MERCURY

MERCURY

Service Manual



135/150 OptiMax

Direct Fuel Injection

Starting Model Year 1998 Thru 1999
Serial Number 0G590000 Thru 0G960499

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135/150 OptiMax
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Notice

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

Notice to Users of This Manual

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

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

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

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

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

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

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

Cleanliness and Care of Outboard Motor

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

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

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

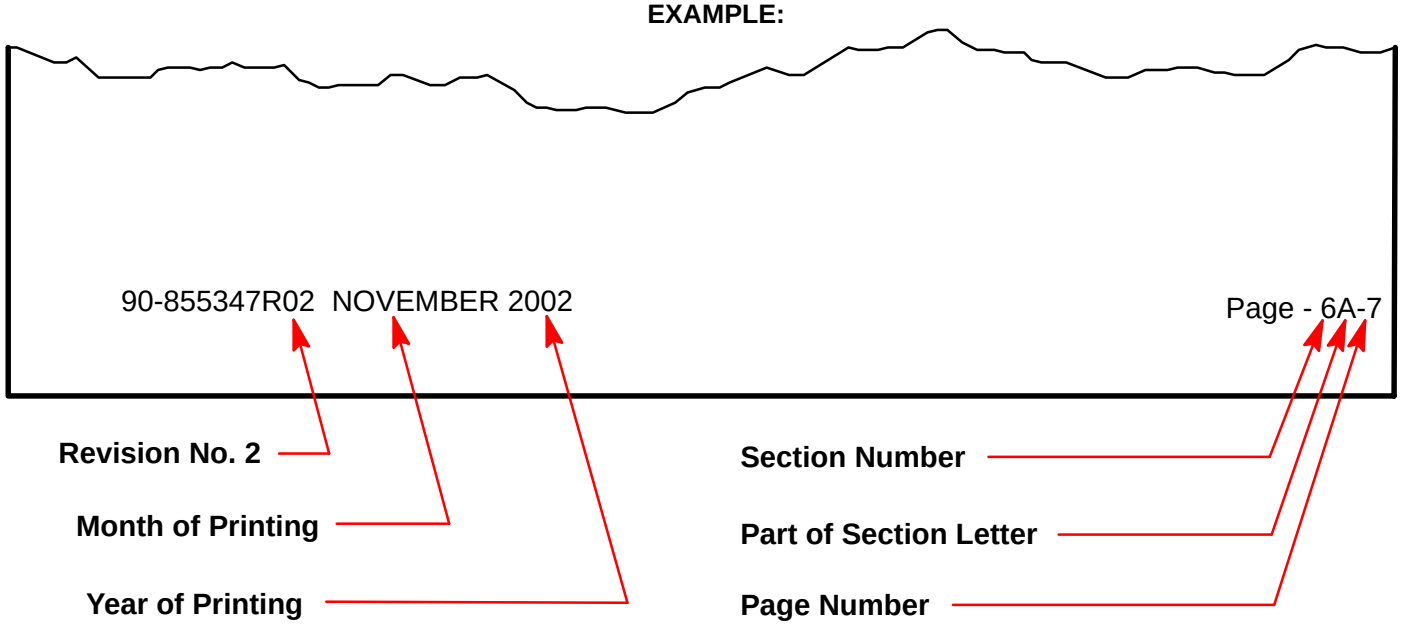
We reserve the right to make changes to this manual without prior notification.

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

Page Numbering

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

EXAMPLE:



Service Manual Outline

Section 1 - General Information & Specifications
- A - Specifications
- B - Maintenance
- C - General Information
- D - Outboard Installation

Section 2 - Electrical
- A - Ignition
- B - Charging & Starting System
- C - Timing, Synchronizing & Adjusting
- D - Wiring Diagrams

Section 3 - Fuel System
- A - Fuel Pump
- B - Direct Fuel Injection
- C - Oil Injection
- D - Emissions

Section 4 - Powerhead
- A - Powerhead
- B - Cooling

Section 5 - Mid-Section
- 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

IMPORTANT INFORMATION

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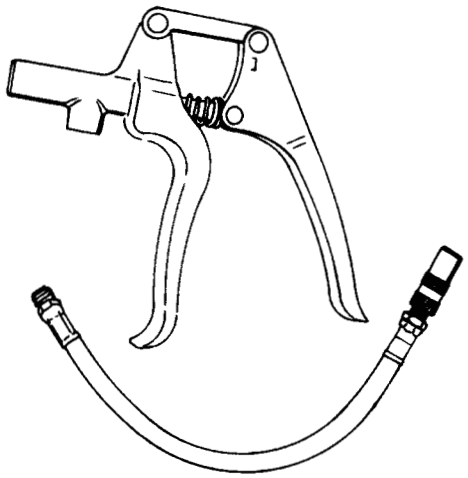
Specifications

Gear Case Lubricant Capacity

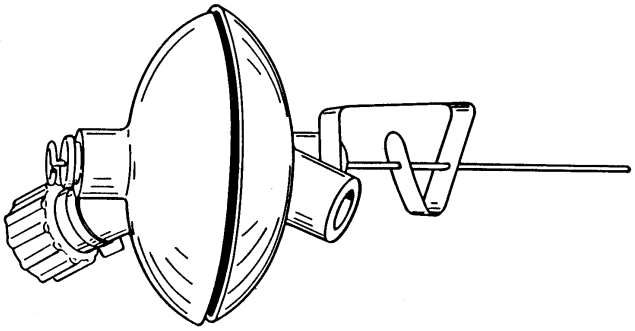
Gear Case Ratio	Capacity
1.87:1	22.5 fl. oz. (665ml)
2.00:1	22.5 fl. oz. (665ml)
2.30:1	22.5 fl. oz. (665ml)

Special Tools

1. Grease Gun 91-37299A1



2. Flushing Attachment 44357Q2



Mercury/Quicksilver Lubricants and Sealants

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

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

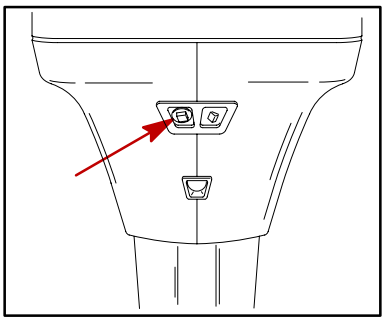
Flushing Engine

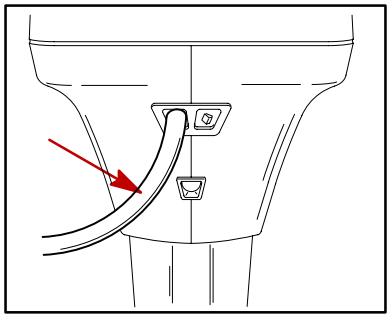
Flushing Cooling System – Using Cowl Flush Plug

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

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

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





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

Flushing Cooling System – Using Flushing Attachment

⚠ WARNING

AVOID POSSIBLE INJURY! When flushing, verify that area in vicinity of propeller is clear and that no person is standing nearby. It is recommended to remove propeller as a precautionary measure.

1. Install Flushing Attachment 44357Q2 (or equivalent tool) onto gear housing from the FRONT side, positioning the rubber cups over the water intake openings.
2. Connect hose [1/2 in. (12.7mm) I.D. or larger] between flushing attachment and water tap.

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

3. With outboard in normal operating position, partially open water tap and adjust water flow so there is significant water loss around rubber cups. It is not necessary to use full water pressure.
4. Start engine and idle in NEUTRAL. Increase engine speed, not to exceed 2500 RPM.
5. Flush or service engine as required. Verify adequate cooling water is provided.
   a. Water must be discharged through tell tale.

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

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

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

Fuel System

⚠ WARNING

AVOID SERIOUS INJURY OR DEATH from gasoline fire or explosion. Carefully follow all fuel system service instructions. Always stop the engine and DO NOT smoke or allow open flames or sparks in the area while servicing any part of the fuel system.

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

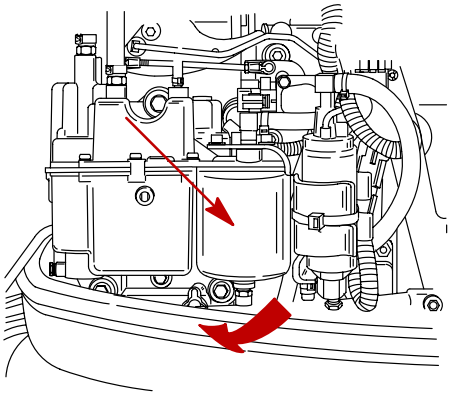
Fuel Line Inspection

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

Water Separating Fuel Filter

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

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

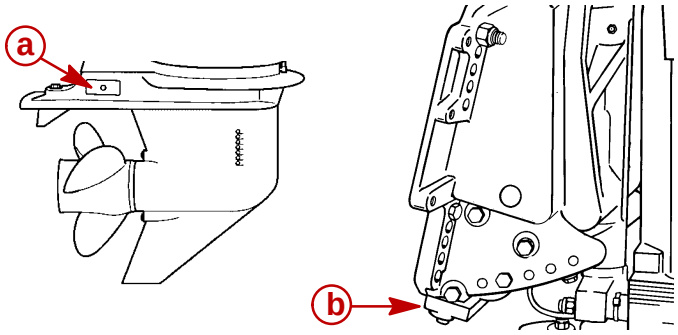


2. Remove and replace filter as follows:
   a. Turn ignition key switch to “OFF” position.
   b. Disconnect wire at bottom of filter.
   c. Remove filter by turning the filter in the direction of the arrow (clockwise). Tip the filter to drain fluid in a suitable container.
   d. Lubricate the sealing ring on the filter with light oil. Thread on the filter and tighten securely by hand. Reconnect the wire to the filter.

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

Corrosion Control Anode

The gearcase 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.

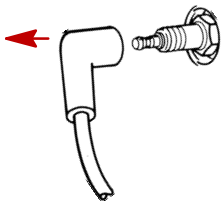


Each anode requires periodic inspection, especially in salt water which will accelerate the erosion. To maintain corrosion protection, always replace the anode before it is completely eroded. Never paint or apply a protective coating on the anode as this will reduce effectiveness of the anode.

Spark Plug Inspection

Inspect spark plugs at the recommended intervals.

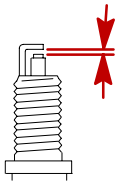
1. Remove the spark plug leads by twisting the rubber boots slightly and pull off. Inspect spark plug boots and replace if cracked.



2. Remove the spark plugs to inspect and clean. Replace spark plug if electrode is worn or the insulator is rough, cracked, broken, blistered or fouled.



3. Set the spark plug gap. See Specification Chart in General Information Section.



4. Before reinstalling spark plugs, clean away dirt on the spark plug seats. Install plugs finger tight, and tighten 1/4 turn or torque to 20 lb. ft. (27 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.

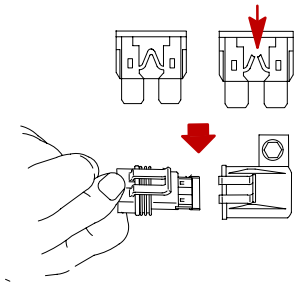
1. Turn off the engine before servicing the battery.
2. Add water as necessary to keep the battery full.
3. Make sure the battery is secure against movement.
4. Battery cable terminals should be clean, tight, and correctly installed. Positive to positive and negative to negative.
5. Make sure the battery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

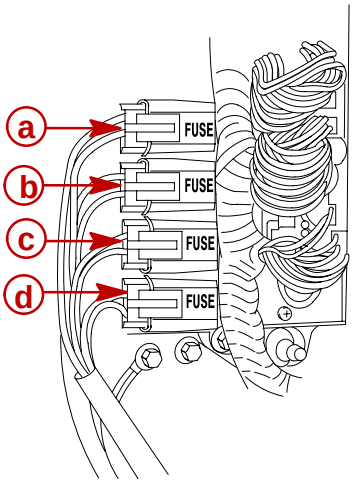
Fuse Replacement

IMPORTANT: Always carry spare SFE 20 AMP fuses.

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

1. Open the fuse holder and look at the silver colored band inside the fuse. If band is broken, replace the fuse. Replace fuse with a new fuse with the same rating.
2. The fuses and circuits are identified as follows:
   a. Electric Fuel Pump Circuit – SFE 20 AMP Fuse.
   b. Fuel/Air Injector Circuits – SFE 20 AMP Fuse.
   c. Starting Circuit – SFE 20 AMP Fuse.
   d. Ignition Coil/Oil Pump Circuit – SFE 20 AMP Fuse.



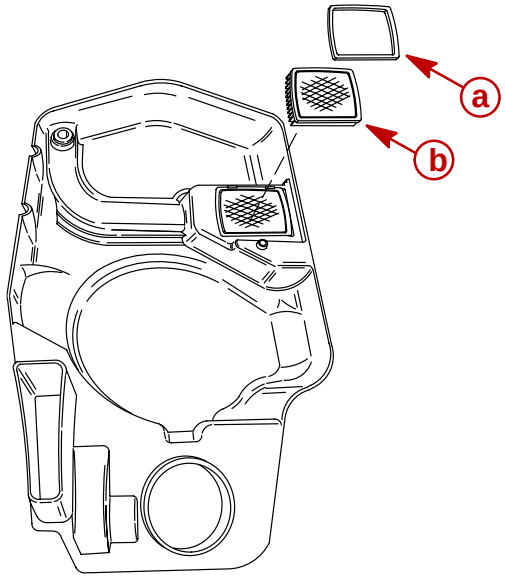


Compressor Air intake Filter

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

Removal

1. Remove flywheel cover from the engine. Snap out the retainer and remove filter.



a - Retainer
b - Filter

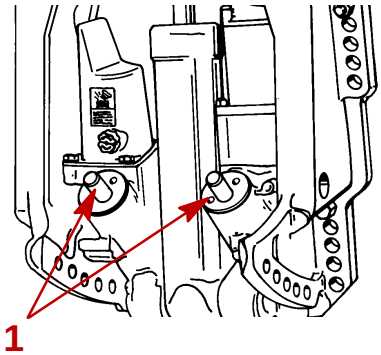
Installation

Install filter into the cover. Secure filter into cover with retainer.

Lubrication Points

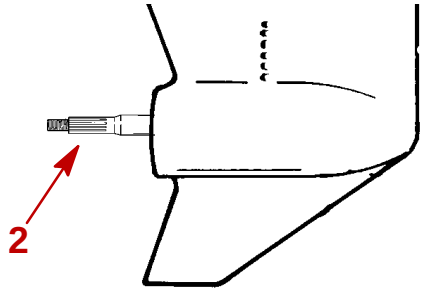
Lubricate Point 1 with Special Lubricant 101.

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



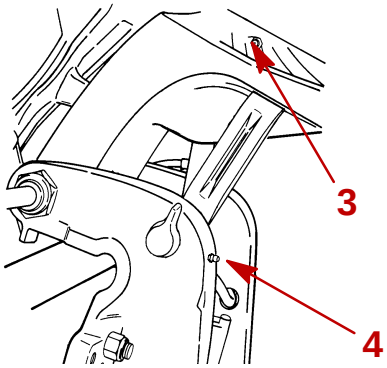
Lubricate Point 2 with Anti-Corrosion Grease or 2-4-C with Teflon.

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.

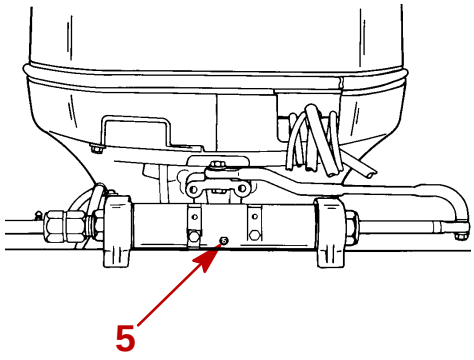


Lubricate Points 3 through 5 with 2-4-C with Teflon or Special Lubricant 101.

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



5. Tilt Tube – Lubricate through fitting.



Lubricate Point 6 with 2-4-C with Teflon or Special Lubricant 101.

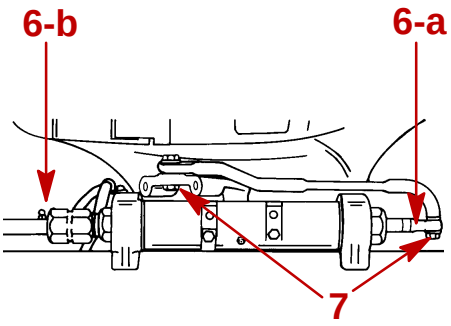
6. Steering Cable Grease Fitting (If Equipped) – Rotate steering wheel to fully retract the steering cable end (a) into the outboard tilt tube. Lubricate through fitting (b).

⚠ WARNING

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

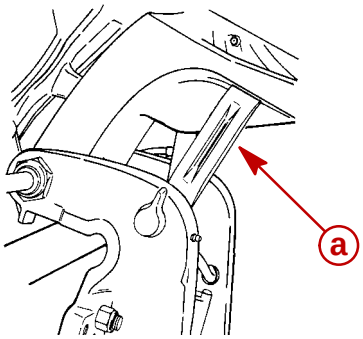
Lubricate Points 7 With Light Weight Oil.

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



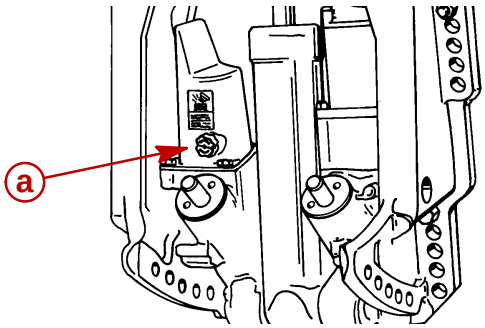
Checking Power Trim Fluid

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



a - Tilt Support Lock

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



a - Fill Cap

Gear Case Lubrication

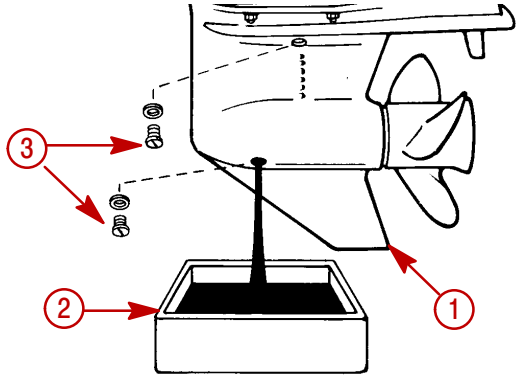
When adding or changing gear case lubricant, visually check for the presence of water in the lubricant. If water is present, it may have settled to the bottom and will drain out prior to the lubricant, or it may be mixed with the lubricant, giving it a milky colored appearance. If water is noticed, have 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.

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

DRAINING GEAR CASE

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

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



GEAR CASE LUBRICANT CAPACITY

Gear case lubricant capacity is approximately 22.5 fl. oz. (666 ml).

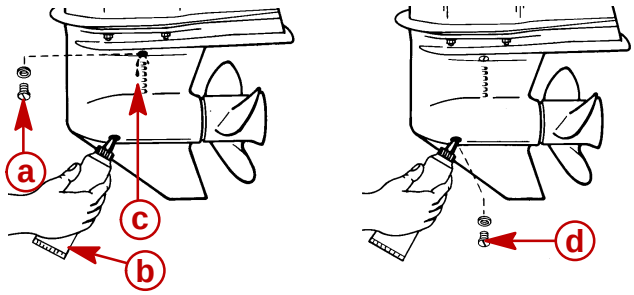
CHECKING GEAR CASE LUBRICANT LEVEL AND REFILLING GEAR CASE

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.
3. Place lubricant tube into the fill hole and add lubricant until it appears at the vent hole.

IMPORTANT: Replace sealing washers if damaged.

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



a - Vent Plug and Sealing Washer
b - Lubricant Tube
c - Vent Hole
d - Fill/Drain Plug and Sealing Washer

Storage Preparation

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

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

⚠ CAUTION

Never start or run your outboard (even momentarily) without water circulating through 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.

OPTION 1

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 Gasoline Stabilizer (follow instructions on container) into fuel tank. Tip fuel tank back and forth to mix stabilizer with the fuel.
2. Permanently Installed Fuel Tank – Pour the required amount of Gasoline Stabilizer (follow instructions on container) into a separate container and mix with approximately one quart (one liter) of gasoline. Pour this mixture into fuel tank.
3. Place the outboard in water or connect flushing attachment for circulating cooling water. Run the engine at 2000 rpm for 25 minutes to allow treated fuel to fill the fuel system.

OPTION 2

1. Remove the water separating fuel filter from engine. Empty the fuel into a suitable container and discard the filter properly.
2. Premix the following in a container:
   8cc (0.27 oz) or 2 teaspoons of Quickleen lubricant.
   8cc (0.27 oz) or 2 teaspoons of Fuel Stabilizer.
3. Pour this mixture in a new water separating fuel filter. Reinstall the fuel filter.
4. Place 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

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.

1
C

IMPORTANT INFORMATION

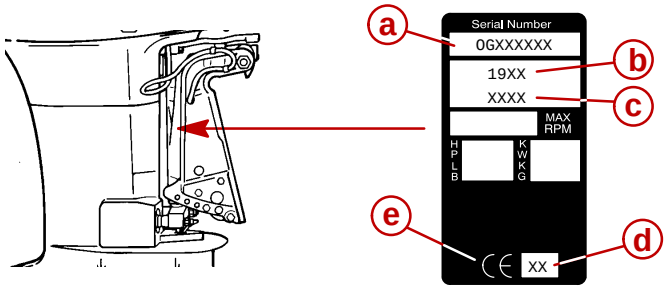
Section 1C - General Information

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Serial Number Location

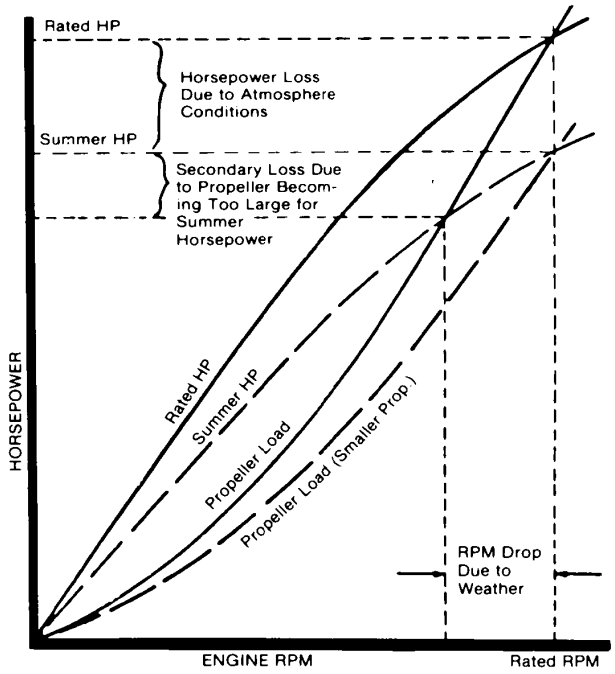
The engine serial number is located on the lower starboard side of the engine block. A serial number is also located on the starboard side of the swivel bracket.



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 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 summer weather and the consequent drop in available horsepower, this propeller will, in effect, become too large. Consequently, the engine operates at less than its recommended RPM.

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

To obtain optimum engine performance under changing weather conditions, the engine MUST be propped to allow it to operate at or near the top end of the recommended maximum RPM range at wide-open-throttle with a normal boat load.

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

Boat

WEIGHT DISTRIBUTION

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

BOTTOM

1. **Boat Bottom:** For maximum speed, a boat bottom should be nearly a flat plane where it contacts the water and particularly straight and smooth in fore-and-aft direction.
   a. **Hook:** Exists when bottom is concave in fore-and-aft direction when viewed from the side. When boat is planing, hook causes more lift on bottom near transom and allows bow to drop, thus greatly increasing wetted surface and reducing boat speed. Hook frequently is caused by supporting boat too far ahead of transom while hauling on a trailer or during storage.
   b. **Rocker:** The reverse of hook and much less common. Rocker exists if bottom is convex in fore-and-aft direction when viewed from the side, and boat has strong tendency to porpoise.
   c. **Surface Roughness:** Moss, barnacles, etc., on boat or corrosion of motor's gear housing increase skin friction and cause speed loss. Clean surfaces when necessary.
   d. **Gear Housing:** If unit is left in the water, marine vegetation may accumulate over a period of time. This growth MUST be removed from unit before operation, as it may clog the water inlet holes in the gear housing and cause the engine to overheat.

Trim

TRIMMING OUTBOARD OUT (UP)

⚠ WARNING

Excessive trim out may reduce the stability of some high speed hulls. To correct instability at high speed, reduce power GRADUALLY and trim outboard in slightly before resuming high speed operation. Rapid reduction in power will cause a sudden change of steering torque and may cause additional momentary boat instability.

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

TRIMMING OUTBOARD IN (DOWN)

⚠ 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 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 from a sharp edge or angle on the gearcase, 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 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.

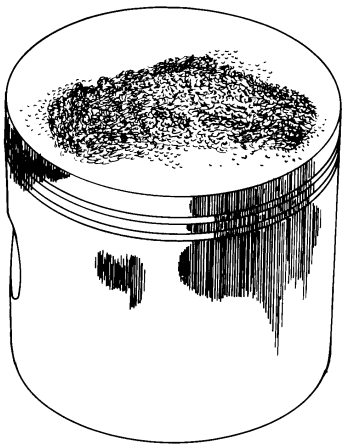
Detonation is an explosion of an unburned portion of the fuel/air charge after the spark plug has fired. Detonation creates severe shock waves in the engine, and these shock waves often find or create a weakness: The dome of a piston, cylinder head/gasket, piston rings or piston ring lands, piston pin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



51115

Engine Compression

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

Following Complete Submersion

Salt Water Submersion

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

Submerged While Running

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

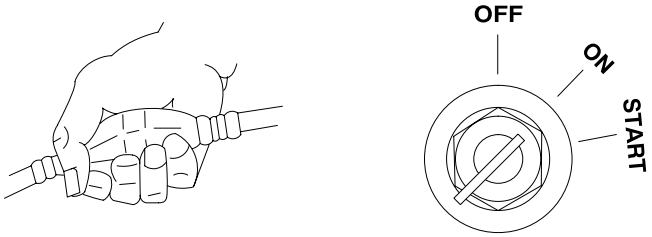
SUBMERGED ENGINE (FRESH WATER)

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

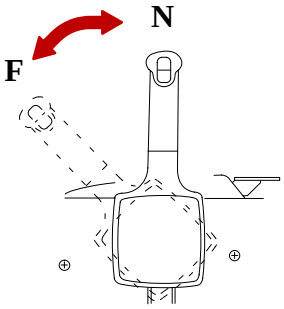
NOTE: *If sand has entered the air intake on the engine, DO NOT attempt to the start the engine. Sand will cause internal engine damage. disassembly is required to clean all internal engine components of sand.*

1. Recover engine from water as quickly as possible.
2. Remove cowling.
3. Clean the exterior of the outboard with fresh water.
4. Dry all wiring and electrical components using compressed air.
5. Drain water from fuel system as follows:
   a. Disconnect remote fuel hose from engine.
   b. Remove drain plug from vapor separator and drain fuel/water. Reinstall plug after draining.
   c. Remove fuel hose from bottom of port side fuel rail and drain fuel/water. Reinstall hose.
   d. Remove the water separating fuel filter and empty contents.
6. Drain water from air compressor system as follows:
   a. Dry or replace the air filter for the compressor.
   b. Remove air outlet hose for the air compressor and drain water from compressor and hose. Reinstall hose.
   c. Remove the air hose from bottom of port side fuel rail and drain water. Reinstall hose.

7. Drain water from engine as follows:
   a. Remove air sensor from front of air plenum. Tilt outboard up and drain water out of the air plenum through the air sensor mounting hole. Reinstall sensor.
   b. Remove spark plugs from engine.
   c. Rotate flywheel manually to blow out any water from the cylinders.
   d. Add approximately one ounce (30ml) of engine oil into each spark plug hole. Rotate the flywheel manually several times to distribute the oil in the cylinders. Reinstall spark plugs.
8. Drain water from the oil injection system as follows:
   a. Remove remote oil hose (BLACK without BLUE stripe) from pulse fitting on starboard side of engine.
   b. Drain any water from hose and reconnect.
   c. If water was present in hose, check for water in the remote oil tank. Drain tank if water is present.
9. Disassemble the engine starter motor and dry components.
10. Prime the oil injection pump as follows:
    a. Fill the engine fuel system with fuel. Connect fuel hose and squeeze primer bulb until it feels firm.
    b. Turn the ignition key switch to the “ON” position.



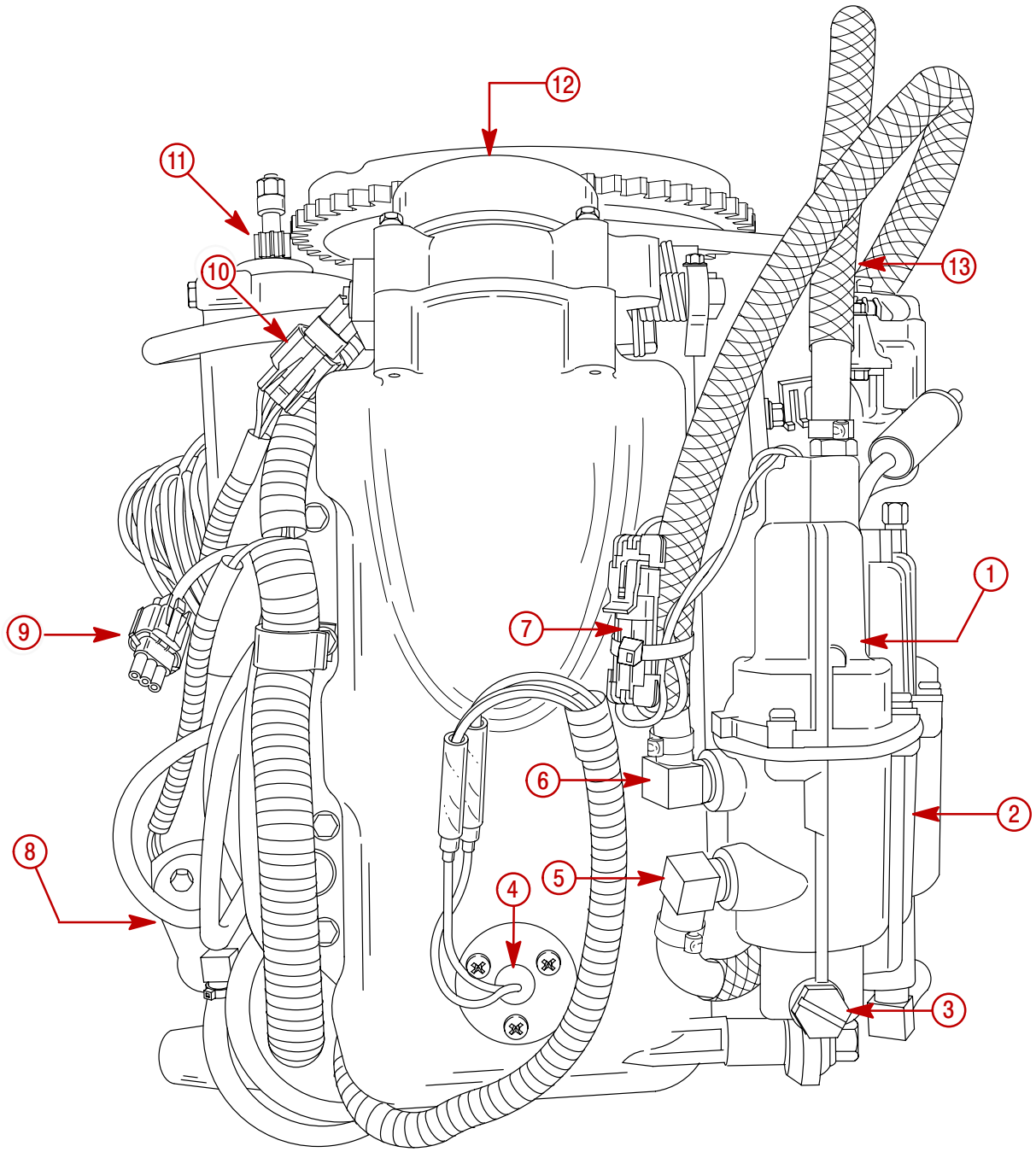
    c. Within the first 10 seconds after the key switch has been turned on, move the remote control handle from NEUTRAL (“N”) into FORWARD (“F”) gear 3 to 5 times. This will automatically start the priming process.



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

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

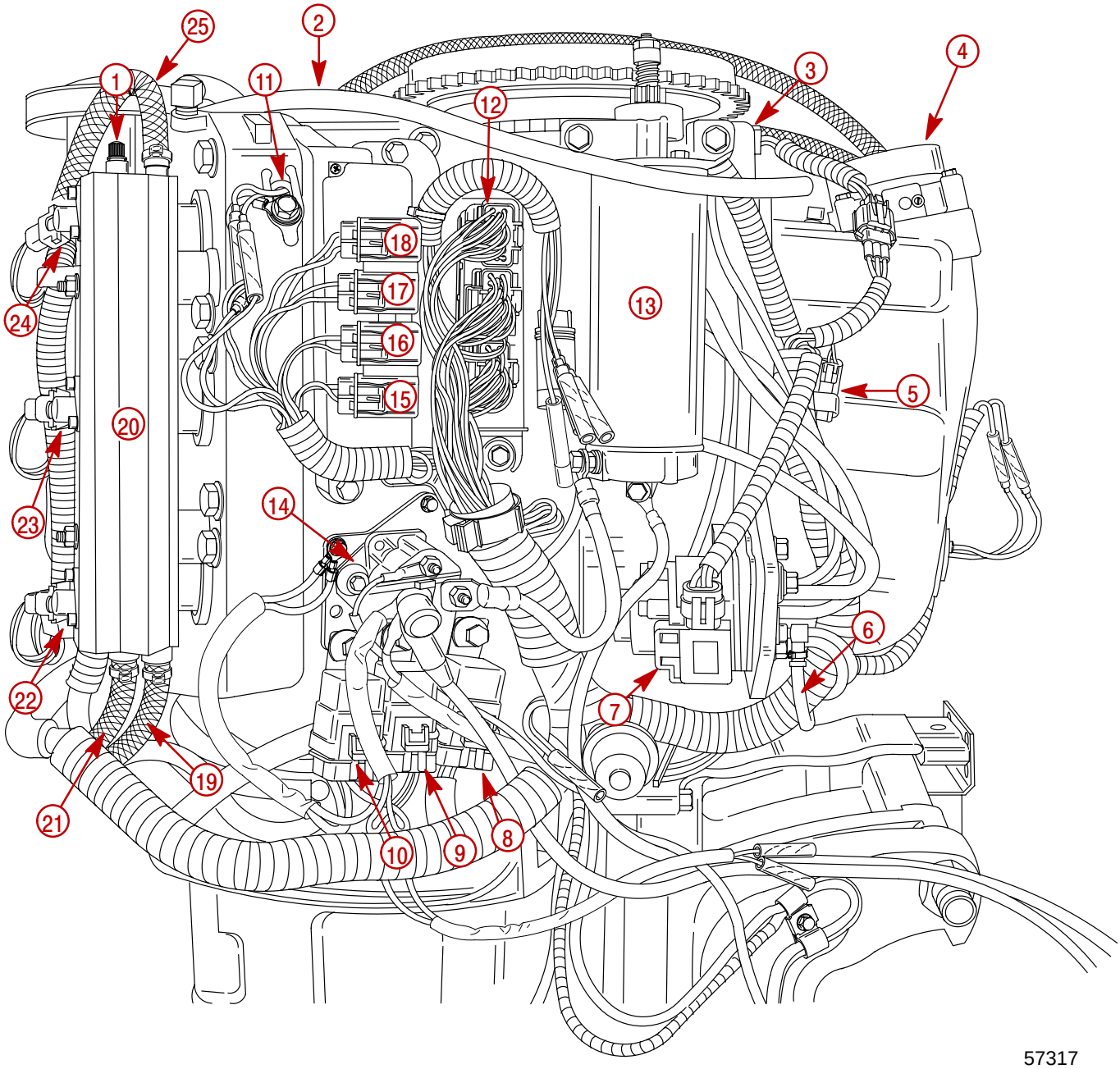
Model 135/150 DFI Powerhead Front View



57314

1 - High Pressure Electric Fuel Pump (Inside Vapor Separator)
2 - Vapor Separator
3 - Vapor Separator Drain Plug
4 - Air Temperature Sensor
5 - Fuel Hose Outlet from Low Pressure Electric Fuel Pump
6 - Fuel Return Hose from Fuel Cooler
7 - Electric Fuel Pump Harness Connection
8 - Electric Oil Pump (Hidden)
9 - Digital Diagnostic Terminal Harness Connection
10 - Crank Position Sensor Harness Connection
11 - Starter Motor
12 - Throttle Plate Assembly
13 - Fuel Hose Out to Fuel Rails (High Pressure)

Model 135/150 DFI Powerhead Starboard View

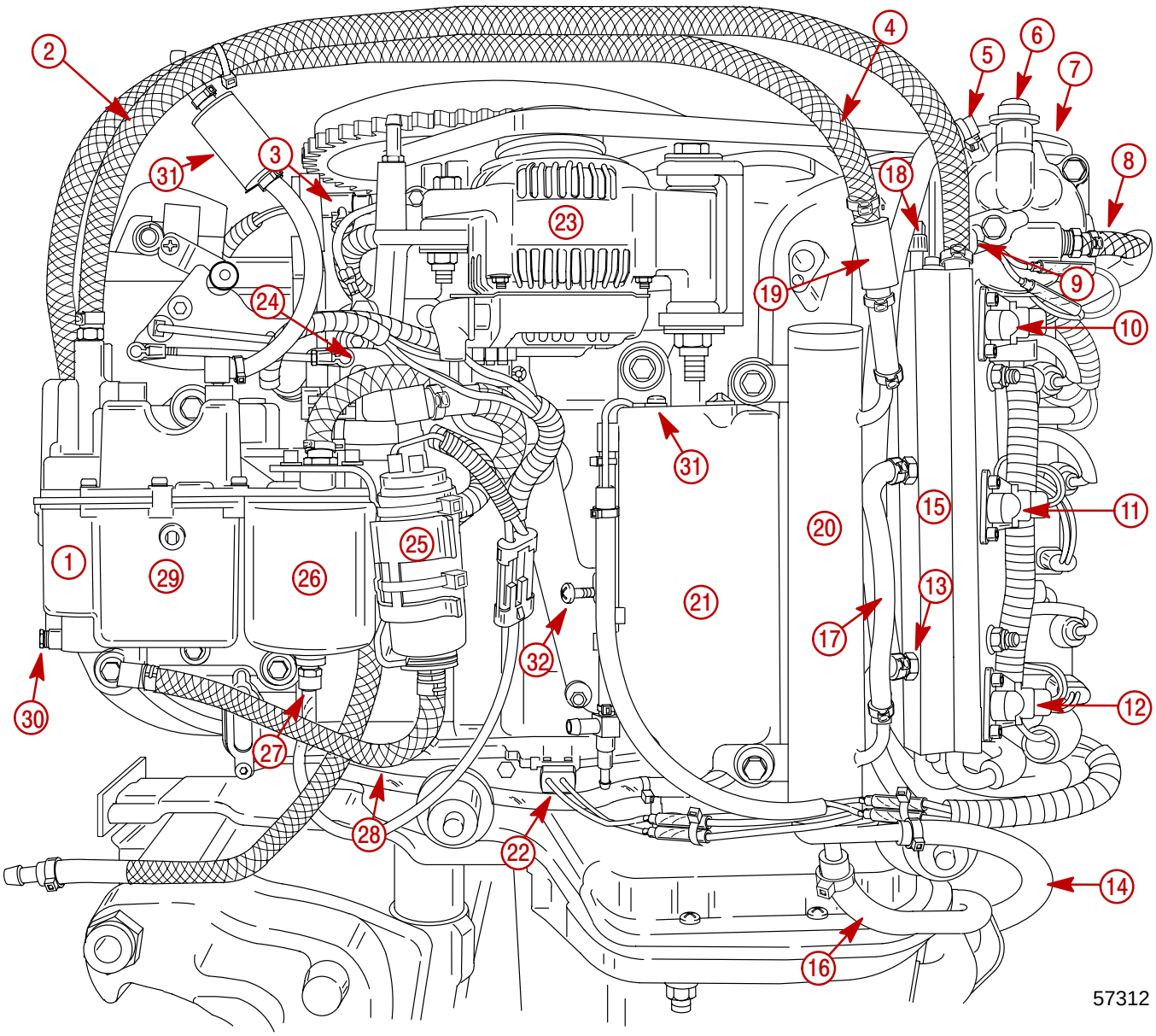


57317

1 - Fuel Pressure Test Valve
2 - Air Compressor Oil Return Line
3 - Crank Position Sensor
4 - Throttle Plate/Air Plenum Assembly
5 - Digital Diagnostic Terminal Connector
6 - Oil Hose from Oil Reservoir to Oil Pump
7 - Oil Pump
8 - Main Power Relay(1998 Model)*
9 - Trim DOWN Relay
10 - Trim UP Relay (1998 Model)*
11 - Temperature Sensor
12 - Electronic Control Module
13 - Starter Motor
14 - Starter Solenoid
15 - Oil Pump Fuse
16 - Harness Fuse (20 Ampere)
17 - ECM Fuse (20 Ampere)
18 - Electric Fuel Pump Fuse (20 Ampere)
19 - Air Hose
20 - Starboard Fuel Rail
21 - Fuel Hose
22 - #5 Fuel Injector
23 - #3 Fuel Injector
24 - #1 Fuel Injector
25 - Air Hose from Air Compressor

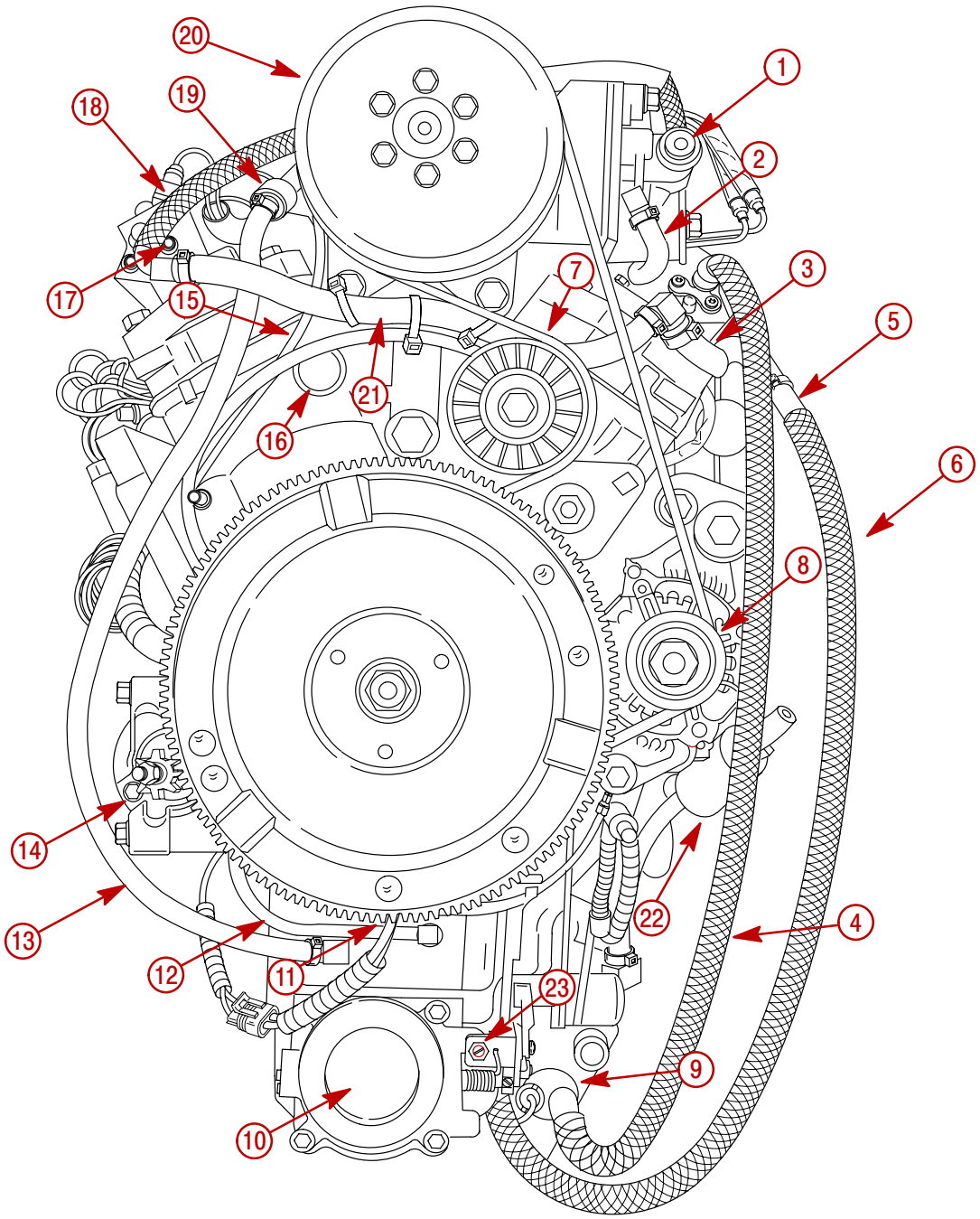
NOTE: **The location for 1999 Model Main Power Relay and Trim UP Relay are reversed.*

Model 135/150 DFI Powerhead Port View



1 - High Pressure Electric Fuel Pump
2 - Fuel Out (90 psi)
3 - Crank Position Sensor
4 - Fuel Return from Fuel Cooler
5 - Water Out (tell-tale) from Air Compressor
6 - Air Restrictor/Air Inlet to Air Compressor
7 - Air Compressor
8 - Air Pressure Out from Air Compressor
9 - Temperature Sensor (Air Compressor)
10 - #2 Fuel Injector
11 - #4 Fuel Injector
12 - #6 Fuel Injector
13 - Excess Air to Adaptor Plate
14 - Water Inlet to Fuel Cooler from Adaptor Plate
15 - Port Fuel Rail
16 - Water Out to Poppet Valve
17 - Excess Fuel Return to Fuel Cooler
18 - Air Pressure Test Port
19 - 40 psi Check Valve
20 - Fuel Cooler
21 - Oil Reservoir
22 - Neutral Shift Interrupt Switch
23 - 60 Ampere Alternator
24 - Throttle Position Sensor (2 each)
25 - Low Pressure Electric Fuel Pump
26 - Fuel/Water Separator
27 - Fuel/Water Sensor
28 - Low Pressure Fuel Pump Inlet Hose
29 - Vapor Separator
30 - Vapor Separator Drain Plug
31 - Vent Canister
32 - Idle Stop Screw

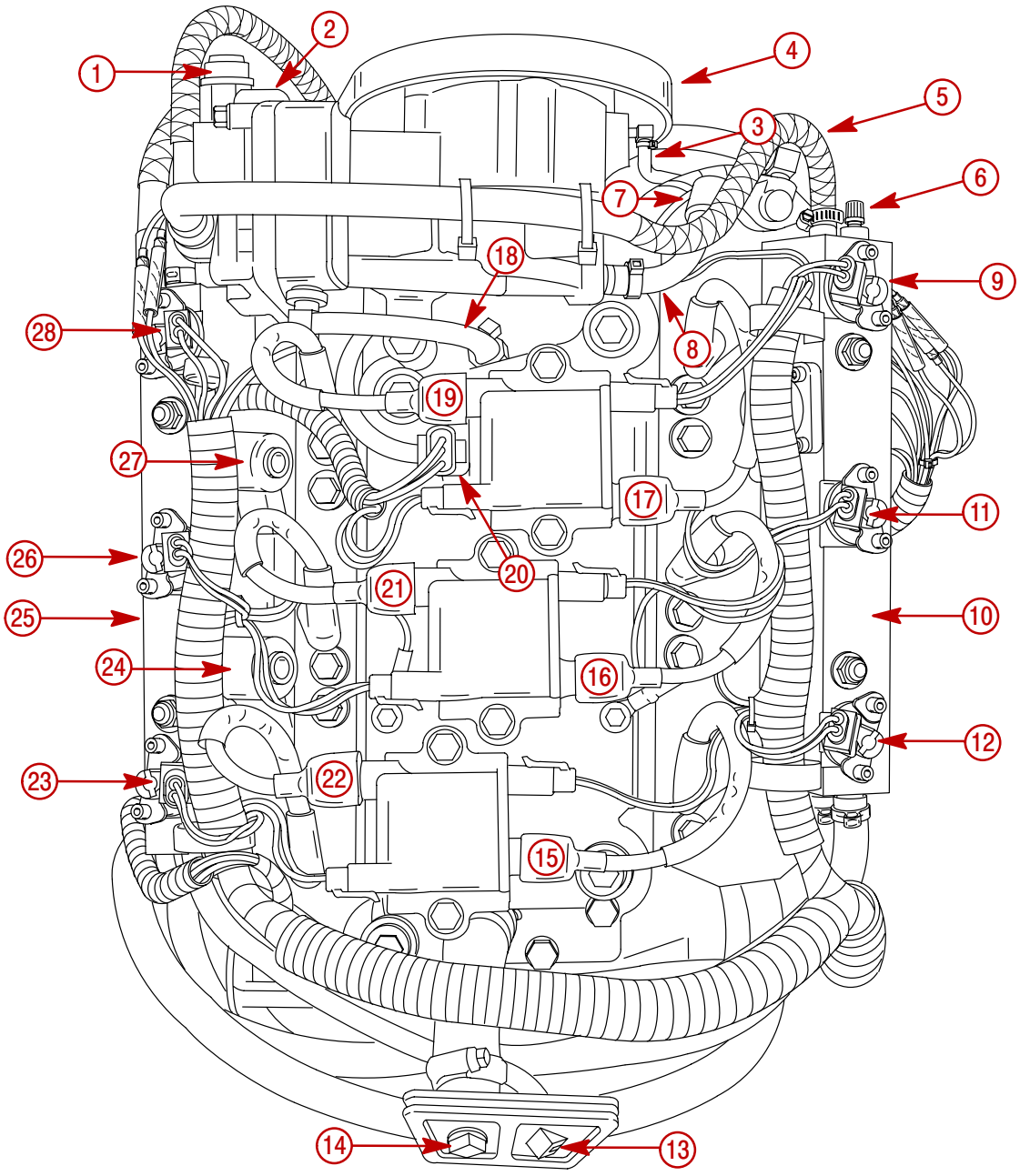
Model 135/150 DFI Powerhead Top View



57313

1 - Air Compressor Inlet Nozzle
2 - Water Outlet (Tell-Tale) Hose
3 - Thermostat Outlet Hose to Adaptor Plate
4 - Fuel (90 PSI) to Fuel Rails
5 - 40 psi Check Valve
6 - Fuel Return to Vapor Separator
7 - Belt Tensioner
8 - 60 Ampere Alternator
9 - Electric Fuel Pump
10 - Throttle Plate Assembly
11 - Crank Position Sensor
12 - MAP Sensor Hose
13 - Oil Return Hose from Air Compressor
14 - Starter Motor
15 - Oil Hose from Oil Pump to Air Compressor
16 - Serial Number Plug
17 - Fuel Pressure Test Valve
18 - Air Hose (80 PSI) to Fuel Rail
19 - Check Valve
20 - Air Compressor
21 - Starboard to Port Thermostat Hose
22 - Vent Canister
23 - Throttle Plate Adjustment Screw

Model 135/150 DFI Powerhead Aft View



57315

1 - Air Compressor Restrictor/Air Inlet
2 - Water Out (tell-tale) from Air Compressor
3 - Air Compressor Oil Inlet from Oil Pump
4 - Air Compressor
5 - Air Pressure Out (80 psi)
6 - Fuel Pressure Test Valve
7 - Check Valve
8 - Excess Oil Return from Air Compressor
9 - #1 Fuel Injector
10 - Starboard Fuel Rail
11 - #3 Fuel Injector
12 - #5 Fuel Injector
13 - Tell-Tale Outlet
14 - Flush Plug
15 - #5 Ignition Coil
16 - #3 Ignition Coil
17 - #1 Ignition Coil
18 - Water Inlet to Air Compressor
19 - #2 Ignition Coil
20 - MAP Sensor
21 - #4 Ignition Coil
22 - #6 Ignition Coil
23 - #6 Fuel Injector
24 - Air Regulator
25 - Port Fuel Rail
26 - #4 Fuel Injector
27 - Fuel Regulator
28 - #2 Fuel Injector

Painting Procedures

Cleaning & Painting Aluminum Propellers & Gear Housings

⚠ WARNING

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

PROPELLERS

1. Sand the entire area to be painted with 3M 120 Regalite Polycut or coarse Scotch-Brite, disc or belts.
2. Feather edges of all broken paint edges. Try not to sand through the primer.
3. Clean the surface to be painted using PPG Industries DX330 Wax and Grease Remover or equivalent (Xylene or M.E.K.).
4. If bare metal has been exposed, use 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 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 Gray, 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 $^{1}/_{2}$ 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

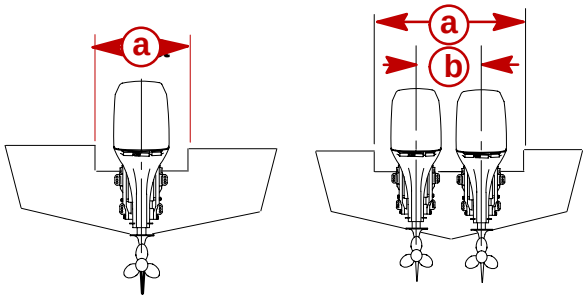
Section 1D - Outboard Motor Installation

1 D

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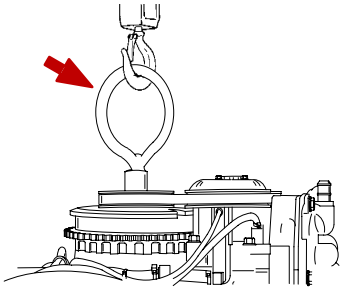
Installation Specifications



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

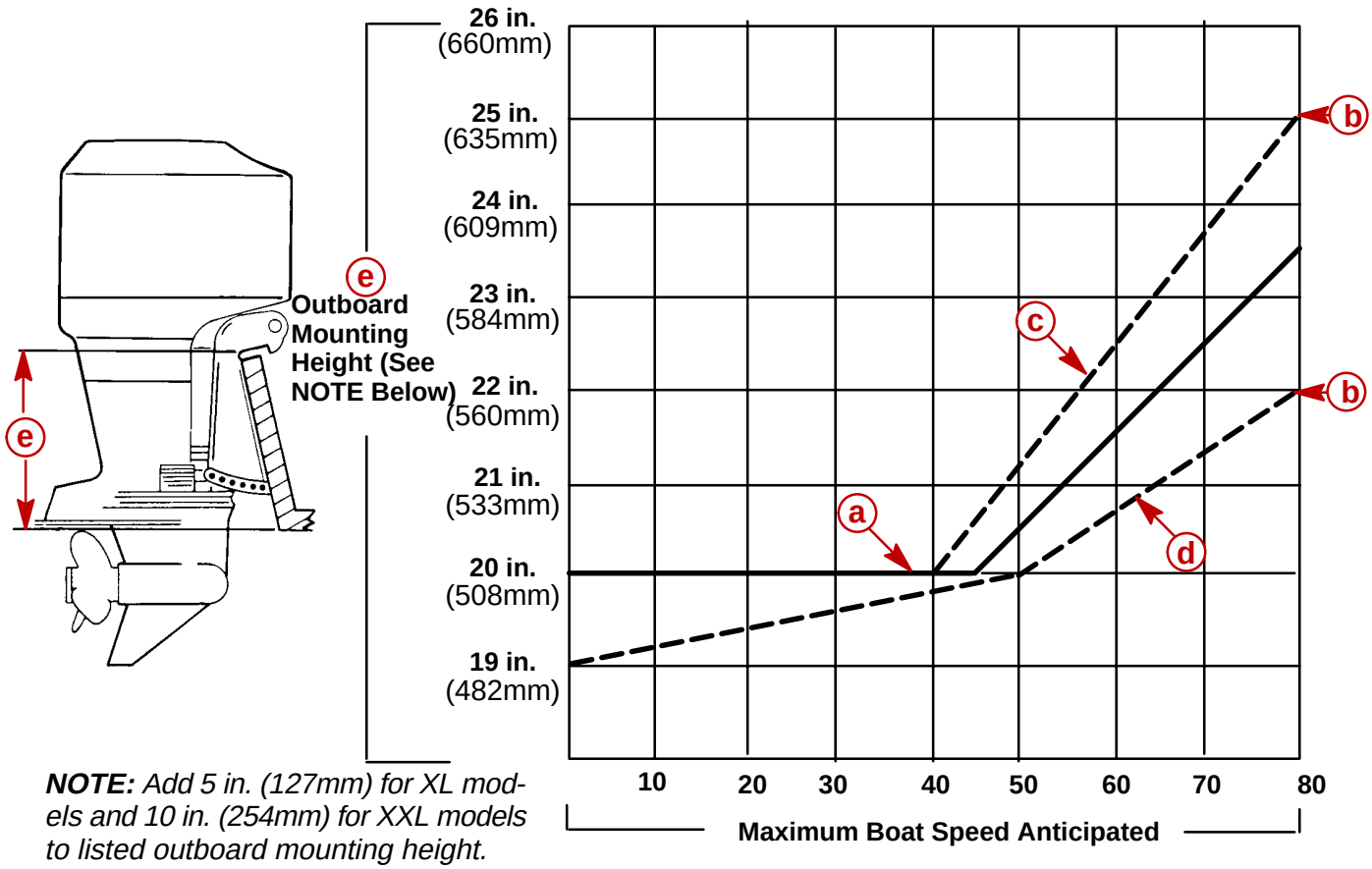
Lifting Outboard

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



Installing Outboard to Boat Transom

Determining Recommended Outboard Mounting Height



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

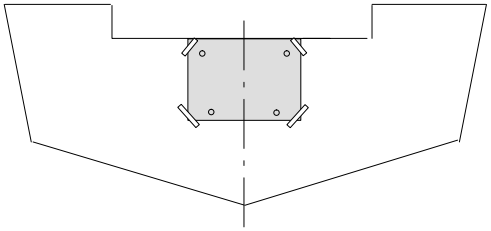
NOTICE TO INSTALLER:

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

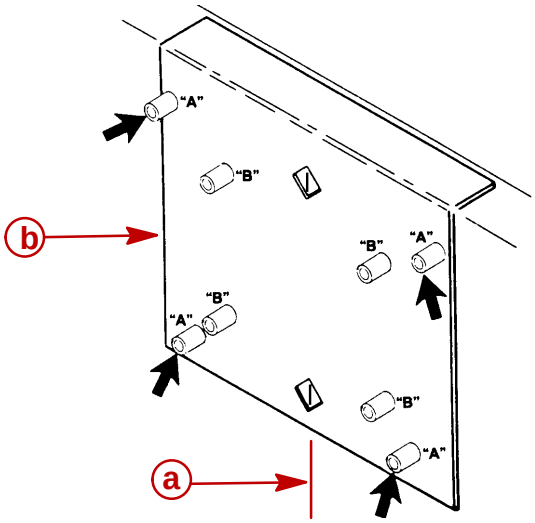
Installing Outboard

Drilling Outboard Mounting Holes

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

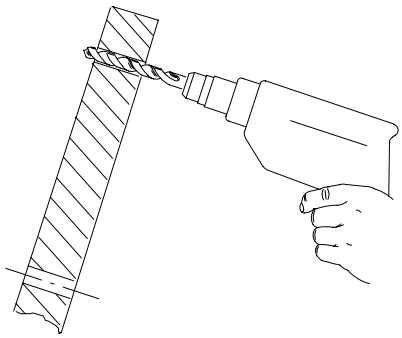


IMPORTANT: If using Transom Drilling Fixture, use drill guide holes marked “A” when drilling outboard mounting holes.



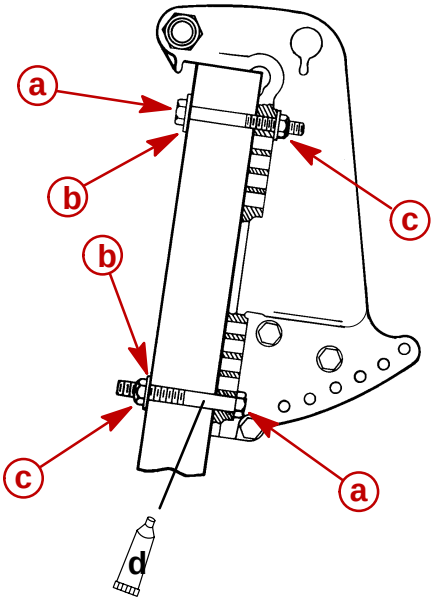
a - Centerline of Transom
b - Transom Drilling Fixture (91-98234A2)

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.

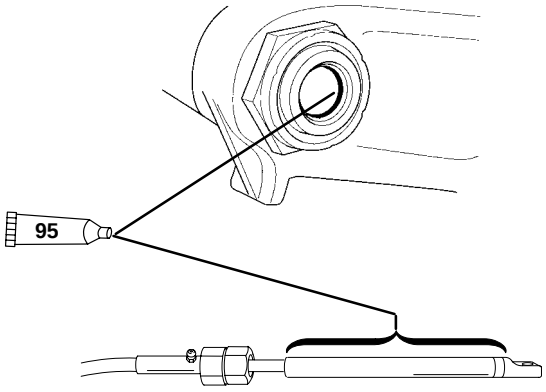


a - 1/2 In. Diameter Bolts (4)
b - Flat Washers (4)
c - Locknuts (4)
d - Marine Sealer - Apply to Shanks of Bolts, Not Threads

Steering Cable

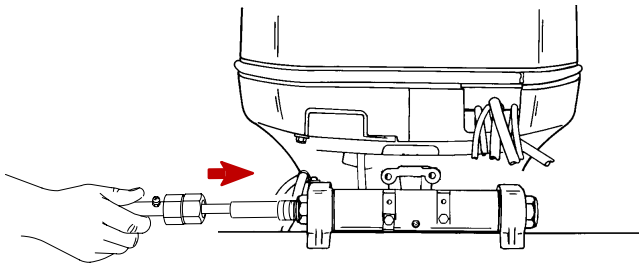
STARBOARD SIDE ROUTED CABLE

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

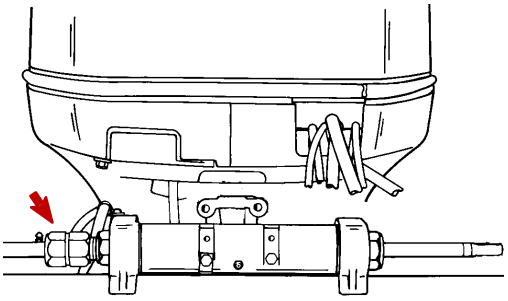


95 2-4-C with Teflon

2. Insert steering cable into tilt tube.

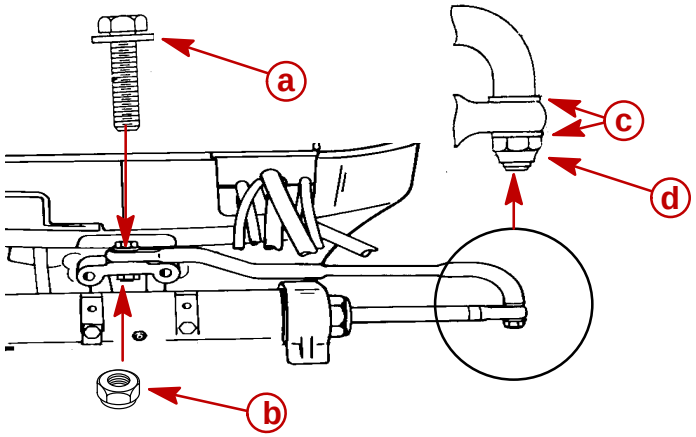


3. Torque nut to 35 lb. ft. (47.5 Nm).



Steering Link Rod

1. Install steering link rod per illustration.



a - Special Bolt (10-856680) Torque to 20 lb-ft (27 Nm)
b - Nylon Insert Locknut (11-34863) Torque to 20 lb-ft (27 Nm)
c - Flat Washer (2)
d - Nylon Insert Locknut (11-34863) Tighten Locknut Until it Seats, Then Back Nut Off 1/4 Turn

IMPORTANT: The steering link rod that connects the steering cable to the engine must be fastened using special washer head bolt ("a" – Part Number 10-849838) and self locking nuts ("b" & "d" – Part Number 11-34863). These locknuts must never be replaced with common nuts (non locking) as they will work loose and vibrate off freeing the link rod to disengage.

⚠ WARNING

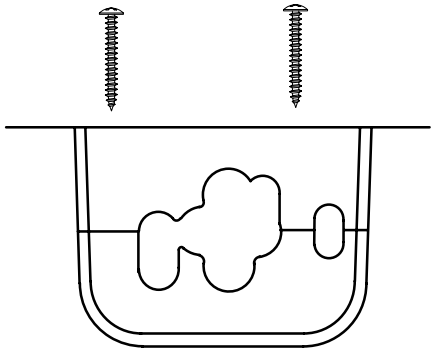
Disengagement of a steering link rod can result in the boat taking a full, sudden, sharp turn. This potentially violent action can cause occupants to be thrown overboard exposing them to serious injury or death.

Electrical, Hoses and Control Cables

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

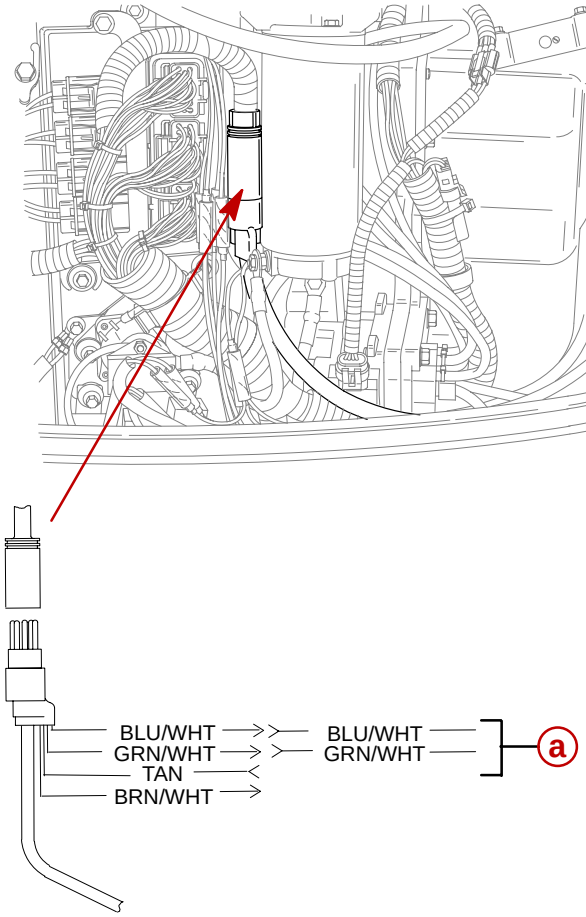
Installation Note

Open the front clamp assembly.



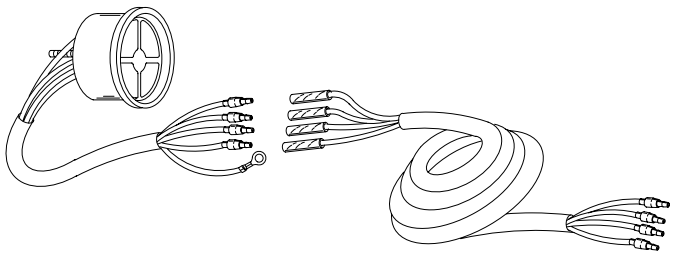
Remote Wiring Harness

1. Connect wiring. Place harness into the holder.

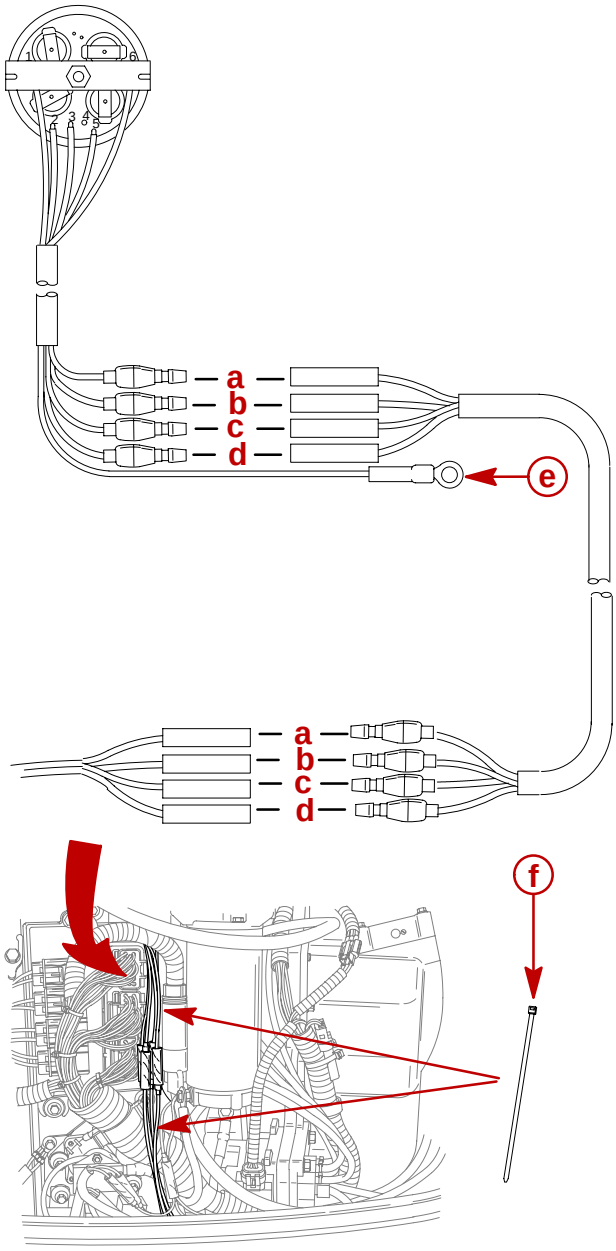


a - Power Trim Connections

Warning Gauge Harness



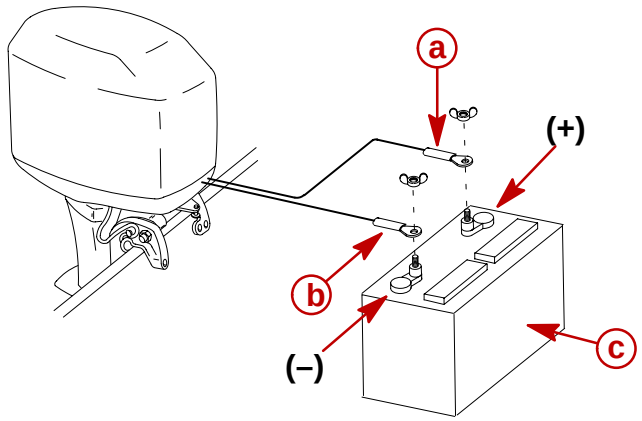
Connect the harness extension to gauge and engine.



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

Battery Cables

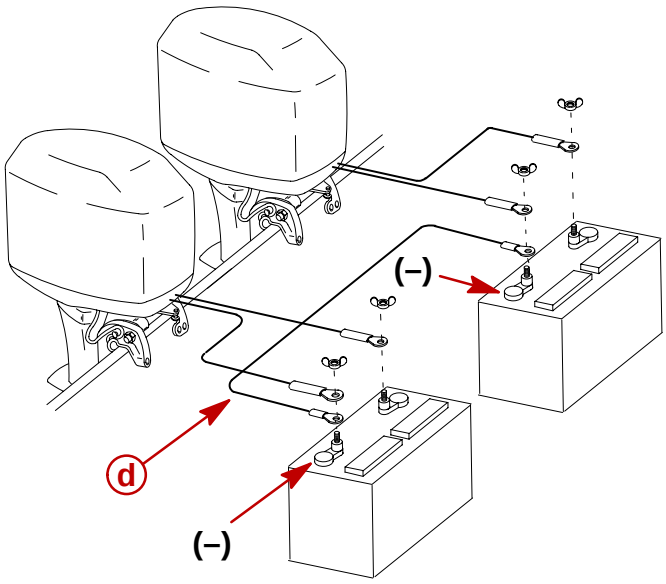
Single Outboard



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

Dual Outboard

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



d - Common Ground Cable

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.

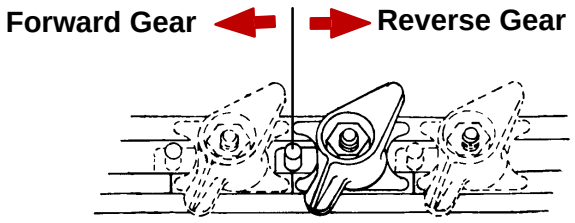
The Dual Engine Console Mount Control, (88688A22 or 88688A52), is required to shift the counter rotation outboard. The installation instructions shipped with the control explain the procedure required to connect this control to a counter rotation outboard.

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.

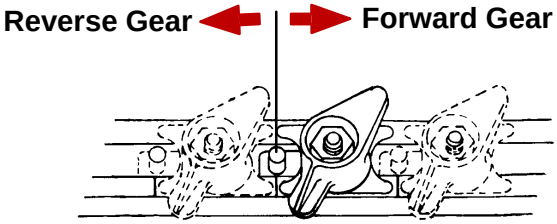
OUTBOARD SHIFTING DIRECTION

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

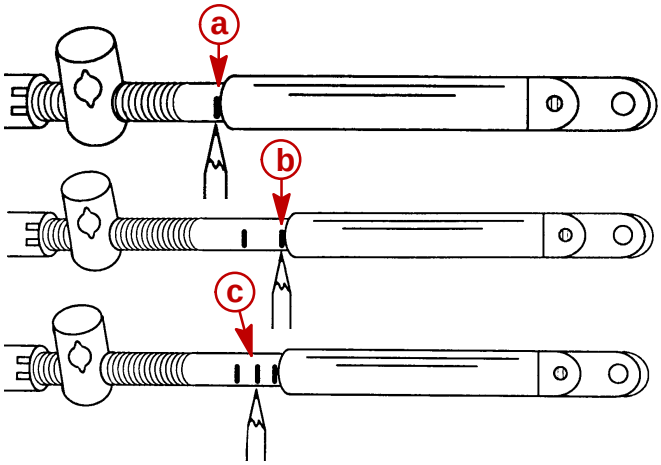


Installation

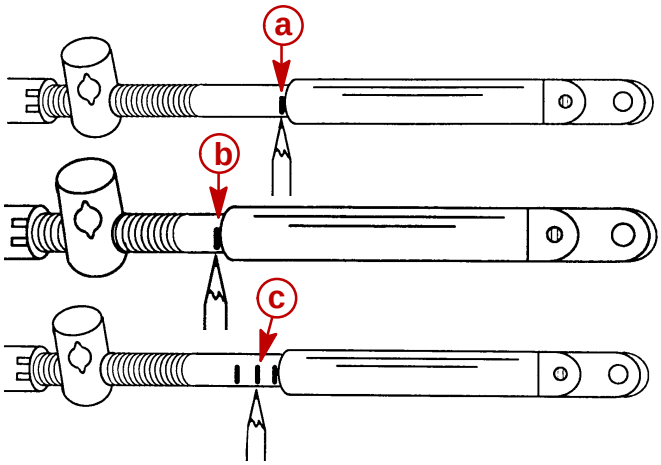
IMPORTANT: Step 1 must be followed for proper adjustment of the shift cable.

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.

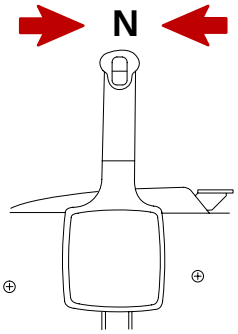
STANDARD ROTATION OUTBOARDS



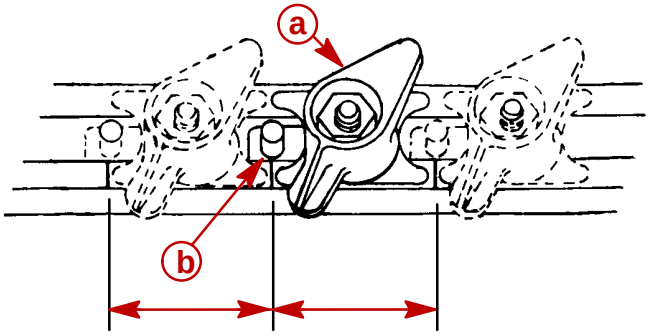
COUNTER ROTATION OUTBOARDS



2. Position remote control and outboard into neutral.

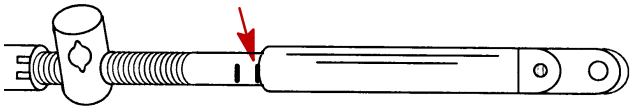


3. Slide the shift cable retainer forward until resistance is felt, then slide cable anchor toward rear until resistance is felt. Center the anchor pin between resistance points.

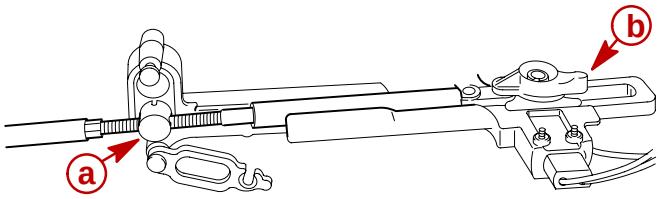


a - Shift Cable Retainer
b - Anchor Pin

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



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



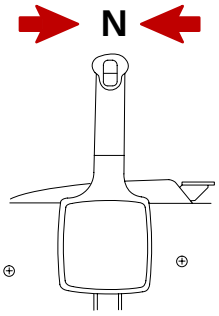
a - Cable Barrel
b - Shift Cable Retainer

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

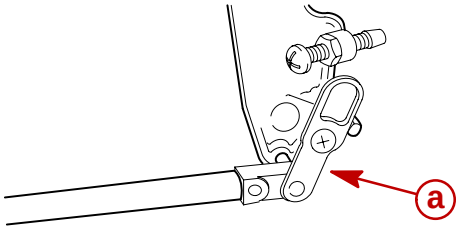
Throttle Cable

INSTALLATION

1. Position remote control into neutral.

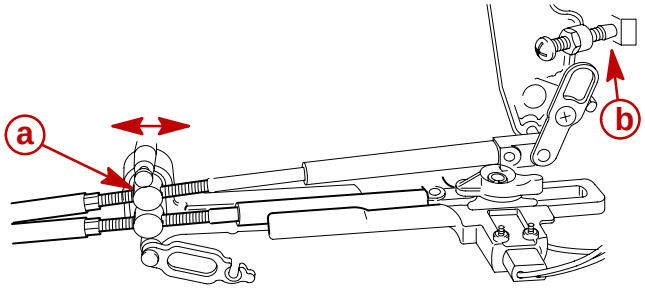


2. Attach throttle cable to the throttle lever. Secure with latch.



a - Latch

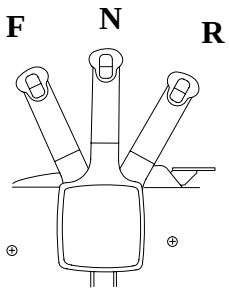
3. Adjust the cable barrel so that the installed throttle cable will hold the idle adjustment screw against the stop.



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

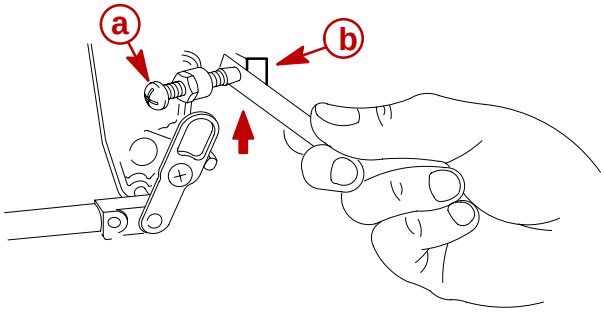
4. Check throttle cable adjustment as follows:

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



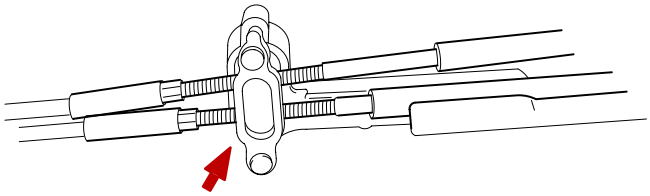
   b. Return remote control to neutral. Place a thin piece of paper between idle adjustment screw and idle stop. Adjustment is correct when the paper can be removed without tearing, but has some drag on it. Readjust cable barrel if necessary.

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



a - Idle Adjustment Screw
b - Idle Stop

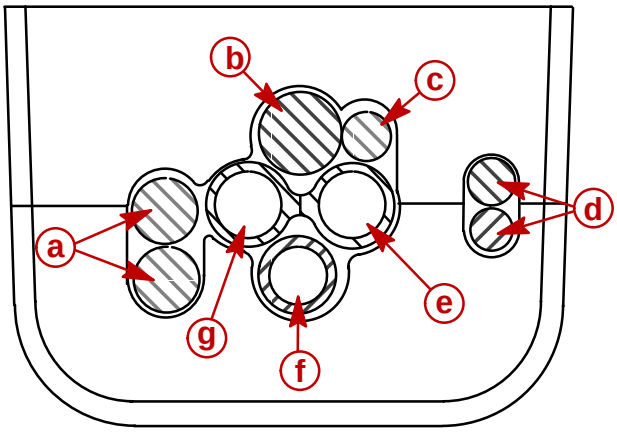
5. Lock the barrel holder in place with the cable latch.



Front Clamp Reassembly

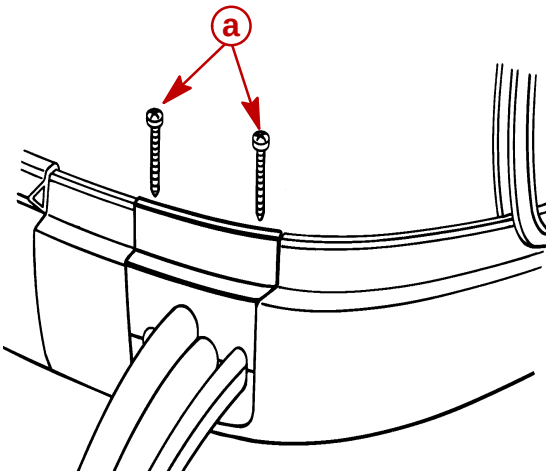
IMPORTANT: Sufficient slack must exist in engine wiring harness, battery cables, fuel hose, and oil hoses routed between clamp and engine attachment point, to relieve stress and prevent hoses from being kinked or pinched.

1. Place the clamp over the wiring, hoses, and control cables as shown.



a - Battery Cables
b - Remote Wiring Harness
c - Warning Gauge Wiring Harness
d - Control Cables
e - Oil Hose with Blue Stripe
f - Fuel Hose
g - Oil Hose

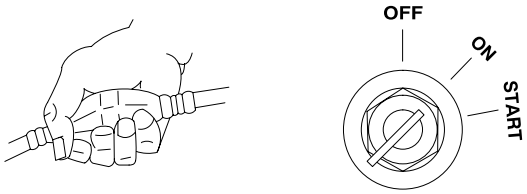
2. Fasten clamp together with two screws.



a - Screws

Filling Fuel System

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

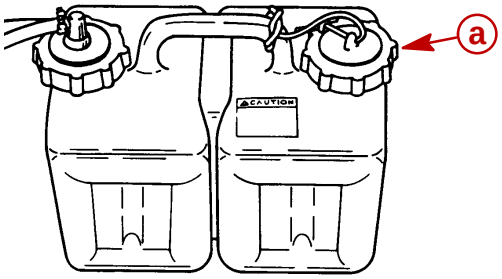


- *Squeeze the fuel line primer bulb until it feels firm.*
- *Turn the ignition key switch to the ON position for three seconds. This operates the electric fuel pump.*
- *Turn the ignition key switch back to the OFF position, and squeeze the primer bulb again until it feels firm. Turn the ignition key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

Oil Injection Set-Up

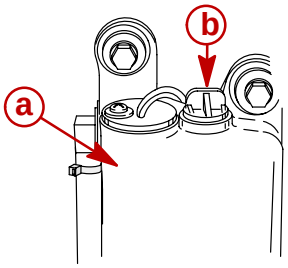
Filling

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



a - Fill Cap

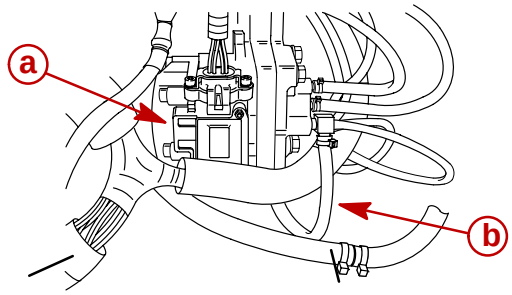
2. Remove cap and fill engine oil tank with oil. Reinstall the fill cap.



a - Engine Oil Tank
b - Fill Cap

Priming the Oil Injection Pump

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



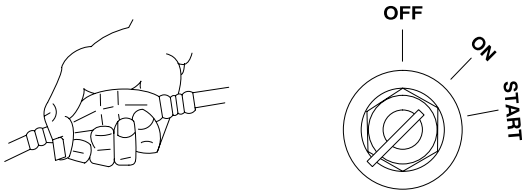
a - Oil Injection Pump
b - Oil Supply Hose

⚠ CAUTION

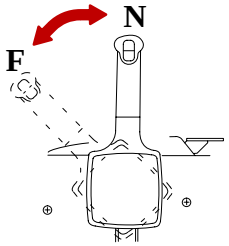
To prevent damage to the fuel pumps, fill the engine fuel system with fuel. Otherwise the fuel pumps will run without fuel during the priming process.

Prime the oil injection pump as follows:

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



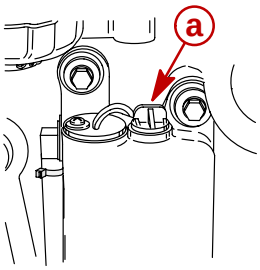
3. Within the first 10 seconds after the key switch has been turned on, move the remote control handle from neutral into forward gear 3 to 5 times. This will automatically start the priming process.



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

Purging Air From the Engine Oil Tank

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



a - Fill Cap

Trim “In” Angle Adjustment

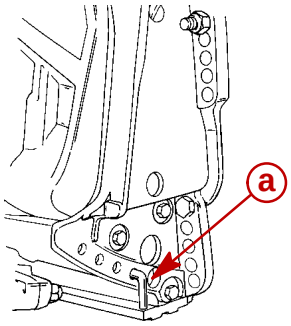
Some outboard boats, particularly some bass boats, are built with a greater than normal transom angle which will allow the outboard to be trimmed further “in” or “under”. This greater trim “under” capability is desirable to improve acceleration, reduce the time spent in a bow high boat, and in some cases,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

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

In rare circumstances, the owner may decide to limit the trim under. This can be accomplished by purchasing a stainless steel tilt pin (P/N 17-49930A1) and inserting it through whatever pin hole is desired. The non-stainless steel shipping bolt should not be used in this application other than on a temporary basis.

⚠ WARNING

Avoid possible serious injury or death. Adjust outboard to an intermediate trim position as soon as boat is on plane to avoid possible ejection due to boat spin-out. Do not attempt to turn boat when engine is trimmed extremely under or in.



a - Tilt Pin

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.

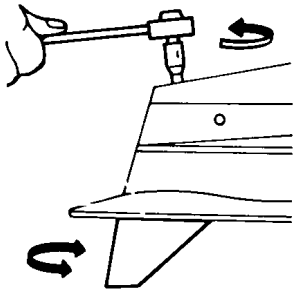
Models Without Power Steering

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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2 A

Specifications

Ignition Coil Ohm Test

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

Temperature Sensor Test

Temperature Sensors	
Between BLACK and each TAN/BLACK wire.	No Continuity
Between each lead and ground	No Continuity

Direct Injector Test

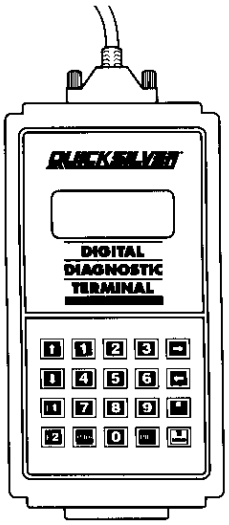
Direct Injector Ohm Test (Injector Lead Disconnected)	
Connect meter leads between each injector terminal pin.	1 - 1.6 Ω

Fuel Injector Test

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

Special Tools

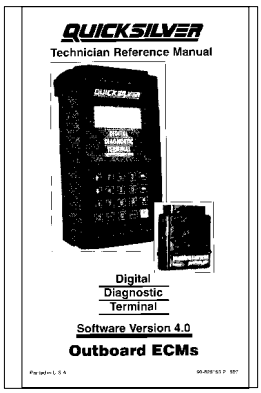
1. Digital Diagnostic Terminal (DDT) 91-823686A2



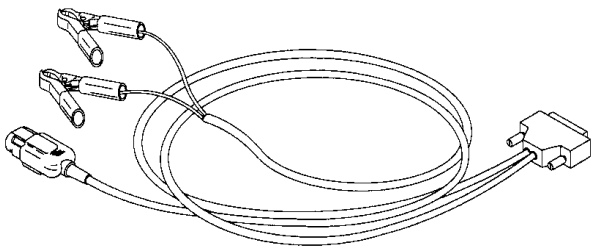
2. Software Cartridge 91-822608--4, 91-822608--5, 91-822608--6



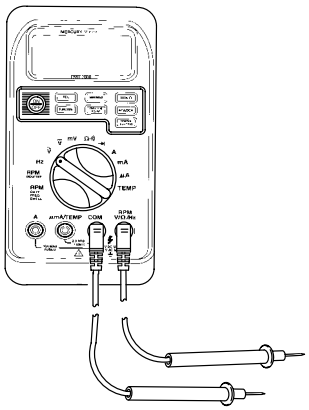
3. DDT Reference Manual 90-825159-2, 90-825159-3, 90-825159-4



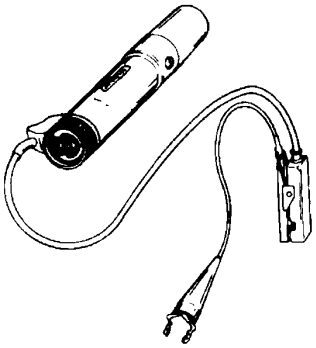
4. Adaptor Harness 84-822560A5



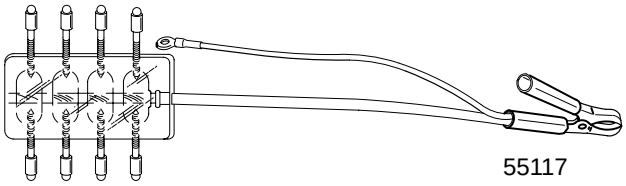
5. DMT 2000 Digital Tachometer Multimeter 91-854009A1



6. Inductive Timing Light 91-99379

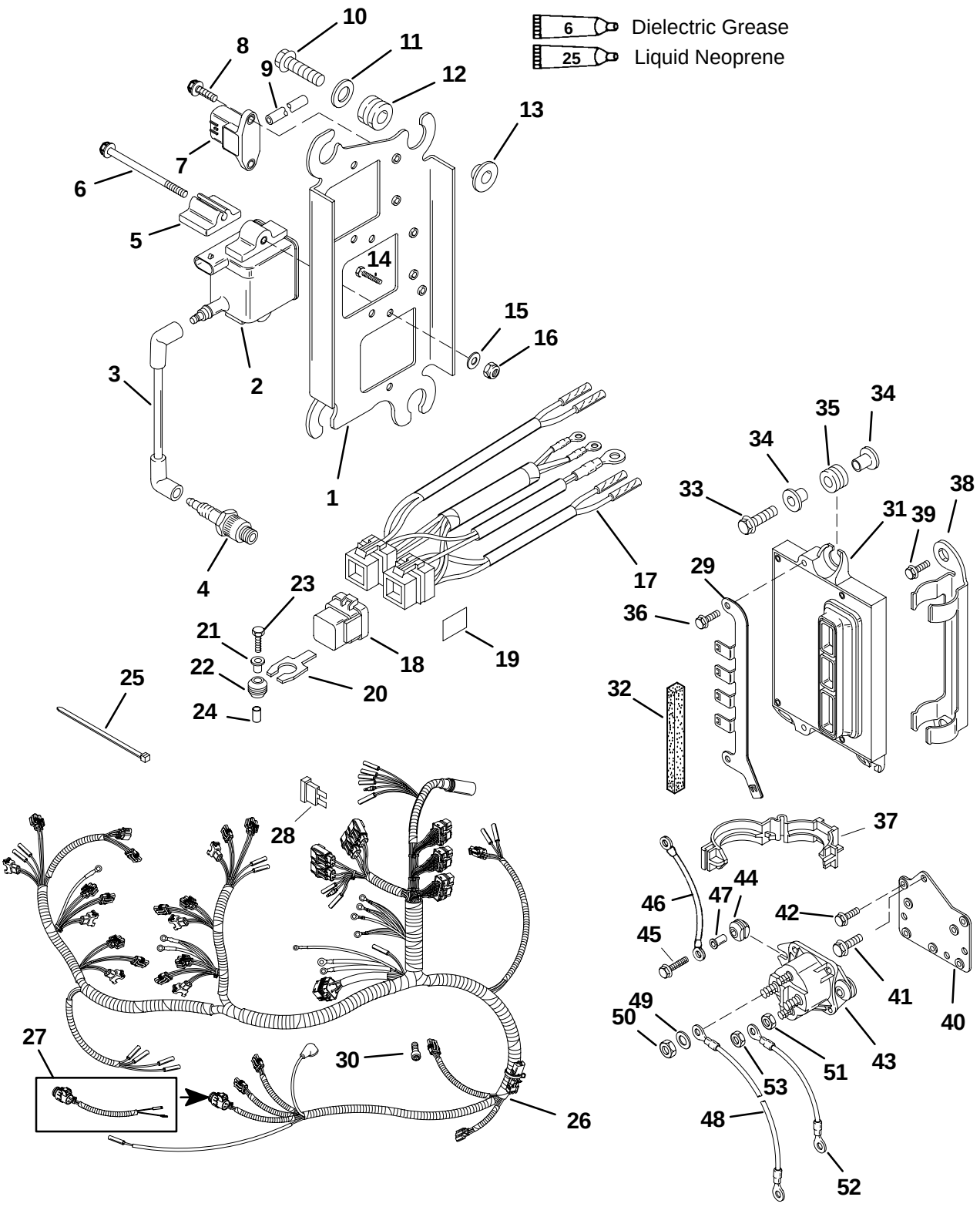


7. Spark Gap Tester 91-850439T



55117

Electrical Components



NOTE: COAT ALL EYELET WIRING TERMINALS WITH #25 GACO N700 (LIQUID NEOPRENE)

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

Electrical Components

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	ELECTRICAL MOUNTING PLATE			
2	6	IGNITION COIL			
3	1	HI-TENSION CABLE			
4	6	SPARK PLUG **(HEAVY DUTY)**		20	27
5	6	SPACER			
6	6	SCREW (1/4-20 x 3-1/4 IN.)			
7	1	MAP SENSOR			
8	2	SCREW (M6 x 14)	35		4
9	1	TUBING (31 IN.)			
10	4	SCREW (.312-18 x 1-1/4 IN.)		19.6	26.5
11	4	WASHER			
12	4	GROMMET			
13	4	BUSHING			
14	2	SCREW-engine harness ground (M6 x 14)	35		4
15	6	WASHER			
16	6	NUT			
17	1	TRIM HARNESS			
18	3	RELAY			
19	3	DECAL-Trim Relay			
20	3	BRACKET			
21	3	BUSHING			
22	3	GROMMET			
23	2	SCREW (M6 x 25)	35		4
24	1	BUSHING			
25	2	STA-STRAP			
26	1	ENGINE HARNESS			
27	1	HARNESS **(SERVICE ITEM)**			
28	4	FUSE			
29	1	BRACKET-Fuse Holder			
30	2	SCREW (M4 x 8)			
31	1	ECM **(135)**			
		ECM **(150)**			
32	1	PAD			
33	3	SCREW (M6 x 25)	70		8
34	6	BUSHING			
35	3	GROMMET			
36	2	SCREW (M6 x 14)	100		11.5
37	1	CLIP			
38	1	CLAMP			
39	2	SCREW (10-16 x 3/8 IN.)			
40	1	SOLENOID MOUNTING PLATE			
41	3	SCREW (M6 x 12)	150		17
42	2	SCREW (M6 x 14)	35		4
43	1	STARTER SOLENOID			
44	2	GROMMET			
45	2	SCREW (M6 x 25)	35		4
46	1	CABLE **(BLACK)**			
47	2	BUSHING			
48	1	BATTERY CABLE **(POSITIVE)**			
49	2	LOCKWASHER			
50	2	NUT (5/16-18)	50		5.5
51	2	NUT (10-32)	8		0.9
52	1	CABLE			
53	1	CAP NUT			

Theory of Operation

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

Ignition Component Description

Electronic Control Module (ECM)

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

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

The ECM performs the following functions:

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

Flywheel

The 24 teeth under the flywheel ring gear provide engine RPM and crankshaft position information to the ECM through the crank position sensor.

Ignition Coils

Inductive type ignition coils are used on the DFI engines.

Ignition Coil Ohm Test

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

Crank Position Sensor

The Crank Position Sensor senses the 24 teeth located on the flywheel under ring gear. It supplies the ECM with crank position information and engine speed. If sensor should fail, the engine will stop running.

Throttle Position Sensor (TPS)

Two (2) Throttle Position Sensors are used in conjunction with one another. If one sensor should fail, the dash mounted CHECK ENGINE light will light and the warning horn will sound. RPM will be limited to 3000 rpm. If both TPS's should fail, rpm will be reduced to idle by the ECM. TPS settings are not adjustable. TPS settings can be monitored with the Digital Diagnostic Terminal through the ECM.

Charging System Alternator

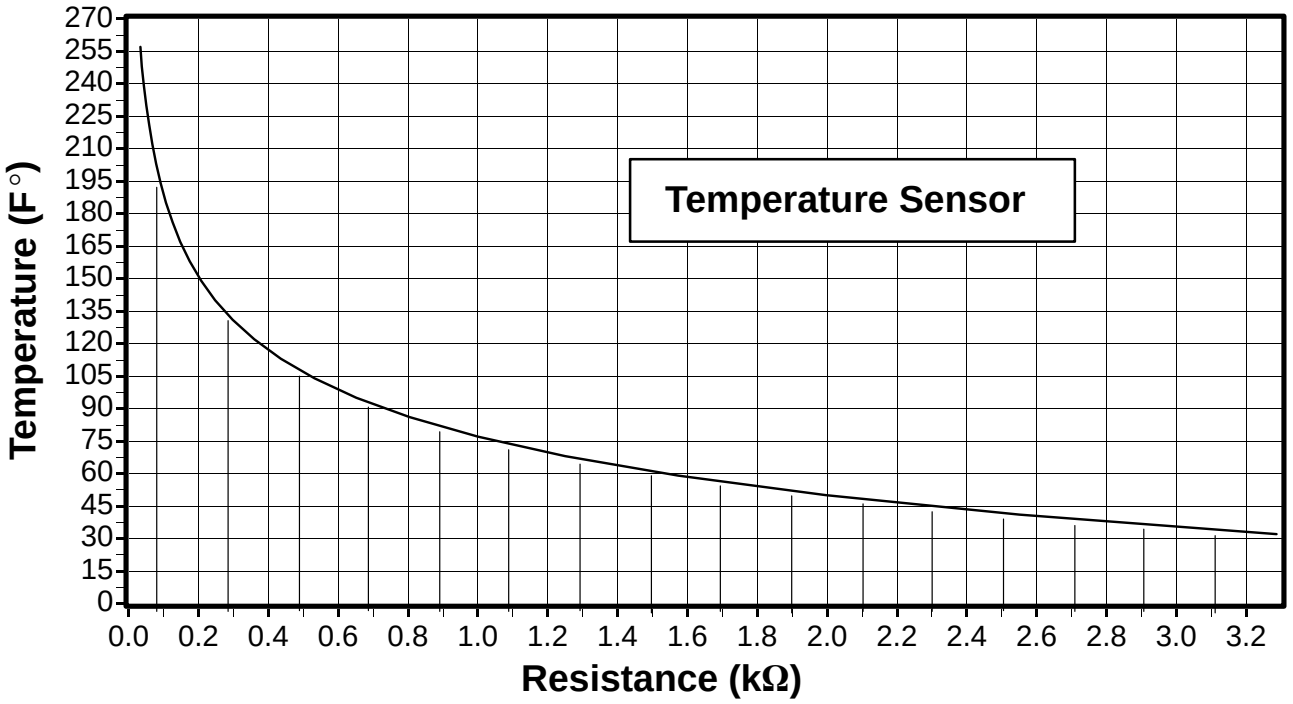
The battery charging system is contained within the belt driven alternator, including the regulator. At cranking speeds, electrical power for the engine is provided by the boat battery – minimum recommended size is 750 CCA, or 1,000 MCA, cold cranking amperes. Above 550 RPM, all electrical power is provided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

Temperature Sensor

Two (2) temperature sensors are used to provide cylinder head temperature information to the ECM. One sensor is mounted in the starboard cylinder head and one in the air compressor cylinder head. The ECM uses this information to increase injector pulse width for cold starts and to retard timing in the event of an over-heat condition.

An ohms test of the temperature sensor 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(s)	
Between BLACK and each TAN/BLACK wire.	No Continuity
Between each lead and ground	No Continuity

Manifold Absolute Pressure (MAP) Sensor

The MAP sensor is mounted between the cylinder heads. A vacuum hose connects the MAP sensor to the intake manifold. The ECM regulates fuel flow, in part, based on manifold absolute pressure. Drawing a vacuum on the MAP sensor hose will create a lean fuel condition.

Air Temperature Sensor

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

Direct Injectors

Six (6) direct injectors (1 per cylinder) are used to inject a fuel/air mix into cylinders. The direct injectors are mounted between fuel rails and cylinder heads. There should be no continuity between the metal housing and either injector terminal.

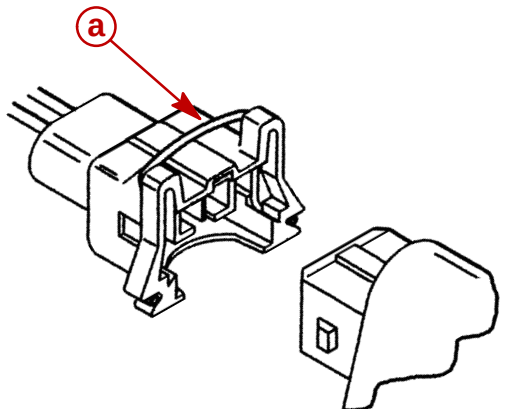
Direct Injector Ohm Test (Injector Lead Disconnected)	
Connect meter leads between each injector terminal pin.	1 - 1.6 Ω

Fuel Injectors

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

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

Disconnecting Harness Connectors from Ignition Coils and/or Injectors



54871

a - Wire Clip (push center down to remove)

Troubleshooting

The ECM is designed such that if a sensor fails, the ECM will compensate so that the engine does not go into an over-rich condition.

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

Troubleshooting Without Digital Diagnostic Terminal

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

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

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

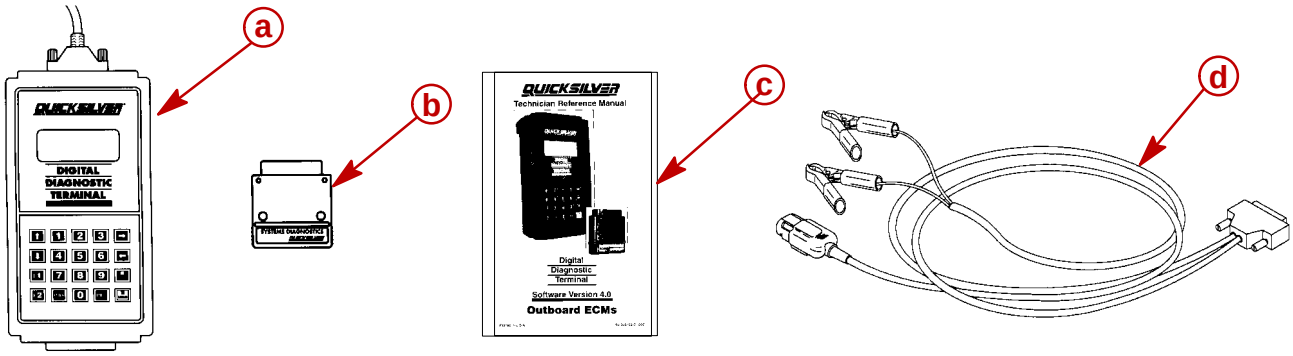
NOTE: *ECMs are capable of performing a cylinder misfire test to isolate problem cylinders. Once a suspect cylinder is located, an output load test on the ignition coil, fuel injector and direct injector may be initiated through use of the DDT.*

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

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

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

Troubleshooting with the Digital Diagnostic Terminal



a - Digital Diagnostic Terminal (91-823686A2)
b - Software Cartridge (91-822608--4, --5, or --6)
c - DDT Reference Manual (90-825159-2, -3, -4)
d - Adapter Harness (84-822560A5)

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

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

The ECM program can help diagnose intermittent engine problems. It will record the state of the engine sensors and switches for a period of time and then can be played back to review the recorded information.

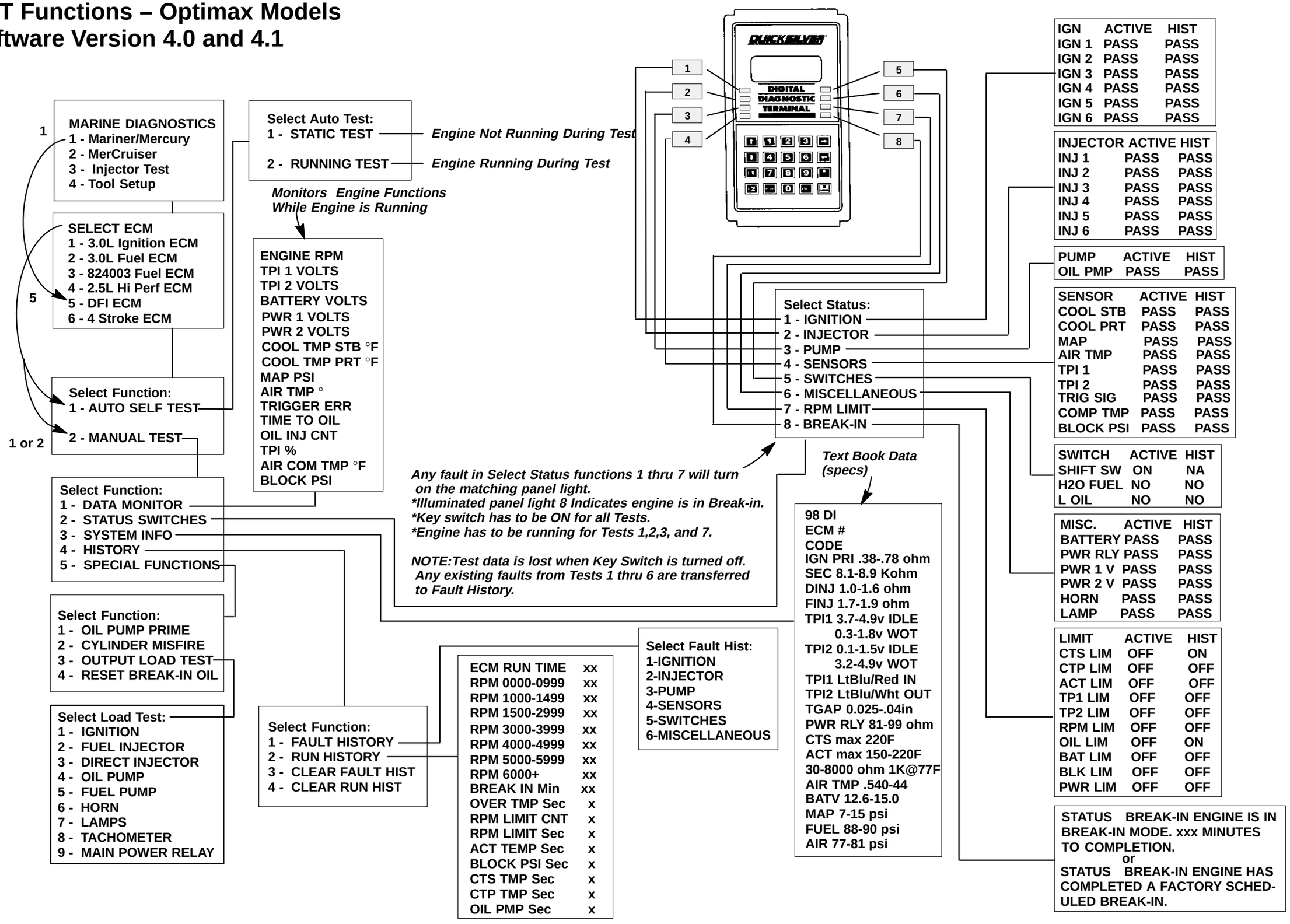
Refer to the Digital Diagnostic Terminal Reference Manual for complete diagnostic procedures.

NOTE: *When performing the fuel injector load test using the DDT, the port side fuel injectors (2, 4 and 6) may only cycle two or three times compared to the starboard side (1,3 and 5) which normally will cycle ten times.*

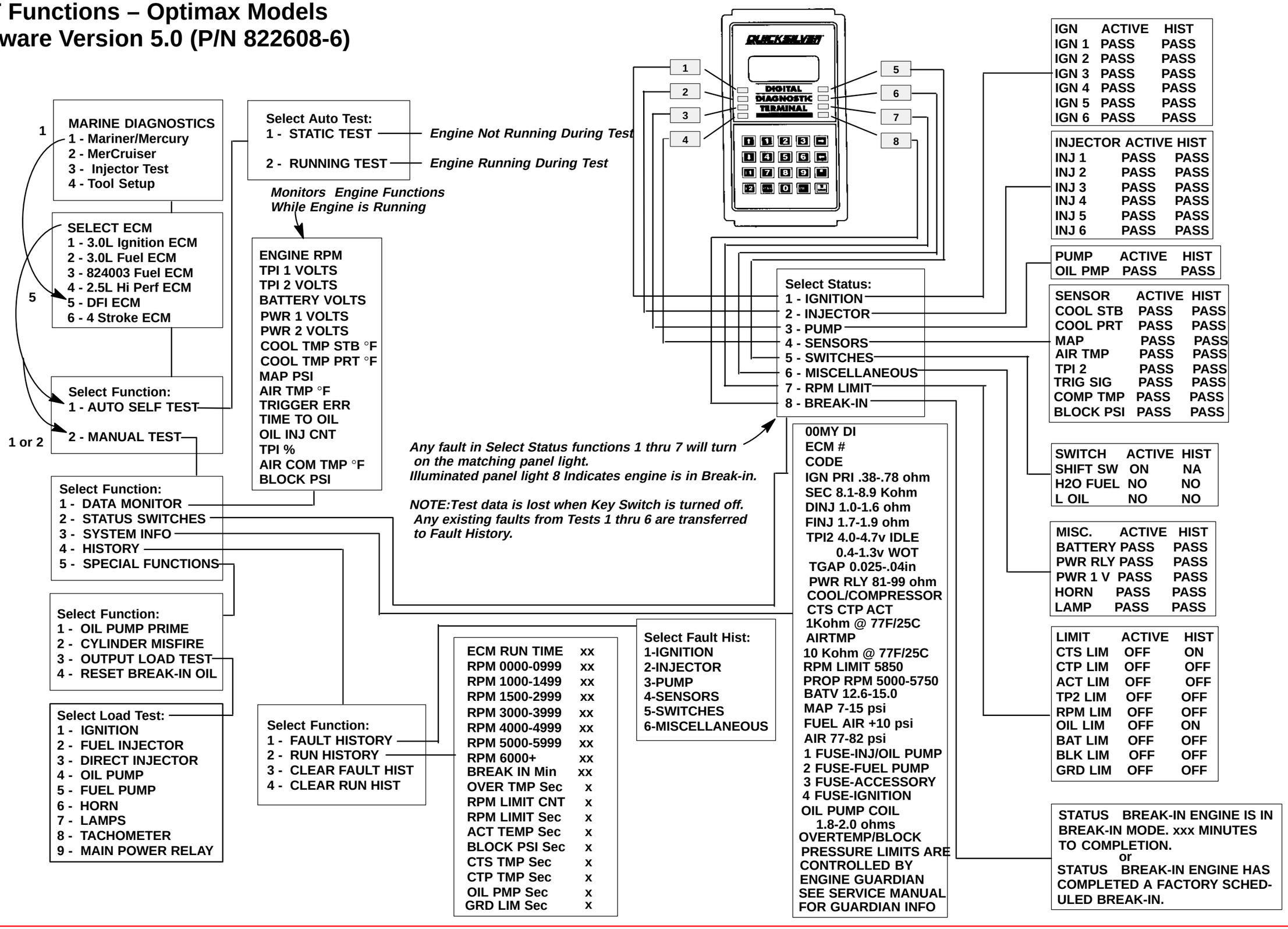
NOTE: *In 1998 model year engines when doing the fuel injector load test with the DDT, the sound from the #4 and #6 injectors may not be as loud or as many pulses as the other injectors. This is normal and should not be considered a problem or fault in the engine electrical system. The 1999 ECM software has corrected this condition.*

Notes:

DDT Functions – Optimax Models
Software Version 4.0 and 4.1



DDT Functions – Optimax Models
Software Version 5.0 (P/N 822608-6)



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

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

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

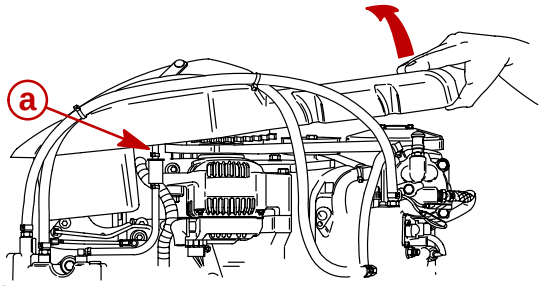
DFI Troubleshooting Guide (continued)		
Symptom	**Cause**	**Action**
7. Speed Reduction (RPM reduced or limited to 3000)	**7.1** Low battery voltage ECM requires 8 volts minimum Fuel Pump requires 9 volts	Check battery and/or alternator. Check electrical connections.
	7.2 Overheat condition (engine and/or air compressor)	Check water pump impeller/cooling system.
	7.3 Oil pump electrical failure	Check electrical connection.
	7.4 TPS failure If one (1) TPS fails rpm is reduced to 3,000. If both TPS's fail, rpm is reduced to idle	Check electrical connections.
8. Engine RPM reduced to idle only	**8.1** Both TPS's failed	See **2.4**
	8.2 Battery voltage below 9.5 volts	Use DDT or volt meter to check battery voltage
9. Loss of spark on 1 cylinder	**9.1** Loose wire or pin in connectors between ECM and coil primary.	Check connectors.
	9.2 Faulty ignition coil.	Replace coil.
	9.3 Faulty spark plug.	Replace spark plug.
	9.4 Faulty spark plug wire	Replace spark plug wire.
	Note: Due to the long spark duration of this ignition system, the DDT may indicate the incorrect cylinder as having an ignition fault. Example: If the DDT indicates an ignition fault on cylinder #4, the problem may be on the prior cylinder in the firing order – I.E. cylinder number #3.	

Ignition Components Removal and Installation

Flywheel Cover Removal and Installation

REMOVAL

Remove flywheel cover by lifting off. Disconnect the vent hose.



a - Vent Hose

INSTALLATION

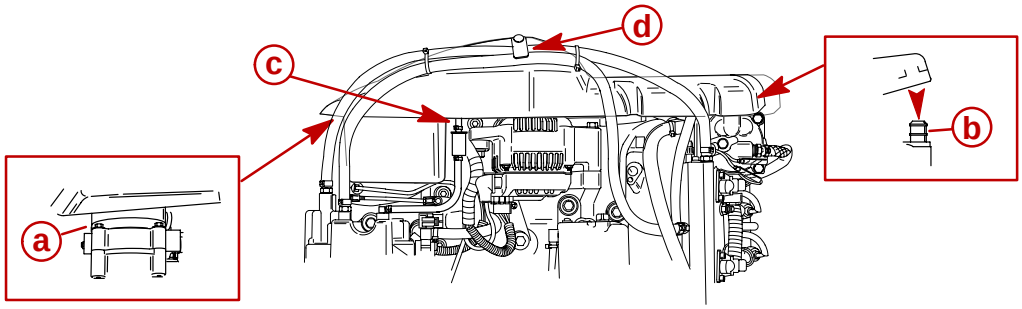
Install flywheel cover as follows:

a. Place cover onto the front flange.

b. Push rear of the cover down onto the rear pin and air intake tube for the air compressor.

c. Connect vent hose onto fitting.

d. Position hoses into holder.

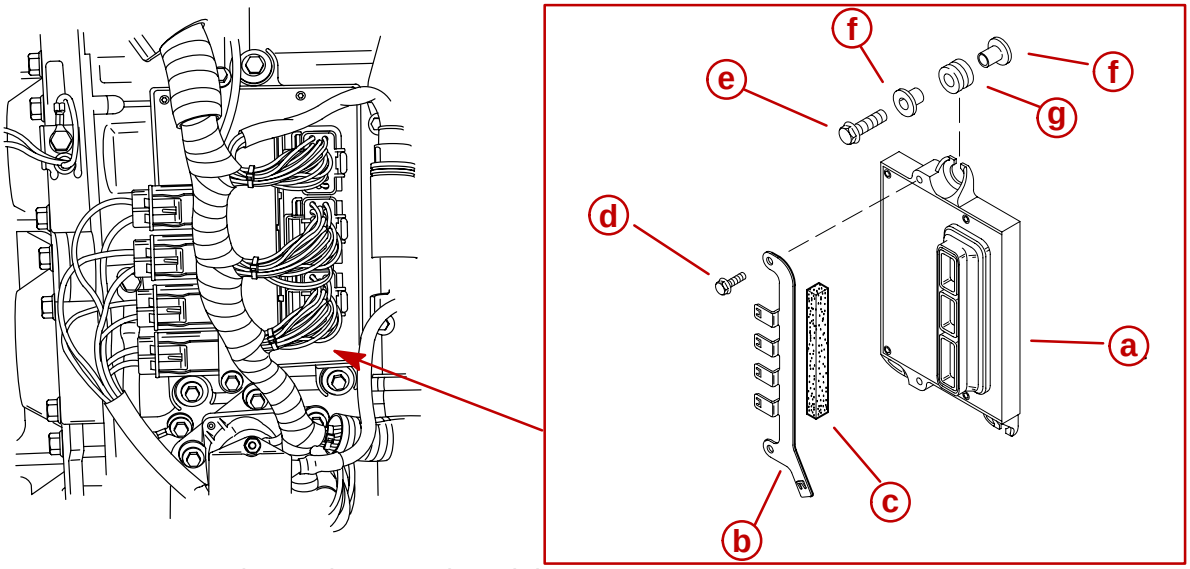


a - Front Flange
b - Air Intake Tube
c - Fitting
d - Holder

Electronic Control Module (ECM)

REMOVAL

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



a - Electronic Control Module
b - Bracket – Fuse Holder
c - Rubber Pad
d - Bolt (2) – Torque to 80 lb-in (9 Nm).
e - Bolt (3) – Torque to 80 lb-in (9 Nm)
f - Bushing
g - Rubber Grommet

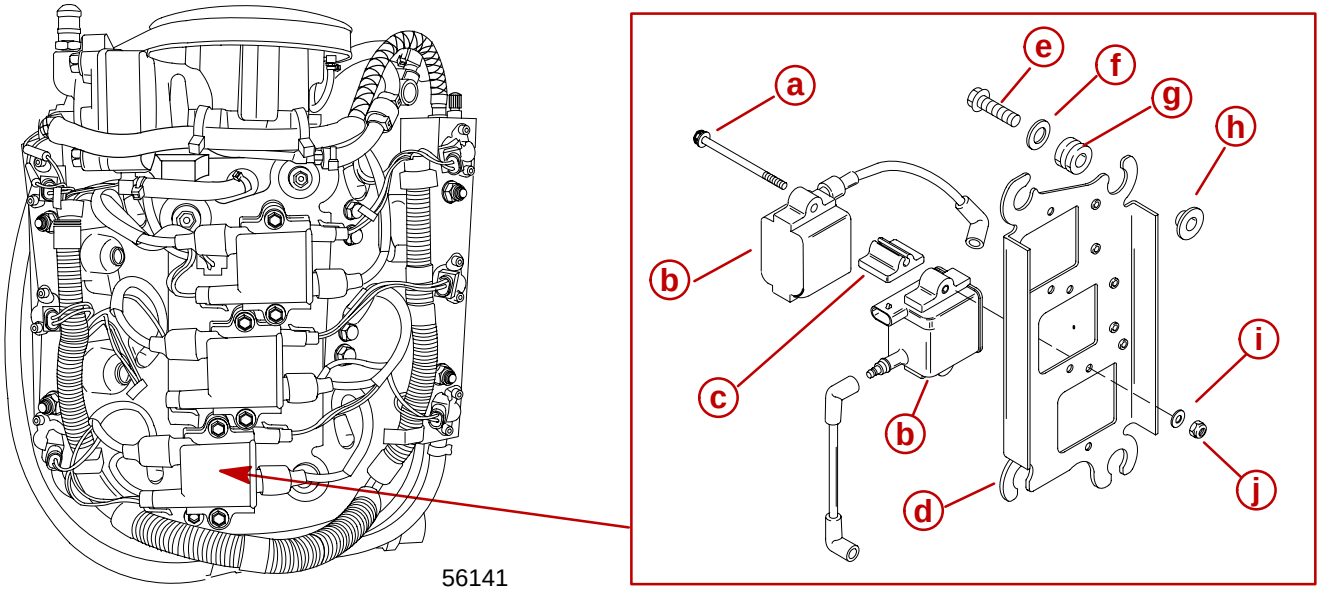
INSTALLATION

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

Ignition Module (Coil)

REMOVAL

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



a - Bolts (6) –Torque to 80 lb-in (9 Nm).
b - Ignition Coils (6)
c - Spacer – Place on Bolts between coils
d - Electrical Mounting Plate
e - Bolts (4) – Torque to 235 lb-in (27 Nm).
f - Washer
g - Rubber Grommet
h - Bushing
i - Washer
j - Locknut (6)

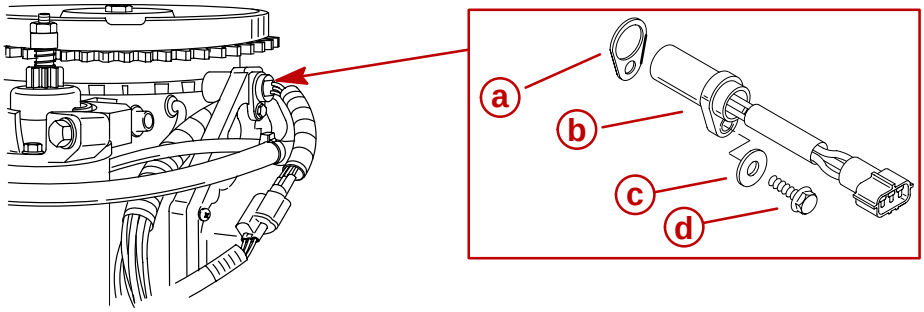
INSTALLATION

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

Crank Position Sensor

REMOVAL

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



56069

a - Shim (0.010 or 0.020 in.) (0.254 mm 0.508 mm)
b - Crank Position Sensor
c - Washer
d - Bolt – Torque to 50 lb-in (5.5 Nm)

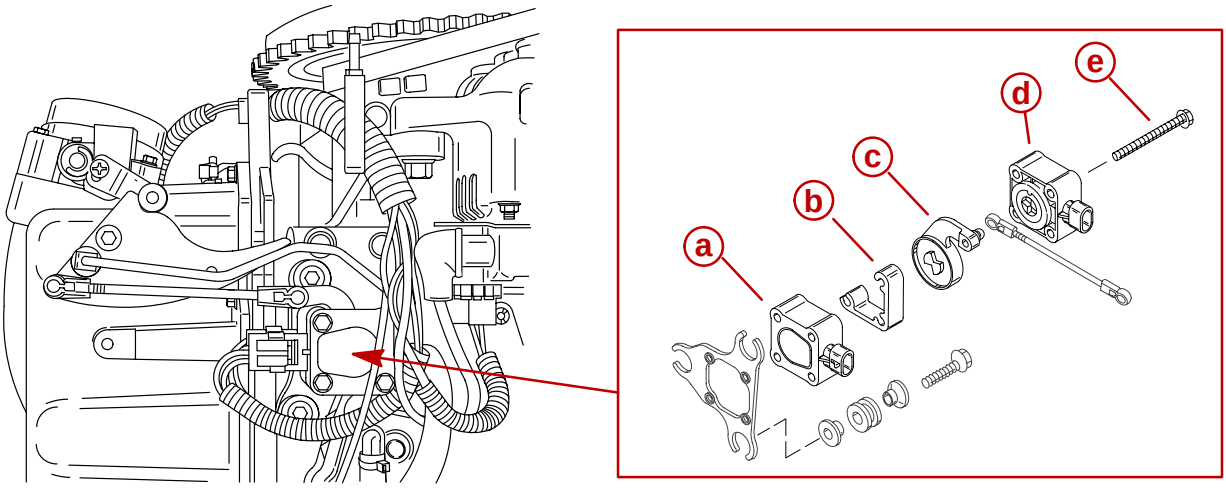
INSTALLATION

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

Throttle Position Sensors (TPS)

REMOVAL

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



a - Throttle Sensor – Inside
b - Spacer
c - TPS Lever
d - Throttle Sensor – Outside
e - Screw (3) – Torque to 20 lb-in (2.5 Nm).

INSTALLATION

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

ELECTRICAL

Section 2B – Charging & Starting System

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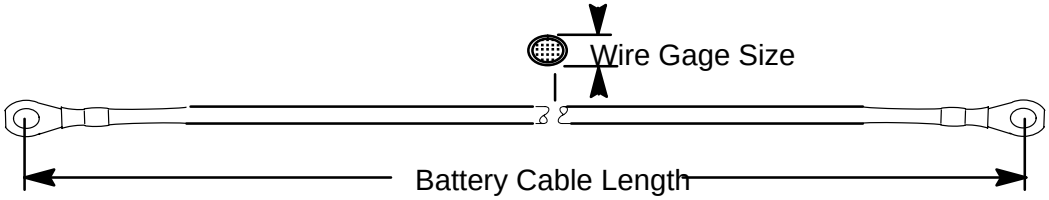
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Specifications

CHARGING SYSTEM	**Alternator Output (Regulated)**	32 - 38 Amperes @ 2000 RPM @ Battery 52 - 60 Amperes @ 2000 RPM @ Alternator
	Brush Length	Std Exposed Length: 0.413 in. (10.5 mm) Min. Exposed Length: 0.059 in. (1.5 mm)
	Voltage Output	13.5 to 15.1 Volts
	Regulator Current Draw	0.15 mA (Ign. Switch Off) 30.0 mA (Ign. Switch On)
STARTING SYSTEM	**Electric Start – All Models**	
	Starter Draw (Under Load)	165 Amperes
	Starter Draw (No Load)	30 Amperes
	Minimum Brush Length	0.25 in. (6.35 mm)
	Battery Rating	1000 (Minimum) Marine Cranking Amps (MCA) 750 (Minimum) Cold Cranking Amps (CCA)

Battery Cable Size

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



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

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

Replacement Parts

⚠ WARNING

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

Recommended Battery

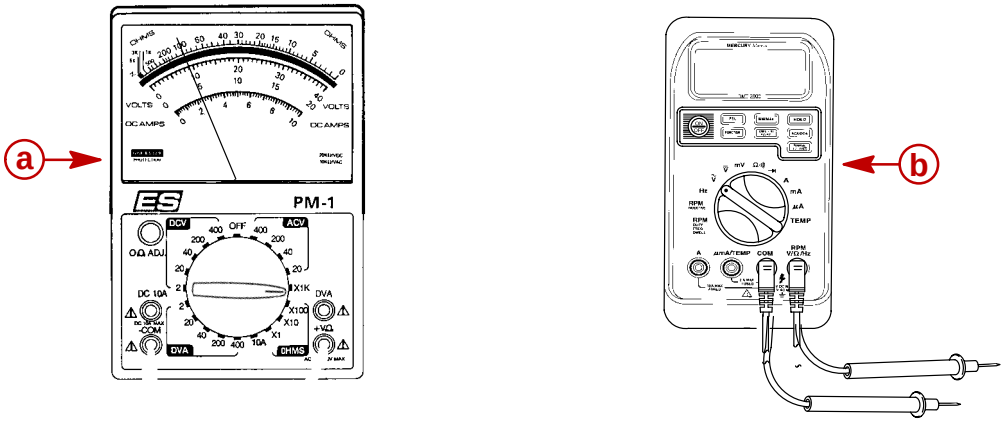
A 12 volt marine battery with a minimum Cold Cranking amperage rating of 750 amperes or 1000 (minimum) Marine Cranking amperes should be used.

⚠ 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.

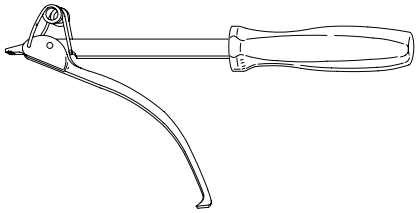
Special Tools

1. Volt/Ohm Meter or DMT 2000 Digital Tachometer Multimeter



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

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

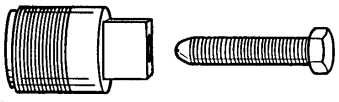


54964

4. Protector Cap 91-24161



5. Flywheel Puller 91-73687A1



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 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

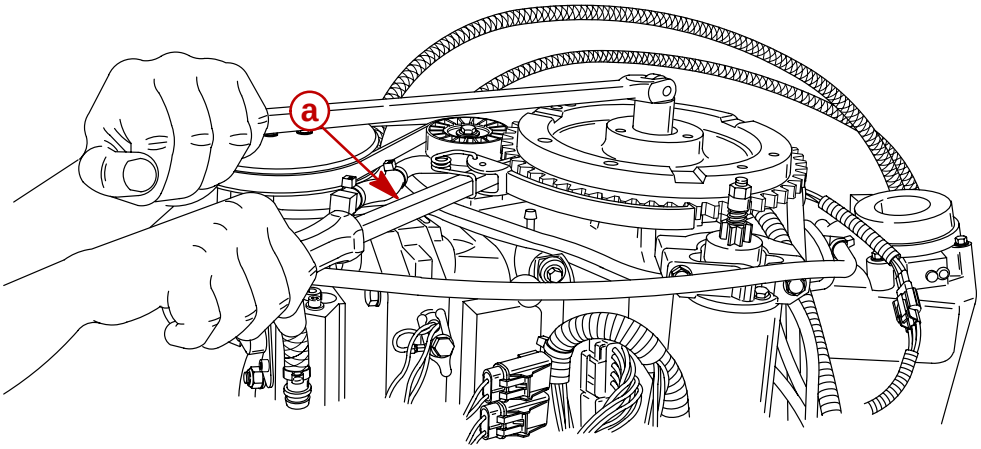
Removal

1. Remove flywheel cover from engine.

⚠ WARNING

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

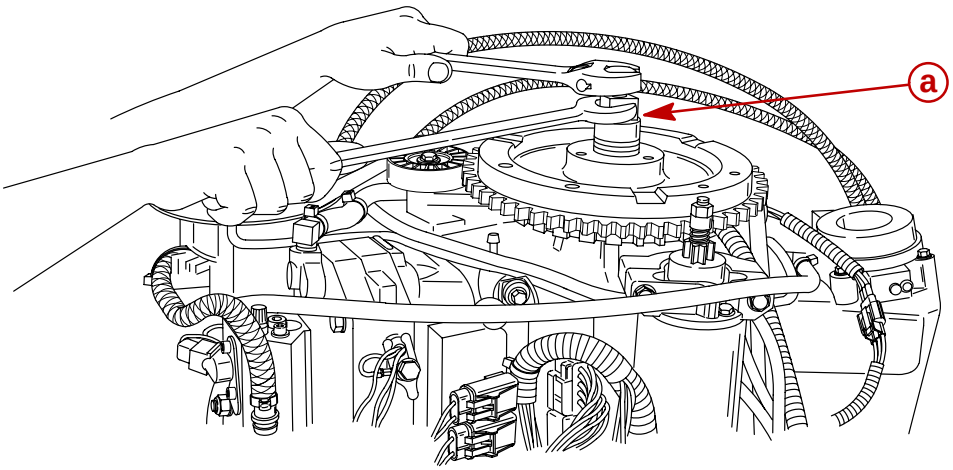
2. Disconnect spark plug leads from spark plugs.
3. While holding flywheel with flywheel holder, remove flywheel nut and washer.



57415

a - Flywheel Holder (91-25344)

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



57413

a - Flywheel Puller (91-73687A2)

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.*

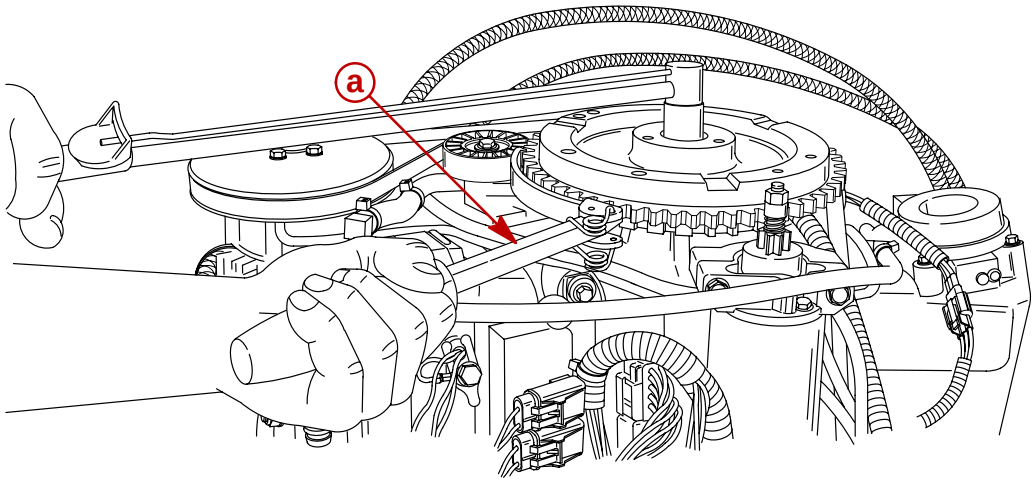
6. Remove flywheel. Inspect flywheel for cracks or damage.

Installation

IMPORTANT: Inspect flywheel magnets for clinging debris. Failure to remove debris before installing flywheel may result in damage to flywheel or electrical components under flywheel when outboard is initially started.

IMPORTANT: Do not apply any greases, oils or lubricants to flywheel/crankshaft taper surfaces. Clean flywheel/crankshaft taper with solvent and assemble dry.

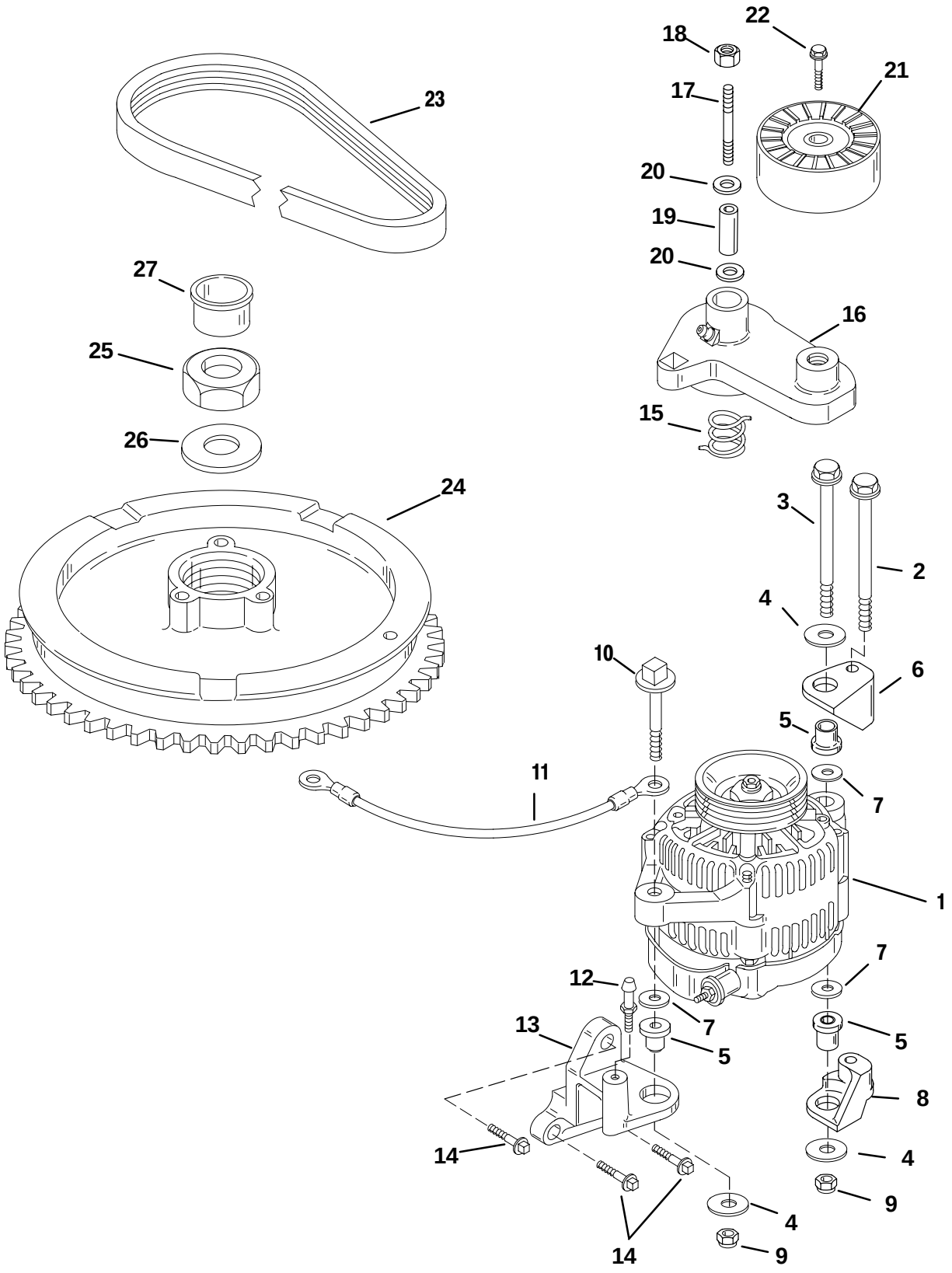
1. Install flywheel.
2. Install flywheel washer and nut.
3. Hold flywheel with Flywheel Holder. Torque nut to 125 lb-ft (169.5 Nm).



57414

a - Flywheel Holder (91-52344)

Flywheel/Alternator

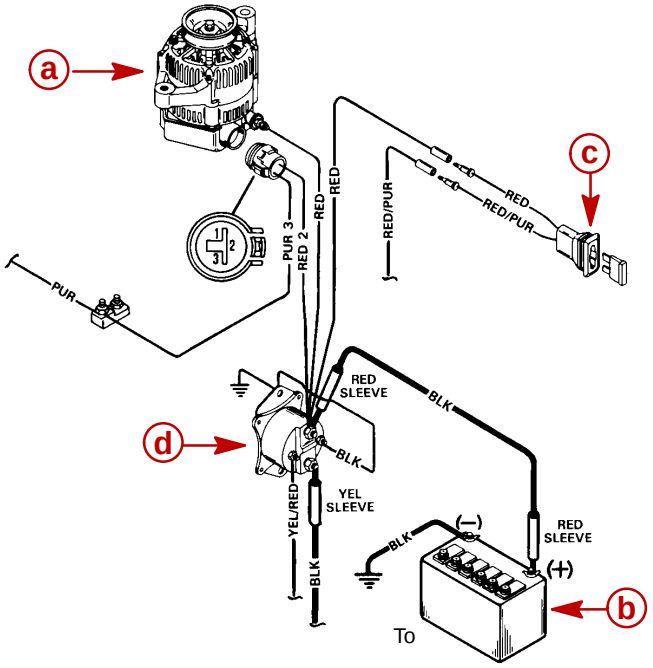


Flywheel/Alternator

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	ALTERNATOR			
2	1	SCREW (M10 x 100)		40	54
3	1	SCREW (M10 x120)		23	31
4	3	WASHER			
5	3	MOUNT			
6	1	BRACKET			
7	3	WASHER			
8	1	BRACKET			
9	2	NUT		23	31
10	1	SCREW (M10 x 55)		23	31
11	1	CABLE			
12	1	PIN			
13	1	BRACKET			
14	3	SCREW (5/16-18 x 1 IN.)		15.5	21
15	1	SPRING			
16	1	BELT TENSIONER			
17	1	STUD (M10 x 85)			
18	1	NUT		15	20
19	1	BUSHING			
20	2	WASHER			
21	1	PULLEY			
22	1	SCREW (M10 x 35)		25	34
23	1	BELT			
24	1	FLYWHEEL			
25	1	NUT		125	169
26	1	WASHER			
27	1	PLUG			

System Components

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



51708

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

Precautions

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

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

Alternator Description

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

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

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

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

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

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

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

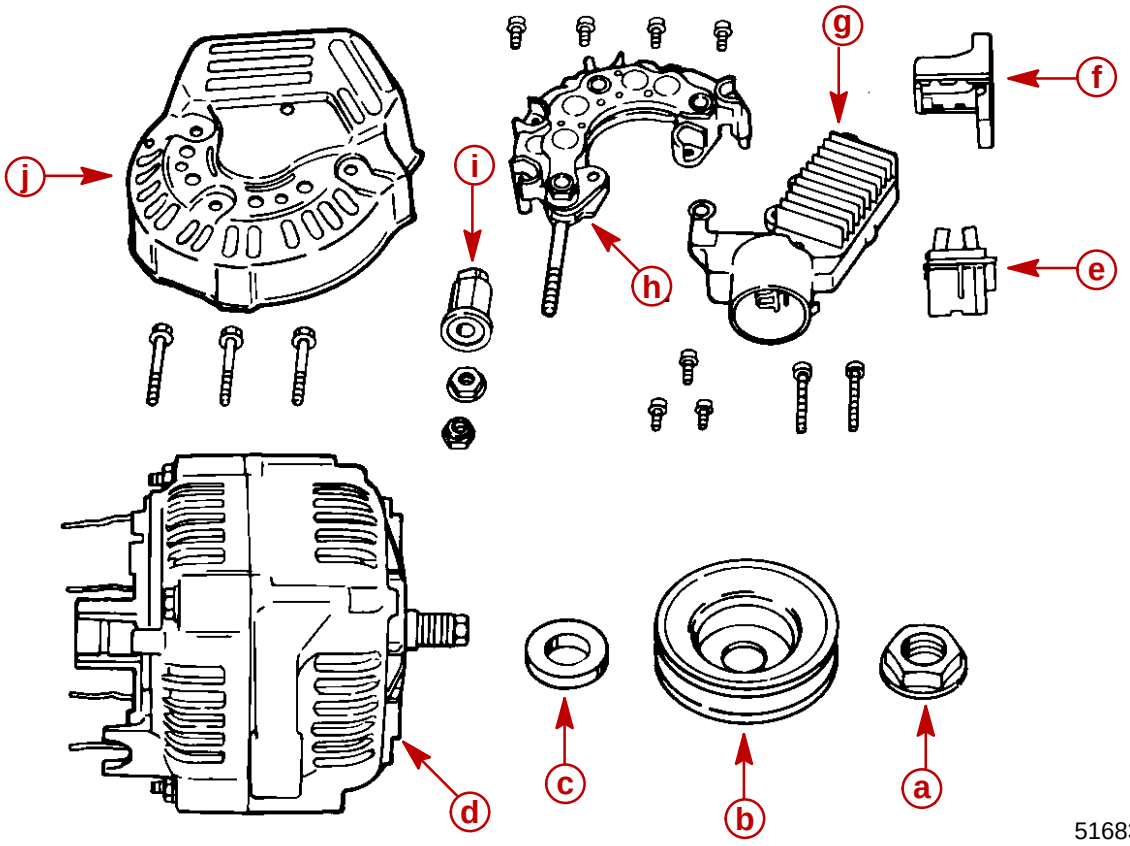
Diagnosis of Alternator System on Engine

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

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

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

Alternator Assembly



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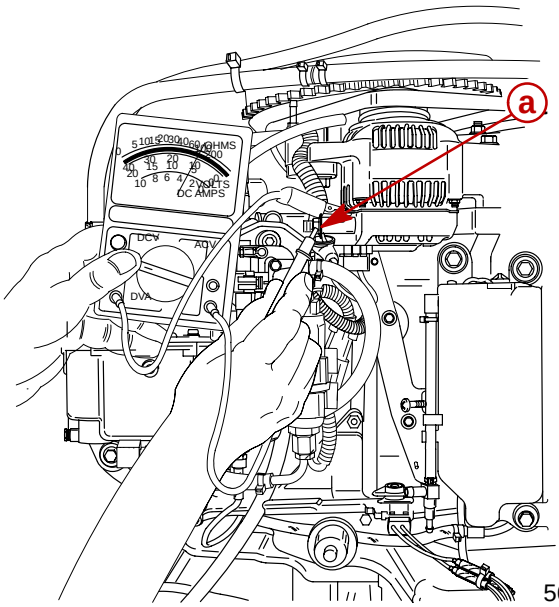
a - Pulley Nut
b - Pulley
c - Spacer
d - Frame and Rotor Assembly
e - Brush Holder
f - Brush Cover
g - Regulator
h - Rectifier (Diode Assembly)
i - Insulator
j - End Cover

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/dirty connections or damaged wiring.

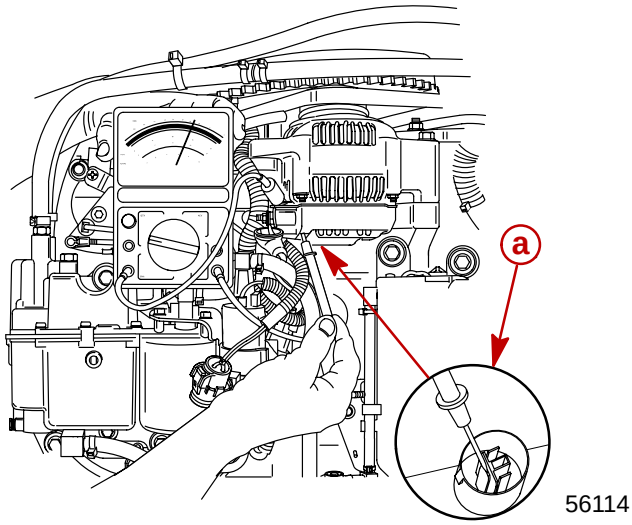


56113

a - Terminal B

Sensing Circuit

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

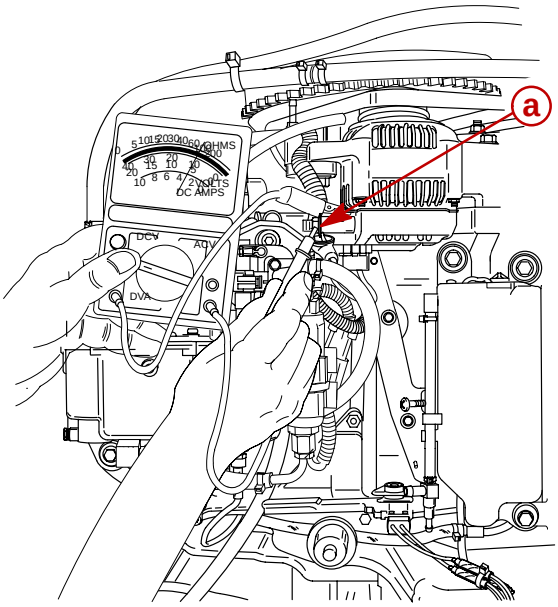


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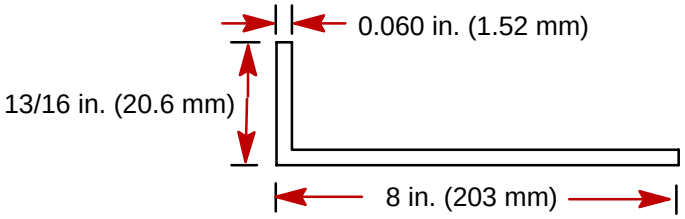
a - Sense Lead (RED)

Voltage Output

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

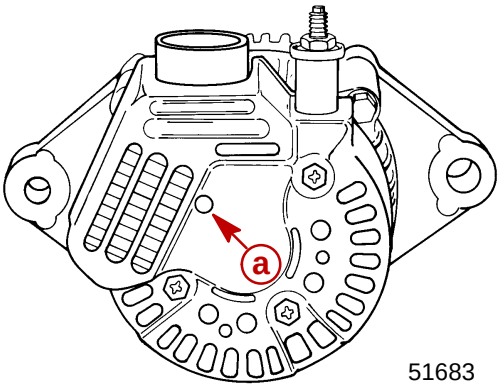


56113

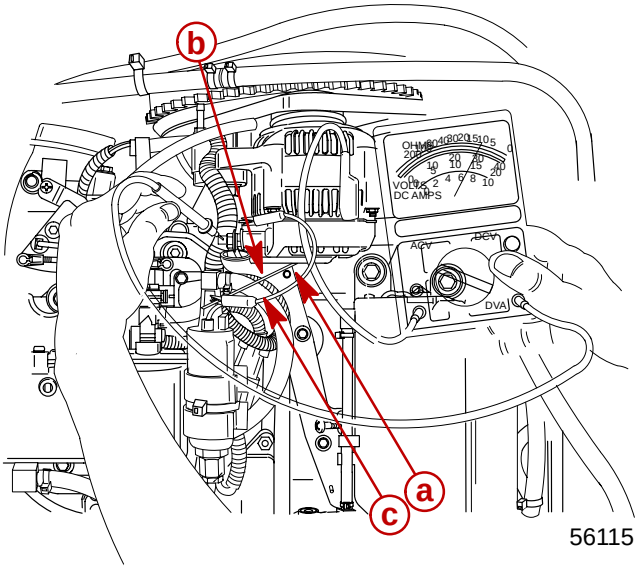


a - Terminal B

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



51683



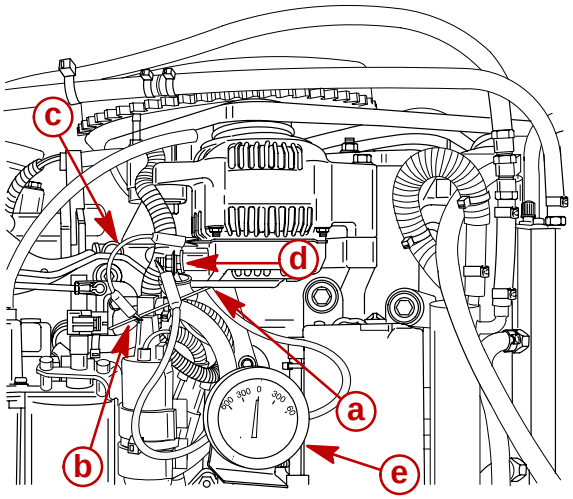
56115

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

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

Current Output

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



56116

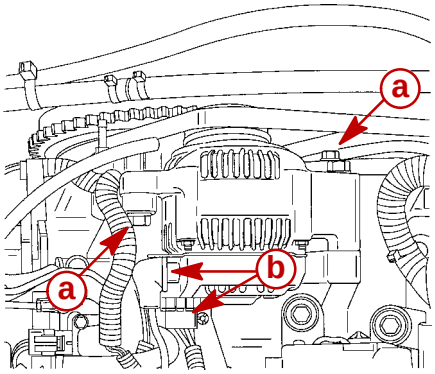
a - Terminal F
b - Tool
c - Jumper Wire to Engine Ground
d - Terminal B
e - Ammeter

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

Repair

Removal

1. Remove top cowling.
2. Disconnect battery cables from battery.
3. Disconnect wiring harness from alternator.
4. Remove pivot bolt and tension bolt.

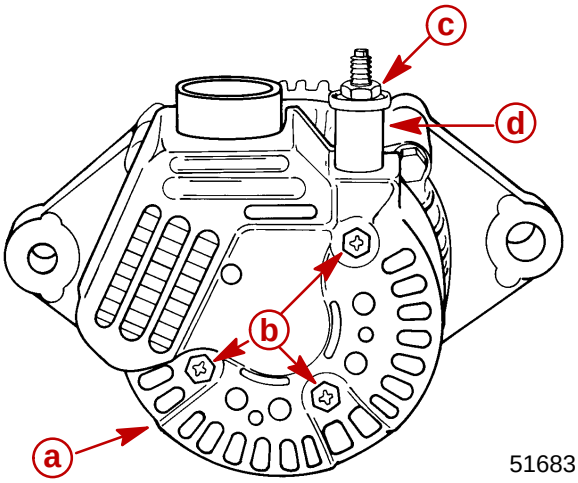


56117

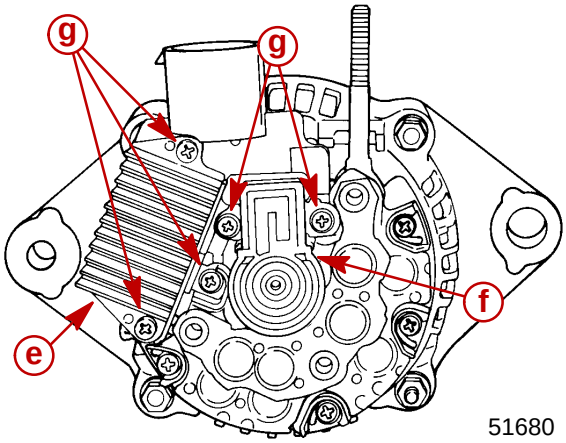
a - Attaching Bolt
b - Harnesses

Disassembly and Test

1. Remove 3 screws and nut securing end cover and remove insulator and cover.
2. Remove 5 screws securing regulator and brush assembly.



51683



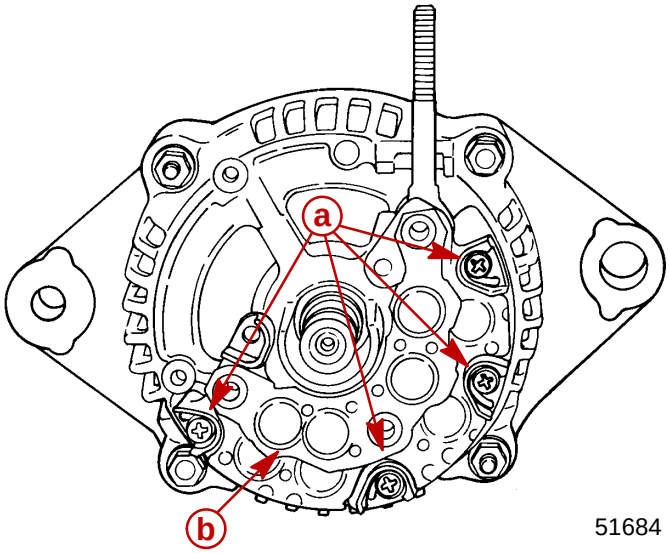
51680

a - Cover
b - Screws (3)
c - Nut
d - Insulator
e - Regulator
f - Brush Assembly
g - Screws (5)

NOTE: *Proper regulator operation can be determined by* ***VOLTAGE OUTPUT*** *and* ***CURRENT OUTPUT*** *(previous). If regulator does not meet specifications, replace regulator. Torque regulator screws to 17 lb-in (2 Nm).*

NOTE: *Brushes are replaced as an assembly. Inspect assembly for stuck brushes or excessive brush wear. Normal exposed brush length is 0.156 in. (4.0 mm). Minimum exposed brush length is 0.059 in. (1.5 mm).*

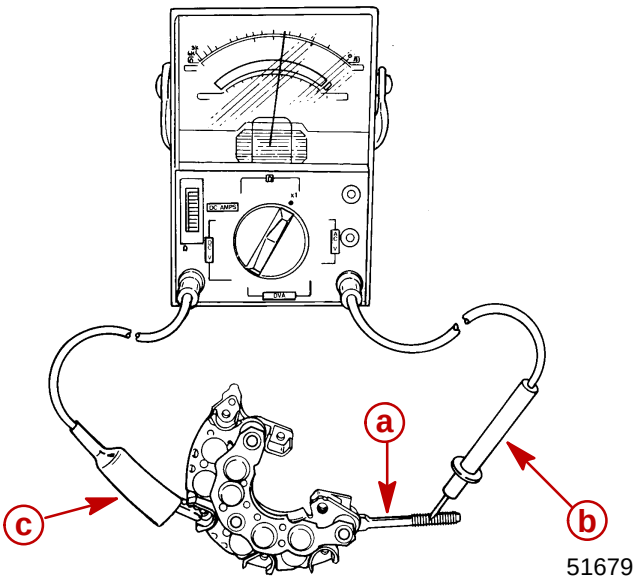
3. Remove 4 screws securing rectifier (diode assembly) to alternator.



51684

a - Screws (4)
b - Rectifier (Diode Assembly)

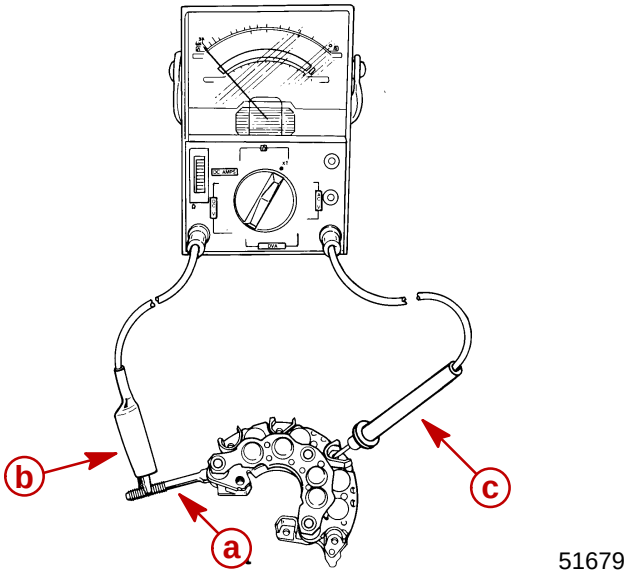
NOTE: *To test rectifier assembly, touch POSITIVE (+) lead from ohmmeter to POSITIVE stud and NEGATIVE (–) lead from ohmmeter to each diode terminal. The ohmmeter should indicate continuity.*



51679

a - Positive Stud
b - Positive Ohm Lead
c - Negative Ohm Lead

4. Reverse leads – NEGATIVE lead on POSITIVE stud and POSITIVE lead on each diode assembly. NO CONTINUITY should be observed. If continuity is observed in both tests, or no continuity is observed in both tests, the rectifier assembly is defective and must be replaced. Torque rectifier screws to 17 lb-in (1.9 Nm).



51679

a - Positive Stud
b - Negative Ohm Lead
c - Positive Ohm Lead

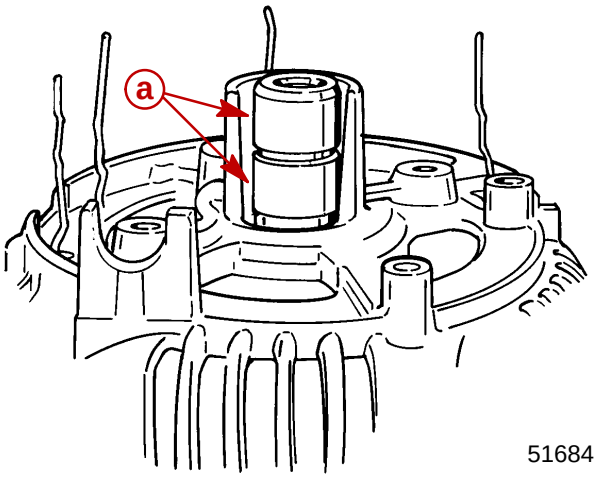
IMPORTANT: Depending on the polarity of the ohmmeter, reversed readings may be obtained – I.E. – CONTINUITY is observed when the NEGATIVE lead touches the POSITIVE stud and NO CONTINUITY is observed when the POSITIVE lead touches the POSITIVE stud.

IMPORTANT: The regulator, rectifier and brush assembly are the only components individually replaceable on this alternator. If the rotor or stator is defective, the entire rotor, stator and housing must be replaced as an assembly.

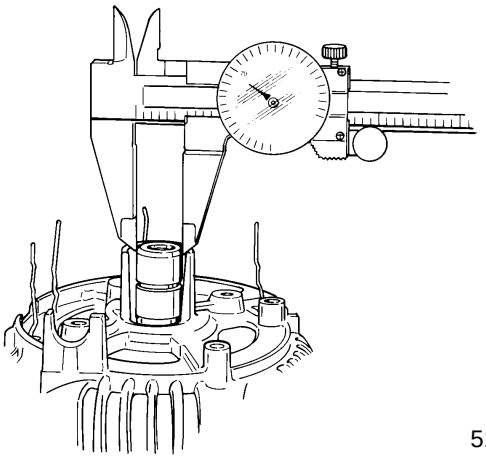
IMPORTANT: Clean anti-corrosion paint from electrical connections prior to reassembly. Coat all electrical connections with Liquid Neoprene.

Rotor Test

1. Inspect slip ring surface for roughness, abnormal wear and/or burning. If such conditions exist, rotor is not considered serviceable and alternator should be replaced.
2. Measure the outer diameter of the slip rings using vernier calipers. STANDARD DIAMETER: 0.567 in. (14.4 mm); MINIMUM DIAMETER: 0.551 in. (14 mm). If slip ring diameter is less than minimum, rotor is not considered serviceable and alternator should be replaced.



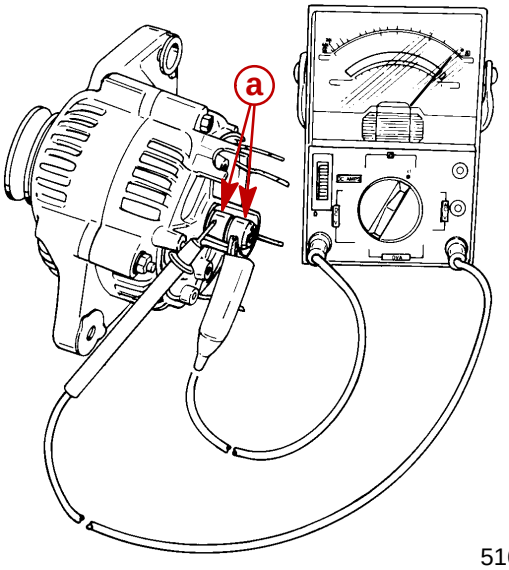
51684



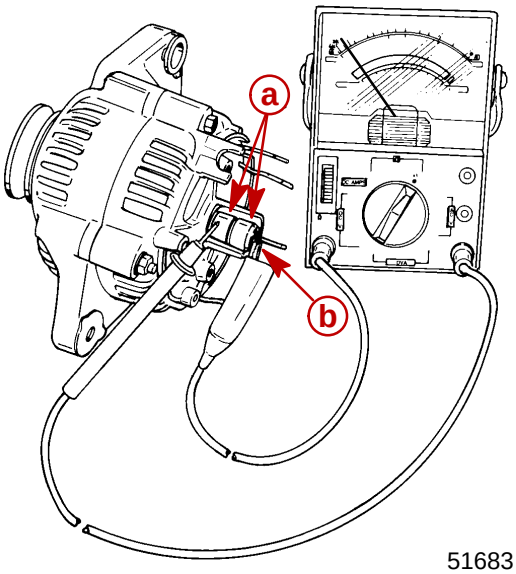
51680

a - Slip Rings

3. Inspect rotor for an open circuit. Using an ohmmeter, check for continuity between slip rings. Resistance should not exceed 3 ohms. If no continuity exists, rotor is defective.
4. Check rotor for short to ground. NO CONTINUITY should exist between slip rings and rotor shaft. If continuity exists, rotor is defective.



51682

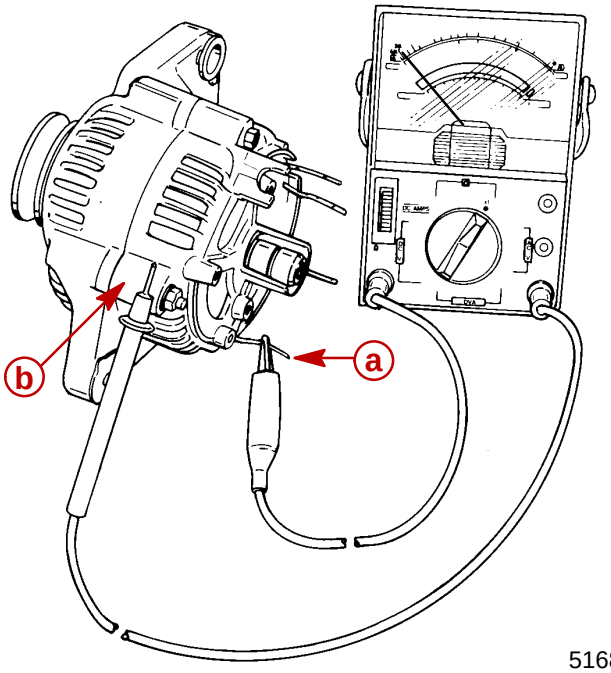


51683

a - Slip Rings
b - Rotor Shaft

Stator Test

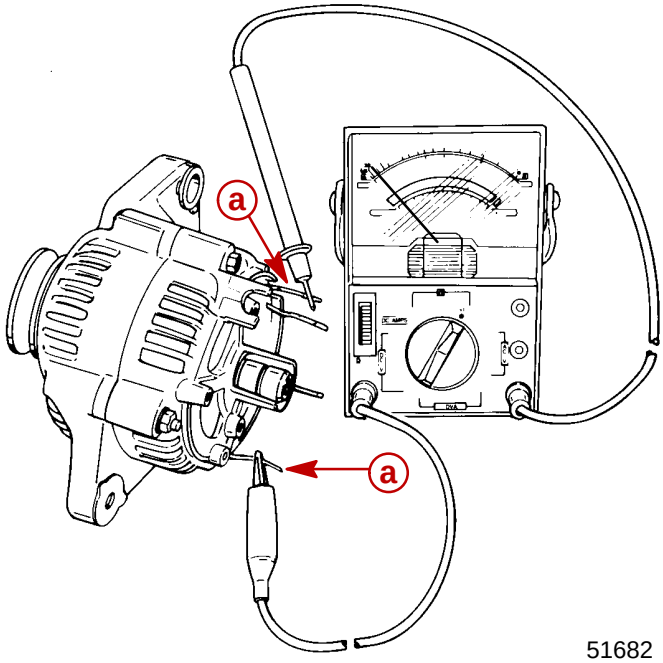
1. With rectifier removed, use an ohmmeter to check for a short circuit between each stator lead and the stator frame. If continuity exists, stator is defective.



51682

a - Stator Leads
b - Frame

2. Inspect stator for open circuit. Using an ohmmeter, check for an open circuit between each of the stator leads. If no continuity exists, stator is defective.

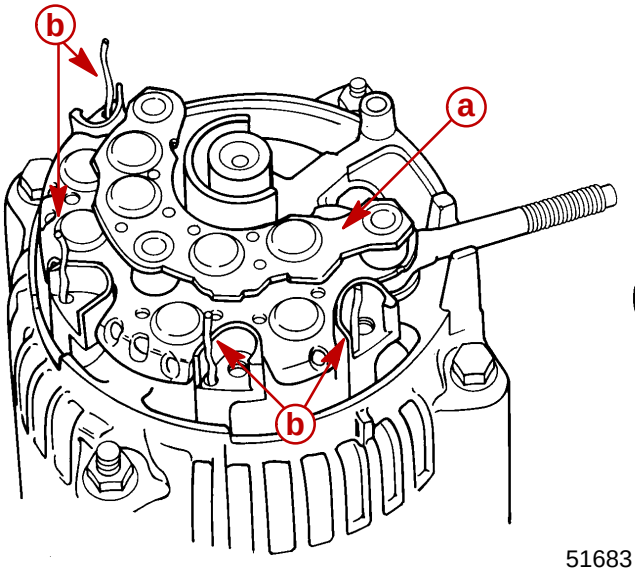


51682

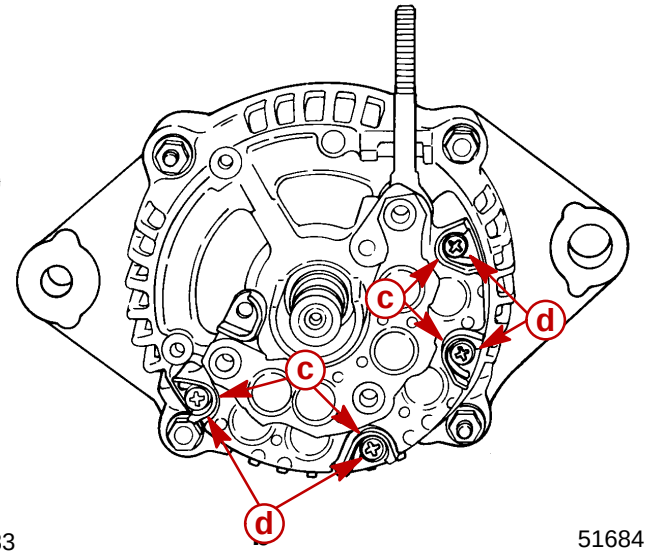
a - Stator Leads

Reassembly

1. Position rectifier assembly over stator leads.
2. Form stator leads in a clockwise loop and secure leads to rectifier with 4 screws. Torque screws to 17 lb-in (1.9 Nm).



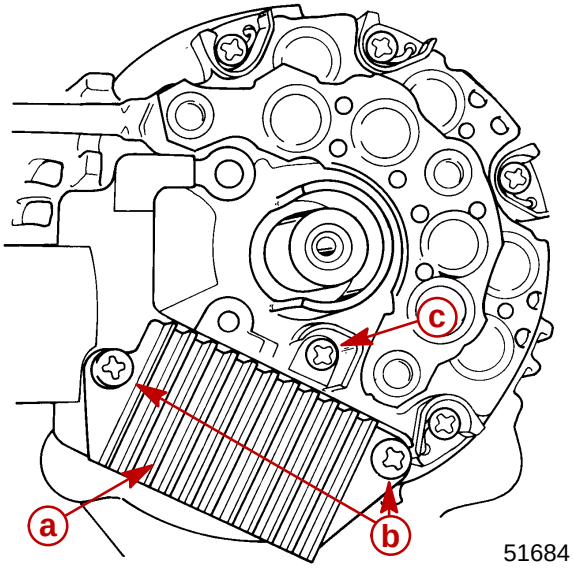
51683



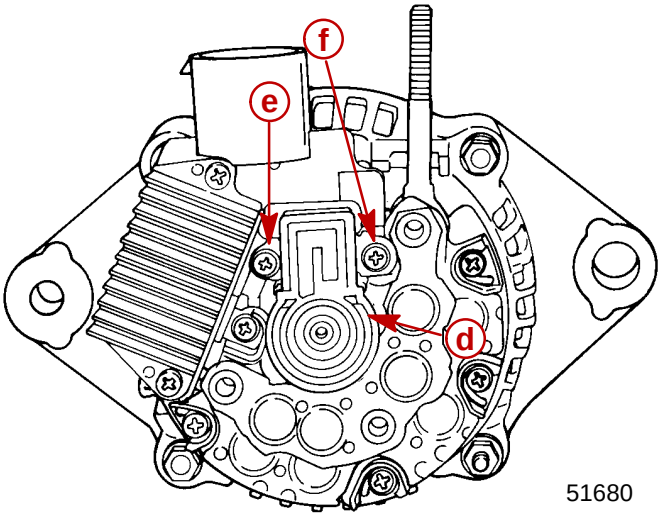
51684

a - Rectifier Assembly
b - Stator Leads
c - Stator Leads
d - Screws (4) [Torque to 17 lb-in (1.9 Nm)]

3. Secure regulator to alternator with 2 screws [1 in. (25.4 mm) long]; 1 screw [0.25 in. (6.4 mm) long] and lockwashers. DO NOT tighten screws at this time.
4. Secure brush assembly with 2 screws – [0.25 in. (6.4 mm) long] and [0.312 in. (8.0 mm) long].



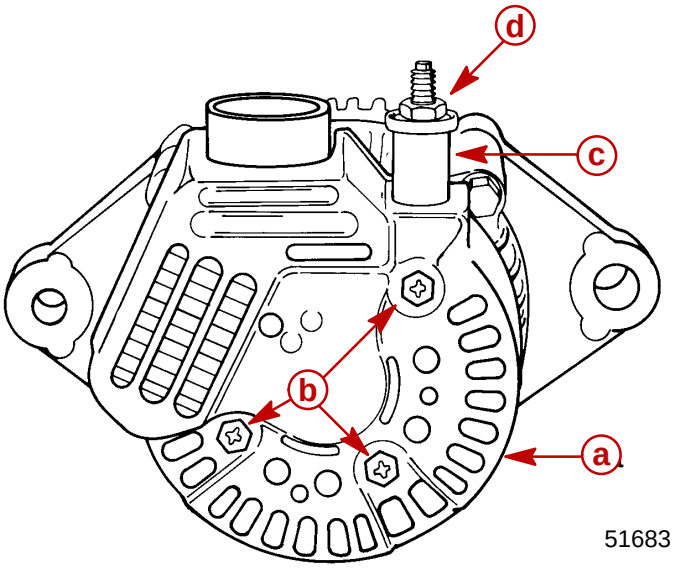
51684



51680

a - Regulator
b - Screws (2) [1 in. (25.4 mm)]
c - Screw (1) [0.25 in. (6.4 mm)]
d - Brush Assembly
e - Screw (1) [0.25 in. (6.4 mm)]
f - Screw (1) [0.312 in. (8.0 mm)]

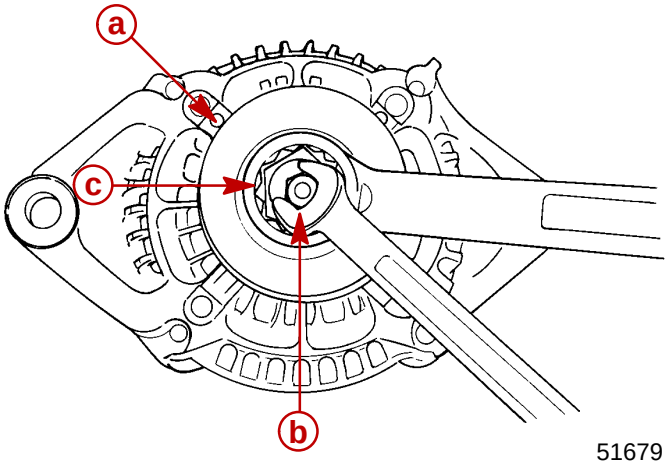
5. Install end cover. Secure cover with 3 screws. Torque screws to 23 lb-in. (2.5 Nm). Install terminal insulator. Torque nut to 36 lb-in (4 Nm).

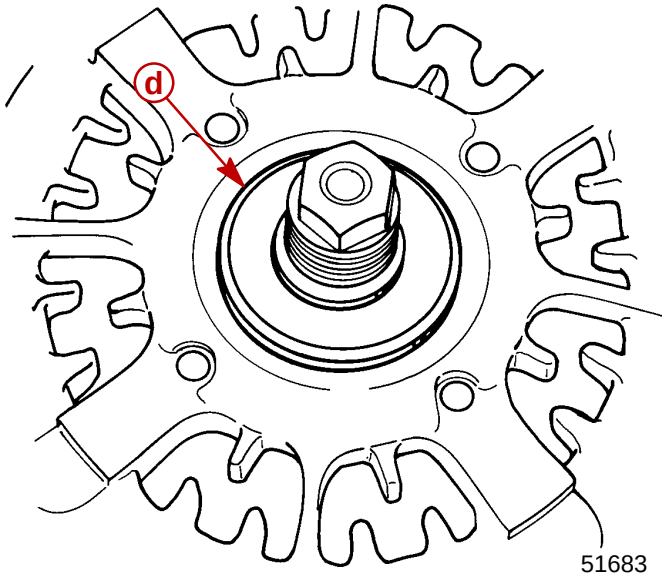


a - Cover
b - Screws (3) [Torque to 23 lb-in (2.5 Nm)]
c - Terminal Insulator
d - Nut [Torque to 36 lb-in. (4 Nm)]

Pulley

1. While holding rotor shaft, remove pulley nut.
2. Before reinstalling pulley, verify spacer is installed on rotor shaft.



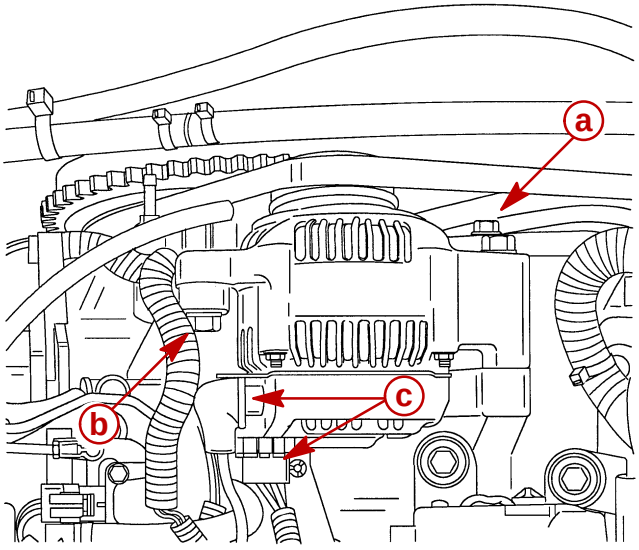


a - Pulley
b - Rotor Shaft
c - Nut
d - Spacer

3. Torque pulley nut to 50 lb-ft (68 Nm).

Installation

1. Secure alternator to engine block with attaching bolts. Torque top bolt to 40 lb-ft (54 Nm). Torque bottom bolt to 35 lb-ft (47.5 Nm).
2. Install alternator belt in V-groove of flywheel and alternator pulley.
3. Reconnect electrical harness to alternator.

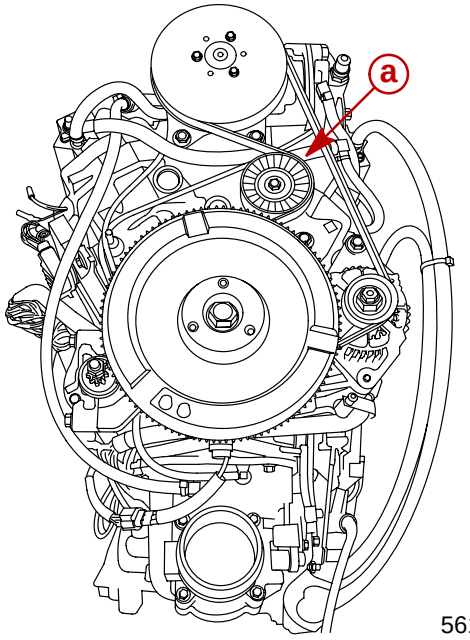


56117

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

Alternator Belt Tension Adjustment

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



56142

a - Belt Tensioner Assembly

Starter System

Starter Motor Amperes Draw

STARTER MOTOR PART NO.	NO LOAD AMP. DRAW	NORMAL AMP. DRAW
50-833153-1	30 AMPS	165 AMPS

Starter System Components

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

Description

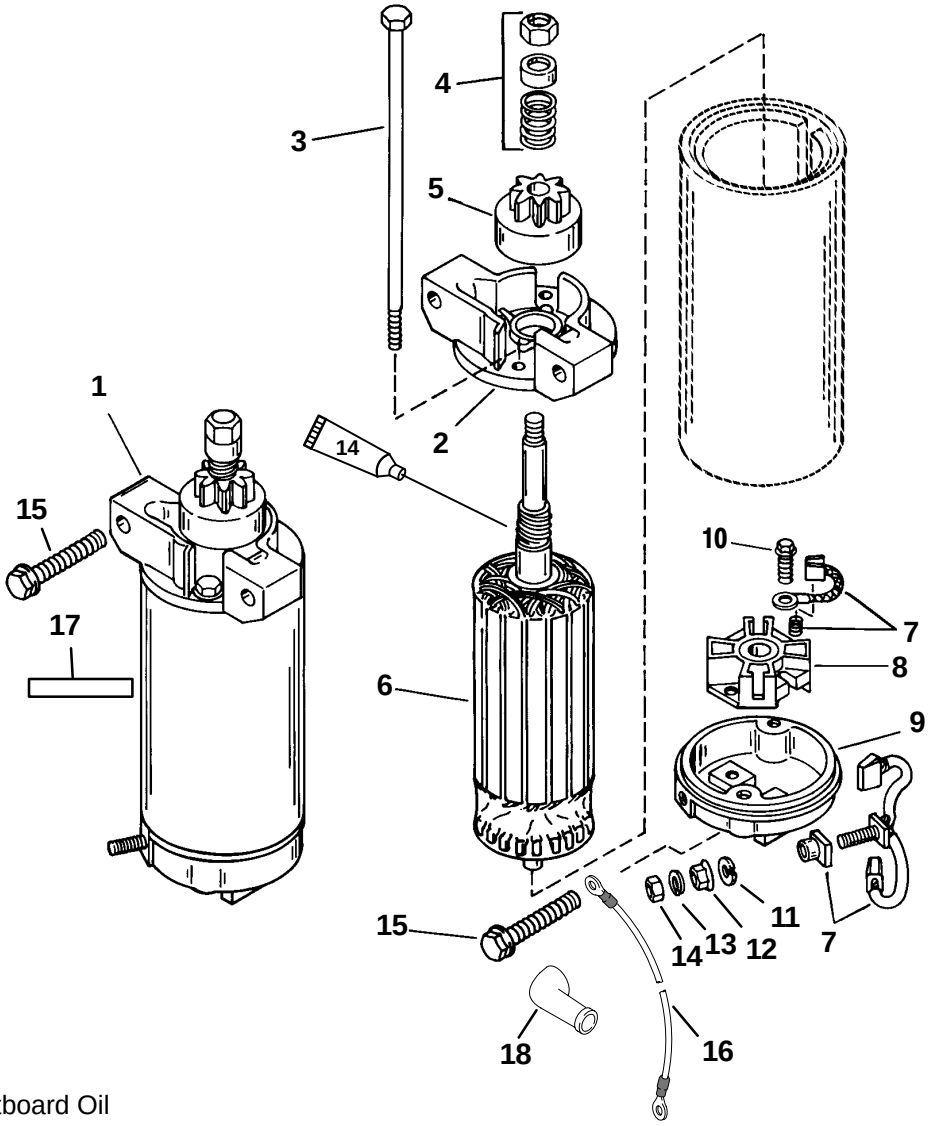
The battery supplies electricity to activate the starter motor. When the ignition is turned to the “START” position, the starter solenoid is energized and completes the starter circuit between the battery and starter.

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



14 2 Cycle Outboard Oil

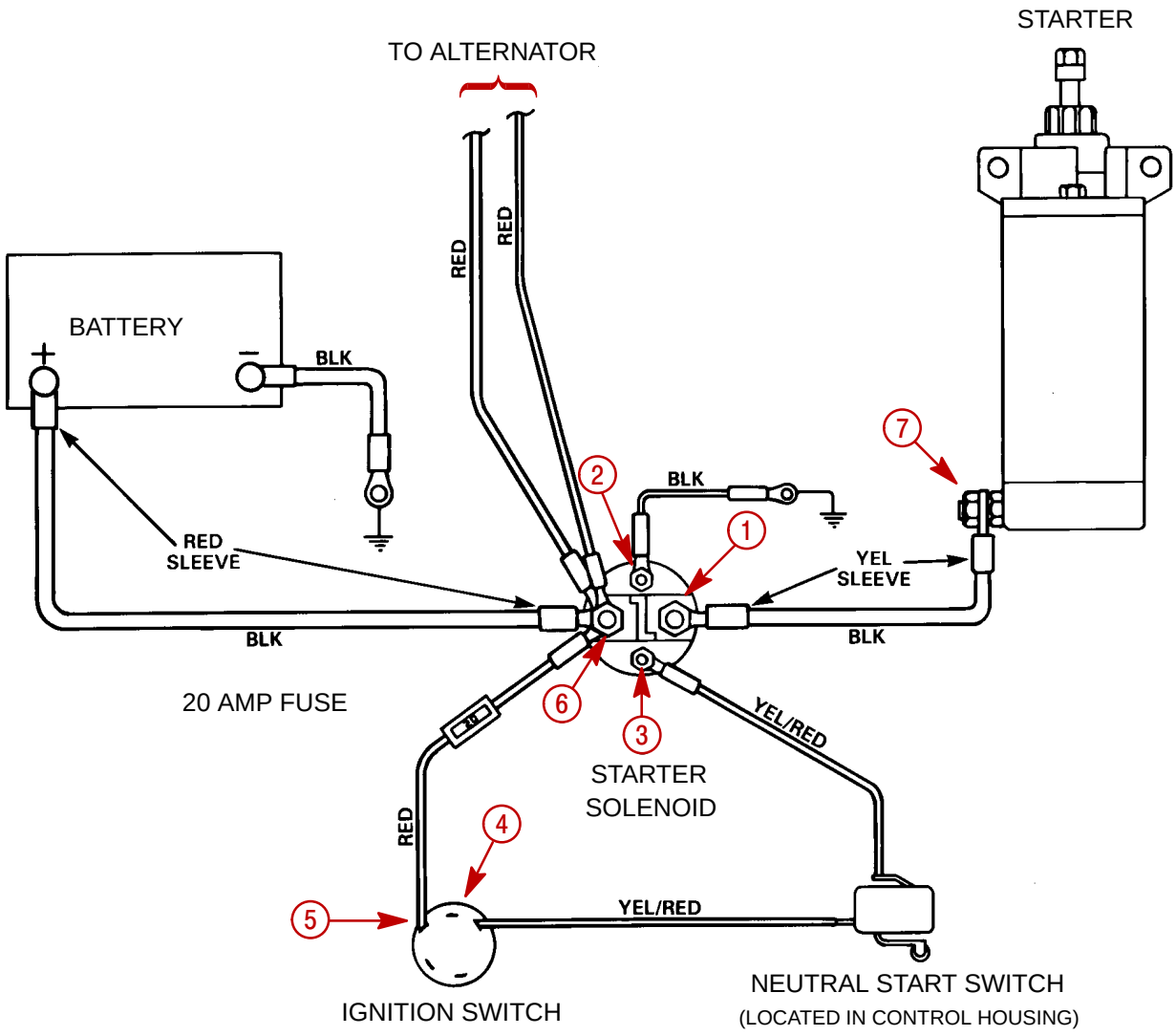
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	STARTER MOTOR			
2	1	DRIVE CAP			
3	2	THRU BOLT	70		8
4	1	DRIVE KIT			
5	1	PINION			
6	1	ARMATURE			
7	1	BRUSH/SPRING KIT			
8	1	BRUSH HOLDER			
9	1	COMMUTATOR CAP			
10	2	SCREW	Drive Tight		
11	1	LOCKWASHER			
12	1	NUT (1/4-20)	35		4.0
13	1	LOCKWASHER			
14	1	NUT (1/4-20)	35		4.0
15	3	SCREW (5/16-18 x 1-3/4)		17.5	24
16	1	BATTERY CABLE **(NEGATIVE)**			
17	1	DECAL-Warning-High Voltage			
18	1	BOOT			

Troubleshooting the Starter Circuit

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

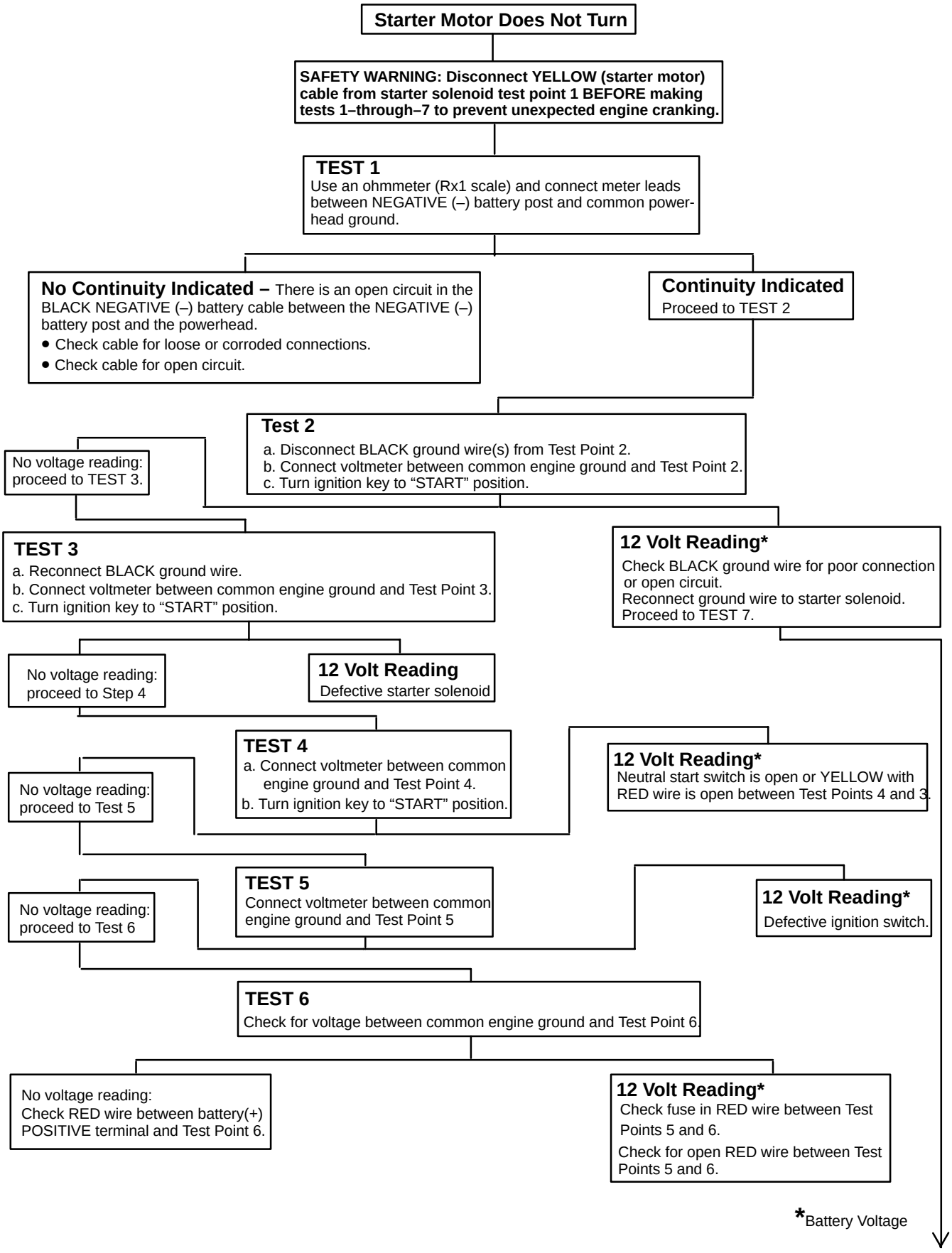
1. Confirm that battery is fully charged.
2. Check that control lever is in NEUTRAL position.
3. Check terminals for corrosion and loose connections.
4. Check cables and wiring for frayed and worn insulation.
5. Check 20 amp fuse.

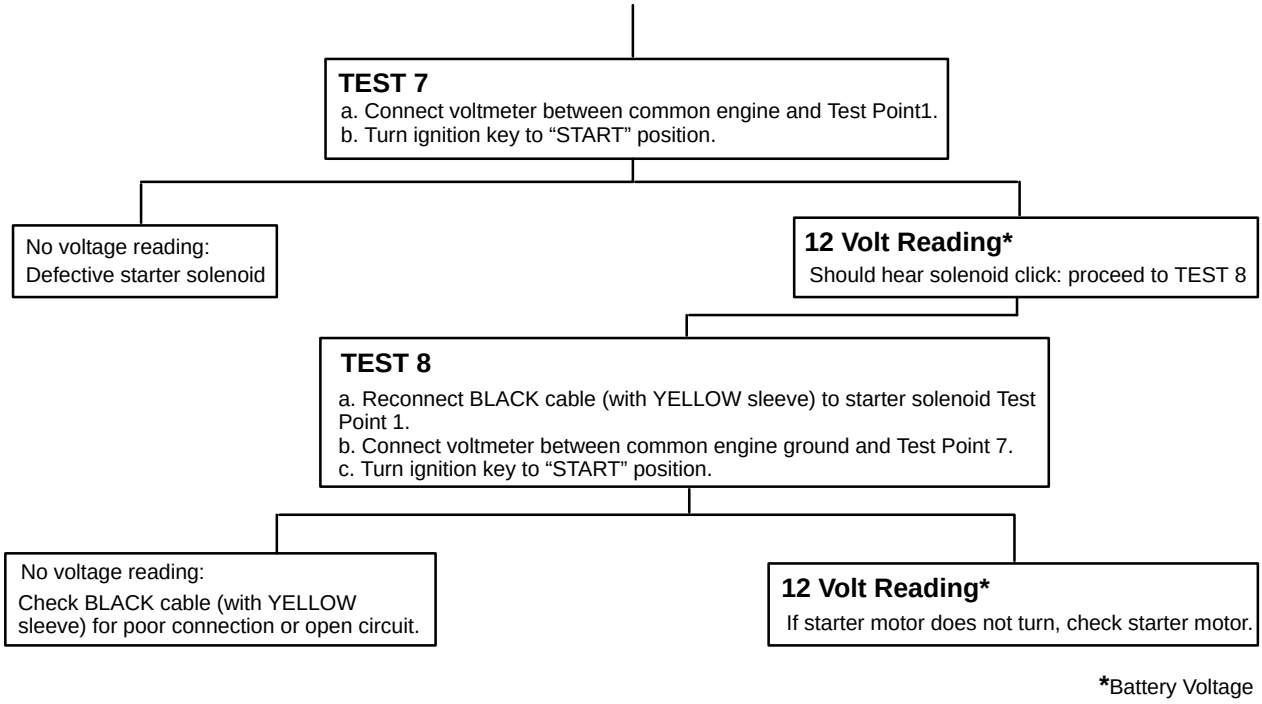
Location of Test Points (called out in flow chart) are numbered below.



Starter Circuit

Starter Circuit Troubleshooting Flow Chart





*Battery Voltage

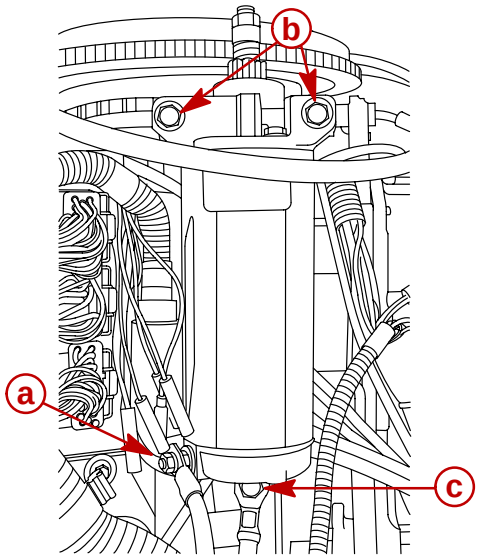
Starter Removal and Installation

Removal

⚠ CAUTION

Disconnect battery leads from battery before removing starter.

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

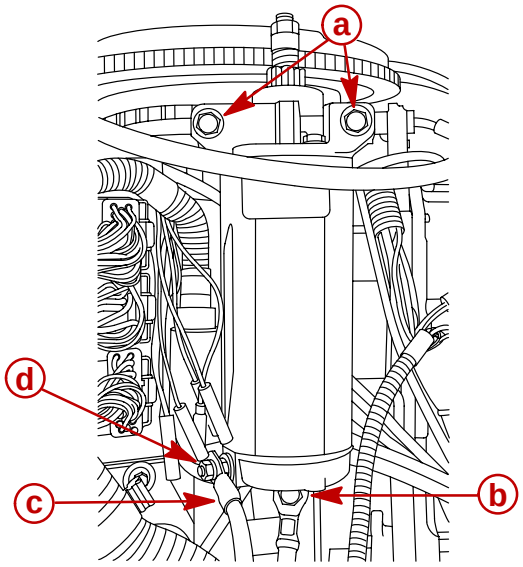


52135

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

Installation

1. Secure starter to engine with 3 bolts. Use Left top bolt to attach BLACK NEGATIVE (–) battery cable.
2. Torque top attaching bolts to 23 lb-ft (31 Nm). Torque bottom attaching bolt to 21 lb-ft (28.5 Nm).
3. Secure BLACK cable (with YELLOW sleeve) to POSITIVE (+) terminal on starter. Torque nut to 60 lb-in (7 Nm).

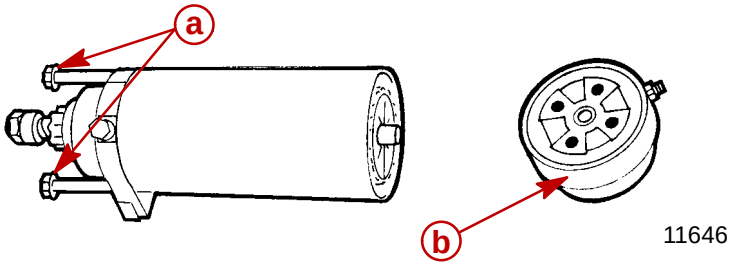


52135

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

Disassembly

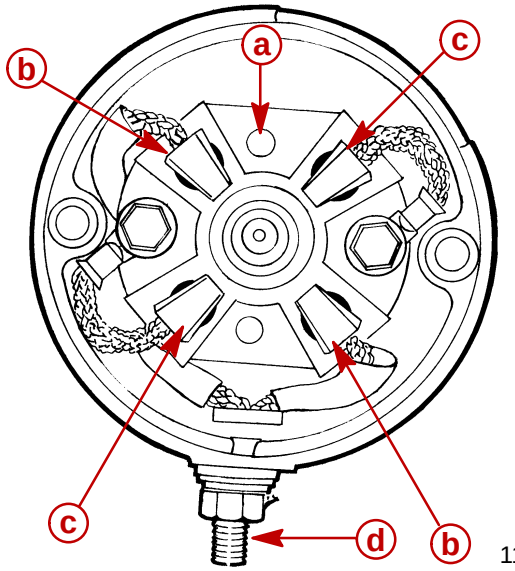
1. Remove starter as outlined in **Starter Removal and Installation** (preceeding).
2. Remove 2 thru-bolts from starter.
3. Tap commutator end cap to loosen and remove from frame. Do not loose brush springs.



11646

a - Thru-Bolts
b - Commutator End Cap

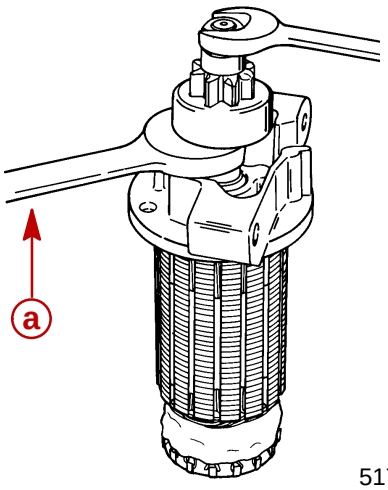
4. Brush replacement is recommended if brushes are pitted, chipped or worn to less than 0.25 in. (6.4 mm). If necessary, remove brushes as follows:
   a. Remove hex nut and washers from POSITIVE (+) terminal and remove POSITIVE brushes and terminal as an assembly.
   b. Remove 2 bolts securing NEGATIVE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



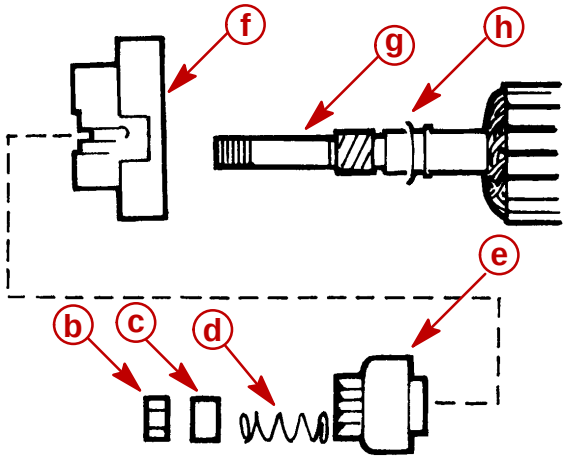
11656

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

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



51711



11658

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

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. (6.4 mm) in length.
6. Inspect the armature conductor (commutator bar junction) for a tight connection. A loose connection (excessive heat from prolonged cranking melts solder joints) results in a burned commutator bar.
7. Resurface and undercut a rough commutator as follows:

⚠ CAUTION

Do not turn down the commutator excessively.

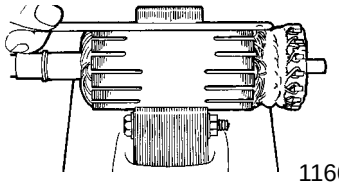
   a. Resurface the commutator and undercut the insulation between the commutator bars 1/32 in. (0.8mm) to the full width of the insulation and so that the undercut is flat.
   b. Clean the commutator slots after undercutting.
   c. Sand the commutator lightly with No. 00 sandpaper to remove burrs, then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

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 **Testing** (following).

Testing

ARMATURE TEST FOR SHORTS

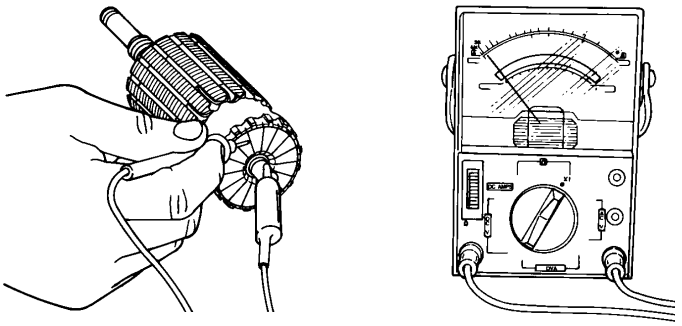
Check armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. If saw blade vibrates, armature is shorted. Recheck after cleaning between commutator bars. If saw blade still vibrates, replace armature.



11669

ARMATURE TEST FOR GROUND

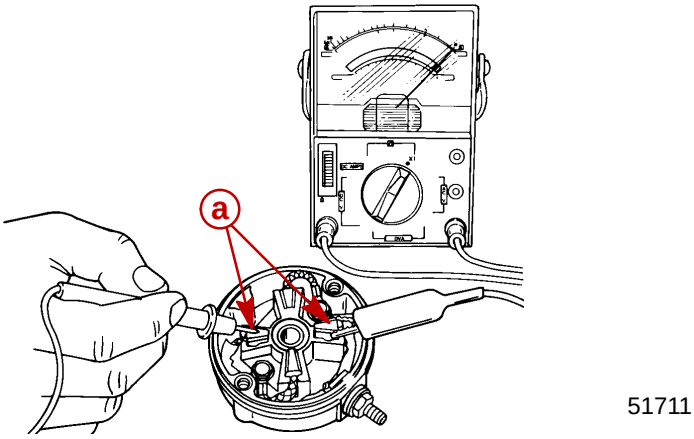
1. Set ohmmeter to (R x 1 scale). Place one lead of ohmmeter on armature core or shaft and other lead on commutator.
2. If meter indicates continuity, armature is grounded and must be replaced.



51711

CHECKING POSITIVE BRUSHES AND TERMINAL

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

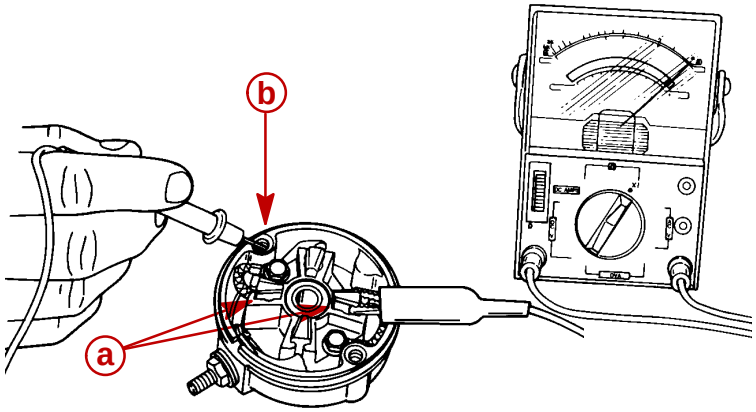


51711

a - POSITIVE (+) Brushes

TESTING NEGATIVE BRUSHES FOR GROUND

3. 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).
4. If meter indicates NO continuity, replace the NEGATIVE brush. Repeat this procedure on the other NEGATIVE brush.

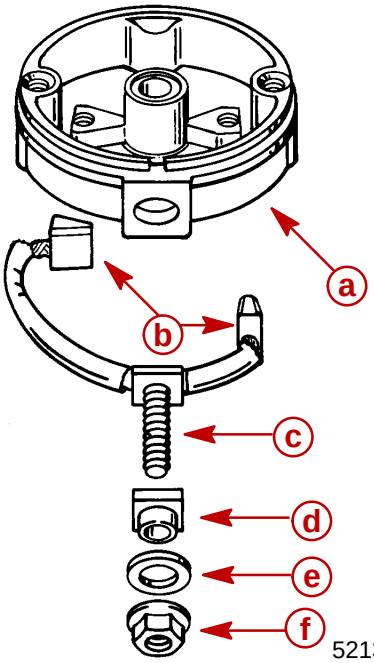


51711

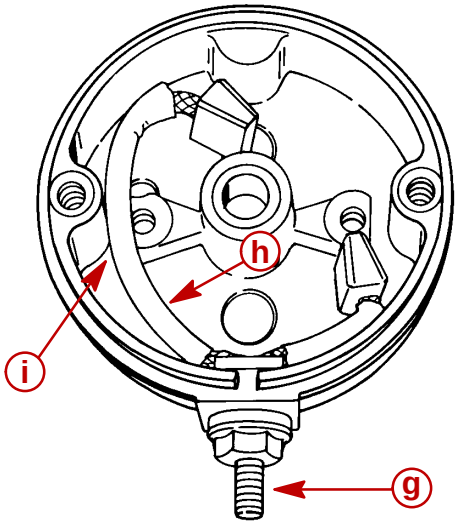
a - NEGATIVE (–) Brushes
b - End Cap

Starter Reassembly

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



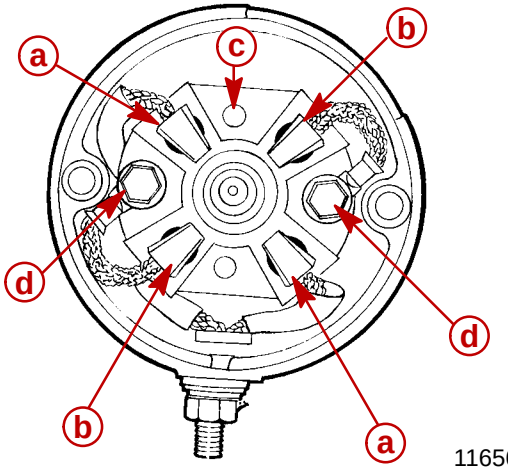
52131



51713

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

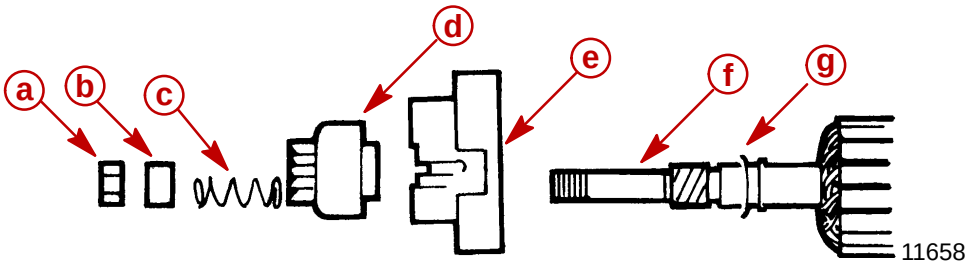
b. Install NEGATIVE brushes (along with brush holder).



11656

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

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

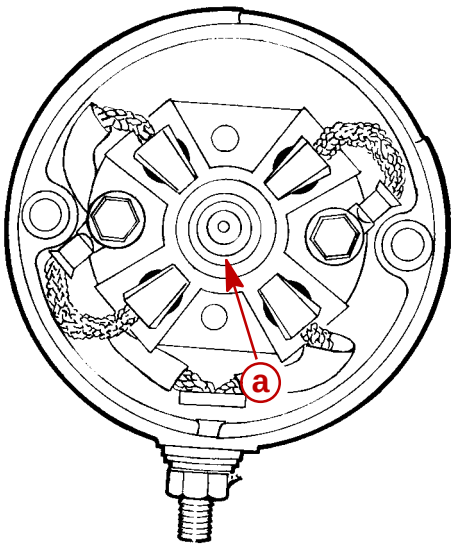


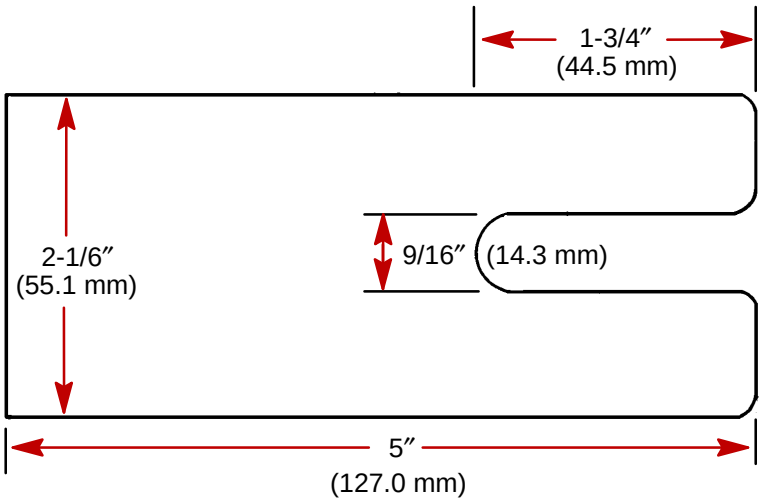
11658

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 4-Stroke Outboard Oil.
4. Lubricate bushing in drive end plate with a drop of 4-Stroke Outboard Oil.
5. Position armature into starter frame.
6. Lubricate bushing (located in commutator end cap) with a drop of 4-Stroke Outboard Oil. DO NOT overlubricate.

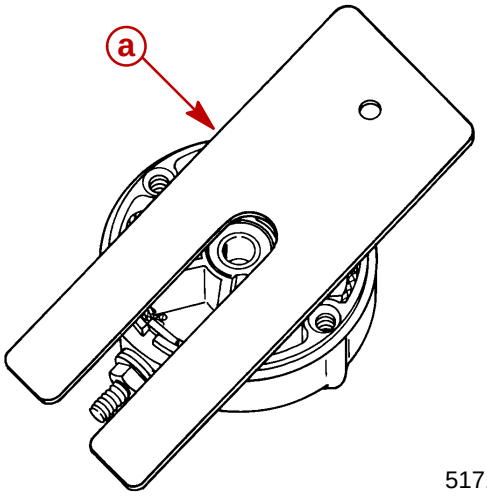
7. To prevent damage to brushes and springs when installing commutator end cap, it is recommended that a brush retaining tool be made as shown:



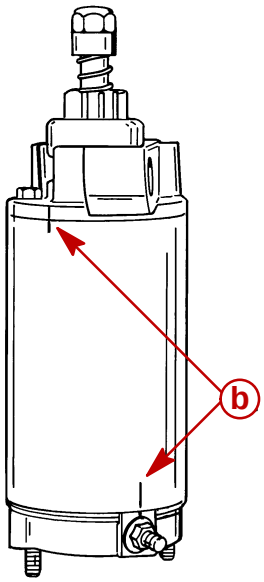


a - Bushing (DO NOT overlubricate)

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



51713

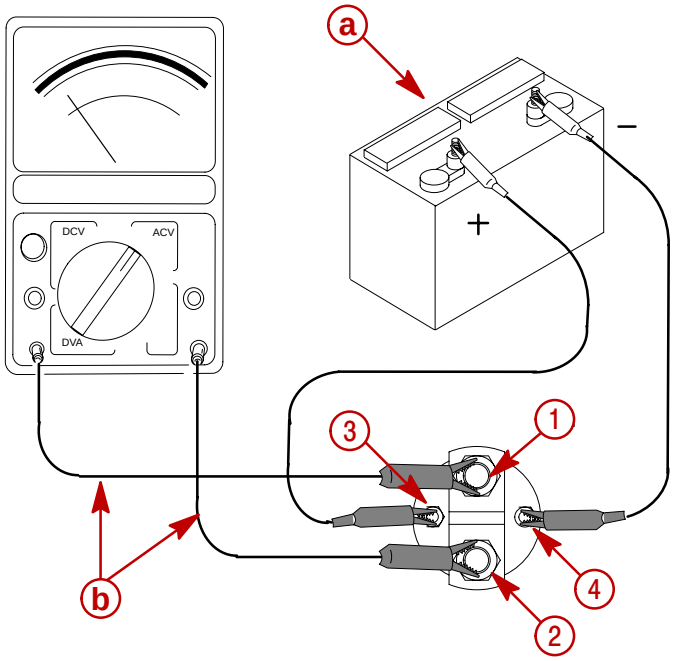


52130

a - Brush Retainer Tool
b - Alignment Marks

Starter Solenoid Test

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

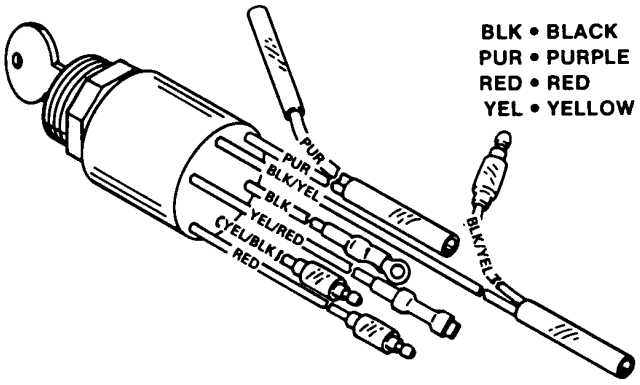


a - 12-VOLT Supply
b - VOA Leads

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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Throttle Plate Screw 2C-5
Throttle Position Sensor (TPS) Adjustment 2C-5
Idle Speed 2C-5

2C

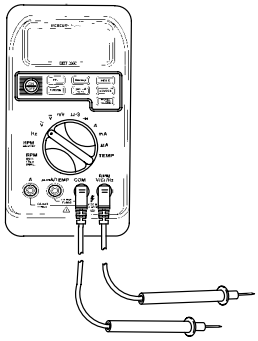
Specifications

FULL THROTTLE RPM RANGE	5000 - 5600
IDLE RPM (IN FORWARD GEAR)	550 ± 25
MAXIMUM TIMING: @ WIDE OPEN	Not Adjustable Controlled by ECM
IDLE TIMING	Not Adjustable Controlled by ECM
SPARK PLUG TYPE **LIGHT DUTY** **HEAVY DUTY** **SPARK PLUG GAP**	 NGK: ZFR5F-11 Champion RC12MC4 NGK: PZFR5F-11 (Heavy Duty)* 0.040 in. (1.0 mm)
FIRING ORDER	1-2-3-4-5-6
THROTTLE POSITION SENSOR 1 (INNER TPS) **@ IDLE** **@ W.O.T.**	 3.70 - 4.90 VDC 0.30 - 1.80 VDC
THROTTLE POSITION SENSOR 2 (OUTER TPS) **@ IDLE** **@ W.O.T.**	 0.10 - 1.50 VDC 3.20 - 4.90 VDC

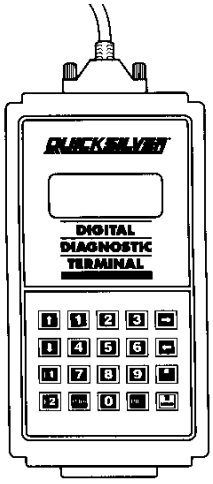
*Standard with engine

Special Tools

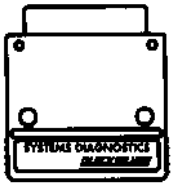
1. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1



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



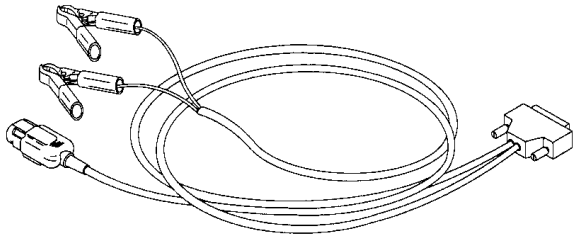
3. Software Cartridge 91-822608--4, --5, or --6



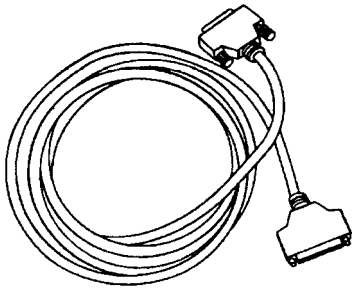
4. DDT Reference Manual 90-825159-2, -3, -4



5. ECM Harness 84-822560--5



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



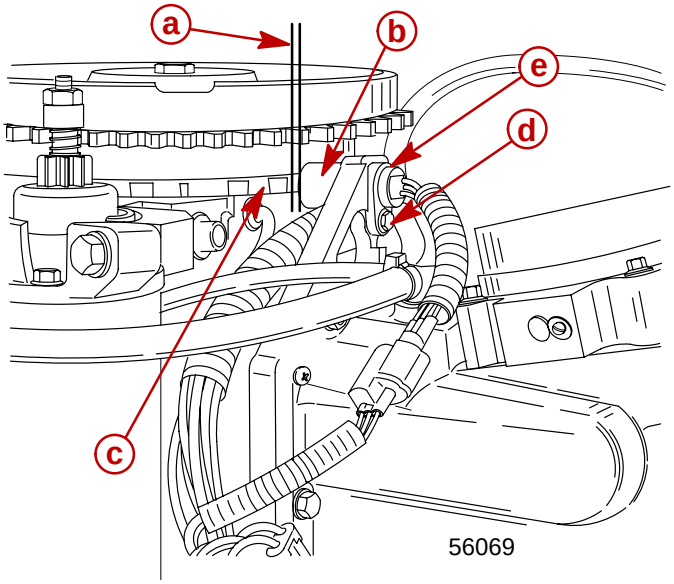
Crank Position Sensor

NOTE: *Crank Position Sensor is normally not adjustable, but shims are available if sensor is found to be to close to flywheel.*

1. Remove flywheel cover.
2. Using a feeler gauge, measure the air gap between the crank position sensor and a tooth on the flywheel. Gap should be 0.025 in. - 0.040 in. (0.635 mm - 1.02 mm).

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

3. Reinstall flywheel cover.

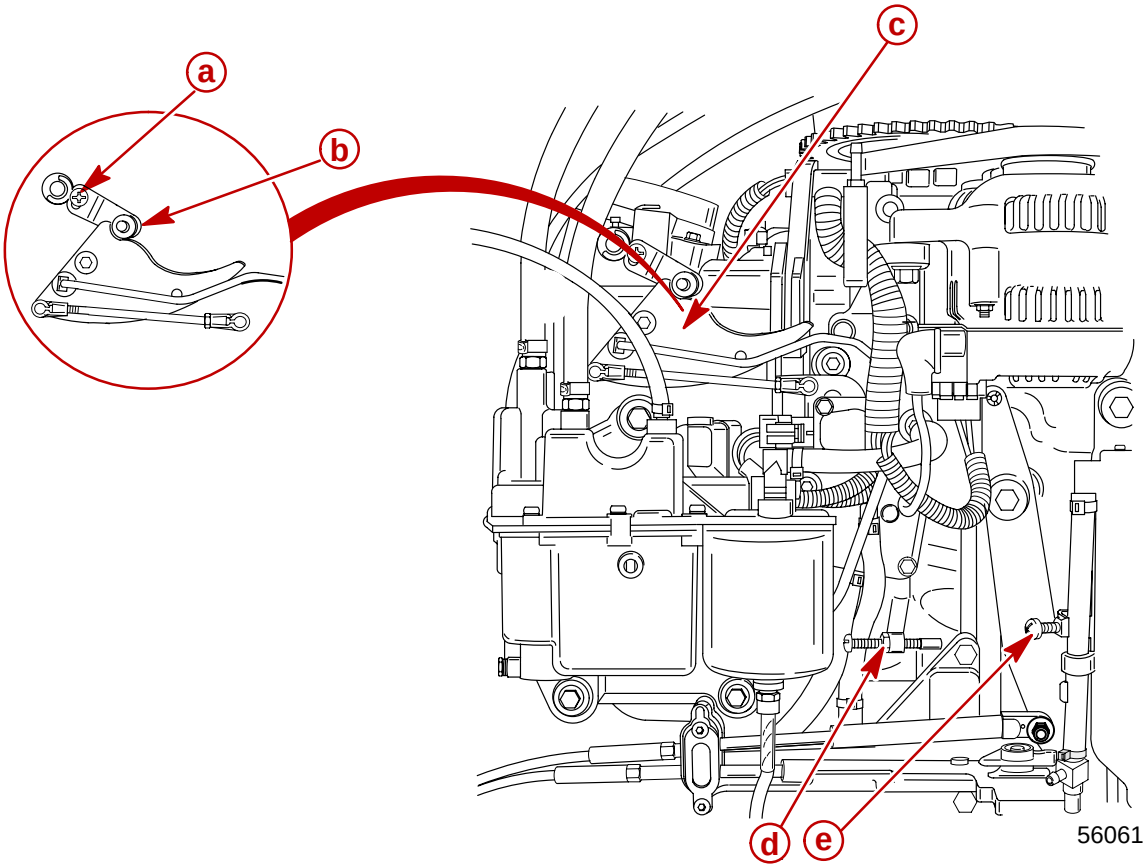


a - Air Gap [0.025 in - 0.040 in.(0.635 mm - 1.02 mm)]
b - Crank Position Sensor
c - Flywheel Tooth
d - Bracket Screw (Drive Tight)
e - 0.010 in. (0.254 mm) or 0.020 in. (0.508 mm) Shim if required – refer to parts manual

Throttle Cam Adjustment

NOTE: *Low pressure electric fuel pump is removed for viewing purpose.*

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

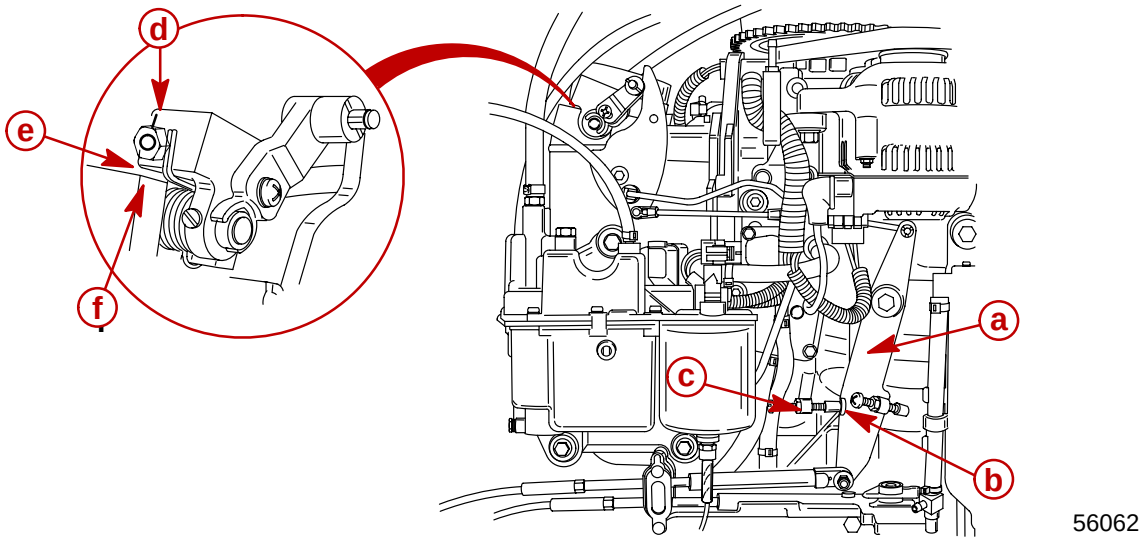


a - Roller Arm Screw
b - Roller
c - Throttle Cam
d - Wide Open Throttle Stop Screw
e - Idle Stop Screw

Maximum Throttle

1. Hold throttle arm against full throttle stop.
2. Adjust full throttle stop screw (located behind electric fuel pump) to allow full throttle valve opening while maintaining a 0.020 in. (0.508 mm) clearance between arm of throttle shaft and stop on attenuator box.
3. Tighten jam nut on full throttle stop screw.

4. Check for free play (roller lifts from cam) between roller and cam at full throttle to prevent linkage from binding. Readjust full throttle stop screw, if necessary.

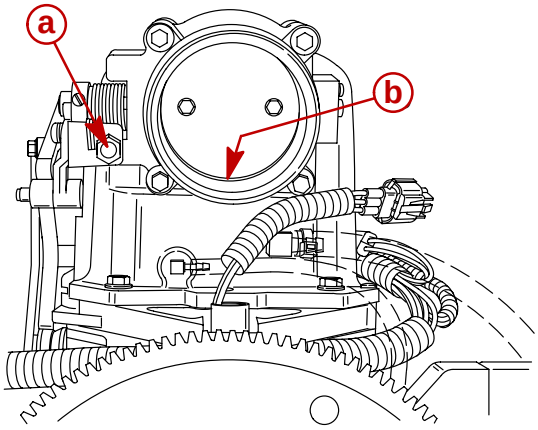


56062

a - Throttle Arm
b - Stop
c - Full Throttle Stop Screw
d - Throttle Shaft Arm
e - 0.020 in. (0.508 mm) Clearance
f - Stop on Attenuator Box

Throttle Plate Screw

IMPORTANT: DO NOT adjust throttle plate stop screw from factory setting. However, should the throttle plate require adjustment, use the throttle plate stop screw to set the throttle plate clearance @ 0.045 in. (1.143 mm) using a #56 drill.



56151

a - Throttle Plate Stop Screw
b - Throttle Plate Clearance – Set @ 0.045 in. (1.143mm)

Throttle Position Sensor (TPS) Adjustment

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

Idle Speed

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

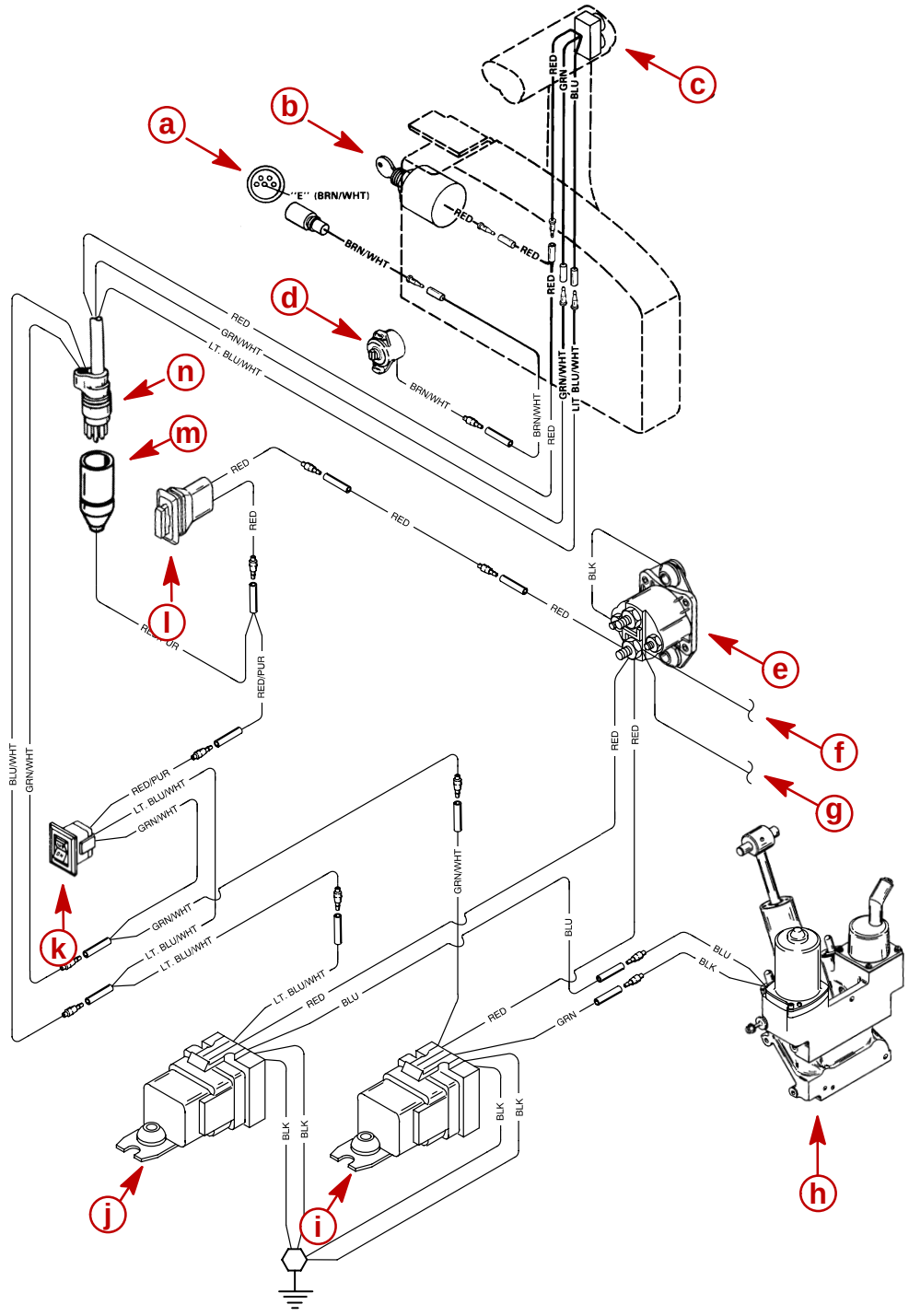
ELECTRICAL

Section 2D – Wiring Diagrams

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Oil Level Gauge Wiring Diagram 2D-7
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Power Trim Wiring Diagram



a - Tachometer 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.)

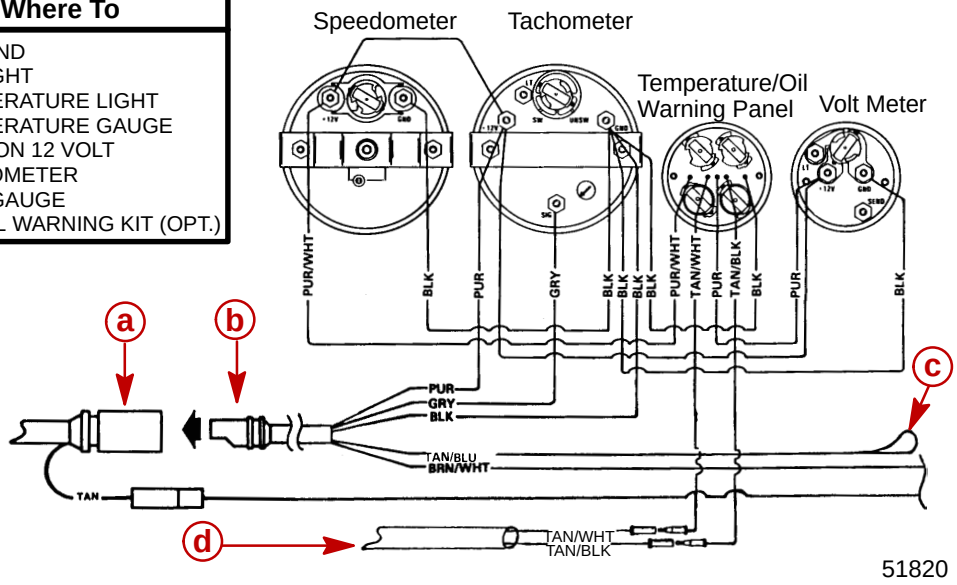


Figure 1 – Without Light Switch

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

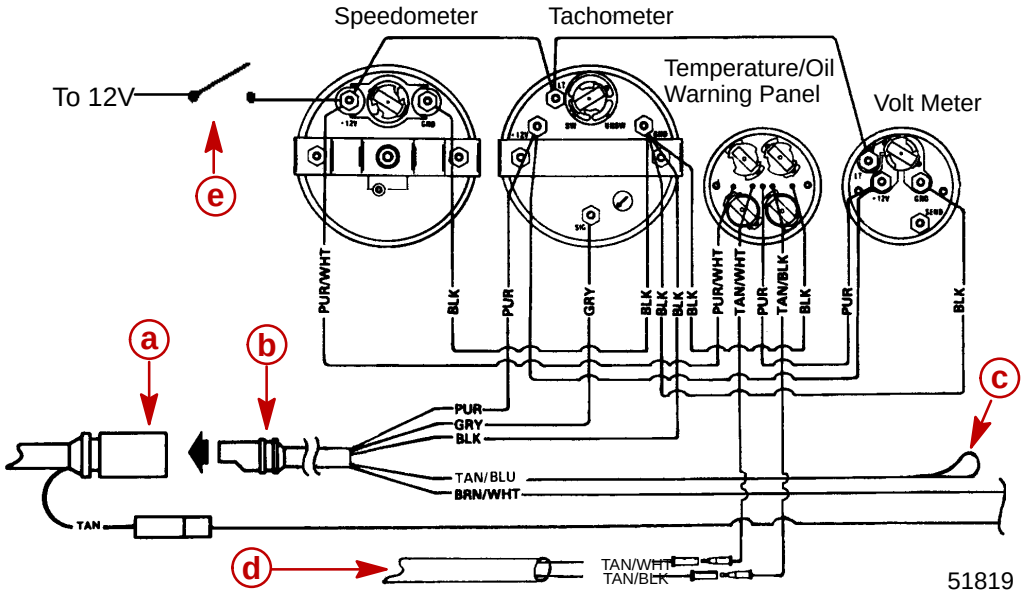
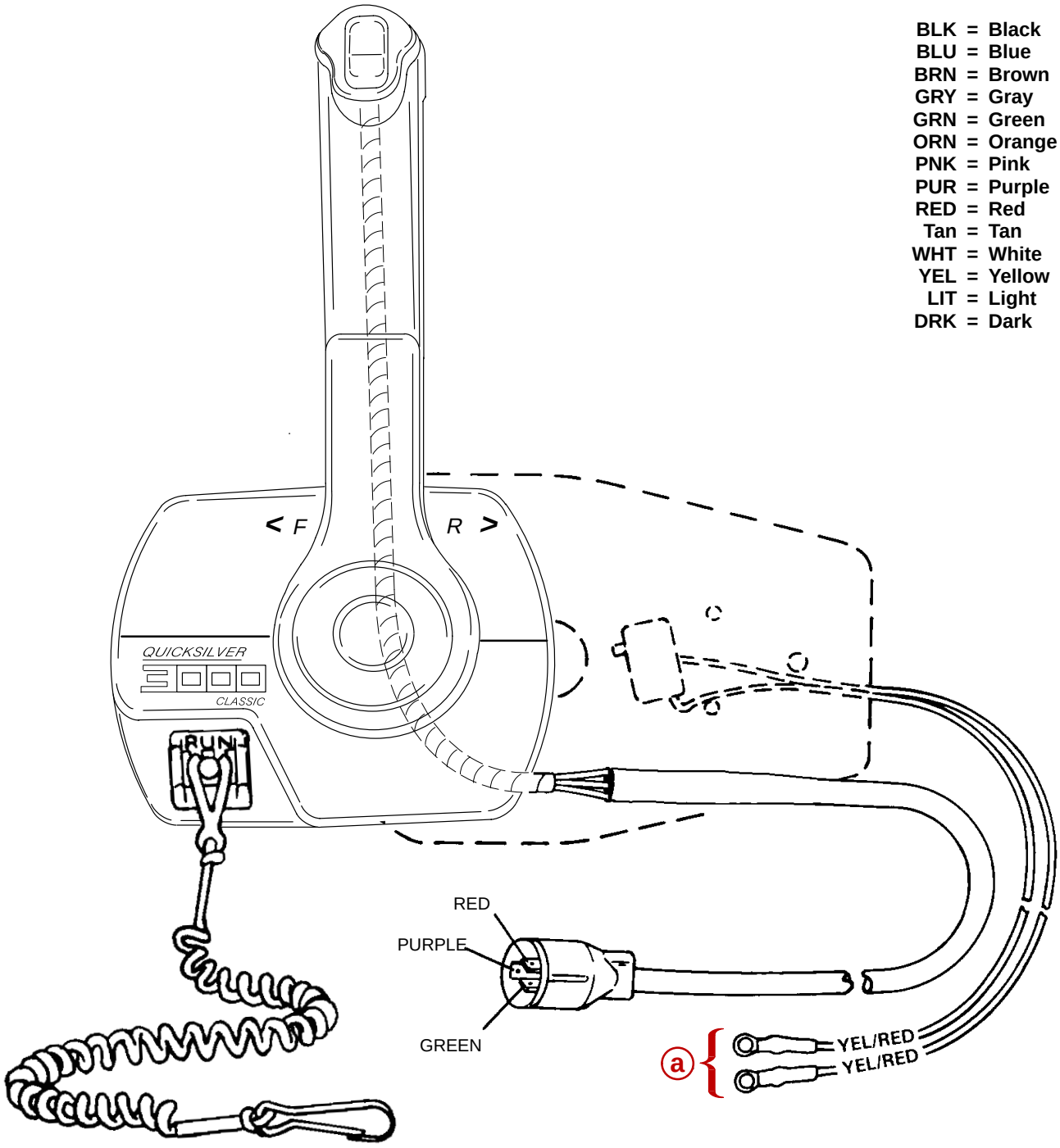


Figure 2 – With Light Switch

- **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** - Cable Extension (For Two Function Warning Panel)
- **e** - Light Switch

Commander 3000 Classic Panel Remote Control

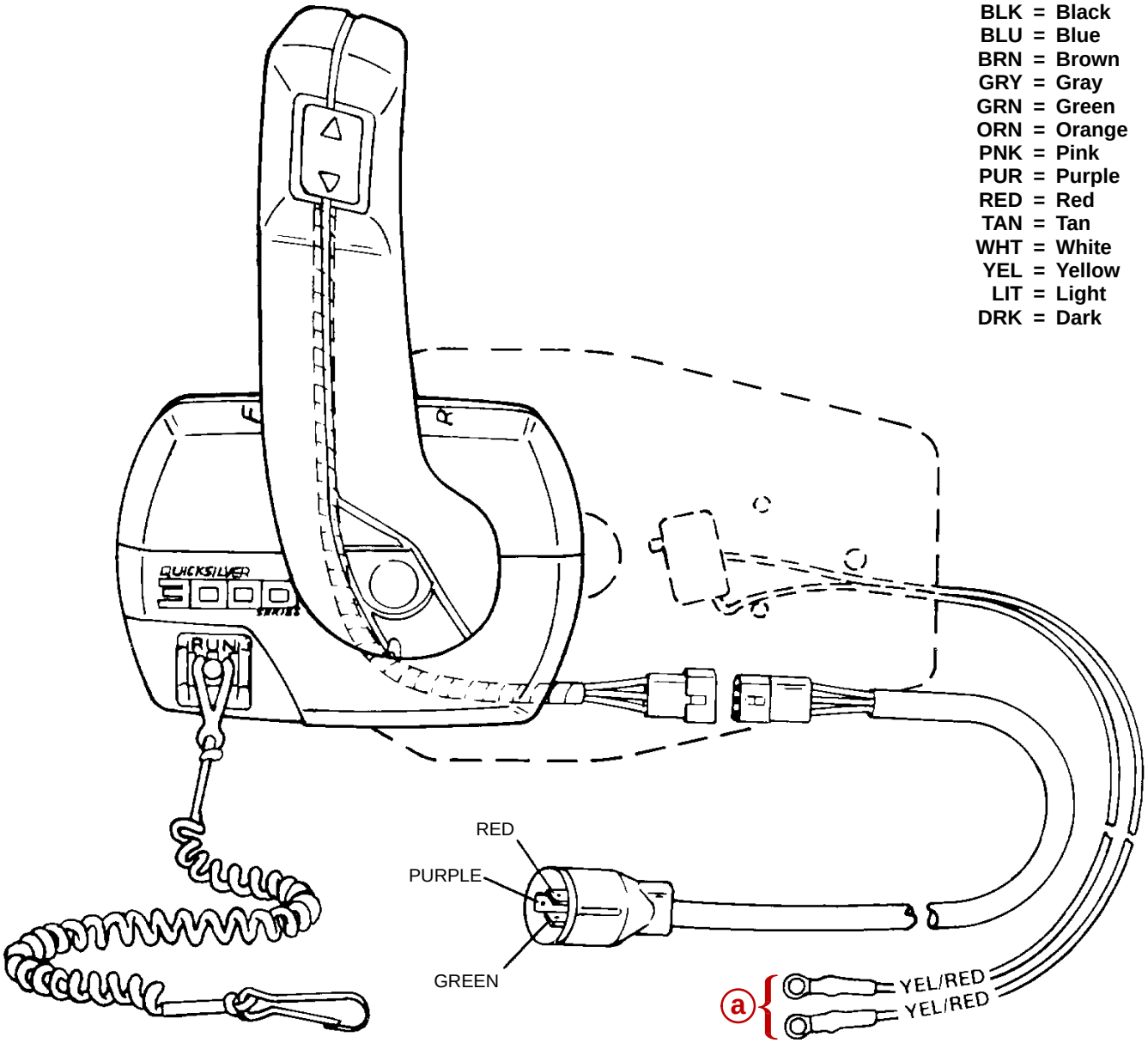
BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
Tan = Tan
WHT = White
YEL = Yellow
LIT = Light
DRK = Dark



a - Neutral Interlock Switch

Commander 3000 Panel Remote Control

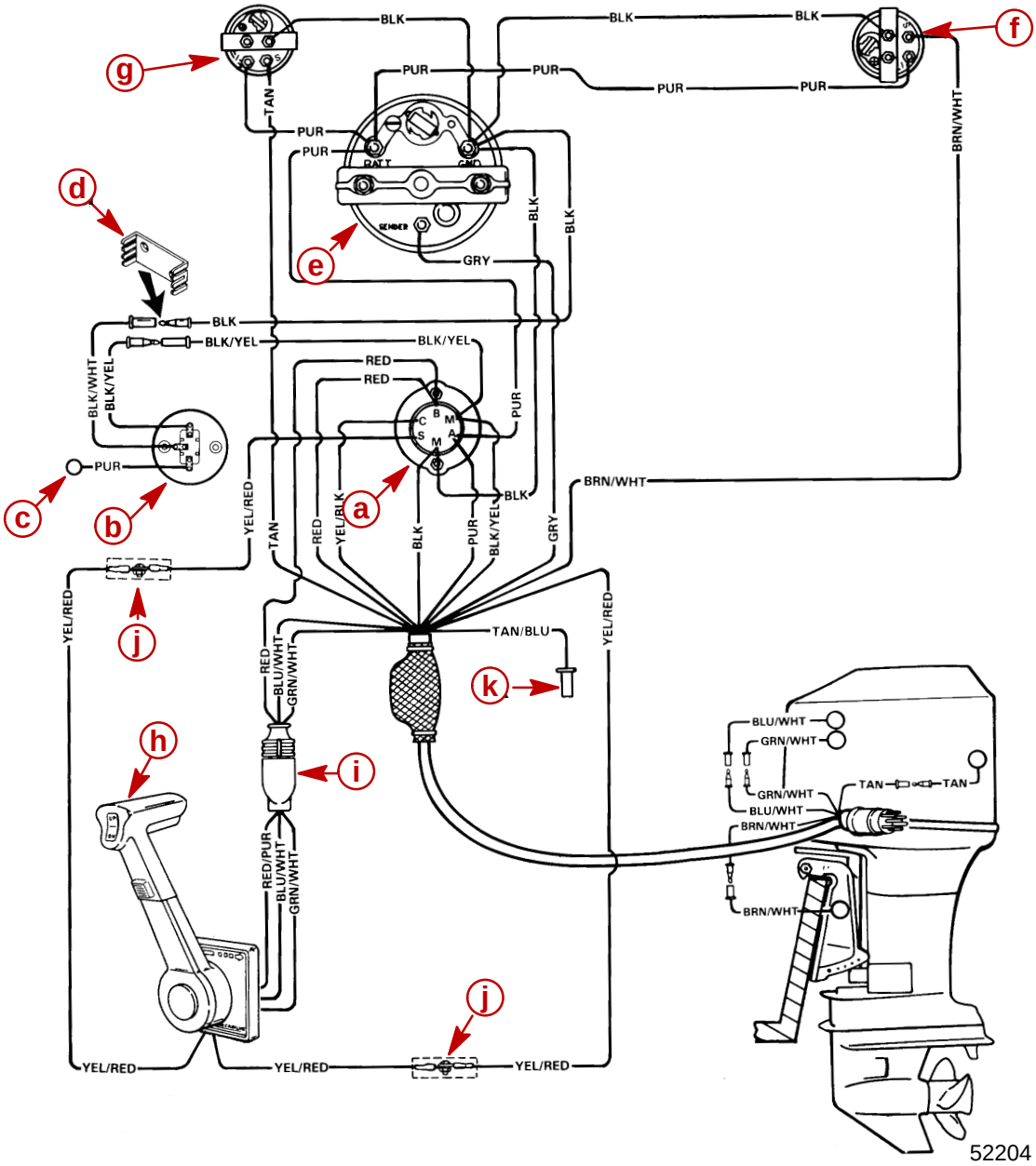
BLK = Black
BLU = Blue
BRN = Brown
GRY = Gray
GRN = Green
ORN = Orange
PNK = Pink
PUR = Purple
RED = Red
TAN = Tan
WHT = White
YEL = Yellow
LIT = Light
DRK = Dark



a - Neutral Interlock Switch

Instrument/Lanyard Stop Switch Wiring Diagram

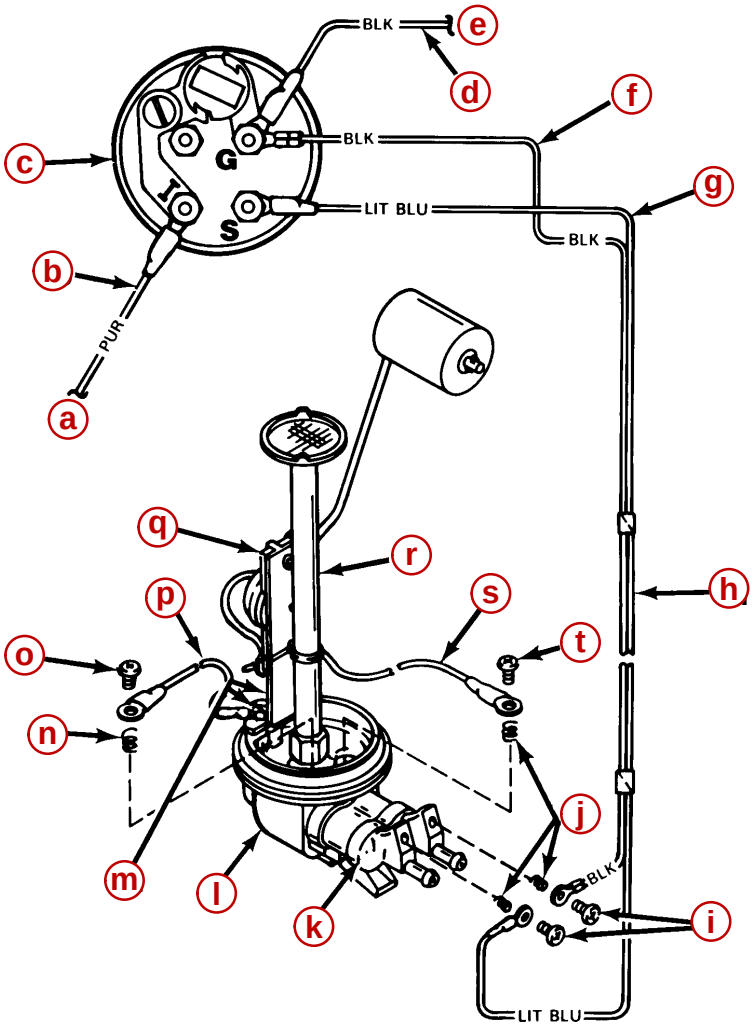
BLK=BLACK
BLU=BLUE
BRN=BROWN
GRN=GREEN
GRY=GRAY
PUR=PURPLE
RED=RED
TAN=TAN
WHT=WHITE
YEL=YELLOW



a - Ignition/Choke Switch
b - Lanyard Stop Switch
c - Lead Not Used on Outboard Installations
d - Retainer
e - Tachometer
f - Trim Indicator Gauge (Optional)
g - Temperature Gauge
h - Remote Control
i - Power Trim Harness Connector
j - Connect Wires Together with 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.

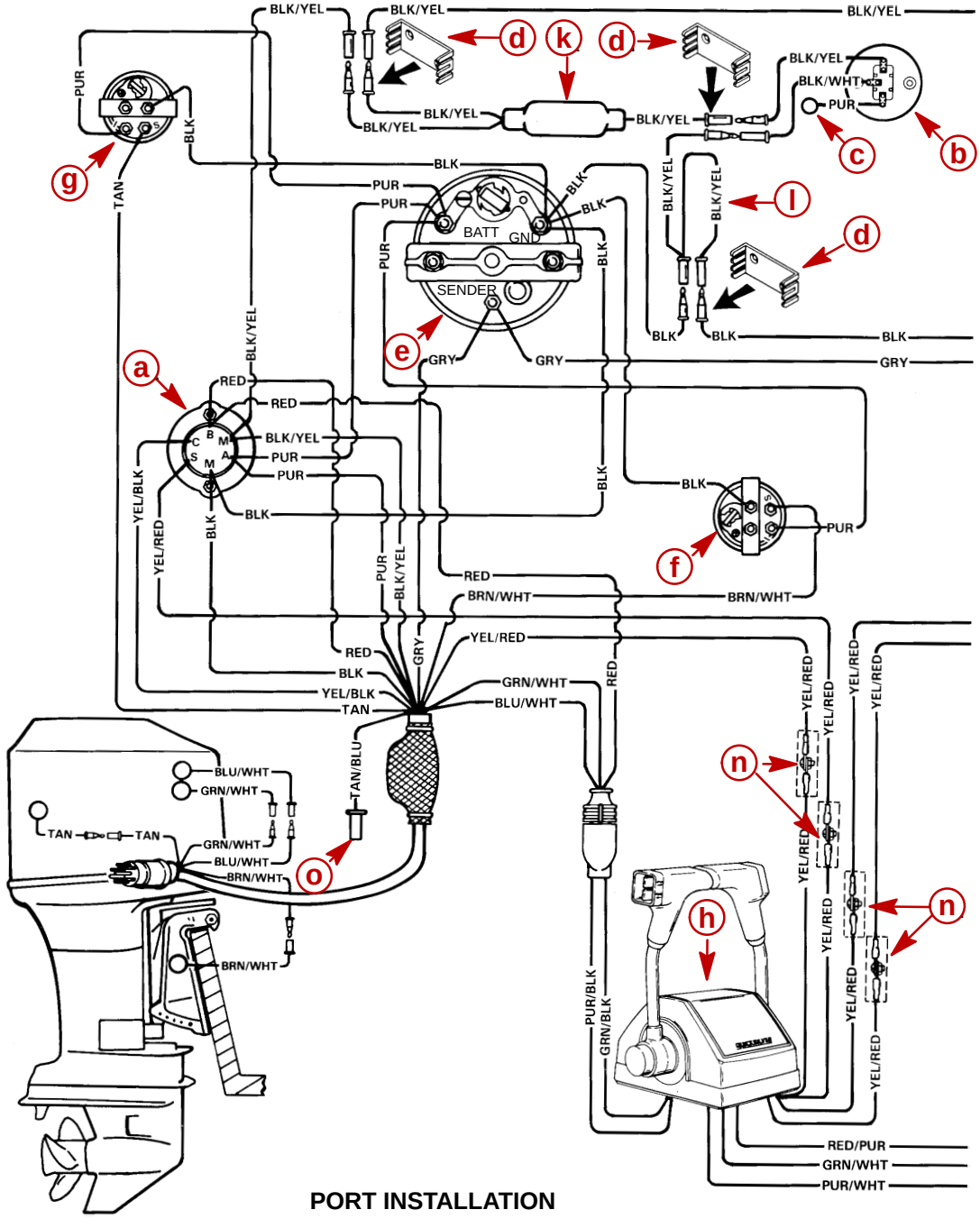
Oil Level Gauge Wiring Diagram



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.)

Instrument/Lanyard Stop Switch Wiring Diagram (Dual Outboard)

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

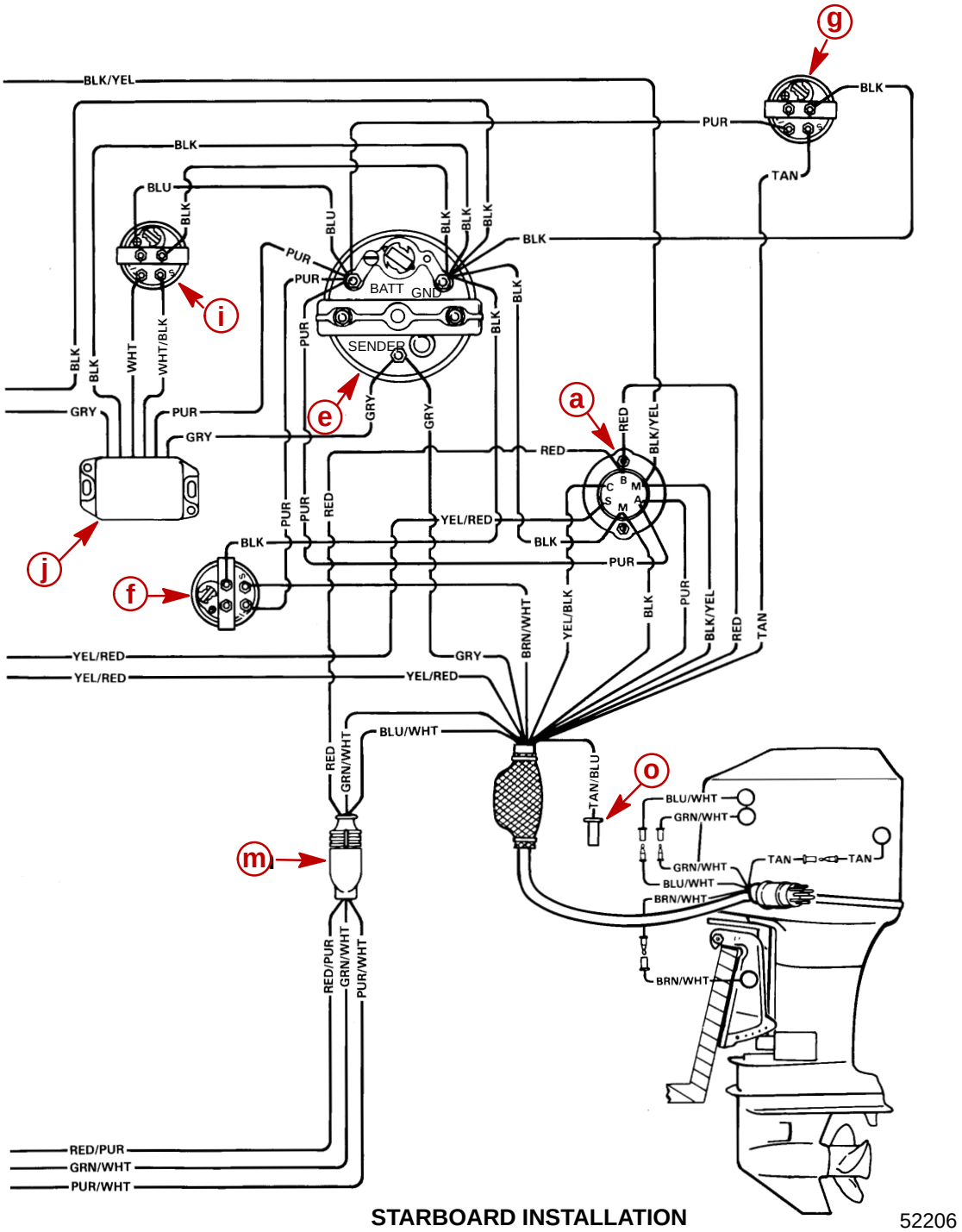


52205

PORT INSTALLATION

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

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



STARBOARD INSTALLATION 52206

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

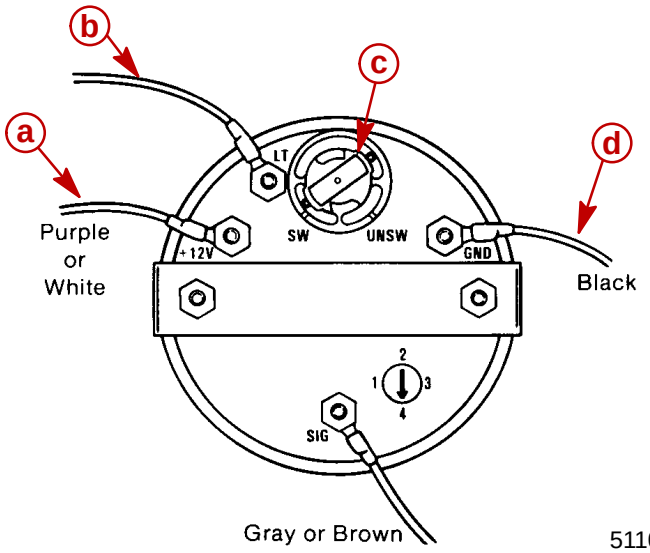
QSI Gauge Wiring Diagrams

Tachometer Wiring Diagram

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

WIRING DIAGRAM A

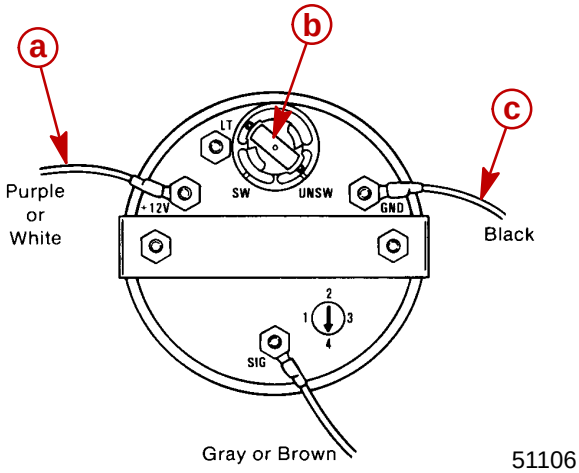
Use this wiring diagram when using a separate light switch for instrument lighting.



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

WIRING DIAGRAM B

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

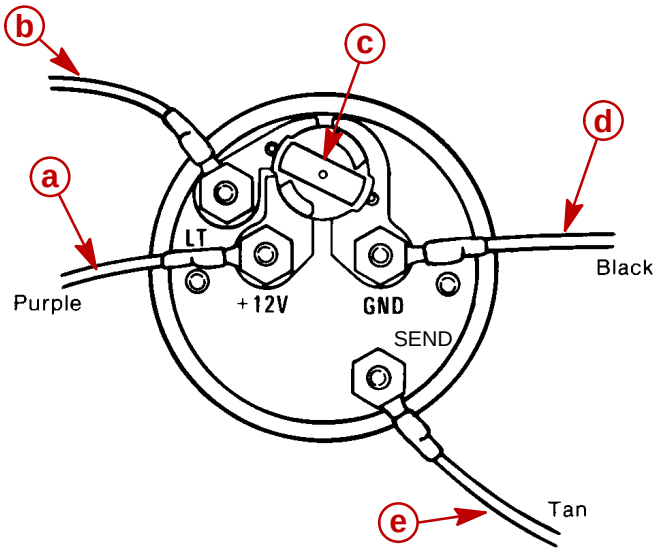


a - Connect to +12 Volt
b - Position Light Bulb to the Unswitched Position
c - Connect to NEGATIVE (–) Ground

Water Temperature Gauge

WIRING DIAGRAM A

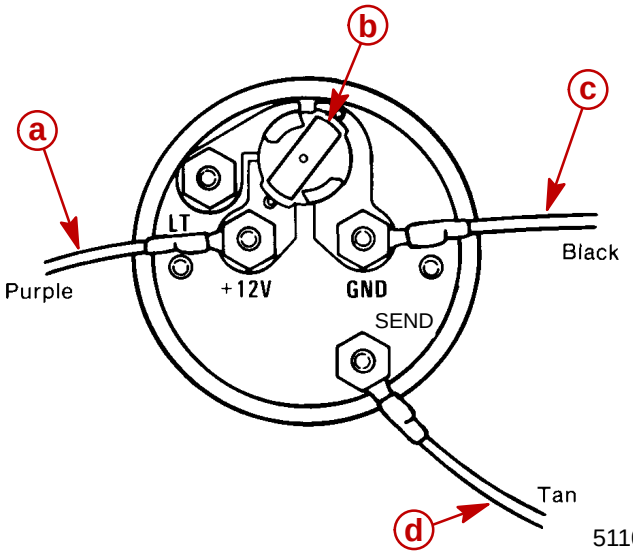
Use this wiring diagram when using a separate light switch for instrument lighting.



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

WIRING DIAGRAM B

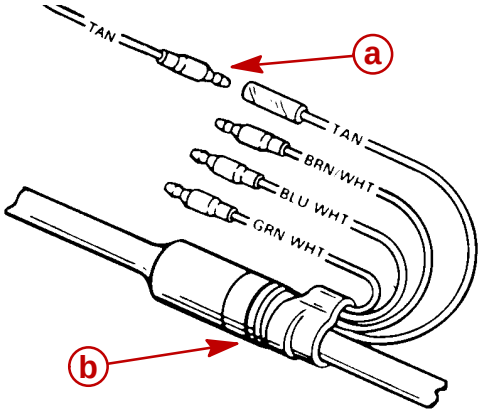
Use this wiring diagram when instrument lighting is wired directly to the ignition key switch. (Instrument lights are on when ignition key is turned on.)



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

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

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



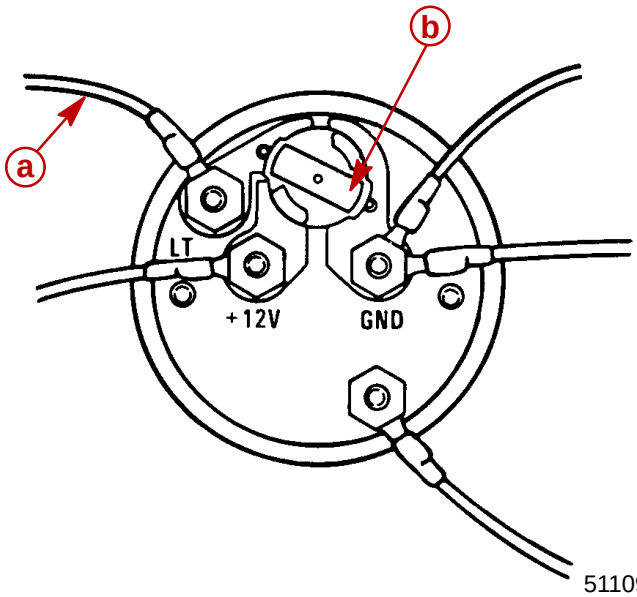
28086

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

Oil Level Gauge Wiring

LIGHT BULB POSITION A

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

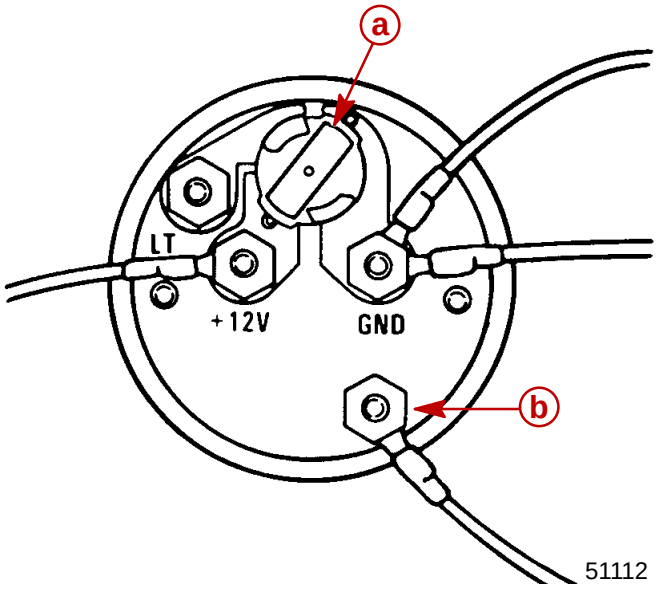


51109

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

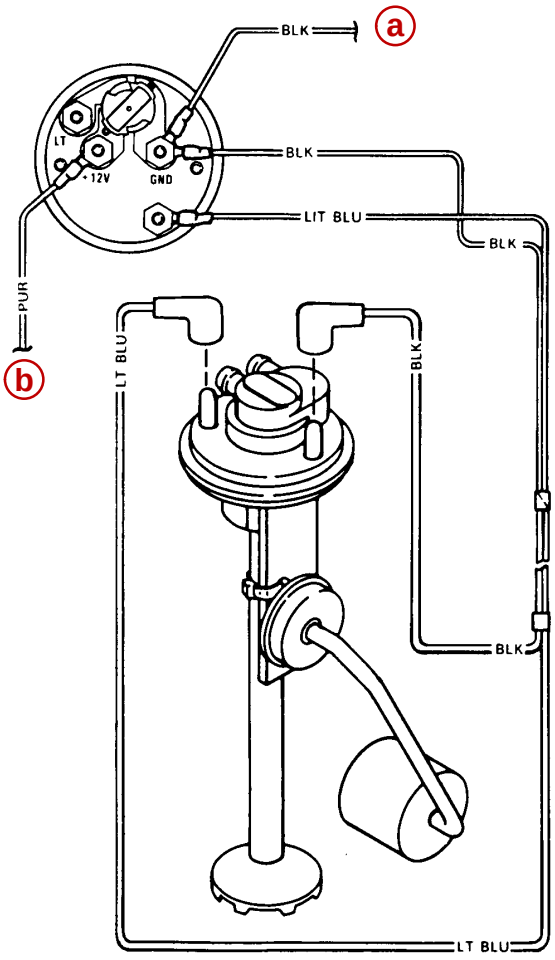
LIGHT BULB POSITION B

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



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

SENDER WIRING

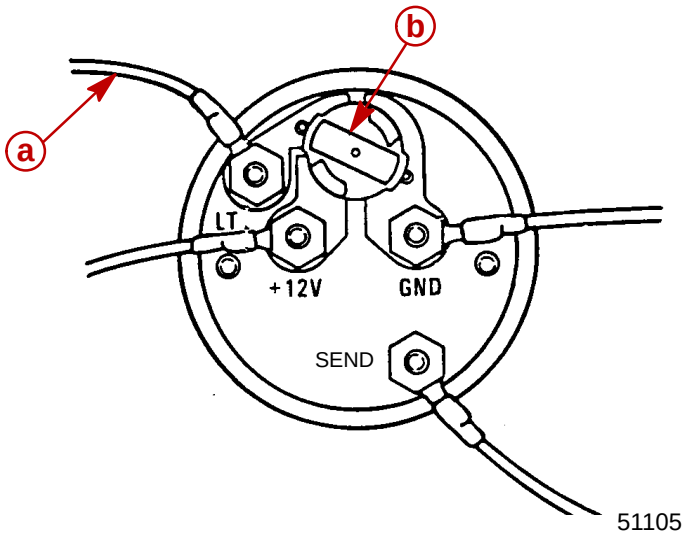


a - Connect to +12 Volt
b - Connect to NEGATIVE (–) Ground

Engine Synchronizer Wiring Diagram

LIGHT BULB POSITION A

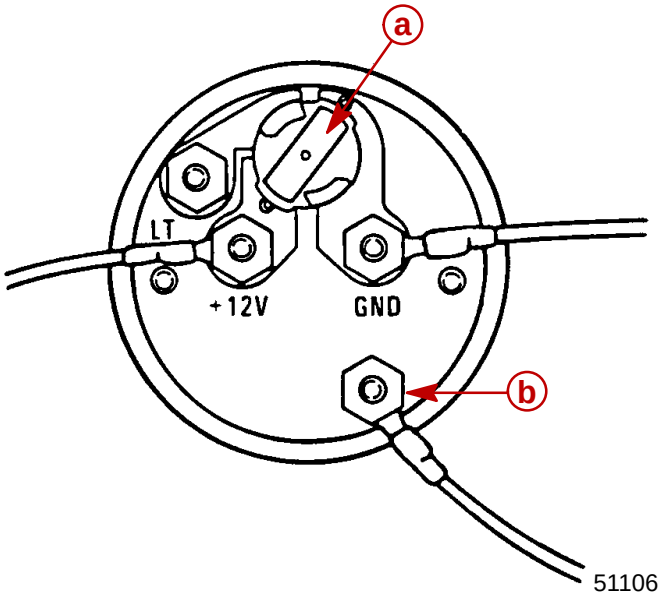
Use this position when using a separate light switch for instrument lighting.



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

LIGHT BULB POSITION B

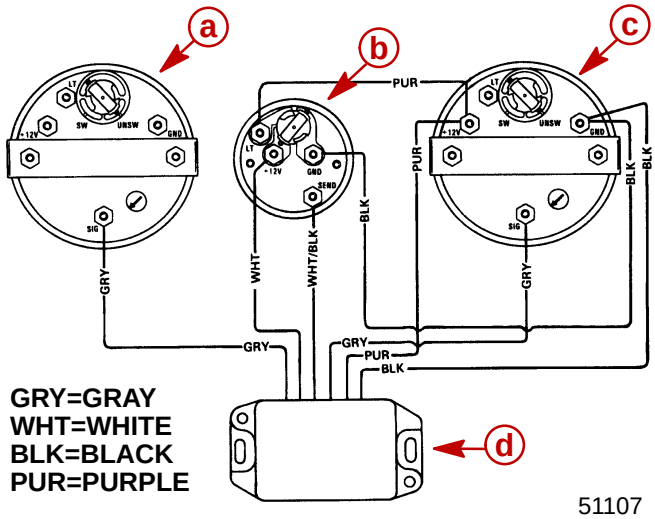
Use this position when instrument lighting is wired directly to the ignition key switch. (Instrument lights are on when ignition key switch is turned on.)



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

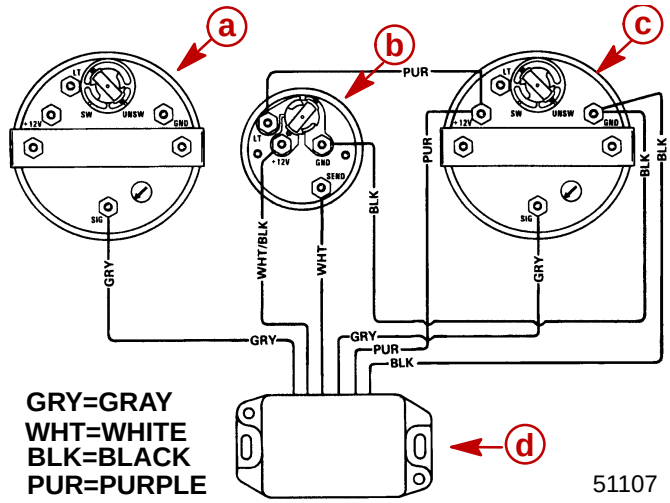
Synchronizer wiring can be accomplished two different ways as an option to the user.

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.

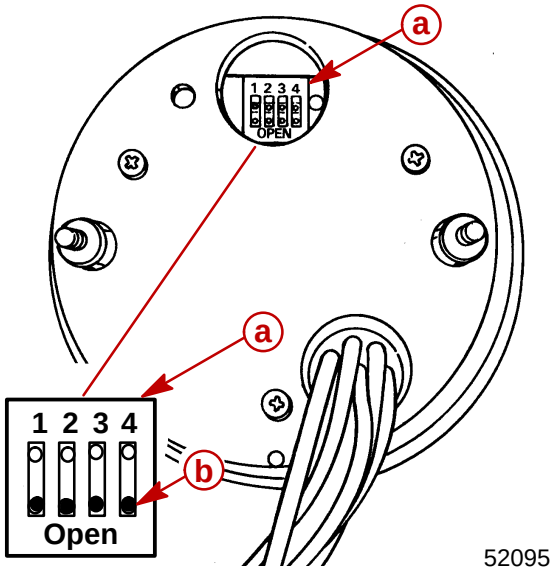
Multi-Function Gauge

Dip Switch Setting/Testing

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

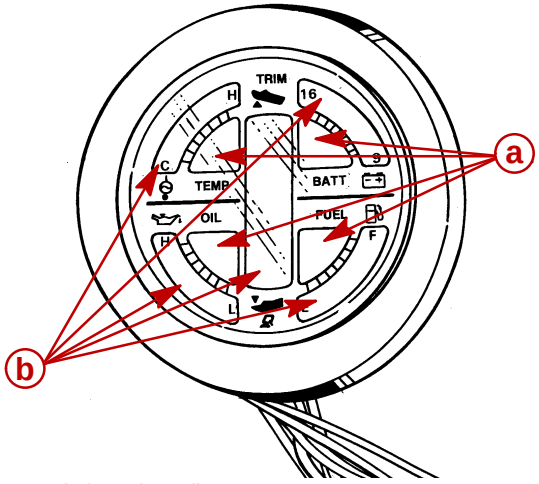
IMPORTANT: Test the gauge and related wiring BEFORE making final Dip Switch settings and BEFORE securing the gauge to dashboard of boat.

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



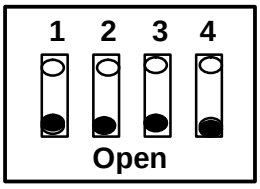
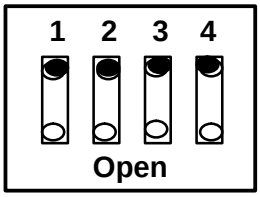
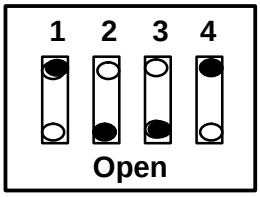
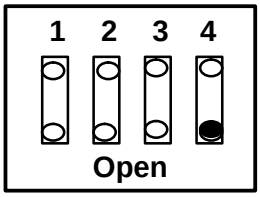
a - Dip Switch (shown in test position)
b - Black Dot - Switch in "Open" Position

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



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

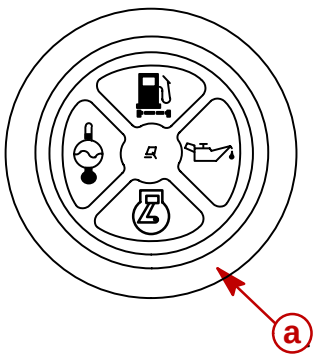
Outboard Multi-Function Gauge Setting

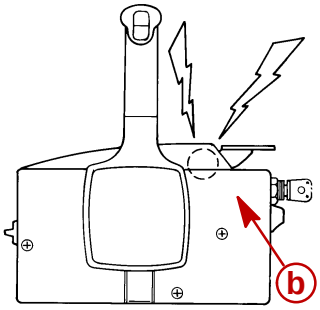
Model	Dip Switch Setting
Test Display (All)	
275 hp (3.4 Litre) Outboards (single engine)	
135-250 hp Outboards (single engine)	
Note: On Dual Engine/Single Fuel Tank Applications Position Dip Switch 4 Open*	

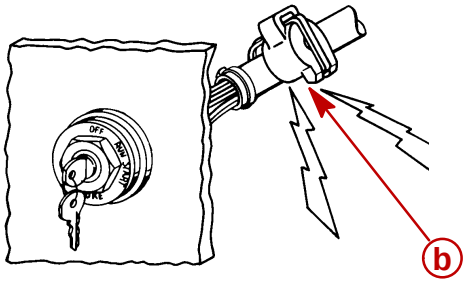
* Dip Switch (4) in Open Position For Dual Engine Single Fuel Tank Applications. Switches 1, 2, 3 Must Be In Specified Model Position.

Warning System

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







a - Warning Light Gauge
b - Warning Horn

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

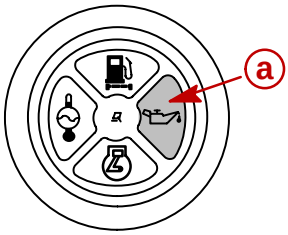
Warning System Signals

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

Problem	Horn	Check Engine Light	Low Oil Light	Over Heat Light	Water In Fuel Light	Engine Speed Reduction Activated (approx. 3000 RPM)
Power Up/System Check	Single Beep	Yes	Yes	Yes	Yes	No
Low Oil	4 Beep... 2 Minutes Off		Yes			No
No Oil Flow To The Electric Oil Pump	Continuous Beep	Yes	Yes			Yes (Limits to 3000 RPM)
Oil Pump Electrical Failure		Yes	Yes			Yes (Limits to 3000 RPM)
Over Heat	Continuous Beep			Yes		Yes (Limits to 3000 RPM)
Water In Fuel	4 Beep... 2 Minutes Off				Yes	
Over Speed	Continuous Beep					Yes (Activated at 5800 RPM)
Coolant Sensor Failure	No	Yes				
MAP Sensor Failure	No	Yes				
Air Temperature Sensor Failure	No	Yes				
Ignition Coil Failure	No	Yes				
Injector Failure	No	Yes				
Horn Failure	N/A	Yes				No
Battery Voltage too high (16V) or too low (11V) or very low (9.5V)	No	Yes				Yes – If battery voltage is less than 10.4 V – RPM is reduced to 3000. If voltage is 9.5V or less, RPM is reduced to idle.
Over Heat Cyl. Head/ Compressor	Continuous Beep			Yes		Yes
Throttle Sensor Failure	Continuous Intermittant Beeping	Yes				RPM reduces to 3000 if 1 sensor fails. RPM is reduced to Idle speed only if both sensors fail.

Warning System Operation

LOW OIL LEVEL



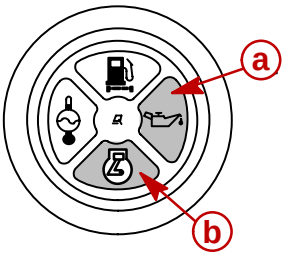
a - Oil Light

The system is activated when the oil in the engine mounted oil reservoir tank drops below 22 fl. oz. (175 ml). There is still an oil reserve remaining for 30 minutes of full speed operation.

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

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

NO OIL FLOW TO THE ELECTRIC OIL PUMP

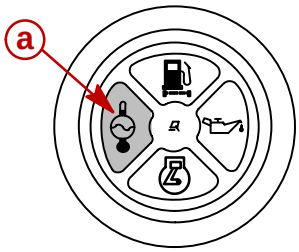


a - Oil Light
b - Check Engine Light

The system is activated when the flow of oil to the oil pump is blocked. No lubricating oil is being supplied to the engine. Stop the engine as soon as possible. Continuing to operate the engine can result in severe engine damage.

The OIL light and CHECK ENGINE light will come on and the warning horn will begin sounding. The warning system will automatically reduce and limit the engine speed to 3000 RPM. The engine has to be shut off to reset the warning system.

ENGINE OVERHEAT

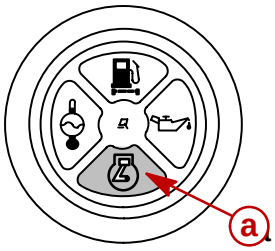


a - Overheat Light

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

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

IGNITION COIL, SENSOR, OR INJECTOR NOT FUNCTIONING

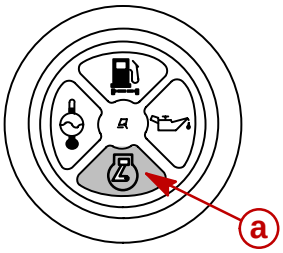


a - Check Engine Light

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

The CHECK ENGINE light will turn on.

THROTTLE SENSOR NOT FUNCTIONING

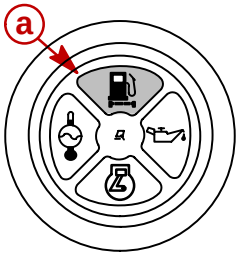


a - Check Engine Light

The system is activated if the throttle sensors are not functioning correctly.

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

WATER SEPARATING FUEL FILTER IS FULL OF WATER

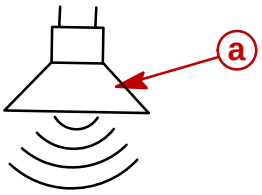


a - Water Detection Light

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

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

ENGINE OVER-SPEED PROTECTION SYSTEM



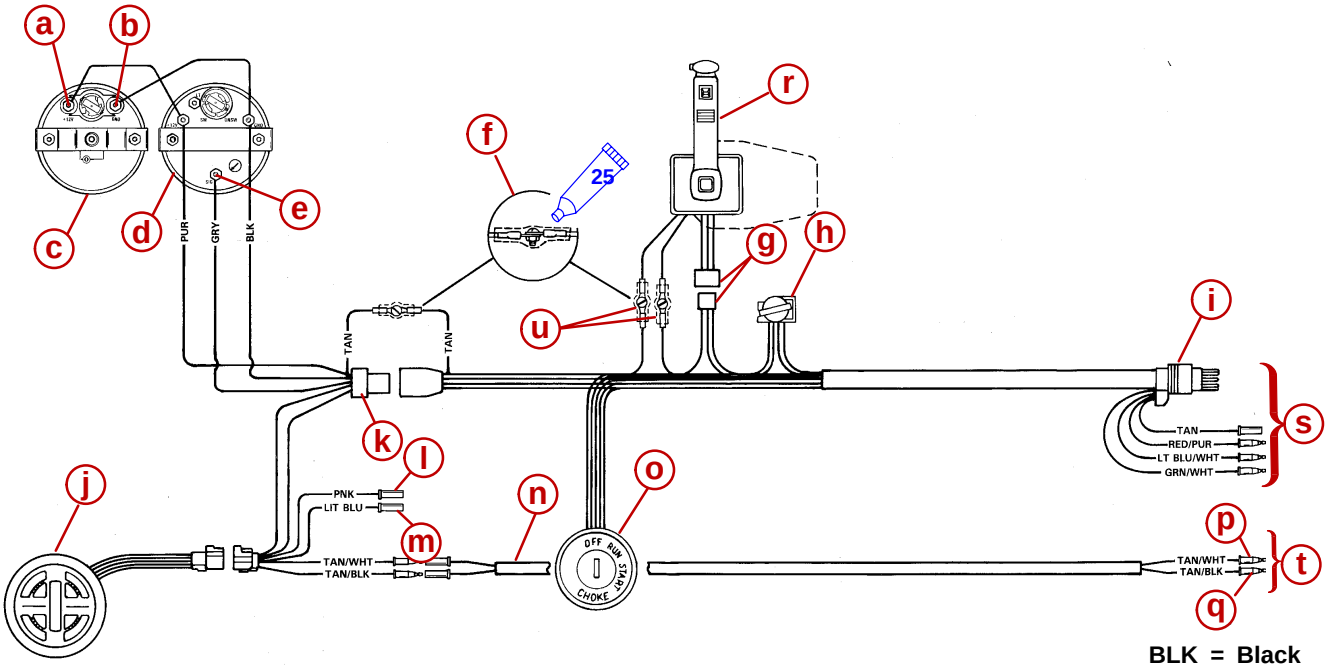
a - Warning Horn

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

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

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

Panel Mount Remote Control Wiring Installation



25 Liquid Neoprene

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

1998 Model 135/150 DFI Wiring Diagram

1 - Fuel Injector #1
2 - Fuel Injector #2
3 - Fuel Injector #3
4 - Direct Injector #1
5 - Direct Injector #2
6 - Direct Injector #3
7 - Direct Injector #4
8 - Direct Injector #5
9 - Direct Injector #6
10 - Oil Pump
11 - MAP Sensor
12 - T.P.S. #1 (Inner)
13 - T.P.S. #2 (Outer)
14 - Crank Position Sensor
15 - Air Temperature Sensor
16 - Water Sensor
17 - Shift Switch
18 - Low-Oil Switch
19 - Cylinder Head Temperature Switch
20 - Digital Diagnostic Terminal Connector
21 - Compressor Temperature Sensor
22 - Fuel Pump 20 Ampere Fuse
23 - Injector 20 Ampere Fuse
24 - ACC. and Trim Pump 20 Ampere Fuse
25 - Ignition Coils and Oil Pump 20 Ampere Fuse
26 - Fuel Pump #2 (Outside Vapor Separator)
27 - Fuel Pump #1 (Inside Vapor Separator)
28 - 12 Volt Battery
29 - Starter Solenoid
30 - To Remote Control Trim Switch
31 - Remote Control
32 - Auxiliary
33 - Check Engine Light
34 - Water In Fuel Light
35 - Over-Heat Light
36 - Low Oil Light
37 - Temperature Gauge
38 - Electronic Control Module
39 - Main Power Relay
40 - Trim Down Relay
41 - Trim Up Relay
42 - Cowl Mounted Trim Switch
43 - Trim Pump
44 - 60 Ampere Alternator
45 - Starter
46 - Ignition Coil #6
47 - Ignition Coil #5
48 - Ignition Coil #4
49 - Ignition Coil #3
50 - Ignition Coil #2
51 - Ignition Coil #1
52 - Fuel Injector #4
53 - Fuel Injector #5
54 - Fuel Injector #6

BLK = Black
BLU = Blue
BRN = Brown
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GRN = Green
ORN = Orange
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LT. = Light
DK. = Dark

1999 Model 135/150 DFI Wiring Diagram

1 - Fuel Injector #1
2 - Fuel Injector #2
3 - Fuel Injector #3
4 - Direct Injector #1
5 - Direct Injector #2
6 - Direct Injector #3
7 - Direct Injector #4
8 - Direct Injector #5
9 - Direct Injector #6
10 - Oil Pump
11 - MAP Sensor
12 - T.P.S. #1 (Inner)
13 - T.P.S. #2 (Outer)
14 - Crank Position Sensor
15 - Air Temperature Sensor
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47 - Ignition Coil #5
48 - Ignition Coil #4
49 - Ignition Coil #3
50 - Ignition Coil #2
51 - Ignition Coil #1
52 - Fuel Injector #4
53 - Fuel Injector #5
54 - Fuel Injector #6

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BRN = Brown
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FUEL SYSTEM

Section 3A – Pulse Crankcase Driven Fuel Pump

Table of Contents

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Specifications

Fuel Pump Pressure @ W.O.T.

Maximum – 10 psi
Normal – 8-10 psi
Minimum – 3 psi

Fuel Pump Pressure @ Idle

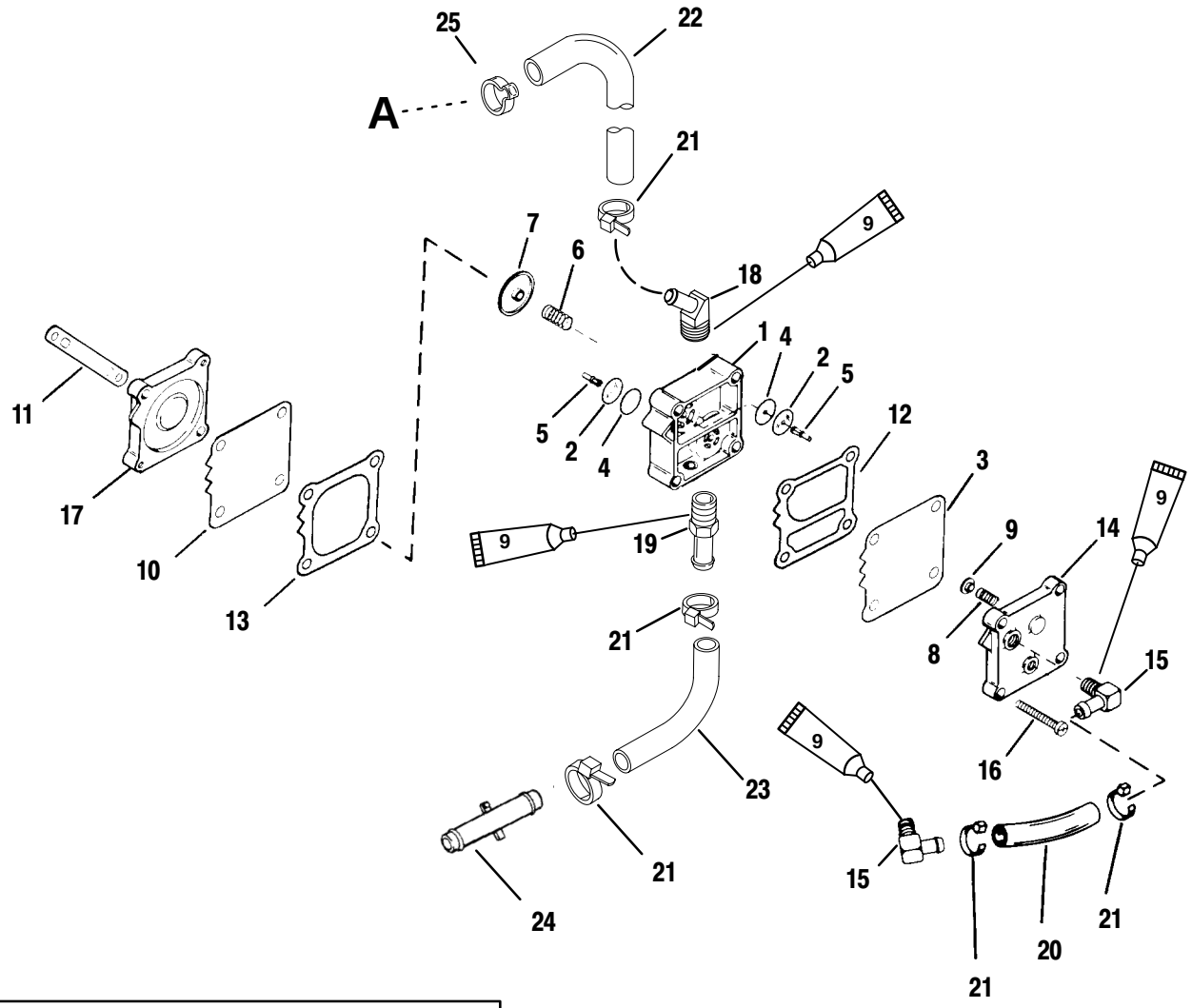
Normal – 2-3 psi
Minimum – 1 psi

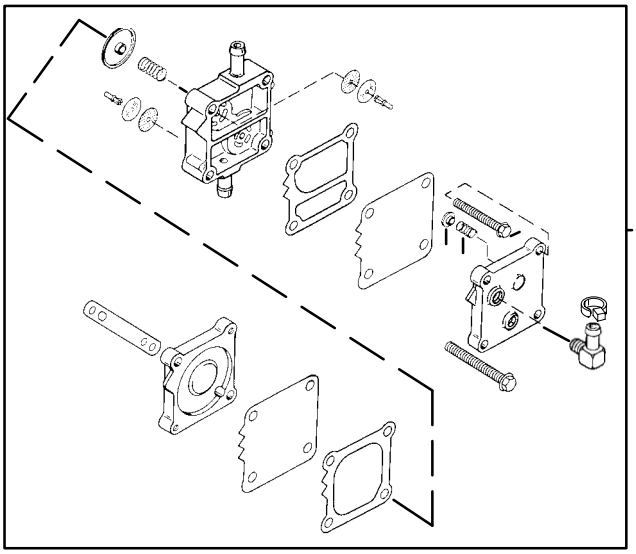
NOTE: *Electric fuel pump pressure, if used in conjunction with engine mechanical fuel pump, must be limited to no more than 4 psi.*

Special Tools

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

Fuel Pump





9 Loctite PST Pipe Sealant

A = TO VAPOR SEPARATOR FUEL INLET FITTING

B = REFER TO SERVICE BULLETIN 98–8

Fuel Pump

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm.
1	1	FUEL PUMP ASSEMBLY			
2	2	DIAPHRAGM KIT			
3	1	DIAPHRAGM			
4	2	RUBBER CHECK VALVE			
5	2	RETAINER			
6	1	SPRING			
7	1	CAP			
8	1	SPRING			
9	1	CAP			
10	1	DIAPHRAGM			
11	1	GASKET			
12	1	GASKET–boost			
13	1	GASKET–pulse			
14	1	PLATE			
15	2	FITTING			
16	2	SCREW–fuel pump (M5 x 40)	55		6
	2	SCREW–pump to crankcase (M6 x 50)	55		6
17	1	BASE			
18	1	ELBOW (45 Degrees)			
19	1	FITTING			
20	1	TUBING (6 IN.)			
21	5	STA-STRAP			
22	1	HOSE (with Insulating Sleeve) (7 in.)(177.8 mm)			
23	1	HOSE (with Insulating Sleeve) (18 in.)(457.2 mm)			
24	1	CONNECTOR			
25	1	CLAMP			

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 a fuel/air mixture [from Vapor Separator Tank (VST)] into crankcase. This vacuum also pulls in on the fuel pump diaphragm, thus 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 fuel/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.

Checking for Restricted Fuel Flow Caused by Anti-Siphon Valves

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

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

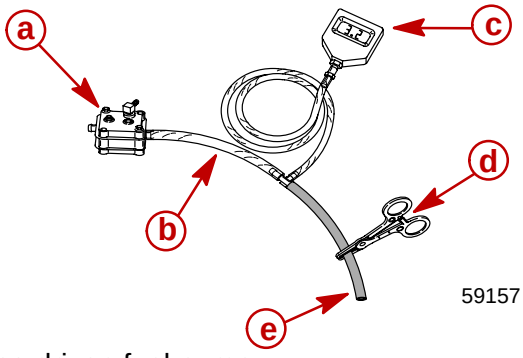
Since any type of anti-siphon device must be located between the outboard fuel inlet and fuel tank outlet, a simple method of checking [if such a device (or bad fuel) is a problem source] is to operate the outboard with a separate fuel supply which is known to be good, such as a remote fuel tank.

If, after using a separate fuel supply, it is found that the anti-siphon valve is the cause of the problem, there are 2 solutions to the problem; either 1) remove the anti-siphon valve 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 T-Fitting
c - Vacuum gauge (digital)
d - Tubing clamp P/N 91-804063
e - Fuel supply hose from fuel tank

Testing Fuel Pump

Vacuum Test Troubleshooting

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 and run at idle speed. Pinch off/restrict the fuel supply hose between the vacuum gauge and fuel tank, using tubing clamp.

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

Reading below 2.5 in. vacuum (mercury) →	• 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 →	Air leak on intake side of fuel system • Pick up 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 system 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)

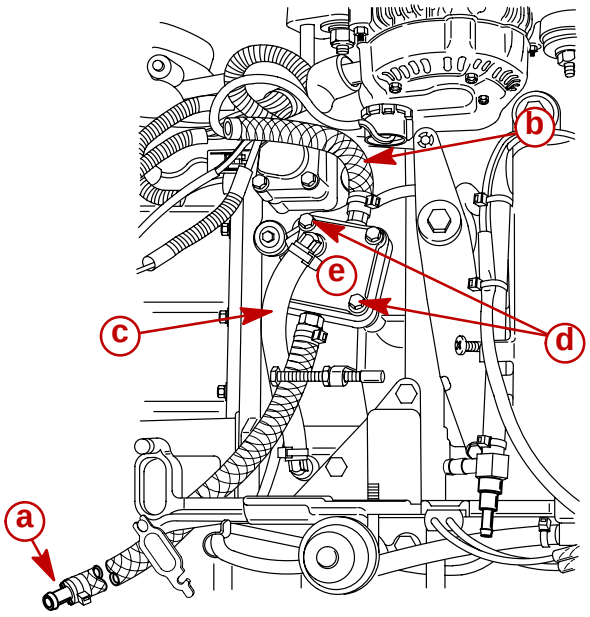
Reading above 2.5 in. of vacuum (mercury) →	Restriction within the fuel system • Restricted anti-siphon valve • Restricted or malfunctioning primer bulb • Kinked or collapsed fuel hose • Plugged water separating fuel filter (in the boat) • Restriction in fuel line thru-hull fitting • Restriction in fuel 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.

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

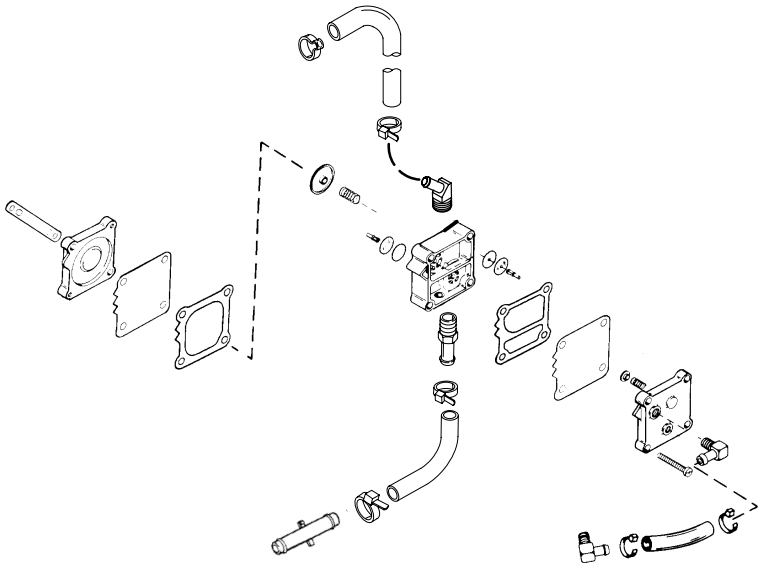
1. Disconnect fuel hoses from fuel pump.
2. Disconnect pulse hose.
3. Remove two mounting screws and remove fuel pump from engine.



57298

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

4. Disassemble fuel pump.



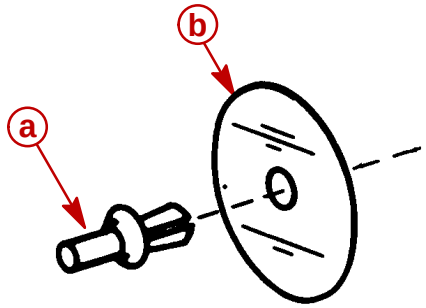
Cleaning/Inspection

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

Reassembly/Installation

ASSEMBLY

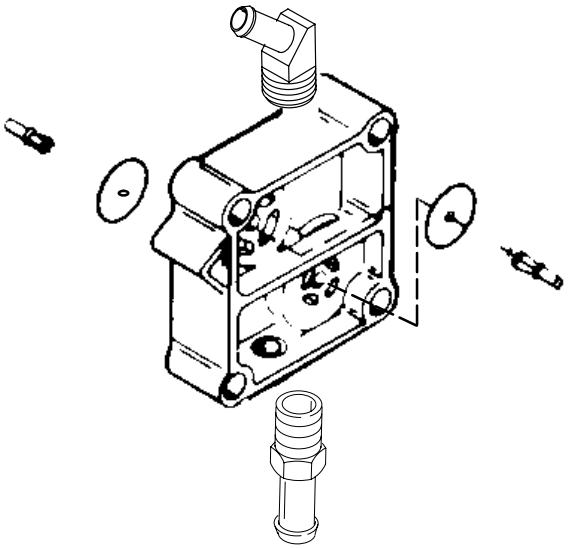
1. Insert retainer through plastic disc and rubber check valve.



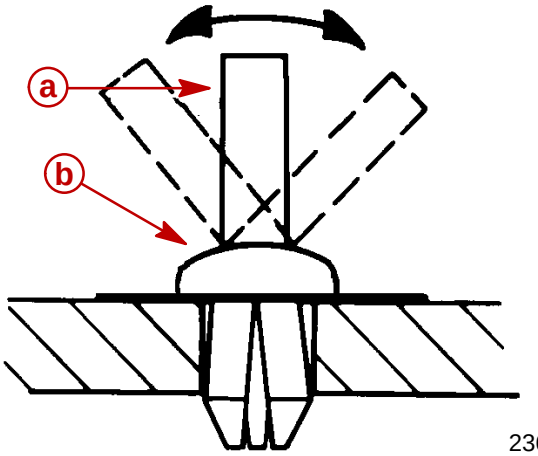
23601_2

a - Retainer
b - Plastic Disc

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



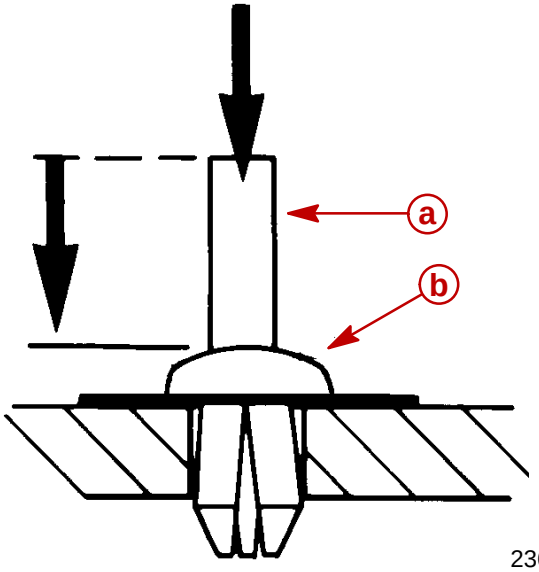
3. With retainer installed in pump body, break retainer rod from retainer by bending sideways.



23601

a - Rod
b - Retainer Cap

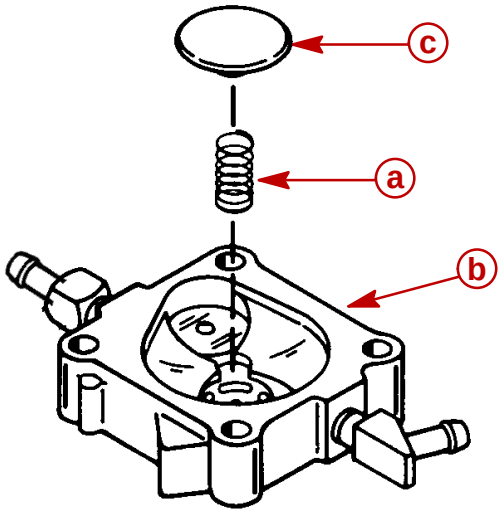
4. Reinstall rod into retainer cap and, use a small hammer or hammer and punch to tap rod down into retainer until flush with top of retainer.



23601

a - Rod
b - Retainer Cap

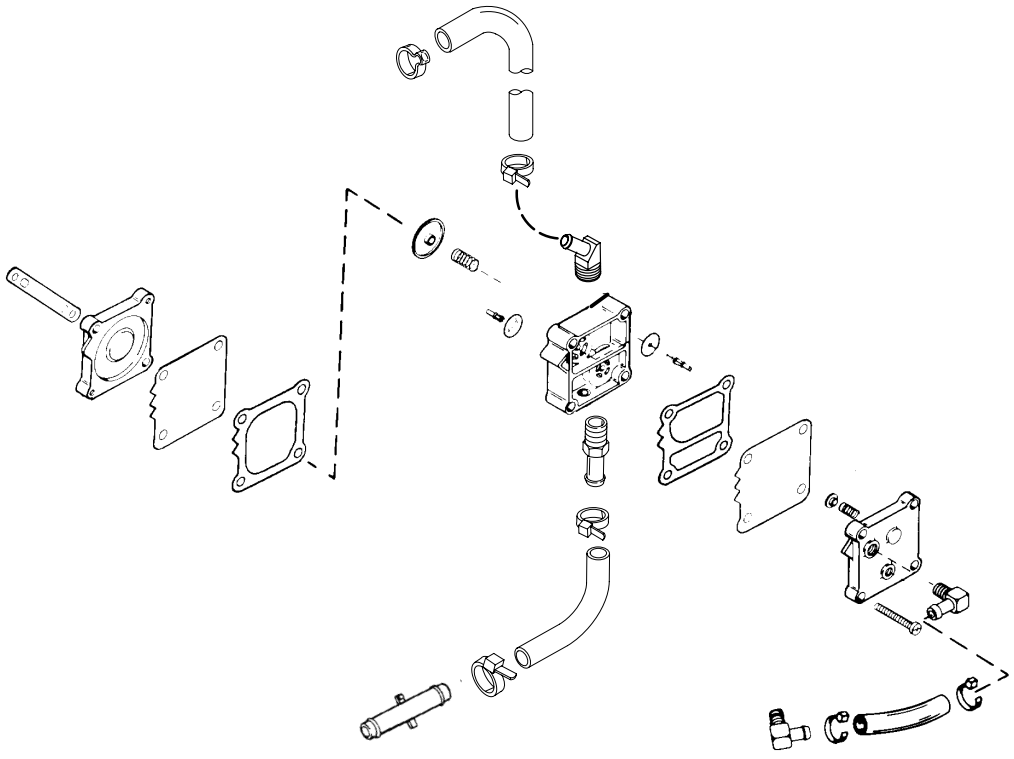
5. Place boost spring into pump body and place cap onto boost spring.



50161

a - Boost Spring
b - Pump Body
c - Cap

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



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

FUEL SYSTEM

Section 3B – Direct Fuel Injection

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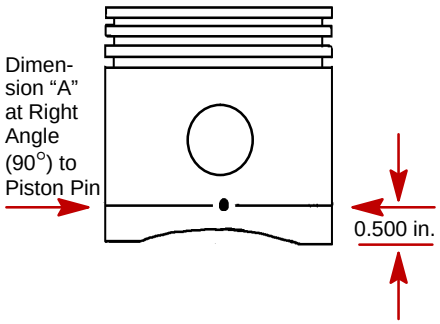
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Specifications

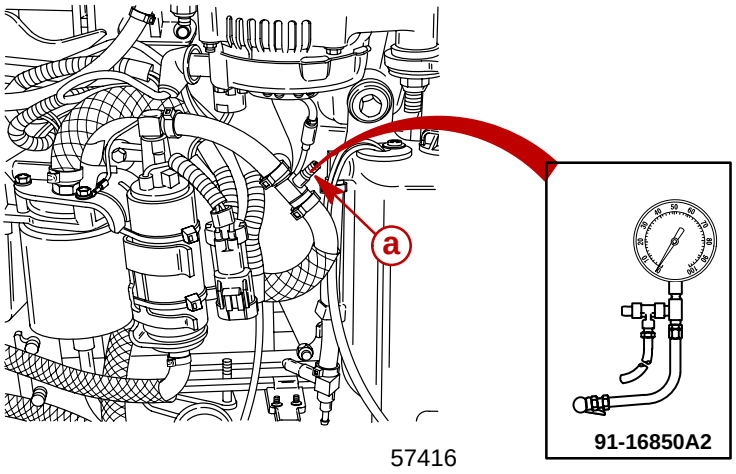
Fuel System Specifications	
Fuel Pressure	89 ± 2 psi (613.5 ± 13.8 kPa)
Air Pressure	79 ± 2 psi (544.0 ± 13.8 kPa)
Fuel/Air Differential	10 psi (68.5 kPa)
High Pressure Electric Fuel Pump Amperage Draw	6-9 Amps
Low Pressure Electric Fuel Pump Amperage Draw	1-2 Amps
Low Pressure Electric Fuel Pump Output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

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

Special Tools

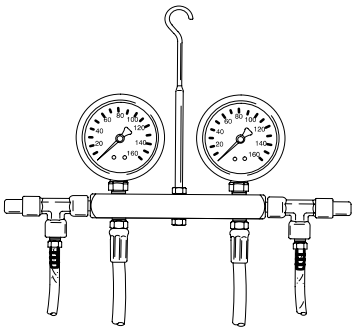
1. Single Fuel/Air Pressure Gauge 160 psi – 91-16850A2

NOTE: *To convert 100 psi gauge 91-16850A1 to 160 psi gauge, order upgrade 91-16850--1.*



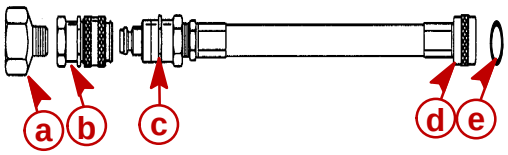
a - Schrader Valve (22-849606) – part of Schrader Valve Fuel Pressure Kit (849021A4)

2. Duel Fuel Air/Air Pressure Gauge 160 psi – 91-852087A1 or A2



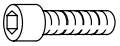
3. Adaptors to convert pressure gauge 91-852087A1/A2 to an A3

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



b - a-1/2 in. to 1/4 in. Adapter – if required
c - b-Female quick disconnect
d - c-Male quick disconnect
e - d-Screw on Schrader
f - e-O-ring 25-803803

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



5. Flat Washer (2 each) – 12-30164.

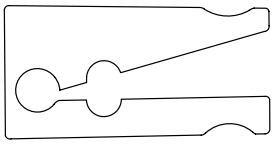


6. Seal/Teflon Ring Installation Tool – 91-851980



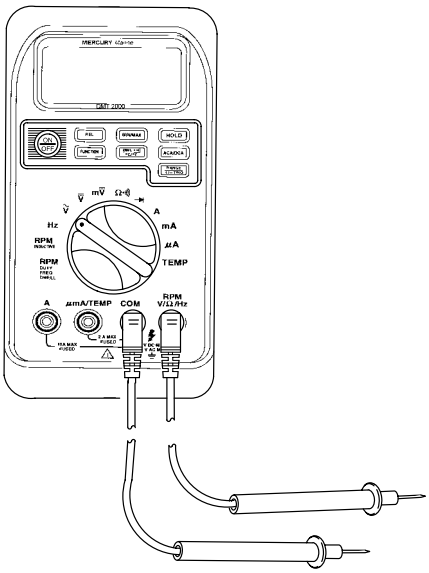
56015

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

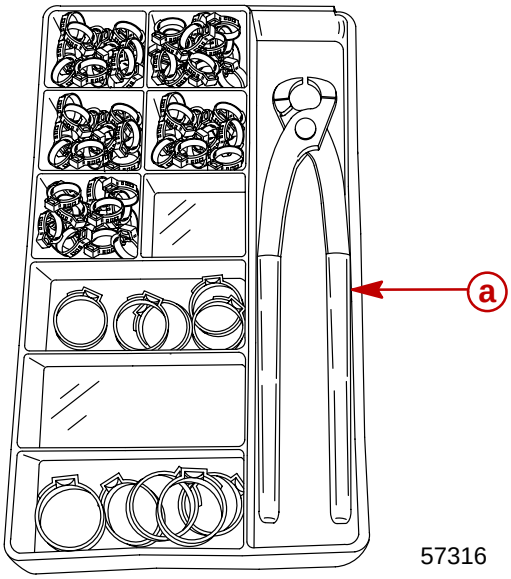


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8. DMT 2000 Digital Tachometer Multi-meter P/N 91-854009A1



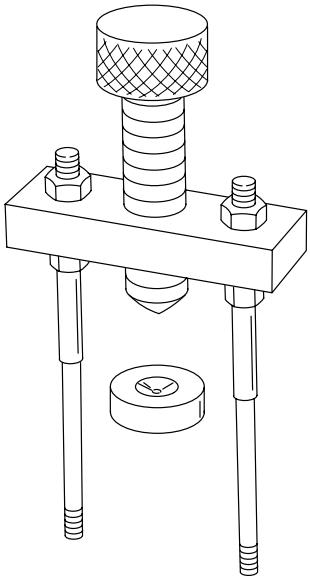
9. Clamp Tool Kit



57316

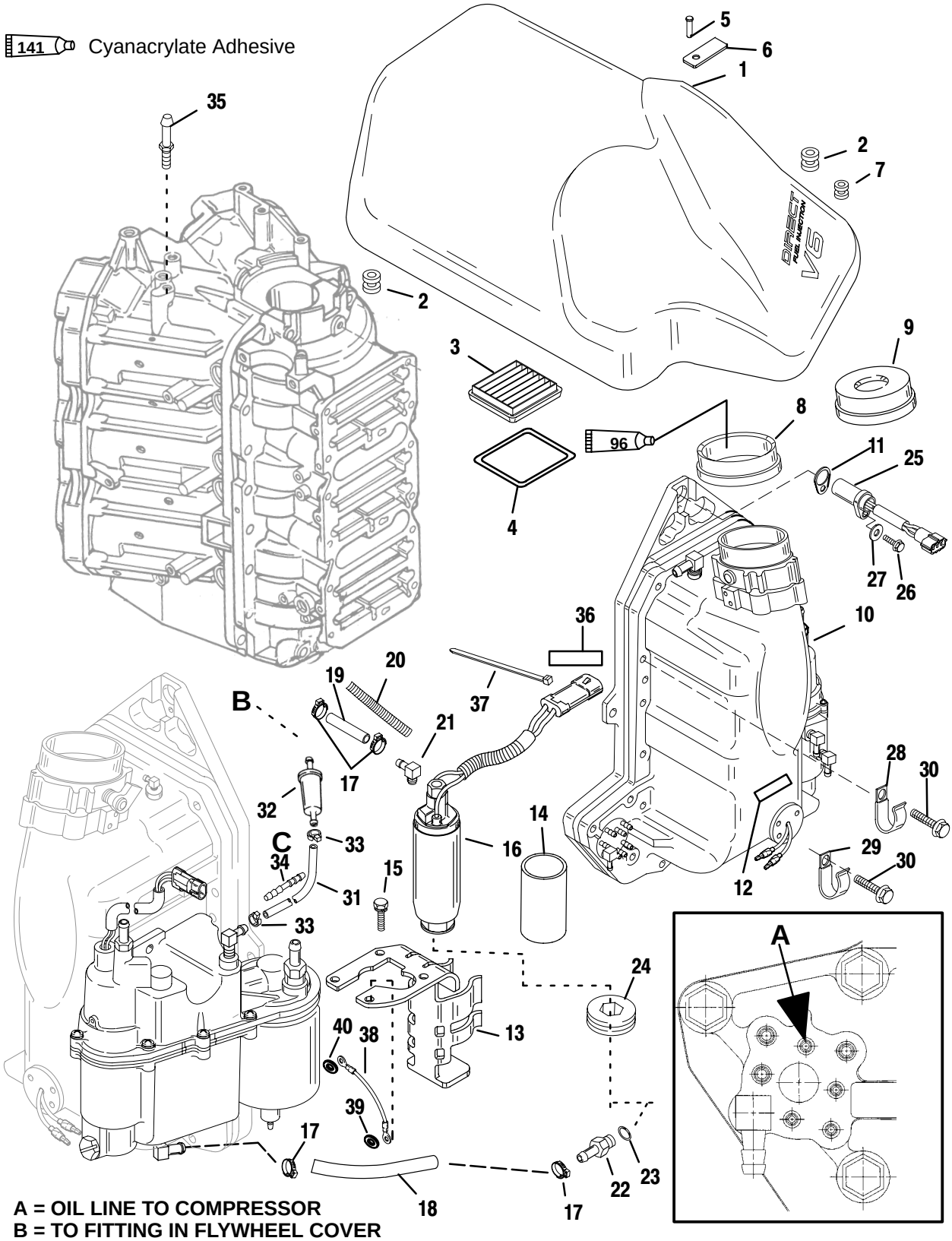
a - Clamp Tool 91-803146A04

10. Regulator Installation Tool (91-889431)



59361

Air Handler

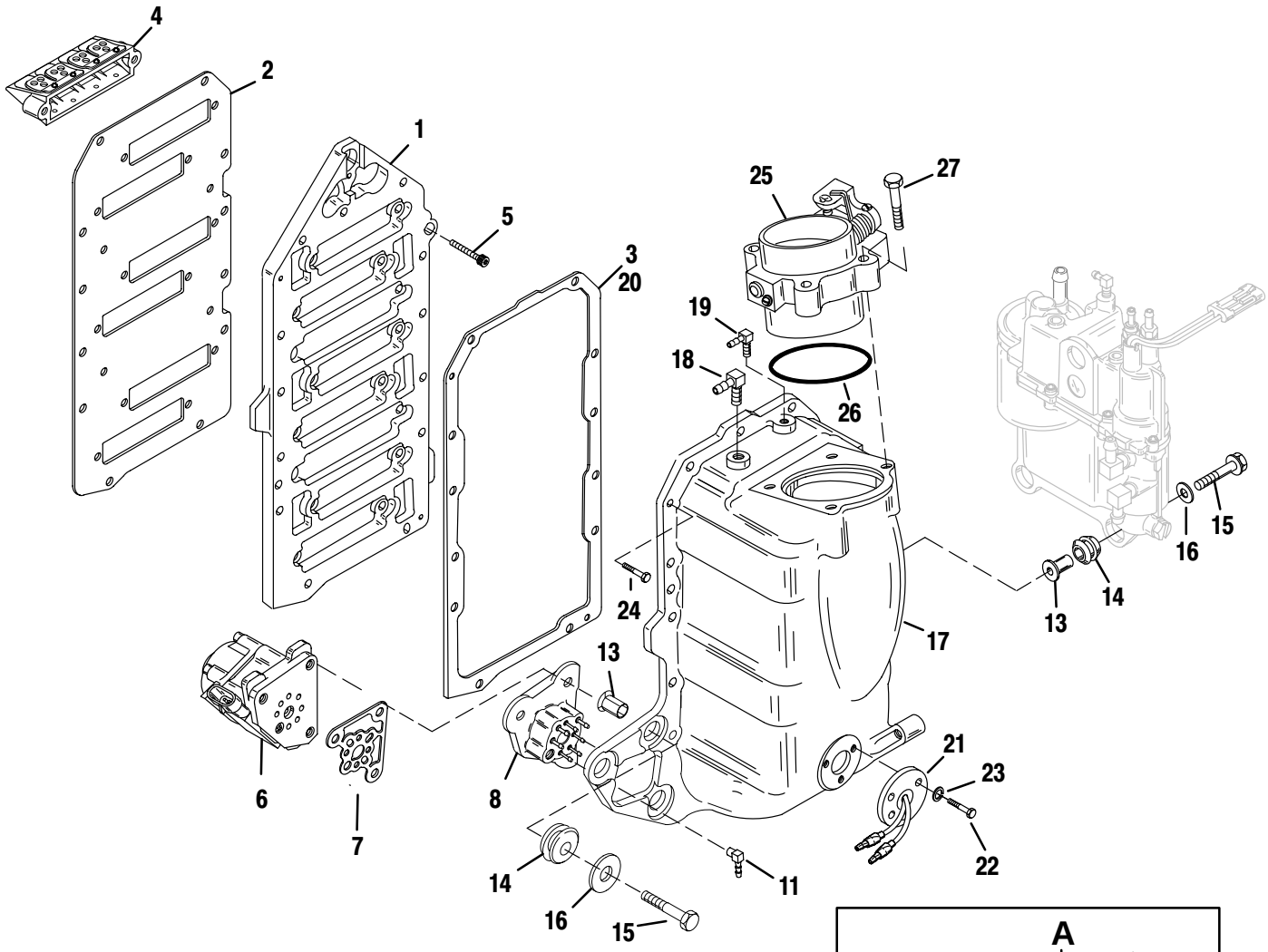

141 Cyanacrylate Adhesive
96
A = OIL LINE TO COMPRESSOR
B = TO FITTING IN FLYWHEEL COVER
C = PRESS INTO TUBING

Air Handler

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	COVER ASSEMBLY			
2	2	GROMMET			
3	1	AIR FILTER			
4	1	COVER			
5	1	RIVET			
6	1	RETAINER			
7	1	GROMMET			
8	1	GROMMET **(150)**			
9	1	GROMMET **(135)**			
10	1	AIR HANDLER ASSEMBLY (See Breakdown on Air Handler Components)			
11	1	SHIM **(.020 THICK)**			
	1	SHIM **(.010 THICK)**			
12	1	DECAL-Caution-Start in Gear			
13	1	BRACKET			
14	1	SLEEVE			
15	4	SCREW (M6 x 16)	100		11.5
16	1	FUEL PUMP			
17	4	CLAMP			
18	1	HOSE			
19	1	TUBING (18 IN.)			
20	1	INSULATING SLEEVE			
21	1	ELBOW			
22	1	FITTING			
23	1	O-RING			
24	1	GROMMET			
25	1	ENCODER			
26	1	SCREW (10-24 x 5/8 IN.)	Drive Tight		
27	1	WASHER			
28	2	J CLAMP (Upper Stbd.)			
29	1	CLAMP-(Lower)			
30	12	SCREW (1/4-20 x 1-1/2 IN.)	100		11.5
31	1	TUBING (5-3/4 IN.)			
32	1	CANISTER-Vent			
33	3	STA-STRAP			
34	1	CONNECTOR			
35	1	PIN			
36	1	DECAL EPA LABEL **(1999) (SEE NOTE)**			
37	1	CABLE TIE (14 IN.)			
38	1	CABLE			
39	1	WASHER			
40	1	WASHER			

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

Air Handler Components

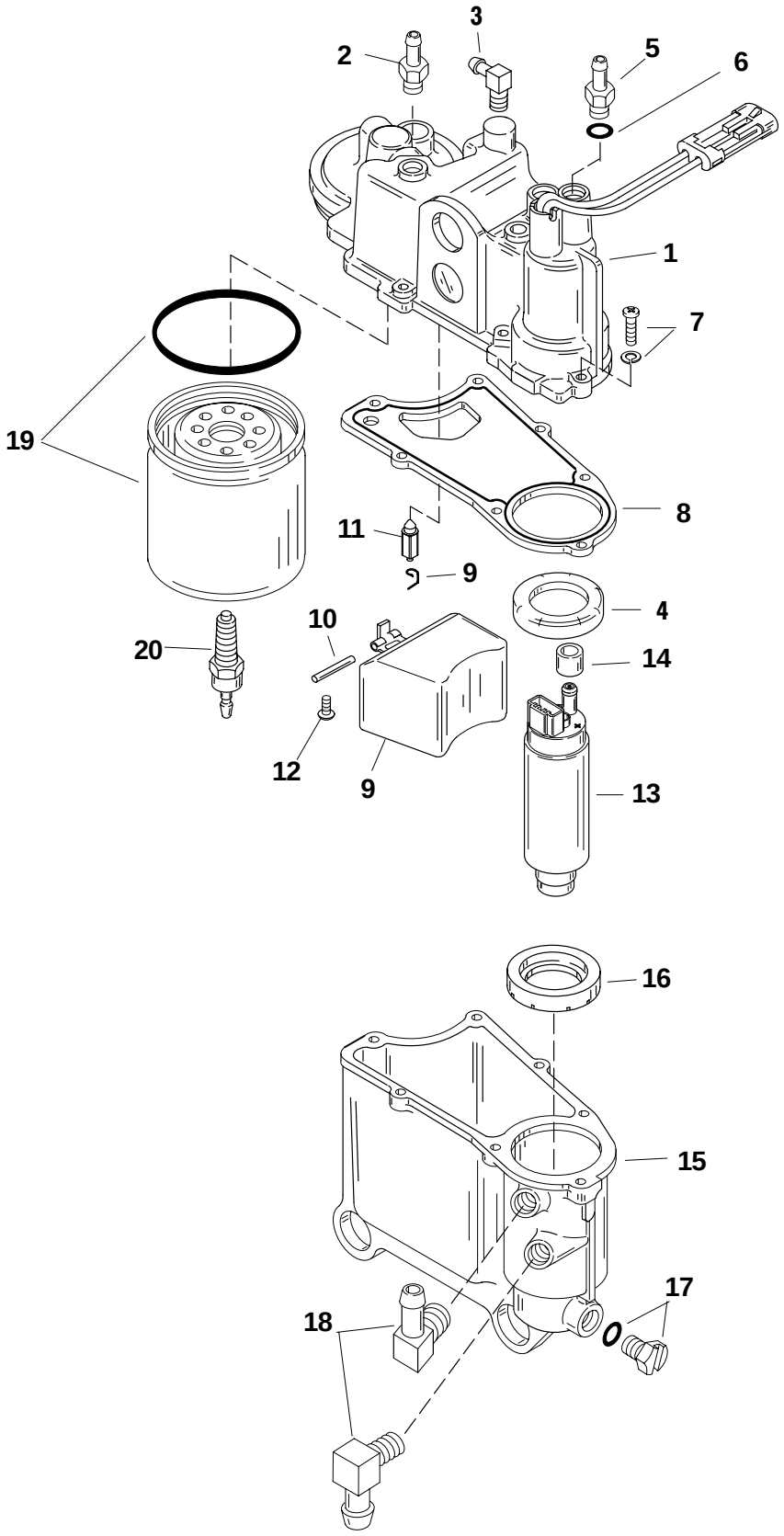


A = OIL LINE TO COMPRESSOR

Air Handler Components

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
–	1	AIR HANDLER			
1	1	ADAPTOR PLATE KIT			
2	1	GASKET			
3	1	GASKET			
4	6	REED BLOCK			
5	12	SCREW (1/4-20 x .88)	100		11.5
6	1	OIL PUMP			
7	1	GASKET			
8	1	BRACKET			
9	3	FITTING			
10	3	FITTING			
11	1	ELBOW			
12	1	FITTING (STRAIGHT)			
13	6	BUSHING			
14	6	GROMMET			
15	6	SCREW	140		16
16	6	WASHER			
17	1	AIR PLENUM KIT			
18	1	ELBOW			
19	1	ELBOW **(.236 O.D.)**			
	1	ELBOW **(.159 O.D.)**			
20	1	GASKET			
21	1	TEMPERATURE SENSOR			
22	3	SCREW	Drive Tight		
23	3	LOCKWASHER			
24	2	SCREW (M4 x 16)	Drive Tight		
25	1	THROTTLE BODY KIT			
26	1	O-RING			
27	4	SCREW	100		11.5

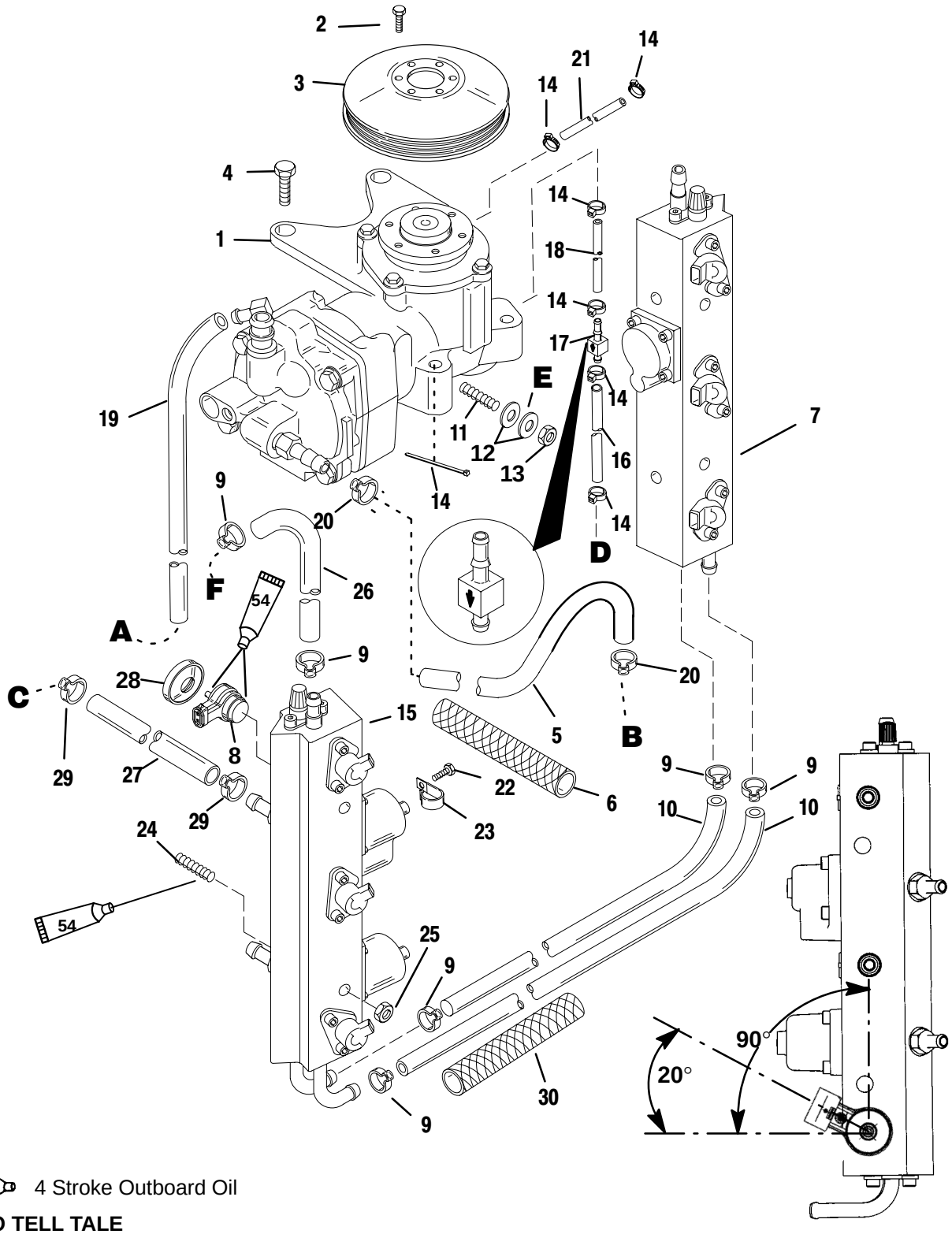
Vapor Separator Components



Vapor Separator Components

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	COVER KIT			
2	1	FITTING - Straight			
3	1	ELBOW			
4	1	SEAL			
5	1	FITTING KIT-Pump Outlet			
6	1	O-RING			
7	7	SCREW	30		3.5
8	1	GASKET			
9	1	FLOAT KIT			
10	1	FLOAT PIN			
11	1	NEEDLE VALVE			
12	1	SCREW	10		1.0
13	1	FUEL PUMP KIT			
14	1	SLEEVE			
15	1	BOWL KIT			
16	1	SEAL			
17	1	PLUG KIT			
18	2	ELBOW			
19	1	FUEL FILTER ASSEMBLY			
20	1	PROBE			

Fuel Rails/Air Compressor Hose Routing



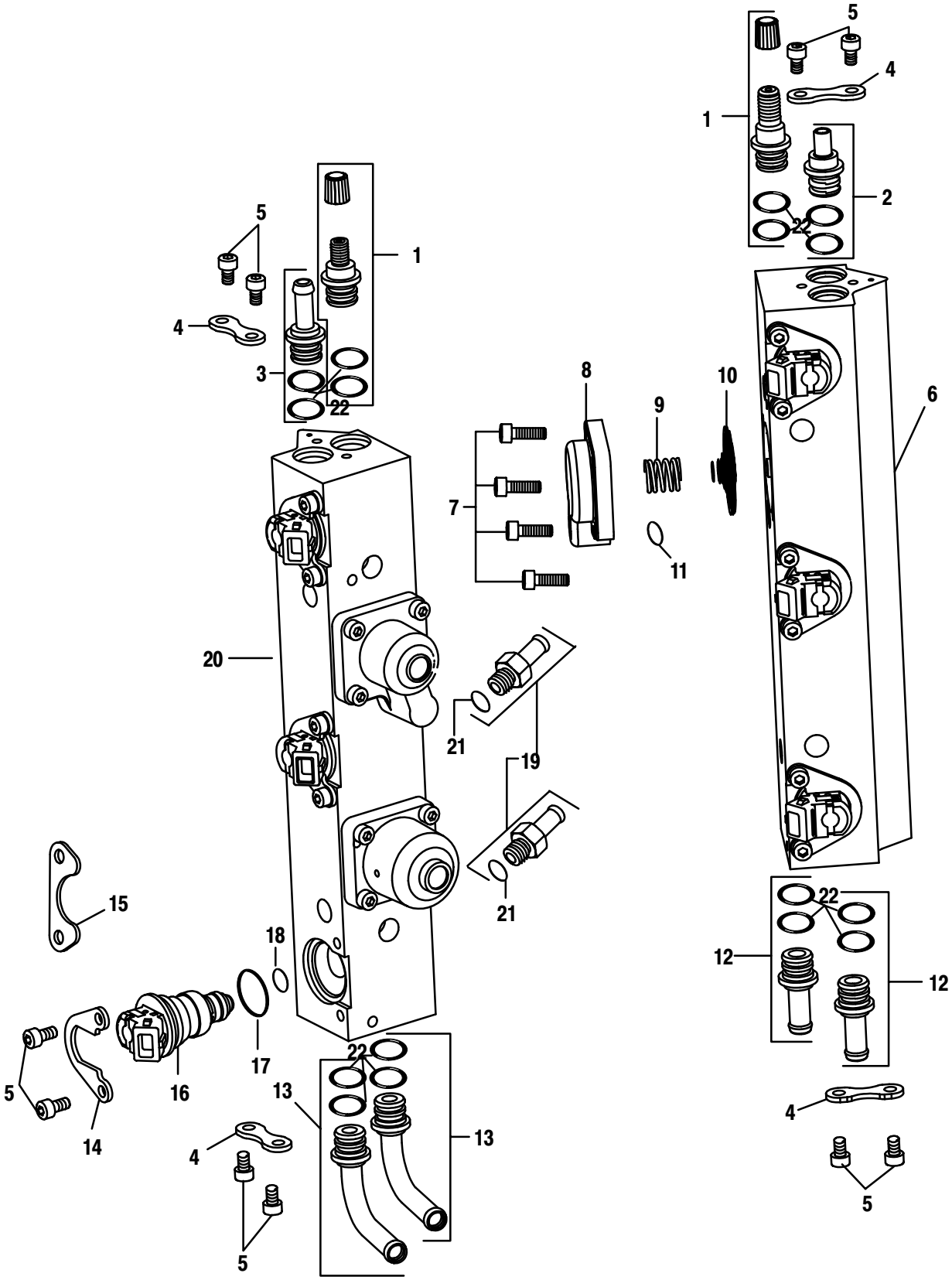
110 4 Stroke Outboard Oil

A = TO TELL TALE
B = TO STARBOARD FUEL RAIL
C = TO FUEL COOLER
D = TO TOP OF AIR HANDLER
E = QTY. OF ONE (1) ON EACH SIDE OF COMPRESSOR FLANGE
F = TO VAPOR SEPARATOR

Fuel Rails/Air Compressor Hose Routing

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	AIR COMPRESSOR (See breakdown on Air Compressor Components)			
2	5	SCREW (M6 x 12)	100		11.5
3	1	PULLEY			
4	2	SCREW		40	54
5	1	HOSE			
6	1	INSULATOR SLEEVE (16 IN.)			
7	1	FUEL RAIL **(STARBOARD)**			
8	6	INJECTOR			
9	4	CLAMP			
10	2	HOSE (16 IN.)			
11	1	STUD			
12	2	WASHER			
13	1	NUT		25	34
14	8	STA-STRAP			
15	1	FUEL RAIL **(PORT)**			
16	1	TUBING (22-1/2 IN.)			
17	1	CHECK VALVE			
18	1	TUBING (2-1/2 IN.)			
19	1	TUBING (28-1/2 IN.)			
20	2	CLAMP			
21	1	TUBING (28-1/2 IN.)			
22	4	SCREW (M5 x 10)			
23	4	CLAMP			
24	4	STUD			
25	4	NUT		33	45
26	1	HOSE (30 IN.) (with INSULATING SLEEVE)			
27	1	HOSE (with INSULATING SLEEVE)			
28	6	CUPPED WASHER			
29	4	CLAMP			
30	1	INSULATOR SLEEVE (18 IN.)			

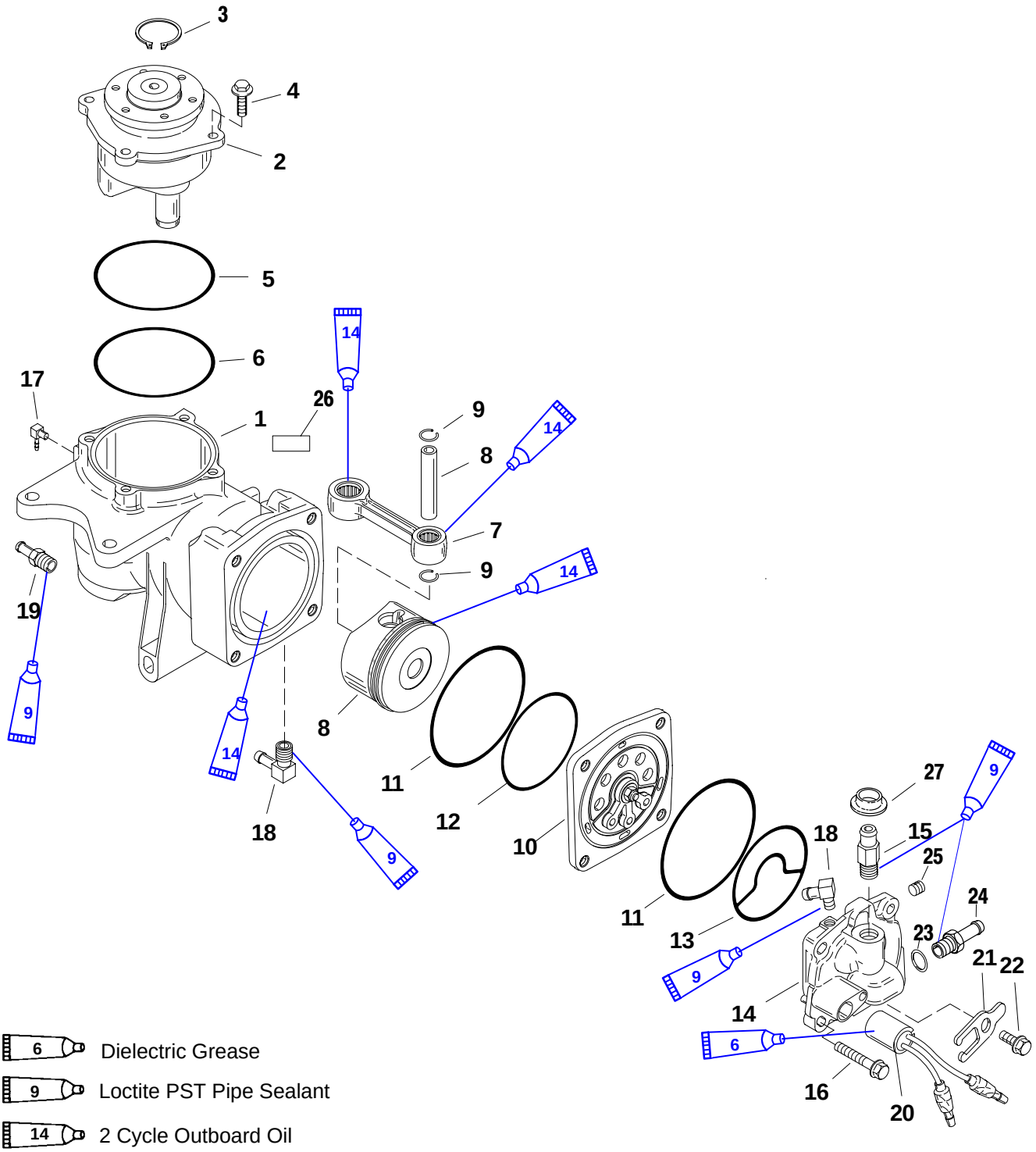
Fuel Rails


5
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5

Fuel Rails

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	2	SCHRADER VALVE KIT (air and fuel)			
2	1	FITTING (air inlet)			
3	1	FITTING (fuel inlet)			
4	4	CLAMP (fitting retainer)			
5	10	SCREW M5X8	70		8
6	1	RAIL (Starboard) without injectors			
7	4	SCREW M5X16	70		8
8	1	COVER (tracker valve)			
9	1	SPRING (tracker valve)			
10	1	DIAPHRAGM (tracker valve)			
11	1	O-RING (tracker cover)			
12	2	FITTING (air/fuel) starboard			
13	2	FITTING (air/fuel) port			
14	6	RETAINER (injector) DESIGN II			
15	6	RETAINER (injector) DESIGN I			
16	6	INJECTOR (fuel)			
17		O-RING KIT (large) 6 per kit			
18		O-RING KIT (small) 6 per kit			
19	2	FITTING			
20	1	RAIL (port) without injectors			
21		O-RING (2 per kit)			
22		O-RING fitting/schrader (16 per kit)			

Air Compressor Components



Air Compressor Components

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	AIR COMPRESSOR			
2	1	END CAP			
3	1	RETAINING RING			
4	4	SCREW (M6 x 20)	100		11.5
5	1	O-RING			
6	1	O-RING			
7	1	CONNECTING ROD			
8	1	PISTON ASSEMBLY			
9	1	LOCK RING			
10	1	REED PLATE ASSEMBLY			
11	1	O-RING			
12	1	O-RING			
13	1	SEAL			
14	1	COMPRESSOR HEAD			
15	1	FITTING-Straight			
16	4	SCREW (M8 x 35)		20	27
17	1	ELBOW			
18	1	ELBOW			
19	1	FITTING-Straight			
20	1	TEMPERATURE SENSOR			
21	1	RETAINER			
22	1	SCREW (M8 x 12)		20	27
23	1	O-RING			
24	1	FITTING			
25	1	PIPE PLUG			
26	1	DECAL-Important			
27	1	GROMMET			
–		**O-RING KIT**			

DFI Operation

Air Induction Through Crankcase

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

Once inside the cowl, the air enters the plenum through the throttle shutter which is located in the plenum assembly. The air then continues through the reed valves and into the crankcase. The throttle shutter is actuated by the throttle shaft. Mounted onto a separate shaft are two throttle position sensors (TPS). These sensors tell the engine control module (ECM) the position of the throttle.

Two TPS's are installed on the DFI engine for safety redundancy. If one TPS should fail, the dash mounted CHECK ENGINE light will flash and the warning horn will sound. Engine speed will be reduced to 3000 RPM. If both TPS's should fail, engine speed will be reduced to idle. DFI engines require large amounts of air into the cylinders at idle speed. To accomplish this, the throttle shutters are partially open at low engine speeds. The dual TPS system reads the shaft movement in both directions, one reads movement up (increasing resistance), while the other reads the same movement as down (decreasing resistance). The ECM reads both and calculates the throttle shutter position.

Air Compressor System

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

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

Fuel

Fuel for the engine is stored in a typical fuel tank. A primer bulb is installed into the fuel line to allow priming of the fuel system. A crankcase mounted, pulse-driven, diaphragm fuel pump draws fuel through the fuel line, primer bulb, and fuel pump assembly. It then pushes the fuel through a water separating fuel filter. This filter removes any contaminates and water before the fuel reaches the vapor separator. Fuel vapors are bled through a vent canister into the air compressor inlet in the front of the flywheel cover.

The electric fuel pump is different than the fuel pump that is utilized on the standard EFI engine (non DFI), and is capable of developing fuel pressures in excess of 90 psi. Fuel inside the rail must remain pressurized at exactly 10 psi over the air rail pressure or the ECM (map) calibrations will be incorrect.Fuel from the vapor separator is supplied to the top of one fuel rail. A fuel line connects the bottom of the first rail to the opposite fuel rail. Fuel is stored inside the rail until an injector opens. A fuel pressure regulator controls pressure in the fuel rails, and allows excess fuel to return into the vapor separator. The fuel regulator not only regulates fuel pressure but also regulates it at approximately 10 p.s.i. higher than whatever the air rail pressure is. The fuel regulator diaphragm is held closed with a spring that requires 10 p.s.i. to force the diaphragm off the diaphragm seat. The back side of the diaphragm is exposed to air rail pressure. As the air rail pressure increases, the fuel pressure needed to open the regulator will equally increase. Example: If there is 50 p.s.i. of air pressure on the air rail side of the diaphragm, 60 p.s.i. of fuel pressure will be required to open the regulator. The return fuel line to the vapor separator is water cooled.

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

Oil

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

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

Electrical

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

Operation

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

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

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

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

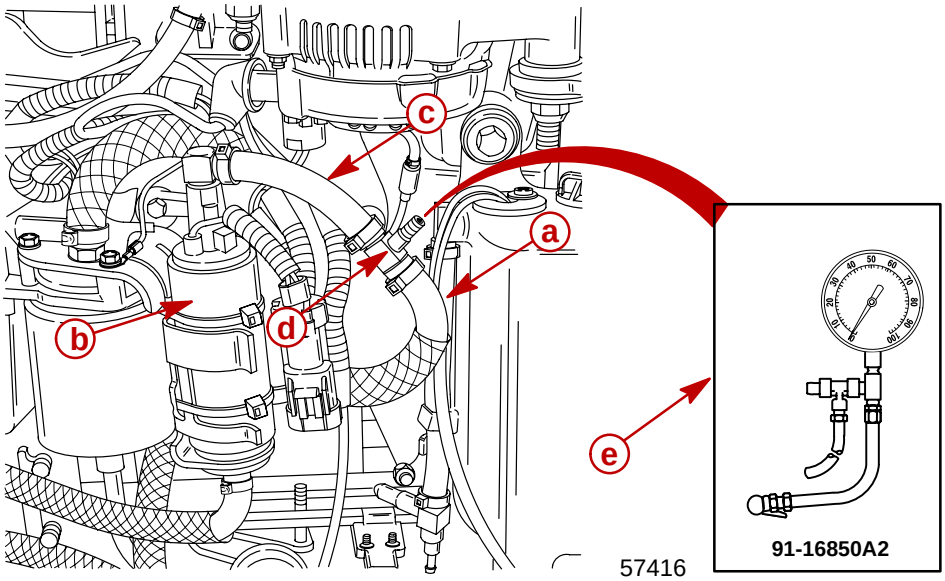
The crankshaft position sensor is different from the standard 3.0 liter sensor. The crank position sensor serves two functions (flywheel speed and position).

Testing Electric Fuel Pump Pressure Output

Low Pressure Electric Fuel Pump

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

1. Remove outlet fuel hose from low pressure pump. Install a short piece of hose onto pump outlet fitting. Install Schrader Valve T-fitting from Schrader Valve Fuel Pressure Kit (849021A4) between outlet fuel hose (removed from pump) and new fuel hose (installed on pump). Secure hose connections with sta-straps. Connect Fuel/Air Pressure Gauge to Schrader Valve. Gauge should indicate 6-9 psi (41.37 – 62.04 kPa).

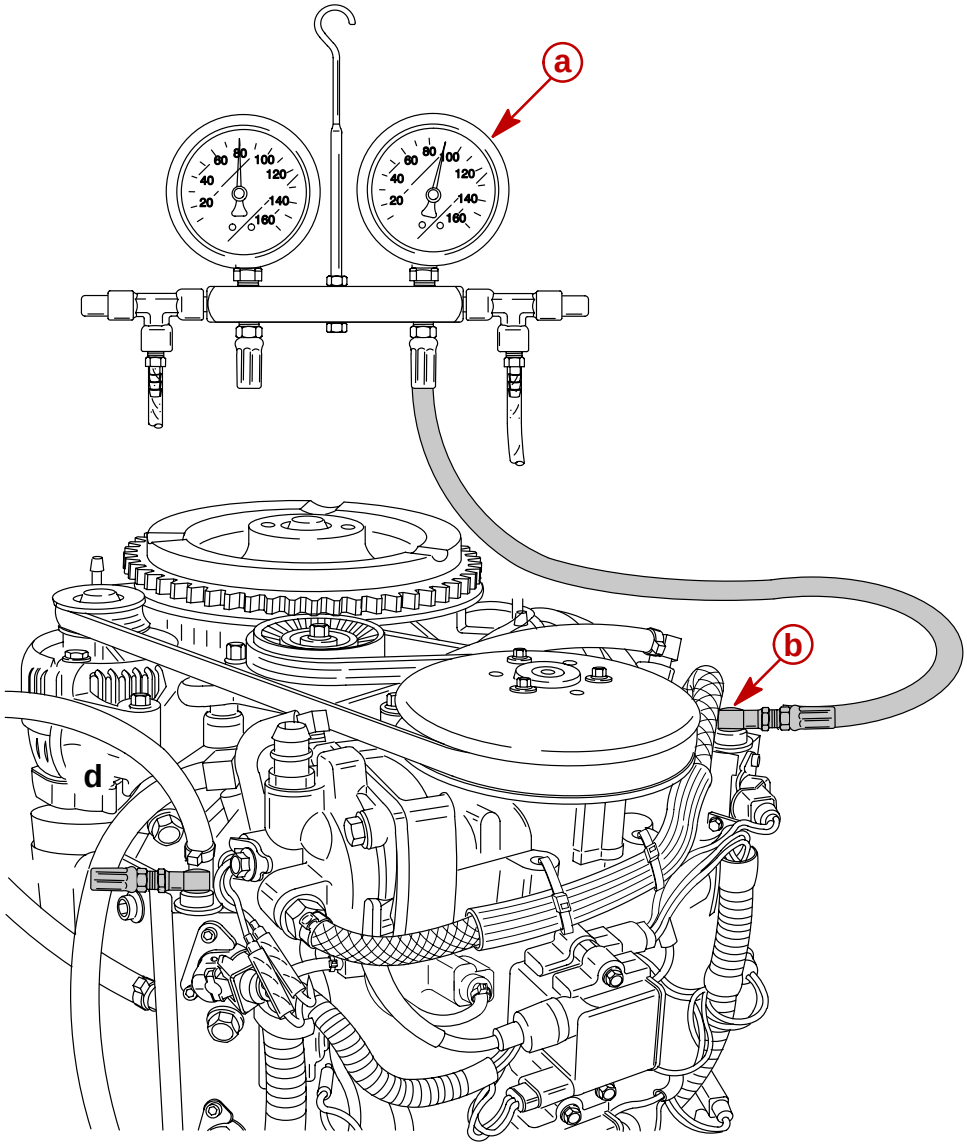


a - Outlet Fuel Hose
b - Low Pressure Electric Fuel Pump
c - Fuel Hose (obtain locally)
d - Schrader Valve T-Fitting (22-849606)
e - Fuel/Air Pressure Gauge (91-16850A2)

High Pressure Electric Fuel Pump

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

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



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

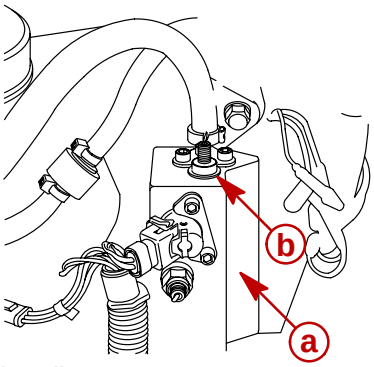
Fuel Management Assembly Removal and Installation

⚠ CAUTION

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

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

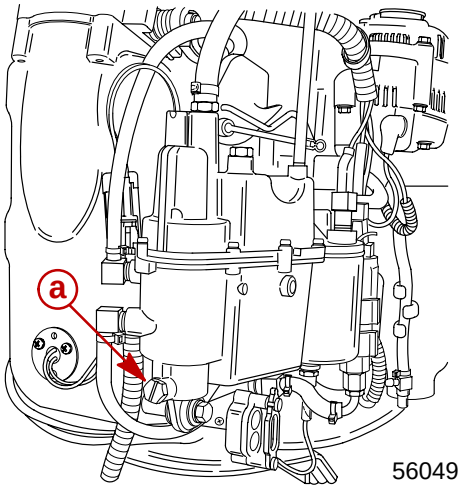
1. De-pressurize fuel system.



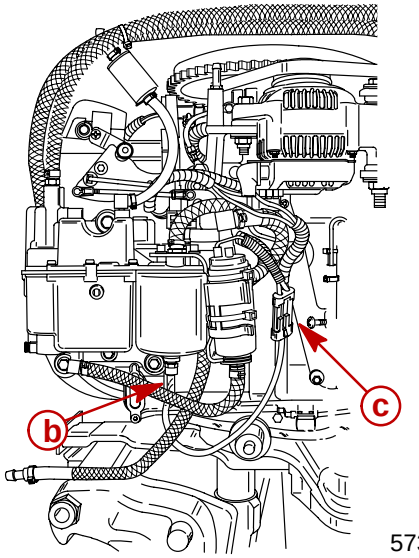
a - Starboard Fuel Rail
b - Fuel Pressure Port

Vapor Separator Removal

2. Place suitable container underneath vapor separator drain plug and remove plug.
3. Disconnect electric fuel pump harness connector.



56049



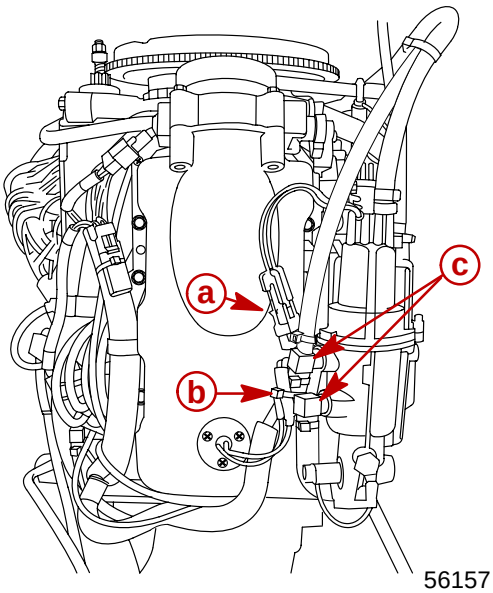
57317

a - Drain Plug
b - Sensor Lead
c - Harness Connector

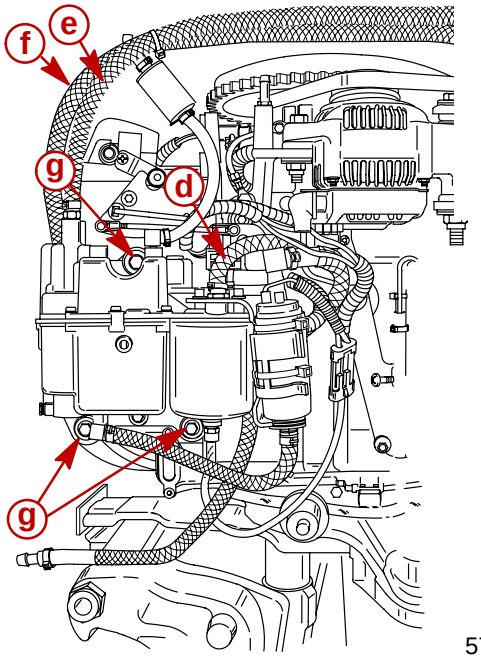
4. Remove sta-strap securing air temperature sensor harness to fuel hose.
5. Disconnect the high pressure fuel pump harness connector
6. Remove vapor separator vent hose to air plenum.

NOTE: *Upper fuel hose goes to fuel cooler. Lower fuel hose goes to electric pump beside fuel/water separator.*

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



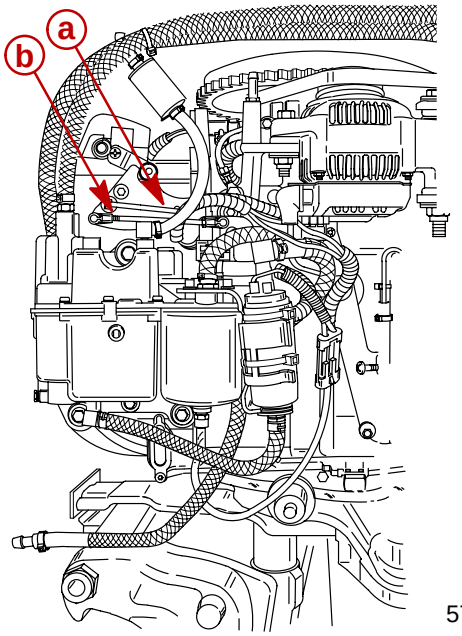
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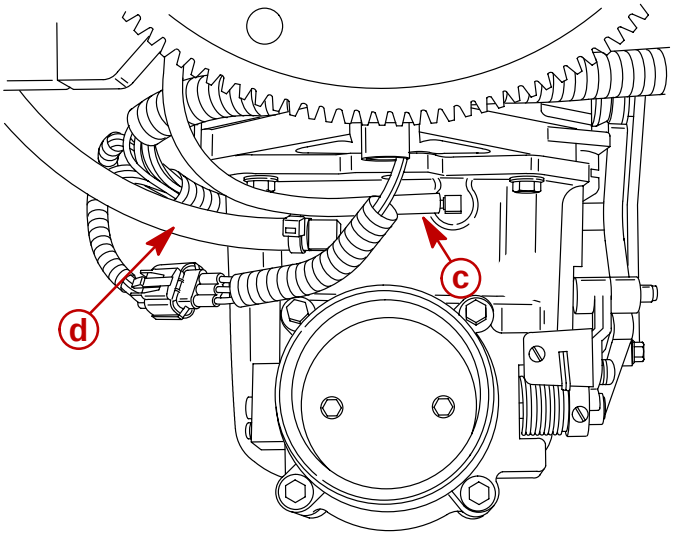
57317

a - Harness Connector
b - Sta-strap
c - Fuel Hoses
d - Fuel Inlet Hose
e - Fuel Outlet Hose
f - Fuel Return Hose
g - Mounting Bolts

10. Disconnect throttle cam link rod and the Throttle Position Sensor link rod.
11. Disconnect MAP Sensor hose and compressor oil return hose from air management assembly.



57317

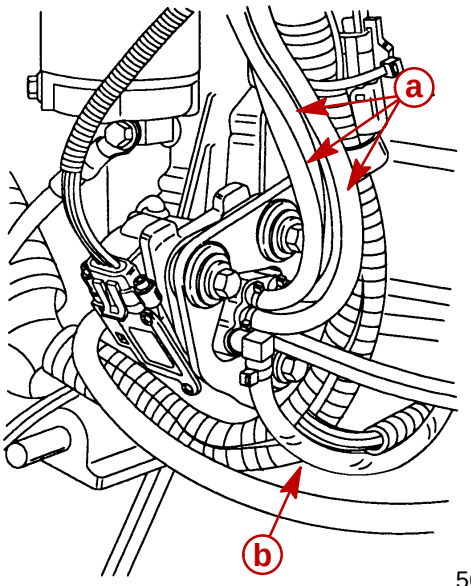


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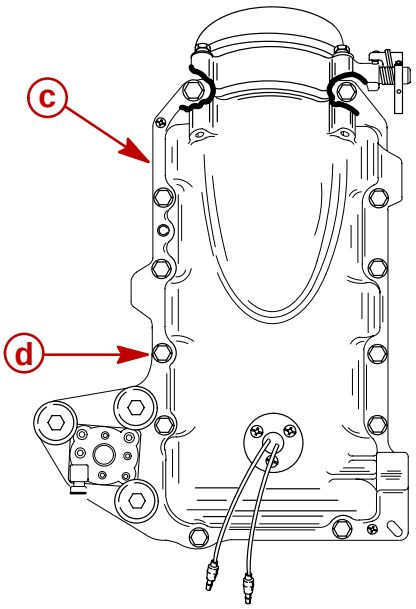
a - Throttle Link Rod
b - Throttle Position Sensor Link Rod
c - MAP Sensor Hose
d - Oil Return Hose

Air Management Assembly Removal

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



56140



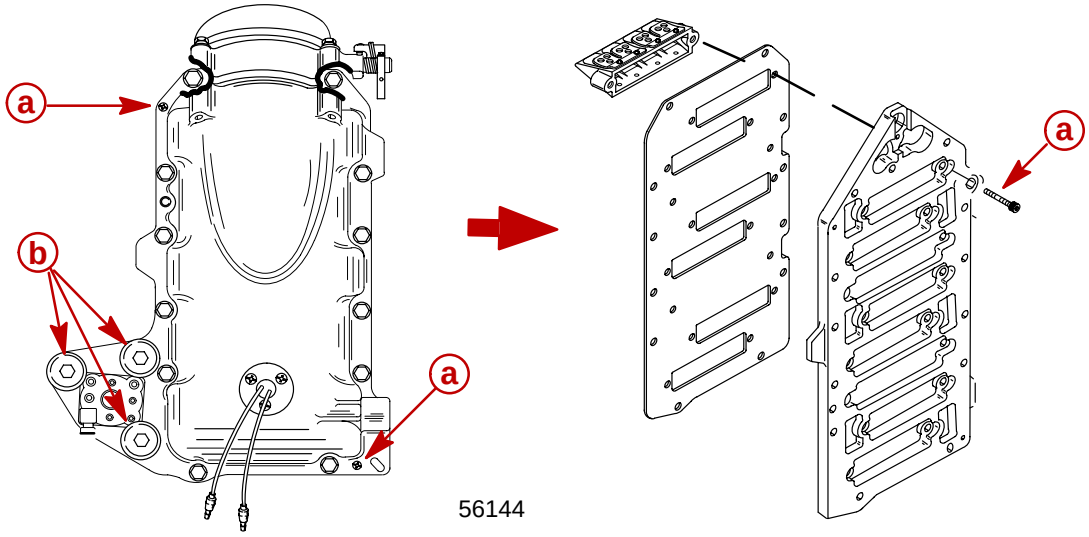
56144

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

Reed Block Assembly Removal and Installation

REMOVAL

1. Remove 2 screws securing air plenum to reed plate assembly.
2. Remove 3 bolts securing oil pump adaptor plate to air plenum assembly.



56144

a - Screws (2 each)
b - Bolts (3 each)

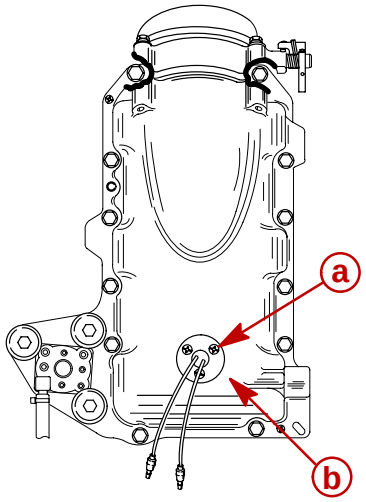
INSTALLATION

1. Secure oil pump adaptor plate to air plenum with 3 bolts. Torque bolts to 16 lb. ft. (22.0 Nm).
2. Secure air plenum to reed plate with 2 screws. Drive screws tight.

Air Temperature Sensor Removal and Installation

REMOVAL

Remove 3 screws securing Air Temperature Sensor, and remove sensor.



56144

a - Screws
b - Sensor

INSTALLATION

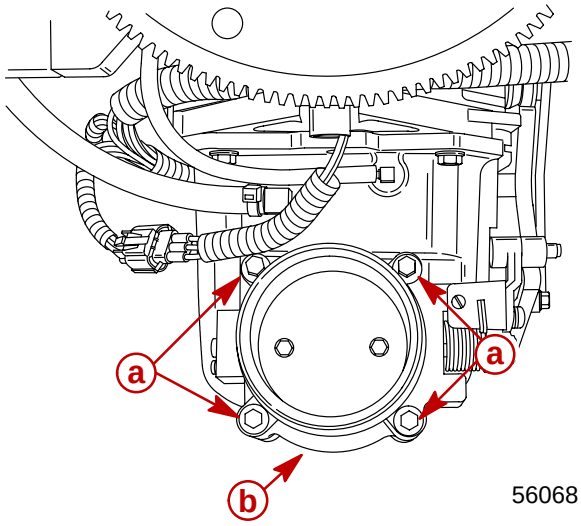
Secure Air Temperature Sensor in air plenum with 3 screws. Drive screws tight.

Throttle Plate Assembly Removal and Installation

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.



56068

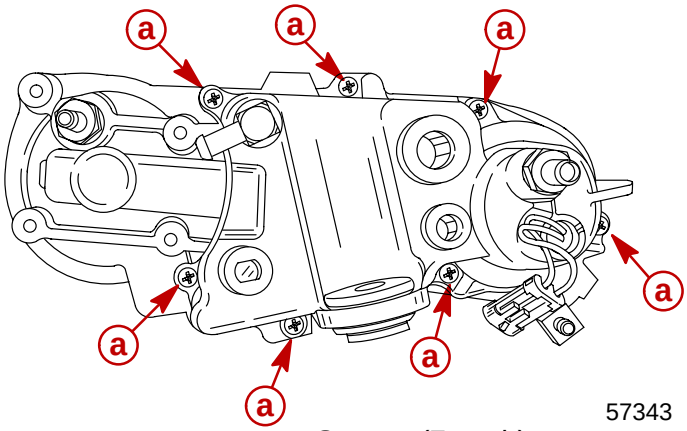
a - Bolts
b - Throttle Plate Assembly

INSTALLATION

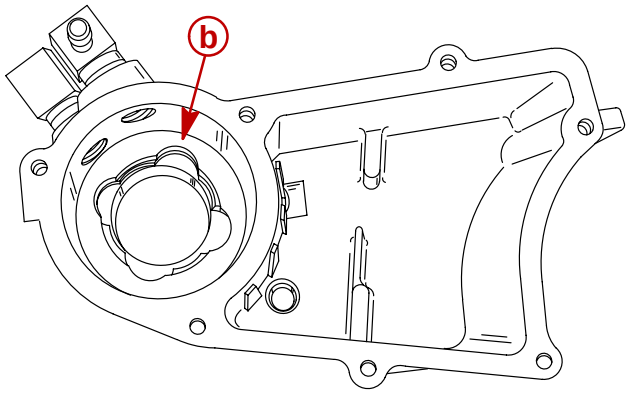
Secure throttle plate assembly to air plenum with 4 bolts. Torque bolts to 100 lb. in. (11.5 Nm).

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 with Teflon to seal lips.



57343



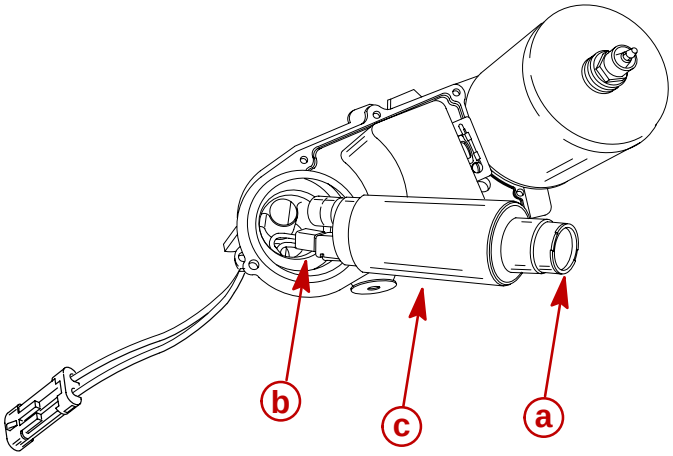
57342

a - Screws (7 each)
b - Seal

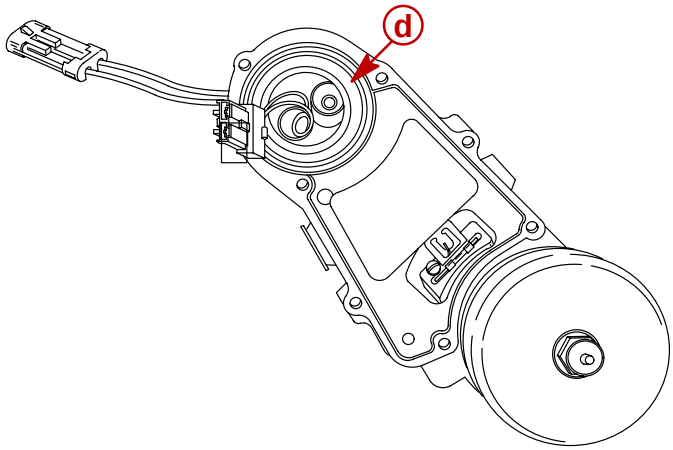
3. Fuel pump may be removed from cover by wiggling slightly while pulling outward.

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

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



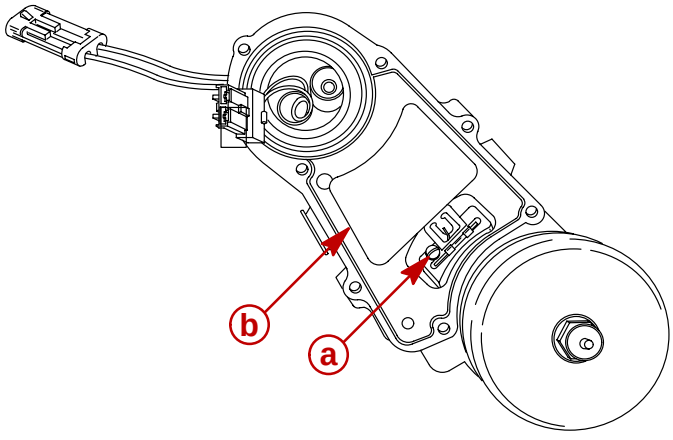
56057



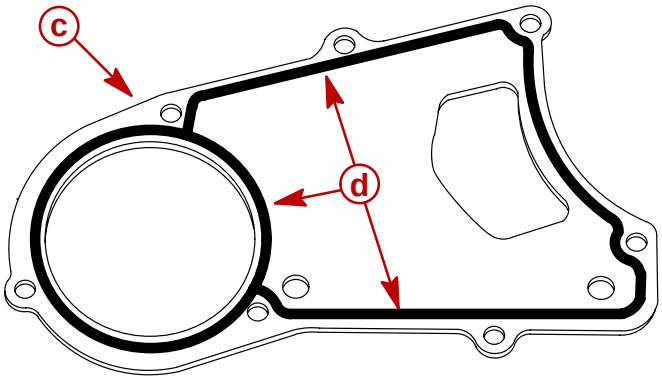
56058

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

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



56058

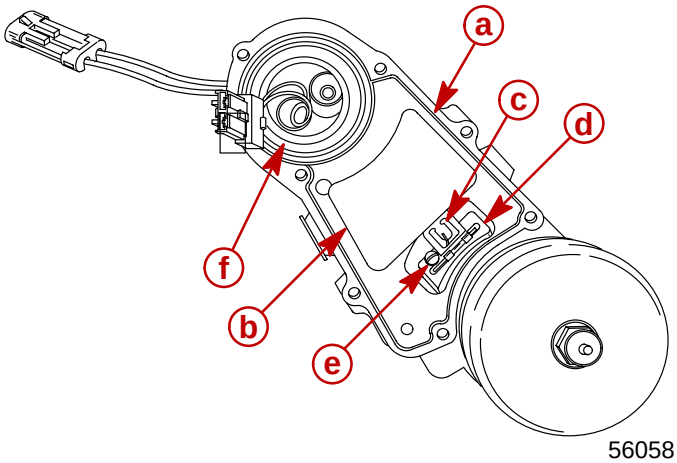


56059

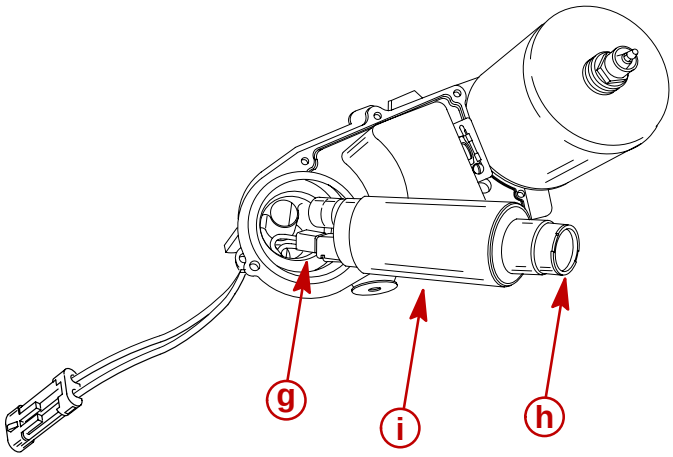
a - Screw
b - Float
c - Plate
d - Seal

Vapor Separator Reassembly

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



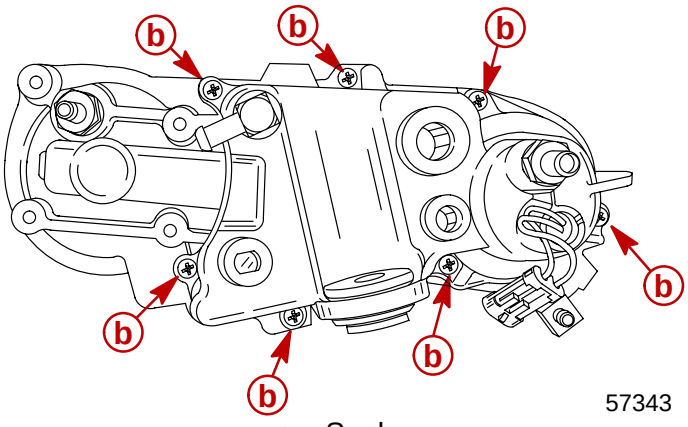
56058



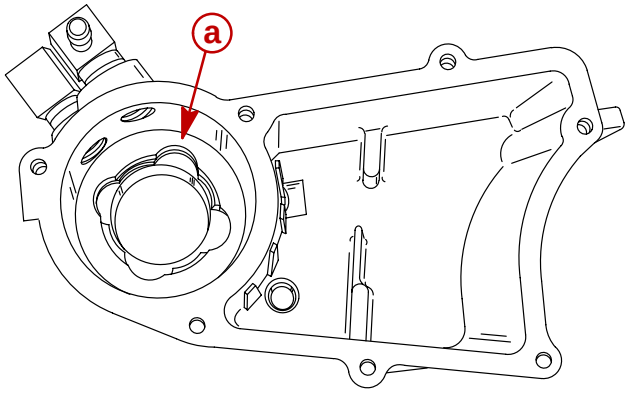
56057

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

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



57343

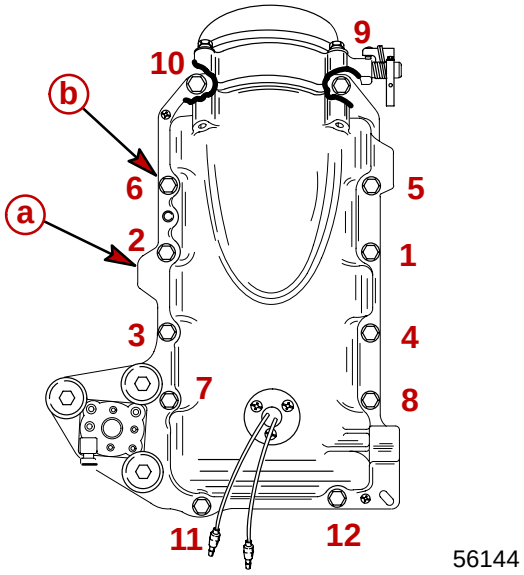


57342

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

Air Plenum Installation

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

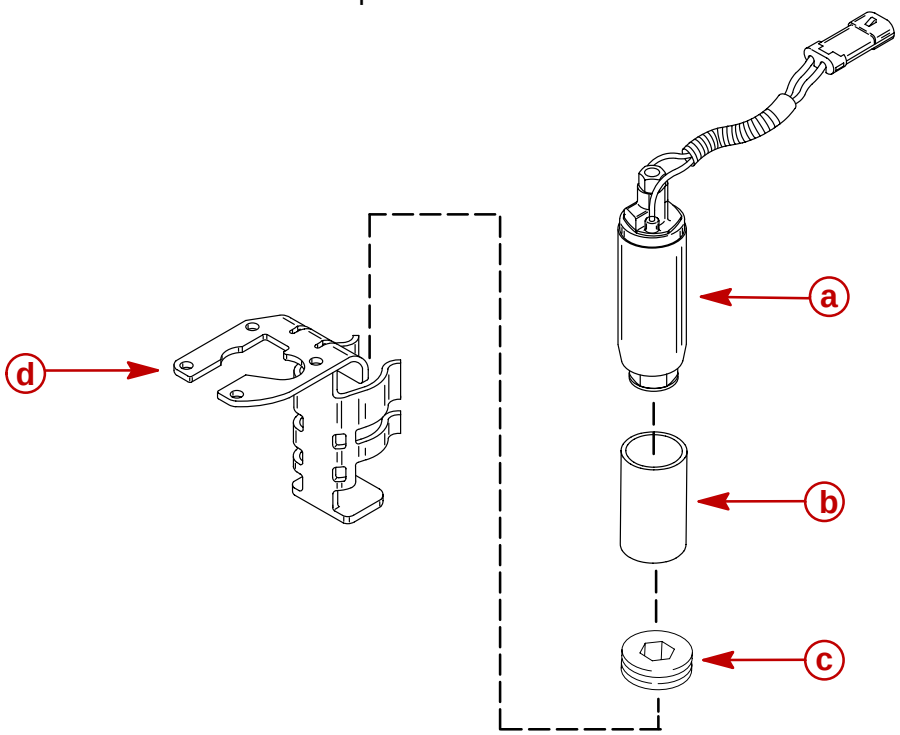


a - Air Plenum
b - Bolts [Torque to 100 lb. in. (11.5 Nm)]

Low Pressure Electric Fuel Pump Installation

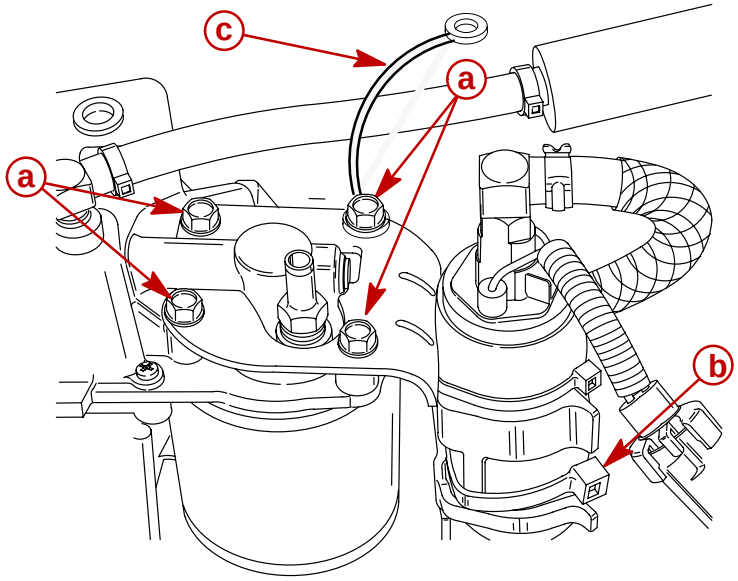
NOTE: *If pump does not have a sleeve or grommet, refer to Service Bulletin 98-8.*

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



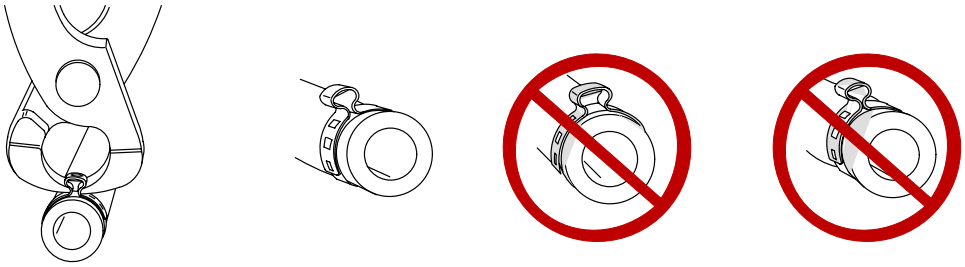
a - Low Pressure Electric Fuel Pump
b - Sleeve
c - Grommet
d - Bracket

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

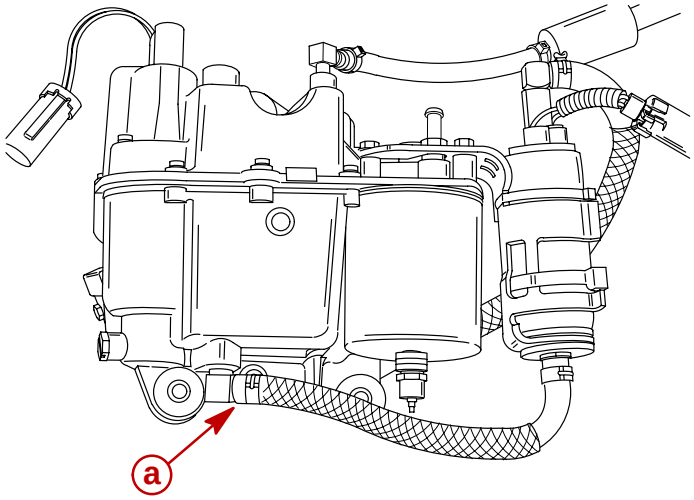


a - Screws – Torque to 100 lb. in. (11.5 Nm)
b - Sta-strap securing pump to bracket
c - Ground lead – attach to air plenum

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



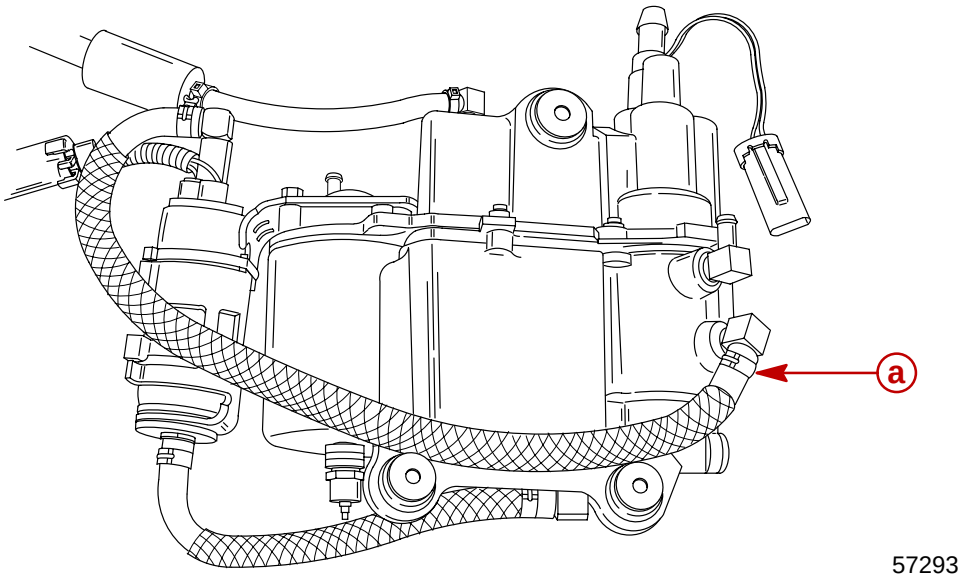
3. Connect fuel hose from bottom of low pressure fuel pump to 90° elbow in bottom of vapor separator. Secure hose with 16.2 mm full circle clamp (54-855697) using crimping tool 91-803146T.



27291

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

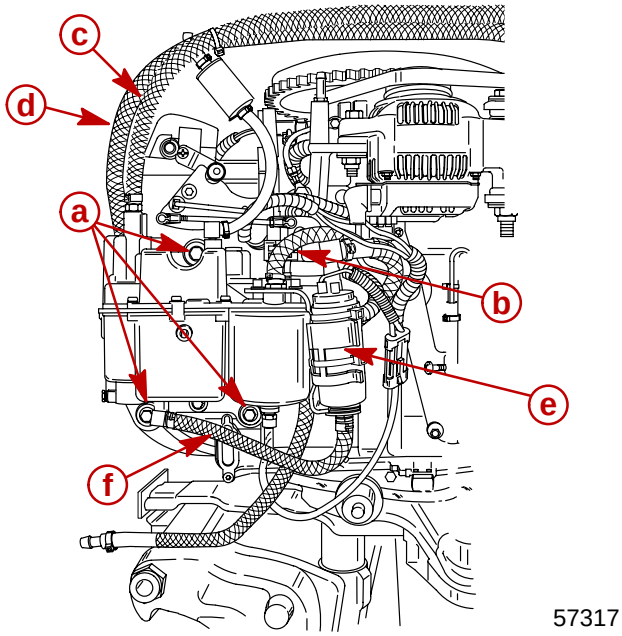
4. Connect fuel hose from top of low pressure fuel pump to 90° elbow on back side of vapor separator. Secure hose with 15.3 mm full circle clamp (54-856880) using crimping tool 91-803146T. (Back view of vapor separator shown below)



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

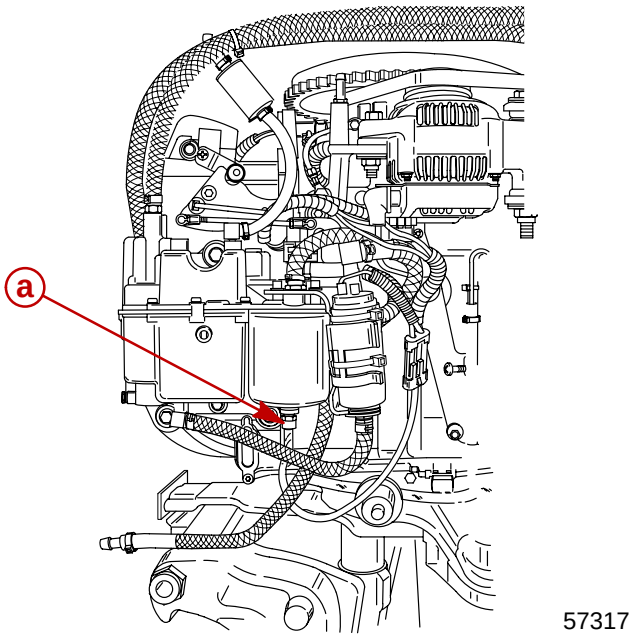
Vapor Separator Installation

1. Secure vapor separator to air plenum with 3 bolts. Torque bolts to 45 lb. in. (5.0 Nm).
2. Connect fuel inlet hose from pulse pump.
3. Connect fuel outlet hose and fuel return hose to vapor separator.



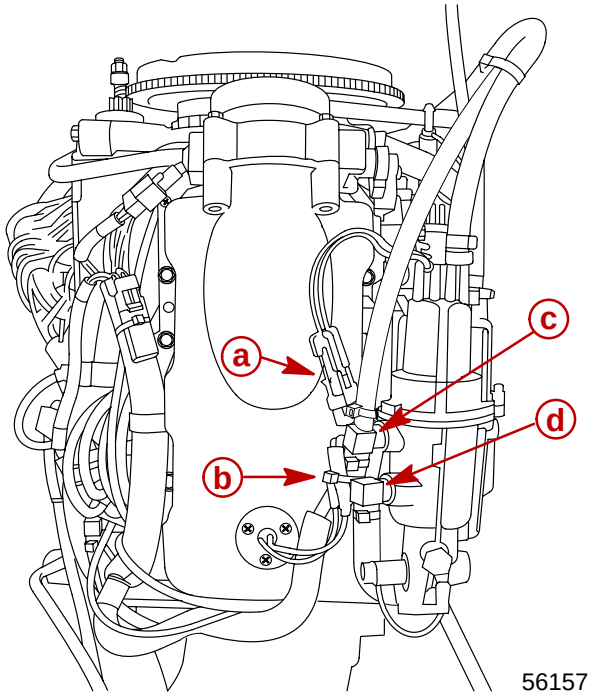
a - Mounting Bolts [Torque to 45 lb. in. (5.0 Nm)
b - Fuel Inlet Hose
c - Fuel Outlet Hose
d - Fuel Return Hose
e - Low Pressure Electric Fuel Pump (6 - 9 psi)
f - Inlet Fuel Hose to Low Pressure Pump

4. Connect water separator sensor lead to water separator.



a - Sensor Lead

5. Connect electric fuel pump harness.
6. Connect vapor separator vent hose to air plenum.
7. Secure air temperature sensor leads to fuel hose with sta-strap.



a - Electric Fuel Pump Harness Connector
b - Sta-Strap
c - Top Fuel Hose (Fuel return from fuel cooler)
d - Bottom Fuel Hose (Inlet from low pressure pump)

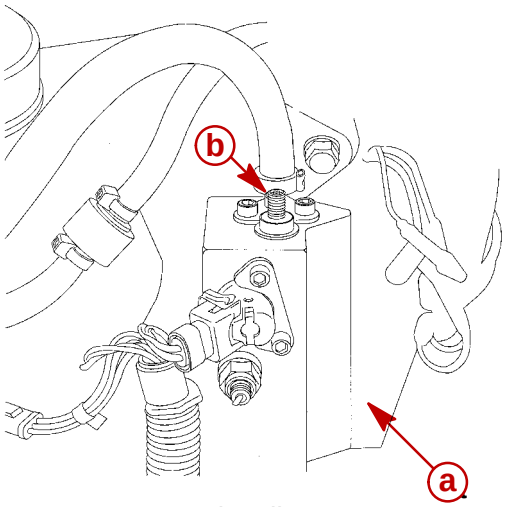
Fuel Rail Removal

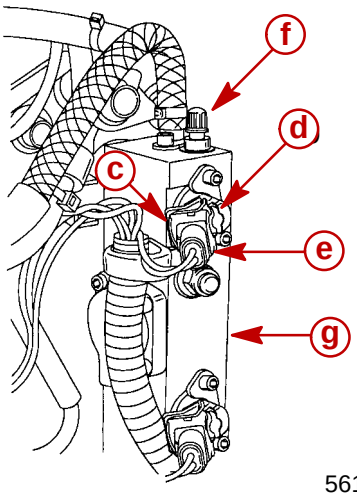
⚠ CAUTION

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

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

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



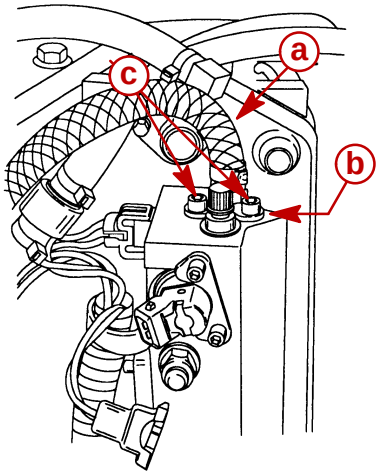


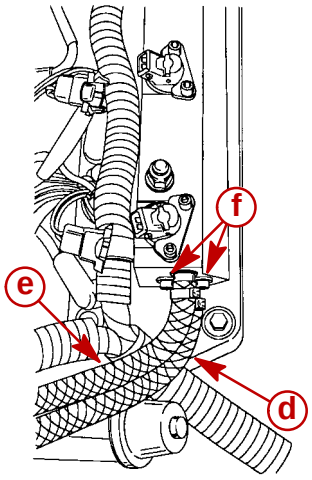
56118

a - Port Fuel Rail
b - Air Pressure Port
c - Spring Clip
d - Fuel Injector
e - Harness Connector
f - Fuel Pressure Port
g - Starboard Fuel Rail

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

3. Remove fuel inlet hose, fuel outlet hose and air hose from fuel rail.





56140

Top Fuel Rail Connections

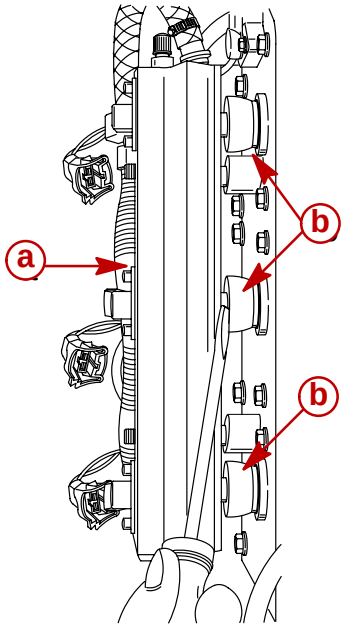
a - Air Hose
b - Retainer
c - Allen Screws (remove)

Bottom Fuel Rail Connections

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

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

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



56121

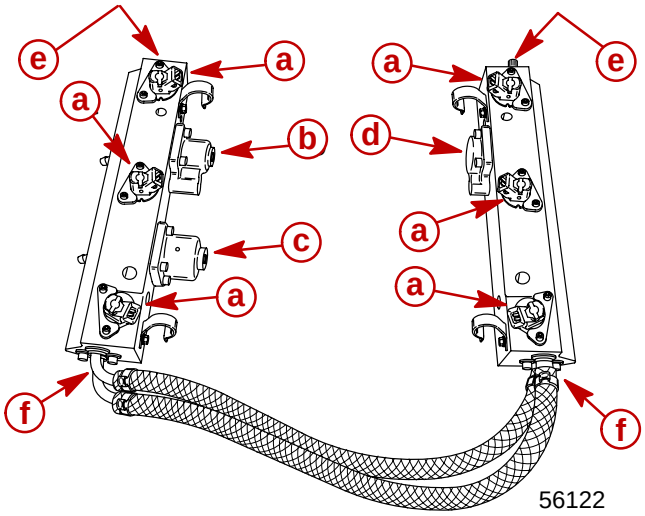
a - Fuel Rail
b - Direct Injectors

Fuel Rail Disassembly

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

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

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



56122

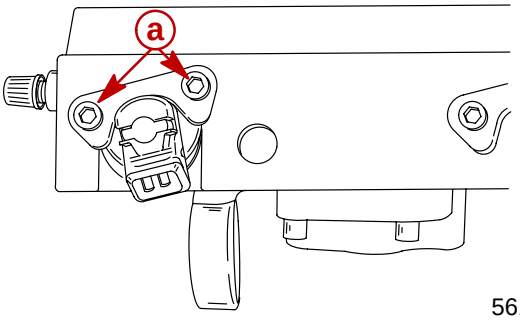
a - Fuel Injector
b - Fuel Regulator
c - Air Regulator
d - Tracker Valve
e - Fuel/Air Inlet (hidden)
f - Fuel/Air Outlet

FUEL INJECTOR REMOVAL

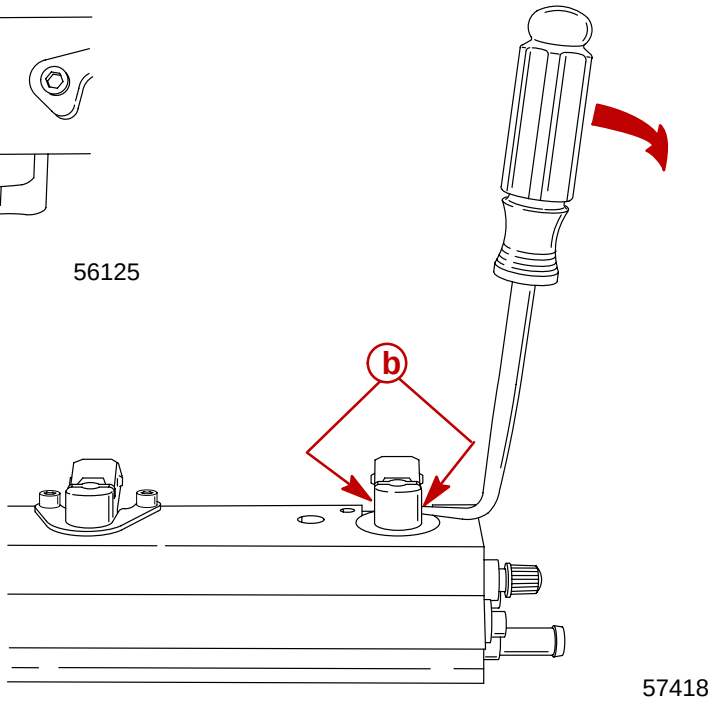
1. Remove 2 screws securing injector.

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

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



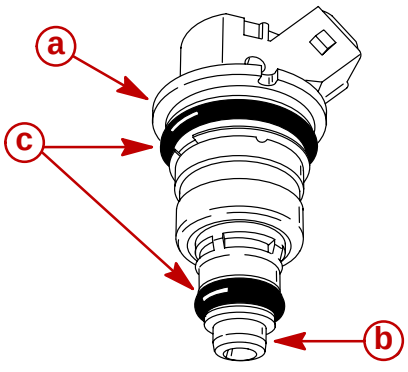
56125



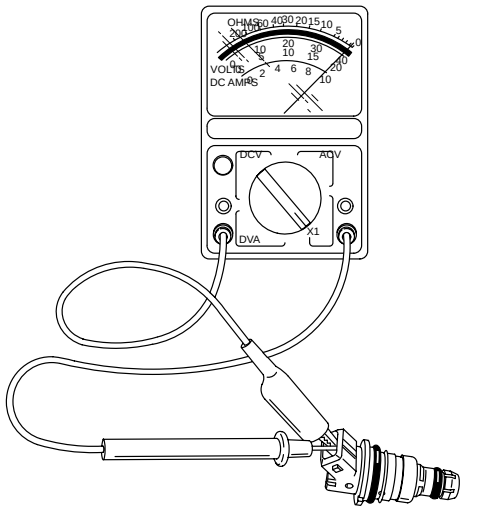
57418

a - Screws
b - Pry Holes

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



56124



56002

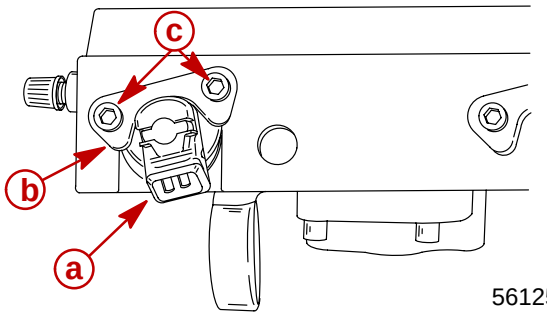
a - Fuel Injector
b - Fuel Nozzle
c - O-Rings

FUEL INJECTOR INSTALLATION

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

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

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

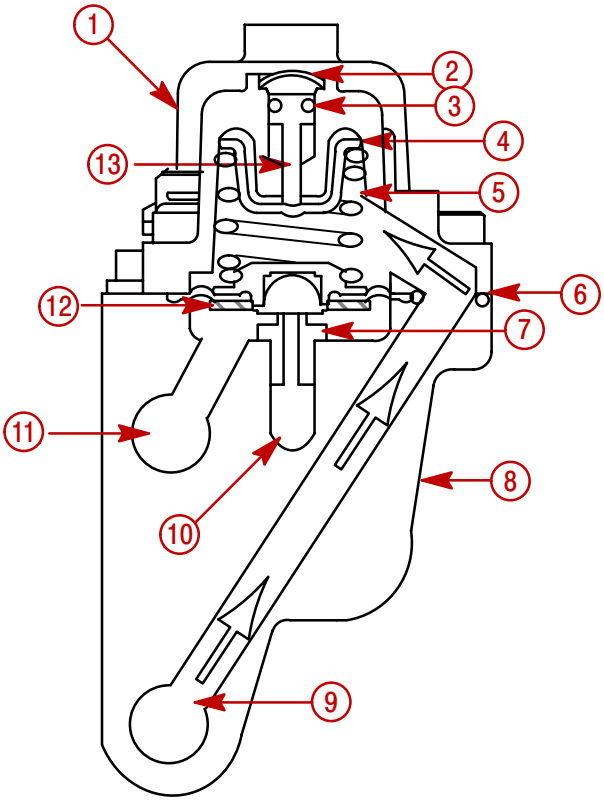


56125

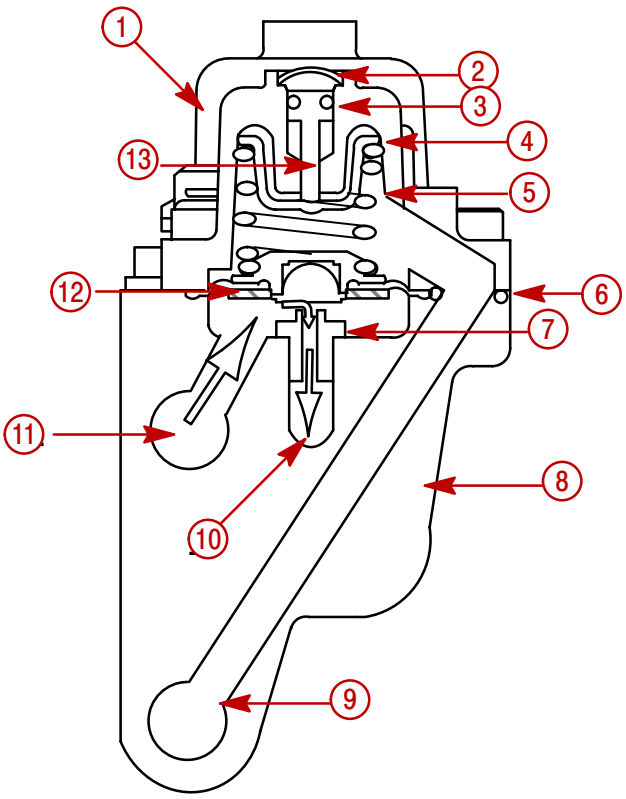
a - Injector
b - Retainer
c - Screws [Torque to 70 lb. in. (8.0 Nm)]

Fuel Pressure Regulator

Regulator Closed



Regulator Open



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

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

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

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

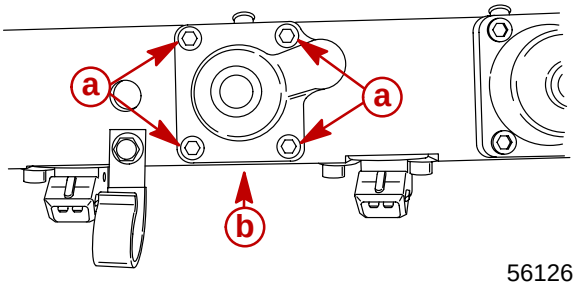
When the engine is not running (no air pressure on the spring side of the diaphragm) the fuel pressure required to move the diaphragm is 10 psi.

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

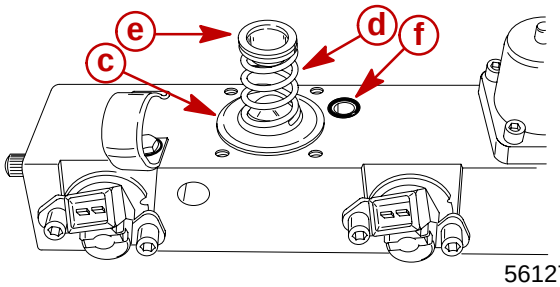
The air pressure (80 psi) and spring pressure (10 psi) combine to regulate system fuel pressure to 90 psi - or 10 psi higher than the air pressure in the DFI system fuel/air rails.

FUEL REGULATOR REMOVAL

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



56126



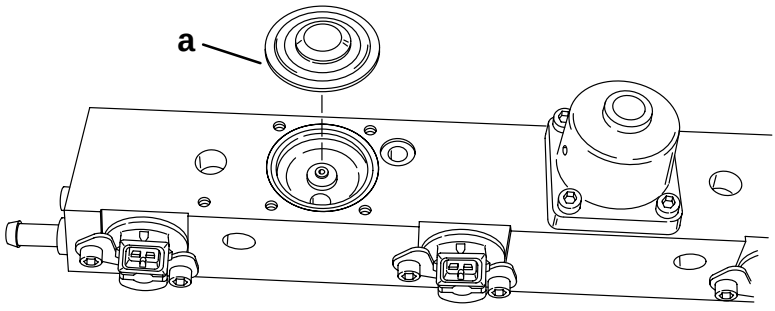
56127

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

FUEL REGULATOR INSTALLATION

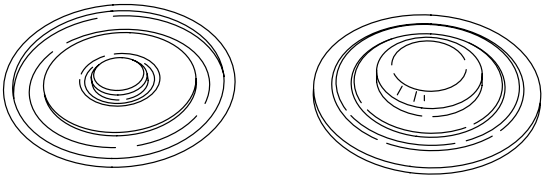
NOTE: *Apply a light coat of 2-4-C with Teflon to diaphragm and o-ring groove area on the fuel rail to aid in the retention of diaphragm and o-ring on fuel rail during reassembly.*

1. Position diaphragm on fuel rail.



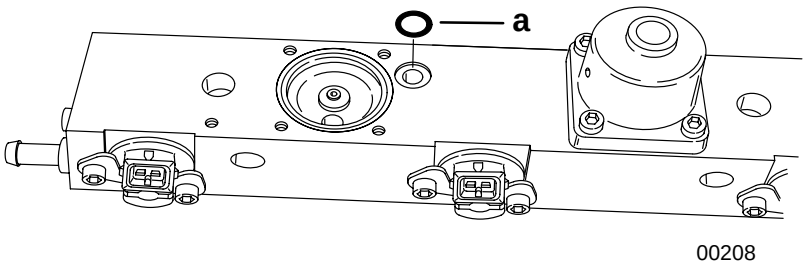
00207

a - Diaphragm



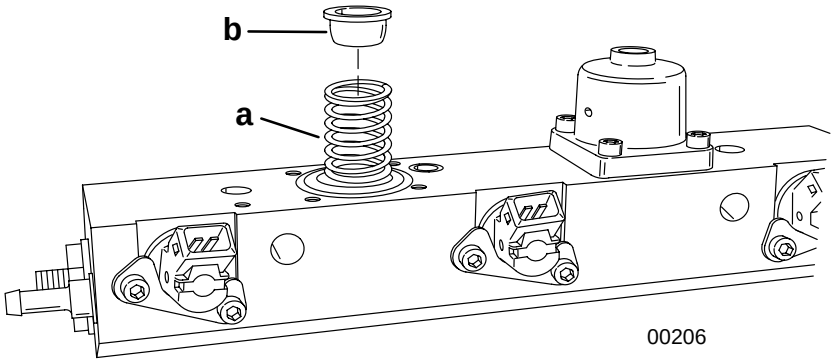
RAIL SIDE **SPRING SIDE**

2. Position o-ring on fuel rail.



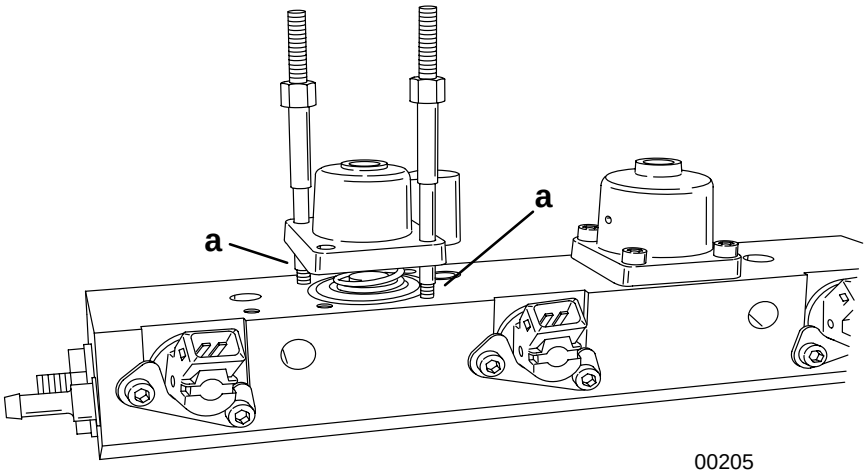
a - O–Ring

3. Position spring and cup onto diaphragm.



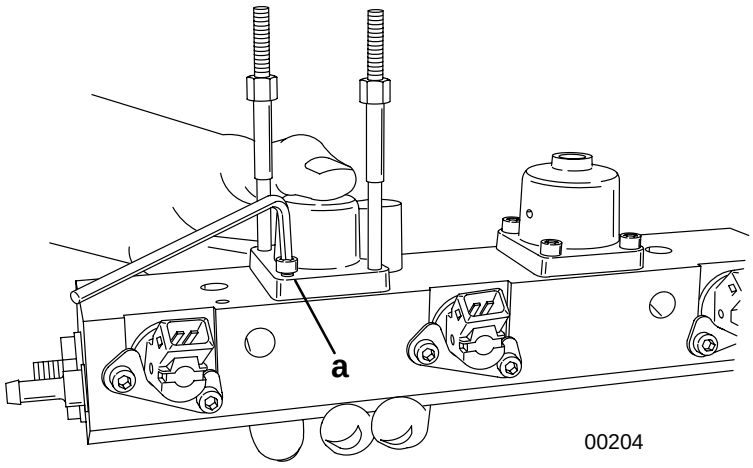
a - Spring
b - Cup

4. Place cover over spring/cup/diaphragm assembly. Place the alinement pins from the special tool (91-889431) through two of the regulator cover mounting holes and thread them into the corresponding threaded holes in the fuel rail.



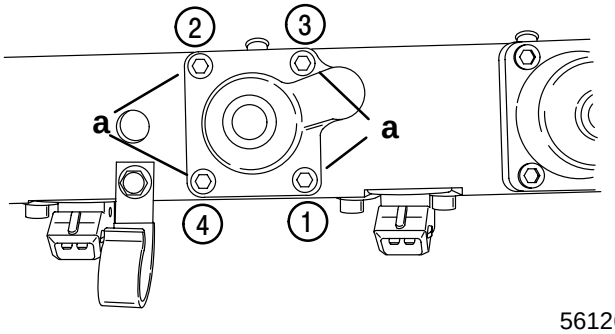
a - Alignment Pins

5. Push the regulator cover against the fuel rail. While holding the cover down install two cover retaining screws through the open holes in the cover. Thread the two screws down until the head of the screw makes contact with the cover. Do not torque screws at this time.



a - Screw

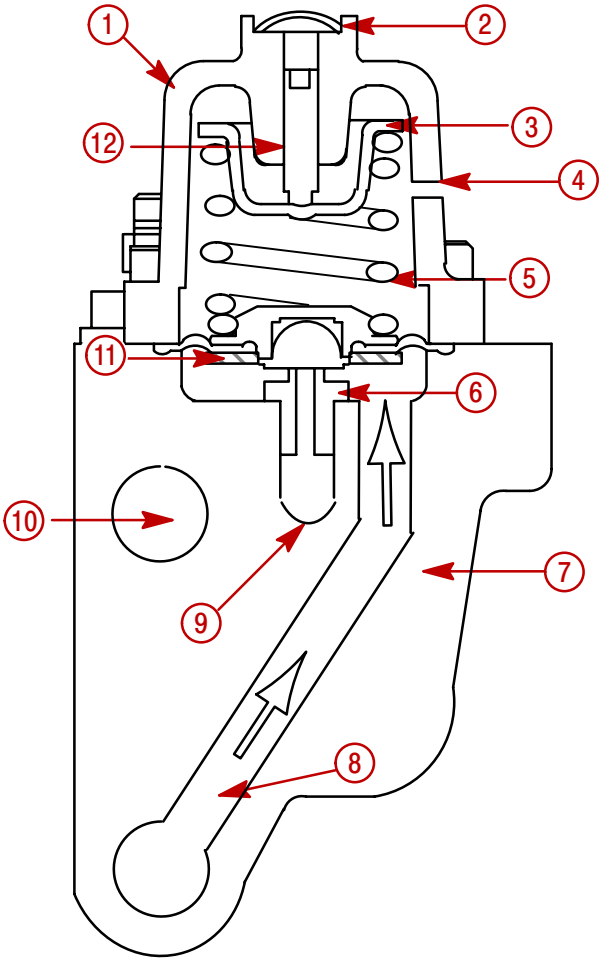
6. Remove the alignment pins and install the two remaining screws. Torque in two stages, First torque to 50 lb in. (5.6 Nm) then to 70 lb in. (8 Nm).



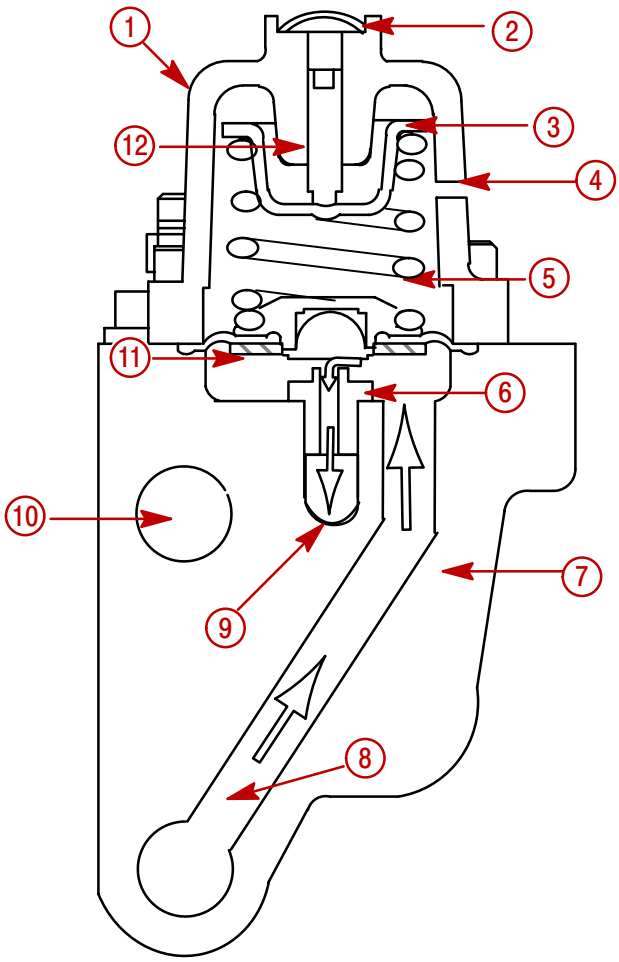
a - Screws

Air Pressure Regulator

Regulator Closed



Regulator Open



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

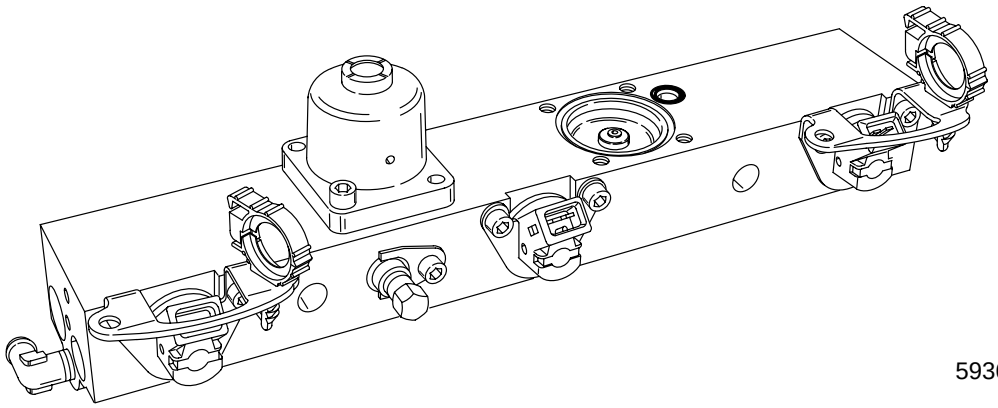
The air pressure regulator is designed to limit the air pressure inside the rails to approximately 80 psi.

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

DESIGN 1 AIR REGULATOR REMOVAL

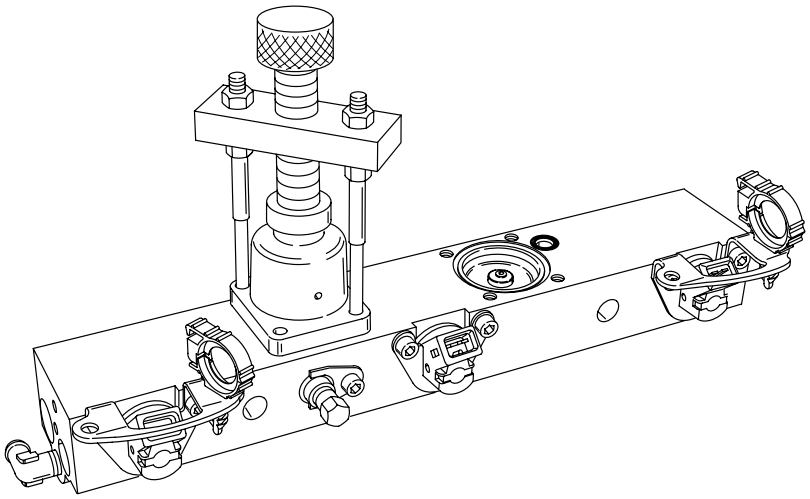
NOTE: *Due to the stiffness of the regulator spring, it is recommended that Regulator Installation Tool 91-889431 be utilized when removing the air regulator cover.*

1. Remove two opposing screws from regulator cover and install regulator installation tool.



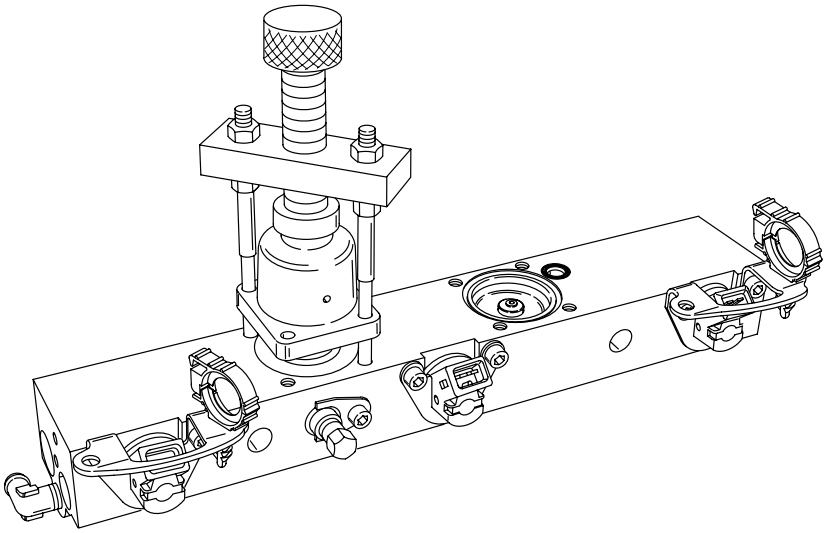
59360

2. With installation tool applying pressure to regulator cover, remove remaining cover screws.



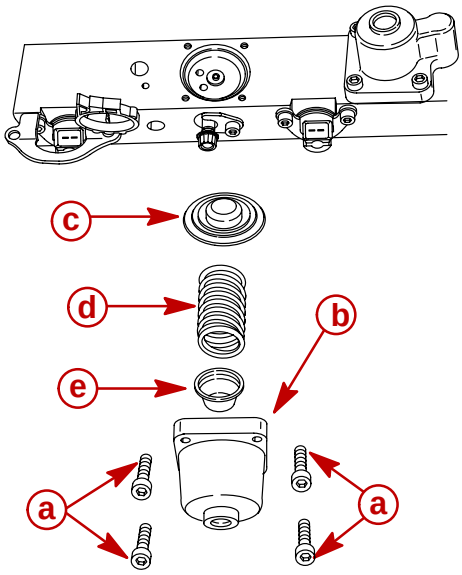
59357

3. Loosen installation tool and remove cover.



59356

4. Inspect regulator diaphragm for cuts or tears. Replace as required.



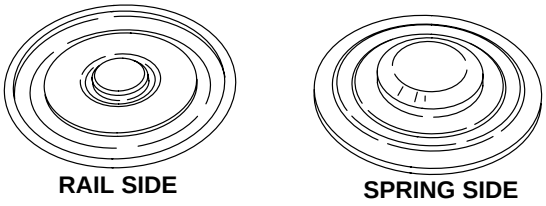
57974

a - Screws
b - Air regulator cover
c - Diaphragm
d - Spring
e - Cup

DESIGN 1 AIR REGULATOR INSTALLATION

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

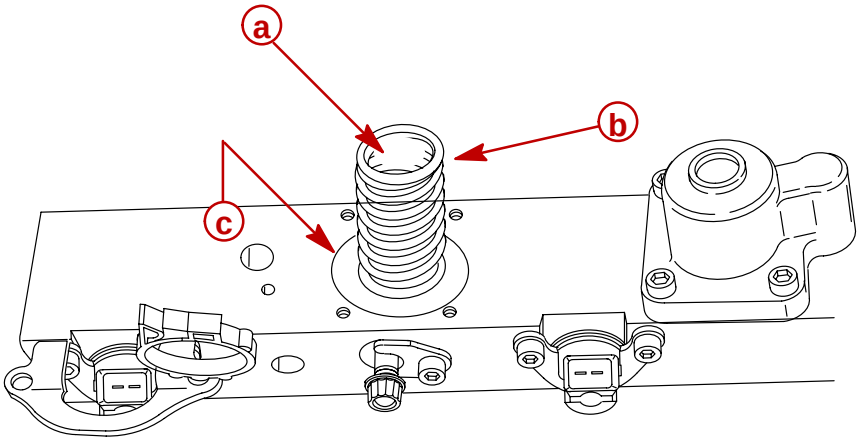
1. Position diaphragm, spring and cup onto fuel rail with fuel rail in horizontal position.



59354

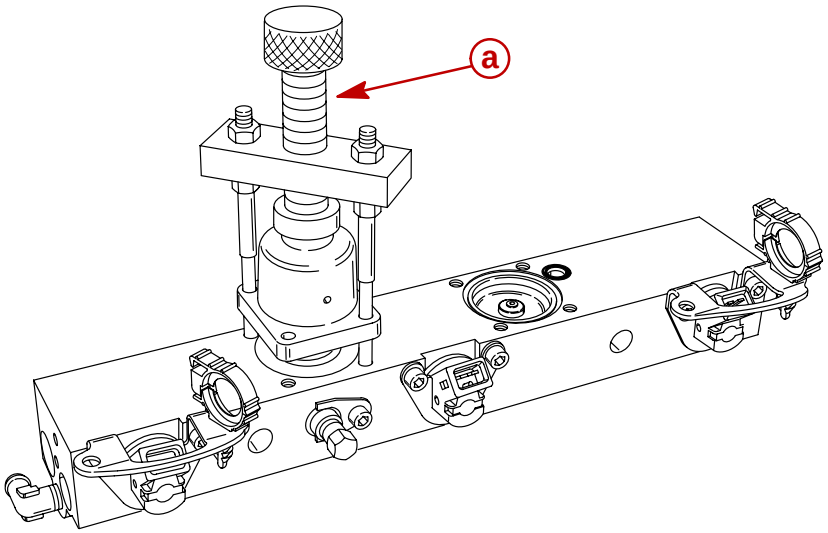
NOTE: *Apply anti-seize grease (obtain locally) or 2-4-C with Teflon to regulator attaching screw threads.*

NOTE: *Due to the stiffness of the regulator spring, it is recommended that Regulator Installation Tool 91-889431 be utilized when installing the air regulator cover.*



a - Cup
b - Spring
c - Diaphragm

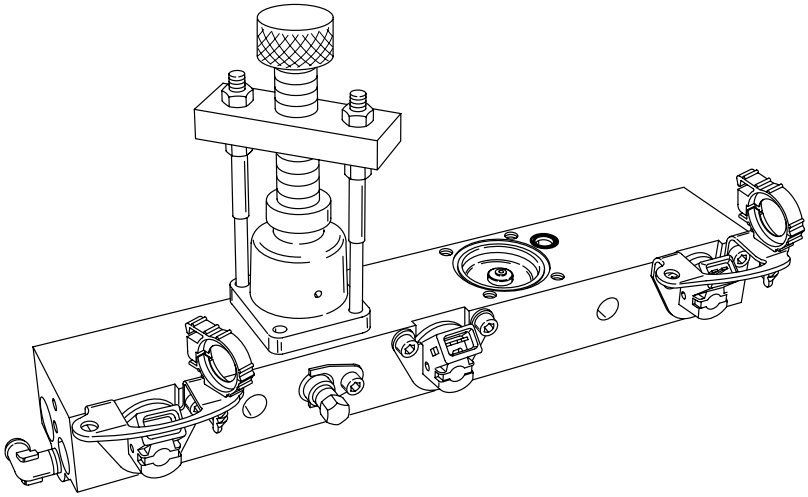
2. Position cover over diaphragm spring and install Regulator Installation Tool 91-889431.



59356

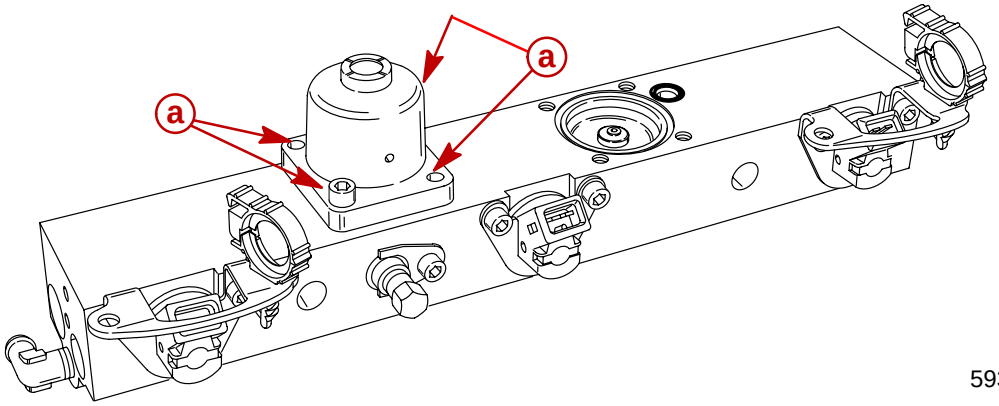
a - Regualtaor installation tool (91-889431)

3. Gently apply pressure to cover with installation tool until cover is seated against fuel rail.



59357

4. Install two retaining screws. Remove installation tool. Install remaining two screws. Torque in two stages, firsr torque to 50 lb. in. (5.6 Nm) then to 70 lb. in. (8 Nm).



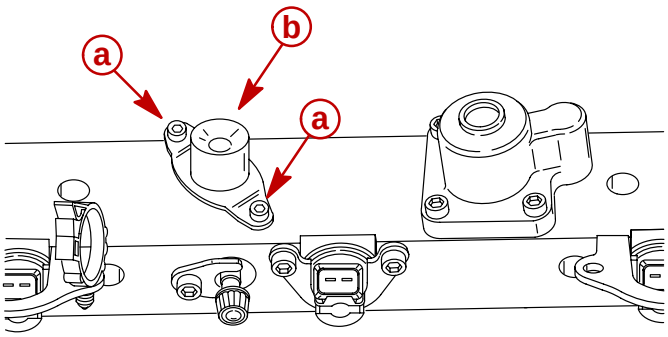
59360

a - Screws

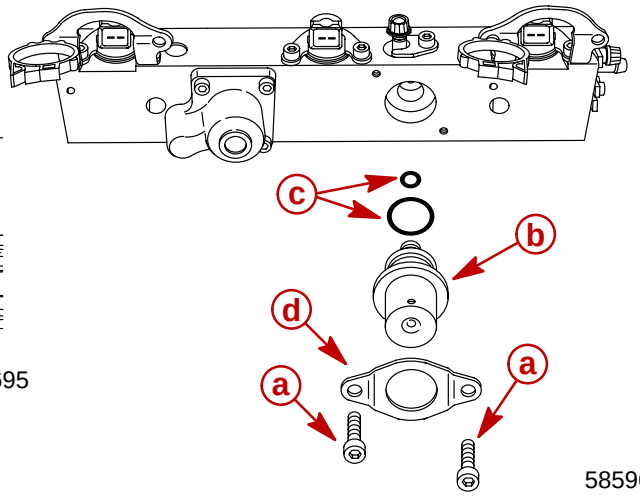
DESIGN 2 AIR REGULATOR REMOVAL

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

NOTE: *Air regulator is not serviceable. If regulator doesn't maintain approximately 80 psi (551.5 kPa), replace it.*



58695



58596

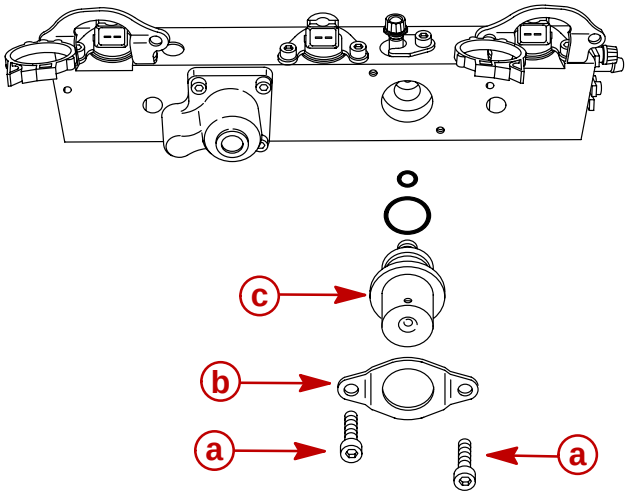
a - Screws
b - Air regulator
c - O-rings
d - Retainer

DESIGN 2 AIR REGULATOR INSTALLATION

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

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

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

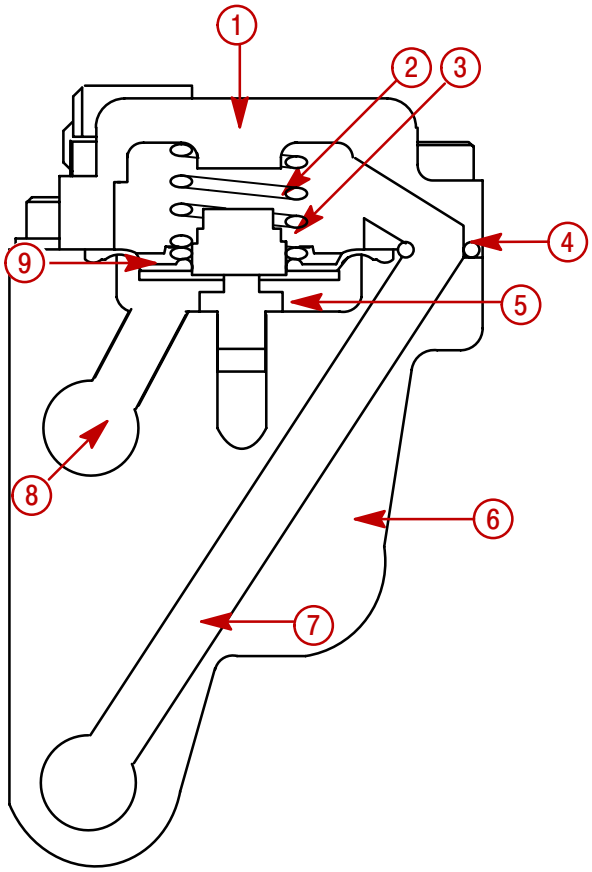


58596

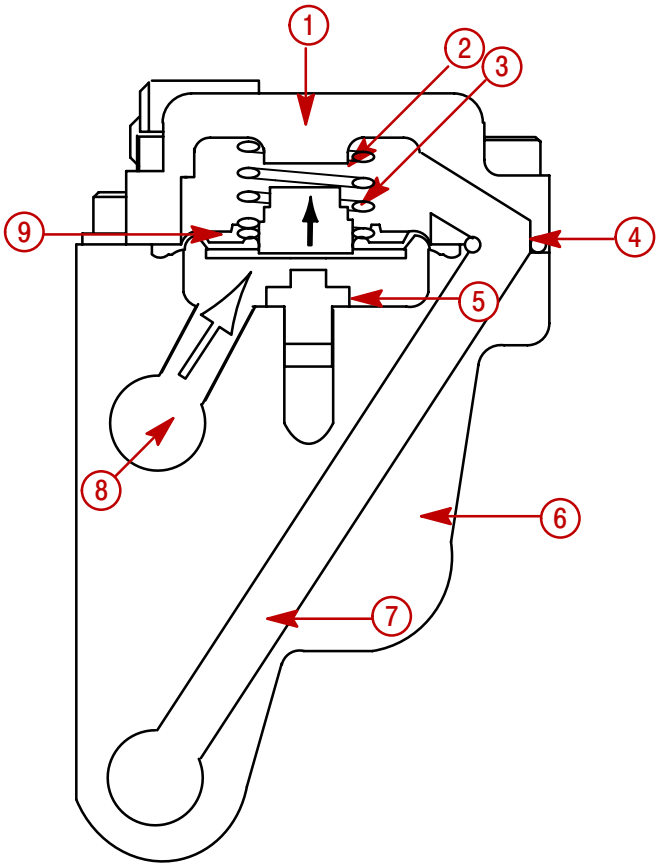
a - Screws
b - Retainer
c - Air regulator

Tracker Valve

Engine Off (No Pressure)



Engine at Operating Pressures



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

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

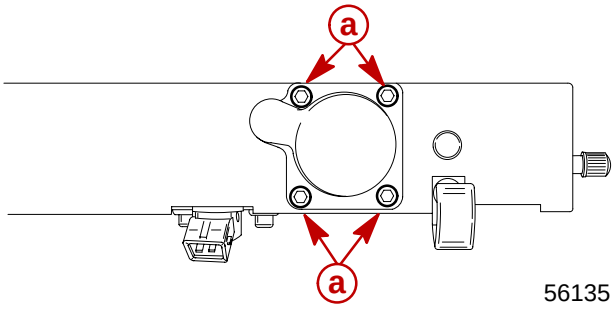
After the engine starts, and the fuel and air pressure reach normal operating range, the fuel pressure will compress the spring and the diaphragm will move slightly away from the seat (to a neutral position). At this point the pressure on both sides of the tracker diaphragm is equal (10 psi spring pressure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

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

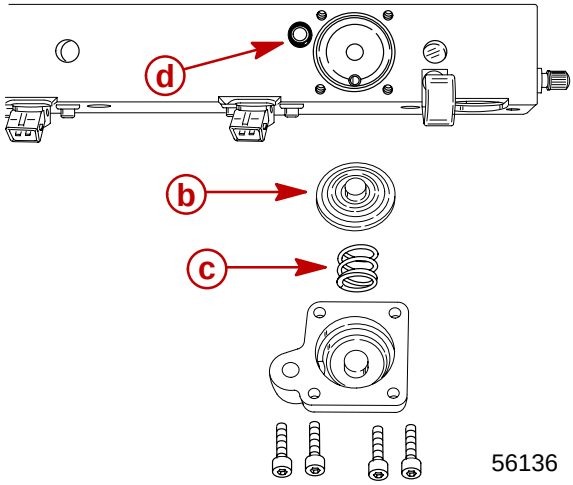
NOTE: *To prevent excessive wear in the seat, the tracker is calibrated to allow the diaphragm to be slightly away from the seat during normal operation.*

TRACKER VALVE REMOVAL

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



56135



56136

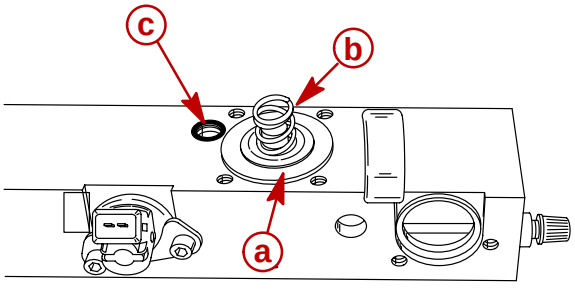
a - Screws
b - Diaphragm
c - Spring
d - O-ring

TRACKER VALVE INSTALLATION

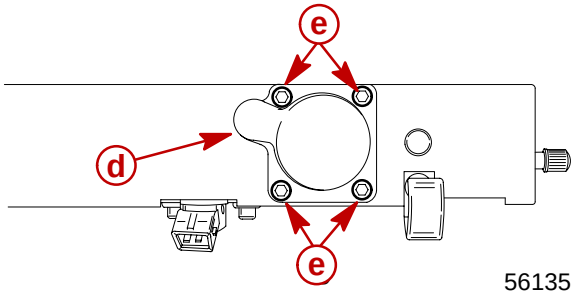
NOTE: *Apply a light coat of 2-4-C with Teflon to tracker diaphragm and cover O-ring to aid in their retention on fuel rail while reinstalling tracker valve to fuel rail.*

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

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



56137

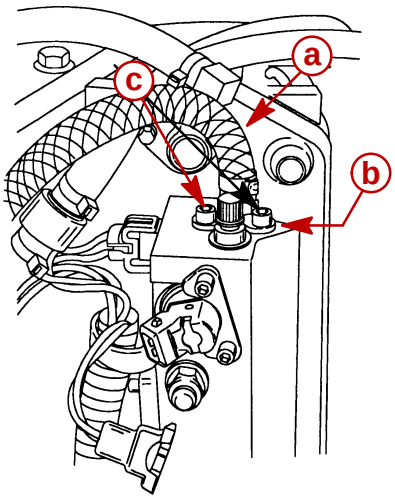


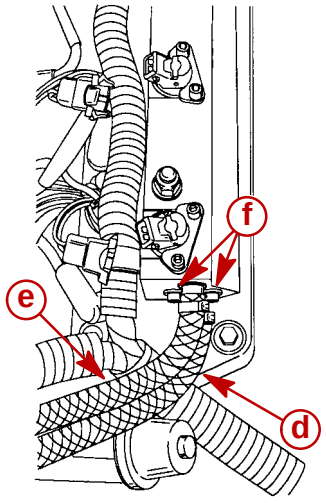
56135

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

Fuel Rail Cleaning

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





56140

Top Fuel Rail Connections

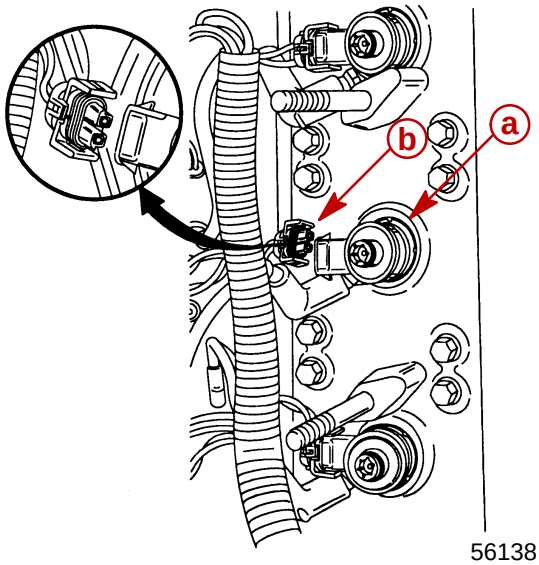
a - Air Hose
b - Retainer
c - Allen Screws (remove)

Bottom Fuel Rail Connections

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

Direct Injector Removal

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

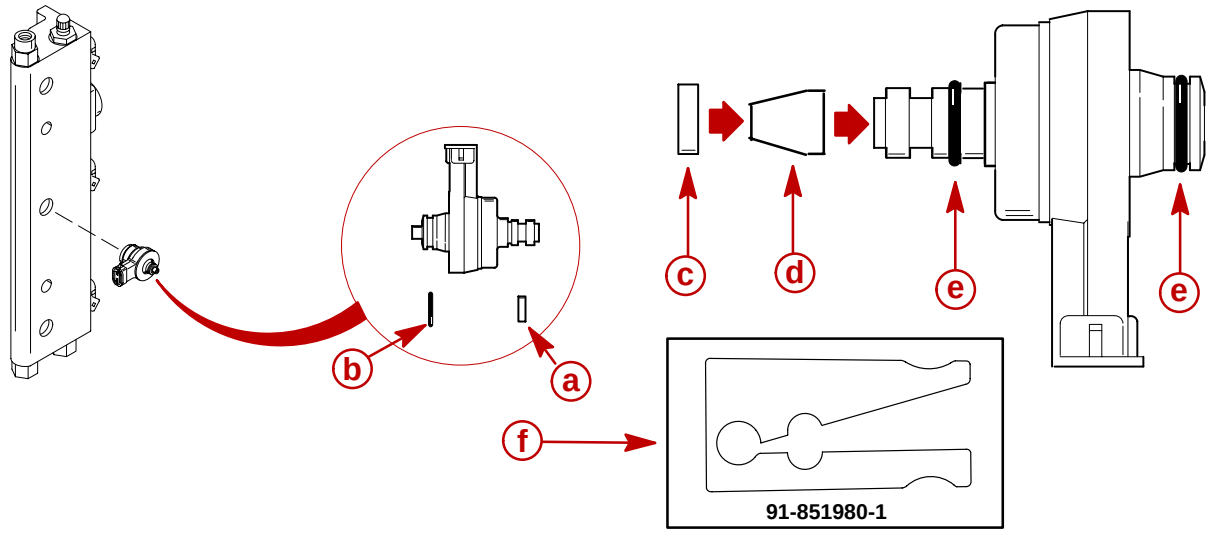


56138

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

3. Inspect injector teflon sealing ring (white) for signs of combustion blowby (teflon ring will be streaked brownish black). If blowby is present, replace teflon sealing ring. If blowby is not present, sealing ring may be reused.
4. Inspect O-rings and cork gasket for cuts or abrasions. Replace components as required.

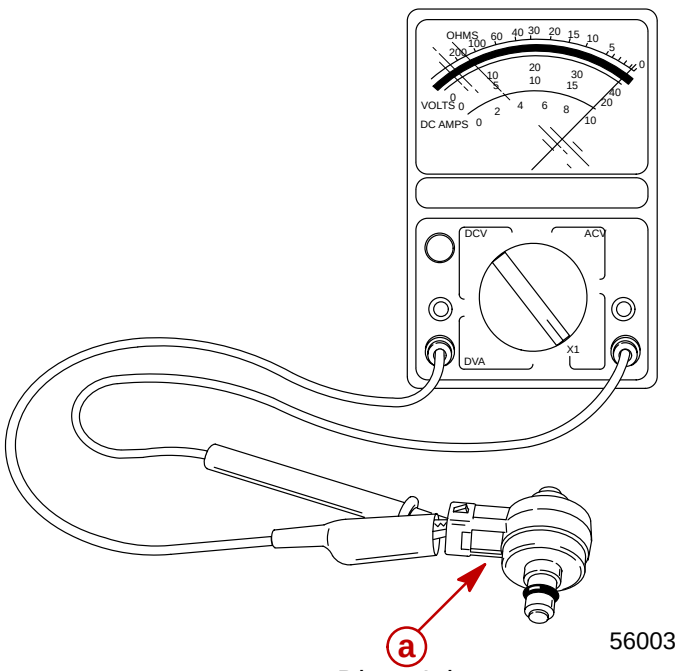
5. If teflon seal requires replacement, use teflon ring installation tool 91-851980 to slide new seal onto injector. Following installation of teflon ring, the teflon ring sizing tool (91-851980-1) can be used to compress the teflon seal to aid in the installation of the injector into the cylinder head.



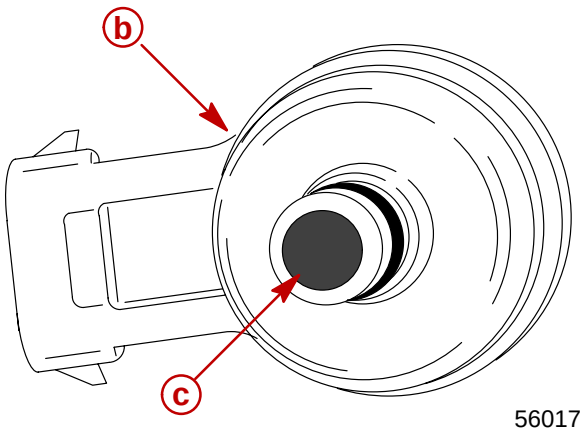
a - Teflon Sealing Ring
b - O-ring
c - Teflon Seal
d - Seal Installation Tool (91-851980)
e - O-ring
f - Teflon Ring Sizing Tool (91-851980-1)

6. An ohm test of the direct injector may be made by connecting test leads to injector terminals. Ohm reading should be 1.3 ± 0.3 ohm.

7. Carbon buildup on tip of direct injector may be removed by use of a brass wire hand brush.



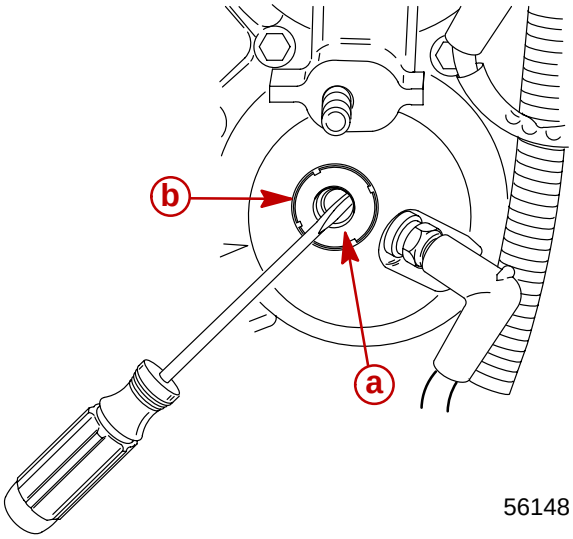
56003



56017

a - Direct Injector
b - Direct Injector
c - Tip

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



56148

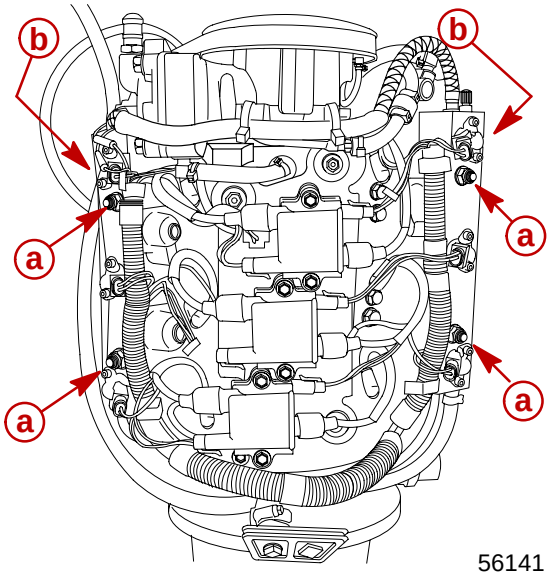
a - Cup Washer
b - Retainer

Fuel Rail and Direct Injector Installation

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

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

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

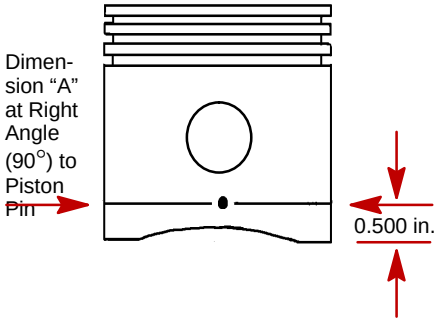


56141

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

Air Compressor

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

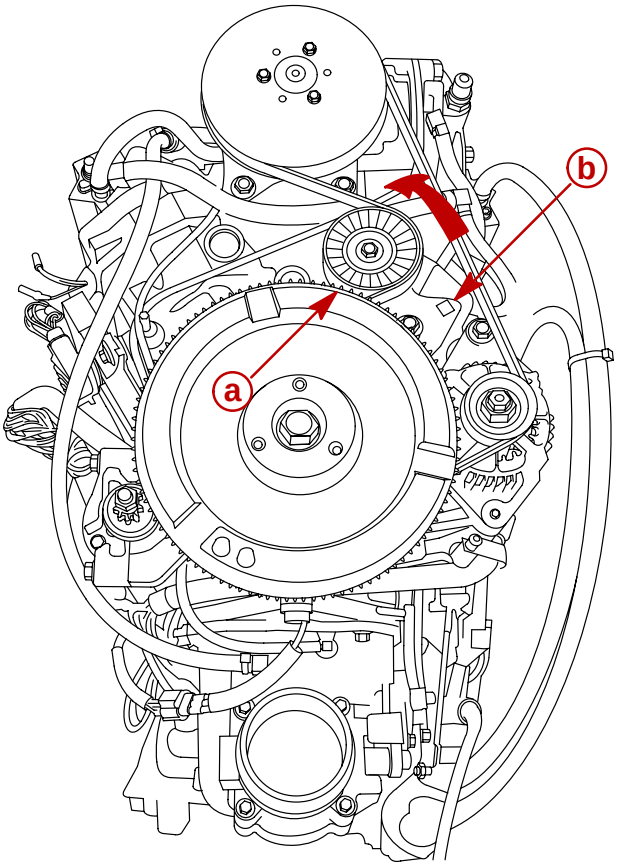
Air Compressor Specifications		
Air Compressor	Type Compressor Output	Reciprocating Piston (1 to 1 ratio with engine RPM) @ Idle – 80 psi @ W.O.T. – 110 psi
Cylinder Block	Displacement	7.07 cu. in. (116 cc)
Cylinder Bore	Diameter (Standard) Taper/Out-of-Round/Wear Maximum Bore Type	2.5591 in. (65.0 mm)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

COMPRESSOR REMOVAL

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

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

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



56142

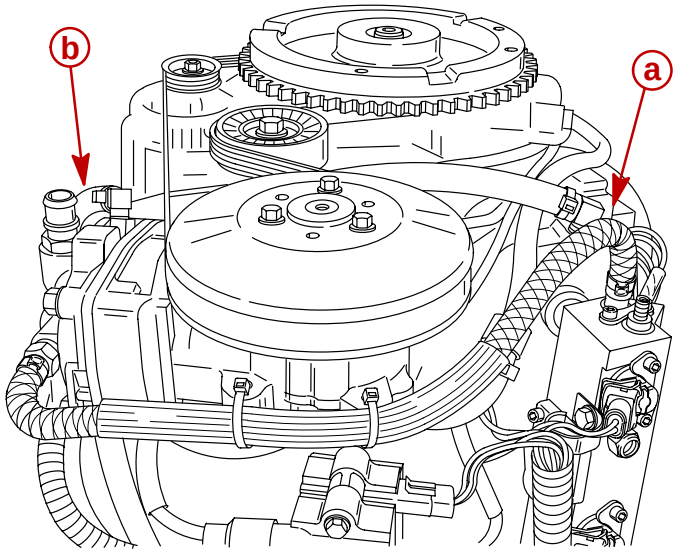
a - Belt Tensioner
b - 3/8 in. (9.5 mm) drive

⚠ CAUTION

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

5. Disconnect air pressure outlet hose.

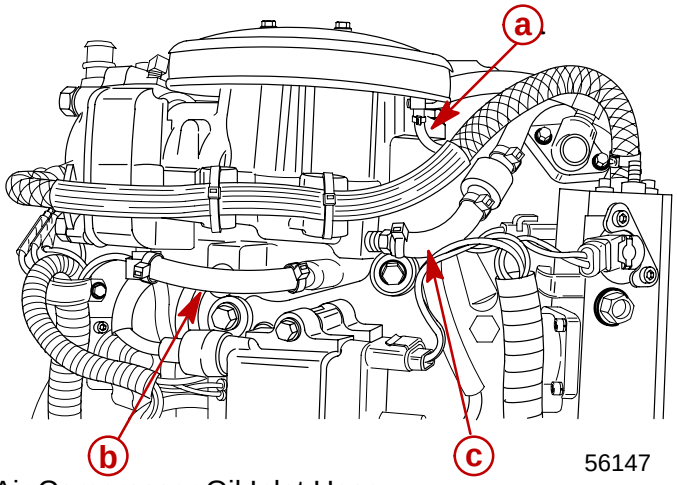
6. Disconnect water outlet hose (tell-tale).



56149

a - Air Pressure Outlet Hose
b - Water outlet Hose (tell-tale)

7. Disconnect air compressor oil inlet hose.
8. Disconnect water inlet hose.
9. Disconnect excess oil return hose.



56147

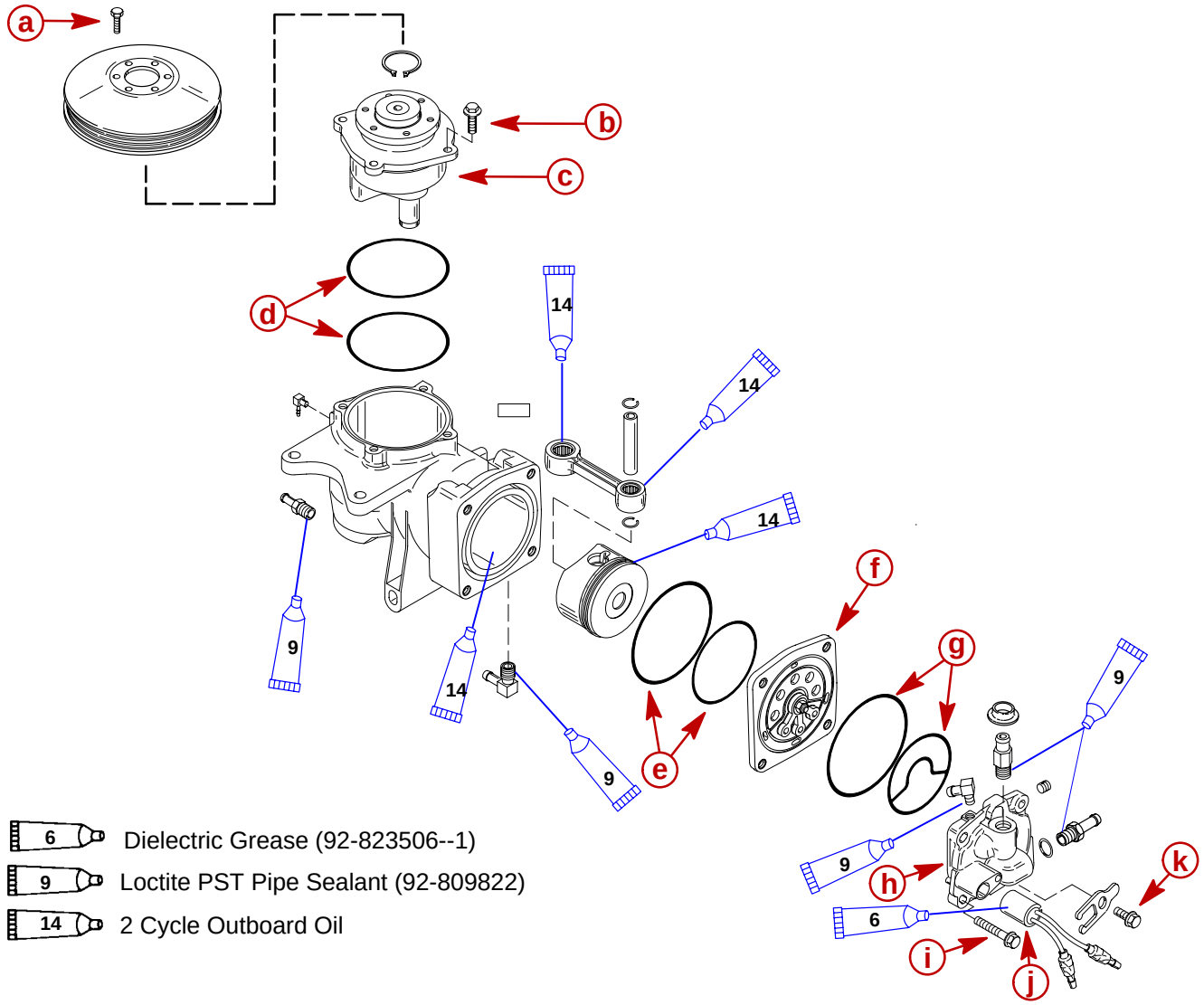
a - Air Compressor Oil Inlet Hose
b - Water Inlet Hose
c - Excess Oil Return Hose

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

Air Compressor Disassembly/Reassembly

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

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

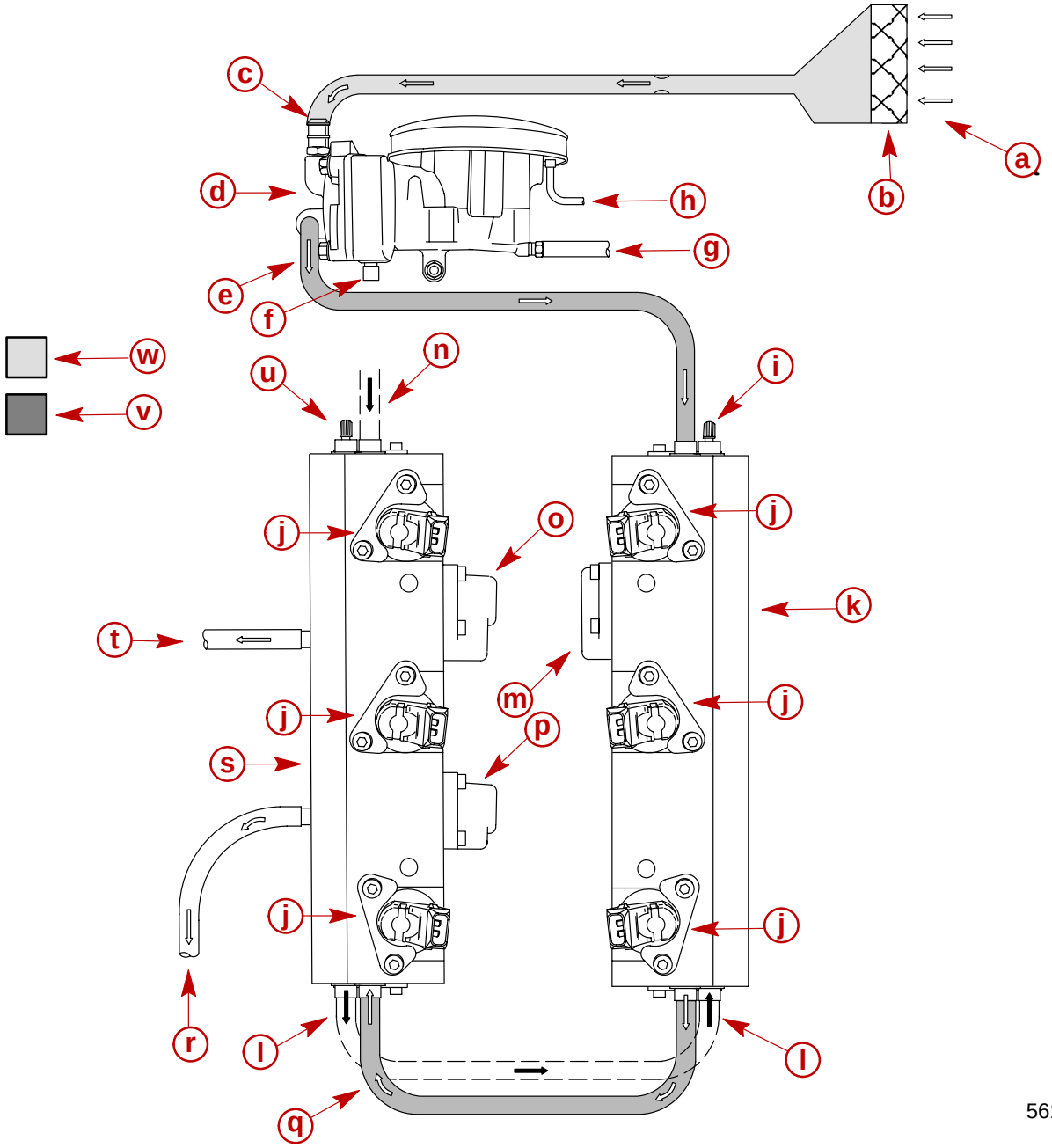


NOTE: *End cap bearing and seal are not sold separately. End cap must be replaced as an assembly*

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

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

Air Compressor Flow Diagram

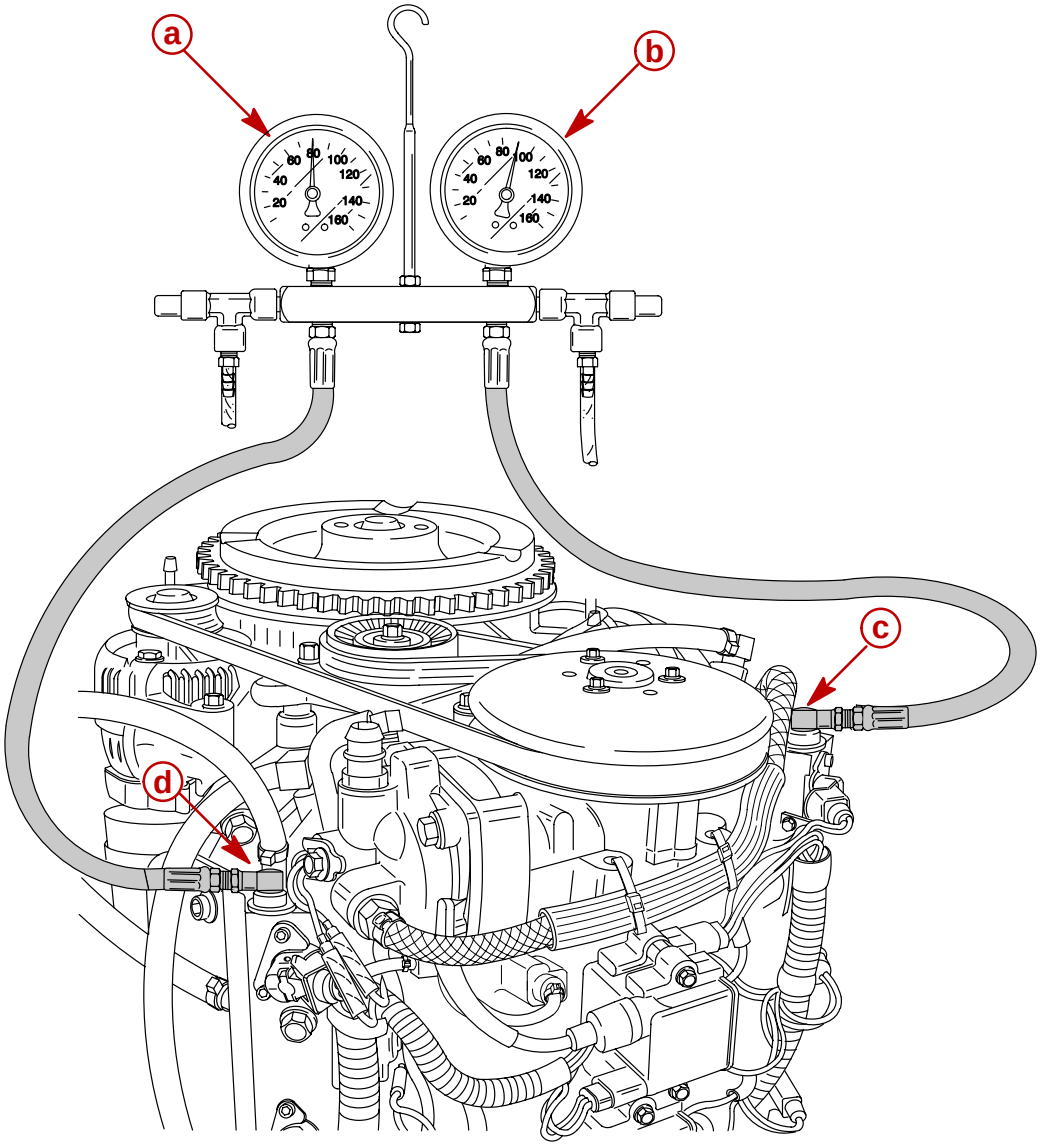


a - Air Inlet
b - Air Filter
c - Compressor Air Inlet with Inlet Restrictor
d - Air Compressor
e - Compressor Air Outlet
f - Compressor Water Inlet
g - Excess Oil Return
h - Compressor Oil Inlet
i - Fuel System Pressure Test Valve
j - Fuel Injector
k - Starboard Fuel Rail
l - High Pressure Fuel [89 ± 2 psi (613.5 ± 13.8 kPa)]
m - Tracker Valve
n - Fuel Inlet
o - Fuel Regulator [89 ± 2 psi (613.5 ± 13.8 kPa)]
p - Air Regulator [79 ± 2 psi (544.0 ± 13.8 kPa)]
q - Air [79 ± 2 psi (544.0 ± 13.8 kPa)]
r - Excess Air Return to Exhaust Adaptor Plate
s - Port Fuel Rail
t - Excess Fuel Return to Fuel Cooler
u - Air Pressure Test Valve
v - High Pressure
w - Low Pressure

Air Compressor Pressure Test

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

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



56146

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

FUEL PRESSURE AND AIR PRESSURE TROUBLESHOOTING CHART

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

FUEL SYSTEM

Section 3C – Oil Injection

Table of Contents

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Oil System Operation

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

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

NOTE: *On some light boat applications after the break-in is completed and the engine is being run at cruising speed – between 4000 and 5000 RPM – the fuel to oil ratio may be as high as 28:1. This results from a reduced throttle opening with a corresponding reduction in fuel consumption.*

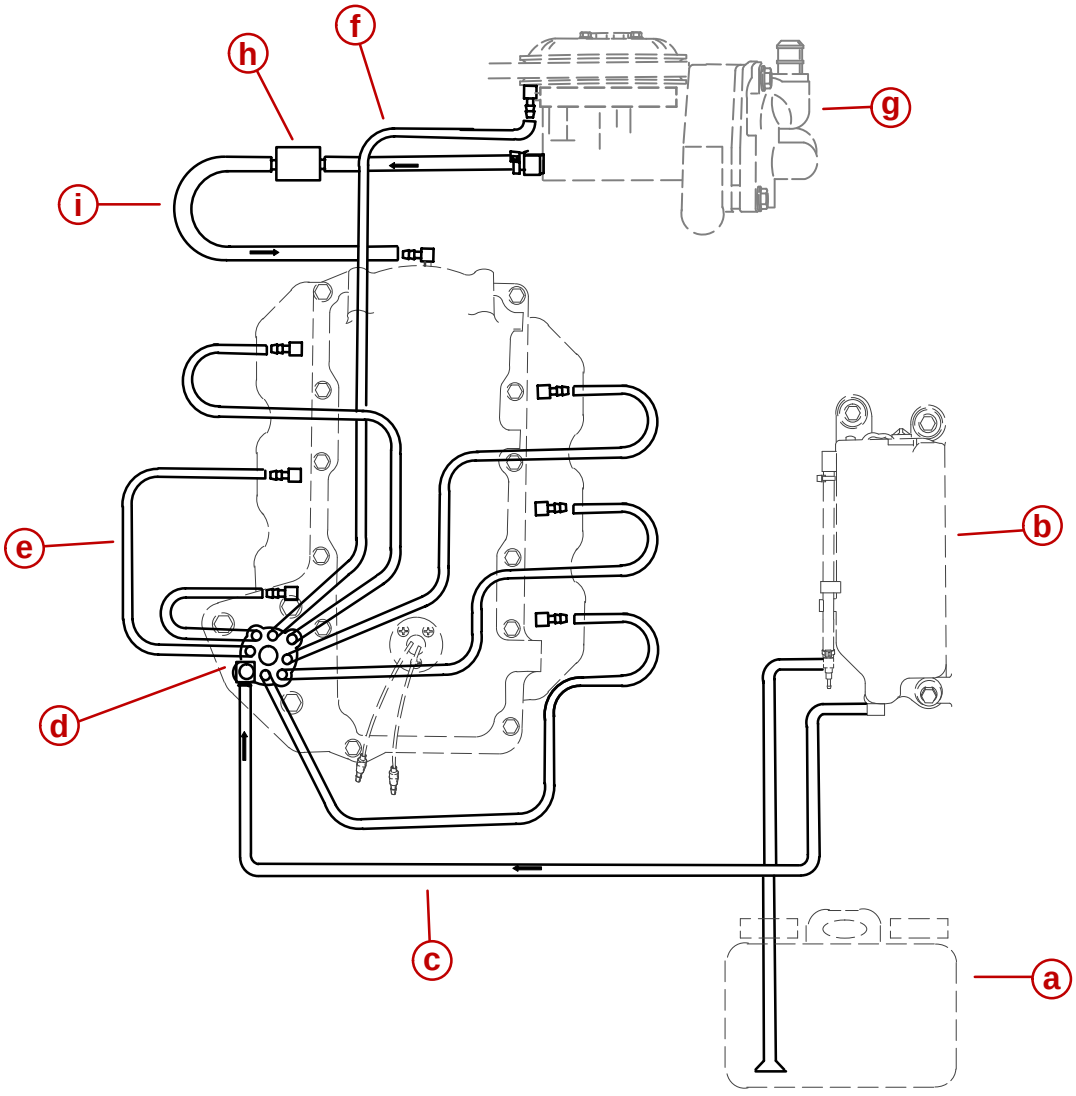
Oil Pump Output

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

To check the oil pump output:

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

Oil System



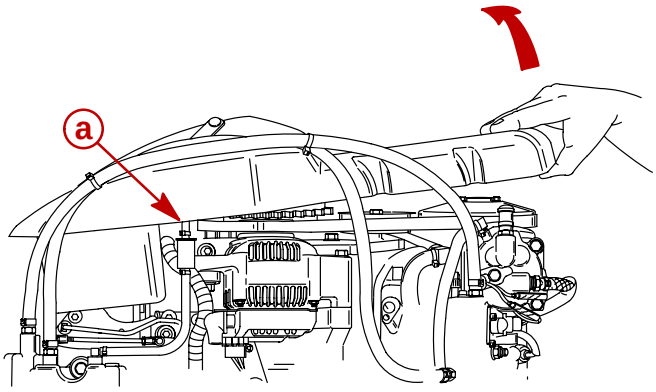
a - Remote Oil Tank
b - Engine Oil Reservoir
c - Oil Supply Hose to the Oil Pump
d - Oil Pump
e - Oil Supply Hoses to the Cylinders (6)
f - Oil Supply Hose to the Air Compressor
g - Air Compressor
h - Check Valve
i - Oil Return Hose from the Air Compressor

Oil Hose Check Valve Installation on 1998 Model 135/150 DFI Outboards SN 0G886266 and Below

To prevent possible momentary oil starvation in the oil pump delivery hoses, it is recommended that check valve kit 21-858945A2 be installed as follows:

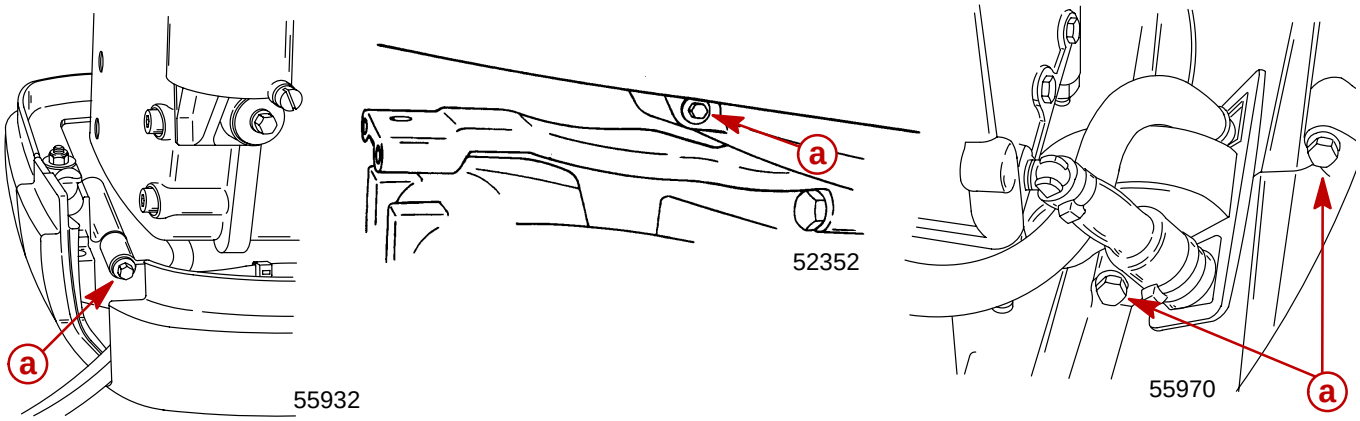
NOTE: *Refer to Service Bulletin 98-23.*

1. Remove flywheel cover. Pull out vent hose.



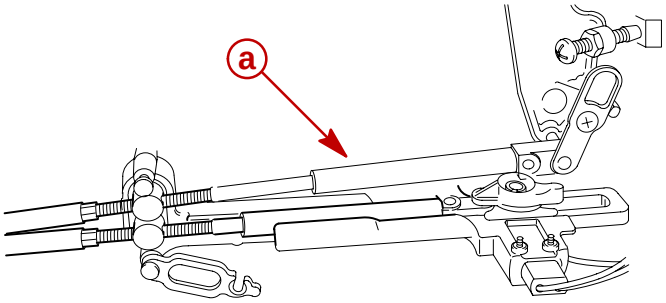
a - Vent Hose

2. Remove 4 bolts securing bottom cowl halves and remove bottom cowling.



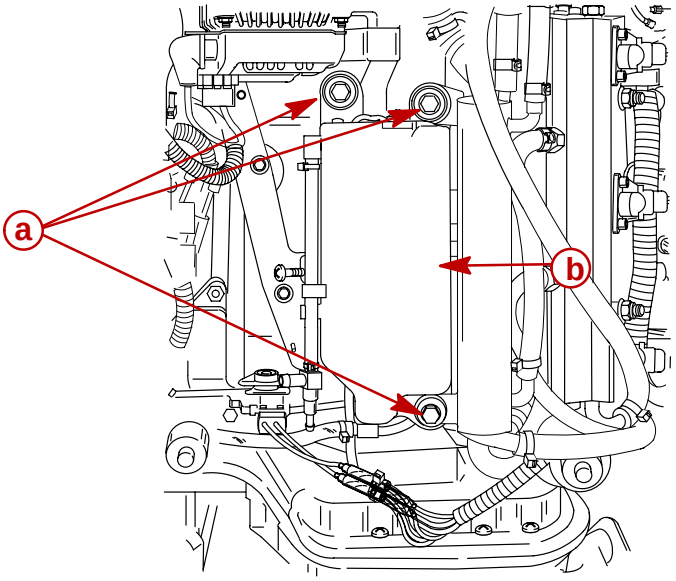
a - Bolts

3. Remove throttle cable from throttle arm.



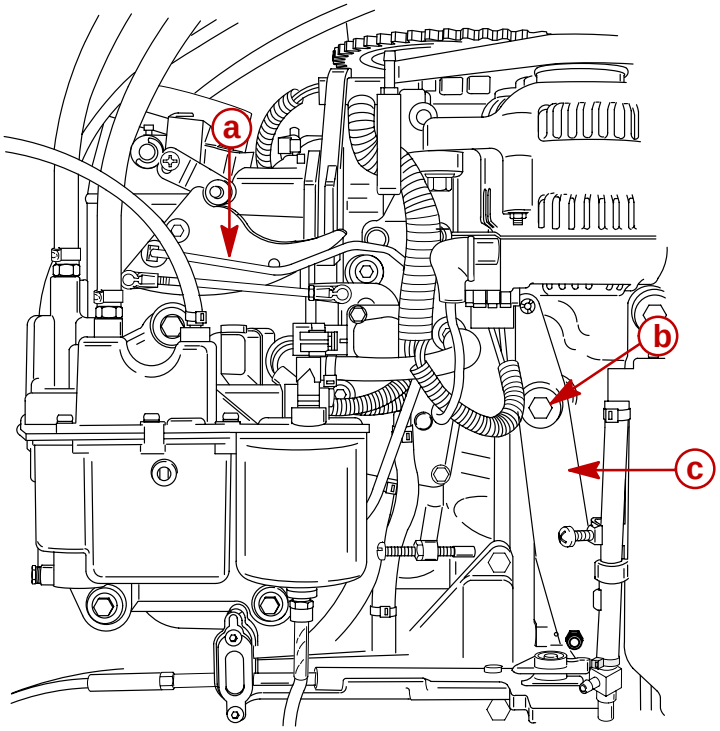
a - Throttle Cable

4. Remove 3 bolts securing oil reservoir and lay reservoir off to one side.



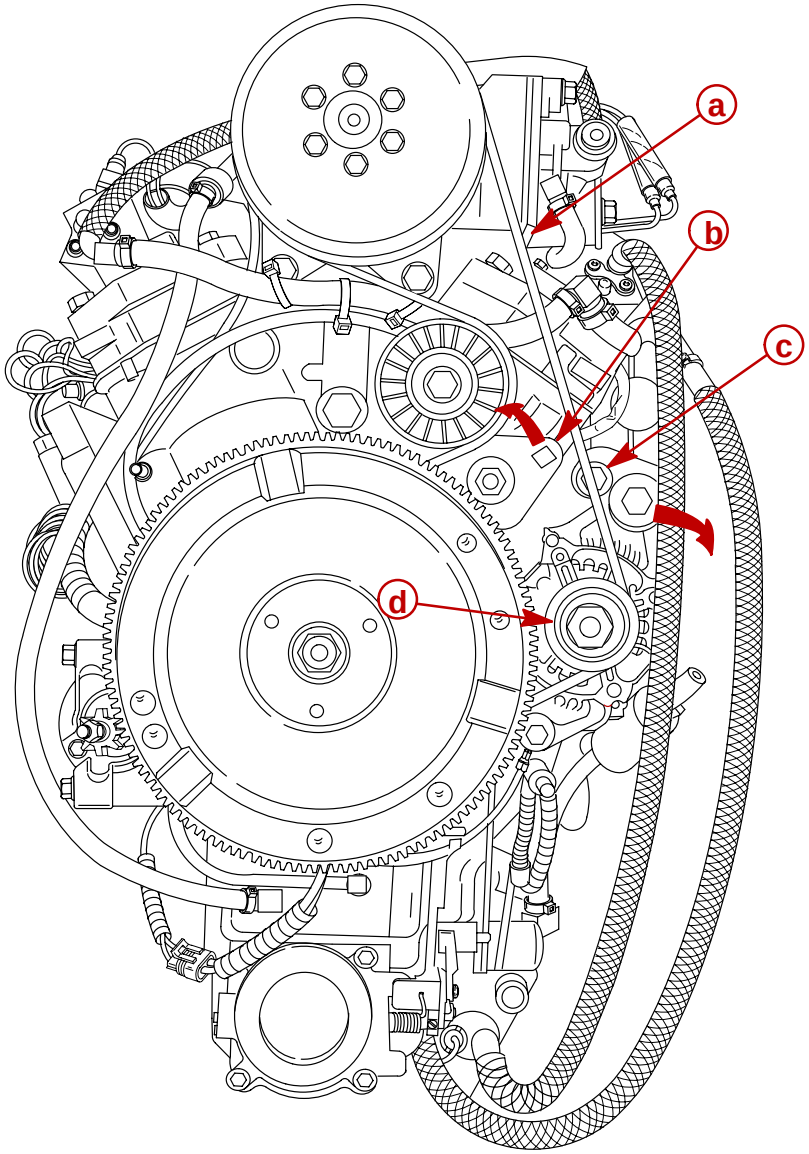
a - Bolts
b - Oil Reservoir

5. Remove throttle link arm and bolt securing throttle arm. Remove throttle arm.



a - Throttle Link Arm
b - Bolt
c - Throttle Arm

6. Remove alternator/air compressor belt.
7. Remove aft alternator bolt and pivot alternator forward.



a - Alternator/Air Compressor Belt
b - Belt Tensioner (rotate counterclockwise)
c - Aft Alternator Bolt
d - Alternator (rotate forward)

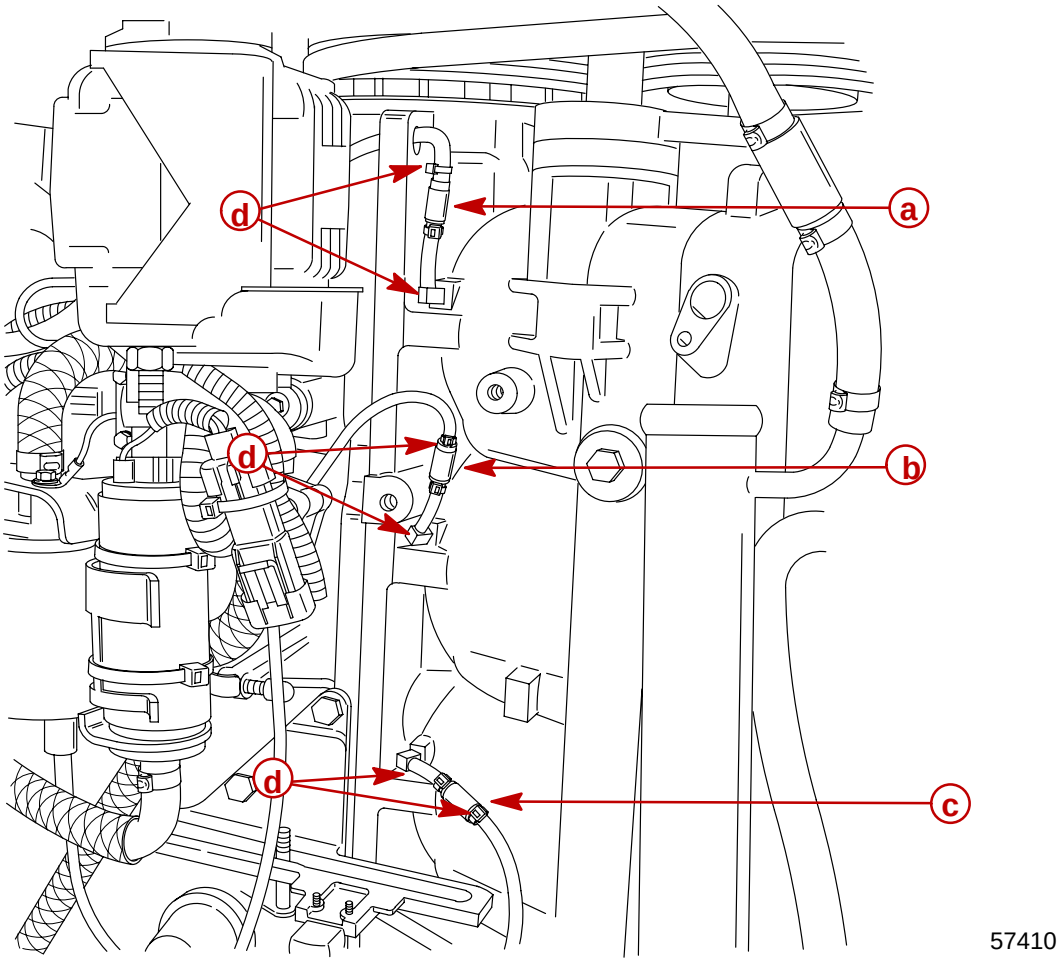
NOTE: *It is recommended that a razor knife be used to make a small slit in the oil hoses to aid in removal. Removing hoses without cutting them may result in the breakage of the oil fitting. Trim cut portion off of oil hose before reinstalling hose.*

8. Remove oil hoses from fittings on #2, #4, and #6 cylinders.

NOTE: *All check valve/hose assemblies for cylinders 2, 4, 6 are brass colored and have 1.250 (31.75 mm) long hoses attached to check valve.*

IMPORTANT: Due to the close proximity of the #2 cylinder oil hose to the flywheel, it will be necessary to trim the length of the #2 oil hose to provide adequate clearance between the oil hose and the flywheel when the check valve assembly is installed.

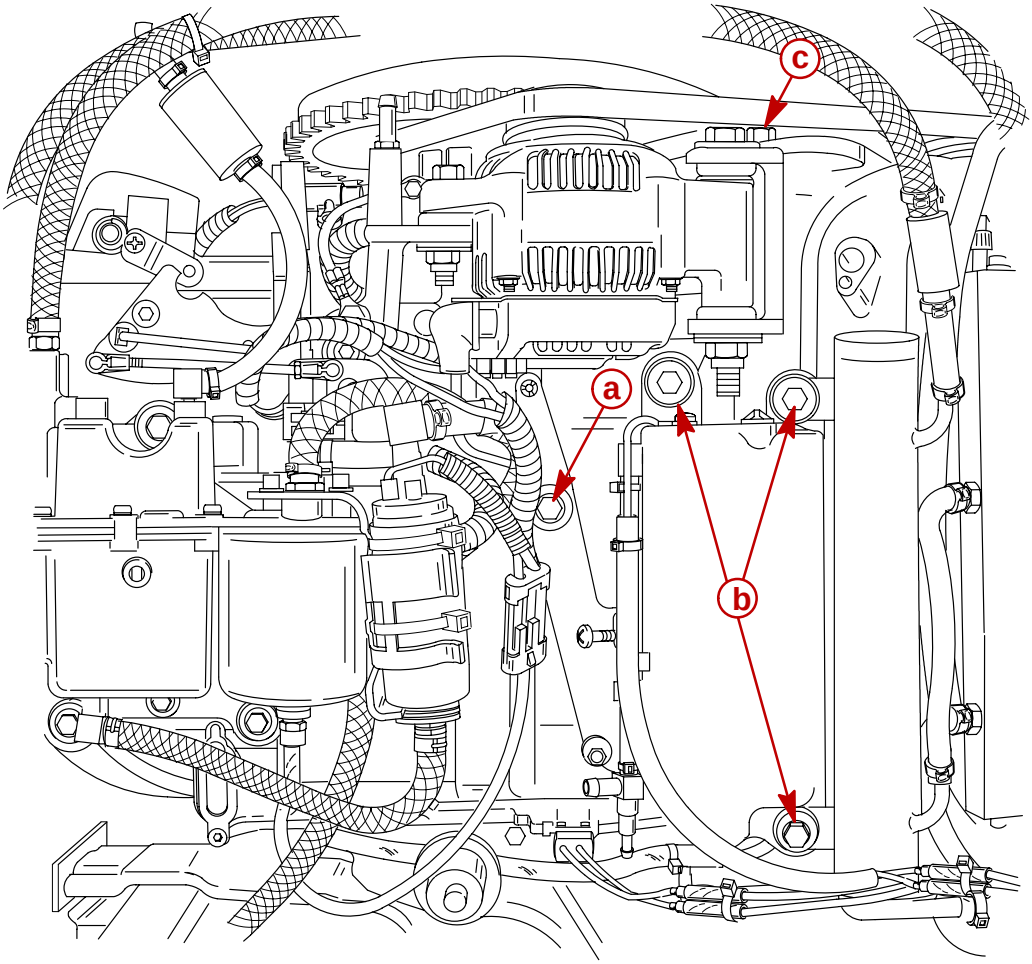
9. Trim off #2 cylinder oil hose to an appropriate length (to provide clearance between hose and flywheel) and install new check valve/hose assembly. Secure hose connections with sta-straps.
10. Install new check valve/hose assemblies on cylinders #4 and #6. Secure all hose connections with sta-straps.



57410

a - #2 Cylinder Oil Hose [Trim hose length as required]
b - #4 Check Valve/Hose Assembly
c - #6 Check Valve/Hose Assembly
d - Sta-straps

11. Reinstall throttle control arm. Connect throttle link to throttle cam. Torque bolt to 20 lb. ft. (27 Nm).
12. Reinstall oil reservoir. Torque bolts to 170 lb. in. (19 Nm).
13. Reinstall alternator. Torque bolt to 40 lb. ft. (54 Nm).



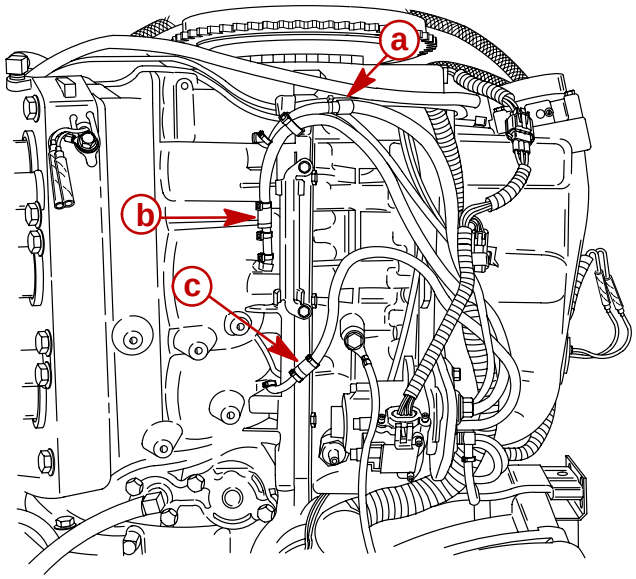
57409

a - Torque Bolt to 20 lb. ft. (27 Nm)
b - Torque Bolts to 170 lb. in. (19 Nm)
c - Torque bolt to 40 lb. ft. (54 Nm)

14. Reinstall alternator/air compressor belt.
15. Remove Electronic Control Module (ECM) (lay off to one side).
16. Remove solenoid/trim relay plate (lay off to one side).
17. Remove starter motor (lay off to one side).

NOTE: *All check valve/hose assemblies for cylinders 1, 3, 5 have a BLUE stripe/band and a 3.125 in. (79.37 mm) long hose attached to the check valve.*

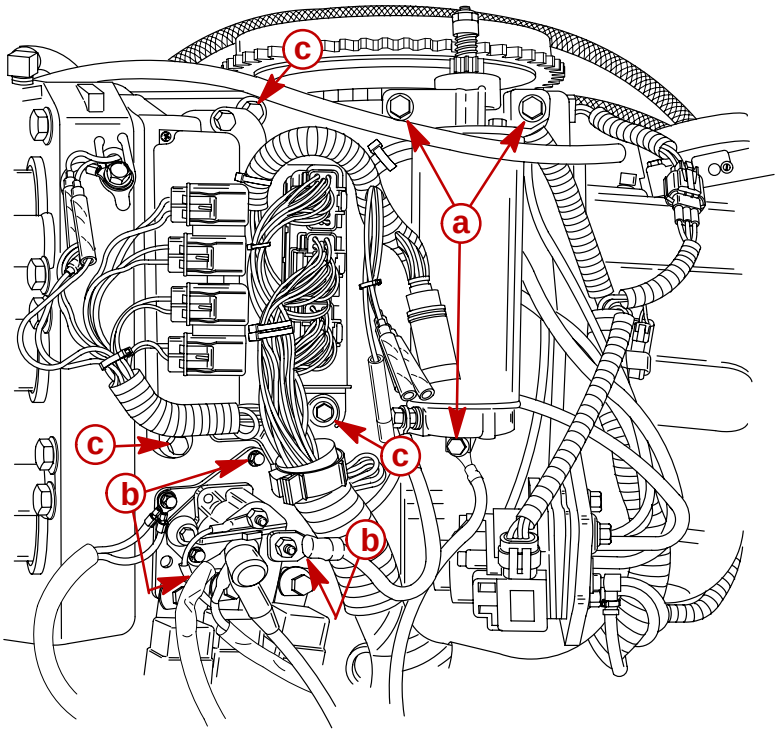
18. Install new check valve/hose assemblies on cylinders #1, #3 and #5. Secure all hose connections with sta-straps.



57411

a - #1 Cylinder Check Valve/Hose Assembly
b - #3 Cylinder Check Valve/Hose Assembly
c - #5 Cylinder Check Valve/Hose Assembly

19. Reinstall starter motor. Torque bolts to 17.5 lb ft. (23.5 Nm).
20. Reinstall starter solenoid/trim relay plate. Torque bolts to 150 lb. in. (17 Nm).
21. Reinstall ECM. Torque bolts to 70 lb. in. (8 Nm).



57412

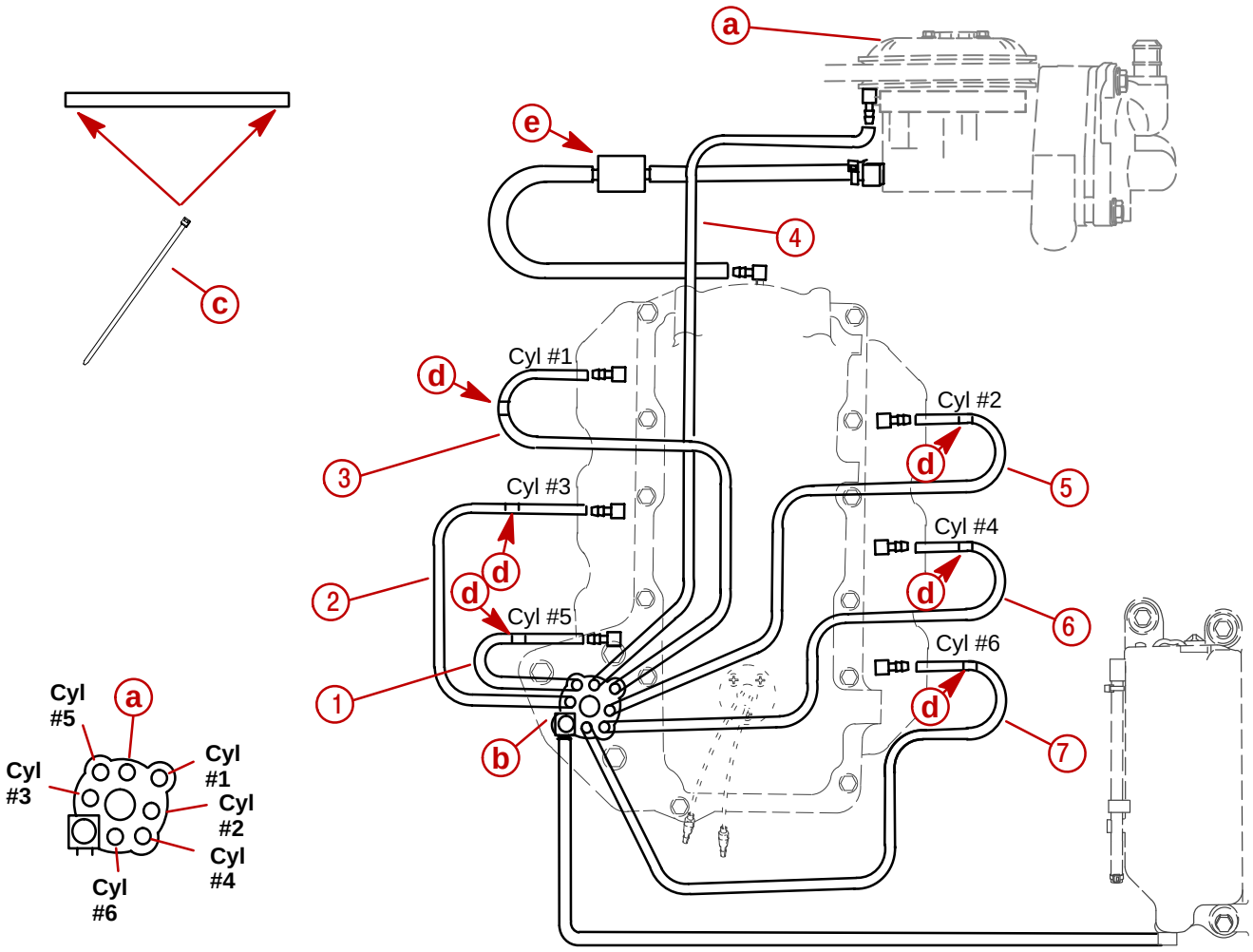
a - Torque bolts to 17.5 lb ft. (23.5 Nm)
b - Torque bolts to 150 lb. in. (17 Nm)
c - Torque bolts to 70 lb. in. (8 Nm)

22. Reinstall bottom cowling.
23. Reinstall flywheel cover.

Oil Injection Hose Installation

Install the correct inside diameter and length of hose between oil pump and fittings on the engine (see chart below). Cylinders #1, #3, #5 only have a BLUE stripe/band.

Fasten hoses on both ends with sta-straps.



a - Air Compressor
b - Oil Pump
c - Fasten Hose Ends with Sta-Straps
d - Check Valves
e - Check Valve (oil return)

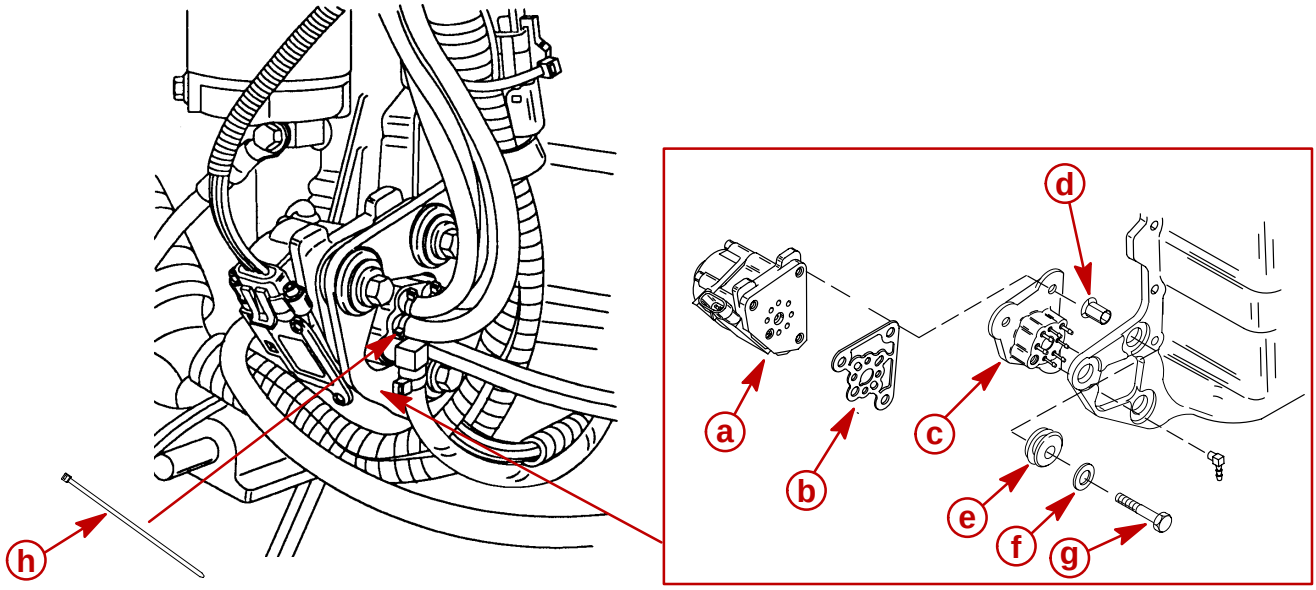
Cyl. #1	0.078 in. (1.98 mm) I.D. Check Valve with 3.125 in. (79.4 mm) length Hose
Cyl. #3	0.078 in. (1.98 mm) I.D. Check Valve with 3.125 in. (79.4 mm) length Hose
Cyl. #5	0.078 in. (1.98 mm) I.D. Check Valve with 3.125 in. (79.4 mm) length Hose
Cyl. #2	0.063 in. (1.60 mm) I.D. Check Valve with 1.250 in. (31.7 mm) length Hose
Cyl. #4	0.063 in. (1.60 mm) I.D. Check Valve with 1.250 in. (31.7 mm) length Hose
Cyl. #6	0.063 in. (1.60 mm) I.D. Check Valve with 1.250 in. (31.7 mm) length Hose
Note	All check valve I.D. measurements given are ± 0.002 in. (0.050 mm)

Oil Hose Sizes		
Hose	Inside Diameter ± .01 (0.25mm)	Length ± 0.20 (5.1 mm)
1	0.125 (3.2 mm)	16 in. (406 mm)
2	0.125 (3.2 mm)	20 in. (508 mm)
3	0.125 (3.2 mm)	16 in. (406 mm)
4	0.092 (2.3 mm)	28 in. (711 mm)
5	0.092 (2.3 mm)	24 in. (610 mm)
6	0.092 (2.3 mm)	24 in. (610 mm)
7	0.092 (2.3 mm)	24 in. (610 mm)

Oil Pump Removal and Installation

REMOVAL

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



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

INSTALLATION

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

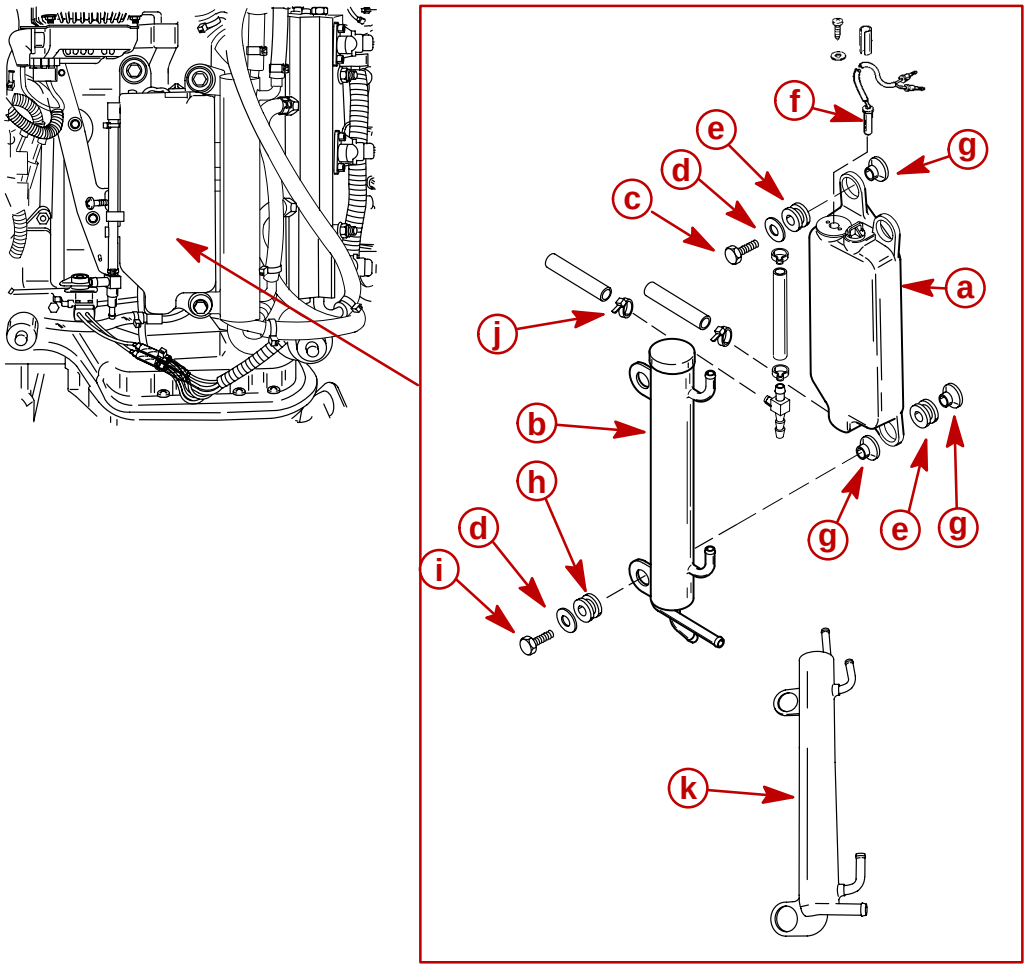
NOTE: *Replacement oil pump may have 2 pin electrical connection vs. 4 pin with original oil pump. The 2 pin connection will still function with the existing wire harness.*

4. Refill the oil system. Refer to Priming the Oil Pump.

Engine Oil Reservoir Removal and Installation

REMOVAL

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



a - Oil Reservoir
b - Fuel Cooler (Design 1)
c - Bolt (1) – Torque to 170 lb. in. (19 Nm)
d - Washer (3)
e - Rubber Grommet (3) – Insert into Holes
f - Low Oil Switch
g - Bushing (3)
h - Grommet (2) – Insert into Hole
i - Bolt (2) – Torque to 170 lb. in. (19 Nm)
j - Sta-Straps – Fasten All Hose Ends
k - Fuel Cooler (Design 2)

INSTALLATION

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

Priming the Oil Pump

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

There are three methods for priming the oil pump:

METHOD 1 – SHIFT SWITCH ACTIVATION PRIME

This method does three things:

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

b. Activates break-in oil ratio.

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

Refer to priming procedure following.

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

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

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

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

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

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

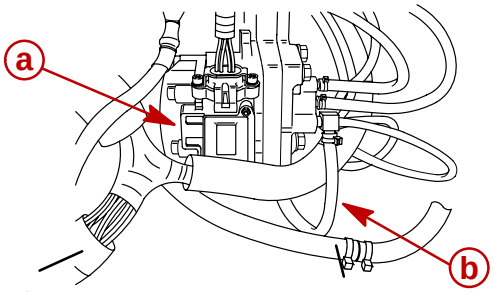
Conditions Requiring Priming the Oil Pump

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

Priming Procedure – Method 1

METHOD 1 – SHIFT SWITCH ACTIVATION PRIME PROCEDURE

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



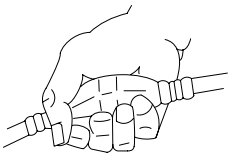
a - Oil Injection Pump
b - Oil Supply Hose

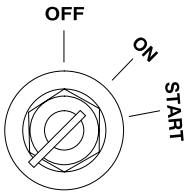
⚠ CAUTION

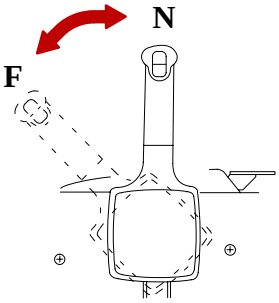
To prevent damage to the fuel pumps, fill the engine fuel system with fuel. Otherwise the fuel pumps will run without fuel during the priming process.

Prime the oil injection pump as follows:

1. Fill the engine fuel system with fuel. Connect fuel hose and squeeze primer bulb until it 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.





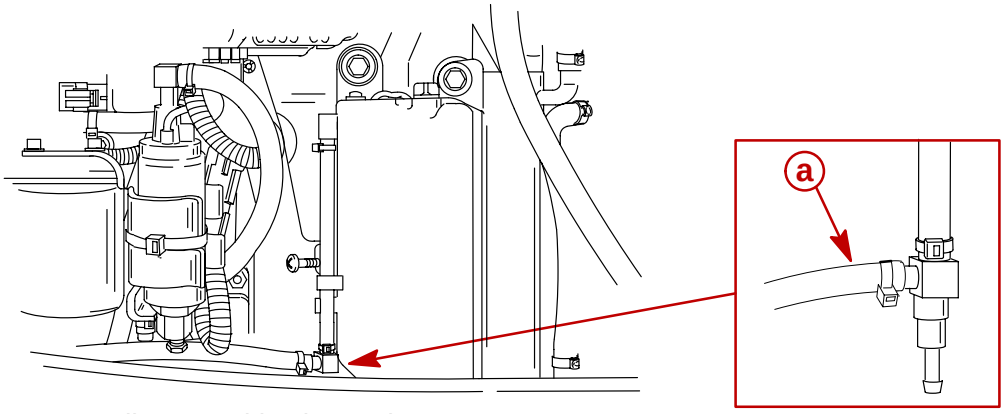


NOTE: *It may take a few minutes for the pump to complete the priming process.*

Remote Oil Hose Connections

CONNECTING OIL HOSE WITH BLUE STRIPE

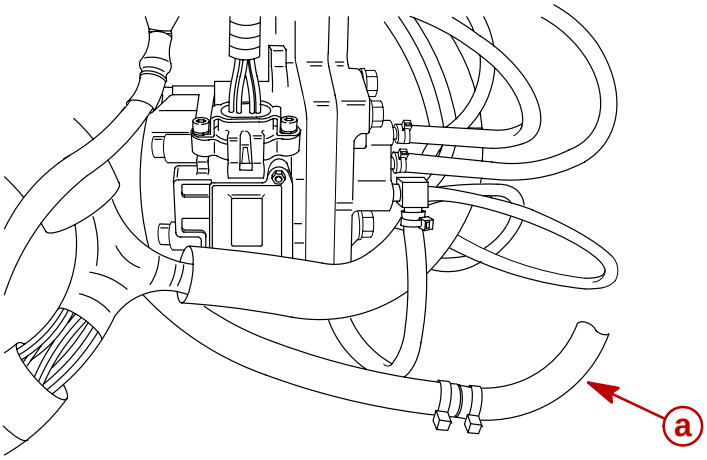
1. Remove shipping cap from fitting and connect oil hose (a). Fasten hose with sta-strap.



a - Oil Hose with Blue Stripe

CONNECTING OIL HOSE WITHOUT BLUE STRIPE

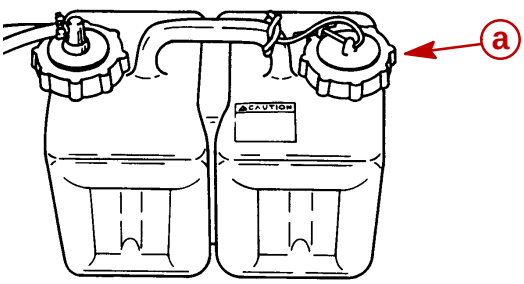
1. Remove shipping cap from fitting and connect hose (a). Fasten hose with sta-strap.

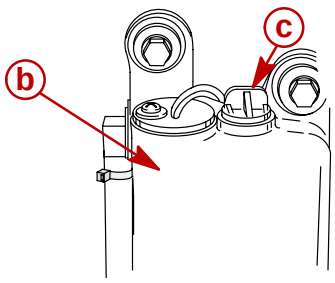


a - Oil Hose Without Blue Stripe

Filling the Oil Tanks

1. Fill remote oil tank with the recommended oil listed in the Operation and Maintenance Manual. Tighten fill cap.
2. Remove cap and fill engine oil tank with oil. Reinstall the fill cap.
3. Remove air from remote oil hose. Refer to Purging Air from the Engine Oil Reservoir and Remote Oil Hose.



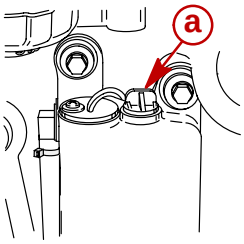


a - Fill Cap
b - Engine Oil Reservoir
c - Fill Cap

Purging Air From the Engine Oil Reservoir and Remote Oil Hose

NOTE: *Before starting engine, make sure the oil pump has been primed.*

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



a - Fill Cap

Oil Warning Systems

LOW OIL LEVEL

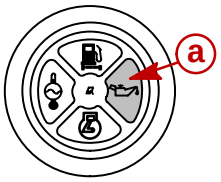
NOTE: *The low oil condition must exist for a minimum of 15 seconds before horn or light is activated.*

The system is activated when the oil in the engine mounted oil reservoir tank drops below 22 fl. oz. (175 ml). There is still an oil reserve remaining for 30 minutes of full speed operation.

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

The warning system works as follows:

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



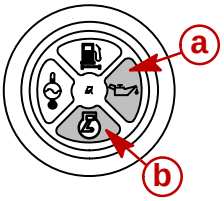
OIL PUMP NOT FUNCTIONING ELECTRICALLY

The system is activated if the oil pump stops functioning electrically. No lubricating oil is being supplied to the engine. Stop the engine as soon as possible. Continuing to operate the engine can result in severe engine damage.

The warning system works as follows:

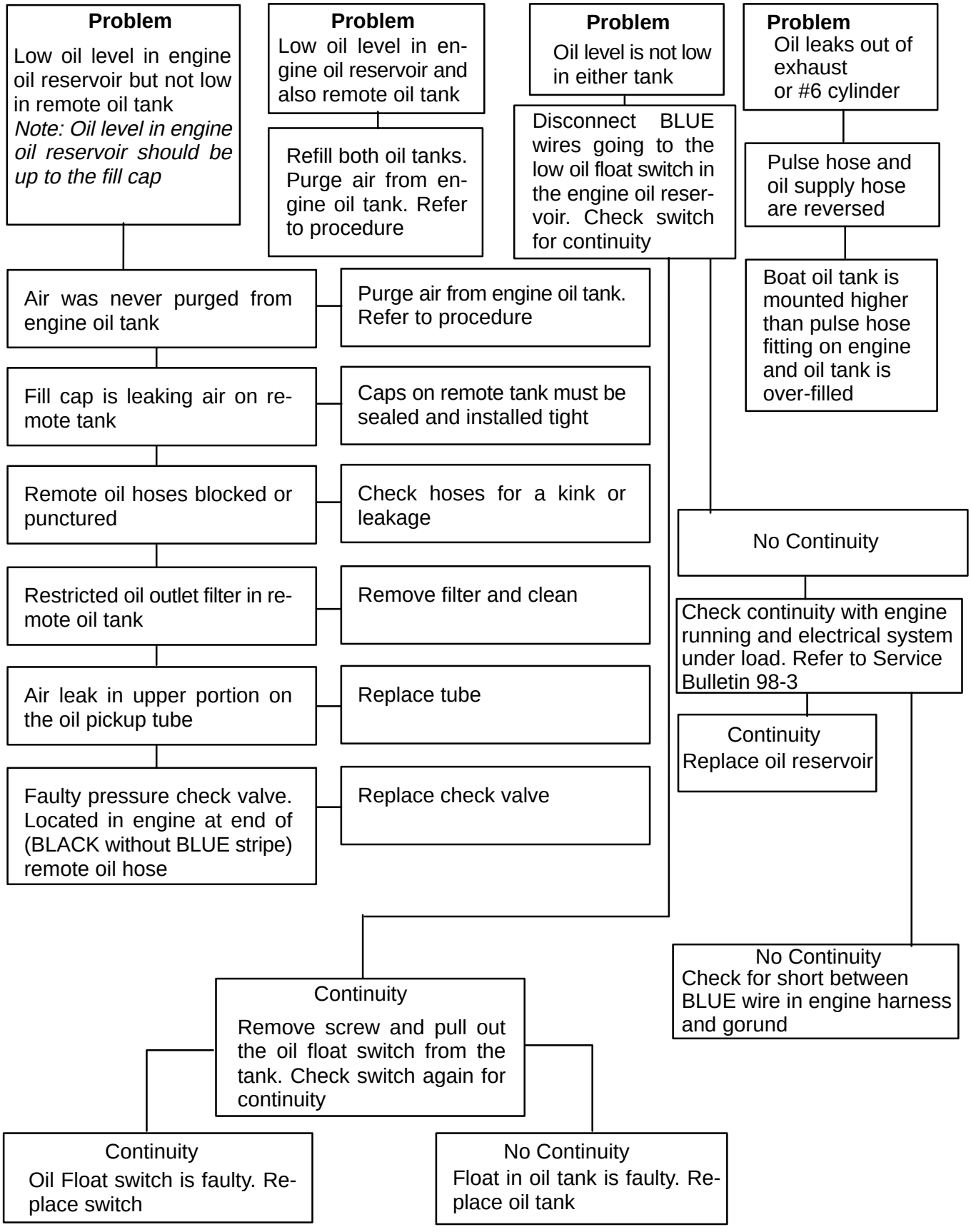
The OIL light and CHECK ENGINE light will come on and the warning horn will begin sounding. The warning system will automatically reduce and limit the engine speed to 3000 RPM.

The engine has to be shut off to reset the warning system.



Oil System Troubleshooting

Low Oil Warning System is Activated



FUEL SYSTEM

Section 3D – Emissions

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Exhaust Emissions Standards

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

What Are Emissions?

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

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

Hydrocarbons – HC

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

Carbon Monoxide – CO

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

Oxides of Nitrogen - NOx

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

Controlling Emissions

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

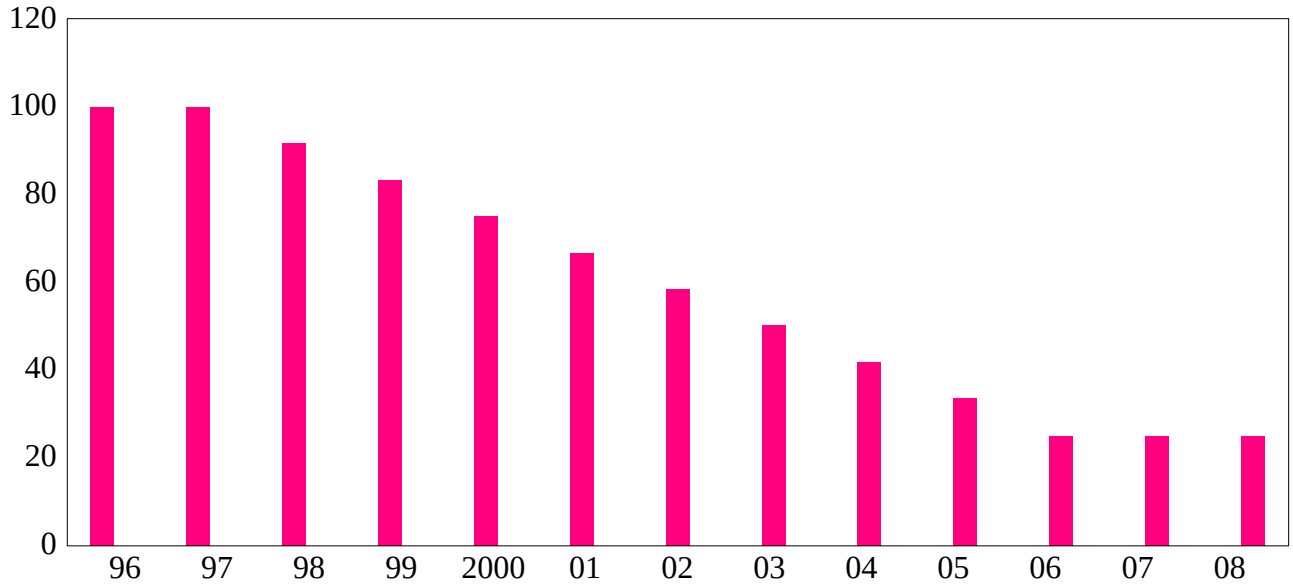
Stoichiometric (14.7:1) Air/Fuel Ratio

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

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

Outboard Hydrocarbon Emissions Reductions

8 1/3% ↓ per Year Over 9 Model Years



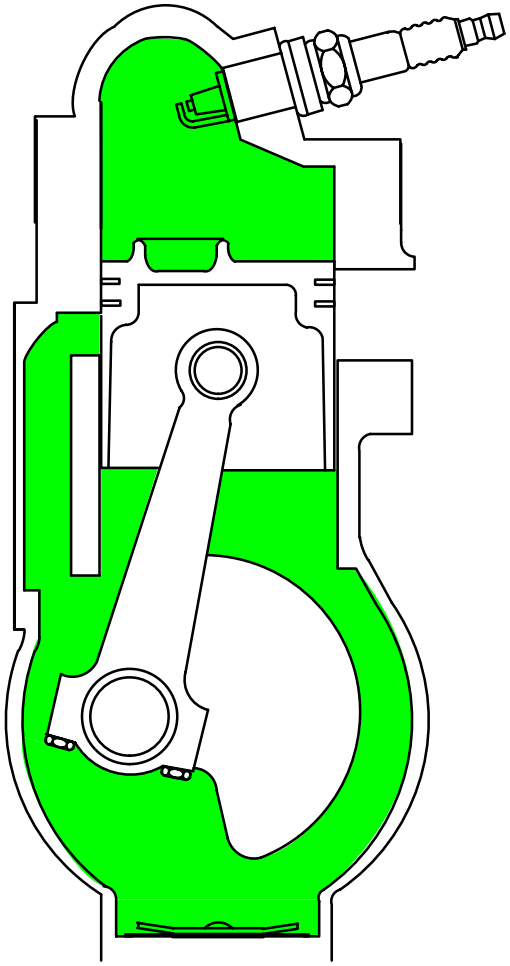
Stratified vs Homogenized Charge

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

Homogenized Charge

A homogenized charge has the fuel/air particles mixed evenly throughout the cylinder. This mixing occurs inside the carburetor venturi, reed blocks and crankcase. Additional mixing occurs as the fuel is forced through the transfer system into the cylinder.

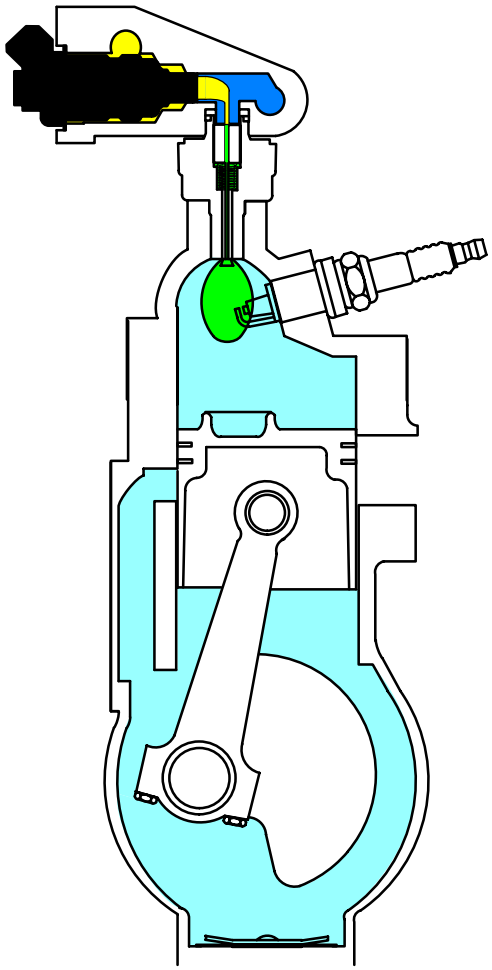
The homogenized charge is easy to ignite when the air/fuel ratio is approximately 14.7:1.



Stratified Charge

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

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



Emissions Information

Manufacturer's Responsibility:

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

Dealer Responsibility:

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

Adjustments must be kept within published factory specifications.

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

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

Exceptions include manufacturers prescribed changes, such as that for altitude adjustments. Also included would be factory authorized:

- Installation of performance style gear housings by Mercury Marine.
- Service replacement parts modified, changed or superceded by Mercury Marine.

Owner Responsibility:

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

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

Single engine exceptions may be allowed with permission from the EPA for racing and testing.

EPA Emission Regulations:

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

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

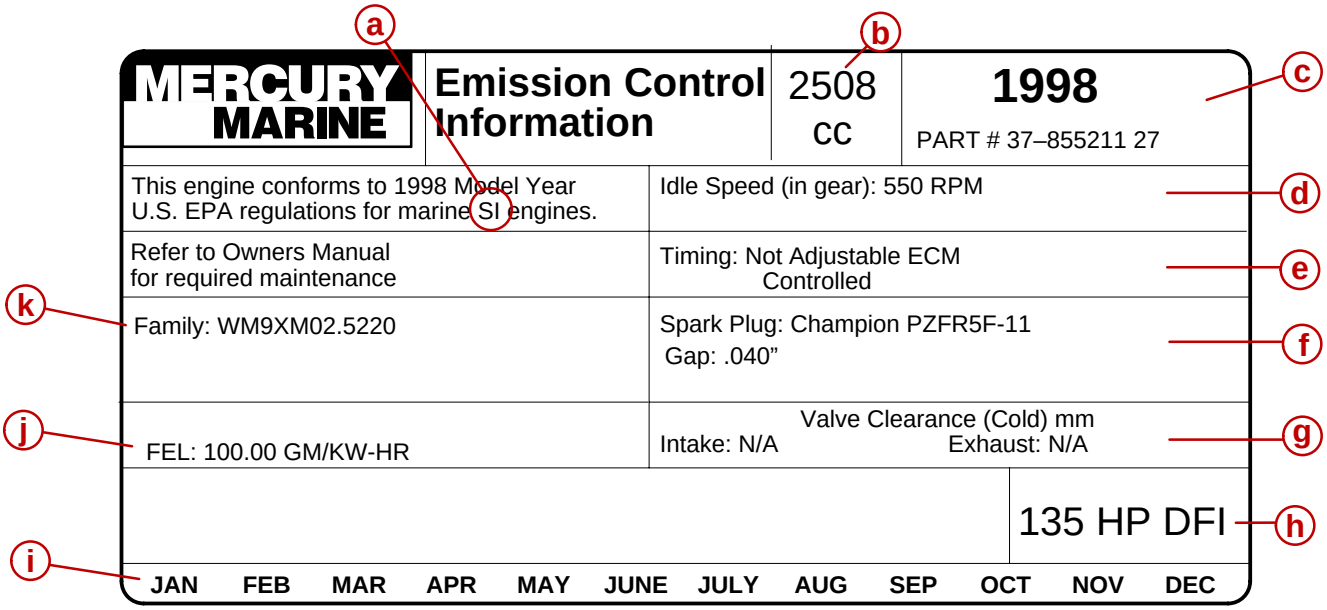
VIA U.S. POSTAL SERVICE:
Office of Mobile Sources
Engine Programs and Compliance Division
Engine Compliance Programs Group (6403J)
401 M St. NW
Washington, DC 20460

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

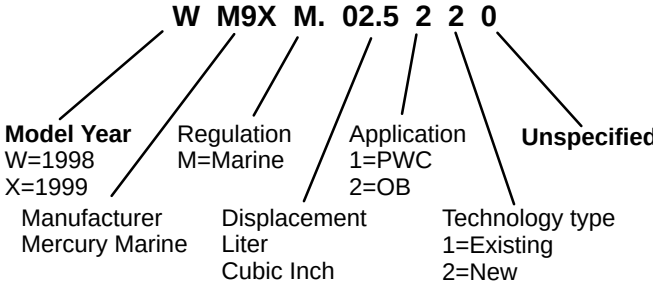
EPA INTERNET WEB SITE:
http:/www.epa.gov/omswww

CERTIFICATION LABEL:

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



- **a** - Spark Ignition (SI)
- **b** - Cubic Centimeter
- **c** - Model year of engine and production decal part number
- **d** - Idle Speed (In Gear)
- **e** - Timing specifications when adjustable
- **f** - Recommended spark plug for best engine performance
- **g** - Valve Clearance (Four Stroke engines only)
- **h** - Engine Horsepower rating
- **i** - Month of production (Boxing month will punched)
- **j** - FEL: Represents (Mercury Marine) statement of the maximum emissions output for the engine family
- **k** - Family example



Decal Location:

Model	Production Part No.	Service Part No.	Location on Engine
1998 Merc/Mar 2.5 L V6 DFI (135 – 150 H.P.)	37-855211 26	37-855577 26	Intake Plenum STBD Side or Flywheel Cover
1999 Merc/Mar 2.5 L V6 DFI (135 – 150 H.P.)	37-856984 13	37-856985 13	Intake Plenum STBD Side or Vapor Separator

Replacement of Certification Label

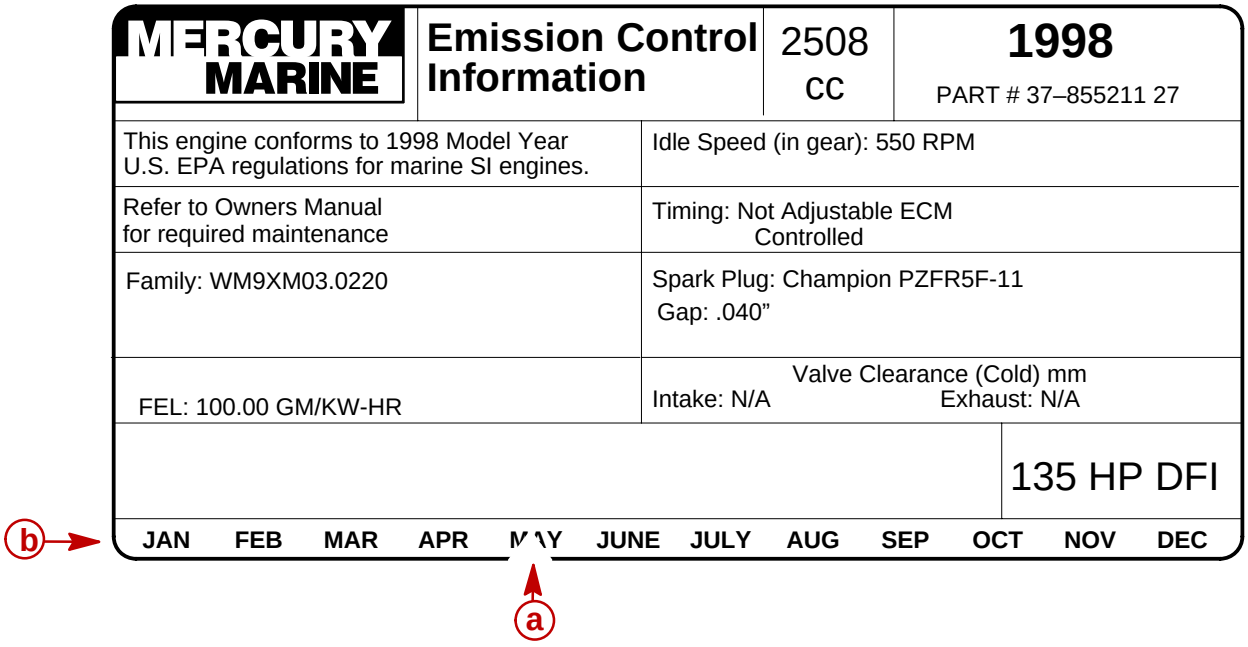
IMPORTANT: By federal law, it is required that all 1998 and newer Mercury Marine outboards have a visible and legible emission certification label. If this label is missing or damaged, replacement labels can be obtained from Mercury Marine.

Removal

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

Date Code Identification

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



a - “V” Notch
b - Month of Manufacture

Installation

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

POWERHEAD

Section 4A

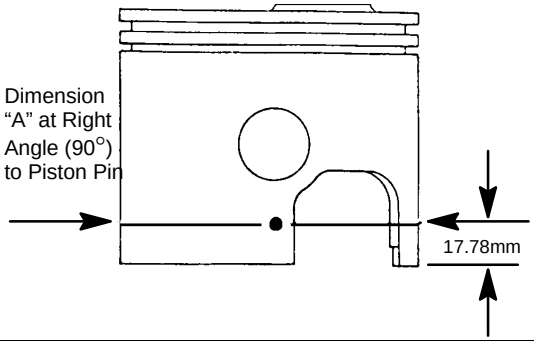
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4 A

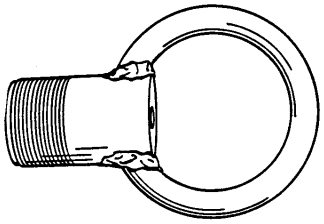
Powerhead Specifications

CYLINDER BLOCK	**Type** **Displacement**	V-6 Cylinder, Two Cycle, Direct Injected 153 cu. in. (2508 cc) 60° Vee
STROKE	**Length (All Models)**	2.65 in. (67.3 mm)
CYLINDER BORE	**Diameter (Std)** **Diameter 0.015 in. Oversize** **Taper/Out of Round/Wear Maximum** **Bore Type**	3.501 in. (88.925 mm) 3.516 in. (89.306 mm) 0.003 in. (0.076 mm) Cast Iron
PISTON	**Piston Type** **Diameter Standard** **Diameter 0.015 in. Oversize**	Aluminum 3.4925 in. ± .0005 in. (88.7095 mm ± 0.0127 mm) 3.5075 in. ± 0.0005 in. (89.0905 mm ± 0.0127 mm)
CRANKSHAFT	**Maximum Runout**	0.006 in. (0.152 mm)

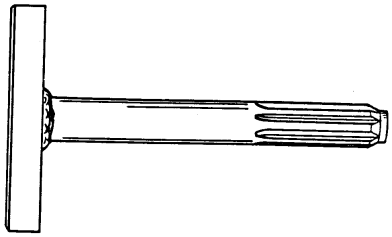
PISTON DIAMETER		3.4925 in. ± .0005 in. (88.7095 mm ± .0127 mm) **Using a micrometer, measure dimension "A" at location shown. Dimension "A" should be 3.4925 in. ± .0005 for a STANDARD size piston (new) Dimension "A" will be 0.001 - 0.0015 less if coating is worn off piston (used)**
REEDS	**Reed Stand 0pen (Max.)**	0.020 in. (0.50 mm)

Special Tools

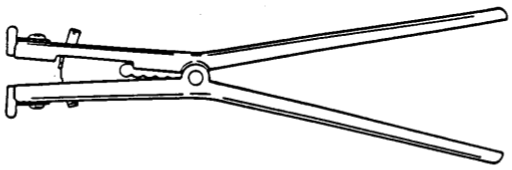
1. Lifting Eye 91-90455



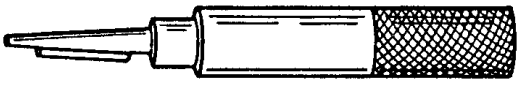
2. Powerhead Stand 91-30591A1



3. Piston Ring Expander 91-24697



4. Lockring Removal Tool 91-52952A1



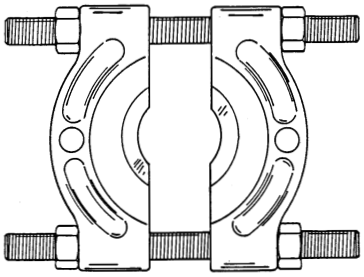
5. Piston Pin Tool 91-74607A1



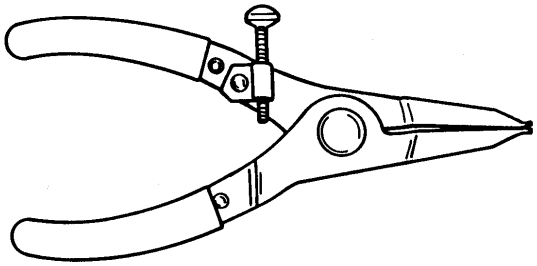
6. Driver Head 91-55919



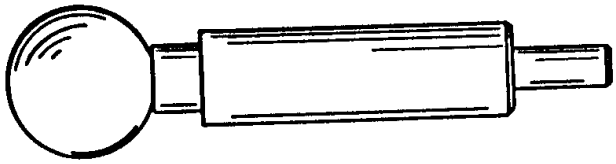
7. Universal Puller Plate 91-37241



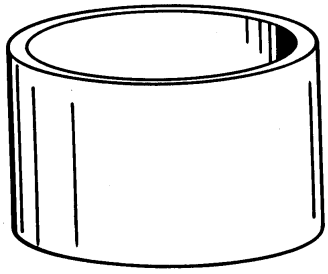
8. Snap Ring Pliers 91-24283



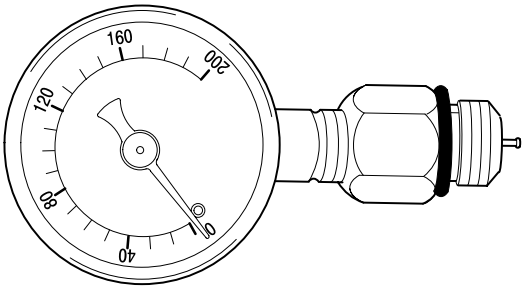
9. Lockring Installation Tool 91-77109A1



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



11. Compression Tester 91-29287

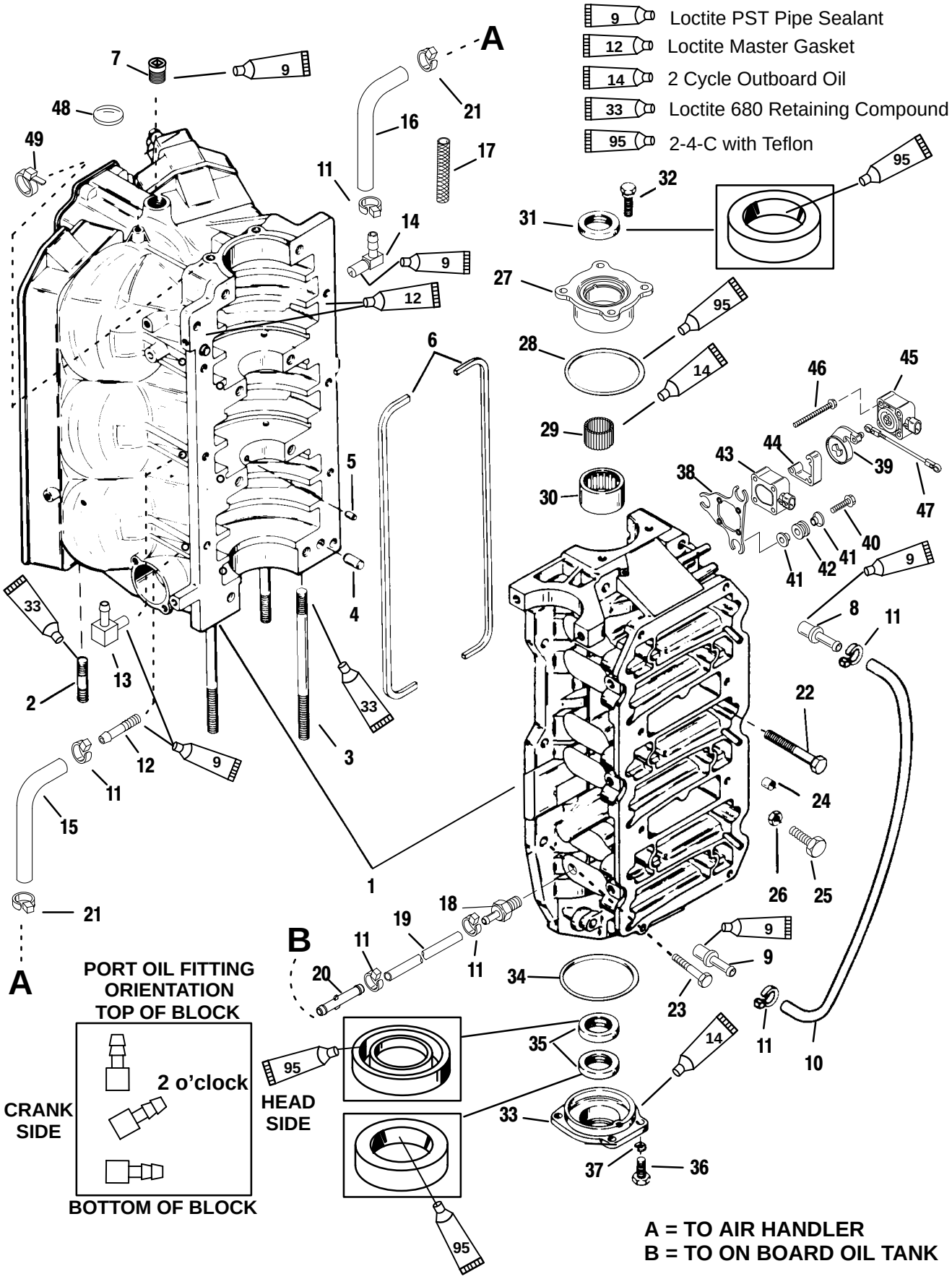


Powerhead Repair Stand

A powerhead repair stand may be purchased from:

Bob Kerr's Marine Tool Co.
P.O. Box 1135
Winter Garden, FL 32787
Telephone: (305) 656-2089

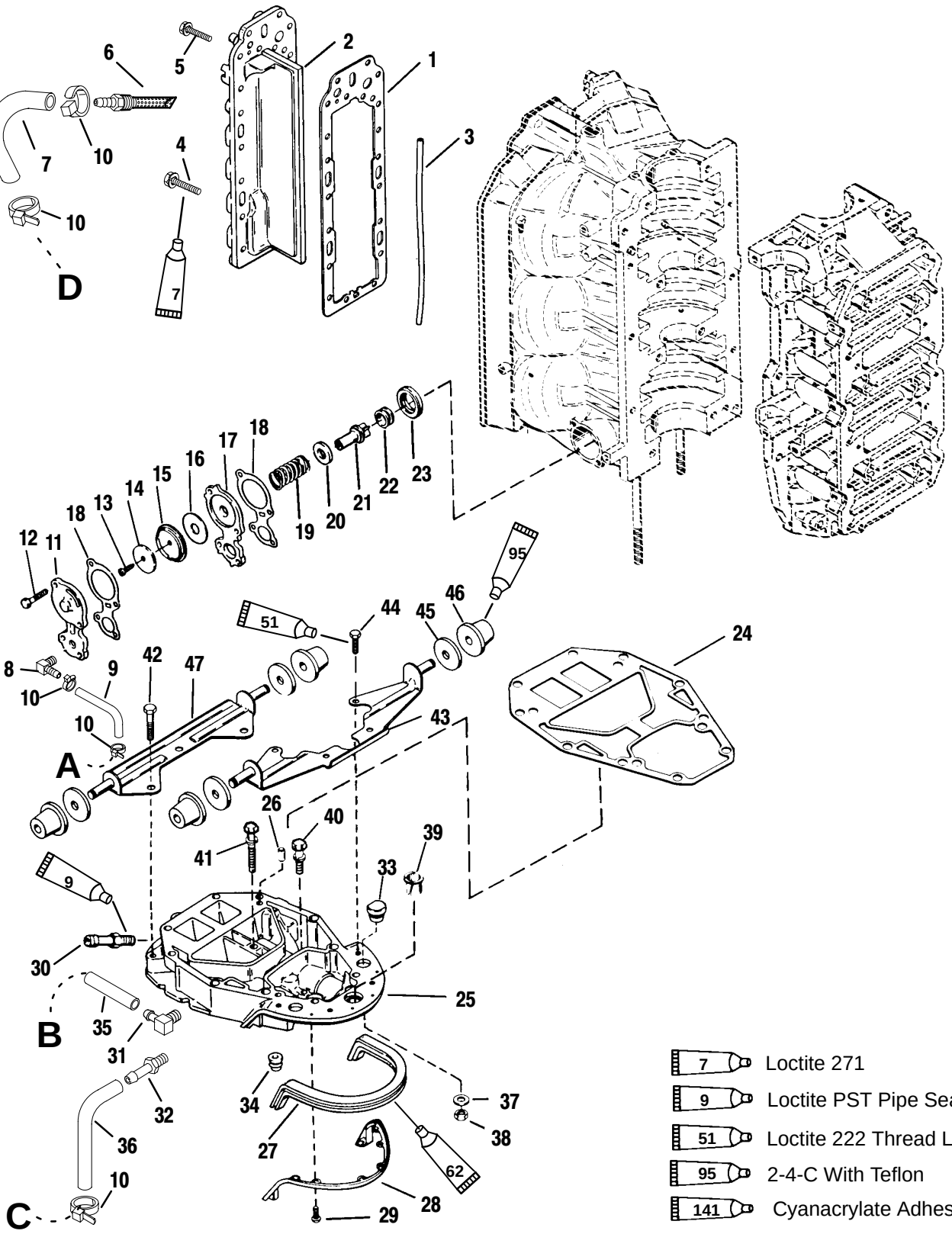
Cylinder Block and End Caps



Cylinder Block and End Caps

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	CYLINDER BLOCK			
2	6	STUD–powerhead (1-3/4 IN.)			
3	2	STUD–powerhead (5-1/2 IN.)			
	2	STUD–powerhead (6-3/4 IN.)			
4	2	DOWEL PIN–locating			
5	2	DOWEL PIN (BEARING RACE)			
6	2	GASKET–sealing			
7	1	PIPE PLUG (1/2-14)	Drive Tight		
8	1	CHECK VALVE			
9	1	CHECK VALVE			
10	1	TUBING (19 IN.)			
11	10	STA STRAP			
12	2	FITTING (STRAIGHT)**(STARBOARD - TOP/BOTTOM)**			
13	1	FITTING (ELBOW) **(STARBOARD - CENTER)**			
14	3	FITTING (ELBOW) **(PORT)**			
15	2	TUBING (16 IN.) **(TOP/BOTTOM)**			
	1	TUBING (20 IN.) **(CENTER)**			
16	3	TUBING (24-1/2 IN.)			
17	1	CONDUIT (7 IN.)			
18	1	FITTING			
19	1	TUBING (11-1/2 IN.)			
20	1	CONNECTOR			
21	6	STA-STRAP			
22	8	SCREW (3/8-16 x 3-1/4)		37	50
23	6	SCREW (.312-18 x 1-1/4)		15	20
24	1	CAP			
25	1	ADJUSTING SCREW (1/4-20 x 1-3/4)			
26	1	JAM NUT			
27	1	UPPER END CAP			
28	1	O-RING			
29	1	ROLLER BEARING			
30	1	BEARING RACE			
31	1	OIL SEAL			
32	4	SCREW (5/16-18 x 1)		17	23
33	1	LOWER END CAP			
34	1	O-RING (3-1/4 IN. I.D.)			
35	2	OIL SEAL			
36	4	SCREW (1/4-20 x 3/4)	80		9
37	4	LOCKWASHER			
38	1	BRACKET			
39	1	TPI LEVER			
40	3	SCREW -Bracket to crankcase	70		8
41	6	BUSHING			
42	3	GROMMET			
43	1	THROTTLE POSITION SENSOR **(INSIDE)**			
44	1	SPACER			
45	1	THROTTLE POSITION SENSOR **(OUTSIDE)**			
46	3	SCREW -TPS to bracket (#10-32 x 2-3/4 IN.)	15		1.7
47	1	THROTTLE LINK			
48	1	PLUG-Serial Number			
49	1	STA-STRAP-Oil Lines			

Exhaust Manifold and Exhaust Plate

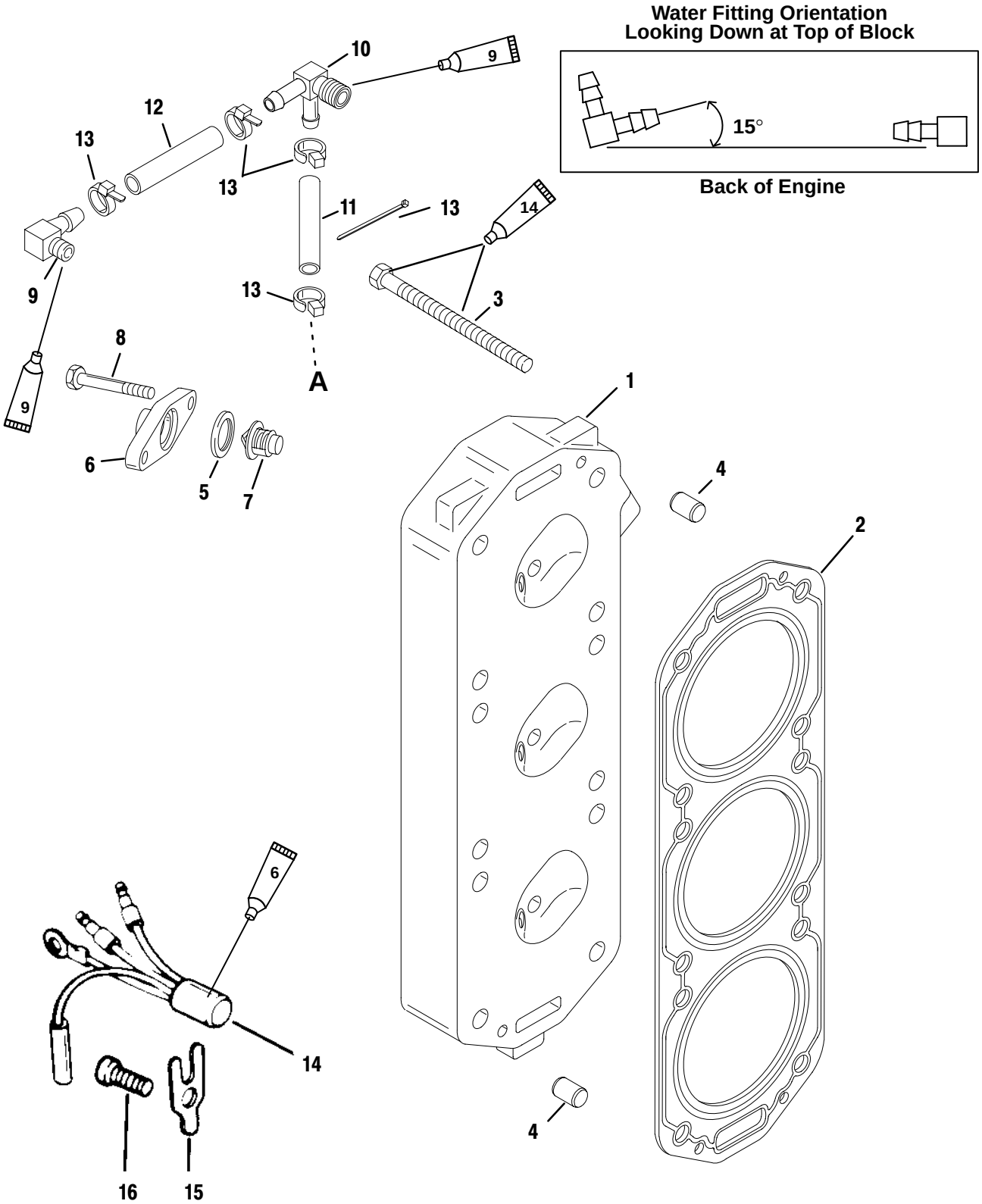


A = TO FUEL COOLER WATER IN B = TO FUEL COOLER WATER OUT FITTING
C = TO LOWER PORT FUEL RAIL SIDE FITTING
D = TO AIR COMPRESSOR LOWER WATER INLET FITTING

Exhaust Manifold and Exhaust Plate

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	GASKET			
2	1	DIVIDER PLATE			
3	1	SEAL			
4	17	SCREW (5/16-18 x 1-1/2 IN.)		13	18
5	2	SCREW (5/16-18 x 1 IN.)		13	18
6	1	STRAINER			
7	1	HOSE (4-1/2 IN.)			
8	1	ELBOW			
9	1	HOSE (21-1/2 IN.)			
10	5	STA-STRAP			
11	1	COVER–relief valve			
12	4	SCREW (5/16-18 x 1-1/4 IN.)		12.5	17
13	1	SCREW (10-16 x 3/4 IN.)	25		3
14	1	WASHER			
15	1	DIAPHRAGM			
16	1	WATER DEFLECTOR			
17	1	PLATE			
18	2	GASKET			
19	1	SPRING			
20	1	WASHER			
21	1	POPPET			
22	1	GROMMET			
23	1	CARRIER			
24	1	GASKET			
25	1	EXHAUST PATE			
26	2	DOWEL PIN			
27	1	SEAL			
28	1	BRACKET			
29	8	SCREW (10-16 x 1/2 IN.)	80		9
30	1	FITTING (STRAIGHT)**(BACK)**			
31	1	ELBOW **(STARBOARD-TOP HOLE)**			
32	1	FITTING (STRAIGHT)**(STARBOARD-BOTTOM HOLE)**			
33	1	GROMMET			
34	1	GROMMET			
35	1	HOSE (25 IN.)			
36	1	HOSE			
37	4	WASHER			
38	6	NUT		23	31
39	1	BUSHING			
40	1	SCREW (5/16-18 x 1-1/4 IN.)		45	61
41	1	SCREW (5/16-18 x 2-1/2 IN.)		45	61
42	3	SCREW (3/8-16 x 3-1/2 IN.)		23	31
43	1	FRONT BRACKET ASSEMBLY			
44	4	SCREW (5/16-18 x 1/2 IN.)		17	23
45	4	WASHER			
46	4	GROMMET			
47	1	REAR BRACKET ASSEMBLY			

Cylinder Head



6 Dielectric Grease

9 Loctite 567 PST Pipe Sealant

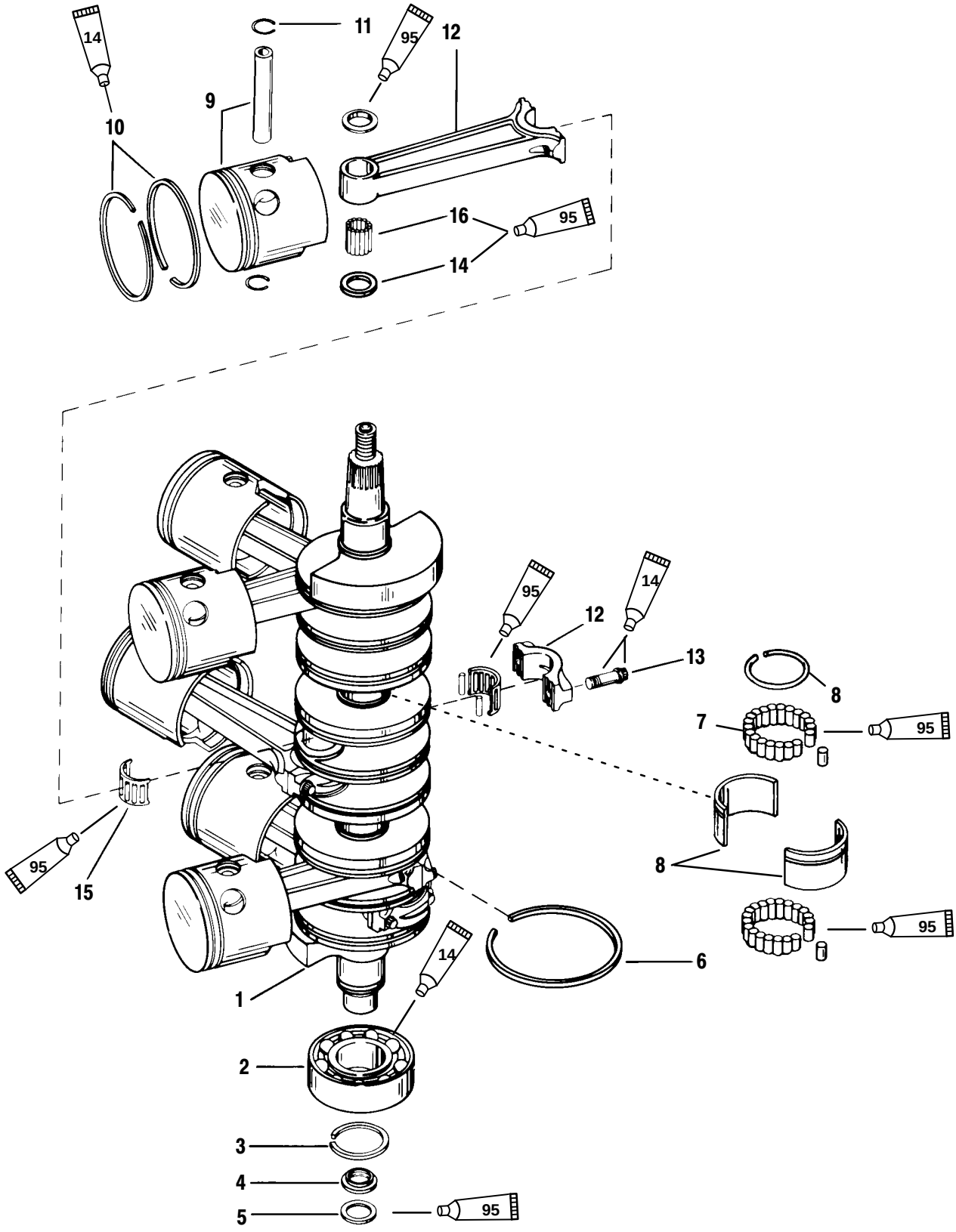
14 2 Cycle Premium Outboard Oil

A = TO STRAIGHT FITTING ON BACK OF EXHAUST PLATE

Cylinder Head

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	CYLINDER HEAD **(PORT)**			
	1	CYLINDER HEAD **(STARBOARD)**			
2	2	GASKET			
3	24	BOLT (2 IN.)	30 lb-ft (40.7 Nm) then tighten additional 90°		
4	4	DOWEL PIN			
5	2	GASKET			
6	2	COVER			
7	2	THERMOSTAT (143 degrees)			
8	4	SCREW (M6 x 25)		16.5	22.5
9	1	ELBOW **(STARBOARD)**			
10	1	ELBOW **(PORT)**			
11	1	HOSE (21-1/2 IN.)			
12	1	HOSE (11-1/2 IN.)			
13	5	STA-STRAP			
14	1	TEMPERATURE SENSOR **(STARBOARD)**			
15	1	RETAINER			
16	1	SCREW (M8 x 12)		16.5	22.5

Crankshaft, Pistons and Connecting Rods



14 2 Cycle Premium Outboard Oil

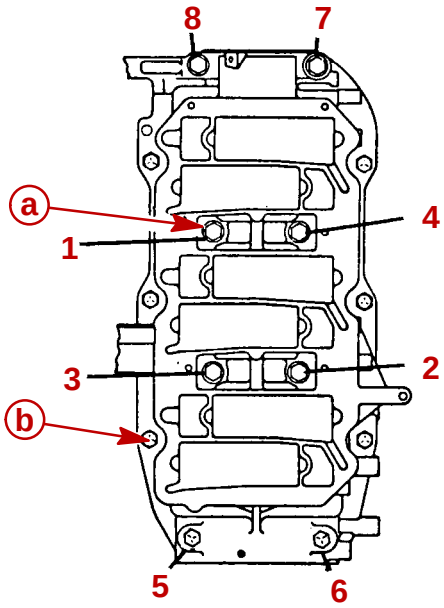
95 2-4-C with Teflon

Crankshaft, Pistons and Connecting Rods

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	CRANKSHAFT ASSEMBLY			
2	1	BALL BEARING (LOWER)			
3	1	RETAINING RING			
4	1	CARRIER ASSEMBLY			
5	1	SEAL			
6	7	RING–sealing			
7	2	ROLLER BEARING			
8	2	RACE			
9	3	PISTON **(STARBOARD)**			
	3	PISTON **(PORT**)			
10	1	PISTON RING			
11	12	LOCK RING			
12	6	CONNECTING ROD ASSEMBLY			
13	12	SCREW	1st Torque: 15 lb-in 2nd Torque: 30 lb-ft Turn Screw addition-al 90° after 2nd torque		
14	12	WASHER			
15	6	ROLLER BEARING ASSEMBLY			
16	174	NEEDLE BEARING–piston end			

Torque Sequence

CRANKCASE COVER BOLTS (AND TORQUE SEQUENCE)

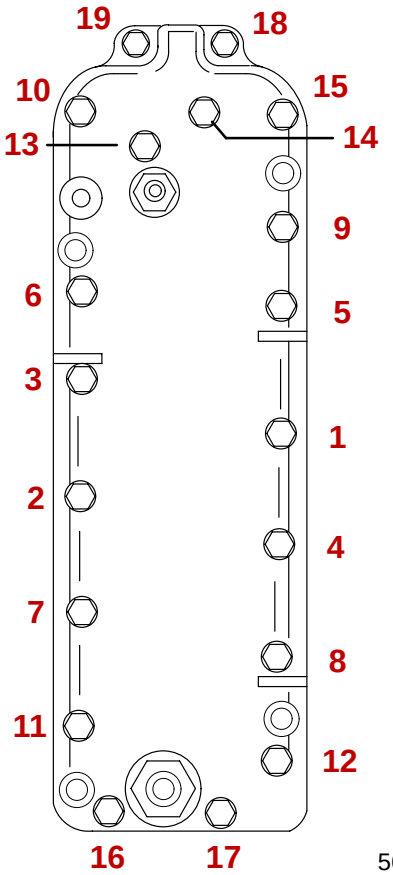


a - Add light oil to threads and bolt face: 8 Bolts (3/8 in. - 16 in.) 38 lb. ft. (51.5 Nm)

b - Bolts (5/16 in. - 18) 180 lb. in. (20 Nm)

EXHAUST DIVIDER PLATE BOLTS

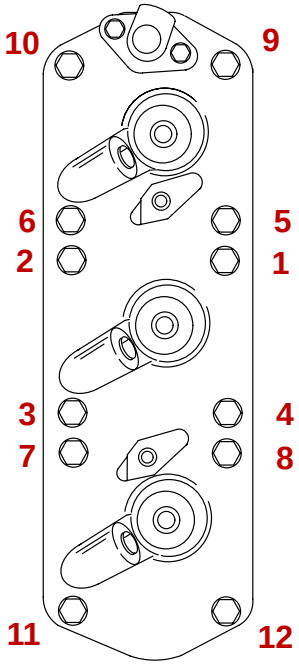
Apply Loctite 271 to threads: 200 lb. in. (22.5 N·m)



56167

CYLINDER HEAD BOLTS

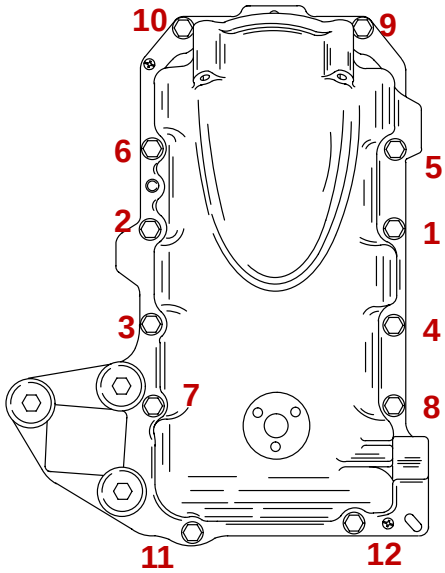
Add light oil to threads and bolt face: 30 lb. ft. (41 N·m) then turn an additional 90°.



56168

AIR PLENUM/REED BLOCK ASSEMBLY PLATE BOLTS

100 lb. in. (11.3 N·m)



56160

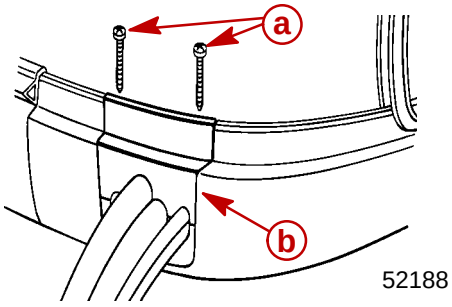
General Information

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, preceeding) Usually, complete disassembly of powerhead will be required.

If major powerhead repairs are to be performed, remove powerhead from drive shaft housing. Removal of powerhead is not required for 1) inspection of cylinder walls and pistons (refer to Powerhead Removal and Disassembly, following, and remove cylinder heads and exhaust cover), 2) minor repairs on components, such as ignition system, fuel injection, reed blocks and cylinder heads and checking operation of thermostats.

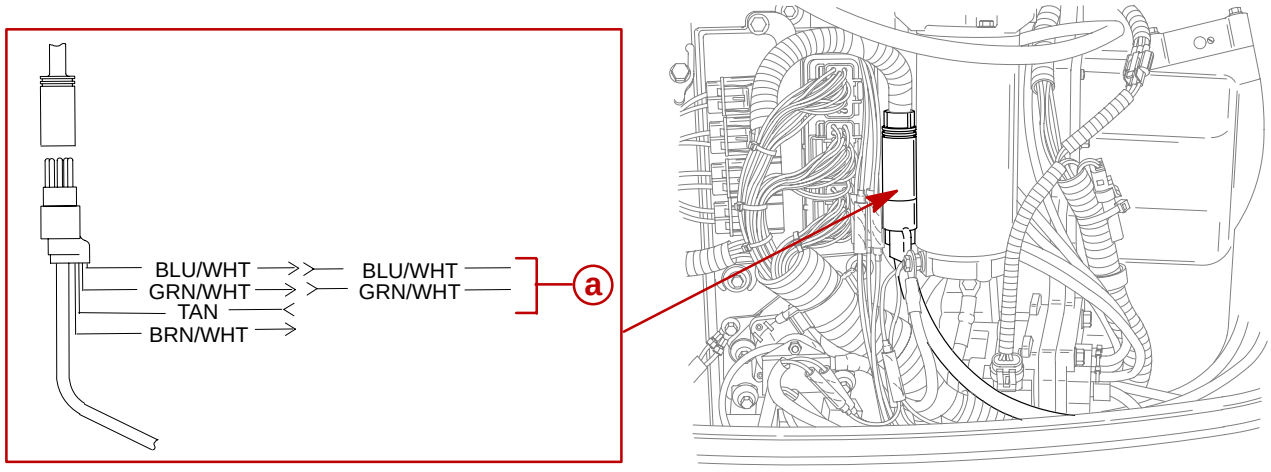
Powerhead Removal from Driveshaft Housing

1. Disconnect battery cables from battery terminals.
2. Disconnect fuel tank hose from outboard.
3. Remove top cowling.
4. Remove two screws which secure remote control harness retainer and remove retainer.



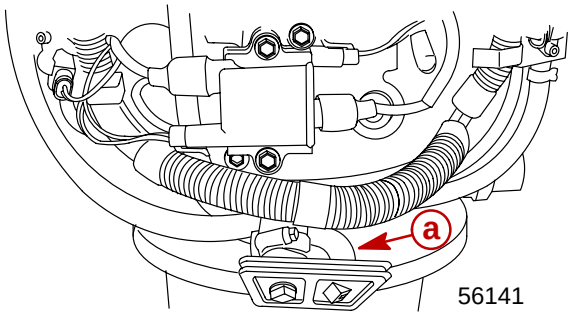
a - Screws
b - Retainer

5. Disconnect remote oil tank hose connector.
6. Disconnect remote control harness from powerhead harness connector and wires as shown.



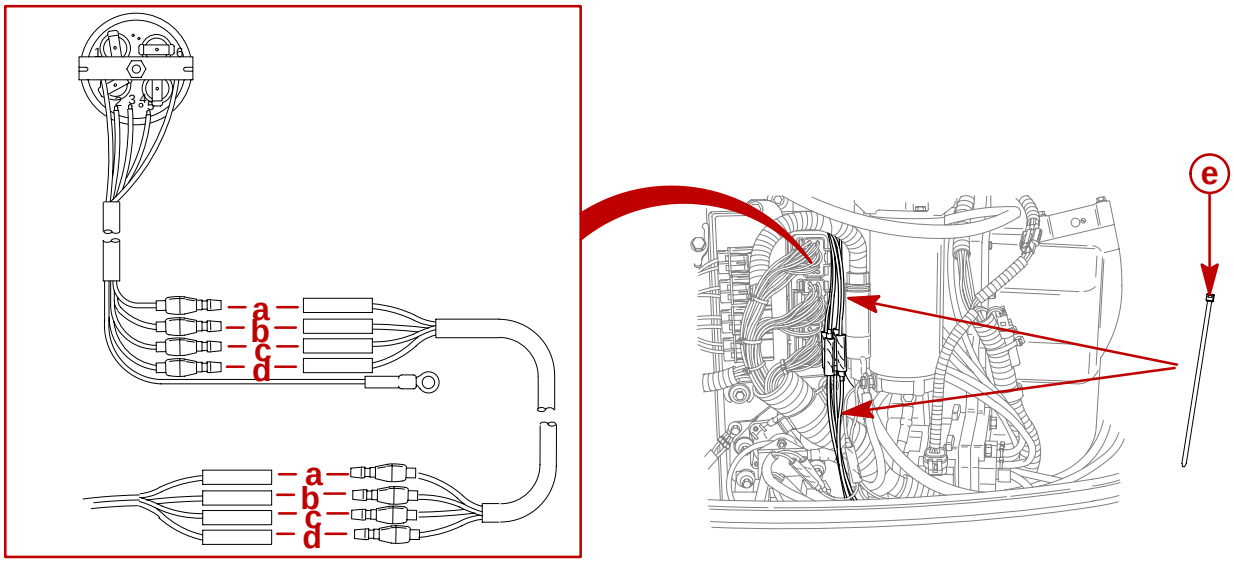
a - Power Trim Connections

7. Remove sta-strap which secures tell-tale hose to fitting on lower cowl and remove hose from fitting.



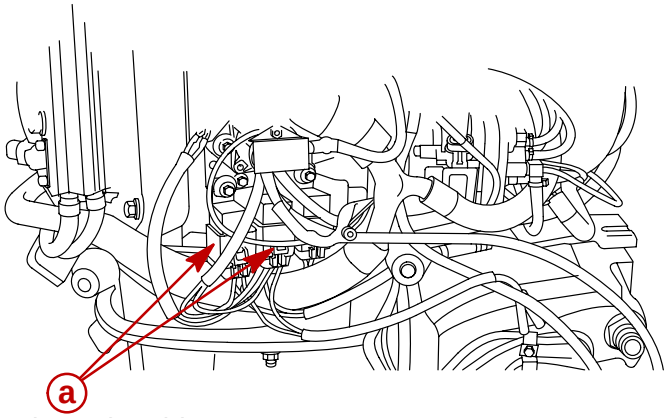
a - Tell-tale Hose

8. Disconnect warning gauge harness.



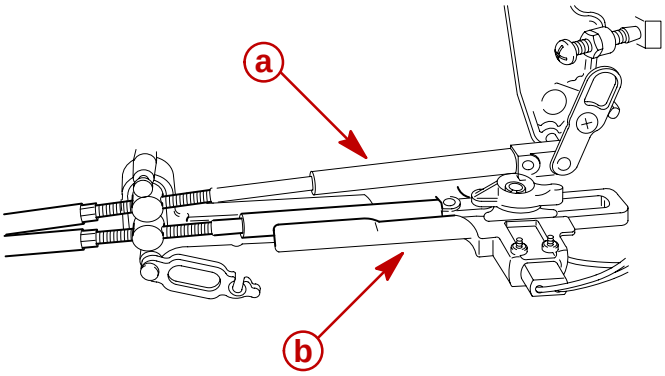
a - TAN/BLACK
b - TAN/WHITE
c - PINK/LT. BLUE to PINK/LT. BLUE
d - ORANGE
e - Sta-Straps

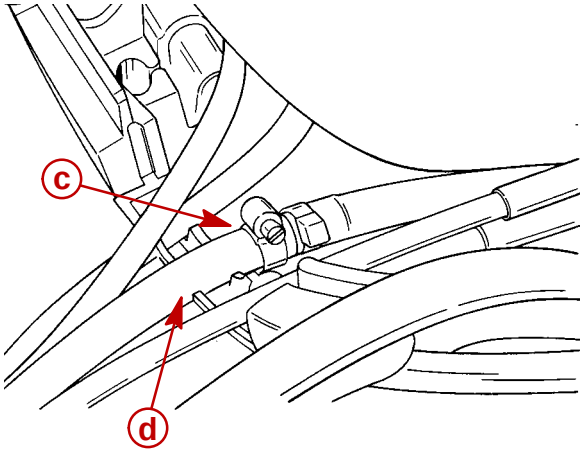
9. Remove BLUE and GREEN trim harness leads from trim solenoids.



a - Trim Solenoids

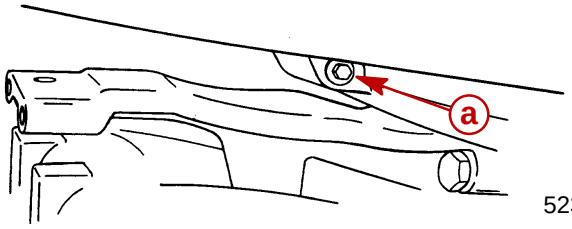
10. Slide outboard shift lever into neutral position.
11. Remove throttle cable.
12. Remove locknut that secures the shift cable latch assembly and remove latch, flat washer, nylon wear plate, spring and shift cable from control cable anchor bracket.
13. Disconnect input fuel line.



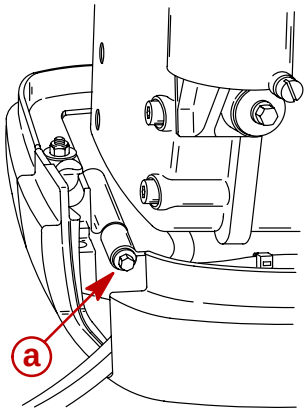


a - Throttle Cable
b - Shift Cable
c - Hose Clamp
d - Fuel Line

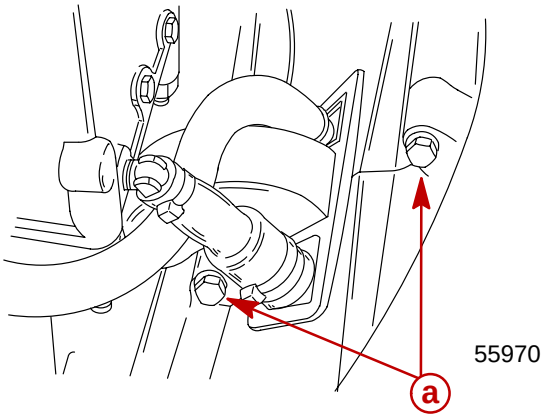
14. Remove 4 bolts securing bottom cowl halves and remove bottom cowling.



52352



55932

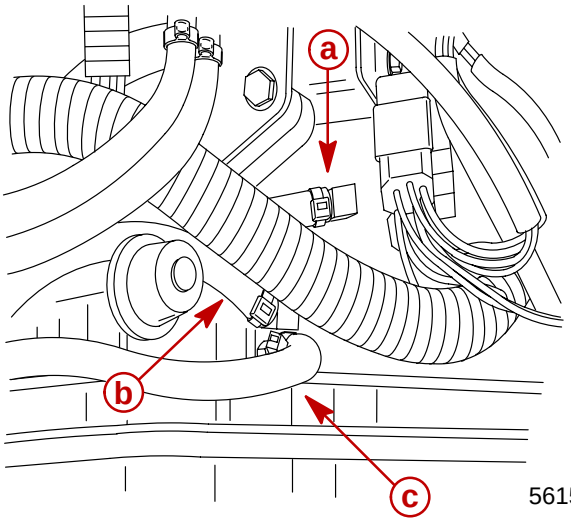


55970

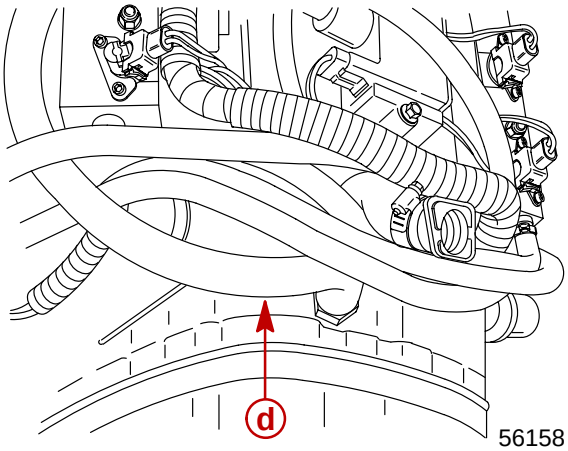
a - Bolt

15. Remove fuel cooler inlet and outlet water hoses from fittings on exhaust adaptor plate and poppet valve cover. Remove excess air hose (from port fuel rail) from fitting on exhaust adaptor plate.

16. Remove thermostat cover hose from exhaust adaptor plate.



56159

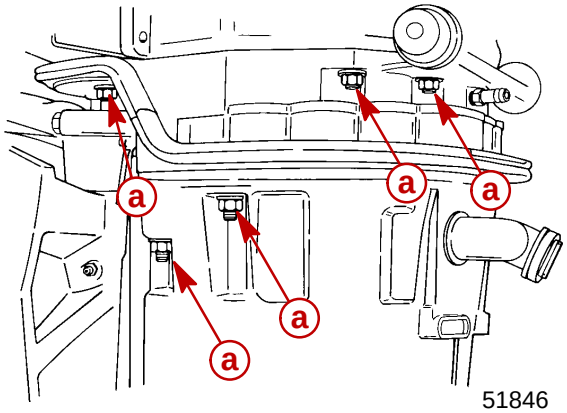


56158

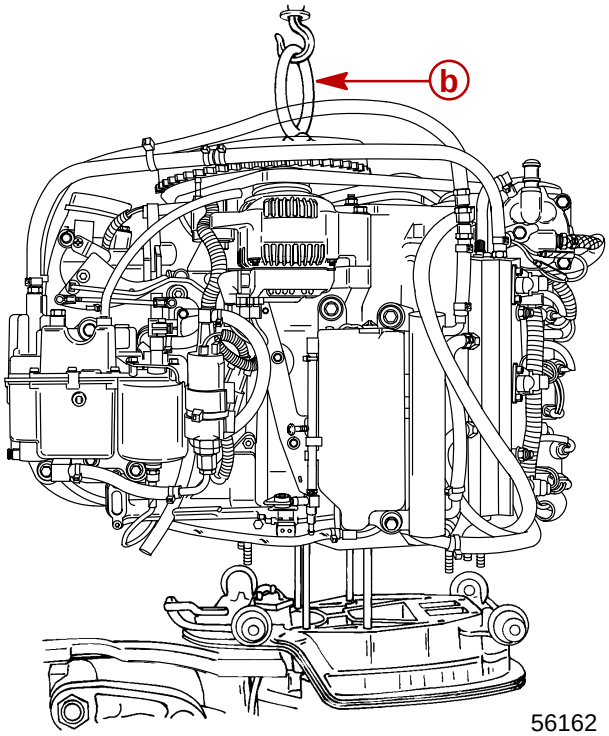
a - Fuel Cooler Outlet Water Hose
b - Fuel Cooler Inlet Water Hose
c - Air Hose
d - Thermostat Cover Hose

17. Remove 10 nuts and washers (five each side) from powerhead base.

18. Remove plastic cap from center of flywheel and install lifting eye into flywheel at least five full turns. Using a hoist, lift powerhead assembly from driveshaft housing.



51846



56162

a - Nuts and Washers (5 Each Side)
b - Lifting Eye (91-90455)

REMOVING ENGINE COMPONENTS

Remove the following engine components:

Section 2 Starter Motor
Starter Motor
*Electronic Control Module
*Ignition Coil
*Starter Solenoid
Alternator
Flywheel

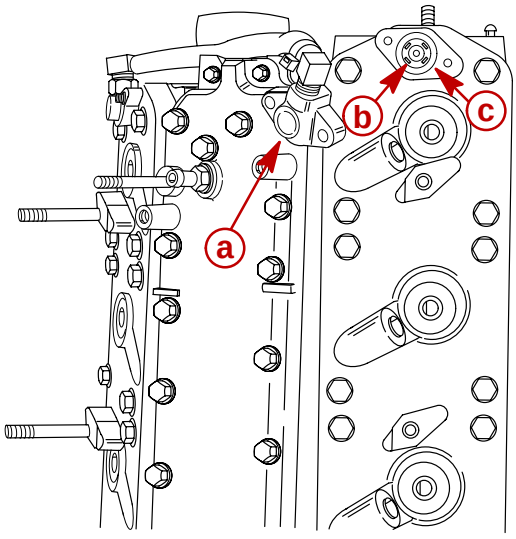
Section 3
Direct Fuel Injection
Fuel Pump
On-Board Oil Tank
Oil Pump

Section 7
Shift Cable Latch Assembly
Control Cable Anchor Bracket

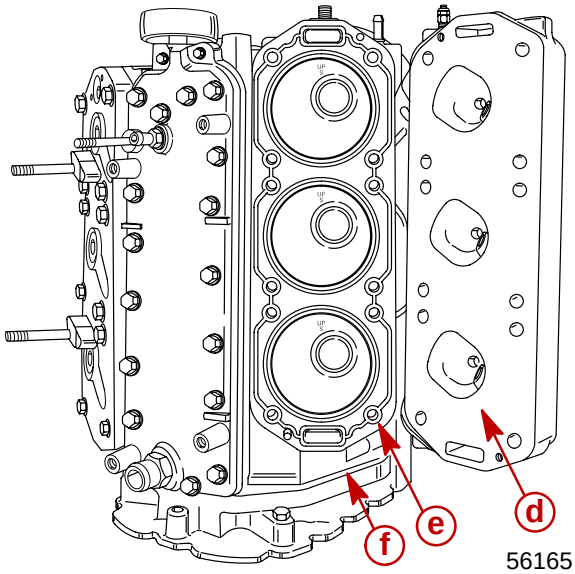
***All ignition and electrical components should remain attached to electrical plate. Plate with components can be removed as an assembly.**

Powerhead Disassembly

1. Place powerhead in repair stand or on a bench.
2. Remove thermostat covers, thermostats and gaskets.
3. Remove cylinder heads from engine block.



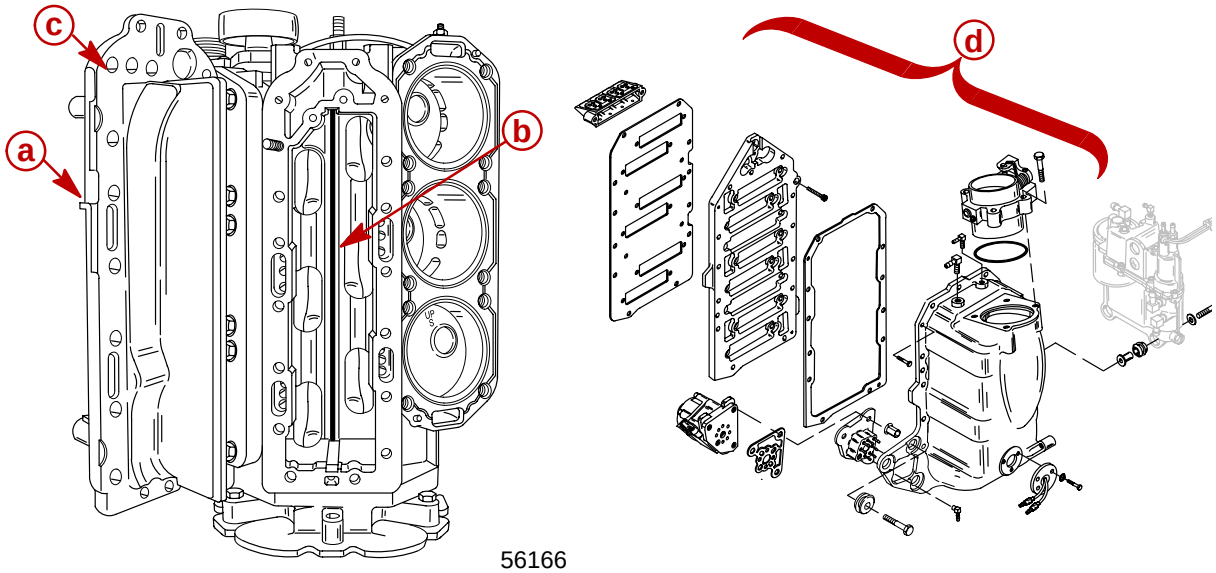
56163



56165

a - Thermostat Cover
b - Thermostat
c - Gasket
d - Cylinder Head
e - Gasket
f - Engine Block

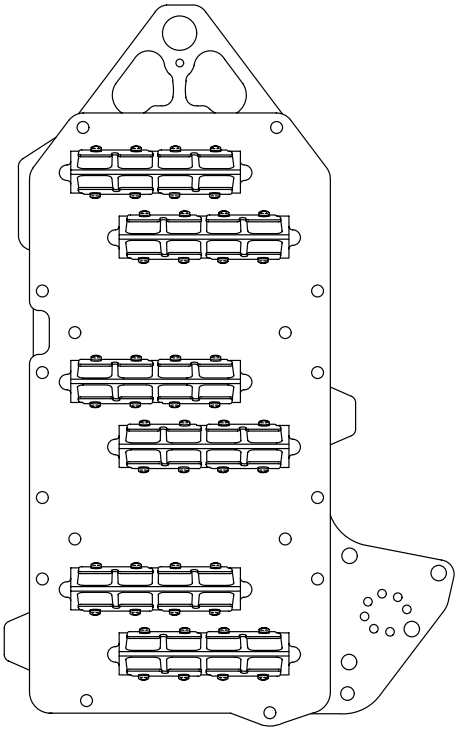
4. Remove exhaust manifold cover and seal.
5. Referring to **Section 3B**, remove air plenum/reed block/adaptor plate assembly from cylinder block.



56166

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

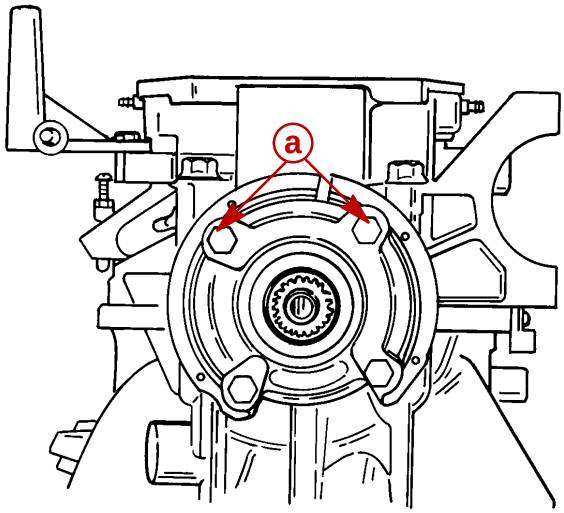
6. Inspect reeds as outlined in Cleaning and Inspection.



56169

7. Remove bolts from end caps.

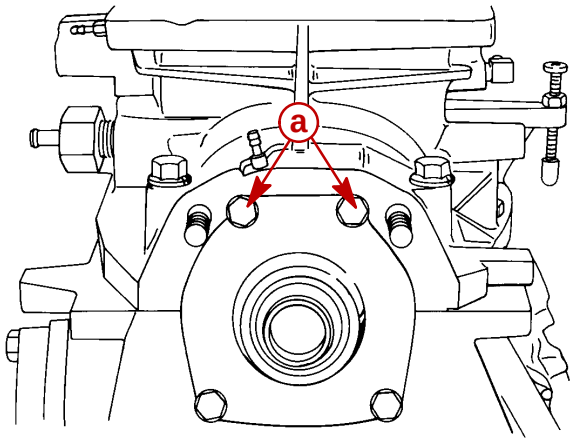
Upper End Cap



51854

a - Crankcase Attaching End Cap Bolts

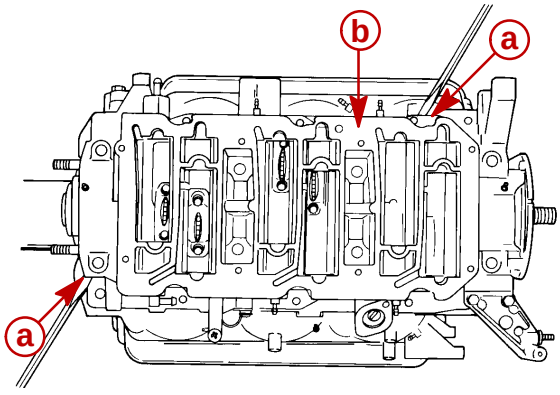
Lower End Cap



51849

a - Crankcase Attaching End Cap Bolts

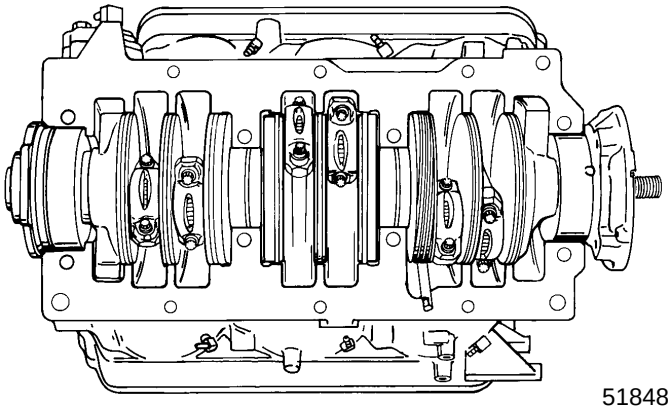
1. Remove bolts which secure crankcase cover to cylinder block.
2. Pry crankcase cover off cylinder block using pry bars in locations shown.



51845

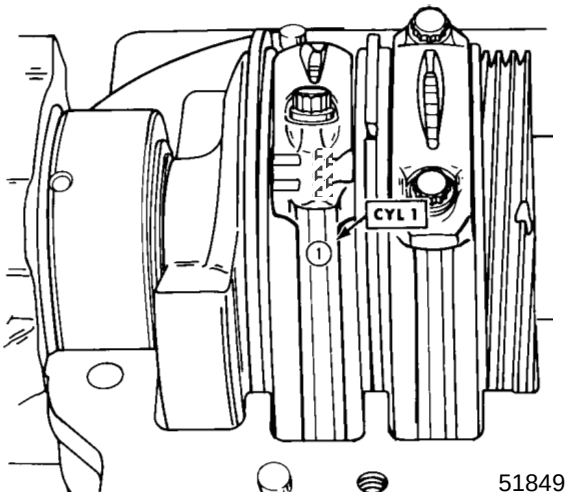
a - Pry Points
b - Crankcase Cover

CRANKCASE COVER REMOVED



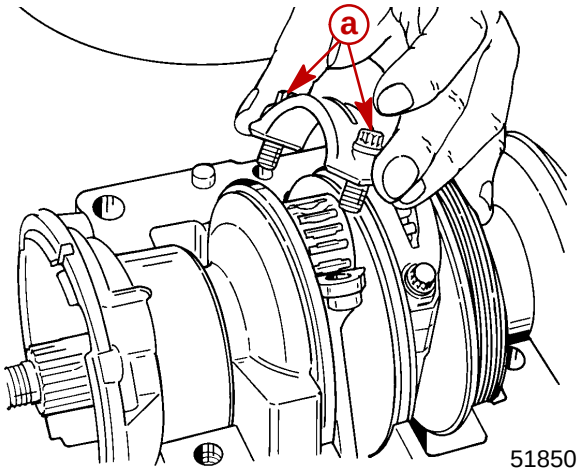
51848

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



51849

3. Use a 5/16 in. 12 point socket to remove connecting rod bolts, then remove rod cap, roller bearings and bearing cage from connecting rod.



51850

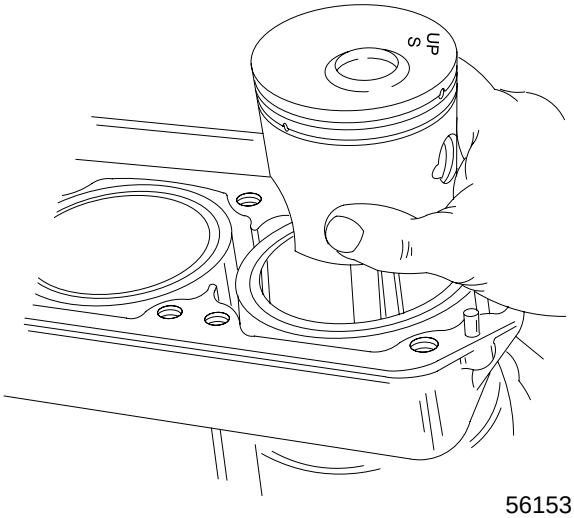
a - Connecting Rod Bolts

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

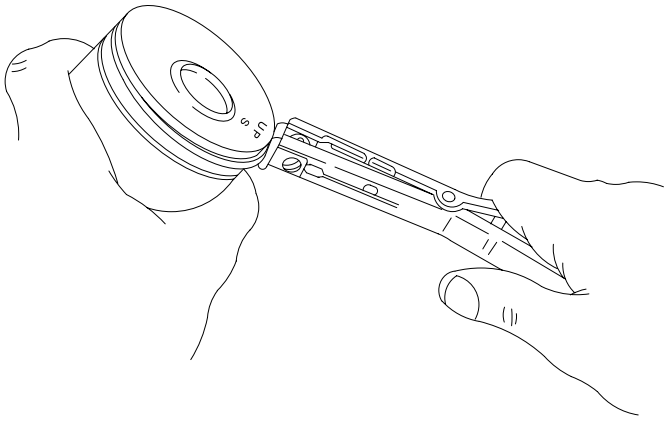
⚠ CAUTION

Each connecting rod and end cap are a matched machined set and must never be mismatched.

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

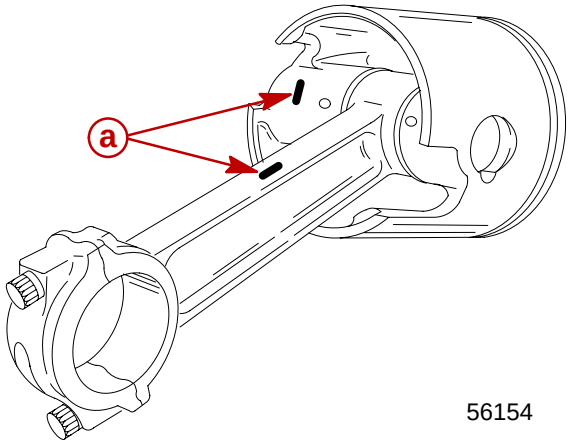


56153

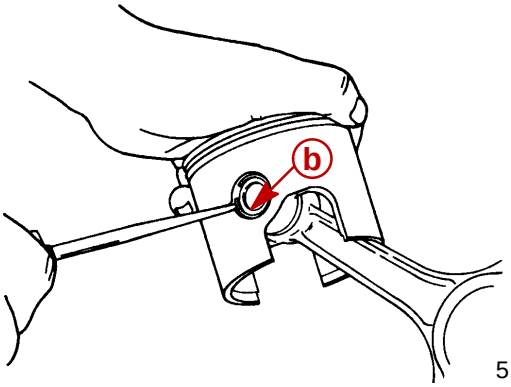


56155

8. Using an awl, scribe identification number of connecting rod on inside of piston. Reassemble piston on same connecting rod.
9. Using tool (91-52952A1), remove piston pin lockrings from both ends of piston pin. Never re-use piston pin lockrings.



56154



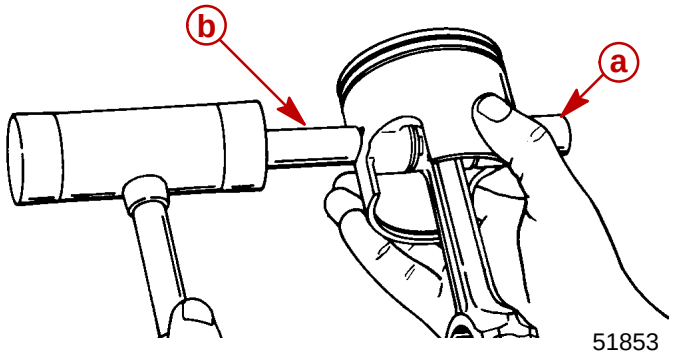
51083

a - Scribe Identification Number
b - Lockring

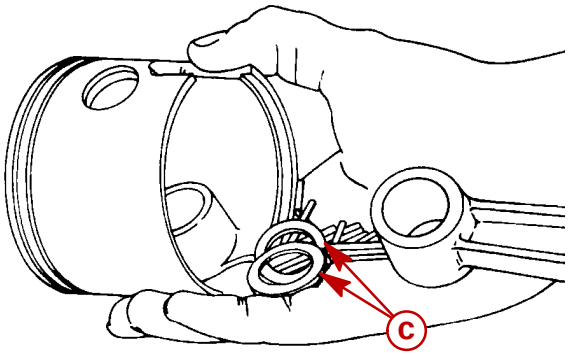
IMPORTANT: Warming the piston dome using a torch lamp will ease removal and installation of piston pin.

10. Support piston and tap out piston pin using service tool as shown.
11. Remove piston pin needle bearings (29 per piston) and locating washers (2 per piston) as shown.

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



51853

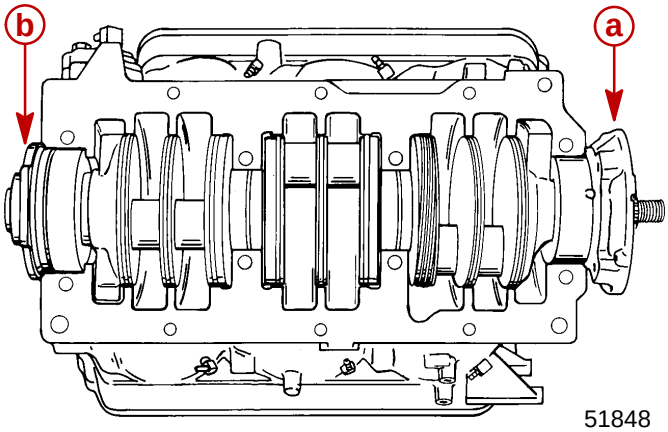


51088

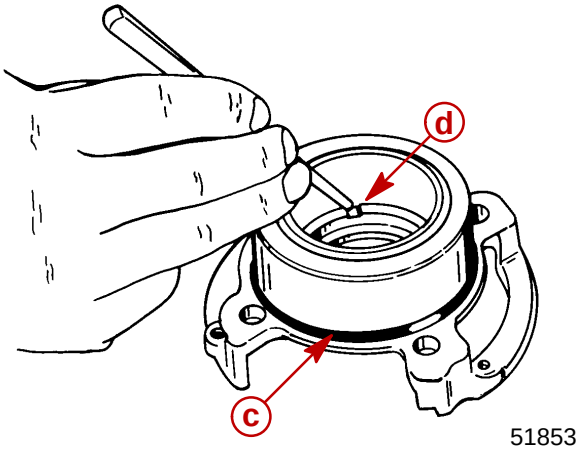
a - Piston Pin
b - Piston Pin Tool (91-76159A1)
c - Needle Bearing Locating Washers

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

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



51848



51853

a - Upper End Cap
b - Lower End Cap
c - O-Ring
d - Seal

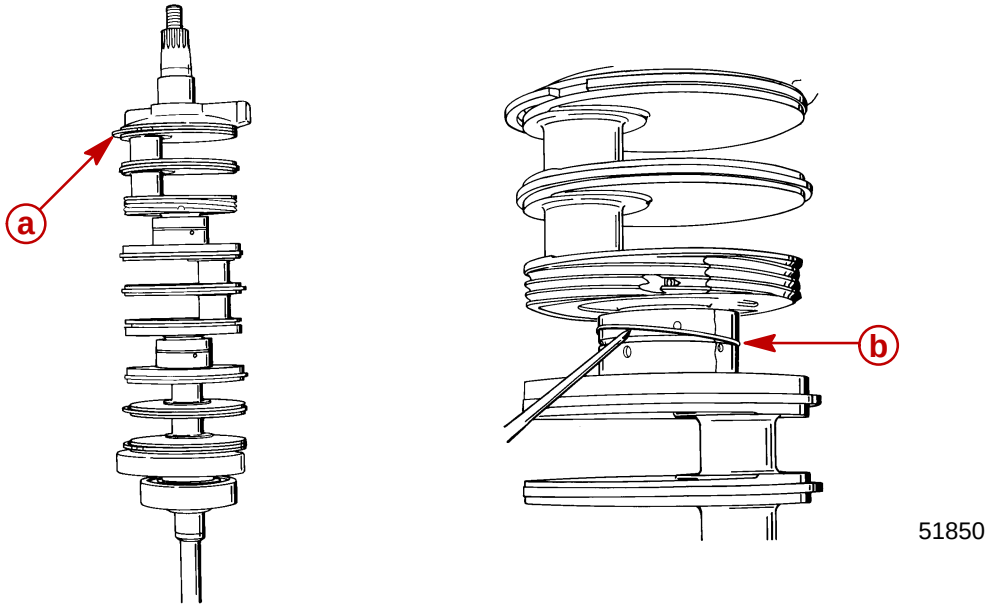
16. Remove crankshaft and place in powerhead stand as shown.

IMPORTANT: DO NOT remove crankshaft sealing rings from crankshaft, unless replacement of one or more sealing rings is necessary. Usually, crankshaft sealing rings do not require replacement, unless broken.

⚠ CAUTION

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

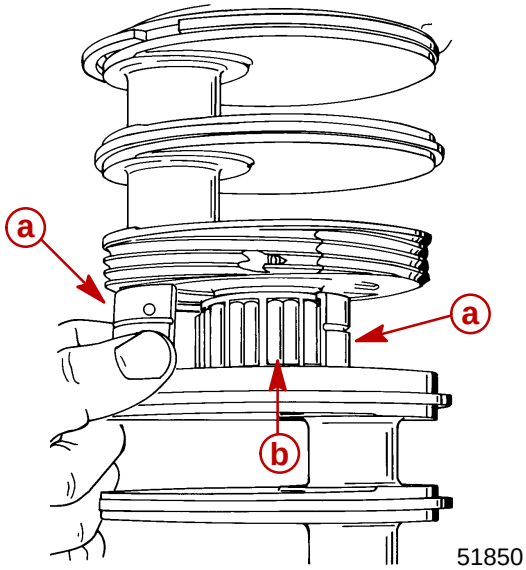
17. Remove retaining ring as shown.



a - Sealing Rings
b - Retaining Ring

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

IMPORTANT: Keep same bearing races and roller bearings together.



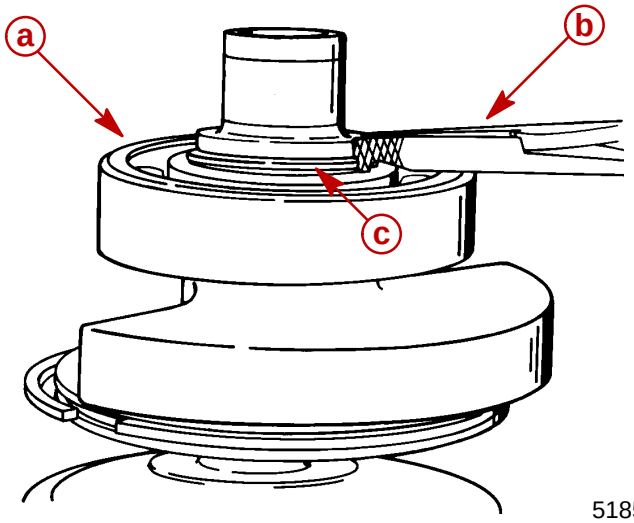
a - Bearing Race Halves
b - Roller Bearings

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

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

20. Remove lower ball bearing from crankshaft as follows:

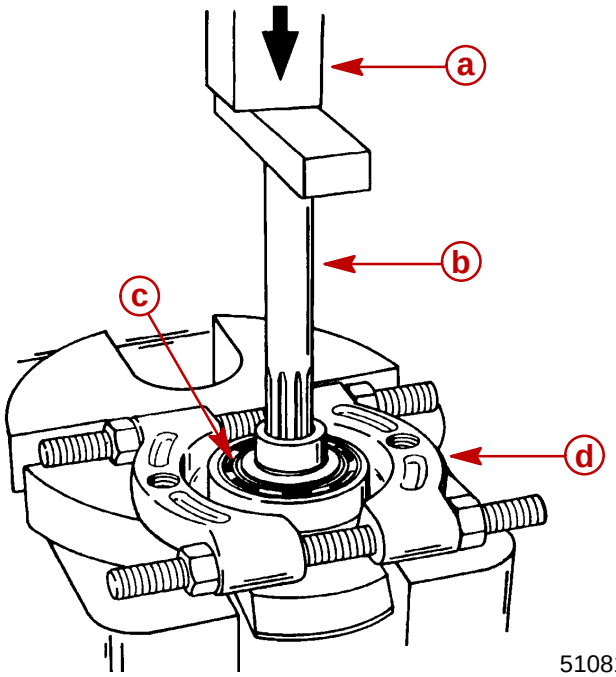
a. Remove retaining ring using a pair of snap ring pliers.



51854

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

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

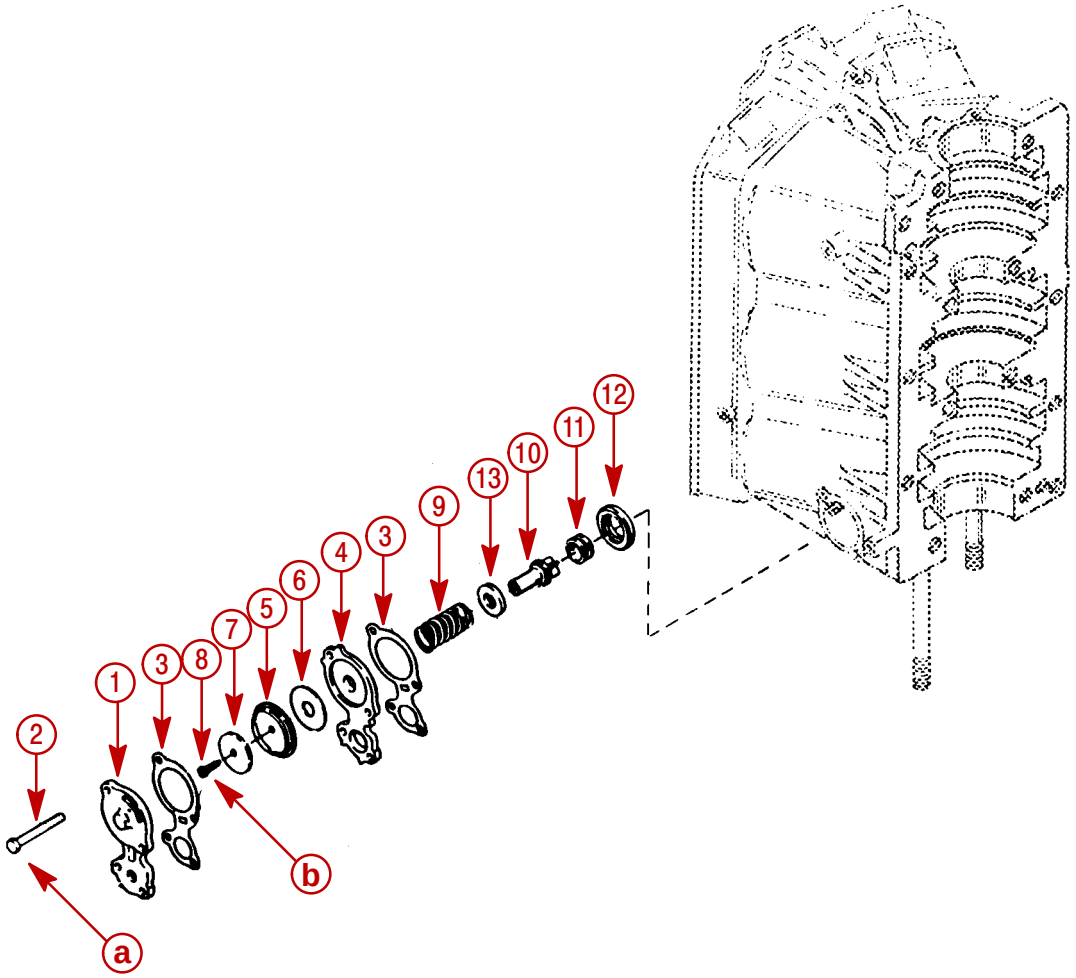


51081

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

Water Pressure Relief Valve Components

1. If necessary, remove water pressure relief valve components as shown.



50803

1 - Cover
2 - Bolt
3 - Gasket
4 - Relief Valve Plate
5 - Diaphragm
6 - Water Deflector
7 - Washer
8 - Screw
9 - Spring
10 - Poppet Valve
11 - Grommet
12 - Carrier
13 - Washer

Torque Specifications

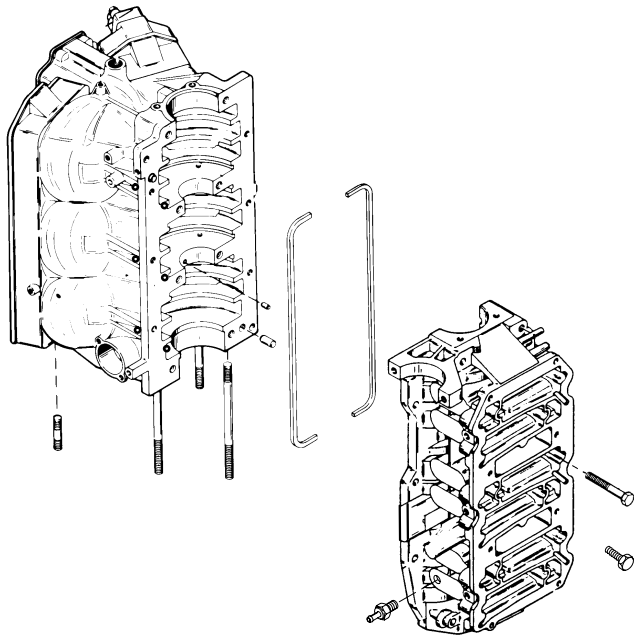
(a) 150 lb. in. (17 Nm)

(b) 25 lb. in. (3 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 such as “TIDY BOWL CLEANER” should be applied to the areas of the cylinder bore where transfer of aluminum has occurred. After the acidic solution has removed the transferred aluminum, thoroughly flush the cylinder bore to remove any remaining acid. Cylinder walls may now be honed to remove any glaze and to aid in the seating of new piston rings.

HONING PROCEDURE

a. When cylinders are to be honed, follow the hone manufacturer’s recommendations for use of the hone and cleaning and lubrication during honing.

b. For best results, a continuous flow of honing oil should be pumped into the work area. If pumping oil is not practical, use an oil can. Apply oil generously and frequently on both stones and work area.

⚠ CAUTION

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

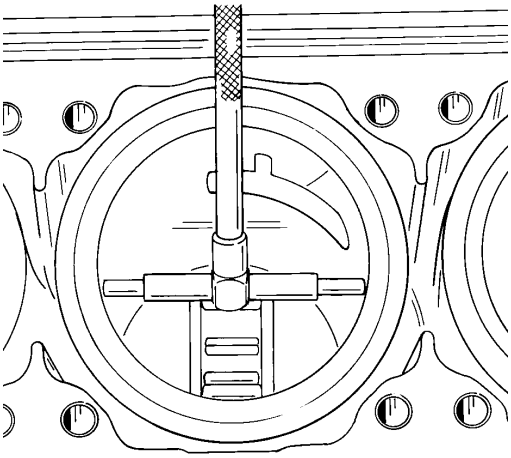
c. Start stroking at smallest diameter. Maintain firm stone pressure against cylinder wall to assure fast stock removal and accurate results.

d. Localize stroking in the smallest diameter until drill speed is constant throughout length of bore. Expand stones, as necessary, to compensate for stock removal and stone wear. Stroke at a rate of 30 complete cycles per minute to produce best cross-hatch pattern. Use honing oil generously.

e. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. A good cleaning is essential. If any of the abrasive material is allowed to remain in the cylinder bore, it will cause rapid wear of new piston rings and cylinder bore in addition to bearings. After cleaning, bores should be swabbed several times with engine oil and a clean cloth, then wiped with a clean, dry cloth. Cylinders **SHOULD NOT** be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

2. Hone all cylinder walls **just enough** to de-glaze walls.

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



51846

135/150 Models

Models	Cylinder Block Finish Hone
Standard Piston Bore	3.501 in. (88.93mm)
.015 in. (0.381mm) Oversize Piston Bore	3.516 in. (89.31mm)

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

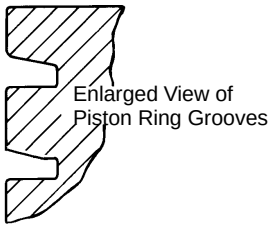
Keystone (tapered) ring grooves

⚠ 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 (135/150 Models)



MEASURING PISTON ROUNDNESS

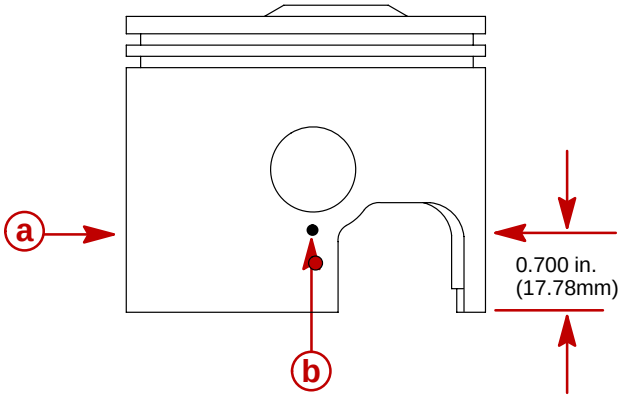
Piston has a barrel profile shape and is not a true diameter.

Standard 135/150 Models - 153 cu. in. (2508 cc)

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

Piston	Dimension “A”
Standard Piston	3.4925 in. ± 0.0005 in.
0.015 in. Oversize Piston	3.5075 in. ± 0.0005 in.

2. Using a micrometer, measure dimension “B” at location shown. Dimension “B” should be within 0.008 in. of dimension “A.”



a - Dimension “A” at RIGHT Angle (90°) to Piston Pin
b - Dimension “B” (in line with Piston Pin)

Cylinder Heads and Exhaust Divider Plate

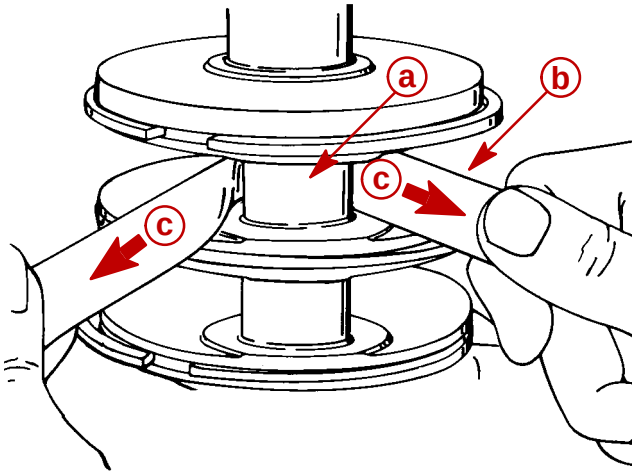
1. Inspect internal surface of cylinder heads for possible damage (as a result of piston or foreign material striking cylinder heads).

IMPORTANT: Cylinder head warpage should not exceed 0.004 in. (0.1 mm) over the ENTIRE length of the cylinder head. If measured warpage, as determined on a surface block, exceeds 0.004 in. (0.1 mm) or a discontinuity of up to 0.004 in. (0.1 mm) exists in a narrow portion of the cylinder head's surface length, then the cylinder head may be re-surfaced up to 0.010 in. (0.25 mm).

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

Crankshaft

1. Inspect crankshaft to drive shaft splines for wear. (Replace crankshaft, if necessary.)
2. Check crankshaft for straightness. Maximum runout is 0.006 in. (0.152 mm). (Replace as necessary.)
3. Inspect crankshaft oil seal surfaces. Sealing surfaces must not be grooved, pitted or scratched. (Replace as necessary.)
4. Check all crankshaft bearing surfaces for rust, water marks, chatter marks, uneven wear and/or overheating. (Refer to Connecting Rods.)
5. If necessary, clean crankshaft surfaces with crocus cloth.



51847

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

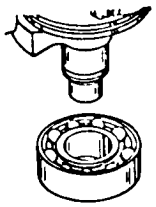
⚠ WARNING

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

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

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



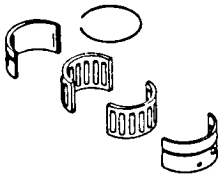
Lower Ball Bearing

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

⚠ CAUTION

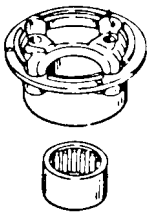
DO NOT intermix halves of upper and lower crankshaft center main roller bearings. Replace bearings in pairs only.

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



Center Main Roller Bearing

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

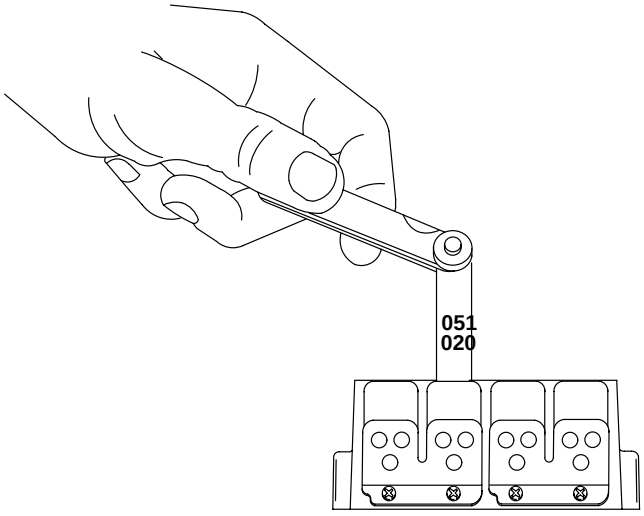


Upper Roller Bearing

Reed Block Assembly

IMPORTANT: 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 may cause leakage. Replace parts as necessary.
2. Inspect reed block neoprene surface for wear, cuts or abrasions. Replace reed blocks as required.
3. Check for chipped and broken reeds.



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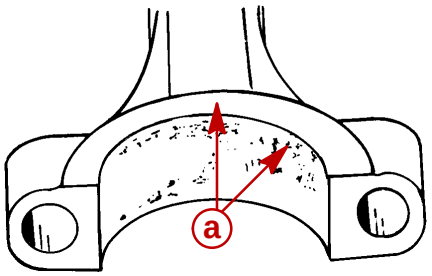
Allowable reed opening is 0.020 in. (0.51 mm) or less. Replace reeds if either reed is standing open more than 0.020 in. (0.51 mm).

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

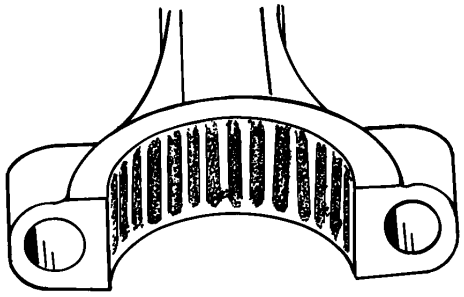
1. Check connecting rods for alignment by placing rods on a surface plate. If light can be seen under any portion of machined surfaces, if rod has a slight wobble on plate, or if a 0.002 in. (0.051 mm) feeler gauge can be inserted between any machined surface and surface plate, rod is bent and must be 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 surfaces.



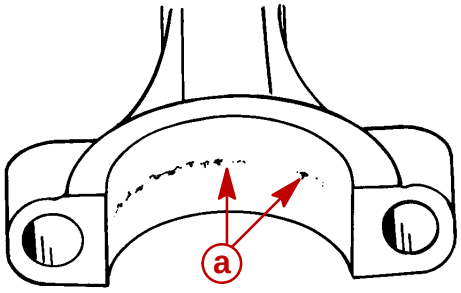
51853

a - Pitting

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


51853

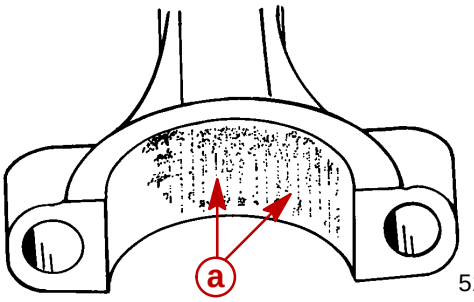
5. **Spalling:** Spalling is the loss of bearing surface, and it resembles flaking or chipping. Spalling will be most evident on the thrust portion of the connecting rod in line with the I-beam. General bearing surface deterioration could be caused by or accelerated by improper lubrication.



51853

a - Spalling

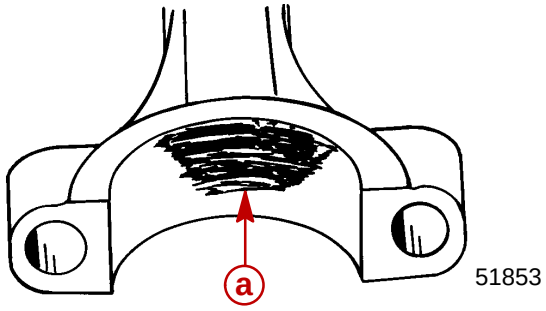
6. **Chatter Marks:** Chatter marks are the result of a combination of low speed - low load - cold water temperature operation, aggravated by inadequate lubrication and/or improper fuel. Under these conditions, the crankshaft journal is hammered by the connecting rod. As ignition occurs in the cylinder, the piston pushes the connecting rod with tremendous force, and this force is transferred to the connecting rod journal. Since there is little or no load on the crankshaft, it bounces away from the connecting rod. The crankshaft then remains immobile for a split second until the piston travel causes the connecting rod to catch up to the waiting crankshaft journal, then hammers it. The repetition of this action causes a rough bearing surfaces 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 rods.



51853

a - Chatter Marks Between Arrows

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



a - Uneven Wear Between Arrows

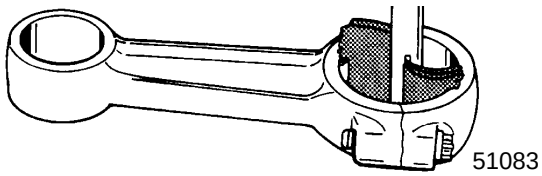
8. If necessary, clean connecting rod bearing surfaces, as follows:
   a. Be sure that etched marks on connecting rod (crankshaft end) are perfectly aligned with etched marks on connecting rod cap. Tighten connecting rod cap attaching bolts securely.

⚠ CAUTION

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

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

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

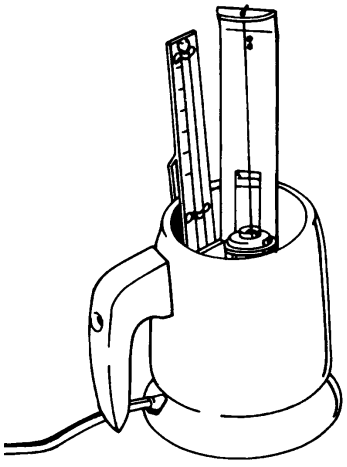


   c. **Clean PISTON PIN END of connecting rod**, using same method as in Step “b”, preceding, but using 320 grit carborundum cloth instead of crocus cloth.
   d. Thoroughly wash connecting rods to remove abrasive grit. Recheck bearing surfaces of connecting rods. Replace any connecting rods that cannot be properly cleaned up. Lubricate bearing surfaces of connecting rods (which will be re-used) with light oil to prevent rust.

Thermostats

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 130° F (56° C)] before testing the other thermostat.*



51087

Powerhead Reassembly and Installation

General

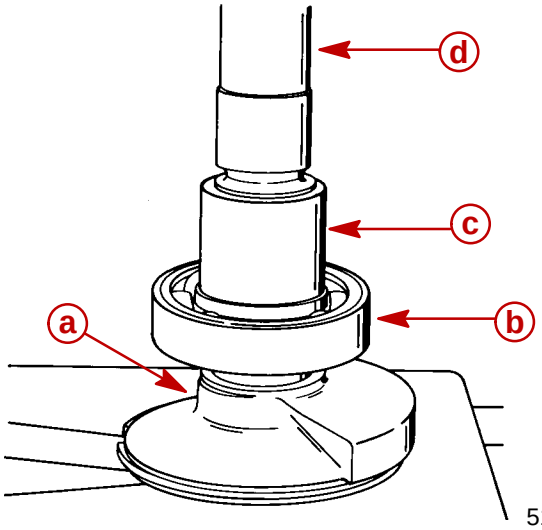
Before proceeding with powerhead reassembly, be sure that all parts to be re-used have been carefully cleaned and thoroughly inspected, as outlined in Cleaning and Inspection, preceding. Parts, which have not been properly cleaned (or which are questionable), can severely damage an otherwise perfectly 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 Premium Outboard Oil whenever light oil is specified. Part numbers of lubricants, sealers and locking compounds and tools are listed in **Section 1A - Mercury/Quicksilver Lubricants and Sealants**.

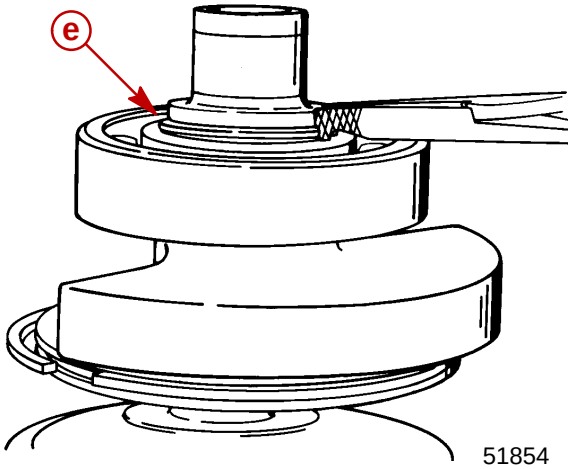
A torque wrench is **essential** for correct reassembly of powerhead. DO NOT attempt to reassemble powerhead without using a torque wrench. Attaching bolts for covers, housings and cylinder heads MUST BE torqued by tightening bolts in 3 progressive steps (following specified torque sequence) until specified 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 counterweight.
2. Reinstall retaining ring using a suitable pair of Snap Ring Pliers.



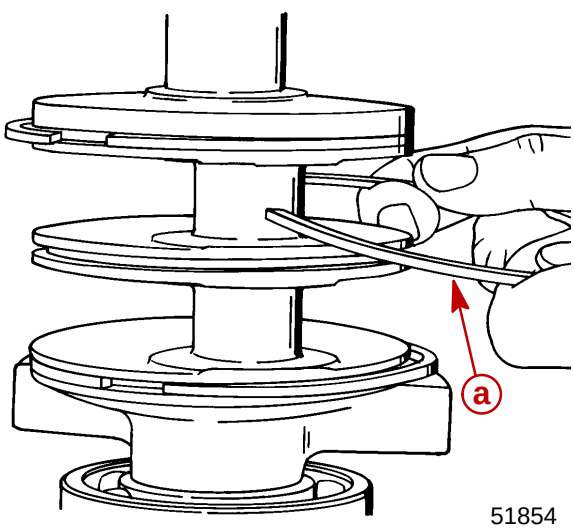
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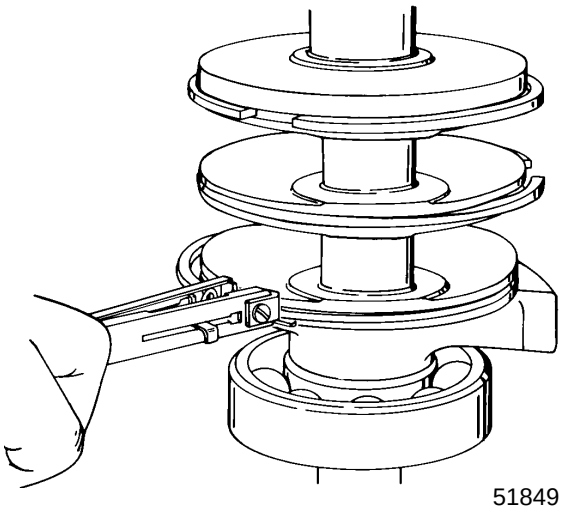
51854

a - Crankshaft
b - Crankshaft Ball Bearing
c - Suitable Mandrel
d - Press
e - Retaining Ring

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



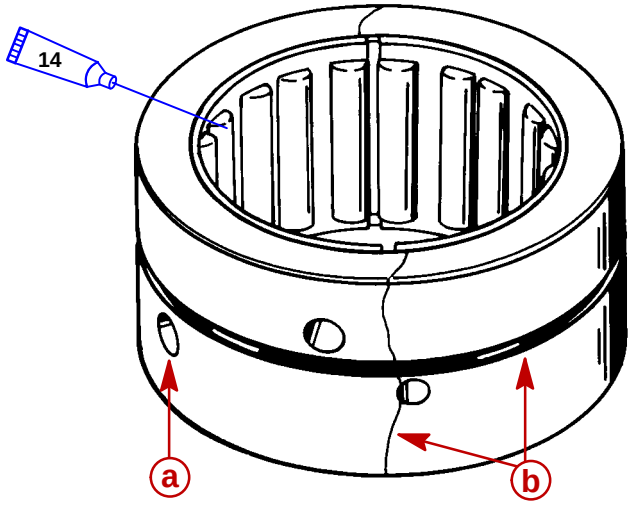
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51849

a - Crankshaft Sealing Rings

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

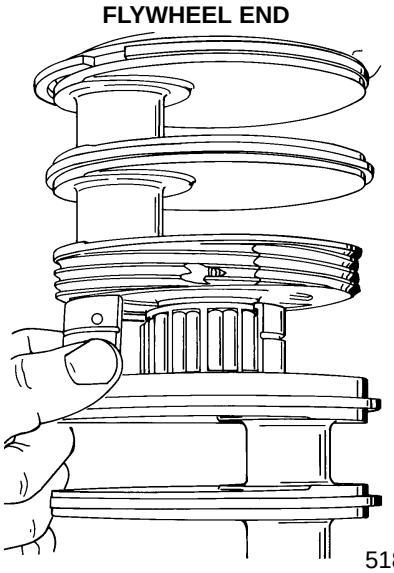


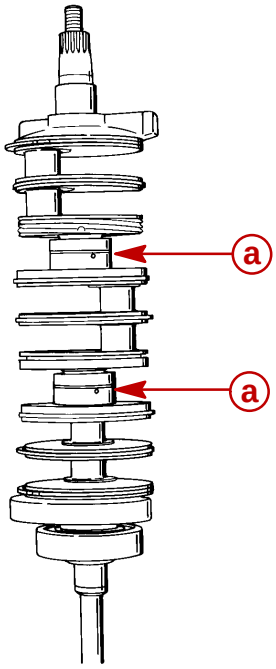
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14 2 Cycle Outboard Oil

a - Install so LARGER of the 3 holes is toward DRIVE SHAFT end of crankshaft
b - Verify retaining ring bridges the separating lines of the bearing race

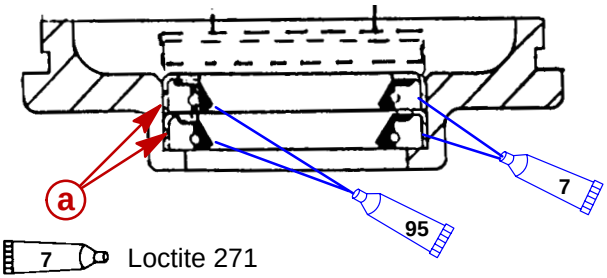
6. Place center main crankshaft roller bearings on upper and lower main bearing journals as shown.
7. Install center main bearing races as shown.
8. Secure center main bearing races together with retaining rings. Make sure retaining ring bridges the separating lines of the bearing race.

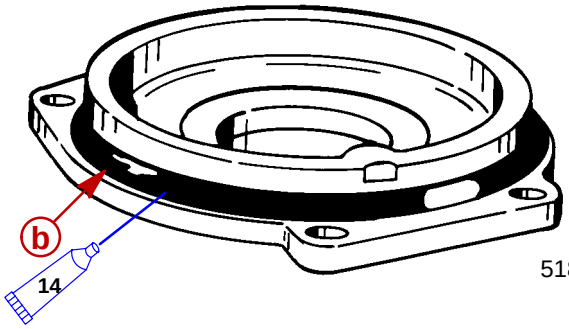




a - Center Main Bearing Races

9. Install oil seals into lower end cap as follows:
   a. Apply a thin bead of Loctite 271 to outer diameter on 2 lower end cap oil seals.
   b. Using driver head (91-55919) press one oil seal (lip facing down) into lower end cap until firmly seated. Remove any excess Loctite.
   c. Press second oil seal (lip facing down) until firmly seated on first oil seal. Remove any excess Loctite.
   d. Lubricate oil seal lips with 2-4-C with Teflon.
   e. Lubricate O-ring seal surface on end cap with 2 cycle oil. Install O-ring over lower end cap.

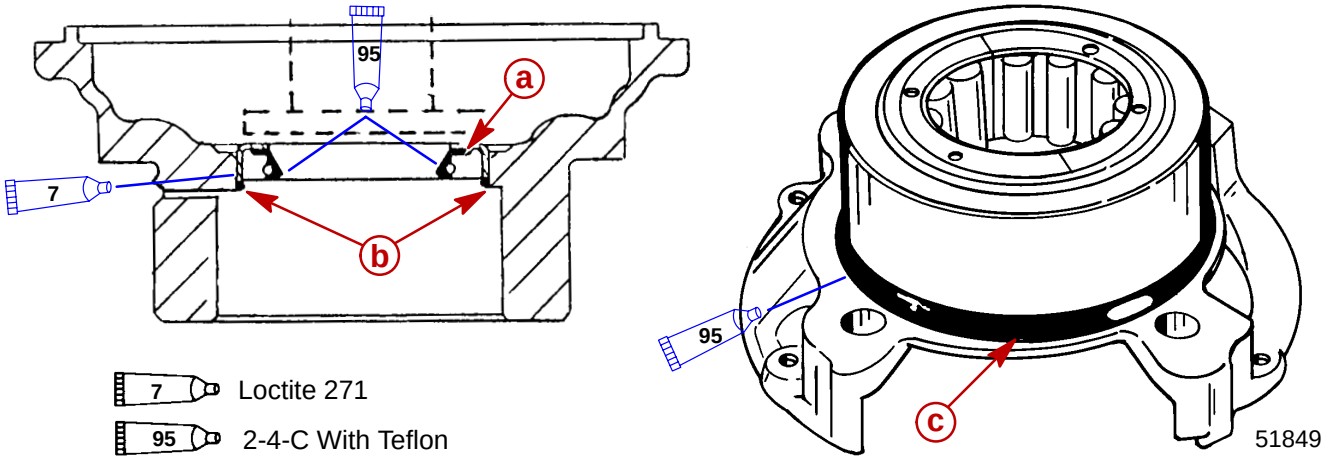




7 Loctite 271
14 2 Cycle Outboard Oil
95 2-4-C With Teflon

a - Oil Seal
b - O-ring

10. Install oil seal into upper end cap as follows:
    a. Apply a thin bead of Loctite 271 to outer diameter of upper end cap oil seal.
    b. Use a suitable mandrel, press oil seal into upper end cap (lip facing down) until bottomed out on lip of end cap. Remove any excess Loctite.
    c. Lubricate oil seal lip with 2-4-C with Teflon.
    d. Lubricate O-ring seal surface on end cap with 2-4-C with Teflon. Install O-ring on end cap.



7 Loctite 271
95 2-4-C With Teflon

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

Crankshaft Installation

SPECIAL INFORMATION

Installing A New Crankshaft Assembly Into Cylinder Block

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

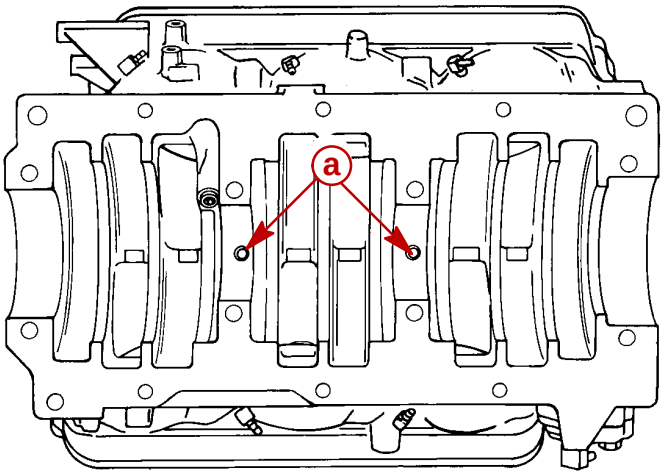
Before installing crankshaft, remove any burrs that may exist on groove edges.

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

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

Install crankshaft as follows:

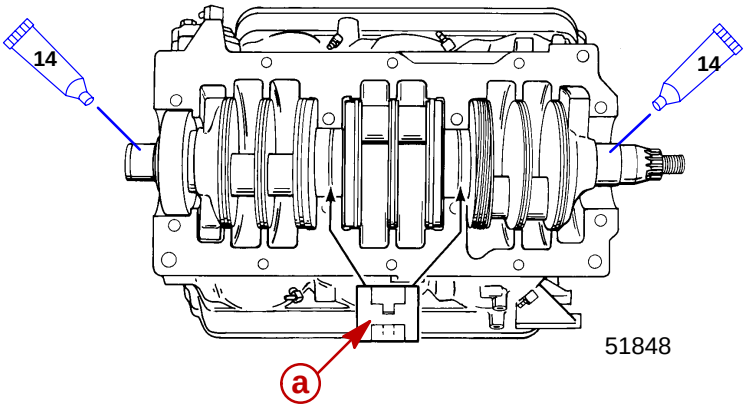
1. Lubricate crankshaft sealing rings with light oil.
2. Check cylinder block to be sure that dowel pins are in place.



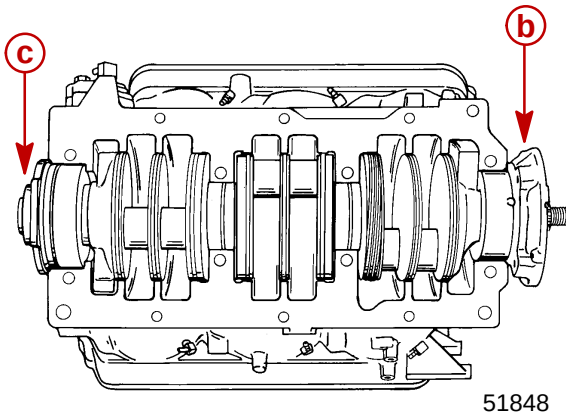
51848

a - Dowel Pins

3. Position all crankshaft seal ring gaps straight up.
4. Align hole in each center main bearing race with dowel pin.
5. Gently push crankshaft down into position making sure that the dowel pins are lined up with the holes in center main bearings and crankshaft seal rings are in place.
6. Lubricate crankshaft ends (oil seal areas) with light oil, then install upper and lower end caps (a and b). Secure end caps to cylinder block with attaching bolts. DO NOT tighten end cap bolts at this time.



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14 2 Cycle Outboard Oil

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

Piston and Connecting Rod Reassembly

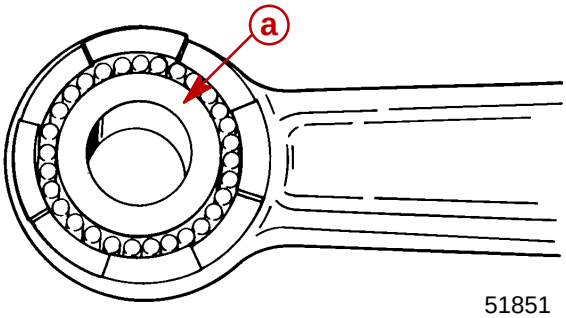
1. Place needle bearings on a clean piece of paper and lubricate with 2-4-C with Teflon.

NOTE: *There are 29 needle bearings per piston.*

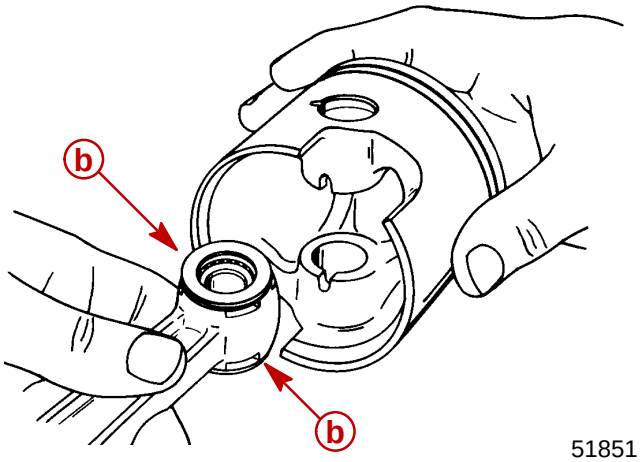
2. Place sleeve which is part of piston pin tool assembly into connecting rod and install needle bearings around sleeve as shown.
3. Place locating washers on connecting rod.

IMPORTANT: Position connecting rod part number facing towards flywheel.

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



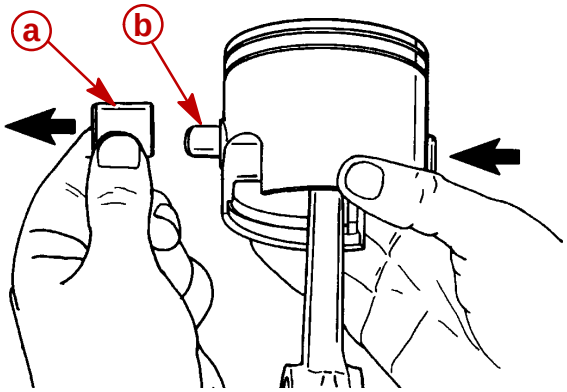
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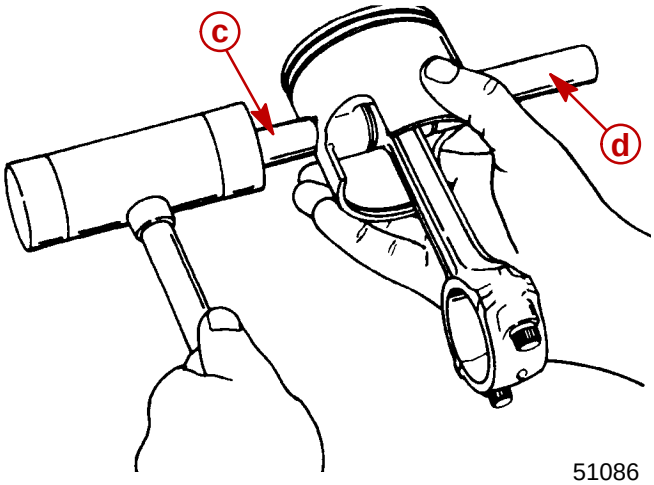
51851

a - Sleeve (Part of Tool Assembly 91-74607A1)
b - Locating Washers

4. Insert piston pin tool and push sleeve out of piston. Keep piston pin tool in piston.
5. Use a mallet and tap piston pin into piston and push piston pin tool out.



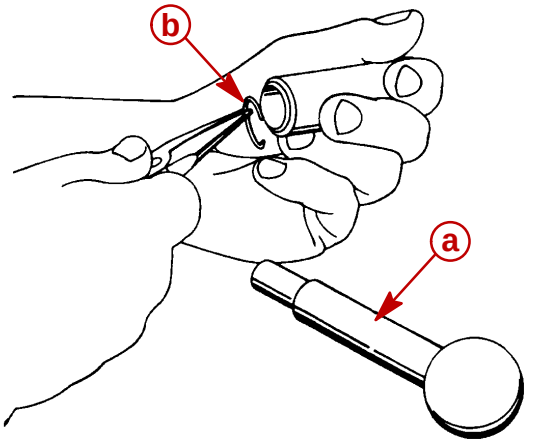
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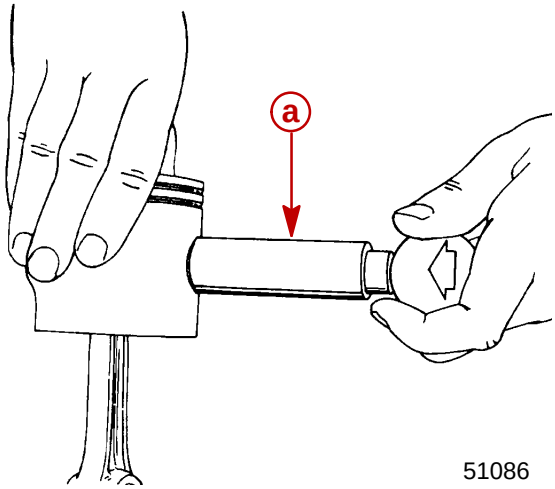
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a - Piston Pin Tool (91-74607A1)
b - Sleeve
c - Piston Pin
d - Piston Pin Tool

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



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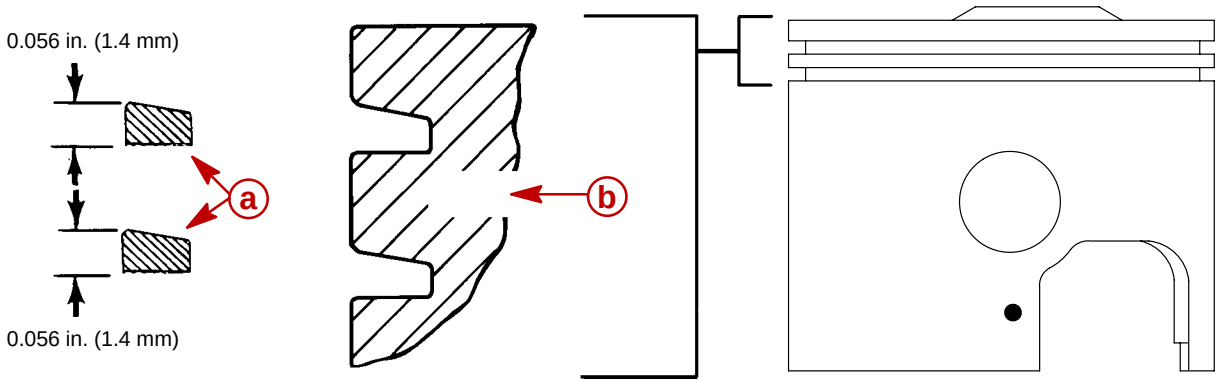
a - Lockring Installation Tool (91-77109A1)
b - Lockring

Piston and Piston Ring Combinations

153 CU. IN. (2508 cc) MODELS

All 153 cu. in. (2508 cc) models have two half keystone (half tapered) rings.

Pistons with two half keystone (half tapered) rings.

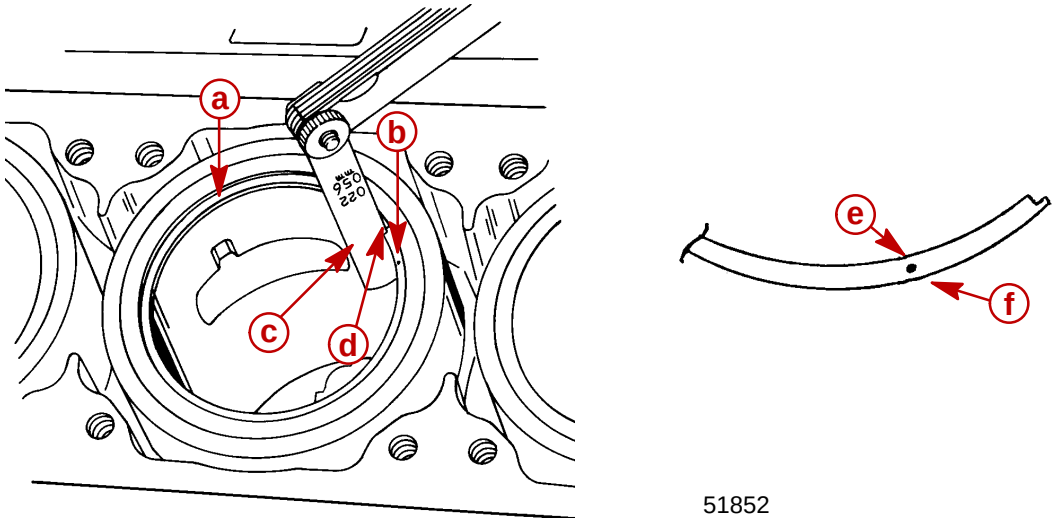


a - Half Keystone (half tapered) Piston Ring
b - Enlarged View of Piston Ring Grooves

Piston Installation

1. Before installing new piston rings, check gap between ring ends by placing each ring in its respective cylinder, then pushing ring about 1/2 in. (12.7 mm) into cylinder using piston to assure proper position.
2. Check end gap of each new piston ring with a feeler gauge. End gap must be within 0.010 in. to 0.018 in. (0.25 mm to 0.45 mm). If end gap is greater, check other piston rings in cylinder bore, until rings (within tolerance) are found.

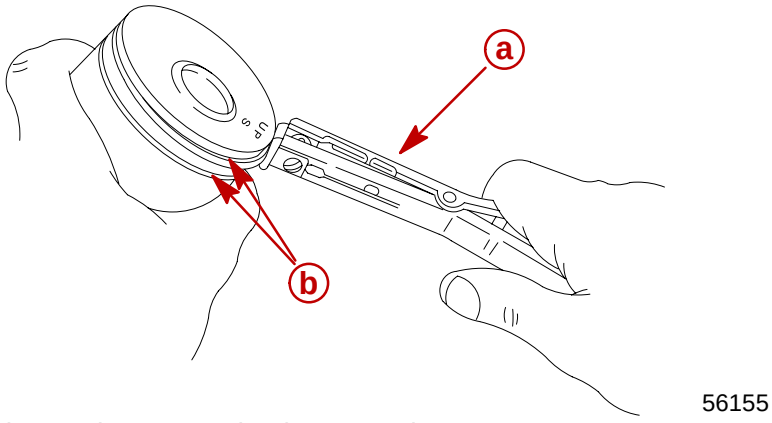
IMPORTANT: Piston ring side with dot or letter must be facing up.



51852

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

3. Use Piston Ring Expander 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 Premium Outboard Oil.



56155

a - Piston Ring Expander (91-24697)
b - Dot Side “Up” on Piston Ring

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

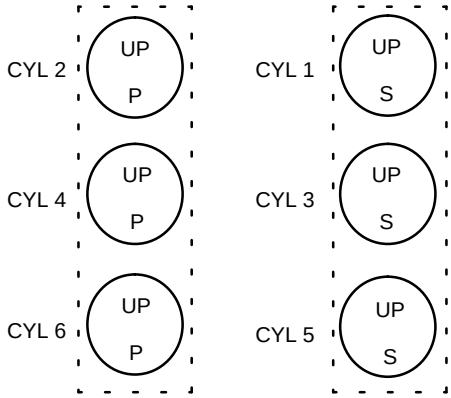
IMPORTANT: Piston must be correctly installed and positioned as shown.

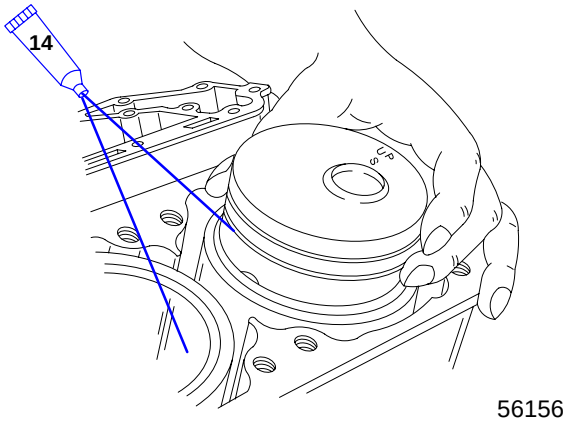
Pistons marked with the word “UP” and with the letter “P” or “S” on top of piston.

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

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

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





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14 2 Cycle Outboard Oil

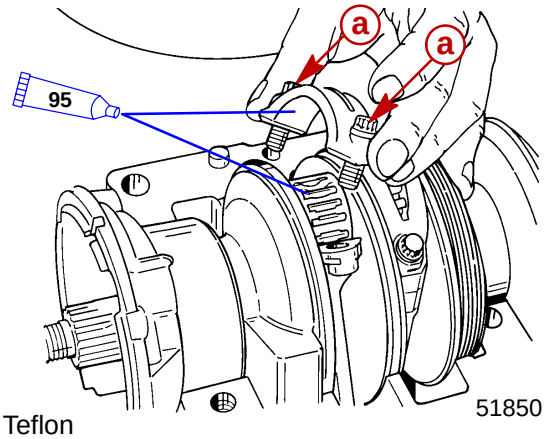
10. Apply 2-4-C with Teflon to bearing surface of connecting rod and install bearing assembly, as shown.
11. Place connecting rod cap on connecting rod. Apply light oil to threads and face of connecting rod bolts. Thread connecting rod bolts finger-tight while checking for correct alignment of the rod cap as shown.

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

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

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

12. Tighten connecting rod bolts (using a 5/16 in. - 12 point socket). First torque to 15 lb. in. (1.7 Nm) then 30 lb. ft. (41 Nm). Turn each bolt an additional 90° after 2nd torque is attained. Recheck alignment between rod cap and rod as shown.



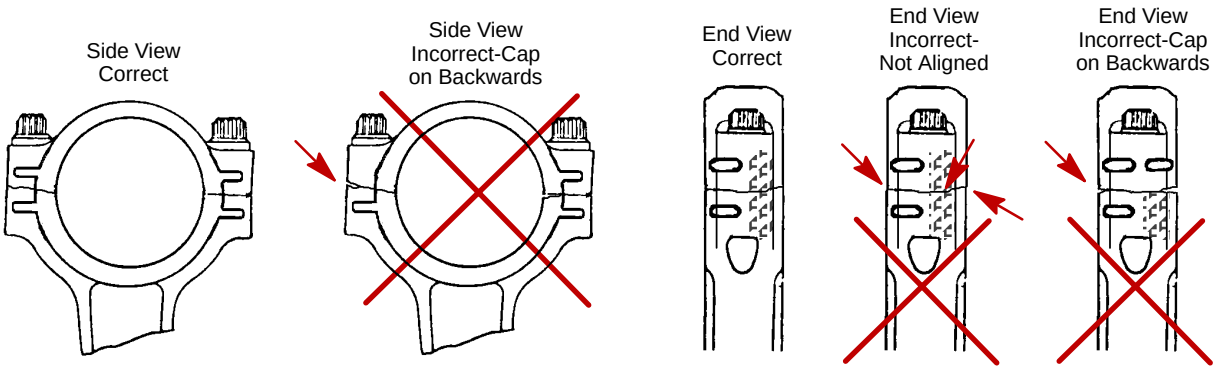
95 2-4-C With Teflon

a - Connecting Rod Screws

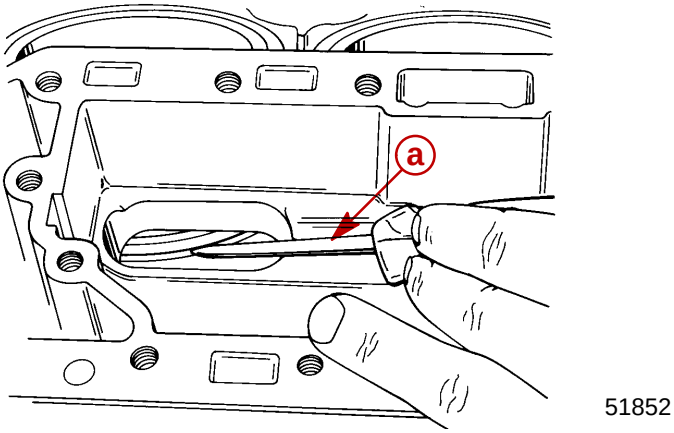
13. Rotate crankshaft several times (using powerhead stand) to assure free operation (no binds and catching).

CONNECTING ROD CAP ALIGNMENT

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



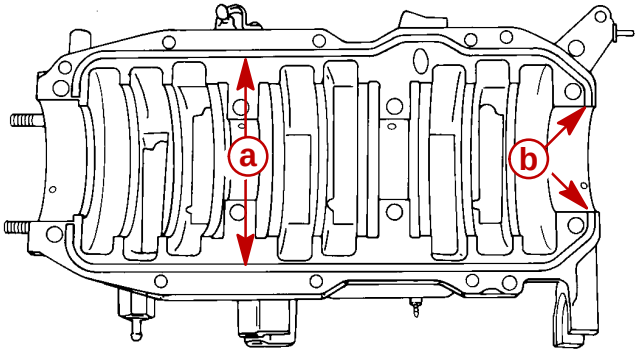
14. Verify that no piston rings were broken during installation by pressing in on each piston ring through exhaust port using a screwdriver. If no spring tension exists (ring fails to return to position), it's likely ring is broken and must be replaced.



a - Screwdriver

Crankcase Cover Installation

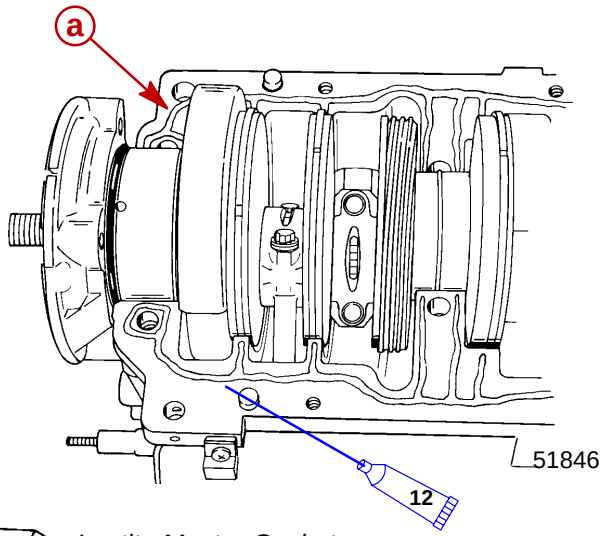
1. Thoroughly remove all oil from mating surfaces of crankcase cover and cylinder block with Loctite 7649 Primer N.
2. Install gasket strips into grooves in crankcase cover. Trim end of each gasket strip flush with edge of cover as shown.



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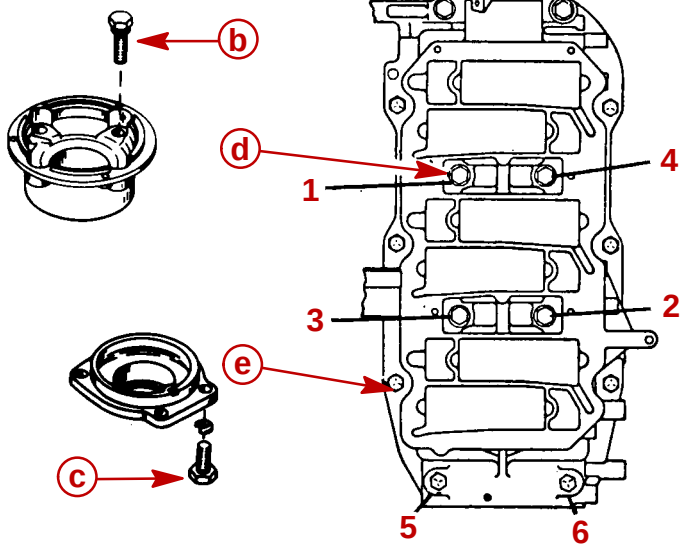
a - Gasket Strips
b - Edge of Cover

3. Apply a thin, even coat of Loctite Master Gasket on mating surfaces of crankcase cover and cylinder block.
4. Place crankcase cover in position on cylinder block. Turn the 8 center main bolts in a little at a time, (following torque sequence) compressing crankshaft seal rings until crankshaft cover has been drawn down to cylinder block. Tighten eight bolts evenly in three progressive steps (following torque sequence).
5. Install remaining crankcase cover flange bolts.
6. Tighten end cap bolts to specified torque.



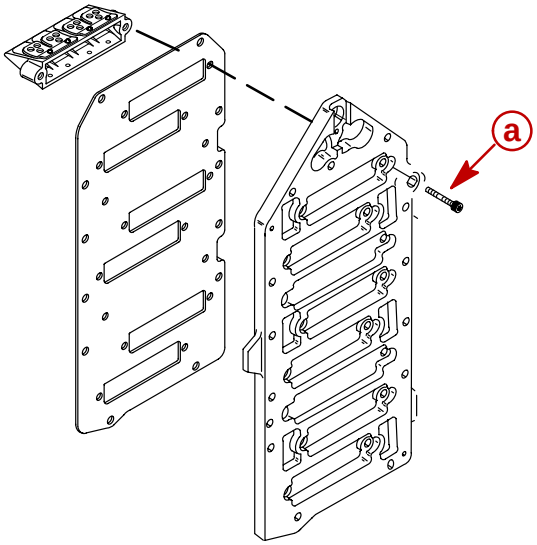
51846

12 Loctite Master Gasket



a - Loctite Master Gasket
b - Upper End Cap Bolts – Torque to 150 lb. in. (17 Nm)
c - Lower End Cap Bolts – Torque to 80 lb. in. (9 Nm)
d - Add Light Oil to Threads and Bolt Face – 8 Bolts (3/8 in.-18) Torque to 38 lb. ft. (51.5 Nm)
e - Bolts (5/16 in.-18) Torque to 180 lb. in. (20 Nm)

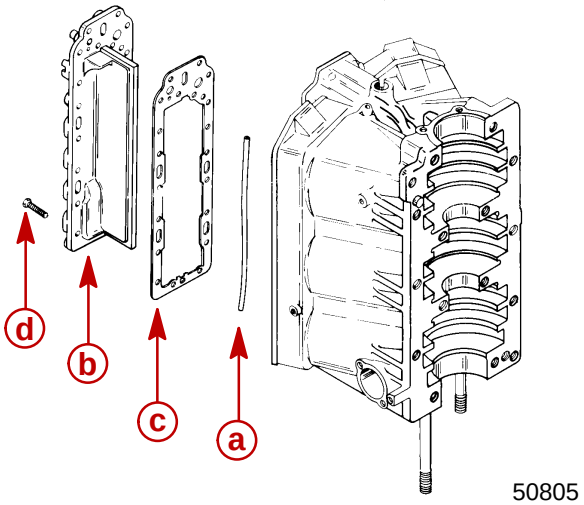
Assembly of Reed Blocks to Intake Manifold



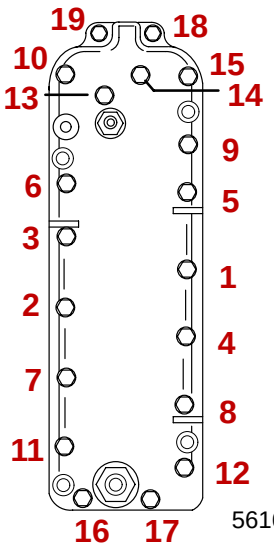
a - Torque to 105 lb. in. (12 Nm)

Assembly of Exhaust Divider Plate to Block

1. Place exhaust divider seal into slot in block.
2. Install exhaust divider plate with gasket.
3. Clean bolt threads with Loctite 7649 Primer N.
4. Apply Loctite 271 to bolt threads and torque bolts to 16.5 lb. ft. (22 Nm).
5. Torque exhaust divider plate bolts in following sequence. Torque bolts to 16.5 lb. ft. (22 Nm). Add Loctite 271 to threads.



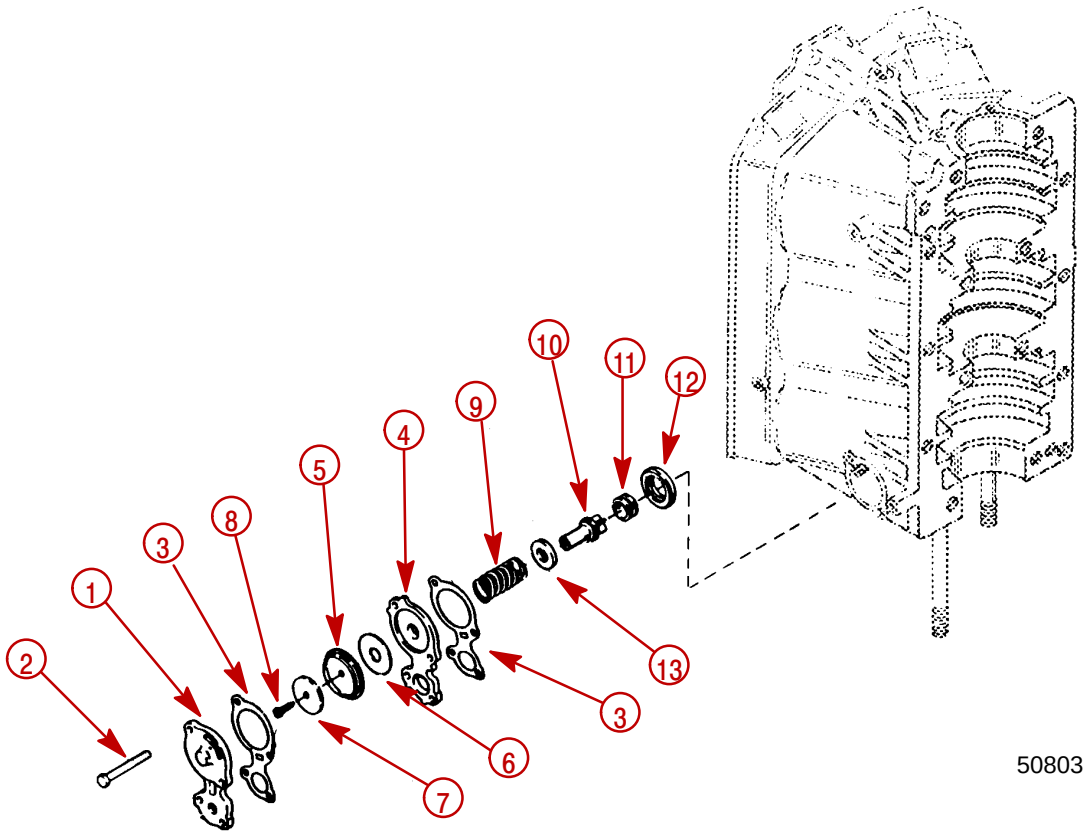
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a - Divider Seal
b - Exhaust Divider Plate
c - Gasket
d - Attaching Bolt

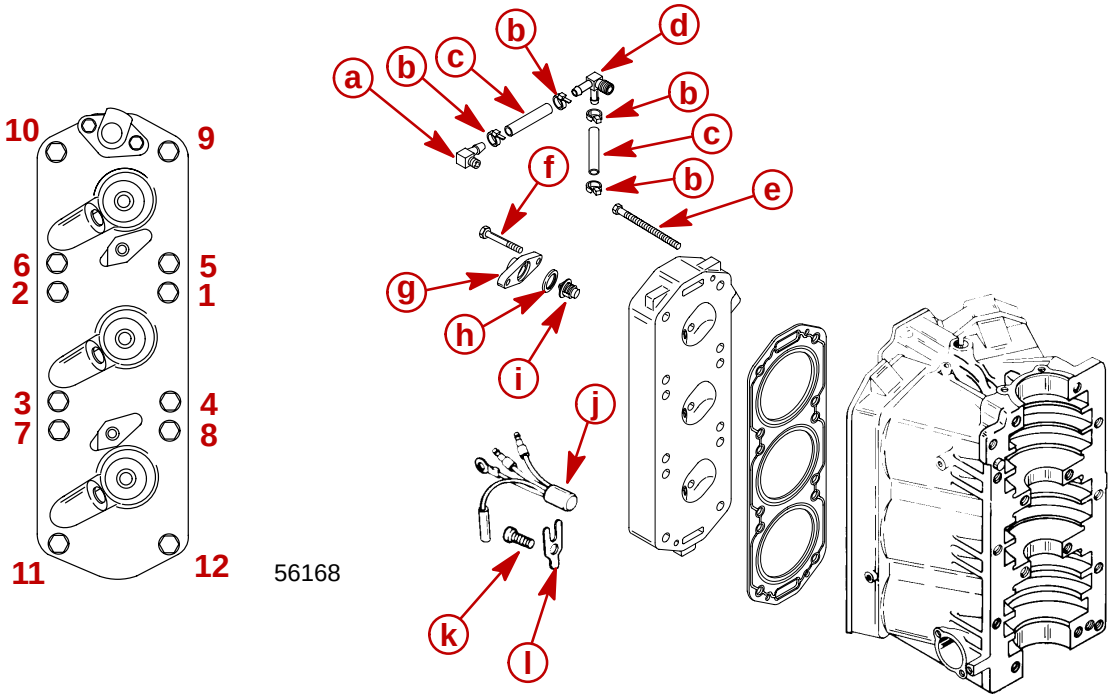
6. If removed, install water pressure relief valve components as shown. Torque bolts to specifications.



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

CYLINDER HEAD INSTALLATION

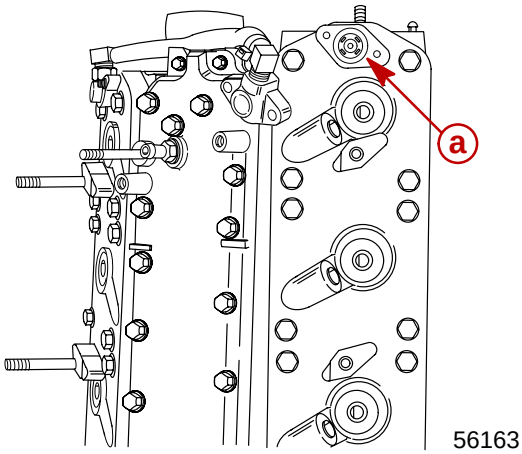
1. Install each cylinder head to engine block with thermostat pocket UP. Apply light oil to cylinder head bolt threads and torque bolts to 30 lb. ft. (41 Nm) then turn an additional 90°.
2. Install thermostat assembly into each cylinder head.
3. Install overheat temperature sensor into STARBOARD cylinder head below #1 spark plug.



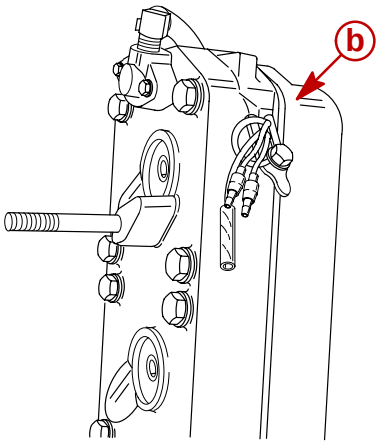
a - Elbow (Starboard)
b - Sta-strap
c - Hose
d - Elbow (Port)
e - Bolt [Torque to 30 lb. ft. (41 Nm) and then turn 90°]
f - Bolt [Torque to 17 lb. ft. (23.0 Nm)]
g - Cover
h - Gasket
i - Thermostat (143°)
j - Temperature Sensor (Starboard)
k - Bolt [Torque to 17 lb. ft. (23.0 Nm)]
l - Retainer

NOTE: *The temperature sender provides continuous temperature information to the ECU while the engine is running. Should temperature reach approximately 221° F (104.5° C), the ECU will activate a warning horn and warning light.*

4. Thermostat and temperature sensor installed.



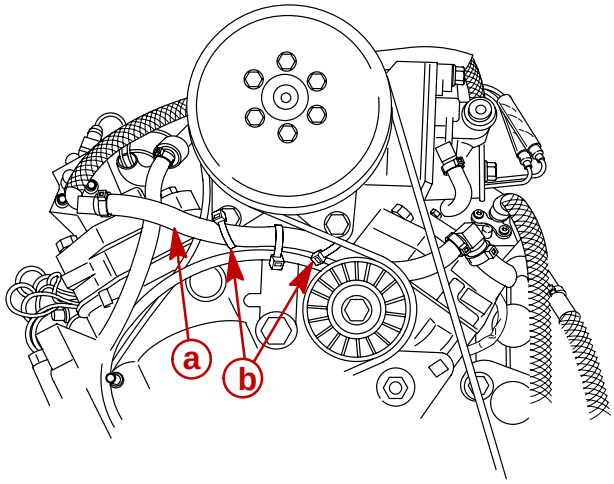
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56164

a - Thermostat (143° F 61.7° C)
b - Overheat Temperature Sensor

NOTE: *When installing thermostat hoses, secure starboard to port thermostat hose with sta-straps to prevent hose from being cut by alternator/air compressor belt.*



a - Port Thermostat Hose
b - Sta-Straps

Reinstalling Engine Components

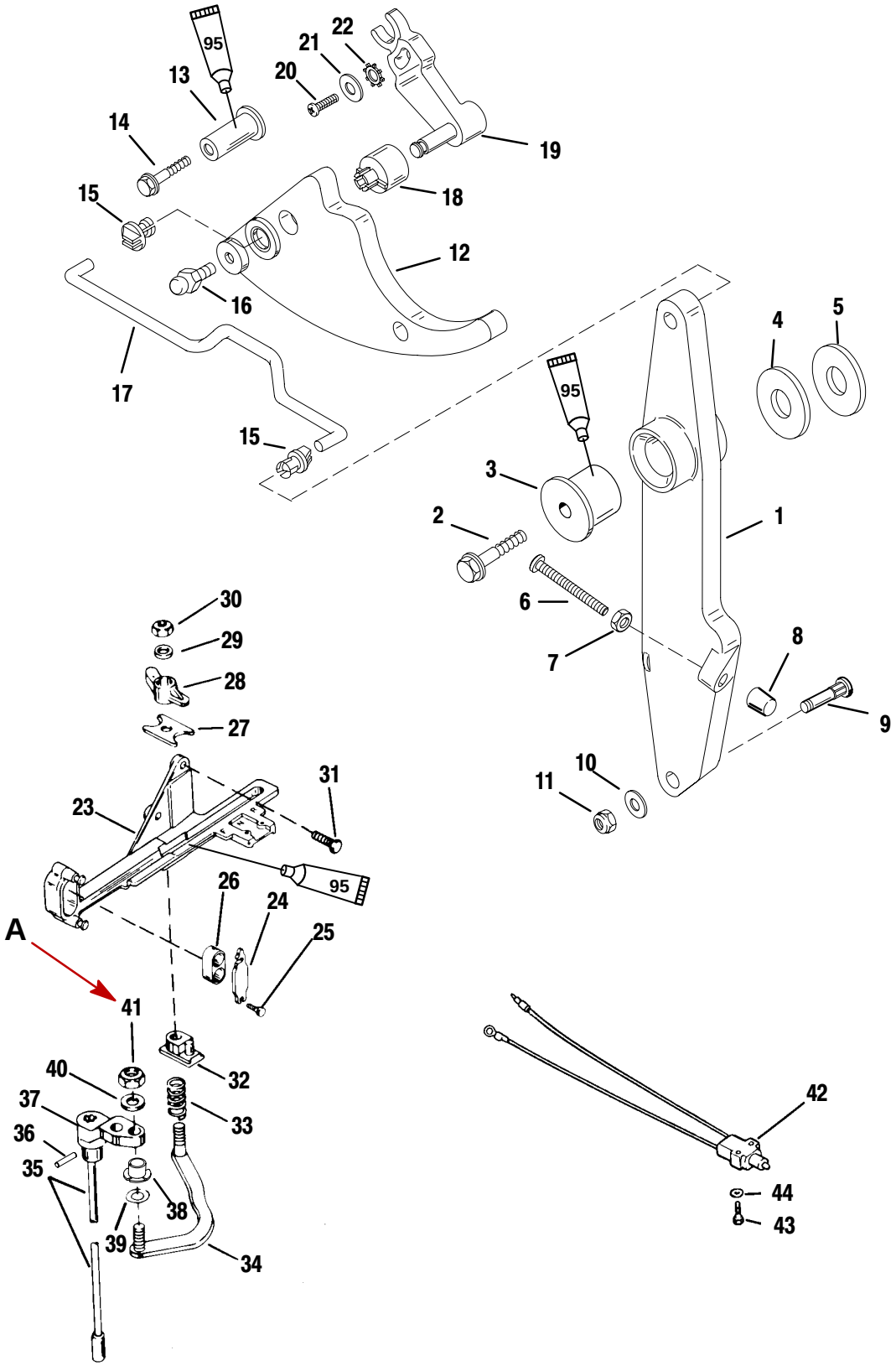
Reinstall the following engine components:

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

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

Section 7
Shift Cable Latch Assembly
Control Cable Anchor Bracket

Throttle Lever and Shift Shaft



95 2-4-C with Teflon

A – Tighten and back off 1/2 turn

Throttle Lever and Shift Shaft

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	THROTTLE CONTROL LEVER			
2	1	SCREW (.375-16 x 1-3/4 IN.)		20	27
3	1	BUSHING			
4	1	WASHER			
5	1	WASHER			
6	1	SCREW (2-1/8 IN.)			
7	1	NUT (1/4-20)			
8	1	CAP			
9	1	INSERT			
10	1	WASHER			
11	1	NUT	50		5.5
12	1	CAM			
13	1	BUSHING			
14	1	SCREW (M6 x 40)	45		5
15	2	SWIVEL BUSHING			
16	1	THREADED BALL	Drive Tight		
17	1	LINK			
18	1	ROLLER			
19	1	THROTTLE ROLLER			
20	1	SCREW (M5 x 16)	Drive Tight		
21	1	WASHER			
22	1	STAR WASHER			
23	1	ANCHOR BRACKET			
24	1	LATCH			
25	2	SCREW-Drive			
26	1	CAP			
27	1	WEAR PLATE			
28	1	LATCH			
29	1	WASHER			
30	1	NUT			
31	3	SCREW (.312-18 x 7/8)	160		18
32	1	GUIDE BLOCK			
33	1	SPRING			
34	1	LINK ROD ASSEMBLY			
35	1	SHIFT SHAFT ASSEMBLY			
36	1	ROLL PIN			
37	1	SHIFT SHAFT LEVER–UPPER			
38	1	BUSHING			
39	1	WAVE WASHER			
40	1	WASHER			
41	1	NUT			
42	1	IDLE STABILIZING SHIFT KIT			
43	2	SCREW (6-32)	15		1.7
44	2	WASHER			

Powerhead Installation on Driveshaft Housing

1. Install Lifting Eye into flywheel.

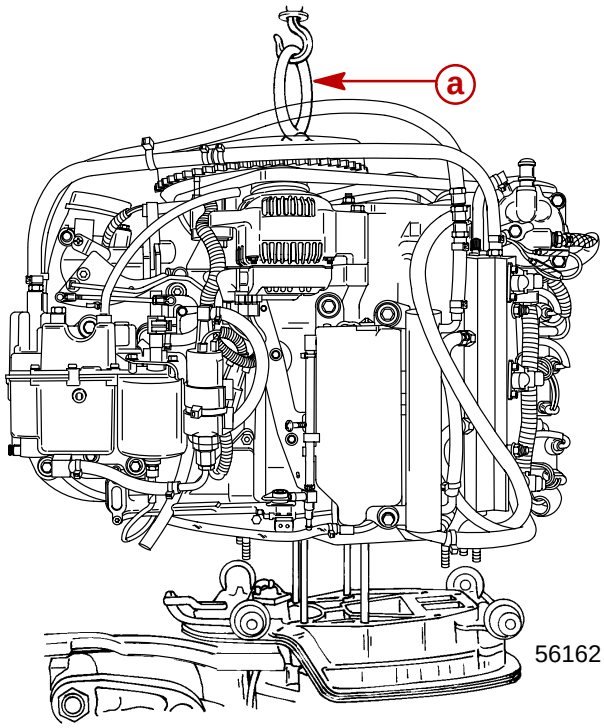
⚠ WARNING

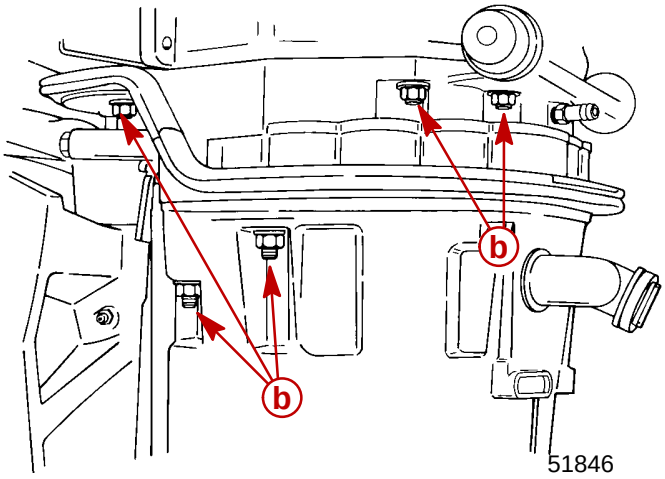
BE SURE that Lifting Eye is threaded into flywheel as far as possible BEFORE lifting powerhead.

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

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

4. Apply a small amount of 2-4-C with Teflon onto driveshaft splines.
5. Use hoist to lower powerhead onto driveshaft housing. It may be necessary to turn flywheel (aligning crankshaft splines with driveshaft splines) so that powerhead will be fully installed.
6. Install 10 flat washers and10 locknuts which secure powerhead to exhaust extension plate/driveshaft housing. Torque locknuts in 3 progressive steps until secured.
7. Disconnect hoist from Lifting Eye and remove Lifting Eye from flywheel.
8. Reinstall plastic cap into center of flywheel cover.

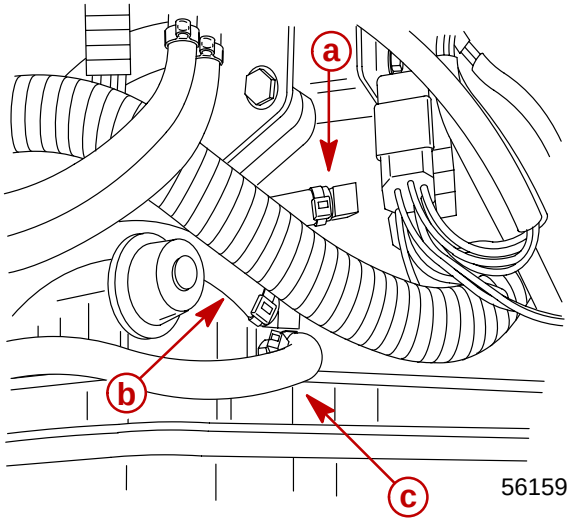




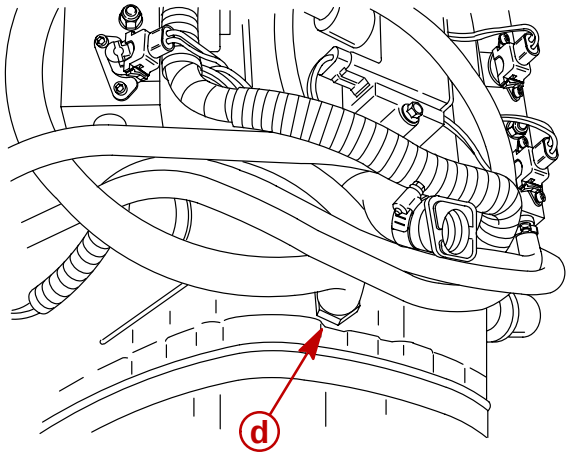
a - Lifting Eye (91-90455)
b - Powerhead Attaching Locknuts and Flat Washers – Torque Nuts to 23 lb. ft. (27 Nm)

9. Install fuel cooler inlet and outlet water hoses to fittings on exhaust adaptor plate and poppet valve cover. Install air hose from port fuel rail to fitting on exhaust adaptor plate. Secure all hoses with sta-straps.

10. Install thermostat cover hose to exhaust adaptor plate.



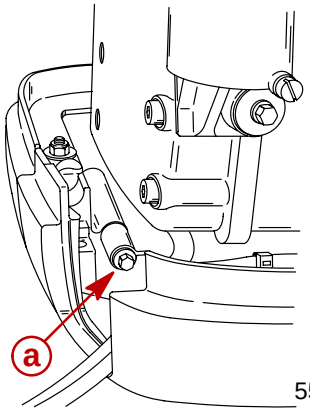
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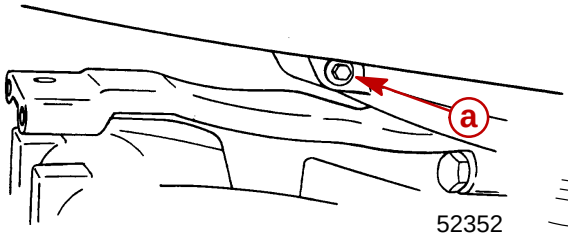
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a - Fuel Cooler Outlet Water Hose
b - Fuel Cooler Inlet Water Hose
c - Air Hose
d - Thermostat Cover Hose

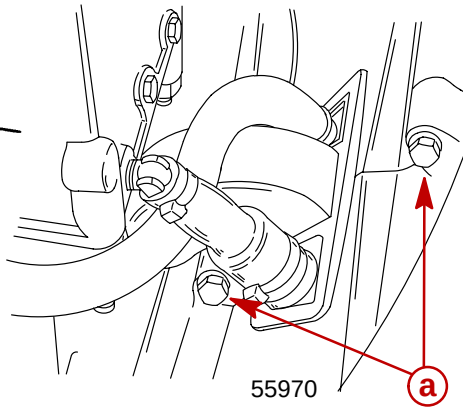
11. Install 4 bolts securing bottom cowl halves and install bottom cowling.



55932



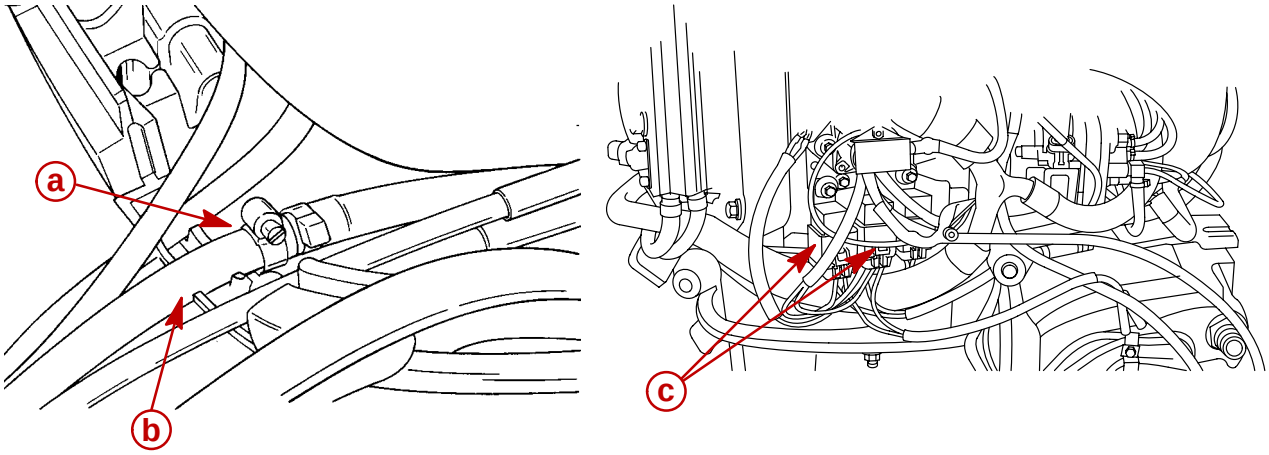
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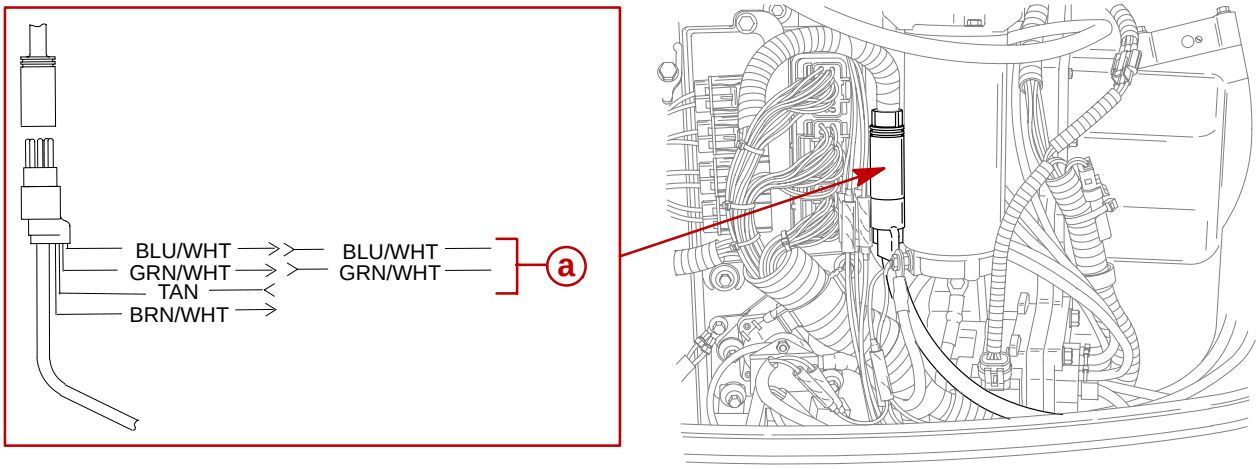
a - Bolt

12. Reconnect input fuel line.
13. Reconnect BLUE and GREEN trim harness leads to trim solenoids.



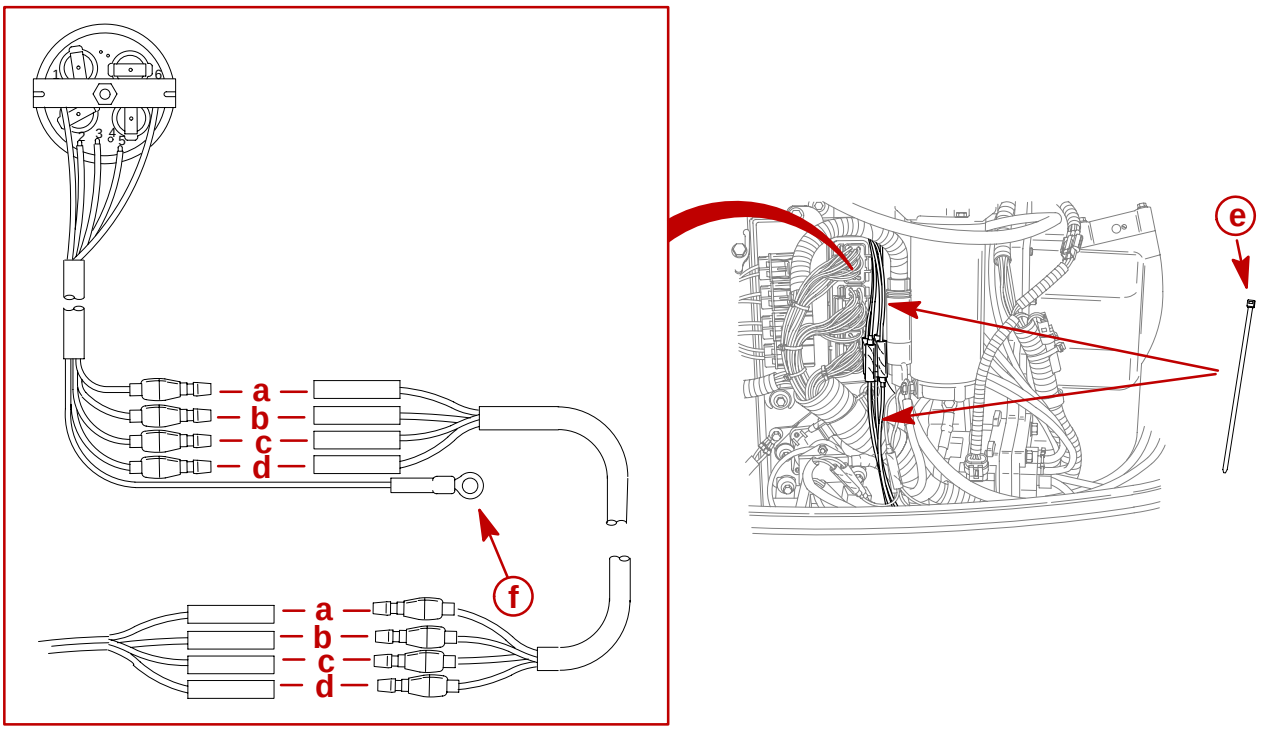
a - Hose Clamp
b - Fuel Line
c - Trim Solenoids

14. Reconnect remote control harness to powerhead harness connector and wires as shown.



a - Power Trim Connections

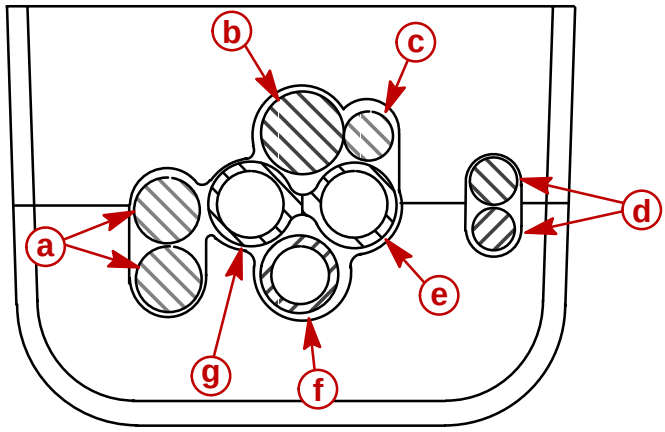
15. Reconnect warning gauge harness.



a - TAN/BLACK
b - TAN/WHITE
c - PINK/LT. BLUE to PINK/LT. BLUE
d - ORANGE
e - Sta-Straps
f - Connect PURPLE to 12 Volt Source or Adjacent Gauge

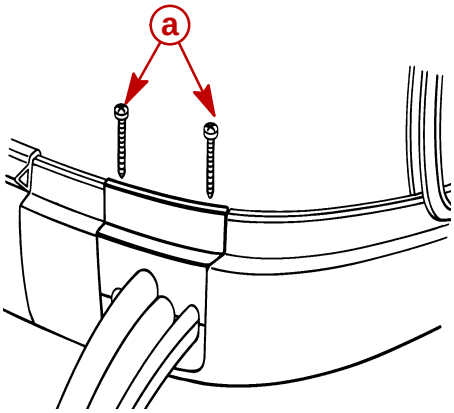
IMPORTANT: Sufficient slack must exist in engine wiring harness, battery cables, fuel hose, and oil hoses routed between clamp and engine attachment point, to relieve stress and prevent hoses from being kinked or pinched.

1. Place the clamp over the wiring, hoses, and control cables as shown.



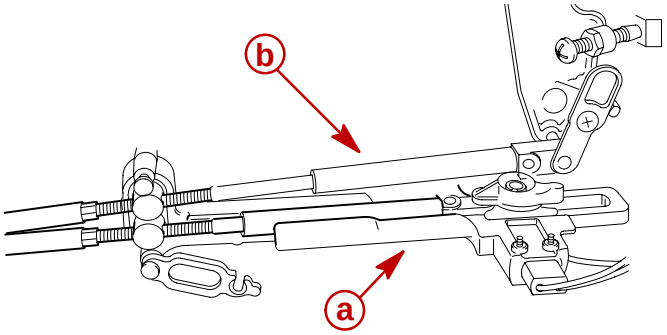
a - Battery Cables
b - Remote Wiring Harness
c - Warning Gauge Wiring Harness
d - Control Cables
e - Oil Hose with Blue Stripe
f - Fuel Hose
g - Oil Hose

2. Fasten clamp together with two screws.



a - Screws

3. Slide outboard shift lever into neutral position.
4. Install shift cable and secure with spring, nylon wear plate, flat washer, latch and lock nut. Install throttle cable and secure with latch.



a - Shift Cable
b - Throttle Cable

Refer to **Section 2 - Timing/ Synchronizing/Adjusting** for engine set-up procedures.

Break-In Procedure

⚠ CAUTION

Severe damage to the engine can result by not complying with the Engine Break-in Procedure.

FUEL REQUIREMENTS

DO NOT use pre-mixed gas and oil in this engine. Use straight gasoline during engine break-in and after engine break-in. The ECM is programmed to signal the oil pump to provide additional oil (50:1 ratio) during the first 120 minutes of operation. The ECM will monitor this period through its own internal clock. At the end of this period, the ECM will signal the oil pump to go to a standard ratio of 300 – 400:1 @ idle and 60:1 @ W.O.T.

ENGINE BREAK-IN PROCEDURE (ALL MODELS)

For proper procedures on initiating Engine Break-In sequence, refer to **Section 3C**.

Vary the throttle setting during the first hour of operation. Avoid remaining at a constant speed for more than two minutes and avoid sustained wide open throttle.

POWERHEAD

Section 4B - Cooling

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4 B

Specifications

Water Pressure

Idle	1.0 – 3.0 PSI (6.8 – 20.5 kPa)
Poppet Valve Opening	4 – 9 PSI (27.4 – 61.6 kPa)
W.O.T.	12.0 PSI (82.1 kPa) Minimum

Thermostat . . . . . 120°F (48.9°C)

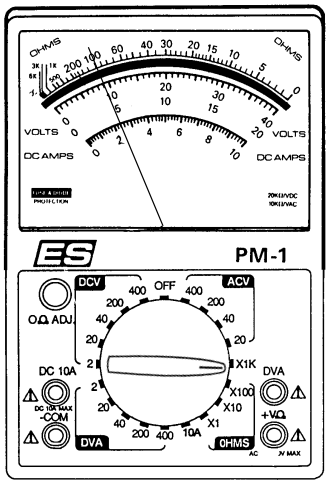
Temperature Sensor

Temperature Sensor Location	
Starboard Cylinder Head Horn Activation Speed Reduction (3000 RPM)	221°F (105°C)
Compressor Horn Activation	221°F (105°C)

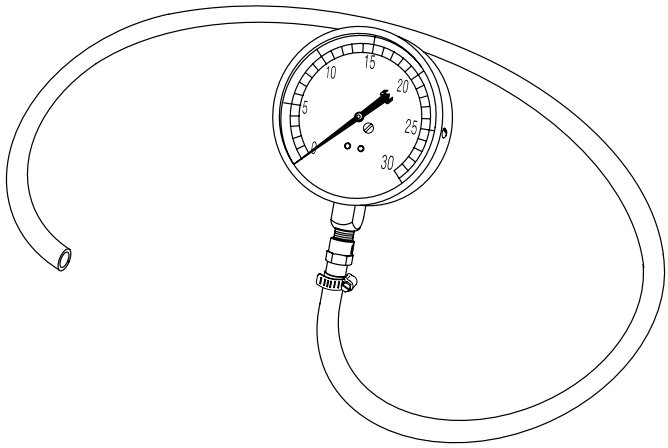
Temperature Sensor(s)	
Between Black and each TAN/BLK wire.	No Continuity
Between each lead and ground	No Continuity

Special Tools

1. Volt/Ohm Meter 91-99750A1

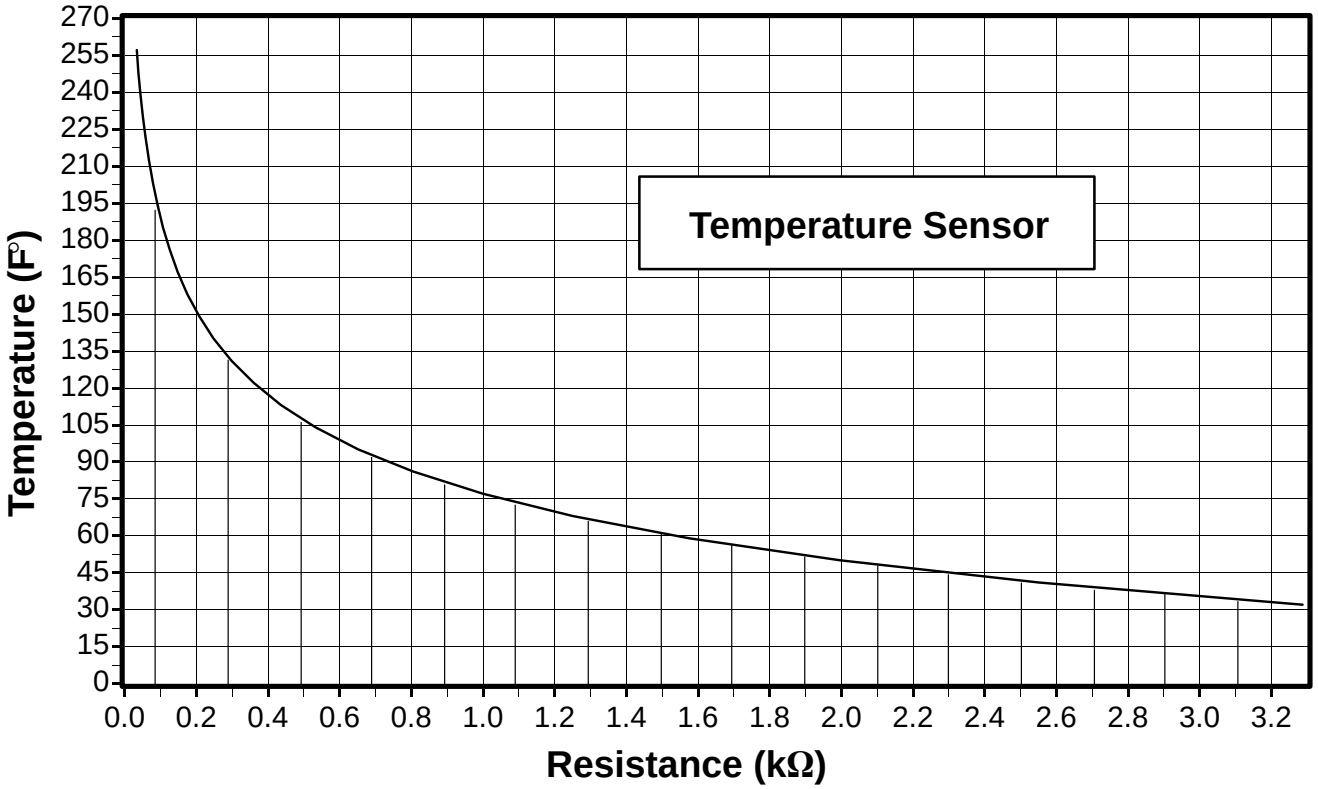


2. Water Pressure Gauge 91-79250A2



56725

Temperature Sensor



Two temperature sensors are used to provide cylinder head temperature information to the ECM. A sensor is mounted in starboard cylinder head and one in the air compressor cylinder head. The ECM uses this information to increase injector pulse width for cold starts and to retard timing in the event of an over-heat condition.

An ohms test of the temperature sensor 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%.

NOTE: *The air compressor temperature sensor and cylinder head temperature sensors are the same part number. The ECM has been programmed to activate a warning circuit at different temperatures depending upon sensor location.*

NOTE: *The Digital Diagnostic Terminal (DDT) can be used to monitor temperature readings from all three temperature sensors.*

2.5 Liter Optimax/DFI Water Flow

Description

Cooling water enters the cooling system through the lower unit water inlets. The pump assembly forces water through the water tube and exhaust adapter plate passages filling the powerhead 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 also exits the top of the exhaust plate through a strainer screen to supply water to the air compressor.

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:

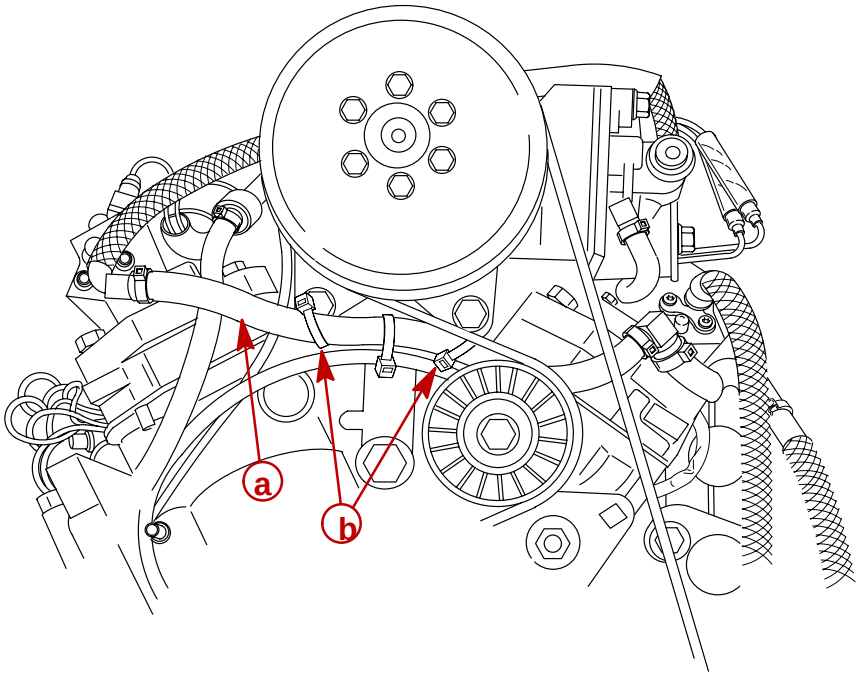
- Helps silence the exhaust
- Prevents air from being drawn into the pump

Water exits the engine in 3 locations:

- Excess water from the wall of water exits around anodes on the gear housing.
- Water that passes through the air compressor 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.

NOTE: *When installing thermostat hoses, secure starboard to port thermostat hose with sta-straps to prevent hose from being cut by alternator/air compressor belt.*

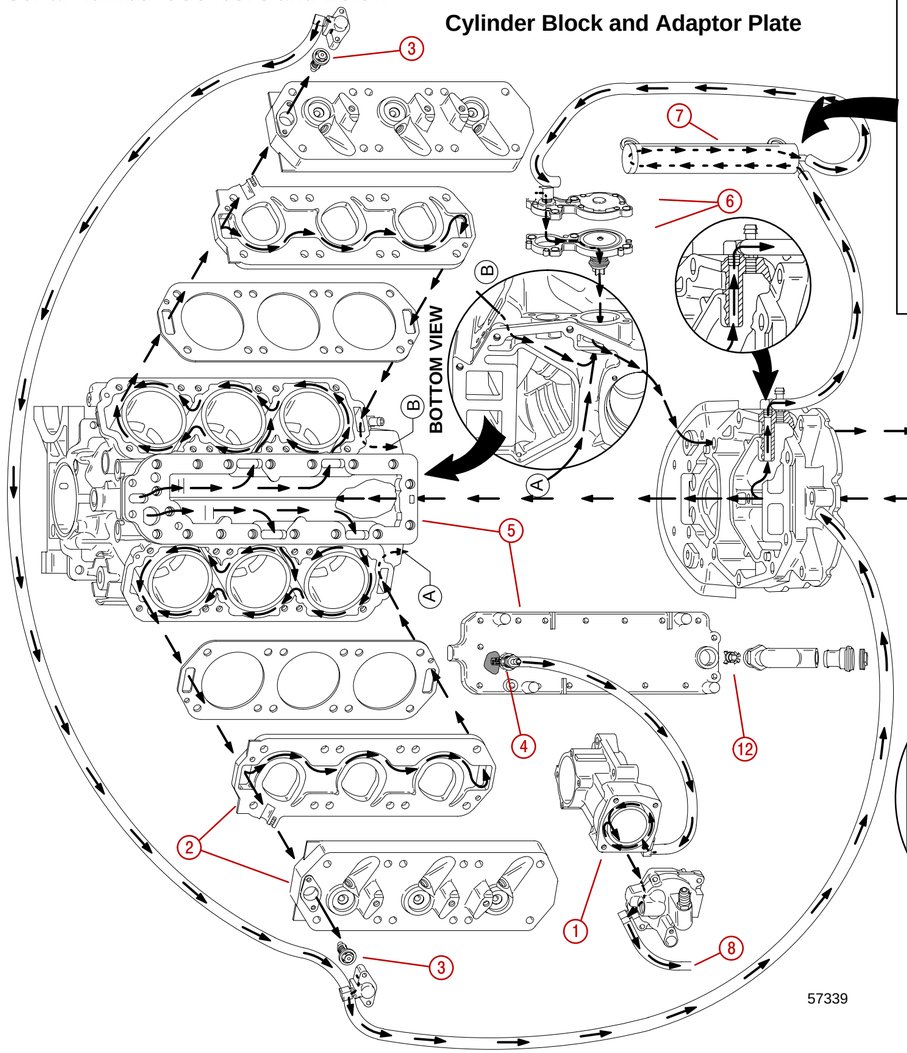


a - Port Thermostat Hose
b - Sta-Straps

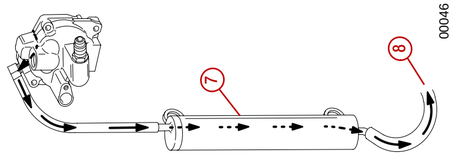
1998/1999 Water Flow Diagram

Serial Number 0G940378 and Below

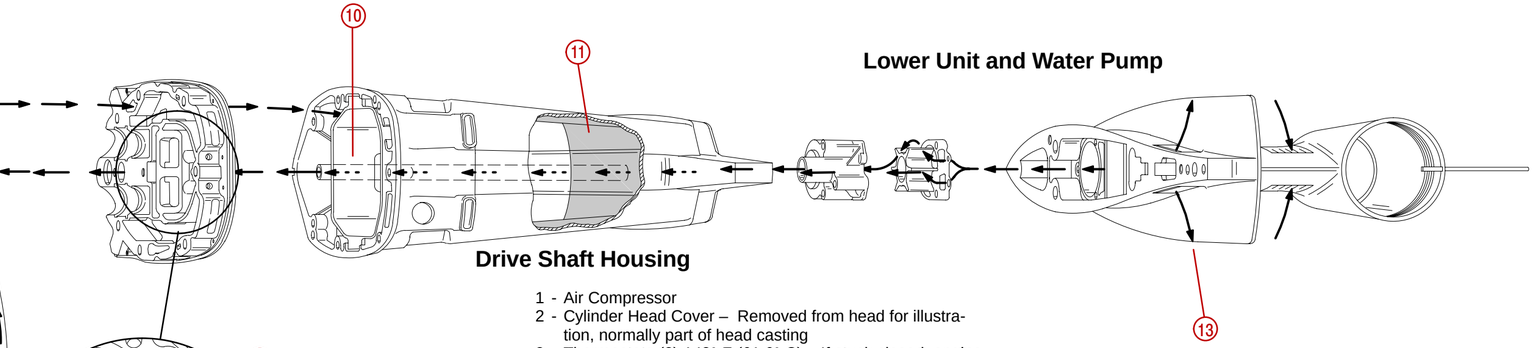
Cylinder Block and Adaptor Plate



Serial Number 0G940379 and Up



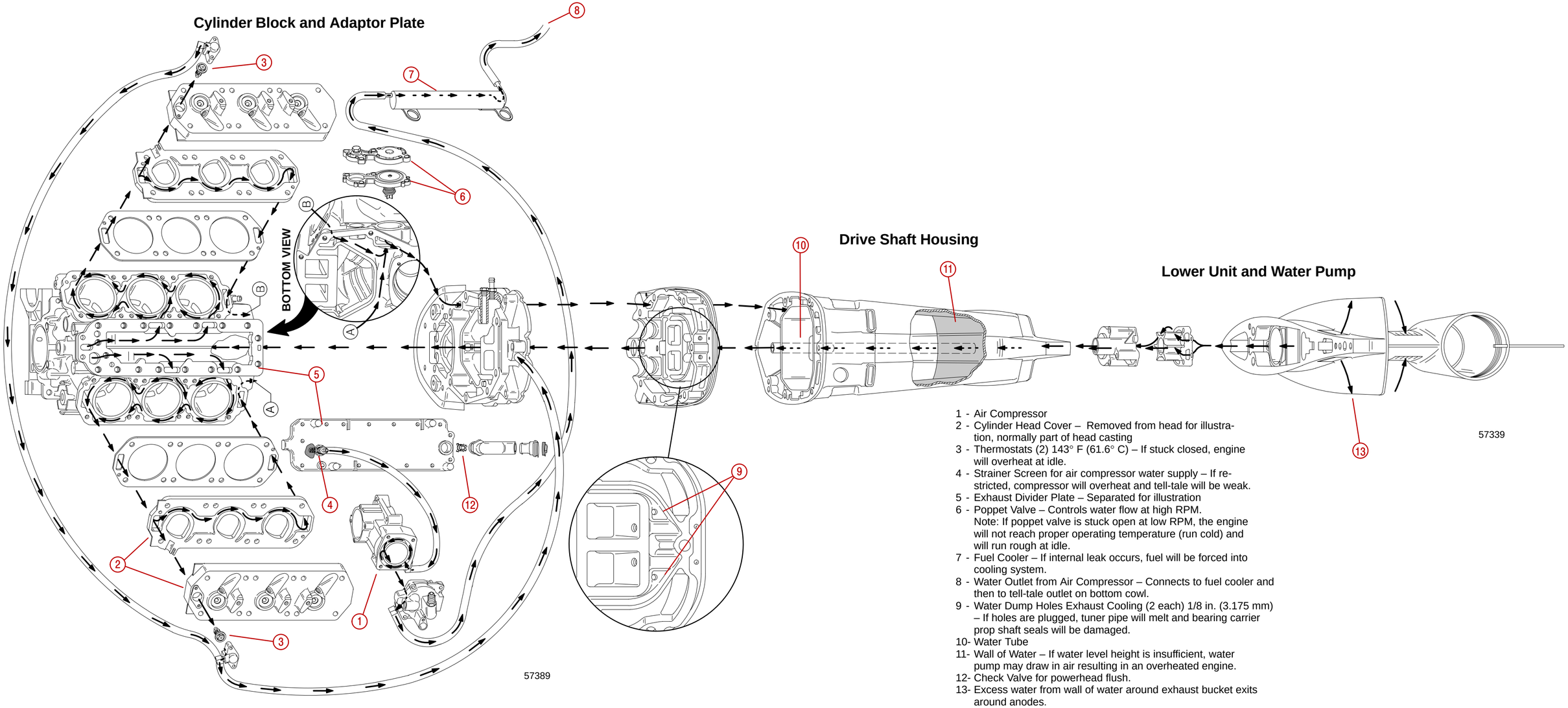
Lower Unit and Water Pump



Drive Shaft Housing

1 - Air Compressor
2 - Cylinder Head Cover – Removed from head for illustration, normally part of head casting
3 - Thermostats (2) 143° F (61.6° C) – If stuck closed, engine will overheat at idle.
4 - Strainer Screen for air compressor water supply – If restricted, compressor will overheat and tell-tale will be weak.
5 - Exhaust Divider Plate – Separated for illustration
6 - Poppet Valve – Controls water flow at high RPM.
Note: If poppet valve is stuck open at low RPM, the engine will not reach proper operating temperature (run cold) and will run rough at idle.
7 - Fuel Cooler – If internal leak occurs, fuel will be forced into cooling system.
8 - Water Outlet from Air Compressor – Connects to tell-tale outlet on bottom cowl.
9 - Water Dump Holes Exhaust Cooling (2 each) 1/8 in. (3.175 mm) – If holes are plugged, tuner pipe will melt and bearing carrier prop shaft seals will be damaged.
10- Water Tube
11- Wall of Water – If water level height is insufficient, water pump may draw in air resulting in an overheated engine.
12- Check Valve for powerhead flush.
13- Excess water from wall of water around exhaust bucket exits around anodes.

1999 1/2 Water Flow Diagram



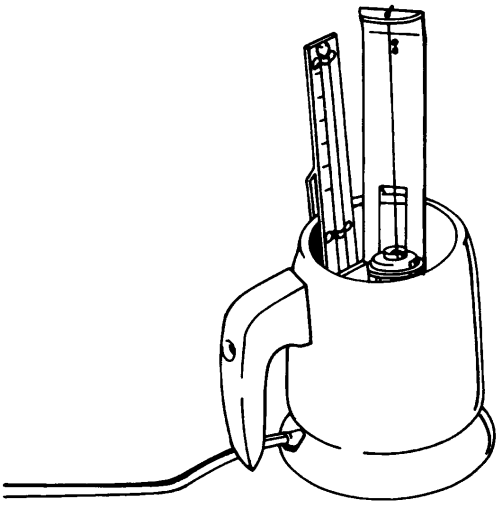
1 - Air Compressor
2 - Cylinder Head Cover – Removed from head for illustration, normally part of head casting
3 - Thermostats (2) 143° F (61.6° C) – If stuck closed, engine will overheat at idle.
4 - Strainer Screen for air compressor water supply – If restricted, compressor will overheat and tell-tale will be weak.
5 - Exhaust Divider Plate – Separated for illustration
6 - Poppet Valve – Controls water flow at high RPM.
Note: If poppet valve is stuck open at low RPM, the engine will not reach proper operating temperature (run cold) and will run rough at idle.
7 - Fuel Cooler – If internal leak occurs, fuel will be forced into cooling system.
8 - Water Outlet from Air Compressor – Connects to fuel cooler and then to tell-tale outlet on bottom cowl.
9 - Water Dump Holes Exhaust Cooling (2 each) 1/8 in. (3.175 mm) – If holes are plugged, tuner pipe will melt and bearing carrier prop shaft seals will be damaged.
10- Water Tube
11- Wall of Water – If water level height is insufficient, water pump may draw in air resulting in an overheated engine.
12- Check Valve for powerhead flush.
13- Excess water from wall of water around exhaust bucket exits around anodes.

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 and insert a thread between valve and thermostat body. Allow valve to close against thread.
   b. Suspend thermostat (from thread) and thermometer inside tester so that neither touches the container. Bottom of thermometer must be even with bottom of thermostat to obtain correct temperature of thermostat opening.
   c. Fill thermostat tester with water to cover thermostat.
   d. Plug tester into electrical outlet.
   e. Observe temperature at which thermostat begins to open. (Thermostat will drop off thread, that was installed in Step “a”, when it starts to open.) Thermostat must begin to open when temperature reaches 140°-145° F (60°-63° C).
   f. Continue to heat water until thermostat is completely open.
   g. Unplug thermostat tester.
   h. Replace thermostat, if it fails to open at the specified temperature, or if it does not fully open.

NOTE: *BE SURE that water in thermostat tester is allowed to cool sufficiently [below 110° F (43.3° C)] before testing the other thermostat.*



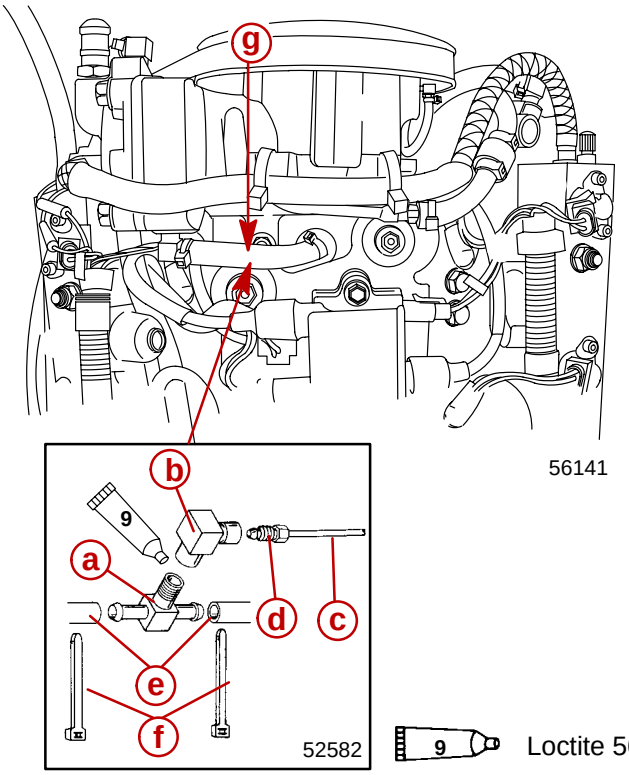
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IMPORTANT: DO NOT operate engine without thermostats installed.

Water Pressure Check

Using Water Pressure Gauge 91-79250A2, cut compressor water inlet hose and install tee fitting (provided) as shown.

NOTE: *This is also the same location for installing the water pressure hose for a dash mounted water pressure gauge.*



a - Tee Fitting (22-64706)
b - Fitting (22-63651)
c - Tubing
d - Compression Nut (22-63670)
e - Compressor Water Inlet Hose (Cut and splice in this location)
f - Sta-straps
g - Compressor Water Inlet Hose

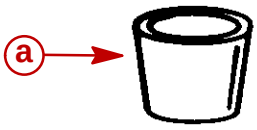
⚠ WARNING

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

Idle	1.0 – 3.0 PSI (6.8 – 20.5 kPa)
Poppet Valve Opening	4 – 9 PSI (27.4 – 61.6 kPa)
W.O.T.	12.0 PSI (82.1 kPa) Minimum

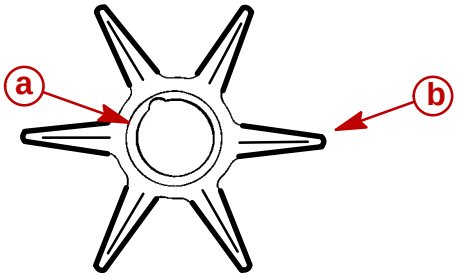
Water Pump Cleaning and Inspection

1. Inspect the water tube coupling for wear or damage. If necessary replace.



a - Water Tube Coupling

2. Inspect water pump impeller for wear on end, top and bottom of impeller blades. Replace impeller if this condition is found.
3. Inspect for improper bonding between hub and impeller. Replace impeller if improper bonding is found.

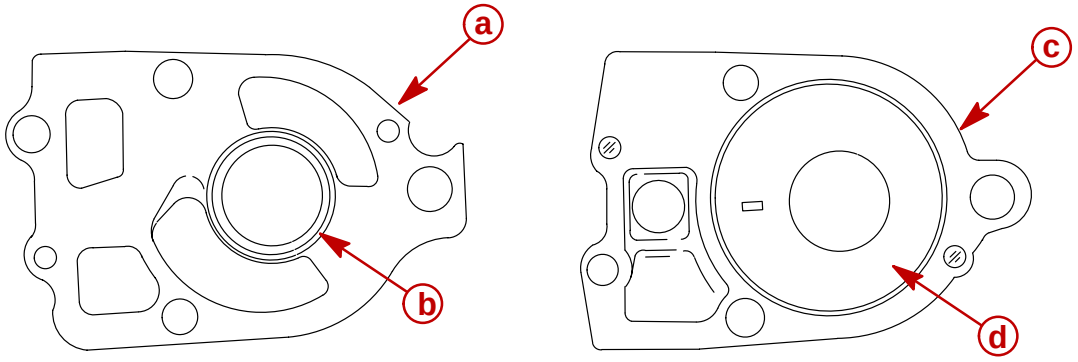


a - Hub
b - Impeller

4. Inspect impeller blades to see if they are cracked, burnt, hard or deformed. Replace impeller if blades are in this condition.

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting cover and plate. The depth of the groove will not affect water pump output.

5. Replace cover if plastic is melted from excessive heat (lack of water). Replace stainless insert and/or face plate if grooves (other than impeller sealing bead groove) are more than 0.010 in. (0.254 mm) deep.



a - Water Pump Face Plate
b - Sealing Groove (disregard)
c - Water Pump Cover
d - Stainless Insert [discard if grooves exceed 0.010 in. (0.254 mm)]

IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

IMPORTANT: It is recommended that water pump impeller be replaced whenever gearcase is removed for maintenance. However, if it is necessary to re-use impeller, DO NOT install in reverse to original rotation as premature impeller failure will occur.

Problem Diagnosis

Condition	Recommended Range	Possible Cause
Pressure below specification @ idle	1.0 – 3.0 PSI (6.8 – 20.5 kPa)	•Poppet valve spring defective (weak, broken, missing) •Defective poppet valve seal •Thermostat stuck open •Severe internal leak •Low output water pump •Inlet restriction •Strainer screen for air compressor water supply is restricted
Pressure above 5 psi (34.2 kPa) @ idle	1.0 – 3.0 PSI (6.8 – 20.5 kPa)	•Plugged poppet by-pass passage or fuel cooler
Pressure does not drop between 1000 – 2500 RPM indicating poppet valve has opened	4 – 9 PSI (27.4 – 61.6 kPa) between 1000 – 2200 RPM	•Wrong poppet valve spring •Low output water pump •Inlet restriction •Poppet valve vent hole plugged or restricted •Severe internal leak •Defective poppet valve seal
Poppet valve flutter/water pressure drop does not stabilize prior to 2500 RPM	4 – 9 PSI (27.4 – 61.6 kPa) between 1000 – 2200 RPM	•Wrong poppet valve spring •Low output water pump •Inlet restriction •Broken diaphragm in poppet valve •Severe internal leak •Defective poppet valve seal
Pressure is below minimum specification @ W.O.T.	12 PSI (54.9 – 68.5 kPa)	•Inlet restriction •Engine mounted too high on transom •Engine trimmed out too far •Configuration of boat bottom interfering with adequate flow of water to coolant inlets •Severe internal leak •Low output water pump •Plugged strainer screen for air compressor water supply
Pressure higher than normal @ W.O.T., but engine still indicates overheat condition	Maximum pressure – 23 PSI (157.4 kPa)	•Outlet water passages restricted. •Steam pocket has formed at top of powerhead due to lack of cooling water

MID-SECTION

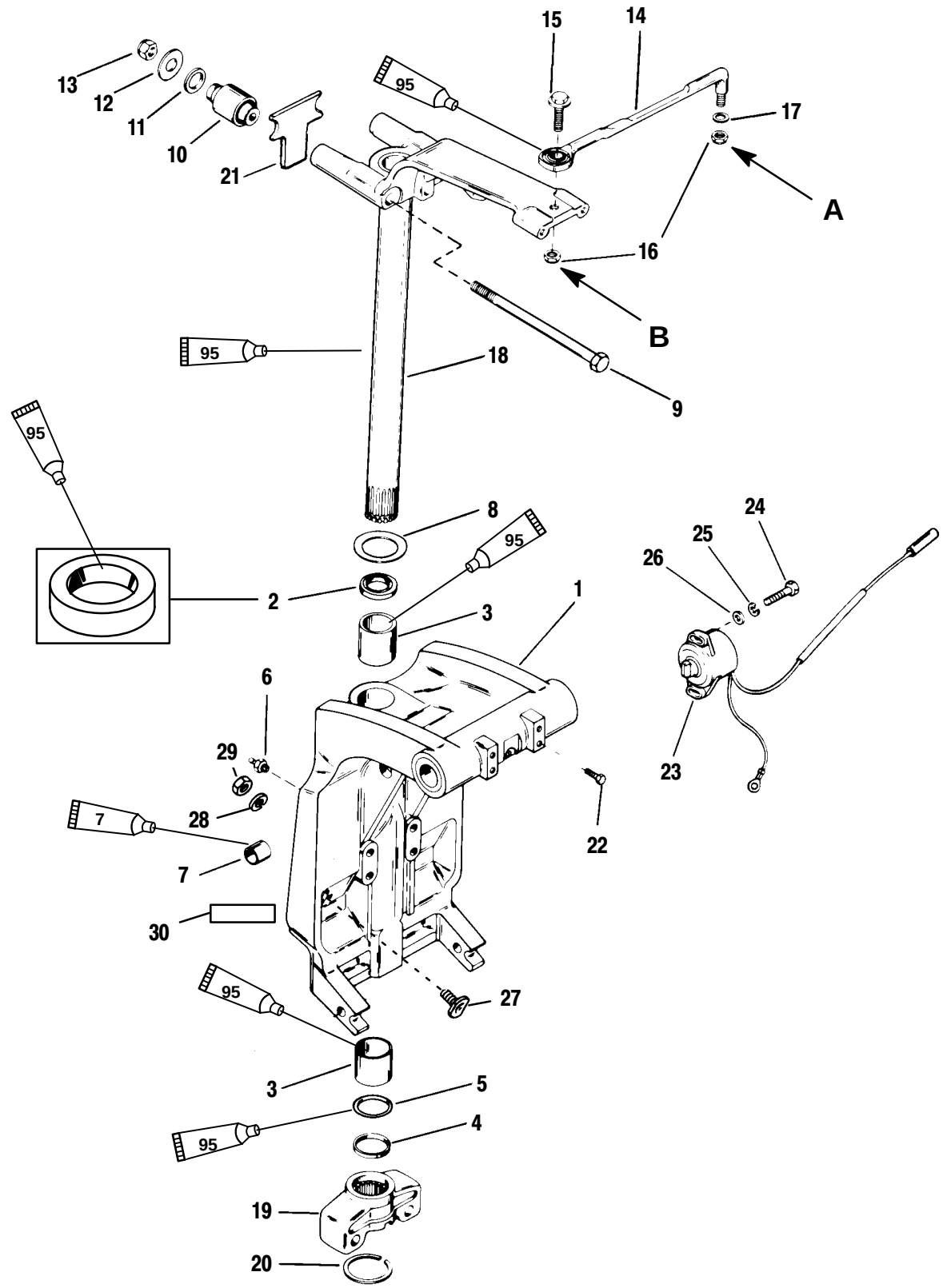
Section 5A – Clamp/Swivel Brackets & Drive Shaft Housing

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Reassembly and Installation 5A-11

5 A

Swivel Bracket and Steering Arm



7 Loctite 271 Thread Locker

95 2-4-C with Teflon

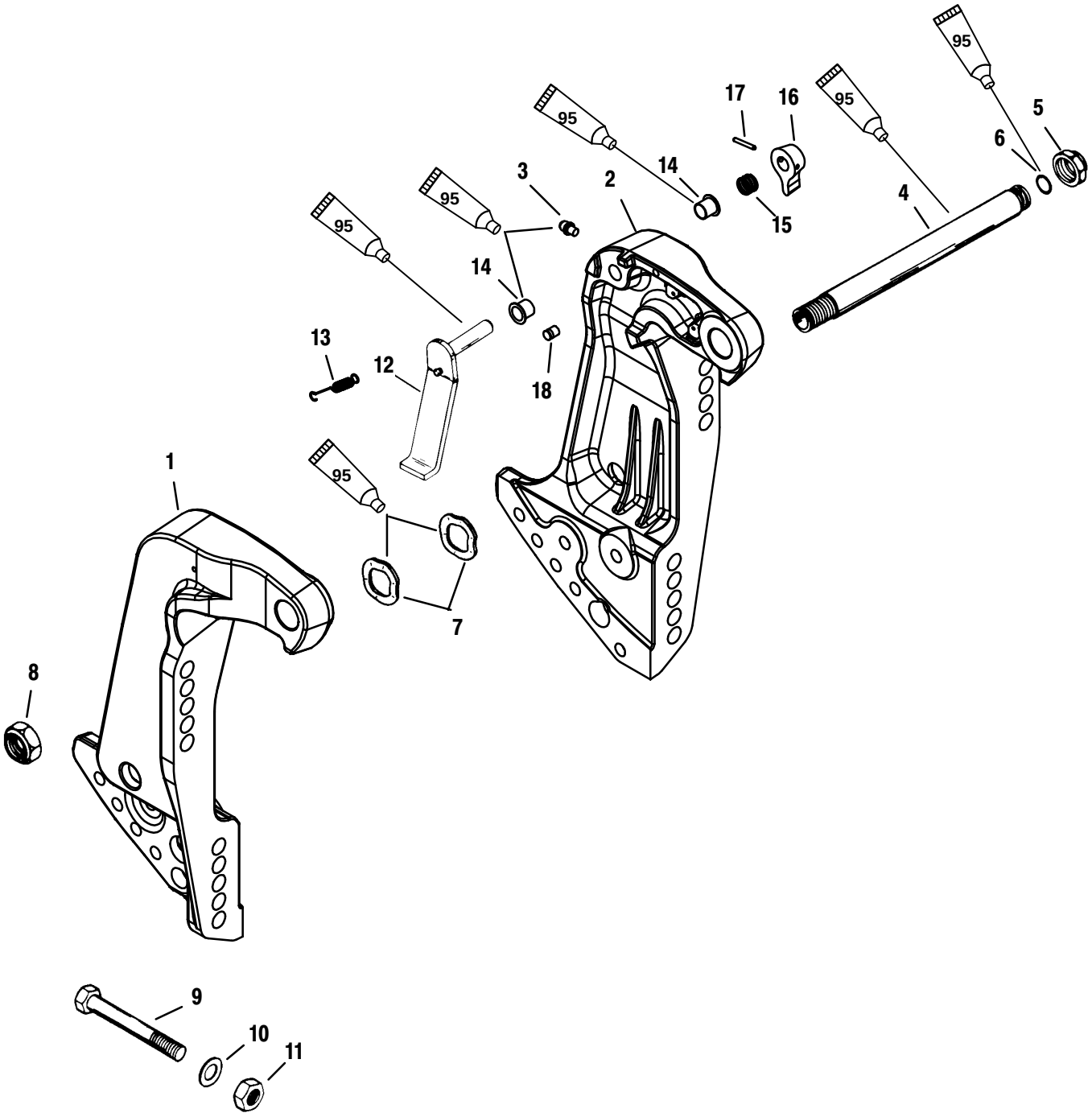
Swivel Bracket and Steering Arm

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	SWIVEL BRACKET ASSEMBLY **(BLACK)**			
2	1	OIL SEAL (LOWER)			
3	2	BUSHING			
4	1	SPACER			
5	1	O-RING			
6	2	GREASE FITTING	75		8.5
7	2	BUSHING			
8	1	THRUST WASHER			
9	2	SCREW (7/16-20 x 7-1/2 IN.)			
10	2	MOUNT			
11	2	WASHER			
12	2	WASHER			
13	2	NUT		50	68
14	1	STEERING LINK ASSEMBLY			
15	1	SCREW (3/8-24 x 1-1/4 IN.)		20	27
16	2	NUT	See Note		
17	2	WASHER			
18	1	SWIVEL PIN AND STEERING ARM **(BLACK)**			
19	1	BOTTOM YOKE **(BLACK)**			
20	1	RETAINING RING			
21	1	BUMPER			
22	2	SCREW (1/4-28 x 1/2 IN.)	100		11.5
23	1	TRIM SENDER ASSEMBLY			
24	2	SCREW	15		1.7
25	2	LOCKWASHER			
26	2	WASHER			
27	2	STRIKER PLATE			
28	2	LOCKWASHER			
29	2	NUT		23	31
30	1	DECAL-Serial Number Overlaminate			

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

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

Transom Brackets

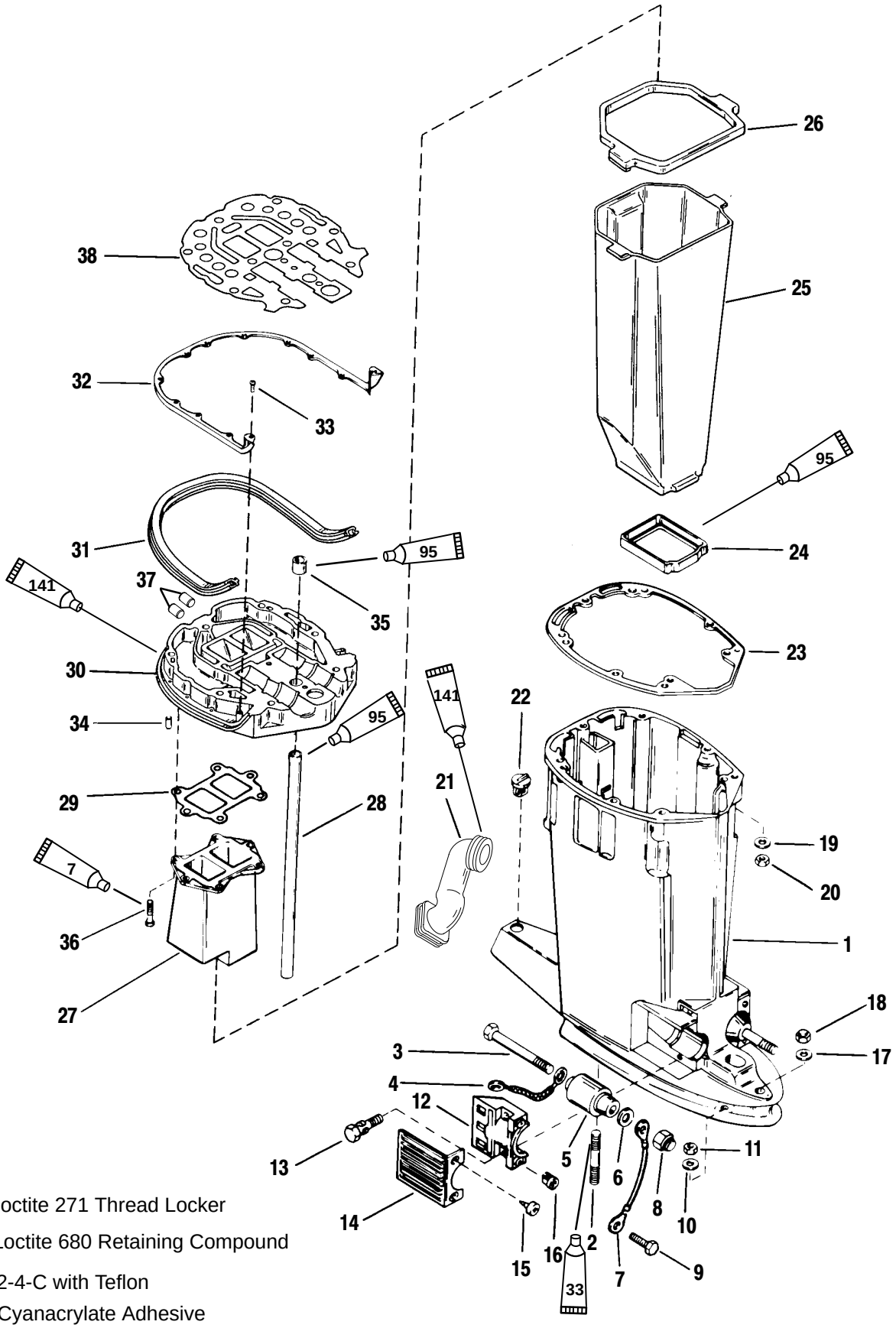


95 2-4-C with Teflon

Transom Brackets

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

Drive Shaft Housing and Exhaust Tube



Drive Shaft Housing and Exhaust Tube

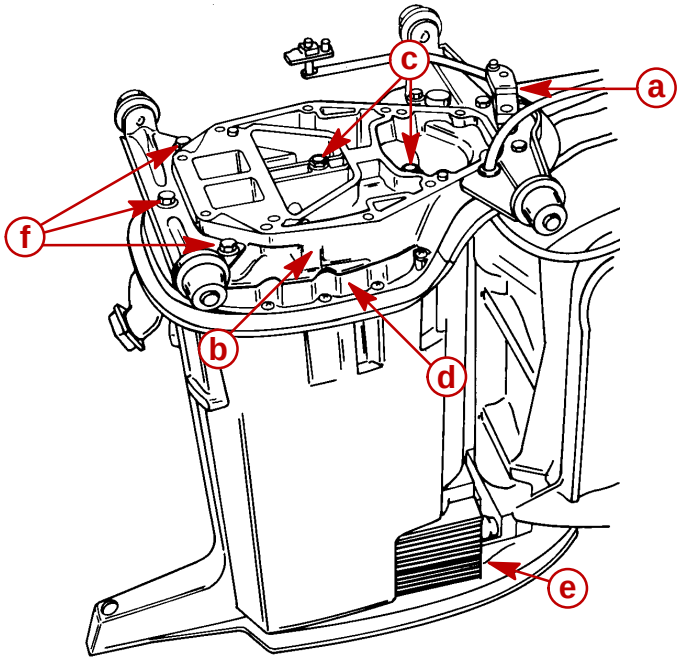
REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	DRIVE SHAFT HOUSING **(LONG)(BLACK)**			
	1	DRIVE SHAFT HOUSING **(X-LONG)(BLACK)**			
2	2	STUD			
3	2	SCREW (1/2-20 x 6 IN.)			
4	1	GROUND WIRE			
5	2	LOWER MOUNT			
6	2	WASHER			
7	1	GROUND WIRE			
8	2	NUT		50	68
9	1	SCREW (1/4-20 x 3/8 IN.)			
10	2	WASHER			
11	2	NUT		50	68
12	2	CLAMP			
13	4	SCREW (5/16-18 x 1-1/4 IN.)		22	30
14	2	COVER **(BLACK)**			
15	4	SCREW (12-24 x 5/8 IN.)	17		1.9
16	4	NUT		25	34
17	1	WASHER			
18	1	NUT		57	77
19	4	WASHER			
20	4	NUT		23	31
21	1	IDLE EXHAUST BOOT			
22	1	PLUG			
23	1	GASKET			
24	1	SEAL (LOWER)			
25	1	EXHAUST TUBE			
26	1	SEAL (UPPER)			
27	1	EXHAUST EXTENSION **(150)**			
	1	EXHAUST EXTENSION **(135)**			
28	1	WATER TUBE **(LONG)**			
	1	WATER TUBE **(X-LONG)**			
29	1	GASKET			
30	1	PLATE ASSEMBLY			
31	1	SEAL			
32	1	BRACKET			
33	12	SCREW (10-16 x 1/2 IN.)	80		9
34	2	DOWEL PIN			
35	1	SEAL			
36	6	SCREW (1/4-20 x 3/4 IN.)	60		7
37	2	PLUG **(USE WHERE APPLICABLE)**			
38	1	GASKET			

Drive Shaft Housing and Dyna-Float Suspension

Refer to Section 4A - Powerhead Removal from Drive Shaft to remove powerhead. Refer to Lower Unit Removal in this section to remove lower unit.

Removal and Disassembly

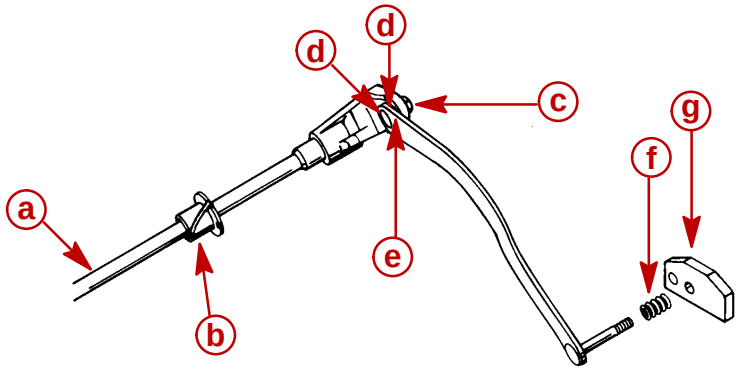
1. Remove shift shaft from driveshaft housing by pulling straight up on shaft.
2. Remove 5 bolts which secure exhaust extension plate to drive shaft housing. After bolts are removed, lift exhaust extension plate off drive shaft housing.
3. Remove screws, which secure lower mount covers to drive shaft housing, then remove covers.



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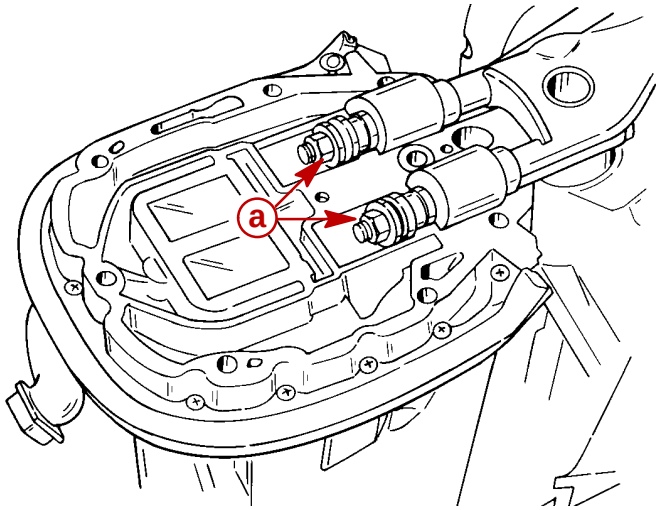
a - Shift Shaft Linkage
b - Exhaust Extension Plate
c - Exhaust Plate to Drive Shaft Housing Bolts
d - Driveshaft Housing Plate
e - Lower Mount Cover (One Each Side)
f - Mounting Bracket Bolts

SHIFT LINKAGE ASSEMBLY



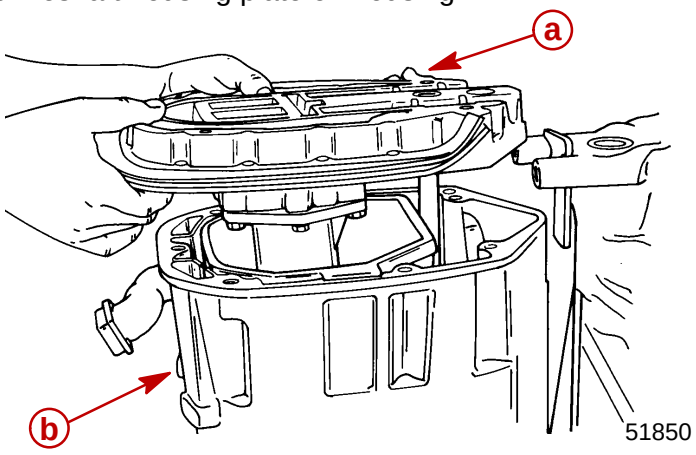
a - Shift Shaft Assembly
b - Bushing
c - Lock Nut
d - Washer (2)
e - Bushing (Hidden)
f - Spring
g - Guide Block

1. Remove upper mount nuts and flat washers.



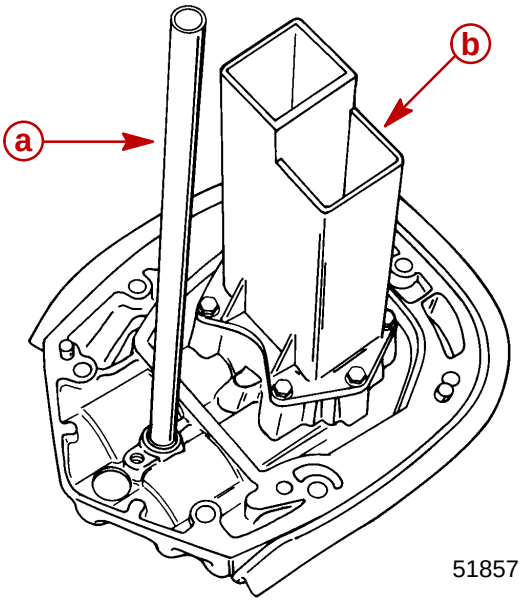
a - Upper Mount Nuts

2. Lift driveshaft housing plate off housing.

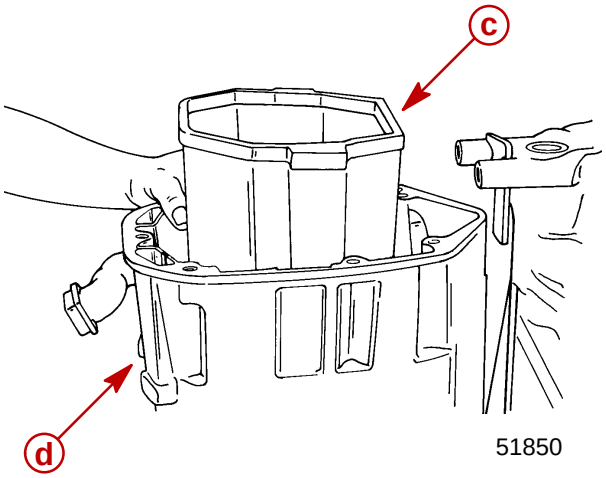


a - Drive Shaft Housing Plate
b - Drive Shaft Housing

3. Remove water tube from driveshaft housing plate.
4. Exhaust diffuser is secured to housing plate with 6 bolts. Remove bolts, then remove diffuser.
5. Pull exhaust tube out of drive shaft housing.



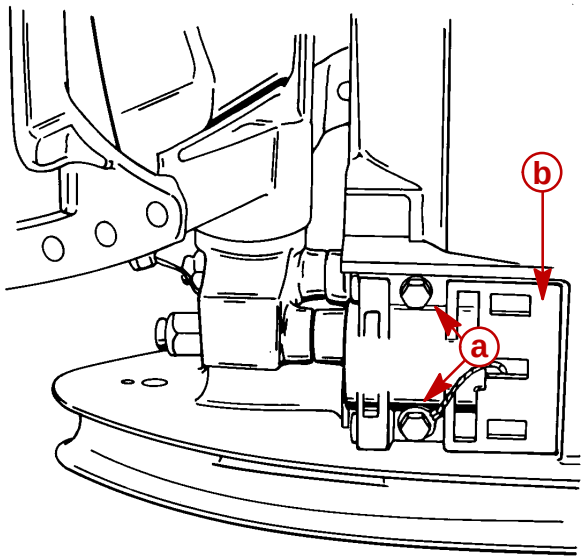
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a - Water Tube
b - Exhaust Diffuser
c - Exhaust Tube
d - Drive Shaft Housing

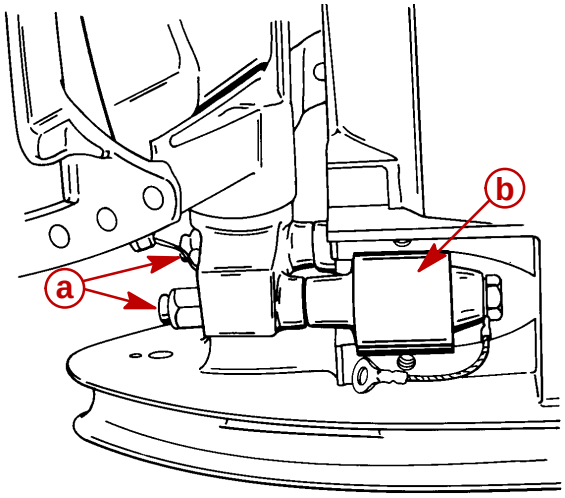
6. Remove all gasket material from driveshaft housing and related components.
7. Remove bolts, which secure lower mount retainers to drive shaft housing, and remove retainers.
8. Remove rubber caps from lower mount bolts.



51855

a - Bolts
b - Lower Mount Retainer (One Each Side)

9. Remove lower mount nuts.



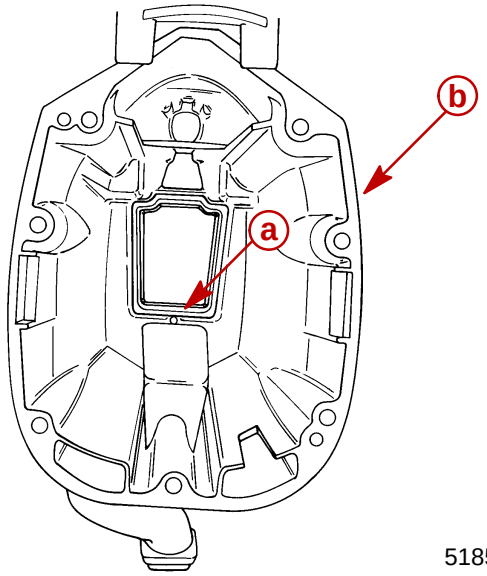
51855

a - Lower Mount Nuts
b - Lower Mount

10. Remove driveshaft housing from swivel bracket by pulling alternately from top to bottom on housing.
11. Remove upper and lower mounts by lifting them out of driveshaft housing.

Reassembly and Installation

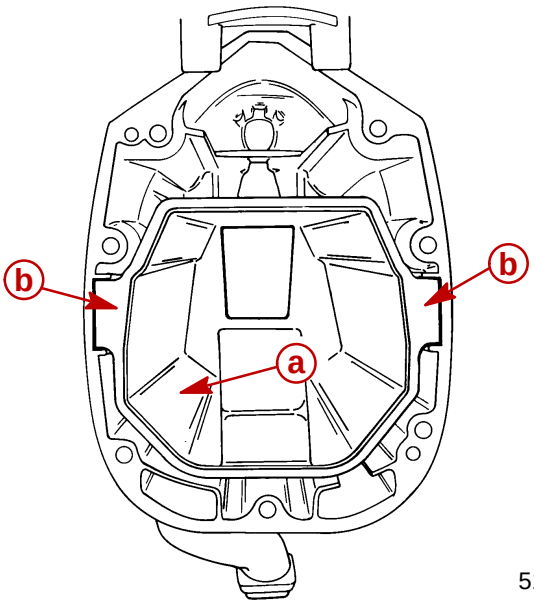
1. Apply a thin coat of 2-4-C with Teflon onto inside portion of exhaust tube seal.
2. Install exhaust tube seal into driveshaft housing with tapered side of seal facing up.



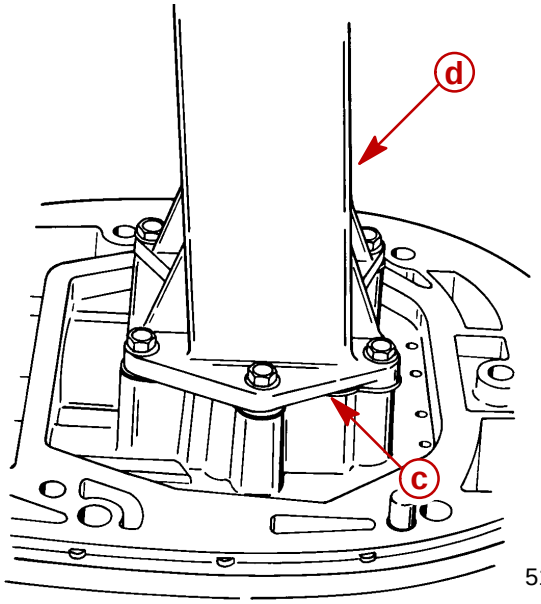
51856

a - Exhaust Tube Seal
b - Driveshaft Housing

3. Push exhaust tube boots onto tabs on each side of exhaust tube.
4. Position exhaust tube in drive shaft housing and push down on tube until boots rest in grooves on inside of housing.
5. Position driveshaft housing to plate gasket on top of housing.
6. Install an exhaust diffuser gasket and exhaust diffuser onto plate, then secure both to plate with 6 bolts. Clean bolts with Loctite 7649 Primer N and then apply Loctite 271 to bolt threads. Torque bolts to 60 lb. in. (7.0 Nm).



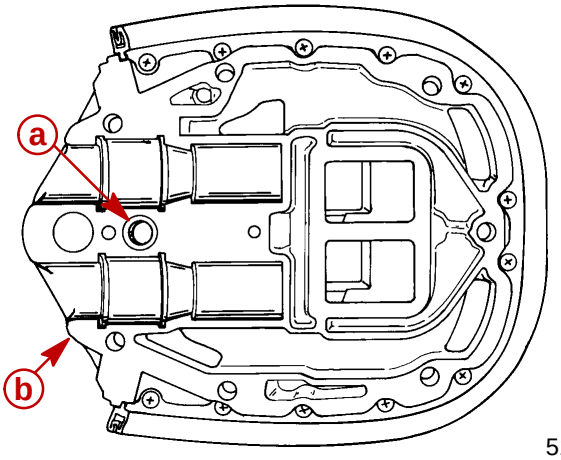
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51857

a - Exhaust Tube
b - Exhaust Tube Boots
c - Exhaust Diffuser Gasket
d - Exhaust Diffuser

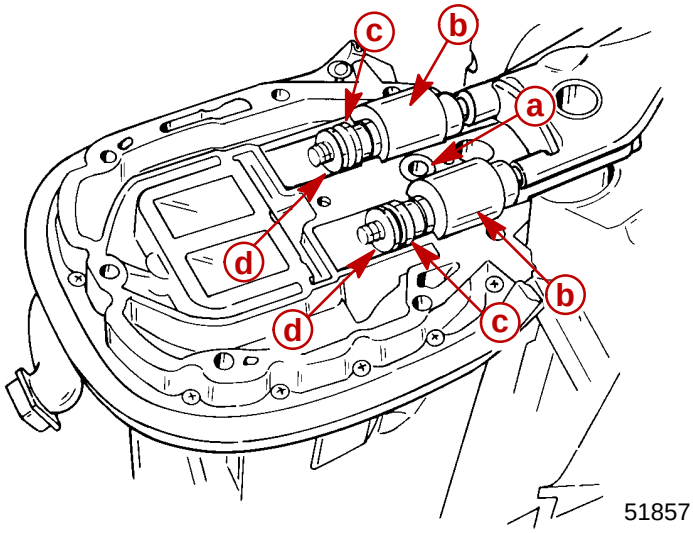
7. Apply a small amount of 2-4-C with Teflon onto water tube seal.
8. Install water tube seal into driveshaft housing plate with plastic end of seal facing up and install water tube.



51856

a - Water Tube Seal
b - Driveshaft Housing Plate

9. Position drive shaft housing plate on top of housing.
10. Apply a thin coat of Perfect Seal onto metal portion of upper dyna-float mounts.
11. Position mounts on drive shaft housing plate.
12. Install a rubber washer onto each upper mount, followed by a metal washer.



51857

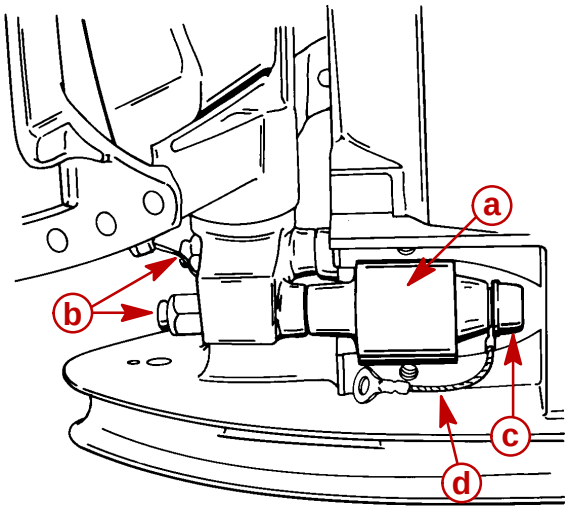
a - Water Tube Seal (Plastic End)
b - Dyna-Float Mounts
c - Rubber Washers
d - Metal Washer

13. Install a ground strap onto one of the lower mount mounting bolts.

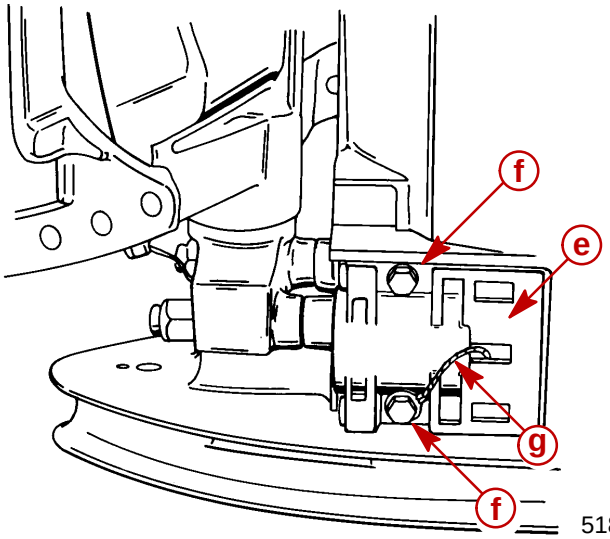
NOTE: *Apply Perfect Seal along length of lower mount bolts.*

14. Insert a mounting bolt through the short end of each lower mount.
15. Position a mount on each lower side of driveshaft housing.
16. Install a flat washer over each lower mounting bolt.
17. Position a bumper on steering arm between mounting bolts.
18. Start upper mounting bolts in upper mounts and align lower mounting bolts with holes in swivel pin yoke. Slide driveshaft housing up against yoke and bumper.
19. Secure upper mounts to steering arm with flat washers and self-locking nuts. Torque nuts to 50 lb. ft. (68.0 Nm).
20. Install ground strap (if equipped) between port lower mount bolt and swivel bracket.
21. Secure lower mounts to swivel pin yoke with self- locking nuts. Torque nuts to 50 lb. ft. (68.0 Nm). Place a rubber cap over each lower mounting bolt head.

22. Install lower mount retainers and secure each retainer with 2 bolts. (Secure ground strap with the nearest retainer bolt.) Torque bolts to 160 lb. in. (18.0 Nm).



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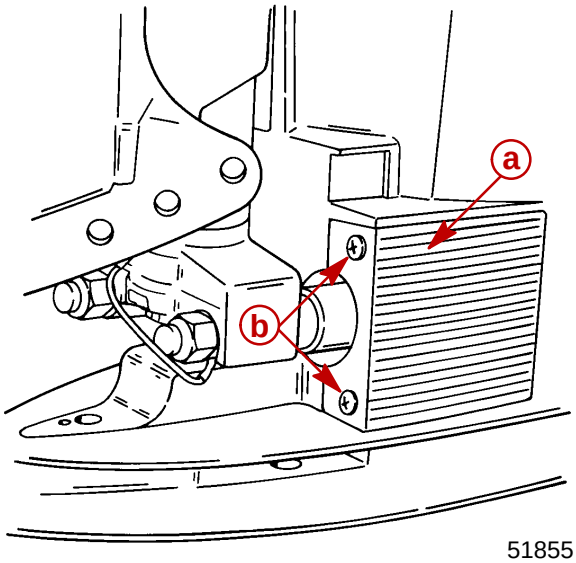


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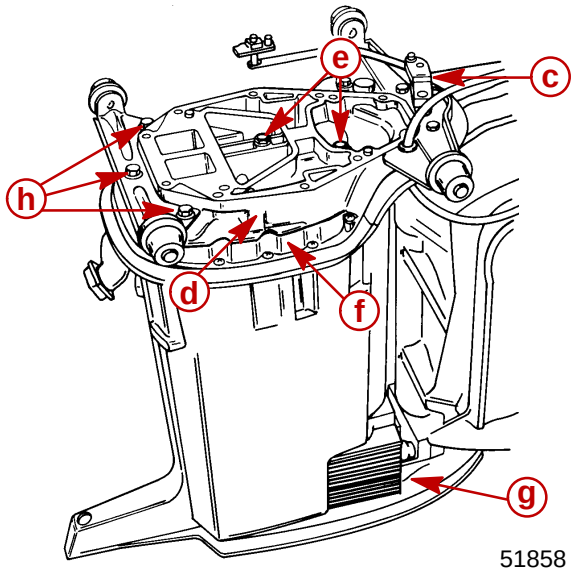
a - Lower Mount
b - Nut [Torque to 50 lb. ft. (68.0 Nm)]
c - Rubber Cap
d - Ground Strap (only one side)
e - Lower Mount Retainer
f - Bolts [Torque to 160 lb. in. (18.0 Nm)]
g - Ground Strap

23. Install lower mount covers and secure each cover with 2 screws.

24. Install exhaust extension plate on driveshaft housing with shift shaft assembly. Secure extension plate to drive shaft housing with 5 bolts.



51855



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a - Cover (One Each Side)
b - Screws (Two for Each Cover)
c - Shift Shaft Linkage
d - Exhaust Extension Plate
e - Exhaust Plate to Driveshaft Housing Bolts, Torque to 25 lb. ft. (34 Nm)
f - Drive Shaft Housing Plate
g - Lower Mount Cover (One Each Side)
h - Mounting Bracket Bolts, Torque to 40 lb. ft. (54 Nm)

MID-SECTION

Section 5B – Power Trim

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5 B

Power Trim Specifications

NOTE: *Maximum acceptable amount of leak down in 24 hours is 2 inches (50.8 mm).*

Test	Reading
Trim “UP”	1300 PSI (91kg/cm^2) Maximum Pressure
Trim “DOWN”	500 PSI (35kg/cm^2) Minimum Pressure

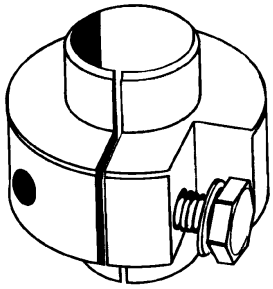
Special Tools

1. Alignment Tool 91-11230



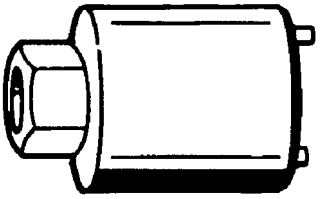
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2. Trim Rod Removal Tool 91-44486A1



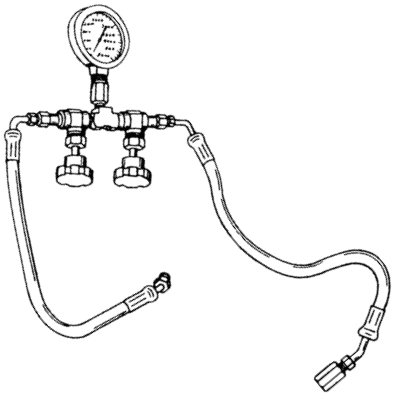
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3. Trim Rod Guide Removal Tool 91-44487A1



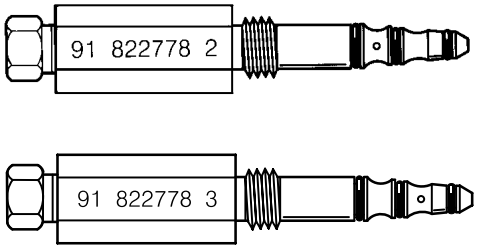
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4. Power Trim Test Gauge Kit 91-52915A6



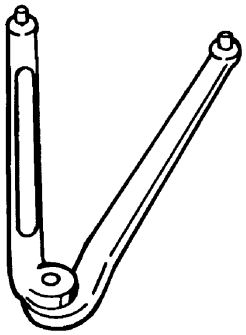
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5. Adaptor Fitting 91-82278A2 and 91-82278A3



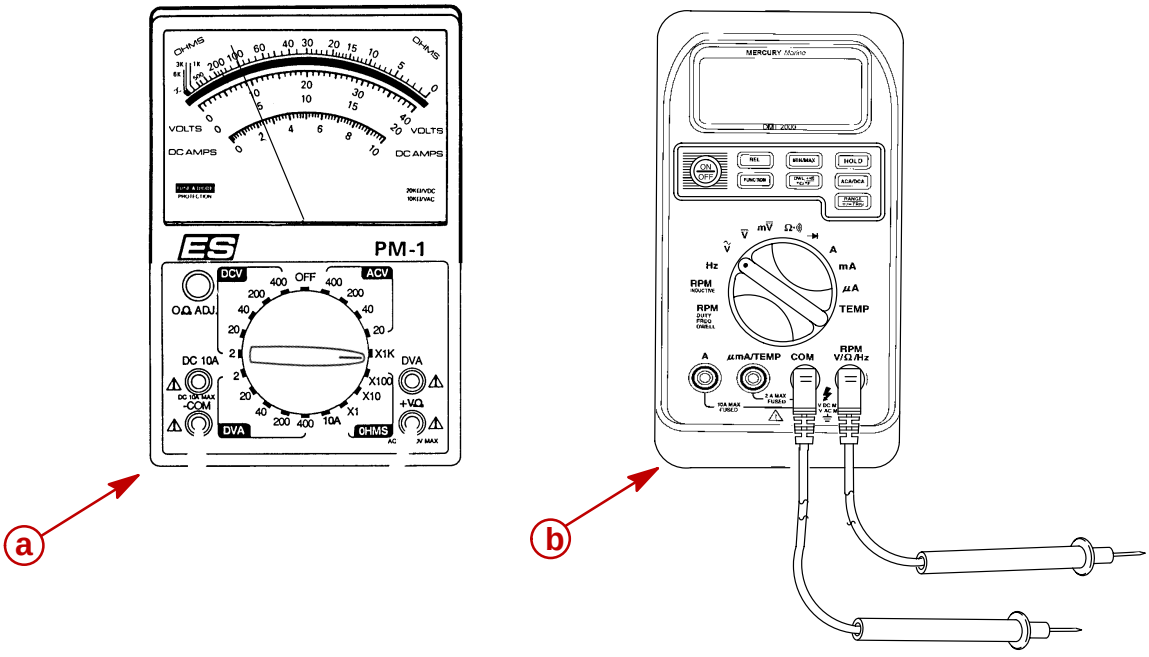
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6. Spanner Wrench 91-74951



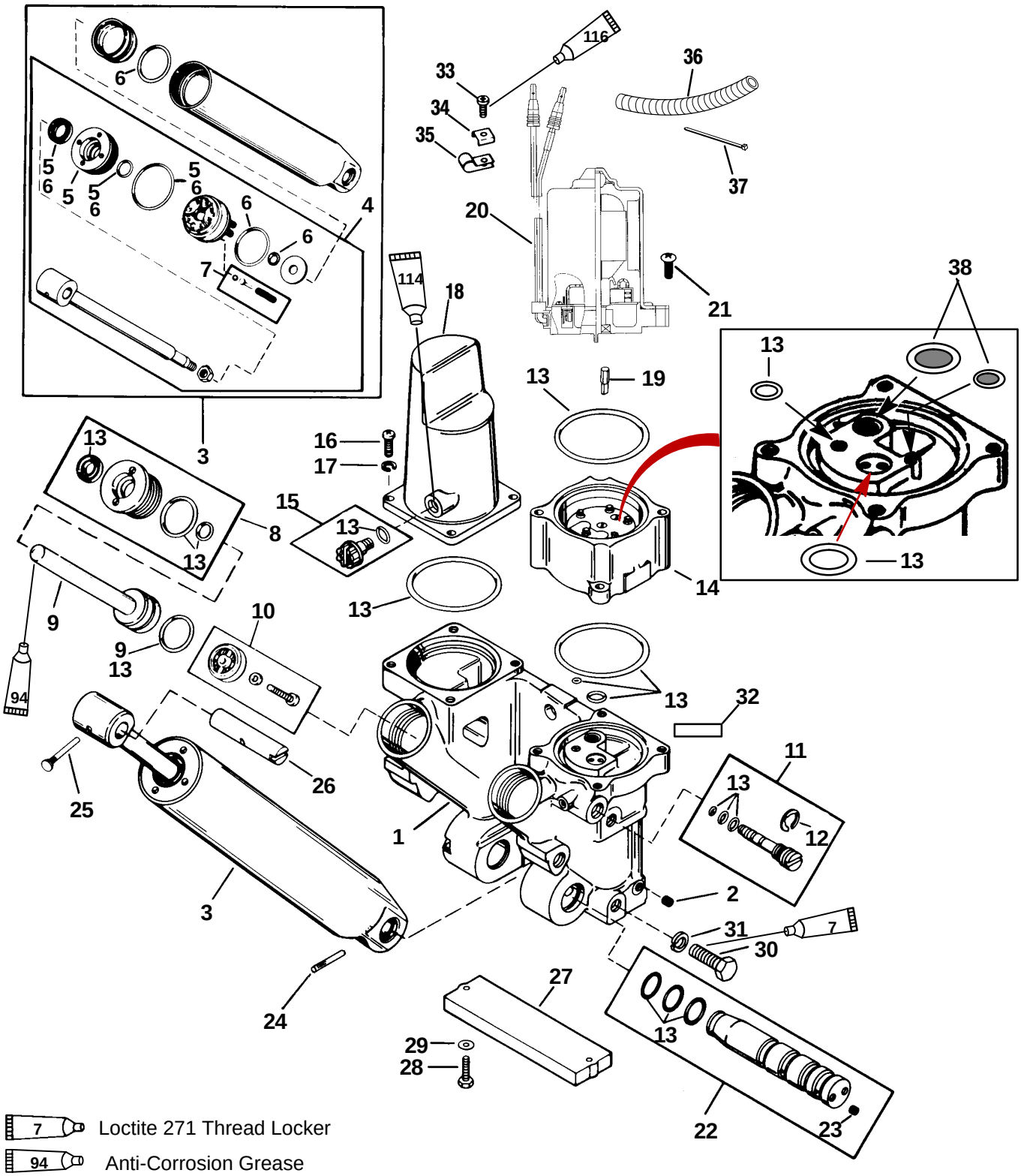
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7. Multi-Meter DVA Tester or DMT 2000 Digital Tachometer Multi-meter



a - Multi-Meter DVA Tester 91-99750A1
b - DMT 2000 Digital Tachometer Multi-meter 91-854009A1

Power Trim Components



7 Loctite 271 Thread Locker

94 Anti-Corrosion Grease

114 Power Trim & Steering Fluid

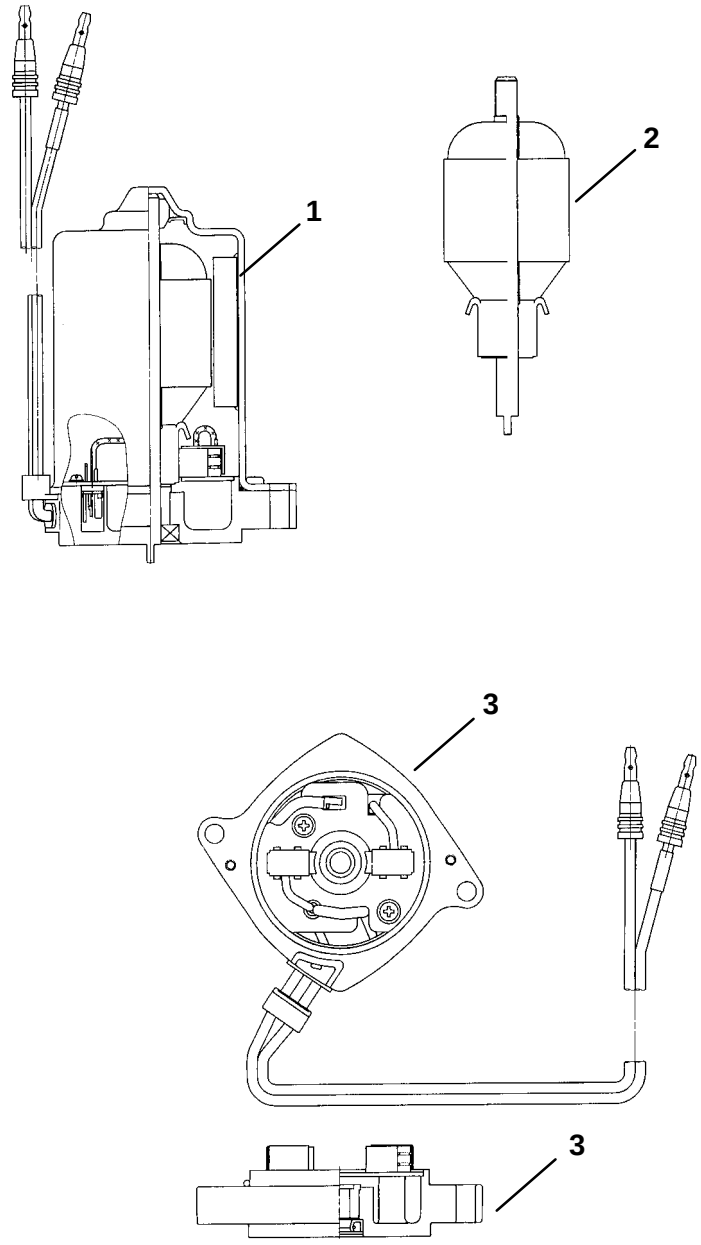
116 RTV 587 Silicone Sealer

Power Trim Components

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
–	1	POWER TRIM ASSEMBLY–Complete			
1	1	MANIFOLD ASSEMBLY			
2	9	PIPE PLUG			
3	1	TILT CYLINDER ASSEMBLY			
4	1	PISTON ROD			
5	1	GUIDE KIT			
6	1	REPAIR KIT			
7	1	CHECK VALVE KIT			
8	2	GUIDE ASSEMBLY			
9	1	PISTON/ROD ASSEMBLY **(PORT)**			
	1	PISTON/ROD ASSEMBLY **(STBD.)**			
10	1	TRIM FILTER ASSEMBLY			
11	1	VALVE ASSEMBLY			
12	1	E-RING			
13	1	O-RING KIT			
14	1	PUMP			
15	1	PLUG ASSEMBLY			
16	4	SCREW			
17	4	WASHER			
18	1	COVER			
19	1	DRIVE SHAFT			
20	1	TRIM MOTOR (Breakdown on Power Trim Motor)			
21	2	SCREW **(LONG)**	80		9
	2	SCREW **(SHORT)**	80		9
22	1	SHAFT ASSEMBLY			
23	2	PIPE PLUG			
24	1	GROOVE PIN			
25	1	GROOVE PIN			
26	1	SHAFT			
27	1	ANODE ASSEMBLY			
28	2	SCREW (M6 x 1 x 25)	70		8
29	2	WASHER			
30	6	SCREW (M10 x 1.5 x 30)		45	61
31	6	WASHER			
32	1	DECAL-Caution power trim			
33	1	SCREW (10-16 x 3/5 IN.)			
34	1	C WASHER			
35	2	CLAMP			
36	1	TUBING			
37	1	STA-STRAP			
38	2	FILTER SCREENS			

NOTE: *Lubricate all O-rings with Power Trim and Steering Fluid.*

Power Trim Motor



REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb.in.	lb.ft.	Nm
–	1	POWER TRIM MOTOR			
1	1	BRUSH AND SEAL KIT			
2	1	ARMATURE KIT			
3	1	END FRAME **(Complete)**			

Power Trim - General Information

Description

The Power Trim System consists of an electric motor, pressurized fluid reservoir, pump, tilt cylinder, and two trim rams.

The remote control (or trim panel) has switches that trim the outboard UP or DOWN and tilt the engine for trailering. The outboard can be trimmed and tilted under power or when the outboard is not running.

Trimming Characteristics

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

TRIMMING OUTBOARD UP (OUT):

⚠ WARNING

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

- Will lift boat bow, increasing top speed.
- Transfers steering torque harder to port (left) on installations below 23 in. (584.2 mm) transom height.
- Increases gearcase clearance over submerged objects.
- Excess trim can cause porpoising and/or ventilation.

⚠ WARNING

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

The UP circuit actuates the up solenoid (under outboard cowl) and closes the motor circuit. The electric motor drives the pump, forcing fluid through passageways into the up side of the trim cylinders.

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

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

TRIMMING OUTBOARD DOWN (IN):

⚠ WARNING

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

- Aids planing, particularly with heavy loads.
- Improves ride in choppy water conditions.
- Excess trim IN can cause bow steer (boat veers to left or right).
- Transfers steering torque to starboard (right).
- Improves acceleration to planing speed.

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

Trailering Outboard

The UP circuit first moves the trim cylinders. When the trim cylinders extend fully, the tilt ram extends to tilt the outboard to the full up position for trailering.

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

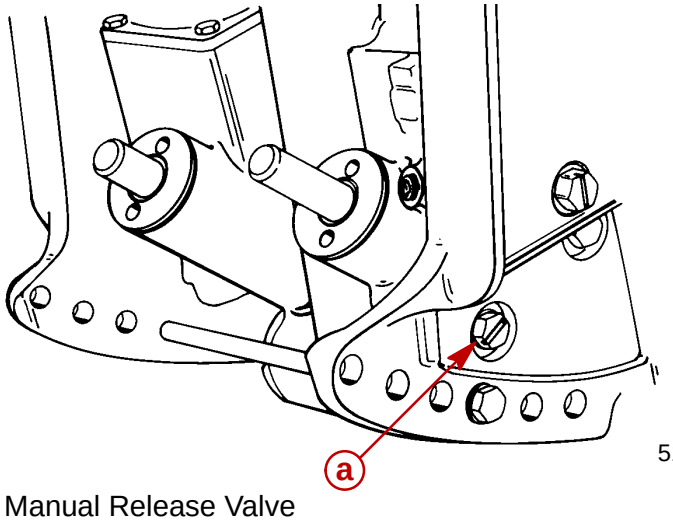
If the outboard must be tilted for clearance between skeg and pavement, a device such as a Transom Saver should be installed to prevent stress to boat transom from outboard weight while the boat/outboard are being trailered.

Tilting Outboard Manually

⚠ WARNING

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

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



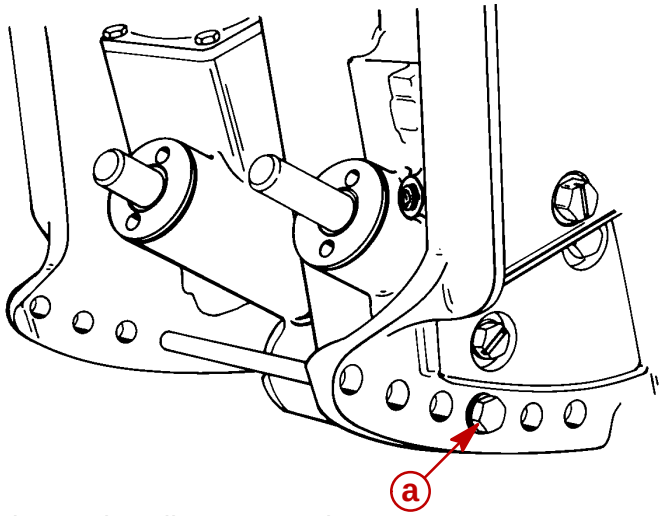
a - Manual Release Valve

Trim In Angle Adjustment

⚠ WARNING

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

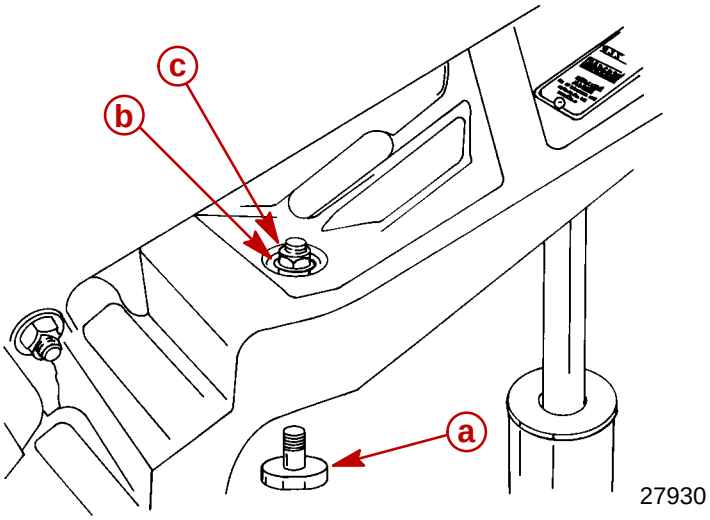
IMPORTANT: Some boat/motor combinations not using the trim angle adjustment pin and trimmed to the full IN trim angle position may not exhibit any undesirable and/or unsafe handling and/or steering characteristics at planing speed. If so, not using the trim angle adjustment bolt may be advantageous to 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

Striker Plate Replacement

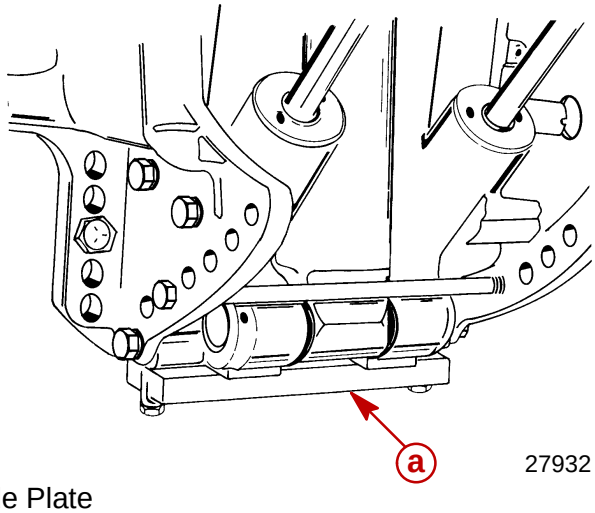
Visually inspect striker plates and replace if worn excessively.



a - Striker Plate (2)
b - Lockwasher
c - Locknut. Torque to 80 lb. in. (9.0 Nm)

Anode Plate

An anode plate is a self-sacrificing alloy plate that is consumed gradually by corrosion while providing protection to the midsection and power trim from galvanic corrosion. Replace anode plate when it is 50% consumed.



a - Anode Plate

IMPORTANT: DO NOT paint or place protective coating on anode plate, or corrosion protection function will be lost.

Trim Indicator Gauge

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

Check, Fill and Purge - Power Trim System

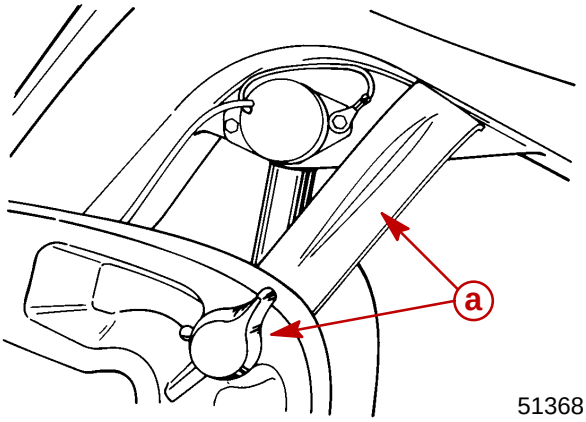
TO CHECK:

⚠ CAUTION

Tilt outboard to full UP position and engage tilt lock lever before checking fluid level. System is pressurized. Extend trim and tilt rams fully to depressurize system.

Remove fill plug and O-ring. System is full when oil level is present at filler hole. Tighten fill plug securely.

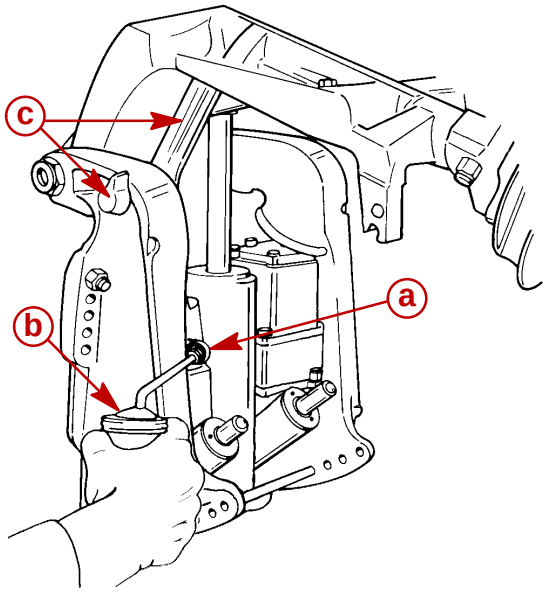
NOTE: *Automatic Transmission Fluid (ATF) Type F, FA, Dexron II or Dexron III may be used.*



a - Tilt Lock Lever

TO FILL:

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



51344

a - Fill Plug and O-ring (remove to fill system, tighten securely)
b - Oil Can (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 the system.

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

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

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

Troubleshooting

IMPORTANT: Determine if Electrical or Hydraulic problem exists.

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

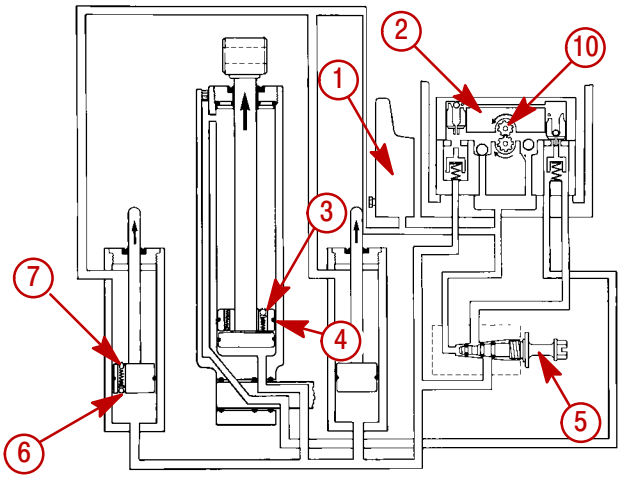
HYDRAULIC SYSTEM TROUBLESHOOTING

IMPORTANT: Make one correction at a time. Check operation of trim system before proceeding to the next check.

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

PROBLEM

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



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External Mounted Hydraulic System

ELECTRICAL SYSTEM TROUBLESHOOTING

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

PROBLEM

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

POWER TRIM RELAY TEST PROCEDURE

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

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

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

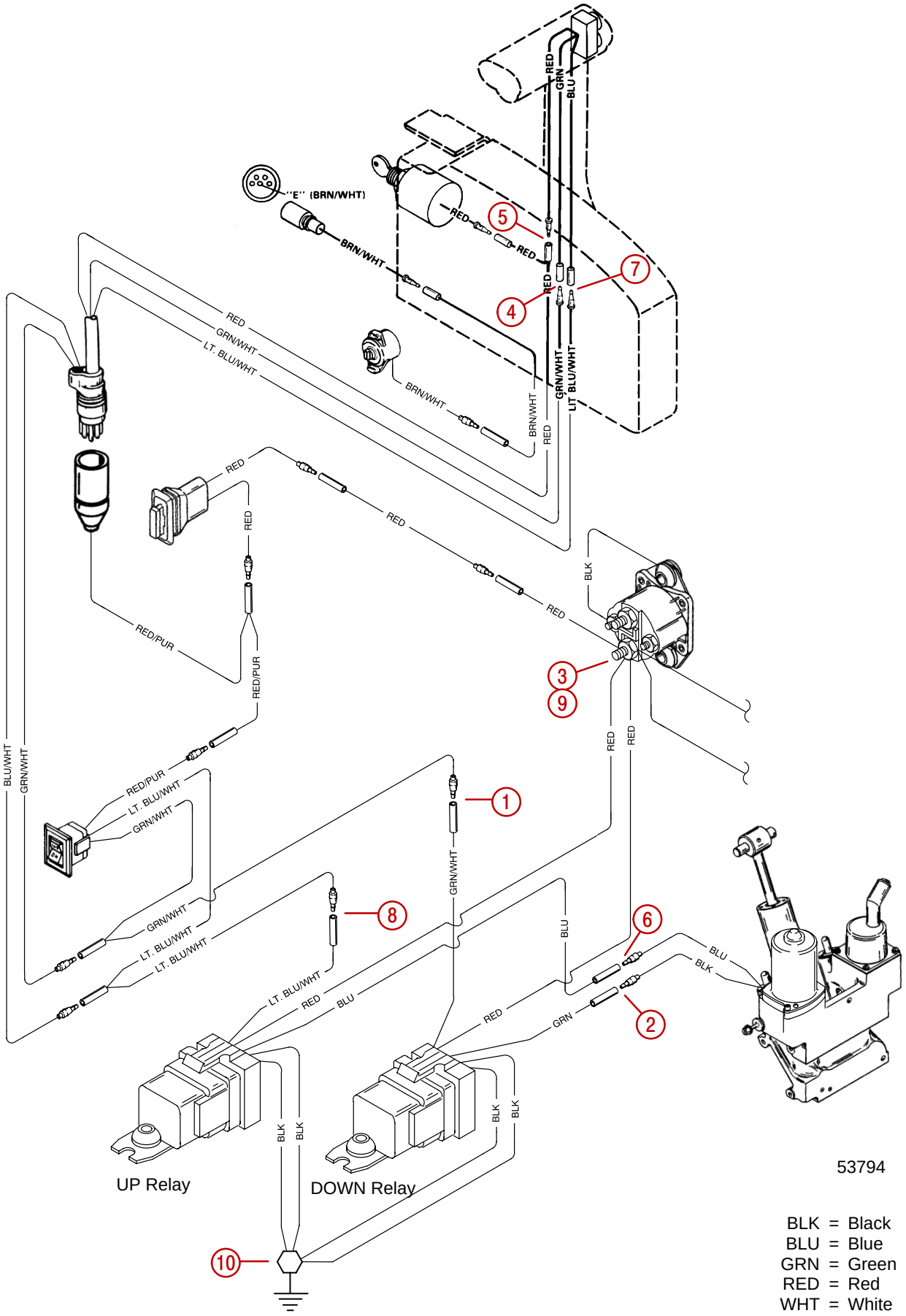
1. Disconnect the heavy gauge pump wires from the trim control relay.
2. Check for continuity between the heavy leads from the trim relays to ground.

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

Replace the relay that does not have continuity.

3. Connect a voltmeter to the heavy BLUE lead and to ground. You should have 12 volts on the BLUE lead when the UP switch is pushed. You should should also have 12 volts on the GREEN lead when the DOWN switch is pushed. Replace the relay that does not switch the lead to positive.

Power Trim System with Relays and 2 Wire Trim Motor



53794

BLK = Black
BLU = Blue
GRN = Green
RED = Red
WHT = White

Electrical System Troubleshooting

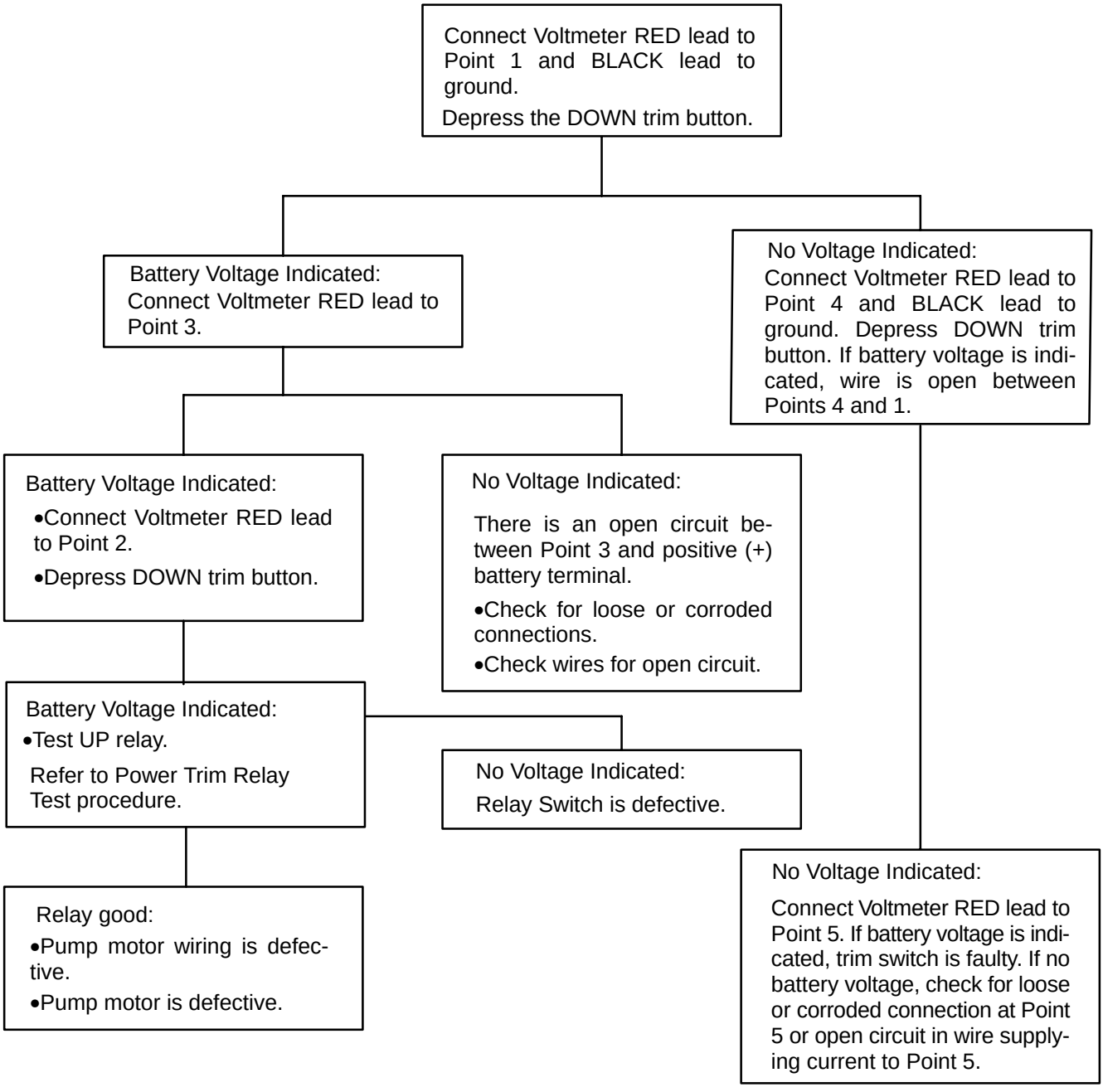
General Checks

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

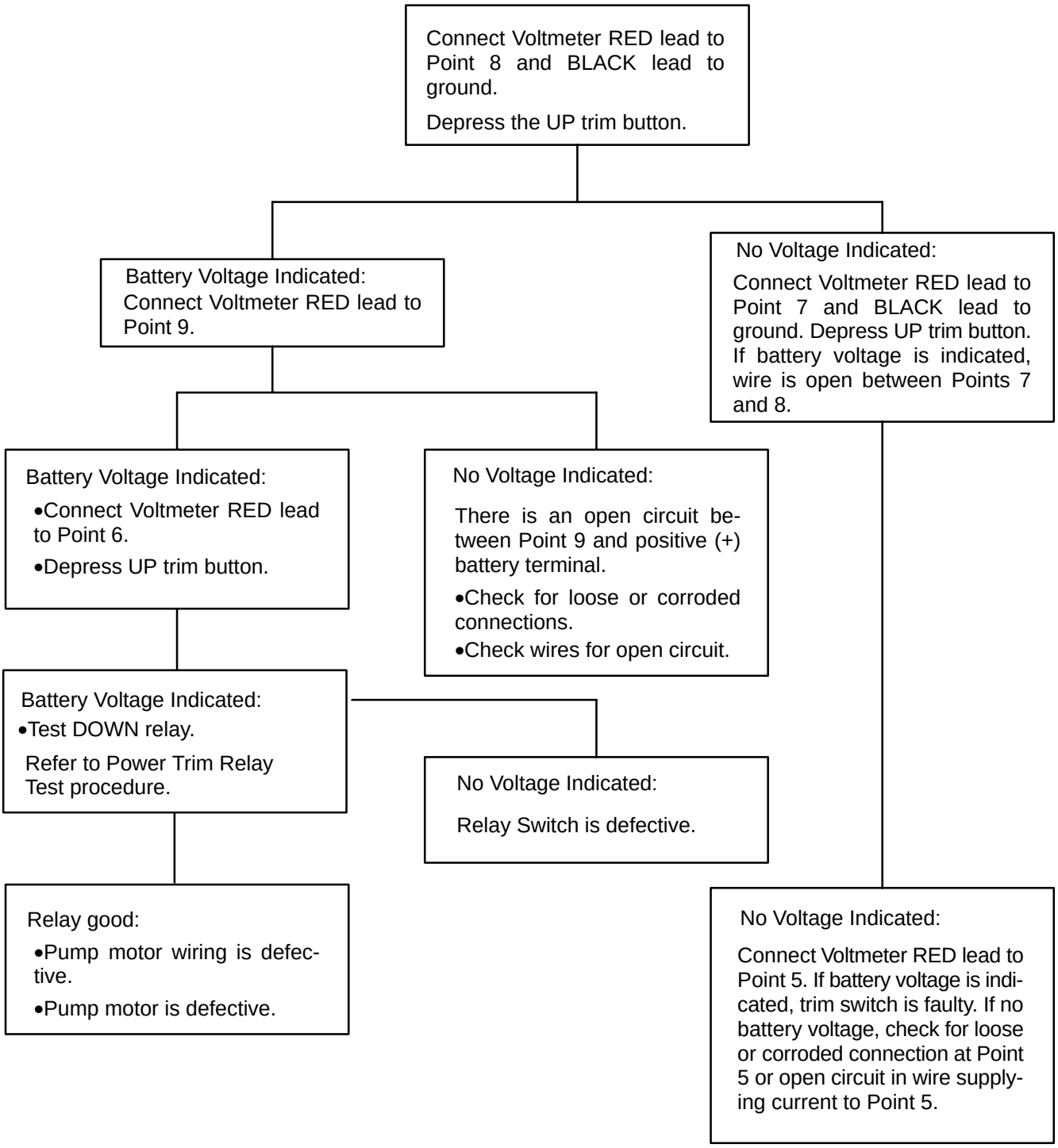
1. Check for disconnected wires.
2. Make certain all connections are tight and corrosion free.
3. Check that plug-in connectors are fully engaged.
4. Make certain battery is fully charged.

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

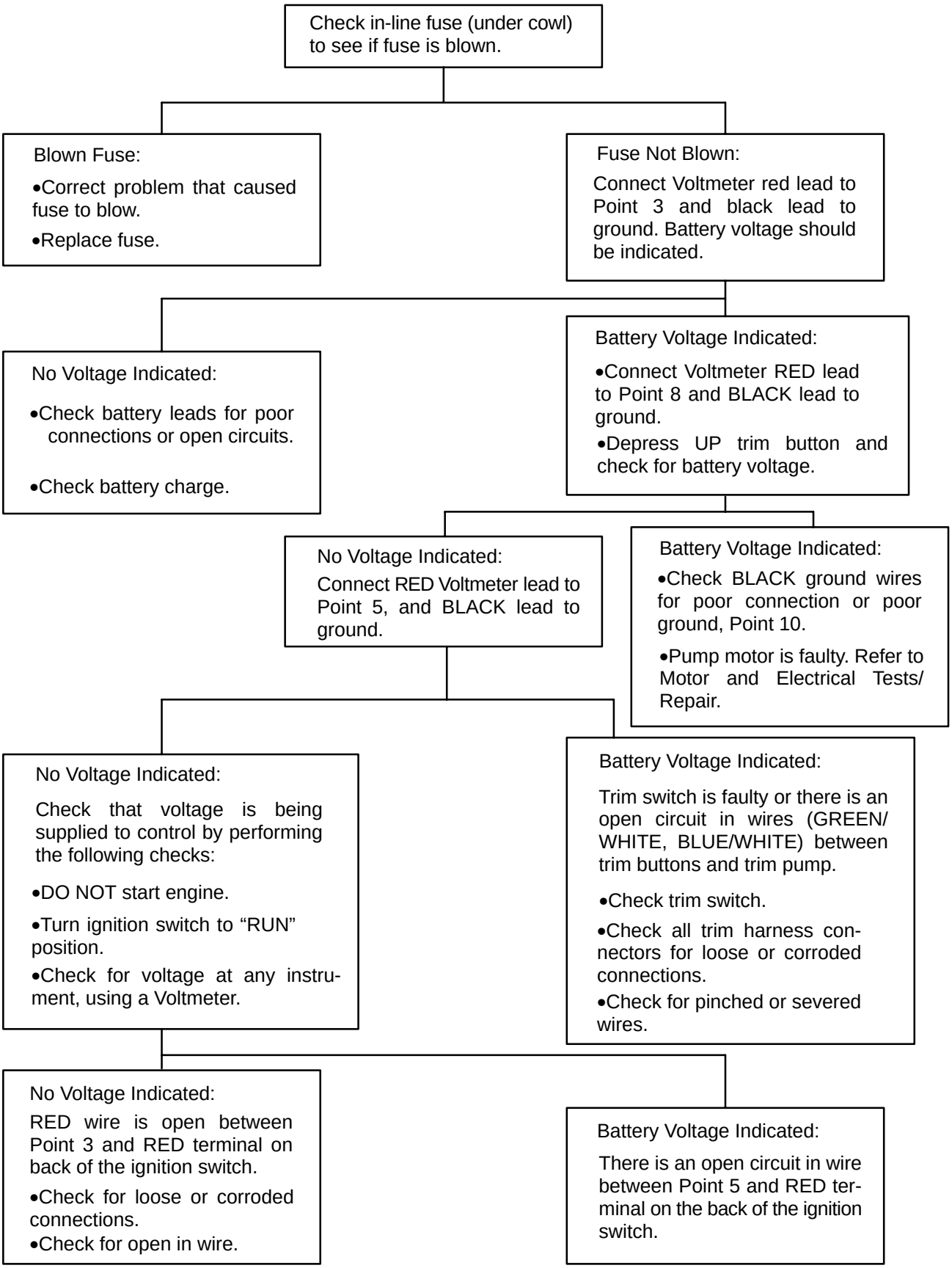
Troubleshooting the Down Circuit



Troubleshooting the Up Circuit



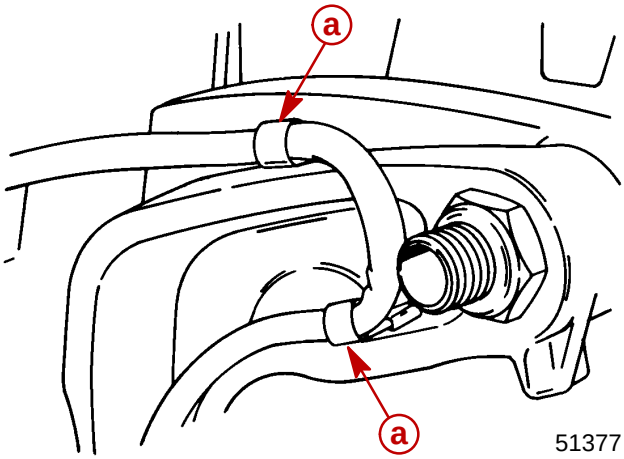
Troubleshooting the Down and Up Circuits (All Circuits Inoperative)



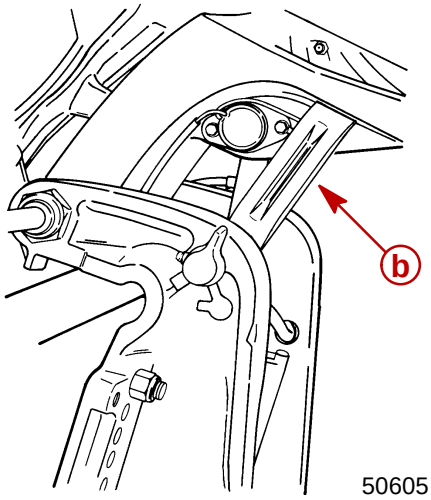
Power Trim Assembly Removal and Installation

Removal

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



51377

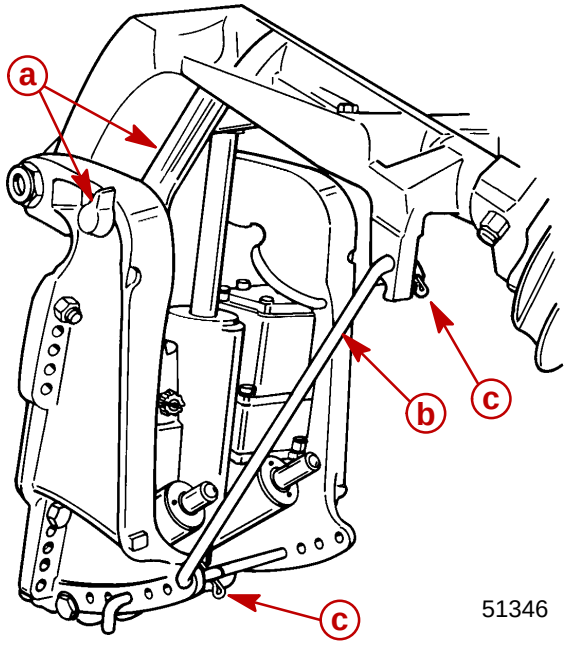


50605

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.



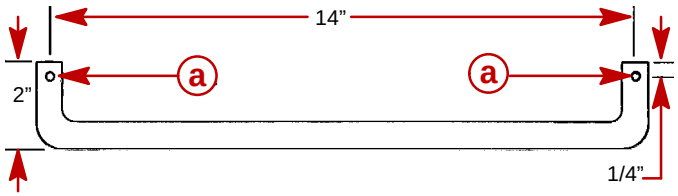
51346

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

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

SUPPORT TOOL

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



a - Drill holes for retaining clips

METRIC CONVERSION

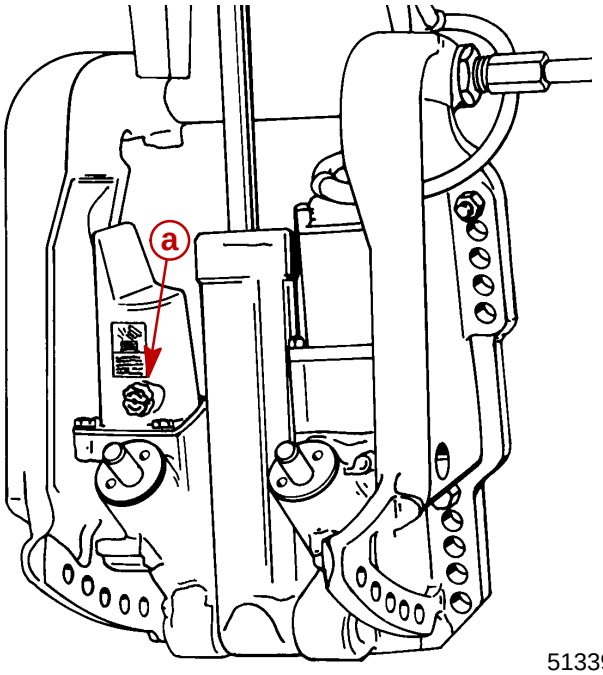
14 in. = 35.56 cm	2 in. = 50.8 mm
3/8 in. = 9.5 mm	1/4 in. = 6.35 mm

⚠ CAUTION

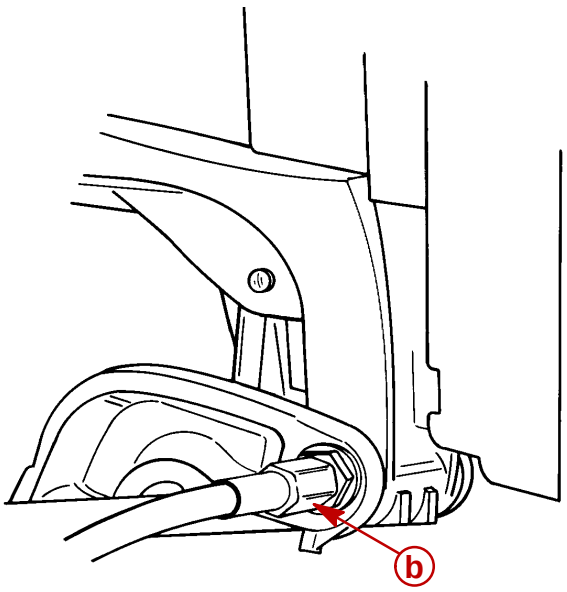
Disconnect battery cables at battery before removing power trim wires from solenoids.

3. Disconnect power trim wires at solenoids (BLUE, GREEN, and BLACK) or if relay style, disconnect (BLUE and GREEN) bullet connector harness.
4. Open filler cap and release any remaining pressure in the system.

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



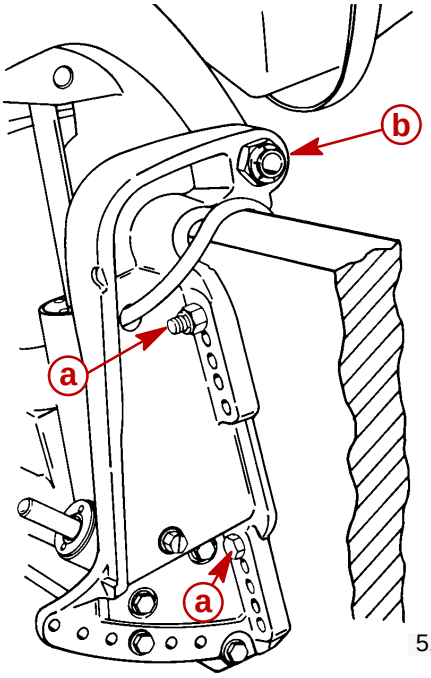
51339



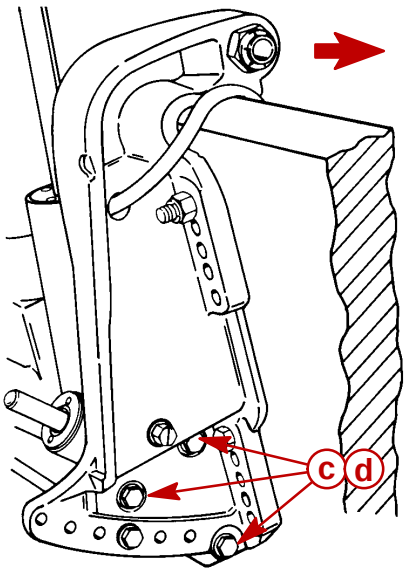
51354

a - Filler Cap
b - Retaining Nut

5. Remove outboard transom mounting bolts, and loosen tilt tube nut until nut is flush with end of tilt tube thread.
6. Remove 3 screws and washers and remove starboard transom bracket.



51375

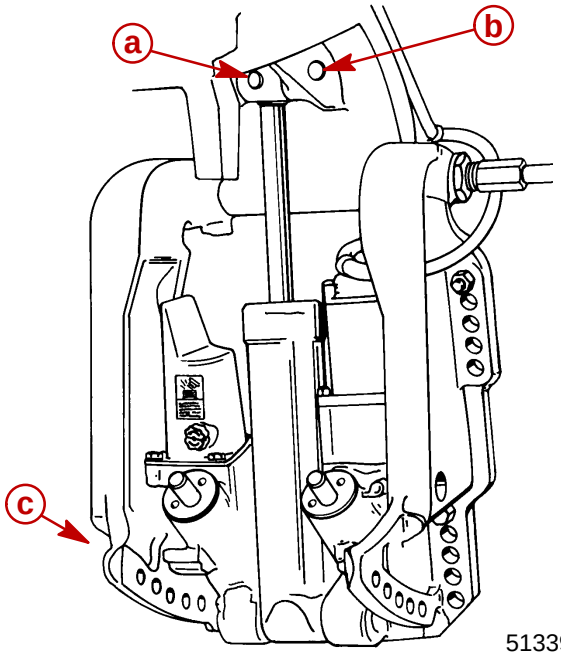


51375

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

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

7. Drive out cross pin, push out upper swivel pin, and remove 3 screws and washers retaining trim system. Remove system from outboard.

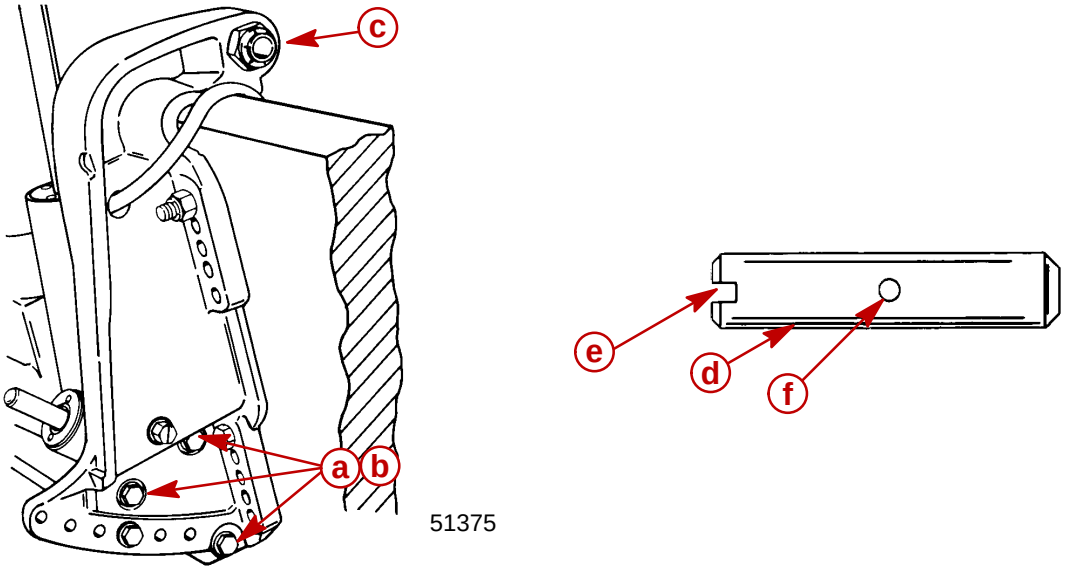


51339

a - Cross Pin
b - Upper Swivel Pin
c - Port Transom Bracket Screws and Washers (3)

Installation

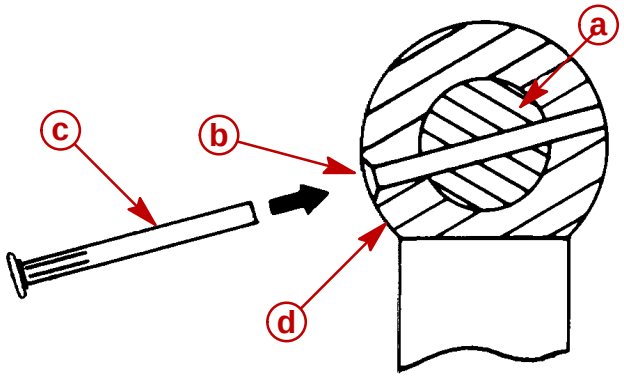
1. Paint any exposed metal surfaces to prevent corrosion.
2. Apply Loctite 271 to screws. Install trim system, starboard transom bracket, and tilt tube nut.
3. Use a 12 volt power source to extend tilt ram up to align upper swivel shaft hole and end of ram. Connect trim motor wires [BLUE wire to POSITIVE (+), BLACK wire to NEGATIVE (–)]. If ram extends too far, retract ram by connecting GREEN wire to POSITIVE (+).
4. Install Upper Swivel Pin with slotted end to left (port) side of engine.



a - Screw (6) Torque to 40 lb. ft. (54.0 Nm)
b - Lockwasher (6) Install one per screw
c - Tilt Tube Nut
d - Upper Swivel Pin
e - Slotted end
f - Cross hole (in line with slotted end)

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

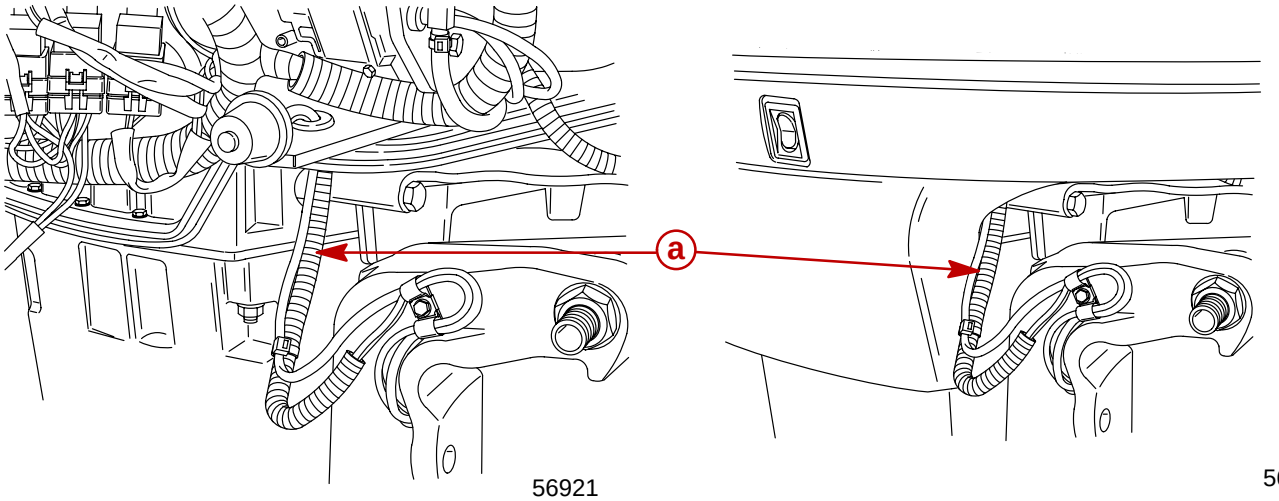
5. Position slot on end of swivel shaft in line with hole in tilt ram end. Insert a punch into tilt ram hole to align cross hole in upper swivel shaft. Tap new cross pin in until flush.



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

6. Connect trim motor wires to solenoids. Refer to Wiring Diagrams in this manual. Route trim wires as specified in this manual.

NOTE: *The 2 power leads going to the trim motor should be encapsulated with conduit tubing. If tubing has not been previously installed, order 32-828547-353 and cut to appropriate length.*



a - Conduit Tubing

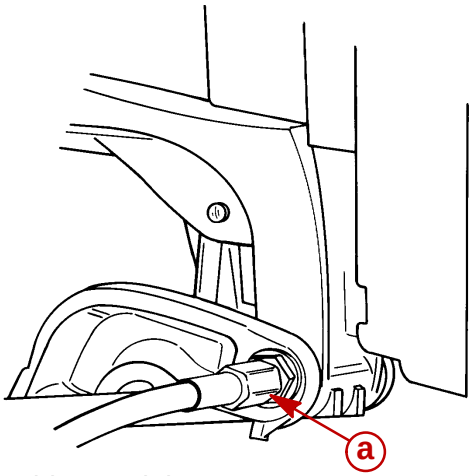
7. Apply marine sealer to shanks of mount bolts and install transom mount bolts.

IMPORTANT: Do not use an impact driver to tighten transom mount bolts.

8. Apply marine sealer to threads of transom mount bolts. Secure with flat washers and locknuts. Be sure installation is watertight.

9. 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

10. Apply Liquid Neoprene on all electrical connections.

⚠ WARNING

Electrical wires passing through cowl openings must be protected from chafing or being cut. Follow the recommended procedures outlined in Section 1D. 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.

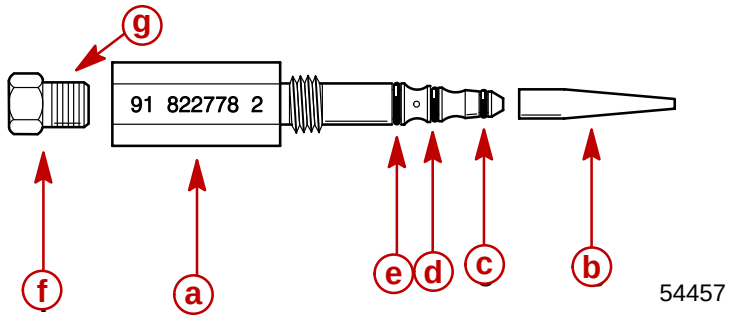
UP Pressure Check

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.

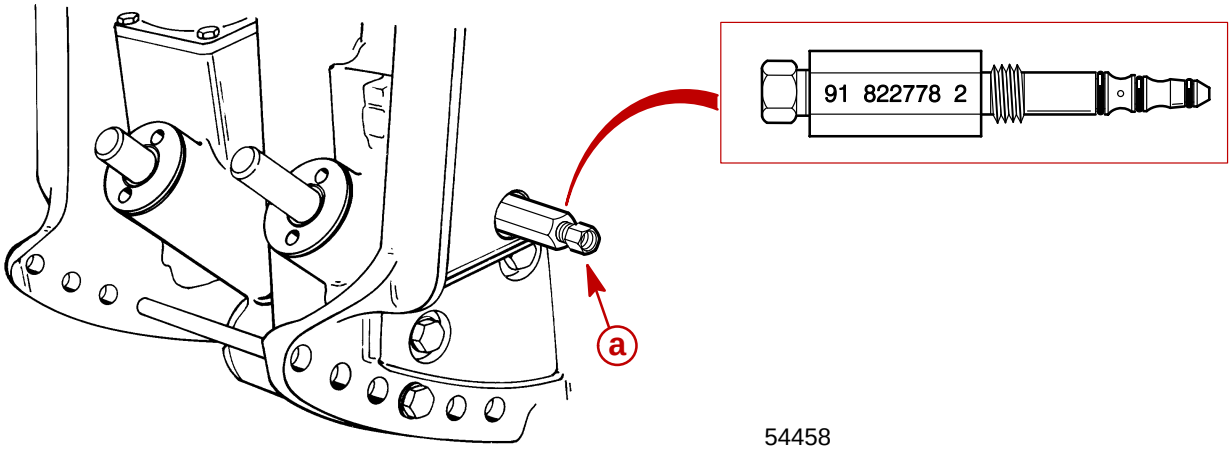
NOTE: *A small amount of trim fluid may drip from manual release valve hole. Place a suitable container under trim assembly to collect any leakage.*

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.*



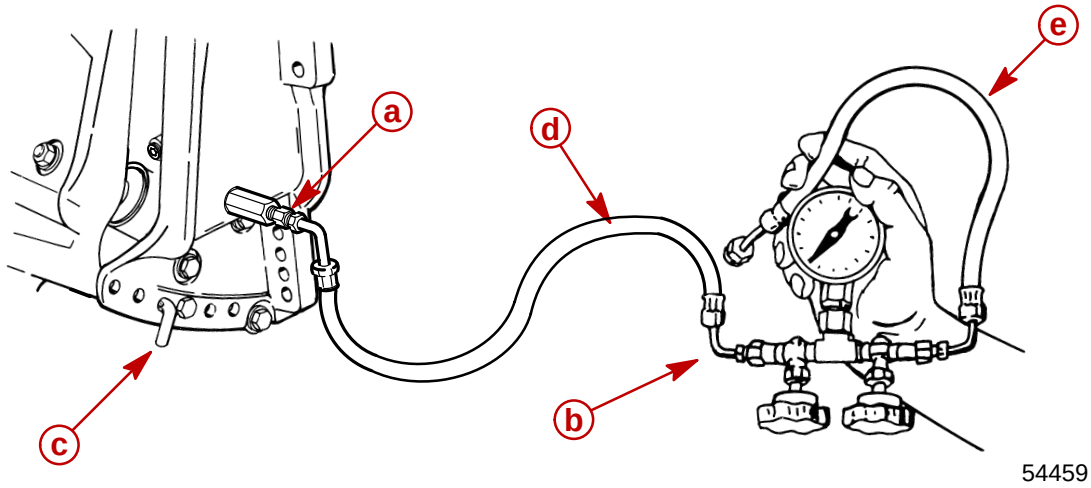
a - Test Adaptor (91-822778A2)
b - O-ring Installation Tool
c - Small O-ring (Install 1st)
d - Medium O-ring (Install 2nd)
e - Large O-ring (Install Last)
f - Brass Fitting
g - Apply Teflon Tape

4. Install test adaptor 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

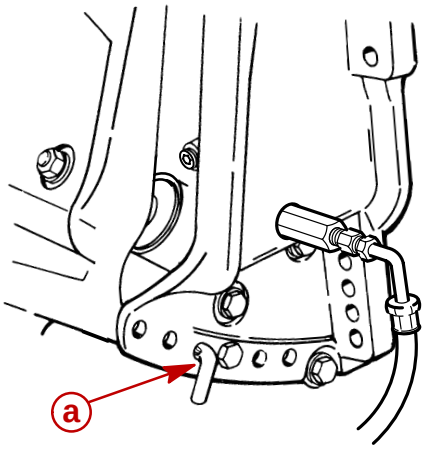
a - Brass Fitting
b - Test Gauge Assembly
c - Tilt Pin (Position in Hole Shown)
d - Hose
e - Hose (Not Used)

6. Reinstall fill plug.
7. Disengage tilt lock lever.

⚠ CAUTION

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

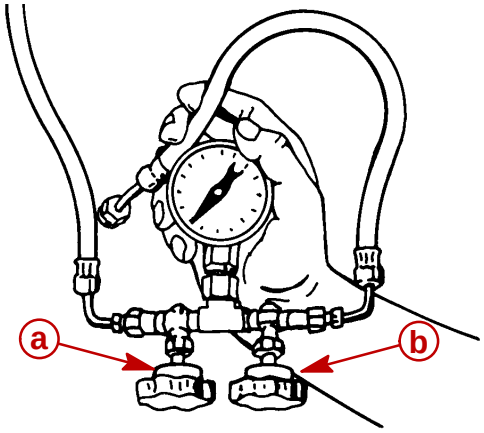
8. Move outboard IN until hole in swivel bracket ear aligns with the 3rd tilt hole in transom bracket. Lock engine in trim range by installing a 3/8 in. (9.5 mm) diameter tilt pin or two 3/8 in. (9.5 mm) hardened bolts and nuts through the transom brackets and swivel bracket in the hole shown.



54460

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

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



51374

10. Run trim UP. The minimum pressure should be 1300 P.S.I. (91 kg/cm^2).
11. Run trim DOWN to release pressure and remove spare tilt pin or bolts and nuts.
12. Tilt outboard full UP and engage tilt lock lever.
13. Slowly remove Fill plug to bleed pressure.
14. Remove test gauge hose and adapter.
15. Reinstall Manual Release Valve and secure valve with circlip.
16. Retighten Fill plug.

NOTE: *If pressure is less than 1300 PSI (91 kg/cm^2), troubleshoot system per instructions in Troubleshooting the Up Circuit.*

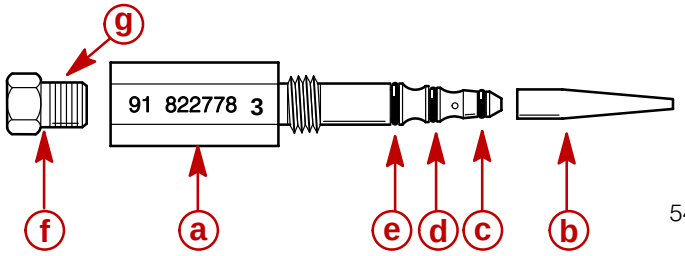
DOWN Pressure Check

IMPORTANT: Insure battery is fully charged before performing tests.

1. Tilt outboard to full Up position and engage tilt lock lever.
2. Slowly remove Fill plug to bleed pressure from reservoir.
3. Remove circlip securing manual release valve and unscrew release valve from trim assembly.

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

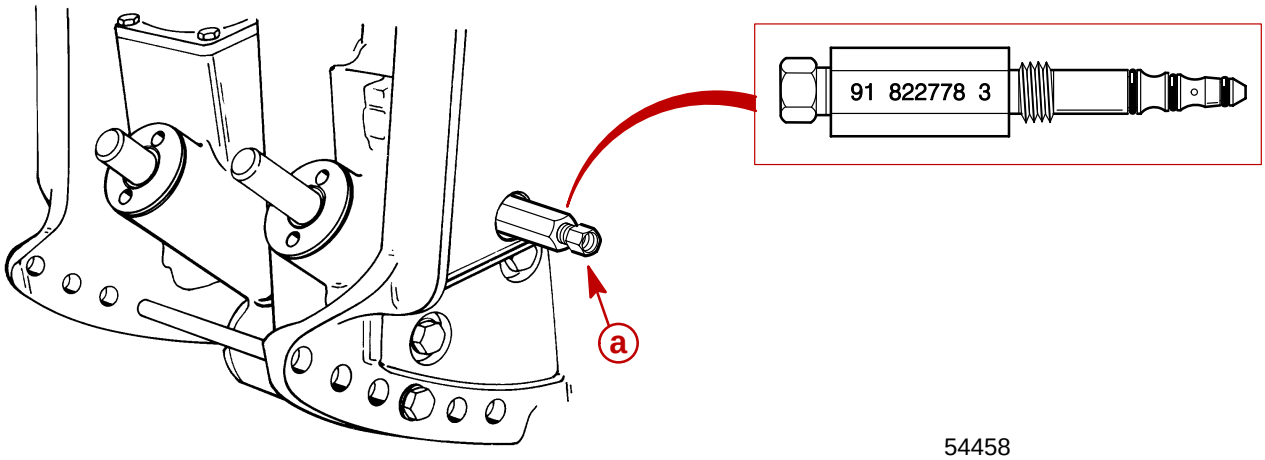
NOTE: *Assemble test adaptor by using O-ring installation tool to position small O-ring onto adaptor 1st, then install medium O-ring and lastly large O-ring. Thread brass fitting into test adaptor securely using teflon tape on threads.*



54457

a - Test Adaptor (91-822778A3)
b - O-ring Installation Tool
c - Small O-ring (Install 1st)
d - Medium O-ring (Install 2nd)
e - Large O-ring (Install Last)
f - Brass Fitting
g - Apply Teflon Tape

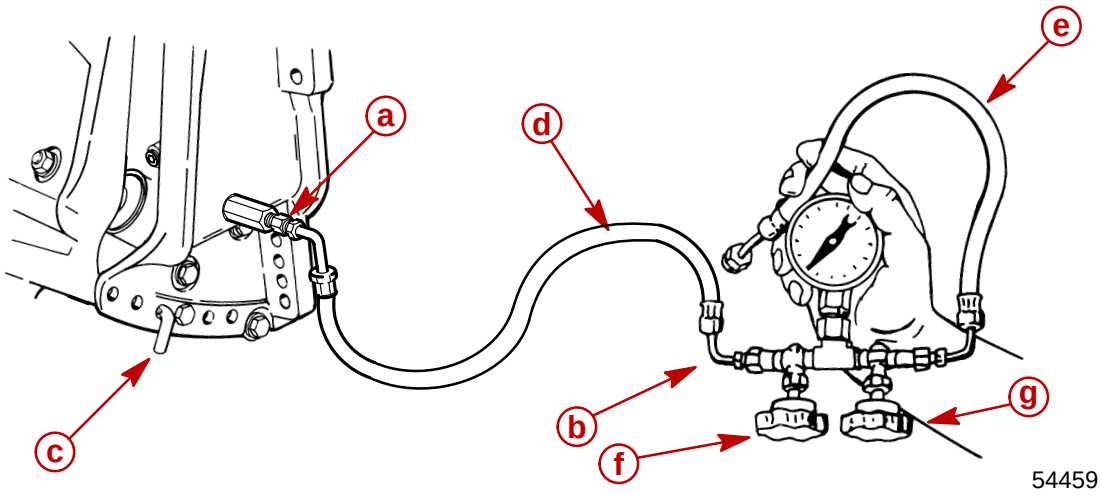
4. Install test adaptor into manual release valve hole.



54458

a - Test Adaptor (91-822778A3)

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



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

6. Reinstall fill plug.
7. Disengage tilt lock lever.
8. Open valve (f) and close valve (g).
9. Run trim DOWN. Minimum pressure should be 500 P.S.I. (35 kg/cm^2).
10. Tilt outboard full UP and engage tilt lock lever.
11. Slowly remove Fill plug to bleed pressure.
12. Remove test gauge hose and adaptor.
13. Reinstall manual release valve and secure valve with circlip.
14. Retighten Fill plug.

NOTE: *If pressure is less than 500 PSI (35 kg/cm^2), troubleshoot system per instructions in Troubleshooting the Down Circuit.*

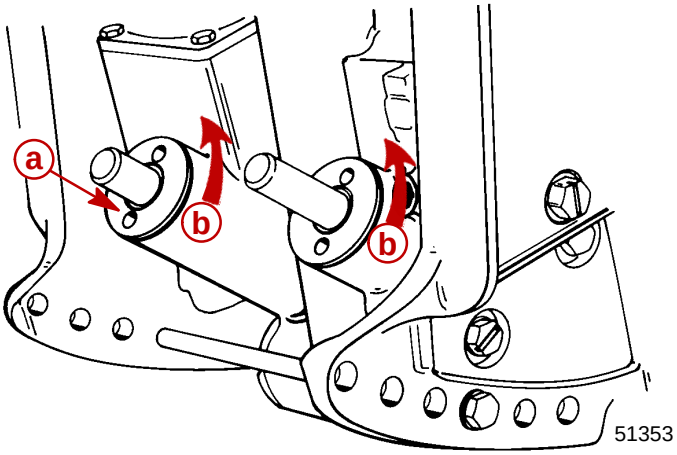
Hydraulic Repair

TRIM ROD REMOVAL AND REPAIR

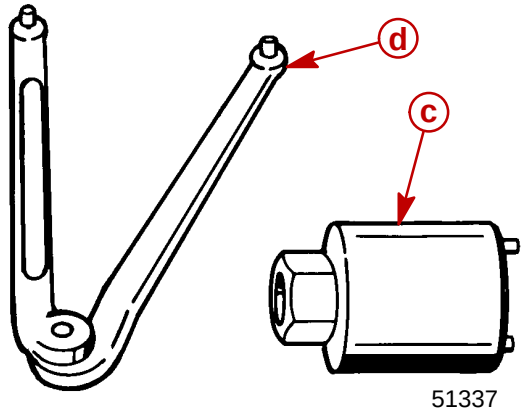
NOTE: *Power Trim does not have to be removed from outboard to remove trim rods.*

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

NOTE: *Place a clean pan under trim system to catch fluid.*



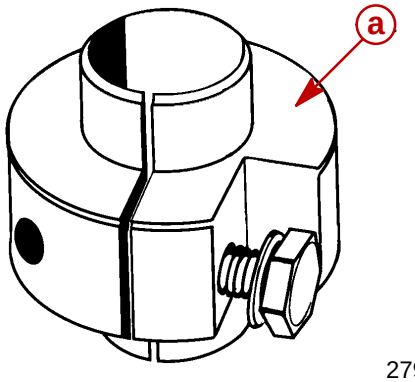
51353



51337

a - Trim Rod Cylinder Cap
b - Turn Counterclockwise to Remove
c - Removal Tool (91-44487A1)
d - Spanner Wrench (91-74951)

5. Install trim rod removal tool and pull trim rod from cylinder.



27933

a - Trim Rod Removal Tool (91-44486A1)

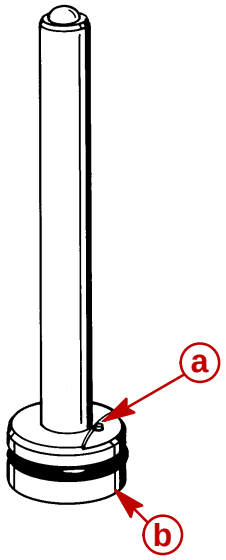
CLEANING AND INSPECTION - TRIM RODS AND CAPS

⚠ CAUTION

Do not remove check valve. 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.*

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

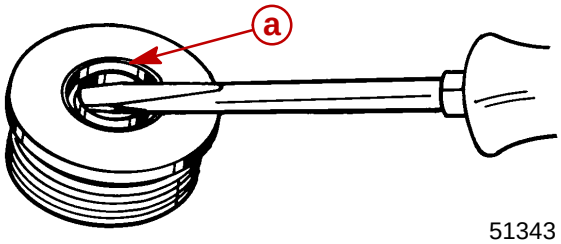


51352

a - Check Valve
b - Check Valve Screen

Trim Rod End Cap Seal

1. Inspect trim cap end seal and replace if damaged or if seal does not keep trim rod clean.



51343

a - Seal (remove as shown)

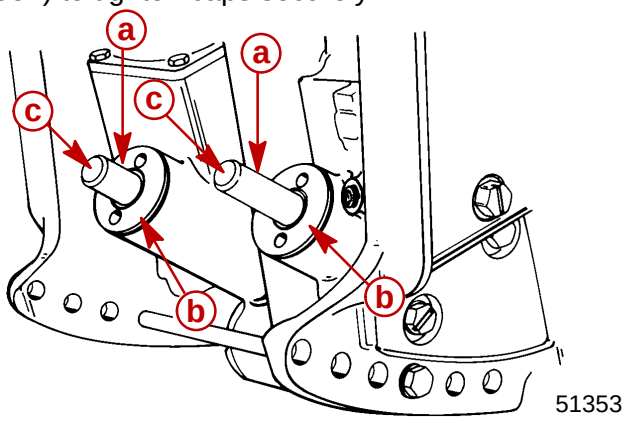
2. Install new seal with seal lip up.

TRIM ROD INSTALLATION

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

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

1. Apply 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.



51353

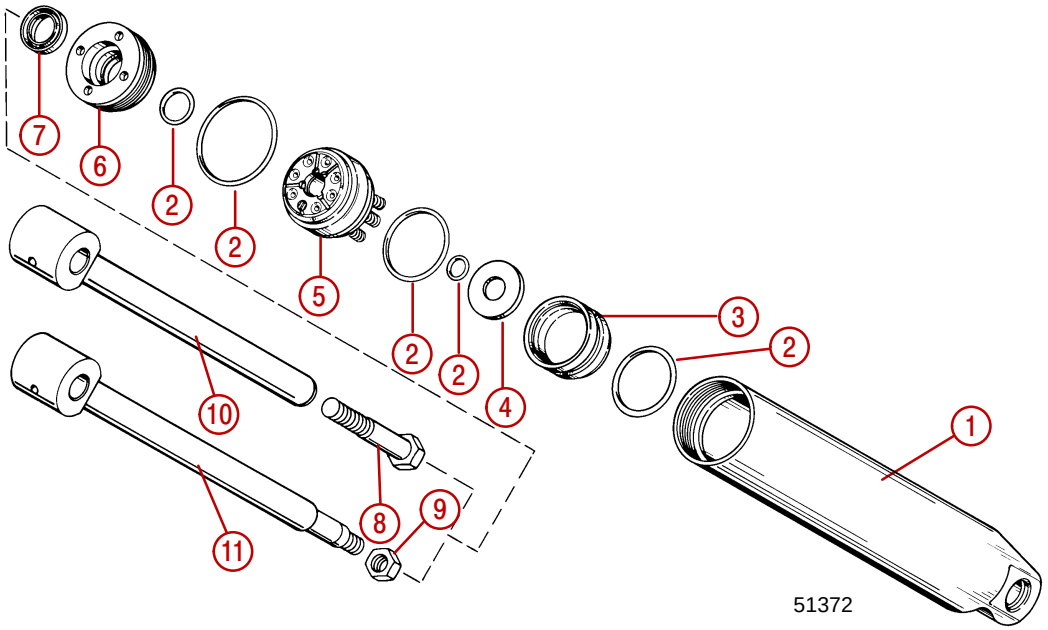
a - Trim Rods
b - Cylinder End Caps
c - Rod End Rollers (lubricate with Anti-Corrosion Grease or Special Lubricant 101)

Tilt Ram

REMOVAL - TILT ROD ASSEMBLY ONLY

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

TILT RAM COMPONENTS



1 - Housing - Tilt Ram
2 - O-ring* (5)
3 - Memory Piston**
4 - Washer
5 - Piston Assembly
6 - End Cap
7 - Oil Seal
8 - Bolt (Design 1)
9 - Nut (Design 2)
10 - Tilt Rod (Design 1)
11 - Tilt Rod (Design 2)

*O-ring Repair Kit Available, P.N. 811607A1 (Includes item 7, Oil Seal)

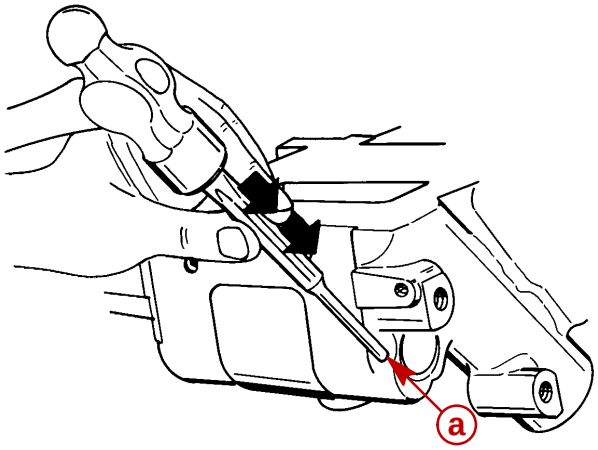
**Memory piston (3) for tilt rods (10 and 11) are different and must be used with correct tilt rod/cylinder assembly. Memory piston for Design 1 tilt rod is flat, Design 2 is dished to clear nut and thread.

TILT RAM REMOVAL - POWER TRIM SYSTEM REMOVED FROM OUTBOARD

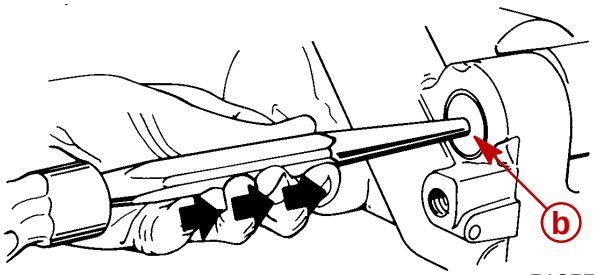
⚠ CAUTION

Insure trim system is depressurized prior to tilt ram removal.

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



51366

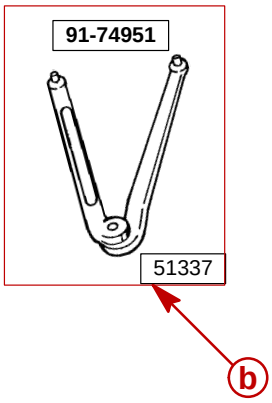


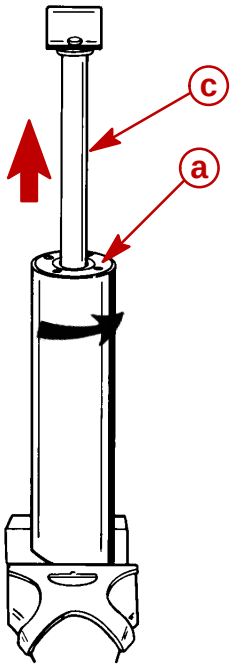
51355

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.

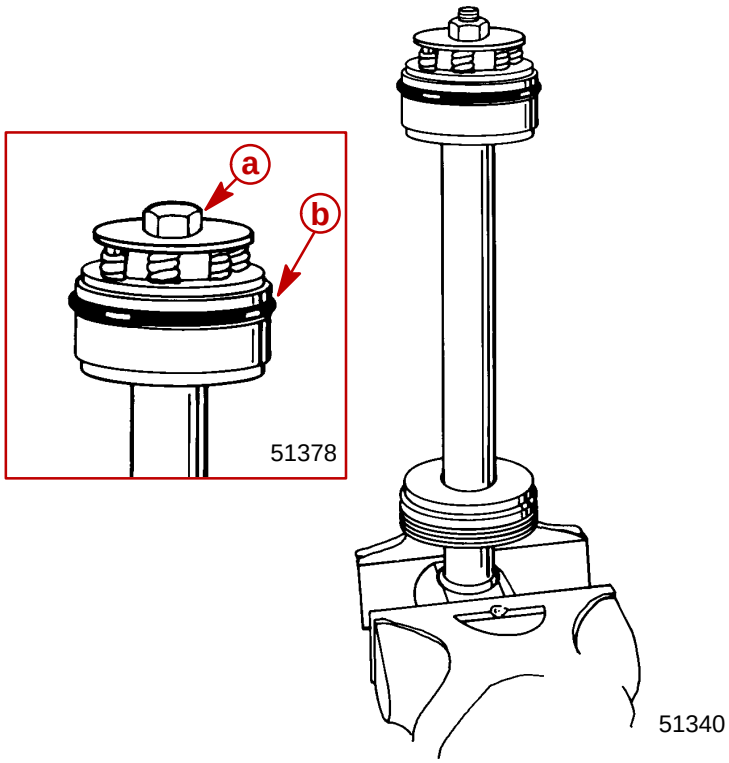




51364

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

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

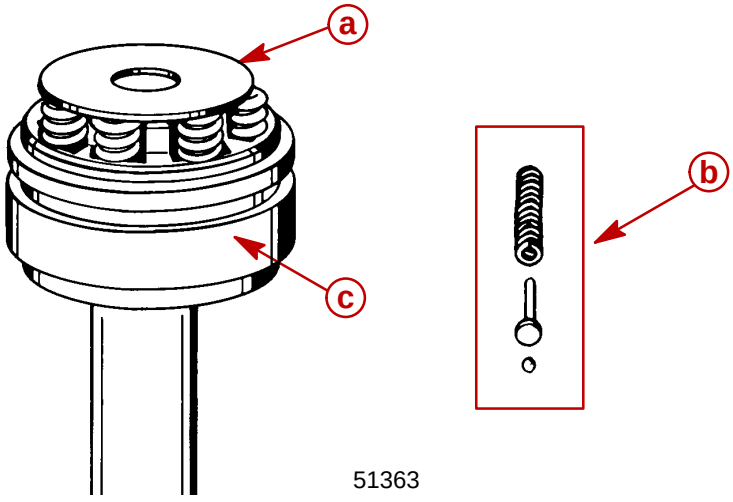


a - Bolt (Design 1) or Stud/Nut (Design 2)
b - O-Ring

IMPORTANT: Design 1 tilt rod assembly can be used to replace a Design 2 tilt rod assembly. Design 1 or Design 2 cylinder assemblies (complete) can be used as replacements. Design 2 WILL NOT fit a cylinder originally using a Design 1 tilt rod assembly. Memory Pistons for Design 1 and 2 differ also and must be used only on the cylinder the piston was removed from.

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

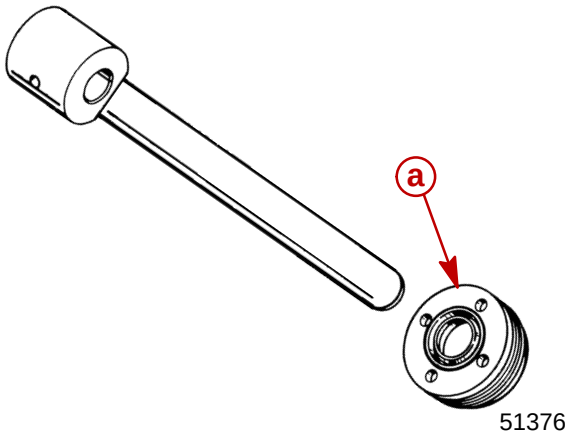
NOTE: *Check valve held in by roll pin can be cleaned but not removed.*



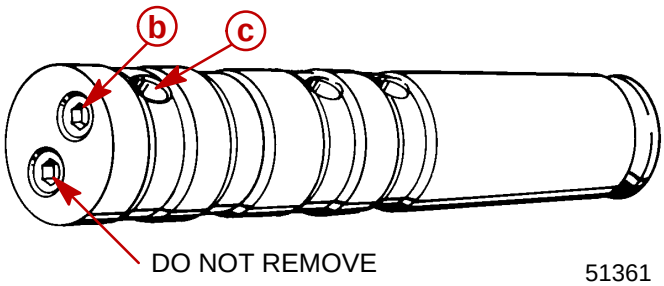
a - Washer
b - Check Valve Assembly (7)
c - Piston

4. Remove end cap from tilt rod.
5. Remove allen plug.

IMPORTANT: Remove plug from same side as holes in shaft.



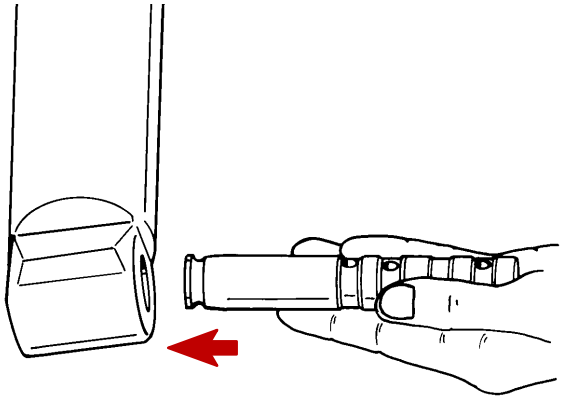
51376



51361

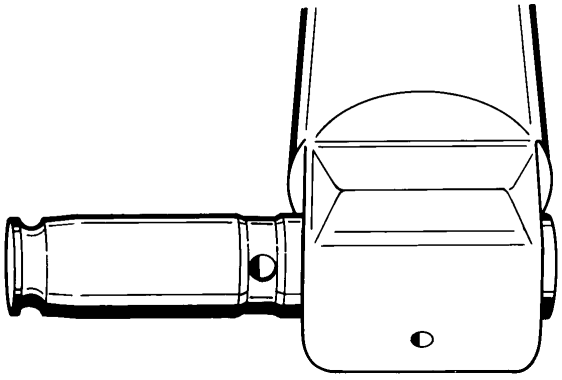
a - End Cap
b - Allen Plug
c - Hole In Shaft

6. Lubricate shaft with Power Trim and Steering Fluid. Insert shaft into cylinder.



51342

7. Tap shaft into cylinder until shaft is positioned as shown.

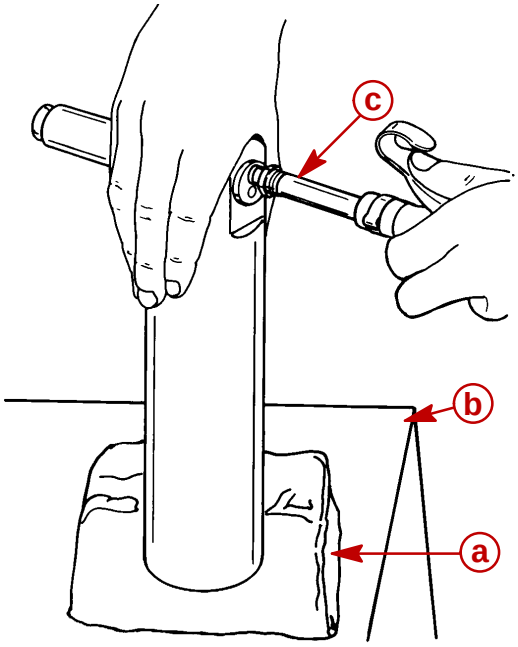


51365

⚠ WARNING

Memory Piston Cup may be expelled at a high velocity when air pressure is applied. Failure to place cylinder as shown below could result in personal injury.

8. Place cylinder as shown. Hold down on cylinder and inject air into shaft opening.



51353

a - Shop Cloth
b - Solid Surface
c - Air Nozzle

9. Remove shaft after Memory Piston Cup has been expelled. Replace allen plug removed in Step 5 and tighten securely.

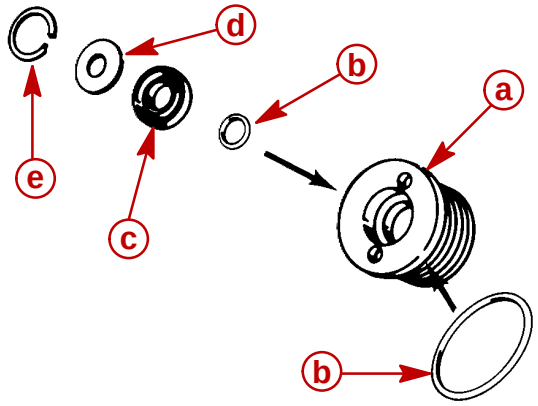
CLEANING AND INSPECTION

1. Inspect all internal parts for damage or wear. Clean and replace parts as necessary.
2. Inspect tilt rod for scratches. Replace scraper seal in rod end cap if tilt rod is scratched or worn.

NOTE: *Slight scratches or tool marks less than 0.005 in. (0.1 mm) deep in cylinder are acceptable.*

Scraper Seal Replacement

1. Remove components from end cap.



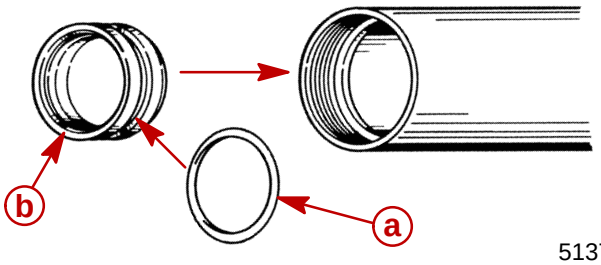
a - Cap
b - O-ring (2)
c - Scraper Seal
d - Washer
e - Retaining Ring

REASSEMBLY

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

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

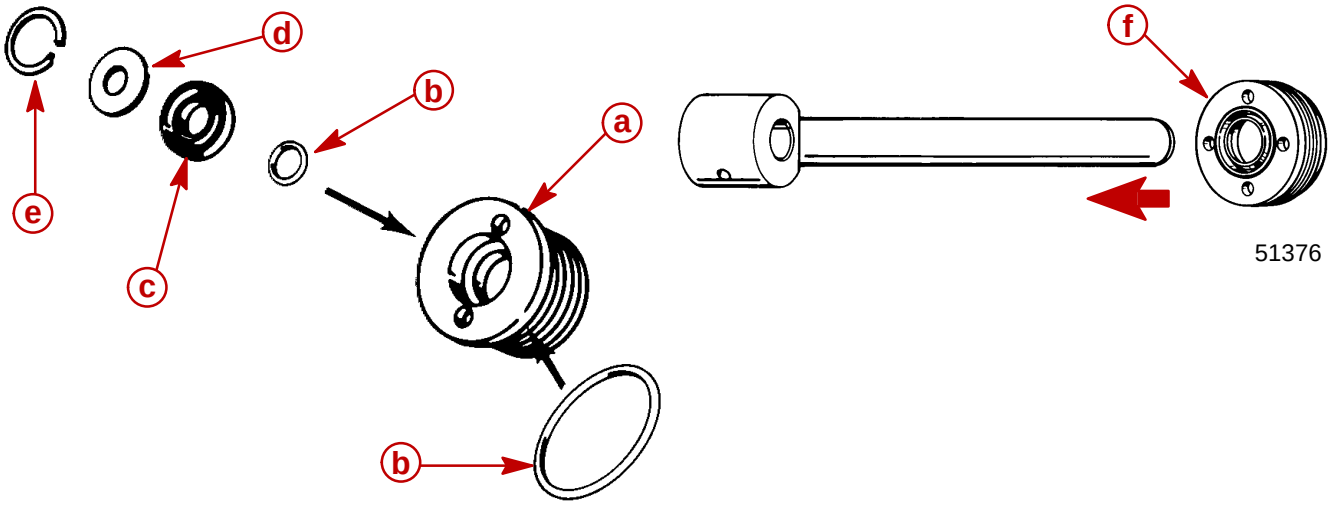
1. Apply Power Trim and Steering Fluid on O-rings prior to reassembly.
2. Install O-ring on Memory Piston Cup and install in cylinder.



51372

a - O-ring
b - Memory Piston Cup (Design 1 shown)

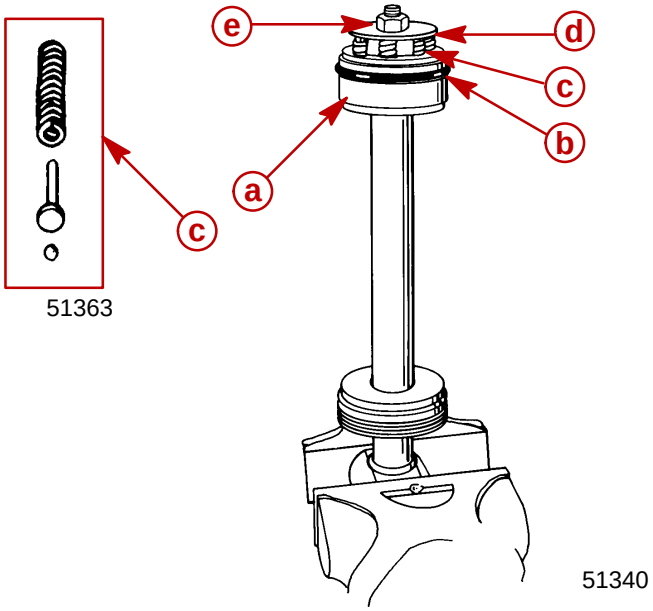
3. Assemble and install end cap.



51376

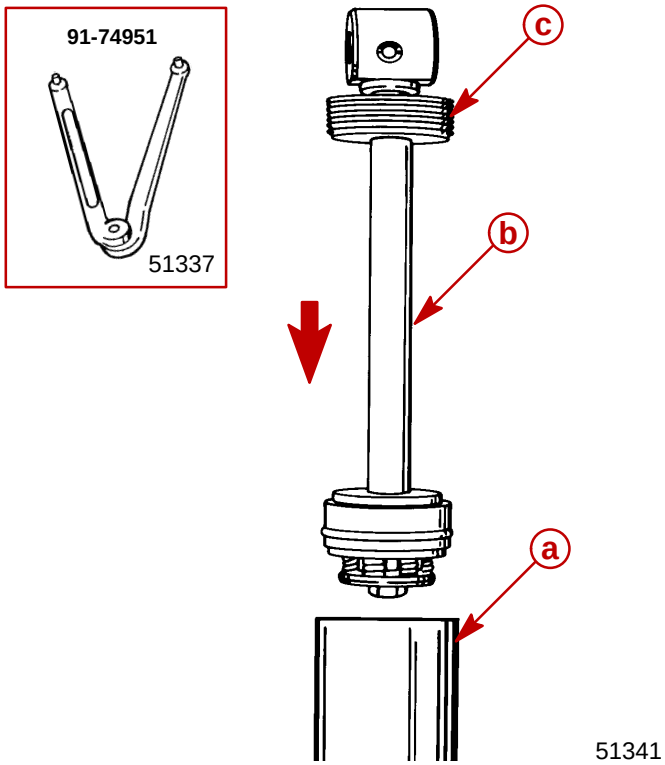
a - End Cap
b - O-Ring (2)
c - Scraper Seal
d - Washer
e - Retaining Ring
f - End Cap

4. Install components on rod.



a - Piston
b - O-ring
c - Check Valve Assembly (7)
d - Washer
e - Bolt or Locknut. (Tighten securely)

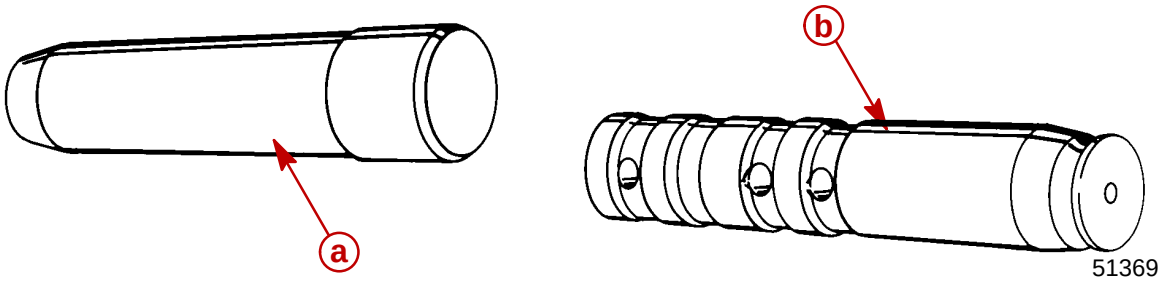
5. Clamp cylinder in a soft jawed vise and install tilt rod assembly. Use spanner wrench and tighten end cap securely.



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

TILT RAM ASSEMBLY INSTALLATION

1. Lubricate alignment tool and shaft with Power Trim and Steering Fluid.

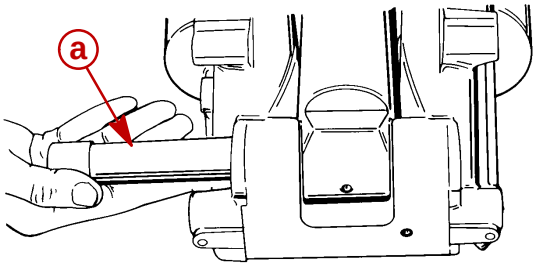


51369

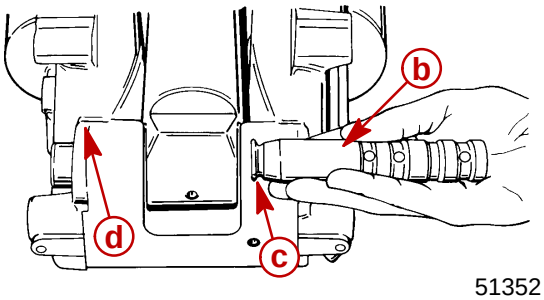
a - Alignment Tool (91-11230)
b - Shaft

2. Align tilt ram and housing using alignment tool.

3. Install shaft.



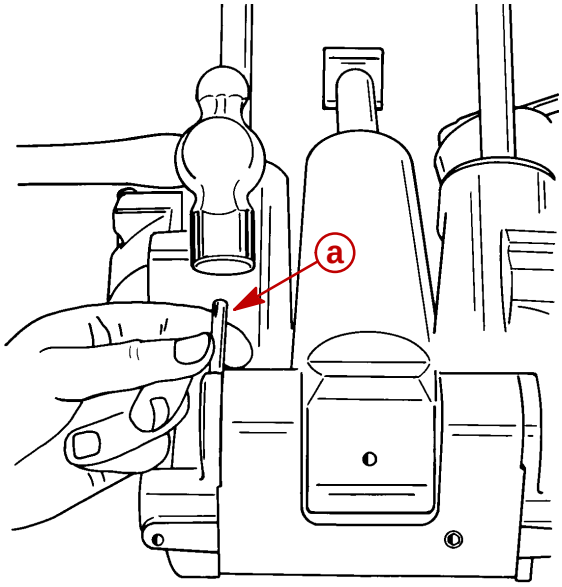
51348



51352

a - Alignment Tool (91-11230)
b - Shaft
c - Groove
d - Hole [Groove (c) will Align with this Hole]

4. Drive pin in until flush.



51356

a - Pin (Drive Against Knurled End)

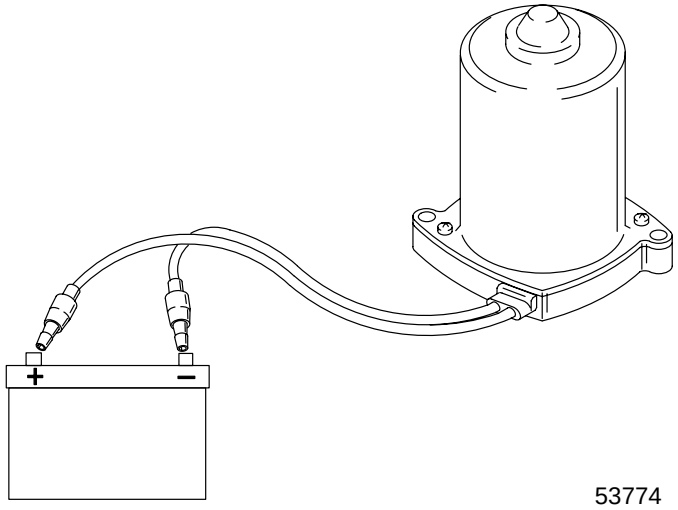
Motor and Electrical Tests/Repair

Trim Pump Motor Test

⚠ WARNING

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

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

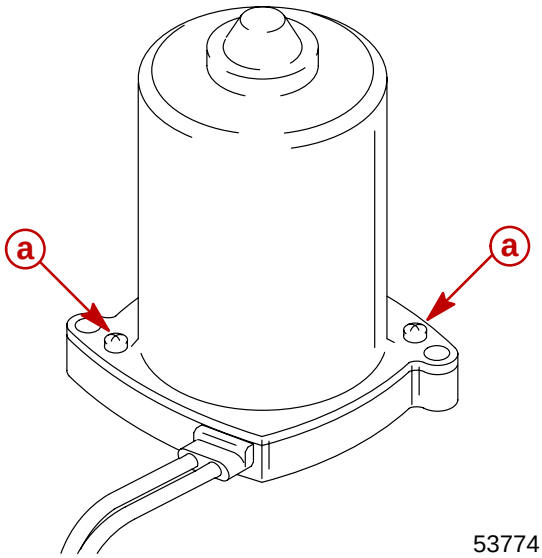


53774

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

Motor Disassembly

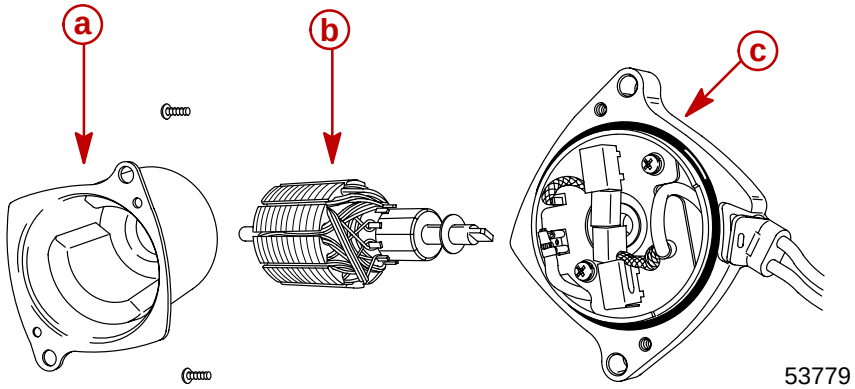
1. Remove 2 screws.



53774

a - Screw (2)

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



a - Frame
b - Armature
c - End Cap

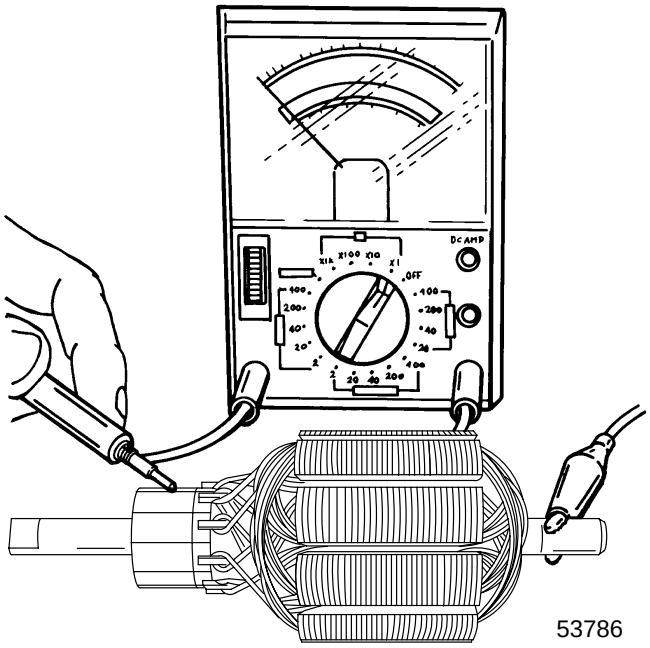
Armature Tests

TEST FOR SHORTS

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

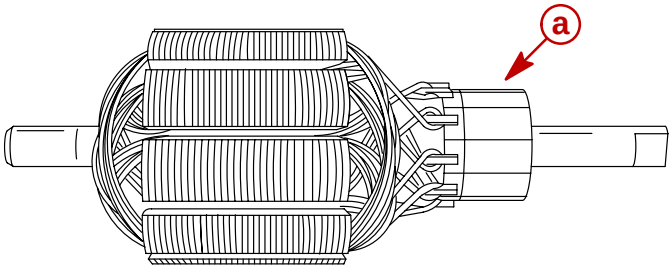
TEST FOR GROUND

1. Use an Ohmmeter (Rx1 scale). Connect one lead on armature shaft and other lead on commutator. If continuity is indicated, armature is grounded. Replace armature.



CHECKING AND CLEANING COMMUTATOR

1. If commutator is worn it may be turned on an armature conditioner or a lathe.
2. Clean commutator with “OO” sandpaper.



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 BLACK Motor Wires	0	(Rx1)
BLACK Motor Wire, and Frame (Motor Housing)	No Continuity	(Rx1)
BLUE Motor Wire and Frame	No Continuity	(Rx1)

*If specified readings are not obtained, check for:

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

If defective components are found, repair or replace components and retest.

Motor Repair

REMOVAL

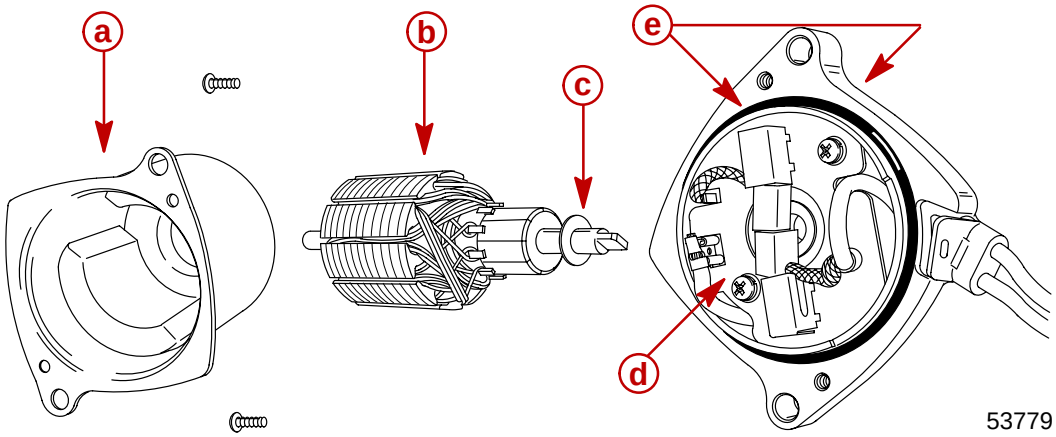
NOTE: *Power Trim System does not have to be removed from outboard to repair/replace motor.*

DISASSEMBLY

Refer to **Motor Disassembly** to disassemble motor from pump.

CLEANING AND INSPECTION

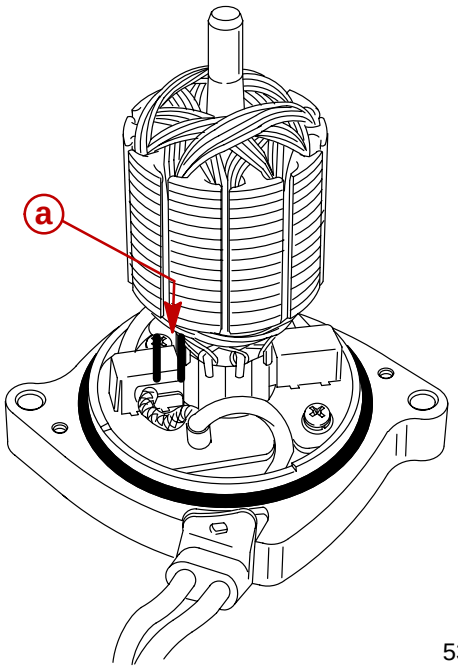
Inspect O-rings and replace if necessary. Carefully inspect power cord for cuts or tears which will allow water to enter motor. Replace cord if cut or torn. Clean, inspect, and test motor components. Refer to **Brush Replacement**, **Armature Test**, and **Field Tests** for inspection and test procedures.



a - Frame
b - Armature
c - Shim
d - Brush Card Assembly
e - O-rings

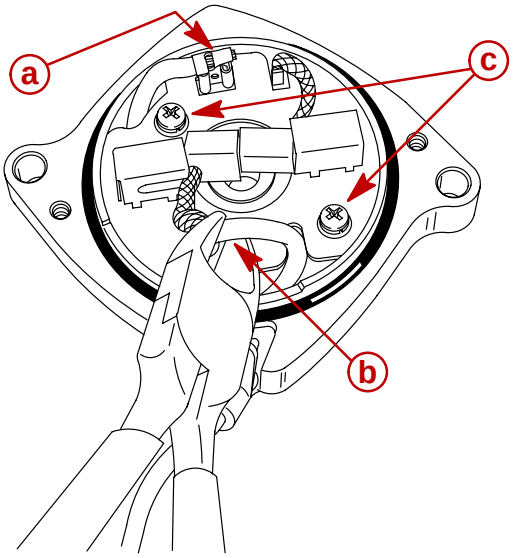
BRUSH REPLACEMENT

1. Brush replacement is required if brushes are pitted, chipped, or if distance (a) between the brush pigtail and end of brush holder slot is 1/16 in. or less. Check distance with armature installed.



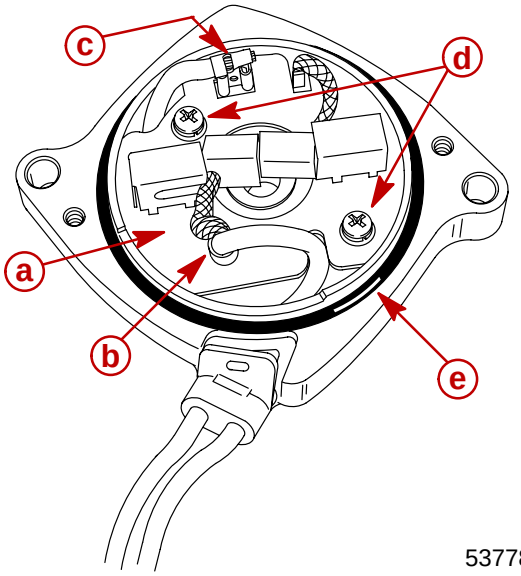
a - 1/16 in.

2. To replace brush card, disconnect spade terminal.
3. Cut crimped brush lead.
4. Remove 2 screws securing brush card to end cap.



a - Spade Terminal
b - Crimped Brush Lead
c - Screws

5. Install new brush card (BRUSH and SEAL KIT 828714A1).
6. Crimp metal connector onto motor lead and new brush lead.
7. Connect spade connector motor lead to brush card connector.
8. Secure brush card to end cap with 2 screws and lockwashers.
9. Inspect O-ring for cuts and abrasions. Replace O-ring as required (BRUSH and SEAL KIT 828714A1).

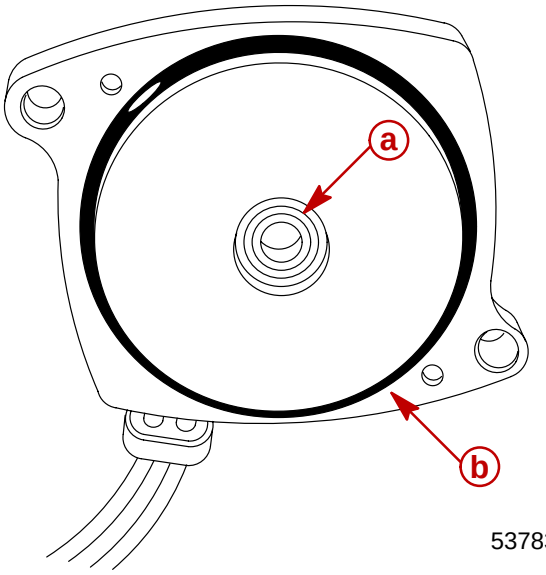


53778

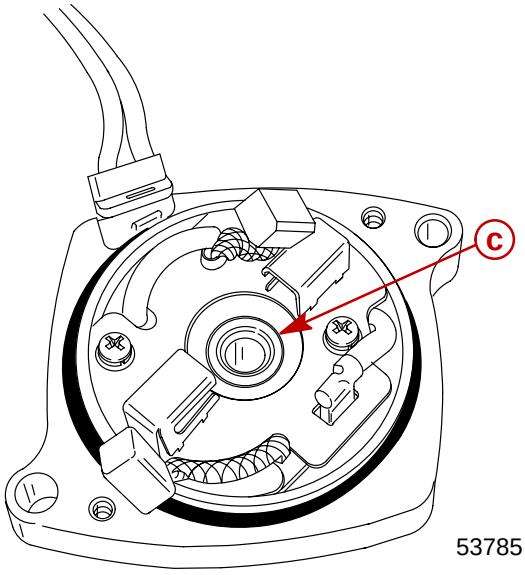
a - Brush Card
b - Metal Connector
c - Spade Connector
d - Screws and Lockwashers
e - O-ring

END CAP INSPECTION

1. Inspect seal and O-ring for cuts and abrasions. If replacement is required, install BRUSH and SEAL KIT 828714A1.
2. Inspect bushing for wear. If bushing appears to be excessively worn – grooves, scratches, etc. – install END FRAME ASSEMBLY (COMPLETE) 828715A1.



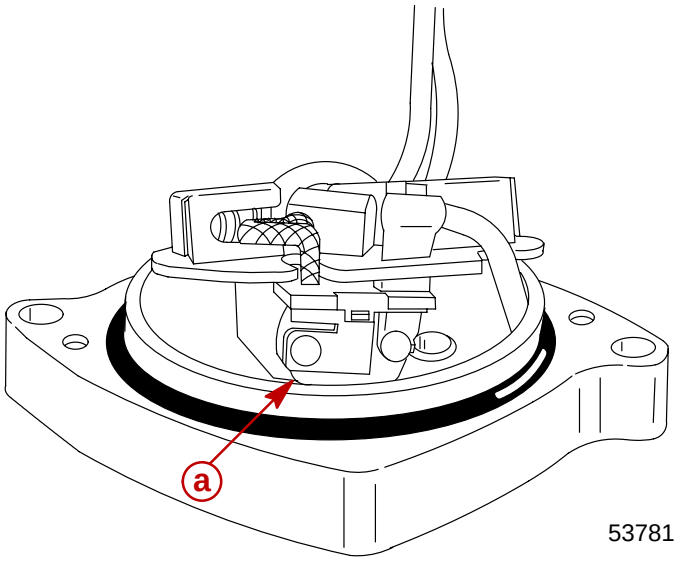
53783



53785

a - Seal (Apply 2-4-C with Teflon to seal lips)
b - O-ring
c - Bushing

3. If trim motor is overheated, a thermoswitch located under brush card will open. Normally, this switch will reset itself within 1 minute.



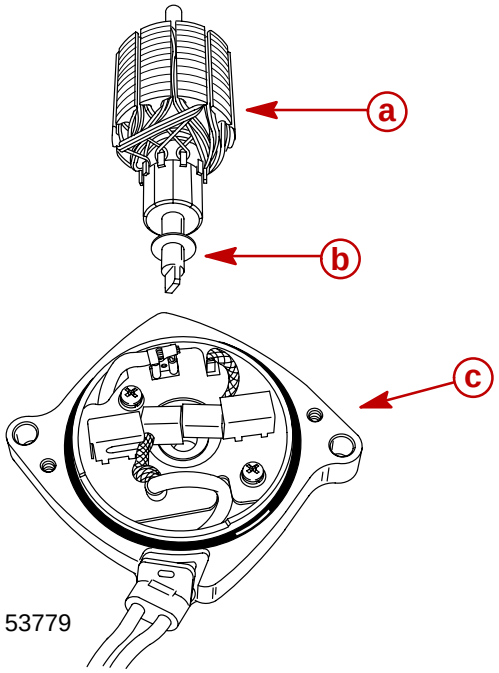
53781

a - Thermoswitch

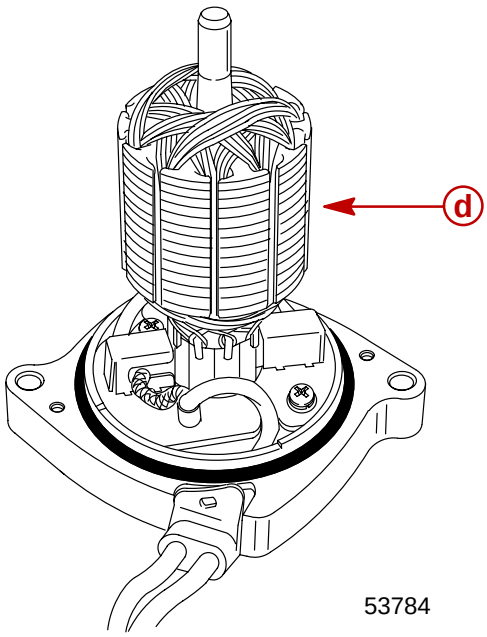
Reassembly

IMPORTANT: Components must be clean. Any debris in power trim system can cause system to malfunction.

1. Install armature into end cap/brush card assembly.



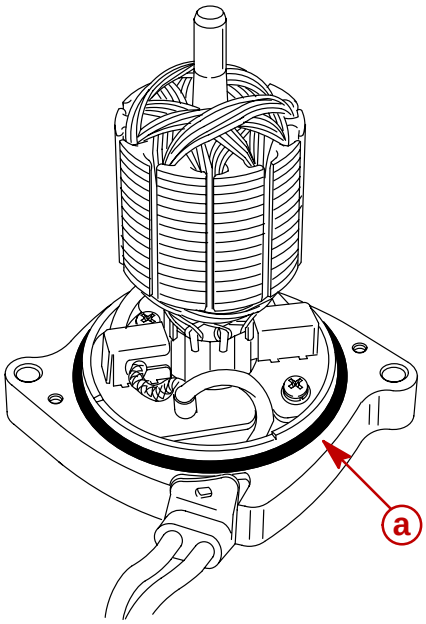
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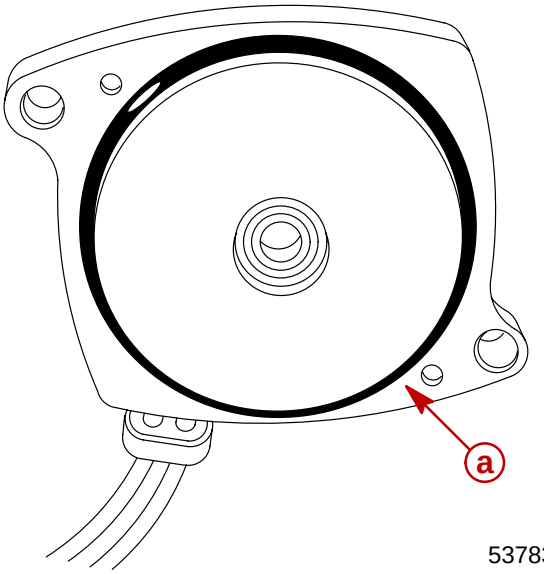
53784

a - Armature
b - Shim
c - End Cap Assembly
d - Armature (Spread brushes to install armature into end cap)

2. Install O-rings in end cap.



53784

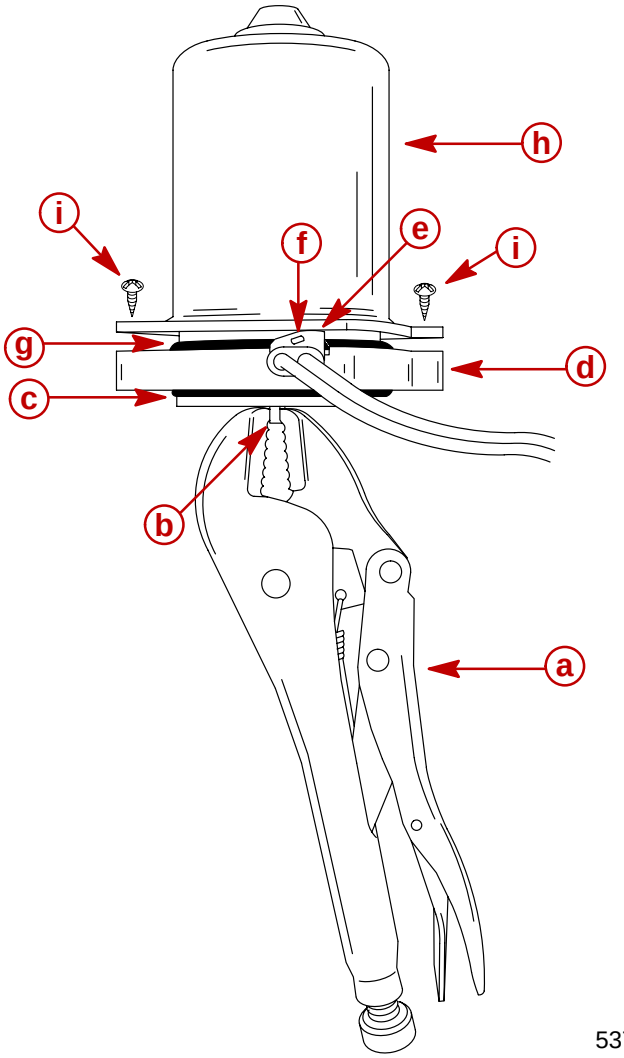


53783

a - O-rings

IMPORTANT: Attach Vise Grip® pliers to armature shaft before installing frame assembly. The Vise Grip® pliers will prevent the armature from being drawn out of the brush card assembly by the frame magnets while installing the frame assembly.

3. Install Vise Grip® pliers on armature shaft.
4. Carefully install frame assembly over armature.
5. Position harness retainer hole over tab in end cap.
6. Secure frame assembly to end cap with 2 screws.



53776

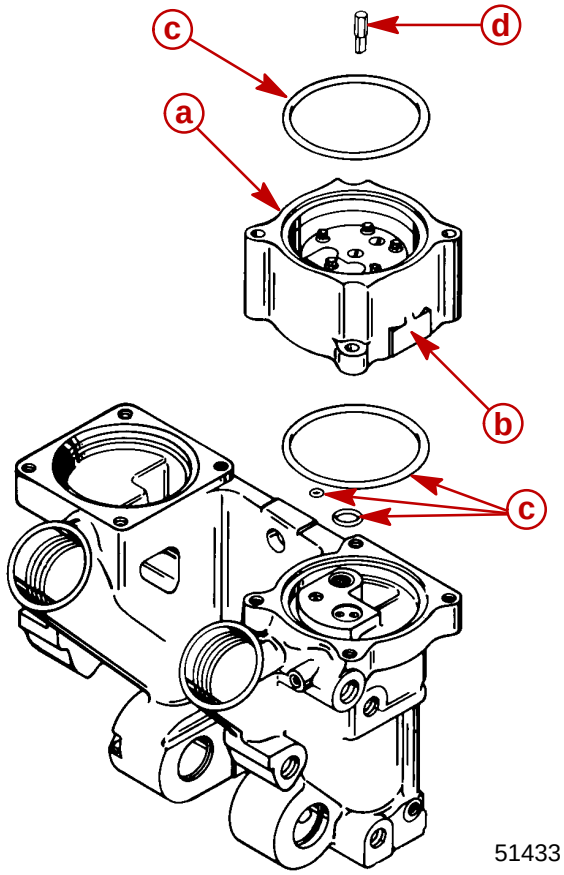
a - Vise Grip® Pliers
b - Armature Shaft
c - O-ring
d - End Cap
e - Harness Retainer
f - Retainer Hole
g - O-ring
h - Frame Assembly
i - Screws

Reassembly - Motor and Pump

NOTE: *Drive shaft is a loose part and may fall out of position.*

1. Install pump onto power trim manifold. Insure O-rings are in proper locations. Secure with two (2) screws. Torque screws to 80 lb. in. (9 Nm).

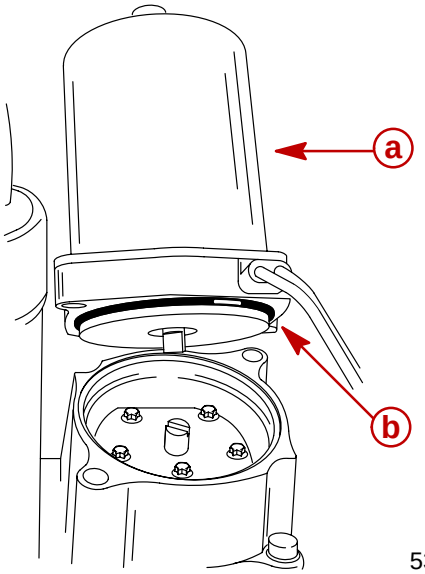
IMPORTANT: Install pump with location flat facing towards starboard transom bracket.



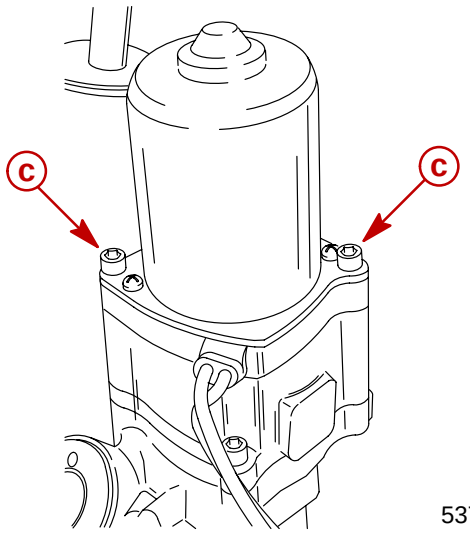
a - Pump (Flat Towards Starboard Transom Bracket)
b - Flat - Faces Starboard Transom Bracket)
c - O-rings (4)
d - Drive Shaft (Install in **Center** Hole in Pump)

2. Fill pump with Power Trim and Steering Fluid prior to installing motor.
3. Install motor, secure with two (2) screws. Route wiring; refer to Wiring Diagrams in this service manual.

NOTE: *Verify motor and drive shaft are aligned.*



53782



53777

a - Motor
b - O-ring
c - Screw (2) Tighten securely.

4. Complete reassembly of Power Trim System as outlined in **Installation**.

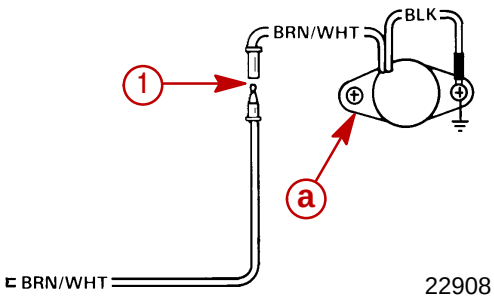
Priming Power Trim System

1. Fill system with Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) Type F,FA, Dexron II or Dexron III. Refer to **Fill, Check, and Purge**.

IMPORTANT: Run Trim System in short jogs until pump motor primes and trim system moves. If trim motor is run without priming pump, drive shaft failure could result.

Trim Sender Test

1. Check trim sender black lead for proper ground.
2. Trim outboard to full DOWN position.
3. Place ignition switch to ON position.
4. Disconnect BROWN/WHITE trim sender wire from trim sender harness.
5. Connect Ohmmeter (Rx1 scale) leads between outboard ground and Point 1 (trim sender end).
6. Depress UP button. Ohmmeter needle should move as the outboard is trimmed up. If needle does not move, trim sender is defective.

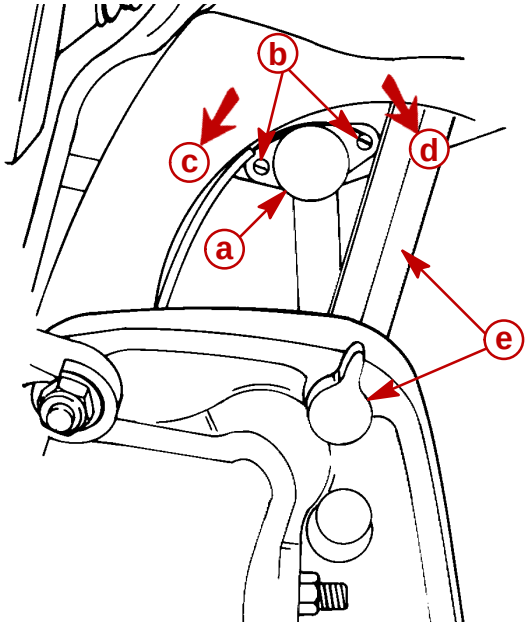


22908

a - Trim sender

Trim Indicator Gauge Needle Adjustment

1. Turn ignition key to RUN position.
2. Tilt outboard to full IN position. Needle of trim indicator gauge should be in full IN position.
3. If not, tilt outboard to full OUT position to gain access to trim sender and engage tilt lock lever.
4. Loosen trim sender screws and reposition trim sender.
5. Tighten trim sender screws.

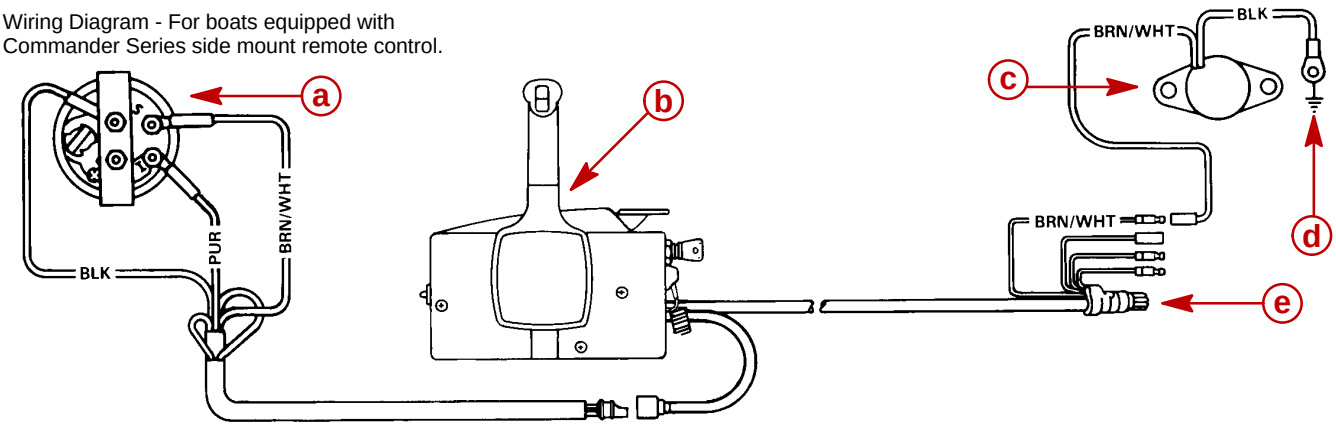


22744

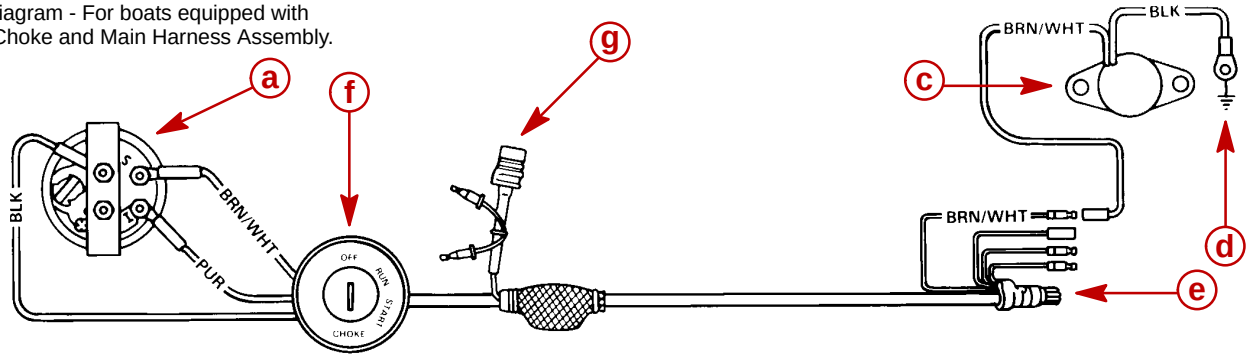
a - Trim Sender
b - Screws, Loosen to Rotate Sender
c - Turn Sender **Counterclockwise** to raise needle reading
d - Turn Sender **Clockwise** to Lower Needle Reading
e - Tilt lock lever

Trim Indicator Wiring Diagrams

Wiring Diagram - For boats equipped with Commander Series side mount remote control.



Wiring Diagram - For boats equipped with Ignition/Choke and Main Harness Assembly.



22908

a - Trim Indicator
b - Remote Control
c - Trim Sender
d - Engine Ground
e - To Engine
f - Ignition Switch
g - Power Trim Harness

LOWER UNIT

Section 6A – Right Hand Non-Ratcheting

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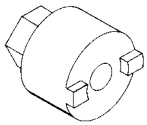
6 A

Gear Housing Specifications (Standard Rotation)

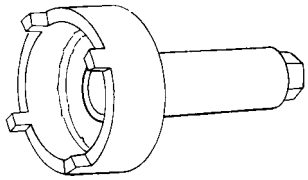
Ratio	Pinion Depth	Forward Gear Backlash	Reverse Gear Backlash
1.87:1	0.025 in. (0.635 mm) With Tool 91-12349A2 using Disc #2 and Flat #7	0.018 in. to 0.027 in. (0.460 mm to 0.686 mm) Pointer on line mark #1	0.030 in. to 0.050 in. (0.762 mm to 1.27 mm)
2.0:1	0.025 in. (0.635 mm) With Tool 91-12349A2 using Disc #2 and Flat #7	0.015 in. to 0.022 in. (0.38 mm to 0.56 mm) Pointer on line mark #2	0.030 in. to 0.050 in. (0.762 mm to 1.27 mm)
2.3:1	0.025 in. (0.635 mm) With Tool 91-12349A2 using Disc #2 and Flat #7	0.018 in. to 0.023 in. (0.46 mm to 0.58 mm) Pointer on line mark #4	0.030 in. to 0.050 in. (0.762 mm to 1.27 mm)
Gearcase Lubricant Capacity			
All Ratios		22.5 fl. oz. (665.4 ml)	

Special Tools

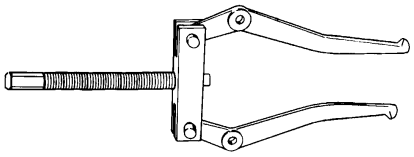
1. Shift Shaft Bushing Tool 91-31107



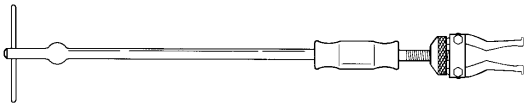
2. Gear Housing Cover Nut Tool 91-61069



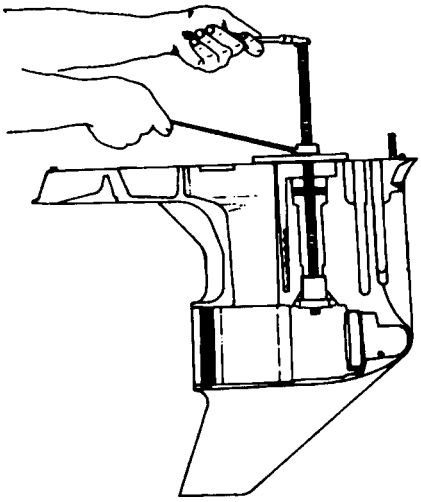
3. Bearing Carrier Removal Tool 91-46086A1 and Puller Bolt 91-85716



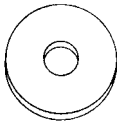
4. Slide Hammer Puller 91-34569A1



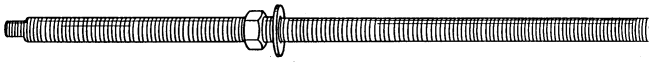
5. Bearing Removal and Installation Kit 91-31229A5. This kit contains the following tools: Pilot 91-36571; Puller Rod 91-31229; Nut 11-24156; Puller Plate 91-29310; Mandrel 91-38628; and Driver Rod 91-37323.



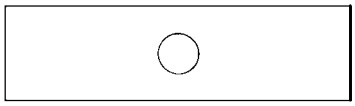
6. Pilot 91-36571



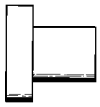
7. Puller Rod 91-31229 and Nut 91-24156



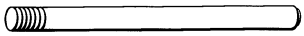
8. Puller Plate 91-29310



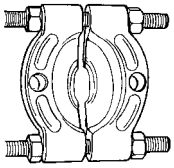
9. Mandrel 91-38628



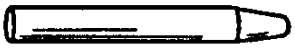
10. Driver Rod 91-37323



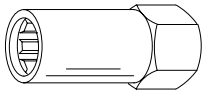
11. Universal Puller Plate 91-37241



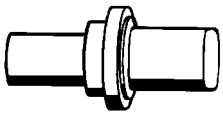
12. Cross Pin Tool 91-86642



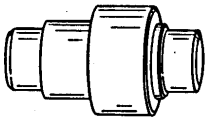
13. Driveshaft Holding Tool 91-34377A1or 91-90094



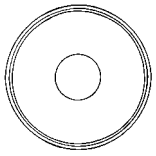
14. Oil Seal Driver 91-31108



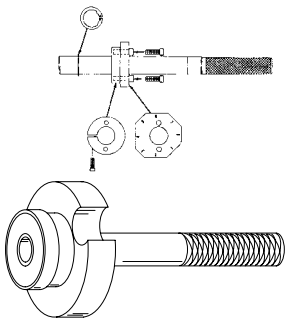
15. Forward Gear Bearing Tool 91-86943



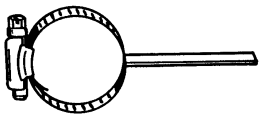
16. Bearing Driver Cup 91-87120



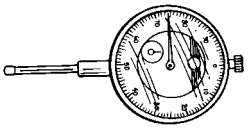
17. Pinion Gear Locating Tool 91-12349A2 or 91-74776



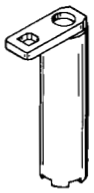
18. Backlash Indicator Rod 91-78473



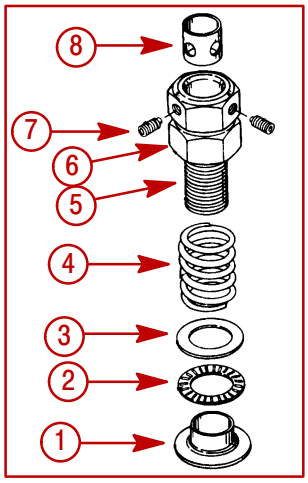
19. Dial Indicator 91-58222A1



20. Bearing Retainer Tool 91-43506



21. Bearing Preload Tool 91-14311A1



1 - Adaptor (N.S.S.)
2 - Bearing (N.S.S.)
3 - Washer (N.S.S.)
4 - Spring (24-14111)
5 - Bolt (10-12580)
6 - Nut (11-13953)
7 - Set Screw (10-12575)
8 - Sleeve (23-13946)

22. Mandrel 91-92788



23. Mandrel 91-15755



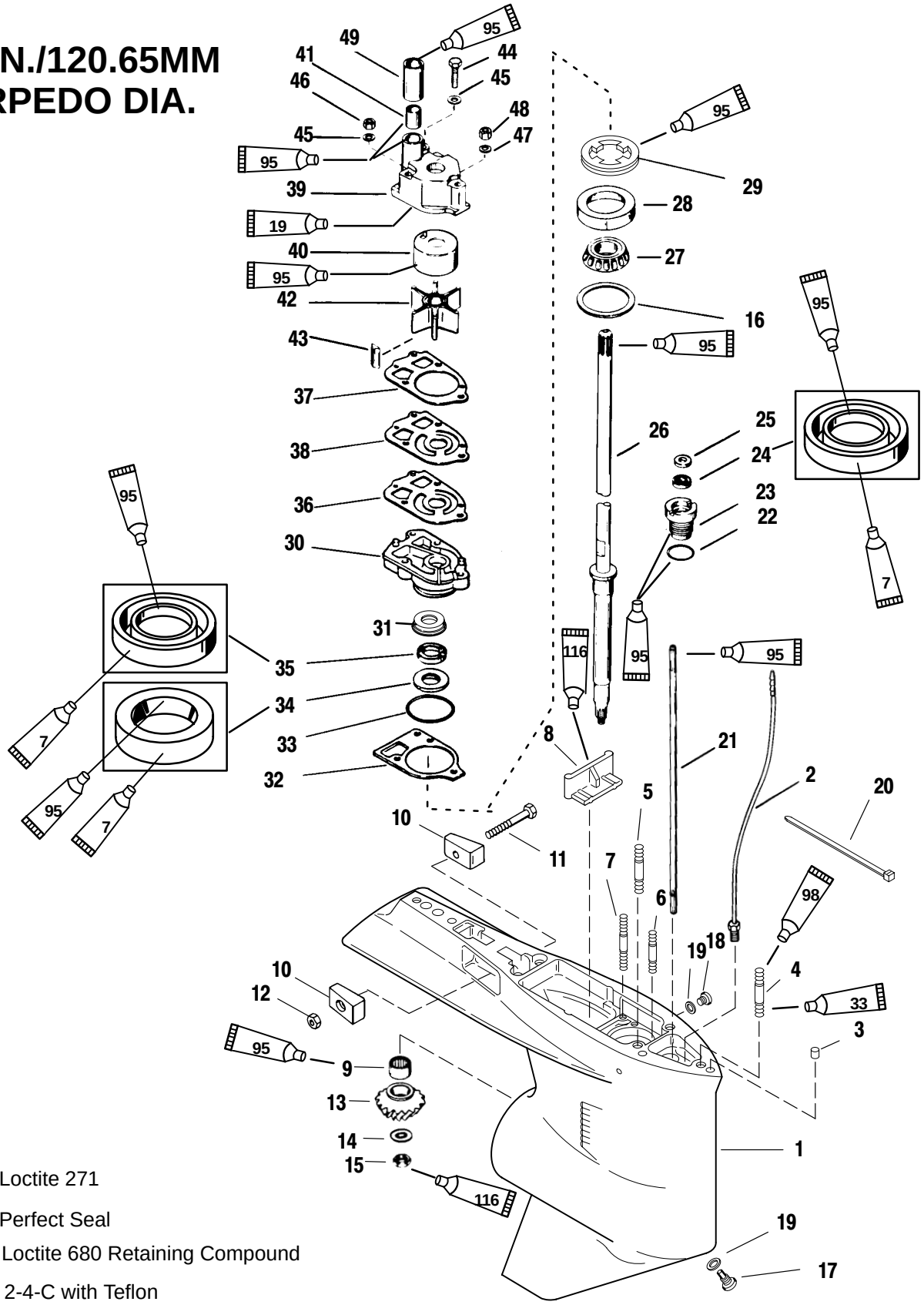
24. Dial Indicator Holder 91-89897



Notes:

Gear Housing (Drive Shaft)(Standard Rotation)

4.75 IN./120.65MM TORPEDO DIA.

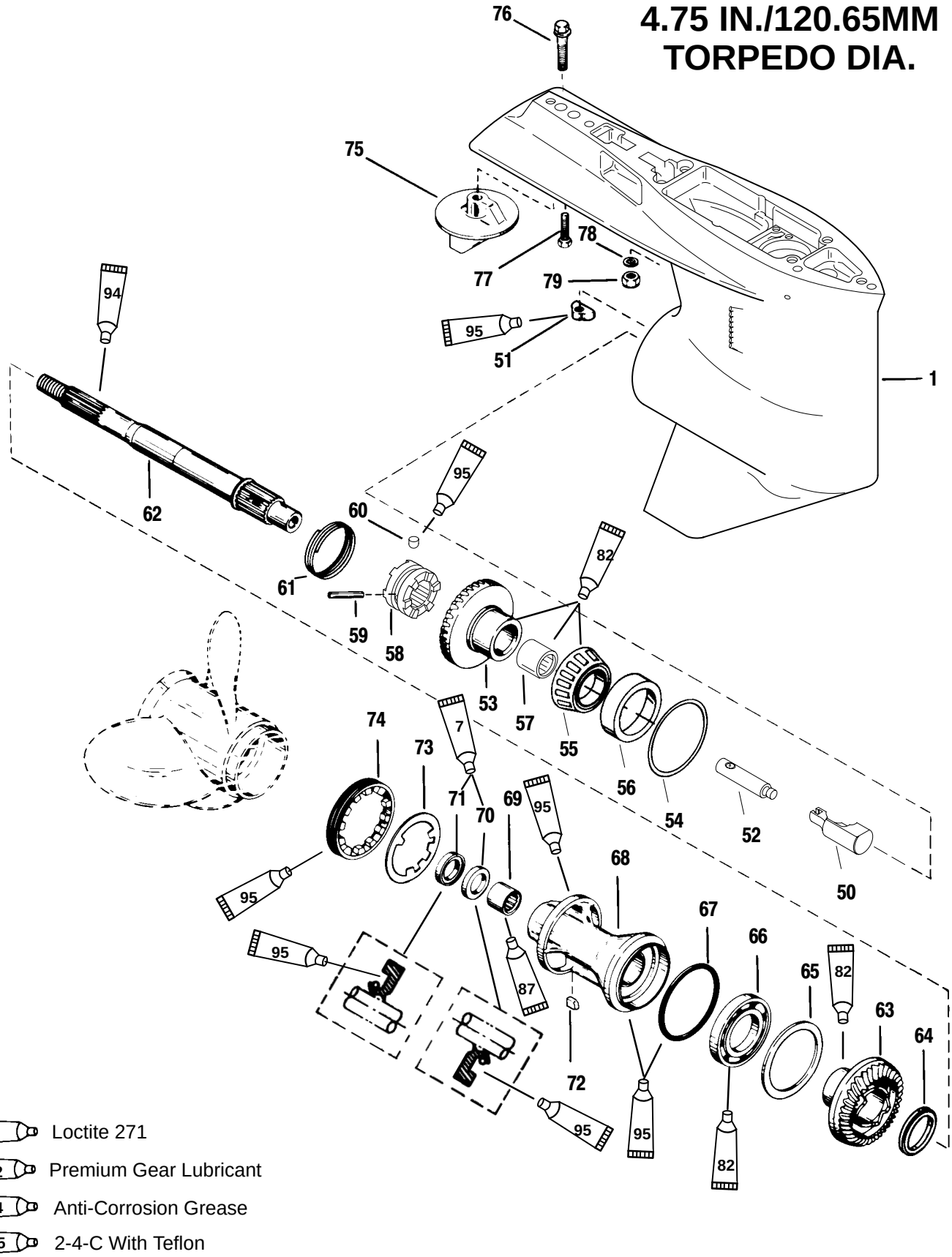


- 7 Loctite 271
- 19 Perfect Seal
- 33 Loctite 680 Retaining Compound
- 95 2-4-C with Teflon
- 116 RTV 587 Silicone Sealer

Gear Housing (Drive Shaft)(Standard Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	GEAR HOUSING **(BLACK)(BASIC)**			
2	1	CONNECTOR ASSEMBLY	50		5.5
3	2	DOWEL PIN			
4	1	STUD (3-1/8 IN.) **(LONG)**			
	1	STUD (3-11/16 IN.) **(X-LONG)**			
5	2	STUD (2-1/16 IN.)			
6	1	STUD (3-3/8 IN.)			
7	2	STUD (3-1/8 IN.)			
8	1	FILLER BLOCK			
9	1	ROLLER BEARING			
10	2	ANODE			
11	1	SCREW (M6 x 40)			
12	1	NUT	60		7
13	1	PINION GEAR **(1.87:1 - 15 TEETH)(150)(Part of 43-828174A2)**			
	1	PINION GEAR **(2:1 - 14 TEETH)(135)(Also part of 43-828176A2)**			
14	1	WASHER			
15	1	NUT		75	101
16	AR	SHIM SET			
17	1	SCREW–drain (MAGNETIC)	60		7
18	1	SCREW–grease filler	60		7
19	2	WASHER			
20	1	STA-STRAP			
21	1	SHIFT SHAFT			
22	1	O-RING			
23	1	BUSHING ASSEMBLY		50	5.5
24	1	OIL SEAL			
25	1	WASHER–rubber			
26	1	DRIVE SHAFT **(LONG)**			
	1	DRIVE SHAFT **(X-LONG)**			
27	1	ROLLER BEARING			
28	1	CUP			
29	1	RETAINER		100	135
30	1	WATER PUMP BASE			
31	1	RETAINER			
32	1	GASKET			
33	1	O-RING			
34	1	OIL SEAL			
35	1	OIL SEAL			
36	1	GASKET–lower			
37	1	GASKET–upper			
38	1	FACE PLATE			
39	1	WATER PUMP BODY ASSEMBLY			
40	1	INSERT			
41	1	SEAL–rubber			
42	1	IMPELLER			
43	1	KEY			
44	1	SCREW (#14-8 x 2-1/4 IN.)	35		4
45	2	WASHER			
46	2	NUT		50	68
47	1	WASHER			
48	1	NUT		50	68
49	1	SLEEVE			

Gear Housing (Prop Shaft)(Standard Rotation)



7 Loctite 271

82 Premium Gear Lubricant

94 Anti-Corrosion Grease

95 2-4-C With Teflon

Gear Housing (Prop Shaft)(Standard Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	GEAR HOUSING **(BLACK)(BASIC)**			
50	1	CAM FOLLOWER			
51	1	SHIFT CAM			
52	1	ROD			
53	1	FORWARD GEAR **(1.87:1 – 15/28)(150)**			
	1	FORWARD GEAR **(2:1 – 14/28)(135)**			
54	AR	SHIM SET			
55	1	TAPERED ROLLER BEARING			
56	1	CUP			
57	1	NEEDLE BEARING			
58	1	CLUTCH			
59	1	CROSS PIN			
60	1	DETENT PIN			
61	1	SPRING			
62	1	PROPELLER SHAFT			
63	1	REVERSE GEAR **(1.87:1 – 15/28)(150)**			
	1	REVERSE GEAR **(2:1 – 14/28)(135)**			
64	1	THRUST SPACER			
65	1	THRUST RING			
66	1	BALL BEARING			
67	1	O-RING			
68	1	BEARING CARRIER ASSEMBLY			
69	1	ROLLER BEARING			
70	1	OIL SEAL **(INSIDE)**			
71	1	OIL SEAL **(OUTSIDE)**			
72	1	KEY			
73	1	TAB WASHER			
74	1	COVER		210	285
75	1	TRIM TAB			
76	1	SCREW (1-3/4 IN.)		25	34
77	1	SCREW (3/8-16 x 1 IN.)		30	41
78	2	WASHER			
79	2	NUT		50	68

General Service Recommendations

There may be more than one way to disassemble or reassemble a particular part, 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 the reassembly and installation of that component in the reassembly part of this section. Use the Table of Contents 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 through the bearing. DO NOT spin bearing with compressed air, as this may cause bearing to score from lack of lubrication. After cleaning, lubricate bearings with Premium 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 with Teflon on all O-rings. To prevent wear, apply 2-4-C with Teflon on I.D. of oil seals.

To prevent corrosion damage after reassembly, apply 2-4-C with Teflon to external surfaces of bearing carrier and cover nut threads prior to installation.

Removal, Disassembly, Cleaning and Inspection – Standard Rotation

Removal

⚠ WARNING

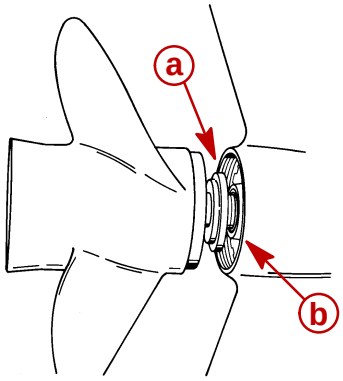
Disconnect high tension leads from spark plugs and remove spark plugs from engine before removing gear housing from drive shaft housing.

1. Disconnect high tension leads from spark plugs and remove spark plugs from engine.

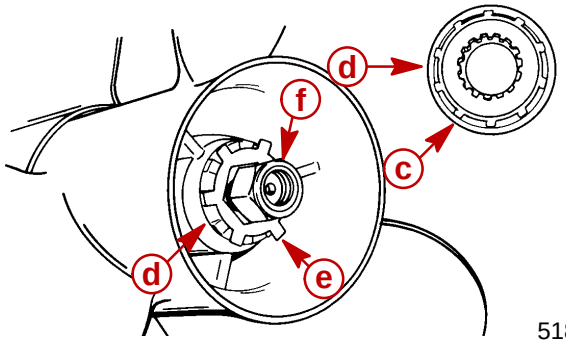
⚠ CAUTION

Gear housing MUST BE in NEUTRAL position and shift shaft MUST BE removed from gear housing BEFORE propeller shaft can be removed from gear housing.

2. Shift engine into neutral position.
3. Tilt engine to full up position and engage tilt lock lever.
4. Bend tabs of propeller tab washer away from thrust hub (rear), then remove propeller locknut, tab washer, thrust hub (rear), propeller and thrust hub (forward) from propeller shaft.



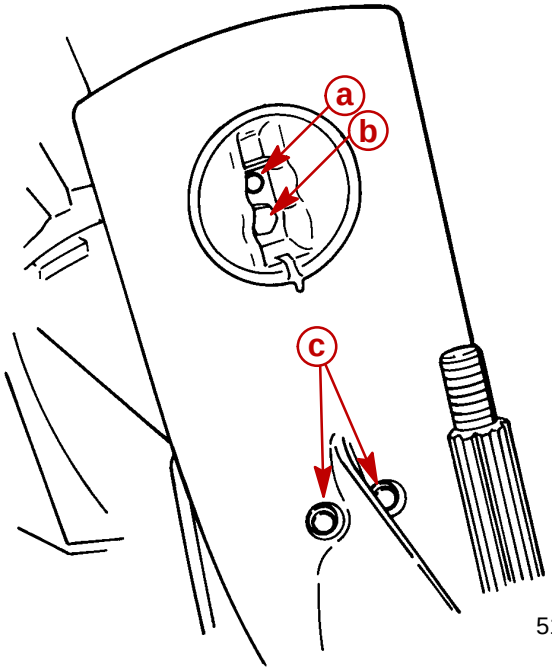
51866



51871

a - Thrust Hub (Forward)
b - Propeller Shaft
c - Continuity Washer (If Equipped)
d - Rear Thrust Hub
e - Tab Washer
f - Propeller Nut

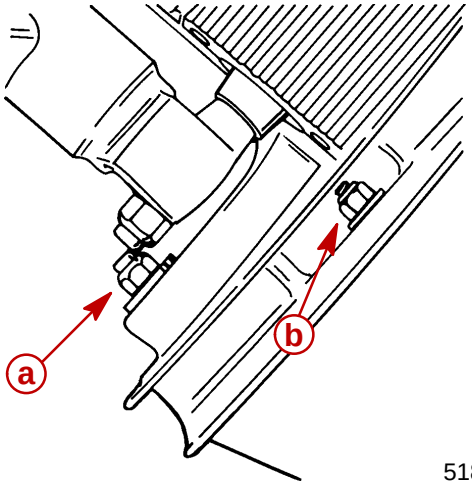
5. Mark gear housing and trim tab so that trim tab can be reinstalled in the same position. Remove plastic cap at rear edge of drive shaft housing, then unthread bolt that secures trim tab and remove trim tab from gear housing.
6. Once trim tab is removed, remove bolt from inside of trim tab cavity.
7. Remove 2 locknuts from bottom middle of anti-cavitation plate.



51866

a - Bolt (Secures Trim Tab)
b - Bolt (Inside Trim Tab Cavity)
c - Locknuts and Washers

8. Remove locknut from the front gear housing mounting stud.
9. Loosen the side mounting locknuts. (DO NOT attempt to remove one nut before opposite side is loosened sufficiently, or drive shaft housing could be damaged.)
10. Pull gear housing away from drive shaft housing as far as the loosened nuts (in Step 9) will allow, then remove loosened nuts. (DO NOT allow gear housing to fall, as it now is free.)
11. Pull gear housing from drive shaft housing.



51879

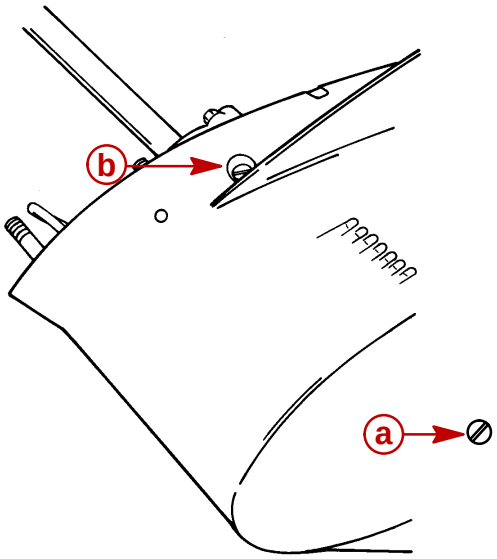
a - Front Mounting Locknut
b - Side Mounting Locknut (One Each Side)

Draining and Inspecting Gear Housing Lubricant

1. Place gear housing in a suitable holding fixture or vise with the drive shaft 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.



51871

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 gearcase will be a light chocolate brown in color due to agitation/aeration. Oil which is stabilized will be a clear yellow brown in color.*

Water Pump

CLEANING AND INSPECTION

1. Clean all water pump parts with solvent and dry with compressed air.
2. Inspect water pump cover and base for cracks and distortion (from overheating).
3. Inspect face plate and water pump insert for grooves and/or rough surfaces.

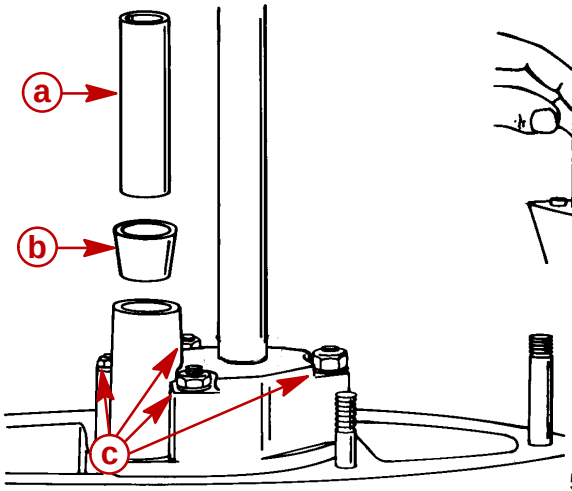
IMPORTANT: When completing gear housing repairs that require removal of water pump impeller, it is recommended that the impeller be replaced. However if it is necessary to re-use impeller, DO NOT install in reverse to its original rotation, or premature impeller failure will occur.

4. Inspect impeller side seal surfaces and ends of impeller blades for cracks, tears and wear. Replace impeller if any of these conditions are found.
5. Inspect impeller bonding to impeller hub.
6. Inspect impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace impeller if any of these conditions exist.

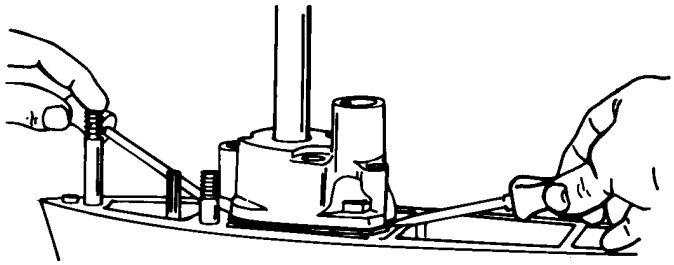
IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

REMOVAL AND DISASSEMBLY

1. Slide rubber centrifugal slinger up and off drive shaft.
2. Remove water tube guide and seal from water pump cover. Retain guide for reassembly and discard seal.
3. Remove (and retain) 3 nuts, one bolt and all washers which secure water pump cover to gear housing.
4. Using 2 pry bars, lift water pump cover up and off drive shaft.



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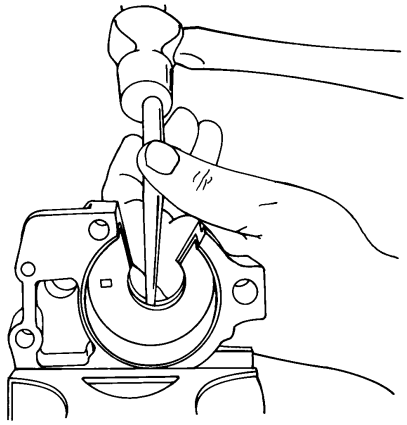
a - Water Tube Guide
b - Water Tube Seal
c - Nuts, Bolt and Washers To Be Removed

5. Inspect water pump cover and insert, as outlined in **Cleaning and Inspection**.

6. If inspection of water pump insert determines that replacement is required, follow Step “a” or “b” to remove insert from water pump cover.

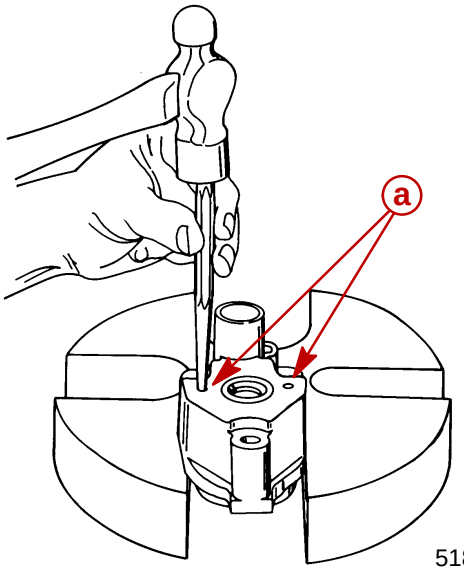
NOTE: *Try Step “a” first. If insert cannot be removed with Step “a,” use Step “b”.*

a. Drive water pump insert out of water pump cover with a punch and hammer.



51874

b. Drill two 3/16 in. (4.8mm) diameter holes through the top of water pump cover (but not through insert). Drive insert out of cover with a punch and hammer.

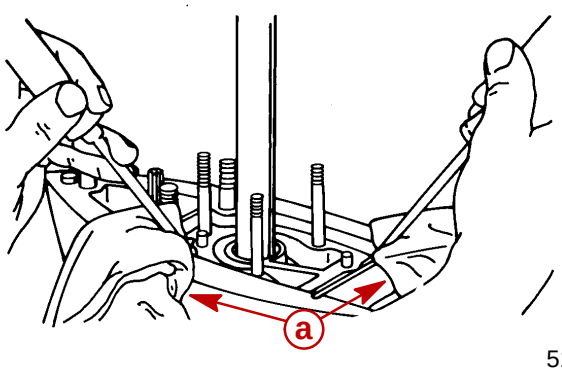


51873

a - Drill Two Holes at These Locations

7. Remove impeller from drive shaft. (It may be necessary to use a punch and hammer to drive impeller upward on drive shaft. In extreme cases, it may be necessary to split hub of impeller with a hammer and chisel.)
8. Once impeller is removed, remove impeller drive key from drive shaft.
9. Remove water pump face plate and both gaskets (one above and below face plate) from water pump base.

10. Using 2 pry bars, positioned and padded as shown, lift water pump base up and off drive shaft.



51874

a - Pads

11. Remove (and discard) O-ring from O-ring groove on water pump base.
12. Using a screwdriver, pry oil seals out of water pump base from gear housing side of base.

Bearing Carrier and Propeller Shaft Removal

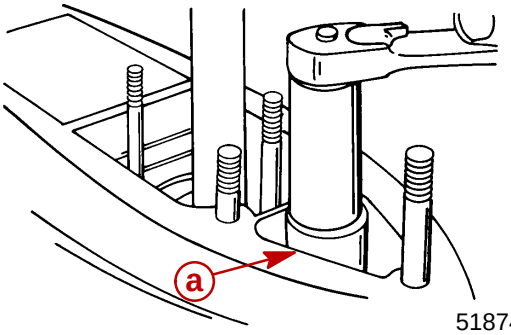
⚠ CAUTION

Gear housing MUST BE in NEUTRAL position, and shift shaft MUST BE removed from gear housing before propeller shaft can be removed from gear housing.

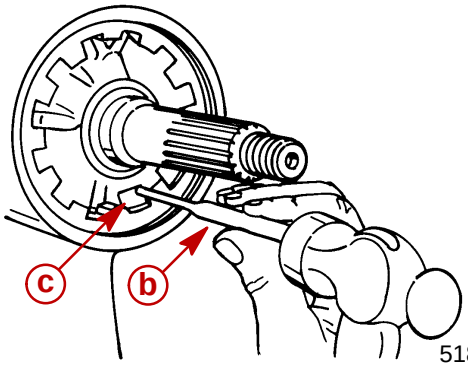
1. Place gear housing in a suitable holding fixture with propeller shaft in a horizontal position.
2. Use the Shift Shaft Bushing Tool to unthread shift shaft bushing. (DO NOT remove bushing from shift shaft at this time.)

IMPORTANT: Prior to removal of shift shaft from gear housing, recheck that gear housing is in NEUTRAL position.

3. Bend cover nut lock tab out of cover nut recess.



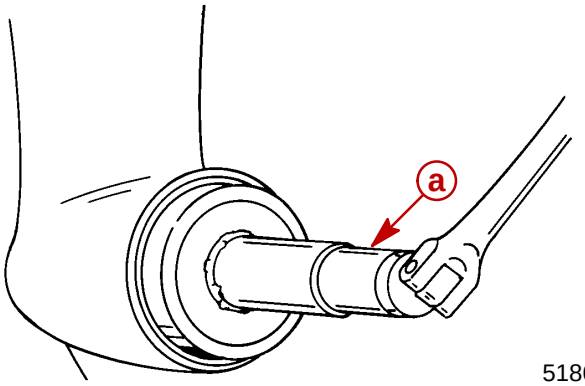
51874



51865

a - Shift Shaft Bushing Tool (91-31107)
b - Punch
c - Tab of Tab Washer

4. Remove gear housing cover nut with Cover Nut Tool.



a - Cover Nut Tool (91-61069)

5. After cover nut has been removed, remove lock tab washer from gear housing.

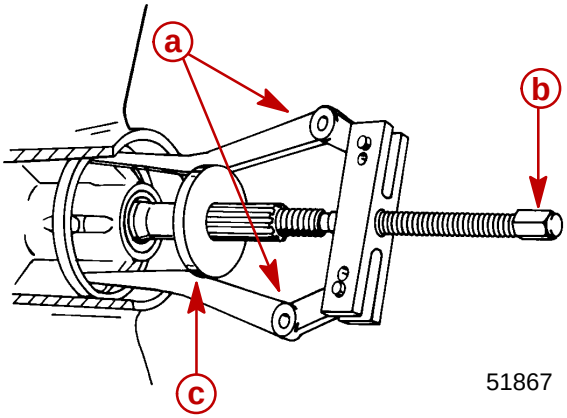
⚠ CAUTION

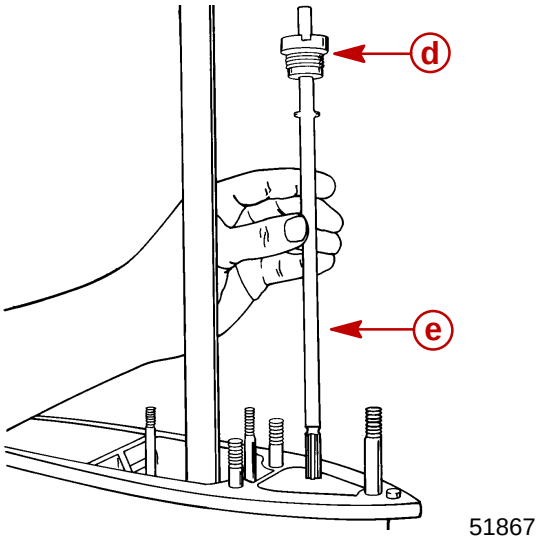
Once bearing carrier is removed from gear housing, extreme care MUST BE taken not to apply any side force on propeller shaft. Side force on propeller shaft may break the neck of the clutch actuator rod.

6. Use long Puller Jaws and Puller Bolt to remove bearing carrier. (Use propeller thrust hub to maintain outward pressure on puller jaws.)

NOTE: *When bearing carrier is removed from gear housing, the bearing carrier alignment key will come out with it.*

7. With gear housing in NEUTRAL, pull shift shaft out of gear housing. If necessary, use a pliers to pull shift shaft out of gear housing. If pliers are used to pull shift shaft out, wrap a strip of soft metal (aluminum) around splines before clamping pliers. DO NOT turn shaft (clockwise OR counterclockwise) while pulling shaft out.





a - Long Puller Jaws (91-46086A1)
b - Puller Bolt (91-85716)
c - Thrust Hub
d - Shift Shaft Bushing
e - Shift Shaft

⚠ CAUTION

Propeller shaft, cam follower and shift cam, in most cases, will come out of gear housing by simply pulling outward on propeller shaft. DO NOT FORCE shaft sideways or ATTEMPT TO PULL with a slide hammer or any mechanical puller.

8. Remove propeller shaft, cam follower and shift cam by pulling shaft straight out of gear housing. (DO NOT JERK propeller shaft.) If propeller shaft will not come out, proceed with Step “a” or “b”, following:

   a. Push the propeller shaft back into place against the forward gear. Visually inspect location of shift cam by looking down shift shaft hole (illuminated with a flashlight). If splined hole in shift cam is visible, reinstall shift shaft and rotate shift shaft to NEUTRAL position. Remove shift shaft, then remove propeller shaft as instructed in Step 8, immediately preceding.

   b. Push propeller shaft back into place against forward gear. Slide bearing carrier back into gear housing (to support propeller shaft). Place gear housing on its left side (viewed from rear) and strike upper leading end of gear housing with a rubber mallet. This will dislodge the shift cam from cam follower into a clearance pocket in left side of gear housing. Remove bearing carrier and pull propeller shaft out of gear housing.

NOTE: *If Step 8-b was used to remove propeller shaft, the shift cam can be retrieved after removal of forward gear.*

Shift Shaft

CLEANING AND INSPECTION

1. Clean shift shaft and bushing with solvent and dry with compressed air.
2. Check shift shaft splines on both ends for wear and/or corrosion damage.
3. Inspect shift shaft for grooves at shift shaft bushing seal surface.
4. Inspect shift shaft bushing for corrosion damage.
5. Inspect shift shaft bushing oil seal for wear and/or cuts.

NOTE: *Oil seal in shift shaft bushing should be replaced as a normal repair procedure.*

DISASSEMBLY

1. Remove (and discard) shift shaft bushing oil seal by prying it out or driving it out with a punch and hammer.

CLEANING/INSPECTION - BEARING CARRIER

IMPORTANT: It is recommended that all seals and O-rings be replaced (as a normal repair procedure) to assure effective repair.

1. Clean bearing carrier with solvent and dry with compressed air.

⚠ CAUTION

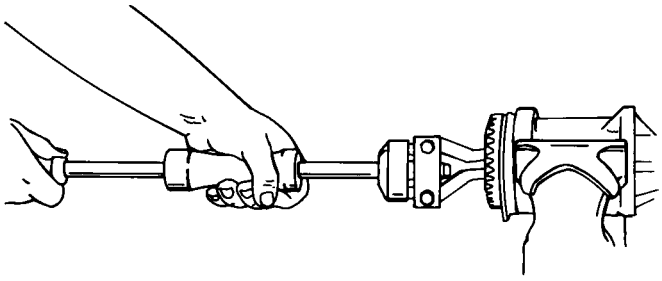
DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

2. Bearing carrier propeller shaft needle bearing condition is determined by propeller shaft bearing surface condition. (See Propeller Shaft Inspection.)
3. Inspect reverse gear to pinion gear wear pattern (should be even and smooth). If not, replace reverse gear and pinion gear.

4. Check clutch jaws on reverse gear for damage. Replace reverse gear, if damage is found on clutch jaws.
5. Apply light oil to reverse gear bearing. Rotate reverse gear bearing while checking bearing for rough spots and/or catches. Push in and pull out on reverse gear to check for bearing side wear. Replace bearing if any of the listed conditions exist.

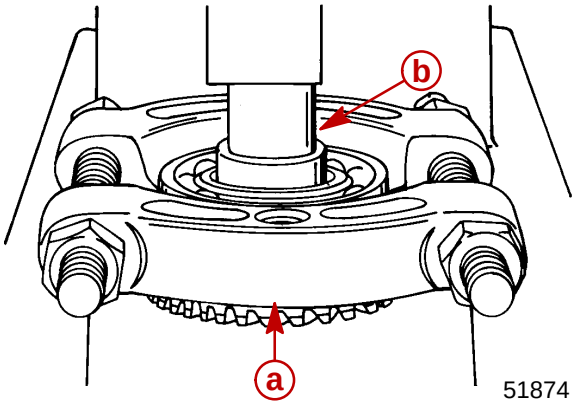
DISASSEMBLY - BEARING CARRIER

1. Remove and discard O-ring from between bearing carrier and thrust washer.
2. If inspection of reverse gear or reverse gear bearing determines that replacement of gear or bearing is required, remove gear and bearing as follows:
   a. Position bearing carrier in a soft jaw vise.
   b. Use Slide Hammer (91-34569A1) and remove reverse gear.



51868

   c. If reverse gear bearing remains attached to reverse gear, install Universal Puller Plate and position puller plate, gear and bearing on a press with gear side down. Use a suitable mandrel and press gear out of bearing.



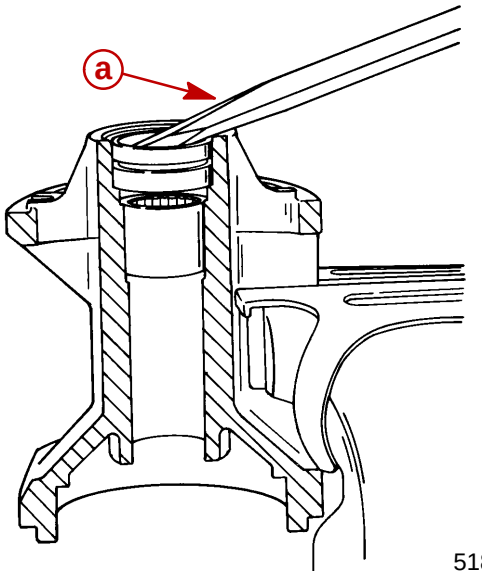
51874

a - Universal Puller Plate (91-37241)
b - Mandrel

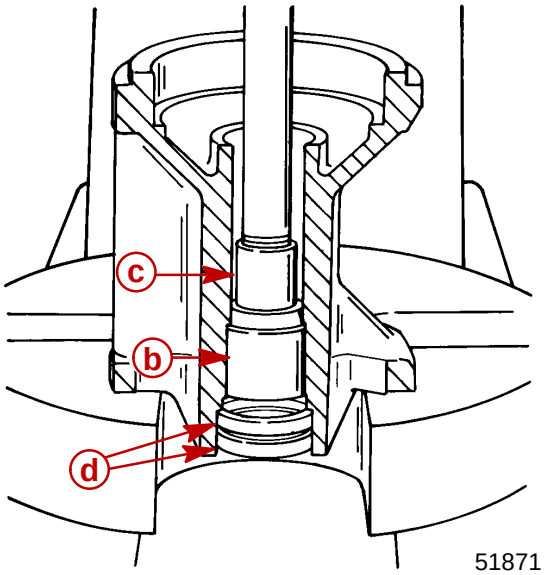
   d. If reverse gear bearing has remained in bearing carrier, use slide hammer to remove bearing in the same method as was used to remove reverse gear (Step “b”).

3. Propeller shaft oil seals can be removed by 1) using a pry bar, or 2) pressing seals out when propeller shaft needle bearing is pressed out of bearing carrier.
4. If inspection of propeller shaft needle bearing determines that replacement of bearing is required, use Universal Bearing Removal and Installation Tool (91-31229A1) to press bearing and seals out of bearing carrier.

NOTE: *Reverse gear must be removed from bearing carrier before propeller shaft needle bearing can be removed.*



51868



51871

a - Pry Bar
b - Propeller Shaft Needle Bearing
c - Mandrel
d - Oil Seals

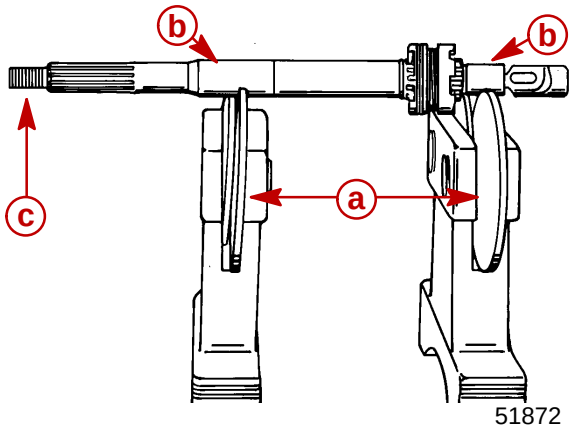
Propeller Shaft

INSPECTION

1. Clean propeller shaft assembly with solvent and dry with compressed air.
2. Inspect bearing carrier oil seal surfaces for grooves. Run fingernail across seal surface to check for groove. Replace shaft if groove is found.
3. Visually check bearing surfaces of propeller shaft for pitting, grooves, scoring, uneven wear or discoloration (bluish color) from overheating. Replace shaft and corresponding needle bearing if any of the above conditions are found. (Bearing carrier needle bearing contacts propeller shaft just in front of oil seal surface. Forward gear bearing contacts propeller shaft in front of sliding clutch splines.)
4. Inspect propeller shaft splines for wear and/or corrosion damage.

5. Check propeller shaft for straightness. Use either method, following:

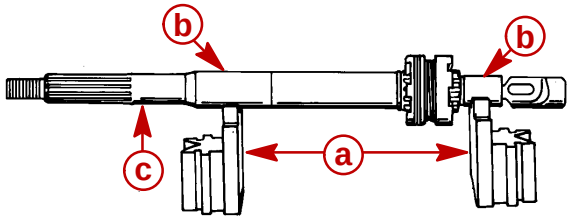
   a. Place propeller shaft on balance wheels. Rotate propeller shaft and observe propeller end of shaft for wobble. Replace shaft if any wobble is observed.



51872

a - Balance Wheels
b - Bearing Surfaces
c - Watch for Wobble

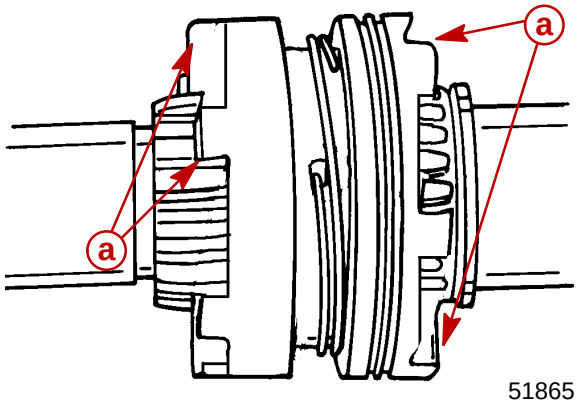
   b. Position the propeller shaft roller bearing surfaces on vee blocks. Mount a dial indicator at front edge of propeller splines. Rotate propeller shaft. Dial indicator movement of more than 0.006 in. (0.152 mm) (or noticeable wobble) is reason for replacement.



51872

a - Vee Blocks
b - Bearing Surfaces
c - Measure with Dial Indicator at this Point

6. Inspect sliding clutch. Check reverse gear and forward gear clutch jaws. Rounded jaws indicate one or more of the following:
   a. Improper shift cable adjustment.
   b. Improper shift habits of operators (shift from NEUTRAL to REVERSE gear too slowly).
   c. Engine idle speed too high (while shifting).



51865

a - Clutch Jaws

7. Check condition of cam follower. If it shows wear (pitting, scoring or rough surface), replace cam follower and shift cam.

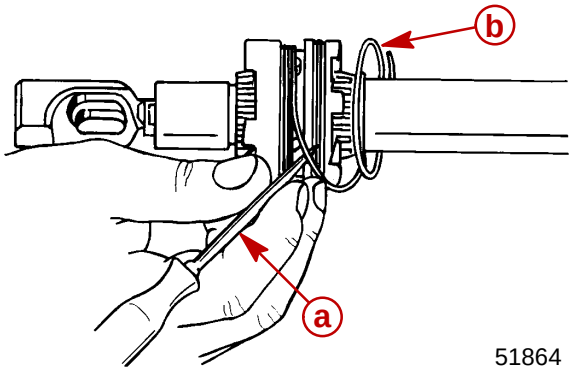
DISASSEMBLY

1. Remove shift cam from cam follower.
2. Insert a thin blade screwdriver or awl under first coil of cross pin retainer spring and rotate propeller shaft to unwind spring from sliding clutch. DO NOT over-stretch spring.

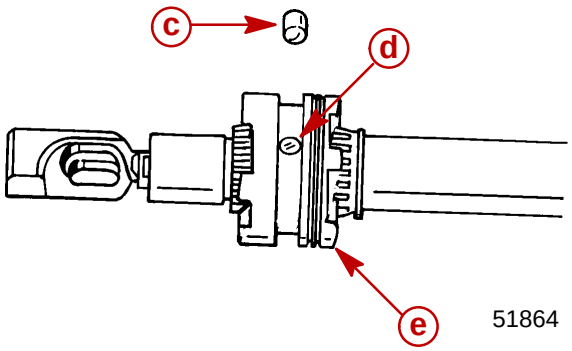
⚠ CAUTION

Detent pin is free and can fall out of sliding clutch. Care MUST BE taken not to lose pin.

3. Detent pin is free and can be removed from sliding clutch at this time.



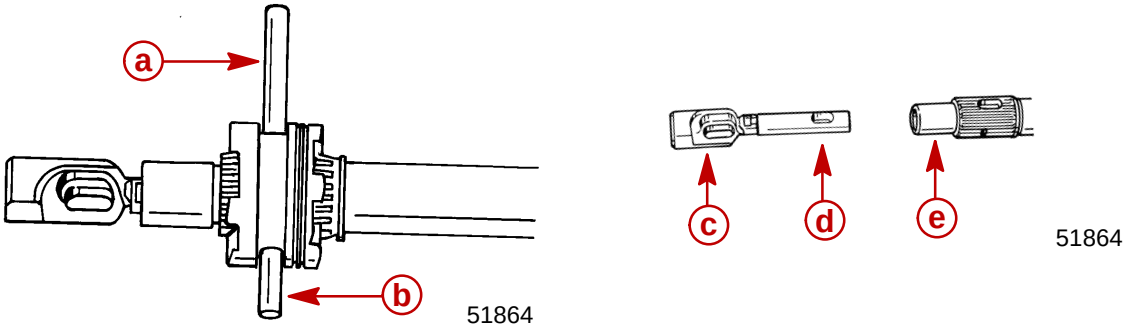
51864



51864

a - Awl
b - Cross Pin Retainer Spring
c - Detent Pin
d - Cross Pin
e - Sliding Clutch

4. Push cross pin out of sliding clutch and propeller shaft with Cross Pin Tool.
5. Pull sliding clutch off propeller shaft.
6. Pull cam follower and clutch actuator rod out of propeller shaft. DO NOT force cam follower up-or-down or side-to-side when pulling from propeller shaft.



51864

a - Cross Pin Tool (91-86642)
b - Cross Pin
c - Cam Follower
d - Clutch Actuator Rod
e - Propeller Shaft

7. Once cam follower and clutch actuator rod are removed from propeller shaft, lift rod out of cam follower.

Clutch Actuator Rod

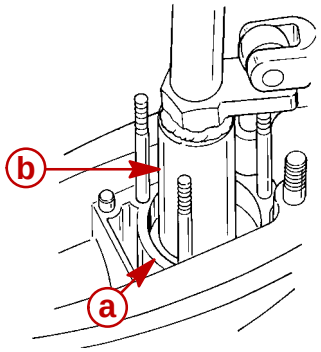
CLEANING AND INSPECTION

1. Clean clutch actuator rod in solvent and dry with compressed air.
2. Inspect actuator components for wear or damage. Replace components as required.

Pinion Gear and drive shaft

REMOVAL

1. Remove bearing retainer using Bearing Retainer Tool.



51865

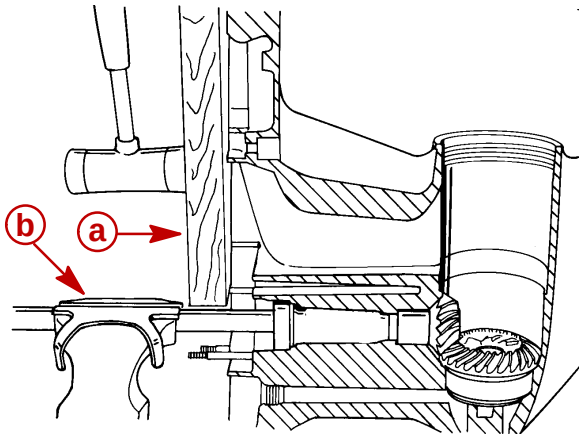
a - Bearing Retainer
b - Bearing Retainer Tool (91-43506)

2. Place drive shaft Holding Tool (91-34377A1) over drive shaft splines.
3. Use a socket and flex handle to hold pinion nut. (Pad area of gear housing where flex handle will make contact to prevent damage to gear housing.)
4. Use a socket and flex handle on drive shaft Holding Tool to loosen pinion nut. Remove pinion nut and drive shaft Holding Tool.

5. Remove gear housing from vise and re-position it as shown. Be sure to use soft jaw vise covers and clamp as close as possible to water pump studs.
6. Place a block of wood on gear housing mating surface. Use a mallet and carefully tap gear housing away from drive shaft.

⚠ CAUTION

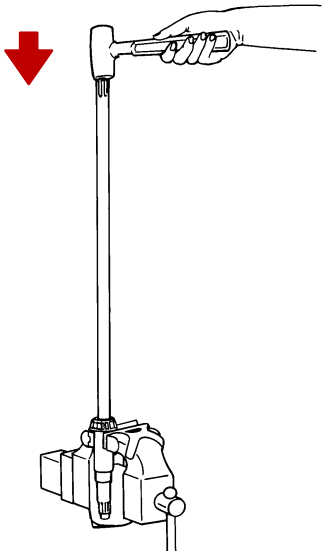
DO NOT strike gear housing hard with the mallet or allow gear housing to fall.



51870

a - Wooden Block
b - Soft Jaw Vise Covers

7. Reach into gear housing and remove pinion gear and forward gear assembly.
8. After drive shaft is removed from gearcase, remove and retain shims that were located under upper tapered drive shaft bearing.
9. If inspection determines that replacement of drive shaft tapered bearing is required, remove bearing from drive shaft as follows:
   a. Position drive shaft in a vise. DO NOT tighten vise jaws against shaft.
   b. Strike shaft with a lead hammer; take care not to drop shaft.



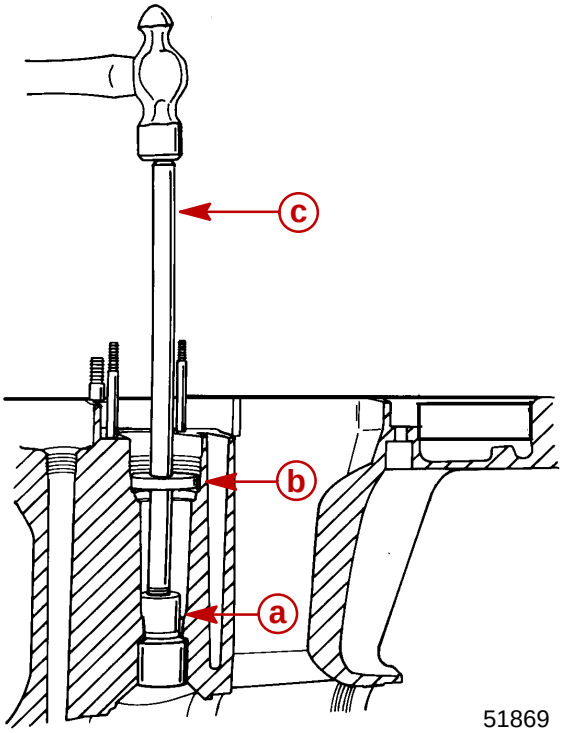
51866

10. Remove 18 loose needles from outer race of drive shaft needle bearing.

11. If inspection of drive shaft needle bearing surface determines that replacement of needle bearing is required, the 18 loose needle bearings previously removed must be reinstalled in bearing race to provide surface for mandrel to drive against.

NOTE: *FORWARD gear must be removed first BEFORE removing drive shaft needle bearing.*

IMPORTANT: Discard drive shaft needle bearing after removal. (Bearing cannot be reused.)



51869

a - Mandrel (91-37263)
b - Pilot* (91-36571)
c - Driver Rod* (91-37323)
*From Bearing Removal and Installation Kit (91-31229A5)

CLEANING AND INSPECTION

1. Clean drive shaft, tapered bearing and race, and pinion gear with solvent. Dry with compressed air. DO NOT allow drive shaft bearing to spin while drying.
2. Inspect pinion gear for pitting, grooves, scoring, uneven wear and/or discoloration from overheating. Replace pinion gear, if any of the above conditions are found.
3. Inspect drive shaft needle bearing surface (area just above pinion gear splines) for pitting, grooves, scoring, uneven wear and/or discoloration from overheating. Replace drive shaft and drive shaft needle bearing, if any of the preceding conditions are found.
4. Inspect drive shaft to crankshaft splines for wear. Replace drive shaft if wear is excessive.
5. Inspect tapered bearing race for pitting, grooves, scoring, uneven wear and discoloration from overheating. Replace tapered bearing and race as a set, if any of the preceding conditions are found.
6. Inspect drive shaft for grooves where water pump base oil seals contact shaft. Replace drive shaft if grooves are found.

Forward Gear

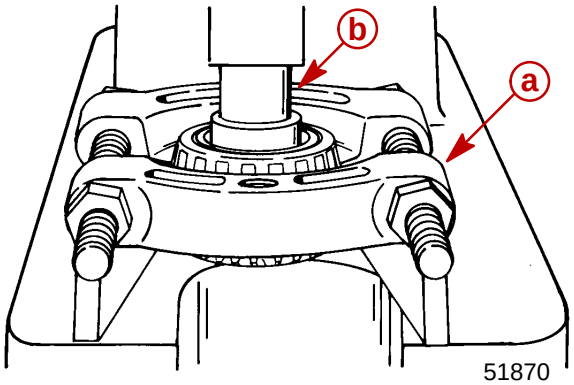
REMOVAL AND DISASSEMBLY

NOTE: *Forward gear can only be removed from gear housing after drive shaft and pinion gear have been removed.*

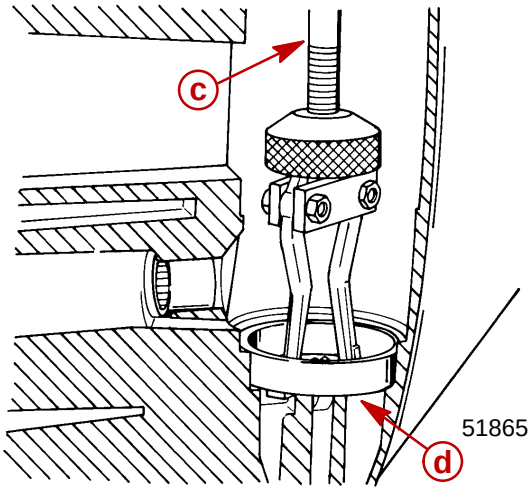
1. Reach into gear housing and lift out forward gear.

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, remove bearing from gear and bearing race from gear housing (tapered bearing and race MUST BE replaced as a set), as follows:
   a. Install Universal Puller Plate between forward gear and tapered bearing.
   b. Place forward gear, bearing and puller plate on a press and press gear out of bearing with a suitable mandrel.
   c. Use Slide Hammer to remove forward gear tapered bearing race.



51870



51865

a - Universal Puller Plate (91-37241)
b - Mandrel
c - Slide Hammer (91-34569A1)
d - Tapered Bearing Race

   d. After forward gear tapered bearing race is removed from gear housing, lift out and retain shims which were behind bearing race.

3. If inspection determines that replacement of propeller shaft needle bearings in forward gear is required, remove bearing from gear as follows:
   a. Clamp forward gear in a soft jaw vise securely.
   b. From toothed-side of gear, drive propeller shaft needle bearings out of gear with a punch and hammer.

CLEANING AND INSPECTION

⚠ CAUTION

DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

1. Clean forward gear and bearings with solvent and dry with compressed air.
2. Inspect gear teeth for pitting, grooves, scoring, uneven wear and for discoloration (from overheating). Replace gear if any of these conditions are found.
3. Check clutch jaws on forward gear for damage. Replace forward gear if damage is found.
4. Inspect tapered bearing race for pitting, grooves, scoring, uneven wear and discoloration (from overheating). Replace tapered bearing (on forward gear) and race if any of these conditions are found. (Always replace tapered bearing and race as a set.)
5. To determine condition of propeller shaft needle bearings (in forward gear), inspect propeller shaft forward gear needle bearing surface as outlined in Propeller Shaft Inspection.

Gear Housing

CLEANING AND INSPECTION

1. Clean gear housing with solvent and dry with compressed air.
2. Check gear housing carefully for impact damage.
3. Check for loose fitting bearing cups and needle bearings.
4. Inspect bearing carrier cover nut retainer threads in gear housing for corrosion damage and/or stripped threads.

Reassembly and Installation Standard Rotation

Drive Shaft Needle Bearing

REASSEMBLY/INSTALLATION

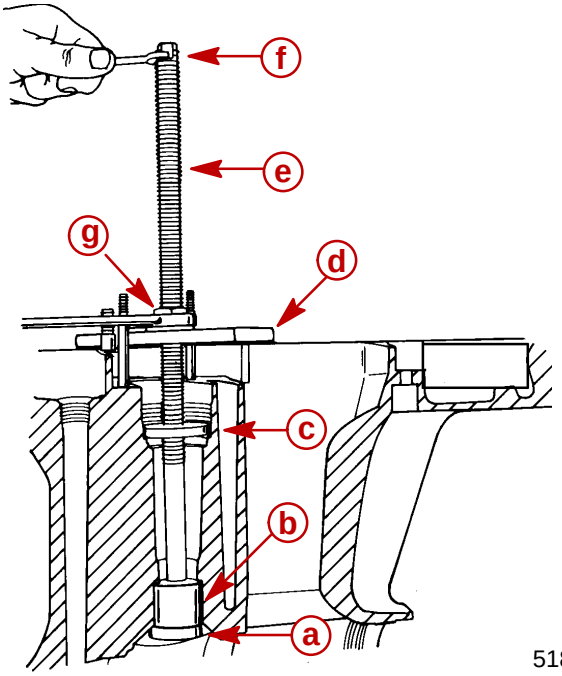
⚠ CAUTION

If drive shaft needle bearing failure has occurred, and original bearing race has turned in the gear housing, gear housing MUST be replaced. Loose fitting needle bearing will move out of position and cause repeated failures.

1. Apply a thin coat of 2-4-C with Teflon to drive shaft needle bearing bore in gear housing.
2. By way of propeller shaft cavity, place needle bearing in driveshaft bore with numbered side of bearing facing up driveshaft bore.

3. Install and seat needle bearing with the following tools: Puller Rod*, Nut*, Pilot*, Plate*, and Mandrel (models with preloaded driveshaft use 91-38628*; models with standard driveshaft use 91-92788). Pull bearing up into bore until it bottoms on gear housing shoulder. (DO NOT use excessive force.)

*From Bearing Removal and Installation Kit (91-31229A5)



51869

a - Mandrel
b - Bearing
c - Pilot (91-36571)
d - Plate (91-29310)
e - Puller Rod (91-31229)
f - Hold
g - Nut (11-24156)

Bearing Carrier

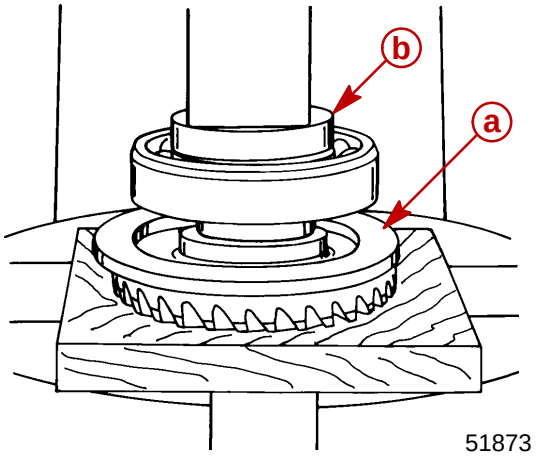
REASSEMBLY

1. Place reverse gear on a press with gear teeth facing down.

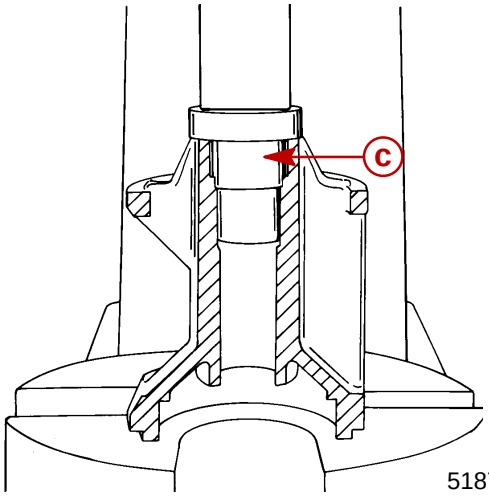
IMPORTANT: The reverse gear thrust washer has a tapered outside diameter so that one side is larger than the other. The larger outside diameter of washer must be toward reverse gear.

2. Place thrust washer over gear with the larger outside diameter down toward gear.
3. Apply a light coat of Premium Gear Lubricant onto inside diameter of reverse gear ball bearing.
4. Position ball bearing over gear (with numbered side of bearing up).

5. Press ball bearing onto gear with a suitable mandrel until firmly seated. (Be sure to press only on inner race of bearing and that bearing is firm against gear.)
6. Apply a light coat of Premium Gear Lubricant onto outside diameter of propeller shaft needle bearing.
7. Place propeller shaft needle bearing into aft end of bearing carrier with numbered side toward aft end.
8. Use Mandrel and press needle bearing into bearing carrier.



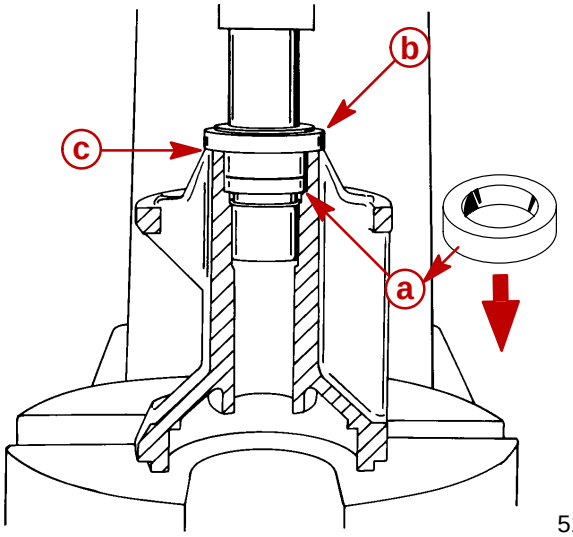
51873



51872

a - Thrust Washer
b - Mandrel
c - Mandrel (91-15755)

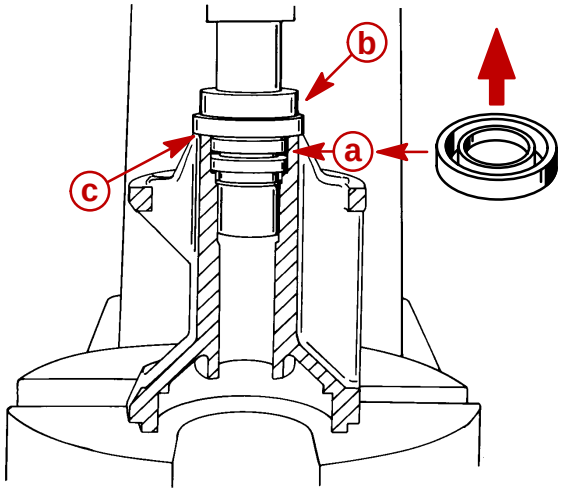
9. Apply Loctite 271 to outer diameter of propeller shaft oil seals.
10. Place one seal on longer shoulder side of Oil Seal Driver with lip of seal facing away from shoulder. Press seal into bearing carrier until seal driver bottoms against bearing carrier.



51872

a - Oil Seal (Lip of Seal Down)
b - Oil Seal Driver (91-31108)
c - Seated

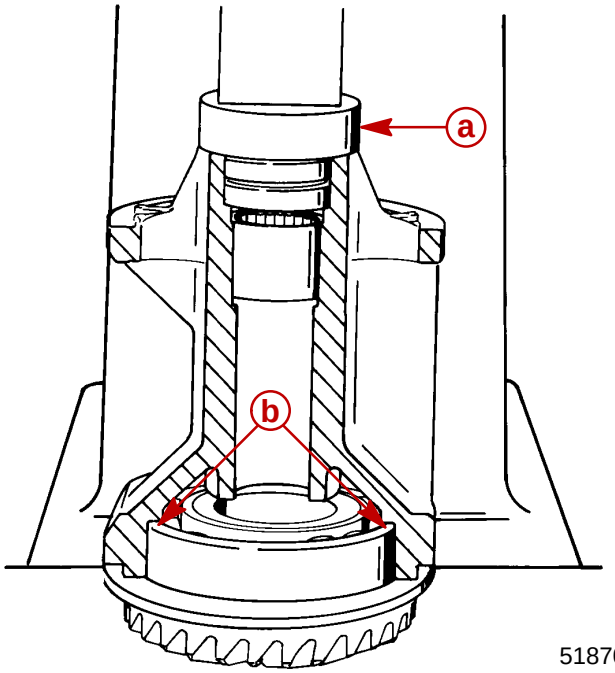
11. Place second seal on short shoulder side of seal driver with lip of seal toward shoulder. Press seal into bearing carrier until seal driver bottoms against bearing carrier.



51872

a - Oil Seal (Lip of Seal Up)
b - Oil Seal Driver
c - Seated

12. Wipe off excess Loctite.
13. Apply a light coat of Premium Gear Lubricant onto the outside diameter of reverse gear ball bearing.
14. Place bearing carrier over reverse gear and bearing assembly. Press bearing carrier onto bearing.



51870

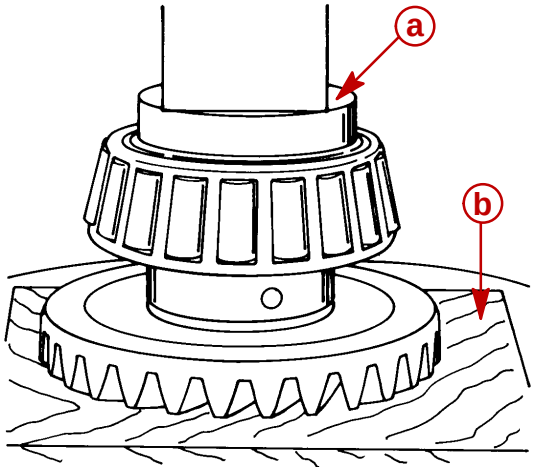
a - Mandrel
b - Seated

15. Place O-ring over bearing carrier and position it between bearing carrier and thrust washer.
16. Lubricate oil seals and O-ring with 2-4-C with Teflon.

Forward Gear

REASSEMBLY

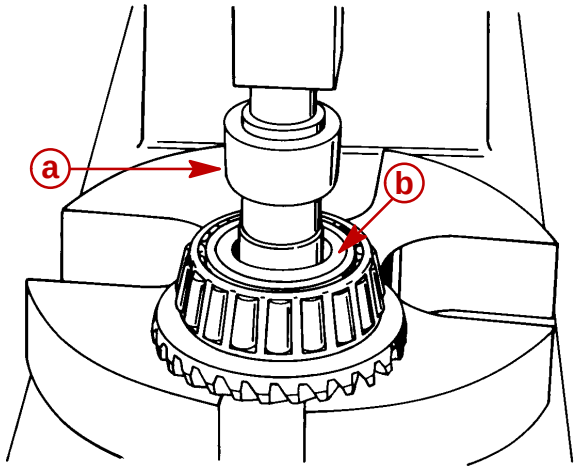
1. Place forward gear on a press with gear teeth down.
2. Apply a light coat of Premium Gear Lubricant onto the inside diameter of forward gear tapered bearing.
3. Position forward gear tapered bearing over gear.
4. Press bearing onto gear until firmly seated. (Be sure to press only on inner race of bearing and that bearing is firm against the gear.)



51869

a - Mandrel
b - Wooden Block

5. Apply a light coat of Premium Gear Lubricant to bore in center of forward gear.
6. Place one forward gear needle bearing on longer shoulder side of Forward Gear Bearing Tool with numbered side of bearing toward shoulder. Press bearing into forward gear until bearing tool bottoms against gear.



51873

a - Forward Gear Bearing Tool (91-86943)
b - Numbered Side of Needle Bearing

7. Place second needle bearing on short shoulder side of bearing tool with numbered side of bearing toward shoulder. Press bearing into forward gear until bearing tool bottoms against gear.

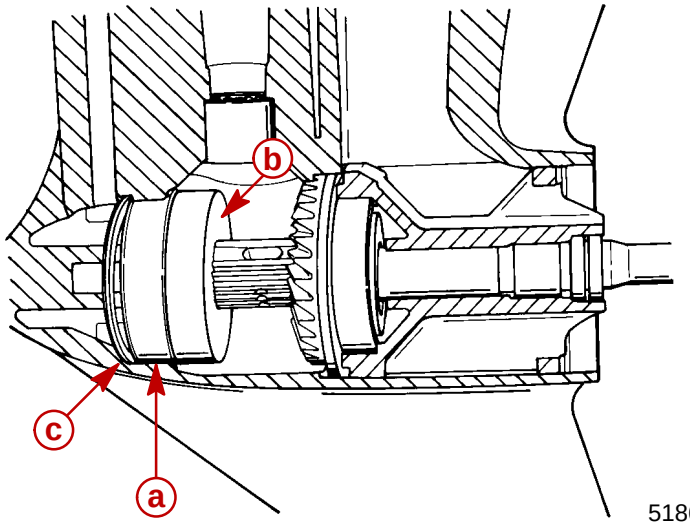
Forward Gear Bearing Race

INSTALLATION

1. Place shims (retained from disassembly) into gear housing. If shims were lost or a new gear housing is being used, start with approximately 0.010 in. (0.254 mm).
2. Apply a light coat of Premium Gear Lubricant to forward gear bearing race bore in gear housing.
3. Position tapered bearing race squarely over bearing bore in front portion of gear housing.
4. Place Bearing Driver Cup over tapered bearing race.

NOTE: *A used propeller shaft is recommended for use in Step 5. If it is necessary, however, to use the propeller shaft that will be installed in gear housing, the propeller shaft must be disassembled. (Refer to Propeller Shaft Disassembly, preceding.)*

5. Place propeller shaft into hole in center of Bearing Driver Cup.
6. Install bearing carrier assembly over propeller shaft and lower it into gear housing. Bearing carrier acts as a pilot to assure proper bearing race alignment.
7. Thread a nut onto propeller shaft to protect propeller shaft threads.
8. Use a mallet to drive propeller shaft against bearing driver cup until tapered bearing race is seated against shims.



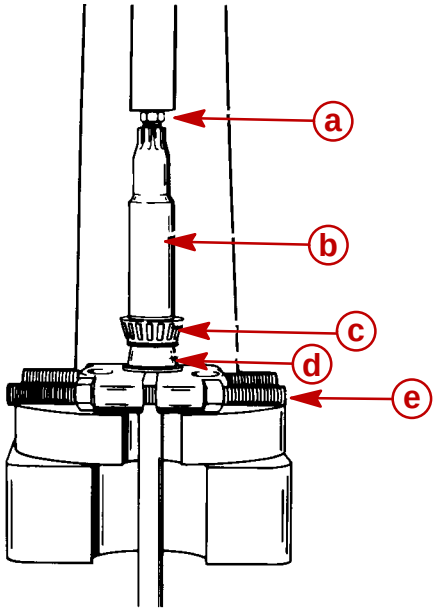
a - Tapered Bearing Race
b - Bearing Driver Cup (91-87120)
c - Shim(s)

9. Remove nut from propeller shaft, then remove bearing carrier and propeller shaft from gear housing. Lift bearing driver cup out of gear housing.
10. Apply a light coat of oil on tapered bearing race, then place forward gear assembly into forward bearing race.

Driveshaft and Pinion Gear

REASSEMBLY/INSTALLATION

1. Apply a light coat of Premium Gear Lubricant on I.D. of driveshaft tapered bearing.
2. Thread a used pinion nut onto end of driveshaft. Leave approximately 1/16 in. (2 mm) of nut threads exposed. Driveshaft threads MUST NOT extend beyond nut or thread damage could result while pressing.
3. Place bearing over driveshaft.
4. Using an old driveshaft bearing inner race or other suitable mandrel (which applies pressing force on center bearing race only), press bearing onto shaft until seated.



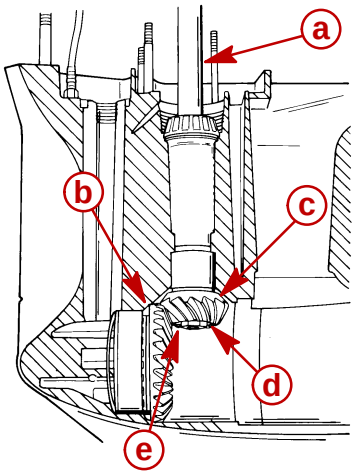
a - Used Pinion Nut
b - Driveshaft
c - Tapered Bearing
d - Old Bearing Inner Race
e - Universal Puller Plate

5. Position pinion gear in gear housing below driveshaft bore with teeth of pinion gear meshed with teeth of reverse gear.
6. Insert driveshaft into driveshaft bore while holding pinion gear. Rotate driveshaft to align and engage driveshaft splines with pinion gear splines. Continue to insert drive-shaft into gear housing until driveshaft tapered bearing is against bearing race.

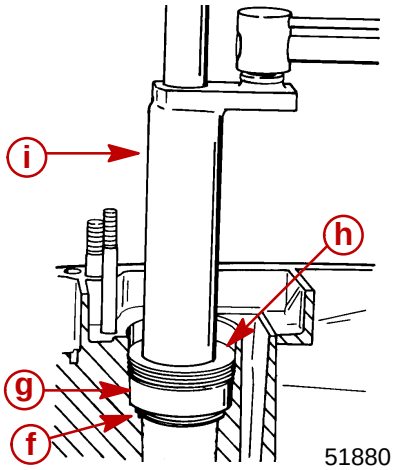
NOTE: *It is recommended that after final pinion depth is obtained, a new pinion nut be installed. Clean pinion nut threads with Loctite 7649 Primer N before applying Loctite 271.*

7. Place a small amount of Loctite 271 onto threads of pinion nut. Install flat washer and nut on drive shaft with flat side of nut away from pinion gear. Hand tighten pinion nut.

8. Place shims (retained from disassembly) into gear housing. If shims were lost or are not reusable (damaged), start with approximately 0.010 in. (0.254 mm).
9. Install bearing race and bearing retainer.



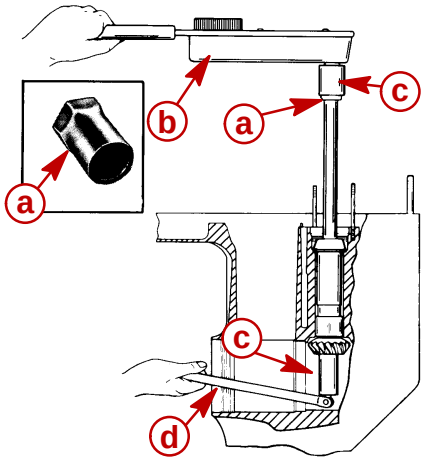
51867



51880

a - Driveshaft (rotate to engage splines with pinion gear)
b - Forward Gear Assembly
c - Pinion Gear
d - Washer (located above pinion nut)
e - Pinion Nut
f - Shims
g - Bearing Race
h - Bearing Retainer (Word “OFF” must be visible) Torque to 100 lb. ft. (135.5 Nm)
i - Bearing Retainer Tool (91-43506)

10. Use socket and flex handle to hold pinion nut (pad area where flex handle will contact gear housing) while torquing nut.
11. Place Driveshaft Holding Tool over crankshaft end of drive shaft. Torque pinion nut to 75 lb. ft. (101.5 Nm).



a - Driveshaft Holding Tool (91-34377A1 or 91-90094)
b - Torque Wrench
c - Socket
d - Breaker Bar

IMPORTANT: Wipe any excess Loctite from pinion nut and pinion gear.

Pinion Gear Depth/Forward Gear Backlash/Reverse Gear Backlash

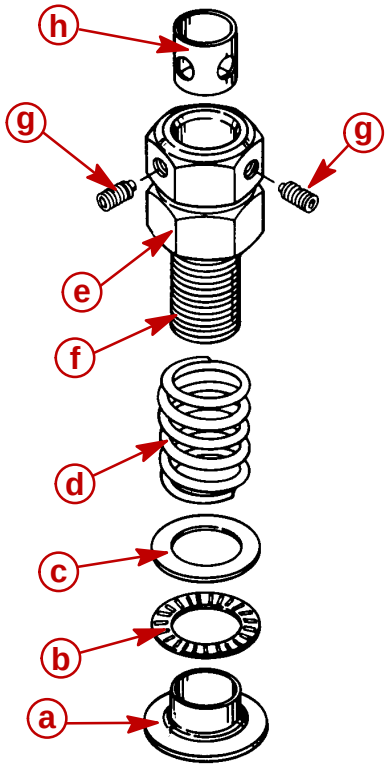
DETERMINING PINION GEAR DEPTH

NOTE: *Read entire procedure before attempting any change in shim thickness.*

IMPORTANT: Forward gear assembly must be installed in gear housing when checking pinion gear depth or an inaccurate measurement will be obtained.

1. Clean the gear housing bearing carrier shoulder.
2. Install Bearing Preload Tool (91-14311A1) over driveshaft in sequence shown.

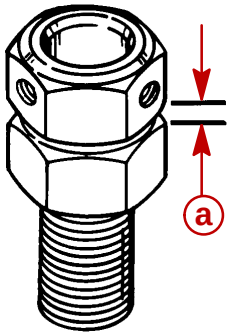
NOTE: *Bearing Preload Tool (91-44307A1) may also be used. Follow instructions provided with tool for proper installation.*

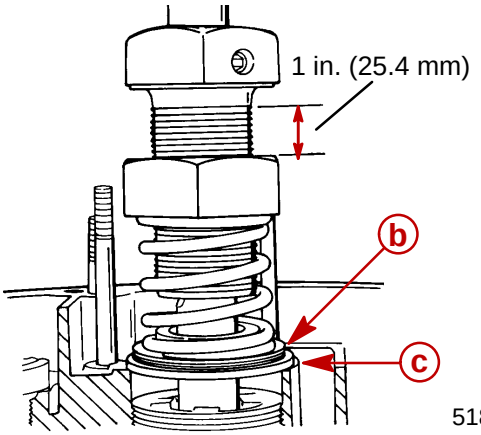


a - Adaptor
b - Bearing
c - Washer
d - Spring
e - Nut; thread nut all the way onto bolt
f - Bolt
g - Set Screw
h - Sleeve; Holes in sleeve must align with set screw

3. Align adaptor on driveshaft bearing pocket ledge.
4. With tool installed over driveshaft, tighten both set screws securely, making certain to align sleeve holes to allow set screws to pass through.

5. Measure distance “a“ and increase that distance by 1 in. (25.4 mm) by turning bottom nut away from top nut.



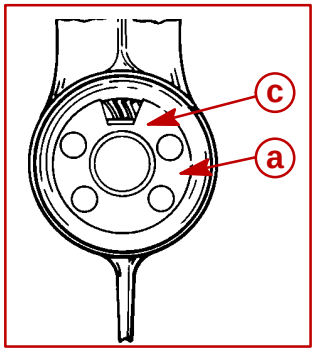


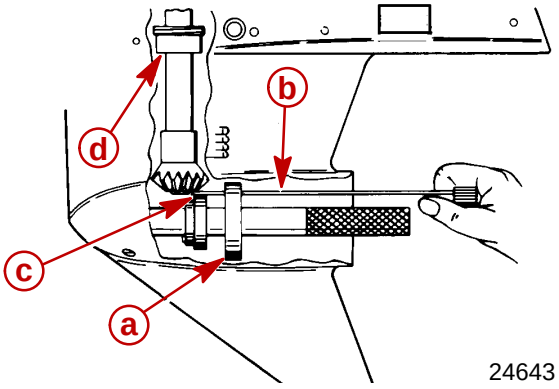
a - Distance
b - Adaptor
c - Ledge

6. Turn driveshaft clockwise 2 or more turns to seat driveshaft bearings.
7. Insert Pinion Gear Locating Tool into gear housing until it bottoms out on bearing carrier shoulder.

NOTE: *Pinion Gear Locating Tool (91-12349A2) can be used. Use flat #7 and disc #2. Follow instructions supplied with tool.*

8. Determine pinion gear depth by inserting feeler gauge through access slot in pinion gear shimming tool.
9. Clearance between locating tool and pinion gear should be 0.025 in. (0.64 mm).
10. If clearance is correct, leave Bearing Preload Tool on driveshaft for Determining Forward Gear Backlash, following.
11. If clearance is not correct, add (or subtract) shims at location shown to raise (or lower) pinion gear. When reinstalling pinion nut, apply Loctite 271 on threads of nut and retorque pinion nut.





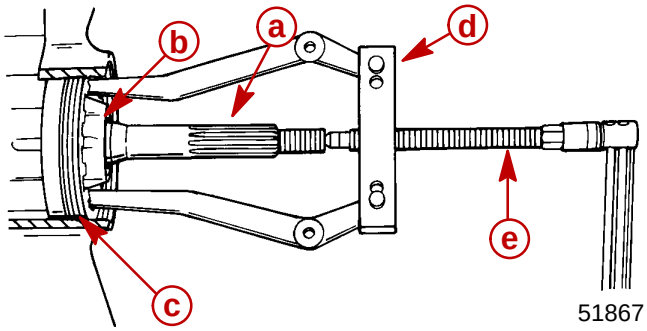
a - Pinion Gear Locating Tool (91-74776)
b - Feeler Gauge
c - Obtain 0.025 in. (0.64 mm) Clearance between Locating Tool and Pinion Gear
d - Add or Subtract Shims Here

NOTE: *Bearing Preload Tool (91-14311A1) should remain installed on driveshaft after setting pinion gear depth. It is required to properly check forward gear and reverse gear backlash.*

DETERMINING FORWARD GEAR BACKLASH

IMPORTANT: Bearing carrier must be assembled to provide pilot for propeller shaft.

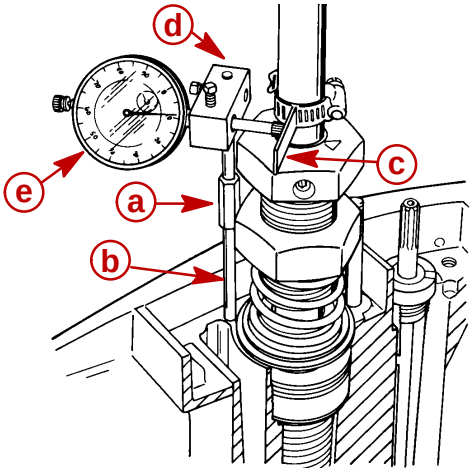
1. Insert propeller shaft into position in gear housing. (DO NOT place shift cam on propeller shaft.)
2. Place bearing carrier into gear housing and thread cover nut tightly against bearing carrier. (It is not necessary to torque cover nut against bearing carrier.)
3. Attach Bearing Carrier Removal Tool and Puller Bolt onto gear housing.
4. Torque puller bolt against propeller shaft to 45 lb. in. (5 Nm). Turn driveshaft 10 revolutions with the load applied to propeller shaft. This will seat forward gear bearing.



51867

a - Propeller Shaft (DO NOT install shift cam)
b - Bearing Carrier (assembled)
c - Cover Nut (Tighten; DO NOT torque)
d - Bearing Carrier Removal Tool (91-46086A1)
e - Puller Bolt (91-85716); Torque to 45 lb. in. (5 Nm)

5. Fasten dial indicator to gear housing and Backlash Indicator Tool to driveshaft.
6. Recheck torque on puller bolt [45 lb. in. (5 Nm)].
7. Position dial indicator pointer (on Backlash Indicator Tool) on line marked “1” if gear ratio is 1.87:1 (15 teeth on pinion gear), on line marked “2” if gear ratio is 2:1 (14 teeth on pinion gear) or on line marked “4” if gear ratio is 2.3:1 (13 teeth on pinion gear).



51880

a - Thread Stud Adaptor (from 91-14311A1)
b - Stud
c - Backlash Indicator Tool (91-78473)
d - Dial Indicator Holder (91-89897)
e - Dial Indicator (91-58222A1)

8. Lightly turn driveshaft back-and-forth (no movement should be noticed at propeller shaft).
9. Dial indicator registers amount of backlash which must be 0.018 in. to 0.027 in. (0.46 mm to 0.69 mm) for the 1.87:1 gear ratio, 0.015 in. to 0.022 in. (0.38 mm to 0.56 mm) for the 2:1 gear ratio and 0.018 in. to 0.023 in. (0.46 mm to 0.58 mm) for the 2.3:1 gear ratio.
10. If backlash is LESS than the specified minimum, REMOVE shims from in front of the forward gear bearing race to obtain correct backlash. When reinstalling the pinion nut, apply Loctite 271 on threads of nut.
11. If backlash is MORE than the specified MAXIMUM, add shims in front of forward gear bearing race to obtain correct backlash. When reinstalling pinion nut, apply Loctite 271 on threads of nut.

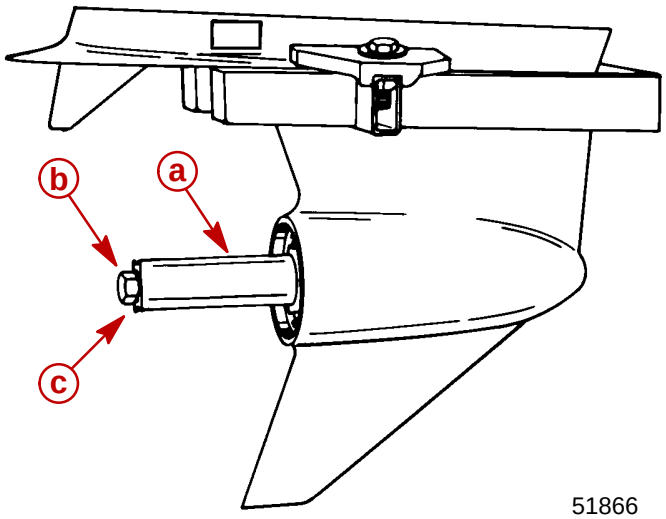
NOTE: *By adding or subtracting a 0.001 in. (0.025 mm) shim, the backlash will change approximately 0.001 in. (0.025 mm).*

REVERSE GEAR

Determining Reverse Gear Backlash

Although reverse gear backlash is not adjustable, it may be checked as follows:

1. Propeller shaft and bearing carrier must be completely assembled and installed in gearcase.
2. Install shift shaft in gearcase.
3. Shift gearcase into reverse.
4. Slide 6 in. x 1.5 in. I.D. (152.5 mm x 38.0 mm) piece of PVC pipe over propeller shaft and position pipe against bearing carrier.
5. Secure pipe against carrier with propeller nut and tab washer.



51866

a - Pipe [6 in. x 1.5 in. (152.5 mm x 38.0 mm)]
b - Propeller Nut
c - Tab Washer

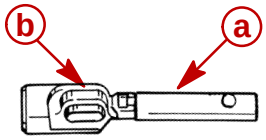
6. Torque propeller nut to 45 lb. in. (5 Nm).
7. Gently rock driveshaft. Dial indicator should show backlash of 0.030 in.-0.050 in. (0.762 mm- 01.27 mm).

If backlash is not as indicated, gearcase is not properly assembled or parts are excessively worn and must be replaced before returning gearcase to service.

Clutch Actuator Rod

REASSEMBLY

1. Place a small amount of 2-4-C with Teflon on actuator rod and install cam follower.



a - Actuator Rod
b - Cam Follower

Shift Shaft Bushing

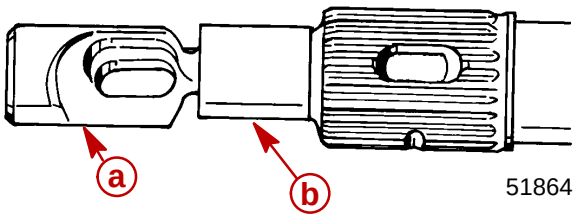
REASSEMBLY

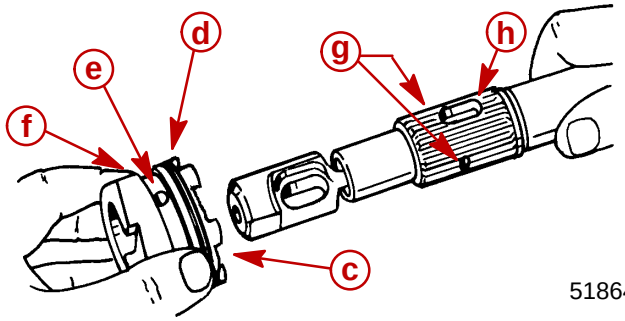
1. Position shift shaft bushing on a press with threaded side down.
2. Apply Loctite 271 to outside diameter of oil seal.
3. Press oil seal into shift shaft bushing with lip of seal up.
4. Wipe any excess Loctite from oil seal and bushing.
5. Place rubber washer against oil seal.
6. Install O-ring over threads and up against shoulder of bushing.
7. Lubricate O-ring and oil seal with 2-4-C with Teflon.

Propeller Shaft

REASSEMBLY/INSTALLATION

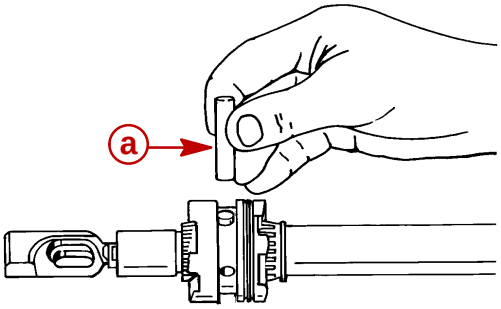
1. Insert clutch actuator rod assembly into end of propeller shaft. Align cross pin slot in actuator rod with cross pin slot in propeller shaft.
2. On production model gearcases, position sliding clutch onto propeller shaft with grooved rings (on sliding clutch) toward propeller end of propeller shaft. Cross pin hole and detent holes (in sliding clutch) must line up with cross pin slot and detent notches on propeller shaft.



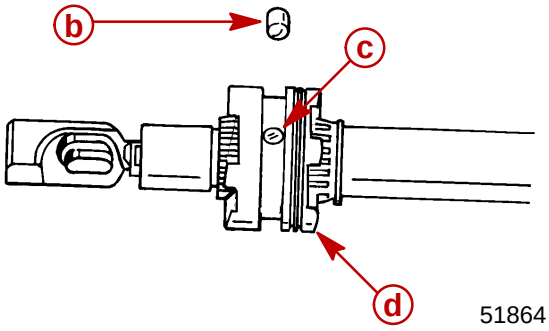


a - Cam Follower
b - Propeller Shaft
c - Sliding Clutch
d - Grooved Rings
e - Cross Pin Hole
f - Detent Hole (Behind Finger and Thumb)
g - Detent Notch (One on Each Side)
h - Cross Pin Slot

3. Insert cross pin through sliding clutch, propeller shaft and actuator rod, forcing cross pin tool out.
4. Apply a small amount of 2-4-C with Teflon on detent pin. Position a detent pin in detent pin hole of sliding clutch with rounded end of pin toward propeller shaft.



51864



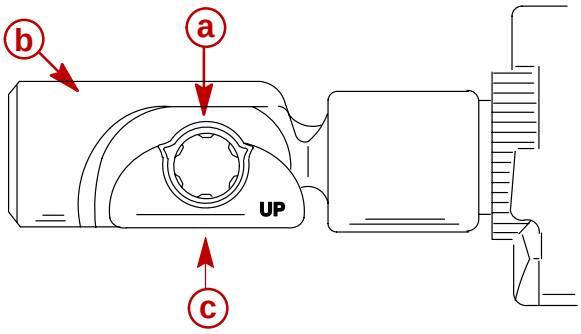
51864

a - Cross Pin
b - Detent Pin
c - Cross Pin
d - Sliding Clutch

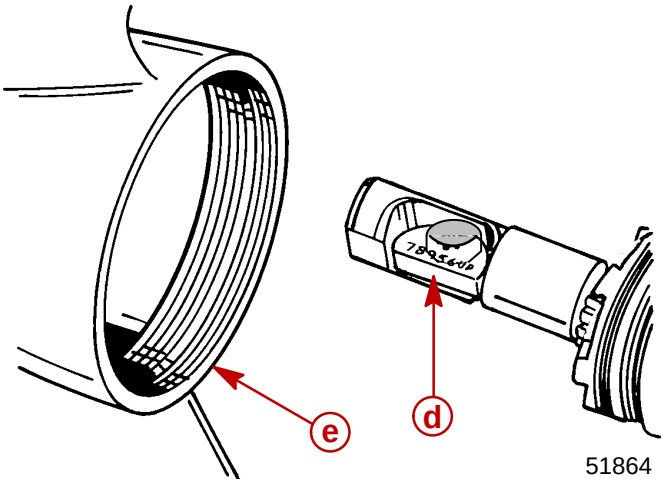
5. Install cross pin retaining spring onto sliding clutch as follows:

IMPORTANT: DO NOT over-stretch retaining spring when installing onto sliding clutch.

6. Spirally wrap spring into groove on sliding clutch.
7. Place gear housing in a soft jaw vise with the driveshaft in a vertical position.
8. Coat cam pocket of cam follower with 2-4-C with Teflon.
9. Place shift cam into cam pocket of cam follower with numbered side of cam facing up.
10. With shift cam positioned as shown, insert propeller shaft through forward gear until shaft bottoms out.



55095



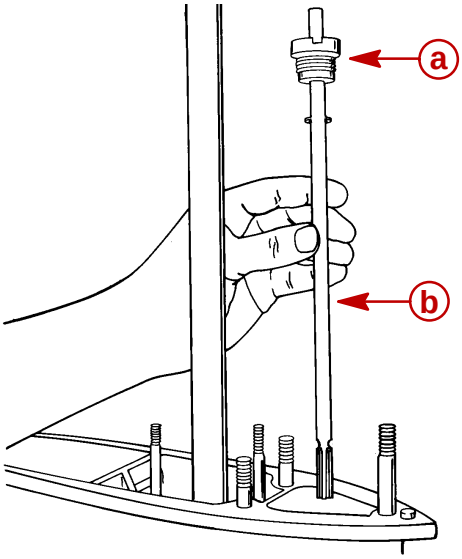
51864

a - Cam Pocket
b - Cam Follower
c - Shift Cam
d - Shift Cam (Position as Shown)
e - Gear Housing

⚠ CAUTION

Until bearing carrier is installed into gear housing, extreme care MUST BE taken not to apply any side force on propeller shaft. Side force on propeller shaft may break the neck of the clutch actuator rod.

11. Insert shift shaft down shift shaft hole (of gear housing) and through shift cam and cam follower. (It may be necessary to rotate shift shaft back-and-forth slightly for it to enter shift cam.)
12. Apply a light coat of 2-4-C with Teflon to threads of shift shaft bushing. (Thread bushing into position, but do not tighten down at this time)



51867

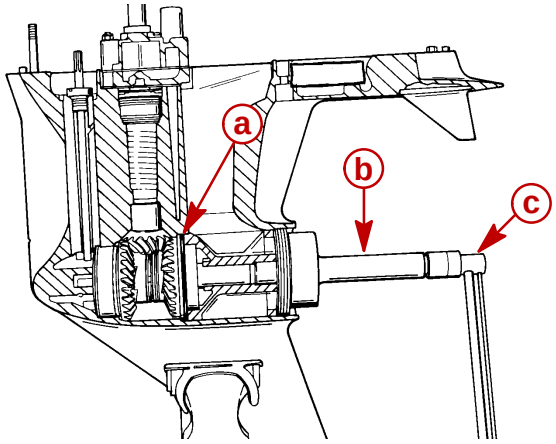
a - Shift Shaft Bushing
b - Shift Shaft

13. Lubricate O-ring on bearing carrier with 2-4-C with Teflon.
14. Apply a light coat of 2-4-C with Teflon to outside diameter of bearing carrier (where carrier contacts gear housing).

NOTE: *When performing Step 15, rotate driveshaft clockwise (viewed from top) to mesh pinion gear with reverse gear.*

15. Position bearing carrier over propeller shaft and slide it into gear housing. (Be sure to align bearing carrier keyway with gear housing keyway.)
16. Push bearing carrier in as far as possible by hand, then install bearing carrier key.
17. Place tab washer against bearing carrier.
18. Apply 2-4-C with Teflon to threads of cover nut and install cover nut in gear housing (verify that the word “OFF” and arrow are visible).

19. Start cover nut a few turns by hand, then using Cover Nut Tool and torque wrench, torque cover nut to 210 lb. ft. (285 Nm).



51871

a - O-ring
b - Cover Nut Tool (91-61069)
c - Torque Wrench

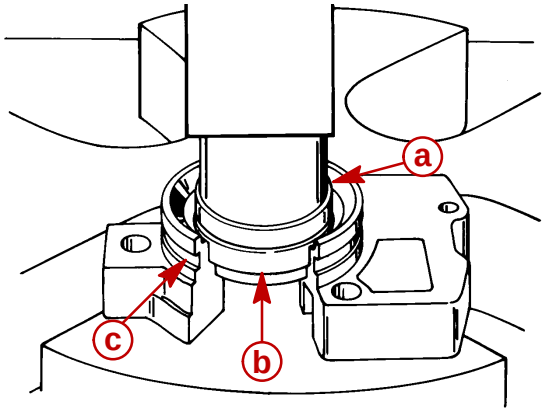
20. Bend one lock tab of tab washer into cover nut (only one will align).
21. Bend remaining tabs of tab washer toward front of gear housing.
22. Use Shift Shaft Bushing Tool (91-31107) and torque shift shaft bushing to 30 lb. ft. (41 Nm).

Water Pump

REASSEMBLY/INSTALLATION

1. Install oil seals into water pump base, as follows:
   a. Place water pump base on a press.
   b. Just before installing each seal apply Loctite 271 on outside diameter of oil seal.
   c. With a suitable mandrel, press the smaller diameter oil seal into pump base with lip of oil seal toward impeller side of base.
   d. With a suitable mandrel, press the larger diameter oil seal into pump base with lip of oil seal toward gear housing side of base.
   e. Wipe any excess Loctite from oil seals and water pump base.

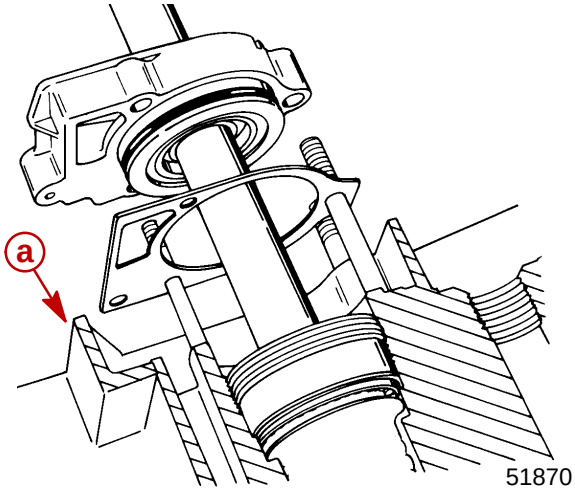
2. Install O-ring into O-ring groove of water pump base. Lubricate O-ring and oil seals with 2-4-C with Teflon.



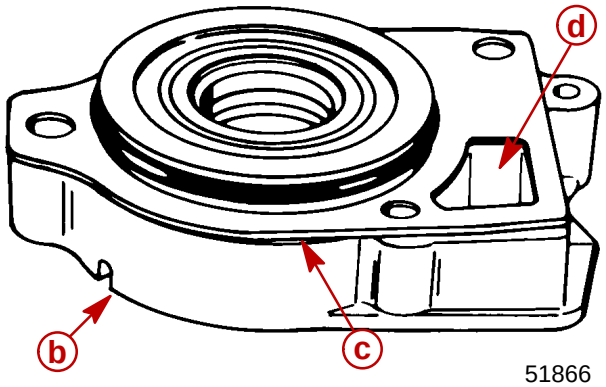
51869

a - Mandrel
b - Oil Seal (Smaller OD)
c - O-ring Groove

3. Install divider block if removed. Use RTV 587 Silicone Sealer to seal seams between divider block and gear housing.
4. Install a new water pump base gasket and install water pump base.



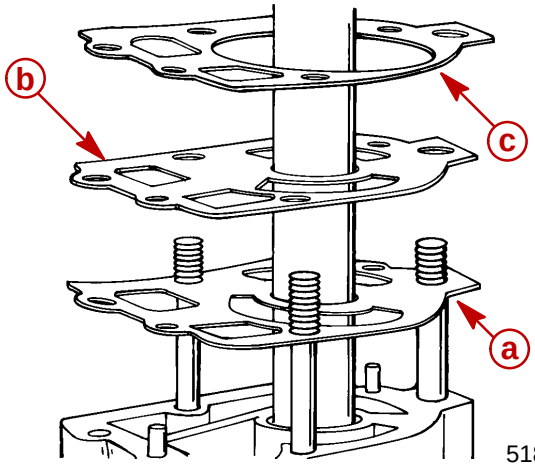
51870



51866

a - Divider Block
b - Water Pump Base
c - Gasket
d - Hole (MUST be positioned as shown)

5. Install the following in order: Pump base to face plate gasket, face plate gasket and face plate to pump cover gasket. Gaskets and face plate are indexed by dowel pin location and must be installed correctly.



51868

a - Gasket (Water Pump Base to Face Plate)
b - Face Plate
c - Gasket (Face Plate to Water Pump Cover)

6. Place impeller drive key on flat of driveshaft. Hold key on driveshaft with a small amount of 2-4-C with Teflon.

IMPORTANT: When completing gear housing repair, that requires removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to reuse the impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur. Original rotation is clockwise.

⚠ CAUTION

A visual inspection of impeller drive key MUST BE made to determine that drive key is on flat of driveshaft after impeller is installed. If key has moved off flat of driveshaft, repeat Steps 7 and 8.

7. Slide impeller down driveshaft to impeller drive key. Align drive key with keyway in the center hub of impeller, and slide impeller over drive key.
8. If removed, install new water pump insert into pump cover as follows:
   a. Apply Perfect Seal to water pump insert area of pump cover.
   b. Install water pump insert into pump cover. Verify that tab on insert enters recess in pump cover.
   c. Wipe any excess Perfect Seal from insert and cover.

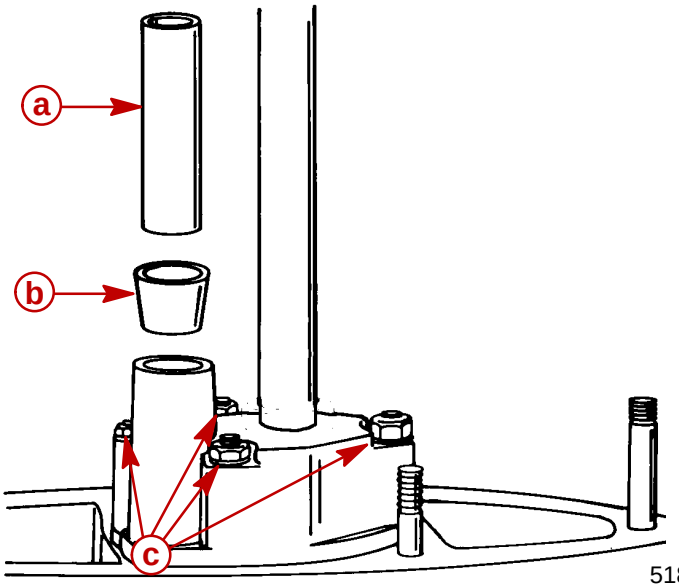
NOTE: *If 2 holes were drilled in top of the water pump cover to aid in removal of insert, fill holes with RTV 587 Silicone Sealer or equivalent. Allow to cure for 24 hours prior to operating engine.*

9. Install water tube seal into pump cover, being sure that plastic side of seal goes into cover first.
10. Reinstall water tube guide into water pump cover.
11. Apply a light coat of 2-4-C with Teflon inside of water pump insert.
12. Position assembled water pump cover over driveshaft and lower over water pump studs. Rotate driveshaft in a clockwise direction (viewed from top), while pushing down on pump cover to ease impeller entry into cover.
13. Install water pump cover retainer washers, nuts and bolt.

⚠ CAUTION

DO NOT over torque nuts and bolt, as this could cause cover to crack during operation.

14. Torque water pump nuts to 50 lb. in. (5.5 Nm), and water pump bolt to 35 lb. in. (4 Nm).
15. Install centrifugal slinger over driveshaft and down against pump cover.



51874

a - Water Tube Guide
b - Water Tube Seal
c - Nuts, Bolt and Washers

Gear Lubricant Filling Instructions

1. Remove any gasket material from Fill and Vent screws and gear housing.
2. Install new gaskets on Fill and Vent screws.

IMPORTANT: Never apply lubricant to gear housing without first removing Vent screw, or gear housing cannot be filled because of trapped air. Fill gear housing ONLY when housing is in a vertical position.

3. Slowly fill housing through 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

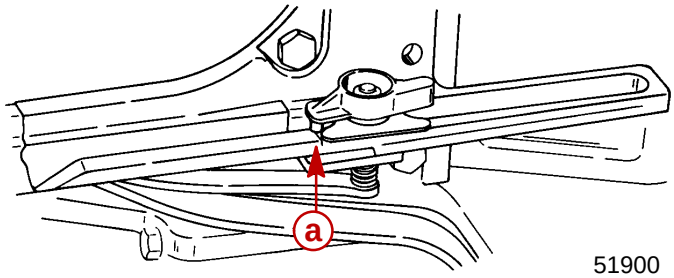
Disconnect high tension leads from spark plugs and remove spark plugs from engine before installing gear housing onto driveshaft housing.

1. Tilt engine to full up position and engage the tilt lock lever.
2. Apply a light coat of 2-4-C 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 with Teflon onto shift shaft splines. (DO NOT allow lubricant on top of shift shaft.)
4. Apply a thin bead of RTV 587 Silicone Sealer against the top of divider block.
5. Insert trim tab bolt into hole in rear of gear housing to driveshaft housing machined surface.
6. Shift gear housing into forward gear and place guide block anchor pin into forward gear position.



51900

a - Guide Block Anchor Pin

7. Position gear housing so that the driveshaft is protruding into driveshaft housing.

NOTE: *If, while performing Step 8, the driveshaft splines will not align with crankshaft splines, place a propeller onto propeller shaft and turn it counterclockwise as the gear housing is being pushed toward driveshaft housing.*

8. Move gear housing up toward driveshaft housing, while aligning shift shaft splines and water tube with water tube guide (in water pump cover).
9. Place flat washers onto studs (located on either side of driveshaft housing). Start a nut 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.

IMPORTANT: Do not force gearcase up into place with attaching nuts.

12. Evenly tighten the 2 nuts which were started in Step 9. Torque to listing in **Torque Specifications,** preceding.
13. After 2 nuts (located on either side of driveshaft housing) are tightened, check shift operation as follows:
    a. Place guide block anchor pin into forward gear position. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate clockwise.
    b. Place guide block anchor pin into neutral position. Propeller shaft should rotate freely clockwise/counterclockwise.
    c. Place guide block anchor pin into reverse gear position. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate counterclockwise.

IMPORTANT: If shifting operation is not as described, preceding, the gear housing must be removed and the cause corrected.

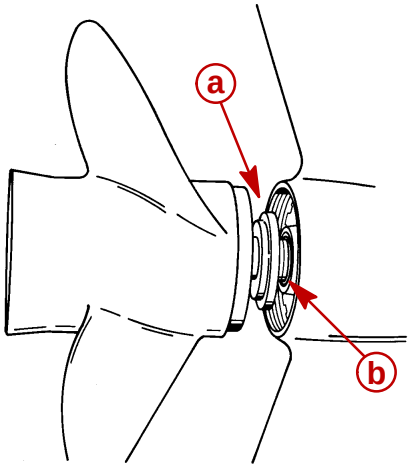
14. Install washers and nuts onto studs (located on bottom center of anti-cavitation plate). Torque to listing in **Torque Specifications,** preceding.
15. Install special flat washer and nut on stud at leading edge of driveshaft housing. Torque to listing in **Torque Specifications,** preceding.
16. Torque bolt (started in Step 10) to listing in **Torque Specifications,** preceding.
17. Install trim tab, adjust to position in which it had previously been installed, and tighten securely.
18. Install plastic cap into trim tab bolt opening at rear edge of driveshaft housing.

Propeller Installation

⚠ WARNING

When installing or removing propeller, because of the engine's ease in starting, be sure that the remote control is in neutral position and that the key switch is "OFF." Place a block of wood between the anti-cavitation plate and propeller to prevent accidental starting and to protect hands from propeller blades while removing or installing nut.

1. To aid in future removal of the propeller, liberally coat the propeller shaft splines with one of the following products:
   -- Anti-Corrosion Grease
   -- Special Lubricant 101
   -- 2-4-C Marine Lubricant
   -- Perfect Seal
2. Place forward thrust hub over propeller shaft with shoulder side toward propeller.
3. Place propeller on propeller shaft and slide it up against thrust hub.



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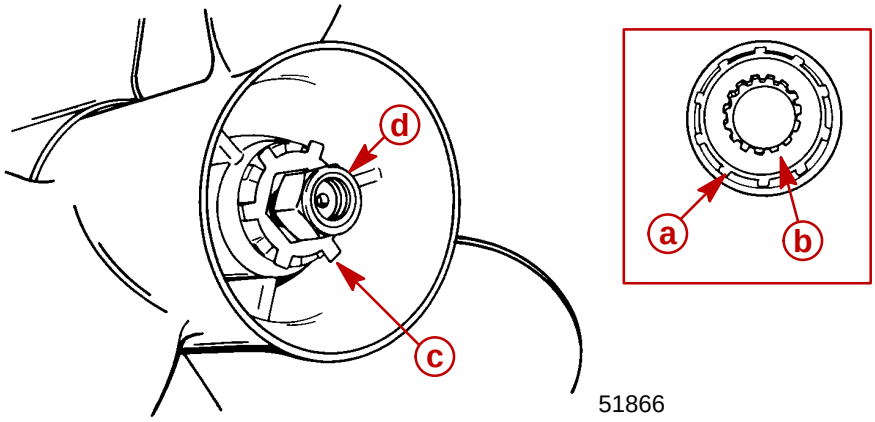
a - Forward Thrust Hub
b - Propeller Shaft

4. Place continuity washer (if equipped) onto shoulder of rear thrust hub.
5. Place rear thrust hub, tab washer and propeller nut on propeller shaft.
6. Thread propeller nut onto propeller shaft until nut is recessed into tab washer.
7. After propeller nut is recessed into tab washer, tighten nut securely [minimum of 55 lb. ft. (74.5 Nm) torque].
8. Bend 3 of the tabs of tab washer down in grooves of rear thrust hub to secure propeller nut. (If tab washer tabs do not align with slots, continue to tighten propeller nut to obtain alignment. DO NOT loosen nut to align tabs.)

⚠ 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.



51866

a - Continuity Washer (if Equipped)
b - Rear Thrust Hub
c - Tab Washer
d - Propeller Nut

LOWER UNIT

Section 6B – Left Hand Non-Ratcheting

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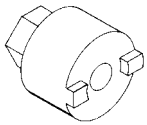
6 B

Gear Housing Specifications (Counter Rotation)

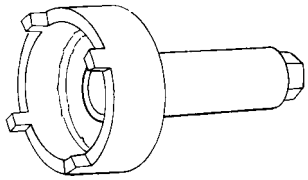
Ratio	Pinion Depth	Forward Gear Backlash	Reverse Gear Backlash
1.87:1	0.025 in. (0.635 mm) With Tool 91-12349A2 using Disc #2 and Flat #7	0.018 in. to 0.027 in. (0.460 mm to 0.686 mm) Pointer on line mark #1	0.030 in. to 0.050 in. (0.762 mm to 1.27 mm)
2.0:1	0.025 in. (0.635 mm) With Tool 91-12349A2 using Disc #2 and Flat #7	0.015 in. to 0.022 in. (0.38 mm to 0.56 mm) Pointer on line mark #2	0.030 in. to 0.050 in. (0.762 mm to 1.27 mm)
Gearcase Lubricant Capacity			
All Ratios		22.5 fl. oz. (665.4 ml)	

Special Tools

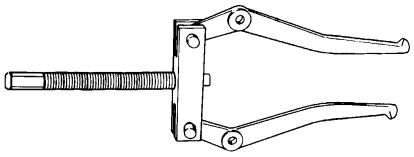
1. Shift Shaft Bushing Tool 91-31107T



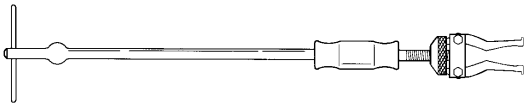
2. Gear Housing Cover Nut Tool 91-61069



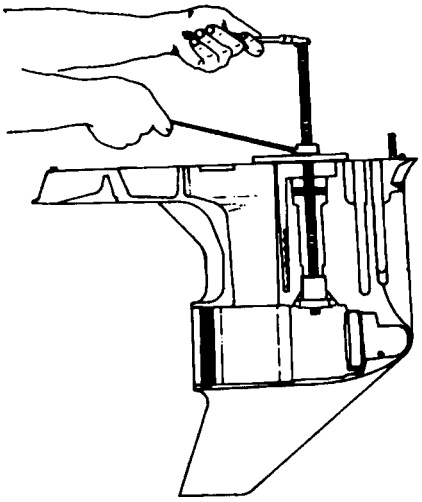
3. Bearing Carrier Removal Tool 91-46086A1 and Puller Bolt 91-85716



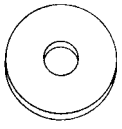
4. Slide Hammer Puller 91-34569A1



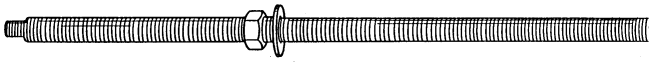
5. Bearing Removal and Installation Kit 91-31229A5. This kit contains the following tools: Pilot 91-36571; Puller Rod 91-31229; Nut 11-24156; Puller Plate 91-29310; Mandrel 91-38628; and Driver Rod 91-37323.



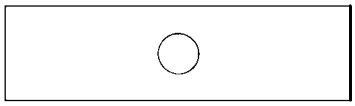
6. Pilot 91-36571



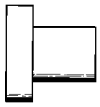
7. Puller Rod 91-31229 and Nut 91-24156



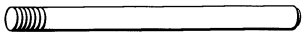
8. Puller Plate 91-29310



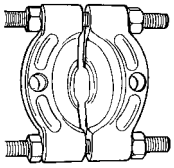
9. Mandrel 91-38628



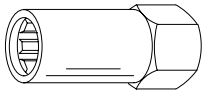
10. Driver Rod 91-37323



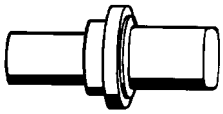
11. Universal Puller Plate 91-37241



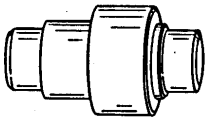
12. Drive Shaft Holding Tool 91-34377A1 or 91-90094



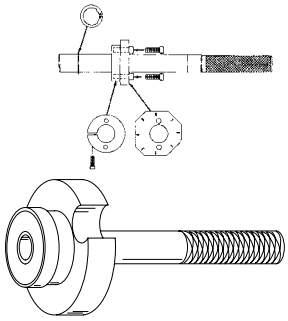
13. Oil Seal Driver 91-31108



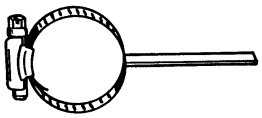
14. Forward Gear Bearing Tool 91-86943



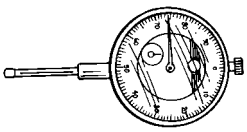
15. Pinion Gear Locating Tool 91-12349A2 or 91-74776



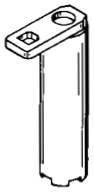
16. Backlash Indicator Rod 91-78473



17. Dial Indicator 91-58222A1



18. Bearing Retainer Tool 91-43506



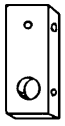
19. Mandrel 91-92788



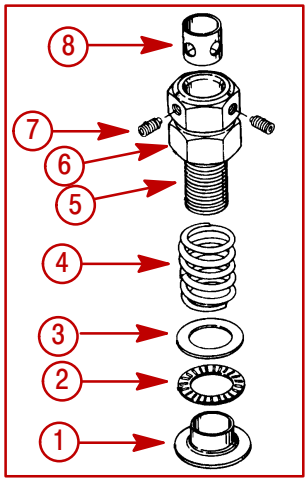
20. Mandrel 91-15755



21. Dial Indicator Holder 91-89897

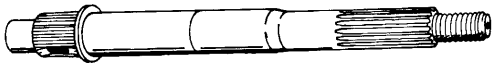


22. Bearing Preload Tool 91-14311A1



1 - Adaptor (N.S.S.)
2 - Bearing (N.S.S.)
3 - Washer (N.S.S.)
4 - Spring (24-14111)
5 - Bolt (10-12580)
6 - Nut (11-13953)
7 - Set Screw (10-12575)
8 - Sleeve (23-13946)

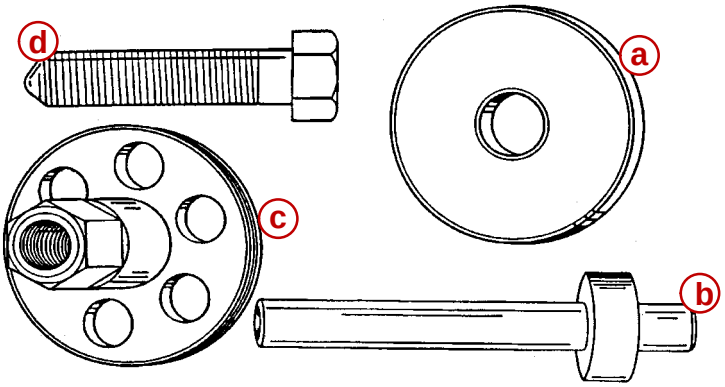
23. Propeller Shaft 44-93003 and Load Washer 12-37429



24. Forward Gear Installation Tool 91-815850



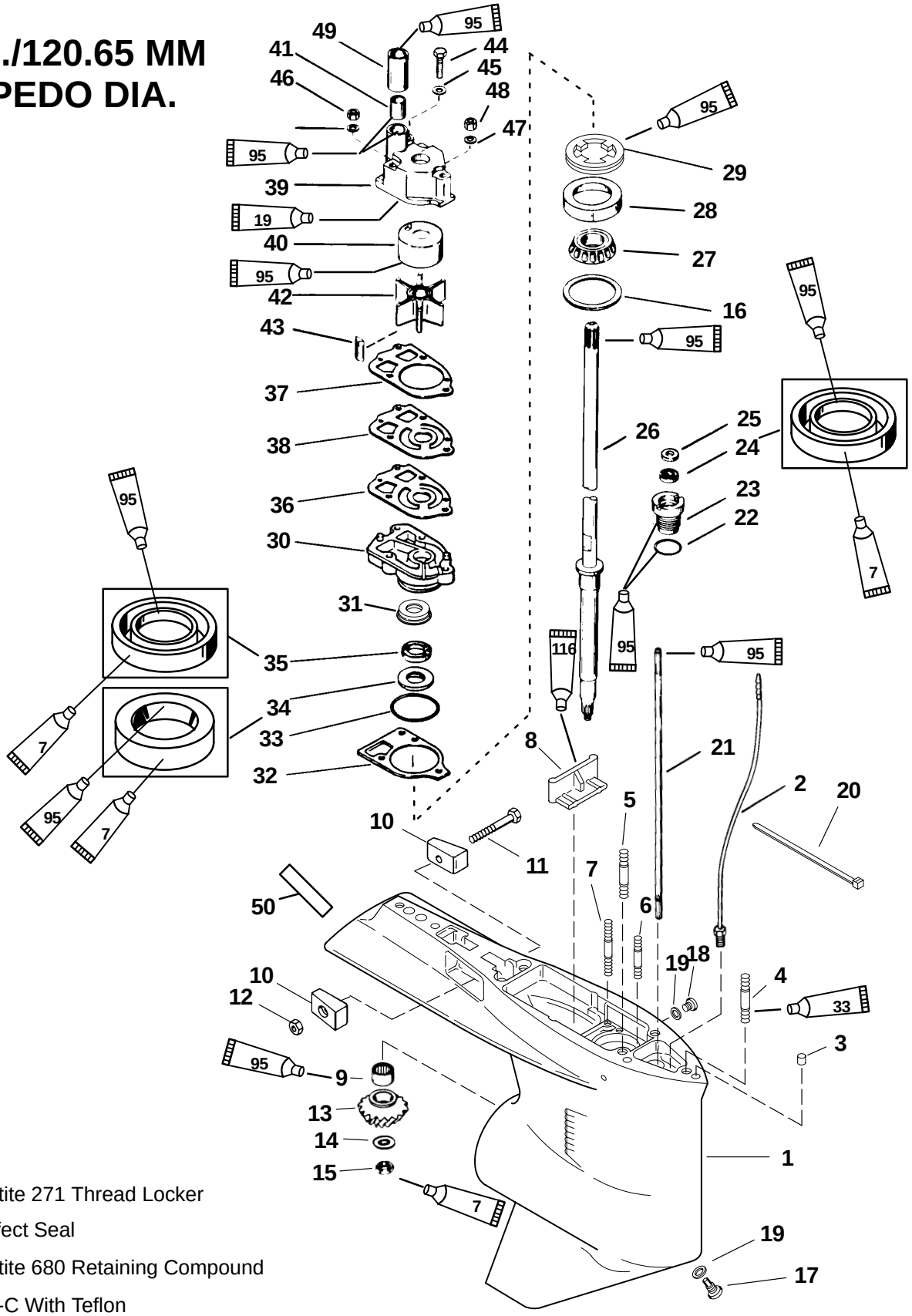
25. Reverse Gear Installation Kit 91-18605A1 includes Pilot 91-18603; Retainer 91-18604; Shaft 91-18605 and Screw 10-18602



a - Pilot 91-18603
b - Shaft 91-18605
c - Retainer 91-18604
d - Screw 10-18602

Gear Housing (Drive Shaft)(Counter Rotation)

4.75 IN./120.65 MM TORPEDO DIA.



7 Loctite 271 Thread Locker

19 Perfect Seal

33 Loctite 680 Retaining Compound

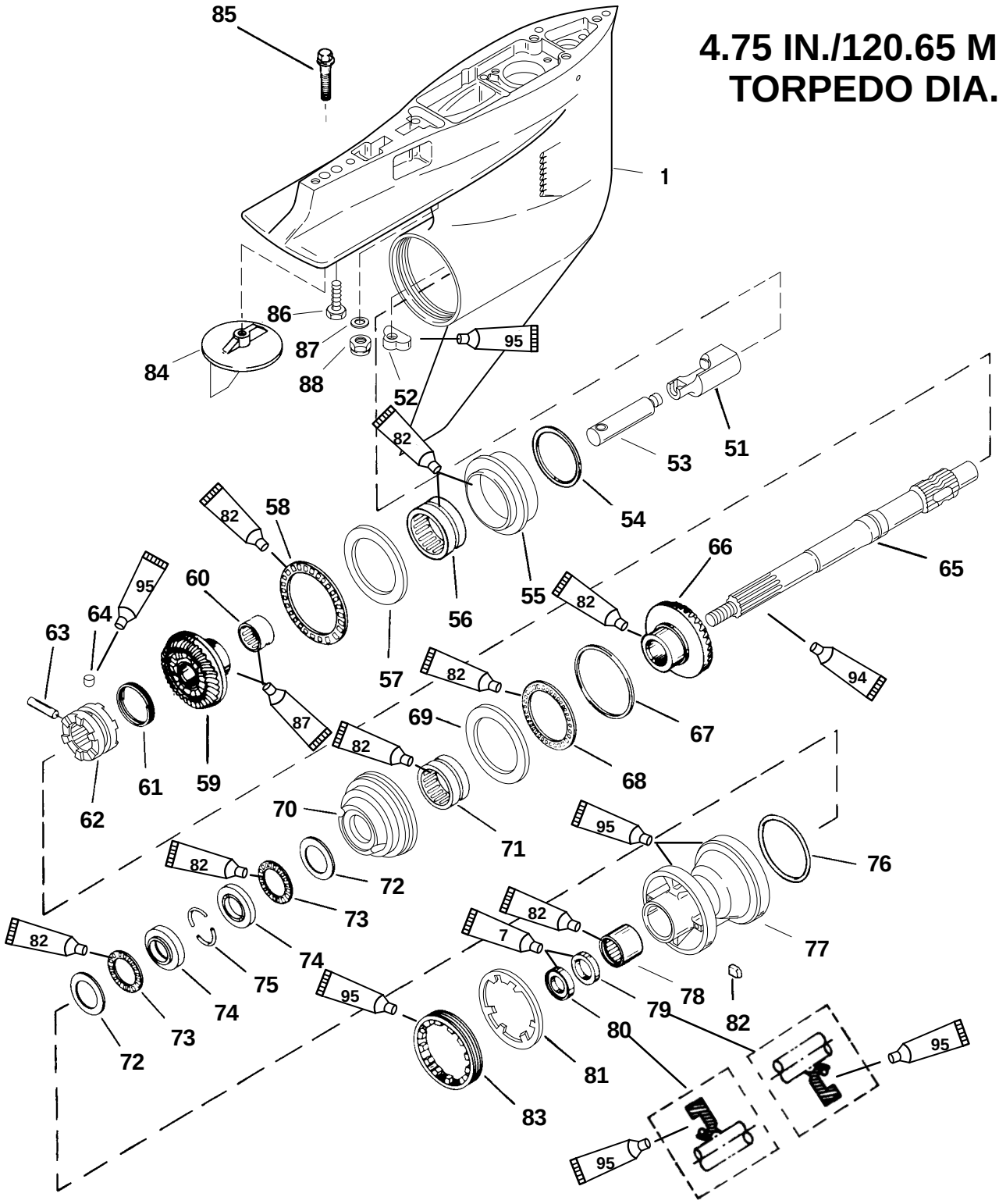
95 2-4-C With Teflon

116 RTV 587 Silicone Sealer

Gear Housing (Drive Shaft)(Counter Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	GEAR HOUSING **(BLACK)(BASIC)**			
2	1	CONNECTOR ASSEMBLY			
3	2	DOWEL PIN			
4	1	STUD (3-11/16 IN.)			
5	2	STUD (2-1/16 IN.)			
6	1	STUD (3-3/8 IN.)			
7	2	STUD (3-1/8 IN.)			
8	1	FILLER BLOCK			
9	1	ROLLER BEARING			
10	2	ANODE			
11	1	SCREW			
12	1	NUT	60		7
13	1	PINION GEAR **(1.87:1 - 15 TEETH)(150)(Part of 43-828701A1)**			
	1	PINION GEAR **(2:1 - 14 TEETH)-(135)(Also part of 43-828703A1)**			
14	1	WASHER			
15	1	NUT		75	101
16	AR	SHIM SET			
17	1	SCREW–drain (MAGNETIC)	60		7
18	1	SCREW–grease filler	60		7
19	2	WASHER			
20	1	STA-STRAP			
21	1	SHIFT SHAFT			
22	1	O-RING			
23	1	BUSHING ASSEMBLY		50	5.5
24	1	OIL SEAL			
25	1	WASHER–rubber			
26	1	DRIVE SHAFT			
27	1	ROLLER BEARING			
28	1	CUP			
29	1	RETAINER		100	11.5
30	1	WATER PUMP BASE			
31	1	RETAINER			
32	1	GASKET			
33	1	O-RING			
34	1	OIL SEAL			
35	1	OIL SEAL			
36	1	GASKET–lower			
37	1	GASKET–upper			
38	1	FACE PLATE			
39	1	WATER PUMP BODY ASSEMBLY			
40	1	INSERT			
41	1	SEAL–rubber			
42	1	IMPELLER			
43	1	KEY			
44	1	SCREW (#14-8 x 2-1/4 IN.)	35		4
45	2	WASHER			
46	2	NUT	50		5.5
47	1	WASHER			
48	1	NUT	50		5.5
49	1	SLEEVE			
50	1	DECAL-Counter Rotation			

Gear Housing (Prop Shaft)(Counter Rotation)



7 Loctite 271 Thread Locker

82 Premium Gear Lubricant

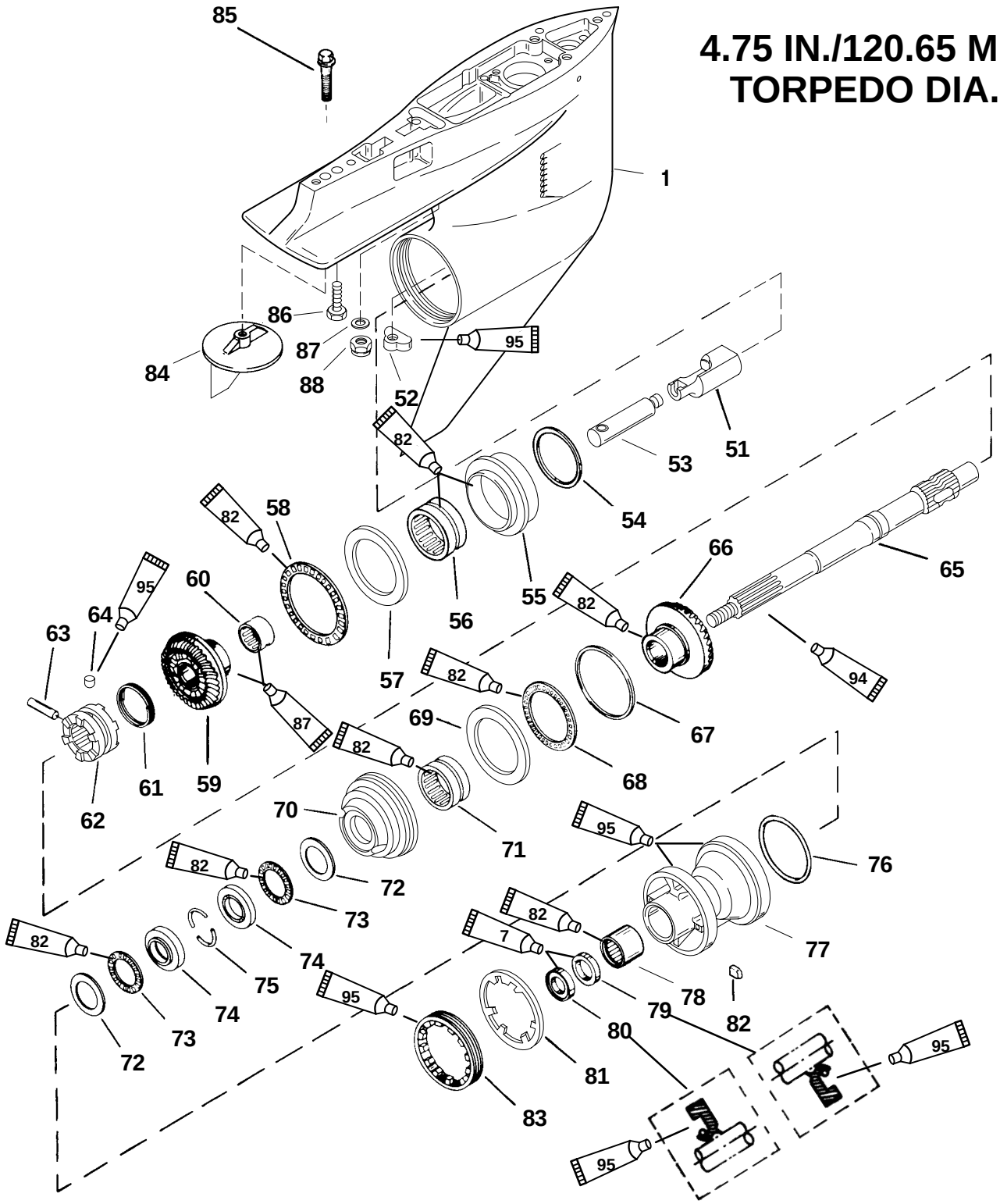
94 Anti-Corrosion Grease

95 2-4-C With Teflon

Gear Housing (Prop Shaft)(Counter Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	GEAR HOUSING **(BLACK)(BASIC)**			
51	1	CAM FOLLOWER			
52	1	SHIFT CAM			
53	1	ROD			
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 **(1.87:1 – 15/28)(150)**			
	1	REVERSE GEAR **(2:1 – 14/28)-(135)**			
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 **(1.87:1 – 15/28)(150)**			
	1	FORWARD GEAR **(2:1 – 14/28)-(135)**			
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.			

Gear Housing (Prop Shaft)(Counter Rotation)



7 Loctite 271 Thread Locker

82 Premium Gear Lubricant

94 Anti-Corrosion Grease

95 2-4-C With Teflon

Gear Housing (Prop Shaft)(Counter Rotation)

REF. NO.	QTY.	DESCRIPTION	TORQUE		
			lb-in	lb-ft	Nm
1	1	GEAR HOUSING **(BLACK)(BASIC)**			
68	1	ROLLER BEARING			
69	1	THRUST WASHER			
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	KEY			
83	1	COVER		210	285
84	1	TRIM TAB			
85	1	SCREW (1-3/4 IN.)		25	34
86	1	SCREW (3/8-16 x 1)		30	41
87	2	WASHER			
88	2	NUT		50	68

General Service Recommendations

There may be more than one way to disassemble or reassemble a particular part, 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 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 through the bearing. DO NOT spin bearing with compressed air, as this may cause bearing to score from lack of lubrication. After cleaning, lubricate bearings with Premium Gear Lubricant. DO NOT lubricate tapered bearing cups until after inspection.

Inspect all bearings for roughness, catches and bearing race side wear. Work the inner bearing race in and out, while holding outer race, to check for side wear. When inspecting tapered bearings, determine condition of rollers and inner bearing race by inspecting bearing cup for pitting, scoring, grooves, uneven wear, imbedded particles and/or discoloration from over-heating. Always replace tapered bearing and race as a set.

Roller bearing condition is determined by inspecting the bearing surface of the shaft that the roller bearing supports. Check shaft surface for pitting, scoring, grooving, imbedded particles, uneven wear and/or discoloration from overheating. The shaft and bearing must be replaced, if the conditions described are found.

SHIMS

Keep a record of all shim amounts and location during disassembly to aid in reassembly. Be sure to follow shimming instructions during reassembly, as gears must be installed to correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

SEALS

As a normal procedure, all O-rings and oil seals SHOULD BE REPLACED without regard to appearance. To prevent leakage around oil seals, apply Loctite 271 to outer diameter of all metal case oil seals. When using Loctite on seals or threads, surfaces must be clean and dry. To ease installation, apply 2-4-C with Teflon on all O-rings. To prevent wear, apply 2-4-C with Teflon on I.D. of oil seals. To prevent corrosion damage after reassembly, apply 2-4-C with Teflon to external surfaces of bearing carrier and cover nut threads prior to installation.

Removal, Disassembly, Cleaning and Inspection of Counter Rotation (Left Hand) Gear Housing

REMOVAL

⚠ WARNING

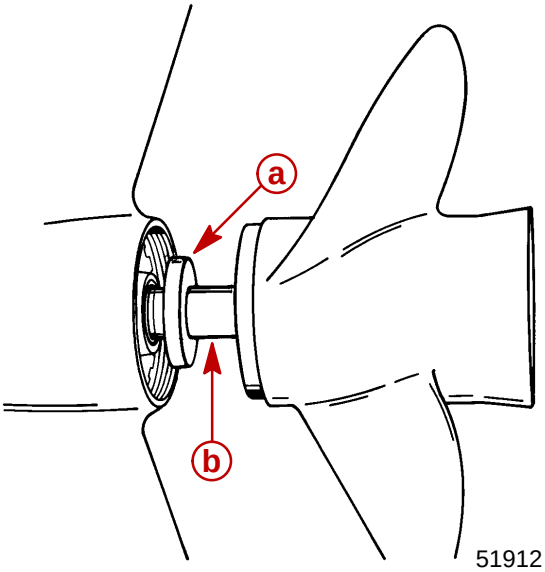
Disconnect high tension leads from spark plugs and remove spark plugs from engine before removing gear housing from drive shaft housing.

1. Disconnect high tension leads from spark plugs and remove spark plugs from engine.

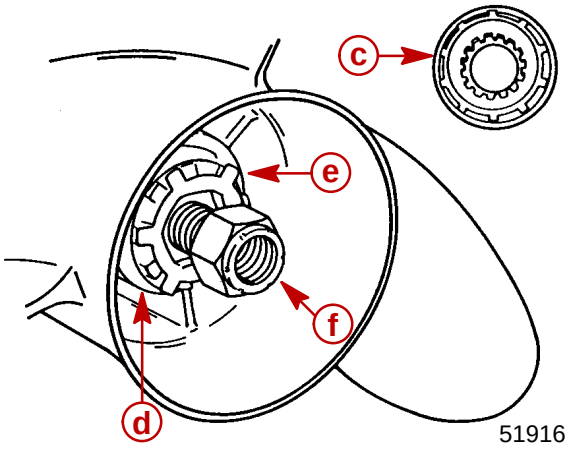
⚠ CAUTION

Gear housing MUST BE in NEUTRAL position and shift shaft MUST BE removed from gear housing BEFORE propeller shaft can be removed from gear housing.

2. Shift engine into NEUTRAL position.
3. Tilt engine to full up position and engage tilt lock lever.
4. Bend tabs of propeller tab washer away from thrust hub (rear), then remove propeller locknut, tab washer, thrust hub (rear), propeller and thrust hub (forward) from propeller shaft.



51912

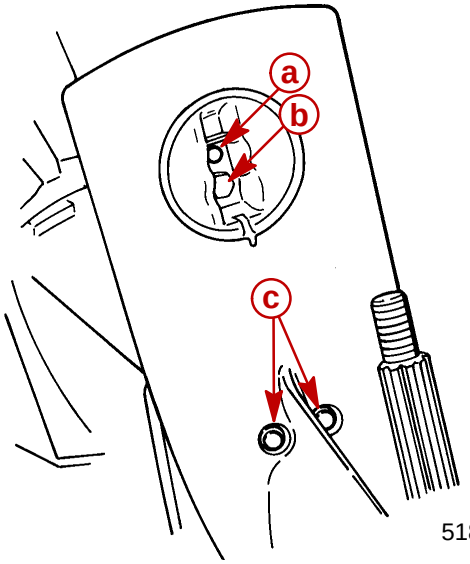


51916

a - Thrust Hub (Forward)
b - Propeller Shaft
c - Continuity Washer (If Equipped)
d - Rear Thrust Hub
e - Tab Washer
f - Propeller Nut

5. Mark gear housing and trim tab so that trim tab can be reinstalled in the same position. Remove plastic cap at rear edge of driveshaft housing. Remove bolt that secures trim tab and remove tab from gear housing.
6. Once trim tab is removed, remove bolt from inside of trim tab cavity.

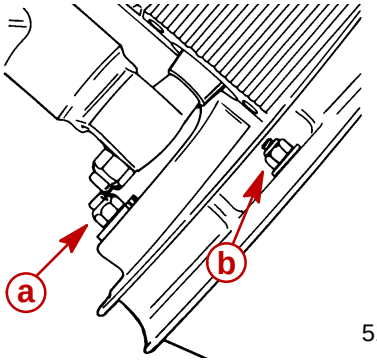
7. Remove 2 locknuts from bottom middle of anti-cavitation plate.



51866

a - Bolt (Secures Trim Tab)
b - Bolt (Inside Trim Tab Cavity)
c - Locknuts and Washers

8. Remove locknut from the front gear housing mounting stud.
9. Loosen the side mounting locknuts. (DO NOT attempt to remove one nut before the opposite side is loosened sufficiently, or driveshaft housing could be damaged.)



51873

a - Front Mounting Locknut
b - Side Mounting Locknut (One Each Side)

10. Pull gear housing away from driveshaft housing as far as the loosened nuts (in Step 9) will allow, then remove loosened nuts. (DO NOT allow gear housing to fall, as it now is free.)
11. Pull gear housing from driveshaft housing.

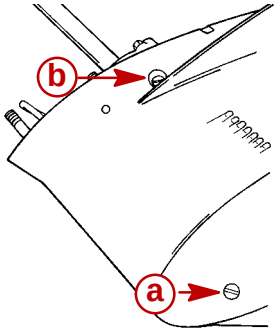
DRAINING AND INSPECTING GEAR HOUSING LUBRICANT

1. Place gear housing in a suitable holding fixture or vise with the driveshaft in a vertical position, as shown.

NOTE: *Drain and Fill screws may be located on the starboard side of gearcase on later models.*

2. Position a clean drain pan under gear housing and remove Fill and Vent screws from gear housing.
3. Inspect gear lubricant for metal particles. Presence of a small amount of fine metal particles (resembling powder) indicates normal wear. Presence of larger particles (or a large quantity of fine particles) indicates need for gear housing disassembly, and component inspection.
4. Note the color of gear lubricant. White or cream color indicates presence of water in lubricant. Check drain pan for water separation from lubricant. Presence of water in gear lubricant indicates the need for disassembly, and inspection of oil seals, seal surfaces, O-rings and gear housing components.

IMPORTANT: Gear lubricant drained from a recently run gearcase will be a light chocolate brown in color due to agitation/aeration. Oil which is stabilized will be a clear yellow brown in color.



51871

a - Fill Screw
b - Vent Screw

Water Pump

CLEANING AND INSPECTION

1. Clean all water pump parts with solvent and dry with compressed air.
2. Inspect water pump cover and base for cracks and distortion (from overheating).
3. Inspect face plate and water pump insert for grooves and/or rough surfaces.

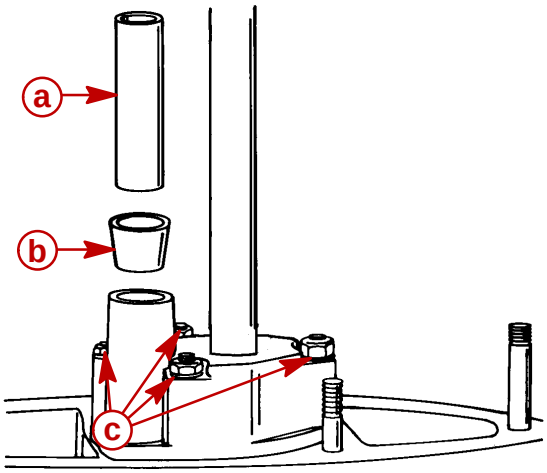
IMPORTANT: When completing gear housing repairs, that require removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary to re-use impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur.

4. Inspect impeller side seal surfaces and ends of impeller blades for cracks, tears and wear. Replace impeller if any of these conditions are found.
5. Inspect impeller bonding to impeller hub.
6. Inspect impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace impeller if any of these conditions exist.

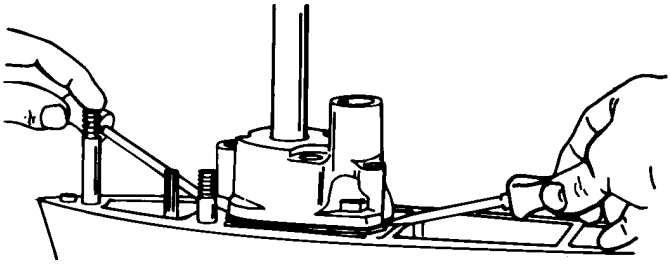
IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

REMOVAL AND DISASSEMBLY

1. Slide rubber centrifugal slinger up and off driveshaft.
2. Remove water tube guide and seal from water pump cover. (Retain guide for reassembly and discard seal.)
3. Remove (and retain) 3 nuts, one bolt and all washers which secure water pump cover to gear housing.
4. Using 2 pry bars, lift water pump cover up and off driveshaft.



51874


51874

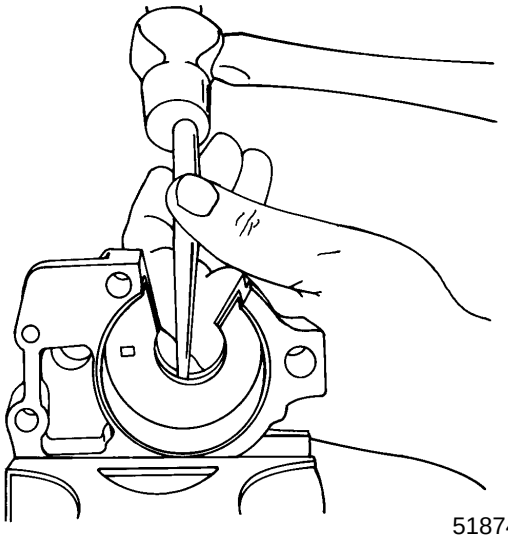
a - Water Tube Guide
b - Water Tube Seal
c - Nuts, Bolt and Washers to be Removed

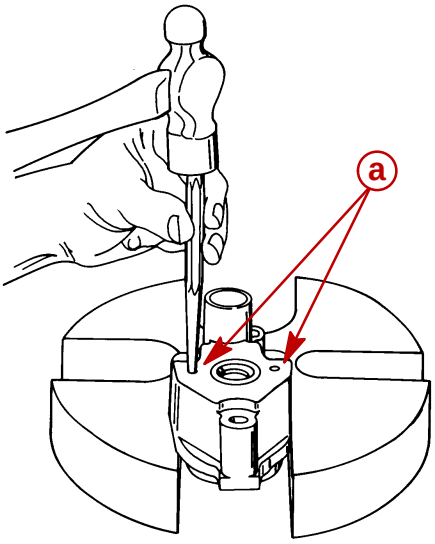
5. Inspect water pump cover and insert as outlined in Cleaning and Inspection, previous.
6. If inspection of water pump insert determines that replacement is required, follow Step "a" or "b" (immediately following) to remove insert from water pump cover.

NOTE: *Try Step "a" first. If insert cannot be removed with Step "a," use Step "b."*

a. Drive water pump insert out of water pump cover with a punch and hammer.

b. Drill two 3/16 in. (4.8 mm) diameter holes through the top of water pump cover (but not through insert). Drive insert out of cover with a punch and hammer.

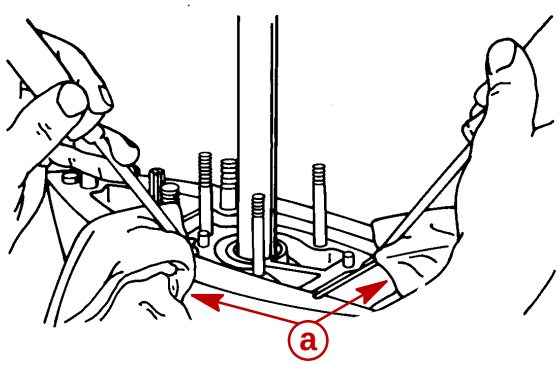

51874



51873

a - Drill Two Holes at These Locations

7. Remove impeller from driveshaft. (It may be necessary to use a punch and hammer to drive impeller upward on driveshaft. In extreme cases, it may be necessary to split hub of impeller with a hammer and chisel.)
8. Once impeller is removed, remove impeller drive key from driveshaft.
9. Remove water pump face plate and both gaskets (one above and below face plate) from water pump base.
10. Using 2 pry bars, positioned and padded as shown, lift water pump base up and off driveshaft.



51874

a - Pads

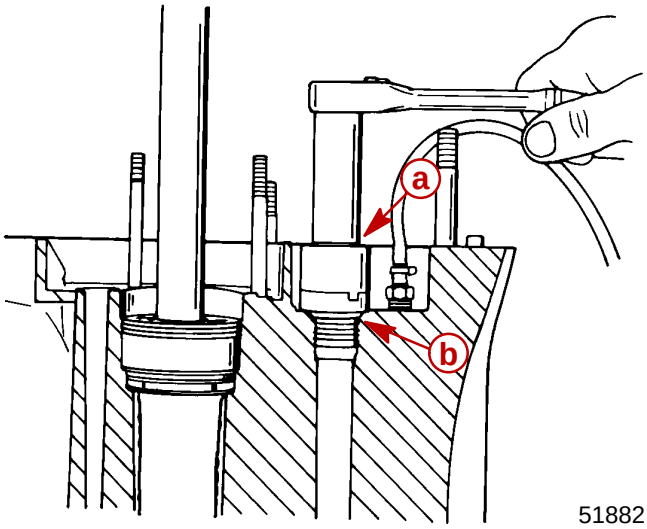
11. Remove (and discard) O-ring from O-ring groove on water pump base.
12. Using a screwdriver, pry oil seals out of water pump base from gear housing side of base.

Bearing Carrier and Propeller Shaft Removal

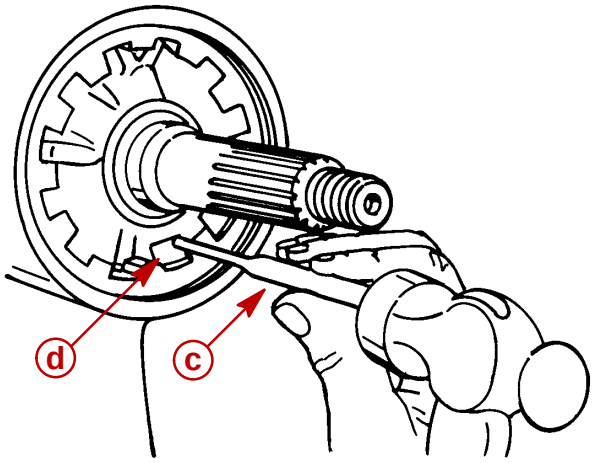
⚠ CAUTION

Gear housing MUST BE in neutral position, and shift shaft MUST BE removed from gear housing before propeller shaft can be removed from gear housing.

1. Place gear housing in a suitable holding fixture (or vise), with propeller shaft in a horizontal position.
2. Use Shift Shaft Bushing Tool to unthread shift shaft bushing. (DO NOT remove bushing from shift shaft at this time.)
3. Bend retainer nut lock tab out of retainer nut recess.



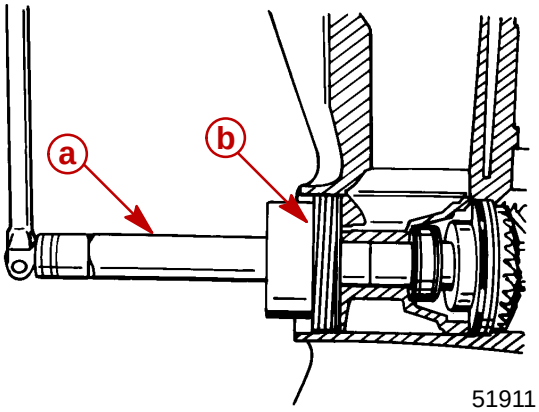
51882



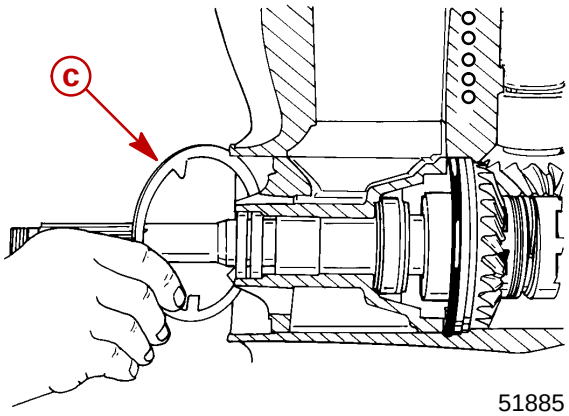
51865

a - Shift Shaft Bushing Tool (91-31107)
b - Shift Shaft Bushing
c - Punch
d - Tab of Tab Washer

4. Remove gear housing retainer nut with Retainer Nut Tool.
5. After retainer nut has been removed, remove lock tab washer from gear housing.



51911



51885

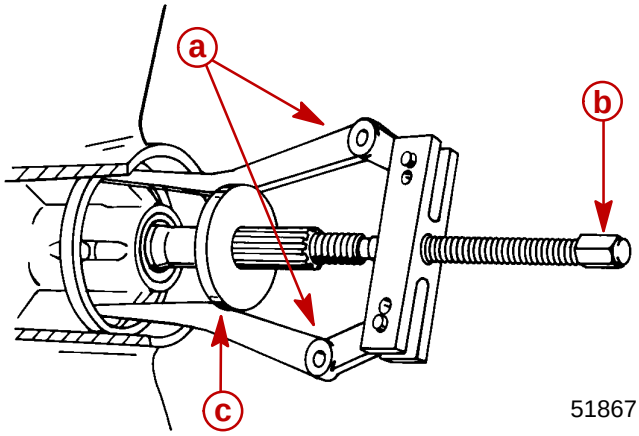
a - Retainer Nut Tool (91-61069)
b - Retainer Nut
c - Tab Washer

⚠ CAUTION

Once bearing carrier is removed from gear housing, extreme care MUST BE taken not to apply any side force on propeller shaft. Side force on propeller shaft may break the neck of the clutch actuator rod.

6. Use long Puller Jaws and Puller Bolt to remove bearing carrier. (Use propeller thrust hub to maintain outward pressure on puller jaws.)

NOTE: *When bearing carrier is removed from gear housing, the bearing carrier alignment key will come out with it.*



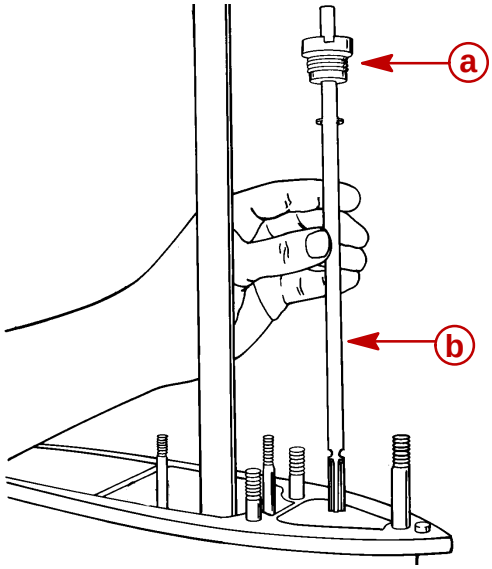
51867

a - Long Puller Jaws (91-46086A1)
b - Puller Bolt (91-85716)
c - Thrust Hub

SHIFT SHAFT REMOVAL

IMPORTANT: Prior to removal of shift shaft from gear housing, recheck that gear housing is in neutral position.

7. With gear housing in neutral, pull shift shaft out of gear housing. If necessary, use a pliers to pull shift shaft out of gear housing. If pliers are used to pull shift shaft out, wrap a strip of soft metal (aluminum) around splines before clamping pliers. DO NOT turn shaft (clockwise OR counterclockwise) while pulling shaft out.



51867

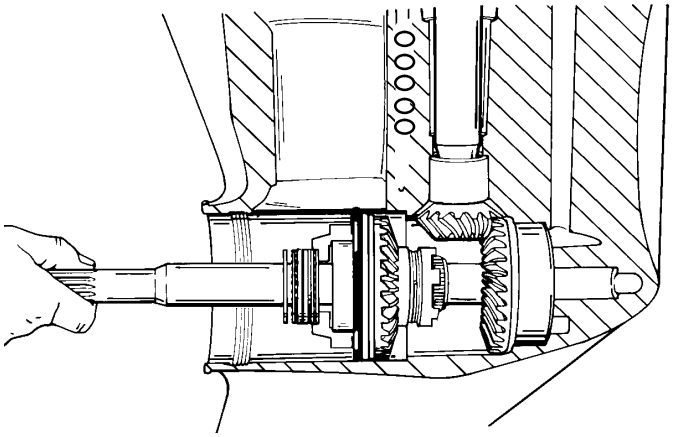
a - Shift Shaft Bushing
b - Shift Shaft

⚠ CAUTION

Propeller shaft, cam follower and shift cam, in most cases, will come out of gear housing by simply pulling outward on propeller shaft. DO NOT FORCE shaft sideways or ATTEMPT TO PULL with a slide hammer or any mechanical puller.

8. Remove propeller shaft, cam follower and shift cam by pulling shaft straight out of gear housing. (DO NOT JERK propeller shaft.)

NOTE: *Sliding clutch, forward gear assembly, bearing adaptor, thrust washer and thrust bearings will be removed from gearcase with propeller shaft.*



51877

9. If propeller shaft will not come out, proceed with Step “a” or “b,” following:
   a. Push propeller shaft back into place against the reverse gear. Visually inspect location of shift cam by looking down shift shaft hole (illuminated with a flashlight). If splined hole in shift cam is visible, reinstall shift shaft and rotate shift shaft to neutral position. Remove shift shaft, then remove propeller shaft as instructed in Step 8, immediately preceding.
   b. Push propeller shaft back into place against reverse gear. Slide bearing carrier back into gear housing (to support propeller shaft). Place gear housing on its left side (viewed from rear) and strike upper leading end of gear housing with a rubber mallet. This will dislodge the shift cam from cam follower into a clearance pocket in left side of gear housing. Remove bearing carrier and pull propeller shaft out of gear housing.

NOTE: *If Step 9-b was used to remove propeller shaft, the shift cam can be retrieved after removal of reverse gear.*

SHIFT SHAFT CLEANING AND INSPECTION

1. Clean shift shaft and bushing with solvent and dry with compressed air.
2. Check shift shaft splines on both ends for wear and/or corrosion damage.
3. Inspect shift shaft for grooves at shift shaft bushing seal surface.
4. Inspect shift shaft bushing for corrosion damage.
5. Inspect shift shaft bushing oil seal for wear and/or cuts.

SHIFT SHAFT DISASSEMBLY

1. Remove (and discard) shift shaft bushing oil seal by prying it out or driving it out with a punch and hammer.

Bearing Carrier

CLEANING/INSPECTION

IMPORTANT: It is recommended that all seals and O-rings be replaced (as a normal repair procedure) to assure effective repair.

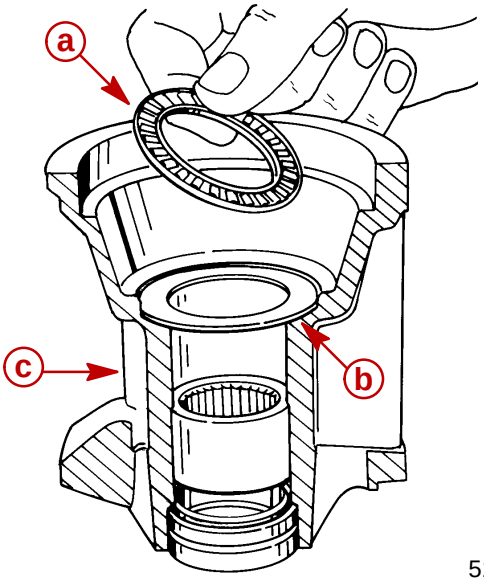
⚠ CAUTION

DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

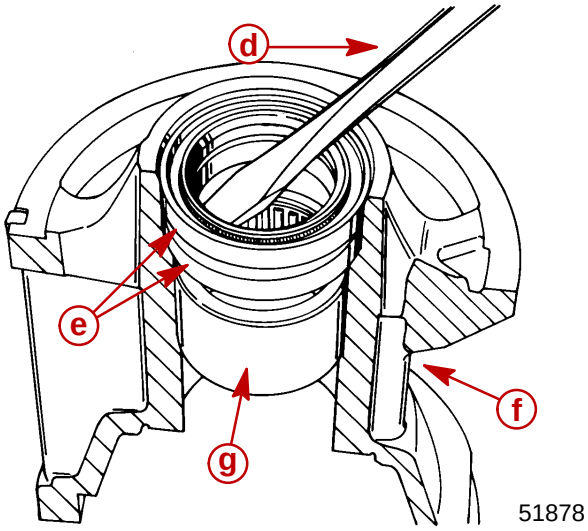
1. Clean bearing carrier with solvent and dry with compressed air.
2. Bearing carrier propeller shaft needle bearing condition is determined by propeller shaft bearing surface condition. (See **Propeller Shaft Inspection.**)

DISASSEMBLY

1. Remove thrust bearing and thrust washer from bearing carrier.
2. If thrust bearing, thrust washer or thrust bearing surface on propeller shaft shows signs of rust, pitting or discoloration (blueing) from lack of lubricant, components should be discarded.
3. Remove bearing carrier oil seals.



51886

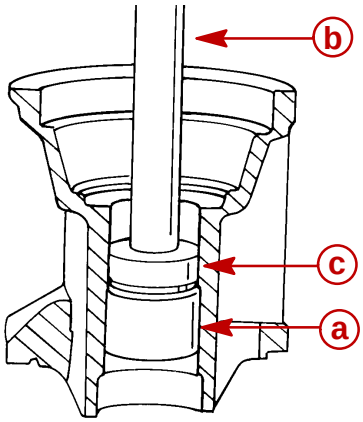


51878

a - Thrust Bearing
b - Thrust Washer
c - Bearing Carrier
d - Pry Bar
e - Oil Seals
f - Bearing Carrier
g - Bearing Carrier Needle Bearing

NOTE: *Do not remove bearing carrier needle bearing unless replacement is needed.*

4. Use Driver Rod and Mandrel (from Bearing Removal and Installation Tool) to press bearings out of bearing carrier.



51885

a - Needle Bearing
b - Driver Rod (91-37323)
c - Mandrel (91-38628T)

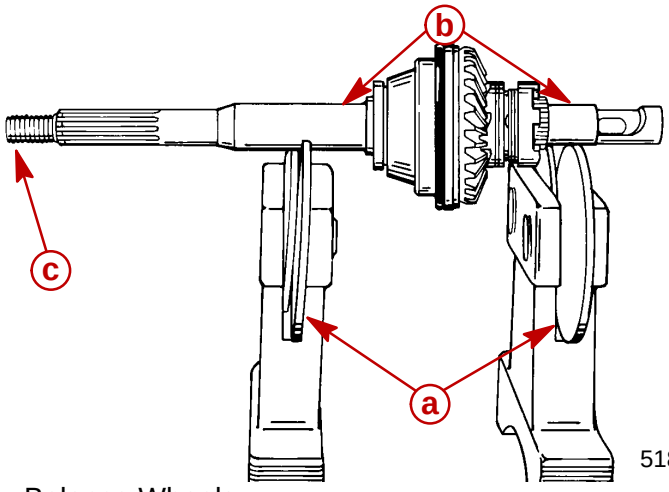
Propeller Shaft

INSPECTION

1. Clean propeller shaft assembly with solvent and dry with compressed air.
2. Inspect bearing carrier oil seal surfaces for grooves. Run fingernail across seal surface to check for groove. Replace shaft if groove is found.
3. Visually check bearing surfaces of propeller shaft for pitting, grooves, scoring, uneven wear or discoloration from overheating. Replace shaft and corresponding needle bearing if any of these conditions are found. (Bearing carrier needle bearing contacts propeller shaft just in front of oil seal surface. Reverse gear bearing contacts propeller shaft in front of sliding clutch splines.)
4. Inspect propeller shaft splines for wear and/or corrosion damage.
5. Check propeller shaft for straightness. Use either method, following:

Balance Wheels

Place propeller shaft on balance wheels, as shown. Rotate propeller shaft and observe propeller end of shaft for wobble. Replace shaft if any wobble is observed.



51877

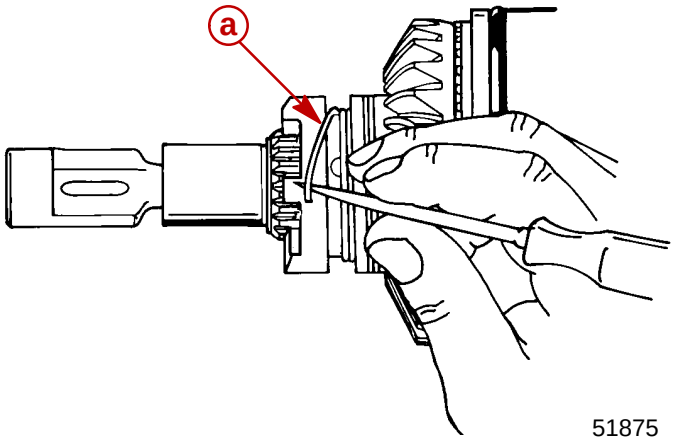
a - Balance Wheels
b - Bearing Surfaces
c - Watch for Wobble

"Vee" Blocks and Dial Indicator

Position propeller shaft roller bearing surfaces on vee blocks. Mount a dial indicator at front edge of propeller splines. Rotate propeller shaft. Dial indicator movement of more than 0.006 in. (0.152 mm) (or noticeable wobble) is reason for replacement.

DISASSEMBLY

1. Remove shift cam from cam follower.
2. Insert a thin blade screwdriver or awl under first coil of cross pin retainer spring and rotate propeller shaft to unwind spring from sliding clutch. DO NOT overstretch spring.

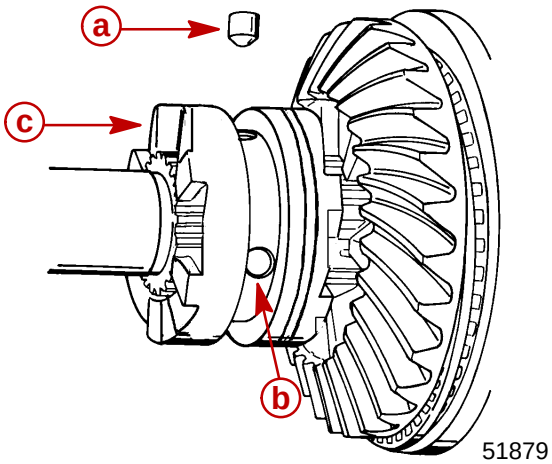


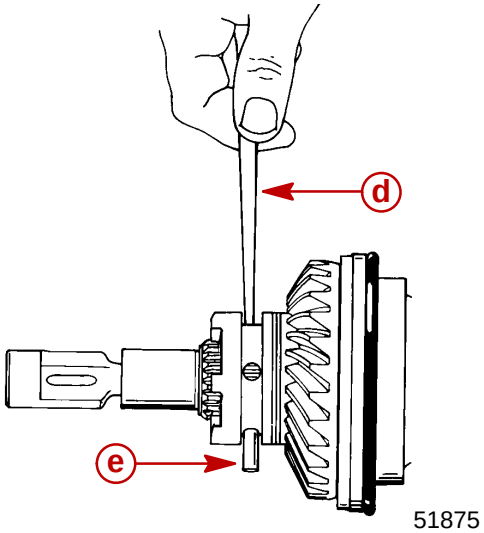
a - Cross Pin Retainer Spring

⚠ CAUTION

Detent pin is free and can fall out of sliding clutch. Care MUST BE taken not to lose pin.

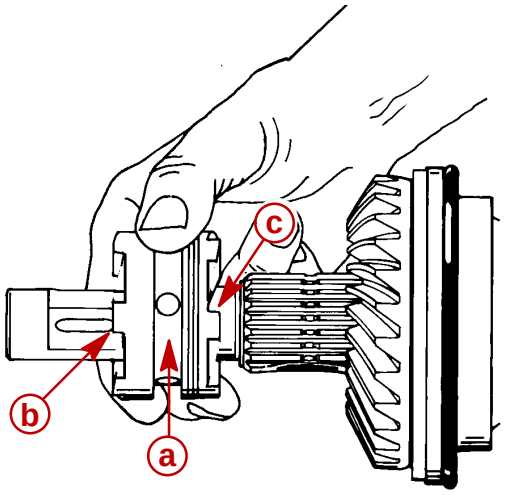
3. Detent pin is free and can be removed from sliding clutch at this time.
4. Push cross pin out of sliding clutch and propeller shaft with a punch.





a - Detent Pin
b - Cross Pin
c - Sliding Clutch
d - Cross Pin
e - Punch

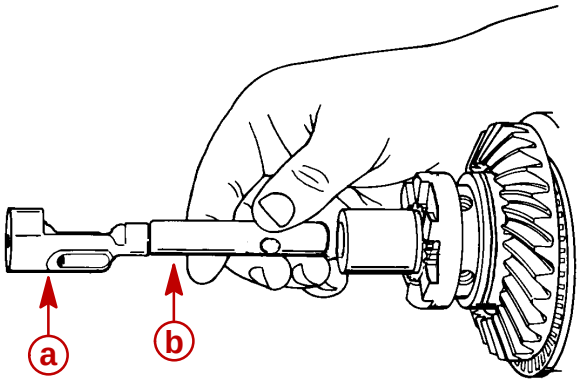
5. Pull sliding clutch off propeller shaft.
6. Inspect sliding clutch. Check reverse gear clutch jaws and forward gear clutch jaws. Rounded jaws indicate one or more of the following:
   a. Improper shift cable adjustment.
   b. Improper shift habits of operators (shift from neutral to reverse gear or forward gear too slowly).
   c. Engine idle speed too high (while shifting).



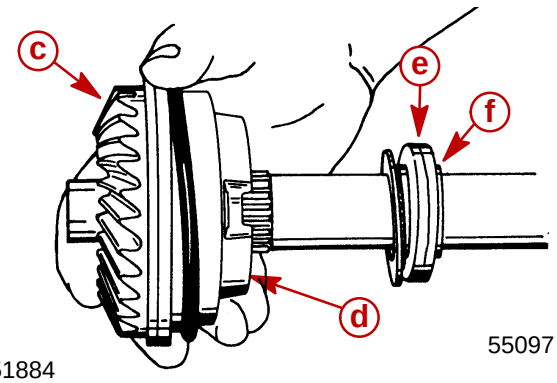
51875

a - Sliding Clutch
b - Reverse Gear Clutch Jaws
c - Forward Gear Clutch Jaws

7. Pull cam follower and clutch actuator rod out of propeller shaft. DO NOT force cam follower up or down or side to side when pulling from propeller shaft.
8. Once cam follower and clutch actuator rod are removed from propeller shaft, lift rod out of cam follower.
9. Check condition of cam follower. If it shows wear (pitting, scoring or rough surface), replace cam follower and shift cam.
10. Remove forward gear and bearing adaptor assembly.
11. Remove 2 thrust races and 2 keepers from prop shaft.



51884



55097

a - Cam Follower
b - Clutch Actuator Rod
c - Forward Gear
d - Bearing Adaptor Assembly
e - Thrust Races (2)
f - Keepers (hidden) (2)

Clutch Actuator Rod

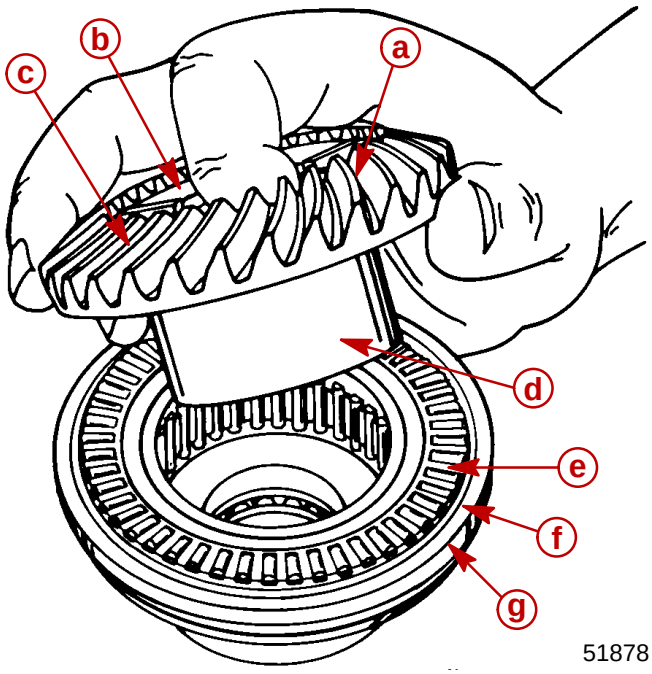
CLEANING AND INSPECTION

1. Clean clutch actuator rod in solvent and dry with compressed air.
2. Inspect actuator components for wear or damage. Replace components as required.

Forward Gear and Bearing Adapter

DISASSEMBLY/CLEANING/INSPECTION

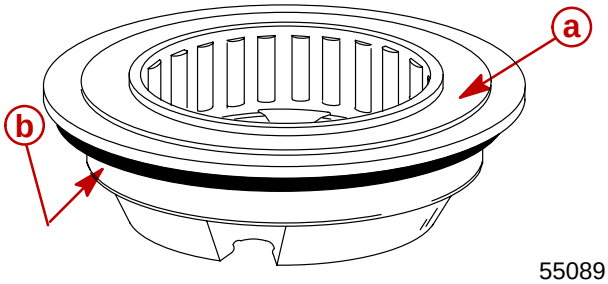
1. Remove forward gear from bearing adapter.
2. Inspect forward gear clutch teeth for signs of wear. If clutch teeth are worn, sliding clutch should be replaced also.
3. Inspect forward gear teeth for full tooth contact, chips, pits and signs of rust. If forward gear teeth are damaged, pinion gear must be inspected and replaced if necessary.
4. Inspect forward gear hub for signs of pitting, rust, scoring or discoloration due to lack of lubricant.
5. Remove the thrust bearing and spacer shim. Inspect thrust bearing for pits, rust, or discoloration due to lack of lubricant.



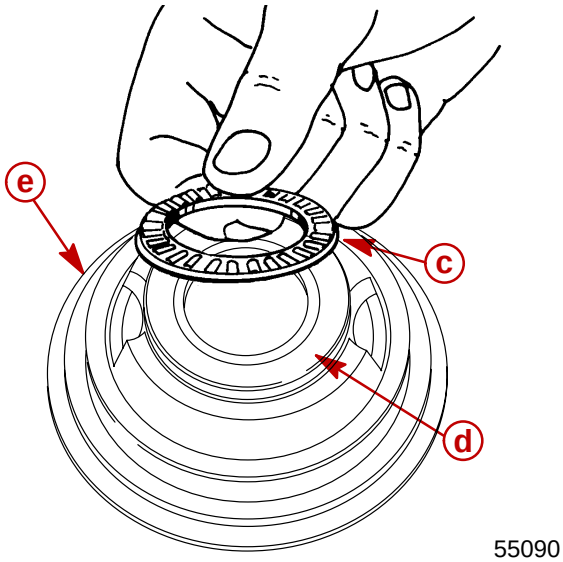
51878

a - Forward Gear
b - Forward Gear Clutch Teeth
c - Forward Gear Teeth
d - Forward Gear Hub
e - Thrust Bearing
f - Thrust Washer
g - Spacer Shim

6. Remove thrust washer and O-ring. The thrust washer acts as a bearing surface for the thrust bearing and it should be inspected for pits, rust, scoring or discoloration due to lack of lubricant. O-ring should be inspected for cuts or abrasions and replaced if necessary.
7. Remove thrust bearing and thrust washer from bearing adaptor. Thrust roller bearing should be inspected for pitting, rust or signs of discoloration due to lack of lubricant. If thrust roller bearing must be replaced, the bearing surfaces on the thrust washer and propeller shaft where the thrust roller bearing rides should also be inspected for signs of wear.



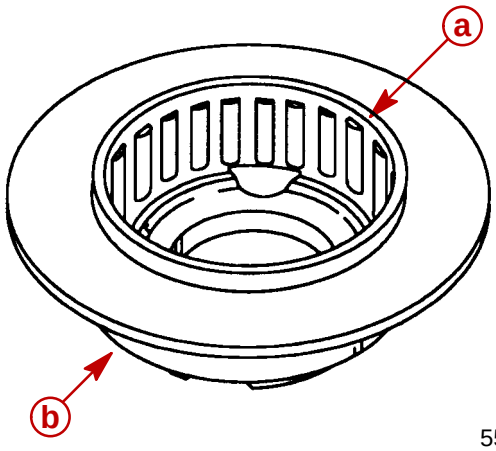
55089



55090

a - Thrust Washer
b - O-Ring (hidden)
c - Thrust Bearing
d - Thrust Washer
e - Bearing Adaptor

8. The forward gear bearing should be carefully inspected for smoothness of movement, pits, rust, or signs of discoloration due to lack of lubricant. If the bearing must be replaced, it is recommended that a hammer and cape chisel be used to break the bearing loose from the bearing adapter. Be careful not to damage bearing adapter when removing roller bearing.



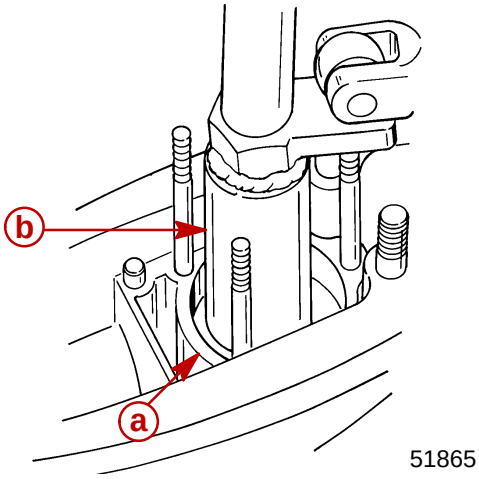
55091

a - Forward Gear Bearing
b - Bearing Adaptor

Pinion Gear and Driveshaft

REMOVAL

1. Remove bearing retainer using Bearing Retainer Tool.

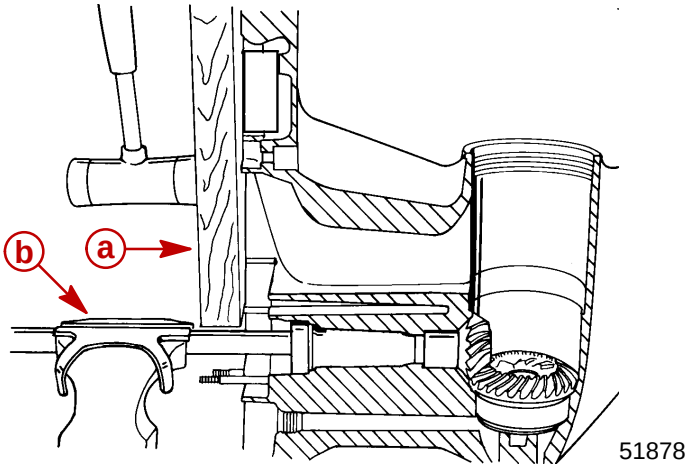


a - Bearing Retainer
b - Bearing Retainer Tool (91-43506)

2. Place Driveshaft Holding Tool (91-34377A1) over driveshaft splines.
3. Use a socket and flex handle to hold pinion nut. (Pad area of gear housing, where flex handle will make contact, to prevent damage to gear housing.)
4. Use a socket and flex handle on Driveshaft Holding Tool to loosen pinion nut. Remove pinion nut and Driveshaft Holding Tool.
5. Remove gear housing from vise and reposition it as shown. Be sure to use soft jaw vise covers and clamp as close as possible to water pump studs.
6. Place a block of wood on gear housing mating surface. Use a mallet and carefully tap gear housing away from driveshaft.

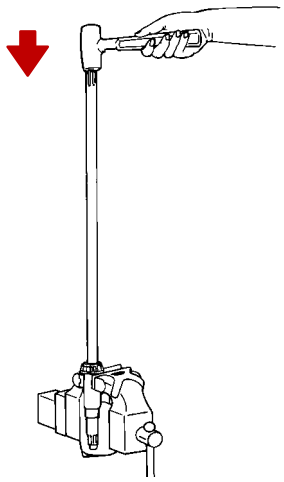
⚠ CAUTION

DO NOT strike gear housing hard with the mallet or allow gear housing to fall.



a - Wooden Block
b - Soft Jaw Vise Covers

7. Reach into gear housing and remove pinion gear.
8. After driveshaft is removed from gearcase, remove and retain shims that were located under upper tapered driveshaft bearing.
9. If inspection determines that replacement of driveshaft tapered bearing is required, remove bearing from driveshaft as follows:
   a. Position driveshaft in a vise; DO NOT tighten vise jaws against shaft.
   b. Strike shaft with a lead hammer; take care not to drop shaft.

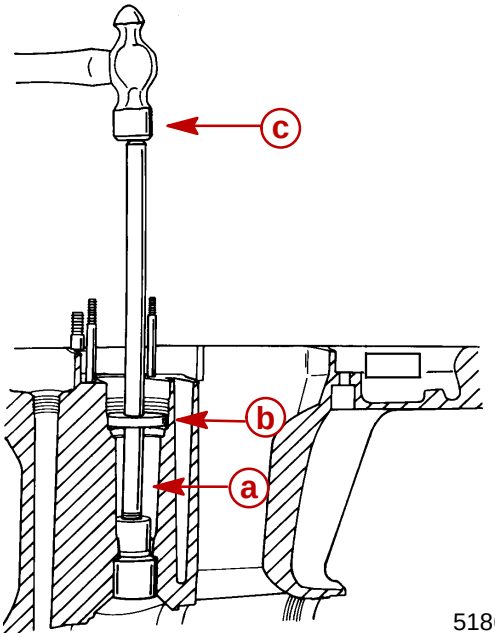


51866

10. Remove 18 loose needles from outer race of driveshaft needle bearing.
11. If inspection of driveshaft needle bearing surface determines that replacement of needle bearing is required, the 18 loose needle bearings previously removed must be reinstalled in bearing race to provide surface for mandrel to drive against.

NOTE: *Reverse gear must be removed first before removing driveshaft needle bearing.*

IMPORTANT: Discard driveshaft needle bearing after removal. (Bearing cannot be reused.)



51869

a - Mandrel (91-37263)
b - Pilot* (91-36571)
c - Driver Rod* (91-37323)

*From Bearing Removal and Installation Kit (91-31229A5)

CLEANING AND INSPECTION

1. Clean driveshaft, tapered bearing and race, and pinion gear with solvent. Dry with compressed air. DO NOT allow driveshaft bearing to spin while drying.
2. Inspect pinion gear for pitting, grooves, scoring, uneven wear and/or discoloration from overheating. Replace pinion gear, if any of the above conditions are found.
3. Inspect driveshaft needle bearing surface (area just above pinion gear splines) for pitting, grooves, scoring, uneven wear and/or discoloration from overheating. Replace driveshaft and driveshaft needle bearing, if any of the preceding conditions are found.
4. Inspect drive shaft to crankshaft splines for wear. Replace the drive shaft if wear is excessive.
5. Inspect tapered bearing race for pitting, grooves, scoring, uneven wear and/or discoloration from overheating. Replace tapered bearing and race as a set, if any of the preceding conditions are found.
6. Inspect driveshaft for grooves where water pump base oil seals contact shaft. Replace driveshaft if grooves are found.

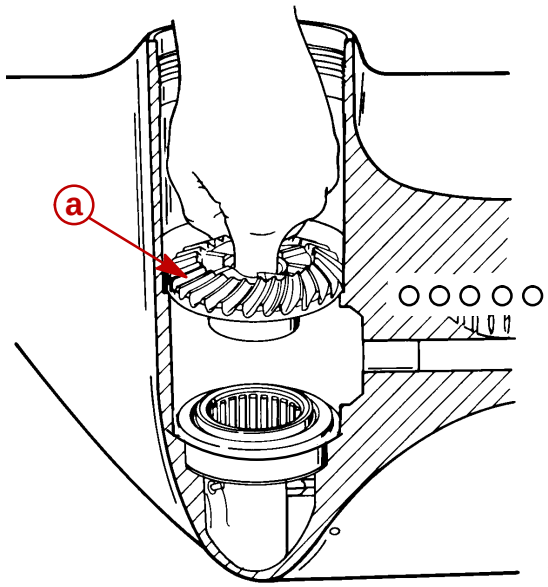
Reverse Gear

REMOVAL AND DISASSEMBLY

NOTE: *Reverse gear can be removed from gear housing only after driveshaft and pinion gear have been removed.*

NOTE: *Cautiously applying heat to both sides of gearcase where reverse gear assembly is located will aid in removal of bearing cup adapter.*

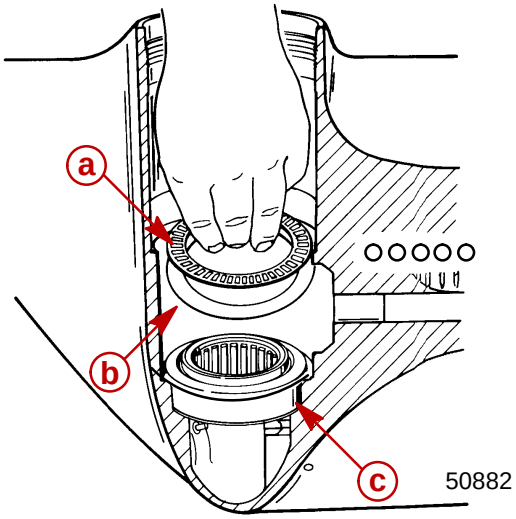
1. Remove reverse gear by hand.

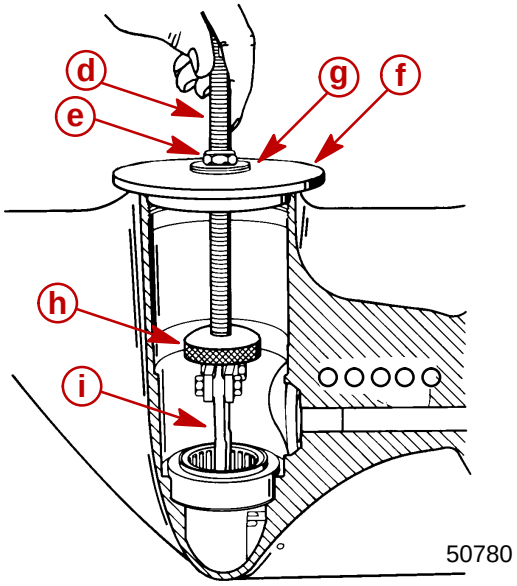


a - Reverse Gear

IMPORTANT: DO NOT remove needle bearing from reverse gear unless replacement of bearing is required. Bearing cannot be reused after it has been removed.

2. Remove thrust bearing and thrust washer from reverse gear bearing cup.
3. Remove reverse gear bearing adaptor. Remove, measure and make note of the shim thickness and **discard (DO NOT reuse) the shims.**





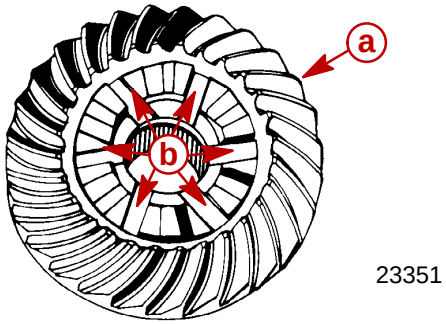
a - Thrust Bearing
b - Thrust Washer
c - Reverse Gear Bearing Adaptor
d - Bolt (91-31229)
e - Nut (91-11-24156)
f - Guide Plate (91-816243)
g - Washer (91-34961)
h - Puller Head (from Slide Hammer Puller Kit 91-34569A1)
i - Jaws (91-816242)

CLEANING AND INSPECTION

⚠ CAUTION

DO NOT spin bearings dry with compressed air, This could cause bearing to score.

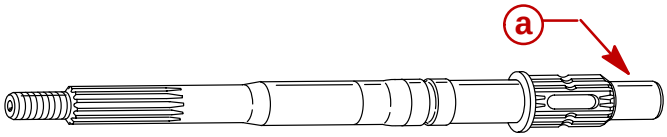
1. Clean reverse gear and bearing with solvent and dry with compressed air. DO NOT spin the bearing.
2. Inspect gear teeth for pitting, grooves, scoring, uneven wear and for discoloration (from overheating). Replace gear if any of these conditions are found.
3. Check clutch jaws on reverse gear for damage. Replace reverse gear if damage is found.



a - Reverse Gear Teeth
b - Clutch Jaws

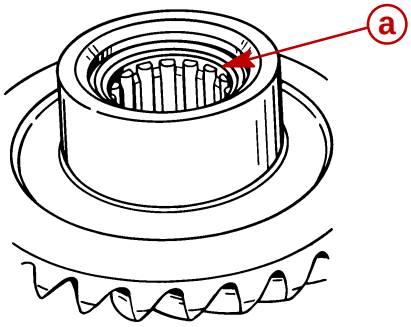
NOTE: *The needle bearings in the reverse gear should not be removed unless damage has been found. Inspect to ensure that all of the needles are present and in position. Needles that have been dislodged may be snapped back into place as long as no damage has occurred to the bearing cage.*

4. Inspect the needle bearings on the inside of the reverse gear and the bearing surface on the propeller shaft. If either the needle bearings or the bearing surface of propeller shaft is pitted grooved, worn unevenly, discolored from overheating or has embedded particles, replace the propeller shaft and needle bearing in the reverse gear.



a - Reverse Gear Needle Bearing Contact Area

5. If reverse gear needle bearing is found to be damaged, place reverse gear in a press and use mandrel 91-36569T to press bearing out of gear.



50778

a - Bearing

Gear Housing

CLEANING AND INSPECTION

1. Clean gear housing with solvent and dry with compressed air.
2. Check gear housing carefully for impact damage.
3. Check for loose fitting bearing adaptors and needle bearings.

NOTE: *If bearing adaptors have spun in gearcase, gear housing must be replaced.*

4. Inspect bearing carrier cover nut retainer threads in gear housing for corrosion damage and/or stripped threads.

Reassembly and Installation of Counter Rotation Gear Housing

Drive Shaft Needle Bearing

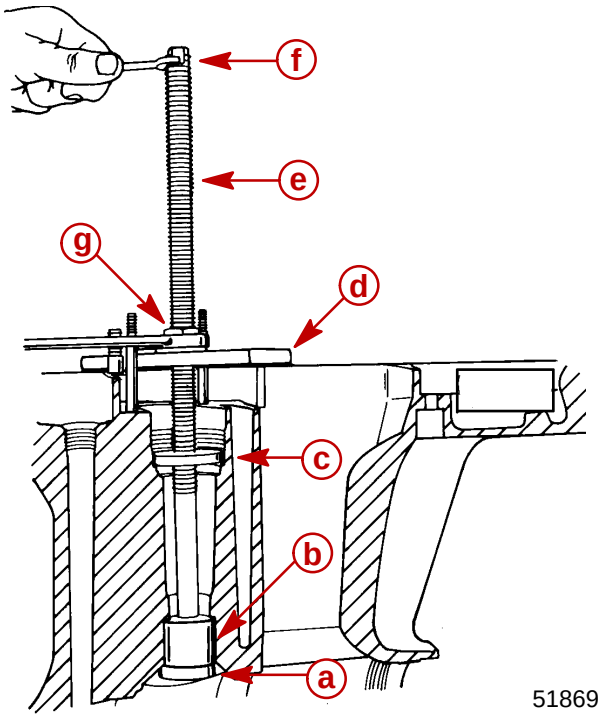
REASSEMBLY/INSTALLATION

⚠ CAUTION

If drive shaft needle bearing failure has occurred, and original bearing race has turned in the gear housing, gear housing must be replaced. Loose fitting needle bearing will move out of position and cause repeated failures.

NOTE: *Drive shaft needle bearing must be installed prior to installation of reverse gear.*

1. Apply a thin coat of 2-4-C with Teflon to drive shaft needle bearing bore in gear housing.
2. By way of propeller shaft cavity, place needle bearing in drive shaft bore with numbered side of bearing facing up drive shaft bore.
3. Install and seat needle bearing with the following tools: Puller Rod, Nut, Pilot, Plate, and Mandrel. Pull bearing up into bore until it bottoms on gear housing shoulder. (DO NOT use excessive force.)



51869

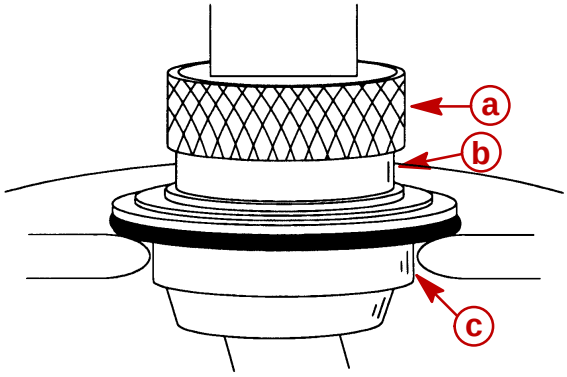
a - Mandrel* (91-92788)
b - Bearing
c - Pilot* (91-36571)
d - Plate* (91-29310)
e - Puller Rod* (91-31229)
f - Hold
g - Nut* (91-24156)

*From Bearing Removal and Installation Kit (91-31229A5)

Bearing Carrier, Forward Gear and Bearing Adaptor

REASSEMBLY

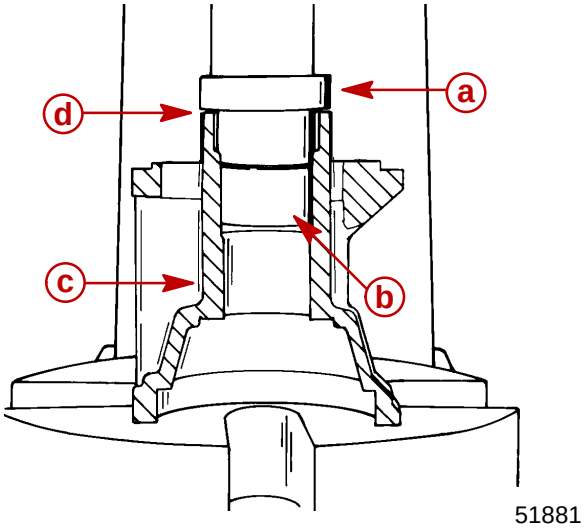
1. Using suitable mandrel, press forward gear bearing into bearing adaptor until bearing is flush with lip of adaptor.



a - Suitable Mandrel
b - Forward Gear Bearing
c - Bearing Adaptor

PROPELLER SHAFT NEEDLE ROLLER BEARING AND OIL SEAL INSTALLATION

1. Using mandrel, press bearing carrier needle bearing (number side up) into bearing carrier until mandrel shoulder contacts bearing carrier.

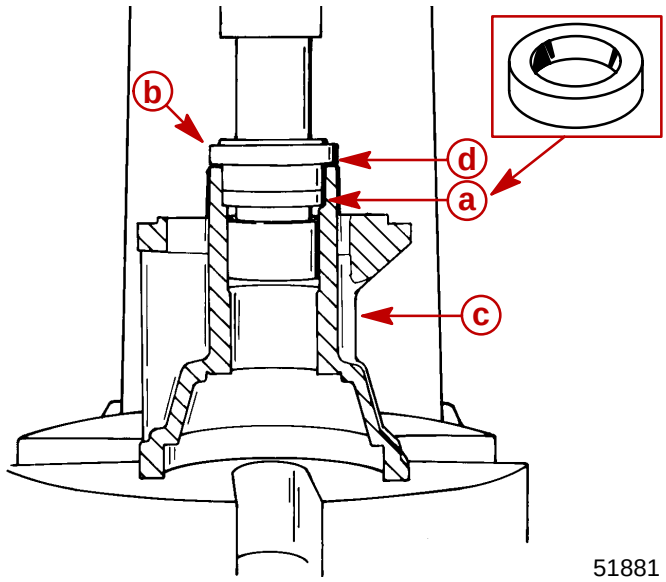


51881

a - Mandrel (91-15755)
b - Bearing Carrier Needle Bearing
c - Bearing Carrier
d - Shoulder

2. Apply Loctite 271 to outside diameter of oil seals.

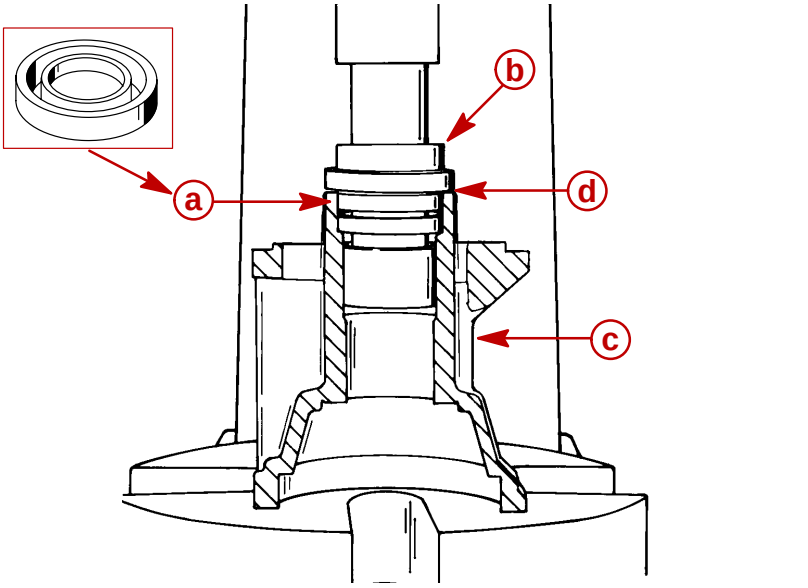
3. With seal lip facing towards bearing, press inner seal using long end of mandrel into bearing carrier until mandrel shoulder bottoms out on bearing carrier.



51881

a - Inner Seal
b - Mandrel (91-31108)
c - Bearing Carrier
d - Mandrel Shoulder

4. With seal lip facing towards mandrel, press outer seal using short end of mandrel into bearing carrier until mandrel shoulder bottoms out on bearing carrier.



51881

a - Outer Seal
b - Mandrel (91-31108)
c - Bearing Carrier
d - Mandrel Shoulder

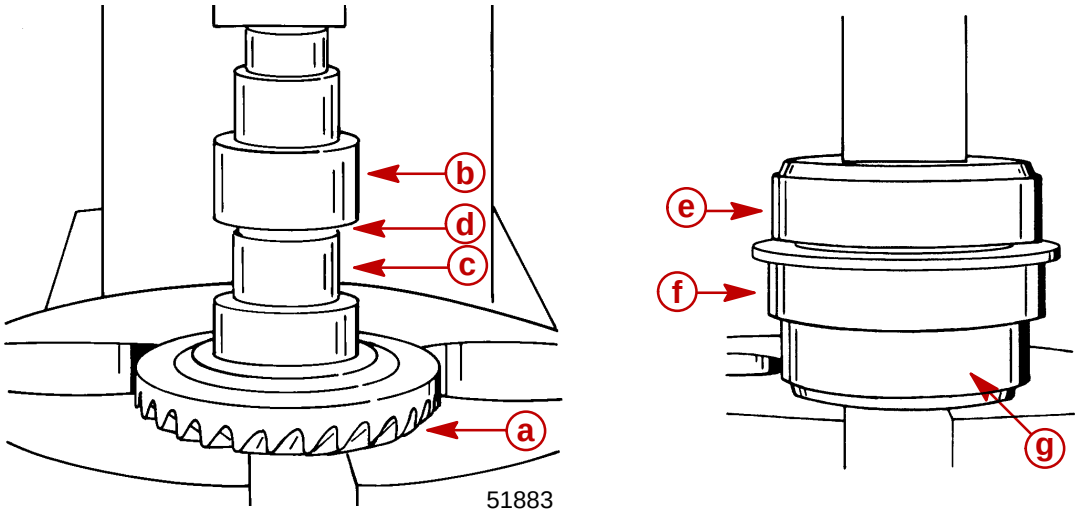
5. Lubricate both seal lips with 2-4-C with Teflon.

REVERSE GEAR AND BEARING CUP ADAPTOR REASSEMBLY

1. With reverse gear teeth facing down, use mandrel to press the propeller shaft needle bearing (numbers/letters up) into reverse gear until the short shoulder on the mandrel bottoms on reverse gear.

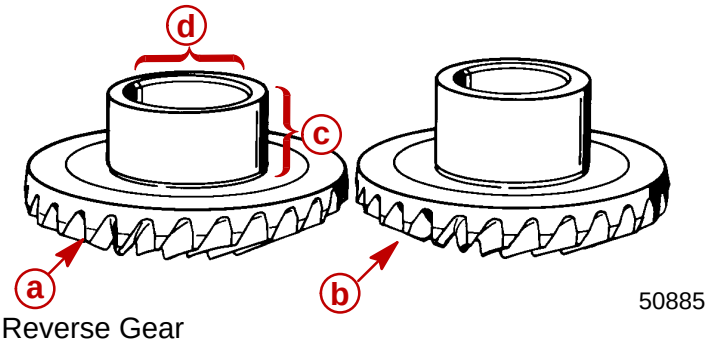
NOTE: *If gear housing has been replaced or inspection determines that reverse gear bearing adapter must be replaced, assemble and install as follows:*

2. Place reverse gear roller bearing (number/letters up) in press. Using suitable mandrel, press bearing cup adapter onto reverse gear bearing.



a - Reverse Gear Teeth
b - Mandrel (91-86943)
c - Propeller Shaft Needle Bearing
d - Shoulder
e - Mandrel
f - Bearing Cup Adapter
g - Reverse Gear Roller Bearing

IMPORTANT: The appearance of the forward and reverse gear is almost identical. There are two ways to distinguish between the reverse and forward gears. The reverse gear has a shorter hub and it has a smaller inner diameter needle bearing bore.



a - Reverse Gear
b - Forward Gear
c - Shorter Length Hub
d - Smaller Diameter Bearing Bore

Reverse Gear Bearing Adaptor Assembly

INSTALLATION

NOTE: *If the reverse gear, reverse gear adaptor, large thrust bearing, or bearing race in the gear housing were not replaced, install the same shims (or the same thickness of shims) that were taken out when adaptor was removed. If the reverse gear, reverse gear adaptor, large thrust bearing, bearing race, or gear housing were replaced, install 0.008 in. (0.51 mm) of shims.*

NOTE: *If backlash has already been checked and it has determined that it needs to be adjusted, (see Checking Reverse Gear Backlash), adding 0.001 in. (0.025 mm) shims will* ***reduce*** *the gear backlash by approximately 0.001 in. (0.025 mm). Subtracting 0.001 in. (0.025 mm) shims will* ***increase*** *backlash by approximately the same amount.*

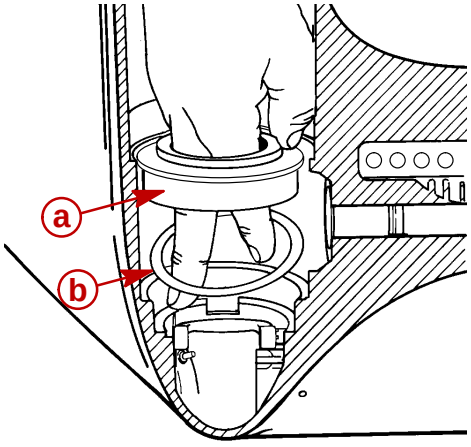
Example 1 (if backlash is too high)

Backlash checks:	0.045 in.	(1.14 mm)
(subtract) middle of specification:	0.025 in.	(0.64 mm)
You get:	0.020 in.	(0.51 mm)
add this quantity of shims:		

Example 2 (if backlash is too low)

middle of specification:	0.025 in.	(0.64 mm)
Backlash checks:	0.009 in.	(0.23 mm)
(subtract) You get:	0.016 in.	(0.41 mm)
subtract this quantity of shims:		

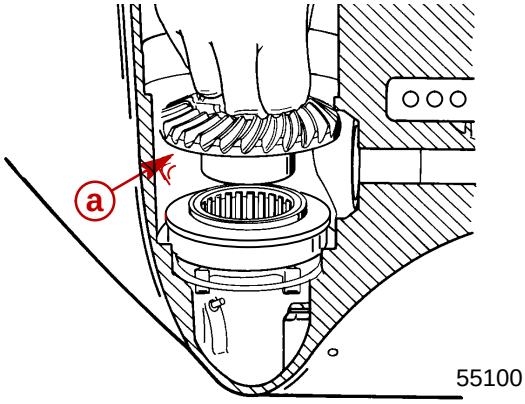
1. Lubricate the bore into which the reverse gear bearing adaptor is to be installed with Premium Gear Lubricant.
2. Place the shims into reverse bore of gear housing.
3. Position the bearing adaptor in the gear housing.

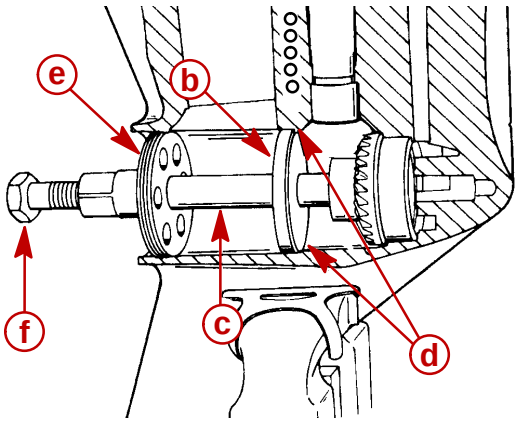


a - Bearing Adaptor
b - Shims

4. Position reverse gear (without the thrust race or thrust bearing) into gear housing and into the adaptor.

5. Install pilot ring over driver tool and seat pilot ring in gearcase against inner ledge. Thread retainer into bearing carrier threads. Install screw into retainer and gently tighten screw against driver tool while holding retainer securely. Continue to apply pressure against driver rod until reverse gear/bearing cup adaptor just seats in gear-case. DO NOT OVER-SEAT the adaptor as the reverse gear bearing will be damaged. As bearing adaptor begins to seat, the effort required to turn screw will increase con-siderably.

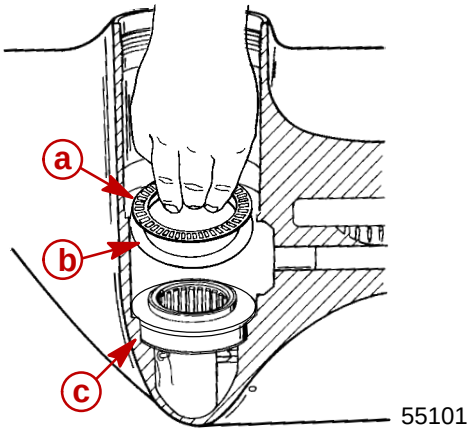


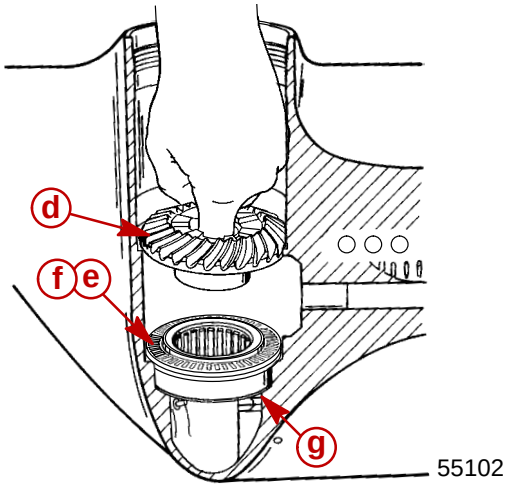


a - Reverse Gear
b - Pilot Ring (91-18603)
c - Driver Tool (91-18605)
d - Inner Ledge
e - Retainer (91-18604)
f - Screw (10-18602)

6. After reverse bearing adaptor is seated, remove screw, retainer, driver tool, pilot ring and reverse gear. Apply Premium Gear Lubricant to thrust bearing and install thrust race and bearing onto bearing adaptor.

7. Reinstall reverse gear into bearing adaptor.



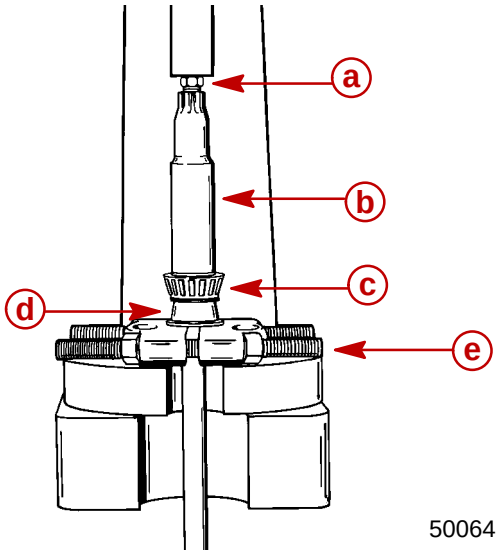


a - Thrust Bearing
b - Thrust Washer
c - Bearing Adaptor
d - Reverse Gear
e - Thrust Bearing
f - Thrust Washer (under thrust bearing)
g - Bearing Adaptor

Drive Shaft and Pinion Gear

REASSEMBLY/INSTALLATION

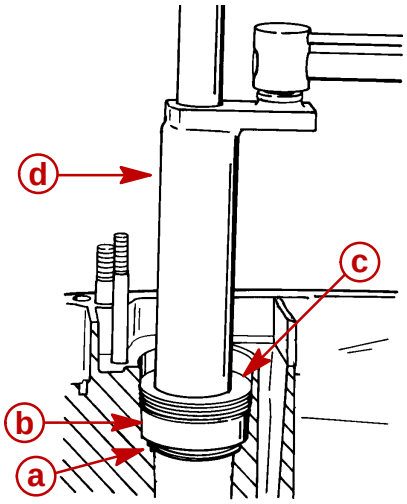
1. Apply a light coat of Premium Gear Lubricant on I.D. of drive shaft tapered bearing.
2. Thread a used pinion nut onto end of drive shaft. Leave approximately 1/16 in. (2 mm) of nut threads exposed. drive shaft threads MUST NOT extend beyond nut or thread damage could result while pressing.
3. Place bearing over drive shaft.
4. Using an old drive shaft bearing inner race or other suitable mandrel (which applies pressing force on center bearing race only), press bearing onto shaft until seated.



a - Used Pinion Nut
b - Drive Shaft
c - Tapered Bearing
d - Old Bearing Inner Race
e - Universal Puller Plate

5. Position pinion gear in gear housing below drive shaft bore with teeth of pinion gear meshed with teeth of reverse gear.
6. Insert drive shaft into drive shaft bore while holding pinion gear. Rotate drive shaft to align and engage drive shaft splines with pinion gear splines. Continue to insert drive shaft into gear housing until drive shaft tapered bearing is against bearing race.
7. Apply Loctite 271 to threads of pinion gear nut and install flat washer and nut on drive shaft with flat side of nut away from pinion gear.
8. Place shims (retained from disassembly) into gear housing. If shims were lost or are not reusable (damaged), start with approximately 0.010 in. (0.254 mm).

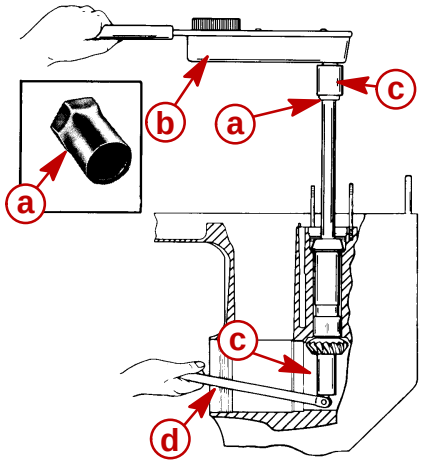
9. Install bearing race and bearing retainer.



51880

a - Shims
b - Bearing Race
c - Bearing Retainer (Word “OFF” must be visible); Torque to 100 lb. ft. (135.5 Nm)
d - Bearing Retainer Tool (91-43506)

10. Use a socket and breaker bar to hold pinion nut (pad area where flex handle will contact gear housing while torquing nut).
11. Place Drive Shaft Holding Tool over crankshaft end of drive shaft. Torque pinion nut to 75 lb. ft. (101.5 Nm).



a - Drive Shaft Holding Tool (91-34377A1)
b - Torque Wrench; Torque Nut to 75 lb. ft. (101.5 Nm)
c - Socket
d - Breaker Bar

IMPORTANT: Wipe any excess Loctite from pinion nut and pinion gear.

Pinion Gear Depth

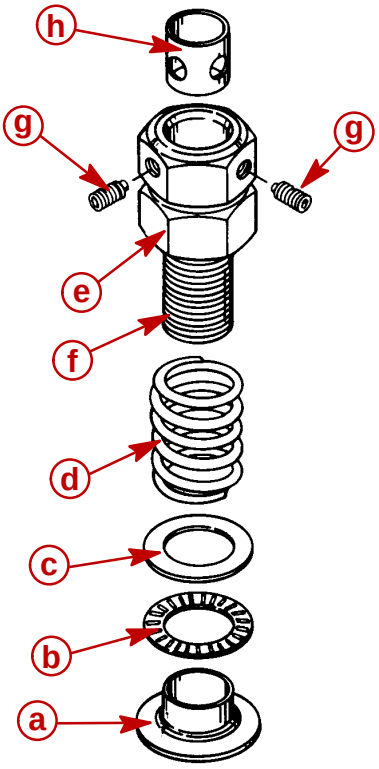
DETERMINING PINION GEAR DEPTH

NOTE: *Read entire procedure before attempting any change in shim thickness.*

IMPORTANT: Reverse gear assembly must be installed in gear housing when checking pinion gear depth or an inaccurate measurement will be obtained.

1. Clean gear housing bearing carrier shoulder.
2. Install Bearing Preload Tool (91-14311A1) over drive shaft in sequence shown.

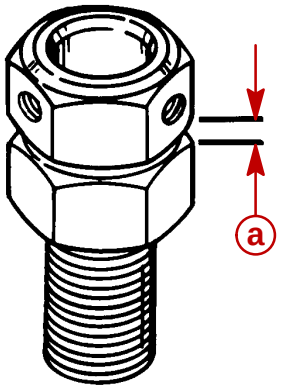
NOTE: *Bearing Preload Tool (91-44307A1) may also be used. Follow instructions provided with tool for proper installation.*



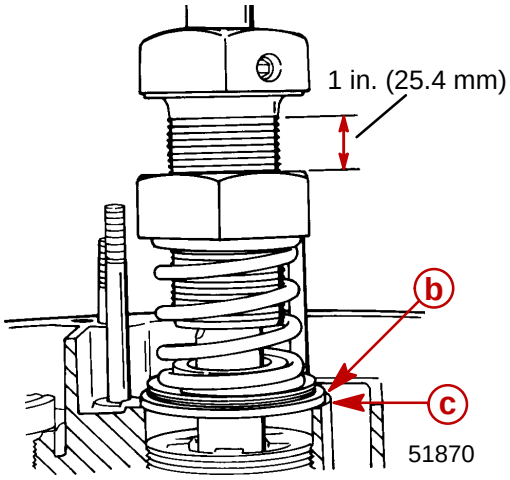
a - Adaptor
b - Bearing
c - Washer
d - Spring
e - Nut; thread nut all the way onto bolt
f - Bolt
g - Set Screw
h - Sleeve; holes in sleeve must align with set screws

3. Align adaptor on drive shaft bearing pocket ledge.
4. With tool installed over drive shaft, tighten both set screws securely, making certain to align sleeve holes to allow set screws to pass through.

5. Measure distance (a) and increase that distance by 1 in. (25.4 mm) by turning bottom nut away from top nut.



a - Distance

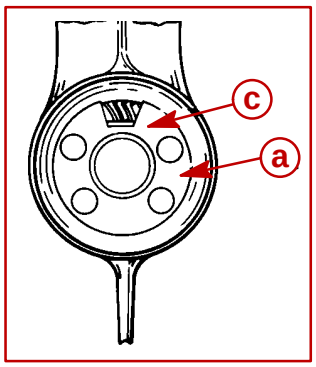


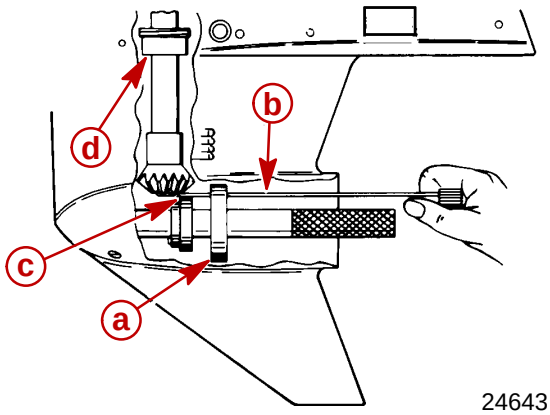
b - Adaptor
c - Ledge

6. Turn drive shaft clockwise 2 or more turns to seat drive shaft bearings.
7. Insert Pinion Gear Locating Tool into gear housing until it bottoms out on bearing carrier shoulder.

NOTE: *Pinion Gear Locating Tool (91-12349A2) can be used. Use flat #7 and disc #2. Follow instructions supplied with tool.*

8. Determine pinion gear depth by inserting a feeler gauge through access slot in pinion gear shimming tool.
9. Clearance between shimming tool and pinion gear should be 0.025 in. (0.64 mm).
10. If clearance is correct, leave Bearing Preload Tool on drive shaft for **Determining Forward Gear Backlash,** following.
11. If clearance is not correct, add/subtract shims at location shown to raise/lower pinion gear. When reinstalling pinion nut, apply Loctite 271 on threads of nut and retorque pinion nut.





a - Pinion Gear Locating Tool (91-74776 or 91-12349A2)
b - Feeler Gauge
c - Obtain 0.025 in. (0.64 mm) Clearance between Locating Tool and Pinion Gear
d - Add or Subtract Shims Here

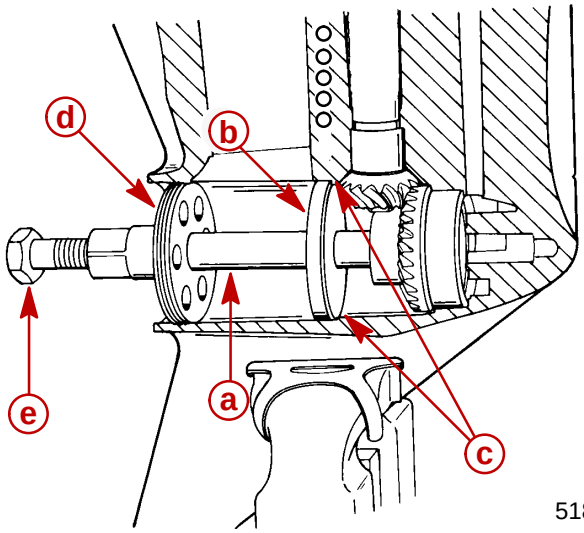
NOTE: *Bearing Preload Tool should remain installed on drive shaft after setting pinion gear depth as it is required to properly check forward gear and reverse gear backlash.*

Reverse Gear

DETERMINING REVERSE GEAR BACKLASH

NOTE: *Reverse gear backlash is adjustable using shims; it can be checked as follows:*

1. Install Driver Tool into reverse gear assembly.
2. Slide Pilot Ring over driver tool and seat pilot ring against inner ledge in gearcase.
3. Thread Retainer into gearcase cover nut threads.
4. Torque Screw to 45 lb. in. (5 Nm) against driver tool.

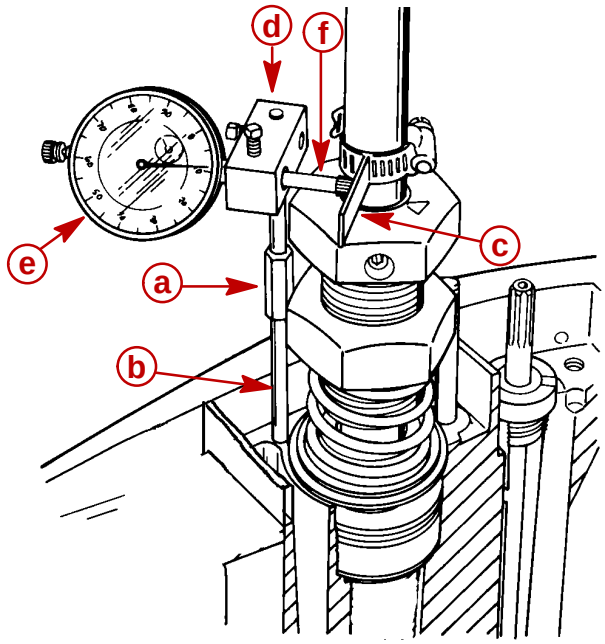


51884

a - Driver Tool (91-18605)
b - Pilot Ring (91-18603)
c - Inner Ledge
d - Retainer (91-18604)
e - Screw (91-18602) [Torque to 45 lb. in. (5 Nm)]

5. Thread stud adapter (from Bearing Preload Tool) all the way onto stud.
6. Install the following:
   a. Backlash Indicator Tool
   b. Dial Indicator Holder
   c. Dial Indicator
7. Position dial indicator pointer on line marked “1” on Backlash Indicator Tool, if gear ratio is 1.87:1 (15 teeth on pinion gear), or on line marked “2” on Backlash Indicator Tool, if gear ratio is 2:1 (14 teeth on pinion gear).
8. Lightly turn drive shaft back-and-forth (no movement should occur at propeller shaft).

9. Dial Indicator registers amount of backlash, which should be 0.030 in. to 0.050 in. (0.76 mm to 1.27 mm).



51880

a - Stud Adaptor (from 91-14311A1)
b - Stud
c - Backlash Indicator Tool (91-78473)
d - Dial Indicator Holder (91-89897)
e - Dial Indicator (91-58222A1)
f - Dial Indicator Pointer

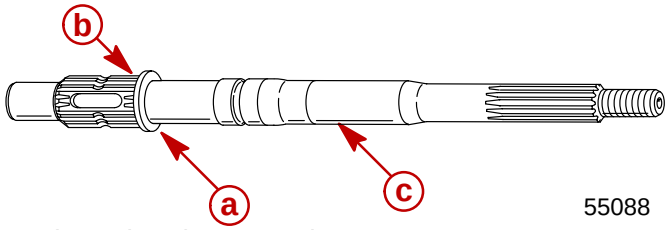
NOTE: *If reverse gear backlash is not within specifications, then gearcase is not properly assembled or components within gearcase are excessively worn and must be replaced before returning gearcase to service.*

10. Remove Driver Tool, Pilot Ring, Retainer and Screw from gearcase.

Forward Gear

DETERMINING FORWARD GEAR BACKLASH

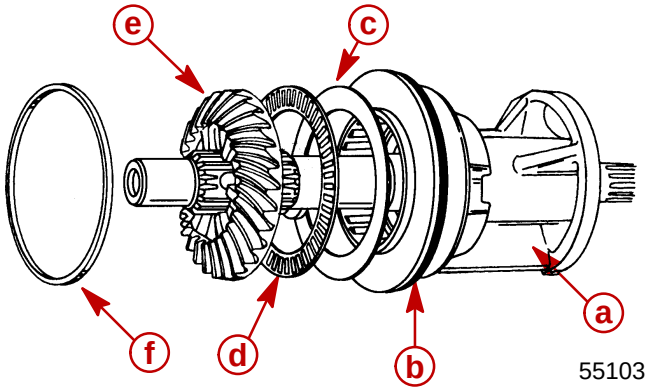
1. Install a load washer over a propeller shaft so that it seats against the REAR shoulder of the clutch spline teeth.



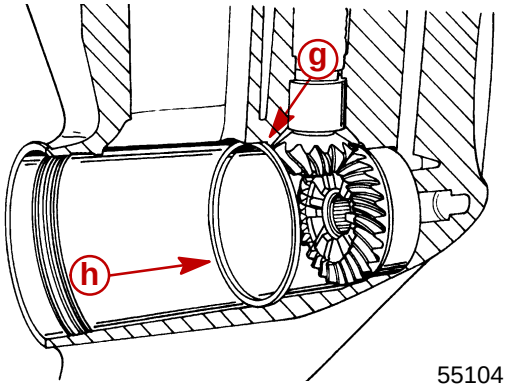
55088

a - Load Washer (12-37429)
b - Shoulder
c - Propeller Shaft (44-93003)

2. Assemble bearing carrier, bearing adaptor, thrust washer, thrust bearing, and forward gear onto propeller shaft.
3. Position shim against shoulder in gearcase.



55103



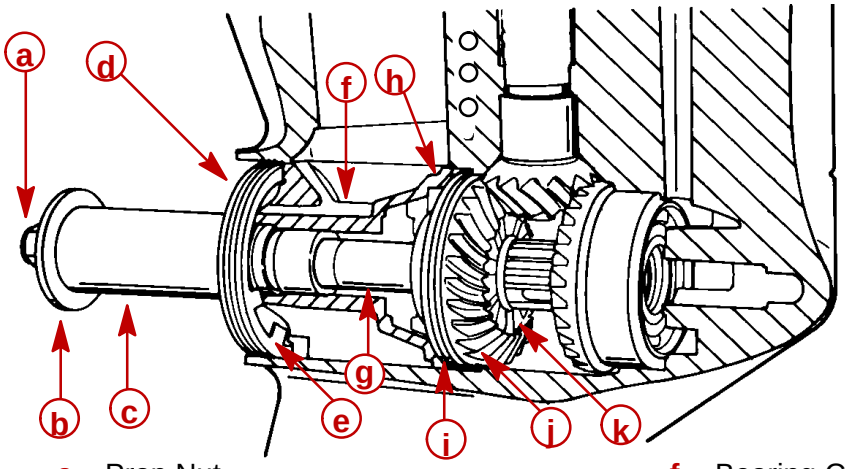
55104

a - Bearing Carrier
b - Bearing Adaptor
c - Thrust Washer
d - Thrust Bearing
e - Forward Gear
f - Shim (PLACE IN GEARCASE FIRST)
g - Shoulder
h - Shim

4. Insert entire propeller assembly into gearcase.
5. Install tab washer and cover nut. Torque cover nut to 100 lb. ft. (135.5 Nm) to seat forward gear assembly in gearcase.

NOTE: *Drill a 3/8 in. (22.2 mm) diameter hole through the side (propeller nut end) of a 5 in. x 2 in. (127 mm x 50.8 mm) long piece of PVC pipe. A screwdriver may be inserted through pipe into propeller shaft splines to prevent PVC pipe from turning while tightening retaining nut.*

6. Install a 5 in. x 2 in. (127 mm x 50.8 mm) long piece of PVC pipe (obtain locally) over propeller shaft and secure it against the bearing carrier with a flat washer and nut.



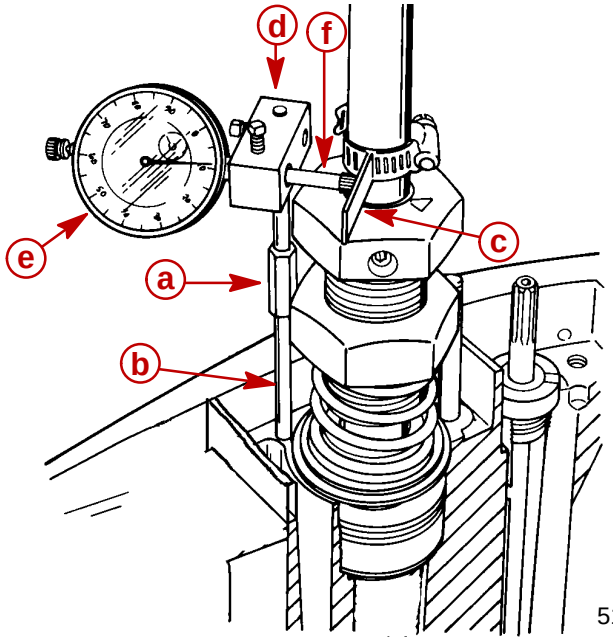
51882

a - Prop Nut
b - Flat Washer
c - PVC Pipe [5 in. x 2 in. (127 mm x 50.8 mm)]
d - Cover Nut
e - Tab Washer
f - Bearing Carrier
g - Prop Shaft
h - Bearing Adaptor
i - Shim
j - Forward Gear
k - Load Washer

7. Tighten nut to 45 lb. in. (5 Nm). This will seat the forward gear against the forward thrust bearing and tends to hold the propeller shaft from moving when measuring backlash.

NOTE: *Bearing Preload Tool (91-44307A1) should still be installed from having previously been used to determine pinion gear depth and reverse gear backlash. If it is not still installed on gearcase, refer to DETERMINING PINION GEAR DEPTH, for the proper installation procedure.*

8. With the proper preload applied to the propeller shaft and the drive shaft, rotate the drive shaft clockwise 5 to 10 complete revolutions. This will seat the forward gear and upper drive shaft bearings and thus provide the most accurate backlash readings.
9. If not previously installed:
   a. Thread stud adaptor (from Bearing Preload Tool) all the way onto stud.
   b. Install the following:
      (1.) Backlash Indicator Tool
      (2.) Dial Indicator Holder
      (3.) Dial Indicator
10. Position dial indicator pointer on line marked “1” on BACKLASH INDICATOR TOOL, if gear ratio is 1.87:1 (15 teeth on pinion gear), or on line marked “2” on BACKLASH INDICATOR TOOL, if gear ratio is 2:1 (14 teeth on pinion gear).



51880

a - Stud Adaptor (from 91-44307A1)
b - Stud
c - Backlash Indicator Tool (91-78473)
d - Dial Indicator Holder (91-89897)
e - Dial Indicator (91-58222A1)
f - Dial Indicator Pointer

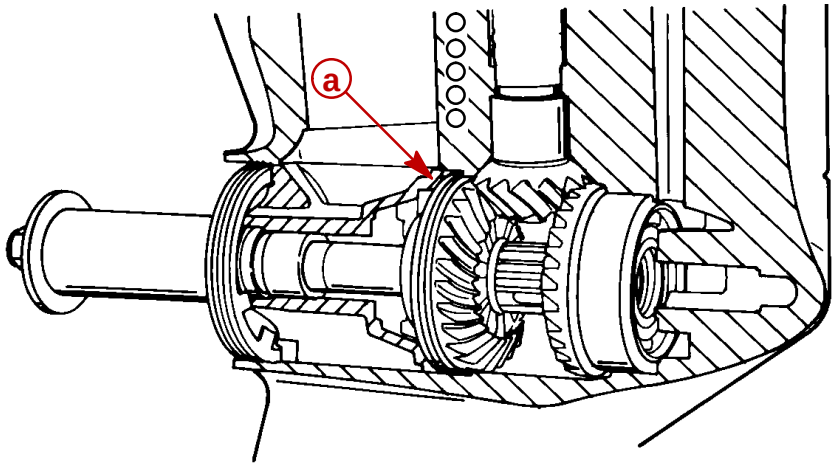
11. Gently rock drive shaft back and forth to determine forward gear backlash.

NOTE: *Models with 1.87:1 Ratio = 0.018 in. to 0.027 in. (0.46 mm - 0.69 mm) backlash.*

NOTE: *Models with 2.00:1 Ratio = 0.015 in. to 0.022 in. (0.38 mm - 0.56 mm) backlash.*

12. If backlash is less than specification, a larger shim should be installed. Conversely, if the backlash indicated is greater than specification, a smaller shim should be installed.

NOTE: *By adding or subtracting 0.002 in. (0.051 mm) shim, the backlash will change approximately 0.002 in. (0.051 mm).*



51882

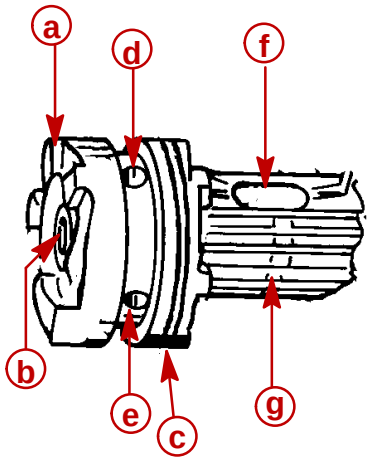
a - Shim

13. If forward gear backlash is within specifications, then Bearing Preload Tool, Dial Indicator, Backlash Indicator Tool/Dial Indicator Holder, PVC pipe, forward gear assembly, bearing adaptor, bearing carrier and test propeller shaft can all be removed from the gearcase.

Propeller Shaft/Forward Gear Bearing Adapter/Bearing Carrier

REASSEMBLY

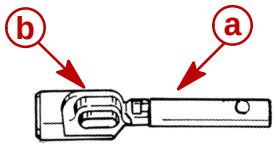
1. Position sliding clutch onto propeller shaft. The grooved rings are for manufacturing purposes only and may be positioned towards either gear. Cross pin hole and detent hole in sliding clutch must line up with cross pin slot and detent notch in propeller shaft.



51913

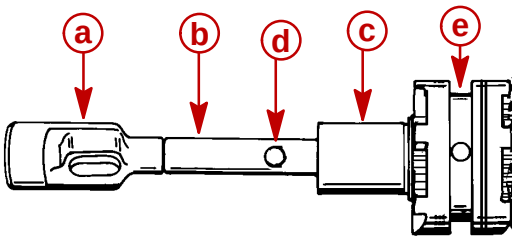
a - Sliding Clutch
b - Propeller Shaft
c - Grooved Rings
d - Cross Pin Hole
e - Detent Hole
f - Cross Pin Slot
g - Detent Notches

2. Place a small amount of 2-4-C with Teflon on actuator rod and install cam follower.



a - Actuator Rod
b - Cam Follower

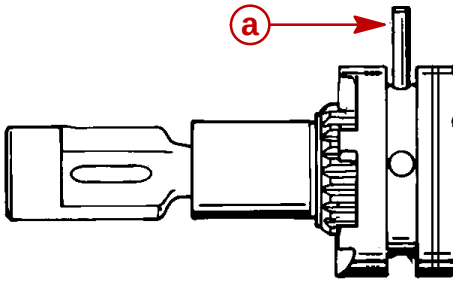
3. Slide clutch actuator assembly into propeller shaft. Align cross pin slot in actuator rod with cross pin slot in clutch/propeller shaft.



51875

a - Cam Follower
b - Clutch Actuator Rod
c - Propeller Shaft
d - Cross Pin Slot
e - Clutch/Propeller Shaft

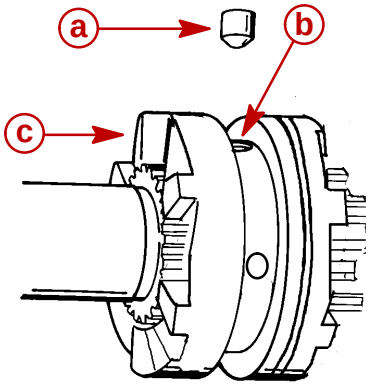
4. Insert cross pin through sliding clutch, propeller shaft and actuator rod forcing cross pin tool out.



51875

a - Cross Pin

5. Apply a small amount of 2-4-C with Teflon to rounded end of detent pin. Position detent pin in detent pin hole of sliding clutch with rounded end of pin toward propeller shaft.



51879

a - Detent Pin
b - Detent Pin Hole
c - Sliding Clutch

6. Install cross pin retaining spring onto sliding clutch as follows:

IMPORTANT: DO NOT over-stretch retaining spring when installing onto sliding clutch.

   a. Spirally wrap spring into groove on sliding clutch.

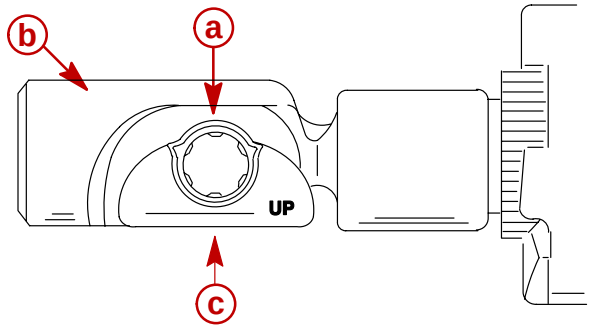
   b. Position spring in groove so that straight end of spring is against the side of groove.

7. Place gear housing in a soft jaw vise with the drive shaft in a vertical position.

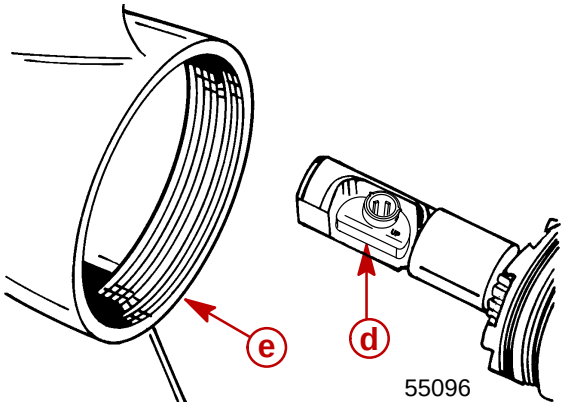
8. Coat cam pocket of cam follower with 2-4-C with Teflon.

9. Place shift cam into cam pocket of cam follower with numbered side of cam facing up.

10. Slide propeller shaft assembly into reverse gear assembly.



55095

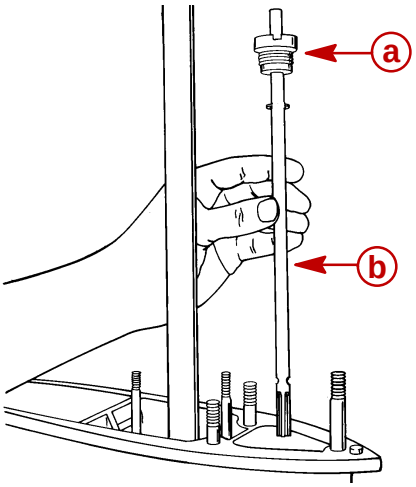


55096

a - Cam Pocket
b - Cam Follower
c - Shift Cam
d - Shift Cam (Position as Shown)
e - Gear Housing

11. Apply a light coat of 2-4-C with Teflon to the threads of the shift shaft bushing.

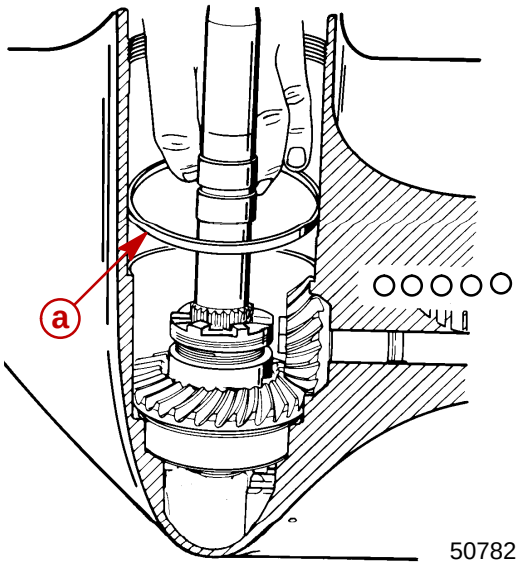
12. Insert shift shaft down shift shaft hole in gear housing and into shift cam. It may be necessary to rotate shift shaft back and forth slightly in order for splines of shift shaft to match up with splines of shift cam. Thread bushing into position, but do not tighten down at this time.



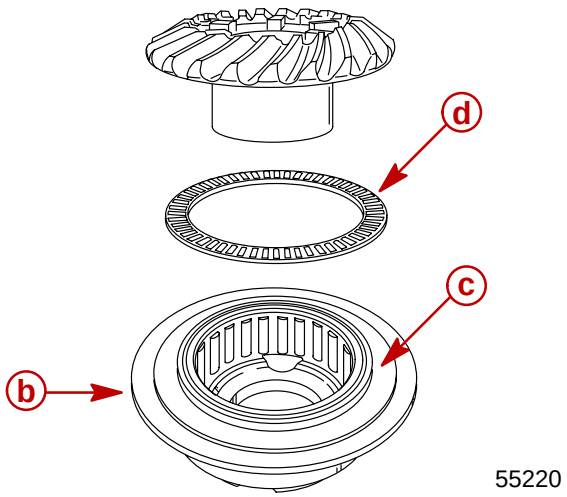
51867

a - Shift Shaft Bushing
b - Shift Shaft

13. Install appropriate spacer shim into the gear housing.
14. Apply Premium Lubricant to to thrust bearing and install thrust bearing and thrust race onto forward gear bearing adaptor.



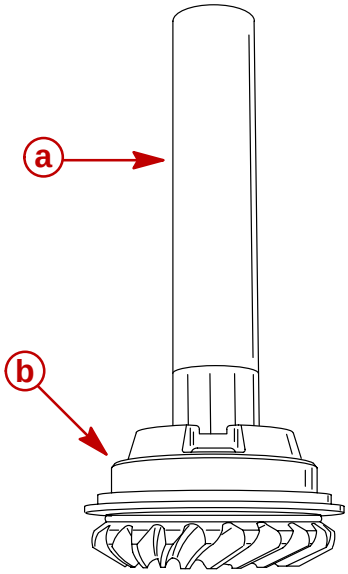
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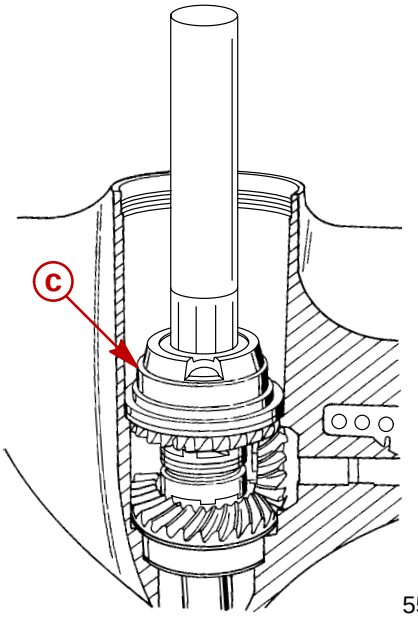
55220

a - Shim
b - Bearing Adaptor
c - Thrust Washer
d - Thrust Bearing

15. Insert Forward Gear Installation Tool into forward gear/bearing adaptor assembly.
16. Install tool with adaptor assembly over propeller shaft and into gear housing. Applying downward pressure to bearing adaptor, remove installation tool from assembly.



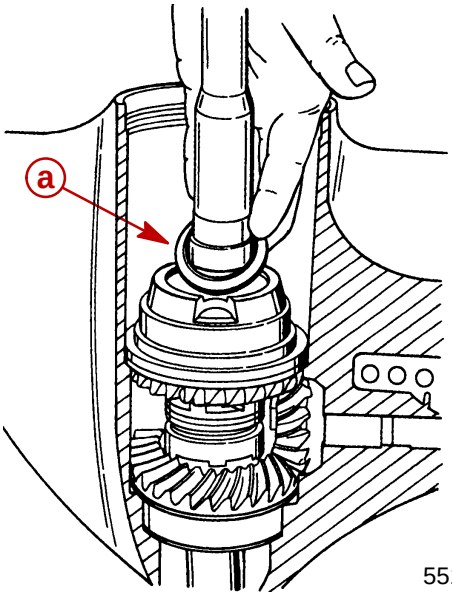
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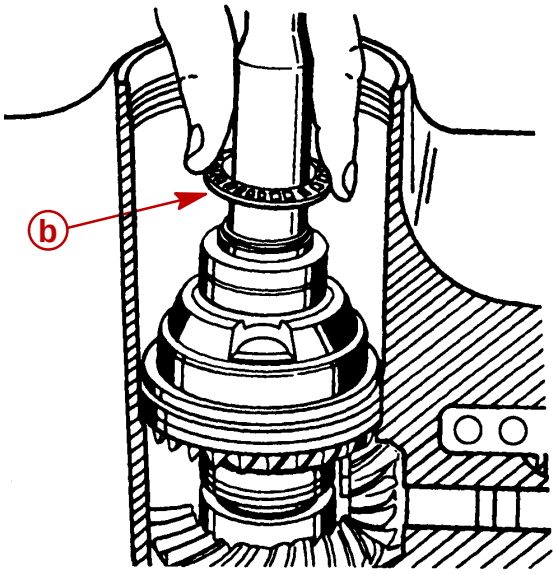
55202

a - Forward Gear Installation Tool (91-815850)
b - Forward Gear/Bearing Adaptor Assembly
c - Forward Gear Bearing Adaptor

17. Install thrust race on top of bearing adaptor.
18. Apply Premium Gear Lubricant to small thrust bearing and install bearing on thrust race.



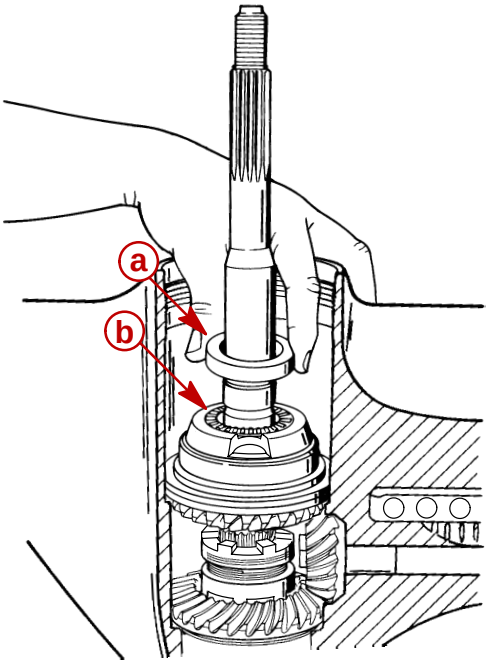
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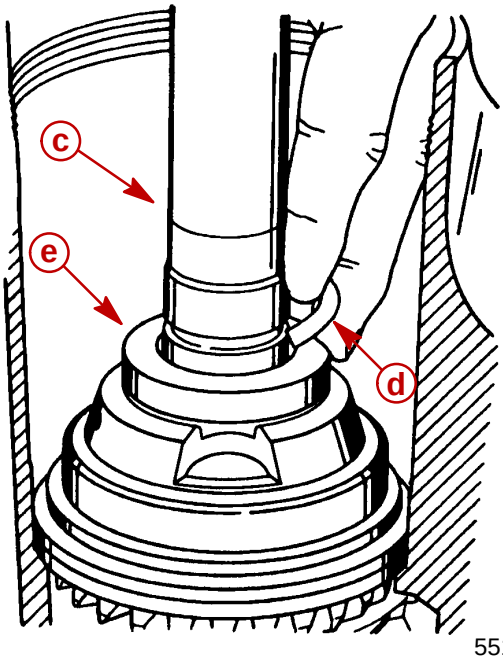
55108

a - Thrust Race
b - Thrust Bearing

19. Install thrust collar with its **STEPPED SIDE DOWN** toward the small thrust bearing.
20. Pull up slightly on the propeller shaft to gain access to the groove on the shaft for the keepers. Install the 2 keepers into the groove and lower the propeller shaft.



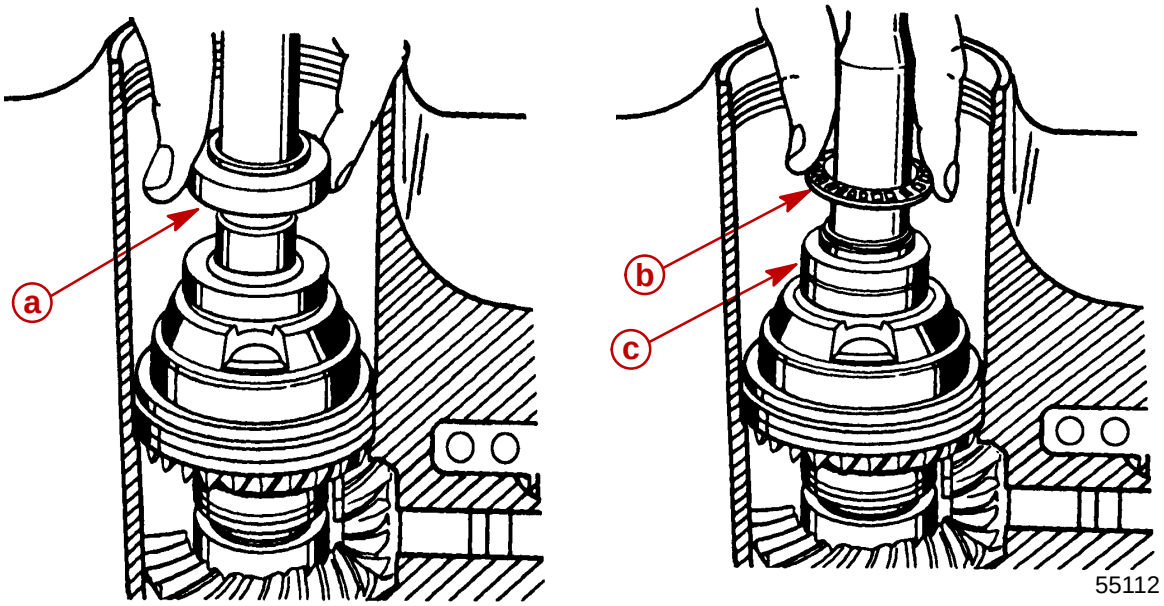
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55110

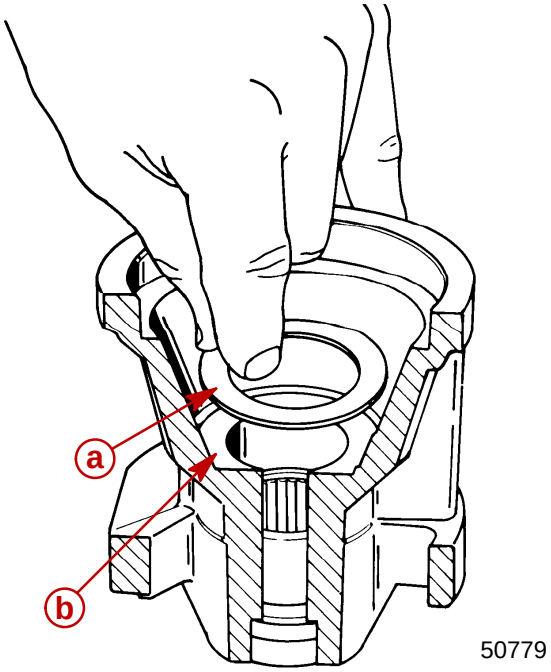
a - Thrust Collar
b - Thrust Bearing
c - Propeller Shaft
d - Keepers (2)
e - Thrust Collar

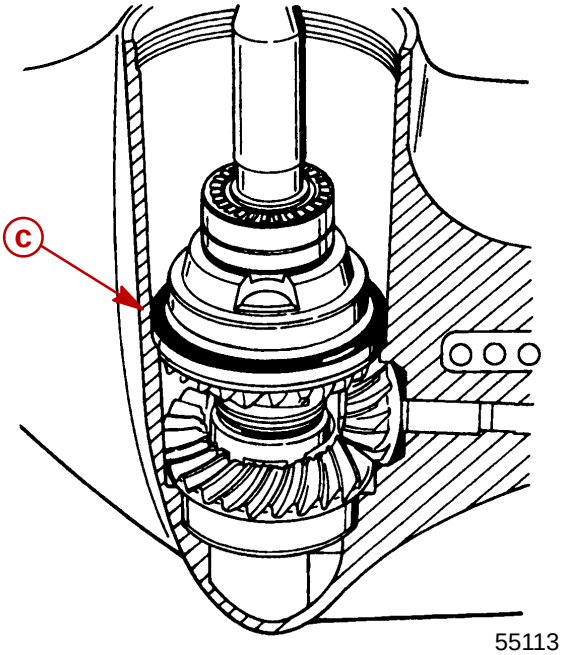
21. Install second thrust collar with its stepped side **UP**.
22. Apply Premium Gear Lubricant to the second thrust bearing and install it on top of the second thrust collar.



a - Thrust Collar
b - Thrust Bearing
c - Thrust Collar

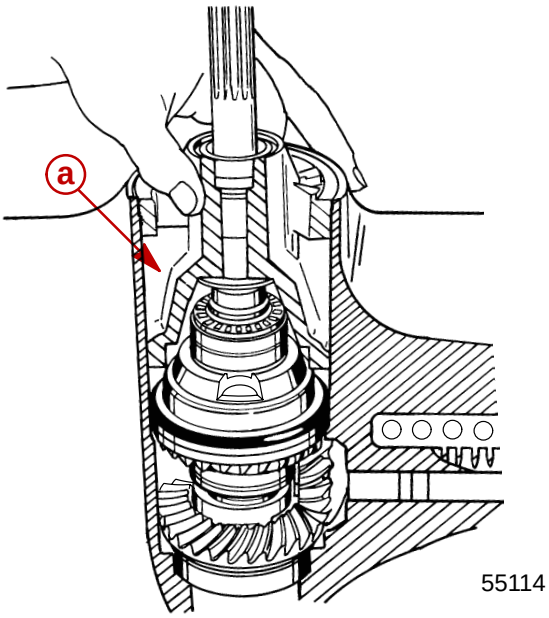
23. Apply Premium Gear Lubricant to to second small thrust bearing race and install race to the surface inside of the bearing carrier.
24. Apply 2-4-C with Teflon to bearing carrier O-ring. Install O-ring onto bearing adaptor.



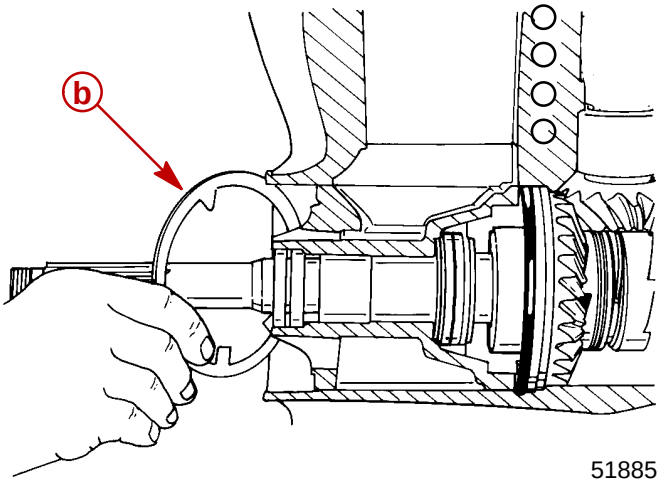


a - Thrust Race
b - Bearing Carrier Race Surface
c - O-ring

25. Apply 2-4-C with Teflon to:
    a. Outer diameter of bearing carrier which contacts gearcase.
    b. Space between carrier oil seals.
26. Apply Premium Gear Lubricant to bearing carrier needle bearing.
27. Install bearing carrier into gear housing.
28. Verify bearing carrier keyway is aligned with gear housing keyway and install bearing carrier key.
29. Place tab washer against bearing carrier.



55114



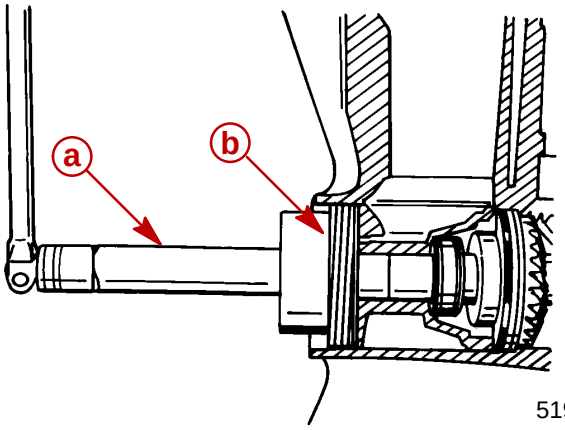
51885

a - Bearing Carrier
b - Tab Washer

30. Apply 2-4-C with Teflon to threads of cover nut and install cover nut in gear housing. Verify that the word “OFF” and arrow are visible.

NOTE: *Before torquing bearing carrier cover nut, gearcase should either be mounted in a stand specifically designed for holding gearcases or bolted to a drive shaft housing to avoid possible damage to the gearcase.*

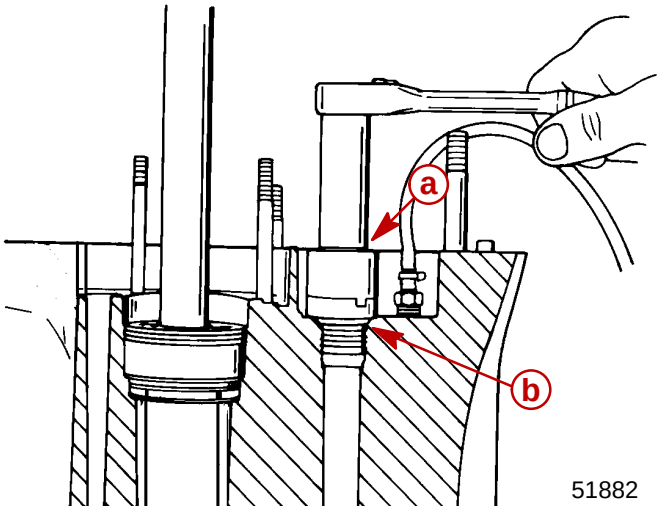
31. Using Gear Housing Cover Nut Tool, torque cover nut to 210 lb. ft. (285 Nm).



51911

a - Gear Housing Cover Nut Tool (91-61069)
b - Retainer Nut

32. Bend one lock tab of tab washer into cover nut (only one will align).
33. Bend remaining tabs of tab washer toward front of gear housing.
34. Use Shift Shaft Bushing Tool and torque shift shaft bushing to 50 lb. ft. (68 Nm).

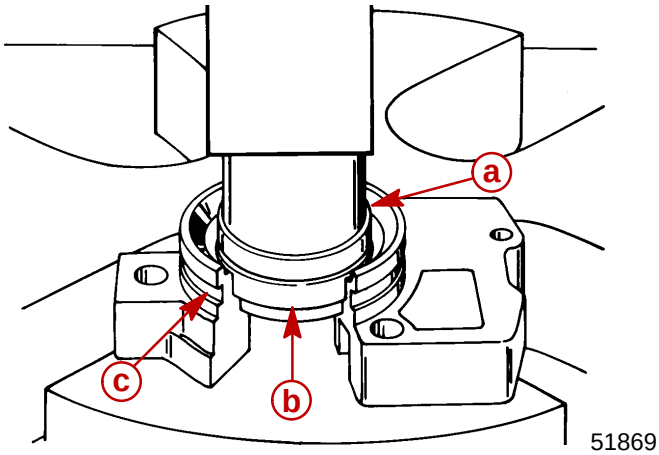


a - Shift Shaft Bushing Tool (91-31107)
b - Shift Shaft Bushing

Water Pump

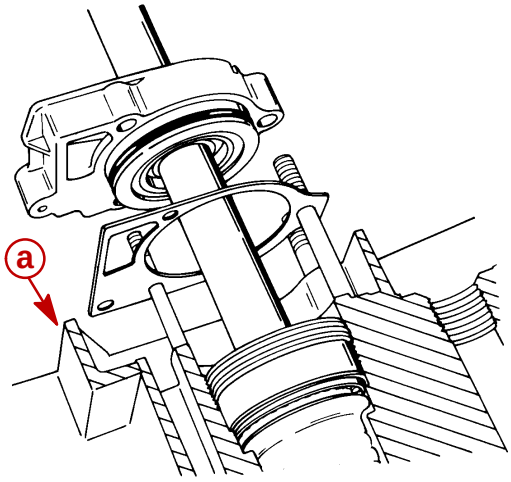
REASSEMBLY/INSTALLATION

1. Install oil seals into water pump base, as follows:
   a. Place water pump base on a press.
   b. Just before installing each seal apply Loctite 271 on outside diameter of oil seal.
   c. With a suitable mandrel, press the smaller diameter oil seal into pump base with lip of oil seal toward impeller side of base.
   d. With a suitable mandrel, press the larger diameter oil seal into pump base with lip of oil seal toward gear housing side of base.
   e. Wipe any excess Loctite from oil seals and water pump base.
2. Install O-ring into O-ring groove of water pump base. Lubricate O-ring and oil seals with 2-4-C with Teflon.

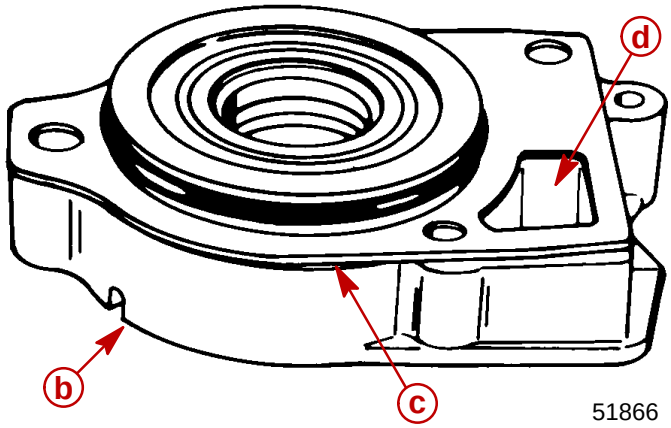


a - Mandrel
b - Oil Seal (Smaller OD)
c - O-Ring Groove

3. Install divider block if removed. Use RTV 587 Silicone Sealer to seal seams between divider block and gear housing.
4. Install a new water pump base gasket and install water pump base.



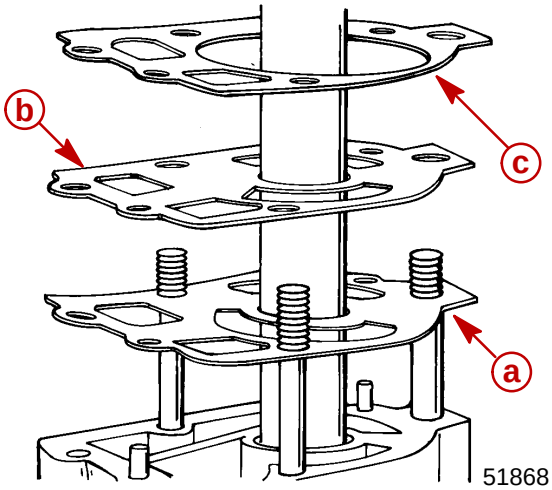
51878



51866

a - Divider Block
b - Water Pump Base
c - Gasket
d - Hole (MUST be positioned as shown)

5. Install the following in order: Pump base to face plate gasket, face plate to pump cover gasket. Gaskets and face plate are indexed by dowel pin location and must be installed correctly.



51868

a - Gasket (Water Pump Base to Face Plate)
b - Face Plate
c - Gasket (Face Plate to Water Pump Cover)

6. Place impeller drive key on flat of drive shaft. Hold key on drive shaft with a small amount of 2-4-C with Teflon.

IMPORTANT: When completing gear housing repair that requires removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary to reuse the impeller, DO NOT install in reverse to original rotation or premature impeller failure will occur. Original rotation is clockwise.

⚠ CAUTION

A visual inspection of impeller drive key MUST BE made to determine that drive key is on flat of drive shaft after impeller is installed. If key has moved off flat of drive shaft, repeat Steps 7 and 8.

7. Slide impeller down driveshaft to impeller drive key. Align drive key with keyway in the center hub of impeller, and slide impeller over drive key.
8. If removed, install new water pump insert into pump cover as follows:
   a. Apply Perfect Seal to water pump insert area of pump cover.
   b. Install the water pump insert into pump cover, being sure that the tab on the insert enters recess in pump cover.
   c. Wipe any excess Perfect Seal from insert and cover.

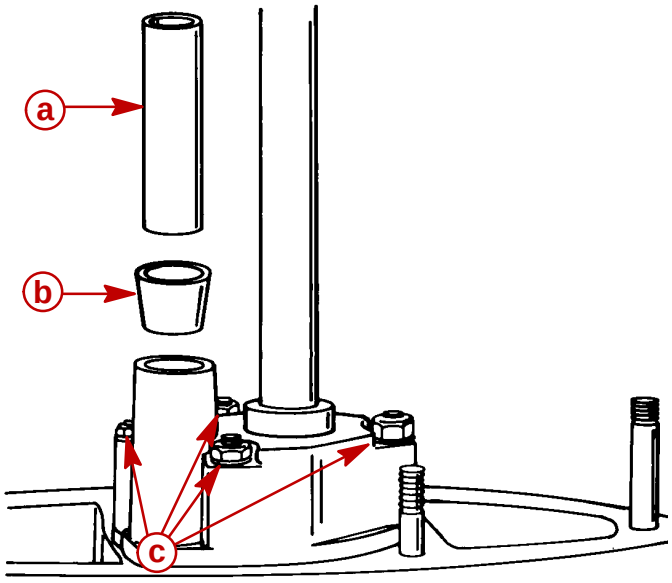
NOTE: *If 2 holes were drilled in top of water pump cover to aid in removal of insert, fill holes with RTV 587 Silicone Sealer (or equivalent). Allow to cure 24 hours prior to operating engine.*

9. Install water tube seal into pump cover. Plastic side of seal goes into cover first.
10. Reinstall water tube guide into water pump cover.
11. Apply a light coat of 2-4-C with Teflon to inside of water pump insert.
12. Position assembled water pump cover over driveshaft and lower over water pump studs. Rotate driveshaft in a clockwise direction (viewed from top), while pushing down on pump cover to ease impeller entry into cover.
13. Install water pump cover retainer washers, nuts and bolt.

⚠ CAUTION

DO NOT over-torque nuts and bolt, as this could cause cover to crack during operation.

14. Torque water pump nuts to 50 lb. in. (6.0 Nm), and water pump bolt to 35 lb. in. (4 Nm).
15. Install centrifugal slinger over driveshaft and down against pump cover.



51874

a - Water Tube Guide
b - Water Tube Seal
c - Nuts, Bolts and Washers

Gear Lubricant Filling Instructions

1. Remove any gasket material from Fill and Vent screws and gear housing.
2. Install new gaskets on Fill and Vent screws.

IMPORTANT: Never apply lubricant to gear housing without first removing Vent screw, or gear housing cannot be filled because of trapped air. Fill gear housing ONLY when housing is in a vertical position.

3. Slowly fill housing through 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 Drive Shaft Housing

⚠ WARNING

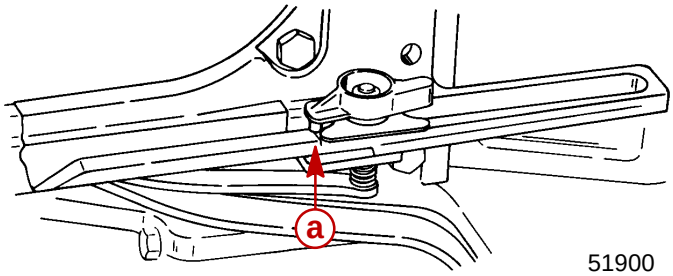
Disconnect high tension leads from spark plugs and remove spark plugs from engine before installing gear housing onto driveshaft housing.

1. Tilt engine to full up position and engage the tilt lock lever.
2. Apply a light coat of 2-4-C with Teflon onto driveshaft splines.

⚠ CAUTION

DO NOT allow lubricant on top of drive shaft. Excess lubricant, that is trapped in the clearance space, will not allow drive shaft to fully engage with crankshaft. Subsequently, tightening the gear housing nuts (while excess lubricant is on top of drive shaft) will load the drive shaft/crankshaft and damage the powerhead and/or gear housing. Top of drive shaft is to be wiped free of lubricant.

3. Apply a light coat of 2-4-C with Teflon onto shift shaft splines. (DO NOT allow lubricant on top of shift shaft.)
4. Apply a thin bead of RTV 587 Silicone Sealer against the top of divider block.
5. Insert trim tab bolt into hole in rear of gear housing to driveshaft housing machined surface.
6. Shift gear housing into forward gear and place guide block anchor pin into forward gear position.



51900

a - Guide Block Anchor Pin

7. Position gear housing so that the drive shaft is protruding into drive shaft housing.

NOTE: *If, while performing Step 8, the drive shaft splines will not align with crankshaft splines, place a propeller onto propeller shaft and turn it counterclockwise as the gear housing is being pushed toward drive shaft housing.*

8. Move gear housing up toward drive shaft 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 drive shaft 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.

IMPORTANT: Do not force gearcase up into place with attaching nuts.

12. Evenly tighten the 2 nuts which were started in Step 9. Torque to listing in **Torque Specifications,** preceding.
13. After 2 nuts (located on either side of drive shafthousing) are tightened, check shift operation as follows:
    a. Place guide block anchor pin into forward gear position while turning prop shaft. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate clockwise.
    b. Place guide block anchor pin into NEUTRAL position. Propeller shaft should rotate freely clockwise/counterclockwise.
    c. Place guide block anchor pin into REVERSE gear position. Rotate flywheel clockwise (viewed from top). Propeller shaft should rotate counterclockwise.

IMPORTANT: If shifting operation is not as described, preceding, the gear housing must be removed and the cause corrected.

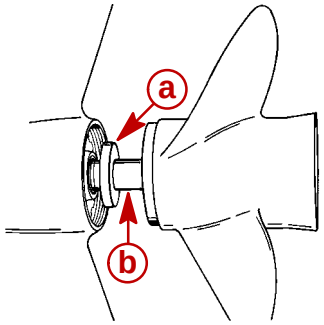
14. Install washers and nuts onto studs (located on bottom center of anti-cavitation plate). Torque to listing in **Torque Specifications,** preceding.
15. Install special flat washer and nut on stud at leading edge of drive shaft housing. Torque to listing in **Torque Specifications,** preceding.
16. Torque bolt (started in Step 10) to listing in **Torque Specifications,** preceding.
17. Install trim tab, adjust to position in which it had previously been installed, and tighten the bolt securely.
18. Install plastic cap into trim tab bolt opening at rear edge of drive shafthousing.

Propeller Installation

⚠ WARNING

When installing or removing propeller, because of the engine's ease in starting, VERIFY that the remote control is in NEUTRAL position and that the key switch is "OFF." Place a block of wood between the anti-cavitation plate and propeller to prevent accidental starting and to protect hands from propeller blades while removing or installing nut.

1. To aid in future removal of the propeller, liberally coat the propeller shaft splines with one of the following products:
   a. Anti-Corrosion Grease
   b. Special Lubricant 101
   c. 2-4-C with Teflon
   d. 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.



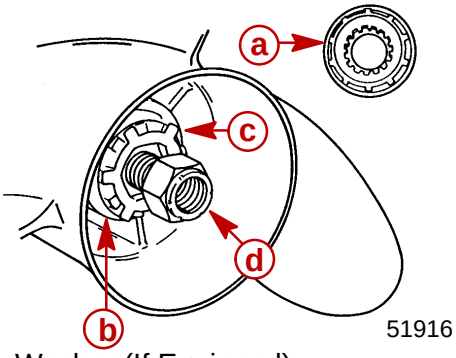
a - Forward Thrust Hub
b - Propeller Shaft

4. Place continuity washer (if equipped) onto shoulder of rear thrust hub.
5. Place rear thrust hub, tab washer and propeller nut on propeller shaft.
6. Thread propeller nut onto propeller shaft until nut is recessed into tab washer.
7. After propeller nut is recessed into tab washer, tighten nut securely [minimum of 55 lb. ft. (74.5 Nm) torque].
8. Bend 3 of the tabs of tab washer down in grooves of rear thrust hub to secure propeller nut. (If tab washer tabs do not align with slots, continue to tighten propeller nut to obtain alignment. DO NOT loosen nut to align tabs.)

⚠ 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.



a - Continuity Washer (If Equipped)
b - Rear Thrust Hub
c - Tab Washer
d - Propeller Nut

ATTACHMENTS / CONTROL LINKAGE

Section 7A

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7

Ride Guide Steering Cable/Attaching Kit Installation (92876A1)

Single Cable

Refer to the Mercury/Quicksilver Accessories Guide to determine correct length of steering cable and remote control cables.

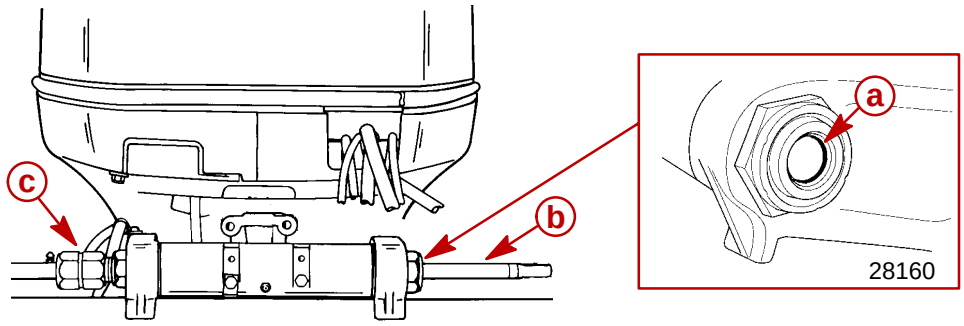
IMPORTANT: Steering cable and remote control cables must be the correct length. Sharp bends on too-short cables result in kinks; too-long cables require unnecessary bends and/or loops. Both conditions place extra stress on the cables and will reduce the performance of the steering system.

INSTALLING RIDE GUIDE CABLE TO OUTBOARD TILT TUBE

IMPORTANT: Before installing steering cable in tilt tube, lubricate entire cable end with 2-4-C with Teflon.

NOTE: *Ride Guide steering cable is lubricated at the factory and requires no additional lubrication at initial installation.*

1. Lubricate seal inside of outboard tilt tube and entire cable end with 2-4-C with Teflon.
2. Insert steering cable end through outboard tilt tube and secure steering cable to tilt tube with steering cable attaching nut, as shown. Torque nut to 35 lb. ft. (47.5 Nm).



a - Seal
b - Cable End
c - Steering Cable Attaching Nut

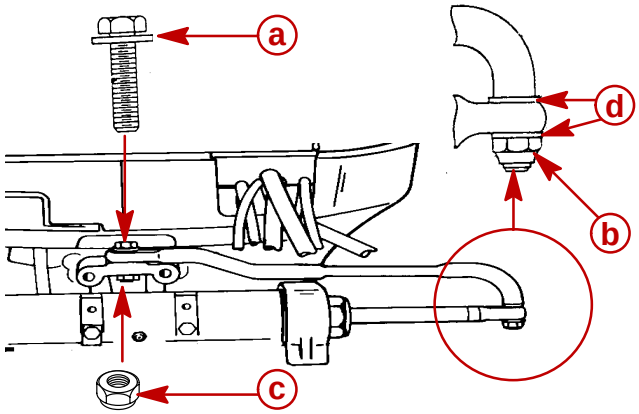
STEERING LINK ROD INSTALLATION

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.

1. Assemble steering link rod to steering cable with two flat washers and nylon insert locknut (“b” - Part Number 11-826709113). Tighten locknut until it seats, then back nut off 1/4 turn.
2. **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 to 20 lb. ft. (27 Nm), then torque locknut to 20 lb. ft. (27 Nm).



a - Special Washer Head Bolt (10-849838) Torque to 20 lb. ft. (27 Nm)
b - Nylon Insert Locknut (11-826709113) Tighten until seats then back off 1/4 turn
c - Nylon Insert Locknut (11-826709113) Torque to 20 lb. ft. (27 Nm)
d - Flat Washers (2)

⚠ 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.**

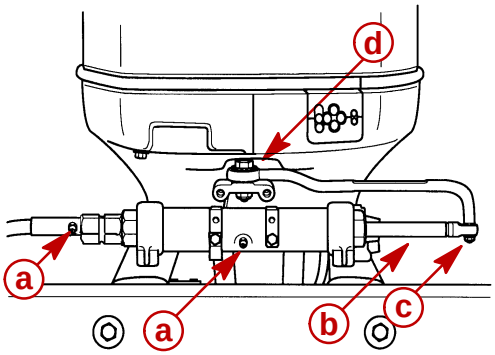
1. Carefully check steering system components for wear. Replace worn parts.
2. Check steering system fasteners to be sure they are torqued to correct specifications.

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 with 2-4-C with Teflon. Lubricate exposed portion of cable end with 2-4-C with Teflon.
4. Lubricate pivot point of steering link rod and ball joint of link rod with Light Oil.
5. Inspection and lubrication of steering head assembly (rotary or straight rack) should be performed once each year (by your Authorized Dealer) or whenever steering mount and/or steering head are disassembled, or if steering effort has increased. Lubricate with 2-4-C with Teflon.



28169

a - Grease Fittings
b - Cable End
c - Pivot Point
d - Ball Joint

Ride Guide Steering Cable/Attaching Kit Installation (92876A3)

Dual Cable - Single Outboard

⚠ WARNING

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 the Mercury/Quicksilver Accessories Guide to determine correct length of steering cables and remote control cables.

IMPORTANT: Steering cables and remote control cables MUST BE THE CORRECT LENGTH. Sharp bends on too-short cables result in kinks; too-long cables require unnecessary bends and/or loops. Both conditions place extra stress on the cables and will reduce the performance of the steering system.

⚠ CAUTION

With this kit installed, the upper (outboard) mounting bolts MUST BE installed so that hex head end of bolts is on the inside of boat transom, as illustrated. Failure to install upper mounting bolts, as shown in illustration, could result in interference between steering cable nut and ends of mounting bolts when outboard is tilted up.

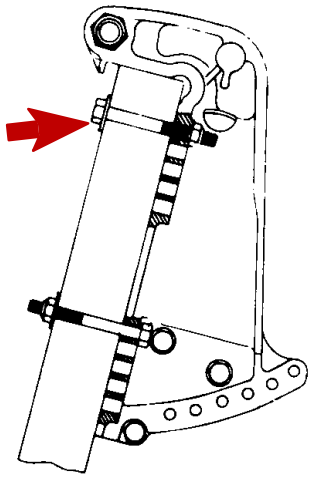
⚠ CAUTION

Marine sealer must be used on shanks bolts to make a water-tight installation.

IMPORTANT: DO NOT use an impact driver when tightening transom bolts.

Apply marine sealer to shanks of mounting bolts (not threads) and secure outboard to transom with 4 bolts, flat washers and locknuts, as shown. Be sure that installation is water-tight.

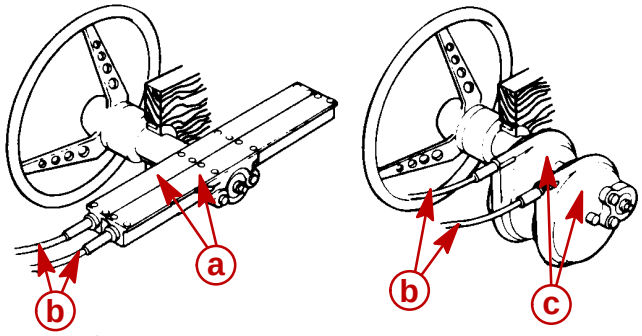
Install upper bolts so that hex head end of bolts is on the inside of boat transom.



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.

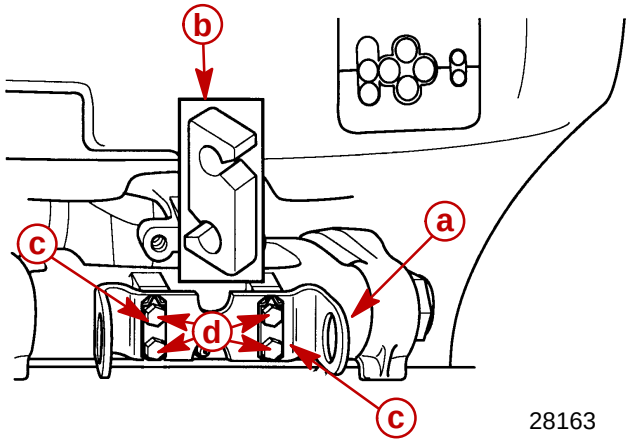


a - Gear Rack
b - Steering Cables
c - Rotary Steering Heads

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.

1. Secure mounting bracket for steering cable mounting tube onto swivel bracket of outboard.

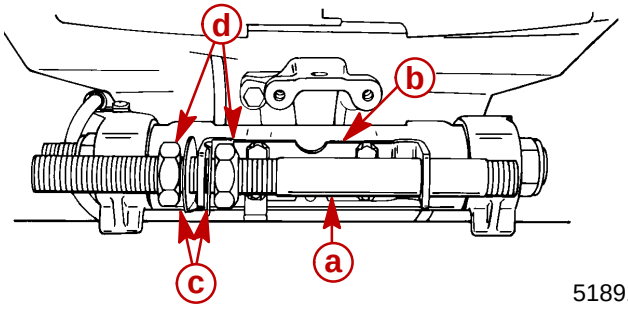


a - Mounting Bracket for Steering Cable Mounting Tube
b - Spacer (2)
c - Locking Retainer (2)
d - Bolts (4) - 7/8 in. (22 mm) Long - Torque to 100 lb. in. (11.5 Nm), then Bend Corner Tabs of Locking Retainers Up and Against Flats on Each Bolt

⚠ 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.

2. 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.
3. Temporarily adjust tube so that longer threaded end of tube extends out the same distance as the outboard tilt tube. Do not tighten adjustment nuts at this time.



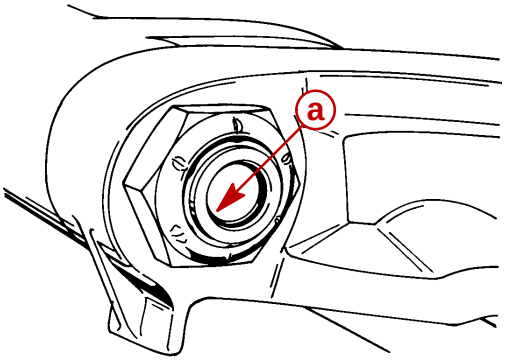
51891

a - Steering Cable Mounting Tube (End of Tube with Longer Threads Toward Starboard Side of Boat)
b - Mounting Bracket
c - Locking Tab Washers (2)
d - Adjustment Nuts (Flats of Nuts Facing Toward Locking Tab Washer)

Installing Steering Cables

IMPORTANT: Lubricate inside of outboard tilt tube, inside of steering cable mounting tube and rubber O-ring seal (located in outboard tilt tube) with 2-4-C with Teflon before installing steering cables.

1. Lubricate inside of outboard tilt tube and inside of steering cable mounting tube with 2-4-C with Teflon. Verify rubber O-ring seal (located in outboard tilt tube) is lubricated.

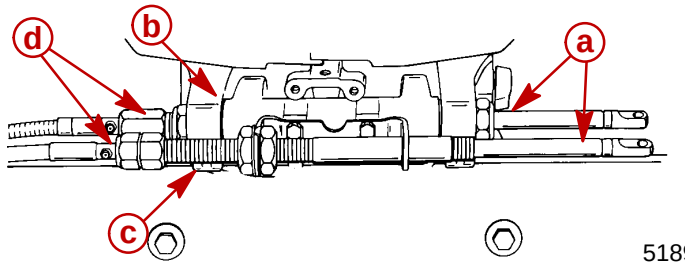


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a - O-Ring Seal

2. Insert steering cable ends through outboard tilt tube and cable mounting tube. Thread steering cable attaching nuts on to tubes hand tight.

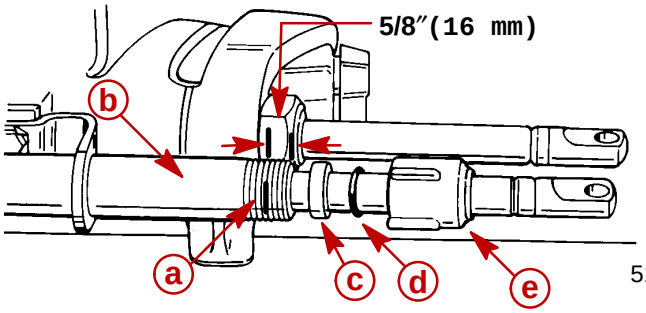
NOTE: *Torque steering cable attaching nuts only after final steering adjustments have been made.*



51891

a - Steering Cable Ends
b - Tilt Tube
c - Cable Mounting Tube
d - Steering Cable Attaching Nuts

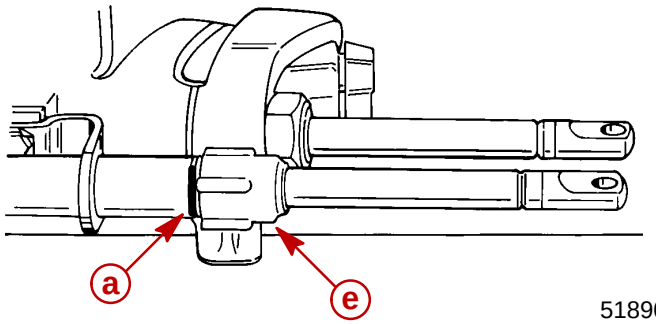
3. Place a mark on steering cable mounting tube 5/8 in. (16 mm) from end of mounting tube. Slide plastic spacer, O-ring and cap over steering cable.



51890

a - Mark
b - Steering Cable Mounting Tube
c - Spacer
d - O-Ring
e - Cap

4. Thread cap (e) onto steering cable mounting tube, up to mark (a).



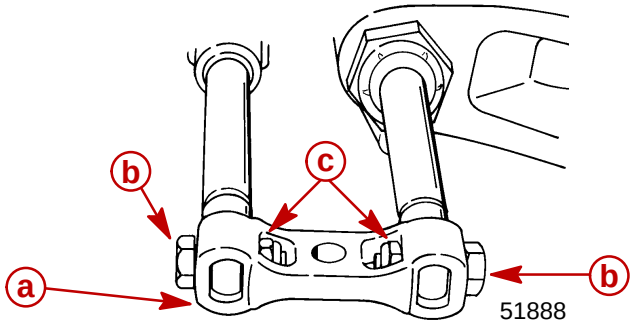
51890

Coupler Installation

⚠ WARNING

Locknuts must be used with bolts to secure steering cables to coupler. Failure to adhere to this requirement could result in steering system failure.

1. Slide coupler onto steering cable ends and secure each steering cable to coupler with bolts and locknuts as shown. Tighten to a torque of 20 lb. ft. (27 Nm).



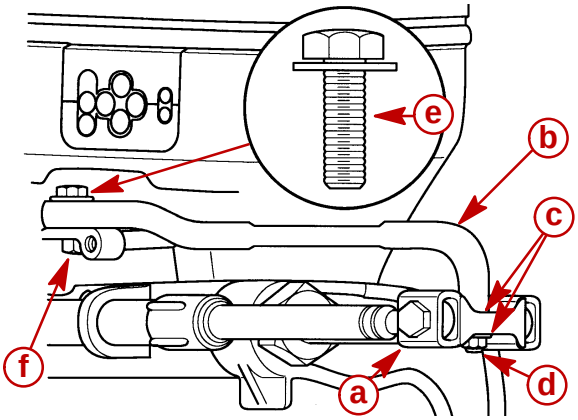
a - Coupler
b - Bolts
c - Locknuts

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.

1. Lubricate hole in steering coupler, with 2-4-C with Teflon. Assemble steering link rod to steering coupler using 2 flat washers (one each side of coupler) and nylon insert locknut. Tighten locknut until it seats [DO NOT exceed 120 lb. in. (13.5 Nm) of torque], then back nut off 1/4 turn.
2. Lubricate ball joint in steering link rod with light oil. Secure link rod to outboard steering arm using special washer head bolt (10-849838) provided and nylon insert locknut as shown. Torque special bolt to 20 lb. ft. (27 Nm), then torque locknut to 20 lb. ft. (27 Nm).

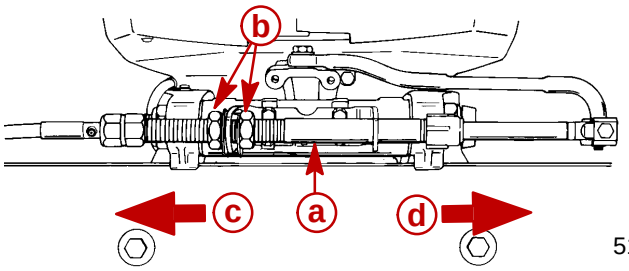


a - Steering Coupler
b - Steering Link Rod
c - Flat Washer (2)
d - Nylon Insert Locknut (11-826709113) Torque until it seats then back off 1/4 turn
e - Special Washer Head Bolt (10-849838) Torque to 20 lb. ft. (27 Nm)
f - Nylon Insert Locknut (11-826709113) Torque to 20 lb. ft. (27 Nm)

STEERING SYSTEM TENSION ADJUSTMENT

IMPORTANT: After this dual steering cable attachment kit is installed, there must be proper tension in the 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.

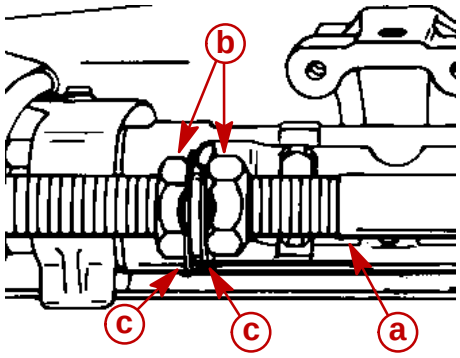
1. Loosen adjustment nuts and pull steering cable mounting tube (by hand) away from end of steering cable (to remove slack in steering system).
2. Tighten adjustment nuts against mounting bracket and check system for slack (play). If steering system is too tight, readjust tube toward end of steering 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

3. After steering system tension is adjusted correctly, tighten adjustment nuts (against mounting bracket) to a torque of 35 lb. ft. (47.5 Nm). Bend a tab lock washer against flat on each adjustment nut.

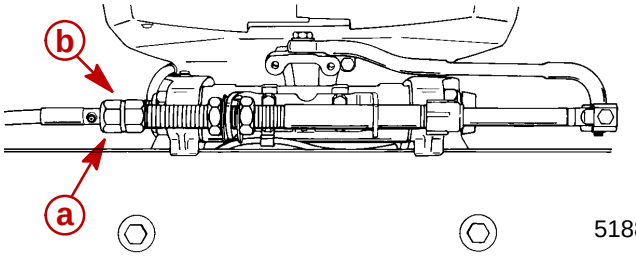


51887

a - Steering Cable Mounting Tube
b - Adjustment Nuts; Torque to 35 lb. ft. (47.5 Nm)
c - Tab Lock Washer (Bend Against Flat on Each Adjustment Nut)

4. 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 the outer circumference of the nut are self locking and do not require locking sleeves.*



a - Cable Attaching Nut
b - "V" Groove

⚠ WARNING

After installation is complete [and before operating outboards], 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 the owner's responsibility and must be performed at intervals specified:
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.

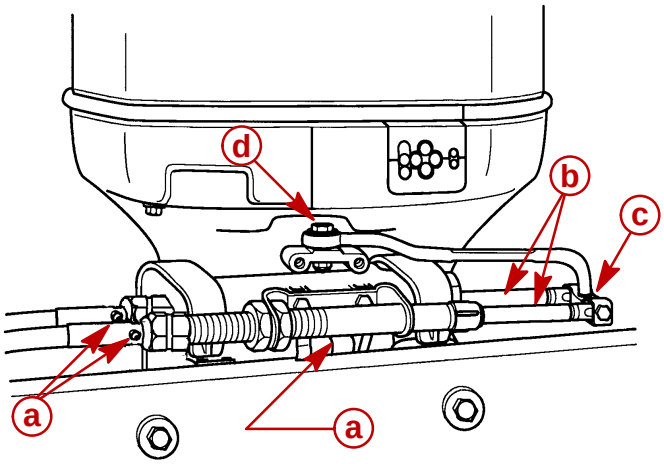
1. Carefully check steering system components for wear. Replace worn parts.
2. Check steering system fasteners to be sure they are torqued to correct specifications.

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 with Teflon. Lubricate exposed portion of cable ends with 2-4-C with Teflon.
4. Lubricate pivot point of steering link rod and ball joint of link rod/steering coupler with light oil.
5. Inspection and lubrication of steering head assembly (rotary or straight rack) should be performed once each year (by your Authorized Dealer) or whenever steering mount and/or steering head are disassembled, or if steering effort has increased. Lubricate with 2-4-C with Teflon.



28170

a - Grease Fittings
b - Cable Ends
c - Pivot Point
d - Ball Joint

Ride Guide Steering Cable/Attaching Kit Installation (92876A6)

Dual Cable - Dual Outboard

⚠ WARNING

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 the Mercury/Quicksilver Accessories Guide to determine the 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. through 27-1/2 in. (597 mm through 699 mm) outboard centerline spacing. If the outboard centerline distance is other then specified, refer to the end of this instruction manual for optional extension couplers.

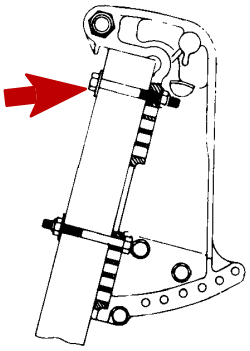
DETERMINE ROUTING OF STEERING CABLES

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.**
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.**

⚠ 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.



3. 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

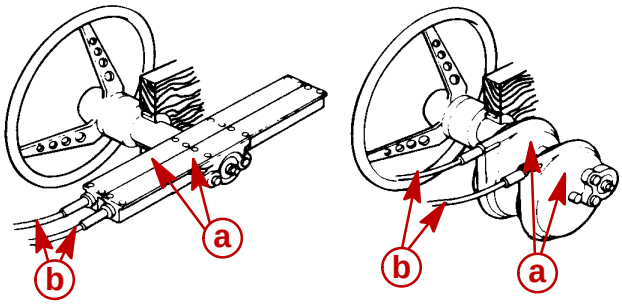
(Both Steering Cables Routed Together Down Starboard Side of Boat)

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.

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 according to instructions included with 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.

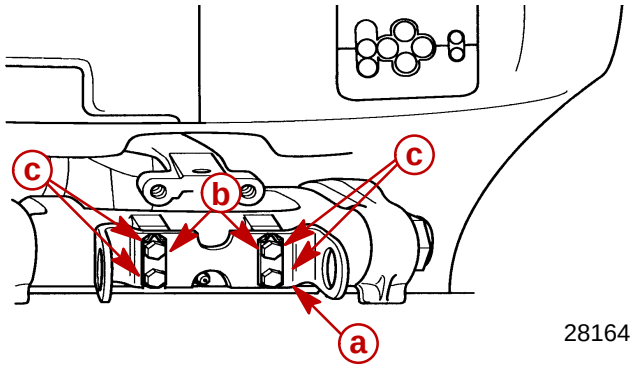


a - Straight Rack (Left); Rotary Steering (Right)
b - Steering Cables (Install so that Both Cables Will Push and Pull Together)

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.

1. Secure mounting bracket for steering cable mounting tube, onto swivel bracket of starboard outboard.



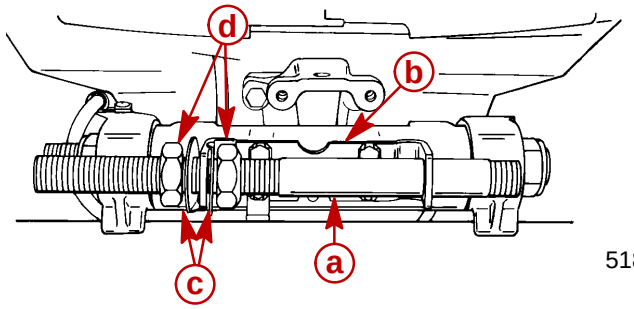
28164

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.

2. Install steering cable mounting tube into mounting bracket with 2 adjusting nuts and 2 locking tab washers. Be sure longer threaded end is toward starboard side of boat.
3. Temporarily adjust tube, so that longer threaded end of tube extends out the same distance as the outboard tilt tube. Do not tighten adjustment nuts at this time.



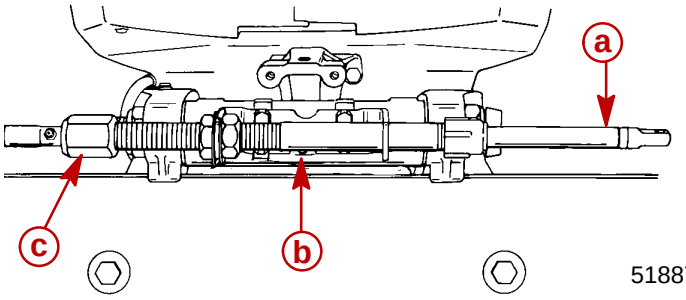
51891

a - Steering Cable Mounting Tube (End of Tube with Longer Threads Toward Starboard Side of Boat)
b - Mounting Bracket
c - Locking Tab Washers (2)
d - Adjustment Nuts (Flats of Nuts Facing Toward Locking Tab Washer)

IMPORTANT: Lubricate inside of steering cable mounting tube with 2-4-C with Teflon before installing steering cable.

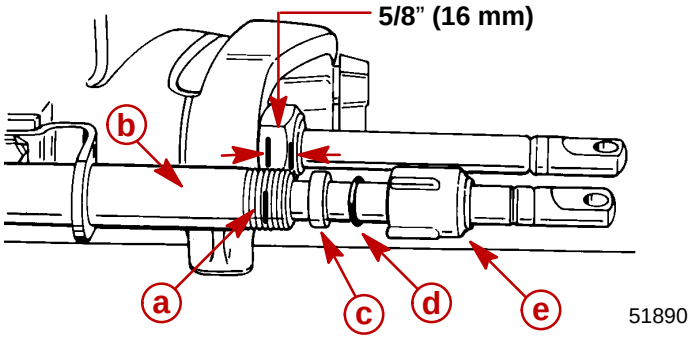
4. Lubricate inside of steering cable mounting tube (starboard outboard) with 2-4-C with Teflon.
5. Insert steering cable end through cable mounting tube and thread steering cable attaching nut onto tube hand tight.

NOTE: *Torque steering cable attaching nut only after final steering adjustments have been made.*



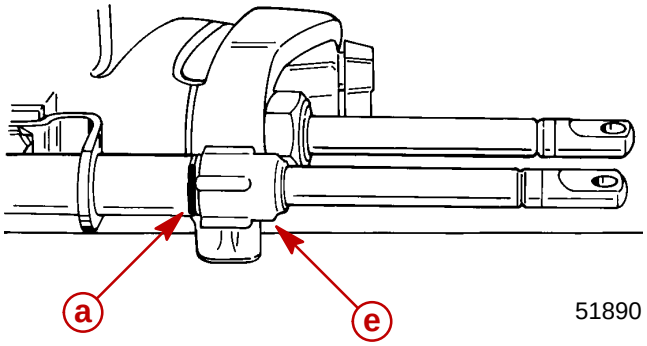
a - Steering Cable End
b - Cable Mounting Tube
c - Steering Cable Attaching Nut

6. Place a mark on steering cable mounting tube 5/8 in. (16 mm) from end of mounting tube. Slide plastic spacer, O-ring and cap over steering cable.



a - Mark
b - Steering Cable Mounting Tube
c - Plastic Spacer
d - O-Ring
e - Cap

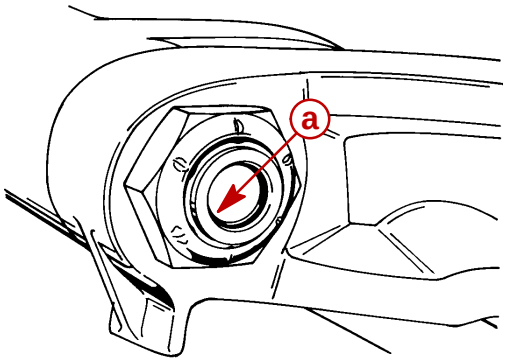
Thread cap (e) onto steering cable mounting tube, up to mark (a).



STEERING CABLE INSTALLATION - PORT OUTBOARD

IMPORTANT: Lubricate inside of port outboard's tilt tube and rubber O-ring seal located inside tilt tube with 2-4-C with Teflon, before installing steering cable.

1. Lubricate inside of port outboard's tilt tube and rubber O-ring seal with 2-4-C with Teflon.

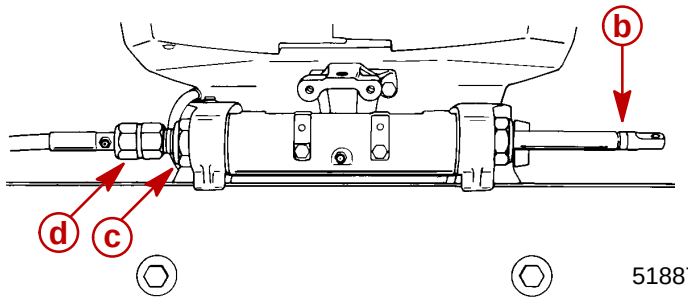


51890

a - O-Ring Seal

2. Insert steering cable end through tilt tube of port outboard and thread steering cable attaching nut onto tilt tube hand tight.

NOTE: *Torque steering cable attaching nuts only after final steering adjustments have been made.*



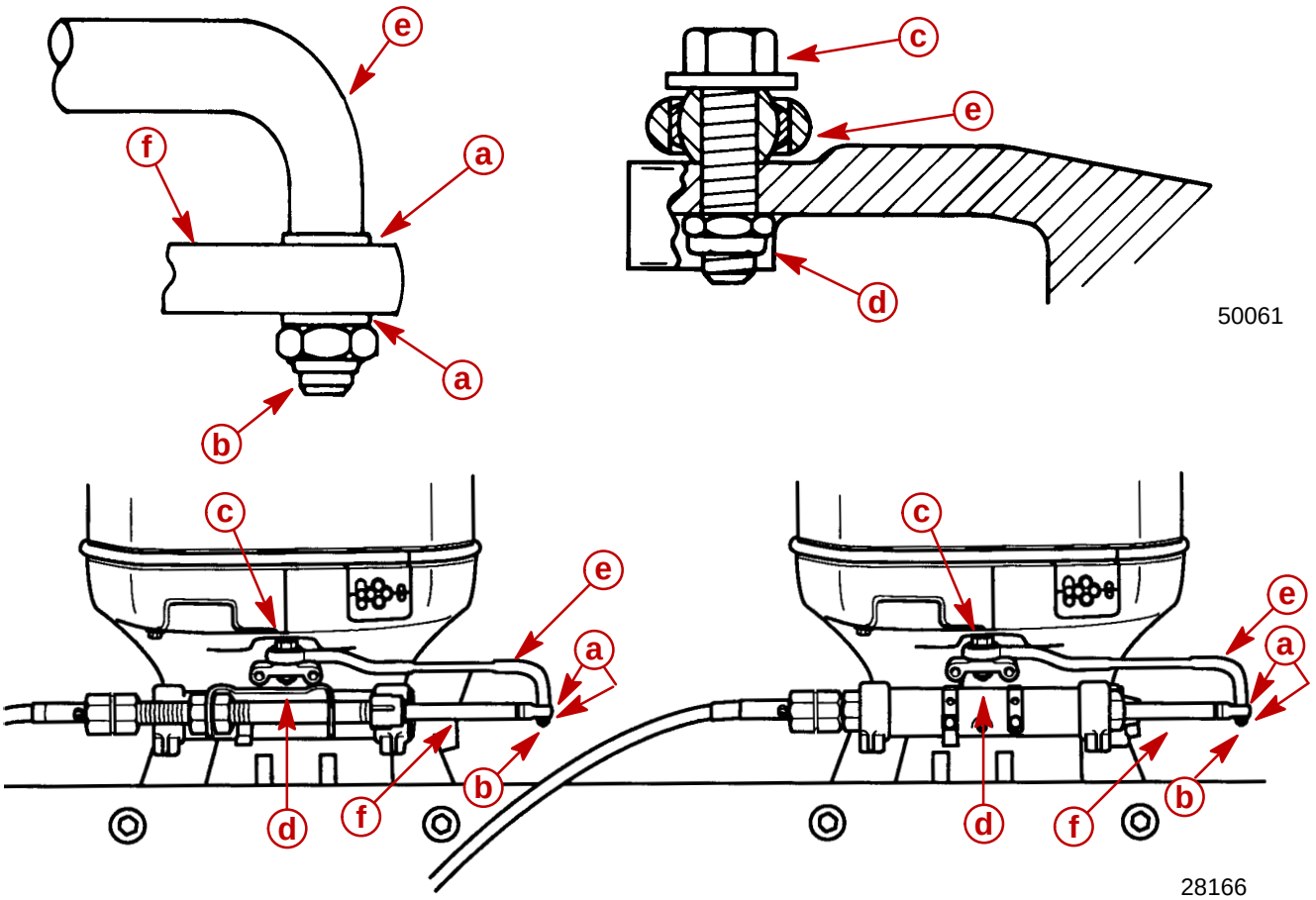
51887

b - Steering Cable End
c - Tilt Tube
d - Steering Cable Attaching Nut

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.

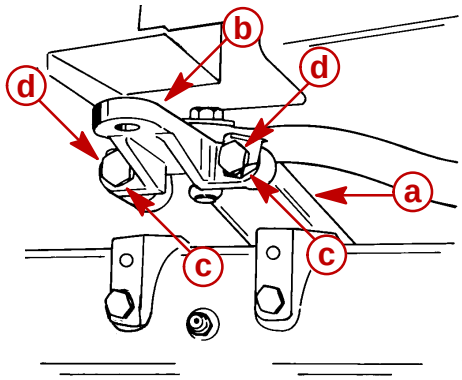


- **a** - Flat Washer (2 Each Link Rod)
- **b** - Nylon Insert Locknut - Torque Until it Seats [DO NOT Exceed 120 lb. in. (13.5 Nm) of Torque], Then Back Off 1/4 Turn
- **c** - Special Washer Head Bolt (10-849838) - Torque to 20 lb. ft. (27 Nm)
- **d** - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)
- **e** - Steering Link Rod
- **f** - Steering Cable End

1. Lubricate holes in ends of steering cables, with 2-4-C with Teflon. Assemble steering link rods to steering cable ends of each outboard, using flat washers and nylon insert locknuts. Tighten locknuts until they seat [DO NOT exceed 120 lb. in. (13.5 Nm) of torque], then back nut off 1/4 turn.
2. Lubricate ball joints in steering link rods with light oil. Secure link rods to outboard steering arms, using special washer head bolts (10-849838) provided and nylon insert locknuts as shown. Torque special bolts to 20 lb. ft. (27 Nm) then torque locknuts to 20 lb. ft. (27 Nm).

STEERING ARM EXTENSION BRACKET INSTALLATION

1. Secure a steering arm extension bracket to each outboard's steering arm.



51889

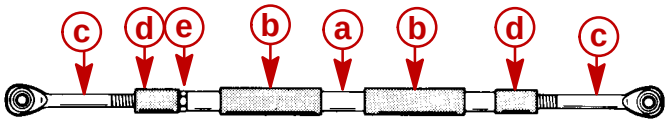
a - Steering Arm (Port Outboard Shown)
b - Extension Bracket
c - Locking Retainer (2 Each Bracket)
d - Bolts (2 Each Bracket) 1-1/4 in. (31.8 mm) Long - Torque to 23 lb. ft. (31 Nm), Then Bend Corner Tabs of Locking Retainers Up Against Flats on Each Bolt

⚠ 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

1. Position outboards so they are facing straight forward. (Distance between threaded hole centers of steering arm extensions MUST BE equal to distance between propeller shaft centerlines.)
2. Lubricate inside of rubber sleeves with 2-4-C with Teflon and slide sleeves on steering coupler.
3. Work rubber bushings onto threaded ends of steering eyes.
4. Thread jam nut on starboard steering eye.
5. 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.

6. Lubricate ball joint in steering eyes, with light oil.
7. Assemble steering coupler between outboard steering arm extension brackets, using special washer head bolts (10-849838) provided and nylon insert locknuts as shown.

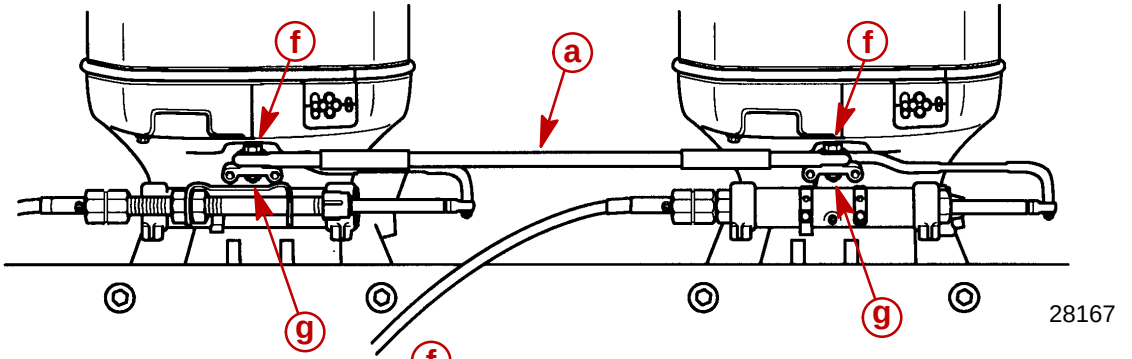
IMPORTANT: With assembled steering coupler installed and before tightening special washer head bolts/locknuts, check outboard alignment. Distance between centers of special washer head bolts MUST BE equal to distance between propeller shaft center lines, for proper steering. If adjustment is necessary, temporarily remove special washer head bolt/locknut from one steering eye and turn eye in or out to correct alignment.

8. Torque special washer head bolts to 20 lb. ft. (27 Nm), then torque locknuts to 20 lb. ft. (27 Nm).

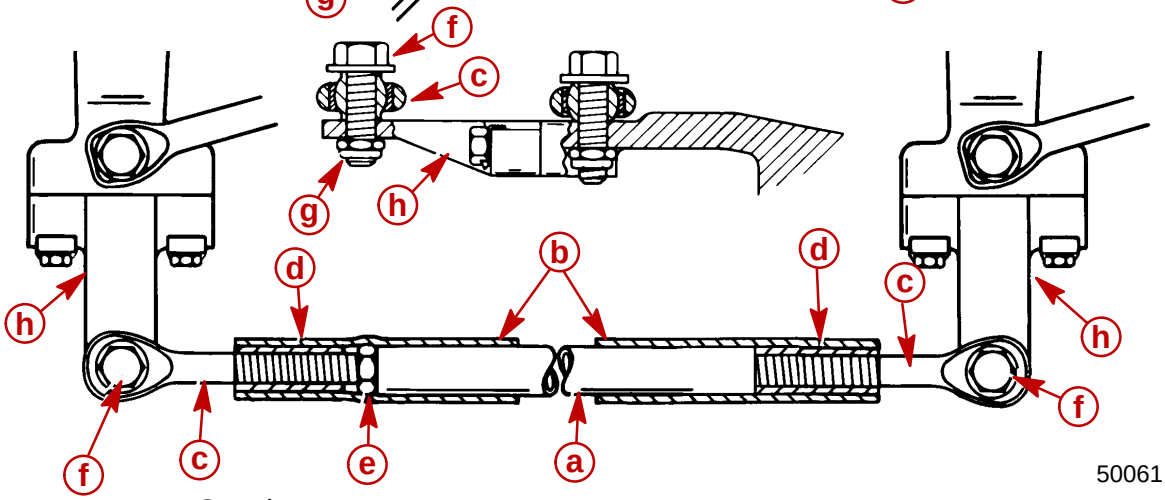
⚠ WARNING

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).

9. Tighten jam nut against coupler. Torque jam nut to 20 lb. ft. (27 Nm).
10. Spray Corrosion Guard on exposed threads of steering eyes and position rubber bushings and rubber sleeves to cover exposed threads of steering eyes.



28167



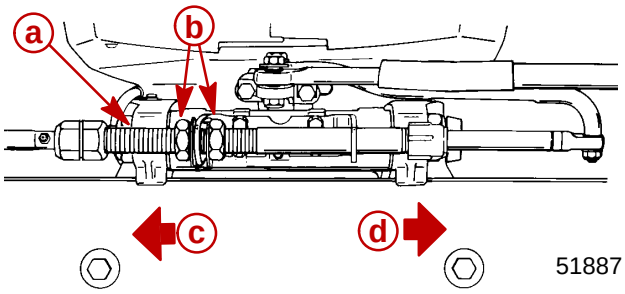
50061

a - Coupler
b - Rubber Sleeve
c - Steering Eye
d - Rubber Bushing
e - Jam Nut - Torque (Against Coupler) to 20 lb. ft. (27 Nm)
f - Special Washer Head Bolt (10-849838) - Torque to 20 lb. ft. (27 Nm)
g - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)
h - Steering Arm Extension Bracket

STEERING SYSTEM TENSION ADJUSTMENT (PARALLEL ROUTED STEERING CABLES)

IMPORTANT: For proper operation of 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.

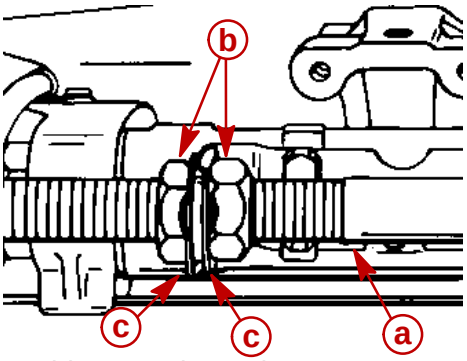
1. Loosen adjustment nuts and pull steering cable mounting tube (by hand) away from end of steering cable (to remove slack in steering system).
2. Tighten adjustment nuts against mounting bracket and check system for slack (play). If steering system is too tight, readjust tube toward end of steering 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

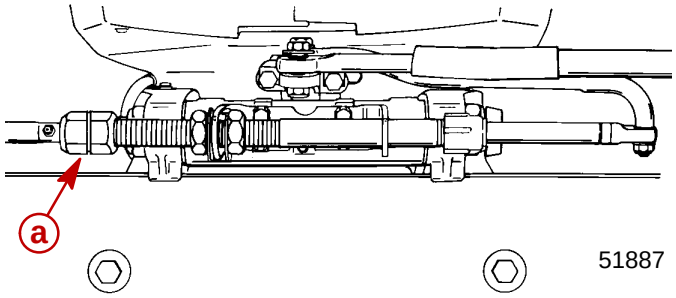
3. After steering system tension is adjusted correctly, tighten adjustment nuts against mounting bracket, to a torque of 35 Ib. ft. (47.5 Nm) and bend a tab lock washer against a flat on each nut.



51887

a - Steering Cable Mounting Tube
b - Adjustment Nuts
c - Tab Lock Washer

4. Torque steering cable attaching nuts of each steering cable to 35 lb. ft. (47.5 Nm).



a - Cable Attaching Nut

⚠ WARNING

After installation is complete [and before operating outboards], 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.

5. Adjust trim tabs of both outboards, as outlined in **Trim Tab Adjustment.**

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

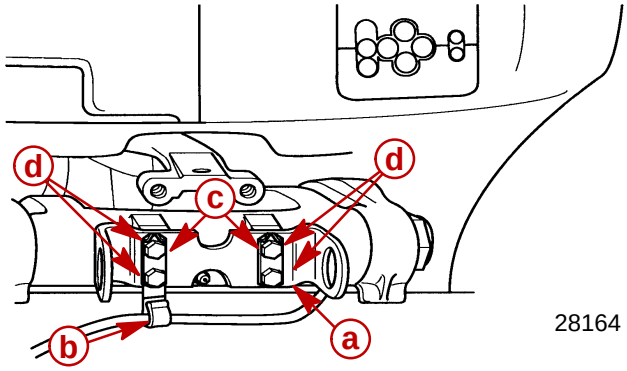
IMPORTANT: Steering cable must be installed into tilt tube of port outboard before outboard is mounted on boat transom.

1. 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.

1. Secure mounting bracket for steering cable mounting tube, onto swivel bracket of starboard outboard.



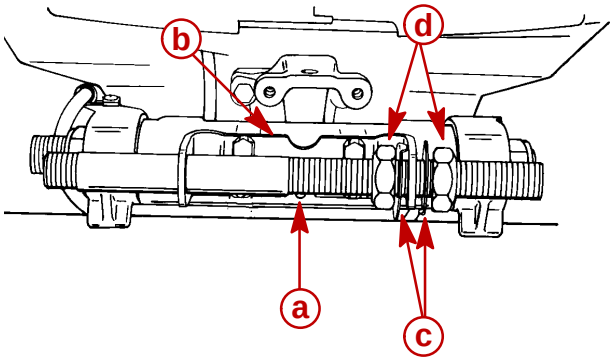
28164

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.

2. Install Steering Cable mounting tube into mounting bracket with 2 adjusting nuts and 2 locking tab washers. Verify the longer threaded end of tube is toward center of boat transom.
3. 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.



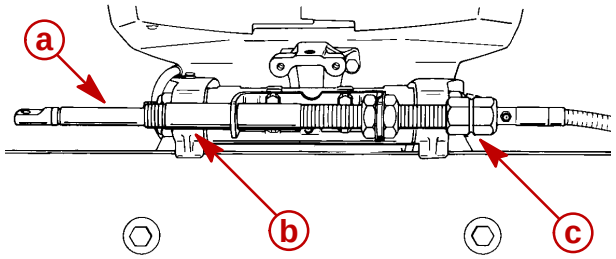
51891

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 with Teflon before installing steering cable.

4. Lubricate inside of steering cable mounting tube (starboard outboard) with 2-4-C with Teflon.
5. Insert steering cable end (steering cable routed down port side of boat) through cable mounting tube and thread steering cable attaching nut onto tube hand tight.

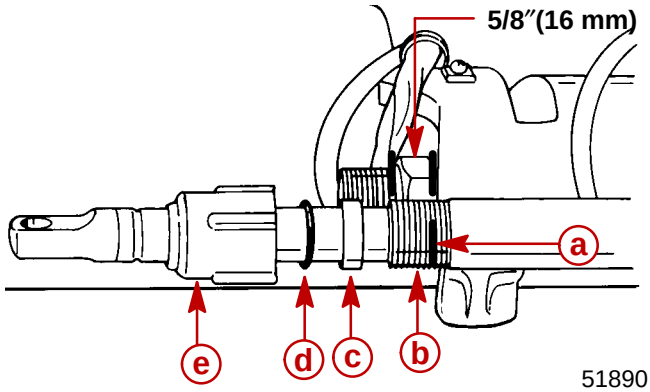
NOTE: *Torque steering cable attaching nut only after final steering adjustments have been made.*



51887

a - Steering Cable End
b - Cable Mounting Tube
c - Steering Cable Attaching Nut

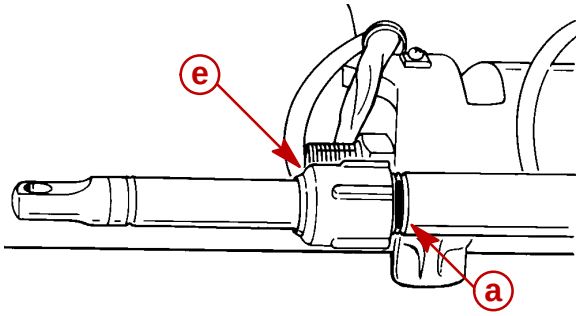
6. Place a mark on steering cable mounting tube 5/8 in (16 mm) from end of mounting tube. Slide plastic spacer, O-ring and cap over steering cable.



51890

a - Mark
b - Steering Cable Mounting Tube
c - Plastic Spacer
d - O-Ring
e - Cap

Thread cap (e) onto steering cable mounting tube, up to mark (a).

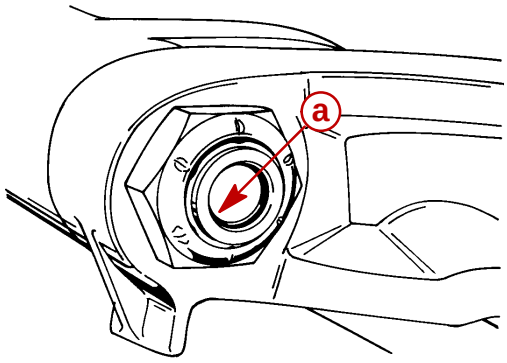


51888

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 with Teflon, before installing steering cable.

1. Lubricate inside of the port outboard's tilt tube and rubber O-ring seal with 2-4-C with Teflon.

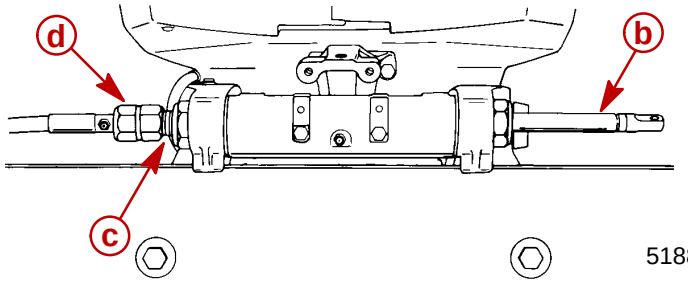


51890

a - O-Ring Seal

2. Insert steering cable end (steering cable routed down starboard side of boat) through tilt tube of port outboard and thread steering cable attaching nut onto tilt tube hand tight.

NOTE: *Torque steering cable attaching nut only after final steering adjustments have been made.*



51887

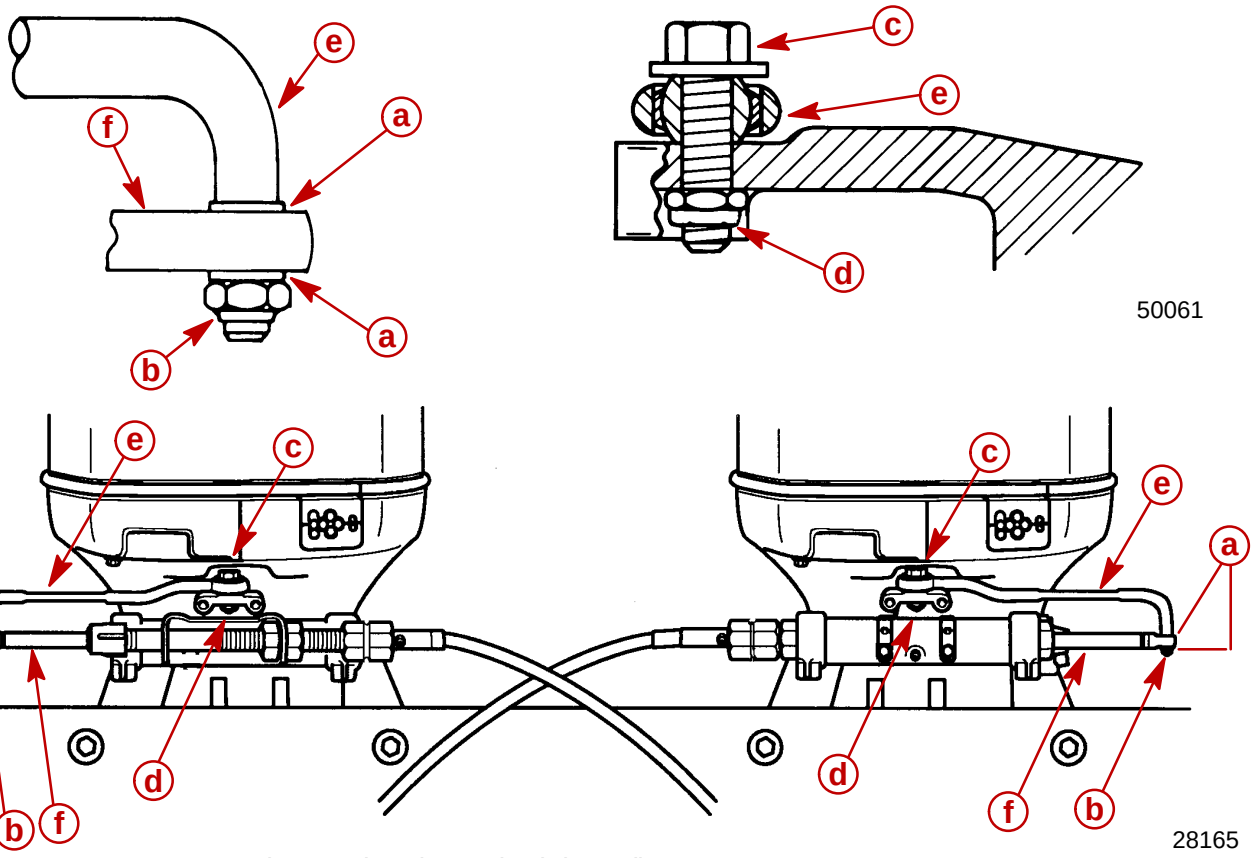
b - Steering Cable End
c - Tilt Tube
d - Steering Cable Attaching Nut

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.

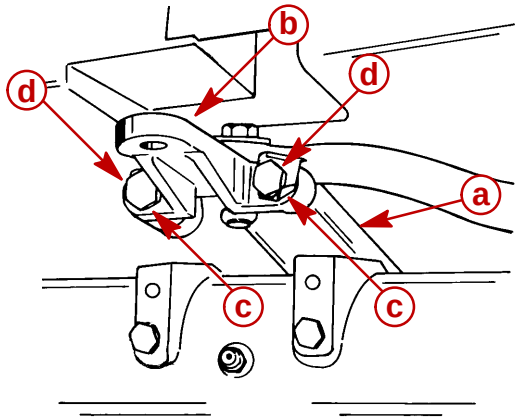
1. Lubricate holes in ends of steering cables, with 2-4-C with Teflon. Assemble steering link rods to steering cable ends of each outboard, using flat washers and nylon insert locknuts. Tighten locknuts until they seat [DO NOT exceed 120 lb. in. (13.5 Nm) of torque], then back nut off 1/4 turn.
2. Lubricate ball joints in steering link rods with light oil. Secure link rods to outboard steering arms, using special washer head bolts (10-849838) provided and nylon insert locknuts as shown. Torque special bolts to 20 lb. ft. (27 Nm) then torque locknuts to 20 lb. ft. (27 Nm).



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

1. Secure a steering arm extension bracket to each outboard's steering arm.



51889

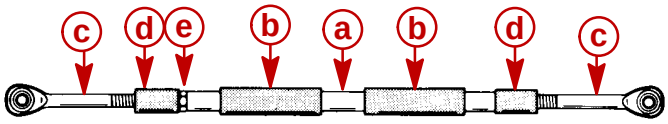
a - Steering Arm (Port Outboard Shown)
b - Extension Bracket
c - Locking Retainer (2 Each Bracket)
d - Bolts (2 Each Bracket) 1-1/4 in. (31.8 mm) Long - Torque to 23 lb. ft. (31 Nm), Then Bend Corner Tabs of Locking Retainers Up Against Flats on Each Bolt

⚠ 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

1. 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.)
2. Lubricate inside of rubber sleeves with 2-4-C with Teflon and slide sleeves on steering coupler.
3. Work rubber bushings onto threaded ends of steering eyes.
4. Thread jam nut on starboard steering eye.
5. 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.

6. Lubricate ball joint in steering eyes with light oil.
7. Assemble steering coupler between outboard steering arm extension brackets, using special washer head bolts (10-849838) provided and nylon insert locknuts, as shown.

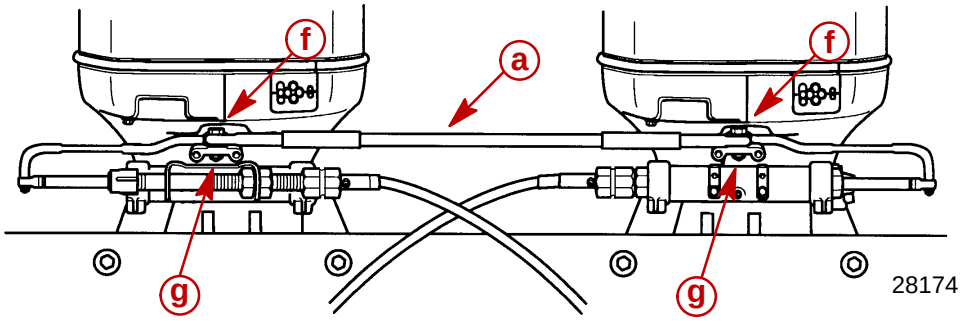
IMPORTANT: With assembled steering coupler installed, before tightening special washer head bolts/locknuts, check outboard alignment. Distance between centers of special washer head bolts MUST BE equal to distance between propeller shaft center lines, for proper steering. If adjustment is necessary, temporarily remove special washer head bolt/locknut from one steering eye and turn eye in or out to correct alignment.

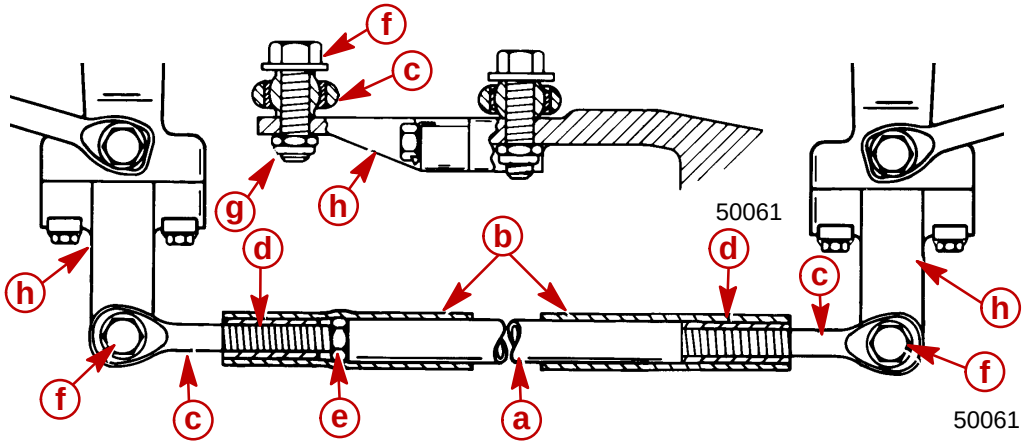
8. Torque special washer head bolts to 20 lb. ft. (27 Nm), then torque locknuts to 20 lb. ft. (27 Nm).

⚠ 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).

9. Tighten “jam” nut against coupler. Torque “jam” nut to 20 lb. ft. (27 Nm).
10. Spray Corrosion Guard on exposed threads of steering eyes and position rubber bushings and rubber sleeves to cover exposed threads of steering eyes.



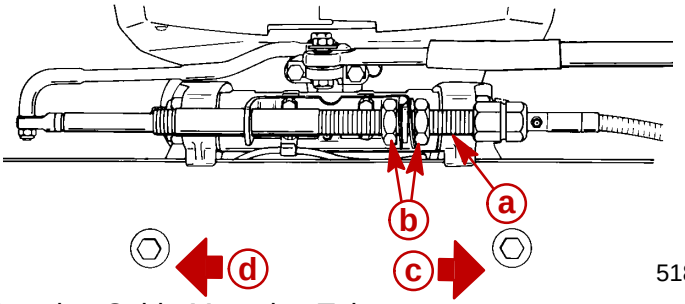


- **a** - Coupler
- **b** - Rubber Sleeve
- **c** - Steering Eye
- **d** - Rubber Bushing
- **e** - Jam Nut - Torque (Against Coupler) to 20 lb. ft. (27 Nm)
- **f** - Special Washer Head Bolt (10-849838) - Torque to 20 lb. ft. (27 Nm)
- **g** - Nylon Insert Locknut - Torque to 20 lb. ft. (27 Nm)
- **h** - 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.

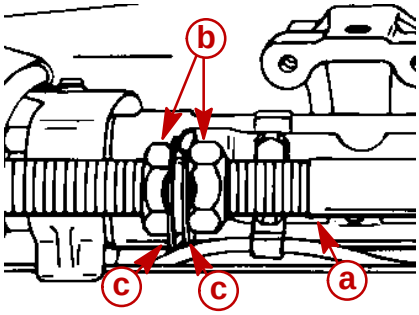
1. Loosen adjustment nuts and pull steering cable mounting tube (by hand) away from end of steering cable (to remove slack in steering system).
2. Tighten adjustment nuts against mounting bracket and check system for slack (play). If steering system is too tight, readjust tube toward end of steering 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

3. 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)

4. 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 outboards], 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.

5. Adjust trim tabs of both outboards, as outlined in **Trim Tab Adjustment.**

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 drive shaft 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.

   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.

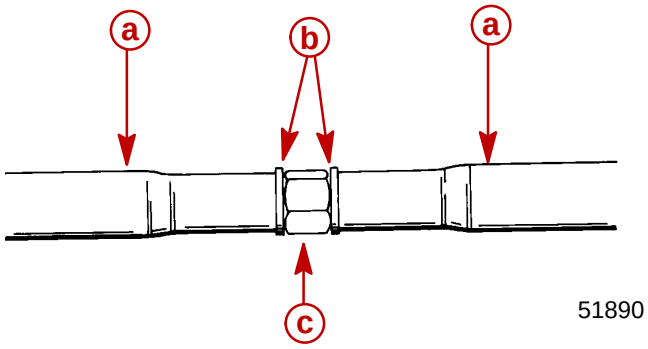
Ride Guide Steering Attachment Extension Couplers

Listed below are typical couplers available. Refer to the current Mercury/Quicksilver Accessory Guide for specific coupler lengths and part numbers.

Outboard Center Line Distance	Required Couplers 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.**

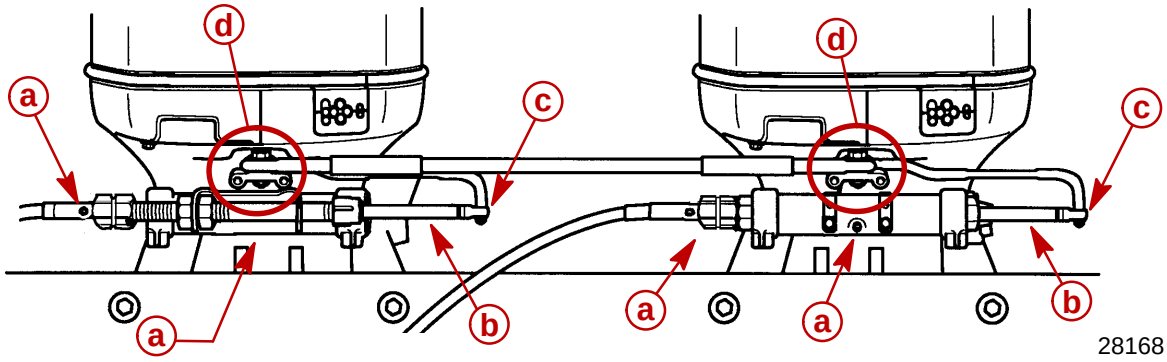
1. Carefully check steering system components for wear. Replace worn parts.
2. Check steering system fasteners to be sure they are torqued to correct specifications.

NOTE: *Ride-Guide Steering Cables are lubricated at the factory and require no additional lubrication at initial installation.*

⚠ WARNING

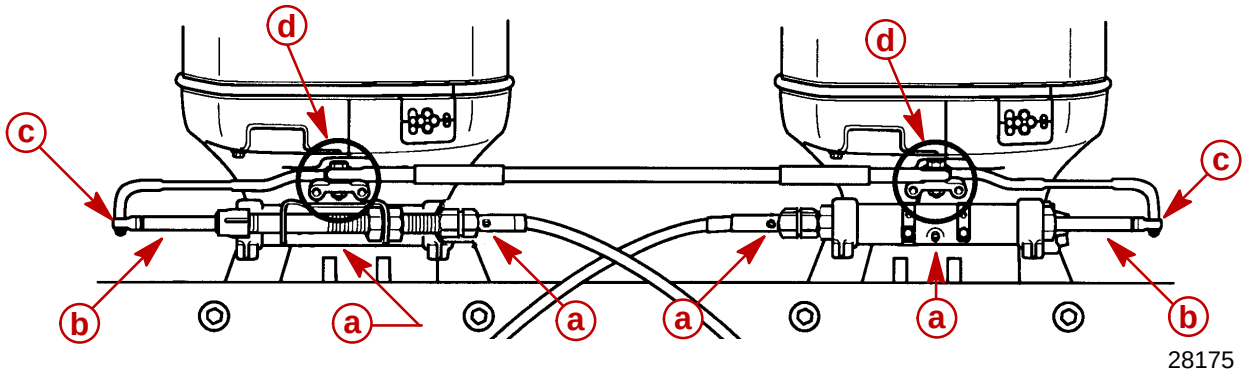
Core of each steering cable (transom end) must be fully retracted into cable housing before lubricating cable. If cable is lubricated while extended, hydraulic lock of cable could occur.

3. With core of Ride-Guide Steering Cable (transom end) fully retracted, lubricate transom end of steering cables through grease fittings with 2-4-C with Teflon. Lubricate exposed portion of cable ends with 2-4-C with Teflon.
4. Lubricate pivot points of steering link rods and ball joints of link rods/steering coupler with light oil.
5. Inspection and lubrication of steering head assembly (rotary or straight rack) should be performed once each year (by your Authorized Dealer) or whenever steering mount and/or steering head are disassembled, or if steering effort has increased. Lubricate with 2-4-C with Teflon.



28168

Lubrication Points for Parallel Cable Routing Installations



28175

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 with Teflon.
2. Place pivot block on pivot spacer and secure to transom bracket with 3/8 in. x 2-1/2 in. (9.5 mm x 63.5 mm) bolt, flat washer and locknut, as shown in Figure 1. Torque locknut to 20 lb. ft. (27 Nm).

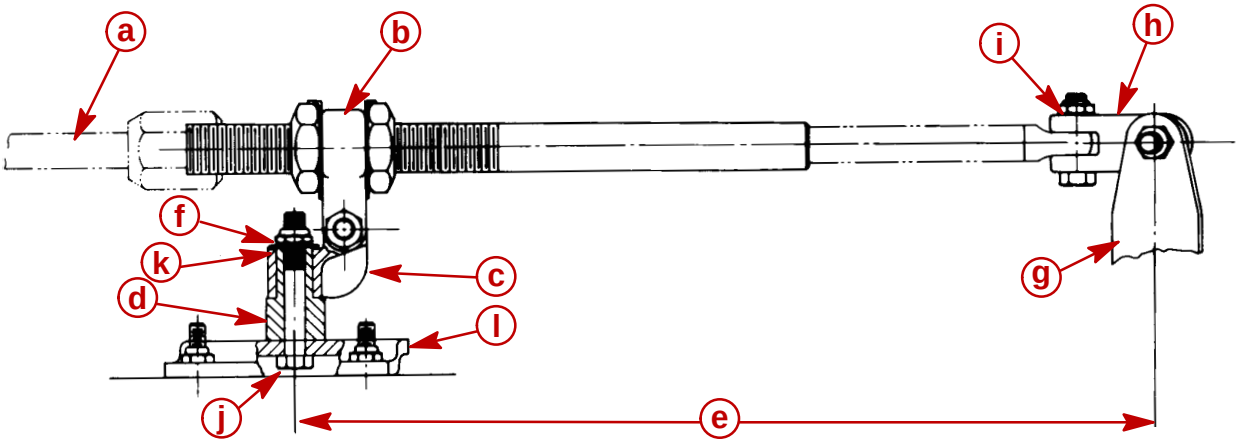


Figure 1

- **a** - Ride-Guide Cable
- **b** - Ride-Guide Yoke
- **c** - Pivot Block
- **d** - Pivot Spacer
- **e** - 15 in. (381 mm) (Centerline of Attaching Kit Pivot to Centerline of Outboard)
- **f** - Pivot Attaching Locknut [Torque to 20 lb. ft. (27 Nm)]
- **g** - Outboard Steering Arm
- **h** - Clevis Kit
- **i** - Ride-Guide Cable Attaching Locknut [Torque to 10 lb. ft. (13.5 Nm)]
- **j** - Bolt [3/8 in. x 2-1/2 in. (9.5 mm x 63.5 mm)]
- **k** - Flat Washer
- **l** - Transom Bracket

3. Place Ride-Guide yoke on pivot block and secure with 7/16 in. x 1-3/4 in. (11.1 mm x 44.5 mm) bolt and locknut, as shown in Figures 1 and 2. Torque locknut to 10 lb. ft. (13.5 Nm), **then back off 1/4-turn.**

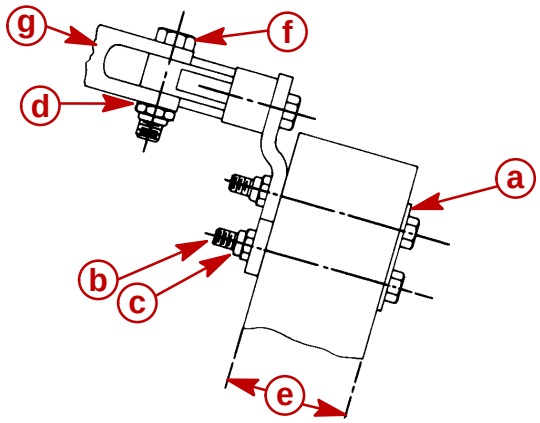


Figure 2

- **a** - Transom Backing Plate
- **b** - Bolt [5/16 in. x 3-1/4 in. (7.9 mm x 82.5 mm)]
- **c** - Locknut [Torque to 10 lb. ft. (13.5 Nm)]
- **d** - Ride-Guide Yoke Attaching Locknut [Torque to 10 lb. ft. (13.5 Nm) then back off 1/4-turn]
- **e** - 2-3/8 in. (60.3 mm) Maximum Transom Thickness
- **f** - Bolt [7/16 in. x 1-3/4 in. (11.1 mm x 44.5 mm)]
- **g** - Ride-Guide Yoke

4. Install one cable tube jam nut onto steering cable tube. Place tab washer over Ride-Guide yoke, then insert cable tube through tab washer and yoke. Install second cable tube jam nut onto cable tube but do not tighten at this time. (Figure 3)

5. Position transom attaching kit on transom as shown:
   a. Determine centerline of outboard, then measure 15 in. (38.1 cm) over from this centerline and draw a vertical line on transom. (Figure 1)
   b. Position attaching kit on transom so that **transom bracket is centered on the 15 in. (38.1 mm)** (Figure 1) at a height where the **center of Ride-Guide yoke is even with, or not more than 1/2 in. (12.7 mm)** above top edge of transom. (Figure 3)

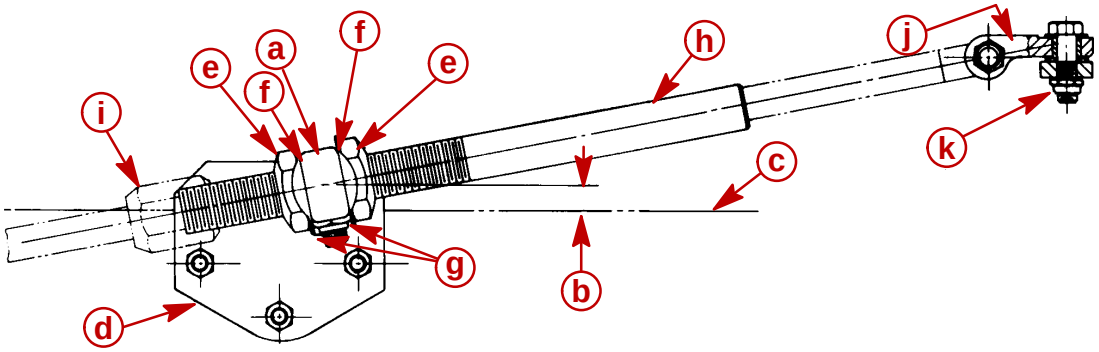


Figure 3

- **a** - Ride-Guide Yoke
- **b** - 0 in. to 1/2 in. (0 mm to 12.8 mm) (Center of Ride-Guide Yoke to Top of Transom)
- **c** - Top of Transom
- **d** - Transom Bracket
- **e** - Cable Tube Jam Nuts [Torque to 35 lb. ft. (47.5 Nm)]
- **f** - Tab Washer
- **g** - After Jam Nuts Are Torqued to Specification, Bend Locking Tabs against Nuts
- **h** - Cable Guide Tube
- **i** - Ride-Guide Cable Attaching Nut [Torque to 35 lb. ft. (47.5 Nm)]
- **j** - Clevis Kit
- **k** - Clevis Attaching Locknut [Torque to 20 lb. ft. (27 Nm)]

NOTE: *When drilling through transom, be sure 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 through 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 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 the 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 with Teflon.

NOTE: *Ride-Guide steering cable is lubricated at the factory and requires no additional lubrication at initial installation.*

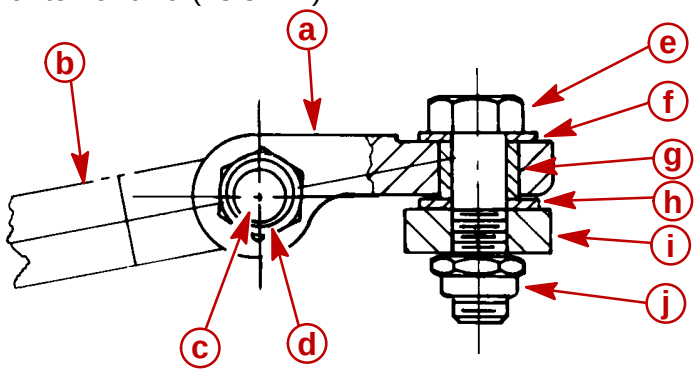
2. Lubricate all steering system pivot points (and exposed portion of steering cable core) with 2-4-C with Teflon. Lubricate at intervals specified preceding.
3. Carefully check the steering system components for wear (at intervals specified, preceding). Replace worn parts.
4. Check steering system fasteners (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 a* ***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 with Teflon, then secure clevis to steering cable with this bolt and a locknut. Torque locknut “d” to 10 lb. ft. (13.5 Nm).



a - Clevis
b - Steering Cable
c - Bolt [3/8 in. x 1-3/8 in. (9.5 mm x 34.9 mm)]
d - Clevis to Steering Cable Locknut [Torque to 10 lb. ft. (13.5 Nm)]
e - Bolt [3/8 in. x 1-1/4 in. (9.5 mm x 31.8 mm)] [Torque to 20 lb. ft. (27 Nm)]
f - Thin Washer [1/16 in. (1.6 mm) Thick]
g - Spacer
h - Thick Washer [1/8 in. (3.2 mm) Thick]
i - Engine Steering Arm
j - Clevis to Engine Locknut [Torque to 20 lb. ft. (27 Nm)]

3. Lubricate spacer (supplied with this kit) with 2-4-C with Teflon.
4. Attach clevis to top of outboard steering arm with a 3/8 in. x 1-1/4 in. (9.5 mm x 31.8 mm) bolt, thin washer, spacer, thick washer (thick washer must be installed between clevis and steering arm) and locknut, as shown. Torque bolt “e” to 20 lb. ft. (27 Nm), then torque locknut “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.