

MERCURY

MERCURY

Service Manual



225/250
3.0 Litre Work

**Electronic
Fuel Injection**


Starting Model Year 2002
Starting Serial Number 0T409000

3.0 Litre Work 225/250 EFI

Starting Model Year 2002
90-884294 OCTOBER 2001



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.

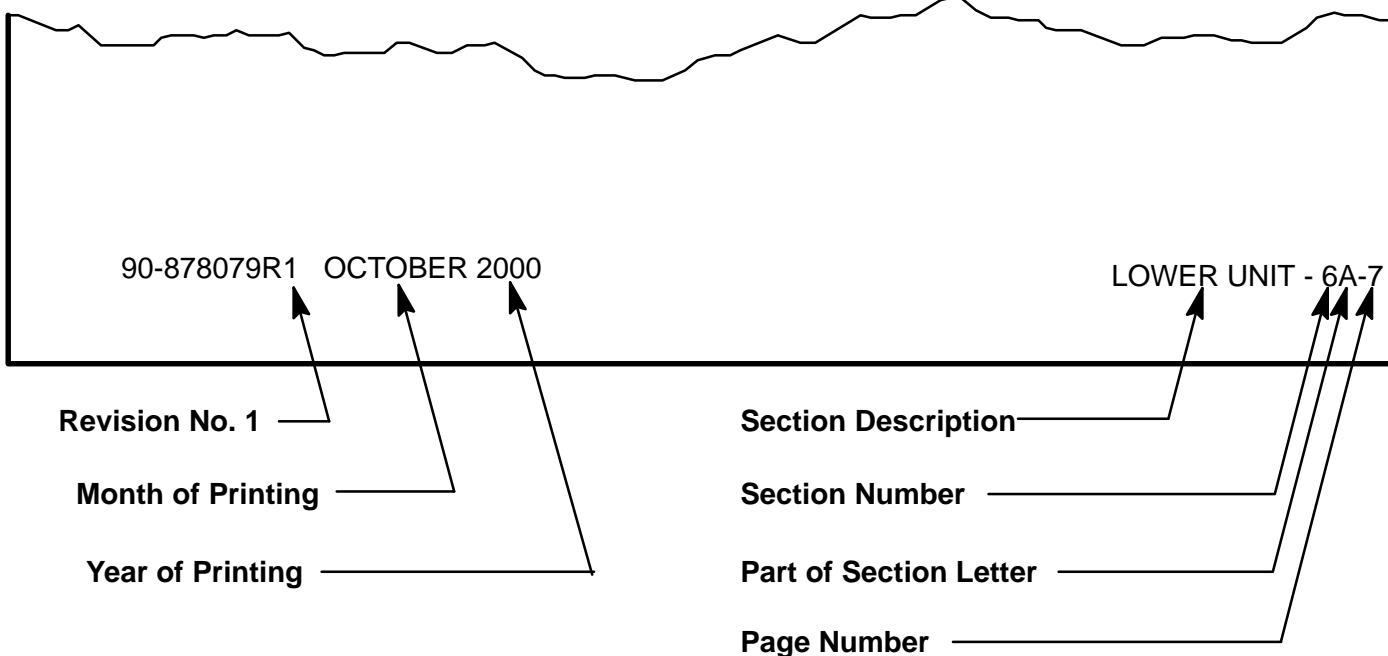
We reserve the right to make changes to this manual without prior notification.

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:





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- A - Specifications
- B - Maintenance
- C - General Information
- D - Outboard Installation

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- C - Timing, Synchronizing & Adjusting
- D - Wiring Diagrams

Section 3 - Fuel System

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- D - Emissions

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- A - Clamp/Swivel Brackets & Drive Shaft Housing
- B - Power Trim

Section 6 - Gear Housing

- A - Right Hand Non-Ratcheting
- B - Left Hand Non-Ratcheting

Section 7 - Attachments/Control Linkage

Section 8 - Color Diagrams

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& Specifications

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IMPORTANT INFORMATION

Section 1A - Specifications

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A**

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Specifications

Model 3 Liter Work/225 EFI/250 EFI		
HORSEPOWER (KW)	Model 3 Liter Work Model 225 EFI Model 250 EFI Full Throttle RPM (All Models) Idle RPM (In Gear) (All Models) RPM Limiter All Models	200 (149.1) 225 (167.8) 250 (186.5) 5000 – 5800 625 ± 50 Refer to System Information in the Digital Diagnostic Terminal (DDT) for latest information
OUTBOARD WEIGHT	Model 3 Liter Work/225 EFI/250 EFI – 20 in. (50.8 cm) Shaft – 25 in. (63.5 cm) Shaft – 30 in. (76.2 cm) Shaft	458.0 lbs. (207.7 kg) 463.0 lbs. (210.0 kg) 479.0 lbs. (217.3 kg)
CYLINDER BLOCK	Model 3 Liter Work/225 EFI/250 EFI Type Displacement Thermostat	V–6 Cylinder, Two Cycle, Loop Charged 185.9 cu. in. (3047 cc) 120 °F (48.8 °C)
STROKE	Length (All Models)	3.00 in. (76.2 mm)
CYLINDER BORE	Models 3 Liter Work/225 EFI/250 EFI Diameter (Std) Taper/Out of Round/Maximum Wear Bore Type	3.625 in. (92.075 mm) 0.003 in. (0.076 mm) Cast Iron
CRANKSHAFT	Maximum Runout	0.006 (0.152 mm)
PISTON	Piston Type Models 3 Liter Work/225 EFI/250 EFI Standard 0.015 in. (0.381 mm) Oversize 0.030 in. (0.762 mm) Oversize	Aluminum 3.621 in. ± 0.0005 in. (91.973 mm ± 0.0127 mm) 3.636 in. ± 0.0005 in. (92.3544 mm ± 0.0127 mm) 4.383 in. ± 0.0005 in. (111.328 ± 0.0127 mm)
COMPRESSION	All Models – Using a fully charged battery, throttle shutters wide open and cylinder block warm	90 – 110 psi (616.3 – 753.5 kPa) Variance between cylinders should not exceed 15 psi (102.7 kPa)



SPECIFICATIONS

REEDS	Model 3 Liter Work/225 EFI/ 250 EFI Reed Type Reed Stand Open (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 Champion QL77CC 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 Battery Rating	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) Min. 630 Marine Cranking Amps (MCA) or 490 Cold Cranking Amps (CCA)



GEAR HOUSING	Gear Ratio – All Models (Standard) – All Models (High Altitude) Gearcase Capacity – 1.75:1/1.87:1 Pinion Height – All Models Forward Gear Backlash – 1.75:1/1.87:1 Reverse Gear Backlash – Standard Rotation – Counter Rotation Water Pressure @ RPM – @ Idle – @ 5000 RPM	1.75:1 (12/21 teeth) 1.87:1 (15/28 teeth) 28 fl oz (828.0 ml) 0.025 in. (0.64 mm) 0.017 in. – 0.028 in. (0.43 mm – 0.71 mm) 0.028 in. to 0.052 in. (0.71 mm to 1.32 mm) 0.040 in. to 0.060 in. (1.0 mm to 1.52 mm) 1-1/2 – 4-1/2 psi (10.3 – 30.8 kPa) 8 – 10 psi (54.8 – 68.5 kPa) Minimum
OIL INJECTION	Recommended Oil Oil Tank Capacity Approx. Time – All Models Reserve Capacity/Approx. Time Oil Pump Output – All Models	Quicksilver or Mercury Precision Lubricants NMMA/BIA Certified TC-W3 2 Cycle Outboard Oil 3 gal. (11.4 Liter) 6.0 hrs. Approx. 1.5 qt. (1.45 Liter) 30 – 35 min. 26cc during auto prime time period
FUEL INJECTION	Idle RPM – All Models Wide Open Throttle (WOT) RPM – All Models 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 5000 – 5800 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
SAE 30W Oil	Obtain Locally	Obtain Locally



Description	Mercury Part Number	Quicksilver Part Number
RTV 587 Silicone 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
Fuel System Treatment & Stabilizer [12 oz. (355 ml)]	92-802875A1	92-802875Q1
Corrosion Guard [11 oz. (325 ml)] Spray Can	92-802878-55	92-802878Q55



IMPORTANT INFORMATION

Section 1B - Maintenance

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Specifications

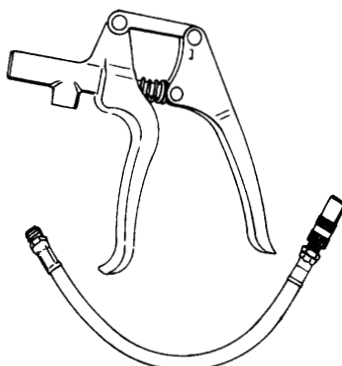
Gear Case Lubricant Capacity

Gear Case Ratio	Capacity
1.75:1	28.0 fl. oz. (828.0 ml)
1.87:1	28.0 fl. oz. (828.0 ml)

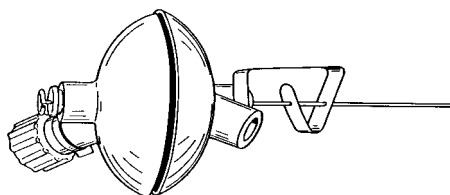


Special Tools

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.

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

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

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

* *This item should be serviced by an authorized dealer.*



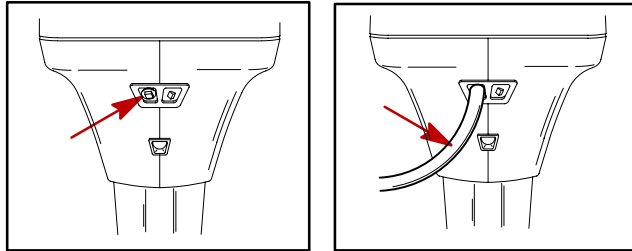
Flushing Engine

Flushing Cooling System – Using Cowl Flush Plug

After each use in salt, polluted or muddy water, flush the internal water passages of the outboard with fresh 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.

⚠ CAUTION

It is recommended that the front water pickups on the leading end of the torpedo be blocked off (duct tape, etc.) while applying water to side mounted water pickups during powerhead flushing or engine testing to prevent possible engine overheat from air injection.

1. Install Flushing Attachment 44357Q2 (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

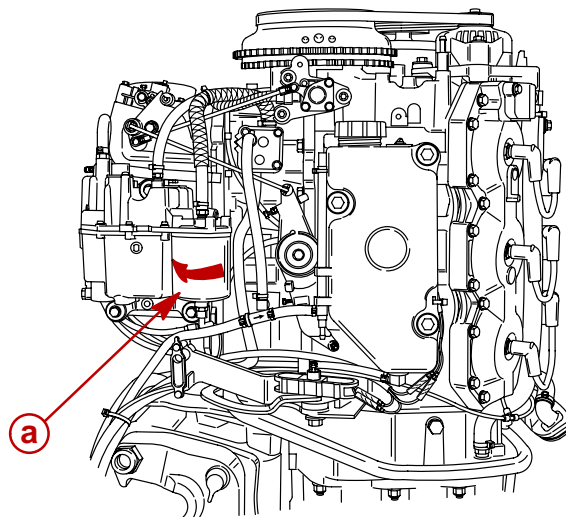
Visually inspect the fuel line and primer bulb for cracks, swelling, leaks, hardness, or other signs of deterioration or damage. If any of these conditions is found, the fuel line or primer bulb must be replaced.

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.



a - Fuel/Water Separator Filter

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Remove and replace filter as follows:

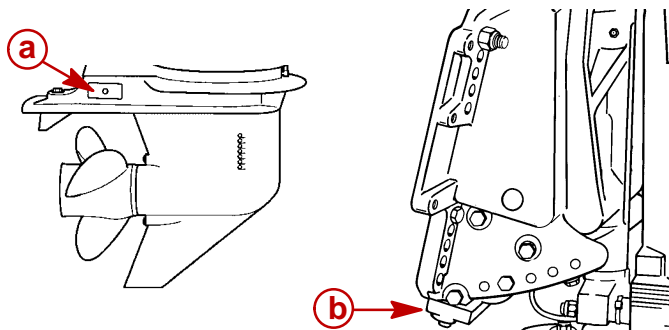
2. Turn ignition key switch to OFF position.
3. Disconnect wire at bottom of filter.



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

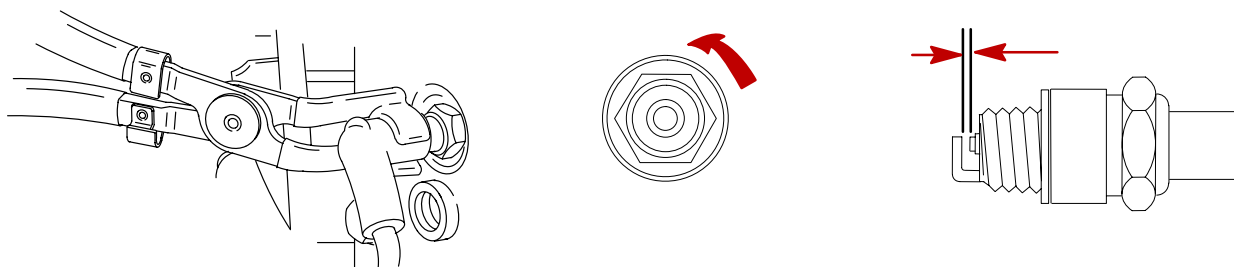
Spark Plug Inspection and Replacement

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.

- Remove the spark plug leads by twisting the rubber boots slightly and pulling off.
- 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.



- Set the spark plug gap. See Specification Chart.
- 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.

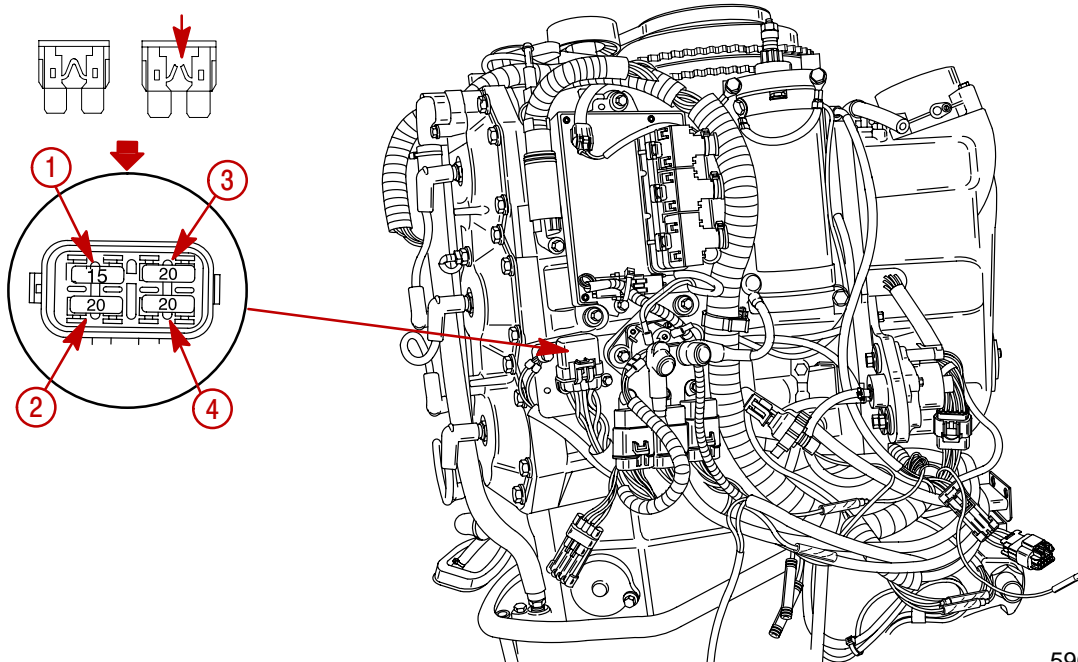
1. Turn off the engine before servicing the battery.
2. Add water as necessary to keep the battery full.
3. Make sure the battery is secure against movement.
4. Battery cable terminals should be clean, tight, and correctly installed. Positive to positive and negative to negative.
5. Make sure the battery 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 - SFE 20 Ampere Fuse
 3. Main Power Relay, Remote Control Harness and Power Trim - SFE 20 Ampere Fuse
 4. Ignition Coils - SFE 20 Ampere Fuse



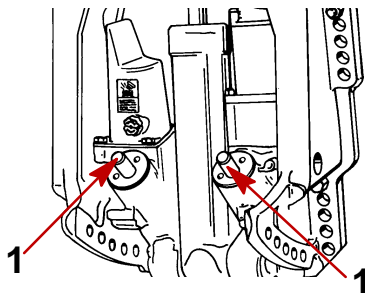
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Lubrication Points

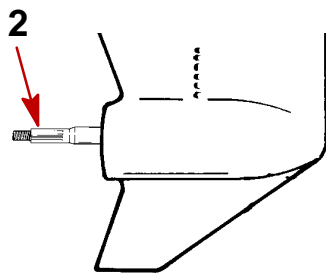
Lubricate Point 1 with Special Lubricant 101.

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



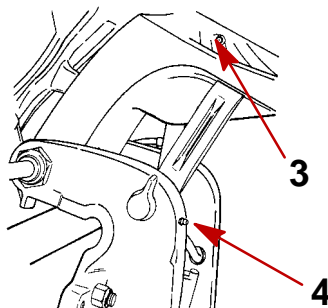
Lubricate Point 2 with Anti-Corrosion Grease or 2-4-C Marine Lubricant with Teflon.

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.

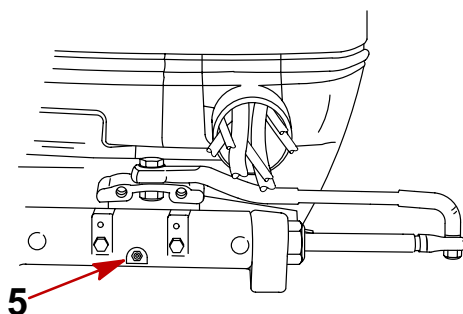


Lubricate Points 3 through 6 with 2-4-C Marine Lubricant with Teflon or Special Lubricant 101.

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



5. Tilt Tube – Lubricate through fitting.



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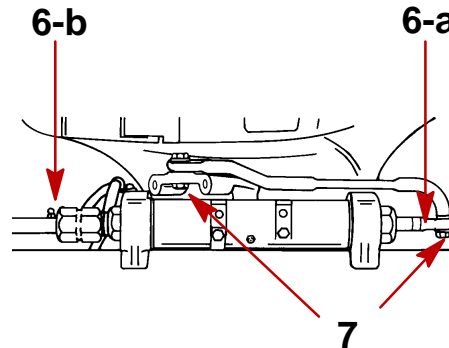
- Steering Cable Grease Fitting (If Equipped) – Rotate steering wheel to fully retract the steering cable end (a) into the outboard tilt tube. Lubricate through fitting (b).

⚠ 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.

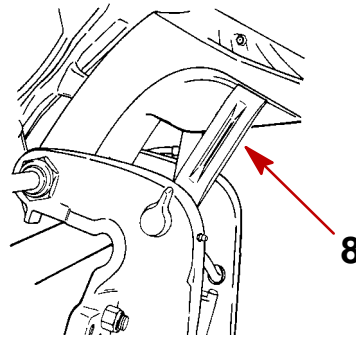
Lubricate Points 7 With Light Weight Oil.

- Steering Link Rod Pivot Points – Lubricate pivot points.

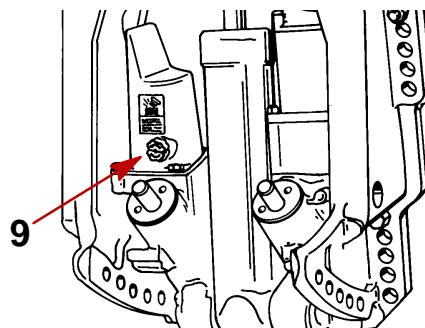


Checking Power Trim Fluid

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



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





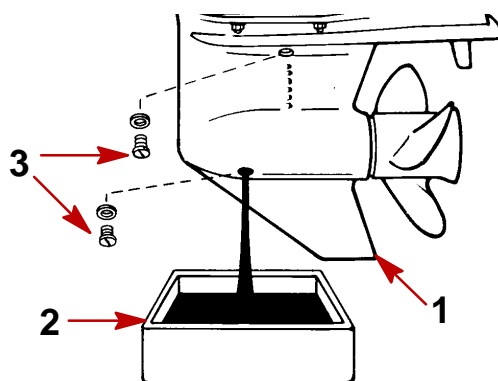
Gear Case Lubrication

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 28.0 fl. oz. (828 ml).

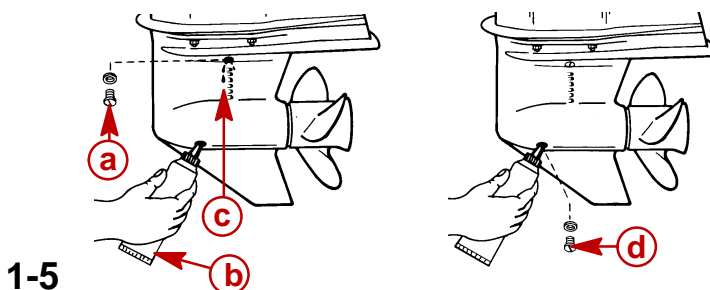
CHECKING GEAR CASE LUBRICANT LEVEL AND REFILLING GEAR CASE

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).





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 Fuel System Treatment & 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 Fuel System Treatment & 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 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

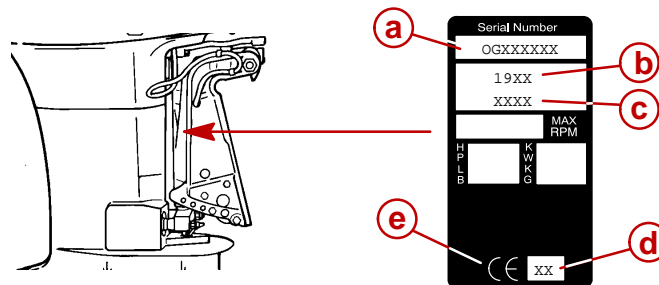
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Serial Number Location

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.

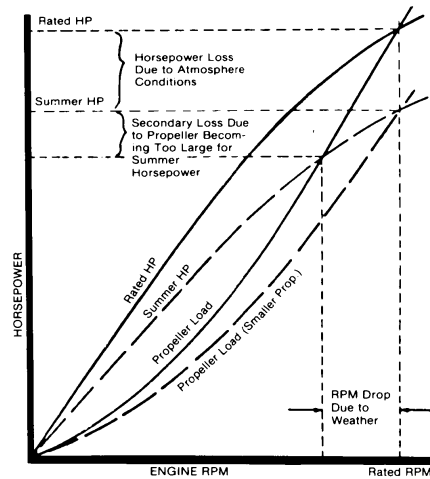


- a** - Serial Number
- b** - Model Year
- c** - Model Description
- d** - Year Manufactured
- e** - Certified Europe Insignia



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 lose 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 over-heat.

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.



GENERAL INFORMATION

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.

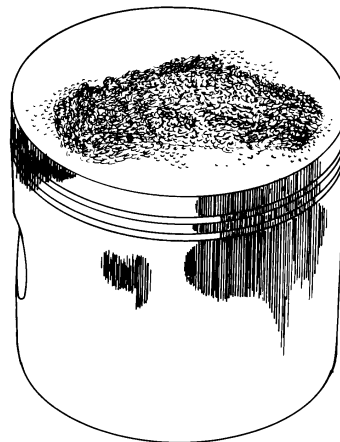
Detonation is an explosion of an unburned portion of the fuel/air charge after the spark plug has fired. Detonation creates severe shock waves in the engine, and these shock waves often find or create a weakness: The dome of a piston, cylinder head/gasket, piston rings or piston ring lands, piston pin 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 90 – 110 psi (616.3 – 753.5 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.*

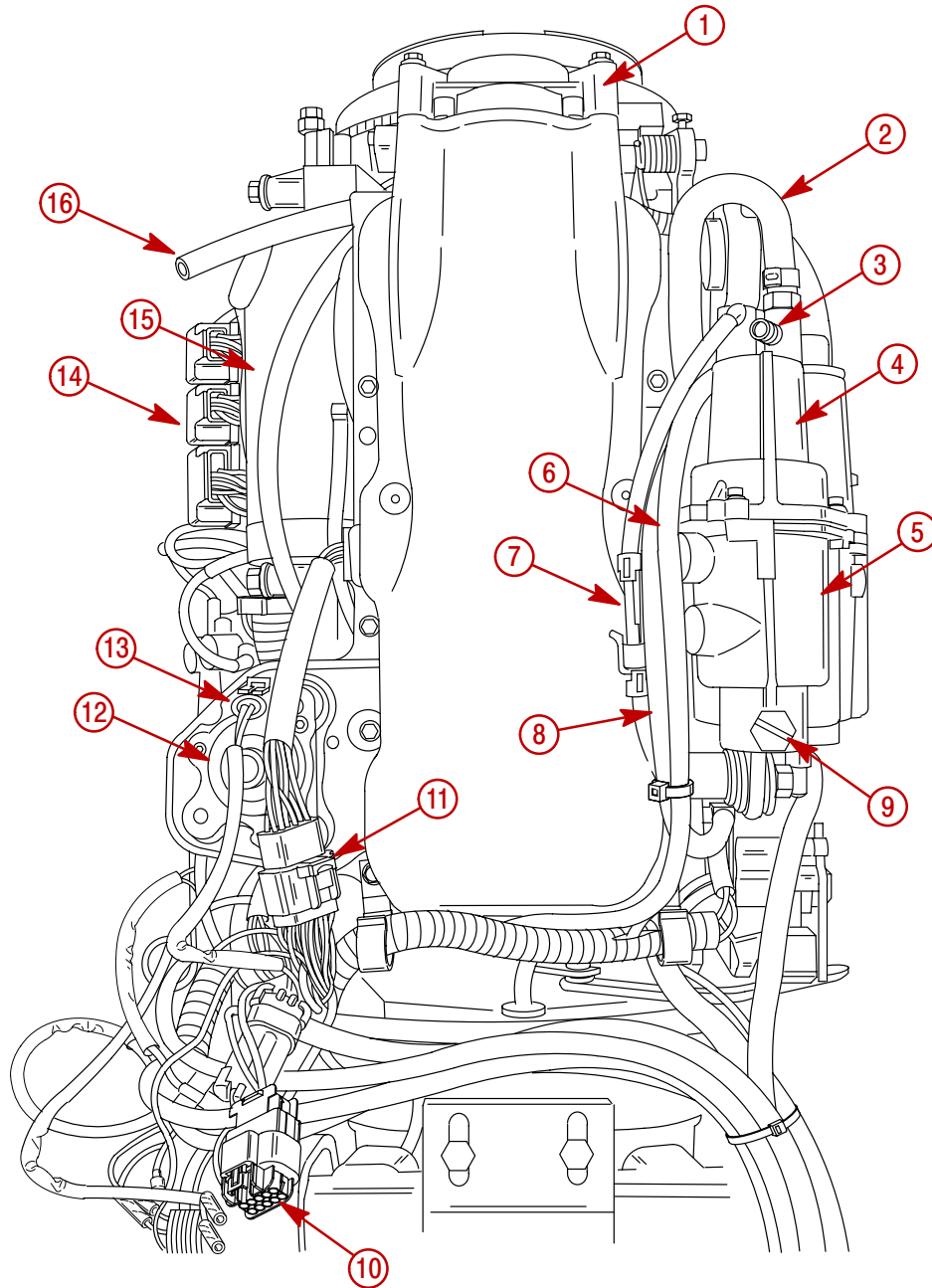
1. Recover engine from water as quickly as possible.
2. Remove cowling.
3. Clean the exterior of the outboard with fresh water.
4. Dry all wiring and electrical components using compressed air.
5. Drain water from fuel system as follows:
 - a. Disconnect remote fuel hose from engine.
 - b. EFI Models – 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 absorb 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 3 Liter Work/225 EFI/250 EFI Powerhead Front View

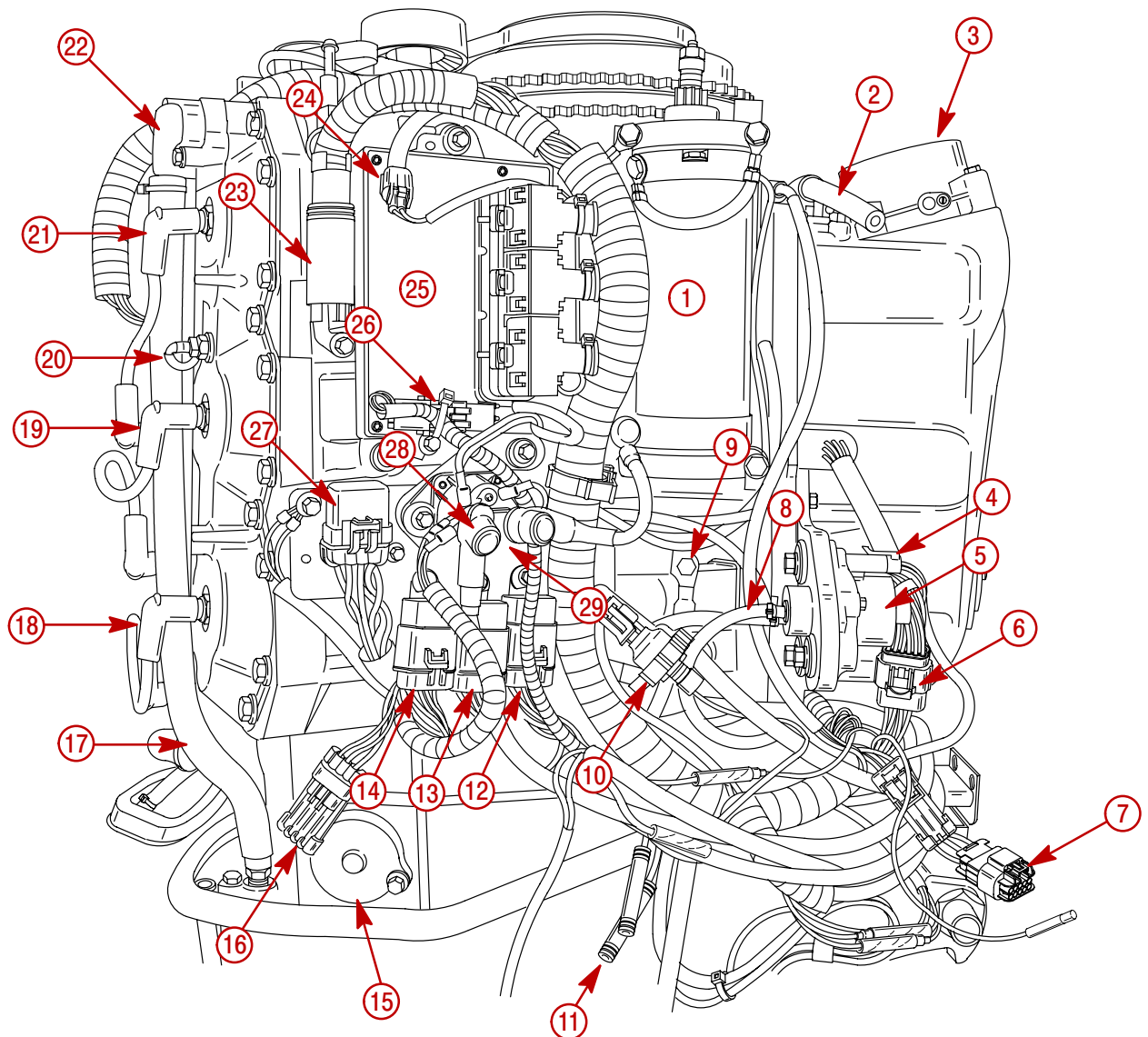


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- | | |
|--|--|
| 1 - Throttle Plate Assembly | 9 - VST Drain Plug |
| 2 - Fuel Hose [43 psi \pm 2 psi (296 kPa \pm 14 kPa)]
to Fuel Rail | 10 - Smartcraft Harness Connector |
| 3 - Fuel Pressure Test Point | 11 - Fuel Injector Harness Connector |
| 4 - Electric Fuel Pump (inside VST) | 12 - Oil Pump |
| 5 - Vapor Separator Tank (VST) | 13 - Oil Pump Harness Connector |
| 6 - Oil Input Hose to VST | 14 - Electronic Control Module |
| 7 - Electric Fuel Pump Harness Connector | 15 - Starter Motor |
| 8 - Fuel Regulator Vacuum Hose | 16 - Vapor Separator Tank (VST) Vent Hose |



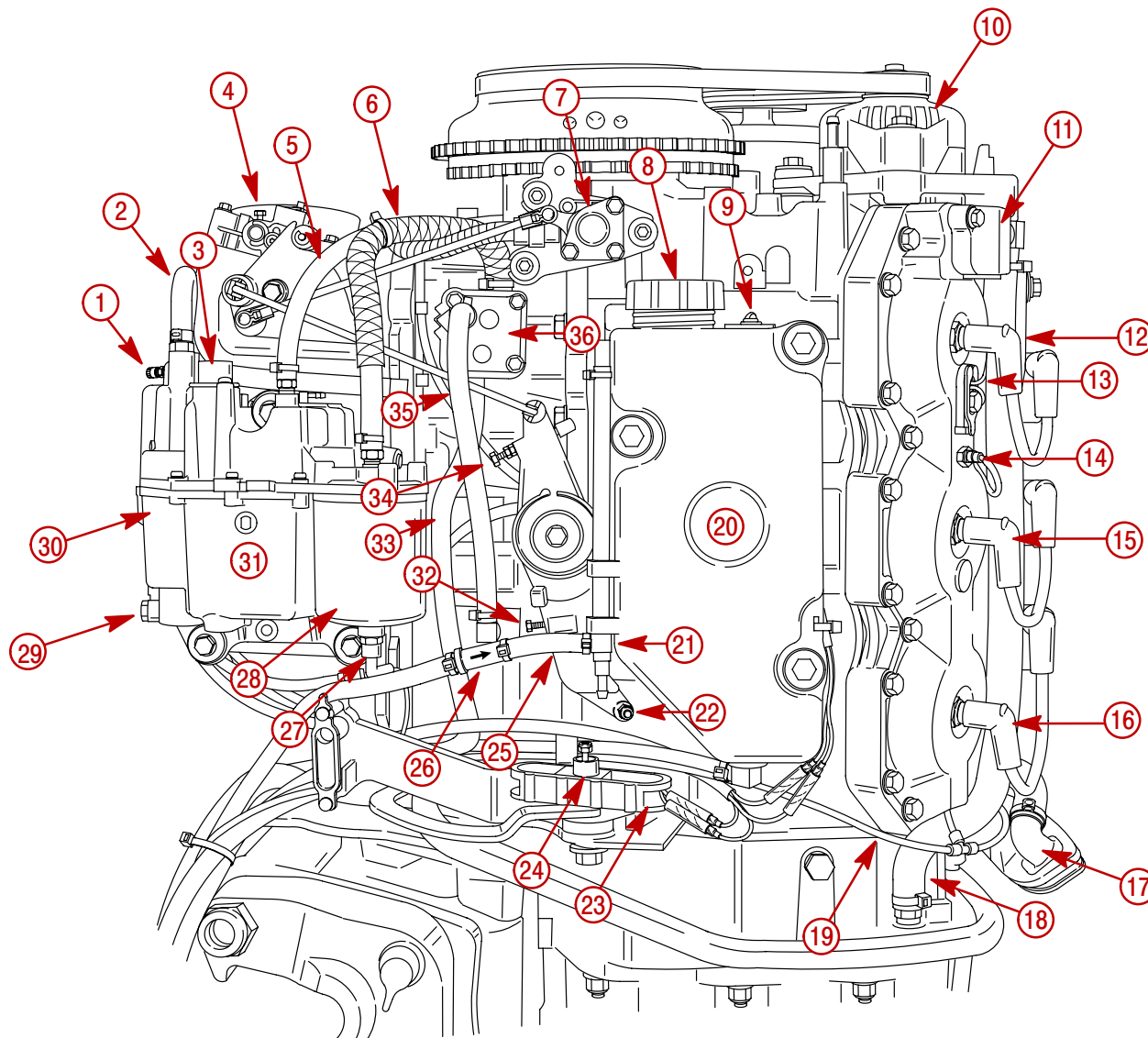
Model 3 Liter Work/225 EFI/250 EFI Powerhead Starboard View



- | | |
|--|---|
| 1 - Starter Motor | 16 - Detonation Sensor Connector (200 EFI Only) |
| 2 - Vapor Separator Tank (VST) Vent Hose | 17 - Thermostat Discharge Hose |
| 3 - Throttle Plate Assembly | 18 - #5 Cylinder |
| 4 - Oil Pump Harness Connector | 19 - #3 Cylinder |
| 5 - Oil Pump | 20 - Temperature Sensor (Engine Overheat) |
| 6 - Fuel Injector Harness Connector | 21 - #1 Cylinder |
| 7 - SmartCraft Harness Connector | 22 - Starboard Thermostat [120 °F (48.8 °C)] |
| 8 - Oil Pump Output Hose | 23 - Engine Harness Connector |
| 9 - Negative Battery Cable | 24 - Crank Position Sensor Connector |
| 10 - Digital Speedometer Pressure Sensor | 25 - Electronic Control Module (ECM) |
| 11 - Trim Motor Bullet Connectors | 26 - Digital Diagnostic Terminal Connector |
| 12 - Trim DOWN Relay | 27 - 20 Ampere Fuses (3); 15 Ampere Fuse (1) |
| 13 - Trim UP Relay | 28 - Positive Battery Cable |
| 14 - Main Power Relay | 29 - Starter Solenoid |
| 15 - Poppet Valve Assembly | |



Model 3 Liter Work/225 EFI/250 EFI Powerhead Port View

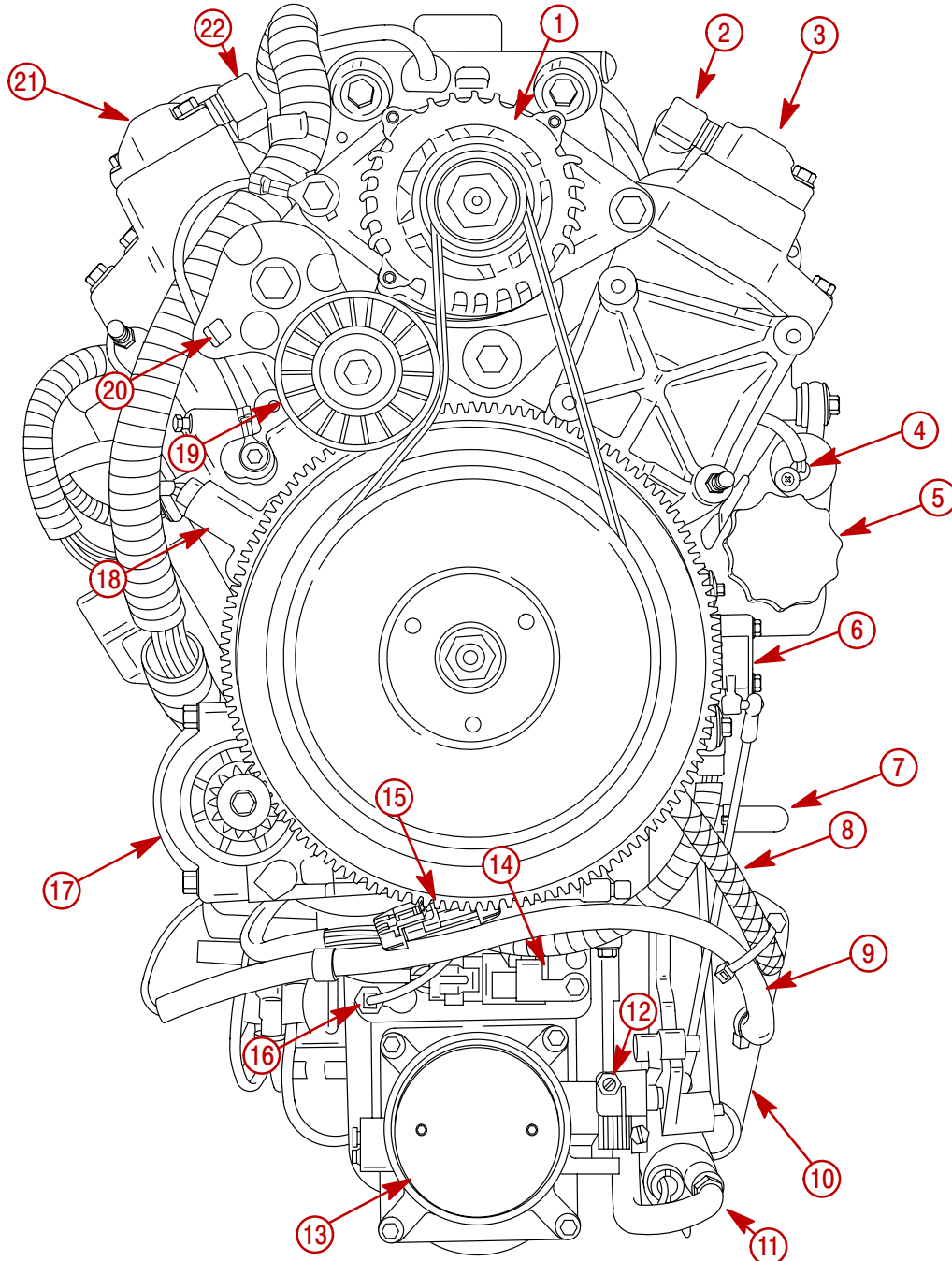


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|---|---|
| 1 - Fuel Pressure Test Point | 19 - Block Pressure Hose |
| 2 - Fuel Out to Fuel Rail | 20 - Oil Reservoir [0.74 qt. (0.70 Liter)] |
| 3 - Fuel Pressure Regulator | 21 - 4 psi (27 kPa) Check Valve |
| 4 - Throttle Plate Assembly | 22 - Throttle Cable Anchor Pin |
| 5 - Vapor Separator Vent Hose | 23 - Shift Interrupt Switch |
| 6 - Fuel Outlet to Fuel /Water Separator | 24 - Shift Cable Slide |
| 7 - Throttle Position Sensor | 25 - Oil Inlet Hose |
| 8 - Oil Reservoir Fill Cap | 26 - Oil Filter |
| 9 - Low Oil Sensor | 27 - Water Sensor |
| 10 - 60 Ampere Alternator | 28 - Fuel/Water Separator |
| 11 - Port Thermostat [120 °F (48.8 °C)] | 29 - VST Drain Plug |
| 12 - #2 Cylinder | 30 - Electric Fuel Pump (inside Vapor Separator) |
| 13 - Temperature Sender (Analog Gauge) | 31 - Vapor Separator Tank (VST) |
| 14 - Temperature Sensor (Digital) | 32 - Idle Stop Screw |
| 15 - #4 Cylinder | 33 - Fuel Inlet Hose to Pulse Pump |
| 16 - #6 Cylinder | 34 - Wide Open Throttle Stop Screw |
| 17 - Powerhead Flush Hose | 35 - Pulse Pump Vacuum Hose |
| 18 - Thermostat Discharge Hose | 36 - Pulse Fuel Pump |



Model 3 Liter Work/225 EFI/250 EFI Powerhead Top View

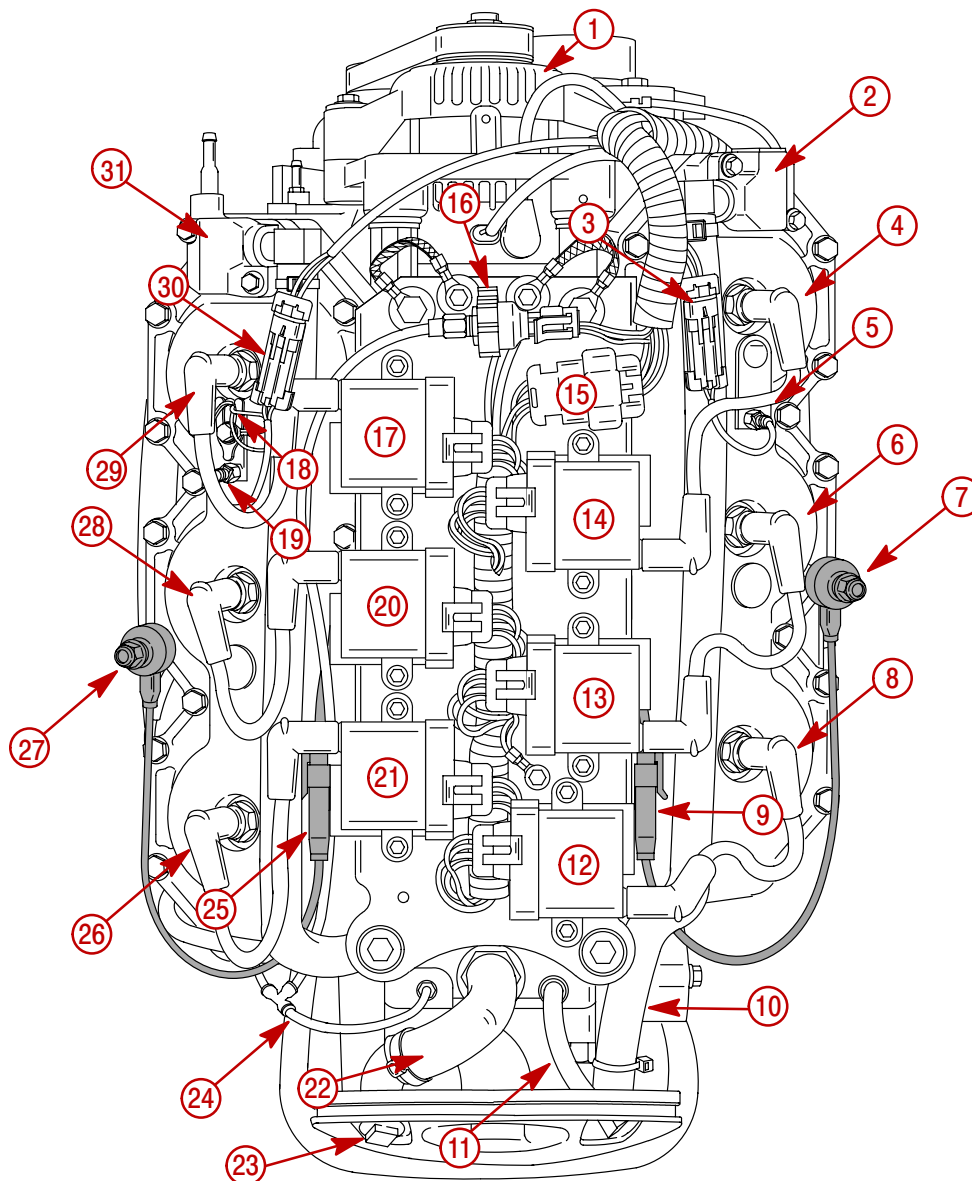


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|--|---|
| 1 - 60 Ampere Alternator | 12 - Throttle Plate Adjustment Screw (Sealed at Factory) |
| 2 - Port Thermostat Discharge Hose | 13 - Throttle Plate Assembly |
| 3 - Port Thermostat [120 °F (48.8 °C)] | 14 - Manifold Air Pressure (MAP) Sensor |
| 4 - Low Oil Sensor | 15 - Air Temperature Sensor Harness Connector |
| 5 - Oil Reservoir Fill Cap | 16 - Air Temperature Sensor |
| 6 - Throttle Position Sensor | 17 - Starter Motor |
| 7 - Pulse Fuel Pump Vacuum Hose | 18 - Crank Position Sensor |
| 8 - Fuel Outlet Hose to Fuel/Water Separator | 19 - Belt Tensioner |
| 9 - Vapor Separator Vent Hose | 20 - Belt Tension Release Slot |
| 10 - Vapor Separator Tank (VST) | 21 - Starboard Thermostat [120 °F (48.8 °C)] |
| 11 - Fuel Hose to Fuel Rail [43 psi ± 2 psi (296 kPa ± 14 kPa)] | 22 - Starboard Thermostat Discharge Hose |



Model 3 Liter Work/225 EFI/250 EFI Powerhead Aft View



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- | | |
|---|---|
| 1 - 60 Ampere Alternator | 17 - #2 Ignition Coil |
| 2 - Starboard Thermostat [120 °F (48.8 °C)] | 18 - Temperature Sensor (Analog) |
| 3 - Starboard Temperature Sensor (Digital) Harness Connector | 19 - Port Temperature Sensor (Digital) |
| 4 - #1 Cylinder | 20 - #4 Ignition Coil |
| 5 - Starboard Temperature Sensor (Digital) | 21 - #6 Ignition Coil |
| 6 - #3 Cylinder | 22 - Cylinder Block Flush Hose |
| 7 - Starboard Detonation Sensor (200 Work Only) | 23 - Flush Adaptor Plug |
| 8 - #5 Cylinder | 24 - Block Pressure Hose |
| 9 - Detonation Sensor Harness Connector | 25 - Detonation Sensor Harness Connector |
| 10 - Starboard Thermostat Discharge Hose | 26 - #6 Cylinder |
| 11 - Tell-Tale Hose | 27 - Port Detonation Sensor (200 Work Only) |
| 12 - #5 Ignition Coil | 28 - #4 Cylinder |
| 13 - #3 Ignition Coil | 29 - #2 Cylinder |
| 14 - #1 Ignition Coil | 30 - Port Temperature Sensor (Digital) Harness Connector |
| 15 - Ignition Coil Harness Connector | 31 - Port Thermostat [120 °F (48.8 °C)] |
| 16 - Water Pressure Sensor | |



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 Mercury/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 Mercury/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**. DO NOT use a soap that contains petroleum based solvents.

* Automotive Body Filler Squeegee

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 $\frac{1}{2}$ 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 its 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).



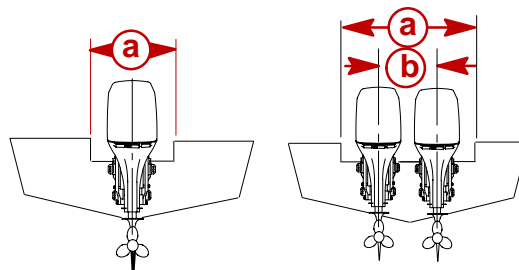
IMPORTANT INFORMATION

Section 1D - Outboard Motor Installation

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Installation Specifications



a – Transom Opening – Minimum

Single Engine – 33-3/8 in. (848 mm)

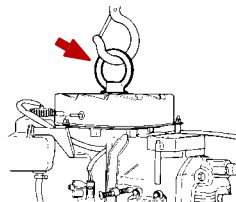
Dual Engines – 59-3/4 in. (1518 mm)

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.

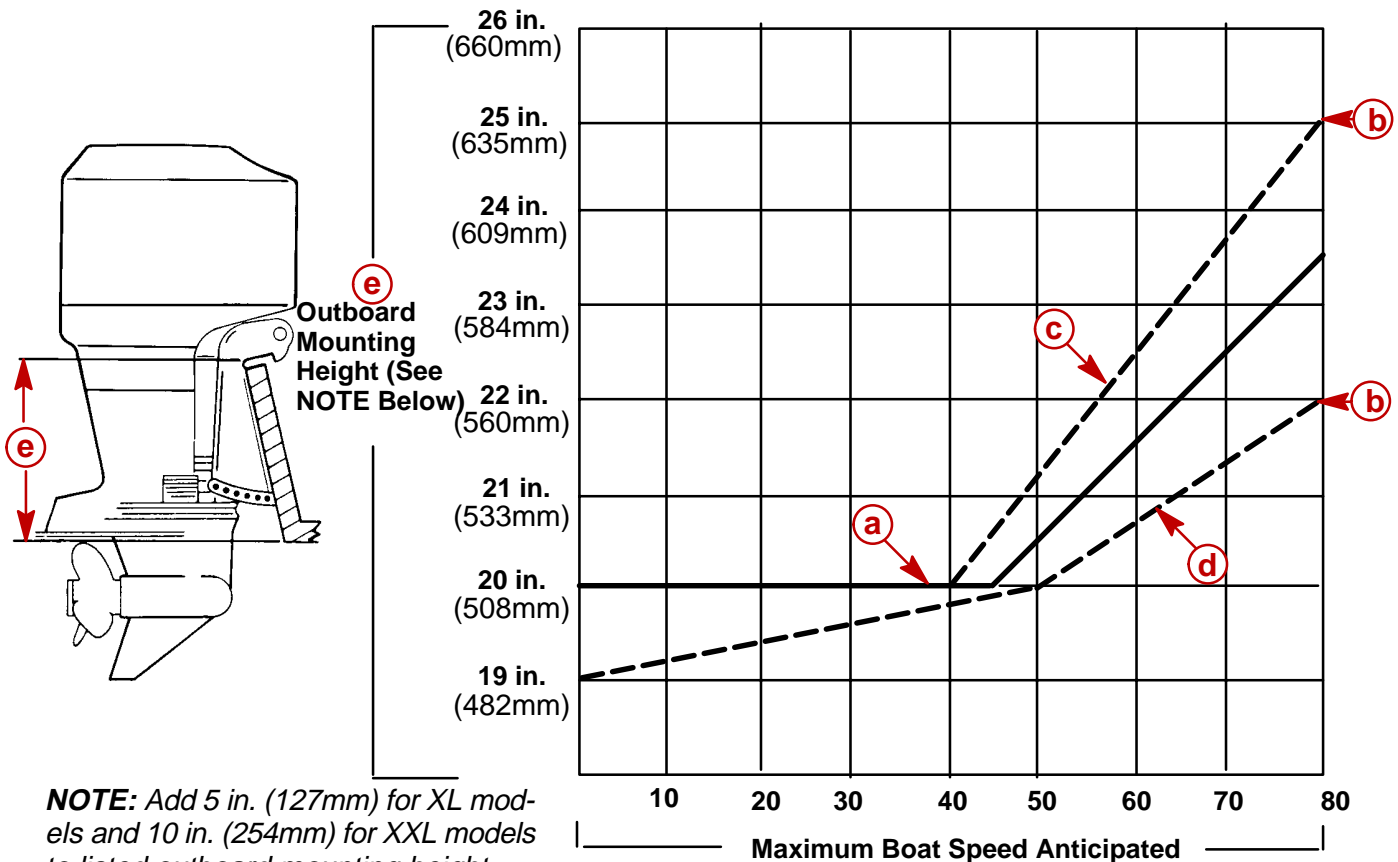


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Installing Outboard to Boat Transom

Determining Recommended Outboard Mounting Height



NOTICE TO INSTALLER:

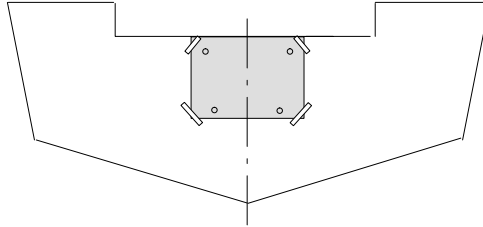
1. The outboard should be mounted high enough on the transom so that the exhaust relief hole will stay at least 1 in. (25.4 mm) above the water line when the engine is running at idle speed. This will prevent exhaust restriction.
2. The mounting height (e) of the outboard must not exceed 25 in. (635 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.



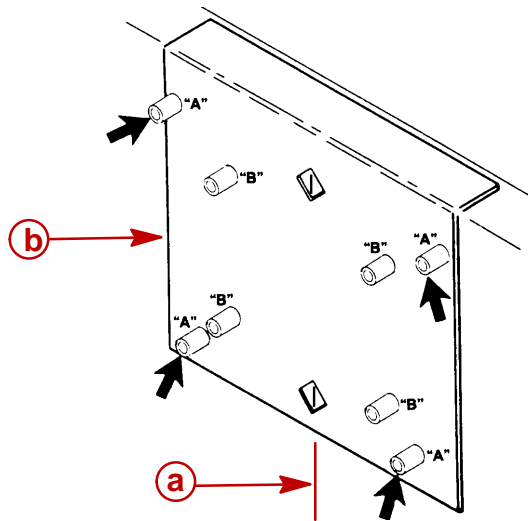
Installing Outboard

Drilling Outboard Mounting Holes

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

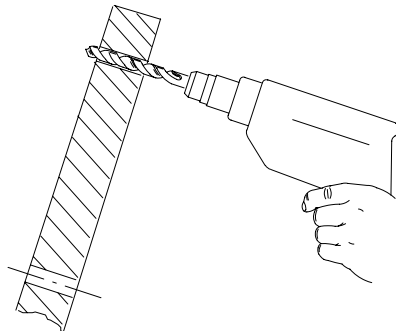


IMPORTANT: If using Transom Drilling Fixture (91-98234A2), use drill guide holes marked "A" when drilling outboard mounting holes.



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

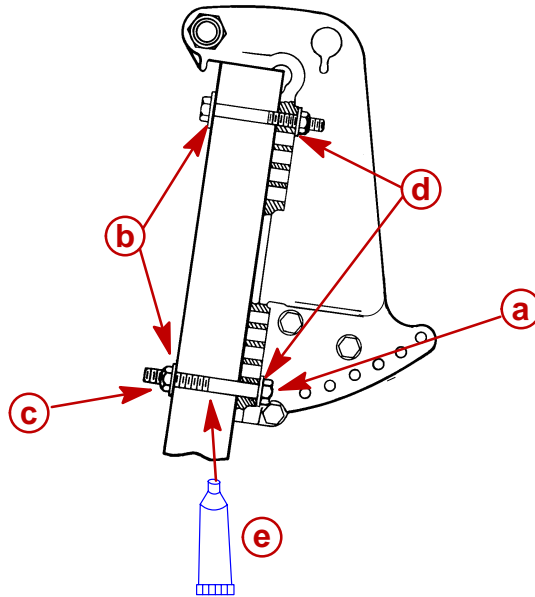
2. Mark and drill four 17/32 in. (13.5mm) mounting holes.





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)

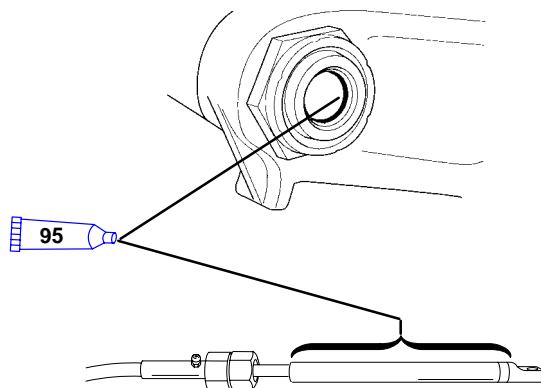
d - Flat Washers(4)

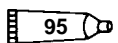
e - Marine Sealer - Apply to
Shanks of Bolts, Not
Threads

Steering Cable

STARBOARD SIDE ROUTED CABLE

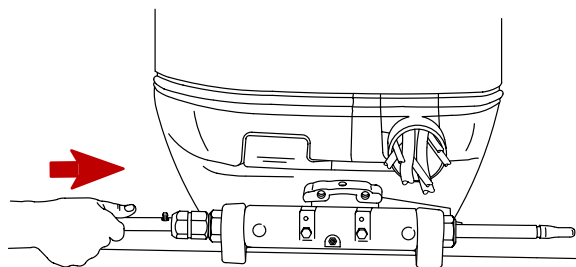
1. Lubricate O-ring seal and entire cable end.



 2-4-C Marine Lubricant with Teflon

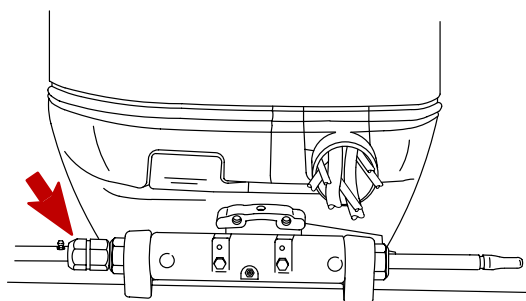


2. Insert steering cable into tilt tube.



57832

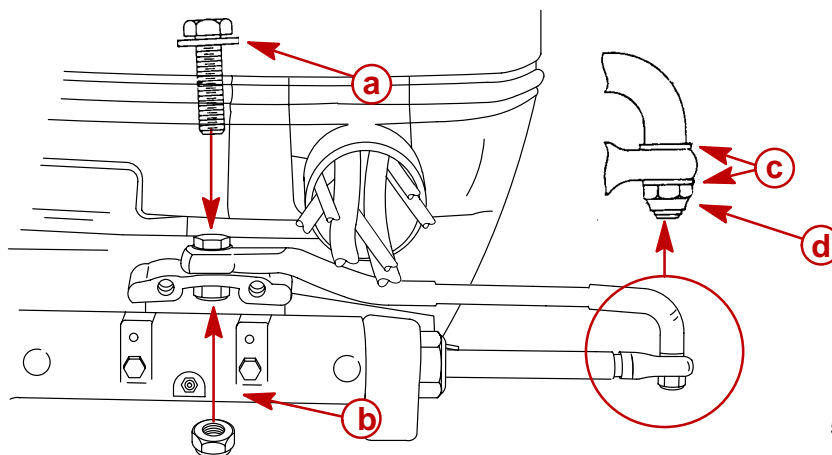
3. Torque nut to 35 lb. ft. (47.5 N-m).



57833

Steering Link Rod

1. Install steering link rod per illustration.



57834

- a** - Special Bolt (10-849838) Torque to 20 lb-ft (27 N-m)
- b** - Nylon Insert Locknut (11-826709113) Torque to 20 lb-ft (27 N-m)
- c** - Flat Washer (2)
- d** - Nylon Insert Locknut (11-826709113) 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 10-849838) 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.

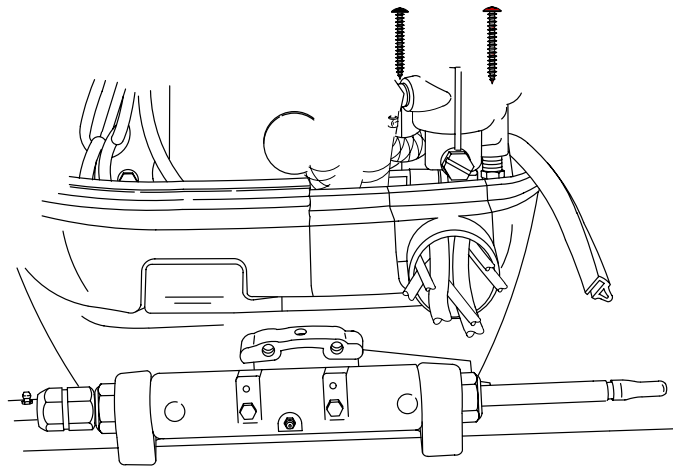


Electrical, Hoses and Control Cables

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

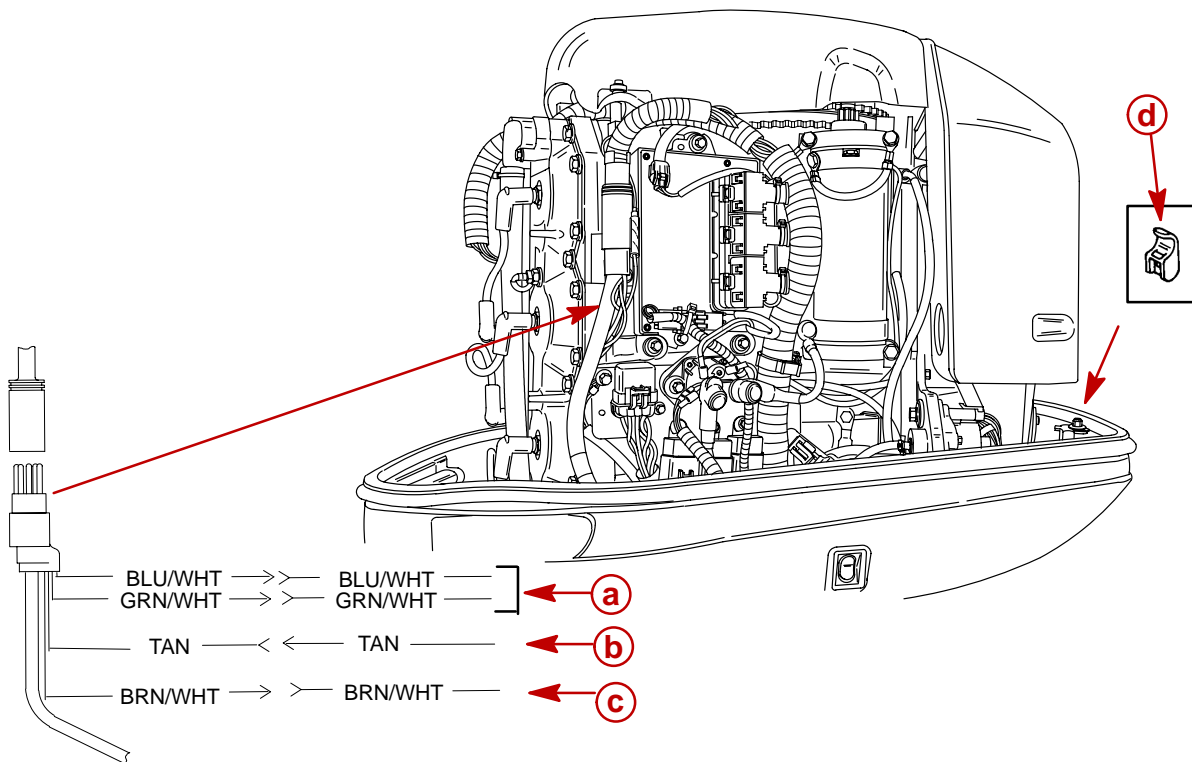
Open the front clamp assembly.



57841

Remote Wiring Harness

1. Connect wiring. Place harness into the holder.



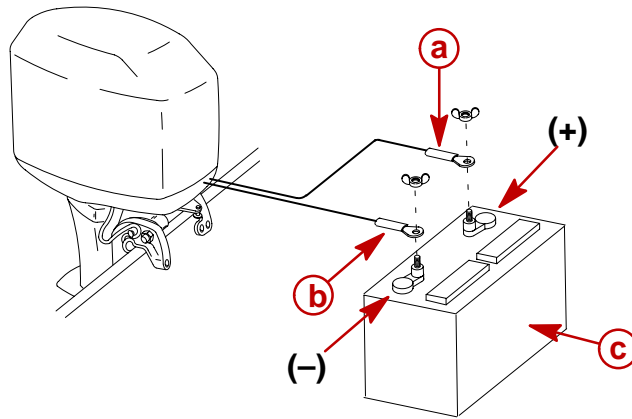
59027

- a** - Power Trim Connections
- b** - Wire Connection For Non SmartCraft Water Temp Gauge
- c** - Connection For Non SmartCraft Analog Trim Gauge
- d** - Harness Holder (Located in Cowl) – Place Wiring Harness and Battery Cables into Holder



Battery Cables

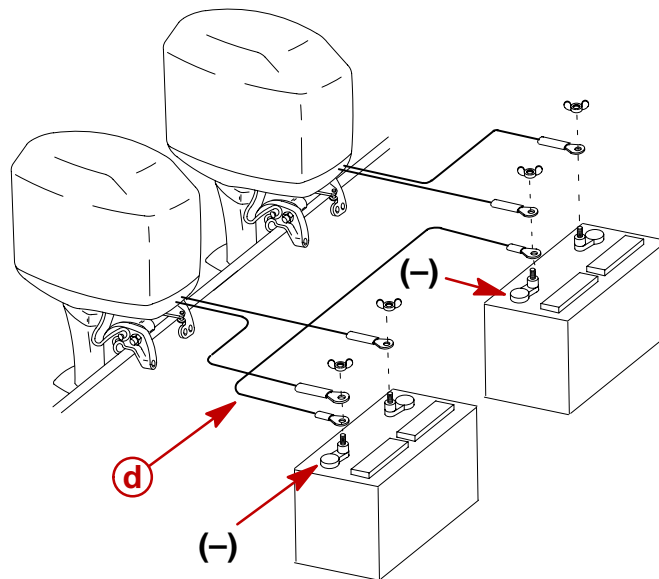
SINGLE OUTBOARD



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



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

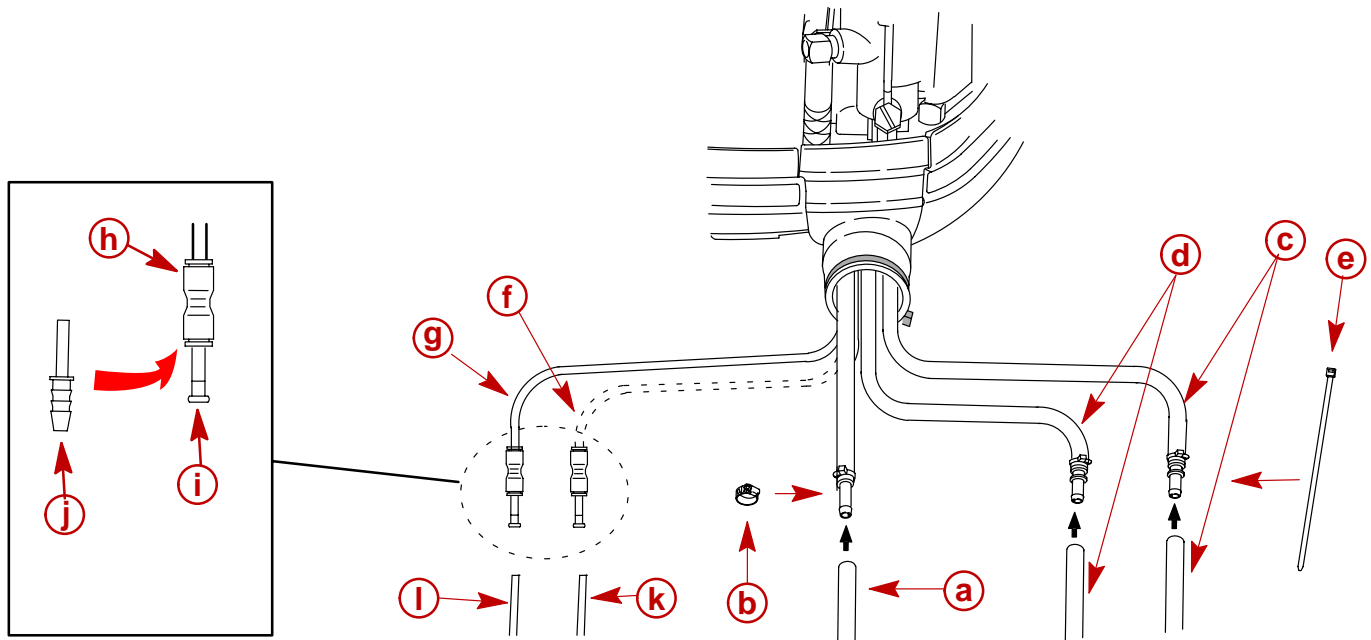
Connect the remote oil hoses to the engine hose connections as shown. Fasten hose connections with sta-straps.

Speedometer Tubing Connection

This outboard has a speedometer water pickup 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.

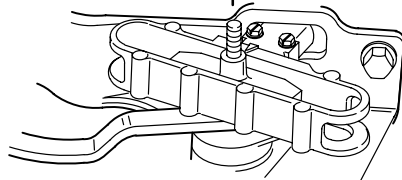
IMPORTANT: If the counter rotation outboard is rigged similar to a standard rotation outboard OR if a standard rotation outboard is rigged similar to a counter rotation outboard, the reverse gear and bearing in the gear case must function as forward gear. THE REVERSE GEAR/BEARING ARE NOT DESIGNED TO 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.

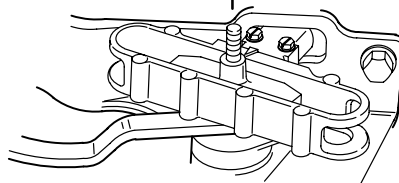
STANDARD ROTATION GEAR OUTBOARDS

Forward Gear ← → Reverse Gear



COUNTER ROTATION OUTBOARDS

Reverse Gear ← → Forward Gear



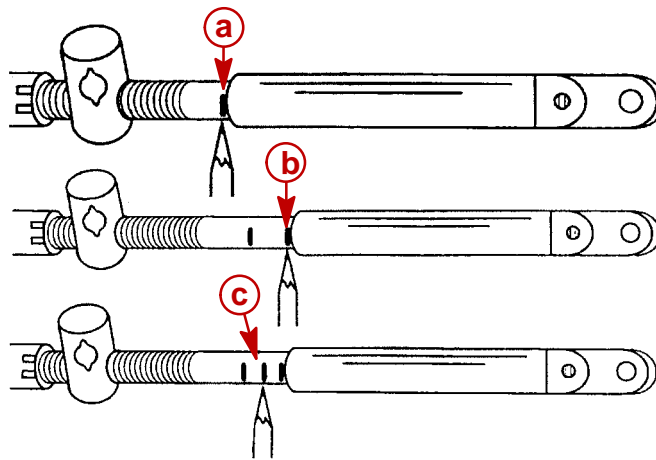


Installation

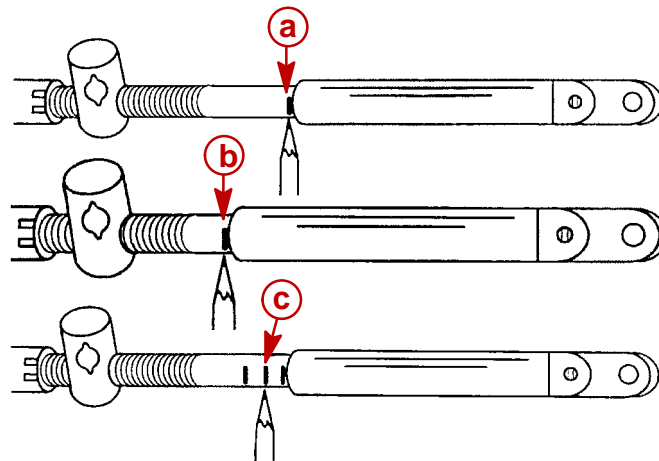
IMPORTANT: Step 1 must be followed for proper adjustment of the shift cable.

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



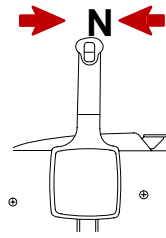
COUNTER ROTATION OUTBOARDS



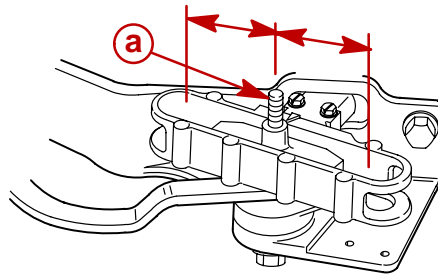
- d. Return remote control handle to neutral. The propeller should turn freely without drag. If not, adjust barrel closer to cable end guide. Repeat steps a thru d.



2. Position remote control and outboard into neutral.

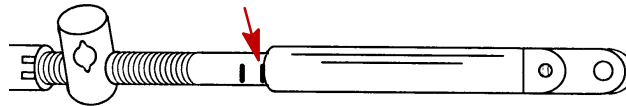


3. Slide the shift cable anchor pin forward until resistance is felt, then slide anchor pin toward rear until resistance is felt. Center the anchor pin between resistance points.

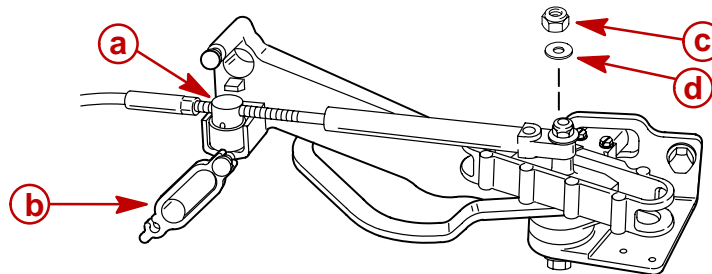


a - Anchor Pin

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



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



a - Cable Barrel
b - Shift Cable Retainer

c - Locknut – Tighten locknut then back off locknut 1/4 turn
d - Nylon Washer

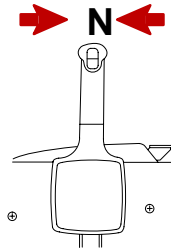
7. Check shift cable adjustments as follows:
 - a. With remote control in forward, the propshaft should lock solidly in gear. If not, adjust cable barrel closer to cable end guide.
 - b. Shift remote control into neutral. The propshaft should turn freely without drag. If not, adjust barrel away from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



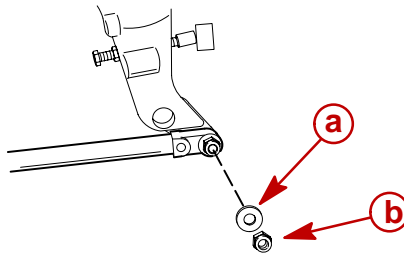
Throttle Cable

INSTALLATION

1. Position remote control into neutral.

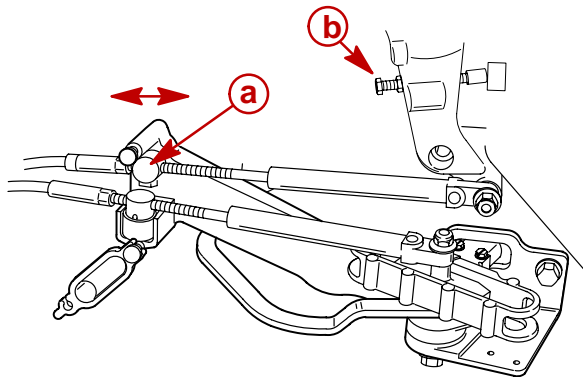


2. Attach throttle cable to the throttle lever. Secure with washer and locknut.



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

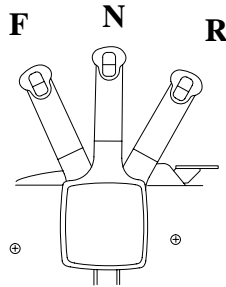
3. Adjust the cable barrel so that the installed throttle cable will hold the idle stop screw against the stop.



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

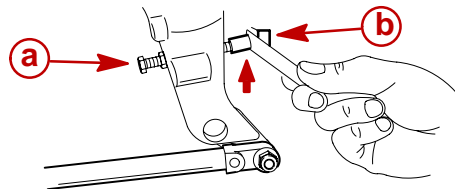


4. Check throttle cable adjustment as follows:
 - a. Shift outboard into gear a few times to activate the throttle linkage. Make sure to rotate the propeller shaft while shifting into reverse.



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

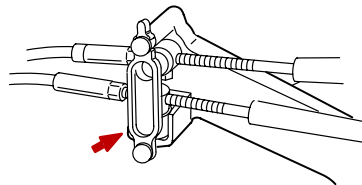
IMPORTANT: The idle stop screw must be touching the stop.



a - Idle Stop Screw

b - Idle Stop

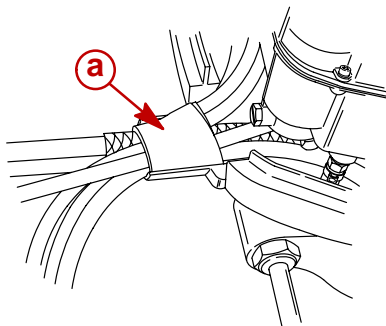
5. Lock the barrel holder in place with the cable latch.



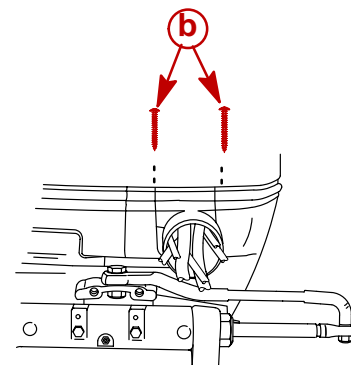
Front Clamp Reassembly

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 through 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.



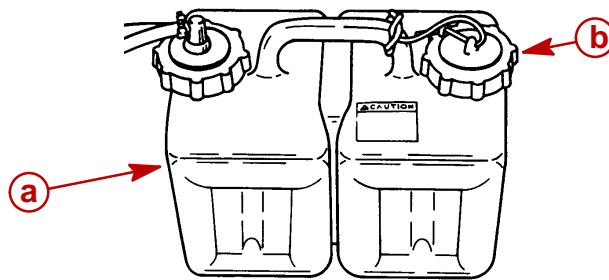
Filling

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.

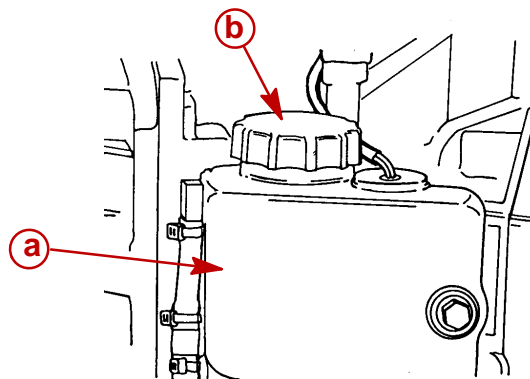
1. Fill remote oil tank with the recommended oil listed in the Operation and Maintenance Manual. Tighten fill cap.



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

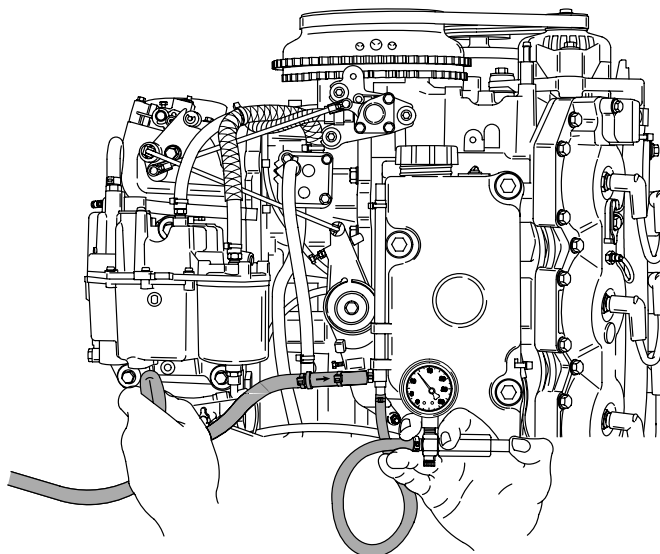
b - Fill Cap



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. 91-880118A2.

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. 91-880118A2.

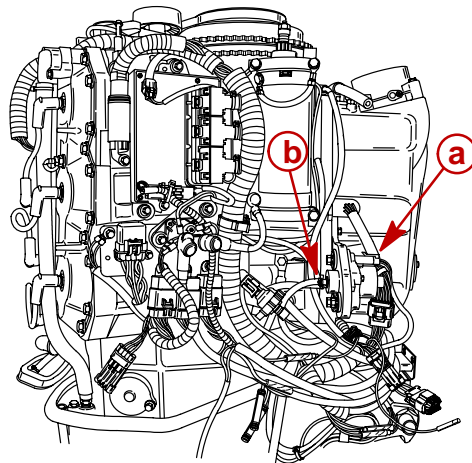


Conditions Requiring Priming the Oil Pump	
Condition	Priming Procedure
New engine	Use Method 1 or 2
Rebuilt Powerhead	Use Method 1 or 2
New Powerhead	Use Method 1 or 2
Oil system ran out of oil	Use Method 3
Oil drained from oil supply hose feeding pump	Use Method 3
Oil pump removed	Use Method 3
Oil injection hoses drained	Use Method 3

Priming Procedure – Method 1

METHOD 1 – SHIFT SWITCH ACTIVATION PRIME PROCEDURE

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



a - Oil Injection Pump

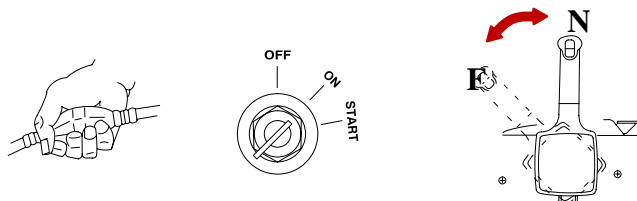
b - Oil Supply Hose

CAUTION

To prevent damage to the fuel 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.

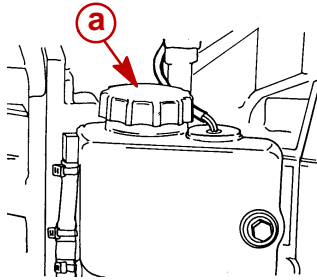


NOTE: It may take a few minutes for the pump to complete the priming process.



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

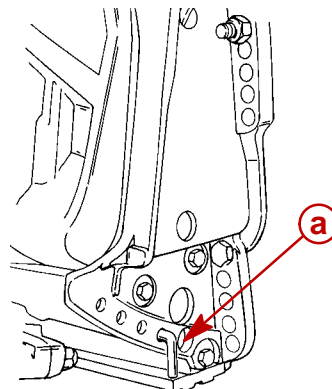
Some outboard boats, particularly some bass boats, are built with a greater than normal transom angle which will allow the outboard to be trimmed further “in” or “under”. This greater trim “under” capability is desirable to improve acceleration, reduce the angle and time spend in a bow high boat during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

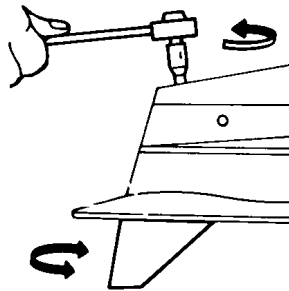
Models Without Power Steering

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

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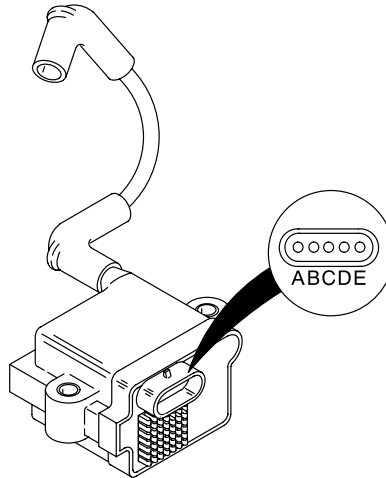
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Specifications

IGNITION SYSTEM	Type Spark Plug Type Spark Plug Gap	Digital Inductive NGK BPZ8HS-10 0.040 in. (1.0 mm)
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Ignition Coil Ohms Test

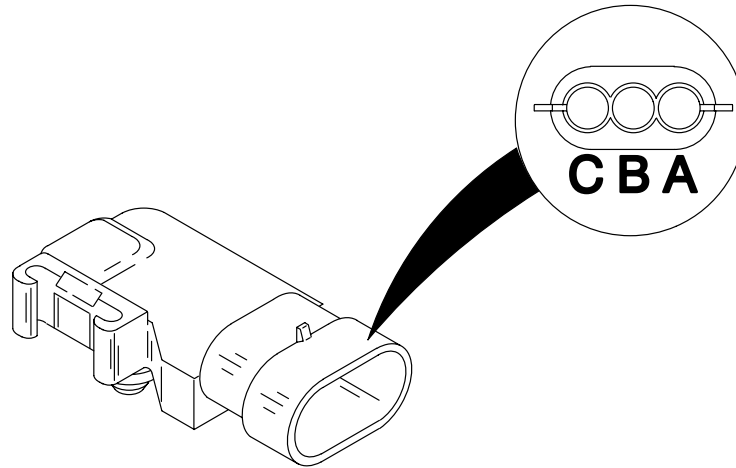


58903

BLACK METER LEAD							
RED METER LEAD		Secondary Tower	EST PIN A	EST Low PIN B	Secondary Low Pin C	Primary Ground Pin D	Battery + Pin E
	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:

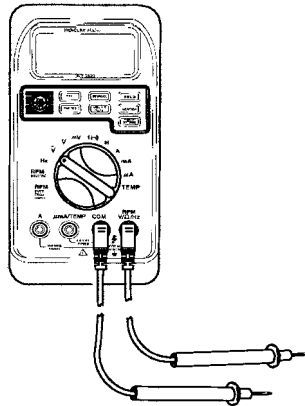
Disconnect temperature sensor harness and check continuity with digital or analog ohm-meter test leads between both connector pins. With engine at temperature (F°) indicated, ohm readings should be as indicated $\pm 10\%$. There should be no continuity between each connector pin and ground.

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



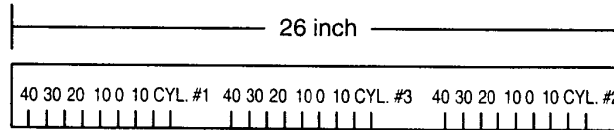
Special Tools

- 1. DMT 2000 Digital Tachometer Multimeter 91-854009A1

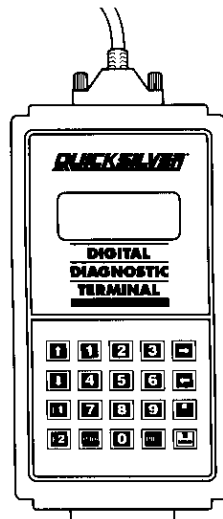


- 2. Cylinder Timing Decal 91-853883-1

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



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

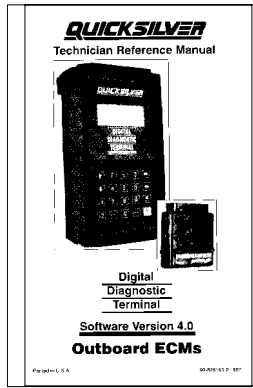


- 4. Software Cartridge 91-880118A2

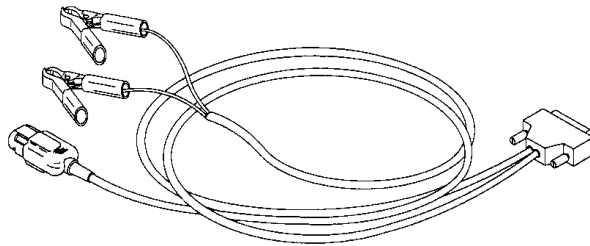




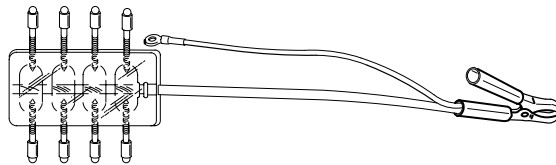
- 5. DDT Reference Manual 90-881204--1



- 6. Adaptor Harness 84-822560A5

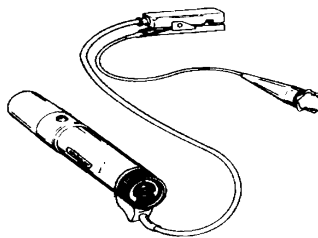


- 7. Spark Gap Tester 91-850439



55117

- 8. Timing Light 91-99379



- 9. Crank Shaft Protector Cap 91-24161



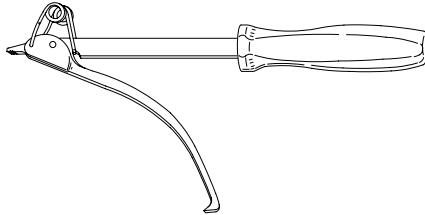


10. Flywheel Puller 91-849154T1

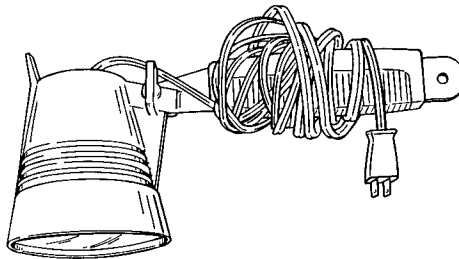


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11. Flywheel Holder 91-52344

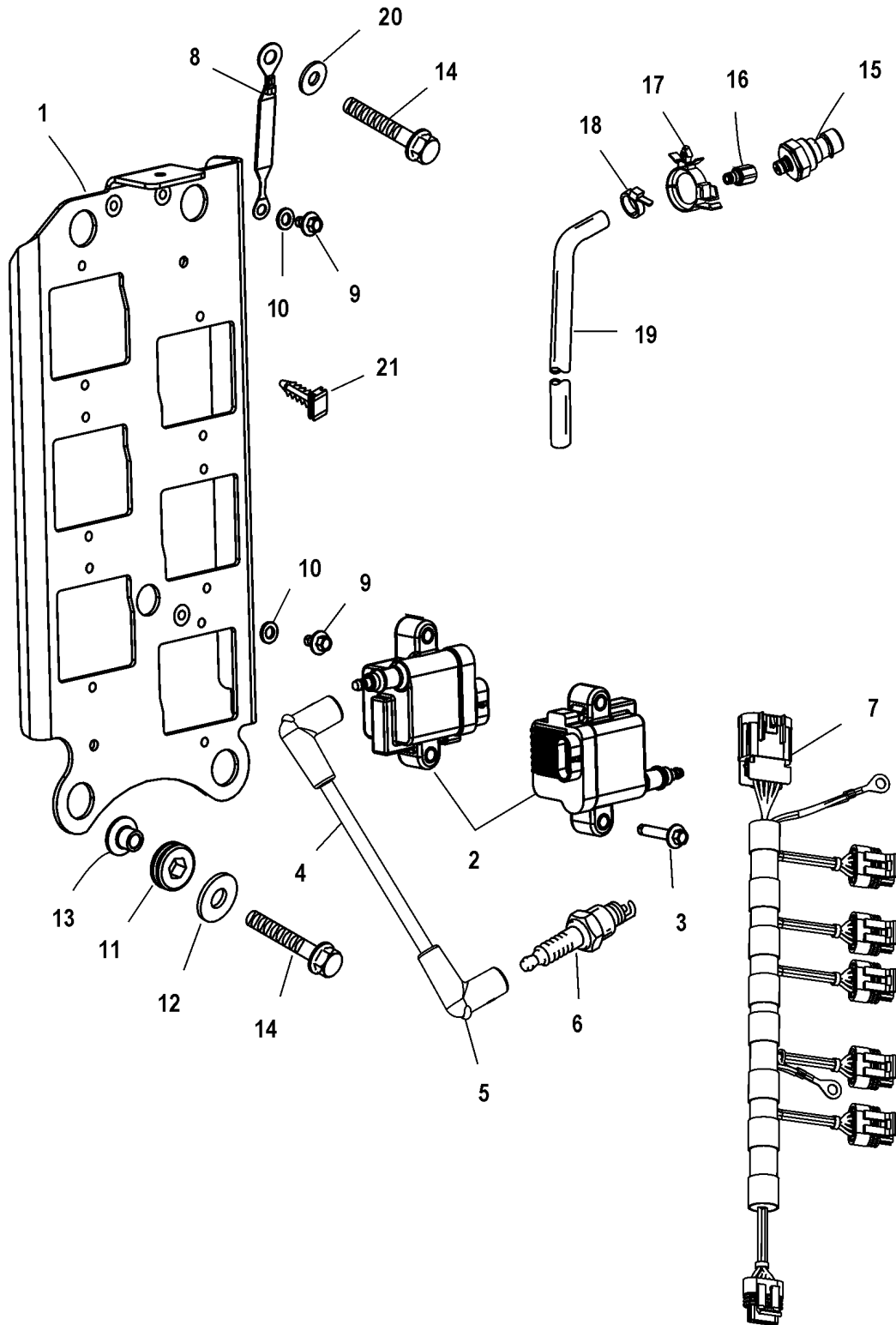


12. Heat Lamp 91-63209





Coil Plate Assembly



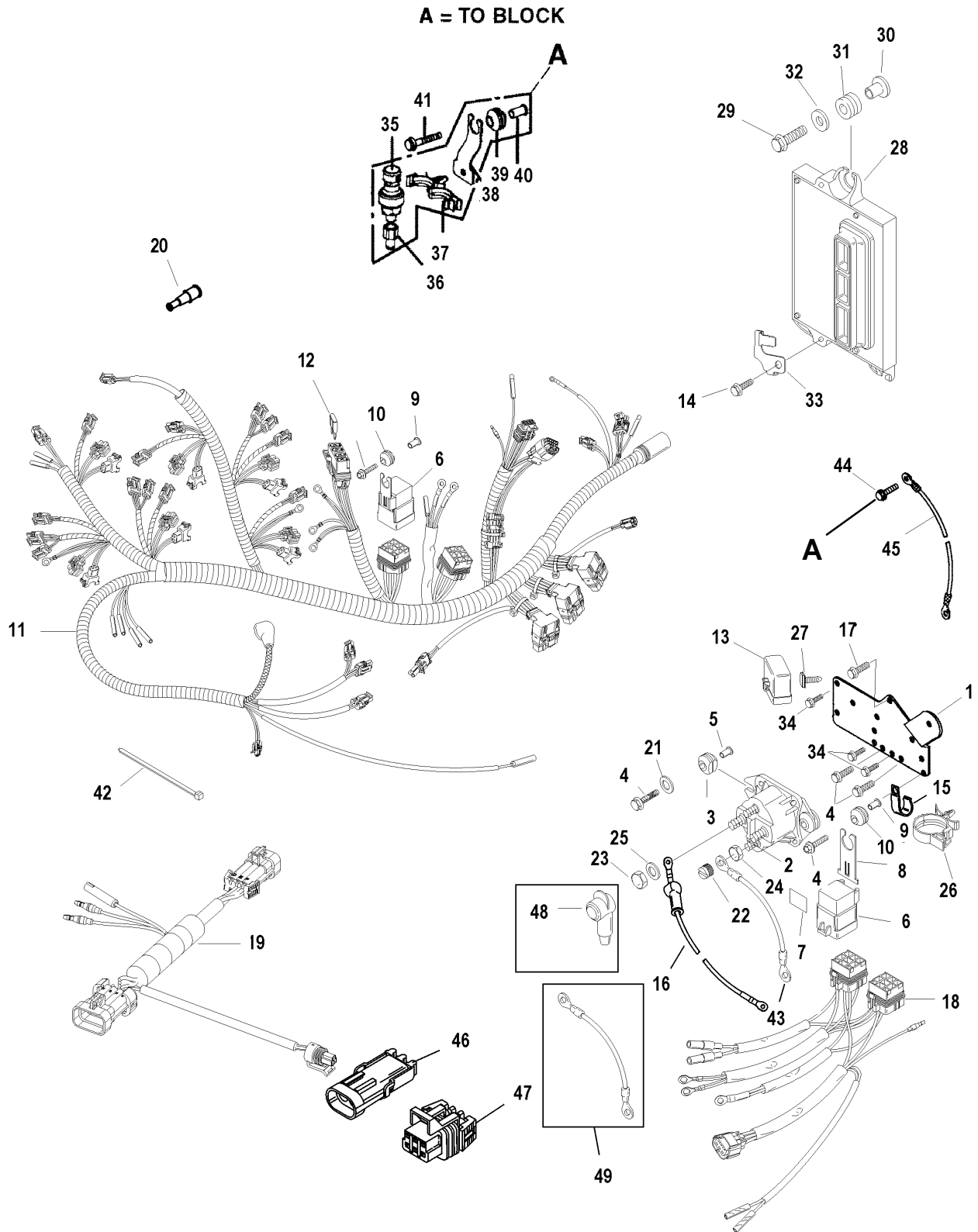


Coil Plate Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	COIL MOUNTING PLATE			
2	6	IGNITION COIL			
3	12	SCREW	100		11.3
4	6	HI-TENSION CABLE			
5	12	BOOT			
6	6	SPARK PLUG (NGK#BPZ8HS10)		20	27
7	1	COIL HARNESS			
8	2	CABLE			
9	3	SCREW (M6 x 10)	60		7
10	3	WASHER			
11	4	GROMMET			
12	4	WASHER			
13	4	BUSHING			
14	4	SCREW (.312-18 x 1-1/4)		20	27
15	1	SENSOR-BLOCK PRESSURE [0-50 psi (0-345 kPa)]			
16	1	FITTING			
17	1	CLIP			
18	AR	STA-STRAP			
19	1	TUBING [18 IN. (45.7 CM)]			
20	2	WASHER			
21	1	CLIP			



Electrical Plate Assembly



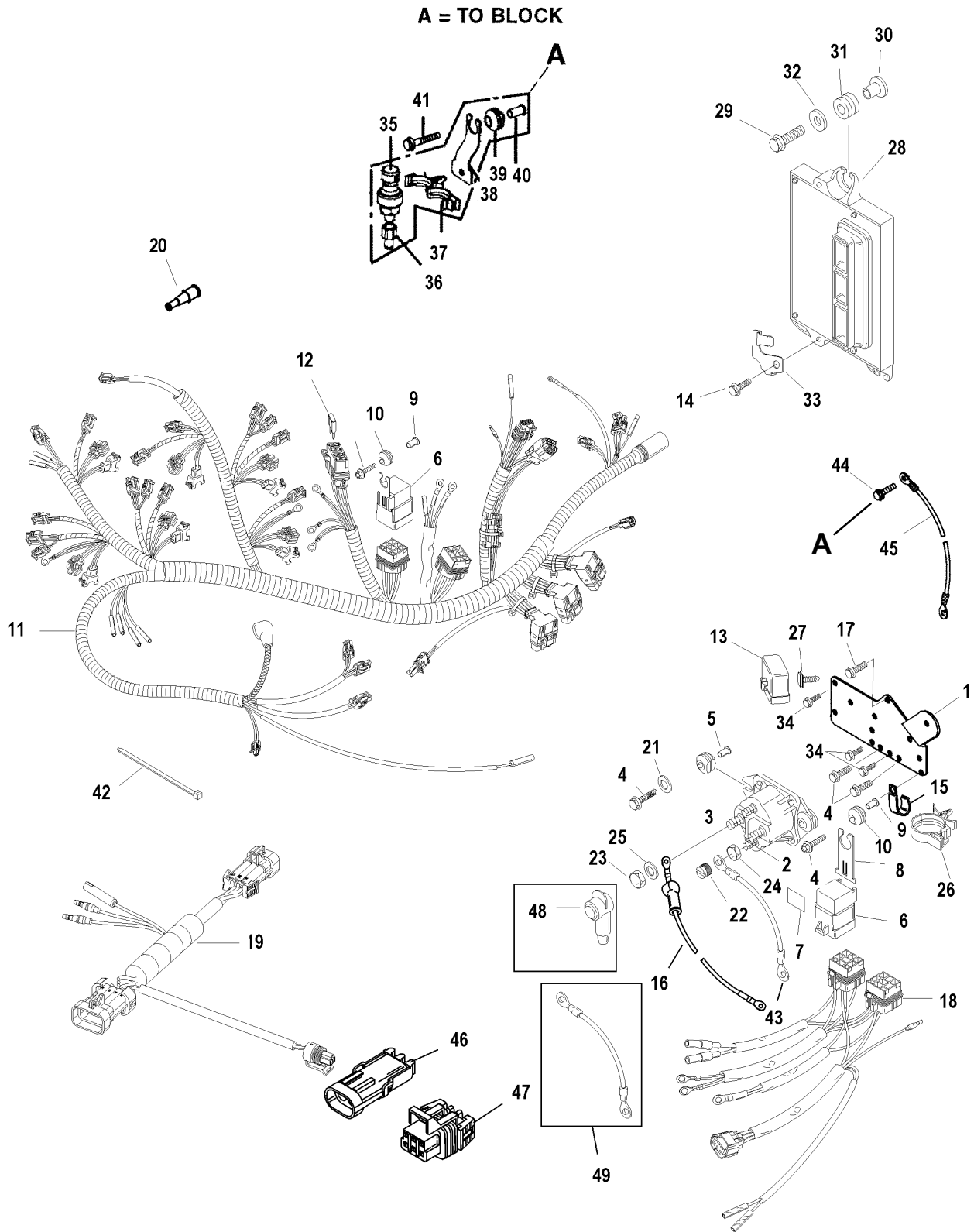


Electrical Plate Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	SOLENOID MOUNTING PLATE			
2	1	SOLENOID			
3	2	GROMMET			
4	5	SCREW (M6 x 25)	35		4
5	2	BUSHING			
6	3	RELAY ASSEMBLY			
7	3	DECAL-TRIM RELAY			
8	3	BRACKET			
9	3	BUSHING			
10	3	GROMMET			
11	1	ENGINE HARNESS			
12	1	FUSE (3 – 20 AMP) (1 – 15 AMP)			
13	1	FUSE COVER			
14	1	SCREW (M6 x 14)			
15	1	J-CLIP			
16	1	GROUND WIRE (BLACK)			
17	3	SCREW (M6 x 12)	100		11.3
18	1	TRIM HARNESS			
19	1	HARNESS-SMARTCRAFT			
20	1	PLUG (MALE)			
21	1	WASHER			
22	2	CAP NUT			
23	1	NUT (5/16-18)	50		5.5
24	1	NUT (10-32)(BRASS)	8		0.9
25	2	LOCKWASHER			
26	1	CLIP			
27	1	CLIP			
28	1	ECM			
29	3	SCREW (M6 x 25)	70		8
30	3	BUSHING			
31	3	GROMMET			
32	3	WASHER			
33	1	CLIP			
34	3	SCREW (M6 x 10)			
35	1	SENSOR-FUEL PRESSURE			
36	1	FITTING-STRAIGHT			
37	1	CLIP			
38	1	BRACKET			
39	1	GROMMET			
40	1	BUSHING			
41	1	SCREW (M6 x 25)			
42	AR	STA-STRAP			
43	1	CABLE			
44	1	SCREW (M8 x 20)		18	24.5



Electrical Plate Assembly





Electrical Plate Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
45	1	BATTERY CABLE			
46	1	CONNECTOR			
47	2	CONNECTOR (6 PIN PLUG)			
48	5	INSULATOR BOOT (RED)			
49	2	CABLE (YELLOW/BLACK)			
50	1	SCREW (M6 x 35)	35		4



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.

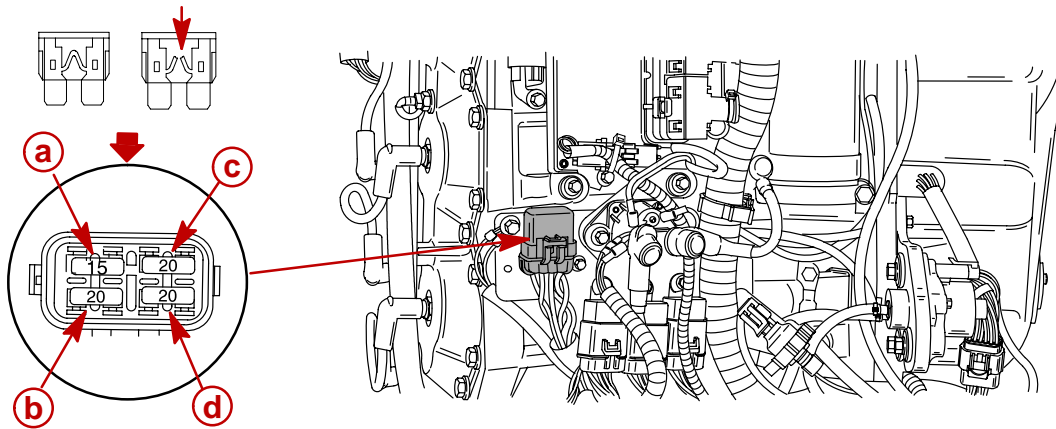


Ignition Component Description

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 - SFE 20 Ampere Fuse
 - c. Main Power Relay, Remote Control Harness and Power Trim - SFE 20 Ampere Fuse
 - d. Ignition Coils - SFE 20 Ampere Fuse

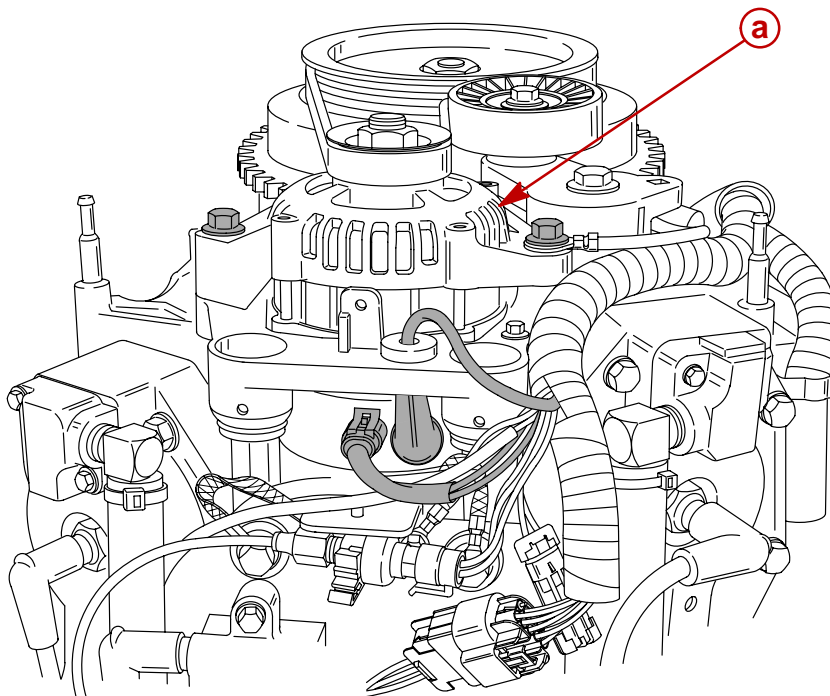


59035



Charging System Alternator

Battery charging system, including the regulator, is contained within the belt driven alternator. At cranking speeds, electrical power for the engine is provided by the boat battery – minimum recommended size is 490 Cold Cranking Amperes (CCA) or 630 Marine Cranking Amperes (MCA). 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.

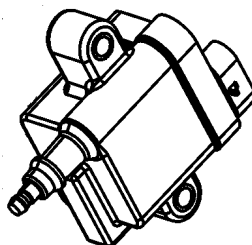


a - Alternator

59067

Ignition Coil

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





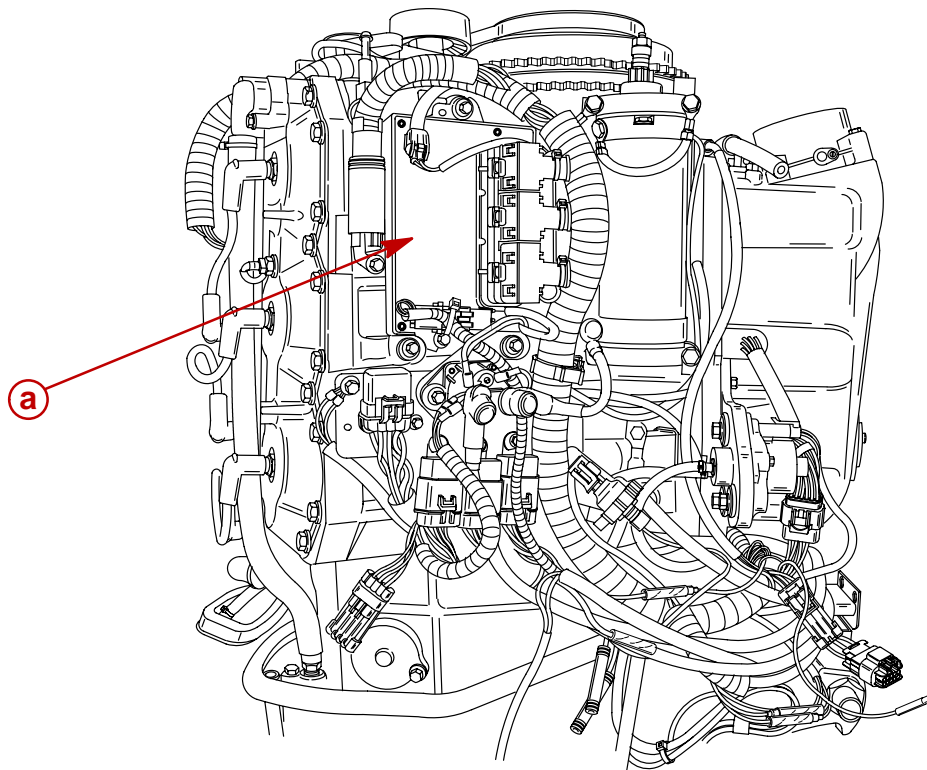
Electronic Control Module (ECM)

The ECM requires 8 VDC minimum to operate. If the ECM should fail, the engine will stop running.

The inputs to the ECM can be monitored and tested by the Digital Diagnostic Terminal 91-823686A2 using adaptor harness 84-822560A5.

The ECM performs the following functions:

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



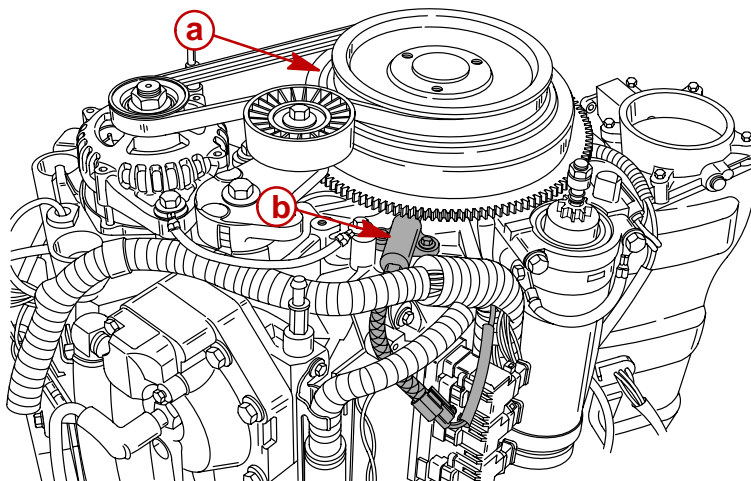
a - Electronic Control Module (ECM)

59026



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.



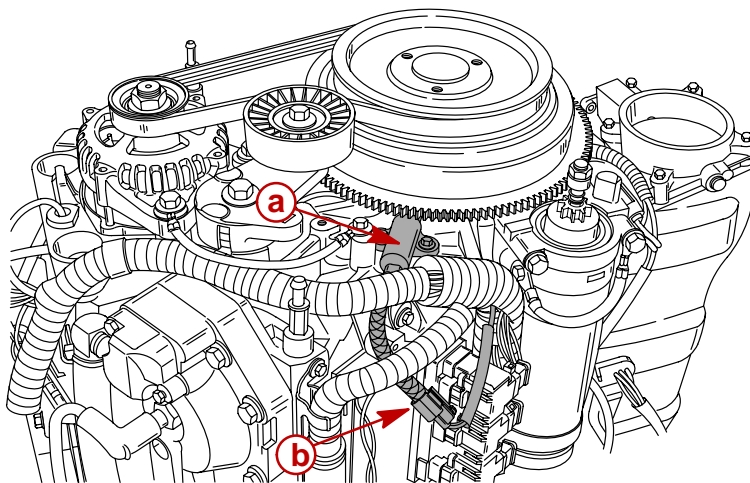
59070

a - Flywheel

b - Crank Position Sensor

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.



59070

a - Crank Position Sensor

b - Crank Position Sensor Connector

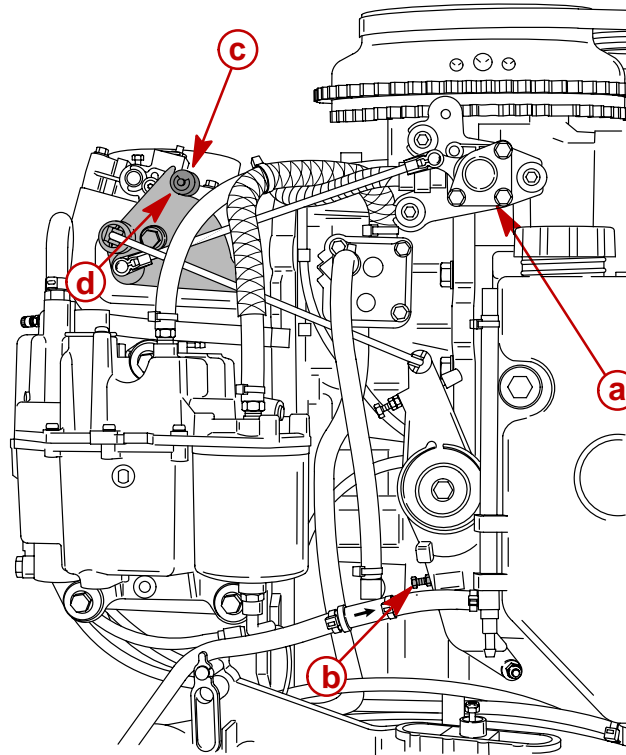
Crank Position Sensor Resistance Test

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



59031

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.

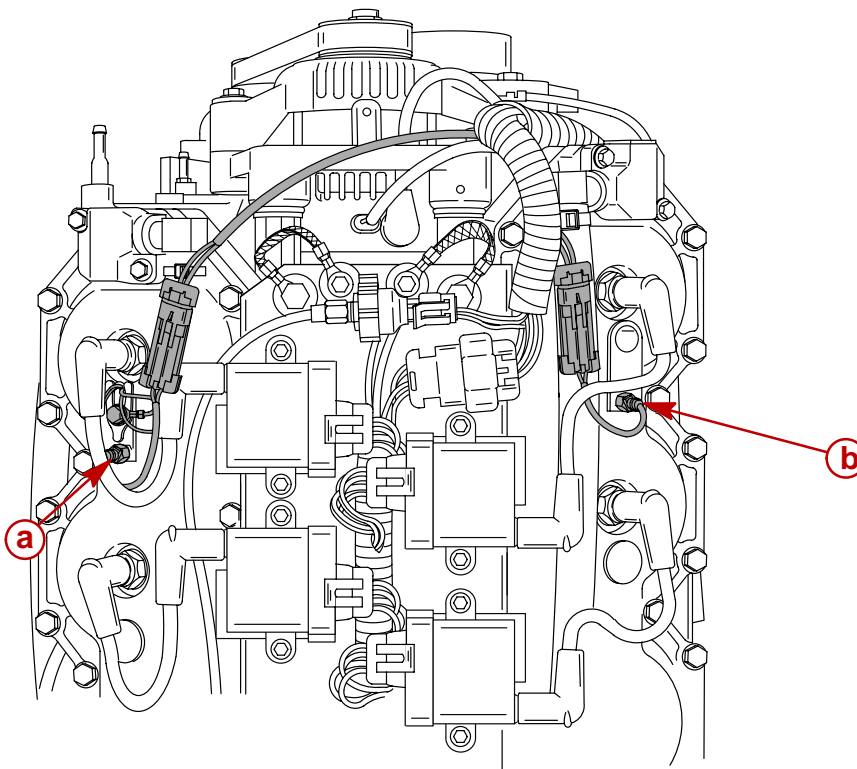
- Check throttle cable adjustment. The throttle stop screw on the throttle arm must be against the throttle stop on the cylinder block when the engine is started. Pre-load the throttle cable barrel 1 or 2 turns if necessary.
- Verify driver is not pushing on throttle (if foot throttle is used) or advancing 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).

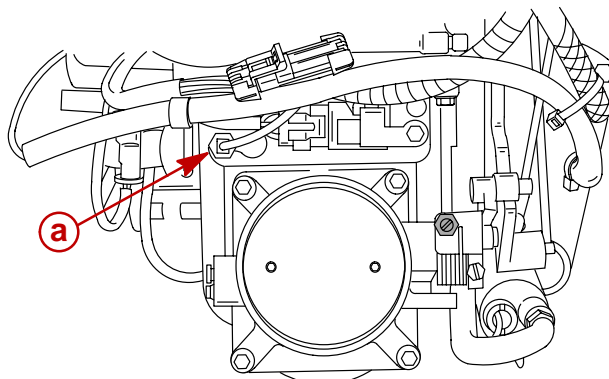


59037

- 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).



59025

- 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 ohm-meter test leads between both connector pins. With engine at temperature (F°) indicated, ohm readings should be as indicated $\pm 10\%$. 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



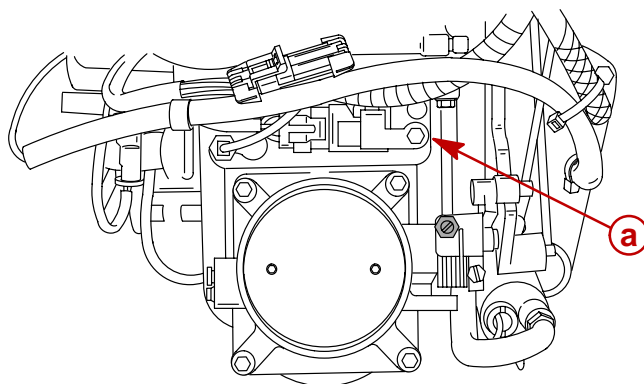
Manifold Absolute Pressure (MAP) Sensor

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 MAP sensor's DDT readout will vary according to altitude, throttle plate opening and barometric pressure. However, for a given location and weather conditions (I.E. altitude and barometric pressure), the MAP sensor readout between engines should be approximately the same when the ignition key is turned to the "ON" position. For example, if two engines indicate 15 psi when the key is turned "ON" and a third engine indicates 10 psi, the third engine's MAP sensor would be suspect. When the engines are started, MAP sensor readout should drop. When the engines are initially accelerated, the MAP sensor readout will drop momentarily and then begin to rise. Throttle plate opening will also affect the MAP readout. Refer to Section 2C for correct throttle plate clearance.

The Digital Diagnostic Terminal (DDT) can be used to determine 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.



59025

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.



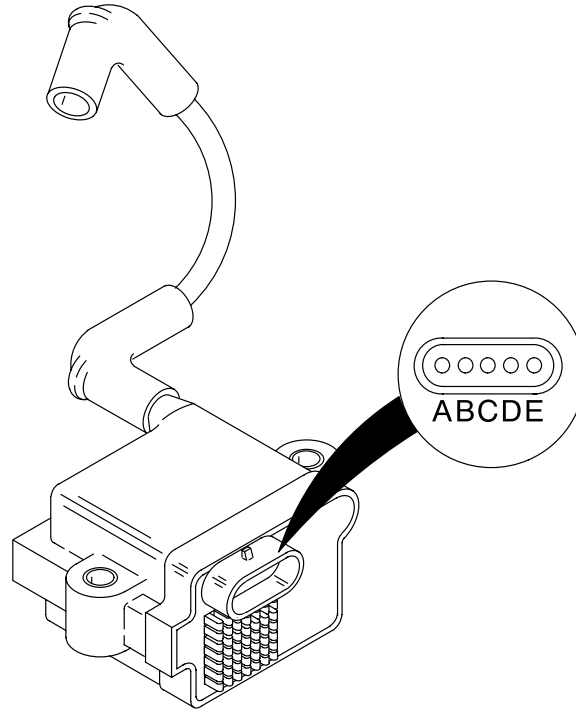
Symptom	Cause	Action
3. Engine idle is rough	3.1 Fouled spark plug	Replace spark plug: if carbon bridges electrode gap or if it is completely black. If it is not firing and is wet with fuel. <i>Note: If spark plug is grey or completely black with aluminum specs, this indicates a scuffed piston.</i>
	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 7.2 Overheat condition 7.3 Oil pump electrical failure 7.4 TPS failure If TPS fails, rpm is reduced to idle	Check battery and/or alternator. Check electrical connections. Check water pump impeller/cooling system. Check electrical connection. See 2.2
8. Engine RPM reduced to idle only	8.1 TPS failed 8.2 Battery voltage below 9.5 volts	See 2.2 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. 9.2 Faulty ignition coil. 9.3 Faulty spark plug. 9.4 Faulty 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.	Check connectors. Replace coil. Replace spark plug. Replace spark plug wire.



Ignition Coil Ohms Test



58903

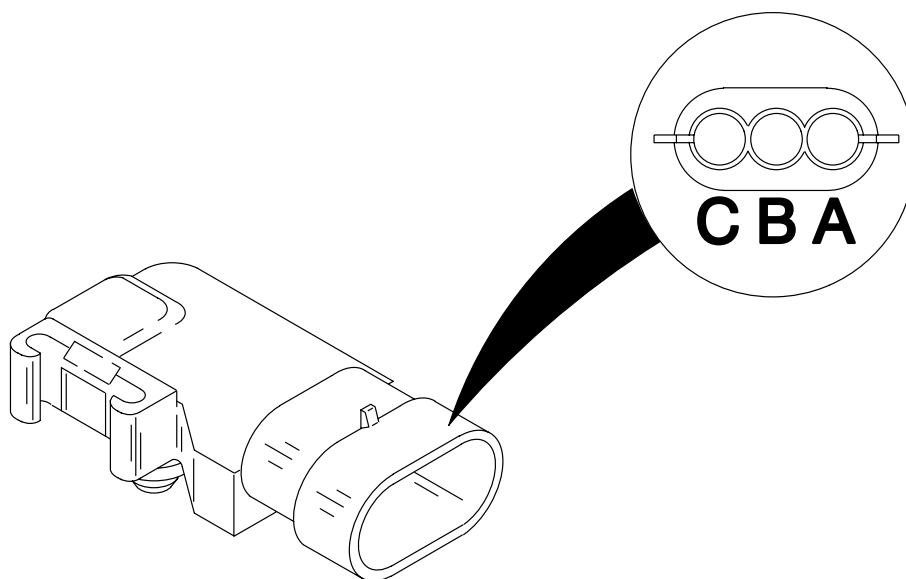
BLACK METER LEAD							
RED METER LEAD		Secondary Tower	EST PIN A	EST Low PIN B	Secondary Low Pin C	Primary Ground Pin D	Battery + Pin E
	Secondary Tower	X	No Continuity	No Continuity	850 – 1200 ohm	No Continuity	No Continuity
	EST PIN A	No Continuity	X	8500 – 12000 ohm	No Continuity	29000 – 39000 ohm	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

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 \pm 50 rpm.

RPM-Limit Circuit

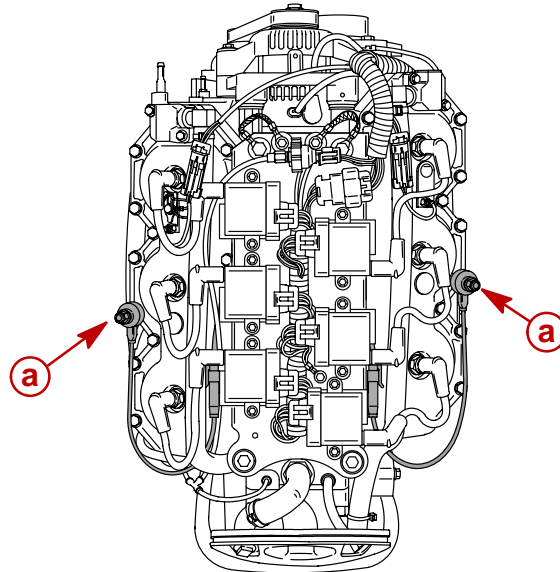
The rpm limit circuitry is contained within the ECM. When the rpm limit point is reached (this point will vary between engine models), a warning horn will sound. If the rpm continues to increase, ignition spark will be cut to cylinders #1, #3 and #5. If the rpm still continues to rise, fuel and ignition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



EFI Detonation Control System (200 Work 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)



59034

a - Detonation Sensor (1 per cylinder head)

Detonation Circuit Test

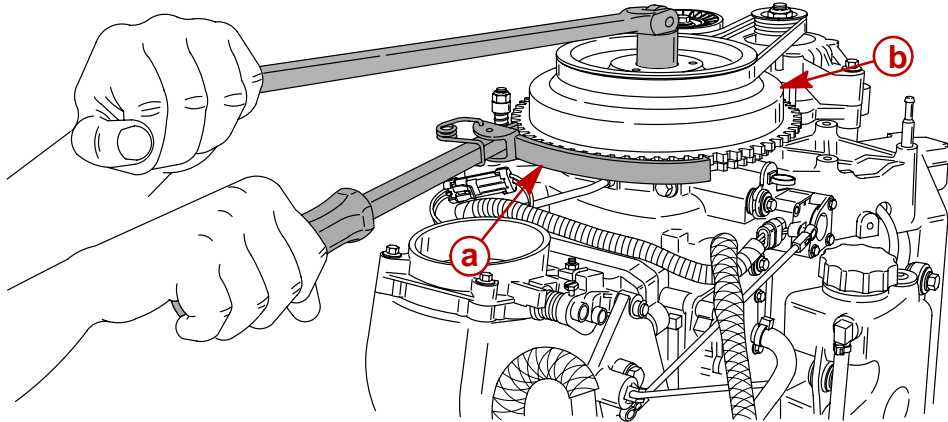
1. Turn key switch to RUN position (do not start engine). With Digital Diagnostic Terminal connected to engine, DDT should indicate over 6 volts for knock voltage output.
2. Start engine and run at idle. DDT indicated knock voltage output should drop below 1.0 volt. If voltage does not drop below 1.0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



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.



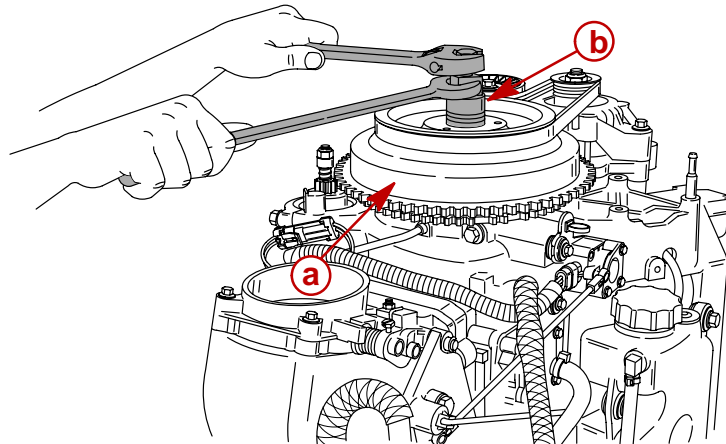
59071

- 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 may be damaged.



59072

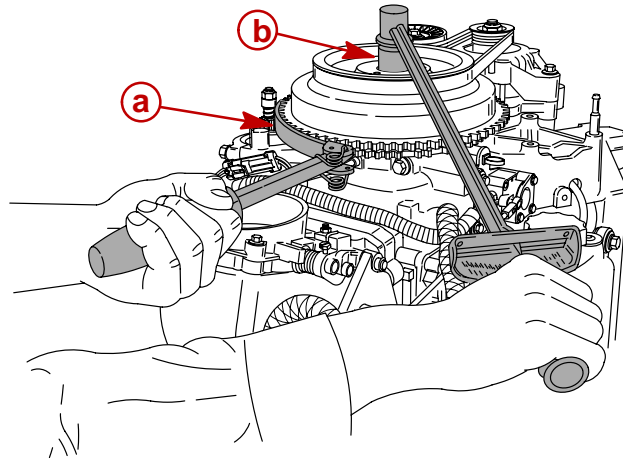
- a** - Flywheel
b - Flywheel Puller (91-849154T1)



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 N m).



59073

a - Flywheel Holder (91-52344)

b - Torque Nut to 120 lb. ft. (163 Nm)

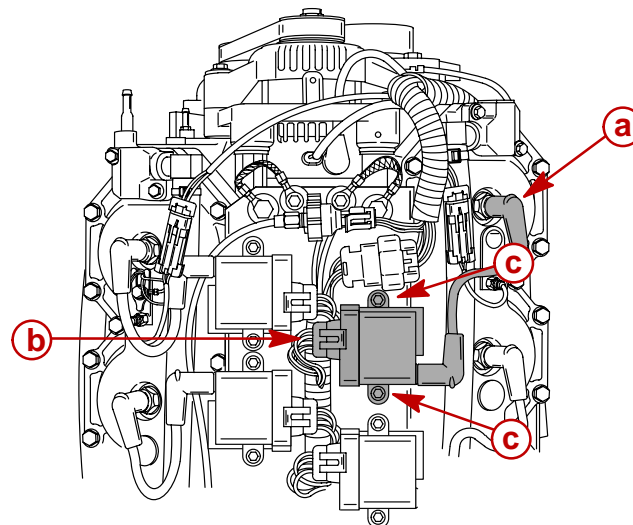
2. Reinstall flywheel cover on engine.

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 which 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.



59036

a - Spark Plug Lead

c - Bolts

b - Harness Connector

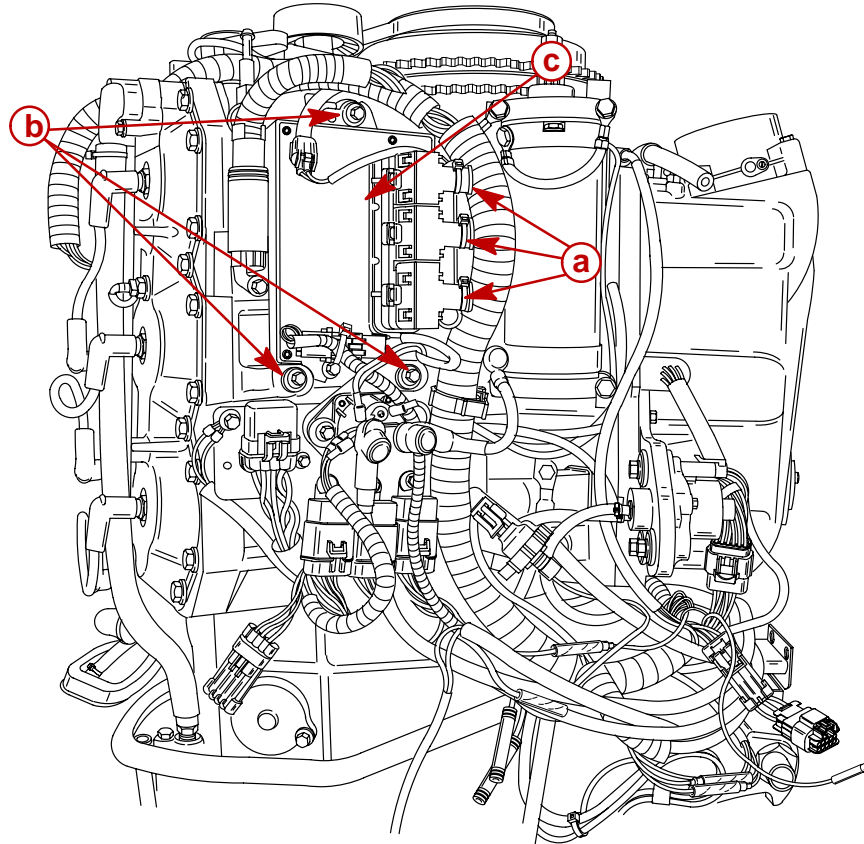


Ignition Coil Installation

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

59026

Electronic Control Module Installation

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



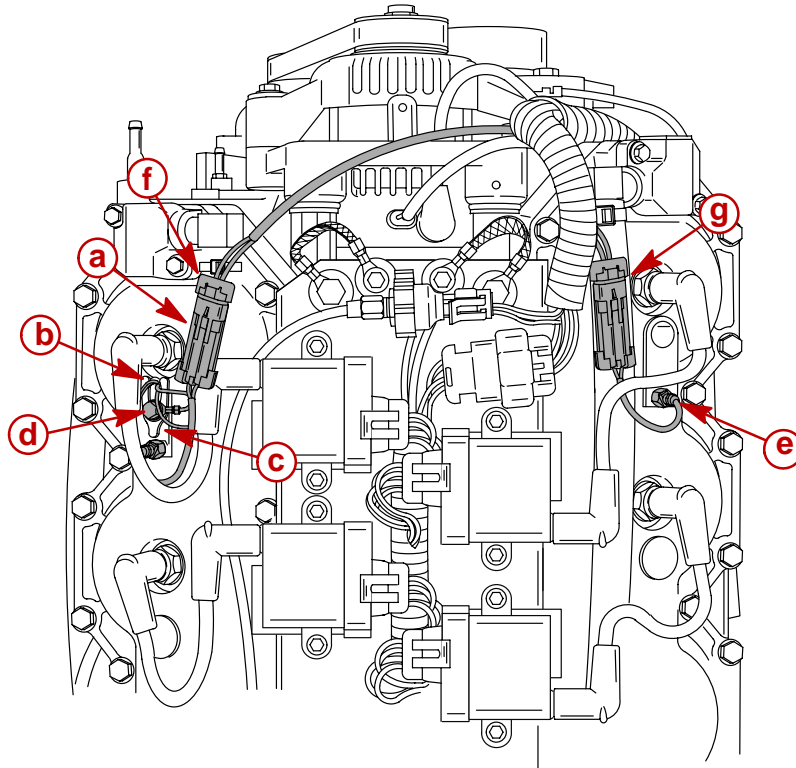
Temperature Sensor Removal

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.



59037

- a** - Bullet Connector (hidden)
- 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.

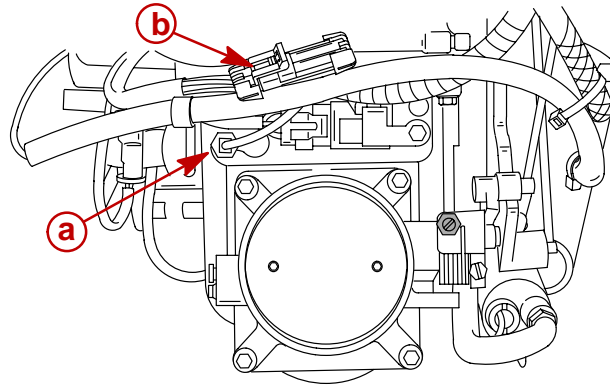
DIGITAL TEMPERATURE SENSOR

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.



59025

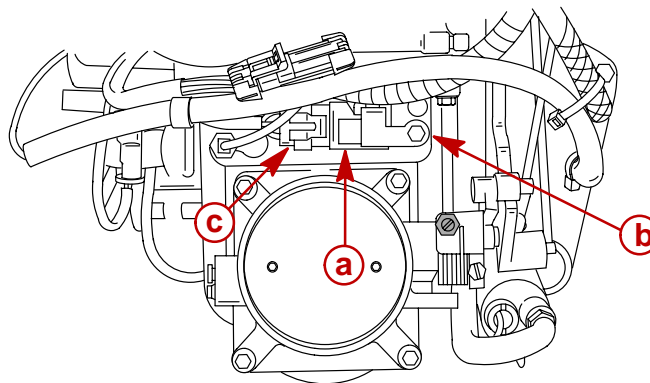
- a** - Air Temperature Sensor
b - Harness Connector

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.



59025

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

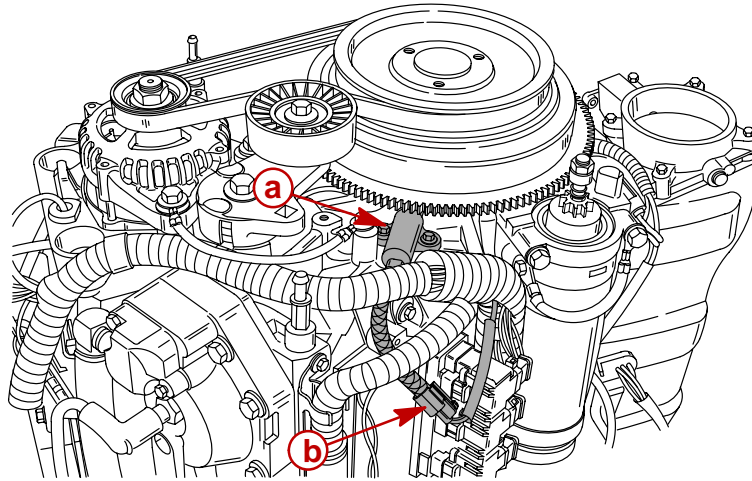
Manifold Absolute Pressure (MAP) Sensor Installation

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.



59070

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

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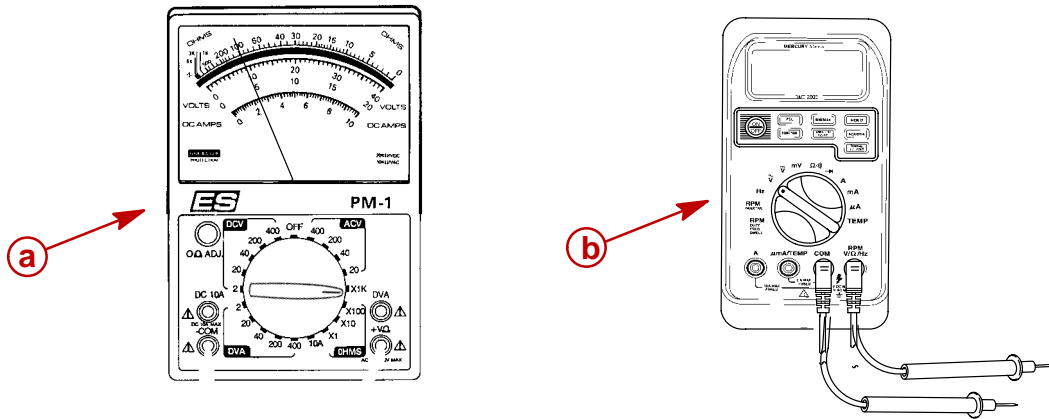
Specifications

<p>CHARGING SYSTEM</p>	<p>Alternator Output (Regulated)</p> <p>Brush Length</p> <p>Voltage Output</p> <p>Regulator Current Draw</p>	<p>35 - 41 Amperes @ 2000 RPM @ Battery 36 - 44 Amperes @ 2000 RPM @ Alternator</p> <p>Std Exposed Length: 0.413 in. (10.5 mm) Min. Exposed Length: 0.059 in. (1.5 mm)</p> <p>13.5 to 15.1 Volts</p> <p>0.15 mA (Ign. Switch Off) 30.0 mA (Ign. Switch On)</p>
<p>STARTING SYSTEM</p>	<p>Electric Start – All Models</p> <p>Centrifugal Bendix</p> <p>Starter Draw (Under Load)</p> <p>Starter Load (No Load)</p> <p>Minimum Brush Length</p> <p>Solenoid Driven Bendix</p> <p>Starter Draw (Under Load)</p> <p>Starter Load (No Load)</p> <p>Minimum Brush Length</p> <p>Battery Rating</p>	<p>165 Amperes 30 Amperes 0.25 in. (25.4 mm)</p> <p>175 Amperes 60 Amperes 0.25 in. (25.4 mm)</p> <p>Min. 630 Marine Cranking Amps (MCA) or 490 Cold Cranking Amps (CCA)</p>



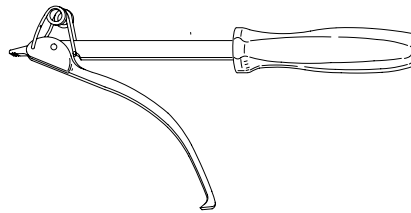
Special Tools

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

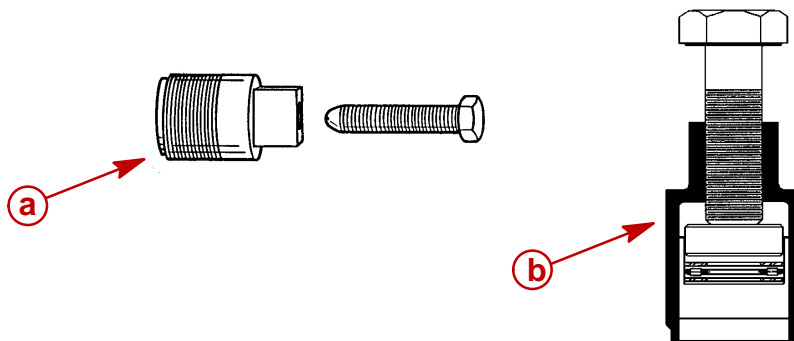


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4. Protector Cap 91-24161 (Used with Puller 91-73687A1)



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

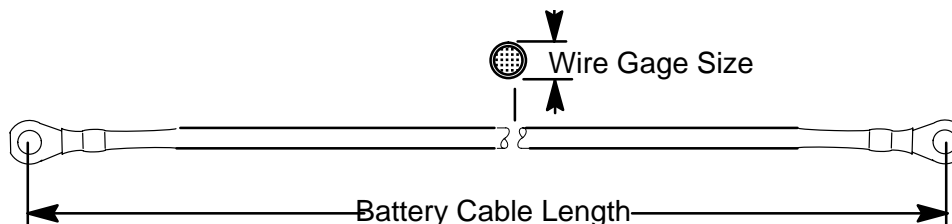


- a** - Puller 91-73687A1
- b** - Puller 91-849154T1



Battery Cable Size

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



Battery Cable Wire Gauge Size Mercury/Mariner Outboards																	
Models	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
Wire Gauge 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 gauge 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 starting battery with a minimum Cold Cranking amperage rating of 490 amperes or 630 (minimum) Marine Cranking amperes should be used.

⚠ CAUTION

Deep-cycle batteries are not suitable for use as engine starting batteries or for use as accessory batteries that are connected to high output engine charging systems. Deep-cycle battery life may be shortened by high output engine charging systems. Refer to individual battery maker instructions for specific battery charging procedures and applications.



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 with Teflon 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

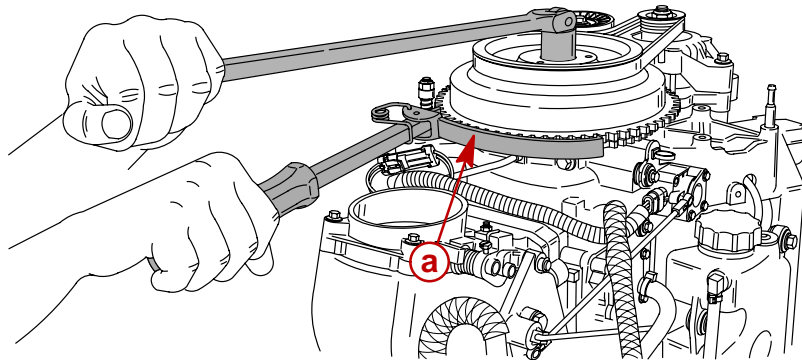
Removal

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.

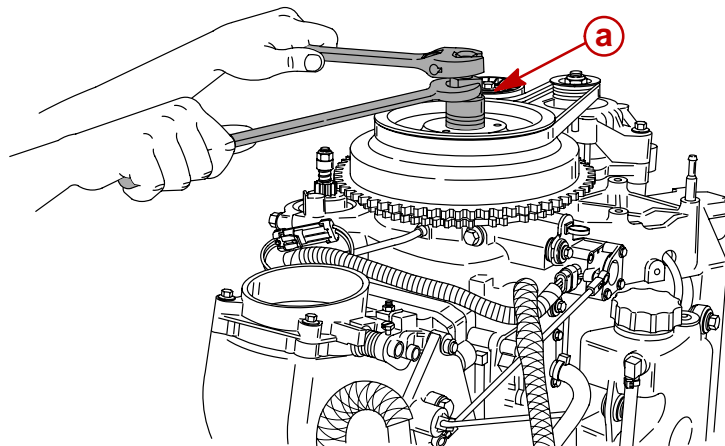
2. Disconnect spark plug leads from spark plugs.
3. While holding flywheel with flywheel holder (91-52344), remove flywheel nut and washer.



59071

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.



59072

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.

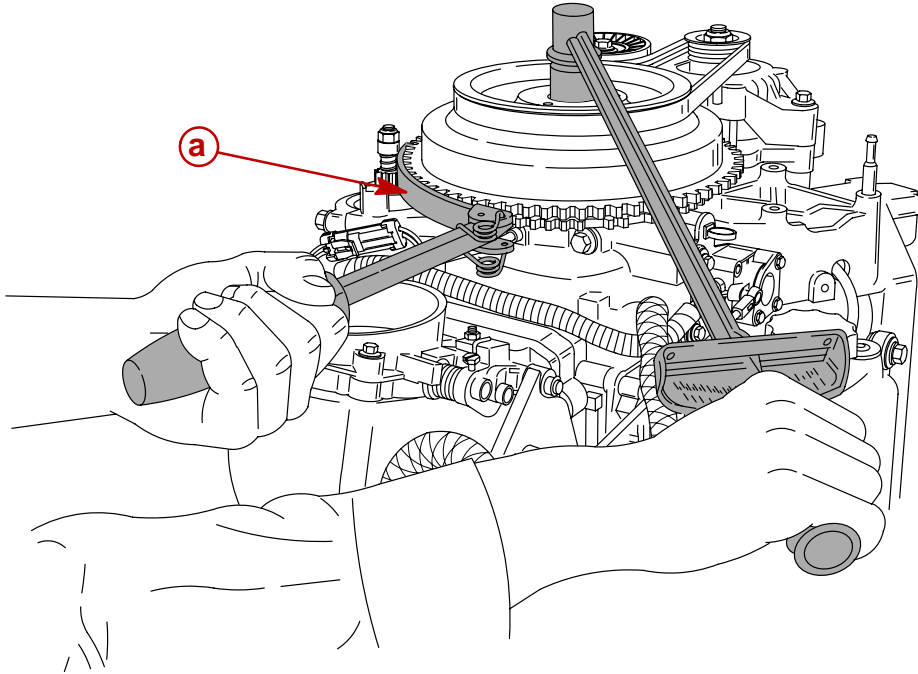
6. Remove flywheel. Inspect flywheel for cracks or damage.



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).



59073

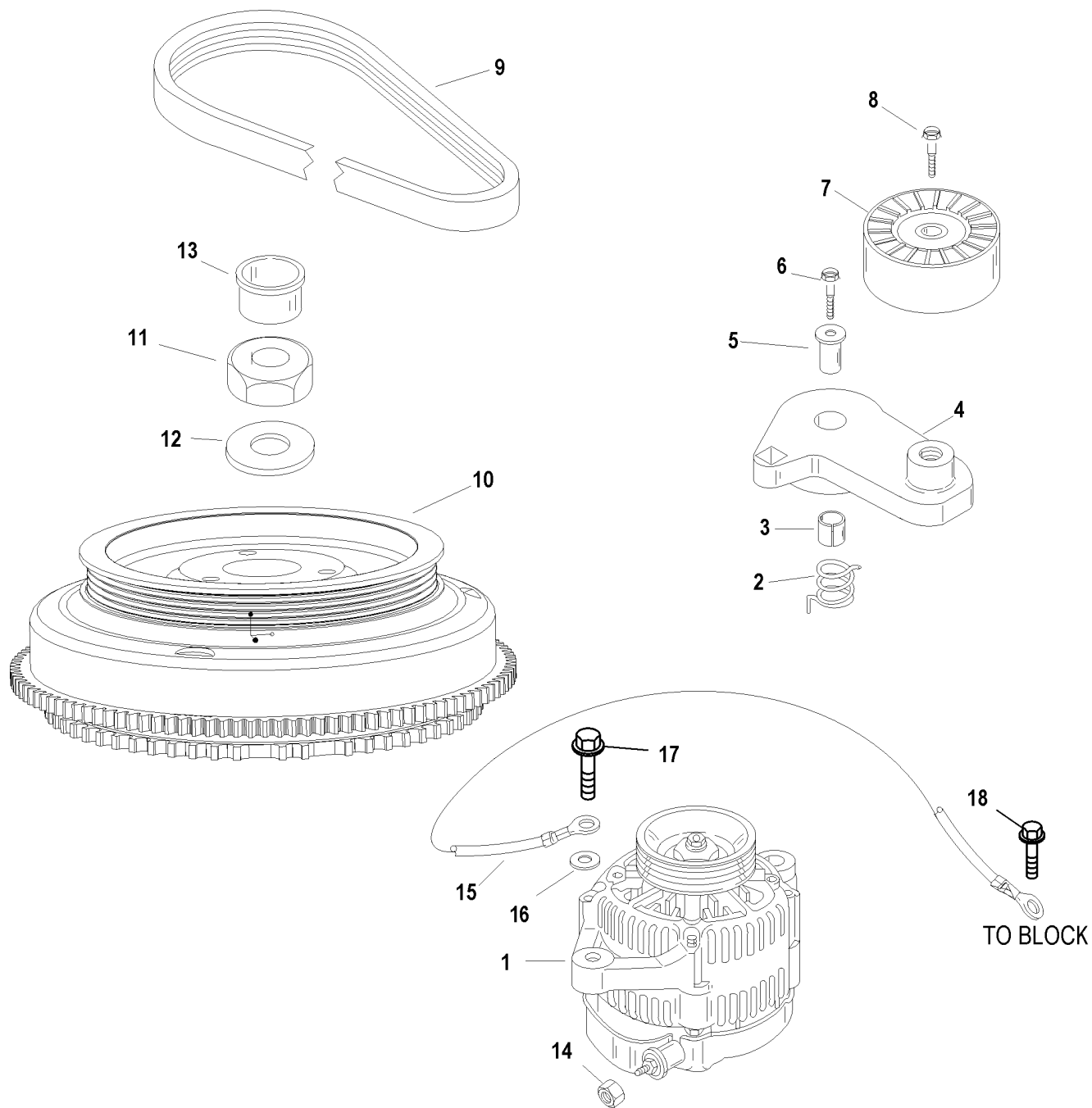
a - Flywheel Holder (91-52344)



Notes:



Flywheel/Alternator



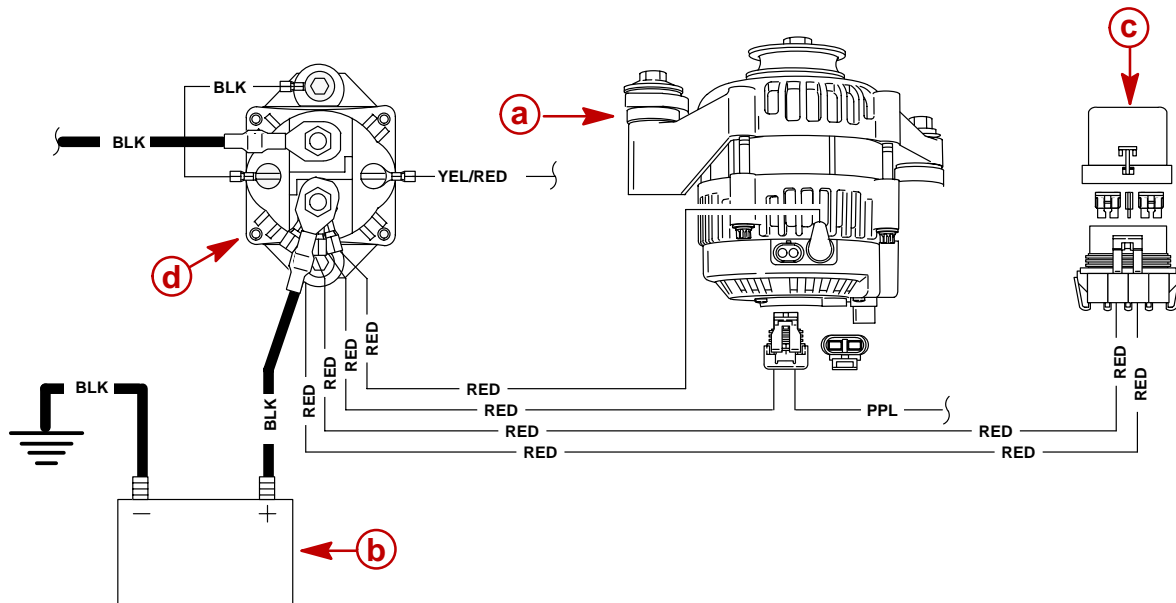


Flywheel/Alternator

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb. in.	lb. ft.	Nm
1	1	ALTERNATOR			
2	1	SPRING			
3	1	BEARING			
4	1	BELT TENSIONER ARM ASSY			
5	3	BUSHING			
6	1	SCREW (M10 x 45)		15	20
7	1	PULLEY			
8	1	SCREW (M10 x 35)		25	34
9	1	BELT			
10	1	FLYWHEEL			
11	1	NUT (0.625-18)		125	170
12	1	WASHER			
13	1	PLUG			
14	1	NUT			
15	1	CABLE			
16	1	WASHER			
17	1	SCREW (M10 x 50)		40	54
18	1	SCREW (M6 x 12)		40	54

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

59049



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.

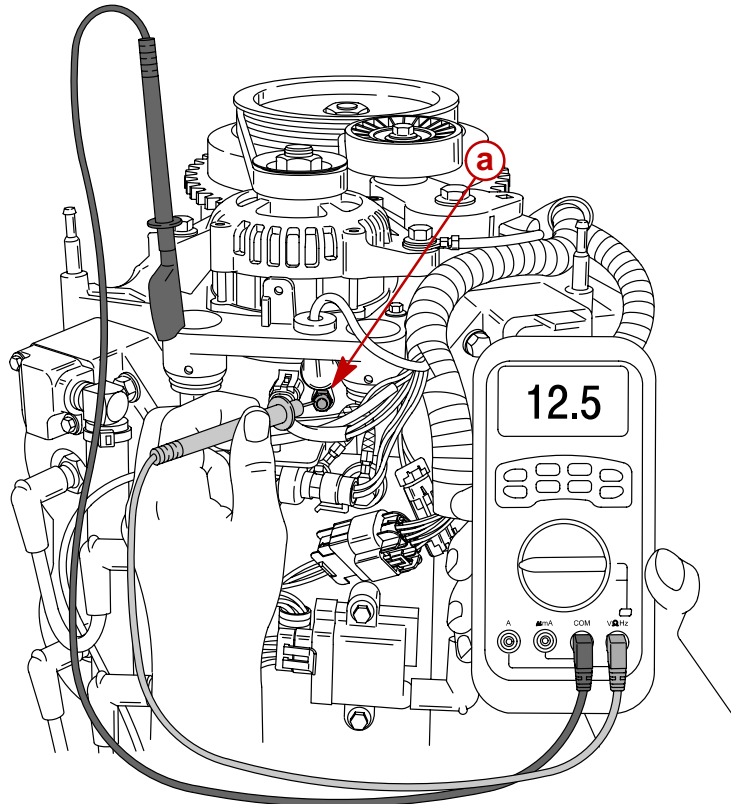


Alternator System Circuitry Test

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.



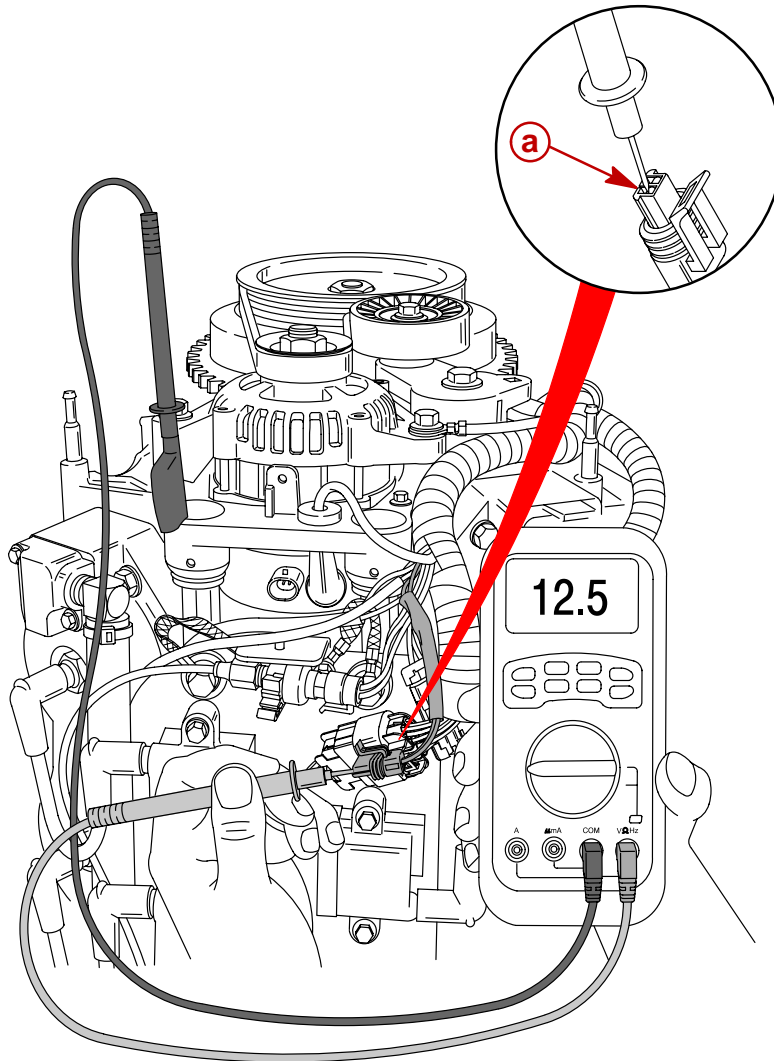
a - Terminal B

59069



Sensing Circuit

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



a - Sense Lead (RED)

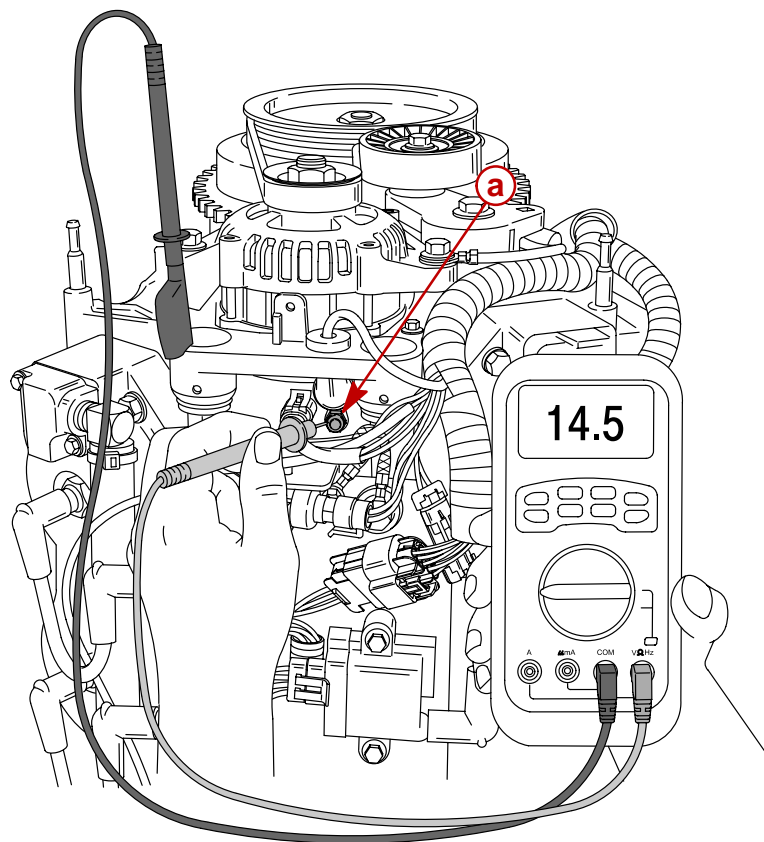
59065



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

59068

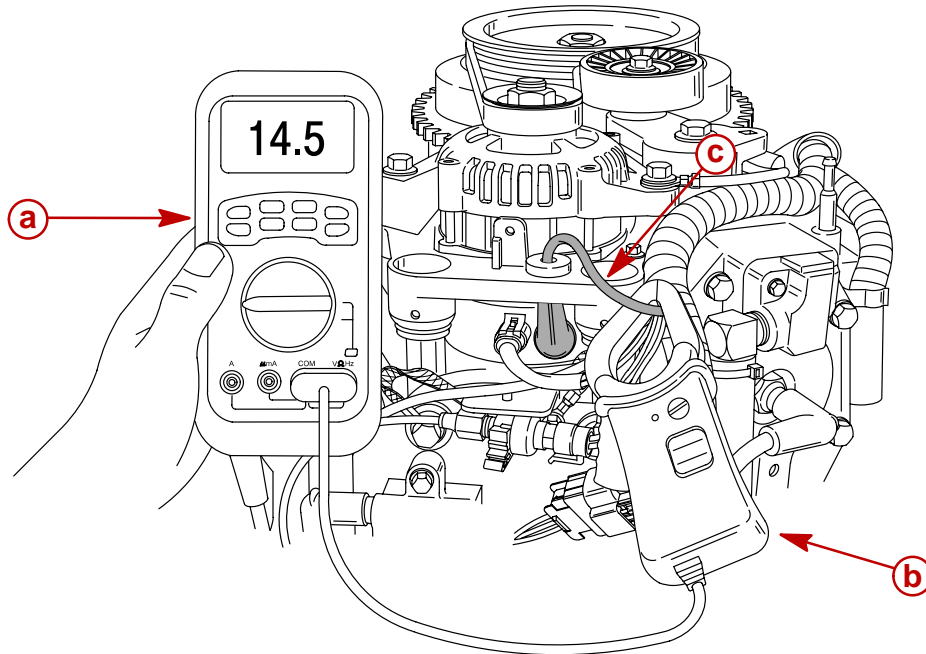


Current Output

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. **Example:** If engine is revolving at 2000 RPM current meter should be approximately 14.5 ± 3 Amps.



59066

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



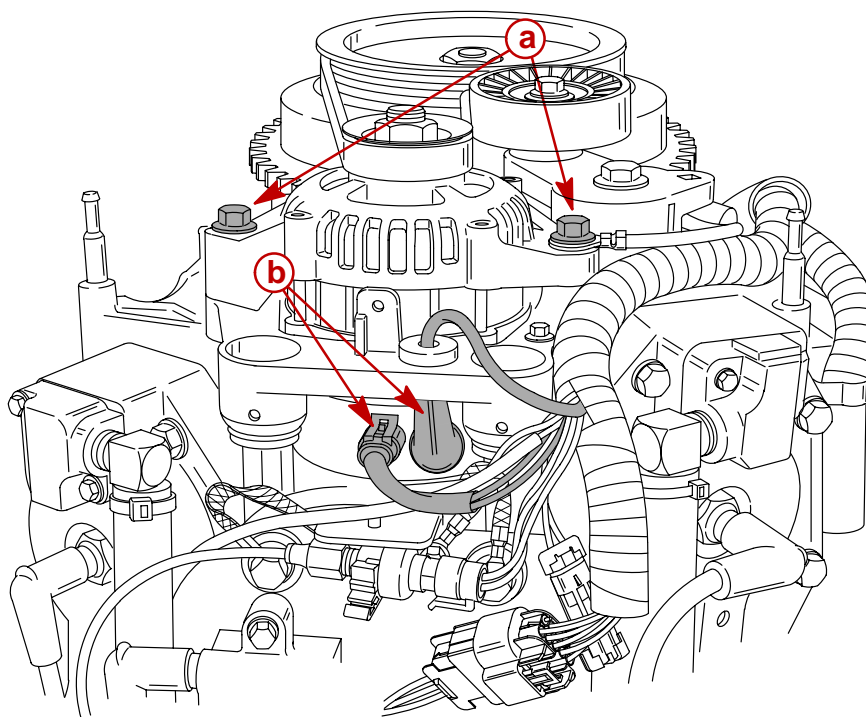
Current Output Troubleshooting

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.



a - Attaching Bolt

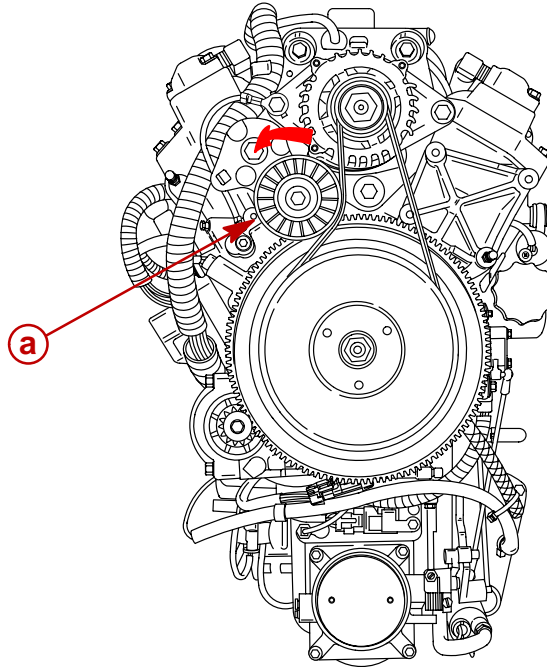
b - Harnesses

59067



Installation

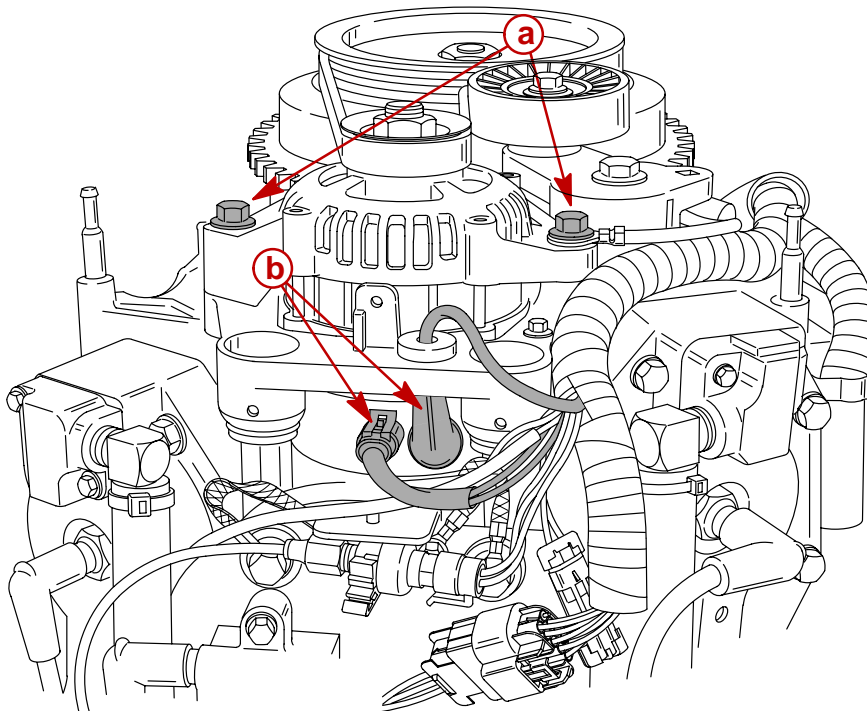
1. Secure alternator to engine block with attaching bolts. Torque top bolt to 40 lb-ft (54 Nm). Torque bottom nut to 35 lb-ft (47.5 Nm).
2. Rotate belt tensioner and install alternator belt in groove of flywheel and alternator pulley.



59024

a - Belt Tensioner (Rotate Counterclockwise)

3. Reconnect electrical harness to alternator.



59067

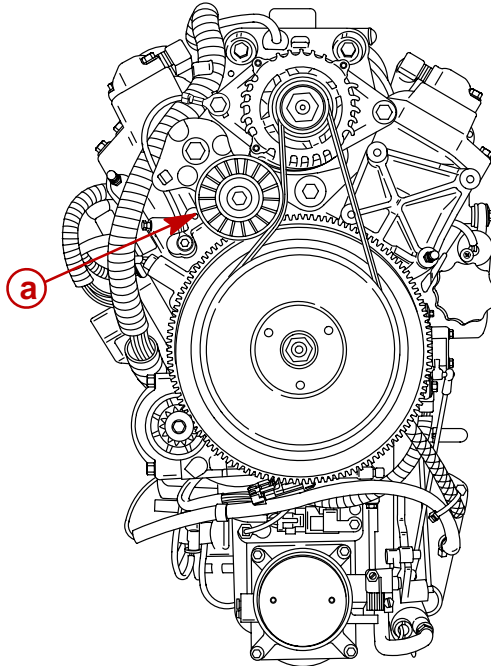
a - Top Bolt [Torque to 40 lb-ft (54 Nm)]

b - Harnesses



Alternator Belt Tension Adjustment

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



a - Belt Tensioner Assembly

59024



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.

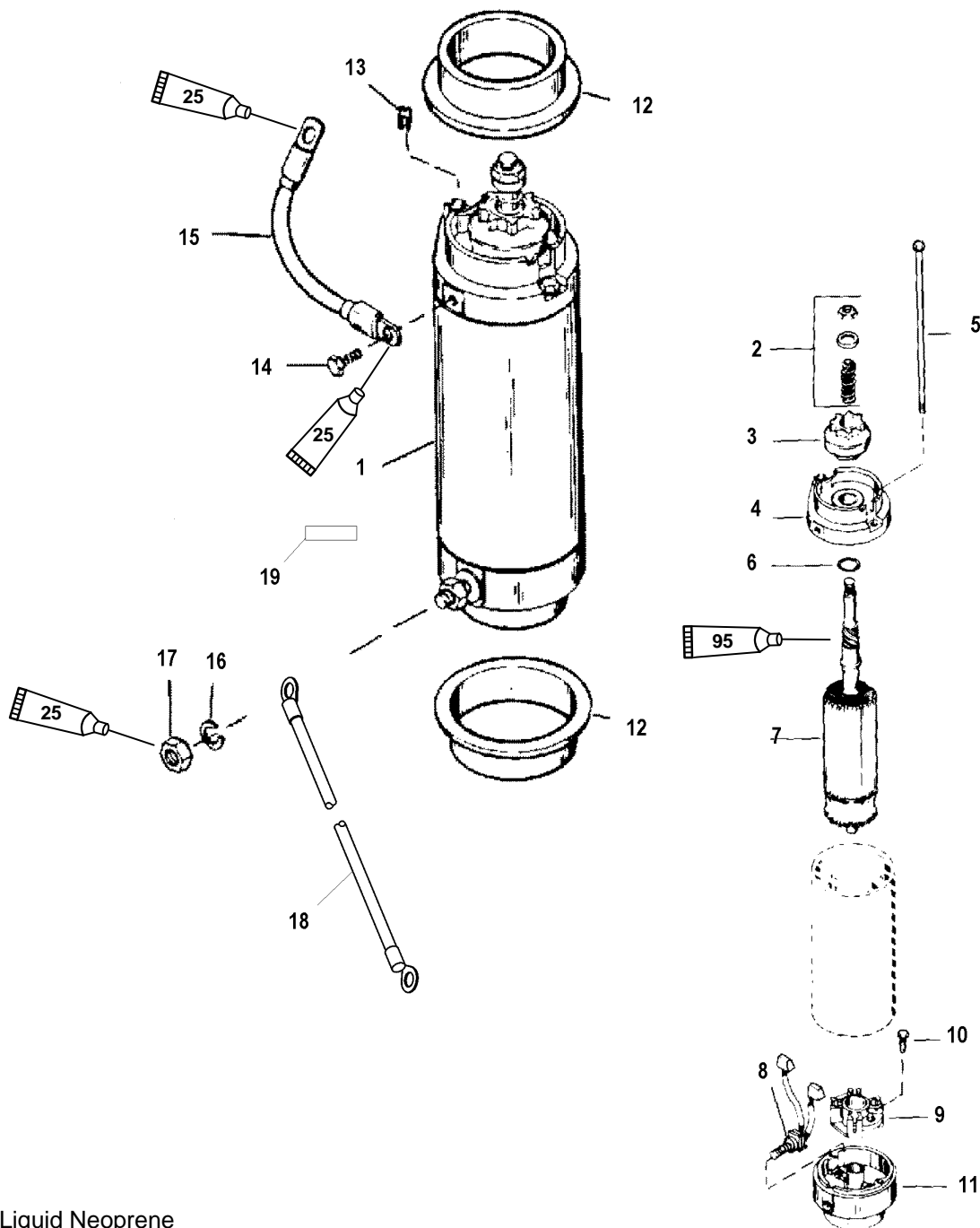
The neutral start switch opens the starter circuit when the shift control lever is not in neutral thus preventing accidental starting when the engine is in gear.

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)





Starter Motor (Centrifugal Bendix)

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			

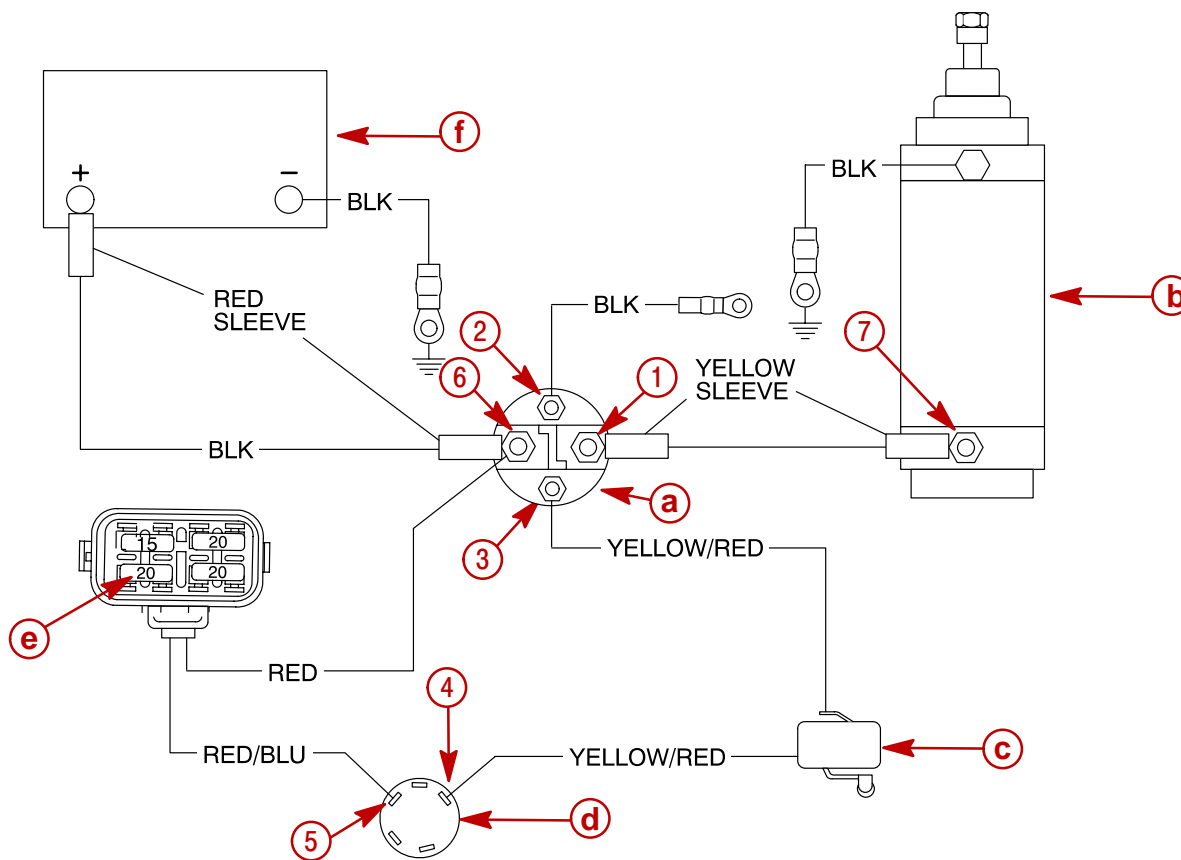


Troubleshooting the Starter Circuit (Centrifugal Bendix)

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.



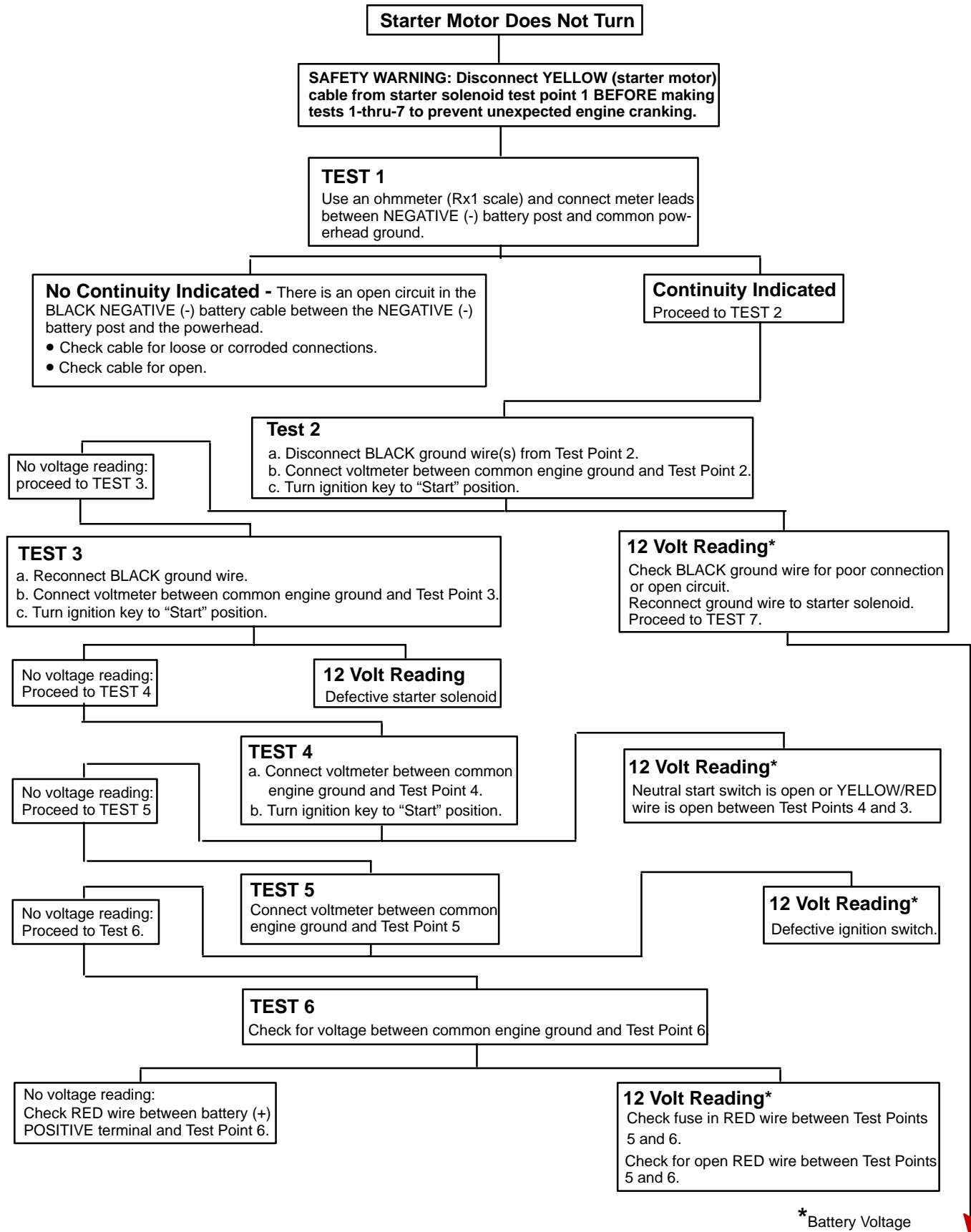
58064

- a** - Starter Solenoid
- b** - Starter
- c** - Neutral Start Switch

- d** - Ignition Switch
- e** - 20 Ampere Fuse
- f** - Battery

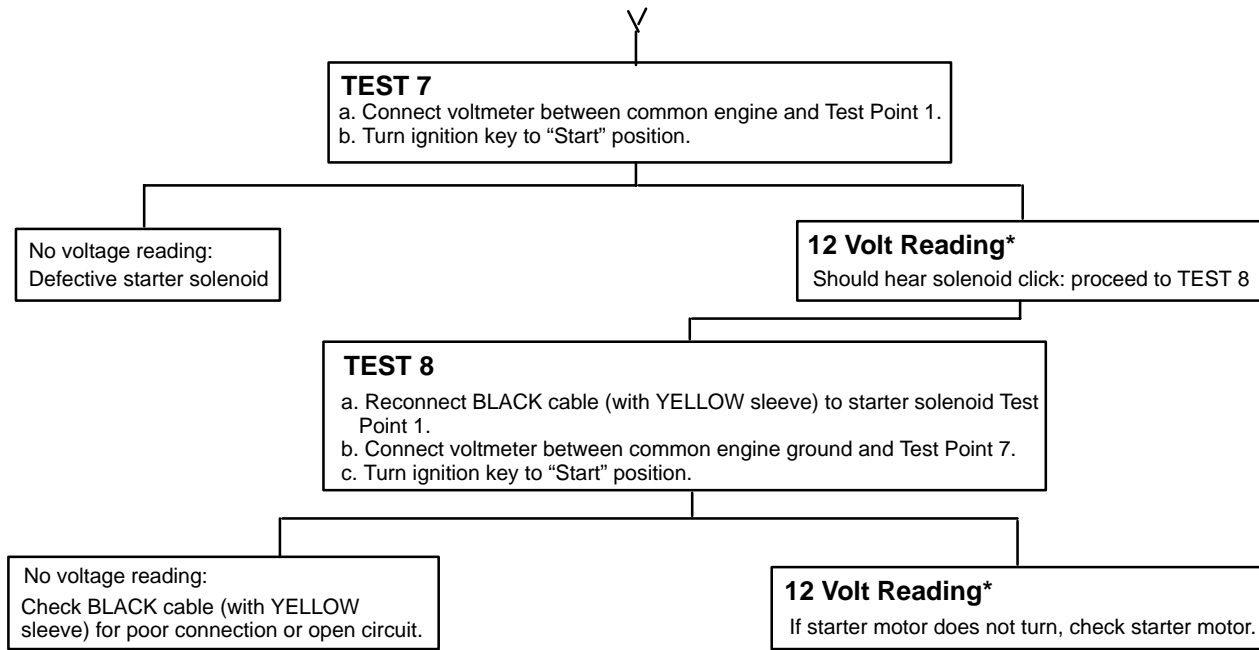


Starter Circuit Troubleshooting Flow Chart (Centrifugal Bendix)





Flow Chart (continued)



*Battery Voltage

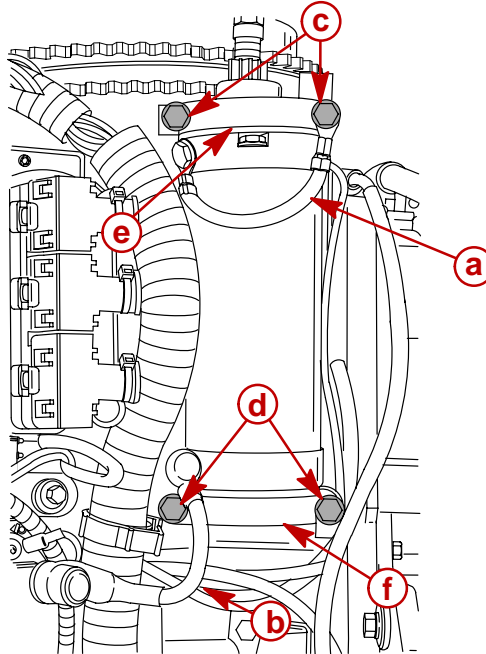


Starter Removal (Centrifugal Bendix)

⚠ 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.



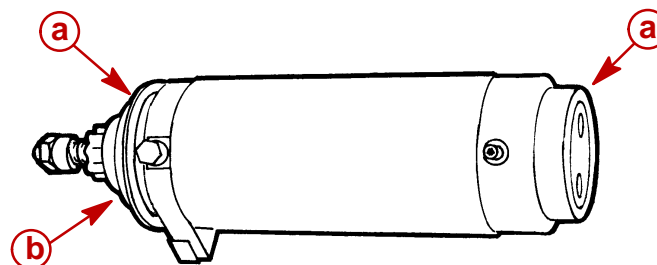
- a** - BLACK ground cable
b - BLACK (with YELLOW sleeve) + 12 volt cable
c - Upper Mount Bolts

- d** - Lower Mount Bolts
e - Upper Clamp
f - Lower Clamp

59044

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.



- a** - Rubber Collar

- b** - Spacer (If Equipped)

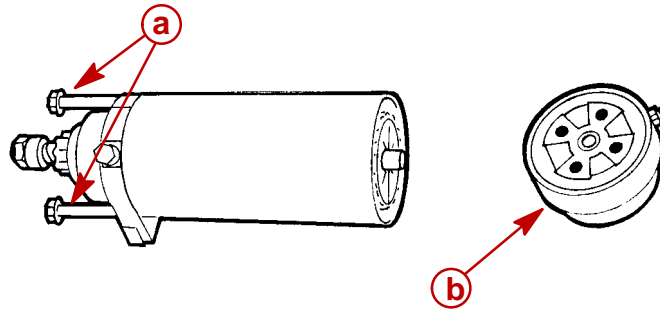
11645

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)

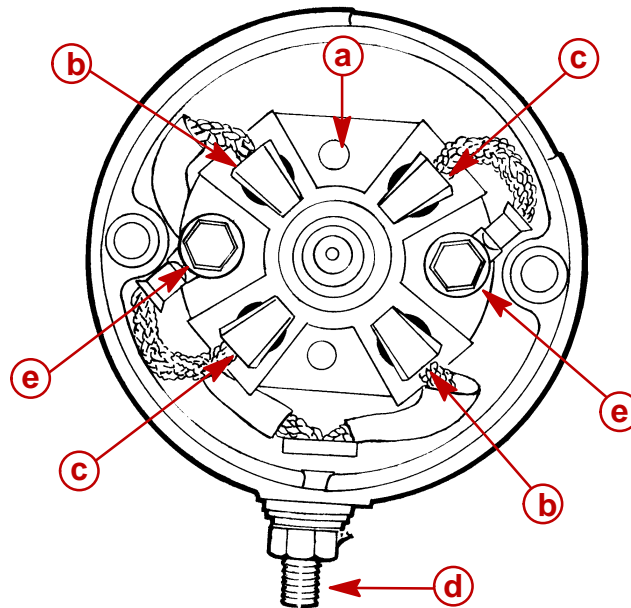
1. Remove starter as outlined in **Starter Removal**.
2. Remove 2 through bolts from starter.



- a** - Through Bolts
b - Commutator End Cap

11646

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.

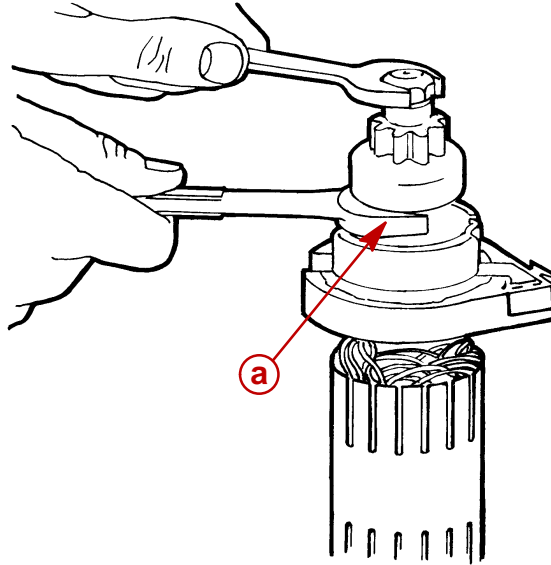


- a** - Brush Holder
b - Positive Brushes
c - Negative Brushes
d - Positive Terminal
e - Bolts (fasten negative brushes and holder)

11656

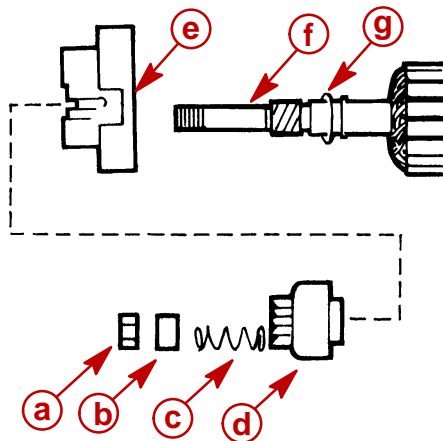


5. Remove armature (with drive end cap) from starter frame.
6. Remove locknut and remove drive assembly from armature shaft.



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

7. Remove parts from shaft.



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

11658



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:

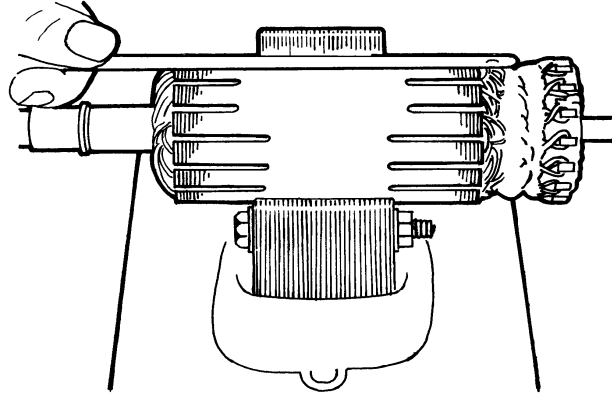
CAUTION

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**

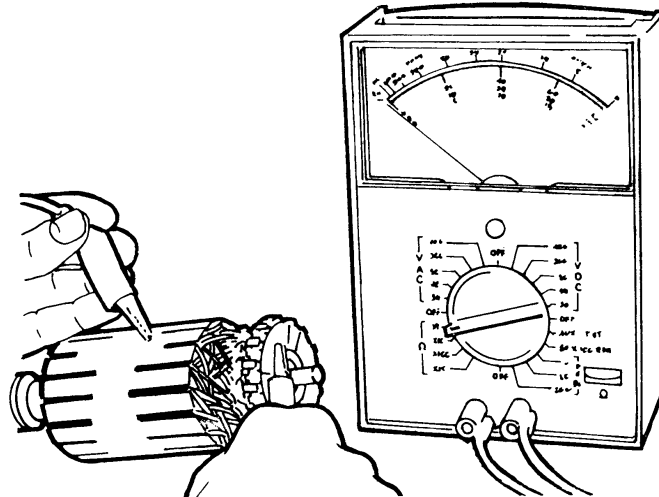
Check armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. If saw blade vibrates, armature is shorted. Re-check after cleaning between commutator bars. If saw blade still vibrates, replace armature.



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.

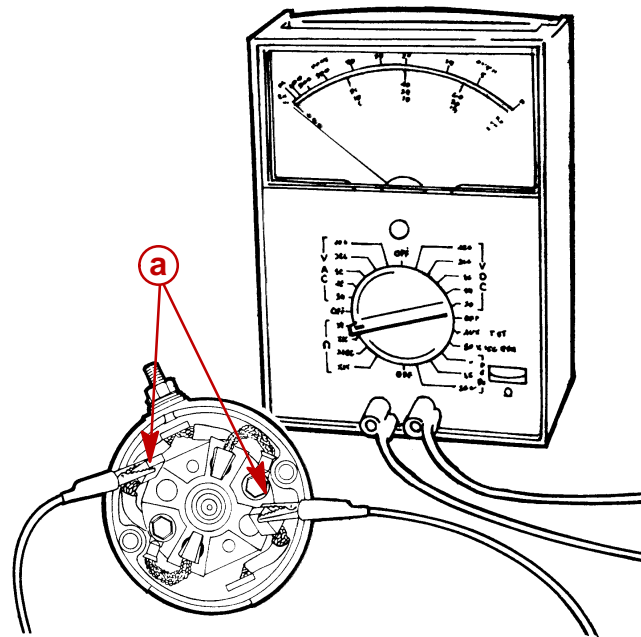


11675



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.

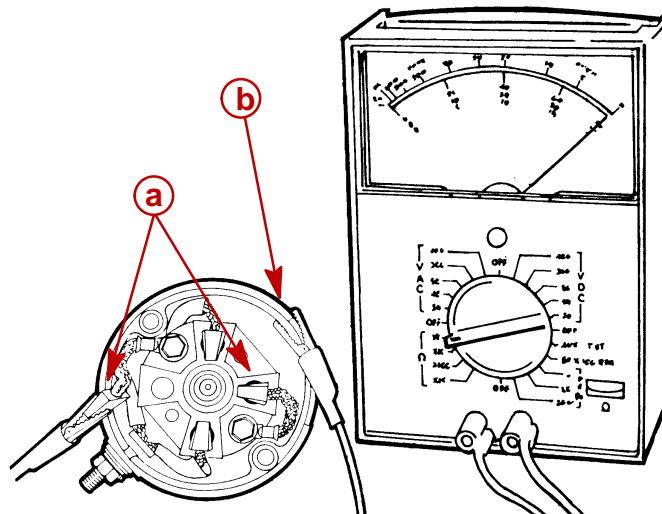


a - Positive (+) Brushes

11673

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.



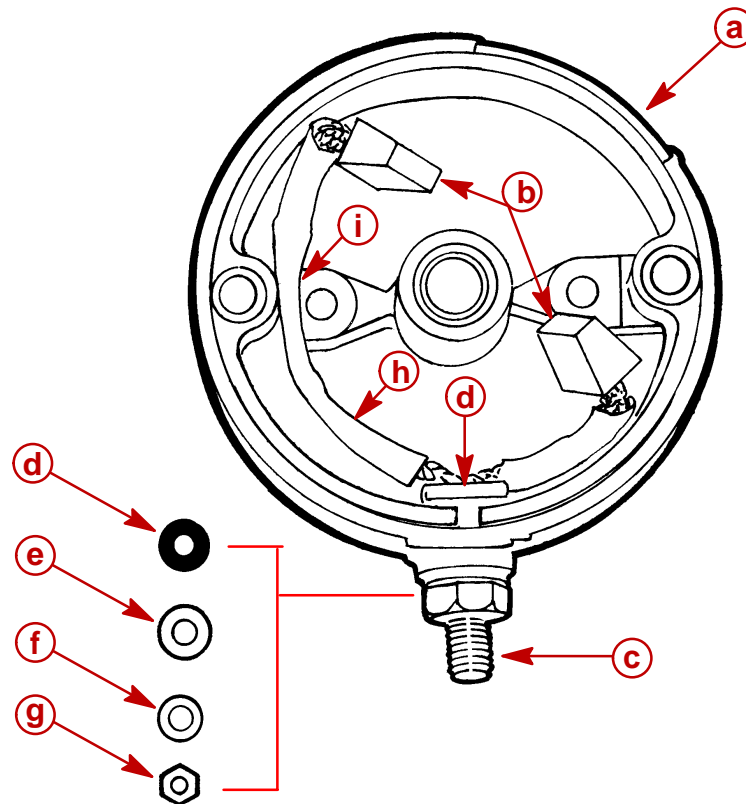
a - Negative (-) Brushes
b - End Cap

11674



Starter Reassembly

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

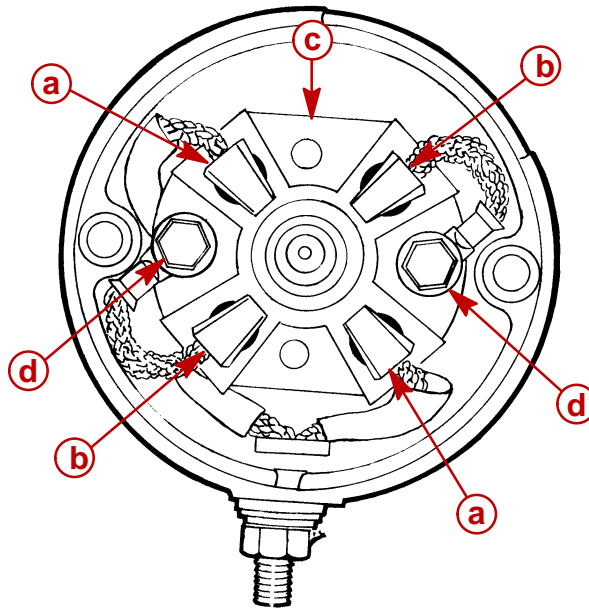


- a** - End Cap
- b** - Positive Brushes
- c** - Positive Terminal
- d** - Insulating Bushing
- e** - Washer
- f** - Split Washer
- g** - Hex Nut
- h** - Long Brush Lead
- i** - Push Lead into Slot

11660



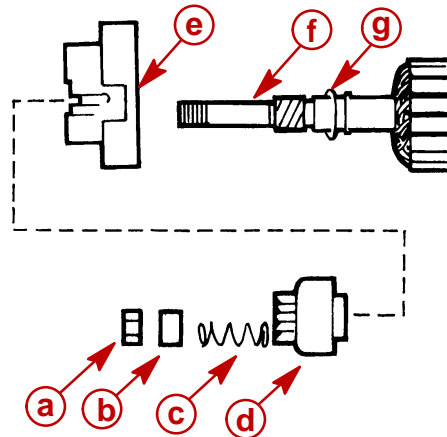
b. Install NEGATIVE brushes (along with brush holder).



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.



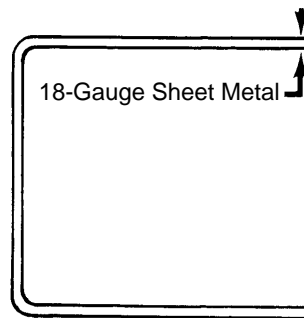
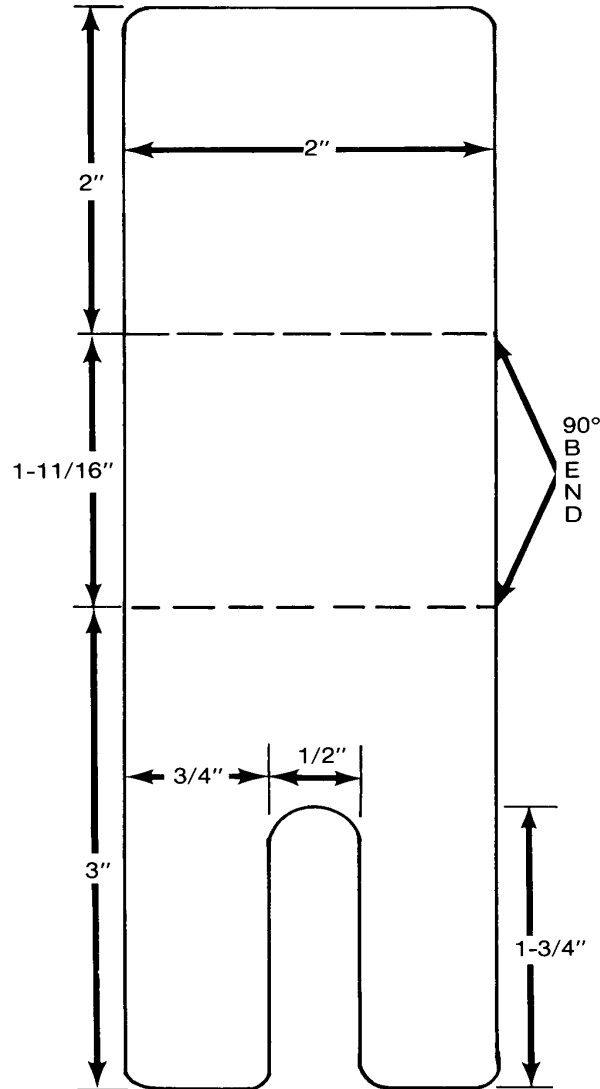
11658

- 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 (obtain locally).
4. Lubricate bushing in drive end plate with a drop of SAE 10W Oil (obtain locally).
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:



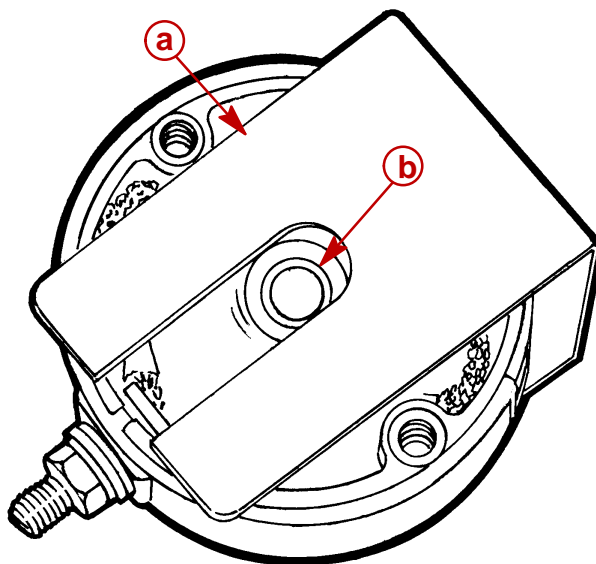
METRIC SCALE

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 (obtain locally). DO NOT over lubricate.



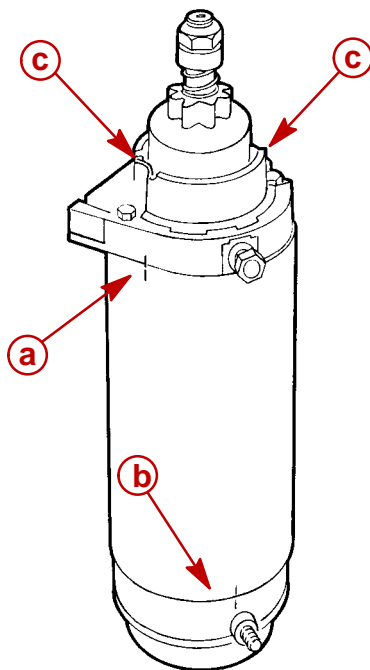
8. Place springs and brushes into brush holder and hold in place with brush retainer tool.



11661

- a** - Brushing Retainer Tool
- b** - Brushing (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 and torque to 70 lb. in. (8.0 N·m).



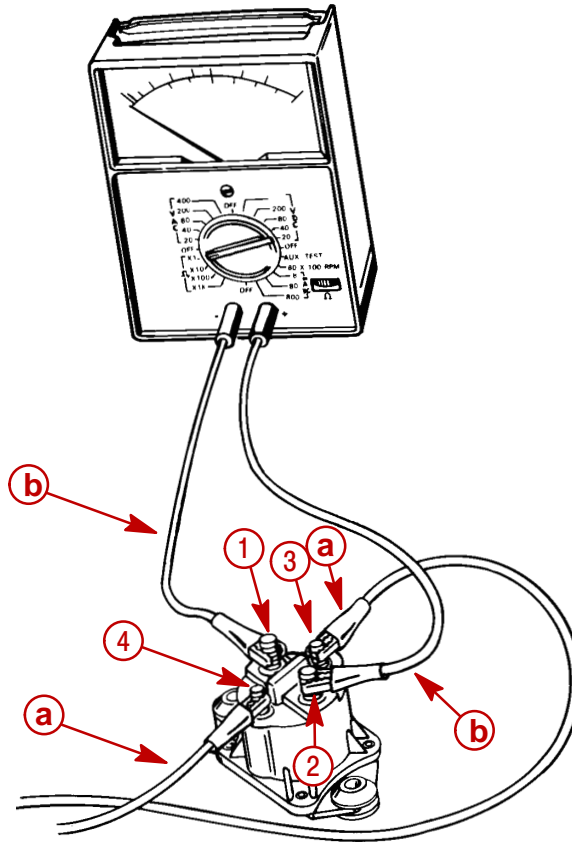
11648

- 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.

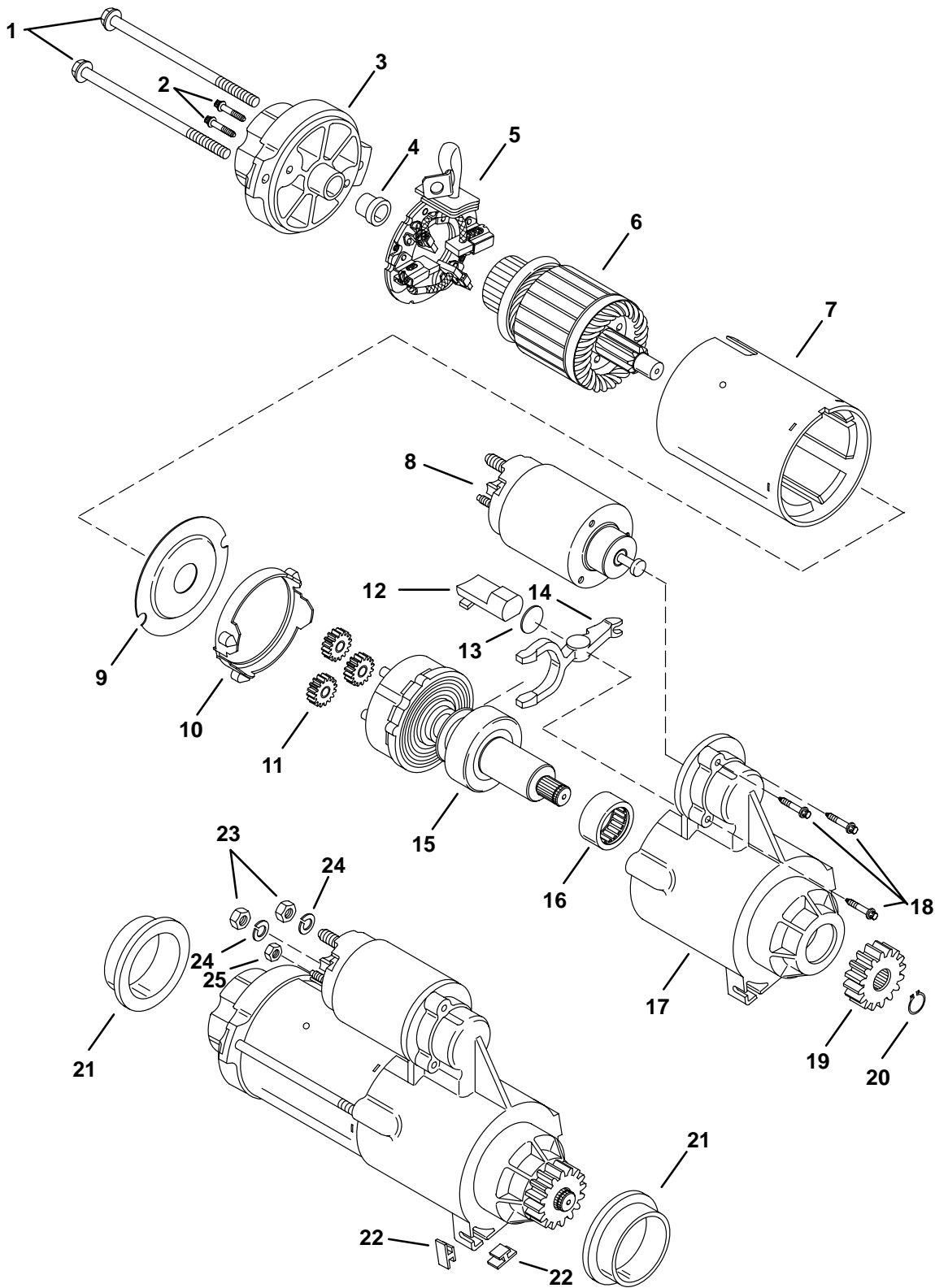


a - 12 Volt Supply
b - VOA Leads

51809



Starter Motor (Solenoid Driven Bendix)



58430



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

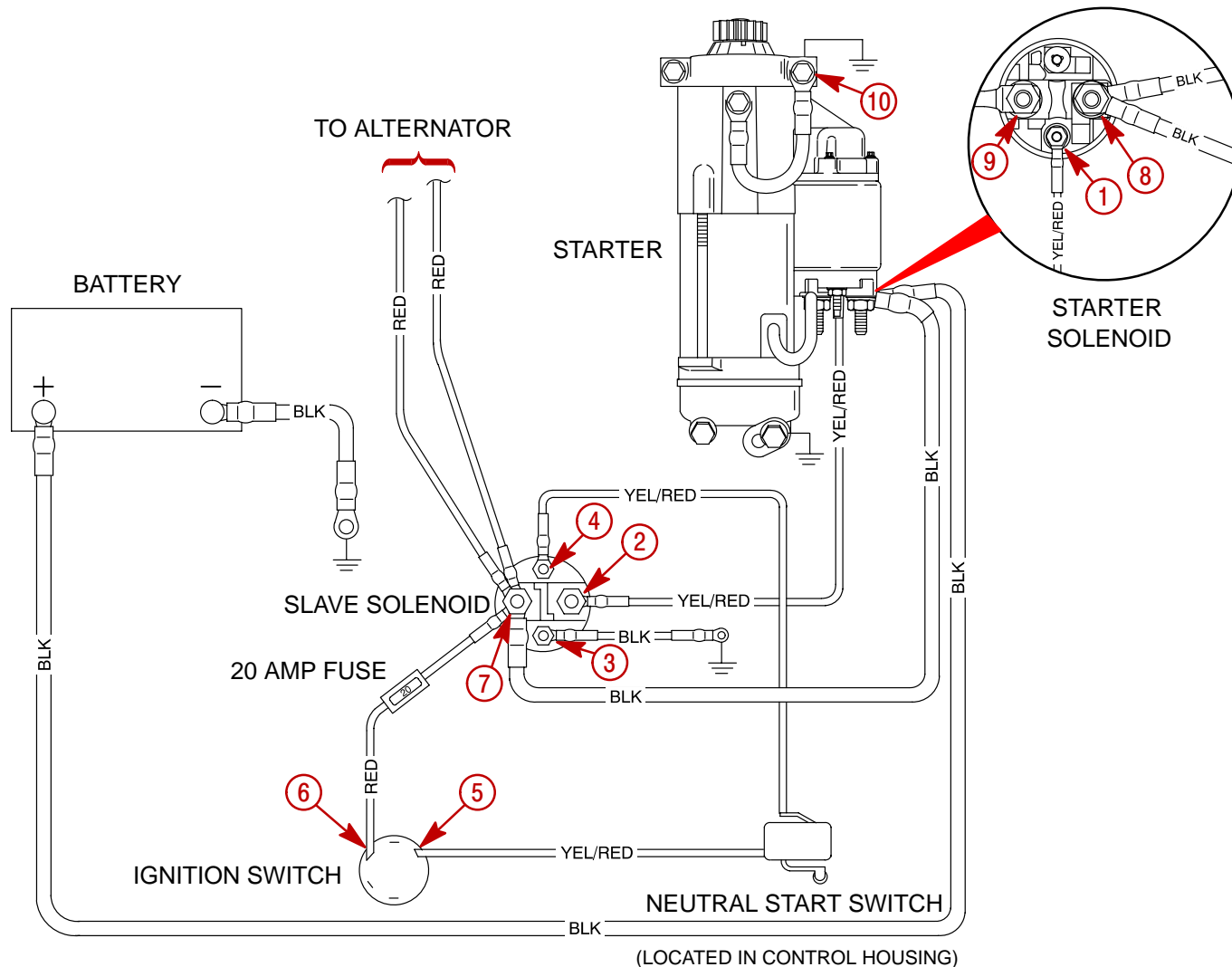


Troubleshooting the Solenoid Driven Bendix Starter Circuit

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.

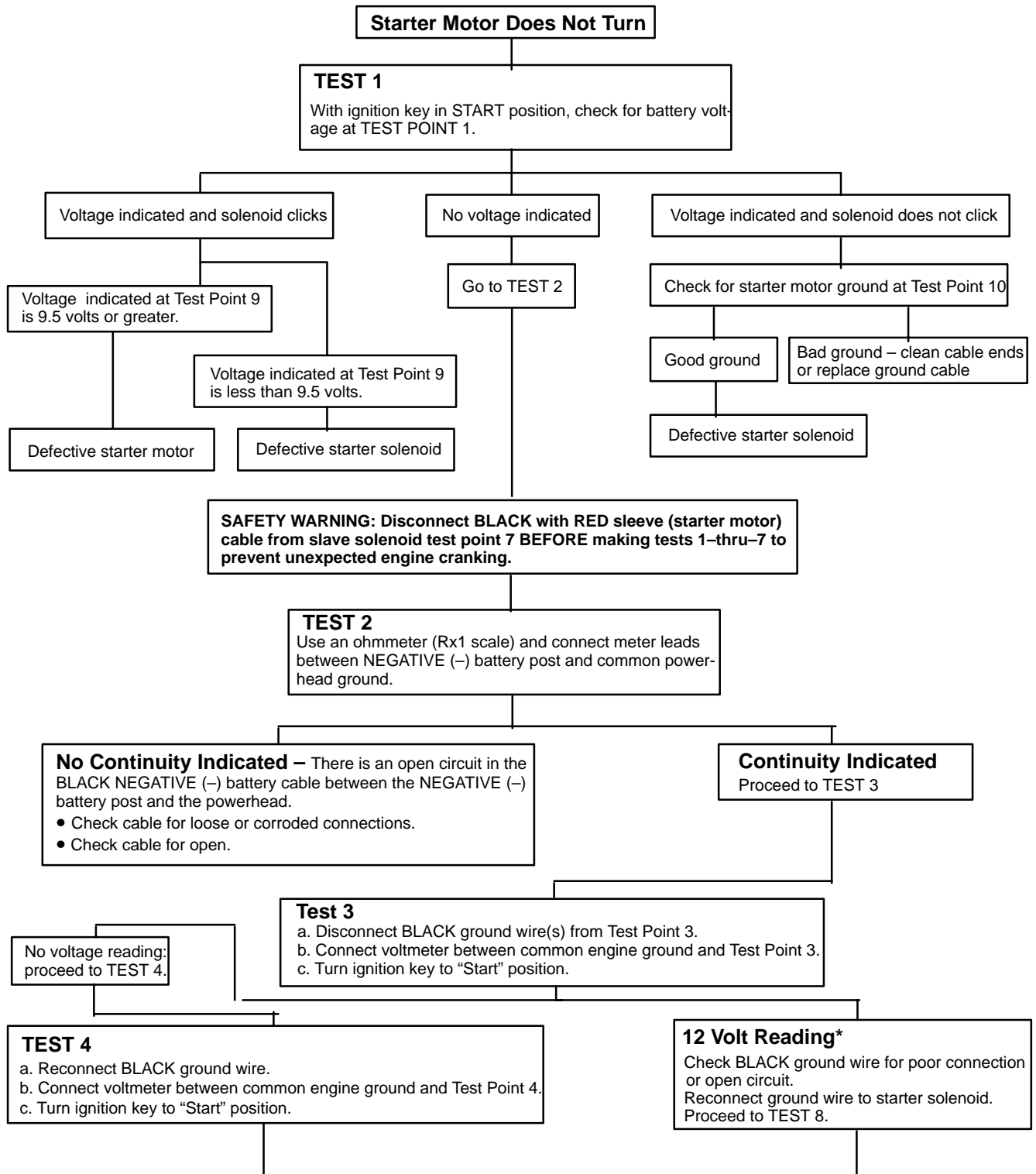


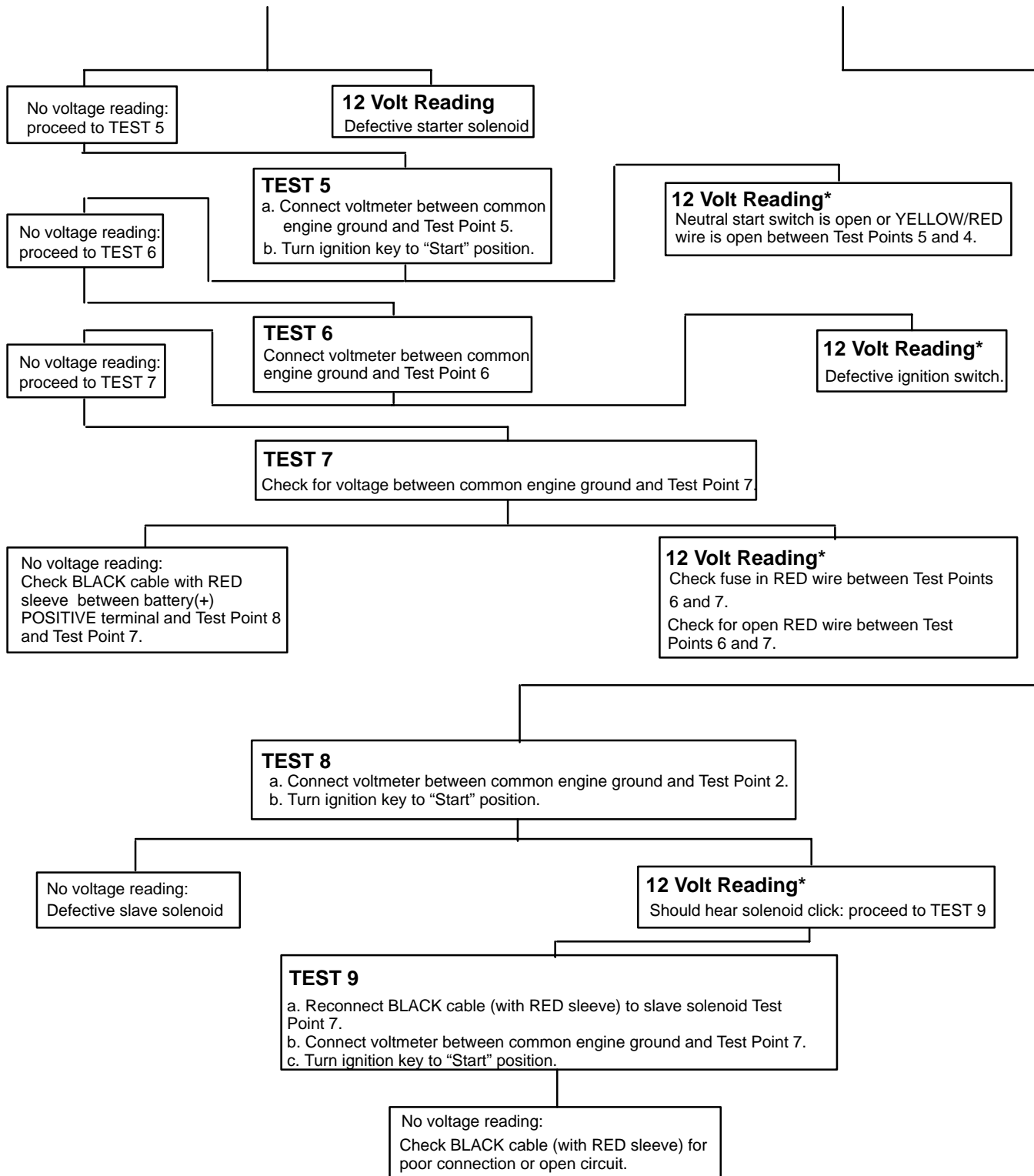
Solenoid Driven Bendix Starter Circuit

58431



Starter Circuit Troubleshooting Flow Chart (Solenoid Driven Bendix)





*Battery Voltage

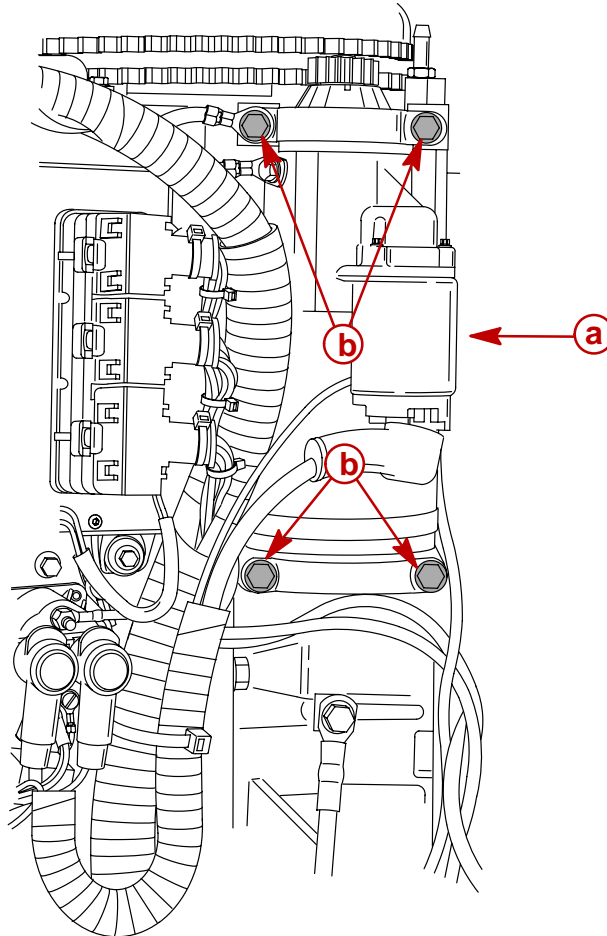


Starter Removal (Solenoid Driven Bendix)

⚠ 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.



59038

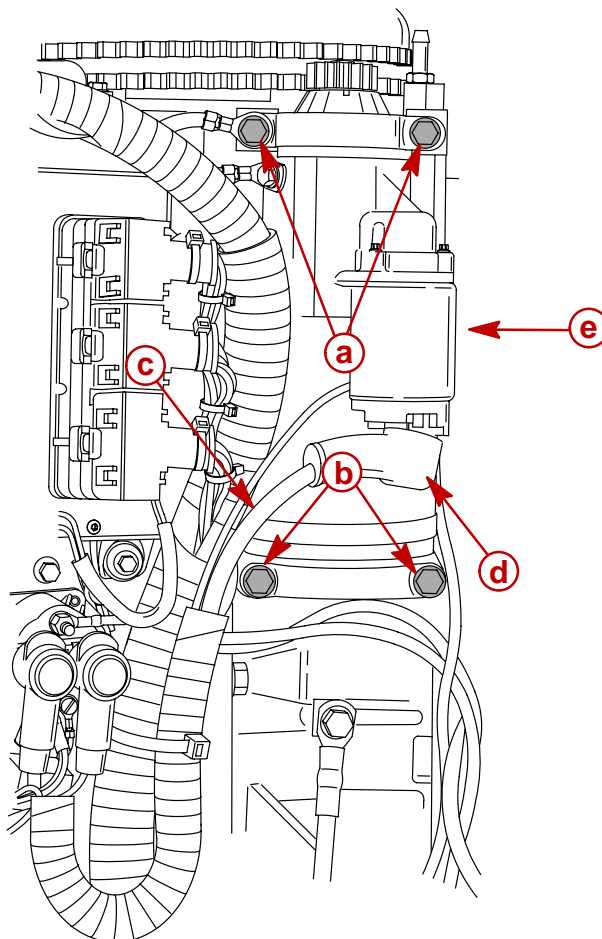
- a** - Starter Solenoid
b - Mounting Bolts

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).



- Secure BLACK cables (with RED sleeves) to POSITIVE (+) terminal on starter solenoid. Torque nut to 55 lb-in (6 Nm).



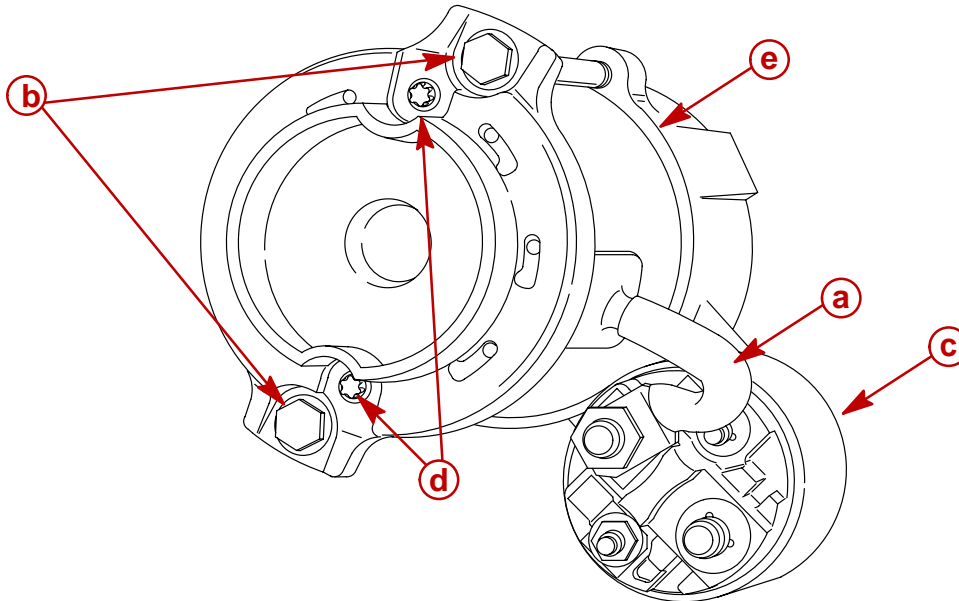
- a** - Top Bolts [Torque to 23 lb-ft (31 Nm)]
- b** - Bottom Bolts [Torque to 21 lb-ft (28.5 Nm)]
- c** - BLACK Cable (with RED sleeve)
- d** - Nut [Torque to 55 lb-in (6 Nm)]
- e** - Starter Solenoid

59038



Disassembly (Solenoid Driven Bendix Starter)

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



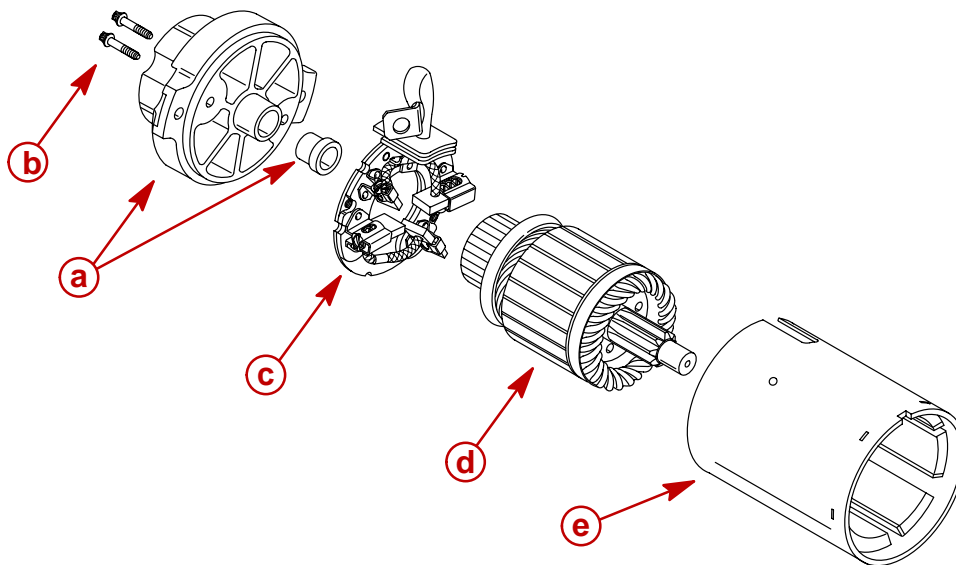
58434

- 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.

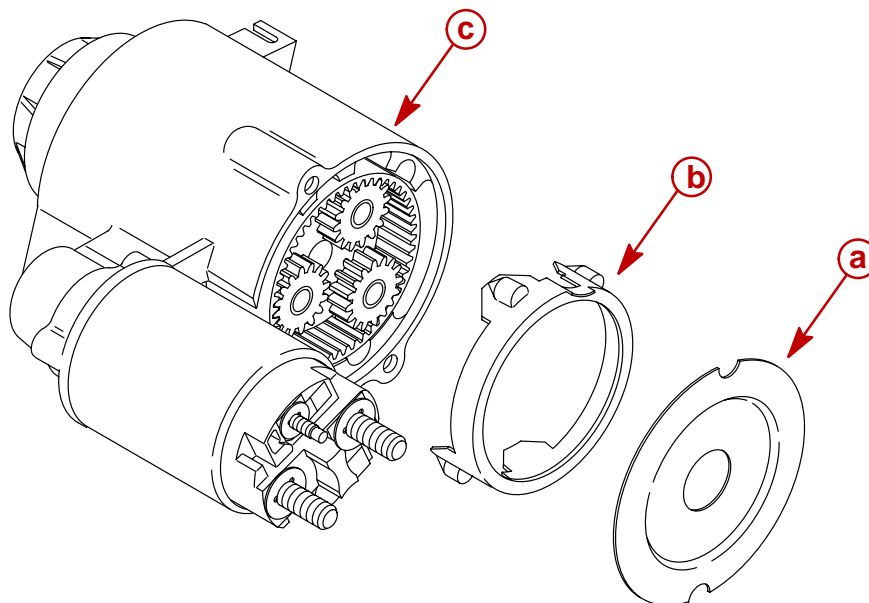


58430

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



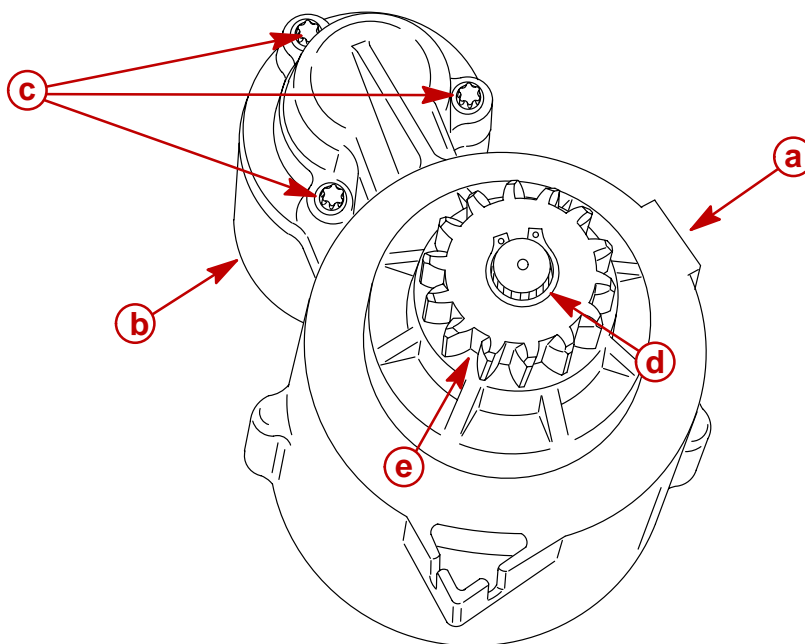
3. Remove shield and cushion from drive housing.



58432

- 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.

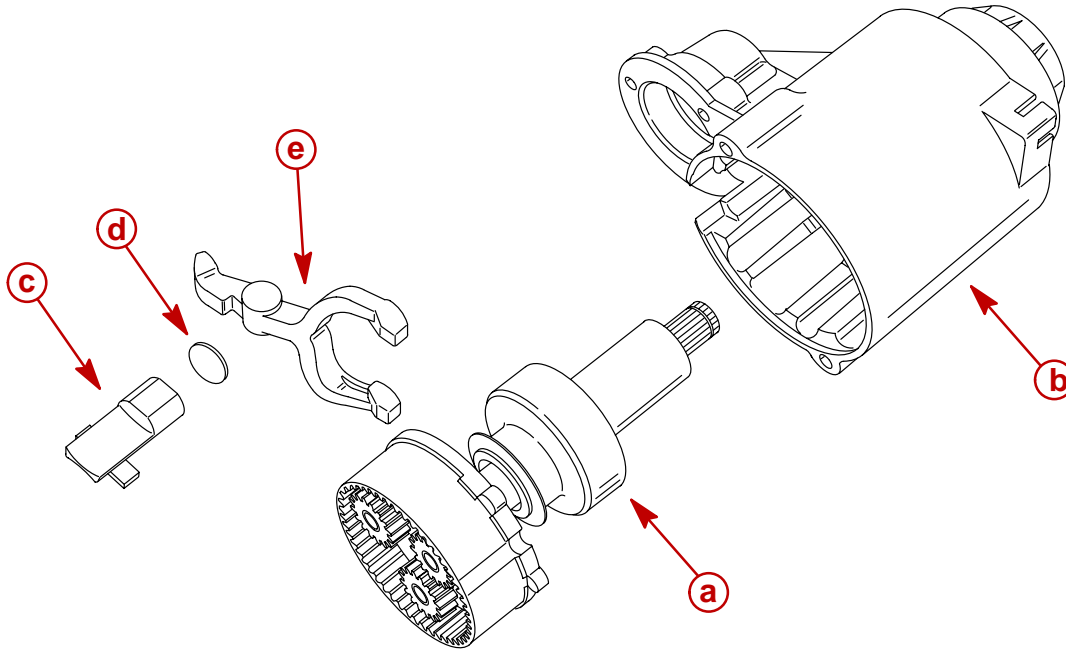


58436

- 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.



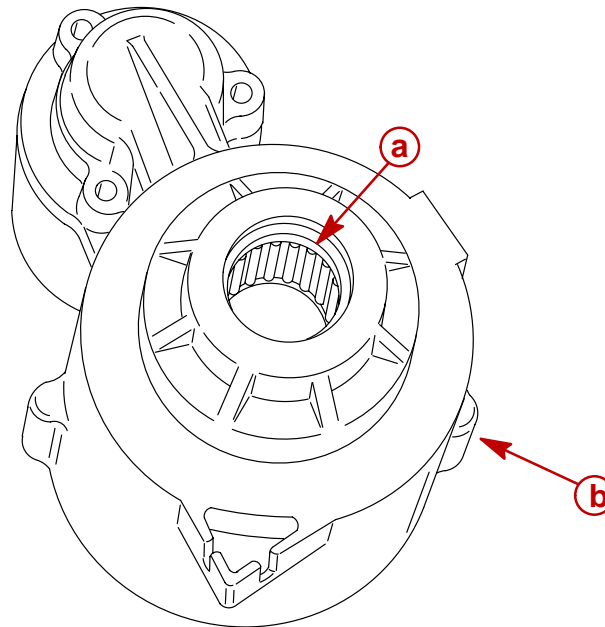
- a - Planetary Gear and Clutch Assembly
- b - Drive Housing
- c - Plug

- d - Metal Disc
- e - Solenoid Arm

58437

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

58439



Cleaning and Inspection

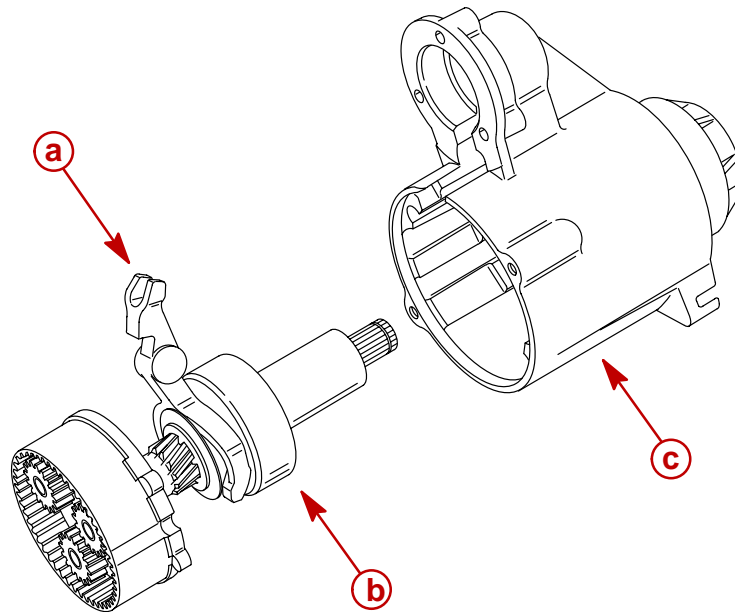
IMPORTANT: Do not use grease dissolving solvents to clean electrical components, planetary gears or drive clutch. Solvent will damage insulation and wash the lubricant out of the clutch drive and gears. Use clean rags and compressed air to clean components.

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)

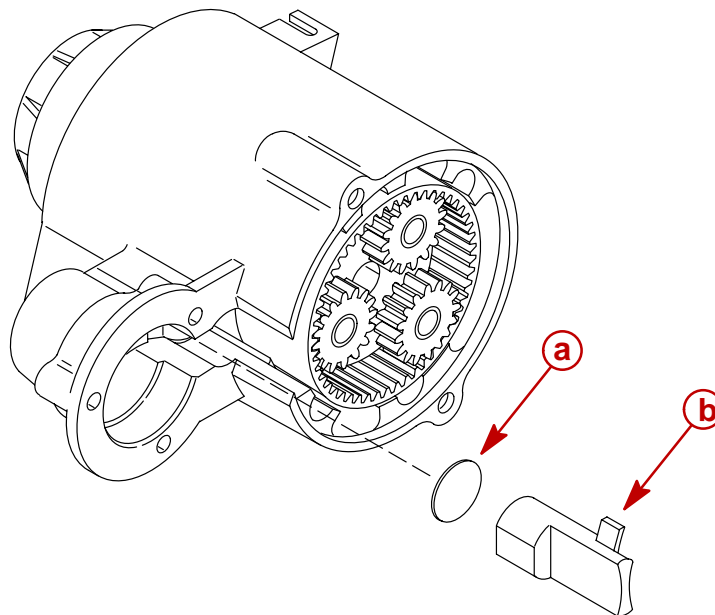
1. Install solenoid arm with planetary gear and clutch assembly into drive housing.



58438

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

2. Install metal disc and plug into drive housing.

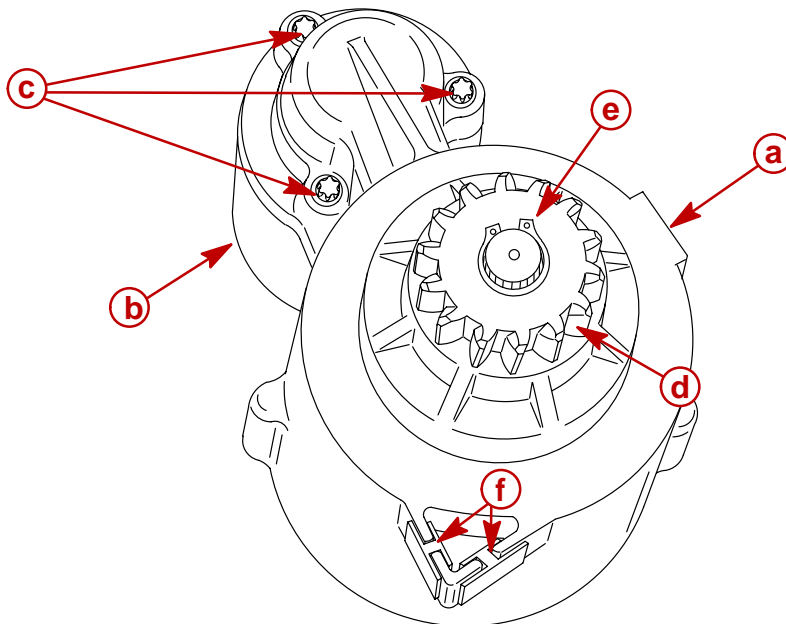


58433

- 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.

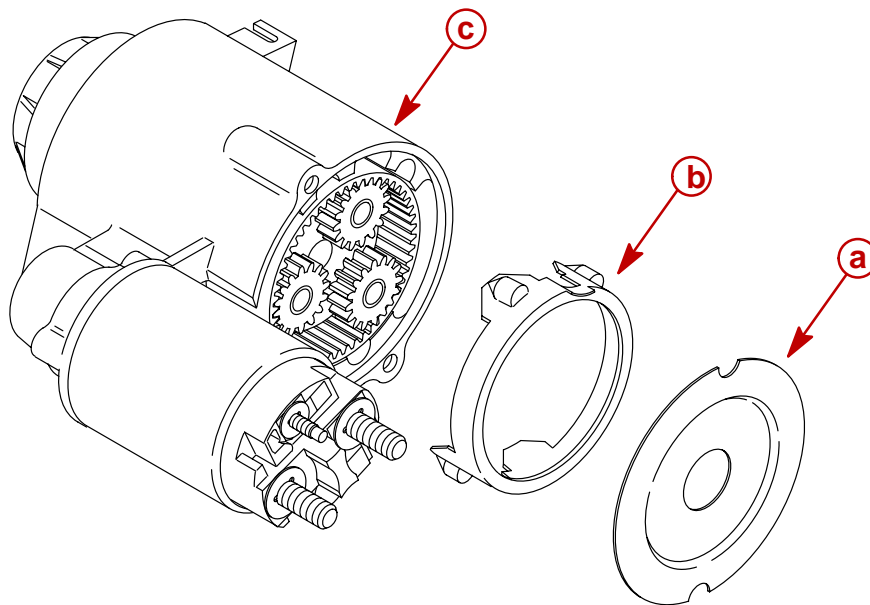


- a - Drive Housing
- b - Starter Solenoid
- c - Screw (3) [Torque to 40 lb-in (4.5 N.m)]

- d - Drive Gear
- e - Snap Ring
- f - Bumpers

58436

6. Install cushion and shield in drive housing.



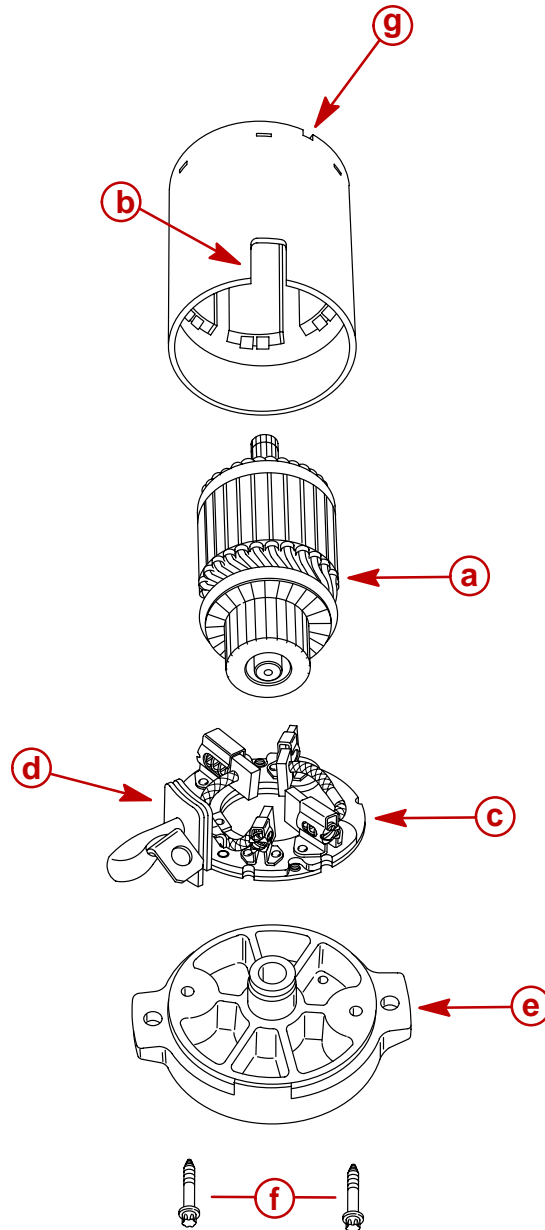
- a - Shield
- b - Cushion
- c - Drive Housing

58432



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.

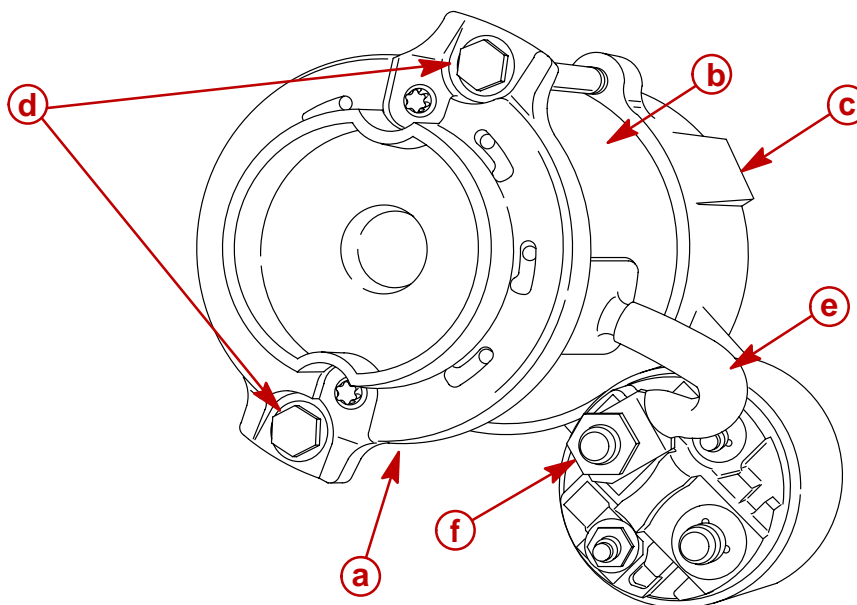


- a - Armature
- b - Field Frame Grommet Slot
- c - Brush Plate
- d - Brush Lead Grommet
- e - End Plate
- f - Screws [Torque to 30 lb-in (3.4 Nm)]
- g - Field Frame Plug Slot

58435



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).



- 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)]

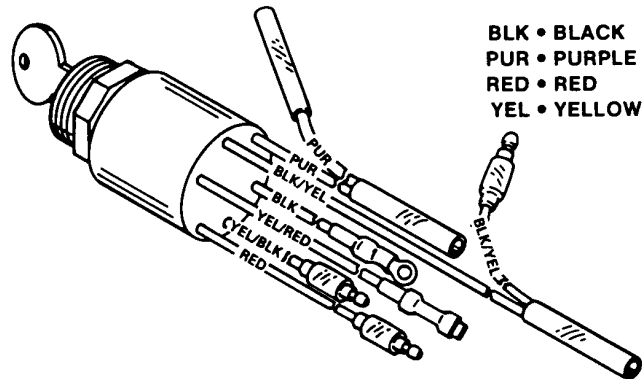
58434



Commander 2000 Key Switch Test

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

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



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



ELECTRICAL

Section 2C - Timing, Synchronizing & Adjusting

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Timing	2C-4	Throttle Plate Screw	2C-6

Specifications

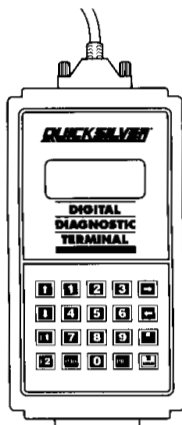
EFI MODELS	Idle RPM – All Models Wide Open Throttle (WOT) RPM – All Models Float Adjustment (Vapor Separator) Float Level	625 ± 50 5000 – 5800 Preset @ Factory
IGNITION SYSTEM	Type Spark Plug Type Spark Plug Gap Firing Order Throttle Position Sensor @ Idle* @ W.O.T.*	Digital Inductive Champion QL77CC 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 – All Models Maximum Timing @ W.O.T.* – All Models	0° – 6° BTDC 22° BTDC

***NOTE:** Although the Throttle Position Sensor voltage and the idle and maximum timing settings are not adjustable, they can be monitored by using a Digital Diagnostic Terminal (DDT).



Special Tools

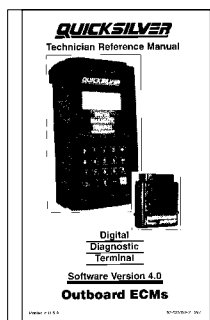
1. Digital Diagnostic Terminal (DDT) 91-823686A2



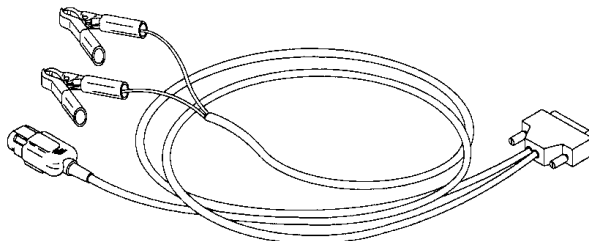
2. Software Cartridge 91-880118A2



3. DDT Reference Manual 90-881204-1



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



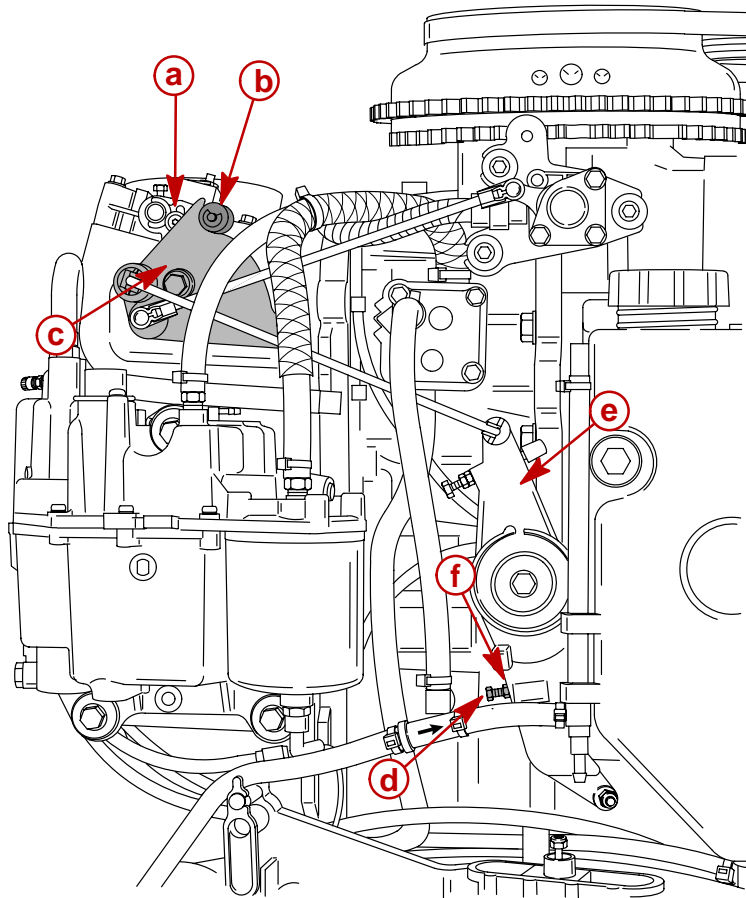


Adjustments

IMPORTANT: All throttle linkage adjustments have been set at factory and appropriately secured to prevent unnecessary 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, using Snap-On Tool TTXR25E, allowing cam follower to move freely.
2. Allow roller to rest on throttle cam. Adjust idle stop screw on throttle arm to align curved radius on throttle cam with center of roller. Tighten jam nut.
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.



59031

- 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.

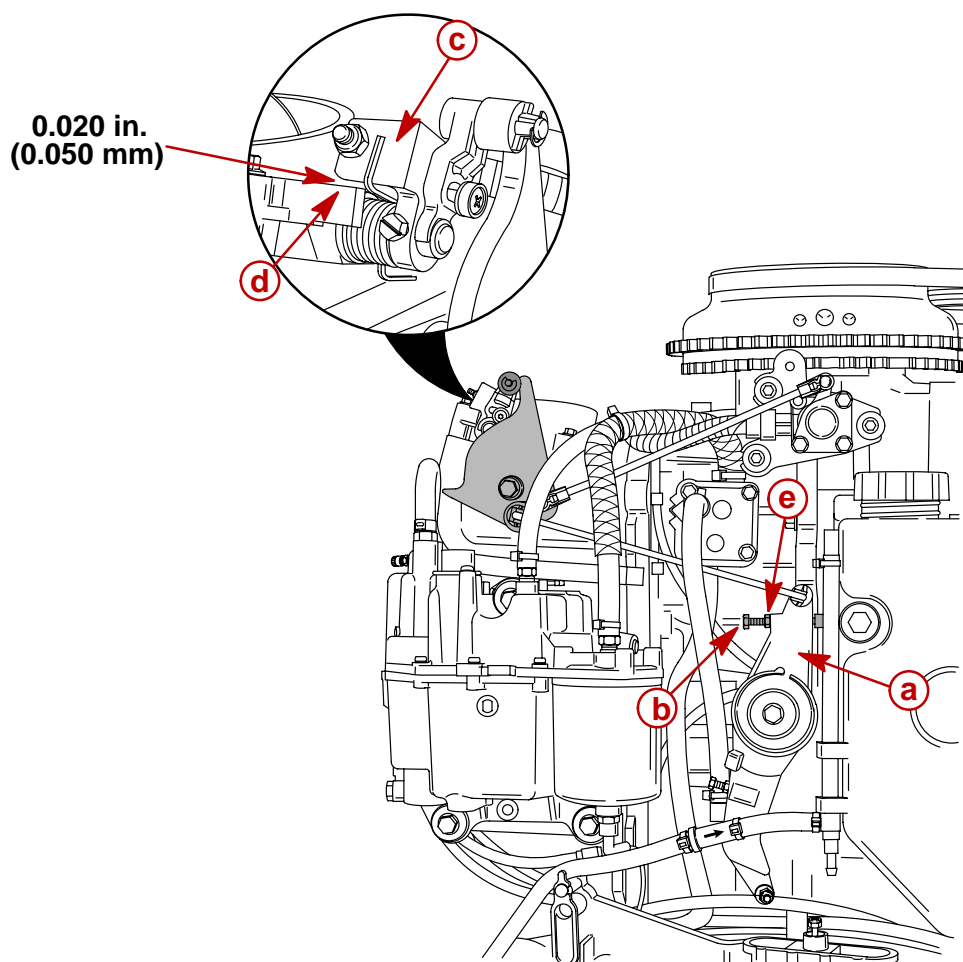
The ECM will use ignition timing to maintain an rpm of approximately 700 in neutral and 625 in forward gear. An engine that is cold will require more timing advance than an engine that is at normal operating temperature.

Engine timing at idle should be between 0° to 6° BTDC with the engine at normal operating temperature.

Engine timing at 5000 rpm should be approximately 22° BTDC for all models.

Maximum Throttle Adjustment

1. Hold throttle arm against full throttle stop screw. Adjust full throttle stop screw to allow full throttle valve opening, while maintaining a clearance of 0.020 in. (0.50 mm) between arm of throttle shaft and stop on throttle assembly. Tighten locknut.
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

59032



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
------------------------	---	-----------------------------------

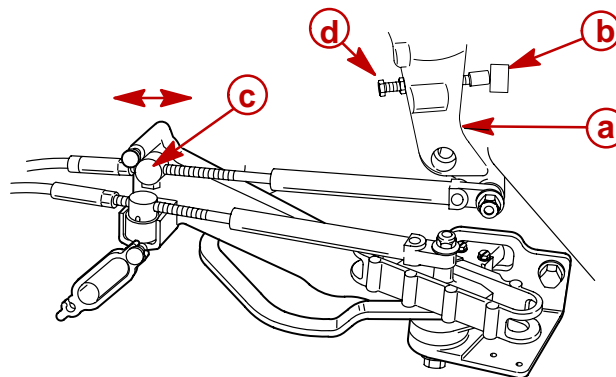
Idle Speed

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 against idle stop. 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.

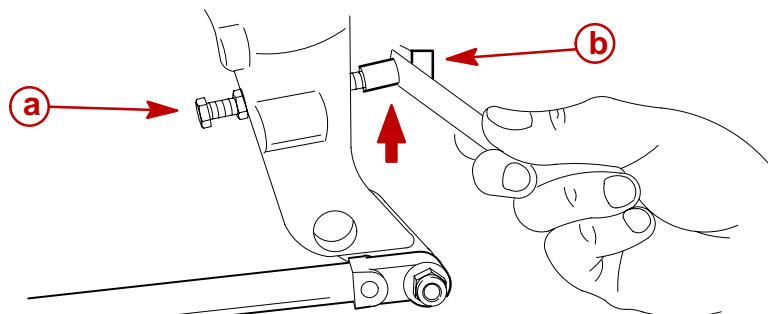
IMPORTANT: Excessive preload on throttle cable will cause difficulty when shifting from “FORWARD” to “NEUTRAL” (readjust throttle cable barrel, if necessary).



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 and idle stop. Preload is correct when paper can be removed without tearing, but has some drag on it (readjust throttle barrel, if necessary).



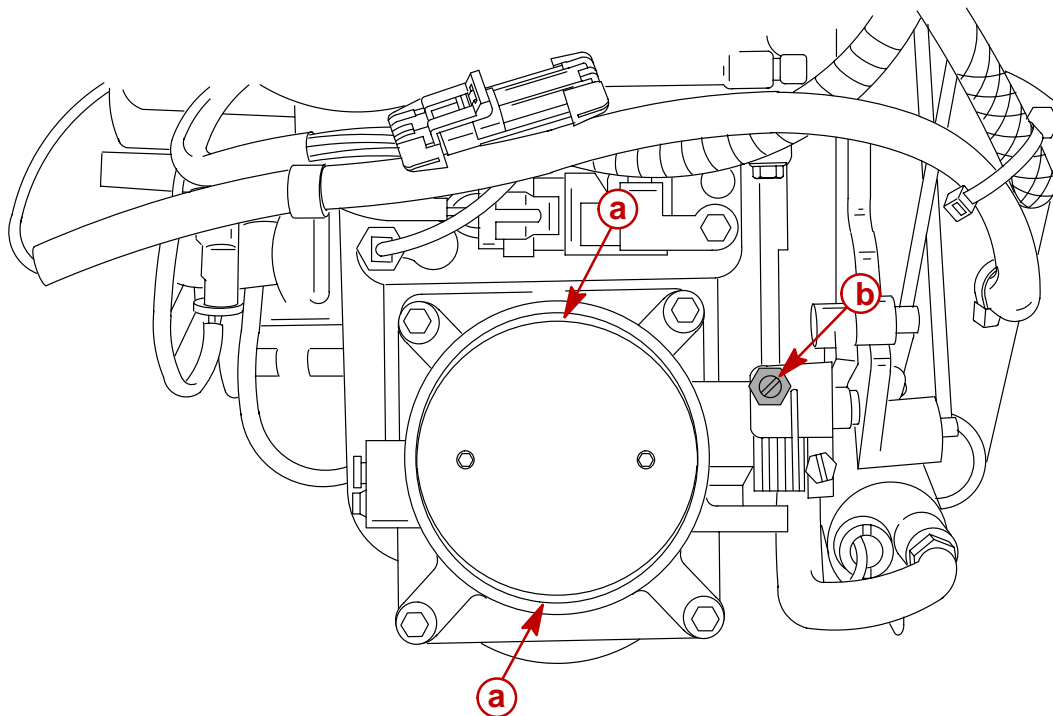
a - Idle Stop Screw

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.



59025

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



ELECTRICAL

Section 2D – Wiring Diagrams

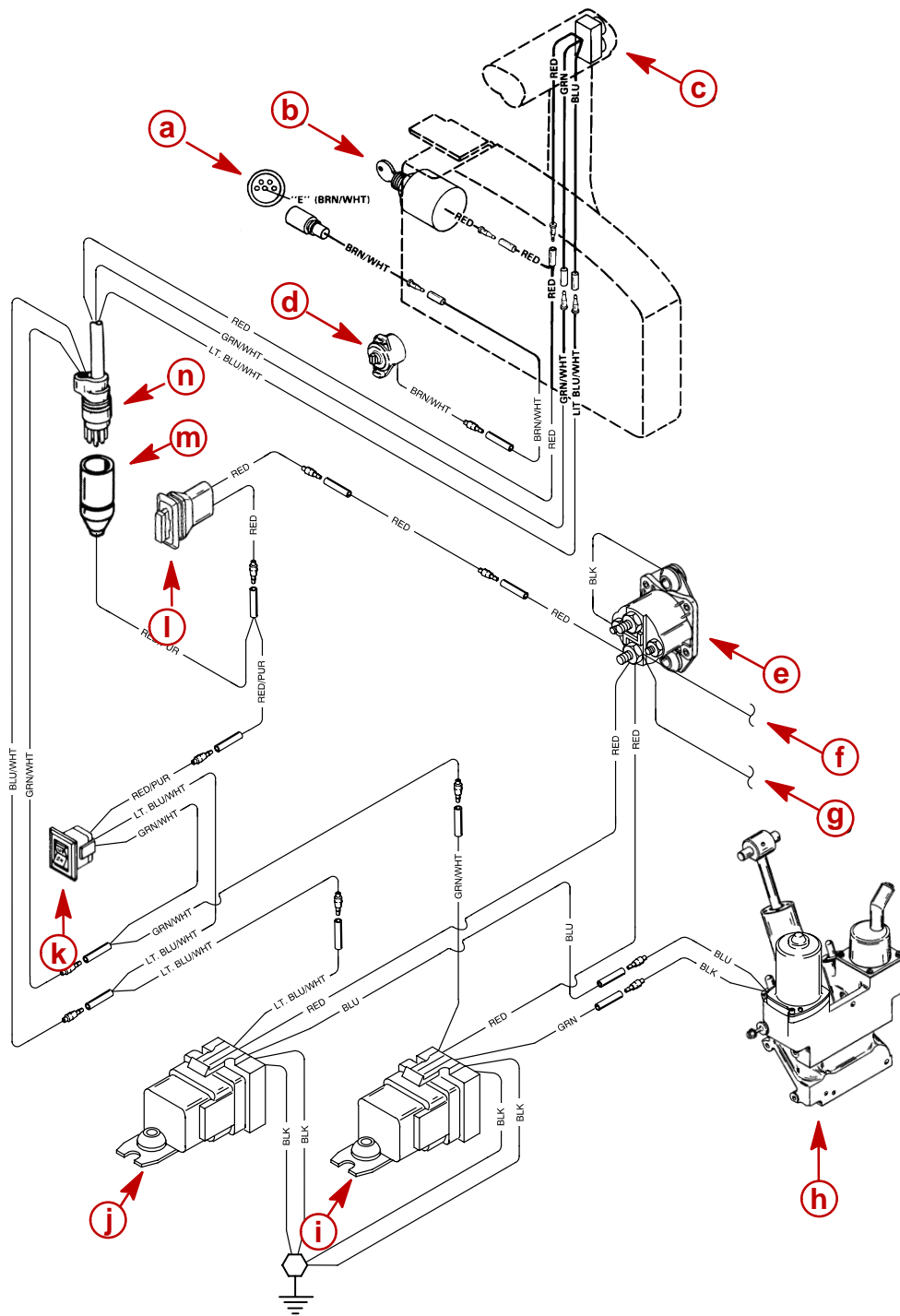
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Power Trim Wiring Diagram



- a** - Tach. Connector
- b** - Key Switch Assembly
- c** - Trim Switch
- d** - Trim Sender
- e** - Start Solenoid
- f** - To Battery
- g** - To Alternator

- h** - Trim Pump and Motor
- i** - DOWN Solenoid
- j** - UP Solenoid
- k** - Bottom Cowl Switch
- l** - 20 Ampere Fuse
- m** - Engine Harness
- 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.)

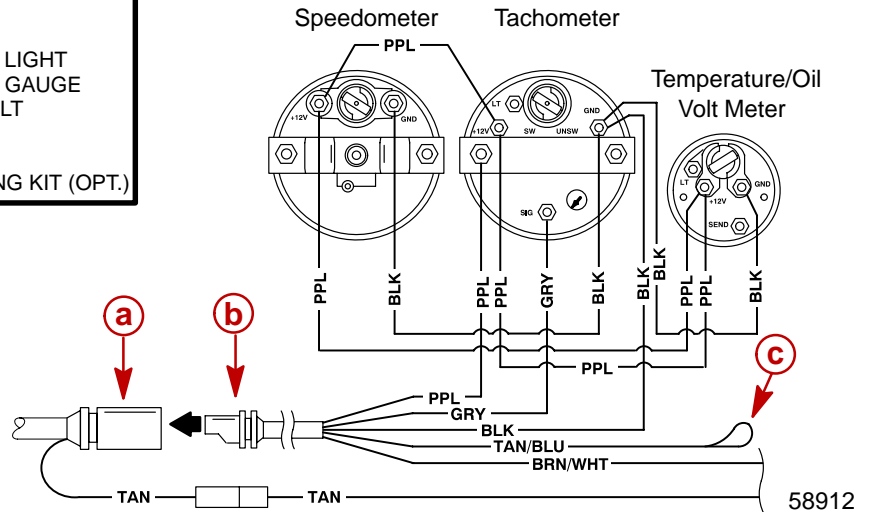


Figure 1 – Without Light Switch

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

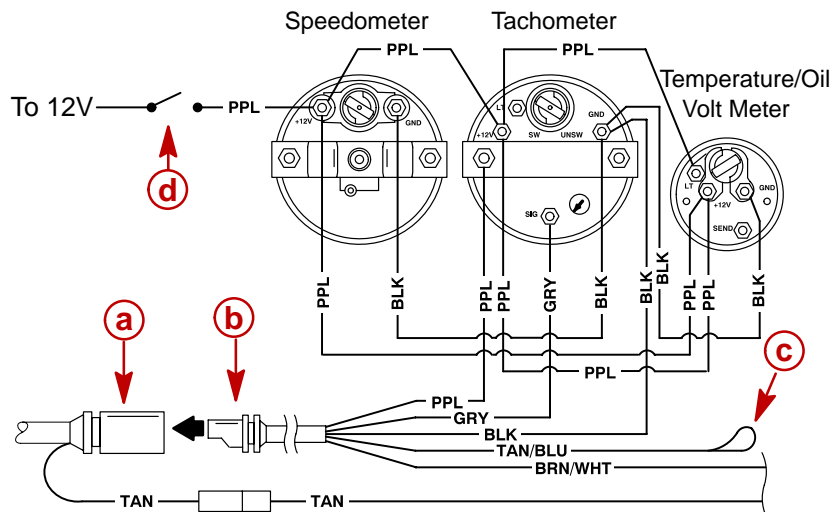


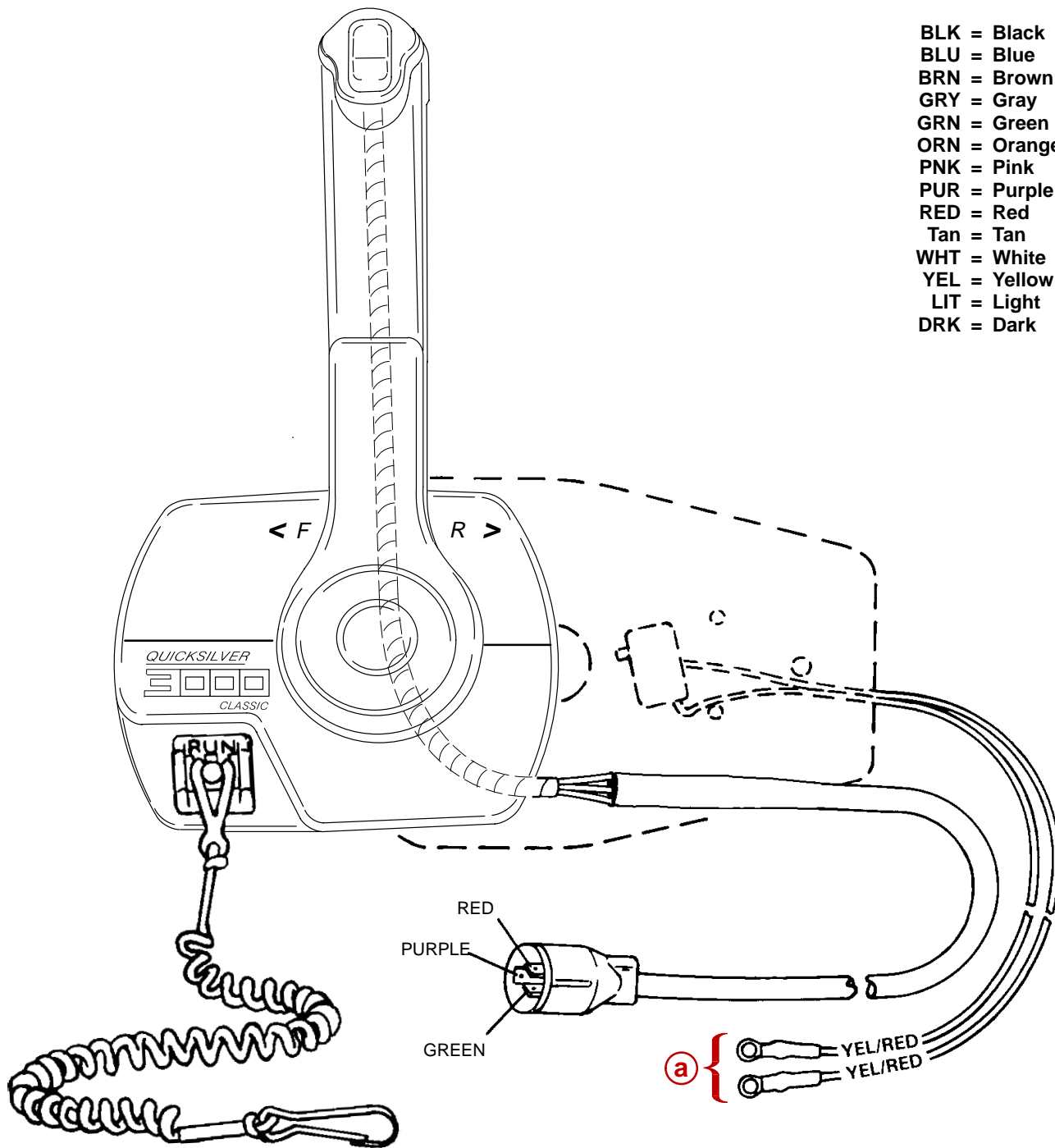
Figure 2 – With Light Switch

- 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

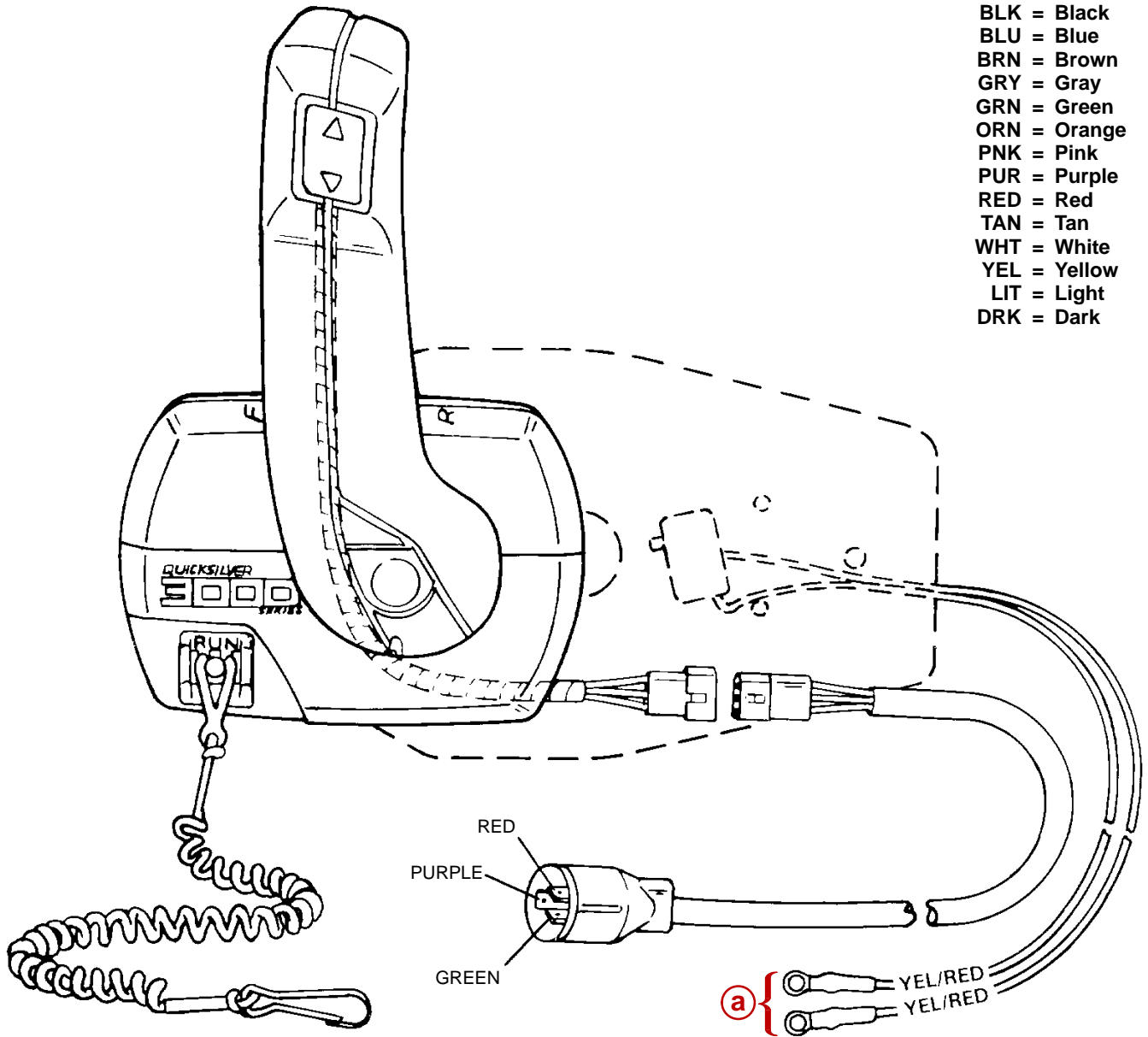


a - Neutral Interlock Switch



Commander 3000 Panel Remote Control

- 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

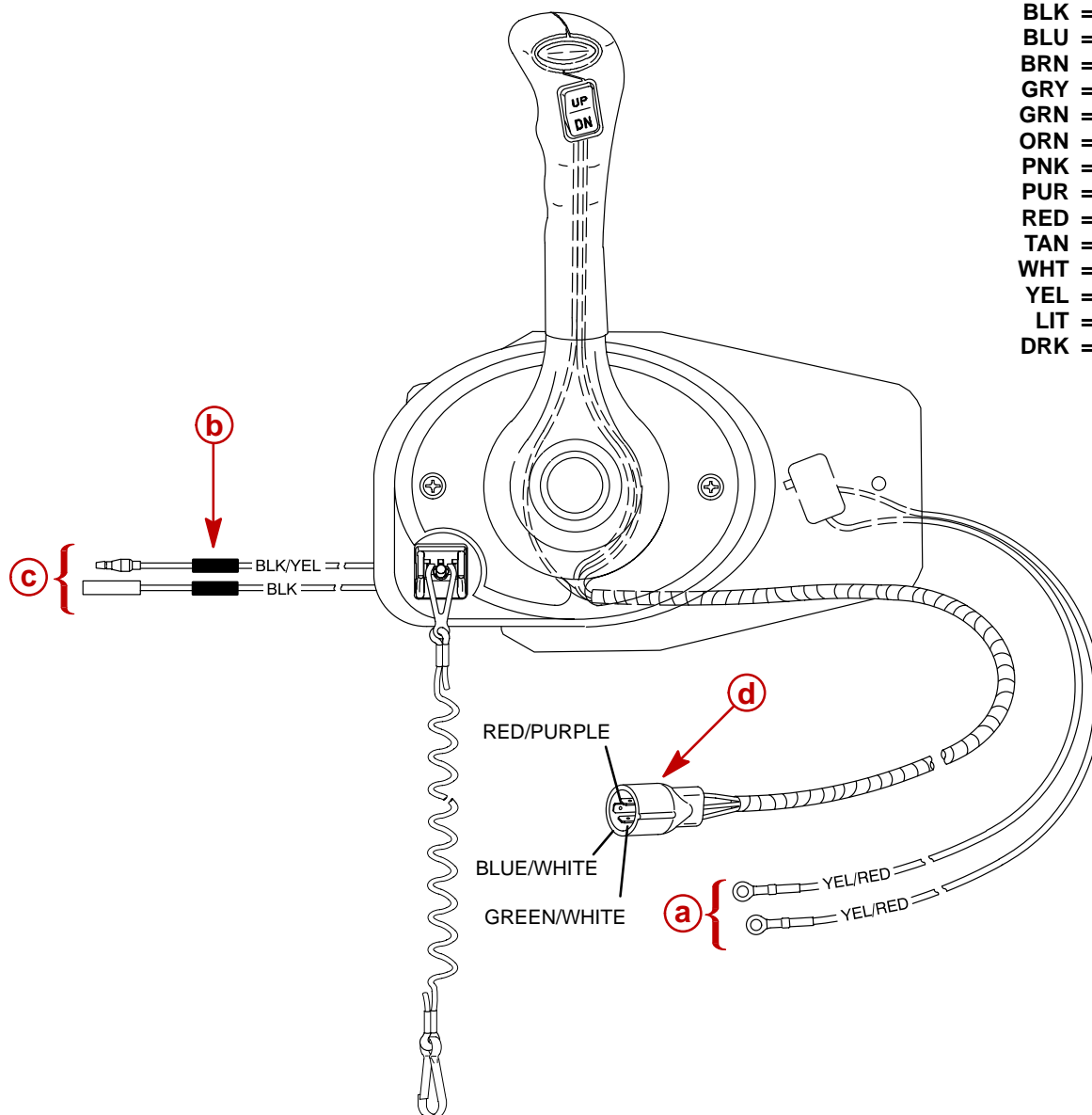


a - Neutral Interlock Switch



4000 Series Mechanical Panel 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



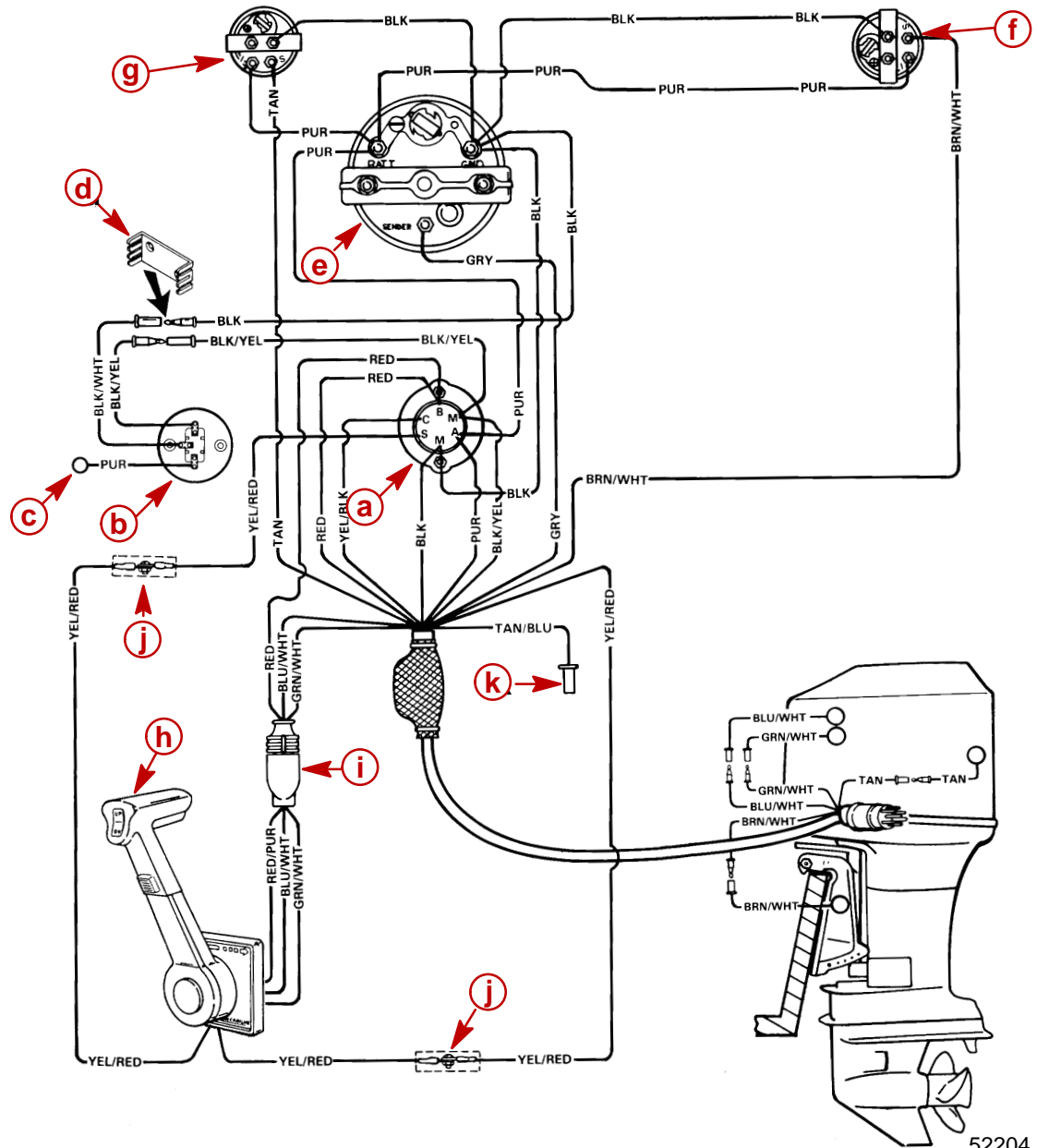
58629

- 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



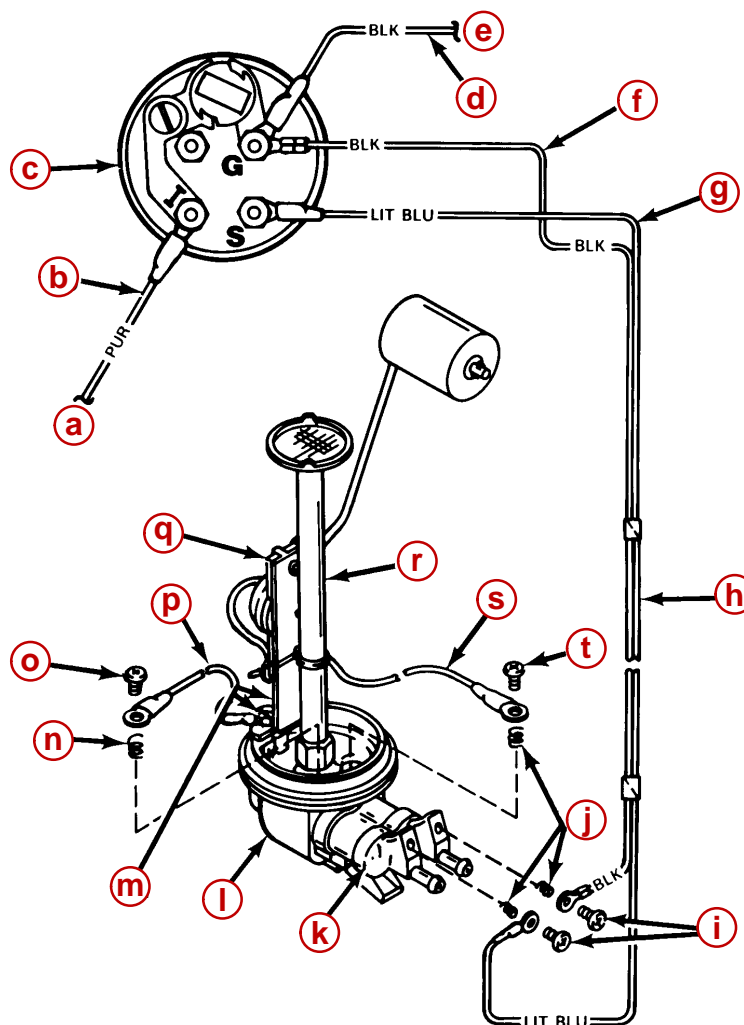
52204

- 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.)

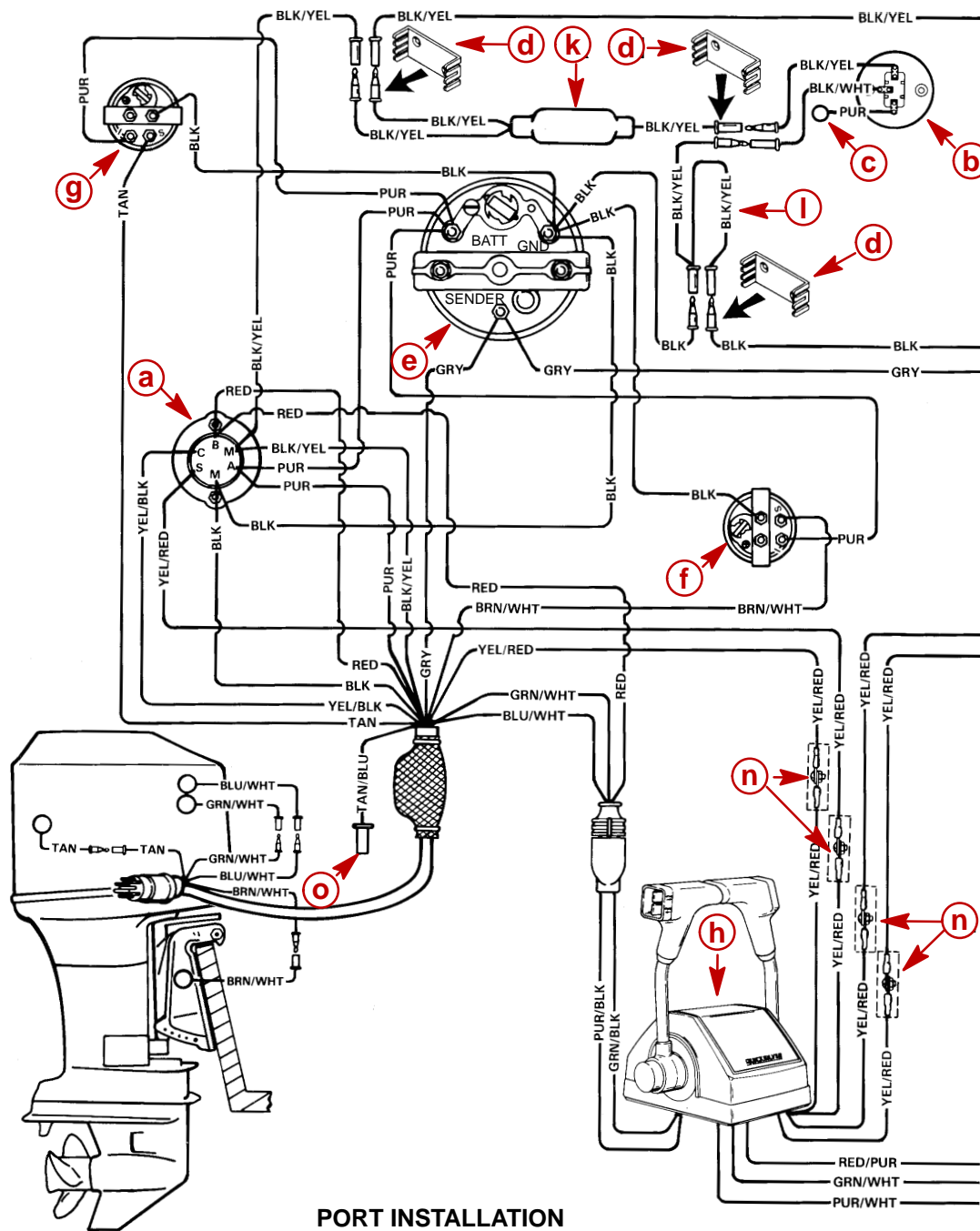


Notes:



Instrument/Lanyard Stop Switch Wiring Diagram (Dual Outboard)

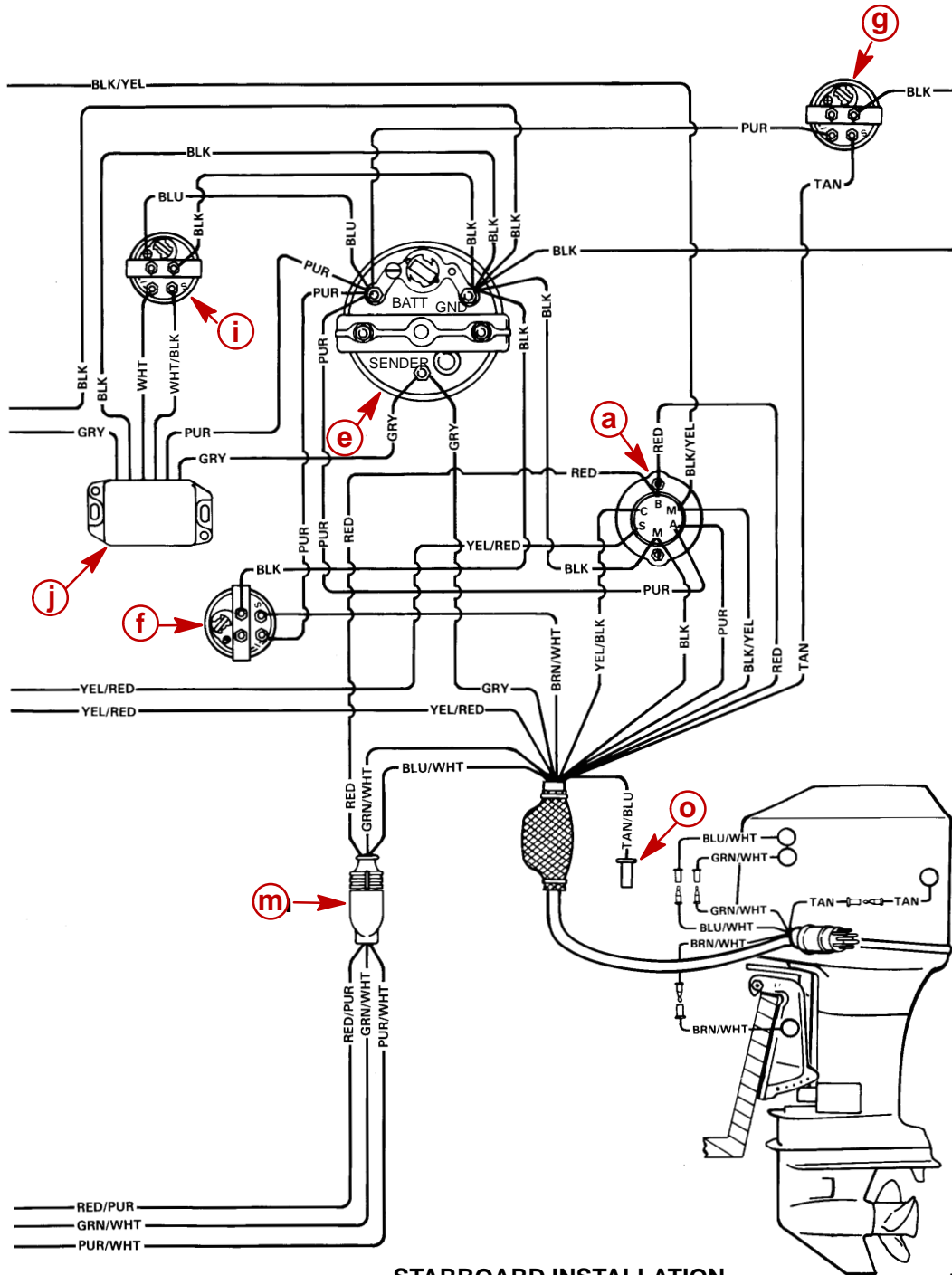
BLK=BLACK
 BLU=BLUE
 BRN=BROWN
 GRN=GREEN
 GRY=GRAY
 PUR=PURPLE
 RED=RED
 TAN=TAN
 WHT=WHITE
 YEL=YELLOW



- a** - Ignition/Choke Switch
- b** - Lanyard Stop Switch
- c** - Lead not used on Outboard Installations
- d** - Retainer
- e** - Tachometer
- f** - Trim Indicator Gauge
- g** - Temperature Gauge
- h** - Remote Control



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



STARBOARD INSTALLATION

52206

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



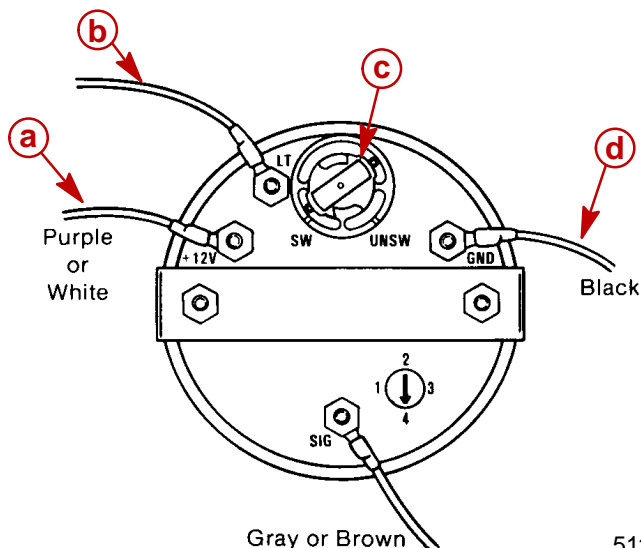
QSI Gauge Wiring Diagrams

Tachometer Wiring Diagram

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

WIRING DIAGRAM A

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

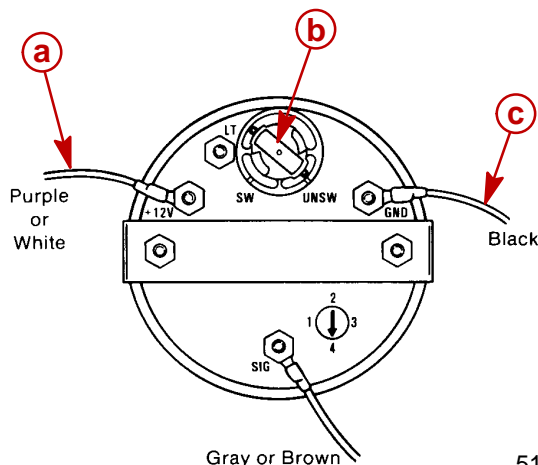


51106

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

WIRING DIAGRAM B

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



51106

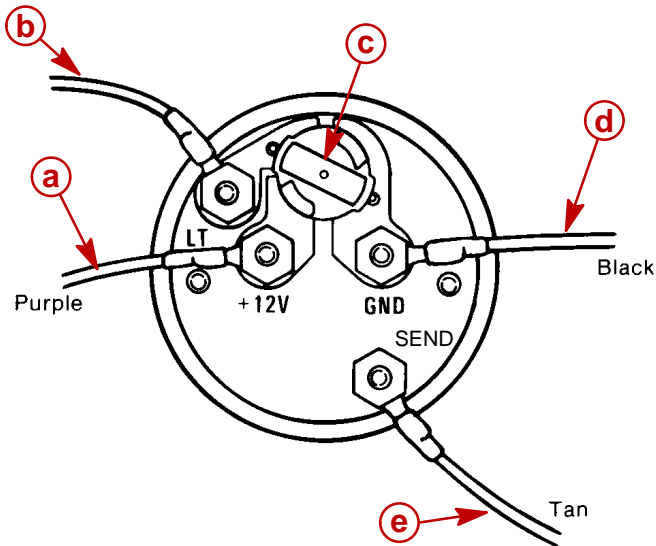
- a** - Connect to +12 Volt
- b** - Position Light Bulb to the Unswitched Position
- c** - Connect to NEGATIVE (-) Ground



Water Temperature Gauge

WIRING DIAGRAM A

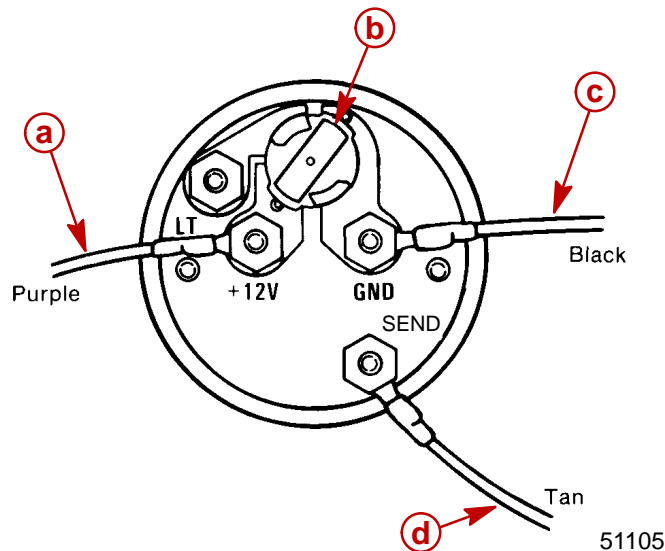
Use this wiring diagram when using a separate light switch for instrument lighting.



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

WIRING DIAGRAM B

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

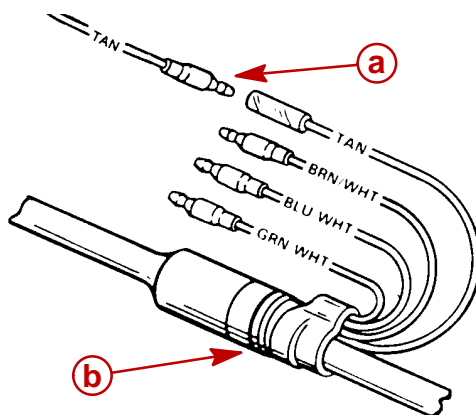


- a** - Connect to +12 Volt
- b** - Position Light Bulb to the Unswitched Position
- c** - Connect to NEGATIVE (-) Ground
- d** - Connect to TAN Lead located at the Tachometer Receptacle on Commander Side Mount Remote Control or TAN Lead coming from Accessory Ignition/ Choke Assembly



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.



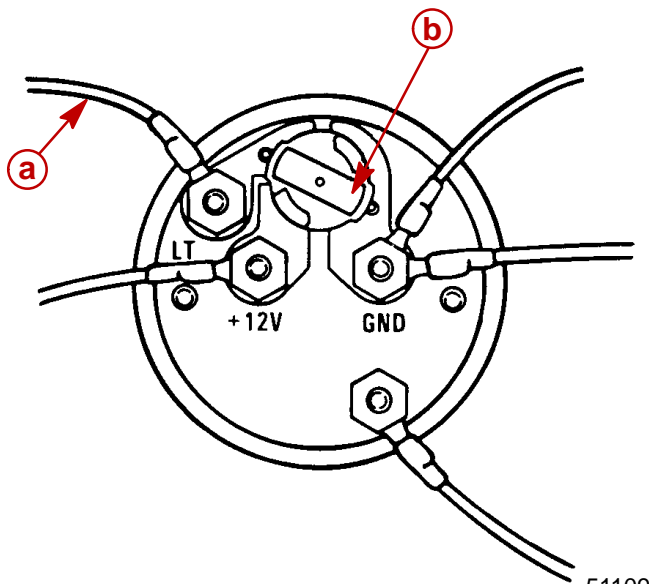
28086

- 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.



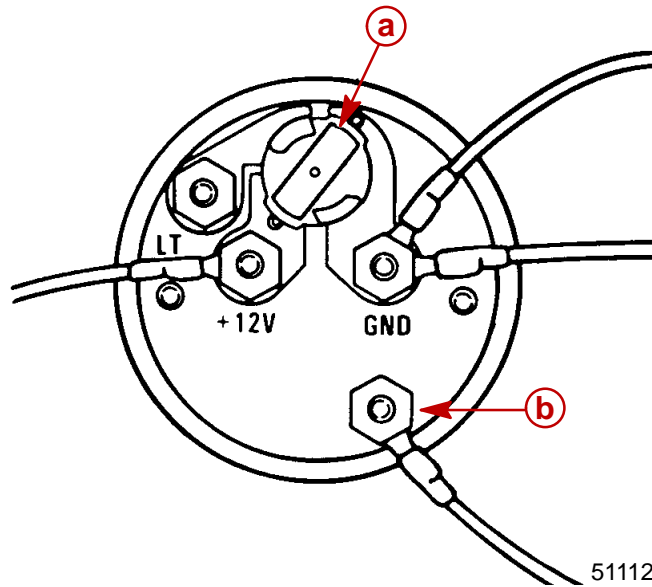
51109

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



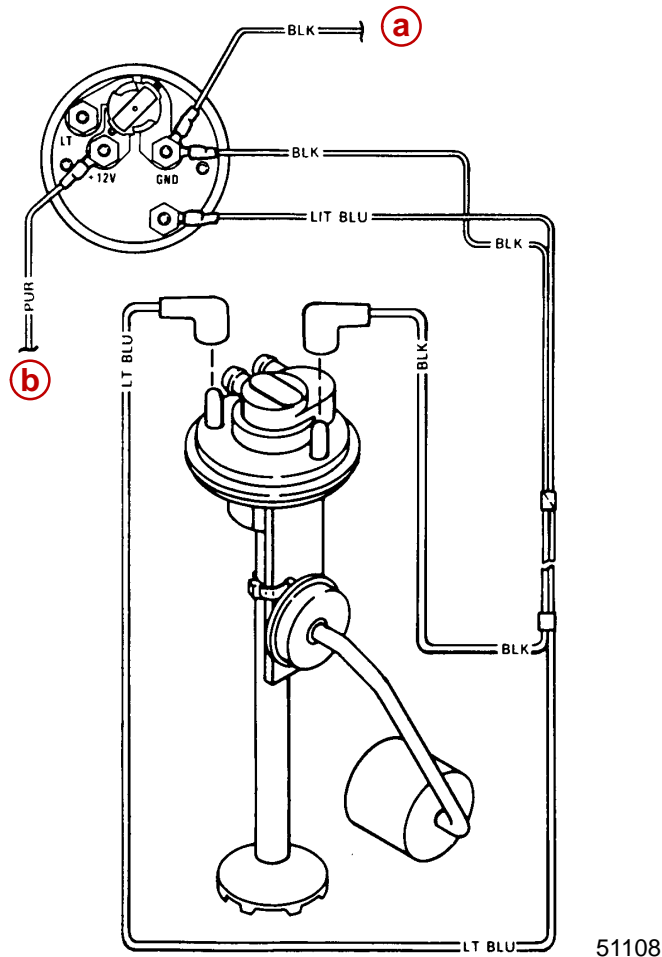
LIGHT BULB POSITION B

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.)



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

SENDER WIRING



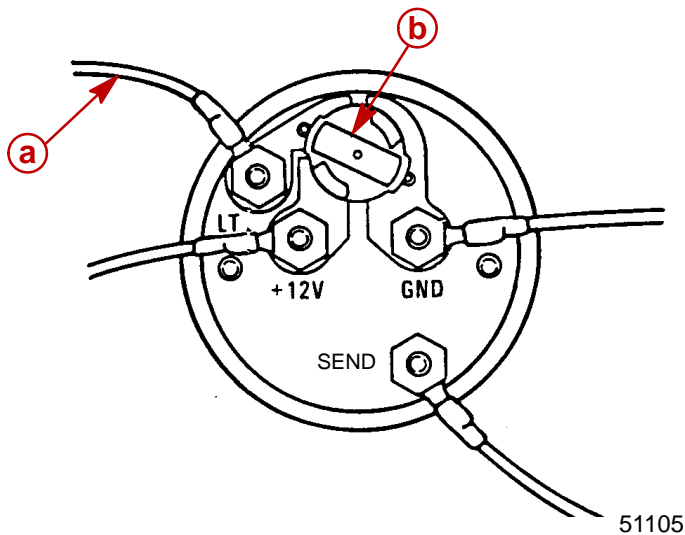
- a** - Connect to +12 Volt
- b** - Connect to NEGATIVE (-) Ground



Engine Synchronizer Wiring Diagram

LIGHT BULB POSITION A

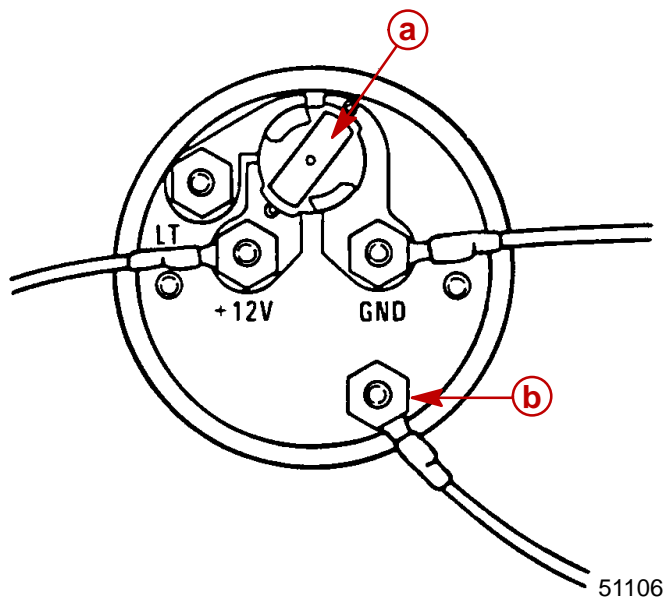
Use this position when using a separate light switch for instrument lighting.



- 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.)

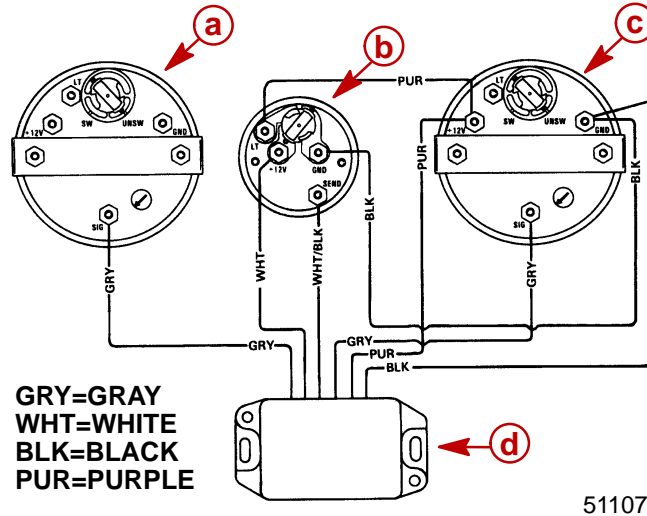


- a** - Position Light Bulb to the Switched Position
- b** - Sender



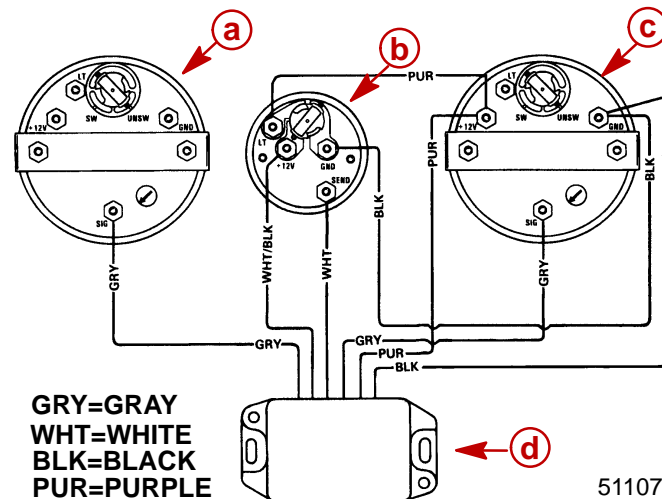
Synchronizer wiring can be accomplished two different ways as an option to the user.

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 vary 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.

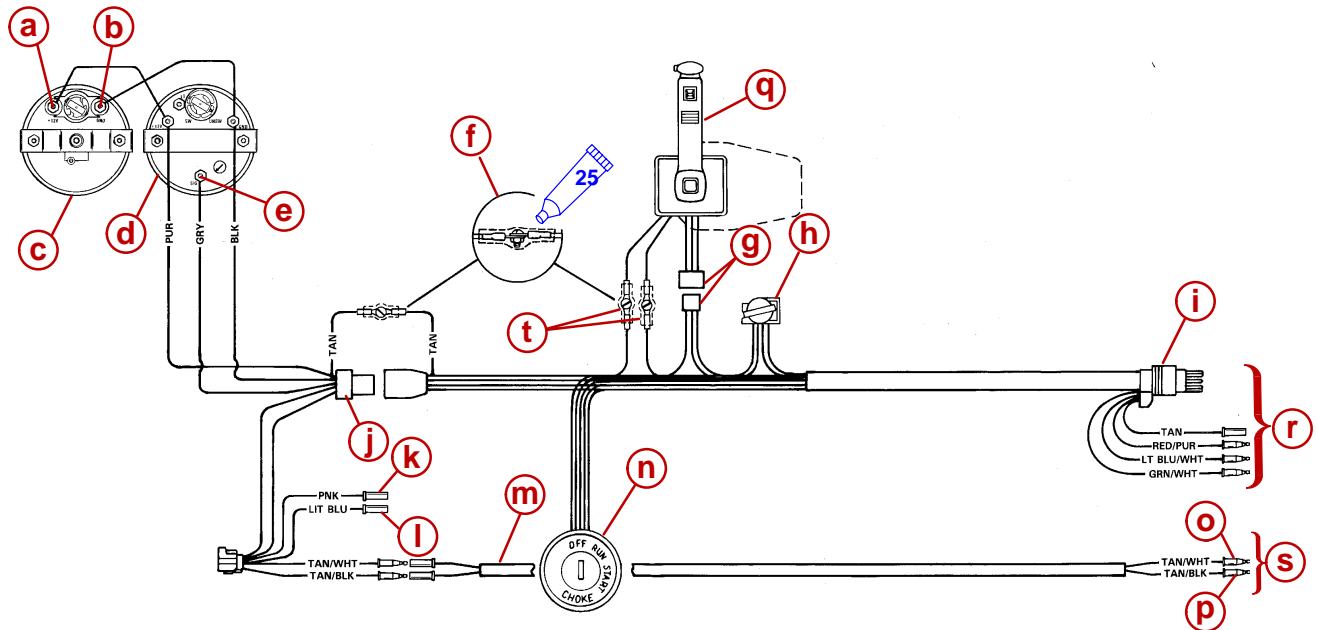



WIRING DIAGRAMS

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



 Liquid Neoprene

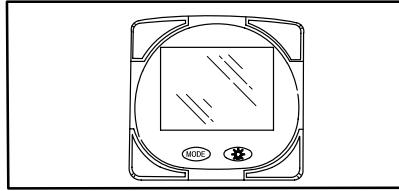
- a** - (+) 12 Volt Terminal
- b** - (-) Ground Terminal
- c** - Speedometer
- d** - Tachometer
- e** - Tachometer Signal Terminal
- f** - Connect Wires Together with Screw and Hex Nut (3 Places); Apply Liquid Neoprene to Connections and Slide Rubber Sleeve Over Each Connection.
- g** - Power Trim Connector
- 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

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



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.

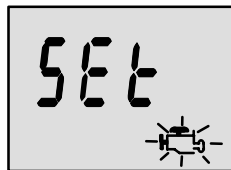
The display includes a backlight which allows you to read it at night. The backlight brightness is adjustable using  button.

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 *Cal.1* 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.



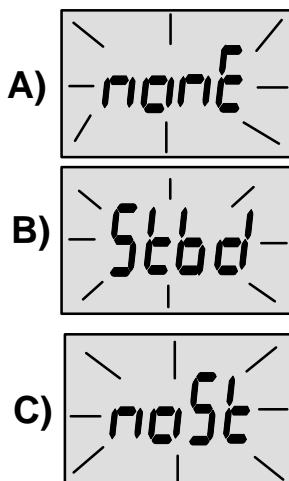
Press the **MODE** button.

The unit will begin its “**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 in-board 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.



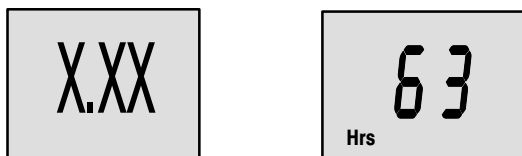
NOTE: If you see the flashing message, (A) “nonE” after the Auto-detection occurs, the gauge can not find an engine. Please check wiring for correct connection. If you receive one of the following other flashing messages: (B) “Stbd” or, (C) “noSt” refer to the “Set-Up Errors Section”.



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.

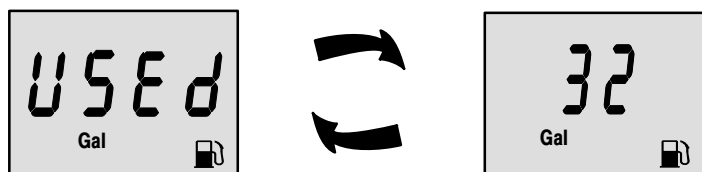
RPM SCREEN

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 perform a **Fuel Used Reset** anytime 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

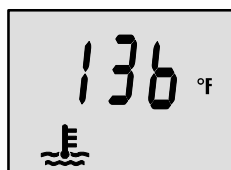
Displays trim position of the propulsion unit up to the maximum trim position, and then displays trailer position. 0 = down, 10 = maximum trim, and 25 = full trailer.



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

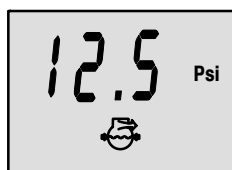
Displays the engine temperature in degrees Fahrenheit (°F) or Celsius (°C).



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

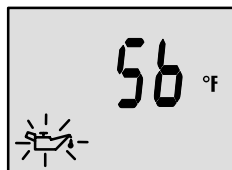
WATER PRESSURE SCREEN

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).





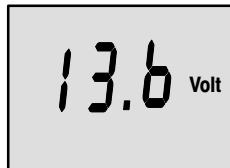
OIL PRESSURE SCREEN

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.

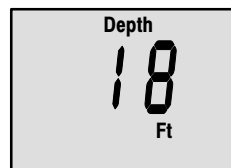


NOTE: To activate this screen, you must perform the fuel tank calibration in Cal2. Refer to the Cal2 Calibration Section for details.

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).





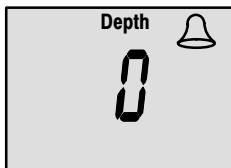



SHALLOW WATER ALARM FEATURE

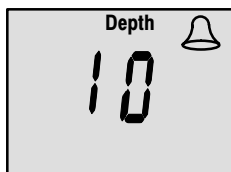
You can set an alarm to trigger whenever the boat moves into water shallower than the alarm level.

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.



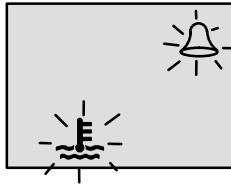
Warning Display Screens

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 out-board: 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.

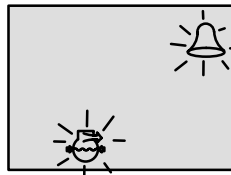
If a steady stream of water is coming out of the water pump indicator hole and the warning horn continues to sound, there still may be insufficient cooling water or an engine problem. Stop engine. Operating the engine while overheated will cause engine damage.

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.

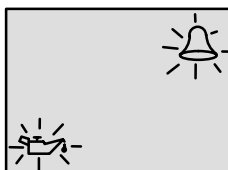


If no water is coming out of the water pump indicator hole, or flow is intermittent, stop engine and check cooling water intake holes for obstruction. If no obstruction is found, this may indicate a blockage in the cooling system or a water pump problem. Have the outboard checked by your dealer. Operating 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

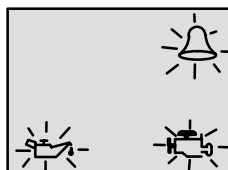
The bell and oil icons are displayed and the warning horn begins sounding a series of four beeps every two minutes to inform the driver that the oil level is critically low in the engine mounted oil reservoir tank. When the oil level gets close to empty, the horn begins sounding continuously and the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

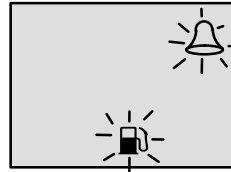


NOTE: Engine speed should never reach the maximum limit to activate the system unless the propeller is ventilating, an incorrect propeller is being used, or the propeller is faulty.



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.

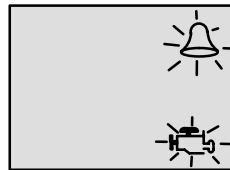


ALARM – LOW FUEL

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.

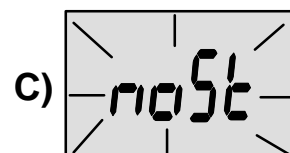
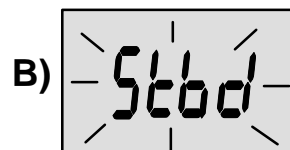
ALARM – ENGINE MALFUNCTION

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. Perform 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.







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.

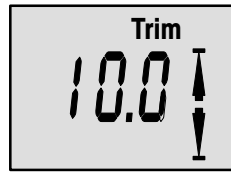
Set the trim sensor as follows:



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  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  button to move to the next function.



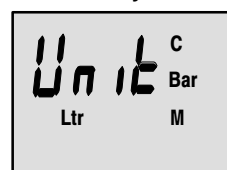
ENGLISH OR METRIC READINGS SELECTION


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




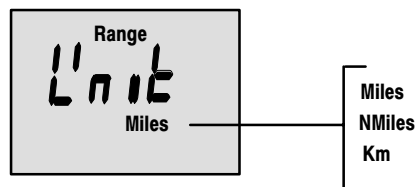
Metric System



Press the  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  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  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

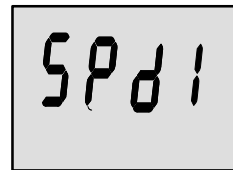
CAL2 HEADER SCREEN

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.

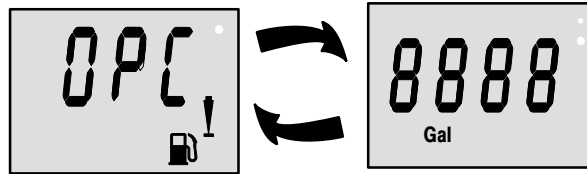
Select whether you want to calibrate the fuel tank “t1”. (The gauge will not let you calibrate the fuel tank until the capacity had been entered). Press the  button to select 0= off or 1= on.



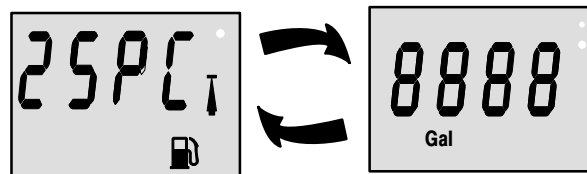


Selecting “1” will bring up the following calibration screens.

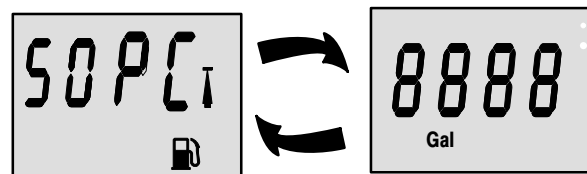
Calibration 0% – The “0 percent” display alternates between percent of tank capacity and quantity of fuel to add based on total capacity entered in *Cal2*. Add fuel to total quantity displayed and push the button to save. Press the **MODE** button to advance to the Calibration 25% setting.



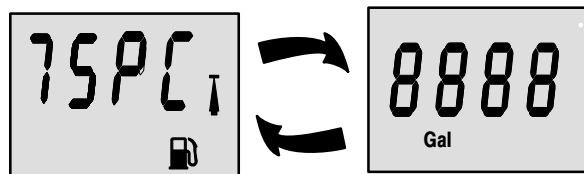
Calibration 25% – The “25 percent” display alternates between percent of tank capacity and quantity of fuel to add based on total capacity entered in *Cal2*. Add fuel to total quantity displayed and press the button to save. Press the **MODE** button to advance to the Calibration 50% setting.



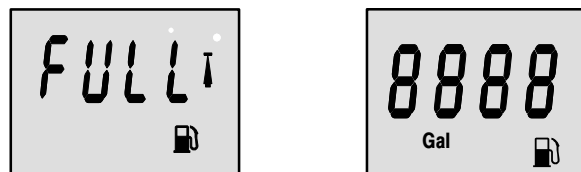
Calibration 50% – The “50 percent” display alternates between percent of tank capacity and quantity of fuel to add based on total capacity entered in *Cal2*. Add fuel to total quantity displayed and press the button to save. Press the **MODE** button to advance to the Calibration 75% setting.



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.



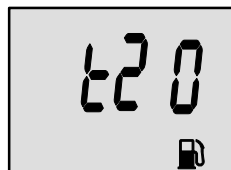
Calibration FULL – The “FULL percent” display alternates between percent of tank capacity and quantity of fuel to add based on total capacity entered in *Cal2*.



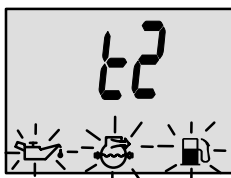
Add fuel to fill tank and press the button to save. Press the **MODE** button to move to the next function.



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 button to continue.



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

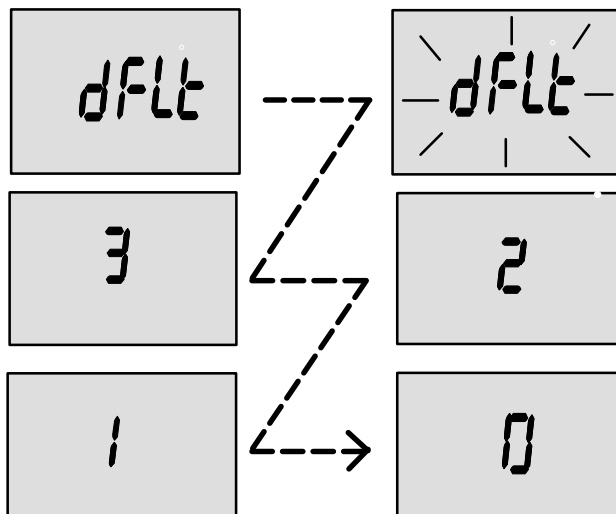
Repeat tank calibration procedure described on page 34 and 35 if calibration of the second tank is desired.

Master Reset Command

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

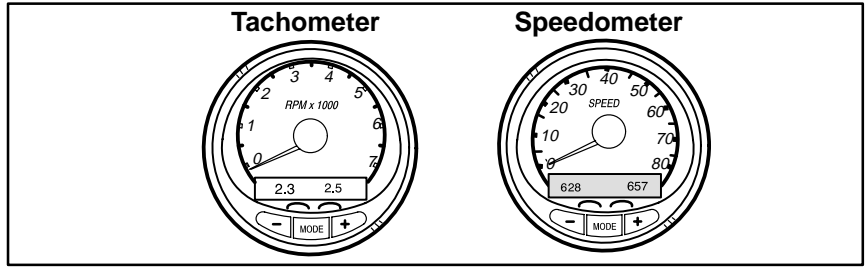
IMPORTANT: Performing a master reset will reset the unit back to all factory defaults, thus eliminating any installation calibrations performed during set up of product.

1. Hold in and for approximately 12 seconds. You will see the word “dFLt” let go of the buttons.
2. Immediately press and hold in 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.

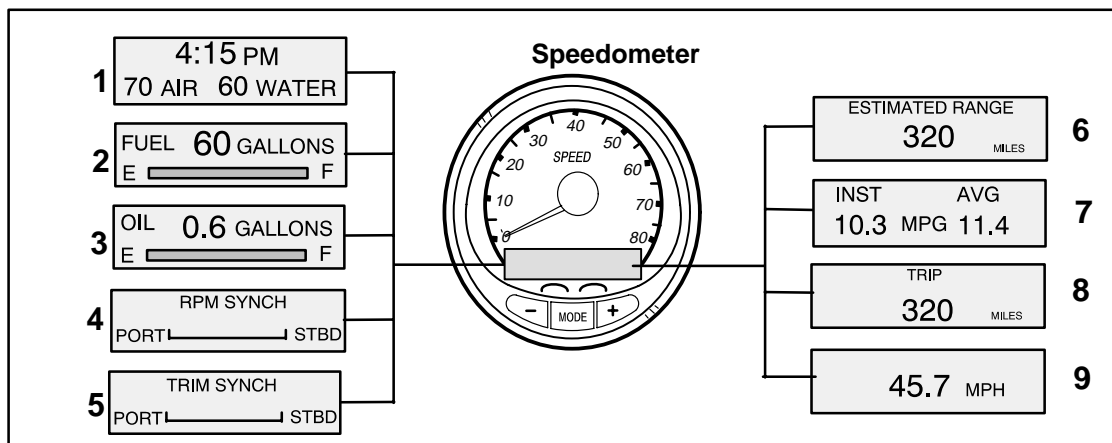
Warning System: The system will sound the warning horn and display the warning message.

Digital Display Screen: Displays the following engine information.

Tachometer Display Screen:	Speedometer Display Screen:
<p>DEPENDENT ON ENGINE TYPE</p> <ul style="list-style-type: none"> Engine Break-in Engine Temperature Oil Psi Trim and RPM Trim and Water Pressure Water Pressure Battery Voltage and Engine Hours Fuel Flow and Fuel Used RPM 	<p>DEPENDENT ON ENGINE TYPE Speed</p> <ul style="list-style-type: none"> Fuel Used COG/SOG – If GPS Input Distance and fuel to way point – <i>if way point programmed into optional GPS</i> Clock – Air/Sea Temp Inst. and Ave. Fuel Economy Trip Odometer Fuel Tank Levels Oil Tank Levels Fresh Water Tank2 or Level(s) Waste Water Level(s) or <i>Dual Engine</i> 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**”.

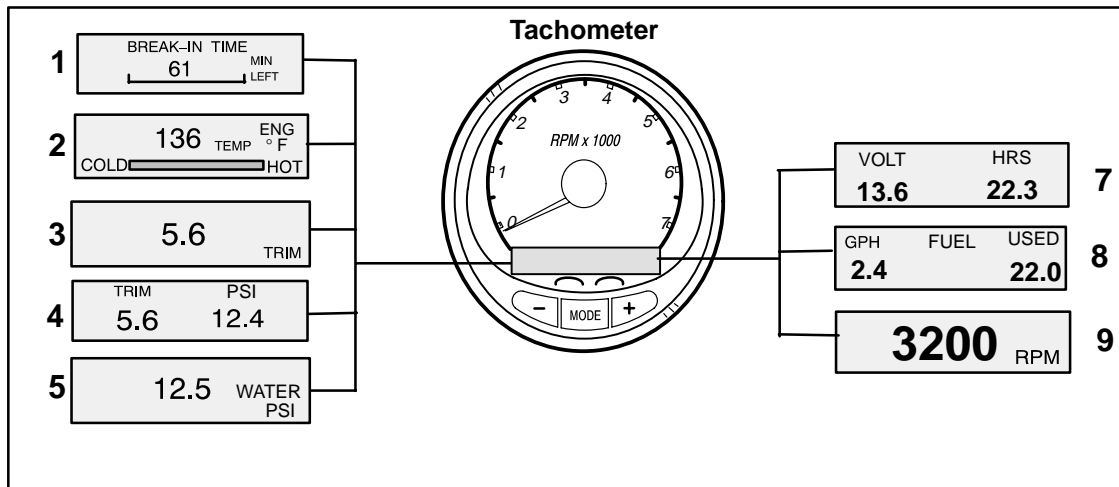
Fuel Reset – To reset, select the display screen and press **MODE** and **TROLL** buttons.

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.

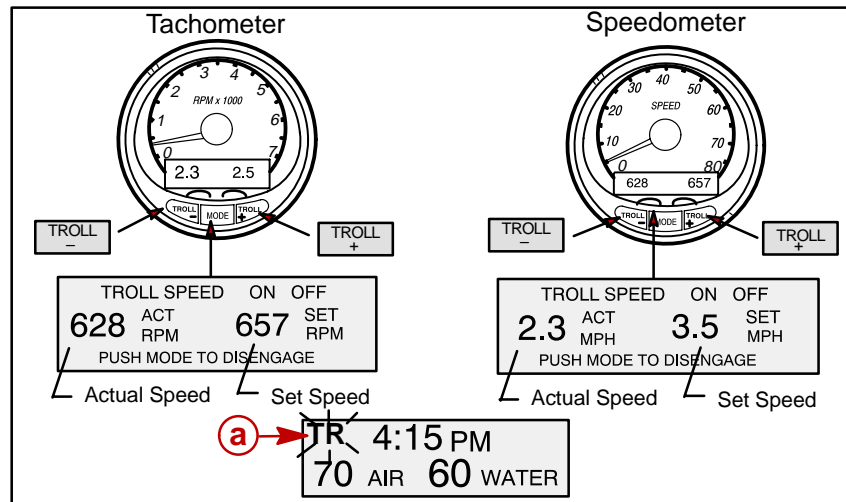
NOTE: Readings can be displayed in English (U.S.) or Metric. Refer to Calibration.

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 to 1000 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.

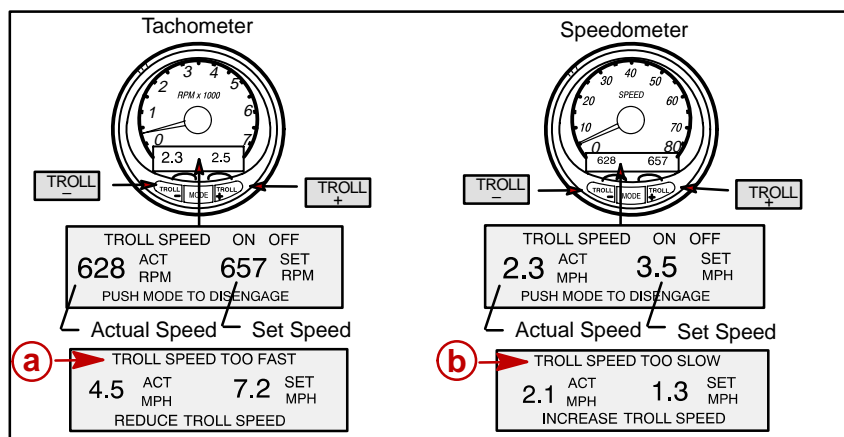
If you have troll control set at a desired speed and then you shut off the troll control, the system remembers the set speed and will return to that speed when re-engaged.

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



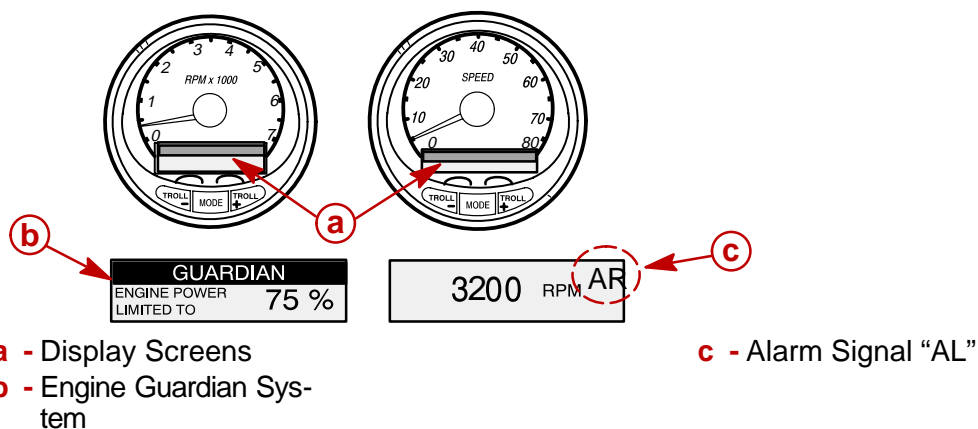
1. With the engine running, shift engine into gear. Set engine speed at idle.
2. Push in the **TROLL +** or **TROLL -** button to bring up the troll control display screen.
3. Press **MODE** to engage (turn on) the troll control.
4. Use the **TROLL +** **TROLL -** buttons to set the desired speed. Use **(+)** 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 **TROLL 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 **TROLL 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 engine owners manual for a complete list of failures.

The SmartCraft warning system incorporates the display screens 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 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” 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

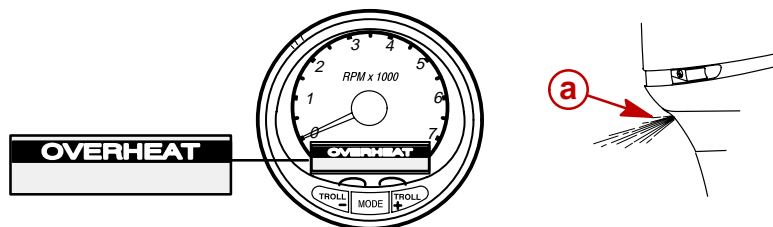


OVERHEAT

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.

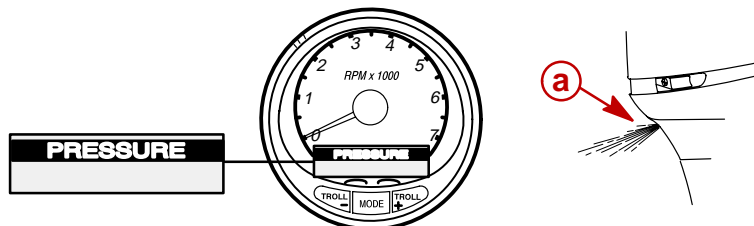
The overheat problem must be corrected before you can resume normal operation.

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.

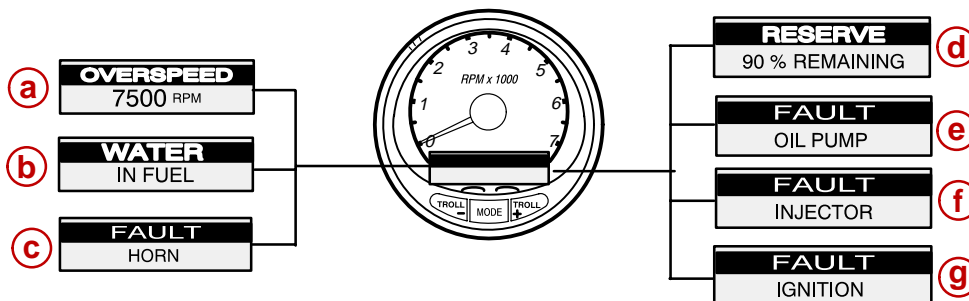
NOTE: The throttle will have to be returned to idle to reset the system.

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

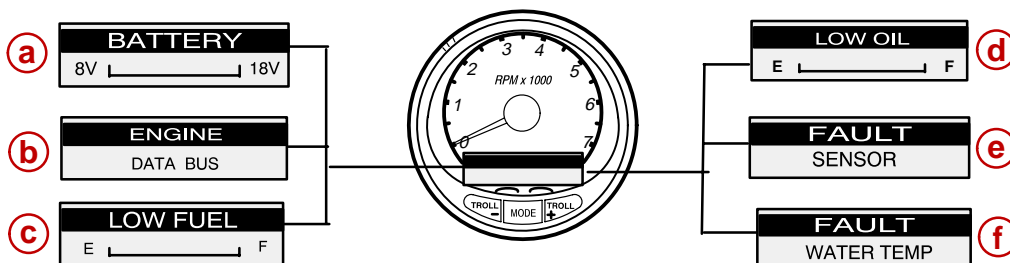
If the throttle sensor has failed, the warning horn will sound a continuous beeping and the engine will not reach its full power.

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.

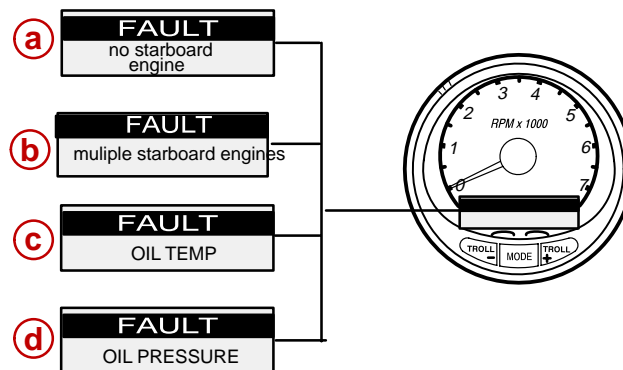
If you have a dual engine application, you must first program the port engine with a Quicksilver Diagnostic Tool.

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  and  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.

<p>REMOTE SCREENS?</p> <p>[NO] [SAVE] [YES]</p>	<p>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.</p>
<p>REMOTE LCD LIGHT?</p> <p>[NO] [SAVE] [YES]</p>	<p>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.</p>
<p>REMOTE LCD CONTRAST?</p> <p>[NO] [SAVE] [YES]</p>	<p>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.</p>
<p>TRIM POPUP?</p> <p>[NO] [SAVE] [YES]</p>	<p>Do you want power trim display screen to pop up momentarily when you trim the engine?</p>



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



WIRING DIAGRAMS

<p>WATER PSI SCREEN?</p> <p>[NO] [SAVE] [YES]</p>	<p>Do you want to turn on the water pressure screen?</p>
<p>TRIM AND RPM SCREEN?</p> <p>[NO] [SAVE] [YES]</p>	<p>Do you want to turn on the trim and RPM split screen?</p>
<p>RPM SCREEN?</p> <p>[NO] [SAVE] [YES]</p>	<p>Do you want to turn on the digital RPM screen?</p>
<p>SIMULATOR MODE?</p> <p>[NO] [SAVE] [YES]</p>	<p>Do you want to turn on a simulation mode? (used for demonstration purposes).</p>
<p>EXIT?</p> <p>[NO] [SAVE] [CAL2]</p>	<p>Do you want to exit calibration? Or jump straight into calibration level 2?</p>
<p>EXTERNAL SENSORS</p> <p>[SKIP] [EDIT]</p>	<p>This section lets you enable or disable the following external sensor inputs.</p>
<p>PITOT SENSOR?</p> <p>[NO] [SAVE] [YES]</p>	<p>Is the boat equipped with a pitot sensor to measure boat speed?</p>
<p>PADDLE SENSOR?</p> <p>[NO] [SAVE] [YES]</p>	<p>Is the boat equipped with a paddle wheel to measure boat speed?</p>
<p>TRIM SENSOR?</p> <p>[NO] [SAVE] [YES]</p>	<p>Is the boat equipped with a trim sensor?</p>
<p>SEA TEMP?</p> <p>[NO] [SAVE] [YES]</p>	<p>Is the boat equipped with a water temperature sensor?</p>
<p>INVERT STEERING</p> <p>[NO] [SAVE] [YES]</p>	<p>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.</p>

**TACH CALIBRATION – CAL 2 LEVEL**

<p>SPEED OPTION</p> <p>[SKIP] [EDIT]</p>	This section lets you configure the following speed sensors.
<p>PITOT SENSOR?</p> <p>[NO] [SAVE] [YES]</p>	Select pitot transducer type. You can choose 100 or 200 PSI. (100 PSI is the most common)
<p>PITOT SENSOR MULTIPLIER</p> <p>[DOWN] [SAVE] [UP]</p>	Adjust the pitot pressure sensor for correcting display readings that are to high/low.
<p>PADDLE SENSOR PULSE FACTOR</p> <p>[DOWN] [SAVE] [UP]</p>	Adjust paddle wheel frequency for display readings that are to high/low.
<p>PADDLE TO PITOT TRANSITION</p> <p>[DOWN] [SAVE] [UP]</p>	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 (following), 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 (following) completely System Tach will display an estimated range value that factors in the tank shape.

<p>FUEL TANK CAPACITY</p> <p>[DOWN] [SAVE] [UP]</p>	Lets you enter the capacity of your boats fuel tank. This option is the same for tank 1 as it is for tank 2.
<p>CALIBRATION FUEL TANK</p> <p>[SKIP] [EDIT]</p>	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.
<p>FILL TO 1/4 THEN PRESS PLUS BUT- TON</p> <p>[DFLT] [SKIP] [SAVE]</p>	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.



<p style="text-align: center;">FILL TO 1/2 THEN PRESS PLUS BUTTON</p> <p>[DFLT] [SKIP] [SAVE]</p>	<p>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.</p>
<p style="text-align: center;">FILL TO 3/4 THEN PRESS PLUS BUTTON</p> <p>[DFLT] [SKIP] [SAVE]</p>	<p>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.</p>
<p style="text-align: center;">FILL TO FULL THEN PRESS PLUS BUTTON</p> <p>[DFLT] [SKIP] [SAVE]</p>	<p>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.</p>
<p style="text-align: center;">DEPTH SENSOR OFFSET</p> <p>[DOWN] [SAVE] [UP]</p>	<p>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.</p>
<p style="text-align: center;">DEPTH ALARM</p> <p>[DOWN] [SAVE] [UP]</p>	<p>Lets you enter a depth value. When the depth transducer reads that value or below, the shallow water alarm will sound.</p>
<p style="text-align: center;">EMPTY TANK THEN PRESS PLUS BUT- TON</p> <p>[DFLT] [SKIP] [SAVE]</p>	<p>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.</p>

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.

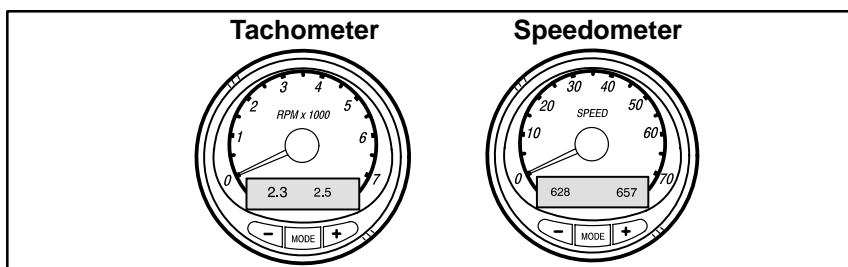
**SPEEDOMETER CALIBRATION CAL 1 LEVEL**

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

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:

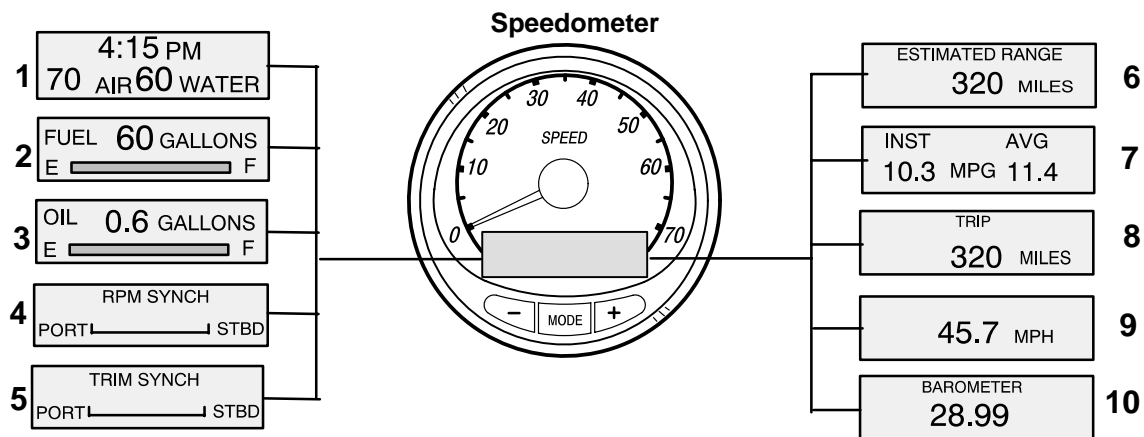
- Digital Tachometer
- Hour Meter
- Power Trim Angle
- Fuel Flow
- Engine Temperature
- Battery Voltage
- Water Pressure

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



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

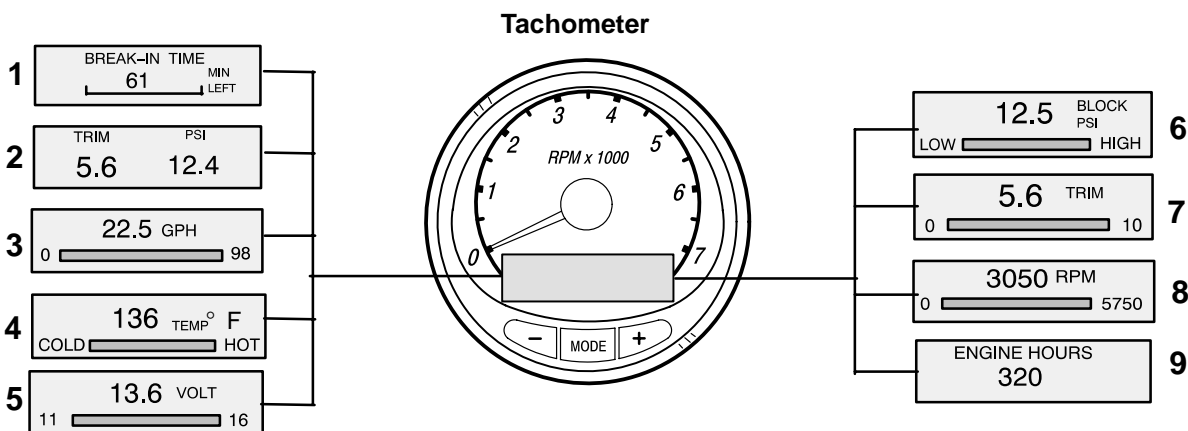
NOTE: Readings can be displayed in English or Metric. Refer to Calibration.

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.

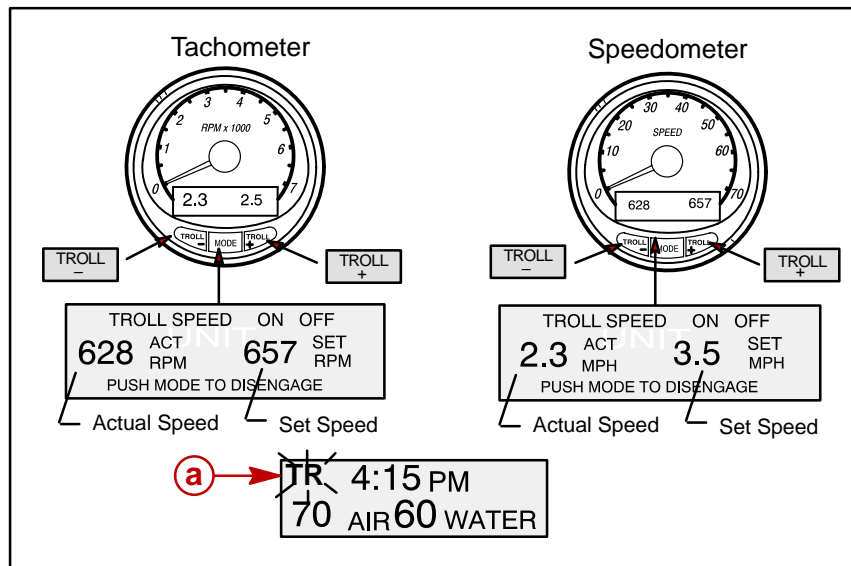
Press **MODE** to change display screens. You can revert back to the previous screen by pressing and holding **MODE** for 2 seconds. This will reverse the display rotation.

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 then 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



a - Flashing Signal "TR"

BASIC OPERATION

With Troll control you can maintain a trolling speed of 450 to 1000 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" 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 **TROLL 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 **TROLL SPEED TOO SLOW** message will appear. Increase troll speed.

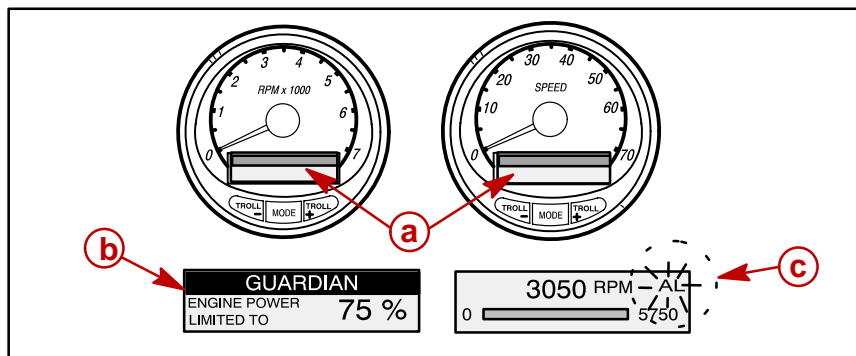


EXITING TROLL CONTROL

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



- a** - Display Screens
- b** - Engine Guardian System
- c** - Alarm Signal "AL"

The SmartCraft warning system incorporates the display screens 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 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 tell you what to do about it.
If problem will not cause immediate engine damage – The horn will sound but not continuously.
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" 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

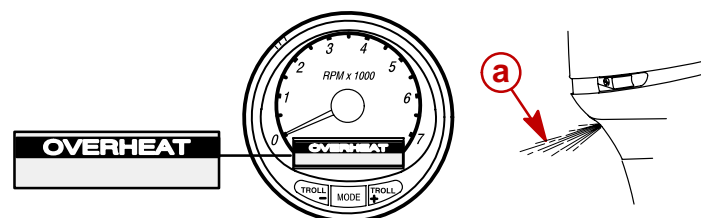
These messages will appear and the horn will sound if there is a problem detected in one of the outboard systems.

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.

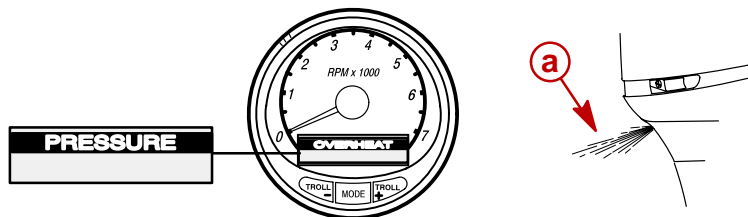
If a steady stream of water is coming out of the water pump indicator hole and the warning horn continues to sound, there still may be insufficient cooling water or an engine problem. Stop engine. Operating the engine while overheated will cause engine damage.



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.

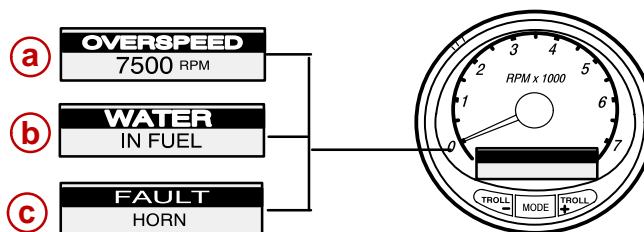
NOTE: Your engine speed should never reach the maximum limit to activate the system unless the propeller is ventilating, an incorrect propeller is being used, or the propeller is faulty.

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)

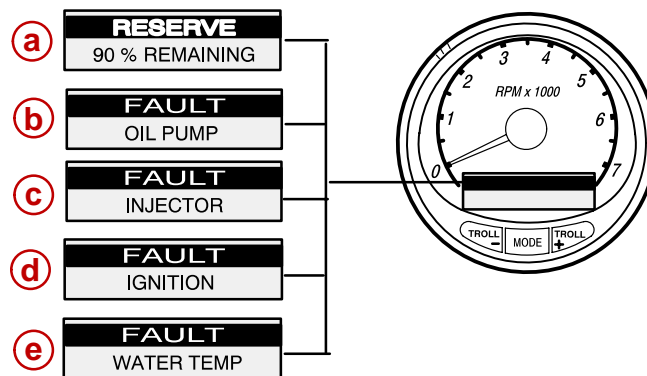
This alarm informs you if one or more of the fuel injectors have stopped functioning electrically.

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 dual 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.

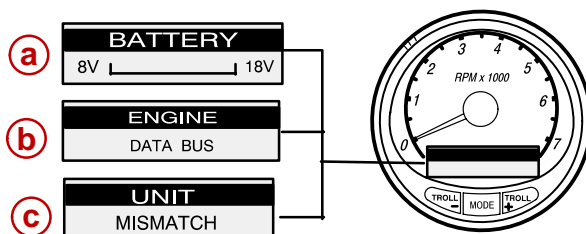
ENGINE DATA BUS (b)

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.

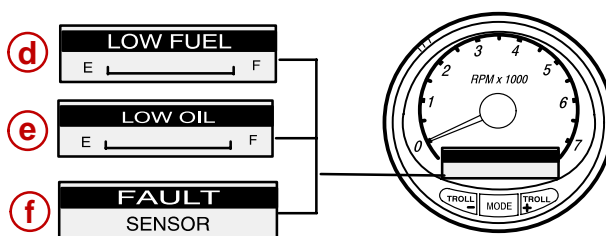
FAULT-SENSOR (f)

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.

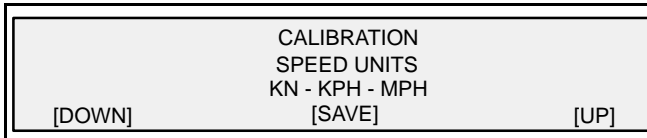
Simple Calibration – This calibration for setting lighting and a few other common screens can be made while engine is running.

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

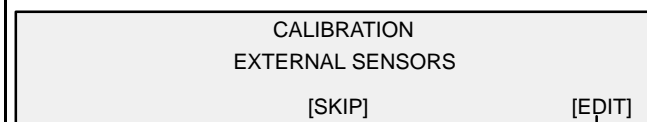
Advanced Calibration – This calibration goes through the entire mode selections.

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.

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



Display boat speed in KN (knots), KPH (kilometers per hour), MPH (miles per hour). **Press + or –** to select setting. **Press MODE** to save.



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

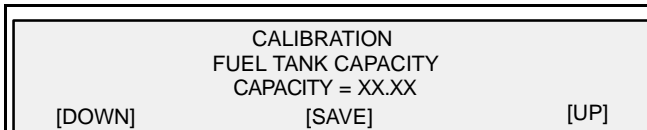
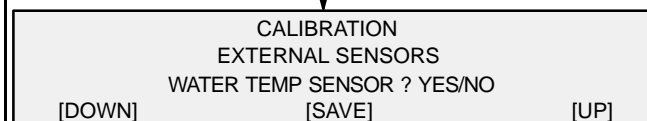
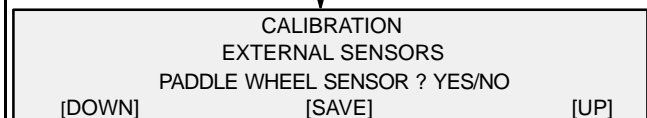
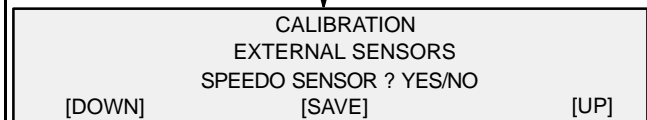
Editing External Sensors

Add Yes or No for each sensor

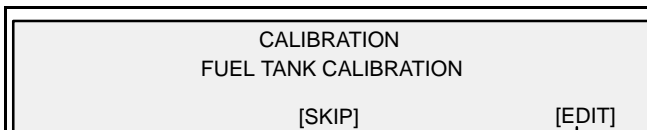
No = not used Yes = in use

Press + or – for correct setting

Press MODE to save and advance to next sensor



Add the capacity of the fuel tank. **Press + or –** to select. **Press MODE** to save.



This calibration sets the fuel level of the tank.

NOTE: If the fuel tank is not calibrated, fuel range cannot be displayed

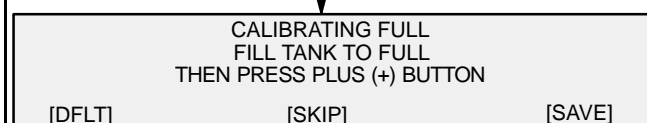
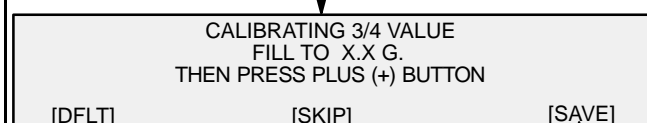
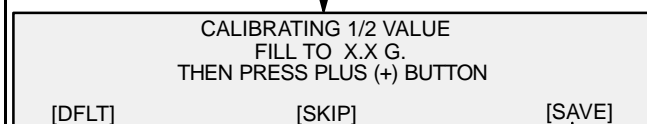
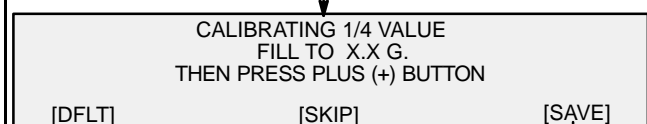
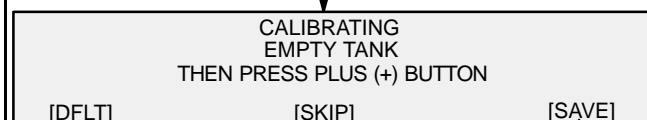
Press MODE to skip to the next display. **Press +** (edit) to calibrate the fuel tank.

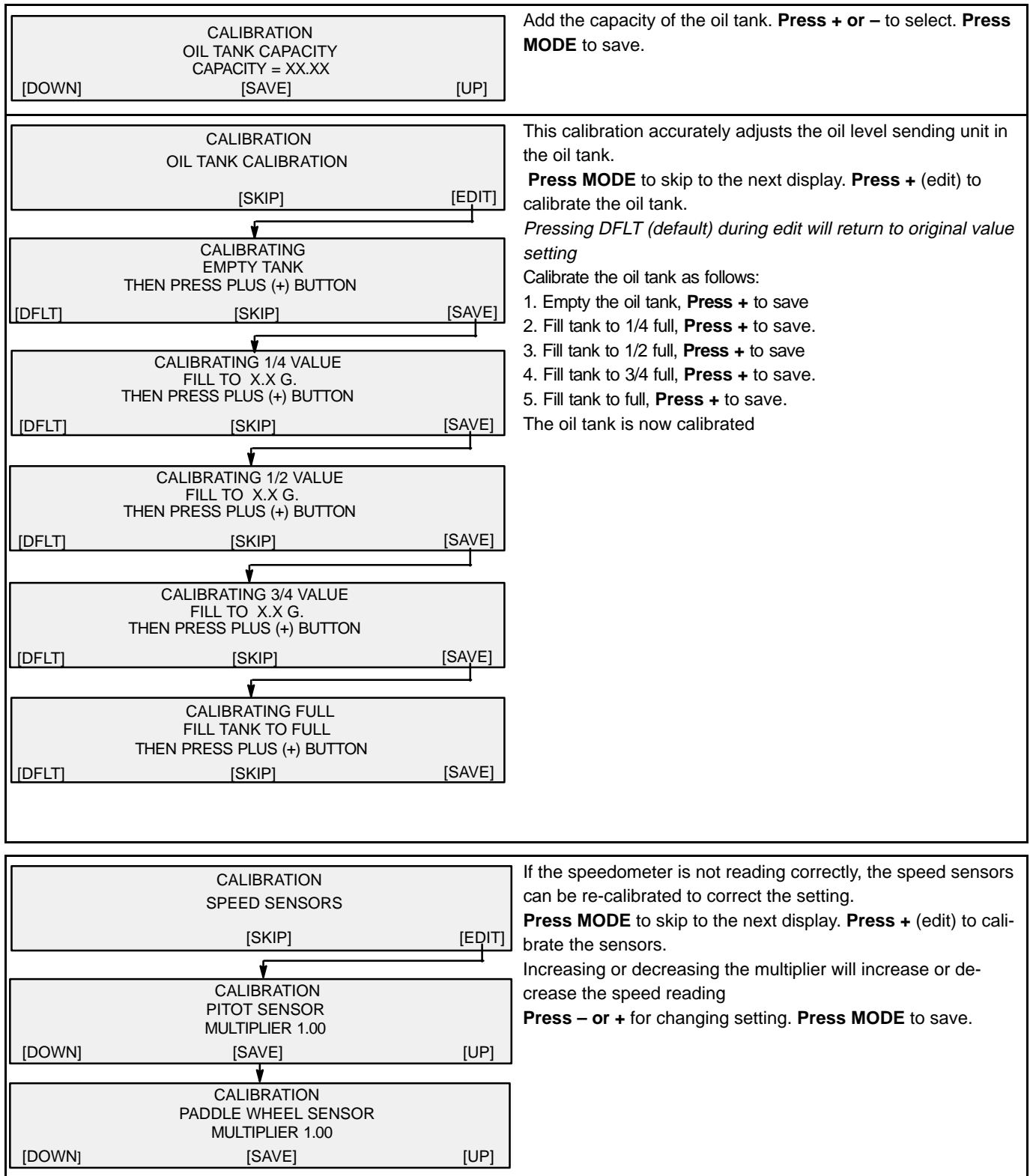
Pressing DFLT (default) during edit will return to original value setting

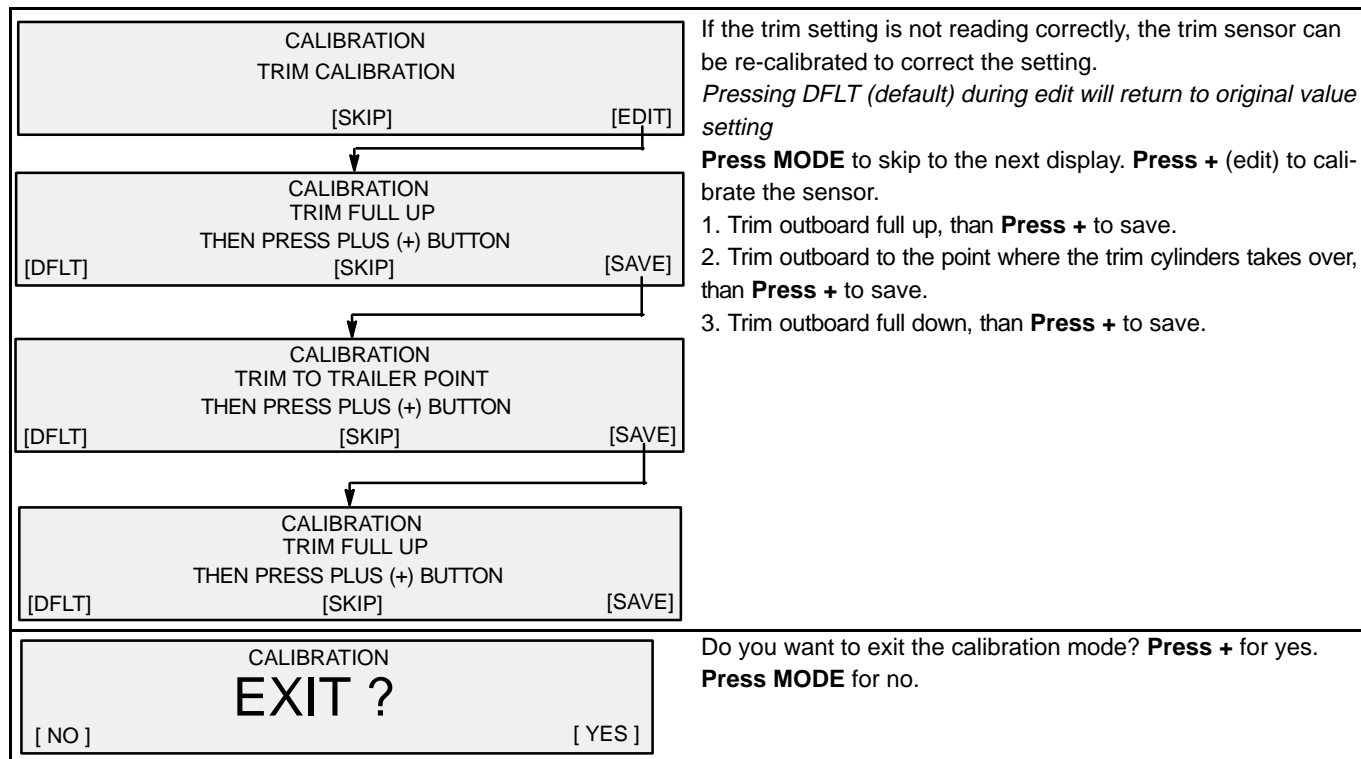
Calibrate the fuel tank as follows:

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







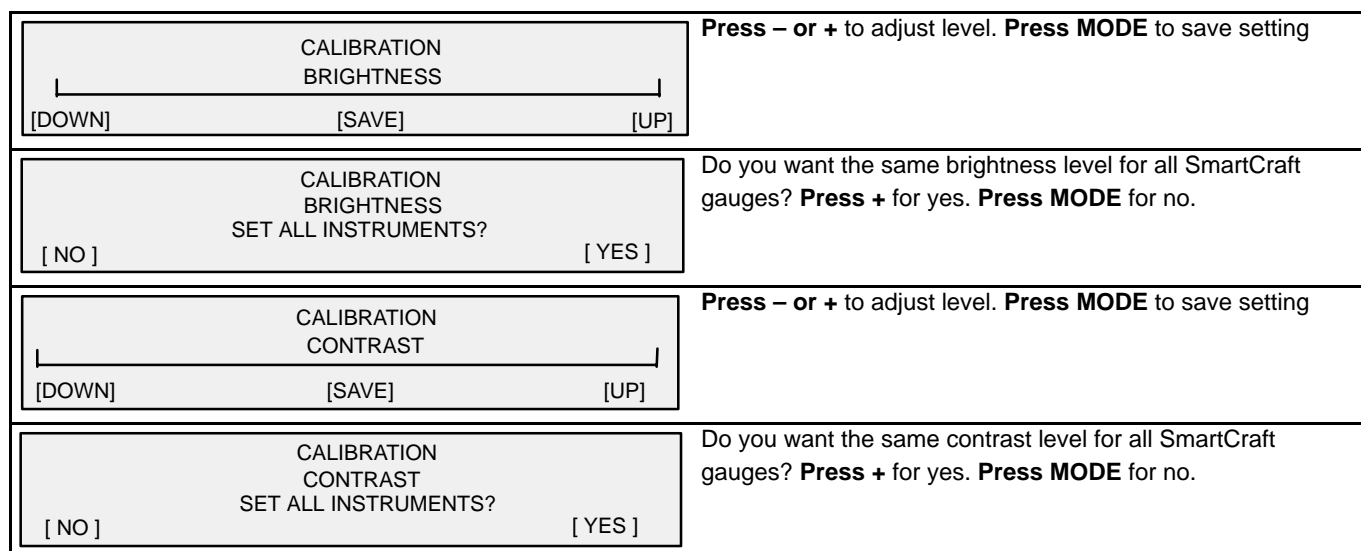
Speedometer Calibration

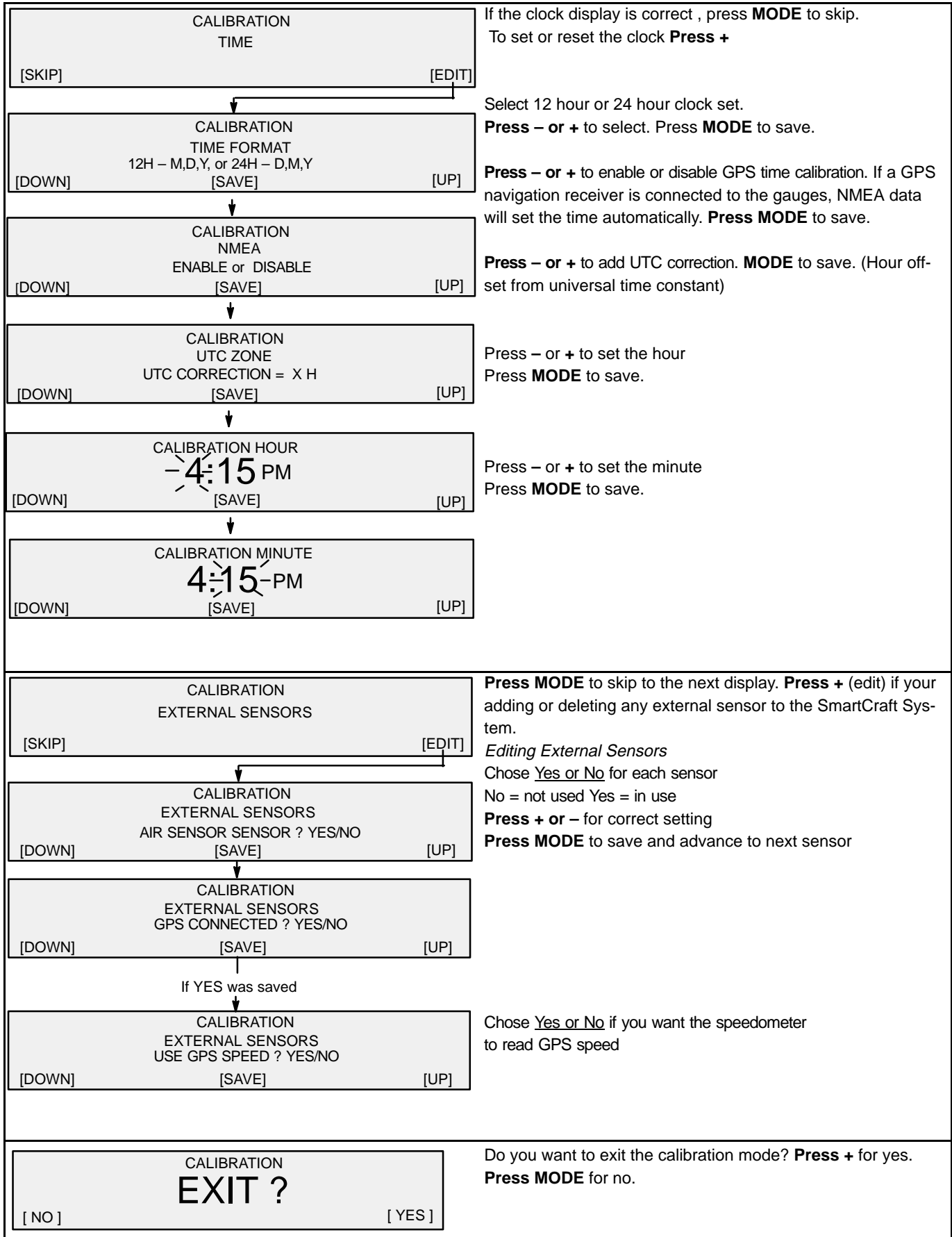
Simple Calibration – This calibration for setting lighting and setting the clock can be made while engine is running.

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.





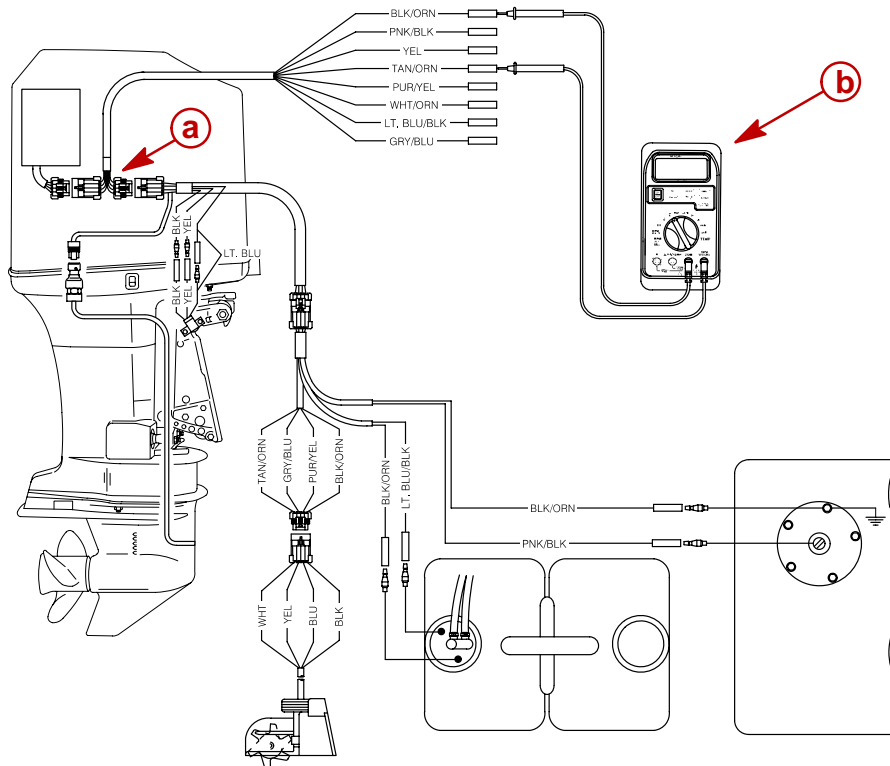


SmartCraft Gauge Test Specifications

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.

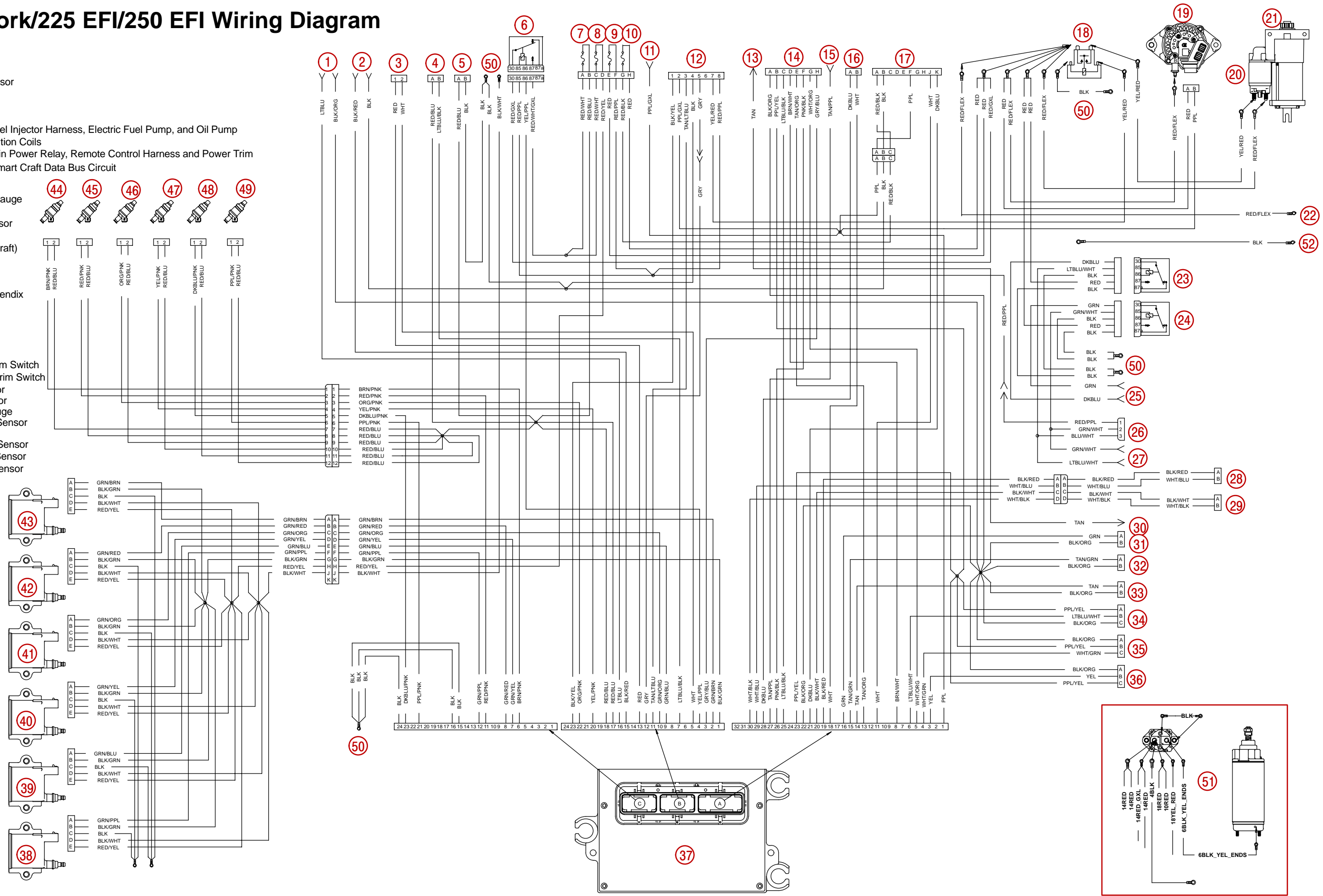


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SENSOR	RED TEST LEAD	BLACK TEST LEAD	RANGE
Trim	Yellow	Black/Orange	2.7 vdc UP – 0.6 vdc DOWN
Fuel Sender	Pink/Black	Black/Orange	0.65 vdc FULL – 2.92 vdc EMPTY
Lake Temperature	Tan/Orange	Black/Orange	2.5 vdc @ room temp. (Voltage decreases as temperature 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.

3 Liter Work/225 EFI/250 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 - Sbd Knock Sensor
- 30 - Temp Sensor Gauge
- 31 - Port Head Temp Sensor
- 32 - Air Temp Sensor
- 33 - Sbd 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

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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)

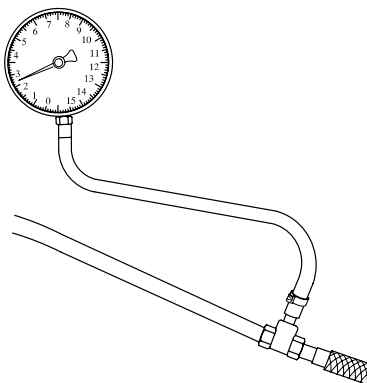
Fuel Pump Pressure @ Idle

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).

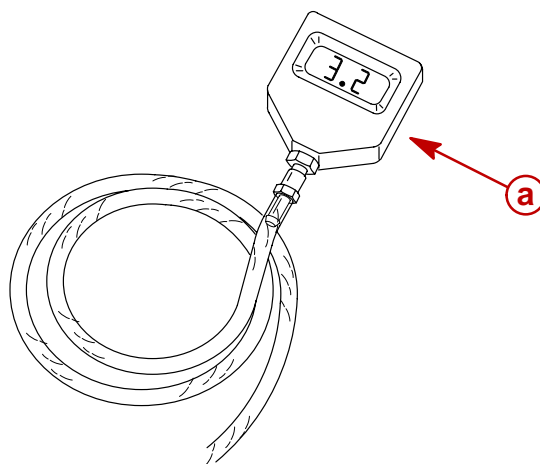
Special Tools

1. Fuel Pressure Gauge (0–15 psi) (Obtain Locally)



57721

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



59157

a - Digital Vacuum Gauge



Notes:



Fuel Pump Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	FUEL PUMP ASSEMBLY			
2	1	DIAPHRAGM KIT			
3	2	DIAPHRAGM			
4	2	RETAINER			
5	1	SPRING			
6	1	CAP			
7	1	SPRING			
8	1	CAP			
9	1	DIAPHRAGM			
10	1	GASKET-BOOST			
11	1	GASKET-PULSE			
12	1	GASKET			
13	1	PLATE			
14	1	FITTING			
15	2	SCREW-FUEL PUMP (M5 x 40)	55		6.0
16	2	SCREW-PUMP TO CRANKCASE (M6 x 50)	55		6.0
17	1	BASE			
18	1	ELBOW			
19	AR	STA STRAP			
20	1	HOSE			
21	1	CONNECTOR			
22	1	HOSE			
23	1	CAP			
24	1	HOSE/SLEEVE			
25	1	HOSE [16 IN. (40.6 CM)]			
26	1	INLINE CONNECTOR			
27	1	CLAMP			
28	1	HOSE			
29	1	TUBING [15 IN. (38 CM)]			
30	1	TUBING [28 IN. (71 CM)]			
31	AR	STA STRAP			
32	1	CONDUIT			



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.

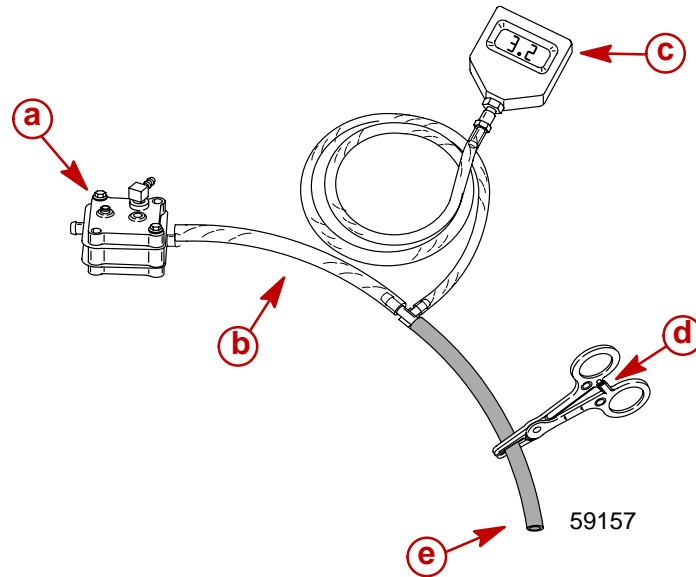
If after using a separate fuel supply it is found that the anti-siphon valve is the cause of the problem, there are 2 solutions to the problem: 1) replace the anti-siphon valve with one that has lighter spring tension or 2) replace it with a solenoid-operated fuel shut off valve.



Checking Fuel Pump Lift (Vacuum)

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

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



- a** - Pulse Driven Fuel Pump
- b** - Clear hose connected between pulse pump and "Tee" fitting

- c** - Vacuum Gauge (Digital)
- d** - Tubing Clamp (91-804063)
- e** - Fuel supply hose from fuel tank



Fuel Pump Capability Test

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	2.5 in. of vacuum (mercury) or higher, proceed to fuel system leak test
----------------	---

Reading below 2.5 in. of vacuum (mercury)	<ul style="list-style-type: none"> • Pump check valves defective, replace valves • Pump diaphragm defective, replace diaphragms • Air leak in pump, rebuild pump with new gasket, check fitting for leaks • Low crankcase pressure, check for crankcase leaks or plugged pulse pump pressure/vacuum passageways
---	---

Fuel System Leak Test

This test is done with the engine running, and the tubing clamp removed. The clear hose that was installed previously is used to view the fuel flow to the pulse pump.

No air bubbles seen in clear hose	No air leaks, perform vacuum test (following)
-----------------------------------	---

Air bubbles seen in clear hose	<p>Air leak on intake side of fuel system –</p> <ul style="list-style-type: none"> • Pickup tube in fuel tank leaking • Outlet fitting at fuel tank leaking • Fuel inlet hose not properly clamped at fitting • Leaking fuel tank valve • Fuel line from kicker engine connected into fuel line of main engine
--------------------------------	---

Vacuum Test

The vacuum test is normally performed at an idle speed. As engine RPM increases, there will be a slight increase in vacuum; this increase should not exceed normal readings at any RPM.

Normal Reading	Below 2.5 in. of vacuum (mercury)
----------------	-----------------------------------

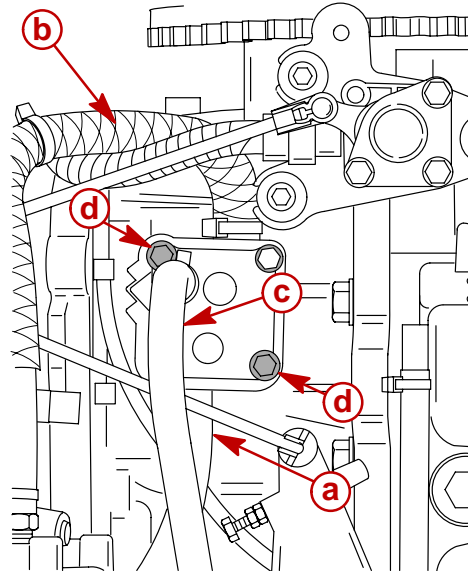
Reading below 2.5 in. of vacuum (mercury)	<p>Restriction within the fuel system –</p> <ul style="list-style-type: none"> • Restricted anti-siphon valve • Restricted or malfunctioning primer bulb • Kinked or collapsed fuel hose • Plugged water separating fuel filter (in the boat) • Restriction in fuel line thru-hull fitting • Restriction in fuel tank switching valves • Plugged fuel tank pick-up screen
---	--



Fuel Pump Removal/Disassembly

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

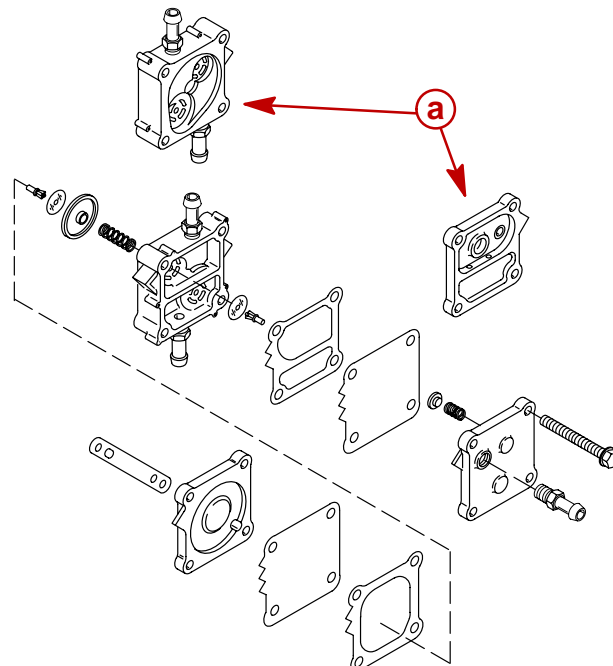
1. Disconnect fuel hoses from fuel pump.
2. Disconnect pulse hose.
3. Remove two mounting screws.
4. Remove fuel pump from engine.



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

59042

5. Disassemble fuel pump.



- a** - Reverse View of Pump Body

59040



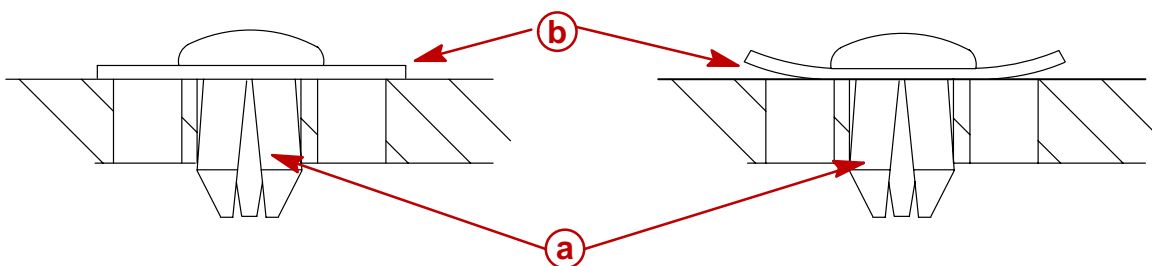
Cleaning/Inspection

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 too tightly against the check valve, this may cause valve to deform.



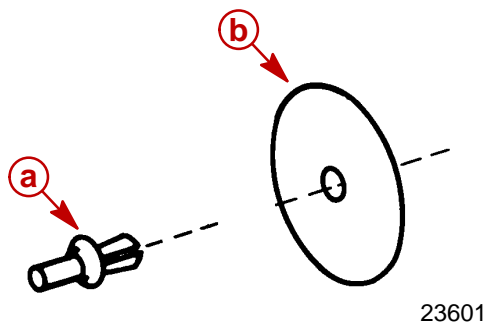
CORRECT

INCORRECT

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

1. Insert retainer through plastic check valve.

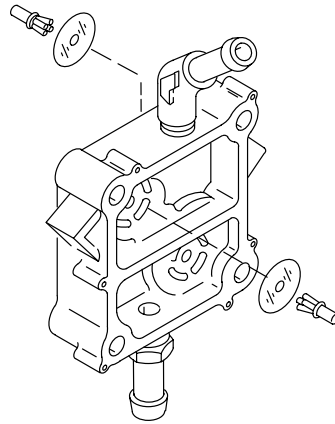


- a** - Retainer
- b** - Plastic Check Valve

23601

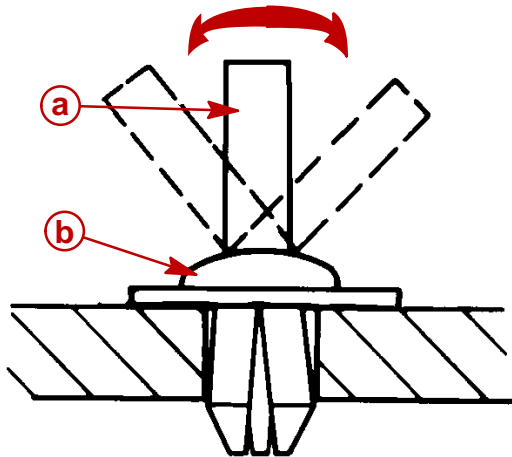


2. Install check valves and retainers into fuel pump body.



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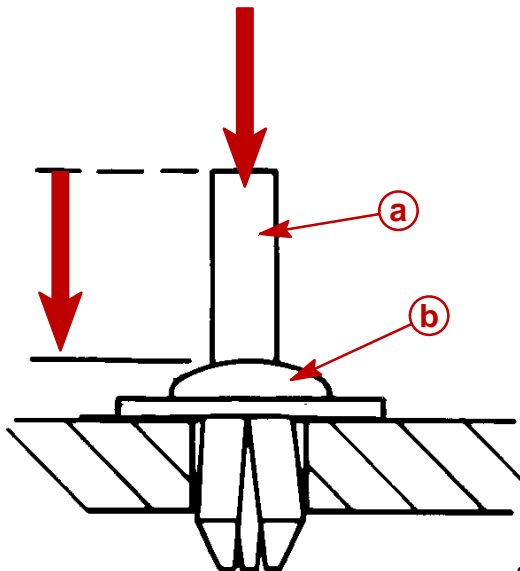
3. With retainer installed in pump body, break retainer rod from retainer by bending side-ways.



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.

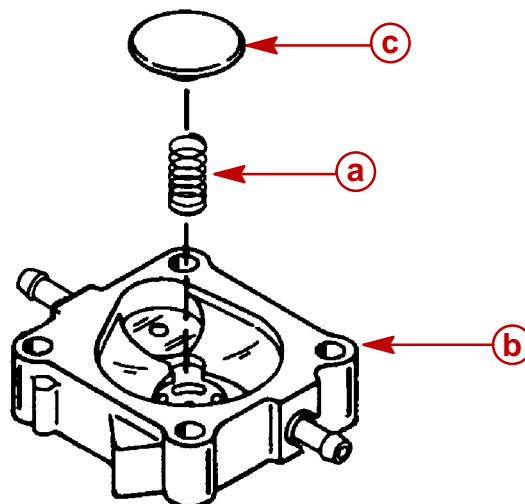


23601

- a** - Rod
- b** - Retainer Cap



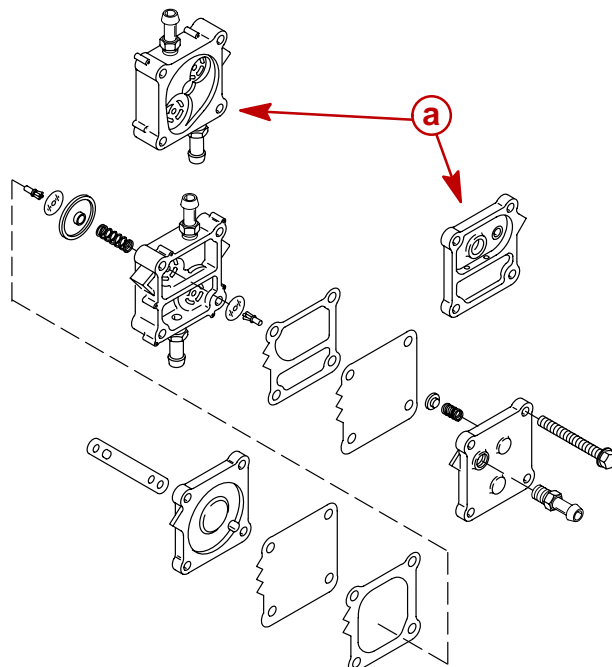
- Place boost spring into pump body and place cap onto boost spring.



50161

- a** - Boost Spring
- b** - Pump Body
- c** - Cap

- Assemble remainder of components as shown and install retaining screws through to align.



59040

- a** - Reverse View of Pump Body

INSTALLATION

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



FUEL SYSTEM

Section 3B - Fuel Injection

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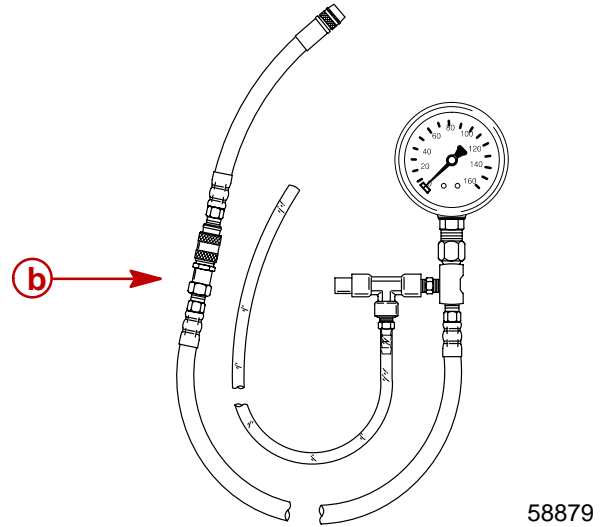
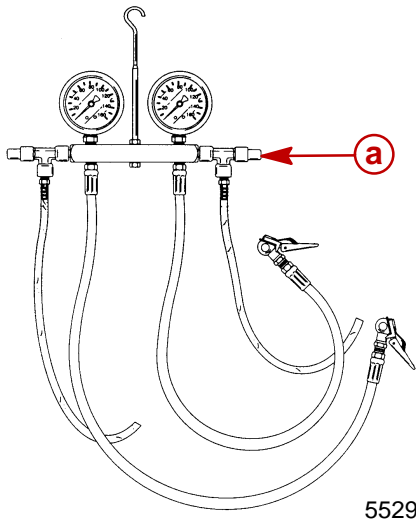
Specifications

FUEL INJECTION	Idle RPM – All Models Wide Open Throttle (WOT) RPM – All Models 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	 650 ± 50 5000 – 5800 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
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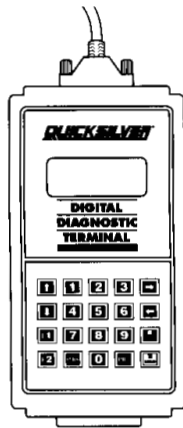


Special Tools

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



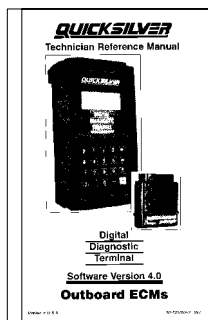
2. Digital Diagnostic Terminal (DDT) 91-823686T2



3. Software Cartridge 91-880118A2

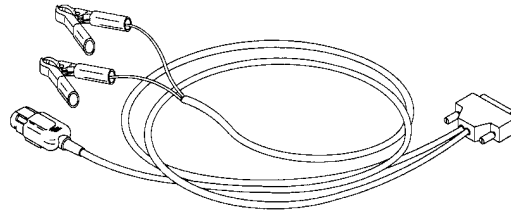


4. DDT Reference Manual 90-881204-1

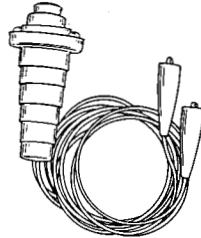




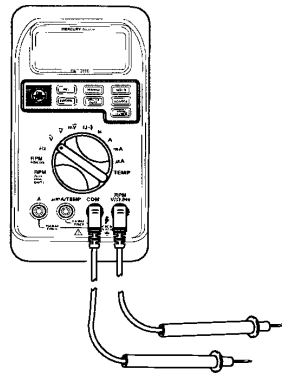
- 5. Adaptor Harness 84-822560A5 (use with DDT)



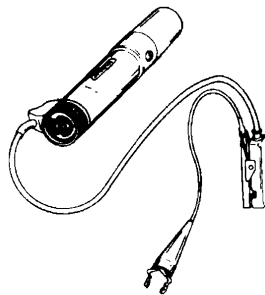
- 6. Remote Starter Switch 91-52024A1



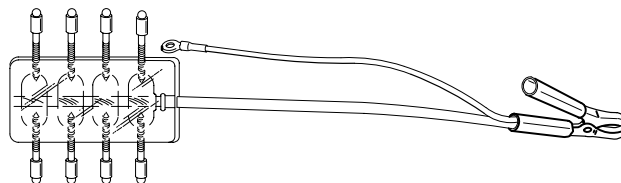
- 7. DMT 2000 Digital Tachometer Multi-meter 91-854009A1



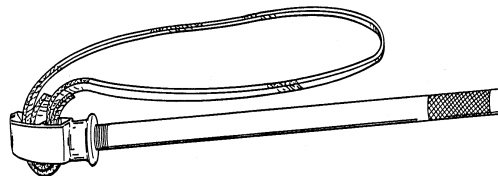
- 8. Inductive Timing Light 91-99379



- 9. Spark Gap Tester 91-850439T



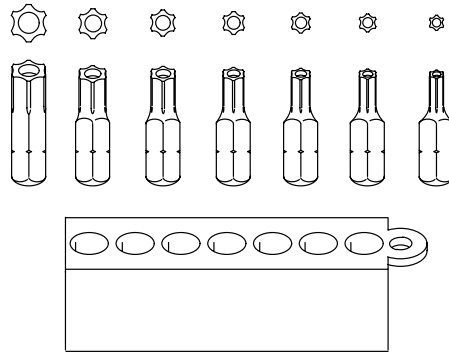
- 10. Strap Wrench 91-24937A1



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11. Tamper Proof Torx Screw Set 91-881828



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Notes:

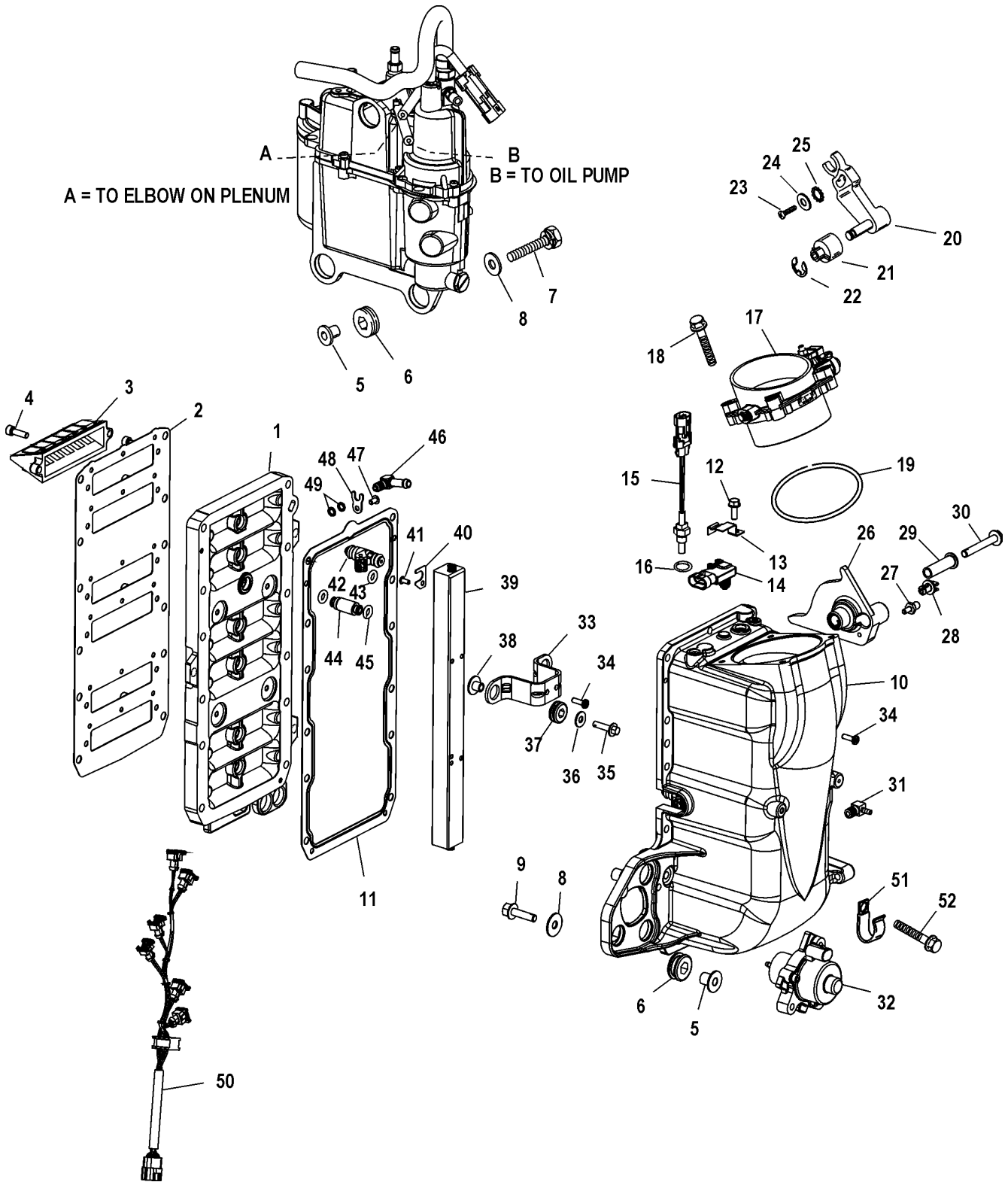


Fuel Management System

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
-	1	FUEL MANAGEMENT ASSEMBLY			
1	1	ADAPTOR PLATE			
2	1	GASKET			
3	6	REED BLOCK			
4	12	SCREW (M6 x 1)	90		10
5	6	BUSHING			
6	6	GROMMET			
7	3	SCREW (M8 x 35)	140		16
8	6	WASHER			
9	3	SCREW			
10	1	AIR PLENUM KIT			
11	1	GASKET			
12	1	SCREW	80		9
13	1	BRACKET			
14	1	MAP SENSOR			
15	1	TEMPERATURE SENSOR			
16	3	O-RING			
17	1	THROTTLE BODY			
18	4	SCREW	100		11.3
19	1	O-RING			
20	1	THROTTLE ARM			
21	1	ROLLER			
22	1	RETAINING RING			
23	1	SCREW (M5 x 16)			Drive Tight
24	1	WASHER			
25	1	STAR WASHER			
26	1	CAM ASSEMBLY			
27	1	THREADED BALL			
28	1	SWIVEL BUSHING			
29	1	BUSHING			
30	1	SCREW (M8 x 40)	145		16.4
31	1	ELBOW			
32	1	OIL PUMP			
33	2	BRACKET			
34	6	SCREW			
35	4	SCREW	65		7.3
36	4	WASHER			Drive Tight
37	4	GROMMET			
38	4	BUSHING			
39	1	FUEL RAIL			
40	7	RETAINER			
41	7	SCREW (8-32 x 0.38)			
42	6	FUEL INJECTOR			
43	12	O-RING			



Fuel Management System



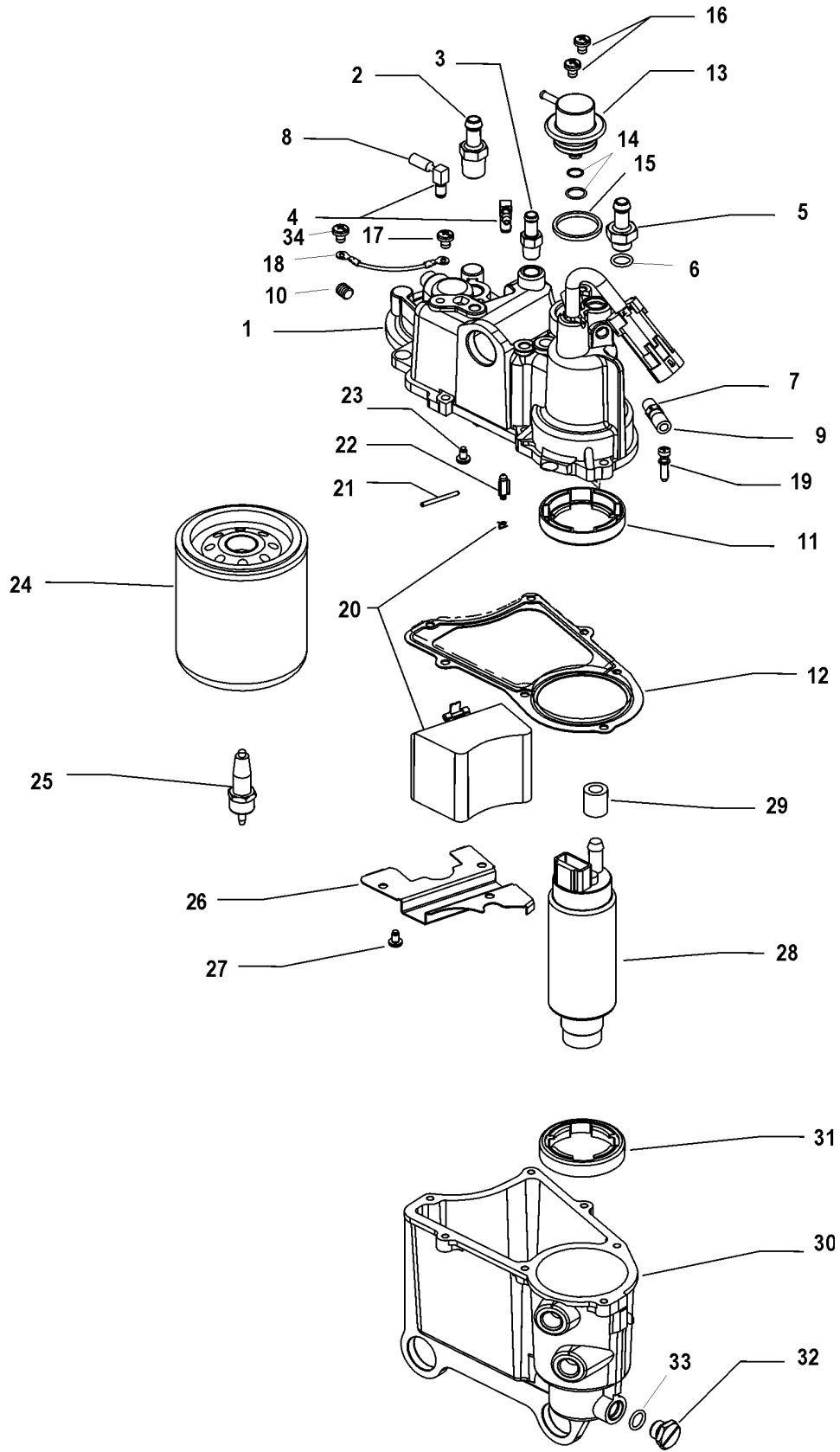


Fuel Management System

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
44	1	FUEL TUBE			
45	2	O-RING			
46	1	ELBOW			
47	1	SCREW (10-24 x 0.375)			
48	1	RETAINER			
49	2	O-RING			
50	1	FUEL RAIL HARNESS			
51	2	CLAMP			
52	12	SCREW (M6 x 40)	100		11.3



Vapor Separator Components





Vapor Separator Components

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb. in.	lb. ft.	N-m
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	1	SCREW (M6 x 8)			Drive Tight



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.

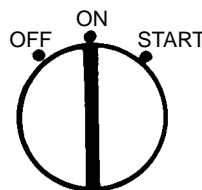
IMPORTANT: The following preliminary steps **MUST BE FOLLOWED** before attempting EFI problem diagnosis.

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 (91-850439T1) to a good ground on engine. Connect Spark Plug Extensions (91-877870A1) between tester and spark plug leads.
3. Connect Remote Starter Switch (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.

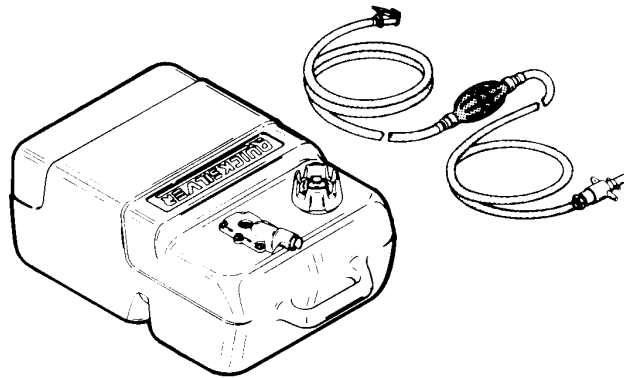


Electronic Fuel Injection Set Up

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.

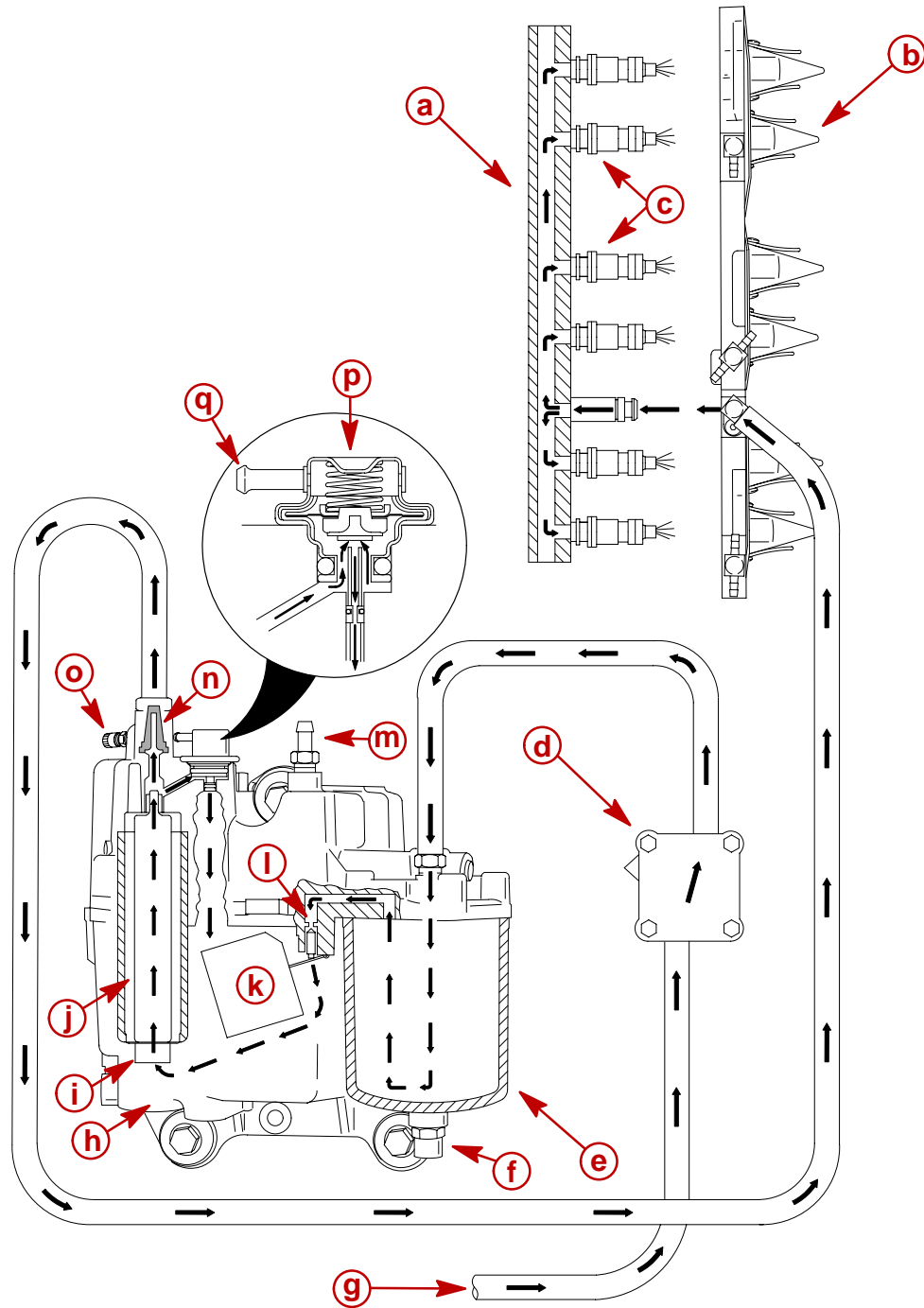
Low Battery Voltage

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



58901

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



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
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WATER SENSING SYSTEM

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

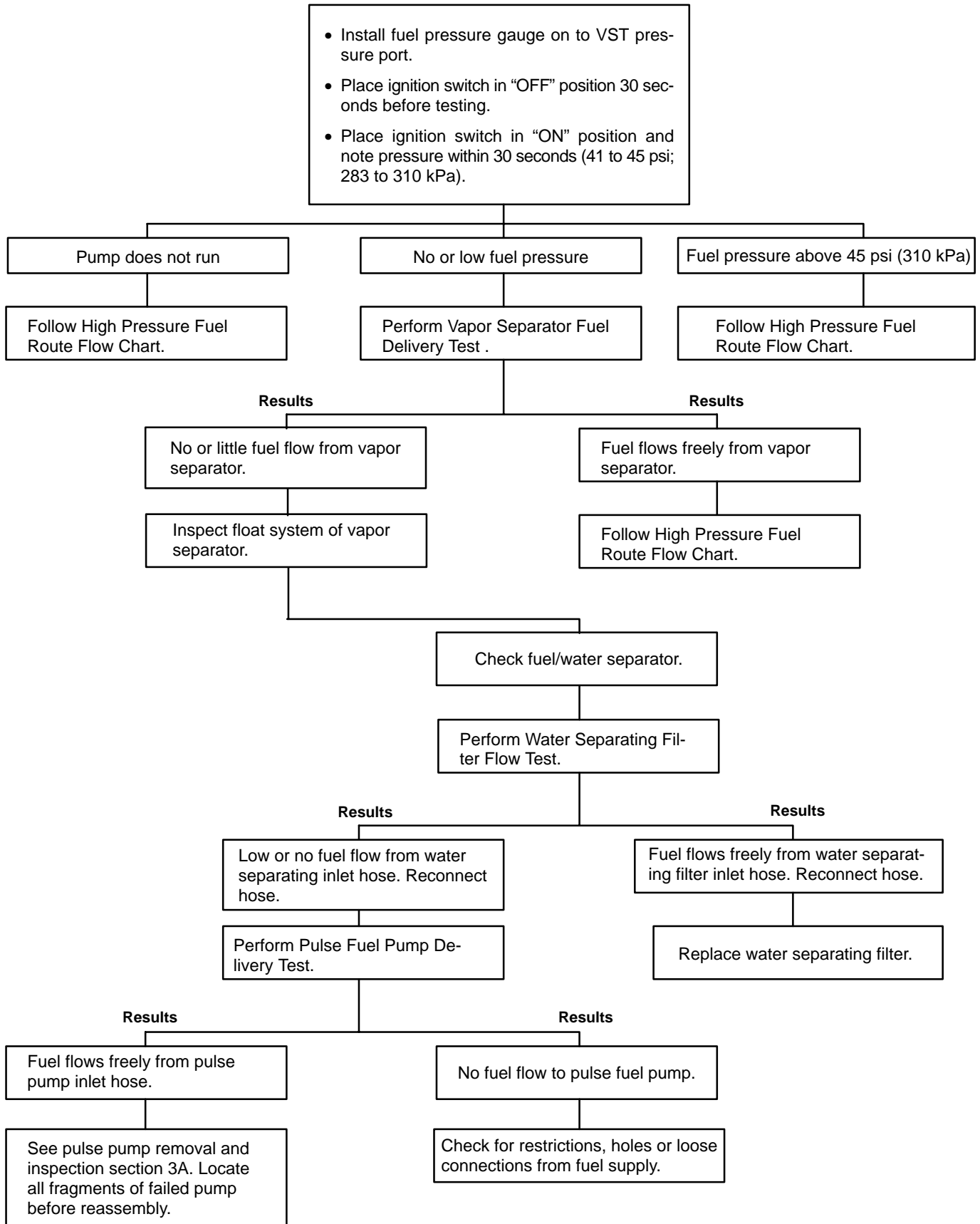
WATER SENSING SYSTEM FUNCTION

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 intermittently 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.



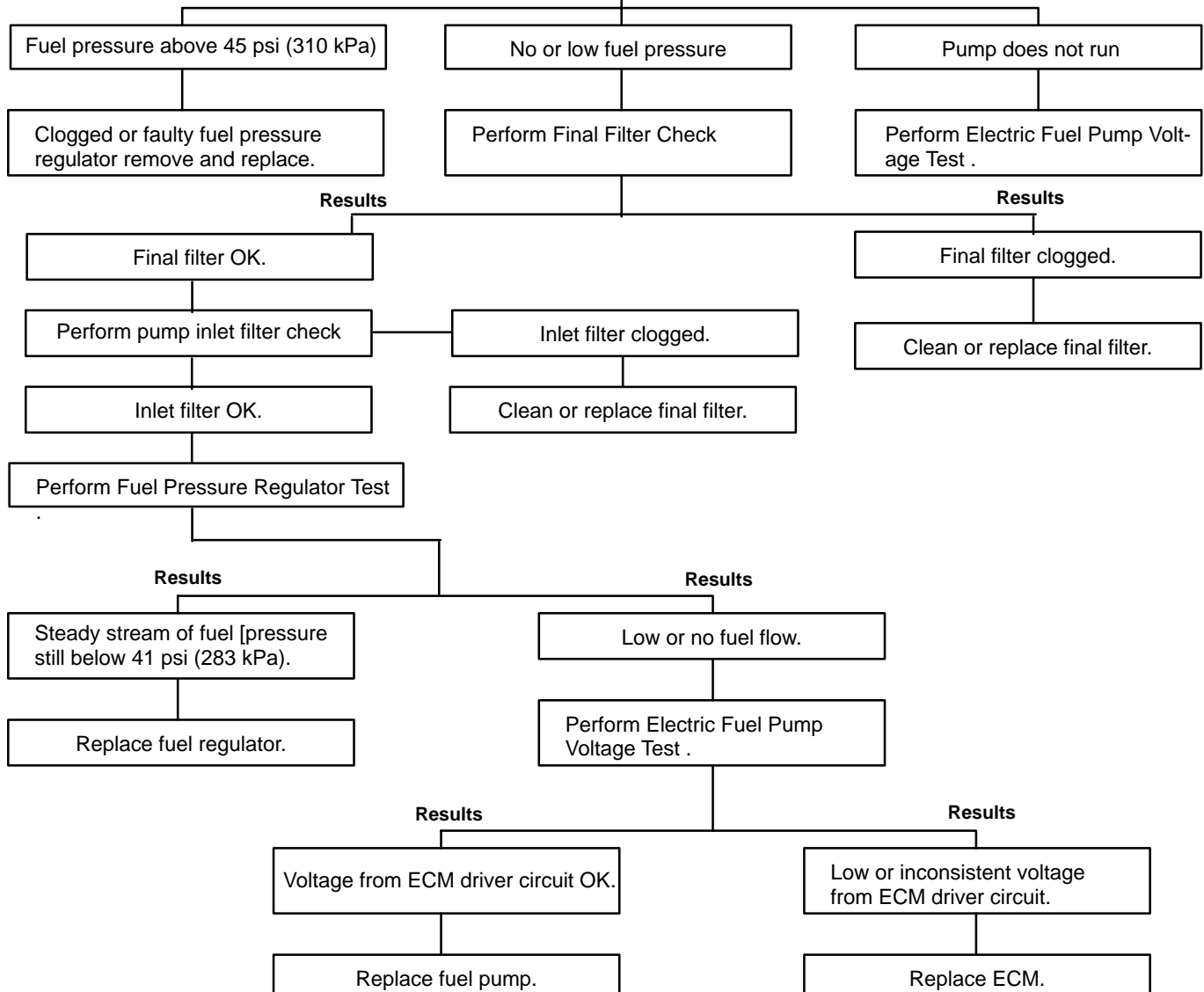
EFI Fuel Management (Low Pressure Fuel Route)





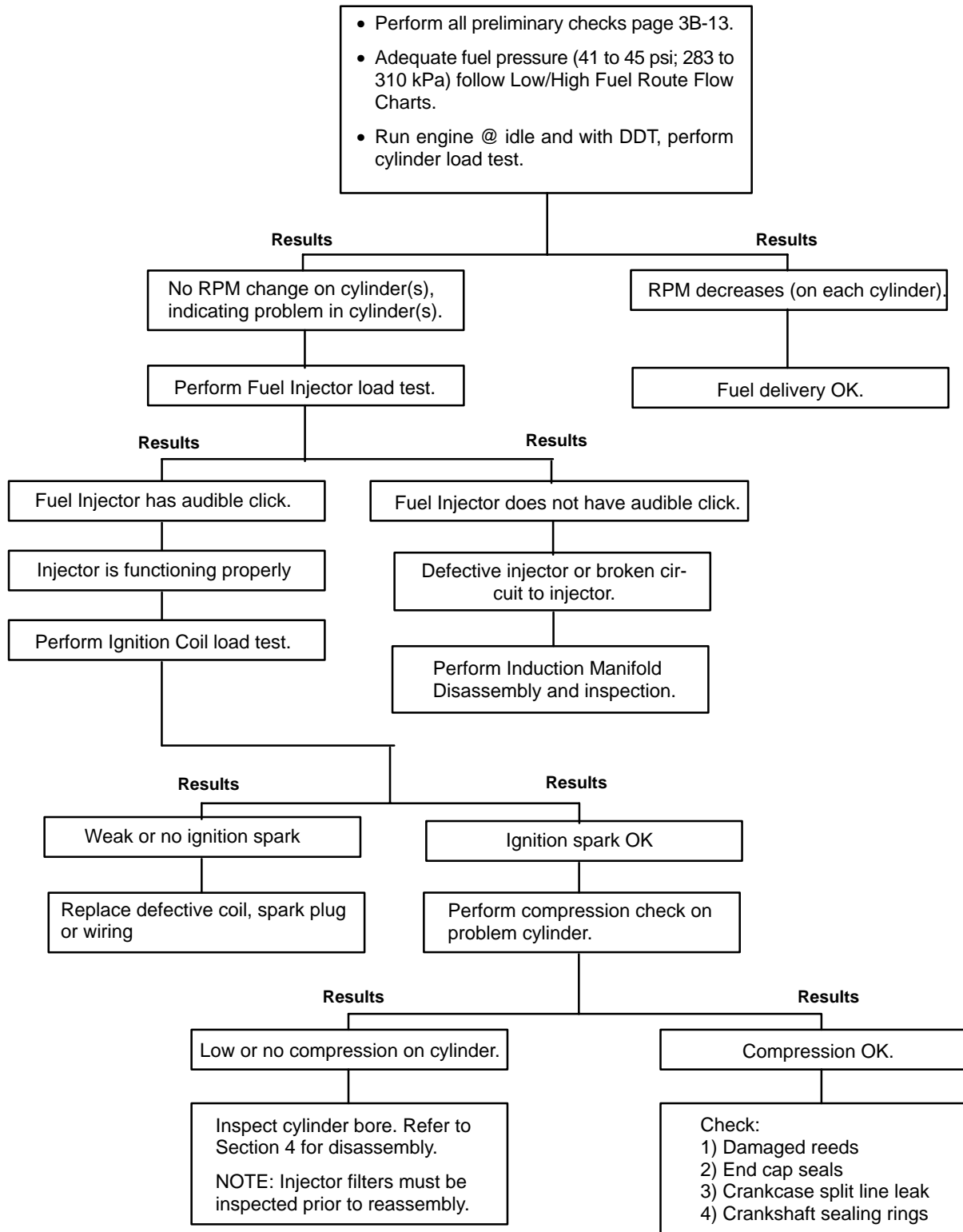
EFI Fuel Management (High Pressure Fuel Route)

- Perform low pressure checks before performing checks on high pressure route.
- Install fuel pressure gauge (P/N 91-852087A3) or (P/N 91-881834A1) on to manifold pressure port.
- Place ignition switch in "OFF" position 30 seconds before testing.
- Place ignition switch in "ON" position and note pressure (41 to 45 psi; 283 to 310 kPa).





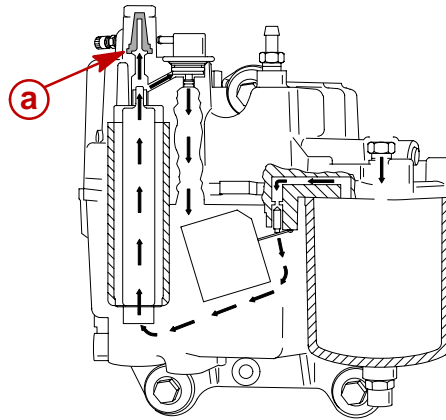
Fuel Rail Electrical/Fuel Determination





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

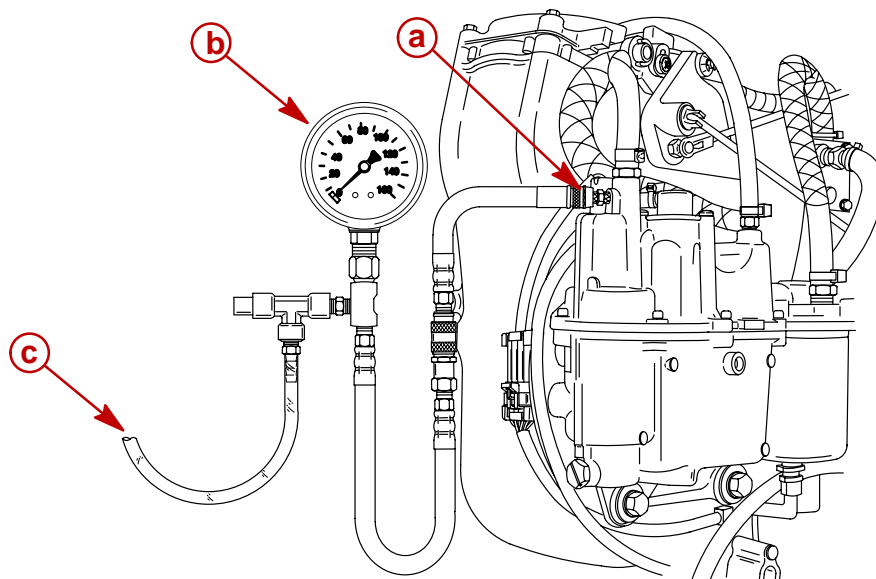
Fuel Gauge Connection/Pressure Test

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.



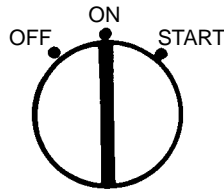
a - Pressure Port
b - Fuel Pressure Gauge
(91-881834A1)

c - Direct fuel into suitable container

59053



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.

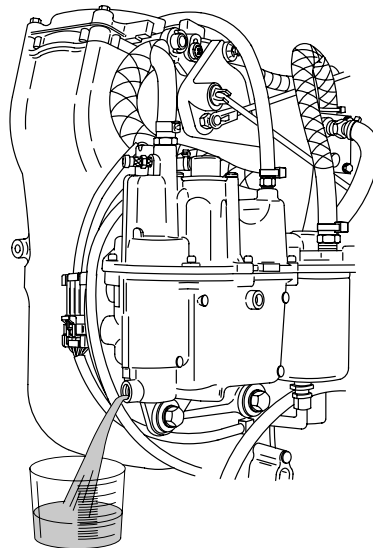
If fuel pressure is well below 41 psi (283 kPa), fuel delivery to electric fuel pump, fuel pump failure or other related problem exists. Inspect final filter for debris.

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.



59052

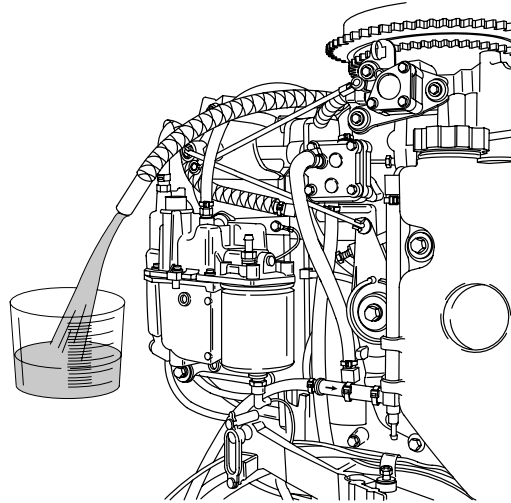
Results: Fuel should flow when plug is removed and continue to flow as primer bulb is pumped. If fuel flow is not present, inspect pulse fuel pump, water separator filter or VST float and needle valve. If fuel flow is present, go to **High Pressure Flow Chart**.



Pulse Fuel Pump Delivery Test

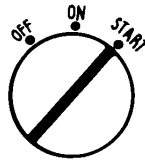
Purpose: This test will indicate pulse fuel pump is capable of supplying the low pressure fuel route with adequate fuel supply.

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



59050

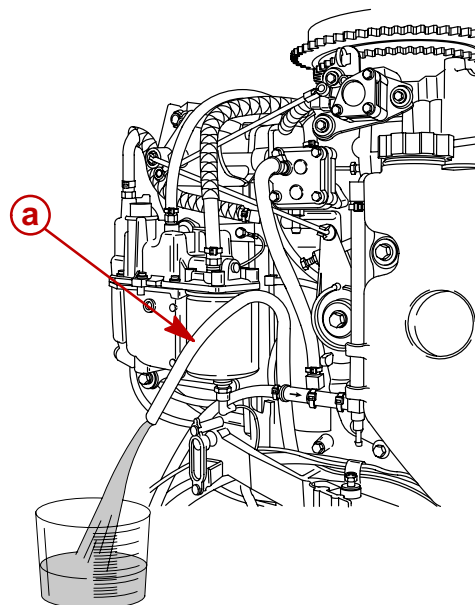
3. Turn ignition key switch to “START” and operate starter motor for 10 to 20 seconds.



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.

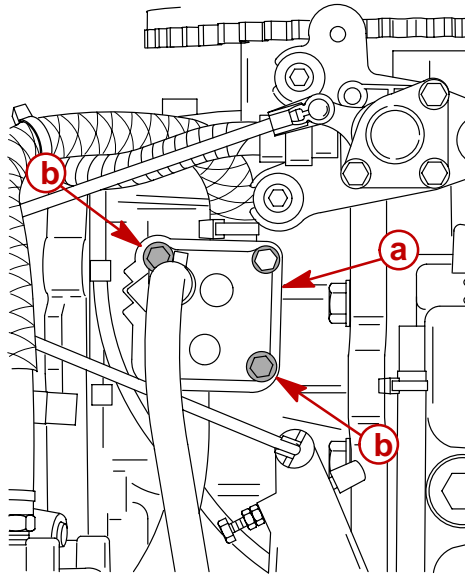


59056

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.



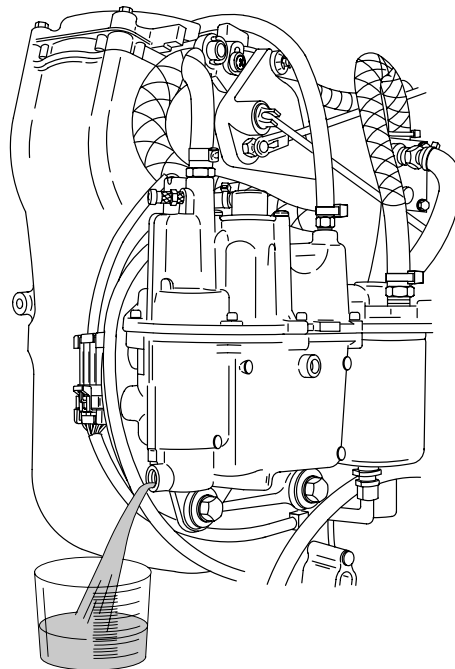
59042

a - Pulse Fuel Pump**b** - Attaching Screws

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.



59052

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**.



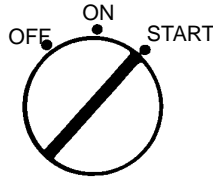
Vapor Separator Float Test

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.

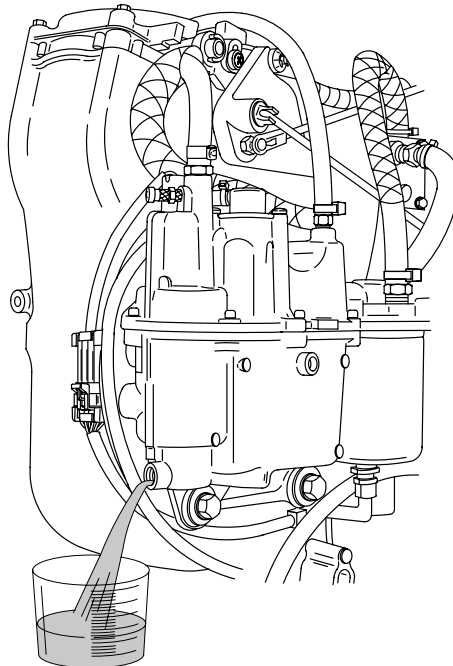
Purpose: This test will indicate if float is stuck in the up (closed) position.

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.



59052

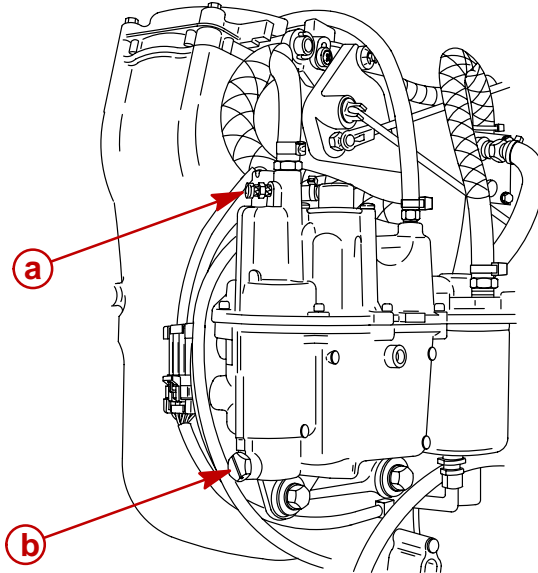
Results: If fuel flow is low or not present, remove, disassemble and inspect float assembly. See vapor separator disassembly.



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.

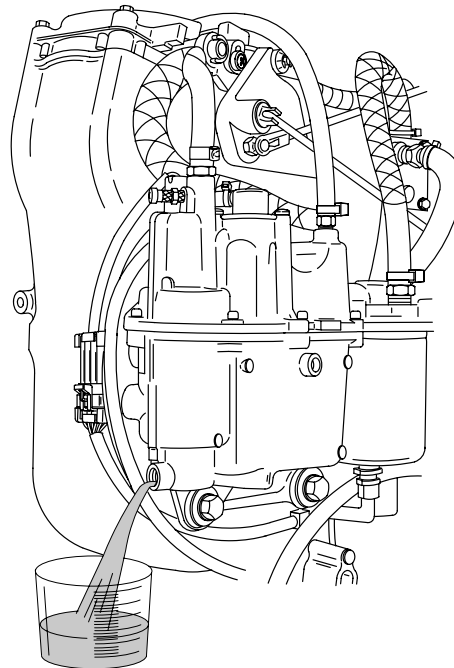
1. De-pressurize EFI fuel system by wrapping a clean cloth around pressure port valve and inserting tip of screwdriver into valve, depressing valve core. Let fuel drain from valve.



59053

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

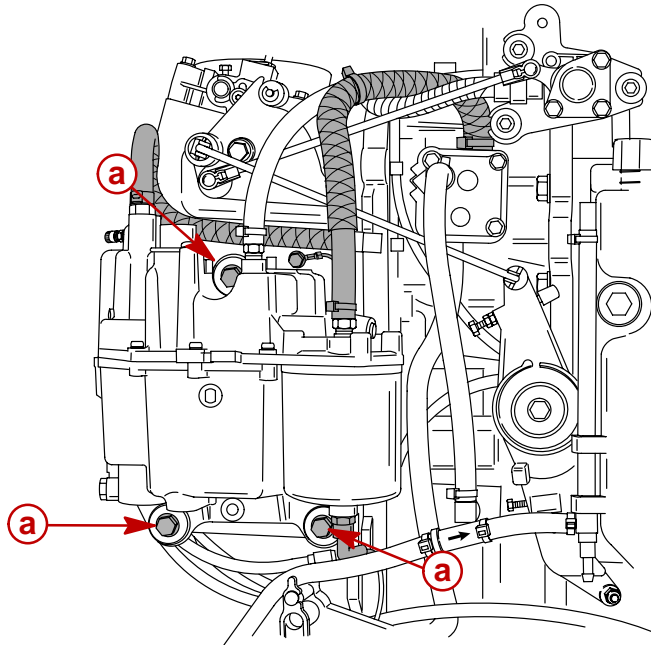
2. Remove drain plug from vapor separator and allow fuel to drain into suitable container.



59052



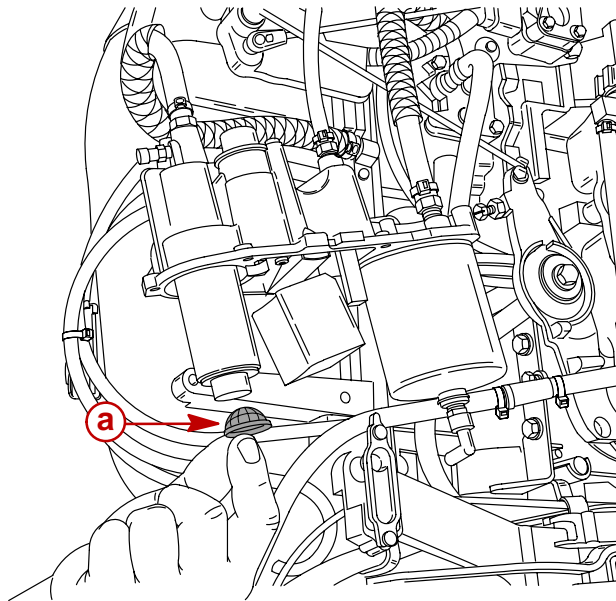
- Remove 3 bolts securing vapor separator assembly to manifold.



59047

a - Bolts

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



59055

a - Inlet Filter

- 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**.

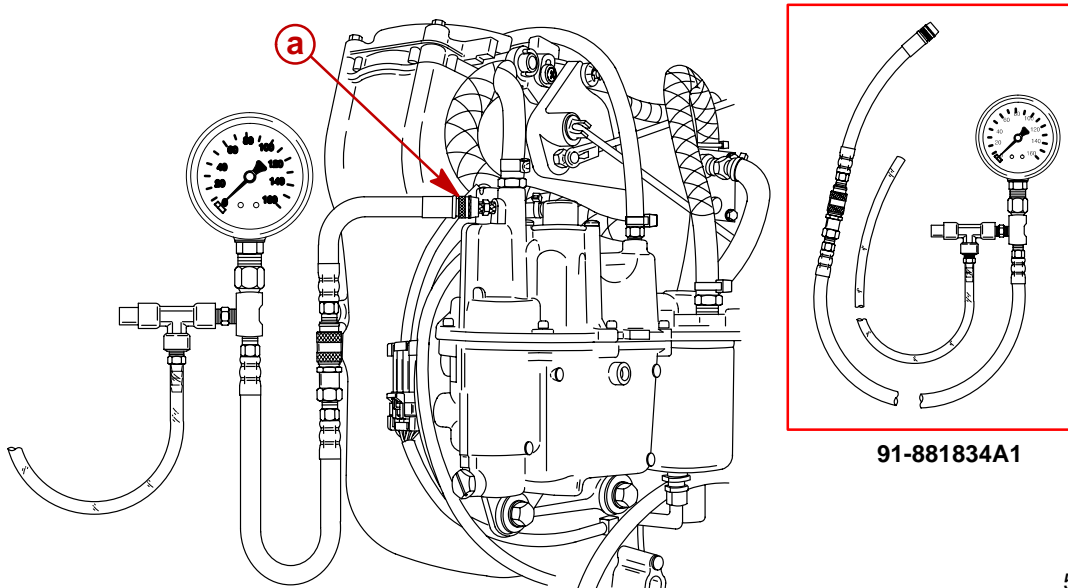


Pressure Regulator Test

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.

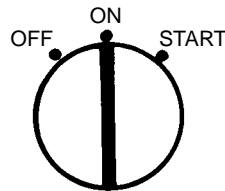


91-881834A1

59053

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.



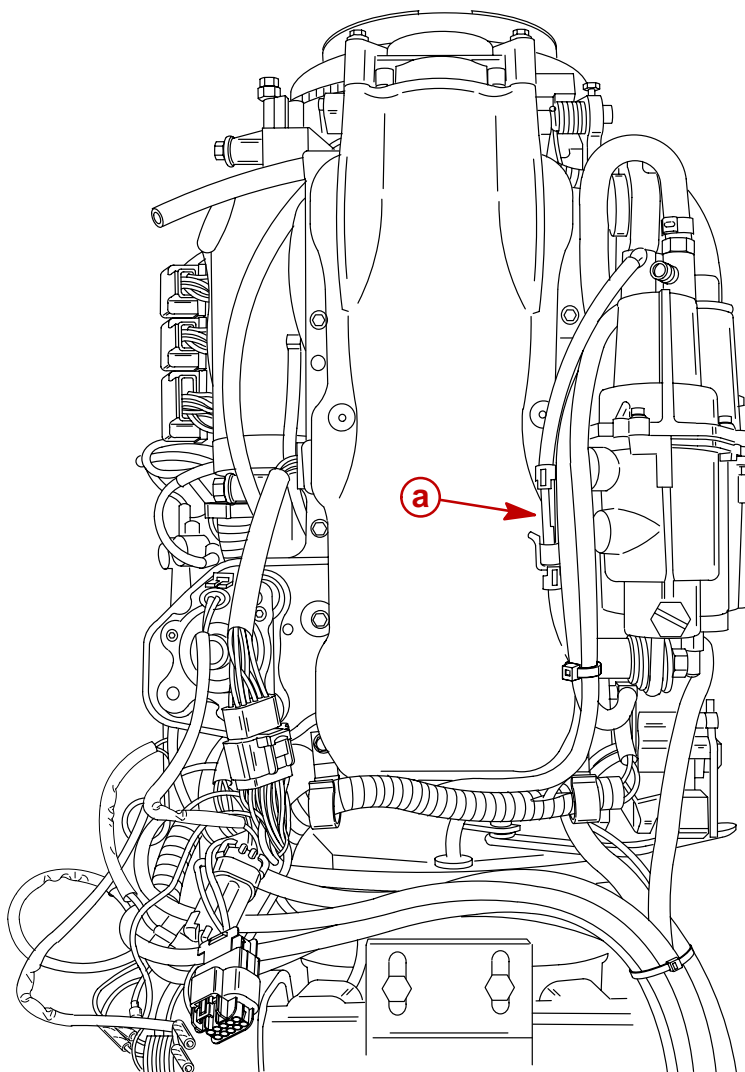


Electric Fuel Pump Voltage/Pressure Test

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).



59029

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.

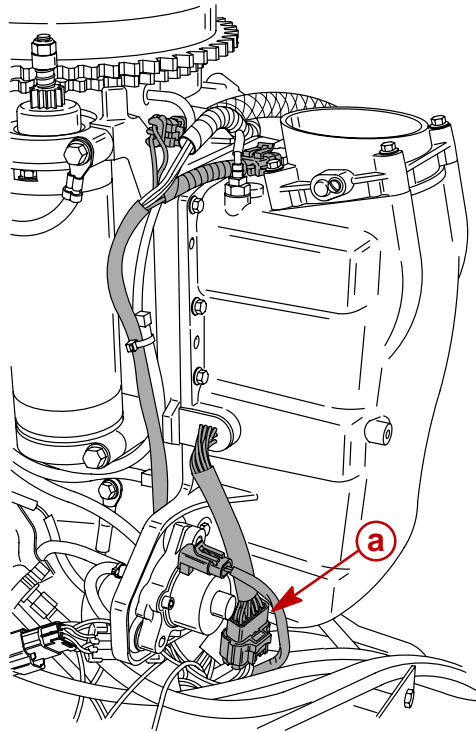
Results: If battery voltage is not present, inspect battery, battery connections and harness for corrosion, damage or loose connections. If correct battery voltage is present, replace electric pump.

NOTE: If electric fuel pump runs but fuel pressure is low, perform amperage draw test on electric pump. Amperage draw should be 4 amperes \pm 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

59058

59058

Injector Resistance

#1 Cylinder – RED + BRN Leads	12.3 ohms ± 0.5 ohms
#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	



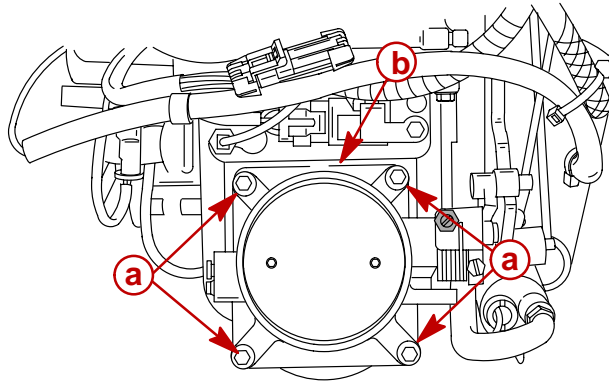
Injector Load Test

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.

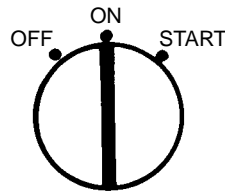


59025

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.

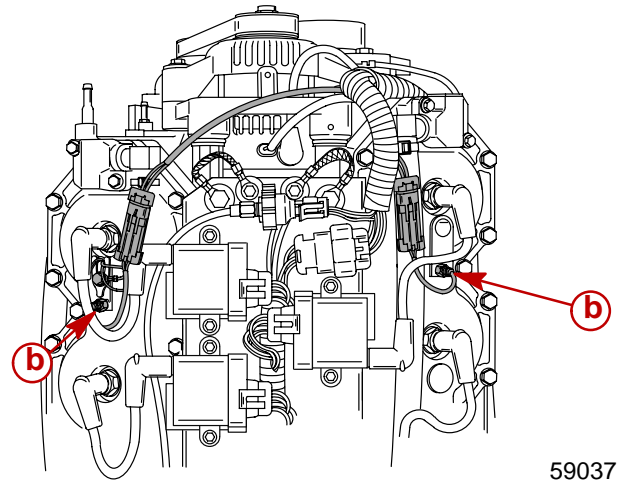
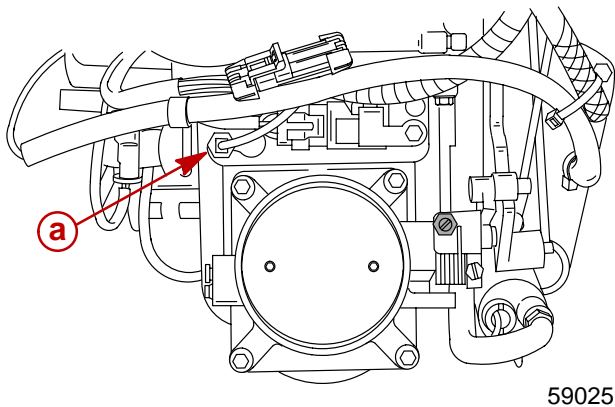
Results: If leakage is observed, refer to **Fuel Rail Removal**. Replace o-rings and/or injectors as required.



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 Multi-meter 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 $\pm 10\%$. 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.

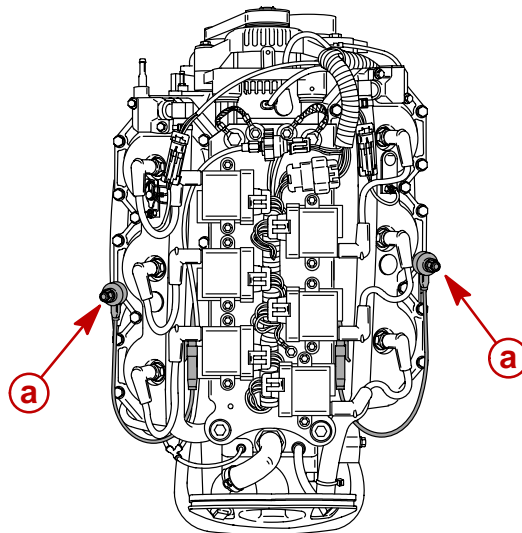
Results: Resistance does not change inversely with temperature change. Replace defective temperature sensor. Resistance changes inversely with temperature change. Temperature sensor OK.

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



Temperature Sensor Specifications		
Fahrenheit	Centigrade	OHMS
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 Work Models Only)



59034

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.

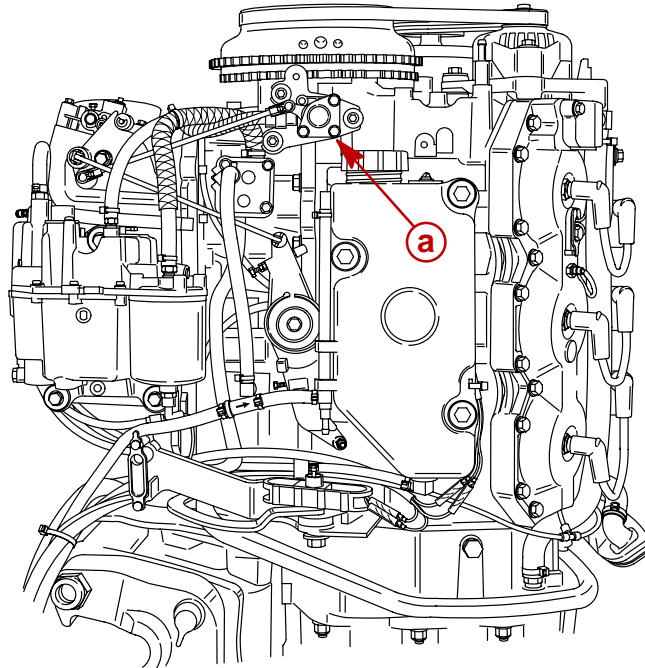
NOTE: If either knock sensor is not functioning, #4 LED indicator light on DDT will be illuminated.

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



59030

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.



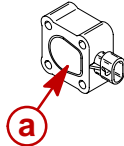
PRESSURE TEST

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

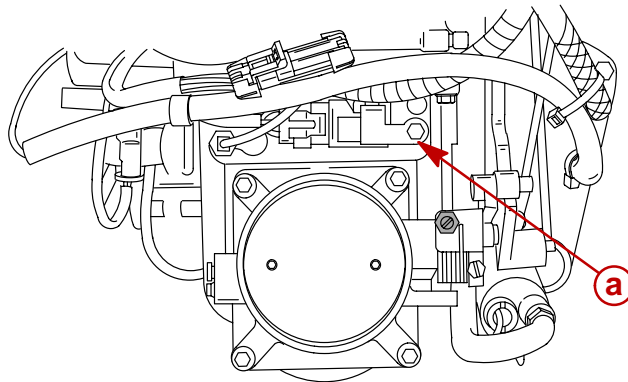
5. Voltage reading should change:
 - Less than a couple of digits (i.e. 1.90 v to 1.92 v)

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



59025

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	<ul style="list-style-type: none">- Failed Ignition Coil- Low Compression- Broken Reed- Fuel Delivery Problem- Fuel Rail Leak- Vapor Separator Flooding Over, Engine Running Rich.- Cylinder Head Temperature Sensor Circuit Failed.	<p>Refer to Section 2 Electrical and Ignition Tests.</p> <p>Refer to Section 4 Power Head.</p> <p>Inspect Reeds.</p> <p>Follow Low/High Pressure Fuel Route Flow Charts and Fuel Rail Electrical/Fuel Determination Flow Chart.</p> <p>Perform Fuel Rail Leak Test.</p> <p>Check for fuel coming out of vapor separator vent hose.</p> <p>Check cylinder head temperature sensor.</p>
Poor Acceleration – Idles Ok, Top Speed Ok	<ul style="list-style-type: none">- Improper EFI Set Up.- Water Covering Idle Relief Exhaust Ports.- T.P.S. Failure.- MAP Sensor Failure- R.F.I. Problem*	<p>Refer to Section 2 Electrical and Ignition for proper EFI set up procedures.</p> <p>Boats with extended transoms or low engine mount can cause engine to load up on acceleration.</p> <p>Refer to page 3B-33.</p> <p>Refer to page 3B-34.</p> <p>Install BPZ8HS-10 Spark Plugs.</p>



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)	<ul style="list-style-type: none"> – Ignition Coil Failure. – Broken Reed. 	<p>Refer to Section 2A Electrical and Ignition Tests.</p> <p>Inspect Reed Assembly</p>
Engine Runs but Slowly Drops RPM then Dies.	<ul style="list-style-type: none"> – Restrictions in Fuel System between Tank and Engine. – Clogged Final Filter. – Pulse Fuel Pump Failure. – Electric Fuel Pump Delivery Failure. 	<p>Install remote gas tank with fresh, high quality fuel.</p> <p>Perform Final Filter Check.</p> <p>Follow Low Pressure Fuel Route Flow Chart.</p> <p>Follow High Pressure Fuel Route Flow Chart.</p>
Engine Stops for No Apparent Reason or Does Not Start.	<ul style="list-style-type: none"> – Battery Undercharged. – EFI Harness Connections. – Ignition System Failure. – Pulse Fuel Pump Failure. – Electric Fuel Pump Failure. – ECM Failure. 	<p>Check battery connections, under charged battery or worn out battery.</p> <p>Check EFI harness connector for improper connection.</p> <p>Refer to Section 2A Electrical and Ignition Tests.</p> <p>Follow Low Pressure Fuel Route Flow Chart.</p> <p>Follow High Pressure Fuel Route Flow Chart.</p> <p>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.</p>
Engine Stops for No Apparent Reason, but will Restart.	<ul style="list-style-type: none"> – Restriction in Fuel System 	<p>Check fuel pressure on fuel rail at the RPM that failure occurs.</p>

*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)



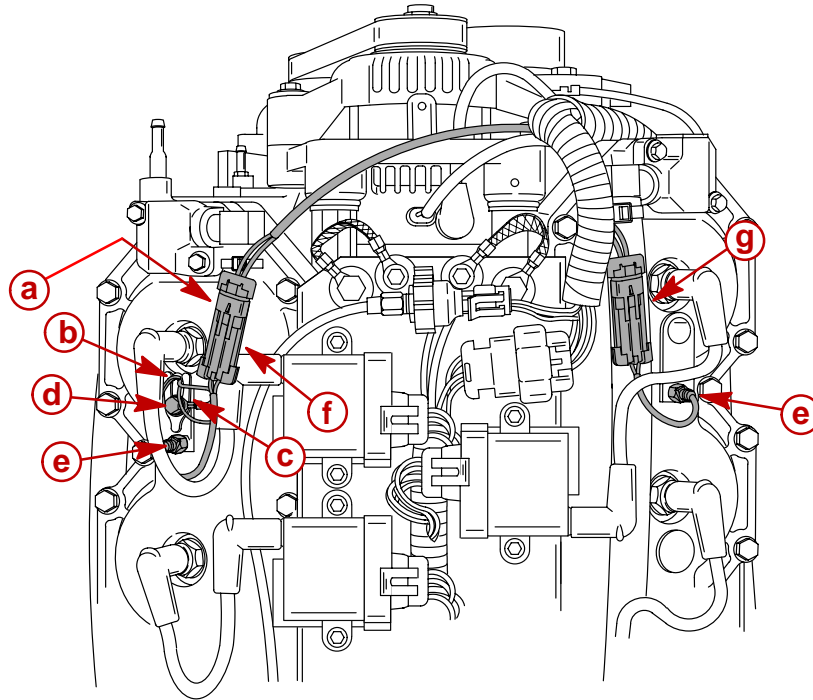
Engine Head Temperature Sensor Removal

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



59037

- a** - Bullet Connector (hidden)
- 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.



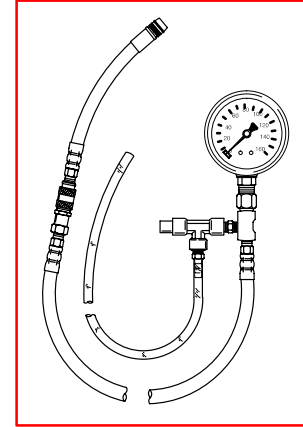
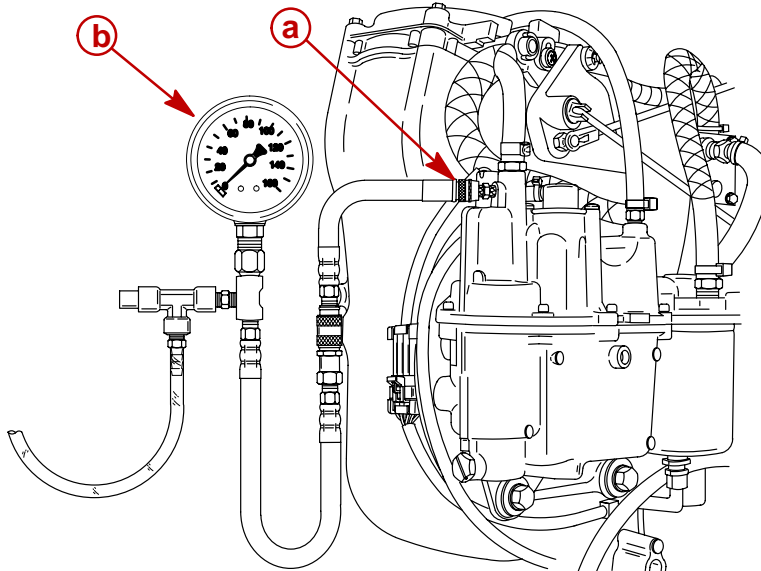
Fuel Management Assembly Removal

⚠ 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.

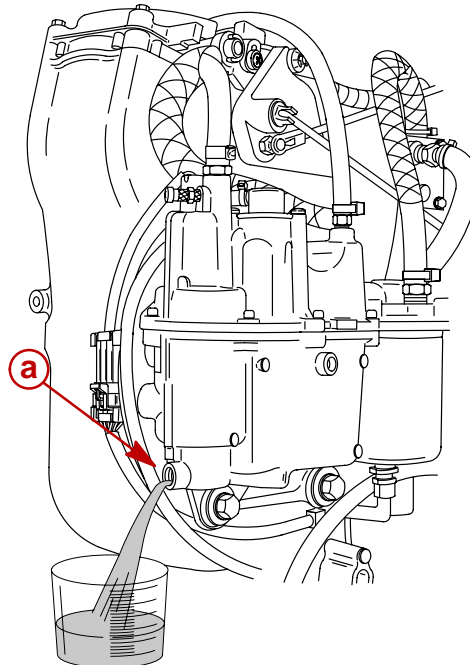


91-881834A1

a - Fuel Pressure Port

b - Fuel Pressure Gauge 91-881834A1

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

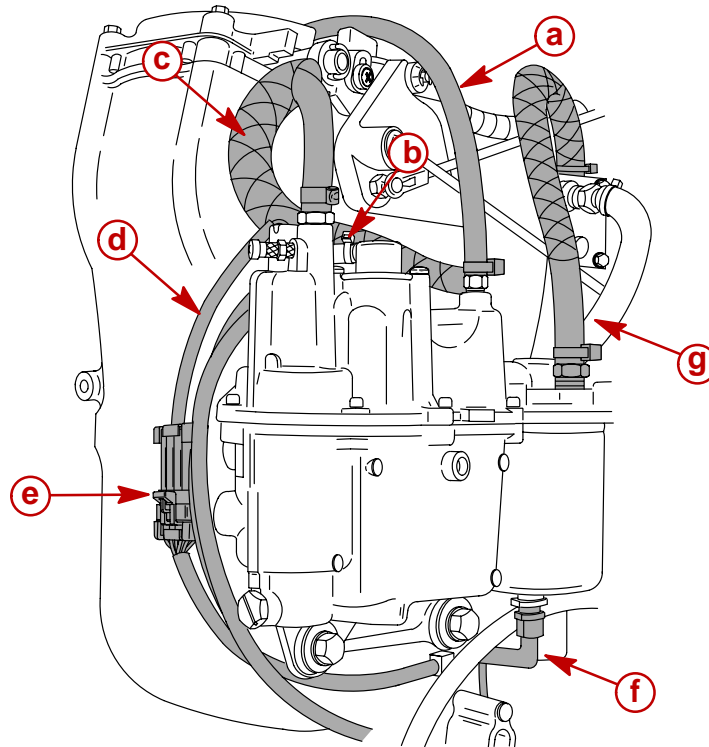


a - Drain Plug

59052



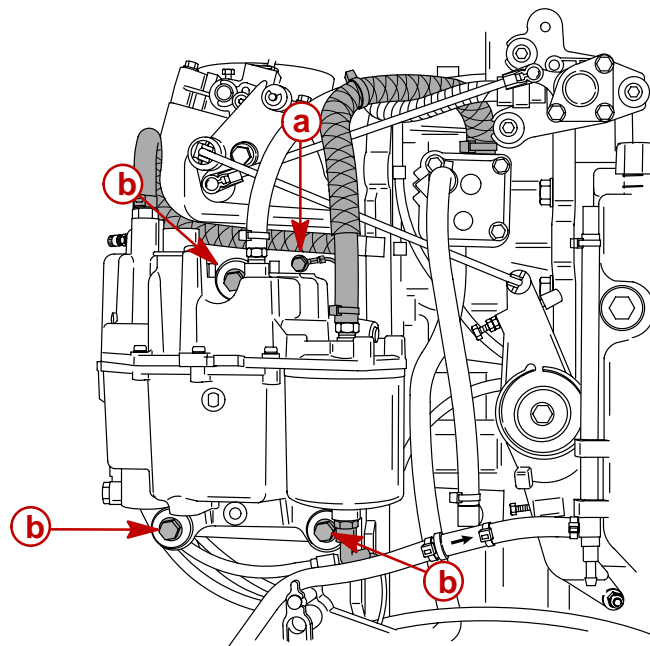
3. Disconnect the following hoses and connectors:



59051

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

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

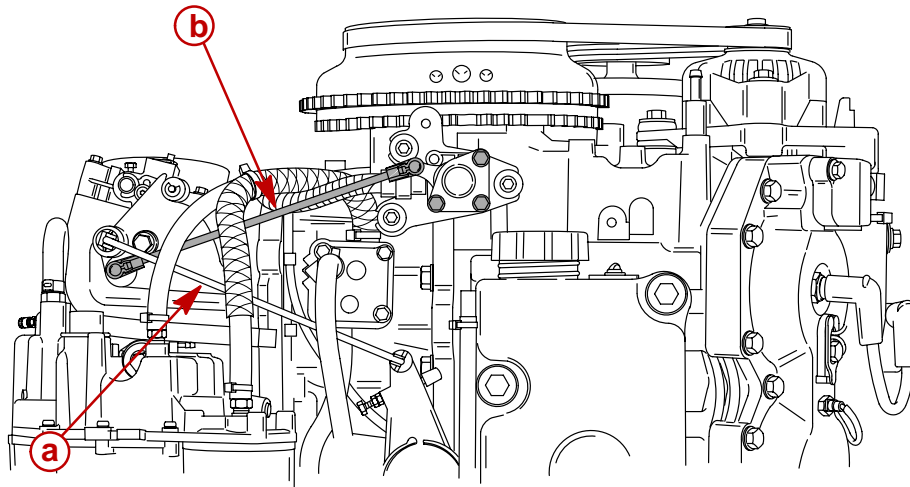


59047

- | | |
|----------------------------|--------------------------------|
| a - VST Ground Lead | b - VST Attaching Bolts |
|----------------------------|--------------------------------|



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

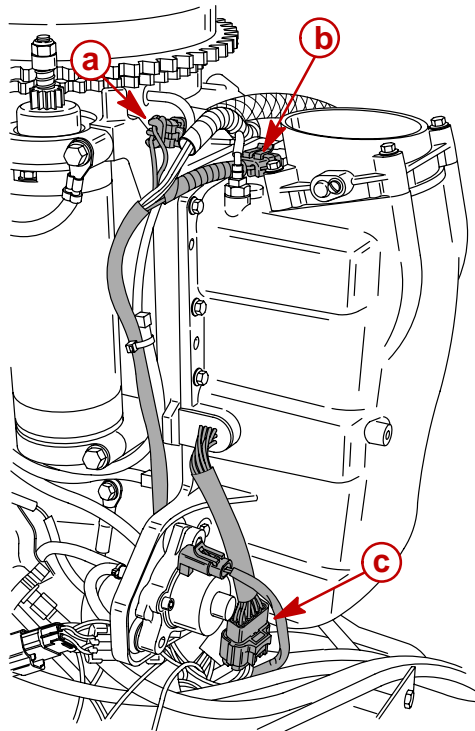


59046

a - Throttle Cam Link Rod

b - Throttle Position Sensor Link Rod

7. Disconnect the following hoses and connectors:



59058

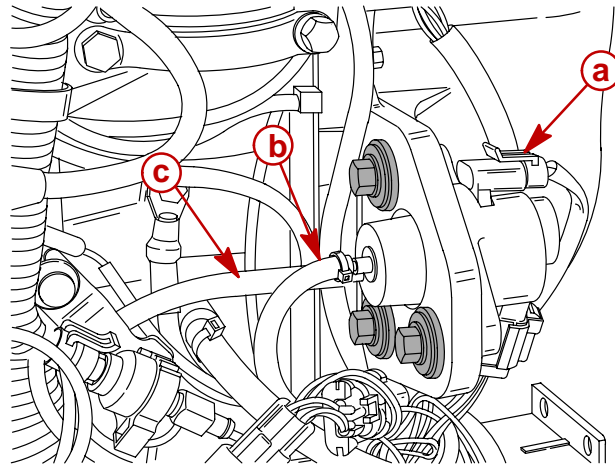
a - Air Temperature Sensor

b - MAP Sensor

c - Fuel Injector Harness Connector



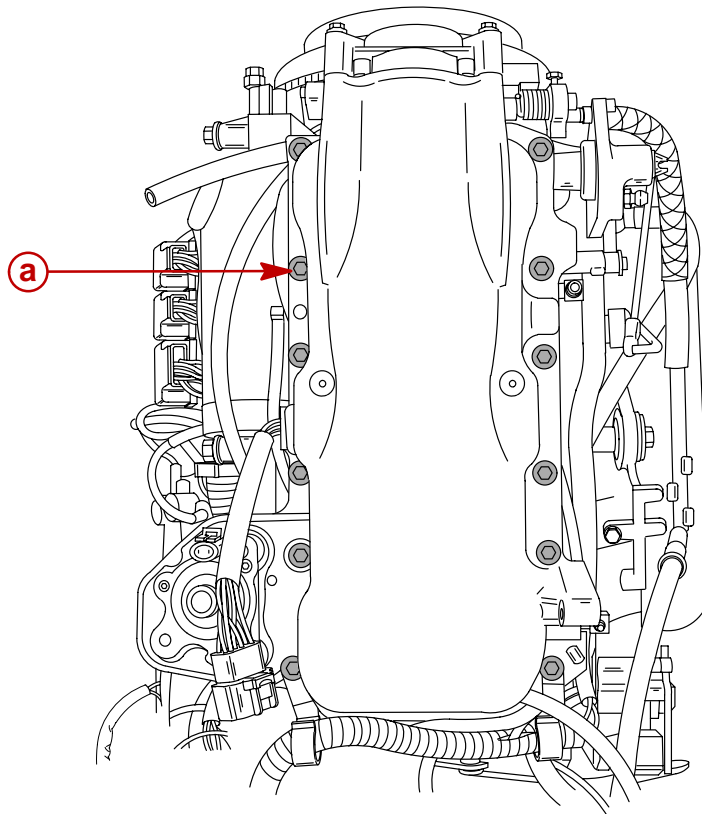
- Disconnect oil pump electrical harness, oil pump inlet and outlet hoses.



59039

- a** - Electrical Harness
- b** - Oil Outlet Hose
- c** - Oil Inlet Hose

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



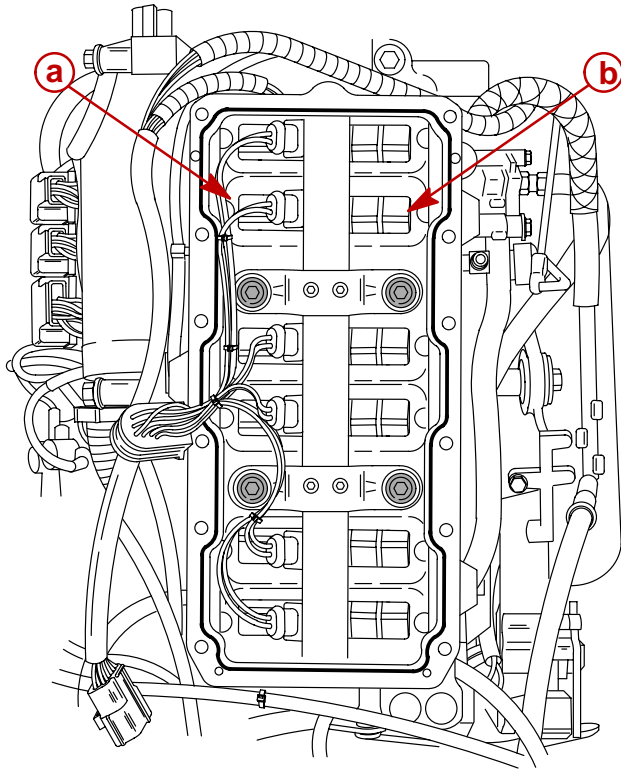
59061

- a** - Bolts (12 each)



Fuel Rail Removal

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

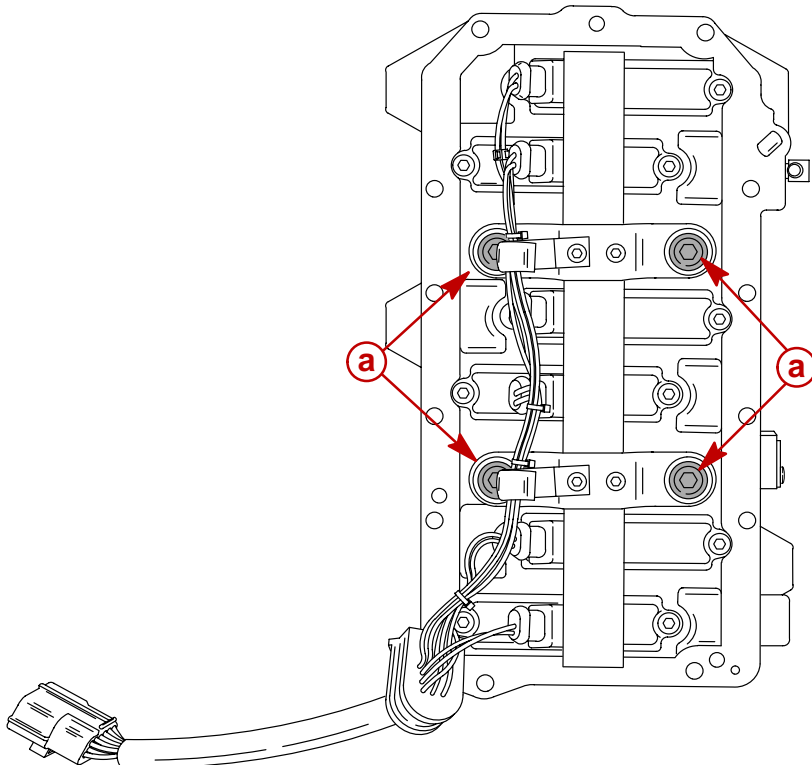


59057

a - Fuel Rail/Injector Assembly

b - Reed Block Assembly

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

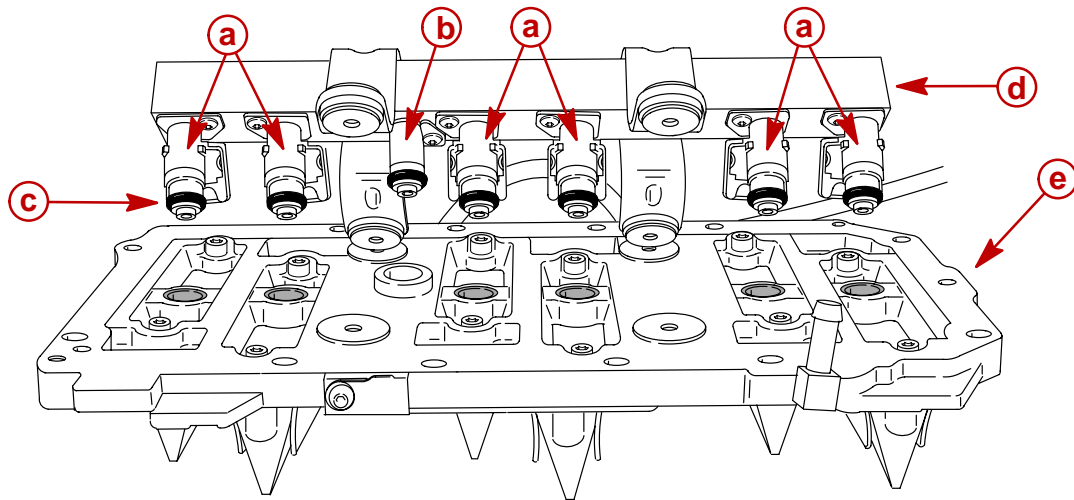


59054

a - Screws



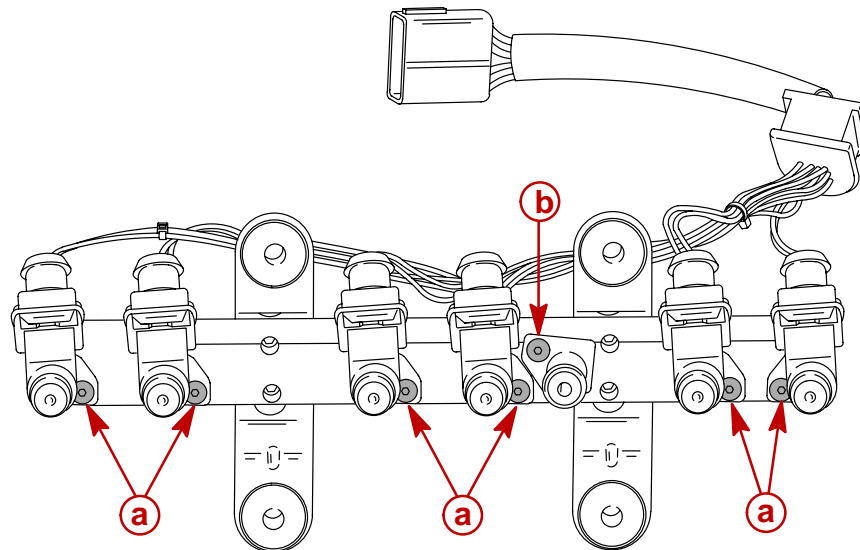
2. Lift fuel rail assembly from reed block assembly.
3. Inspect o-rings for cuts and abrasions. Replace if necessary.



59048

- 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.



58792

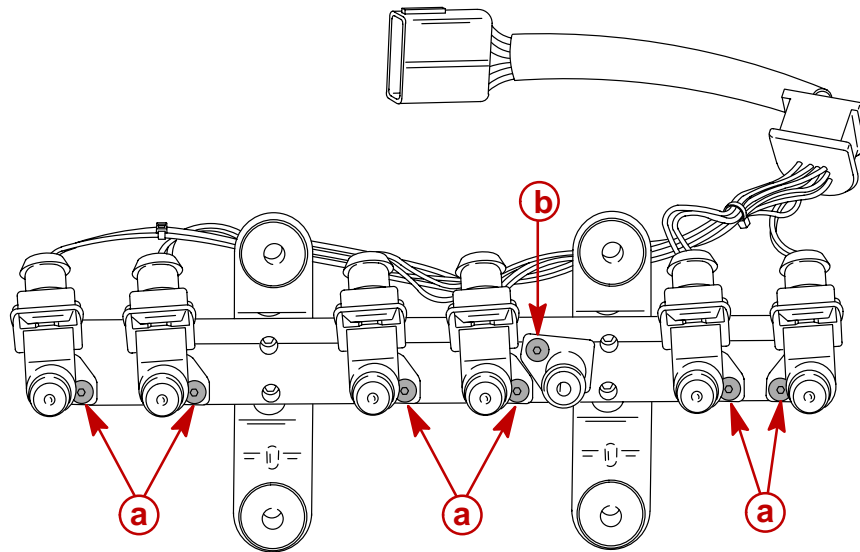
- a** - Fuel Injector Attaching Screws
- b** - Fuel Inlet Pipe Attaching Screw



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].

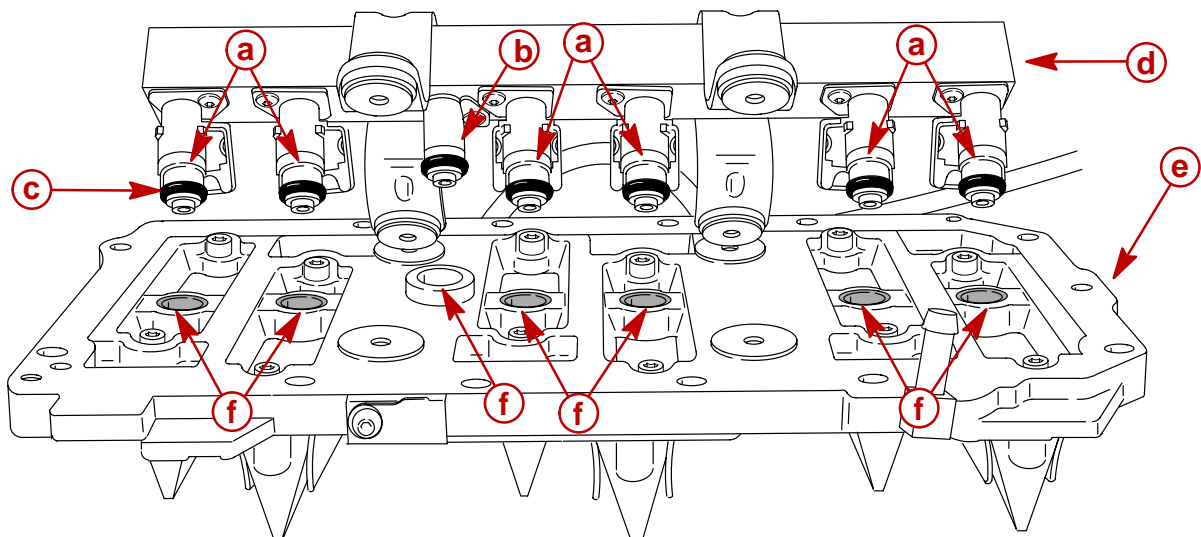


58792

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.



58881

a - Fuel Injectors (6)

b - Fuel Rail Fuel Inlet Pipe

c - O-Rings

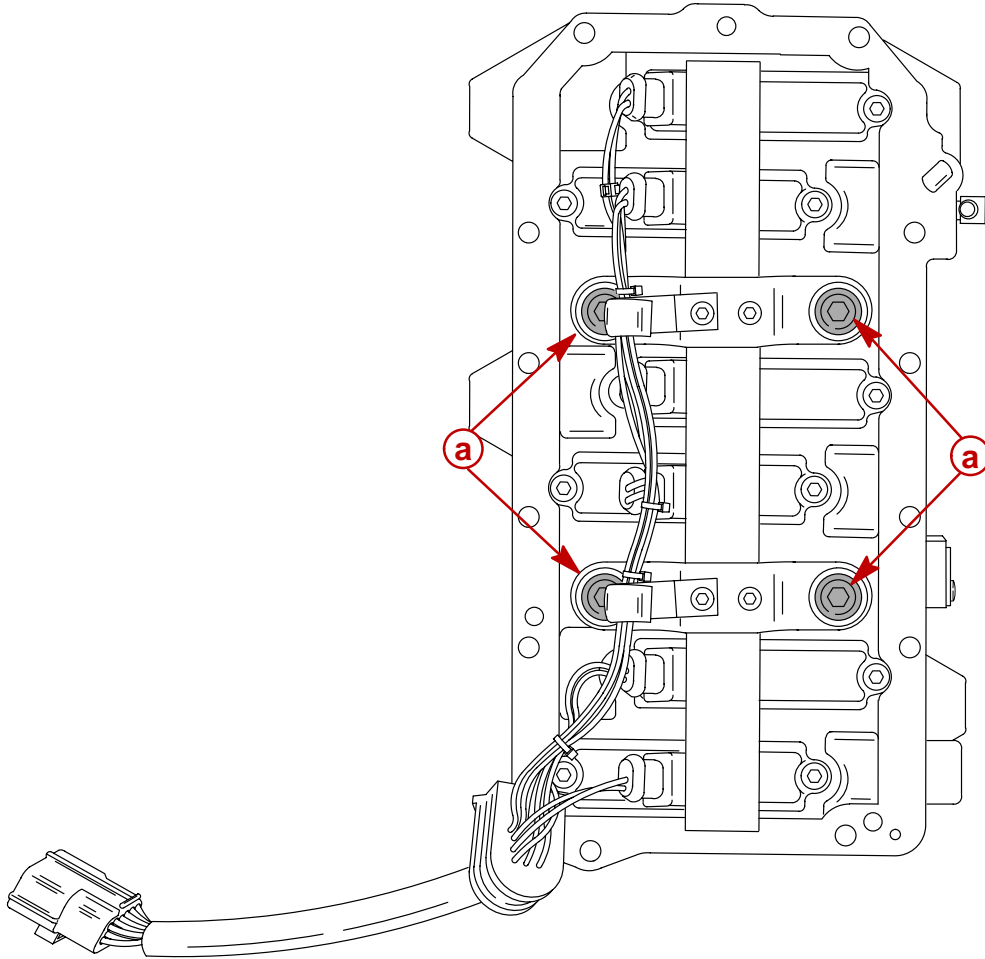
d - Fuel Rail

e - Reed Block Assembly

f - O-Ring Contact Surface



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



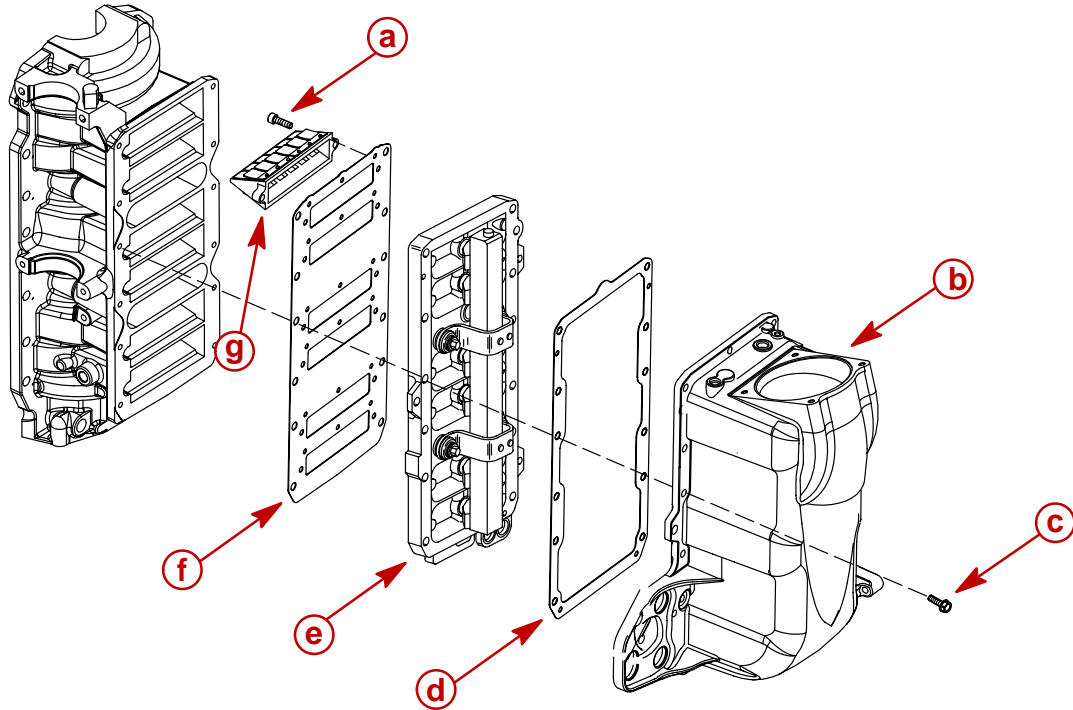
59054

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.



59045

- 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

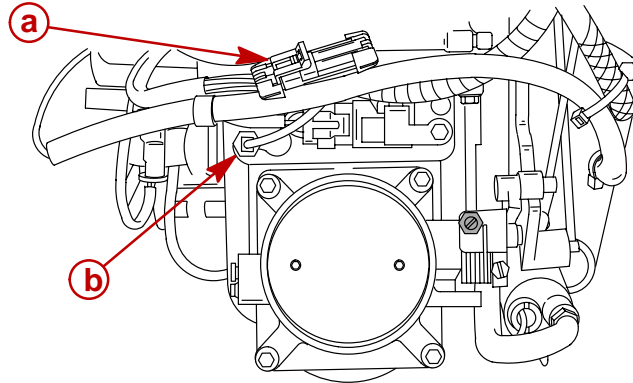
NOTE: The gasket between the air plenum and the adaptor plate has a sealing bead which faces toward the air plenum during assembly. Gaskets may be reused if they do not show signs of tears, abrasions or oil saturation. Replace gaskets if necessary.

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.



a - Temperature Sensor Harness

b - Air Temperature Sensor

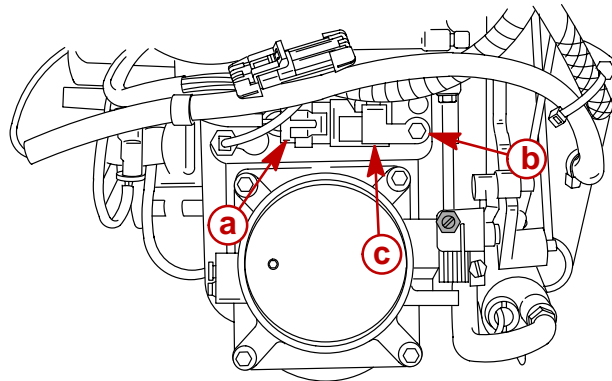
59025

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.



a - MAP Harness Connector

b - Retaining Screw

c - MAP Sensor

59025

Manifold Absolute Pressure (MAP) Sensor Installation

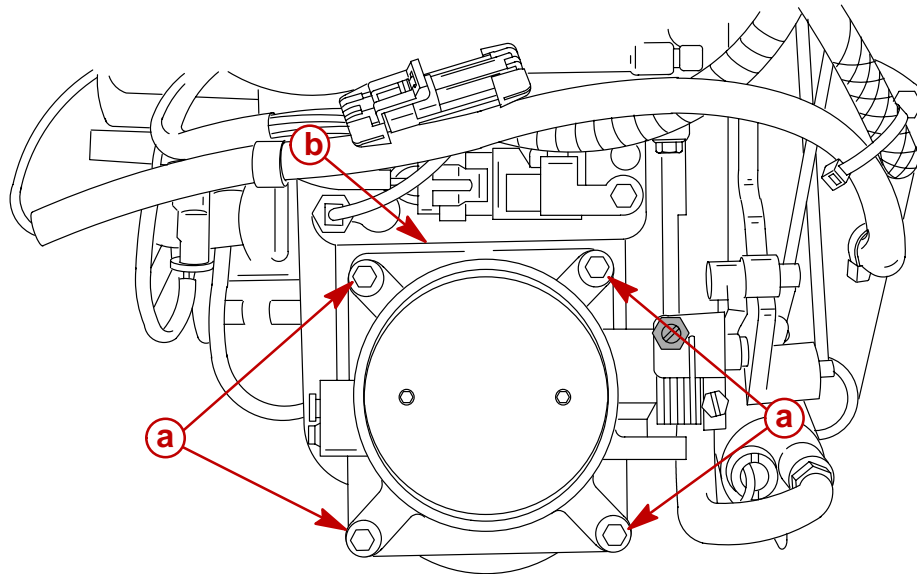
1. Secure MAP sensor with screw. Torque screw to 80 lb. in. (9.0 Nm).
2. Reconnect sensor harness.



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.



a - Bolts

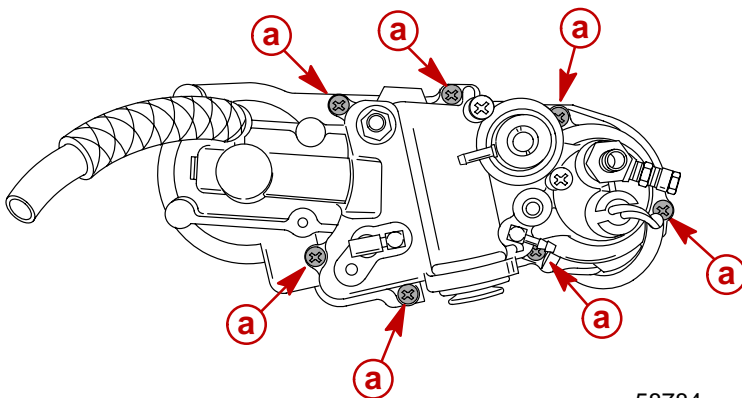
b - Throttle Plate Assembly

Throttle Plate Assembly Installation

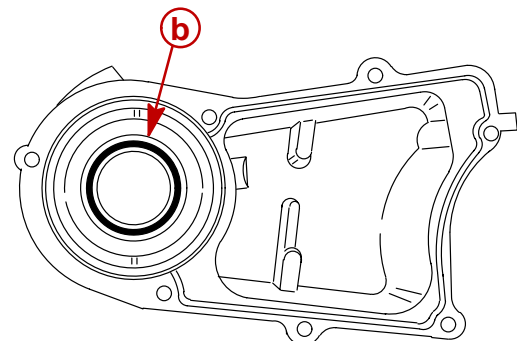
Secure throttle plate assembly to air plenum with 4 bolts. Torque bolts to 100 lb. in. (11.5 Nm).

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 abrasions. Replace seal if necessary. If seal is serviceable, apply 2-4-C Marine Lubricant with Teflon to seal lips.



58784



58783

a - Screws (7 each)

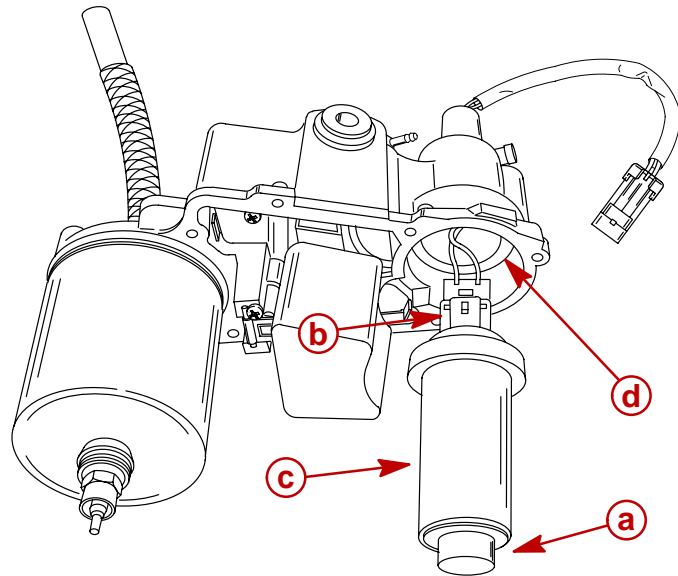
b - Seal

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 abrasions. Replace seal if necessary. Apply 2-4-C Marine Lubricant with Teflon to seal lips.

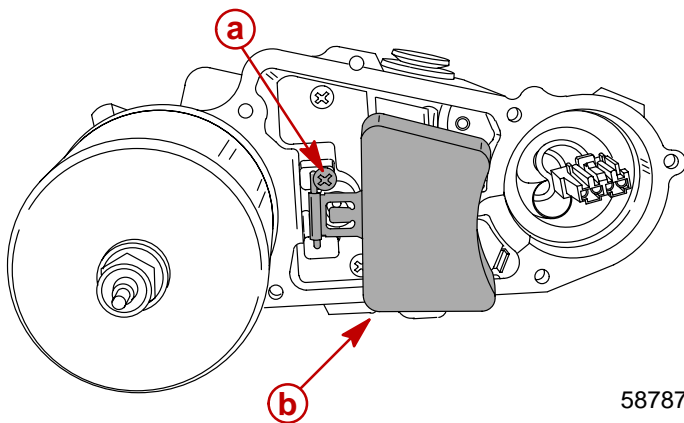


a - Filter Screen
b - Harness Connector

c - Pump
d - Seal (Seal shoulder faces OUT)

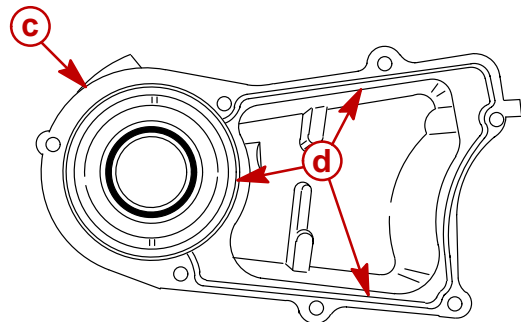
58786

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 abrasions. Replace gasket/seal assembly as required.



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

58787



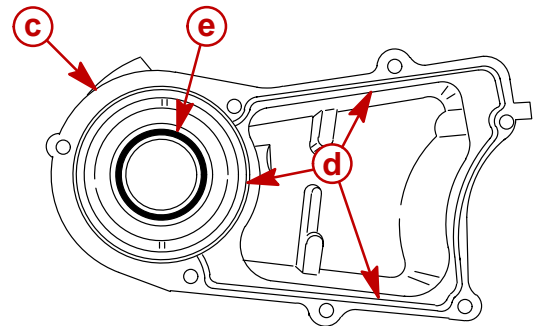
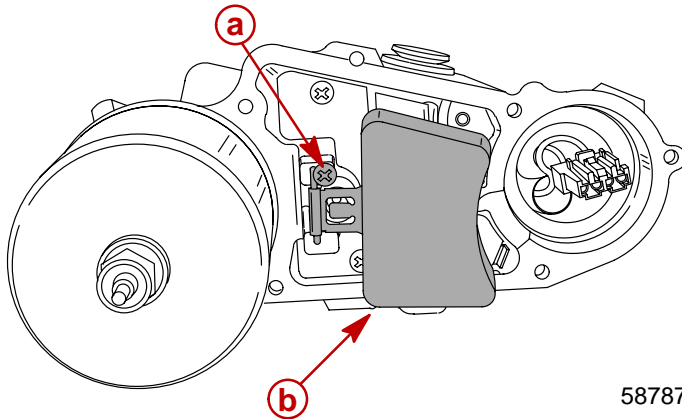
58783



Vapor Separator Reassembly

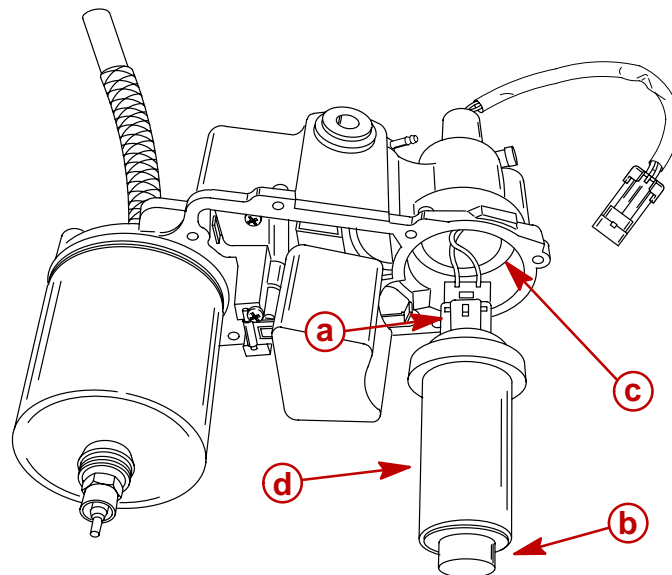
NOTE: Inspect VST cover gasket with sealing bead for cuts or abrasions. Replace if necessary. Inspect fuel pump seal in VST cover for cuts or abrasions. Replace if necessary.

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 Marine Lubricant with Teflon to lips of seal in separator cover.



- a - Screw [Torque to 10 lb. in. (1.0 Nm)]
- b - Float
- c - Gasket
- d - Sealing Bead
- e - Seal (Seal shoulder faces OUT)

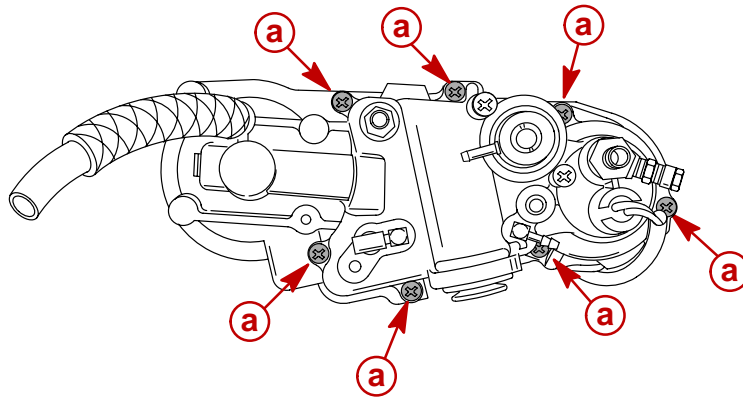
4. Connect electrical harness to fuel pump. Inspect fuel pump filter screen for debris. Remove screen and clean as required.
5. Seat fuel pump and harness into separator cover being careful not to pinch harness.



- 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).

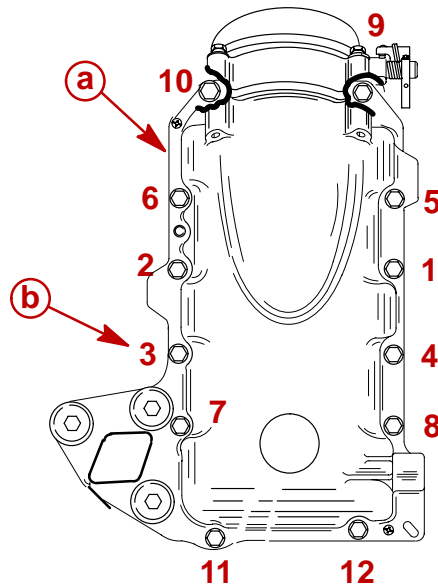


58784

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



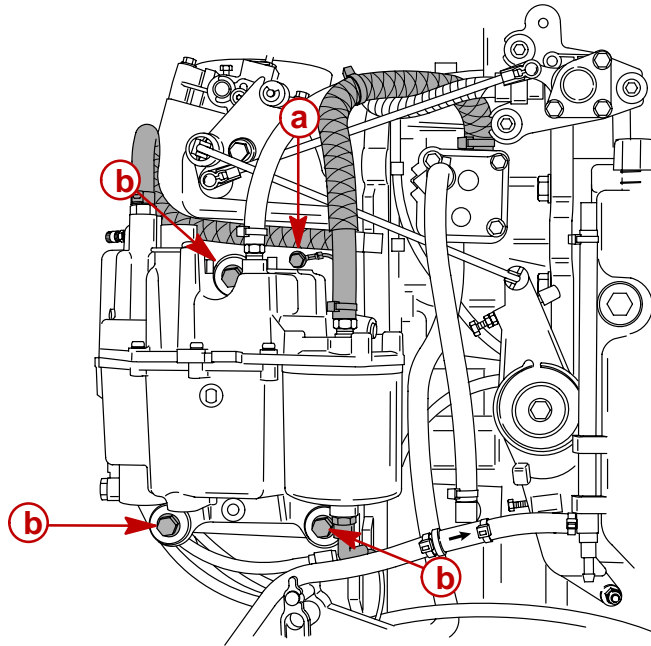
56144

a - Air Plenum
b - Bolts [Torque to 125 lb. in. (14 Nm)]



Vapor Separator (VST) Installation

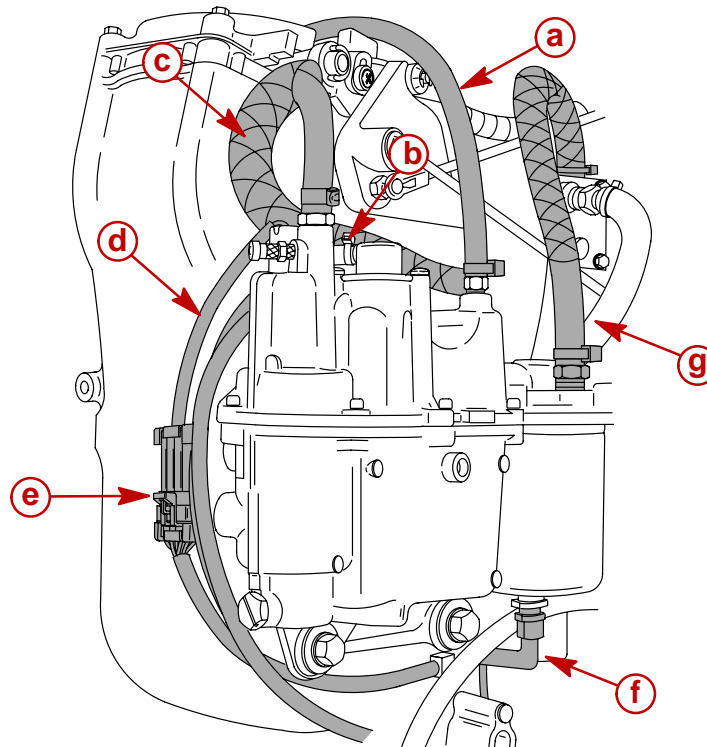
1. Install ground lead between VST and air plenum.
2. Install 3 bolts securing VST to air plenum. Torque bolts to 140 lb. in. (16 Nm).



59047

a - VST Ground Lead**b** - Bolts [Torque to 140 lb. in. (16 Nm)]

3. Reconnect the following hoses and connectors:



59051

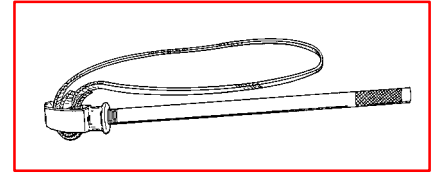
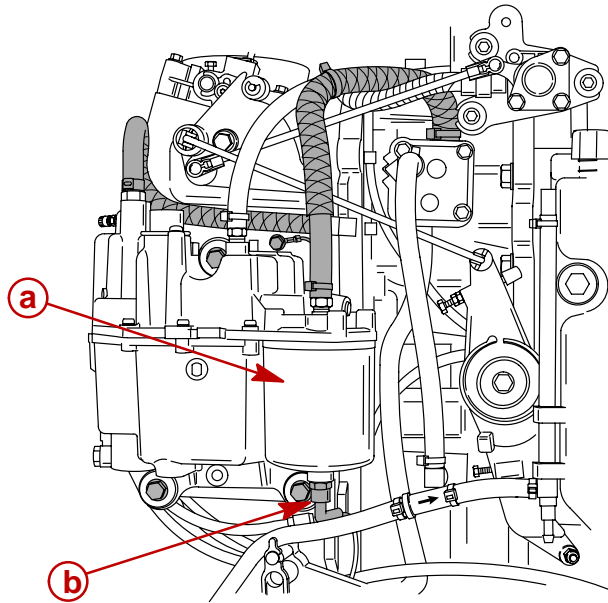
a - VST Vent Hose**b** - Fuel Pressure Regulator Vent Hose**c** - VST Output Fuel Hose**d** - VST Oil Input Hose**e** - VST Electric Fuel Pump Harness Connector**f** - Water Sensor Bullet Connector**g** - Fuel/Water Separator Input Fuel Hose



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.



91-24937A1

- a** - Water Separator
b - Water Sensor Lead

59047

Water Separating Filter Assembly Installation

IMPORTANT: Apply a light coat of outboard oil to the rectangular sealing ring on the water separator before installation.

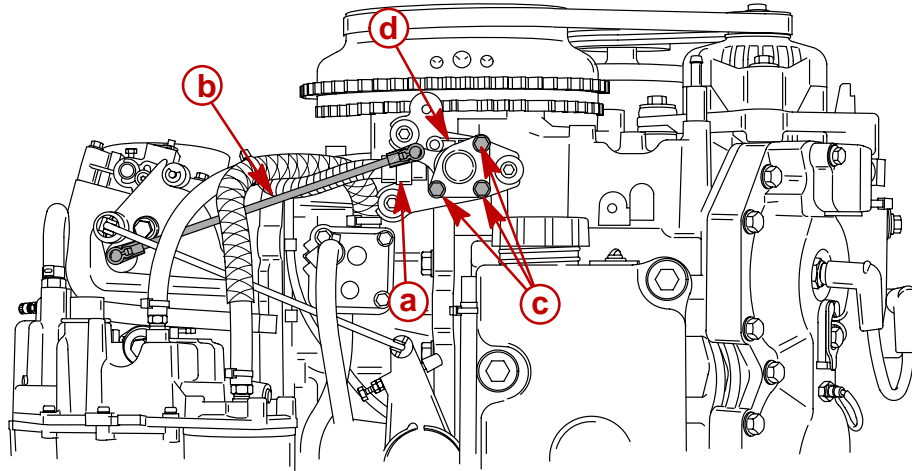
1. After applying oil to sealing ring of water separator, install separator onto bracket.
2. **HAND TIGHTEN SEPARATOR. DO NOT** use strap wrench or other tool to tighten separator.
3. Reconnect water sensor lead to bottom of separator.



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.



59046

a - Sensor Harness Connector
b - Sensor Link Rod

c - Retaining Screws
d - Throttle Position Sensor

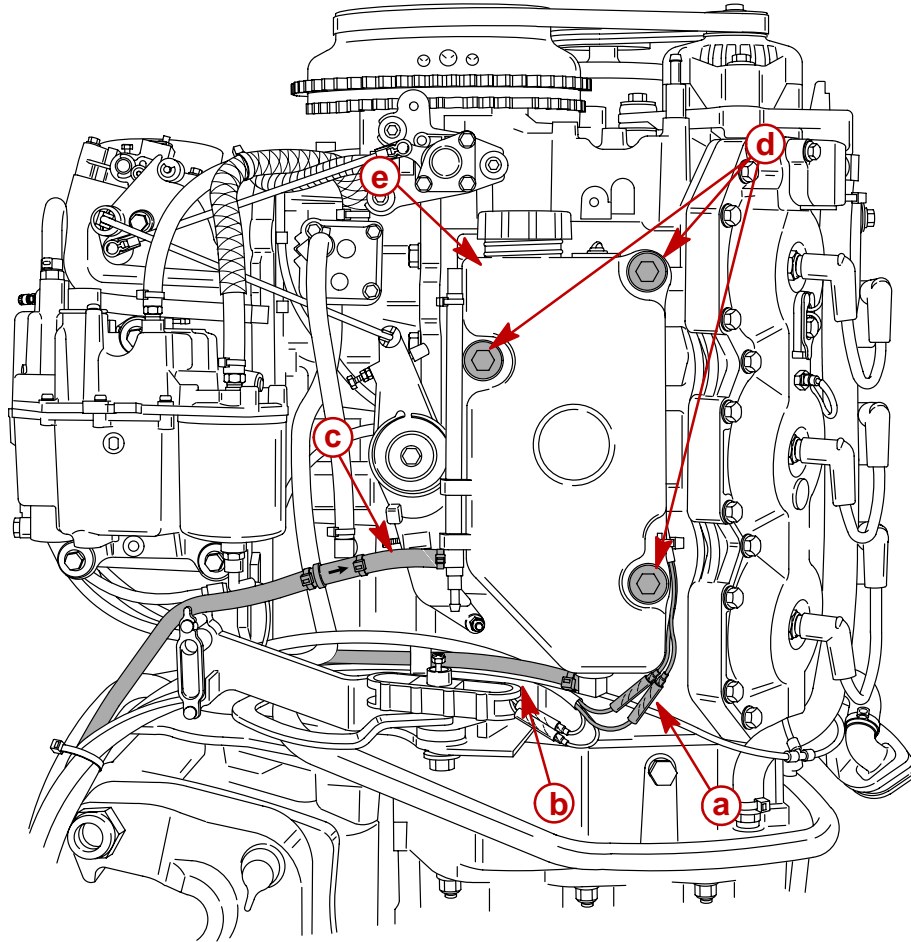
Throttle Position Sensor Installation

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.



59063

- 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

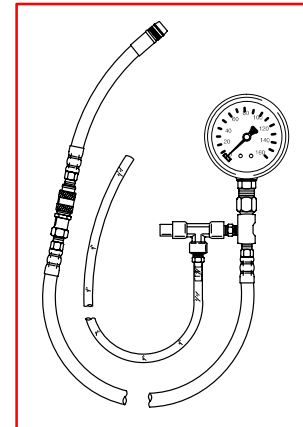
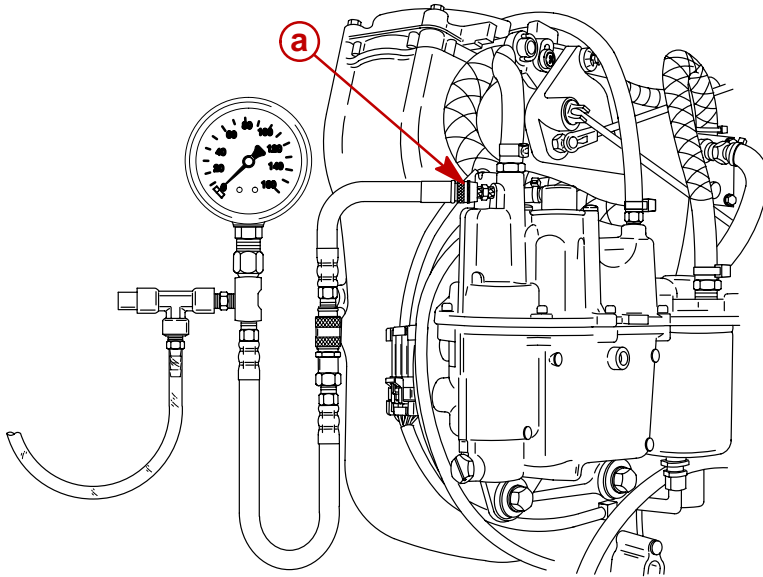
1. Disconnect boat battery from engine harness.

⚠ 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.

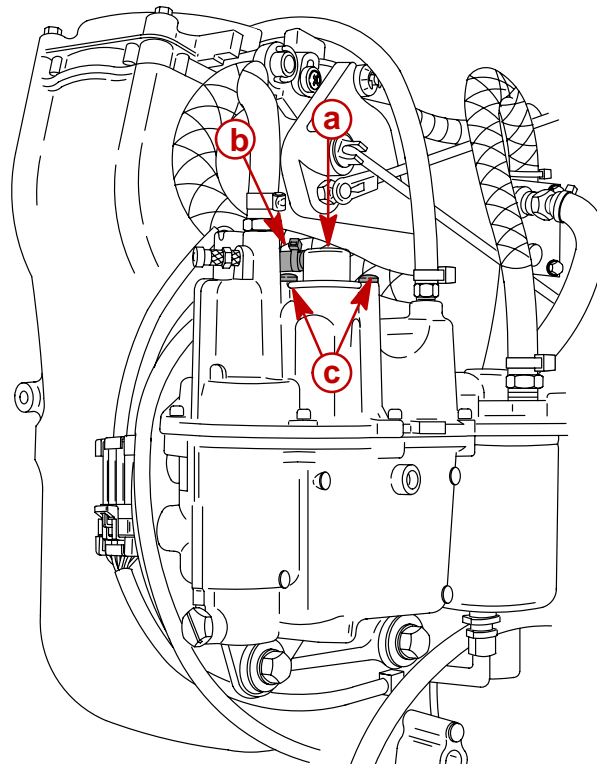


91-881834A1

59053

a - Fuel Pressure Port

2. Remove fuel regulator vent hose from pressure regulator.
3. Remove 2 screws securing regulator to separator and remove regulator.



59064

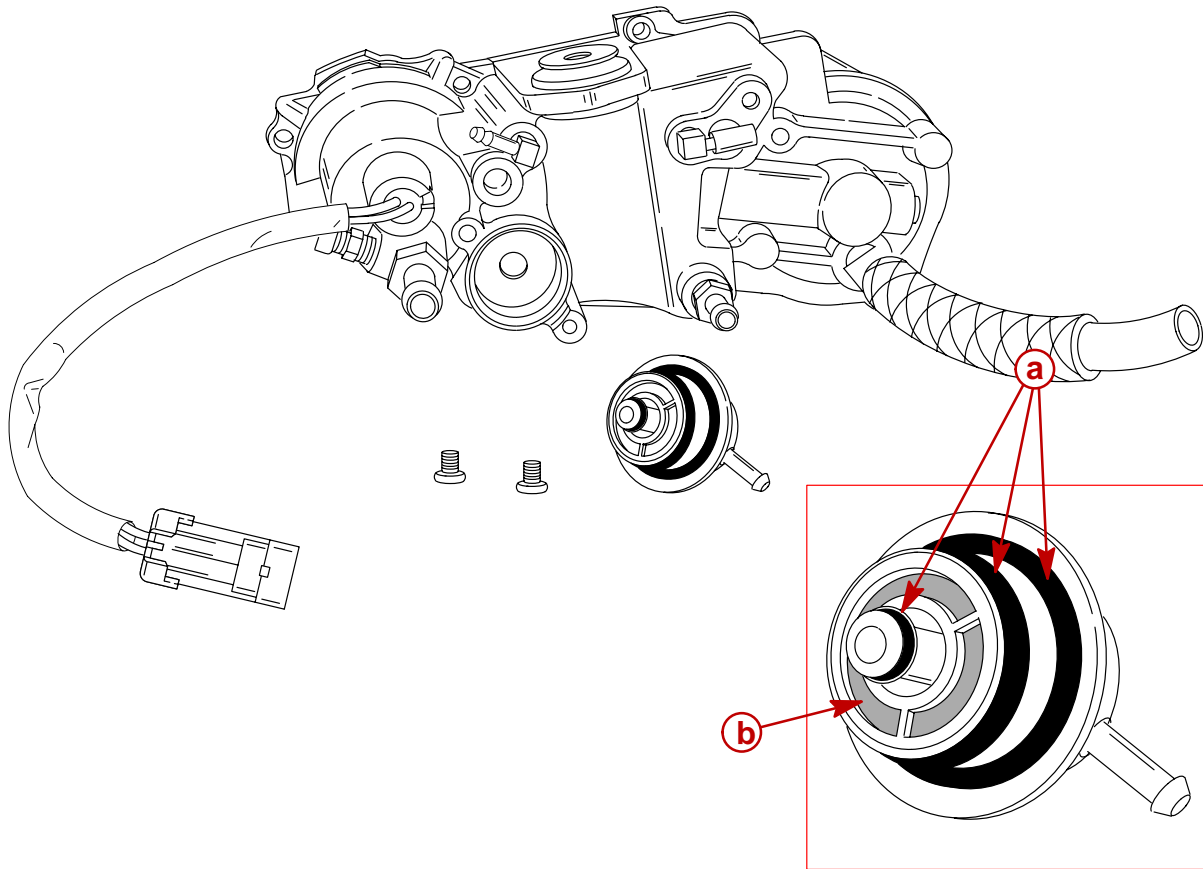
a - Fuel Pressure Regulator
b - Regulator Vent Hose

c - Screws



Fuel Pressure Regulator Disassembly

1. Inspect O-rings for cuts and abrasions. Replace as required.
2. Inspect fuel filter for debris. Clean with solvent as required.



58789

- 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

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Specifications

OIL INJECTION	Recommended Oil Oil Tank Capacity Approx. Time – All Models Reserve Capacity/Approx. Time Oil Pump Output – All Models	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
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**⚠ 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)

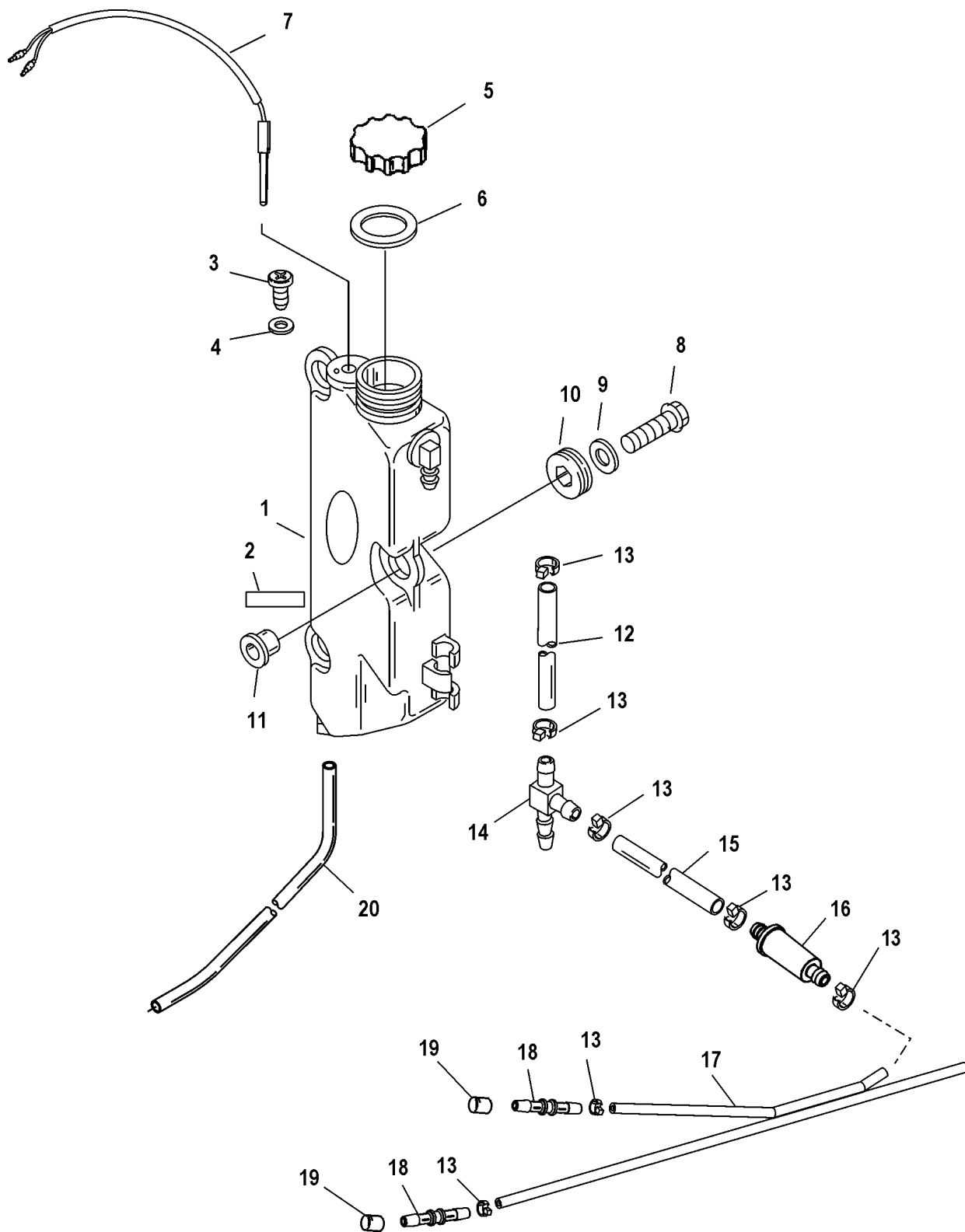
1. Operate engine following the break-in procedure outlined in the Operation and Maintenance Manual. If warning horn should sound an intermittent “beep,” “beep,” “beep” during operation, this indicates low oil level in the engine mounted oil reservoir. Refer to troubleshooting following, to correct the 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	DECAL-RESERVOIR			
3	1	SCREW [0.164-18 x 1-1/4 IN)	Drive Tight		
4	1	WASHER			
5	1	CAP ASSEMBLY			
6	1	GASKET			
7	1	SWITCH ASSEMBLY-LOW OIL			
8	3	SCREW (M8 x 35)		15	20
9	3	WASHER			
10	3	GROMMET			
11	3	BUSHING			
12	1	TUBING (7 IN) (17.7 CM)			
13	AR	STA-STRAP			
14	1	FITTING			
15	1	HOSE			
16	1	FILTER			
17	1	HOSE			
18	2	CONNECTOR			
19	2	PLUG			
20	1	TUBING (22 IN.) (55.8 CM)			



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 \pm 2 psi (296.5 kPa \pm 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)

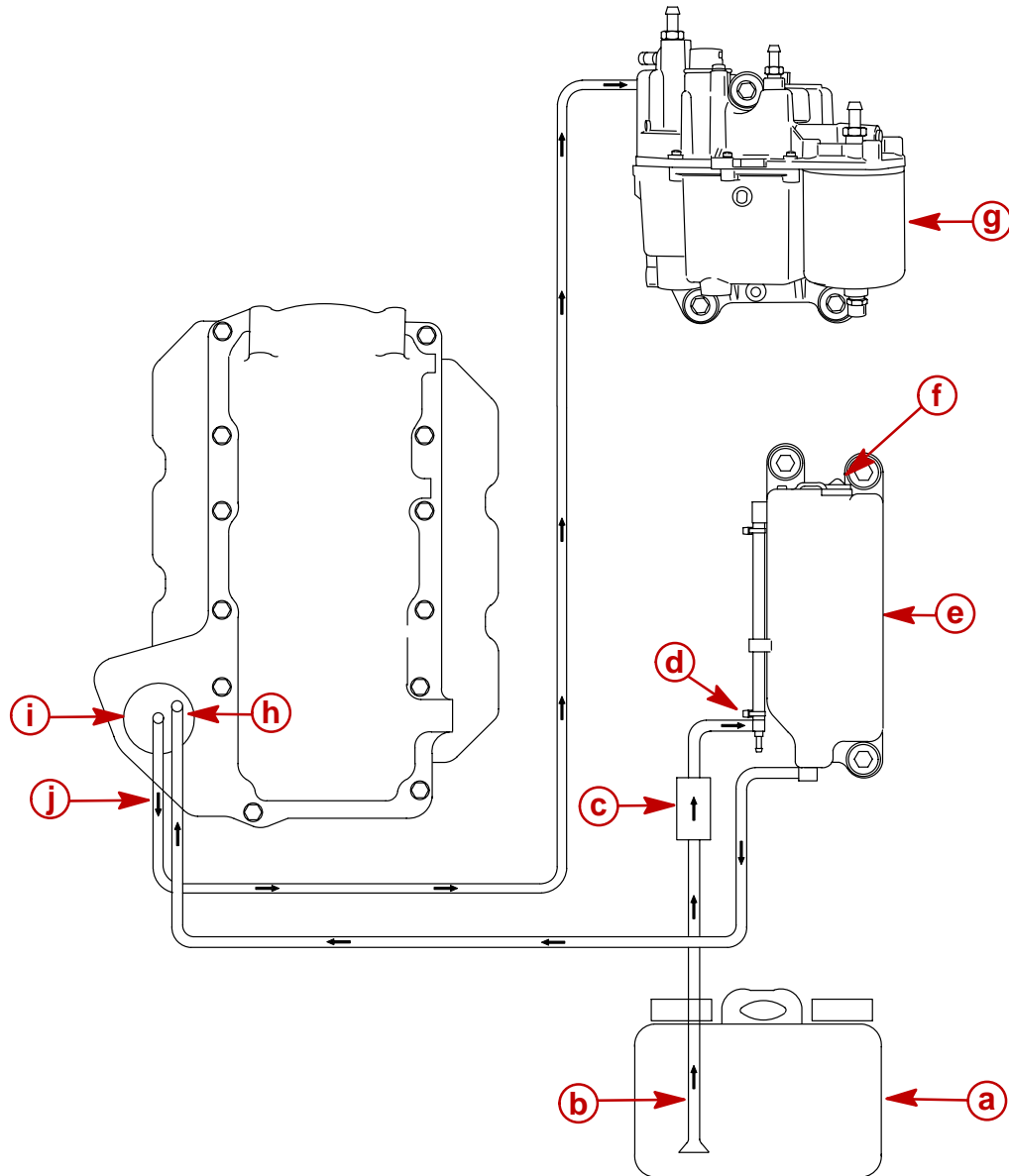
Injection pump is electrically operated and controlled by the ECM. Pump varies oil ratio from 120:1 at idle to 50:1 at wide open throttle.

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

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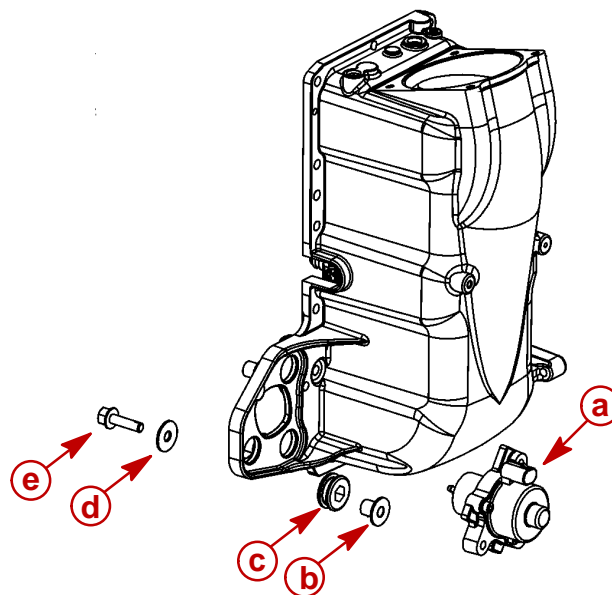
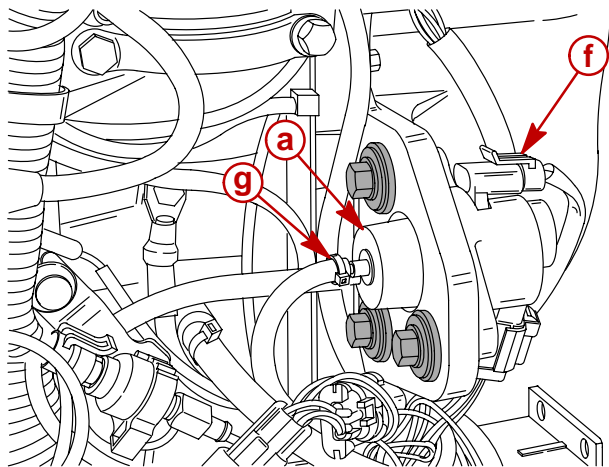
Oil Pump Removal and Installation

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.



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- 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

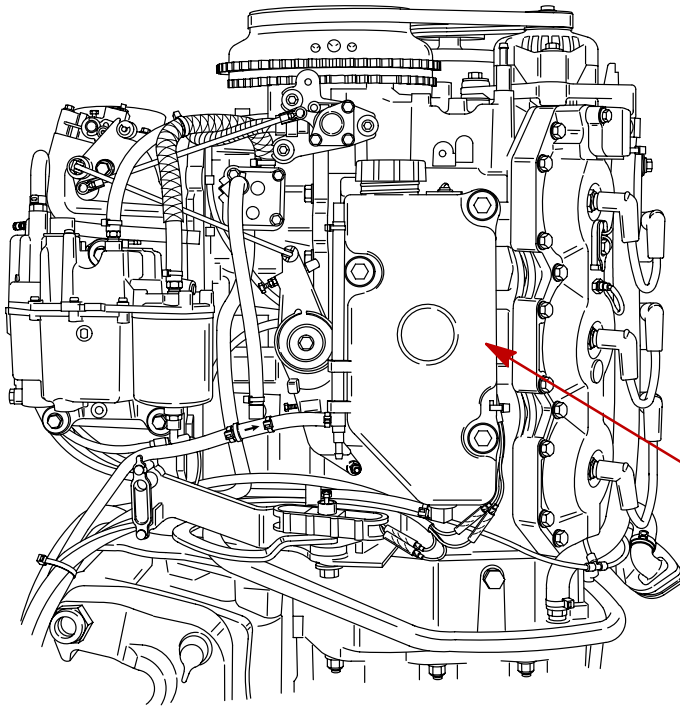
1. Install pump as shown.
2. Reconnect the oil hoses. Refer to Oil Injection Hose Installation for correct location. Fasten hoses to pump fittings with sta-straps.
3. Connect the wiring harness.
4. Refill the oil system. Refer to Priming the Oil Pump.



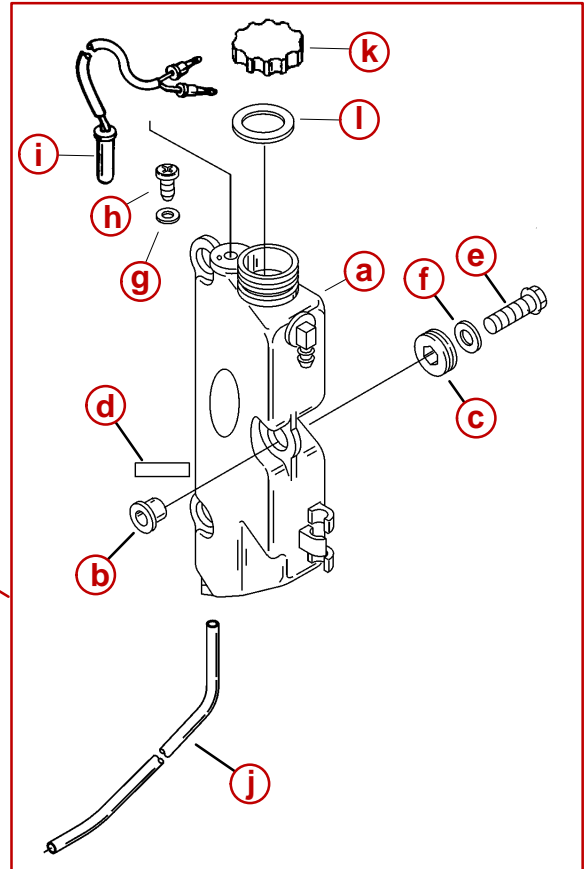
Engine Oil Reservoir Removal and Installation

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.



59030



- 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)
- j** - Tubing [22 in. (55.8 cm)]
- k** - Cap
- l** - Gasket

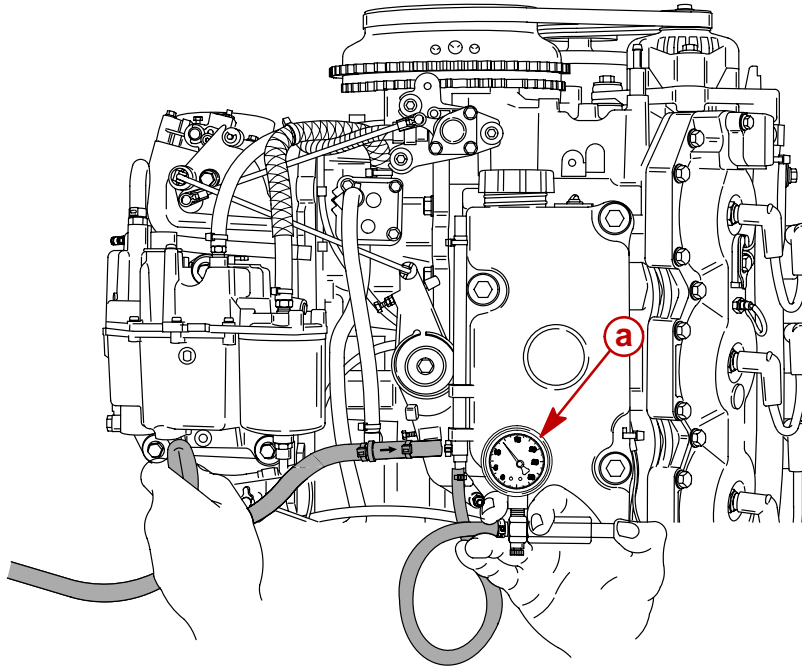
INSTALLATION

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). 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.



59033

a - Gearcase Leakage Tester

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.



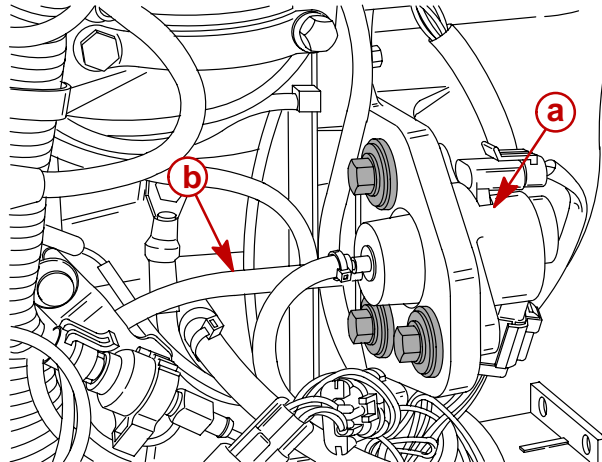
Refer to procedure in the Technician Reference Manual provided with the Digital Diagnostic Software Cartridge Part. No. 91-880118--1.

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.



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

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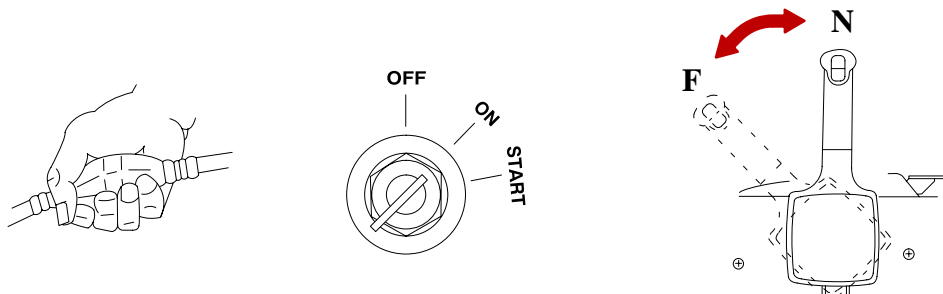
CAUTION

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.



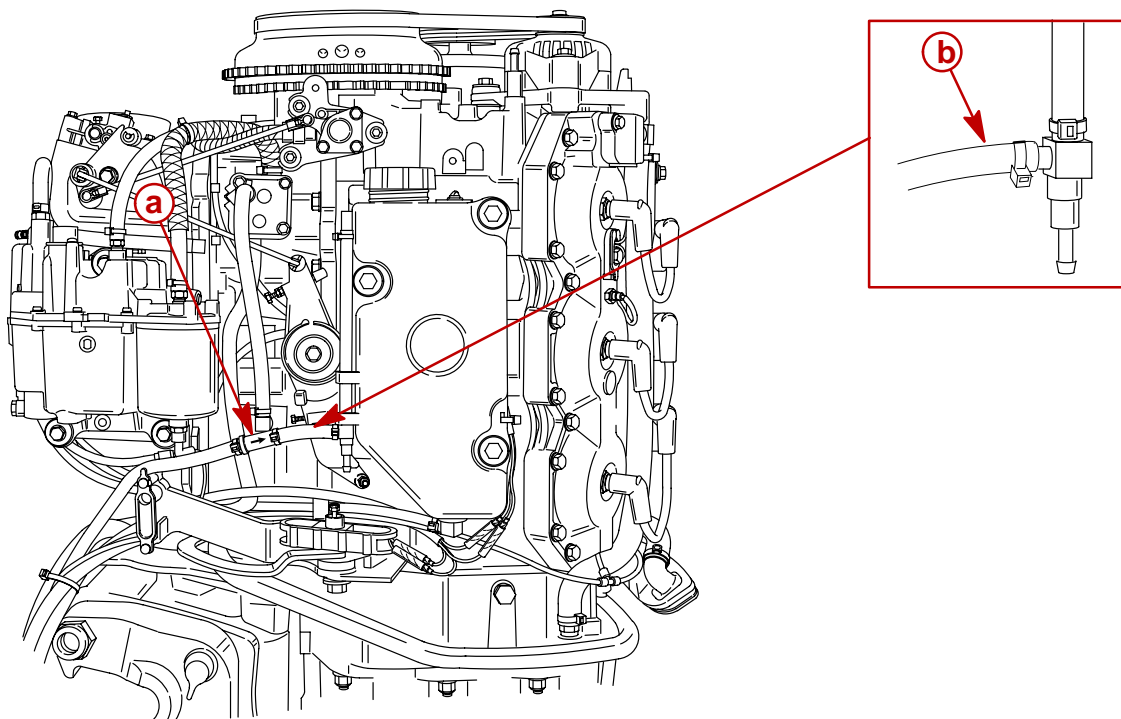
NOTE: It may take a few minutes for the pump to complete the priming process.

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. Fasten hose with sta-strap.



a - Directional Oil Filter

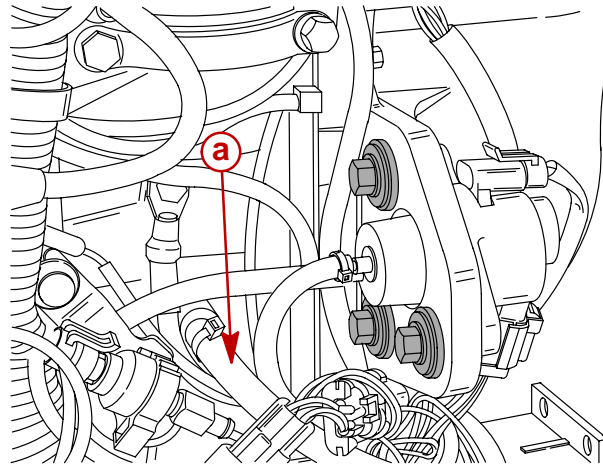
b - Oil Hose with Blue Stripe

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CONNECTING OIL HOSE WITHOUT BLUE STRIPE

1. Remove shipping cap from fitting and connect hose. Fasten hose with sta-strap.

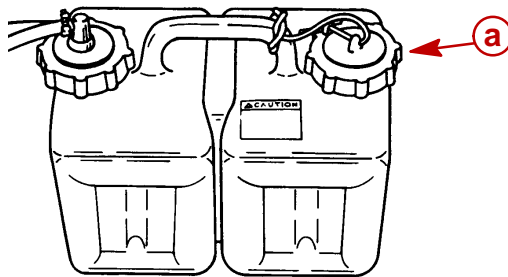


a - Oil Hose Without Blue Stripe

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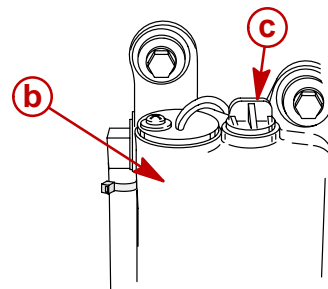
Filling the Oil Tanks

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

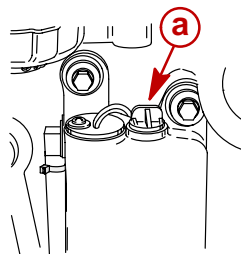


c - Fill Cap

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

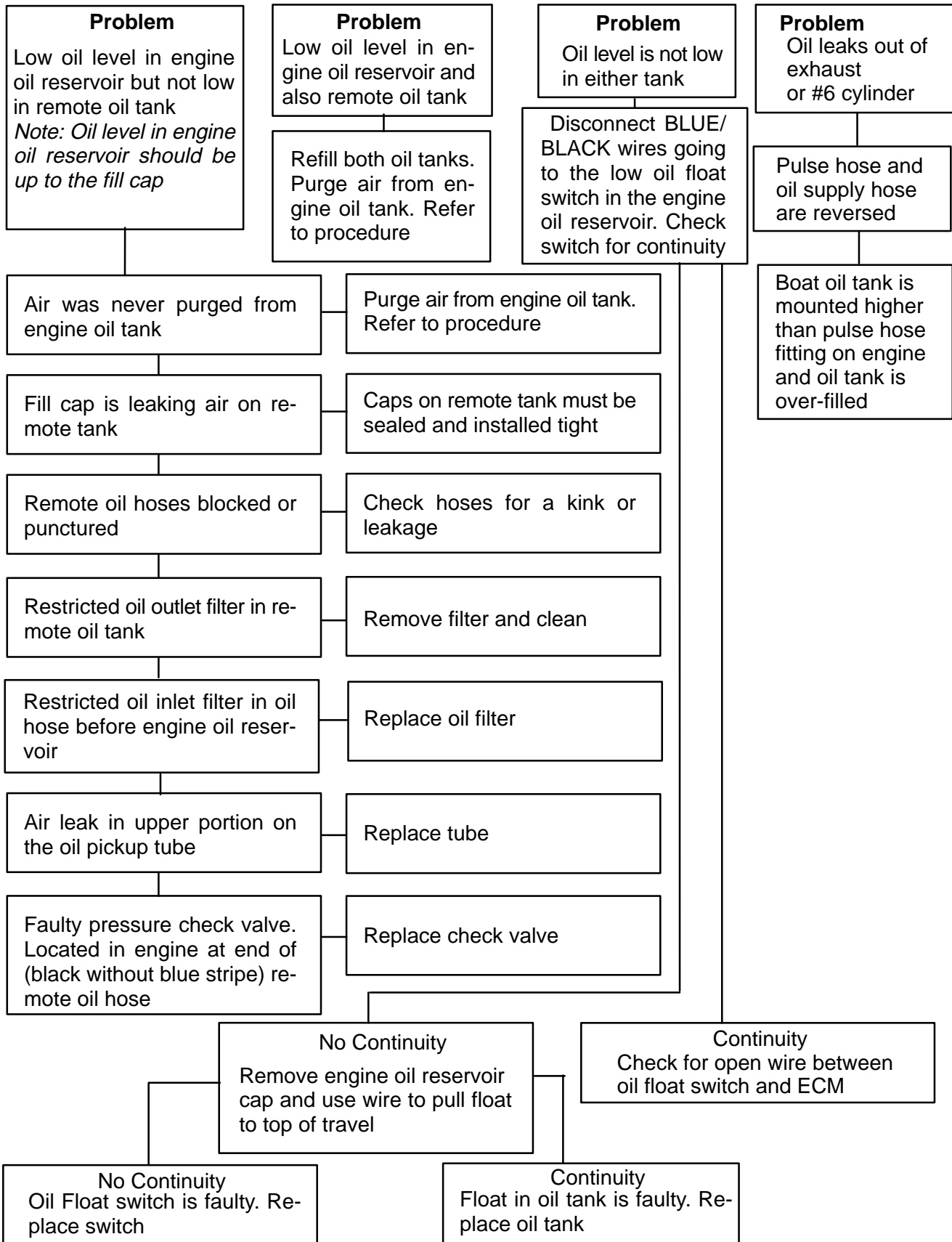
Warning Horn		
Function	Sound	Description
Start Up	One Beep	Normal System Test
Low Oil Reserve	Four Beeps every 2 Minutes	Oil level is low in the engine mounted oil reservoir tank. Refill the engine mounted oil reservoir tank along with the remote oil tank. Refer to Fuel & Oil Section.
Oil Level is Critically 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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**3
D**

Exhaust Emissions Standards

Through the Environmental Protection Agency (EPA), the federal government has established exhaust emissions standards for all new marine engines sold in the 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 (CO₂). CO₂ 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, enriching 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





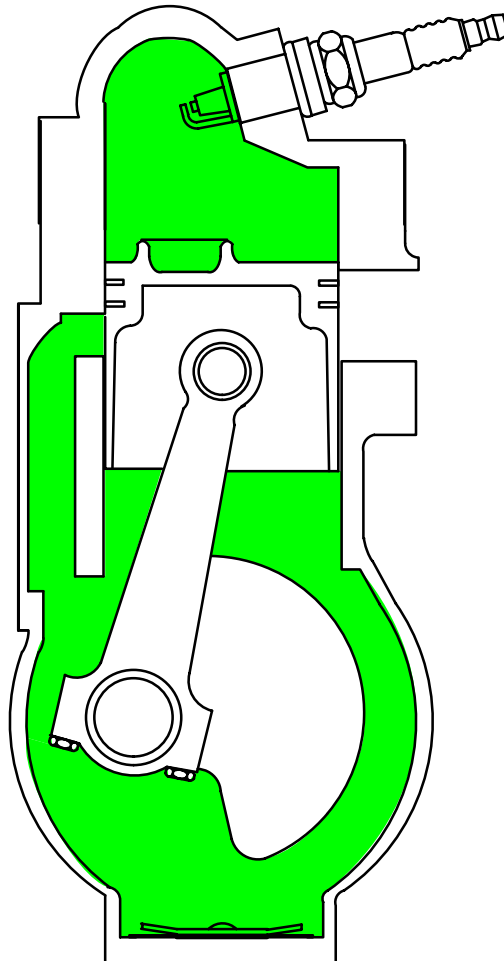
Stratified vs Homogenized Charge

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.

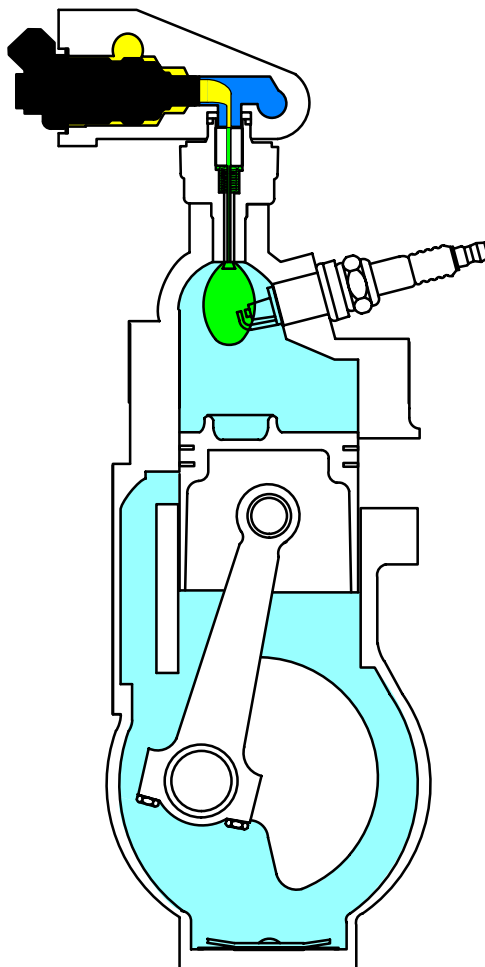




Stratified Charge

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 superseded 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>

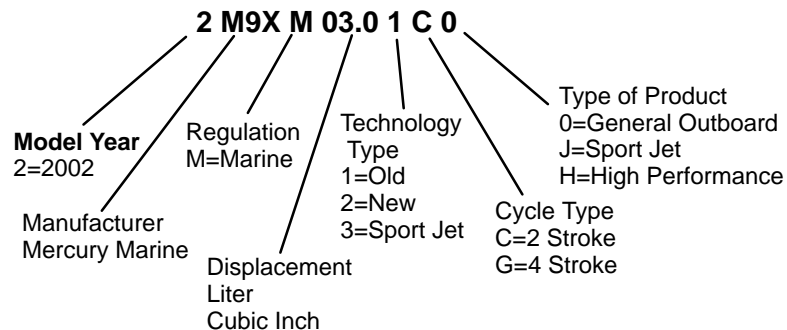


Manufacturer's Certification Label:

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).

		Emission Control Information	
This engine conforms to 2002 Model Year U.S. EPA regulations for Marine SI engines. Refer to Owners Manual for required maintenance			
j	Idle Speed (in gear): 650 RPM	Family: 2M9XM03.01C0	
i	225 HP	3047 cc	FEL: 195.43 GM/KW-HR
h	Timing (in degrees): Idle – 0 – 9° ATDC WOT – 20° BTDC		
g	Standard Spark Plug: NGK BPZ8HS-10 Gap: 0.040 in. (1.0 mm)		e JUN 2001
f	Valve Clearance (Cold) mm	Intake: N/A Exhaust: N/A	

- 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.

	Emission Control Information	3047 CC	2002 PART # 37-804670-02
This engine conforms to 2002 Model Year U.S. EPA regulations for marine SI engines.		Idle Speed (in gear): 650 RPM	
Refer to Owners Manual for required maintenance		Timing: Idle – 0 – 9° ATDC WOT – 20° BTDC	
Family: 2M9XM03.01C0		Spark Plug: NGK BPZ8HS-10 Gap: 0.040 in. (1.0 mm)	
FEL: 195.43 GM/KW-HR		Intake: N/A Valve Clearance (Cold) mm Exhaust: N/A	
			225 HP
<div style="display: flex; justify-content: space-between; text-align: center;"> (b) → JAN FEB MAR APR MAY JUNE JULY AUG SEP OCT NOV DEC </div> <div style="text-align: center; margin-top: 10px;"> (a) </div>			

- 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 3.0 L V6 (200 H.P.)	37-804670-02	Starboard side of Air Handler Assembly (EFI)
2002 Merc/Mar 3.0 L V6 (225 H.P.)	37-804670-02	Starboard side of Air Handler Assembly (EFI)
2002 Merc/Mar 3.0 L V6 (250 H.P.)	37-804670-02	Starboard side of Air Handler Assembly (EFI)



POWERHEAD

Section 4A - Powerhead

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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)

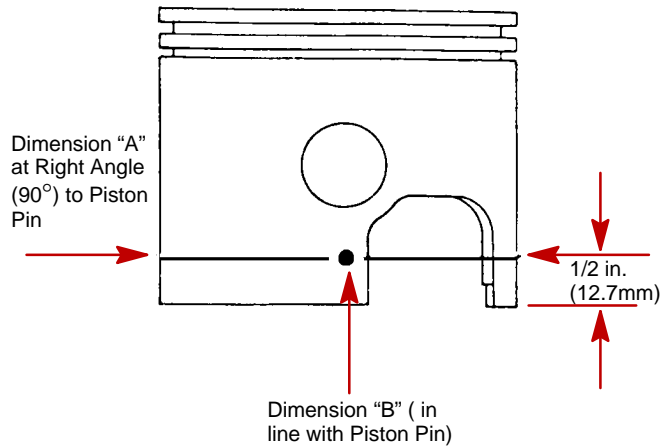
Cylinder Bore

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)

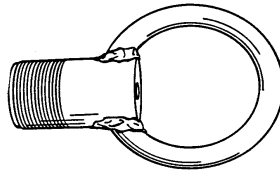
IMPORTANT: Using a micrometer, measure dimension “B” at location shown. Dimension “B” should be 0.008 in. or less than dimension “A”.



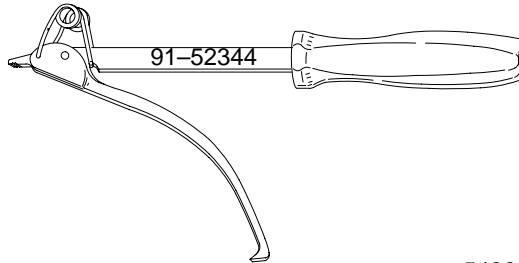


Special Tools

- 1. Lifting Eye 91-90455



- 2. Flywheel Holder 91-52344



54964

- 3. Protector Cap 91-24161

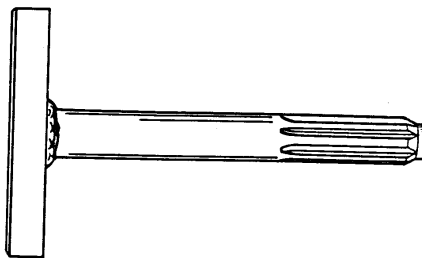


- 4. Flywheel Puller 91-849154T1

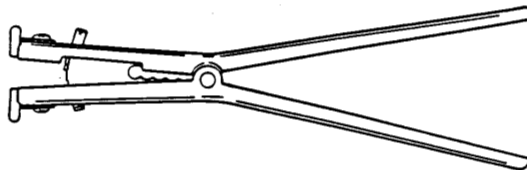


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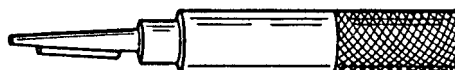
- 5. Powerhead Stand 812549T



- 6. Piston Ring Expander 91-24697

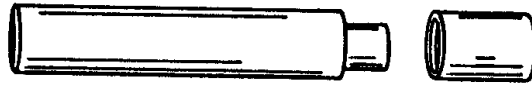


- 7. Lockring Removal Tool 91-52952A1

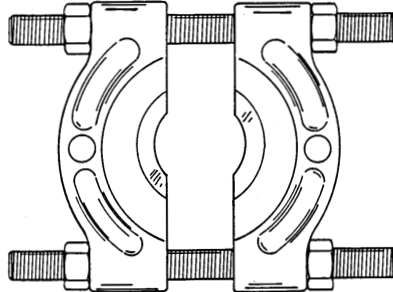




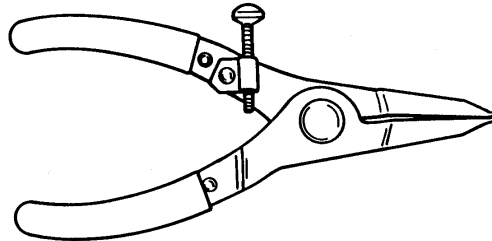
8. Piston Pin Tool 91-74607A1



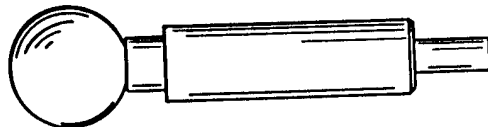
9. Universal Puller Plate 91-37241



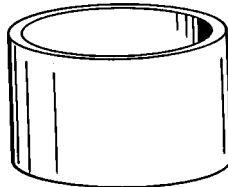
10. Snap Ring Pliers 91-24283



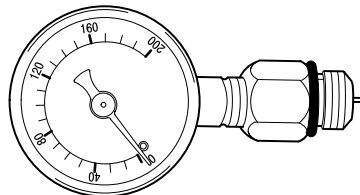
11. Lockring Installation Tool 91-91-79109A3



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

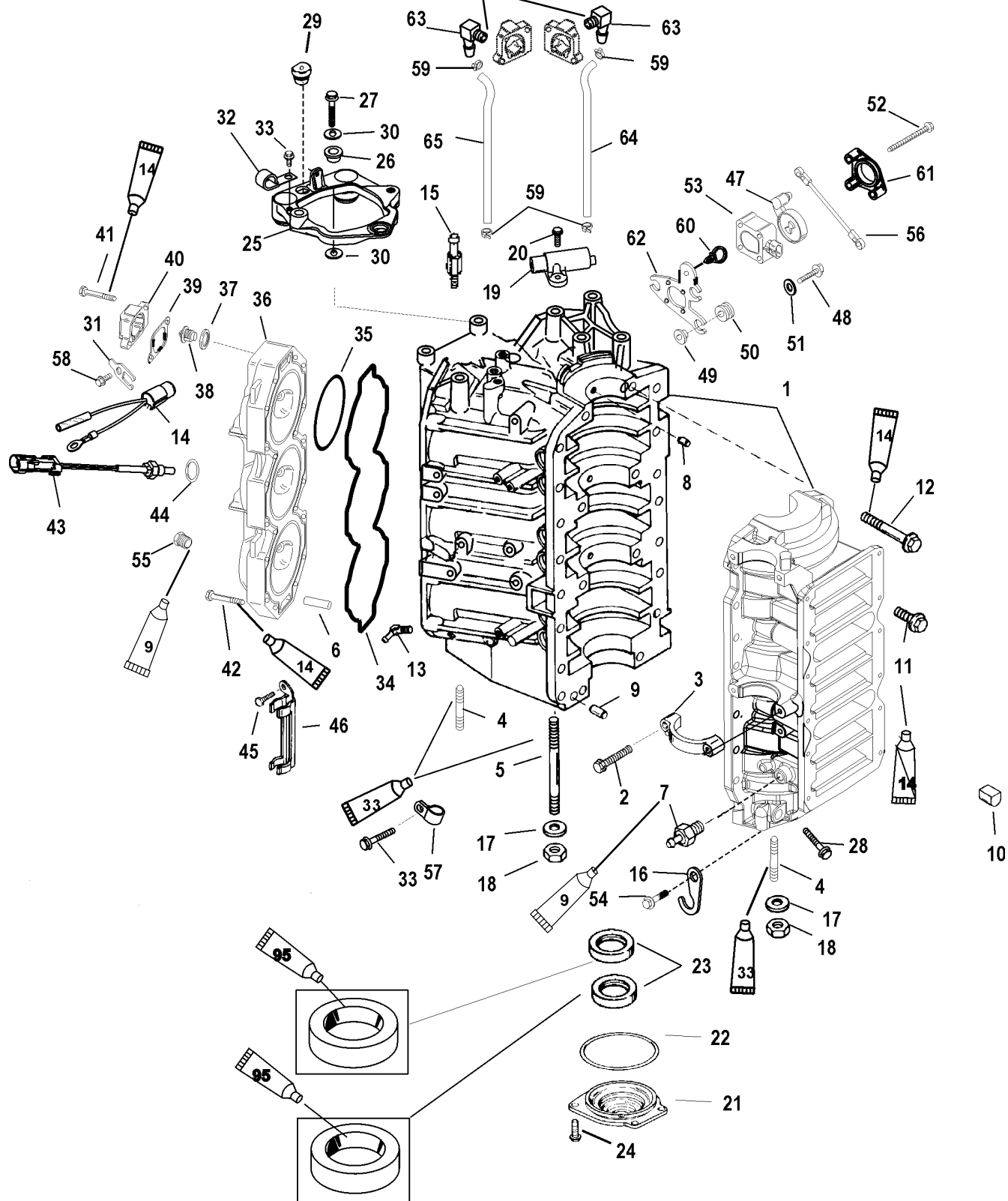
9 Loctite PST Pipe Sealant

12 Loctite Master Gasket

14 2 Cycle Outboard Oil

33 Loctite 680

95 2-4-C Marine Lubricant with Teflon





Cylinder Block Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	CYLINDER BLOCK			
2	4	SCREW (M8 X 40)		21	28.5
3	2	COVER			
4	4	STUD-POWERHEAD (M10 X 1.5 X 64)			
5	6	STUD-POWERHEAD (M10 X 1.5 X 155)			
6	6	WATER DEFLECTOR			
7	6	CHECK VALVE			
8	3	CENTER MAIN PIN			
9	1	DOWEL PIN-LOCATING			
10	6	STOP PLUG			
11	14	SCREW (M8 X 35)		21	28.5
12	8	SCREW (M10 X 1.5)	Note A		
13	1	ELBOW			
14	1	TEMPERATURE SENSOR	14		1.6
15	2	PIN			
16	1	OIL LINE RETAINER			
17	10	WASHER			
18	10	NUT		50	69
19	1	SENSOR - CRANK POSITION			
20	2	SCREW (M5 X 16)	100		11
21	1	LOWER END CAP			
22	1	O-RING			
23	2	OIL SEAL			
24	4	SCREW (M6 X 20)		38	51.5
25	1	PLATE ASSEMBLY			
26	3	MOUNT			
27	3	SCREW (M10 X 45)		38	51.5
28	2	SCREW (M6 X 12)			
29	1	GROMMET - SPLIT			
30	6	WASHER			
31	1	RETAINER			
32	1	CLAMP			
33	1	SCREW (M6 X 12)			
34	2	SEAL - CYLINDER HEAD			
35	6	SEAL			
36	2	CYLINDER HEAD			
37	2	SEAL - THERMOSTAT			
38	2	THERMOSTAT			
39	2	GASKET - THERMOSTAT COVER			
40	2	COVER - THERMOSTAT			
41	4	SCREW (M6 X 25)	100		11
42	40	SCREW (M8 X 50)	Note B		

Note A – Torque bolts to 30 lb. ft. (40.5 Nm) and then rotate 90°

Note B – Torque bolts to 20 lb. ft. (27 Nm) and then rotate 90°



Cylinder Block Assembly

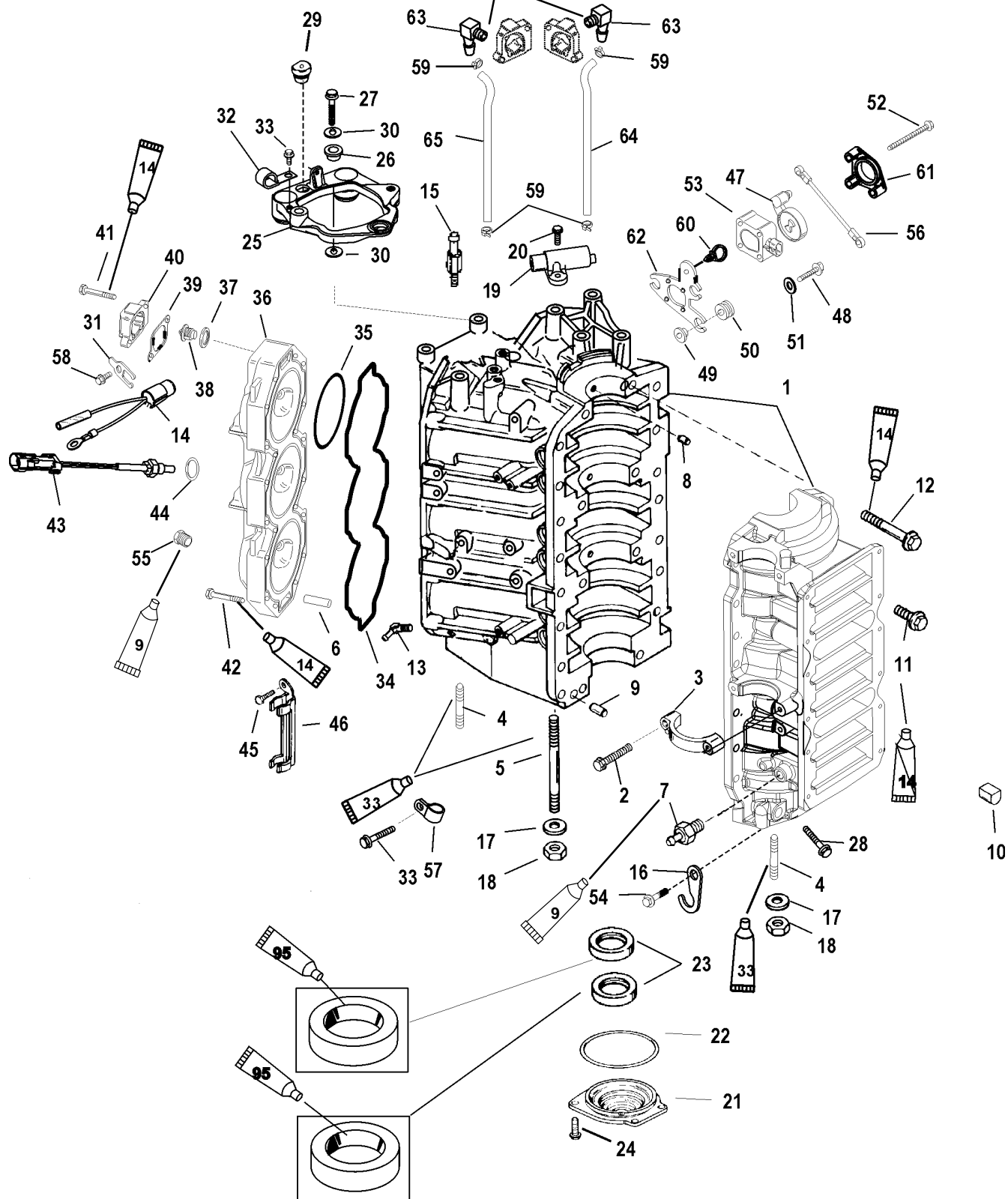
9 Loctite PST Pipe Sealant

12 Loctite Master Gasket

14 2 Cycle Outboard Oil

33 Loctite 680

95 2-4-C Marine Lubricant with Teflon



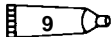
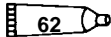
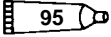


Cylinder Block Assembly

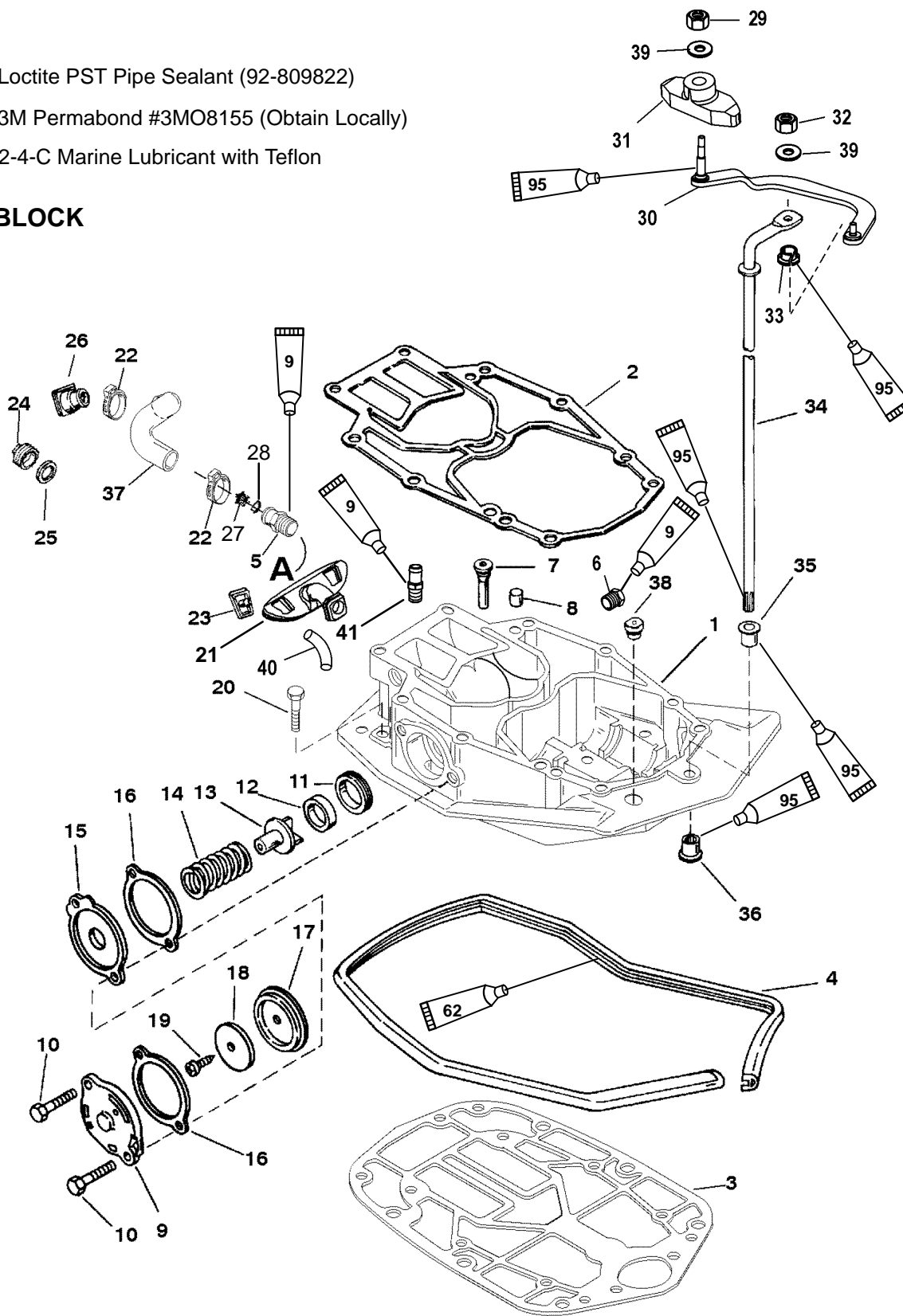
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
43	2	TEMPERATURE SENSOR			
44	2	O-RING			
45	2	SCREW (M6 X 12)			
46	2	CLAMP			
47	1	TPS LEVER			
48	3	SCREW (M6 X 25)	55		6
49	3	BUSHING			
50	3	GROMMET			
51	3	WASHER			
52	3	SCREW (M6 x 25)	35		4
53	1	THROTTLE POSITION SENSOR			
54	1	SCREW			
55	1	PIPE PLUG			
56	1	LINK			
57	1	CLIP			
58	1	SCREW (M6 X 14)		16	22
59	AR	STA-STRAP			
60	1	CLIP			
61	1	TPS COVER			
62	1	BRACKET			
63	2	FITTING			
64	1	HOSE (STARBOARD)			
65	1	HOSE (PORT)			



Exhaust Adaptor Plate

-  95 2-4-C Marine Lubricant with Teflon
-  62 3M Permabond #3MO8155 (Obtain Locally)
-  9 Loctite PST Pipe Sealant (92-809822)

A = TO BLOCK



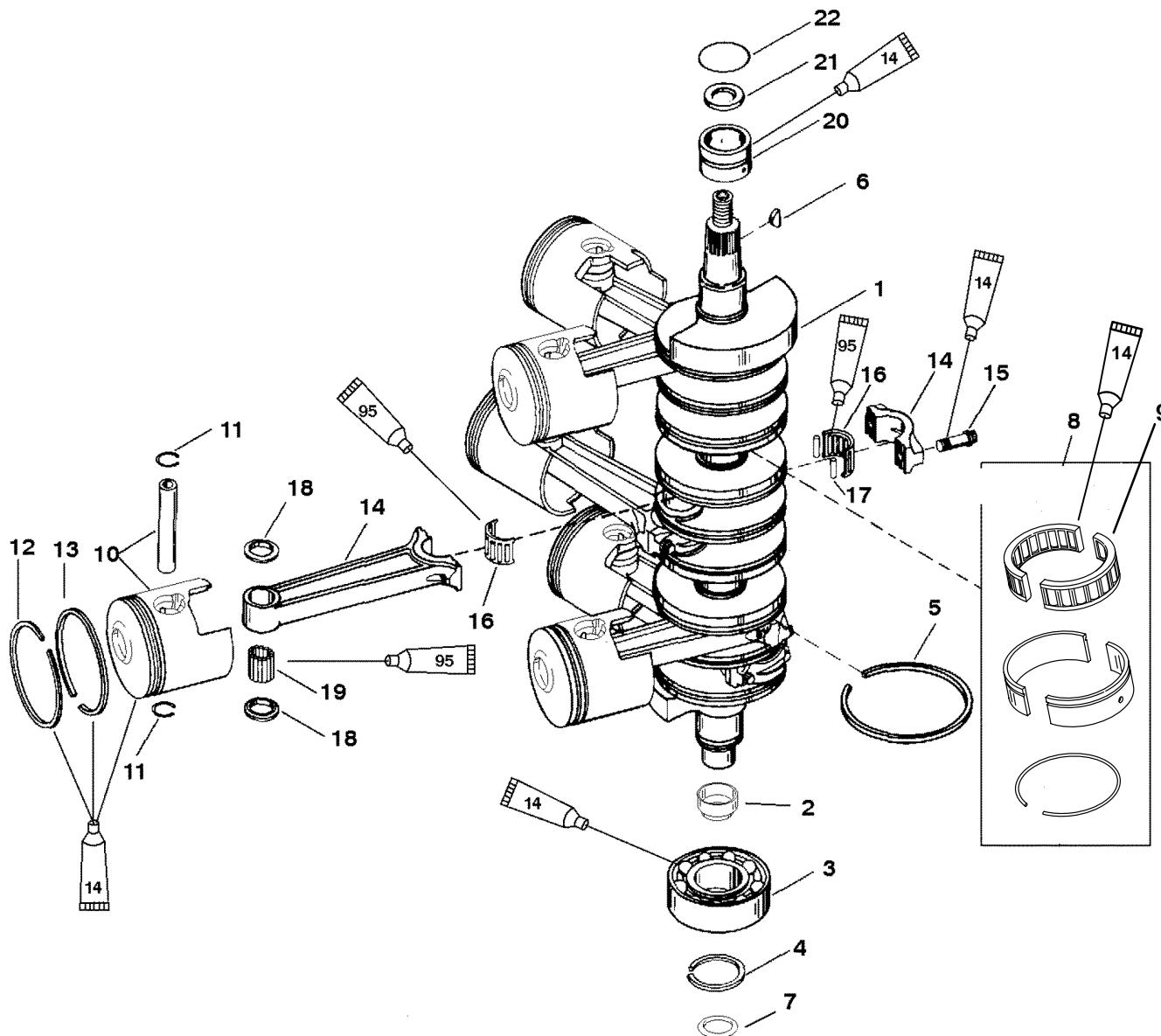


Exhaust Adaptor Plate

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	EXHAUST PLATE			
2	1	GASKET			
3	1	GASKET (LOWER)			
4	1	SEAL			
5	1	CHECK VALVE FITTING			
6	1	PIPE PLUG			
7	2	DRAIN CHECK VALVE			
8	4	DOWEL PIN			
9	1	COVER			
10	2	SCREW (M8 X 35)	150		17
11	1	CARRIER			
12	1	GROMMET			
13	1	POPPET			
14	1	SPRING			
15	1	RELIEF VALVE PLATE ASSEMBLY			
16	2	GASKET			
17	1	DIAPHRAGM			
18	1	WASHER			
19	1	SCREW (10-16 X 3/4 IN.)	25		3
20	6	SCREW (M8 X 35)		25	34
21	1	IDLE EXHAUST BOOT			
22	2	CLAMP			
23	1	FITTING – TELL TALE			
24	1	PLUG			
25	1	WASHER			
26	1	FITTING			
27	1	CHECK VALVE			
28	1	O-RING			
29	1	NUT			
30	1	SHIFT LINK			
31	1	SLIDE			
32	1	NUT			
33	1	BUSHING			
34	1	UPPER SHIFT SHAFT			
35	1	BUSHING			
36	1	COUPLING			
37	1	HOSE (INLET)			
38	1	GROMMET SPLIT			
39	2	WASHER			
40	1	TUBING (3 IN.)			
41	2	FITTING			



Crankshaft, Pistons and Connecting Rods



 14 2 Cycle Outboard Oil

 95 2-4-C Marine Lubricant with Teflon

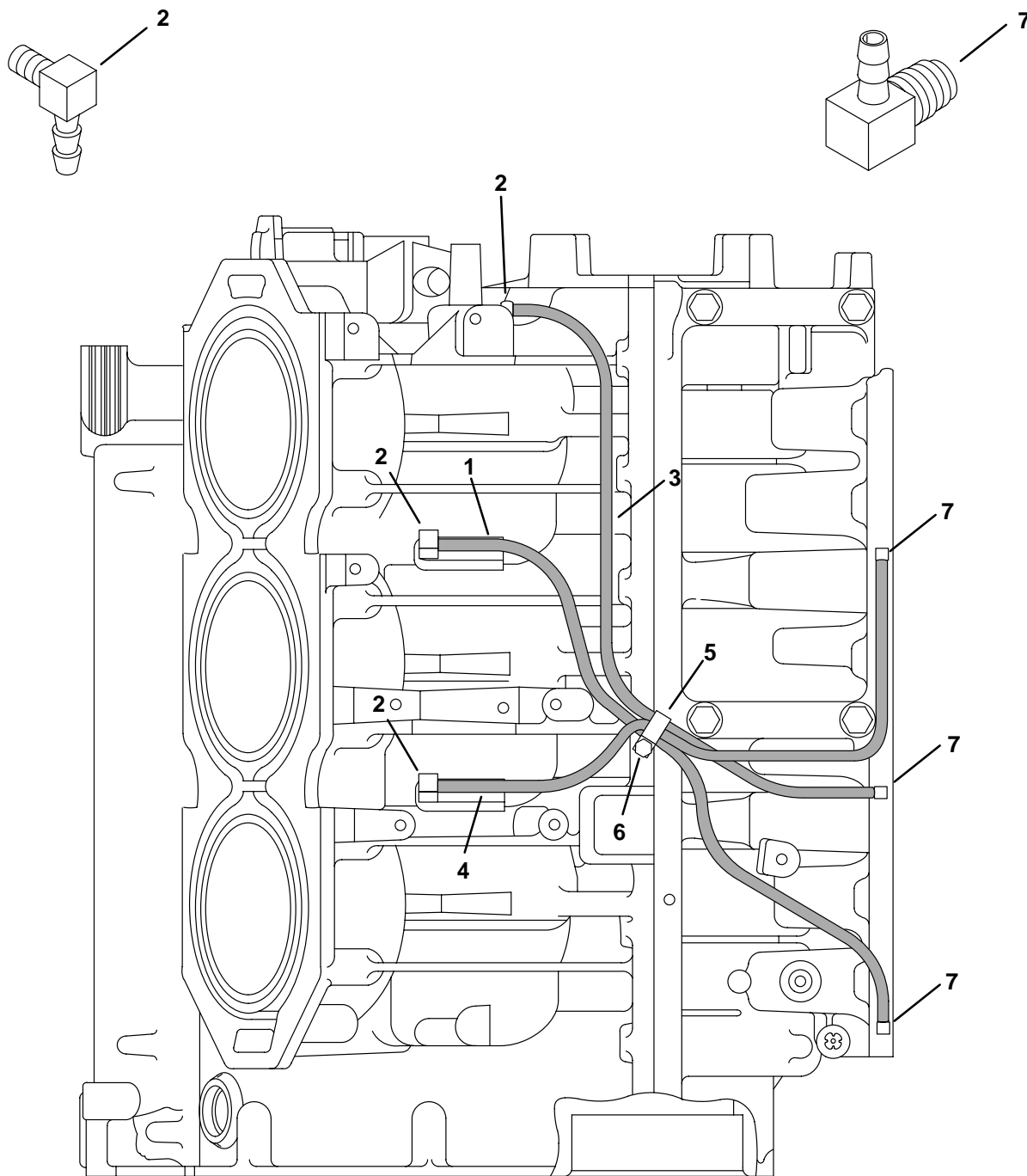


Crankshaft, Pistons and Connecting Rods

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	CRANKSHAFT ASSEMBLY			
2	1	WEAR SLEEVE			
3	1	BALL BEARING (LOWER)			
4	1	RETAINING RING			
5	1	RING-SEALING			
6	1	WOODRUFF KEY			
7	7	O-RING			
8	2	BEARING RACE			
9	2	ROLLER BEARING			
10	3	PISTON (STARBOARD)			
	3	PISTON (PORT)			
11	12	LOCK RING			
12	6	PISTON RING SET			
13	6	PISTON RING (LOWER)			
14	6	CONNECTING ROD ASSEMBLY			
15	12	SCREW (1-1/4 IN.)	1st Torque: 15 lb-in 2nd Torque: 20 lb-ft Turn screw additional 90 degrees after 2nd torque. ▼		
16	12	BEARING CAGE			
17	96	ROLLER BEARING			
18	12	THRUST WASHER			
19	204	NEEDLE ROLLER BEARING			
20	1	MAIN BEARING (UPPER)			
21	1	OIL SEAL			
22	1	O-RING			



Starboard Bleed System Routing



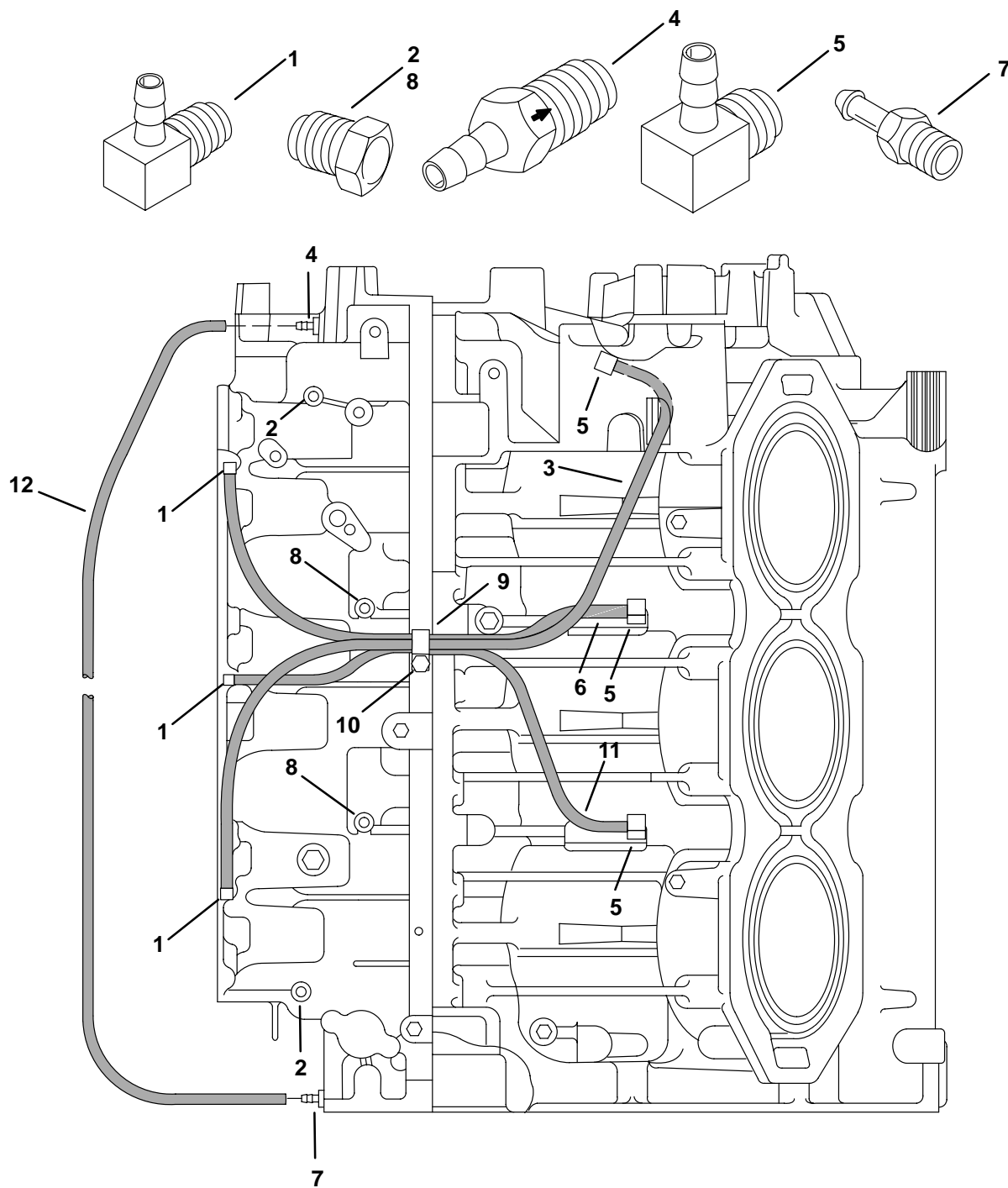


Starboard Bleed System Routing

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	TUBING [15-1/2 IN (39.3 CM)]			
2	3	CHECK VALVE (90°)			
3	1	TUBING [16-1/2 IN (3.8 CM)]			
4	1	TUBING [15 IN (38.1 CM)]			
5	1	CLIP			
6	1	SCREW (10 – 16 X 1/2)			
7	3	CHECK VALVE			



Port Bleed System Routing





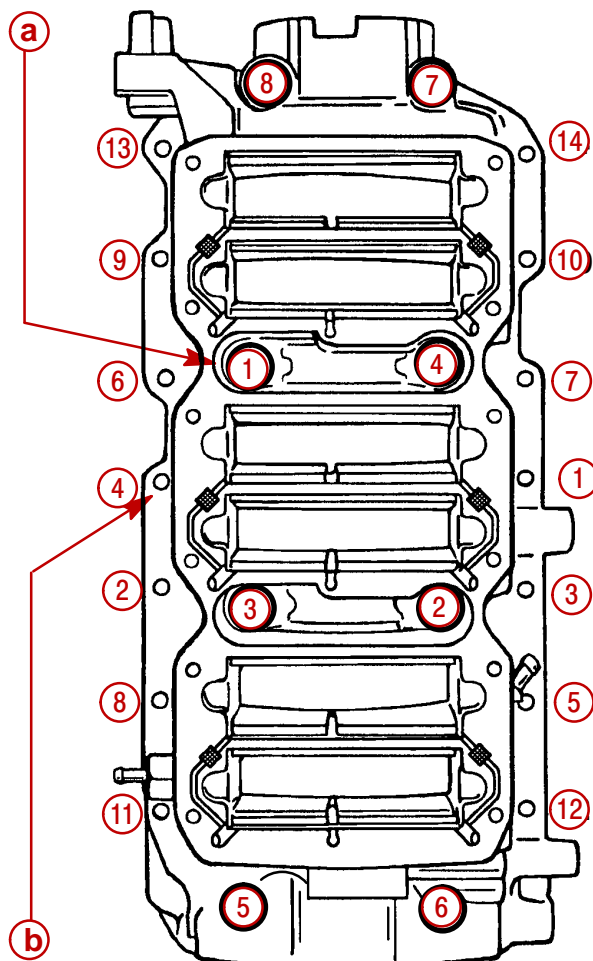
Port Bleed System Routing

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	3	CHECK VALVE			
2	2	PIPE PLUG			
3	1	TUBING [20.5 IN (52 CM)]			
4	1	CHECK VALVE			
5	3	CHECK VALVE (90 DEGREE)			
6	1	TUBING [13 IN (33 CM)]			
7	1	CHECK VALVE			
8	2	PIPE PLUG			
9	1	CLIP			
10	1	SCREW (10 – 16 X 1/2)			
11	1	TUBING [11 IN (27.9 CM)]			
12	1	TUBING [22.5 IN (57 CM)]			



Torque Sequence

CRANKCASE COVER BOLTS



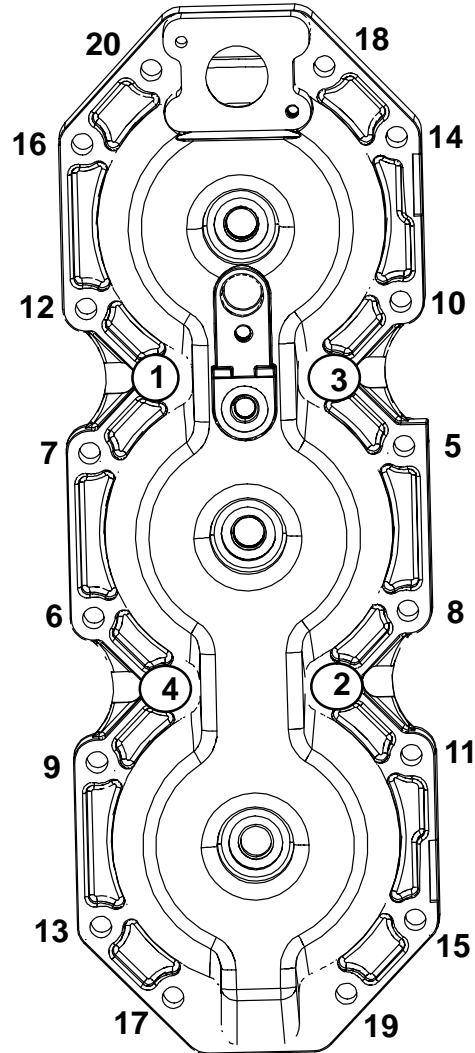
55986

- a** - Add light oil to threads and bolt face: 8 Bolts (3/8 in. - 16 in.)
38 lb. ft. (51.5 N·m)
- b** - Bolts (M8 x 1.25 x 35) 28 lb. ft. (38 N·m)



CYLINDER HEAD BOLTS

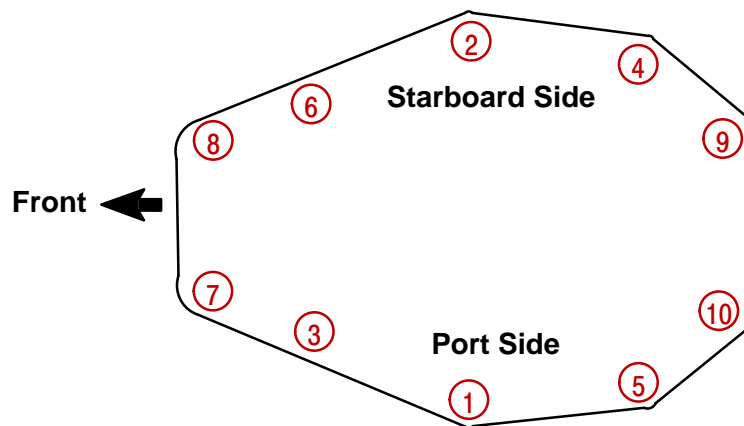
Apply light oil to threads and bolt face: 30 lb. ft. (40.7 N-m) and rotate 90°



52132

POWERHEAD TO ADAPTOR PLATE ATTACHING NUT

Torque nuts to 25 lb. ft. (33.8 Nm)





General Information

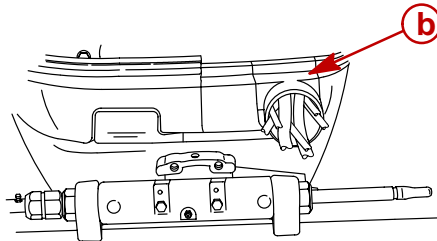
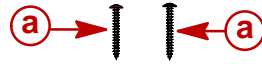
Powerhead “Disassembly” and “Reassembly” instructions are printed in a sequence that should be followed to assure best results when removing or replacing powerhead components. If complete disassembly is not necessary, start reassembly at point disassembly was stopped. (Refer to “Table of Contents,” preceding.)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

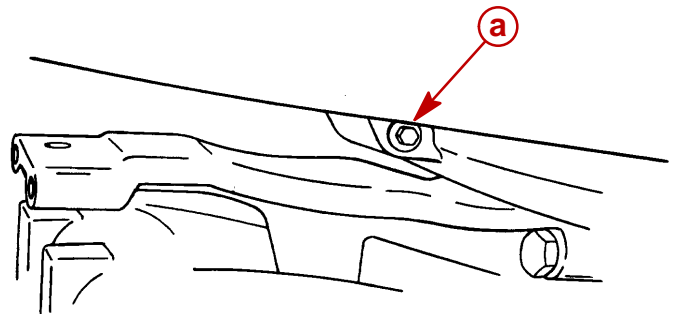
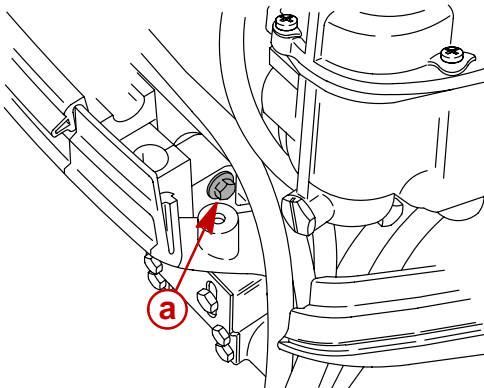


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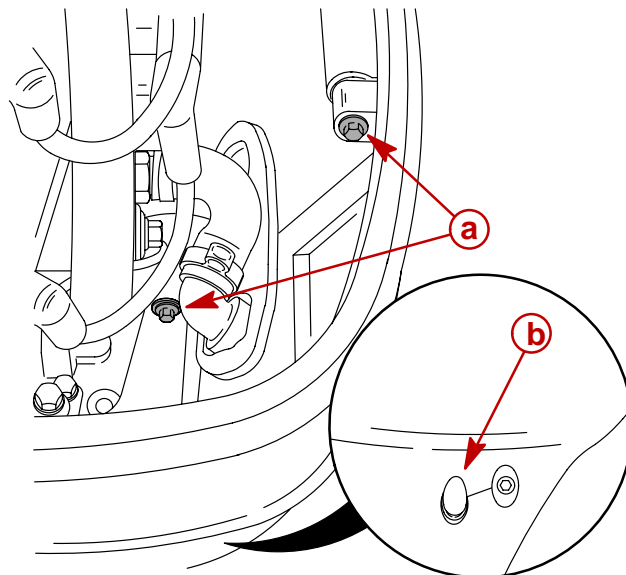
a - Screws

b - Retainer

4. Remove bottom cowls.



59075

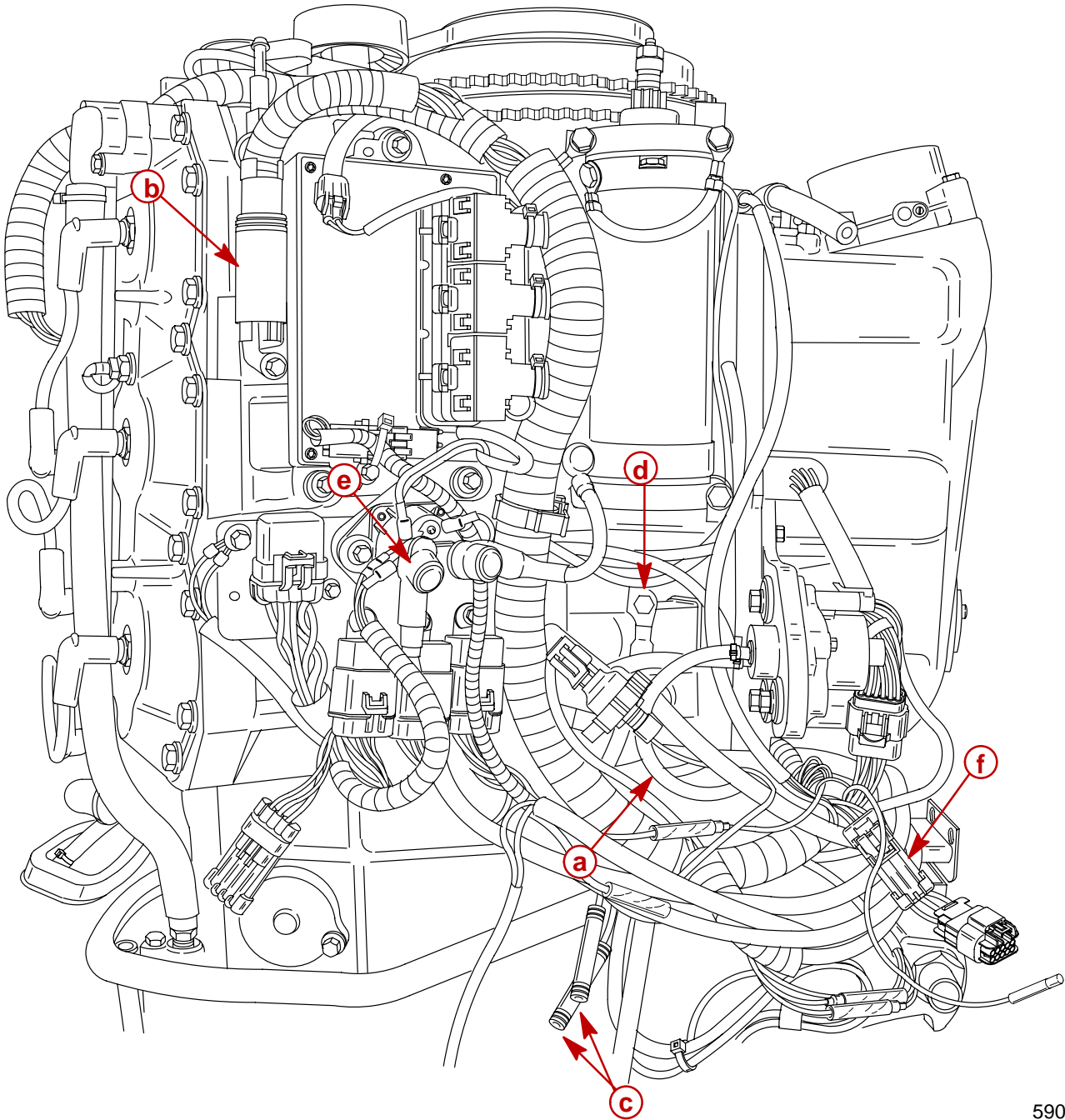


a - Screws

b - Access Cover to Lower Screw



5. Disconnect and/or remove the following:

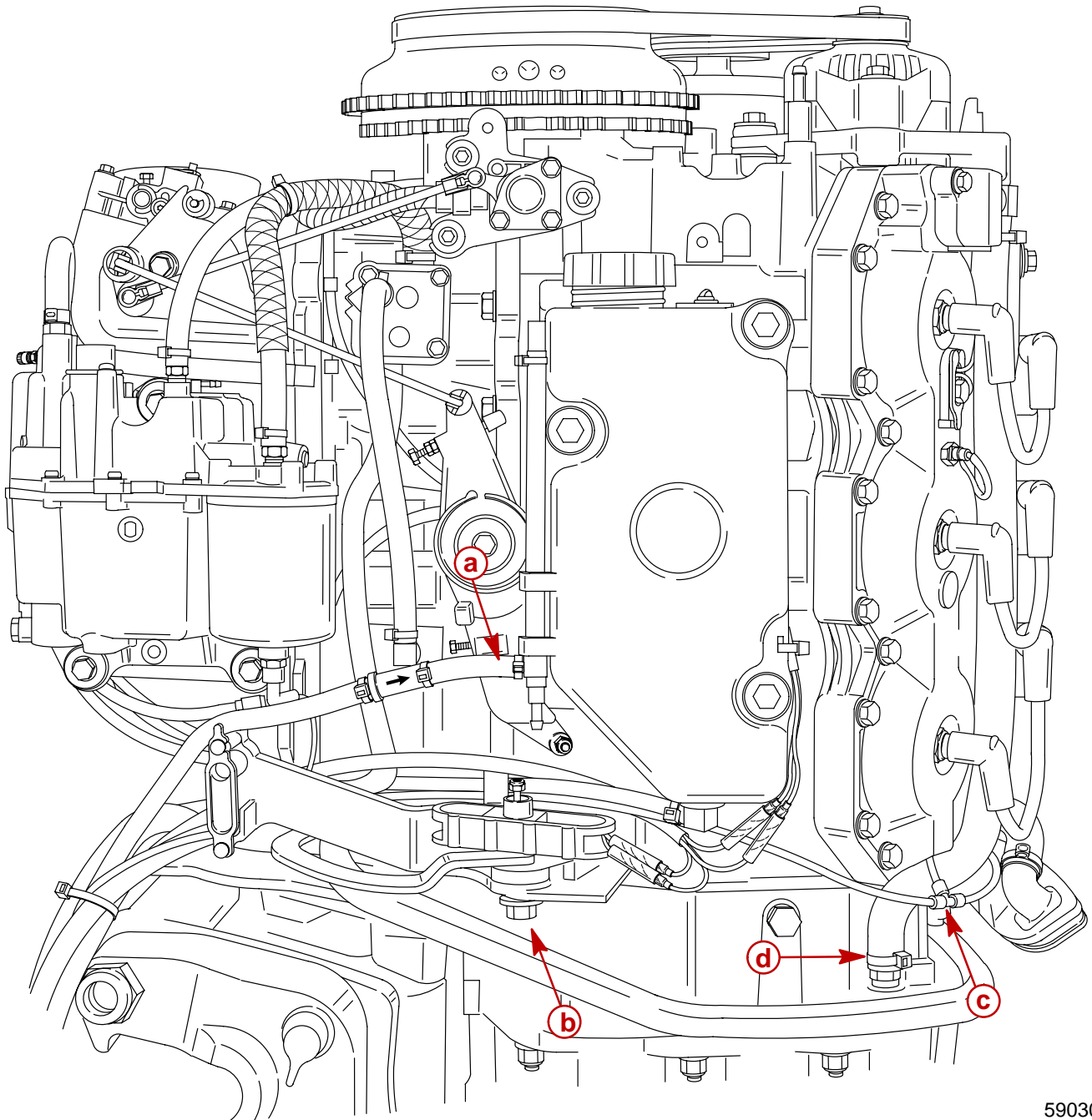


59026

- 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:

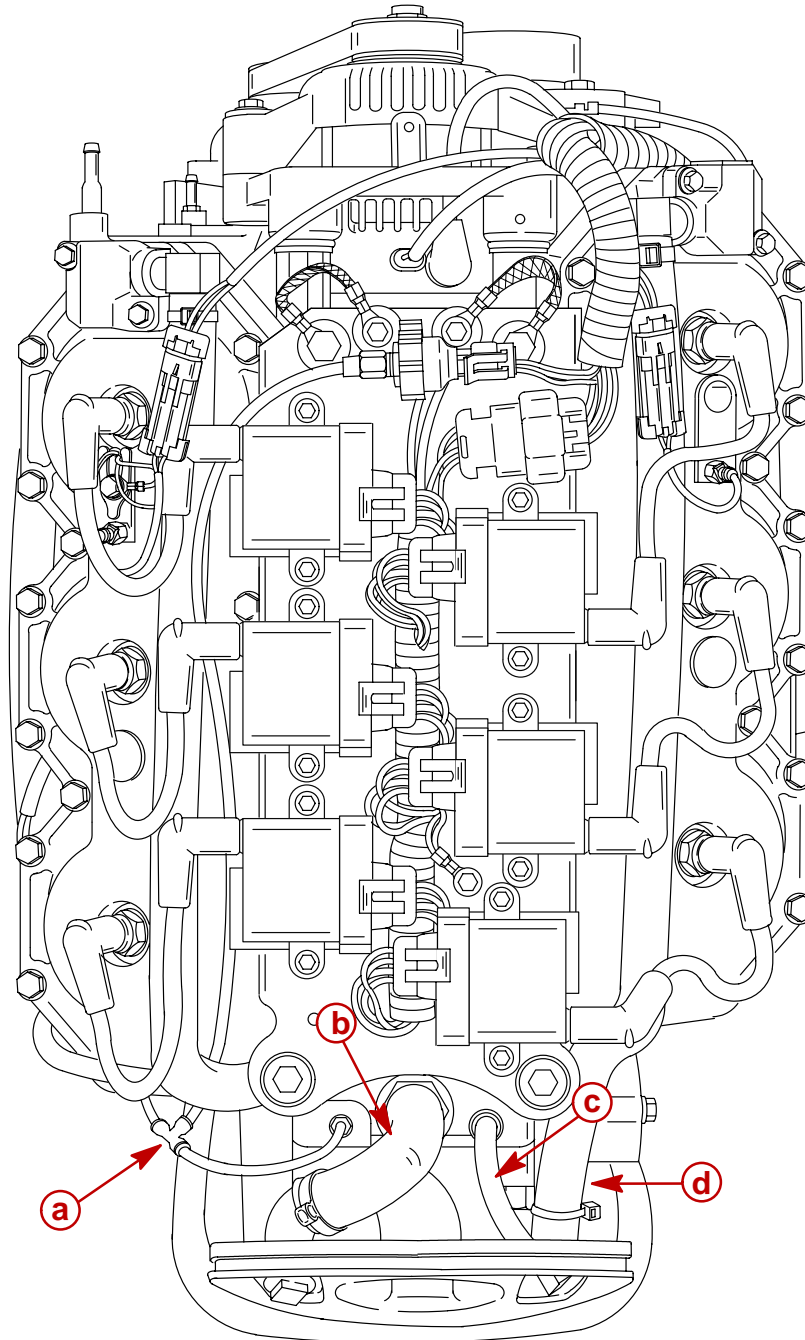


59030

- a** - Oil Supply Hose
- b** - Shift Lever Bracket Assembly
- c** - Water Pressure Hose (GREY)
- d** - Starboard Thermostat Discharge Hose



7. Disconnect the following:

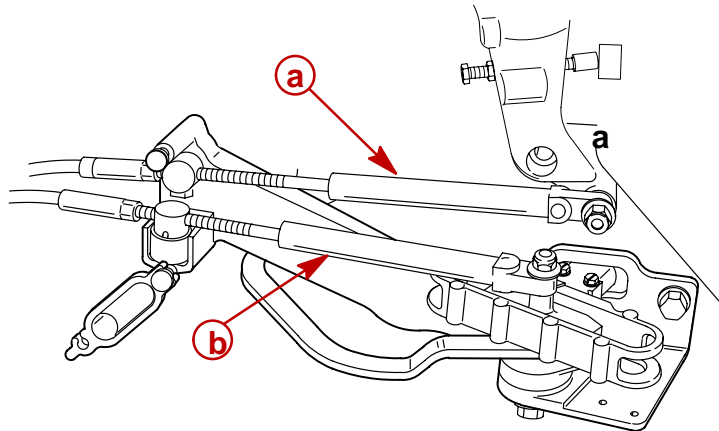


59028

- a** - Water Pressure Sensor Hose (GREY)(for Digital Gauges) (If not previously disconnected)
- b** - Engine Flush Hose
- c** - Tell-Tale Hose
- d** - Starboard Thermostat Discharge Hose

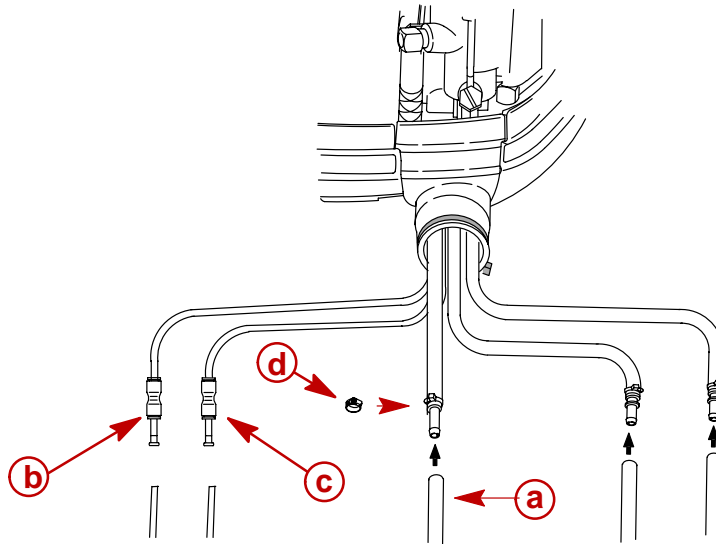


8. Slide outboard shift lever into neutral position.
9. Remove throttle cable and shift cable from control cable anchor bracket.



- a** - Throttle Cable
- b** - Shift Cable

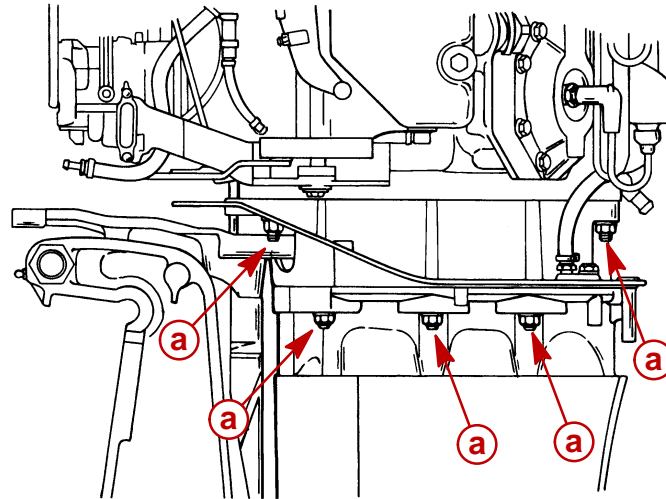
10. Disconnect input fuel line, water pressure hose and speedometer hose.



- a** - Input Fuel Hose
- b** - Water Pressure Hose (GRAY) (Analog Gauges)
- c** - Speedometer Hose (BLACK) (Analog Gauges)
- d** - Hose Clamp



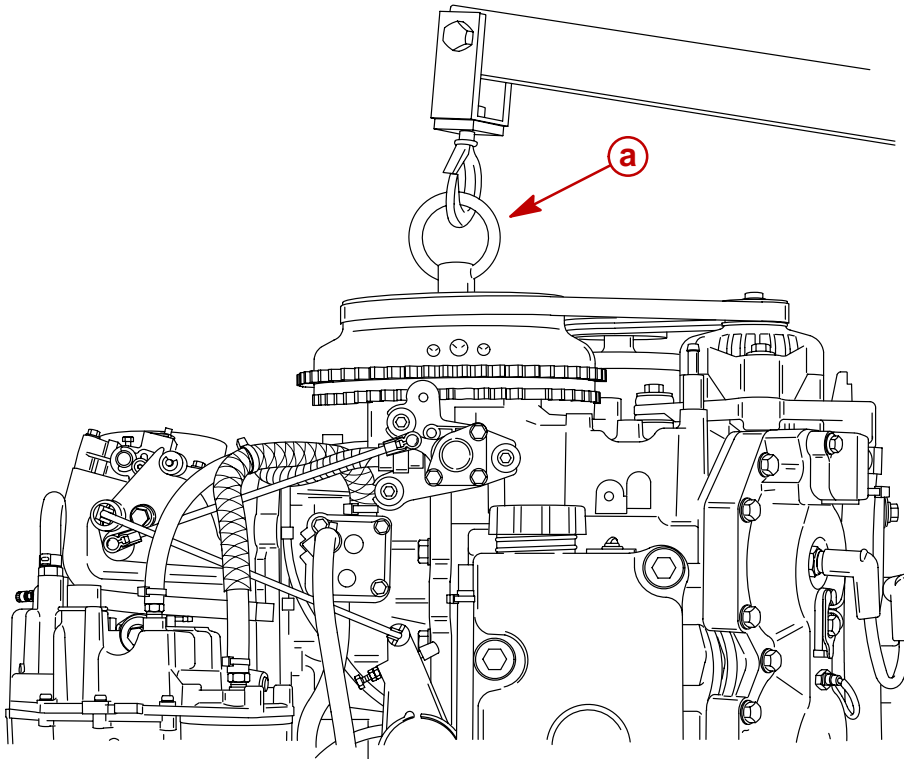
11. Remove 10 nuts and 10 washers (5 each side) from powerhead base.



52373

a - Nuts and Washers (5 each side)

12. 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.



59076

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.

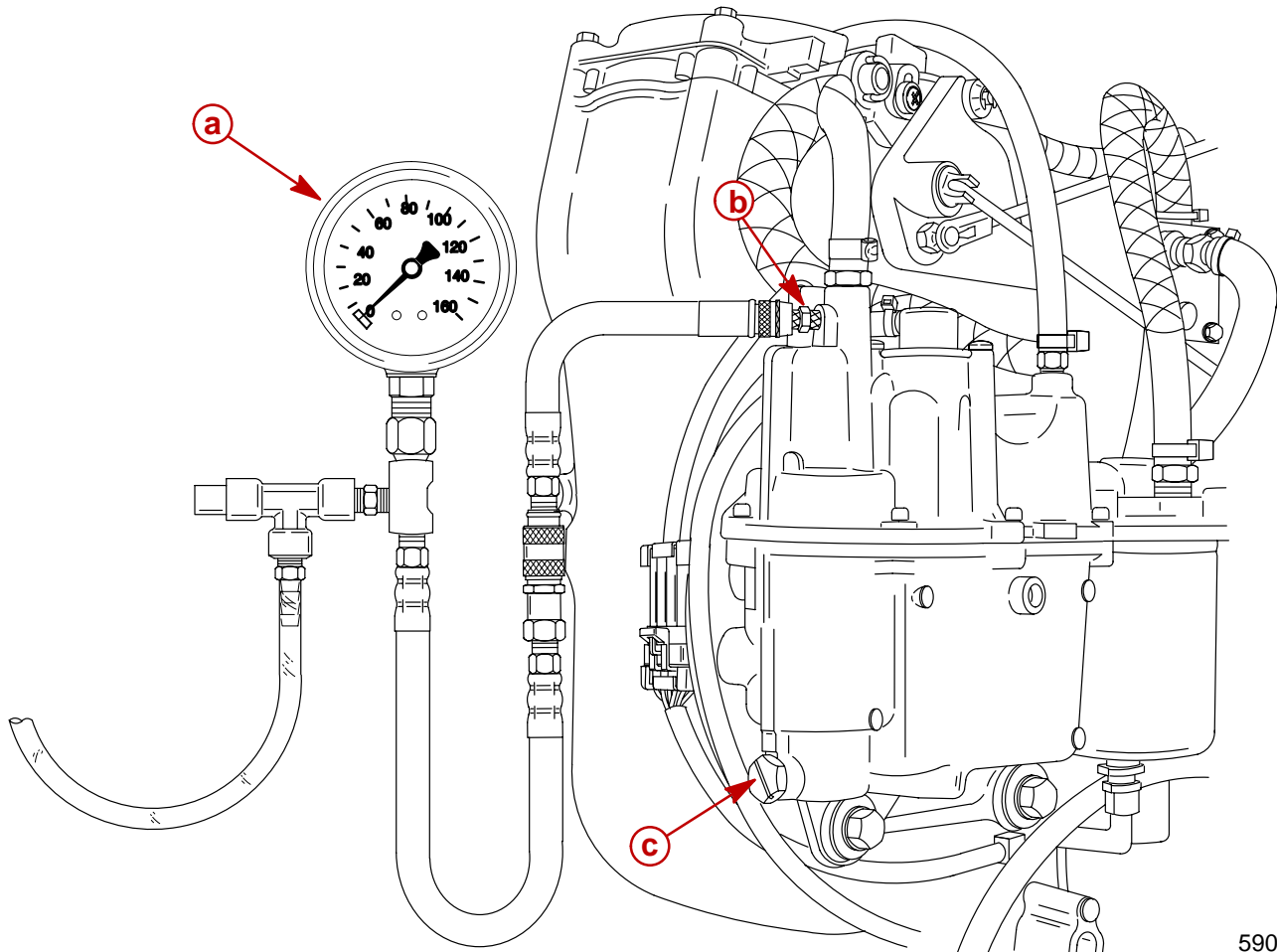


Vapor Separator Tank (VST) Removal

⚠ 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.

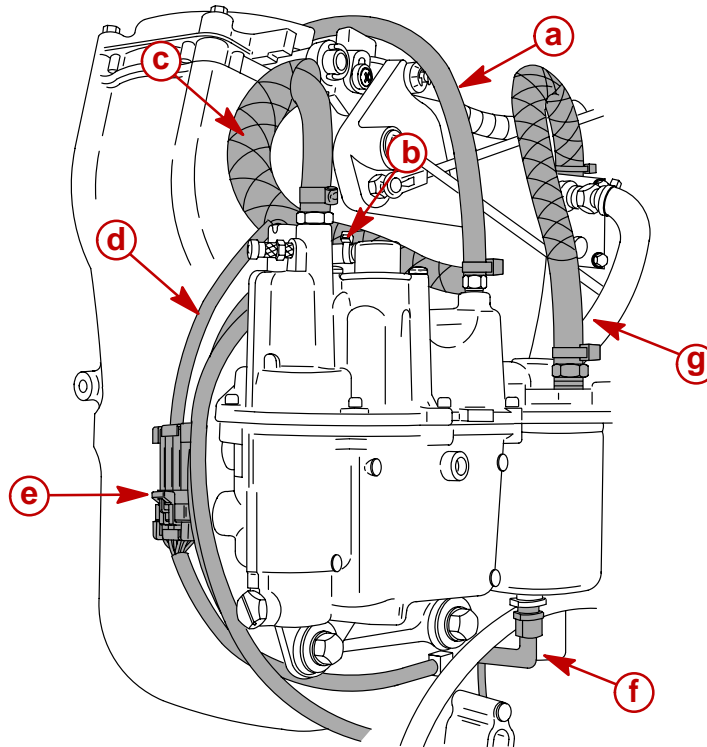


59053

- a** - Fuel Pressure Gauge 91-881834A1
- b** - Fuel Pressure Test Port
- c** - Drain Plug



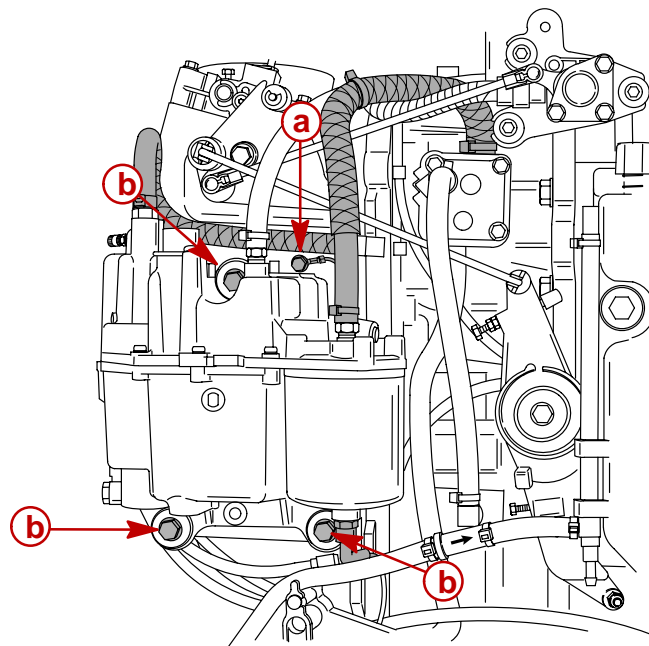
3. Disconnect the following hoses and connectors:



59051

- 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.

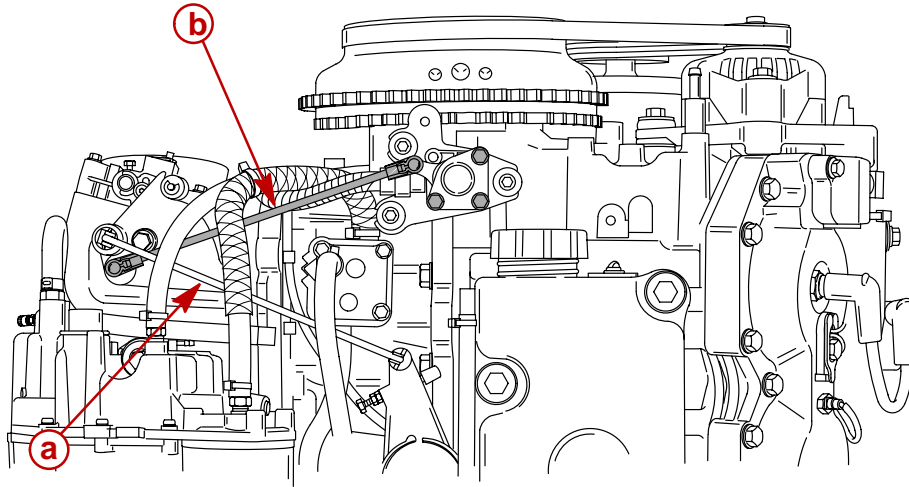


59047

- a - VST Ground Lead
- b - VST Attaching Bolts



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



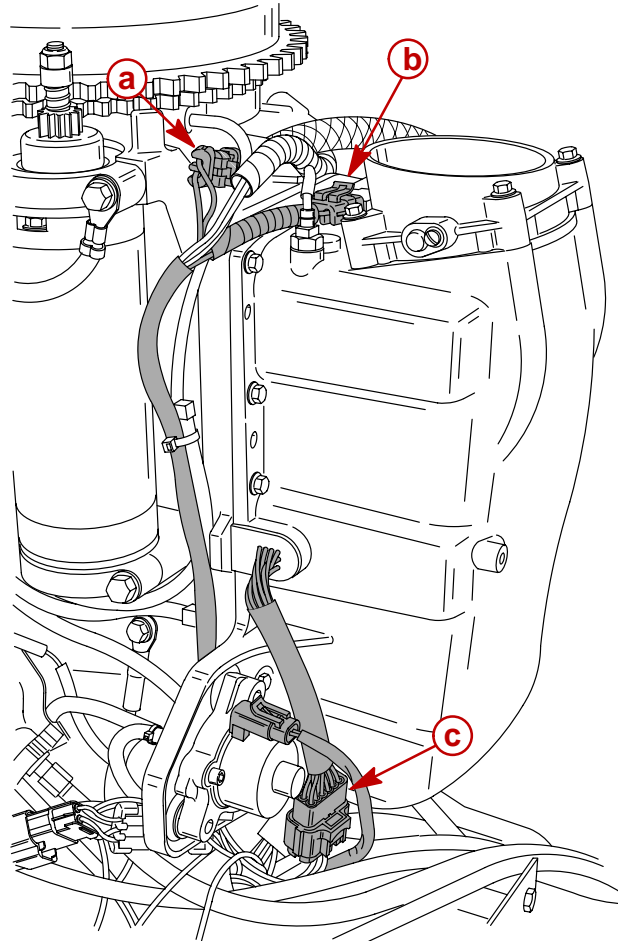
59046

a - Throttle Cam Link Rod

b - Throttle Position Sensor Link Rod

Air Plenum Removal

- Disconnect the following hoses and connectors:

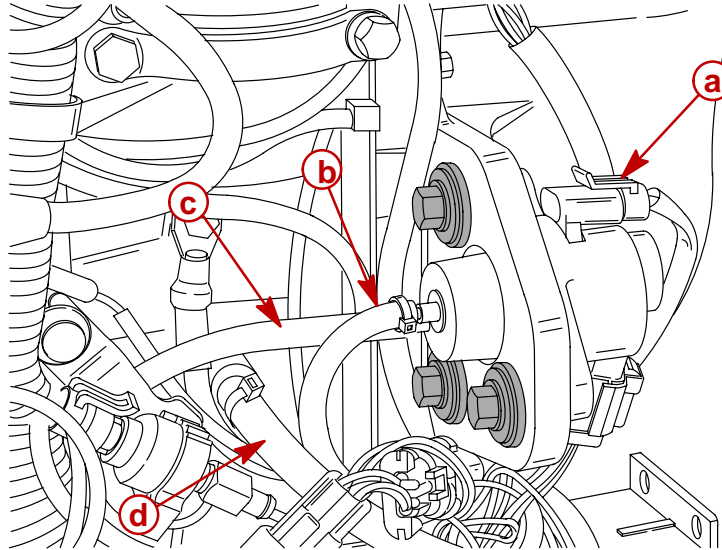


59058

a - Air Temperature Sensor
b - MAP Sensor
c - Fuel Injector Harness Connector



2. Disconnect oil pump electrical harness, oil pump inlet and outlet hoses and oil tank pressure hose.

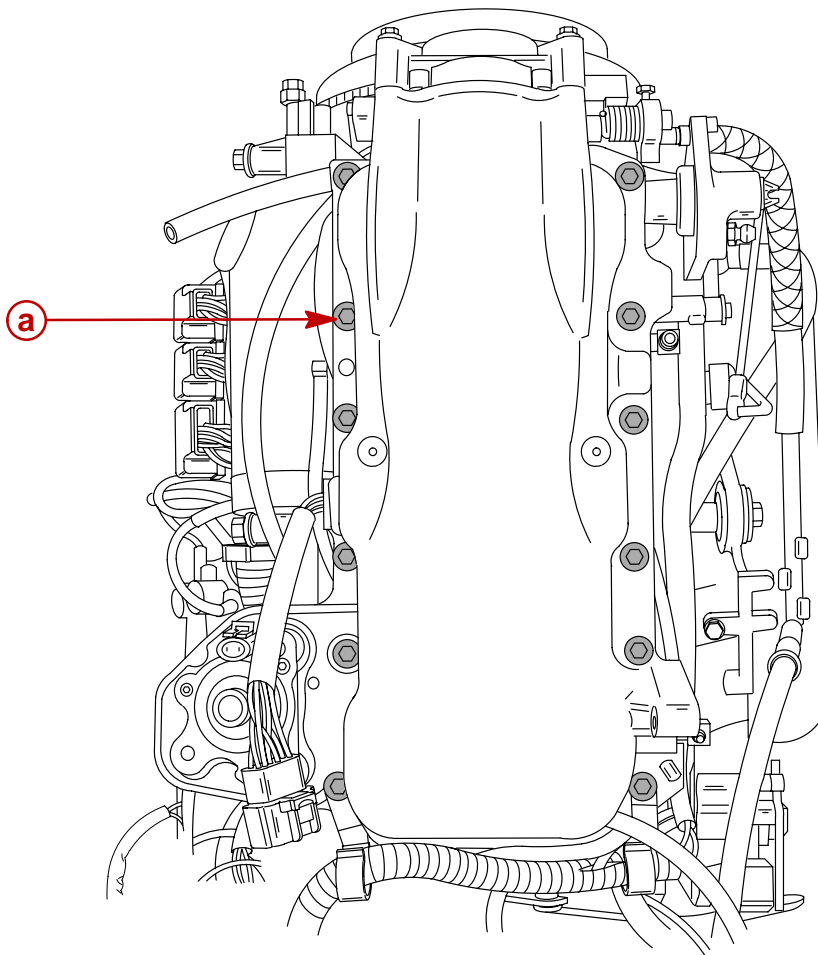


59039

a - Electrical Harness
b - Oil Outlet Hose

c - Oil Inlet Hose
d - Oil Tank Pressure Hose

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



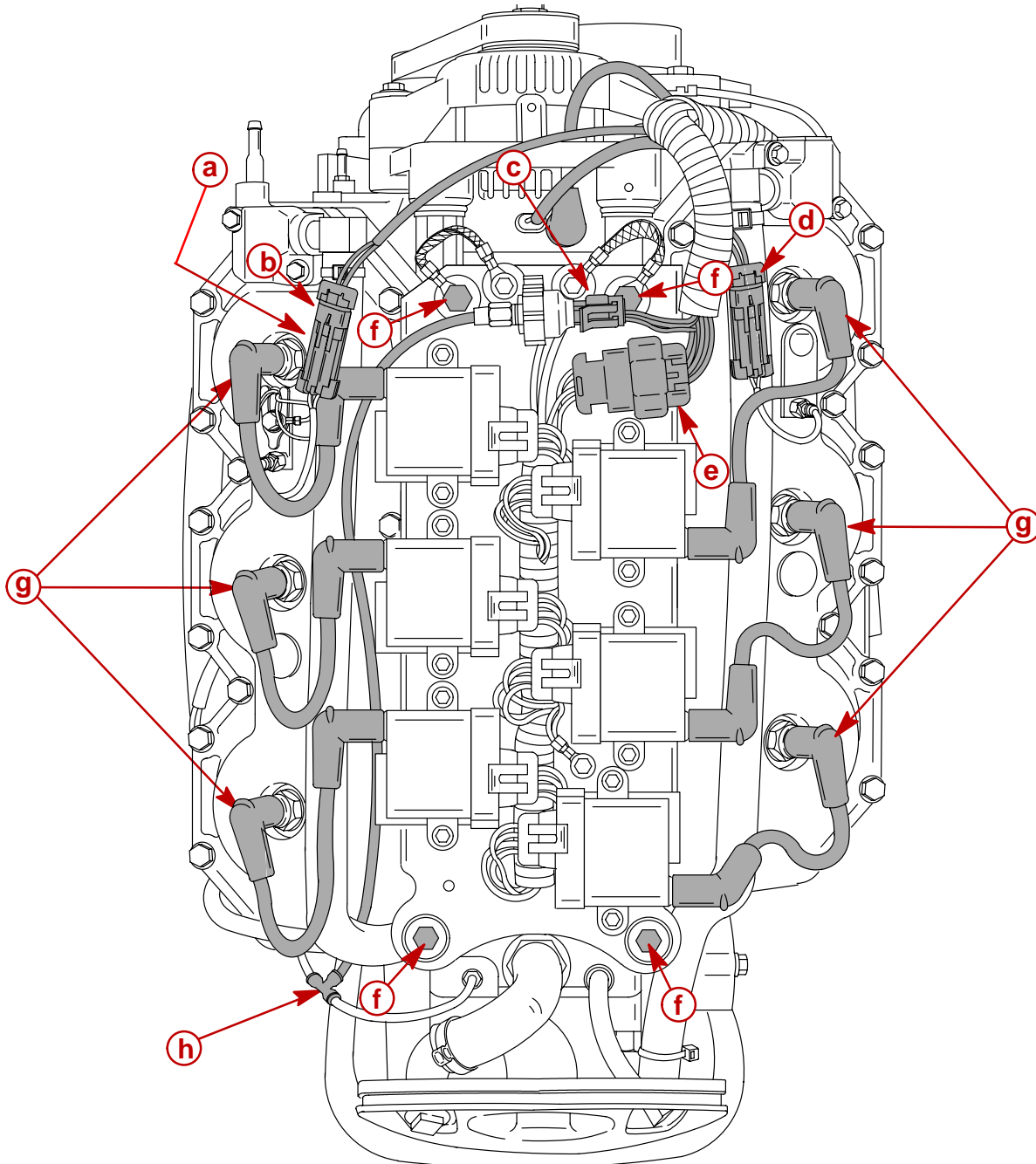
a - Bolts (12 each)

59061



Ignition Coil Plate and Harness Removal

Disconnect the following:

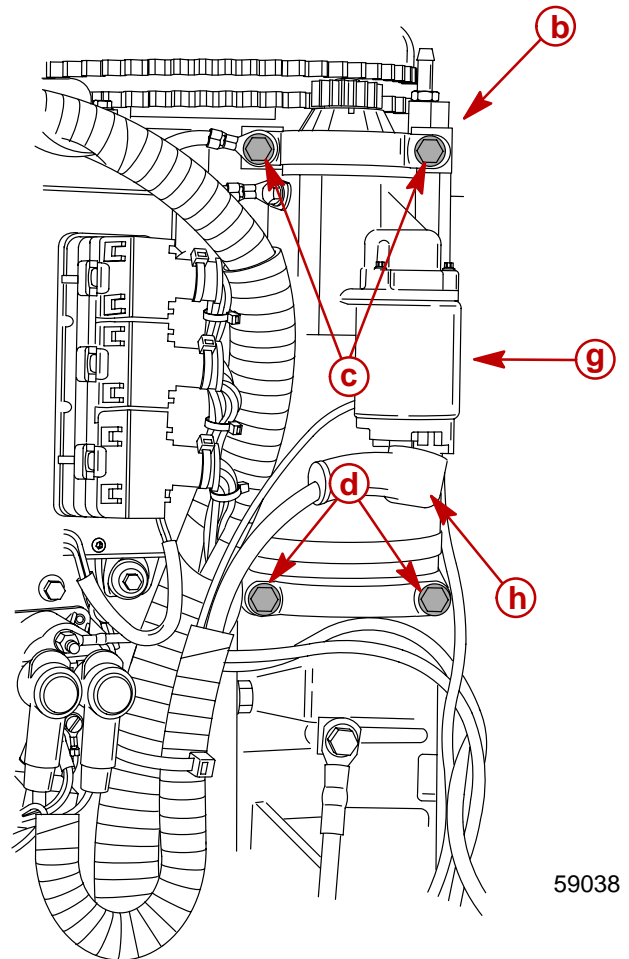
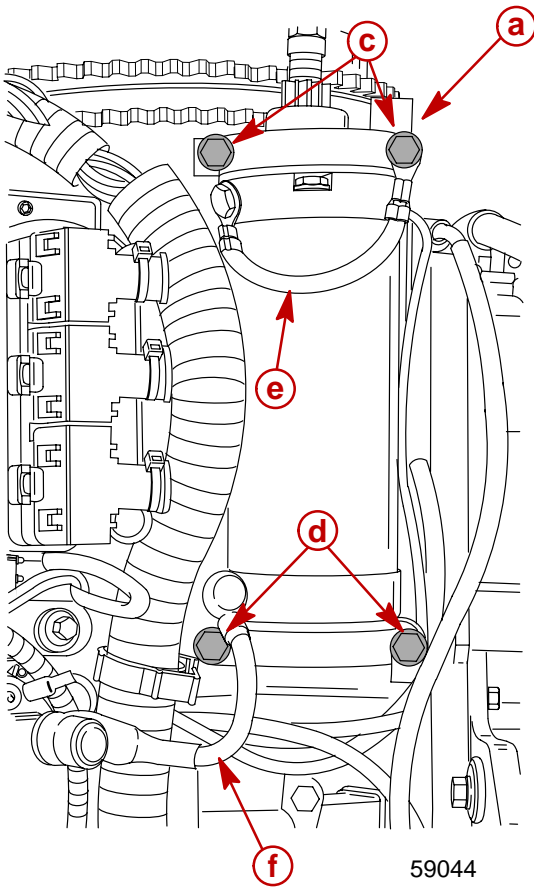


- a** - Temperature Gauge Bullet Connectors (Hidden)
- b** - Port Temperature Sensor Connector
- c** - Water Pressure Sensor Connector
- d** - Starboard Temperature Sensor Connector
- e** - Ignition Coil Harness Connector
- f** - Bolts (4)
- g** - Spark Plug Leads (Use proper tool to remove spark plug boot to avoid damage to boot)
- h** - Water Pressure Hose (Disconnect)



Starter Motor

Disconnect and/or remove the following:



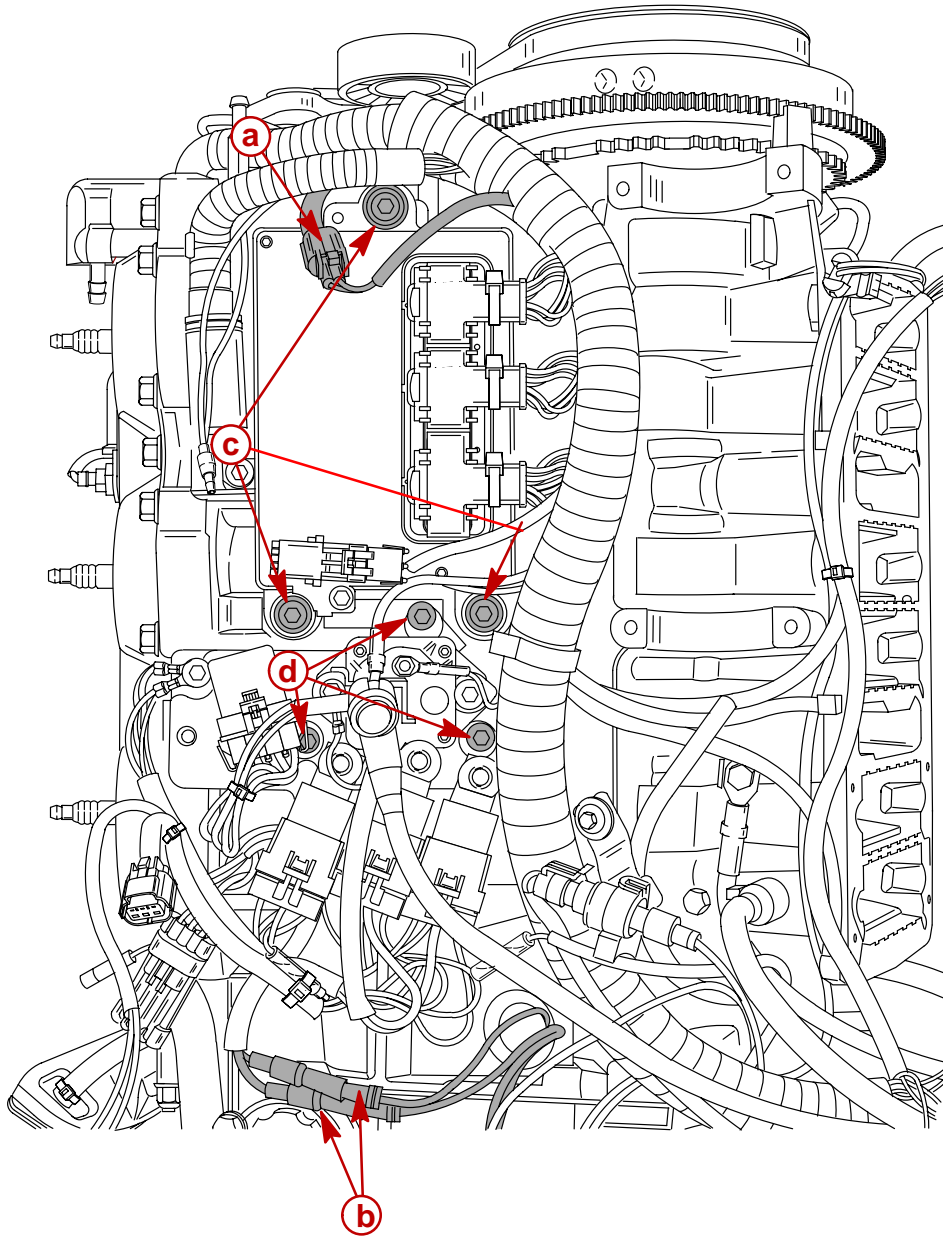
- a** - Centrifugal Bendix Starter
- b** - Solenoid Driven Bendix Starter
- c** - Upper Mount Bolts
- d** - Lower Mount Bolts
- e** - BLACK ground cable

- f** - BLACK (with YELLOW sleeve) + 12 volt cable
- g** - Starter Solenoid
- h** - BLACK (with RED sleeve) + 12 volt cable



Electrical Plate Removal

Disconnect and/or remove the following:

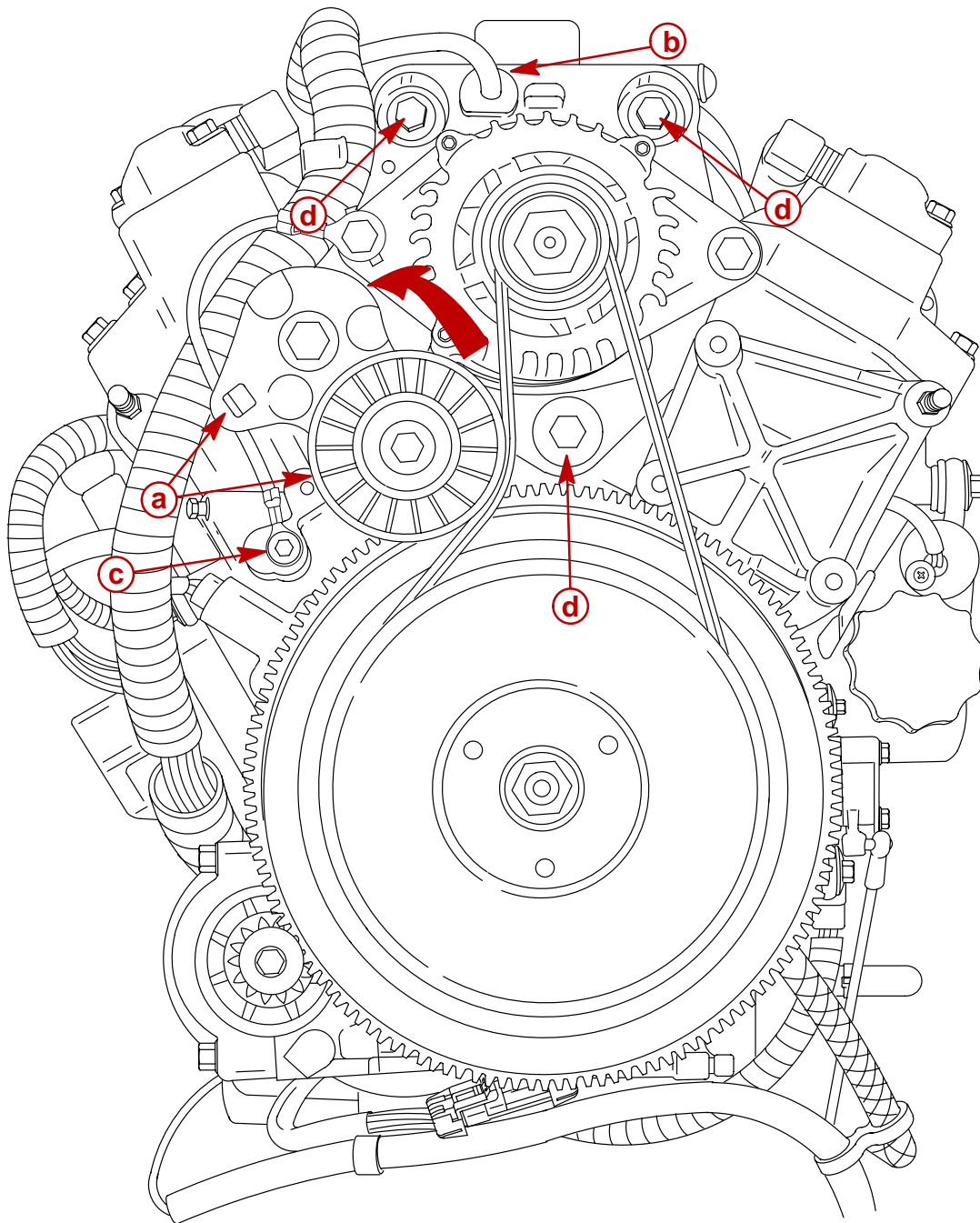


59078

- a** - Crank Position Sensor Connector
- b** - Trim Motor Bullet Connectors
- c** - ECM Screws (3)
- d** - Solenoid Plate Screws (3)



Alternator Removal



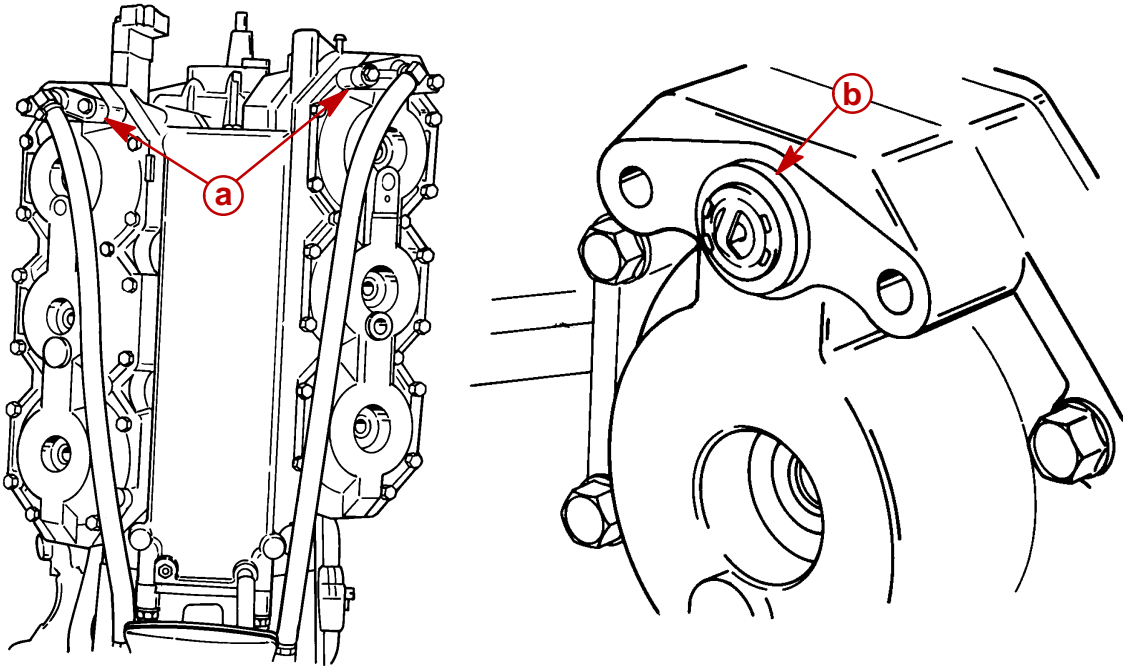
58907

- a** - Rotate Belt Tensioner with 3/8 in. Drive and Remove Belt
- b** - Remove Alternator Output Lead and Harness Connector
- c** - Remove Ground Lead Screw
- d** - Remove 3 Bolts and Remove Alternator Assembly



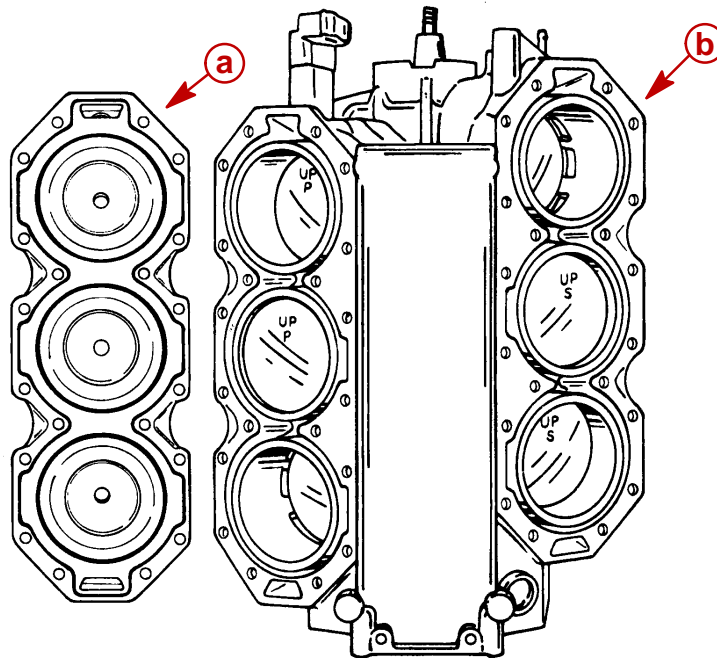
Powerhead Disassembly

1. Place powerhead in repair stand or on a bench.
2. Remove thermostat covers and washers.



a - Cover
b - Washer

3. Remove cylinder heads from engine block.

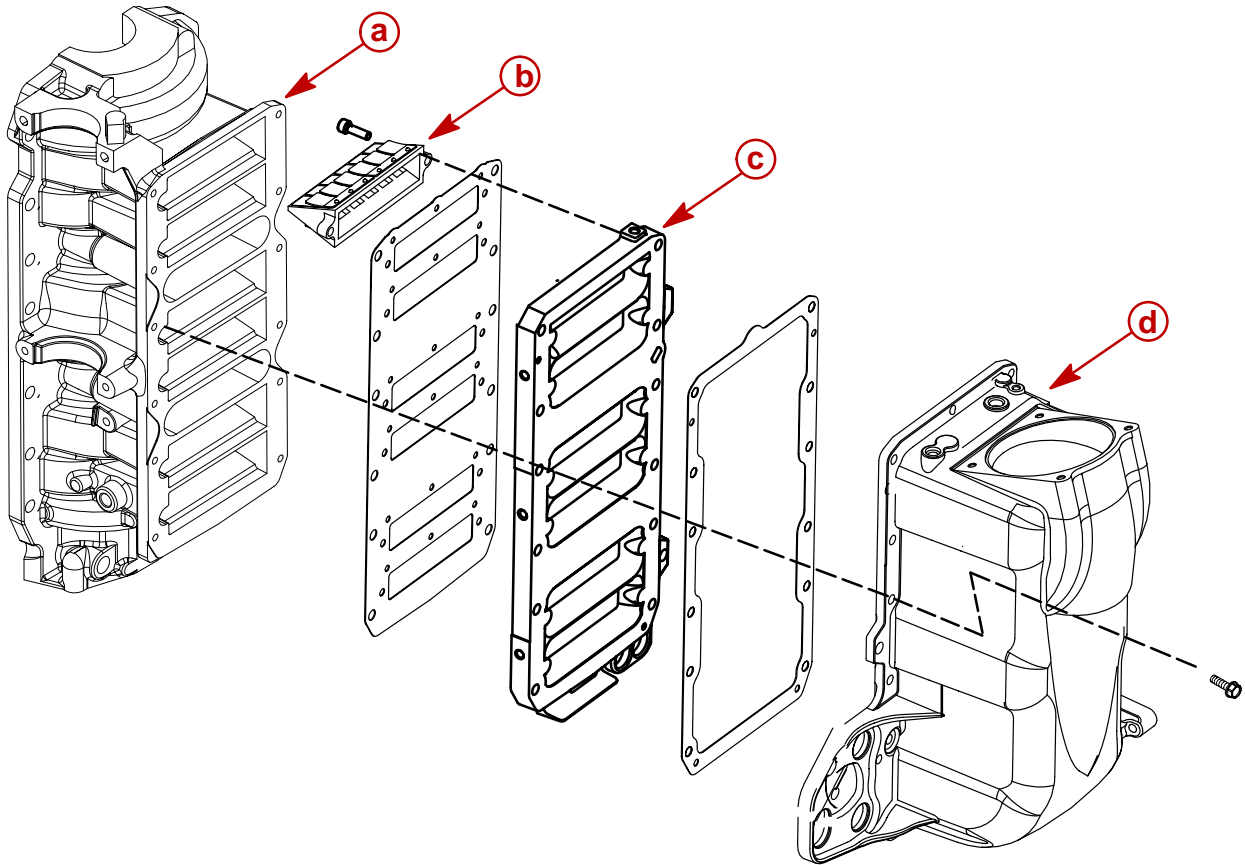


a - Cylinder Head
b - Engine Block

52214



4. Remove reed block housing from cylinder block.
5. Inspect reeds as outlined in "Cleaning and Inspection".

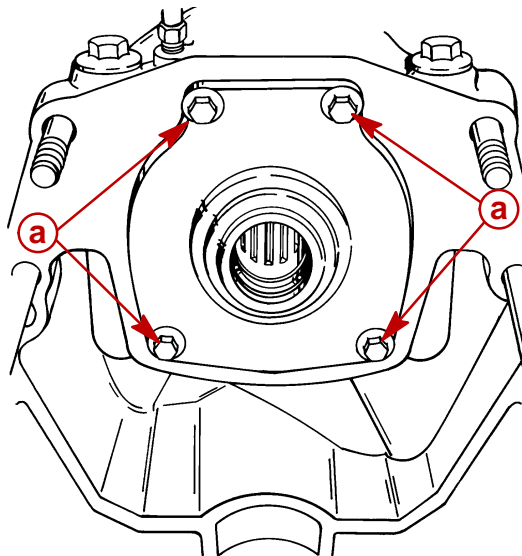


- a** - Reed Block Housing
- b** - Reed Block
- c** - Adapter Plate
- d** - Air Plenum



LOWER END CAP

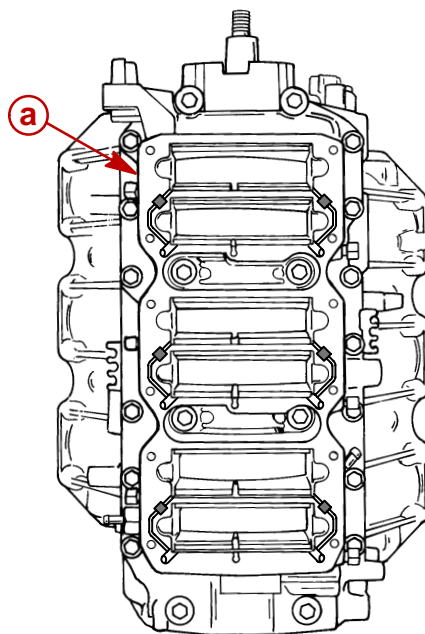
1. Remove lower end cap bolts.



52325

a - Crankcase Attaching End Cap Bolts

2. Remove bolts which secure crankcase cover to cylinder block.



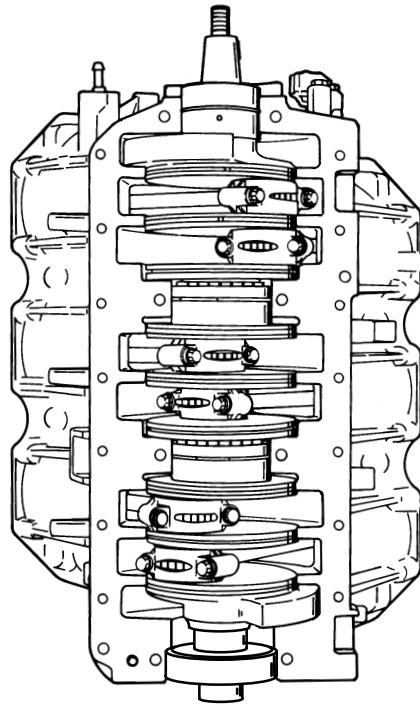
55977

a - Crankcase Cover

3. Remove crankcase end cap.

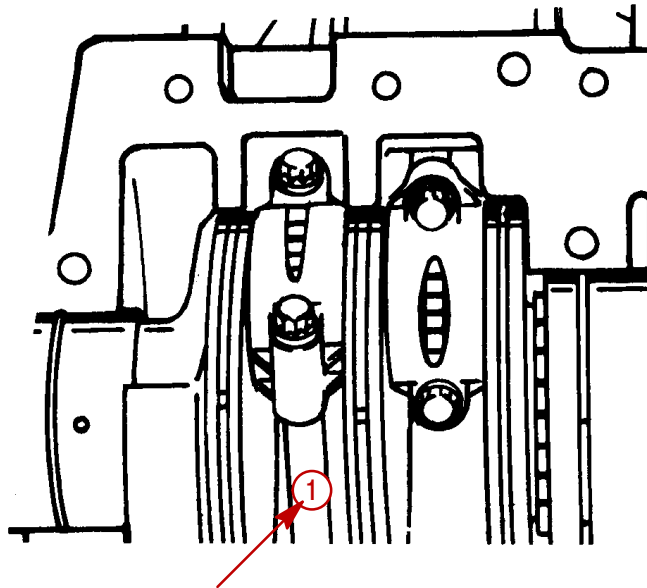


CRANKCASE COVER REMOVED



55978

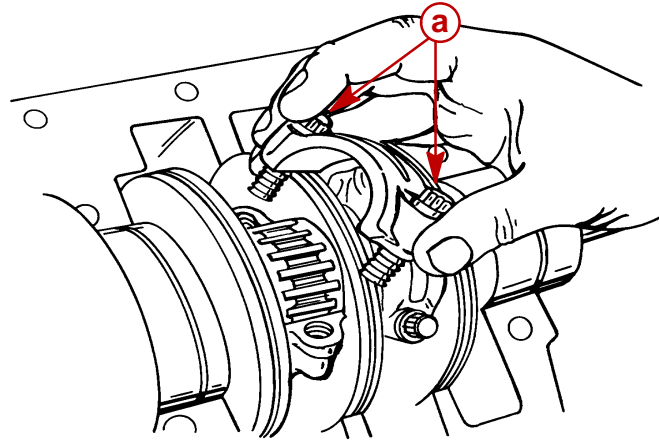
4. Use Powerhead Stand (91-30591A1) for rotating crankshaft to desired position for removal of connecting rods.
5. Using an awl or electric pencil, scribe the cylinder identification number on each connecting rod as shown. Reassemble connecting rods in same cylinder.



52347



6. Use a 3/8 in. 12 point socket to remove connecting rod bolts, then remove rod cap, roller bearings and bearing cage from connecting rod.



a - Connecting Rod Bolts

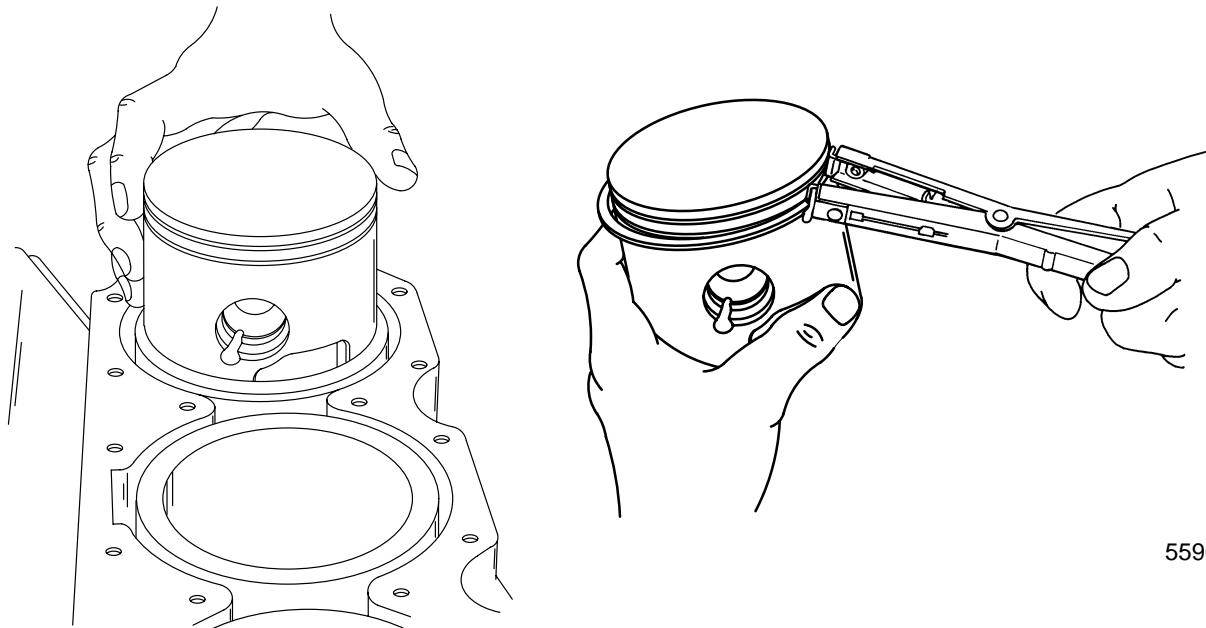
52316

7. Push piston out of cylinder block.
8. 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.

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

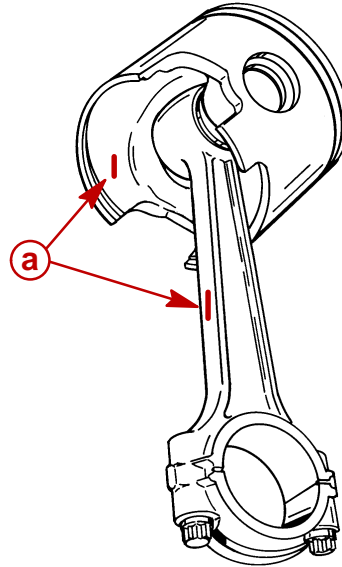


55966

55967



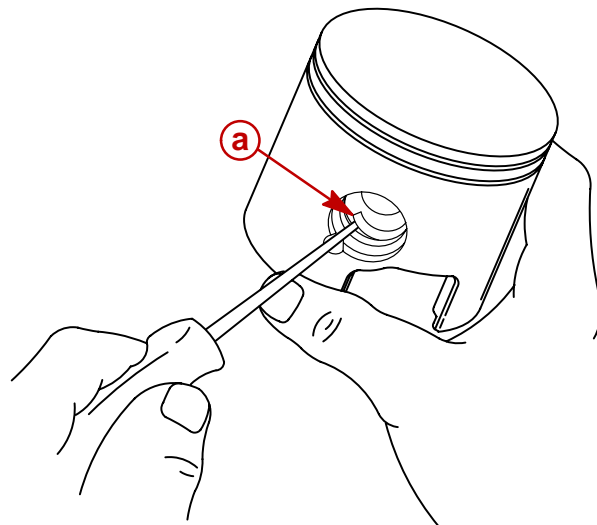
11. Using an awl, scribe identification number of connecting rod on inside of piston. Reassemble piston on same connecting rod.



55968

a - Scribe Identification Number

12. Using tool (91-52952A1), remove piston pin lockrings from both ends of piston pin. Never re-use piston pin lockrings.



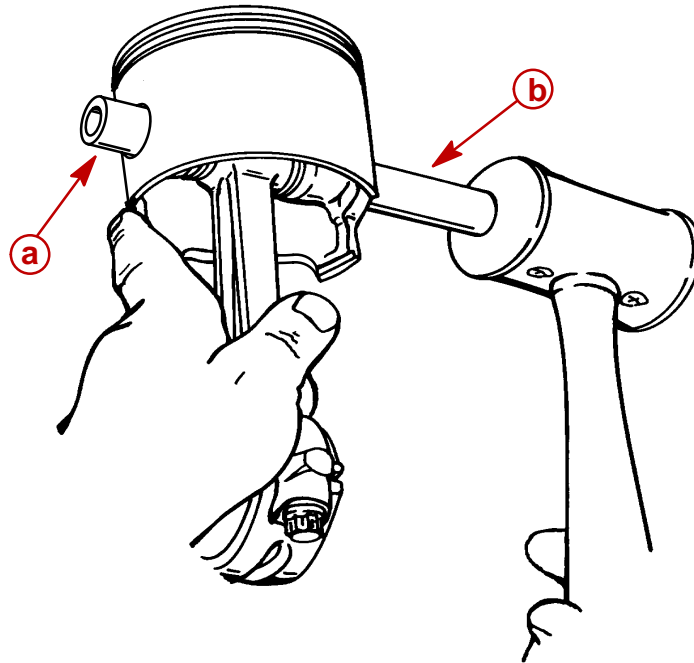
55969

a - Lockring



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

13. Support piston and tap out piston pin using service tool (91-92973A1) as shown.

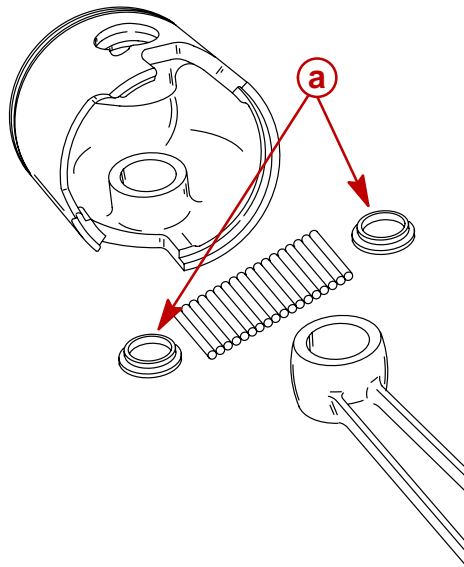


55957

- a - Piston Pin
- b - Piston Pin Tool (91-92973A1)

14. Remove piston pin needle bearings (34 per piston) and locating washers (2 per piston) as shown.

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

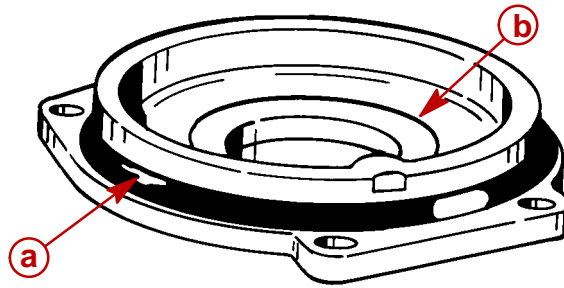


55958

- a - Needle Bearing Locating Washers



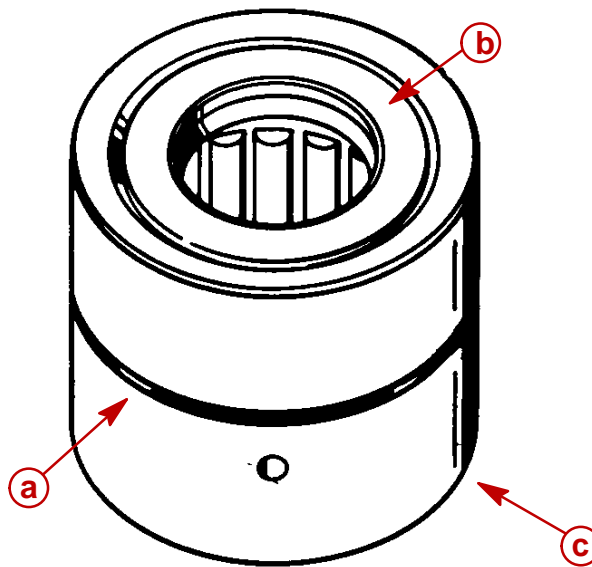
- 15. Remove lower end cap from crankshaft.
- 16. Remove and discard O-ring seal from end cap.
- 17. Remove oil seals from end cap by driving seals out with a punch and hammer.



51849

- a - O-ring
- b - Seal

- 18. Inspect roller bearing in upper end cap as outlined in "Cleaning and Inspection".
- NOTE :** *If roller bearing is damaged, replace roller bearing carrier assembly.*



51473

- a - O-Ring
- b - Seal
- c - Carrier



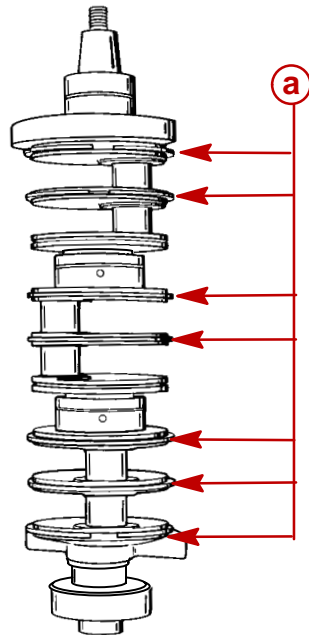
19. Remove crankshaft and place in powerhead stand as shown.

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.

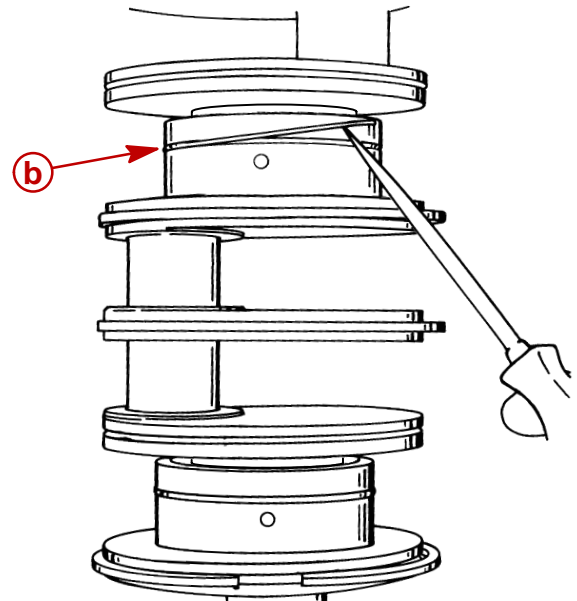
CAUTION

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

20. Remove retaining ring as shown.



58991

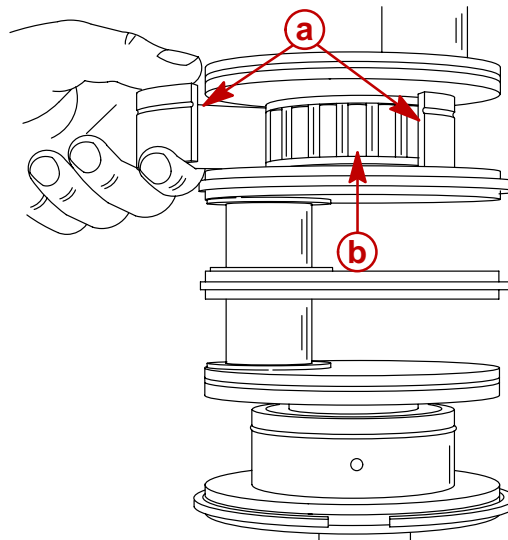


58992

a - Sealing Rings
b - Retaining Ring

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

IMPORTANT: Keep same bearing races and roller bearings together.



58989

a - Bearing Race Halves
b - Roller Bearings

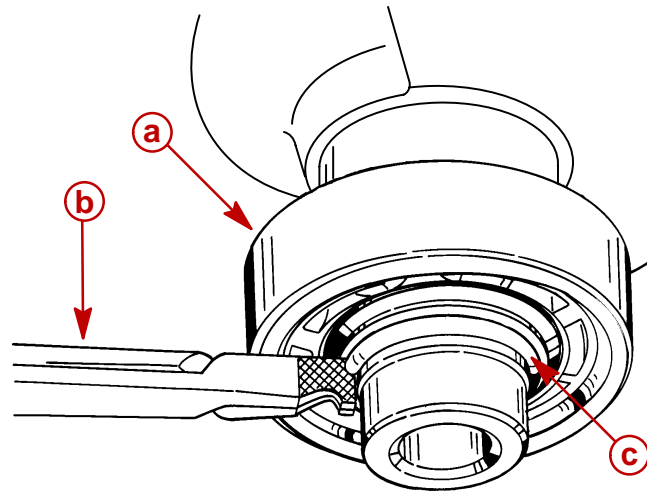


Inspect crankshaft ball bearing as outlined in “Cleaning and Inspection,” following.

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

22. Remove lower ball bearing from crankshaft as follows:

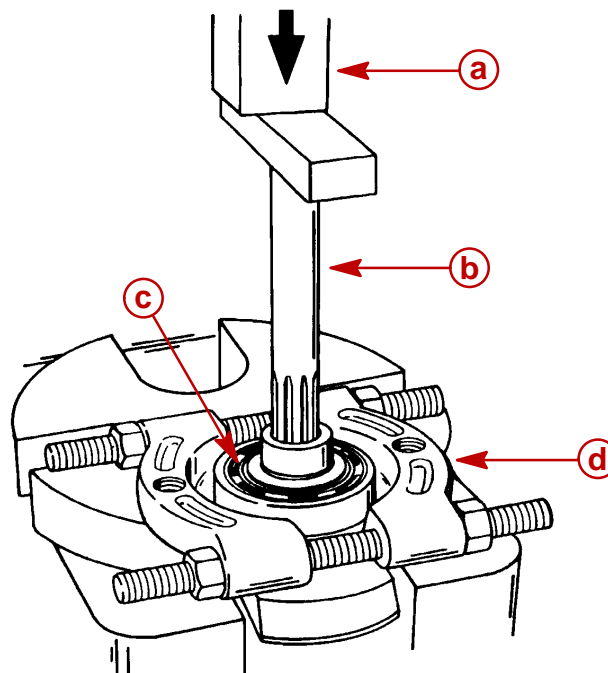
a. Remove retaining ring using a pair of snap ring pliers.



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

55983

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



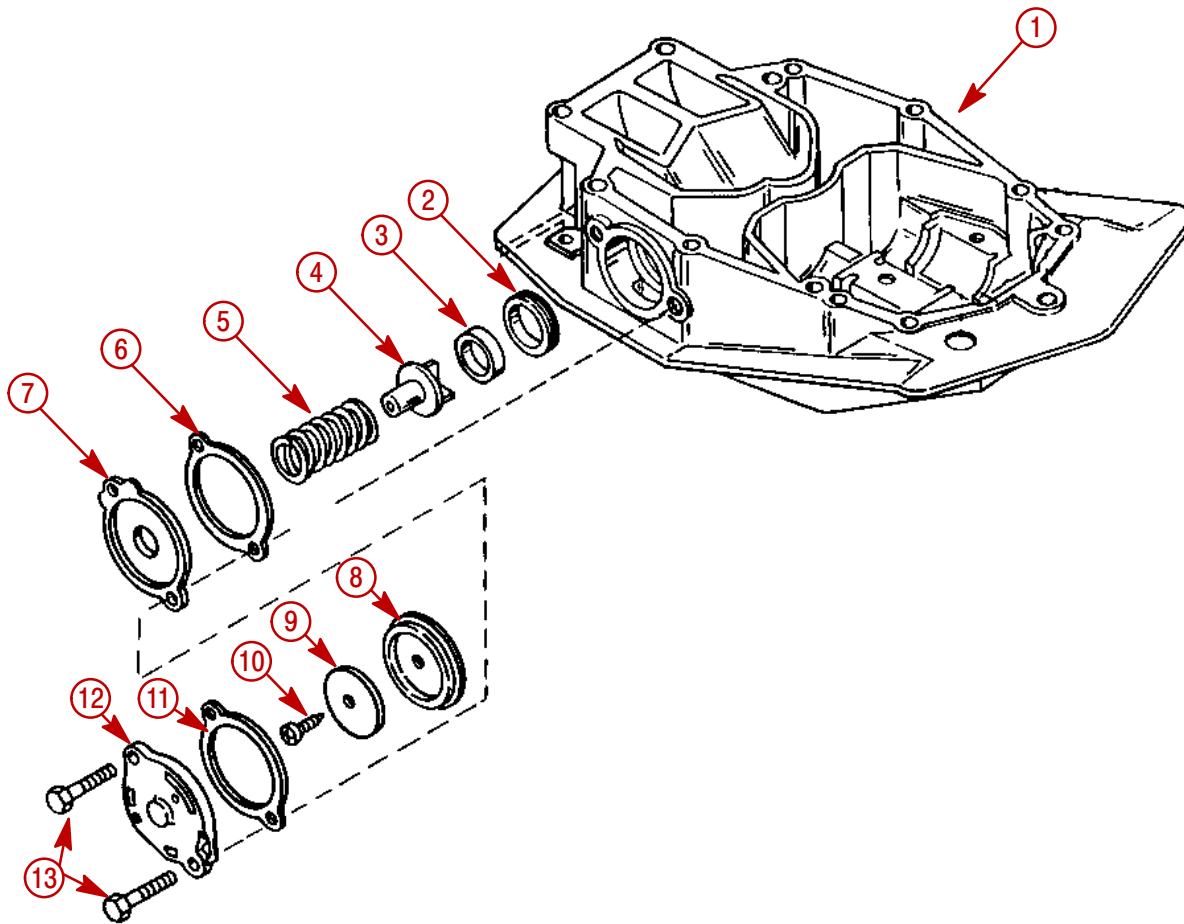
- a - Press
- b - Powerhead Stand (91-812549A1)
- c - Crankshaft Ball Bearing
- d - Universal Puller Plate (91-37241)

51081



Water Pressure Relief Valve Components

1. Remove and inspect water pressure relief valve components for debris or damage. Replace components as required.



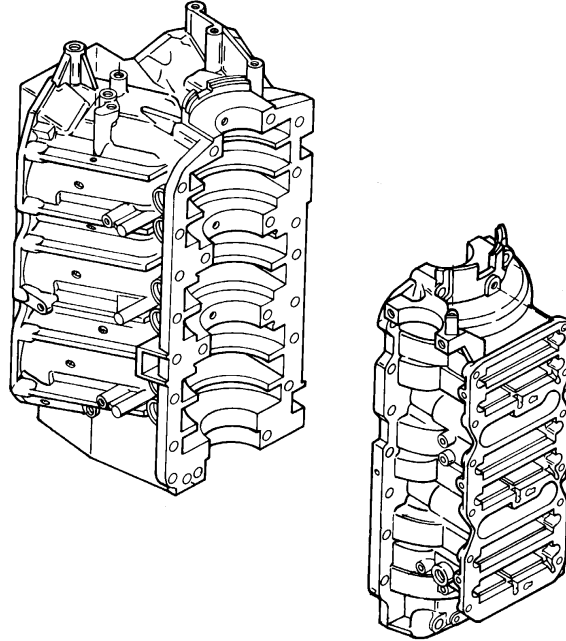
- 1** - Exhaust Plate
- 2** - Carrier
- 3** - Grommet
- 4** - Poppet/Relief Valve
- 5** - Spring
- 6** - Gasket
- 7** - Inner Plate
- 8** - Diaphragm
- 9** - Washer
- 10** - Screw [Torque to 25 lb. in. (3 Nm)]
- 11** - Gasket
- 12** - Outer Cover
- 13** - Bolts [Torque to 20 lb. ft. (27 Nm)]



Cleaning and Inspection

Cylinder Block and Crankcase Cover

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



CAUTION

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

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

Special Service Information

Grooves in Cylinder Block Caused By Crankshaft Sealing Rings

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



Cylinder Bores

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

HONING PROCEDURE

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

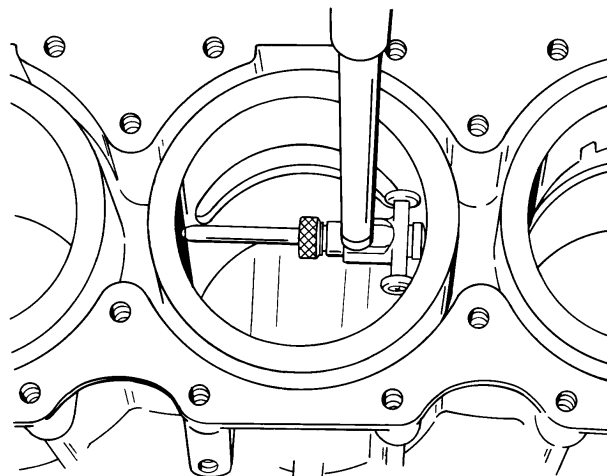
CAUTION

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

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



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



52324

200/225/250 Models

Model	Cylinder Block Finish Hone
200/225/250	3.6265 in. (92.1131 mm)
0.015 in. (0.38 mm) Oversize	3.6415 in. (92.4941 mm)
0.030 in. (0.76 mm) Oversize	3.6565 in. (92.8751 mm)

4. If a cylinder bore is tapered, out-of-round or worn more than 0.003 in. (0.076 mm) from standard "Cylinder Block Finish Hone" diameter (refer to chart, preceding), it will be necessary to re-bore that cylinder(s) to 0.015 in. (0.381 mm) oversize 0.030 in. (0.762 mm) oversize and install oversize piston(s) and piston rings during reassembly.

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

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

Pistons and Piston Rings

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

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

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



CLEANING PISTON RING GROOVES

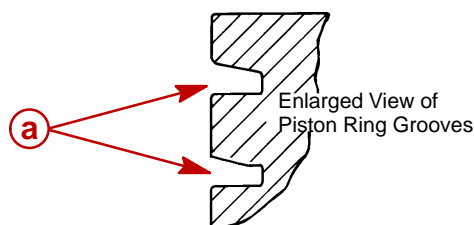
Keystone (tapered) ring grooves

⚠ CAUTION

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

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

Piston with two half keystone (half tapered) rings



a - Ring Grooves

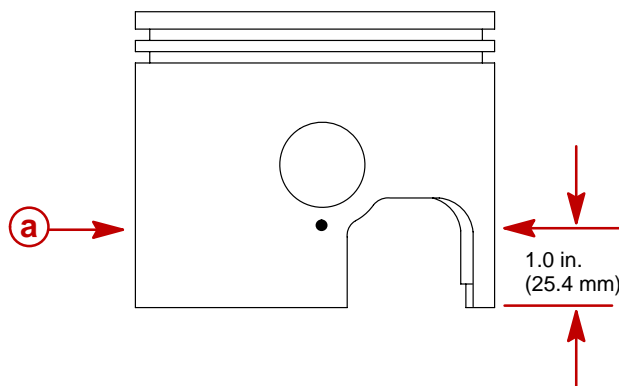
MEASURING PISTON ROUNDNESS

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

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

Piston	Dimension "A"
Standard Piston	3.6210 in. \pm .0005 in. (91-9734 mm \pm .0127 mm)
0.015 in. Oversize Piston	3.636 in. \pm .0005 in. (92.354 mm \pm .0127 mm)
0.030 in. Oversize Piston	3.651 in. \pm .0005 in. (92.735 mm \pm .0127 mm)

2. Using a micrometer, measure dimension "A" at location shown. Dimension "A" should be 3.6210 in. \pm 0.0005 in. for a STANDARD size piston.



a - Dimension "A" at RIGHT Angle (90°) to Piston Pin



Cylinder Heads

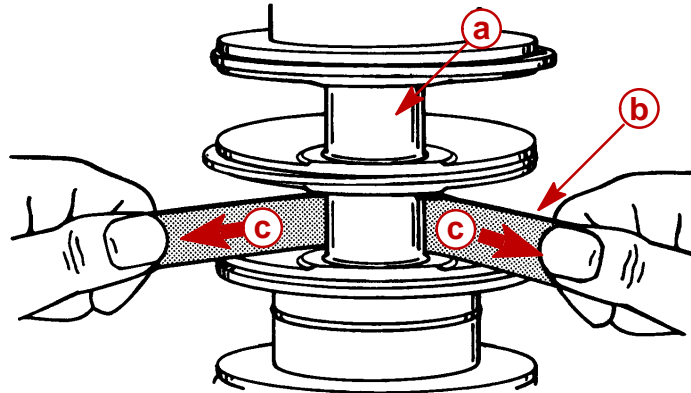
1. Inspect internal surface of cylinder heads for possible damage (as a result of piston or foreign material striking cylinder heads).

IMPORTANT: Cylinder head warpage should not exceed 0.005 in. (0.127 mm) over the ENTIRE length of the cylinder head. If measured warpage, as determined on a surface block, exceeds 0.005 in. (0.127 mm) or a discontinuity of up to 0.005 in. (0.127 mm) exists in a 1.0 in. (25.4 mm) portion of the cylinder head's surface length, then the cylinder head must be replaced.

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

Crankshaft

1. Inspect crankshaft to drive shaft splines for wear. Replace crankshaft if necessary.
2. Check crankshaft for straightness. Maximum runout is 0.002 in. (0.0508 mm). Replace as necessary.
3. Inspect crankshaft oil seal surfaces. Sealing surfaces must not be grooved, pitted or scratched. Replace as necessary.
4. Check all crankshaft bearing surfaces for rust, water marks, chatter marks, uneven wear and/or overheating. (Refer to "Connecting Rods".)
5. If necessary, clean crankshaft surfaces with crocus cloth.



52323

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

⚠ WARNING

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

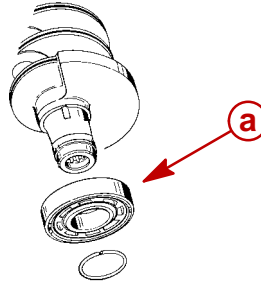
6. Thoroughly clean (with solvent) and dry crankshaft and crankshaft ball bearing. Re-check surfaces of crankshaft. Replace crankshaft, if surfaces cannot be properly "cleaned up." If crankshaft will be re-used, lubricate surfaces of crankshaft with light oil to prevent rust. DO NOT lubricate crankshaft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



Crankshaft (and End Cap) Bearings

IMPORTANT: When overhauling powerhead assembly, it is recommended that all crankshaft bearings – upper/lower, center main, connecting rod and wrist pin bearings – be replaced to ensure optimum powerhead performance and longevity.

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



52326

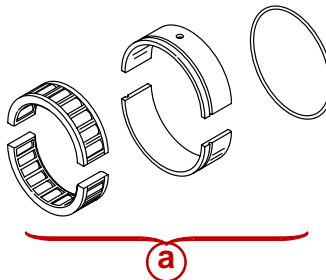
a - Lower Crankshaft Ball Bearing

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

⚠ CAUTION

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

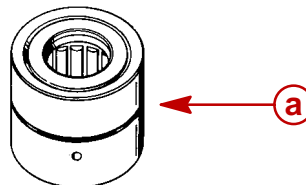
4. Thoroughly inspect center main roller bearings. Replace bearings if they are rusted, fractured, worn, galled or badly discolored.



52153

a - Center Main Roller Bearing

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



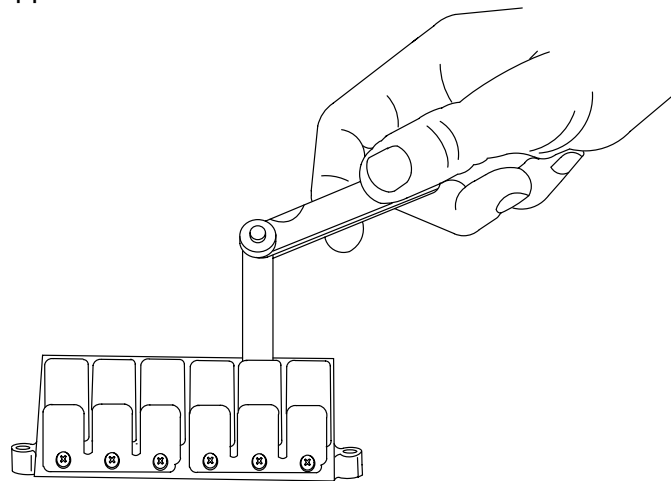
a - Upper Roller Bearing



Reed Block Assembly

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

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



56023

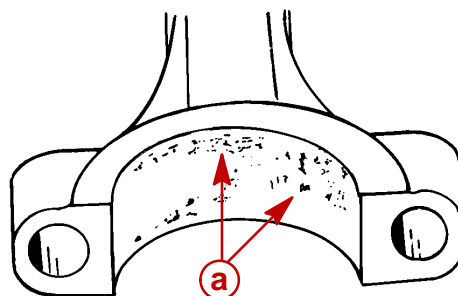
Allowable reed opening is 0.020 in. (0.51 mm) or less. Replace reeds if either reed is standing open more than 0.020 in. (0.51 mm).

End Bearing Bleed System

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

Connecting Rods

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

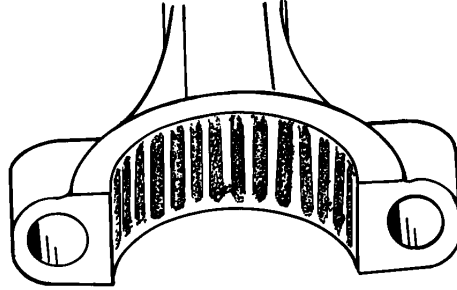


a - Pitting

51853

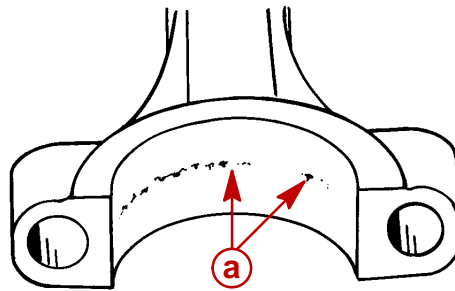


4. **Water Marks:** When bearing surfaces are subjected to water contamination, a bearing surface “etching” occurs. This etching resembles the size of the bearing.



51853

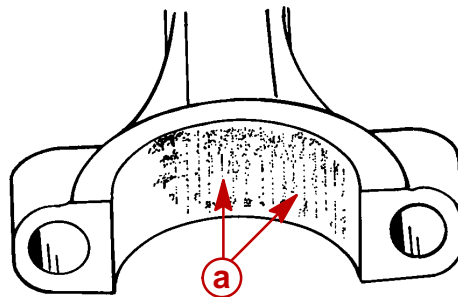
5. **Spalling:** Spalling is the loss of bearing surface, and it resembles flaking or chipping. Spalling will be most evident on the thrust portion of the connecting rod in line with the “I” beam. General bearing surface deterioration could be caused by or accelerated by improper lubrication.



51853

a - Spalling

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

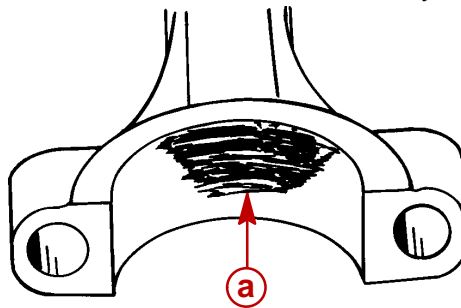


51853

a - Chatter Marks Between Arrows



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



51853

a - Uneven Wear Between Arrows

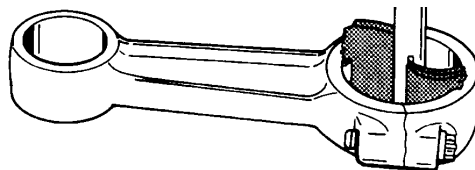
8. If necessary, clean connecting rod bearing surfaces, as follows:
- Be sure that “etched” marks on connecting rod (crankshaft end) are perfectly aligned with “etched” marks on connecting rod cap. Tighten connecting rod cap attaching bolts securely.

⚠ CAUTION

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

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

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



51083

- 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.
- Thoroughly wash connecting rods to remove abrasive grit. Recheck bearing surfaces of connecting rods. Replace any connecting rod(s) that cannot be properly “cleaned up.” Lubricate bearing surfaces of connecting rods (which will be re-used) with light oil to prevent rust.

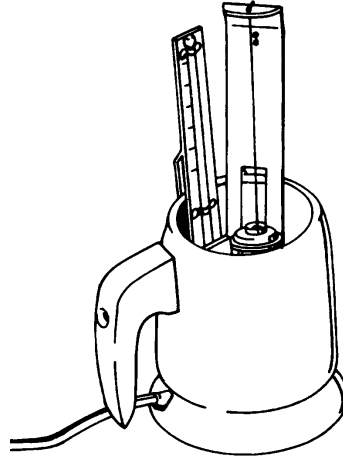
Thermostats (120°F) (49°C)

- Inspect thermostat covers and cylinder head covers (thermostat opening) for cracks and corrosion damage that could cause leakage. Replace parts as necessary.
- Remove and discard gasket from each thermostat.
- Wash thermostats with clean water.
- Using a thermostat tester, similar to the one shown, test each thermostat as follows:
 - Open thermostat valve, then insert a thread between valve and thermostat body. Allow valve to close against thread.
 - 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.
 - Fill thermostat tester with water to cover thermostat.



- d. Plug tester into electrical outlet.
- e. Observe temperature at which thermostat begins to open. (Thermostat will drop off thread, that was installed in Step “a”, when it starts to open.) Thermostat must begin to open when temperature reaches 118°-122 °F (48°-50 °C).
- f. Continue to heat water until thermostat is completely open.
- g. Unplug thermostat tester.
- h. Replace thermostat if it fails to open at the specified temperature, or if it does not fully open.

NOTE : *BE SURE that water in thermostat tester is allowed to cool sufficiently [below 110 °F (43 °C)] before testing the other thermostat.*



51087

Powerhead Reassembly and Installation

General

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

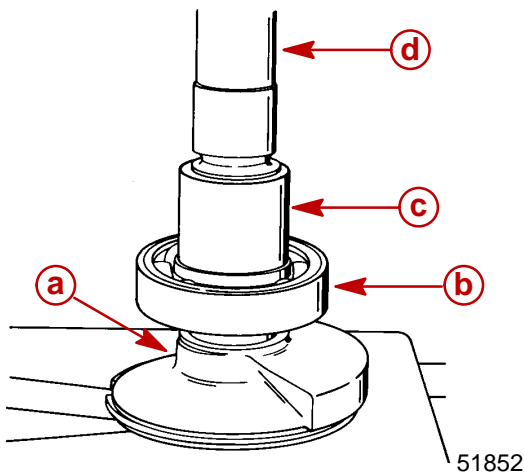
During reassembly, lubricate parts with 2-Cycle Outboard Oil whenever “light oil” is specified. Mercury/Quicksilver part numbers of lubricants, sealers and locking compounds are listed in “Mercury/Quicksilver Lubricants and Sealants” located in section 1A, and special tools are listed in “Powerhead General Information,” preceding.

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

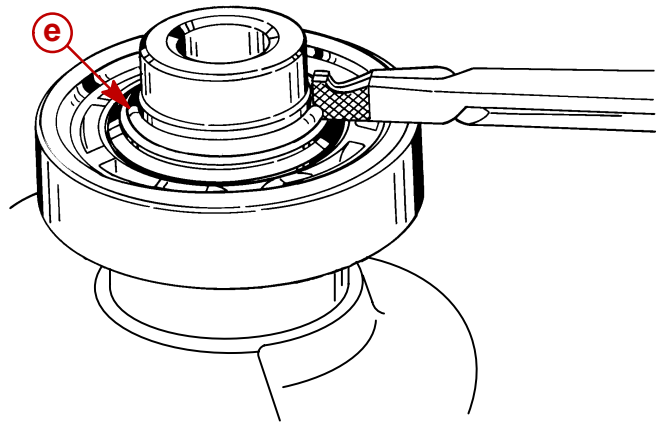
EXAMPLE: If cylinder head attaching bolts require a torque of 30 lb. ft. (41 N·m), a) tighten all bolts to **10 lb. ft. (13.5 Nm)**, following specified torque sequence, b) tighten all bolts to **20 lb. ft. (27 Nm)**, following torque sequence, then finally c) tighten all bolts to **30 lb. ft. (41 Nm)**,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



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

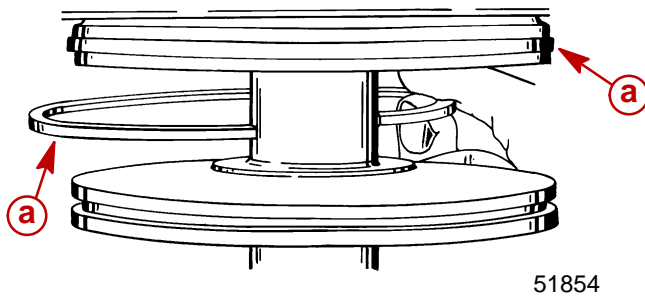


a - Crankshaft
b - Crankshaft Ball Bearing

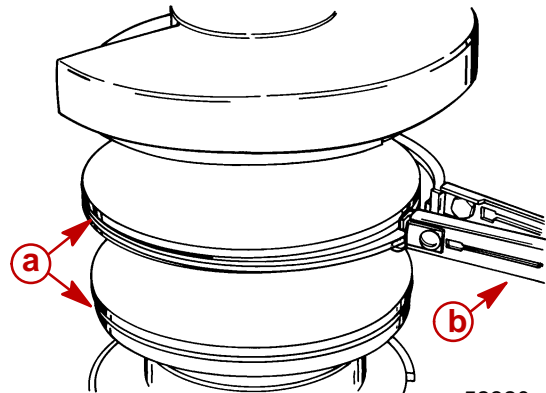


c - Suitable Mandrel
d - Press
e - Retaining Ring

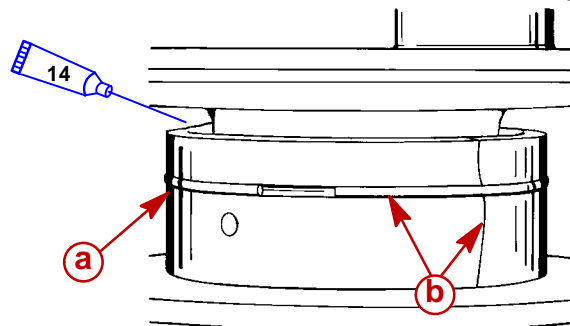
3. If removed, spread new crankshaft sealing rings just enough to slide over crankshaft journal.
4. Use Piston Ring Expander (91-24697) and install crankshaft sealing rings into groove.



a - Crankshaft Sealing Rings
b - Piston Ring Expander (91-24697)



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

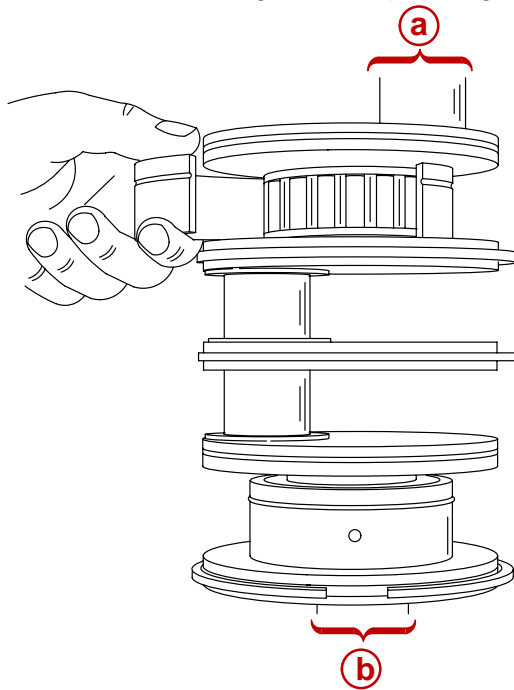


14 2 Cycle Outboard Oil

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

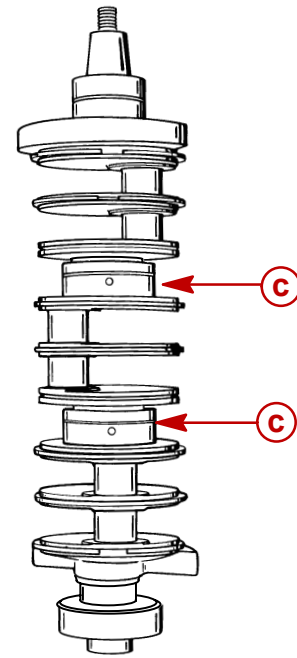


6. Place center main crankshaft roller bearings on upper and lower main bearing journals as shown.
7. Install center main bearing races as shown.
8. Secure center main bearing races together with retaining rings. Make sure retaining ring bridges the separating lines of the bearing race.



a - Flywheel End
b - Drive Shaft End

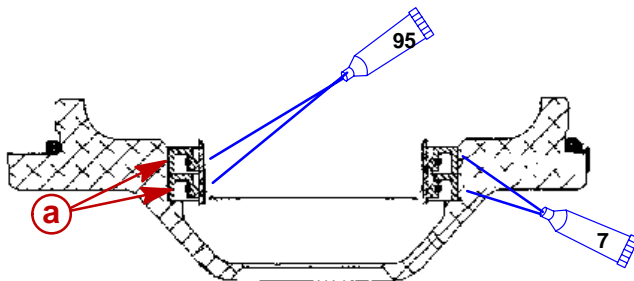
58989



c - Center Main Bearing Races

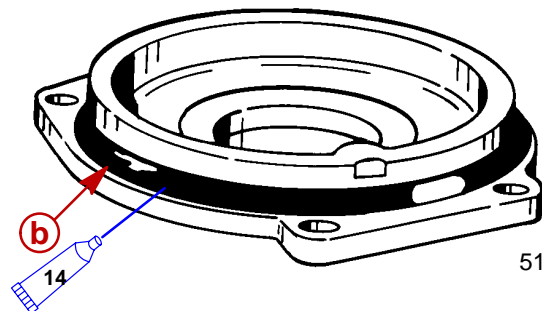
58991

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.
 - b. Use suitable mandrel to press one oil seal (lip facing down) into lower end cap until firmly seated. Remove any excess Loctite.
 - c. Press second oil seal (lip facing down) until firmly seated on first oil seal. Remove any excess Loctite.
 - d. Lubricate oil seal lips with 2-4-C Marine Lubricant 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 Marine Lubricant with Teflon

a - Oil Seal



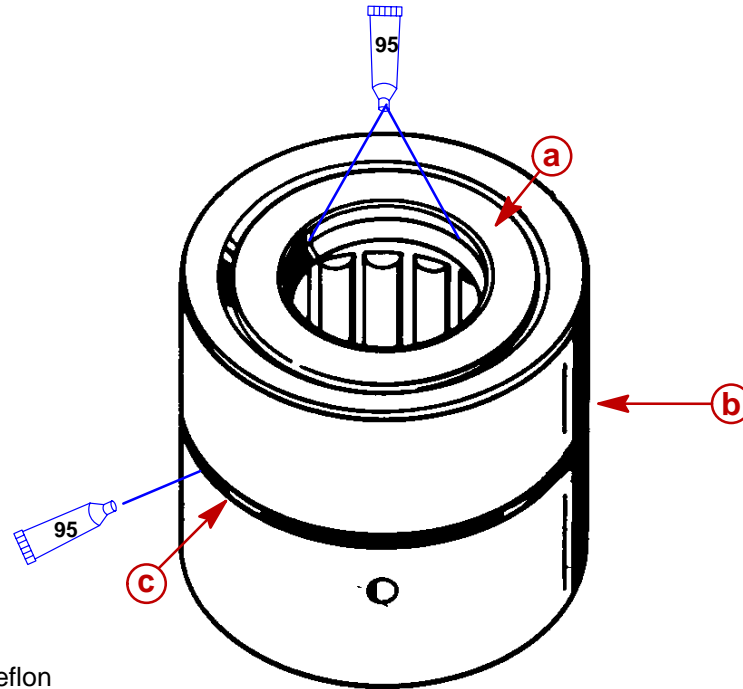
b - O-ring

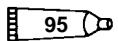
51849



10. Install oil seal into upper bearing carrier as follows:

- Apply a light film of 2-4-C Marine Lubricant with Teflon to outer diameter of upper end cap oil seal. This will ease seal installation into carrier.
- Lubricate oil seal lip with 2-4-C Marine Lubricant with Teflon.
- Use a suitable mandrel, press oil seal into bearing carrier (lip facing down) until bottomed out on shoulder of carrier.
- Lubricate O-ring seal surface on end cap with 2-4-C Marine Lubricant with Teflon and install on carrier.



 2-4-C With Teflon

51473

- a** - Oil Seal
- b** - Bearing Carrier
- c** - O-ring

Crankshaft Installation

SPECIAL INFORMATION

Installing A New Crankshaft Assembly Into Cylinder Block

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

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

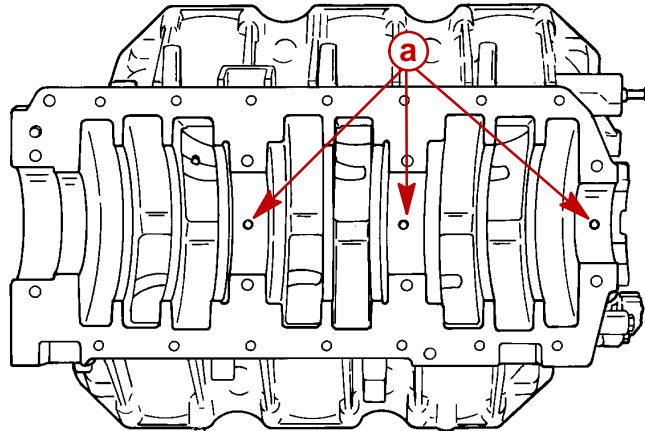
Lubricate sealing rings with light oil and install new crankshaft as instructed.

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



Install crankshaft as follows:

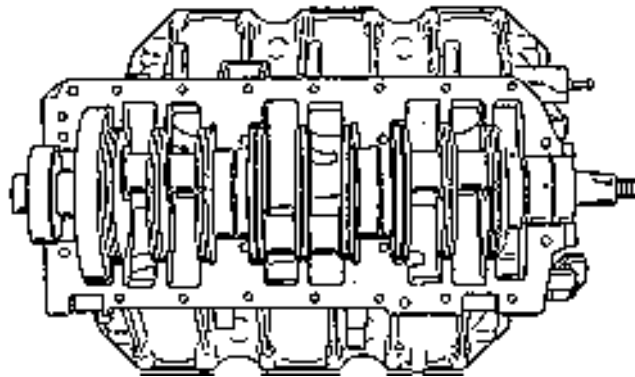
1. Lubricate crankshaft sealing rings with light oil.
2. Check cylinder block to be sure that dowel pins are in place.



55992

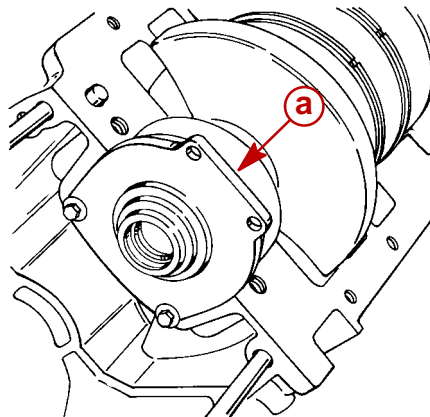
a - Dowel Pins

3. Position all crankshaft seal ring gaps straight up.
4. Align hole in each center main bearing race with dowel pin.
5. Gently push crankshaft down into position making sure that the dowel pins are lined up with the holes in center main bearings and crankshaft seal rings are in place.



55993

6. Lubricate lower crankshaft end (oil seal area) with light oil, then install lower end cap. Secure end cap to cylinder block with attaching bolts. DO NOT tighten end cap bolts at this time.



52328

a - Lower End Cap



Piston and Connecting Rod Reassembly

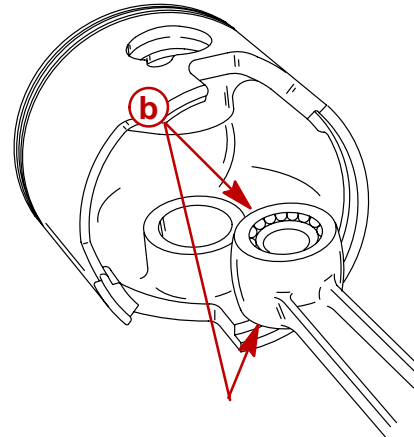
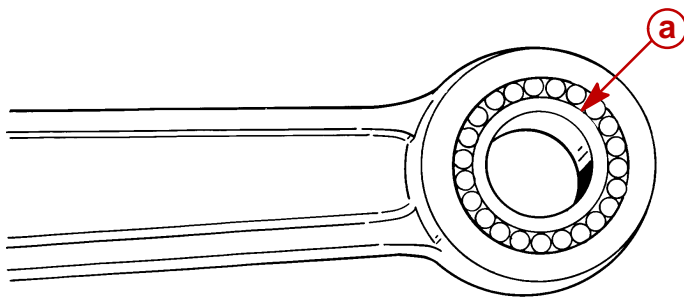
1. Place needle bearings on a clean piece of paper and lubricate with 2-4-C Marine Lubricant with Teflon.

NOTE : There are 34 needle bearings per piston.

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

IMPORTANT: Position connecting rod part number facing towards flywheel.

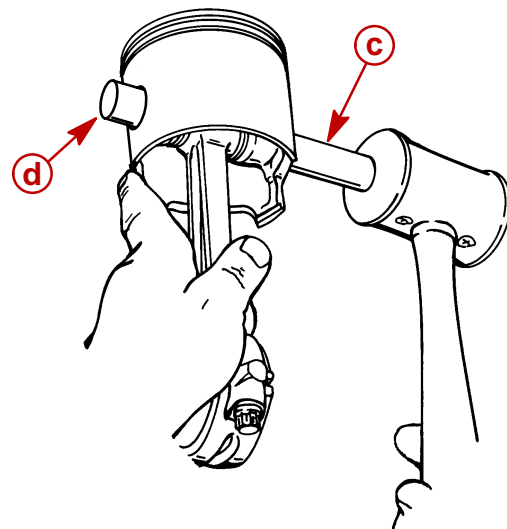
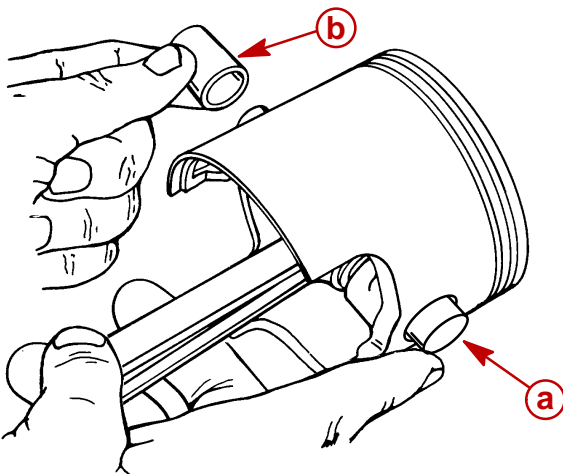
Carefully position piston over end of rod. Make sure locating washers remain in place.



- a** - Sleeve (Part of Tool Assy. 91-92973A1)
b - Locating Washers

55960

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



- a** - Piston Pin Tool
(91-92973A1)
b - Sleeve

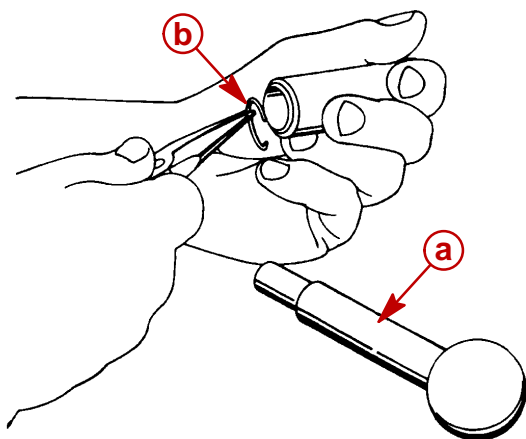
- c** - Piston Pin
d - Piston Pin Tool

55961

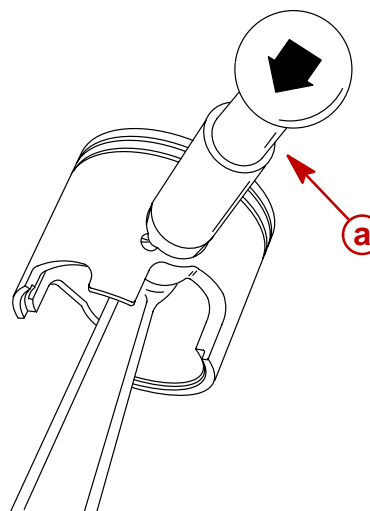
55962



6. Install new piston pin lockrings (one each end of piston pin) with Lockring Installation Tool (91-93004A2).
7. Make sure lockrings are properly seated in piston grooves.



51086

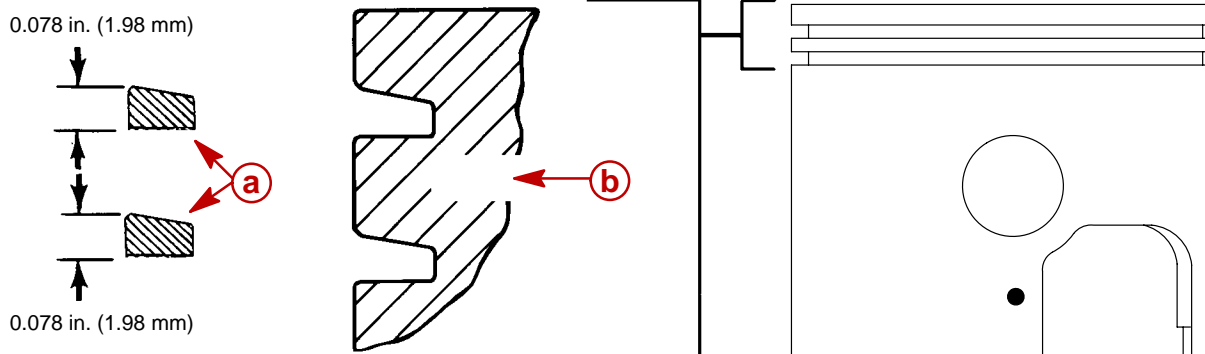


55963

- a** - Lockring Installation Tool (91-93004A2)
- b** - Lockring

Piston and Piston Ring Combinations

Pistons with two half keystone (half tapered) rings



55964

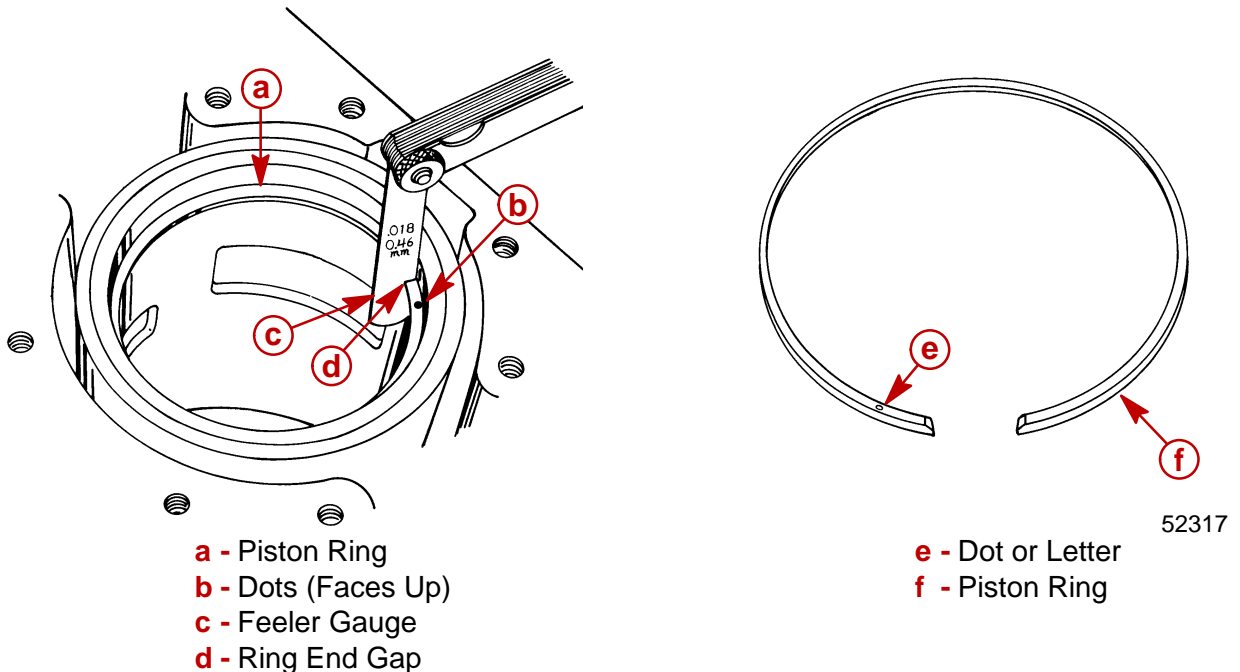
- a** - Half Keystone (half tapered) Piston Ring
- b** - Enlarged View of Piston Ring Grooves



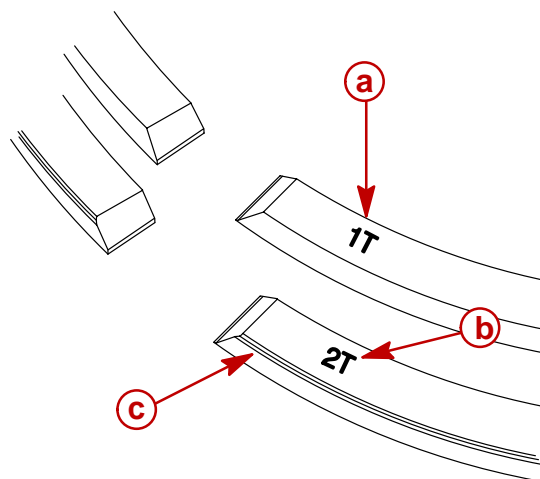
Piston Installation

1. Before installing new piston rings, check gap between ring ends by placing each ring in its respective cylinder, then pushing ring about 1/2 in. (12.7 mm) into cylinder using piston to assure proper position.
2. Check end gap of each new piston ring with a feeler gauge. End gap must be within 0.010 in. to 0.018 in. (0.25 mm to 0.46 mm). If end gap is greater, check other piston rings in cylinder bore, until rings (within tolerance) are found.

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



IMPORTANT: 3 Liter Work/225 EFI/250 EFI engines have top and bottom indicated piston rings and should be installed accordingly. The top ring is marked T1 and the bottom ring is marked T2. The "T" represents the top side of of the ring. The bottom ring is stepped to trap oil and bring it into the cylinder bores on the upward stroke.

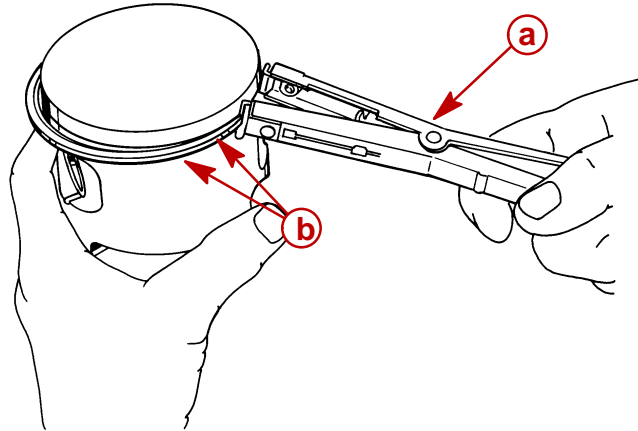


58126

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

52319

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

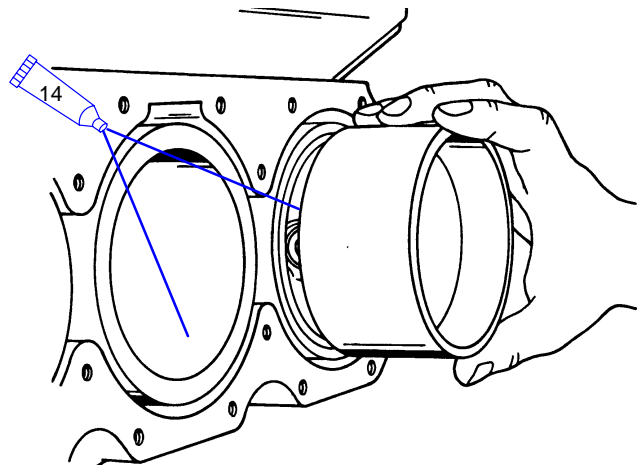
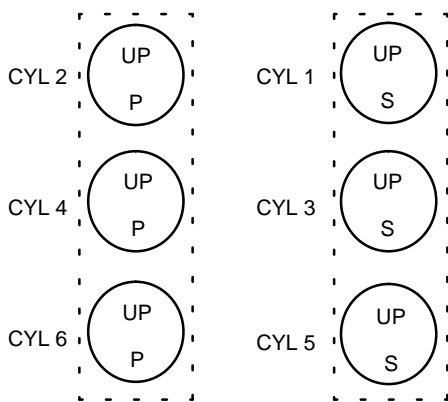
IMPORTANT: Piston must be correctly installed and positioned as shown.

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

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

Pistons with the letter "S" must be installed in the starboard side of engine and the word "UP" toward top of engine.

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



14 2 Cycle Outboard Oil

52328



10. Apply 2-4-C Marine Lubricant 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.

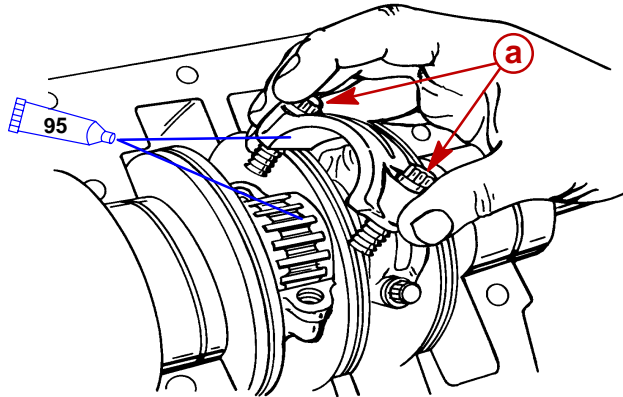
11. Place connecting rod cap on connecting rod. Apply light oil to threads and face of connecting rod bolts. Thread connecting rod bolts finger-tight while checking for correct alignment of the rod cap as shown.

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

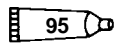
- Run a pencil lightly over ground area.
- If pencil stops at fracture point, loosen bolts, retighten, and check again.

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

12. Tighten connecting rod bolts (using a 3/18 in. - 12 point socket). First torque to 15 lb. in. (1.7 N·m) then 30 lb. ft. (41 N·m). Turn each bolt an additional 90° after 2nd torque is attained. Recheck alignment between rod cap and rod as shown.



52316



2-4-C With Teflon

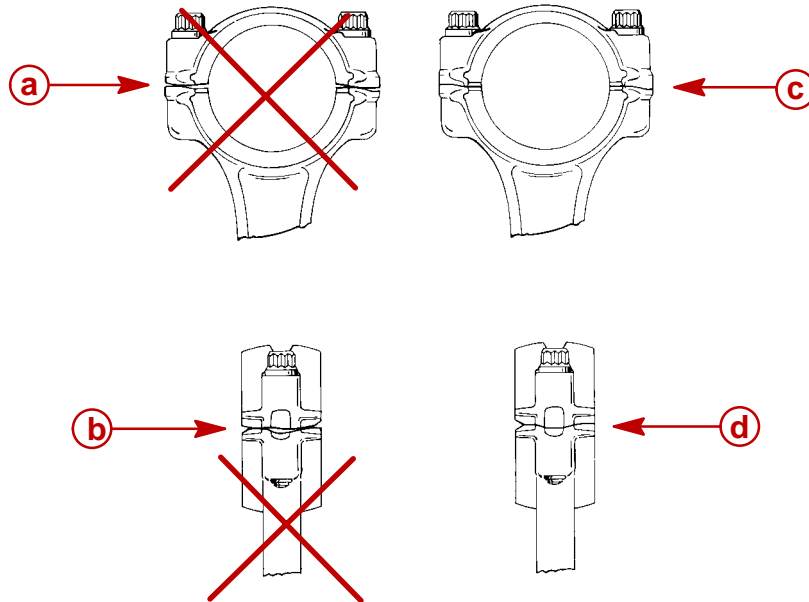
a - Connecting Rod Screws

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



Connecting Rod Cap Alignment

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



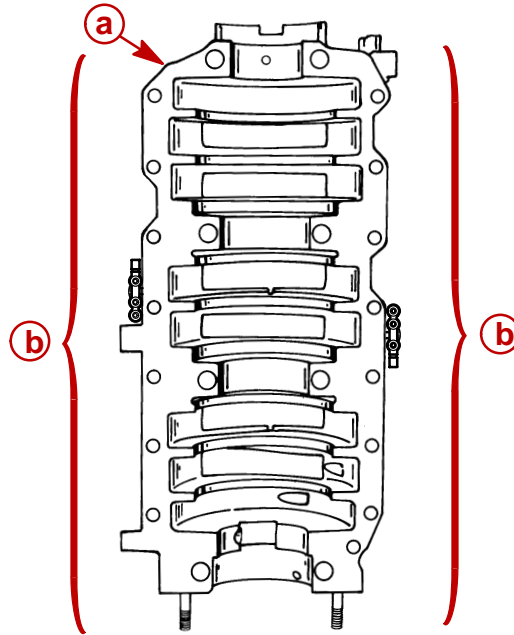
- a** - Side View Incorrect – Cap on Backwards
- b** - End View Incorrect – Cap on Backwards
- c** - Side View Correct
- d** - End View Correct

52381



Crankcase Cover Installation

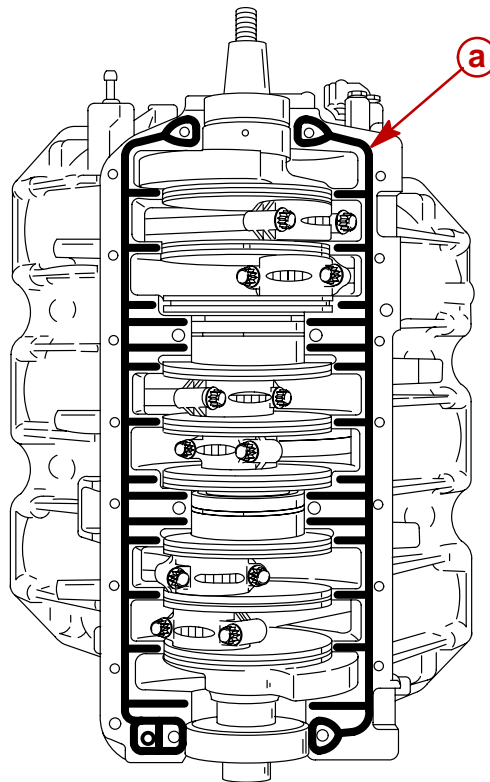
1. Thoroughly remove all oil from mating surfaces of crankcase cover and cylinder block with Loctite 7649 Primer.



55984

- a** - Crankcase Cover
- b** - Remove all Oil

2. Apply a thin, even coat of Loctite Master Gasket on mating surfaces of cylinder block.

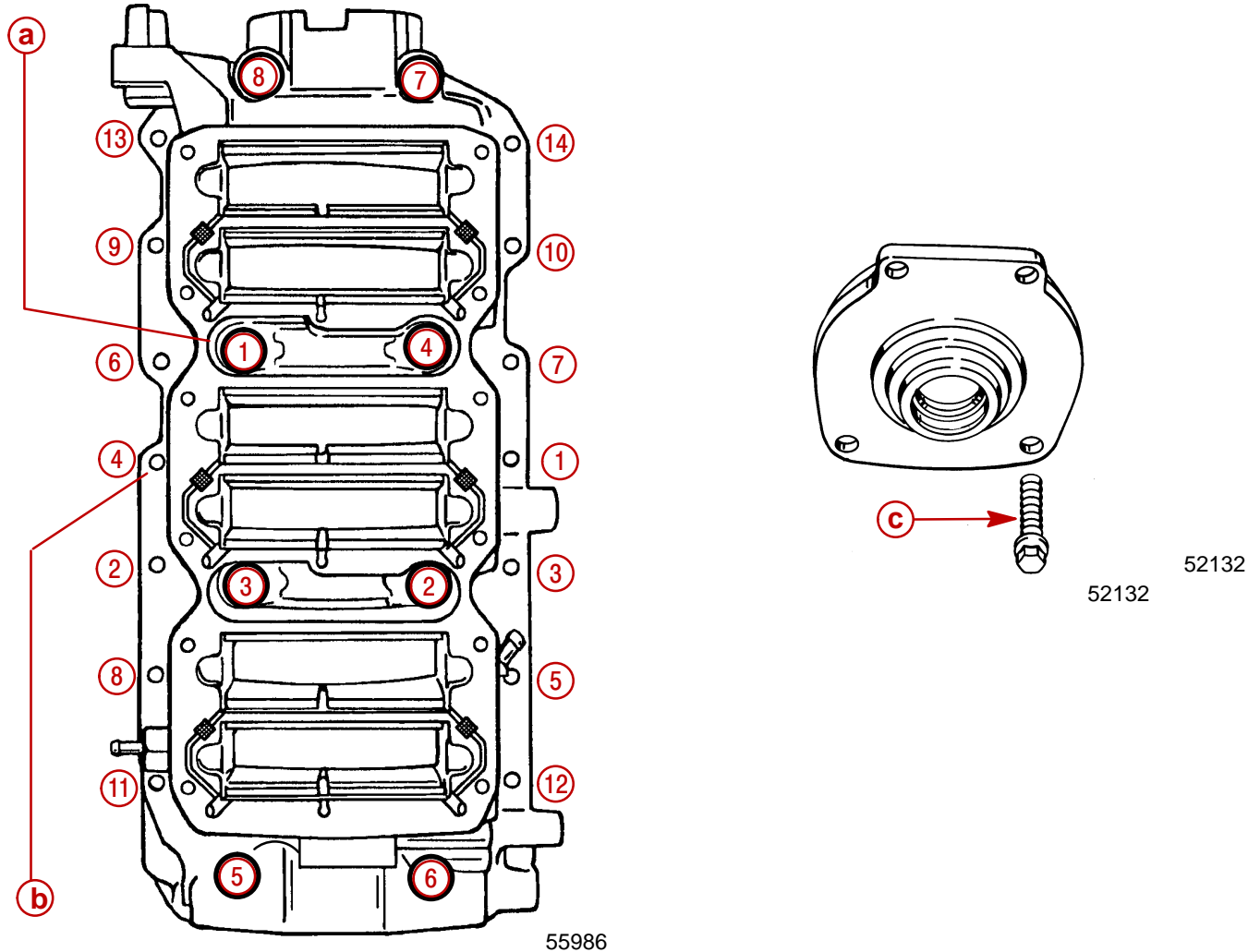


58993

- a** - Loctite Master Gasket



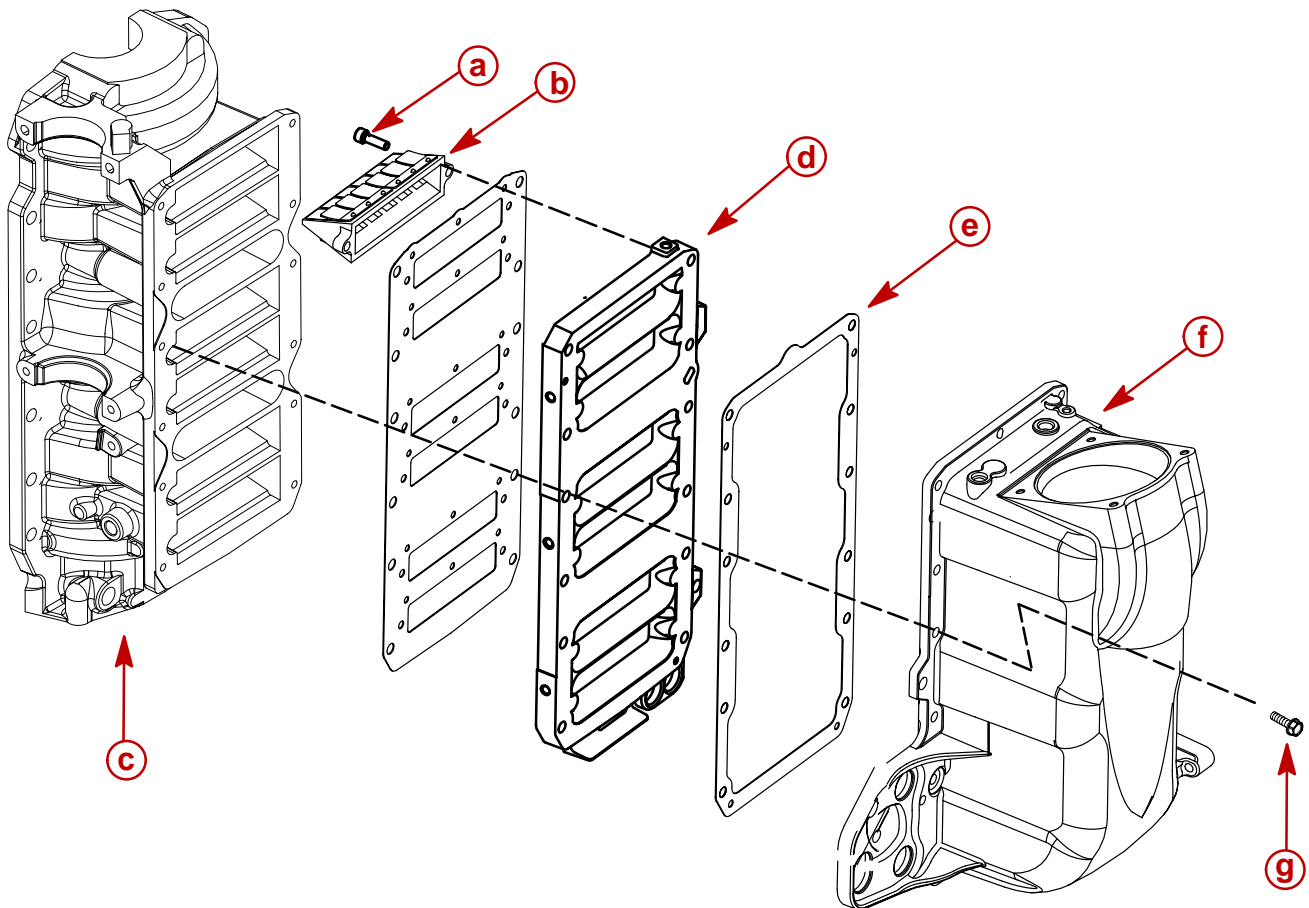
3. Place crankcase cover in position on cylinder block. Turn the 8 center main bolts in a LITTLE at a time, (following torque sequence) compressing crankshaft seal rings until crankshaft cover has been drawn down to cylinder block. Tighten eight bolts evenly in three progressive steps (following torque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



- a** - Apply Light Oil to Threads of Bolt Face; 8 Bolts (M10 x 1.5 x 80); Torque bolts to 30 lb. ft. (41 Nm) and rotate 90°
- b** - 14 Bolts; (M8 x 1.25 x 35); Torque bolts to 28 lb. ft. (38 Nm)
- c** - Lower End Cap Bolts – Torque to 85 lb. in. (9.5 Nm)



Assembly of Reed Blocks to Reed Block Adaptor Plate

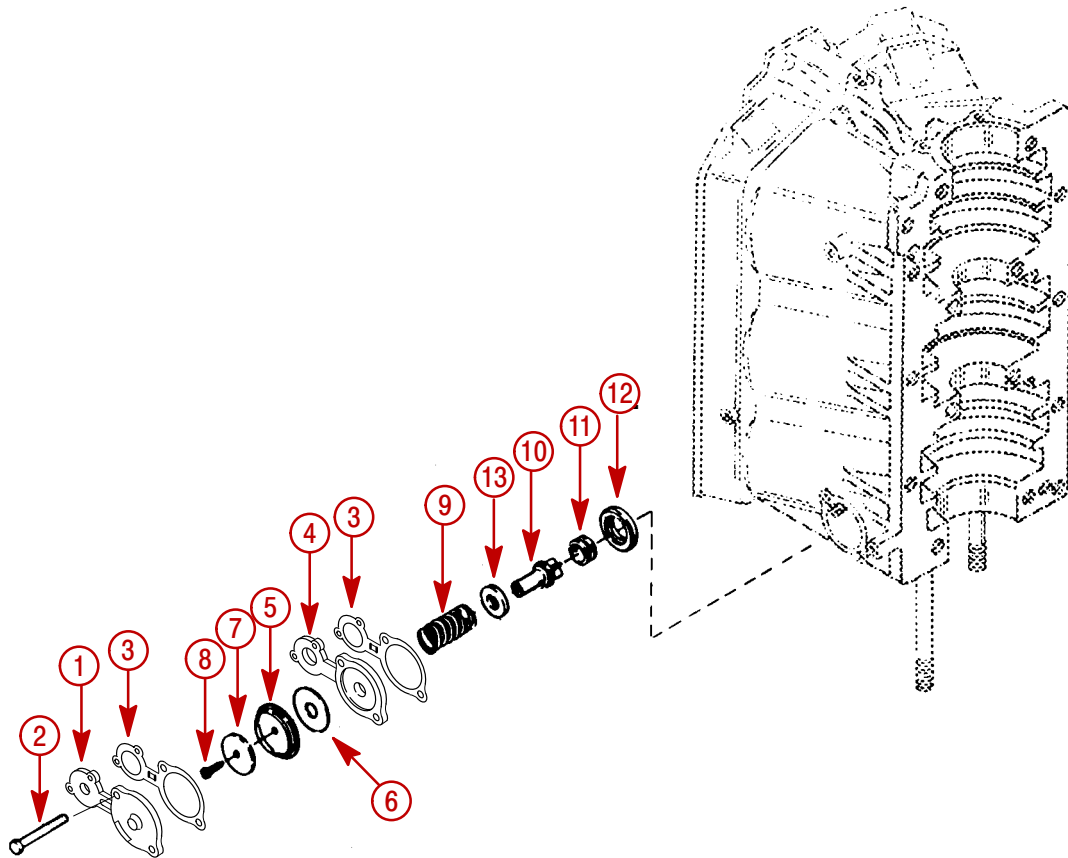


NOTE : Air plenum gasket is beaded on 1 side. Bead side of the gasket faces the air plenum.

- a** - Torque to 90 lb. in. (10 Nm)
- b** - Reed Block (6)
- c** - Cylinder Block Cover
- d** - Adaptor Plate
- e** - Air Plenum Gasket (bead faces air plenum)
- f** - Air Plenum
- g** - Torque to 100 lb. in. (11.5 Nm)



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



- | | |
|--|--------------------------------------|
| 1 - Cover | 7 - Washer |
| 2 - Bolt - 150 lb. in.
(17 Nm) | 8 - Screw - 25 lb. in. (3 Nm) |
| 3 - Gasket | 9 - Spring |
| 4 - Relief Valve Plate | 10 - Poppet Valve |
| 5 - Diaphragm | 11 - Grommet |
| 6 - Water Deflector | 12 - Carrier |
| | 13 - Washer |

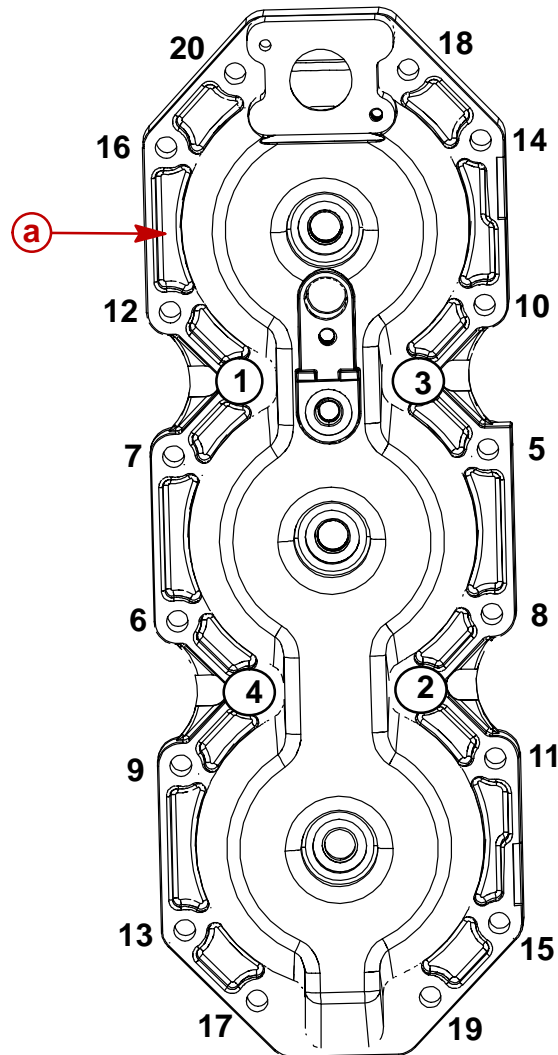
50803



CYLINDER HEAD INSTALLATION

NOTE : The 3 Liter 200 Work cylinder heads are low compression in design and can be identified by the casting number 812851C13. The 225 EFI and 250 EFI cylinder heads can be identified by the casting number 812851C15.

1. Install each cylinder head to engine block with thermostat pocket "UP". Apply light oil to cylinder head bolt threads and torque bolts to 20 lb. ft. (27 Nm) then turn an additional 90°.

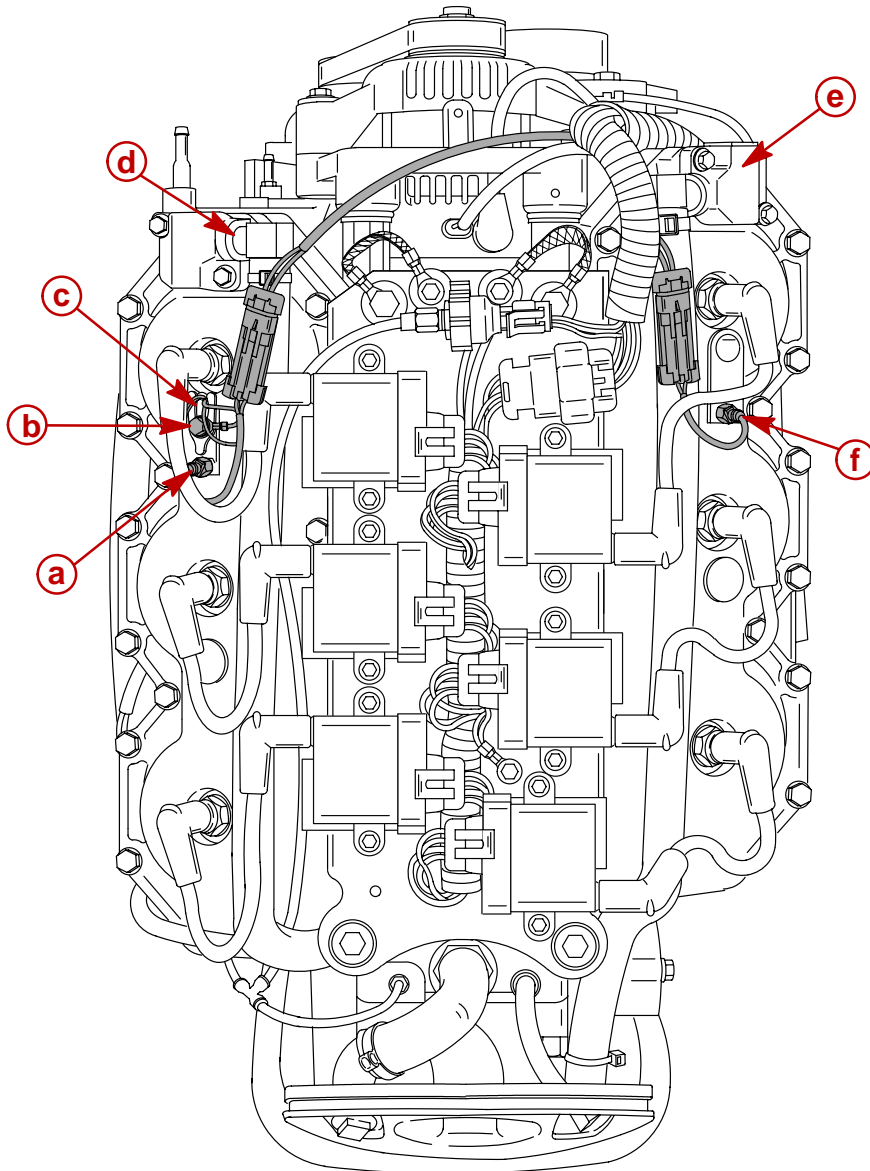


52132

a - Cylinder Head Casting Number Location



2. Install thermostat assembly into each cylinder head.
3. Install temperature sensors into STARBOARD and PORT cylinder heads.



59037

- | | |
|---|--|
| <p>a - Temperature Sensor (Port) (Overheat)</p> <p>b - Temperature Sensor (Analog Temperature Gauge)</p> <p>c - Bolt [Torque to 17 lb. ft. (23. Nm)]</p> | <p>d - Port Thermostat</p> <p>e - Starboard Thermostat</p> <p>f - Temperature Sensor (Starboard) (Overheat)</p> |
|---|--|

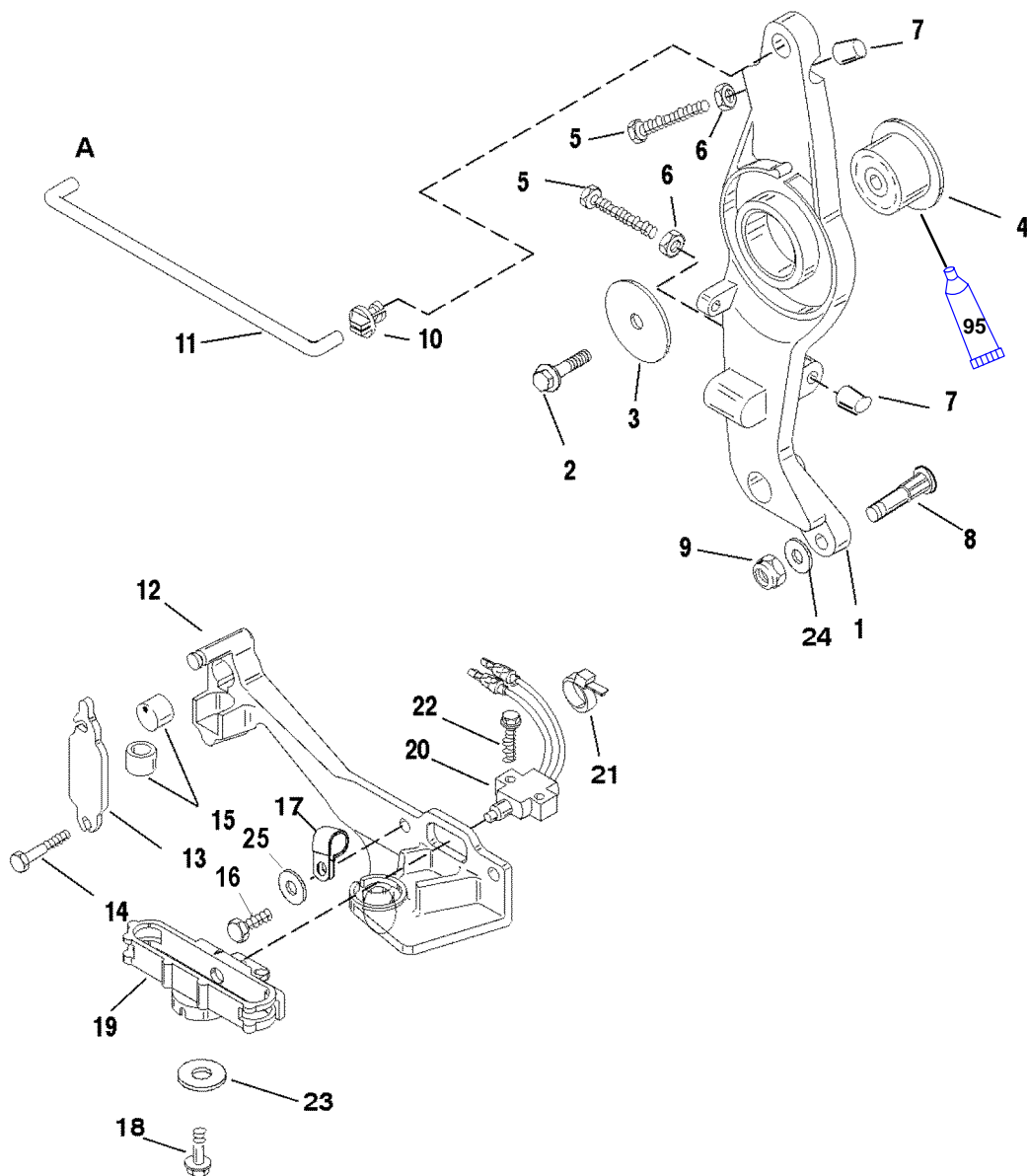
NOTE : The temperature sensors provide continuous temperature information to the ECM while the engine is running. Should temperature reach approximately 180 °F 82 °C, the ECM will activate a warning horn and warning light.



Notes:



Throttle Lever and Shift Platform Assembly



A = TO CAM

 95 2-4-C Marine Lubricant with Teflon



Throttle Lever and Shift Platform Assembly

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	THROTTLE CONTROL LEVER			
2	1	SCREW (M8 x 35)		21	28
3	1	WASHER			
4	1	BUSHING			
5	2	SCREW (M6 x 55)			
6	2	NUT			
7	2	CAP			
8	1	PIN INSERT			
9	1	NUT	50		5.5
10	1	SWIVEL BUSHING			
11	1	LINK			
12	1	ANCHOR BRACKET			
13	1	LATCH			
14	2	SCREW-DRIVE			
15	2	CUP			
16	2	SCREW (M8 x 25)		18	24
17	1	CLAMP			
18	1	SCREW (M8 x 25)		20	27
19	1	ROLLER GUIDE			
20	1	SWITCH			
21	1	STA-STRAP			
22	1	SCREW (M3.5 x 20)			
23	1	WASHER			
24	1	WASHER			
25	1	WASHER			



Powerhead Installation On Driveshaft Housing

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

⚠ WARNING

BE SURE that Lifting Eye is threaded into flywheel a minimum of five (5) turns BEFORE lifting powerhead.

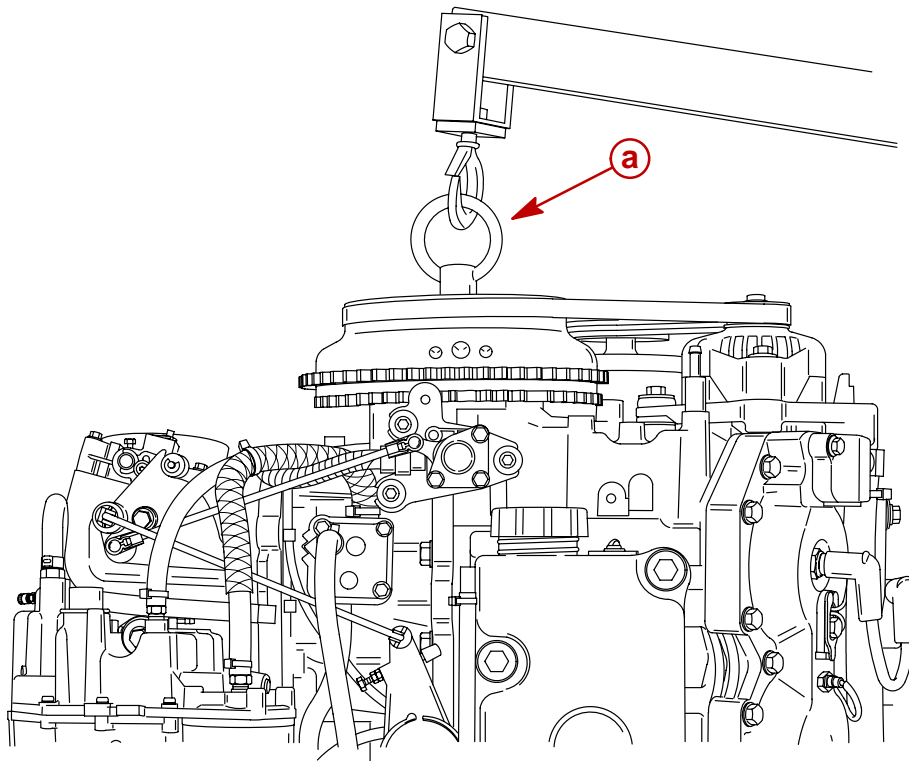
2. Using a hoist, lift powerhead high enough to allow removal of powerhead from repair stand. Remove powerhead from repair stand, being careful not to damage drive shaft housing gasket surface of powerhead.
3. Place a new gasket around powerhead studs and into position on base of powerhead.

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 Marine Lubricant with Teflon 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.

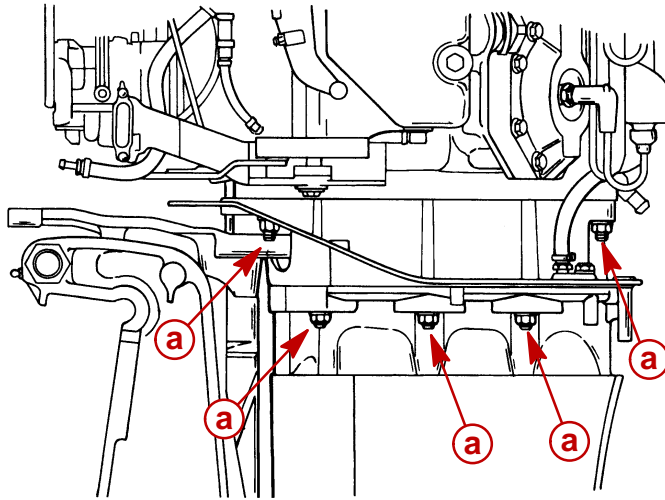


a - Lifting Eye (90-90455)

59076



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.

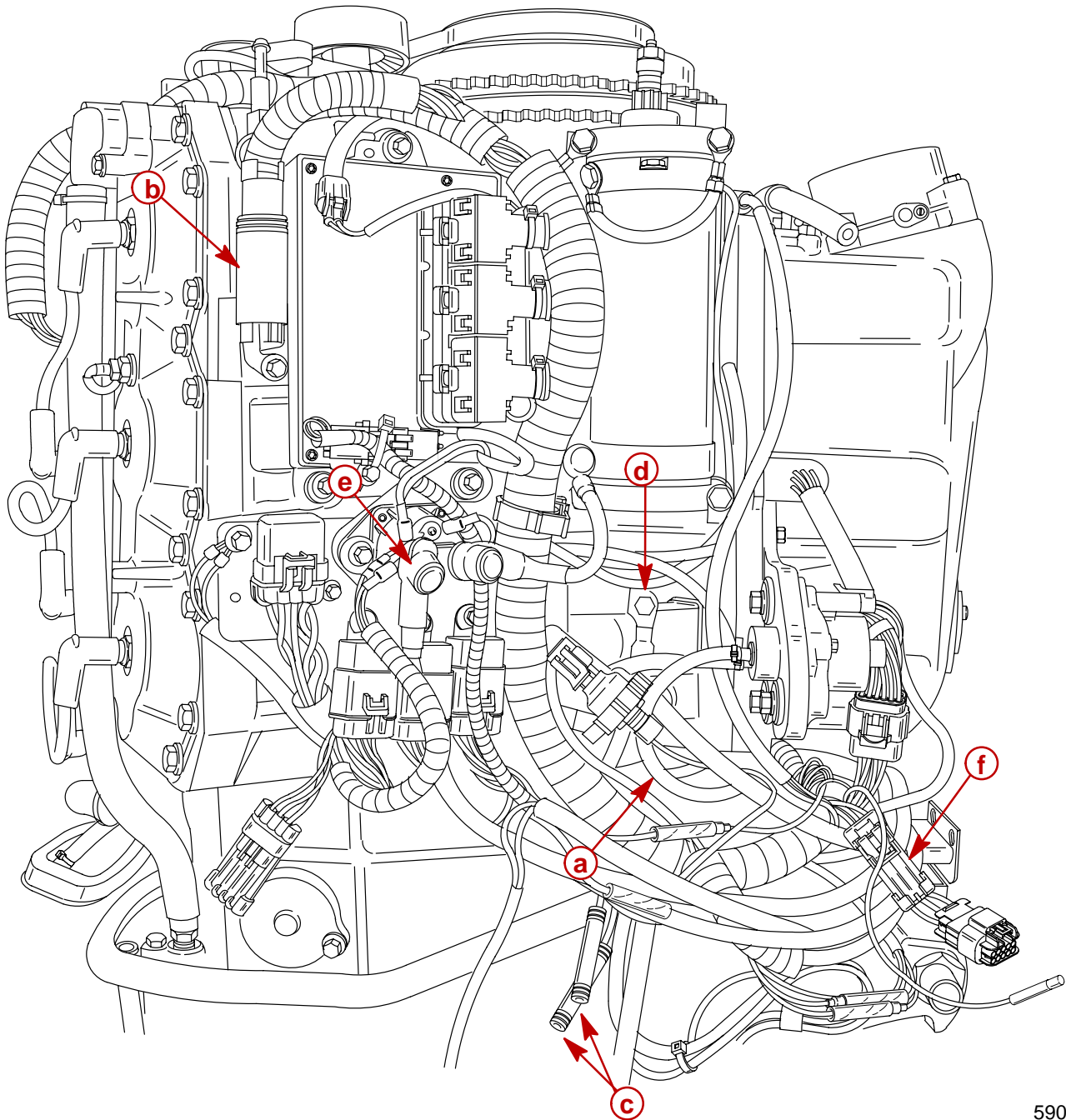


a - Locknuts and Washers – Torque nuts to 20 lb. ft. (27 N m)

52373



9. Reconnect and/or reinstall the following:

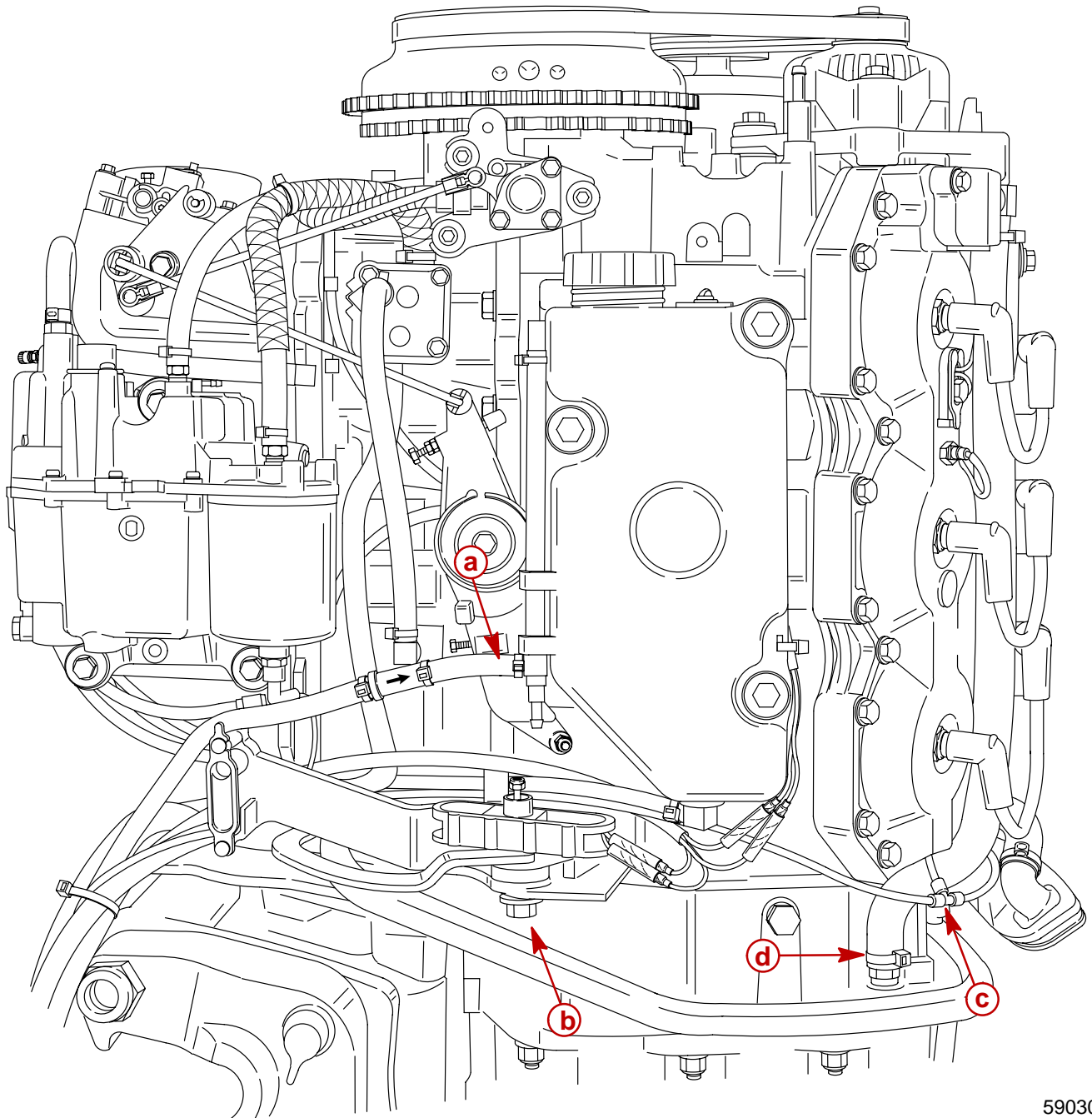


59026

- 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



10. Reinstall the following:

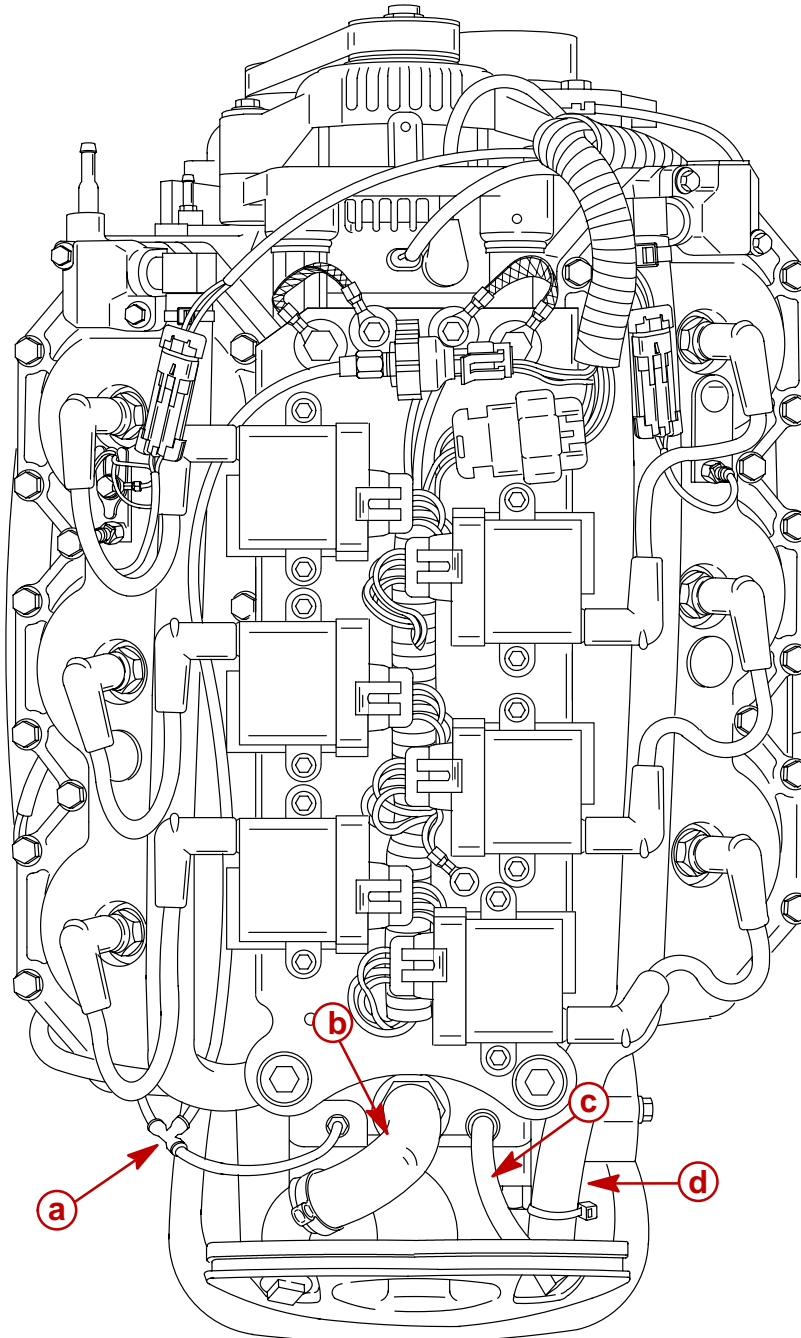


59030

- a** - Oil Supply Hose
- b** - Shift Lever Bracket Assembly
- c** - Water Pressure Hose (GREY)
- d** - Starboard Thermostat Discharge Hose



11. Reconnect the following:

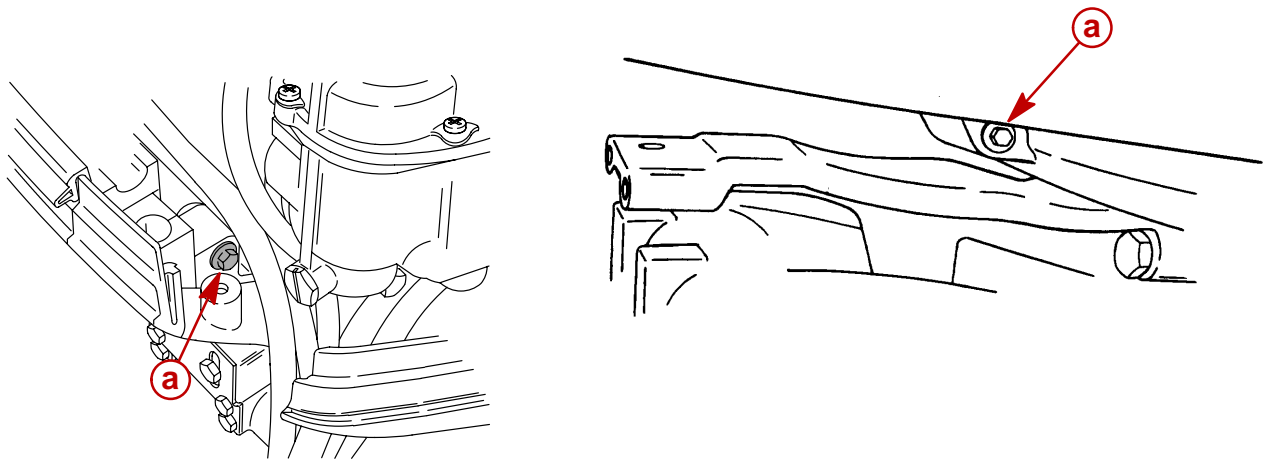


- a** - Water Pressure Sensor Hose (GREY)(for Digital Gauges)
- b** - Engine Flush Hose
- c** - Tell-Tale Hose
- d** - Starboard Thermostat Discharge Hose

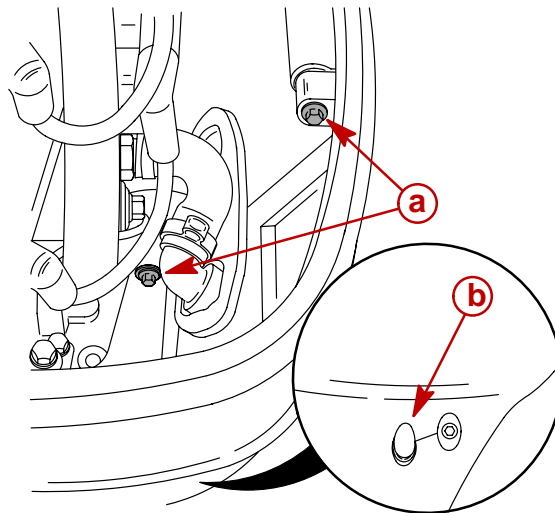
59028



12. Install bottom cowls.



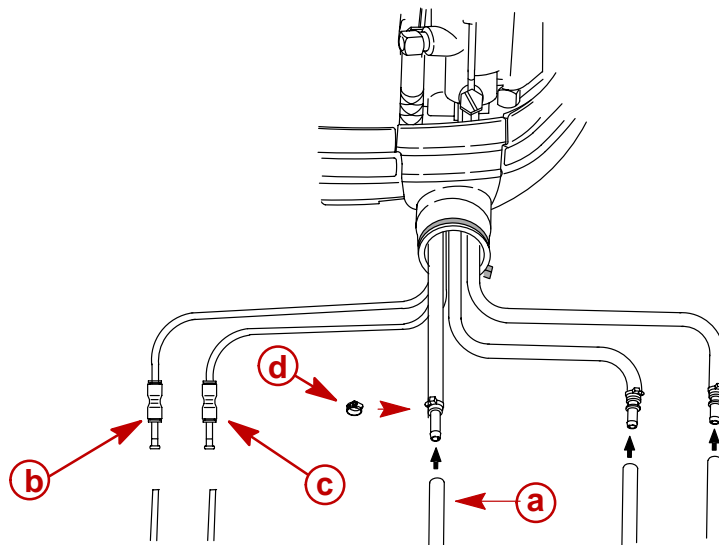
59075



a - Screws

b - Access Cover to Lower Screw

13. 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)
d - Hose Clamp



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.

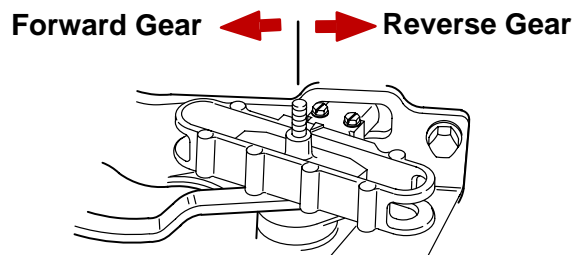
The Dual Engine Console Mount Control (88688A22 or 88688A52) is required to shift the counter rotation outboard. The installation instructions shipped with the control explain the procedure required to connect this control to a counter rotation outboard.

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.**

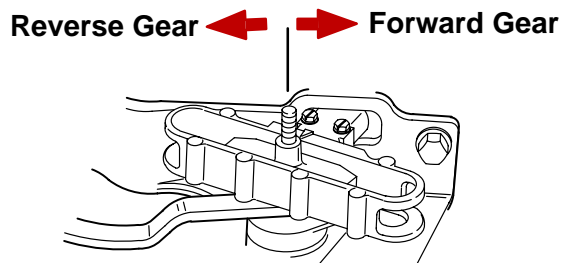
OUTBOARD SHIFTING DIRECTION

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



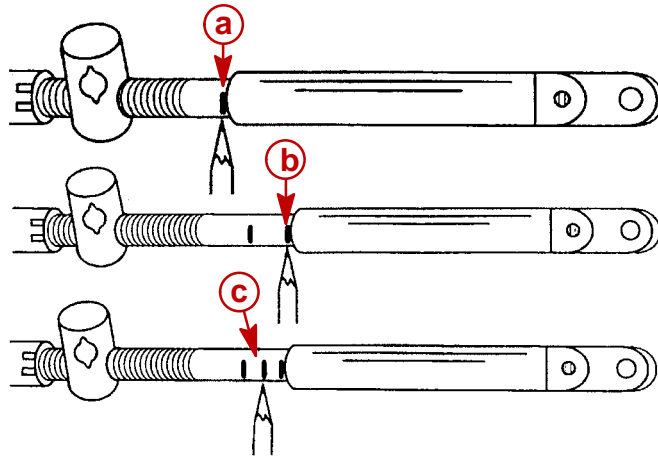


Installation

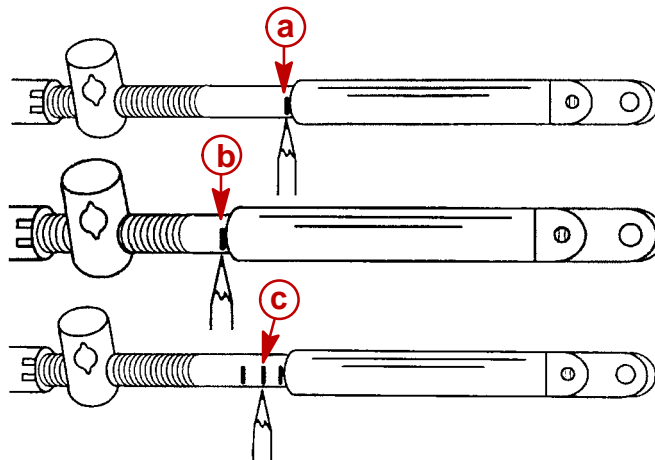
IMPORTANT: Step 1 must be followed for proper adjustment of the shift cable.

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



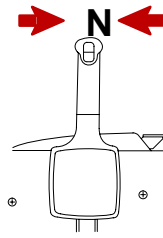
COUNTER ROTATION OUTBOARDS



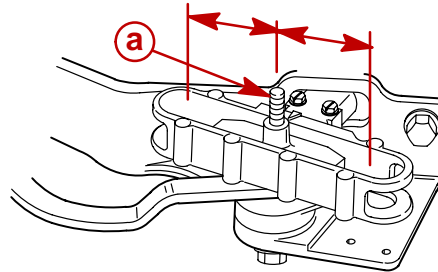
- d. Return remote control handle to neutral. The propeller should turn freely without drag. If not, adjust barrel closer to cable end guide. Repeat steps a thru d.



2. Position remote control and outboard into neutral.

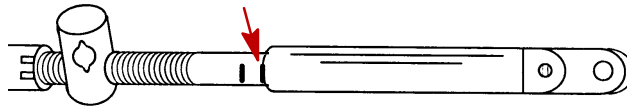


3. Slide the shift cable anchor pin forward until resistance is felt, then slide anchor pin toward rear until resistance is felt. Center the anchor pin between resistance points.

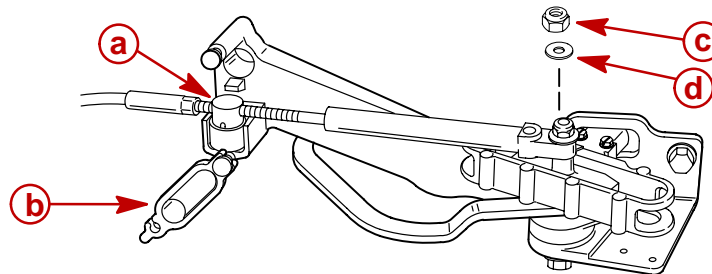


a - Anchor Pin

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



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



a - Cable Barrel
b - Shift Cable Retainer

c - Locknut – Tighten locknut then back off locknut 1/4 turn
d - Nylon Washer

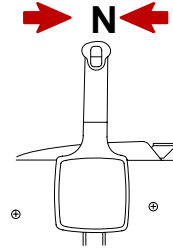
7. Check shift cable adjustments as follows:
 - a. With remote control in forward, the propshaft should lock solidly in gear. If it does not, adjust cable barrel closer to cable end guide.
 - b. Shift remote control into neutral. The propshaft should turn freely without drag. If not, adjust barrel away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



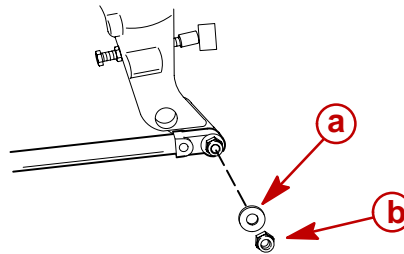
Throttle Cable

INSTALLATION

1. Position remote control into neutral.



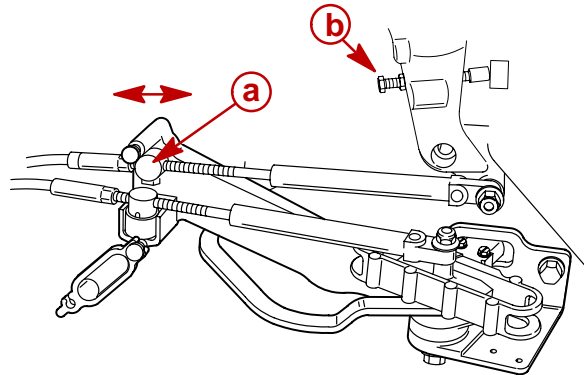
2. Attach throttle cable to the throttle lever. Secure with washer and locknut.



a - Nylon Washer

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

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

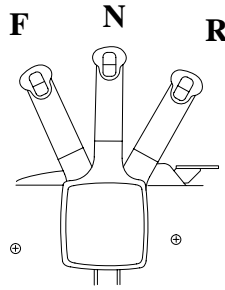


a - Cable Barrel – Adjust To Hold Idle Stop Screw Against Stop

b - Idle Stop Screw

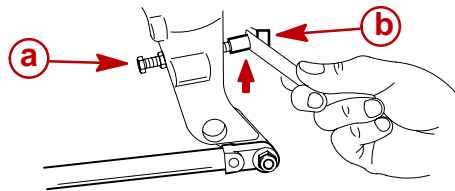


4. Check throttle cable adjustment as follows:
 - a. Shift outboard into gear a few times to activate the throttle linkage. Make sure to rotate the propeller shaft while shifting into reverse.



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

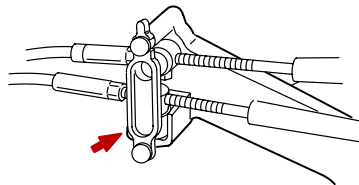
IMPORTANT: The idle stop screw must be touching the stop.



a - Idle Stop Screw

b - Idle Stop

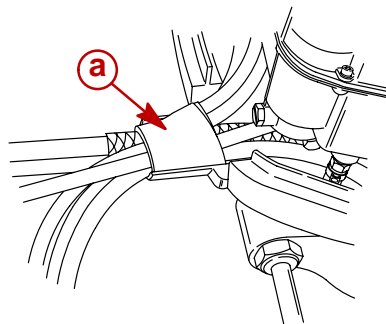
5. Lock the barrel holder in place with the cable latch.



Front Clamp Reassembly

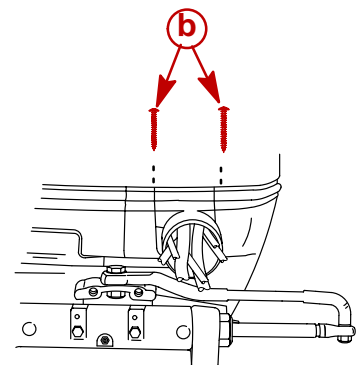
IMPORTANT: Sufficient slack must exist in engine wiring harness, battery cables, fuel hose, and oil hoses routed between clamp and engine attachment point, to relieve stress and prevent hoses from being kinked or pinched.

1. Place the neoprene wrap over the wiring, hoses, and control cables as shown.
2. Fasten clamp together with two screws and retainer.



a - Neoprene Wrap

b - Screws





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 than 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

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Analog Temperature Sensor	4B-4	Water Pressure Check	4B-10
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Water Flow	4B-6	Problem Diagnosis	4B-12
Description	4B-6		



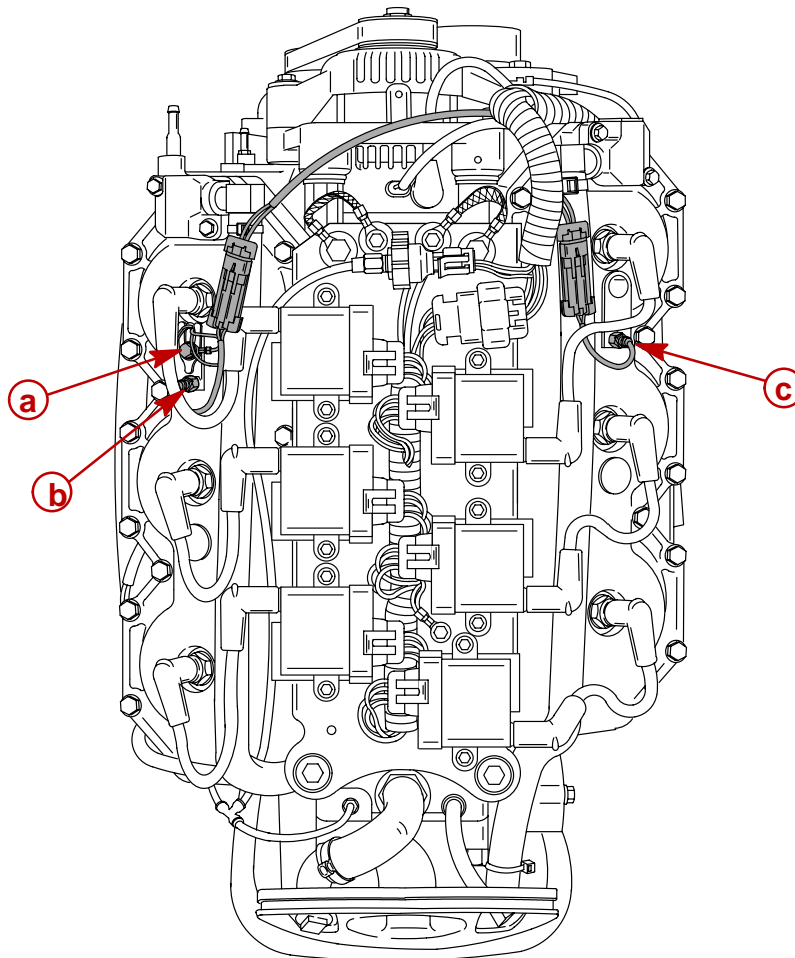


Specifications

Thermostat 143 °F (61.7 °C)

Water Pressure

Idle	1.5 – 4.5 PSI (10.3 – 30.8 kPa)
Poppet Valve Opening	6.0 – 7.0 PSI (41.3 – 48.2 kPa)
W.O.T.	8 – 10 PSI (54.8 – 68.5 kPa) Minimum



- 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 ohm-meter test leads between both connector pins. With engine at temperature (F°) indicated, ohm readings should be as indicated $\pm 10\%$. 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

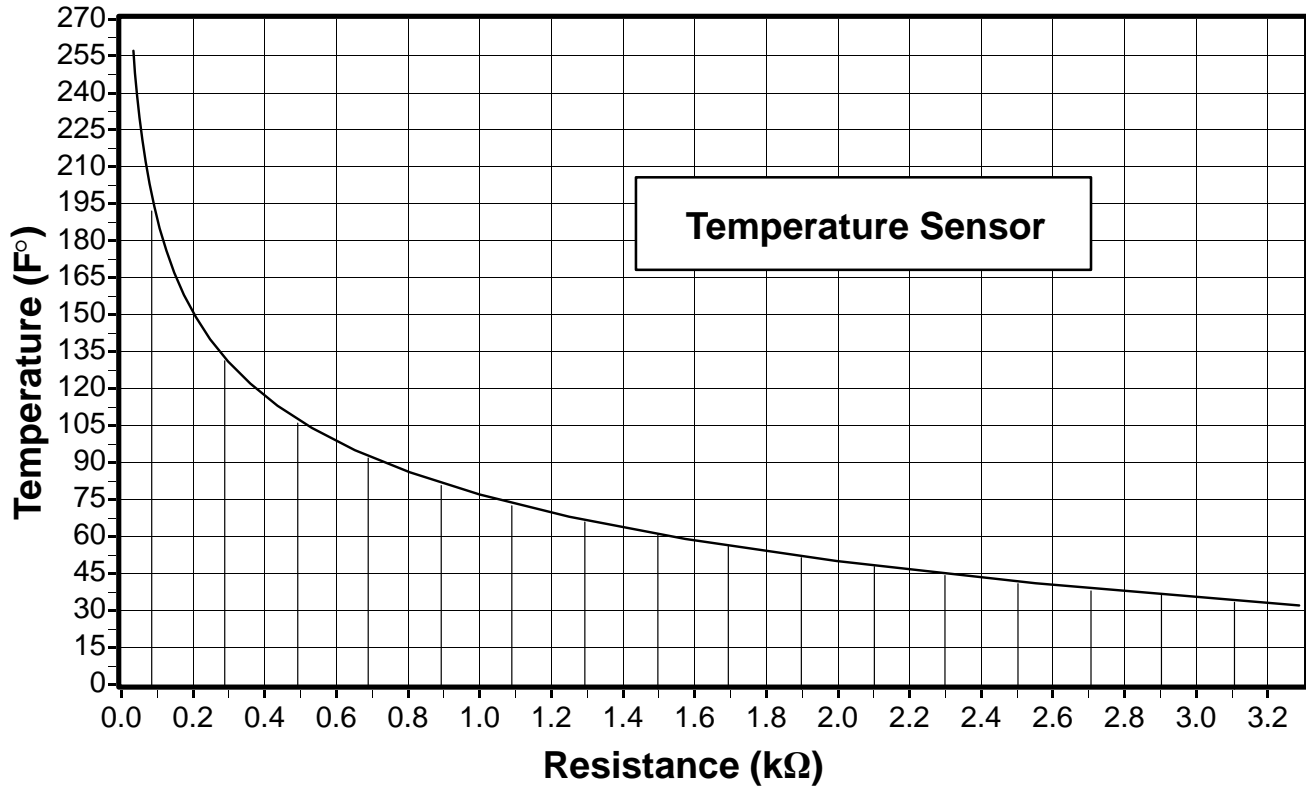


Analog Temperature Sensor

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%.

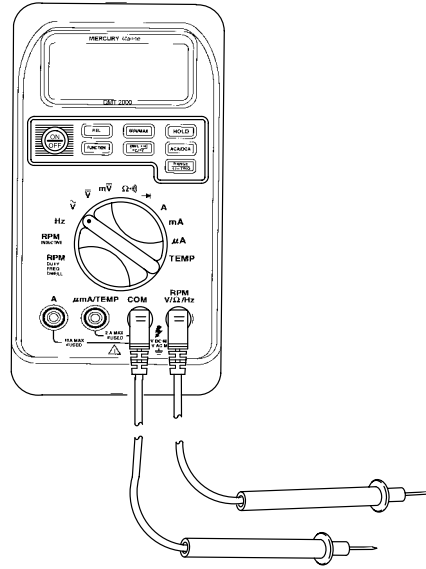


Temperature Sensor	
Between Black and each TAN/BLK wire.	No Continuity
Between each lead and ground	No Continuity
Between each TAN/BLK wire	Resistance will vary with temperature

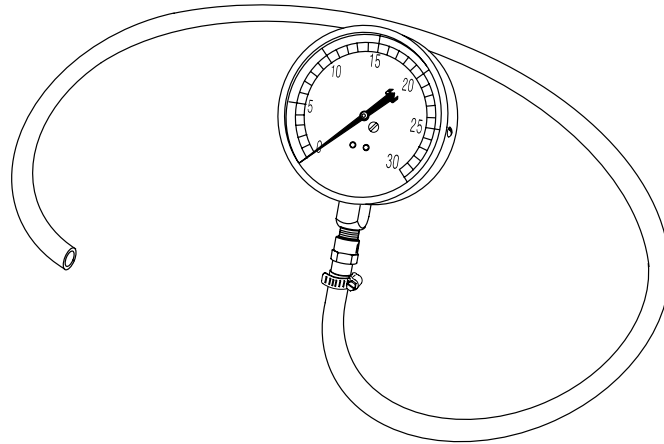


Special Tools

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



2. Water Pressure Gauge 91-79250A2



56725



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

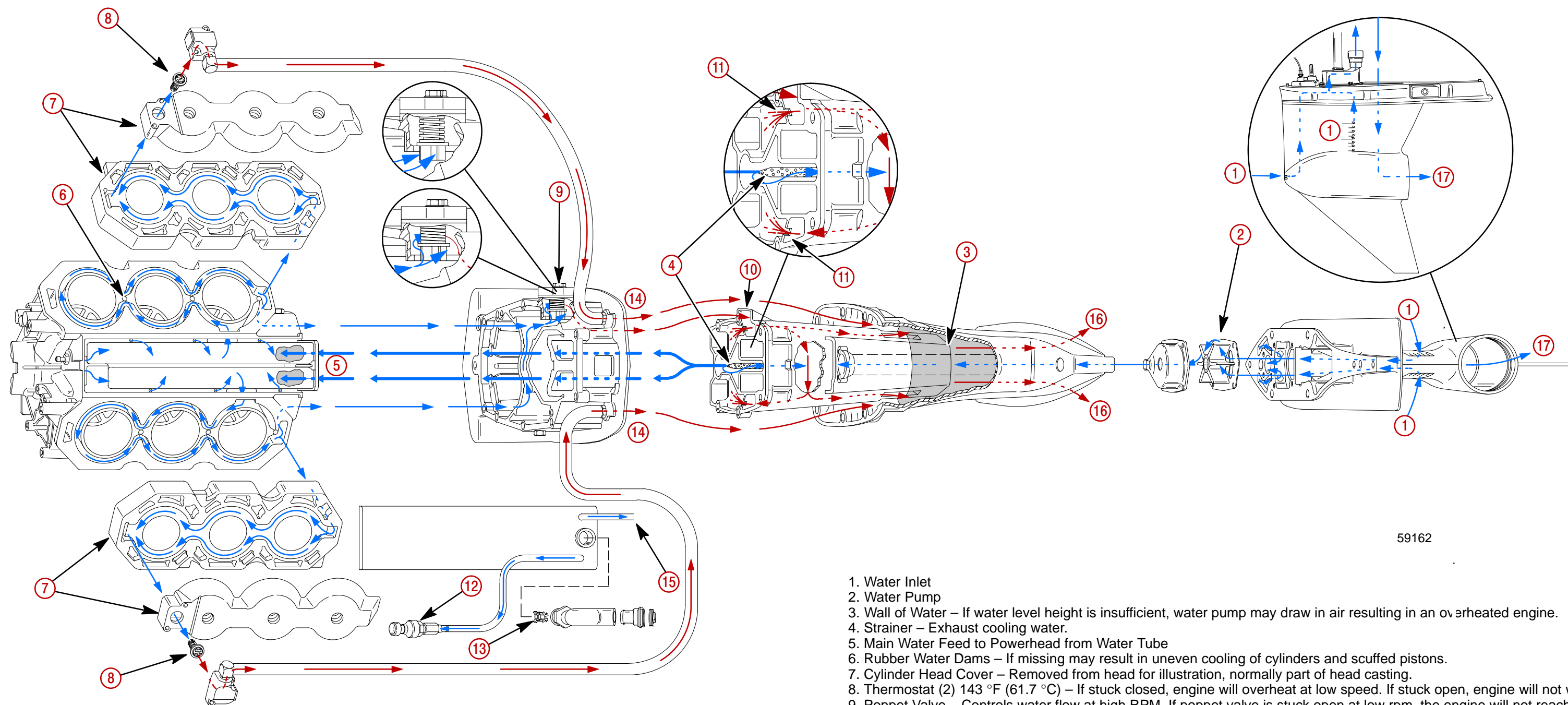
Water exits the engine in 3 locations:

- 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.



3 Liter Work/225 EFI/250 EFI Water Flow Diagram



- 59162
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. Strainer – Exhaust cooling water.
 5. Main Water Feed to Powerhead from Water Tube
 6. Rubber Water Dams – If missing may result in uneven cooling of cylinders and scuffed pistons.
 7. Cylinder Head Cover – Removed from head for illustration, normally part of head casting.
 8. 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 discharge into exhaust relief passage.
 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:

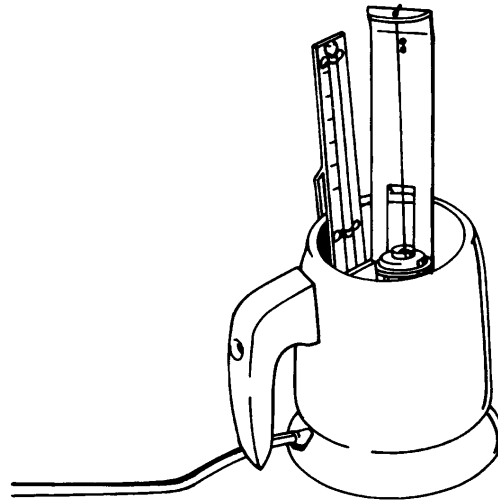


Troubleshooting

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.



51087

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

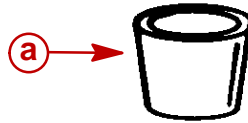
Shut off engine and refer to troubleshooting chart if water pressure is not within specification. DO NOT exceed 3000 RPM in neutral.

Idle	1.5 – 4.5 PSI (10.3 – 30.8 kPa)
Poppet Valve Opening	6 – 7 PSI (41.1 – 47.9 kPa)
W.O.T.	8 – 10 PSI (54.9 – 68.5 kPa) Minimum



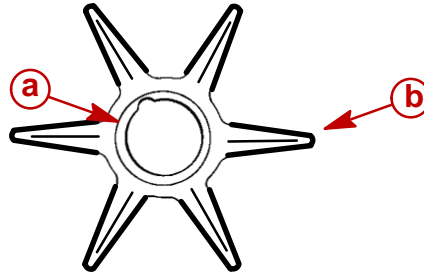
Water Pump Cleaning and Inspection

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.

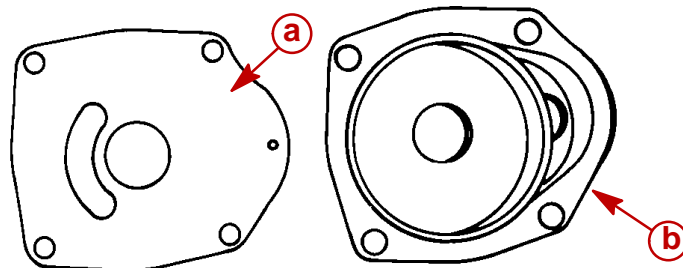


a - Hub
b - Impeller

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 and/or face plate if grooves (other than impeller sealing bead groove) are more than 0.030 in. (0.76 mm) deep.



a - Water Pump Face Plate
b - Water Pump Cover

70609

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	1.5 – 4.5 PSI (10.3 – 30.8 kPa)	<ul style="list-style-type: none"> •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	1.5 – 4.5 PSI (10.3 – 30.8 kPa)	<ul style="list-style-type: none"> •Plugged poppet by-pass passage or tell-tale
Pressure does not drop between 1000 – 2500 RPM indicating poppet valve has opened	6 – 7 PSI (41.1 – 47.9 kPa) between 1000 – 2200 RPM	<ul style="list-style-type: none"> •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		<ul style="list-style-type: none"> •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.	8 PSI (54.8 kPa)	<ul style="list-style-type: none"> •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 – 30 PSI (206.8 kPa)	<ul style="list-style-type: none"> •Outlet water passages restricted. •Steam pocket has formed at top of powerhead due to lack of cooling water



MID-SECTION

Section 5A – Clamp/Swivel Brackets & Drive Shaft Housing

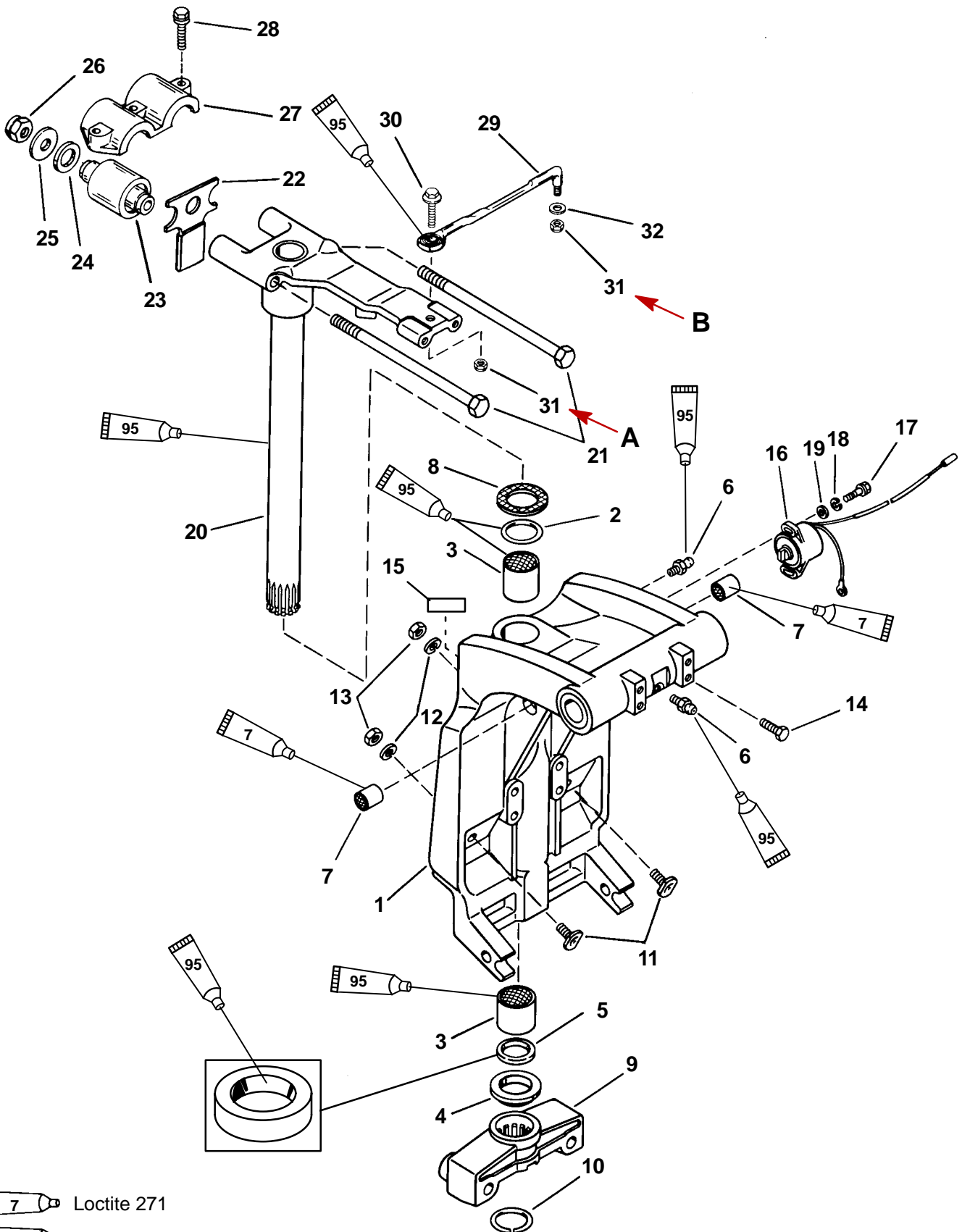
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Transom Brackets	5A-4	Removal and Disassembly	5A-8
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Swivel Bracket and Steering Arm





Swivel Bracket and Steering Arm

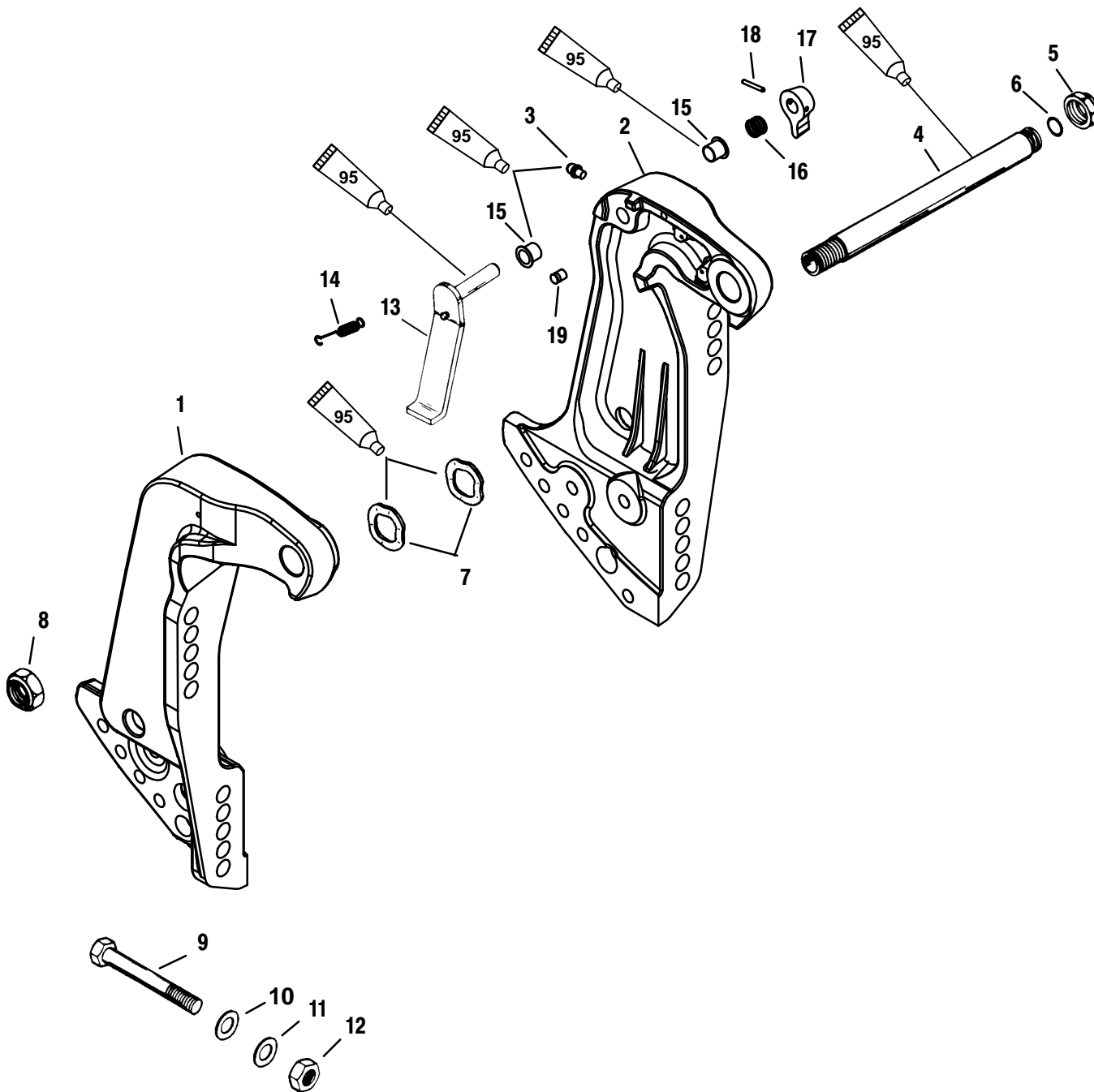
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb. in.	lb. ft.	N·m
1	1	SWIVEL BRACKET			
2	1	O RING			
3	2	BUSHING			
4	1	SPACER			
5	1	OIL SEAL (LOWER)			
6	2	GREASE FITTING	85		9.5
7	2	BUSHING			
8	1	THRUST WASHER			
9	1	BOTTOM YOKE (LONG – CARBON STEEL)			
	1	BOTTOM YOKE (XL–STAINLESS STEEL)			
10	1	RETAINING RING			
11	2	STRIKER PLATE			
12	2	LOCKWASHER			
13	2	NUT		25	34
14	2	SCREW (1/4-28 x 1/2 IN.)	100		11.5
15	1	DECAL-Serial Overlamine			
16	1	TRIM SENDER			
17	2	SCREW (10-24 x 3/4 IN.)	15		1.7
18	2	LOCKWASHER			
19	2	WASHER			
20	1	SWIVEL PIN/STEERING ARM (LONG – CARBON STEEL)			
	1	SWIVEL PIN/STEERING ARM(XL–STAINLESS STEEL)			
21	2	SCREW (M12 x 1.75 x 190)			
22	1	BUMPER			
23	2	UPPER MOUNT			
24	2	WASHER			
25	2	WASHER			
26	2	NUT		50	68
27	1	CLAMP			
28	3	SCREW (M8 x 35)		20	27
29	1	STEERING LINK ASSEMBLY			
30	1	SCREW		20	27
31	2	NUT (.375-24)			
32	2	WASHER			

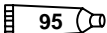
NOTE: A – Torque nut to 120 lb. in. (13.5 Nm) and then back off 1/4 turn.

NOTE: B – Torque nut to 20 lb. ft. (27 Nm)



Transom Brackets



 95 2-4-C Marine Lubricant with Teflon

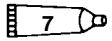
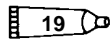
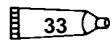
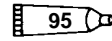


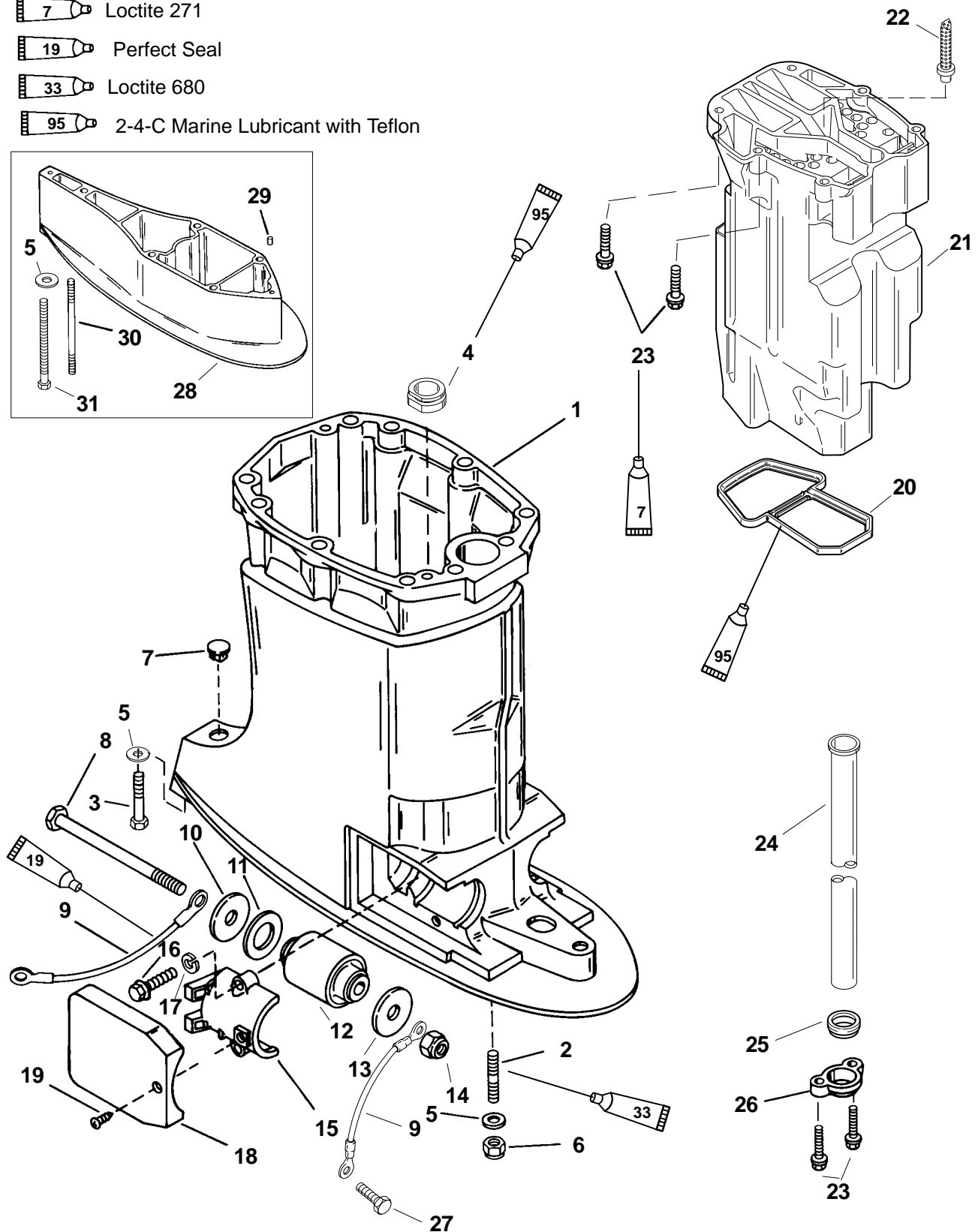
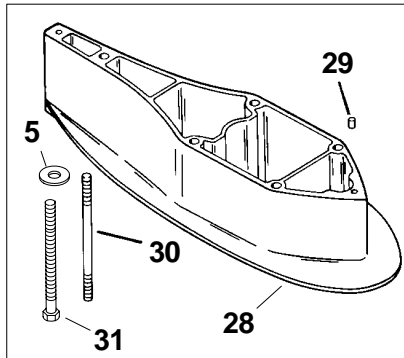
Transom Brackets

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	TRANSOM BRACKET (STARBOARD)			
2	1	TRANSOM BRACKET (PORT)			
3	1	GREASE FITTING (PORT)	80		9
4	1	TILT TUBE			
5	1	NUT (1 IN.-14)		45	61
6	1	O-RING			
7	2	WAVE WASHER			
8	1	NUT (7/8-14)		45	61
9	4	BOLT			
10	4	WASHER			
11	4	WASHER			
12	4	NUT			
13	1	TILT LOCK LEVER ASSEMBLY			
14	1	SPRING			
15	2	BUSHING			
16	1	SPRING			
17	1	KNOB			
18	1	GROOVE PIN			
19	1	PIN			



Drive Shaft Housing and Exhaust Tube

-  7 Loctite 271
-  19 Perfect Seal
-  33 Loctite 680
-  95 2-4-C Marine Lubricant with Teflon





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/XX-LONG)			
2	4	STUD (M12 x 1.75 x 54) LONG/X-LONG			
3	1	SCREW (M12 x 35)		45	61.0
4	1	GROMMET			
5	5	WASHER			
6	4	NUT (M12 x 1.75)		55	74.5
7	1	PLUG			
8	2	SCREW (M14 x 2 x 178)			
9	2	GROUND WIRE			
10	2	WASHER			
11	2	WASHER			
12	2	MOUNT			
13	2	WASHER			
14	2	NUT		90	122
15	2	CLAMP			
16	4	SCREW (M8 x 35)		20	27.0
17	1	LOCKWASHER			
18	2	COVER			
19	2	SCREW (10-16 x 7/16 IN.)		Drive Tight	
20	1	SEAL			
21	1	EXHAUST TUBE			
22	1	STRAINER			
23	6	SCREW (M8 x 35)		16.5	22.5
24	1	WATER TUBE (LONG)			
	1	WATER TUBE (X-LONG)			
	1	WATER TUBE (XX-LONG)			
25	1	SEAL			
26	1	CLAMP			
27	1	SCREW (1/4-20 x .375)			
28	1	SPACER			
29	2	DOWEL PIN XX-LONG			
30	4	STUD (M12 x 179)			
31	1	SCREW (M12 x 160)			

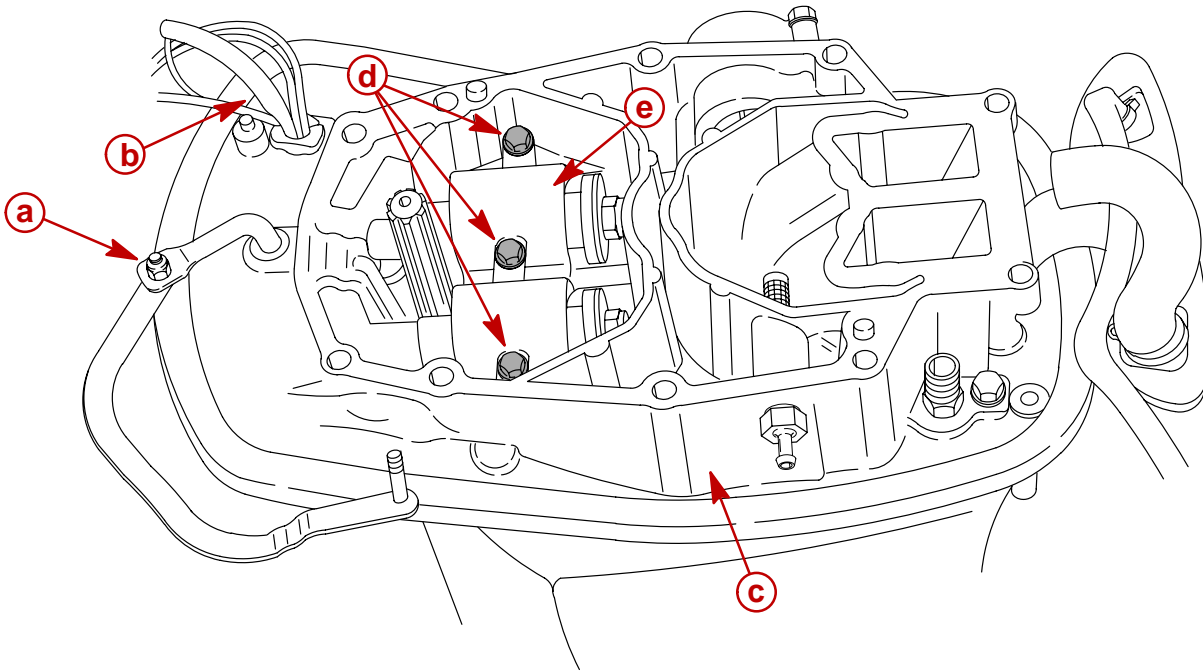


Drive Shaft Housing and Dyna-Float Suspension

Refer to “Powerhead Removal” section to remove powerhead. Refer to “Lower Unit Removal” in this section to remove lower unit.

Removal and Disassembly

1. Remove shift shaft from driveshaft housing by pulling straight up on shaft.
2. Remove power trim wiring harness from exhaust adaptor plate.
3. Remove 3 bolts which secure upper mount cover to adaptor plate. Remove cover.

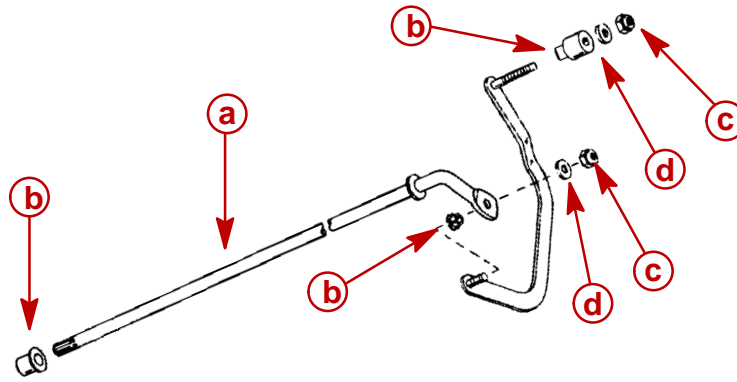


58005

- a** - Shift Shaft Linkage
- b** - Wiring Harness
- c** - Adaptor Plate
- d** - Bolts
- e** - Upper Mount Cover

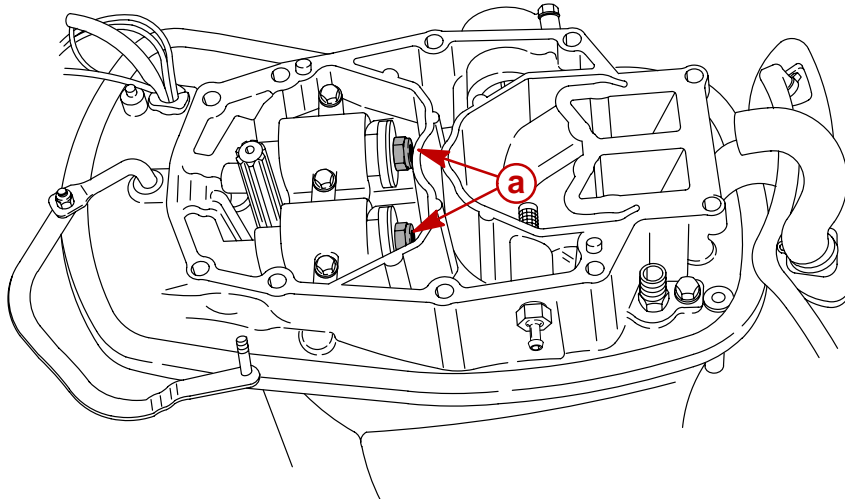


SHIFT LINKAGE ASSEMBLY



- a** - Shift Shaft Assembly
- b** - Bushing (3)
- c** - Lock Nut (2)
- d** - Washer (2)

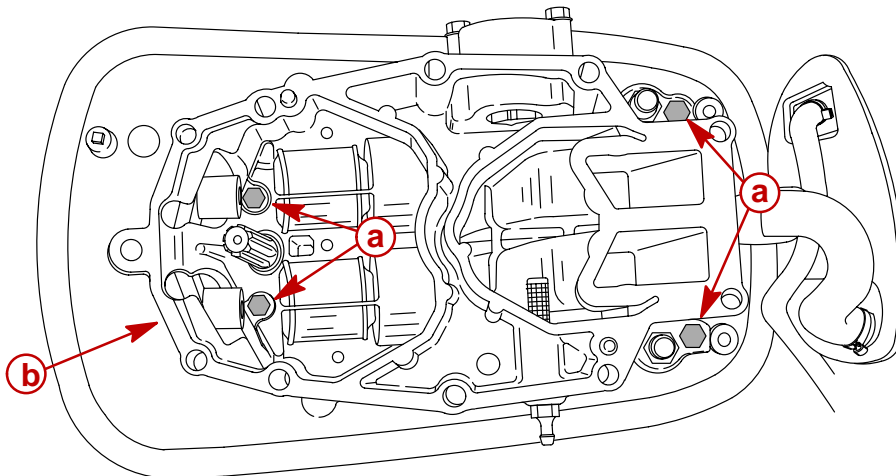
1. Remove upper mount nuts and flat washers.
2. Pull mount bolts through mounts and remove mounts.



- a** - Upper Mount Nuts

58004

3. Remove 4 bolts securing exhaust adaptor plate to drive shaft housing.

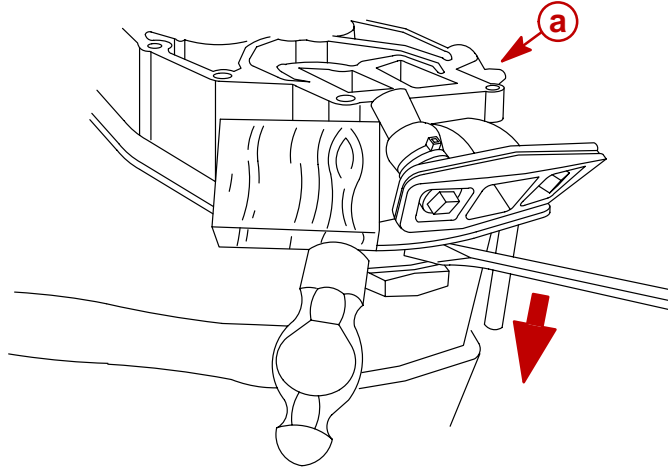


- a** - Bolts
- b** - Adaptor Plate

58003

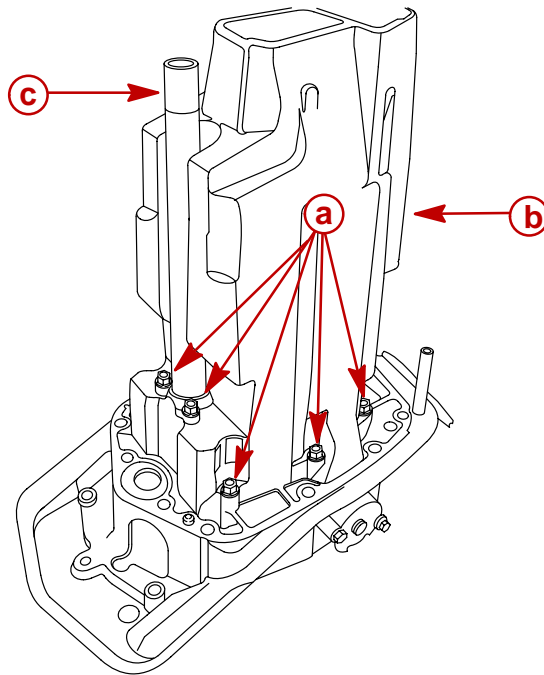


4. While applying upward pressure on rear of adaptor plate, use a mallet and a piece of hardwood against the adaptor plate to loosen gasket adhesion.



a - Adaptor Plate

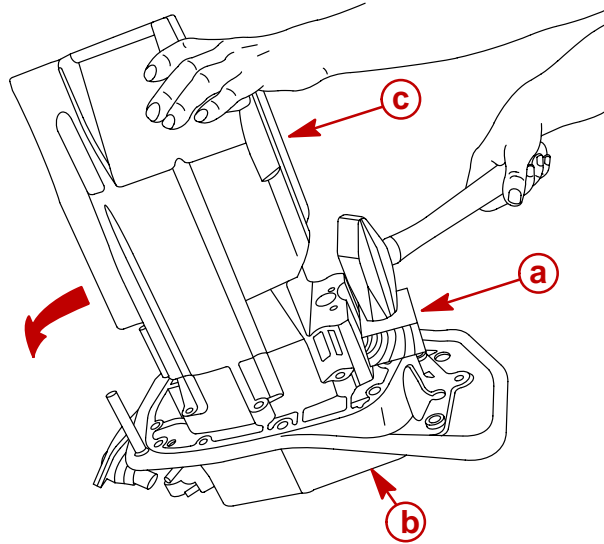
5. Remove 2 bolts securing water tube to adaptor plate and remove tube. Remove 6 bolts securing exhaust tube to adaptor plate.



a - Bolts
b - Exhaust Tube
c - Water Tube

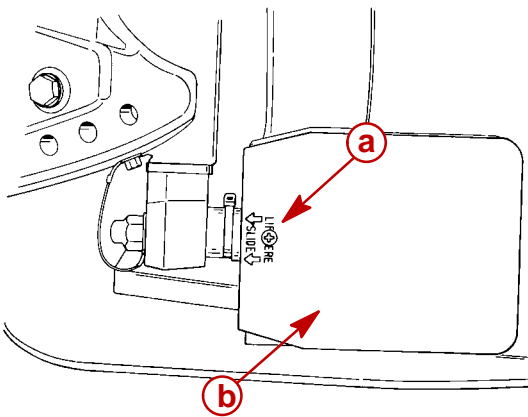


6. While tilting adaptor plate/exhaust tube assembly, use a piece of hardwood and a mallet to loosen gasket adhesion. Remove exhaust tube.



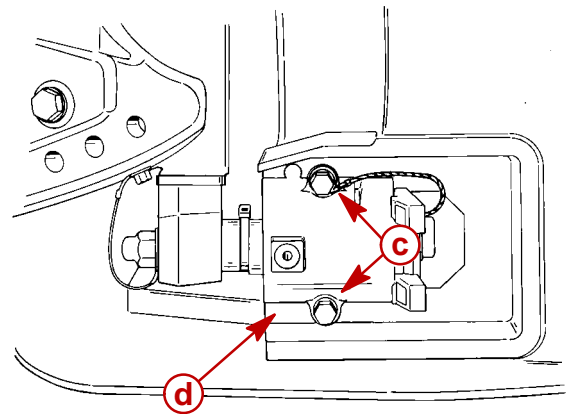
- a - Hardwood
- b - Adaptor Plate
- c - Exhaust Tube

7. Remove all gasket material from driveshaft housing and related components.
8. Remove screw, which secure lower mount cover to drive shaft housing, and remove cover.
9. Remove bolts securing lower mount retainers to drive shaft housing. Remove retainers.



52307

- a - Screw
- b - Cover

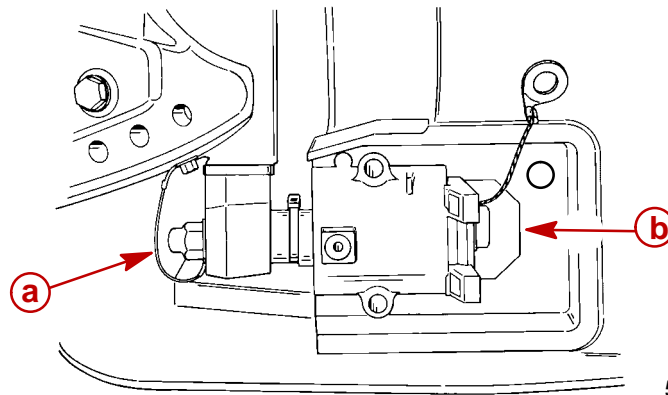


52308

- c - Bolts
- d - Lower Mount Retainer
(1 each side)



10. Remove lower mount nuts and rubber caps.



52308

a - Lower Mount Nuts

b - Rubber Caps

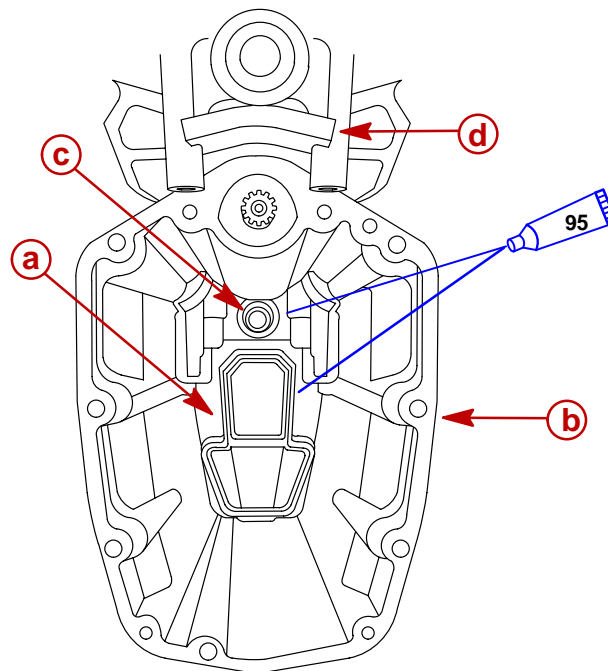
11. Remove drive shaft housing from swivel bracket by pulling alternately from top to bottom on housing.

12. Remove upper and lower mounts by lifting them out of drive shaft housing.

Reassembly and Installation

1. Apply a thin coat of 2-4-C Marine Lubricant with Teflon onto inside portion of exhaust tube seal and water tube grommet.

2. Install exhaust tube seal into driveshaft housing with tapered side of seal facing up.



 2-4-C Marine Lubricant with Teflon

a - Exhaust Tube Seal

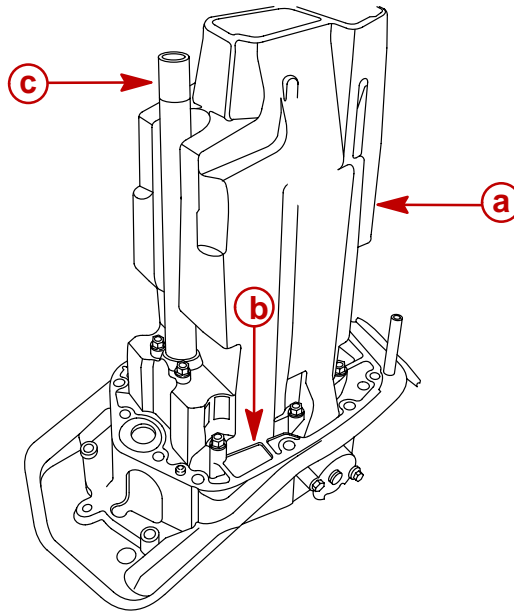
b - Driveshaft Housing

c - Water Tube Grommet

d - Leather Bumper

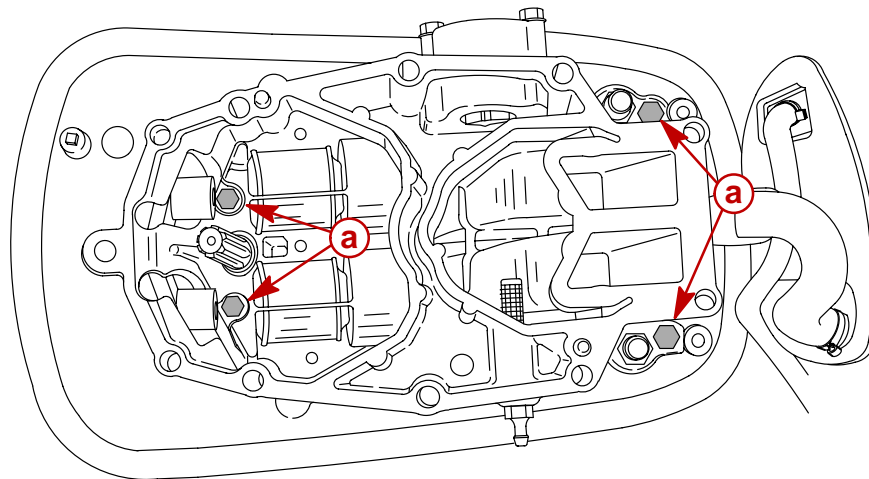


3. Position exhaust tube and gasket on adaptor plate. Secure both to plate with 6 bolts. Torque bolts to 21 lb. ft. (28.5 Nm).
4. Secure tube to adaptor plate with 2 bolts. Torque bolts to 80 lb. in. (9 Nm).



- a** - Exhaust Tube
- b** - Gasket
- c** - Water Tube

5. Position adaptor plate on top of housing.
6. Secure adaptor plate to drive shaft with 4 bolts. Torque bolts to 25 lb. ft. (34 Nm).

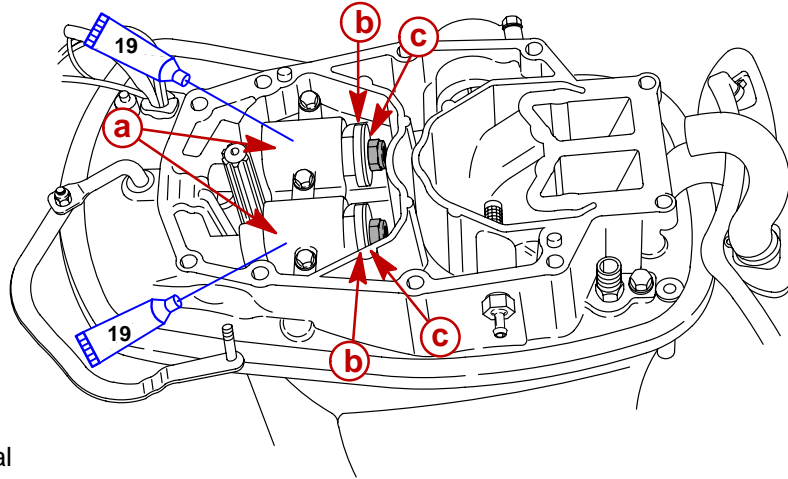


- a** - Bolts [Torque to 25 lb. ft. (34 Nm)]

58003



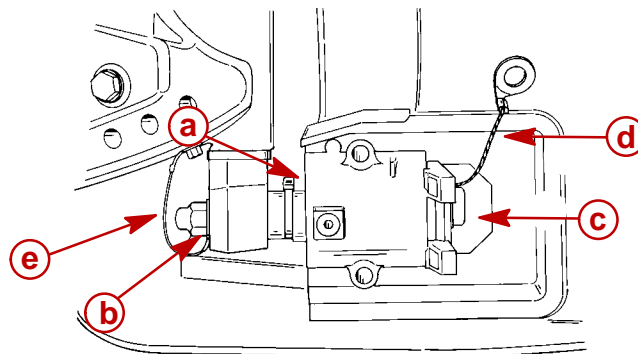
7. Apply a small amount of Perfect Seal onto metal portion of upper dyna-float mounts.
8. Position mounts on drive shaft housing plate.
9. Install a rubber washer onto each upper mount, followed by a metal washer.
10. Push bolts through mounts.



58004

- a** - Dyna-Float Mounts
- b** - Rubber Washers
- c** - Metal Washer

11. Install a ground strap onto port lower mount bolt.
- NOTE:** Apply Perfect Seal along length of lower mount bolts.
12. Insert a mounting bolt through the short end of each lower mount.
 13. Position a mount on each lower side of drive shaft housing.
 14. Install a flat washer over each lower mounting bolt.
 15. Start upper mounting bolts in upper mounts and align lower mounting bolts with holes in swivel pin yoke. Slide drive shaft housing up against yoke and bumper.
 16. Secure upper mounts to steering arm with flat washers and self-locking nuts. Torque nuts to 50 lb. ft. (68 Nm).
 17. Install ground strap between port lower mount bolt and swivel bracket.
 18. Secure lower mounts to swivel pin yoke with self-locking nuts. Torque nuts to 90 lb. ft. (122 Nm). Place a rubber cap over each lower mounting bolt head.

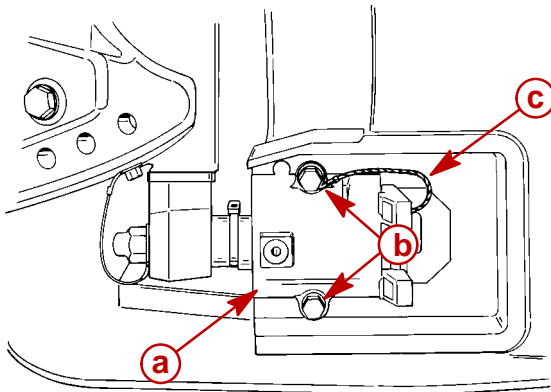


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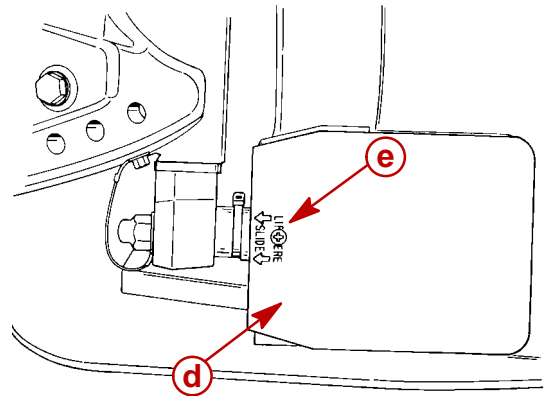
- a** - Lower Mount
- b** - Nut [Torque to 90 lb. ft. (122 Nm)]
- c** - Rubber Cap
- d** - Ground Strap (only 1 side)
- e** - Ground Strap (to swivel bracket)



- 19. Install lower mount retainers and secure each retainer with 2 bolts. Secure ground strap with the nearest retainer bolt and flat washer. Torque bolts to 20 lb. ft. (27 Nm).
- 20. Install lower mount covers and secure each cover with a screw.



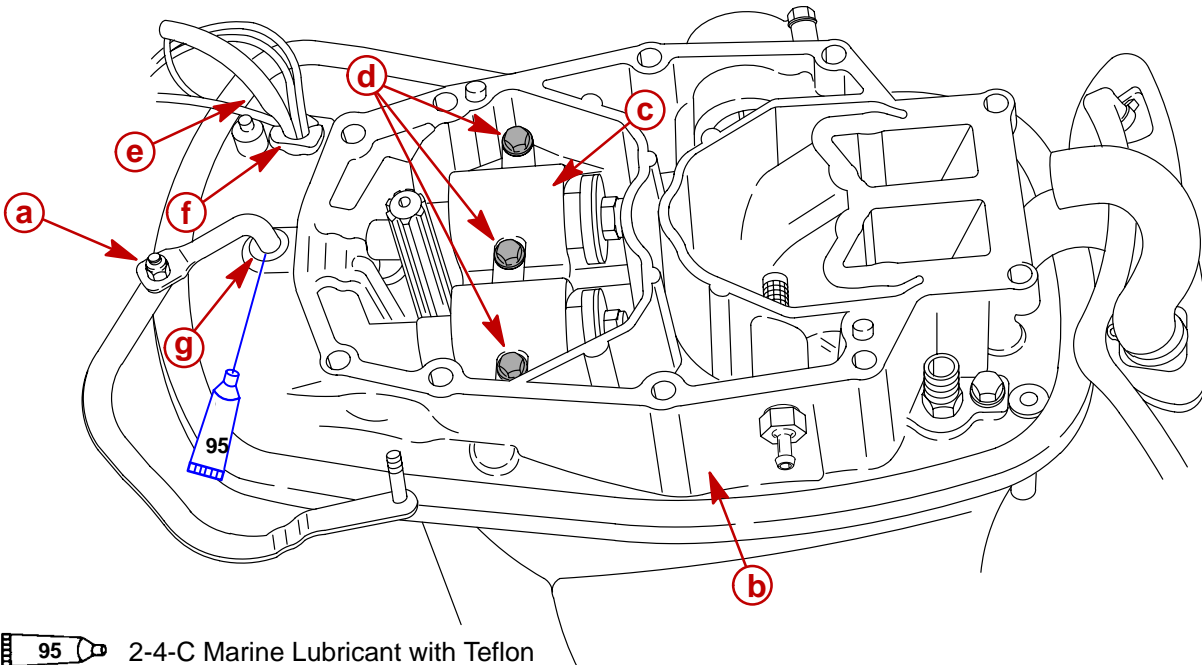
52308



52307

- a** - Lower Mount Retainer
- b** - Bolts [Torque to 20 lb. ft. (27 Nm)]
- c** - Ground Strap
- d** - Cover
- e** - Screw (1 for each cover)

- 21. Install upper mount cover on adaptor plate. Secure cover with 3 bolts. Torque bolts to 20 lb. ft. (27 Nm).
- 22. Route power trim harness thru grommet in adaptor plate.
- 23. Reinstall shift shaft with bushing into adaptor plate. Apply 2-4-C Marine Lubricant with Teflon to bushing.



58005

- a** - Shift Shaft Linkage
- b** - Exhaust Adaptor Plate
- c** - Upper Mount Cover
- d** - Bolts [Torque to 20 lb. ft. (27 Nm)]
- e** - Power Trim Harness
- f** - Grommet
- g** - Bushing



MID-SECTION

Section 5B – Power Trim - (Oildyne)

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**5
B**

Power Trim Specifications

POWER TRIM	(Oildyne) Trim “UP” Trim “DOWN” Leak Down	2000 PSI (91kg/cm ²) Maximum Pressure 600 PSI (35kg/cm ²) Minimum Pressure Maximum Acceptable Amount of Leak Down in 24 hours is 1 in. (25.4 mm)
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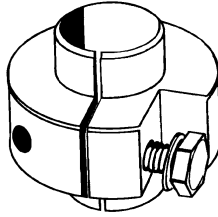
Special Tools

1. Alignment Tool 91-11230



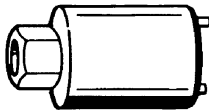
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2. Trim Rod Removal Tool 91-44486A1



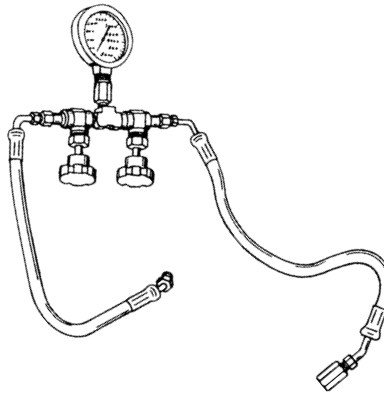
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3. Trim Rod Guide Removal Tool 91-44487A1



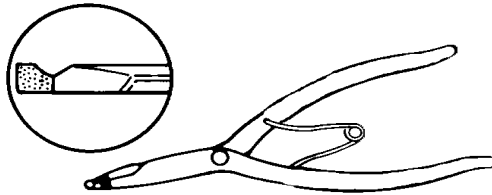
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4. Power Trim Test Gauge Kit 91-52915A6



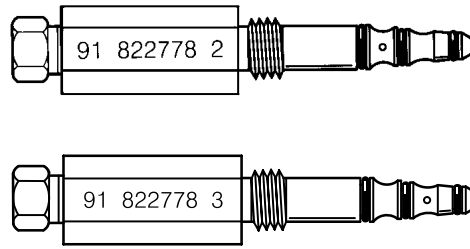
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5. Lock-Ring Pliers P/N SRP-4 (Snap-On)



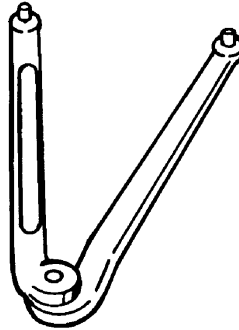


6. Adaptor Fitting 91-82278A2 and 91-82278A3



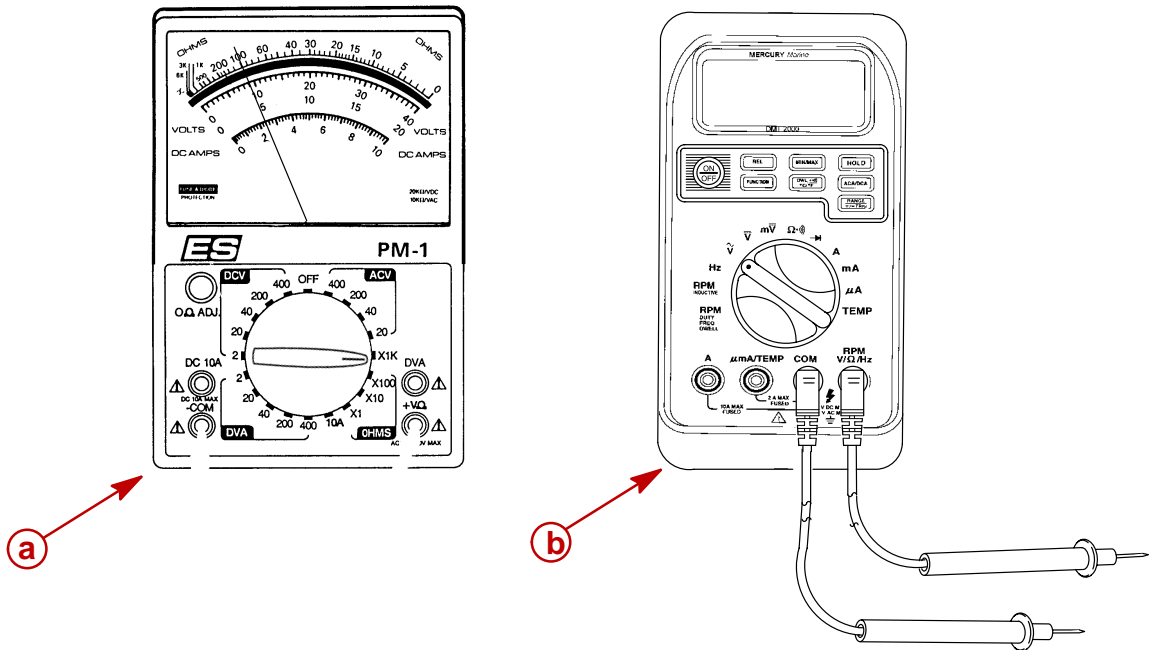
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7. Spanner Wrench 91-74951



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8. Multi-Meter DVA Tester 91-99750A1 or DMT 2000 Digital Tachometer Multi-meter 91-854009A1

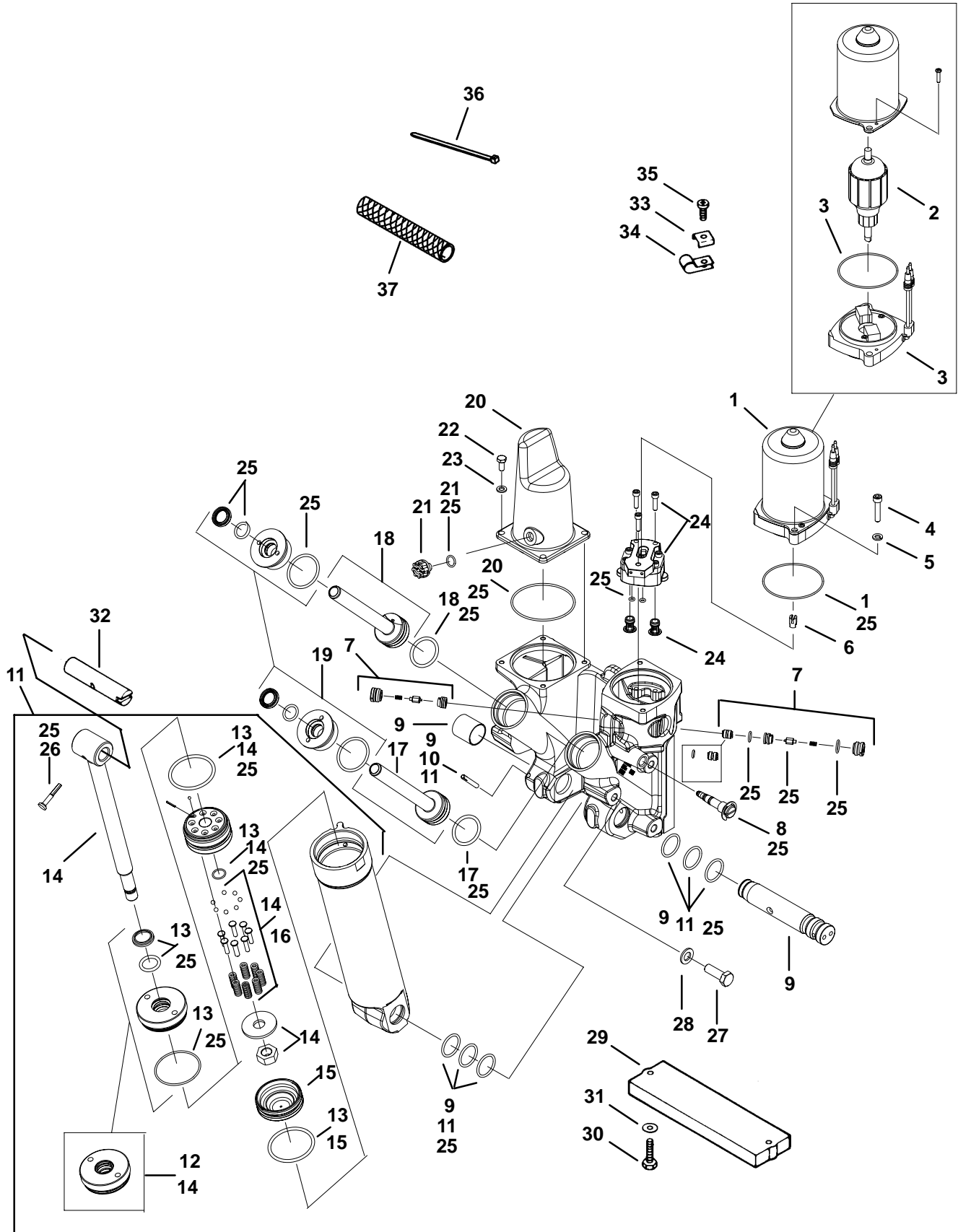


a - Multi-Meter DVA Tester 91-99750A1

b - DMT 2000 Digital Tachometer Multi-meter 91-854009A1



Power Trim Components (Oildyne)





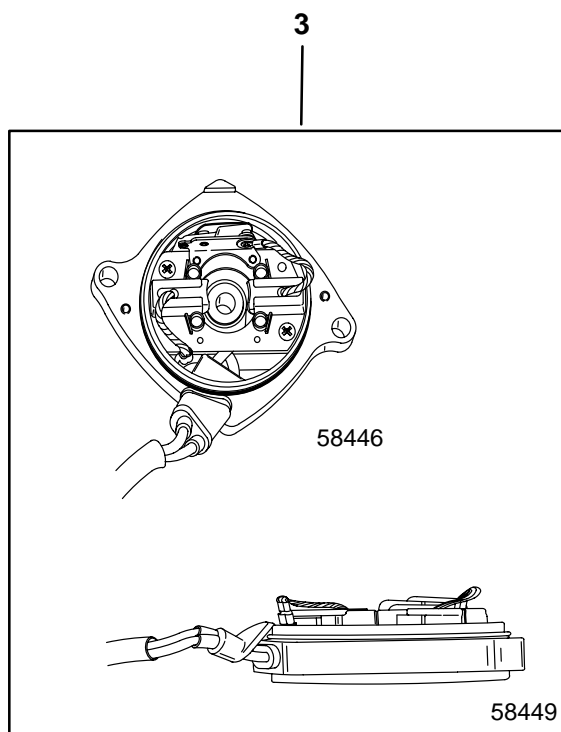
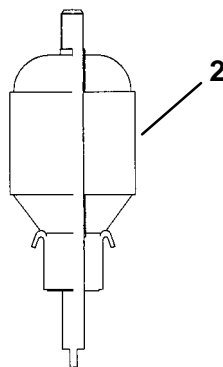
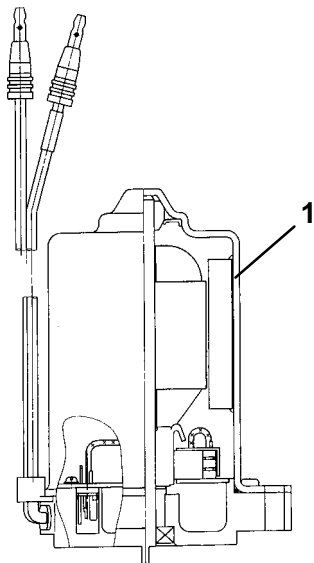
Power Trim Components (Oildyne)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
–	1	POWER TRIM ASSEMBLY–Complete			
1	1	TRIM MOTOR			
2	1	ARMATURE			
3	1	END FRAME			
4	2	SCREW (M6 x 30)	80		9
5	2	LOCKWASHER			
6	1	DRIVE SHAFT			
7	1	CHECK VALVE KIT	120		13.5
8	1	RELIEF VALVE ASSEMBLY	22		2.5
9	1	SHAFT KIT (Includes. Ref. #26)			
10	1	GROOVE PIN			
11	1	TILT CYLINDER ASSEMBLY			
12	1	END CAP (Includes. Ref. #26)		45	61
13	1	O RING KIT (Includes. Ref. #26)			
14	1	SHOCK ROD KIT		95	129
15	1	MEMORY PISTON			
16	1	CHECK VALVE REPAIR KIT (Includes. Ref. #26)			
17	1	STARBOARD TRIM ROD			
18	1	PORT TRIM ROD			
19	2	END CAP TRIM ROD		70	95
20	1	RESERVOIR KIT			
21	1	PLUG KIT	22		2.5
22	4	SCREW (M6 x 14)	60		7
23	4	WASHER			
24	1	PUMP KIT			
25	1	POWER TRIM REPAIR KIT			
26	1	GROOVE PIN			
27	6	SCREW (M10 x 30)		45	61
28	6	WASHER			
29	1	ANODE			
30	2	SCREW (M6 x 25)	70		8
31	2	WASHER			
32	1	SHAFT			
33	1	C WASHER			
34	2	CLIP			
35	2	SCREW (10-16 x 5/8)		Drive Tight	
36	1	STA-STRAP			
37	1	CONDUIT [12 IN. (30.5 CM)]			

NOTE: Lubricate all o-rings with ATF Dexron III or Power Trim and Steering Fluid.



Power Trim Motor (Oildyne)



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			



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 “Trailing”. The outboard can be trimmed and tilted under power or when the outboard is not running.

Trimming Characteristics

NOTE: Because hull designs react differently in varying water conditions, varying the trim position will often improve the ride and boat handling. When trimming from a mid-trim position (with outboard trim tab in a straight fore and aft position), expect the following:

TRIMMING OUTBOARD “UP” (OUT):

⚠ WARNING

Excessive trim “Out” may reduce the stability of some high speed hulls. To correct instability, reduce the power gradually and trim the outboard “In” slightly before resuming high speed operation. A rapid reduction in power will result in a sudden change of steering torque and may cause additional boat instability.

Will lift boat bow, increasing top speed.

Transfers steering torque harder to port (left) on installations below 23 in. (584.2 mm) transom height.

Increases gearcase clearance over submerged objects.

Excess trim can cause “porpoising” and/or ventilation.

⚠ WARNING

Excessive outboard trim angle will result in insufficient water supply causing water pump and/or powerhead overheating damage. Insure water level is above water intake holes whenever outboard is running.

The “Up” circuit actuates the up relay (under outboard cowl) and closes the motor circuit. The electric motor drives the pump, forcing fluid thru passageways into the up side of the trim cylinders.

The trim cylinders position the outboard at the desired trim angle in the 20 degree maximum trim range. The system will not allow the outboard to be trimmed above the 20 degree trim range as long as the engine RPM is above approximately 2000 RPM.

The outboard can be trimmed above the 20 degree maximum trim angle (for shallow water operation, etc.), by keeping the engine RPM below 2000. If the RPM increases over 2000, propeller thrust (if propeller is deep enough) will cause the trim system to return the outboard to the 20 degree maximum trim position.



TRIMMING OUTBOARD “DOWN” (IN):

⚠ WARNING

Excessive speed at minimum trim “In” may result in undesirable and/or unsafe steering conditions. Test for handling characteristics after any adjustment is made to the trim angle (and tilt pin location).

Aids planing, particularly with heavy loads.

Improves ride in choppy water conditions.

Excess trim “In” can cause “bow steer” (boat veers to left or right).

Transfers steering torque to starboard (right).

Improves acceleration to planing speed.

The “Down” circuit actuates the down relay (under engine cowl) and closes the motor circuit. The electric motor drives the pump in the opposite direction as the up circuit, forcing fluid thru passageways into the “down” side of the tilt ram. The tilt ram moves the engine down to the desired position.

Trailing Outboard

The “Up” circuit first moves the trim cylinders; when the trim cylinders extend fully, the tilt ram extends to tilt the outboard to the full up position for trailering.

Before the boat is trailered, the operator should check for clearance between the outboard skeg and pavement to prevent damage to skeg from striking pavement.

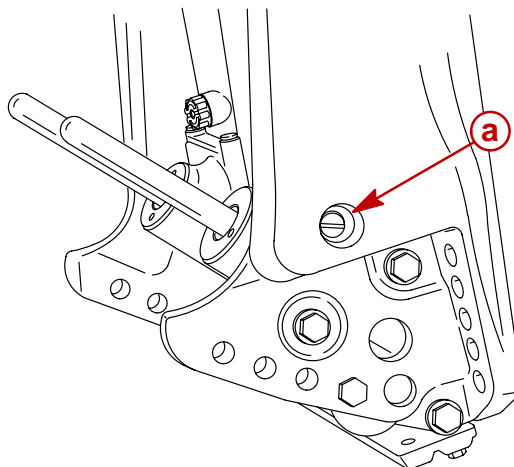
If the outboard must be tilted for clearance between skeg and pavement, a device such as a “Transom Saver” should be installed to prevent stress to boat transom from outboard weight while the boat/outboard are being trailered.

Tilting Outboard Manually

⚠ WARNING

Before opening the manual release valve, insure all persons are clear of outboard as outboard will drop to full “Down” when valve is opened.

The outboard can be raised or lowered manually by opening the manual release valve 3 to 4 turns counterclockwise. Close manual release valve to hold outboard at the desired tilt position.



a - Manual Release Valve

58450

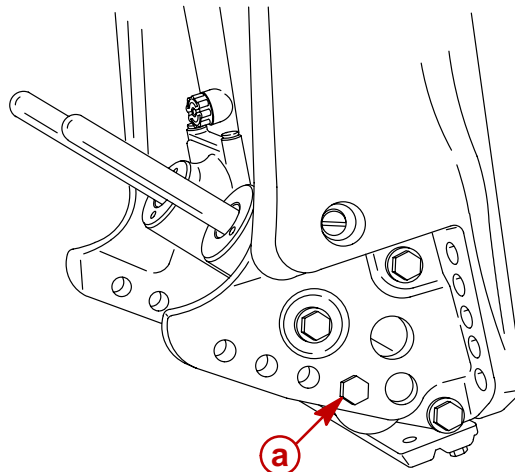


Trim “In” Angle Adjustment

⚠ WARNING

Boat operation with outboard trimmed to the full “In” trim angle [not using the trim angle adjustment bolt] 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 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.

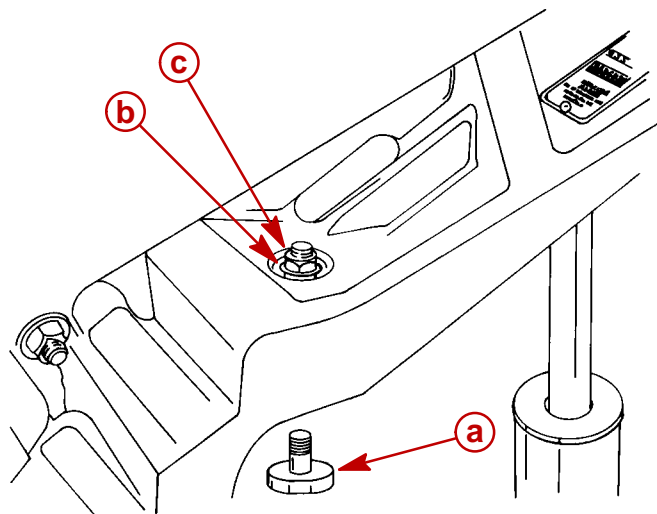


a - Trim Angle Adjustment Bolt

58450

Striker Plate Replacement

Visually inspect striker plates and replace if worn excessively.



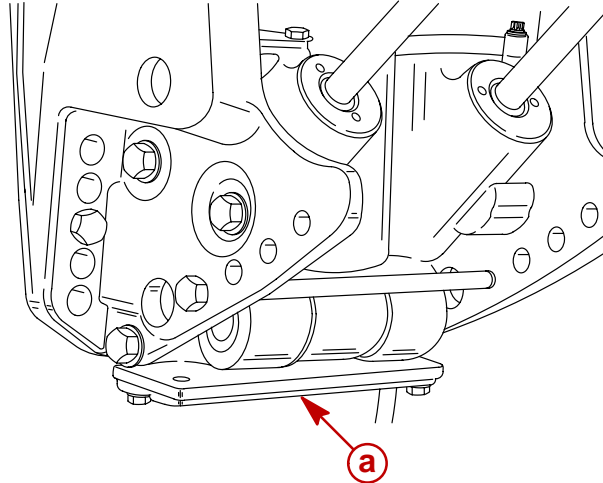
- a** - Striker Plate (2)
- b** - Lockwasher
- c** - Locknut. Torque to 80 lb. in. (9 Nm)

27930



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.



58445

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 Trim Indicator Gauge accessory kit is available for the power trim sender (if not previously installed).

Check, Fill and Purge - Power Trim System

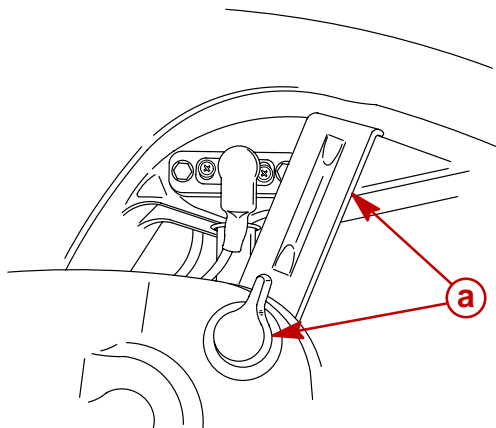
TO CHECK:

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.

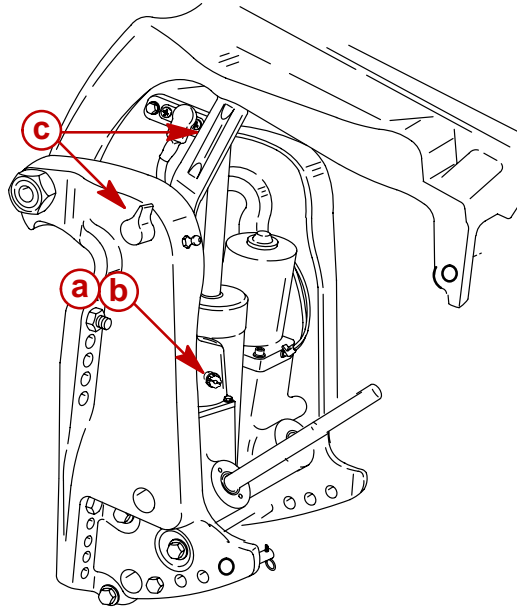


58451

a - Tilt Lock Lever

**TO FILL:**

IMPORTANT: This trim system is pressurized. Remove “Fill” plug only when outboard is tilted to the full “Up” position or the trim/tilt rams are fully extended. Retighten “Fill” plug before tilting outboard down or retracting tilt/trim rams. Remove “Fill” plug and O-ring. System is full when oil level is present at fill hole. Tighten “Fill” plug securely.



58612

- a** - Fill Plug and O-ring (remove to fill system, tighten securely)
- b** - Fill system with Power Trim and Steering Fluid
- c** - Tilt Lock Lever (engage to support engine in “Up” position)

TO PURGE:

IMPORTANT: Fill plug and O-ring must be tightened securely before purging system.

IMPORTANT: Run Trim System in short “jogs” until pump is primed and trim system moves. If trim motor is run without priming pump, driveshaft failure could result.

Cycle outboard through entire trim/tilt range 4 times. Check fluid level after purging system.

Push down on outboard when trim rams are slightly extended. If rams retract more than 1/8 in. (3.2 mm), air is present in system. Cycle system again and check fluid level.



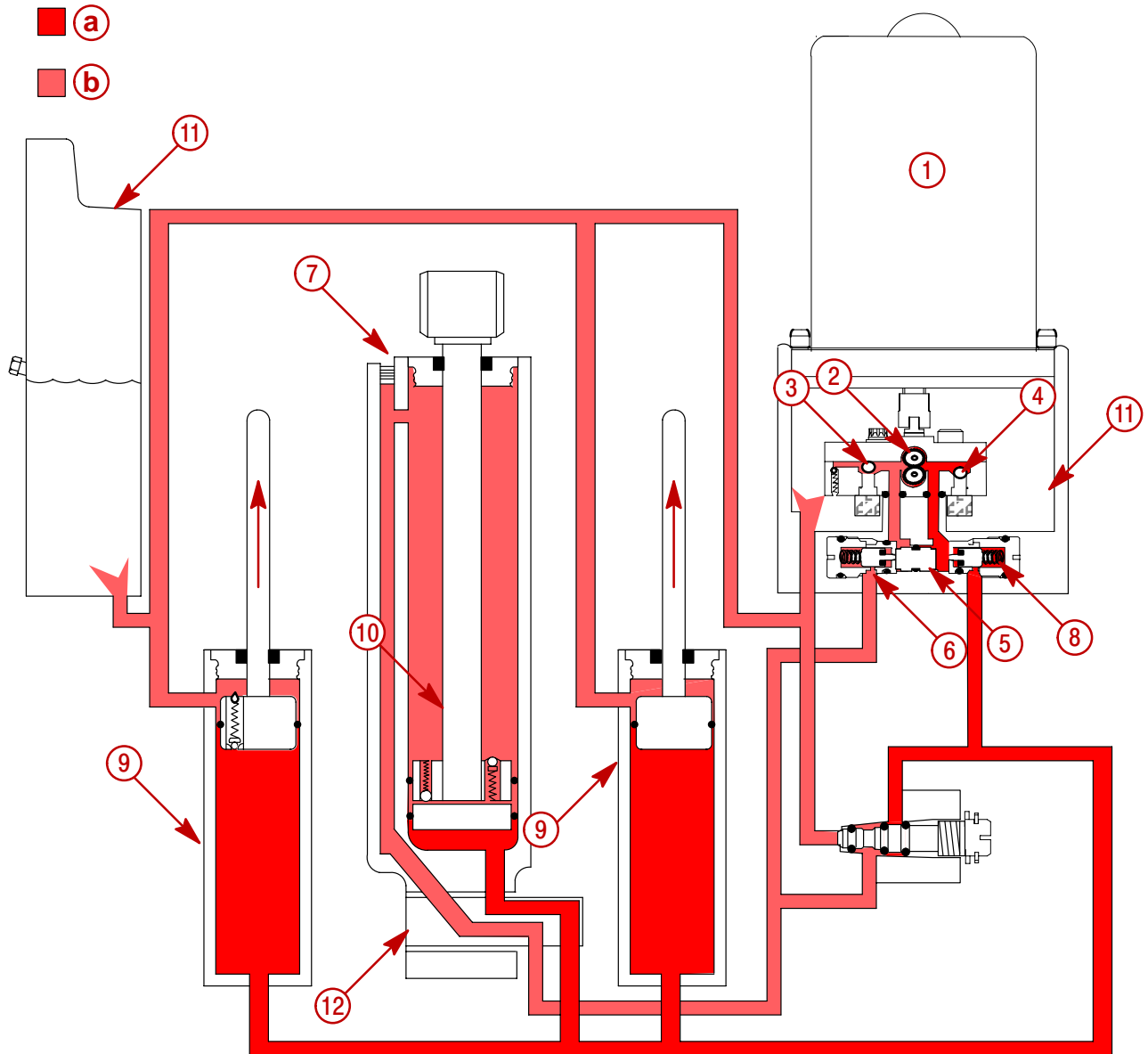
Trim Circuit

When the up button is activated the electric motor (1) will rotate the oil pump gears (2). As the oil pump gears begin to rotate, oil is drawn through the up circuit suction check valve (3) and into the pump, supplying flow for the up circuit. Oil under pressure opens the up circuit pressure operated valve (8), allowing oil enter the up pressure passages inside the manifold casting. The oil continues on through the up passages into the bottom of the cylinders below the pistons, pushing the trim (9) and tilt (10) rams up and out. Oil, from the pump, is blocked from returning into the reservoir by the closed down suction check valve (4). Oil, under pressure slides the shuttle spool (5) to the left, against the down circuit pressure operated valve (6). The shuttle spool will mechanically open the down pressure operated valve, allowing oil to return into the pump from top of the tilt cylinder (7). Oil returning from the top side of the tilt cylinder piston flows through an interconnecting passage on the side of the tilt cylinder, through the lower pivot pin (12), past the open down pressure operated valve, and into the pump, supplying some of the oil required for the up circuit. Oil returns into the reservoir (11), from the trim rams, through passages cast inside of the manifold.

Up pressure varies from 850 psi to 1150 psi unloaded to approximately 3000 psi against full engine thrust.



Trim Circuit



- a** - High Pressure
- b** - Low Pressure
- 1** - Electric Motor
- 2** - Oil Pump/Gears
- 3** - Up Circuit Suction Check Valve
- 4** - Down Circuit Suction Check Valve
- 5** - Shuttle Spool
- 6** - Down Circuit Pressure Operated Valve
- 7** - Tilt Cylinder
- 8** - Up Circuit Pressure Operated Valve
- 9** - Trim Cylinders
- 10** - Tilt Cylinder Piston
- 11** - Reservoir
- 12** - Lower Pivot Pin



Tilt Circuit

In the up mode, as the trim rams (1) reach the limit of their travel, the mechanical check valve (2) of the trim relief valve, in the port trim ram piston (3), contacts the cylinder cap. The “pin” contact with the cover mechanically opens the shut off valve, allowing the trim relief valve to bypass oil and perform the following functions.

- Trim Limit

While the engine is running under thrust (at high engine RPM), the high pressure develops below the pistons. The high pressure will open the check ball on the bottom of the trim relief valve (850-1150 psi), allowing oil to flow through the port trim ram piston. If the operator continues to depress the “up” button, the up pressure will not be sufficient to overcome the propeller thrust, so the trim range is limited to the length of the trim rams. When the engine thrust falls (low engine rpms), the check ball in the trim relief valve closes, allowing oil flow to extend the tilt cylinder ram into the tilt range.

- Over Trim At High Thrust

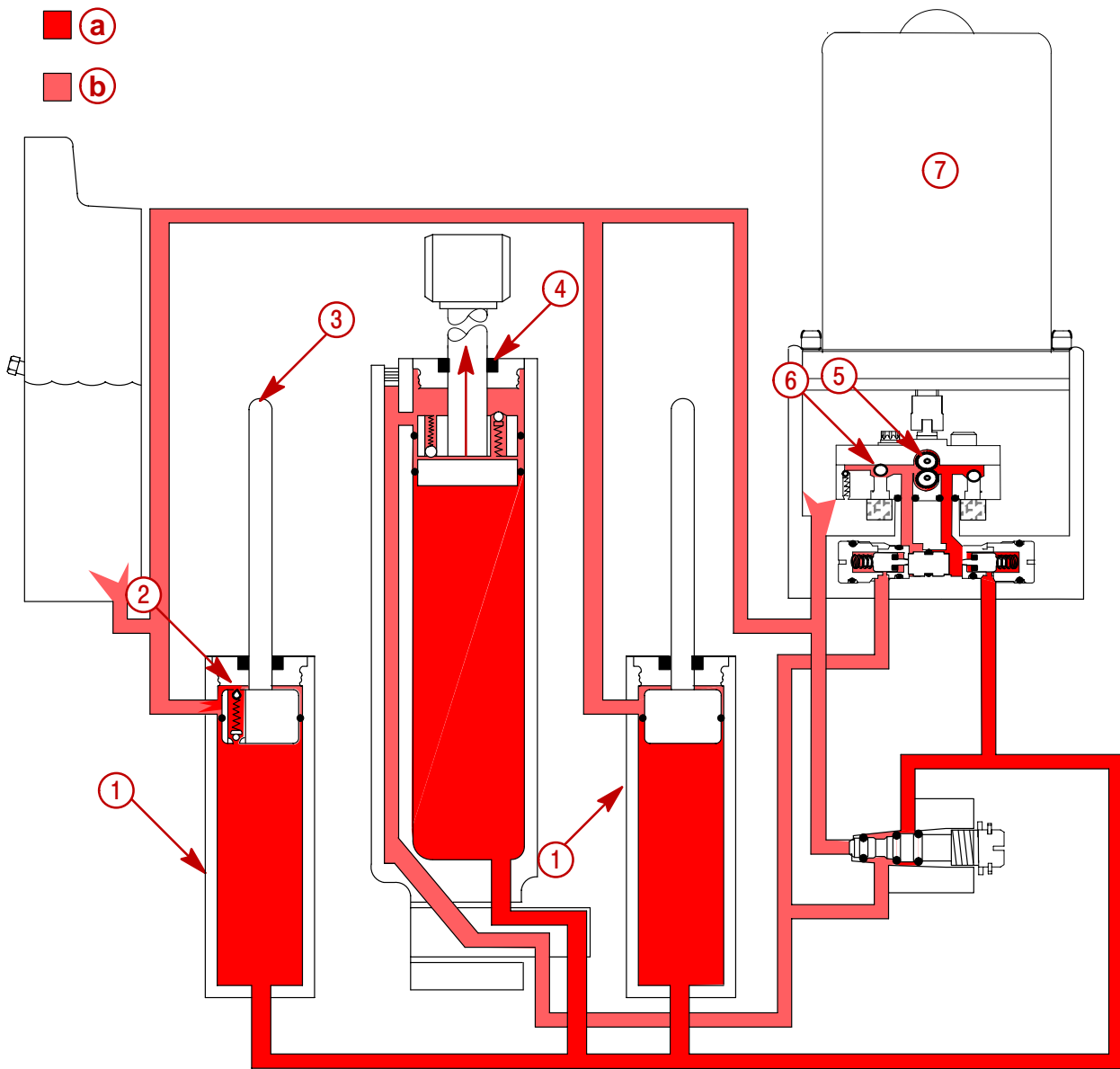
As the operator increases the engine rpms when the engine is raised beyond the trim range, the pressure below the pistons begin to rise. When the pressure is sufficient, the high pressure will open the check ball on the bottom of the trim relief valve (850-1150 psi), allowing oil to flow through the port trim ram piston. Oil will continue to flow through the valve until either the engine contacts the trim rams and the mechanical shut off valve closes or the engine rpm's are reduced.

- Maximum Up Pressure Reduction

As the tilt ram extends to its limit, the up pressure below the pistons will increase and open the trim relief check valve to relief the up pressure. If the up button is not released, the up flow will continue to dump over relief causing the electric motor to heat up. The thermal overload switch inside the motor will open, stopping the motor.



Tilt Circuit



- a** - High Pressure
- b** - Low Pressure
- 1** - Trim Cylinders
- 2** - Trim Relief Valve
- 3** - Port Trim ram
- 4** - Tilt Cylinder
- 5** - Pump/Gears
- 6** - Up Circuit Suction Check Valve
- 7** - Electric Motor

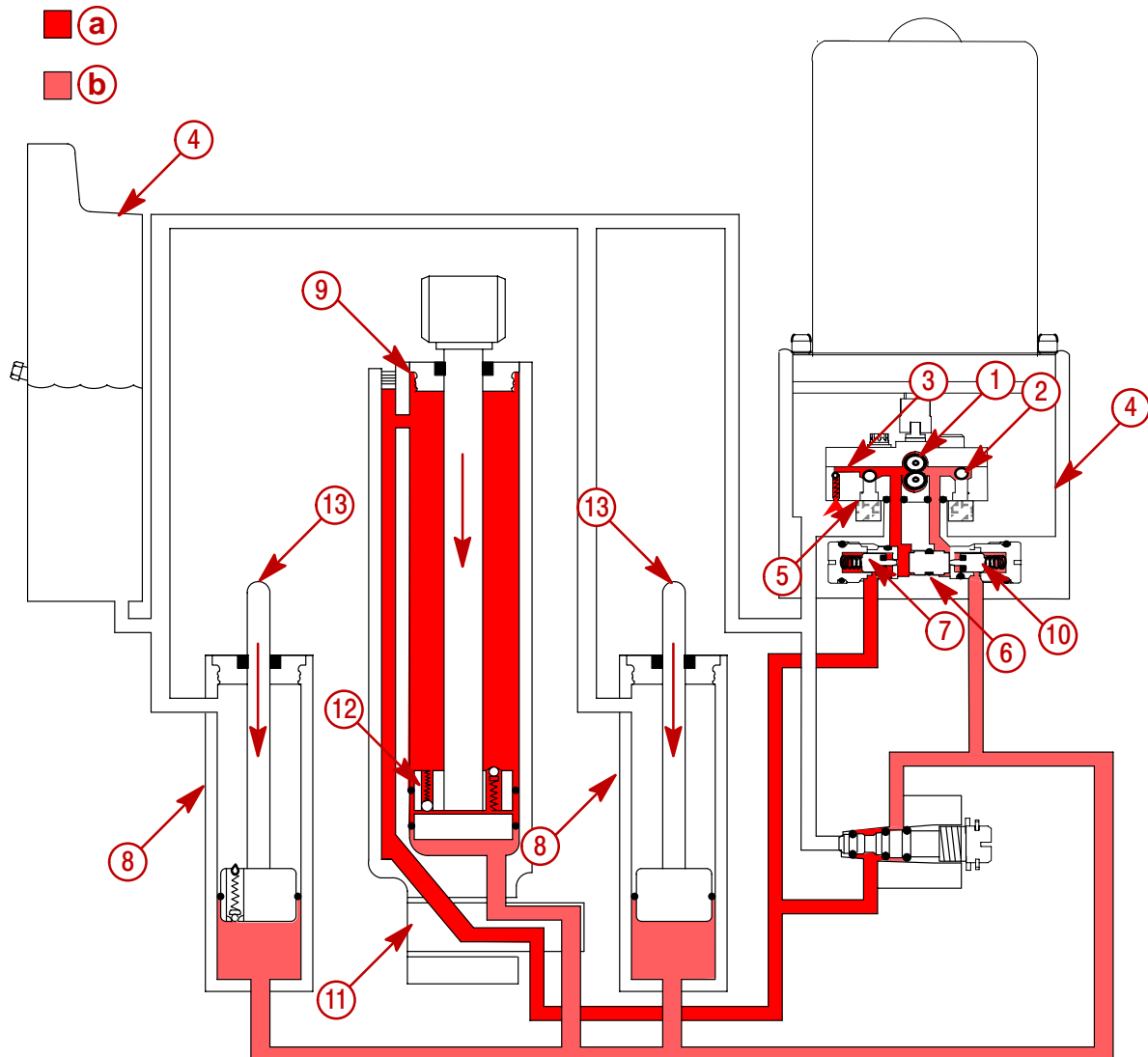


Down Circuit

When you depress the down button, the power trim pump (1) is activated in the opposite direction. As the oil pump gears begin to rotate, oil is drawn through the down circuit suction check valve (2) and into the pump, supplying flow for the down circuit. Down circuit oil pressure is lowered by the down pressure regulating valve (3) (640 psi to 1050 psi) allowing excess oil to return into the reservoir (4). Oil is blocked from returning into the reservoir by the closed up circuit suction check valve (5). Oil under pressure then moves the shuttle spool (6) to the right, mechanically opening the “up” pressure operated valve (7), allowing oil from the bottom of the trim (8) and tilt cylinders (9) to supply oil to the trim pump for the down circuit. At this same time, oil under pressure opens the down circuit pressure operated valve (10) allowing oil to exit through the down pressure port. The oil then continues through the down pressure passage, through the pivot pin (11), and into the interconnecting passage of the tilt cylinder leading to the cavity above the shock piston (12), and pushes the piston and ram assembly in (down). As the outboard engine contacts the extended trim rams (13), the weight of the motor, propeller thrust and pump down pressure will force the trim rams to retract.



Down Circuit



- a** - High Pressure
- b** - Low Pressure
- 1** - Pump/Gears
- 2** - Down Circuit Suction Check Valve
- 3** - Down Pressure Regulating valve
- 4** - Reservoir
- 5** - Up Circuit Suction Check Valve
- 6** - Shuttle Spool
- 7** - Up Circuit Pressure Operated Valve
- 8** - Trim Cylinders
- 9** - Tilt Cylinder
- 10** - Down Circuit Pressure Operated Valve
- 11** - Pivot Pin
- 12** - Shock Piston
- 13** - Trim Ram



Trail Over System

Should the outboard motor strike a submerged object with light steady pressure, while in forward motion, oil will build up sufficient pressure in the top of the tilt cylinder (4) to open the piston trail over relief valve (7) (600 psi). Oil on the bottom side of the cylinder is locked in by the up circuit pressure operated valve (1) and manual tilt valve (3). Therefore, the piston trail over relief valve allows the oil from the down side cavity of the trim cylinder to pass through the piston trail over relief valve, into the area between the tilt ram piston (5) and the memory piston (6). The return valve (8) allows the oil to return through the piston, back to the down side cavity as the outboard returns to its normal running position. Propeller thrust and the weight of the outboard provides the return motion for the engine.

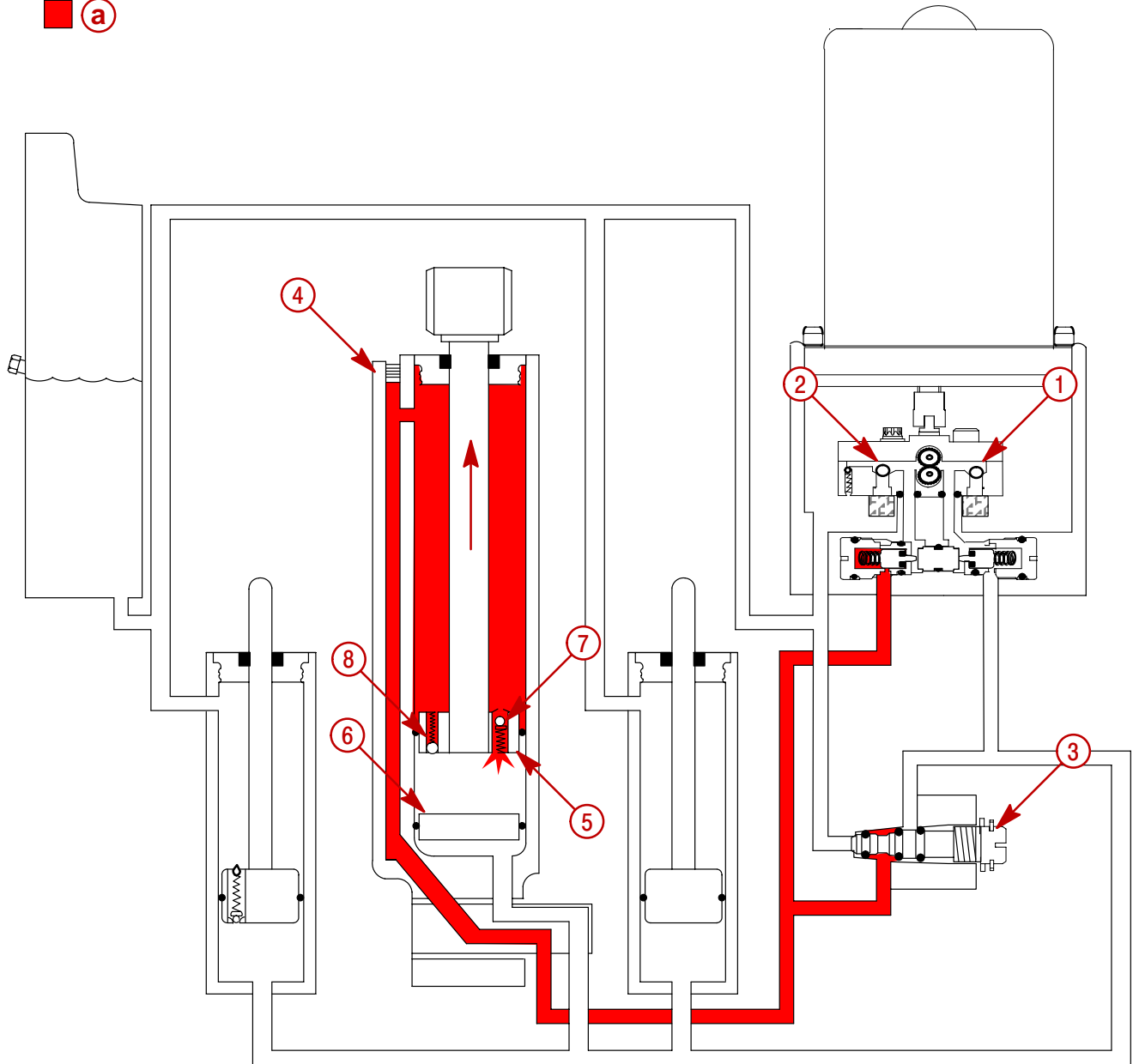
Shock System

When a submerged object is hit with great force, oil will build up sufficient pressure in the top of the tilt cylinder (4) to open both the trail over valve and the piston impact relief valves (7) (3200 psi). Oil on the bottom side of the cylinder is locked in by the up circuit pressure operated valve (1) and manual tilt valve (3). Therefore, the piston impact relief valve allows the oil from the down side cavity of the trim cylinder to pass through the piston impact relief valve, into the area between the tilt ram piston (5) and the memory piston (6). The return valve (8) allows the oil to return through the piston, back to the down side cavity as the outboard returns to its normal running position. Propeller thrust and the weight of the outboard provides the return motion for the engine.



Trail Over and Shock Absorber

a



- a** - High Pressure
- 1** - Up Circuit Pressure Operated Valve
- 2** - Down Circuit Pressure Operated Valve
- 3** - Manual Tilt Valve
- 4** - Tilt Cylinder
- 5** - Shock Piston
- 6** - Memory Piston
- 7** - Impact Relief & Trail over Valves
- 8** - Return Valve



Manual Tilt System

If the outboard motor is to be raised or lowered manually, turn the manual release (tilt) valve (1) counterclockwise approximately 3 turns to the full out position. When in the full (out) position, oil in the tilt cylinder (2) can flow freely from the up side to the down side or from the down side to the up side. The oil return line into the reservoir (3) is also open, allowing free oil flow to either side of the tilt cylinder to accommodate the differential oil capacities between the tilt cylinder up side and down side cavities.

When trimming the outboard in either the up or down position, with the manual tilt valve open or leaking, little or no movement will occur. Oil pressure from the pump (4) will move to both, the up cavity and through the manual tilt valve into the down cavity, each cavity would have equal pressure resulting in little or no movement.

Reverse Operation

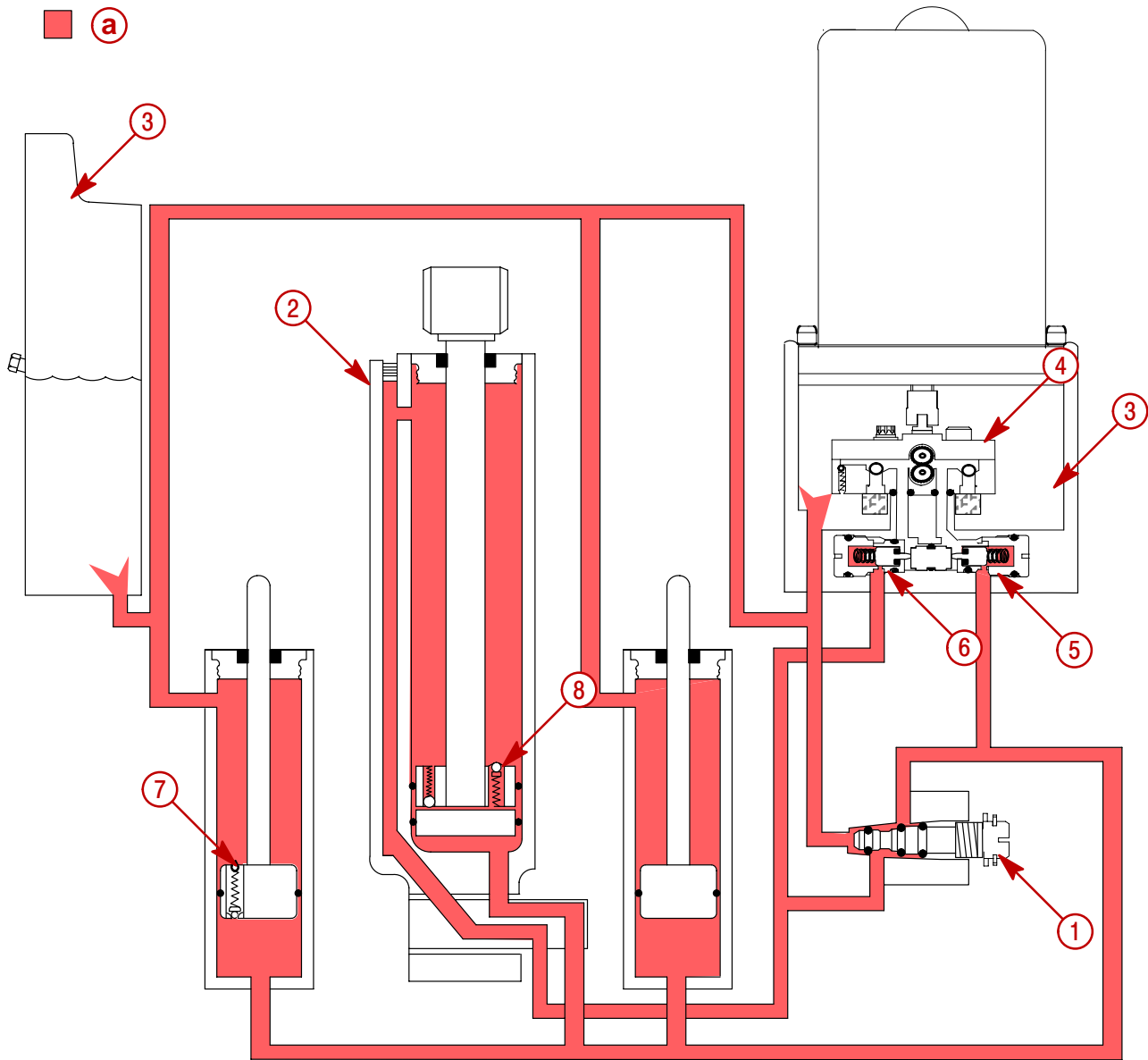
To prevent the outboard from coming up or trailing out, when shifted into reverse and/or throttling back rapidly, oil in the trim system must be locked in a static position. This is accomplished by closing the:

- up (5) pressure operated valve
- down (6) pressure operated valves
- trim relief valve (7)
- trail over valve (8)
- impact relief valves (8)
- manual release valve (1)

Thus, not allowing oil in the system to move in either direction.



Manual Tilt



- a** - Low Pressure
- 1** - Manual Release Valve
- 2** - Tilt Cylinder
- 3** - Reservoir
- 4** - Pump
- 5** - Up Pressure Operated Valve
- 6** - Down Pressure Operated Valve
- 7** - Trim Relief Valve
- 8** - Impact Relief Valves



Troubleshooting

IMPORTANT: Determine if Electrical or Hydraulic problem exists.

IMPORTANT: Acceptable power trim leak down should not exceed 1 in. (25.4 mm) (when measured at the tilt ram) in a 24 hour period.

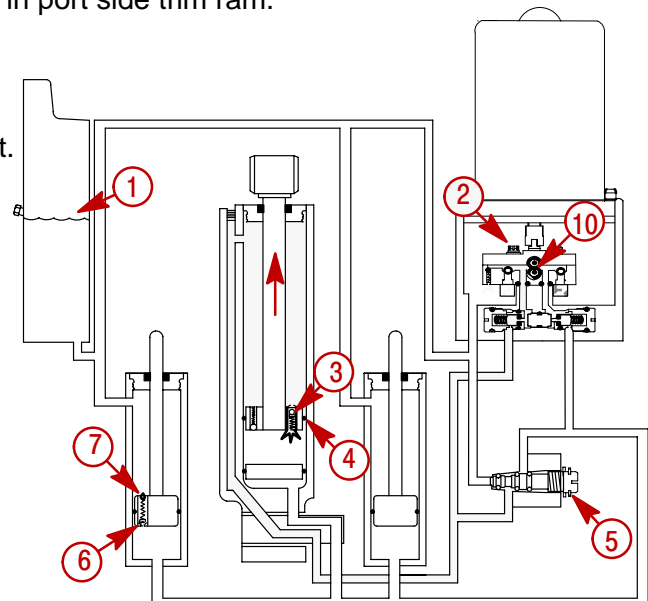
HYDRAULIC SYSTEM TROUBLESHOOTING

CONDITION OF TRIM SYSTEM	PROBLEM
A. Trim motor runs; trim system does not move up or down.	1, 5, 10, 11
B. Does not trim full down. Up trim OK.	3, 4, 5
C. Does not trim full up. Down trim OK.	1, 5
D. Partial or "Jerky" down/up.	1, 3
E. "Thump" noise when shifting.	3
F. Does not trim under load.	5, 8, 9
G. Does not hold trim position under load.	5, 6, 7
H. Trail out when backing off from high speed.	3, 4
I. Leaks down and does not hold trim.	5, 6, 7
J. Trim motor working hard and trims slow up and down.	8, 9
K. Trims up very slow.	1, 2, 5, 6, 8, 9
L. Starts to trim up from full down position when "IN" trim button is depressed.	3, 4
M. Trim position will not hold in reverse.	3, 4

PROBLEM

1. Low oil level.
2. Pump assembly faulty.
3. Tilt ram piston ball not seated (displaced, dirt).
4. Tilt ram piston O-ring leaking or cut.
5. Manual release valve leaking (check condition of O-rings) (Valve not fully closed).
6. Lower check valve not seating in port side trim ram.
7. Upper check valve not seating in port side trim ram.
8. Check condition of battery.
9. Replace motor assembly.
10. Broken motor/pump drive shaft.
11. Air pocket under pump.

External Mounted Hydraulic System





ELECTRICAL SYSTEM TROUBLESHOOTING

CONDITION OF TRIM SYSTEM	PROBLEM
A. Trim motor does not run when trim button is depressed.	1, 2, 4, 5, 6, 7, 8
B. Trim system trims opposite of buttons.	3
C. Cowl mounted trim buttons do not activate trim system.	2, 4, 5, 6, 7

PROBLEM

1. Battery low or discharged.
2. Open circuit in trim wiring.
3. Wiring reversed in remote control, cowl switch or trim leads.
4. Wire harness corroded through.
5. Internal motor problem (brushes, shorted armature).
6. Blown fuse(s).
7. Trim switch failure.
8. Verify relays are functioning correctly.

POWER TRIM RELAY TEST PROCEDURE

The trim motor relay system used on permanent magnet trim systems connect each of the two wires from the trim motor to either ground or positive in order to allow the motor to run in both directions.

If the motor will not run in the UP direction, it could be either the UP relay is not making contact to 12 volts **OR** the DOWN relay is not making contact to ground. The opposite is true if the system will not run DOWN. When the system is not energized, both relays should connect the heavy motor leads to ground.

To test which relay is faulty if the trim system does not operate in one direction:

1. Disconnect the heavy gauge pump wires from the trim control relay.
2. Check for continuity between the heavy leads from the trim relays to ground.

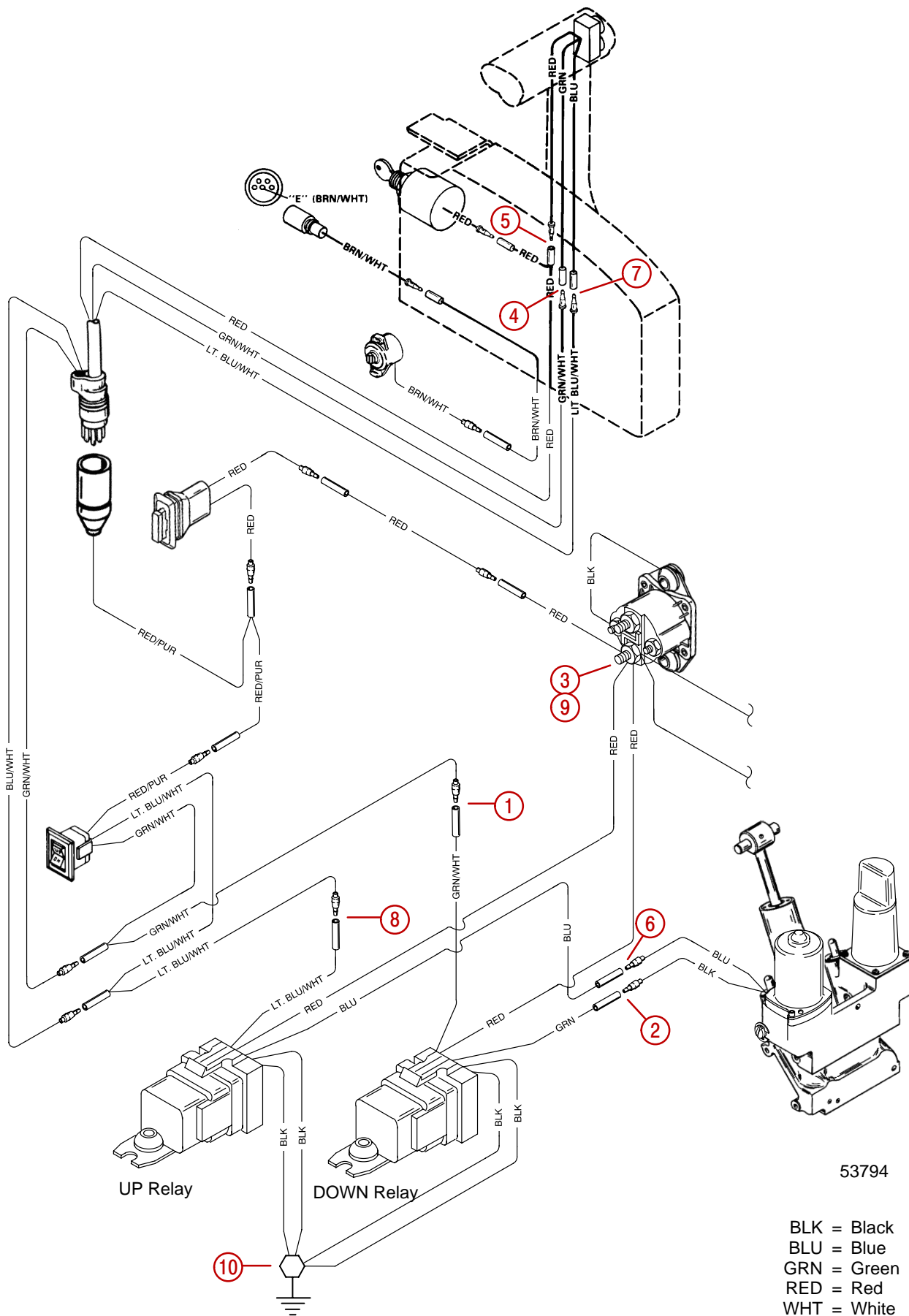
Ohmmeter Leads Between	Resistance (Ohms)	Scale Reading* (x _____)
GREEN and Ground	0	Full Continuity (Rx1)
BLUE and Ground	0	Full Continuity (Rx1)

Replace the relay that does not have continuity.

3. Connect a voltmeter to the heavy BLUE lead and to ground. You should have 12 volts on the BLUE lead when the UP switch is pushed. You should 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





Electrical System Troubleshooting

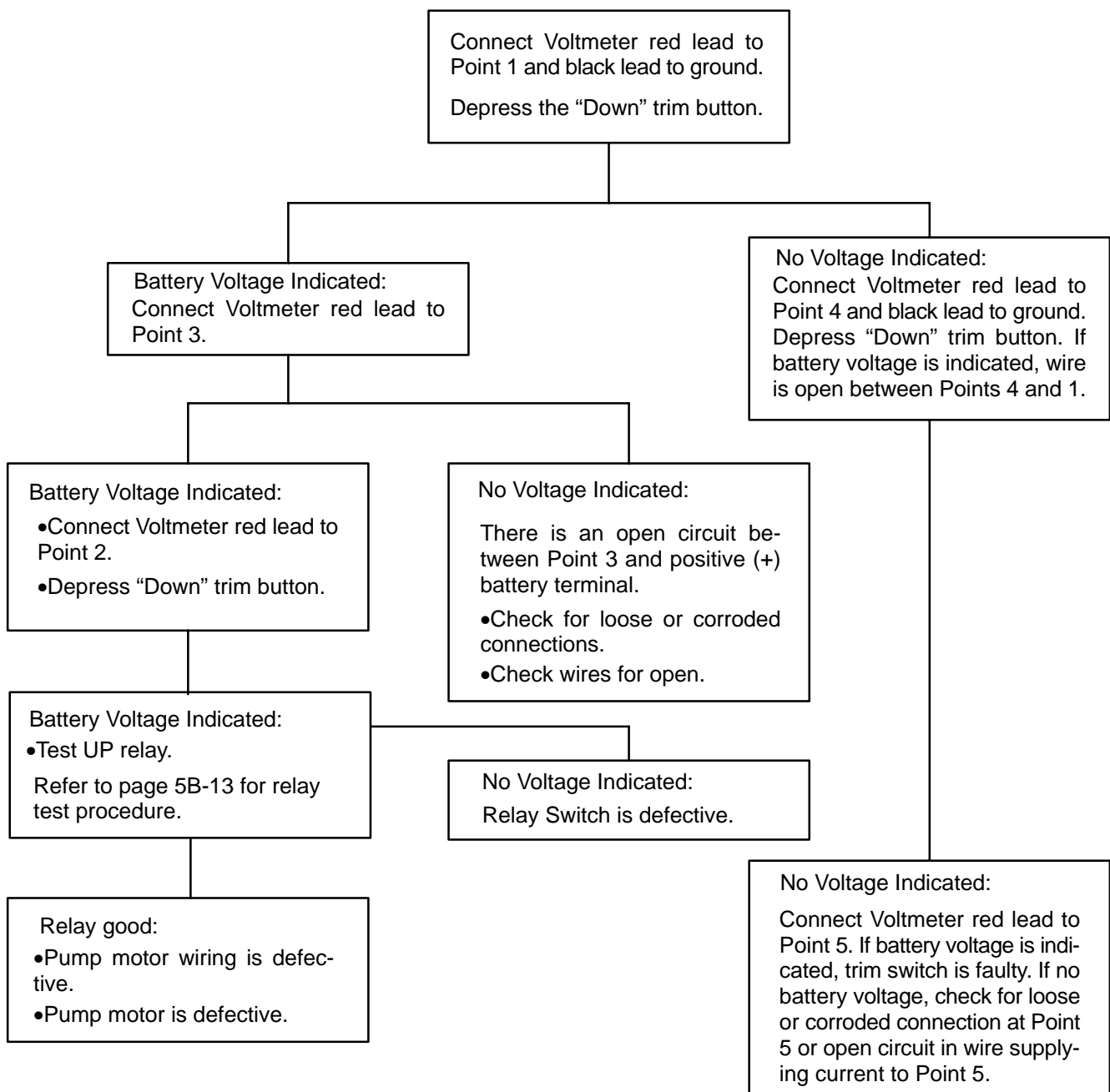
General Checks

Before troubleshooting the Power Trim electrical system, check the following:

1. Check for disconnected wires.
2. Make certain all connections are tight and corrosion free.
3. Check that plug-in connectors are fully engaged.
4. Make certain battery is fully charged.

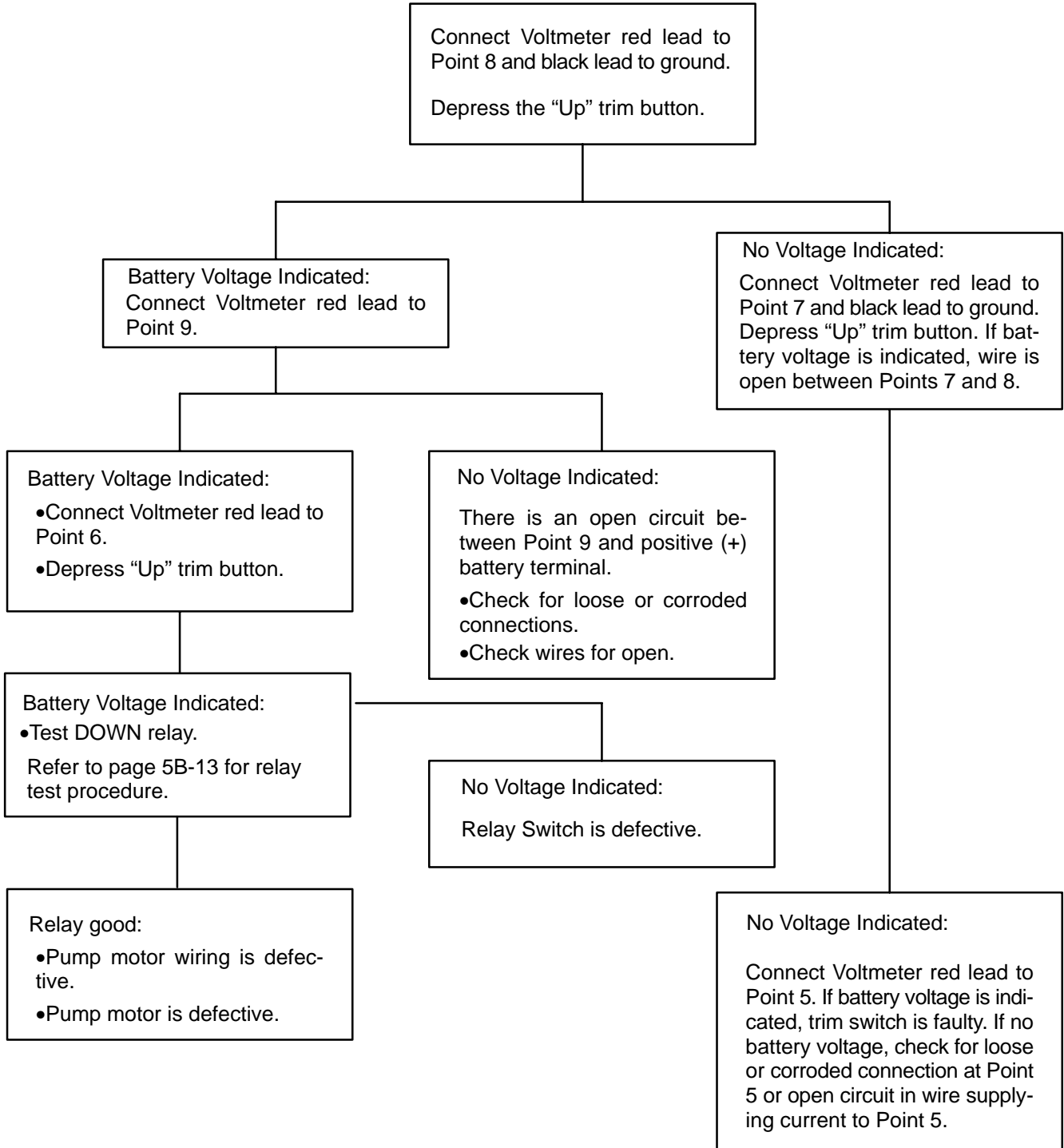
Refer to the preceding four wiring diagrams for connection points when troubleshooting the electrical systems (Connection points are specified by number.)

Troubleshooting the “Down Circuit”



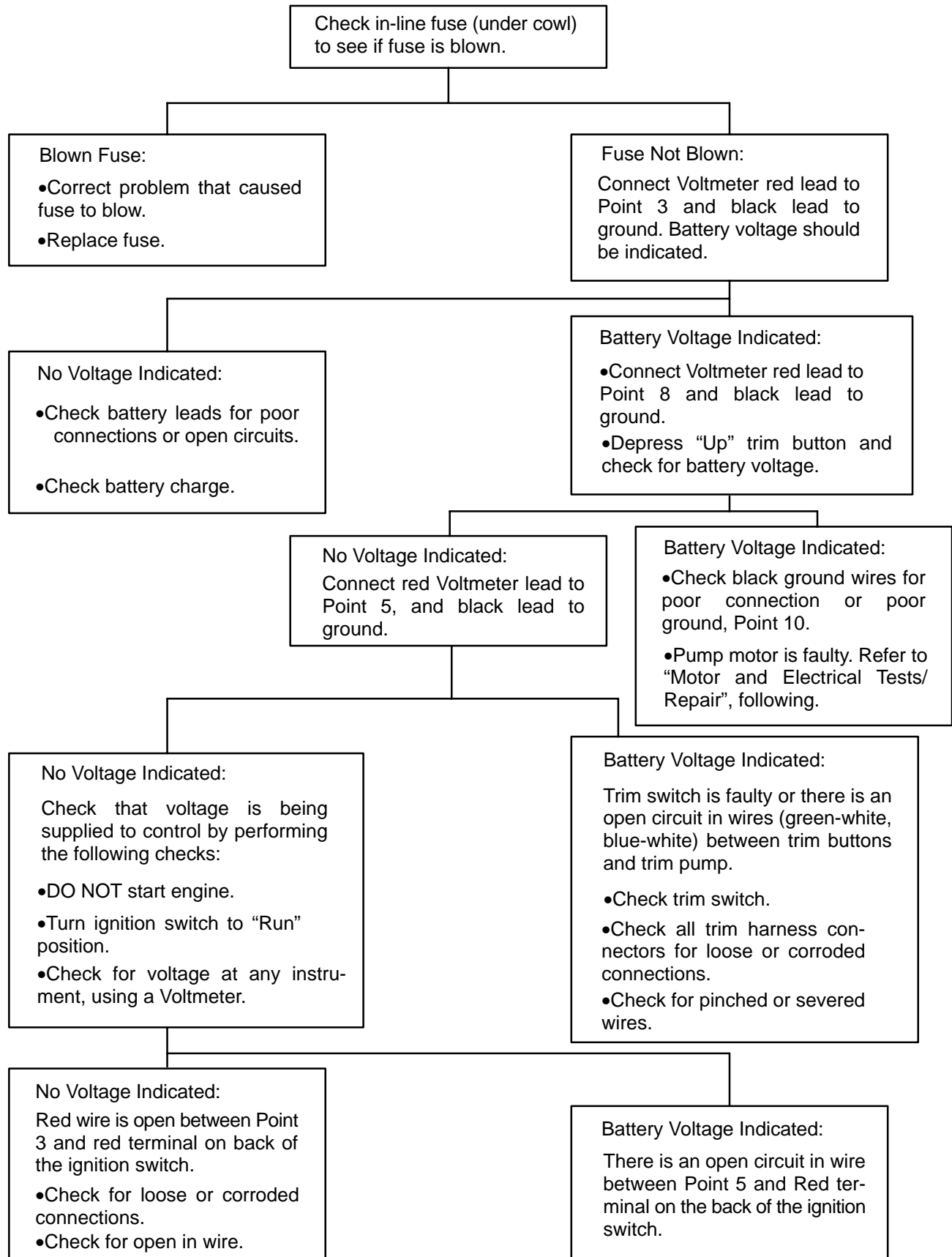


Troubleshooting the “Up” Circuit





Troubleshooting the “Down” and “Up” Circuits (All Circuits Inoperative)

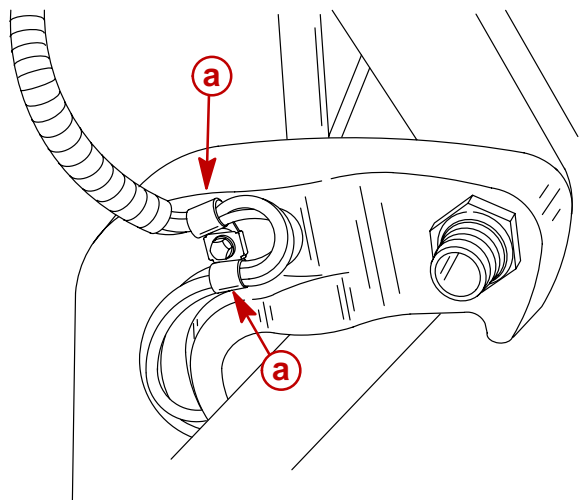




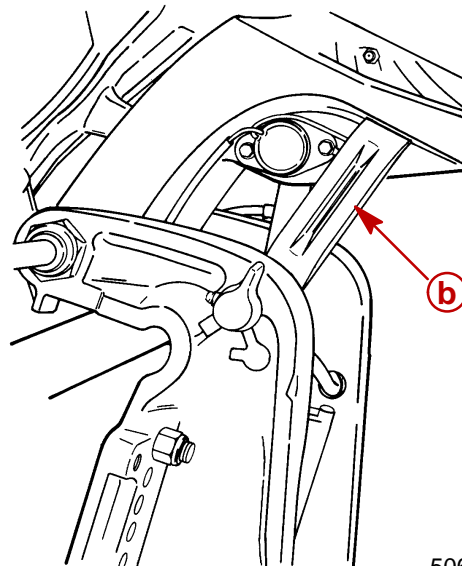
Power Trim Assembly Removal and Installation

Removal

1. Remove clamps on transom bracket to free power trim wiring.
2. Raise outboard to full "Up" position and engage tilt lock lever.
3. Remove trim indicator.



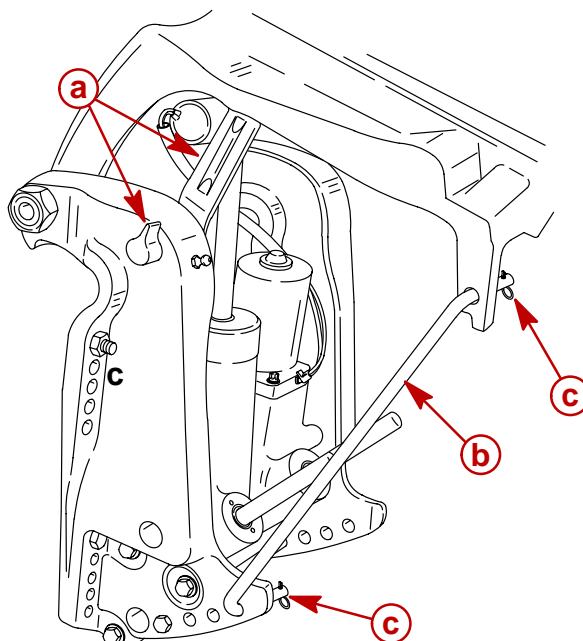
58448



50605

- a - Clamps
- b - Tilt Lock Lever

⚠ WARNING
Failure to support outboard as shown could result in personal injury and/or damage to outboard or boat.



58447

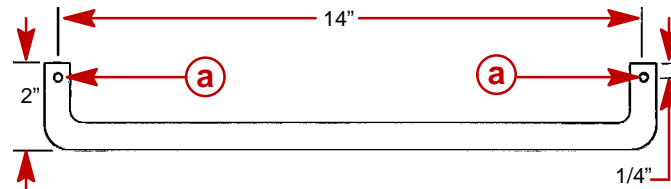
- a - Tilt Lock Lever
- b - Support Tool
- c - Retaining Clips



IMPORTANT: Support outboard as shown above to prevent engine from tipping when power trim retaining pin is removed.

SUPPORT TOOL

3/8 in. diameter metal rod (a used shift shaft works well)



a - Drill holes for retaining clips

METRIC CONVERSION

14 in. = 35.56 cm.

2 in. = 50.8 mm

3/8 in. = 9.5 mm.

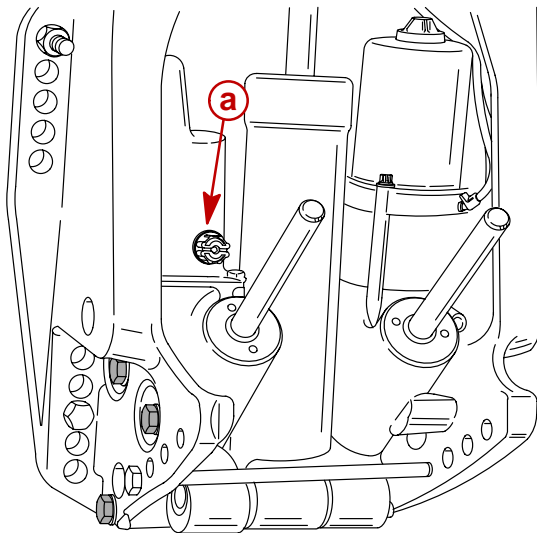
1/4 in. = 6.35 mm.

⚠ CAUTION

Disconnect battery cables at battery before removing power trim wires from solenoids.

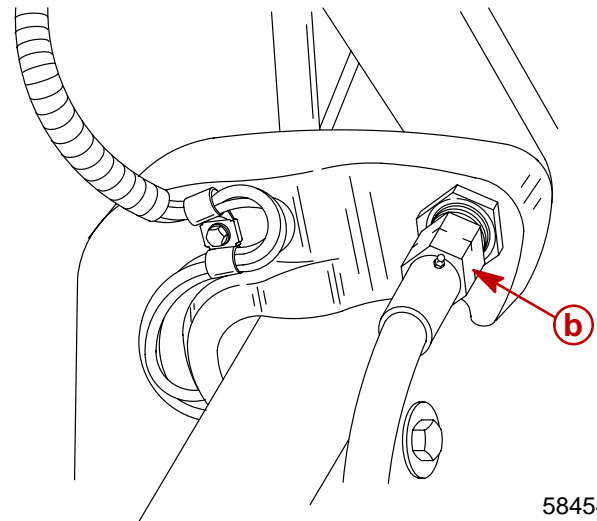
4. Disconnect (BLUE and GREEN) bullet connector harness.
5. Open filler cap and release any remaining pressure in the system.

IMPORTANT: Outboards equipped with through-the-tilt-tube steering - remove steering link arm from end of steering cable and cable retaining nut from tilt tube.



58444

a - Filler Cap
b - Retaining Nut



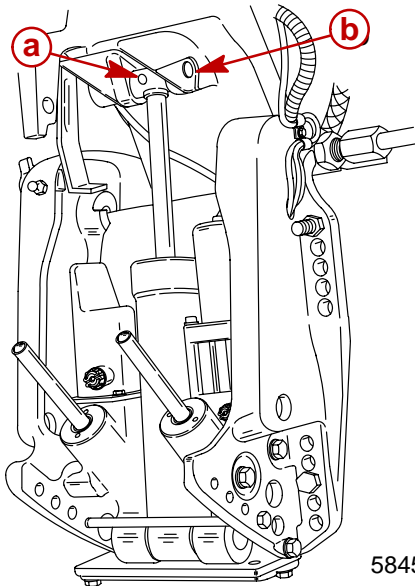
58454



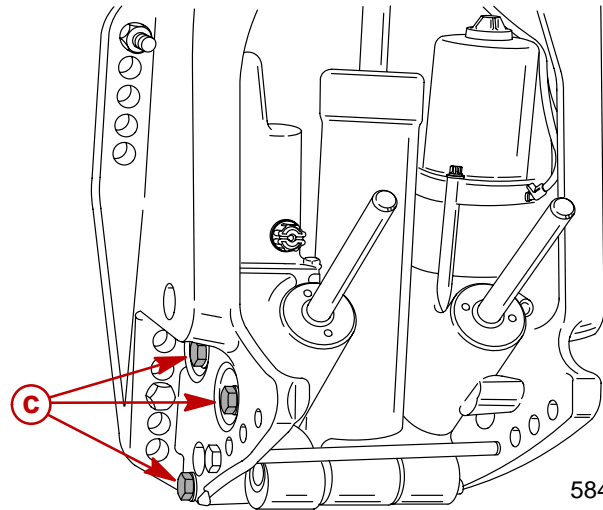
IMPORTANT: Cross pin should not be reused. Replace with new cross pin.

NOTE: 6 trim mounting bolts should not be reused. Replace with new patch lock bolts.

6. Drive out cross pin, push out upper swivel pin, and remove 3 bolts and washers in port clamp bracket.



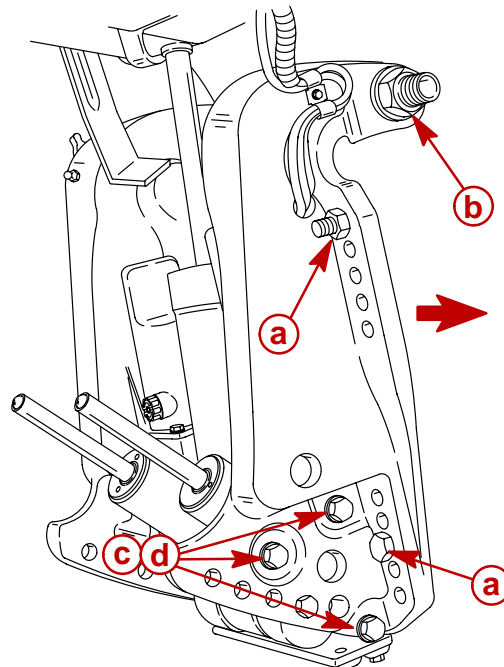
58452



58444

- a** - Cross Pin
- b** - Upper Swivel Pin
- c** - Port Transom Bracket Bolts and Washers (3). Remove to release Trim System from Outboard.

7. Remove 3 bolts and washers and in starboard transom bracket.



58453

- a** - Transom Mount Bolts (2)
- b** - Tilt Tube Nut (flush with end of thread)
- c** - Screws (3)
- d** - Washers (3)

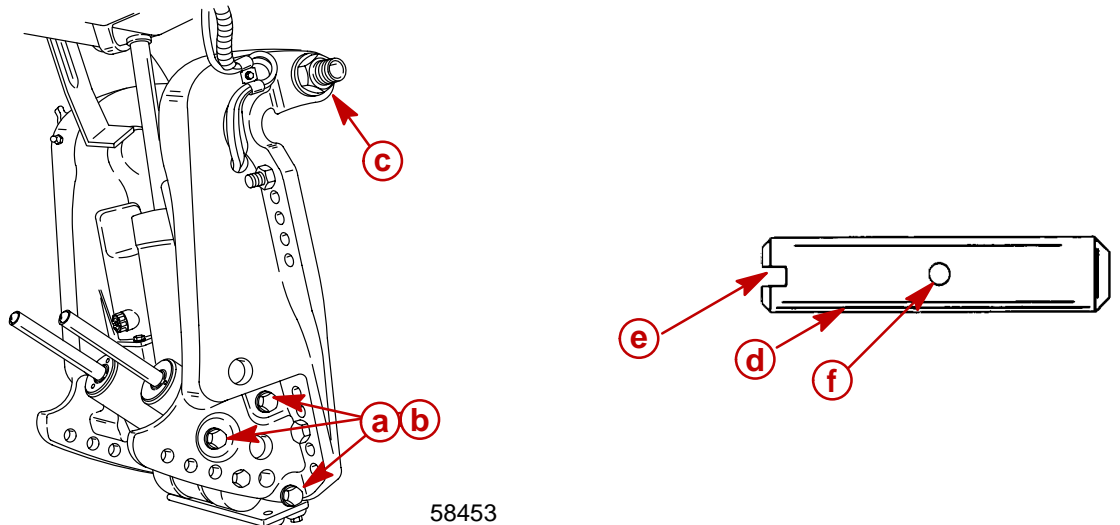
8. Remove outboard transom mounting bolts and loosen tilt tube nut until nut is flush with end of tilt tube thread. Remove system from outboard.



Installation

NOTE: Upper swivel pin bushings in swivel bracket should be inspected for wear and replaced as required. The trim rod shoes in the swivel bracket should also be replaced.

1. Paint any exposed metal surfaces to prevent corrosion.
2. Install trim system, starboard transom bracket, and tilt tube nut.
3. Use a 12 volt power source to extend tilt ram up to align upper swivel shaft hole and end of ram. Connect trim motor wires [BLUE wire to POSITIVE (+), GREEN wire to NEGATIVE (-)]. If ram extends too far, retract ram by connecting GREEN wire to POSITIVE (+) and BLUE wire to NEGATIVE (-).
4. Install Upper Swivel Pin with slotted end to left (port) side of engine.

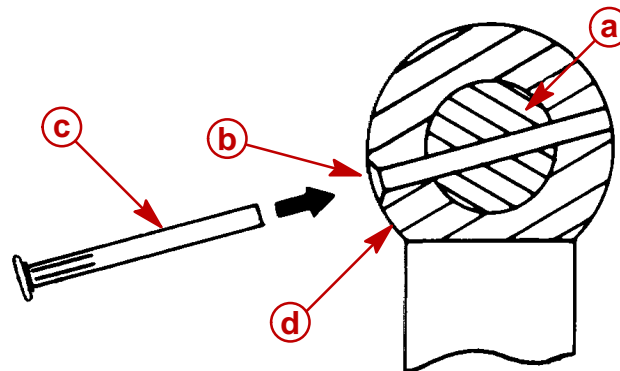


58453

- a** - Screw (6) Torque to 45 lb. ft. (61.0 N·m)
- b** - Flat washer (6) Install one per screw
- c** - Tilt Tube Nut
- d** - Upper Swivel Pin
- e** - Slotted end
- f** - Cross hole (in line with slotted end)

IMPORTANT: Cross pin should not be reused. Install a new pin.

5. Position slot on end of swivel shaft in line with hole in tilt ram end. Insert a punch into tilt ram hole to align cross hole in upper swivel shaft. Tap new cross pin in until flush.

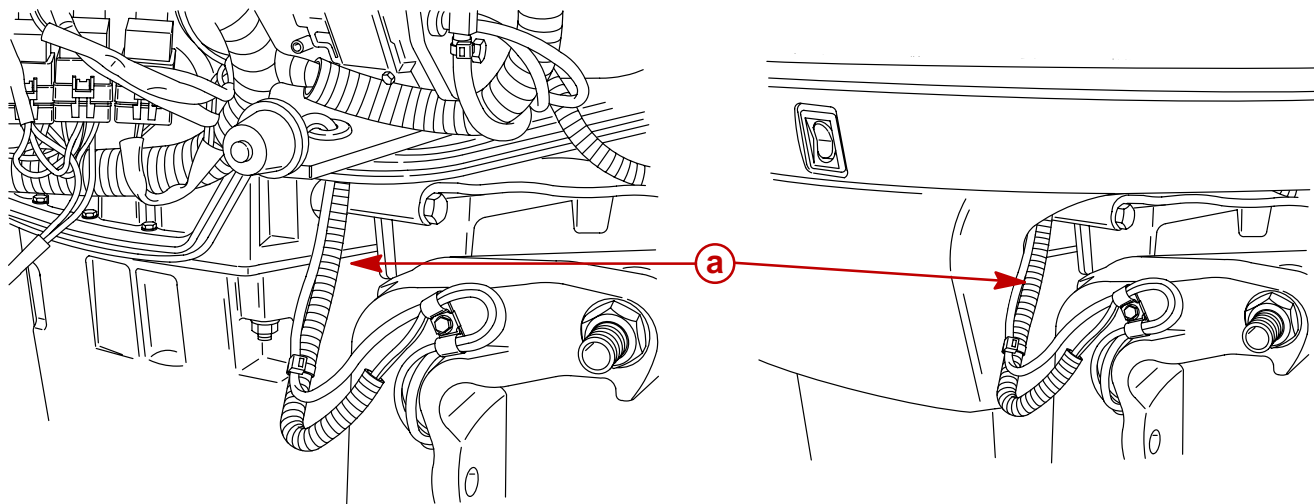


- a** - Upper Swivel Shaft (Slot is in line with cross hole)
- b** - Chamfered End of Hole (Faces away from transom)
- c** - Retaining Pin
- d** - Tilt Ram End



- Connect trim motor wires to relays. Refer to Wiring Diagrams in this manual. Route trim wires as specified in this manual.

NOTE: The 2 power leads going to the trim motor should be encapsulated with conduit tubing.



a - Conduit Tubing

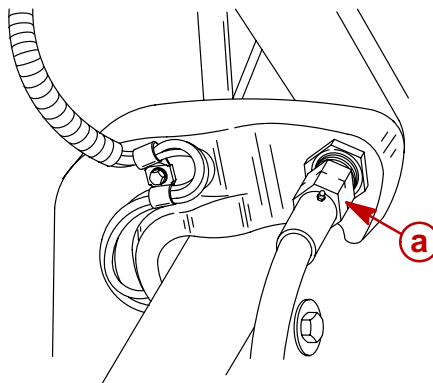
- Apply marine sealer to shanks of mount bolts and install transom mount bolts.

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.

- Tighten tilt tube nut securely.

IMPORTANT: Outboards equipped with through-the-tilt-tube steering: Tighten steering cable retaining nut securely to tilt tube.



a - Steering Cable Retaining Nut

58454

⚠ 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.

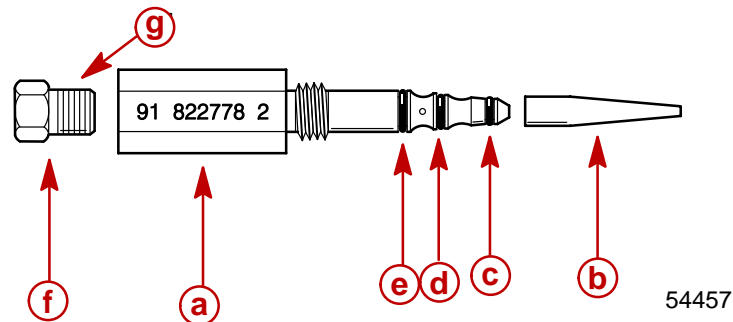
“UP” Pressure Check

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.

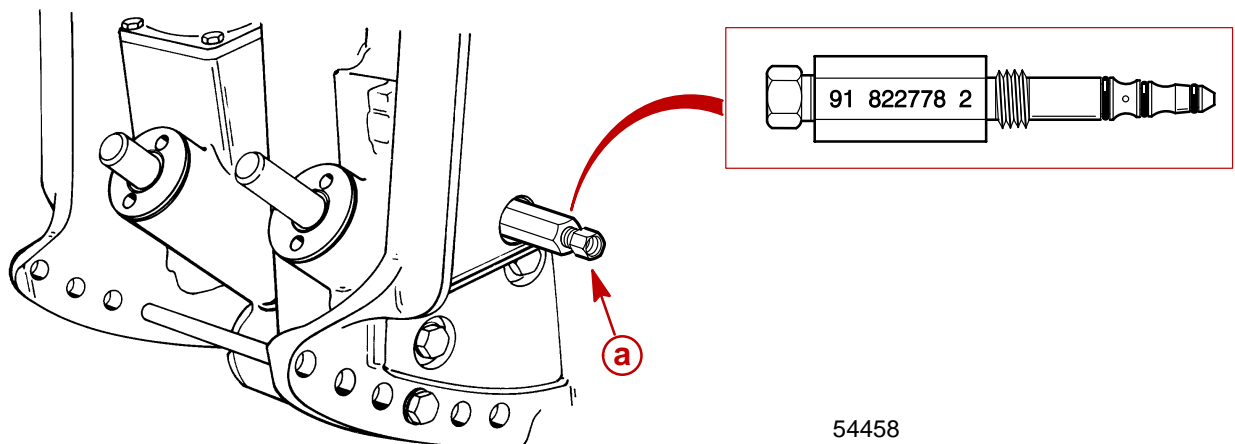
NOTE: A small amount of trim fluid may drip from manual release valve hole. Place a suitable container under trim assembly to collect any leakage.

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

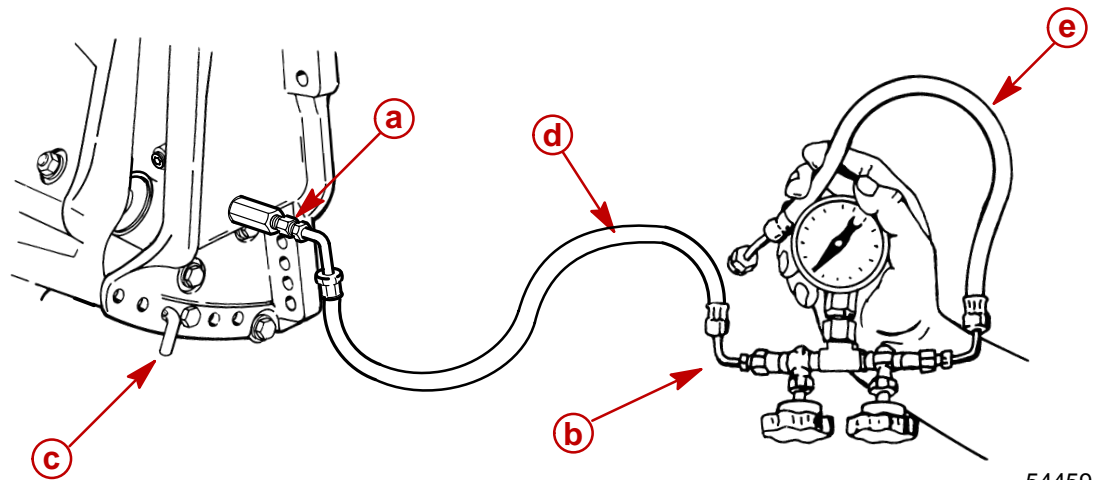
4. Install Test Adaptor 91-822778A2 into manual release valve hole.



- a** - Test Adaptor (91-822778A2)



5. Thread hose from Test Gauge Kit (91-52915A6) into brass fitting on adaptor.



54459

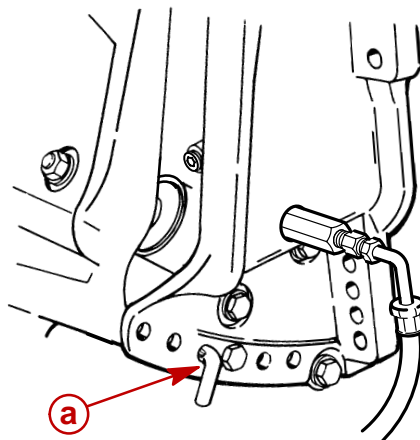
- a** - Brass Fitting
- b** - Test Gauge Assembly
- c** - Tilt Pin (Position in Hole Shown)
- d** - Hose
- e** - Hose (Not Used)

6. Reinstall fill plug.
7. Run trim "UP".
8. Disengage tilt lock lever.

**⚠ CAUTION**

Failure to install spare tilt pin (or hardened bolts and nuts) in hole shown could result in transom bracket failure and possible injury.

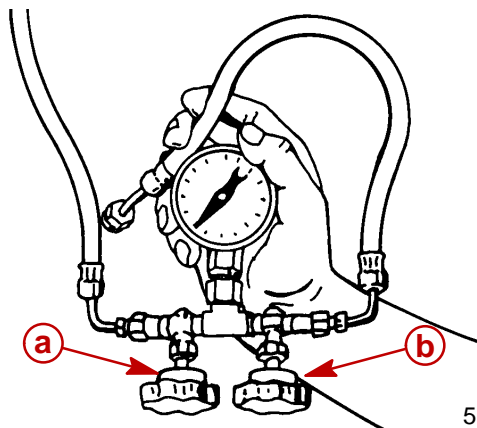
9. Move outboard "IN" until hole in swivel bracket "ear" aligns with the 3rd tilt hole in transom bracket. Lock engine in trim range by installing a 3/8 in. (9.5 mm) diameter tilt pin or two 3/8 in. (9.5 mm) hardened bolts and nuts thru the transom brackets and swivel bracket in the hole shown.



54460

a - Tilt Pin Hole (Install Spare Tilt Pin or Hardened Bolts and Nuts)

10. Open valve (a) and close valve (b).



51374

11. Run trim "UP". The minimum pressure should be 2000 P.S.I. (140.6 kg/cm²).
12. Run trim "DOWN" to release pressure and remove spare tilt pin or bolts and nuts.
13. Tilt outboard full "UP" and engage tilt lock lever.
14. Slowly remove "Fill" plug to bleed pressure.
15. Remove test gauge hose and adapter.
16. Reinstall Manual Release Valve and secure valve with circlip.
17. Retighten "Fill" plug.

NOTE: If pressure is less than 2000 PSI (140.6 kg/cm²), troubleshoot system per instructions on page 5B-22.



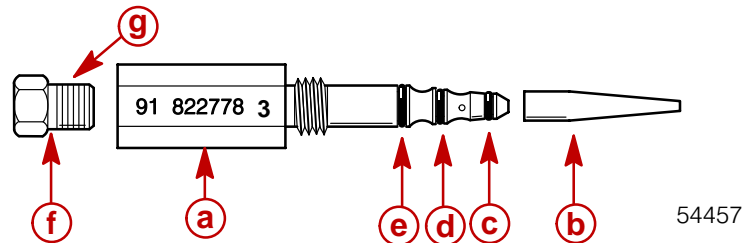
“DOWN” Pressure Check

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.

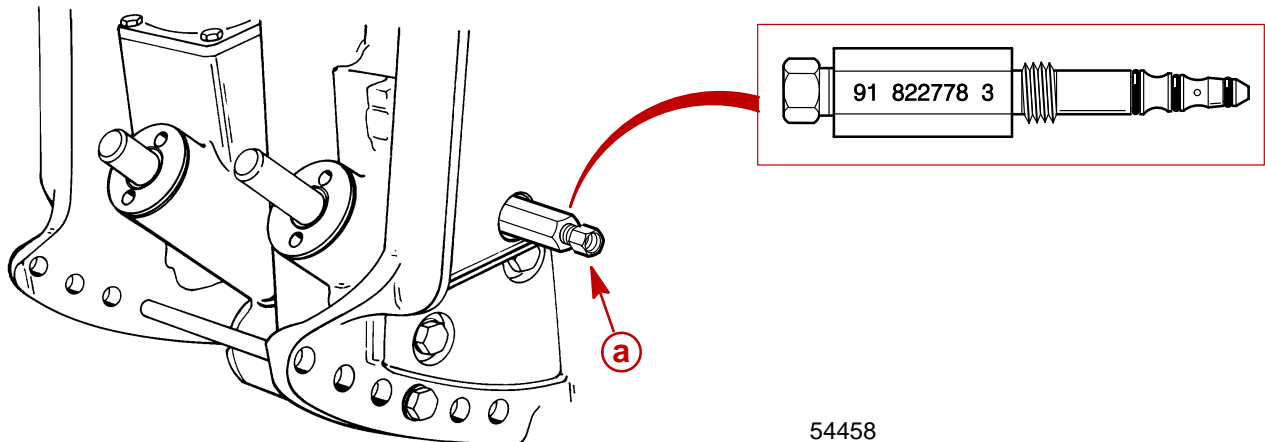
NOTE: A small amount of trim fluid may drip from manual release valve hole. Place a suitable container under trim assembly to collect any leakage.

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.



- 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

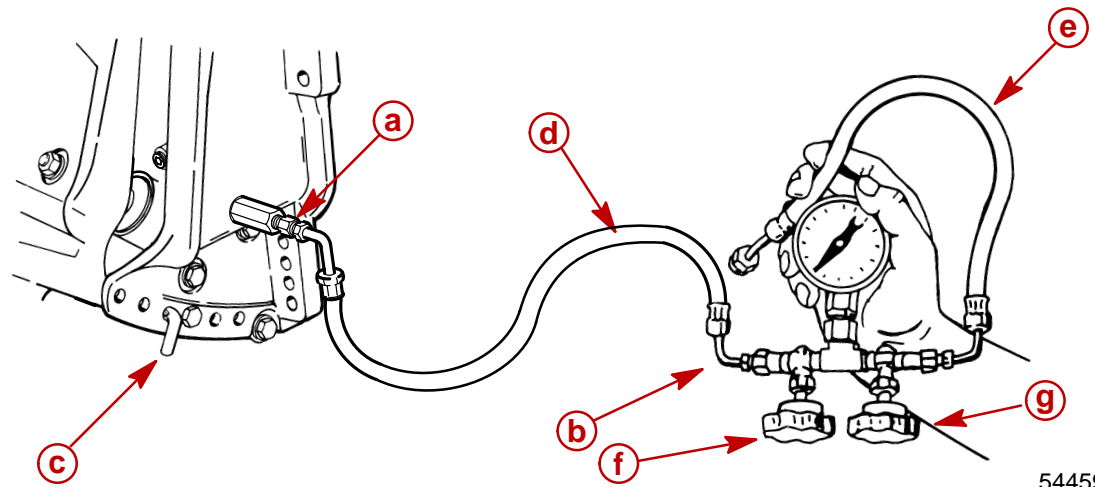
4. Install test adaptor 91-822778A3 into manual release valve hole.



- a** - Test Adaptor (91-822778A3)



5. Thread hose from Test Gauge Kit (91-52915A6) into brass fitting on adaptor.



- a - Brass Fitting
- b - Test Gauge Assembly
- c - Tilt Pin (Position in Hole Shown)
- d - Hose
- e - Hose (Not Used)
- f - OPEN Valve
- g - CLOSE Valve

6. Reinstall fill plug.
7. Run trim "UP".
8. Disengage tilt lock lever.
9. Open valve (f) and close valve (g).
10. Run trim "DOWN". Minimum pressure should be 600 P.S.I. (42 kg/cm²).
11. Tilt outboard full "UP" and engage tilt lock lever.
12. Slowly remove "Fill" plug to bleed pressure.
13. Remove test gauge hose and adaptor.
14. Reinstall manual release valve and secure valve with circlip.
15. Retighten "Fill" plug.

NOTE: If pressure is less than 600 PSI (42 kg/cm²), troubleshoot system per instructions on Page 5B-22.



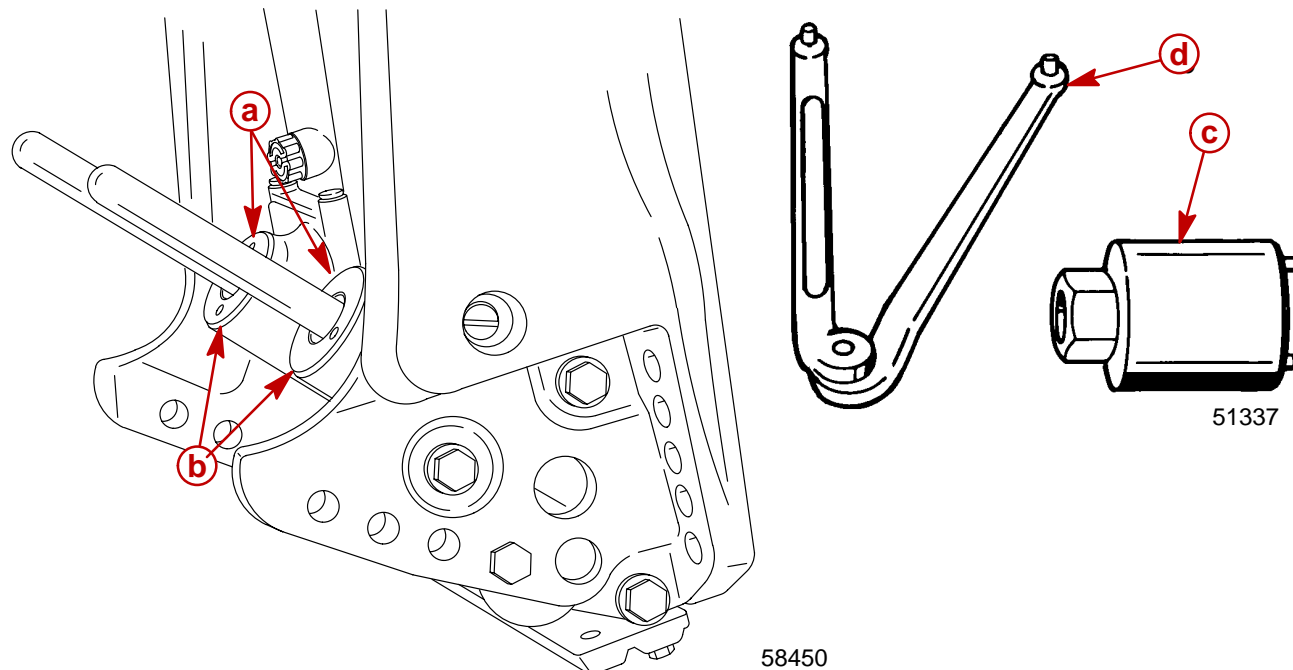
Hydraulic Repair

TRIM ROD REMOVAL AND REPAIR

NOTE: Power Trim does not have to be removed from outboard to remove trim rods.

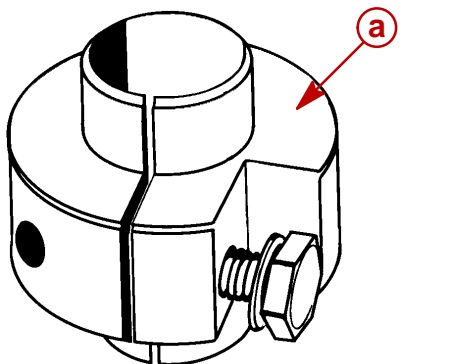
1. Tilt outboard to full "UP" position and engage tilt lock lever.
2. Slowly remove "Fill" plug to bleed reservoir pressure.
3. Turn Manual Release Valve 3 to 4 turns (counterclockwise) to bleed remaining pressure.
4. Remove trim rod cylinder caps.

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

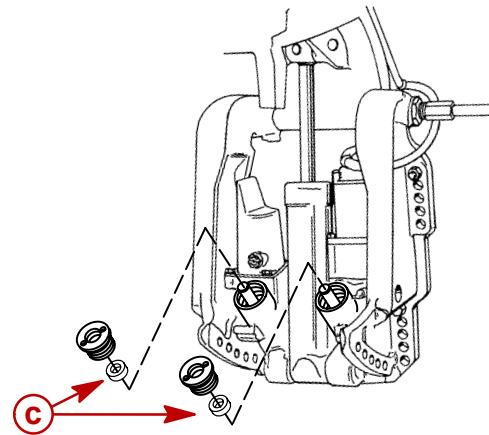
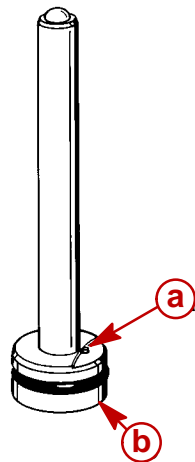
CAUTION

Do not remove check valve. Check valve is preset to operate at a specific pressure. Removal and installation of check valve could result in improper operating pressure and possible system damage.

NOTE: Check valve is in port side trim rod only.

NOTE: Certain models may have trim limit reducers installed on the trim rod to limit trim out angle. Each reducer limits the amount of total trim by 2°. A maximum of 5 reducers may be installed on each trim rod.

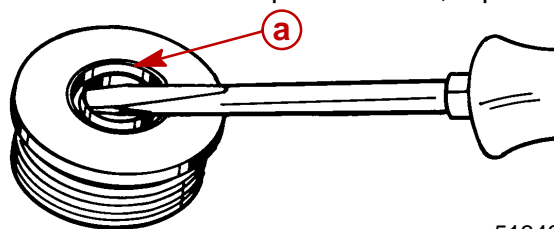
1. Inspect check valve and check valve screen for debris; if debris cannot be removed, replace trim rod assembly. Clean trim rod with parts cleaner and dry with compressed air.



- a - Check Valve
- b - Check Valve Screen
- c - Trim Limit Reducers

Trim Rod End Cap Seal

1. Inspect trim cap end seal and replace if damaged or if seal does not keep trim rod clean.
2. Inspect trim cap internal o-ring and replace if damaged or worn.
3. Inspect inner surface of the cap and if worn, replace trim cap.



- a - Seal (remove as shown)

4. Install new seal with seal lip up.

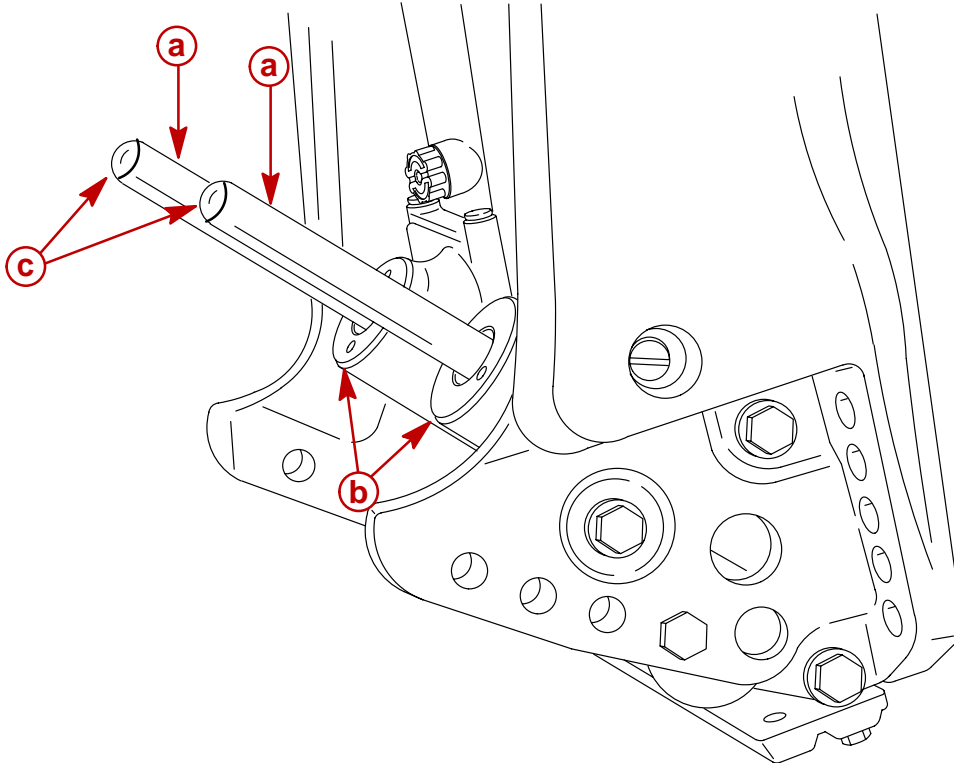


TRIM ROD INSTALLATION

IMPORTANT: Components must be free of dirt and lint. Any debris in the system can cause system to malfunction.

NOTE: Install trim rod with check valve in the port (left) cylinder.

1. Apply ATF Dexron III or Power Trim and Steering Fluid on all O-rings and seals before installation.
2. Install trim rods and caps. Use installation tool (91-44487A1) or spanner wrench (91-74951) to tighten caps securely – 70 lb. ft. (95 N m).



- a** - Trim Rods
- b** - Cylinder End Caps
- c** - Rod End Rollers (lubricate with Anti-Corrosion Grease or Special Lubricant 101)

58450

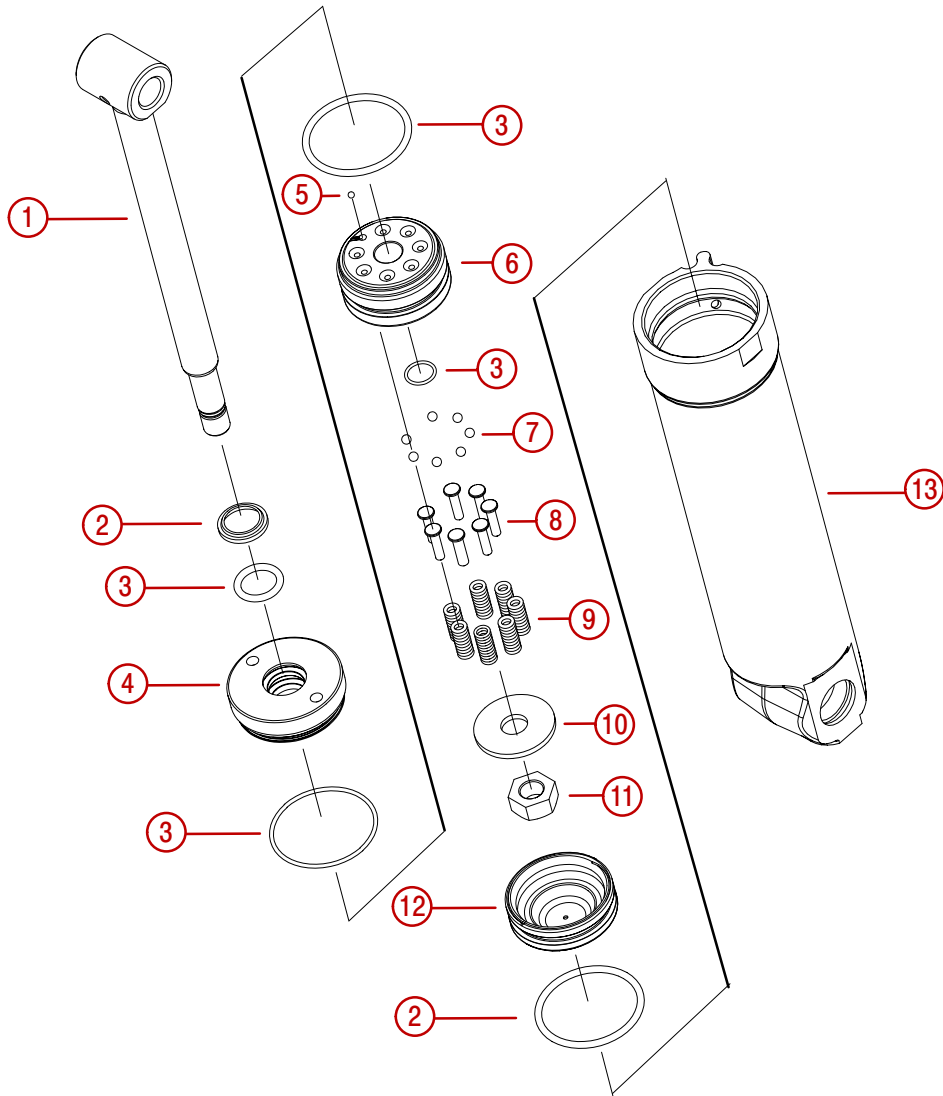


Tilt Ram

REMOVAL - TILT ROD ASSEMBLY ONLY

NOTE: Tilt Rod Assembly can be removed from cylinder without removing entire power trim system from outboard.

TILT RAM COMPONENTS



- 1 - Tilt Cylinder Rod
- 2 - Scraper Seal
- 3 - O-ring*
- 4 - Cylinder Cap
- 5 - Return Ball
- 6 - Shock Piston
- 7 - Shock Balls
- 8 - Spring Keepers – (1 is RED)

- 9 - Shock Springs – (1 is RED for low speed trail over)
- 10 - Washer
- 11 - Nut
- 12 - Memory Piston
- 13 - Housing

*O-ring Repair Kit Available, 811607A1 (Includes item 2, Scraper Seal)

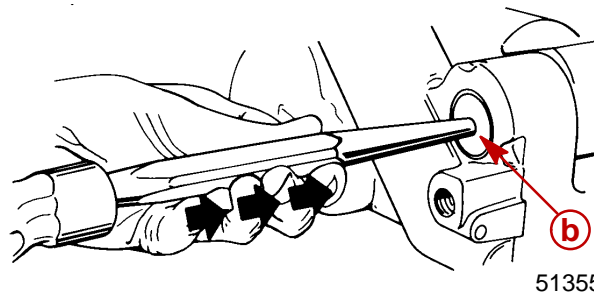
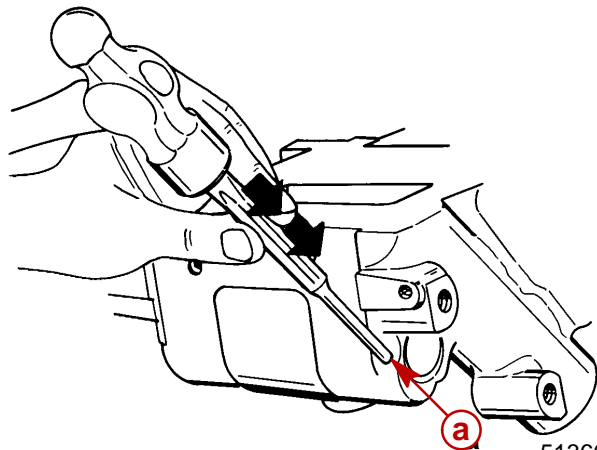


TILT RAM REMOVAL - POWER TRIM SYSTEM REMOVED FROM OUTBOARD

⚠ CAUTION

Insure trim system is depressurized prior to tilt ram removal.

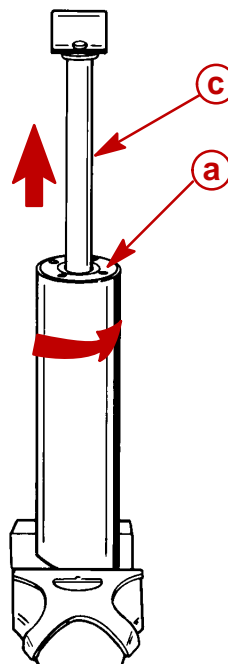
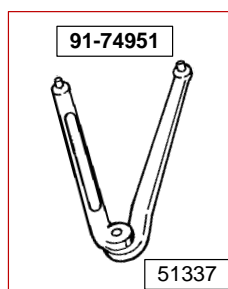
1. Remove cross pin.
2. Remove lower swivel pin.



- a** - Cross Pin (Remove as shown)
- b** - Lower Swivel Pin (Remove as shown)

Disassembly

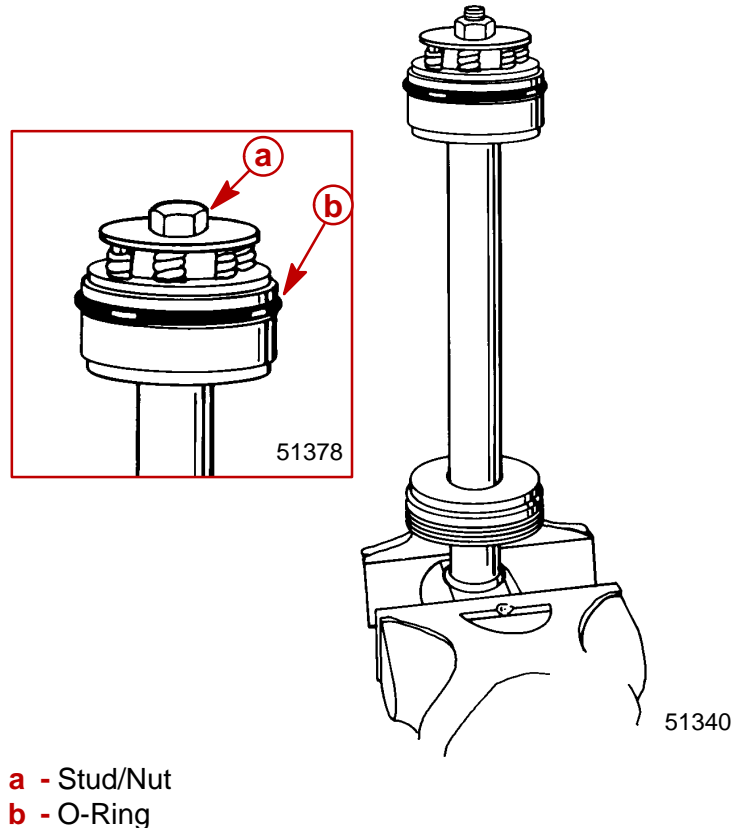
1. Secure tilt ram in a soft jawed vise. Remove tilt rod and cap.



- a** - Cap (Turn Counterclockwise to Remove)
- b** - Spanner Wrench (91-74951)
- c** - Tilt Rod - Pull to Remove



2. Clamp tilt rod in a soft jawed vise. Remove bolt or nut as applicable to disassemble rod assembly. Remove O-ring.

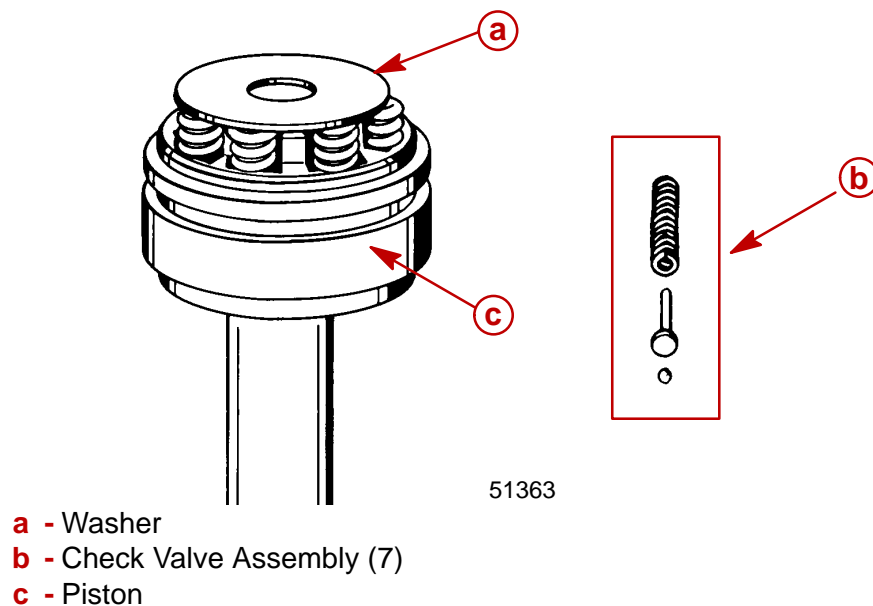


IMPORTANT: Design 1 tilt rod assembly can be used to replace a Design 2 tilt rod assembly. Design 1 or Design 2 cylinder assemblies (complete) can be used as replacements.

Design 2 will NOT fit a cylinder originally using a Design 1 tilt rod assembly. Memory Pistons for Design 1 and 2 differ also and must be used only on the cylinder the piston was removed from.

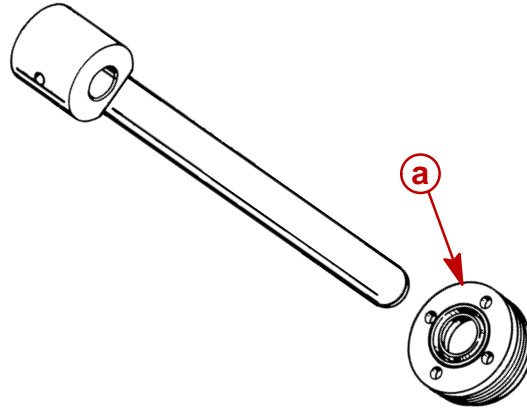
3. Remove washer, check valve assemblies, and piston.

NOTE: Check valve held in by roll pin can be cleaned but not removed.





- Remove end cap from tilt rod.

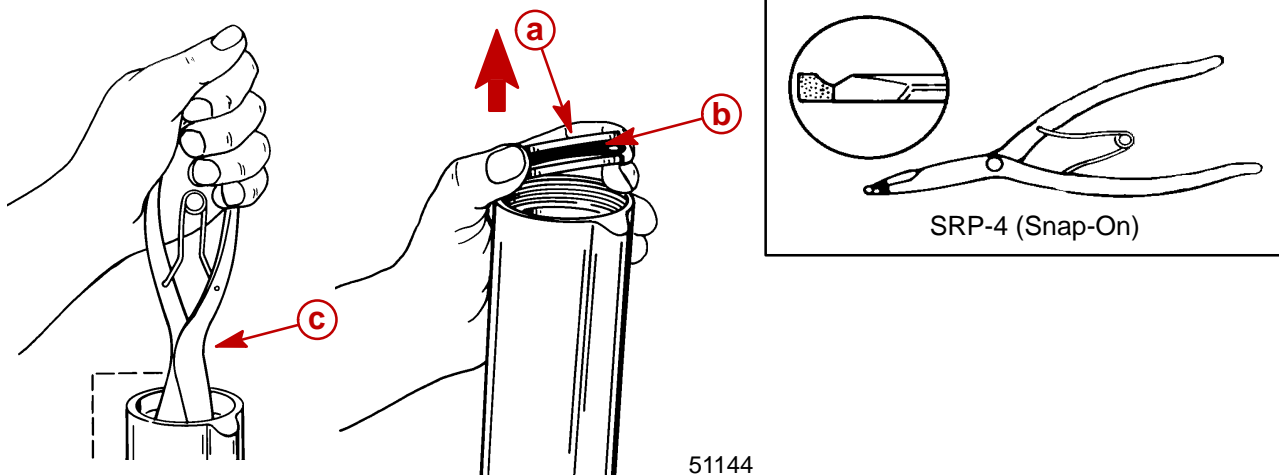


a - End Cap

51376

Memory Piston Removal

- Remove memory piston from cylinder using Snap-On lock ring pliers SRP-4 or similar tool.
- Remove o-ring from memory piston.



a - Memory Piston
b - O-Ring
c - Snap-On Pliers SRP-4

51144



Cleaning/Inspection/Repair

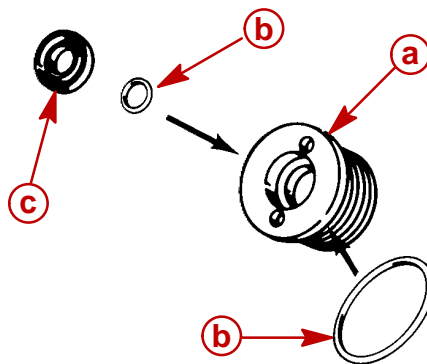
1. Inspect all internal parts for damage or wear. Clean and replace parts as necessary.
2. Inspect tilt rod for scratches. Replace scraper seal in rod end cap if tilt rod is scratched or worn.
3. Slight scratches or tool marks less than 0.005 in. (0.1 mm) deep in cylinder are acceptable.

IMPORTANT: Components must be dirt and lint free. Slightest amount of debris in Power Trim system could cause system to malfunction.

4. Clean shock rod and components with parts cleaner and dry with compressed air.
5. It is recommended that all O-rings in trim system be replaced.
6. Lubricate all O-rings with Power Trim Fluid. If not available, use automotive (ATF) automatic transmission fluid.

Scraper Seal Replacement

1. Remove components from end cap.



- a - Cap
- b - O-ring (2)
- c - Scraper Seal

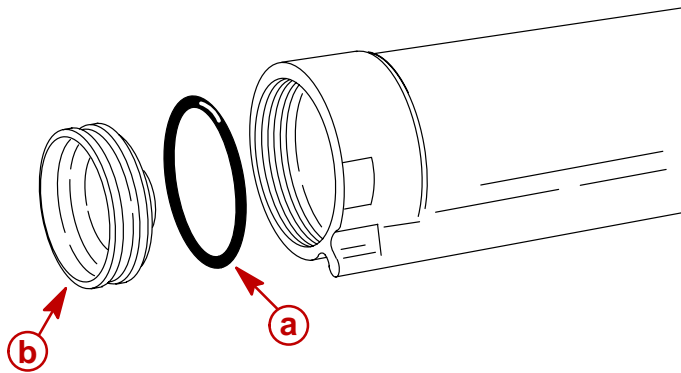


REASSEMBLY

IMPORTANT: Components must be clean for reassembly. Any debris in the system can cause the system to malfunction.

NOTE: Refer to "Tilt Ram Components" for proper O-ring sizes.

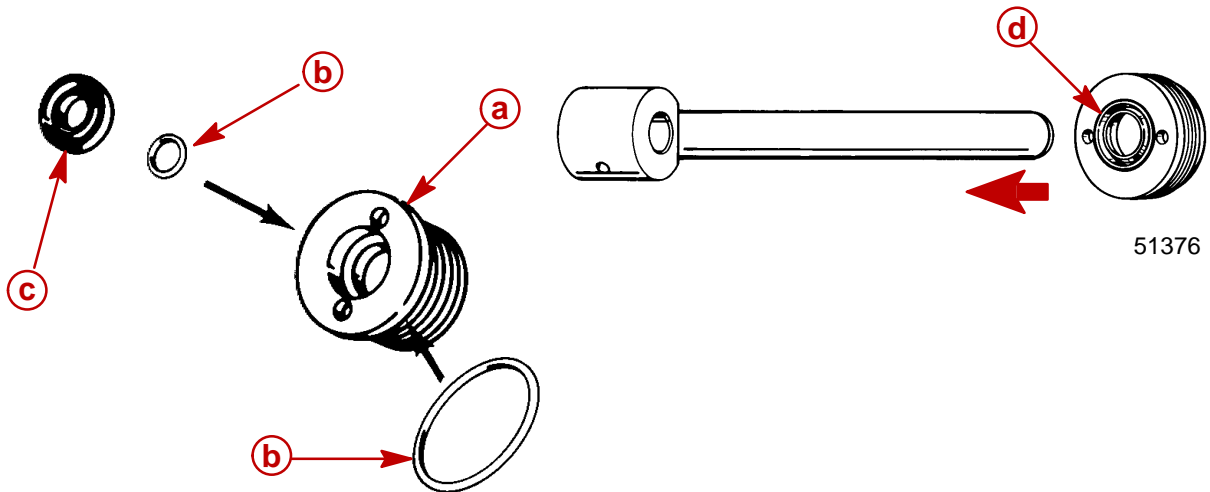
1. Apply ATF Dexron III or Power Trim and Steering Fluid on O-rings prior to reassembly.
2. Install O-ring on Memory Piston Cup and install in cylinder.
3. Inspect and replace as required 3 O-rings in the bottom of the tilt cylinder.
4. Inspect and replace as required 3 pivot pin O-rings in the manifold.



58462

- a** - O-ring
- b** - Memory Piston Cup

5. Assemble end cap.
6. Install end cap.

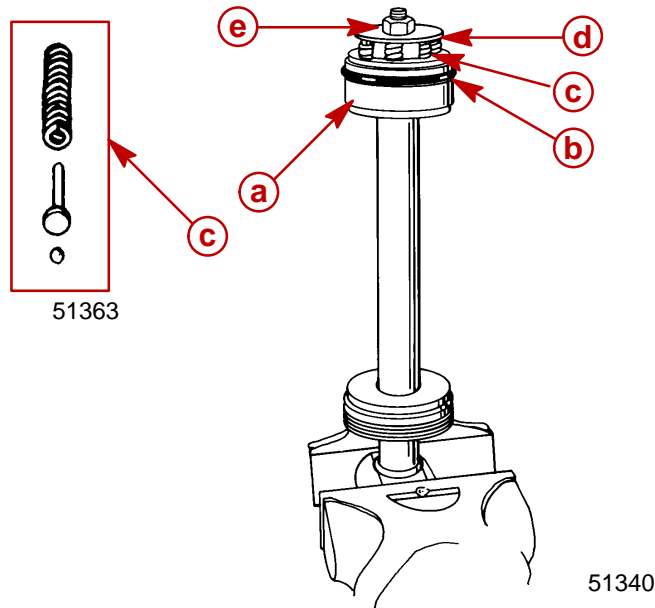


51376

- a** - End Cap
- b** - O-ring (2)
- c** - Scraper seal
- d** - End Cap

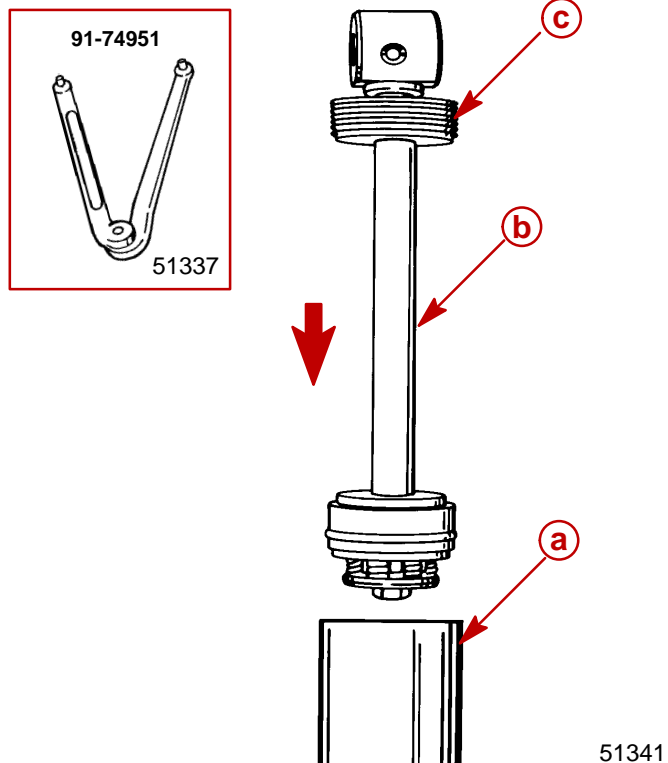


7. Install components on rod.



- a** - Piston
- b** - O-ring
- c** - Check Valve Assembly (7)
- d** - Washer
- e** - Locknut [Torque to 95 lb. ft. (129 N m)]

8. Clamp cylinder in a soft jawed vise and install tilt rod assembly. Use spanner wrench and tighten end cap securely. Torque end cap to 45 lb. ft. (61 N m).

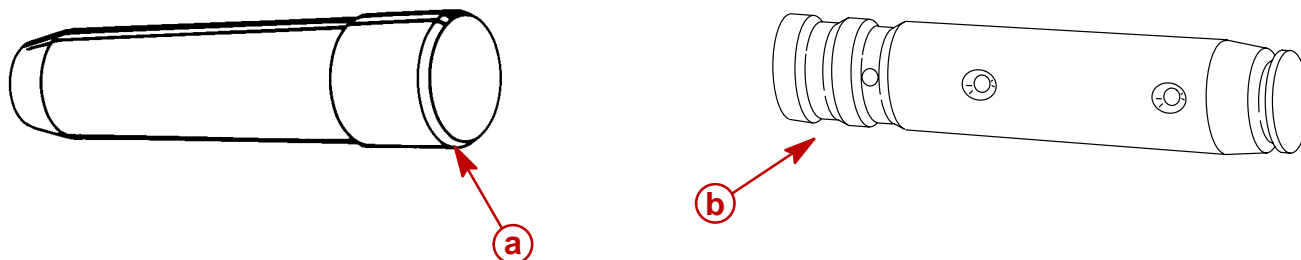


- a** - Cylinder
- b** - Tilt Rod Assembly
- c** - End Cap (Tighten Securely.) Use Spanner Wrench.



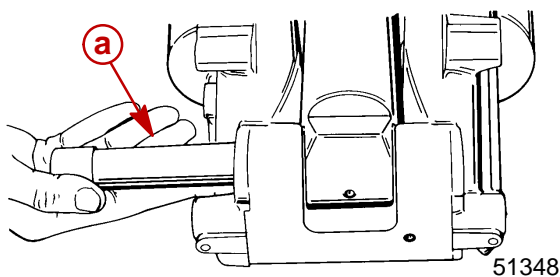
TILT RAM ASSEMBLY INSTALLATION

1. Lubricate alignment tool (91-11230) and shaft. Use ATF Dexron III or Power Trim and Steering Fluid.

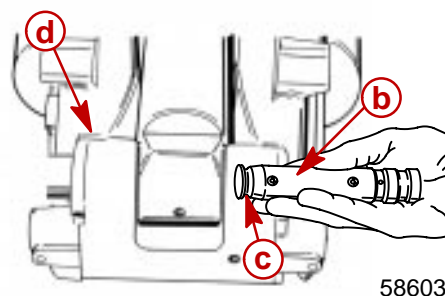


a - Alignment Tool (91-11230)
b - Shaft

2. Align tilt ram and housing using alignment tool.
3. Install shaft.

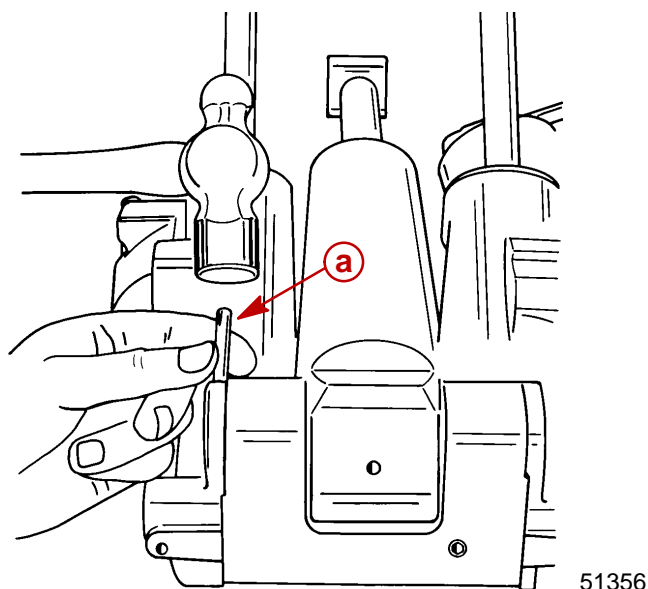


a - Alignment Tool (91-11230)
b - Shaft



c - Groove
d - Hole [Groove (c) will Align with this Hole]

4. Drive pin in until flush.



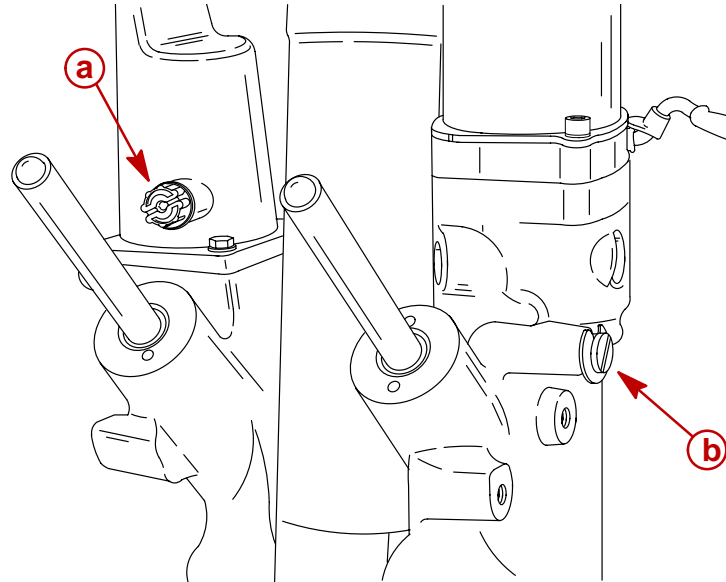
a - Pin (Drive Against Knurled End)



Power Trim Disassembly

IMPORTANT: Power trim is pressurized. Trim rams must be in the full up position (fully extended) prior to fill/drain plug or manual release valve removal.

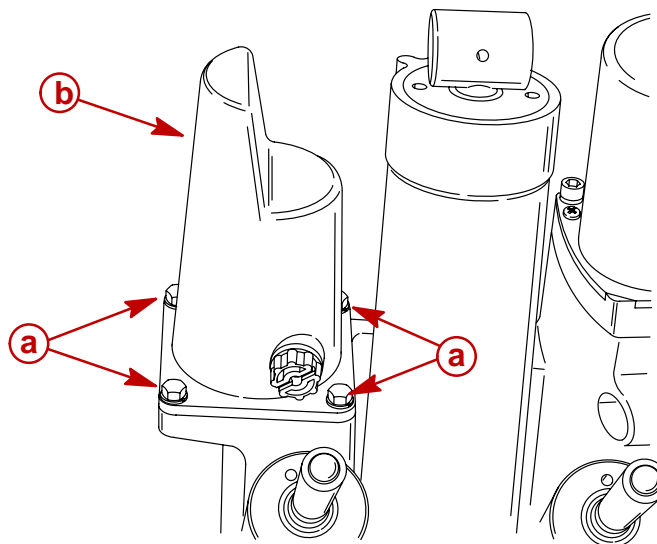
1. Remove reservoir cap to drain oil.
2. Remove manual release valve to drain any remaining oil.



58604

- a - Reservoir Cap
- b - Manual Release Valve

3. Remove 4 screws securing reservoir cover and remove cover.

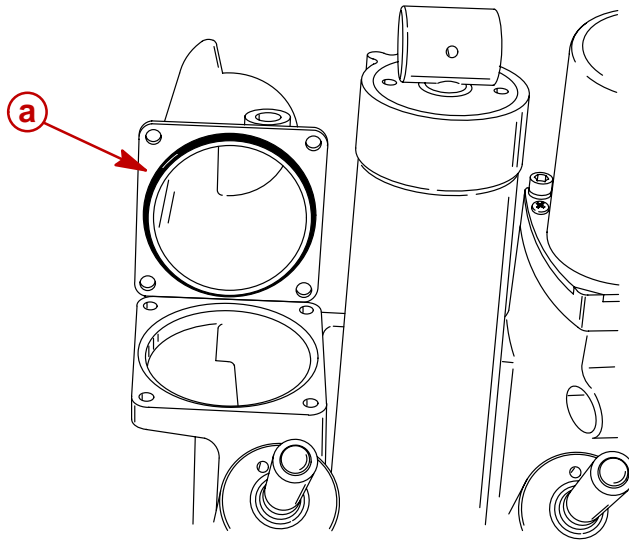


58606

- a - Screws (4)
- b - Reservoir Cover



4. Inspect reservoir cover O-ring for cuts or abrasions. Replace O-ring as required.

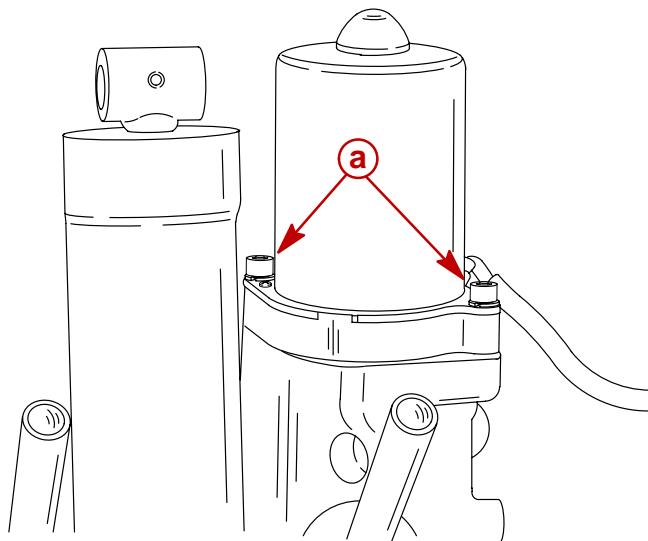


a - O-Ring

58605

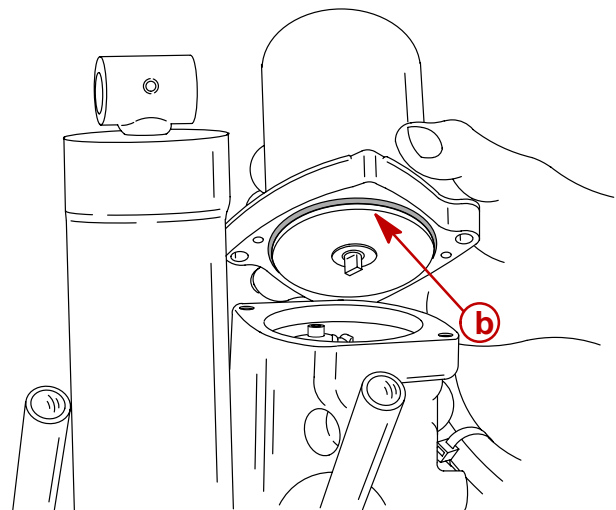
Trim Motor Removal

1. Secure power trim assembly in a soft jaw vise.
2. Remove 2 screws securing motor and remove motor. Remove motor O-ring (yellow) and coupler.
3. Inspect O-ring for cuts and abrasions. Replace O-ring as required.



58611

a - Screws and Washers
b - O-Ring (YELLOW)



58610

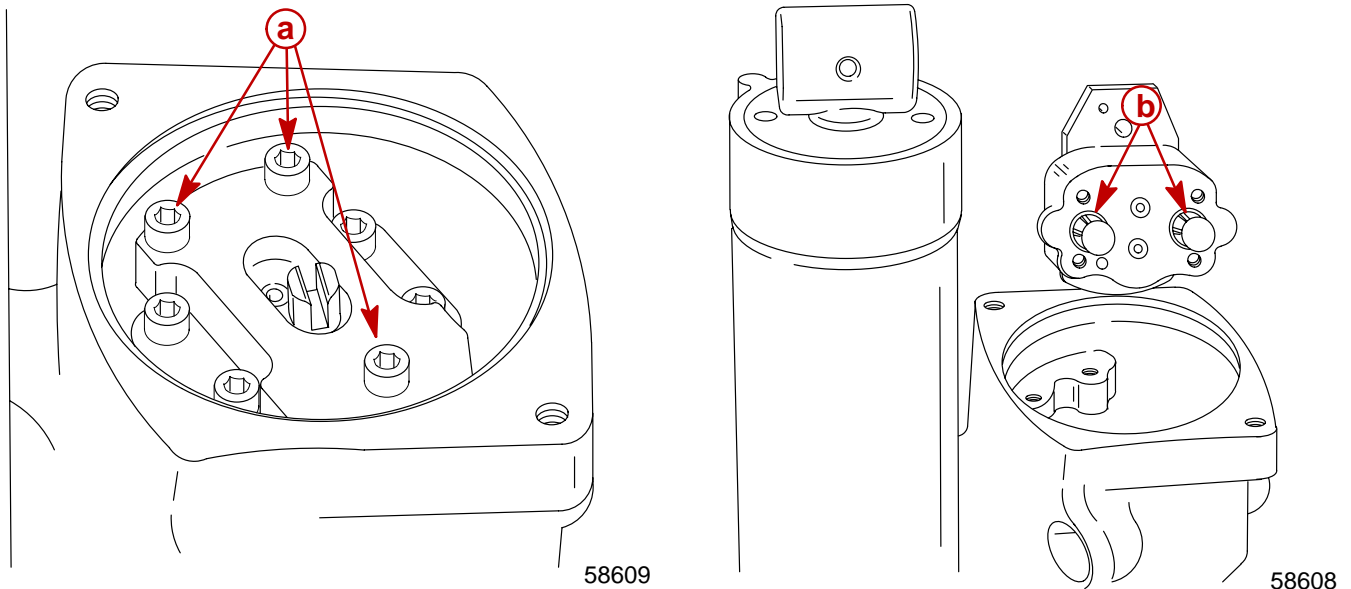


Pump and Component Removal

1. Remove 3 screws securing oil pump.

NOTE: There are no serviceable parts within the oil pump. Failure of or damage to internal components of the pump requires pump assembly replacement.

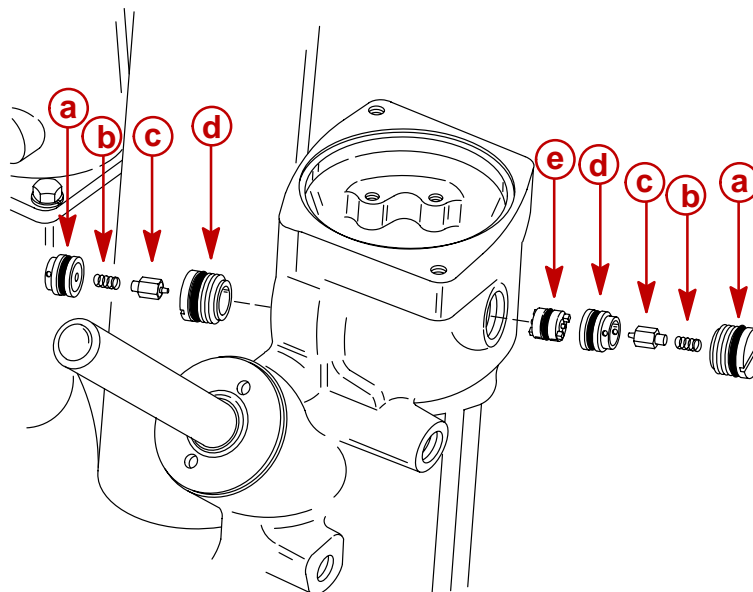
2. Inspect filter/O-ring assemblies on bottom of oil pump. Replace as required.



a - Screws

b - Filter/O-ring Assemblies

3. Remove both plugs in manifold. Remove springs, poppet/check valves and seats from both sides. Remove spool.



a - Plugs

b - Springs (2)

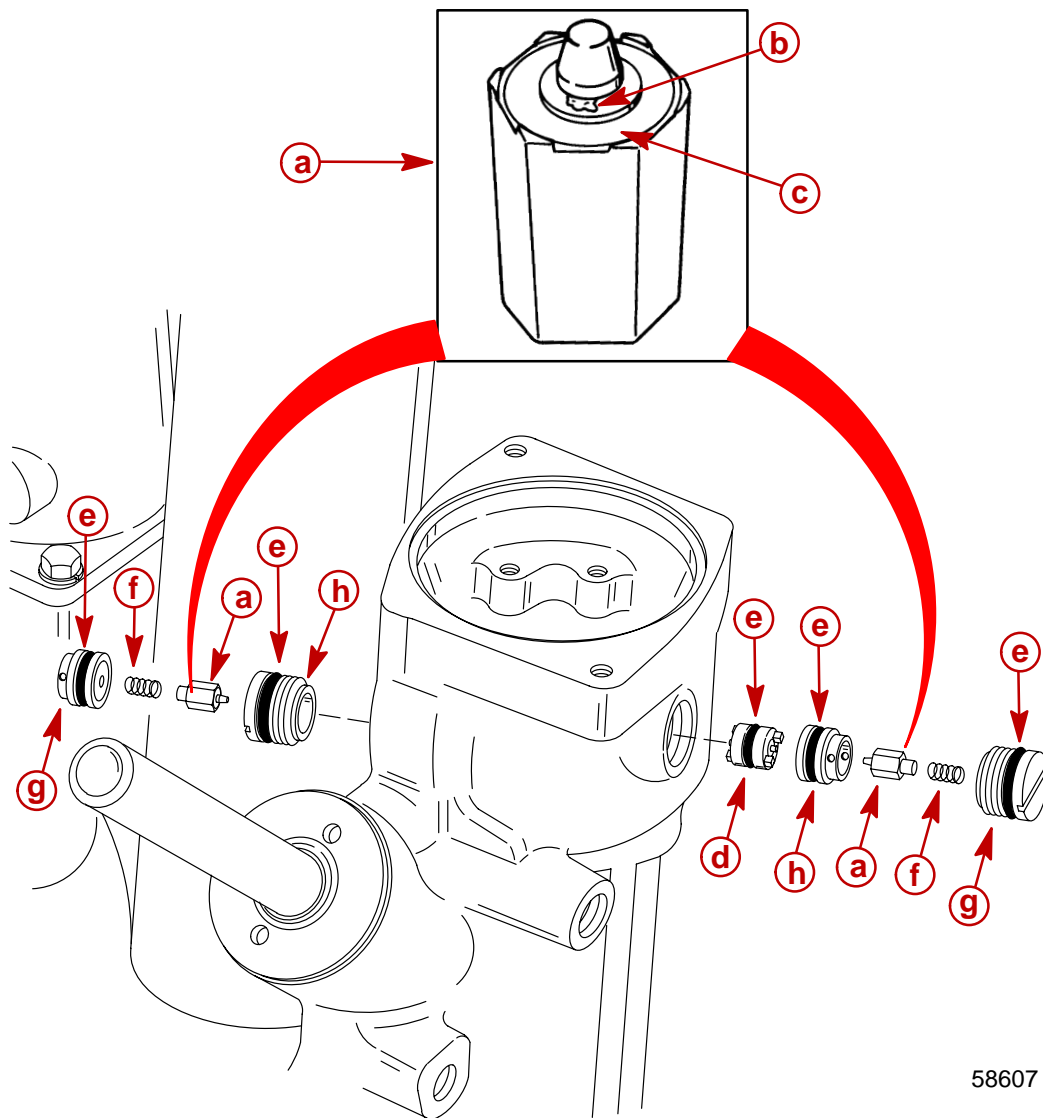
c - Poppet/Check Valves (2)

d - Seats (2)

e - Spool



IMPORTANT: Inspect poppet assembly for debris in the area shown. If debris is found on poppet, replace poppet. Inspect o-rings on both seats and spool for cuts or abrasions. Replace o-rings as required.



58607

- a** - Poppet Assembly
- b** - Debris on Rubber Seat
- c** - Neoprene Seat
- d** - Spool
- e** - O-Rings
- f** - Spring
- g** - Cap
- h** - Seat



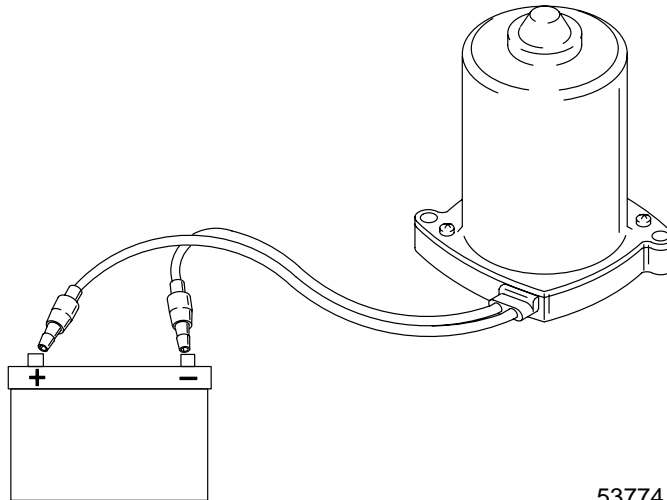
Motor and Electrical Tests/Repair

Trim Pump Motor Test

⚠ WARNING

Do not perform this test near flammable materials, as a spark may occur while making electrical connections.

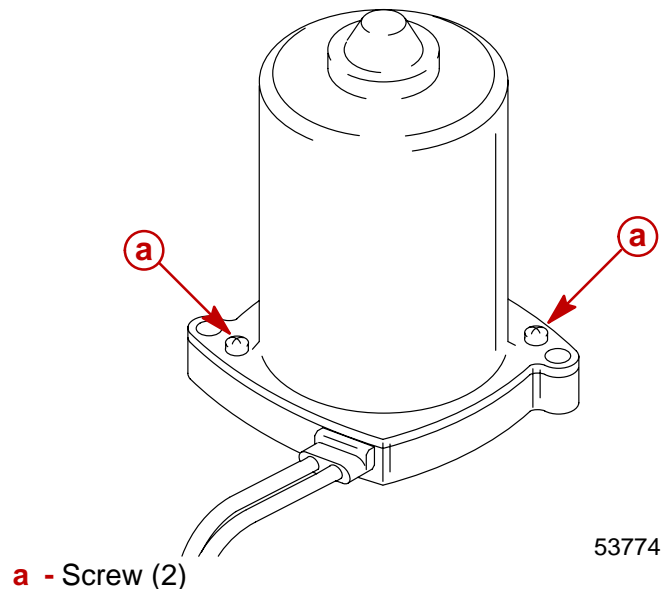
1. Connect a 12 volt power supply to motor wires; one motor lead to POSITIVE (+) battery terminal and the other motor lead to the NEGATIVE (-) battery terminal. Motor should run. Reverse motor leads between battery terminals. Motor should run.



2. If motor does not run, disassemble and check components.

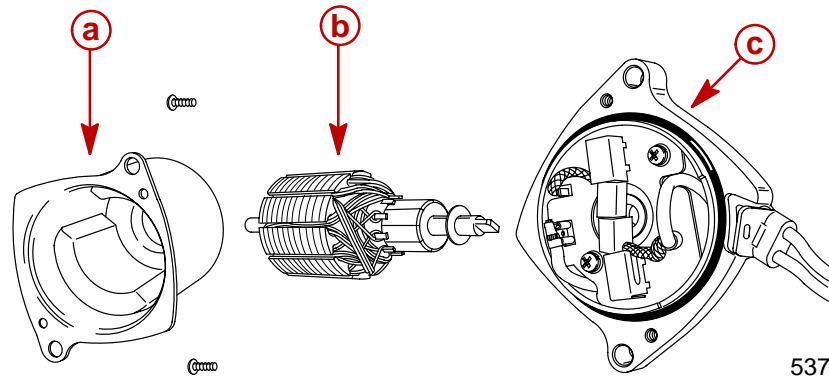
Motor Disassembly

1. Remove 2 screws.





- Remove frame and armature from end cap. Use care not to drop armature.



- a** - Can
b - Armature
c - End Cap

53779

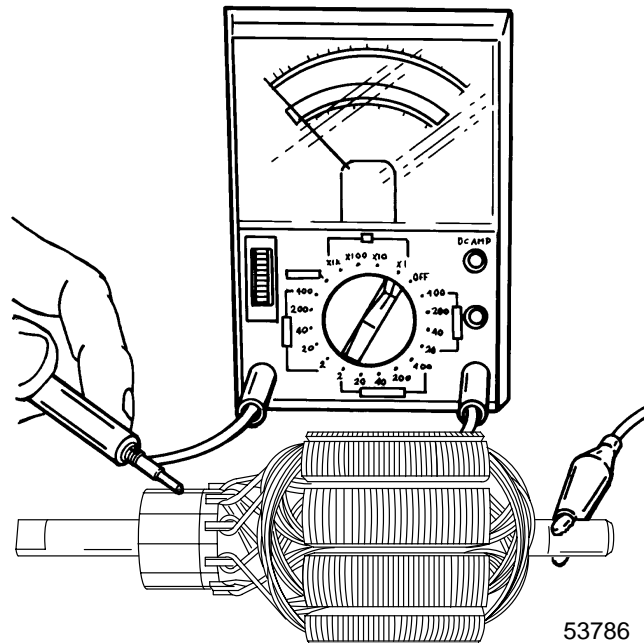
Armature Tests

TEST FOR SHORTS

Check armature on a Growler per the Growler manufacturer's instructions. Replace armature if a short is indicated.

TEST FOR GROUND

- 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.

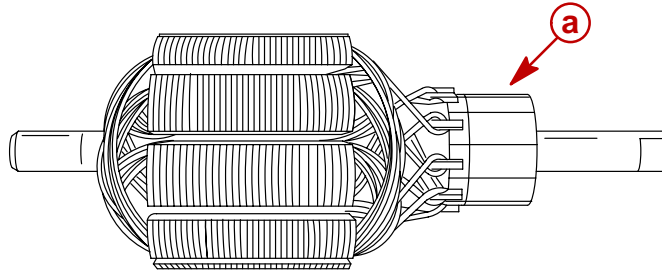


53786



CHECKING AND CLEANING COMMUTATOR

1. If commutator is worn, replace armature.



53775

a - Commutator

FIELD TESTS

IMPORTANT: Commutator end of armature must be installed in brushes when performing the following tests.

Ohmmeter Leads Between	Resistance (Ohms)	Scale Reading* (x _____)
BLUE and GREEN Motor Wires	0	(Rx1)
GREEN Motor Wire, and Frame (Motor Housing)	No Continuity	(Rx1)
BLUE Motor Wire and Frame	No Continuity	(Rx1)

*If specified readings are not obtained, check for:

- defective armature
- dirty or worn brushes
- dirty or worn commutator

If defective components are found, repair or replace component(s) and retest.

Motor Repair

REMOVAL

NOTE: Power Trim System does not have to be removed from outboard to repair/replace motor.

DISASSEMBLY

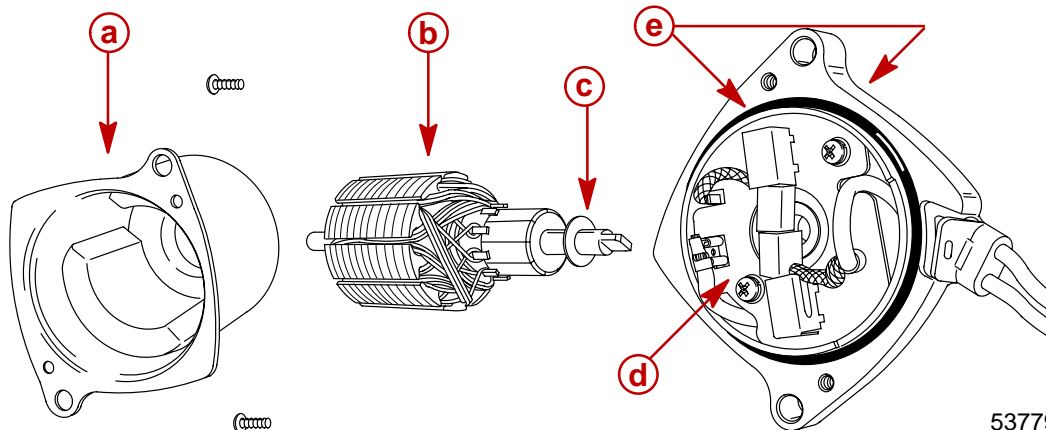
Trim outboard to the full “UP” position and engage tilt lock lever. Open reservoir plug to relieve pressure, then retighten. Use a SNAP ON [5 mm (FABLM5)] ball end allen bolt driver to remove the 2 motor mounting bolts.

Refer to “**Motor Disassembly**” on page 5B-53 to disassemble motor from pump.



CLEANING AND INSPECTION

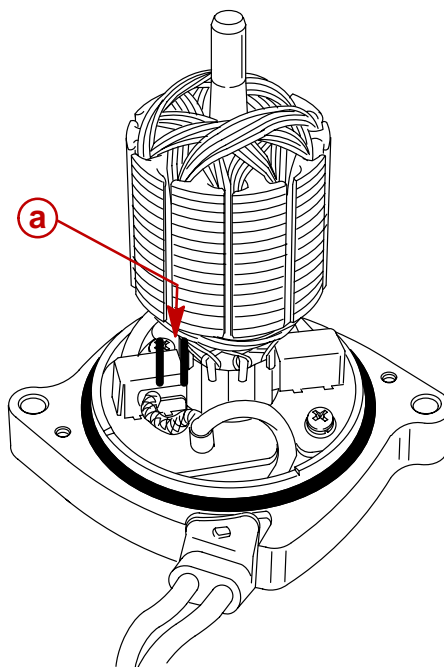
Inspect O-rings and replace if necessary. Carefully inspect power cord for cuts or tears which will allow water to enter motor. If cord is cut or torn, replace motor and power cord as an assembly. Clean, inspect, and test motor components. Refer to “**Brush Replacement**”, “**Armature Test**”, and “**Field Tests**” for inspection and test procedures.



- a** - Can
- b** - Armature
- c** - Shim
- d** - Motor End Frame Assembly
- e** - O-rings

BRUSH REPLACEMENT

If brushes are pitted, chipped, or if distance between the brush pigtail and end of brush holder slot is 1/16 in. or less, complete motor end must be replaced (brushes are not available separately). Check brush distance with armature installed.



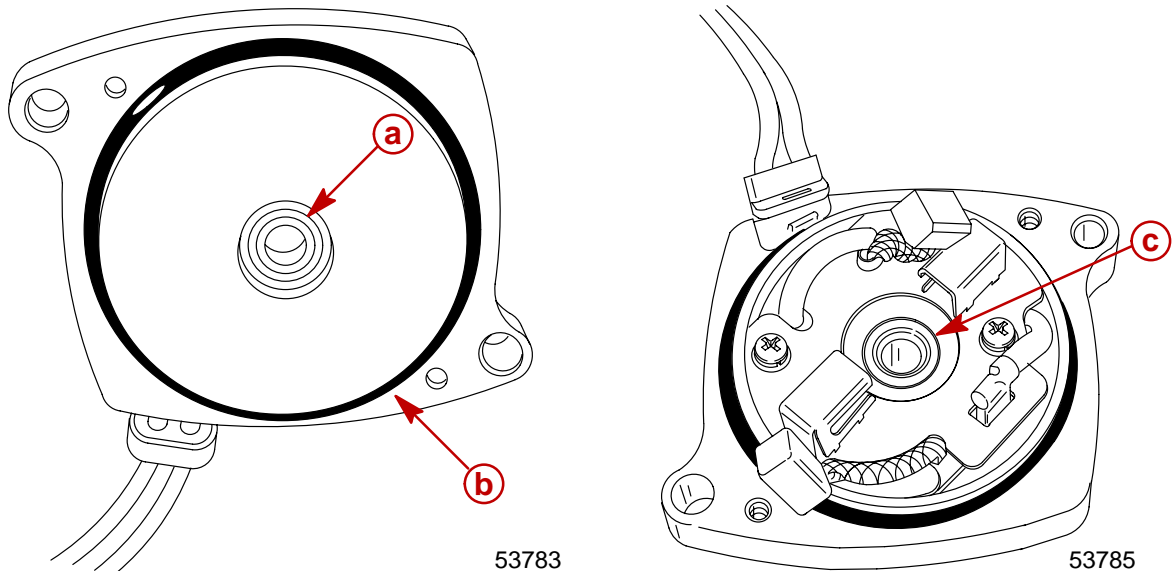
a - 1/16 in.

53784



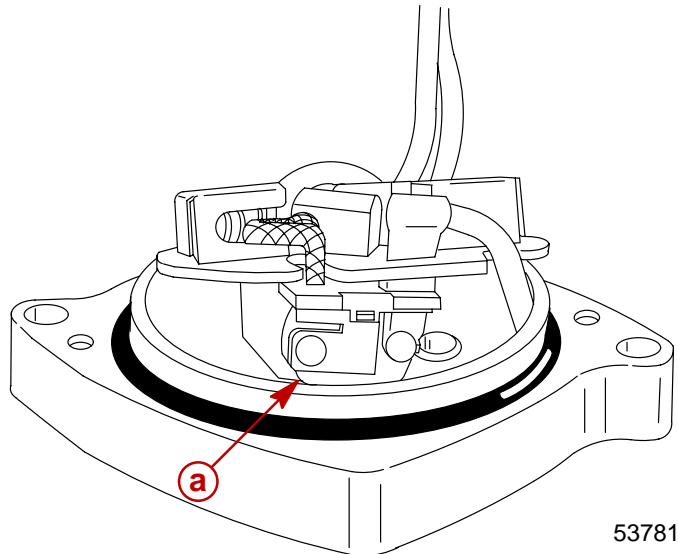
END CAP INSPECTION

1. Inspect seal and O-ring for cuts and abraisions.
2. Inspect bushing for wear. If bushing appears to be excessively worn – grooves, scratches, etc. – replace END FRAME ASSEMBLY (COMPLETE).



- a** - Seal (Apply 2-4-C Marine Lubricant with Teflon to seal lips)
- b** - O-ring
- c** - Bushing

3. If trim motor is overheated, a thermoswitch located on the brush card will open. Normally, this switch will reset itself within 1 minute.



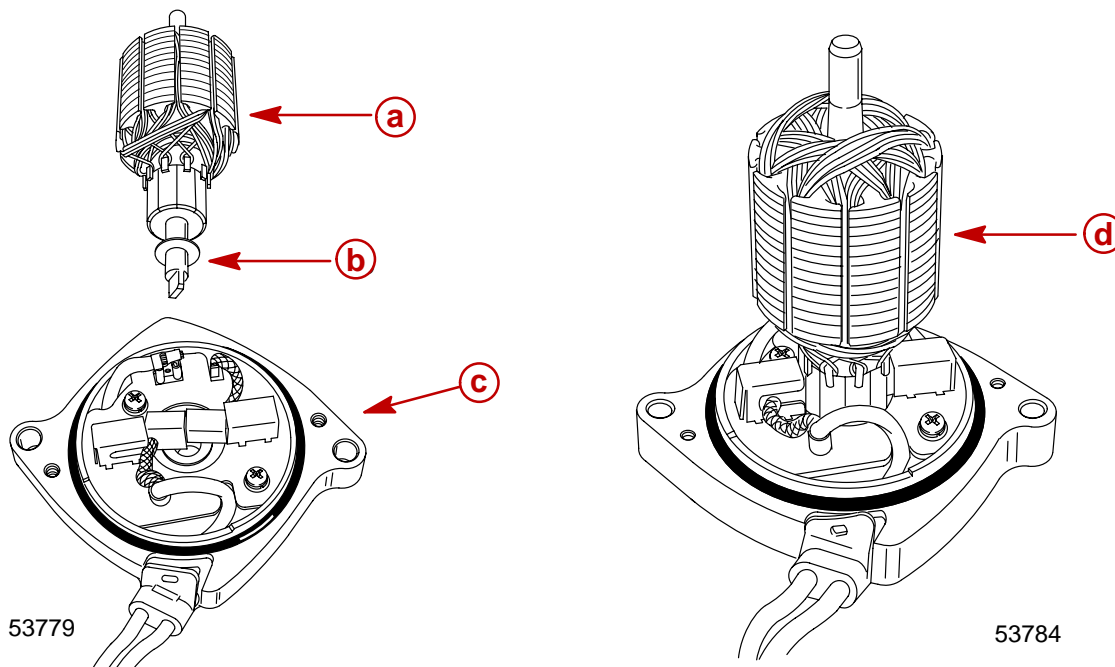
- a** - Thermoswitch



Reassembly

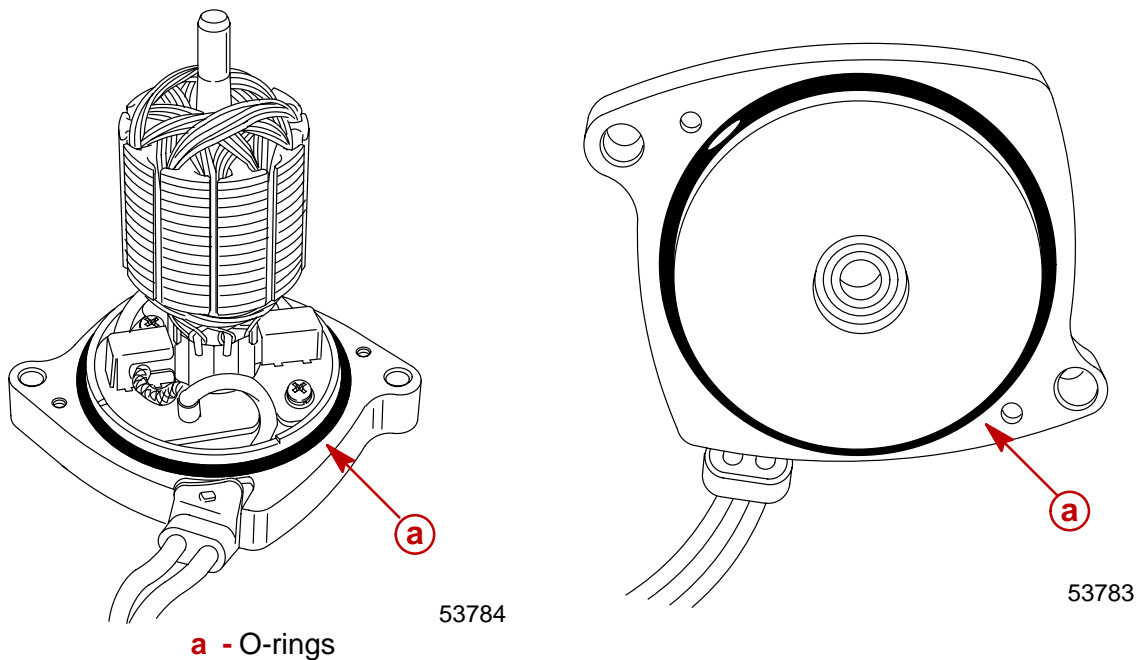
IMPORTANT: Components must be clean. Any debris in power trim system can cause system to malfunction.

1. Install armature into end cap/brush card assembly.



- a** - Armature
- b** - Shim
- c** - End Cap Assembly
- d** - Armature (Spread brushes to install armature into end cap)

2. Install O-rings in end cap.

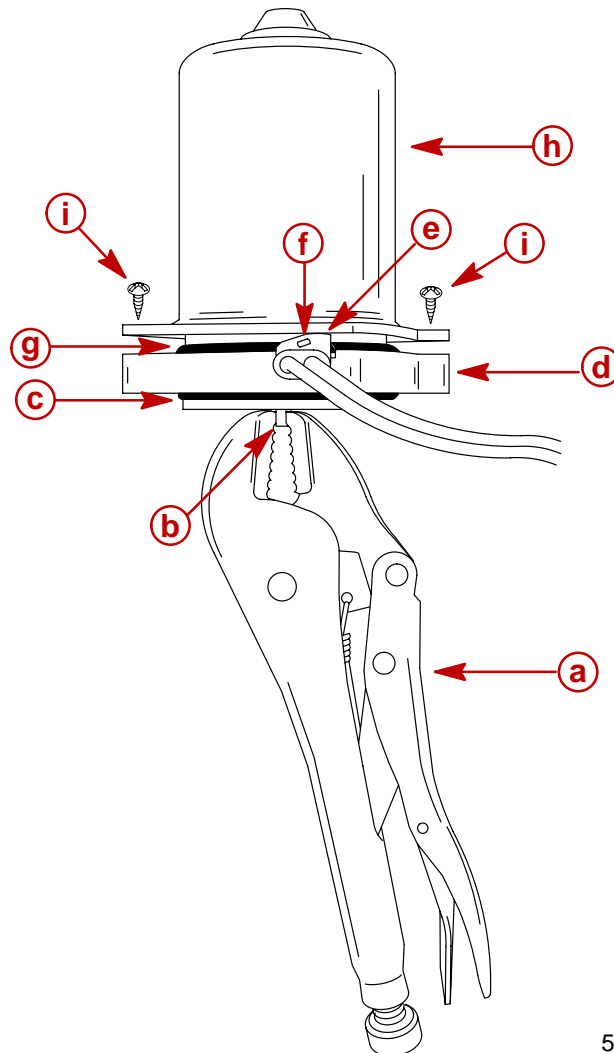


- a** - O-rings



IMPORTANT: Attach Vise Grip® pliers to armature shaft before installing frame assembly. The Vise Grip® pliers will prevent the armature from being drawn out of the brush card assembly by the frame magnets while installing the frame assembly.

3. Install Vise Grip® pliers on armature shaft.
4. Carefully install can over armature.
5. Position harness retainer hole over tab in end cap.
6. Secure frame assembly to end cap with 2 screws.



53776

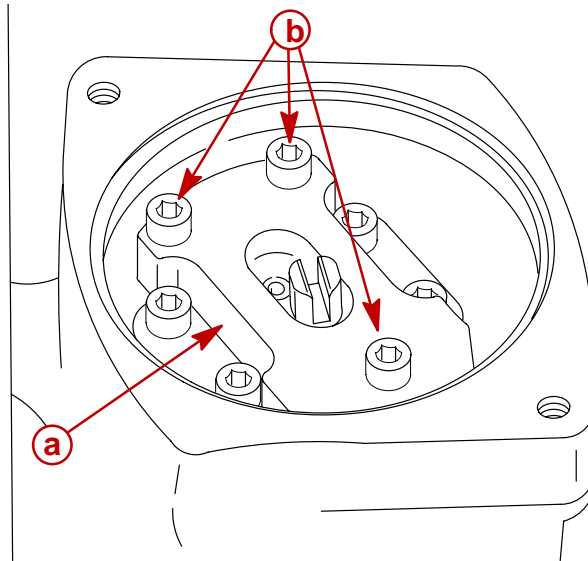
- a** - Vise Grip® Pliers
- b** - Armature Shaft
- c** - O-ring
- d** - End Cap
- e** - Harness Retainer
- f** - Retainer Hole
- g** - O-ring
- h** - Can
- i** - Screws (Drive Tight)



Reassembly - Motor and Pump

NOTE: Drive shaft is a loose part and may fall out of position.

1. Install pump into power trim manifold. Insure O-rings are in proper locations. Secure with 3 screws. Torque screws to 60 lb. in. (7 N-m).



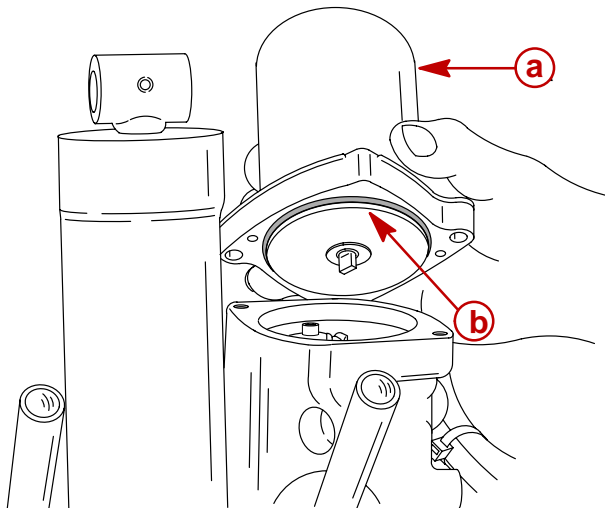
58609

- a** - Oil Pump
- b** - Screws (3) Torque to 60 lb. in. (7 N m)]

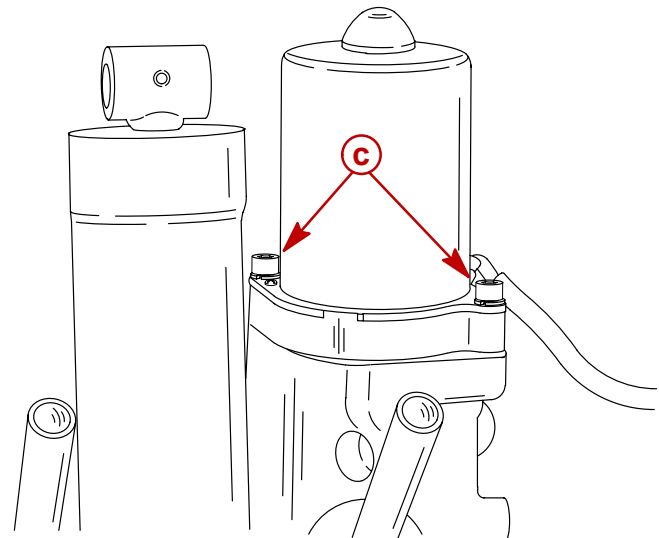
IMPORTANT: Install pump with location flat facing towards starboard transom bracket.

2. Fill pump with ATF Dexron III or Power Trim and Steering Fluid prior to installing motor.
3. Install motor, secure with 2 screws. Torque screw to 80 lb. in. (9 N m). Route wiring; refer to Wiring Diagrams in this service manual.

NOTE: Verify motor and drive shaft are aligned.



58610

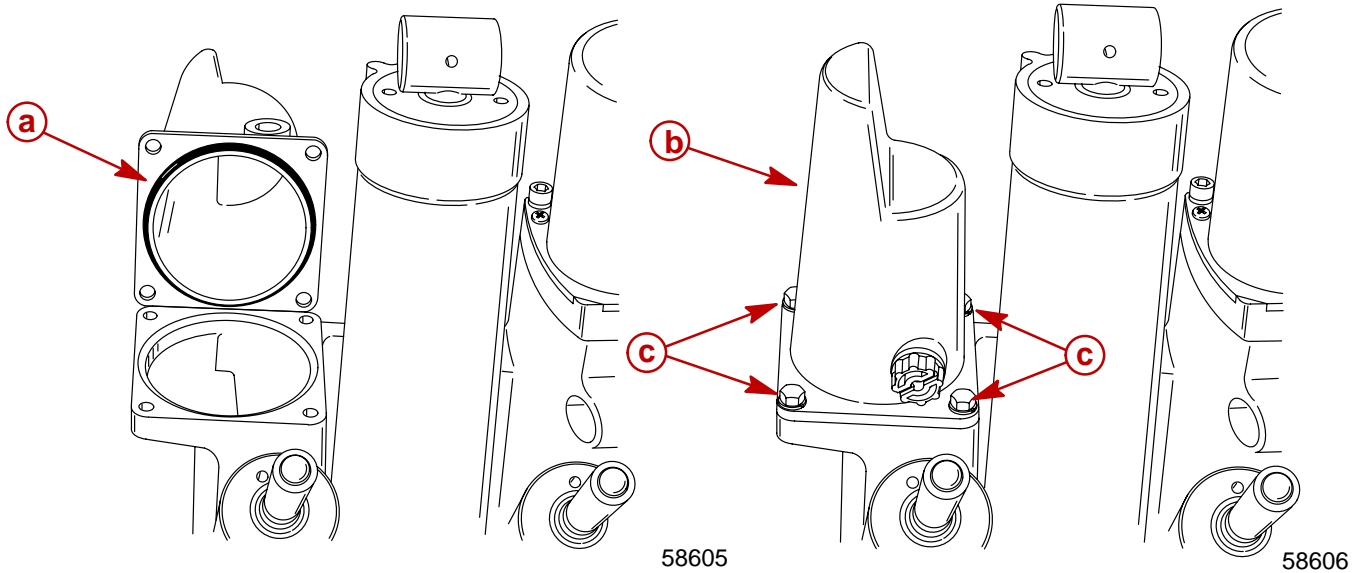


58611

- a** - Motor
- b** - O-ring
- c** - Screw (2) Torque to 80 lb. in. (9 N m).



4. Reinstall reservoir cover. Verify cover O-ring is in place and in serviceable condition. Secure cover with 4 screws. Torque screws to 60 lb. in. (7 Nm).



- a - O-Ring
- b - Reservoir Cover
- c - Screws [Torque to 60 lb. in. (7 Nm)]

5. Complete reassembly of Power Trim System as outlined in “**Installation**” on page 5B-31.



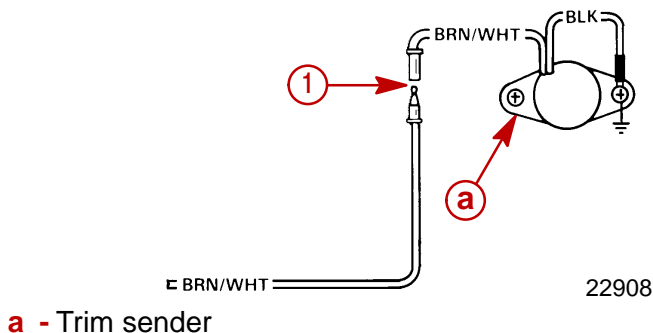
Priming Power Trim System

1. Fill system with Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) Dexron III. Refer to “**Fill, Check, and Purge**” on page 5B-10.

IMPORTANT: Run Trim System in short “jogs” until pump motor primes and trim system moves. If trim motor is run without priming pump, drive shaft failure could result.

Analog Trim Sender Test

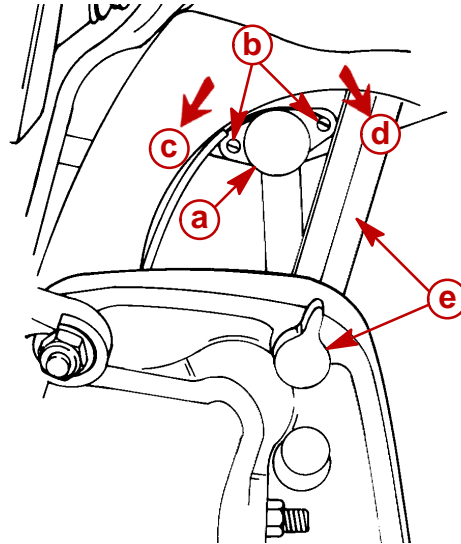
1. Check trim sender black lead for proper ground.
2. Trim outboard to full “DOWN” position.
3. Place ignition switch to “ON” position.
4. Disconnect BRN/WHT trim sender wire from trim sender harness.
5. Connect Ohmmeter (Rx1 scale) leads between outboard ground and Point 1 (trim sender end).
6. Depress “UP” button. Ohmmeter needle should move as the outboard is trimmed up. If needle does not move, trim sender is defective.





Trim Indicator Gauge Needle Adjustment

1. Turn ignition key to "RUN" position.
2. Tilt outboard to full "IN" position. Needle of trim indicator gauge should be in full "IN" position.
3. If not, tilt outboard to full "OUT" position to gain access to trim sender and engage tilt lock lever.
4. Loosen trim sender screws and reposition trim sender.
5. Tighten trim sender screws.

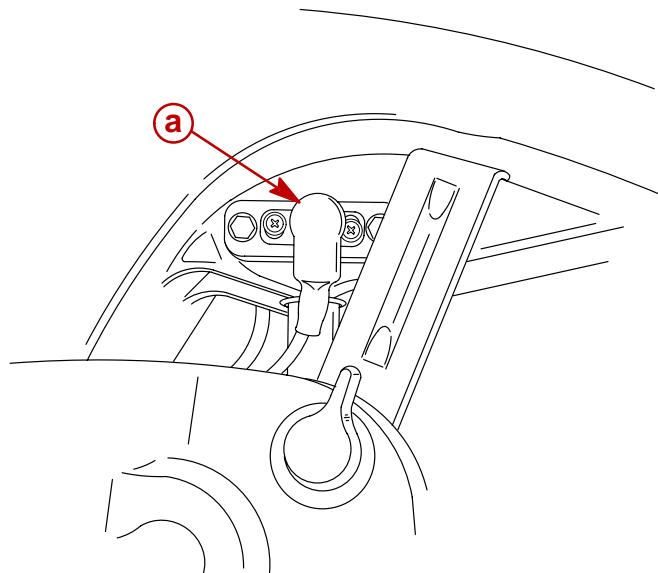


22744

- a - Trim Sender
- b - Screws, Loosen to Rotate Sender
- c - Turn Sender **Counterclockwise** to raise needle reading
- d - Turn Sender **Clockwise** to lower needle reading
- e - Tilt lock lever

Digital Trim Sender

Digital trim senders used with Smartcraft gauges are not adjustable.



58451

- a - Digital Trim Sender



Troubleshooting Digital Trim Sender

Trim sender requires a 5 vdc reference signal from ECU. With the ignition switch in the RUN position and using an appropriate probe (paper clip, etc.) inserted in parallel at the trim sender bullet connectors, this voltage can be checked as follows:

Voltmeter	Sender Harness	Voltage
RED	BLUE	4 – 5 vdc
BLACK	BLACK	

NOTE: 5vdc reference voltage at the ECU can be monitored by the Digital Diagnostic Terminal. Voltage should be $5\text{ vdc} \pm 0.1\text{ v}$. Any other voltage indicates a defective ECU. If ECU reference voltage is correct, but voltage at trim sender is low or not existent, inspect sender wiring and connections.

Voltage at trim sender should rise and fall smoothly as outboard is raised or lowered. Voltage at the full UP position should be $4\text{ vdc} \pm 0.5\text{v}$. Voltage at the full DOWN position should be $1.5\text{ vdc} \pm 0.5\text{ v}$. With the ignition switch in the RUN position and using an appropriate probe (paper clip, etc.) inserted in parallel at the trim sender bullet connectors, this voltage can be checked as follows:

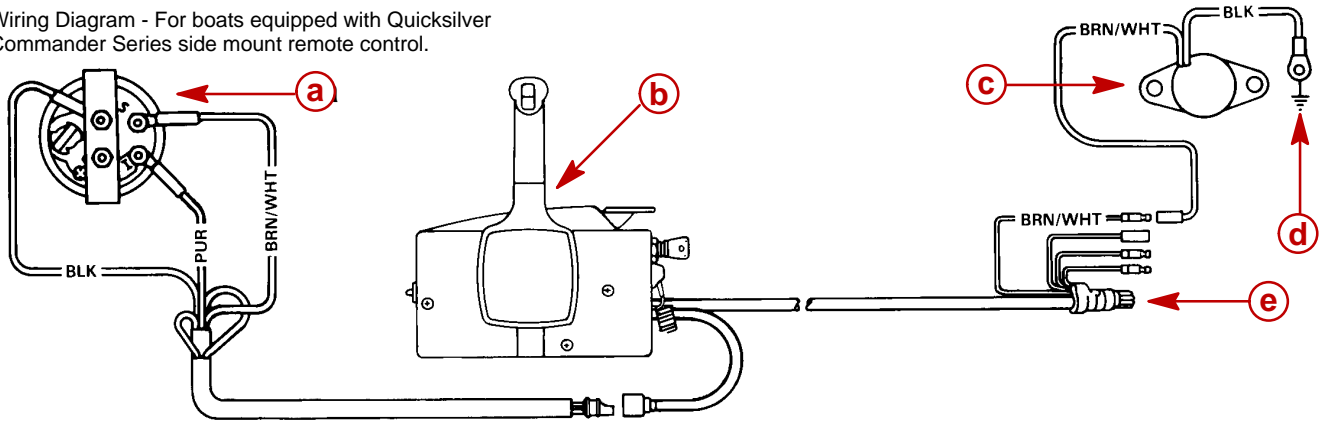
Voltmeter	Sender Harness	FULL UP	FULL DOWN
RED	YELLOW	$4\text{ vdc} \pm 0.5\text{v}$	$1.5\text{ vdc} \pm 0.5\text{v}$
BLACK	BLACK		

If voltage is not as indicated or voltage rise and fall is erratic, trim sender is defective.

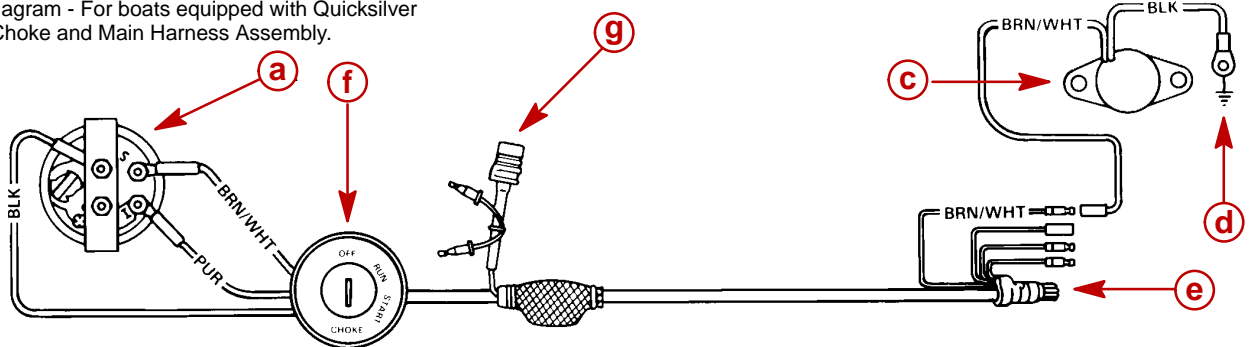


Trim Indicator Wiring Diagrams

Wiring Diagram - For boats equipped with Quicksilver Commander Series side mount remote control.



Wiring Diagram - For boats equipped with Quicksilver Ignition/Choke and Main Harness Assembly.



- a** - Trim Indicator
- b** - Remote Control
- c** - Trim Sender
- d** - Engine Ground
- e** - To Engine
- f** - Ignition Switch
- g** - Power Trim Harness

22908



LOWER UNIT

Section 6A – Right Hand Non-Ratcheting

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**6
A**

Gear Housing Specifications (Standard Rotation)

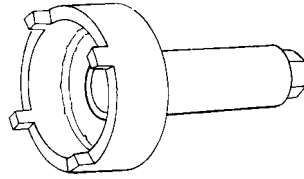
Ratio	Pinion Depth	Forward Gear Backlash	Reverse Gear Backlash
1.75:1 1.87:1	0.025 in. (0.635 mm) With Tool 91-12349A2 using Disc #2 and Flat #4	0.017 in. to 0.028 in. (0.431 mm to 0.711 mm) Pointer on line mark #1	0.030 in. to 0.050 in. (0.762 mm to 1.27 mm)
Gearcase Lubricant Capacity			
All Ratios		27.0 fl. oz. (798.0 ml)	
Gearcase Pressure Check			
Gearcase without Oil		Gearcase should hold 15 psi for 5 minutes without leakage	

Gear Ratio	Teeth on Pinion Gear	Teeth on Forward and Reverse
		Gear
1.75:1	12	21
1.87:1	15	28

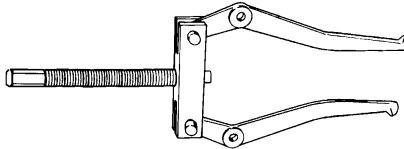


Special Tools

1. Gear Housing Cover Nut Tool 91-61069



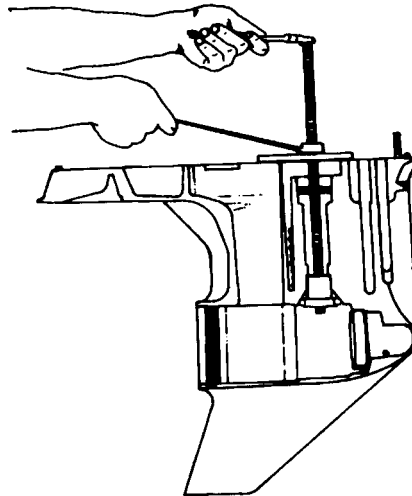
2. Bearing Carrier Removal Tool 91-46086A1 and Puller Bolt 91-85716



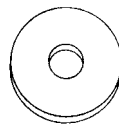
3. Slide Hammer Puller 91-34569A1



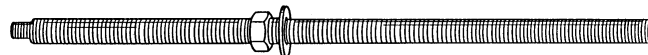
4. Bearing Removal and Installation Kit 91-31229A5. This kit contains the following tools: Pilot 91-36571; Puller Rod 91-31229; Nut 11-24156; Puller Plate 91-29310; Mandrel 91-38628; and Driver Rod 91-37323.



5. Pilot 91-36571

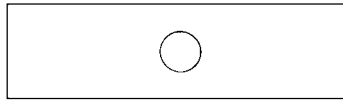


6. Puller Rod 91-31229 and Nut 91-24156

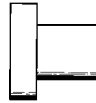




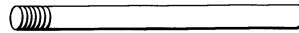
7. Puller Plate 91-29310



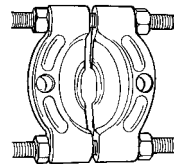
8. Mandrel 91-38628



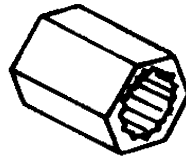
9. Driver Rod 91-37323



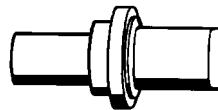
10. Universal Puller Plate 91-37241



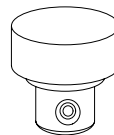
11. Driveshaft Holding Tool 91-56775



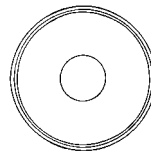
12. Oil Seal Driver 91-31108



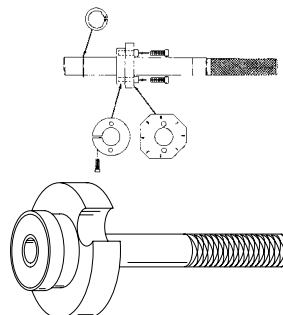
13. Forward Gear Bearing Tool 91-877321A1



14. Bearing Driver Cup 91-31106

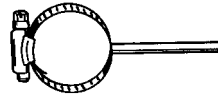


15. Pinion Locating Gear Tool 91-12349A2 or 91-74776

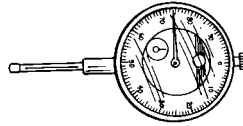




16. Backlash Indicator Rod 91-53459 for (1.75:1 ratio) and 91-78473 for (1.87:1 ratio)



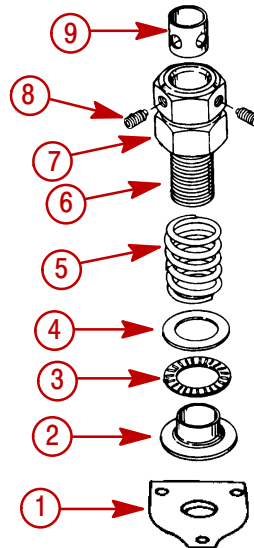
17. Dial Indicator 91-58222A1



18. Bearing Retainer Tool 91-43506



19. Bearing Preload Tool 91-14311A2



- 1 - Plate (44307)
- 2 - Adaptor (N.S.S.)
- 3 - Bearing (N.S.S.)
- 4 - Washer (N.S.S.)
- 5 - Spring (24-14111)

- 6 - Bolt (10-12580)
- 7 - Nut (11-13953)
- 8 - Set Screw (10-12575)
- 9 - Sleeve (23-13946)

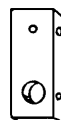
20. Mandrel 91-92788



21. Mandrel 91-15755

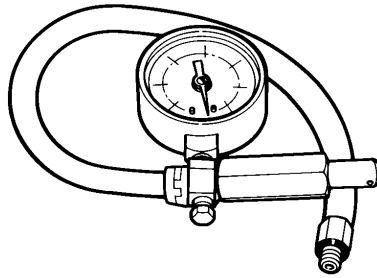


22. Dial Indicator Holder 91-89897

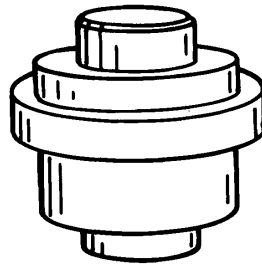




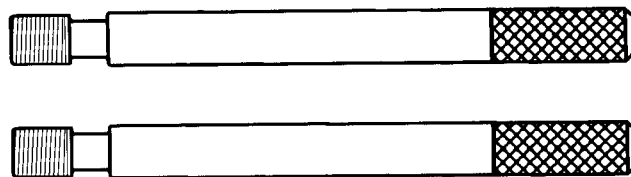
23. Leakage Tester FT8950



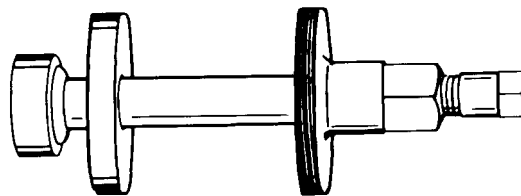
24. Oil Seal Driver 91-817569



25. Water Pump Alignment Pins 91-821571A1



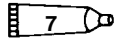
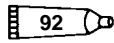
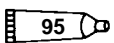
26. Bearing Adaptor Installation Tool 91-18605A2

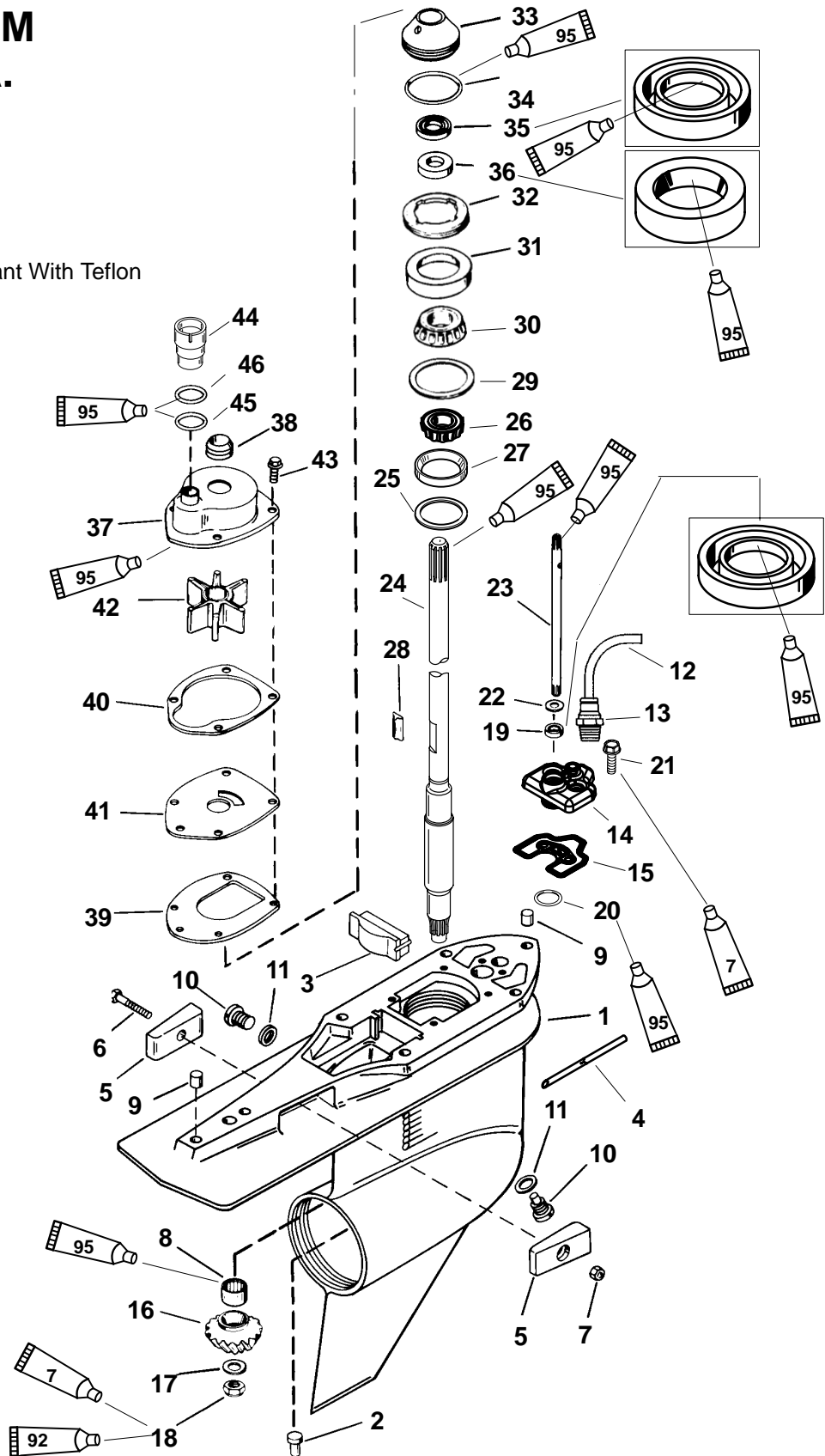




Gear Housing (Drive Shaft)(Standard Rotation)

4.75 IN/120.65MM TORPEDO DIA.

-  7 Loctite 271
-  92 Loctite 7649 Primer
-  95 2-4-C Marine Lubricant With Teflon





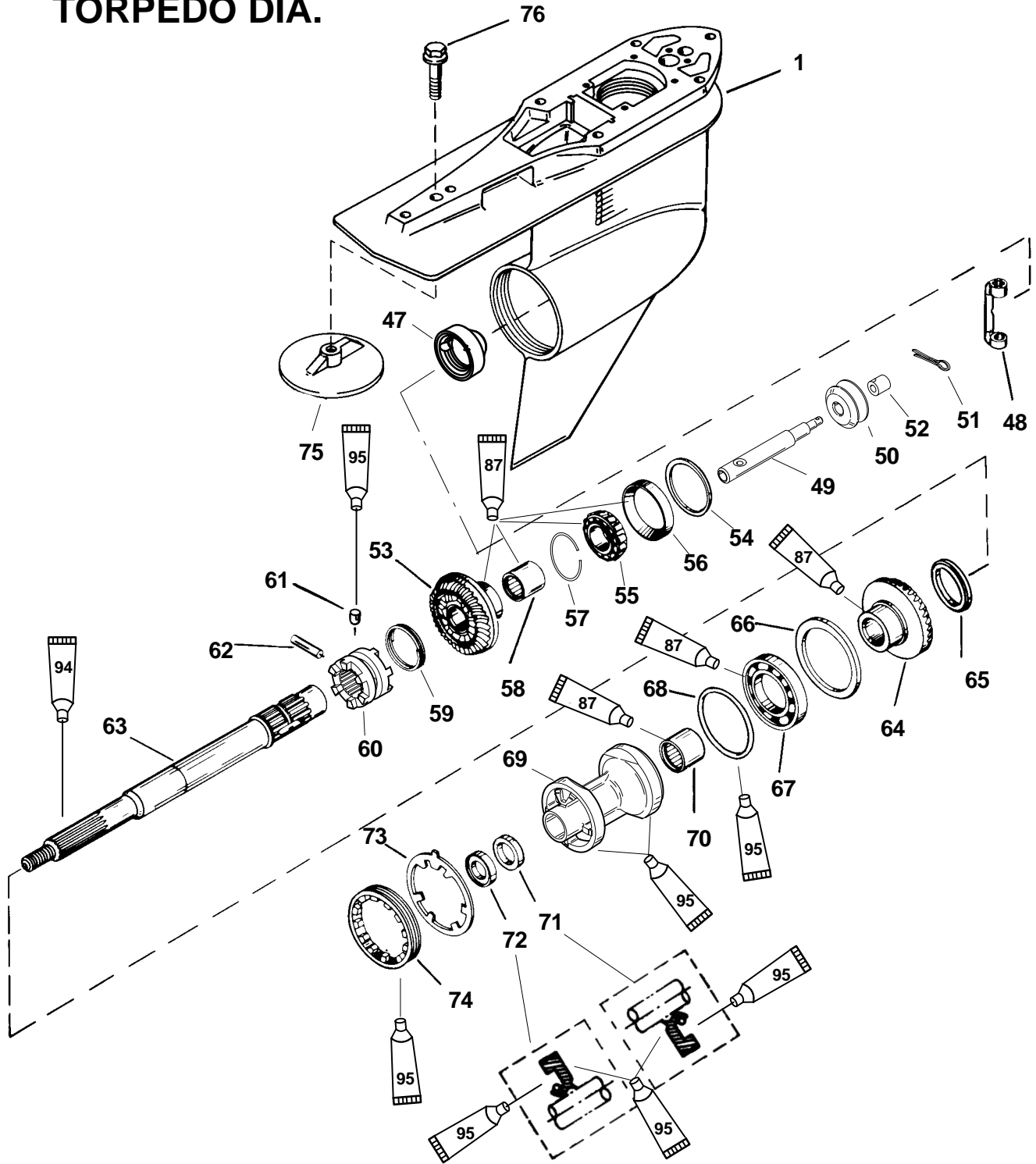
Gear Housing (Drive Shaft)(Standard Rotation)

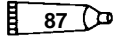
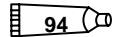
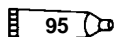
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	GEAR HOUSING (BASIC)			
2	1	PIN			
3	1	FILLER BLOCK			
4	1	PITOT TUBE			
5	2	ANODE			
6	1	SCREW	60		7
7	1	NUT			
8	1	ROLLER BEARING			
9	2	DOWEL PIN			
10	2	SCREW ASSEMBLY	60		7
11	2	SEALING WASHER			
12	1	HOSE(LONG - 7 IN)			
	1	HOSE (X-LONG - 12 IN)			
	1	HOSE(XX-LONG - 17 IN)			
13	1	CONNECTOR			
14	1	COVER			
15	1	GASKET			
16	1	PINION GEAR (1.75:1 - 12/21) (Part of 43-859321A3)			
17	1	WASHER			
18	1	NUT		70	95
19	1	OIL SEAL			
20	1	O RING			
21	2	SCREW (M6 x 16)	60		7
22	1	RUBBER WASHER			
23	1	SHIFT SHAFT (LOWER)			
24	1	DRIVE SHAFT (LONG)			
	1	DRIVE SHAFT (X-LONG)			
	1	DRIVE SHAFT (XX-LONG)			
25	AR	SHIM SET			
26	1	TAPERED ROLLER BEARING			
27	1	CUP			
28	1	KEY			
29	AR	SHIM SET			
30	1	TAPERED ROLLER BEARING			
31	1	CUP			
32	1	RETAINER		100	135
33	1	CARRIER ASSEMBLY			
34	1	O RING			
35	1	OIL SEAL			
36	1	OIL SEAL			
37	1	WATER PUMP ASSEMBLY			
38	1	SEAL			
39	1	GASKET			
40	1	GASKET			
41	1	FACE PLATE			
42	1	IMPELLER			
43	4	SCREW (M6 x 16)	60		7
44	1	COUPLING ASSEMBLY			
45	1	O RING			
46	1	O RING			



Gear Housing (Prop Shaft)(Standard Rotation)

4.75 IN/120.65MM TORPEDO DIA.



-  87 Premium Gear Lubricant
-  94 Anti-Corrosion Grease
-  95 2-4-C Marine Lubricant With Teflon



Gear Housing (Prop Shaft)(Standard Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	GEAR HOUSING (BASIC)			
47	1	PLUG			
48	1	SHIFT CRANK			
49	1	SHAFT			
50	1	SHIFT SPOOL			
51	1	COTTER PIN			
52	1	SLEEVE			
53	1	FORWARD/PINION GEAR SET (1.75:1 - 12/21)			
54	AR	SHIM SET			
55	1	TAPERED ROLLER BEARING			
56	1	CUP			
57	1	RETAINING RING			
58	1	ROLLER BEARING			
59	1	SPRING			
60	1	SLIDING CLUTCH			
61	1	DETENT PIN			
62	1	CROSS PIN			
63	1	PROPELLER SHAFT			
64	1	REVERSE GEAR (1.75:1 - 12/21)			
65	1	THRUST SPACER			
66	1	THRUST RING			
67	1	BALL BEARING			
68	1	O RING			
69	1	BEARING CARRIER			
70	1	ROLLER BEARING			
71	1	OIL SEAL (INSIDE)			
72	1	OIL SEAL (OUTSIDE)			
73	1	TAB WASHER			
74	1	COVER		210	285
75	1	ANODIC PLATE			
76	1	SCREW		40	54



General Service Recommendations

There may be more than one way to “disassemble” or “reassemble” a particular part(s), therefore, it is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

In many cases, disassembly of a sub-assembly may not be necessary until cleaning and inspection reveal 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 Premium 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 2-4-C Marine Lubricant with Teflon on all O-rings. To prevent wear, apply 2-4-C Marine Lubricant with Teflon on I.D. of oil seals.

To prevent corrosion damage after reassembly, apply 2-4-C Marine Lubricant with Teflon to external surfaces of bearing carrier and cover nut threads prior to installation.



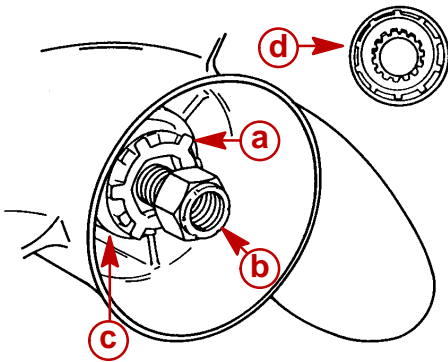
Removal, Disassembly, Cleaning and Inspection – Standard Rotation

Removal

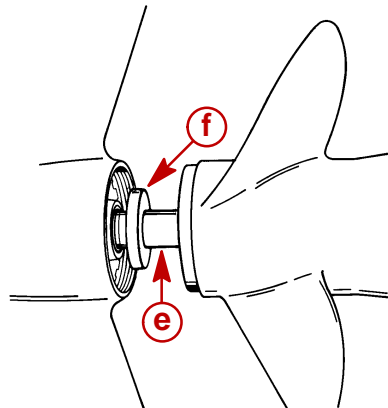
⚠ WARNING

Disconnect high tension leads from spark plugs and remove spark plugs from engine before removing gear housing from driveshaft housing.

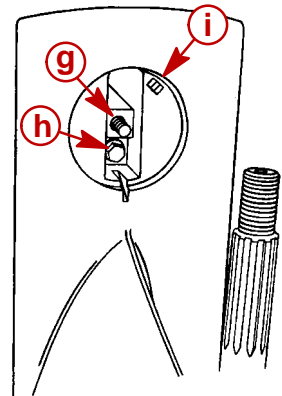
1. Disconnect high tension leads from spark plugs and remove spark plugs from engine.
2. Shift engine into NEUTRAL position.
3. Tilt engine to full up position and engage tilt lock lever.
4. Bend tabs of propeller tab washer away from thrust hub (rear), then remove propeller locknut, tab washer, thrust hub (rear), propeller and thrust hub (forward) from propeller shaft.
5. Mark gear housing and trim tab so that trim tab can be reinstalled in the same position. Remove plastic cap at rear edge of driveshaft housing. Remove bolt that secures trim tab and remove tab from gear housing.
6. Once trim tab is removed, remove bolt from inside of trim tab cavity.



51916



51912

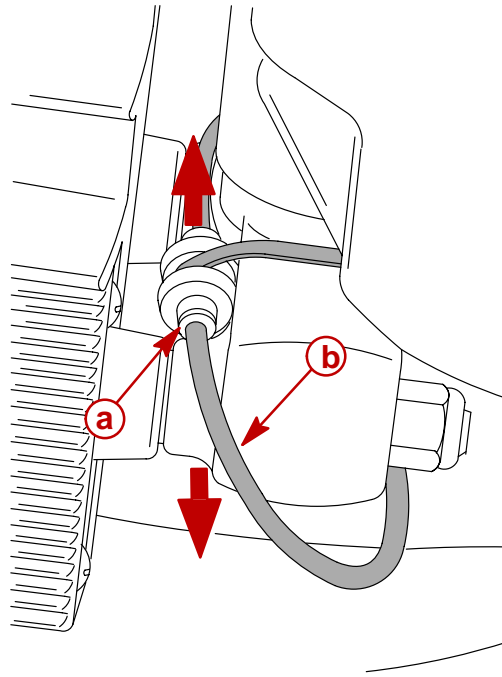


52375

- a** - Tab Washer
- b** - Propeller Nut
- c** - Rear Thrust Hub
- d** - Continuity Washer (if equipped)
- e** - Propeller Shaft
- f** - Thrust Hub (forward)
- g** - Bolt (secures trim tab)
- h** - Bolt (inside trim tab cavity)
- i** - Ribs – Align Carefully with Trim Tab while Securing Tab



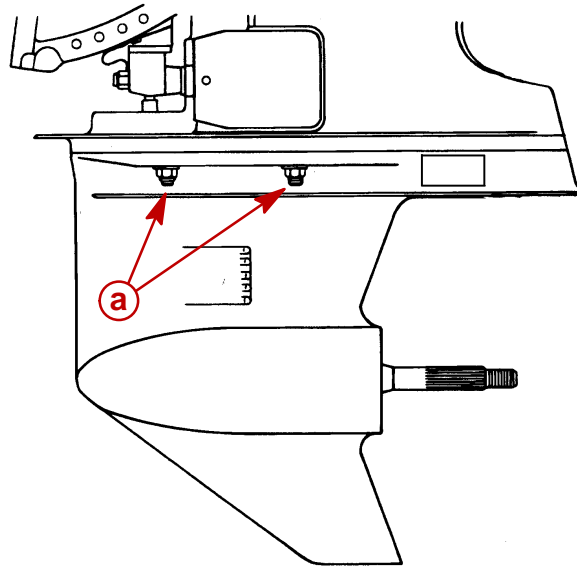
7. While pressing in on speedometer hose junction, pull out on hose to disconnect.



57735

- a** - Press in on Junction
- b** - Pull out on Hose

8. Loosen the side mounting locknuts. (Do not attempt to remove one nut before opposite side is loosened sufficiently, or gear housing could be damaged.)



52374

- a** - Side Mounting Locknuts (2 each side)

9. Pull gear housing away from driveshaft housing as far as the loosened nuts (in Step 8) will allow, then remove loosened nuts. (DO NOT allow gear housing to fall, as it now is free.)
10. Pull gear housing from driveshaft housing.

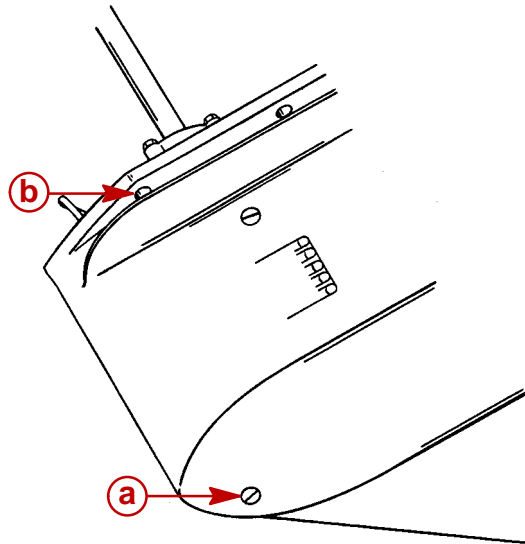


Draining and Inspecting Gear Housing Lubricant

1. Place gear housing in a suitable holding fixture or vise with the driveshaft in a vertical position.

NOTE: Drain and Fill screws may be located on the starboard side of gearcase on later models.

2. Position a clean drain pan under gear housing and remove “Fill” and “Vent” screws from gear housing.



- a** - “Fill” Screw
b - “Vent” Screw

3. Inspect gear lubricant for metal particles. Presence of a small amount of fine metal particles (resembling powder) indicates normal wear. Presence of larger particles (or a large quantity of fine particles) indicates need for gear housing disassembly, and component inspection.
4. Note the color of gear lubricant. White or cream color indicates presence of water in lubricant. Check drain pan for water separation from lubricant. Presence of water in gear lubricant indicates the need for disassembly, and inspection of oil seals, seal surfaces, O-rings and gear housing components.

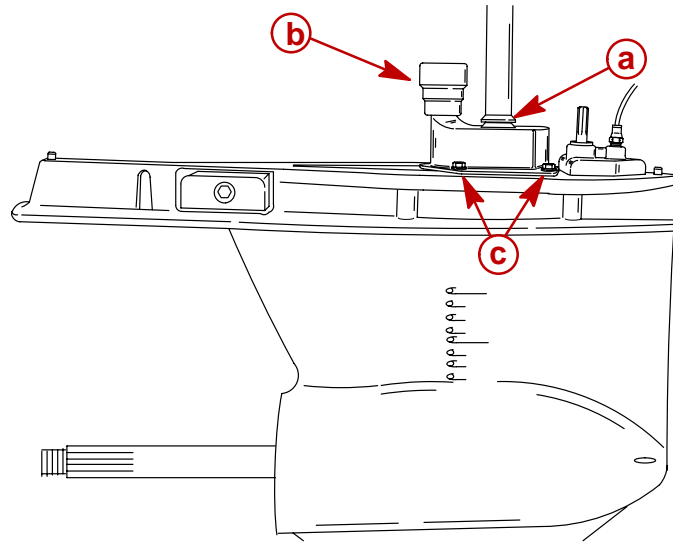
NOTE: Gear lubricant drained from a recently run gear case will be a light chocolate brown in color due to agitation/aeration. Oil which is stabilized will be a clear yellow brown in color.



Water Pump

REMOVAL AND DISASSEMBLY

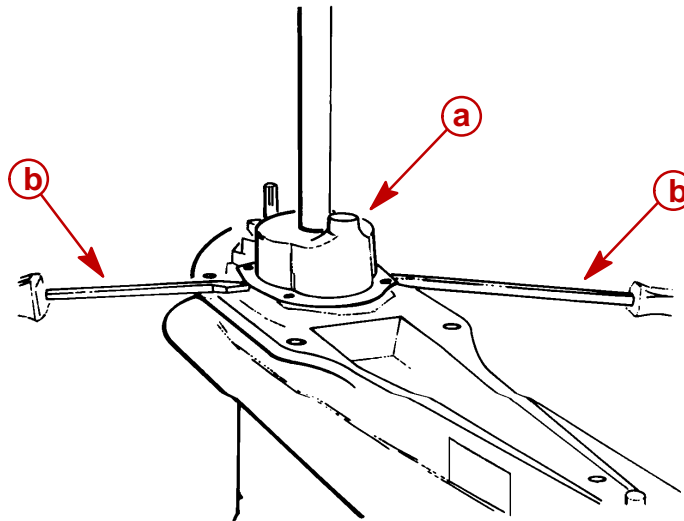
1. Remove the water seal, water tube coupling assembly, and the water pump screws.



57944

- a** - Water Seal
- b** - Water Tube Coupling
- c** - Water Pump Screws (4)

2. Carefully slide the water pump straight up off of the drive shaft. It may be necessary to encourage the water pump up by gently prying up on its mounting flanges with a couple of screwdrivers.

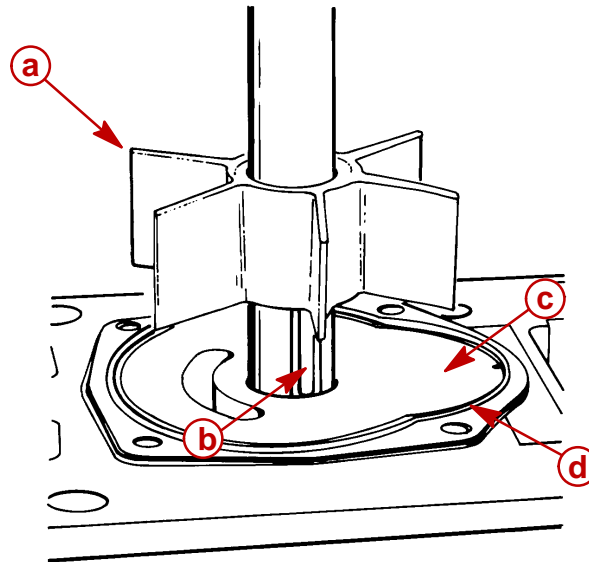


70487

- a** - Water Pump Body
- b** - Screwdrivers



3. Remove the impeller, impeller key, the face plate and gaskets. Discard the gaskets.



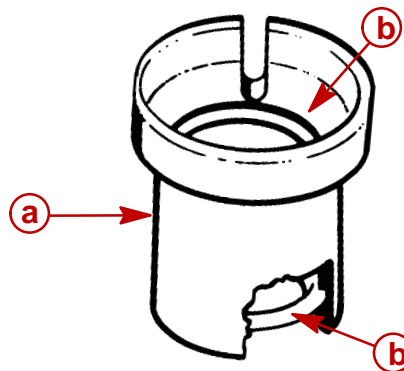
70605

a - Impeller
b - Impeller Key

c - Water Pump Face Plate
d - Gasket (1 each side of face plate)

CLEANING AND INSPECTION

1. Inspect the water tube coupling assembly for wear or damage. If necessary replace the worn or damaged components, especially the two O-rings on the inside, one at the top and one at the bottom.



70613

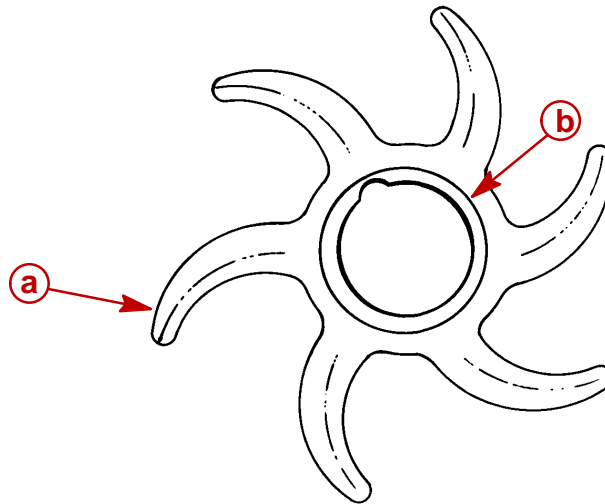
a - Water Tube Adaptor
b - O-rings (2)

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting cover and plate. The depth of the groove will not affect water pump output.

2. Inspect face plate and water pump cover for grooves and/or rough surfaces.
3. Replace cover and /or face plate if grooves (other than sealing grooves) are more than 0.030 in. (0.762 mm) deep.



4. Inspect impeller side seal surfaces and ends of impeller blades for cracks, tears and wear. Replace impeller if any of these conditions are found.
5. Inspect impeller bonding to impeller hub.
6. Inspect impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace impeller if any of these conditions exist.



70500

- a - Impeller
- b - Hub

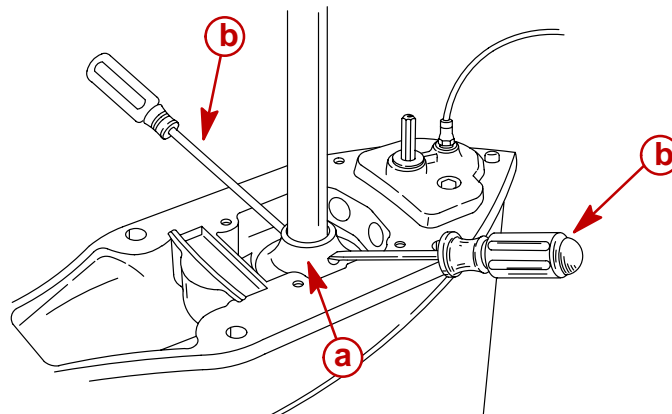
IMPORTANT: When completing gear housing repairs, that require removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to re-use impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur.

IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

Oil Seal Carrier Assembly

REMOVAL

1. Remove the oil seal carrier from the gear housing. It may be necessary to gently pry up on it with two screwdrivers.



57940

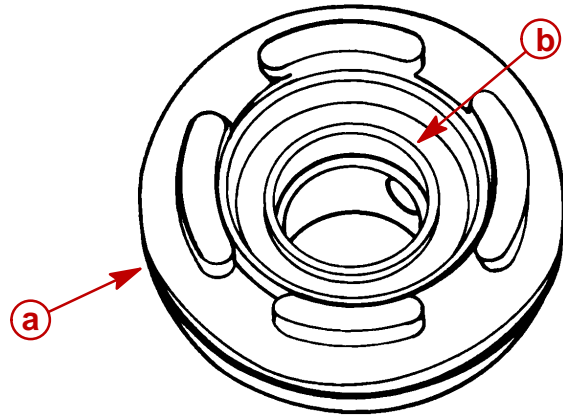
- a - Oil Seal Carrier
- b - Screwdrivers



OIL SEAL CARRIER ASSEMBLY - COMPONENT DISASSEMBLY

NOTE: Complete the instructions in this section only if the assembly components have been found to be defective and are in need of repair or replacement.

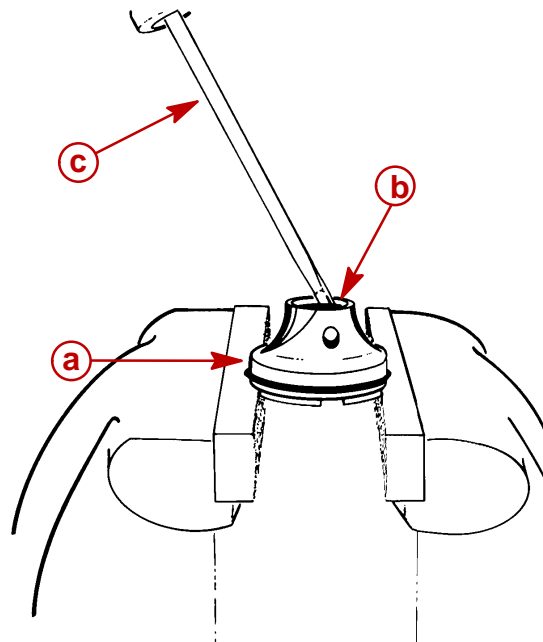
1. Remove the o-ring.



70501

- a** - O-ring
- b** - Oil Seals (2)

2. Remove oil seals.



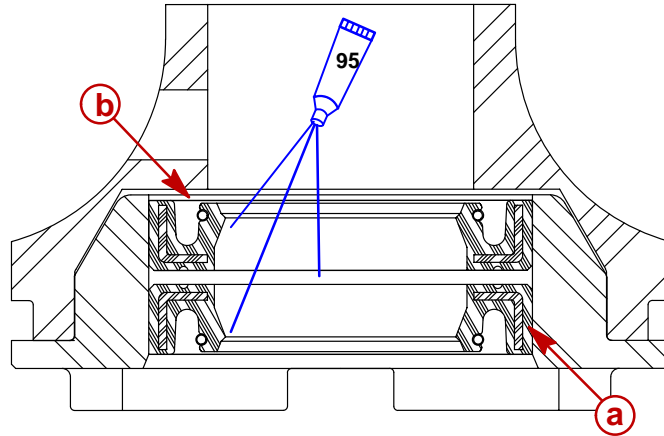
70610

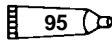
- a** - Oil Seal Carrier
- b** - Oil Seals
- c** - Screwdriver



OIL SEAL CARRIER ASSEMBLY – COMPONENT REASSEMBLY

The oil seals in the carrier assembly are the same diameter. The bottom (first) seal lip faces down; the top (second) seal lip faces up. Apply 2-4-C Marine Lubricant with Teflon to seal lips and between seals. Press seal into carrier with suitable mandrel. Second seal should be pressed in flush with carrier surface.

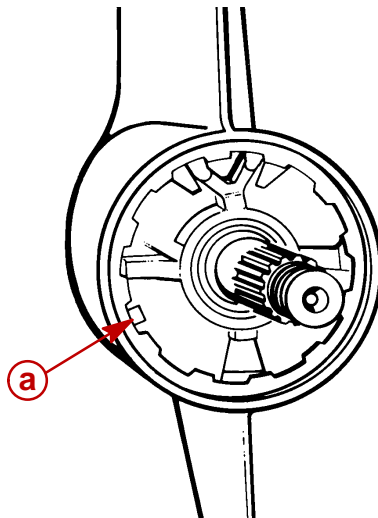


 2-4-C Marine Lubricant with Teflon

- a** - Bottom Seal (lip faces down)
- b** - Top Seal (lip faces up)

Bearing Carrier and Propeller Shaft Removal

1. Straighten the tab on the tab washer.



- a** - Tab on Tab Washer

70490

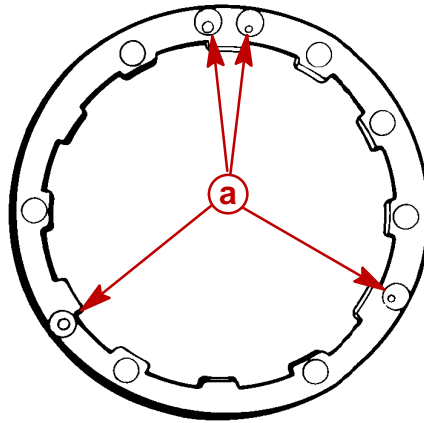


2. Remove the bearing carrier retainer following step a or b as follows:

⚠ CAUTION

DO NOT drill into the gear housing retainer threads when using the following procedure for removing the retainer

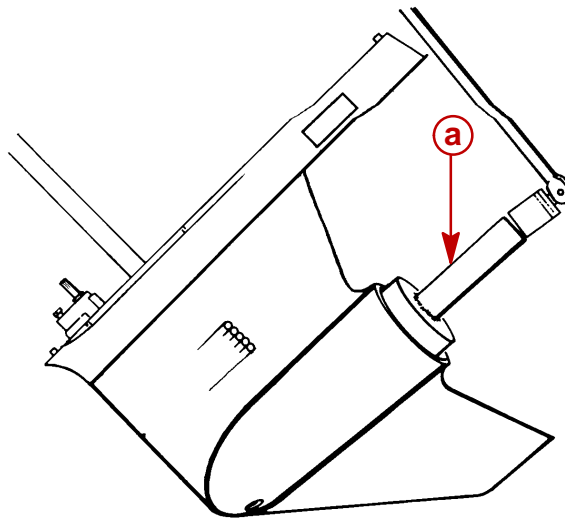
- a. If the retainer is corroded in place, drill 4 holes in the retainer and fracture the retainer with a chisel. Pry the remaining segments out.



23356

a - Drilled Holes

- b. Remove the bearing carrier retainer using the Bearing Carrier Retainer Wrench (91-61069).



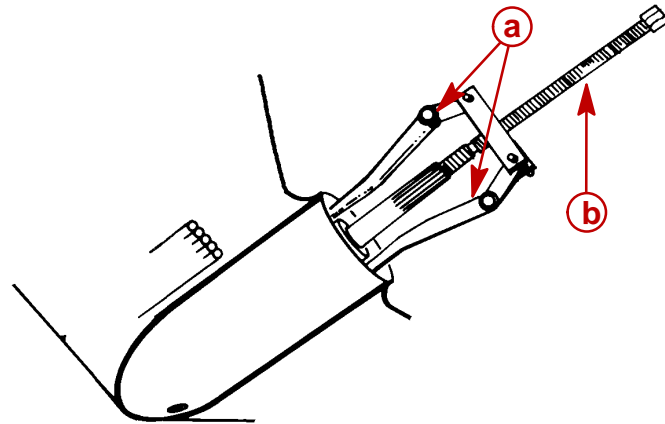
70491

a - Bearing Carrier Retainer Wrench



3. Pull the bearing carrier from the gear housing by pulling on the outer ring of the bearing carrier. POSITION PULLER JAWS CLOSE TO BOSSES IN CARRIER.

NOTE: If the bearing carrier is seized in the gear housing, it may be necessary to use heat to loosen the carrier.



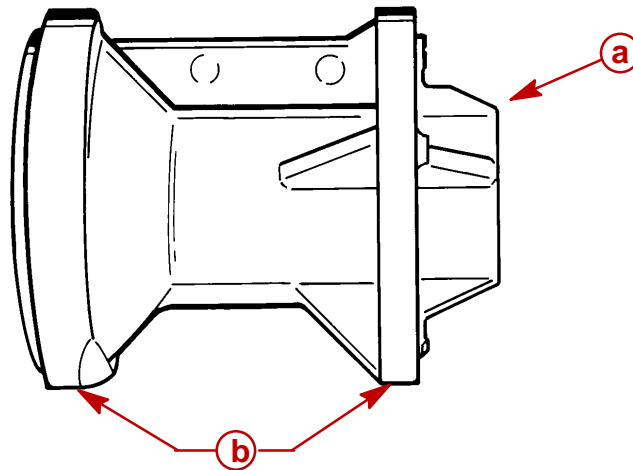
70492

- a - Puller Jaws (91-46086A1)
- b - Puller Bolt (91-85716)

CLEANING/INSPECTION - BEARING CARRIER

IMPORTANT: It is recommended that all seals and O-rings be replaced (as a normal repair procedure) to assure effective repair.

1. Clean bearing carrier with solvent and dry with compressed air.
2. Inspect the bearing carrier for signs of excessive corrosion especially in the area where the bearing carrier touches the gear housing. If excessive corrosion is evident replace the carrier.



50314

- a - Bearing Carrier
- b - Inspect for Corrosion

⚠ CAUTION

DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

3. Bearing carrier propeller shaft needle bearing condition is determined by propeller shaft bearing surface condition. (See "Propeller Shaft Inspection.")



4. Inspect reverse gear to pinion gear wear pattern (should be even and smooth). If not, replace reverse gear and pinion gear.
5. Check clutch jaws on reverse gear for damage. Replace reverse gear, if damage is found on clutch jaws.
6. Apply light oil to reverse gear bearing. Rotate reverse gear bearing while checking bearing for rough spots and/or catches. Push in and pull out on reverse gear to check for bearing side wear. Replace bearing if any of the listed conditions exist.

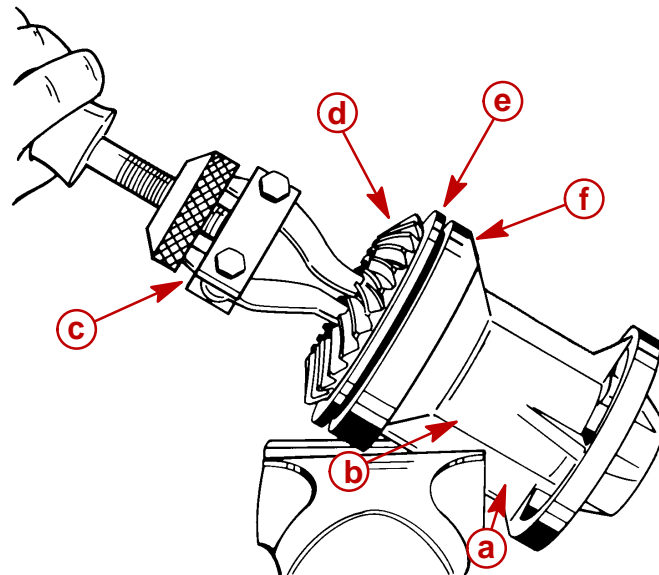
DISASSEMBLY - BEARING CARRIER

1. Remove and discard O-ring from between bearing carrier and thrust washer.
2. If inspection of reverse gear or reverse gear bearing determines that replacement of gear or bearing is required, remove gear and bearing as follows:

⚠ CAUTION

Clamp onto the reinforcing rib of the bearing carrier ONLY, or damage to the carrier may result.

3. Place the bearing carrier in a vise, clamping on the reinforcing rib.
4. Remove the reverse gear, thrust ring, and bearing as an assembly, using a slide hammer puller

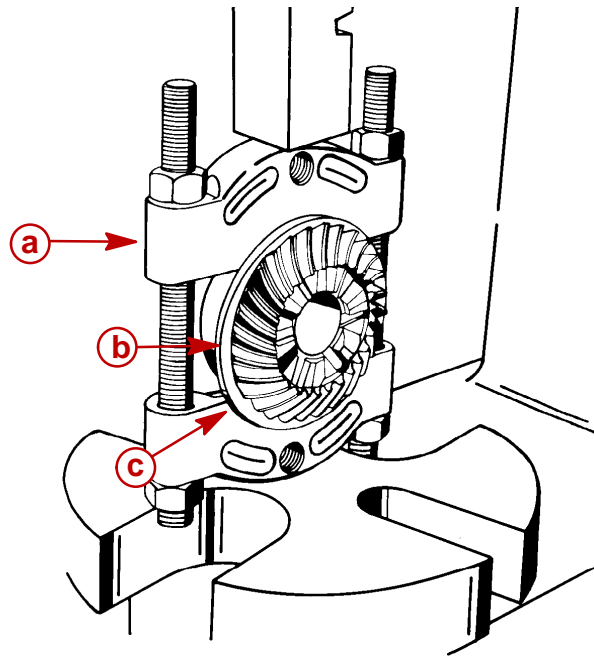


- a** - Bearing Carrier Reinforcing Rib
- b** - Bearing Carrier
- c** - Slide Hammer Puller (91-34569A1)
- d** - Reverse Gear
- e** - Thrust Hub
- f** - Bearing (not seen) - Located in the Carrier



IMPORTANT: The bearing MUST BE replaced if removed from gear.

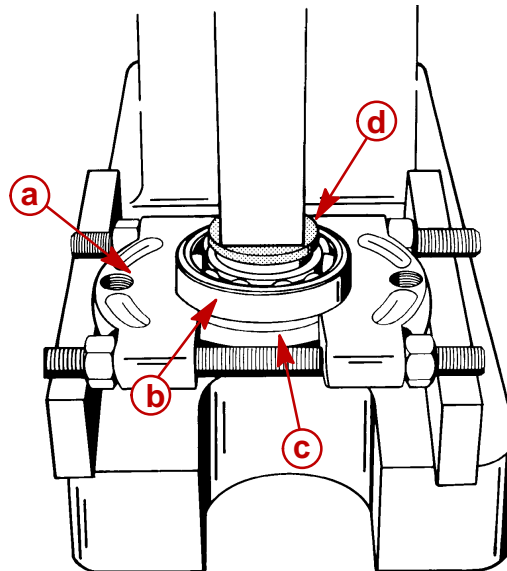
5. Place the universal puller plate between the thrust washer and bearing as shown and press on the plate until it bottoms.



23351

- a** - Universal Puller Plate (91-37241)
- b** - Thrust Washer
- c** - Bearing

6. Using a suitable mandrel and the universal puller plate to support the bearing, press the bearing from the reverse gear as shown.



23351

- a** - Universal Puller Plate (91-37241)
- b** - Bearing
- c** - Gear
- d** - Mandrel

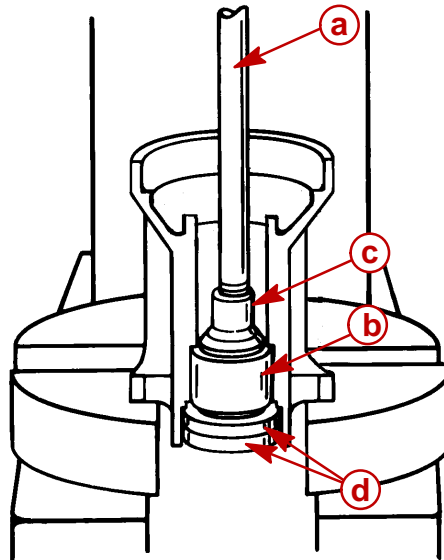
- a. **Discard the bearing.**
- b. Inspect the gear, and thrust washer for excessive wear, cracks, or damage. Replace the appropriate components if any of these conditions are found.



NOTE: Inspection of the bearing surfaces on the propeller shaft where the needles of the bearing carrier needle bearing rolls, gives an indication of the condition of the needle bearing inside the bearing carrier. Replace needle bearing in the bearing carrier if the prop shaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.

7. Perform the following step a. or b. as necessary.

- a. **If Replacing the Needle Bearing and Seals:** Remove the needle bearing and seals with the tools as shown.

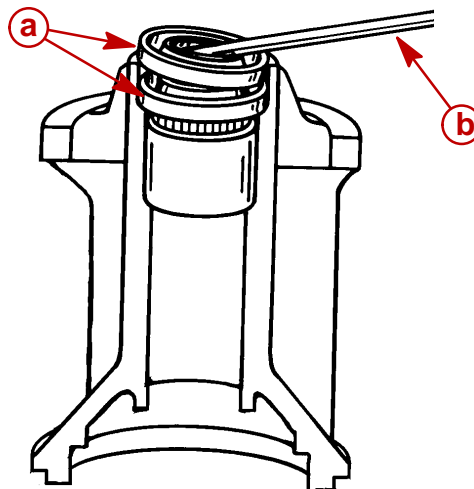


23140

- a - Bearing Driver Rod (91-37323)
- b - Needle Bearing
- c - Driver Head (91-36569)
- d - Oil Seals

(1.) **Discard the needle bearing and both seals.**

- b. **If Replacing the Seal Only:** Remove the oil seals with a suitable pry bar, being careful not to damage the bore of the bearing carrier.



23140

- a - Oil Seals
- b - Pry Bar

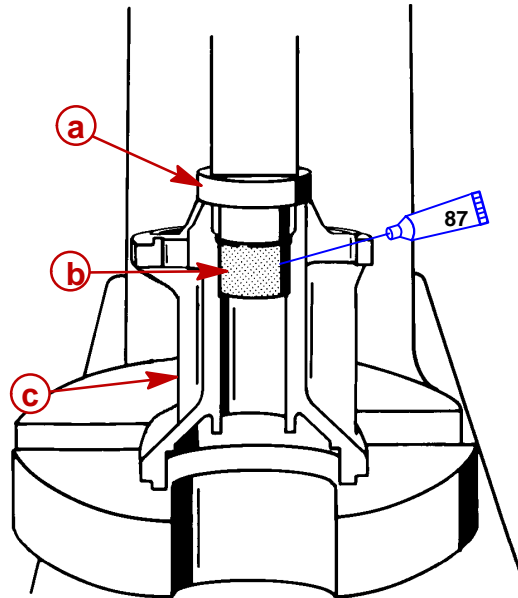
(1.) **Discard both of the seals.**

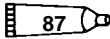


BEARING CARRIER ASSEMBLY Component Reassembly

NOTE: Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.

1. Clean all of the components with a suitable solvent and dry the parts thoroughly using compressed air. Be careful not to spin the bearing.
2. Lubricate the bore that the needle bearing is pressed into with Premium Gear Lubricant.
3. Assemble the needle bearing (with the numbered end of the bearing towards the driver shoulder), onto the driver.
4. Press the needle bearing into the bearing carrier until the driver bottoms out on the bearing carrier. Ensure that the numbered side of the needle bearing faces the seal end (aft end) of the carrier.



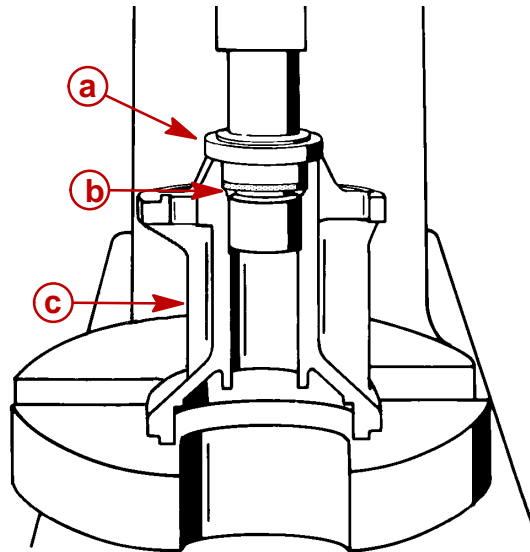
 87 Premium Gear Lubricant

50315

- a** - Needle Bearing Driver (91-15755)
- b** - Needle Bearing
- c** - Bearing Carrier



5. **Thoroughly clean** the bore in which the first seal is to be pressed.
6. Assemble the first seal (with the lips of the seal facing away from the driver shoulder) onto the long end of the oil seal driver.
7. Press on the oil seal driver until the driver bottoms on the bearing carrier.

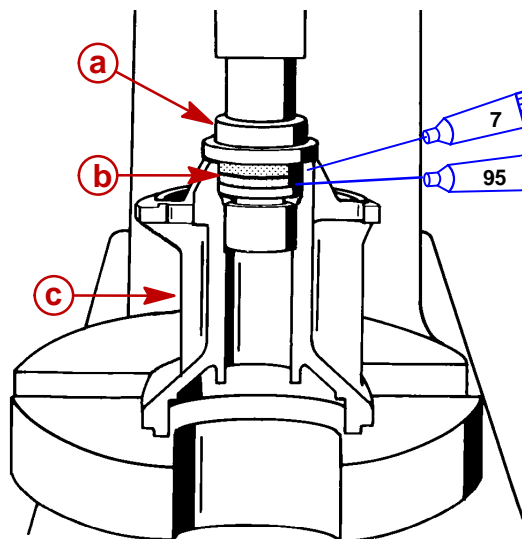


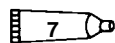
50315

a - Oil Seal Driver
(91-31108)

b - Oil Seal
c - Bearing Carrier

8. Apply a thin film of Loctite 271 to the outer diameter of the second seal.
9. Assemble the second seal (with the lips of the seal facing the driver shoulder) onto the short end of the driver.
10. Press the oil seal with the driver until the driver bottoms out on the bearing carrier.



 7 Loctite 271

 95 2-4-C Marine Lubricant With Teflon

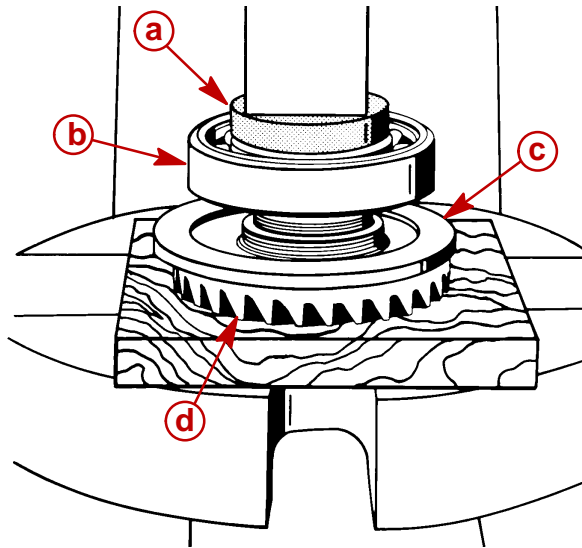
50315

a - Driver (short end)
b - Oil Seal (lips toward driver shoulder)
c - Bearing Carrier

11. Wipe up all of the excess Loctite. Do not allow any of the excess Loctite to spread to other parts of the assembly.
12. Lubricate the seal lips and fill the area between the seals with 2-4-C Marine Lubricant with Teflon.



13. Install the thrust washer and **a new ball bearing** onto the reverse gear. Press on the inner race of the ball bearing using the pilot washer until the bearing bottoms out on the gear.

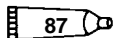
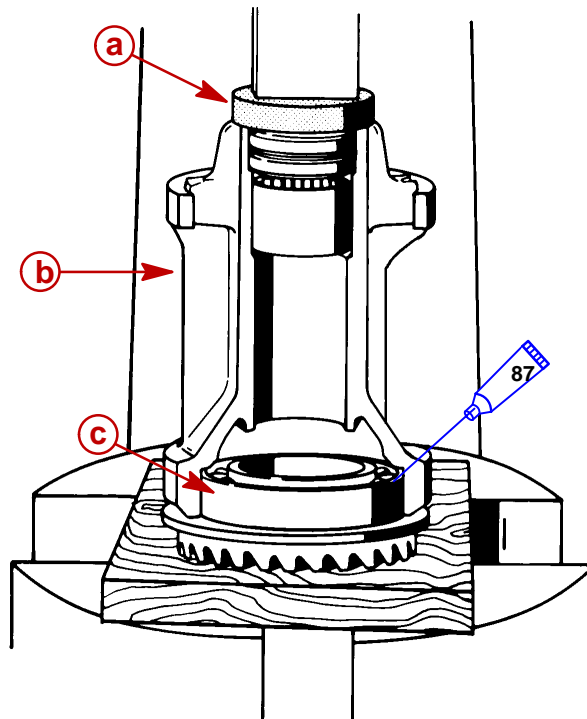


23346

a - Pilot Washer
(91-36571)
b - Ball Bearing

c - Thrust Hub
d - Reverse Gear

14. Lubricate the bore that the bearing is pressed into with Premium Gear Lubricant.
15. Press the bearing carrier onto the reverse gear and bearing until the bearing bottoms out in bearing carrier, using the pilot washer to press against the carrier.



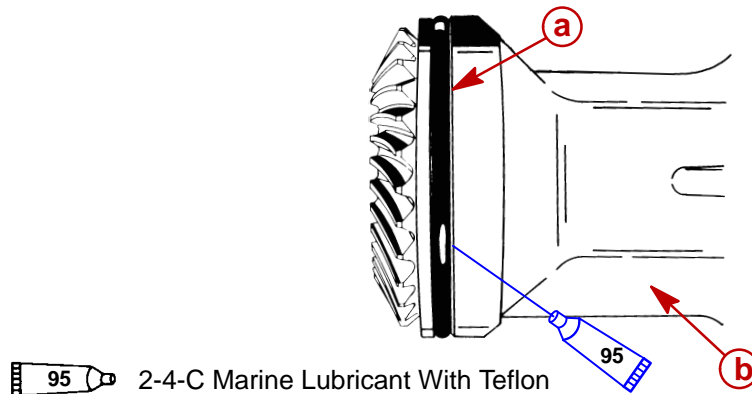
Premium Gear Lubricant

23349

a - Pilot Washer (91-36571)
b - Bearing Carrier
c - Reverse Gear and Bearing Assembly



16. Lubricate the O-ring with 2-4-C Marine Lubricant with Teflon and install the O-ring onto the bearing carrier.



95 2-4-C Marine Lubricant With Teflon

23354

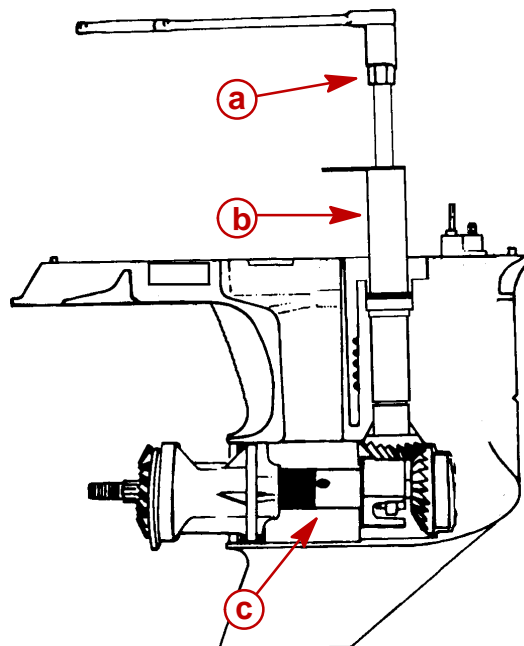
a - O-ring

b - Bearing Carrier

Drive Shaft Assembly

REMOVAL

1. Remove the drive shaft pinion nut as follows:
 - a. Place the drive shaft nut wrench onto the drive shaft. Do not loosen the retainer at this time.
 - b. Insert the pinion nut adapter with the MR slot facing the pinion gear into the gear housing. It may be necessary to slightly lift and rotate the drive shaft to align the pinion gear nut into the pinion nut adapter slot.
 - c. Install the bearing carrier into the gear housing backwards to support the prop shaft and to keep the pinion nut adapter aligned.
 - d. Place the drive shaft nut wrench over the drive shaft splines and **loosen**, (but do not fully unscrew), the pinion nut by rotating the drive shaft counterclockwise.



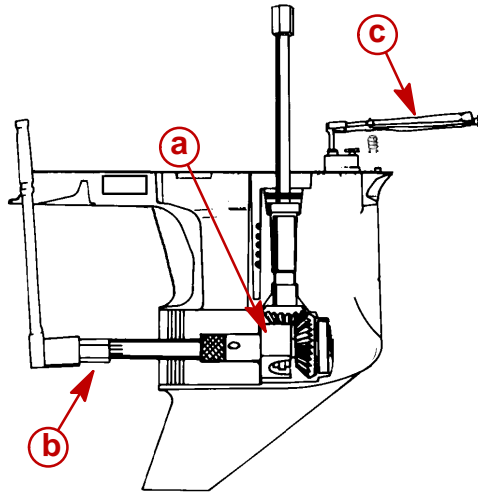
70887

- a - Drive Shaft Nut Wrench (91-56775)
b - Drive Shaft Bearing Retainer Wrench (91-43506)
c - Pinion Nut adapter (MR Slot) (91-61067A2)



- e. **If the drive shaft is broken**, place propeller shaft nut wrench onto the propeller shaft splines, hold shift shaft in forward gear and **loosen**, (but do not fully unscrew), the pinion nut by rotating prop shaft counterclockwise to turn gears, thus loosening the pinion nut.

NOTE: The propeller shaft nut wrench is included with the pinion nut adapter kit



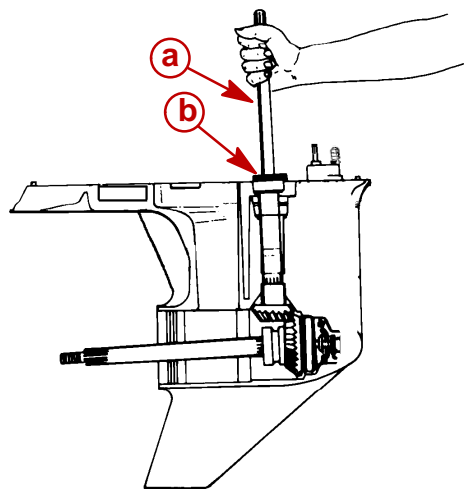
70607

- a** - Pinion Nut Adaptor (MR slot) (91-61067A2)
- b** - Propeller Shaft Nut Wrench (91-61067)
- c** - Shift Shaft (Turn Clockwise) (Protect shaft splines with soft material)

- f. Completely unscrew the drive shaft bearing retainer.
- g. Completely unscrew the pinion nut by rotating the drive shaft (or the propeller shaft) in a counterclockwise direction.
- h. Remove all tools.

IMPORTANT: The pinion bearing rollers are free to fall out of the pinion bearing once the drive shaft is removed. Be careful not to loose the (18) rollers.

- 2. Remove the drive shaft and all components by pulling the drive shaft straight out of the gear housing as shown.



70608

- a** - Drive Shaft
- b** - Drive Shaft Retainer, Bearing Cup, Bearing, and Shims

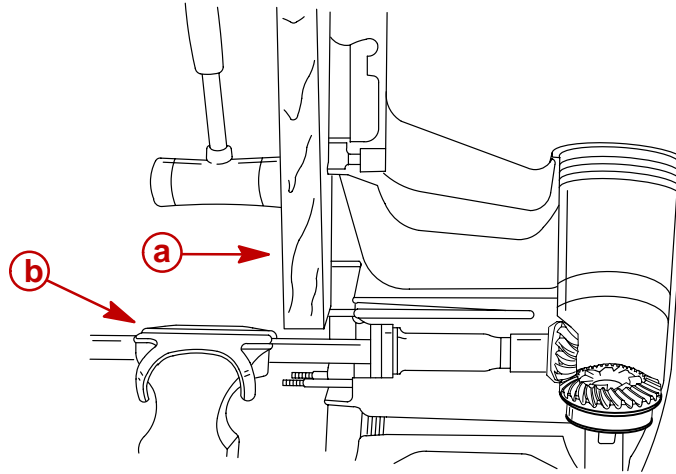
- 3. Move the prop shaft downward and to the PORT side of the gear case.
- 4. Retrieve the pinion gear, the washer and the nut from the inside of the gear housing.



NOTE: If pinion gear is seized onto the driveshaft, place gearcase in vise using soft jaw vise covers. Place a block of wood on gear housing mating surface. Use a mallet and carefully tap gear housing away from drive shaft.

CAUTION

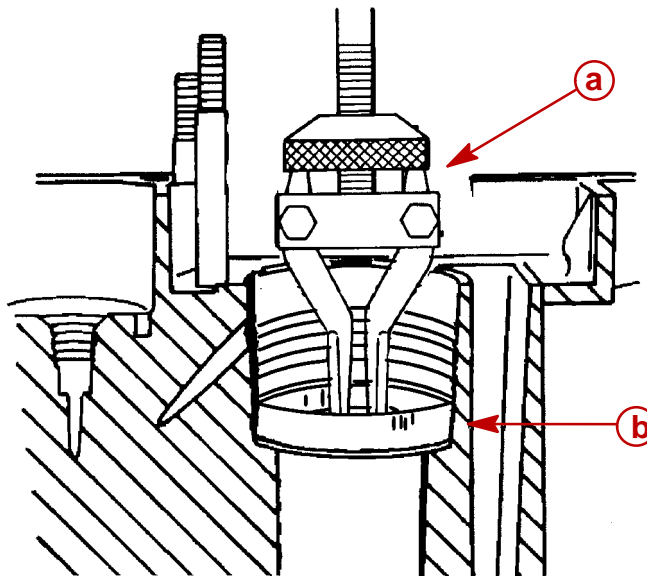
Do not strike gear housing hard with mallet or allow gear housing to fall.



57951

- a - Wood Block
- b - Drive Shaft in Soft Jaw Vise

5. Remove lower drive shaft bearing cup and shims using slide hammer puller (34569A1) (retain shims for re-installation).

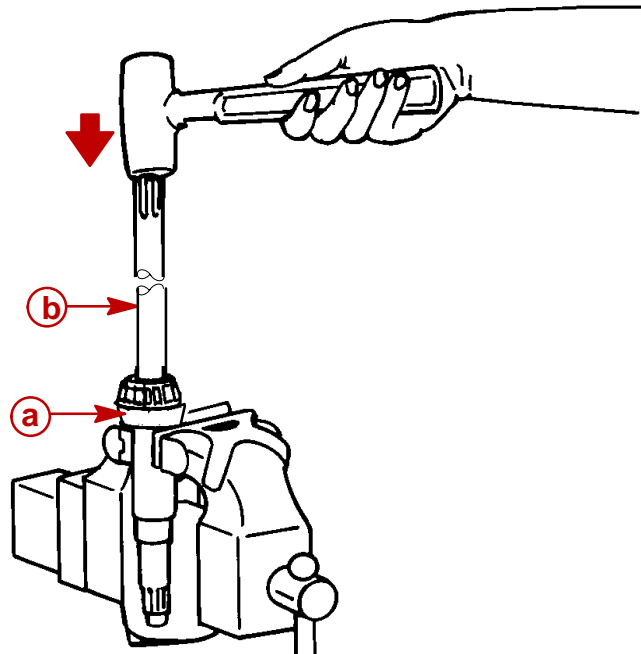


- a - Slide Hammer Puller (91-34569A1)
- b - Lower Drive Shaft Bearing Cup



DISASSEMBLY

1. Both upper and lower tapered roller bearings can be removed from the drive shaft in one operation. Using the bottom bearing cup removed from the gearcase, place the cup on top of a vise leaving the vise jaws open enough to allow the drive shaft to slide through.
2. Place the driveshaft through the cup and vise until the bottom bearing is resting in the cup. While holding the driveshaft, tap on the top of the shaft with a lead hammer until the bearings are free. **Do not drop the shaft when performing this operation.**



- a** - Lower Bearing Cup Removed from Gear Case
b - Drive Shaft With Both Upper and Lower Bearings

DRIVE SHAFT ASSEMBLY - Inspection

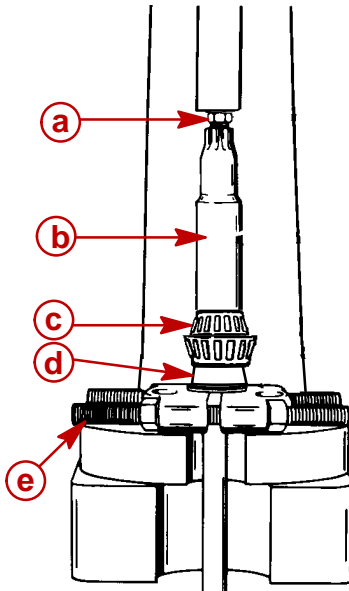
1. Clean all parts with a suitable solvent and dry the parts thoroughly using compressed air, being careful not to spin the bearings.
2. The condition of the drive shaft bearing cup is an indication of the condition of the tapered roller bearing on the drive shaft. Replace the bearing and bearing cup if the cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
3. Inspect the bearing surface on the drive shaft where the needles of the lower pinion bearing roll. Replace the drive shaft if it is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
4. Inspect the splines at both ends of the drive shaft for a worn or twisted condition. Replace the drive shaft if either condition exists.
5. Inspect the gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. **Replace the pinion gear and the forward gear as a set** if any defects are found.
6. Inspect driveshaft for groove(s) where water pump base oil seals contact shaft. Replace driveshaft if groove(s) are found.



REASSEMBLY

NOTE: Complete the instructions in this section only if the components have been disassembled

1. Apply a light coat of Premium Gear Lubricant on I.D. of drive shaft tapered bearing. Apply High Pressure Grease (such as Chicago Manufacturing and Distributing Lube #3) to the O.D. of both bearings.
2. Assemble a new tapered roller bearing to the drive shaft with the large O.D. of the bearing facing the pinion gear end of the drive shaft.
3. Thread a used pinion nut onto end of drive shaft. Leave approximately 1/16" (2mm) of nut threads exposed. Drive shaft threads MUST NOT extend beyond nut or thread damage could result while pressing.
4. Press the tapered roller bearing onto the drive shaft using the universal puller plate and a suitable mandrel, (an old tapered roller bearing inner race).



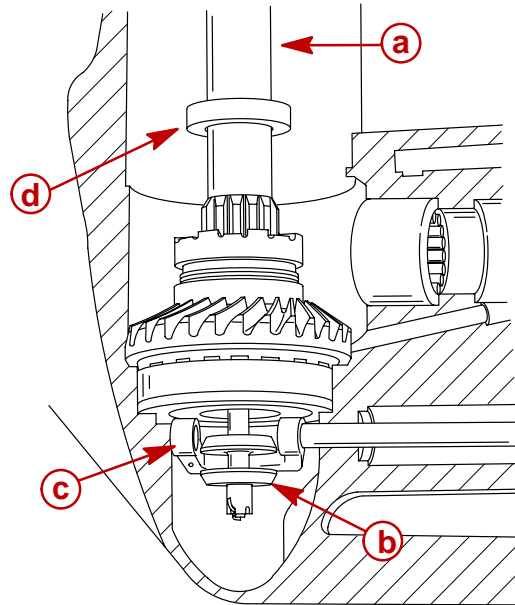
- a - Used Pinion Nut
- b - Drive Shaft
- c - Tapered Bearing(s)
- d - Old Bearing Inner Race
- e - Universal Puller Plate



Propeller Shaft Assembly and Forward Gear Bearing Cup

REMOVAL

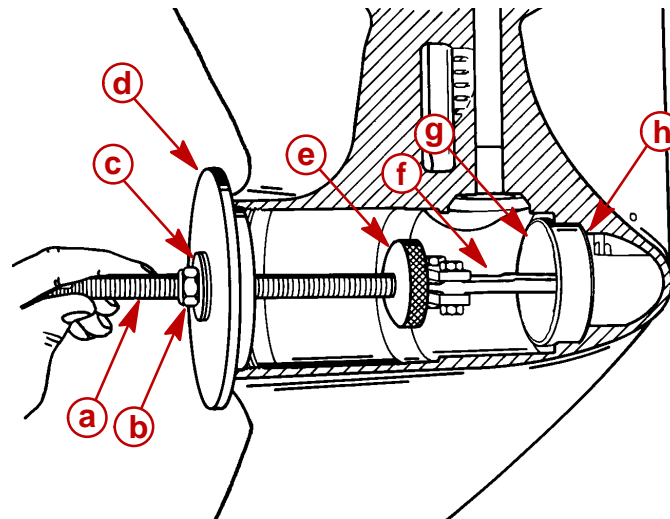
1. Tilt the propeller shaft to the port side of the gear housing and remove the shaft by pulling it straight up and out.



58016

- a** - Propeller Shaft Assembly
- b** - Shift Spool
- c** - Shift Crank
- d** - Thrust Washer (Reverse Gear)

2. Remove the forward gear bearing cup and shims. Measure and make note of the shim thickness. If the shims are not damaged, they may be reused.



50780

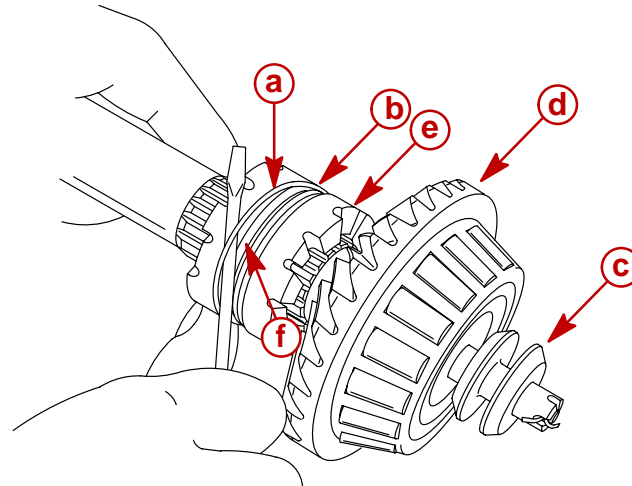
- a** - Puller Shaft (91-31229)
- b** - Nut (11-24156)
- c** - Washer (91-34961)
- d** - Guide Plate (91-816243)
- e** - Puller Head (from Slide Hammer Puller Kit 91-34569A1)
- f** - Jaws (from Slide Hammer Puller Kit)
- g** - Bearing Cup
- h** - Shims



PROPELLER SHAFT ASSEMBLY - Component Disassembly

NOTE: When accomplishing the next step, all of the parts are free to come apart. Work closely over a work bench to ensure that the parts are not dropped or damaged and to avoid personal injury

1. Remove the spring around the clutch being careful not to over-stretch it during removal. If the spring does not coil back to its normal position once it has been removed, it must be replaced.
2. Remove detent pin.
3. Remove the cross pin that goes through the clutch.
4. Remove the remainder of the components

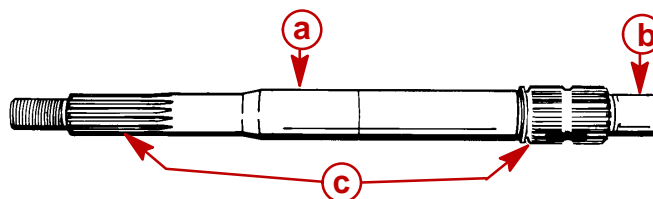


58017

- a - Spring
- b - Cross Pin
- c - Shift Spool Assembly
- d - Forward Gear Assembly
- e - Sliding Clutch
- f - Detent Pin (hidden)

PROPELLER SHAFT ASSEMBLY - Component Inspection

1. Clean all the parts with a suitable solvent and dry the parts thoroughly using compressed air, being careful not to spin bearings
2. Inspect the sliding clutch jaws for damage. Jaws must not be chipped or rounded off. Replace the clutch if they are.
3. Inspect the bearing surfaces on the propeller shaft where the needles of the bearing carrier needle bearing and the needles of the forward gear needle bearing roll. Replace the propeller shaft if it is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.

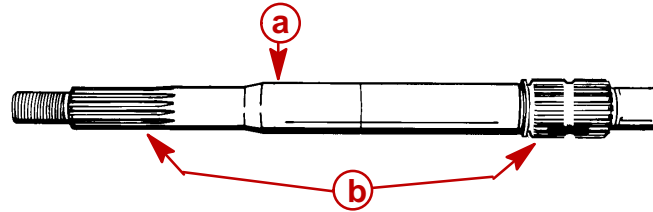


23355

- a - Bearing Carrier Needle Bearing Contact Area
- b - Forward Gear Needle Bearing Contact Area
- c - Splines



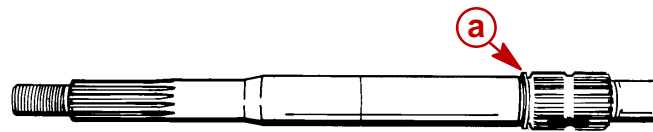
4. Inspect the propeller shaft splines at both ends for a broken, worn, or twisted condition. Replace the propeller shaft if any of these conditions exists.
5. Inspect the surface of the propeller shaft where the bearing carrier seal lips contact the shaft. If the oil seals have made grooves, replace the propeller shaft and oil seals.



23355

- a** - Bearing Carrier Seal Contact Area
- b** - Splines

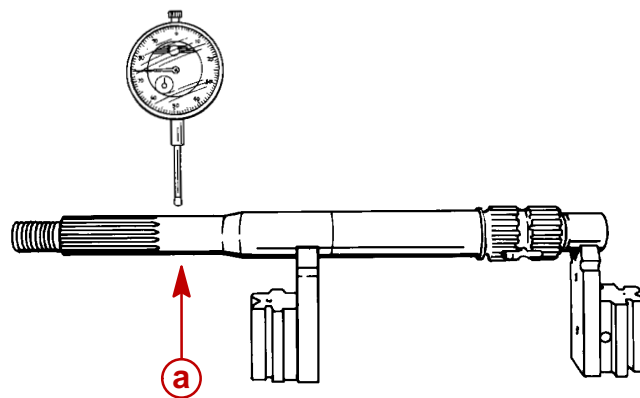
6. Inspect reverse gear thrust washer surface for wear or taper. If surface is worn or tapered, propeller shaft must be replaced.



23355

- a** - Thrust Washer Surface

7. Inspect the propeller shaft for a bent condition.
 - a. **V-Blocks and Dial Indicator**
 - (1.) Position the propeller shaft bearing surfaces on V-blocks.
 - (2.) Adjust the height of V-blocks to level the propeller shaft.
 - (3.) Position the dial indicator tip just forward of the propeller shaft splines.
8. Rotate the propeller shaft and observe the dial indicator movement, If the indicator in the dial moves more than 0.009 in. (0.23mm), replace the propeller shaft.

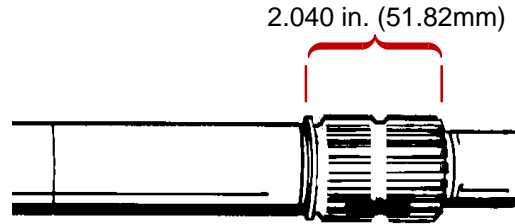


52727

- a** - Check Movement with Dial Indicator (91-58222A1) Here



9. Measure propeller shaft FORWARD to REVERSE shoulder length. If measurement is under 2.040 in. (51.82mm), replace propeller shaft.



23355

10. Inspect REVERSE thrust washer for wear or taper. Measure thickness of washer. If thickness is LESS than 0.240 in. (6.1mm), replace washer

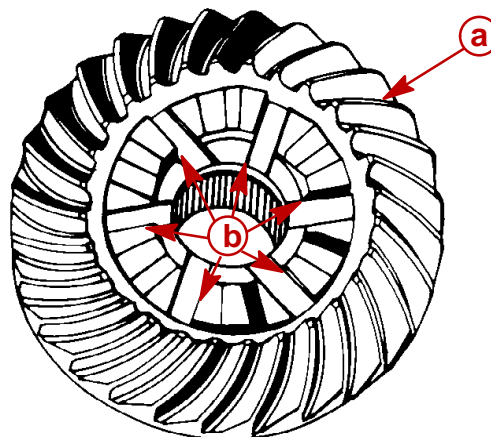
0.240 in. (6.096mm)



Forward Gear Assembly

COMPONENT INSPECTION

1. Clean the forward gear assembly and the forward gear bearing cup with a suitable solvent and dry with compressed air. Be careful not to spin the bearings.
2. Inspect the gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. **Replace the forward gear and the pinion gear as a set** if any defects are found.
3. Inspect the clutch jaws of the gear for damage. The surfaces must not be chipped or rounded off. **Replace both the forward and pinion gear as a set** if any of these conditions exist.

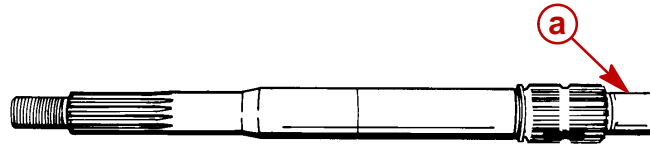


23351

- a** - Forward Gear Teeth
b - Clutch Jaws



4. Inspect the needle bearings on the inside of the forward gear and the bearing surface on the propeller shaft. If either the needle bearing or the bearing surface of the propeller shaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, replace the propeller shaft and remove and replace the needle bearing in the forward gear as outlined in the next section.



23355

a - Forward Gear Needle Bearing Contact Area

5. Inspect the tapered roller bearings on the forward gear and the bearing surface on the forward gear bearing cup. If either the roller bearings or the bearing surface of the forward gear bearing cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, replace the forward gear bearing cup and remove and replace the tapered roller bearings as outlined in the next section.

FORWARD GEAR ASSEMBLY - Component Disassembly

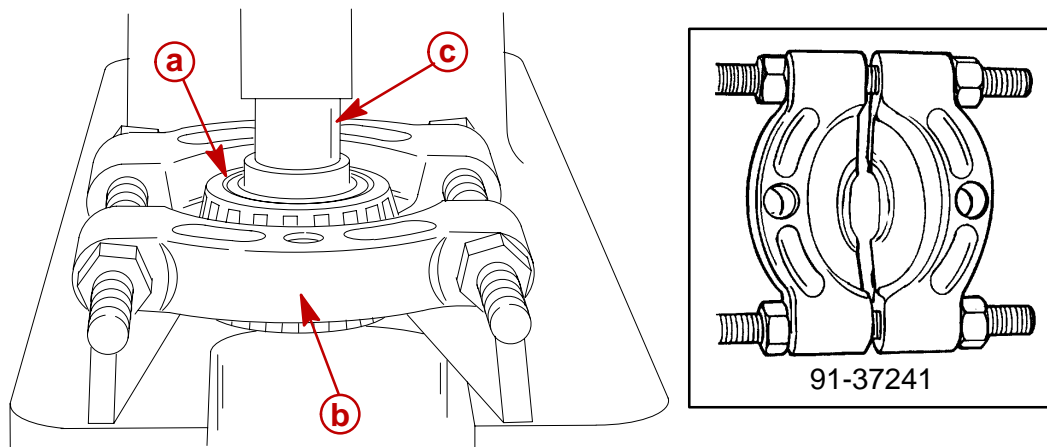
NOTE: Forward gear can only be removed from gear housing after drive shaft and pinion gear have been removed.

1. Reach into gear housing and lift out forward gear.

IMPORTANT: DO NOT remove tapered bearing or needle bearings from forward gear unless replacement of bearings is required. (Bearings cannot be reused after they have been removed.)

2. If inspection determines that replacement of forward gear tapered bearing is required, separate gear from bearing as follows:
 - a. Press Universal Puller Plate (91-37241) between forward gear and tapered bearing.
 - b. Place assembly on press and press gear out of bearing with suitable mandrel.

NOTE: Tapered bearing and race **MUST BE** replaced as a set.

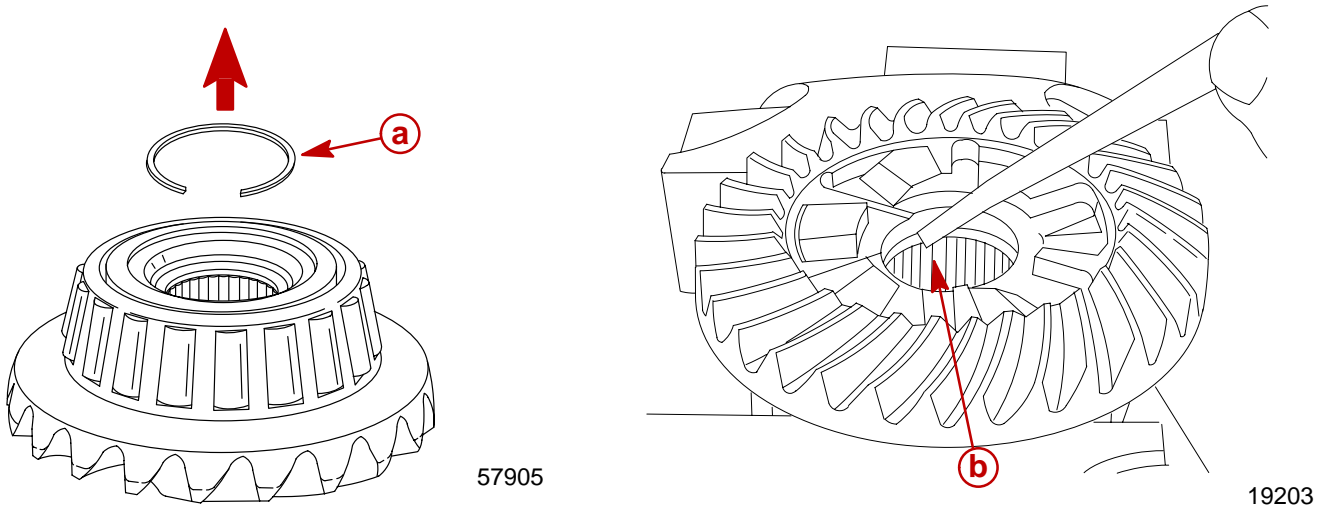


51119

a - Forward Gear Bearing
b - Universal Puller Plate (91-37241)
c - Mandrel



3. If inspection determines that replacement of propeller shaft needle bearings is required, remove bearing as follows:
 - a. Clamp forward gear in a soft jaw vise securely.
 - b. Use suitable tools (screwdriver and awl) to remove retaining ring. Use a punch and hammer to remove bearing.

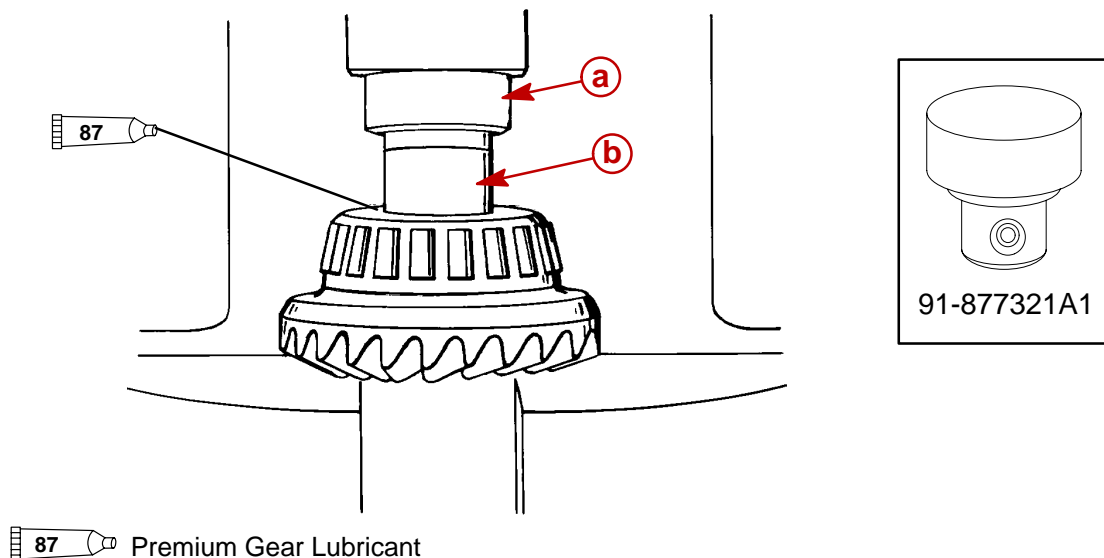


- a** - Retaining Ring
b - Bearing

FORWARD GEAR ASSEMBLY - Component Reassembly

NOTE: Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.

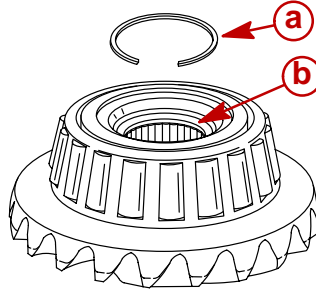
1. Apply Premium Gear Lubricant to I.D. of forward gear. Press bearing into forward gear using Forward Gear Bearing Installer Tool until tool contacts gear.



- a** - Forward Gear Bearing Installer (91-877321A1)
b - Needle Bearing, Numbered Side Toward Installer Tool



2. Install retaining ring into groove of forward gear by starting at one end of retaining ring and working it around until seated in groove.



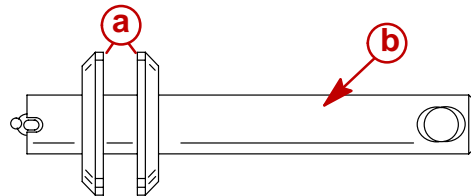
57905

- a** - Retaining Ring
- b** - Groove in Forward Gear

Shift Spool Assembly

INSPECTION

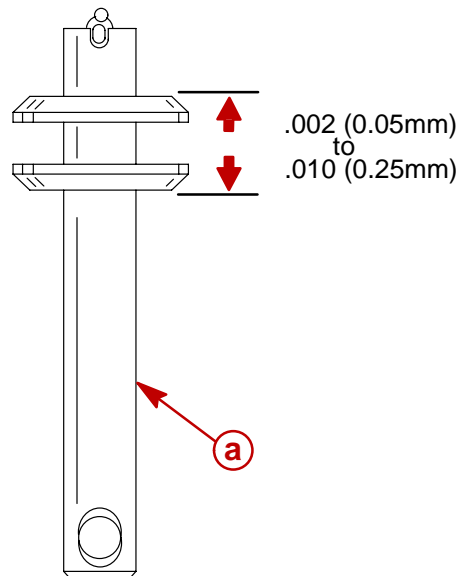
1. Clean the assembly with a suitable solvent and dry the parts using compressed air.
2. Inspect the shift spool assembly for damage. Small nicks and burrs may be smoothed. If any parts are damaged or worn excessively, it will be necessary to replace the complete shift spool assembly. Individual parts are not available for the assembly.
3. Inspect the shift spool for wear in the area where the shift crank comes into contact.



55694

- a** - Contact Area
- b** - Non-Ratcheting Shift Spool

4. Inspect to insure that the spool spins freely (it may be helpful to lightly tap the castle nut end of the shift spool against a firm surface to align the internal parts).
5. Inspect to insure that the spool has 0.002 - 0.010 (0.05 mm - 0.25 mm) end play. This end play may be achieved by turning the castle nut clockwise down until it is snug and then backing off the nut counterclockwise to the first cotter pin slot.



55694



NOTE: If the spool spins freely and has the proper clearance, it will not be necessary to disassemble and reassemble the spool. If the spool does not function properly, proceed with the following disassembly procedures.

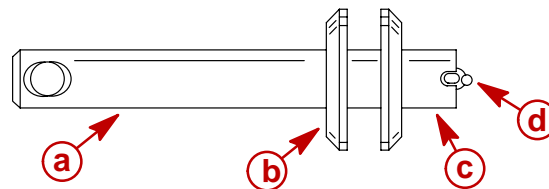
SHIFT SPOOL DISASSEMBLY

NOTE: Disassembly of the shift spool is for cleaning and inspection of the internal parts due to an improperly functioning shift spool assembly or debris in the gear housing and/or shift spool assembly. Individual components for the shift spool are not available as replacement parts. If the shift spool does not function properly and the following cleaning and adjustment procedures do not correct the problem, it will be necessary to order a new shift spool assembly.

1. Remove and discard the cotter pin.
2. Remove the castle nut and spool.
3. Clamp the spool in a vice being careful not to damage the spool.
4. Unscrew the retainer.

SHIFT SPOOL REASSEMBLY

1. Place the shift spool onto the shift spool shaft.
2. Screw the castle nut down until it touches the washer and a slight resistance is felt.
3. Loosen the castle nut until the cotter pin slot of the nut is aligned with the hole in the shaft. If, when the castle nut is screwed down, the cotter pin slot is already aligned at the hole in the shaft, back the castle nut off until the next available slot in the nut is aligned with the hole in the shaft.
4. Insert a new cotter pin and bend ends of the cotter pin in opposite directions.
5. Verify the spool has 0.002 - 0.010 in. (0.05 mm - 0.25 mm) end play. If it does not, readjust the castle nut again.



55694

a - Shift Shaft
b - Spool

c - Castle Nut
d - Cotter Pin

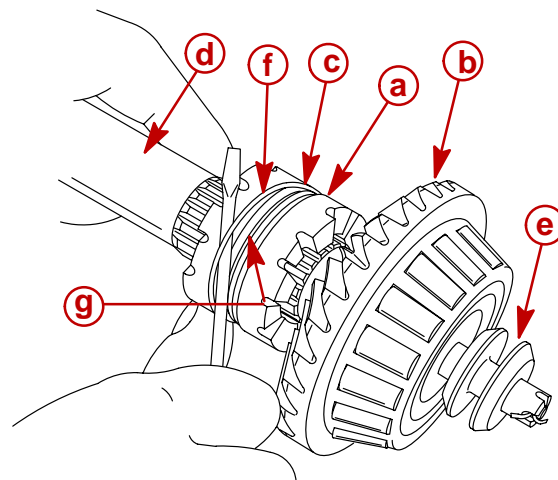
6. If this adjustment did not produce the desired results it will be necessary to disassemble, clean, and reassemble the shift spool assembly. If the spool assembly has already been disassembled and cleaned it will be necessary to replace the shift spool assembly.



Propeller Shaft Assembly

COMPONENT REASSEMBLY

1. Install the sliding clutch on the propeller shaft. Align cross pin holes in the clutch with the slot in the propeller shaft.
2. Assemble the forward gear assembly to the propeller shaft.
3. Assemble the shift spool assembly to the propeller shaft being sure to align the cross pin hole of the shift spool shaft with the clutch.
4. Assemble the cross pin through the sliding clutch, through the propeller shaft and through the shift spool shaft hole.
5. Install detent pin in 3rd hole in clutch.
6. Assemble the cross pin retaining spring over the propeller end of the propeller shaft and wind it around the clutch over the cross pin hole. Be careful not to distort the spring while assembling it. **Make sure that the spring is wound on so that it does not cross over on itself and that it lies flat against the clutch once it is assembled. If it does not lie flat against the clutch, a new spring must be installed.**



58017

- a** - Sliding Clutch
- b** - Forward Gear Assembly
- c** - Cross Pin (hidden)
- d** - Propeller Shaft
- e** - Spool and Actuating Shaft Assembly
- f** - Cross Pin Retaining Spring
- g** - Detent Pin (hidden)

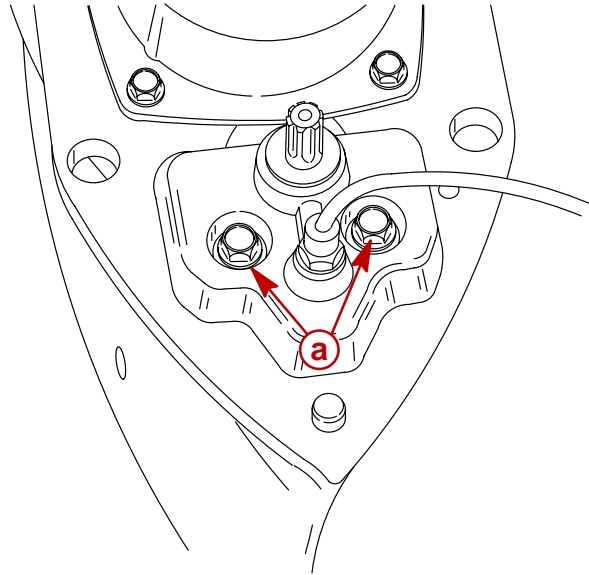


Shift Shaft Assembly

REMOVAL

NOTE: It is possible to remove and service the shift shaft assembly (but not the shift crank inside the gear case) without removing any of the internal components of the gear housing.

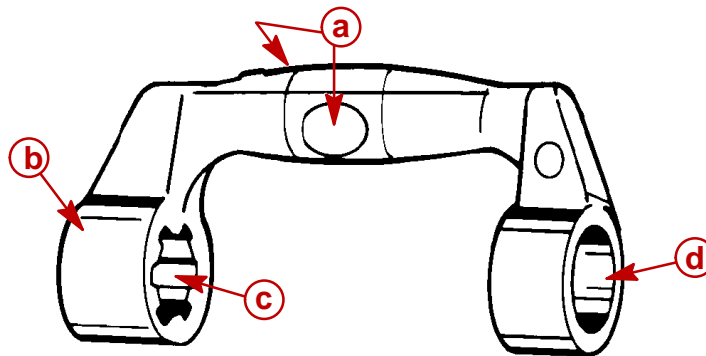
1. Remove the shift shaft bushing screws, and remove the shift shaft and bushing by pulling both straight out of gear housing.



57934

a - Shift Shaft Bushing Screws

2. Remove the shift crank from the inside of the gear housing. Clean it with a suitable solvent and dry it thoroughly. Inspect it for wear in the areas that contact the shift spool and inspect the splines and the diameter that goes over the locating pin for damage or wear.



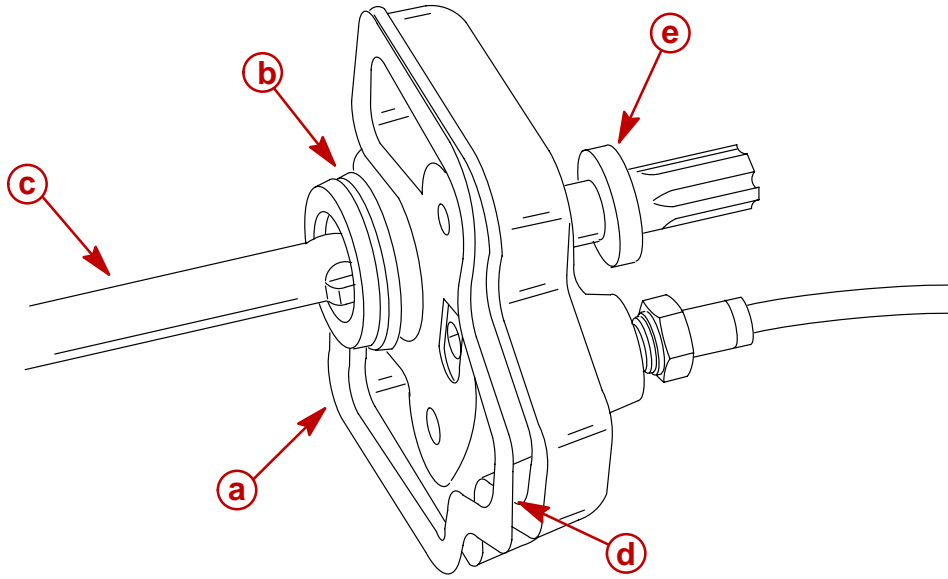
23350

a - Contact Area
b - Shift Crank
c - Splines
d - Diameter for Locating Pin



SHIFT SHAFT ASSEMBLY - Component Disassembly and Inspection

1. Slide the bushing assembly off the shift shaft. Remove the coupler from the shaft.

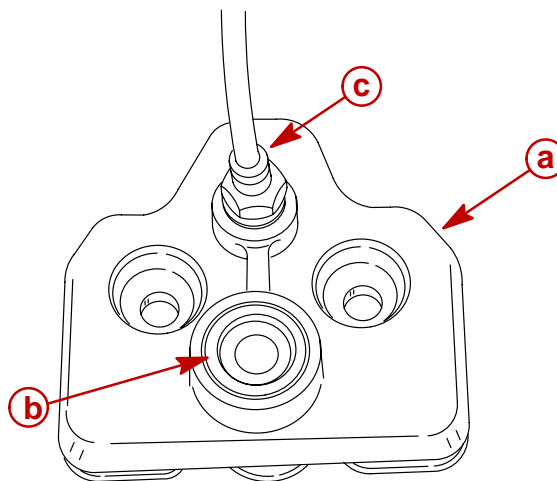


57954

- a** - Shift Shaft Bushing Assembly
- b** - O-ring
- c** - Shift Shaft
- d** - Gasket
- e** - Rubber Washer

2. Clean all components with a suitable solvent and dry thoroughly with compressed air.
 - a. Inspect the shift shaft bushing for cracking, damage, or excessive wear.
 - b. Inspect the oil seal inside the bushing, the sleeve, and the O-rings on the outside of the bushing for damage or excessive wear.
 - c. Inspect the speedometer connector for damage or blockage.

If any of these conditions exist, replace the appropriate components.

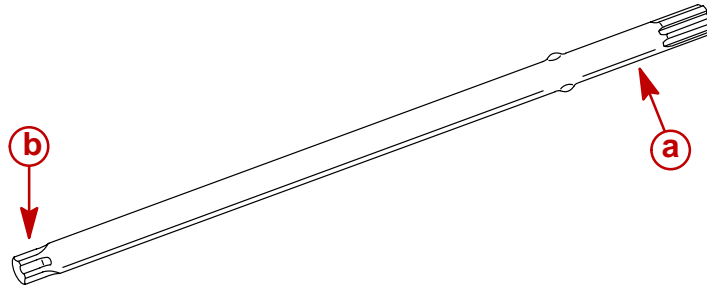


57932

- a** - Shift Shaft Bushing
- b** - Oil Seal (Oil Seal is Replaceable)
- c** - Speedometer Tube Connector



3. Inspect the shift shaft splines and oil seal surface for corrosion and/or excessive wear. Replace the shift shaft if either if these conditions are found.

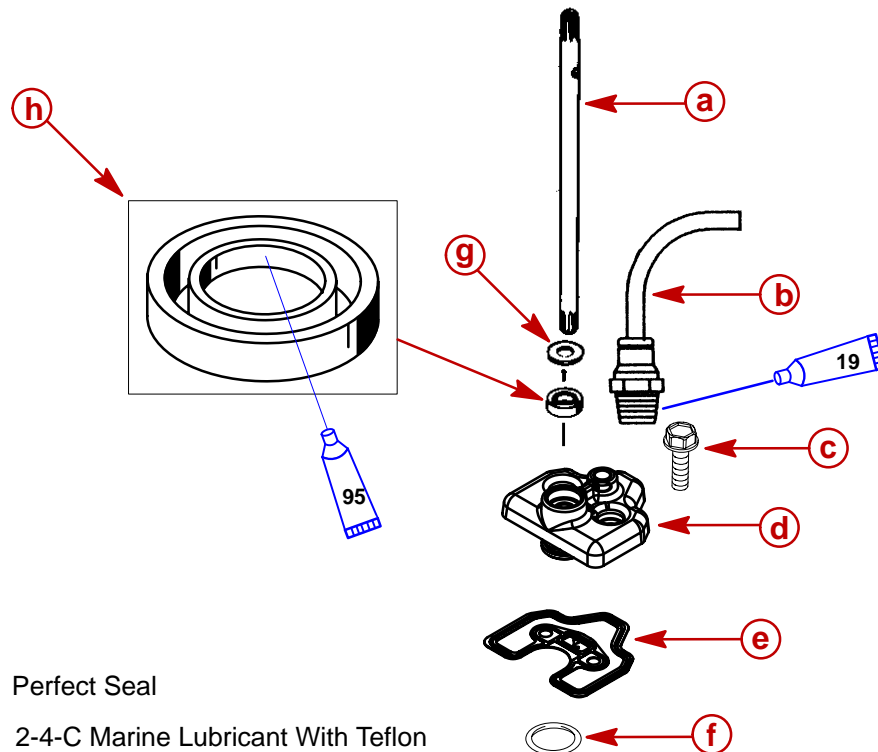


57948

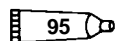
- a** - Oil Seal Surface
b - Spline

SHIFT SHAFT ASSEMBLY - Component Reassembly

1. Lightly lubricate the seat of the O-ring diameter on the bushing and the lip of the oil seal with 2-4-C Marine Lubricant with Teflon.
2. If the speedometer connector was removed and/or replaced, lightly coat the **threads of the connector** with Perfect Seal. Assemble the speedometer connector to the bushing and torque the connector to 4.5 lb. in. (0.5 Nm).
3. Assemble all components as shown below.



 Perfect Seal

 2-4-C Marine Lubricant With Teflon

- a** - Shift Shaft
b - Speedometer Pressure Hose
c - Bolt (2) [Torque to 60 lb. in. (7 Nm)]
d - Bushing
e - Gasket
f - O-ring
g - Rubber Washer
h - Seal (Lip Faces Up)



Pinion Bearing

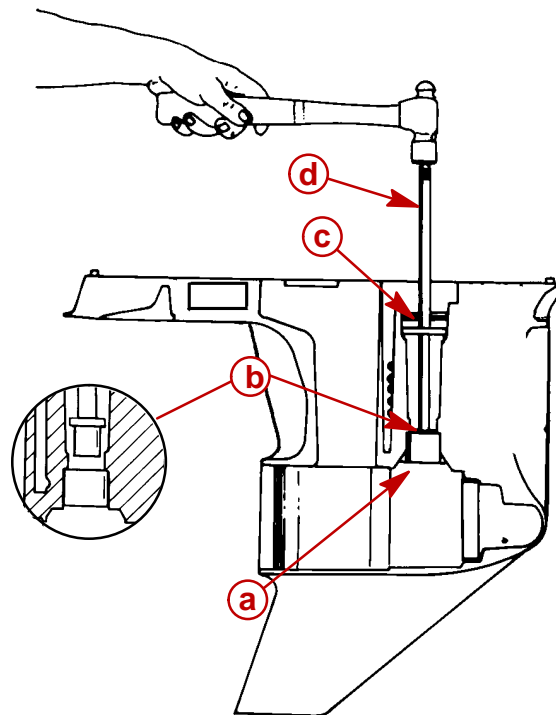
REMOVAL

NOTE: *Inspect the bearing surface on the drive shaft where the needles of the lower pinion bearing roll. The condition of the drive shaft at this location gives an indication of the condition of the needle bearing. Replace lower pinion bearing (needles and race as a set) if the drive shaft is pitted, grooved scored, worn unevenly, discolored from overheating, or has embedded particles.*

IMPORTANT: All the needle bearings (18) **MUST BE** in place inside bearing race while driving the pinion bearing from the gear housing.

IMPORTANT: Do not reuse the bearing (race or rollers) once it has been removed.

1. Remove and discard the pinion bearing (race and rollers) using tools as shown.



70614

- a** - Pinion Bearing
- b** - Bearing Driver (91-36569)
- c** - Pilot Washer (91-36571)
- d** - Driver Rod (91-37323)



Gear Housing Reassembly

Gear Housing Inspection

1. Clean the gear housing thoroughly with a suitable solvent and a hard bristle brush. Dry the gear housing thoroughly using compressed air. Insure that all sealants, locking agents and debris are removed.
2. Verify the 2 oil circulation holes in the drive shaft bore and the shift shaft hole are clear and free of debris.
3. Inspect the gear housing for excessive corrosion, impact or any other damage. Excessive damage and/or corrosion requires replacement of the gear housing.
4. Inspect the bearing carrier retainer threads in the gear housing for corrosion and/or stripped threads. Damage or corrosion to the threads requires replacement of the gear housing.
5. Inspect bearing race/cup contact areas for evidence of bearing cup spinning. Check that bearing cups are not loose in bearing bores. Any one bearing bore in which the race/cup is loose will require replacement of the gear housing.
6. Inspect for blockage in water inlet holes and the speedometer hole, clean as necessary. Be careful not to enlarge the speedometer hole as this could cause erroneous speedometer readings.
7. Verify that the locating pins are in place in the gear housing and that the corresponding holes in the drive shaft housing are not elongated. The drive shaft may break if the housings are not aligned properly due to missing locating pins or elongated holes.

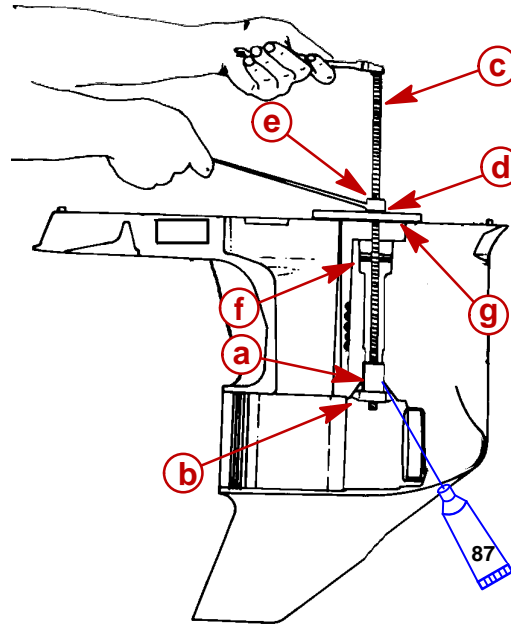


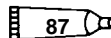
Pinion Bearing

INSTALLATION

IMPORTANT: Install only a new pinion bearing. Do not reinstall a pinion bearing that has been previously removed from a gear housing.

1. Lubricate the bore into which the pinion bearing is to be installed with Premium Gear Lubricant.
2. Position the new pinion bearing (with the cardboard shipping sleeve in place) onto the driver head, with the lettered and numbered side of the bearing oriented upward.
3. Insert the driver with the bearing assembly, into position (by way of the propeller shaft bore) at the drive shaft bore as shown.



 Premium Gear Lubricant

70615

- a** - Drive Shaft Pinion Bearing (With Cardboard Shipping Sleeve)
- b** - Driver Head (91-38628)
- c** - Puller Shaft (91-31229)
- d** - Washer (12-34961)
- e** - Nut (11-24156)
- f** - Pilot Washer (91-36571)
- g** - Puller Plate (91-29310)

4. Install the bearing by screwing down the nut until the bearing is fully seated against the bore shoulder.



Forward Gear Bearing Cup

INSTALLATION

Forward Gear Backlash – .017 in. to .028 in. (0.43mm to 0.71mm)

NOTE: If the forward gear, forward gear bearing and cup, or gear housing were not replaced, install the same quantity of shims that were taken out when cup was removed. If the forward gear, forward gear bearing/cup, or gear housing were replaced, install 0.020 in. (0.51mm) of shims.

NOTE: If backlash has already been checked and it was determined that it needs to be adjusted, (see *Checking Forward Gear Backlash*), adding or subtracting 0.001 in. (0.03mm) shims will **change** the gear backlash by the same amount.

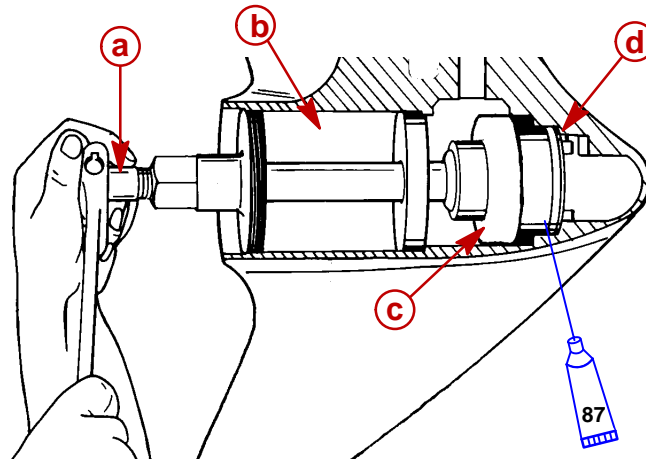
Example 1 (if backlash is too high)		
If Forward Backlash Checks:	.040 in.	(1.02 mm)
(Subtract):	.018 in.	(0.46 mm)
Add This Quantity of Shims:	.022 in.	(0.56 mm)
Provides Backlash of 0.018		(0.46 mm)
Example 2 (if backlash is too low)		
Backlash Checks:	.010 in.	(0.25 mm)
Subtract this Quantity of Shims:	.008 in.	(0.30 mm)
Provides Backlash of 0.018		(0.46 mm)

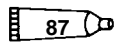
1. Lubricate the bore into which the forward gear bearing cup is to be installed with Premium Gear Lubricant.
2. Place the shim(s) into forward bore of gear housing.



3. Press the bearing cup into the gear housing using the installation tool as follows:

IMPORTANT: Verify that the bearing cup is positioned as straight as possible to avoid cocking it in the bore while pressing it in.



 Premium Gear Lubricant

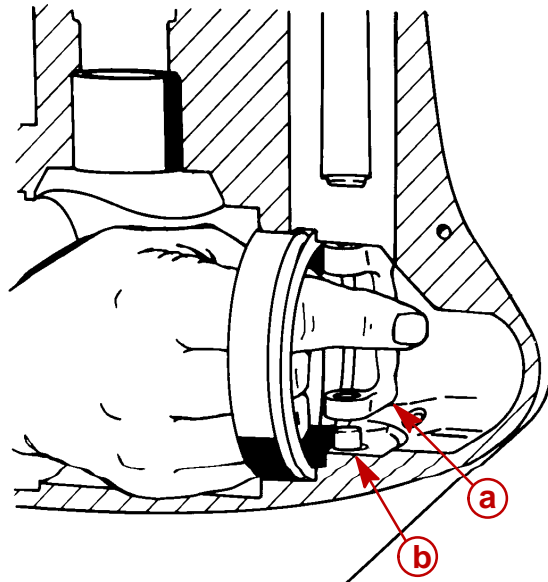
50791

- a** - Hex-Head Screw
- b** - Bearing Cup Installation Tool (91-18605A1)
- c** - Driver Cup (91-31106)
- d** - Shims

Shift Shaft Assembly

INSTALLATION

1. Place the shift crank onto the locating pin in the forward section of the gear housing. Ensure that the shift crank faces towards the left (port) side of the gear housing.

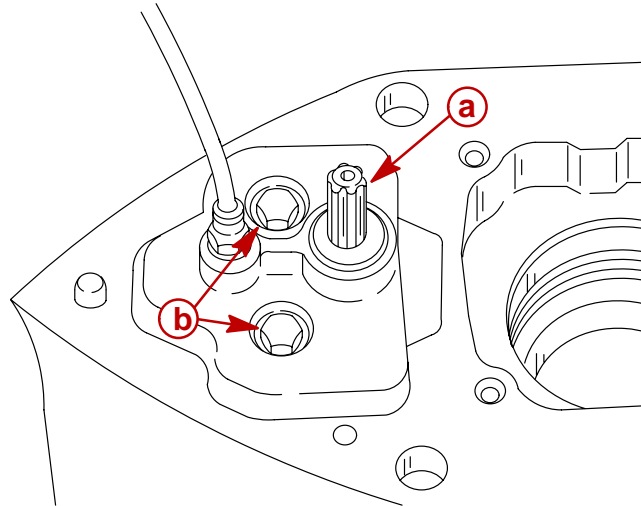


50314

- a** - Shift Crank
- b** - Locating Pin



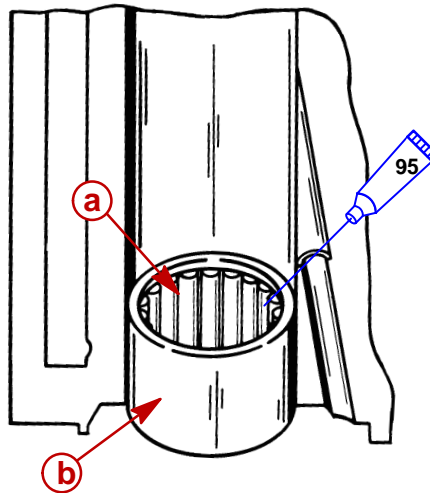
2. Install the shift shaft assembly into the gear housing as shown. Engage the splined end of the shift shaft with the shift crank. Verify O-ring is positioned properly and lubricated with 2-4-C Marine Lubricant with Teflon. Secure shift shaft bushing with 2 screws. Torque screws to 60 lb. in. (7 Nm).

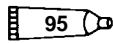


57933

- a - Shift Shaft Assembly
- b - Screws [Torque to 60 lb. in. (7 Nm)]

NOTE: If the pinion bearing needle bearings have fallen out, install 18 needles into needle bearing outer race. Use 2-4-C Marine Lubricant with Teflon, to help hold needles in place.



 2-4-C Marine Lubricant With Teflon

23142

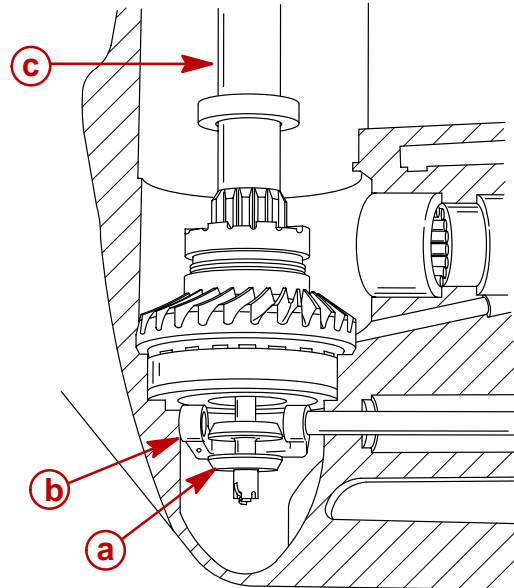
- a - Rollers (18)
- b - Roller Bearing Outer Race



Propeller Shaft Assembly

INSTALLATION

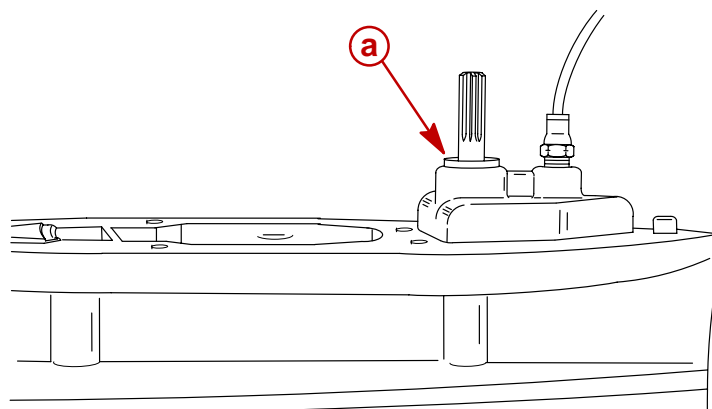
1. To allow for the engagement of the shift spool with the shift crank, tilt the propeller end of the propeller shaft assembly to the left (port) side of gear housing and rotate the shift shaft from reverse to neutral while installing shaft.



58016

- a** - Shift Actuating Spool
- b** - Shift Crank
- c** - Propeller Shaft Assembly

2. Operate the shift shaft to ensure that it has been properly installed. The sliding clutch should move forward when the shift shaft is turned clockwise, and should move aft when the shift shaft is turned counterclockwise.
3. Slide the rubber washer at top end of shift shaft down so that it just touches the oil seal in the bushing.



57947

- a** - Rubber Washer



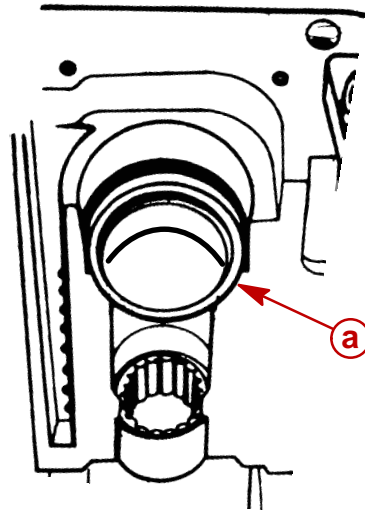
Drive Shaft and Pinion Gear

INSTALLATION

NOTE: If the original shims were not retained or if pinion gear, drive shaft, drive shaft upper tapered roller bearing and cup, or gear housing were replaced, start off by installing a 0.038 in. (0.96 mm) shim(s), for the upper tapered roller bearing.

NOTE: If the original shims were retained (or measurement known) and none of the above listed parts were replaced, reinstall the same shims or same amount of shims.

1. Place the upper tapered bearing shim(s) into the drive shaft housing bore.



70620

a - Shim(s)

NOTE: For ease of installation, glue the washer to the pinion gear, using 3M Adhesive, Bellows Adhesive, or equivalent.

NOTE: If the backlash may have to be changed, it is recommended that Loctite 271 NOT be applied to the pinion nut UNTIL the backlash setting is finalized. DO NOT reuse the old pinion nut. Install a NEW pinion nut after backlash is finalized.

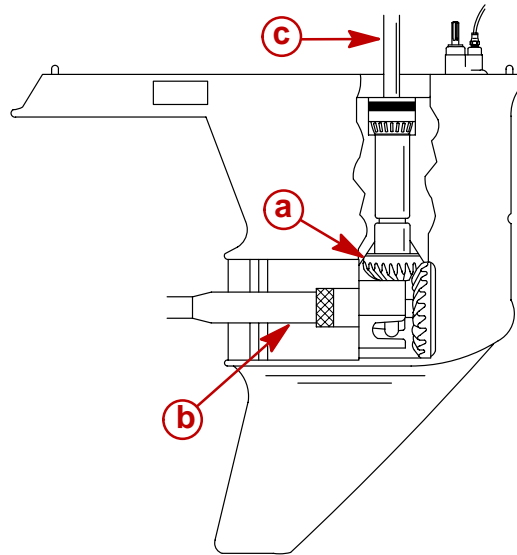
NOTE: Do not install the lower tapered bearing cup or shim(s) at this time.



2. Apply Loctite 271 to the threads of the pinion gear nut and place the pinion gear nut into the MR slot of the pinion nut adapter.

NOTE: Install the pinion gear nut with the flat side of the nut away from the pinion gear.

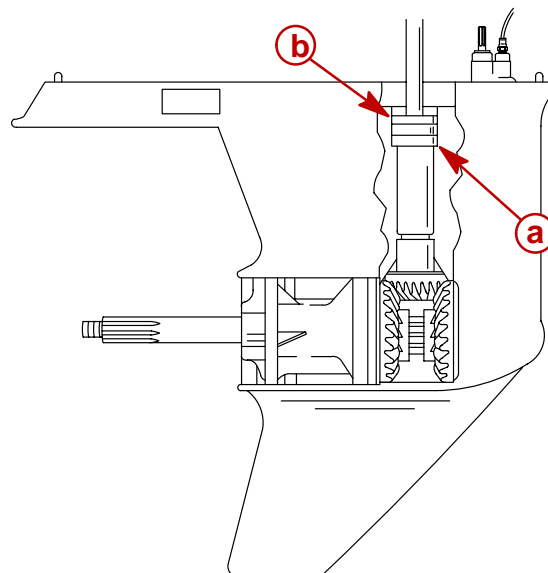
3. Place the pinion gear and washer into the gear housing.
4. Insert the pinion nut adapter (with the nut) into the gear housing.
5. Insert the drive shaft into the gear housing drive shaft bore. It may be necessary to rotate the drive shaft to engage the drive shaft splines into the pinion gear splines.
6. Start the pinion nut onto the drive shaft threads by rotating the drive shaft until the nut is snug.



57952

- a** - Pinion Gear (with the washer glued to it)
- b** - Pinion Nut Adaptor (91-61067A2)
- c** - Drive Shaft

7. Install the upper drive shaft tapered roller bearing cup. Apply 2-4-C Marine Lubricant with Teflon to the retainer threads and install the retainer.

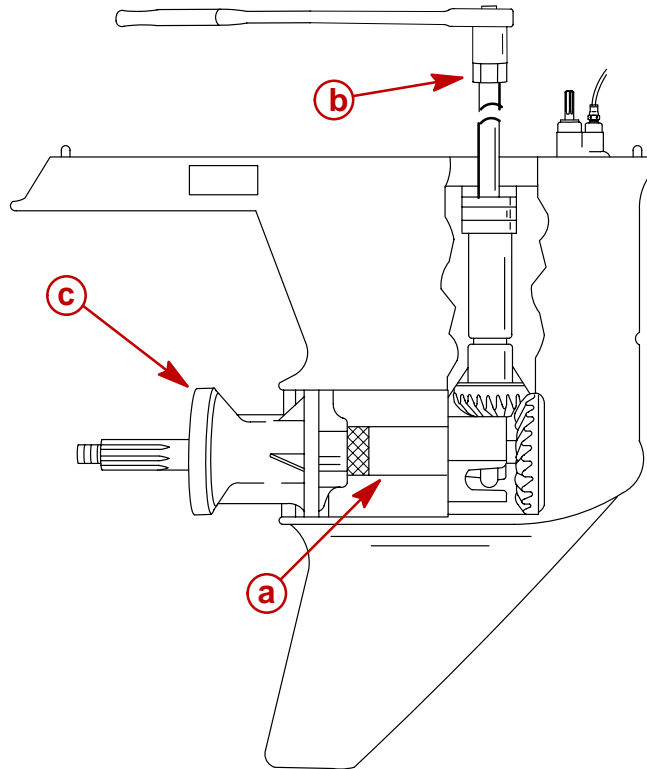


57953

- a** - Tapered Roller Bearing Cup
- b** - Drive Shaft Retainer



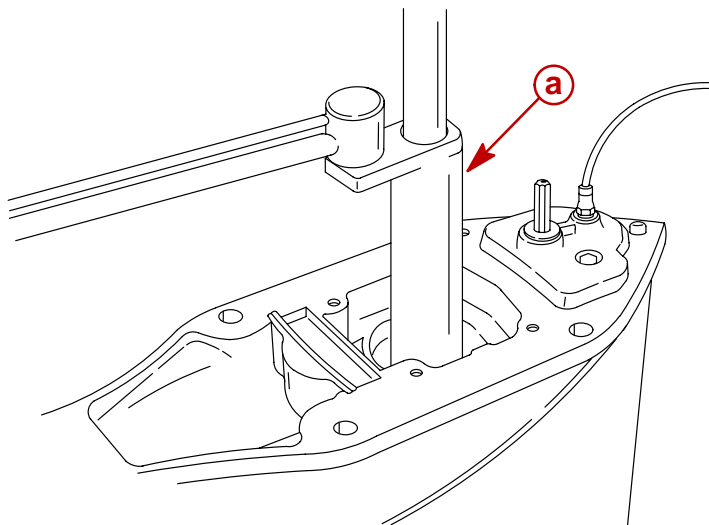
8. Install the bearing carrier into the gear housing backwards to hold the propeller shaft and the pinion nut adaptor in position.
9. Torque the pinion nut to 75 lb. ft. (102 Nm) by turning the drive shaft using the drive shaft nut wrench and torque wrench.



57950

- a** - Pinion Nut Adapter (91-61067A2)
- b** - Drive Shaft Nut Wrench (91-56775)
- c** - Bearing Carrier (installed backwards)

10. Remove the bearing carrier, pinion nut adaptor and drive shaft nut wrench.
11. Torque the retainer to 100 lb. ft. (135 N·m).



57935

- a** - Drive Shaft Bearing Retainer Wrench (91-43506)

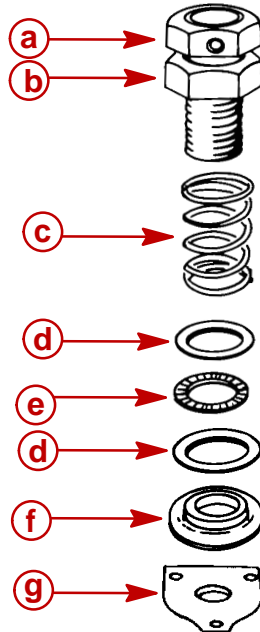


Gear Location/Backlashes/Checking and Adjustment

Drive Shaft - Bearing Preload Tool

INSTALLATION

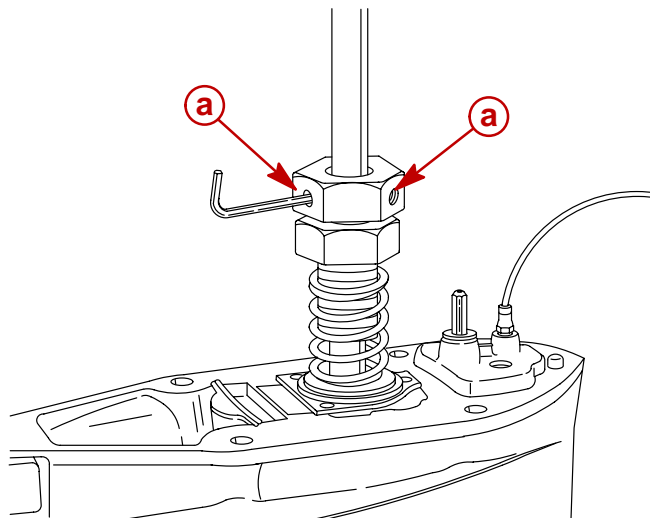
1. Install the components from the Bearing Preload Tool Kit (91-14311A2), over the drive shaft in the order shown.



- a** - Top Nut with Threaded Pipe
- b** - Nut
- c** - Spring
- d** - Thrust Washer (2 Required) (12-18448)
- e** - Thrust Bearing
- f** - Thrust Washer
- g** - Plate

70496

2. Pull up on the drive shaft and tighten the two (2) allen screws in the top nut of the bearing preload tool.

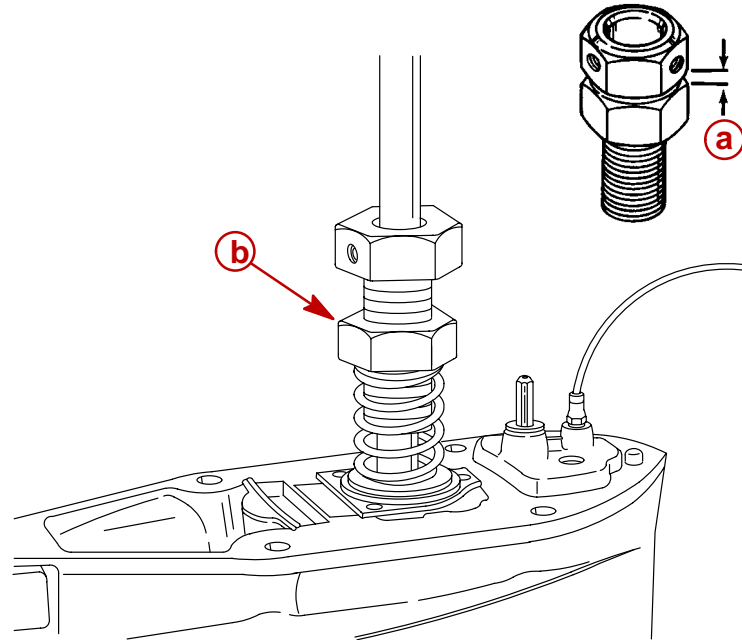


- a** - Allen Screws

57936



3. Measure distance (a) and increase that distance by 1 in. (25.4mm) by turning bottom nut away from top nut.



57937

- a - Distance 1 in. (25.4mm)
- b - Bottom nut [screwed down approximately 1 in. (25.4mm)]

Pinion Gear Location

CHECKING AND ADJUSTING

Pinion Depth – 0.025 in. (0.64mm)

NOTE: If the bearing preload tool has not already been set up, refer to “Drive Shaft - Bearing Preload Tool”, ‘Installation’ section first.

NOTE: The prop shaft and forward gear can be installed when checking pinion height IF Pinion Height Tool 91-56048 is used.

1. Place the pinion gear shimming tool into the gear housing.

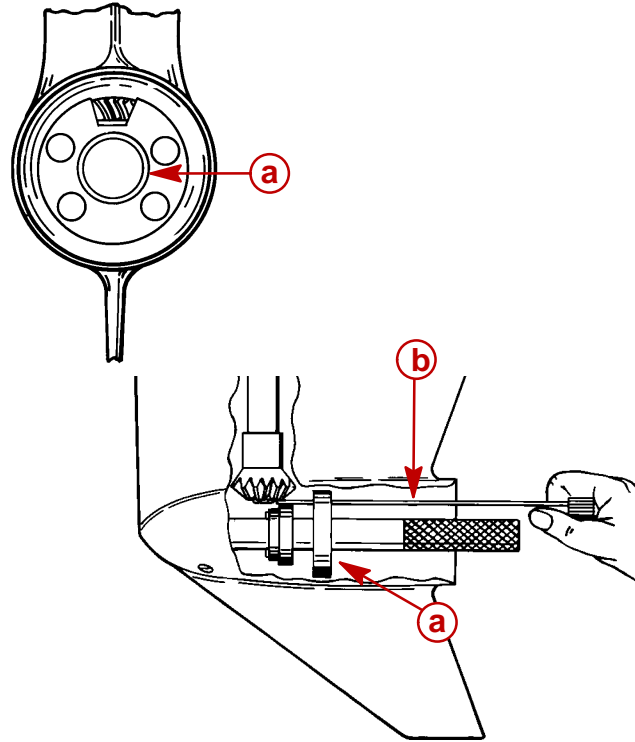
NOTE: Take the following measurements at 3 locations, rotating the drive shaft 120 degrees between each reading (always rotate the drive shaft in a clockwise direction).

2. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and high point of the shimming tool.
3. Rotate the drive shaft 120 degrees in a clockwise direction and take another reading.
4. Repeat this process until 3 readings have been taken.
5. Add the three readings together and divide the sum by 3 to get the average pinion gear height. Make note of this average measurement.

The average pinion gear height should be 0.025 in. (0.64mm).



6. If the average pinion gear height is not correct, remove the bearing preload tool, the drive shaft retainer and the drive shaft tapered roller bearing cup. (The cup can be removed by wiggling the drive shaft back and forth or by turning gear housing and shaking it.) Add or subtract shims beneath the cup to obtain the proper average pinion gear height. Reinstall the cup and retainer. Retorque retainer to 100 lb. ft. (135 Nm). Reinstall the bearing preload tool and rotate the drive shaft at least 3 full turns in a clockwise direction. Recheck the pinion gear height as in step 5 above. Repeat this process until the average pinion gear height is within specification.



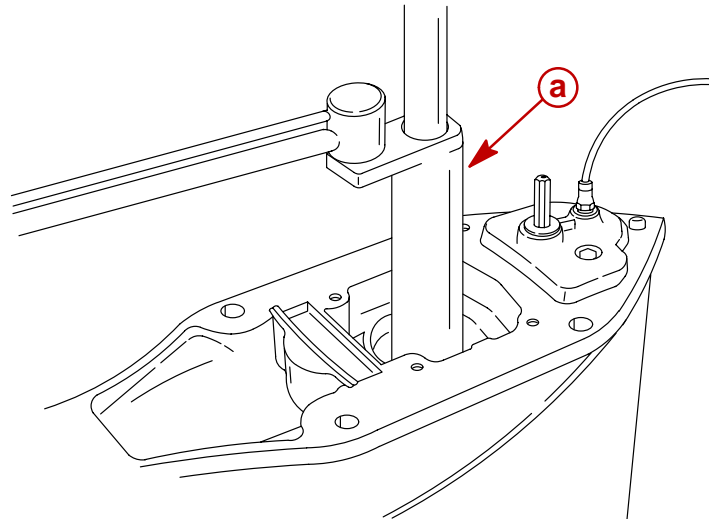
24643

- a** - Pinion Gear Shimming Tool (91-12349A2) Using Disc #2 and Flat #4
- b** - 0.025 in. (0.64mm) Feeler Gauge



UPPER DRIVESHAFT BEARING CLEARANCE

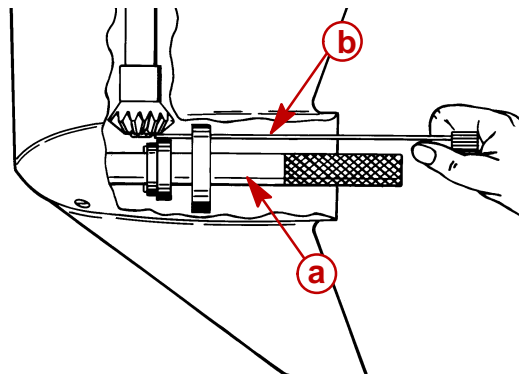
1. When the correct pinion gear height is achieved, remove pinion nut, upper retainer and driveshaft.
2. Apply Premium Gear Lubricant to O.D. of the driveshaft lower bearing cup and install cup into the gear case.
3. Reinstall driveshaft and pinion gear into gear case.
4. Install the upper drive shaft bearing cup and install and torque the upper bearing retainer to 100 lb. ft. (135 Nm).
5. Torque pinion nut to 70 lb. ft. (95 Nm).



57935

a - Bearing Retainer Tool (91-43506)

6. Push down on drive shaft and check clearance between pinion gear and pinion gear shimming tool shoulder. Clearance should be 0.020 in - 0.024 in. (0.51 mm - 0.61 mm).



a - Pinion Gear Shimming Tool (91-12349A2) Using Disc #2 and Flat #4

b - Feeler Gauge

NOTE: Do not change shims under upper bearing cup or pinion height will be changed.

7. Maintain the shims as previously set under the upper drive shaft bearing cup.
8. If clearance is not within specifications, remove the upper bearing cup retainer with tool 91-43506 and remove cup. Leave upper cup shim(s) in place.

NOTE: A 0.001 in. (25.4 mm) change of shims under the lower bearing cup will result in a 0.001 in. (25.4 mm) change in drive shaft end play.



- With new shim(s) under lower bearing cup, reinstall upper bearing cup and torque cup retainer to 100 lb. ft. (135.5 Nm). Recheck drive shaft clearance.

NOTE: Install a NEW pinion nut with Loctite 271 AFTER all clearances are correct.

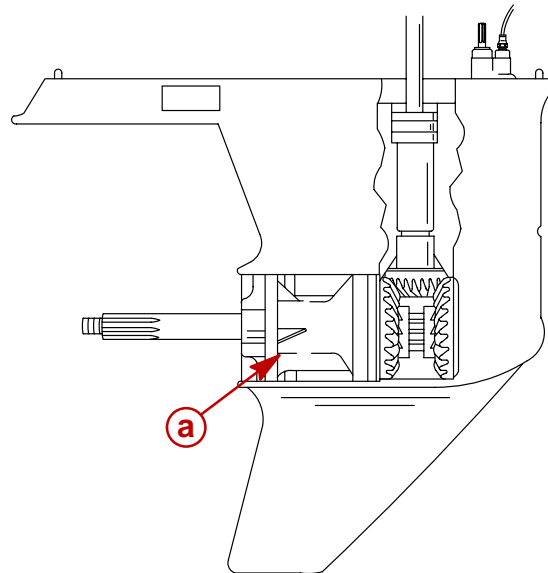
- If clearance is correct, clean drive shaft threads and apply Loctite 271 and install a new pinion nut. Torque nut to 75 lb. ft. (102 Nm).

Bearing Carrier Assembly

INSTALLATION - (FOR CHECKING BACKLASHES)

NOTE: If backlashes have already been checked and they are to specification proceed with "Bearing Carrier Assembly", 'Final Installation' section

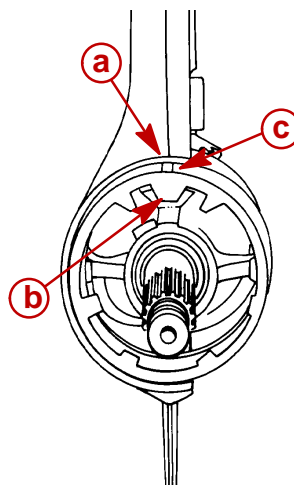
- Place the bearing carrier assembly into the gear housing. It may be necessary to turn the drive shaft to align the teeth of the pinion and the reverse gears.



57953

a - Bearing Carrier Assembly

- Align the bearing carrier "V" shaped notch with the alignment hole in the gear housing and then install the tab washer with the external tab inserted into the hole in the gear housing.

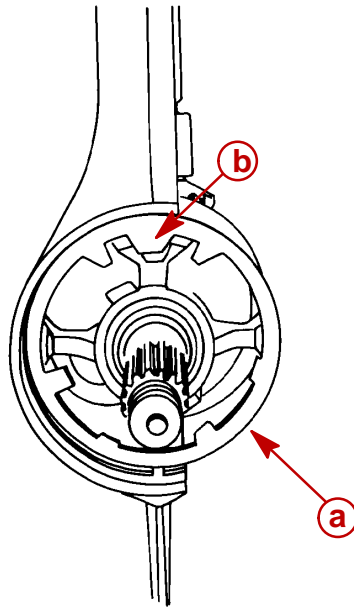


70713

a - Gear Housing Tab Washer Alignment Hole (not seen)
b - "V" Shaped Notch in Bearing Carrier
c - Alignment Tab of Tab Washer



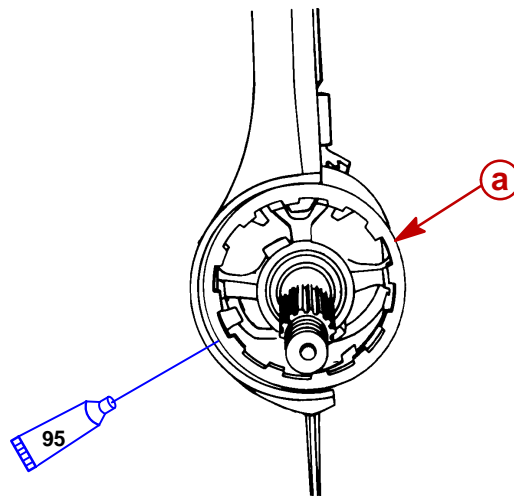
3. Verify that the “V” shaped tab aligns with the “V” notch in bearing carrier.

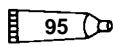


70714

- a - Tab Washer
- b - “V” Tab

4. Lubricate the bearing carrier retainer threads with 2-4-C Marine Lubricant with Teflon. Start the retainer into the gear housing threads and screw it down fully by hand.



 2-4-C Marine Lubricant with Teflon

70715

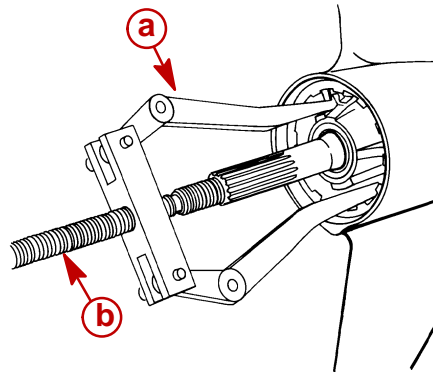
- a - Bearing Carrier Retainer



Forward Gear Backlash

CHECKING

1. Apply forward pressure to propeller shaft as follows:
 - a. Attach puller jaws and puller bolt onto bearing carrier bosses and propeller shaft.



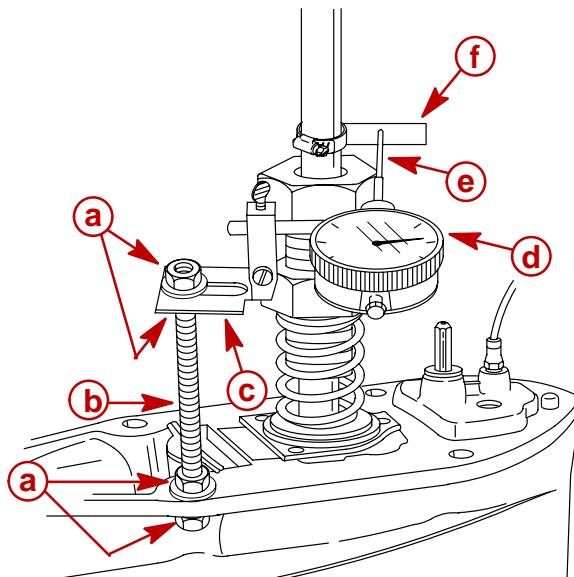
70719

- a** - Puller Jaws (91-46086A1)
- b** - Puller Bolt (91-85716)

- b. Torque the puller bolt to 45 lb. in. (5 Nm). Rotate drive shaft three full turns clockwise and retorque the bolt to 45 lb. in. (5 Nm).

NOTE: If the bearing preload tool has not already been set up, see "Drive Shaft - Bearing Preload Tool", 'Installation' section.

2. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the "I" mark on the dial indicator tool. Tighten the indicator tool onto the drive shaft and rotate the drive shaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.



57939

- a** - Nuts (4) (Obtain Locally)
- b** - Threaded Rod [3/8 in. (9.5mm) obtain locally]
- c** - Dial Indicator Holding Tool (91-83155)
- d** - Dial Indicator (91-58222A1)
- e** - Indicator Pointer
- f** - Backlash Indicator Rod (91-53459) (for 1.75:1)
Backlash Indicator Rod (91-78473) (for 1.87:1 ratio)



3. Take the backlash readings by lightly turning the drive shaft back and forth, (no movement should be noticed at the propeller shaft).
 - a. Observe the dial indicator and record the reading.
 - b. Loosen the indicator tool and rotate the drive shaft 90 degrees in a clockwise direction.
 - c. Repeat step 2 above and take and record another reading. Repeat step 3 until a total of 4 backlash readings have been taken.
4. Add the four readings together and divide the sum by four. This is your average backlash, which should be 0.017 in. - 0.028 in. (0.431 mm - 0.711 mm) (for 1.64:1; 1.75:1 and 1.87 ratios).
5. If backlash is LESS than the specified minimum, REMOVE shim(s) from in front of forward gear bearing race to obtain correct backlash. When reinstalling pinion nut, apply Loctite 271 to threads of nut.
6. If backlash is MORE than the specified MAXIMUM, add shim(s) in front of forward gear bearing race to obtain correct backlash. When reinstalling pinion nut, apply Loctite 271 to threads of nut.

NOTE: By adding or subtracting 0.001 in. (0.025 mm) shim, the backlash will change approximately 0.001 in. (0.025 mm).

Reverse Gear Backlash

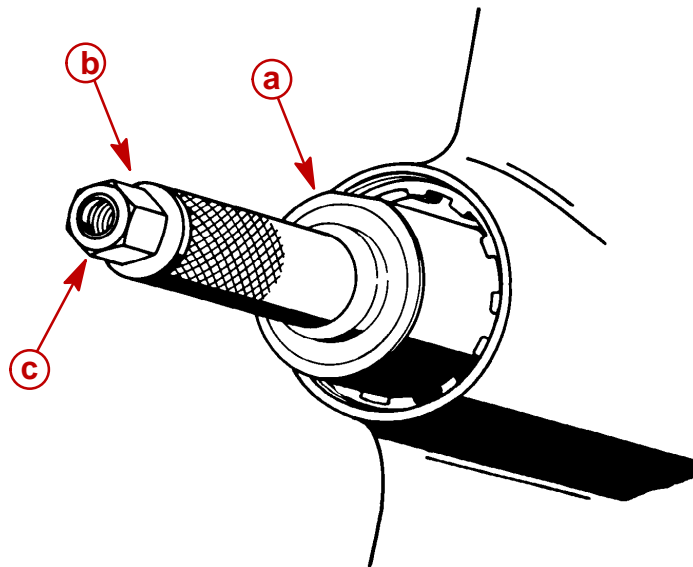
CHECKING

Reverse Gear Backlash – 0.030 in. to 0.050 in. (0.76mm to 1.27mm)

Although reverse gear backlash is not adjustable, it may be checked as follows:

NOTE: Torque cover nut to 210 lb. ft. (285 Nm).

1. Apply backward pressure on the propeller shaft as follows:
 - a. Install the pinion nut adaptor, washer and propeller nut as shown.



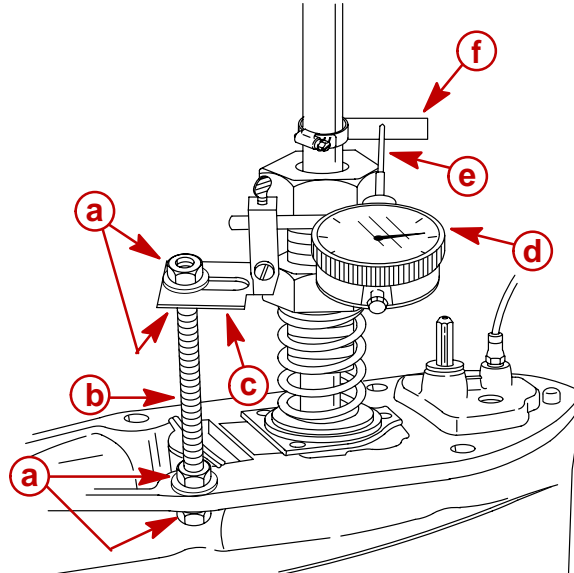
23355

- a - Pinion Nut Adaptor (91-61067A2)
- b - Washer (12-54048)
- c - Prop Nut

- b. Torque the propeller nut to 45 lb. in. (5 Nm). Rotate the drive shaft 3 full turns in a clockwise direction and retorque the propeller nut to 45 lb. in. (5 Nm).



2. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the "I" mark on the dial indicator tool. Tighten the indicator tool onto the drive shaft and rotate the drive shaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.



57939

- a - Nuts (4) (Obtain Locally)
 - b - Threaded Rod [3/8 in. (9.5mm) obtain locally]
 - c - Dial Indicator Holding Tool (91-83155)
 - d - Dial Indicator (91-58222A1)
 - e - Indicator Pointer
 - f - Backlash Indicator Rod (91-53459) (for 1.75:1)
Backlash Indicator Rod (91-78473) (for 1.87:1 ratio)
3. Take the backlash readings by lightly turning the drive shaft back and forth, so as to feel the backlash between the gears, (no movement should be noticed at the propeller shaft).
 - a. Observe the dial indicator and record the reading.
 - b. Loosen the indicator tool and rotate the drive shaft 90 degrees in a clockwise direction.
 - c. Repeat step 2 above and take and record another reading. Repeat step 3 until a total of 4 backlash readings have been taken.
 4. Add the four readings together and divide the sum by four. This is your average backlash and it should be 0.030 in. - 0.050 in. (0.76mm - 1.27mm) (for 1.75:1 and 1.87:1 ratios). If backlash is not as indicated, gear case is not properly assembled or parts are excessively worn and must be replaced before returning gear case to service.
 5. Loosen the backlash indicator tool and remove the propeller nut, washer and pinion nut adaptor. Remove the dial indicator and all its mounting components. **Do not remove the bearing preload tool. The following instructions give specific instructions for its removal.**



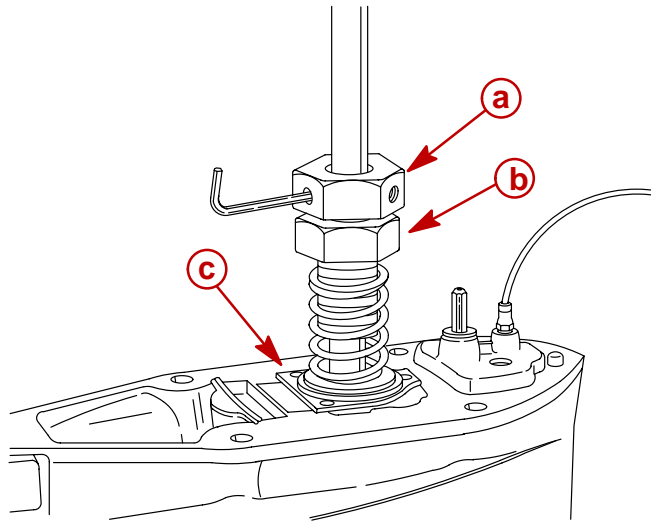
Drive Shaft - Bearing Preload Tool

REMOVAL

CAUTION

Before loosening the top nut allen screws of the bearing preload tool, screw the bottom nut up as close as possible to the top nut.

1. Remove the dial indicator and its supporting tooling.
2. Screw the bottom nut of the bearing preload tool until it is as close as possible to top nut.
3. Loosen the allen screws in the top nut.
4. Remove all components including the water pump face plate.



- a** - Top Nut (with allen screws)
- b** - Bottom Nut
- c** - Water Pump Face Plate

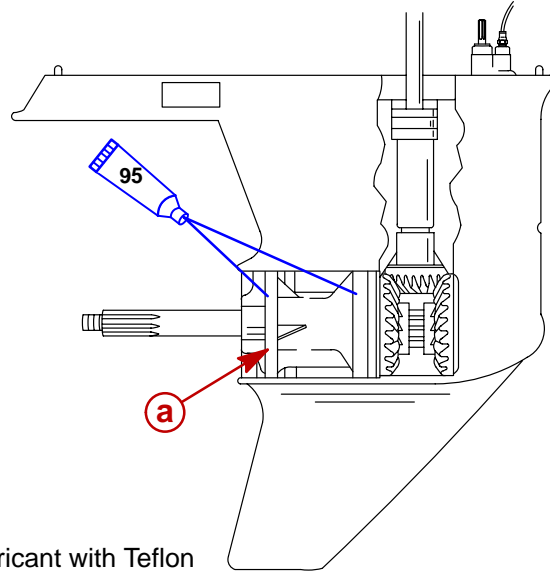
57936



Bearing Carrier Assembly

Final Installation

1. Remove the Bearing Carrier and lubricate the following as specified:
 - a. Lubricate the carrier O-ring with 2-4-C Marine Lubricant with Teflon.
 - b. Lubricate both the forward and aft outer diameters of the bearing carrier and gear case area where carrier will seat with 2-4-C Marine Lubricant with Teflon.
 - c. Fill the space between the carrier oil seals with 2-4-C Marine Lubricant with Teflon.
2. Place the bearing carrier assembly into the gear housing. It may be necessary to turn the drive shaft to align the teeth of the pinion and the reverse gears.

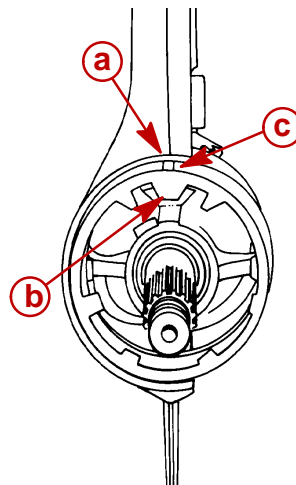


 2-4-C Marine Lubricant with Teflon

57953

a - Bearing Carrier Assembly

3. Align the bearing carrier "V" shaped notch with the alignment hole in the gear housing and then install the tab washer with the external tab inserted into the hole in the gear housing.

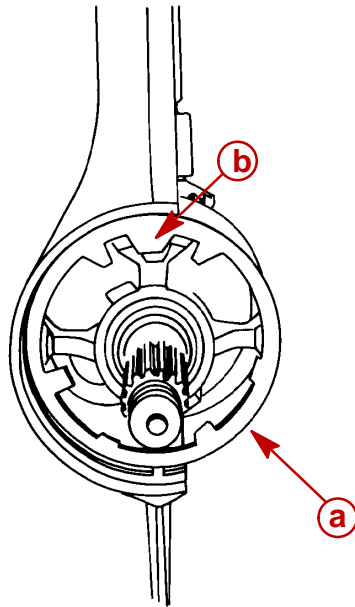


70713

a - Gear Case Alignment Hole
b - "V" Shaped Notch in Bearing Carrier
c - Alignment Tab of Tab Washer



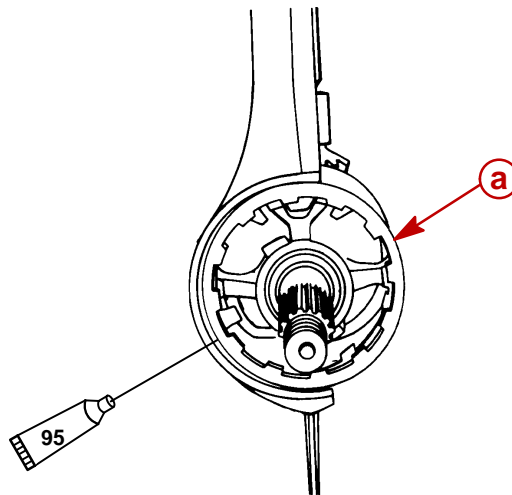
4. Verify the "V" shaped tab aligns with the "V" notch in bearing carrier.



70714

- a** - Tab Washer
- b** - "V" Tab

5. Fill the bearing carrier retainer nut threads and corresponding gear housing threads with 2-4-C Marine Lubricant with Teflon. Start the retainer into the gear housing threads and screw it down fully by hand.



 95 2-4-C Marine Lubricant With Teflon

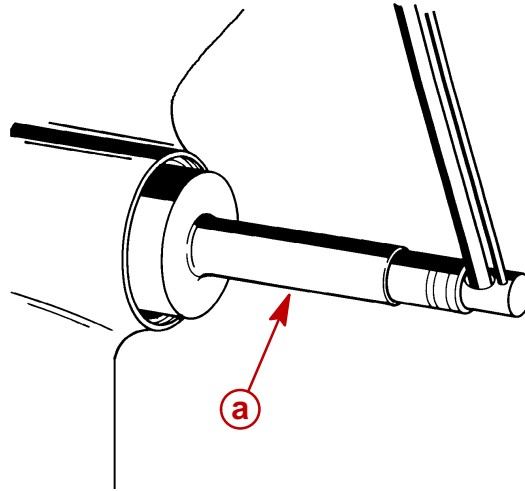
70715

- a** - Bearing Carrier Retainer



IMPORTANT: Before torquing bearing carrier retainer, gear case must be bolted to drive shaft housing or securely fastened in a gear case holding fixture to avoid possible damage to gear housing.

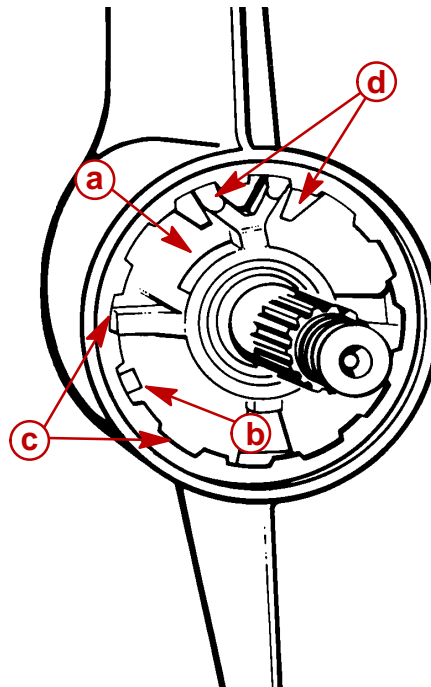
6. Torque the bearing carrier retainer to 210 lb. ft. (285 Nm). If one tab does not align up in space between two of the notches, continue to tighten retainer until alignment is achieved. DO NOT loosen retainer to achieve alignment.



23355

a - Bearing Carrier Retainer Wrench (91-61069)

7. Bend one tab aft (outward) into a space between two of the notches of the retainer. Bend all the remaining tabs forward (inward).



70490

a - Bearing Carrier
b - Tab
c - Retainer Notches
d - Alignment Tabs (Bend Inward)

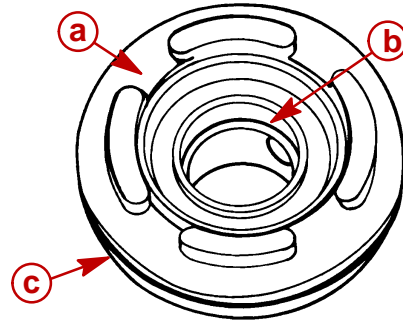


Oil Seal Carrier Assembly

Installation

NOTE: Apply hand pressure only to install the oil seal carrier into position. Do not hammer it into position.

1. Lubricate the oil seal carrier oil seal lips, space between seals and O-ring with 2-4-C Marine Lubricant with Teflon and install the oil seal carrier over the drive shaft and into the gear case.



70501

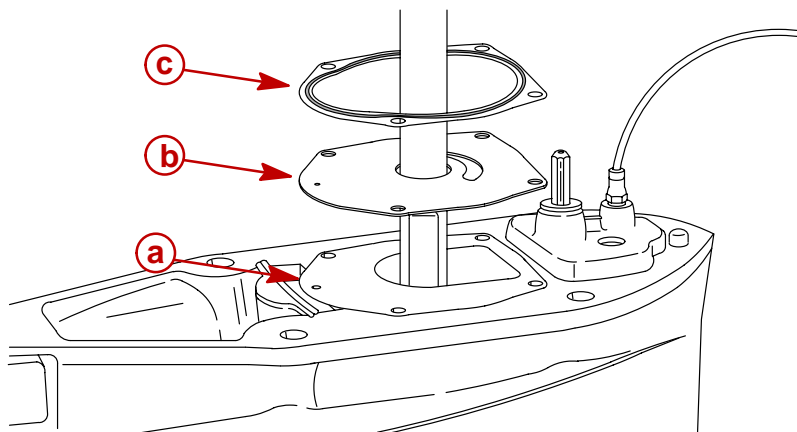
- a - Oil Seal Carrier
- b - Oil Seal Lips
- c - O-ring

Water Pump Assembly

Installation

NOTE: The gaskets/face plate hole pattern is not symmetrical. If the holes of the gaskets/face plate do not align with the screw holes of the gear case and/or each other, one or more of the parts is upside down. Determine which part(s) is (are) upside down and turn the appropriate part(s) over.

1. Install the small hole gasket then the face plate followed by the large hole gasket onto the gear case.



58011

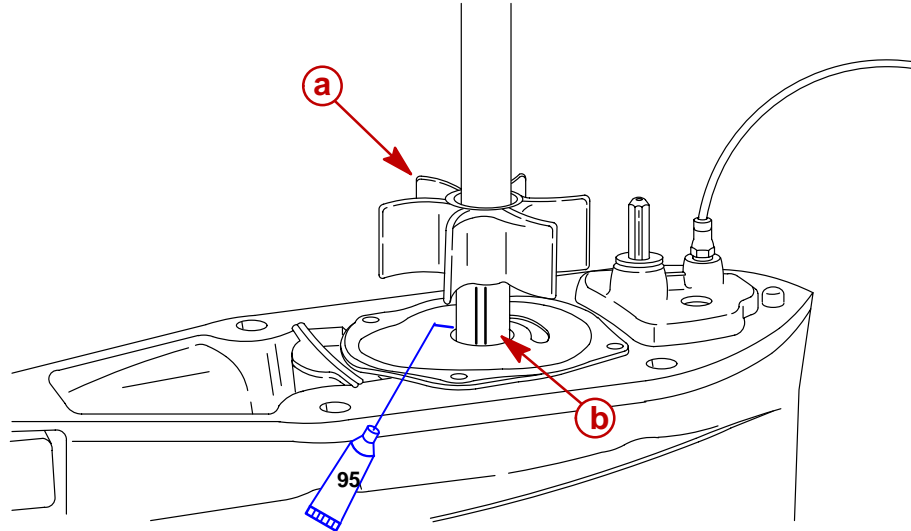
- a - Small Hole gasket
- b - Face Plate
- c - Large Hole Gasket (GRAY sealing ring faces up)

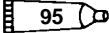


- Place a small amount of 2-4-C Marine Lubricant with Teflon on the flat surface of the impeller key and install the key onto the drive shaft keyway.

IMPORTANT: When using an impeller whose blades have taken a set, face the curl of the blades in a counterclockwise direction. Do not install the impeller with its blades oriented in a reversed direction from original rotation, or premature impeller failure will occur.

- Assemble the water pump impeller onto the drive shaft and down over the key.

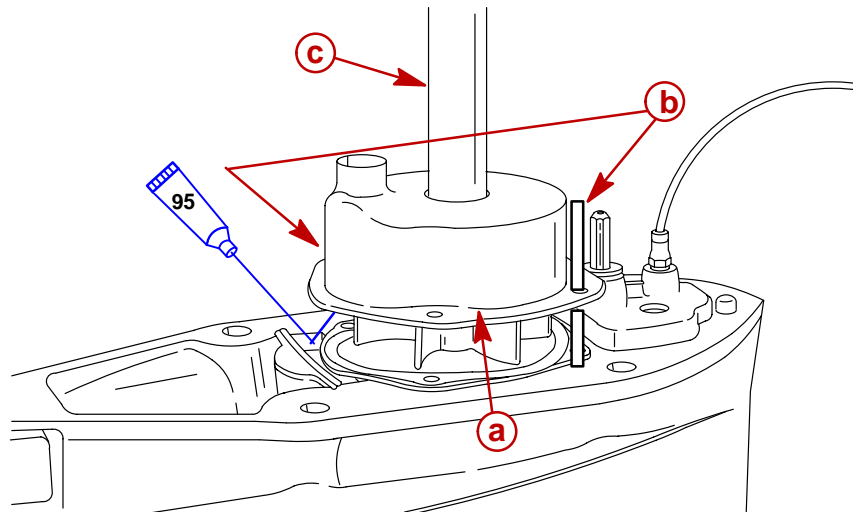


 2-4-C Marine Lubricant With Teflon

57938

- a** - Water Pump Impeller
- b** - Water Pump Impeller Key

- Install the 2 water pump locating pins through the gaskets and face plate.
- Apply a light coat of 2-4-C Marine Lubricant with Teflon to the inside of the pump cover. Position the water pump body over the drive shaft and water pump locating pins. Rotate the drive shaft in a clockwise direction, while pushing down on the water pump body to ease the water pump over the impeller blades.



 2-4-C Marine Lubricant With Teflon

57942

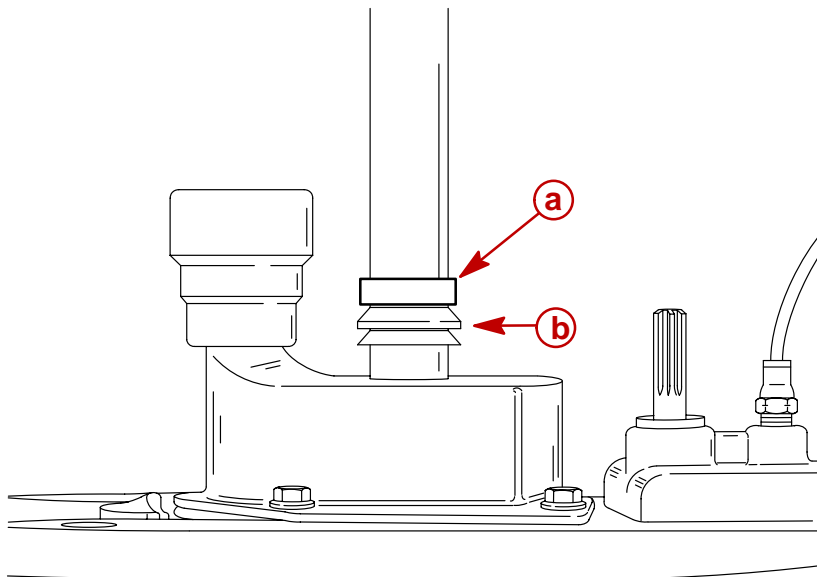
- a** - Water Pump Body
- b** - Water Pump Alignment Pins (91-821571A1)
- c** - Drive Shaft (turn clockwise while installing water pump body)



- Hand start two (2) fasteners into the water pump assembly and remove the water pump locating pins. Install the remaining 2 fasteners. Run all fasteners down and torque to 60 lb. in. (7 Nm).
- Lightly lubricate the O-rings in the water tube coupling with 2-4-C Marine Lubricant with Teflon.
- Install the water tube coupling assembly to the water pump ensuring that the O-rings are not damaged during assembly.

IMPORTANT: If seal installed above pump housing is not at the proper height, air will be drawn into the pump resulting in overheating of the engine.

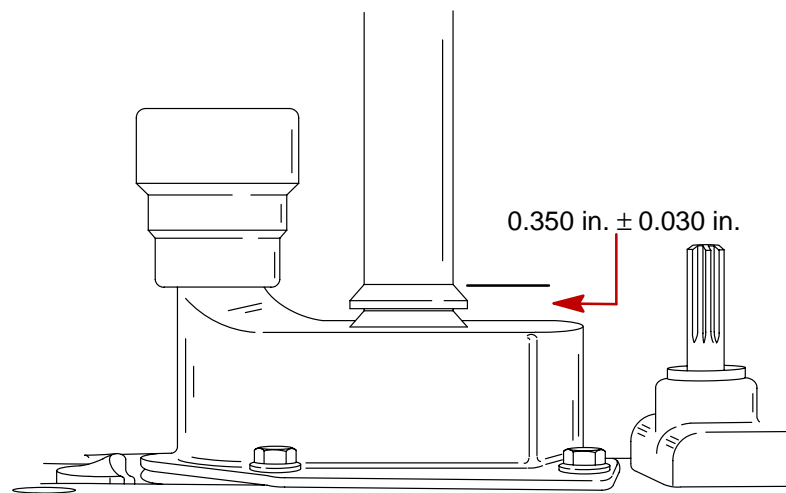
- Using tool provided in seal kit (26-816575A2) or water pump kit (817275A3), press seal down over drive shaft (DO NOT GREASE DRIVE SHAFT) until tool seats against pump housing.



57945

- a - Tool
- b - Seal

If tool is not available, lightly press seal against housing until a height of 0.350 in. \pm 0.030 in. (8.9mm \pm 0.76mm) is obtained.



57946



Gear Lubricant Filling Instructions

1. Inspect "Fill" and "Vent" sealing washers for cuts or abrasions. Replace washers if necessary.
2. Clean any metal debris from magnet on "Fill" plug.

IMPORTANT: Never apply lubricant to gear housing without first removing Vent screw, or gear housing cannot be filled because of trapped air. Fill gear housing ONLY when housing is in a vertical position.

3. Slowly fill housing thru Fill hole with Premium Gear 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

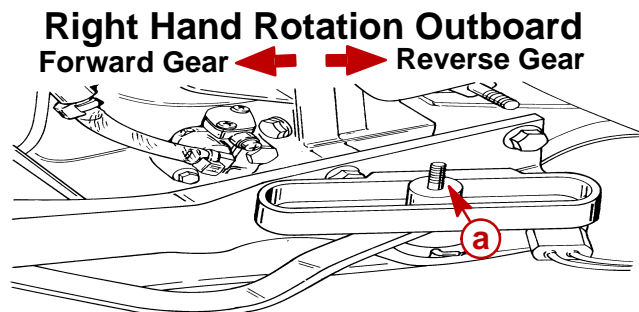
Disconnect high tension leads from spark plugs and remove spark plugs from engine before installing gear housing onto driveshaft housing.

1. Tilt engine to full up position and engage the tilt lock lever.
2. Apply a light coat of 2-4-C Marine Lubricant with Teflon 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 2-4-C Marine Lubricant with Teflon 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 NEUTRAL and place guide block anchor pin into NEUTRAL position



a - Guide Block Anchor Pin

7. Position gear housing so that the driveshaft is protruding into driveshaft housing.



NOTE: If, while performing Step 8, the driveshaft splines will not align with crankshaft splines, place a propeller onto propeller shaft. Shift gearcase into FORWARD and turn propeller counterclockwise as the gear housing is being pushed toward driveshaft housing.

8. Move gear housing up toward driveshaft housing while aligning shift shaft splines and water tube with water tube guide (in water pump cover).
9. Place flat washers onto studs (located on either side of driveshaft housing). Start a nut on these studs and tighten finger-tight.
10. Start bolt at rear of gear housing inside trim tab recess. DO NOT tighten bolt at this time.
11. Recheck shift shaft spline engagement and correct if necessary.

NOTE: Guide block anchor pin should be in FORWARD when gearcase is in FORWARD.

IMPORTANT: Do not force gear case up into place with attaching nuts.

12. Evenly tighten 2 nuts which were started in Step 9. Torque to 55 lb. ft. (75 Nm).
13. After 2 nuts (located on either side of driveshaft housing) are tightened, check shift operation as follows:
 - a. Place guide block anchor pin into forward gear position while turning prop shaft. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate clockwise.
 - b. Place guide block anchor pin into NEUTRAL position. Propeller shaft should rotate freely clockwise/counterclockwise.
 - c. Place guide block anchor pin into REVERSE gear position. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate counterclockwise.

IMPORTANT: If shifting operation is not as described, preceding, the gear housing must be removed and the cause corrected.

14. Install remaining washers and nuts onto drive shaft studs. Torque to 55 lb. ft. (75 Nm).
15. Torque bolt (started in Step 10) to 45 lb. ft. (61 Nm).
16. Position trim tab or anodic plate in gear housing. Align grooves of trim tab with ribs in trim tab pocket. Adjust to position in which it had previously been installed, and while holding trim tab, torque bolt to 40 lb. ft. (54 Nm)
17. Install plastic cap into trim tab bolt opening at rear edge of driveshaft housing.

Propeller Installation

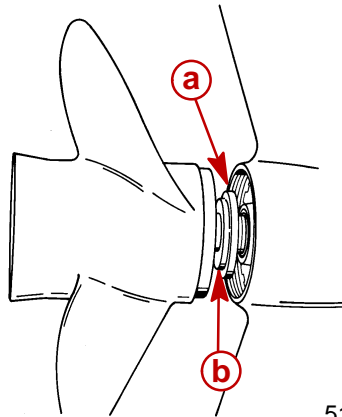
WARNING

When installing or removing propeller, because of the engine's ease in starting, be sure that the remote control is in neutral position and that the key switch is "OFF." Place a block of wood between the anti-cavitation plate and propeller to prevent accidental starting and to protect hands from propeller blades while removing or installing nut.

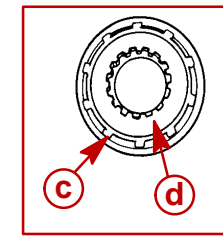
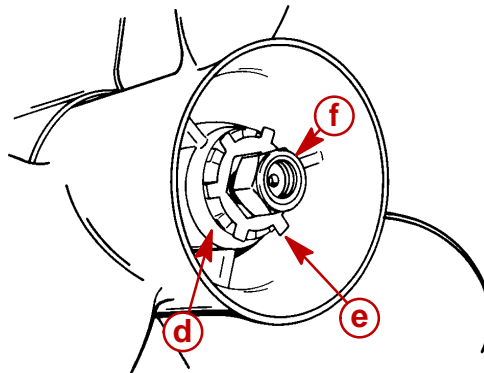
1. To aid in future removal of the propeller, liberally coat the propeller shaft splines with one of the following Quicksilver products:
 - Anti-Corrosion Grease
 - Special Lubricant 101
 - 2-4-C Marine Lubricant with Teflon
 - Perfect Seal



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. (75 Nm) torque].
8. Bend 3 of the tabs of tab washer down in grooves of rear thrust hub to secure propeller nut. (If tab washer tabs do not align with slots, continue to tighten propeller nut to obtain alignment. DO NOT loosen nut to align tabs.)



51866



51866

- a** - Forward Thrust Hub
- b** - Propeller Shaft
- c** - Continuity Washer (if Equipped)

- d** - Rear Thrust Hub
- e** - Tab Washer
- f** - Propeller Nut

⚠ CAUTION

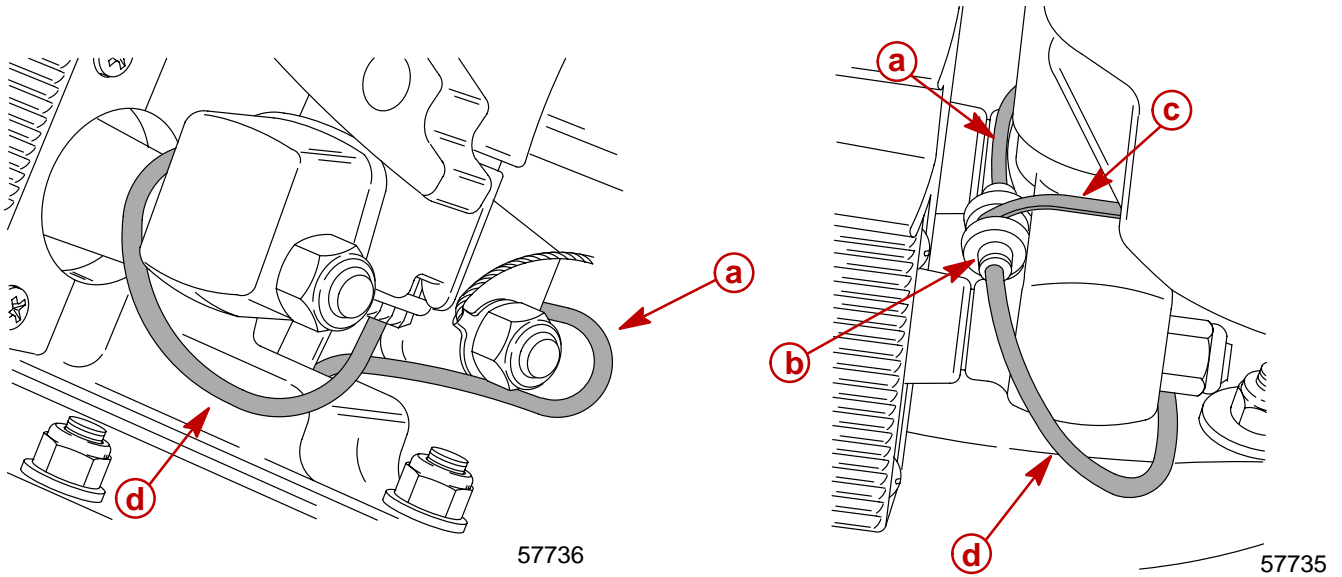
DO NOT misinterpret propeller shaft movement with propeller movement. If propeller and propeller shaft together move forward-and-aft, this is normal; however, propeller should not move forward-and-aft on propeller shaft.

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



LOWER UNIT

Section 6B – Left Hand Non-Ratcheting

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Shift Shaft Assembly 6B-60	Speedometer Tube Installation 6B-103

**6
B**

Gear Housing Specifications (Counter Rotation)

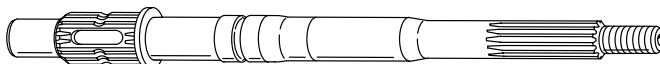
Ratio	Pinion Depth	Forward Gear Backlash	Reverse Gear Backlash
1.75:1 1.87:1	0.025 in. (0.635 mm) With Tool 91-12349A2 using Disc #2 and Flat #4	0.017 in. to 0.028 in. (0.431 mm to 0.711 mm) Pointer on line mark #1	0.040 in. to 0.060 in. (1.01 mm to 1.52 mm)
Gearcase Lubricant Capacity			
All Ratios		27.0 fl. oz. (798.0 ml)	
Gearcase Pressure Check			
Gearcase without Oil		Gearcase should hold 15 psi for 5 minutes without leakage	

Gear Ratio	Pinion Gear Teeth	Forward and Reverse Gear Teeth
1.75:1	12	21
1.87:1	15	28

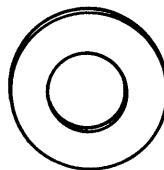


Special Tools

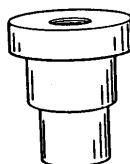
1. Propeller Shaft 44-93003 and Load Washer 12-37429



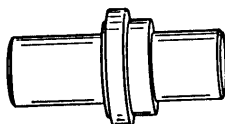
2. Bellville Washer 12-54048



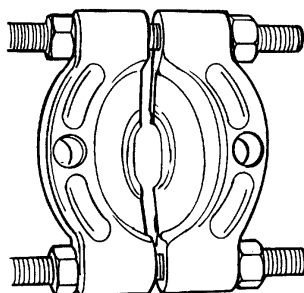
3. Needle Bearing Driver 91-15755



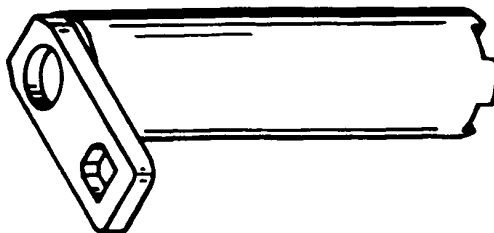
4. Oil Seal Driver 91-31108



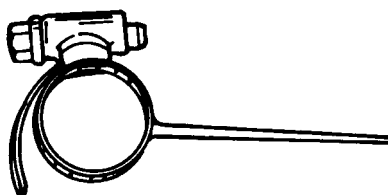
5. Universal Puller Plate 91-37241



6. Bearing Retainer Tool 91-43506

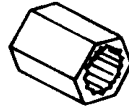


7. Backlash Indicator Rod 91-53459

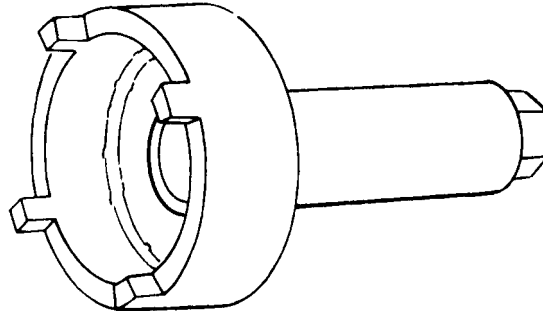




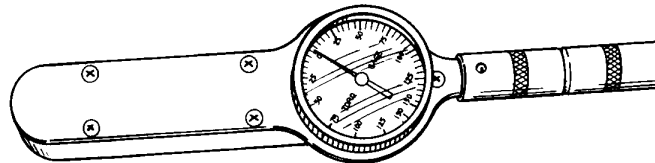
8. Drive Shaft Nut Wrench 91-56775



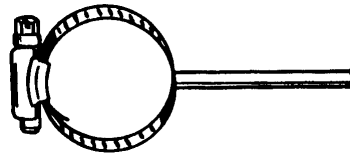
9. Bearing Carrier Retainer Wrench 91-61069



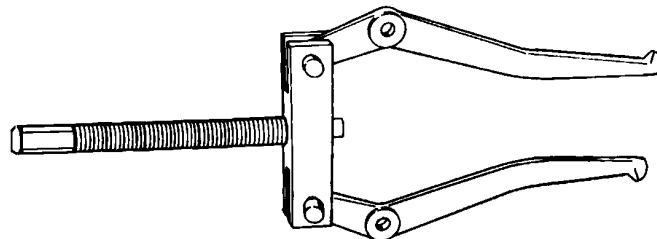
10. Torque Wrench (lb. in.) 91-66274



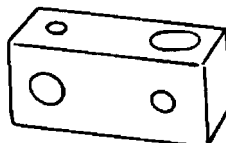
11. Backlash Indicator Rod 91-78473



12. Puller Bolt 91-85716 and Puller Jaws 91-46086A1



13. Dial Indicator Holding Tool 91-89897

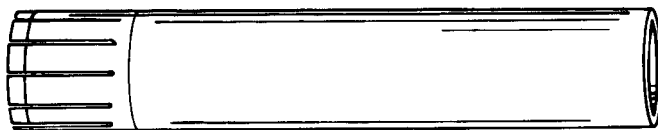


14. Forward Gear Bearing Tool 91-86943

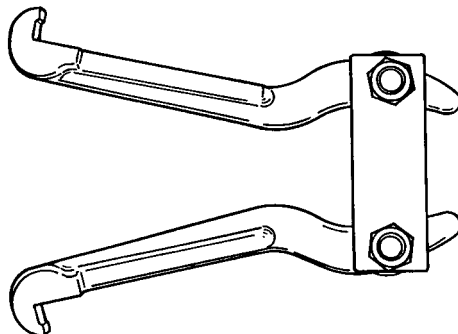




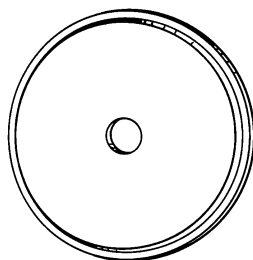
15. Forward Gear Installation Tool 91-815850



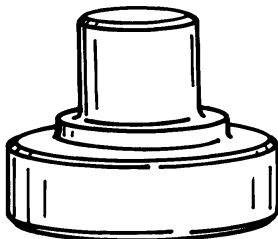
16. Puller Jaws 91-816242



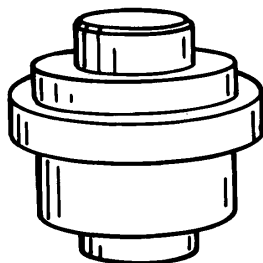
17. Guide Plate 91-816243



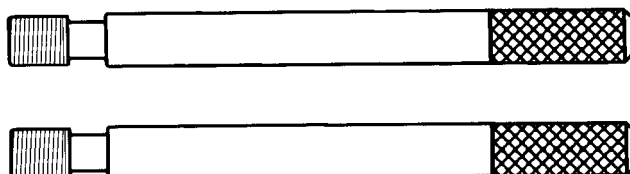
18. Bearing Driver 91-816244



19. Oil Seal Driver 91-817569

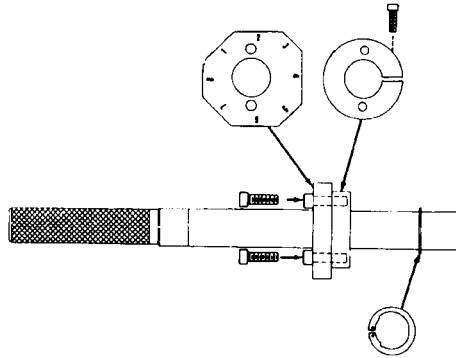


20. Water Pump Alignment Pins 91-821571A1

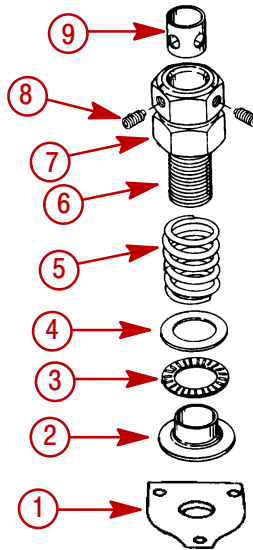




21. Pinion Gear Shimming Tool 91-12349A2



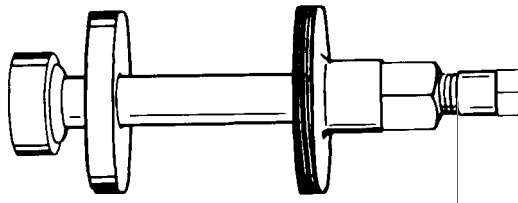
22. Bearing Preload Tool 91-14311A2



- 1 - Plate (44307)
- 2 - Adaptor (N.S.S.)
- 3 - Bearing (N.S.S.)
- 4 - Washer (N.S.S.)
- 5 - Spring (24-14111)

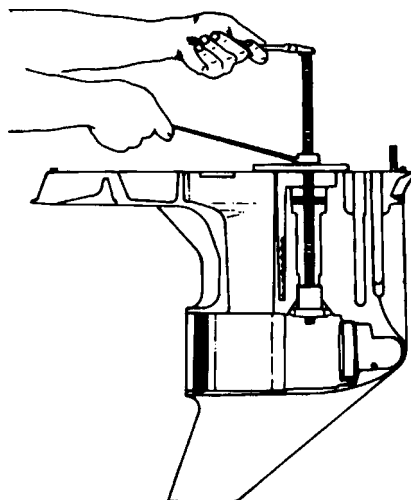
- 6 - Bolt (10-12580)
- 7 - Nut (11-13953)
- 8 - Set Screw (10-12575)
- 9 - Sleeve (23-13946)

23. Bearing Adaptor Installation Tool 91-18605A2





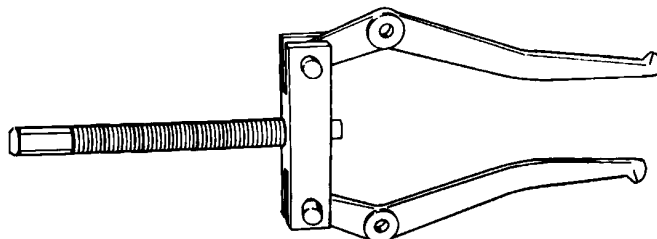
24. Bearing Removal and Installation Tool 91-31229A7 – Includes Driver Head 91-36569; Driver Head Rod 91-37323; Nut 11-24156; Pilot Washer 91-36571; Pilot Plate 91-29310; Puller/Driver Head 91-38628; Mandrel 91-30366; Plate 91-29310; Driver Head 91-32325; Puller Shaft 91-31229; Washer 91-34961.



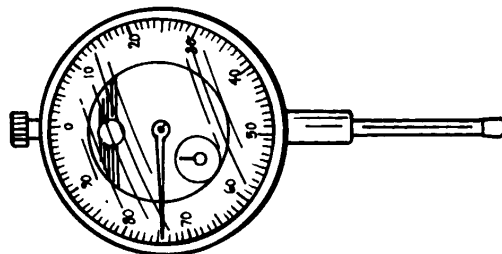
25. Slide Hammer Puller 91-34569A1



26. Puller Bolt 91-85716 and Puller Jaws 91-46086A1

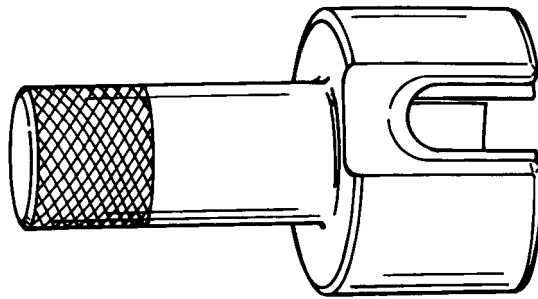


27. Dial Indicator 91-58222A1

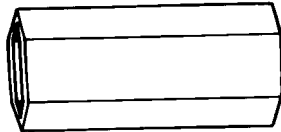




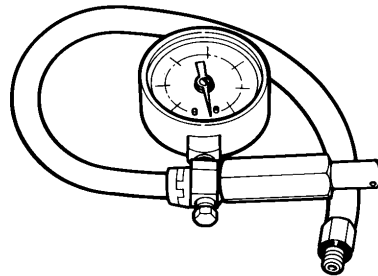
28. Pinion Nut Adaptor 91-61067A3



29. Drive Shaft Adaptor 91-61077



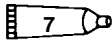
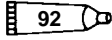
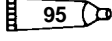
30. Leakage Tester FT8950

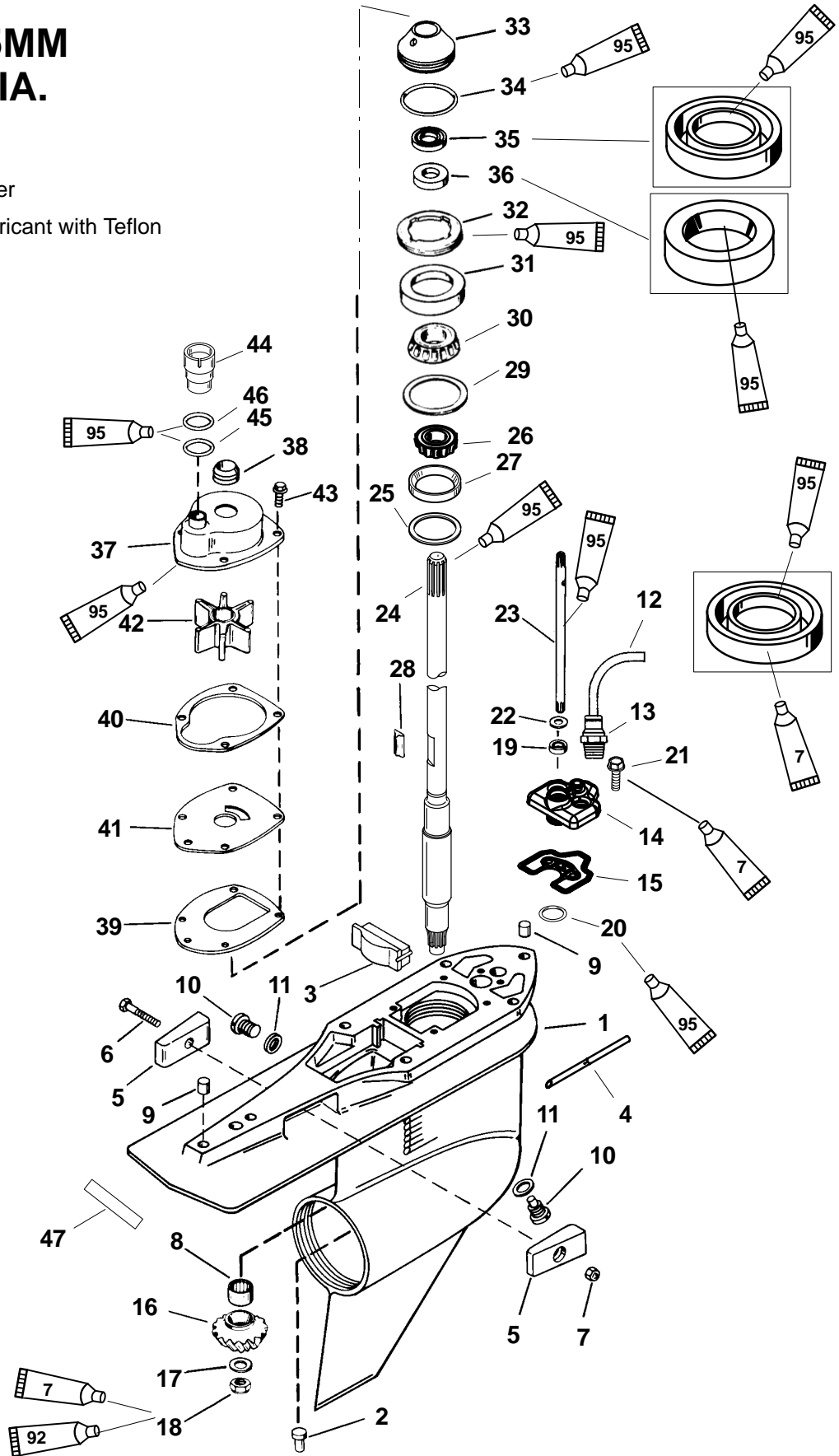




Gear Housing (Drive Shaft)(Counter Rotation)

4.75 IN/120.65MM TORPEDO DIA.

-  7 Loctite 271
-  92 Loctite 7649 Primer
-  95 2-4-C Marine Lubricant with Teflon





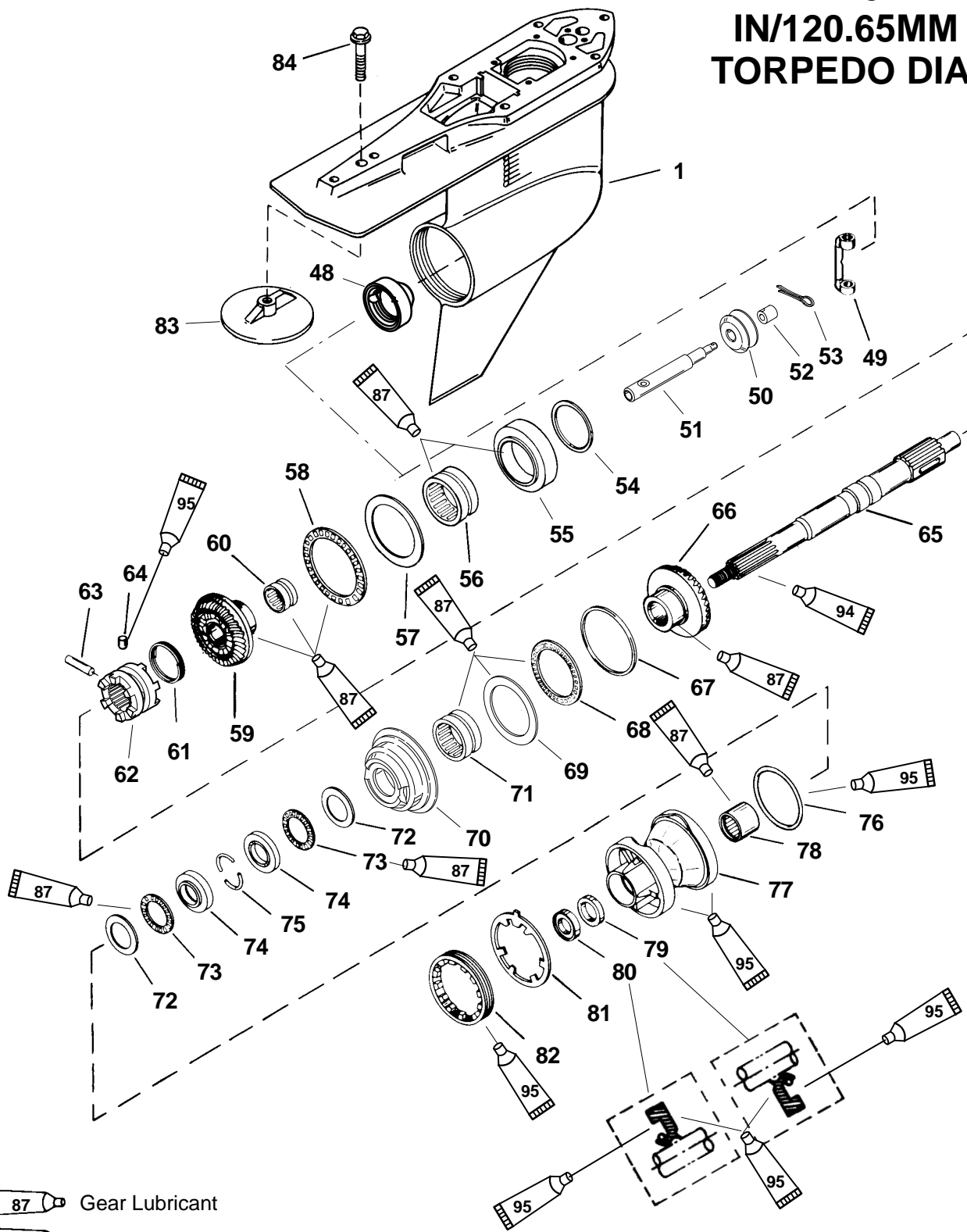
Gear Housing (Drive Shaft)(Counter Rotation)

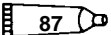
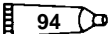
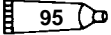
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	GEAR HOUSING			
2	1	PIN			
3	1	FILLER BLOCK			
4	1	PITOT TUBE			
5	2	ANODE			
6	1	SCREW	60		7
7	1	NUT			
8	1	ROLLER BEARING			
9	2	DOWEL PIN			
10	2	SCREW ASSEMBLY	60		7
11	2	SEALING WASHER			
12	1	CONNECTOR (X-LONG - 12 IN.)			
	1	CONNECTOR (XX-LONG - 17 IN)			
13	1	CONNECTOR			
14	1	COVER			
15	1	GASKET			
16	1	PINION GEAR (1.75:1 - 12/21) (PART OF 43-828695A1)			
17	1	WASHER			
18	1	NUT		70	95
19	1	OIL SEAL			
20	1	O RING			
21	2	SCREW (M6 x 16)	60		7
22	1	RUBBER WASHER			
23	1	SHIFT SHAFT (LOWER)			
24	1	DRIVE SHAFT (X-LONG)			
	1	DRIVE SHAFT (XX-LONG)			
25	AR	SHIM SET			
26	1	TAPERED ROLLER BEARING			
27	1	CUP			
28	1	KEY			
29	AR	SHIM			
30	1	TAPERED ROLLER BEARING			
31	1	CUP			
32	1	RETAINER		100	135
33	1	CARRIER ASSEMBLY			
34	1	O RING			
35	1	OIL SEAL			
36	1	OIL SEAL			
37	1	WATER PUMP ASSEMBLY			
38	1	SEAL			
39	1	GASKET			
40	1	GASKET			
41	1	FACE PLATE			
42	1	IMPELLER			
43	4	SCREW (M6 x 16)	60		7
44	1	COUPLING ASSEMBLY			
45	1	O RING			
46	1	O RING			
47	1	DECAL-Counter Rotation			



Gear Housing (Prop Shaft)(Counter Rotation)

4.75 IN/120.65MM TORPEDO DIA.



-  87 Gear Lubricant
-  94 Anti-Corrosion Grease
-  95 2-4-C Marine Lubricant with Teflon



Gear Housing (Prop Shaft)(Counter Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	GEAR HOUSING			
48	1	PLUG			
49	1	SHIFT CRANK			
50	1	SHIFT SPOOL			
51	1	SPOOL			
52	1	SLEEVE			
53	1	COTTER PIN			
54	AR	SHIM SET			
55	1	BEARING ADAPTOR ASSEMBLY			
56	1	ROLLER BEARING			
57	1	THRUST WASHER			
58	1	THRUST BEARING			
59	1	REVERSE GEAR (1.75:1 - 12/21)			
60	1	ROLLER BEARING			
61	1	SPRING			
62	1	SLIDING CLUTCH			
63	1	CROSS PIN			
64	1	DETENT PIN			
65	1	PROPELLER SHAFT			
66	1	FORWARD GEAR (1.75:1 - 12/21)			
67	AR	SPACER SHIM .206 IN.			
	AR	SPACER SHIM .208 IN.			
	AR	SPACER SHIM .210 IN.			
	AR	SPACER SHIM .212 IN.			
	AR	SPACER SHIM .214 IN.			
	AR	SPACER SHIM .216 IN.			
	AR	SPACER SHIM .218 IN.			
	AR	SPACER SHIM .220 IN.			
	AR	SPACER SHIM .222 IN.			
	AR	SPACER SHIM .224 IN.			
	AR	SPACER SHIM .226 IN.			
AR	SPACER SHIM .228 IN.				
AR	SPACER SHIM .230 IN.				
68	1	ROLLER BEARING			
69	1	THRUST RING			
70	1	BEARING ADAPTOR ASSEMBLY			
71	1	ROLLER BEARING			
72	2	THRUST WASHER			
73	2	THRUST BEARING			
74	2	THRUST RACE			
75	2	KEEPER			
76	1	O RING			
77	1	BEARING CARRIER ASSEMBLY			
78	1	ROLLER BEARING			
79	1	OIL SEAL (INSIDE)			
80	1	OIL SEAL (OUTSIDE)			
81	1	TAB WASHER			
82	1	COVER		210	285
83	1	ANODIC PLATE			
84	1	SCREW		40	54.0



General Service Recommendations

There may be more than one way to “disassemble” or “reassemble” a particular part(s), therefore, it is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

In many cases, disassembly of a sub-assembly may not be necessary until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly-reassembly sequence. It is suggested that the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to “reassembly and installation” of that component in the reassembly part of this section. Use the “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, 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 Premium 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 Marine Lubricant with Teflon on all O-rings. To prevent wear, apply 2-4-C Marine Lubricant with Teflon on I.D. of oil seals. To prevent corrosion damage after reassembly, apply 2-4-C Marine Lubricant with Teflon to external surfaces of bearing carrier and cover nut threads prior to installation.



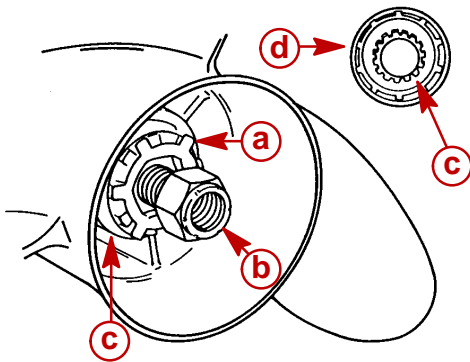
Removal, Disassembly, Cleaning and Inspection of Counter Rotation (Left Hand) Gear Housing

REMOVAL

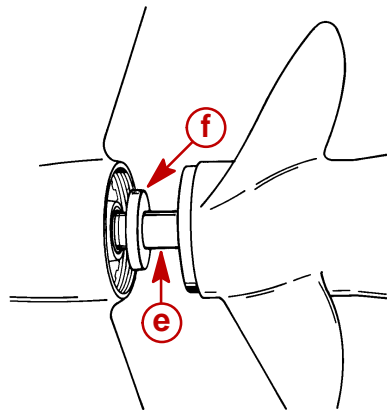
⚠ WARNING

Disconnect high tension leads from spark plugs and remove spark plugs from engine before removing gear housing from driveshaft housing.

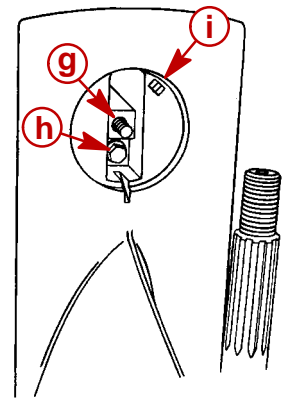
1. Disconnect high tension leads from spark plugs and remove spark plugs from engine.
2. Shift engine into NEUTRAL position.
3. Tilt engine to full up position and engage tilt lock lever.
4. Bend tabs of propeller tab washer away from thrust hub (rear), then remove propeller locknut, tab washer, thrust hub (rear), propeller and thrust hub (forward) from propeller shaft.
5. Mark gear housing and trim tab so that trim tab can be reinstalled in the same position. Remove plastic cap at rear edge of driveshaft housing. Remove bolt that secures trim tab and remove tab from gear housing.
6. Once trim tab is removed, remove bolt from inside of trim tab cavity.



51916



51912

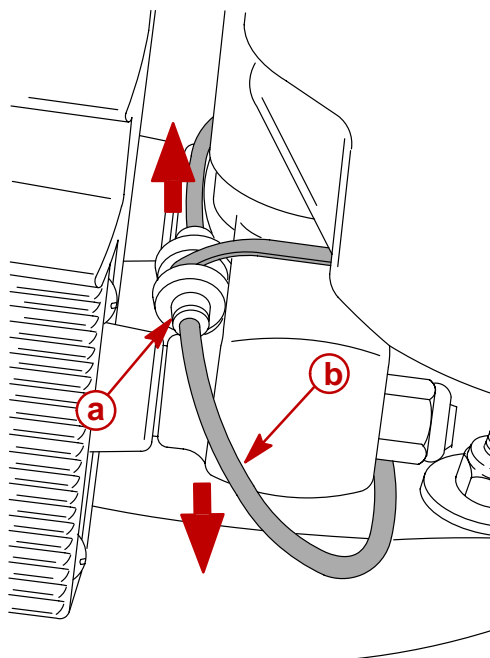


52375

- a - Tab Washer
- b - Propeller Nut
- c - Rear Thrust Hub
- d - Continuity Washer (if equipped)
- e - Propeller Shaft
- f - Thrust Hub (forward)
- g - Bolt (secures trim tab)
- h - Bolt (inside trim tab cavity)
- i - Ribs – Align Carefully with Trim Tab while Securing Tab



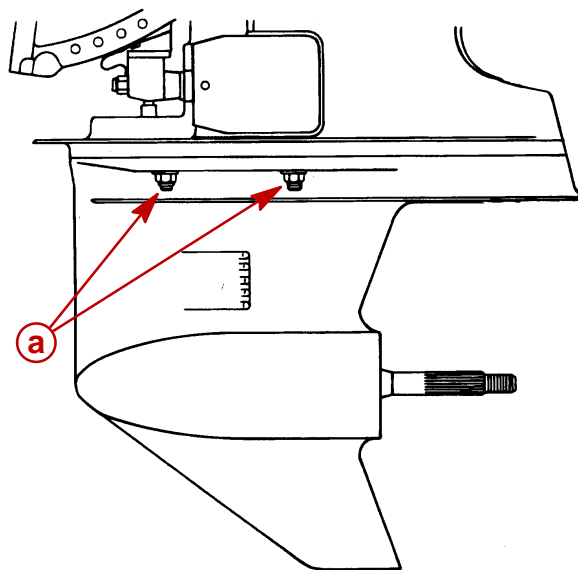
7. While pressing in on speedometer hose junction, pull out on hose to disconnect.



57735

- a** - Press in on Junction
- b** - Pull out on Hose

8. Loosen the side mounting locknuts. (DO NOT attempt to remove one nut before opposite side is loosened sufficiently, or gear housing could be damaged.)



- a** - Side Mounting Locknuts

9. Pull gear housing away from drive shaft housing as far as the loosened nuts (in Step 8) will allow, then remove loosened nuts. (DO NOT allow gear housing to fall, as it now is free.)
10. Pull gear housing from drive shaft housing.



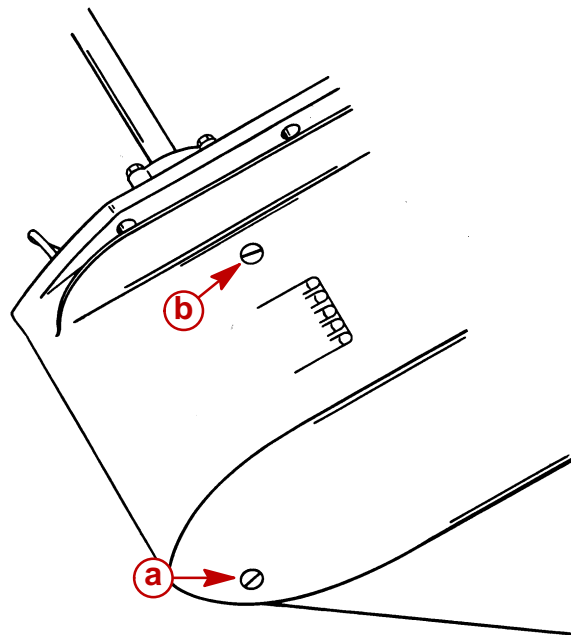
DRAINING AND INSPECTING GEAR HOUSING LUBRICANT

1. Place gear housing in a suitable holding fixture or vise with the driveshaft in a vertical position, as shown.

NOTE: Drain and Fill screws may be located on the starboard side of gearcase on later models.

2. Position a clean drain pan under gear housing and remove "Fill" and "Vent" screws from gear housing.
3. Inspect gear lubricant for metal particles. Presence of a small amount of fine metal particles (resembling powder) indicates normal wear. Presence of larger particles (or a large quantity of fine particles) indicates need for gear housing disassembly, and component inspection.
4. Note the color of gear lubricant. White or cream color indicates presence of water in lubricant. Check drain pan for water separation from lubricant. Presence of water in gear lubricant indicates the need for disassembly, and inspection of oil seals, seal surfaces, O-rings and gear housing components.

IMPORTANT: Gear lubricant drained from a recently run gear case will be a light chocolate brown in color due to agitation/aeration. Oil which is stabilized will be a clear yellow brown in color.



- a** - Fill Screw
b - Vent Screw

52377

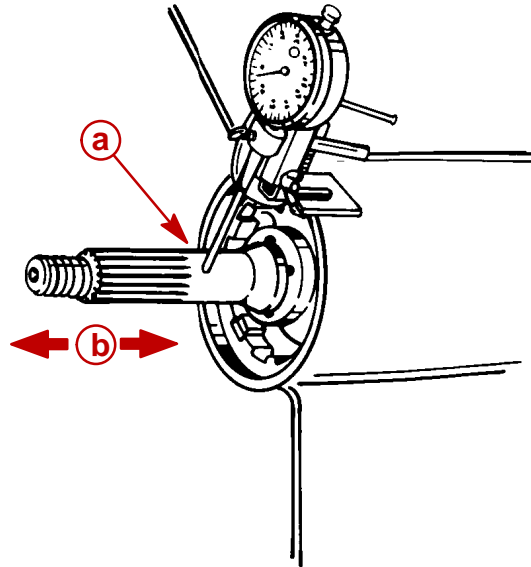


Pre-Disassembly Inspection

Propeller Shaft

INSPECTION

1. Check for a bent propeller shaft as follows:
 - a. Rotate the propeller shaft while observing the dial indicator. If the deflection is more than 0.009 in. (0.23 mm), a bent propeller shaft is indicated.
2. Measure propeller shaft endplay. If it is in excess of 0.093 in. (2.36mm), disassemble gear case and check condition of the reverse shoulder of the propeller shaft, reverse gear and thrust washer. Replace components as required.



- a** - Prop Shaft Runout
b - Prop Shaft Endplay

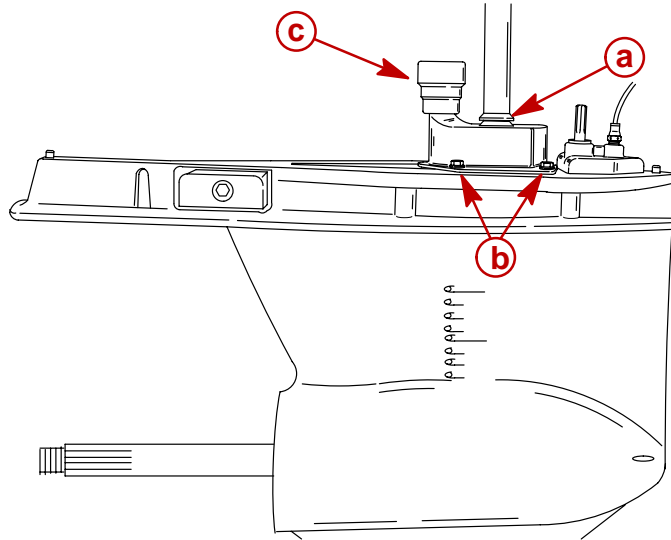
22086



Water Pump

REMOVAL AND DISASSEMBLY

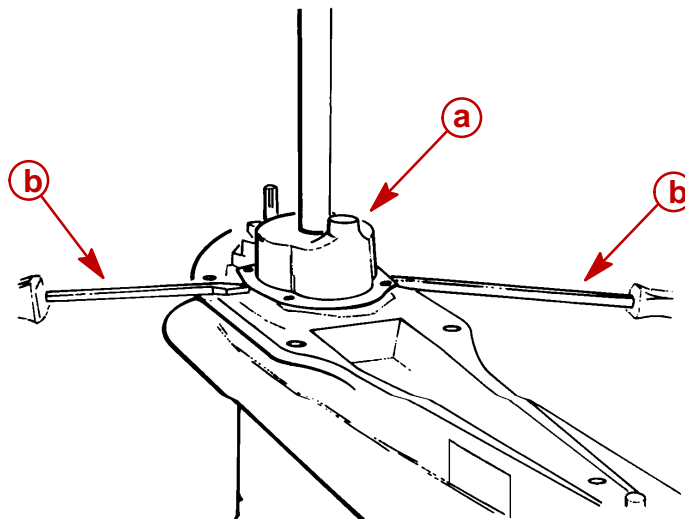
1. Remove the water seal, water tube coupling assembly, and the water pump screws.



57944

- a** - Water Seal
- b** - Water Tube Coupling
- c** - Water Pump Screws (4)

2. Carefully slide the water pump straight up off of the drive shaft. It may be necessary to encourage the water pump up by gently prying up on its mounting flanges with a couple of screwdrivers.

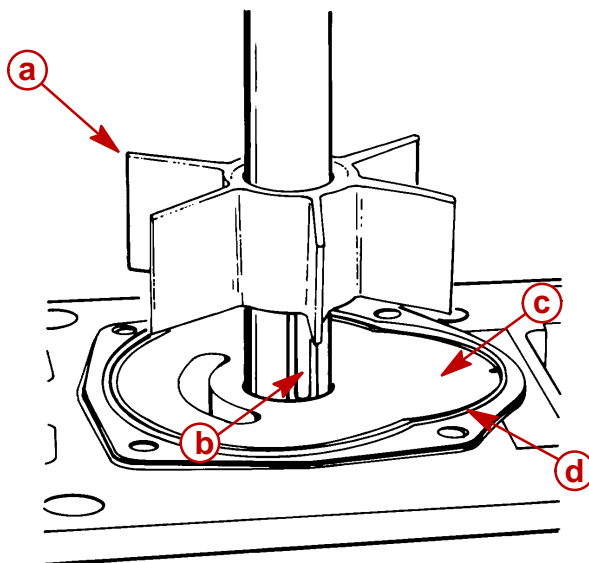


70487

- a** - Water Pump Body
- b** - Screwdrivers



3. Remove the impeller, impeller key, the face plate and gaskets, (discard the gaskets).

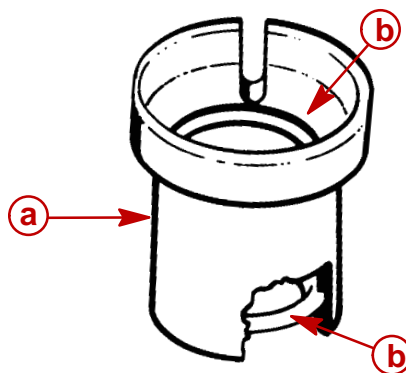


70605

- a** - Impeller
- b** - Impeller Key
- c** - Water Pump Face Plate
- d** - Gasket (1 each side of face plate)

CLEANING AND INSPECTION

1. Inspect the water tube coupling assembly for wear or damage. If necessary replace the worn or damaged components especially the two O-rings on the inside, one at the top and one at the bottom.



70613

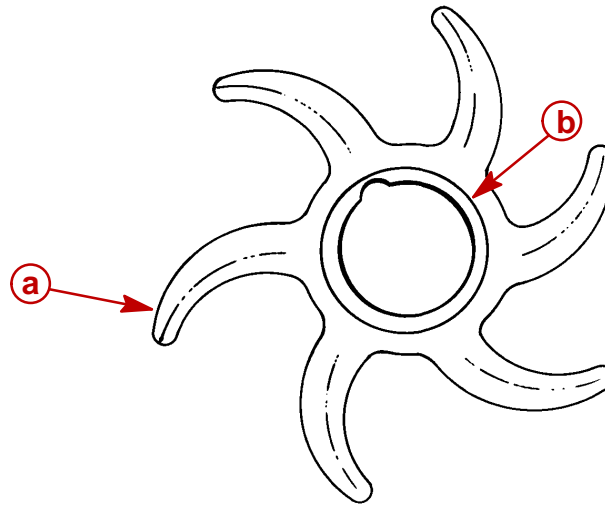
- a** - Water Tube Adaptor
- b** - O-rings (2)

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting cover and plate. The depth of the groove will not affect water pump output.

2. Inspect face plate and water pump cover for grooves and/or rough surfaces.
3. Replace cover and /or face plate if grooves (other than sealing grooves) are more than 0.030 in. (0.762 mm) deep.



4. Inspect impeller side seal surfaces and ends of impeller blades for cracks, tears and wear. Replace impeller if any of these conditions are found.
5. Inspect impeller bonding to impeller hub.
6. Inspect impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace impeller if any of these conditions exist.



- a** - Impeller
b - Hub

70500

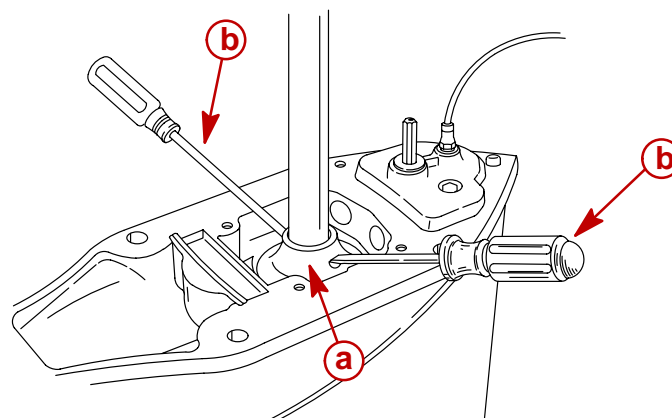
IMPORTANT: When completing gear housing repairs, that require removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to re-use impeller, **DO NOT** install in reverse to original rotation, or premature impeller failure will occur.

IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

Oil Seal Carrier Assembly

REMOVAL

1. Remove the oil seal carrier from the gear housing. It may be necessary to gently pry up on it with two screwdrivers.



- a** - Oil Seal Carrier
b - Screwdrivers

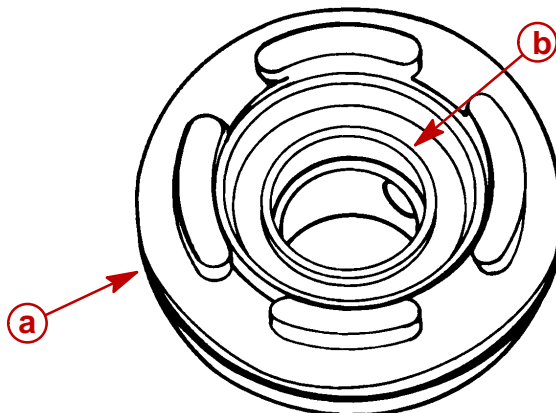
57940



OIL SEAL CARRIER ASSEMBLY - COMPONENT DISASSEMBLY

NOTE: Complete the instructions in this section only if the assembly components have been found to be defective and are in need of repair or replacement.

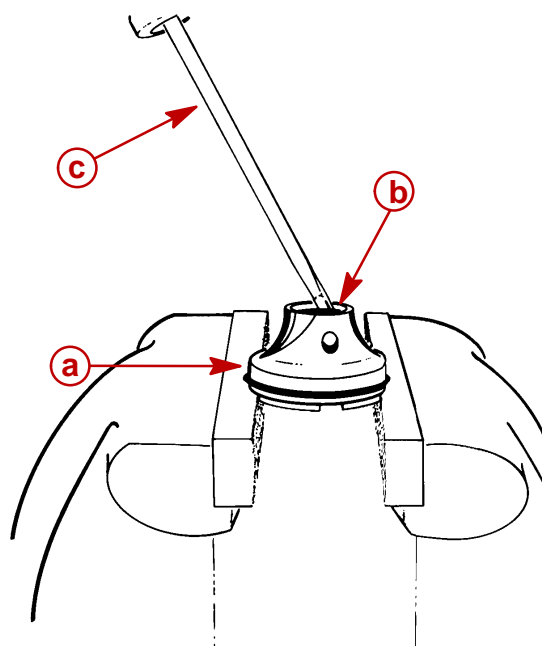
1. Remove the o-ring.



70501

- a** - O-ring
- b** - Oil Seals (2)

2. Remove oil seals.



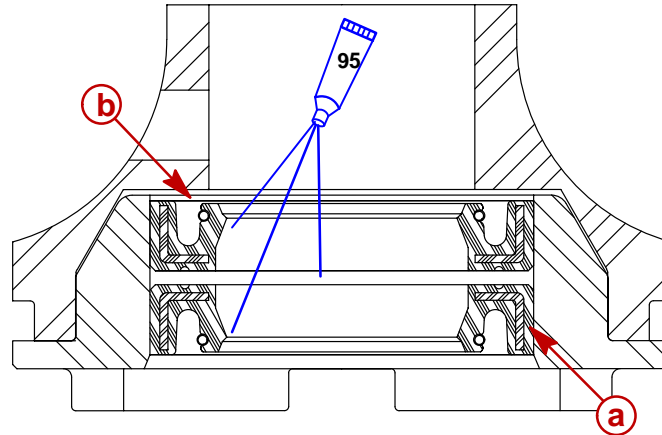
70610

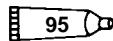
- a** - Oil Seal Carrier
- b** - Oil Seals
- c** - Screwdriver



OIL SEAL CARRIER ASSEMBLY – COMPONENT REASSEMBLY

The oil seals in the carrier assembly are the same diameter. The bottom (first) seal lip faces down; the top (second) seal lip faces up. Apply 2-4-C Marine Lubricant with Teflon to seal lips and between seals. Press seal into carrier with suitable mandrel. Second seal should be pressed in flush with carrier surface.

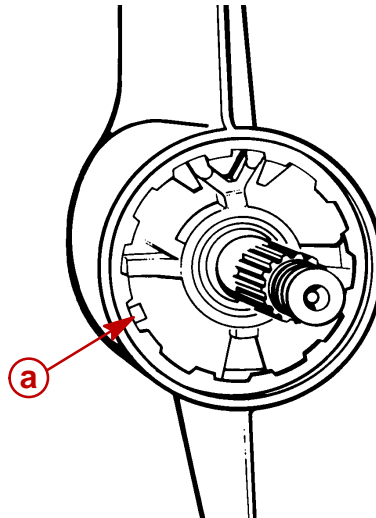


 2-4-C Marine Lubricant with Teflon

- a** - Bottom Seal (lip faces down)
- b** - Top Seal (lip faces up)

Bearing Carrier and Propeller Shaft Removal

1. Straighten the tab on the tab washer.



- a** - Tab on Tab Washer

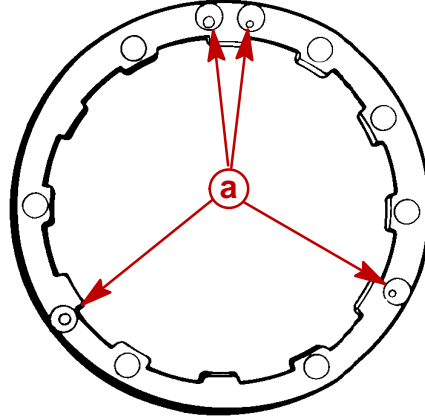
70490



2. Remove the bearing carrier retainer following step a or b as follows:

CAUTION
DO NOT drill into the gear housing retainer threads when using the following procedure for removing the retainer

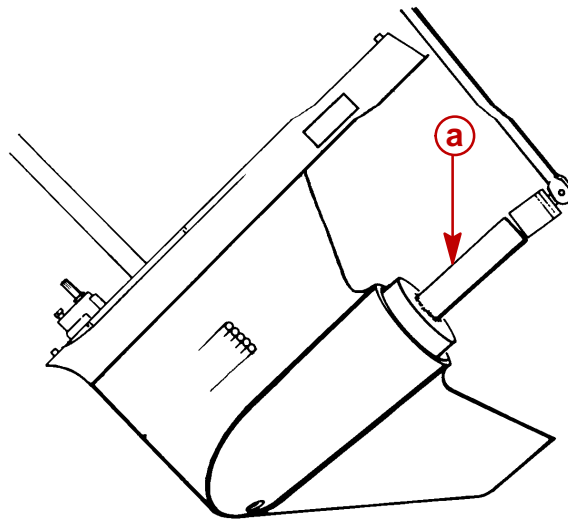
- a. If the retainer is corroded in place, drill 4 holes in the retainer and fracture the retainer with a chisel. Pry the remaining segments out.



23356

a - Drilled Holes

- b. Remove the bearing carrier retainer using the Bearing Carrier Retainer Wrench (91-61069).



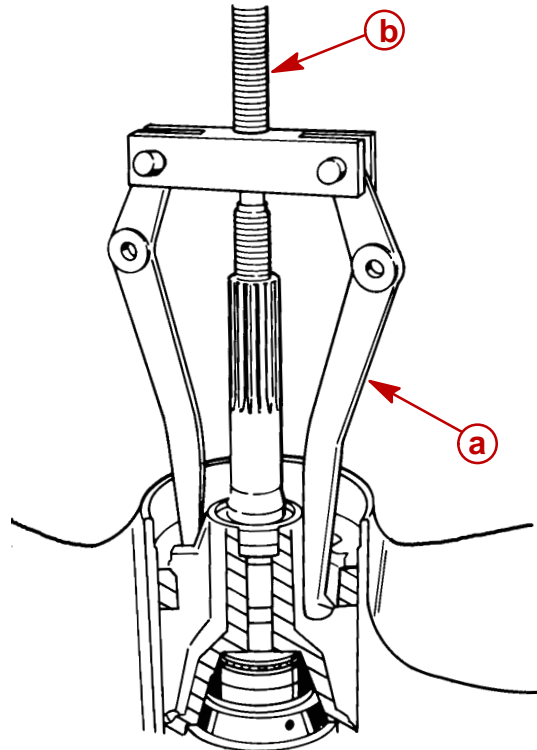
70491

a - Bearing Carrier Retainer Wrench



3. Pull the bearing carrier from the gear housing by pulling on the outer ring of the bearing carrier. POSITION PULLER JAWS CLOSE TO BOSSES IN CARRIER.

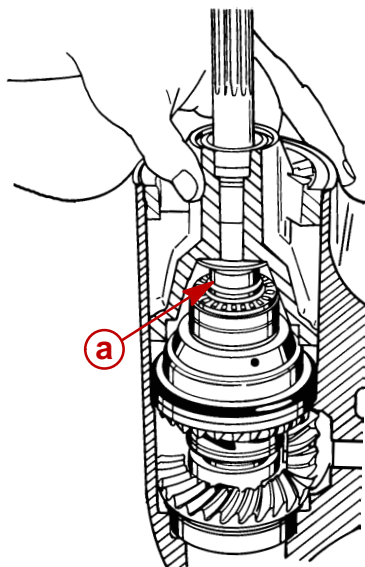
NOTE: If the bearing carrier is seized in the gear housing, it may be necessary to use heat to loosen the carrier.



50786

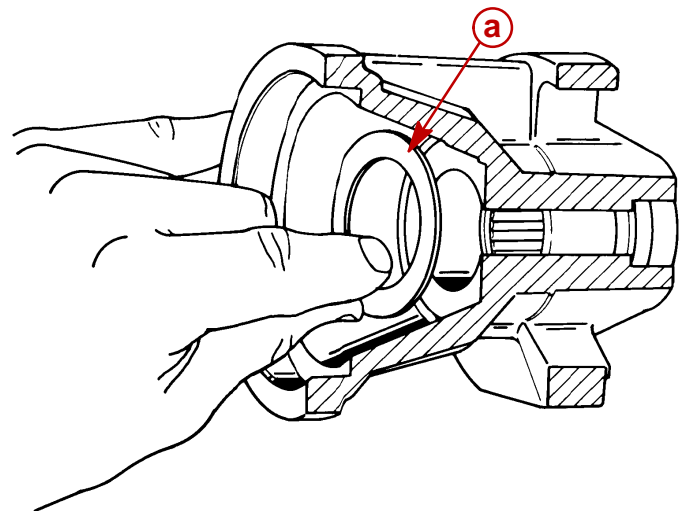
- a - Puller Jaws (91-46086A1)
- b - Puller Bolt (91-85716)

4. Lift the bearing carrier out of the gear housing. Locate and retain the thrust washer that may be stuck to the inside surface of the bearing carrier.



50826

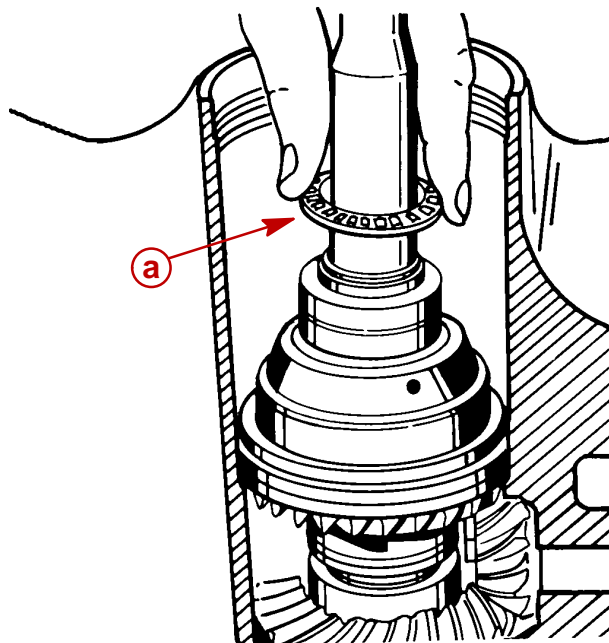
- a - Thrust Washer



50779



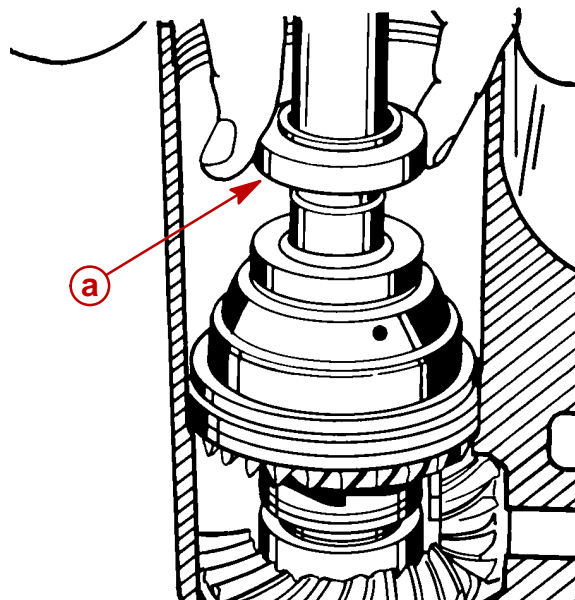
5. Remove the aft thrust bearing.



a - Thrust Bearing

50786

6. Remove the aft thrust collar.

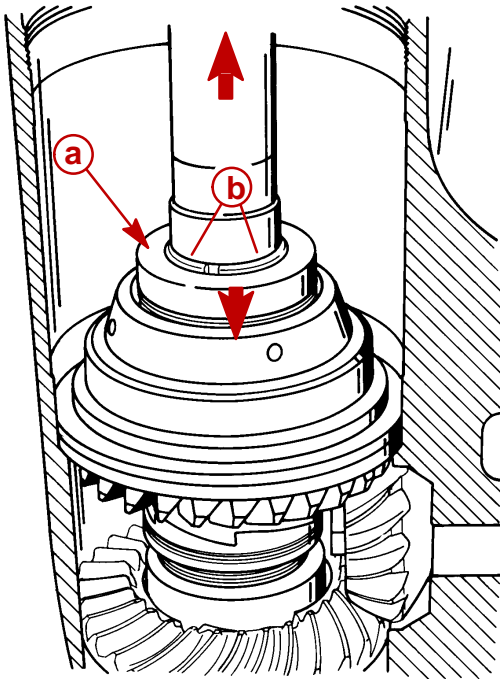


a - Thrust Collar

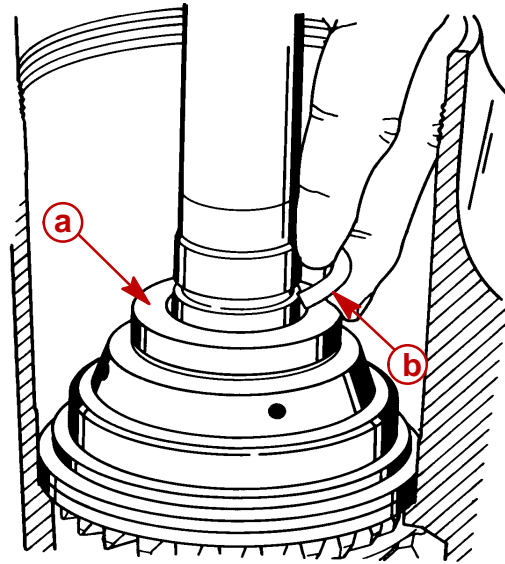
50787



7. Lift up on the propeller shaft and push down on the forward thrust collar to remove the two keepers.



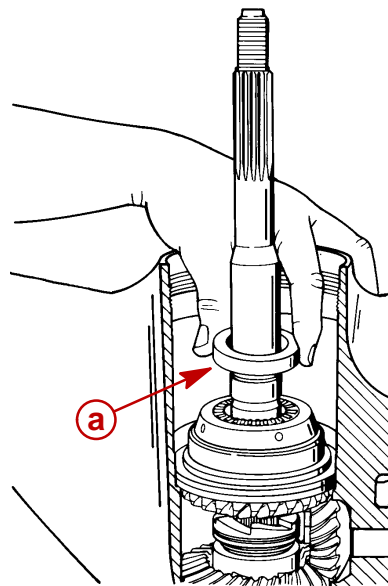
50778



50826

- a - Thrust Collar
- b - Keepers (2)

8. Remove the forward thrust collar.

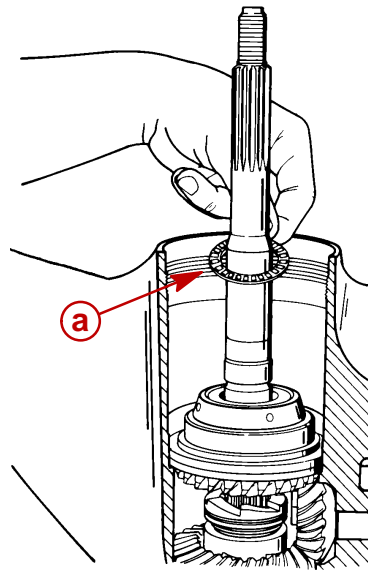


50784

- a - Thrust Collar



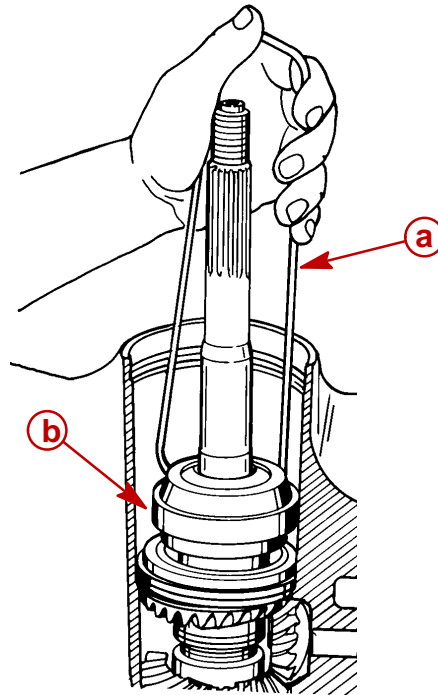
9. Remove the forward thrust bearing.



a - Thrust Bearing

50783

10. Form a tool using a 1/8 in. (3 mm) wire as shown in the following figure and remove the forward gear bearing adaptor.



a - Wire Tool
b - Forward Gear Bearing Adaptor

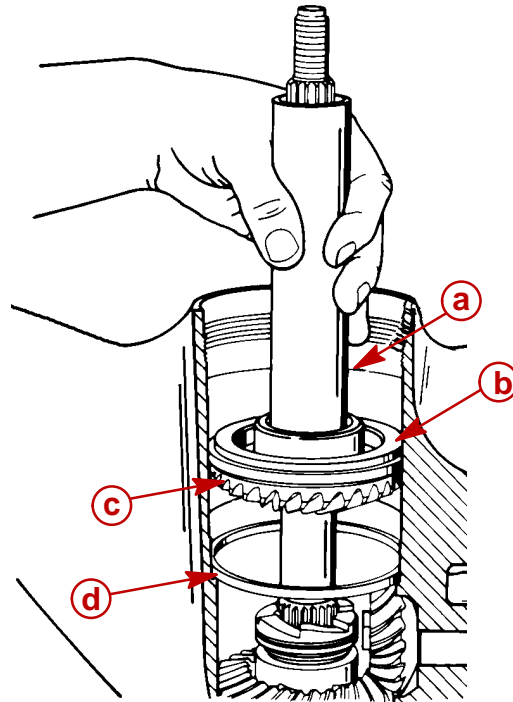
50786

11. Shift gear case into forward gear.

NOTE: The thrust race has a tight fit in the gear housing bore. Use the Forward Gear Installation Tool (91-815850) to remove the thrust race and the forward gear together. If this attempt fails, form a small hook on the end of a stiff piece of wire and while applying heat to the outside of gear case, pull the thrust race up and out of the gear housing.



12. Remove the O-ring from inside the gear housing.
13. Remove the forward gear, thrust race, and the thrust bearing (between the gear and the race).
14. Remove the forward gear shim.



- a** - Forward Gear Installation Tool (91-815850)
- b** - Thrust Race
- c** - Forward Gear
- d** - Shim

50783

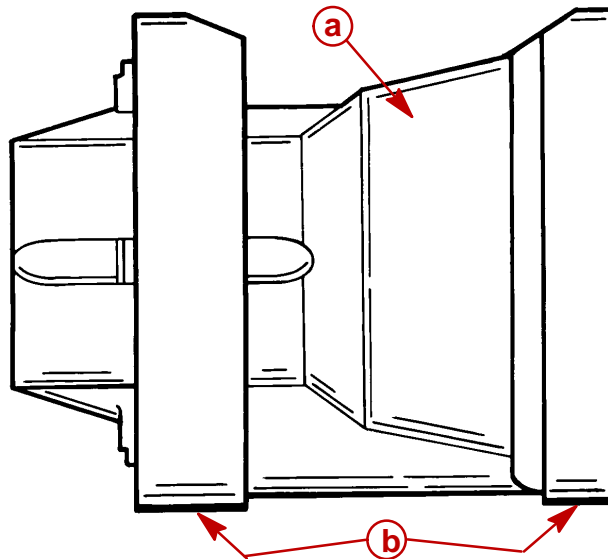


BEARING CARRIER ASSEMBLY - INSPECTION

1. Clean the assembly and all components with a suitable solvent and dry the parts thoroughly using compressed air.

NOTE: If any of the following items are found to be defective complete the appropriate instruction(s) in "Bearing Carrier Assembly", 'Component Disassembly and Inspection' section.

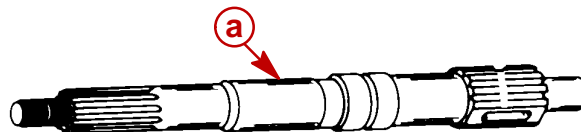
2. Inspect the bearing carrier for signs of excessive corrosion especially in the area where the bearing carrier touches the gear housing. If excessive corrosion is evident replace the carrier.



50818

- a** - Bearing Carrier
- b** - Mating Surfaces

3. The condition of the bearing surface on the propeller shaft in the area that the needle bearing (in the bearing carrier) rides is an indication of the condition of the needle bearing in the bearing carrier. Replace the bearing if the surface of the shaft is pitted, grooved, scored, worn unevenly, discolored from overheating or has embedded metal particles.

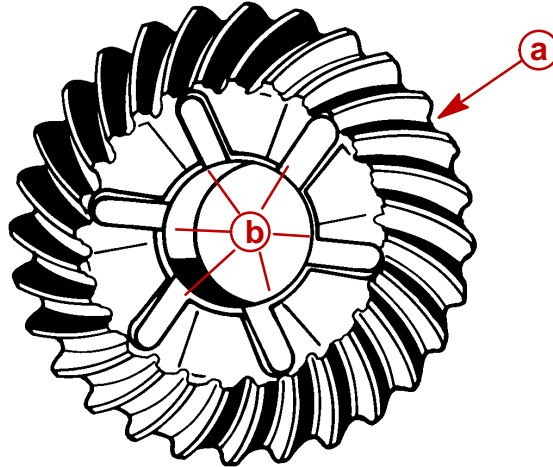


50698

- a** - Propeller Shaft Bearing Contact Area



4. Inspect the forward gear for pitted, chipped, broken teeth, hairline fractures, and excessive or uneven wear. Replace the forward gear and the pinion gear if any defects are found.
5. Inspect the outer hub of the forward gear for excessive wear or damage. Replace the forward and the pinion gear if either of these conditions exist.
6. Inspect the clutch jaws of the gear for damage. Surfaces must not be chipped or rounded off. Replace the forward and the pinion gear if any are found.



23355

- a** - Reverse Gear Teeth
- b** - Clutch Jaws

7. Inspect the thrust bearings, collars and forward gear bearing adaptor for excessive wear in the areas where the thrust bearings come into contact with them. Replace the appropriate components if they are found to be defective.
8. Inspect the bearing carrier retainer for cracks and/or broken or corroded threads. Replace it if any are found.
9. Inspect the large O-ring for damage and/or deterioration. Replace it if either condition is found.

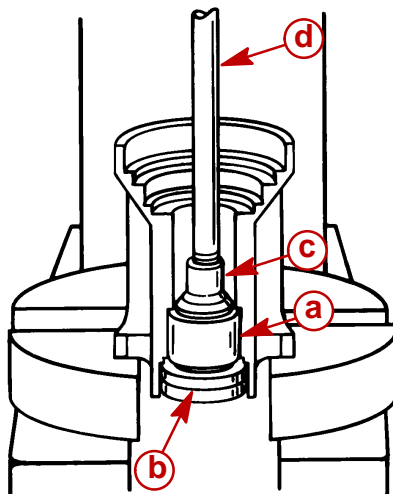


BEARING CARRIER ASSEMBLY - COMPONENT DISASSEMBLY AND INSPECTION

NOTE: Complete the instructions in this section only if the assembly components have been found to be defective.

NOTE: Inspection of the bearing surfaces on the propeller shaft where the needles of the bearing carrier needle bearing rolls, gives an indication of the condition of the needle bearing inside the bearing carrier. Replace needle bearing in the bearing carrier if the prop shaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.

1. Perform the following step a. or b. as necessary.
 - a. **If Replacing the Needle Bearing and Seals:** Remove the needle bearing and seals with the tools as shown.

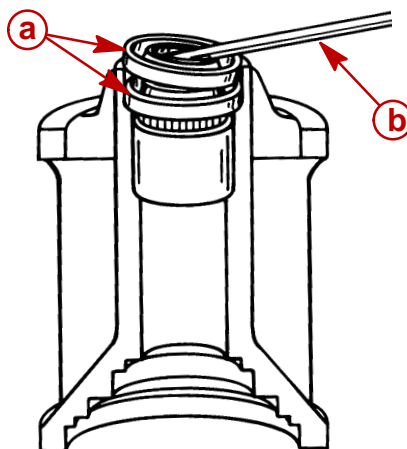


23140

- a** - Needle Bearing
- b** - Oil Seals
- c** - Driver Head (91-36569)
- d** - Bearing Driver Rod (91-37323)

(1.) **Discard the needle bearing and both seals.**

- b. **If Replacing the Seal Only:** Remove the oil seals with a suitable pry bar, being careful not to damage the bore of the bearing carrier.



23140

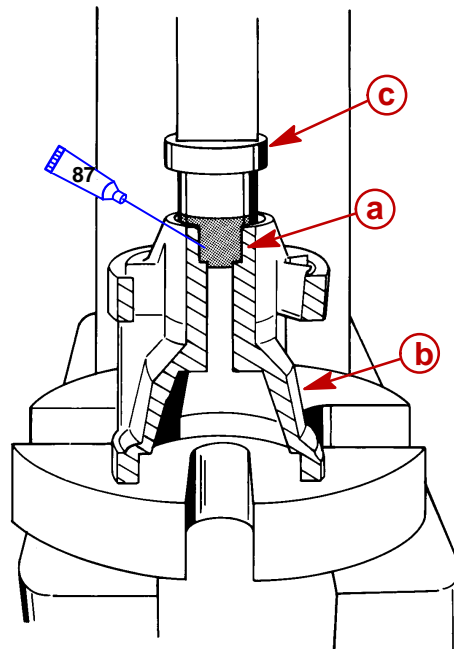
- a** - Oil Seals
- b** - Pry Bar

(1.) **Discard both of the seals.**

**BEARING CARRIER ASSEMBLY - COMPONENT REASSEMBLY**

NOTE: Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.

1. Clean all of the components with a suitable solvent and dry the parts thoroughly using compressed air. Be careful not to spin the bearing.
2. Lubricate the bore that the needle bearing is pressed into with Premium Gear Lubricant.
3. Assemble the needle bearing (with the numbered end of the bearing towards the driver shoulder), onto the driver.
4. Press the needle bearing into the bearing carrier until the driver bottoms out on the bearing carrier. Ensure that the numbered side of the needle bearing faces the seal end (aft end) of the carrier.



 Premium Gear Lubricant

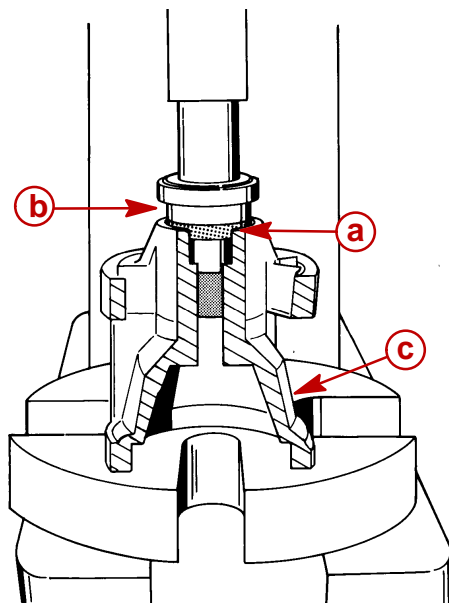
50788

- a** - Needle Bearing
- b** - Bearing Carrier
- c** - Needle Bearing Driver (91-15755)

5. **Thoroughly clean** the bore to which the first seal is to be pressed.
6. Assemble the first seal (with the lips of the seal facing away from the driver shoulder) onto the long end of the oil seal driver.



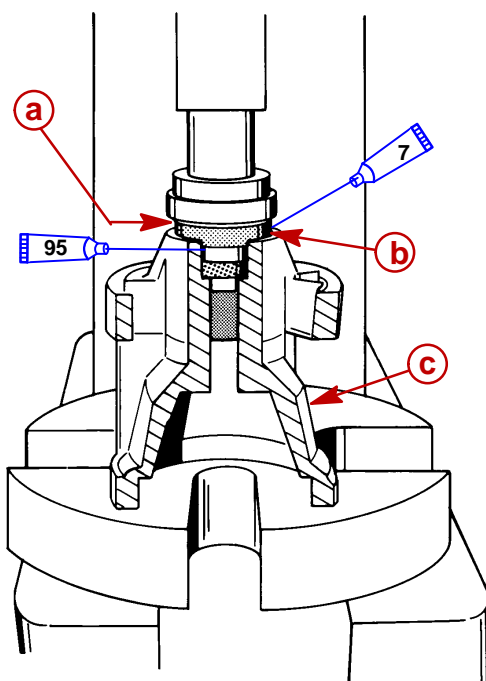
- Press on the oil seal driver until the driver bottoms onto the aft face of the bearing carrier.

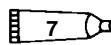
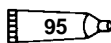


50788

- a** - Oil Seal
- b** - Oil Seal Driver (91-31108) (long end)
- c** - Bearing Carrier

- Apply a thin film of Loctite 271 to the outer diameter of the second seal.
- Assemble the second seal (with the lips seal facing the driver shoulder) onto the short end of the driver.
- Press the oil seal with the driver until the driver bottoms out on the bearing carrier.



-  Loctite 271
-  2-4-C Marine Lubricant with Teflon

50788

- a** - Driver
- b** - Oil Seal (lips toward driver shoulder)
- c** - Bearing Carrier



11. Wipe up all of the excess Loctite. Do not allow any of the excess Loctite to spread to other parts of the assembly.
12. Lubricate the seal lips and fill the area between the seals with 2-4-C Marine Lubricant with Teflon.

Forward Gear Bearing Adaptor Assembly

INSPECTION

1. Thoroughly clean the forward gear bearing adaptor with a suitable solvent and dry it using compressed air.

NOTE: *The condition of the bearing surfaces on the forward gear in the areas that the bearings of the bearing adaptor and the thrust bearing rides, is an indication of the condition of the respective bearings. Replace the bearing(s) if the surface of the gear and/or the thrust washer is pitted, grooved, scored, worn unevenly, discolored from overheating or has embedded metal particles.*

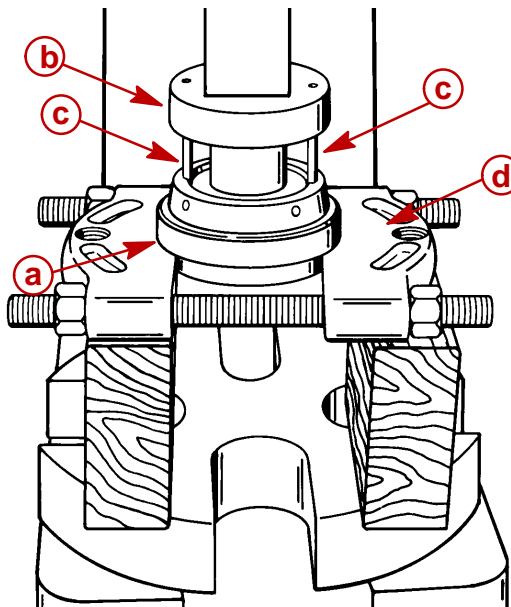
2. Assemble the forward gear to the bearing adaptor. Inspect them for excessive movement or roughness by rotating the gear in the adaptor. Replace the bearing in the adaptor if either of these conditions exist.
3. Inspect the adaptor for other signs of excessive wear or damage. Replace the adaptor if any are found.



FORWARD GEAR BEARING ADAPTOR ASSEMBLY - COMPONENT DISASSEMBLY AND REASSEMBLY

NOTE: Complete the instructions in this section only if the needle bearing in the bearing adaptor is defective and the adaptor is to be reused.

1. Disassemble the adaptor as follows:
 - a. Remove the bearing from the adaptor using the bearing removal tool. Align the pins of the tool with the holes of the adaptor and apply pressure to the center of the tool so that the pressure is equal on both of the pins. **Discard the bearing.**



50874

- a** - Forward Gear Bearing Adaptor
- b** - Bearing Removal Tool (91-816245)
- c** - Pins
- d** - Universal Puller Plate

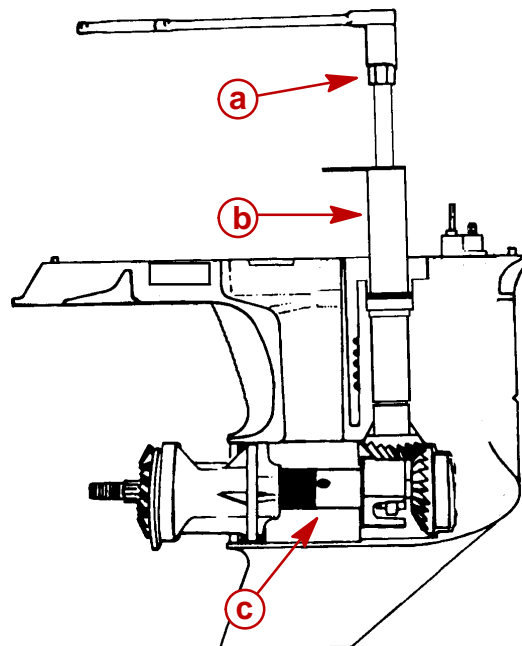
2. Assemble the adaptor as follows:
 - a. Lubricate the bore that the needle bearing is pressed into with 2-4-C Marine Lubricant with Teflon.
 - b. Assemble the needle bearing to the adaptor with the numbered end of the bearing facing the driver shoulder.
 - c. Press the needle bearing into the bearing adaptor using a suitable mandrel until the bearing bottoms in the adaptor.



Drive Shaft Assembly

REMOVAL

1. Remove the drive shaft pinion nut as follows:
 - a. Place the drive shaft bearing retainer wrench onto the drive shaft. Do not loosen the retainer at this time.
 - b. Insert the pinion nut adapter, with the MR slot facing the pinion gear, into the gear housing. It may be necessary to slightly lift and rotate the drive shaft to align the pinion gear nut into the pinion nut adapter slot.
 - c. Install the bearing carrier into the gear housing backwards to support the prop shaft and to keep the pinion nut adapter aligned.
 - d. Place the drive shaft nut wrench over the drive shaft splines and **loosen**, (but do not fully unscrew), the pinion nut by rotating the drive shaft counterclockwise.



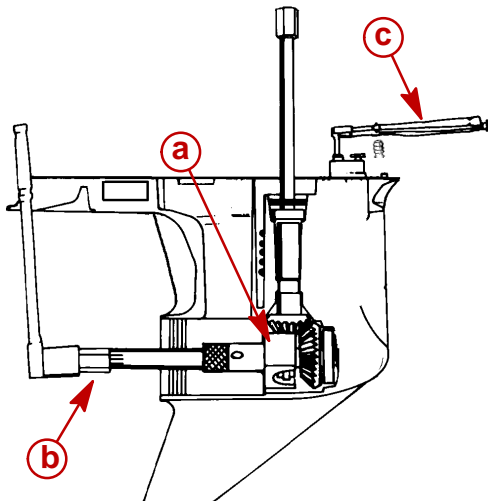
70887

- a** - Drive Shaft Nut Wrench (91-56775)
- b** - Drive Shaft Bearing Retainer Wrench (91-43506)
- c** - Pinion Nut adapter (MR Slot) (91-61067A2)



- e. **If the drive shaft is broken**, place propeller shaft nut wrench onto the propeller shaft splines, hold shift shaft in forward gear and **loosen**, (but do not fully unscrew), the pinion nut by rotating prop shaft counterclockwise to turn gears, thus loosening the pinion nut.

NOTE: The propeller shaft nut wrench is included with the pinion nut adapter kit.



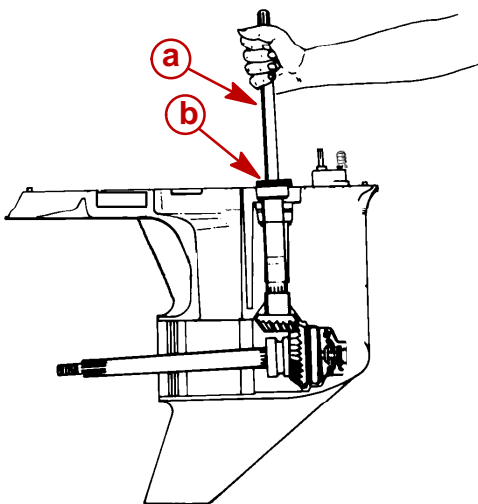
70607

- a** - Pinion Nut Adaptor (MR slot) (91-61067A2)
- b** - Propeller Shaft Nut Wrench (91-61067)
- c** - Shift Shaft (Turn Clockwise) (Protect shaft splines with soft material)

- f. Completely unscrew the drive shaft bearing retainer.
- g. Completely unscrew the pinion nut by rotating the drive shaft (or the propeller shaft) in a counterclockwise direction.
- h. Remove all tools.

IMPORTANT: The pinion bearing rollers are free to fall out of the pinion bearing once the drive shaft is removed. Be careful not to loose the (18) rollers.

2. Remove the drive shaft and all components by pulling the drive shaft straight out of the gear housing as shown.



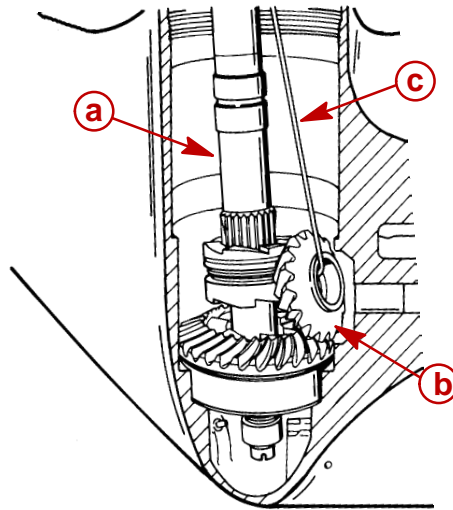
70608

- a** - Drive Shaft
- b** - Drive Shaft Retainer, Bearing Cup, Bearing, and Shims

3. With propeller shaft facing straight up, rotate shift lever into forward. Pull propeller shaft up and over towards port side of gear case.



4. Form a small hook on a stiff piece of wire and attempt to hook onto the top side of the gear and pull it out. It may be necessary to slightly move the propeller shaft from side-to-side to dislodge the pinion gear.



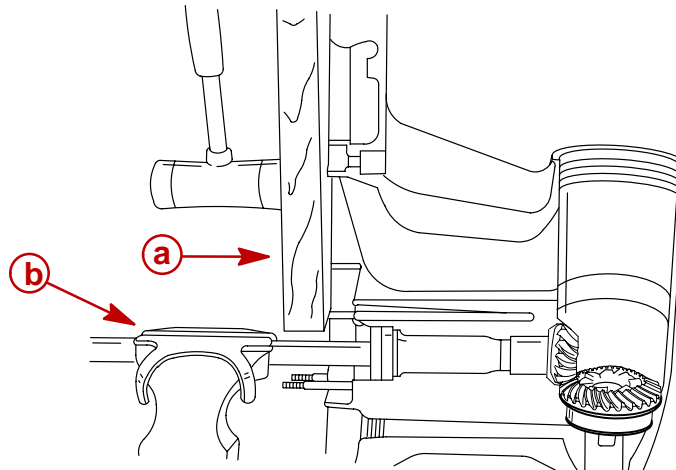
50884

- a - Propeller Shaft
- b - Pinion Gear
- c - Wire Tool

NOTE: If pinion gear is seized onto the driveshaft, place gearcase in vise using soft jaw vise covers. Place a block of wood on gear housing mating surface. Use a mallet and carefully tap gear housing away from drive shaft.

CAUTION

Do not strike gear housing hard with mallet or allow gear housing to fall.

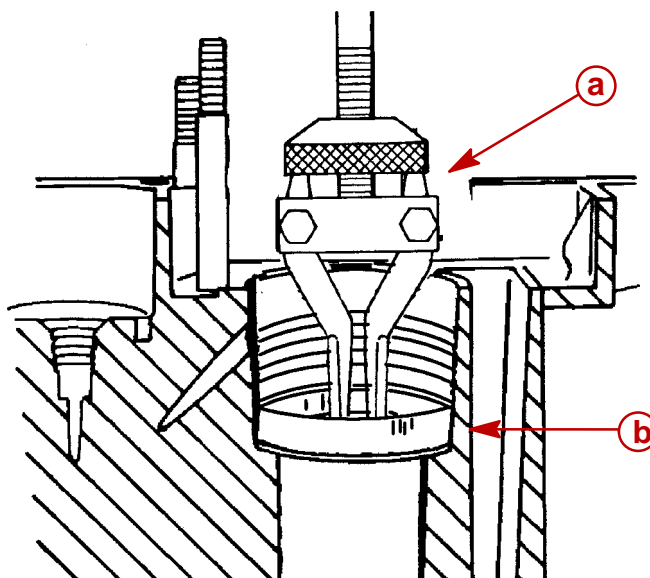


57951

- a - Wood Block
- b - Drive Shaft in Soft Jaw Vise



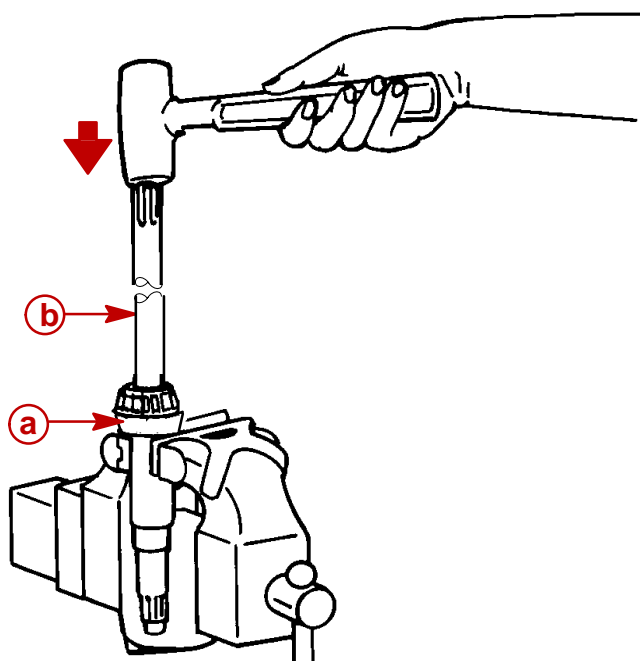
5. Remove lower drive shaft bearing cup and shims using slide hammer puller (34569A1) (retain shims for re-installation).



- a - Slide Hammer Puller (91-34569A1)
- b - Lower Drive Shaft Bearing Cup

DISASSEMBLY

1. Both upper and lower tapered roller bearings can be removed from the drive shaft in one operation. Using the bottom bearing cup removed from the gearcase, place the cup on top of a vise leaving the vise jaws open enough to allow the drive shaft to slide through.
2. Place the driveshaft through the cup and vise until the bottom bearing is resting in the cup. While holding the driveshaft, tap on the top of the shaft with a lead hammer until the bearings are free. **Do not drop the shaft when performing this operation.**



- a - Lower Bearing Cup Removed from Gear Case
- b - Drive Shaft With Both Upper and Lower Bearings

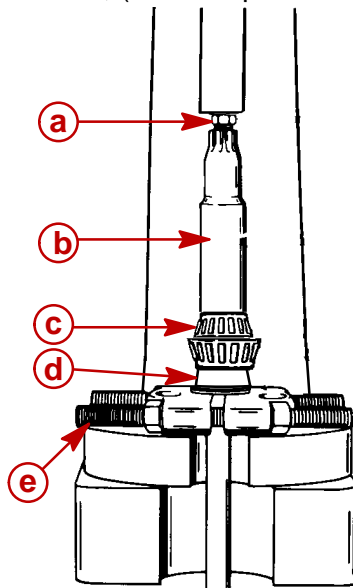


DRIVE SHAFT ASSEMBLY - INSPECTION

1. Clean all parts with a suitable solvent and dry the parts using compressed air. **DO NOT** spin the bearings.
2. The condition of the drive shaft bearing cup is an indication of the condition of the tapered roller bearing on the drive shaft. Replace the bearing and bearing cup if the cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
3. Inspect the bearing surface on the drive shaft where the needles of the lower pinion bearing roll. Replace the drive shaft if it is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
4. Inspect the splines at both ends of the drive shaft for a worn or twisted condition. Replace the drive shaft if either condition exists.
5. Inspect the gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. **Replace the pinion gear and the forward gear** if any defects are found.
6. Inspect driveshaft for groove(s) where water pump base oil seals contact shaft. Replace driveshaft if groove(s) are found.

REASSEMBLY

1. Apply a light coat of Premium Gear Lubricant on I.D. of drive shaft tapered bearing. Apply High Pressure Grease (such as Chicago Manufacturing and Distributing Lube #3) to the O.D. of both bearings.
2. Assemble a new tapered roller bearing to the drive shaft with the large O.D. of the bearing facing the pinion gear end of the drive shaft.
3. Thread a used pinion nut onto end of drive shaft. Leave approximately 1/16" (2mm) of nut threads exposed. Drive shaft threads **MUST NOT** extend beyond nut or thread damage could result while pressing.
4. Press the tapered roller bearing onto the drive shaft using the universal puller plate and a suitable mandrel, (an old tapered roller bearing inner race).



- a - Used Pinion Nut
- b - Drive Shaft
- c - Tapered Bearing(s)
- d - Old Bearing Inner Race
- e - Universal Puller Plate



Propeller Shaft Assembly

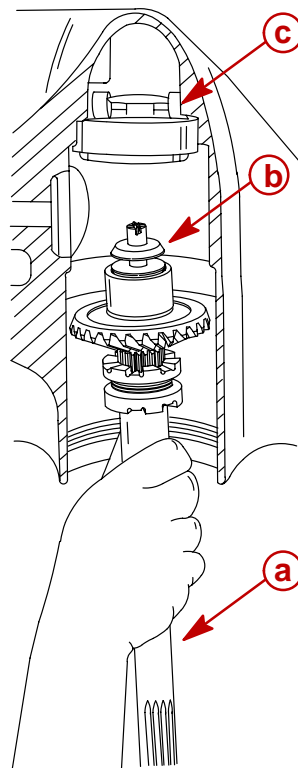
REMOVAL

⚠ CAUTION

Hold onto the propeller shaft assembly in the following step to avoid personal injury and/or dropping components when turning the gear housing over.

1. While holding onto the propeller shaft, turn the gear housing over so that the bore opening is facing down.
2. While moving the propeller shaft to the left (port) side of the gear housing, to allow the shift spool to disengage from the shift crank, lower the propeller shaft out of the gear housing.

NOTE: The rollers of the reverse gear bearing adaptor may become dislodged while removing the propeller shaft assembly. If this occurs, inspect the bearing cage to see if it has been damaged. If it has not been damaged simply snap the rollers back into position. If it has been damaged it will be necessary to remove and replace the bearing as outlined in the "Reverse Gear Bearing Adaptor Assembly", 'Component Disassembly and Reassembly' section.

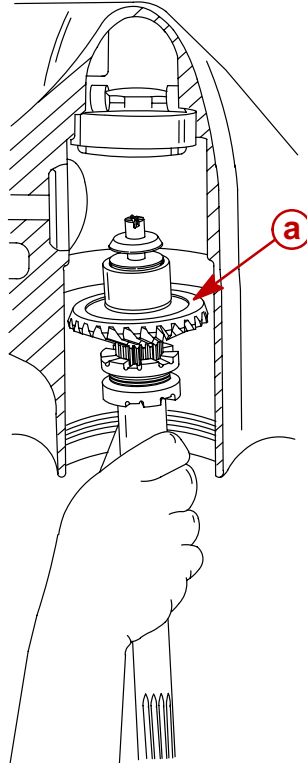


- a** - Propeller Shaft Assembly
- b** - Shift Spool
- c** - Shift Crank

58014



3. Locate and retain the thrust race and thrust bearing which could be on top of the reverse gear (if not, they may be stuck to the reverse gear bearing adaptor).



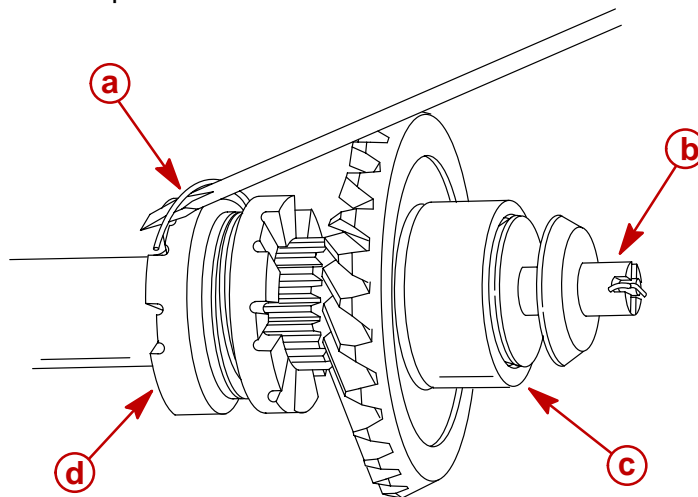
a - Thrust Bearing and Race

58014

PROPELLER SHAFT ASSEMBLY - COMPONENT DISASSEMBLY

IMPORTANT: When accomplishing the next step, all of the parts are free to come apart. Work closely over a work bench to ensure that the parts are not dropped or damaged, and to avoid personal injury.

1. Remove the spring around the clutch being careful not to overstretch it during removal. If the spring does not coil back to its normal position once it has been removed, it must be replaced.

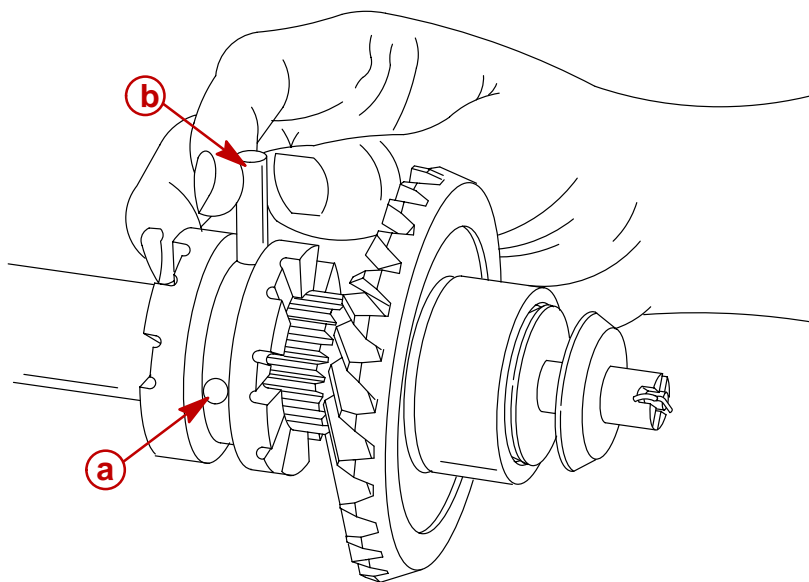


a - Spring
b - Shift Spool Assembly
c - Reverse Gear Assembly
d - Sliding Clutch

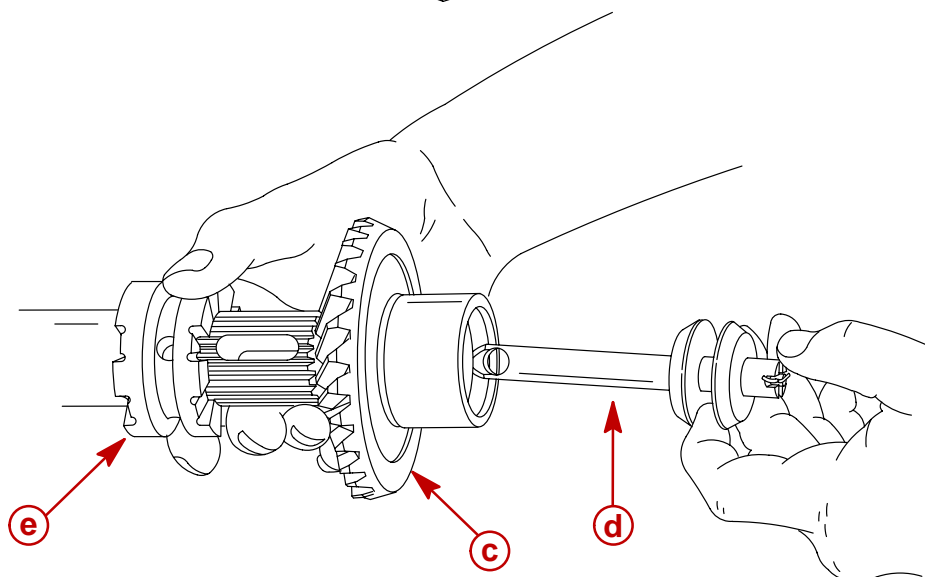
58015



2. Remove detent pin.
3. Remove the cross pin that goes through the clutch dog. Remove the reverse gear and slide the clutch off of the propeller shaft.



58012

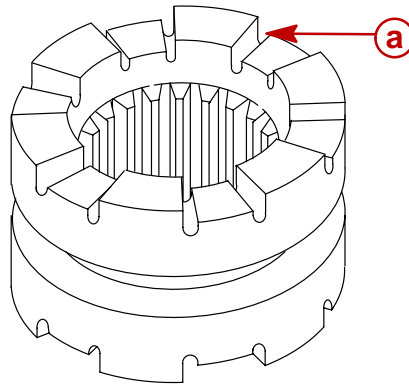


58018

- a** - Detent Pin
- b** - Cross Pin
- c** - Reverse Gear Assembly
- d** - Spool
- e** - Clutch

**PROPELLER SHAFT ASSEMBLY - COMPONENT INSPECTION**

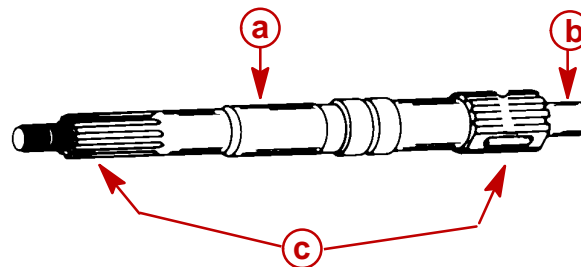
1. Clean all the parts with a suitable solvent and dry the parts thoroughly using compressed air, being careful not to spin bearings.
2. Inspect the sliding clutch jaws for damage. Jaws must not be chipped or rounded off. Replace the clutch if they are.



58013

a - Jaws

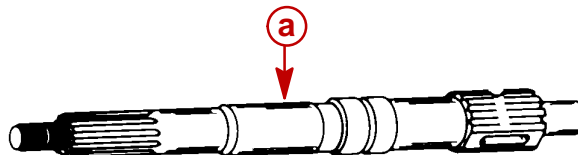
3. Inspect the bearing surfaces on the propeller shaft where the needles of the bearing carrier needle bearing and the needles of the forward gear needle bearing roll. Replace the propeller shaft if it is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.



50698

a - Bearing Carrier Needle Bearing Contact Area
b - Reverse Gear Needle Bearing Contact Area
c - Splines

4. Inspect the propeller shaft splines at both ends for a broken, worn, or twisted condition. Replace the propeller shaft if any of these conditions exists.
5. Inspect the surface of the propeller shaft where the bearing carrier seal lips contact the shaft. If the oil seals have made grooves, replace propeller shaft and seals.

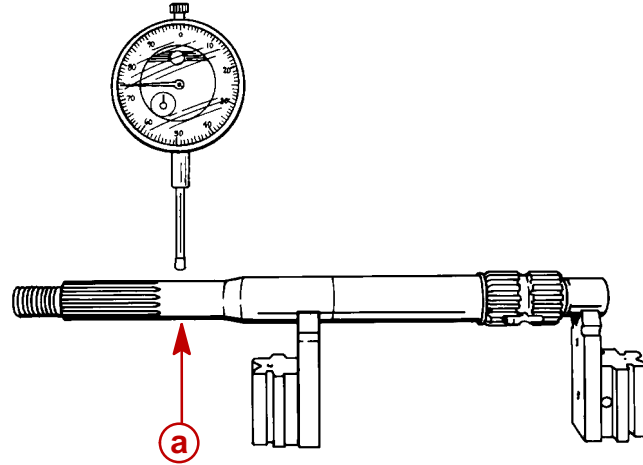


50698

a - Bearing Carrier Seal Contact Area



6. Inspect the propeller shaft for a bent condition.
 - a. **V-Blocks and Dial Indicator**
 - (1.) Position the propeller shaft bearing surfaces on V-blocks.
 - (2.) Adjust the height of V-blocks to level the propeller shaft.
 - (3.) Position the dial indicator tip just forward of the propeller shaft splines.



52727

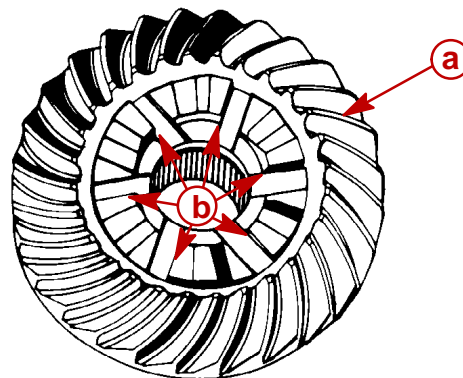
a - Check Movement with Dial Indicator (91-58222A1) Here

7. Rotate the propeller shaft and observe the dial indicator movement. If the indicator in the dial moves more than 0.009 in. (0.23mm), replace the propeller shaft.

Reverse Gear Assembly

COMPONENT INSPECTION

1. Clean the reverse gear assembly with a suitable solvent and dry thoroughly with compressed air. Be careful not to spin the bearings.
2. Inspect the gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. **Replace the reverse gear** if any defects are found.
3. Inspect the clutch jaws of the gear for damage. The surfaces must not be chipped or rounded off. **Replace the reverse gear** if any of these conditions exist.



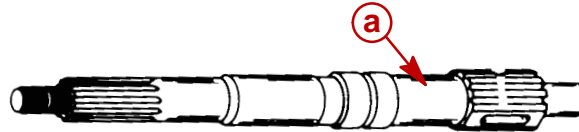
23351

a - Reverse Gear Teeth
b - Clutch Jaws



NOTE: The needle bearing in the reverse gear should not be removed unless damage has been found. Inspect to ensure that all of the needles are present and in position. The needles may have become dislodged while removing the gear from the propeller shaft (and/or while removing the propeller shaft assembly from the gear housing). They may be snapped back into place as long as no damage has occurred to the bearing cage.

4. Inspect the needle bearings on the inside of the reverse gear and the bearing surface on the propeller shaft. If either the needle bearings, or the bearing surface of the propeller shaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, replace the propeller shaft and remove and replace the needle bearing in the reverse gear as outlined in the next section.



50698

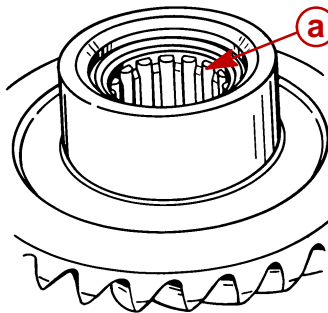
a - Forward Gear Needle Bearing Contact Area

REVERSE GEAR ASSEMBLY - COMPONENT DISASSEMBLY

NOTE: Reverse gear can only be removed from gear housing after drive shaft and pinion gear have been removed.

NOTE: Complete the instructions in this section only if the needle bearing in the gear has been found to be defective and the reverse gear is to be reused. Bearings that have become dislodged may be snapped back into position. If this is the only problem that exists it is not necessary to replace the needle bearing.

1. Replace bearing if it is rusted or does not roll freely.
2. Press the reverse gear needle bearing out using a suitable mandrel.



50778

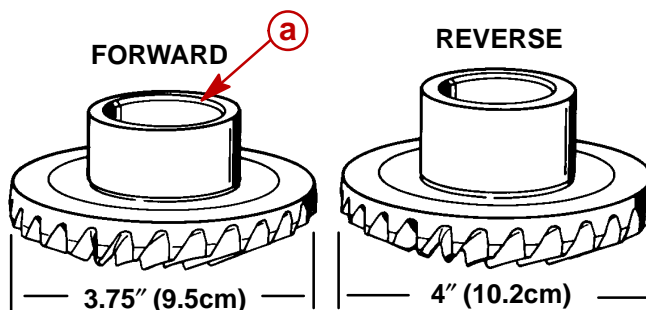
a - Reverse Gear Needle Bearing



REVERSE GEAR ASSEMBLY - COMPONENT REASSEMBLY

NOTE: Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.

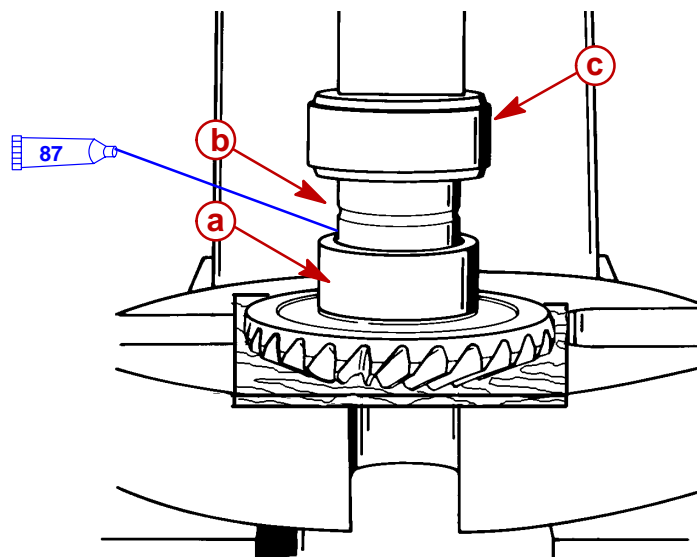
IMPORTANT: The appearance of the forward and reverse gear is almost identical. The forward gear has a shorter hub and is slightly smaller in diameter.



50885

a - Shorter Hub

1. Apply Premium Gear Lubricant to I.D. of forward gear. Press the needle bearing into the reverse gear until tool contacts gear.



Premium Gear Lubricant

50789

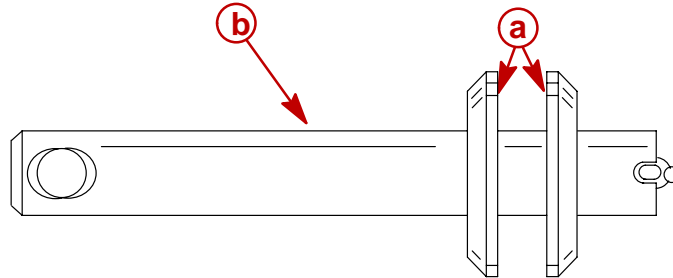
- a** - Reverse Gear
- b** - Needle Bearing
- c** - Bearing Driver (91-86943)



Shift Spool Assembly

INSPECTION

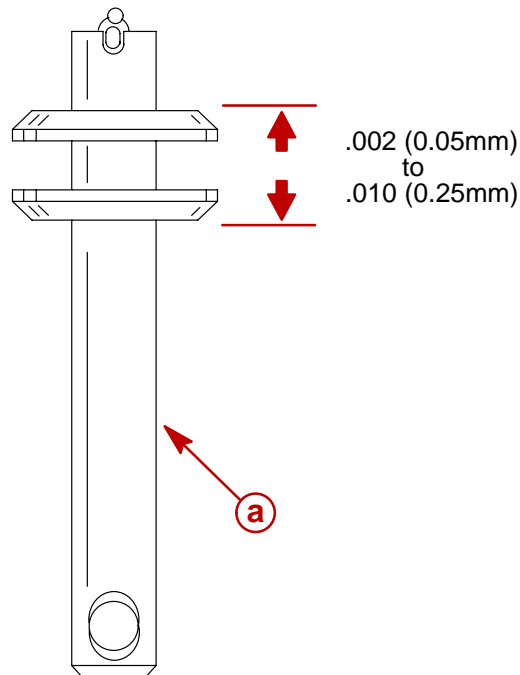
1. Clean the assembly with a suitable solvent and dry the parts using compressed air.
2. Inspect the shift spool assembly for damage. Small nicks and burrs may be smoothed. If any parts are damaged or worn beyond repair it will be necessary to replace the complete shift spool assembly. Individual parts are not available for the assembly.
3. Inspect the shift spool for wear in the area where the shift crank comes into contact.



23356

- a** - Contact Area
b - Shift Spool

4. Inspect to insure that the spool spins freely (it may be helpful to lightly tap the forward [castle nut] end of the shift spool shaft against a firm surface to align the internal parts).
5. Inspect to insure that the spool has no more than 0.002-0.010 (0.05-0.25 mm) end play.



55694

- a** - Spool



SHIFT SPOOL ASSEMBLY - COMPONENT DISASSEMBLY

NOTE: Disassembly of the shift spool is for cleaning and inspection of the internal parts of the assembly due to an improperly functioning shift spool assembly or debris in the gear housing and/or shift spool assembly. Individual components for the shift spool are not available as replacement parts. If the shift spool does not function properly (see the preceding "Shift Spool Assembly - Inspection" section) and the following cleaning and adjustment procedures do not produce the desired results, it will be necessary to order a new shift spool assembly.

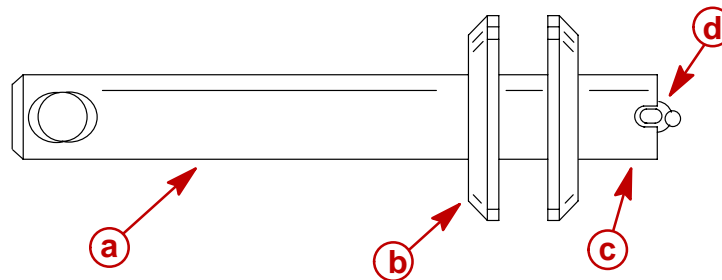
1. Disassemble the shift spool assembly as follows:
 - a. Remove and discard the cotter pin.
 - b. Remove the castle nut and the spool.

SHIFT SPOOL ASSEMBLY - COMPONENT INSPECTION

1. Clean all components with a suitable solvent and dry them with compressed air.
2. Inspect each component for wear or damage. If any components are worn beyond repair, damaged, or broken it will be necessary to replace the complete shift spool assembly. Small nicks or burrs may be smoothed and the parts reused.

SHIFT SPOOL ASSEMBLY - COMPONENT REASSEMBLY

1. Assemble the shift spool and shift spool shaft as follows:
 - a. Place the shift spool onto the shift spool shaft.
 - b. Assemble the castle nut and screw it down until it touches the washer and a slight resistance is felt.
 - c. Loosen the castle nut until the cotter pin slot of the castle nut is aligned with the hole in the shaft. If, when the castle nut is screwed down, the cotter pin slot is already aligned at the hole in the shaft, back the castle nut off until the next available slot in the nut is aligned with the hole in the shaft.
 - d. Insert a new cotter pin and bend ends of the cotter pin in opposite directions.



- a** - Shift Spool Shaft
- b** - Shift Spool
- c** - Castle Nut
- d** - Cotter Pin

55694



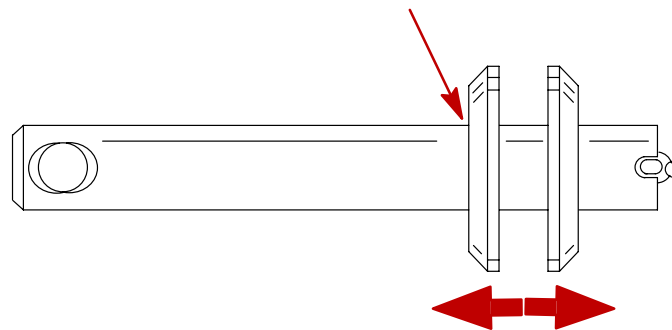
SHIFT SPOOL ASSEMBLY - ADJUSTMENT

NOTE: If the shift spool assembly has been disassembled and reassembled (as in the previous two sections) skip the following instructions (1 through 4).

NOTE: If the shift spool assembly has not been disassembled and reassembled, do all of the following steps.

1. Remove and discard the cotter pin.
2. Screw the castle nut down until it touches the washer and a slight resistance is felt.
3. Loosen the castle nut until the cotter pin slot of the castle nut is aligned with the hole in the shaft. If, when the castle nut is screwed down, the cotter pin slot is not aligned at the hole in the shaft, back off the castle nut until the next available slot in the nut is aligned with the hole in the shaft.
4. Insert a new cotter pin and bend ends in opposite directions.
5. Inspect to insure that the spool spins freely (it may be helpful to lightly tap the forward [castle nut] end of the shift spool shaft against a firm surface to align the internal parts).
6. Inspect to insure that the spool has no more than 0.002-0.010 (0.05-0.25 mm) end play, if it does adjust the castle nut once again as outlined previously.

0.002 - 0.010 in. (0.05 - 0.25 mm)



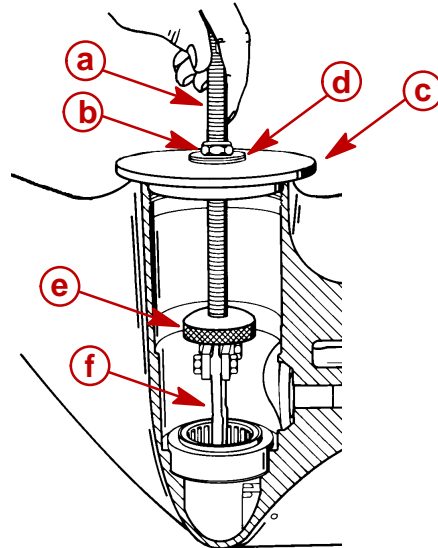
7. If this adjustment did not produce the desired results it will be necessary to disassemble, clean, and reassemble the shift spool assembly. If the spool assembly has already been disassembled and cleaned it will be necessary to replace the shift spool assembly.



Reverse Gear Bearing Adaptor Assembly

REMOVAL

1. Remove the reverse gear bearing adaptor using the tools as shown in the next figure. Remove, measure and make note of the shim thickness. If the shims are not damaged, they may be reused.



50780

- a** - Bolt (91-31229)
- b** - Nut (11-24156)
- c** - Guide Plate (91-816243)
- d** - Washer (91-34961)
- e** - Puller Head (from Slide Hammer Puller Kit 90-34569A1)
- f** - Jaws (91-816242)

REVERSE GEAR BEARING ADAPTOR ASSEMBLY - INSPECTION

1. Thoroughly clean the reverse gear bearing adaptor with a suitable solvent and dry it using compressed air.

NOTE: The condition of the bearing surfaces on the reverse gear in the areas that the bearings of the bearing adaptor and the thrust bearing rides, is an indication of the condition of the respective bearings. Replace the bearing(s) if the surface of the gear and/or the thrust washer is pitted, grooved, scored, worn unevenly, discolored from overheating or has embedded metal particles.

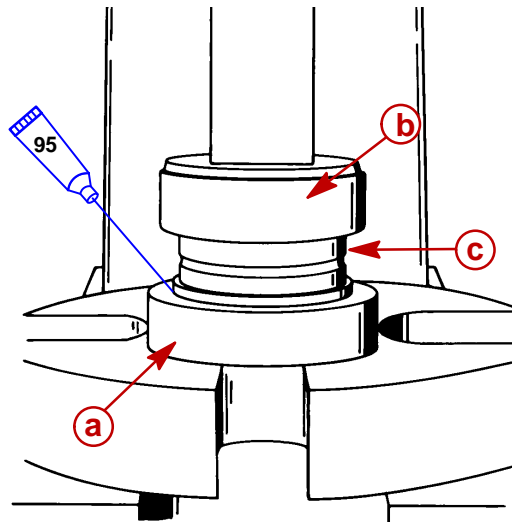
2. Assemble the reverse gear, the thrust bearing, and the thrust race, to the bearing adaptor. Inspect them for excessive movement or roughness by rotating the gear in the adaptor. Replace the bearing in the adaptor and/or the thrust bearing if either of these conditions exist.
3. Inspect the adaptor for other signs of excessive wear or damage. Replace the adaptor if any are found.

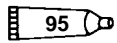


REVERSE GEAR BEARING ADAPTOR ASSEMBLY - COMPONENT DISASSEMBLY AND REASSEMBLY

NOTE: Complete the instructions in this section only if the needle bearing in the bearing adaptor is defective and the adaptor is to be reused.

1. Disassemble the adaptor as follows:
 - a. Remove the bearing from the adaptor using a suitable mandrel.
 - b. **Discard the bearing.**
2. Assemble the adaptor as follows:
 - a. Lubricate the bore that the needle bearing is to be pressed into with 2-4-C Marine Lubricant with Teflon.
 - b. Position the needle bearing on the adaptor with the numbered end of the bearing facing the driver shoulder.
 - c. Press the needle bearing into the bearing adaptor using a suitable mandrel until the bearing is flush with the face of the adaptor.



-  95 2-4-C Marine Lubricant With Teflon
- a** - Reverse Gear Bearing Adaptor
b - Suitable Mandrel
c - Bearing

50790

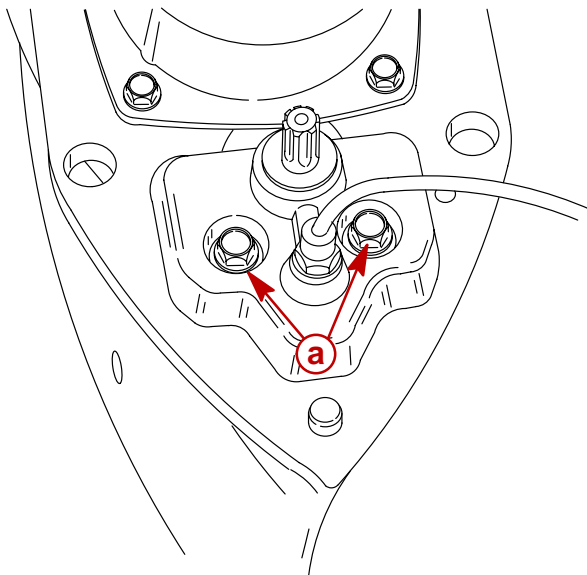


Shift Shaft Assembly

REMOVAL

NOTE: It is possible to remove and service the shift shaft assembly (but not the shift crank inside the gear case) without removing any of the internal components of the gear housing.

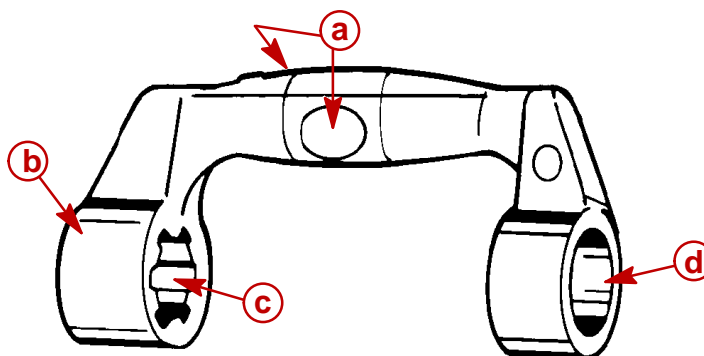
1. Remove the shift shaft bushing screws, and remove the shift shaft and bushing by pulling them straight out of gear housing.



57934

a - Shift Shaft Bushing Screws

2. Remove the shift crank from the inside of the gear housing. Clean it with a suitable solvent and dry it thoroughly. Inspect it for wear in the areas that contact the shift spool and inspect the splines and the diameter that goes over the locating pin for damage or wear.



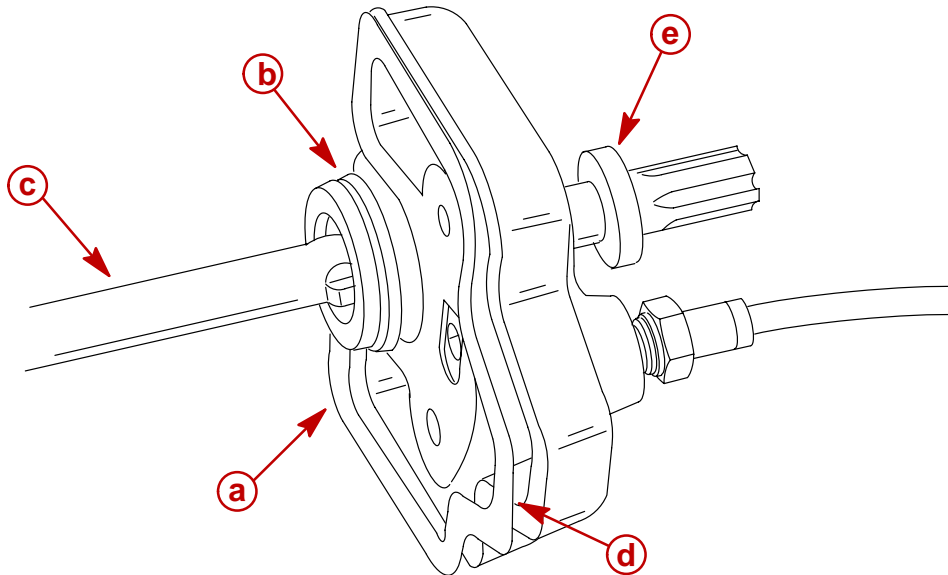
23350

- a** - Contact Area
- b** - Shift Crank
- c** - Splines
- d** - Diameter for Locating Pin



SHIFT SHAFT ASSEMBLY - Component Disassembly and Inspection

1. Slide the bushing assembly off the shift shaft. Remove the coupler from the shaft.

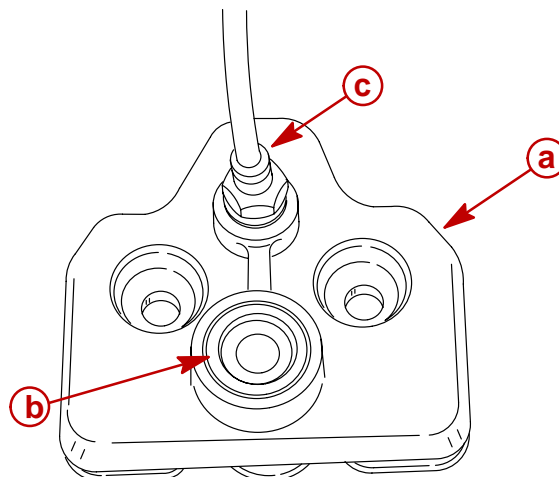


57954

- a** - Shift Shaft Bushing Assembly
- b** - O-ring
- c** - Shift Shaft
- d** - Gasket
- e** - Rubber Washer

2. Clean all components with a suitable solvent and dry thoroughly with compressed air.
 - a. Inspect the shift shaft bushing for cracking, damage, or excessive wear.
 - b. Inspect the oil seal inside the bushing, the sleeve, and the O-rings on the outside of the bushing for damage or excessive wear.
 - c. Inspect the speedometer connector for damage or blockage.

If any of these conditions exist, replace the appropriate components.

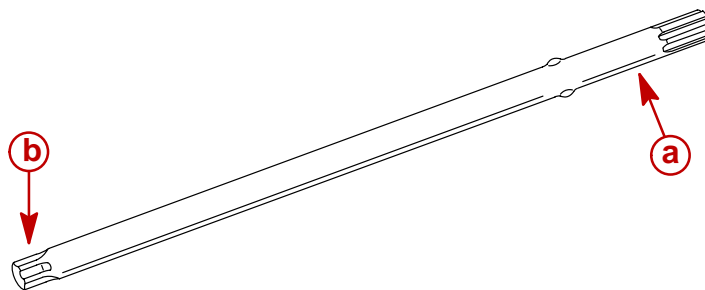


57932

- a** - Shift Shaft Bushing
- b** - Oil Seal (Oil Seal is Replaceable)
- c** - Speedometer Tube Connector



3. Inspect the shift shaft splines and oil seal surface for corrosion and/or excessive wear. Replace the shift shaft if either if these conditions are found.

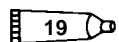
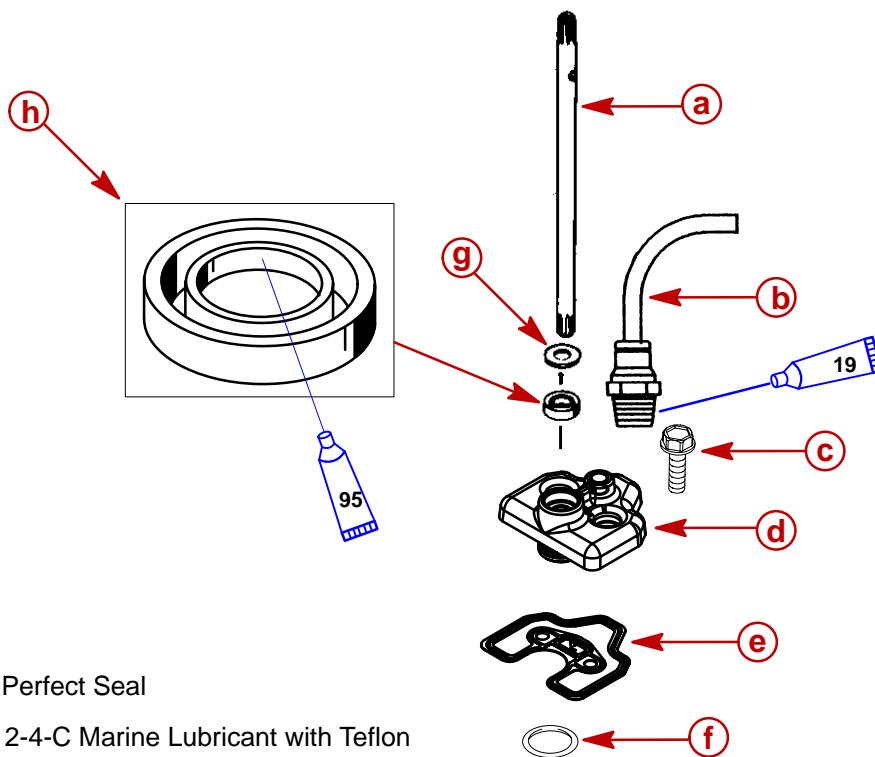


- a - Oil Seal Surface
- b - Spline

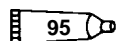
57948

SHIFT SHAFT ASSEMBLY - Component Reassembly

1. Lightly lubricate the seat of the O-ring diameter on the bushing and the lip of the oil seal with 2-4-C Marine Lubricant with Teflon.
2. If the speedometer connector was removed and/or replaced, lightly coat the **threads of the connector** with Perfect Seal. Assemble the speedometer connector to the bushing and torque the connector to 4.5 lb. in. (0.5 Nm).
3. Assemble all components as shown below.



Perfect Seal



2-4-C Marine Lubricant with Teflon

- a - Shift Shaft
- b - Speedometer Pressure Hose
- c - Bolt (2) [Torque to 60 lb. in. (7 Nm)]
- d - Bushing
- e - Gasket
- f - O-ring
- g - Rubber Washer
- h - Seal (Lip Faces Up)



Pinion Bearing

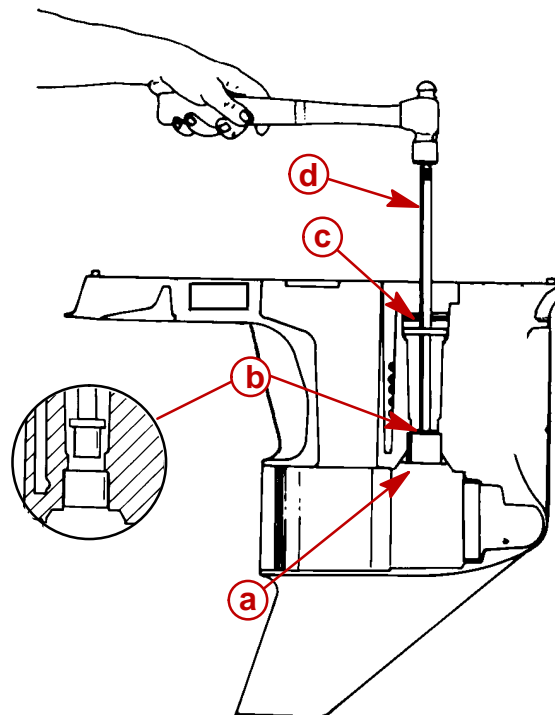
REMOVAL

NOTE: Inspect the bearing surface on the drive shaft where the needles of the lower pinion bearing roll. The condition of the drive shaft at this location gives an indication of the condition of the needle bearing. Replace lower pinion bearing (needles and race as a set) if the drive shaft is pitted, grooved scored, worn unevenly, discolored from overheating, or has embedded particles.

IMPORTANT: All the needle bearings (18) **MUST BE** in place inside bearing race while driving the pinion bearing from the gear housing.

IMPORTANT: Do not reuse the bearing (race or rollers) once it has been removed.

1. Remove and discard the pinion bearing (race and rollers) using tools as shown.



70614

- a** - Pinion Bearing
- b** - Bearing Driver (91-36569)
- c** - Pilot Washer (91-36571)
- d** - Driver Rod (91-37323)



Gear Housing Reassembly

Gear Housing Inspection

1. Clean the gear housing thoroughly with a suitable solvent and a hard bristle brush. Dry the gear housing thoroughly using compressed air. Insure that all sealants, locking agents and debris are removed.
2. Verify the 2 oil circulation holes in the drive shaft bore and the shift shaft hole are clear and free of debris.
3. Inspect the gear housing for excessive corrosion, impact or any other damage. Excessive damage and/or corrosion requires replacement of the gear housing.
4. Inspect the bearing carrier retainer threads in the gear housing for corrosion and/or stripped threads. Damage or corrosion to the threads requires replacement of the gear housing.
5. Inspect bearing race/cup contact areas for evidence of bearing cup spinning. Check that bearing cups are not loose in bearing bores. Any one bearing bore in which the race/cup is loose will require replacement of the gear housing.
6. Inspect for blockage in water inlet holes and the speedometer hole, clean as necessary. Be careful not to enlarge the speedometer hole as this could cause erroneous speedometer readings.
7. Verify that the locating pins are in place in the gear housing and that the corresponding holes in the drive shaft housing are not elongated. The drive shaft may break if the housings are not aligned properly due to missing locating pins or elongated holes.

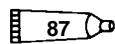
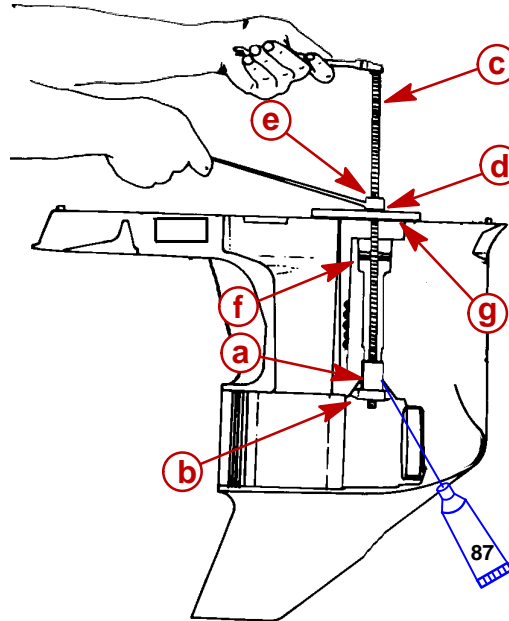


Pinion Bearing

INSTALLATION

IMPORTANT: Install only a new pinion bearing. Do not reinstall a pinion bearing that has been previously removed from a gear housing.

1. Lubricate the bore into which the pinion bearing is to be installed with Premium Gear Lubricant.
2. Position the new pinion bearing (with the cardboard shipping sleeve in place) onto the driver head, with the lettered and numbered side of the bearing oriented upward.
3. Insert the driver with the bearing assembly, into position (by way of the propeller shaft bore) at the drive shaft bore as shown.



Premium Gear Lubricant

70615

- a** - Drive Shaft Pinion Bearing (With Cardboard Shipping Sleeve)
- b** - Driver Head (91-38628)
- c** - Puller Shaft (91-31229)
- d** - Washer (12-34961)
- e** - Nut (11-24156)
- f** - Pilot Washer (91-36571)
- g** - Puller Plate (91-29310)

4. Install the bearing by screwing down the nut until the bearing is fully seated against the bore shoulder.

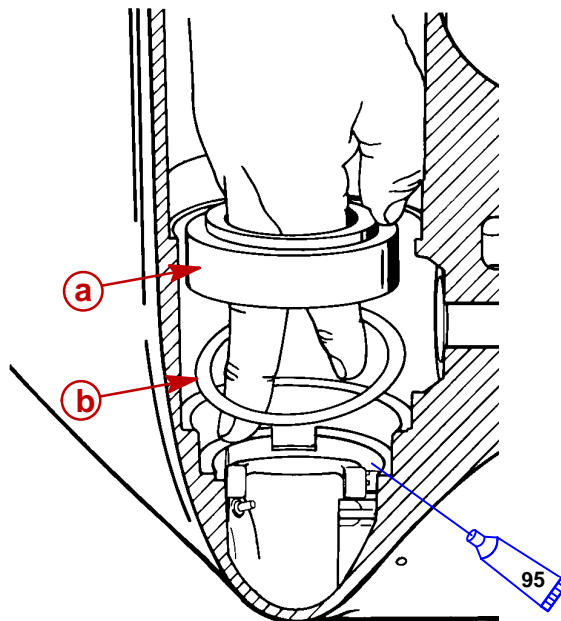


Reverse Gear Bearing Adaptor Assembly

INSTALLATION

NOTE: If the reverse gear, reverse gear adaptor, large thrust bearing, or bearing race in the gear housing were not replaced, install the same shim(s) (or the same thickness of shim(s) that were taken out when adaptor was removed. If the reverse gear, reverse gear adaptor, large thrust bearing, bearing race, or gear housing were replaced, install 0.008 in. (0.51 mm) of shims.

1. Lubricate the bore into which the reverse gear bearing adaptor is to be installed with 2-4-C Marine Lubricant with Teflon.
2. Place the shim(s) into reverse bore of gear housing.
3. Position the bearing adaptor in the gear housing.

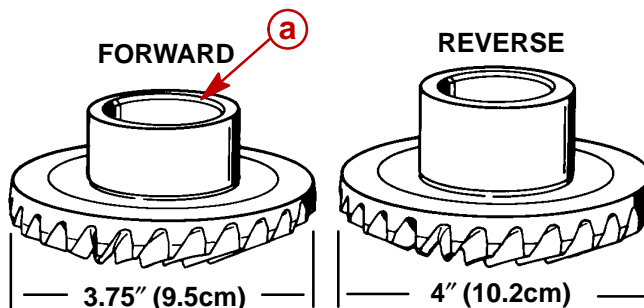


 95 2-4-C Marine Lubricant with Teflon

50781

- a** - Bearing Adaptor
- b** - Shims

IMPORTANT: The appearance of the forward and reverse gear is almost identical. The forward gear has a shorter hub and is slightly smaller in diameter.

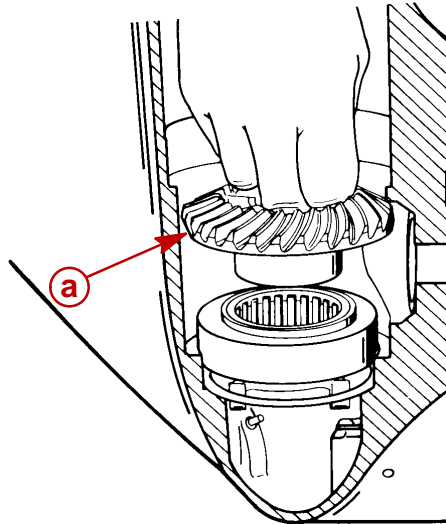


- a** - Shorter Hub

50885



4. Position the reverse gear (without the thrust race or thrust bearing) into the gear housing and into the adaptor.



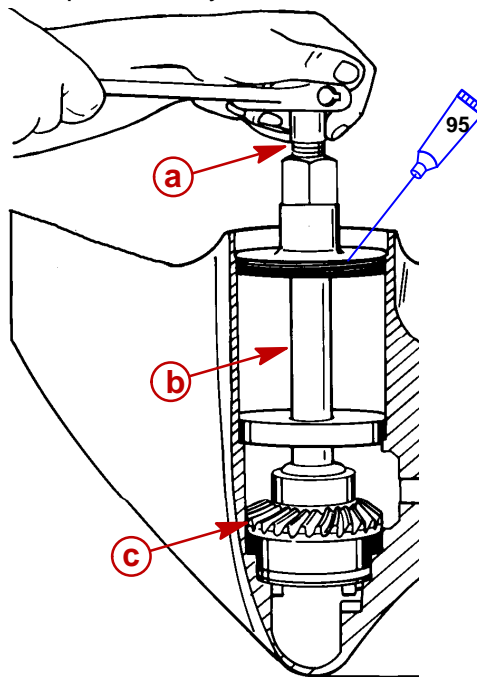
50781

a - Reverse Gear

5. Press the bearing adaptor into the gear housing using the installation tool as follows:

IMPORTANT: Be sure that the bearing adaptor is positioned as straight as possible to avoid cocking it in the bore while pressing it in.

- a. Lubricate the threads of the installation tool with 2-4-C Marine Lubricant with Teflon.
- b. Turn the hex-head screw of the installation tool until the bearing adaptor bottoms out on the gear housing shoulder. **DO NOT** continue to turn the tool once the screw resistance goes up noticeably.



 95 2-4-C Marine Lubricant with Teflon

50791

- a** - Hex-Head Screw
- b** - Bearing Adaptor Installation Tool (91-18605A1)
- c** - Reverse Gear

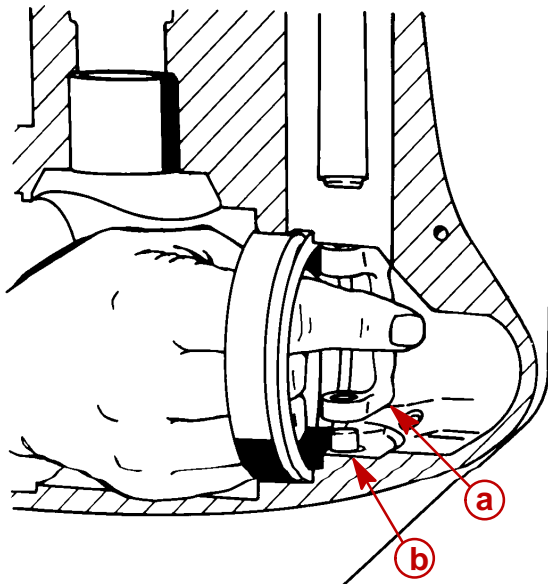
- c. Remove the installation tool **and the reverse gear.**



Shift Shaft Assembly

INSTALLATION

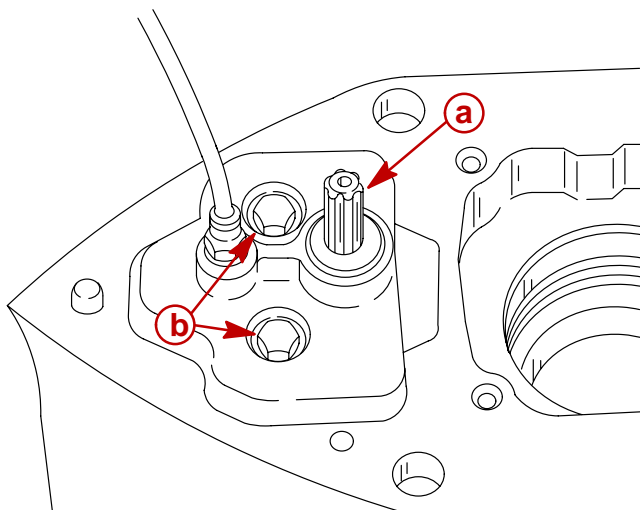
1. Place the shift crank onto the locating pin in the forward section of the gear housing. Ensure that the shift crank faces towards the left (port) side of the gear housing.



50314

- a** - Shift Crank
- b** - Locating Pin

2. Install the shift shaft assembly into the gear housing as shown. Engage the splined end of the shift shaft with the shift crank. Verify O-ring is positioned properly and lubricated with 2-4-C Marine Lubricant with Teflon. Secure shift shaft bushing with 2 screws. Torque screws to 60 lb. in. (7 Nm).

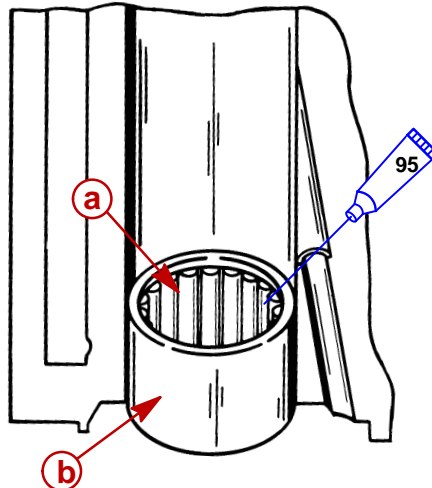


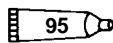
57933

- a** - Shift Shaft Assembly
- b** - Screws [Torque to 60 lb. in. (7 Nm)]



NOTE: If the pinion bearing needle bearings have fallen out, install 18 needles into needle bearing outer race. Use 2-4-C Marine Lubricant with Teflon, to help hold needles in place.



 2-4-C Marine Lubricant with Teflon

23142

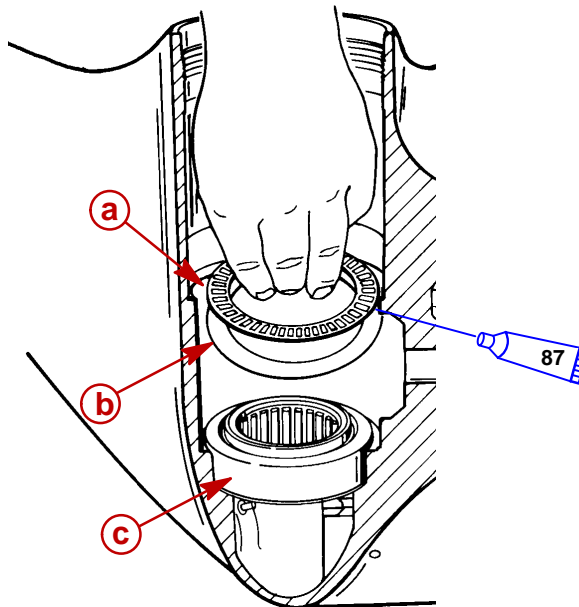
- a** - Rollers (18)
- b** - Roller Bearing Outer Race

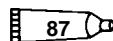
Gear Location/Backlashes Checking and Adjustment

Reverse Gear

INSTALLATION (FOR CHECKING BACKLASH ONLY)

1. Lubricate the large reverse gear thrust bearing with Premium Gear Lubricant and position first the thrust race, then the bearing into the gear housing and onto the reverse gear bearing adaptor.



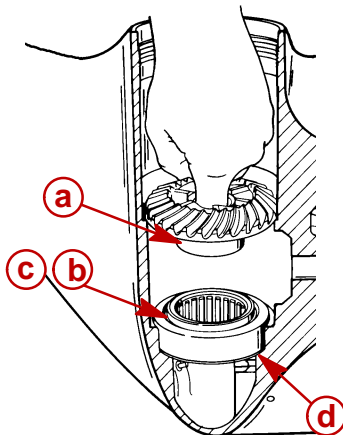
 Premium Gear Lubricant

50882

- a** - Thrust Bearing
- b** - Thrust Race
- c** - Reverse Gear Bearing Adaptor



2. Install the reverse gear into the gear housing and into the reverse gear bearing adaptor.



50884

- a** - Reverse Gear
- b** - Thrust Bearing
- c** - Thrust Race (under Bearing)
- d** - Reverse Gear Bearing Adaptor

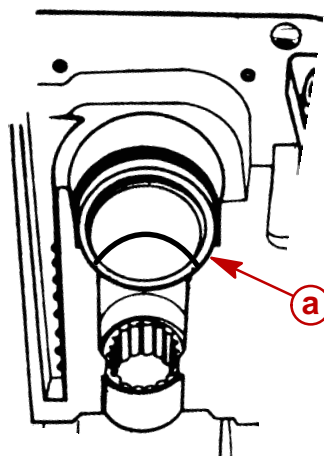
Drive Shaft and Pinion Gear

INSTALLATION

NOTE: If the original shims were not retained or if pinion gear, drive shaft, drive shaft upper tapered roller bearing and cup, or gear housing were replaced, start off by installing a 0.038 in. (0.96 mm) shim(s), for the upper tapered roller bearing.

NOTE: If the original shims were retained (or measurement known) and none of the above listed parts were replaced, reinstall the same shims or same amount of shims.

1. Place the upper tapered bearing shim(s) into the drive shaft housing bore.



70620

- a** - Shim(s)

NOTE: For ease of installation, glue the washer to the pinion gear, using 3M Adhesive, Bellows Adhesive, or equivalent.

NOTE: If the backlash may have to be changed, it is recommended that Loctite 271 NOT be applied to the pinion nut UNTIL the backlash setting is finalized. DO NOT reuse the old pinion nut. Install a NEW pinion nut after backlash is finalized.

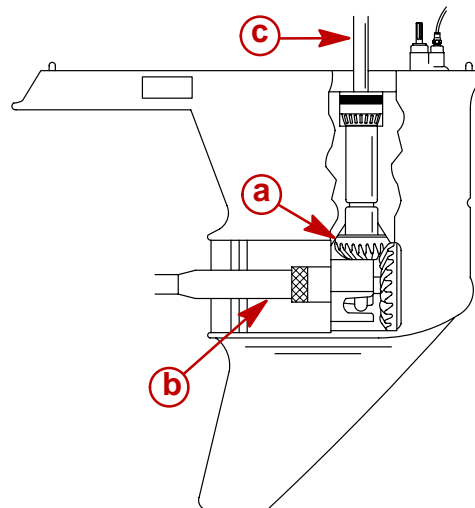
NOTE: Do not install the lower tapered bearing cup or shim(s) at this time.



2. Apply Loctite 271 to the threads of the pinion gear nut and place the pinion gear nut into the MR slot of the pinion nut adapter.

NOTE: Install the pinion gear nut with the flat side of the nut away from the pinion gear.

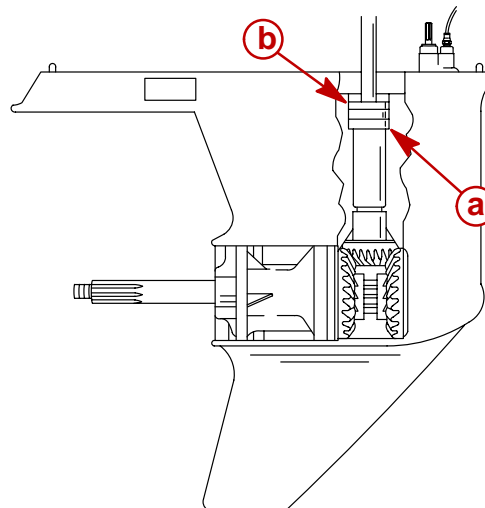
3. Place the pinion gear (with the washer glued to it) into the gear housing.
4. Insert the drive shaft into the gear housing drive shaft bore. It may be necessary to rotate the drive shaft to engage the drive shaft splines into the pinion gear splines.
5. Temporarily install the propeller shaft (without the sliding clutch installed) into reverse gear.
6. Insert the pinion nut adaptor (with the nut) into the gear housing. It may be necessary to raise the drive shaft slightly to clear the tool.
7. Start the pinion nut onto the drive shaft threads by rotating the drive shaft until the nut is snug.



57952

- a** - Pinion Gear (with the washer glued to it)
- b** - Pinion Nut Adaptor (91-61067A2)
- c** - Drive Shaft

8. Install the upper drive shaft tapered roller bearing cup. Apply 2-4-C Marine Lubricant with Teflon to the retainer threads and install the retainer.

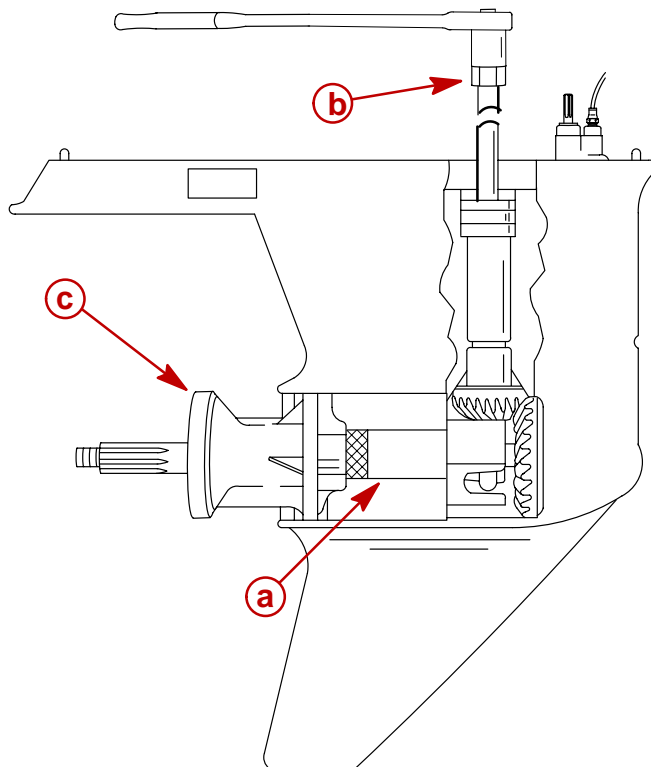


57953

- a** - Upper Tapered Roller Bearing Cup
- b** - Drive Shaft Retainer



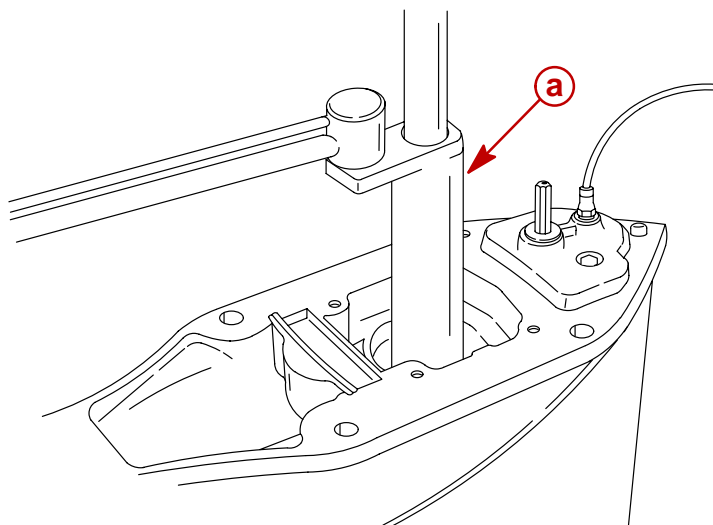
9. Install the bearing carrier into the gear housing backwards to hold the propeller shaft and the pinion nut adaptor in position.
10. Torque the pinion nut to 70 lb. ft. (95 Nm) by turning the drive shaft using the drive shaft nut wrench and torque wrench.



57950

- a** - Pinion Nut Adapter (91-61067A2)
- b** - Drive Shaft Nut Wrench (91-56775)
- c** - Bearing Carrier (installed backwards)

11. Remove the bearing carrier, pinion nut adaptor and drive shaft nut wrench.
12. Torque the retainer to 100 lb. ft. (135 N·m).



57935

- a** - Drive Shaft Bearing Retainer Wrench (91-43506)

13. Remove retainer wrench.

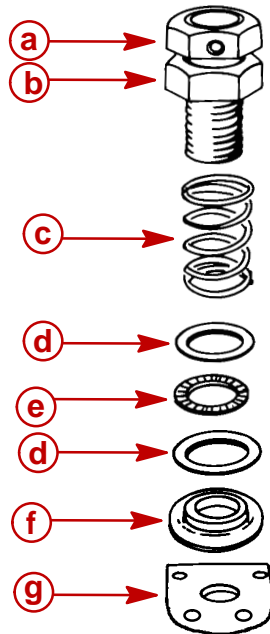


Gear Location/Backlashes/Checking and Adjustment

Drive Shaft - Bearing Preload Tool

INSTALLATION

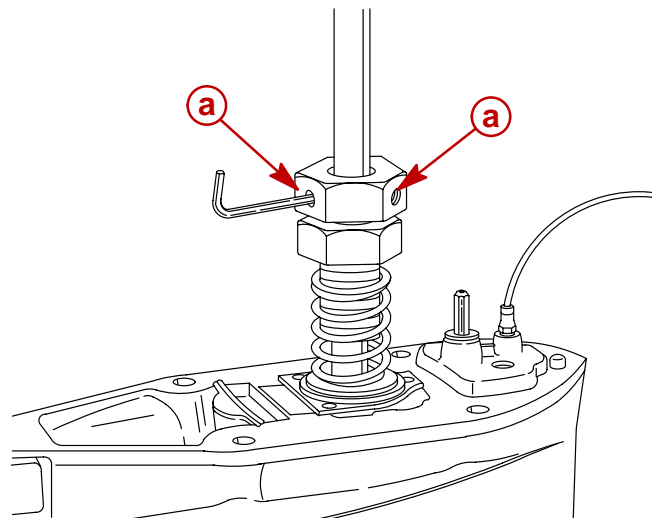
1. Install the components from the Bearing Preload Tool Kit (91-14311A1), over the drive shaft in the order shown.



- a** - Top Nut with Threaded Pipe
- b** - Nut
- c** - Spring
- d** - Thrust Washer (2 Required) (12-18448)
- e** - Thrust Bearing
- f** - Thrust Washer
- g** - Water Pump Face Plate (from your gear housing)

70496

2. Pull up on the drive shaft and tighten the two (2) allen screws in the top nut of the bearing preload tool.

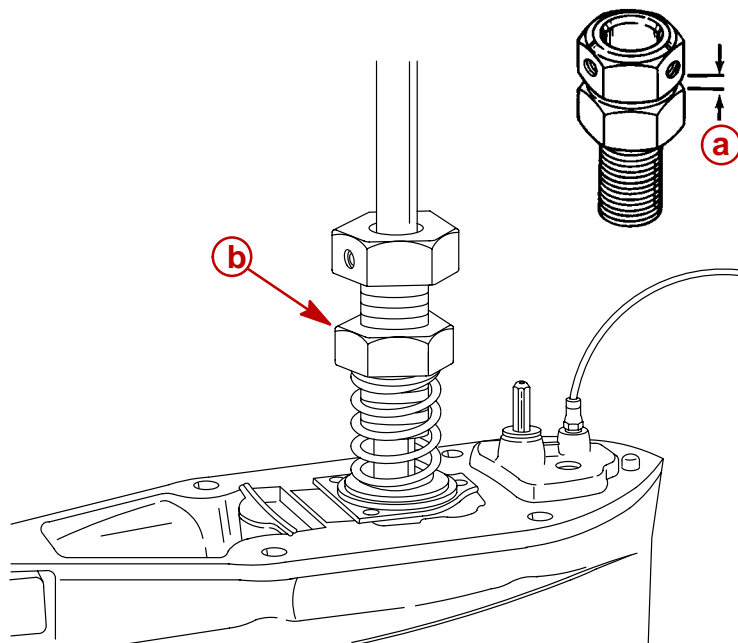


- a** - Allen Screws

57936



3. Measure distance (a) and increase that distance by 1 in. (25.4mm) by turning bottom nut away from top nut.



57937

- a - Distance 1 in. (25.4mm)
- b - Bottom nut [screwed down approximately 1 in. (25.4mm)]

Pinion Gear Location

CHECKING AND ADJUSTING

Pinion Depth – 0.025 in. (0.64mm)

NOTE: If the bearing preload tool has not already been set up, refer to “Drive Shaft - Bearing Preload Tool”, ‘Installation’ section first.

NOTE: The prop shaft and reverse gear can be installed when checking pinion height IF Pinion Height Tool 91-56048 is used.

1. Place the pinion gear shimming tool into the gear housing.

NOTE: Take the following measurements at 3 locations, rotating the drive shaft 120 degrees between each reading (always rotate the drive shaft in a clockwise direction).

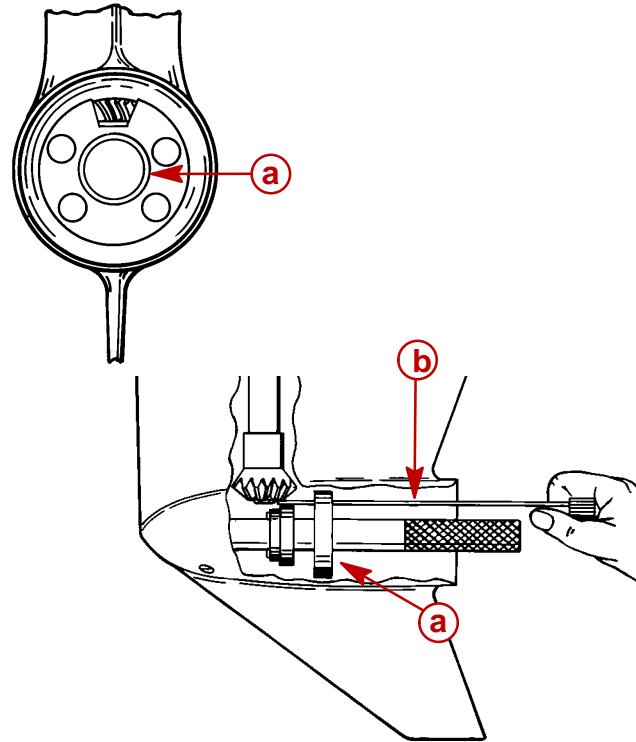
2. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and high point of the shimming tool.
3. Rotate the drive shaft 120 degrees in a clockwise direction and take another reading.
4. Repeat this process until 3 readings have been taken.
5. Add the three readings together and divide the sum by 3 to get the average pinion gear height. Make note of this average measurement.

The average pinion gear height should be 0.025 in. (0.64mm).

6. **A.** If the (average) pinion gear location does not meet the specification of 0.025 in. (0.64 mm) continue with the instructions on the following section.
B. If the (average) pinion gear location meets specification, skip the following section and go on to the “Reverse Gear Backlash”, ‘Checking’ section.



- If the average pinion gear height is not correct, remove the bearing preload tool, the drive shaft retainer and the drive shaft tapered roller bearing cup. (The cup can be removed by wiggling the drive shaft back and forth or by turning gear housing and shaking it.) Add or subtract shims beneath the cup to obtain the proper average pinion gear height. Reinstall the cup and retainer. Retorque retainer to 100 lb. ft. (135 Nm). Reinstall the bearing preload tool and rotate the drive shaft at least 3 full turns in a clockwise direction. Recheck the pinion gear height as in step 5 above. Repeat this process until the average pinion gear height is within specification.



24643

- a** - Pinion Gear Shimming Tool (91-12349A2) Using Disc #2 and Flat #4
- b** - 0.025 in. (0.64mm) Feeler Gauge



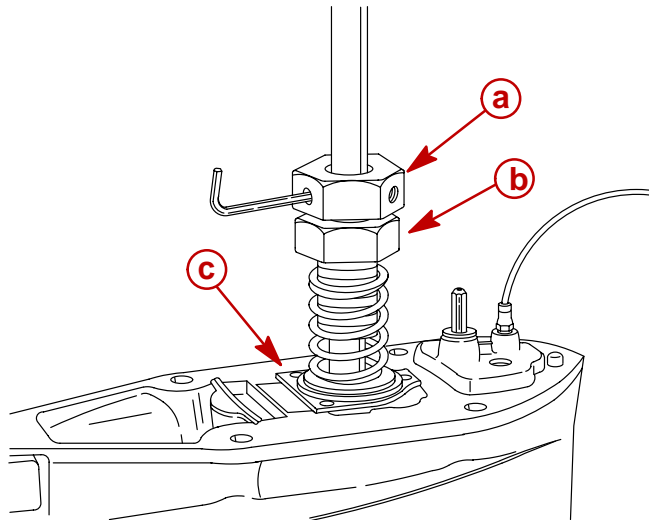
Drive Shaft - Bearing Preload Tool

REMOVAL

CAUTION

Before loosening the top nut allen screws of the bearing preload tool, screw the bottom nut up as close as possible to the top nut.

1. Remove the dial indicator and its supporting tooling.
2. Screw the bottom nut of the bearing preload tool until it is as close as possible to top nut.
3. Loosen the allen screws in the top nut.
4. Remove all components.



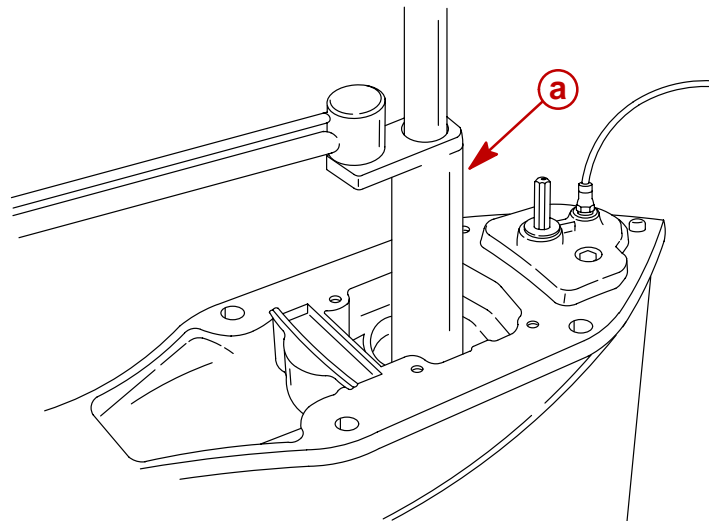
- a** - Top Nut (with allen screws)
- b** - Bottom Nut
- c** - Plate

57936



UPPER DRIVESHAFT BEARING CLEARANCE

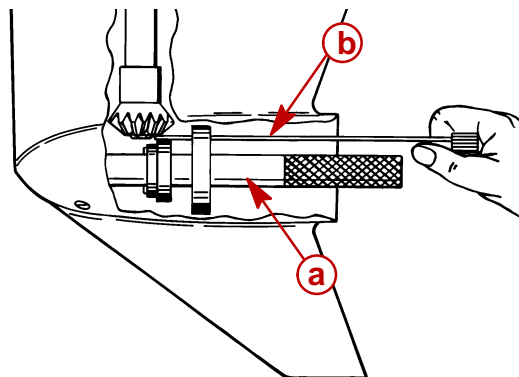
1. When the correct pinion gear height is achieved, remove pinion nut, upper retainer and driveshaft.
2. Apply Premium Gear Lubricant to O.D. of the driveshaft lower bearing cup and install cup into the gear case.
3. Reinstall driveshaft and pinion gear into gear case.
4. Install the upper drive shaft bearing cup and install and torque the upper bearing retainer to 100 lb. ft. (135 Nm).
5. Torque pinion nut to 70 lb. ft. (95 Nm).



57935

a - Bearing Retainer Tool (91-43506)

6. Push down on drive shaft and check clearance between pinion gear and pinion gear shimming tool shoulder. Clearance should be 0.020 in - 0.024 in. (0.51 mm - 0.61 mm).



a - Pinion Gear Shimming Tool (91-12349A2) Using Disc #2 and Flat #4

b - Feeler Gauge

NOTE: Do not change shims under upper bearing cup or pinion height will be changed.

7. Maintain the shims as previously set under the upper drive shaft bearing cup.
8. If clearance is not within specifications, remove the upper bearing cup retainer with tool 91-43506 and remove cup. Leave upper cup shim(s) in place.

NOTE: A 0.001 in. (25.4 mm) change of shims under the lower bearing cup will result in a 0.001 in. (25.4 mm) change in drive shaft end play.



9. With new shim(s) under lower bearing cup, reinstall upper bearing cup and torque cup retainer to 100 lb. ft. (135.5 Nm). Recheck drive shaft clearance.

NOTE: Install a NEW pinion nut with Loctite 271 AFTER all clearances are correct.

10. If clearance is correct, clean drive shaft threads and apply Loctite 271 and install a new pinion nut. Torque nut to 70 lb. ft. (95 Nm).

Reverse Gear Backlash

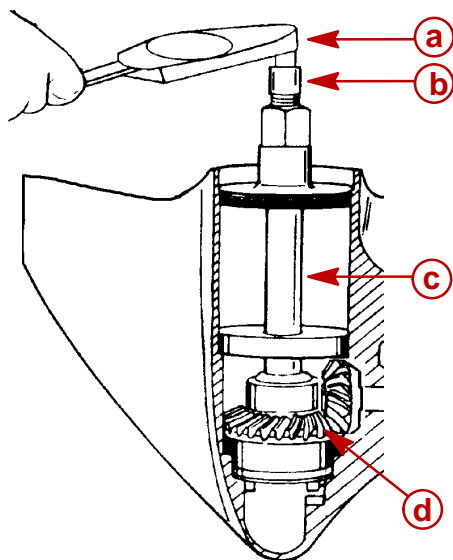
CHECKING

Reverse Gear Backlash Specification: 0.040-0.060 in. (1.01mm-1.5 mm).

NOTE: If the bearing preload tool has not already been set up see “Drive Shaft - Bearing Preload Tool”, ‘Installation’ section first.

NOTE: The reverse gear bearing adaptor installation tool is used to apply a light preload to the reverse gear in the following steps.

1. Install the reverse gear bearing adaptor installation tool into the gear housing to hold the reverse gear against the thrust bearing as follows:
 - a. Assemble the reverse gear bearing adaptor installation tool into the gear housing and tighten it by hand until a slight resistance is felt.
 - b. Torque the adaptor’s driver bolt to 45 lb. in. (5 Nm).

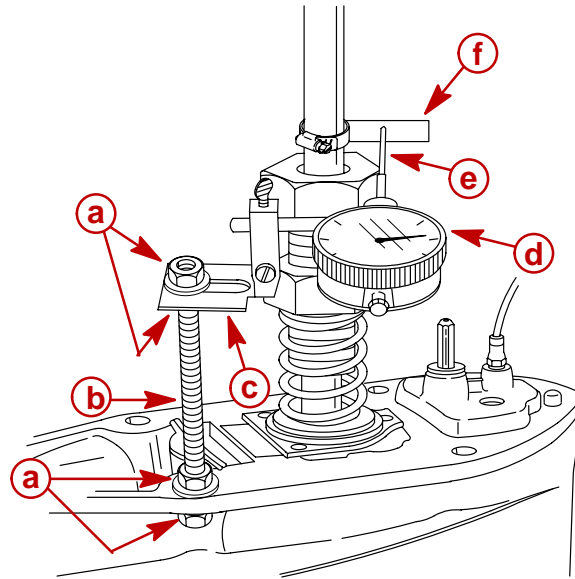


70973

- a** - Torque Wrench (91-66274)
- b** - Driver Bolt
- c** - Bearing Adaptor Installation Tool (91-18605A1)
- d** - Reverse Gear



2. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the "I" mark on the dial indicator tool. Tighten the indicator tool onto the drive shaft and rotate the drive shaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.



57939

- a** - Nuts (4) (Obtain Locally)
- b** - Threaded Rod [3/8 in. (9.5mm) obtain locally]
- c** - Dial Indicator Holding Tool (91-83155)
- d** - Dial Indicator (91-58222A1)
- e** - Indicator Pointer
- f** - Backlash Indicator Rod (91-53459) (for 1.75:1 ratio)
Backlash Indicator Rod (91-78473) (for 1.87:1 ratio)

3. Take the backlash readings by lightly turning the drive shaft back and forth, so as to feel the backlash between the gears, (no movement should be noticed at the propeller shaft).
 - a. Observe the dial indicator and record the reading.
 - b. Loosen the indicator tool and rotate the drive shaft 90 degrees in a clockwise direction.
 - c. Repeat step 2 above and take and record another reading. Repeat step 3 until a total of 4 backlash readings have been taken.
4. Add the four readings together and divide the sum by four. This is your average backlash and it should be 0.040 in. - 0.060 in. (1.0 mm - 1.5 mm) (for 1.75:1 and 1.87:1 ratios).



NOTE: If backlash needs to be adjusted, (see Checking Reverse Gear Backlash), adding 0.001 in. (0.03 mm) shims will **reduce** the gear backlash by approximately 0.001 in. (0.03mm). Subtracting 0.001 in. (0.03mm) shims will **increase** backlash by approximately the same amount.

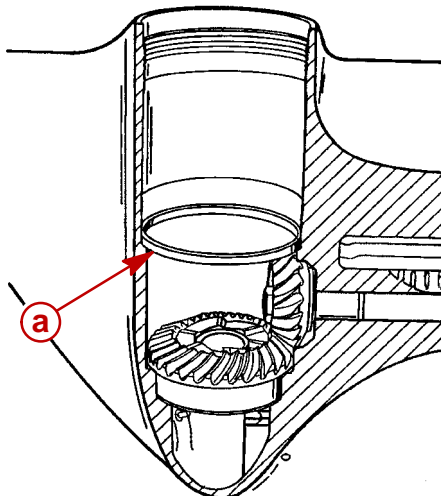
Example 1 (if backlash is too high)		
Backlash checks:	.070 in.	(1.79 mm)
(subtract) middle of specification:	.050 in.	(1.27 mm)
You get:	.020 in.	(0.50 mm)
add this quantity of shims		
Example 2 (if backlash is too low)		
middle of specification:	.050 in.	(1.27 mm)
Backlash checks:	.020 in.	(0.50 mm)
(subtract) You get:	.030 in.	(0.76 mm)
subtract this quantity of shims		

- Loosen the backlash indicator tool and remove the propeller nut, washer and pinion nut adaptor. Remove the dial indicator and all its mounting components. **Do not remove the bearing preload tool. The following instructions give specific instructions for its removal.**

Forward Gear/Bearing Carrier Assembly

CHECKING FORWARD GEAR BACKLASH

- Install the appropriate spacer shim into the gear housing.

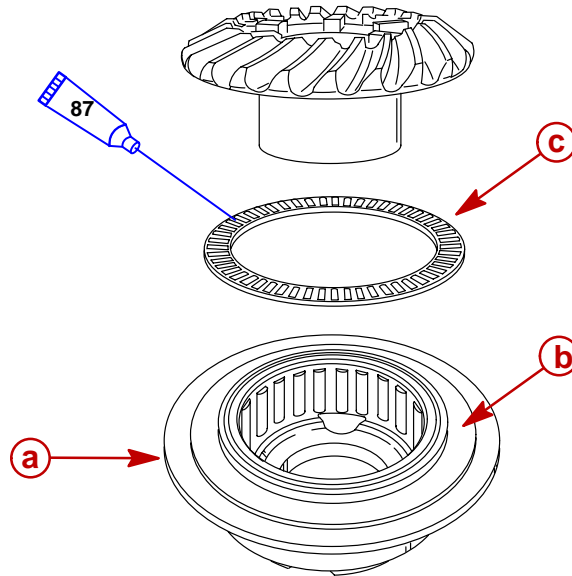


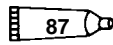
a - Shim

55428



2. Apply Premium Gear Lubricant to thrust bearing and install thrust bearing and thrust race onto forward gear bearing adaptor.

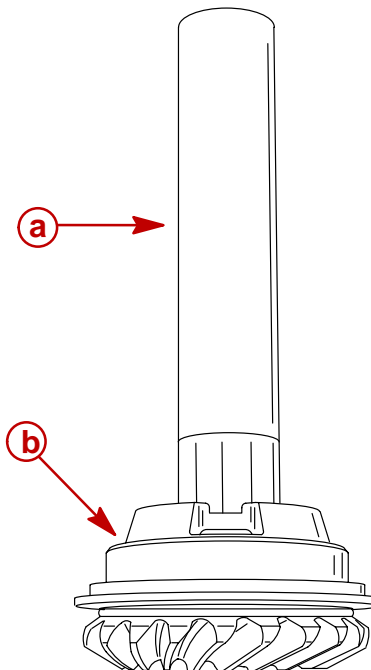


 Premium Gear Lubricant

55220

- a** - Bearing Adaptor
- b** - Thrust Washer
- c** - Thrust Bearing

3. Insert Forward Gear Installation Tool (91-815850) into forward gear/bearing adaptor assembly.



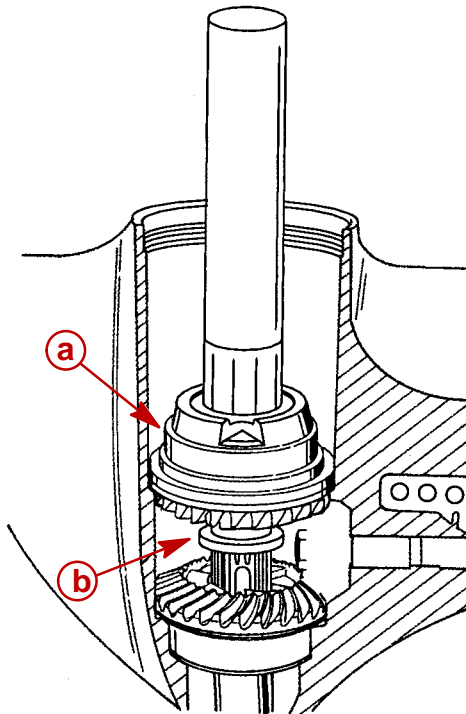
55221

- a** - Forward Gear Installation Tool (91-815850)
- b** - Forward Gear/Bearing Adaptor Assembly



NOTE: Verify load washer is installed on propeller shaft prior to installing forward gear assembly

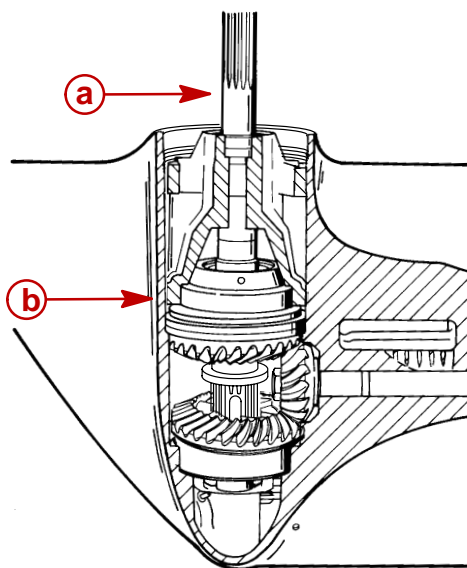
4. Install tool with adaptor assembly over propeller shaft and into gear housing. Applying downward pressure to bearing adaptor, remove installation tool from assembly.



55431

- a** - Forward Gear Bearing Adaptor
- b** - Load Washer

5. Install the bearing carrier over the propeller shaft pushing bearing carrier down until it is fully seated.

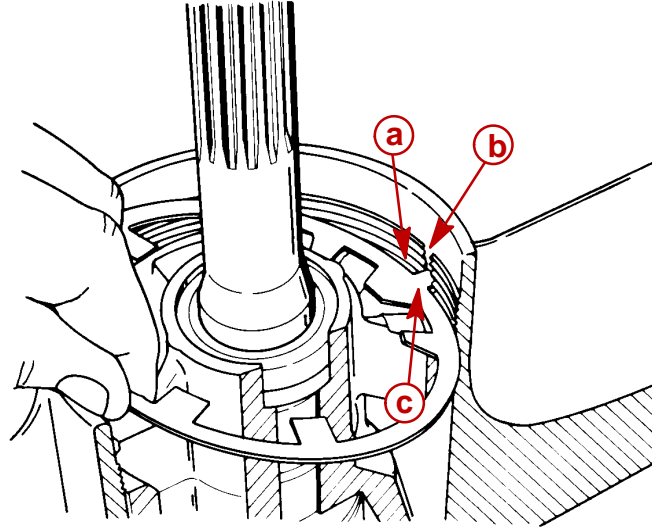


55429

- a** - Propeller Shaft
- b** - Bearing Carrier



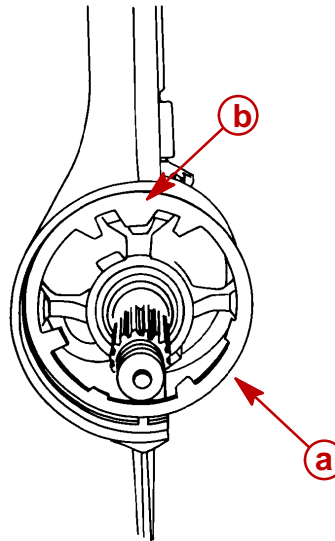
- Align the bearing carrier "V" shaped notch with the alignment hole in the gear housing. Install the tab washer with the external tab inserted into the hole in the gear housing.



50779

- a** - Gear Housing Tab Washer Alignment Hole (not seen)
- b** - "V" Shaped Notch in Bearing Carrier
- c** - Alignment Tab of Tab Washer

- Insure that the "V" shaped tab aligns with the "V" notch in bearing carrier.

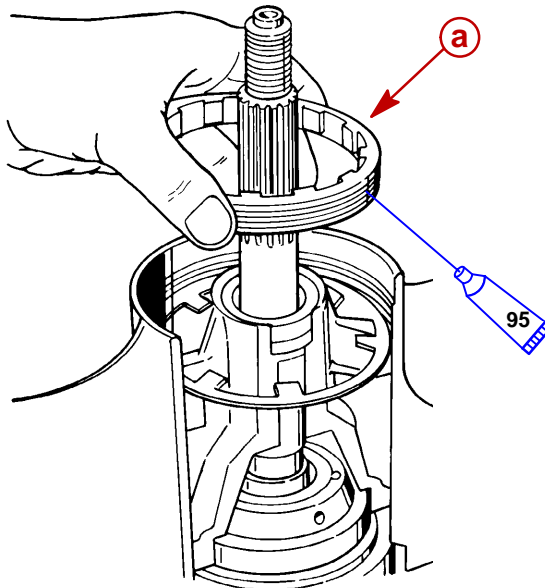


70714

- a** - Tab Washer
- b** - "V" Tab



- Lubricate the bearing carrier retainer threads with 2-4-C Marine Lubricant with Teflon. Start the retainer into the gear housing threads and screw it down fully by hand.

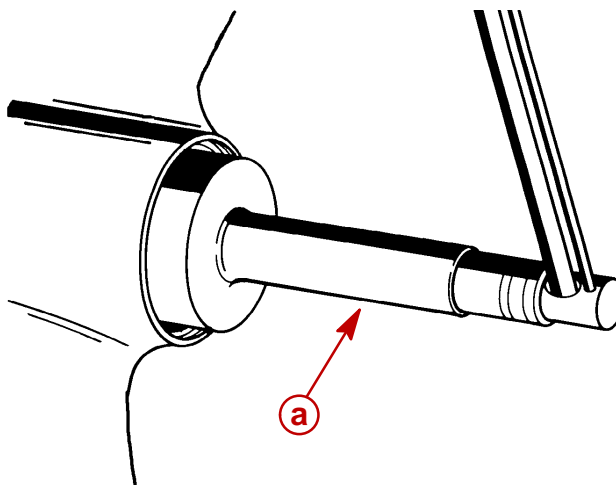


 2-4-C Marine Lubricant with Teflon

50881

a - Bearing Carrier Retainer

- Torque the bearing carrier retainer to 210 lb. ft. (285 Nm) to seat forward gear assembly in gear case.



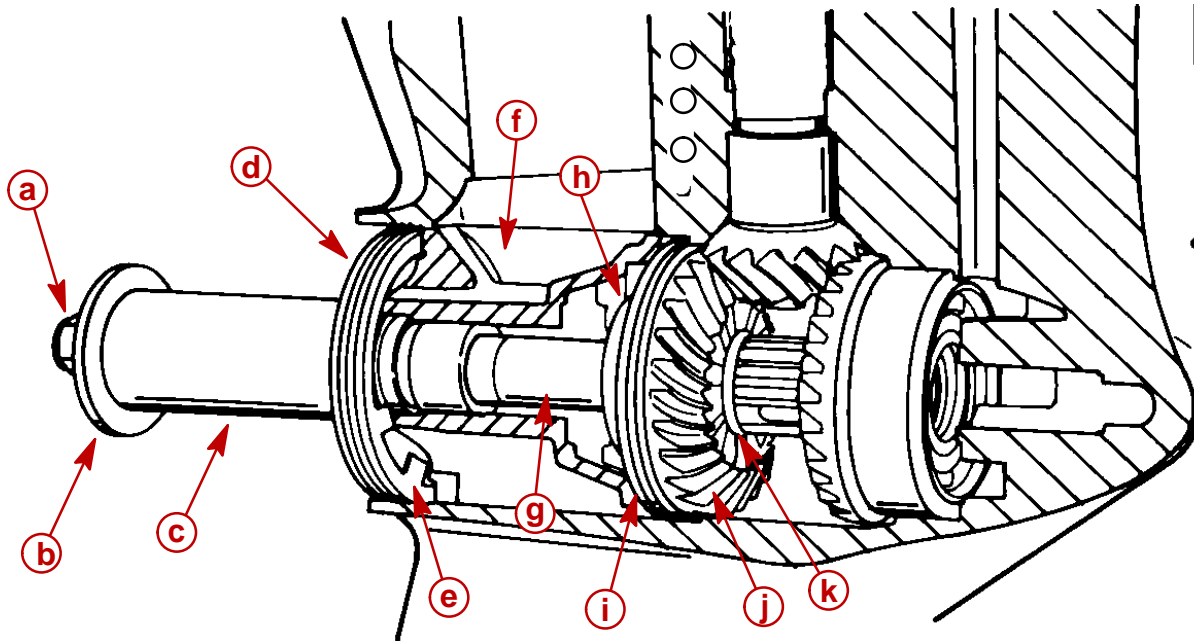
23355

a - Bearing Carrier Retainer Wrench (91-61069)



NOTE: Drill a 3/8" (22.2mm) diameter hole through the side (PROPELLER NUT END) of a 5" x 2" (127mm x 50.8mm) long piece of PVC pipe. A screwdriver may be inserted thru pipe into propeller shaft splines to prevent PVC pipe from turning while tightening retaining nut.

10. Install a 5" x 2" (127mm x 50.8mm) long piece of PVC pipe (obtain locally) over propeller shaft and secure it against the bearing carrier with a flat washer and nut.



51882

- a - Prop Nut
- b - Flat Washer
- c - PVC Pipe [5" x 2" (127mm x 50.8mm)]
- d - Retainer
- e - Tab Washer
- f - Bearing Carrier
- g - Prop Shaft
- h - Bearing Adaptor
- i - Shim
- j - Forward Gear
- k - Load Washer

11. Tighten nut to 45 lb. in. (5 Nm). This will seat the forward gear against the forward thrust bearing and tends to hold the propeller shaft from moving when measuring backlash.

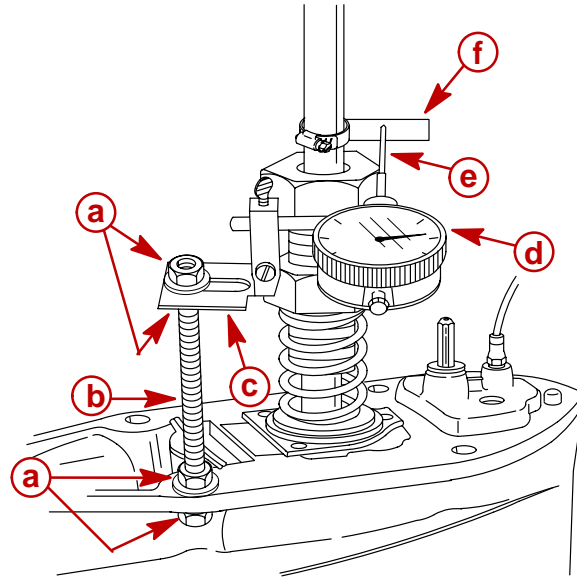


Forward Gear Backlash

CHECKING

NOTE: If the bearing preload tool has not already been set up, see "Drive Shaft - Bearing Preload Tool", 'Installation' section first.

1. Install a dial indicator as shown in the following figure.



57939

- a** - Nuts (4) (Obtain Locally)
- b** - Threaded Rod [3/8 in. (9.5mm) obtain locally]
- c** - Dial Indicator Holding Tool (91-83155)
- d** - Dial Indicator (91-58222A1)
- e** - Indicator Pointer
- f** - Backlash Indicator Rod (91-53459) (for 1.75:1)
Backlash Indicator Rod (91-78473) (for 1.87:1 ratio)

2. Align the dial indicator pointer so that it is perpendicular to and touching the "I" mark on the dial indicator tool. Tighten the indicator tool onto the drive shaft and rotate the drive shaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.
3. Take the backlash readings by lightly turning the drive shaft back and forth.
 - a. Observe the dial indicator and record the reading.
 - b. Loosen the indicator tool and rotate the drive shaft 90 degrees in a clockwise direction.
 - c. Repeat step 4 above and take and record another reading. Repeat step 4 until a total of 4 backlash readings have been taken.
4. Add the four readings together and divide the sum by 4. This is your average backlash, which should be 0.017 in. - 0.028 in. (0.431mm - 0.711mm) (for 1.75:1 and 1.87:1 ratios).
5. If backlash is MORE than the specified MAXIMUM, REMOVE shim(s) from in front of forward gear bearing race to obtain correct backlash. When reinstalling pinion nut, apply Loctite 271 to threads of nut.
6. If backlash is LESS than the specified MINIMUM, add shim(s) in front of forward gear bearing race to obtain correct backlash. When reinstalling pinion nut, apply Loctite 271 to threads of nut.



NOTE: By adding or subtracting 0.001 in. (0.03mm) shim, the backlash will change approximately 0.001 in. (0.03mm).

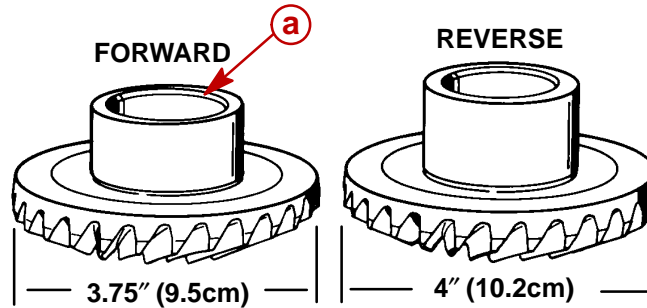
7. Remove the propeller nut, washer, and the pinion nut adaptor.
 - a. **If the Backlash is to Specification**, skip the next step (7b), and go on to step 8 following.
 - b. **If the Backlash is not to Specification**, complete the following instructions to install a different size spacer shim under the forward gear thrust race.
 - (1.) Remove the bearing carrier retainer, tab washer, and the bearing carrier.
 - (2.) Using the hook tool, remove the forward gear bearing adaptor.
 - (3.) Insert the forward gear installation tool into the forward gear and remove the forward gear, thrust bearing and thrust race.
 - (4.) Remove the spacer shim.
 - (5.) Complete the instruction found in section “Forward Gear/Bearing Carrier Assembly”, ‘Installation - (For Checking Forward Gear Backlash)’ section.
 - (6.) Recheck backlash as outlined in the “Forward Gear Backlash”, ‘Checking’ section.
8. Remove the following items as outlined below:
 - a. Remove the bearing carrier retainer, tab washer, and the bearing carrier.
 - b. Using the hook tool remove the forward gear bearing adaptor.
 - c. Insert the forward gear installation tool into the forward gear and remove the forward gear, thrust bearing and thrust race.
 - d. Remove the propeller shaft.
 - e. Remove the spacer shim.
 - f. “Drive Shaft - Bearing Preload Tool”, ‘Removal’ section.
 - g. “Drive Shaft Assembly”, ‘Removal’ section.
 - h. Remove the reverse gear.



Propeller Shaft Assembly

Component Reassembly

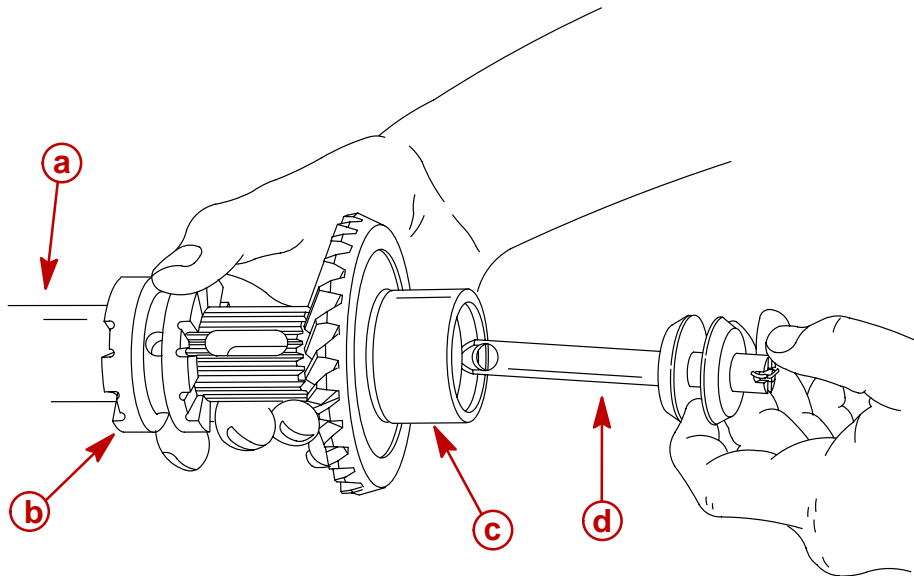
IMPORTANT: The appearance of the forward and reverse gear is almost identical. The forward gear has a shorter hub and is slightly smaller in diameter.



50885

a - Shorter Hub

1. Assemble the sliding clutch on the propeller shaft, being sure to align cross pin holes in the clutch with the slot in the propeller shaft. Make sure that the sliding clutch is placed on the propeller shaft with the grooved end of the clutch facing the propeller end of the shaft.
2. Assemble the reverse gear onto the propeller shaft.
3. Assemble the shift spool assembly to the propeller shaft being sure to align the cross pin hole of the shift spool shaft with the clutch slot.

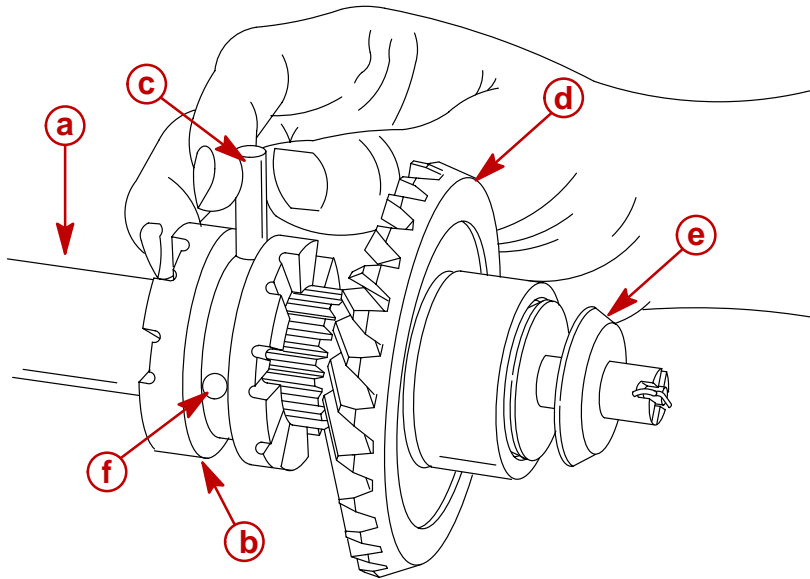


58018

a - Propeller Shaft
b - Sliding Clutch
c - Reverse Gear
d - Shift Spool Assembly



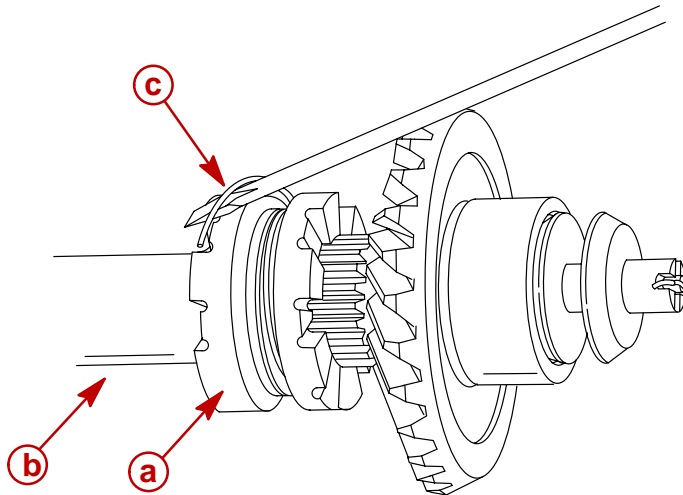
4. Assemble the cross pin through the sliding clutch, through the propeller shaft and through the shift spool shaft hole.
5. Install detent pin in third hole in clutch.



58012

- a - Propeller Shaft
- b - Sliding Clutch
- c - Cross Pin
- d - Reverse Gear
- e - Shift Spool Assembly
- f - Detent Pin

6. Assemble the cross pin retaining spring over the propeller shaft and wind it around the clutch over the cross pin hole. Be careful not to distort the spring while assembling it. **Make sure that the spring is wound on so that it does not cross over on itself and that it lies flat against the clutch once it is assembled. If it does not lie flat against the clutch a new spring must be installed.**



58015

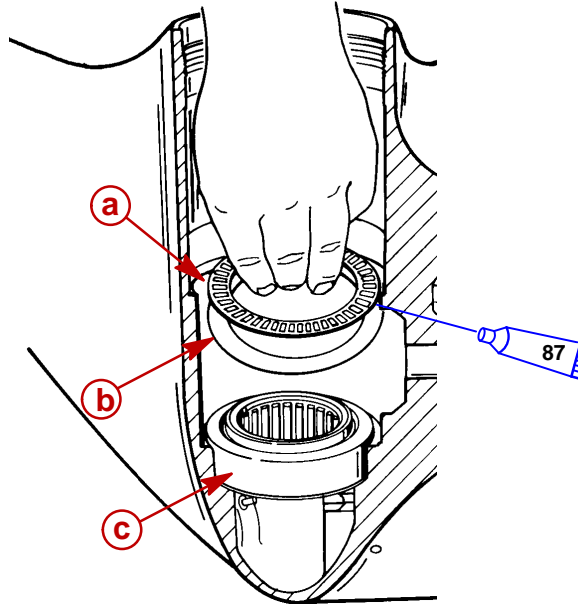
- a - Sliding Clutch
- b - Propeller Shaft
- c - Cross Pin Retaining Spring



Propeller Shaft Assembly

Installation

1. Lubricate the large thrust bearing with Premium Gear Lubricant and position first the thrust race then the bearing into the gear housing onto the reverse gear bearing adaptor.

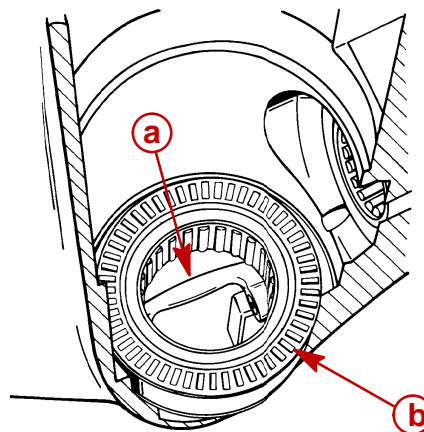


Premium Gear Lubricant

50882

- a** - Thrust Bearing
- b** - Thrust Race
- c** - Reverse Gear Bearing Adaptor

2. Rotate the shift crank toward the aft end of the gear housing until it touches against the bearing adaptor and hold it in this position.



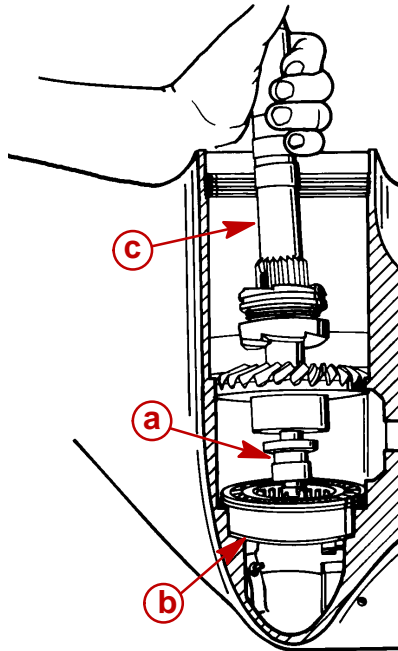
50885

- a** - Shift Crank
- b** - Bearing Adaptor

IMPORTANT: Be careful when inserting the propeller shaft assembly into the gear housing as the needle bearings in the reverse gear bearing adaptor can become dislodged. If it is suspected that a needle has become dislodged, remove the propeller shaft assembly and inspect the needle bearing cages for damage. If the cages have not been damaged and a needle bearing is mispositioned, it can be snapped back into place.



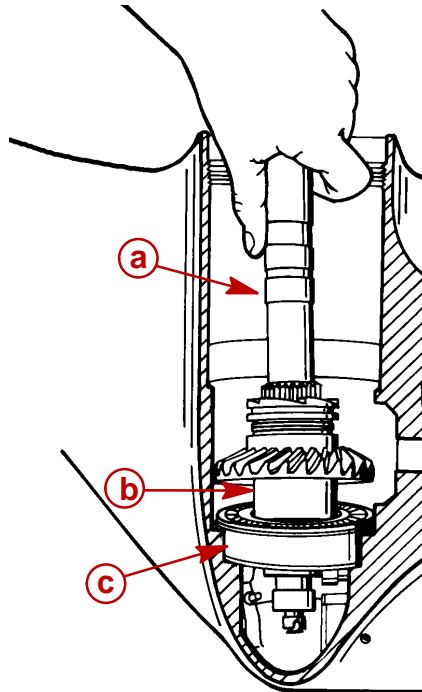
- To allow for the engagement of the shift spool with the shift crank, tilt the propeller end of the propeller shaft assembly to the left (port) side of gear housing and begin to lower it into the gear housing.



50888

- a** - Shift Actuating Spool
- b** - Shift Crank
- c** - Propeller Shaft Assembly

- With the propeller shaft assembly tilted to the port side of the gear housing, continue to lower the assembly until the reverse gear hub comes into contact with the reverse gear bearing adaptor and the propeller shaft is fully inserted into the reverse gear.

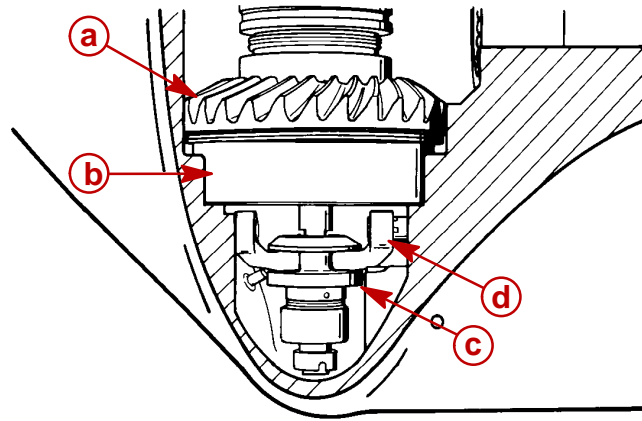


50888

- a** - Propeller Shaft
- b** - Reverse Gear Hub
- c** - Bearing Adaptor



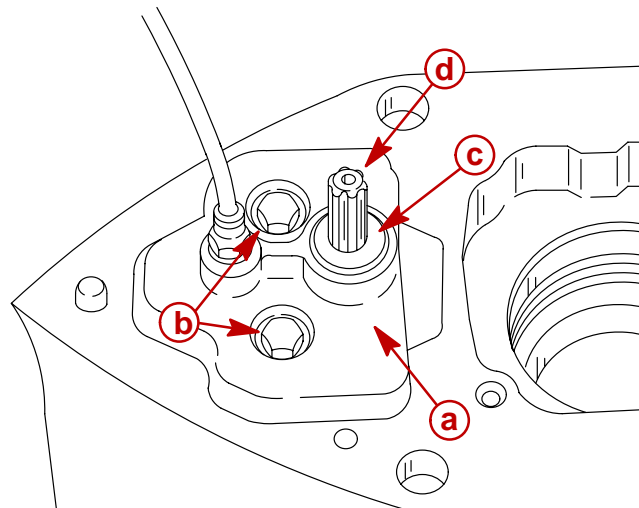
5. Slowly move the propeller shaft to the center of the housing and lower the reverse gear into the bearing adaptor. The shift spool should engage with the shift crank as the propeller shaft centers itself.



50885

- a** - Reverse Gear
- b** - Bearing Adaptor
- c** - Shift Spool
- d** - Shift Crank

6. Operate the shift shaft to ensure that it has been properly installed. The sliding clutch should move forward when the shift shaft is turned clockwise, and should move aft when the shift shaft is turned counterclockwise.
7. Make sure that the O-rings are present and positioned correctly. Install the screws that secure the shift shaft bushing and torque them to 60 lb. in. (7 Nm).
8. Slide the rubber sleeve at top end of shift shaft down so that it just touches the oil seal in the bushing.



57933

- a** - Screws [Torque to 60 lb. in. (7 Nm)]
- b** - Shift Shaft Bushing
- c** - Rubber Sleeve
- d** - Shift Shaft

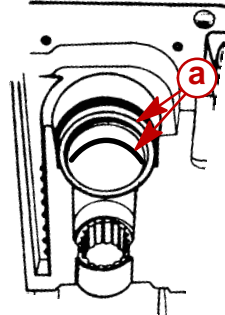


Drive Shaft and Pinion Gear

Final Installation

NOTE: Verify upper and lower driveshaft bearing shims are installed

1. Place the shim(s) into the drive shaft housing bore at the location shown.



a - Shims

70620

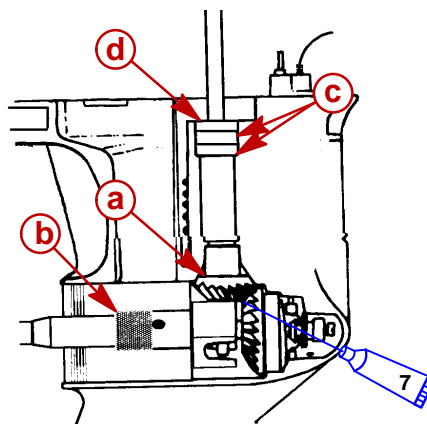
2. Install lower tapered bearing cup.

NOTE: For ease of installation, glue the washer to the pinion gear, using 3M Adhesive, Bellows Adhesive, or equivalent.

3. Apply Loctite Type 271 to the threads of the **NEW** pinion gear **NUT** and assemble the pinion gear nut into the MR slot of the pinion nut adaptor.

NOTE: Install the pinion gear nut with the flat side of the nut away from the pinion gear.

4. Place the pinion gear (with the washer glued to it) into the gear housing.
5. Insert the drive shaft into the gear housing drive shaft bore. It may be necessary to rotate the drive shaft to engage the drive shaft splines into the pinion gear splines.
6. Install upper tapered bearing cup and the retainer
7. Insert the pinion nut adaptor (with the nut assembled to it) into the gear housing. It may be necessary to raise the drive shaft slightly to clear the tool.
8. Start the pinion nut onto the drive shaft threads by rotating the drive shaft until the nut is snug.

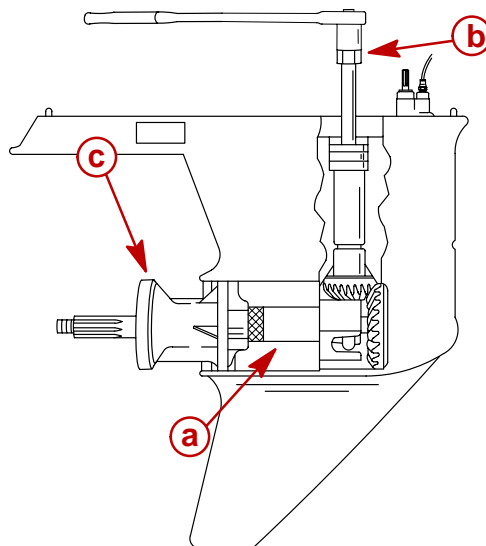


 Loctite 271

- a** - Pinion Gear (with the washer glued to it)
- b** - Pinion Nut Adaptor (91-61067A3)
- c** - Tapered Roller Bearing Cups
- d** - Retainer



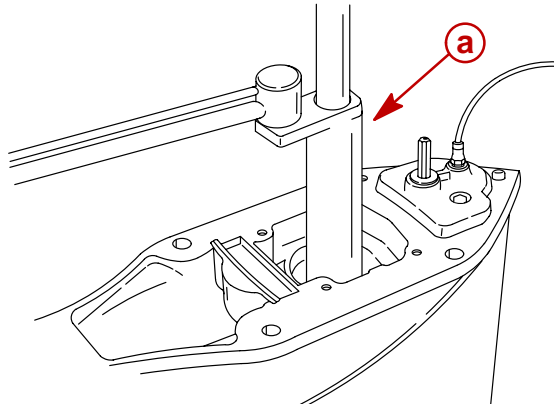
9. Install the bearing carrier into the gear housing backwards to hold the propeller shaft and the pinion nut adaptor in position.
10. Torque the pinion nut by turning the drive shaft using the drive shaft nut wrench and torque wrench with the appropriate socket to 70 lb. ft. (95 Nm).



57950

- a** - Pinion Nut Adaptor (91-61067A2)
- b** - Drive Shaft Nut Wrench (91-56775)
- c** - Bearing Carrier (installed backwards)

11. Remove the bearing carrier, pinion nut adaptor and drive shaft nut wrench.
12. Torque the retainer to 100 lb. ft. (135 Nm).



57935

- a** - Drive Shaft Bearing Retainer Wrench (91-43506)

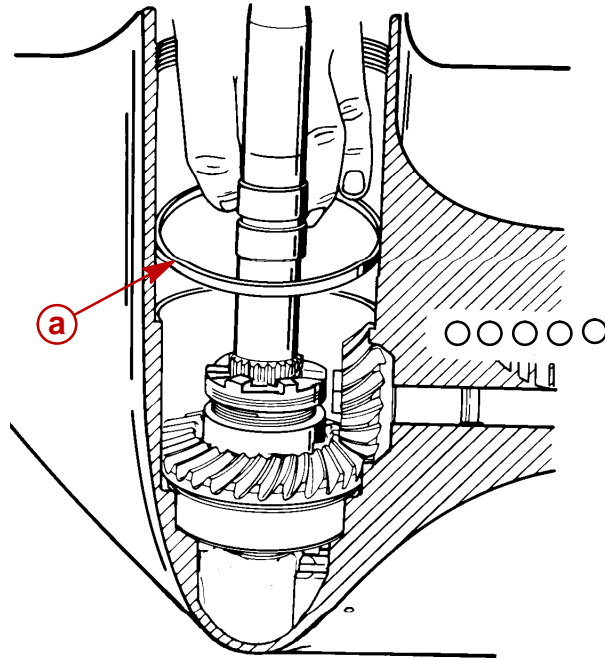
13. Remove the retainer wrench.



Bearing Carrier Assembly

Final Installation

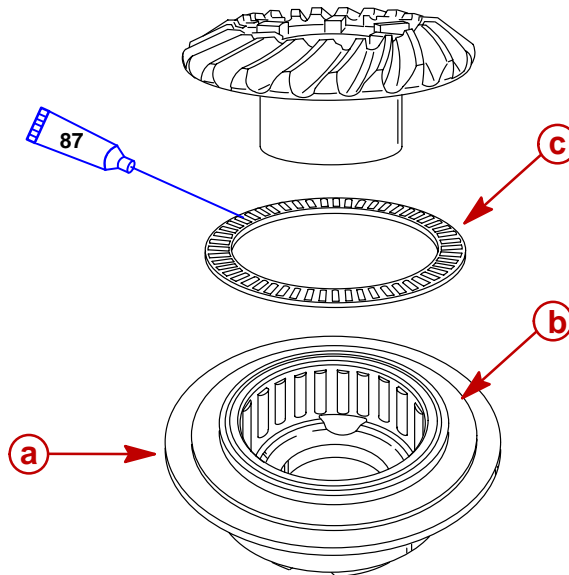
1. Install appropriate spacer shim into the gear housing.

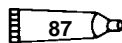


50782

a - Shim

2. Apply Premium Gear Lubricant to thrust bearing and install thrust bearing and thrust race onto forward gear bearing adaptor.



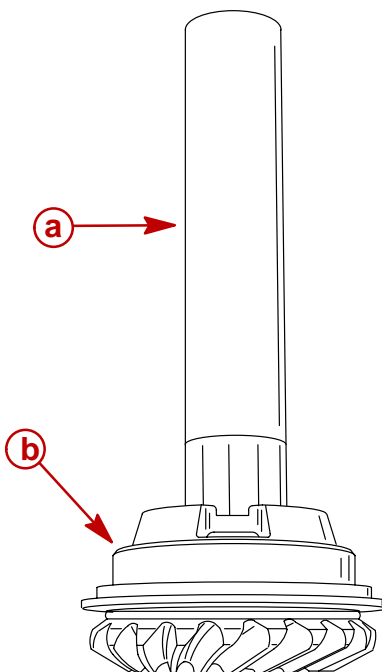
 87 Premium Gear Lubricant

55220

a - Bearing Adaptor
b - Thrust Washer
c - Thrust Bearing



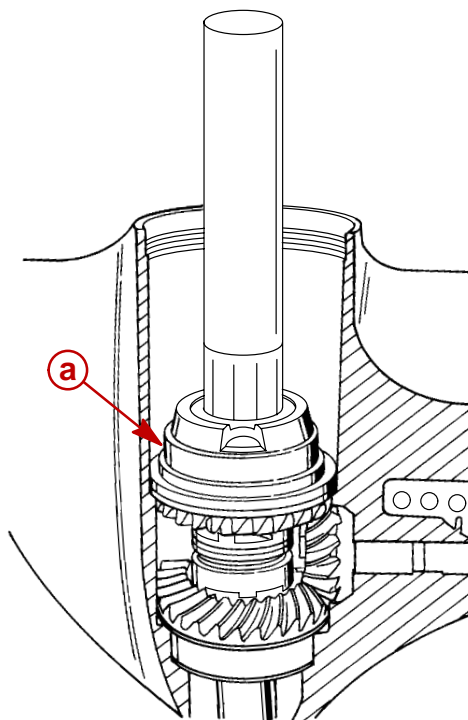
3. Insert Forward Gear Installation Tool (91-815850) into forward gear/bearing adaptor assembly.



55221

- a** - Forward Gear Installation Tool (91-815850)
- b** - Forward Gear/Bearing Adaptor Assembly

4. Install tool with adaptor assembly over propeller shaft and into gear housing. Applying downward pressure to bearing adaptor, remove installation tool from assembly.

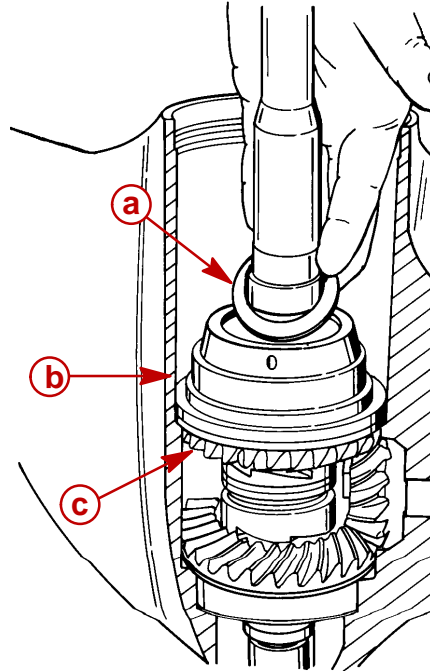


55202

- a** - Forward Gear Bearing Adaptor



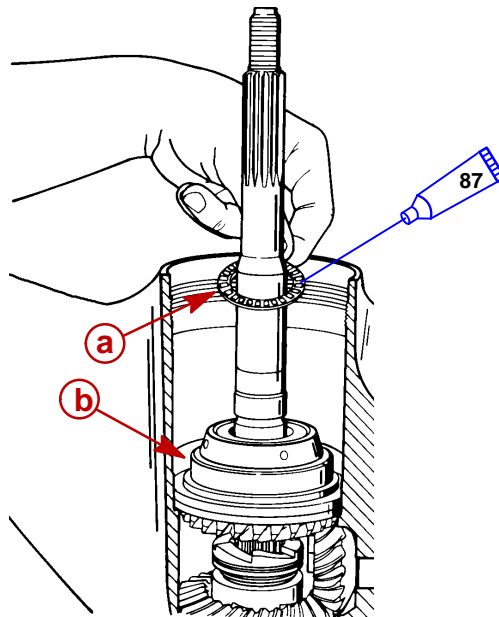
5. Ensure that the top of the bearing adaptor is clean and install the small thrust race on top of the bearing adaptor.

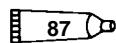


50880

- a** - Thrust Race
- b** - Forward Gear Bearing Adaptor
- c** - Forward Gear

6. Lubricate the small thrust bearing with Premium Gear Lubricant and install it on top of the thrust race.



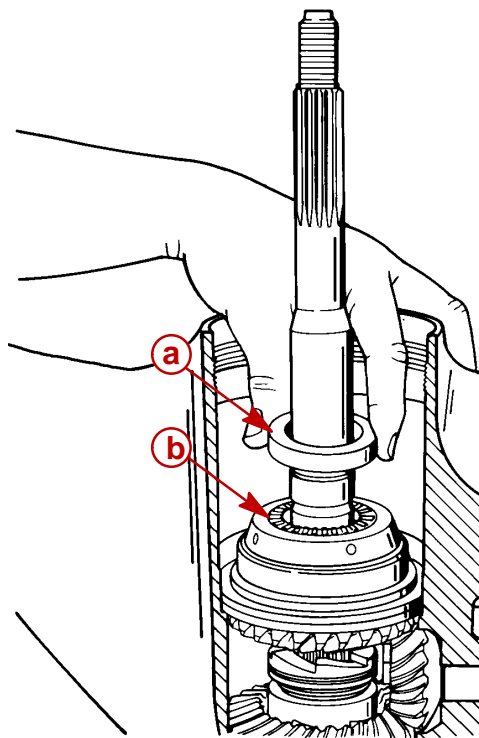
 Premium Gear Lubricant

50783

- a** - Small Thrust Bearing
- b** - Forward Gear Bearing Adaptor



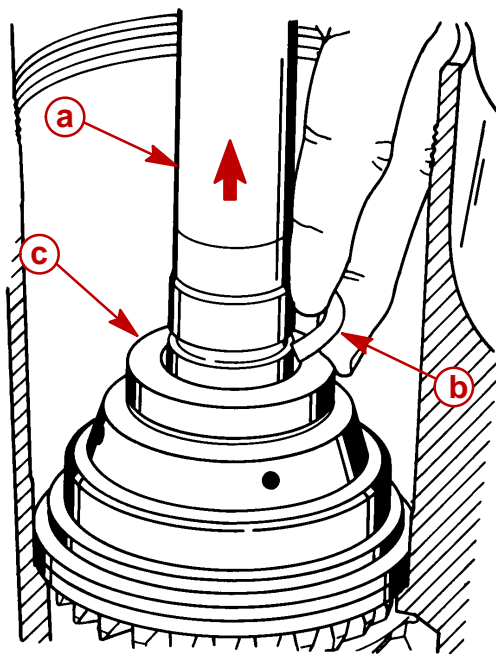
7. Assemble the thrust collar with its STEPPED SIDE DOWN toward the small thrust bearing.



50784

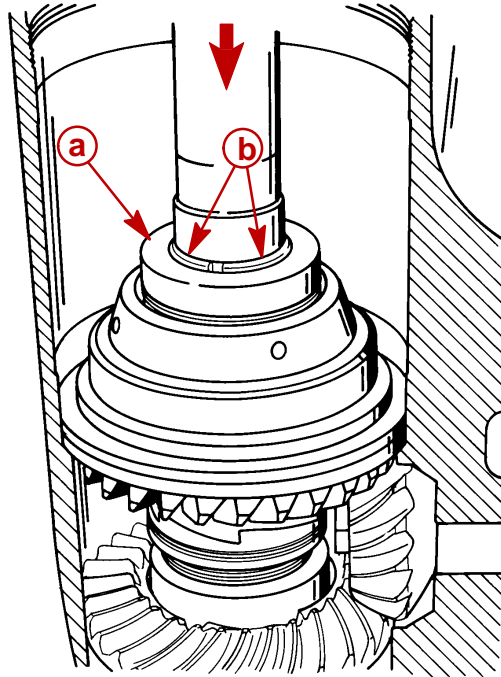
- a** - Thrust Collar
- b** - Small Thrust Bearing

8. Pull up slightly on the propeller shaft to gain access to the groove on the shaft for the keepers. Assemble the two keepers into the groove and lower the propeller shaft.



50826

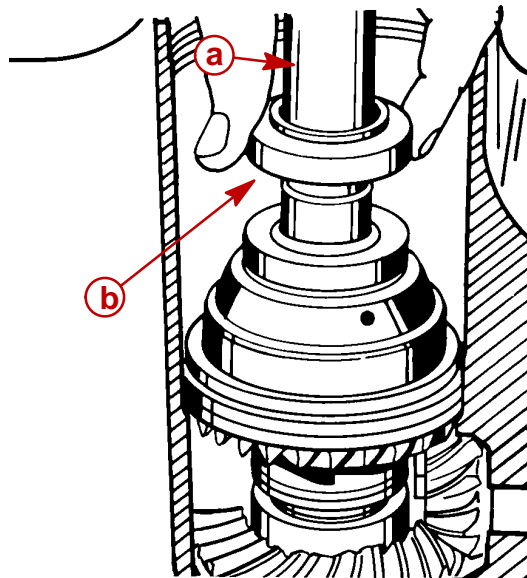
- a** - Propeller Shaft (slightly lifted)
- b** - Keepers (2)
- c** - Thrust Collar



50778

- a** - Thrust Collar
- b** - Keepers

9. Install the second thrust collar with its STEPPED SIDE UP.

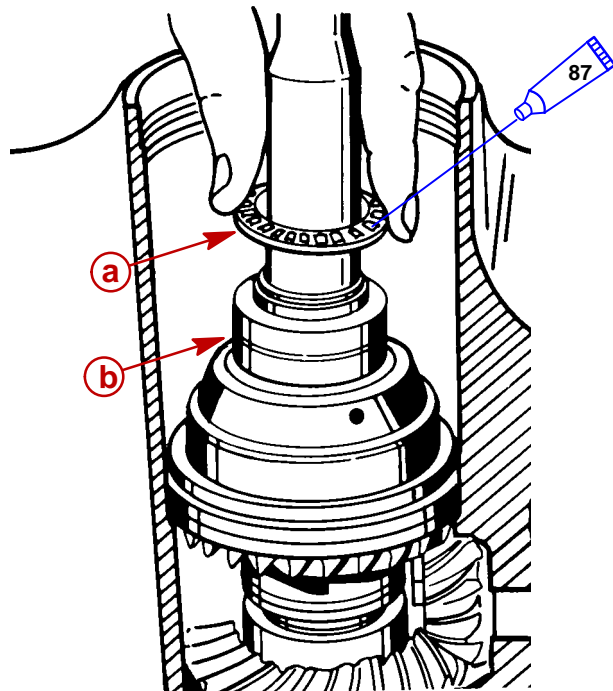


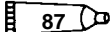
50787

- a** - Propeller Shaft
- b** - Thrust Collar



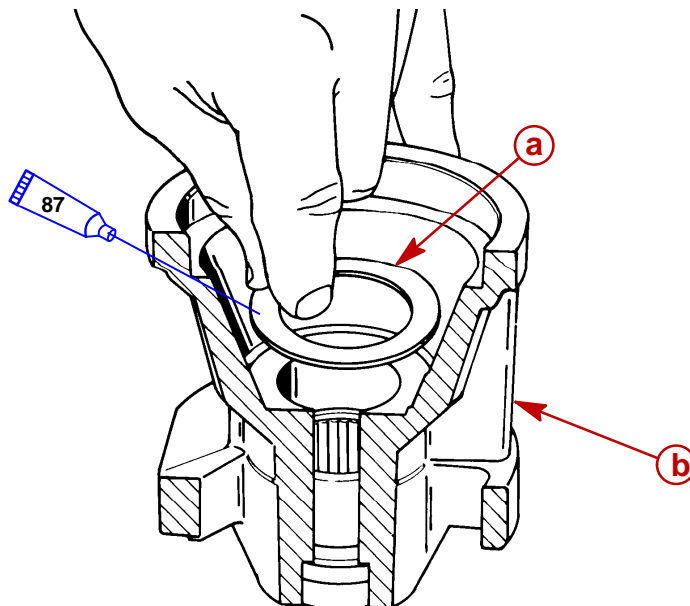
10. Lubricate the second thrust bearing with Premium Gear Lubricant and install it to the top of the thrust collar.

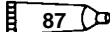


-  Premium Gear Lubricant
- a** - Thrust Bearing
- b** - Thrust Collar

50786

11. Lubricate the second small thrust bearing race with Premium Gear Lubricant. Assemble it to the surface inside of the bearing carrier as shown.

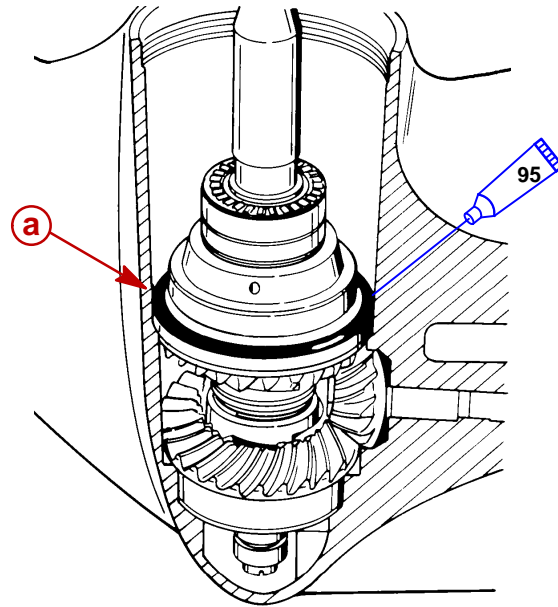


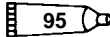
-  Premium Gear Lubricant
- a** - Thrust Race
- b** - Bearing Carrier

50779



12. Lubricate the large O-ring with 2-4-C Marine Lubricant with Teflon and assemble into the gear housing as shown following.



 95 2-4-C Marine Lubricant with Teflon

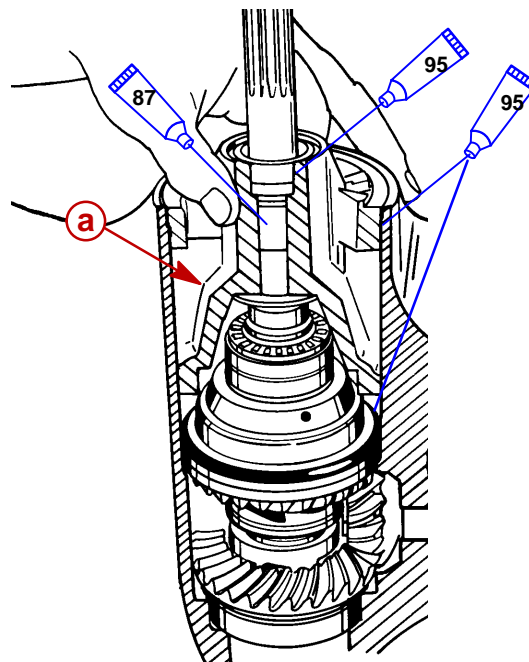
a - O-ring


50886

13. Prepare the bearing carrier for installation as follows:

- Lubricate the outer diameter of the bearing carrier with 2-4-C Marine Lubricant with Teflon.
- Fill the space between the carrier oil seals with 2-4-C Marine Lubricant with Teflon.
- Lubricate the needle bearing with Premium Gear Lubricant.

14. Install the bearing carrier assembly into the gear housing.



 87 Premium Gear Lubricant

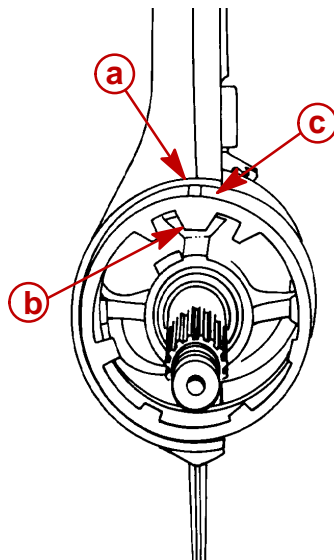
 95 2-4-C Marine Lubricant with Teflon

a - Bearing Carrier Assembly

50826



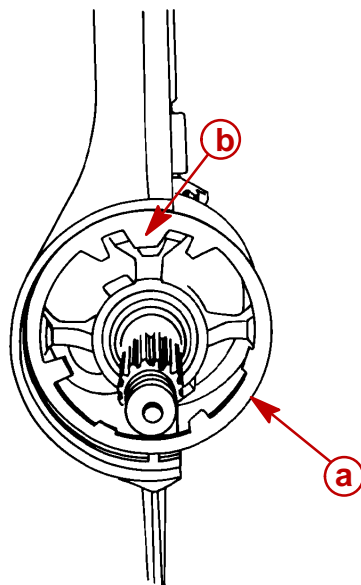
15. Align the bearing carrier “V” shaped notch with the alignment hole in the gear housing and then install the tab washer with the external tab inserted into the hole in the gear housing.



70713

- a** - Gear Case Alignment Hole
- b** - “V” Shaped Notch in Bearing Carrier
- c** - Alignment Tab of Tab Washer

16. Insure that the “V” shaped tab aligns with the “V” notch in bearing carrier.

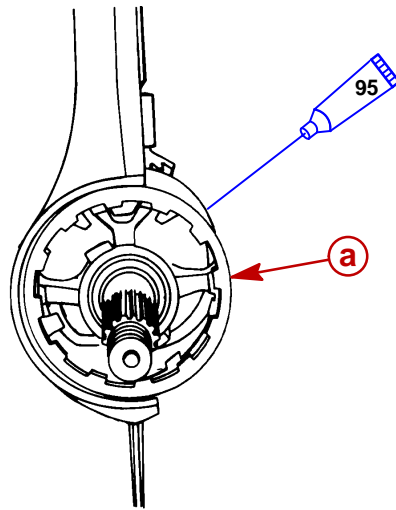


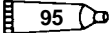
70714

- a** - Tab Washer
- b** - “V” Tab



17. Fill the bearing carrier retainer nut threads and corresponding gear housing threads (360°) with 2-4-C Marine Lubricant with Teflon. Start the retainer into the gear housing threads and screw it down fully by hand.

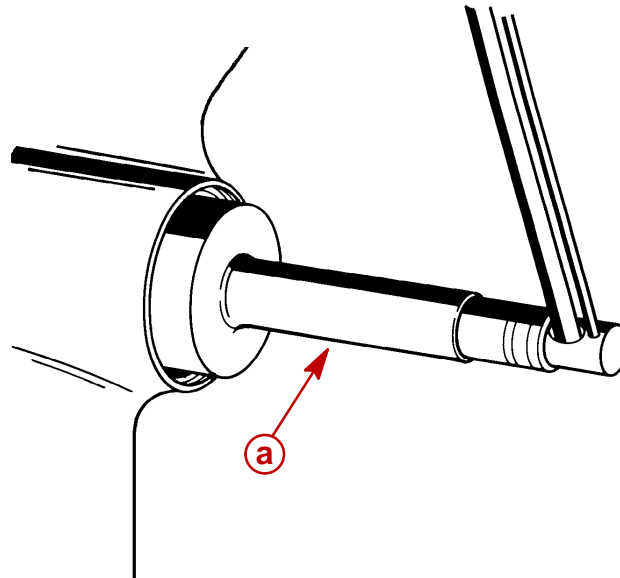


 2-4-C Marine Lubricant with Teflon
a - Bearing Carrier Retainer

70715

IMPORTANT: Before torquing bearing carrier retainer, gear case must be bolted to drive shaft housing or securely fastened in a gear case holding fixture to avoid possible damage to gear housing.

18. Torque the bearing carrier retainer to 210 lb. ft. (284.7 N·m). If one tab does not align up in space between two of the notches, continue to tighten retainer until alignment is achieved. **DO NOT** loosen retainer to achieve alignment.

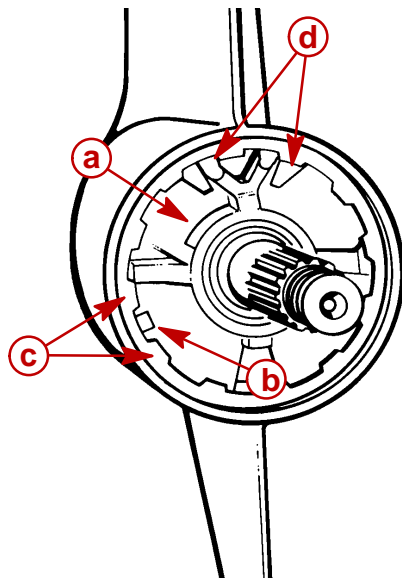


a - Bearing Carrier Retainer Wrench (91-61069)

23355



19. Bend one tab aft (outward) into a space between two of the notches of the retainer. Bend all the remaining tabs forward (inward).



70490

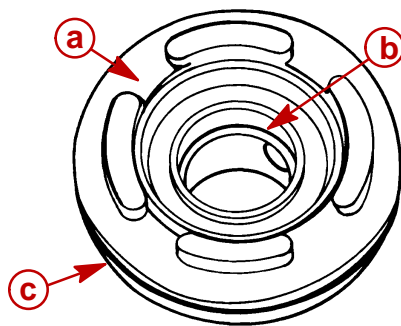
- a** - Bearing Carrier
- b** - Tab
- c** - Retainer Notches
- d** - Alignment Tabs (Bend Inward)

Oil Seal Carrier Assembly

Installation

NOTE: Apply hand pressure only to install the oil seal carrier into position. Do not hammer it into position.

1. Lubricate the oil seal carrier, oil seal lips, space between seals and O-ring with 2-4-C Marine Lubricant with Teflon and install the oil seal carrier over the drive shaft and into the gear case.



70501

- a** - Oil Seal Carrier
- b** - Oil Seal Lips
- c** - O-ring

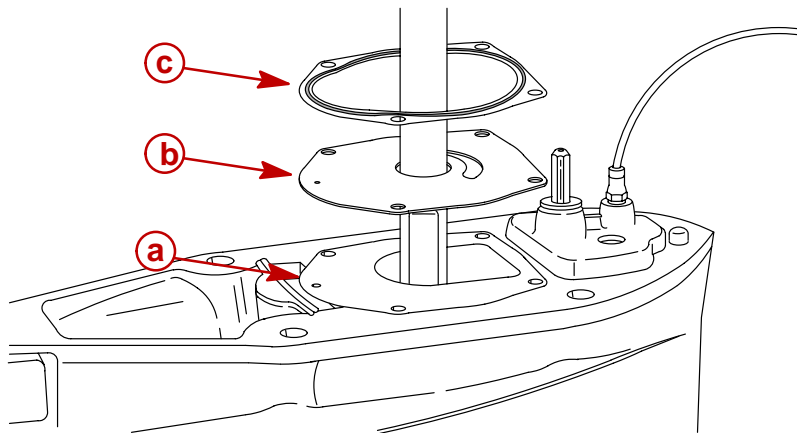


Water Pump Assembly

Installation

NOTE: The gaskets/face plate hole pattern is not symmetrical. If the holes of the gaskets/face plate do not align with the screw holes of the gear case and/or each other, one or more of the parts is upside down. Determine which part(s) is (are) upside down and turn the appropriate part(s) over.

1. Install the small hole gasket then the face plate followed by the large hole gasket onto the gear case.



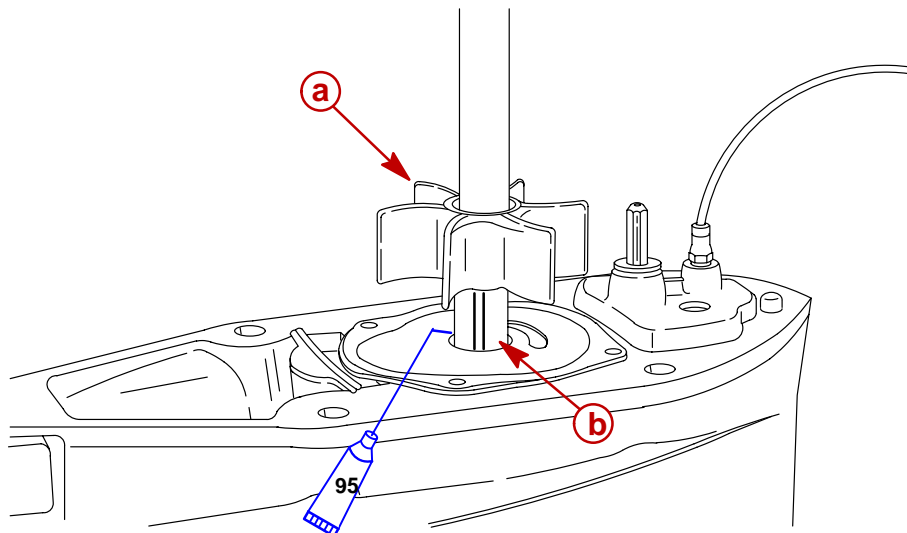
58011

- a** - Small Hole gasket
- b** - Face Plate
- c** - Large Hole Gasket (GRAY sealing ring faces up)

2. Place a small amount of 2-4-C Marine Lubricant with Teflon on the flat surface of the impeller key and install the key onto the drive shaft keyway.

IMPORTANT: When using an impeller whose blades have taken a set, face the curl of the blades in a counterclockwise direction. Do not install the impeller with its blades oriented in a reversed direction from original rotation, or premature impeller failure will occur.

3. Assemble the water pump impeller onto the drive shaft and down over the key.



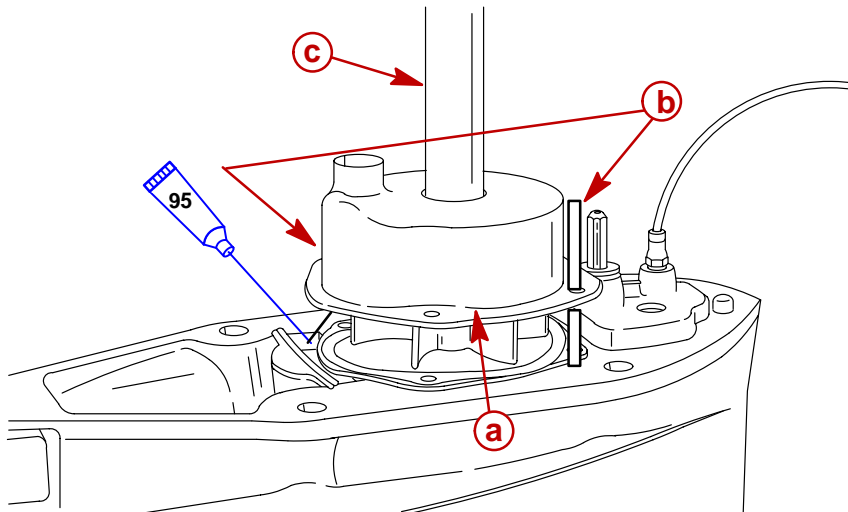
 95 2-4-C Marine Lubricant with Teflon

57938

- a** - Water Pump Impeller
- b** - Water Pump Impeller Key



4. Install the 2 water pump locating pins through the gaskets and face plate.
5. Apply a light coat of 2-4-C Marine Lubricant with Teflon to the inside of the pump cover. Position the water pump body over the drive shaft and water pump locating pins. Rotate the drive shaft in a clockwise direction, while pushing down on the water pump body to ease the water pump over the impeller blades.



 2-4-C Marine Lubricant with Teflon

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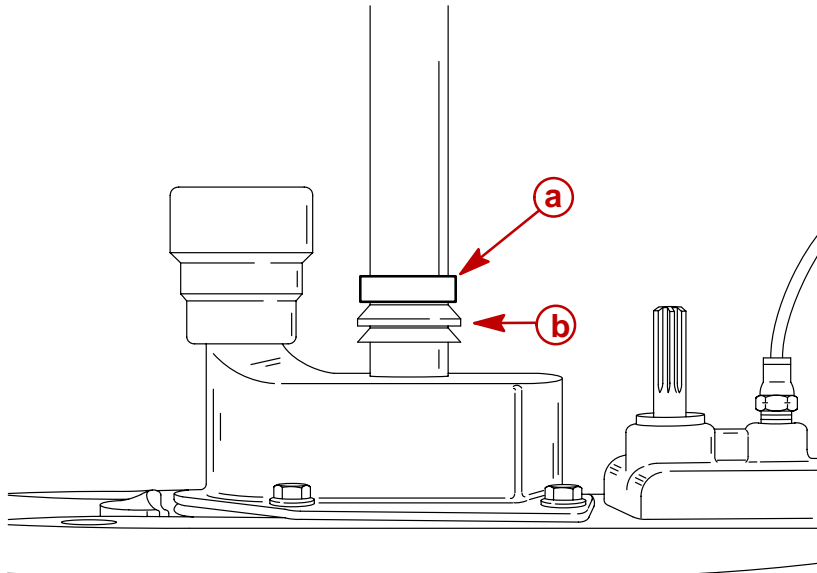
- a** - Water Pump Body
- b** - Water Pump Alignment Pins (91-821571A1)
- c** - Drive Shaft (turn clockwise while installing water pump body)

6. Hand start two (2) fasteners into the water pump assembly and remove the water pump locating pins. Install the remaining 2 fasteners. Run all fasteners down and torque to 60 lb. in. (7 Nm).
7. Lightly lubricate the O-rings in the water tube coupling with 2-4-C Marine Lubricant with Teflon.
8. Install the water tube coupling assembly to the water pump ensuring that the O-rings are not damaged during assembly.

IMPORTANT: If seal installed above pump housing is not at the proper height, air will be drawn into the pump resulting in overheating of the engine.



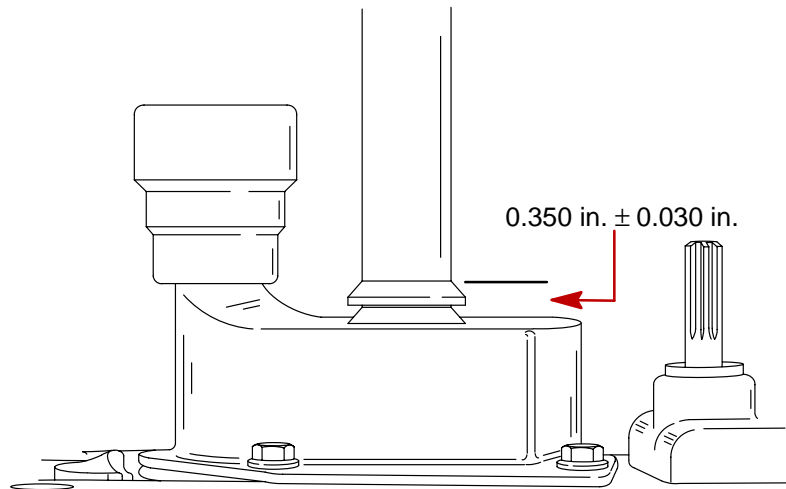
- Using tool provided in seal kit (26-816575A2) or water pump kit (817275A3), press seal down over drive shaft (DO NOT GREASE DRIVE SHAFT) until tool seats against pump housing.



57945

- a** - Tool
- b** - Seal

If tool is not available, lightly press seal against housing until a height of 0.350 in. \pm 0.030 in. (8.9mm \pm 0.76mm) is obtained.



57946



Gear Lubricant Filling Instructions

1. Inspect “Fill” and “Vent” sealing washers for cuts or abrasions. Replace washers if necessary.
2. Clean any metal debris from magnet on “Fill” plug.

IMPORTANT: Never apply lubricant to gear housing without first removing Vent screw, or gear housing cannot be filled because of trapped air. Fill gear housing ONLY when housing is in a vertical position.

3. Slowly fill housing thru Fill hole with Premium Gear 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 2-4-C Marine Lubricant with Teflon onto driveshaft splines.

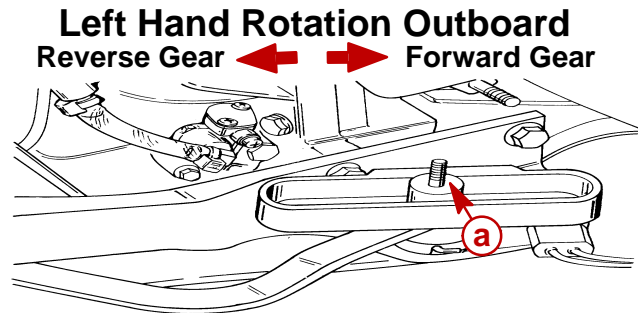
⚠ CAUTION

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 2-4-C Marine Lubricant with Teflon 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.



- Shift gear housing into NEUTRAL and place guide block anchor pin into NEUTRAL position



a - Guide Block Anchor Pin

- Position gear housing so that the driveshaft is protruding into driveshaft housing.
NOTE: If, while performing Step 8, the driveshaft splines will not align with crankshaft splines, place a propeller onto propeller shaft. Shift gearcase into FORWARD and turn propeller counterclockwise as the gear housing is being pushed toward driveshaft housing.
 - Move gear housing up toward driveshaft housing while aligning shift shaft splines and water tube with water tube guide (in water pump cover).
 - Place flat washers onto studs (located on either side of driveshaft housing). Start a nut on these studs and tighten finger-tight.
 - Start bolt at rear of gear housing inside trim tab recess. DO NOT tighten bolt at this time.
 - Recheck shift shaft spline engagement and correct if necessary.
NOTE: Guide block anchor pin should be in FORWARD when gearcase is in FORWARD.
- IMPORTANT: Do not force gear case up into place with attaching nuts.**
- Evenly tighten 2 nuts which were started in Step 9. Torque to 55 lb. ft. (75 Nm).
 - After 2 nuts (located on either side of driveshaft housing) are tightened, check shift operation as follows:
 - Place guide block anchor pin into forward gear position while turning prop shaft. Rotate flywheel clockwise (viewed from top). Propeller shaft should rotate counterclockwise.
 - Place guide block anchor pin into NEUTRAL position. Propeller shaft should rotate freely clockwise/counterclockwise.
 - Place guide block anchor pin into REVERSE gear position. Rotate flywheel clockwise (viewed from top). Propeller shaft should rotate clockwise.
- IMPORTANT: If shifting operation is not as described, preceding, the gear housing must be removed and the cause corrected.**
- Install remaining washers and nuts onto drive shaft studs. Torque to 55 lb. ft. (75 Nm).
 - Torque bolt (started in Step 10) to 45 lb. ft. (61 Nm).
 - Position trim tab or anodic plate in gear housing. Align grooves of trim tab with ribs in trim tab pocket. Adjust to position in which it had previously been installed, and while holding trim tab, torque bolt to 40 lb. ft. (54 Nm)
 - Install plastic cap into trim tab bolt opening at rear edge of driveshaft housing.

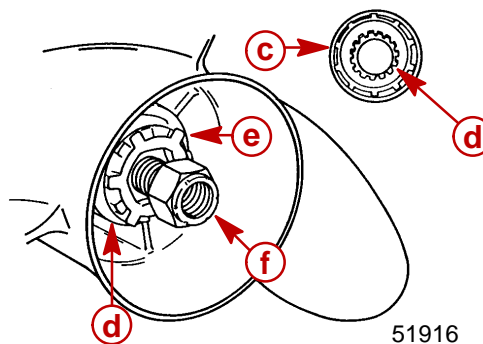
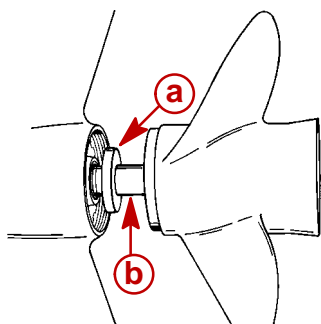


Propeller Installation

⚠ 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.

- 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 with Teflon
 - Perfect Seal
- Place forward thrust hub over propeller shaft with shoulder side toward propeller.
- Place propeller on propeller shaft and slide it up against thrust hub.
- Place continuity washer (if equipped) onto shoulder of rear thrust hub.
- Place rear thrust hub, tab washer and propeller nut on propeller shaft.
- Thread propeller nut onto propeller shaft until nut is recessed into tab washer.
- After propeller nut is recessed into tab washer, tighten nut securely [minimum of 55 lb. ft. (74.5 Nm) torque].
- 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

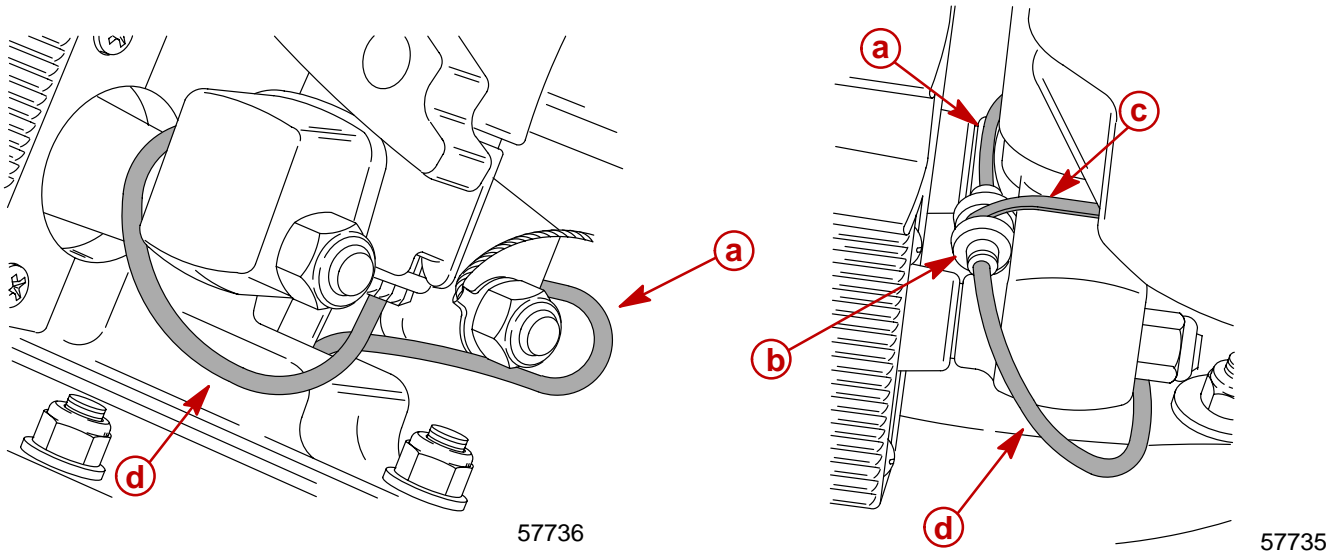
DO NOT misinterpret propeller shaft movement with propeller movement. If propeller and propeller shaft together move forward-and-aft, this is normal; however, propeller should not move forward-and-aft on propeller shaft.

- 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

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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.

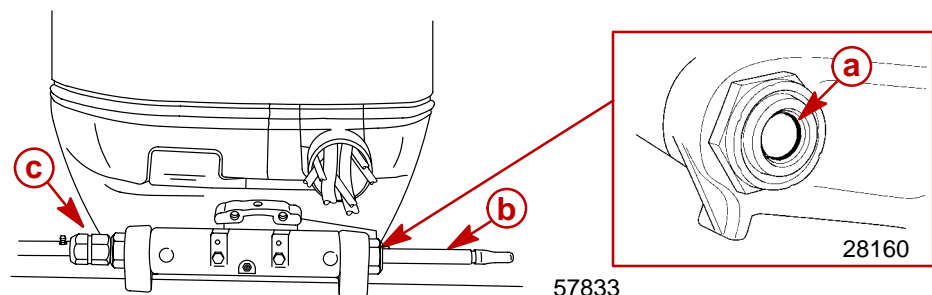
IMPORTANT: Steering cable and remote control cables must be the correct length, sharp bends on too-short cables result in “kinks”; too-long cables require unnecessary bends and/or loops. Both conditions place extra stress on the cables and will reduce the performance of the steering system.

INSTALLING RIDE GUIDE CABLE TO OUTBOARD TILT TUBE

IMPORTANT: Before installing steering cable in tilt tube, lubricate entire cable end with 2-4-C Marine Lubricant 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 2-4-C Marine Lubricant with Teflon.
2. Insert steering cable end through 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

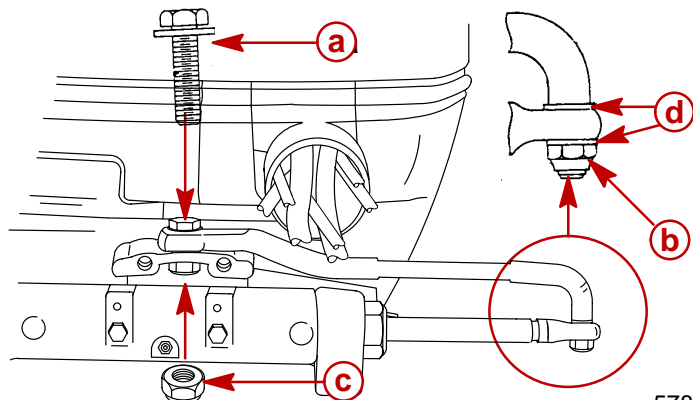
IMPORTANT: The steering link rod that connects the steering cable to the engine must be fastened using special washer head bolt (“a” - Part Number 10-849838) and self locking nuts (“b” & “c” - Part Number 11-826709113). These locknuts must never be replaced with common nuts (non locking) as they will 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.



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⚠ 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 through 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.

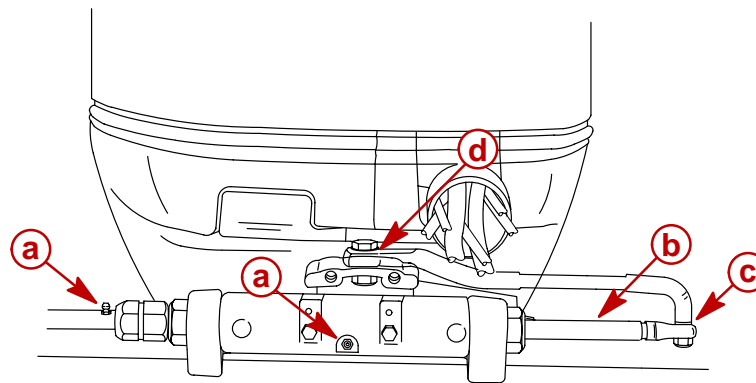


NOTE: Ride-Guide Steering Cables are lubricated at the factory and require no additional lubrication at initial installation.

⚠ 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 through grease fittings (a) with 2-4-C Marine Lubricant with Teflon. Lubricate exposed portion of cable end (b) with 2-4-C Marine Lubricant with Teflon.
4. Lubricate pivot point (c) of steering link rod and ball joint (d) of link rod with SAE 30 Weight Oil (obtain locally).
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 Marine Lubricant 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.



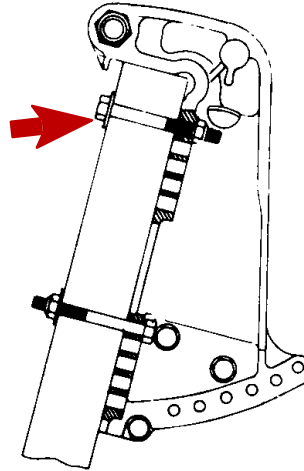
⚠ CAUTION

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.

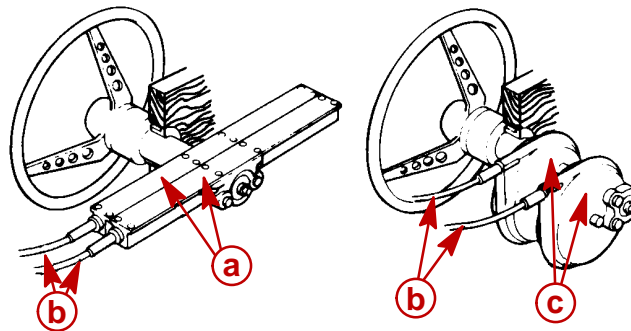
Install upper bolts so that hex head end of bolts is on the inside of boat transom.



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.



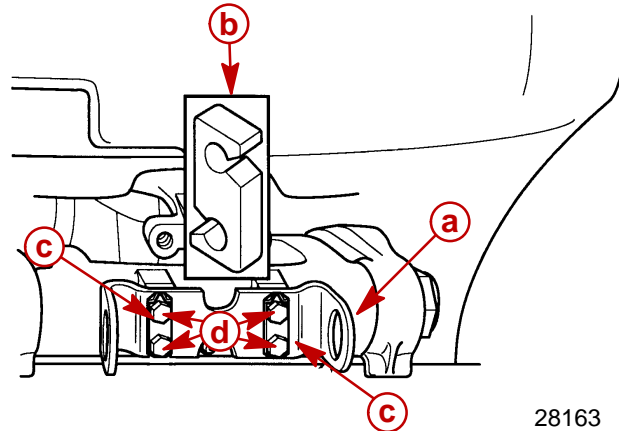
- a** - Gear Rack
- b** - Steering Cables
- c** - Rotary Steering Heads



Steering Cable Mounting Tube Installation

IMPORTANT: Spacers 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.



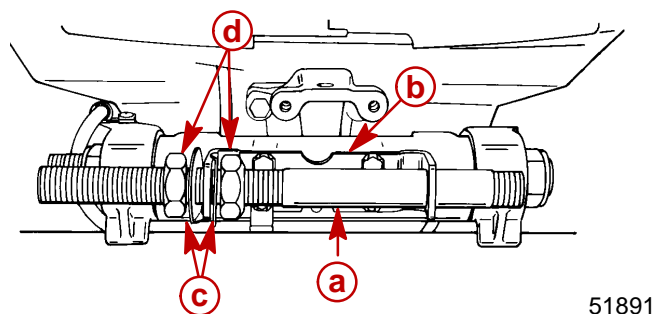
- a** - Mounting Bracket for Steering Cable Mounting Tube
- b** - Spacer (2)
- c** - Locking Retainer (2)
- d** - Bolts (4) - 7/8 in. (22 mm) Long - Torque to 100 lb. in. (11.5 Nm), then Bend Corner Tabs of Locking Retainers Up and Against Flats on Each Bolt

⚠ 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.



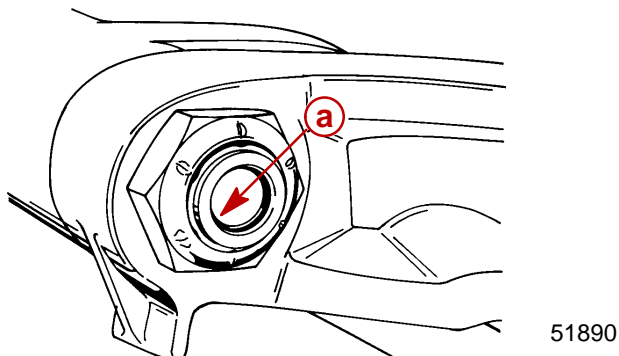
- a** - Steering Cable Mounting Tube (End of Tube with Longer Threads Toward Starboard Side of Boat)
- b** - Mounting Bracket
- c** - Locking Tab Washers (2)
- d** - Adjustment Nuts (Flats of Nuts Facing Toward Locking Tab Washer)



Installing Steering Cables

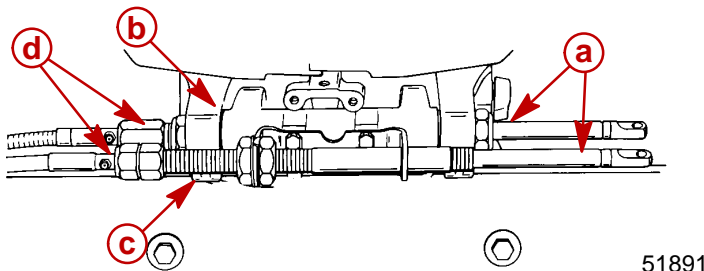
IMPORTANT: Lubricate inside of outboard tilt tube, inside of steering cable mounting tube and rubber O-ring seal (located in outboard tilt tube) with 2-4-C Marine Lubricant with Teflon before installing steering cables.

Lubricate inside of outboard tilt tube and inside of steering cable mounting tube with 2-4-C Marine Lubricant with Teflon. Verify rubber O-ring seal (a) (located in outboard tilt tube) is lubricated.

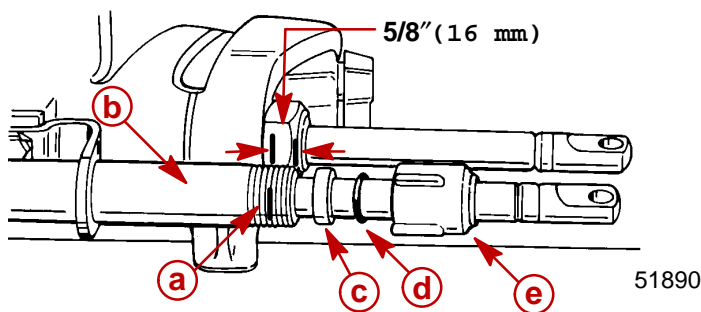


Insert steering cable ends (a) through outboard tilt tube (b) and cable mounting tube (c). Thread steering cable attaching nuts (d) on to tubes hand tight.

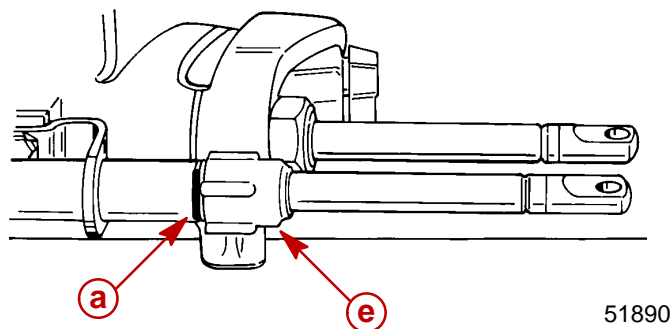
NOTE: Torque steering cable attaching nuts only after final steering adjustments have been made.



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).



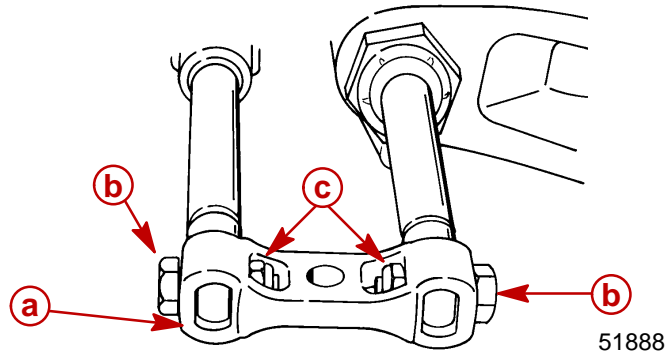


Coupler Installation

⚠ 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).



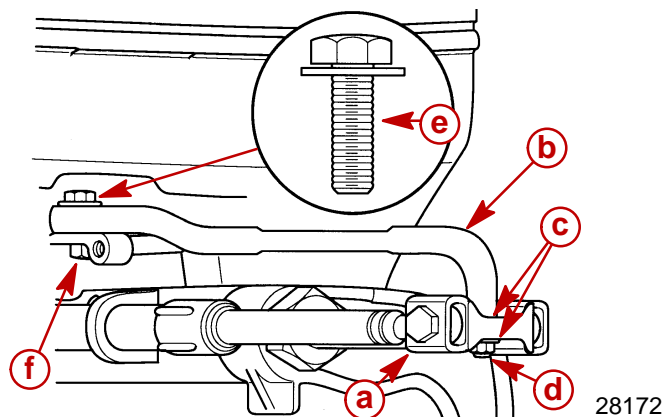
Installing Link Rod

⚠ 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 2-4-C Marine Lubricant 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 (obtain locally). 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).

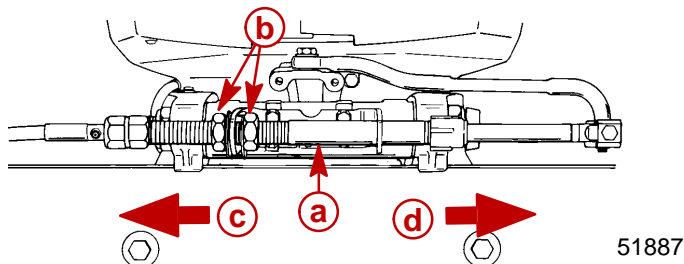


- a - Steering Coupler
- b - Steering Link Rod
- c - Flat Washer (2)
- d - Nylon Insert Locknut - Torque until it seats [DO NOT exceed 120 lb. in. (13.5 Nm) of torque], then back nut off 1/4 turn
- e - Special Washer Head Bolt (10-849838) - Torque to 20 lb. ft. (27 Nm)
- f - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)

**STEERING SYSTEM TENSION ADJUSTMENT**

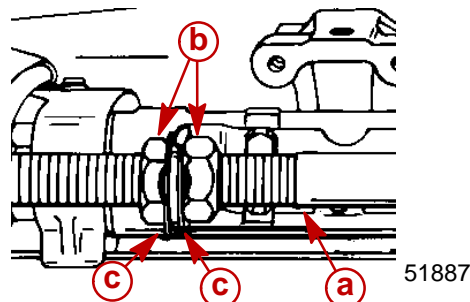
IMPORTANT: After this dual steering cable attachment kit is installed, there must be proper tension in forward mounted steering cable for this attachment kit to operate properly. Not enough tension will cause slack (or play) in steering system. Too much tension will cause steering cables to bind. Perform 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.



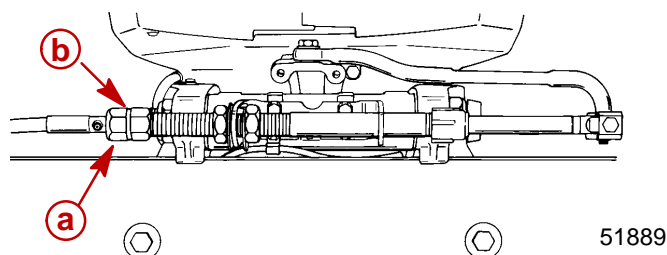
- a** - Steering Cable Mounting Tube
- b** - Adjustment Nuts
- c** - Adjust Tube in This Direction to Remove Slack from Steering System
- d** - Adjust Tube in This Direction to Reduce Tension from Steering System

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 through 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."

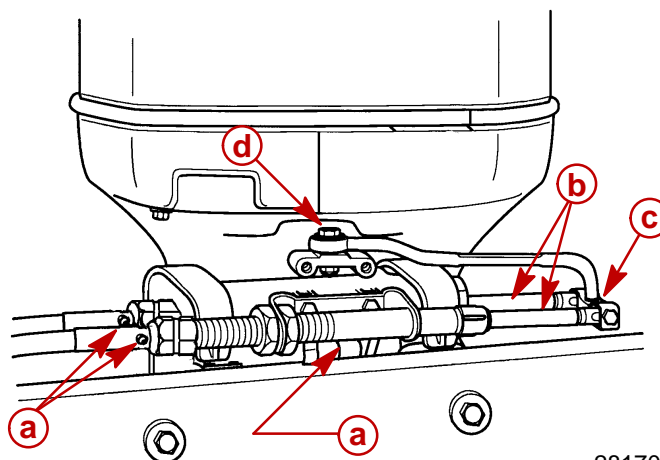
1. Carefully check steering system components for wear. Replace worn parts.
2. Check steering system fasteners to be sure that they are torqued to correct specifications.

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 through grease fittings with 2-4-C Marine Lubricant with Teflon. Lubricate exposed portion of cable ends with 2-4-C Marine Lubricant with Teflon.
4. Lubricate pivot point of steering link rod and ball joint of link rod/steering coupler with SAE 30W Motor Oil (obtain locally).
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 Marine Lubricant with Teflon.



28170

- a** - Grease Fittings
- b** - Cable Ends
- c** - Pivot Point
- d** - Ball Joint



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 than specified, refer to end of this instruction manual for optional extension couplers.

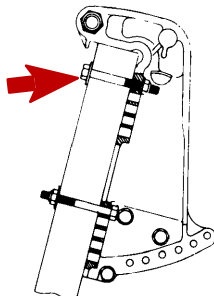
DETERMINE ROUTING OF STEERING CABLES

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

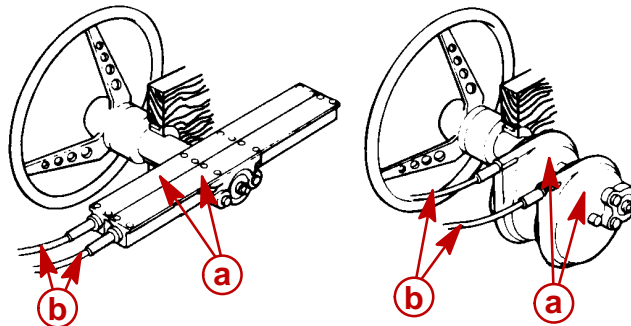
(Both Steering Cables Routed Together Down Starboard Side of Boat)

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.

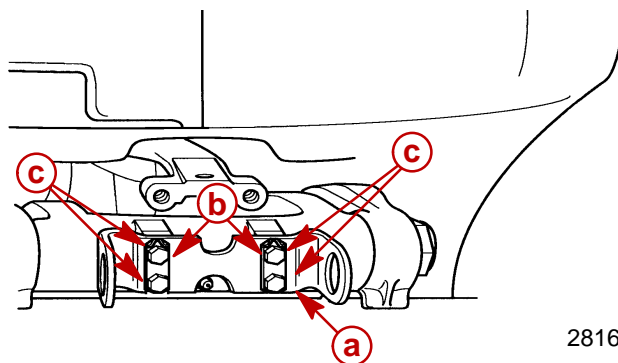


- a** - Straight Rack (Left); Rotary Steering (Right)
b - Steering Cables (Install so that Both Cables Will Push and Pull Together)

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 starboard outboard.



28164

- a** - Mounting Bracket for Steering Cable Mounting Tube
b - Locking Retainers (2)
c - Bolts (4) - 5/8 in. (16 mm) Long - Torque to 100 lb. in. (11.5 Nm), then Bend Corner Tabs of Locking Retainers Up and Against Flats on Each Bolt

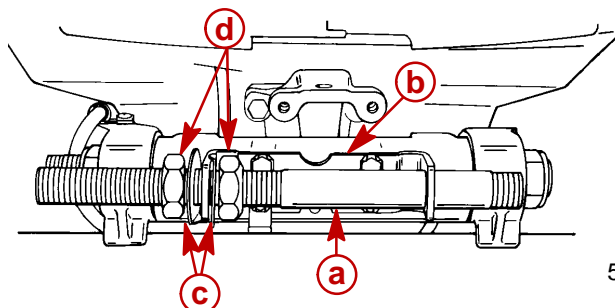
⚠ WARNING

Locking retainer corner tabs, **MUST BE** bent up and against flats on each bolt that secures mounting bracket for steering cable mounting tube to outboard swivel bracket, to prevent bolts from turning out.



Install steering cable mounting tube into mounting bracket with 2 adjusting nuts and 2 locking tab washers. Be sure longer threaded end of tube is toward starboard side of boat.

Temporarily adjust tube, so that longer threaded end of tube extends out the same distance as the outboard tilt tube. Do not tighten adjustment nuts at this time.



51891

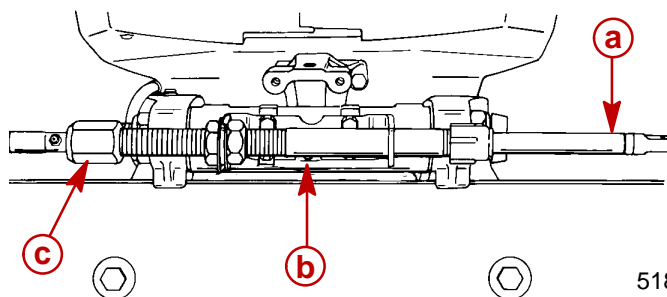
- a** - Steering Cable Mounting Tube (End of Tube with Longer Threads Toward Starboard Side of Boat)
- b** - Mounting Bracket
- c** - Locking Tab Washers (2)
- d** - Adjustment Nuts (Flats of Nuts Facing Toward Locking Tab Washer)

IMPORTANT: Lubricate inside of steering cable mounting tube with 2-4-C Marine Lubricant with Teflon before installing steering cable.

Lubricate inside of steering cable mounting tube (starboard outboard) with 2-4-C Marine Lubricant with Teflon.

Insert steering cable end through cable mounting tube and thread steering cable attaching nut onto tube hand tight.

NOTE: Torque steering cable attaching nut only after final steering adjustments have been made.

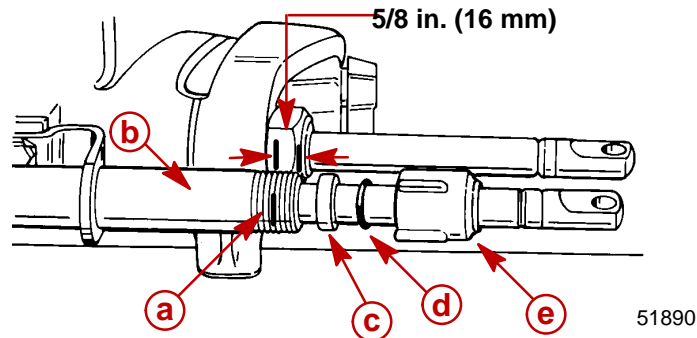


51887

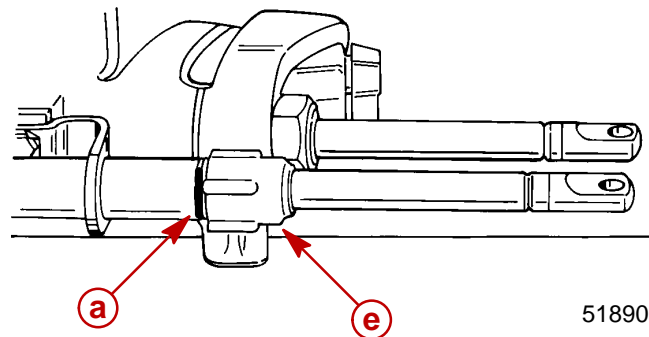
- a** - Steering Cable End
- b** - Cable Mounting Tube
- c** - Steering Cable Attaching Nut



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.



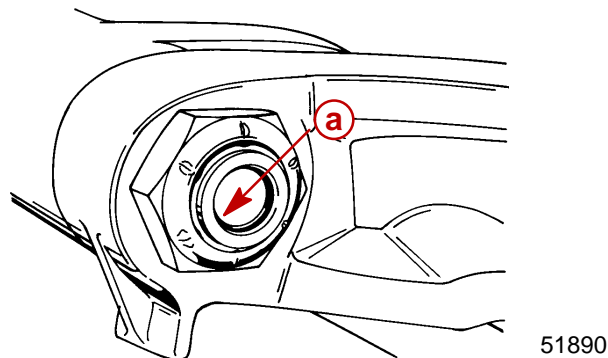
Thread cap (e) onto steering cable mounting tube, up to mark (a).



STEERING CABLE INSTALLATION - PORT OUTBOARD

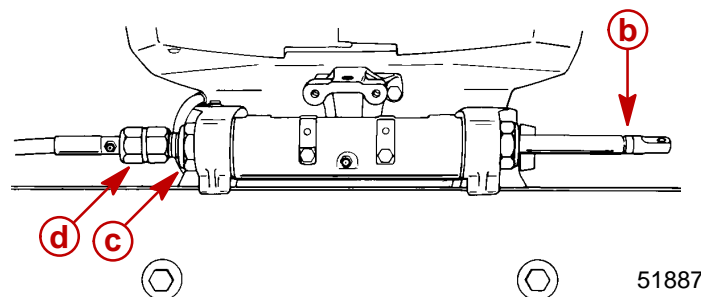
IMPORTANT: Lubricate inside of port outboard's tilt tube and rubber O-ring seal located inside tilt tube with 2-4-C Marine Lubricant with Teflon, before installing steering cable.

Lubricate inside of port outboard's tilt tube and rubber O-ring seal (a) with 2-4-C Marine Lubricant with Teflon.



Insert steering cable end (b) through 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.

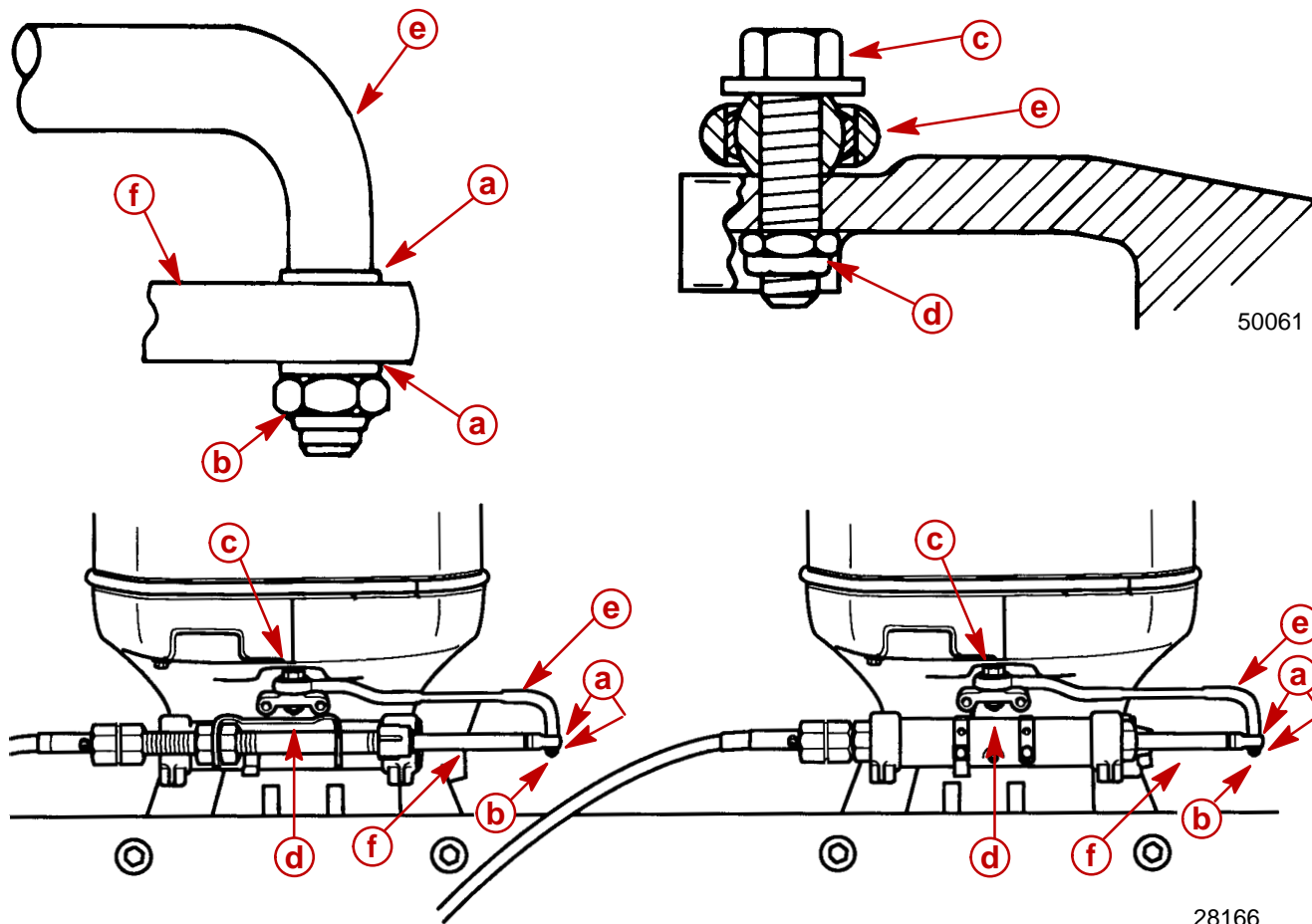




STEERING LINK ROD INSTALLATION

⚠ 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.



- 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

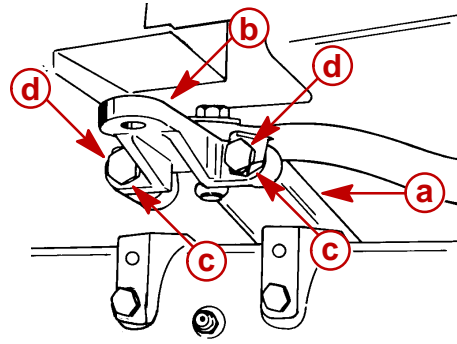
Lubricate holes in ends of steering cables, with 2-4-C Marine Lubricant with Teflon. Assemble steering link rods to steering cable ends of each outboard, using flat washers and nylon insert locknuts. Tighten locknuts until they seat [DO NOT exceed 120 lb. in. (13.5 Nm) of torque], then back nut off 1/4 turn.

Lubricate ball joints in steering link rods with SAE 30W Motor Oil (obtain locally). 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

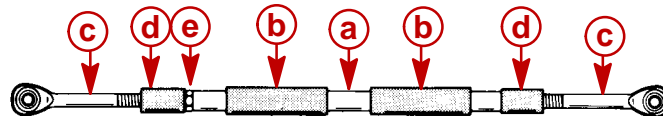
Position outboards so that they are facing straight forward. (Distance between threaded hole centers of steering arm extensions **MUST BE** equal to distance between propeller shaft centerlines.)

Lubricate inside of rubber sleeves with 2-4-C Marine Lubricant 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 (obtain locally).

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.

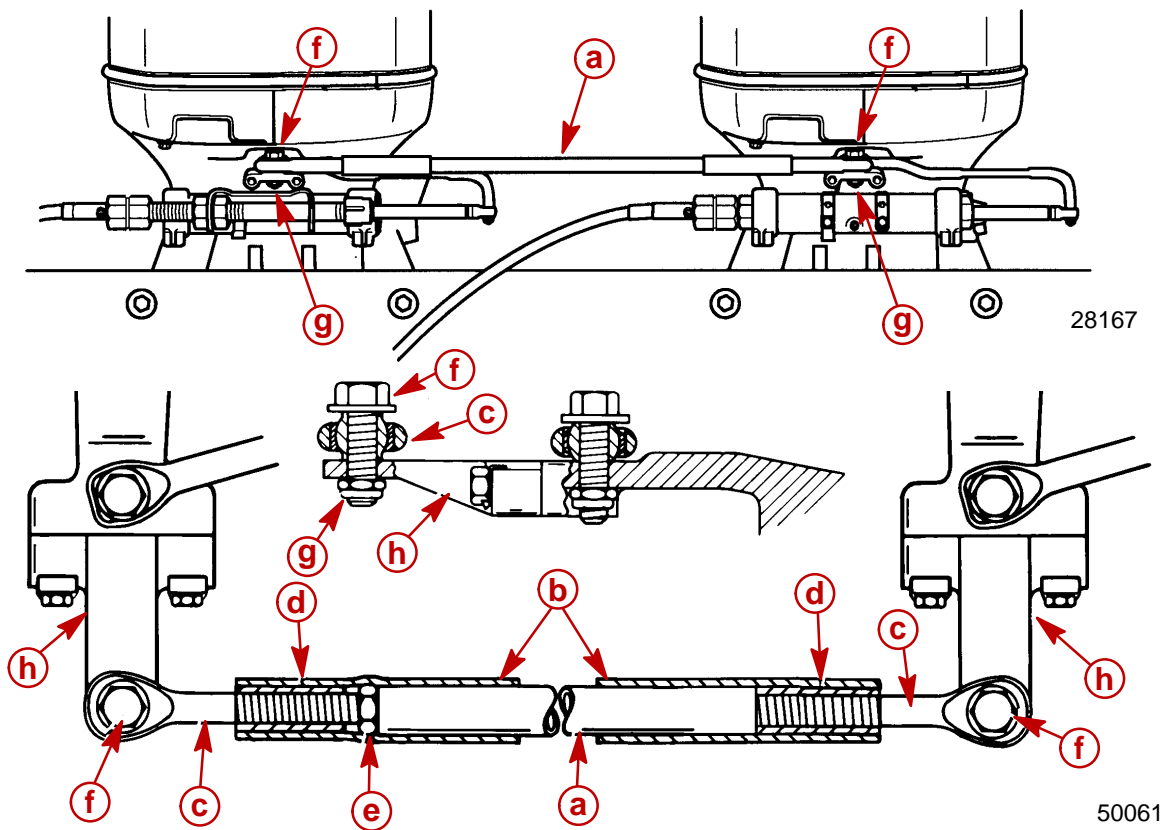
Torque special washer head bolts to 20 lb. ft. (27 Nm), then torque locknuts to 20 lb. ft. (27 Nm).

⚠ 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 N-m).

Tighten "jam" nut against coupler. Torque "jam" nut to 20 lb. ft. (27 Nm).

Spray Corrosion Guard on exposed threads of steering eyes and position rubber bushings and rubber sleeves to cover exposed threads of steering eyes.

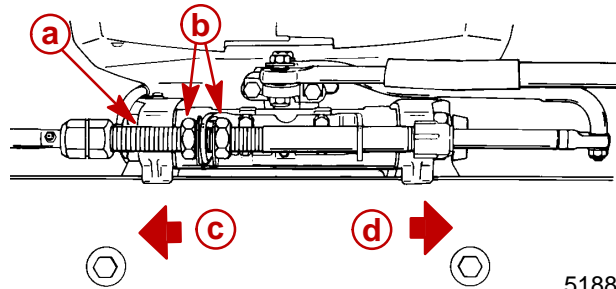


- a - Coupler
- b - Rubber Sleeve
- c - Steering Eye
- d - Rubber Bushing
- e - Jam Nut - Torque (Against Coupler) to 20 lb. ft. (27 Nm)
- f - Special Washer Head Bolt (10-849838) - Torque to 20 lb. ft. (27 Nm)
- g - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)
- h - Steering Arm Extension Bracket

**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.

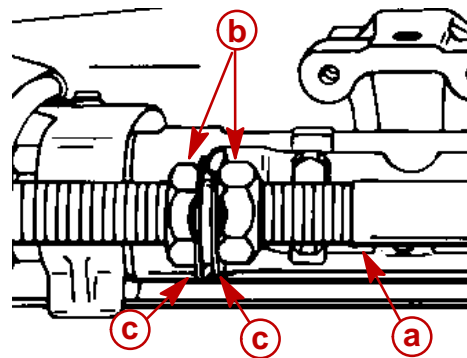
Loosen adjustment nuts and pull steering cable mounting tube (by hand) away from end of steering cable (to remove slack in steering system). Tighten adjustment nuts against mounting bracket and check system for slack (play). If steering system is too tight, readjust tube toward end of steering cable 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.



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

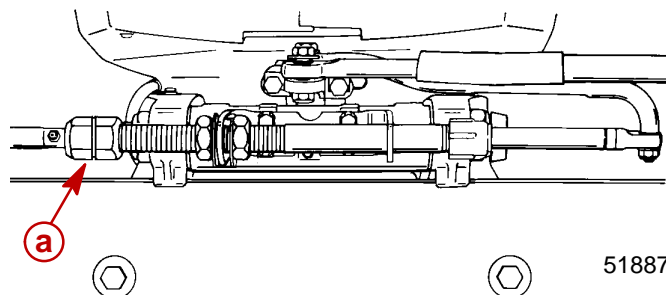
After steering system tension is adjusted correctly, tighten adjustment nuts against mounting bracket, to a torque of 35 lb. ft. (47.5 Nm) and bend a tab lock washer against a flat on each nut.



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

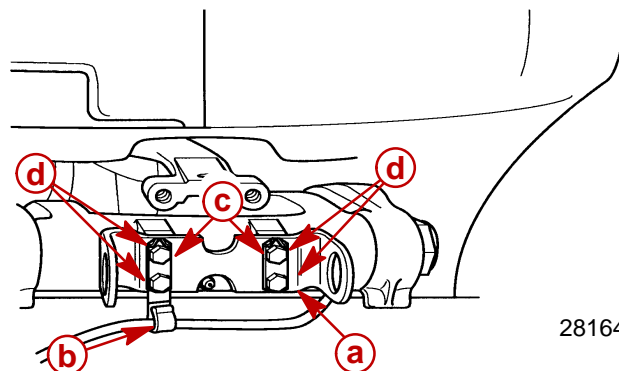
IMPORTANT: Steering cable must be installed into tilt tube of port outboard before outboard is mounted on boat transom.

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.

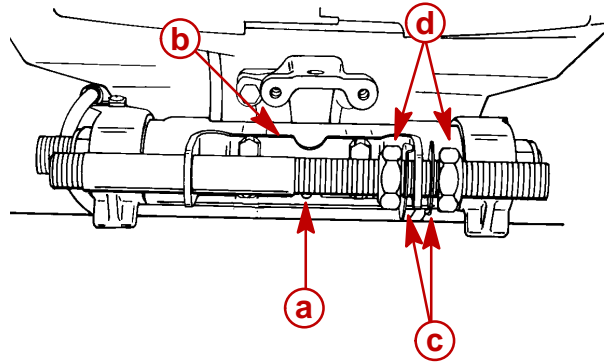
⚠ WARNING

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.



51891

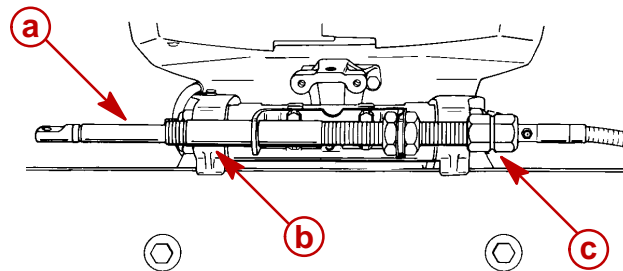
- a** - Steering Cable Mounting Tube (End of Tube with Longer Threads Toward Center of Boat Transom)
- b** - Mounting Bracket
- c** - Locking Tab Washers (2)
- d** - Adjustment Nuts (Flats of Nuts Facing Toward Locking Tab Washer)

IMPORTANT: Lubricate inside of steering mounting tube with 2-4-C Marine Lubricant with Teflon before installing steering cable.

Lubricate inside of steering cable mounting tube (starboard outboard) with 2-4-C Marine Lubricant with Teflon.

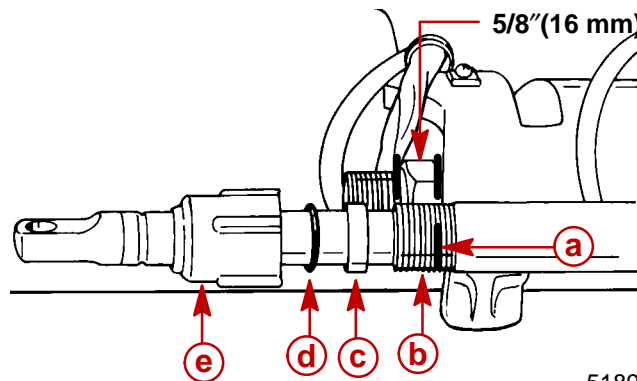
Insert steering cable end (a) (steering cable routed down port side of boat) through cable mounting tube (b) and thread steering cable attaching nut (c) onto tube hand tight.

NOTE: Torque steering cable attaching nut only after final steering adjustments have been made.



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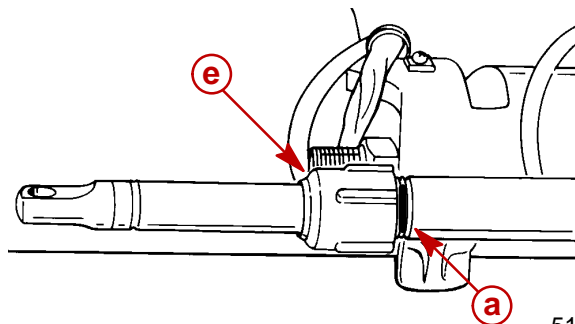
Place a mark (a) on steering cable mounting tube (b) 5/8 in (16 mm) from end of mounting tube. Slide plastic spacer (c), O-ring (d) and cap (e) over steering cable.



51890



Thread cap (e) onto steering cable mounting tube, up to mark (a).

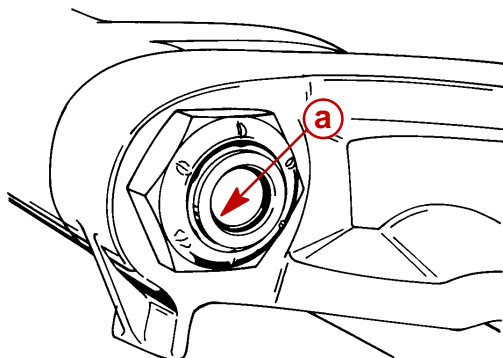


51888

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 Marine Lubricant with Teflon, before installing steering cable.

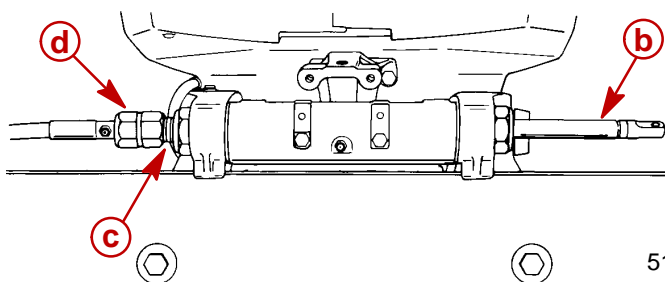
Lubricate inside of port outboard's tilt tube and rubber O-ring seal (a) with 2-4-C Marine Lubricant with Teflon.



51890

Insert steering cable end (b) (steering cable routed down starboard side of boat) through 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

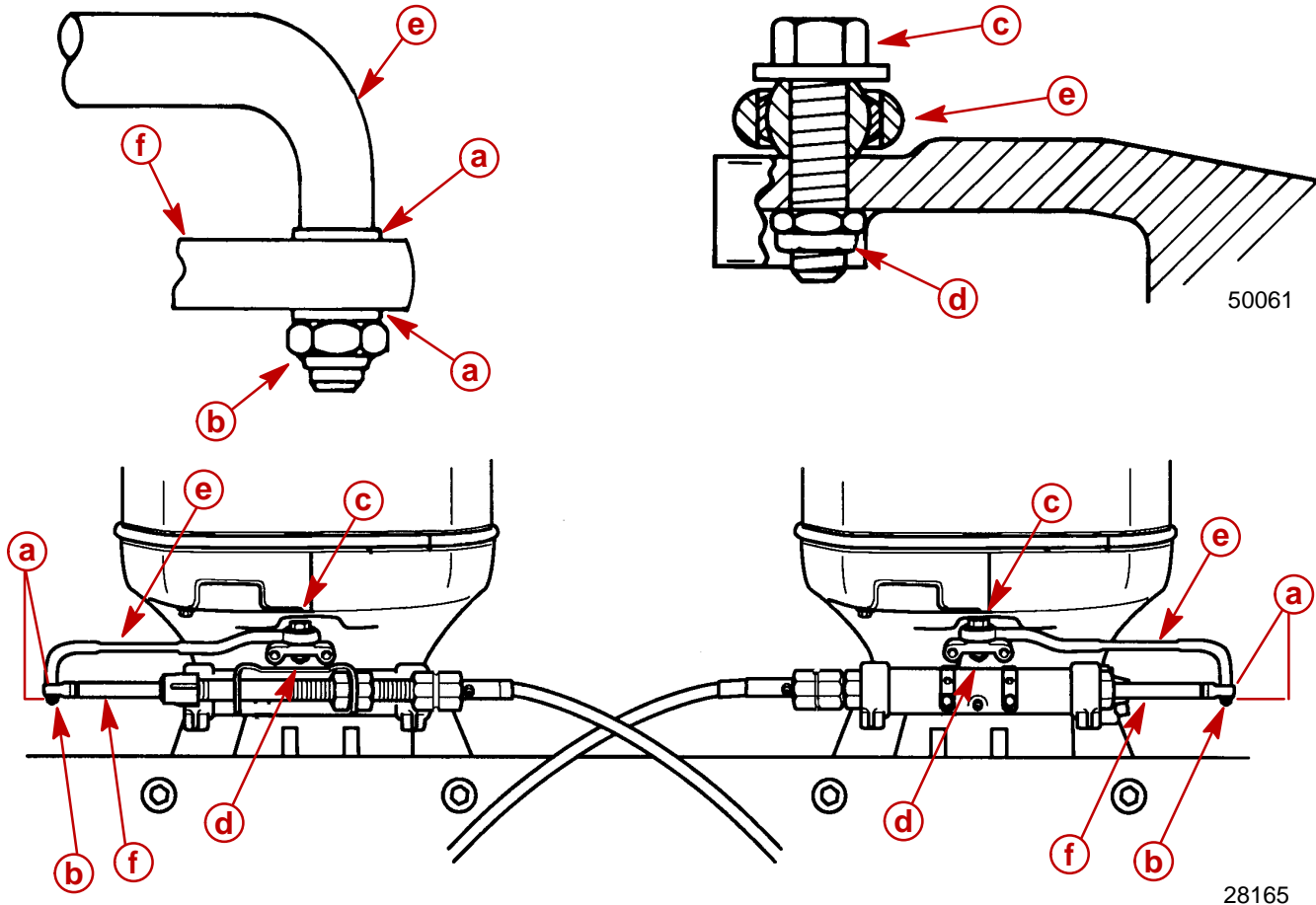
▲ WARNING

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 2-4-C Marine Lubricant 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.

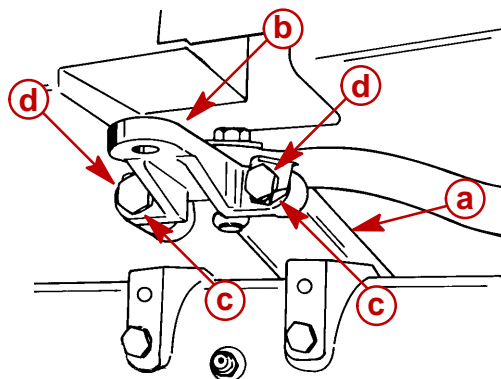
Lubricate ball joints in steering link rods with SAE 30W Motor Oil (obtain locally). Secure link rods to outboard steering arms, using special washer head bolts (10-849838) provided and nylon insert locknuts as shown. Torque special bolts to 20 lb. ft. (27 Nm) then torque locknuts to 20 lb. ft. (27 Nm).



- 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

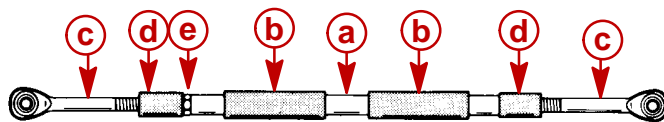
Position outboards so that they are facing straight forward. (Distance between threaded hole centers of steering arm extensions **MUST BE** equal to distance between propeller shaft centerlines.)

Lubricate inside of rubber sleeves with 2-4-C Marine Lubricant 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 (obtain locally).

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.

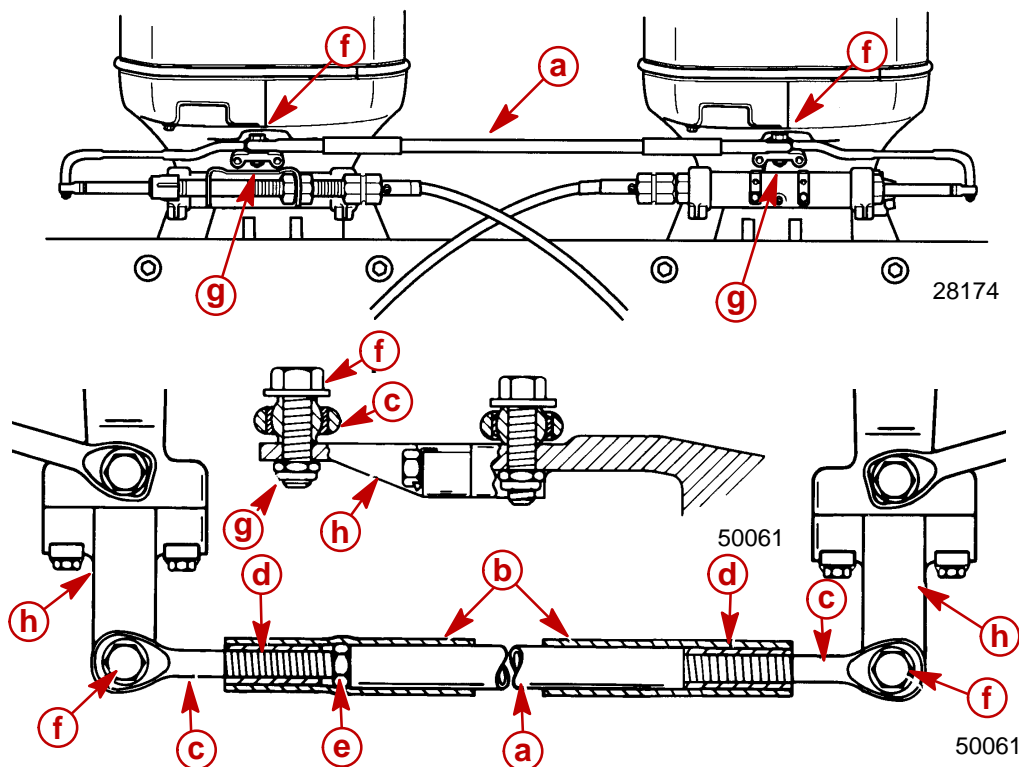
Torque special washer head bolts to 20 lb. ft. (27 Nm), then torque locknuts to 20 lb. ft. (27 Nm).

⚠ 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 Corrosion Guard on exposed threads of steering eyes and position rubber bushings and rubber sleeves to cover exposed threads of steering eyes.



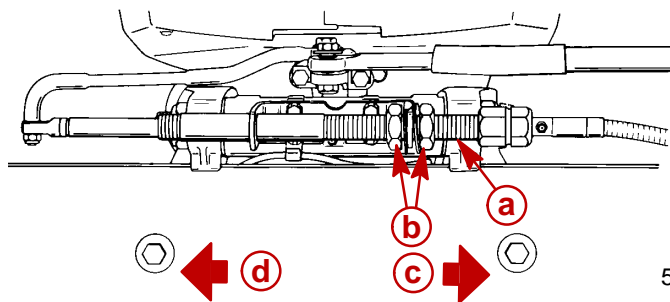
- a** - Coupler
- b** - Rubber Sleeve
- c** - Steering Eye
- d** - Rubber Bushing
- e** - Jam Nut - Torque (Against Coupler) to 20 lb. ft. (27 Nm)

- 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)**

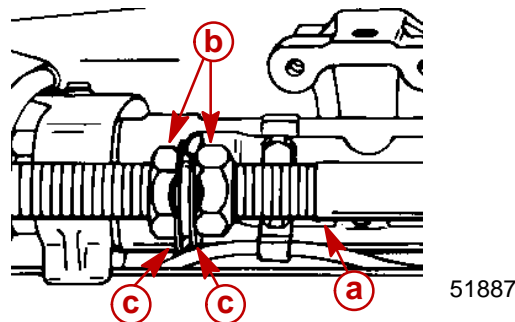
IMPORTANT: For proper operation of this dual cable - dual outboard steering installation, there **MUST BE** proper tension in the steering system. **NOT ENOUGH** tension will cause slack (play) in steering system. **TOO MUCH** tension will cause steering cables to bind. Perform the following steps to 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.

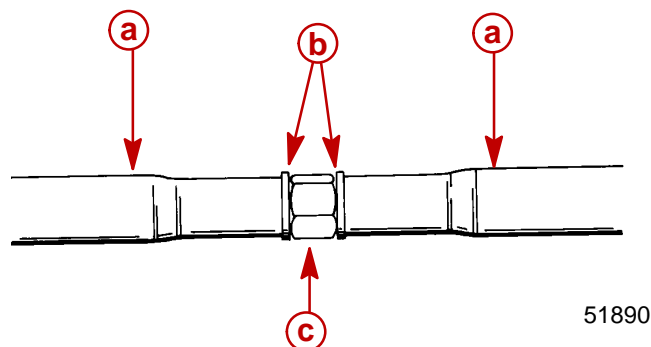
Ride Guide Steering Attachment Extension Couplers

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. through 24-1/2 in. (572 mm through 622 mm)	12" (305 mm) Coupler
23-1/2 in. through 27-1/2 in. (597 mm through 699 mm)	15" (381 mm) Coupler (Supplied with this kit)
26-1/2 in. through 30-1/2 in. (673 mm through 755 mm)	18" (457 mm) Coupler
30 in. through 34 in. (763 mm through 864 mm)	9" (229 mm) Coupler and 12" (305 mm) Coupler (Connected together with coupler link rod)
33 in. through 37 in. (838 mm through 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.

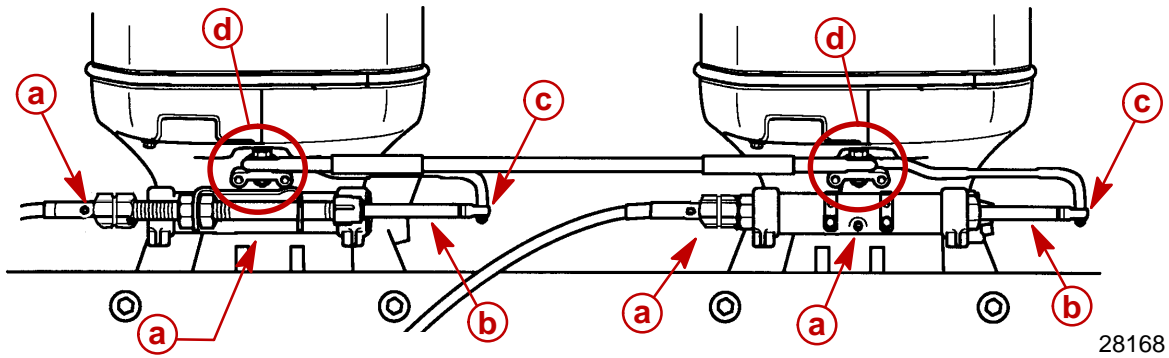
⚠ WARNING

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.

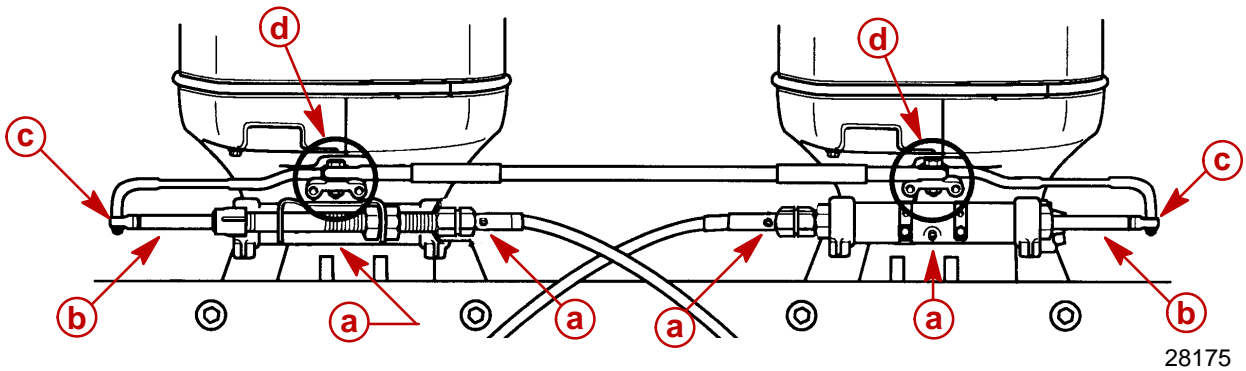
3. With core of Ride-Guide Steering Cable (transom end) fully retracted, lubricate transom end of steering cables through grease fittings (a) with 2-4-C Marine Lubricant with Teflon. Lubricate exposed portion of cable ends (b) with 2-4-C Marine Lubricant with Teflon.
4. Lubricate pivot points (c) of steering link rods and ball joints (d) of link rods/steering coupler with SAE 30W Motor Oil (obtain locally).



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 Marine Lubricant with Teflon.



Lubrication Points for Parallel Cable Routing Installations



Lubrication Points for Opposite Side Cable Routing Installations

- a** - Grease Fittings
- b** - Cable Ends
- c** - Pivot Points
- d** - Ball Joints



Transom Mounted Ride Guide Attaching Kit Installation (73770A1)

Attaching Kit Installation

1. Lubricate both holes in pivot block (Figure 1) with 2-4-C Marine Lubricant 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).

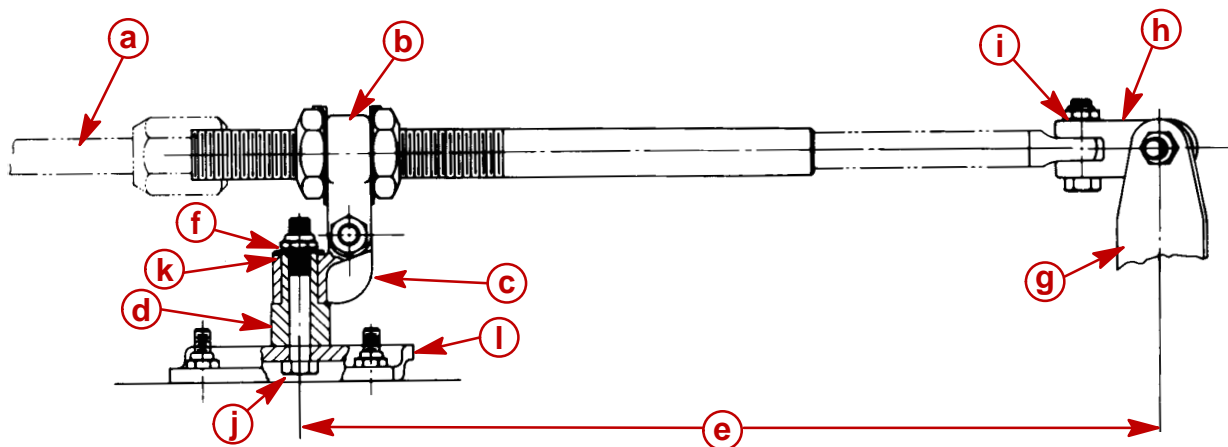


Figure 1

- 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



- 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.**

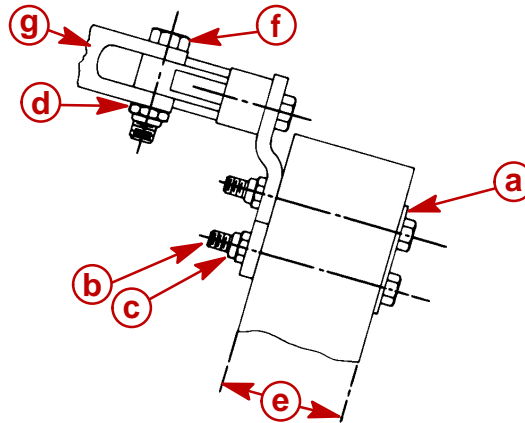


Figure 2

- 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
- Install one cable tube jam nut onto steering cable tube. Place tab washer over Ride-Guide yoke, then insert cable tube through tab washer and yoke. Install second cable tube jam nut onto cable tube but do not tighten at this time. (Figure 3)
 - Position transom attaching kit on transom as shown:
 - 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)

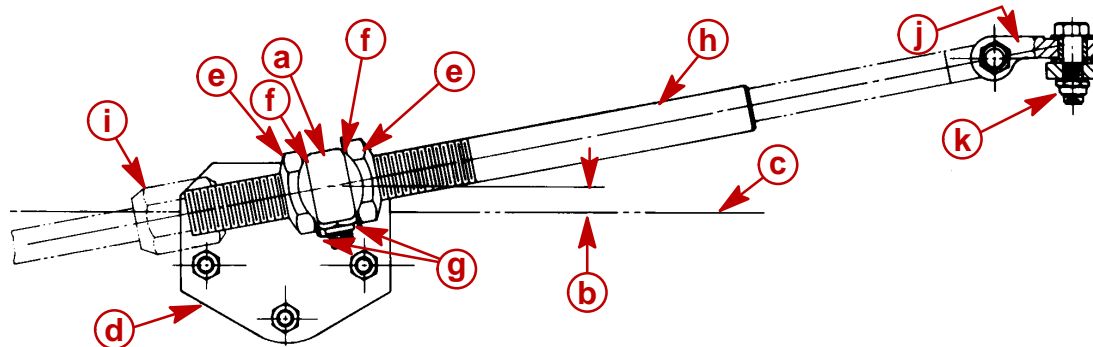


Figure 3

- 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 through 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 2-4-C Marine Lubricant with Teflon.
2. Install steering cable through 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 through 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 (through grease fitting - if equipped - next to cable attaching nut) with 2-4-C Marine Lubricant 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 2-4-C Marine Lubricant 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)

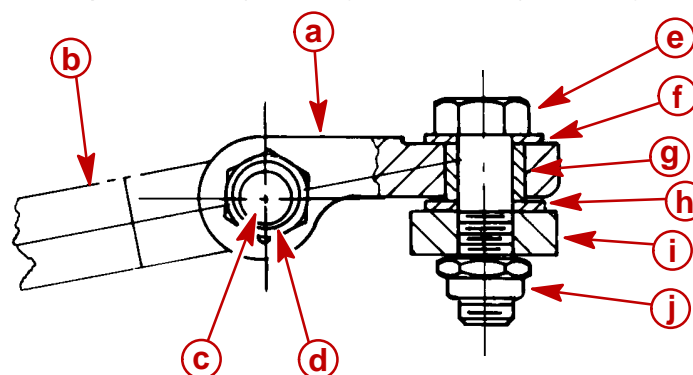


Clevis Attaching Kit Installation (A-70599A5)

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 through 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 Marine Lubricant 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 Marine Lubricant 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:

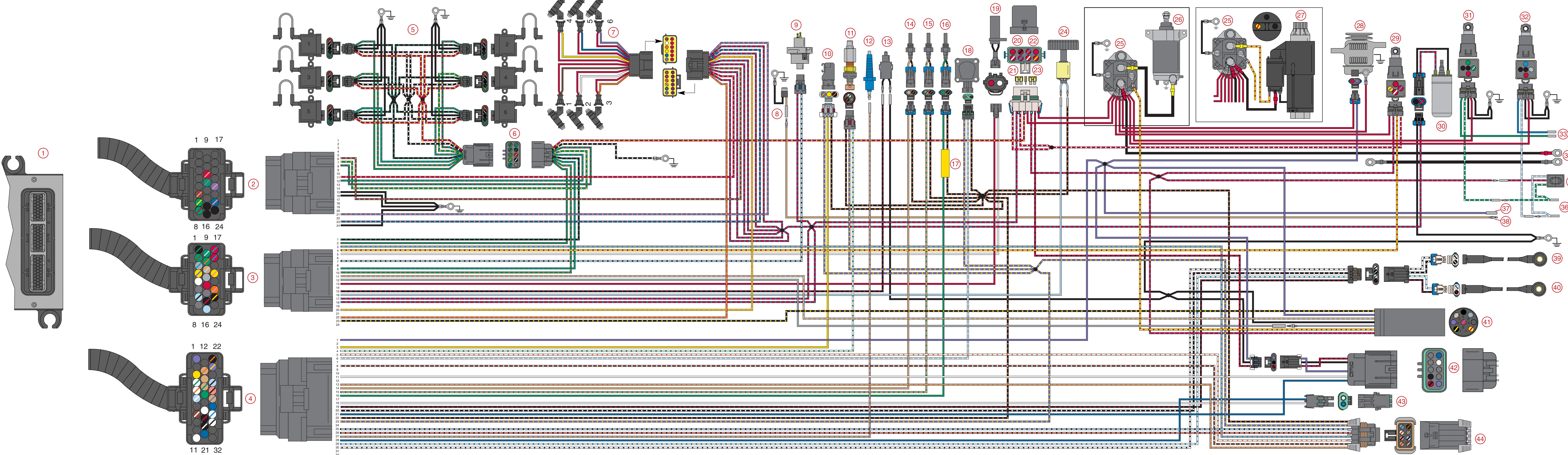


**225/250/3.0 LITRE WORK EFI
WIRING DIAGRAM
2002 MODEL YEAR**



225/250/3.0 Litre Work 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)



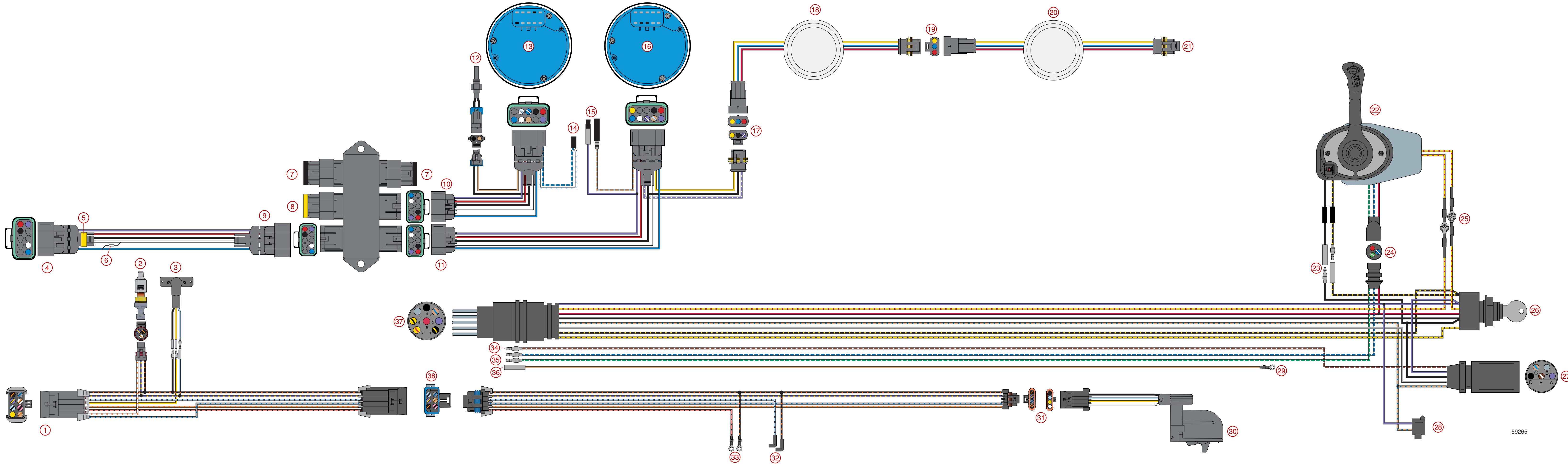


**TYPICAL SMARTCRAFT
SYSTEM TACHOMETER &
SYSTEM SPEEDOMETER
INSTALLATION
WITH SYSTEM LINK GAUGES
2002 MODEL YEAR**



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



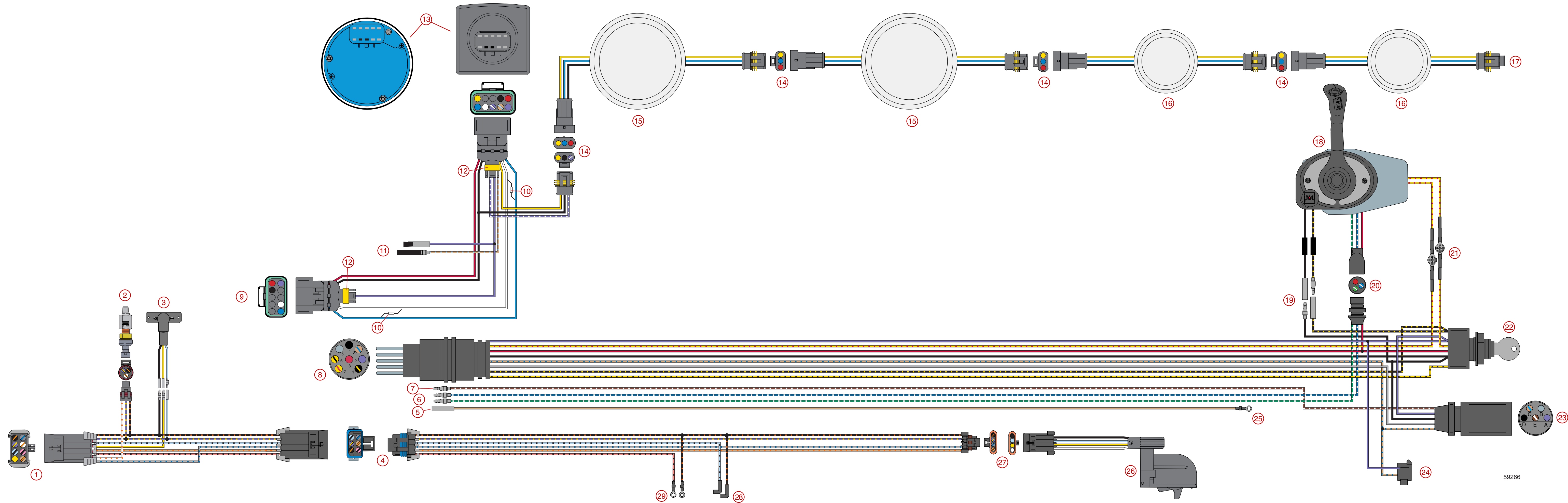


**TYPICAL SMARTCRAFT
SYSTEM MONITOR/TACHOMETER
INSTALLATION
WITH SYSTEM LINK GAUGES
2002 MODEL YEAR**



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



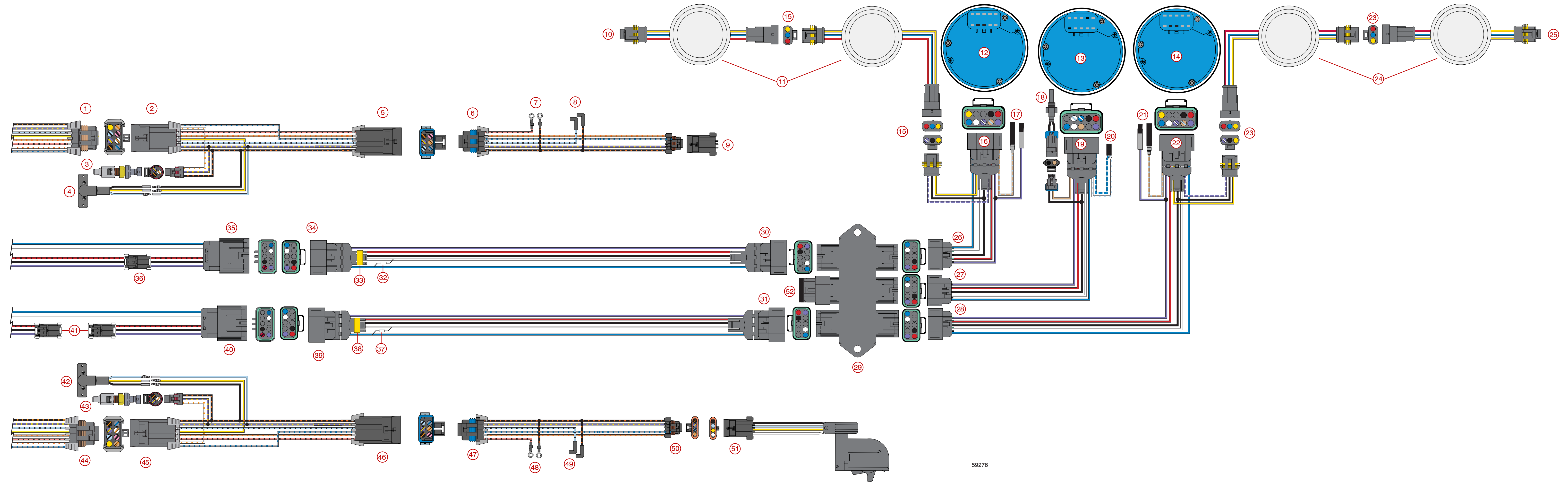


**TYPICAL SMARTCRAFT
DUAL OUTBOARD
INSTALLATION
2002 MODEL YEAR**



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 Dual 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



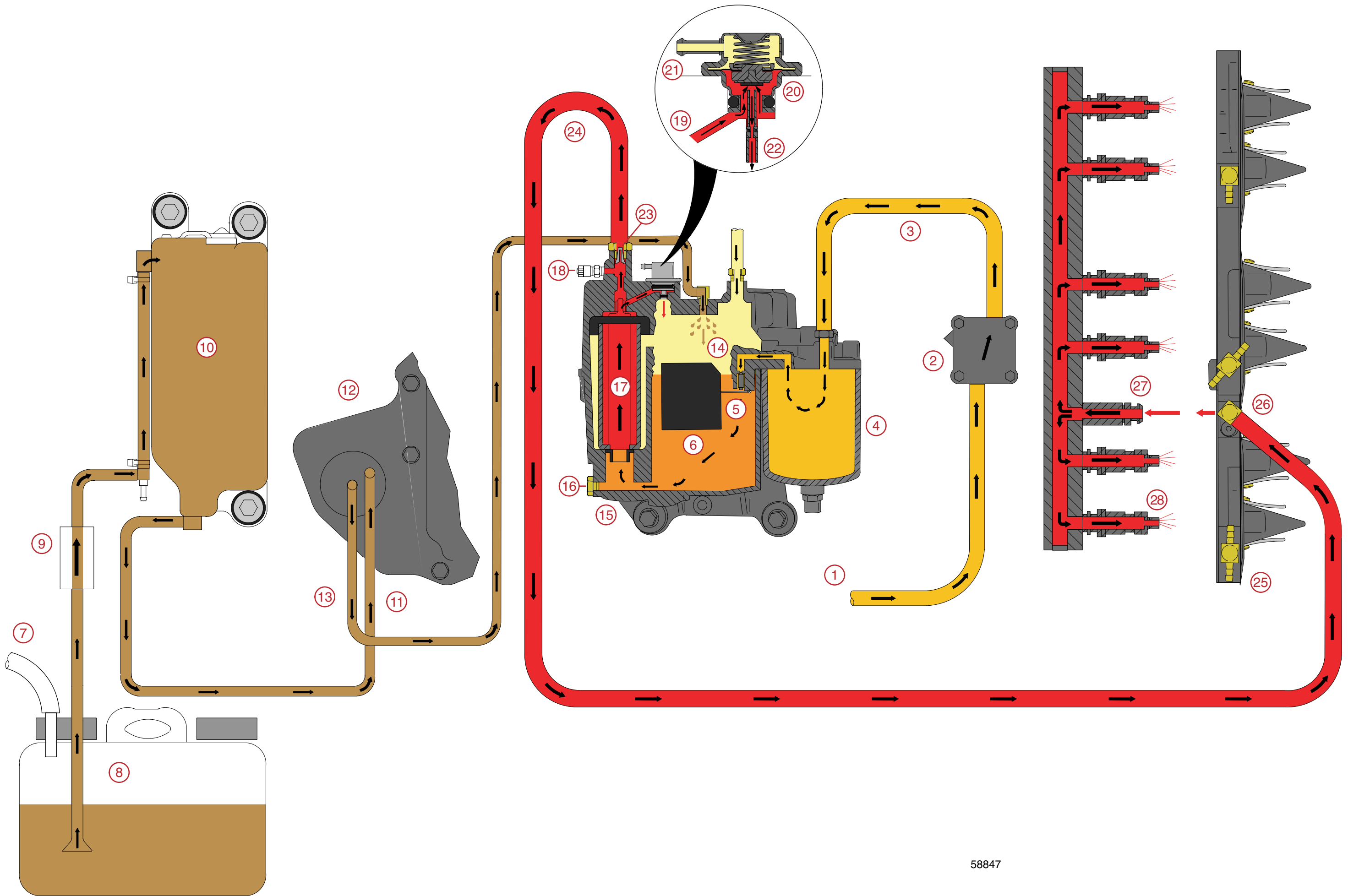


**225/250/3.0 LITRE WORK EFI
OIL & FUEL FLOW DIAGRAM
2002 MODEL YEAR**



225/250/3.0 Litre Work 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





**225/250/3.0 LITRE WORK EFI
WATER FLOW DIAGRAM
2002 MODEL YEAR**



225/250/3.0 Litre Work 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. Strainer - Exhaust cooling water
5. Main Water Feed to Powerhead from Water Tube
6. Rubber Water Dams - If missing may result in uneven cooling of cylinders and scuffed pistons
7. Cylinder Head Cover - Removed from head for illustration, normally part of head casting
8. Thermostats (2) 143° F (61.7° C) - If stuck closed, engine will overheat at 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 discharge into exhaust relief passage
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

