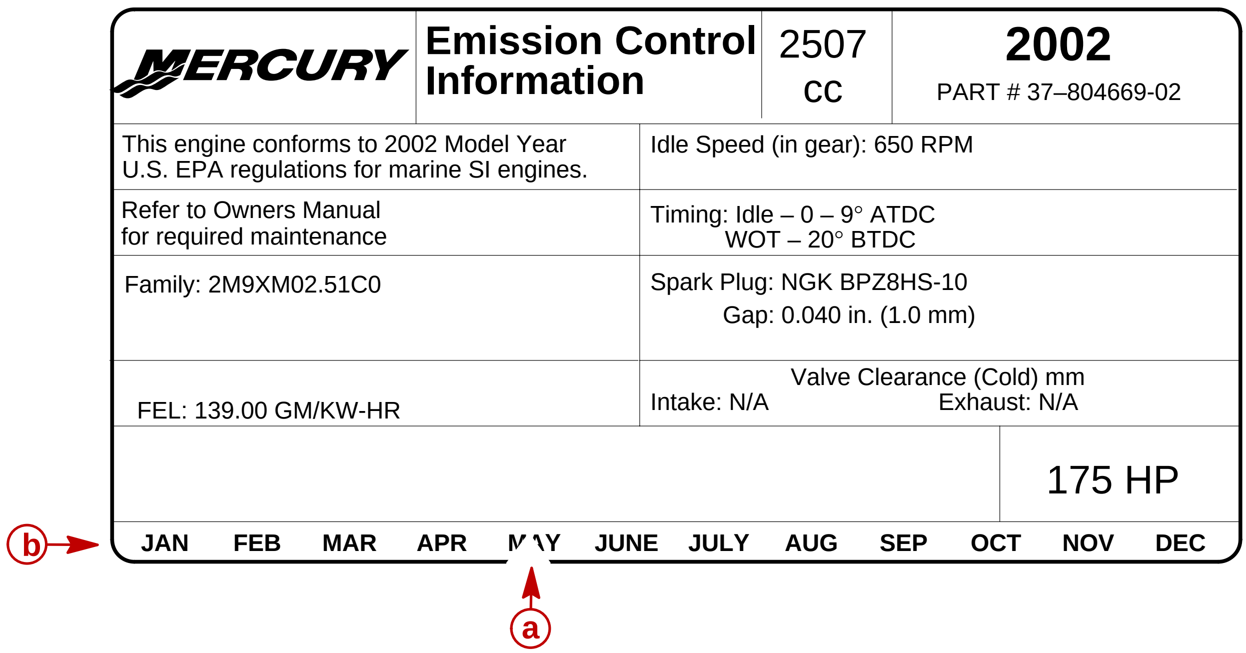
IMPORTANT: By federal law, it is required that all 1998 and newer Mercury Marine outboards have a visible and legible emission certification label. If this label is missing or damaged, contact Mercury Marine Service for replacement if appropriate.

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
2002 Merc/Mar 2.5 L V6 (150 H.P.)	37-804669-02	Air Cover (Carb) Vapor Separator (EFI)
2002 Merc/Mar 2.5 L V6 (175 H.P.)	37-804669-02	Vapor Separator (EFI)
2002 Merc/Mar 2.5 L V6 (200 H.P.)	37-804669-02	Air Cover (Carb) Vapor Separator (EFI)

POWERHEAD

Section 4A - Powerhead

Table of Contents

4
A

Specifications

Block

Type	60° V, 2 Cycle
Displacement	153 cu. in. (2.5 Litre)

Reed Valve Opening

Reed Stand Open (Max.)	0.020 in. (0.50 mm)

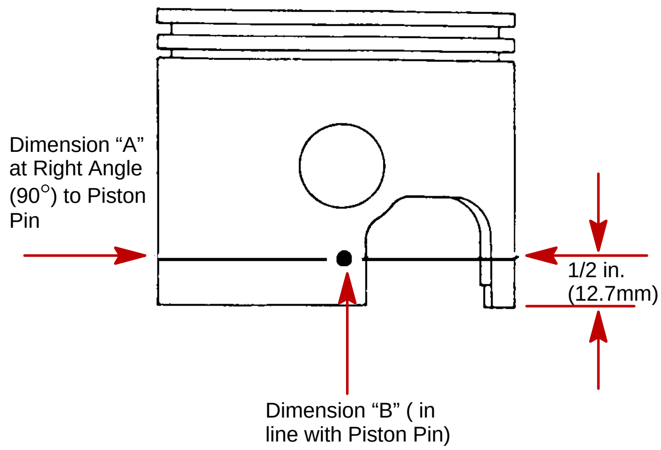
Cylinder Bore

Dia. Standard	3.501 in. (88.925 mm)
Dia. 0.015 in. Oversize	3.516 in. (89.306 mm)
Taper/Out of Round Max.	0.003 in. (0.0762 mm)

Piston

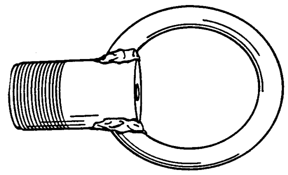
Dia. Standard	3.494 in. ± .001 in. (88.748 mm ± .025 mm)
Dia. 0.015 in. Oversize	3.509 in. ± .001 in. (89.129 mm ± .025 mm)

IMPORTANT: Using a micrometer, measure dimension "B" at location shown. Dimension "B" should be 0.008 in. or less than dimension "A".

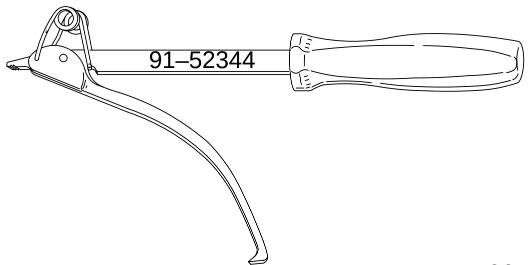


Special Tools

1. Lifting Eye 91-90455



2. Flywheel Holder 91-52344



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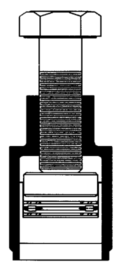
3. Protector Cap 91-24161

4. Flywheel Puller 91-849154T1



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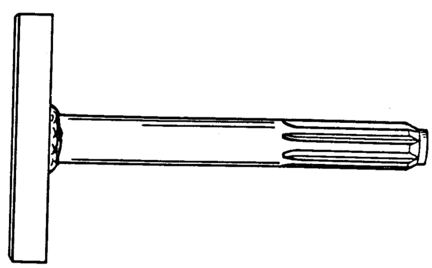
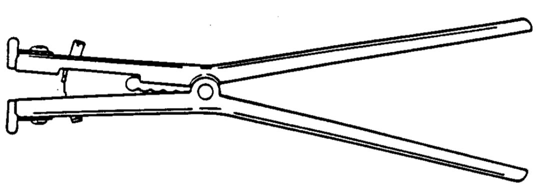
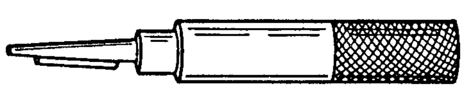
5. Powerhead Stand 812549T



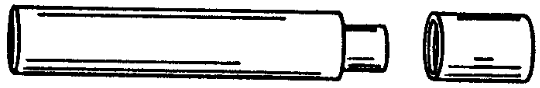
6. Piston Ring Expander 91-24697



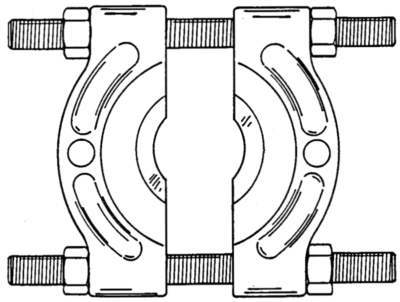
7. Lockring Removal Tool 91-52952A1



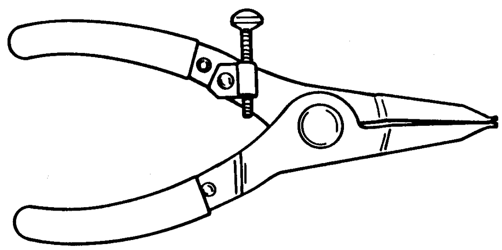
8. Piston Pin Tool 91-74607A1



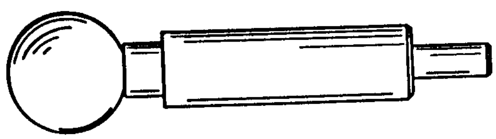
9. Universal Puller Plate 91-37241



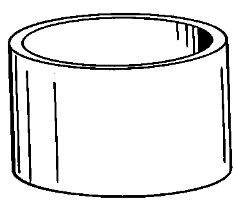
10. Snap Ring Pliers 91-24283



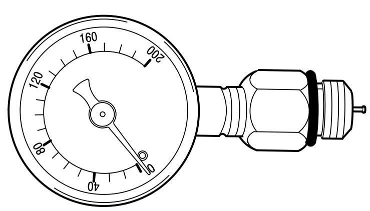
11. Lockring Installation Tool 91-91-79109A3



12. Piston Ring Compressor 91-818773 (for 2.5 Liter)



13. Compression Tester 91-29287



54965

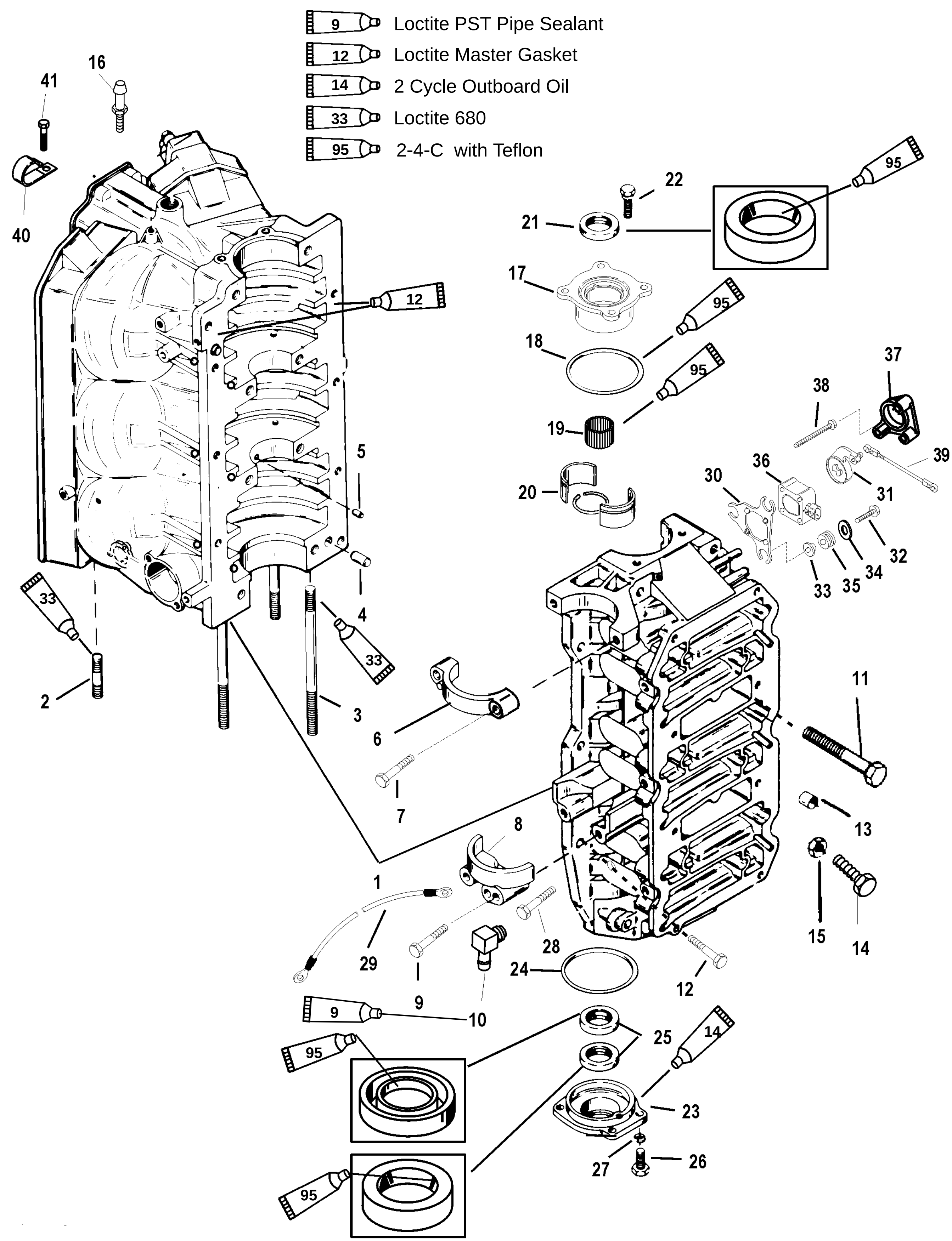
Powerhead Repair Stand

A powerhead repair stand may be purchased from:

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

Notes:

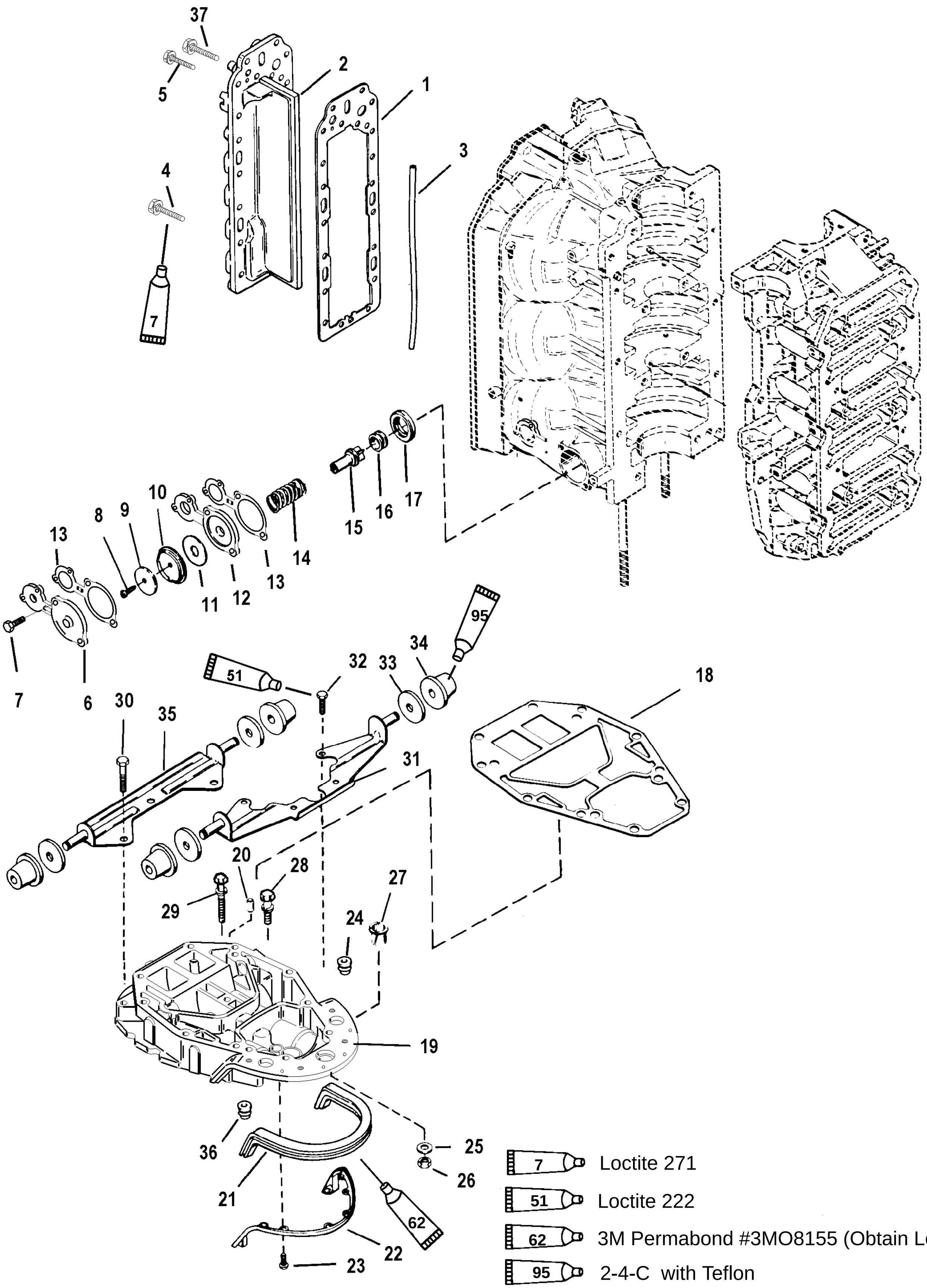
Cylinder Block Assembly



Cylinder Block Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	CYLINDER BLOCK **(150)**			
	1	CYLINDER BLOCK **(175/200)**			
2	6	STUD–POWERHEAD (1-3/4 IN.)			
3	2	STUD–POWERHEAD (5-1/2 IN.)			
	2	STUD–POWERHEAD (6-3/4 IN.)			
4	2	DOWEL PIN–LOCATING			
5	2	DOWEL PIN (BEARING RACE)			
6	1	COVER–STARTER MOTOR (UPPER)			
7	2	SCREW (1-1/2 IN.) (HEX FLANGE)		17.5	23.5
8	1	COVER (LOWER)			
9	2	SCREW (2 IN.)(HEX HEAD FLANGE)		17.5	23.5
10	1	ELBOW			
11	8	SCREW (3/8-16 x 3-1/4 IN.)		38	51.5
12	6	SCREW (0.312-18 x 1-1/4 IN.)		15	20.3
13	1	CAP			
14	1	ADJUSTING SCREW (1/4-20 1-3/4)			
15	1	JAM NUT			
16	1	PIN			
17	1	UPPER END CAP ASSEMBLY			
18	1	O-RING			
19	1	ROLLER BEARING			
20	1	BEARING RACE			
21	1	OIL SEAL			
22	4	SCREW (5/16-18 x 1 IN.)	150		17.0
23	1	LOWER END CAP			
24	1	O-RING (3-1/4 IN. I.D.)			
25	2	OIL SEAL			
26	4	SCREW (1/4-20 x 3/4)	80		9
27	4	LOCKWASHER			
28	1	SCREW (M8 x 14)			
29	1	BATTERY CABLE (NEGATIVE)			
30	1	BRACKET			
31	1	TPS LEVER			
32	3	SCREW (M6 x 25)	70		8
33	3	BUSHING			
34	3	WASHER			
35	3	GROMMET			
36	1	THROTTLE POSITION SENSOR			
37	1	TPS COVER			
38	3	SCREW (10-32 x 2)	15		1.7
39	1	THROTTLE LINK			
40	1	J-CLAMP			
41	1	SCREW (M6 x 16)			

Exhaust Manifold and Exhaust Plate



7 Loctite 271

51 Loctite 222

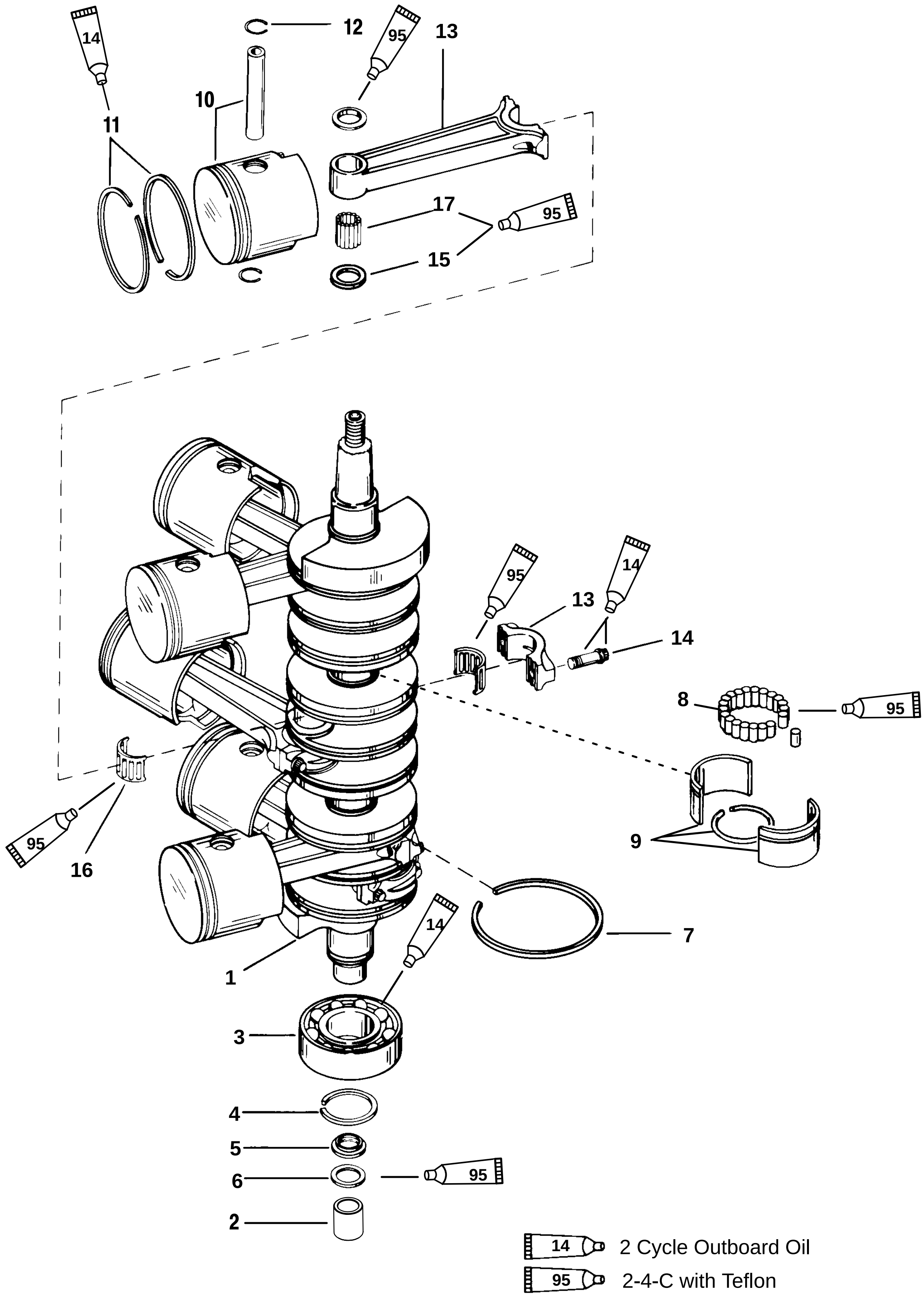
62 3M Permabond #3MO8155 (Obtain Locally)

95 2-4-C with Teflon

Exhaust Manifold and Exhaust Plate

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	GASKET			
2	1	DIVIDER PLATE			
3	1	SEAL			
4	17	SCREW (5/16-18 x 1-1/2)		16.5	22.5
5	2	SCREW (5/16-18 x 1)		16.5	22.5
6	1	COVER-RELIEF VALVE			
7	4	SCREW (5/16-18 x 1-1/4)		16.5	22.5
8	1	SCREW (10-16 x 3/4 in.)	25		2.8
9	1	WASHER			
10	1	DIAPHRAGM			
11	1	WATER DEFLECTOR			
12	1	PLATE			
13	2	GASKET			
14	1	SPRING			
15	1	POPPET			
16	1	GROMMET			
17	1	CARRIER			
18	1	GASKET			
19	1	EXHAUST PATE			
20	2	DOWEL PIN			
21	1	SEAL			
22	1	BRACKET			
23	8	SCREW (10-16 x 1/2 IN.)	80		9
24	1	GROMMET			
25	6	WASHER			
26	6	NUT		23	31.0
27	1	BUSHING			
28	1	SCREW (5/16-18 x 1-1/4 IN.)		25	34.0
29	1	SCREW (5/16-18 x 2-1/2 IN.)		25	34.0
30	3	SCREW (3/8-16 x 3-1/2 IN.)		50	68.0
31	1	FRONT BRACKET ASSEMBLY			
32	4	SCREW (5/16-18 x 1/2 IN.)		25	34
33	4	WASHER			
34	4	GROMMET			
35	1	REAR BRACKET ASSEMBLY			
36	1	GROMMET			
37	1	SCREW (5/16-18 x 1-3/4)			

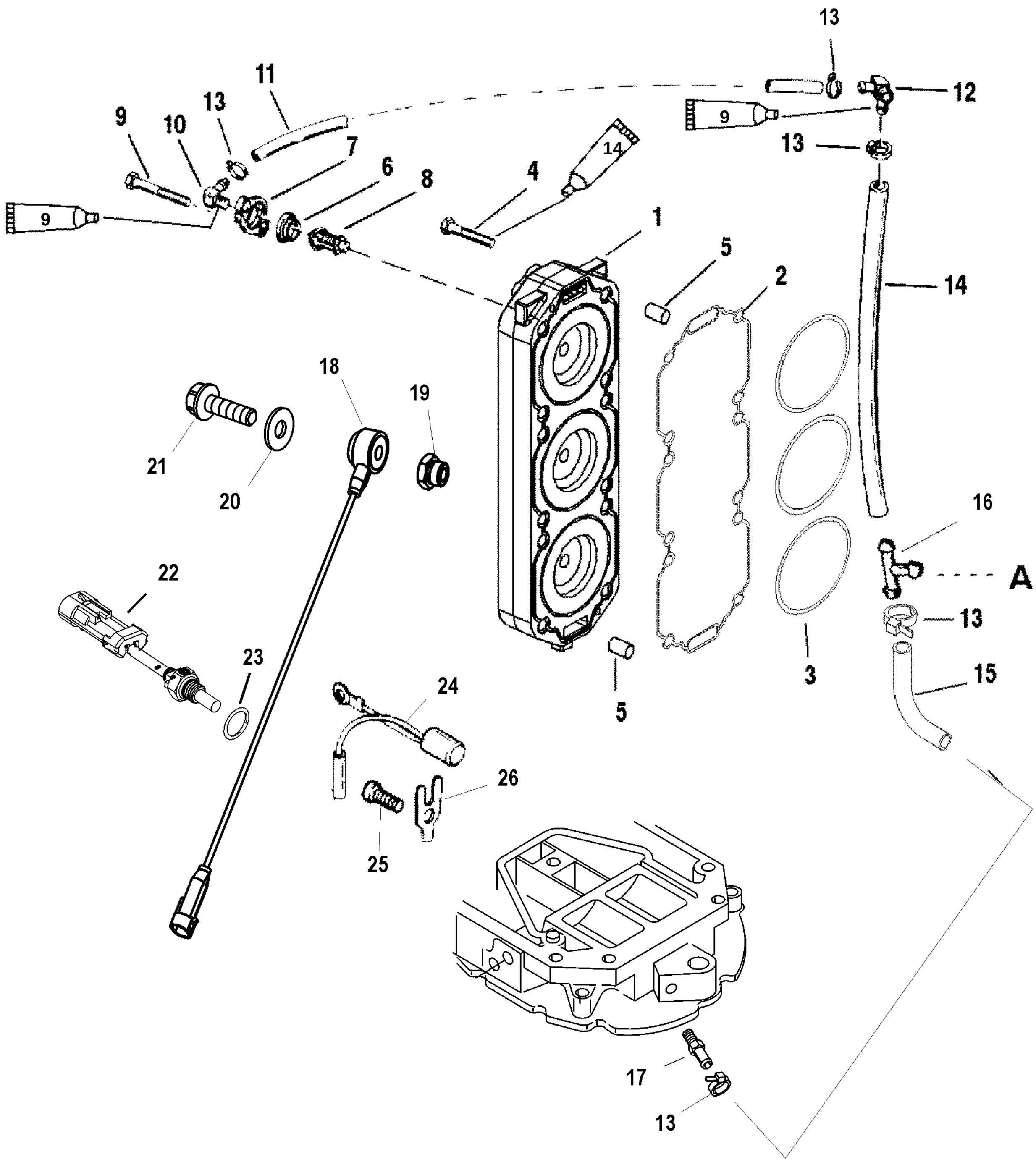
Crankshaft, Pistons and Connecting Rods



Crankshaft, Pistons and Connecting Rods

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

Cylinder Head



9 Loctite PST Pipe Sealant

14 2 Cycle Outboard Oil

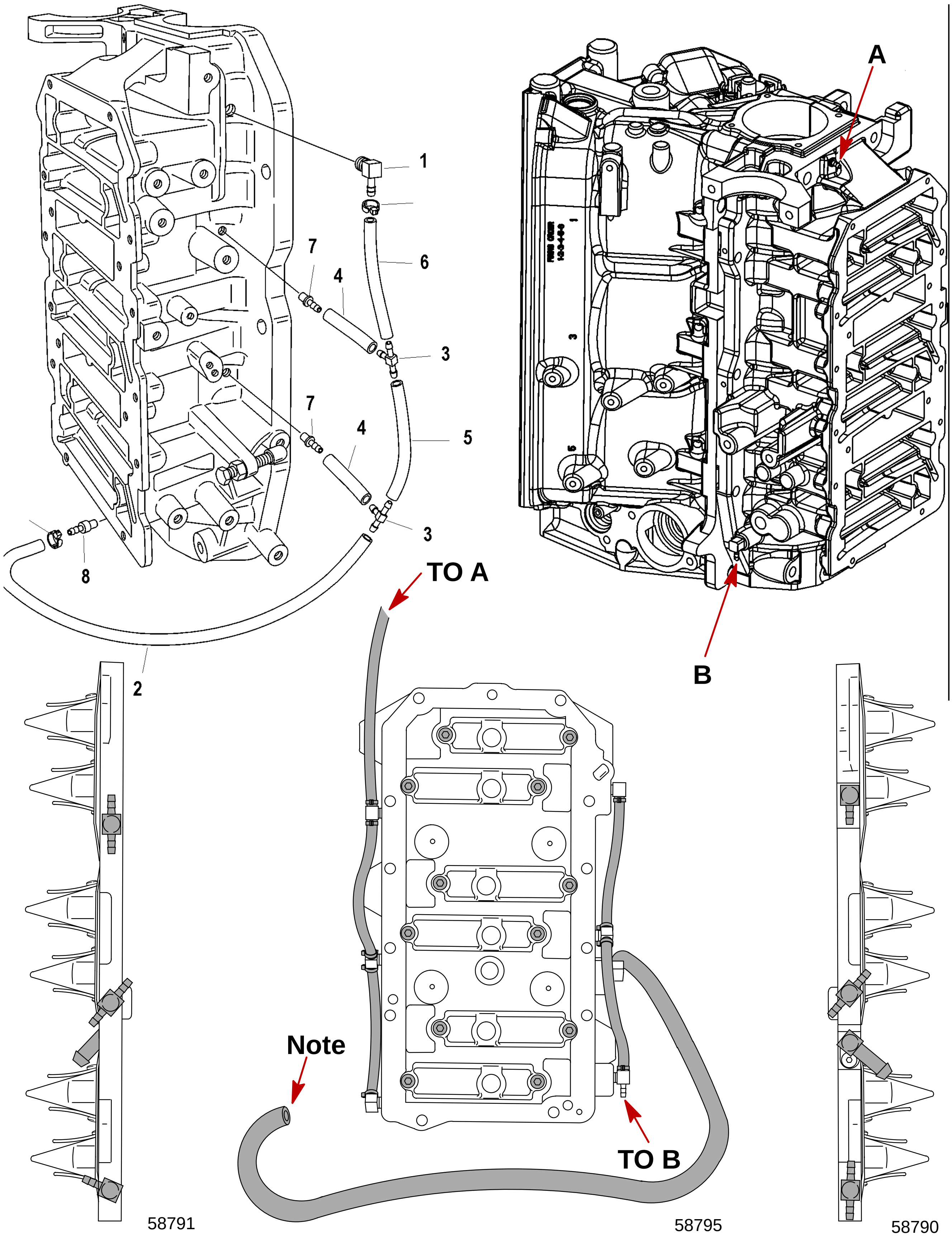
A = TO TELLTAIL

Cylinder Head

REF. NO.		DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	2	CYLINDER HEAD **(150)**			
	2	CYLINDER HEAD **(175/200)**			
2	2	SEAL			
3	6	SEAL			
4	24	SCREW (0.375-16 x 2.30)	**SEE NOTE #1**		
5	4	DOWEL PIN			
6	2	GASKET			
7	2	COVER			
8	2	THERMOSTAT			
9	4	SCREW (M8 x 25)		16.5	22.5
10	1	ELBOW			
11	1	HOSE [12-3/4 IN.(32.3 CM)]			
12	1	FITTING			
13	10	STA-STRAP			
14	1	HOSE [13-1/2 IN.(34.3 CM)]			
15	1	HOSE [4-1/2 IN.(11.4 CM)]			
16	1	T-FITTING			
17	1	FITTING			
18	2	KNOCK SENSOR **(200)**			
19	2	ADAPTOR **(200)**		20	27
20	2	WASHER **(200)**			
21	2	SCREW (M10 x 35) **(200)**		15	20.3
22	2	TEMPERATURE SENSOR			
23	2	O-RING			
24	1	TEMPERATURE SENSOR			
25	2	SCREW (M8 x 14)		16.5	22.5
26	1	RETAINER			

NOTE # 1: APPLY LIGHT OIL TO THREADS - TORQUE TO 30 LB. FT. (40.5 Nm), THEN TIGHTEN ADDITIONAL 90 DEGREES.

Bleed System Routing



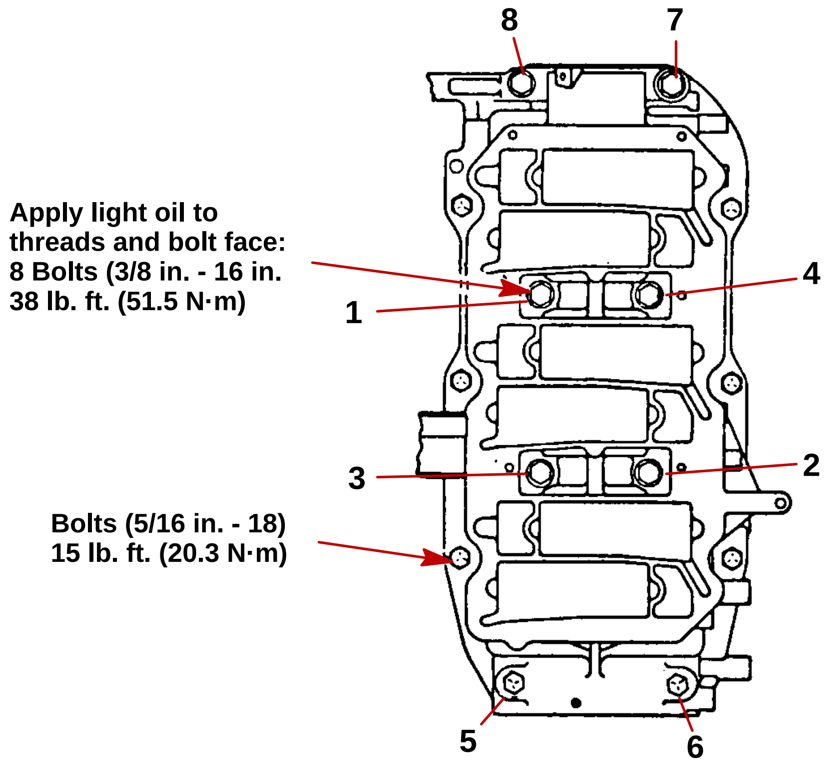
Bleed System Routing

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	FITTING			
2	1	TUBING [22 IN (55.8 CM)]			
3	2	TEE FITTING			
4	2	TUBING [1-1/2 IN (3.8 CM)]			
5	1	TUBING [4-3/4 IN (12 CM)]			
6	1	TUBING [3-1/2 IN (8.9 CM)]			
7	3	CHECK VALVE			
8	1	CHECK VALVE			

NOTE: *High pressure fuel hose from fuel pump in vapor separator to fuel rail fitting on air plenum.*

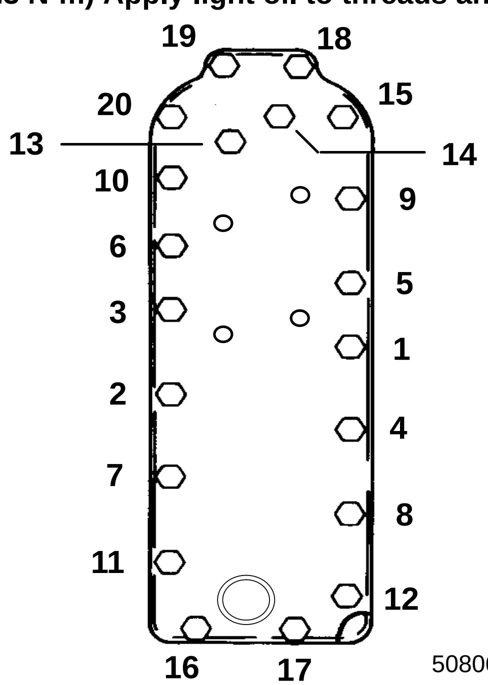
Torque Sequence

CRANKCASE COVER BOLTS



EXHAUST COVER BOLTS

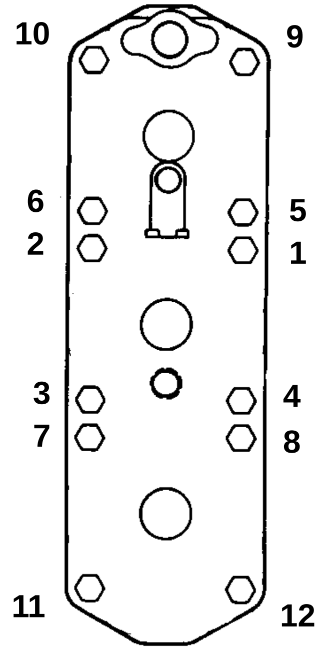
15 lb. ft. (20.3 N·m) Apply light oil to threads and bolt face



50806

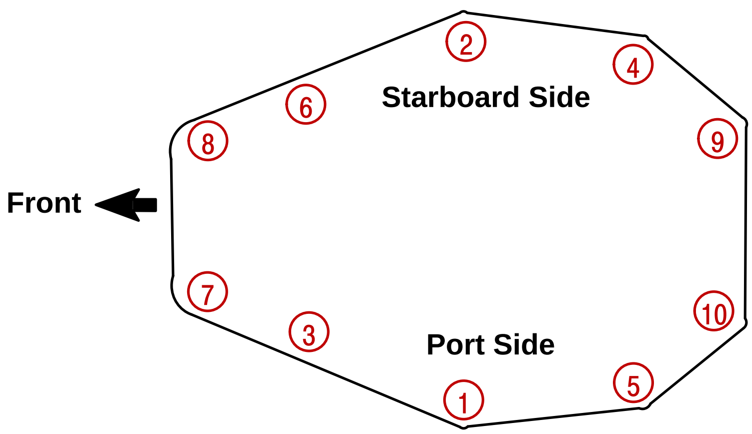
CYLINDER HEAD BOLTS

Apply light oil to threads and bolt face: 30 lb. ft. (40.7 N·m) and rotate 90°



POWERHEAD TO ADAPTOR PLATE ATTACHING NUT

Torque nuts to 25 lb. ft. (33.8 Nm)



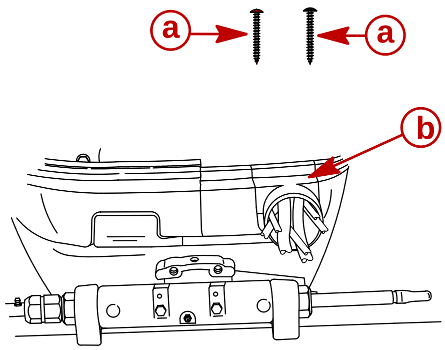
General Information

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, carburetors, reed blocks and cylinder heads and checking operation of thermostats.

Powerhead Removal from Driveshaft Housing

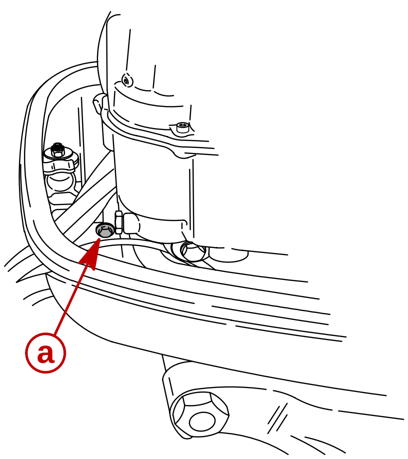
1. Disconnect battery cables from battery terminals.
2. Remove top cowling.
3. Remove two screws which secure remote control harness retainer and remove retainer.

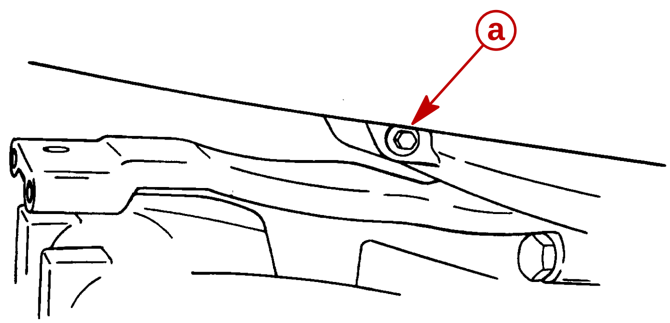


57841

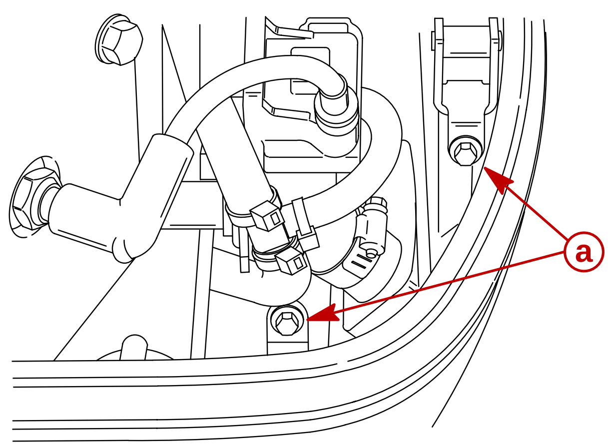
a - Screws
b - Retainer

4. Remove bottom cowls.





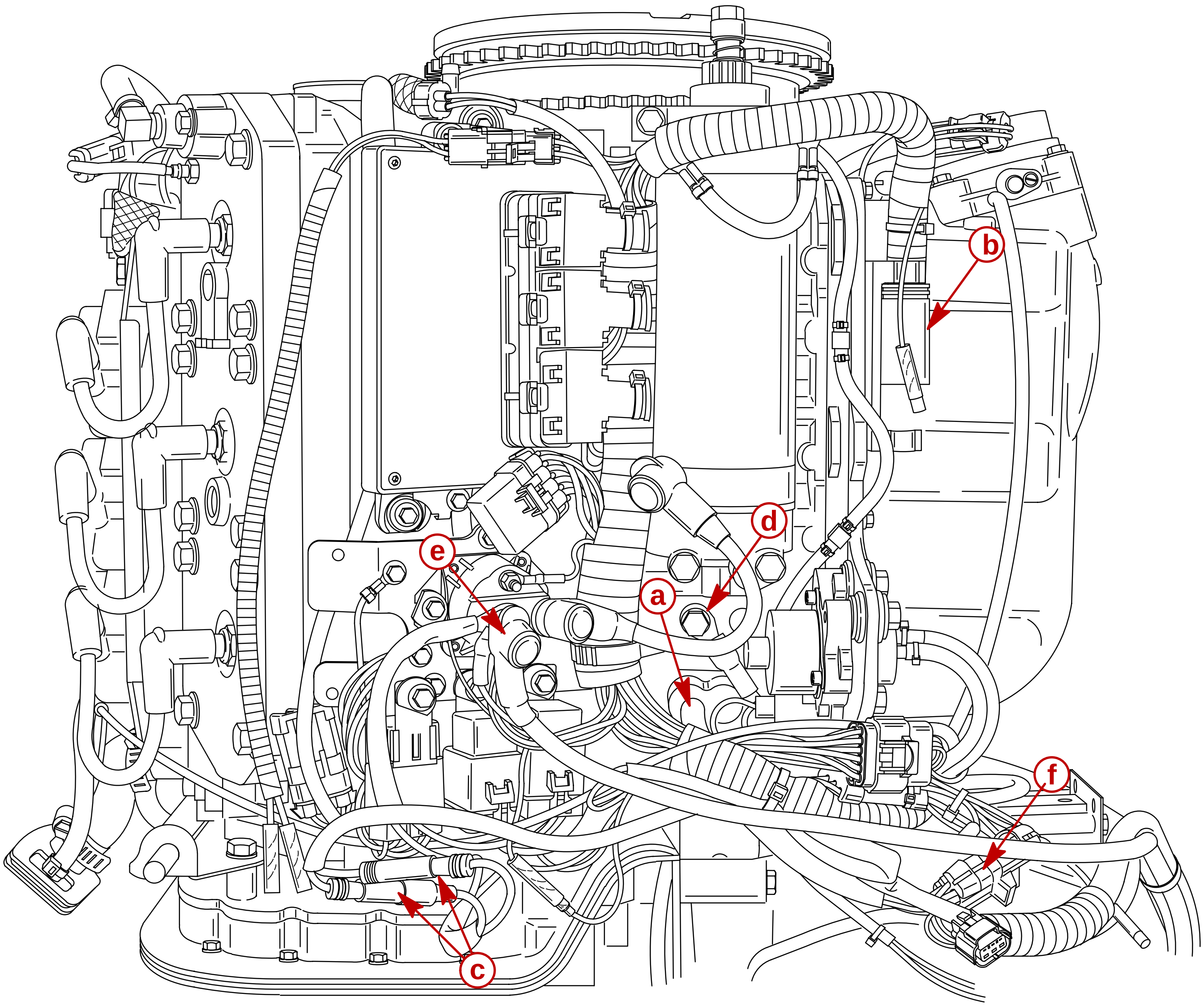
58774



58068

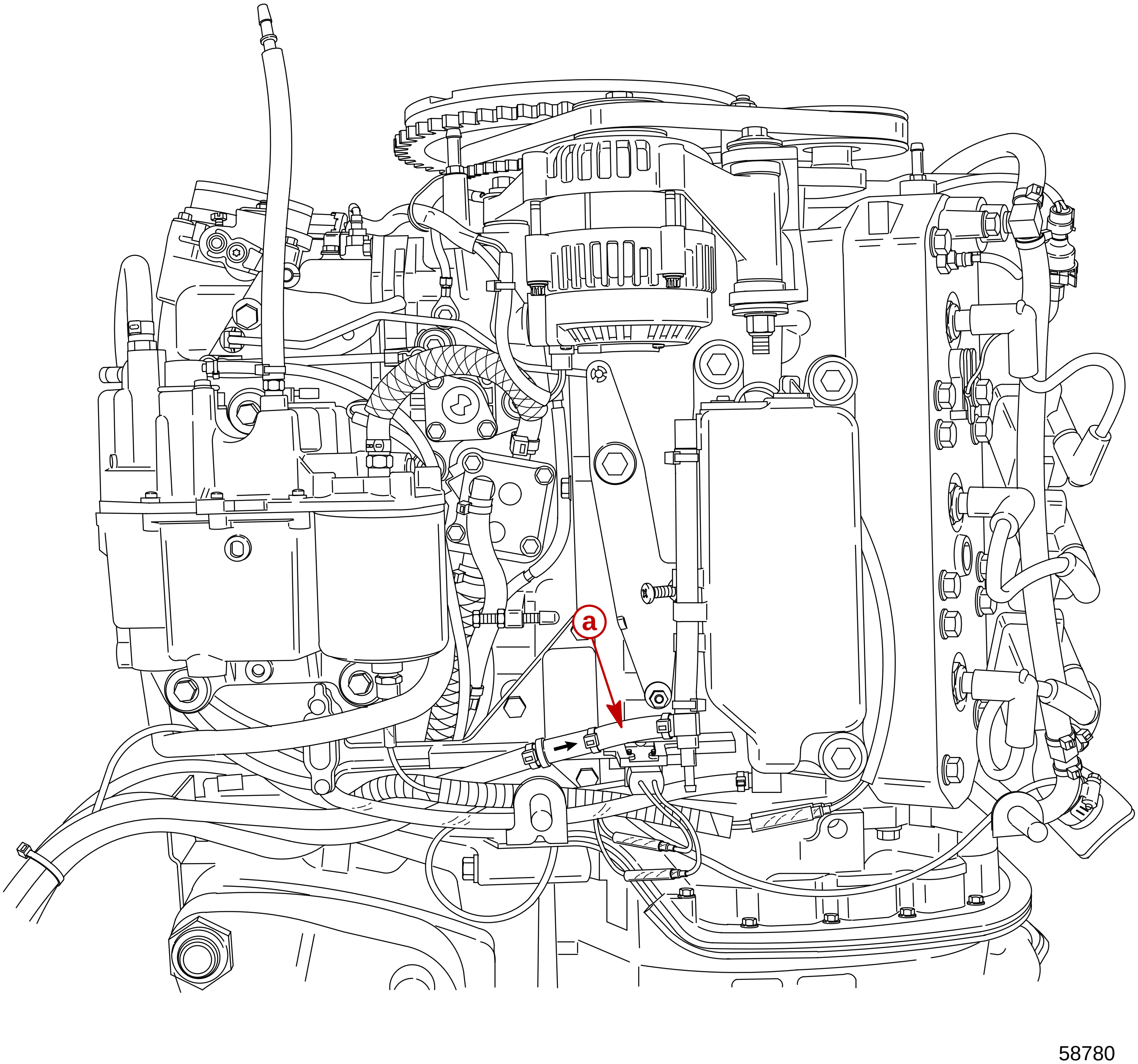
a - Bolts

5. Disconnect and/or remove the following:



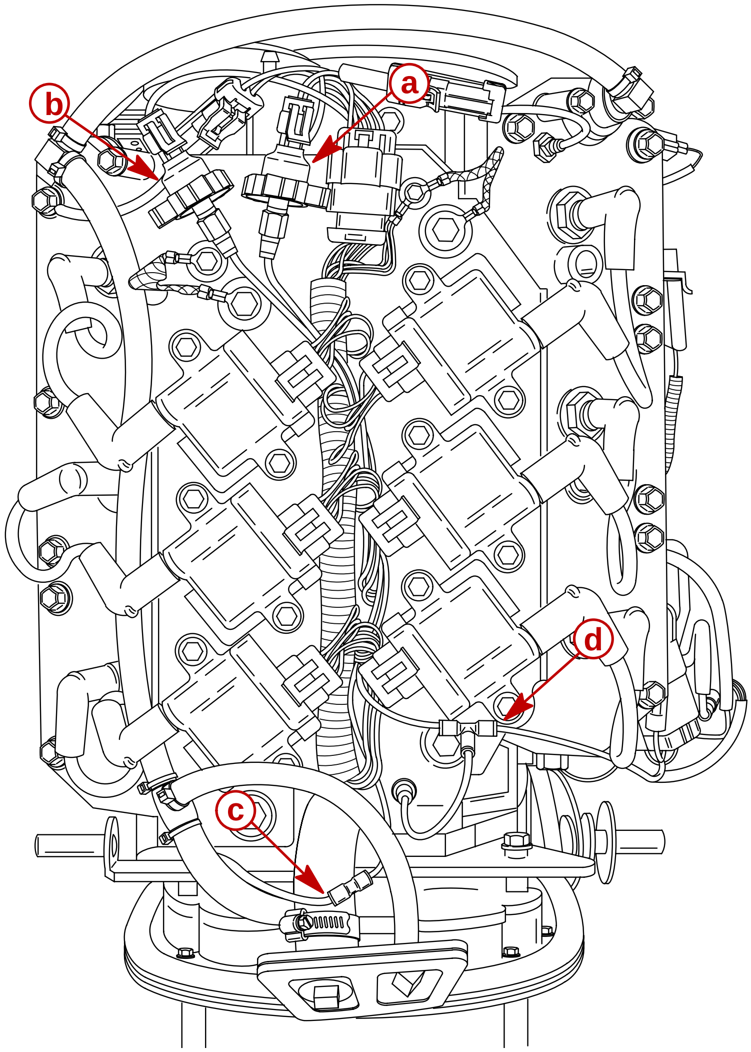
a - Remote Oil Tank Pressure Hose
b - Remote Control Harness
c - Power Trim Wires
d - Negative Battery Cable
e - Positive Battery Cable
f - SmartCraft Harness Connector

6. Disconnect and/or remove the following:



a - Oil Supply Hose

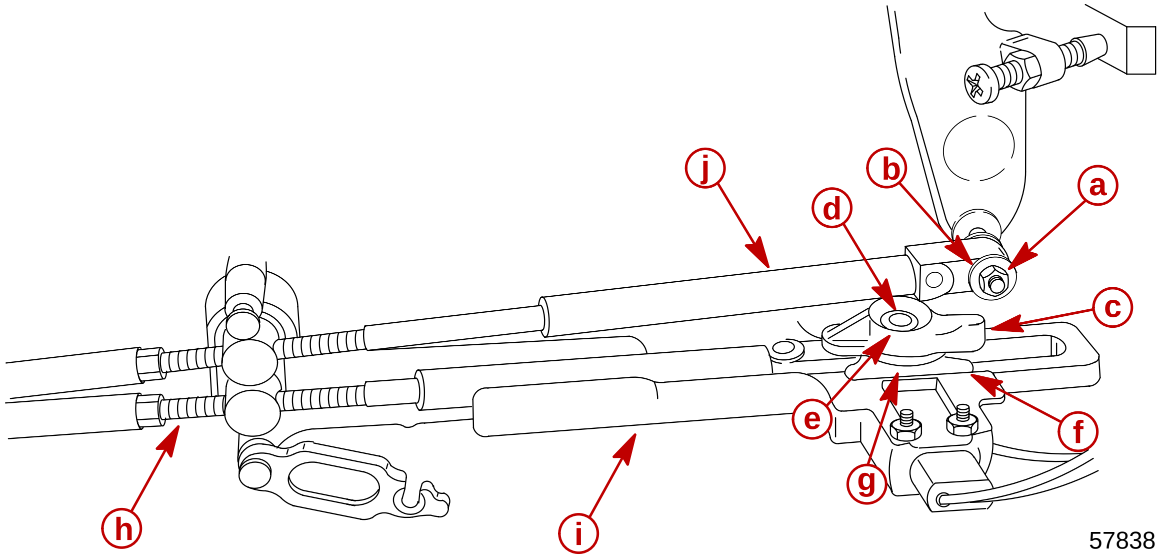
7. Disconnect water pressure sensor (gray) hose and speedometer pressure sensor (black) hose.



58773

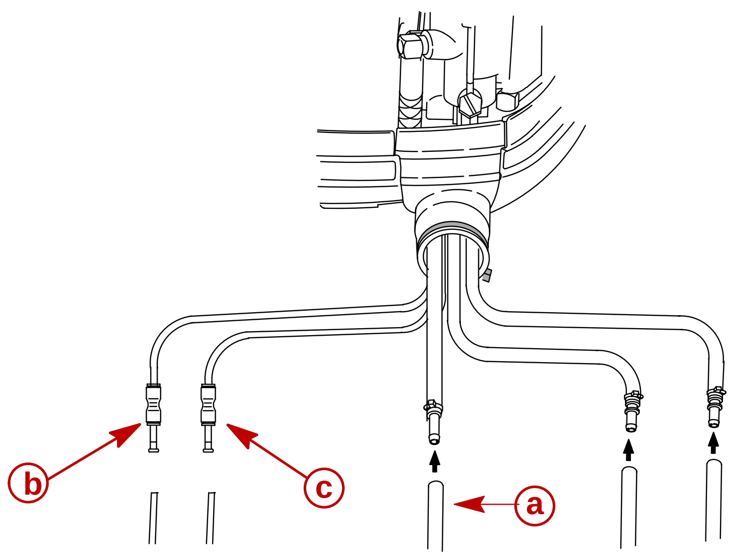
a - Water Pressure Sensor
b - Speedometer Pressure Sensor
c - Speedometer Sensor Hose (BLACK)(for Digital Gauges)
d - Water Pressure Sensor Hose (GRAY)(for Digital Gauges)

8. Slide outboard shift lever into neutral position.
9. Remove locknut and flat washer securing throttle cable and remove cable.
10. Remove locknut that secures shift cable latch assembly and remove latch, flat washer, nylon wear plate, spring and shift cable from control cable anchor bracket.



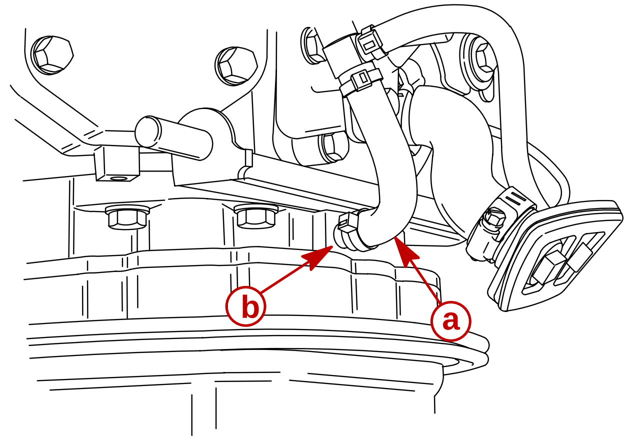
a - Lock Nut (Throttle Cable)
b - Flat Washer
c - Shift Cable Latch
d - Lock Nut (Shift Cable)
e - Flat Washer (Hidden under nut)
f - Nylon Wear Plate
g - Spring (Hidden)
h - Shift Cable
i - Anchor Bracket
j - Throttle Cable

11. Disconnect input fuel line, water pressure hose and speedometer hose.



a - Input Fuel Hose
b - Water Pressure Hose (GRAY) (Analog Gauges)
c - Speedometer Hose (BLACK) (Analog Gauges)

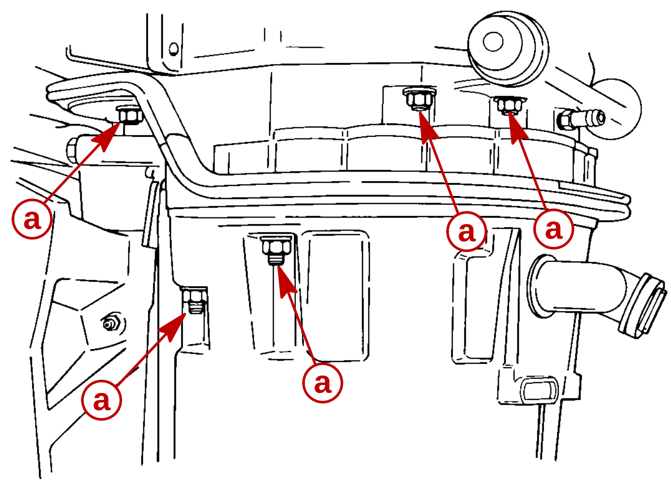
12. Remove water hose from fitting on exhaust adaptor plate.



58069

a - Water Hose
b - Fitting

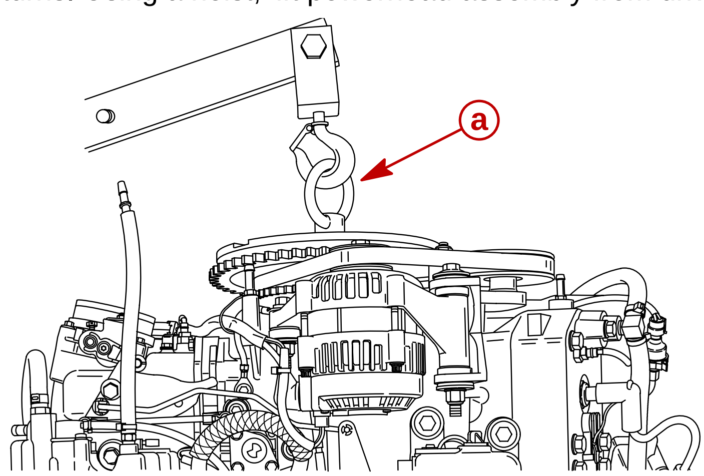
13. Remove 10 nuts and 10 washers (5 each side) from powerhead base.



51846

a - Nuts and Washers (5 each side)

14. Remove plastic cap from center of flywheel and install Lifting Eye 91-90455 into flywheel at least 5 full turns. Using a hoist, lift powerhead assembly from driveshaft housing.



58890

a - Lifting Eye 91-90455

Removing Engine Components

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

Removing Engine Components Individually

Section 2
Starter Motor
*Electronic Control Module
*Ignition Coils
*Starter Solenoid
*Trim Relays
Alternator
Flywheel

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

Section 7
Shift Cable Latch Assembly
Control Cable Anchor Bracket

*All ignition and electrical components should remain attached to the electrical plate and removed as an assembly.

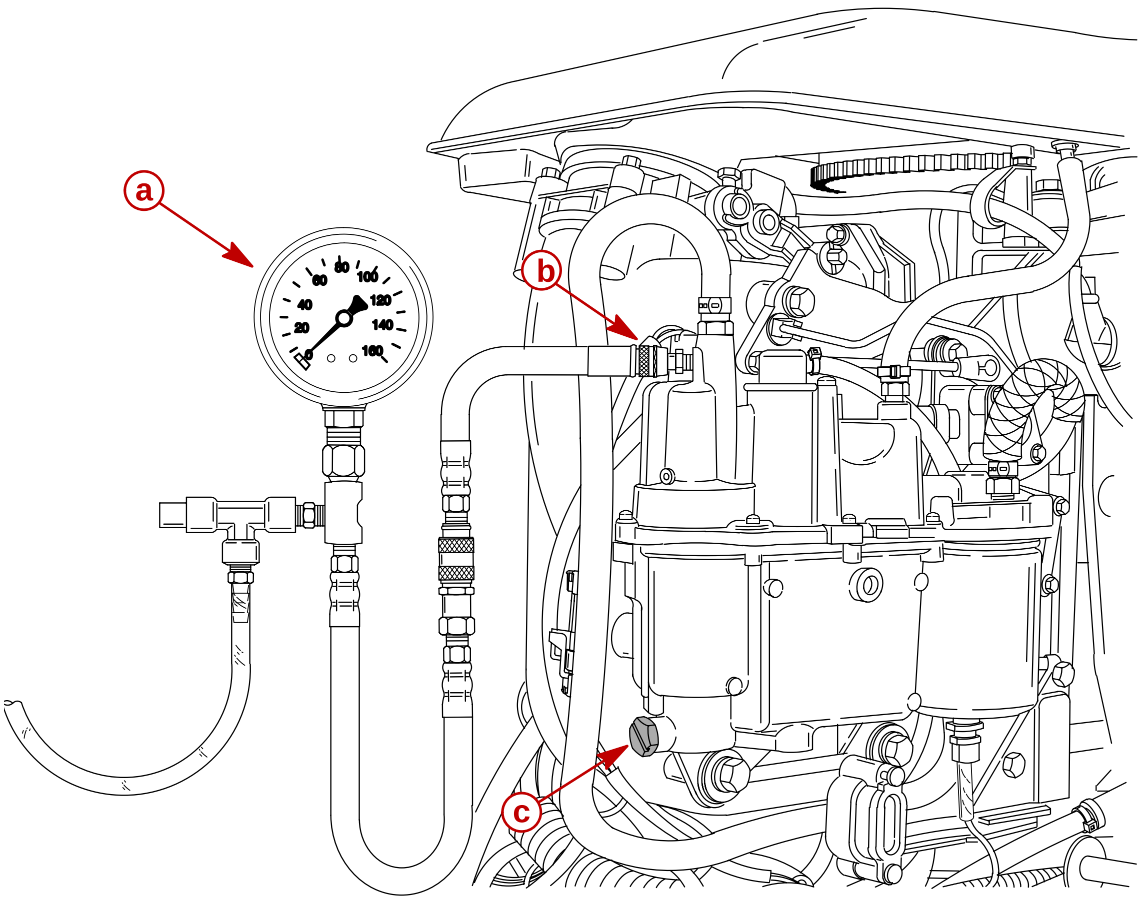
Removing Engine Components as an Assembly

VAPOR SEPARATOR TANK (VST) REMOVAL

CAUTION

Depressurize fuel system prior to opening line connections or removing fuel system components.

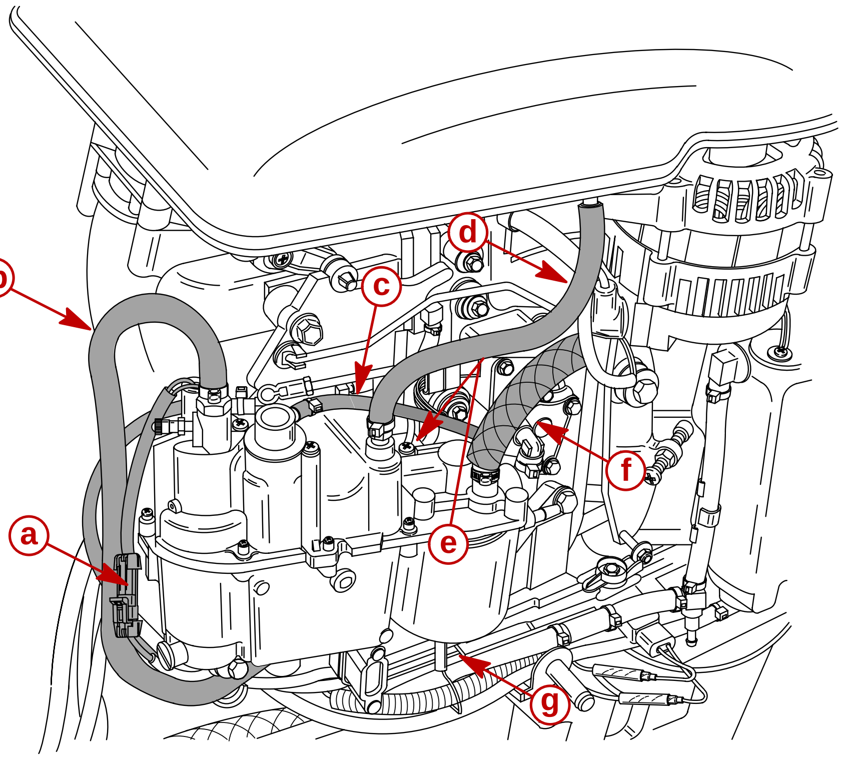
1. Use Fuel/Air Pressure Gauge 91-16850A7 or Fuel Pressure Gauge 91-881834A1 to depressurize fuel system. Direct fuel into suitable container.
2. Remove VST drain plug and allow fuel to empty into suitable container.



58874

a - Fuel Pressure Gauge 91-881834A1
b - Fuel Pressure Test Port
c - Drain Plug

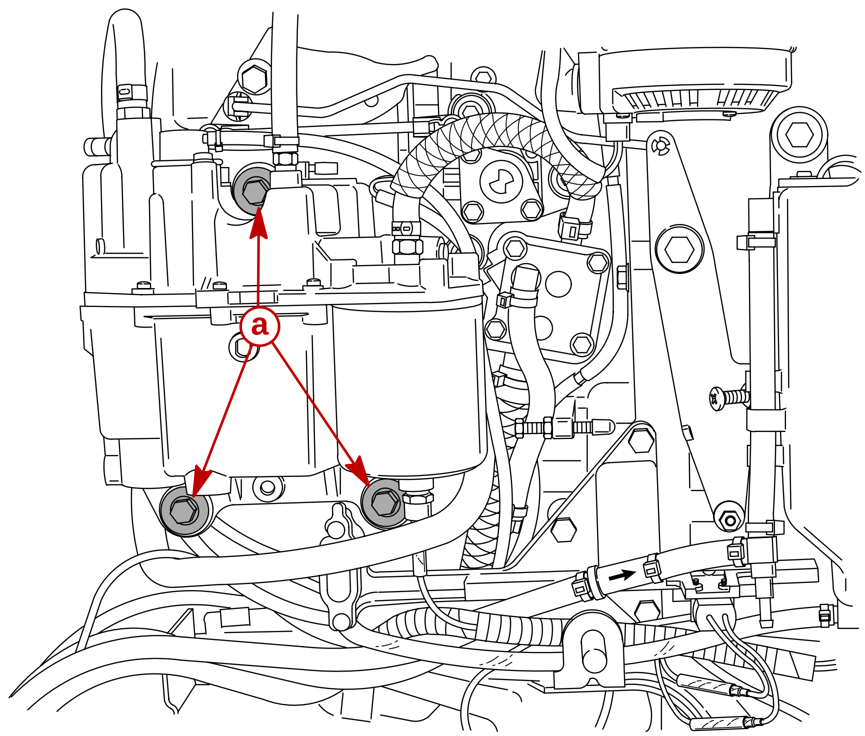
3. Disconnect and/or remove the following:



58878

a - Fuel Pump Harness Connector
b - High Pressure Fuel Hose
c - Fuel Regulator Hose
d - Vent Hose
e - Ground Lead (hidden) between VST and Air Plenum
f - Fuel Inlet Hose
g - Water Sensor Lead

4. Remove 3 bolts securing vapor separator to air plenum.

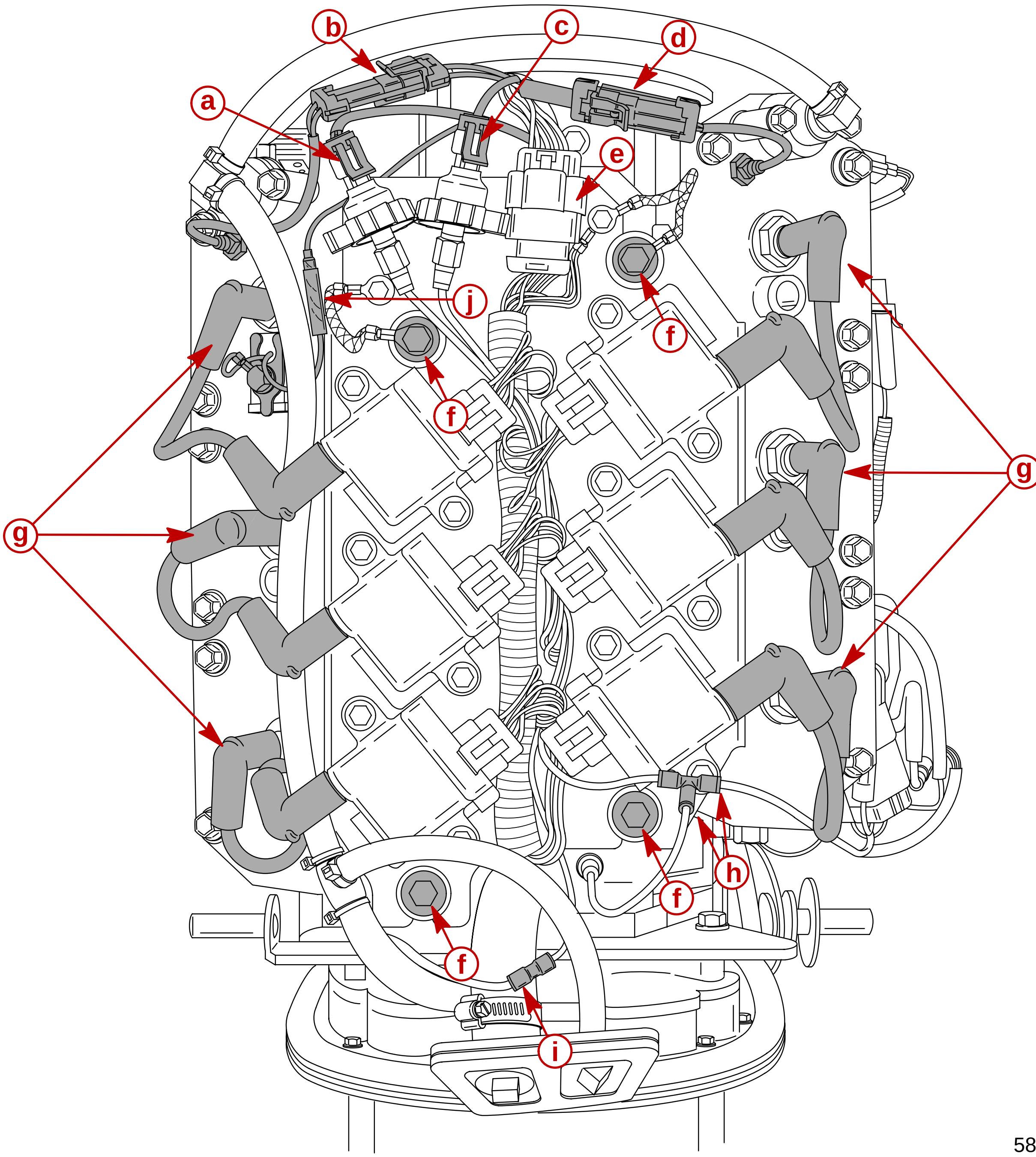


58801

a - Bolts

Ignition Coil Plate and Harness Removal

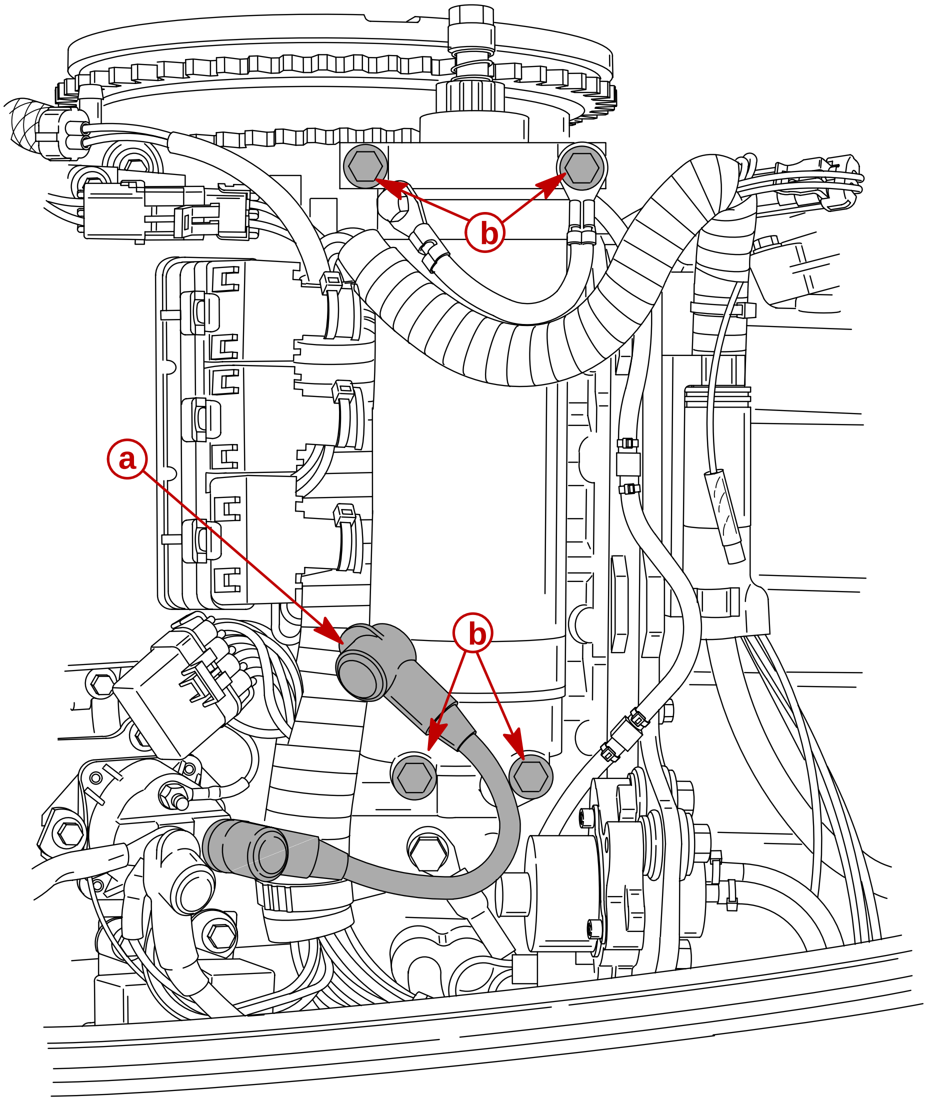
Disconnect the following:



a - Speedometer Sensor
b - Port Temperature Sensor
c - Water Pressure Sensor
d - Starboard Temperature Sensor
e - Ignition Coil Harness Connector
f - Bolts (4)
g - Spark Plug Leads (Use proper tool to remove spark plug boot to avoid damage to boot)
h - Speedometer Hose
i - Water Pressure Hose
j - Temperature Gauge Bullet Connector

Starter Motor

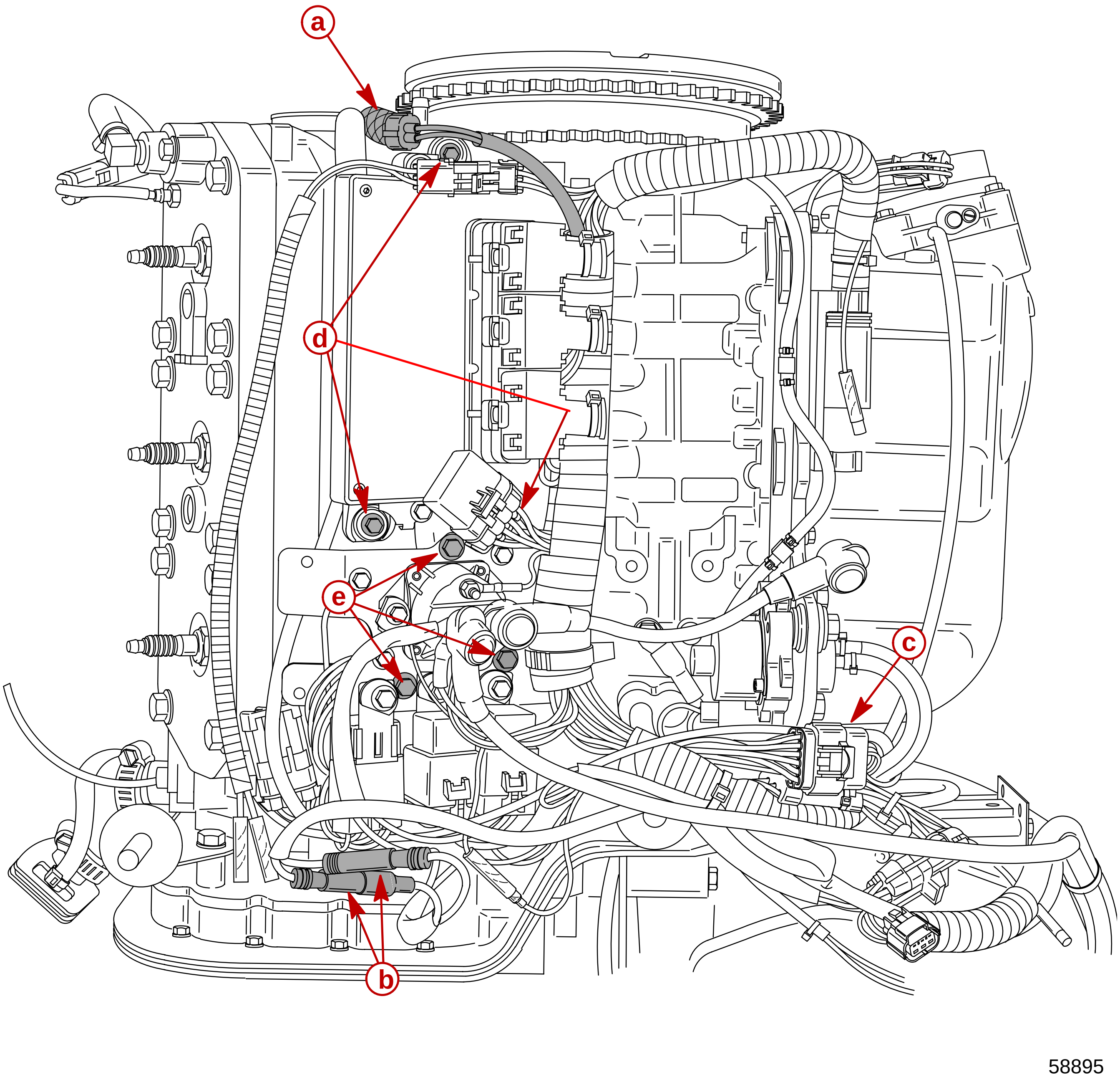
Disconnect and/or remove the following:



a - Yellow Lead from Starter
b - Bolts (4)

Electrical Plate Removal

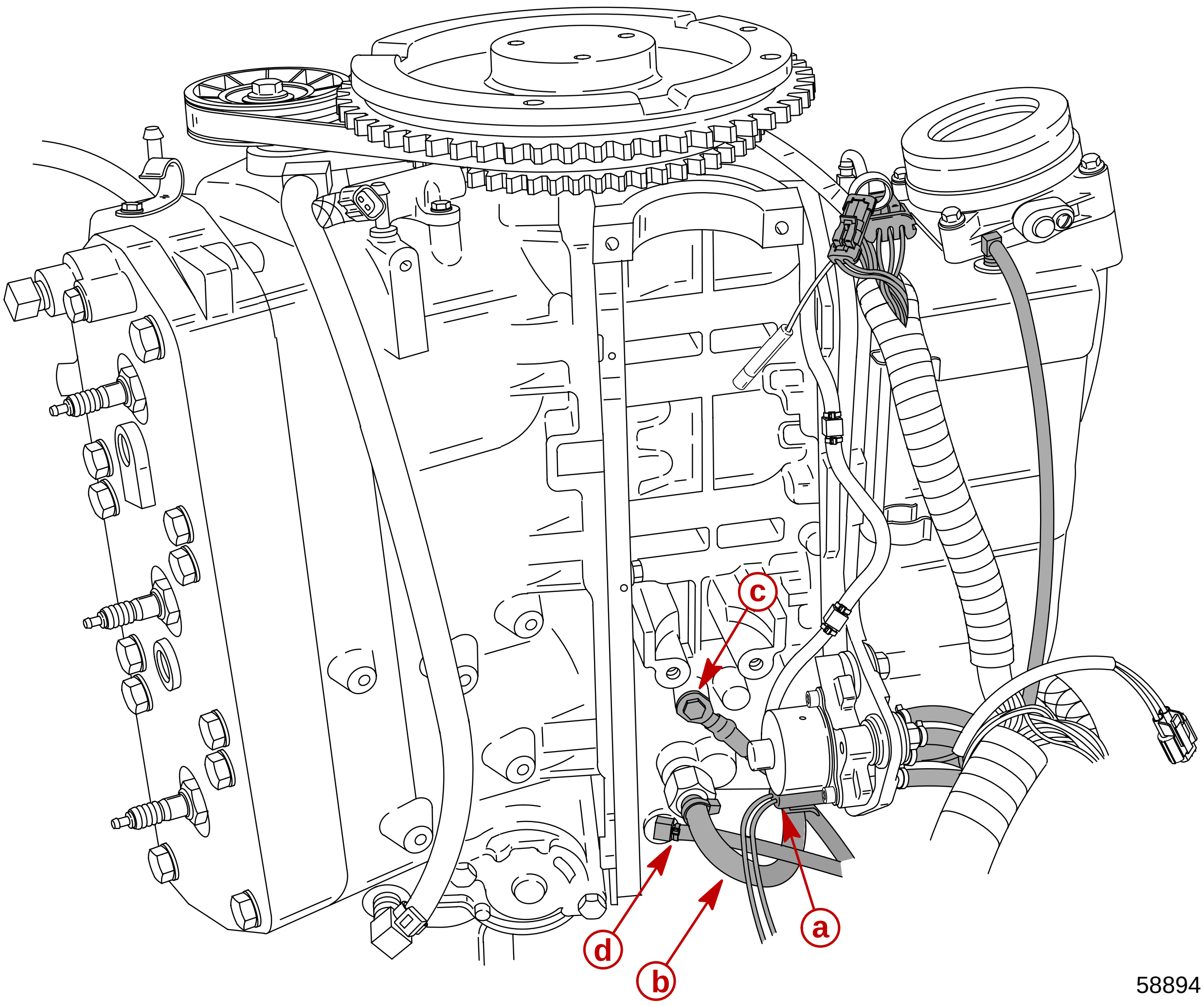
Disconnect and/or remove the following:



a - Crank Position Sensor Connector
b - Trim Motor Bullet Connectors
c - Fuel Injector Harness Connector
d - ECM Screws (3)
e - Solenoid Plate Screws (3)

Oil Pump

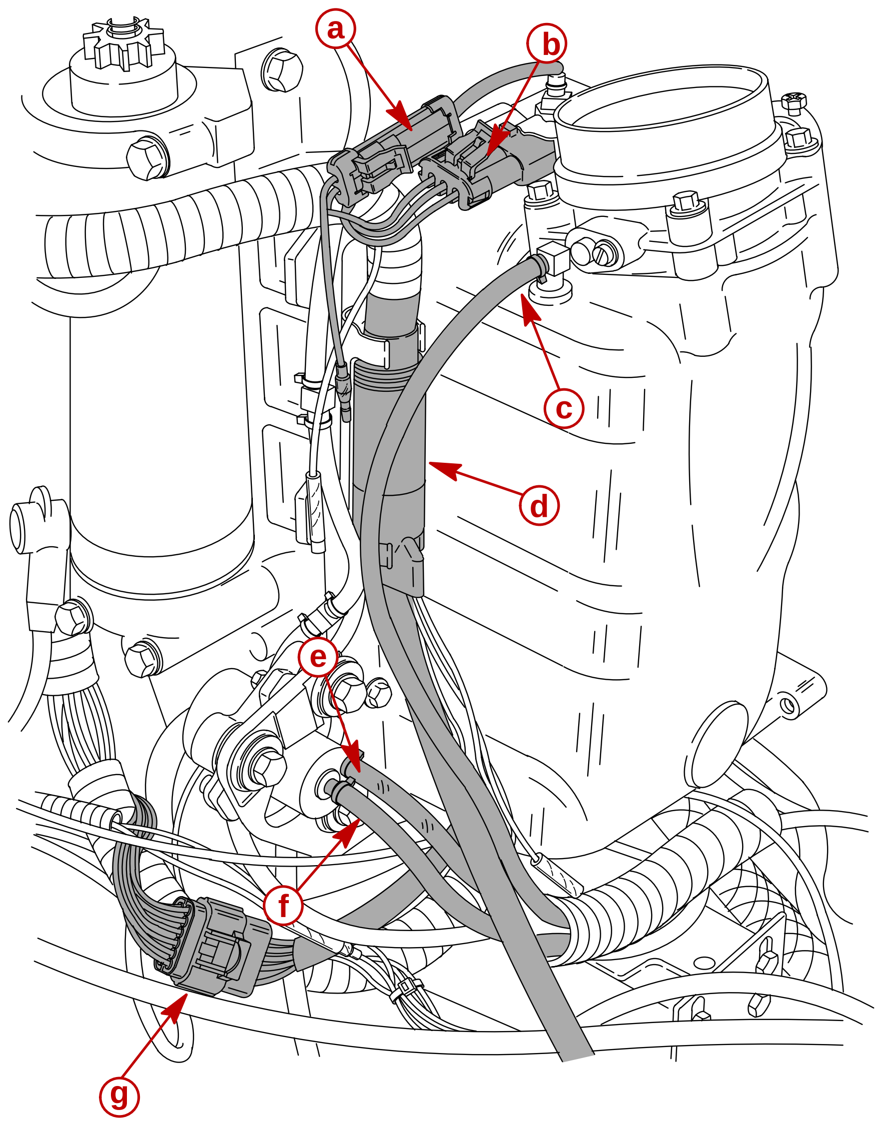
Disconnect and/or remove the following:



a - Oil Pump Electrical Connector
b - Remote Oil Tank Pressure Hose
c - Negative Battery Lead
d - Bleed Hose

Air Plenum

Disconnect and/or remove the following:

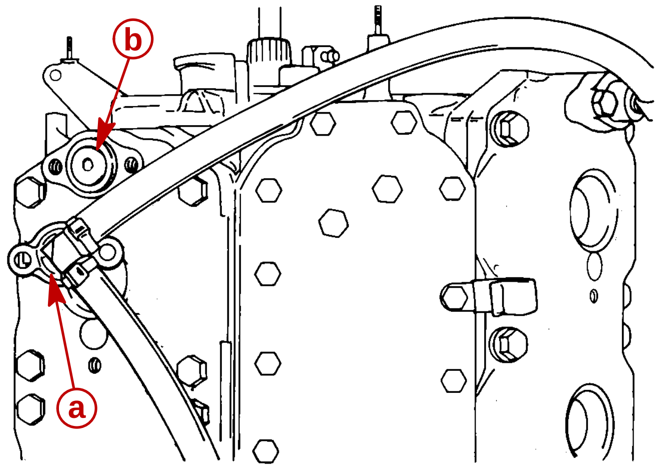


58886

a - Air Temperature Sensor Connector
b - Manifold Pressure Sensor Connector
c - Fuel Regulator Hose
d - Remote Control Harness Connector
e - Oil Pump Inlet Hose (Plug hose to prevent leakage)
f - Oil Pump Outlet Hose (Plug hose to prevent leakage)
g - Fuel Injector Harness Connector

Powerhead Disassembly

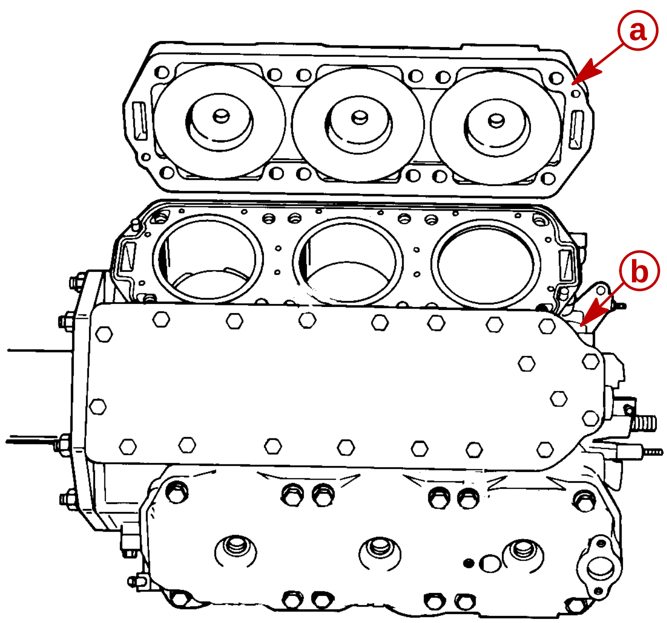
1. Place powerhead in repair stand or on a bench.
2. Remove thermostat covers and washers.



51852

a - Cover
b - Washer

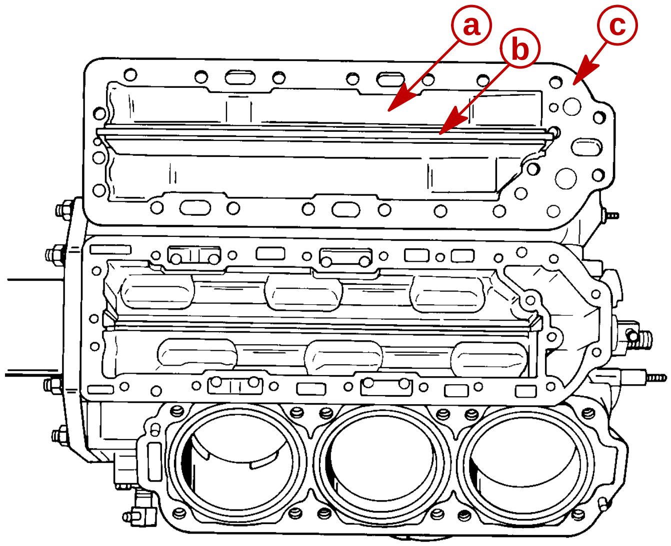
3. Remove cylinder heads from engine block.



51847

a - Cylinder Head
b - Engine Block

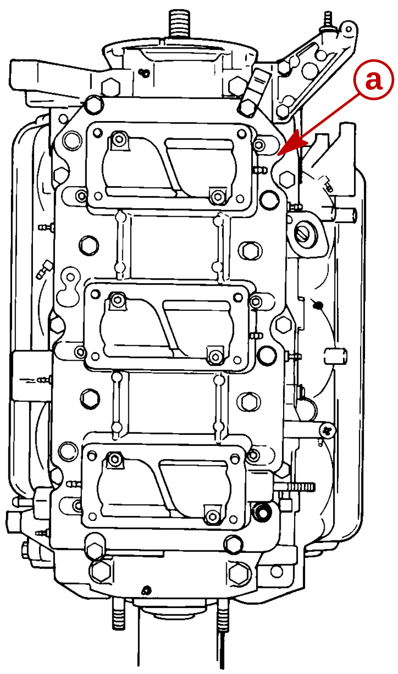
4. Remove exhaust manifold and seal.



51852

a - Exhaust Manifold
b - Seal
c - Gasket

5. Remove reed block housing from cylinder block.



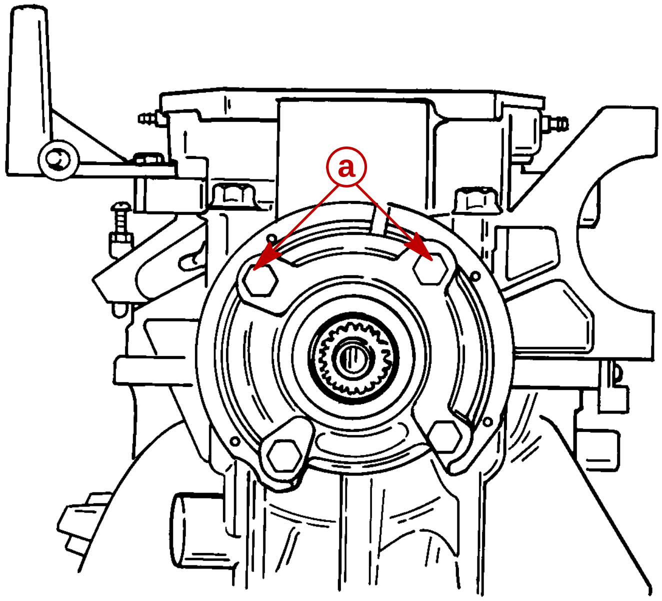
51845

a - Reed Block Housing

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

7. Remove bolts from end caps.

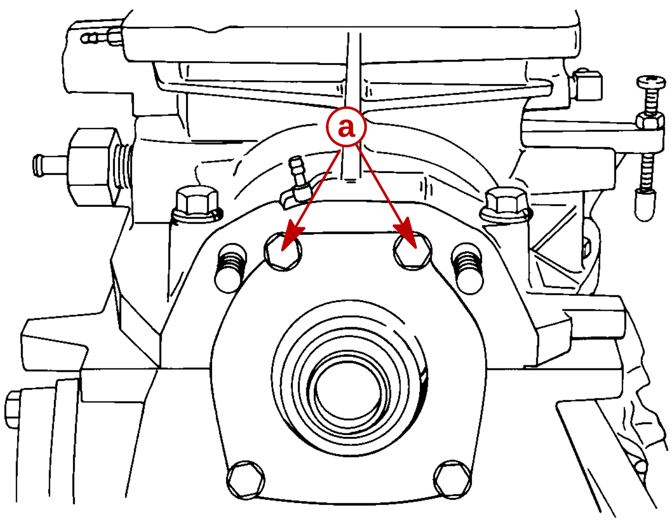
UPPER END CAP



51854

a - Crankcase Attaching End Cap Bolts

LOWER END CAP

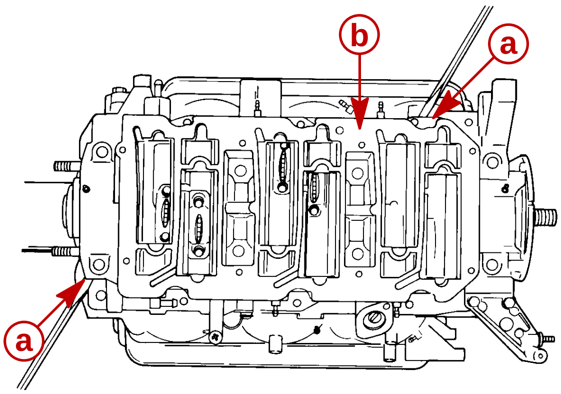


51849

a - Crankcase Attaching End Cap Bolts

8. Remove bolts which secure crankcase cover to cylinder block.

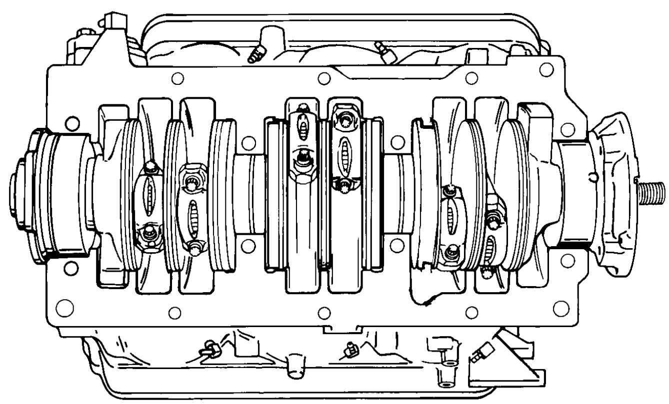
9. Pry crankcase cover off cylinder block using pry bars in locations shown.



51845

a - Pry Points
b - Crankcase Cover

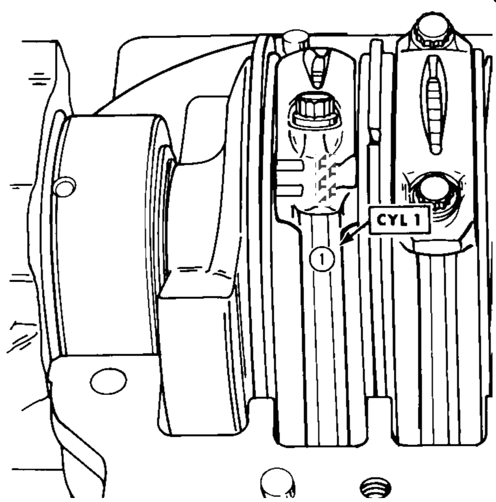
CRANKCASE COVER REMOVED



51848

10. Use Powerhead Stand (91-30591A1) for rotating crankshaft to desired position for removal of connecting rods.

11. Using an awl or electric pencil, scribe the cylinder identification number on each connecting rod as shown. Reassemble connecting rods in same cylinder.



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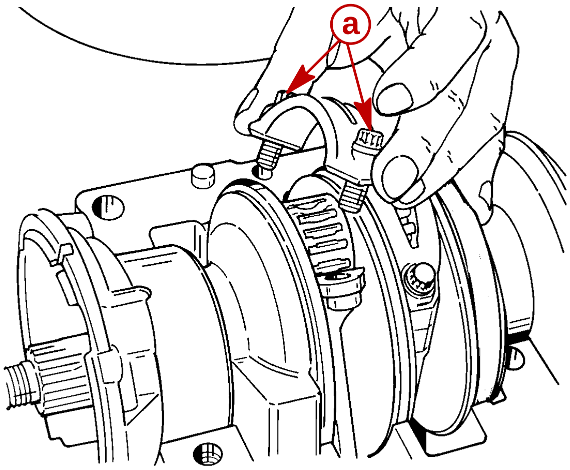
12. Use a 5/16 in. 12 point socket to remove connecting rod bolts, then remove rod cap, roller bearings and bearing cage from connecting rod.



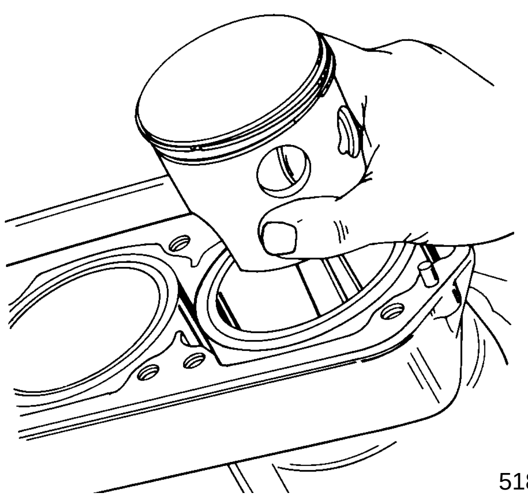
51850

a - Connecting Rod Bolts

13. Push piston out of cylinder block.
14. 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.

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



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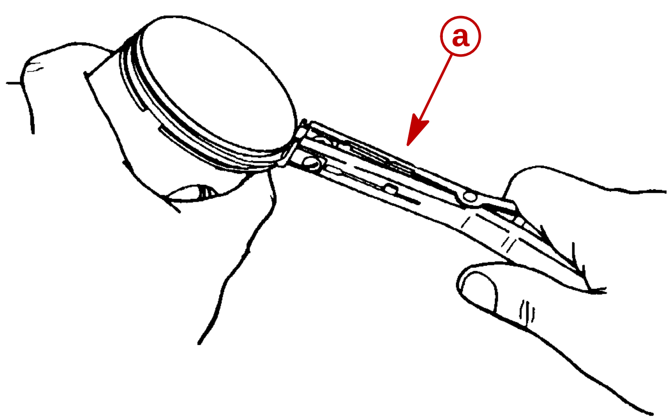
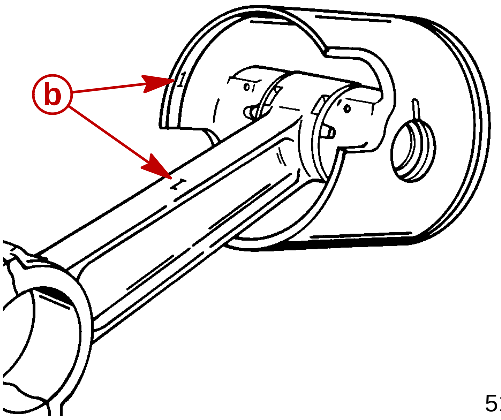


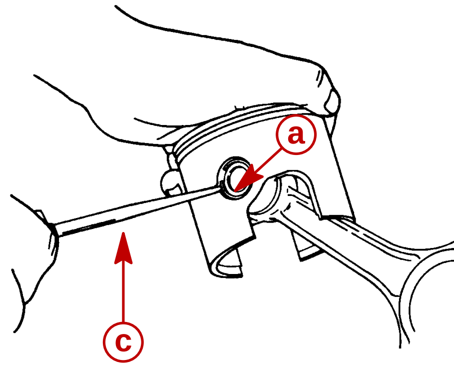
51081

a - Piston Ring Expander (91-24697)

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



51851



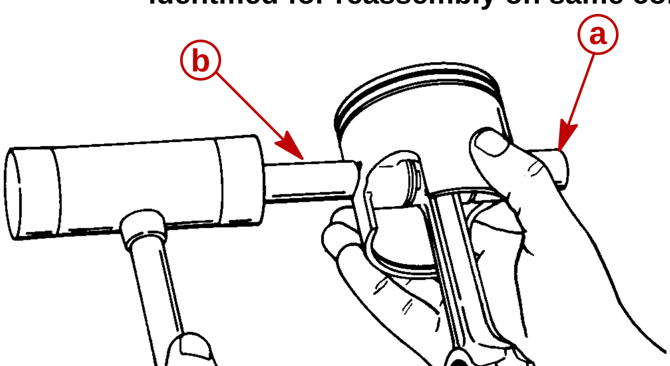
51083

a - Lockring
b - Scribe Identification Number
c - Lockring Tool (91-52952A1)

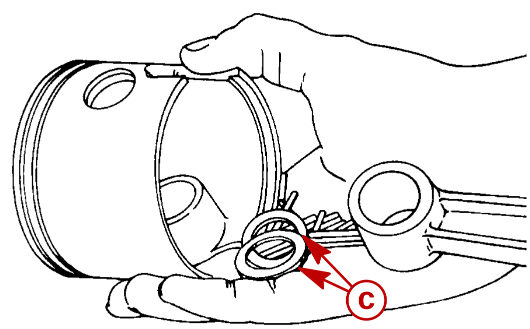
IMPORTANT: Warming the piston dome using a torch lamp will ease removal and installation of piston pin.

19. Support piston and tap out piston pin using service tool (91-76159A1) as shown.
20. Remove piston pin needle bearings (29 per piston) and locating washers (2 per piston) as shown.

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



51853



51088

a - Piston Pin Tool (91-76159A1)
b - Piston Pin
c - Needle Bearing Locating Washers

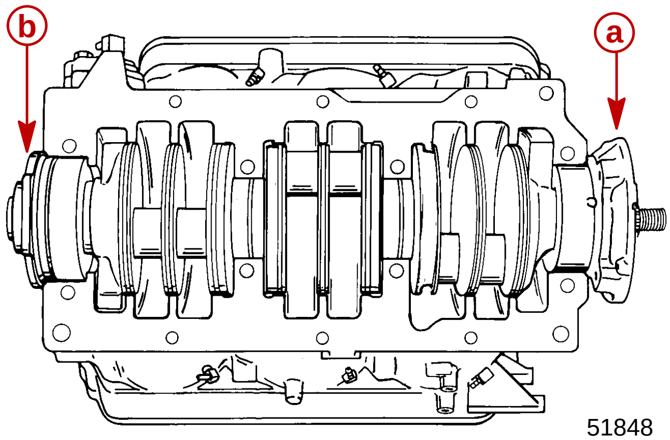
21. Remove upper end cap and lower end cap from crankshaft.

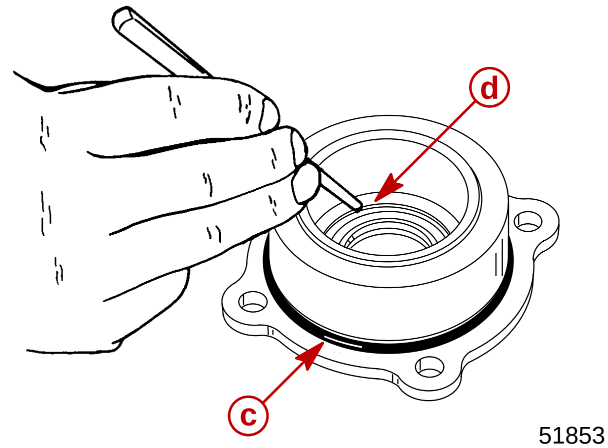
22. Remove and discard O-ring seals from each end cap.

23. Remove oil seal(s) from end of each end cap by driving seal out with a punch and hammer.

24. Inspect roller bearing in upper end cap as outlined in “Cleaning and Inspection”.

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





a - Upper End Cap
b - Lower End Cap
c - O-Ring
d - Seal

25. Remove crankshaft and place in powerhead stand.

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.

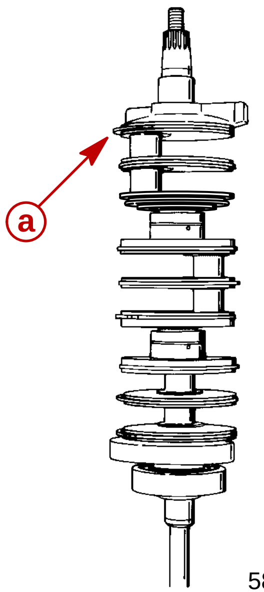
26. Remove crankshaft and place in powerhead stand as shown.

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.

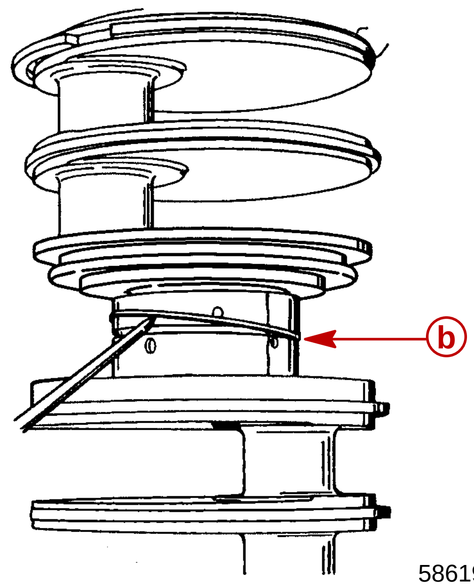
CAUTION

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

27. Remove retaining ring as shown.



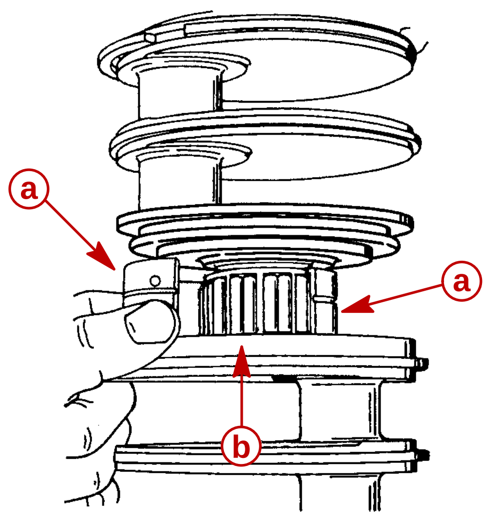
a - Sealing Rings



b - Retaining Ring

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

IMPORTANT: Keep same bearing races and roller bearings together.



58614

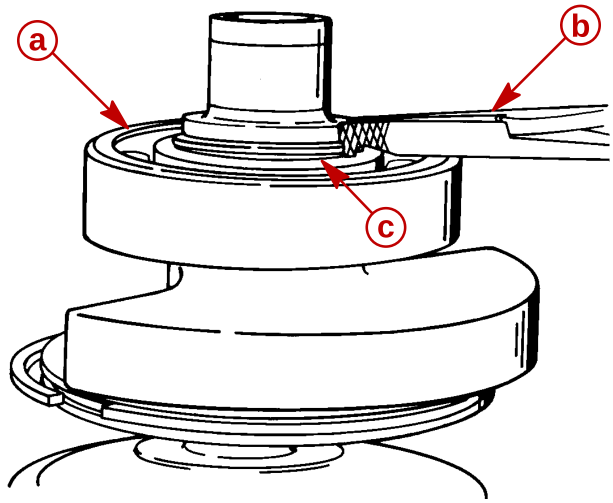
a - Bearing Race Halves
b - Roller Bearings

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

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

29. Remove lower ball bearing from crankshaft as follows:

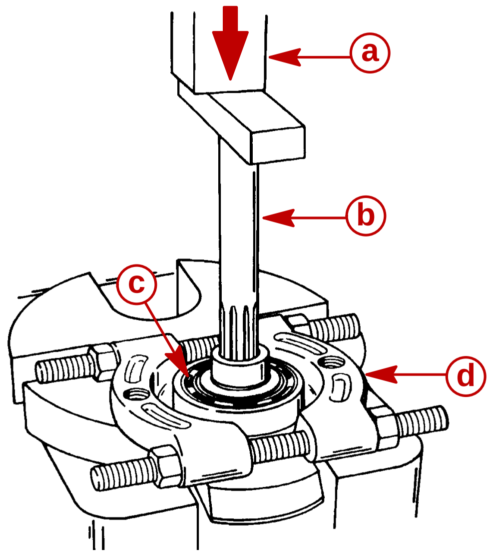
a. Remove retaining ring using a pair of snap ring pliers.



51854

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

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

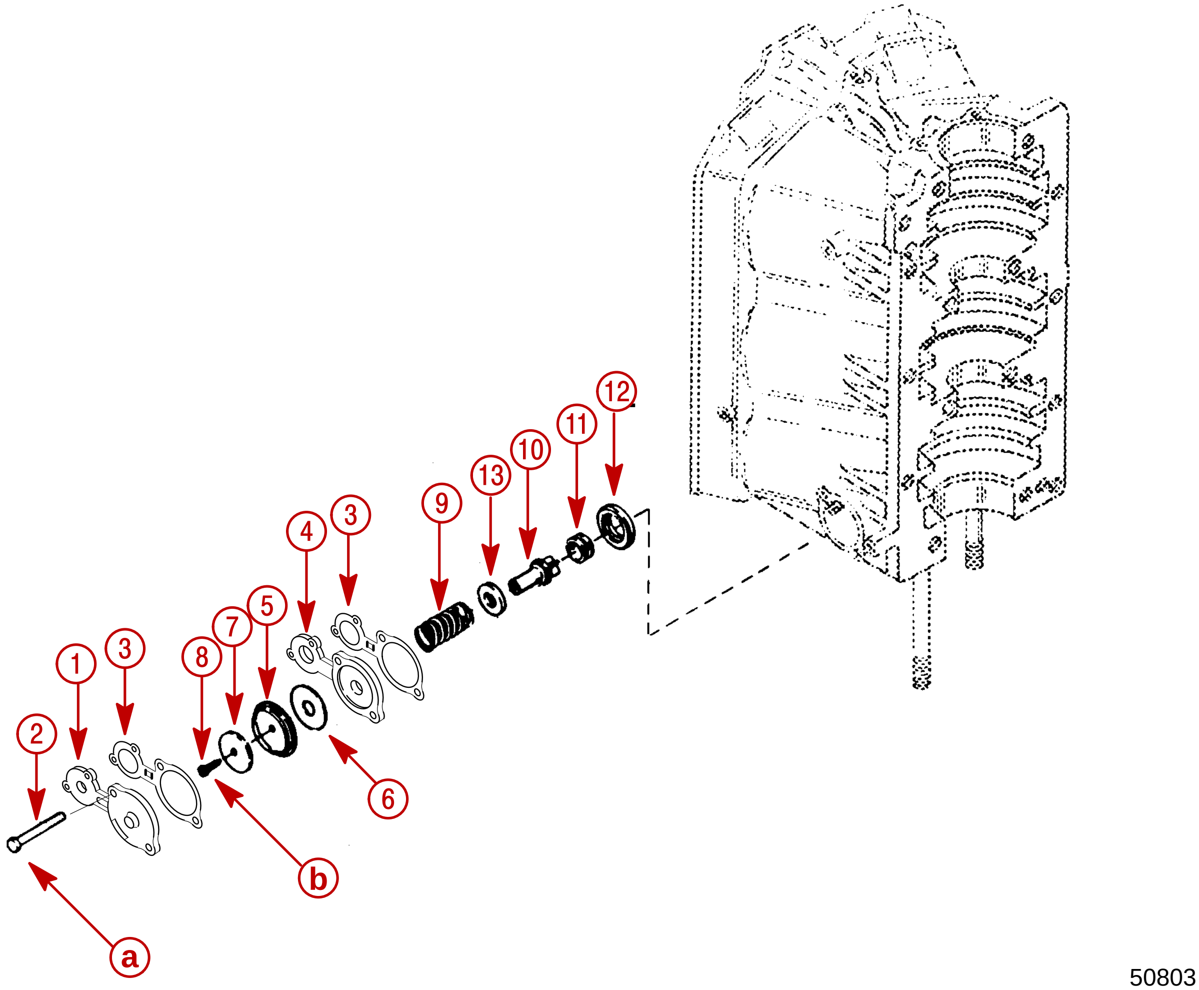


51081

a - Press
b - Powerhead Stand (91-812549T)
c - Crankshaft Ball Bearing
d - Universal Puller Plate (91-37241)

Water Pressure Relief Valve Components

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



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

Torque Specifications

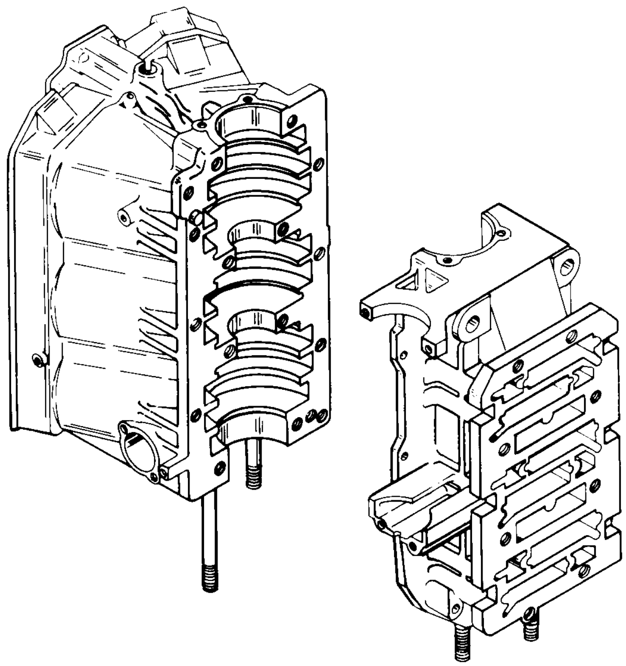
a 150 lb. in. (17 N·m)

b 25 lb. in. (3 N·m)

Cleaning and Inspection

Cylinder Block and Crankcase Cover

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



CAUTION

If crankcase cover or cylinder block is to be submerged in a very strong cleaning solution, it will be necessary to remove the 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 such as “TIDY BOWL CLEANER” should be applied to the areas of the cylinder bore where transfer of aluminum has occurred. After the acidic solution has removed the transferred aluminum, thoroughly flush the cylinder bore(s) to remove any remaining acid. Cylinder walls may now be honed to remove any glaze and to aid in the seating of new piston rings.

HONING PROCEDURE

a. When cylinders are to be honed, follow the hone manufacturer’s recommendations for use of the hone and cleaning and lubrication during honing.

b. For best results, a continuous flow of honing oil should be pumped into the work area. If pumping oil is not practical, use an oil can. Apply oil generously and frequently on both stones and work area.

CAUTION

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

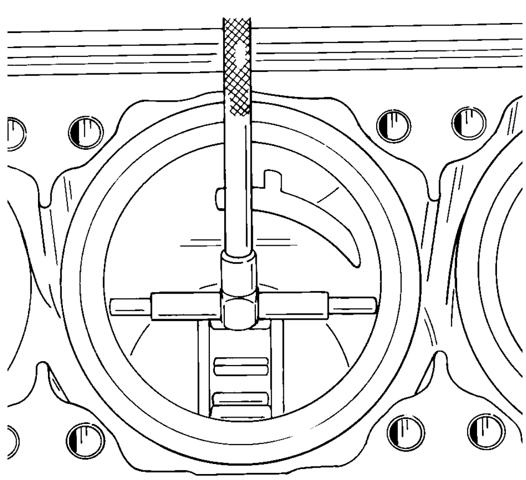
c. Start stroking at smallest diameter. Maintain firm stone pressure against cylinder wall to assure fast stock removal and accurate results.

d. Localize stroking in the smallest diameter until drill speed is constant throughout length of bore. Expand stones, as necessary, to compensate for stock removal and stone wear. Stroke at a rate of 30 complete cycles per minute to produce best cross-hatch pattern. Use honing oil generously.

e. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. A good cleaning is essential. If any of the abrasive material is allowed to remain in the cylinder bore, it will cause rapid wear of new piston rings and cylinder bore in addition to bearings. After cleaning, bores should be swabbed several times with engine oil and a clean cloth, then wiped with a clean, dry cloth. Cylinders **should not** be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

2. Hone all cylinder walls **just enough** to de-glaze walls.

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



51846

Models 150/175/200 2.5 liter	Cylinder Block Finish Hone
Standard Piston	3.501 in. (88.93 mm)
0.015 in. (0.381 mm) Oversize Piston	3.516 in. (89.31 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 or re-sleeve and install oversize piston(s) and piston rings during reassembly.

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

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

Pistons and Piston Rings

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

1. Inspect pistons for scoring and excessive piston skirt wear.
2. Check tightness of piston ring locating pins. Locating pins must be tight.
3. Thoroughly clean pistons. Carefully remove carbon deposits from pistons, with a soft wire brush or carbon removal 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

NOTE: *Cleaning instructions differ between the rectangular ring groove and keystone (tapered) ring groove. Pistons may have two keystone ring grooves or one keystone ring groove and one rectangular ring groove as shown.*

Rectangular ring grooves

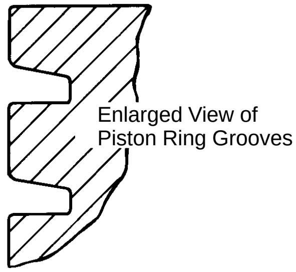
1. A broken rectangular piston ring can be used as a tool for scraping carbon from ring grooves. Carefully scrape carbon from ring grooves without scratching the side surfaces of grooves.

Keystone (tapered) ring grooves

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

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

Piston with two half keystone (half tapered) rings



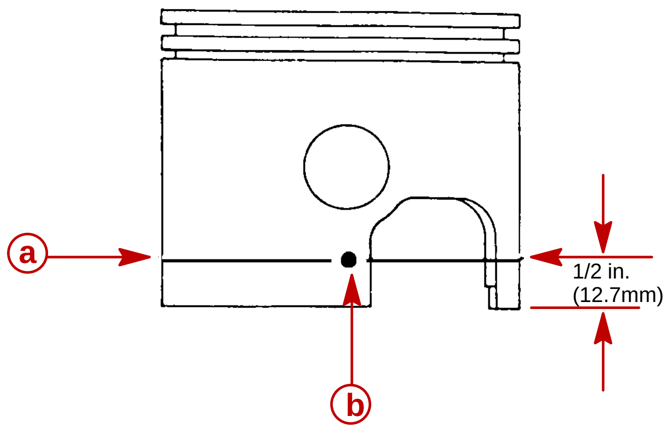
MEASURING PISTON ROUNDNESS

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

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

150/175/200 Piston	Dimension "A"
Standard Piston	3.494 in. ± .001 in. (88.747 mm ± .025 mm)
0.015 in. Oversize Piston	3.509 in. ± .001 in. (89.128 mm ± .025 mm)

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



a - Dimension A at right angle (90°) to Piston Pin
b - Dimension B (inline with Piston Pin)

Cylinder Heads and Exhaust Divider Plate

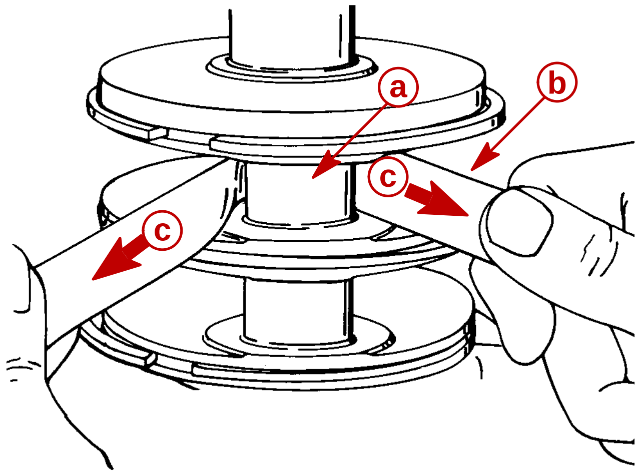
1. Inspect internal surface of cylinder heads for possible damage (as a result of piston or foreign material striking cylinder heads).

IMPORTANT: Cylinder head warpage should not exceed 0.004 in. (0.1 mm) over the ENTIRE length of the cylinder head. If measured warpage, as determined on a surface block, exceeds 0.004 in. (0.1 mm) or a discontinuity of up to 0.004 in. (0.1 mm) exists in a narrow portion of the cylinder head's surface length, then the cylinder head should be replaced.

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



51847

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

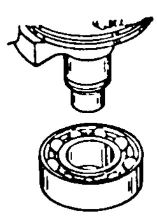
⚠ WARNING

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

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

Crankshaft (and End Cap) Bearings

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



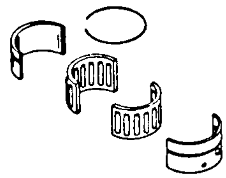
Lower Ball Bearing

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

⚠ CAUTION

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

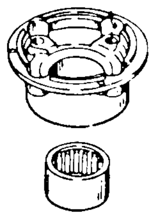
4. Thoroughly inspect center main roller bearings. Replace bearings if they are rusted, fractured, worn, galled or badly discolored.



Center main Roller Bearing

5. Clean (with solvent) and dry crankshaft roller bearing that is installed in upper end cap. Lubricate bearing with light oil.

6. Thoroughly inspect upper end cap roller bearing. If roller bearing is rusted, fractured, worn, galled, badly discolored or loose inside of end cap replace end cap and roller bearing as an assembly.



Upper Roller Bearing

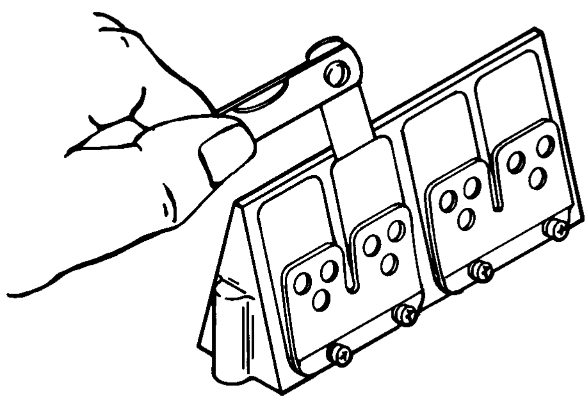
Reed Block Assembly

IMPORTANT: Reed block assembly is not serviceable. If reeds are damaged replace reed block assembly.

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. Check for wear (indentations) on face of each reed block. Replace reed block assembly if reeds have made indentations.

3. Check for chipped and broken reeds.

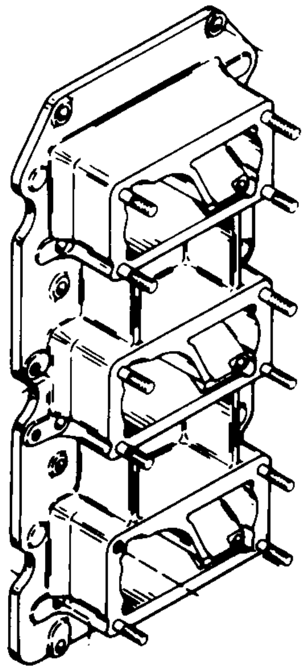


51851

Allowable reed opening is 0.020 in. (0.51 mm) or less. Replace reed block assembly if any reed is standing open more than 0.020 in. (0.51 mm).

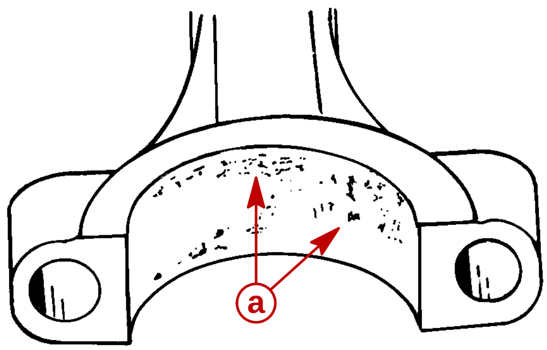
Reed Block Housing

1. Check rubber bleed hoses. Replace any hose that is cracked, cut or deteriorating.
2. Check operation of bleed system check valves in reed block housing. If valves are working properly, air can be drawn thru check valves "one way" only. If air can pass thru a check valve both ways, valve is not working properly and must be replaced.
3. Check that bleed system check valves are pressed tight into reed housing.
4. Inspect passages in reed block housing to be sure that they are not obstructed.



Connecting Rods

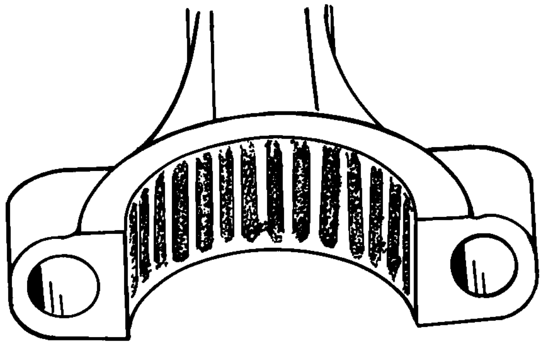
1. Check connecting rods for alignment by placing rods on a surface plate. If light can be seen under any portion of machined surfaces, if rod has a slight wobble on plate, or if a 0.002 in. (0.051 mm) feeler gauge can be inserted between any machined surface and surface plate, rod is bent and must be 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

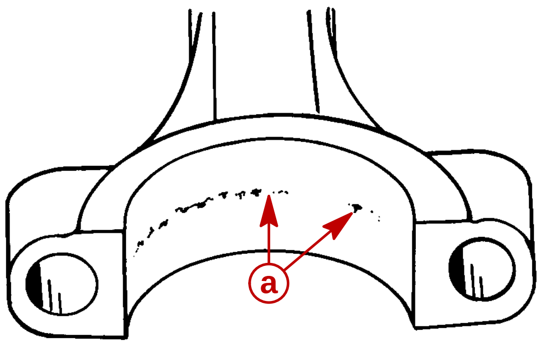
a - Pitting

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

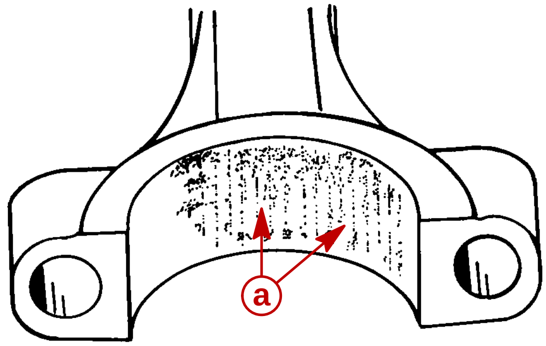
5. **Spalling:** Spalling is the loss of bearing surface, and it resembles flaking or chipping. Spalling will be most evident on the thrust portion of the connecting rod in line with the "I" beam. General bearing surface deterioration could be caused by or accelerated by improper lubrication.



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).



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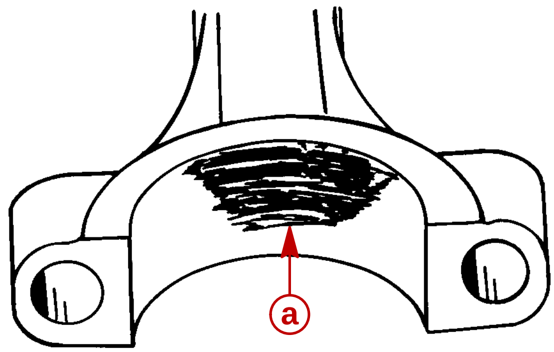
a - Chatter Marks Between Arrows

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:

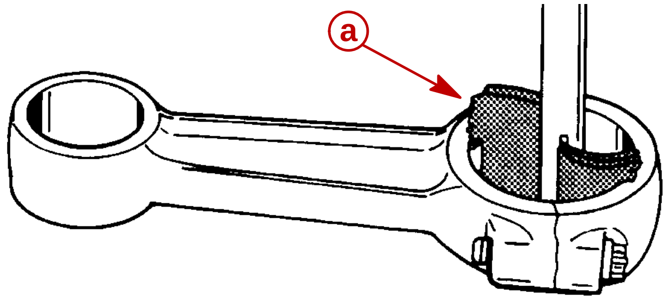
   a. Be sure that “etched” marks on connecting rod (crankshaft end) are perfectly aligned with “etched” marks on connecting rod cap. Tighten connecting rod cap attaching bolts securely.

⚠ 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.



a - Crocus Cloth

c. **Clean PISTON PIN END of connecting rod**, using same method as in Step “b”, preceding, but using 320 grit carborundum cloth instead of crocus cloth.

d. Thoroughly wash connecting rods to remove abrasive grit. Recheck bearing surfaces of connecting rods. Replace any connecting rod(s) that cannot be properly “cleaned up.” Lubricate bearing surfaces of connecting rods (which will be re-used) with light oil to prevent rust.

Powerhead Reassembly and Installation

General

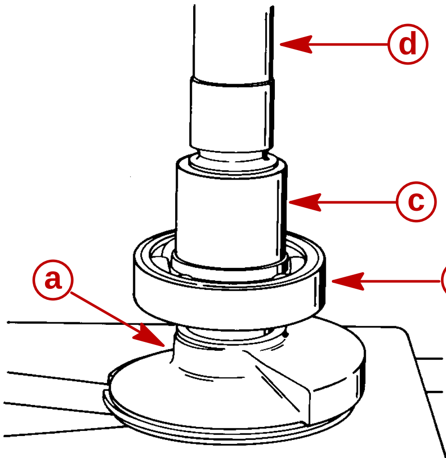
Before proceeding with powerhead reassembly, be sure that all parts to be re-used have been carefully cleaned and thoroughly inspected, as outlined in “Cleaning and Inspection,” preceding. Parts, which have not been properly cleaned (or which are questionable), can severely damage an otherwise perfectly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

During reassembly, lubricate parts with 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. (40.7 N·m), a) tighten all bolts to **10 lb. ft. (13.5 N·m)**, following specified torque sequence, b) tighten all bolts to **20 lb. ft. (27 N·m)**, following torque sequence, then finally c) tighten all bolts to **30 lb. ft. (40.7 N·m)**, following torque sequence.

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



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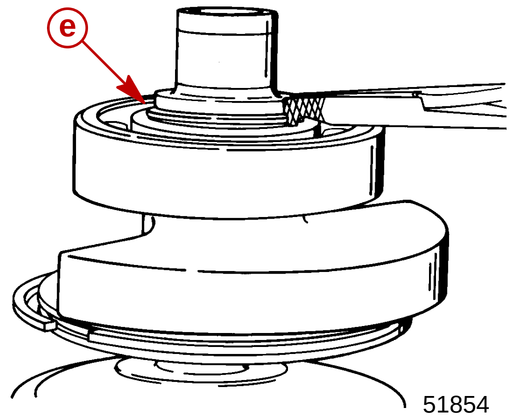
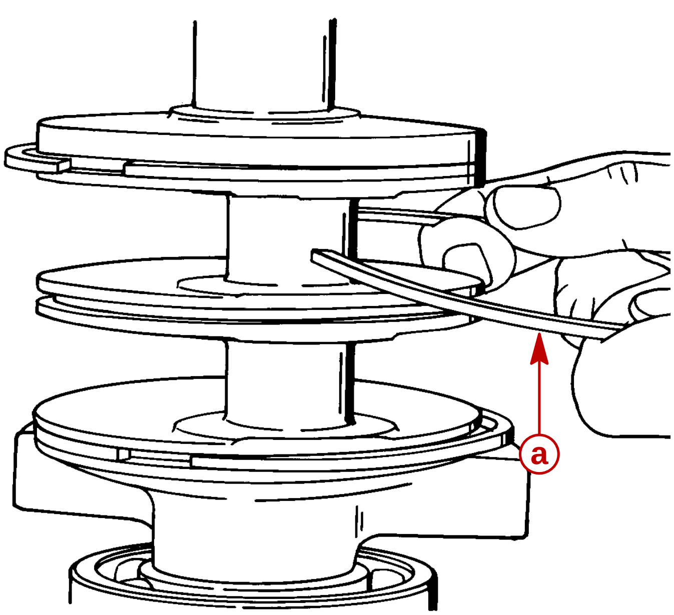


51854

a - Crankshaft
b - 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.



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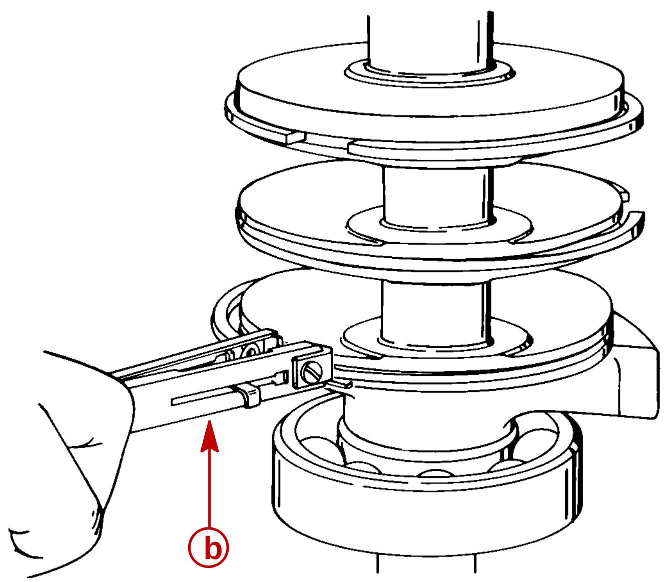
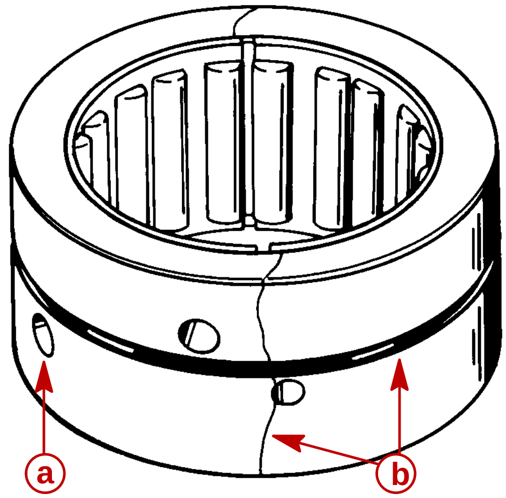


51849

a - Crankshaft Sealing Rings
b - Piston Ring Expander (91-24697)

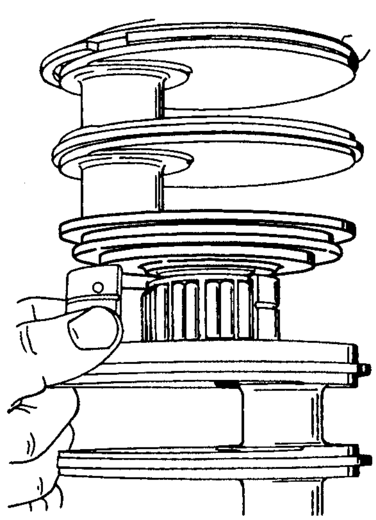
5. Lubricate center main crankshaft roller bearings and races with light oil.



51854

a - Install so larger of the 3 holes is toward bottom 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.



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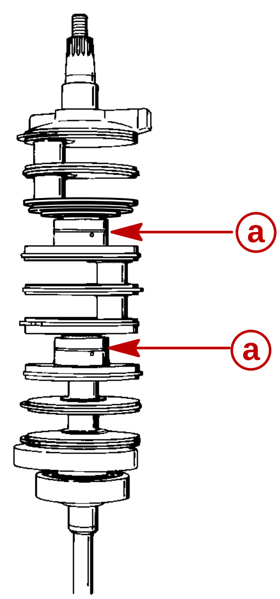


58617

a - Center Main Bearing Races

9. Install oil seals into lower end cap as follows:

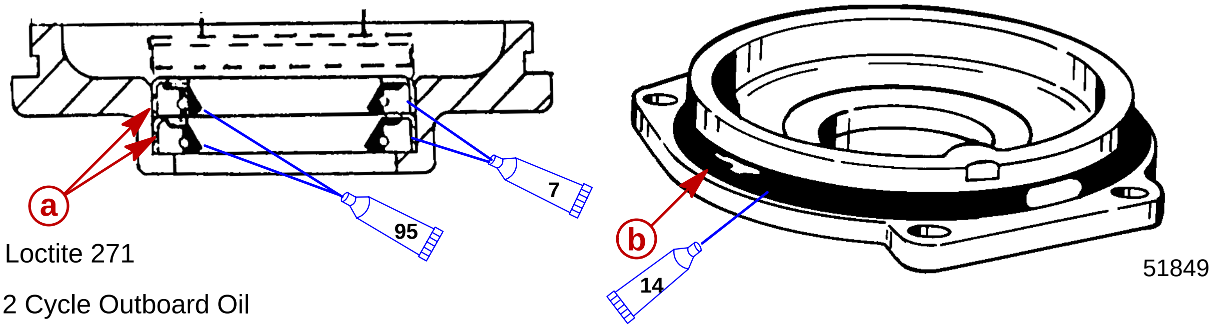
   a. Apply a thin bead of Loctite 271 to outer diameter on 2 lower end cap oil seals (a).

   b. Using driver head (91-55919) press one oil seal (lip facing down) into lower end cap until firmly seated. Remove any excess Loctite.

   c. Press second oil seal (lip facing down) until firmly seated on first oil seal. Remove any excess Loctite.

   d. Lubricate oil seal lips with Quicksilver 2-4-C with Teflon.

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



7 Loctite 271

14 2 Cycle Outboard Oil

95 2-4-C With Teflon

a - Oil Seal

b - O-ring

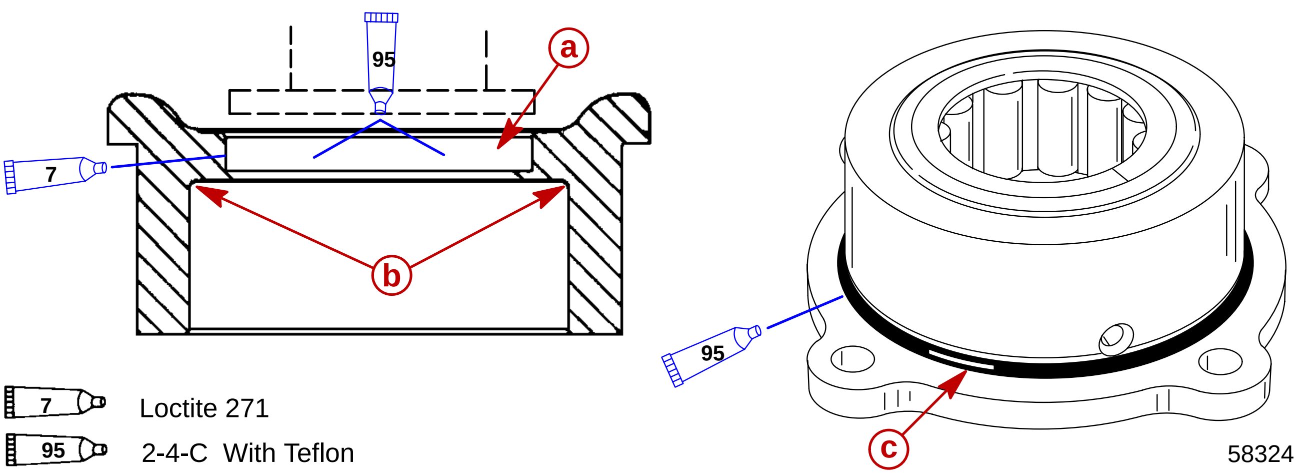
10. Install oil seal into upper end cap as follows:

   a. Apply a thin bead of Loctite 271 to outer diameter of upper end cap oil seal.

   b. Use a suitable mandrel, press oil seal into upper end cap (lip facing down) until bottomed out on lip of end cap. Remove any excess Loctite.

   c. Lubricate oil seal lip with Quicksilver 2-4-C with Teflon.

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



7 Loctite 271

95 2-4-C With Teflon

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

Crankshaft Installation

SPECIAL INFORMATION

Installing A New Crankshaft Assembly Into Cylinder Block

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

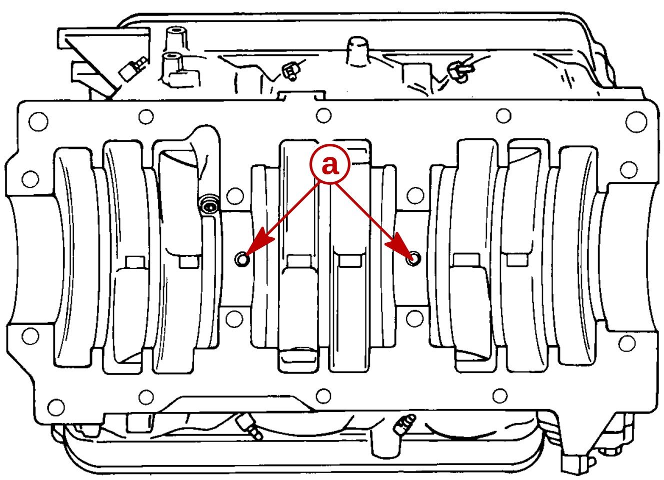
Before installing crankshaft, remove any burrs that may exist on groove edges.

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

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

Install crankshaft as follows:

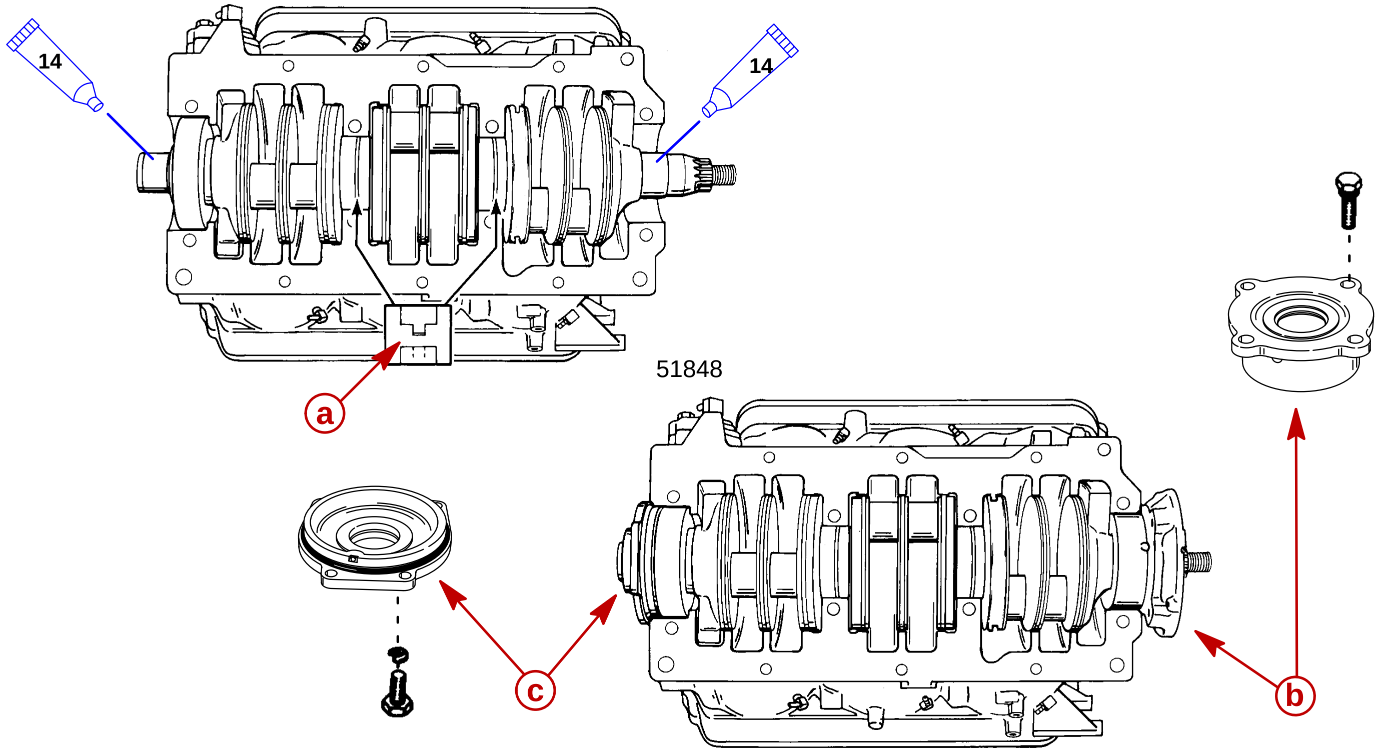
1. Lubricate crankshaft sealing rings with light oil.
2. Check cylinder block to be sure that dowel pins are in place.



a - Dowel Pins

3. Position all crankshaft seal ring gaps straight up.
4. Align hole in each center main bearing race with dowel pin.
5. Gently push crankshaft down into position making sure that the dowel pins are lined up with the holes in center main bearings and crankshaft seal rings are in place.

6. Lubricate crankshaft ends (oil seal areas) with light oil, then install upper and lower end caps (“a” and “b”). Secure end caps to cylinder block with attaching bolts. DO NOT tighten end cap bolts at this time.



14 2 Cycle Outboard Oil

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

Piston and Connecting Rod Reassembly

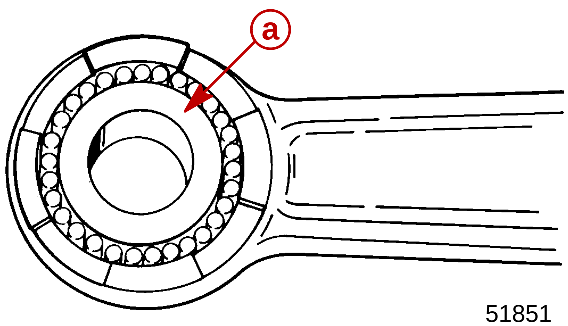
1. Place needle bearings on a clean piece of paper and lubricate with Quicksilver 2-4-C with Teflon Marine Lubricant.

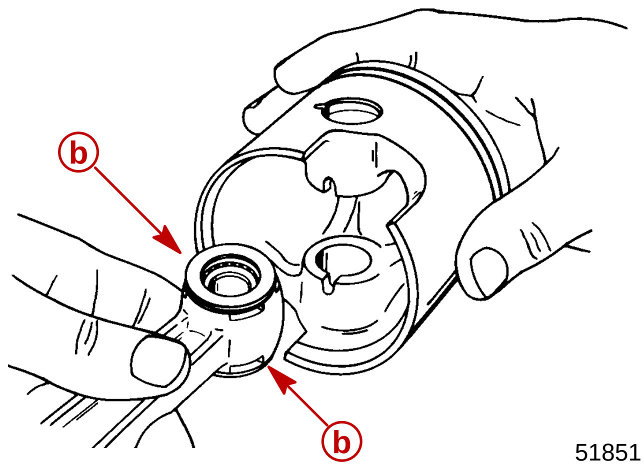
NOTE: *There are 29 needle bearings per piston.*

2. Place sleeve which is part of piston pin tool (91-74607A1) 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.

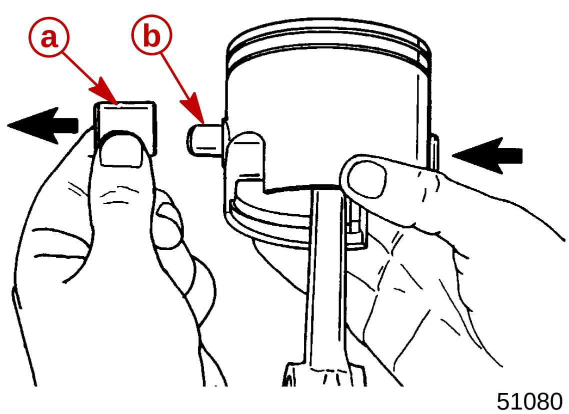
Carefully position piston over end of rod. Make sure locating washers remain in place.

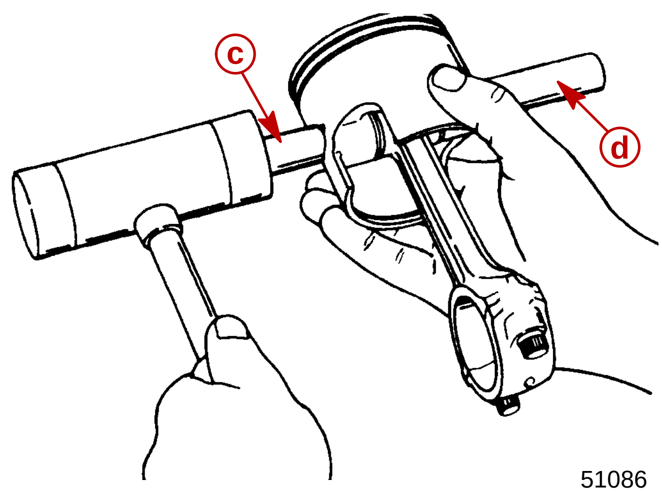




a - Sleeve
b - Locating Washers

4. Insert piston pin tool (91-74607A1) 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.



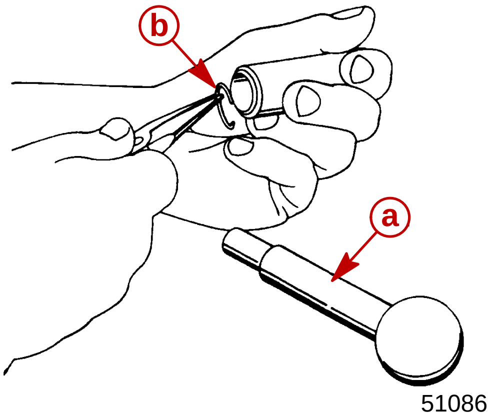


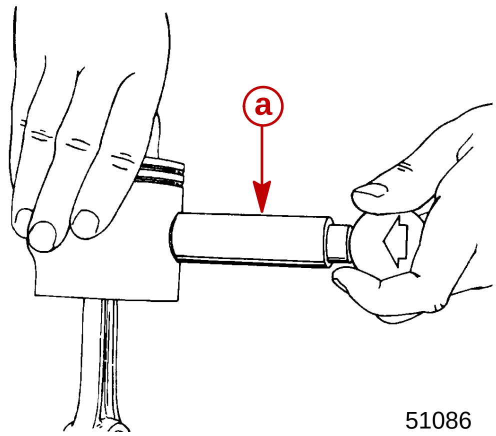
a - Piston Pin Tool
b - Sleeve

c - Piston Pin
d - Piston Pin Tool

6. Install new piston pin lockrings (one each end of piston pin) with Lockring Installation Tool (91-79109A3).

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

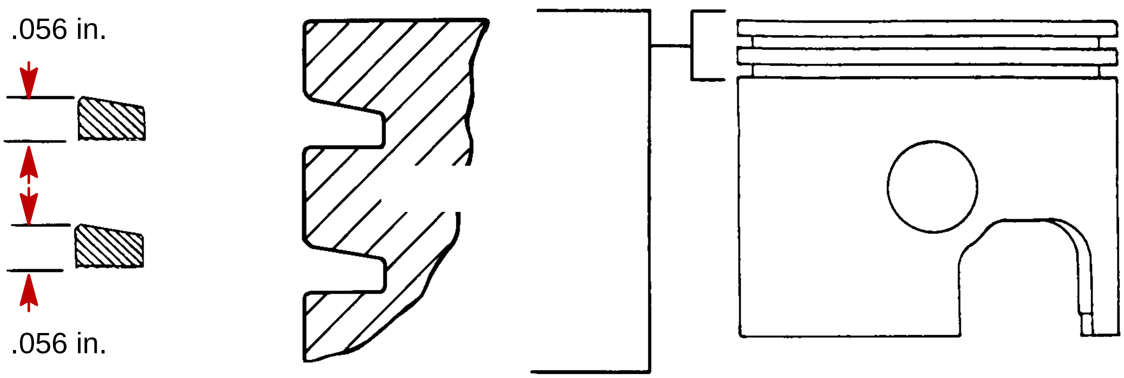




a - Lockring Installation Tool
b - Lockring

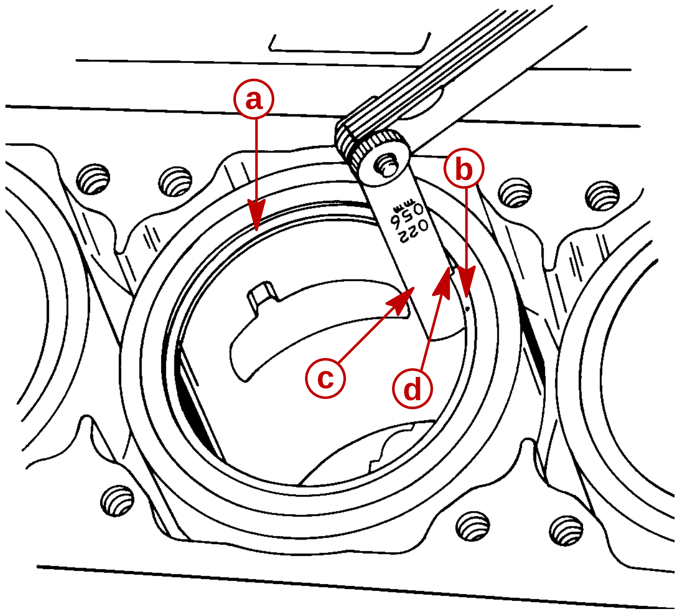
Piston and Piston Ring Combinations

All 153 cu. in. (2.5 Liter) models have two half keystone (half tapered) rings.



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. (12.7mm) 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 0.018 in. to 0.025 in. (0.45mm to 0.64mm). If end gap is greater, check other piston rings in cylinder bore, until rings (within tolerance) are found.



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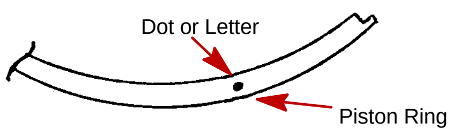
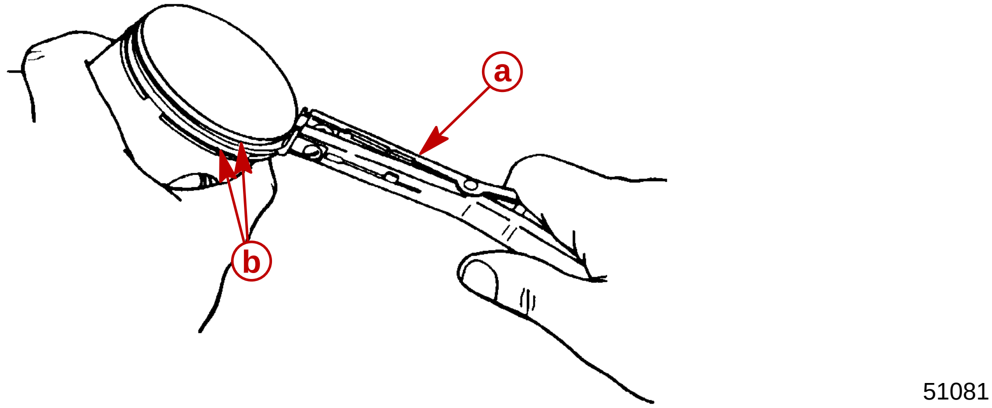
a - Piston Ring
b - Dots (Faces Up)
c - Feeler Gauge
d - Ring End Gap

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



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.



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.

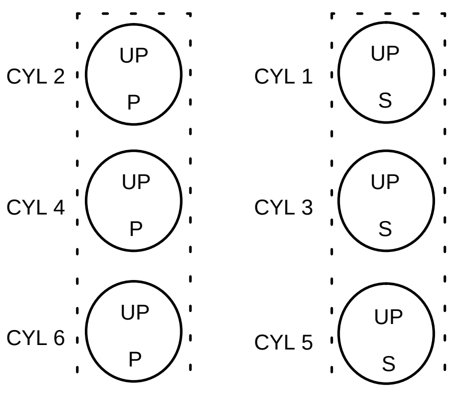
IMPORTANT: Piston must be correctly installed and positioned as shown.

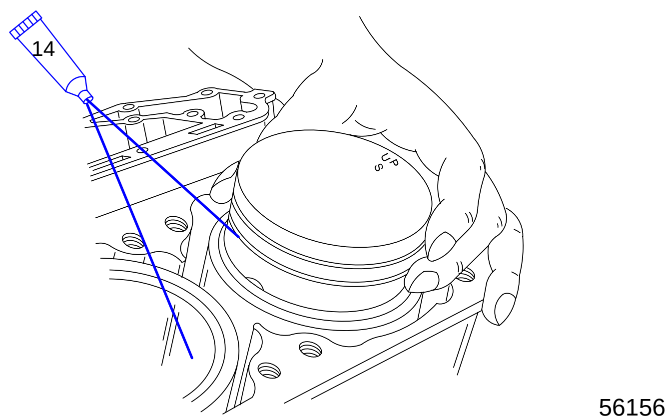
Pistons marked with the word "UP" and with the letter "P" or "S" on top of piston.

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.





2 Cycle Outboard Oil

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

IMPORTANT: It is recommended that connecting rod bolts not be reused.

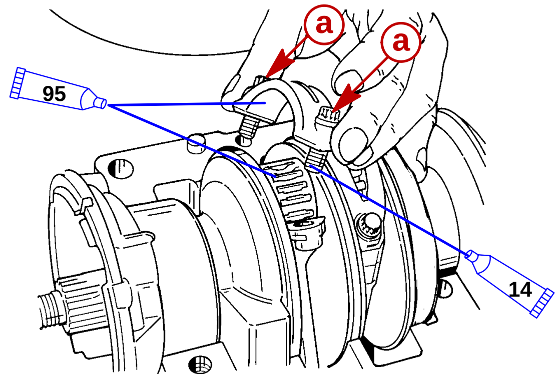
11. Place connecting rod cap on connecting rod. Apply light oil to threads and face of connecting rod bolts. Thread connecting rod bolts finger-tight while checking for correct alignment of the rod cap as shown.

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

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

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

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



14 2 Cycle Outboard Oil

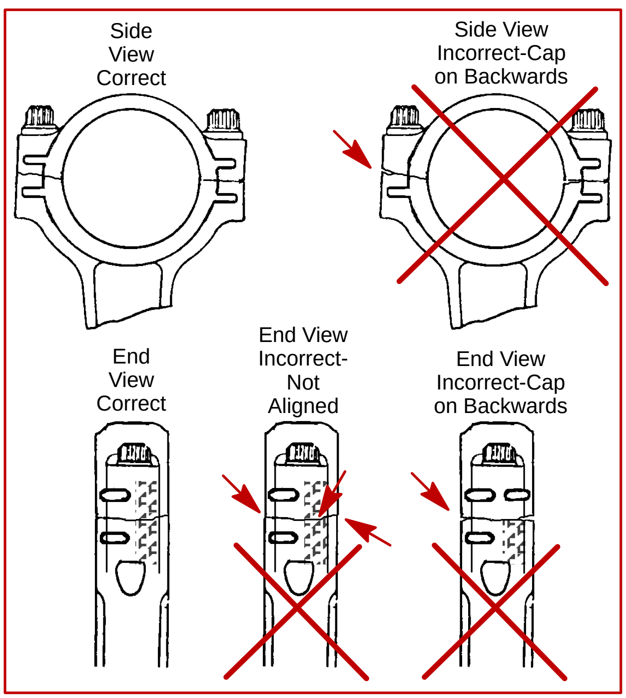
95 2-4-C With Teflon

51850

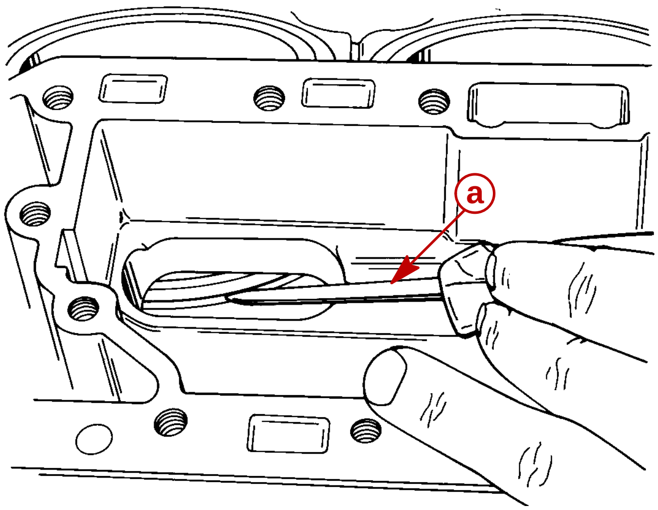
a - Connecting Rod Screws

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

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



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

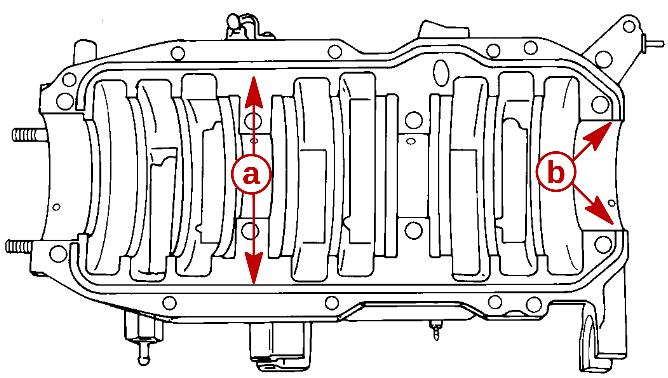


51852

a - Screwdriver

Crankcase Cover Installation

1. Thoroughly remove all oil from mating surfaces of crankcase cover and cylinder block with Loctite 7649 Primer.
2. Install gasket strips into grooves in crankcase cover. Trim end of each gasket strip flush with edge of cover as shown.



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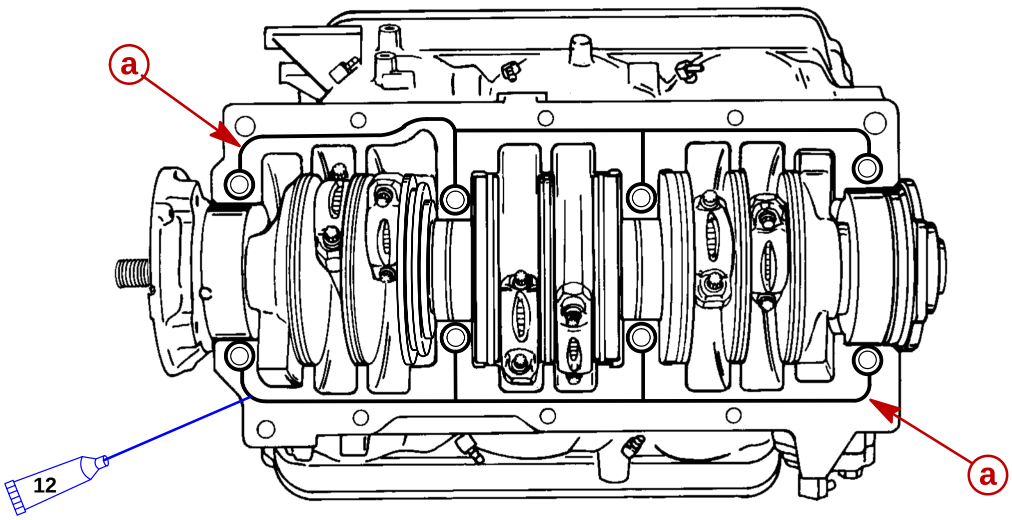
a - Gasket Strips
b - Edge of Cover

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

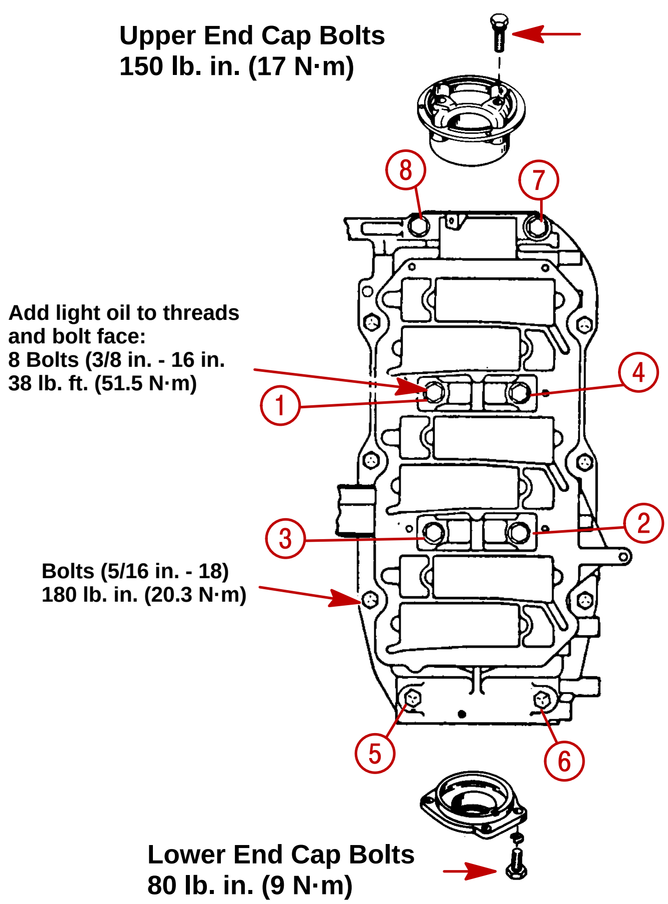


12 Loctite Master Gasket

58620

a - Loctite Master Gasket

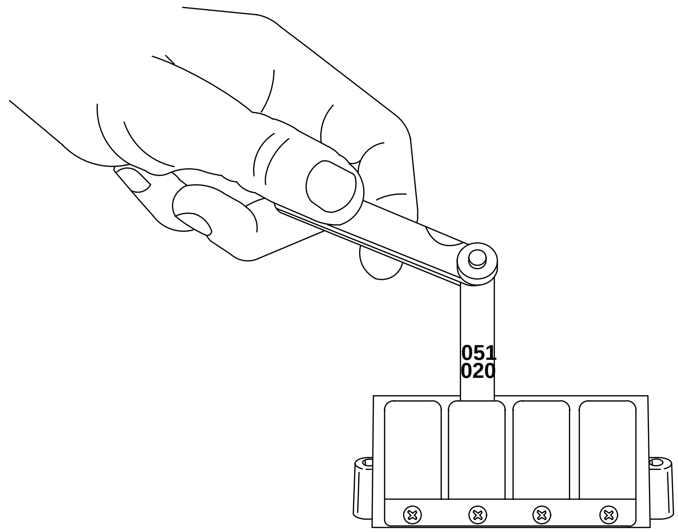
4. Place crankcase cover in position on cylinder block. Turn the 8 center main bolts in a LITTLE at a time, (following torque sequence) compressing crankshaft seal rings until crankshaft cover has been drawn down to cylinder block. Tighten eight bolts evenly in three progressive steps (following torque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



Reed Block Assembly

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

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



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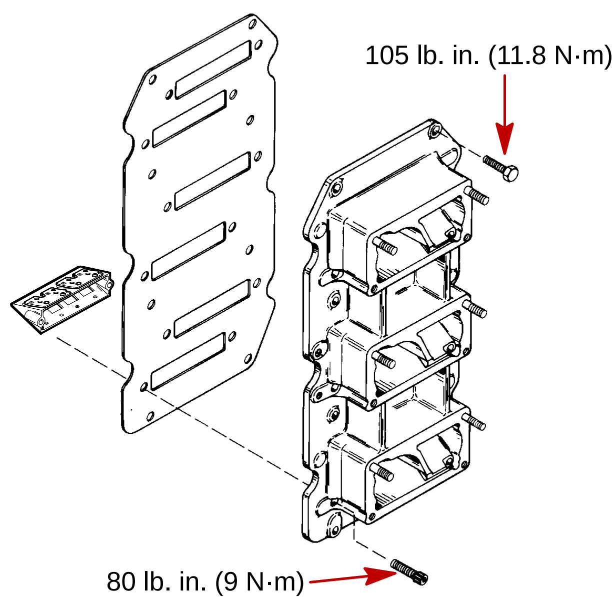
Allowable reed opening is 0.020 in. (0.51 mm) or less. Replace reeds if either reed is standing open more than 0.020 in. (0.51 mm).

Assembly of Reed Blocks to Intake Manifold



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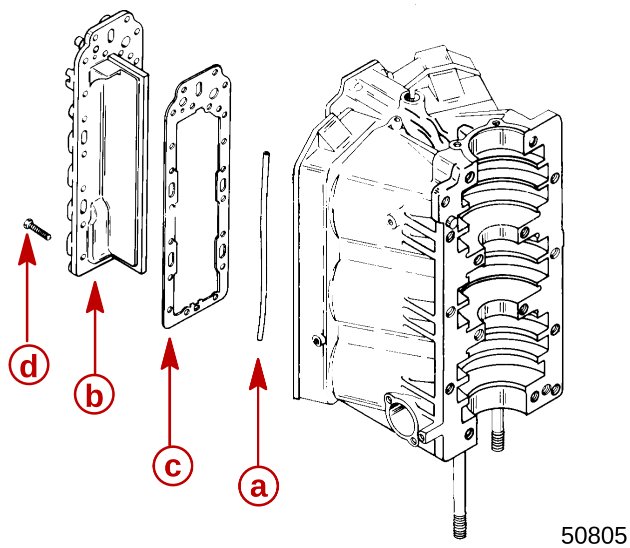
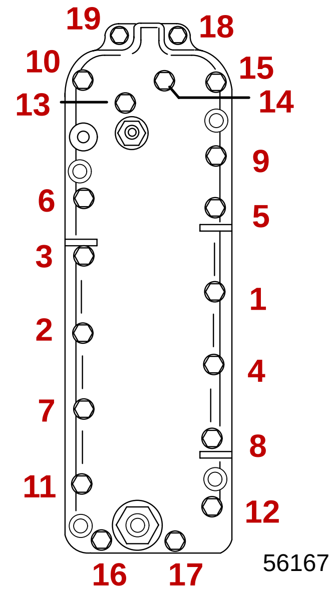
Assembly of Exhaust Divider Plate to Block

1. Place exhaust divider seal into slot in block and install divider plate with gasket.
2. Clean bolt threads with Loctite 7649 Primer.
3. Apply Loctite 271 to bolt threads and torque bolts to 15 lb. ft. (20.3 Nm).

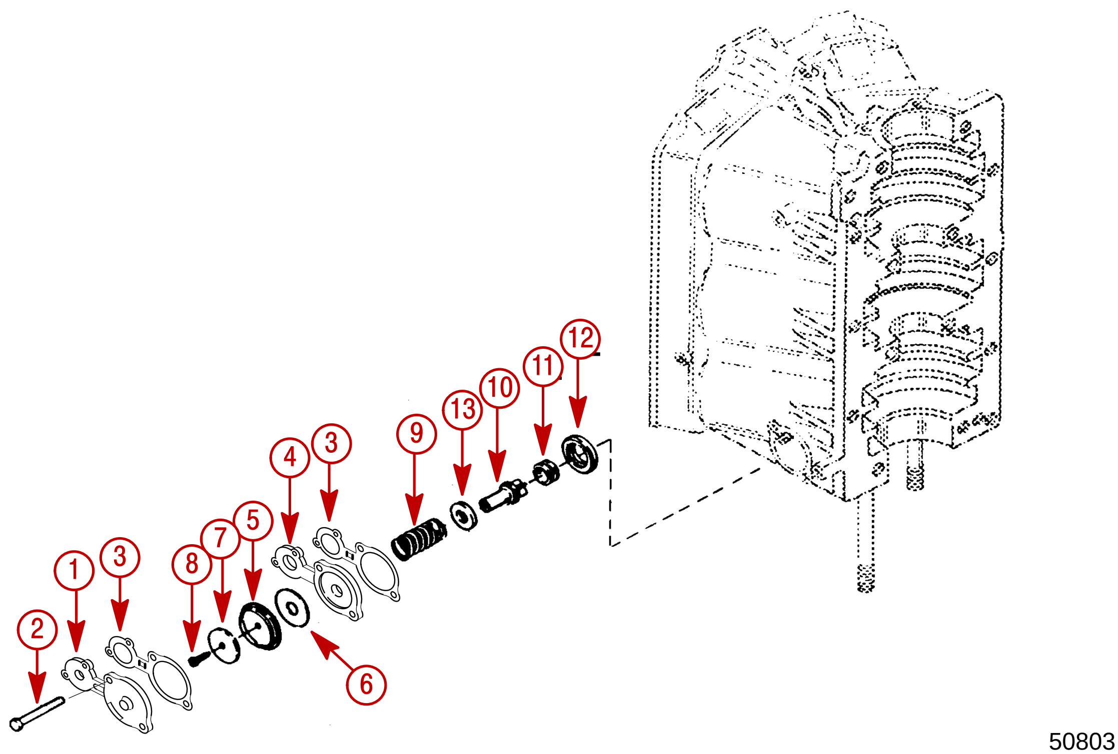
4. Torque exhaust divider plate bolts in following sequence.





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

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

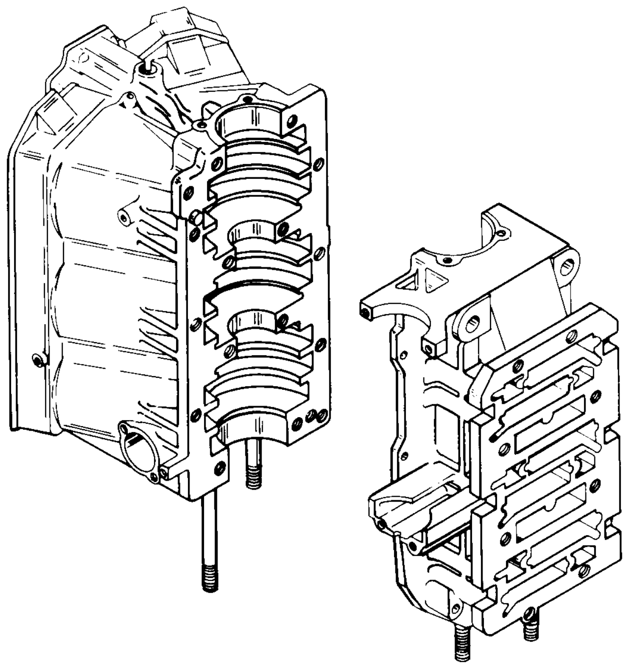


1 - Cover
2 - Bolt - 150 lb. in. (17 N·m)
3 - Gasket
4 - Relief Valve Plate
5 - Diaphragm
6 - Water Deflector
7 - Washer
8 - Screw - 25 lb. in. (3 N·m)
9 - Spring
10 - Poppet Valve
11 - Grommet
12 - Carrier
13 - Washer

Cleaning and Inspection

Cylinder Block and Crankcase Cover

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



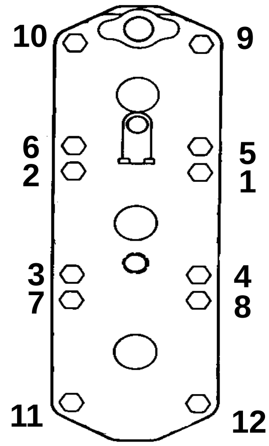
⚠ CAUTION

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.

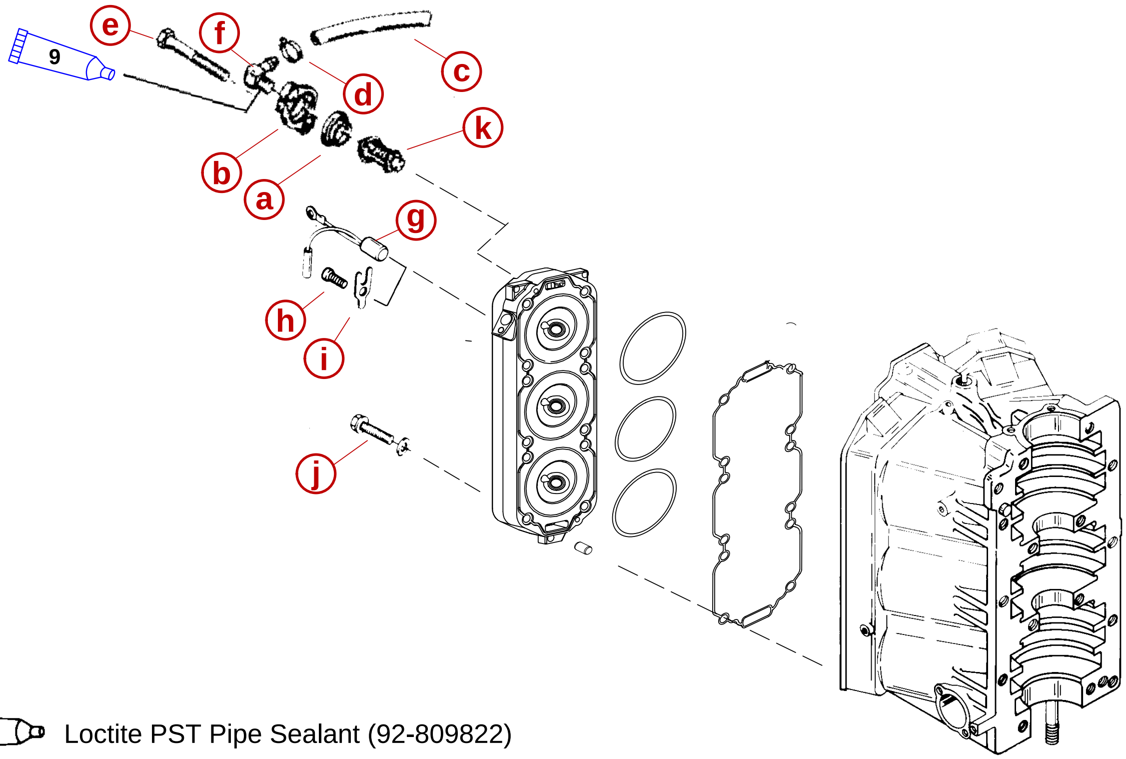
1. Thoroughly clean cylinder block and crankcase cover. Be sure that all sealant and old gaskets are removed from matching surfaces. Be sure that carbon deposits are removed from exhaust ports.
2. Inspect cylinder block and crankcase cover for cracks or fractures.
3. Check gasket surfaces for nicks, 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.

CYLINDER HEAD INSTALLATION

1. Install each cylinder head to engine block with thermostat pocket “UP”. Apply light oil to cylinder head bolt threads and torque bolts to 30 lb. ft. (40.7 N·m) and rotate 90°.



2. Install thermostat washer into each cylinder head.
3. Install analog gauge temperature sensor into port cylinder head below #1 spark plug.



9 Loctite PST Pipe Sealant (92-809822)

a - Washer
b - Thermostat Cover
c - Hose
d - Clamp
e - Bolt (Torque to 200 Lb. in. - 22.6 N·m)
f - 90° Elbow
g - Temperature Sensor (Analog Gauge)
h - Bolt (Torque to 200 Lb. in. - 22.6 N m)
i - Retainer
j - Bolt [Apply Light Oil to Threads - Torque to 30 lb. ft. (40.7 N·m) and rotate 90°]
k - Thermostat (2) 143 °F (61.7 °C)

Reinstalling Engine Components

Install the following engine components:

SECTION 2

a. Starter Motor

b. Ignition Coils

c. Starter Solenoid*

d. Trim Solenoids

e. Alternator

f. Control Module

g. Flywheel

SECTION 3

h. Fuel Pump

i. Oil Reservoir

j. Oil Pump

k. Fuel Injection

SECTION 4

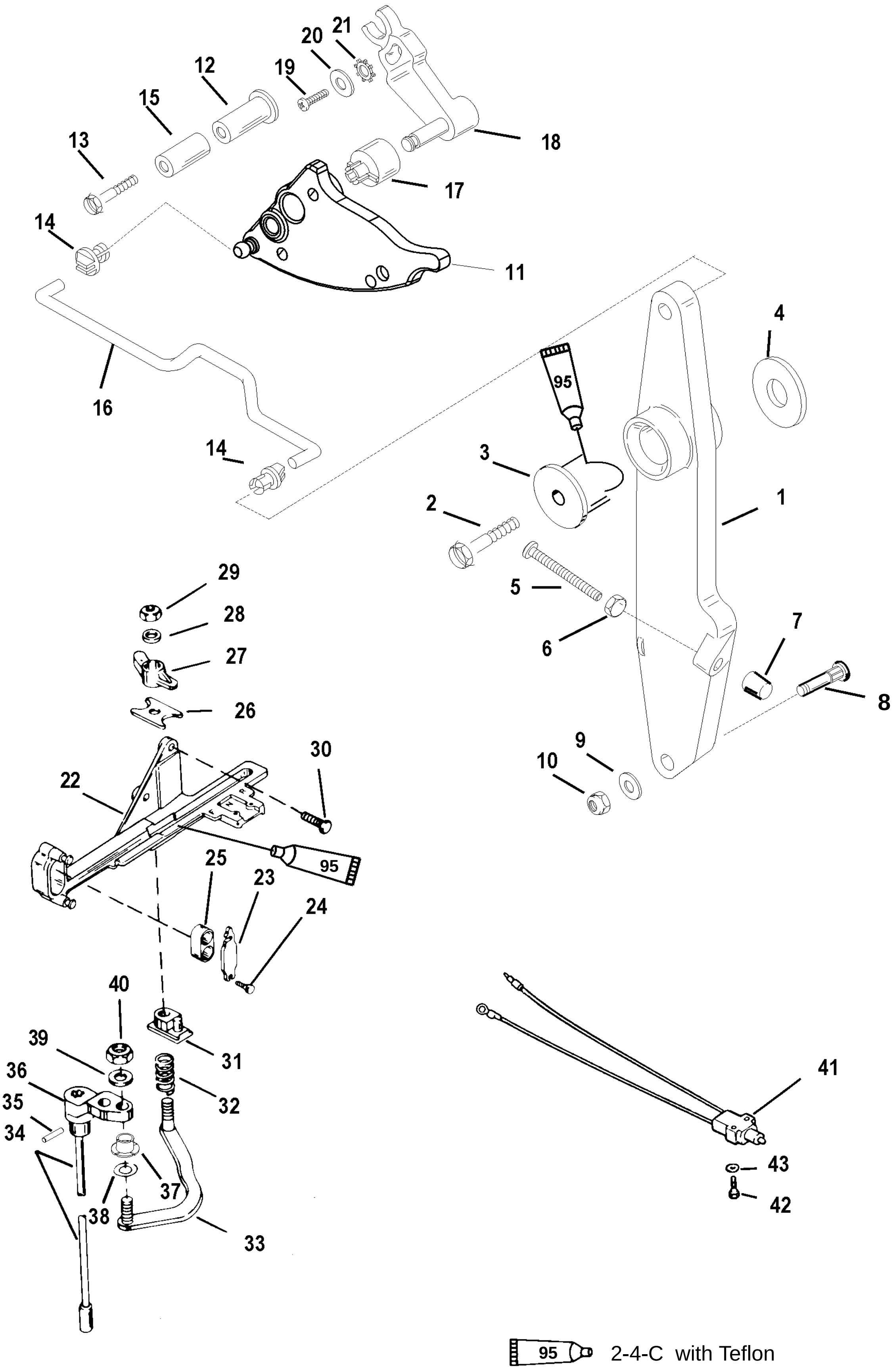
l. Shift Cable Latch Assy.

m. Control Cable Anchor Bracket

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

Notes:

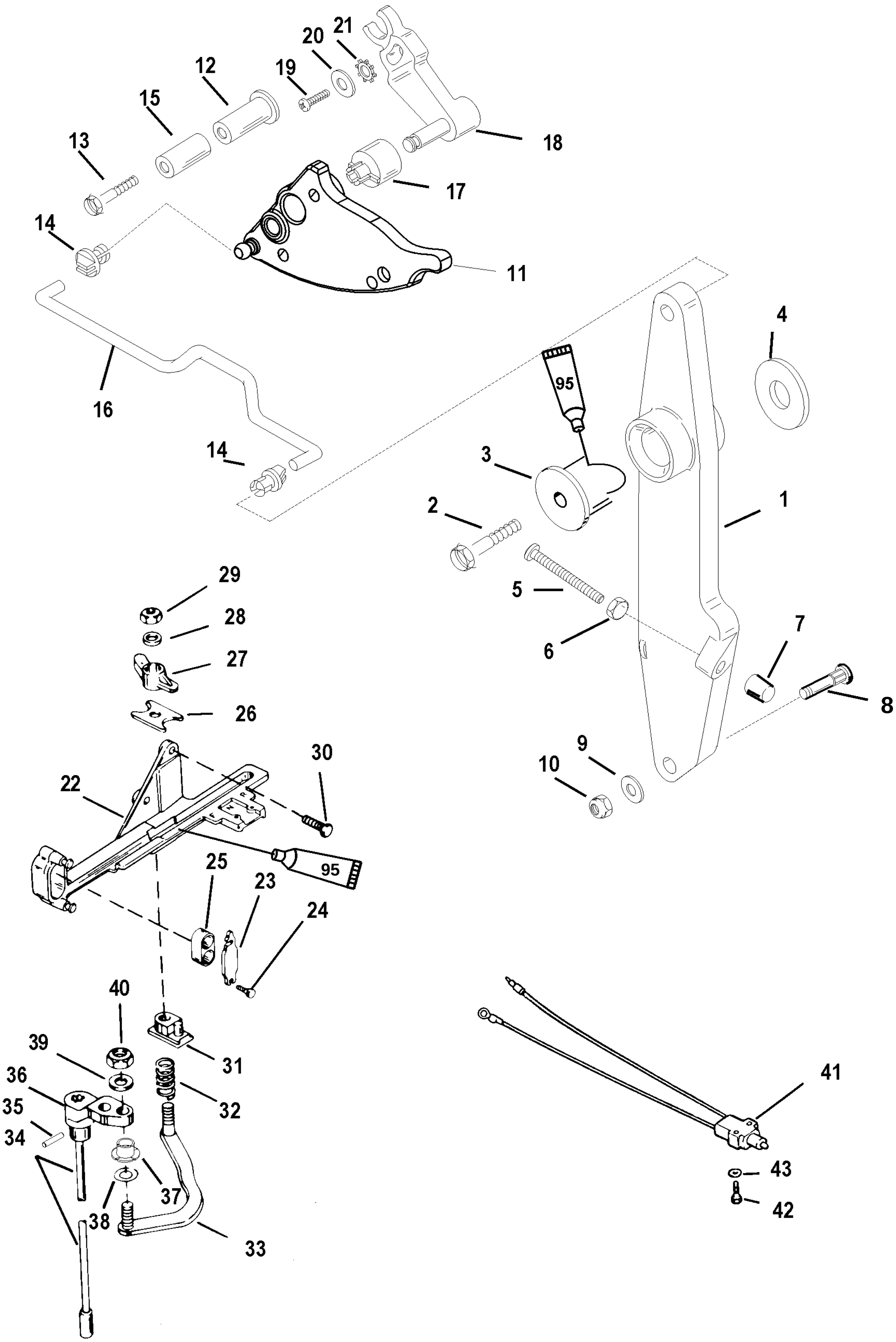
Throttle Lever and Shift Shaft



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 (0.375-16 x 1-3/4 IN.)			
3	1	BUSHING			
4	1	SPACER			
5	1	SCREW (2-1/8 IN.)			
6	1	NUT (1/4-20)			
7	1	CAP			
8	1	INSERT			
9	1	WASHER	35		4.0
10	1	NUT			
11	1	CAM			
12	1	BUSHING			
13	1	SCREW (M8 x 40)			
14	1	SWIVEL BUSHING			
15	1	BEARING			
16	1	LINK			
17	1	ROLLER			
18	1	THROTTLE ROLLER			
19	1	SCREW (M5 x 16)			
20	1	WASHER			
21	1	STAR WASHER			
22	1	ANCHOR BRACKET			
23	1	LATCH			
24	1	SCREW-DRIVE			
25	1	CAP			
26	1	WEAR PLATE			
27	1	LATCH			
28	1	WASHER			
29	1	NUT	Tighten and back off 1/4 turn		
30	3	SCREW (0.312-18 x 7/8)		20	27
31	1	GUIDE BLOCK			
32	1	SPRING			
33	1	LINK ROD			
34	1	SHIFT ASSEMBLY **(LONG)**			
	1	SHIFT ASSEMBLY **(X-LONG)**			
35	1	ROLL PIN			
36	1	SHIFT SHAFT LEVER-UPPER			
37	1	BUSHING			
38	1	WAVE WASHER			
39	1	WASHER			
40	1	NUT	Tighten and back off 1/4 turn		
41	1	IDLE STABILIZING SHIFT KIT			

Throttle Lever and Shift Shaft



95 2-4-C with Teflon

Throttle Lever and Shift Shaft

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
42	2	SCREW (6-32)	15		1.7
43	2	WASHER			

Powerhead Installation On Driveshaft Housing

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

⚠ WARNING

BE SURE that Lifting Eye is threaded into flywheel a minimum of five (5) turns BEFORE lifting powerhead.

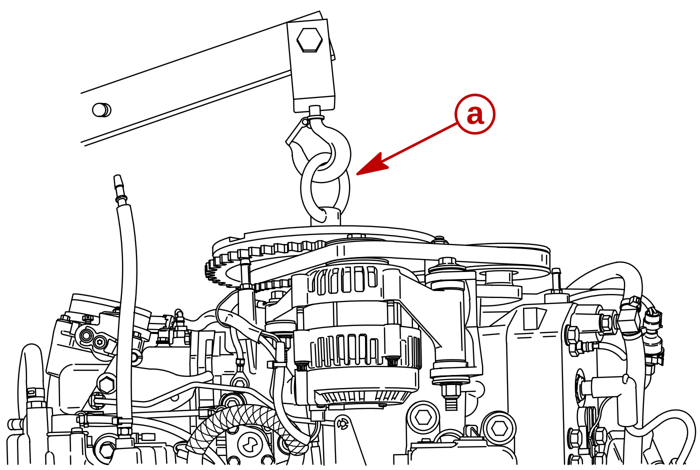
2. Using a hoist, lift powerhead high enough to allow removal of powerhead from repair stand. Remove powerhead from repair stand, being careful not to damage drive shaft housing gasket surface of powerhead.
3. Place a new gasket around powerhead studs and into position on base of powerhead.

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-C with Teflon Marine Lubricant onto driveshaft splines.

NOTE: *Verify shift shaft is properly installed in gearcase/driveshaft housing before installing powerhead.*

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.



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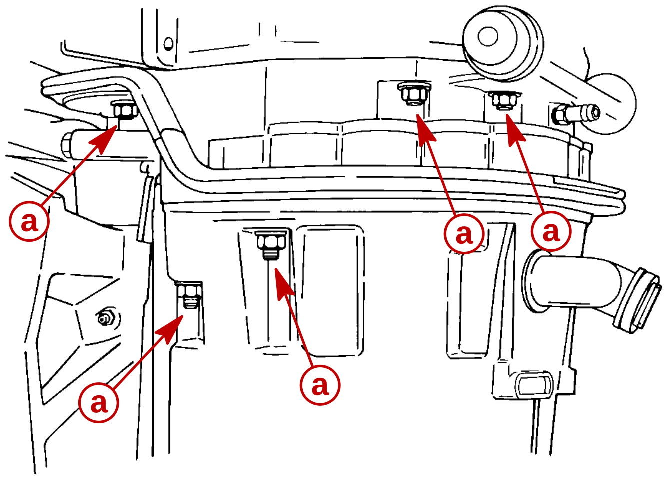
a - Lifting Eye (90-90455)

6. Install 10 flat washers,and 10 locknuts which secure powerhead to exhaust extension plate/driveshaft housing. Torque locknuts in 3 progressive steps until secured.
7. Disconnect hoist from Lifting Eye and remove Lifting Eye from flywheel.
8. Reinstall plastic cap into center of flywheel cover.



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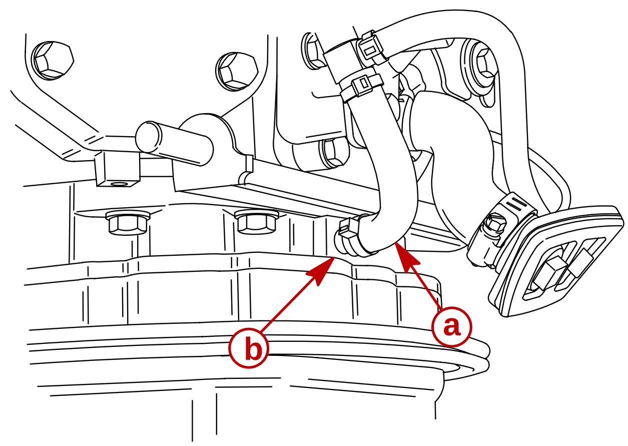
a - Locknuts and Washers – Torque nuts to 20 lb. ft. (27 N m)

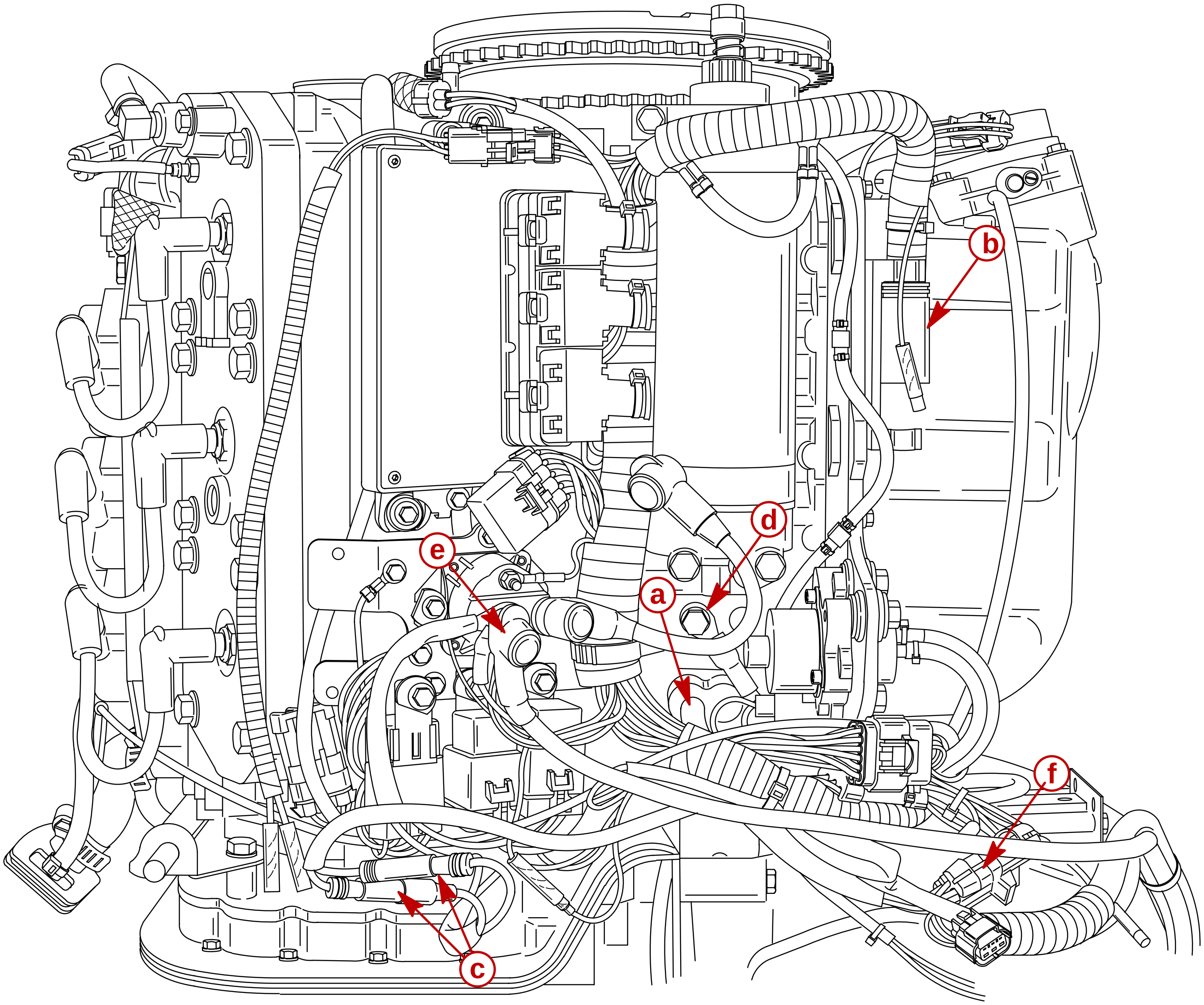
9. Connect water hose to fitting on exhaust adaptor plate.



58069

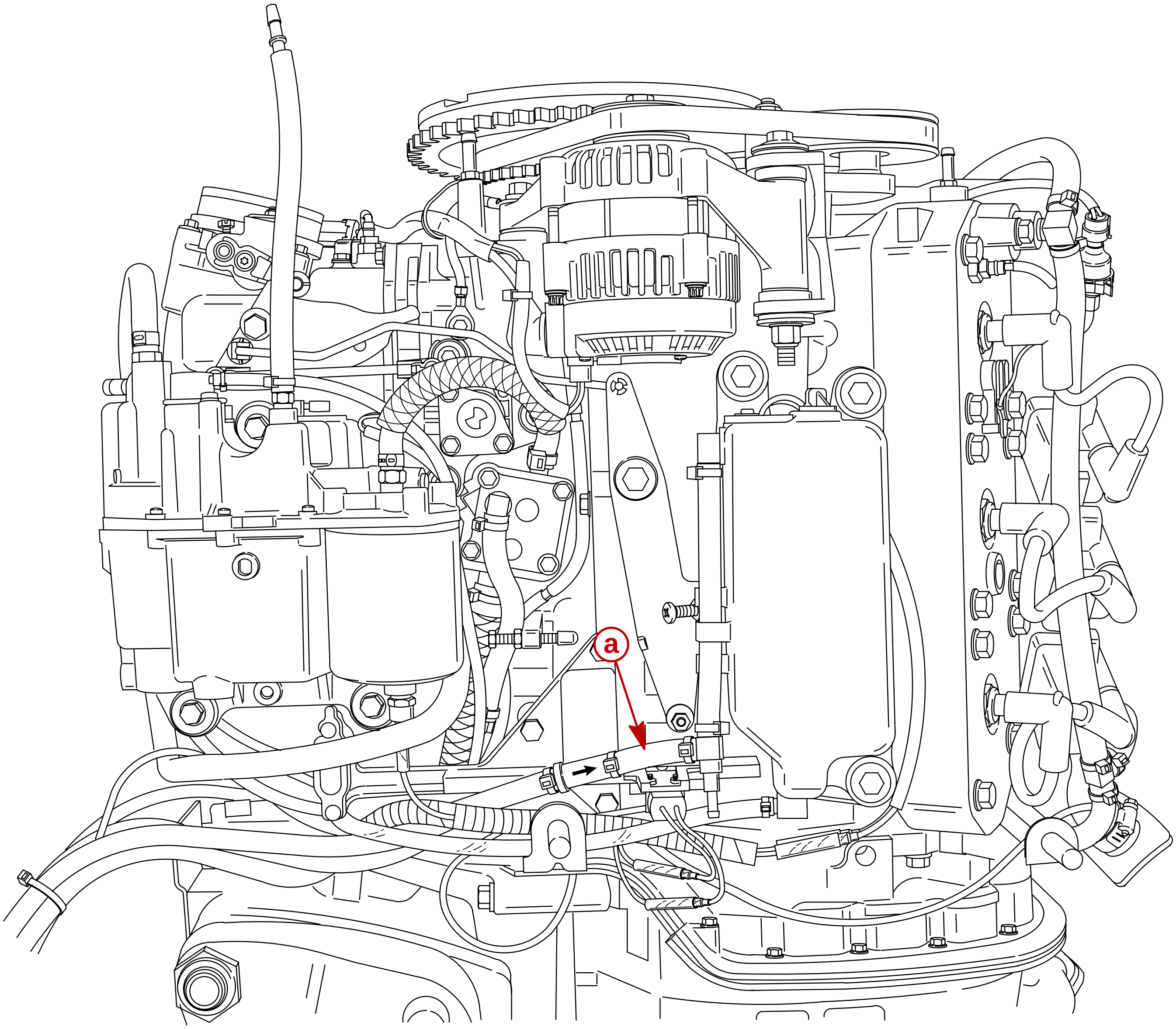
a - Water Hose
b - Fitting

10. Reconnect and/or reinstall the following:



a - Remote Oil Tank Pressure Hose
b - Remote Control Harness
c - Power Trim Wires
d - Negative Battery Cable
e - Positive Battery Cable
f - SmartCraft Harness Connector

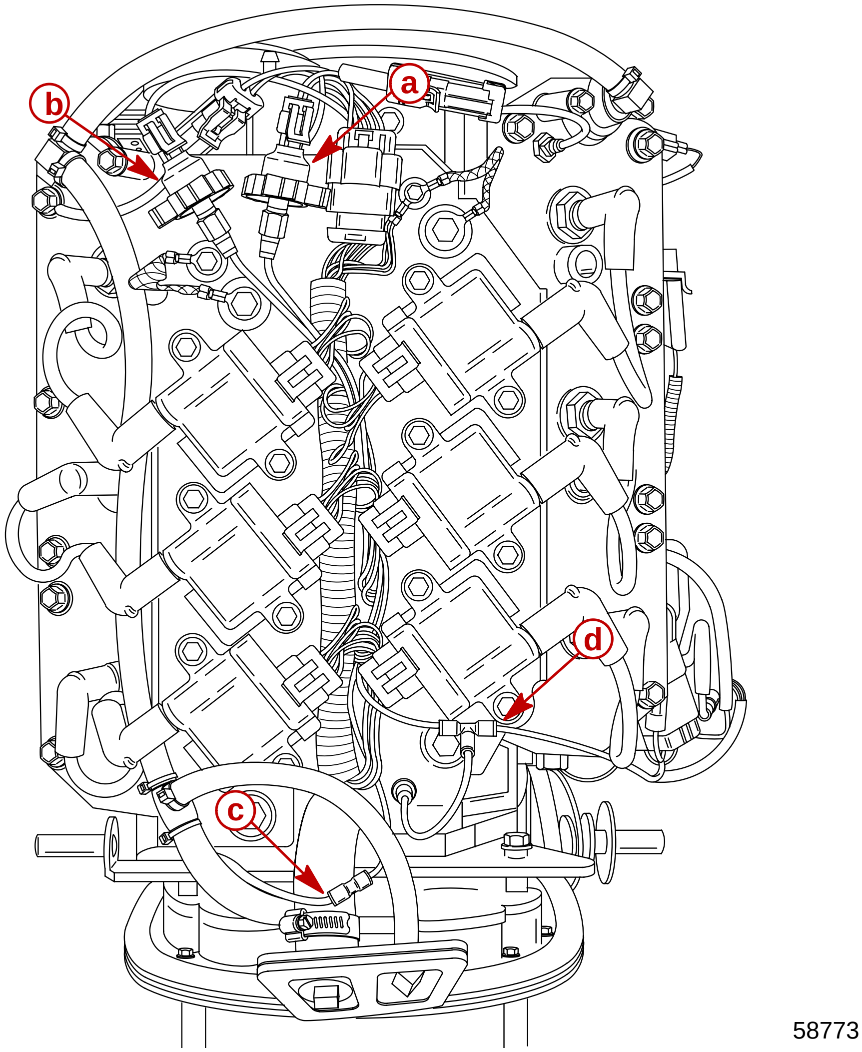
11. Reinstall the following:



58780

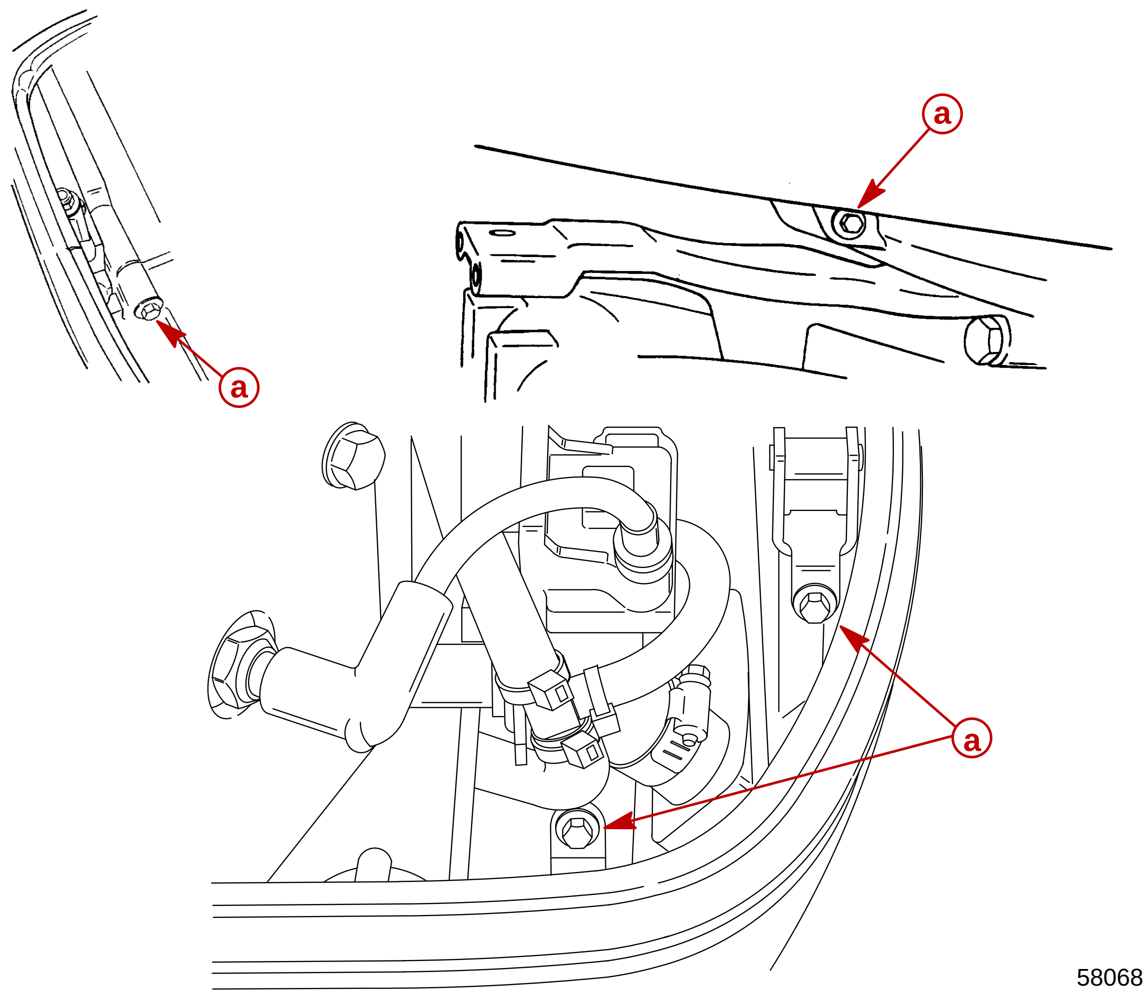
a - Oil Supply Hose

12. Reconnect water pressure sensor (GRAY) hose and speedometer pressure sensor (BLACK) hose.



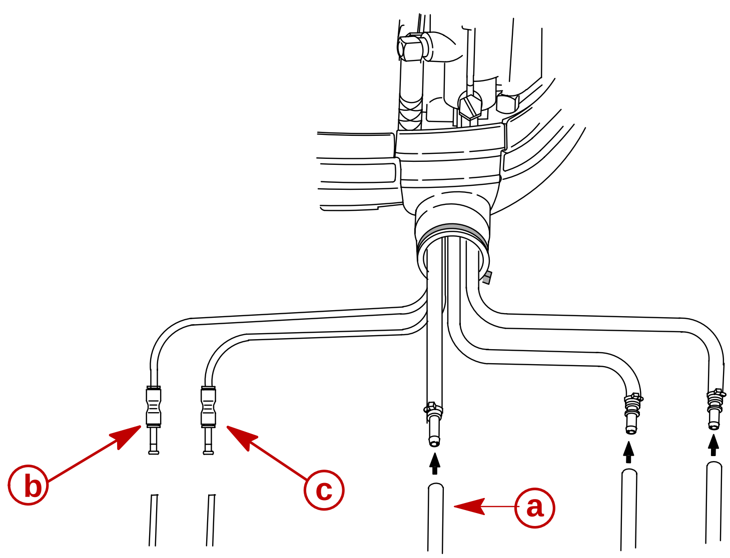
a - Water Pressure Sensor
b - Speedometer Pressure Sensor
c - Speedometer Sensor Hose (BLACK)(for Digital Gauges)
d - Water Pressure Sensor Hose (GRAY)(for Digital Gauges)

13. Install bottom cowls.



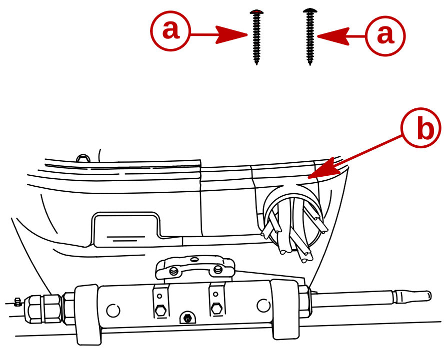
a - Bolts

14. Reconnect input fuel line, water pressure hose and speedometer hose.



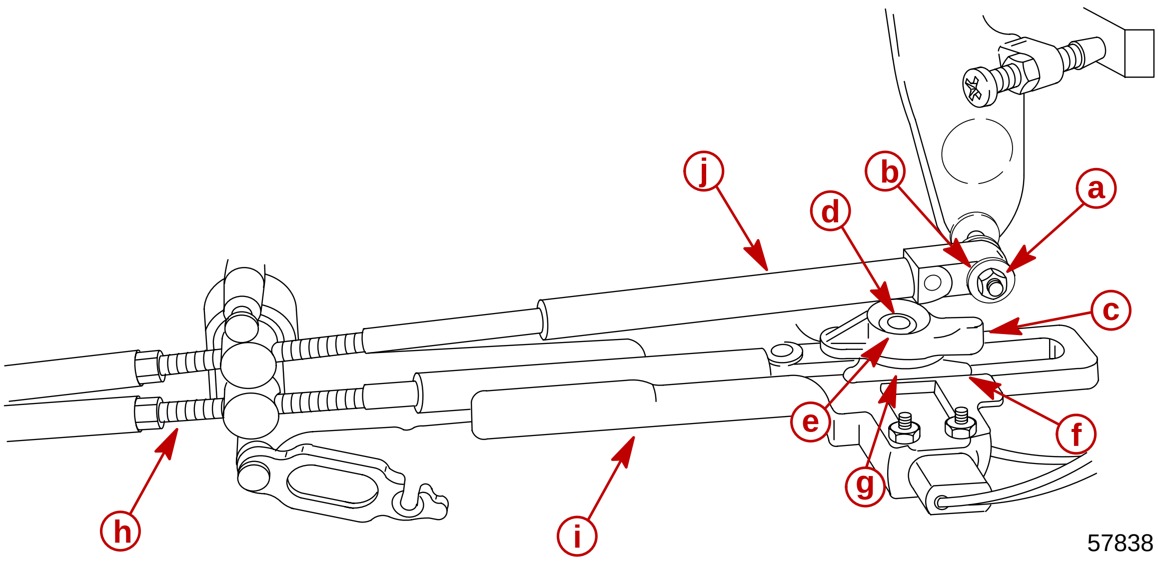
a - Input Fuel Hose
b - Water Pressure Hose (GRAY) (Analog Gauges)
c - Speedometer Hose (BLACK) (Analog Gauges)

15. Install harness retainer and secure with 2 screws.



a - Screws
b - Retainer

16. Slide outboard shift lever into neutral position.
17. Install throttle cable.
18. Install locknut that secures shift cable latch assembly and install latch, flat washer, nylon wear plate, spring and shift cable from control cable anchor bracket.



a - Lock Nut (Throttle Cable)
b - Flat Washer
c - Shift Cable Latch
d - Lock Nut (Shift Cable)
e - Flat Washer (Hidden under nut)
f - Nylon Wear Plate
g - Spring (Hidden)
h - Shift Cable
i - Anchor Bracket
j - Throttle Cable

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

Engine Break-in Procedure

IMPORTANT: Prior to initially starting engine, oil pump prime sequence must be activated using the Digital Diagnostic Terminal (DDT). Initiating the oil pump prime sequence will vacate any air in the oil output hose and mix oil with fuel in the vapor separator thus preventing scoring of internal components during initial startup.

CAUTION

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

Gasoline/Oil Break-In Mixture

MODELS WITH ELECTRONIC FUEL INJECTION (EFI)

Do not use pre-mixed gas and oil during break-in. Oil from the oil injection system will supply adequate lubrication during engine break-in.

Break-In Procedure

FIRST HOUR

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

NEXT THREE HOURS

- Change engine speed every 10 minutes.

NOTE: *It is the driver’s responsibility to always drive in a safe manner. Improper trim angle of the outboard when driving at speed can be difficult and dangerous. The purpose of specifying trim angle is to help guide the operator in determining how to put the proper load on the engine. They are intended to be guidelines and do not suggest or require unsafe boat operation.*

POWERHEAD

Section 4B - Cooling

Table of Contents

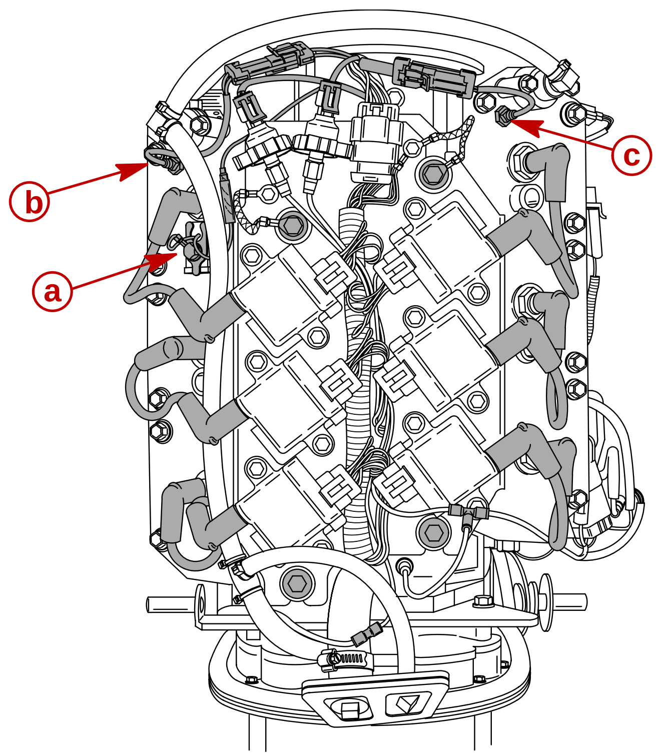
4
B

Specifications

Thermostat .... 143 °F (61.7 °C)

Water Pressure

Idle	1.0 – 3.0 PSI (6.8 – 20.5 kPa)
Poppet Valve Opening	4.0 – 9.0 PSI (27.4 – 61.6 kPa)
W.O.T.	12.0 PSI (82.1 kPa) Minimum



58893

a - Analog Temperature Sensor (EFI Models) and optional gauge sender

b - Digital Temperature Sensor for Port Head

c - Digital Temperature Sensor for Starboard Head

Digital Port and Starboard Temperature Sensors

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

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.

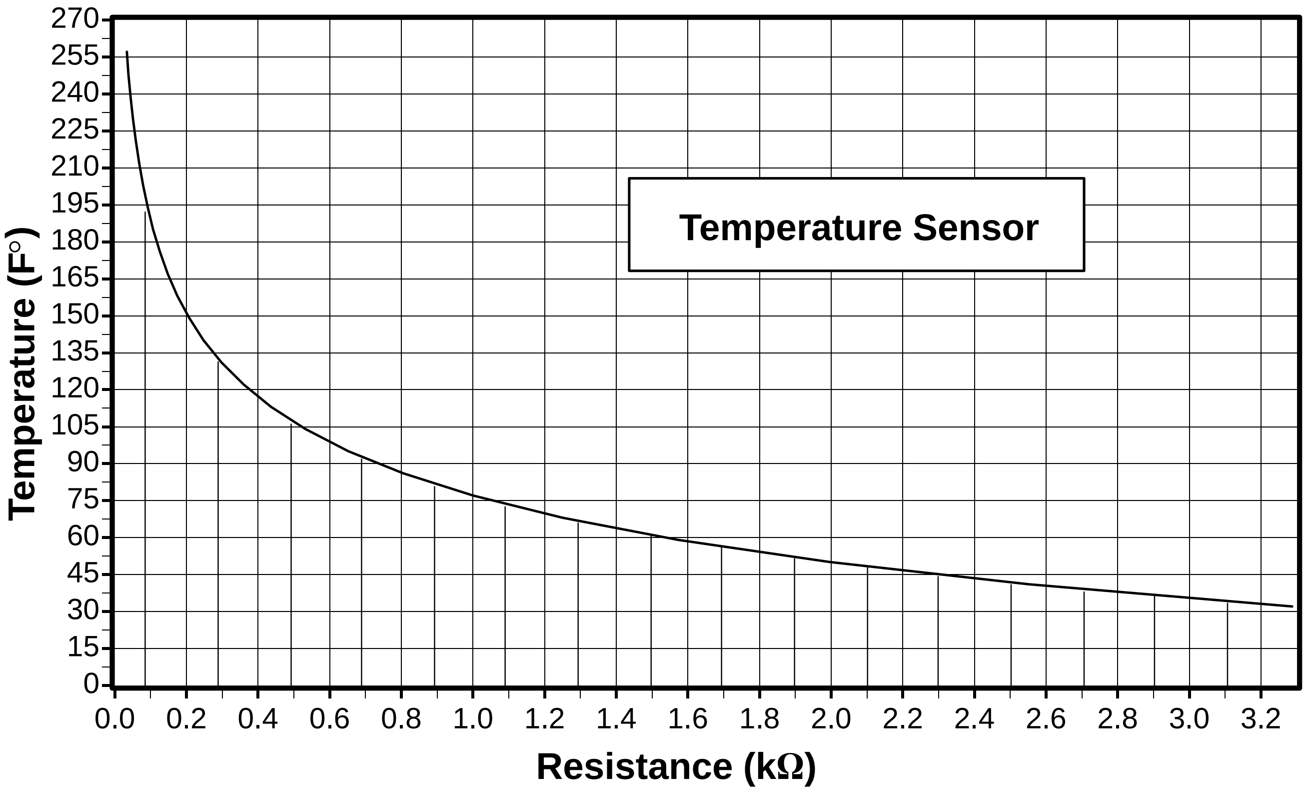
Temperature Sensor Specifications		
Fahrenheit	**Centigrade**	**OHMS**
257	125	340
248	120	390
239	115	450
230	110	517
221	105	592
212	100	680
203	95	787
194	90	915
185	85	1070
176	80	1255
167	75	1480
158	70	1752
149	65	2083
140	60	2488
131	55	2986
122	50	3603
113	45	4370
104	40	5327
95	35	6530
86	30	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

Analog Temperature Sensor

TAN/BLACK sensor lead (in port analog temperature sensor) provides signal for optional temperature gauge.

An ohms test of the analog temperature sensor (in port cylinder head) would be as follows:

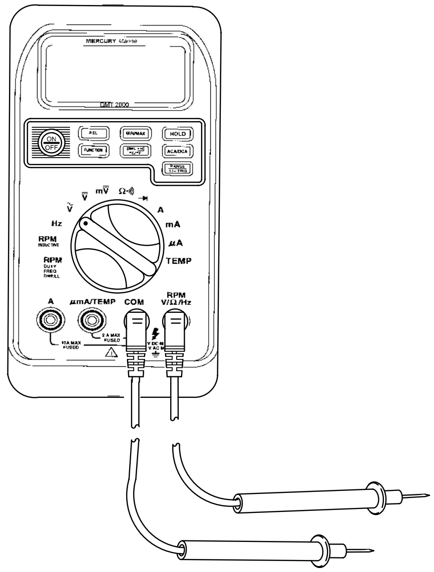
Insert digital or analog ohmmeter test leads into both TAN/BLACK sensor leads. With engine at temperature (F°) indicated, ohm readings should be as indicated ±10%.



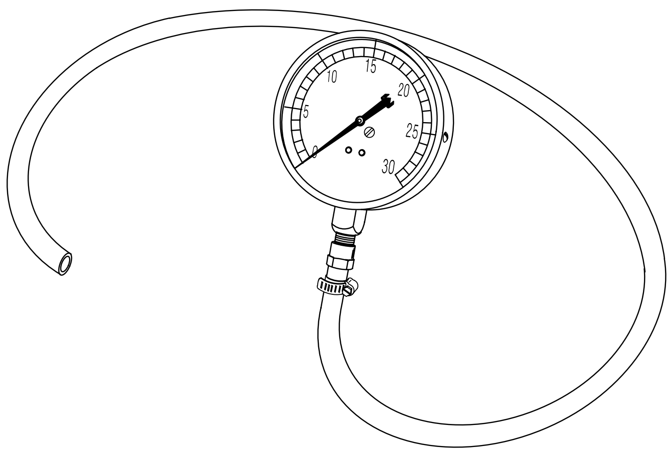
Temperature Sensor	
Between Black and each TAN/BLK wire.	No Continuity
Between each lead and ground	No Continuity
Between each TAN/BLK wire	Resistance will vary with temperature

Special Tools

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



2. Water Pressure Gauge 91-79250A2



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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 2 holes near the top of the exhaust cover.

Water exits the exhaust cover cavity through 4 slots (2 each side) filling the water passages around the cylinders. Water flows around each bank of cylinders to the top of the cylinder block.

Water flow exiting the cylinder block is controlled by the thermostats (1 in each cylinder head) and the poppet valve (located at the bottom starboard side of powerhead). 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 adaptor plates. Water passes through the adaptor plates into the driveshaft housing.

Water dumped into the drive shaft housing builds up a wall of water around the exhaust tube. This performs 2 functions:

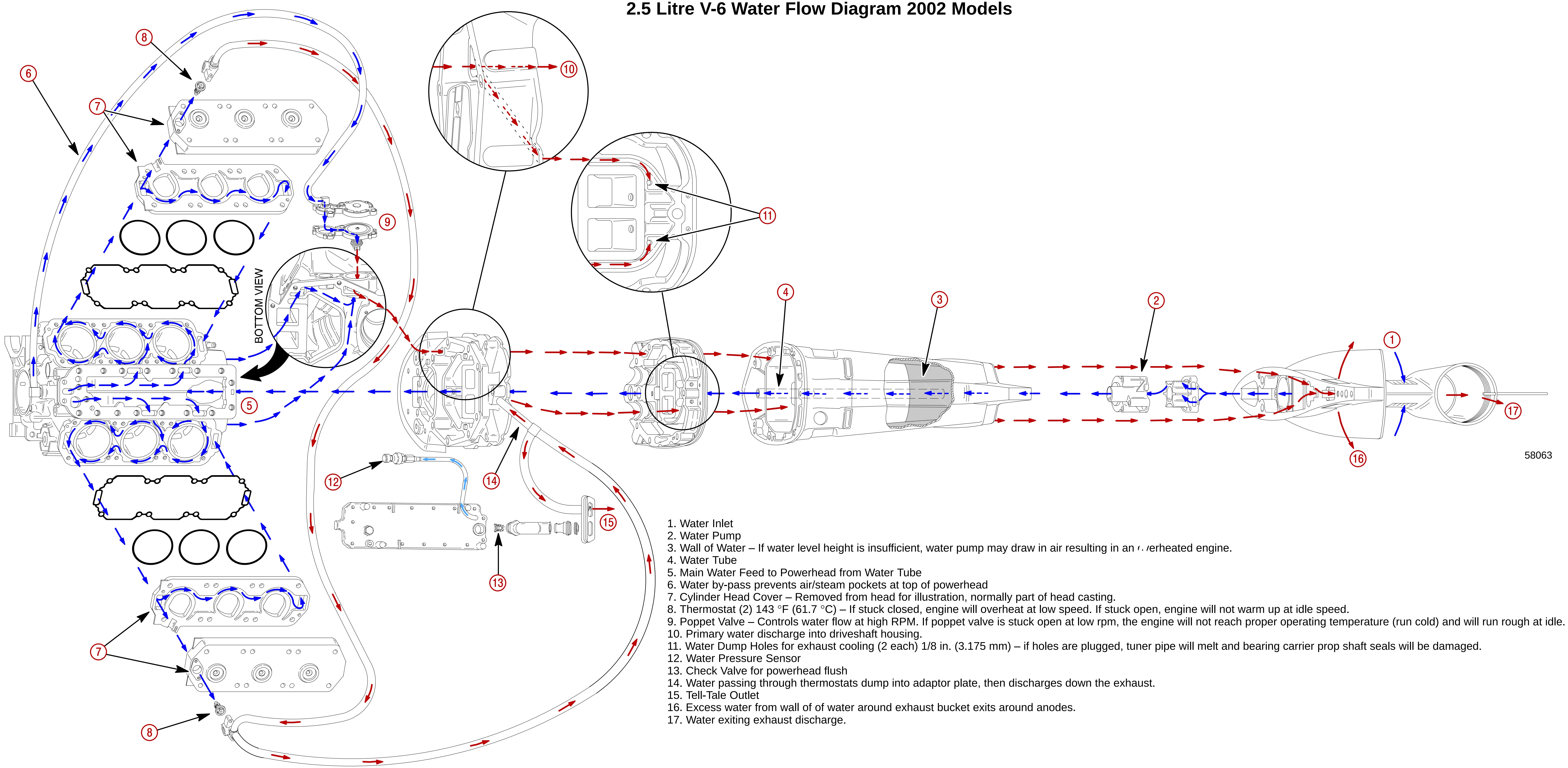
- Helps silence the exhaust
- Prevents air from being drawn into the pump

Water exits the engine in 3 locations:

- Excess water from the wall of water exits around anodes on the gear housing.
- A portion of the water that passes through the thermostats exits out the tell tail.
- Water exits through two 1/8 in. (3.175 mm) holes in the lower adaptor plate into the exhaust.

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.

2.5 Litre V-6 Water Flow Diagram 2002 Models



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. Water Tube
5. Main Water Feed to Powerhead from Water Tube
6. Water by-pass prevents air/steam pockets at top of powerhead
7. Cylinder Head Cover – Removed from head for illustration, normally part of head casting.
8. Thermostat (2) 143 °F (61.7 °C) – If stuck closed, engine will overheat at low speed. If stuck open, engine will not warm up at idle speed.
9. 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.
10. Primary water discharge into driveshaft housing.
11. Water Dump Holes for exhaust cooling (2 each) 1/8 in. (3.175 mm) – if holes are plugged, tuner pipe will melt and bearing carrier prop shaft seals will be damaged.
12. Water Pressure Sensor
13. Check Valve for powerhead flush
14. Water passing through thermostats dump into adaptor plate, then discharges down the exhaust.
15. Tell-Tale Outlet
16. Excess water from wall of of water around exhaust bucket exits around anodes.
17. Water exiting exhaust discharge.

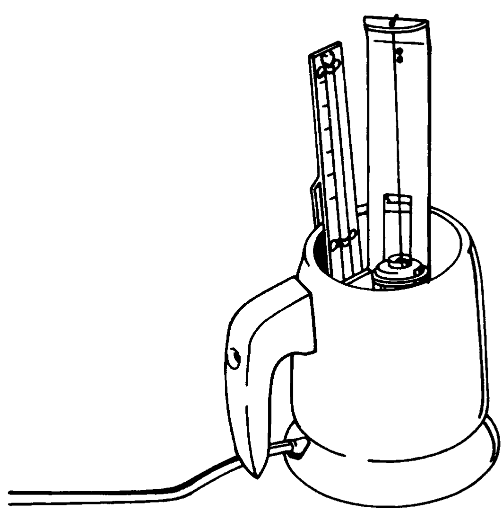
Notes:

Troubleshooting

Thermostat Test

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

NOTE: *BE SURE that water in thermostat tester is allowed to cool sufficiently [below 110 °F (43.3 °C)] before testing the other thermostat.*



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IMPORTANT: DO NOT operate engine without thermostats installed.

Water Pressure Check

Water pressure may be checked by attaching a test pressure gauge to the top of the engine block.

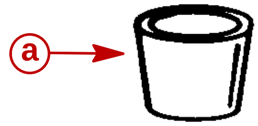
A water pressure line (GRAY colored) is provided that exits at the front of the lower cowl. A dash style gauge may be connected to this line to register water pressure.

WARNING
Shut off engine and refer to troubleshooting chart if water pressure is not within specification. DO NOT exceed 3000 RPM in neutral.

Idle	1.0 – 3.0 PSI (6.8 – 20.5 kPa)
Poppet Valve Opening	4 – 9 PSI (27.4 – 61.6 kPa)
W.O.T.	12.0 PSI (82.1 kPa) Minimum

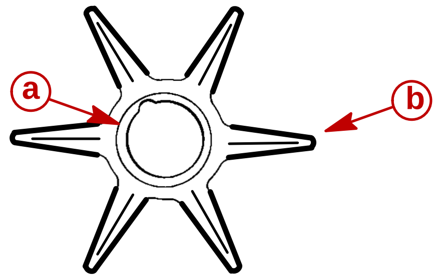
Water Pump Cleaning and Inspection

1. Inspect the water tube coupling for wear or damage. If necessary replace.



a - Water Tube Coupling

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.

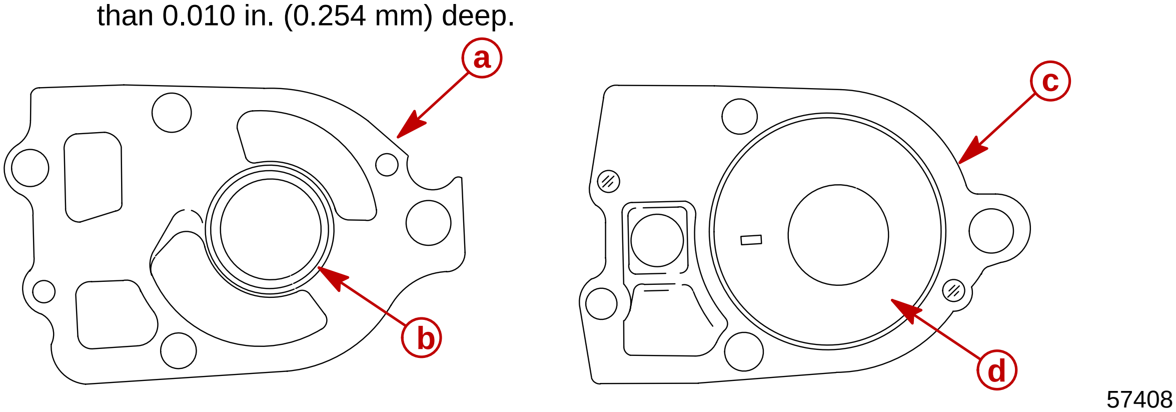


a - Hub
b - Impeller

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 if plastic is melted from excessive heat (lack of water). Replace stainless insert and/or face plate if grooves (other than impeller sealing bead groove) are more than 0.010 in. (0.254 mm) deep.



a - Water Pump Face Plate
b - Sealing Groove (disregard)
c - Water Pump Cover
d - Stainless Insert [discard if grooves exceed 0.010 in. (0.254 mm)]

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

Condition	Recommended Range	Possible Cause
Pressure below specification @ idle	1.0 – 3.0 PSI (6.8 – 20.5 kPa)	•Poppet valve spring defective (weak, broken, missing) •Defective poppet valve seal •Thermostat stuck open •Severe internal leak •Low output water pump •Inlet restriction
Pressure above 5 psi (34.2kPa) @ idle	1.0 – 3.0 PSI (6.8 – 20.5 kPa)	•Plugged poppet by-pass passage or tell-tale
Pressure does not drop between 1000 – 2500 RPM indicating poppet valve has opened	4 – 9 PSI (27.4 – 61.6 kPa) between 1000 – 2200 RPM	•Wrong poppet valve spring •Low output water pump •Inlet restriction •Poppet valve vent hole plugged or restricted •Severe internal leak •Defective poppet valve seal
Poppet valve flutter/water pressure drop does not stabilize prior to 2500 RPM	4 – 9 PSI (27.4 – 61.6 kPa) between 1000 – 2200 RPM	•Wrong poppet valve spring •Low output water pump •Inlet restriction •Broken diaphragm in poppet valve •Severe internal leak •Defective poppet valve seal
Pressure is below minimum specification @ W.O.T.	12 PSI (54.9 – 68.5kPa)	•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

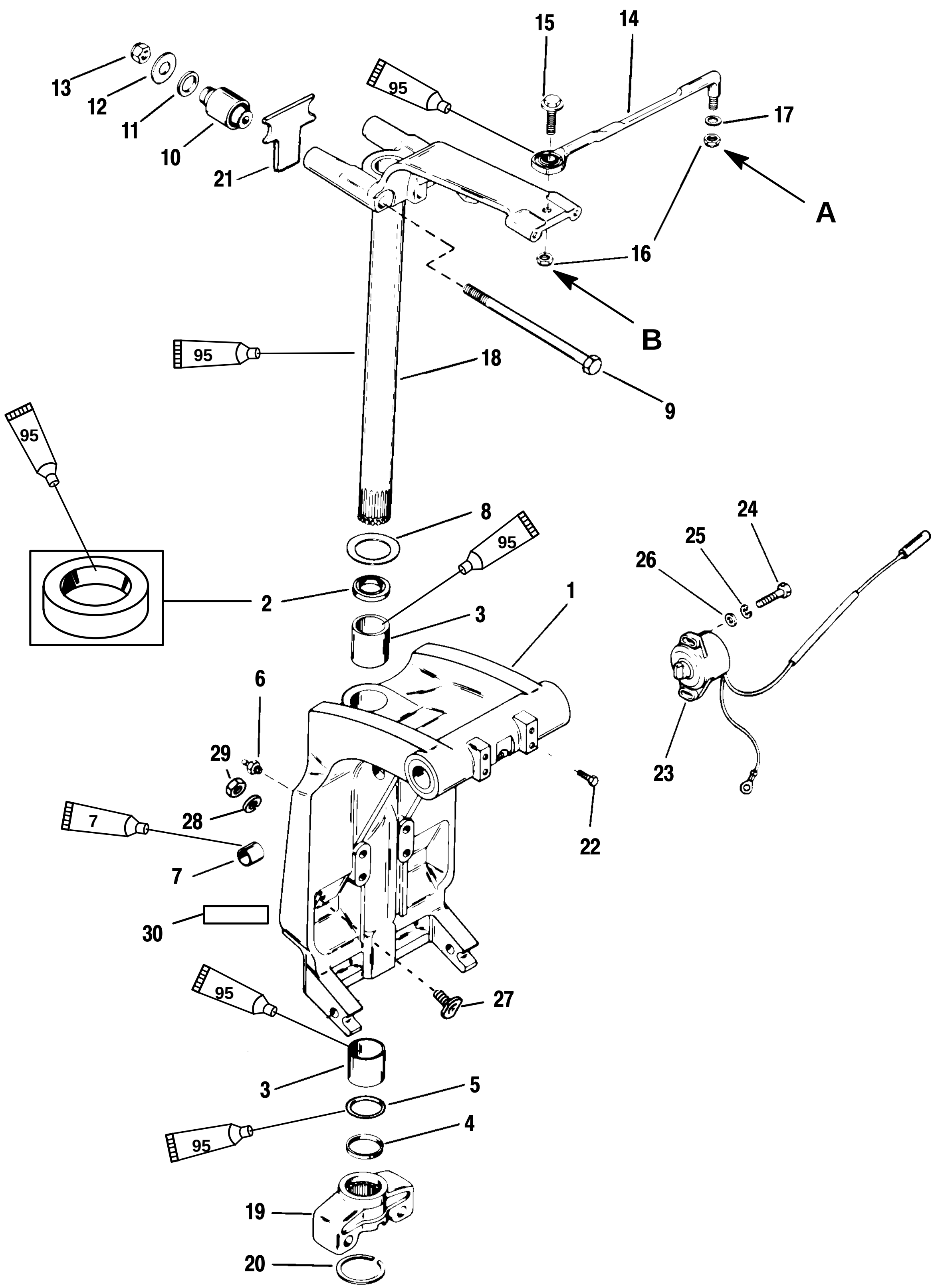
MID-SECTION

Section 5A – Clamp/Swivel Brackets & Driveshaft Housing

Table of Contents

5
A

Swivel Bracket and Steering Arm



7 Loctite 271

95 2-4-C with Teflon

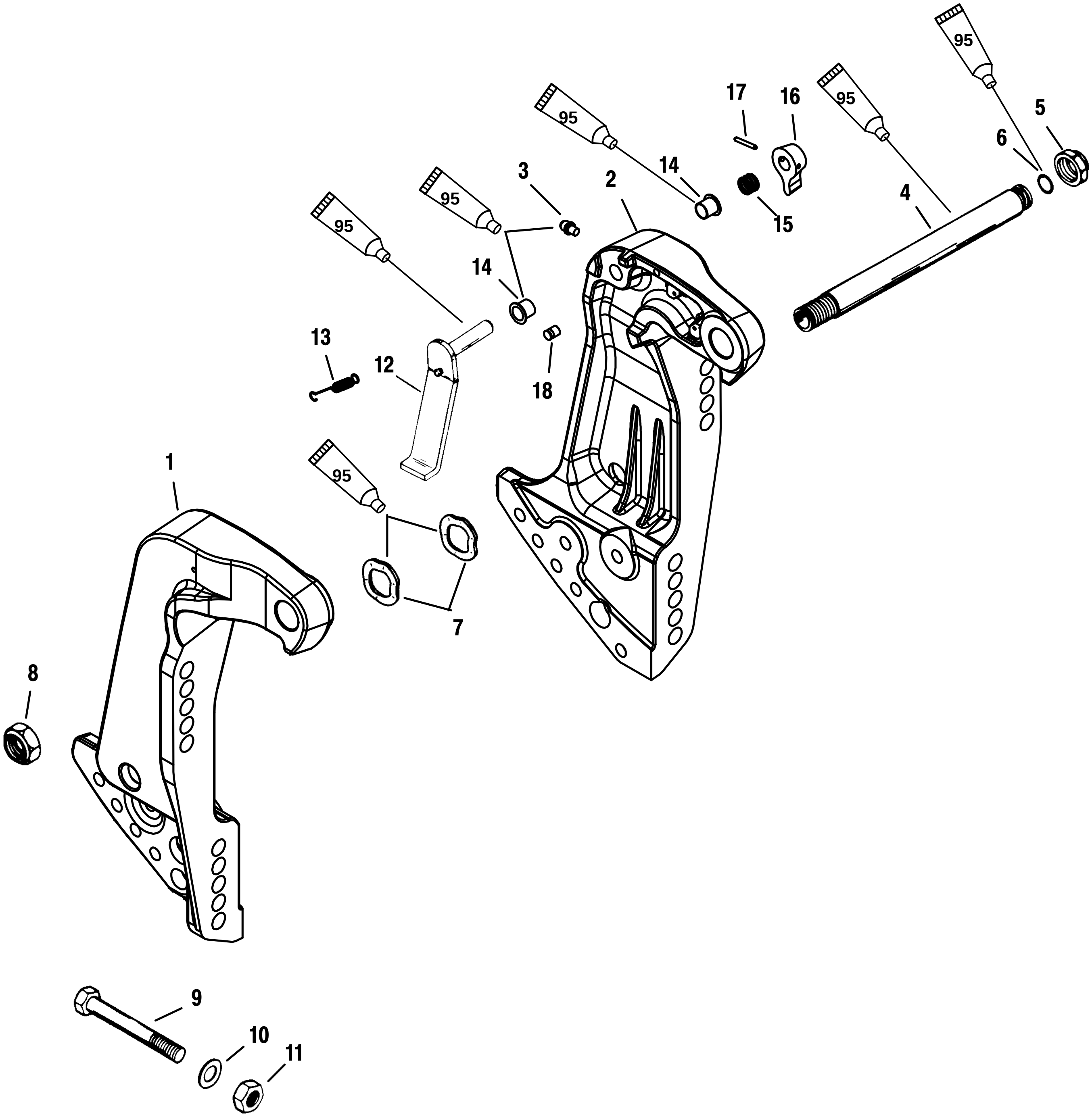
Swivel Bracket and Steering Arm

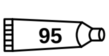
REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	lb-ft	Nm.
1	1	SWIVEL BRACKET ASSEMBLY **(BLACK)**			
2	1	OIL SEAL (LOWER)			
3	2	BUSHING			
4	1	SPACER			
5	1	O-RING			
6	2	GREASE FITTING	75		8.5
7	2	BUSHING			
8	1	THRUST WASHER			
9	2	SCREW (7/16-20 x 7-1/2 IN.)			
10	2	MOUNT			
11	2	WASHER			
12	2	WASHER			
13	2	NUT		50	68
14	1	STEERING LINK ASSEMBLY			
15	1	SCREW (3/8-24 x 1-1/4 IN.)		20	27
16	2	NUT	See Note		
17	2	WASHER			
18	1	SWIVEL PIN AND STEERING ARM **(BLACK)**			
19	1	BOTTOM YOKE **(BLACK)**			
20	1	RETAINING RING			
21	1	BUMPER			
22	2	SCREW (1/4-28 x 1/2 IN.)	100		11.5
23	1	TRIM SENDER ASSEMBLY			
24	2	SCREW	15		1.7
25	2	LOCKWASHER			
26	2	WASHER			
27	2	STRIKER PLATE			
28	2	LOCKWASHER			
29	2	NUT		23	31
30	1	DECAL-Serial Number Overlaminate			

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



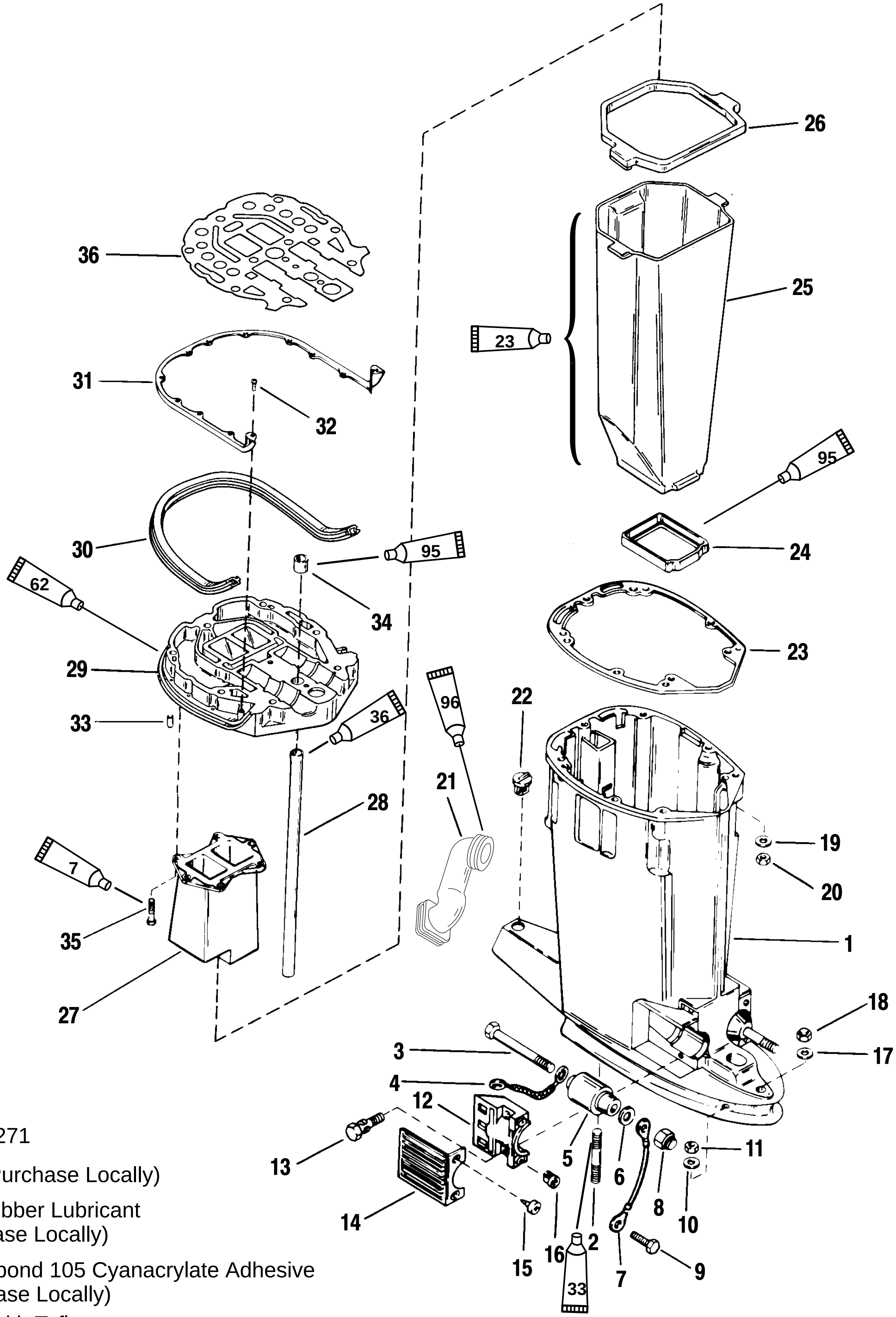


2-4-C with Teflon

Transom Brackets

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	TRANSOM BRACKET **(STARBOARD)(BLACK)**			
2	1	TRANSOM BRACKET **(PORT) (BLACK)**			
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	NUT			
12	1	TILT LOCK LEVER ASSEMBLY			
13	1	SPRING			
14	2	BUSHING			
15	1	SPRING			
16	1	KNOB			
17	1	GROOVE PIN			
18	1	PIN			

Drive Shaft Housing and Exhaust Tube



7	Loctite 271
23	Soap (Purchase Locally)
36	P80 Rubber Lubricant (Purchase Locally)
62	Permabond 105 Cyanacrylate Adhesive (Purchase Locally)
95	2-4-C with Teflon
96	Loctite Superbonder 454 Gel (Purchase Locally)
33	Loctite “RCA/680” Retaining Compound

Drive Shaft Housing and Exhaust Tube

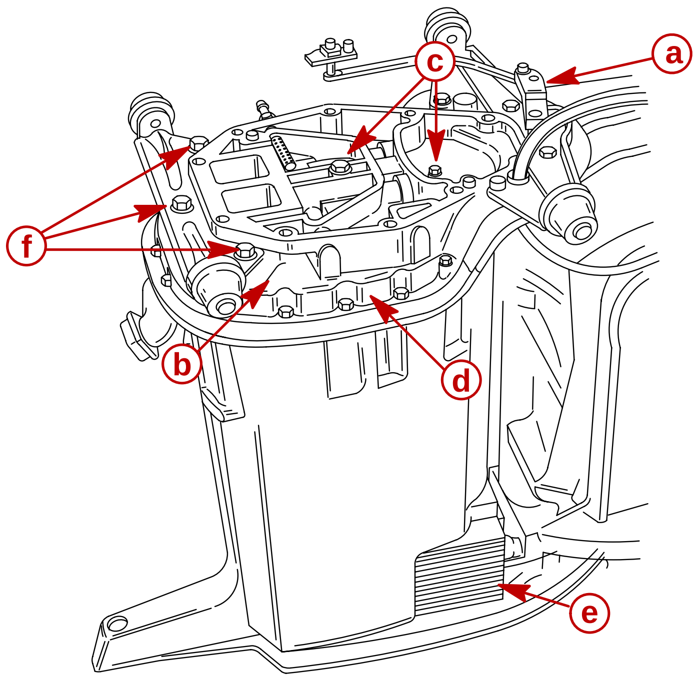
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	DRIVE SHAFT HOUSING **(LONG)**			
	1	DRIVE SHAFT HOUSING **(X-LONG)**			
2	2	STUD			
3	2	SCREW (1/2-20 x 6 IN.)			
4	1	GROUND WIRE			
5	2	LOWER MOUNT			
6	2	WASHER			
7	1	GROUND WIRE			
8	2	NUT		50	68
9	1	SCREW (1/4-20 x 3/8 IN.)			
10	2	WASHER			
11	2	NUT		50	68
12	2	CLAMP			
13	4	SCREW (5/16-18 x 1-1/4 IN.)		22	30
14	2	COVER			
15	4	SCREW (12-24 x 5/8 IN.)	17		2
16	4	NUT		25	34
17	1	WASHER			
18	1	NUT		57	77
19	4	WASHER			
20	4	NUT		23	31
21	1	IDLE EXHAUST BOOT			
22	1	PLUG			
23	1	GASKET			
24	1	SEAL (LOWER)			
25	1	EXHAUST TUBE			
26	1	SEAL (UPPER)			
27	1	EXHAUST EXTENSION			
28	1	WATER TUBE **(LONG)**			
	1	WATER TUBE **(X-LONG)**			
29	1	PLATE ASSEMBLY			
30	1	SEAL			
31	1	BRACKET			
32	12	SCREW (10-16 x 1/2 IN.)	80		9
33	2	DOWEL PIN			
34	1	SEAL			
35	6	SCREW (1/4-20 x 3/4 IN.)	60		7
36	1	GASKET			

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 5 bolts which secure exhaust extension plate to drive shaft housing. After bolts are removed, lift exhaust extension plate off drive shaft housing.
3. Remove screws, which secure lower mount covers to drive shaft housing, then remove covers.



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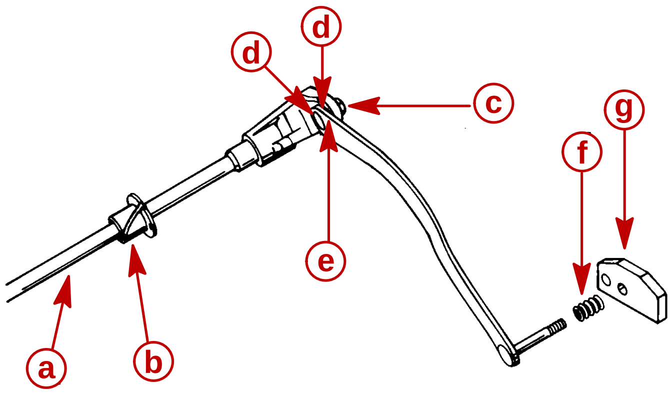
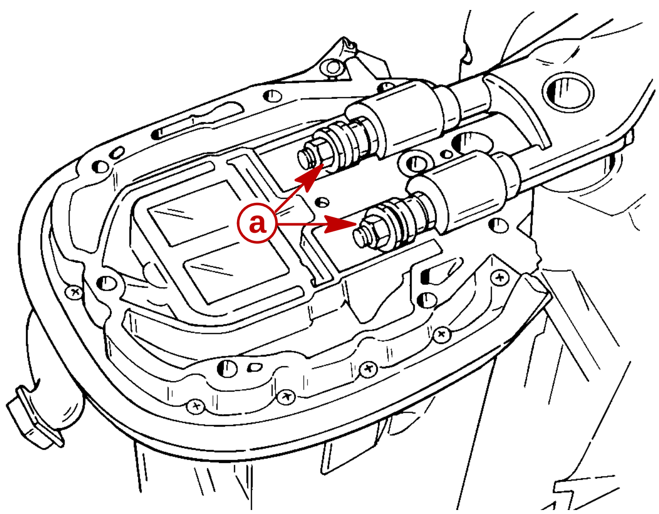
a - Shift Shaft Linkage
b - Exhaust Extension Plate
c - Exhaust Plate to Drive Shaft Housing Bolts
d - Driveshaft Housing Plate
e - Lower Mount Cover (One Each Side)
f - Mounting Bracket Bolts (3)

SHIFT LINKAGE ASSEMBLY



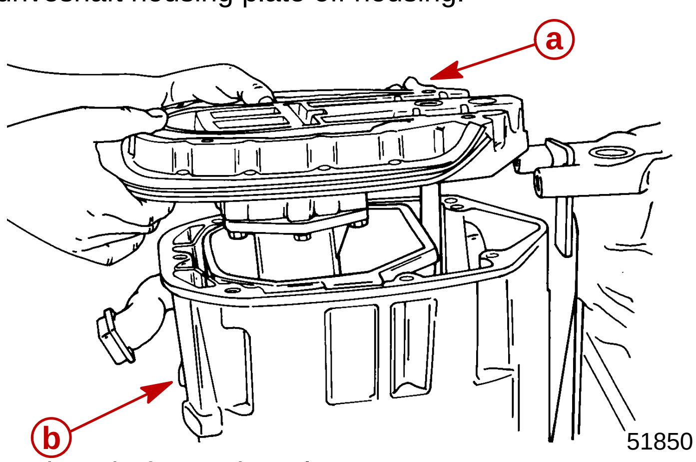
a - Shift Shaft Assembly
b - Bushing
c - Lock Nut
d - Washer (2)
e - Bushing (Hidden)
f - Spring
g - Guide Block

1. Remove upper mount nuts and flat washers.



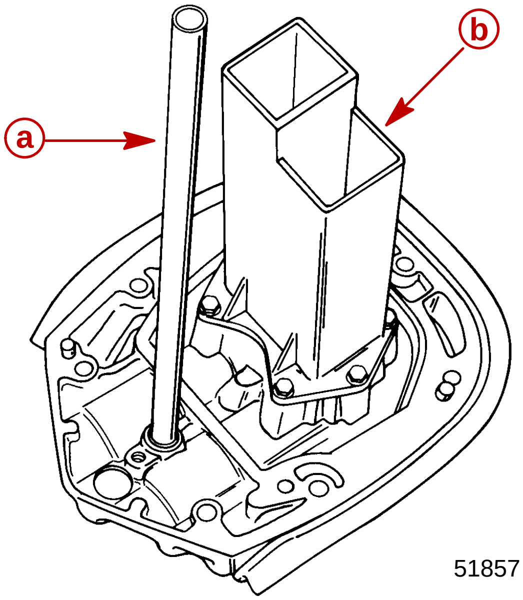
a - Upper Mount Nuts

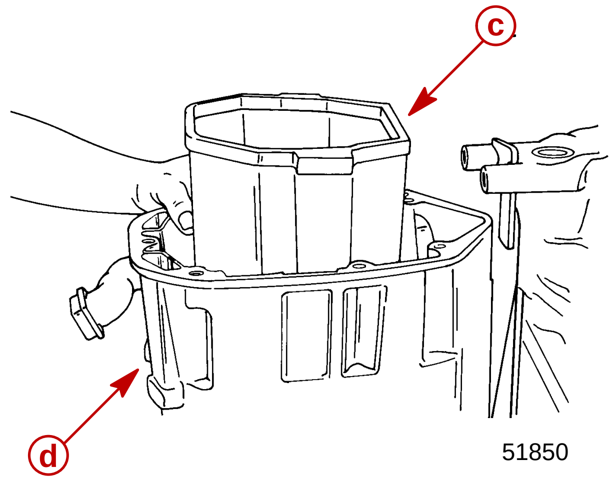
2. Lift driveshaft housing plate off housing.



a - Drive Shaft Housing Plate
b - Drive Shaft Housing

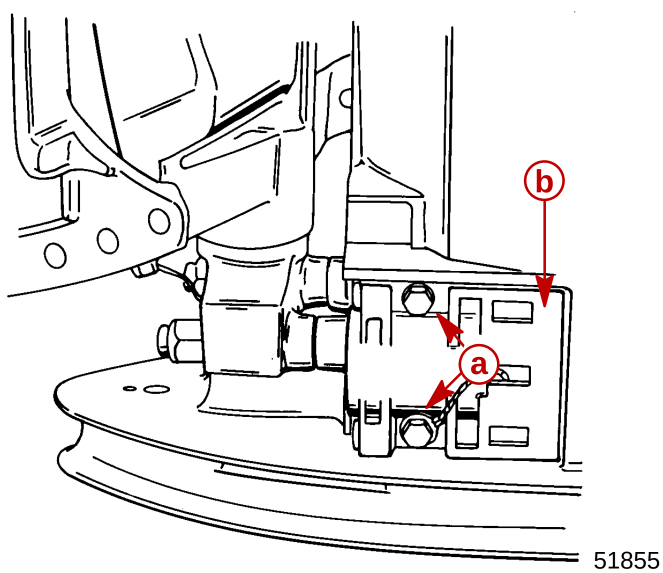
3. Remove water tube from driveshaft housing plate.
4. Exhaust diffuser is secured to housing plate with 6 bolts. Remove bolts, then remove diffuser.
5. Pull exhaust tube out of drive shaft housing.





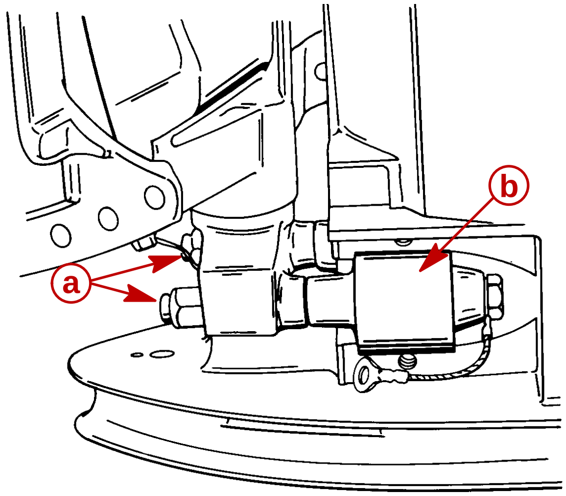
a - Water Tube
b - Exhaust Diffuser
c - Exhaust Tube
d - Drive Shaft Housing

6. Remove all gasket material from driveshaft housing and related components.
7. Remove bolts, which secure lower mount retainers to drive shaft housing, and remove retainers.
8. Remove rubber caps from lower mount bolts.



a - Bolts
b - Lower Mount Retainer (One Each Side)

9. Remove lower mount nuts.



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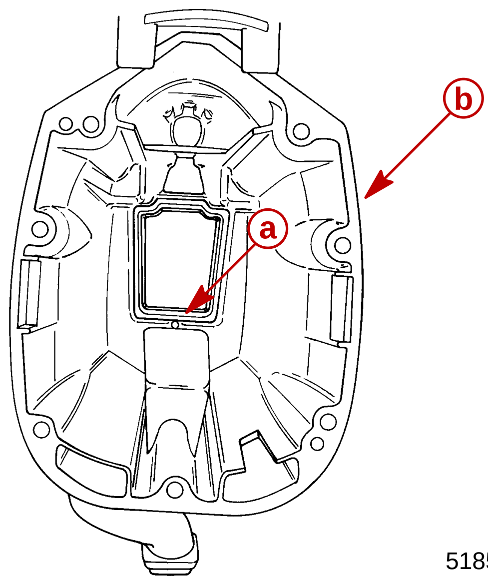
a - Lower Mount Nuts
b - Lower Mount (1 each side)

10. Remove driveshaft housing from swivel bracket by pulling alternately from top to bottom on housing.
11. Remove upper and lower mounts by lifting them out of driveshaft housing.

Reassembly and Installation

1. Apply a thin coat of 2-4-C with Teflon Marine Lubricant onto inside portion of exhaust tube seal.
2. Install exhaust tube seal into driveshaft housing with tapered side of seal facing up.



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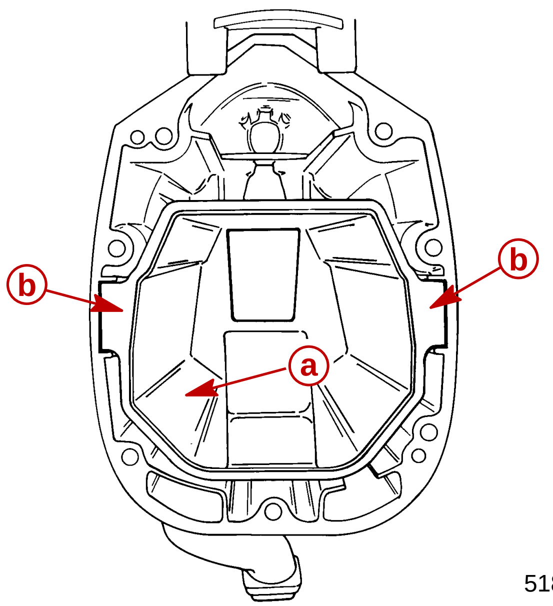
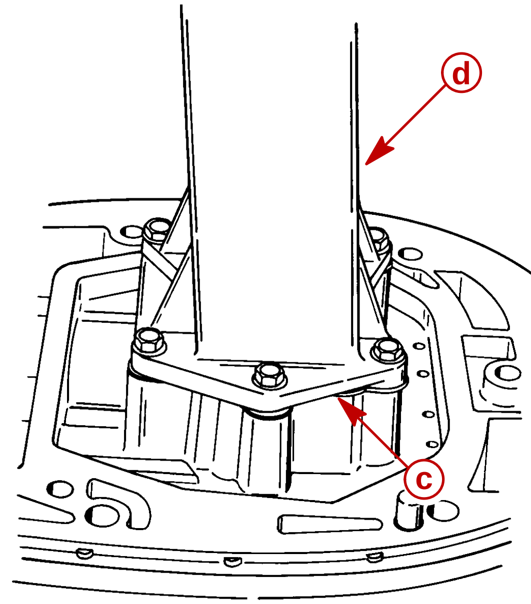
a - Exhaust Tube Seal
b - Driveshaft Housing

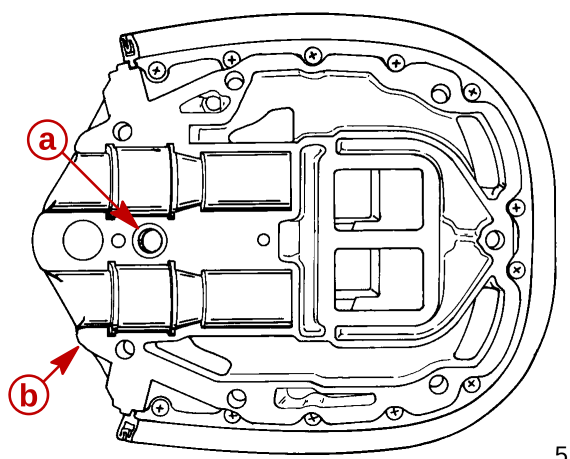
3. Push exhaust tube boots onto tabs on each side of exhaust tube.
4. Position exhaust tube in drive shaft housing and push down on tube until boots rest in grooves on inside of housing.
5. Position driveshaft housing to plate gasket on top of housing.
6. Install an exhaust diffuser gasket and exhaust diffuser onto plate, then secure both to plate with 6 bolts. Clean bolts with Loctite 7649 Primer and then apply Loctite 271 to bolt threads. Torque bolts to 60 lb. in. (7.0 Nm).





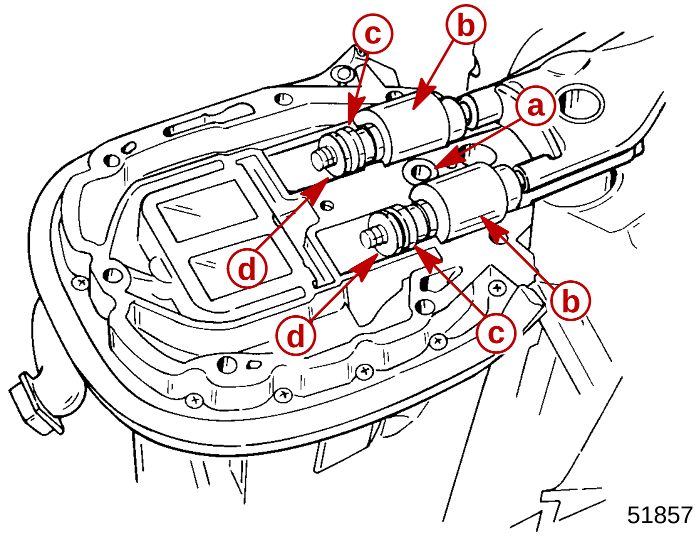
a - Exhaust Tube
b - Exhaust Tube Boots
c - Exhaust Diffuser Gasket
d - Exhaust Diffuser

7. Apply a small amount of 2-4-C with Teflon Marine Lubricant onto water tube seal.
8. Install water tube seal into driveshaft housing plate with plastic end of seal facing up and install water tube.



a - Water Tube Seal
b - Driveshaft Housing Plate

9. Position drive shaft housing plate on top of housing.
10. Apply a thin coat of Perfect Seal onto metal portion of upper dyna-float mounts.
11. Position mounts on drive shaft housing plate.
12. Install a rubber washer onto each upper mount, followed by a metal washer.



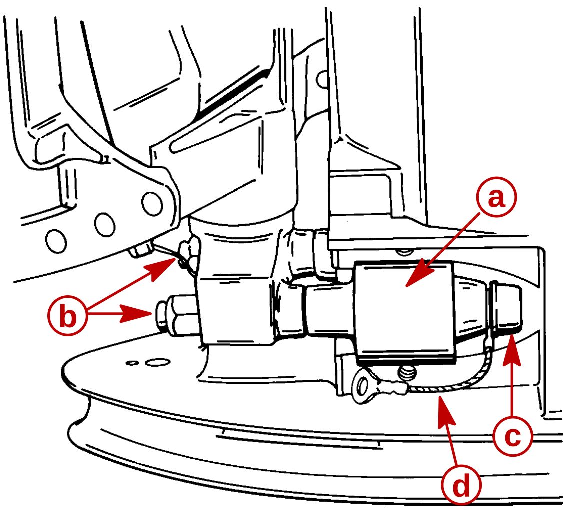
a - Water Tube Seal (Plastic End)
b - Dyna-Float Mounts
c - Rubber Washers
d - Metal Washer

13. Install a ground strap onto one of the lower mount mounting bolts.

NOTE: *Apply Perfect Seal along length of lower mount bolts.*

14. Insert a mounting bolt thru the short end of each lower mount.
15. Position a mount on each lower side of driveshaft housing.
16. Install a flat washer over each lower mounting bolt.
17. Position a bumper on steering arm between mounting bolts.
18. Start upper mounting bolts in upper mounts and align lower mounting bolts with holes in swivel pin yoke. Slide driveshaft housing up against yoke and bumper.
19. Secure upper mounts to steering arm with flat washers and self-locking nuts. Torque nuts to 50 Ib. ft. (68.0 Nm).
20. Install ground strap (if equipped) between port lower mount bolt and swivel bracket.
21. Secure lower mounts to swivel pin yoke with self-locking nuts. Torque nuts to 50 Ib. ft. (68.0 Nm). Place a rubber cap over each lower mounting bolt head.

22. Install lower mount retainers and secure each retainer with 2 bolts. (Secure ground strap with the nearest retainer bolt.) Torque bolts to 160 lb. in. (18.0 Nm).



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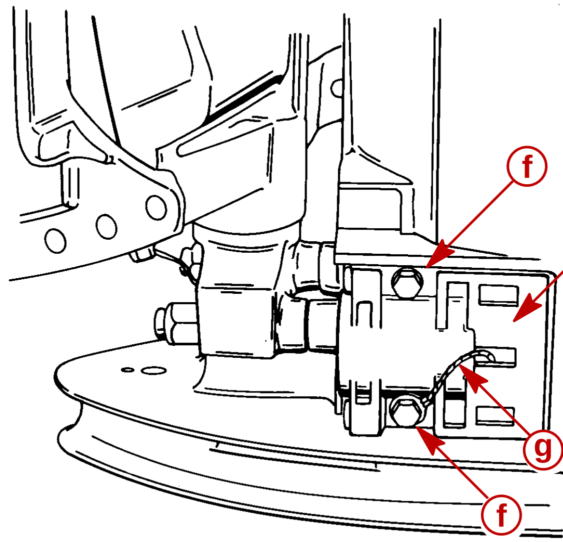

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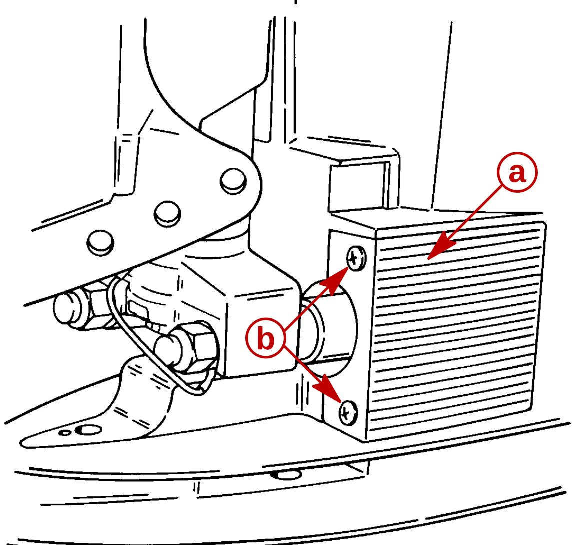
a - Lower Mount
b - Nut (2) [Torque to 50 lb. ft. (68.0 Nm)]
c - Rubber Cap
d - Ground Strap (only one side)
e - Lower Mount Retainer
f - Bolts (2) [Torque to 160 lb. in. (18.0 Nm)]
g - Ground Strap

23. Install lower mount covers and secure each cover with 2 screws.

24. Install exhaust extension plate on driveshaft housing with shift shaft assembly. Secure extension plate to drive shaft housing with 5 bolts.



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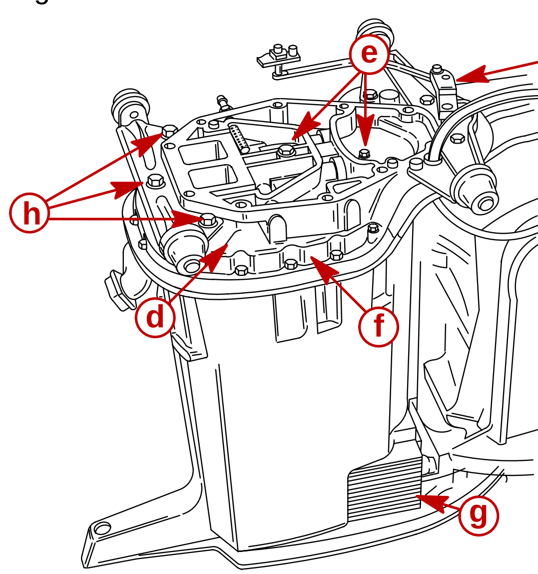


a - Cover (One Each Side)
b - Screws (Two for Each Cover)
c - Shift Shaft Linkage
d - Exhaust Extension Plate
e - Exhaust Plate to Driveshaft Housing Bolts, Torque to 25 lb. ft. (34 Nm)
f - Drive Shaft Housing Plate
g - Lower Mount Cover (One Each Side)
h - Mounting Bracket Bolts, Torque to 40 lb. ft. (54 Nm)

MID-SECTION

Section 5B – Power Trim

Table of Contents

5
B

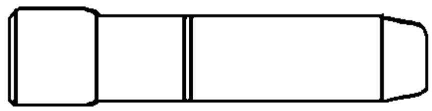
Power Trim Specifications

NOTE: *Maximum acceptable amount of leak down in 24 hours is 1 in. (25.4 mm)*

Test	Reading
Trim “UP”	1300 PSI (91kg/cm^2) Maximum Pressure
Trim “DOWN”	500 PSI (35kg/cm^2) Minimum Pressure

Special Tools

1. Alignment Tool 91-11230



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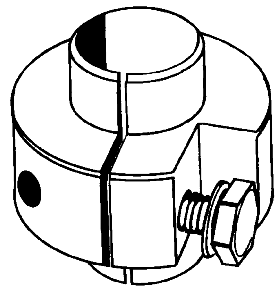
2. Trim Rod Removal Tool 91-44486A1



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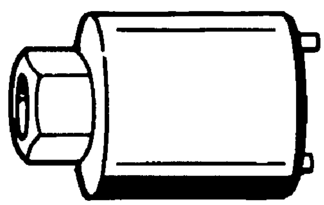
3. Trim Rod Guide Removal Tool 91-44487A1



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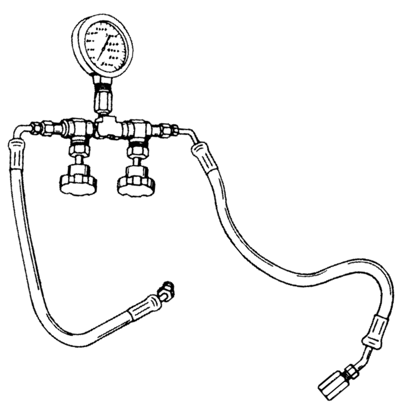
4. Power Trim Test Gauge Kit 91-52915A6



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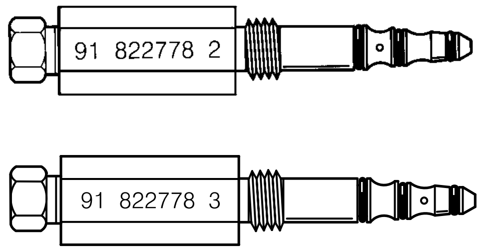
5. Adaptor Fitting 91-82278A2 and 91-82278A3



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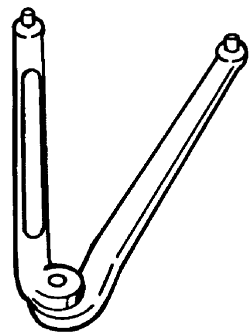
6. Spanner Wrench 91-74951



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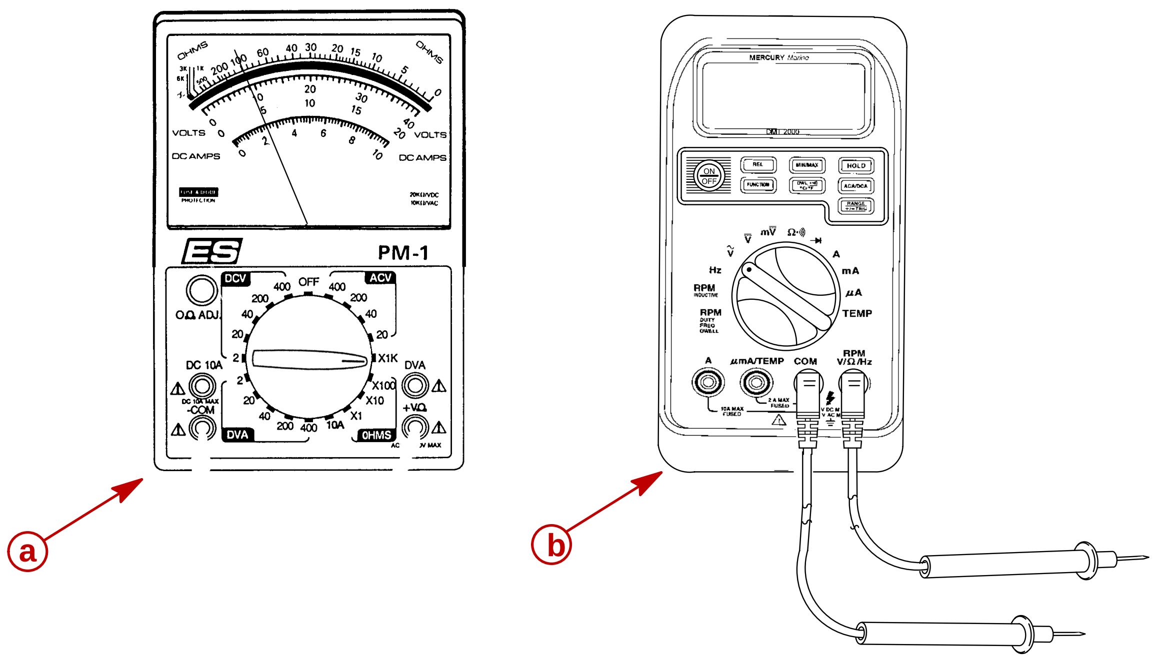
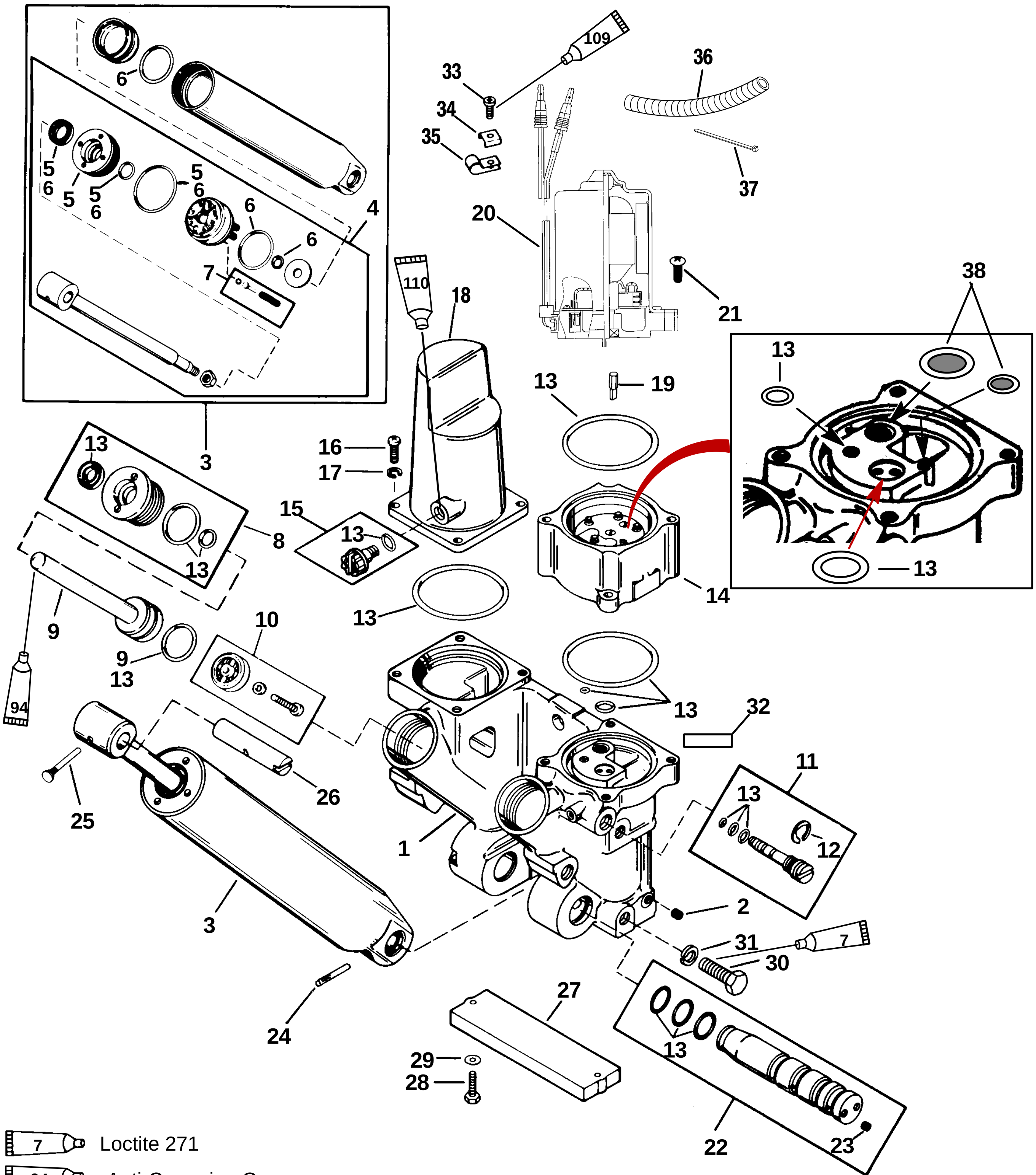
7. Multi-Meter DVA Tester 91-99750A1 or DMT 2000 Digital Tachometer Multi-meter 91-854009A1



a - Multi-Meter DVA Tester 91-99750A1
b - DMT 2000 Digital Tachometer Multi-meter 91-854009A1

Power Trim Components



7 Loctite 271

94 Anti-Corrosion Grease

109 GM Silicone Sealer

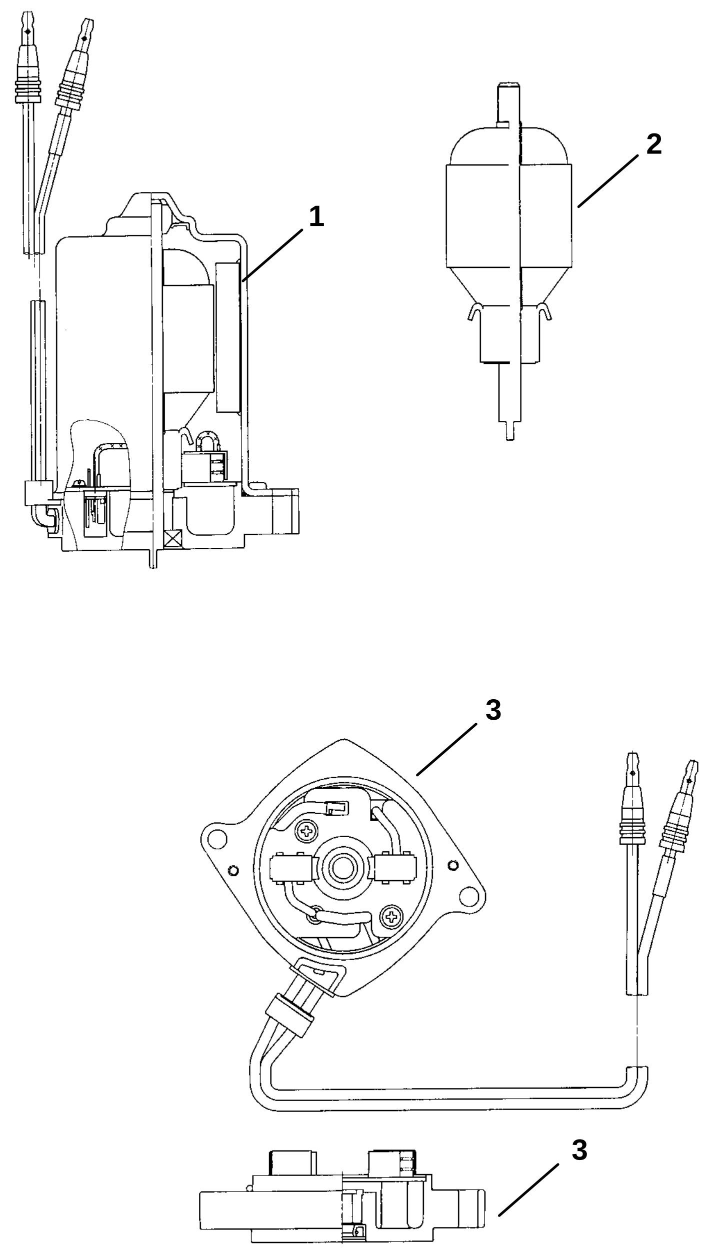
110 Power Trim & Steering Fluid

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.

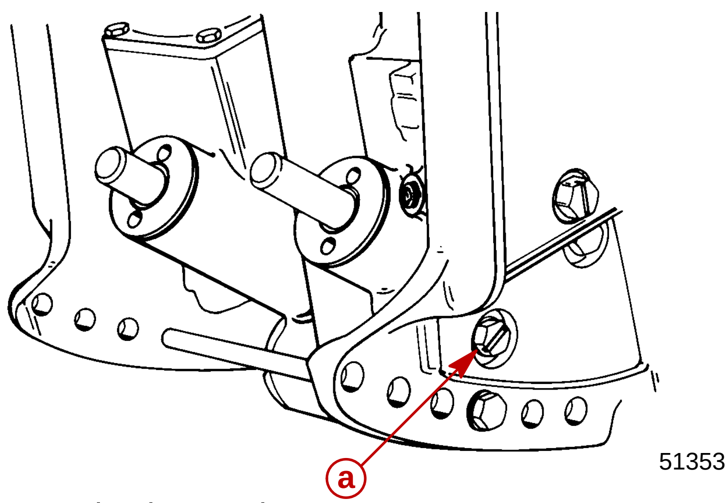
If the outboard must be tilted for clearance between skeg and pavement, a device such as a "Transom Saver" should be installed to prevent stress to boat transom from outboard weight while the boat/outboard are being trailered.

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.



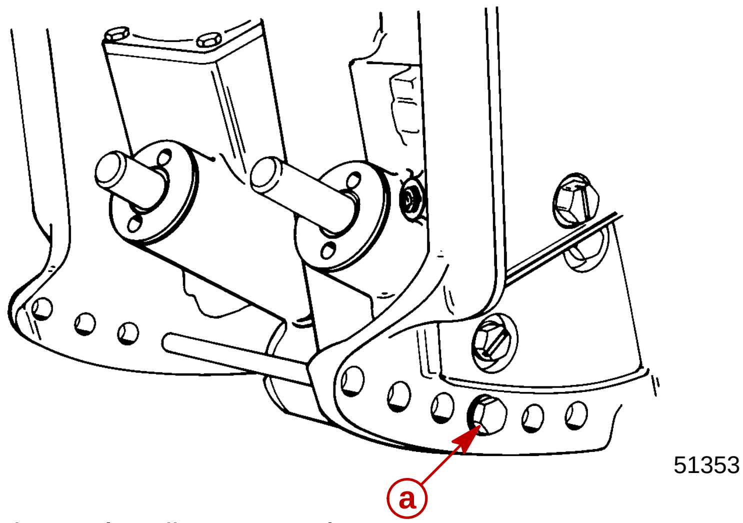
a - Manual Release Valve

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.

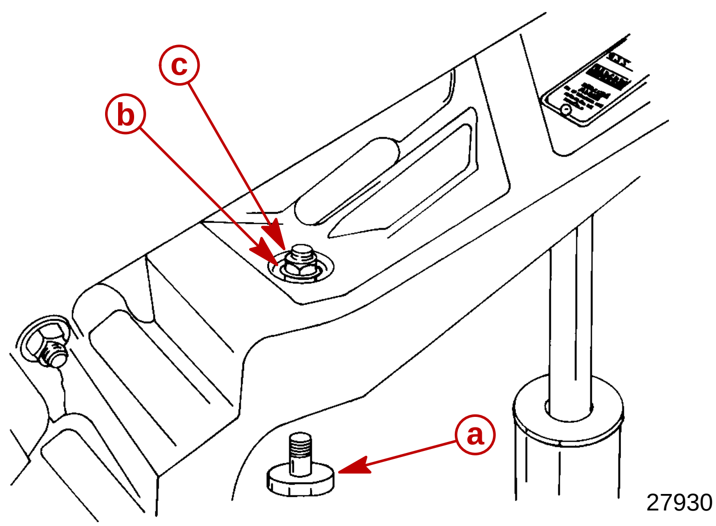
IMPORTANT: Some boat/motor combinations not using the trim angle adjustment pin (a) and trimmed to the full "In" trim angle position may not exhibit any undesirable and/or unsafe handling and/or steering characteristics at planing speed. If so, not using the trim angle adjustment bolt may be advantageous 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

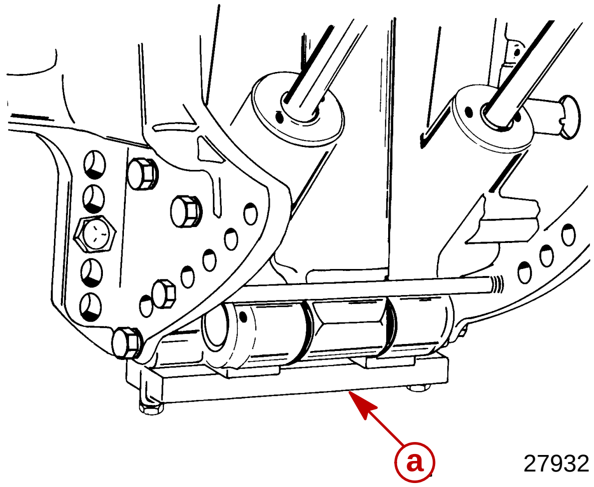
Visually inspect striker plates and replace if worn excessively.



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).

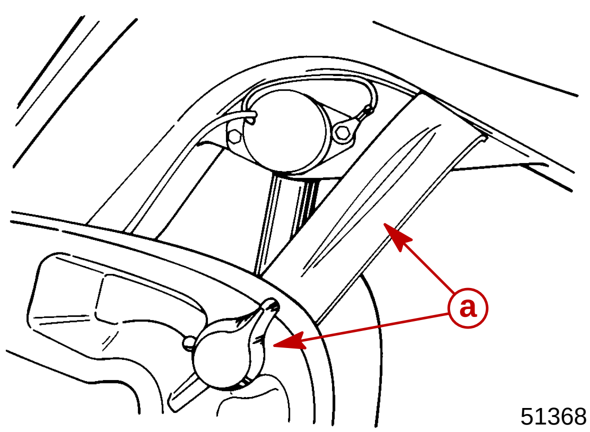
Check, Fill and Purge - Power Trim System

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.

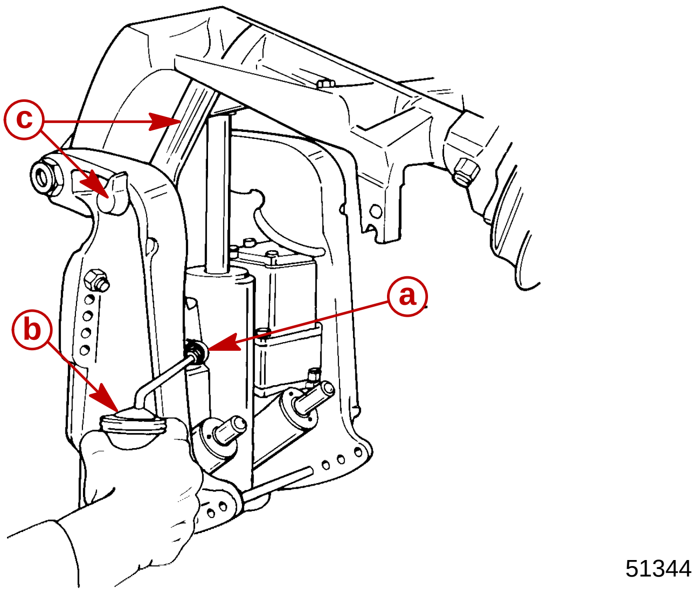
NOTE: *Automatic Transmission Fluid (ATF) Type F, FA, Dexron II or Dexron III may be used.*



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.



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.

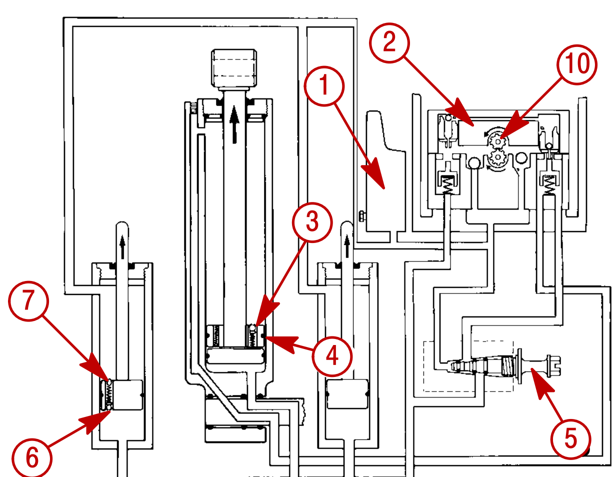
HYDRAULIC SYSTEM TROUBLESHOOTING

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:

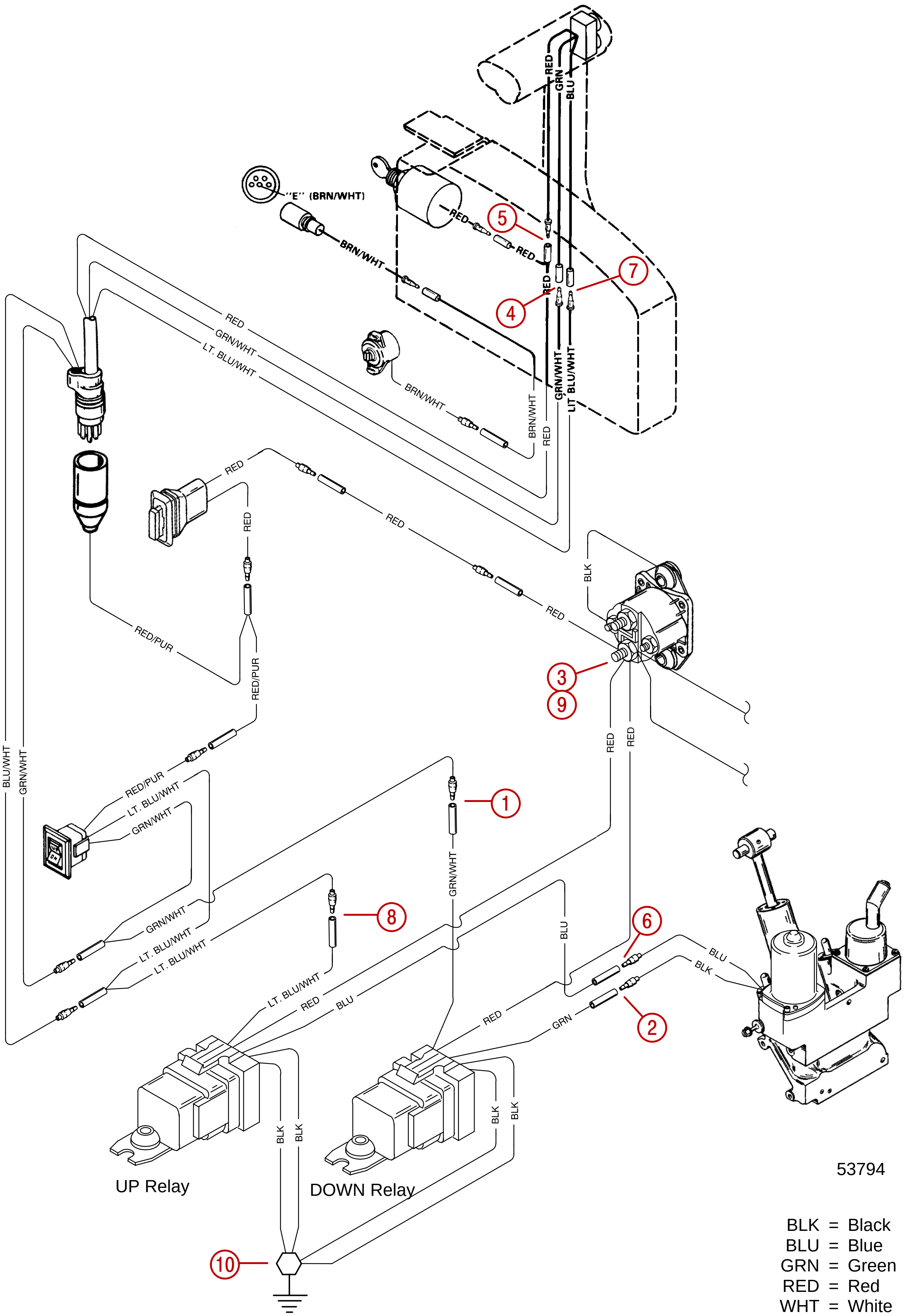
1. Disconnect the heavy gauge pump wires from the trim control relay.
2. Check for continuity between the heavy leads from the trim relays to ground.

Ohmmeter Leads Between	Resistance (Ohms)	Scale Reading (R x 1)
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 circuit.

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 circuit.

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.

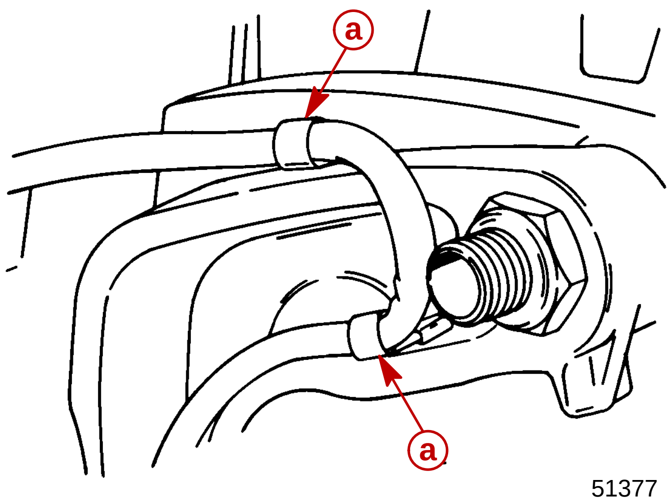
Battery Voltage Indicated:

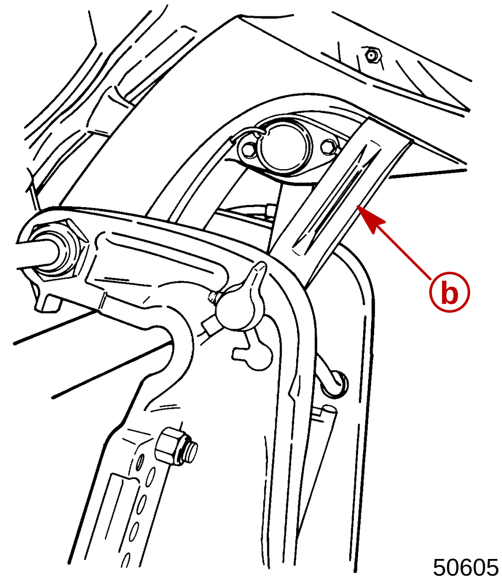
There is an open circuit in wire between Point 5 and Red terminal on the back of the ignition switch.

Power Trim Assembly Removal and Installation

Removal

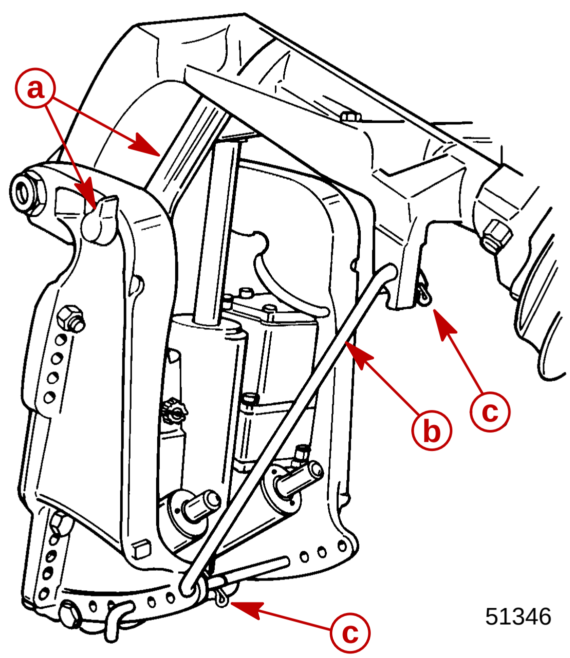
1. Remove clamps on transom bracket to free power trim wiring.
2. Raise outboard to full "Up" position and engage tilt lock lever.





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.

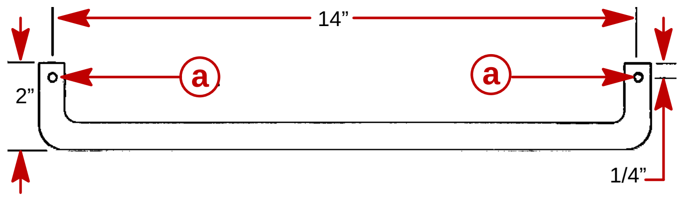


a - Tilt Lock Lever
b - Support Tool
c - Retaining Clips

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

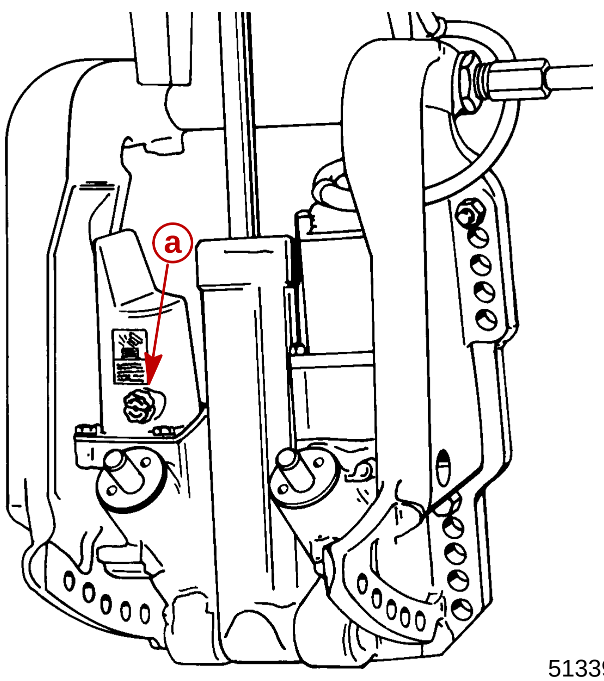
14 in. = 35.56 cm.	2 in. = 50.8 mm
3/8 in. = 9.5 mm.	1/4 in. = 6.35 mm.

⚠ 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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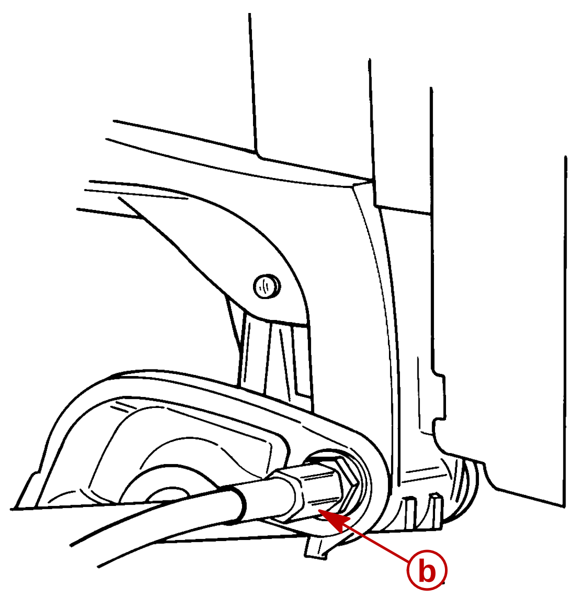

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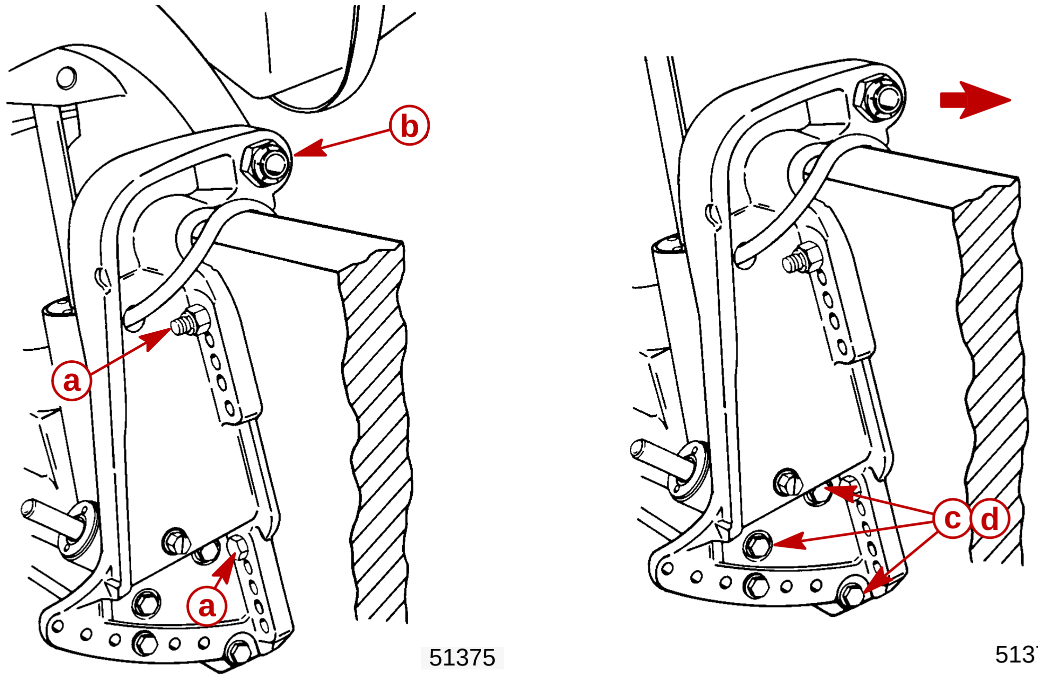
a - Filler Cap
b - Retaining Nut

5. Remove outboard transom mounting bolts, and loosen tilt tube nut until nut is flush with end of tilt tube thread.

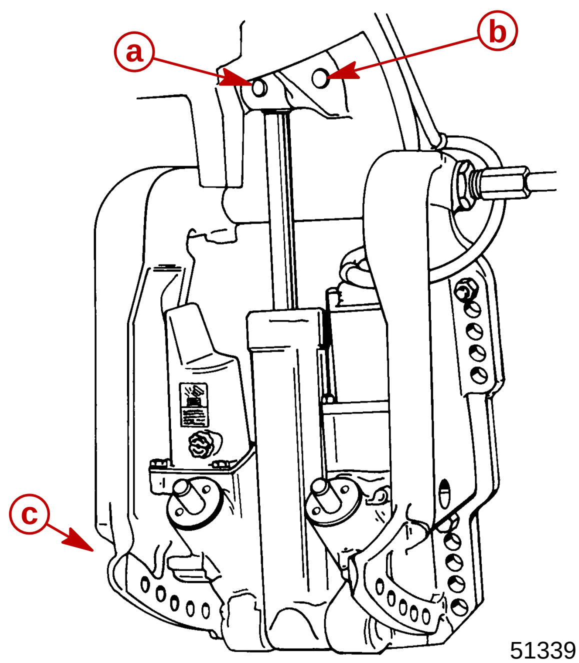
6. Remove 3 screws and washers and move starboard transom bracket.



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.

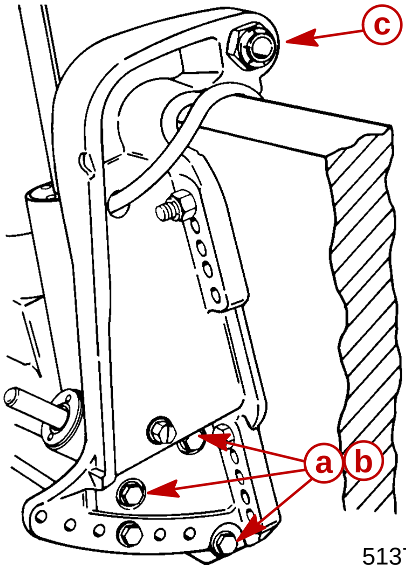
7. Drive out cross pin, push out upper swivel pin, and remove 3 screws and washers retaining trim system. Remove system from outboard.

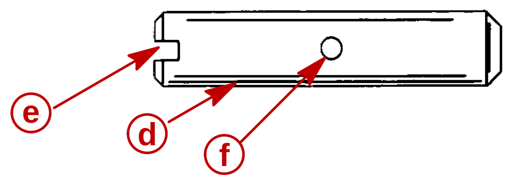


a - Cross Pin
b - Upper Swivel Pin
c - Port Transom Bracket Screws and Washers (3). Remove to Release Trim System from Outboard.

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.





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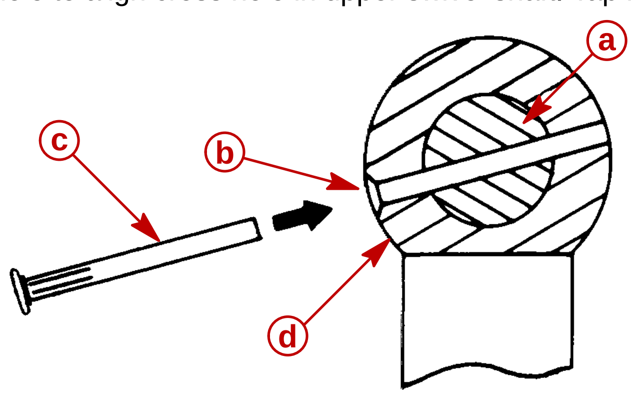
a - Screw (6) Torque to 40 lb. ft. (54.0 N·m)
b - Lockwasher (6) Install one per screw
c - Tilt Tube Nut
d - Upper Swivel Pin
e - Slotted end
f - Cross hole (in line with slotted end)

IMPORTANT: Cross pin should not be reused. Install a new pin.

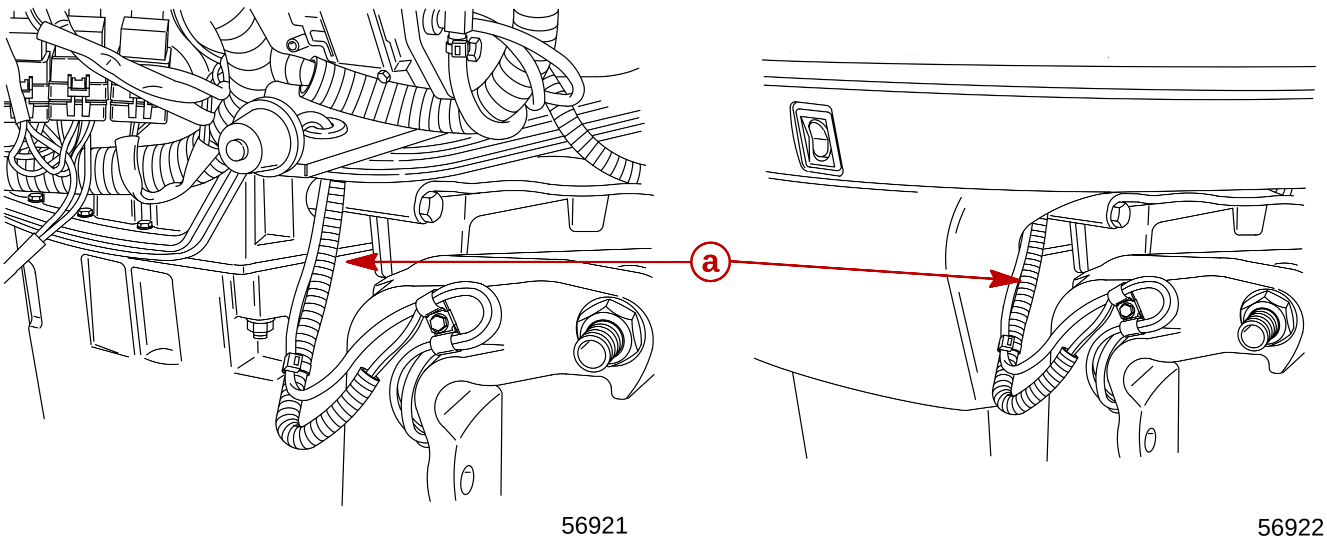
5. Position slot on end of swivel shaft in line with hole in tilt ram end. Insert a punch into tilt ram hole to align cross hole in upper swivel shaft. Tap new cross pin in until flush.



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

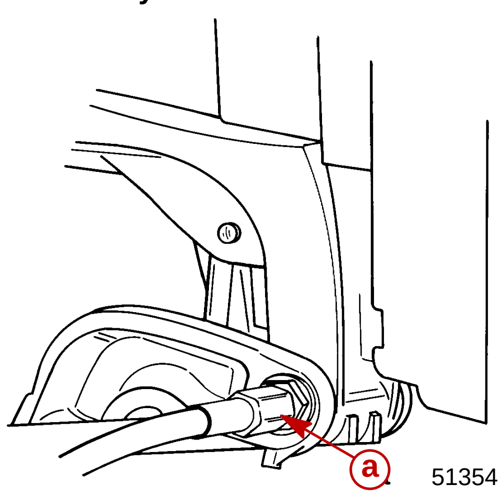
7. Apply marine sealer to shanks of mount bolts and install transom mount bolts.

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 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.

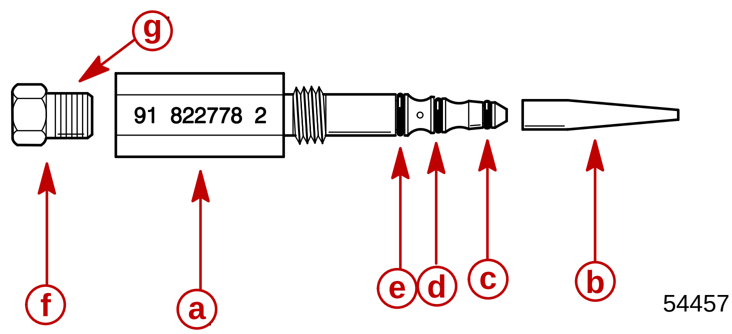
“UP” Pressure Check

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.

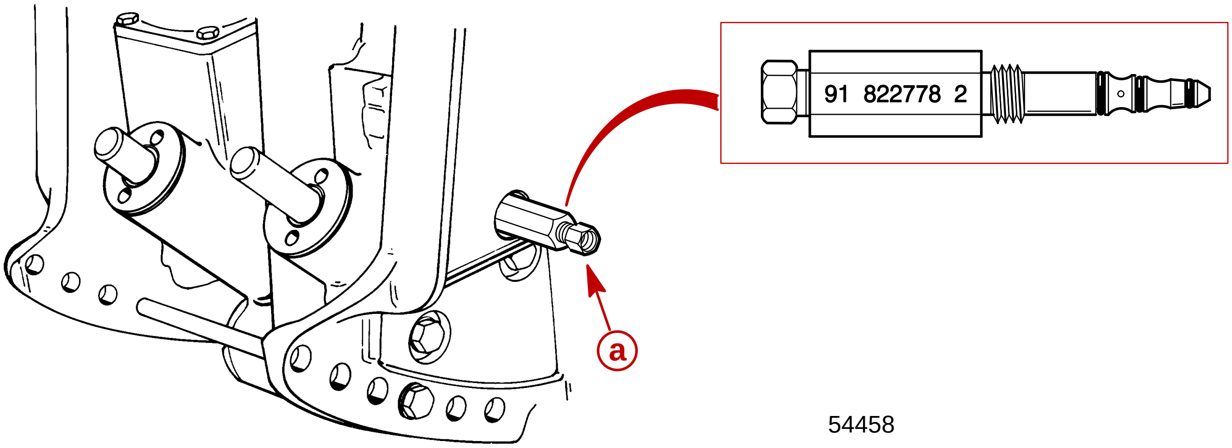
NOTE: *A small amount of trim fluid may drip from manual release valve hole. Place a suitable container under trim assembly to collect any leakage.*

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.*



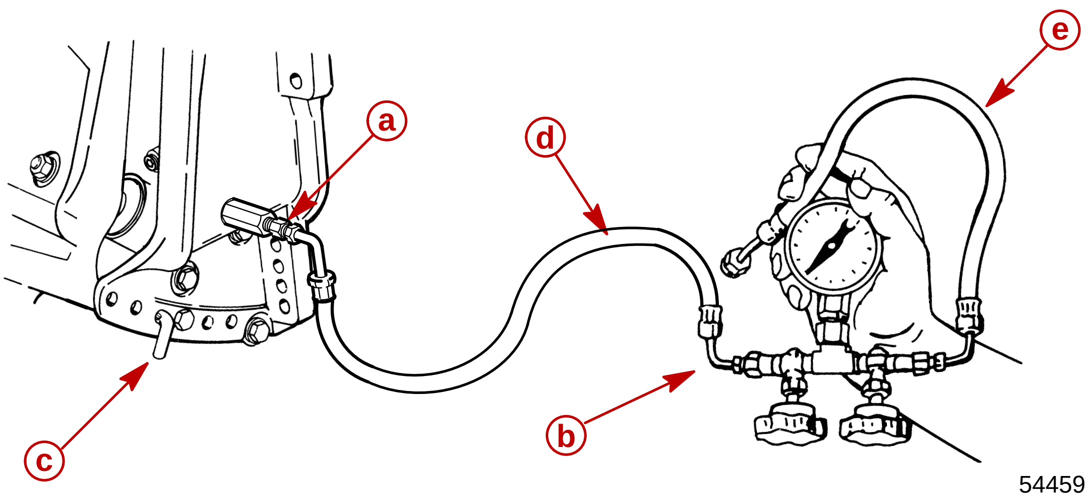
a - Test Adaptor (91-822778A2)
b - O-ring Installation Tool
c - Small O-ring (Install 1st)
d - Medium O-ring (Install 2nd)
e - Large O-ring (Install Last)
f - Brass Fitting
g - Apply Teflon Tape

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.



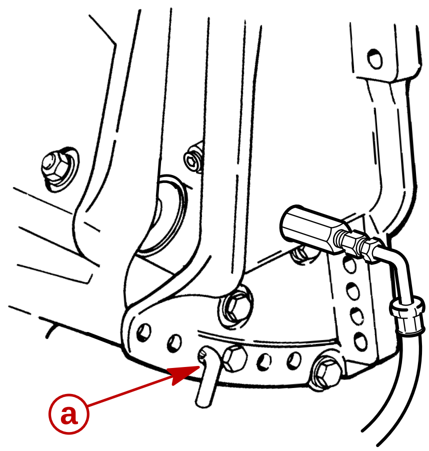
a - Brass Fitting
b - Test Gauge Assembly
c - Tilt Pin (Position in Hole Shown)
d - Hose
e - Hose (Not Used)

6. Reinstall fill plug.
7. Disengage tilt lock lever.

⚠CAUTION

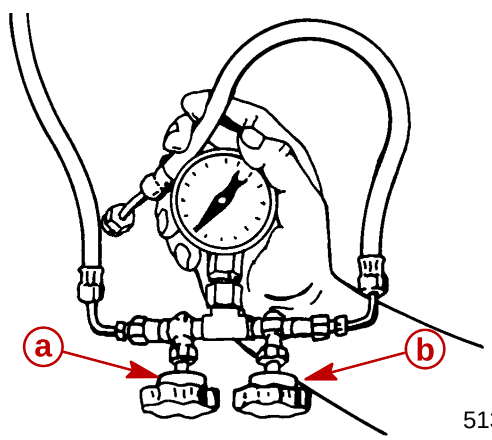
Failure to install spare tilt pin (or hardened bolts and nuts) in hole shown could result in transom bracket failure and possible injury.

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.*

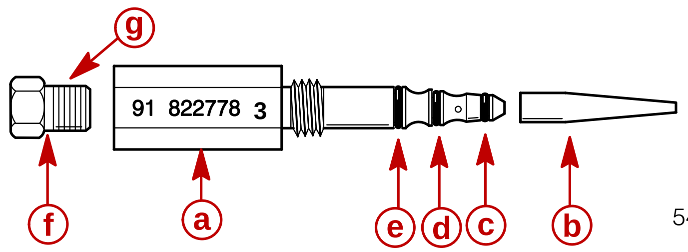
“DOWN” Pressure Check

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.*



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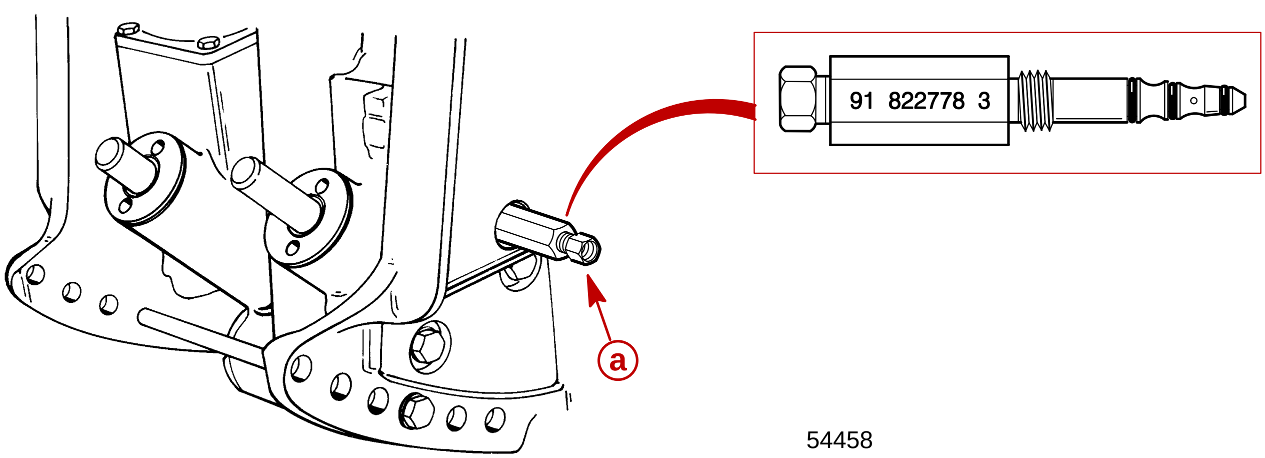
a - Test Adaptor (91-822778A3)
b - O-ring Installation Tool
c - Small O-ring (Install 1st)
d - Medium O-ring (Install 2nd)
e - Large O-ring (Install Last)
f - Brass Fitting
g - Apply Teflon Tape

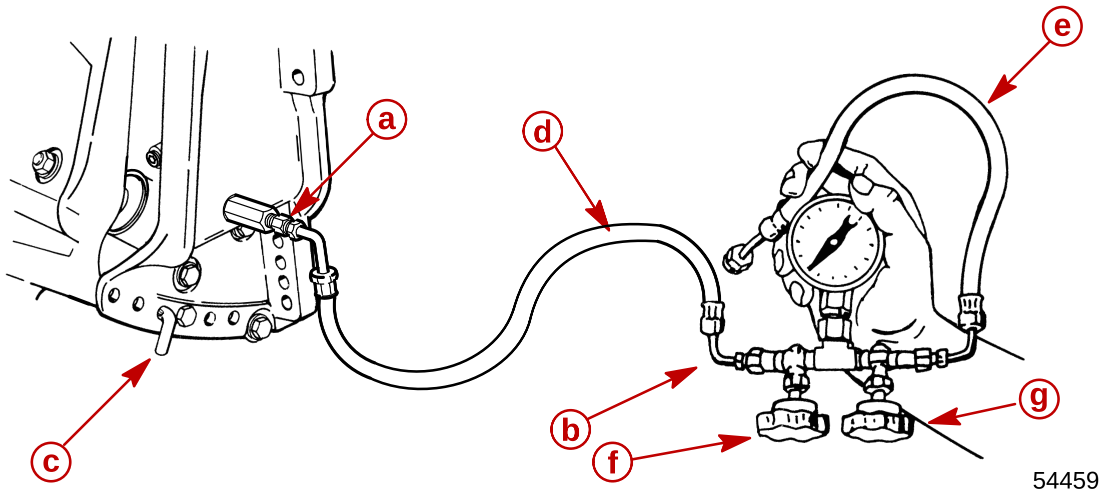
4. Install test adaptor 91-822778A3 into manual release valve hole.



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.*

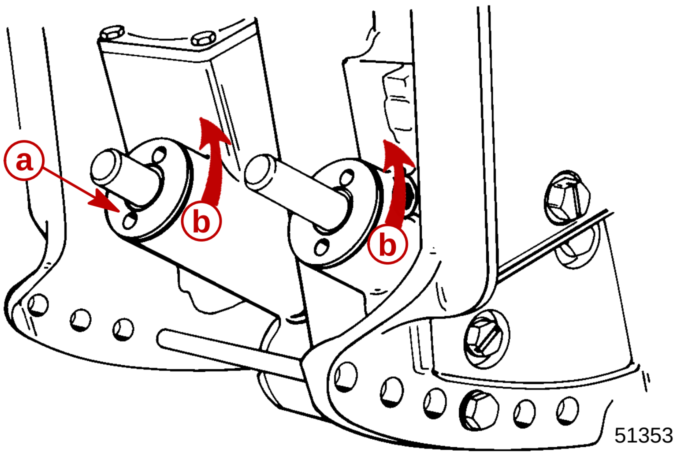
Hydraulic Repair

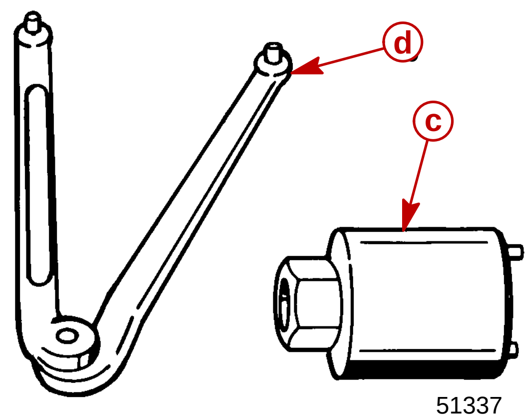
TRIM ROD REMOVAL AND REPAIR

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.

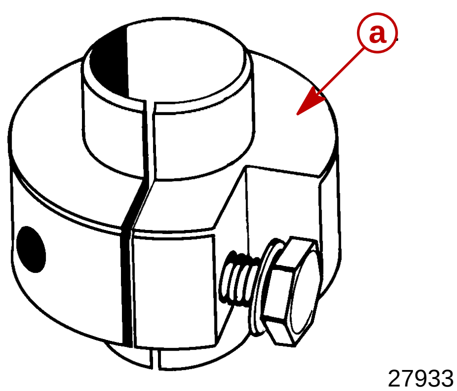
NOTE: *Place a clean pan under trim system to catch fluid.*





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.



a - Trim Rod Removal Tool (91-44486A1)

CLEANING AND INSPECTION - TRIM RODS AND CAPS

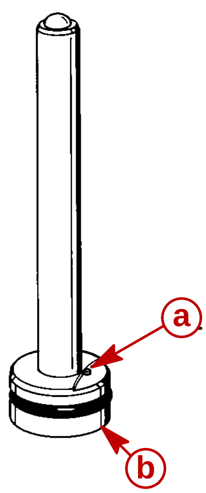
⚠ CAUTION

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.



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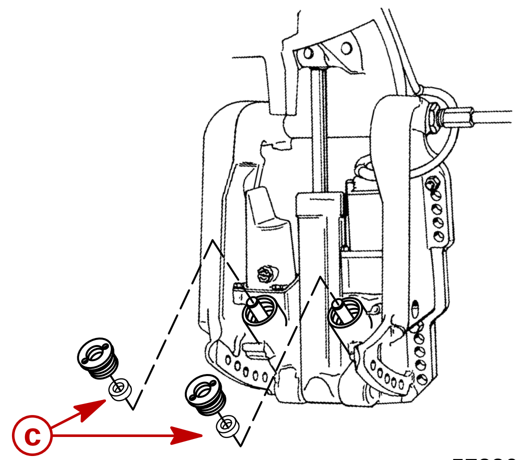
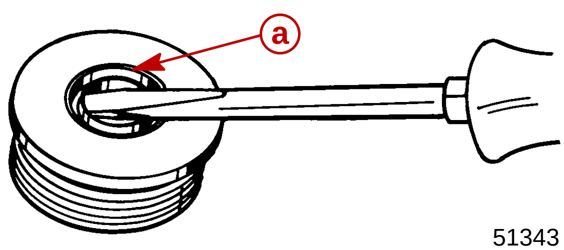


57886

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.

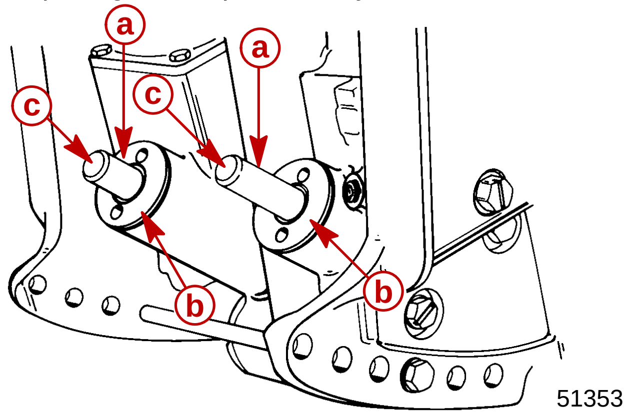
TRIM ROD INSTALLATION

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.



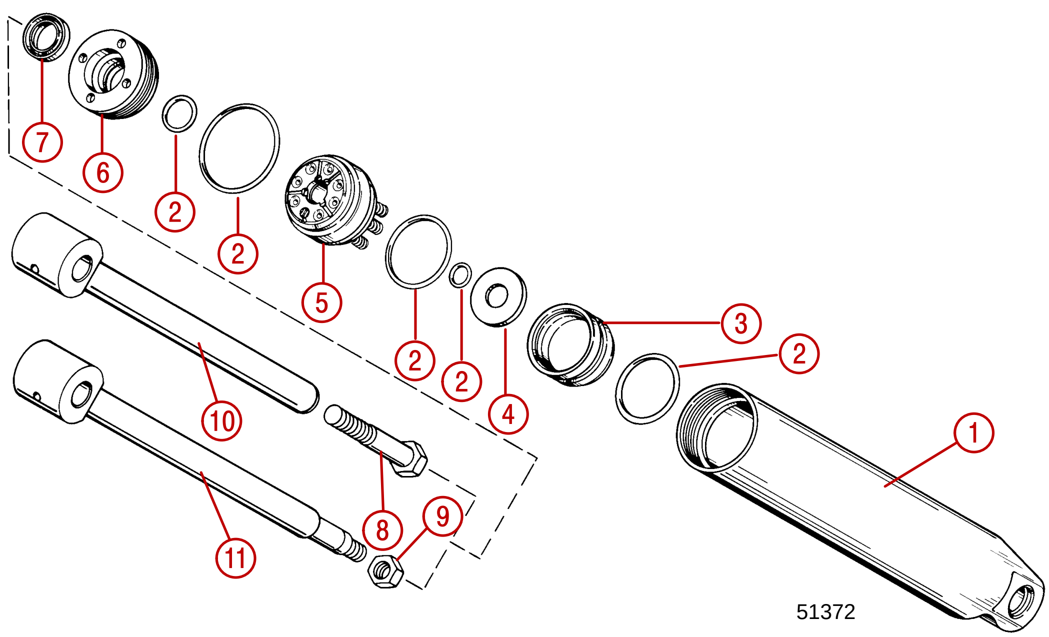
a - Trim Rods
b - Cylinder End Caps
c - Rod End Rollers (lubricate with Quicksilver Anti-Corrosion Grease or Special Lubricant 101)

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)

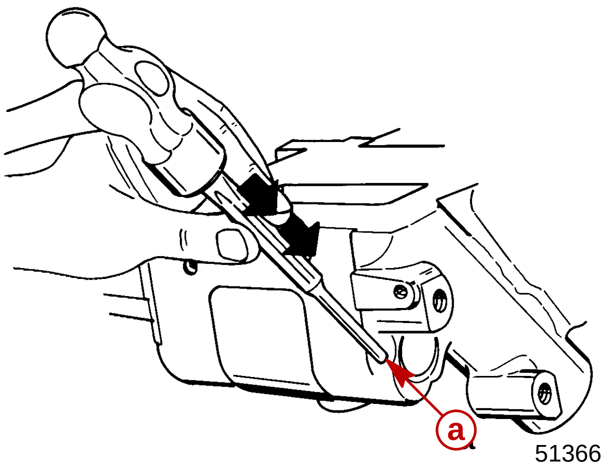
**Memory piston (3) for tilt rods (10 and 11) are different and must be used with correct tilt rod/cylinder assembly. Memory piston for Design 1 tilt rod is flat, Design 2 is dished to clear nut and thread.

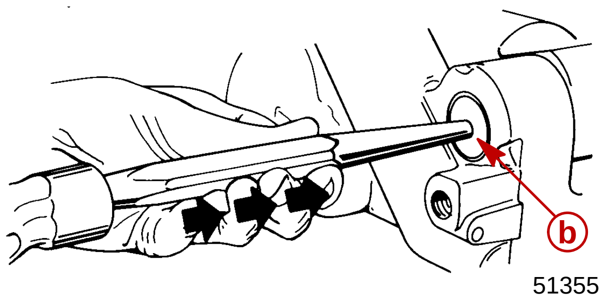
TILT RAM REMOVAL - POWER TRIM SYSTEM REMOVED FROM OUTBOARD

CAUTION

Insure trim system is depressurized prior to tilt ram removal.

1. Remove cross pin.
2. Remove lower swivel pin.

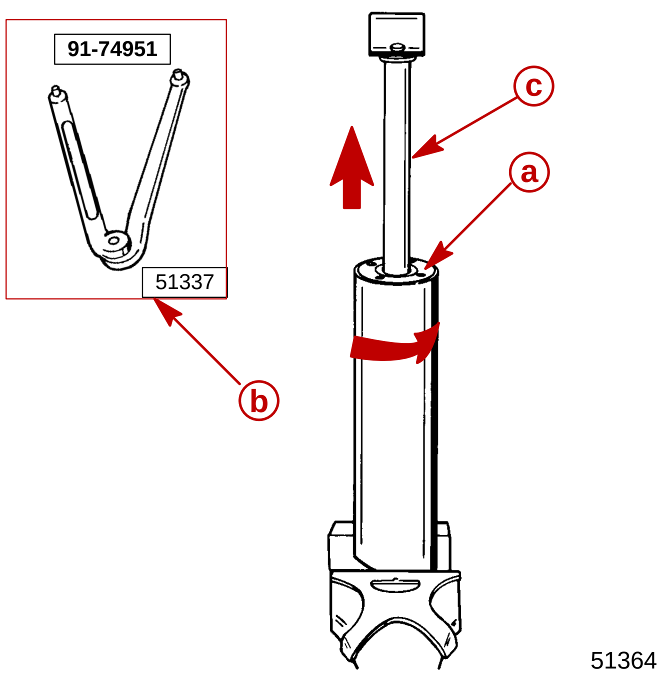




a - Cross Pin (Remove as shown)
b - Lower Swivel Pin (Remove as shown)

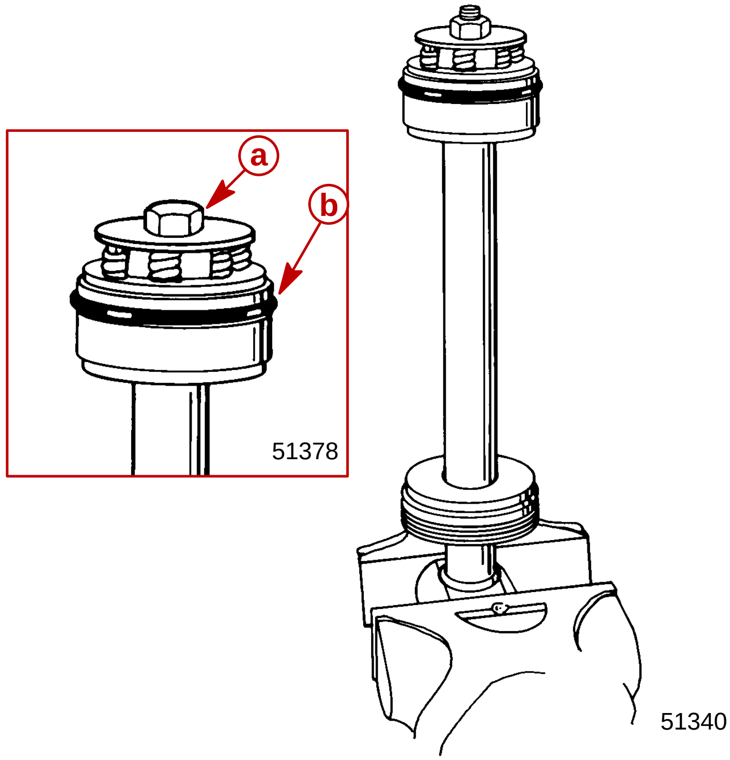
Disassembly

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.

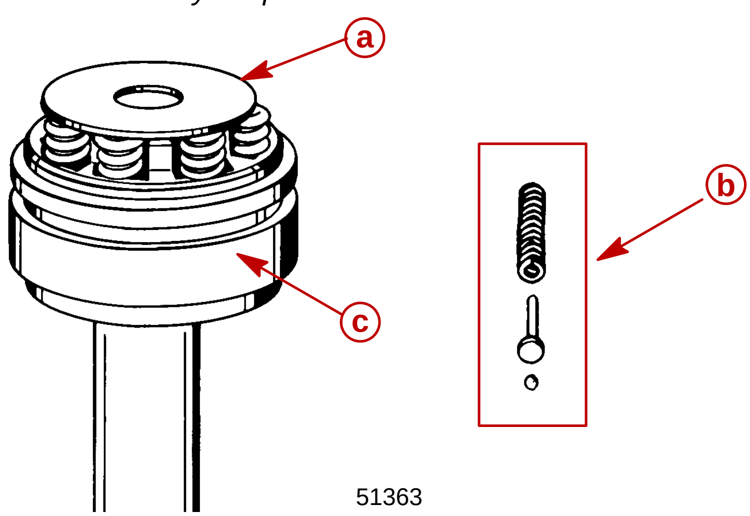


a - Bolt (Design 1) or Stud/Nut (Design 2)
b - O-Ring

IMPORTANT: Note Design 1 and 2 on page 5B-30. Design 1 tilt rod assembly replaces either tilt rod assembly. Either design will fit as a (replace) cylinder assembly complete.
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.

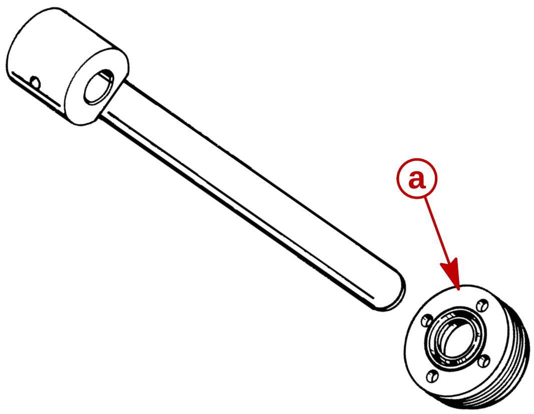
NOTE: *Check valve held in by roll pin can be cleaned but not removed.*



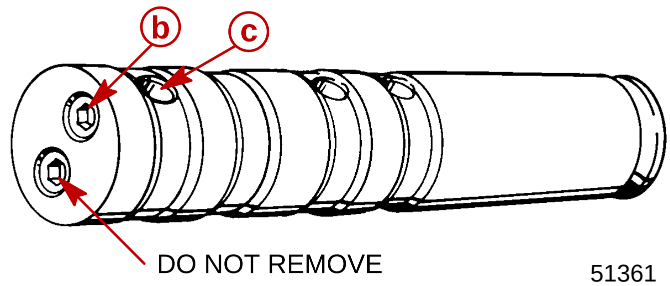
a - Washer
b - Check Valve Assembly (7)
c - Piston

4. Remove end cap from tilt rod.
5. Remove allen plug.

IMPORTANT: Remove plug from same side as holes in shaft.



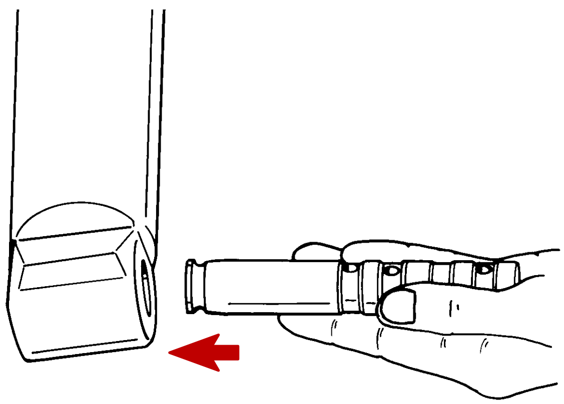
51376



51361

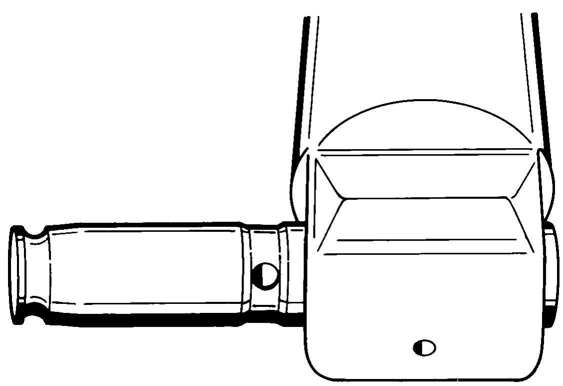
a - End Cap
b - Allen Plug
c - Hole In Shaft

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.

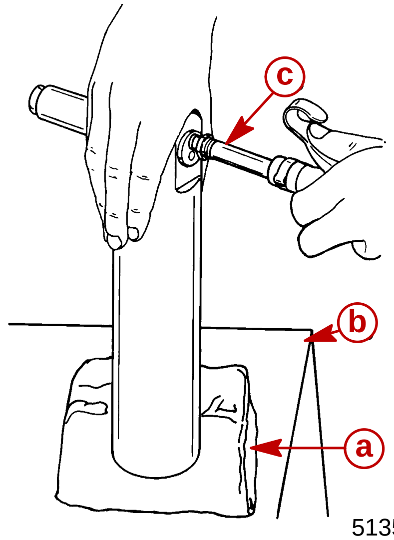


51365

⚠ 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

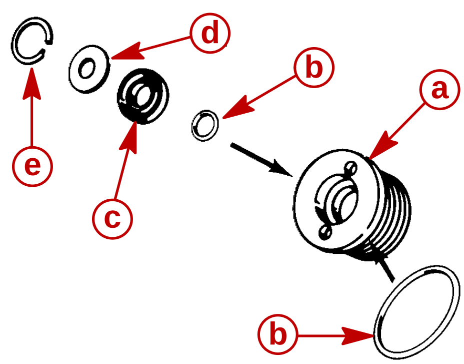
9. Remove shaft after Memory Piston Cup has been expelled. Replace allen plug removed in Step 5 and tighten securely.

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.



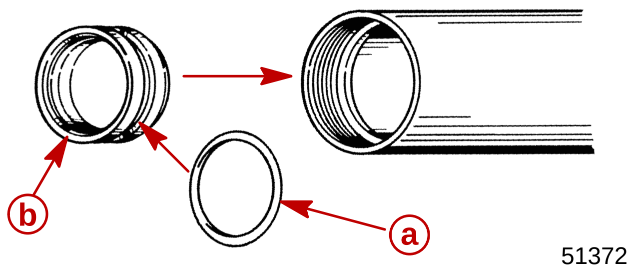
a - Cap
b - O-ring (2)
c - Scraper Seal
d - Washer
e - Retaining Ring

REASSEMBLY

IMPORTANT: Components must be clean for reassembly. Any debris in the system can cause the system to malfunction.

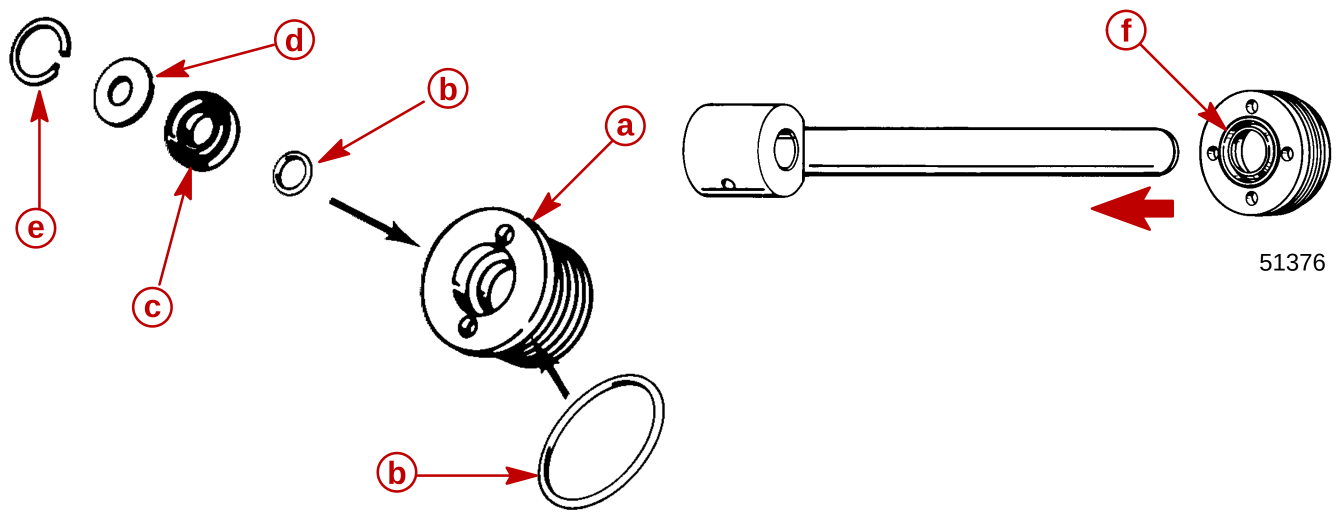
NOTE: *Refer to "Tilt Ram Components" for proper O-ring sizes.*

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.



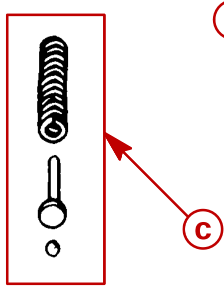
a - O-ring
b - Memory Piston Cup (Design 1 shown)

3. Assemble end cap.
4. Install end cap.

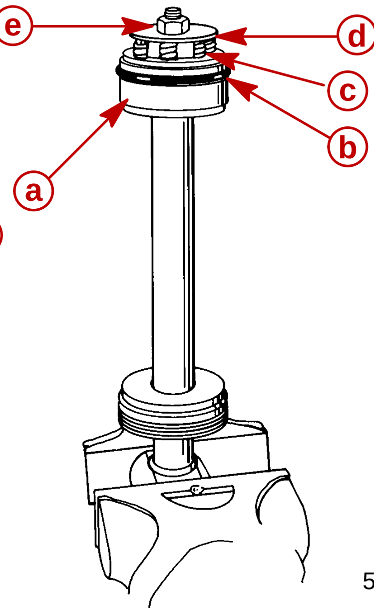


a - End Cap
b - O-ring (2)
c - Scraper seal
d - Washer
e - Retaining Ring
f - End Cap

5. Install components on rod.



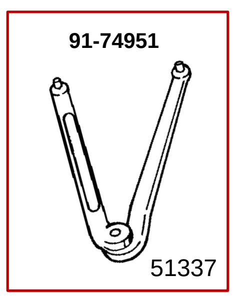
51363

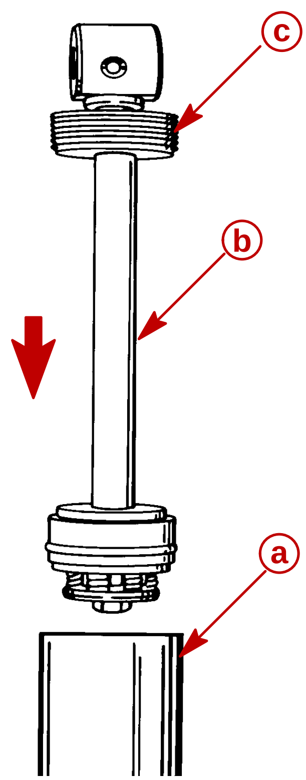


51340

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.



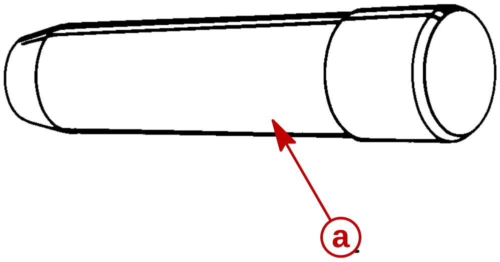


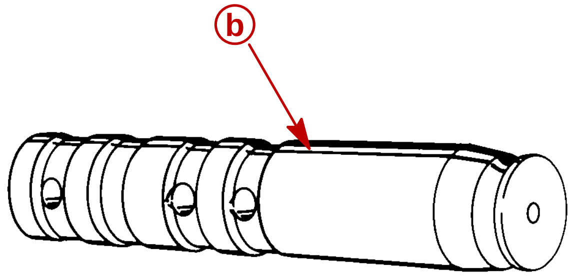
51341

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 Quicksilver Power Trim and Steering Fluid.



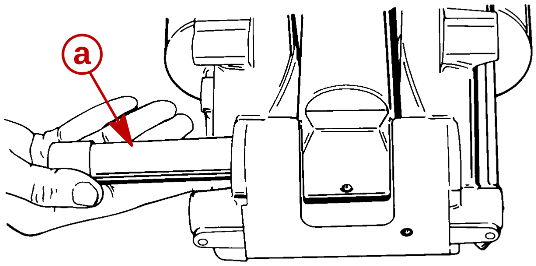


51369

a - Alignment Tool (91-11230)
b - Shaft

2. Align tilt ram and housing using alignment tool.

3. Install shaft.



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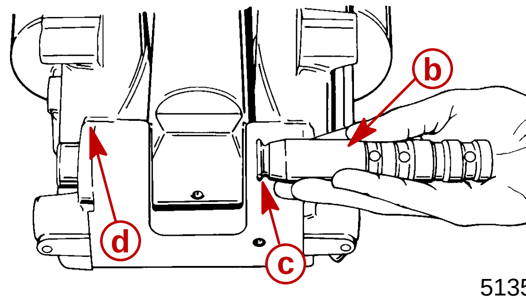
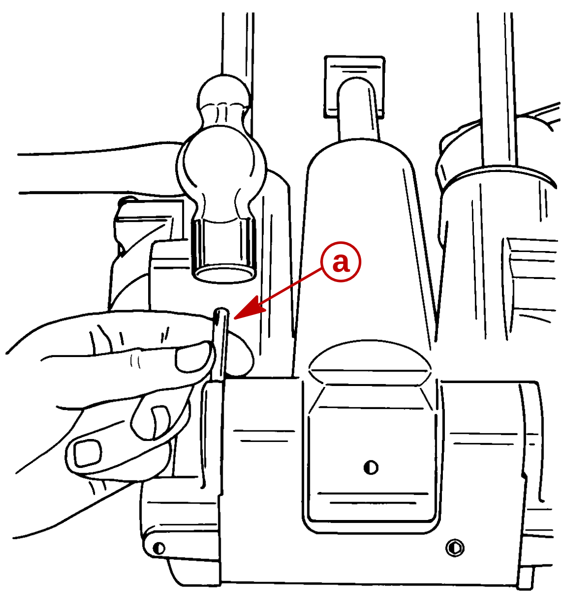


51352

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)

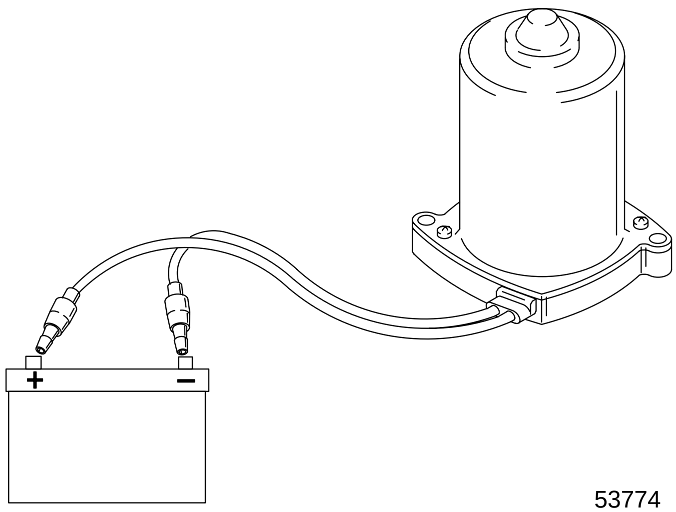
Motor and Electrical Tests/Repair

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.

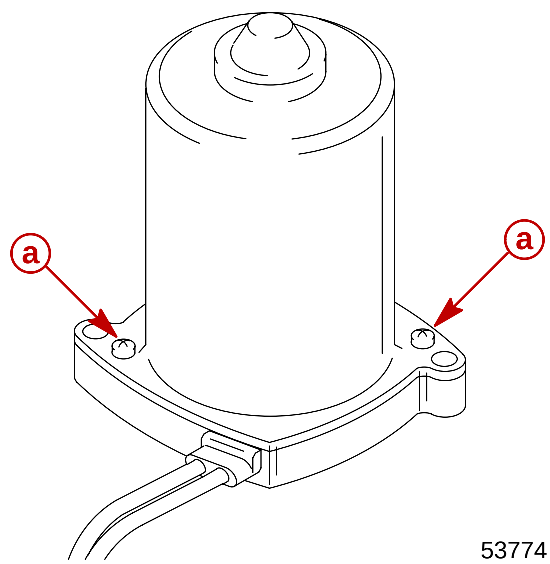


53774

2. If motor does not run, disassemble and check components.

Motor Disassembly

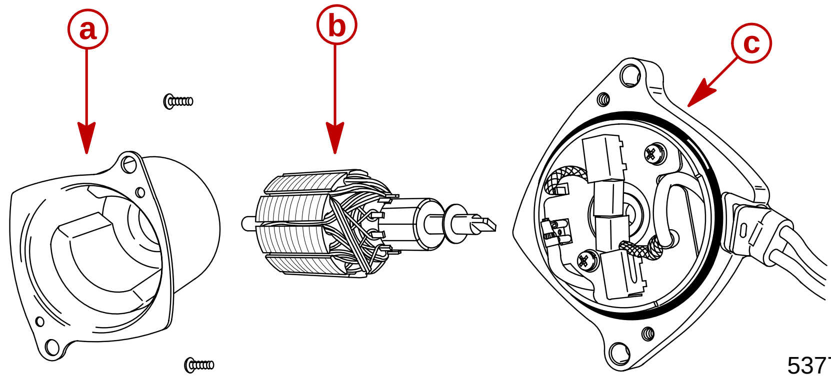
1. Remove 2 screws.



53774

a - Screw (2)

2. Remove field housing and armature from end frame. Use care not to drop armature.



53779

a - Field Housing
b - Armature
c - End Frame

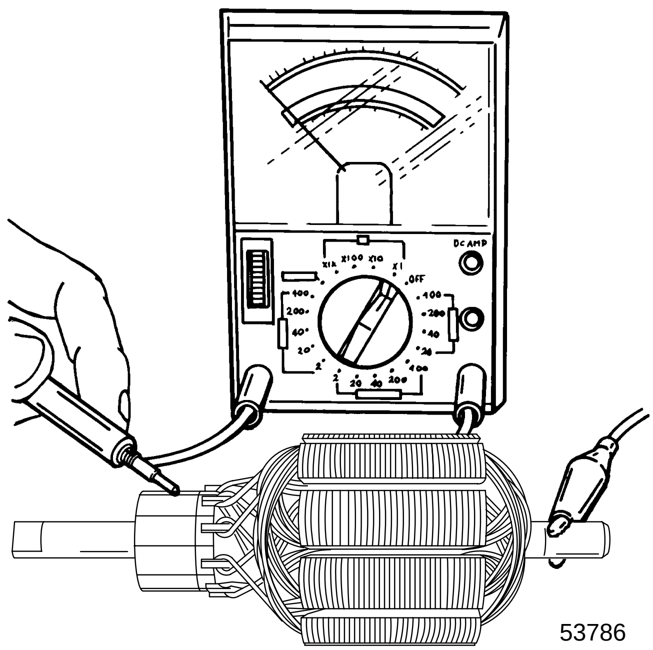
Armature Tests

TEST FOR SHORTS

Check armature on a Growler per the Growler manufacturer's instructions. Replace armature if a short is indicated.

TEST FOR GROUND

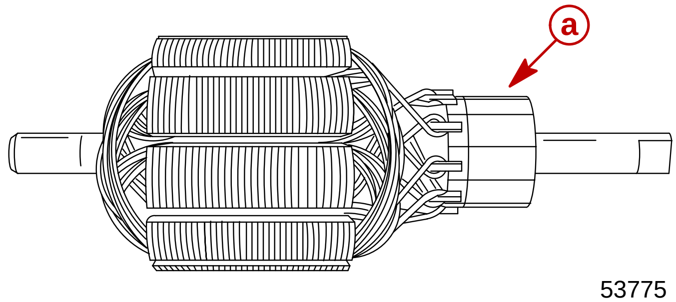
1. Use an Ohmmeter (Rx1 scale). Connect one lead on armature shaft and other lead on commutator. If continuity is indicated, armature is grounded. Replace armature.



53786

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

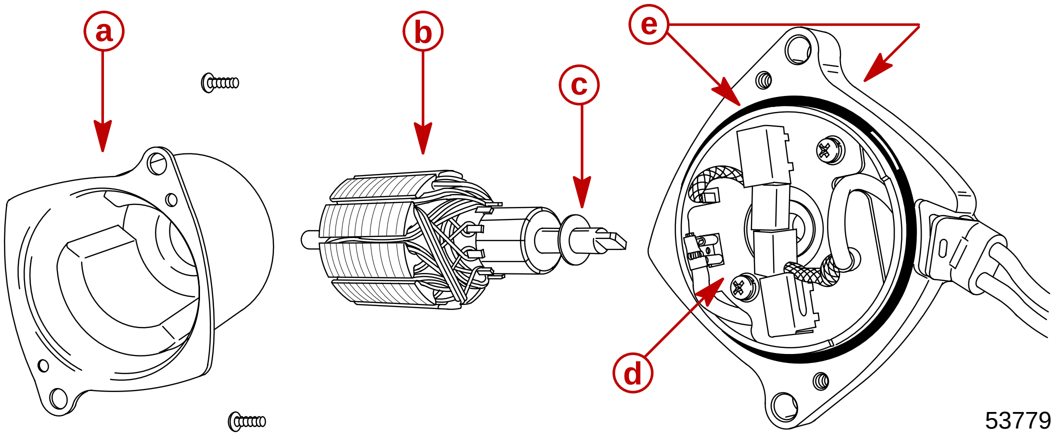
NOTE: *Power Trim System does not have to be removed from outboard to repair/replace motor.*

DISASSEMBLY

Refer to **“Motor Disassembly”** on page 5B-38 to disassemble motor from pump.

CLEANING AND INSPECTION

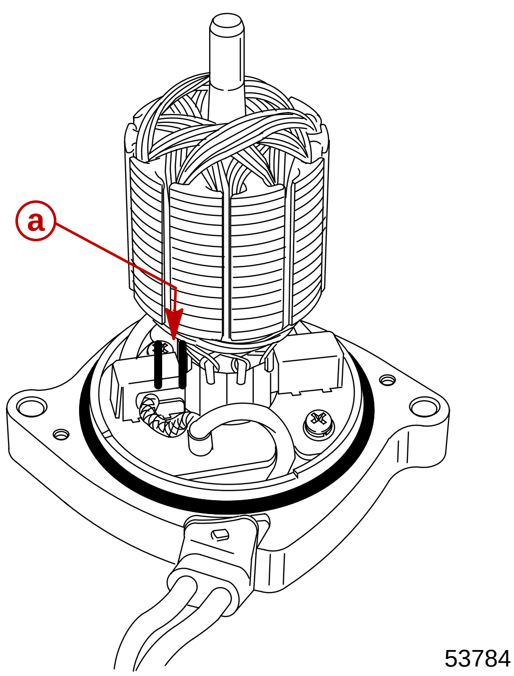
Inspect O-rings and replace if necessary. Carefully inspect power cord for cuts or tears which will allow water to enter motor. Replace cord if cut or torn. Clean, inspect, and test motor components. Refer to **"Brush Replacement"**, **"Armature Test"**, and **"Field Tests"** for inspection and test procedures.



a - Frame
b - Armature
c - Shim
d - Brush Card Assembly
e - O-rings

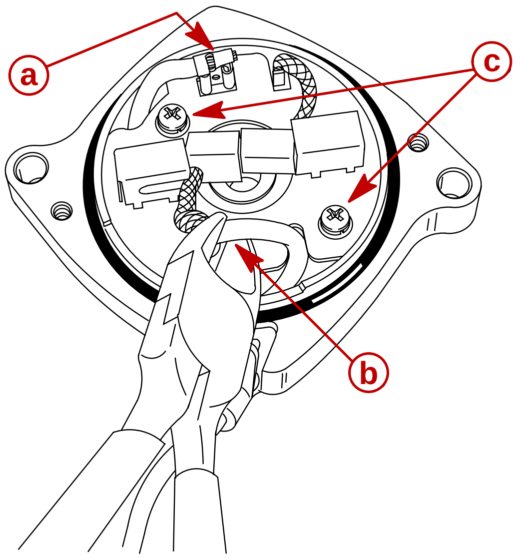
BRUSH REPLACEMENT

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. (1.6 mm) or less. Check distance with armature installed.



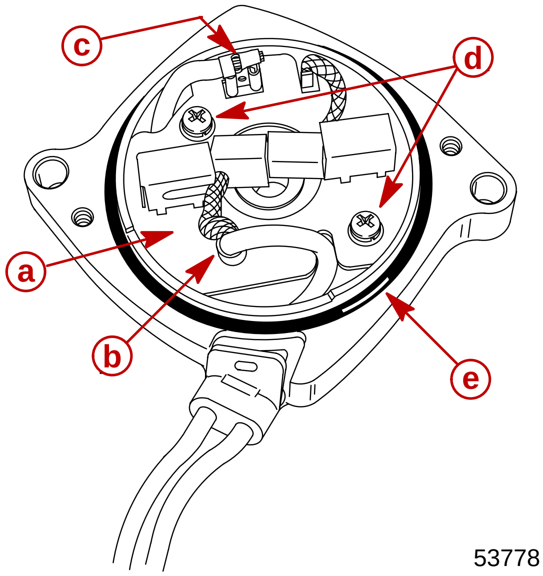
a - 1/16 in. (1.6 mm)

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

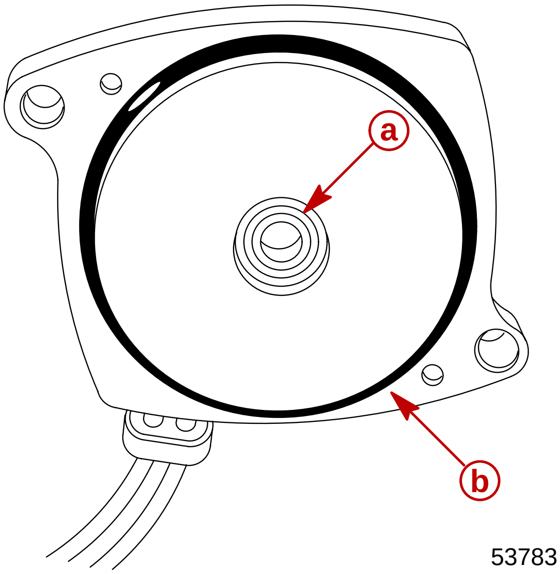
5. Install new brush card (BRUSH and SEAL KIT 828714A1).
6. Crimp metal connector onto motor lead and new brush lead.
7. Connect spade connector motor lead to brush card connector.
8. Secure brush card to end cap with 2 screws and lockwashers.
9. Inspect O-ring for cuts and abraisions. Replace O-ring as required (BRUSH and SEAL KIT 828714A1).

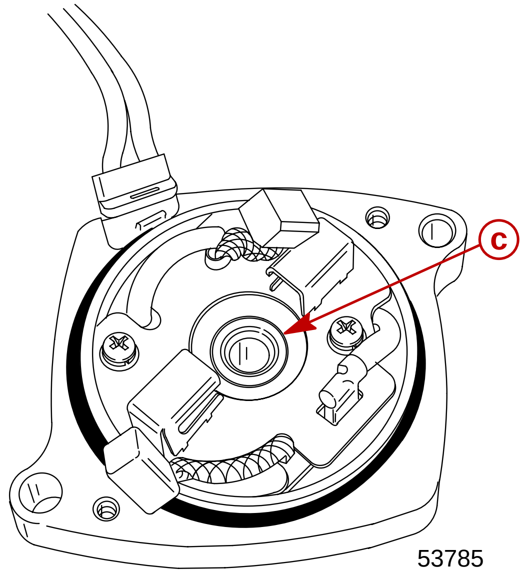


a - Brush Card
b - Metal Connector
c - Spade Connector
d - Screws and Lockwashers
e - O-ring

END CAP INSPECTION

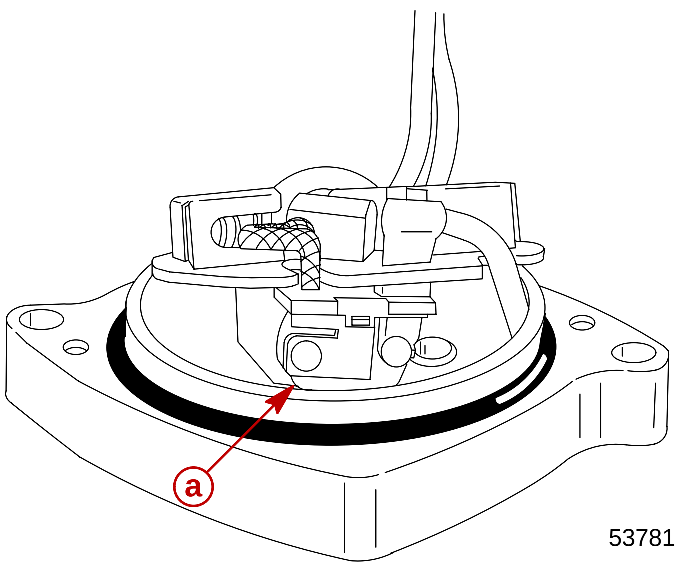
1. Inspect seal and O-ring for cuts and abraisions. If replacement is required, install BRUSH and SEAL KIT 828714A1.
2. Inspect bushing for wear. If bushing appears to be excessively worn – grooves, scratches, etc. – install END FRAME ASSEMBLY (COMPLETE) 828715A1.





a - Seal (Apply 2-4-C with 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.

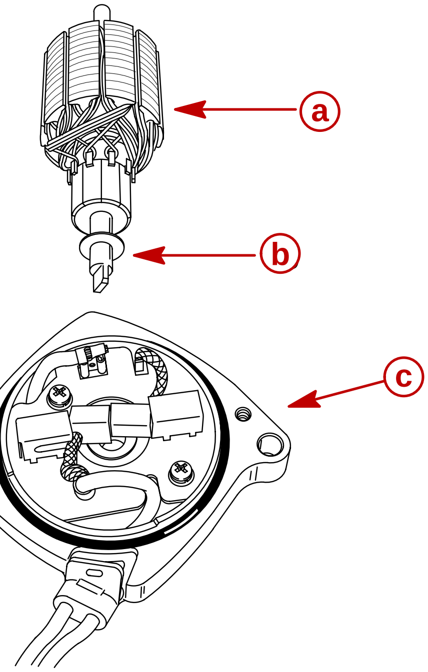


a - Thermoswitch

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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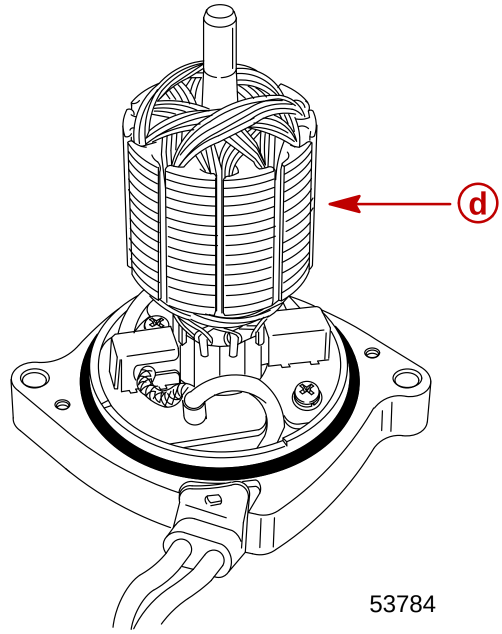
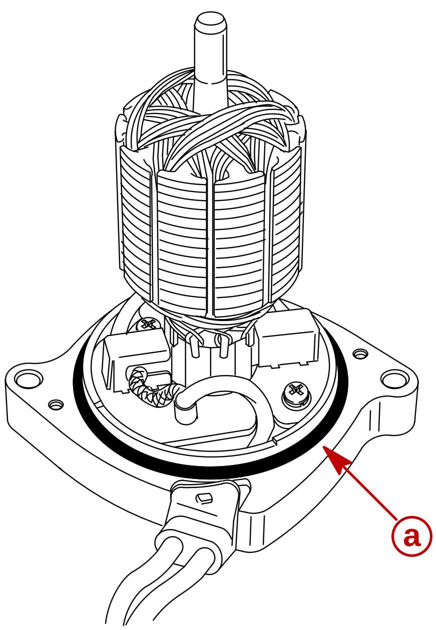


53784

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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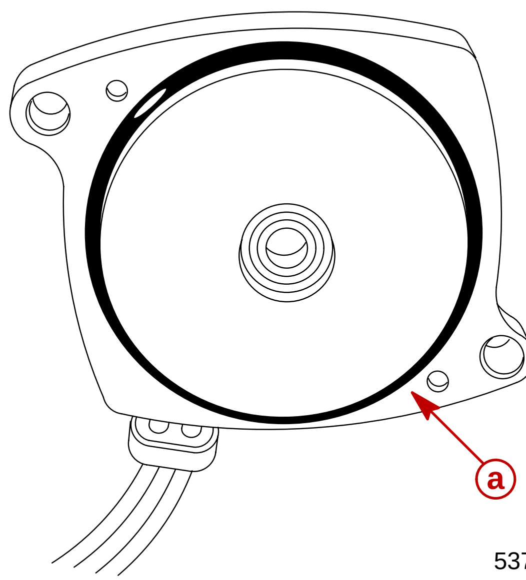
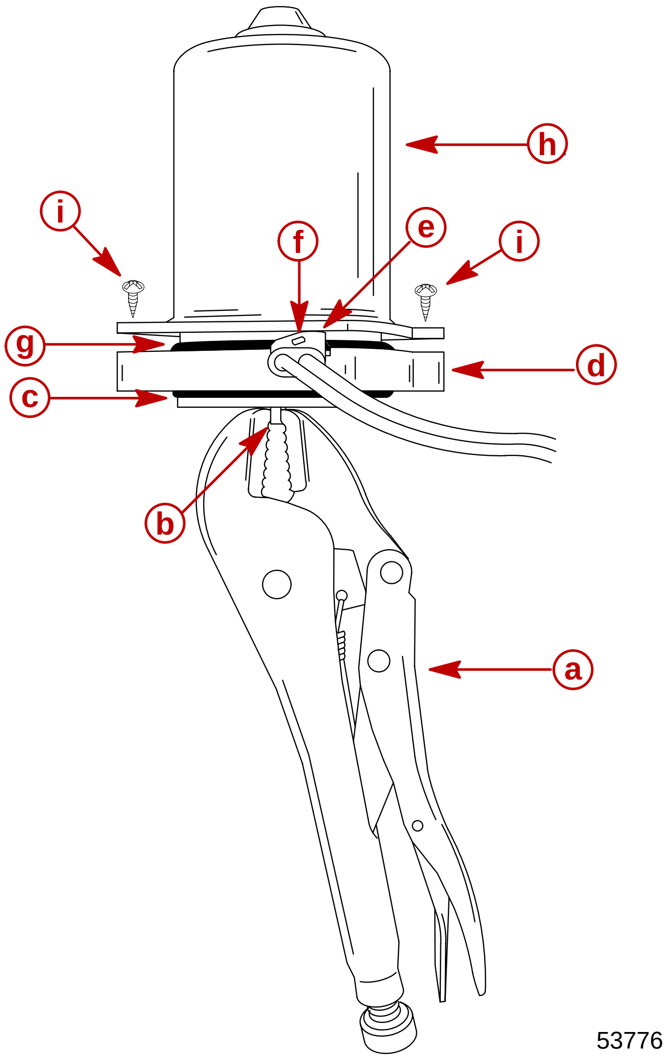


53783

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.



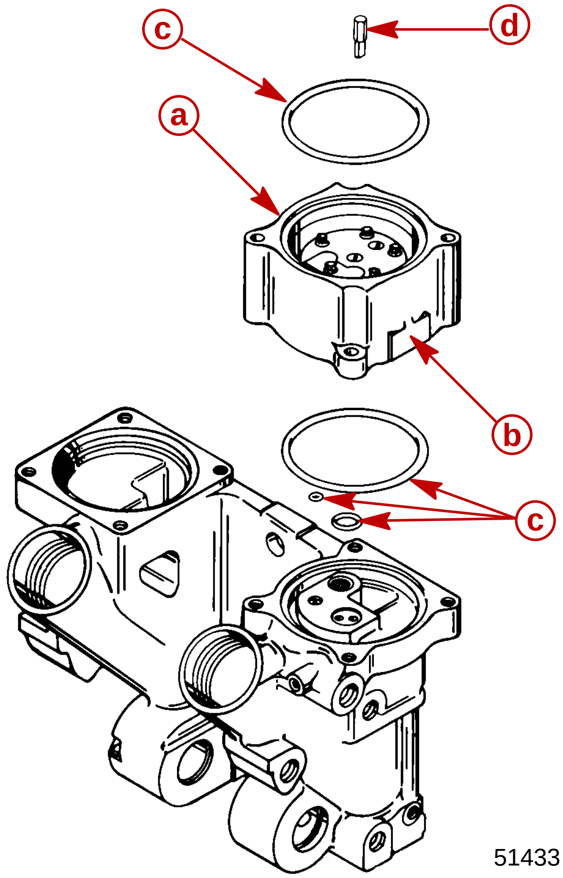
a - Vise Grip® Pliers
b - Armature Shaft
c - O-ring
d - End Cap
e - Harness Retainer
f - Retainer Hole
g - O-ring
h - Frame Assembly
i - Screws

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 N·m).

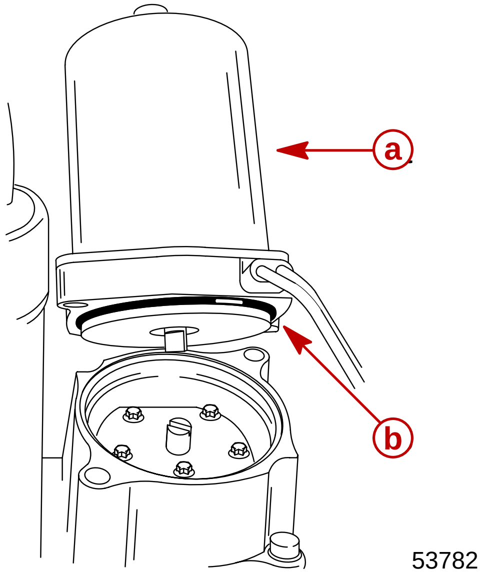
IMPORTANT: Install pump with location flat facing towards starboard transom bracket.

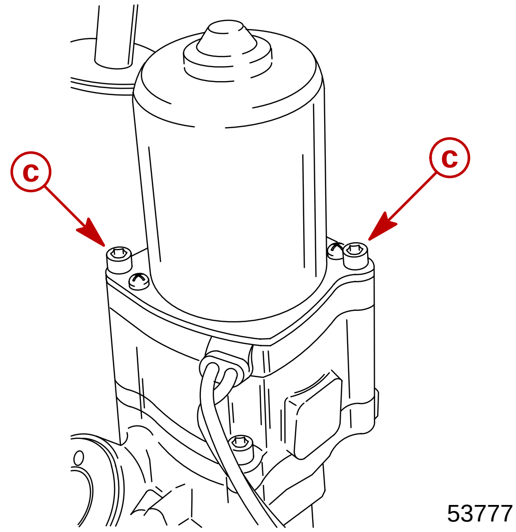


a - Pump (Flat Towards Starboard Transom Bracket)
b - Flat - Faces Starboard Transom Bracket)
c - O-rings (4)
d - Drive Shaft (Install in **Center** Hole in Pump)

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.*





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.

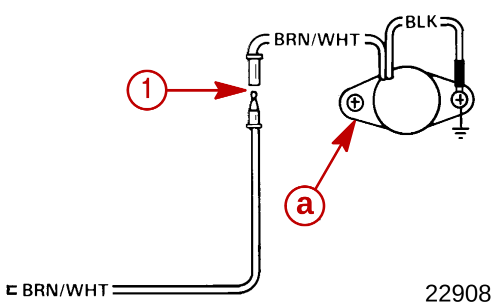
Priming Power Trim System

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

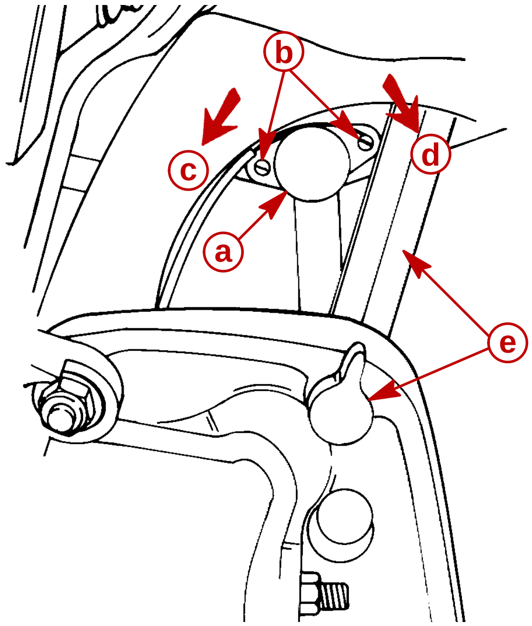
1. Check trim sender BLACK lead for proper ground.
2. Trim outboard to full "DOWN" position.
3. Place ignition switch to "ON" position.
4. Disconnect BRN/WHT trim sender wire from trim sender harness.
5. Connect Ohmmeter (Rx1 scale) leads between outboard ground and Point 1 (trim sender end).
6. Depress "UP" button. Ohmmeter needle should move as the outboard is trimmed up. If needle does not move, trim sender is defective.



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.

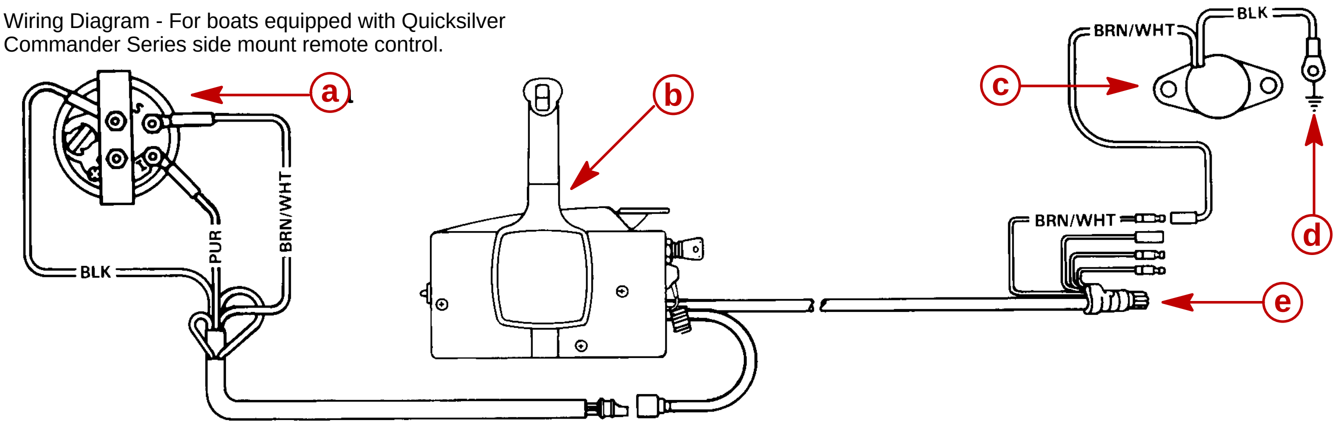


22744

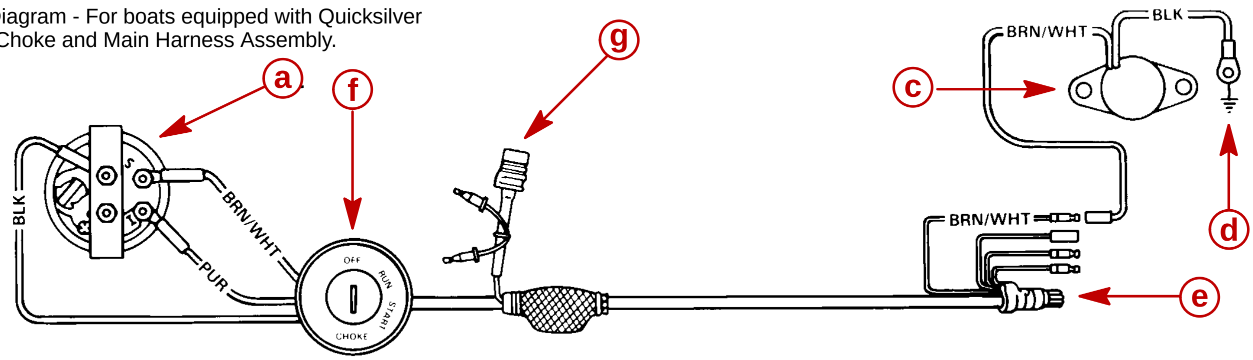
a - Trim Sender
b - Screws, Loosen to Rotate Sender
c - Turn Sender **Counterclockwise** to raise needle reading
d - Turn Sender **Clockwise** to Lower Needle Reading
e - Tilt lock lever

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

6A

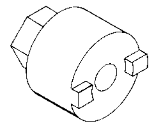
Gear Housing Specifications (Standard Rotation)

Ratio	Pinion Depth	Forward Gear Backlash	Reverse Gear Backlash
1.87:1	0.025 in. (0.635 mm) With Tool 91-12349A2 using Disc #2 and Flat #7	0.018 in. to 0.027 in. (0.460 mm to 0.686 mm) Pointer on line mark #1	0.030 in. to 0.050 in. (0.762 mm to 1.27 mm)
2.00:1	0.025 in. (0.635 mm)With Tool 91-12349A2 using Disc #2 and Flat #7	0.015 in. to 0.022 in. (0.38 mm to 0.56 mm) Pointer on line mark #2	0.030 in. to 0.050 in. (0.762 mm to 1.27 mm)
Gearcase Lubricant Capacity			
All Ratios		22.5 fl. oz. (665.4 ml)	

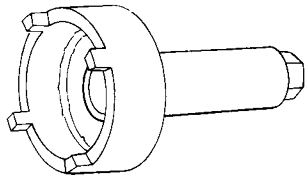
Gear Ratio	Teeth on Pinion Gear	Teeth on Forward and Reverse Gear
1.87:1	15	28
2.00:1	12	24

Special Tools

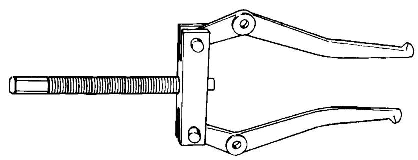
1. Shift Shaft Bushing Tool 91-31107T



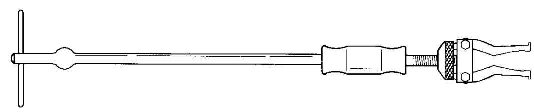
2. Gear Housing Cover Nut Tool 91-61069T



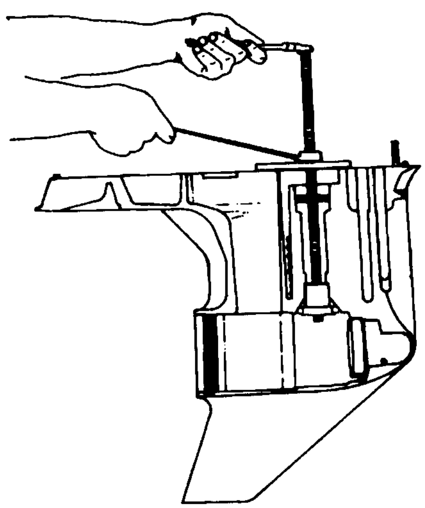
3. Bearing Carrier Removal Tool 91-46086A1 and Puller Bolt 91-85716



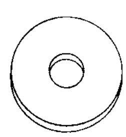
4. Slide Hammer Puller 91-34569A1



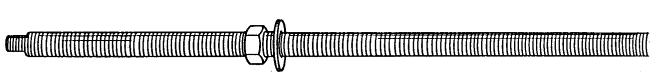
5. Bearing Removal and Installation Kit 91-31229A7. This kit contains the following tools: Pilot 91-36571T; Puller Rod 91-31229; Nut 11-24156; Puller Plate 91-29310; Mandrel 91-38628T; and Driver Rod 91-37323.



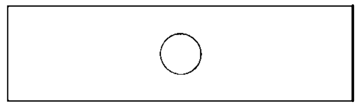
6. Pilot 91-36571T



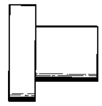
7. Puller Rod 91-31229 and Nut 91-24156



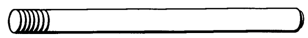
8. Puller Plate 91-29310



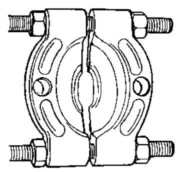
9. Mandrel 91-38628T



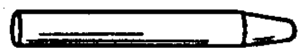
10. Driver Rod 91-37323



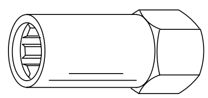
11. Universal Puller Plate 91-37241



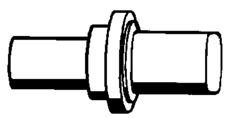
12. Cross Pin Tool 91-86642



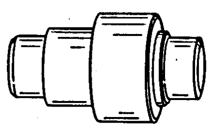
13. Driveshaft Holding Tool 91-90094



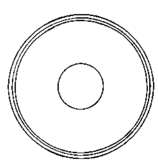
14. Oil Seal Driver 91-31108T



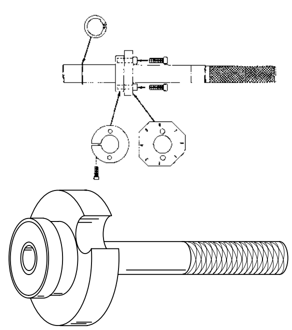
15. Forward Gear Bearing Tool 91-86943T



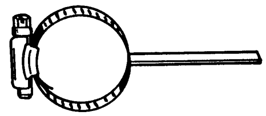
16. Bearing Driver Cup 91-31106



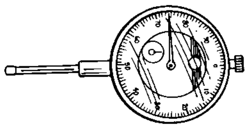
17. Pinion Locating Gear Tool 91-12349A2 or 91-74776T



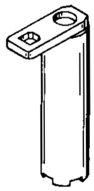
18. Backlash Indicator Rod 91-78473



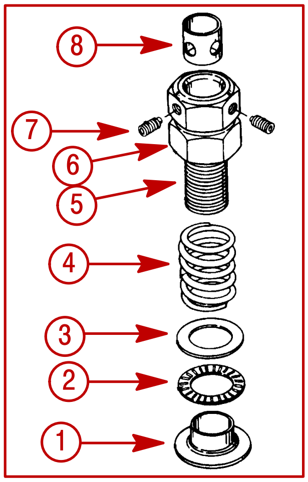
19. Dial Indicator 91-58222A1



20. Bearing Retainer Tool 91-43506T

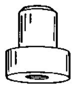


21. Bearing Preload Tool 91-14311A2



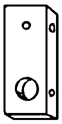
1 - Adaptor (N.S.S.)
2 - Bearing (N.S.S.)
3 - Washer (N.S.S.)
4 - Spring (24-14111)
5 - Bolt (10-12580)
6 - Nut (11-13953)
7 - Set Screw (10-12575)
8 - Sleeve (23-13946)

22. Mandrel 91-92788



23. Mandrel 91-15755

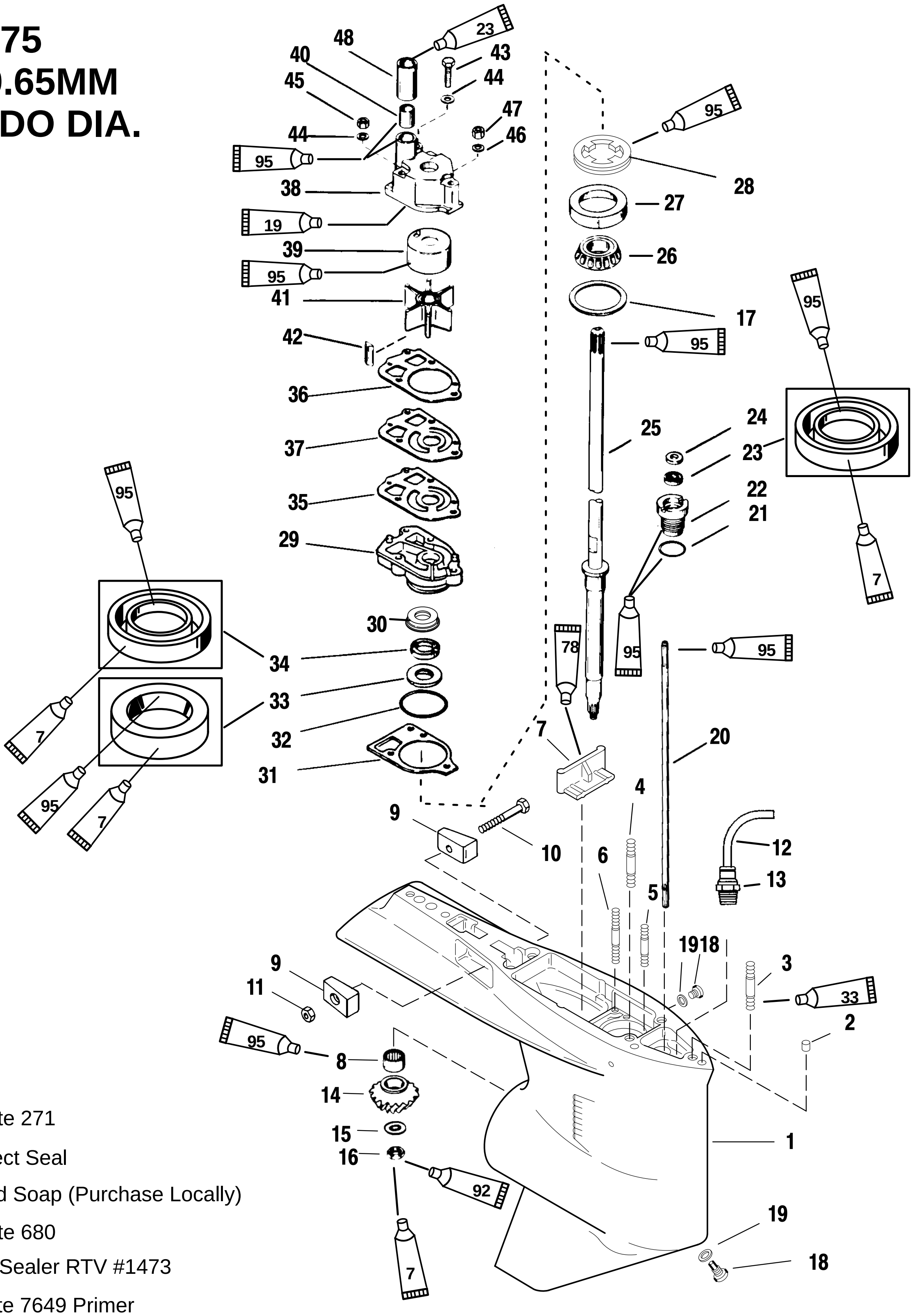
24. Dial Indicator Holder 91-89897



Notes:

Gear Housing (Drive Shaft)(Standard Rotation)

4.75 IN/120.65MM TORPEDO DIA.

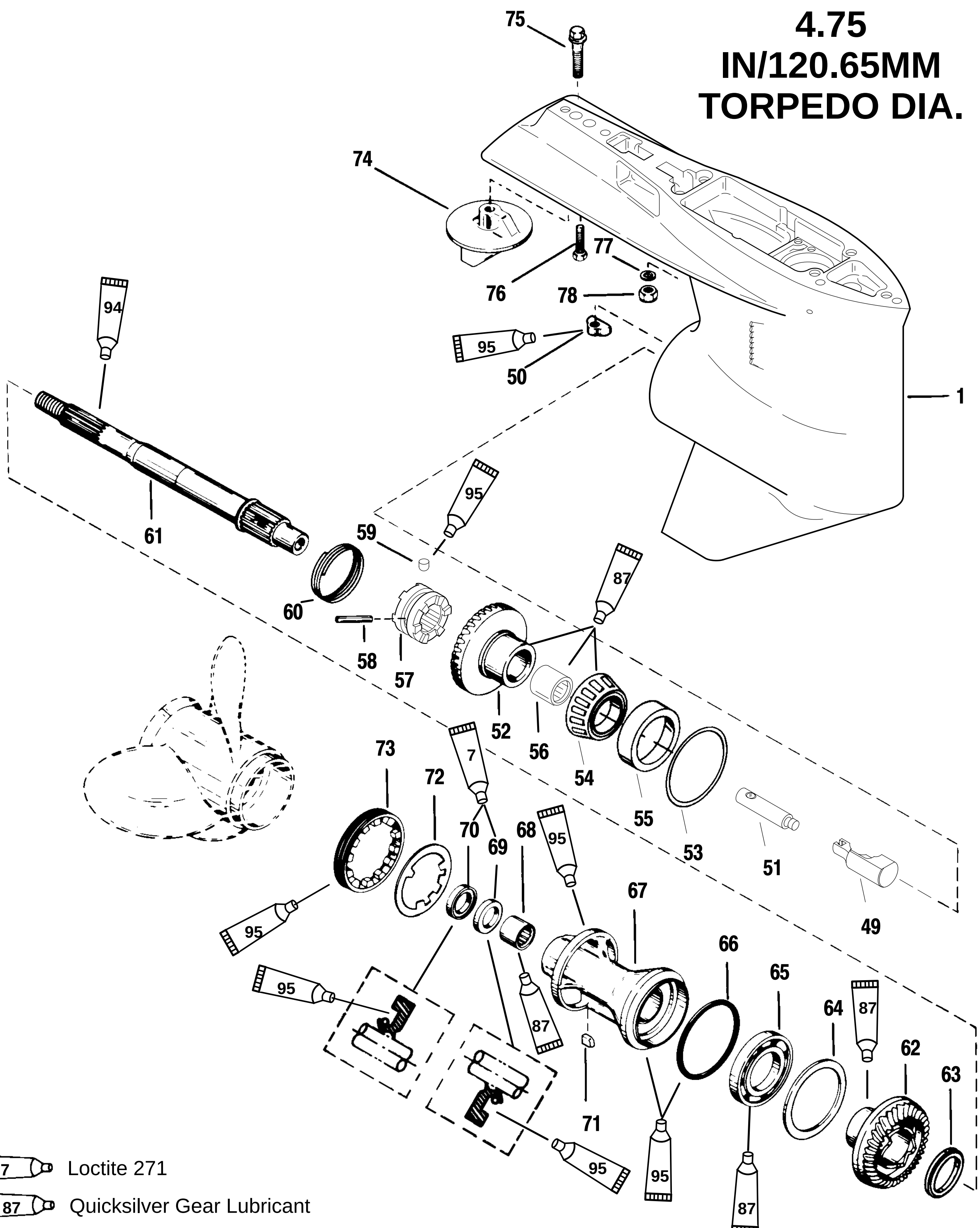


- 7 Loctite 271
- 19 Perfect Seal
- 23 Liquid Soap (Purchase Locally)
- 33 Loctite 680
- 78 G.E. Sealer RTV #1473
- 92 Loctite 7649 Primer
- 95 2-4-C with Teflon

Gear Housing (Drive Shaft)(Standard Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm
1	1	GEAR HOUSING **(BLACK)(BASIC)**			
2	2	DOWEL PIN			
3	1	STUD (3-1/8 IN.) **(LONG)**			
	1	STUD (3-11/16 IN.) **(X-LONG)**			
4	2	STUD (2-1/16 IN.)			
5	1	STUD (3-3/8 IN.)			
6	2	STUD (3-1/8 IN.)			
7	1	FILLER BLOCK			
8	1	ROLLER BEARING			
9	2	ANODE			
10	1	SCREW (M6 x 40)			
11	1	NUT	60		7
12	1	HOSE **(10 IN. - LONG)**			
	1	HOSE **(12 IN. - X-LONG)**			
13	1	FITTING			
14	1	PINION GEAR **(1.87:1- 15 TEETH)**			
	1	PINION GEAR **(2:1 - 14 TEETH))**			
15	1	WASHER			
16	1	NUT		75	101
17	AR	SHIM (006 thru 048)			
18	2	SCREW–drain	60		7
19	2	WASHER			
20	1	SHIFT SHAFT			
21	1	O-RING			
22	1	BUSHING ASSEMBLY		50	68
23	1	OIL SEAL			
24	1	WASHER–rubber			
25	1	DRIVE SHAFT **(LONG)**			
	1	DRIVE SHAFT **(X-LONG)**			
26	1	ROLLER BEARING			
27	1	CUP			
28	1	RETAINER		100	135
29	1	WATER PUMP BASE			
30	1	RETAINER			
31	1	GASKET			
32	1	O-RING			
33	1	OIL SEAL			
34	1	OIL SEAL			
35	1	GASKET–lower			
36	1	GASKET–upper			
37	1	FACE PLATE			
38	1	WATER PUMP BODY ASSEMBLY			
39	1	INSERT			
40	1	SEAL–rubber			
41	1	IMPELLER			
42	1	KEY			
43	1	SCREW (#14-8 x 2-1/4 IN.)	35		4
44	2	WASHER			
45	2	NUT	50		5.5
46	1	WASHER			
47	1	NUT	50		5.5
48	1	SLEEVE			

Gear Housing (Prop Shaft)(Standard Rotation)



- 7 Loctite 271
- 87 Quicksilver Gear Lubricant
- 94 Anti-Corrosion Grease
- 95 2-4-C with Teflon

Gear Housing (Prop Shaft)(Standard Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm
1	1	GEAR HOUSING**(BASIC)**			
49	1	CAM FOLLOWER			
50	1	SHIFT CAM			
51	1	ROD			
52	1	FORWARD GEAR **(1.87:1 – 15/28)(150)**			
	1	FORWARD GEAR **(2:1 – 14/28)(115/135)**			
53	AR	SHIM (.006 thru 050)			
54	1	TAPERED ROLLER BEARING			
55	1	CUP			
56	1	NEEDLE BEARING			
57	1	CLUTCH			
58	1	CROSS PIN			
59	1	DETENT PIN			
60	1	SPRING			
61	1	PROPELLER SHAFT			
62	1	REVERSE GEAR **(1.87:1 – 15/28)**			
	1	REVERSE GEAR **(2:1 – 14/28)**			
63	1	THRUST SPACER			
64	1	THRUST RING			
65	1	BALL BEARING			
66	1	O-RING			
67	1	BEARING CARRIER ASSEMBLY			
68	1	ROLLER BEARING			
69	1	OIL SEAL **(INSIDE)**			
70	1	OIL SEAL **(OUTSIDE)**			
71	1	KEY			
72	1	TAB WASHER			
73	1	COVER		210	285
74	1	TRIM TAB			
	1	ANODIC PLATE **(TRACKER/150 LONG)**			
75	1	SCREW (1-3/4 IN.)		25	34
76	1	SCREW (3/8-16 x 1 IN.)		30	41
77	2	WASHER			
78	2	NUT		50	68

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

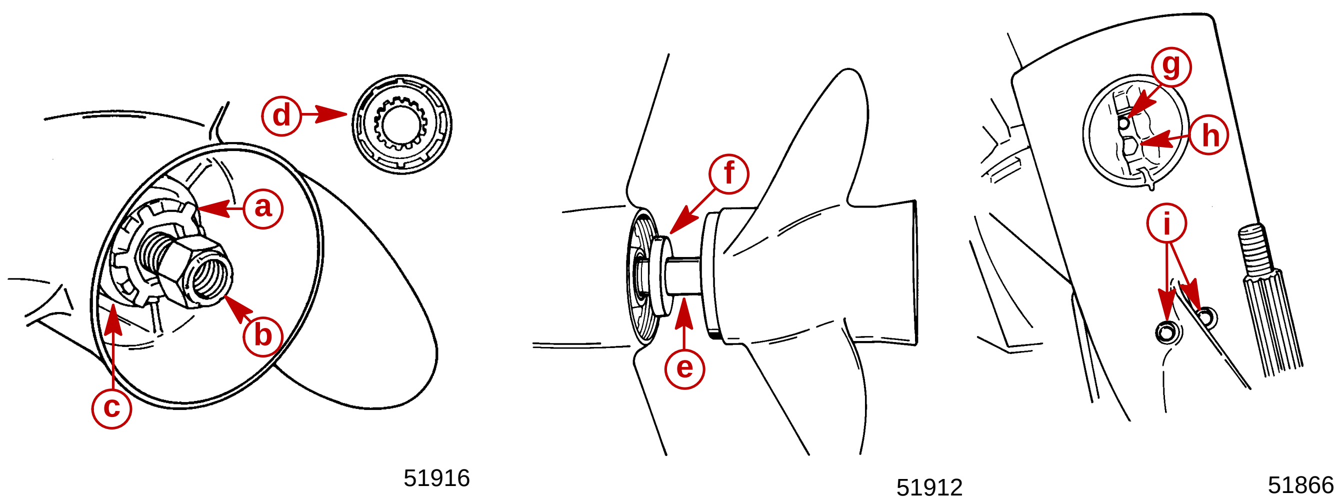
Disconnect high tension leads from spark plugs and remove spark plugs from engine before removing gear housing from driveshaft housing.

1. Disconnect high tension leads from spark plugs and remove spark plugs from engine.

CAUTION

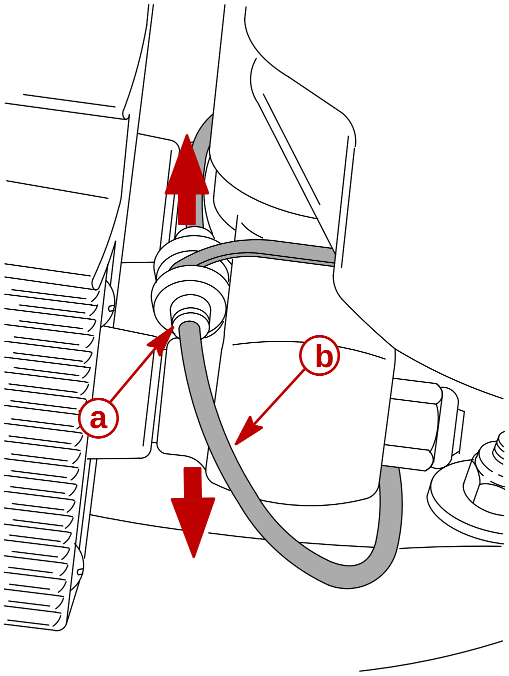
Gear housing MUST BE in NEUTRAL position and shift shaft MUST BE removed from gear housing BEFORE propeller shaft can be removed from gear housing.

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.
7. Remove 2 locknuts from bottom middle of anti-cavitation plate.



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 - Locknuts and Washers

8. While pressing in on speedometer hose junction, pull out on hose to disconnect.



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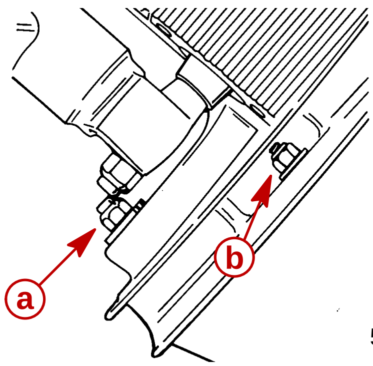
a - Press in on Junction
b - Pull out on Hose

9. Remove locknut from the front gear housing mounting stud.
10. Loosen the side mounting locknuts. (DO NOT attempt to remove one nut before opposite side is loosened sufficiently, or driveshaft housing could be damaged.)



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a - Front Mounting Locknut
b - Side Mounting Locknut (One Each Side)

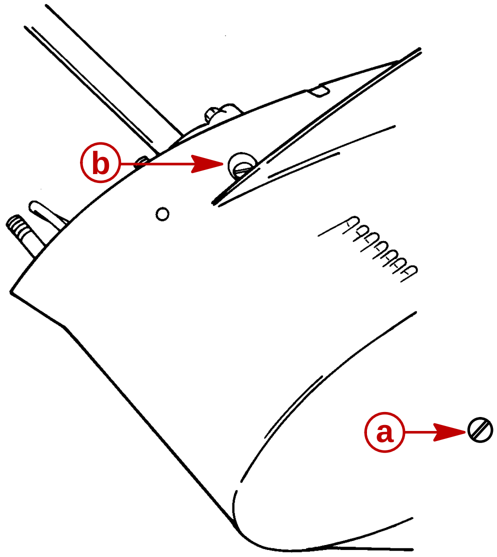
11. Pull gear housing away from driveshaft housing as far as the loosened nuts (in Step 9) will allow, then remove loosened nuts. (DO NOT allow gear housing to fall, as it now is free.)
12. Pull gear housing from driveshaft housing.

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

CLEANING AND INSPECTION

1. Clean all water pump parts with solvent and dry with compressed air.
2. Inspect water pump cover and base for cracks and distortion (from overheating).
3. Inspect face plate and water pump insert for grooves and/or rough surfaces.

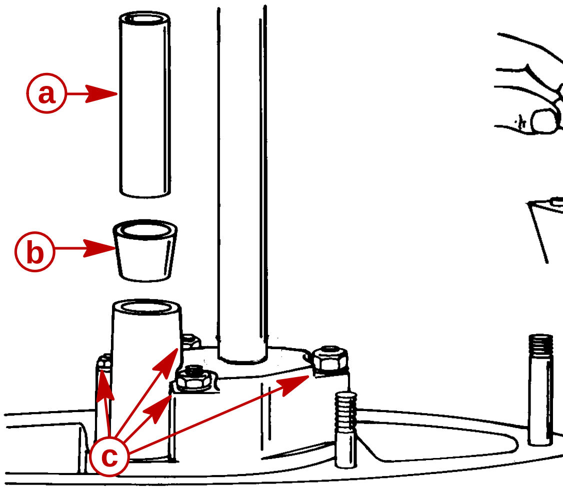
IMPORTANT: When completing gear housing repairs, that require removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to re-use impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur.

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.

IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

REMOVAL AND DISASSEMBLY

1. Slide rubber centrifugal slinger up and off driveshaft.
2. Remove water tube guide and seal from water pump cover. (Retain guide for reassembly and discard seal.)
3. Remove (and retain) 3 nuts, one bolt and all washers which secure water pump cover to gear housing.
4. Using 2 pry bars, lift water pump cover up and off driveshaft.



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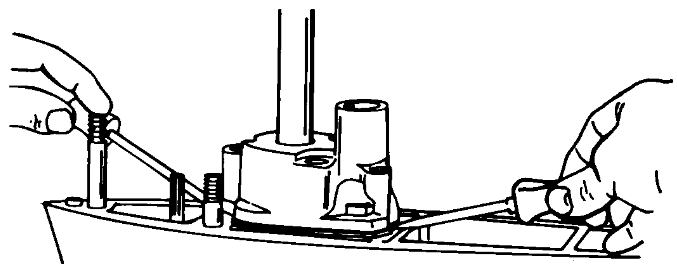
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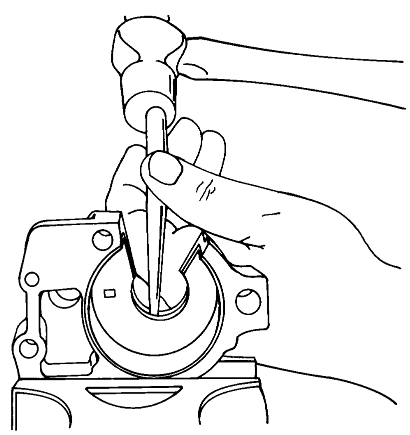
a - Water Tube Guide
b - Water Tube Seal
c - Nuts, Bolt and Washers To Be Removed

5. Inspect water pump cover and insert, as outlined in **"Cleaning and Inspection,"** previous.
6. If inspection of water pump insert determines that replacement is required, follow Step "a" or "b" (immediately following) to remove insert from water pump cover.

NOTE: *Try Step "a" first. If insert cannot be removed with Step "a," use Step "b".*

a. Drive water pump insert out of water pump cover with a punch and hammer.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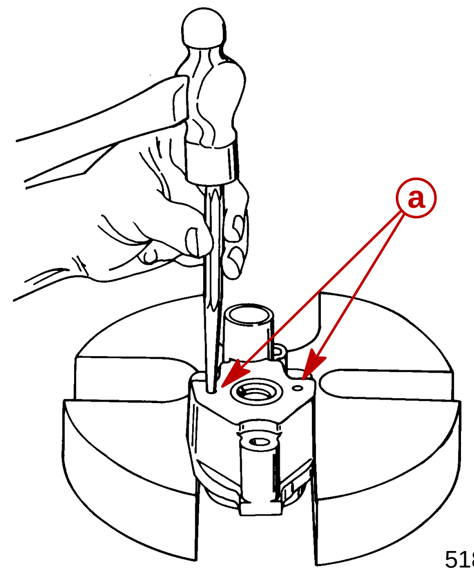
b. Drill two 3/16 in. (4.8mm) diameter holes thru the top of water pump cover (but not thru insert). Drive insert out of cover with a punch and hammer.



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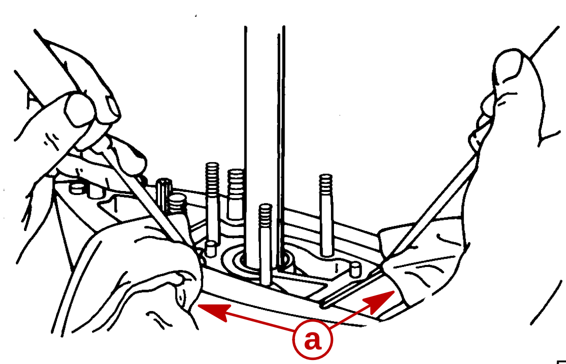
a - Drill Two Holes at These Locations

7. Remove impeller from driveshaft. (It may be necessary to use a punch and hammer to drive impeller upward on driveshaft. In extreme cases, it may be necessary to split hub of impeller with a hammer and chisel.)
8. Once impeller is removed, remove impeller drive key from driveshaft.
9. Remove water pump face plate and both gaskets (one above and below face plate) from water pump base.
10. Using 2 pry bars, positioned and padded as shown, lift water pump base up and off driveshaft.



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a - Pads

11. Remove (and discard) O-ring from O-ring groove on water pump base.
12. Using a screwdriver, pry oil seals out of water pump base from gear housing side of base.

Bearing Carrier and Propeller Shaft Removal

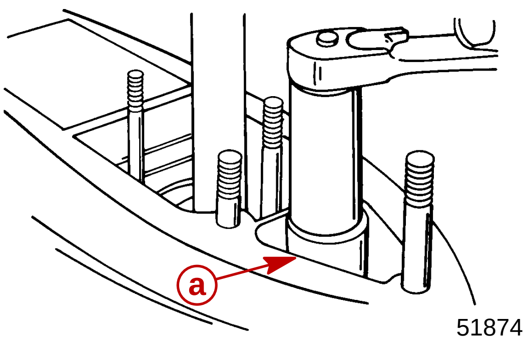
⚠ CAUTION

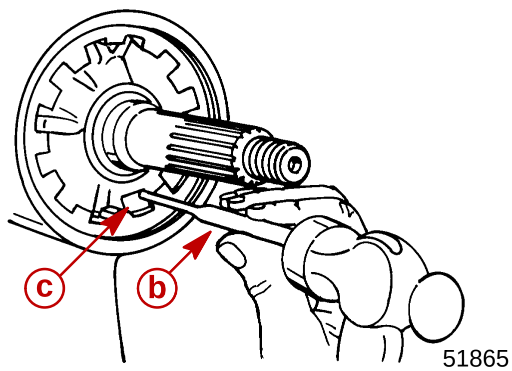
Gear housing MUST BE in NEUTRAL position, and shift shaft MUST BE removed from gear housing before propeller shaft can be removed from gear housing.

1. Place gear housing in a suitable holding fixture with propeller shaft in a horizontal position.
2. Use Shift Shaft Bushing Tool (91-31107) to unthread shift shaft bushing. (DO NOT remove bushing from shift shaft at this time.)

IMPORTANT: Prior to removal of shift shaft from gear housing, recheck that gear housing is in NEUTRAL position.

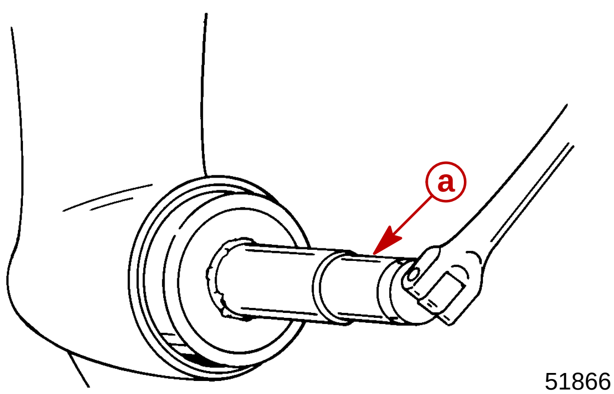
3. Bend cover nut lock tab out of cover nut recess.





a - Shift Shaft Bushing Tool (91-31107)
b - Punch
c - Tab of Tab Washer

4. Remove gear housing cover nut with Cover Nut Tool (91-61069).



a - Cover Nut Tool (91-61069)

5. After cover nut has been removed, remove lock tab washer from gear housing.

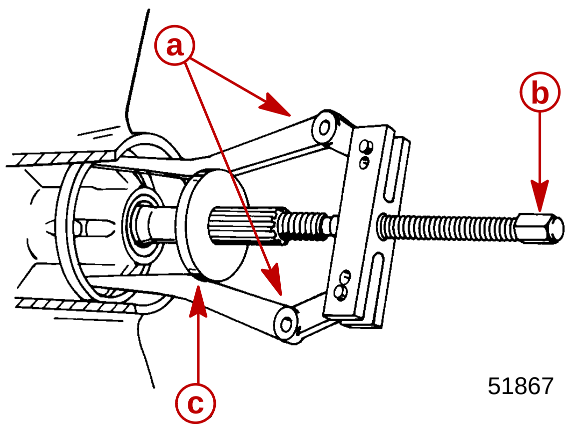
⚠ CAUTION

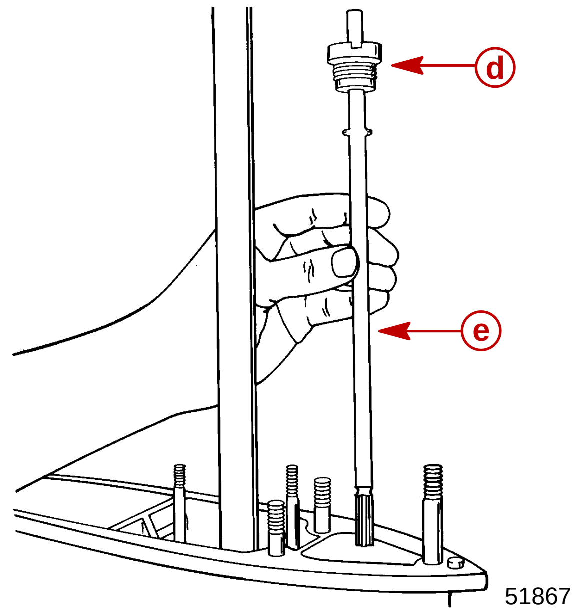
Once bearing carrier is removed from gear housing, extreme care MUST BE taken not to apply any side force on propeller shaft. Side force on propeller shaft may break the neck of the clutch actuator rod.

6. Use long Puller Jaws (91-46086A1) and Puller Bolt (91-85716) to remove bearing carrier. (Use propeller thrust hub to maintain outward pressure on puller jaws.)

NOTE: *When bearing carrier is removed from gear housing, the bearing carrier alignment key will come out with it.*

7. With gear housing in NEUTRAL, pull shift shaft out of gear housing. If necessary, use a pliers to pull shift shaft out of gear housing. If pliers are used to pull shift shaft out, wrap a strip of soft metal (aluminum) around splines before clamping pliers. DO NOT turn shaft (clockwise OR counterclockwise) while pulling shaft out. (For further information on shift shaft, see "Shift Shaft Cleaning/Inspection and Disassembly.")





a - Long Puller Jaws (91-46086A1)
b - Puller Bolt (91-85716)
c - Thrust Hub
d - Shift Shaft Bushing
e - Shift Shaft

CAUTION

Propeller shaft, cam follower and shift cam, in most cases, will come out of gear housing by simply pulling outward on propeller shaft. DO NOT FORCE shaft sideways or ATTEMPT TO PULL with a slide hammer or any mechanical puller.

8. Remove propeller shaft, cam follower and shift cam by pulling shaft straight out of gear housing. (DO NOT JERK propeller shaft.) If propeller shaft will not come out, proceed with Step "a" or "b", following:

   a. Push propeller shaft back into place against the forward gear. Visually inspect location of shift cam by looking down shift shaft hole (illuminated with a flashlight). If splined hole in shift cam is visible, reinstall shift shaft and rotate shift shaft to neutral position. Remove shift shaft, then remove propeller shaft as instructed in Step 8, immediately preceding.

   b. Push propeller shaft back into place against forward gear. Slide bearing carrier back into gear housing (to support propeller shaft). Place gear housing on its left side (viewed from rear) and strike upper leading end of gear housing with a rubber mallet. This will dislodge the shift cam from cam follower into a clearance pocket in left side of gear housing. Remove bearing carrier and pull propeller shaft out of gear housing.

NOTE: *If Step 8-b was used to remove propeller shaft, the shift cam can be retrieved after removal of forward gear.*

Shift Shaft

CLEANING AND INSPECTION

1. Clean shift shaft and bushing with solvent and dry with compressed air.
2. Check shift shaft splines on both ends for wear and/or corrosion damage.
3. Inspect shift shaft for groove(s) at shift shaft bushing seal surface.
4. Inspect shift shaft bushing for corrosion damage.
5. Inspect shift shaft bushing oil seal for wear and/or cuts.

NOTE: *Oil seal in shift shaft bushing should be replaced as a normal repair procedure.*

DISASSEMBLY

1. Remove (and discard) shift shaft bushing oil seal by prying it out or driving it out with a punch and hammer.

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.

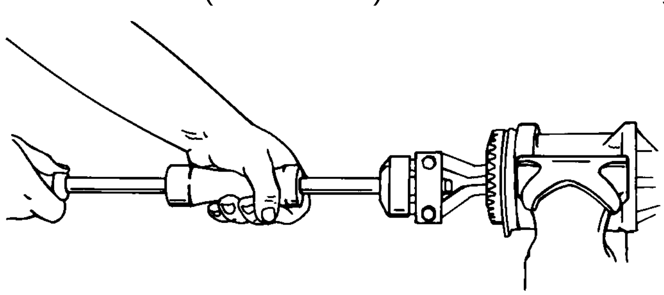
1. Clean bearing carrier with solvent and dry with compressed air.

⚠ CAUTION
DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

2. Bearing carrier propeller shaft needle bearing condition is determined by propeller shaft bearing surface condition. (See “Propeller Shaft Inspection.”)
3. Inspect reverse gear to pinion gear wear pattern (should be even and smooth). If not, replace reverse gear and pinion gear.
4. Check clutch jaws on reverse gear for damage. Replace reverse gear, if damage is found on clutch jaws.
5. 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:
   a. Position bearing carrier in a soft jaw vise.
   b. Use Slide Hammer (91-34569A1) and remove reverse gear.



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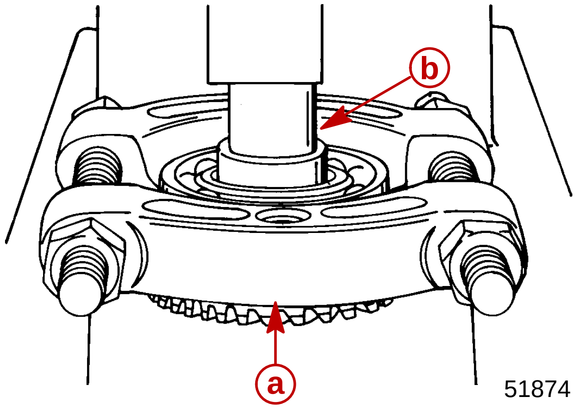
c. If reverse gear bearing remains attached to reverse gear, install Universal Puller Plate (91-37241) and position puller plate, gear and bearing on a press with gear side down. Use a suitable mandrel and press gear out of bearing.



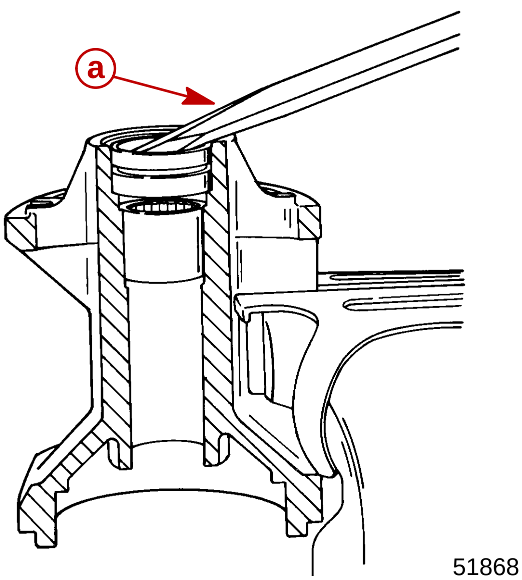
a - Universal Puller Plate
b - Mandrel

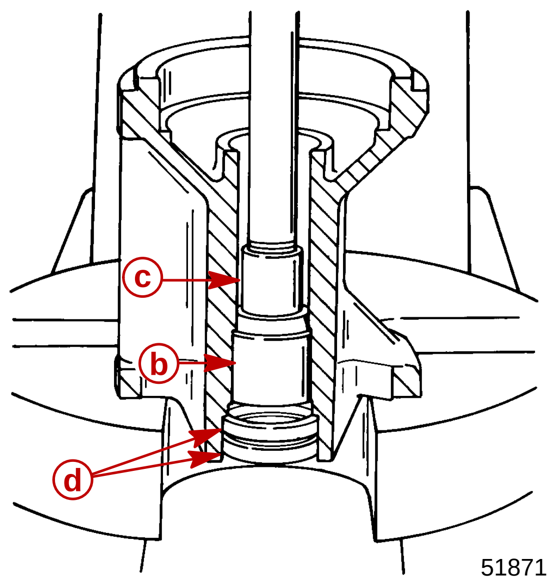
d. If reverse gear bearing has remained in bearing carrier, use slide hammer to remove bearing in the same methods as was used to remove reverse gear (Step "b").

3. Propeller shaft oil seals can be removed by (a) using a pry bar, or (b) pressing seals out when propeller shaft needle bearing is pressed out of bearing carrier.

4. If inspection of propeller shaft needle bearing determines that replacement of bearing is required, use Universal Bearing Removal and Installation Tool (91-31229A1) to press bearing and seals out of bearing carrier.

NOTE: *Reverse gear must be removed from bearing carrier before propeller shaft needle bearing can be removed.*





a - Pry Bar
b - Propeller Shaft Needle Bearing
c - Mandrel
d - Oil Seals

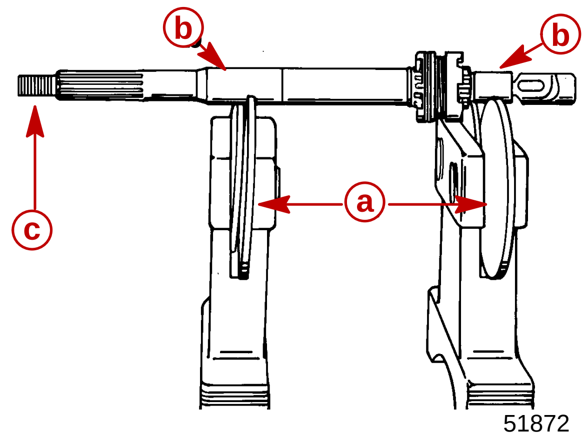
Propeller Shaft

INSPECTION

1. Clean propeller shaft assembly with solvent and dry with compressed air.
2. Inspect bearing carrier oil seal surfaces for grooves. Run fingernail across seal surface to check for groove. Replace shaft if groove is found.
3. Visually check bearing surfaces of propeller shaft for pitting, grooves, scoring, uneven wear or discoloration (bluish color) from overheating. Replace shaft and corresponding needle bearing if any of the above conditions are found. (Bearing carrier needle bearing contacts propeller shaft just in front of oil seal surface. Forward gear bearing contacts propeller shaft in front of sliding clutch splines.)
4. Inspect propeller shaft splines for wear and/or corrosion damage.
5. Check propeller shaft for straightness. Use either method, following:

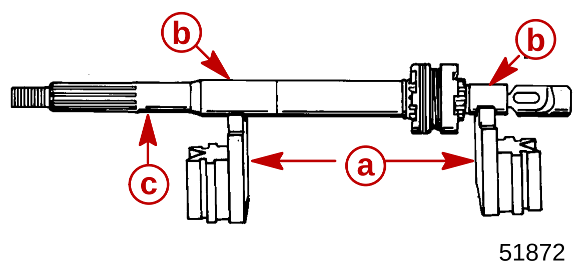
BALANCE WHEELS

Place propeller shaft on balance wheels. Rotate propeller shaft and observe propeller end of shaft for “wobble.” Replace shaft if any “wobble” is observed.



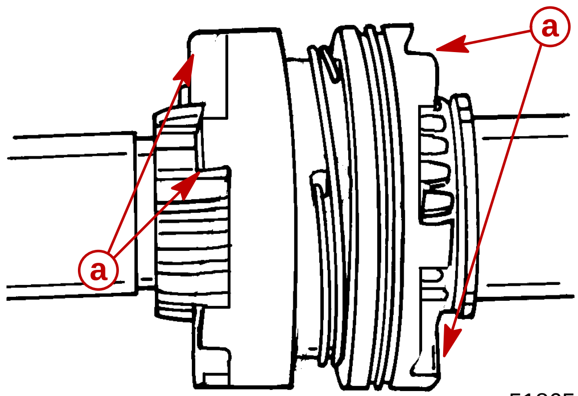
a - Balance Wheels
b - Bearing Surfaces
c - Watch for Wobble

Position propeller shaft roller bearing surfaces on “vee” blocks. Mount a dial indicator at front edge of propeller splines. Rotate propeller shaft. Dial indicator movement of more than 0.006 in. (0.152 mm) (or noticeable “wobble”) is reason for replacement.



a - “Vee” Blocks
b - Bearing Surfaces
c - Measure with Dial Indicator at this Point

6. Inspect sliding clutch. Check reverse gear and forward gear clutch jaws. Rounded jaws indicate one or more of the following:
   a. Improper shift cable adjustment.
   b. Improper shift habits of operator(s) (shift from NEUTRAL to REVERSE gear too slowly).
   c. Engine idle speed too high (while shifting).



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a - Clutch Jaws

7. Check condition of cam follower. If it shows wear (pitting, scoring or rough surface), replace cam follower and shift cam.

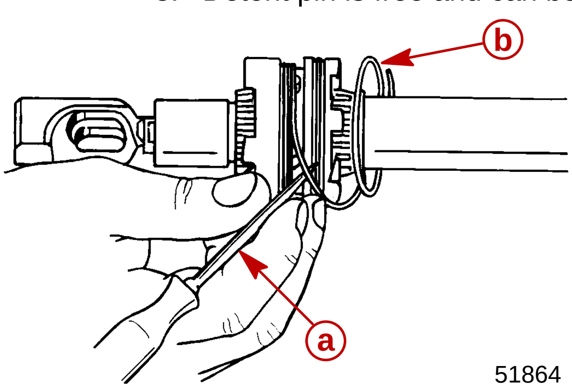
DISASSEMBLY

1. Remove shift cam from cam follower.
2. Insert a thin blade screwdriver or awl under first coil of cross pin retainer spring and rotate propeller shaft to unwind spring from sliding clutch. DO NOT over-stretch spring.

⚠ CAUTION

Detent pin is free and can fall out of sliding clutch. Care MUST BE taken not to lose pin.

3. Detent pin is free and can be removed from sliding clutch at this time.



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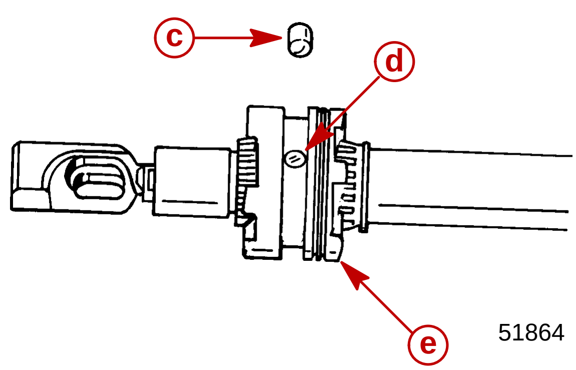

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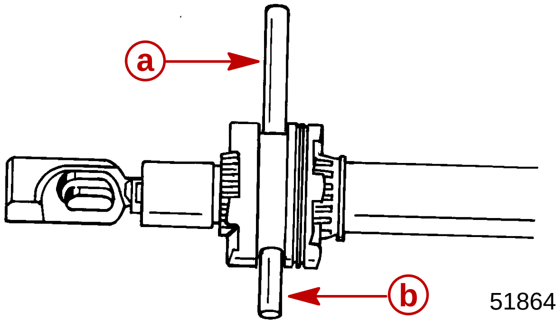
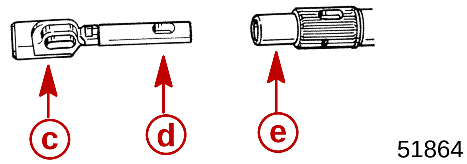
a - Awl
b - Cross Pin Retainer Spring
c - Detent Pin
d - Cross Pin
e - Sliding Clutch

4. Push cross pin out of sliding clutch and propeller shaft with Cross Pin Tool (91-86642).
5. Pull sliding clutch off propeller shaft.
6. Pull cam follower and clutch actuator rod out of propeller shaft. DO NOT force cam follower up-or-down or side-to-side when pulling from propeller shaft.



a - Cross Pin Tool (91-86642)
b - Cross Pin



c - Cam Follower
d - Clutch Actuator Rod
e - Propeller Shaft

7. Once cam follower and clutch actuator rod are removed from propeller shaft, lift rod out of cam follower.

Clutch Actuator Rod

IMPORTANT: If outboard is run on a dynometer, the dynometer head must be securely attached to the propshaft with applied forward pressure (i.e. multiple rubber straps) to prevent possible breakage of the clutch actuator rod.

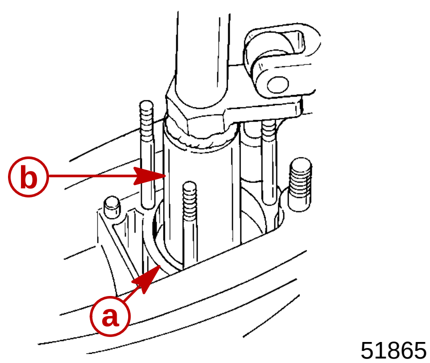
CLEANING AND INSPECTION

1. Clean clutch actuator rod in solvent and dry with compressed air.
2. Inspect actuator components for wear or damage. Replace components as required.

Pinion Gear and Driveshaft

REMOVAL

1. Remove bearing retainer using Bearing Retainer Tool (91-43506T).



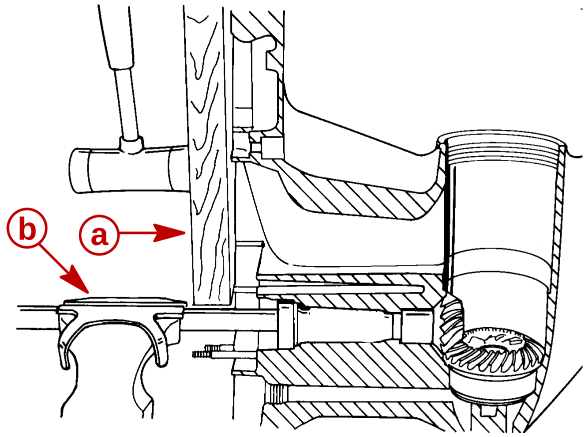
a - Bearing Retainer
b - Bearing Retainer Tool (91-43506T)

2. Place Driveshaft Holding Tool (91-90094) over driveshaft splines.
3. Use a socket and flex handle to hold pinion nut. (Pad area of gear housing where flex handle will make contact to prevent damage to gear housing.)
4. Use a socket and flex handle on Driveshaft Holding Tool to loosen pinion nut. Remove pinion nut and Driveshaft Holding Tool.

5. Remove gear housing from vise and re-position it as shown. Be sure to use soft jaw vise covers and clamp as close as possible to water pump studs.
6. Place a block of wood on gear housing mating surface. Use a mallet and carefully tap gear housing away from driveshaft.

CAUTION

DO NOT strike gear housing hard with the mallet or allow gear housing to fall.



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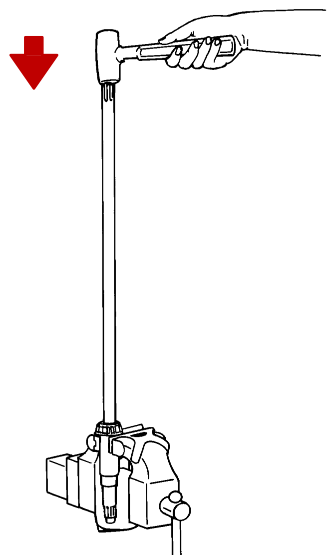
a - Wooden Block
b - Soft Jaw Vise Covers

7. Reach into gear housing and remove pinion gear and forward gear assembly.
8. After driveshaft is removed from gear case, remove and retain shim(s) that were located under upper tapered driveshaft bearing.
9. If inspection determines that replacement of driveshaft tapered bearing is required, remove bearing from driveshaft as follows:
   a. Position driveshaft in a vise; DO NOT tighten vise jaws against shaft.
   b. Strike shaft with a lead hammer; take care not to drop shaft.



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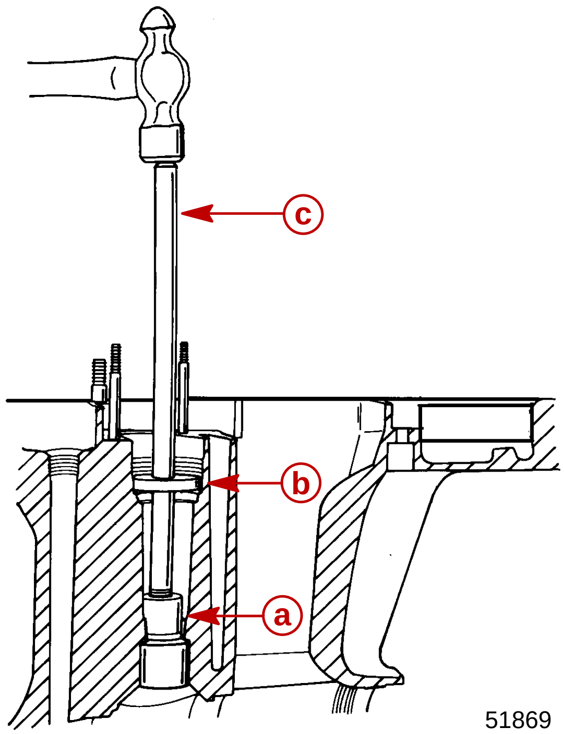
10. Remove 18 loose needles from outer race of driveshaft needle bearing.
11. If inspection of driveshaft needle bearing surface determines that replacement of needle bearing is required, the 18 loose needle bearings previously removed must be reinstalled in bearing race to provide surface for mandrel to drive against.

NOTE: *FORWARD gear must be removed first BEFORE removing driveshaft needle bearing.*

IMPORTANT: Discard driveshaft needle bearing after removal. (Bearing cannot be reused.)



a - Mandrel (91-37263)
b - Pilot* (91-36571)
c - Driver Rod* (91-37323)
*From Bearing Removal and Installation Kit (91-31229A7)

CLEANING AND INSPECTION

1. Clean driveshaft, tapered bearing and race, and pinion gear with solvent. Dry with compressed air. DO NOT allow driveshaft bearing to spin while drying.
2. Inspect pinion gear for pitting, grooves, scoring, uneven wear and/or discoloration from overheating. Replace pinion gear, if any of the above conditions are found.
3. Inspect driveshaft needle bearing surface (area just above pinion gear splines) for pitting, grooves, scoring, uneven wear and/or discoloration from overheating. Replace driveshaft and driveshaft needle bearing, if any of the preceding conditions are found.
4. Inspect driveshaft to crankshaft splines for wear. Replace driveshaft if wear is excessive.
5. Inspect tapered bearing race for pitting, grooves, scoring, uneven wear and discoloration from overheating. Replace tapered bearing and race as a set, if any of the preceding conditions are found.
6. Inspect driveshaft for groove(s) where water pump base oil seals contact shaft. Replace driveshaft if groove(s) are found.

Forward Gear

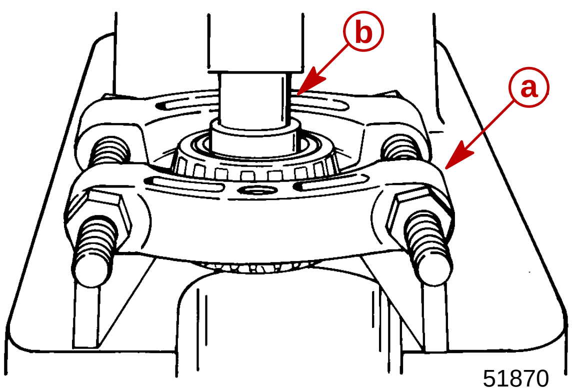
REMOVAL AND DISASSEMBLY

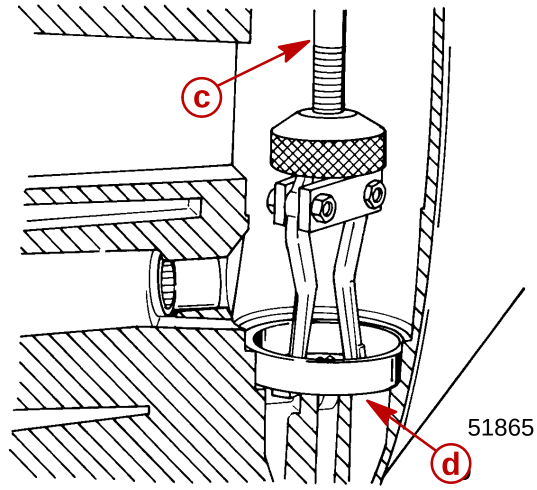
NOTE: *Forward gear can only be removed from gear housing after driveshaft and pinion gear have been removed.*

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, remove bearing from gear and bearing race from gear housing (tapered bearing and race MUST BE replaced as a set), as follows:
   a. Install Universal Puller Plate (91-37241) between forward gear and tapered bearing.
   b. Place forward gear, bearing and puller plate on a press and press gear out of bearing with a suitable mandrel.
   c. Use Slide Hammer (91-34569A1) to remove forward gear tapered bearing race.





a - Universal Puller Plate
b - Mandrel
c - Slide Hammer
d - Tapered Bearing Race

   d. After forward gear tapered bearing race is removed from gear housing, lift out and retain shims which were behind bearing race.

3. If inspection determines that replacement of propeller shaft needle bearings in forward gear is required, remove bearing from gear as follows:
   a. Clamp forward gear in a soft jaw vise securely.
   b. From toothed-side of gear, drive propeller shaft needle bearings out of gear with a punch and hammer.

CLEANING AND INSPECTION

⚠ CAUTION

DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

1. Clean forward gear and bearings with solvent and dry with compressed air.
2. Inspect gear teeth for pitting, grooves, scoring, uneven wear and for discoloration (from overheating). Replace gear if any of these conditions are found.
3. Check clutch jaws on forward gear for damage. Replace forward gear if damage is found.
4. Inspect tapered bearing race for pitting, grooves, scoring, uneven wear and discoloration (from overheating). Replace tapered bearing (on forward gear) and race if any of these conditions are found. (Always replace tapered bearing and race as a set.)
5. To determine condition of propeller shaft needle bearings (in forward gear), inspect propeller shaft forward gear needle bearing surface as outlined in "Propeller Shaft Inspection."

Gear Housing

CLEANING AND INSPECTION

1. Clean gear housing with solvent and dry with compressed air.
2. Check gear housing carefully for impact damage.
3. Check for loose fitting bearing cups and needle bearings.
4. Inspect bearing carrier cover nut retainer threads in gear housing for corrosion damage and/or stripped threads.

Reassembly and Installation Standard Rotation

Driveshaft Needle Bearing

REASSEMBLY/INSTALLATION

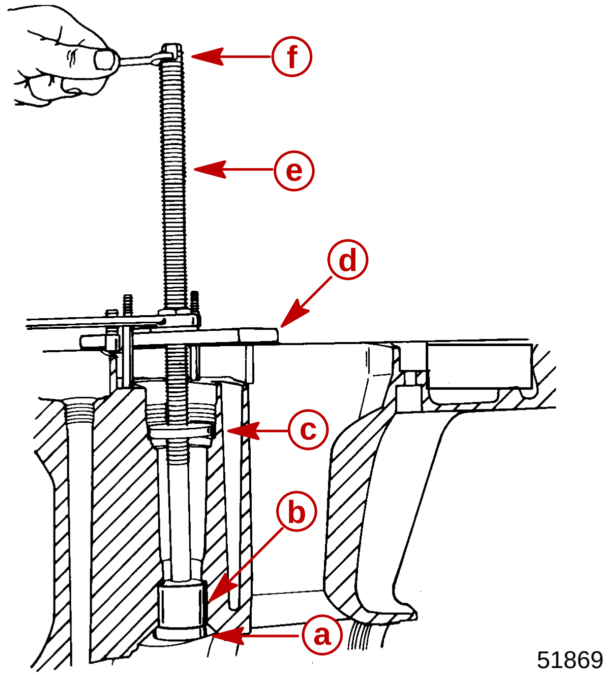
⚠ CAUTION

If driveshaft needle bearing failure has occurred, and original bearing race has turned in the gear housing, gear housing MUST be replaced. Loose fitting needle bearing will move out of position and cause repeated failures.

1. Apply a thin coat of Quicksilver 2-4-C with Teflon Lubricant to driveshaft needle bearing bore in gear housing.
2. By way of propeller shaft cavity, place needle bearing in driveshaft bore with numbered side of bearing facing up driveshaft bore.

3. Install and seat needle bearing with the following tools: Puller Rod* (91-31229), Nut* (11-24156), Pilot* (91-36571T), Plate* (91-29310) and Mandrel* (91-92788). Pull bearing up into bore until it bottoms on gear housing shoulder. (DO NOT use excessive force.)

*From Bearing Removal and Installation Kit (91-31229A7)



a - Mandrel
b - Bearing
c - Pilot
d - Plate
e - Puller Rod
f - Hold

Bearing Carrier

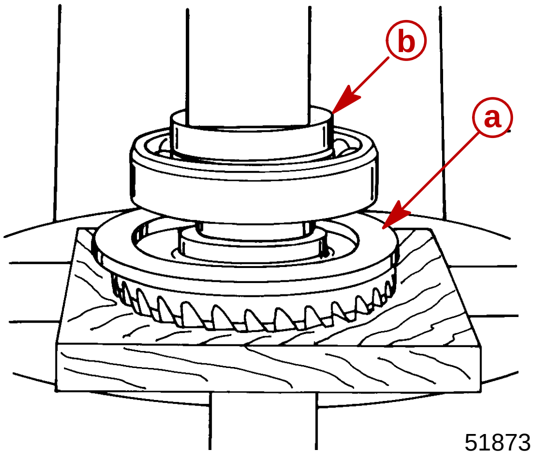
REASSEMBLY

1. Place reverse gear on a press with gear teeth facing down.

IMPORTANT: The reverse gear thrust washer has a tapered outside diameter so that one side is larger than the other. The larger outside diameter of washer must be toward reverse gear.

2. Place thrust washer over gear with the larger outside diameter down toward gear.
3. Apply a light coat of Quicksilver Super Duty Gear Lubricant onto inside diameter of reverse gear ball bearing.
4. Position ball bearing over gear (with numbered side of bearing up).

5. Press ball bearing onto gear with a suitable mandrel until firmly seated. (Be sure to press only on inner race of bearing and that bearing is firm against gear.)
6. Apply a light coat of Quicksilver Super Duty Gear Lubricant onto outside diameter of propeller shaft needle bearing.
7. Place propeller shaft needle bearing into aft end of bearing carrier with numbered side toward aft end.
8. Use Mandrel 91-15755 and press needle bearing into bearing carrier.



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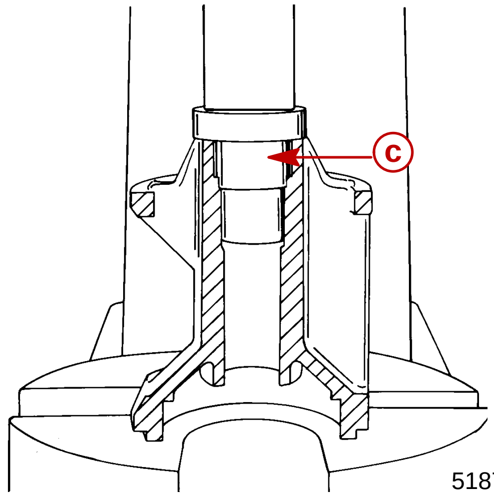
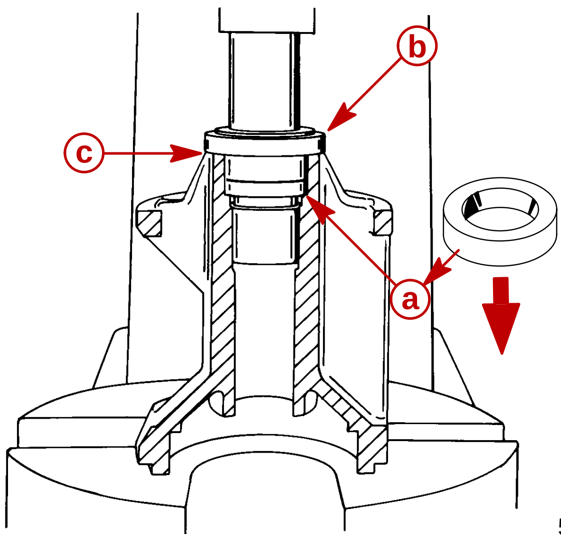


51872

a - Thrust Washer
b - Mandrel
c - Mandrel (91-15755)

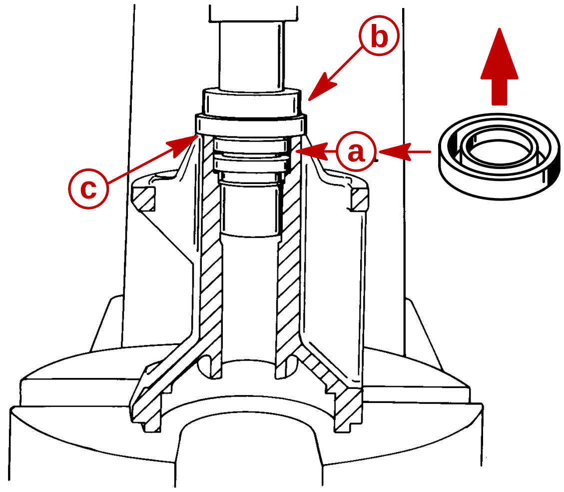
9. Apply Loctite 271 to outer diameter of propeller shaft oil seals.
10. Place one seal on longer shoulder side of Oil Seal Driver (91-31108) with lip of seal away from shoulder. Press seal into bearing carrier until seal driver bottoms against bearing carrier.



51872

a - Oil Seal (Lip of Seal Down)
b - Oil Seal Driver
c - Seated

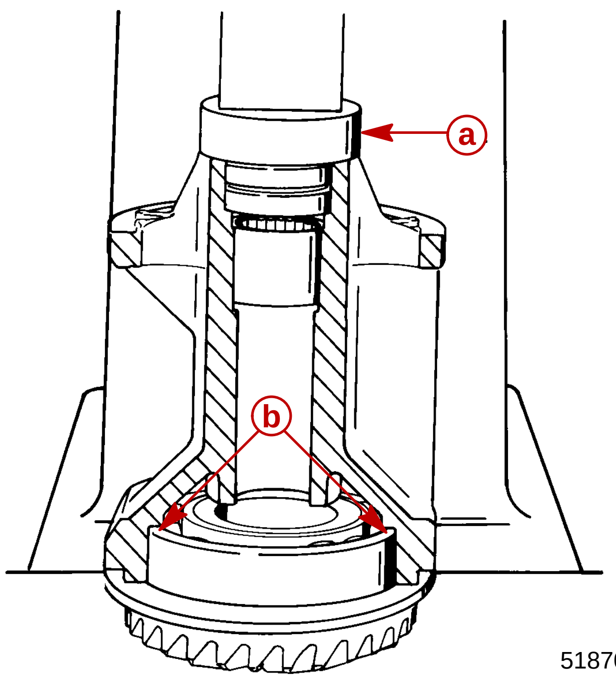
11. Place second seal on short shoulder side of seal driver with lip of seal toward shoulder. Press seal into bearing carrier until seal driver bottoms against bearing carrier.



51872

a - Oil Seal (Lip of Seal Up)
b - Oil Seal Driver
c - Seated

12. Wipe off excess Loctite.
13. Apply a light coat of Quicksilver Super Duty Gear Lubricant onto the outside diameter of reverse gear ball bearing.
14. Place bearing carrier over reverse gear and bearing assembly. Press bearing carrier onto bearing.



51870

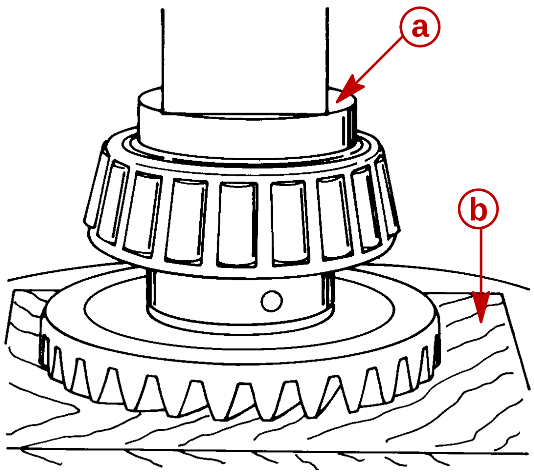
a - Mandrel
b - Seated

15. Place O-ring over bearing carrier and position it between bearing carrier and thrust washer.
16. Lubricate oil seals and O-ring with Quicksilver 2-4-C with Teflon Marine Lubricant.

Forward Gear

REASSEMBLY

1. Place forward gear on a press with gear teeth down.
2. Apply a light coat of Quicksilver Super Duty Gear Lubricant onto the inside diameter of forward gear tapered bearing.
3. Position forward gear tapered bearing over gear.
4. Press bearing onto gear until firmly seated. (Be sure to press only on inner race of bearing and that bearing is firm against the gear.)



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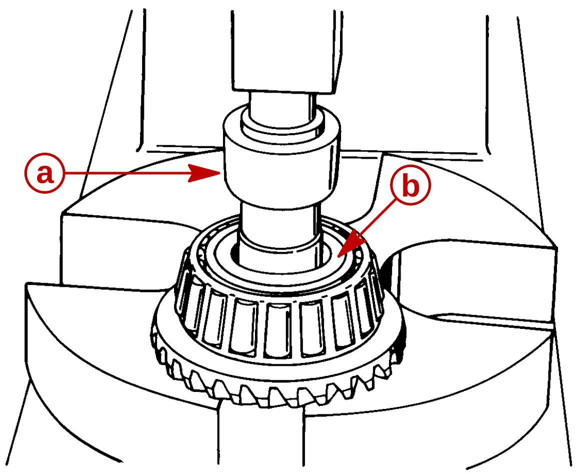
a - Mandrel
b - Wooden Block

5. Apply a light coat of Quicksilver Super Duty Gear Lubricant to bore in center of forward gear.
6. Place one forward gear needle bearing on longer shoulder side of Forward Gear Bearing Tool (91-86943) with numbered side of bearing toward shoulder. Press bearing into forward gear until bearing tool bottoms against gear.



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a - Forward Gear Bearing Tool (91-86943)
b - Numbered Side of Needle Bearing

7. Place second needle bearing on short shoulder side of bearing tool with numbered side of bearing toward shoulder. Press bearing into forward gear until bearing tool bottoms against gear.

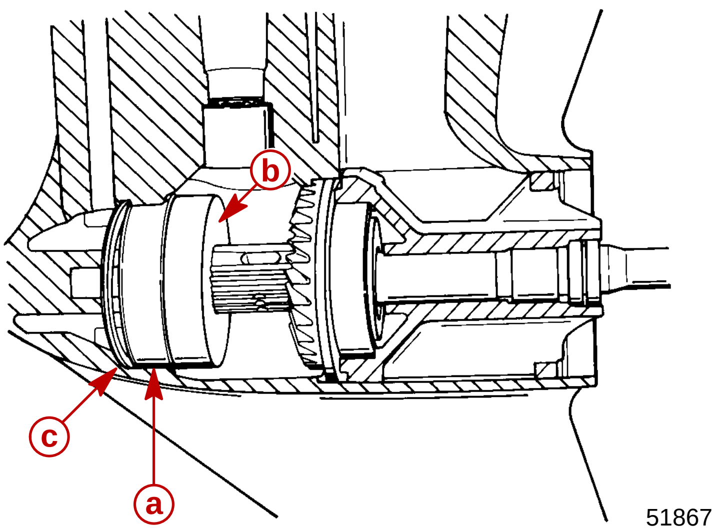
Forward Gear Bearing Race

INSTALLATION

1. Place shim(s) (retained from disassembly) into gear housing. If shim(s) were lost or a new gear housing is being used, start with approximately 0.010 in. (0.254 mm).
2. Apply a light coat of Quicksilver Super Duty Gear Lubricant to forward gear bearing race bore in gear housing.
3. Position tapered bearing race squarely over bearing bore in front portion of gear housing.
4. Place Bearing Driver Cup (91-87120) over tapered bearing race.

NOTE: *A used propeller shaft is recommended for use in Step 5. If it is necessary, however, to use the propeller shaft that will be installed in gear housing, the propeller shaft must be disassembled. (Refer to “Propeller Shaft Disassembly,” preceding.)*

5. Place propeller shaft into hole in center of bearing driver cup.
6. Install bearing carrier assembly over propeller shaft and lower it into gear housing. Bearing carrier acts as a pilot to assure proper bearing race alignment.
7. Thread a nut onto propeller shaft to protect propeller shaft threads.
8. Use a mallet to drive propeller shaft against bearing driver cup until tapered bearing race is seated against shim(s).



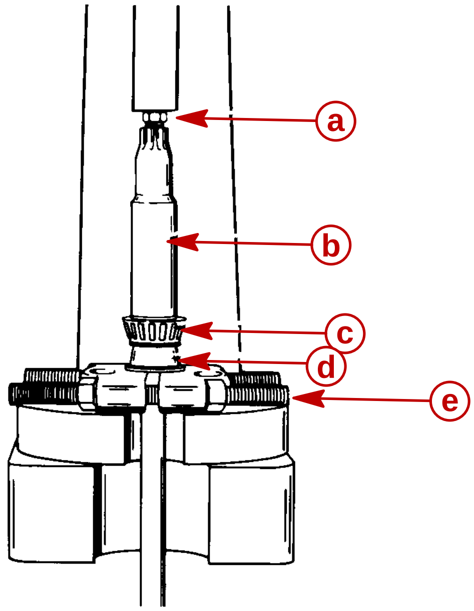
a - Tapered Bearing Race
b - Bearing Driver Cup (91-31106)
c - Shim(s)

9. Remove nut from propeller shaft, then remove bearing carrier and propeller shaft from gear housing. Lift bearing driver cup out of gear housing.
10. Apply a light coat of oil on tapered bearing race, then place forward gear assembly into forward bearing race.

Driveshaft and Pinion Gear

REASSEMBLY/INSTALLATION

1. Apply a light coat of Quicksilver Super Duty Gear Lubricant on I.D. of driveshaft tapered bearing.
2. Thread a used pinion nut onto end of driveshaft. Leave approximately 1/16 in. (1.6 mm) of nut threads exposed. Driveshaft threads MUST NOT extend beyond nut or thread damage could result while pressing.
3. Place bearing over driveshaft.
4. Using an old driveshaft bearing inner race or other suitable mandrel (which applies pressing force on center bearing race only), press bearing onto shaft until seated.



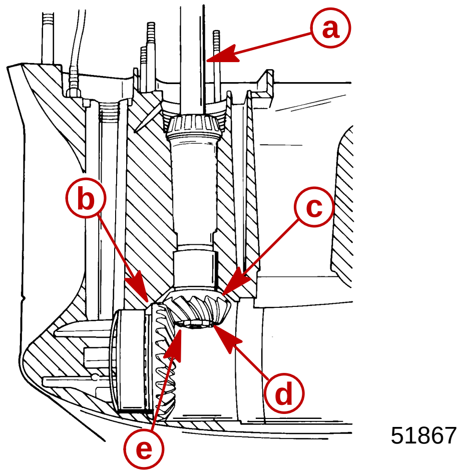
a - Used Pinion Nut
b - Driveshaft
c - Tapered Bearing
d - Old Bearing Inner Race
e - Universal Puller Plate

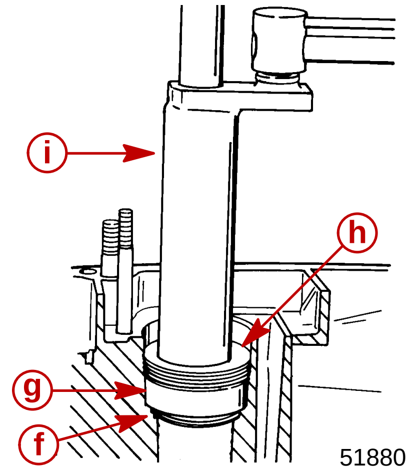
5. Position pinion gear in gear housing below driveshaft bore with teeth of pinion gear meshed with teeth of reverse gear.
6. Insert driveshaft into driveshaft bore while holding pinion gear. Rotate driveshaft to align and engage driveshaft splines with pinion gear splines. Continue to insert driveshaft into gear housing until driveshaft tapered bearing is against bearing race.

NOTE: *It is recommended that after final pinion depth is obtained, a new pinion nut be installed. Clean pinion nut threads with Loctite 7649 Primer before applying Loctite 271.*

7. Place a small amount of Loctite 271 onto threads of pinion gear nut and install flat washer and nut on driveshaft with flat side of nut away from pinion gear. Hand tighten pinion nut.
8. Place shim(s) (retained from disassembly) into gear housing. If shim(s) were lost or are not reusable (damaged), start with approximately 0.010 in. (0.254 mm).

9. Install bearing race and bearing retainer.

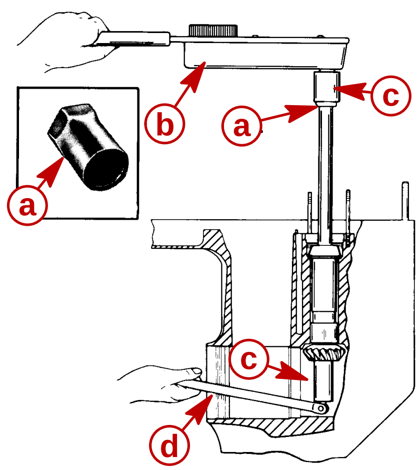




a - Driveshaft (rotate to engage splines with pinion gear)
b - Forward Gear Assembly
c - Pinion Gear
d - Washer (located above pinion nut)
e - Pinion Nut [apply Loctite 271 on threads and install with flat side away from pinion gear.]
f - Shim(s)
g - Bearing Race
h - Bearing Retainer (Word “OFF” must be visible) Torque to 100 lb. ft. (135.5 Nm)
i - Bearing Retainer Tool (91-43506T)

10. Use a socket and flex handle to hold pinion nut (pad area where flex handle will contact gear housing while torquing nut).

11. Place Driveshaft Holding Tool (91-90094) over crankshaft end of driveshaft. Torque pinion nut to 75 lb. ft. (101.5 Nm).



a - Driveshaft Holding Tool (91-90094)
b - Torque Wrench; Torque Nut to 75 lb. ft. (101.5 Nm)
c - Socket
d - Breaker Bar

IMPORTANT: Wipe any excess Loctite from pinion nut and pinion gear.

Pinion Gear Depth/Forward Gear Backlash/Reverse Gear Backlash

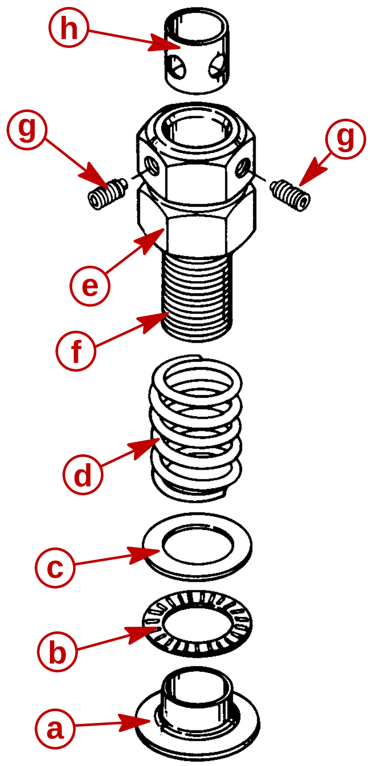
DETERMINING PINION GEAR DEPTH

NOTE: *Read entire procedure before attempting any change in shim thickness.*

IMPORTANT: Forward gear assembly must be installed in gear housing when checking pinion gear depth or an inaccurate measurement will be obtained.

1. Clean the gear housing bearing carrier shoulder.
2. Install Bearing Preload Tool (91-14311A2) over driveshaft in sequence shown.

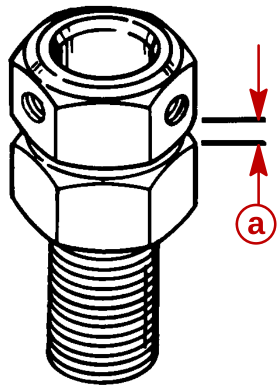
NOTE: *Bearing Preload Tool (91-44307A1) may also be used. Follow instructions provided with tool for proper installation.*

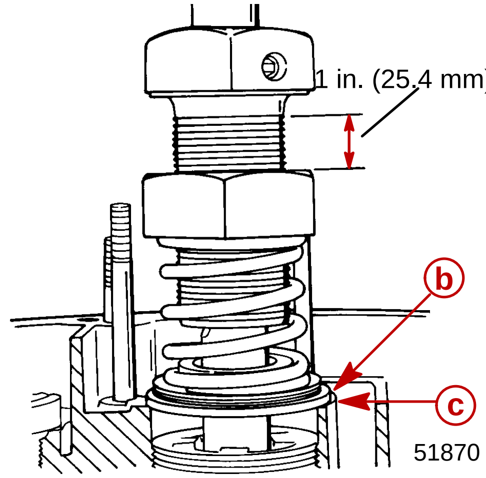


a - Adaptor
b - Bearing
c - Washer
d - Spring
e - Nut; thread nut all the way onto bolt
f - Bolt
g - Set Screw
h - Sleeve; Holes in sleeve must align with set screw

3. Align adaptor on driveshaft bearing pocket ledge.
4. With tool installed over driveshaft, tighten both set screws securely, making certain to align sleeve holes to allow set screws to pass thru.

5. Measure distance (a) and increase that distance by 1 in. (25.4 mm) by turning bottom nut away from top nut.



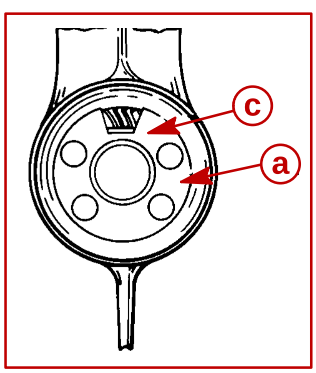


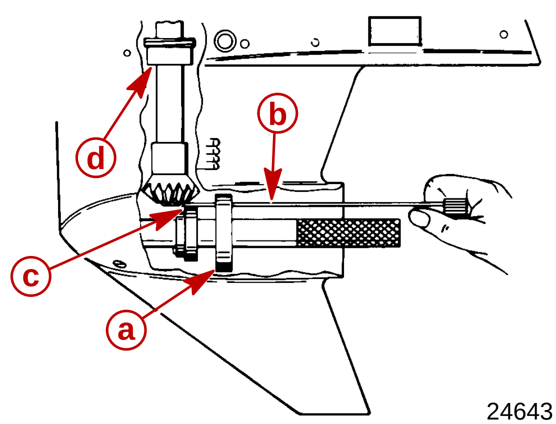
a - Distance
b - Adaptor
c - Ledge

6. Turn driveshaft clockwise 2 or more turns to seat driveshaft bearings.
7. Insert Pinion Gear Locating Tool* (91-74776) into gear housing until it bottoms out on bearing carrier shoulder.

*Pinion Gear Locating Tool (91-12349A2) can be used. Use flat #7 and disc #2. Follow instructions supplied with tool.

8. Determine pinion gear depth by inserting a feeler gauge thru access slot in pinion gear shimming tool.
9. Clearance between shimming tool and pinion gear should be 0.025 in. (0.64 mm).
10. If clearance is correct, leave Bearing Preload Tool on driveshaft for “Determining Forward Gear Backlash,” following.
11. If clearance is not correct, add (or subtract) shims at location shown to raise (or lower) pinion gear. When reinstalling pinion nut, apply Loctite 271 on threads of nut and re-torque pinion nut.





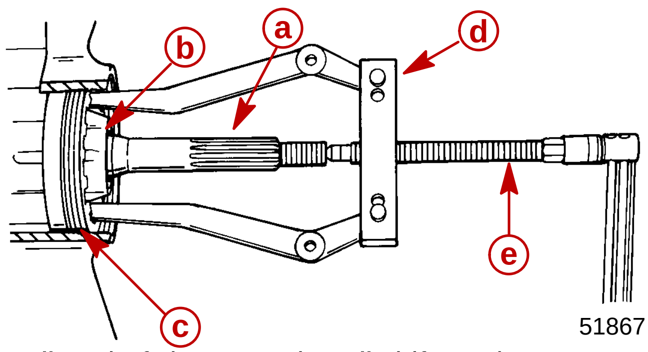
a - Pinion Gear Tool (91-74776 or 91-12349A2)
b - Feeler Gauge
c - Obtain 0.025 in. (0.64 mm) Clearance between Shimming Tool and Pinion Gear
d - Add or Subtract Shim(s) Here

NOTE: *Bearing Preload Tool (91-14311A1) should remain installed on driveshaft after setting pinion gear depth as it is required to properly check forward gear and reverse gear backlash.*

DETERMINING FORWARD GEAR BACKLASH

IMPORTANT: Bearing carrier must be assembled to provide a pilot for propeller shaft.

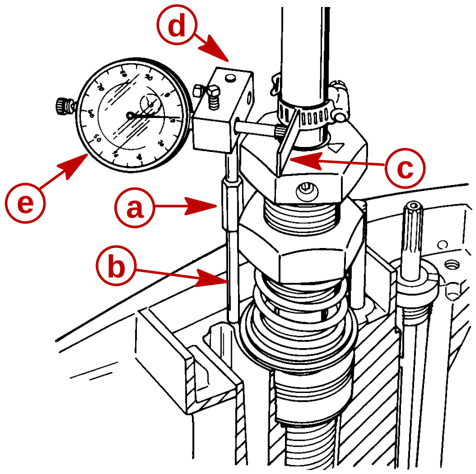
1. Insert propeller shaft into position in gear housing. (DO NOT place shift cam on propeller shaft.)
2. Place bearing carrier into gear housing and thread cover nut tightly against bearing carrier. (It is not necessary to torque cover nut against bearing carrier.)
3. Attach Bearing Carrier Removal Tool (91-46086A1) and Puller Bolt (91-85716) onto gear housing.
4. Torque puller bolt against propeller shaft to 45 lb. in. (5 Nm). Turn driveshaft 10 revolutions with the load applied to propeller shaft. This will seat forward gear bearing.



a - Propeller Shaft (DO NOT install shift cam)
b - Bearing Carrier (assembled)
c - Cover Nut (Tighten; DO NOT torque)
d - Bearing Carrier Removal Tool (91-46086A1)
e - Puller Bolt (91-85716); Torque to 45 lb. in. (5 Nm)

5. Fasten dial indicator to gear housing and Backlash Indicator Tool (91-78473) to driveshaft.
6. Recheck torque on puller bolt [45 lb. in. (5 Nm)].

7. Position dial indicator pointer on line marked “1” on Backlash Indicator Tool, if gear ratio is 1.87:1 (15 teeth on pinion gear), or on line marked “2” on Backlash Indicator Tool, if gear ratio is 2:1 (14 teeth on pinion gear).



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a - Thread Stud Adaptor (from 91-14311A2)
b - Stud
c - Backlash Indicator Tool (91-78473)
d - Dial Indicator Holder (91-89897)
e - Dial Indicator (91-58222A1)

8. Lightly turn driveshaft back-and-forth (no movement should be noticed at propeller shaft).
9. Dial indicator registers amount of backlash which must be 0.018 in. to 0.027 in. (0.46 mm to 0.69 mm) for the 1.87:1 gear ratio, 0.015 in. to 0.022 in. (0.38 mm to 0.56 mm) for the 2:1 gear ratio.
10. 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 on threads of nut.
11. 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 on 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).*

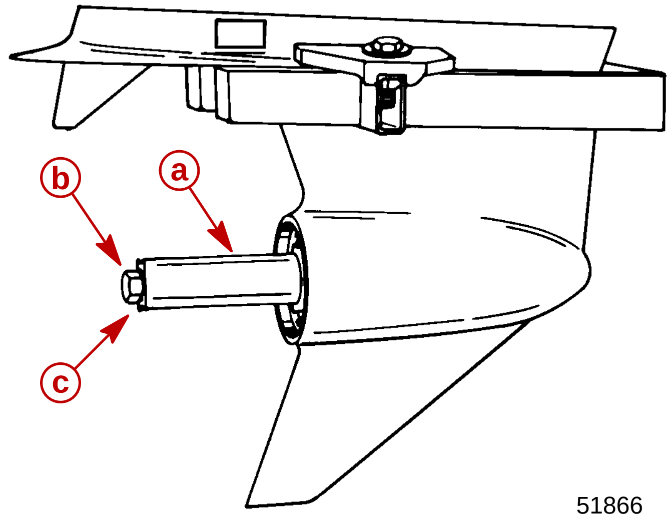
REVERSE GEAR

Determining Reverse Gear Backlash

Although reverse gear backlash is not adjustable, it may be checked as follows:

1. Propeller shaft and bearing carrier must be completely assembled and installed in gearcase.
2. Install shift shaft in gearcase.
3. Shift gearcase into reverse.
4. Slide 5-1/2 in. x 1.5 in. I.D. (139.7 mm x 38.0 mm) piece of PVC pipe over propeller shaft and position pipe against bearing carrier.

5. Secure pipe against carrier with propeller nut and tab washer.



a - Pipe [5-1/2 in. x 1.5 in. (139.7 mm x 38.0 mm)]
b - Propeller Nut
c - Tab Washer

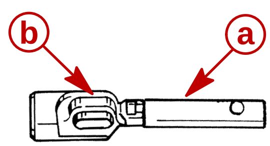
6. Torque propeller nut to 45 lb. in. (5 Nm).
7. Gently rock driveshaft. Dial indicator should show backlash of 0.030 in. – 0.050 in. (0.762 mm – 1.27 mm).

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.

Clutch Actuator Rod

REASSEMBLY

1. Place a small amount of Quicksilver 2-4-C with Teflon Lubricant on actuator rod and install cam follower.



a - Actuator Rod
b - Cam Follower

Shift Shaft Bushing

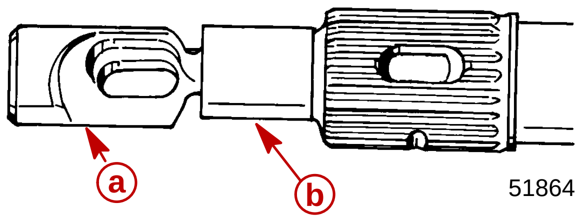
REASSEMBLY

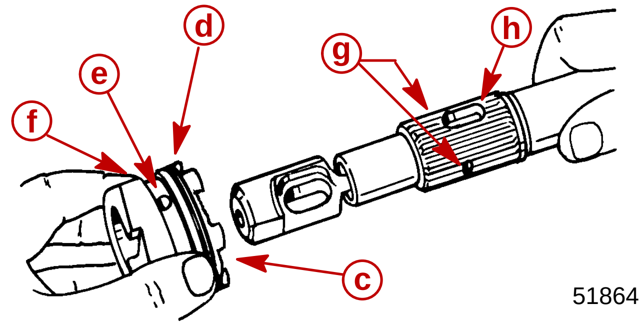
1. Position shift shaft bushing on a press with threaded side down.
2. Apply Loctite 271 to outside diameter of oil seal.
3. Press oil seal into shift shaft bushing with lip of seal up.
4. Wipe any excess Loctite from oil seal and bushing.
5. Place rubber washer against oil seal.
6. Install O-ring over threads and up against shoulder of bushing.
7. Lubricate O-ring and oil seal with Quicksilver 2-4-C with Teflon Marine Lubricant.

Propeller Shaft

REASSEMBLY/INSTALLATION

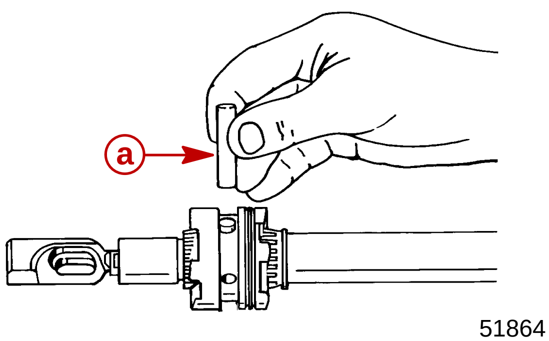
1. Insert clutch actuator rod assembly into end of propeller shaft. Align cross pin slot in actuator rod with cross pin slot in propeller shaft.
2. On PRODUCTION MODEL GEAR CASES, position sliding clutch onto propeller shaft with GROOVED RINGS (ON SLIDING CLUTCH) TOWARD PROPELLER END OF PROPELLER SHAFT. Cross pin hole and detent holes (in sliding clutch) must line up with cross pin slot and detent notches on propeller shaft.

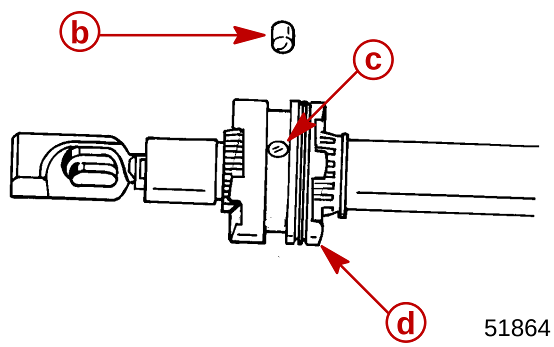




a - Cam Follower
b - Propeller Shaft
c - Sliding Clutch
d - Grooved Rings
e - Cross Pin Hole
f - Detent Hole (Behind Finger and Thumb)
g - Detent Notch (One on Each Side)
h - Cross Pin Slot

3. Insert cross pin thru sliding clutch, propeller shaft and actuator rod, forcing cross pin tool out.
4. Apply a small amount of 2-4-C with Teflon Marine Lubricant on detent pin. Position a detent pin in detent pin hole of sliding clutch with rounded end of pin toward propeller shaft.



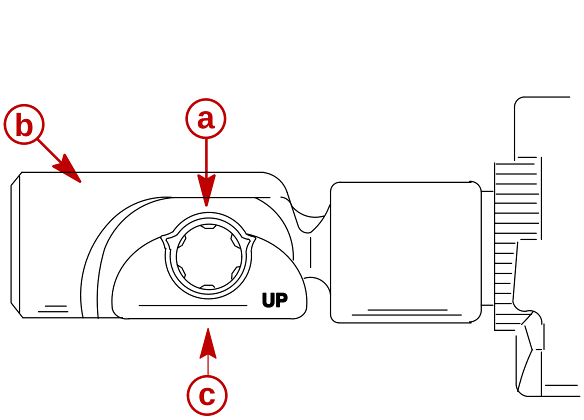


a - Cross Pin
b - Detent Pin
c - Cross Pin
d - Sliding Clutch

5. Install cross pin retaining spring onto sliding clutch as follows:

IMPORTANT: DO NOT over-stretch retaining spring when installing onto sliding clutch.

6. Spirally wrap spring into groove on sliding clutch.
7. Place gear housing in a soft jaw vise with the driveshaft in a vertical position.
8. Coat cam pocket of cam follower with 2-4-C with Teflon Marine Lubricant.
9. Place shift cam into cam pocket of cam follower with numbered side of cam facing up.
10. With shift cam positioned as shown, insert propeller shaft thru forward gear until shaft bottoms out.



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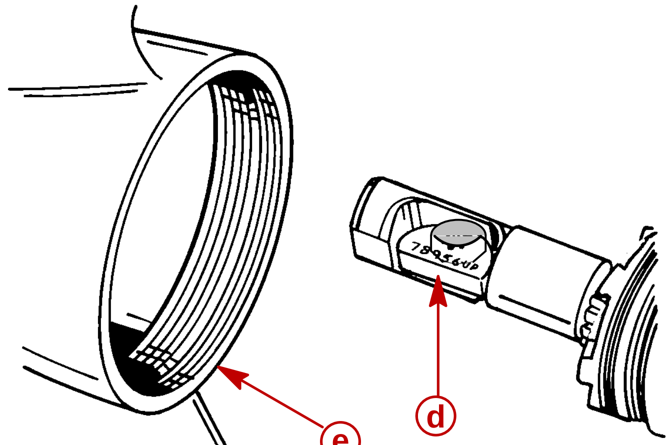

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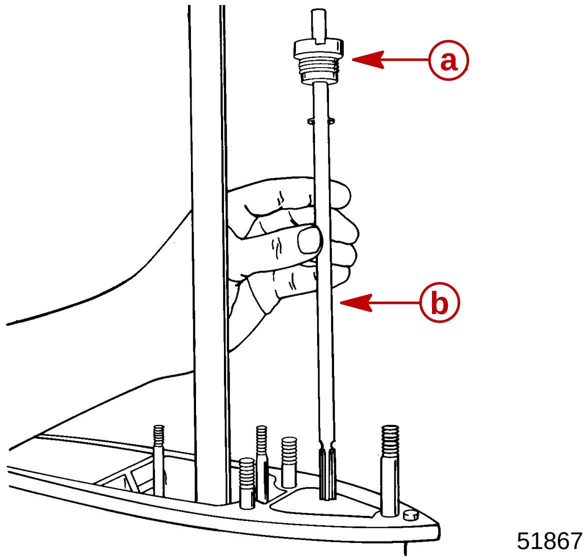
a - Cam Pocket
b - Cam Follower
c - Shift Cam
d - Shift Cam (Position as Shown)
e - Gear Housing

⚠ CAUTION

Until bearing carrier is installed into gear housing, extreme care MUST BE taken not to apply any side force on propeller shaft. Side force on propeller shaft may break the neck of the clutch actuator rod.

11. Insert shift shaft down shift shaft hole (of gear housing) and thru shift cam and cam follower. (It may be necessary to rotate shift shaft back-and-forth slightly for it to enter shift cam.)
12. Apply a light coat of Quicksilver 2-4-C with Teflon Marine Lubricant to threads of shift shaft bushing. (Thread bushing into position, but do not tighten down at this time)



a - Shift Shaft Bushing
b - Shift Shaft

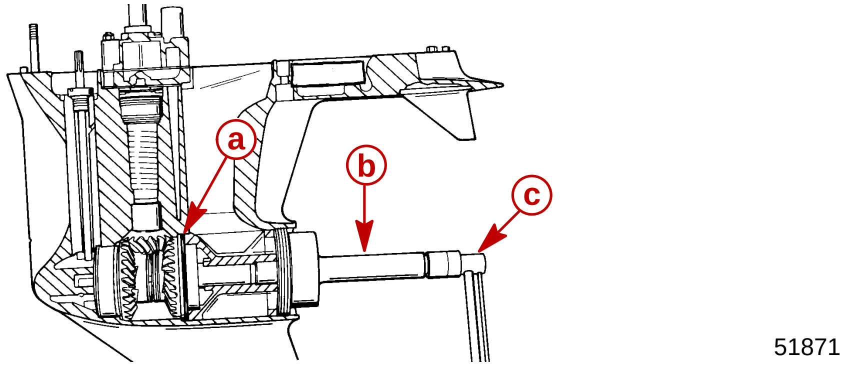
13. Lubricate O-ring on bearing carrier with Quicksilver 2-4-C with Teflon Marine Lubricant.
14. Apply a light coat of Quicksilver 2-4-C with Teflon Marine Lubricant to outside diameter of bearing carrier (where carrier contacts gear housing).

NOTE: *When performing Step 15, rotate driveshaft clockwise (viewed from top) to mesh pinion gear with reverse gear.*

15. Position bearing carrier over propeller shaft and slide it into gear housing. (Be sure to align bearing carrier keyway with gear housing keyway.)
16. Push bearing carrier in as far as possible by hand, then install bearing carrier key.
17. Place tab washer against bearing carrier.
18. Apply Quicksilver 2-4-C with Teflon Marine Lubricant to threads of cover nut and install cover nut in gear housing (verify that the word “OFF” and arrow are visible).

NOTE: *Before torquing bearing carrier cover nut, gear case should either be mounted in a stand specifically designed for holding gear cases or bolted to a driveshaft housing to avoid possible damage to the gear case.*

19. Start cover nut a few turns by hand, then using Cover Nut Tool (91-61069T) and torque wrench, torque cover nut to 210 lb. ft. (285 Nm).



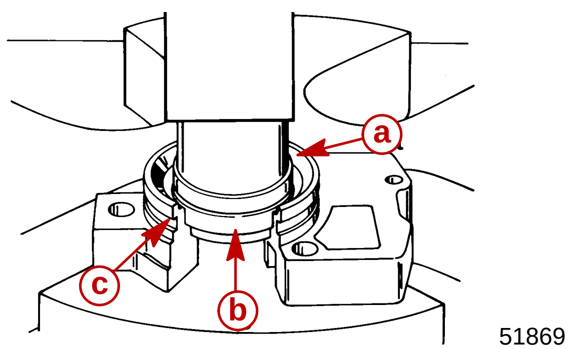
a - O-ring
b - Cover Nut Tool
c - Torque Wrench

20. Bend one lock tab of tab washer into cover nut (only one will align).
21. Bend remaining tabs of tab washer toward front of gear housing.
22. Use Shift Shaft Bushing Tool (91-31107T) and torque shift shaft bushing to 30 lb. ft. (41 Nm).

Water Pump

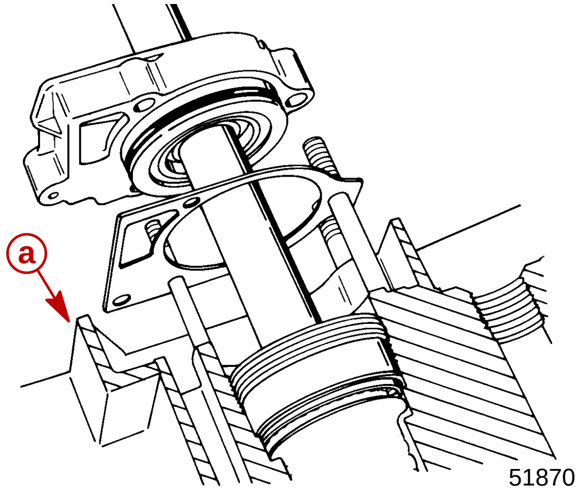
REASSEMBLY/INSTALLATION

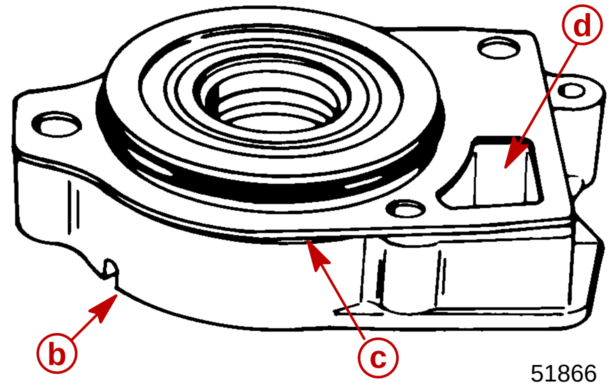
1. Install oil seals into water pump base, as follows:
   a. Place water pump base on a press.
   b. Just before installing each seal apply Loctite 271 on outside diameter of oil seal.
   c. With a suitable mandrel, press the smaller diameter oil seal into pump base with lip of oil seal toward impeller side of base.
   d. With a suitable mandrel, press the larger diameter oil seal into pump base with lip of oil seal toward gear housing side of base.
   e. Wipe any excess Loctite from oil seals and water pump base.
2. Install O-ring into O-ring groove of water pump base. Lubricate O-ring and oil seals with 2-4-C with Teflon Marine Lubricant.



a - Mandrel
b - Oil Seal (Smaller OD)
c - O-ring Groove

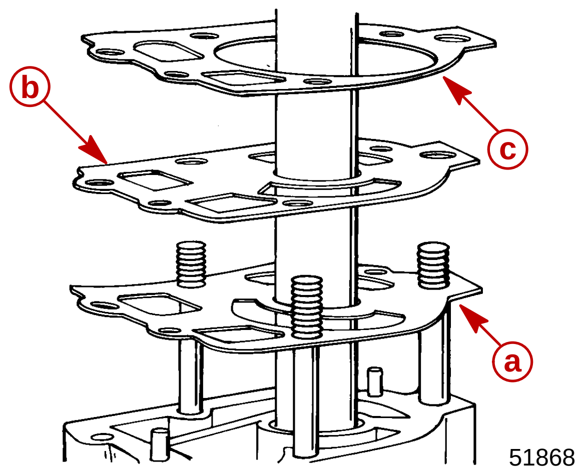
3. Install divider block if removed. Use RTV Sealer to seal seams between divider block and gear housing.
4. Install a new water pump base gasket and install water pump base.





a - Divider Block
b - Water Pump Base
c - Gasket
d - Hole (MUST be positioned as shown)

5. Install the following in order: Pump base to face plate gasket, face plate gasket and face plate to pump cover gasket. Gaskets and face plate are indexed by dowel pin location and must be installed correctly.



a - Gasket (Water Pump Base to Face Plate)
b - Face Plate
c - Gasket (Face Plate to Water Pump Cover)

6. Place impeller drive key on flat of driveshaft. Hold key on driveshaft with a small amount of Quicksilver 2-4-C with Teflon Marine Lubricant.

IMPORTANT: When completing gear housing repair, that requires removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to reuse the impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur. Original rotation is clockwise.

⚠ CAUTION
A visual inspection of impeller drive key MUST BE made to determine that drive key is on flat of driveshaft after impeller is installed. If key has moved off flat of driveshaft, repeat Steps 6 and 7.

7. Slide impeller down driveshaft to impeller drive key. Align drive key with keyway in the center hub of impeller, and slide impeller over drive key.

8. If removed, install new water pump insert into pump cover as follows:

   a. Apply Perfect Seal to water pump insert area of pump cover.

   b. Install water pump insert into pump cover. Verify that tab on insert enters recess in pump cover.

   c. Wipe any excess Perfect Seal from insert and cover.

NOTE: *If 2 holes were drilled in top of water pump cover to aid in removal of insert, fill holes with RTV Sealer or equivalent. Allow to cure, 24 hours prior to operating engine.*

9. Install water tube seal into pump cover, being sure that plastic side of seal goes into cover first.

10. Reinstall water tube guide into water pump cover.

11. Apply a light coat of Quicksilver 2-4-C with Teflon Marine Lubricant inside of water pump insert.

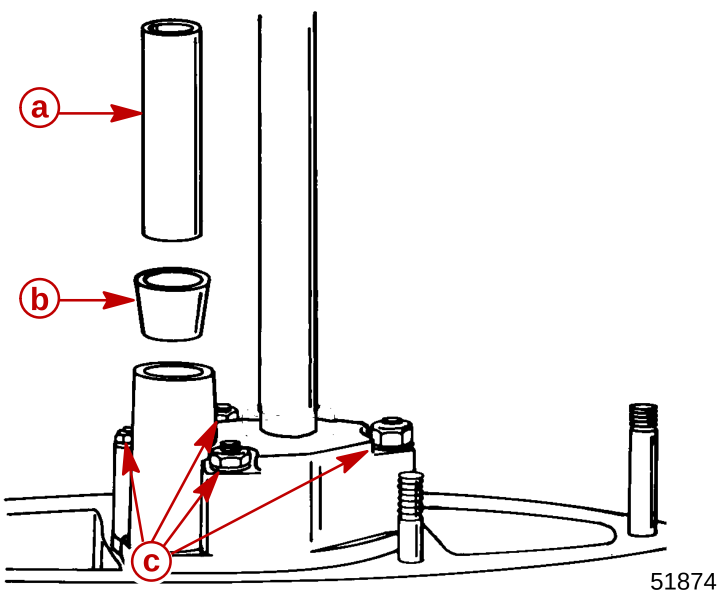
12. Position assembled water pump cover over driveshaft and lower over water pump studs. Rotate driveshaft in a clockwise direction (viewed from top), while pushing down on pump cover to ease impeller entry into cover.

13. Install water pump cover retainer washers, nuts and bolt.

CAUTION
DO NOT over-torque nuts and bolt, as this could cause cover to crack during operation.

14. Torque water pump nuts to 50 lb. in. (5.5 Nm), and water pump bolt to 35 lb. in. (4 Nm).

15. Install centrifugal slinger over driveshaft and down against pump cover.



a - Water Tube Guide
b - Water Tube Seal
c - Nuts, Bolts and Washers

Gear Lubricant Filling Instructions

1. Remove any gasket material from “Fill” and “Vent” screws and gear housing.
2. Install new gaskets on Fill and Vent screws.

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.

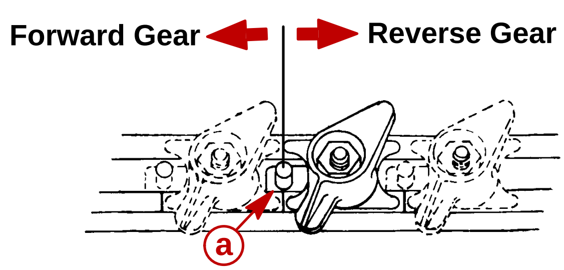
1. Tilt engine to full up position and engage the tilt lock lever.
2. Apply a light coat of Quicksilver 2-4-C with Teflon Marine Lubricant onto driveshaft splines.

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 with 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 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 forward gear and place guide block anchor pin into forward gear position.

Right Hand Rotation Outboard



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 and turn it counterclockwise as the gear housing is being pushed toward driveshaft housing.*

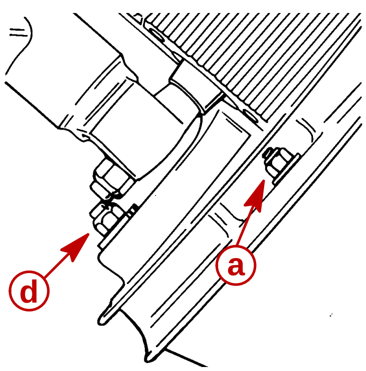
8. Move gear housing up toward driveshaft housing while aligning shift shaft splines and water tube with water tube guide (in water pump cover).
9. Place flat washers onto studs (located on either side of driveshaft housing). Start a nut (a) on these studs and tighten finger-tight.
10. Start bolt (b) 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.

IMPORTANT: Do not force gear case up into place with attaching nuts.

12. Evenly tighten 2 nuts (a) which were started in Step 9. Torque to listing in **"Torque Specifications,"** preceding.
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 washers and nuts (c) onto studs (located on bottom center of anti-cavitation plate). Torque to listing in **"Torque Specifications,"** preceding.



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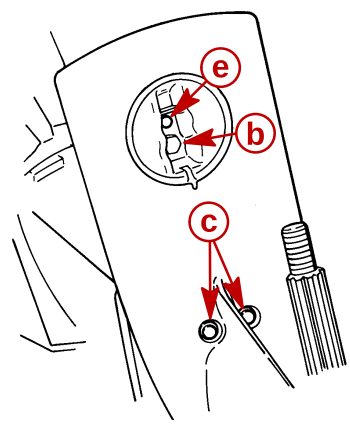

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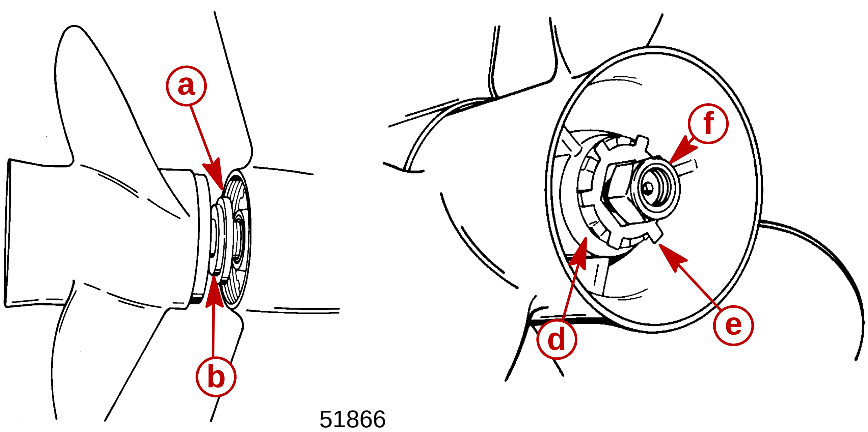
15. Install special flat washer and nut (d) on stud at leading edge of driveshaft housing. Torque to listing in **"Torque Specifications,"** preceding.
16. Torque bolt (started in Step 10) to listing in **"Torque Specifications,"** preceding.
17. Install trim tab, adjust to position in which it had previously been installed, and tighten bolt (e) securely.
18. 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
   - -- Special Lubricant 101
   - -- 2-4-C Marine Lubricant
   - -- Perfect Seal
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.)



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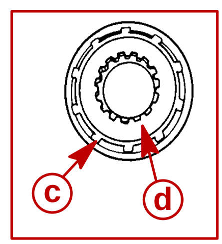

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a - Forward Thrust Hub
b - Propeller Shaft
c - Continuity Washer (if Equipped)
d - Rear Thrust Hub
e - Tab Washer
f - Propeller Nut

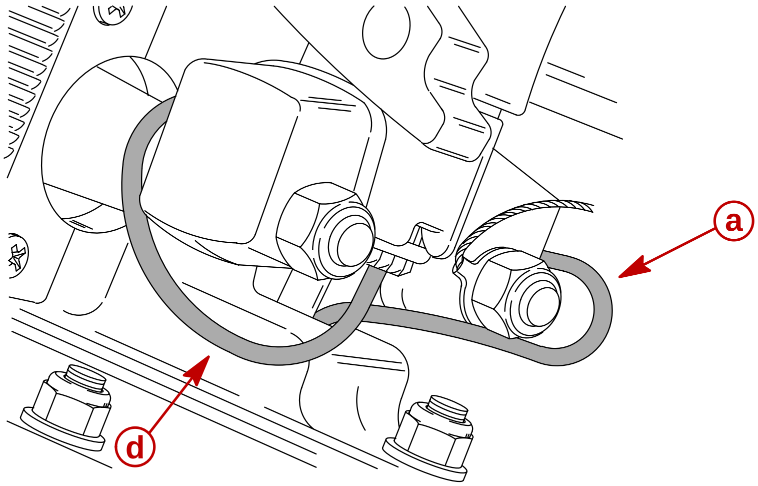
⚠ CAUTION

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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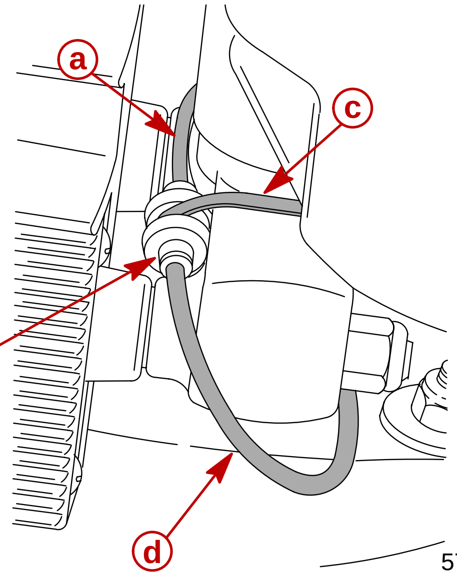

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a - Speedometer Tube from Gearcase
b - Junction
c - Sta-strap
d - Speedometer Tube from Swivel Tube

LOWER UNIT

Section 6B – Left Hand Non-Ratcheting

Table of Contents

6 B

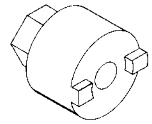
Gear Housing Specifications (Counter Rotation)

Ratio	Pinion Depth	Forward Gear Backlash	Reverse Gear Backlash
1.87:1	0.025 in. (0.635 mm) With Tool 91-12349A2 using Disc #2 and Flat #7	0.018 in. to 0.027 in. (0.460 mm to 0.686 mm) Pointer on line mark #1	0.030 in. to 0.050 in. (0.762 mm to 1.27 mm)
2.0:1	0.025 in. (0.635 mm)With Tool 91-12349A2 using Disc #2 and Flat #7	0.015 in. to 0.022 in. (0.38 mm to 0.56 mm) Pointer on line mark #2	0.030 in. to 0.050 in. (0.762 mm to 1.27 mm)
Gearcase Lubricant Capacity			
All Ratios	22.5 fl. oz. (665.4 ml)		

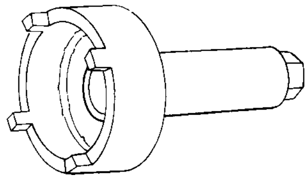
Gear Ratio	Teeth on Pinion Gear	Teeth on Forward and Reverse Gear
1.87:1	15	28
2.00:1	12	24

Special Tools

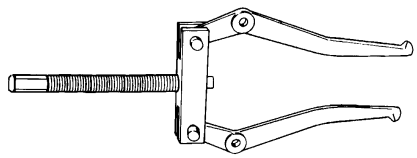
1. Shift Shaft Bushing Tool 91-31107T



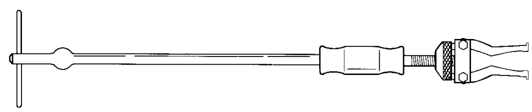
2. Gear Housing Cover Nut Tool 91-61069



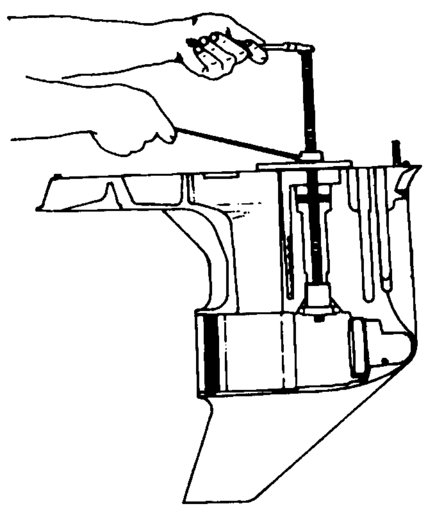
3. Bearing Carrier Removal Tool 91-46086A1 and Puller Bolt 91-85716



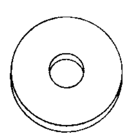
4. Slide Hammer Puller 91-34569A1



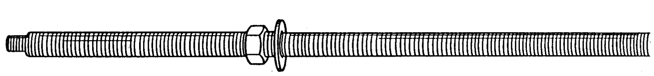
5. Bearing Removal and Installation Kit 91-31229A5. This kit contains the following tools: Pilot 91-36571; Puller Rod 91-31229; Nut 11-24156; Puller Plate 91-29310; Mandrel 91-38628; and Driver Rod 91-37323.



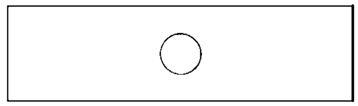
6. Pilot 91-36571



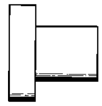
7. Puller Rod 91-31229 and Nut 91-24156



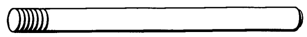
8. Puller Plate 91-29310



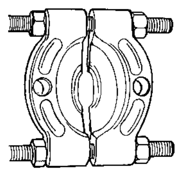
9. Mandrel 91-38628



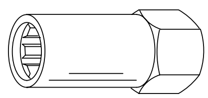
10. Driver Rod 91-37323



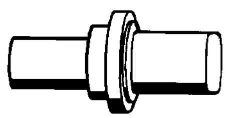
11. Universal Puller Plate 91-37241



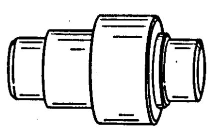
12. Driveshaft Holding Tool 91-34377A1 or91-90094



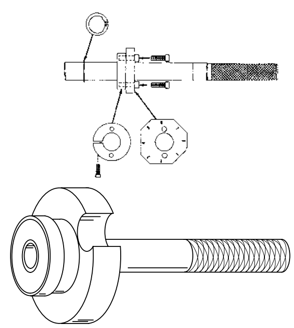
13. Oil Seal Driver 91-31108



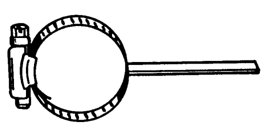
14. Forward Gear Bearing Tool 91-86943



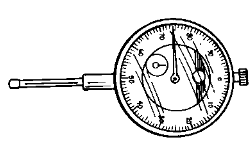
15. Pinion Locating Gear Tool 91-12349A2 or 91-74776



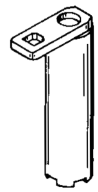
16. Backlash Indicator Rod 91-78473



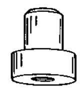
17. Dial Indicator 91-58222A1



18. Bearing Retainer Tool 91-43506

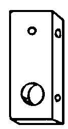


19. Mandrel 91-92788

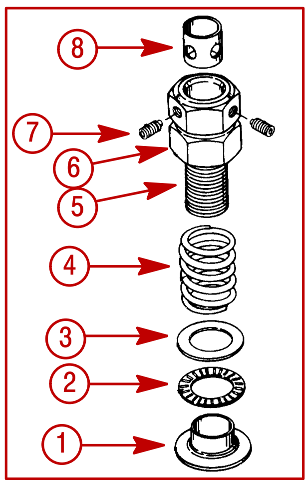


20. Mandrel 91-15755

21. Dial Indicator Holder 91-89897

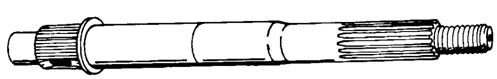


22. Bearing Preload Tool 91-14311A1

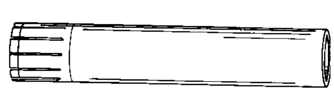


1 **-** Adaptor (N.S.S.)
2 **-** Bearing (N.S.S.)
3 **-** Washer (N.S.S.)
4 **-** Spring (24-14111)
5 **-** Bolt (10-12580)
6 **-** Nut (11-13953)
7 **-** Set Screw (10-12575)
8 **-** Sleeve (23-13946)

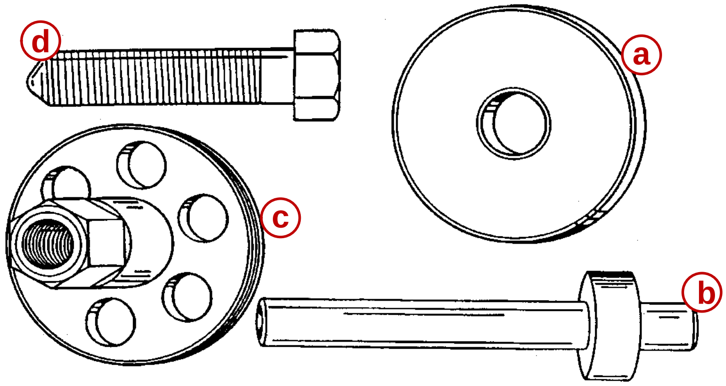
23. Propeller Shaft 44-93003 and Load Washer (i) 12-37429



24. Forward Gear Installation Tool 91-815850



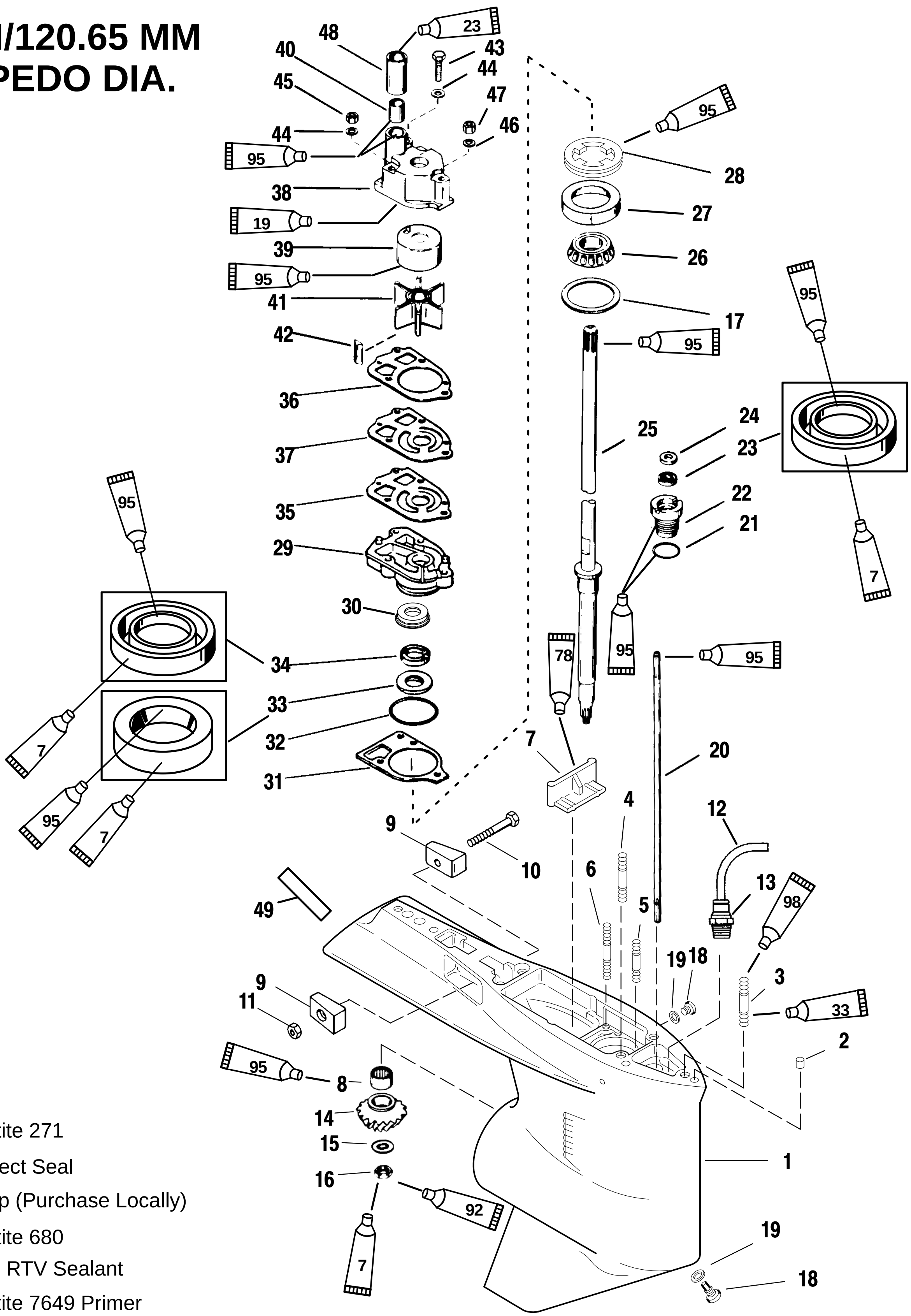
25. Reverse Gear Installation Kit 91-18605A1 includes Pilot 91-18603; Retainer 91-18604; Shaft 91-18605 and Screw 10-18602



a - Pilot 91-18603
b - Shaft 91-18605
c - Retainer 91-18604
d - Screw 10-18602

Gear Housing (Drive Shaft)(Counter Rotation)

4.75 IN/120.65 MM TORPEDO DIA.

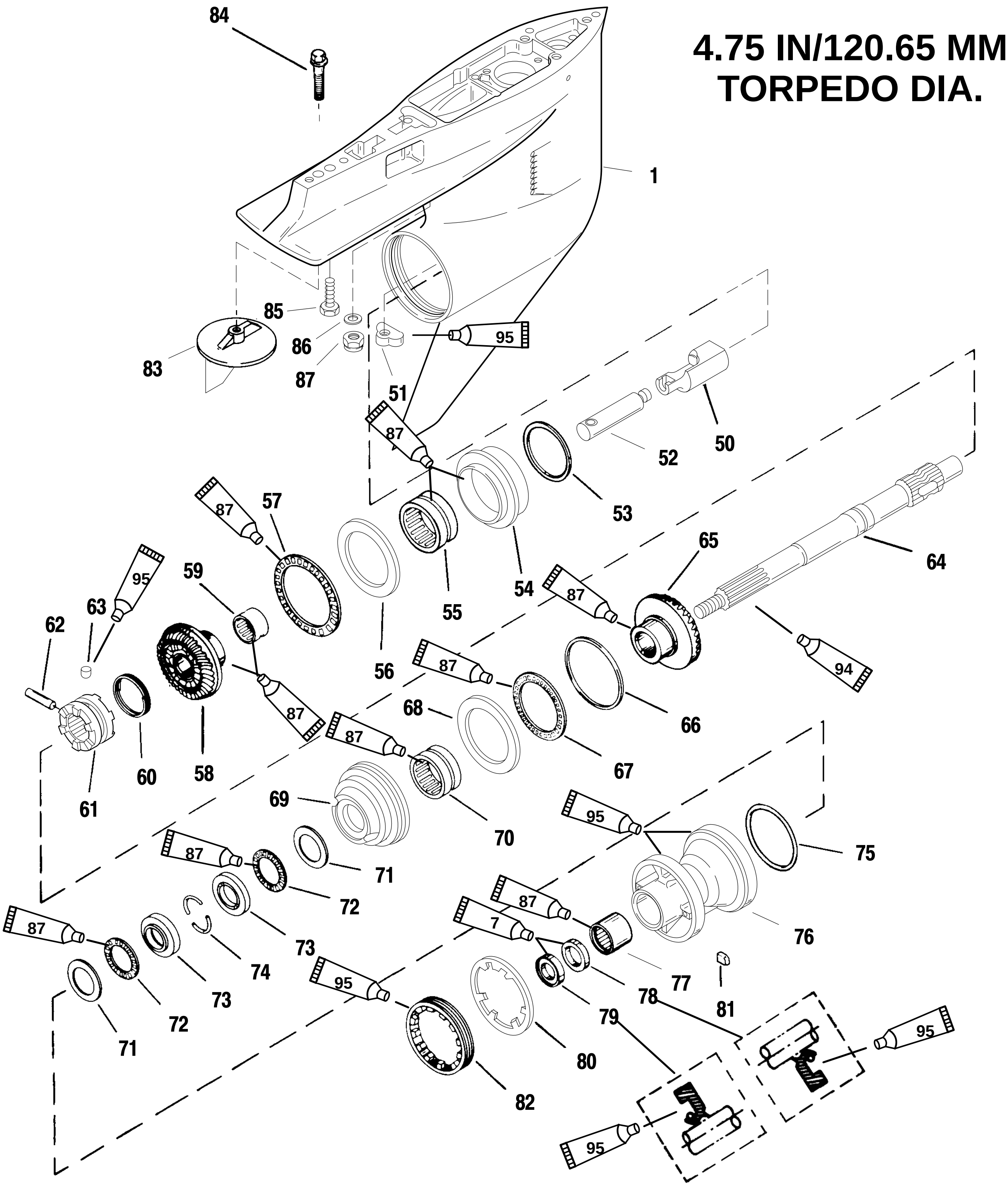


7	Loctite 271
19	Perfect Seal
23	Soap (Purchase Locally)
33	Loctite 680
78	G. E. RTV Sealant
92	Loctite 7649 Primer
95	2-4-C with Teflon

Gear Housing (Drive Shaft)(Counter Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
1	1	GEAR HOUSING **(BASIC)**			
2	2	DOWEL PIN			
3	1	STUD (3-11/16 IN.)			
4	2	STUD (2-1/16 IN.)			
5	1	STUD (3-3/8 IN.)			
6	2	STUD (3-1/8 IN.)			
7	1	FILLER BLOCK			
8	1	ROLLER BEARING			
9	2	ANODE			
10	1	SCREW			
11	1	NUT	60		7
12	1	HOSE (12 IN.)			
13	1	FITTING	50		5.5
14	1	PINION GEAR **(1.87:1 - 15 TEETH)**			
	1	PINION GEAR **(2:1 - 14 TEETH)**			
15	1	WASHER			
16	1	NUT		75	101
17	AR	SHIM (006 thru 048)			
18	2	SCREW–drain	60		7
19	2	WASHER			
20	1	SHIFT SHAFT			
21	1	O-RING			
22	1	BUSHING ASSEMBLY		50	68
23	1	OIL SEAL			
24	1	WASHER–rubber			
25	1	DRIVE SHAFT			
26	1	ROLLER BEARING			
27	1	CUP			
28	1	RETAINER		100	135
29	1	WATER PUMP BASE			
30	1	RETAINER			
31	1	GASKET			
32	1	O-RING			
33	1	OIL SEAL			
34	1	OIL SEAL			
35	1	GASKET–lower			
36	1	GASKET–upper			
37	1	FACE PLATE			
38	1	WATER PUMP BODY ASSEMBLY			
39	1	INSERT			
40	1	SEAL–rubber			
41	1	IMPELLER			
42	1	KEY			
43	1	SCREW (#14-8 x 2-1/4 IN.)	35		4
44	2	WASHER			
45	2	NUT	50		5.5
46	1	WASHER			
47	1	NUT	50		5.5
48	1	SLEEVE			
49	1	DECAL-Counter Rotation			

Gear Housing (Prop Shaft)(Counter Rotation)

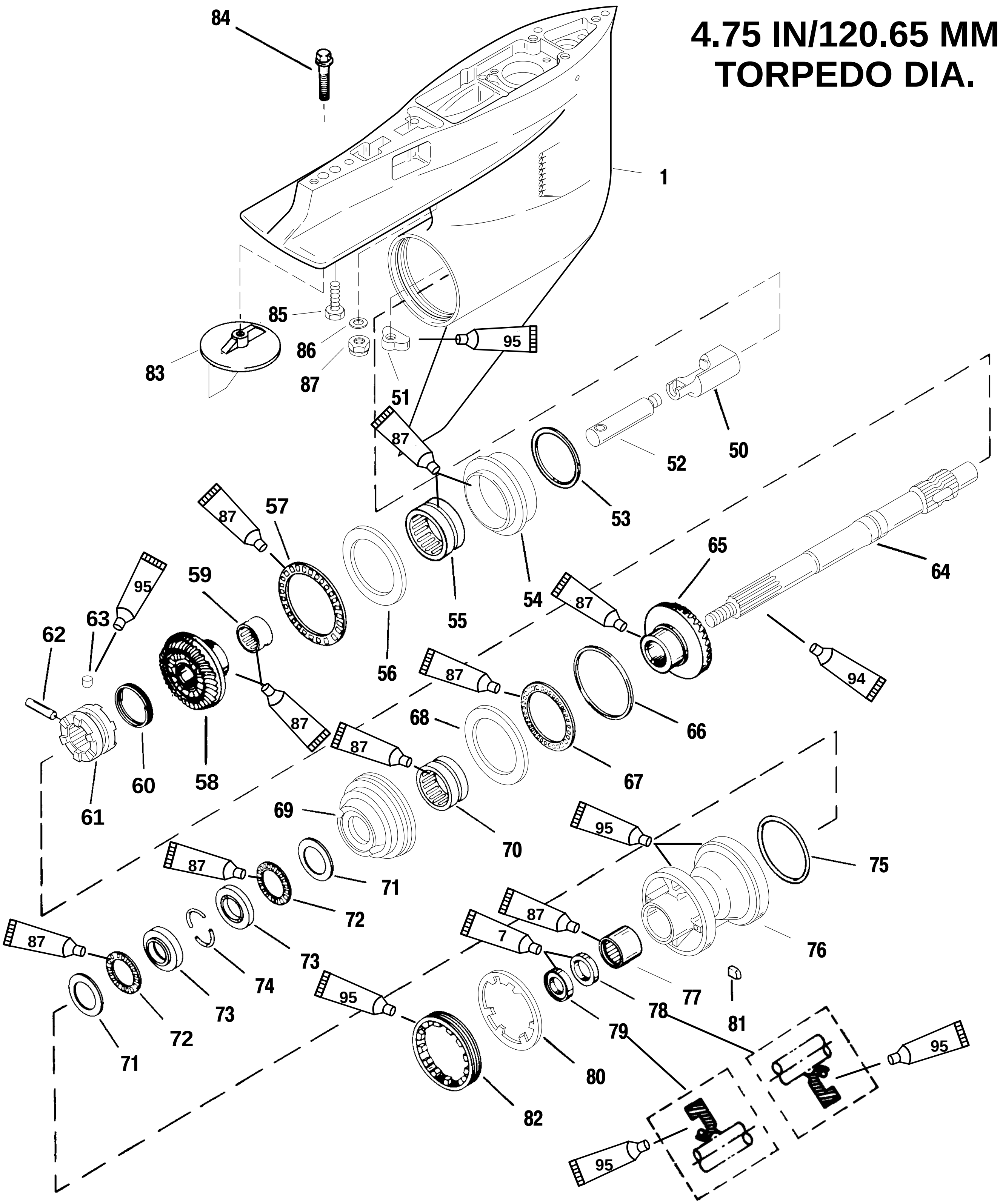


7	Loctite 271
87	Quicksilver Gear Lubricant
94	Anti-Corrosion Grease
95	2-4-C with Teflon

Gear Housing (Prop Shaft)(Counter Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	TORQUE lb-ft	TORQUE Nm.
1	1	GEAR HOUSING **(BLACK)(BASIC)**			
50	1	CAM FOLLOWER			
51	1	SHIFT CAM			
52	1	ROD			
53	AR	SHIM SET			
54	1	BEARING ADAPTOR ASSEMBLY			
55	1	ROLLER BEARING			
56	1	THRUST WASHER			
57	1	THRUST BEARING			
58	1	REVERSE GEAR **(1.87:1 – 15/28)**			
	1	REVERSE GEAR **(2:1 – 14/28)**			
59	1	ROLLER BEARING			
60	1	SPRING			
61	1	SLIDING CLUTCH			
62	1	CROSS PIN			
63	1	DETENT PIN			
64	1	PROPELLER SHAFT			
65	1	FORWARD GEAR **(1.87:1 – 15/28)**			
	1	FORWARD GEAR **(2:1 – 14/28)**			
66	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.			

Gear Housing (Prop Shaft)(Counter Rotation)



7 Loctite 271

87 Quicksilver Gear Lubricant

94 Anti-Corrosion Grease

95 2-4-C With Teflon

Gear Housing (Prop Shaft)(Counter Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE lb-in	lb-ft	Nm.
1	1	GEAR HOUSING **(BLACK)(BASIC)**			
67	1	ROLLER BEARING			
68	1	THRUST WASHER			
69	1	BEARING ADAPTOR ASSEMBLY			
70	1	ROLLER BEARING			
71	2	THRUST WASHER			
72	2	THRUST BEARING			
73	2	THRUST RACE			
74	2	KEEPER			
75	1	O RING			
76	1	BEARING CARRIER ASSEMBLY			
77	1	ROLLER BEARING			
78	1	OIL SEAL (INSIDE)			
79	1	OIL SEAL (OUTSIDE)			
80	1	TAB WASHER			
81	1	KEY			
82	1	COVER		210	285
83	1	TRIM TAB			
84	1	SCREW (1-3/4 IN.)		25	34
85	1	SCREW (3/8-16 x 1)		30	41
86	2	WASHER			
87	2	NUT		50	68

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 with Teflon Marine Lubricant on all O-rings. To prevent wear, apply 2-4-C with Teflon Marine Lubricant on I.D. of oil seals. To prevent corrosion damage after reassembly, apply Quicksilver 2-4-C with 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.

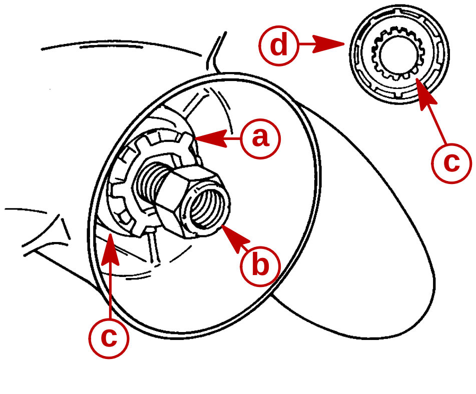
1. Disconnect high tension leads from spark plugs and remove spark plugs from engine.

⚠ CAUTION

Gear housing MUST BE in NEUTRAL position and shift shaft MUST BE removed from gear housing BEFORE propeller shaft can be removed from gear housing.

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.
7. Remove 2 locknuts from bottom middle of anti-cavitation plate.



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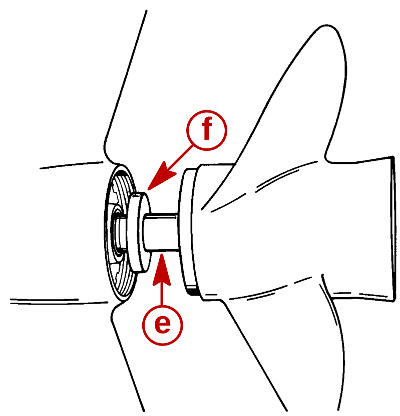

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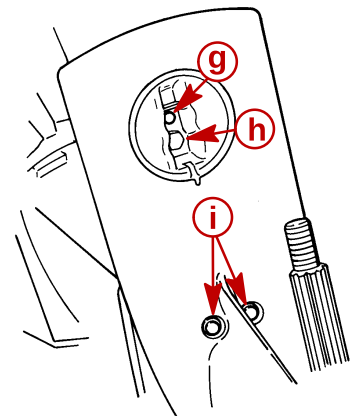

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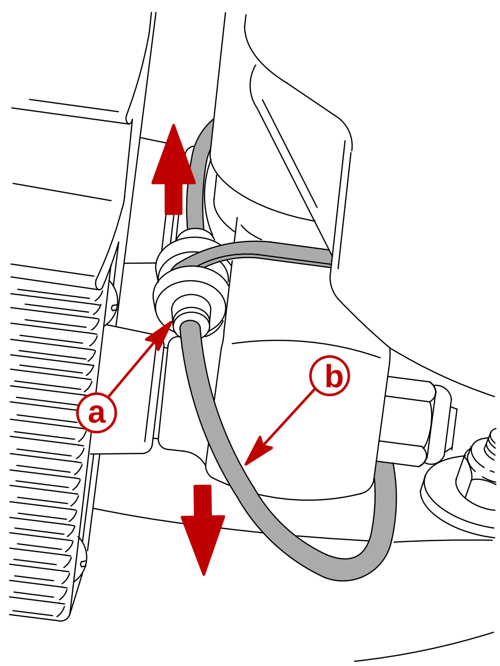
a - Tab Washer
b - Propeller Nut
c - Rear Thrust Hub
d - Continuity Washer (if equipped)
e - Propeller Shaft
f - Thrust Hub (forward)
g - Bolt (secures trim tab)
h - Bolt (inside trim tab cavity)
i - Locknuts and Washers

8. While pressing in on speedometer hose junction, pull out on hose to disconnect.



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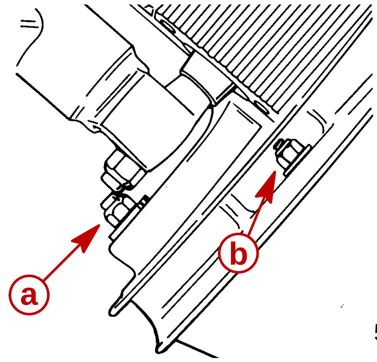
a - Press in on Junction
b - Pull out on Hose

9. Remove locknut from the front gear housing mounting stud.
10. Loosen the side mounting locknuts. (DO NOT attempt to remove one nut before opposite side is loosened sufficiently, or driveshaft housing could be damaged.)



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a - Front Mounting Locknut
b - Side Mounting Locknut (One Each Side)

11. Pull gear housing away from driveshaft housing as far as the loosened nuts (in Step 9) will allow, then remove loosened nuts. (DO NOT allow gear housing to fall, as it now is free.)
12. Pull gear housing from driveshaft housing.

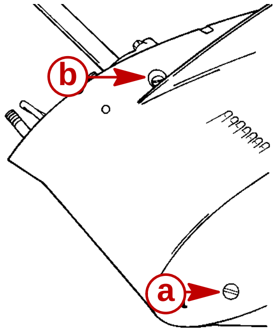
DRAINING AND INSPECTING GEAR HOUSING LUBRICANT

1. Place gear housing in a suitable holding fixture or vise with the driveshaft in a vertical position, 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.



51871

a - Fill Screw
b - Vent Screw

Water Pump

CLEANING AND INSPECTION

1. Clean all water pump parts with solvent and dry with compressed air.
2. Inspect water pump cover and base for cracks and distortion (from overheating).
3. Inspect face plate and water pump insert for grooves and/or rough surfaces.

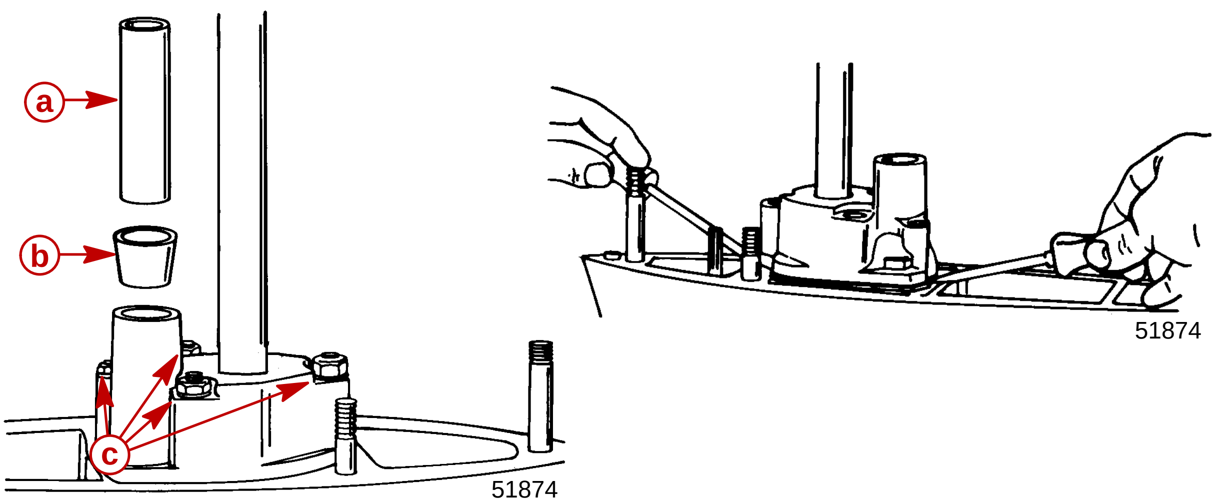
IMPORTANT: When completing gear housing repairs, that require removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to re-use impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur.

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.

IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

REMOVAL AND DISASSEMBLY

1. Slide rubber centrifugal slinger up and off driveshaft.
2. Remove water tube guide and seal from water pump cover. (Retain guide for reassembly and discard seal.)
3. Remove (and retain) 3 nuts, one bolt and all washers which secure water pump cover to gear housing.
4. Using 2 pry bars, lift water pump cover up and off driveshaft.



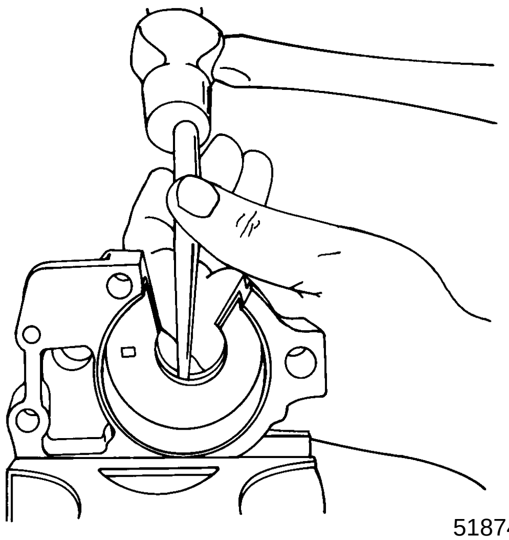
a - Water Tube Guide
b - Water Tube Seal
c - Nuts, Bolt and Washers to be Removed

5. Inspect water pump cover and insert, as outlined in “Cleaning and Inspection,” previous.
6. If inspection of water pump insert determines that replacement is required, follow Step “a” or “b” (immediately following) to remove insert from water pump cover.

NOTE: *Try Step "a" first. If insert cannot be removed with Step "a," use Step "b."*

a. Drive water pump insert out of water pump cover with a punch and hammer.

b. Drill two 3/16 in. (4.8 mm) diameter holes thru the top of water pump cover (but not thru insert). Drive insert out of cover with a punch and hammer.



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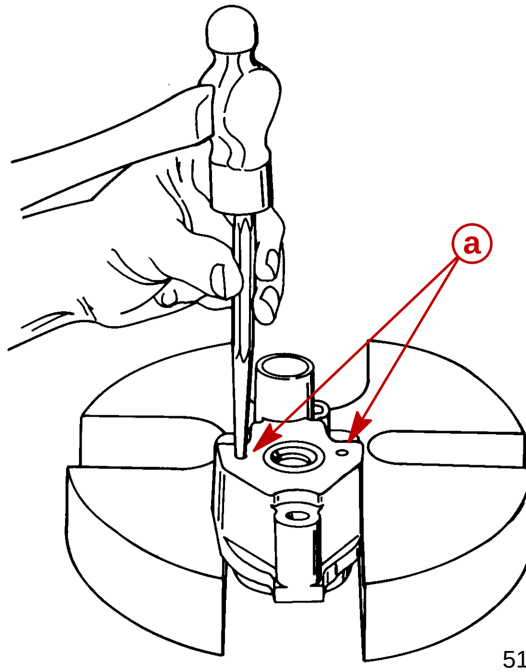
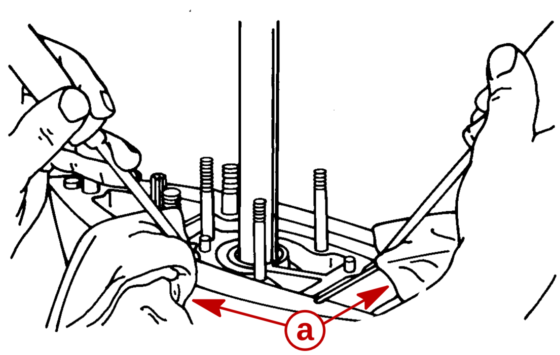


51873

a - Drill Two Holes at These Locations

7. Remove impeller from driveshaft. (It may be necessary to use a punch and hammer to drive impeller upward on driveshaft. In extreme cases, it may be necessary to split hub of impeller with a hammer and chisel.)
8. Once impeller is removed, remove impeller drive key from driveshaft.
9. Remove water pump face plate and both gaskets (one above and below face plate) from water pump base.
10. Using 2 pry bars, positioned and padded as shown, lift water pump base up and off driveshaft.



51874

a - Pads

11. Remove (and discard) O-ring from O-ring groove on water pump base.
12. Using a screwdriver, pry oil seals out of water pump base from gear housing side of base.

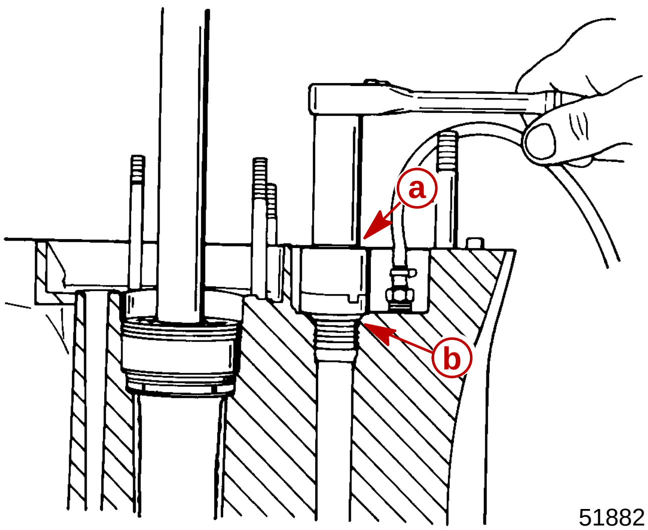
Bearing Carrier and Propeller Shaft

REMOVAL

CAUTION

Gear housing MUST BE in neutral position, and shift shaft MUST BE removed from gear housing before propeller shaft can be removed from gear housing.

1. Place gear housing in a suitable holding fixture or vise with propeller shaft in a horizontal position.
2. Use Shift Shaft Bushing Tool (91-31107) to un-thread shift shaft bushing. (DO NOT remove bushing from shift shaft at this time.)
3. Bend retainer nut lock tab out of retainer nut recess.



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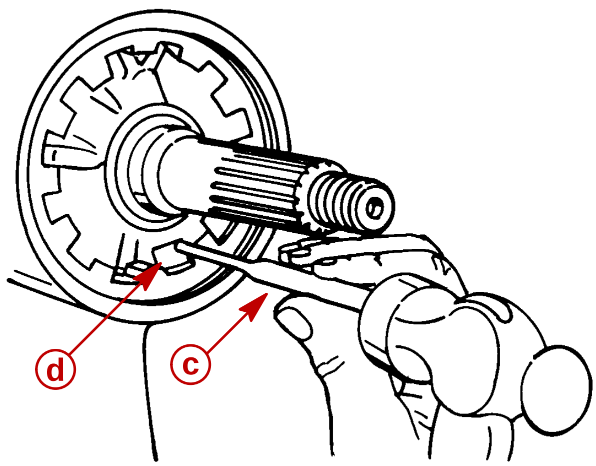

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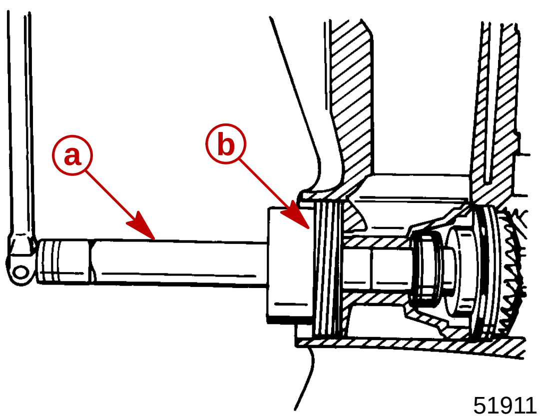
a - Shift Shaft Bushing Tool (91-31107)
b - Shift Shaft Bushing
c - Punch
d - Tab of Tab Washer

4. Remove gear housing retainer nut with Retainer Nut Tool (91-61069).
5. After retainer nut has been removed, remove lock tab washer from gear housing.



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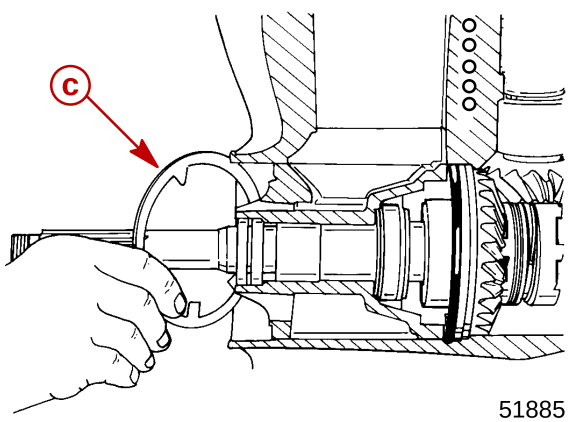

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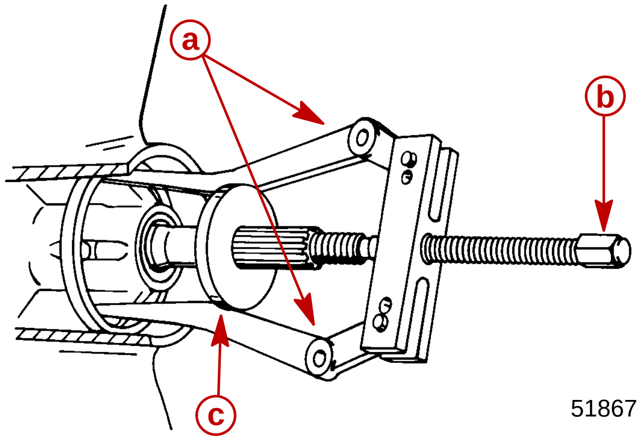
a - Retainer Nut Tool (91-61069)
b - Retainer Nut
c - Tab Washer

⚠CAUTION

Once bearing carrier is removed from gear housing, extreme care MUST BE taken not to apply any side force on propeller shaft. Side force on propeller shaft may break the neck of the clutch actuator rod.

6. Use long Puller Jaws (91-46086A1) and Puller Bolt (91-85716) to remove bearing carrier. (Use propeller thrust hub to maintain outward pressure on puller jaws.)

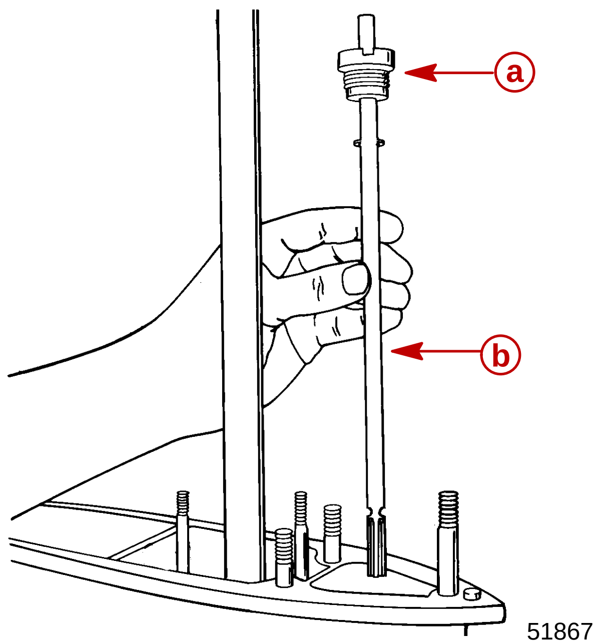
NOTE: *When bearing carrier is removed from gear housing, the bearing carrier alignment key will come out with it.*



a - Long Puller Jaws (91-46086A1)
b - Puller Bolt (91-85716)
c - Thrust Hub

IMPORTANT: Prior to removal of shift shaft from gear housing, recheck that gear housing is in neutral position.

7. With gear housing in neutral, pull shift shaft out of gear housing. If necessary, use a pliers to pull shift shaft out of gear housing. If pliers are used to pull shift shaft out, wrap a strip of soft metal (aluminum) around splines before clamping pliers. DO NOT turn shaft (clockwise OR counterclockwise) while pulling shaft out. (For further information on shift shaft, see “Shift Shaft Cleaning/Inspection and Disassembly.”)



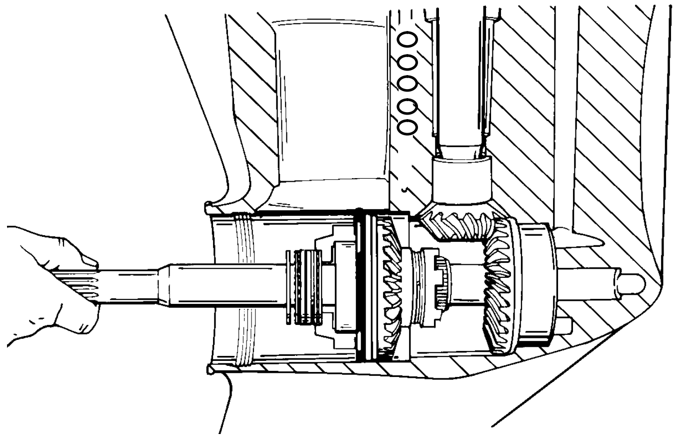
a - Shift Shaft Bushing
b - Shift Shaft

⚠ CAUTION

Propeller shaft, cam follower and shift cam, in most cases, will come out of gear housing by simply pulling outward on propeller shaft. DO NOT FORCE shaft sideways or ATTEMPT TO PULL with a slide hammer or any mechanical puller.

8. Remove propeller shaft, cam follower and shift cam by pulling shaft straight out of gear housing. (DO NOT JERK propeller shaft.)

NOTE: *Sliding clutch, forward gear assembly, bearing adaptor, thrust washer and thrust bearings will be removed from gearcase with propeller shaft.*



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9. If propeller shaft will not come out, proceed with Step "a" or "b," following:
   a. Push propeller shaft back into place against the reverse gear. Visually inspect location of shift cam by looking down shift shaft hole (illuminated with a flashlight). If splined hole in shift cam is visible, reinstall shift shaft and rotate shift shaft to neutral position. Remove shift shaft, then remove propeller shaft as instructed in Step 8, immediately preceding.
   b. Push propeller shaft back into place against reverse gear. Slide bearing carrier back into gear housing (to support propeller shaft). Place gear housing on its left side (viewed from rear) and strike upper leading end of gear housing with a rubber mallet. This will dislodge the shift cam from cam follower into a clearance pocket in left side of gear housing. Remove bearing carrier and pull propeller shaft out of gear housing.

NOTE: *If Step 9-b was used to remove propeller shaft, the shift cam can be retrieved after removal of reverse gear.*

Shift Shaft

CLEANING AND INSPECTION

1. Clean shift shaft and bushing with solvent and dry with compressed air.
2. Check shift shaft splines on both ends for wear and/or corrosion damage.
3. Inspect shift shaft for groove(s) at shift shaft bushing seal surface.
4. Inspect shift shaft bushing for corrosion damage.
5. Inspect shift shaft bushing oil seal for wear and/or cuts.

DISASSEMBLY

1. Remove (and discard) shift shaft bushing oil seal by prying it out or driving it out with a punch and hammer.

CLEANING/INSPECTION - BEARING CARRIER

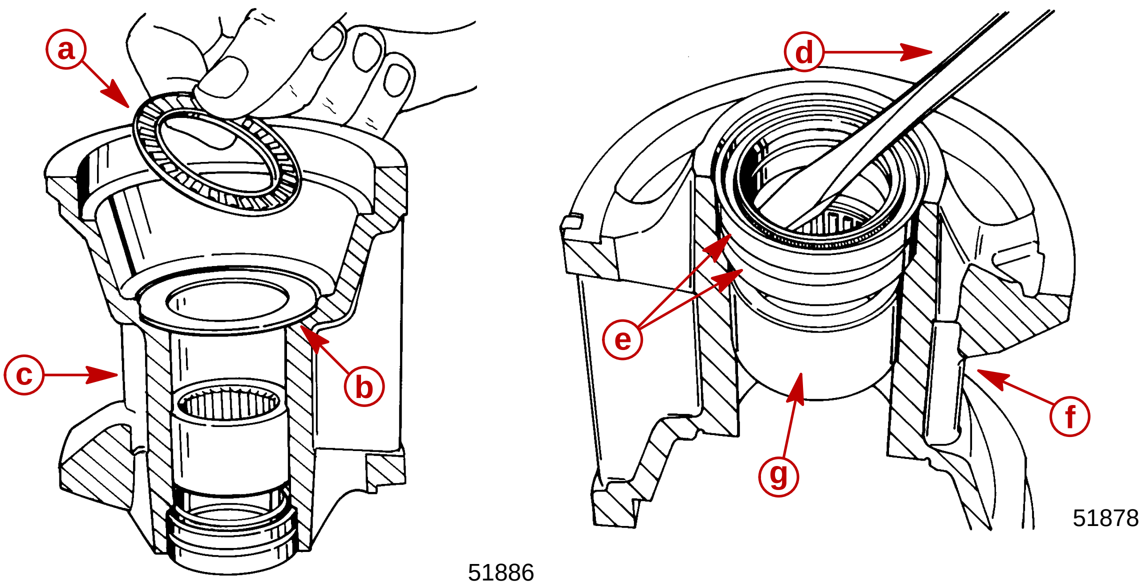
IMPORTANT: It is recommended that all seals and O-rings be replaced (as a normal repair procedure) to assure effective repair.

⚠ CAUTION
DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

1. Clean bearing carrier with solvent and dry with compressed air.
2. Bearing carrier propeller shaft needle bearing condition is determined by propeller shaft bearing surface condition. (See **"Propeller Shaft Inspection."**)

DISASSEMBLY- BEARING CARRIER

1. Remove thrust bearing and thrust washer from bearing carrier.
2. If thrust bearing, thrust washer or thrust bearing surface on propeller shaft shows signs of rust, pitting or blueing from lack of lubricant, component(s) should be discarded.
3. Remove bearing carrier oil seals.



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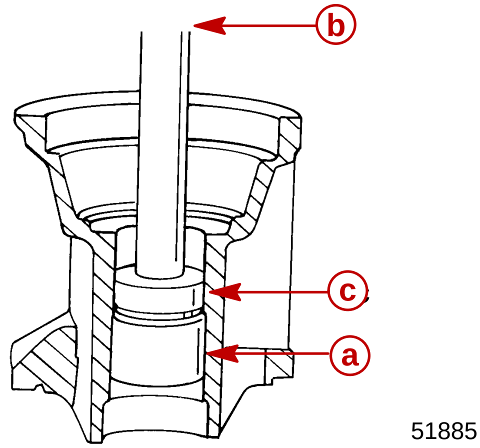
a - Thrust Bearing
b - Thrust Washer
c - Bearing Carrier
d - Pry Bar
e - Oil Seals
f - Bearing Carrier
g - Bearing Carrier Needle Bearing

NOTE: *Do not remove bearing carrier needle bearing unless replacement is needed.*

4. Use bearing removal and replacement tool (91-31229A5) or equivalent to press bearings out of bearing carrier.



a - Needle Bearing
b - Push Rod
c - Mandrel

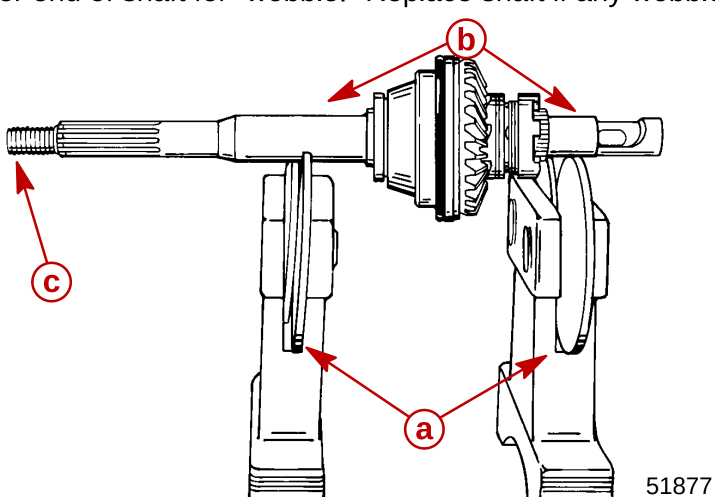
Propeller Shaft

INSPECTION

1. Clean propeller shaft assembly with solvent and dry with compressed air.
2. Inspect bearing carrier oil seal surfaces for grooves. Run fingernail across seal surface to check for groove. Replace shaft if groove is found.
3. Visually check bearing surfaces of propeller shaft for pitting, grooves, scoring, uneven wear or discoloration (bluish color) from overheating. Replace shaft and corresponding needle bearing if any of the above conditions are found. (Bearing carrier needle bearing contacts propeller shaft just in front of oil seal surface. Reverse gear bearing contacts propeller shaft in front of sliding clutch splines.)
4. Inspect propeller shaft splines for wear and/or corrosion damage.
5. Check propeller shaft for straightness. Use either method, following:

Balance Wheels

Place propeller shaft on balance wheels, as shown. Rotate propeller shaft and observe propeller end of shaft for “wobble.” Replace shaft if any wobble is observed.



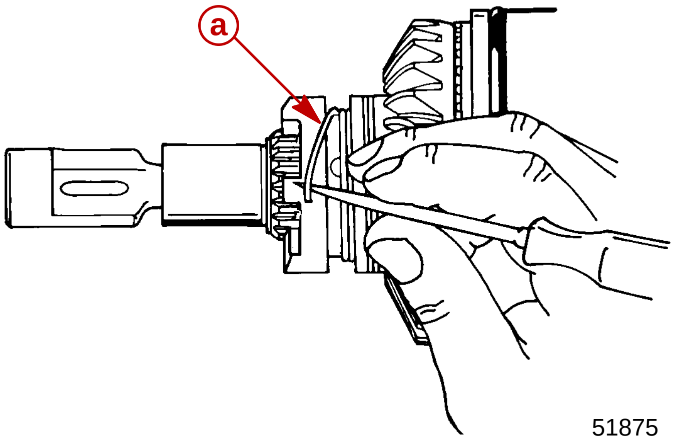
a - Balance Wheels
b - Bearing Surfaces
c - Watch for Wobble

"Vee" Blocks and Dial Indicator

Position propeller shaft roller bearing surfaces on vee blocks. Mount a dial indicator at front edge of propeller splines. Rotate propeller shaft. Dial indicator movement of more than 0.006 in. (0.152 mm) (or noticeable wobble) is reason for replacement.

DISASSEMBLY

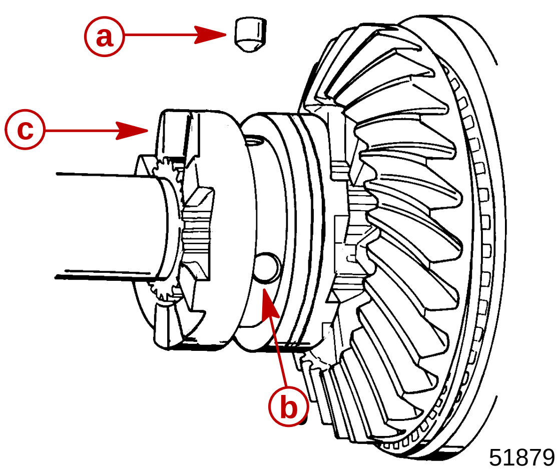
1. Remove shift cam from cam follower.
2. Insert a thin blade screwdriver or awl under first coil of cross pin retainer spring and rotate propeller shaft to unwind spring from sliding clutch. DO NOT overstretch spring.

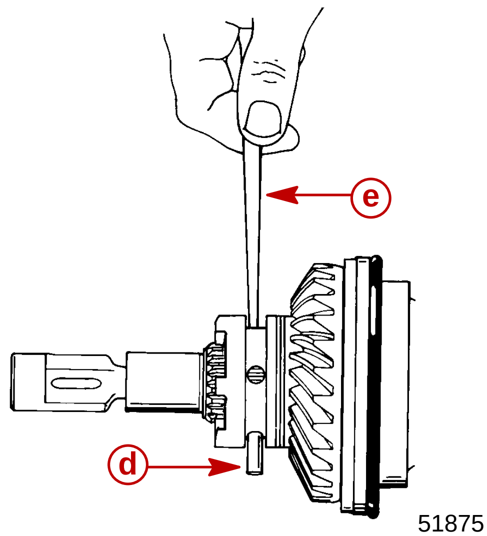


a - Cross Pin Retainer Spring

> **⚠ CAUTION**
>
> **Detent pin is free and can fall out of sliding clutch. Care MUST BE taken not to lose pin.**

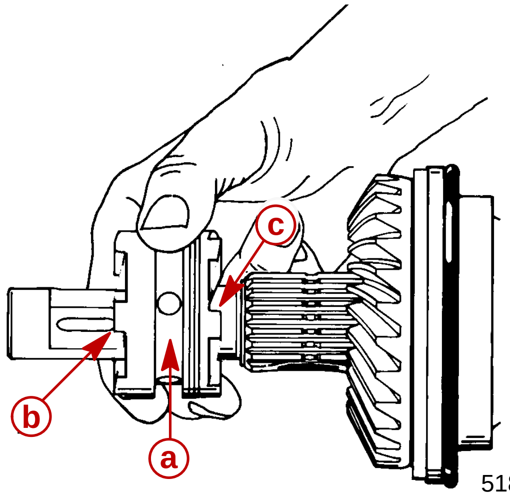
3. Detent pin is free and can be removed from sliding clutch at this time.
4. Push cross pin out of sliding clutch and propeller shaft with a punch.





a - Detent Pin
b - Cross Pin
c - Sliding Clutch
d - Cross Pin
e - Punch

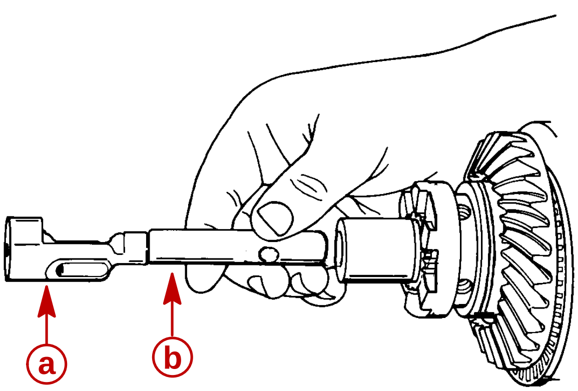
5. Pull sliding clutch off propeller shaft.
6. Inspect sliding clutch. Check reverse gear clutch "jaws" and forward gear clutch "jaws." Rounded "jaws" indicate one or more of the following:
   a. Improper shift cable adjustment.
   b. Improper shift habits of operator(s) (shift from neutral to reverse gear or forward gear too slowly).
   c. Engine idle speed too high (while shifting).



51875

a - Sliding Clutch
b - Reverse Gear Clutch Jaws
c - Forward Gear Clutch Jaws

7. Pull cam follower and clutch actuator rod out of propeller shaft. DO NOT force cam follower up-or-down or side-to-side when pulling from propeller shaft.
8. Once cam follower and clutch actuator rod are removed from propeller shaft, lift rod out of cam follower.
9. Check condition of cam follower. If it shows wear (pitting, scoring or rough surface), replace cam follower and shift cam.
10. Remove forward gear and bearing adaptor assembly.
11. Remove 2 thrust races and 2 keepers from prop shaft.



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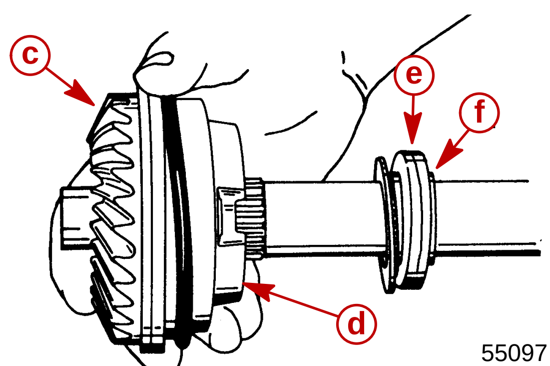


55097

a - Cam Follower
b - Clutch Actuator Rod
c - Forward Gear
d - Bearing Adaptor Assembly
e - Thrust Races (2)
f - Keepers (hidden) (2)

Clutch Actuator Rod

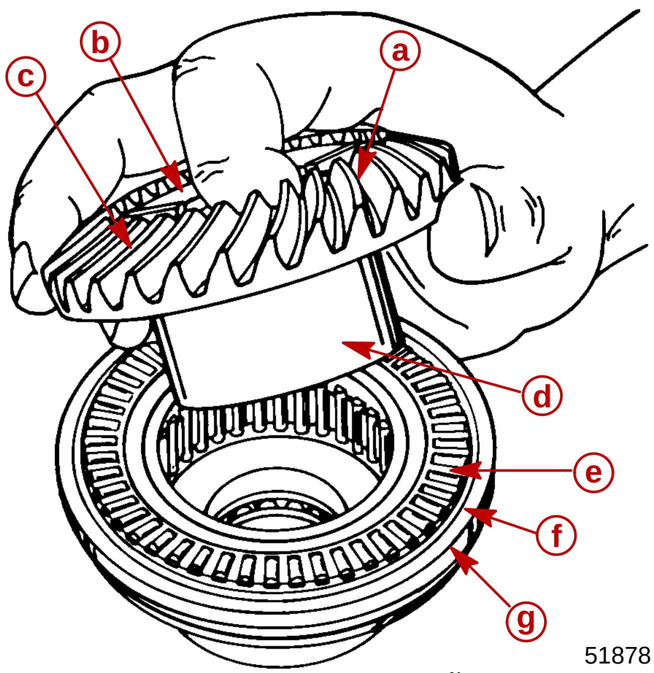
CLEANING AND INSPECTION

1. Clean clutch actuator rod in solvent and dry with compressed air.
2. Inspect actuator components for wear or damage. Replace components as required.

Forward Gear and Bearing Adapter

DISASSEMBLY/CLEANING/INSPECTION

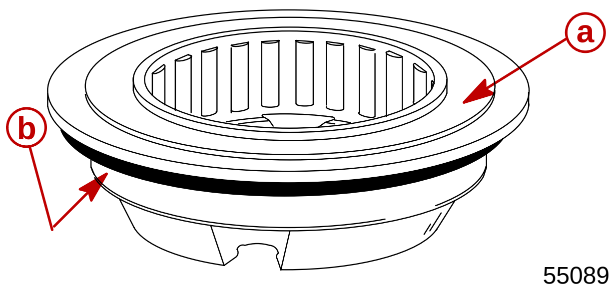
1. Remove forward gear from bearing adapter.
2. Inspect forward gear clutch teeth for signs of wear. If clutch teeth are worn, sliding clutch should be replaced also.
3. Inspect forward gear teeth for full tooth contact, chips, pits and signs of rust. If forward gear teeth are damaged, pinion gear must be inspected and replaced if necessary.
4. Inspect forward gear hub for signs of pitting, rust, scoring or discoloration (blueing) due to lack of lubricant.
5. Remove thrust bearing and spacer shim. Inspect thrust bearing for pits, rust, or discoloration (blueing) due to lack of lubricant.



a - Forward Gear
b - Forward Gear Clutch Teeth
c - Forward Gear Teeth
d - Forward Gear Hub
e - Thrust Bearing
f - Thrust Washer
g - Spacer Shim

6. Remove thrust washer and O-ring. The thrust washer acts as a bearing surface for the thrust bearing and it should be inspected for pits, rust, scoring or discoloration due to lack of lubricant. O-ring should be inspected for cuts or abrasions and replaced if necessary.

7. Remove thrust bearing and thrust washer from bearing adaptor. Thrust roller bearing should be inspected for pitting, rust or signs of discoloration (blueing) due to lack of lubricant. If thrust roller bearing must be replaced, the bearing surfaces on the thrust washer and propeller shaft where the thrust roller bearing rides should also be inspected for signs of wear.



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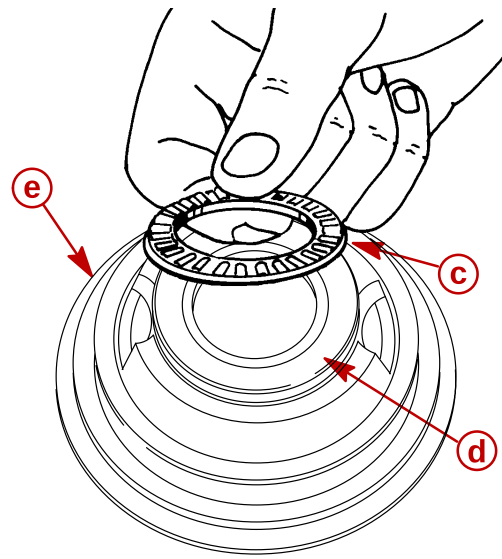
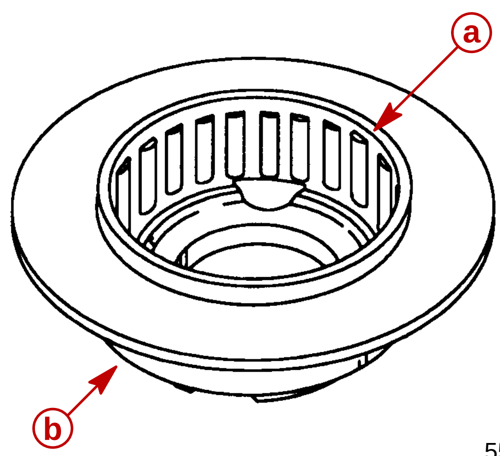


55090

a - Thrust Washer
b - O-Ring (hidden)
c - Thrust Bearing
d - Thrust Washer
e - Bearing Adaptor

8. The forward gear bearing should be carefully inspected for smoothness of movement, pits, rust, or signs of discoloration (blueing) due to lack of lubricant. If the bearing must be replaced, it is recommended that a hammer and cape chisel be used to break the bearing loose from the bearing adapter. Be careful not to damage bearing adapter when removing roller bearing.



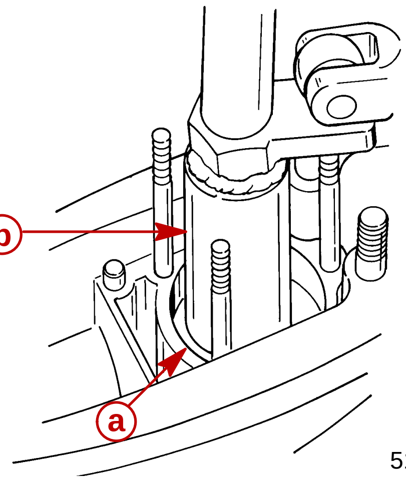
55091

a - Forward Gear Bearing
b - Bearing Adaptor

Pinion Gear and Driveshaft

REMOVAL

1. Remove bearing retainer using Bearing Retainer Tool (91-43506).



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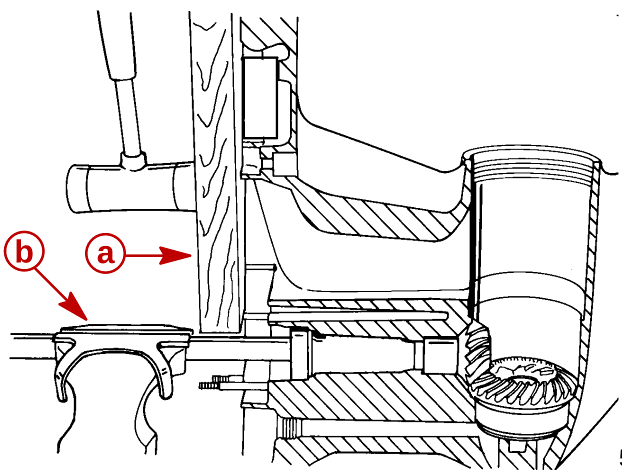
a - Bearing Retainer
b - Bearing Retainer Tool (91-43506)

2. Place Driveshaft Holding Tool (91-34377A1) over driveshaft splines.
3. Use a socket and flex handle to hold pinion nut. (Pad area of gear housing, where flex handle will make contact, to prevent damage to gear housing.)
4. Use a socket and flex handle on Driveshaft Holding Tool to loosen pinion nut. Remove pinion nut and Driveshaft Holding Tool.
5. Remove gear housing from vise and re-position it as shown. Be sure to use soft jaw vise covers and clamp as close as possible to water pump studs.
6. Place a block of wood on gear housing mating surface. Use a mallet and carefully tap gear housing away from driveshaft.

⚠ CAUTION
DO NOT strike gear housing hard with the mallet or allow gear housing to fall.

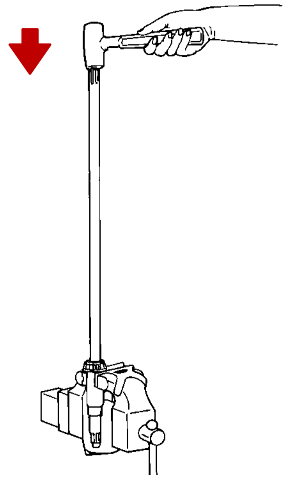


51878

a - Wooden Block
b - Soft Jaw Vise Covers

7. Reach into gear housing and remove pinion gear.

8. After driveshaft is removed from gear case, remove and retain shim(s) that were located under upper tapered driveshaft bearing.
9. If inspection determines that replacement of driveshaft tapered bearing is required, remove bearing from driveshaft as follows:
   a. Position driveshaft in a vise; DO NOT tighten vise jaws against shaft.
   b. Strike shaft with a lead hammer; take care not to drop shaft.



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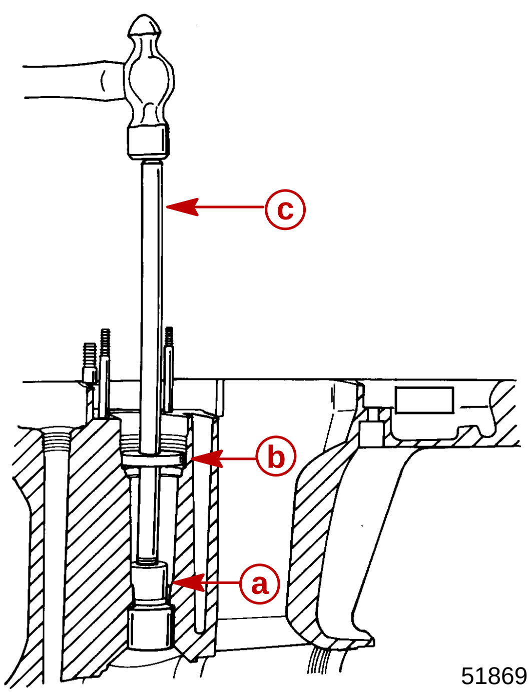
10. Remove 18 loose needles from outer race of driveshaft needle bearing.
11. If inspection of driveshaft needle bearing surface determines that replacement of needle bearing is required, the 18 loose needle bearings previously removed must be reinstalled in bearing race to provide surface for mandrel to drive against.

NOTE: *Reverse gear must be removed first before removing driveshaft needle bearing.*

IMPORTANT: Discard driveshaft needle bearing after removal. (Bearing cannot be reused.)



51869

a - Mandrel (91-37263)
b - Pilot* (91-36571)
c - Driver Rod* (91-37323)

*From Bearing Removal and Installation Kit (91-31229A5)

CLEANING AND INSPECTION

1. Clean driveshaft, tapered bearing and race, and pinion gear with solvent. Dry with compressed air. DO NOT allow driveshaft bearing to spin while drying.
2. Inspect pinion gear for pitting, grooves, scoring, uneven wear and/or discoloration from overheating. Replace pinion gear, if any of the above conditions are found.
3. Inspect driveshaft needle bearing surface (area just above pinion gear splines) for pitting, grooves, scoring, uneven wear and/or discoloration from overheating. Replace driveshaft and driveshaft needle bearing, if any of the preceding conditions are found.
4. Inspect driveshaft to crankshaft splines for wear. Replace driveshaft if wear is excessive.
5. Inspect tapered bearing race for pitting, grooves, scoring, uneven wear and discoloration from overheating. Replace tapered bearing and race as a set, if any of the preceding conditions are found.
6. Inspect driveshaft for groove(s) where water pump base oil seals contact shaft. Replace driveshaft if groove(s) are found.

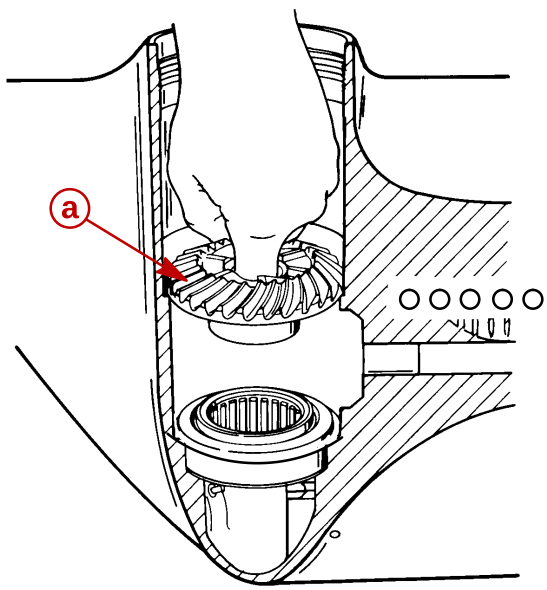
Reverse Gear

REMOVAL AND DISASSEMBLY

NOTE: *Reverse gear can be removed from gear housing only after driveshaft and pinion gear have been removed.*

NOTE: *Cautiously applying heat to both sides of gearcase where reverse gear assembly is located will aid in removal of bearing cup adapter.*

1. Remove reverse gear by hand.



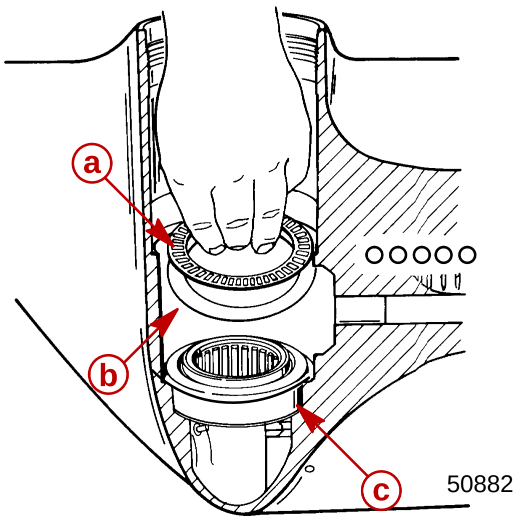
50884

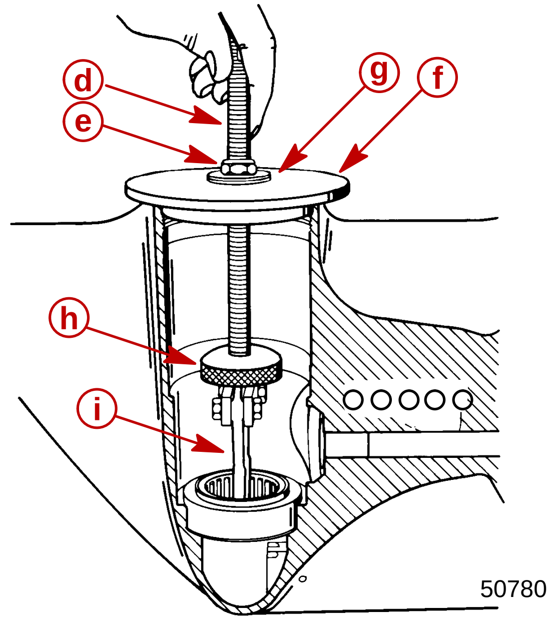
a - Reverse Gear

IMPORTANT: DO NOT remove needle bearing from reverse gear unless replacement of bearing is required. Bearing cannot be reused after it has been removed.

2. Remove thrust bearing and thrust washer from reverse gear bearing cup.

3. Remove reverse gear bearing adaptor. Remove, measure and make note of the shim thickness and **discard (DO NOT reuse shims if they are damaged during removal) the shims.**





a - Thrust Bearing
b - Thrust Washer
c - Reverse Gear Bearing Adaptor
d - Bolt (91-31229)
e - Nut (91-11-24156)
f - Guide Plate (91-816243)
g - Washer (91-34961)
h - Puller Head (from Slide Hammer Puller Kit 91-34569A1)
i - Jaws (91-816242)

CLEANING AND INSPECTION

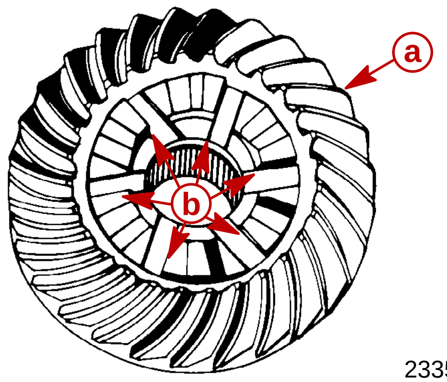
⚠ CAUTION

DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

1. Clean reverse gear and bearing with solvent and dry with compressed air. DO NOT spin the bearing.

2. Inspect gear teeth for pitting, grooves, scoring, uneven wear and for discoloration (from overheating). Replace gear if any of these conditions are found.

3. Check clutch jaws on reverse gear for damage. Replace reverse gear if damage is found.

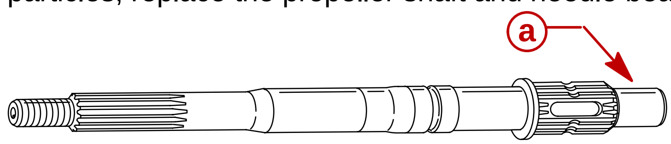


23351

a - Reverse Gear Teeth
b - Clutch Jaws

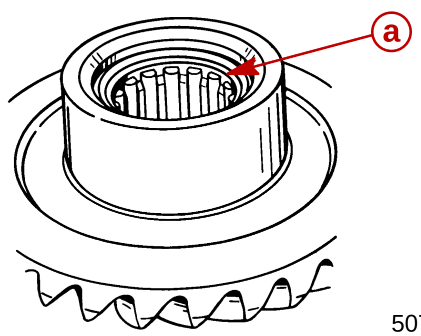
NOTE: *The needle bearings in the reverse gear should not be removed unless damage has been found. Inspect to ensure that all of the needles are present and in position. Needles that have been dislodged may be snapped back into place as long as no damage has occurred to the bearing cage.*

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, worn unevenly, discolored from overheating or has embedded particles, replace the propeller shaft and needle bearing in the reverse gear.



a - Reverse Gear Needle Bearing Contact Area

5. If reverse gear needle bearing is found to be damaged, place reverse gear in a press and use mandrel 91-63569 to press bearing out of gear.



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a - Bearing

Gear Housing

CLEANING AND INSPECTION

1. Clean gear housing with solvent and dry with compressed air.
2. Check gear housing carefully for impact damage.
3. Check for loose fitting bearing adaptors and needle bearings.

NOTE: *If bearing adaptors have spun in gear case, gear housing must be replaced.*

4. Inspect bearing carrier cover nut retainer threads in gear housing for corrosion damage and/or stripped threads.

Reassembly and Installation of Counter Rotation Gear Housing

Driveshaft Needle Bearing

REASSEMBLY/INSTALLATION

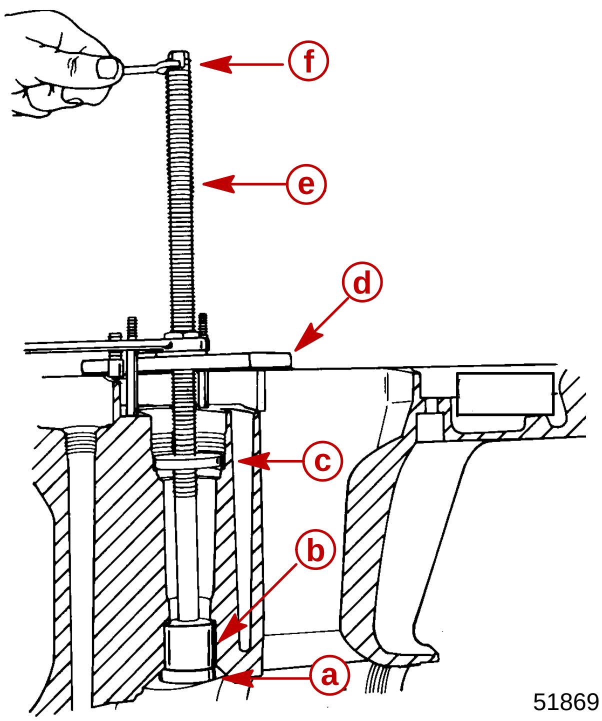
CAUTION

If driveshaft needle bearing failure has occurred, and original bearing race has turned in the gear housing, gear housing must be replaced. Loose fitting needle bearing will move out of position and cause repeated failures.

NOTE: *Driveshaft needle bearing must be installed prior to installation of reverse gear.*

1. Apply a thin coat of Quicksilver 2-4-C w/Teflon Lubricant to driveshaft needle bearing bore in gear housing.
2. By way of propeller shaft cavity, place needle bearing in driveshaft bore with numbered side of bearing facing up driveshaft bore.
3. Install and seat needle bearing with the following tools: Puller Rod* (91-31229), Nut* (91-24156), Pilot* (91-36571), Plate* (91-29310), and Mandrel* (91-92788). Pull bearing up into bore until it bottoms on gear housing shoulder. (DO NOT use excessive force.)

*From Bearing Removal and Installation Kit (91-31229A5)

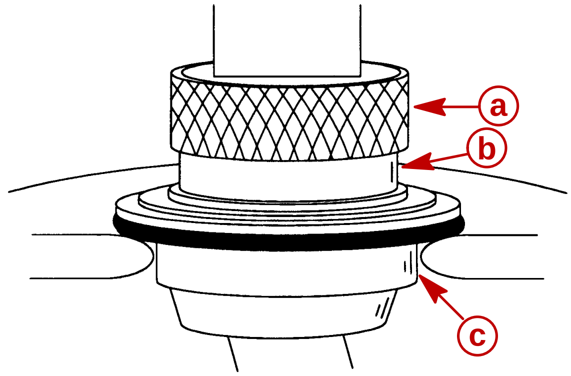


a - Mandrel
b - Bearing
c - Pilot
d - Plate
e - Puller Rod
f - Hold

Bearing Carrier, Forward Gear and Bearing Adaptor

REASSEMBLY

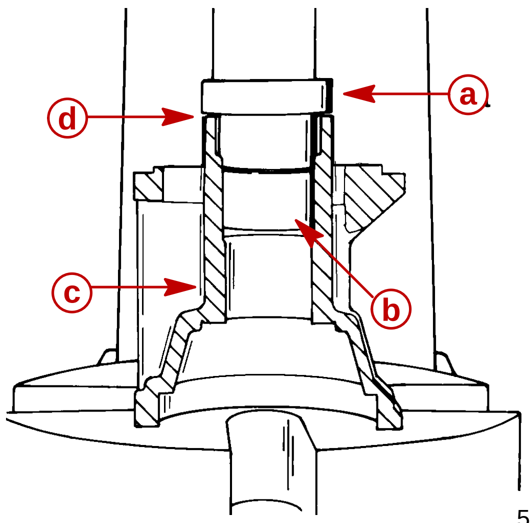
1. Using suitable mandrel, press forward gear bearing into bearing adaptor until bearing is flush with lip of adaptor.



a - Suitable Mandrel
b - Forward Gear Bearing
c - Bearing Adaptor

PROPELLER SHAFT NEEDLE ROLLER BEARING AND OIL SEAL INSTALLATION

1. Using mandrel 91-15755, press bearing carrier needle bearing (number side up) into bearing carrier until mandrel shoulder contacts bearing carrier.



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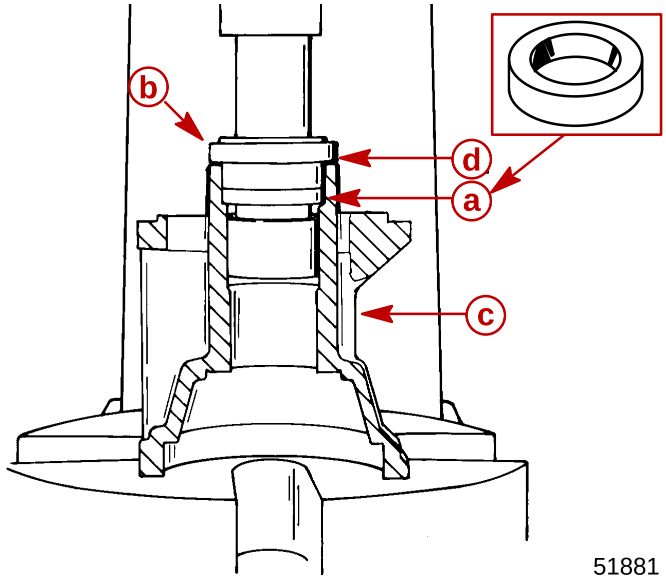
a - Mandrel (91-15755)
b - Bearing Carrier Needle Bearing
c - Bearing Carrier
d - Shoulder

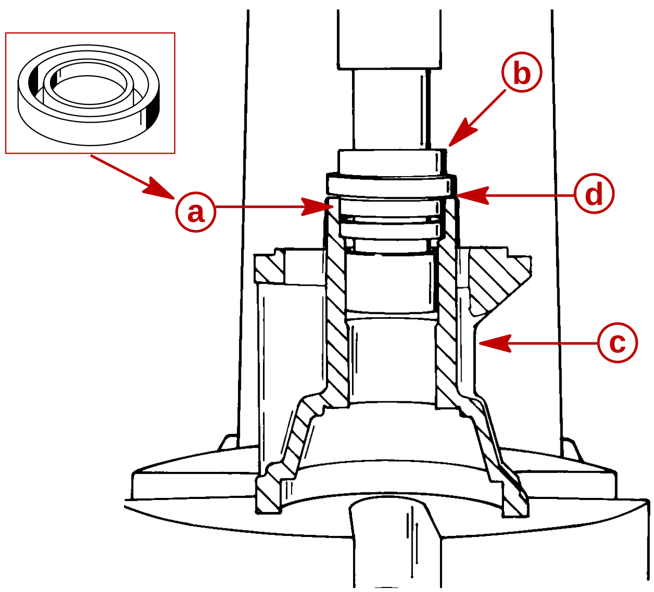
2. Apply Loctite 271 to outside diameter of oil seals.

3. With seal lip facing towards bearing, press inner seal (a) using long end of mandrel (b) (91-31108) into bearing carrier (c) until mandrel shoulder (d) bottoms out on bearing carrier.



a - Inner Seal
b - Mandrel (91-31108)
c - Bearing Carrier
d - Mandrel Shoulder

4. With seal lip facing towards mandrel, press outer seal (a) using short end of mandrel (b) (91-31108) into bearing carrier (c) until mandrel shoulder (d) bottoms out on bearing carrier.



a - Outer Seal
b - Mandrel (91-31108)
c - Bearing Carrier
d - Mandrel Shoulder

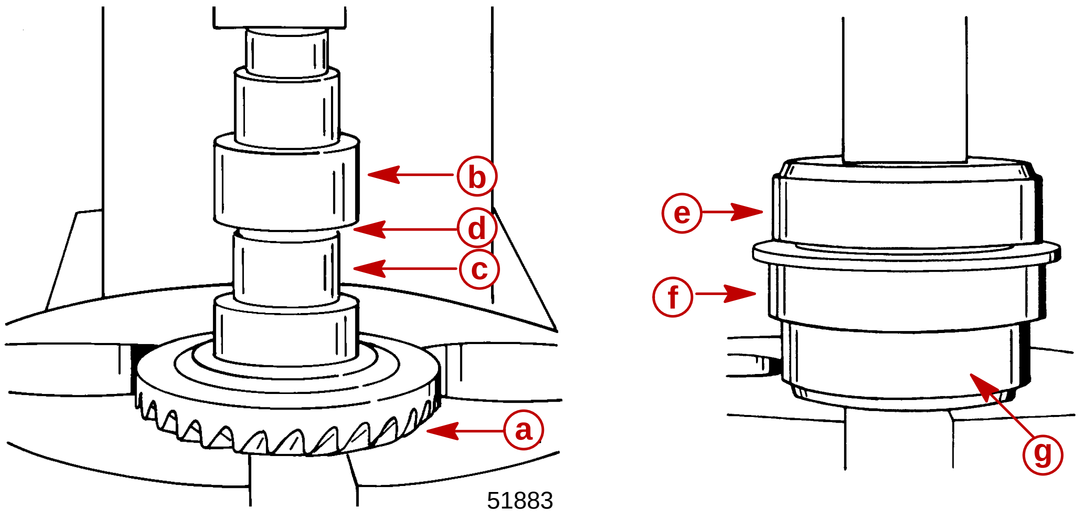
5. Lubricate both seal lips with 2-4-C with Teflon Marine Lubricant.

REVERSE GEAR AND BEARING CUP ADAPTOR REASSEMBLY

1. With reverse gear teeth facing down, use mandrel (91-86943) to press propeller shaft needle bearing (NUMBERS/LETTERS UP) into reverse gear until short shoulder on mandrel bottoms on reverse gear.

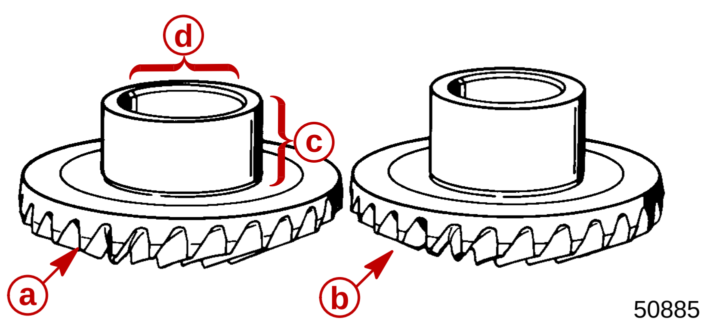
NOTE: *If gear housing has been replaced or inspection determines that reverse gear bearing adapter must be replaced, assemble and install as follows:*

2. Place reverse gear roller bearing (NUMBER/LETTERS UP) in press. Using suitable mandrel, press bearing cup adapter onto reverse gear bearing.



a - Reverse Gear Teeth
b - Mandrel (91-86943)
c - Propeller Shaft Needle Bearing
d - Shoulder
e - Mandrel
f - Bearing Cup Adapter
g - Reverse Gear Roller Bearing

IMPORTANT: The appearance of the forward and reverse gear is almost identical. There are two ways to distinguish between the reverse and forward gears. The reverse gear has a shorter hub and it has a smaller inner diameter needle bearing bore.



a - Reverse Gear
b - Forward Gear
c - Shorter Length Hub
d - Smaller Diameter Bearing Bore

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.*

NOTE: *If backlash has already been checked and it has determined that it needs to be adjusted, (see Checking Reverse Gear Backlash), adding 0.001 in. (0.025 mm) shims will **reduce** the gear backlash by approximately 0.001 in. (0.025 mm). Subtracting 0.001 in. (0.025 mm) shims will **increase** backlash by approximately the same amount.*

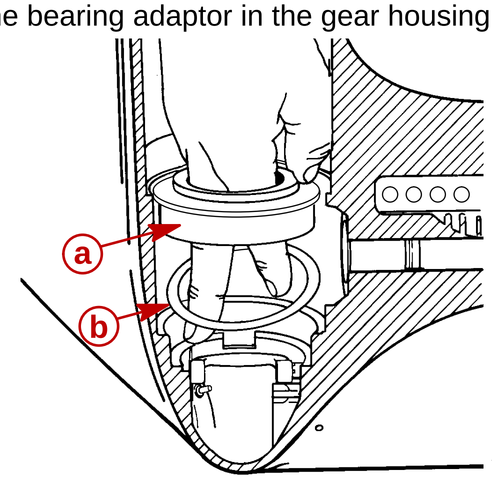
Example 1 (if backlash is too high)

Backlash checks:	0.045 in.	(1.14 mm)
(subtract) middle of specification:	0.025 in.	(0.64 mm)
You get:	0.020 in.	(0.51 mm)
add this quantity of shims:		

Example 2 (if backlash is too low)

middle of specification:	0.025 in.	(0.64 mm)
Backlash checks:	0.009 in.	(0.23 mm)
(subtract) You get:	0.016 in.	(0.41 mm)
subtract this quantity of shims:		

1. Lubricate the bore into which the reverse gear bearing adaptor is to be installed with Quicksilver Super Duty Gear Lubricant.
2. Place the shim(s) into reverse bore of gear housing.
3. Position the bearing adaptor in the gear housing.



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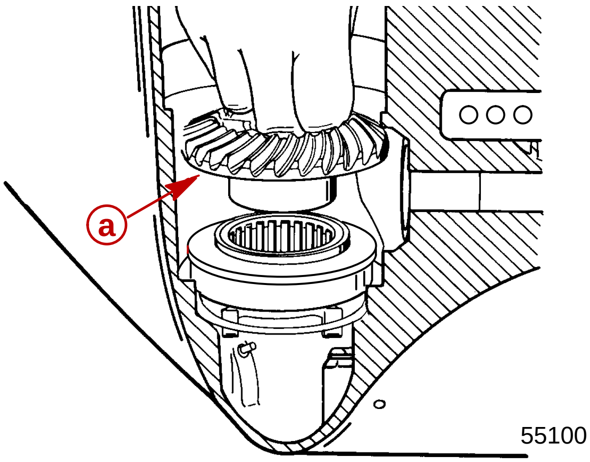
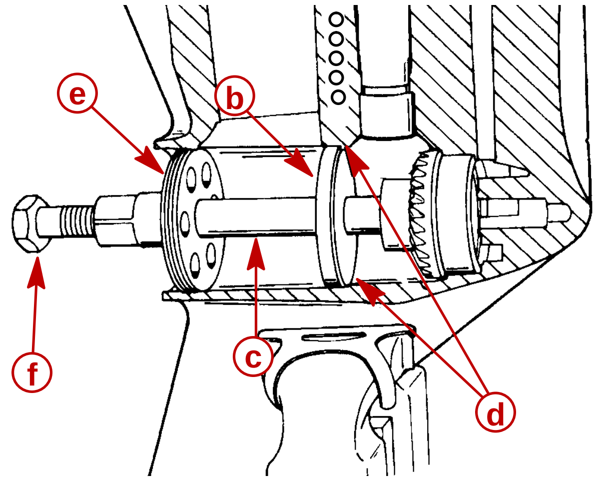
a - Bearing Adaptor
b - Shims

4. Position the reverse gear (without the thrust race or thrust bearing) into the gear housing and into the adaptor.

5. Install PILOT RING (91-18603) over DRIVER TOOL (91-18605) and seat pilot ring in gearcase against inner ledge. Thread RETAINER (91-18604) into bearing carrier threads. Install SCREW (10-18602) into retainer and gently tighten screw against driver tool while holding retainer securely. Continue to apply pressure against driver rod until reverse gear/bearing cup adaptor JUST SEATS in gearcase. DO NOT OVER-SEAT the adaptor as the reverse gear bearing will be damaged. As bearing adaptor begins to seat, the effort required to turn screw will increase considerably.

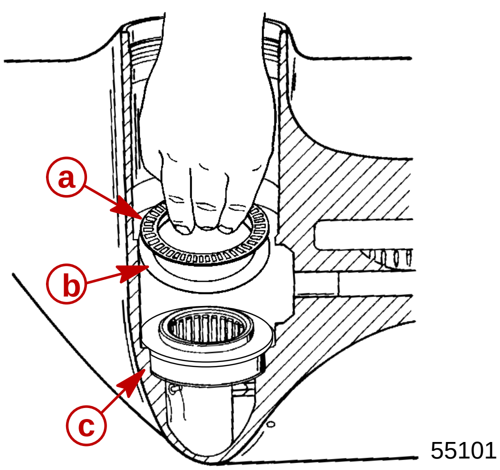


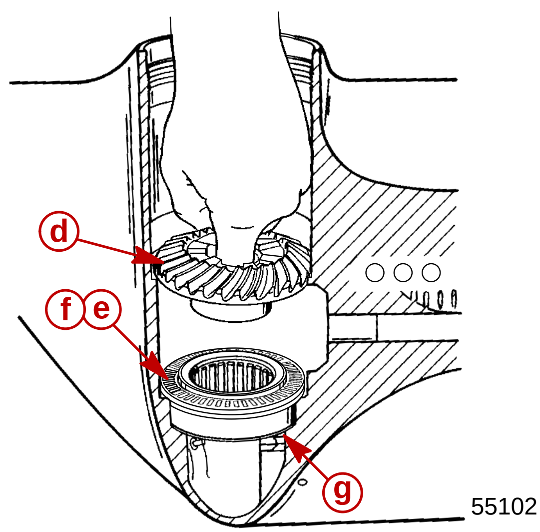


a - Reverse Gear
b - Pilot Ring (91-18603)
c - Driver Tool (91-18605)
d - Inner Ledge
e - Retainer (91-18604)
f - Screw (10-18602)

6. After reverse bearing adaptor is seated, remove screw, retainer, driver tool, pilot ring and reverse gear. Apply Quicksilver Super Duty Gear Lubricant to thrust bearing and install thrust race and bearing onto bearing adaptor.

7. Reinstall reverse gear into bearing adaptor.



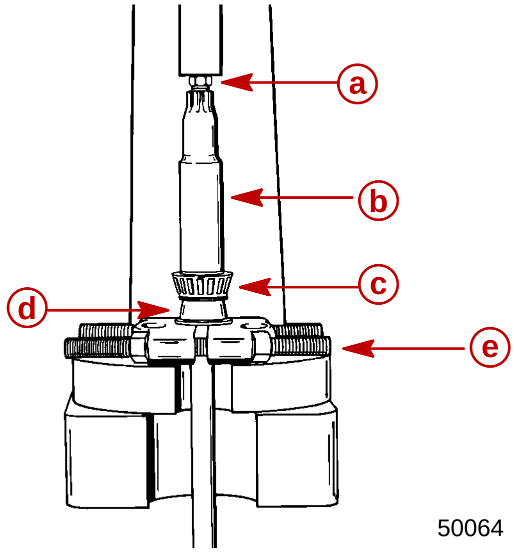


a - Thrust Bearing
b - Thrust Washer
c - Bearing Adaptor
d - Reverse Gear
e - Thrust Bearing
f - Thrust Washer (under thrust bearing)
g - Bearing Adaptor

Driveshaft and Pinion Gear

REASSEMBLY/INSTALLATION

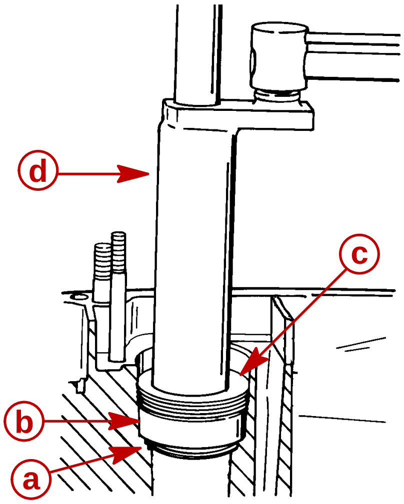
1. Apply a light coat of Quicksilver Super Duty Gear Lubricant on I.D. of driveshaft tapered bearing.
2. Thread a used pinion nut onto end of driveshaft. Leave approximately 1/16 in. (1.6 mm) of nut threads exposed. Driveshaft threads MUST NOT extend beyond nut or thread damage could result while pressing.
3. Place bearing over driveshaft.
4. Using an old driveshaft bearing inner race or other suitable mandrel (which applies pressing force on center bearing race only), press bearing onto shaft until seated.



a - Used Pinion Nut
b - Driveshaft
c - Tapered Bearing
d - Old Bearing Inner Race
e - Universal Puller Plate

5. Position pinion gear in gear housing below driveshaft bore with teeth of pinion gear meshed with teeth of reverse gear.
6. Insert driveshaft into driveshaft bore while holding pinion gear. Rotate driveshaft to align and engage driveshaft splines with pinion gear splines. Continue to insert driveshaft into gear housing until driveshaft tapered bearing is against bearing race.
7. Apply Loctite 271 to threads of pinion gear nut and install flat washer and nut on driveshaft with flat side of nut away from pinion gear.
8. Place shim(s) (retained from disassembly) into gear housing. If shim(s) were lost or are not reusable (damaged), start with approximately 0.010 in. (0.254 mm).

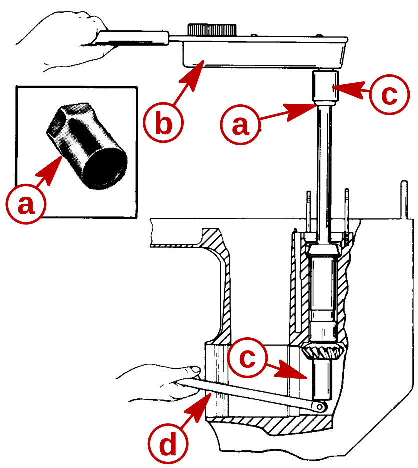
9. Install bearing race and bearing retainer.



a - Shim(s)
b - Bearing Race
c - Bearing Retainer (Word “OFF” must be visible); Torque to 100 lb. ft. (135.5 Nm)
d - Bearing Retainer Tool (91-43506)

10. Use a socket and breaker bar to hold pinion nut (pad area where flex handle will contact gear housing while torquing nut).

11. Place Driveshaft Holding Tool (91-34377A1) over crankshaft end of driveshaft. Torque pinion nut to 75 lb. ft. (101.5 Nm).



a - Driveshaft Holding Tool (91-34377A1)
b - Torque Wrench; Torque Nut to 75 lb. ft. (101.5 Nm)
c - Socket
d - Breaker Bar

IMPORTANT: Wipe any excess Loctite from pinion nut and pinion gear.

Pinion Gear Depth

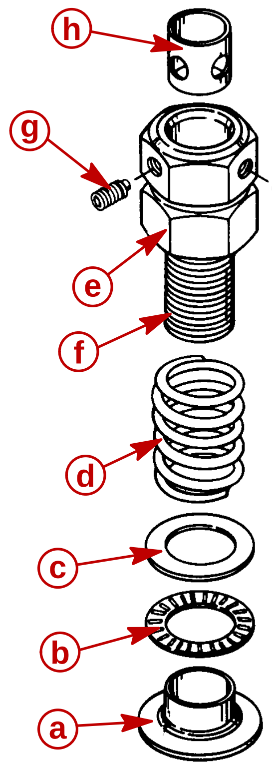
DETERMINING PINION GEAR DEPTH

NOTE: *Read entire procedure before attempting any change in shim thickness.*

IMPORTANT: Reverse gear assembly must be installed in gear housing when checking pinion gear depth or an inaccurate measurement will be obtained.

1. Clean gear housing bearing carrier shoulder.
2. Install Bearing Preload Tool (91-14311A1) over driveshaft in sequence shown.

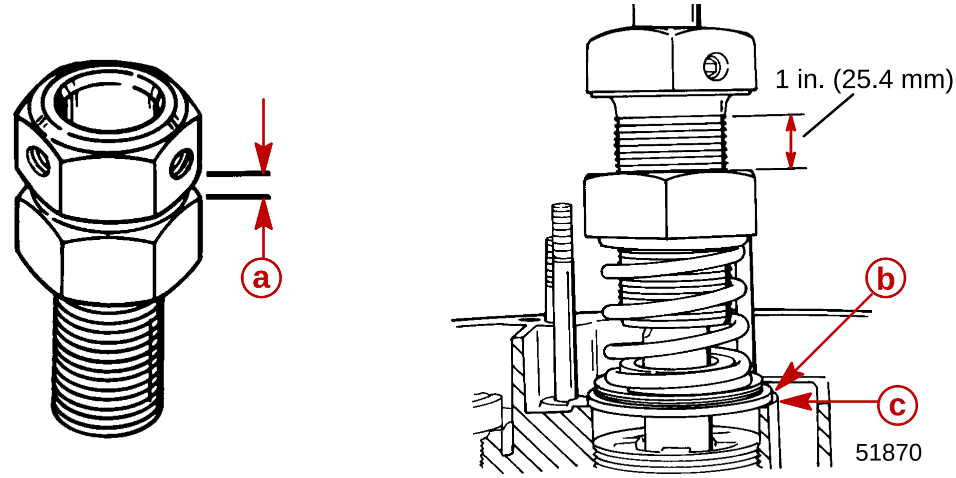
NOTE: *Bearing Preload Tool (91-44307A1) may also be used. Follow instructions provided with tool for proper installation.*



a - Adaptor
b - Bearing
c - Washer
d - Spring
e - Nut; thread nut all the way onto bolt
f - Bolt
g - Set Screw
h - Sleeve; holes in sleeve must align with set screws

3. Align adaptor on driveshaft bearing pocket ledge.
4. With tool installed over driveshaft, tighten both set screws securely, making certain to align sleeve holes to allow set screws to pass thru.

5. Measure distance (a) and increase that distance by 1 in. (25.4 mm) by turning bottom nut away from top nut.

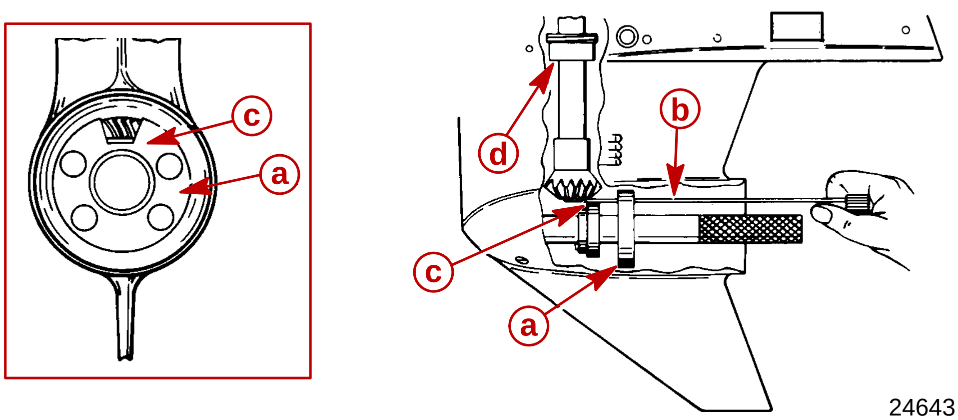


a - Distance
b - Adaptor
c - Ledge

6. Turn driveshaft clockwise 2 or more turns to seat driveshaft bearings.
7. Insert Pinion Gear Locating Tool* (91-74776) into gear housing until it bottoms out on bearing carrier Shoulder.

*Pinion Gear Locating Tool (91-12349A2) can be used. Use flat #7 and disc #2. Follow instructions supplied with tool.

8. Determine pinion gear depth by inserting a feeler gauge thru access slot in pinion gear shimming tool.
9. Clearance between shimming tool and pinion gear should be 0.025 in. (0.64 mm).
10. If clearance is correct, leave Bearing Preload Tool on driveshaft for **"Determining Forward Gear Backlash,"** following.
11. If clearance is not correct, add (or subtract) shims at location shown to raise (or lower) pinion gear.
    When reinstalling pinion nut, apply Loctite 271 on threads of nut and retorque pinion nut.



a - Pinion Gear Shimming Tool (91-74776 or 91-12349A2)
b - Feeler Gauge
c - Obtain 0.025 in. (0.64 mm) Clearance between Shimming Tool and Pinion Gear
d - Add or Subtract Shim(s) Here

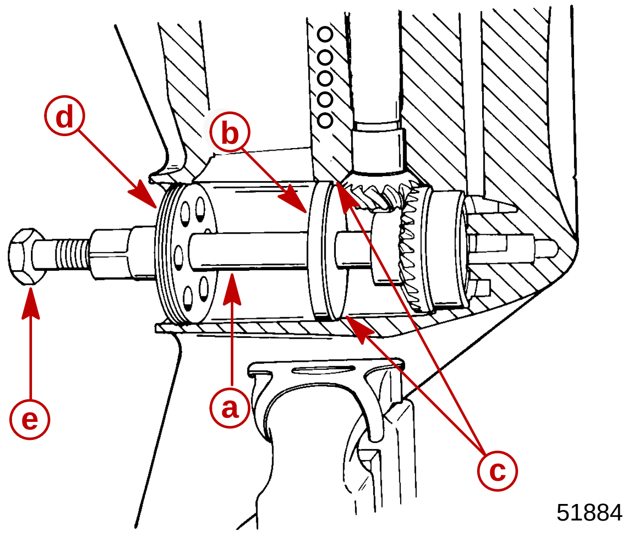
NOTE: *Bearing Preload Tool (91-14311A1) should remain installed on driveshaft after setting pinion gear depth as it is required to properly check forward gear and reverse gear backlash.*

Reverse Gear

DETERMINING REVERSE GEAR BACKLASH

NOTE: *Reverse gear backlash is adjustable using shims; it can be checked as follows:*

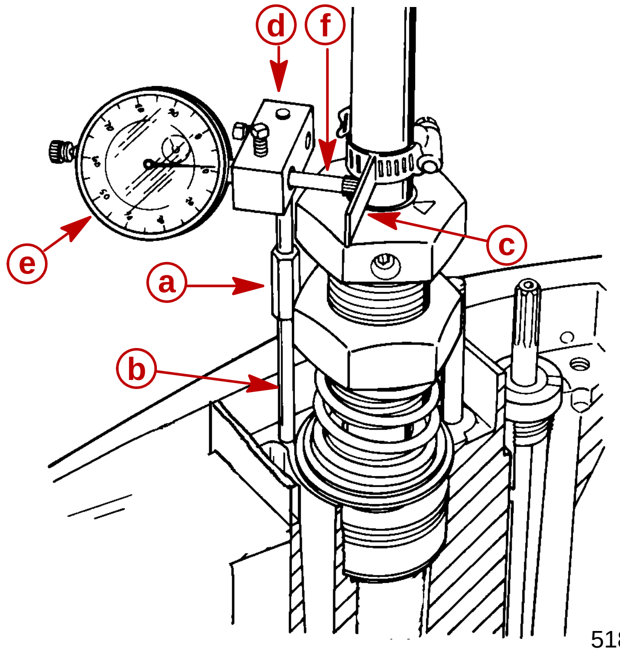
1. Install Driver Tool (91-18605) into reverse gear assembly.
2. Slide Pilot Ring (91-18603) over driver tool and seat pilot ring against inner ledge in gear case.
3. Thread Retainer (91-18604) into gear case cover nut threads.
4. Torque Screw (91-18602) to 45 lb. in. (5 Nm) against driver tool.



a - Driver Tool (91-18605)
b - Pilot Ring (91-18603)
c - Inner Ledge
d - Retainer (91-18604)
e - Screw (91-18602) [Torque to 45 lb. in. (5 Nm)]

5. Thread stud adapter [from Bearing Preload Tool (91-14311A1)] all the way onto stud.
6. Install: Backlash Indicator Tool (91-78473)
   Dial Indicator Holder (91-89897)
   Dial Indicator (91-58222A1)
7. Position dial indicator pointer on line marked “1” on Backlash Indicator Tool, if gear ratio is 1.87:1 (15 teeth on pinion gear), or on line marked “2” on Backlash Indicator Tool, if gear ratio is 2:1 (14 teeth on pinion gear).
8. Lightly turn driveshaft back-and-forth (no movement should occur at propeller shaft).

9. Dial Indicator registers amount of backlash, which should be 0.030 in. to 0.050 in. (0.76 mm to 1.27 mm).



51880

a - Stud Adaptor (from 91-14311A1)
b - Stud
c - Backlash Indicator Tool (91-78473)
d - Dial Indicator Holder (91-89897)
e - Dial Indicator (91-58222A1)
f - Dial Indicator Pointer

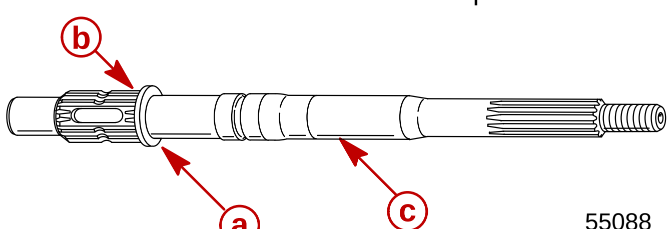
NOTE: *If reverse gear backlash is not within specifications, then gear case is not properly assembled or component(s) within gear case are excessively worn and must be replaced before returning gear case to service.*

10. Remove Driver Tool, Pilot Ring, Retainer and Screw from gear case.

Forward Gear

DETERMINING FORWARD GEAR BACKLASH

1. Install a load washer (12-37429) over a 44-93003 propeller shaft so that it seats against the REAR shoulder of the clutch spline teeth.

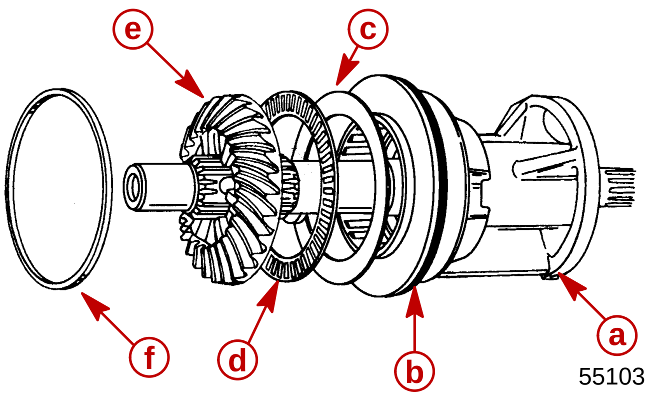


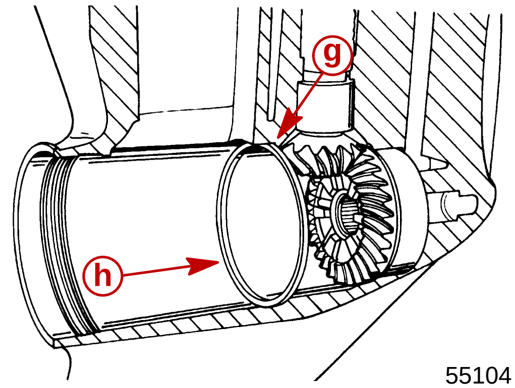
55088

a - Load Washer (12-37429)
b - Shoulder
c - Propeller Shaft (44-93003)

2. Assemble BEARING CARRIER, BEARING ADAPTOR, THRUST WASHER, THRUST BEARING, and FORWARD GEAR onto propeller shaft.

3. Position shim against shoulder in gear case.





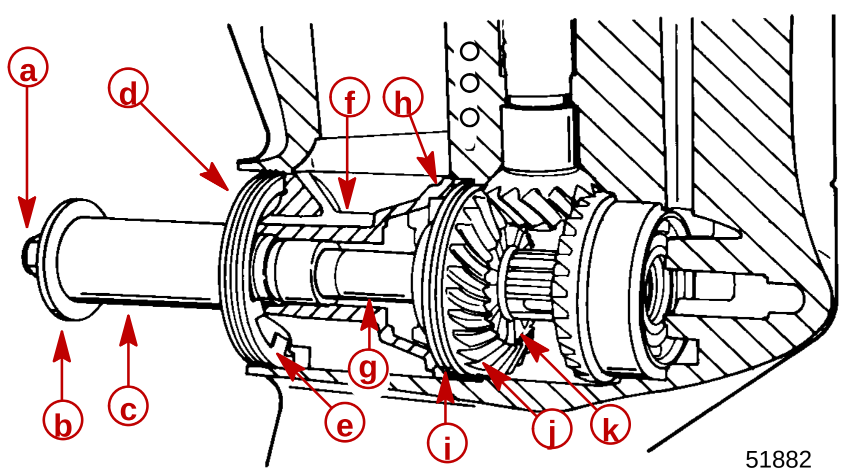
a - Bearing Carrier
b - Bearing Adaptor
c - Thrust Washer
d - Thrust Bearing
e - Forward Gear
f - Shim (PLACE IN GEARCASE FIRST)
g - Shoulder
h - Shim

4. Insert entire propeller assembly into gear case.

5. Install tab washer and cover nut. Torque cover nut to 100 lb. ft. (135.5 N m) to seat forward gear assembly in gear case.

NOTE: *Drill a 3/8 in. (22.2 mm) diameter hole through the side (PROPELLER NUT END) of a 5-1/2 in. x 1-1/2 in. (139.7 mm x 38.1 mm) 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.*

6. Install a 5-1/2 in. x 1-1/2 in. (139.7 mm x 38.1 mm) long piece of PVC pipe (obtain locally) over propeller shaft and secure it against the bearing carrier with a flat washer and nut.

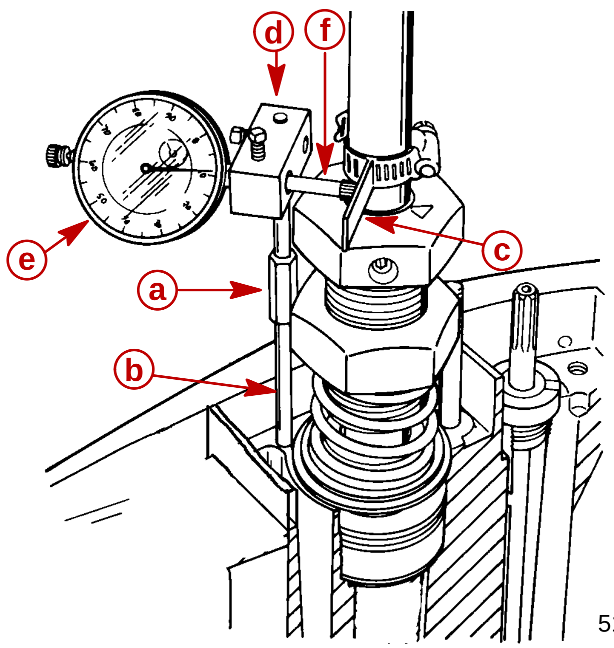


a - Prop Nut
b - Flat Washer
c - PVC Pipe [5 in. x 2 in. (127 mm x 50.8 mm)]
d - Cover Nut
e - Tab Washer
f - Bearing Carrier
g - Prop Shaft
h - Bearing Adaptor
i - Shim
j - Forward Gear
k - Load Washer

7. 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.

NOTE: *Bearing Preload Tool (91-44307A1) should still be installed from having previously been used to determine pinion gear depth and reverse gear backlash. If it is not still installed on gear case, refer to* ***"DETERMINING PINION GEAR DEPTH,"*** *previously, for proper installation procedure.*

8. With the proper preload applied to the propeller shaft and the driveshaft, rotate the driveshaft clockwise 5 to 10 complete revolutions. This will seat the forward gear and upper driveshaft bearings and thus provide the most accurate backlash readings.
9. If not previously installed:
   a. Thread stud adaptor [from bearing preload tool (91-44307A1) all the way onto stud.
   b. Install: Backlash Indicator Tool (91-78473)
      Dial Indicator Holder (91-89897)
      Dial Indicator (91-58222A1)
10. Position dial indicator pointer on line marked "1" on BACKLASH INDICATOR TOOL, if gear ratio is 1.87:1 (15 teeth on pinion gear), or on line marked "2" on BACKLASH INDICATOR TOOL, if gear ratio is 2:1 (14 teeth on pinion gear).



51880

a - Stud Adaptor (from 91-44307A1)
b - Stud
c - Backlash Indicator Tool (91-78473)
d - Dial Indicator Holder (91-89897)
e - Dial Indicator (91-58222A1)
f - Dial Indicator Pointer

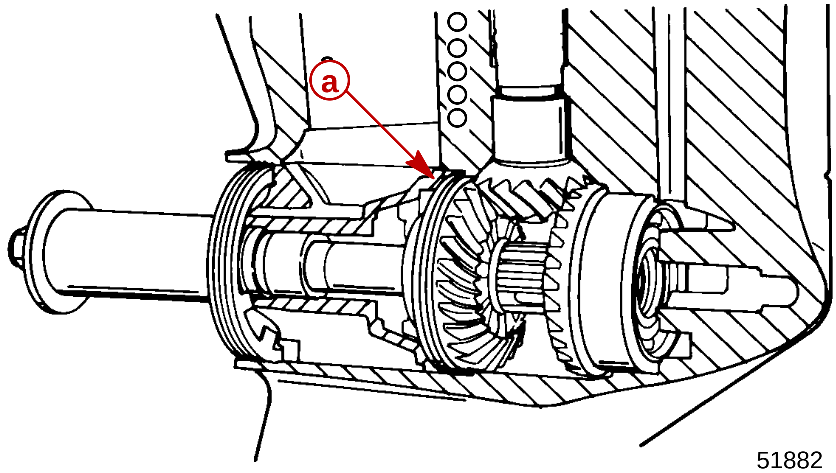
11. Gently rock driveshaft back and forth to determine forward gear backlash.

175 and 200 HP models with 1.87:1 Ratio = 0.018 in. to 0.027 in. (0.46 mm - 0.69 mm) backlash.

135 and 150 HP models with 2.00:1 Ratio = 0.015 in. to 0.022 in. (0.38 mm - 0.56 mm) backlash.

12. If backlash is less than the specifications, then a larger shim should be installed. Conversely, if the backlash indicated is greater than specifications, then a smaller shim should be installed.

NOTE: *By adding or subtracting 0.002 in. (0.051 mm) shim, the backlash will change approximately 0.002 in. (0.051 mm).*



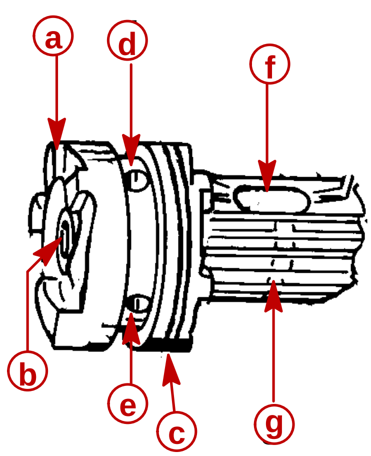
a - Shim

13. If forward gear backlash is within specifications, then Bearing Preload Tool, Dial Indicator, Backlash Indicator Tool/Dial Indicator Holder, PVC pipe, forward gear assembly, bearing adaptor, bearing carrier and test propeller shaft can all be removed from the gear case.

Propeller Shaft/Forward Gear Bearing Adapter/Bearing Carrier

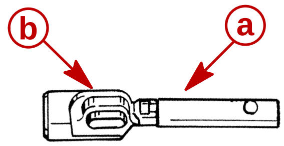
REASSEMBLY

1. Position sliding clutch onto propeller shaft. “GROOVED RINGS” are for manufacturing purposes only and may be positioned towards either gear. Cross pin hole and detent hole in sliding clutch must line up with cross pin slot and detent notch in propeller shaft.



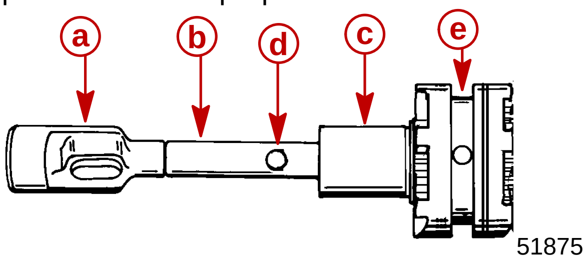
a - Sliding Clutch
b - Propeller Shaft
c - Grooved Rings
d - Cross Pin Hole
e - Detent Hole
f - Cross Pin Slot
g - Detent Notches

2. Place a small amount of Quicksilver 2-4-C with Teflon Lubricant on actuator rod and install cam follower.



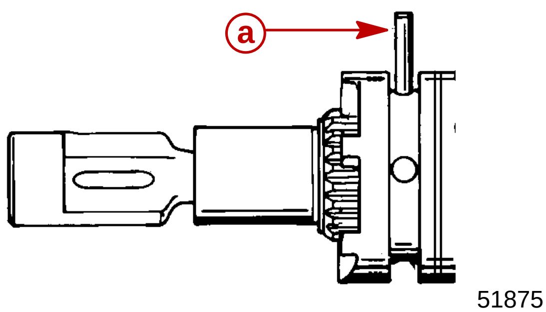
a - Actuator Rod
b - Cam Follower

3. Slide clutch actuator assembly into propeller shaft. Align cross pin slot in actuator rod with cross pin slot in clutch/propeller shaft.



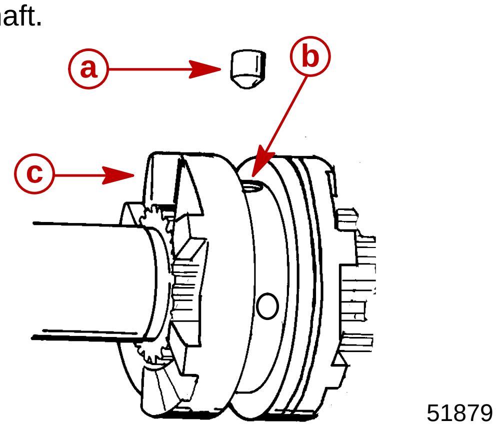
a - Cam Follower
b - Clutch Actuator Rod
c - Propeller Shaft
d - Cross Pin Slot
e - Clutch/Propeller Shaft

4. Insert cross pin through sliding clutch, propeller shaft and actuator rod forcing cross pin tool out.



a - Cross Pin

5. Apply a small amount of 2-4-C with Teflon Marine Lubricant to the rounded end of detent pin. Position detent pin in detent pin hole of sliding clutch with rounded end of pin toward propeller shaft.



a - Detent Pin
b - Detent Pin Hole
c - Sliding Clutch

6. Install cross pin retaining spring onto sliding clutch as follows:

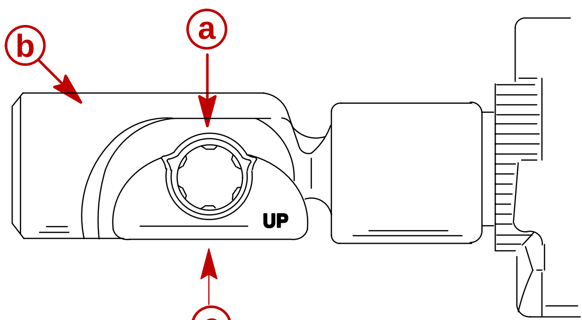
IMPORTANT: DO NOT over-stretch retaining spring when installing onto sliding clutch.

   a. Install spring.

      (1.) Spirally wrap spring into groove on sliding clutch.

      (2.) Position spring in groove so that straight end of spring is against the side of groove.

7. Place gear housing in a soft jaw vise with the driveshaft in a vertical position.
8. Coat cam pocket of cam follower with 2-4-C with Teflon Marine Lubricant .
9. Place shift cam into cam pocket of cam follower with numbered side of cam facing up.
10. Slide propeller shaft assembly into reverse gear assembly.



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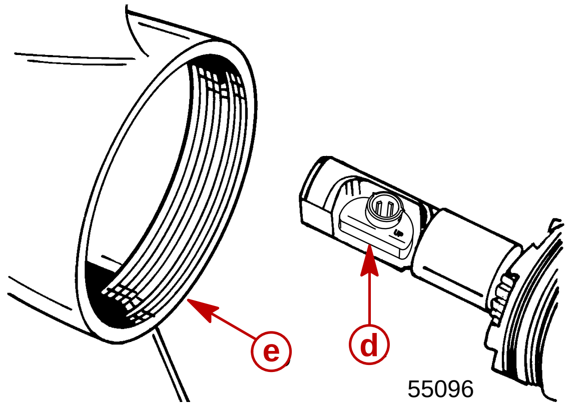
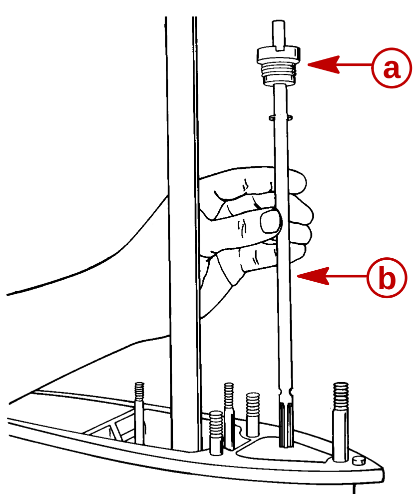


55096

a - Cam Pocket
b - Cam Follower
c - Shift Cam
d - Shift Cam (Position as Shown)
e - Gear Housing

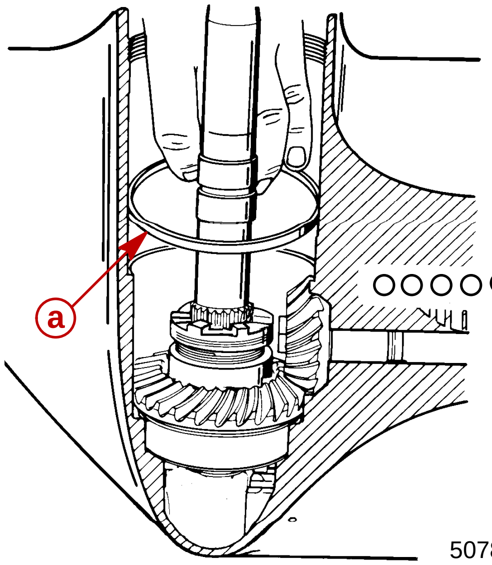
11. Apply a light coat of 2-4-C with Teflon to the threads of the shift shaft bushing.
12. Insert shift shaft down shift shaft hole in gear housing and into shift cam. It may be necessary to rotate shift shaft back-and-forth slightly in order for splines of shift shaft to match up with splines of shift cam. Thread bushing into position, but do not tighten down at this time.



51867

a - Shift Shaft Bushing
b - Shift Shaft

13. Install appropriate spacer shim into the gear housing.
14. Apply Quicksilver Super Duty Gear Lubricant to to thrust bearing and install thrust bearing and thrust race onto forward gear bearing adaptor.



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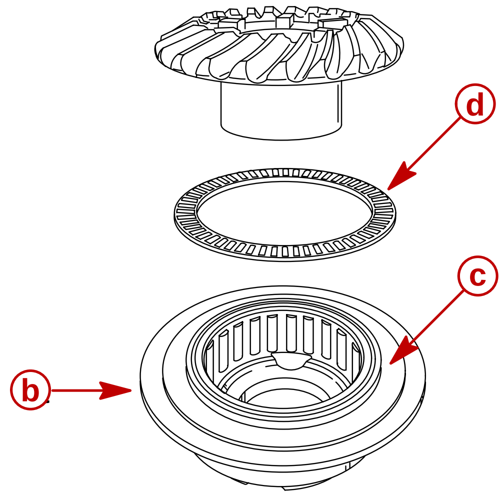
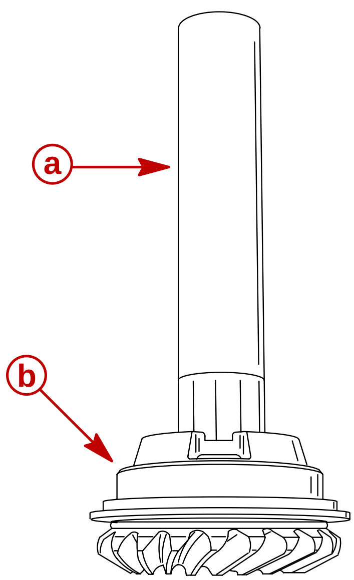


55220

a - Shim
b - Bearing Adaptor
c - Thrust Washer
d - Thrust Bearing

15. Insert Forward Gear Installation Tool (91-815850) into forward gear/bearing adaptor assembly.
16. Install tool with adaptor assembly over propeller shaft and into gear housing. Applying downward pressure to bearing adaptor, remove installation tool from assembly.



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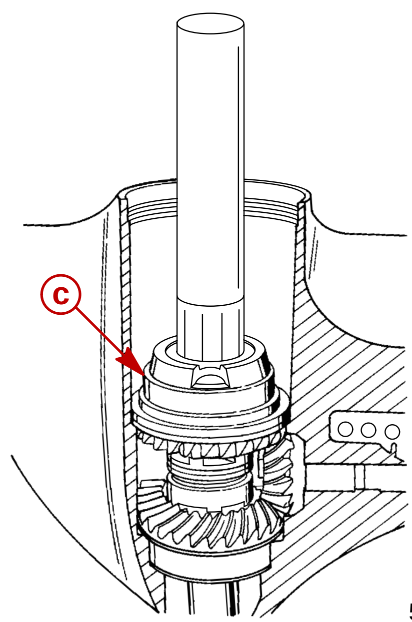
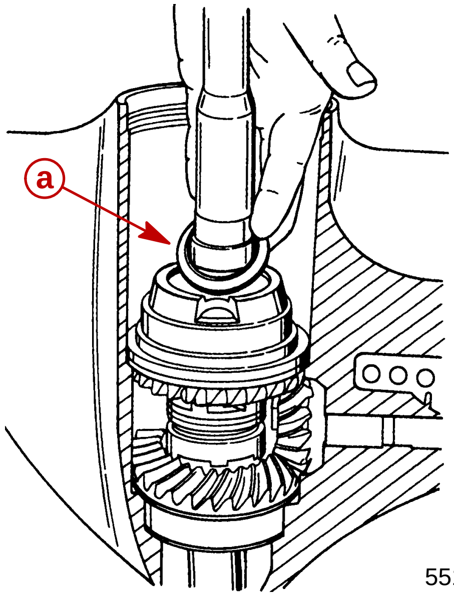


55202

a - Forward Gear Installation Tool (91-815850)
b - Forward Gear/Bearing Adaptor Assembly
c - Forward Gear Bearing Adaptor

17. Install thrust race on top of bearing adaptor.
18. Apply Quicksilver Super Duty Gear Lubricant to small thrust bearing and install bearing on thrust race.



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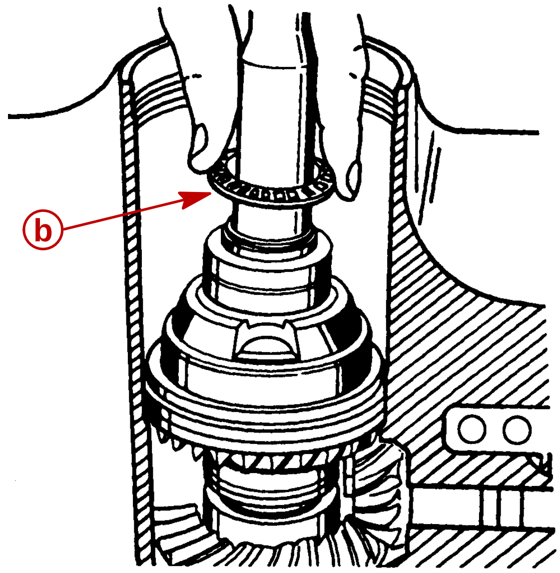
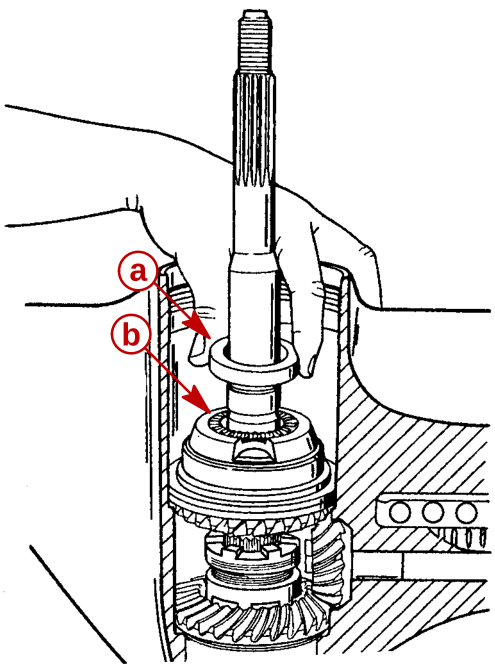


55108

a - Thrust Race
b - Thrust Bearing

19. Install thrust collar with its **STEPPED SIDE DOWN** toward the small thrust bearing.
20. Pull up slightly on the propeller shaft to gain access to the groove on the shaft for the keepers. Install the 2 keepers into the groove and lower the propeller shaft.



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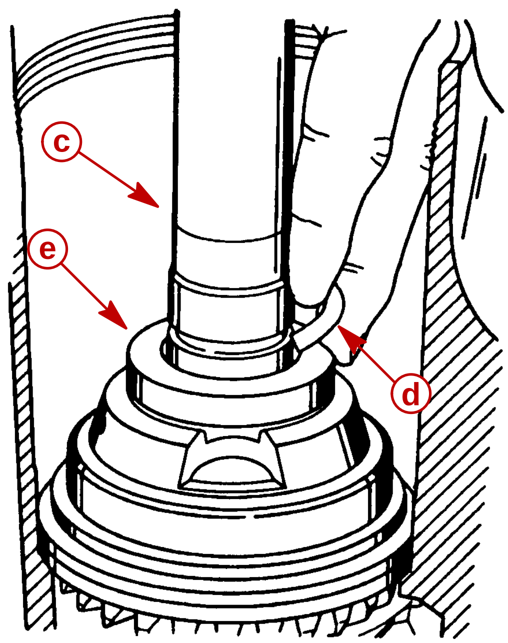
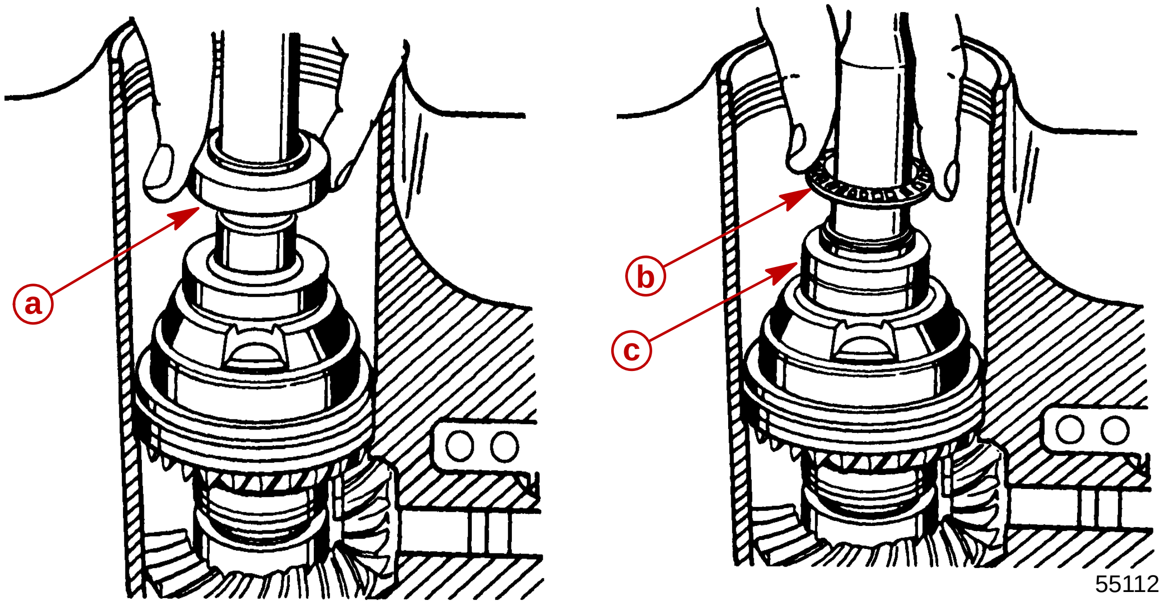


55110

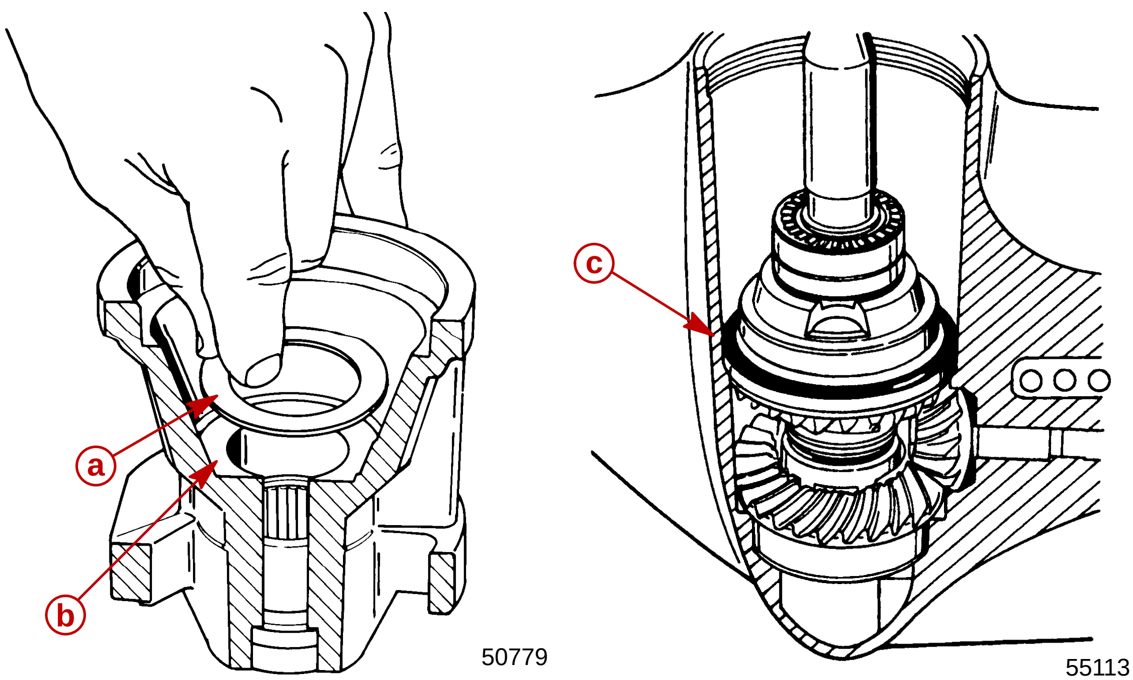
a - Thrust Collar
b - Thrust Bearing
c - Propeller Shaft
d - Keepers (2)
e - Thrust Collar

21. Install second thrust collar with its stepped side **UP**.
22. Apply Quicksilver Super Duty Gear Lubricant to the second thrust bearing and install it on top of the second thrust collar.



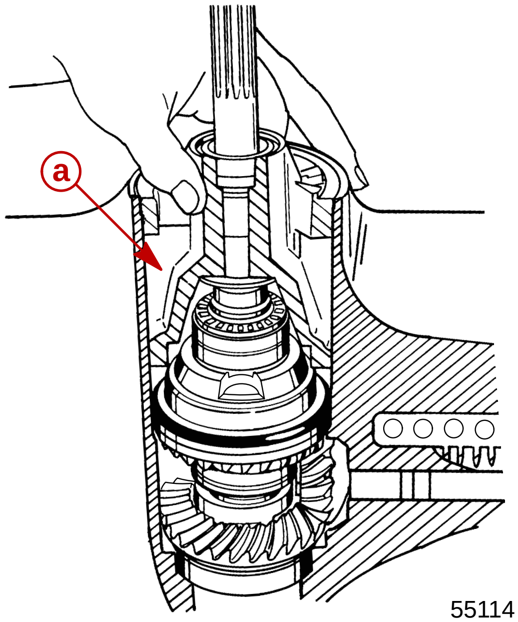
a - Thrust Collar
b - Thrust Bearing
c - Thrust Collar

23. Apply Quicksilver Super Duty Gear Lubricant to to second small thrust bearing race and install race to the surface inside of the bearing carrier.
24. Apply Quicksilver 2-4-C with Teflon Marine Lubricant to bearing carrier O-ring. Install O-ring onto bearing adaptor.



a - Thrust Race
b - Bearing Carrier Race Surface
c - O-ring

25. Apply Quicksilver 2-4-C with Teflon Marine Lubricant to:
    a. Outer diameter of bearing carrier which contacts gear case.
    b. Space between carrier oil seals.
26. Apply Quicksilver Super Duty Gear Lubricant to bearing carrier needle bearing.
27. Install bearing carrier into gear housing.
28. Verify bearing carrier keyway is aligned with gear housing keyway and install bearing carrier key.
29. Place tab washer against bearing carrier.



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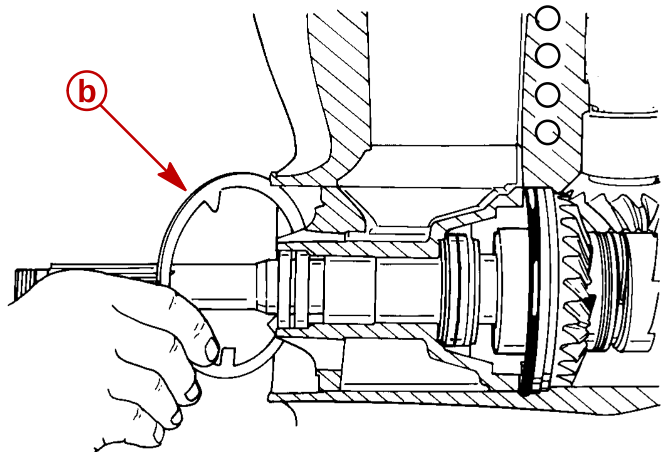


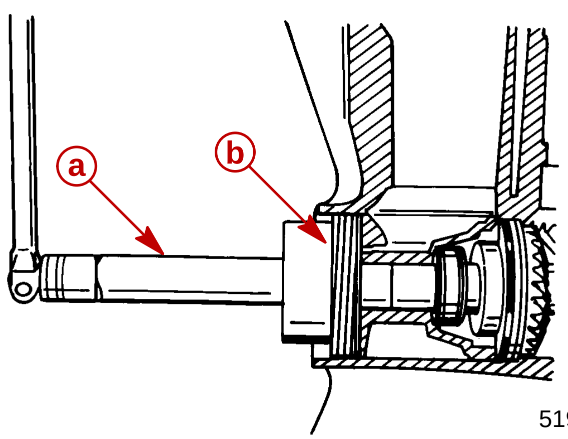
51885

a - Bearing Carrier
b - Tab Washer

30. Apply 2-4-C with Teflon to threads of cover nut and install cover nut in gear housing. Verify that the word “OFF” and arrow are visible.

NOTE: *Before torquing bearing carrier cover nut, gear case should either be mounted in a stand specifically designed for holding gear cases or bolted to a driveshaft housing to avoid possible damage to the gear case.*

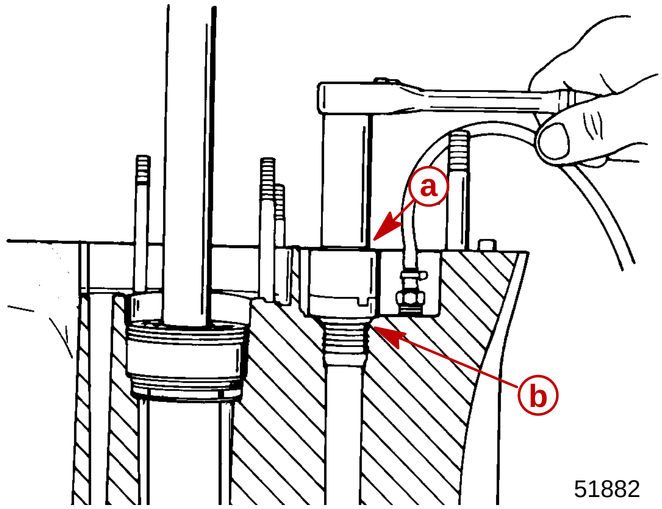
31. Using Cover Nut Tool (91-61069), torque cover nut to 210 lb. ft. (285 Nm).



51911

a - Retainer Nut Tool (91-61069)
b - Retainer Nut

32. Bend one lock tab of tab washer into cover nut (only one will align).
33. Bend remaining tabs of tab washer toward front of gear housing.
34. Use Shift Shaft Bushing Tool (91-31107) and torque shift shaft bushing to 50 lb. ft. (68 Nm).

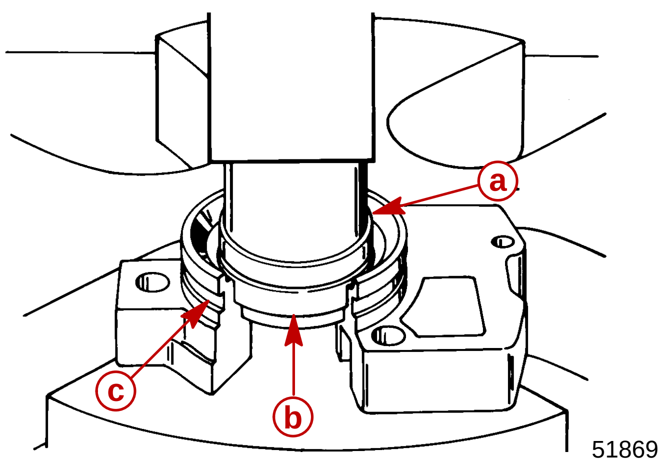


a - Shift Shaft Bushing Tool (91-31107)
b - Shift Shaft Bushing

Water Pump

REASSEMBLY/INSTALLATION

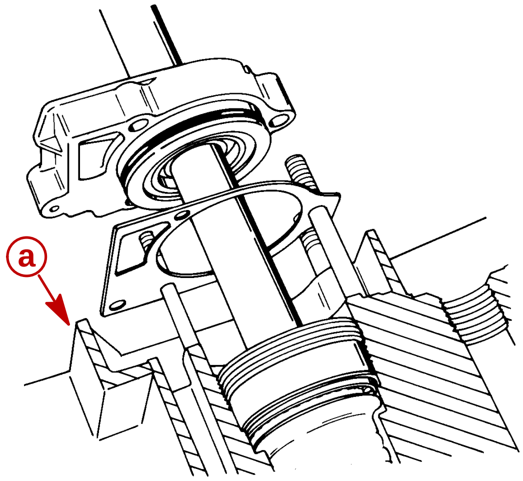
1. Install oil seals into water pump base, as follows:
   a. Place water pump base on a press.
   b. Just before installing each seal apply Loctite 271 on outside diameter of oil seal.
   c. With a suitable mandrel, press the smaller diameter oil seal into pump base with lip of oil seal toward impeller side of base.
   d. With a suitable mandrel, press the larger diameter oil seal into pump base with lip of oil seal toward gear housing side of base.
   e. Wipe any excess Loctite from oil seals and water pump base.
2. Install O-ring into O-ring groove of water pump base. Lubricate O-ring and oil seals with 2-4-C with Teflon Marine Lubricant.

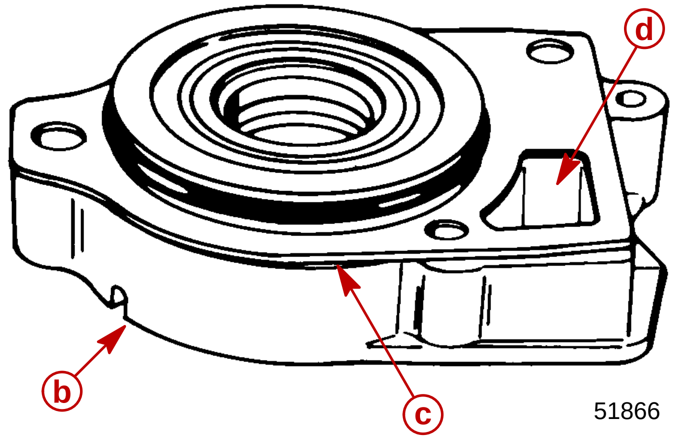


a - Mandrel
b - Oil Seal (Smaller OD)
c - O-Ring Groove

3. Install divider block if removed. Use RTV Sealer to seal seams between divider block and gear housing.

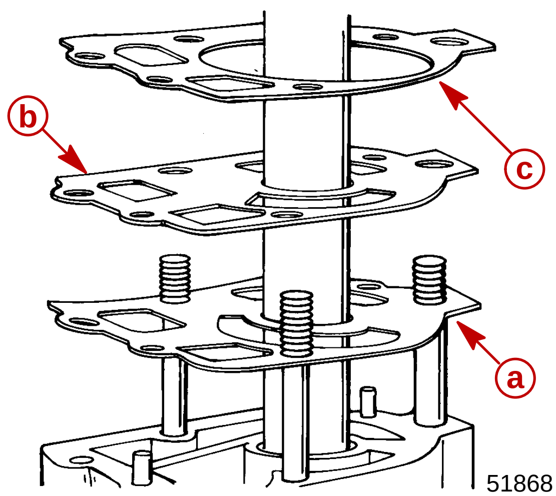
4. Install a new water pump base gasket and install water pump base.





a - Divider Block
b - Water Pump Base
c - Gasket
d - Hole (MUST be positioned as shown)

5. Install the following in order: Pump base to face plate gasket, face plate to pump cover gasket. Gaskets and face plate are indexed by dowel pin location and must be installed correctly.



a - Gasket (Water Pump Base to Face Plate)
b - Face Plate
c - Gasket (Face Plate to Water Pump Cover)

6. Place impeller drive key on flat of driveshaft. Hold key on driveshaft with a small amount of Quicksilver 2-4-C with Teflon Marine Lubricant.

IMPORTANT: When completing gear housing repair that requires removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary to reuse the impeller, DO NOT install in reverse to original rotation or premature impeller failure will occur. Original rotation is clockwise.

⚠ CAUTION
A visual inspection of impeller drive key MUST BE made to determine that drive key is on flat of driveshaft after impeller is installed. If key has moved off flat of driveshaft, repeat Steps 6 and 7.

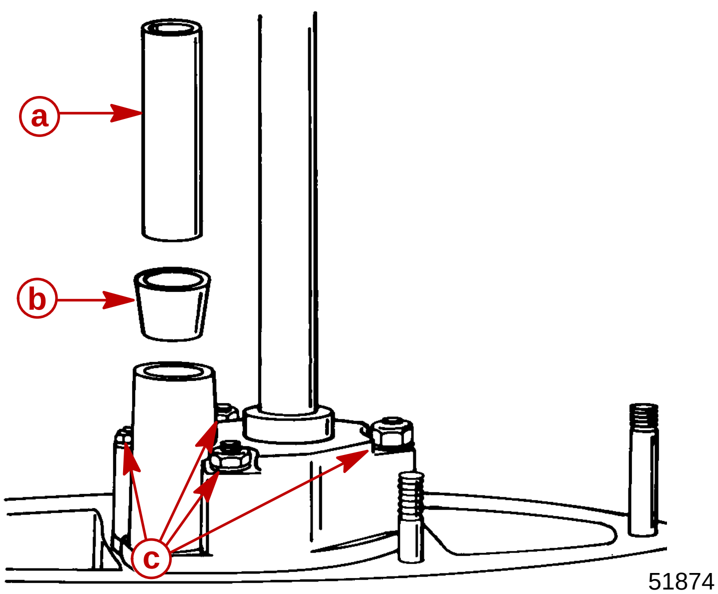
7. Slide impeller down driveshaft to impeller drive key. Align drive key with keyway in the center hub of impeller, and slide impeller over drive key.
8. If removed, install new water pump insert into pump cover as follows:
    a. Apply Quicksilver Perfect Seal to water pump insert area of pump cover.
    b. Install water pump insert into pump cover, being sure that tab on insert enters recess in pump cover.
    c. Wipe any excess Quicksilver Perfect Seal from insert and cover.

NOTE: *If 2 holes were drilled in top of water pump cover to aid in removal of insert, fill holes with RTV Sealer or equivalent. Allow to cure 24 hours prior to operating engine.*

9. Install water tube seal into pump cover. Plastic side of seal goes into cover first.
10. Reinstall water tube guide into water pump cover.
11. Apply a light coat of Quicksilver 2-4-C with Teflon Marine Lubricant to inside of water pump insert.
12. Position assembled water pump cover over driveshaft and lower over water pump studs. Rotate driveshaft in a clockwise direction (viewed from top), while pushing down on pump cover to ease impeller entry into cover.
13. Install water pump cover retainer washers, nuts and bolt.

CAUTION
DO NOT over-torque nuts and bolt, as this could cause cover to crack during operation.

14. Torque water pump nuts to 50 lb. in. (6.0 Nm), and water pump bolt to 35 lb. in. (4 Nm).
15. Install centrifugal slinger over driveshaft and down against pump cover.



a - Water Tube Guide
b - Water Tube Seal
c - Nuts, Bolts and Washers

Gear Lubricant Filling Instructions

1. Remove any gasket material from “Fill” and “Vent” screws and gear housing.
2. Install new gaskets on “Fill” and “Vent” screws.

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. 5. Remove grease tube (or hose) from “Fill” hole and quickly install “Fill” screw into “Fill” hole.

Installing Gear Housing to Driveshaft Housing

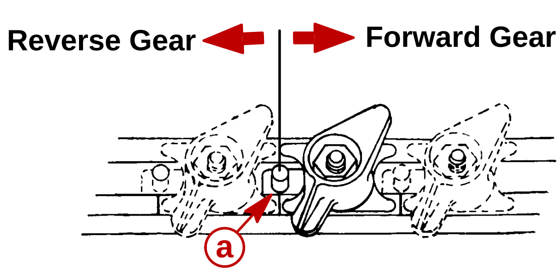
WARNING
Disconnect high tension leads from spark plugs and remove spark plugs from engine before installing gear housing onto driveshaft housing.

1. Tilt engine to full up position and engage the tilt lock lever.
2. Apply a light coat of Quicksilver 2-4-C with 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 with 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 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 forward gear and place guide block anchor pin into forward gear position.

Counter Rotation Outboard



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 and turn it counterclockwise as the gear housing is being pushed toward driveshaft housing.*

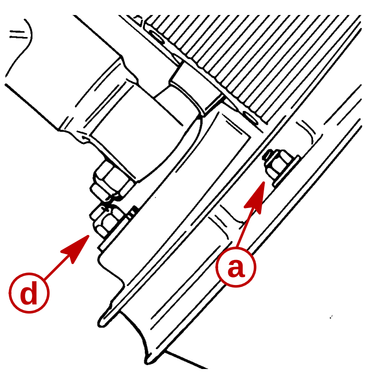
8. Move gear housing up toward driveshaft housing while aligning shift shaft splines and water tube with water tube guide (in water pump cover).
9. Place flat washers onto studs (located on either side of driveshaft housing). Start a nut (a) on these studs and tighten finger-tight.
10. Start bolt (b) 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.

IMPORTANT: Do not force gear case up into place with attaching nuts.

12. Evenly tighten 2 nuts (a) which were started in Step 9. Torque to listing in **"Torque Specifications,"** preceding.
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 washers and nuts (c) onto studs (located on bottom center of anti-cavitation plate). Torque to listing in **"Torque Specifications,"** preceding.



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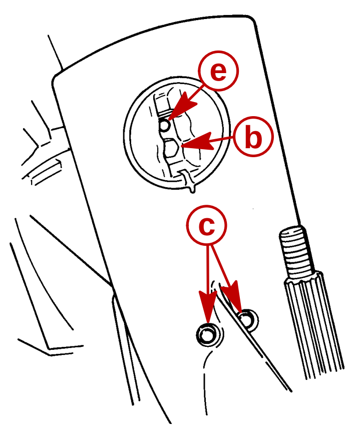

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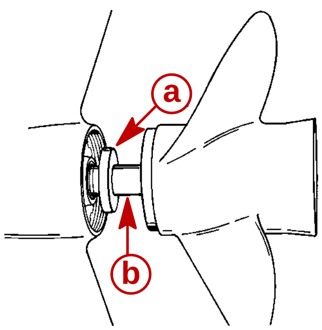
15. Install special flat washer and nut (d) on stud at leading edge of driveshaft housing. Torque to listing in **"Torque Specifications,"** preceding.
16. Torque bolt (started in Step 10) to listing in **"Torque Specifications,"** preceding.
17. Install trim tab, adjust to position in which it had previously been installed, and tighten bolt (e) securely.
18. Install plastic cap into trim tab bolt opening at rear edge of driveshaft housing.

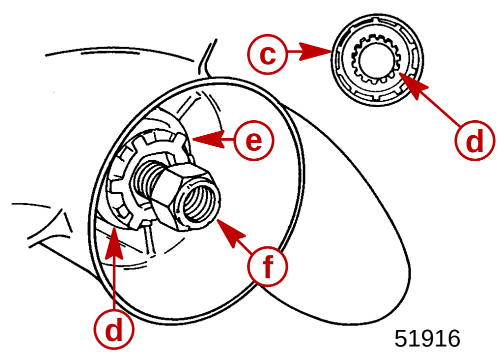
Propeller Installation

⚠ 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
   -- Special Lubricant 101
   -- 2-4-C Marine Lubricant
   -- Perfect Seal
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

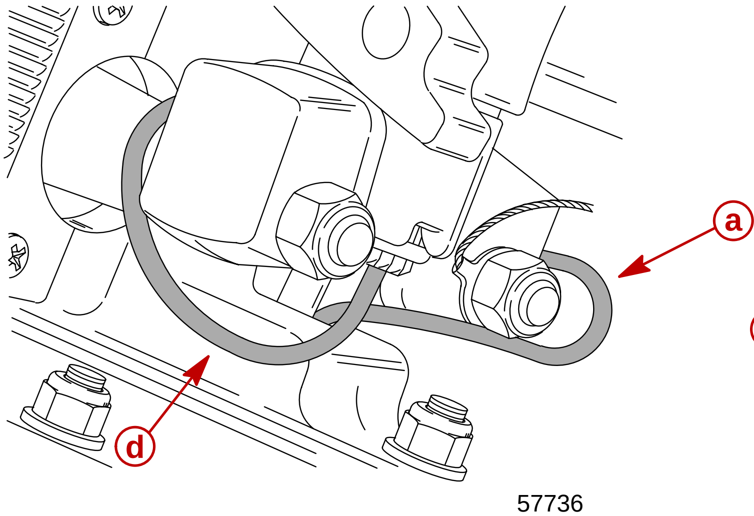
⚠ CAUTION

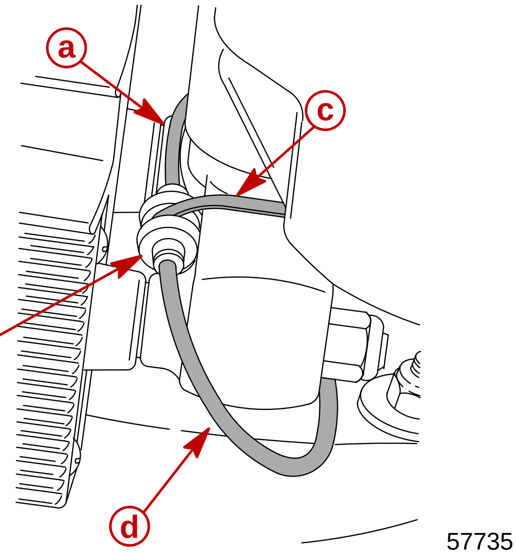
DO NOT misinterpret propeller shaft movement with propeller movement. If propeller and propeller shaft together move forward-and-aft, this is normal; however, propeller should not move forward-and-aft on propeller shaft.

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 (92876A10)

Single Cable

Refer to **"Quicksilver Accessories Guide"** to determine correct length of steering cable and remote control cables.

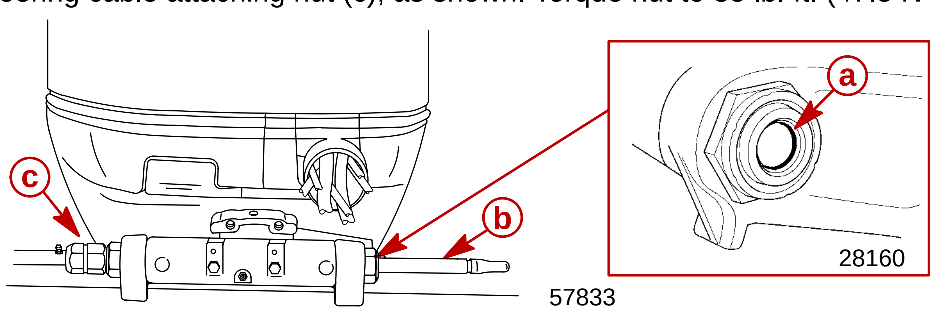
IMPORTANT: Steering cable and remote control cables must be the correct length, sharp bends on too-short cables result in "kinks"; too-long cables require unnecessary bends and/or loops. Both conditions place extra stress on the cables and will reduce the performance of the steering system.

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 with 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 with 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

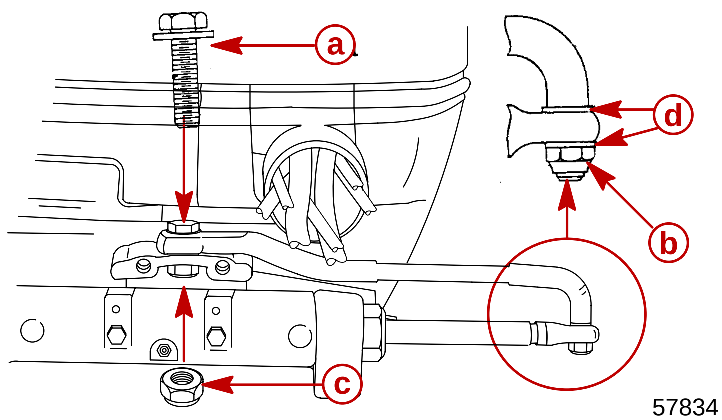
IMPORTANT: The steering link rod that connects the steering cable to the engine must be fastened using special washer head bolt (“a” - Part Number 10-849838) and self locking nuts (“b” & “c” - Part Number 11-826709113). These locknuts must never be replaced with common nuts (non locking) as they will 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 11-826709113). 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 10-849838) and nylon insert locknut (“c” - Part Number 11-826709113). 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.”**

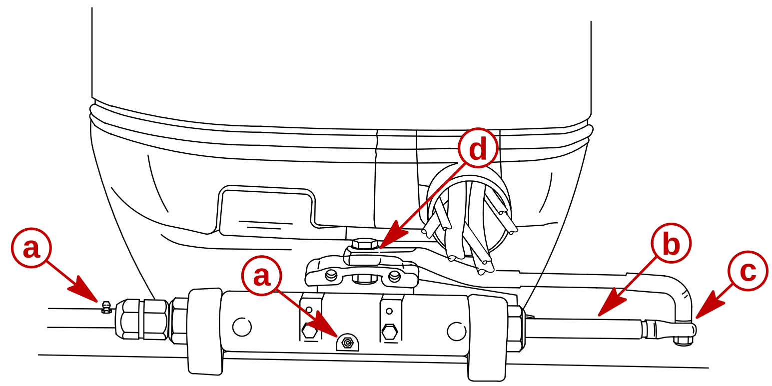
1. Carefully check steering system components for wear. Replace worn parts.
2. Check steering system fasteners to be sure that they are torqued to correct specifications.

***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 with Teflon. Lubricate exposed portion of cable end (b) with 2-4-C with 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 with Teflon.



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Ride Guide Steering Cable/Attaching Kit Installation (92876A8)

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.

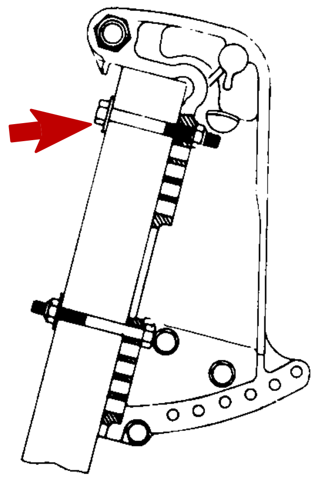
⚠ CAUTION

Marine sealer must be used on shanks of 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.

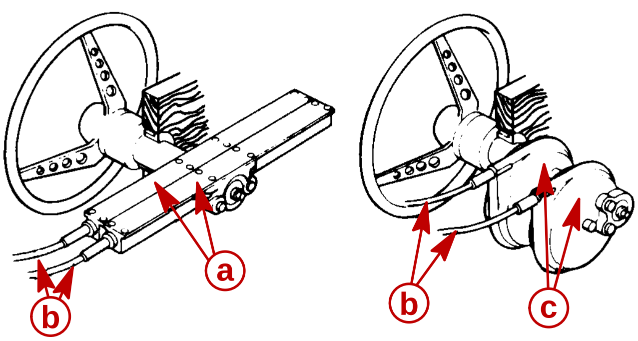
Install upper bolts so that hex head end of bolts is on the inside of boat transom.



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.

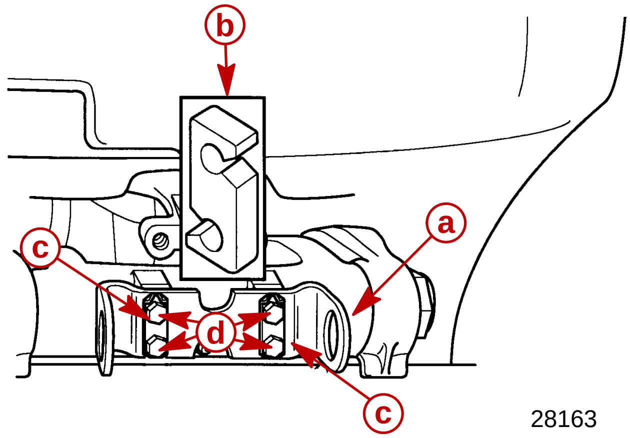


a - Gear Rack
b - Steering Cables
c - Rotary Steering Heads

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.



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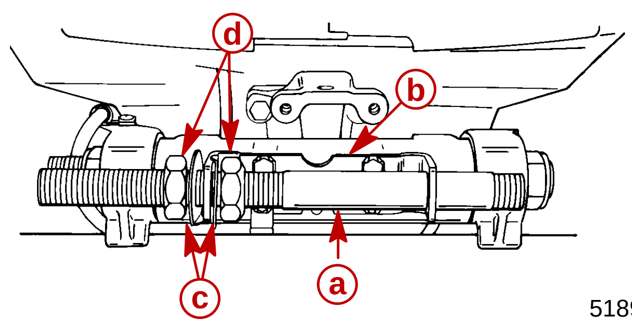
a - Mounting Bracket for Steering Cable Mounting Tube
b - Spacer (2)
c - Locking Retainer (2)
d - Bolts (4) - 7/8 in. (22 mm) Long - Torque to 100 lb. in. (11.5 Nm), then Bend Corner Tabs of Locking Retainers Up and Against Flats on Each Bolt

⚠ 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.



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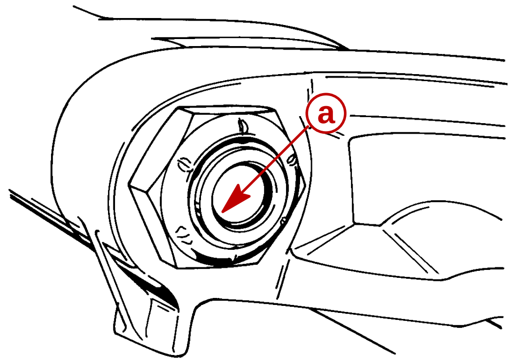
a - Steering Cable Mounting Tube (End of Tube with Longer Threads Toward Starboard Side of Boat)
b - Mounting Bracket
c - Locking Tab Washers (2)
d - Adjustment Nuts (Flats of Nuts Facing Toward Locking Tab Washer)

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 with Teflon before installing steering cables.

Lubricate inside of outboard tilt tube and inside of steering cable mounting tube with Quicksilver 2-4-C with Teflon. Verify rubber O-ring seal (a) (located in outboard tilt tube) is lubricated.



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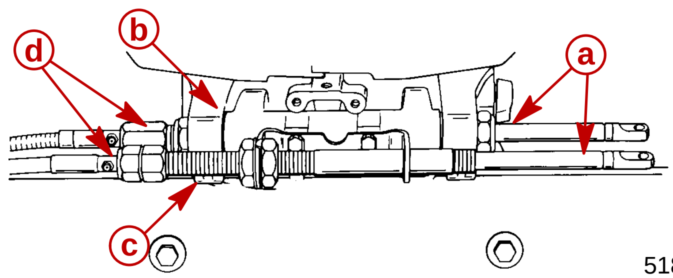
Insert steering cable ends (a) thru outboard tilt tube (b) and cable mounting tube (c). Thread steering cable attaching nuts (d) on to tubes hand tight.

NOTE: *Torque steering cable attaching nuts only after final steering adjustments have been made.*



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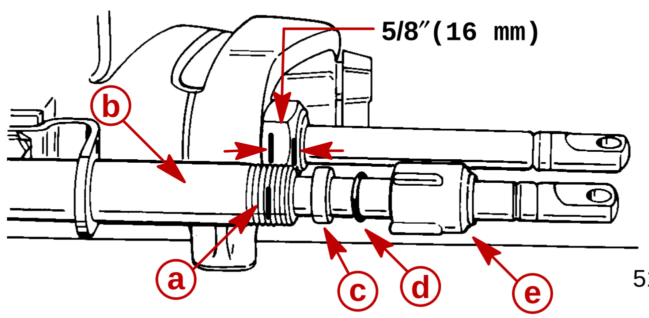
Place a mark (a) on steering cable mounting tube (b) 5/8 in. (16 mm) from end of mounting tube. Slide plastic spacer (c), O-ring (d) and cap (e) over steering cable.



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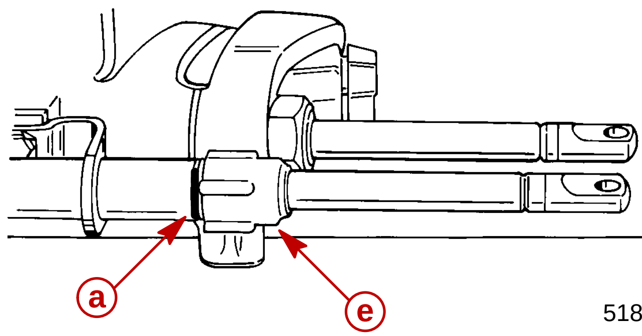
Thread cap (e) onto steering cable mounting tube, up to mark (a).



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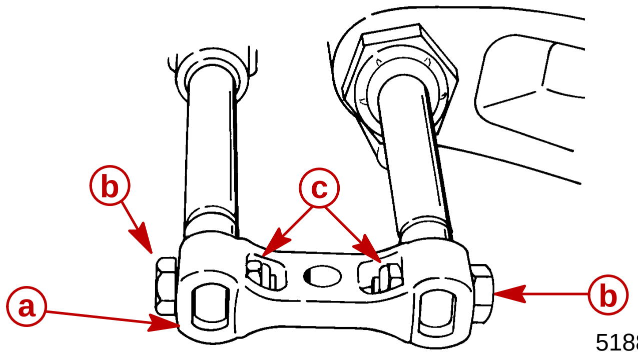
Coupler Installation

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).



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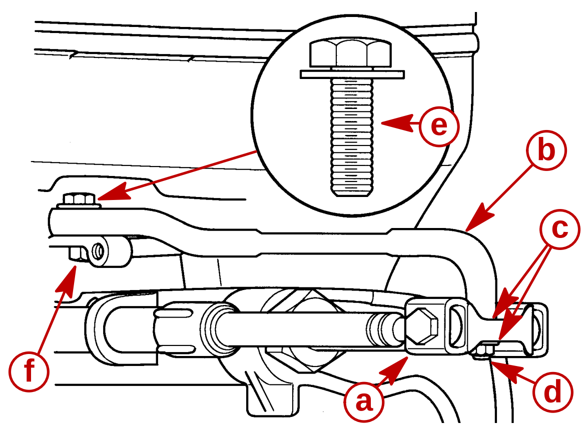
Installing Link Rod

WARNING

Steering link rod MUST BE secured between outboard steering arm and steering coupler, using special washer head bolt (10-849838) and two nylon insert locknuts (11-826709113), 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 with 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 (10-849838) provided and nylon insert locknut as shown. Torque special bolt to 20 lb. ft. (27 Nm), then torque locknut to 20 lb. ft. (27 Nm).



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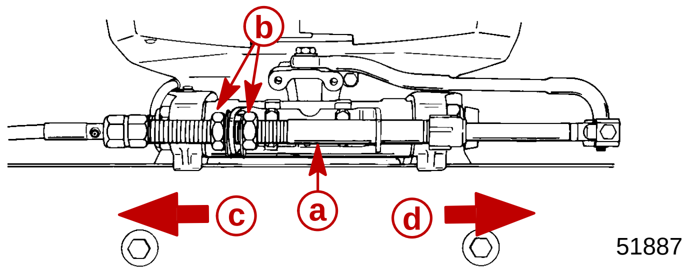
- **a** - Steering Coupler
- **b** - Steering Link Rod
- **c** - Flat Washer (2)
- **d** - Nylon Insert Locknut - Torque until it seats [DO NOT exceed 120 lb. in. (13.5 Nm) of torque], then back nut off 1/4 turn
- **e** - Special Washer Head Bolt (10-849838) - Torque to 20 lb. ft. (27 Nm)
- **f** - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)

STEERING SYSTEM TENSION ADJUSTMENT

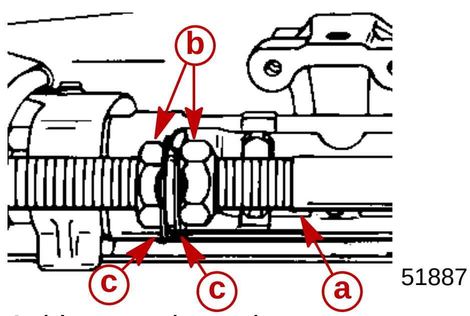
IMPORTANT: After this dual steering cable attachment kit is installed, there must be proper tension in forward mounted steering cable tor this attachment kit to operate properly. Not enough tension will cause slack (or play) in steering system. Too much tension will cause steering cables to bind. Perform 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.



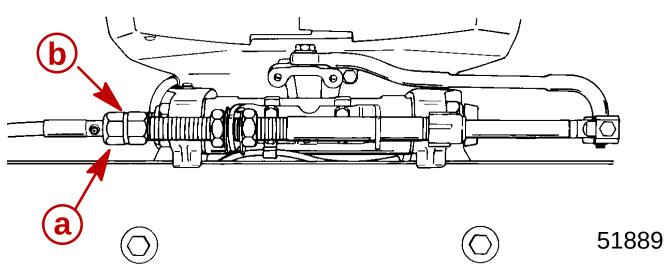
a - Steering Cable Mounting Tube
b - Adjustment Nuts
c - Adjust Tube in This Direction to Remove Slack from Steering System
d - Adjust Tube in This Direction to Reduce Tension from Steering System

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.



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
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."

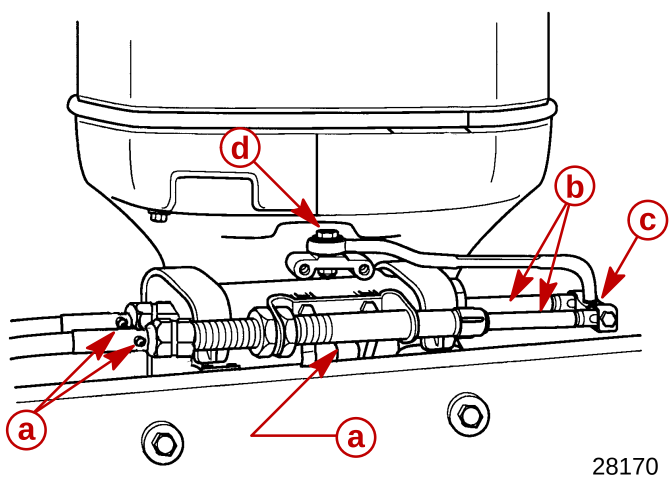
1. Carefully check steering system components for wear. Replace worn parts.
2. Check steering system fasteners to be sure that they are torqued to correct specifications.

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 with Teflon. Lubricate exposed portion of cable ends (b) with 2-4-C with 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 with Teflon.



28170

Ride Guide Steering Cable/Attaching Kit Installation (92876A9)

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.

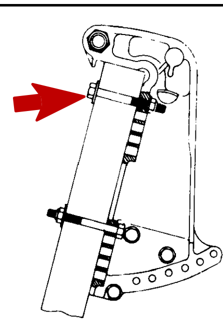
DETERMINE ROUTING OF STEERING CABLES

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 18 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

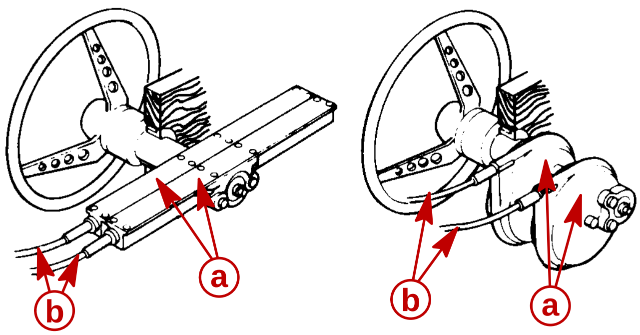
(Both Steering Cables Routed Together Down Starboard Side of Boat)

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.

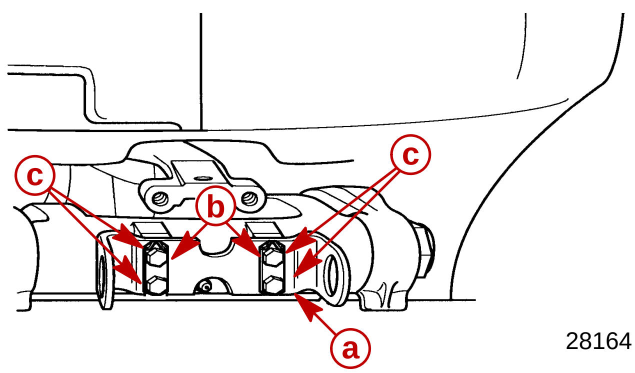


a - Straight Rack (Left); Rotary Steering (Right)
b - Steering Cables (Install so that Both Cables Will Push and Pull Together)

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 star-board outboard.

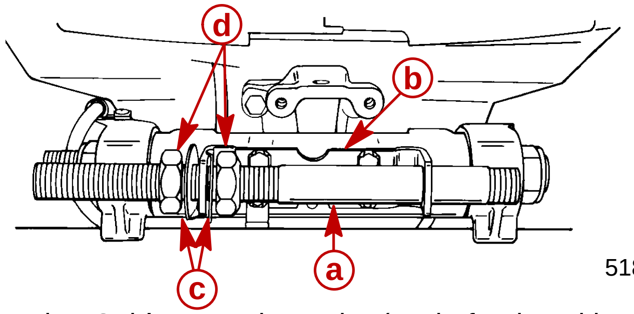


a - Mounting Bracket for Steering Cable Mounting Tube
b - Locking Retainers (2)
c - Bolts (4) - 5/8 in. (16 mm) Long - Torque to 100 lb. in. (11.5 Nm), then Bend Corner Tabs of Locking Retainers Up and Against Flats on Each Bolt

⚠ 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

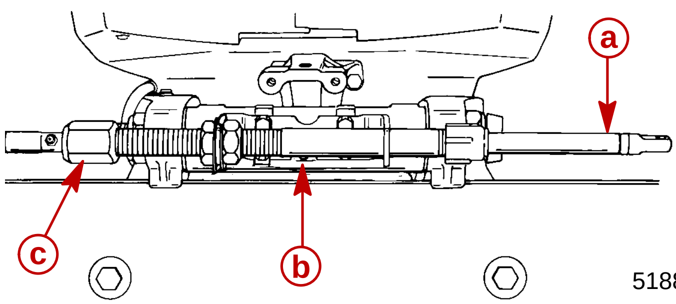
a - Steering Cable Mounting Tube (End of Tube with Longer Threads Toward Starboard Side of Boat)
b - Mounting Bracket
c - Locking Tab Washers (2)
d - Adjustment Nuts (Flats of Nuts Facing Toward Locking Tab Washer)

IMPORTANT: Lubricate inside of steering cable mounting tube with 2-4-C with Teflon before installing steering cable.

Lubricate inside of steering cable mounting tube (starboard outboard) with 2-4-C with Teflon.

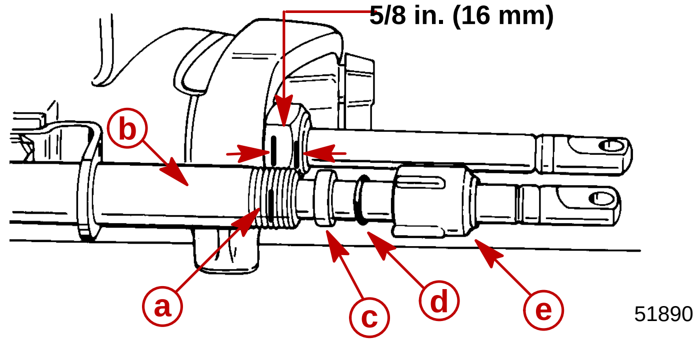
Insert steering cable end (a) thru cable mounting tube (b) and thread steering cable attaching nut (c) onto tube hand tight.

NOTE: *Torque steering cable attaching nut only after final steering adjustments have been made.*

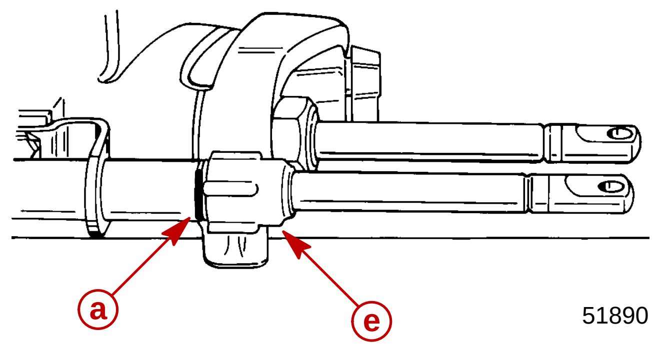


51887

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.



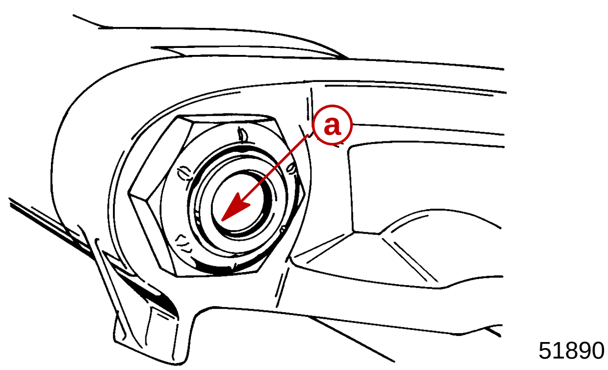
Thread cap (e) onto steering cable mounting tube, up to mark (a).



STEERING CABLE INSTALLATION - PORT OUTBOARD

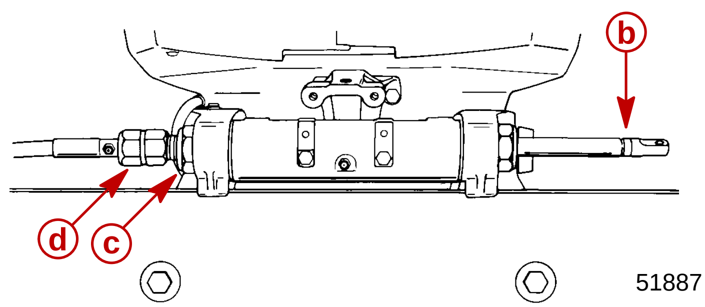
IMPORTANT: Lubricate inside of port outboard's tilt tube and rubber O-ring seal located inside tilt tube with 2-4-C with Teflon, before installing steering cable.

Lubricate inside of port outboard's tilt tube and rubber O-ring seal (a) with 2-4-C with Teflon.



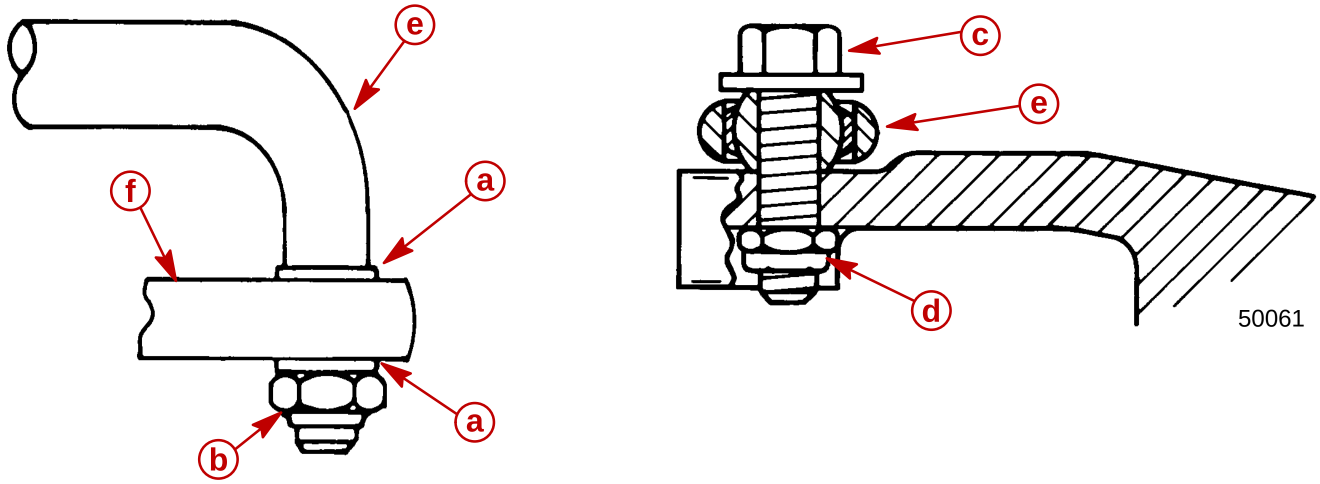
Insert steering cable end (b) thru tilt tube (c) of port outboard and thread steering cable attaching nut (d) onto tilt tube hand tight.

***NOTE:** Torque steering cable attaching nuts only after final steering adjustments have been made.*



STEERING LINK ROD INSTALLATION

> **⚠ WARNING**
>
> **Steering link rods MUST BE secured between outboard steering arm and steering cable end, using special washer head bolt (10-849838) and two nylon insert locknuts (11-826709113), as shown. Both special washer head bolt and nylon insert locknuts MUST BE tightened as specified.**



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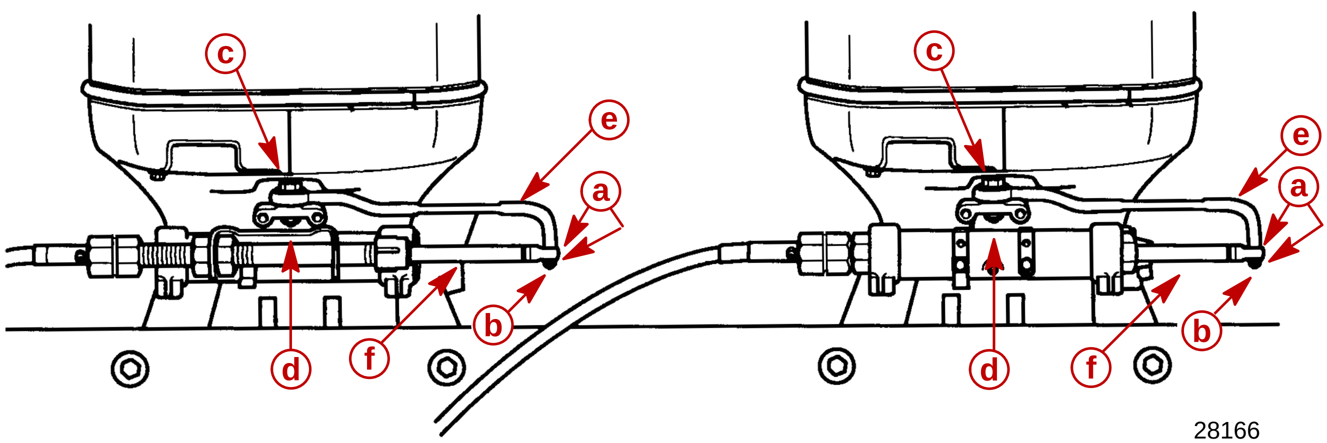


28166

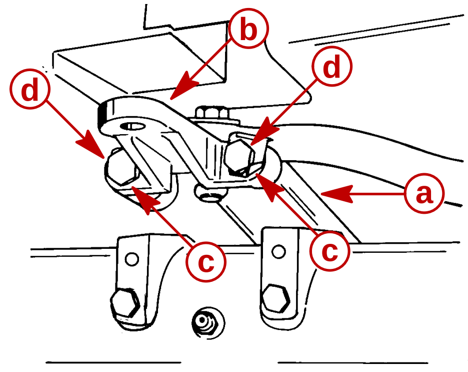
a - Flat Washer (2 Each Link Rod)
b - Nylon Insert Locknut - Torque Until it Seats [DO NOT Exceed 120 lb. in. (13.5 Nm) of Torque], Then Back Off 1/4 Turn
c - Special Washer Head Bolt (10-849838) - Torque to 20 lb. ft. (27 Nm)
d - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)
e - Steering Link Rod
f - Steering Cable End

Lubricate holes in ends of steering cables, with Quicksilver 2-4-C with 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 (10-849838) 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

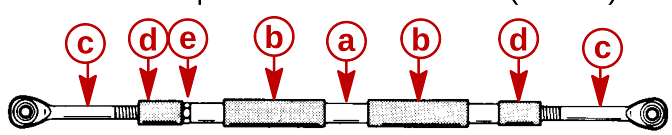
Position outboards so that they are facing straight forward. (Distance between threaded hole centers of steering arm extensions MUST BE equal to distance between propeller shaft centerlines.)

Lubricate inside of rubber sleeves with 2-4-C with 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 (10-849838) provided and nylon insert locknuts as shown.

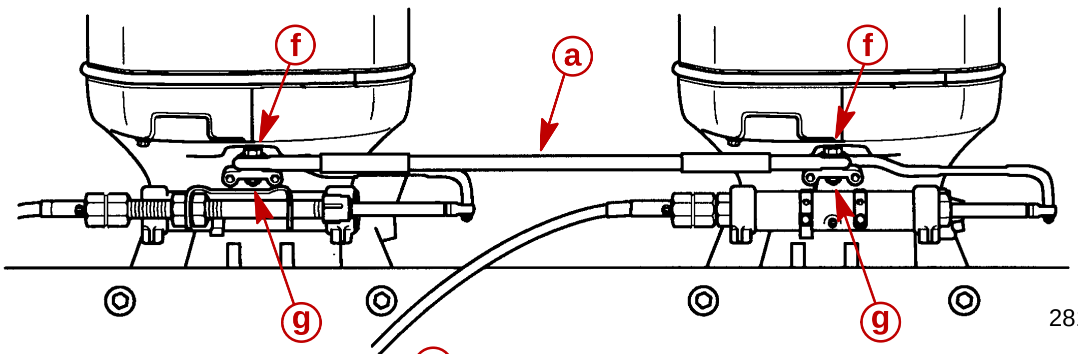
IMPORTANT: With assembled steering coupler installed and before tightening special washer head bolts/locknuts, check outboard alignment. Distance between centers of special washer head bolts MUST BE equal to distance between propeller shaft center lines, for proper steering. It adjustment is necessary, 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 N·m).

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.



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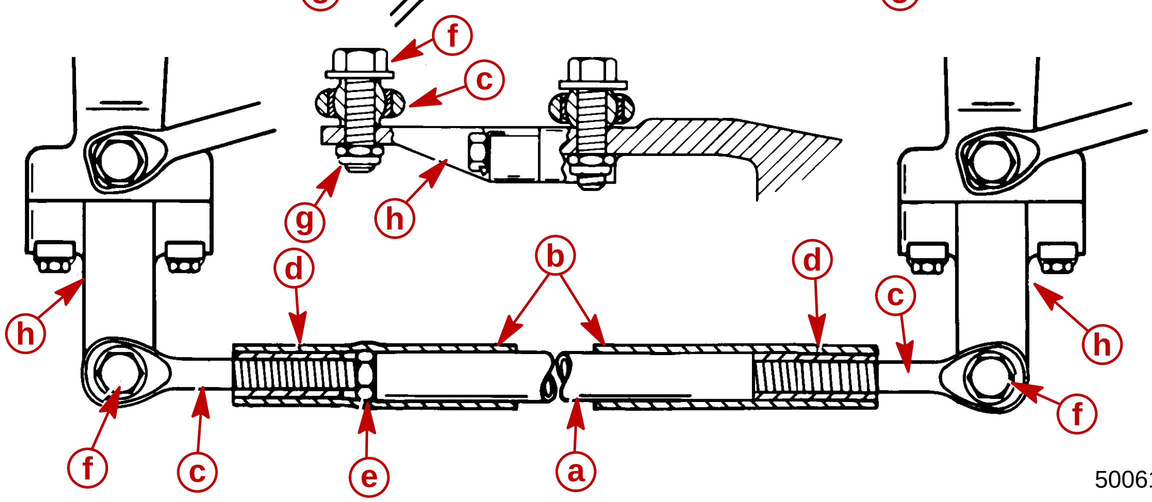


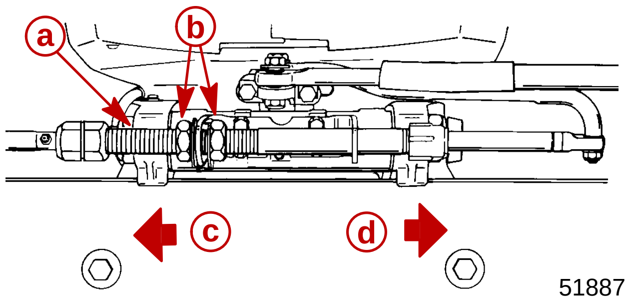
50061

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 (10-849838) - 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.

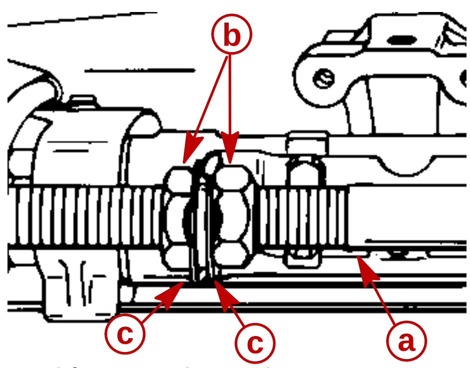
Loosen adjustment nuts and pull steering cable mounting tube (by hand) away from end of steering cable (to remove slack in steering system). Tighten adjustment nuts against mounting bracket and check system for slack (play). If steering system is too tight, readjust tube toward end of steering cable 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 Steering System

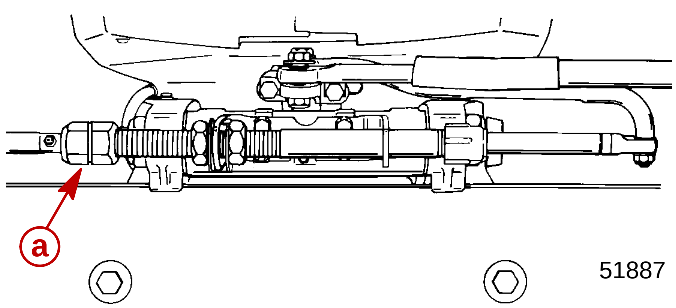
After steering system tension is adjusted correctly, tighten adjustment nuts against mounting bracket, to a torque of 35 lb. ft. (47.5 Nm) and bend a tab lock washer against a flat on each nut.



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 of each steering cable to a torque of 35 lb. ft. (47.5 Nm).



51887

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

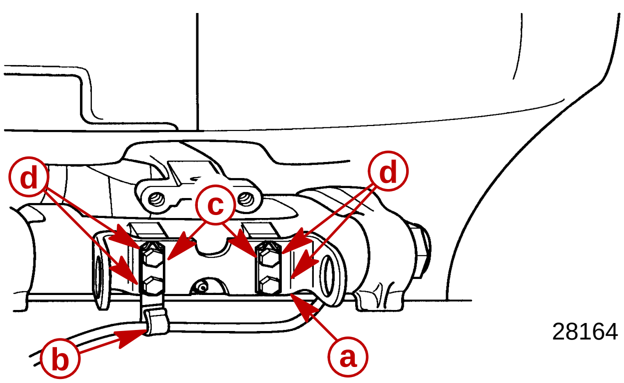
IMPORTANT: Steering cable must be installed into tilt tube of port outboard before outboard is mounted on boat transom.

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.



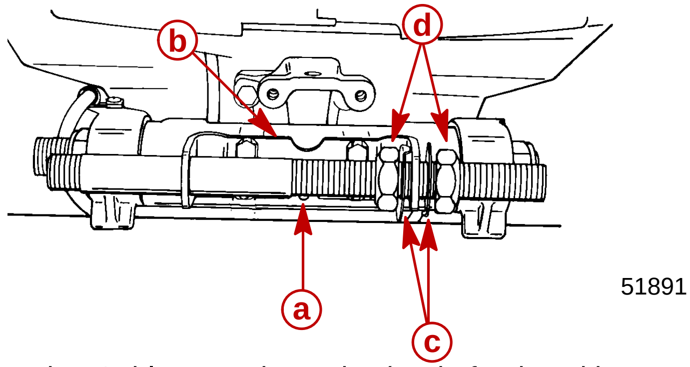
a - Mounting Bracket for Steering Cable Mounting Tube
b - "J" Clip - Supplied with Outboard
c - Locking Retainers (2)
d - Bolts (4) - 5/8 in. (16 mm) Long - Torque to 100 lb. in. (11.5 Nm), Then Bend Corner Tabs of Locking Retainers Up and Against Flats on Each Bolt.

⚠ 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.



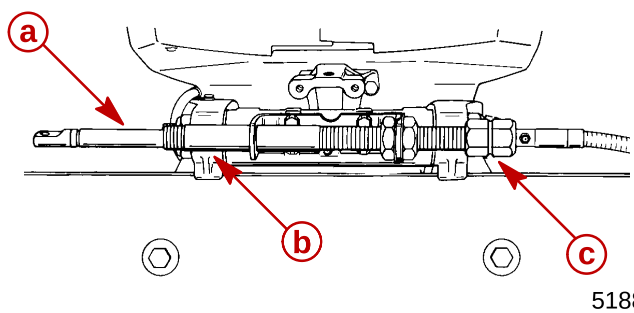
a - Steering Cable Mounting Tube (End of Tube with Longer Threads Toward Center of Boat Transom)
b - Mounting Bracket
c - Locking Tab Washers (2)
d - Adjustment Nuts (Flats of Nuts Facing Toward Locking Tab Washer)

IMPORTANT: Lubricate inside of steering mounting tube with 2-4-C with Teflon before installing steering cable.

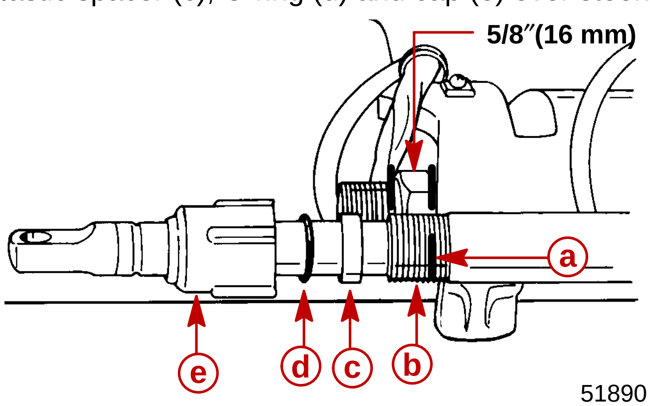
Lubricate inside of steering cable mounting tube (starboard outboard) with 2-4-C with Teflon.

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.

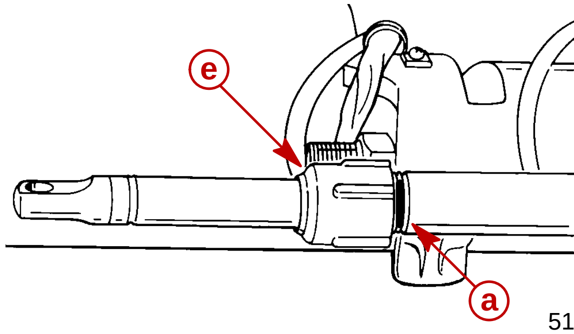
NOTE: *Torque steering cable attaching nut only after final steering adjustments have been made.*



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.



Thread cap (e) onto steering cable mounting tube, up to mark (a).



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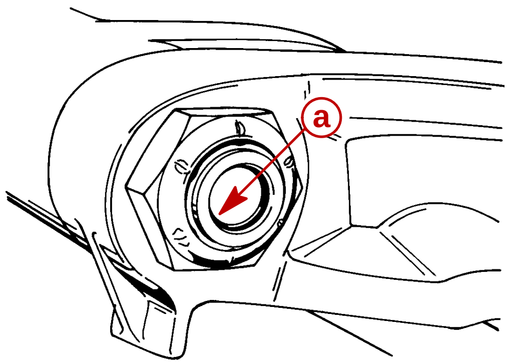
STEERING CABLE INSTALLATION - PORT OUTBOARD

IMPORTANT: Lubricate inside of port outboard's tilt tube and rubber O-ring seal located inside tilt tube with 2-4-C with Teflon, before installing steering cable.

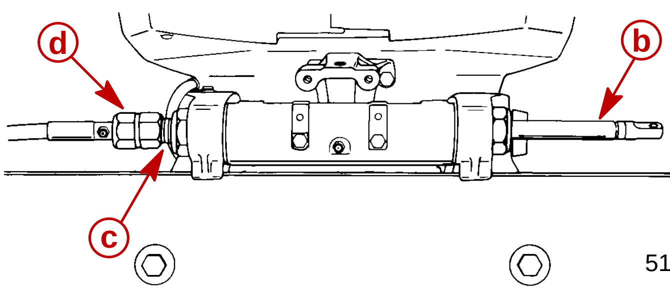
Lubricate inside of port outboard's tilt tube and rubber O-ring seal (a) with 2-4-C with Teflon.



51890

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.*



51887

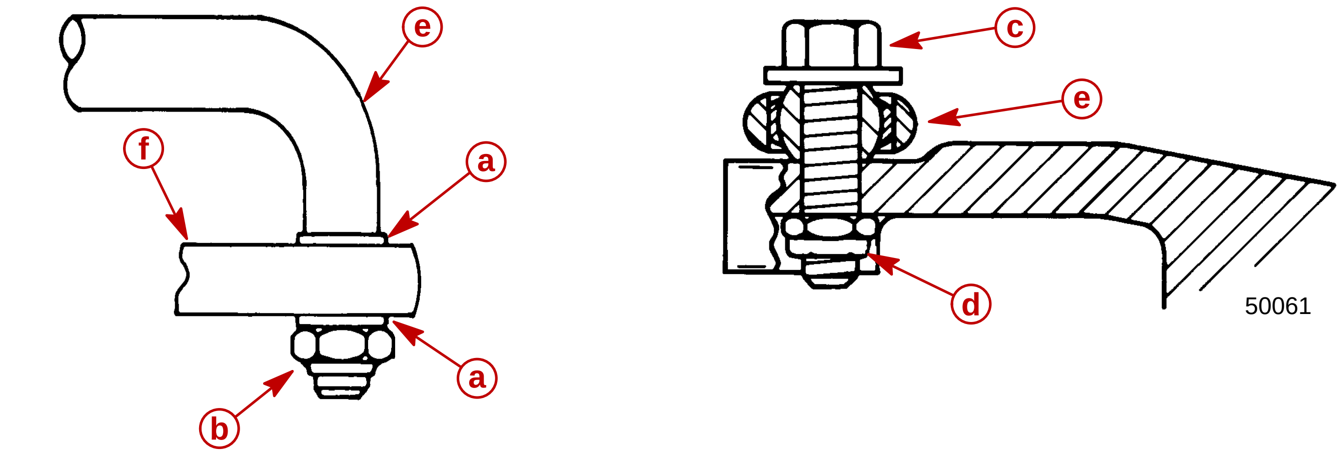
STEERING LINK ROD INSTALLATION

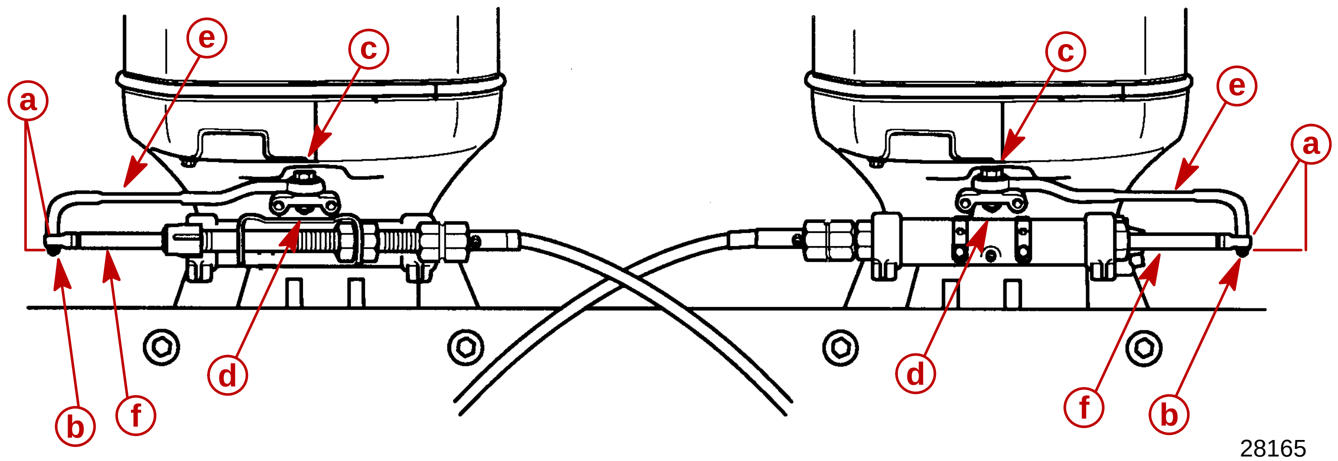
⚠ WARNING

Steering link rods MUST BE secured between outboard steering arm and steering cable end, using special washer head bolt (10-849838) and two nylon insert locknuts (11-826709113), 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 with Teflon. 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 (10-8849838) 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).

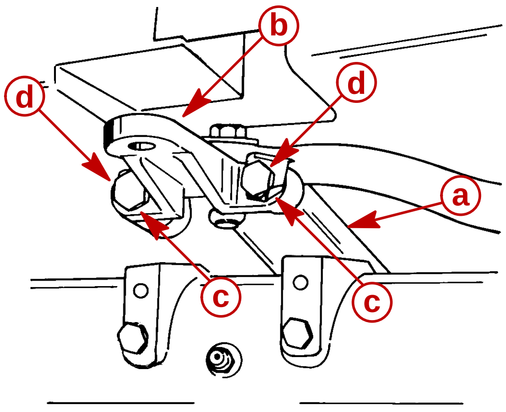




a - Flat Washer (2 Each Link Rod)
b - Nylon Insert Locknut - Torque Until it Seats [DO NOT Exceed 120 lb. in. (13.5 Nm) of Torque], Then Back Off 1/4 Turn
c - Special Washer Head Bolt (10-849838) - Torque to 20 lb.ft. (27 Nm)
d - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)
e - Steering Link Rod
f - Steering Cable End

STEERING ARM EXTENSION BRACKET INSTALLATION

Secure a steering arm extension bracket to each 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

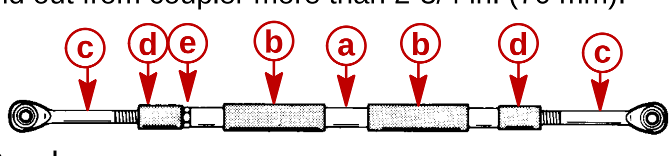
Position outboards so that they are facing straight forward. (Distance between threaded hole centers of steering arm extensions MUST BE equal to distance between propeller shaft centerlines.)

Lubricate inside of rubber sleeves with 2-4-C with 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 (10-849838) provided and nylon insert locknuts, as shown.

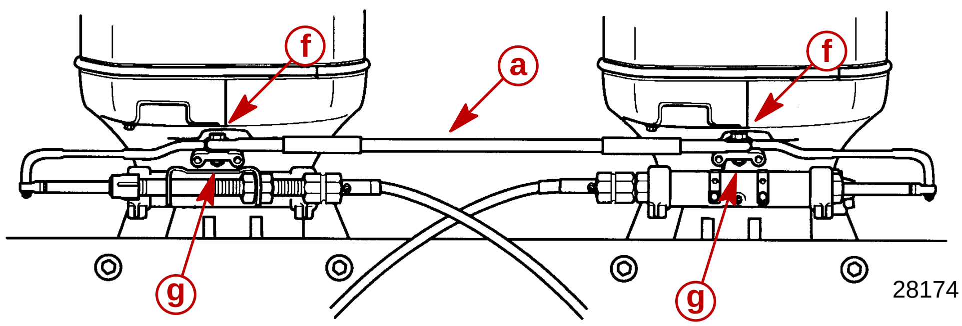
IMPORTANT: With assembled steering coupler installed and before tightening special washer head bolts/locknuts, check outboard alignment. Distance between centers of special washer head bolts MUST BE equal to distance between propeller shaft center lines, for proper steering. If adjustment is necessary, temporarily remove special washer head bolt/locknut from one steering eye and turn eye in or out to correct alignment.

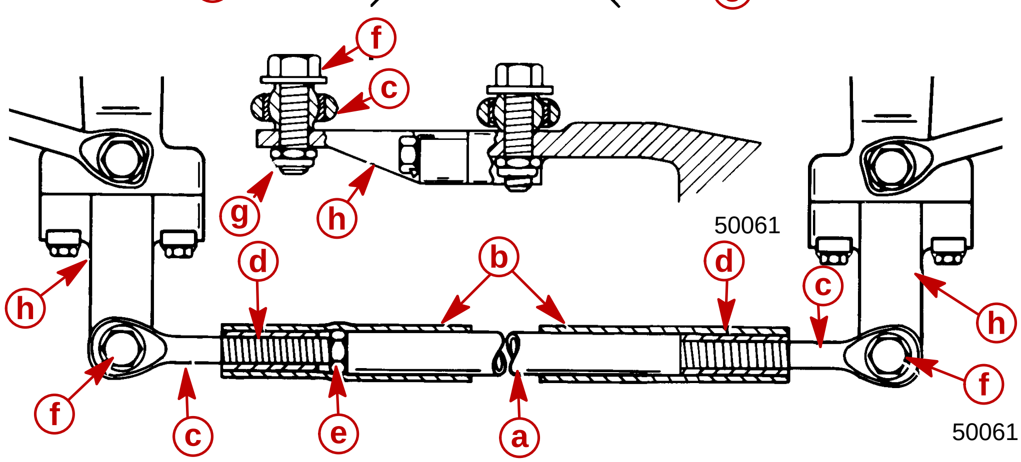
Torque special washer head bolts to 20 lb. ft. (27 Nm), then torque locknuts to 20 lb. ft. (27 Nm).

⚠ 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.



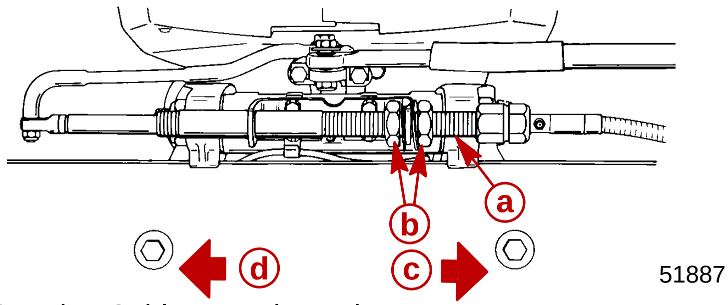


a - Coupler
b - Rubber Sleeve
c - Steering Eye
d - Rubber Bushing
e - Jam Nut - Torque (Against Coupler) to 20 lb. ft. (27 Nm)
f - Special Washer Head Bolt (10-849838) - Torque to 20 lb.ft. (27 Nm)
g - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)
h - Steering Arm Extension Bracket

STEERING SYSTEM TENSION ADJUSTMENT (PARALLEL ROUTED STEERING CABLES)

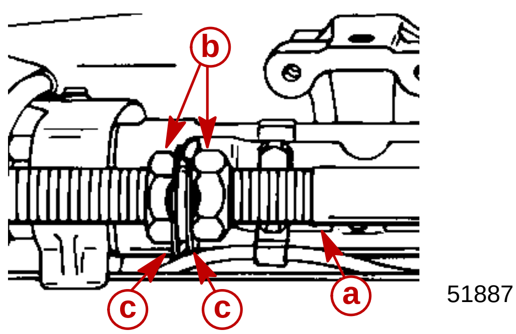
IMPORTANT: For proper operation of this dual cable - dual outboard steering installation, there MUST BE proper tension in the steering system. NOT ENOUGH tension will cause slack (play) in steering system. TOO MUCH tension will cause steering cables to bind. Perform the following steps to correctly adjust 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.



- **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).

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.

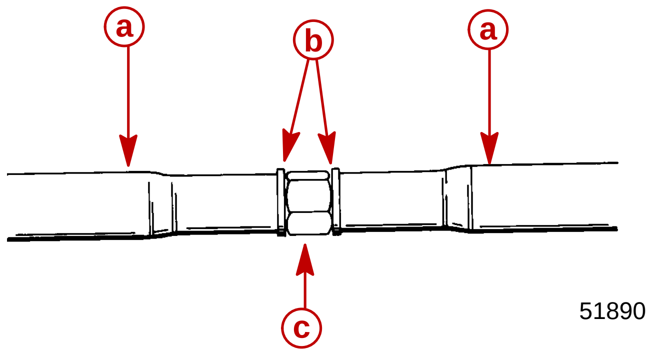
Ride Guide Steering Attachment Extension Couplers

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 Nm) into end of each coupler.



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.

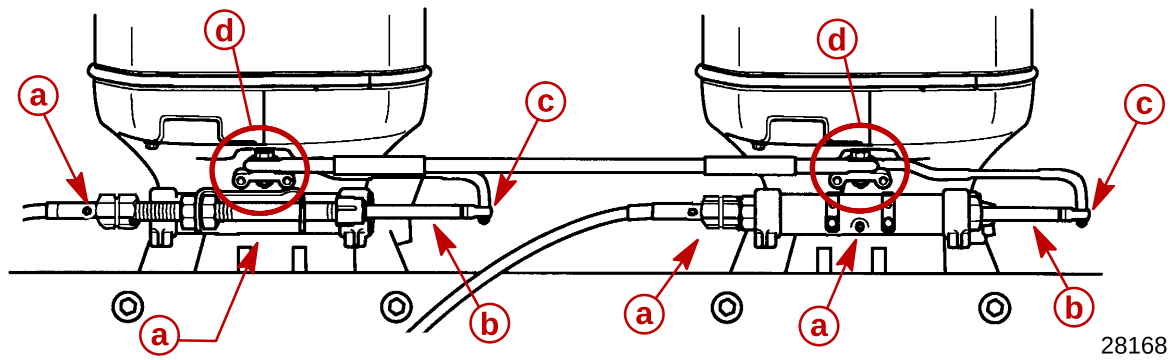
NOTE: *Ride-Guide Steering Cables are lubricated at the factory and require no additional lubrication at initial installation.*

⚠ WARNING

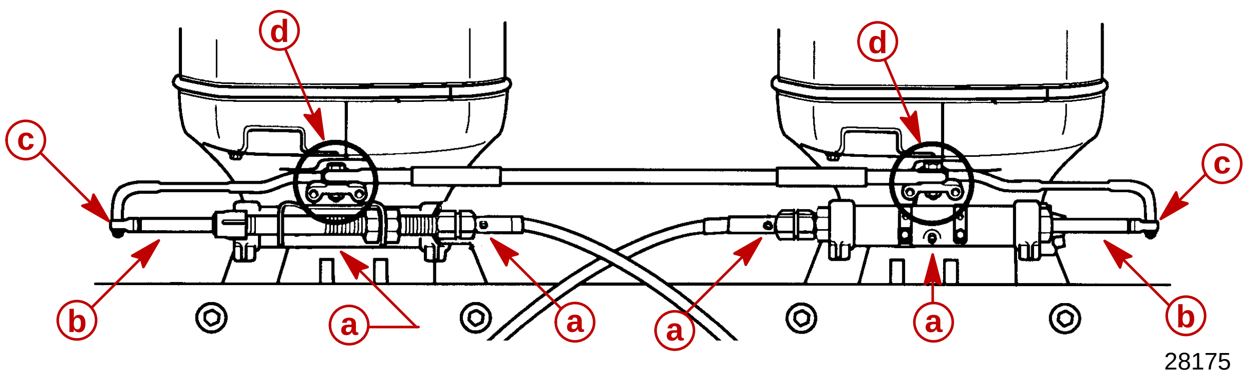
Core of each steering cable (transom end) must be fully retracted into cable housing before lubricating cable. If cable is lubricated while extended, hydraulic lock of cable could occur.

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 with Teflon. Lubricate exposed portion of cable ends (b) with 2-4-C with 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

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 with 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).

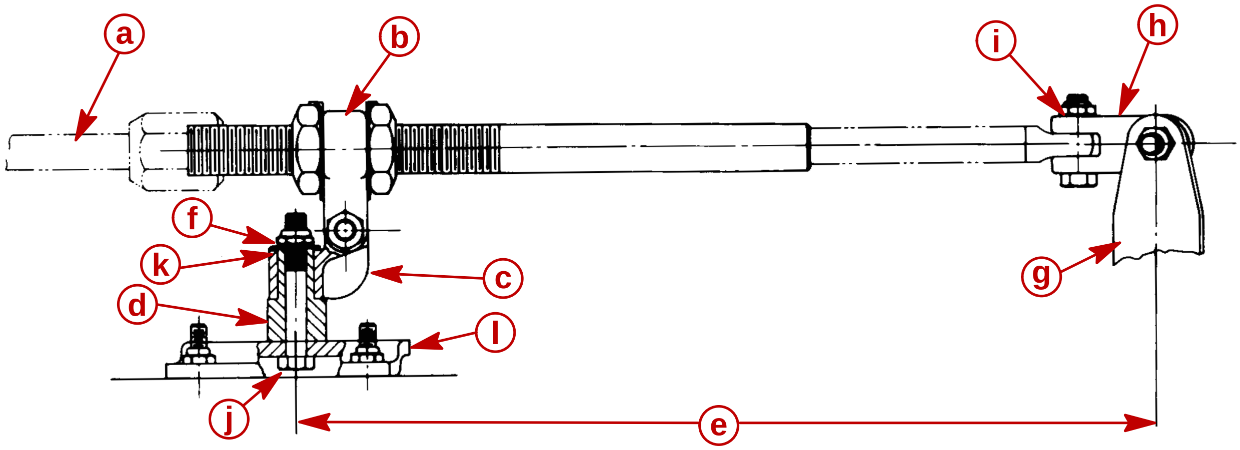


Figure 1

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.**

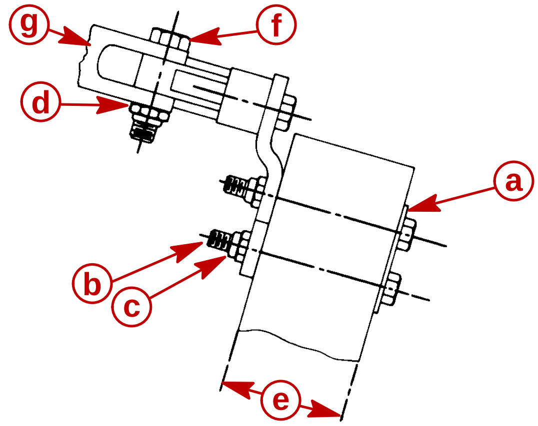


Figure 2

- **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)** (Figure 1) at a height where the **center of Ride-Guide yoke is even with, or not more than 1/2 in. (12.7 mm)** above top edge of transom. (Figure 3)

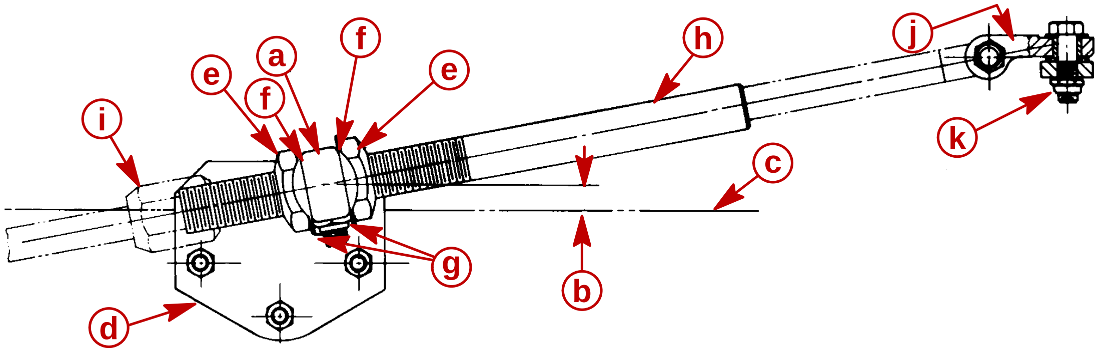


Figure 3

- **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 with Teflon.
2. Install steering cable thru steering cable tube and secure to cable tube 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 with Teflon.

NOTE: *Ride-Guide steering cable is lubricated at the factory and requires no additional lubrication at initial installation.*

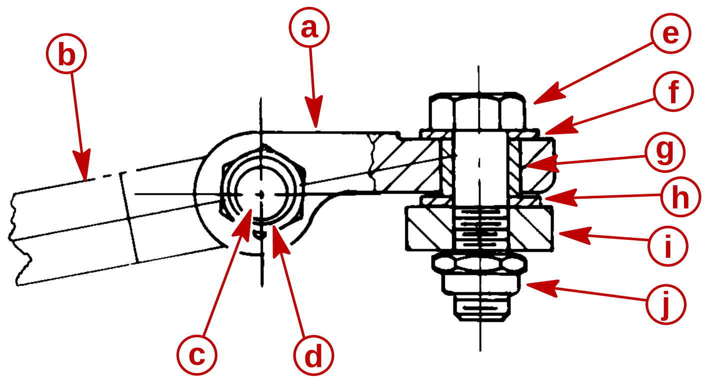
2. Lubricate all steering system pivot points (and exposed portion of steering cable core) with Quicksilver 2-4-C with Teflon. Lubricate at intervals specified preceding.
3. Carefully check steering system components for wear (at intervals specified, preceding). Replace worn parts.
4. Check steering 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 with 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 with 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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Notes:

150/175/200 EFI
WIRING DIAGRAM
2002 MODEL YEAR

150/175/200 EFI 2002 Model Year

1. ECM
2. Top ECM Connector
3. Middle ECM Connector
4. Bottom ECM Connector
5. Ignition Coils
6. Ignition Coil Harness Connection
7. Fuel Injectors
8. Analog Head Temperature Sender - Port Head
9. Oil Pump
10. MAP Sensor
11. Block Pressure Sensor
12. Water Sensor
13. Shift Switch
14. Digital Air Temperature Sensor
15. Digital Temperature Sensor - Starboard Head
16. Digital Temperature Sensor - Port Head
17. Yellow Identifier - 2.5 Liter Only
18. Throttle Position Sensor (TPS)
19. Crank Position Sensor (CPS)
20. Accessories 15 Ampere Fuse
21. Fuel System & Oil Pump 20 Ampere Fuse
22. Main Power Relay, Remote Control Harness & Power Trim Circuit 20 Ampere Fuse
23. Ignition Coils 20 Ampere Fuse
24. Low Oil Switch
25. Starter Solenoid
26. Centrifugal Bendix Starter Motor (Early 2002 Models)
27. Solenoid Driven Bendix Starter Motor (Late 2002 Models)
28. 60 Ampere Alternator
29. Main Power Relay
30. Electric Fuel Pump
31. Trim Down Relay
32. Trim Up Relay
33. To Trim Pump
34. To 12 Volt Battery
35. Cowl Mounted Trim Switch
36. To Remote Control Trim Switch
37. 12 Volt Accessory Power
38. To Analog Temperature Gauge
39. Detonation Sensor - Port Head
40. Detonation Sensor - Starboard Head
41. Engine Harness
42. 10-Pin SmartCraft Harness (Gauges)
43. DDT Data Port
44. 8-Pin SmartCraft Harness (Boat Sensors)


59138

TYPICAL SMARTCRAFT SYSTEM TACHOMETER & SYSTEM SPEEDOMETER INSTALLATION WITH SYSTEM LINK GAUGES 2002 MODEL YEAR

Typical SmartCraft System Tachometer & System Speedometer with System Link Gauges 2002 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. 10-Pin Control Area Network (CAN) Harness Connects to Data Buss 10-Pin CAN Harness on Engine
5. Yellow Identifier Marking Resistor End of CAN Harness
6. Resistors within CAN Harness (120Ω 1/4W 5%)
7. Weather Proof Cap on Un-Used Junction Box Terminals
8. Resistor Cap in Junction Box Terminal
9. 10-Pin Control Area Network (CAN) Harness Connects to Junction Box
10. 10-Pin Control Area Network (CAN) Harness Connection to Junction Box and System Speedometer
11. 10-Pin Control Area Network (CAN) Harness Connection to Junction Box and System Tachometer
12. Ambient Air Temperature Sensor
13. System Speedometer
14. Connections for GPS
15. System Tachometer
16. Connections for Auxiliary Warning Horn for Depth Sensor
17. System Link Series Connection
18. 2-1/4 in. System Link Gauges (Fuel, Temperature, Trim etc.)
19. System Link Series Connection
20. 2-1/4 in. System Link Gauges (Fuel, Temperature, Trim etc.)
21. Plugged Series Connection for Additional System Link Gauges
22. 4000 Series Mechanical Panel Control (MPC 4000)
23. Connections for Lanyard Stop Switch
24. Connection for Power Trim Switch
25. Connections for Neutral Start Safety Switch
26. Ignition Key Switch
27. Analog Tachometer Harness (Not Used on CAN Installation)
28. Warning Horn
29. Analog Temperature Gauge Connection
30. Paddle Wheel/Lake/Sea Water Temperature Sender
31. 4-Pin Digital Sensor Harness Connection to Paddle Wheel
32. Digital Connections to Oil Sender
33. Digital Connections to Fuel Sender
34. Connection for Analog Trim Sender
35. Connection to Trim Relays
36. Connection for Analog Temperature Sender
37. Remote Control Harness Connects to Engine Harness
38. 6-pin Digital Sensor Harness


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TYPICAL SMARTCRAFT SYSTEM MONITOR/TACHOMETER INSTALLATION WITH SYSTEM LINK GAUGES 2002 MODEL YEAR

Typical SmartCraft System Monitor/Tachometer with System Link Gauges 2002 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. Connection 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 Connects 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. Yellow Identifiers Marking Resistor End of CAN Harness
13. Either System Monitor or System Tachometer is Used. If System Tachometer is Used, Tachometer Link Gauge is not Used
14. System Link Series Connection
15. 3-1/4 in. System Link Gauges (Tachometer and Speedometer)
16. 2-1/4 in. System Link Gauges (Fuel, Temperature, Trim etc.)
17. Plugged Series Connection for Additional System Link Gauges
18. 4000 Series Mechanical Panel Control (MPC 4000)
19. Connections for Lanyard Stop Switch
20. Connection 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 to Fuel Sender

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TYPICAL SMARTCRAFT DUAL OUTBOARD INSTALLATION 2002 MODEL YEAR

Typical SmartCraft Dual Outboard Installation 2002 MY

1. 8-Pin Harness from Port Outboard
2. Digital Sensor Harness Extension Port Outboard
3. Digital Speedometer Sensor Port Outboard
4. Digital Trim Sender Port Outboard
5. Digital Sensor Harness Extension Port Outboard to 6-pin Digital Sensor Harness
6. 6-pin Digital Sensor Harness Port Outboard (Only if Duel Fuel and Oil Tanks are Used)
7. Digital Connections for Fuel Sender
8. Digital connections for Oil Sender
9. Weather Proof Cap for 6-Pin Harness
10. Weather Proof Cap for System Link Gauges
11. 2-1/4 in. System Link Gauges (Fuel, Temp, Trim, etc.) Port Outboard
12. System Tachometer Port Outboard
13. System Speedometer
14. System Tachometer Starboard Outboard
15. System Link Series Connections Port Outboard
16. 10-Pin Control Area Network (CAN) Connection to System Tachometer Port Outboard
17. Connections for Auxiliary Warning Horn for Depth Sensor
18. Ambient Air Temperature Sensor
19. 10-Pin Control Area Network (CAN) Connection to System Speedometer
20. Connections for GPS
21. Connections for Auxiliary Warning Horn for Depth Sensor
22. 10-Pin Control Area Network (CAN) Connection to System Tachometer Starboard Outboard
23. System Link Series Connections Starboard Outboard
24. 2-1/4 in. System Link Gauges (Fuel, Temp, Trim, etc.) Starboard Outboard
25. Weather Proof Cap for System Link Gauges
26. 10-Pin Control Area Network (CAN) Connection from System Tachometer Port Outboard to Junction Box
27. 10-Pin Control Area Network (CAN) Connection from System Speedometer to Junction Box
28. 10-Pin Control Area Network (CAN) Connection from System Tachometer Starboard Outboard to Junction Box
29. 10-Pin Control Area Network (CAN) Junction Box
30. 10-Pin Control Area Network (CAN) Connection from Junction Box to Port Outboard 10-Pin Data Buss CAN Harness
31. 10-Pin Control Area Network (CAN) Connection from Junction Box to Starboard Outboard 10-Pin Data Buss CAN Harness
32. Resistor in Port CAN Harness (120Ω 1/4W 5%)
33. Yellow Resistor Identifier on Harness End
34. 10-Pin Control Area Network (CAN) Connection from Junction Box to Port Outboard 10-Pin Data Buss CAN Harness
35. 10-Pin Data Buss CAN Harness Port Outboard
36. 3-Pin Data Buss CAN Connection for Power
37. Resistor in Port CAN Harness (120Ω 1/4W 5%)
38. Yellow Resistor Identifier on Harness End
39. 10-Pin Control Area Network (CAN) Connection from Junction Box to Starboard Outboard 10-Pin Data Buss CAN Harness
40. 10-Pin Data Buss CAN Harness Starboard Outboard
41. 3-Pin Data Buss CAN Connection for Power, Must be Disconnected and Capped on Dual Installation
42. Digital Trim Sender Starboard Outboard
43. Digital Speedometer Sensor Starboard Outboard
44. 8-Pin Harness from Starboard Outboard
45. Digital Sensor Harness Extension Starboard Outboard
46. Digital Sensor Harness Extension Starboard Outboard to 6-pin Digital Sensor Harness
47. 6-pin Digital Sensor Harness Starboard Outboard
48. Digital Connections for Fuel Sender
49. Digital connections for Oil Sender
50. 4-Pin Digital Sensor Harness Connection to Paddle Wheel
51. Paddle Wheel/Lake/Sea Water Temperature Sender
52. Weather Proof Cap for Junction Box Terminal


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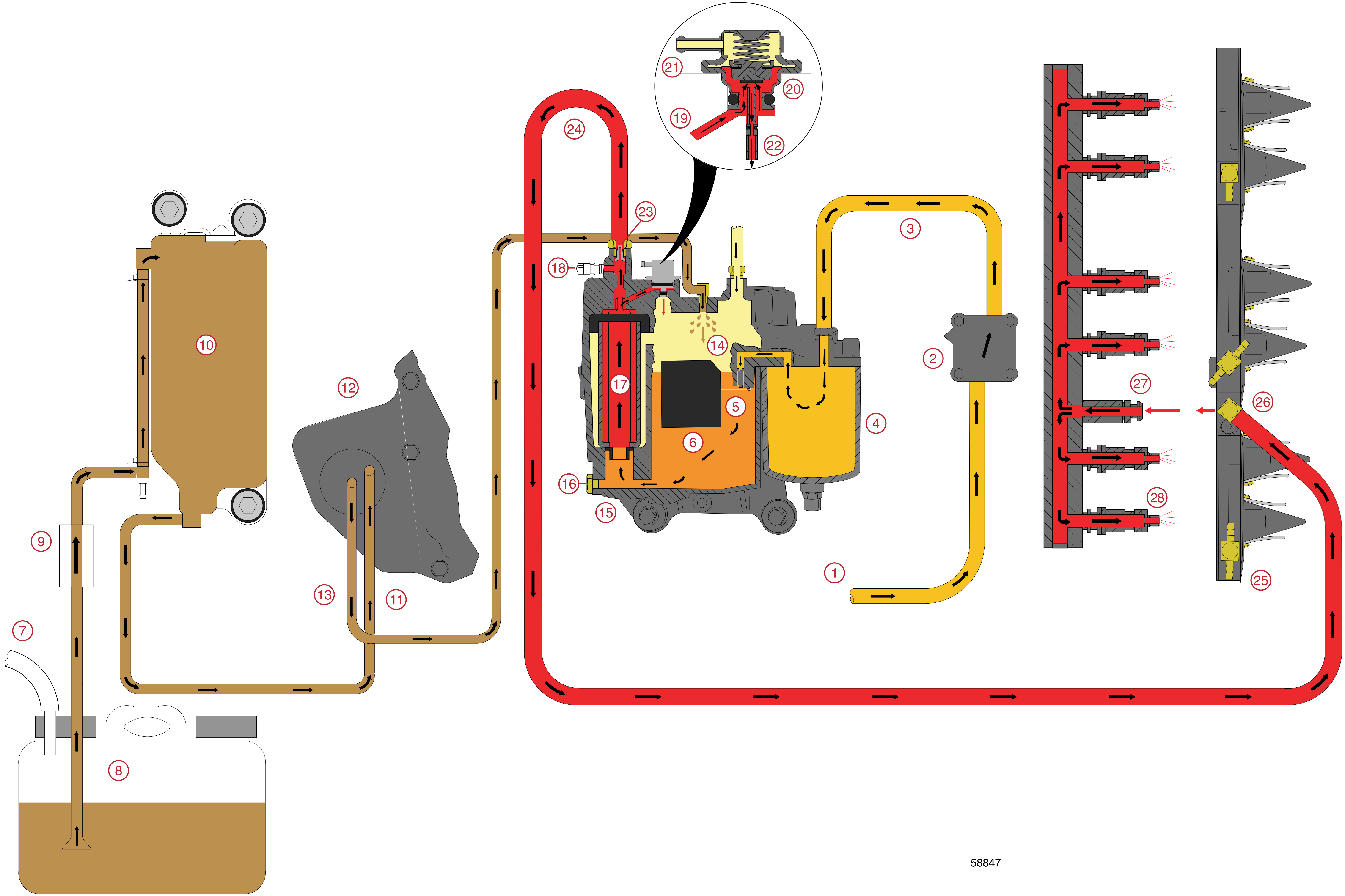
150/175/200 EFI
OIL & FUEL FLOW DIAGRAM
2002 MODEL YEAR

150/175/200 EFI Oil & Fuel Flow 2002 Model Year

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 in Vapor Separator Tank (VST) Assembly
5. Fuel outlet from Needle and Seat
6. Fuel Level Float in VST
7. Pulse Pressure from Cylinder Block
8. On-Board Oil Tank
9. Check Valve in Outlet Hose from Oil Tank
10. Outboard Oil Tank
11. Oil Inlet Hose to Electronic Oil Pump
12. Electronic Oil Pump
13. Oil Outlet Hose from Oil Pump to VST
14. Oil is Mixed with Gas in VST
15. Gas/Oil Mixture is Drawn into High Pressure Fuel Pump
16. Fuel Drain
17. High Pressure Fuel Pump
18. Schrader Valve
19. Fuel Passage to Fuel Regulator
20. Fuel Regulator
21. Ambient Air Pressure
22. Fuel Blow-Off from Fuel Regulator to VST
23. In-Line Fuel Filter
24. High Pressure Fuel Line to Reed Valve Plate Assembly
25. Reed Valve Plate Assembly
26. Fuel Rail Assembly
27. Fuel Injectors



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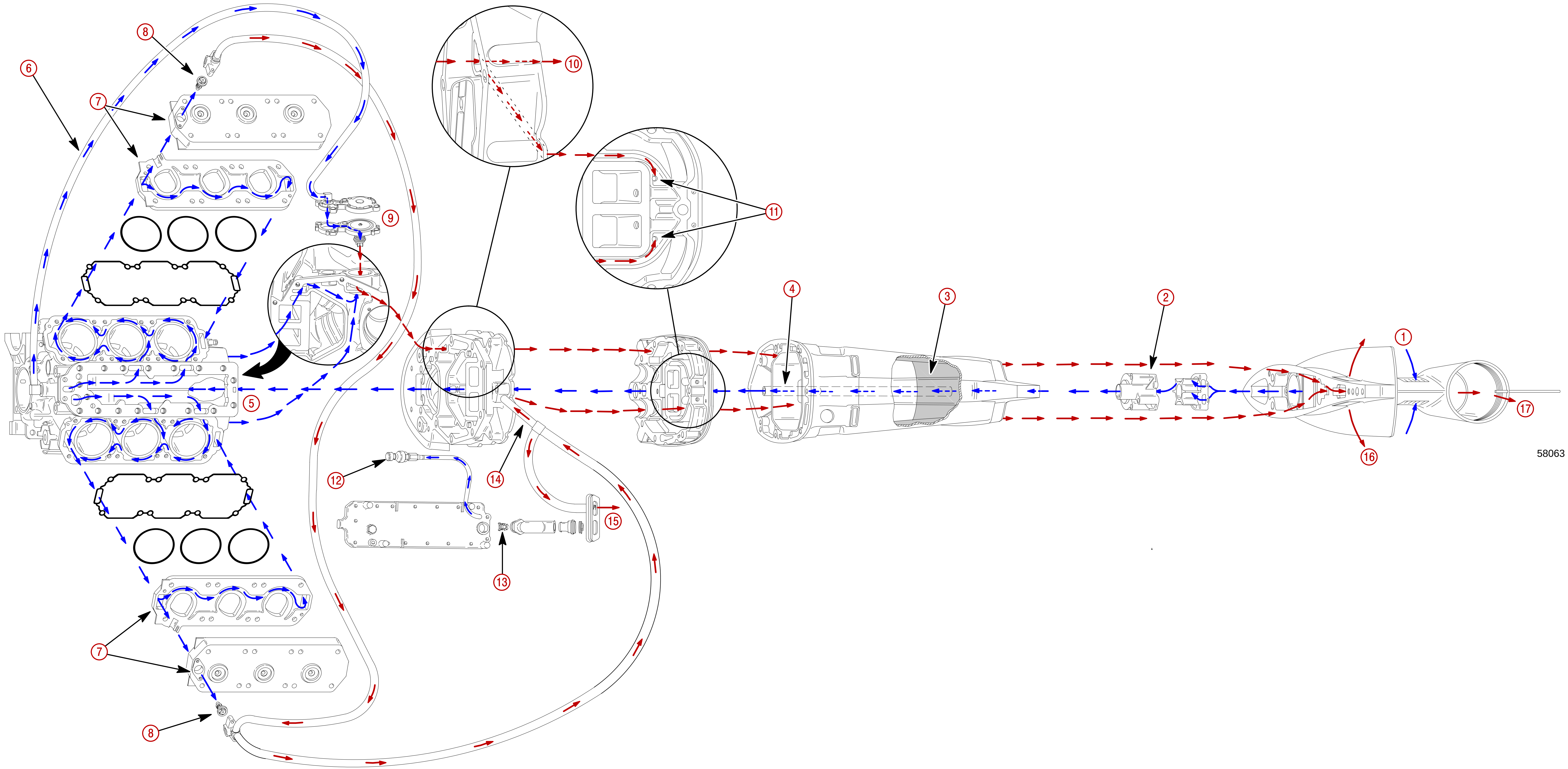
150/175/200 EFI
WATER FLOW DIAGRAM
2002 MODEL YEAR

150/175/200 EFI Water Flow 2002 Model Year

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. Water Tube
5. Main Water Feed to Powerhead from Water Tube
6. Water by-pass prevents air/steam pockets at top of powerhead
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 low speed. If stuck open, engine will not warm up at idle speed.
9. 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
10. Primary water discharge into driveshaft housing.
11. Water Dump Holes for exhaust cooling (2 each) 1/8 in. (3.175 mm) - if holes are plugged, tuner pipe will melt and bearing carrier prop shaft seals will be damaged.
12. Water Pressure Sensor
13. Check Valve for powerhead flush
14. Water passing through thermostats dump into adaptor plate, then discharges down the exhaust.
15. Tell-Tale Outlet
16. Excess water from wall of of water around exhaust bucket exits around anodes.
17. Water Exits with Exhaust Discharge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