# Workshop Manual

## Sterndrive & Transom Shield

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| 2(2) |

**SX-A, DPS-A**

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# General Information



**Safety Messages**

⚠ **Before working on any part of a Volvo Penta sterndrive, be sure to read the Safety Messages that follow the Introduction. Pay special attention to safety messages that appear throughout the text.**

## Introduction

This service manual is divided into sections concerning various systems and assemblies. Refer to the Table of Contents to locate the section covering the system or assembly requiring service. Each chapter's title page has an additional listing that will describe the chapter's contents in more detail.

Since models are subject to change at any time, some images may not depict actual product.

This Workshop Manual contains technical specifications, descriptions, and instructions for the repair of the Volvo Penta products or product types described on the front cover of the manual. Check that you have the correct Workshop Manual for the product you are servicing.

## Safety Messages

In this manual, you will find the following signal words that call attention to a safety message or messages, and that designate a degree or level of hazard severity;

⚠ **DANGER! Indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

⚠ **WARNING! Indicates a hazardous situation which, if not avoided, could result in death or serious injury.**

⚠ **CAUTION! Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.**

⚠ This is a symbol that indicates a potential personal injury hazard. Closely follow all instructions to avoid injury.

In this manual, you will also find the following signal word that calls attention to a property damage message or messages;

***NOTICE!*** **Used to address practices not related to personnal injury, particularly damage to equipment or property.**

Below is a summary of the general risks involved and safety precautions you should always observe or carry out when operating or servicing the sterndrive. Risks specific to individual service procedures are also noted throughout the text of this manual.

**Sterndrive**

⚠ Propellers turning with engine power can cause serious injury. Make sure the engine can not start during work on propeller(s); remove ignition key(s), remove negative (-) battery cable and shift drive into forward or reverse (engage neutral safety).

⚠ Shift cables that come loose due to improper installation will result in loss of shift and boat control, which can result in serious injury or death. Use extreme care and closely follow instructions when re-attaching shift cables. At the drive end, the cable anchor must completely capture the shift cable and be securely attached to the pivot housing. The aft end of the cable must be securely fastened to the shift bracket. At the the shifter end, follow the shifter manufacturer's instructions for cable attachment.

Sterndrives are heavy and awkward to handle. To avoid injury, before beginning sterndrive removal, plan for supporting the sterndrive with a drive cart or overhead hoist before proceeding with removal. Secure the sterndrive to a drive cart or overhead hoist capable of supporting at least 500 lbs (227 kgs).

Upper and lower gear housings and other drive components are heavy and awkward to hold. To avoid injury secure the housings in the holding fixtures specified in the manual before beginning service. When removing lower housings from the drive, plan for supporting the weight when the attaching hardware is loosened.

When working on drives mounted to the transom shield, hands or fingers can be crushed or pinched by moving drive and transom shield components. Keep hands/fingers out of open spaces in the transom shield around the gimbal ring and pivot housing. Secure steering and power trim systems to prevent accidental turning or tilting of the drive during service.

Boat must be out of the water and safely supported on trailer or storage racks before removing sterndrive.

Protect hands from sharp edges of propeller blades by wearing gloves when removing or installing propellers.

Many service steps require the use of a press. Always follow the saftey guidelines published by the press manufacturer. Make sure all parts are safely supported, use the press tools specified in the manual and properly align all parts before beginning press operations.

Always use eye protection when carrying out work where there is a risk of splinters, grinding sparks, acid splashes, or where chemicals are used. The eyes are extremely sensitive: an injury could result in blindness.

Avoid getting oil on the skin. Repeated exposure to oil or exposure over a long period can result in the skin becoming dry. Irritation, dryness, and eczema and other skin problems may occur. From a health perspective, used oil is more dangerous than fresh oil. Use protective gloves and avoid oil soaked clothes and shop rags. Wash regularly, especially before eating. There are special skin creams which counteract drying out of the skin and make it easier to clean off dirt after work is completed.

Many chemicals used on the product (e.g., engine, transmission, gasoline, and diesel oils, and glycol), or chemicals used in the workshop (e.g., degreasing agents and solvents) are dangerous to health. Read the instructions on the product's packaging carefully. Always follow the safety precautions for the product (i.e., use protective mask, glasses, gloves, etc.). Make sure that other personnel are not exposed to hazardous chemicals (for example, in the air). Ensure good ventilation in the work place. Follow the instructions provided when disposing of used or leftover chemicals.

⚠ All fuels and many chemical substances used in the shop are flammable. Do not allow open flame or sparks in the vicinity. Fuel, certain thinner products, and hydrogen from batteries can be extremely flammable and explosive when mixed with air. Smoking is prohibited in the vicinity! Ensure the work area is well ventilated and take the necessary safety precautions before starting welding or grinding operations. Always ensure that there are fire extinguishers on hand when work is being performed.

Ensure that rags soaked in oil or fuel and used fuel or oil filters are stored safely. Rags soaked in oil can spontaneously ignite under certain circumstances. Environmentally dangerous waste products, such as used fuel and oil filters, used lubricating oil, contaminated fuel, paint remnants, solvents, degreasing agents, and waste from washing parts, must be eliminated at an approved disposal site.

⚠ Never work alone when removing heavy engine components or sterndrives, even when using lifting devices such as locking tackle lifts. When a lifting device is in use, two people are usually required to do the work: one to take care of the lifting device and the other to ensure that components are lifted clear and are not damaged during the lifting operations. If working onboard a boat, check before starting work to make sure there is enough room to carry out removal work without risking personal injury.

A clean work environment and a clean engine or sterndrive will eliminate many risks of personal injury.

These instructions are not in any way comprehensive, since it is impossible to predict every circumstance under which service work or repairs may be carried out. Volvo Penta can only indicate the risks considered likely to occur as a result of incorrect working methods in well equipped workshops using approved methods and tools tested by Volvo Penta.

**Engine and general**

This manual describes service procedures for the sterndrives listed on the cover. In the course of the repairs it may be necessary to operate or remove the engine to complete the service. The following are

general safety guidelines covering engines, they are not in any way comprehensive. Before removing or operating the engine consult the specific manuals for that engine, especially the Safety section(s).

⚠ Accidental or unintended engine starts can cause serious injury to the technician or others around the engine, sterndrive or boat. Immobilize the engine by turning off the power supply to the engine at the main switches and lock it (them) in the OFF position or by disconnecting the battery negative (-) lead. Post signage at all helm stations advising that the boat is being serviced.

⚠ Engine exhaust contains carbon monoxide, which is poisonous, odorless and hard to detect. Only operate the engine in a well-ventilated area. If operating the engine in an enclosed area, ensure that there is exhaust ventilation leading out of the engine compartment or workshop area to remove exhaust gasses and crankcase ventilation emissions. Install carbon monoxide detectors in enclosed areas where engines will be operated.

As a general rule, all service operations must be carried out with the engine stopped. However, some operations, such as certain engine adjustments, will require the engine to be running. Approaching an engine that is operating is a safety risk. Loose clothing or long hair may be caught in rotating parts and cause serious injury. If working in the proximity of an engine when it is operating, careless movements, or a dropped tool can result in personal injury. Take care to avoid contact with hot surfaces; e.g., exhaust pipes, turbocharger, air intake pipe, start element, etc.; and hot liquid lines and hoses on an engine which is running or which has just been stopped. Reinstall all protective parts removed during service operations before starting the engine.

Check that all safety labels on the product are always clearly visible. Replace labels which have been damaged or painted over.

Never carry out work on an engine or sterndrive suspended on a hoist without other supporting equipment attached.

Engines equipped with turbocharger: Never start the engine without installing the air cleaner filter. The rotating compressor in the turbo can cause serious personal injury.

Never use ether spray or similar starting fluid when starting the engine. They may cause an explosion in the inlet manifold.

Avoid opening the filler cap for engine coolant systems (freshwater cooled engines) when the engine is still hot. Steam or hot coolant can spray out. Open the filler cap slowly and release the pressure on the system. Take great care if a cock, plug, or engine coolant line must be removed from a hot engine. Steam or hot coolant can spray out in any direction.

Hot oil can cause burns. Avoid getting hot oil on the skin. Ensure that the lubrication system is not under pressure before carrying out any work. Never start or operate the engine with the oil cap removed; otherwise, oil could be ejected.

Stop the engine and close the sea cock before carrying out operations on the engine cooling system.

Exercise extreme care when leak detecting on the fuel system and testing the fuel injector jets. Use eye protection. The jet from a fuel injector nozzle is under extremely high pressure and has a great

penetrative energy, so the fuel can penetrate deep into the body tissue and cause serious personal injury.

⚠ Never expose a battery to open flame or sparks. Never smoke in the proximity of batteries. The batteries give off hydrogen gas during charging which, when mixed with air, can form an explosive gas - oxyhydrogen. This gas is easily ignited and highly volatile. Incorrect connection of the battery can cause an explosion with resulting damage. Do not cross the connections when attempting to start the engine (spark risk) and do not lean over any of the batteries.

Always use protective goggles when charging the batteries or making battery connections. Battery electrolyte contains sulfuric acid, which is highly corrosive. If the battery electrolyte comes into contact with unprotected skin, wash immediately with plenty of water and soap. If battery acid comes in contact with the eyes, immediately flush with plenty of water and obtain medical assistance at once.

To prevent sparks which can ignite fumes, turn off the engine and turn off all electrical power at the main switch, or disconnect the battery negative (-) lead, before carrying out work on the electrical system.

⚠ Contact with AC current can be fatal. Take extra precautions when working on boats with AC systems. Completely disconnect the system when making any repairs where the work could come permit contact with the AC system. Make sure the boat AC system is connected to a proper and tested ground.

Use the lifting eyes fitted on the engine/reverse gear when lifting the unit. Always check that the lifting equipment used is in good condition and has the load capacity to lift the engine (engine weight including reverse gear and any extra equipment installed).

Use an adjustable lifting beam or one designed specifically for the engine to raise the engine to ensure safe handling and to avoid damaging engine parts installed on the top of the engine. All chains and cables should run parallel to each other and as perpendicular as possible in relation to the top of the engine.

If extra equipment is installed on the engine, which alters its center of gravity, a special lifting device is required to obtain the correct balance for safe handling.

The components in the electrical system, in the ignition system (gasoline engines), and in the fuel system on Volvo Penta products are designed and manufactured to minimize the risk of fire and explosion. Do not substitute automotive or other non-approved non-marine parts for these components.

Carefully observe the safety alert symbols shown for dangers, warnings, and cautions exactly as described. They warn you of possible dangers or important information contained in this manual.

# General Service Information

**About this Workshop Manual**

The working methods described in the Workshop Manual apply to work carried out in a workshop.

The Workshop Manual is produced primarily for the use of Volvo Penta workshops and service technicians. For this reason the manual assumes a basic knowledge of marine propulsion systems and that the user can carry out the work described to a general standard of engineering competence.

This Workshop Manual contains technical specifications, descriptions and instructions for the repair of the sterndrives listed on the cover. Always include the model designation and the serial number in all correspondence.

Volvo Penta products are under a continual process of development; therefore, we reserve all rights concerning changes and modifications. All the information in this manual is based on product specifications available at the time of printing. Any changes or modifications introduced into production or updated or revised service methods introduced after the date of publication will be provided in the form of Service Bulletins.

**Special Tools**

All operations described in the Workshop Manual for which there are Volvo Penta special tools available assume that these tools are used by the service technician or person carrying out the repair. Volvo Penta special tools have been specifically developed to ensure as safe and rational working methods as possible. It is, therefore the responsibility of the person or persons using tools other than Volvo Penta special tools or approved Volvo Penta working methods (as described in a Workshop Manual or Service Bulletin), to acquaint themselves of the risk of personal injury or actual mechanical damage or malfunction that can result from failing to use the prescribed tools or working methods.

In some cases, special safety precautions and user instructions may be required to use the tools and chemicals mentioned in the Workshop Manual. Always follow these precautions as there are no specific instructions given in the Workshop Manual.

Special service tools have been specially designed to simplify some of the disassembly and assembly operations. These tools are illustrated in this Service Manual, in many cases in actual use. All Volvo Penta special tools can be ordered from Volvo Penta Parts**.** Individual purchasers of Service Manuals must order Special Tools through an authorized dealer.

By following these basic recommendations and using common sense, it is possible to avoid most of the risks involved in the work.

**Tightening Torques**

The correct tightening torques for critical joints which must be tightened using a torque wrench are listed under Technical Data: Tightening Torques and stated in the method descriptions in the Workshop Manual. All tightening torques apply to cleaned threads, bolt heads, and mating surfaces. Tightening torques stated are for lightly oiled threads. Where grease, locking, or sealing agents are required for screwed joints, it is so stated in both the operation description and in Tightening Torques. Where no tightening torque is stated for a joint use, refer to Volvo Penta's General Information manual (P/N 7731073-8) for information on tightening torques. The

tightening torques stated are a guide and the joint does not have to be tightened using a torque wrench.

**Lock Nuts**

Do not reuse lock nuts that have been removed during disassembly operations, since they have reduced service life when reused. Use new nuts during assembly or reinstallation. For a lock nut with a plastic insert (such as Nylock® nut) that has the same head height as a standard hexagonal nut without plastic insert, reduce the tightening torque by 25% for bolt size 8mm or larger. Where Nylock® nuts are higher, or of the same height as standard hexagonal nut, the tightening torques given in Volvo Penta's General Information manual apply.

Exceptions;

- Forward prop nut on DPS-A, good for 50 uses
- Spirallock nuts securing upper to lower housings, good for 50 uses

**Sealant**

A number of sealants and locking liquids are used on the sterndrives. The agents have varying properties and are used for different types of jointing strengths, operating temperature ranges, resistance to oil and other chemicals, and for different materials and gap sizes.

To ensure service work is correctly carried out, it is important that the correct sealant and locking fluid type is used on the joint where the agents are required.

The manual will indicate the proper sealants and locking liquids where applicable, at the beginning of each chapter and in the text where the chemical is used.

During service operations use the same agent or an alternative from a different manufacturer.

Make sure that mating surfaces are dry and free from oil, grease, paint, and anti-corrosion agents before you apply sealant or locking fluid. Always follow the manufacturer's instructions for use regarding temperature range, curing time, and any other instructions for the product.

In all cases, old sealants may be removed by using methylated spirits.

**Product References, Illustrations & Specifications**

Volvo Penta reserves the right to make changes at anytime, without notice, in specifications and models and also to discontinue models. The right is also reserved to change any specifications or parts at any time without incurring any obligation to equip same on models manufactured prior to date of such change. All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of printing. The right is reserved to make changes at anytime without notice.

All photographs and illustrations used in this manual may not depict actual models or equipment, but are intended as representative views for reference only. The continuing accuracy of this manual cannot be guaranteed.

**Good Service Practice**

Service required for this product is generally one of three kinds:

- **Normal care and maintenance** - which includes putting a new sterndrive into operation, storing sterndrives, lubrication, and care under special operating conditions such as salt water and cold weather.

- **Operating malfunctions** - due to improper engine or drive mounting, propeller condition or size, boat condition, or the malfunction of some part of the sterndrive. This includes sterndrive servicing procedures to keep the sterndrive in prime operating condition.
- **Complete disassembly and overhaul** - such as major service or rebuilding a unit.

It is important to determine before disassembly just what the trouble is and how to correct it quickly, with minimum expense to the owner.

When repairing an assembly, the most reliable way to ensure a good job is to do a complete overhaul on that assembly, rather than just to replace the bad part. Wear not readily apparent on other parts could cause a malfunction soon after the repair job. Repair kits and seal kits contain all the parts needed to ensure a complete repair, to eliminate guesswork, and to save time.

Repair time can also be minimized by the use of special tools. Volvo Penta Special Tools are designed to perform service procedures unique to the product that cannot be completed using tools from other sources. They also speed repair work to help achieve service flat rate times. In some cases, the use of substitute tools can damage the part.

**Preparation for Service**

Proper preparation is extremely helpful for efficient service work. A clean work area at the start of each job will minimize misplaced tools and parts. Obtain tools, instruments and parts needed for the job before work is started. Interrupting a job to locate special tools or repair kits is a needless delay.

**Clean Workspace**

A clean work environment and a clean engine or sterndrive will eliminate many risks of personal injury and engine malfunction.

Clean a sterndrive that is excessively dirty before work starts. Cleaning will occasionally uncover trouble sources.

Above all, when working on the fuel system, engine lubrication system, air intake system, turbocharger unit, hydraulic systems or bearing seals it is extremely important to observe the highest standards of cleanliness and avoid dirt or foreign objects entering the parts or systems, since this can result in reduced service life or malfunctions.

**Replacement Parts**

Replacement parts for the sterndrive are subject to various national safety requirements, for example the United States Coast Guard Safety Regulations. When replacement parts are required, always use genuine Volvo Penta parts, or parts with equivalent characteristics, including type, strength, and material.

Volvo Penta original spare parts meet these specifications. Any type of damage, resulting from the use of replacement parts that are not original Volvo Penta spare parts for the product being serviced, will not be covered under any warranty or guarantee provided by Volvo Penta.

Failure to use the correct part may result in possible injury to the operator and/or passengers and product malfunction.

**Parts Catalogs**

Parts Catalogs contain exploded views showing the correct assembly of all parts, as well as a complete listing of the parts for replacement. These catalogs are helpful as a reference during disassembly and reassembly. They are available on Volvo Penta's Electronic Parts Catalog (EPC) and as printed books.

**Strength Classes**

Bolts and nuts are divided into different classes of strength; the class is indicated by the number on the bolt head. A high number indicates stronger material; for example, a bolt marked 10-9 indicates a higher strength than one marked 8-8. It is important that bolts removed during the disassembly of a bolted joint must be reinstalled in their original position when you reassemble the joint. If a bolt must be replaced, check in the replacement parts catalog to make sure the correct bolt is used.

**Service Policy**

It is a policy to provide dealers with service knowledge so they can give professional service demanded by today's consumer. The Volvo Penta Training Centers, frequent mailing of Service Bulletins, Letters and Promotions, Special Tools and this Service Manual represent our continuing efforts to assist dealers in giving consumers the best and most prompt service possible. If a service question does not appear to be answered in this manual, you are invited to write to the Volvo Penta Service Department for additional help. Always be sure to give complete information, including engine or sterndrive model number and serial number.

Be sure that you are familiar with the warranty statement supplied with the product. If you have any questions, write the Volvo Penta Service Department. If other than genuine Volvo Penta replacement components or parts are used, subsequent warranty claims involving that engine or sterndrive may be refused.

When a brand-name product or specific tool is called for, another item may be used. However, the substitute must have equivalent characteristics, including type, strength, and material. You must determine if incorrect substitution could result in product malfunction and personal injury to anyone. To avoid hazards, equivalent products which are used must meet all current U.S. Coast Guard Safety Regulations and ABYC standards.

**Care of the Environment**

Bear in mind that most of the chemicals used around boats are harmful to the environment if used incorrectly. Volvo Penta recommends the use of biodegradable degreasing agents for all cleaning of components unless otherwise stated in the Workshop Manual. When working aboard a boat, make a special point of preventing oil waste water from washing components entering the bilge; instead, remove all such waste for safe disposal at an approved site.

We would all like to live in a clean and healthy environment—somewhere where we can breathe clean air, see healthy trees, have clean water in our lakes and oceans, and are able to enjoy the sunshine without being worried about our health. Unfortunately, this cannot be taken for granted nowadays; we must work together to achieve this vision.

As a manufacturer of marine engines, Volvo Penta has a special responsibility, where care of the environment is a core value in our product development. Today, Volvo Penta has a broad range of engines on which progress has been made in reducing exhaust emissions, fuel consumption, engine noise, and other detrimental side-effects. We hope you will take care in preserving these qualities.

Always follow any advice given in the manual—concerning fuel grades, operation, and maintenance procedures—and you will avoid unnecessarily harming the environment.

Remember to always leave hazardous waste such as waste oil, coolant, paint and wash residue, flat batteries, and other toxic disposables at a suitable disposal site or destruction plant.

Our joint efforts will make an invaluable contribution to our environment.

# Painting

### Painting the Sterndrive or Transom Shield

1. Remove all marine growth.
2. Remove all loose paint and corrosion by sanding or sandblasting. If sandblasting, use an aluminum oxide blasting media with a particulate size of 0.008-0.028 in. (0.2-0.7 mm).
3. Remove all trace of grease and wash with hot water and detergent. Roughen all painted surfaces with medium 3M Scotchbrite pad. Rinse thoroughly with water.
4. Treat any bare aluminum with chromate conversion coating. Clean the entire area with an acid cleaner that does not contain fluoride, such as DuPont5717. Scrub the surface with 3M Scotchbrite pad until it is completely “wetted” with no beads of water.

***NOTICE!*** **Fluoride in a cleaner causes a “smut” (dark discoloration on silicon-alloy aluminum castings), and paint will not stick to “smut”. If this happens, sand the surface and start over using a different acid cleaner.**

***NOTICE!*** **Do not use steel wool. Small pieces of steel wool become embedded in the aluminum and will cause severe corrosion.**

5. Rinse thoroughly with water. The area must appear “wetted” or the surface is not clean, and paint will not adhere.
6. While the surface is still wet from rinsing, treat all bare aluminum with DuPont 226S chromate conversion solution. Brush the chromate solution as required for 2 to 5 minutes to prevent it from drying on the surface. Rinse the surface thoroughly with water and allow to air dry. Follow the label instructions exactly.
   - — If the chromate is allowed to dry anywhere on the bare aluminum surface, chromic acid salts will form which will prevent paint adhesion and promote corrosion. Sand the surface to bare metal.
   - — It is best to let the part air dry, but if you must wipe the surface to speed up drying, use lint free wipes not treated with anything that may contaminate the surface. Do not scrub the surface, wipe very lightly.
   - — Do not blow dry with shop air unless it is completely free of dirt, oil, and water.
   - — Do not heat the part above 150°F, before painting.
   - — Do not touch the treated surface with bare bands before painting.
   - — The part should be primed soon after it dries, or at least within 24 hours.
7. Where the prime coat is thin or where the surface is unpainted, prime with Volvo Penta Primer or PPG epoxy primer. Do not apply primer over hard finish coat. Primer solvents must be allowed time

to evaporate and the primer must harden before applying the finish coat. Allow 8 to 12 hours drying time.

8. Apply finish coat. The parts catalogs list numbers for finishing products.

**Paints for Sterndrives and Transom Sields**

See the parts catalog for the model in question for the part numbers for paint for the engine, transom bracket or sterndrive. Paint may be obtained from Volvo Penta Parts.

**Recommendations for Antifouling Paints**

**All antifouling paints that prevent marine growth are poisonous and may harm our marine environment.**

The legislation concerning antifouling paints is constantly changing.

In general, the legislation is or will be considerably more restrictive as far as the allowed leakage of the active ingredients in the paint to the water is concerned. Several countries have put into practice (or will put into practice) a more restrictive legislation for pleasure boats than for commercial boats and vessels.

Since the protection of the environment is in the best interests of all concerned, it is important to minimize the use of antifouling paints. Always take care to find out the valid legislation in the area where you intend to use the boat prior to starting the treatment of the boat.

***NOTICE!*** **It may be completely forbidden to use antifouling paints on pleasure boats in some locations.**

**Painting the Sterndrive or Transom Shield with Antifouling Paint**

***NOTICE!*** **On the sterndrive and transom assembly, only use antifouling paint that is specifically designed for aluminum sterndrives.**

Clean the sterndrive carefully. Degrease and flush thoroughly with water. Sand the surface with a water-abrasive paper (grit size 200-240). Make sure not to sand through the original paint of the sterndrive. Damage to drive paint must be carefully repaired with primer and paint. Pure metal must be cleaned prior to the application of primer. Make sure to let the primer and paint harden in accordance with the manufacturer's instructions. Mask the hull around the transom bracket and spots on the sterndrive which are not to be painted.

***NOTICE!*** **Do not paint the anodes.**

***NOTICE!*** **Make sure that you have a good contact between the anodes and the transom bracket or sterndrive. Prior to launching the boat, the anodes must be cleaned (activated) with emery cloth in order to remove the oxide layer. Never use a steel brush when cleaning. The steel brush reduces the galvanic protection.**

**Painting the Hull with Antifouling Paint**

Always follow the manufacturer's instructions. When making the purchase, make sure that you receive the correct product meeting the legislation prevailing in the area where you are going to use the boat. The product must contain the correct properties for the boat hull type. Make sure to prepare the hull in accordance with the directions of the paint manufacturer.

***NOTICE!*** **Leave a 1 in. (25 mm) strip unpainted around the transom bracket AND all metal thru-hull fittings.**

**Contact with bottom paint may cause sever corrosion of the transom and sterndrive assembly.**

## Storage and Maintenance

**Off-Season Storage Preparations**

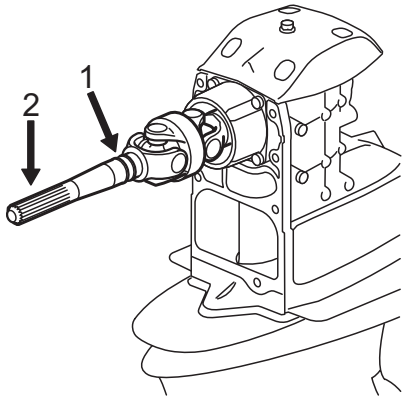
1. **Change** sterndrive lubricant (oil). See sections titled Chapter 2.
2. **Inspect** bellows for wear or leaks. See section titled “Bellows” in “Transom Shield” chapter.
3. **Inspect** sterndrive water pickup screens for obstructions.
4. See **Engine** service manual for additional engine off-season storage procedures.

**Preparation for Boating After Storage**

1. Check drive oil for proper level. Correct as needed. See section titled “Checking Gear Oil Level” in chapter 2.
2. If oil was not replaced before storage, replace before use. See sections titled “Draining Oil from Sterndrive” and “Filling Sterndrive with Oil” in chapter 2.
3. Inspect the bellows when preparing your boat for use after storage. Replace as needed or at least every second year. See section titled “Bellows” in “Transom Shield” chapter.
4. Inspect anodes for proper size. Replace as needed. See section titled “Anodes” in chapter 2.
5. See **Engine** service manual for engine specific information.

**Every other year (every 24 months)**

**Lubricate universal joint splines**




1. Remove sterndrive to lubricate the universal joint shaft splines. See section titled “Sterndrive Removal” in chapter 2.
2. Wipe grease and debris off u-joint shaft and coupler splines Thoroughly clean splines.
3. Replace o-rings (1), apply gear oil to the o-rings.
4. Lubricate splines (2) with Moly Lube™ grease or equivalent.
5. Check engine alignment. Correct if needed.
6. Replace u-joint bellows and clamps.
7. Re-install sterndrive. See section titled “Sterndrive Installation” in chapter 2.

See parts catalogs for part numbers.

## Periodic Maintenance Chart

| Service Point | Every 50 Hours or as Specified | Every 2 Years or as Specified | Recommendations |
|---|---|---|---|
| Gimbal Bearing | No service required,<br>replace if worn or damaged | No service required,<br>replace if worn or damaged | N/A |
| Trim/Tilt Pump, System | No service required<br>Check if trim/tilt performance is poor<br>Check for leaks and proper operation | No service required<br>Check if trim/tilt performance is poor<br>Check for leaks and proper operation. | Use Volvo Penta Power Trim/Tilt and Steering Fluid |
| Sterndrive, gear oil | Drain and refill every **100** hours or once a year.<br>Check level frequently during boating season [1)] | N/A | Use Volvo Penta Synthetic GL-5 Gear Lubricant<br>SAE 75W-90 |
| U-Joint, Shaft Splines | N/A | Remove drive<br>Inspect shaft for wear<br>Lubricate shaft<br>Inspect for correct alignment, correct if needed<br>Replace both bellows when re-installing drive | Use Moly Lube® or equivalent |
| Bellows, u-joint | Check for damage, leaks<br>Check, tighten clamps | Replace bellows during u-joint inspection. | See instructions in Transom Shield section of this manual |
| Bellows, exhaust | Check for damage, leaks<br>Check, tighten clamps | Reaplce bellows during u-joint inspection. | See instructions in Transom Shield section of this manual |
| Anodes | Visual Inspection<br>Replace if eroded more than 30% [2)] | N/A | See Parts Catalog |
| Propeller Shafts, Propeller Hubs | Check for damage, corrosion<br>Lubricate shaft | N/A | Use Volvo Penta grease 828250 |

1. Check at least once per month, if possible. Oil level and condition checks are the best way to catch sterndrive problems before serious damage occurs.

2. Check the parts catalog for correct replacement anode part numbers. Use the correct anode material, based on where the boat will be used;

Aluminum for brackish water, if the type of water is unknown or the boat is used in several types of water.

Zinc for salt water

Magnesium for fresh water

# NOTES

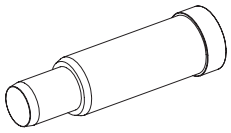
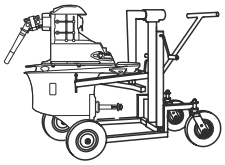
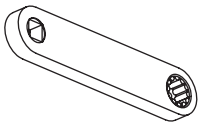
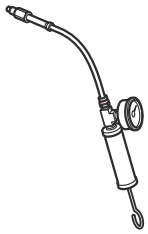
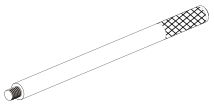
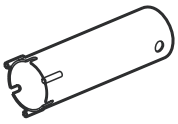
# Sterndrive, General Information



## Safety Messages

Before working on any part of a Volvo Penta sterndrive, read the section called “Safety Messages” in the first chapter of this manual.

## Special Tools

| Tool Name | Part No. | View | Tool Name | Part No. | View |
|---|---|---|---|---|---|
| Alignment Tool | 3851083 |  | Propeller Tool Rear | 3862808 |  |
| Drive Cart “Solo” | 9990001 |  | Wrench | 3849655 |  |
| Pressure Tester | 3810152 |  | Handle | 3850609 |  |
| Propeller Tool Front | 3862797 |  | | | |

**Volvo Penta Service Tools** All tools by Volvo Penta are listed in text by name and **part number.**

**Sealants, Lubricants and Adhesives**

Volvo Penta GL5 Synthetic gear lubricant, 75W90

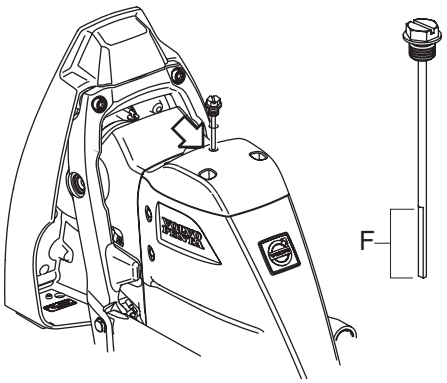
Gasket sealing compound, white, (Locktite™ PST or 565, or equivalent).

Volvo Penta grease p/n **828250**

## Sterndrive Lubrication

### Checking Gear Oil Level

***NOTICE!*** **Improper oil level, under- or overfilled, can result in serious internal sterndrive damage. Check lubricant (oil) level in sterndrive whenever possible.**




Check at least once per month.
Oil level and condition checks are the best way to catch sterndrive problems before serious damage occurs.

Oil level dipstick is located at the top of the sterndrive.
Loosen hexnut to check oil.
Hand tighten dipstick fully into hole, then remove.
Check oil level on dipstick. Oil should show on flat portion (F) of dipstick.
If oil level is low, add small amounts through dipstick opening until oil is at proper level.
If oil level is too high, remove oil until oil is at proper level.
See “Draining Oil from Sterndrive” procedure below.

Check o-ring on dipstick. Replace if needed. Check parts catalog for part numbers. Torque dipstick to 48-72 in. lb (5,4-8,1 N.m).

During oil level check, inspect oil for signs of water intrusion. The oil should be amber in color. Milky looking oil indicates water mixed with the oil. If present find cause and repair before operating drive.

Also check for metal or other debris in oil. If present find cause and repair before operating drive.

**Sterndrive Oil Capacity**

**All SX-A Models;**

**Capacity = 90 oz. (2650ml)**

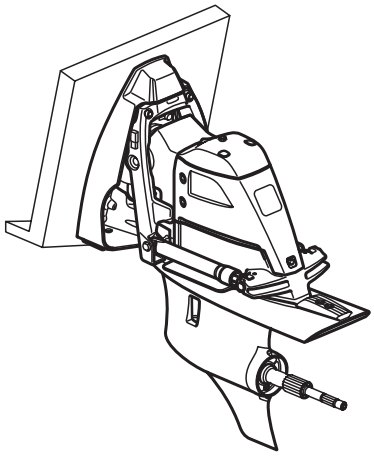
**All DPS-A Models;**

**Capacity = 83 oz. (2450ml)**

***NOTICE!*** **Quantities provided above are for initial fill of new, empty sterndrive. Quantity required for re-fill during service may be different. Always use dipstick to determine correct fill, see procedure above.**

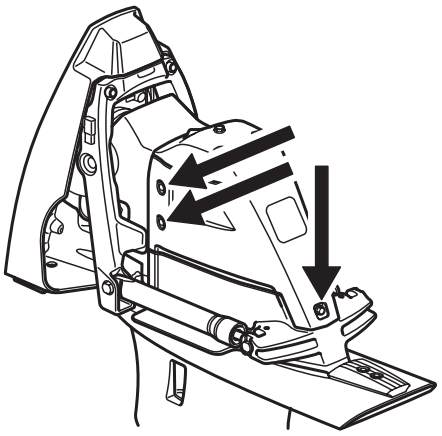
***NOTICE!*** **If your drive is equipped with a 1” drive extension, you will need to add more oil than the recommended amount. Always use dipstick to determine correct fill, see procedure above.**

**Draining Oil from Sterndrive**



Oil drain plug is located in bearing housing in front of propellers.

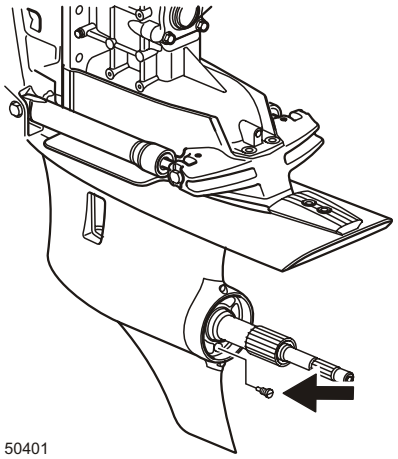
1. Remove propeller(s). See section on “Propeller Removal”.
2. Trim sterndrive to full down position.



3. Remove shift cover. Use 12mm socket, rachet

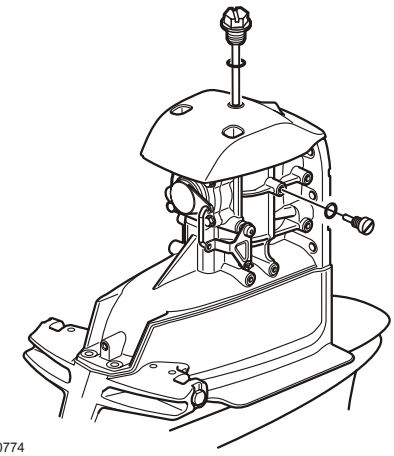
4. Place a 4 quart or larger drain pan under lower gearcase skeg to catch oil.

***NOTICE!*** **Clean area around plugs before removing plugs. Debris in oil can damage sterndrive.**



50401

5. Remove oil drain plug.
   Discard o-ring.



50774

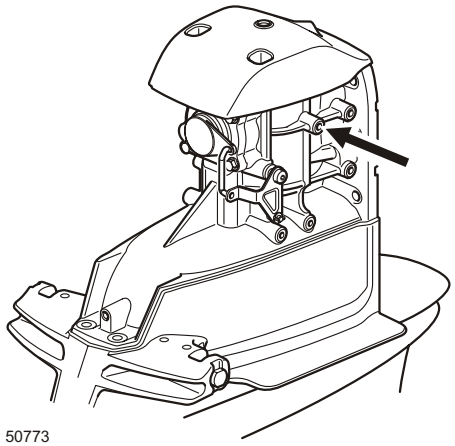
6. Remove oil level plug (side of drive).
   Discard o-ring.
7. Remove dipstick (top of drive).
   Discard o-ring.

Removing dipstick and oil level plug vents sterndrive so oil will drain completely

8. Check magnets on plugs for metal.
   A very fine metal powder on magnet is normal wear. Larger particles, that can be felt between your fingers, indicate problems with metal parts in sterndrive.
   Find cause and repair before operating drive.

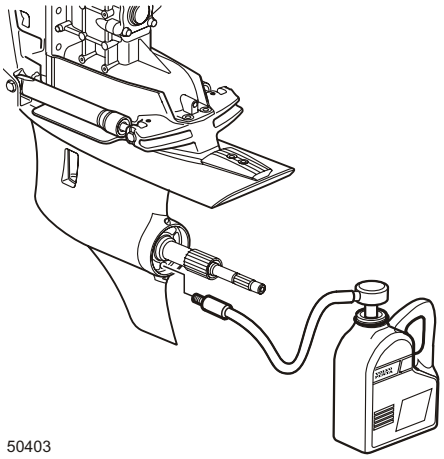
***NOTICE!*** **Dispose of used oil and all oil soaked shop materials according to local laws and regulations.**

### Filling Sterndrive with Oil



50773

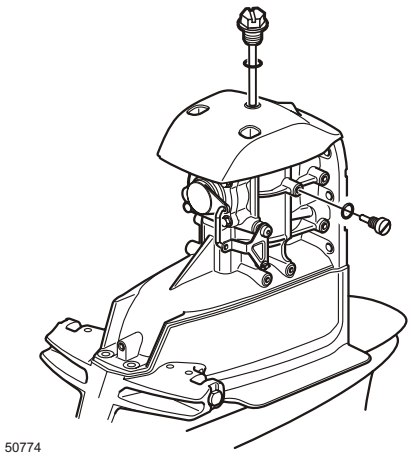
1. When filling drive, proper oil level is determined by filling drive with oil until oil appears at oil level hole on starboard side.



50403

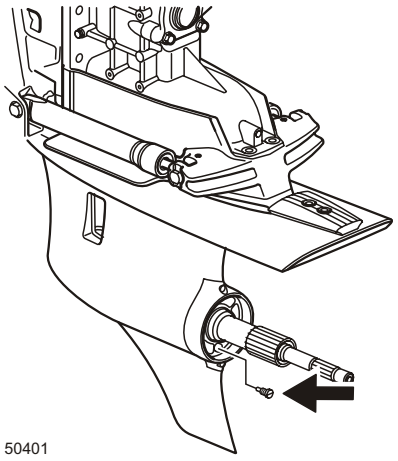
2. Fill with Volvo Penta GL5 Synthetic Gear Lubricant, SAE 75W-90. Use pump with 3/8-16 UNC threaded fitting to fill sterndrive through oil drain hole.
   Fill slowly to purge air.
   Sterndrive is properly filled when oil appears at oil level hole.

***NOTICE!*** **Filling sterndrive too quickly may form air pockets that will cause an inaccurate oil level reading. Running the sterndrive with improper oil level can result in serious internal sterndrive damage.**



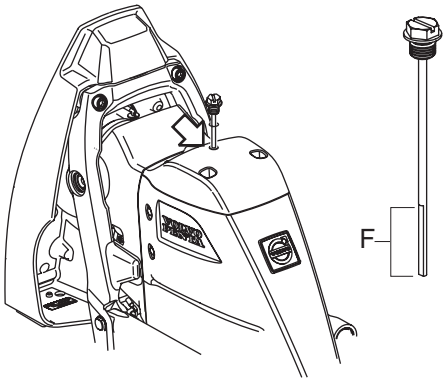
50774

3. When oil is filled to oil level hole, install and hand tighten dipstick and oil level plug (this prevents excessive oil loss when pump is removed from drain hole).
   Make sure new o-rings are installed and seated correctly on plugs and dipstick.



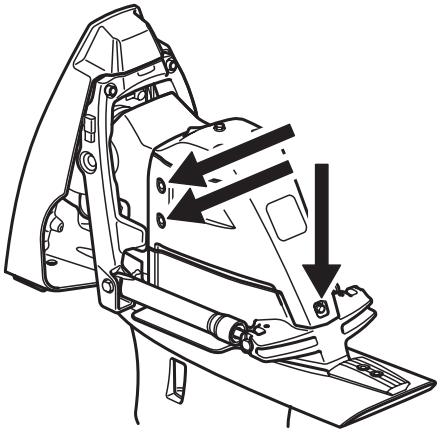
50401

4. Remove pump, then quickly install oil drain plug.
   Make sure o-ring is installed and seated correctly on plug.
   Hand tighten drain plug.




5. Check oil level with dipstick. Oil should show on flat portion of the dipstick. Add oil if required, through the dipstick hole.

6. When oil level is correct;
   Torque drain and oil level plugs to 60-84 in. lb. (6,8-9,5 N.m).
   Torque dipstick to 48-72 in. lb (5,4-8,1 N.m).
7. Install shift link access cover.
   Use 12mm socket and rachet to hand tighten five screws, then torque to 13-17 ft.lbs (17-23N•m)



***NOTICE!*** **After oil change, check level with dipstick before operating drive.**

If oil has been completely changed, oil level must be rechecked after unit has been **briefly** run to purge trapped air. Add oil through dipstick opening to bring oil up to proper level.

**Alternate Fill Procedure**

If you cannot fill drive unit through oil drain plug, you can fill drive by triming drive up a few degrees and adding oil through oil level plug. When oil is at oil level plug hole, reinstall oil level plug, and place drive in down position. Check oil level with dipstick. Oil should show on flat portion of dipstick. Add oil if required, through dipstick hole.

This alternate fill method is slow and you must be careful not to trap air in drive. Oil level must be rechecked after unit has been **briefly** run to purge trapped air. Several cycles may be needed to obtain proper oil level.

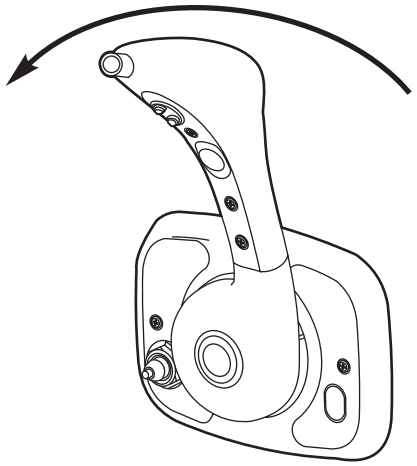
## Propeller Removal

A rubber hub in the propeller is the shock absorber that minimizes impact damage to the sterndrive and engine. If the hub slips, it should be replaced. The hub should be replaced by a reputable propeller shop.

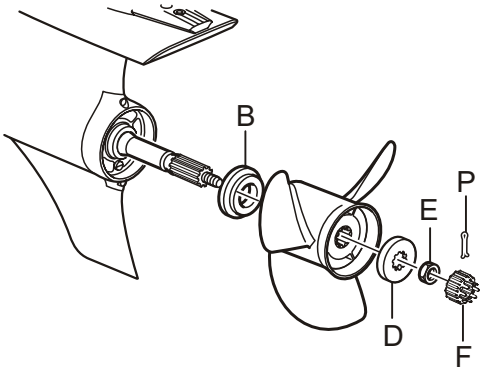
⚠ **WARNING! Propellers turning with engine power can cause serious injury. Make sure the engine can not start during work on propeller(s); remove ignition key(s) and shift drive into forward or reverse.**

⚠ **CAUTION! Protect hands from sharp edges of propeller blades by wearing gloves when removing or installing propellers.**

**SX**

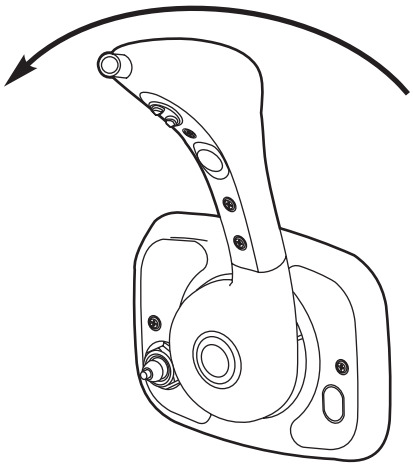


1. Shift the sterndrive into **forward** to lock the propeller shaft.

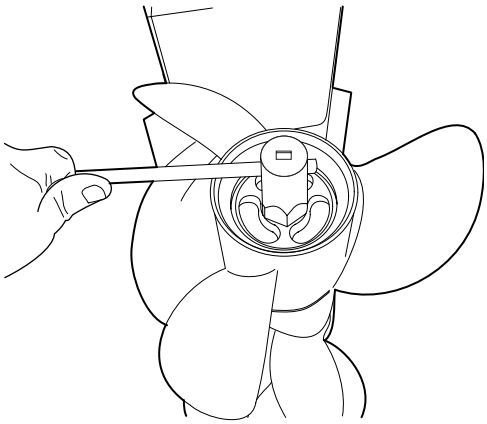



2. Remove the cotter pin (P) and keeper (F).
3. Remove the propeller nut (E) using a 1-1/16 wrench.
4. Remove the thrust washer(D), propeller, and thrust bushing (B).
5. Clean the propeller shaft. Inspect for fishing line or other debris; remove if present.

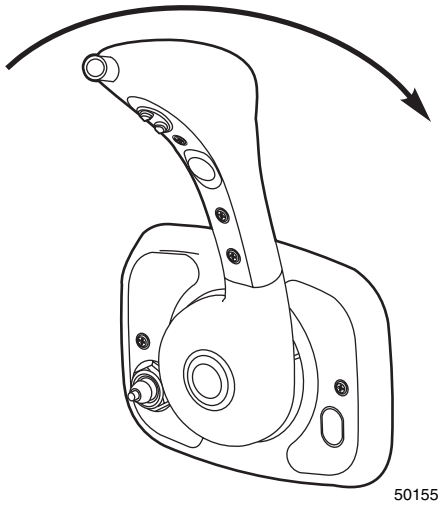
**DPS**



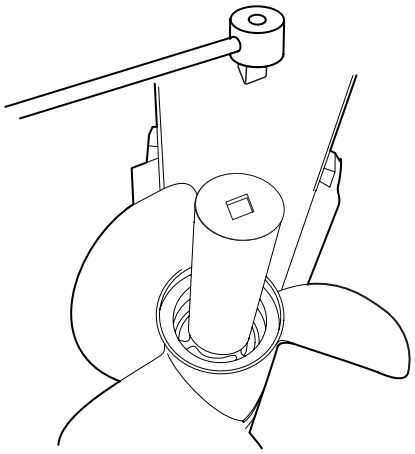
1. Shift the sterndrive into **forward** to lock the propeller shaft.



2. Use propeller tool **3862808** or 30 mm socket and rachet to remove rear propeller nut.
   Remove rear propeller.




3. Shift the sterndrive into **reverse** to lock the propeller shaft.



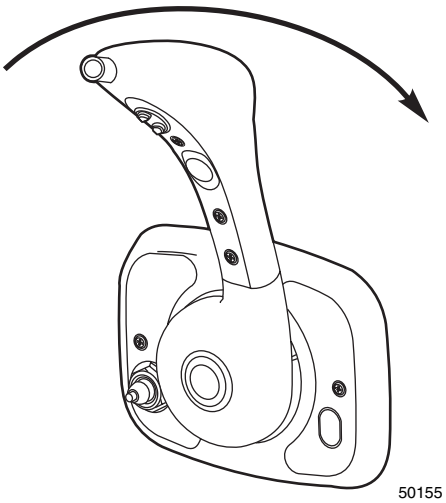
4. Use propeller tool **3862797** and rachet to remove front propeller nut.
   Remove front propeller.
5. Clean the propeller shafts.
   Inspect for fishing line or other debris; remove if present.
   Inspect shaft seals, correct if leaking.

## Propeller Installation

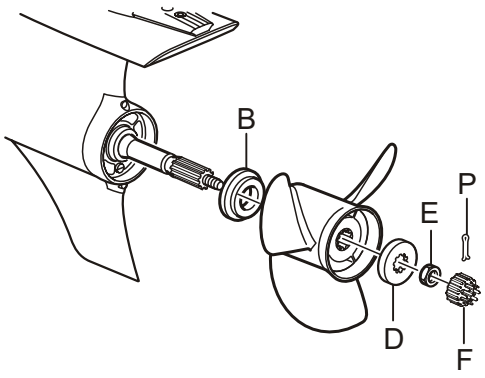
⚠ **WARNING! Propellers turning with engine power can cause serious injury. Make sure the engine can not start during work on propeller(s); remove ignition key(s) and shift drive into forward or reverse to engage neutral safety.**

***NOTICE!*** **Protect hands from sharp edges of propeller blades by wearing gloves when removing or installing propellers.**

**SX**



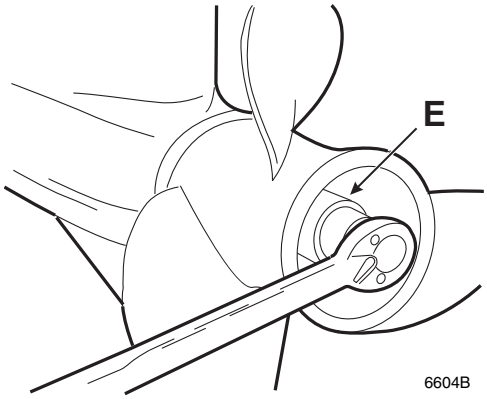

1. Shift the sterndrive into **reverse** to lock the propeller shaft.



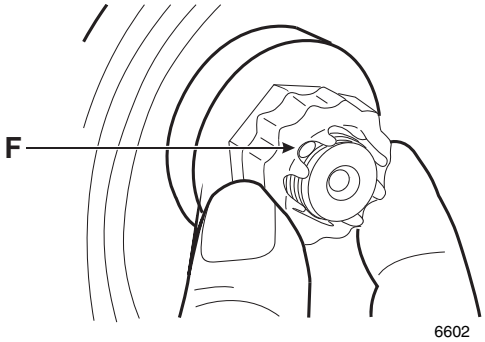

2. Coat propeller shaft and inside of prop hub with grease **828250**. Future removal of the propeller will be difficult if this is not done.

***NOTICE!*** **Failure to install all components could result in propeller loss and damage to sterndrive.**

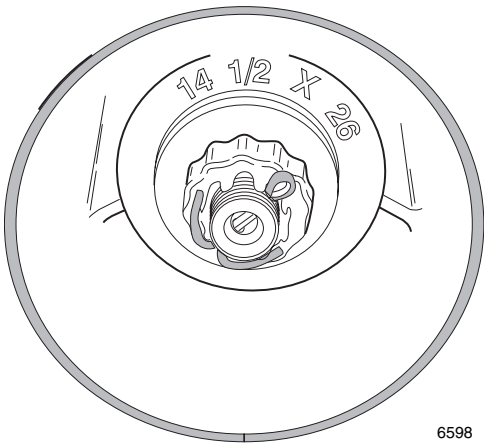
3. Place thrust bushing (B) on propeller shaft with inner taper toward gearcase.
4. Install propeller on shaft, aligning splines, and push propeller onto the thrust bushing until the splines are exposed.
5. Install thrust washer (D) on propeller shaft splines.




6. Install propeller nut (E).
Torque to **70-80 ft. lb. (95-108 N•m)**.

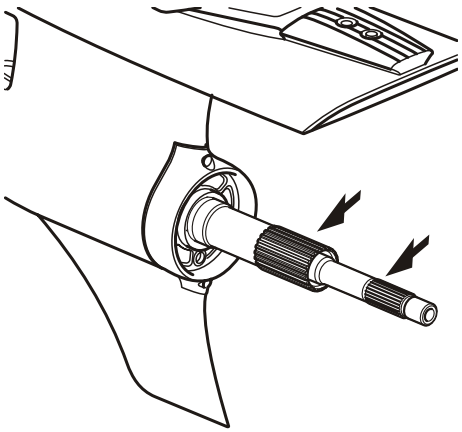



7. Index keeper (F) on propeller nut until a slot is aligned with cotter pin hole.

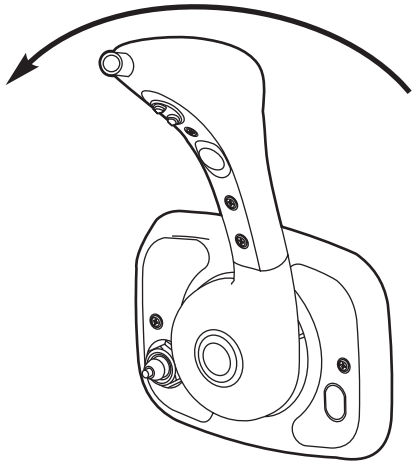



8. Install the cotter pin and bend the ends to secure; use a new cotter pin if necessary.
9. Shift the sterndrive into **neutral** to check propeller movement. Propeller should turn freely.

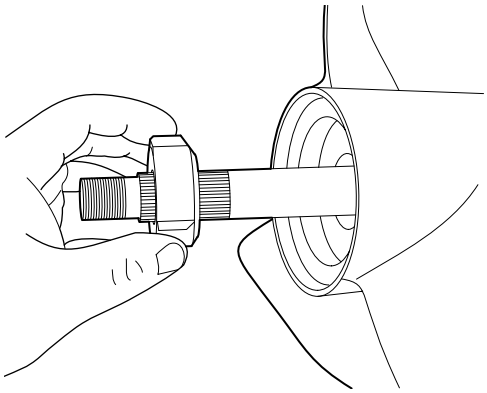
**DPS**



1. Coat the full length of both shafts with grease **828250**.
   Future removal of the propellers will be difficult if this is not done.

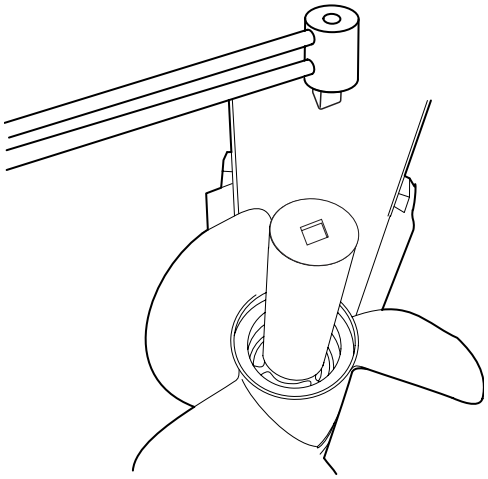


2. Shift the sterndrive into **forward** to lock the propeller shaft.

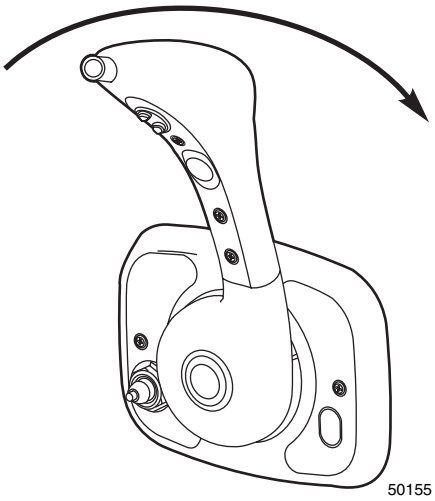


3. Install the front propeller.
   Install the front propeller nut, chamfered edge forward.

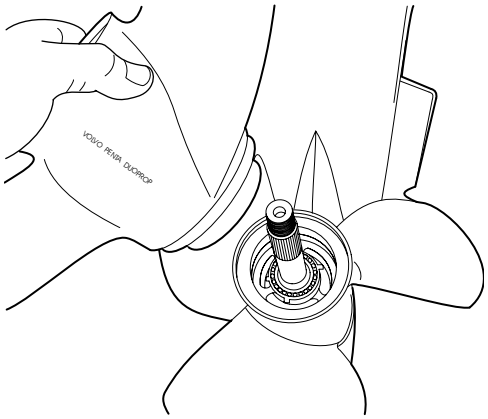
***NOTICE!*** **Be sure the chamfered edge of the propeller nut is facing forward. Failure to install the propeller nut correctly could result in a propeller coming loose and damge to the lower unit and/or propeller.**



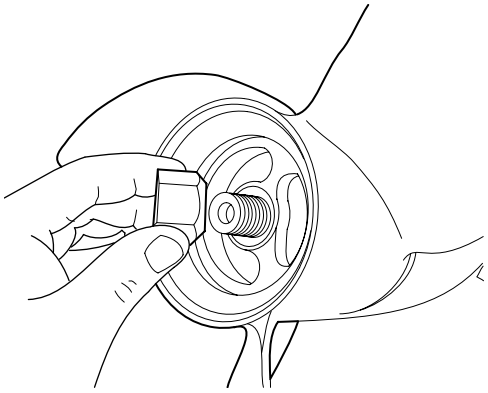
4. Torque nut to 45 ft. lb. (60 N•m).
   Use prop nut tool **3862797** and torque wrench.




5. Shift the sterndrive into **reverse** to lock the propeller shaft.

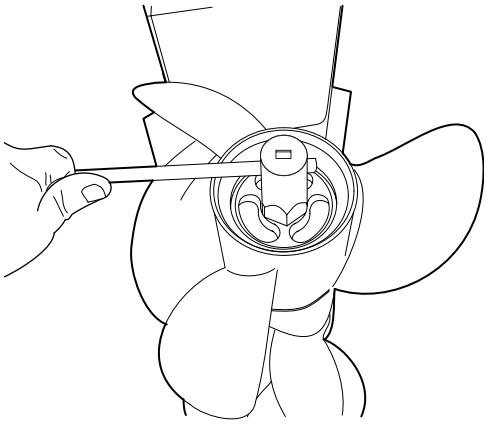


6. Install the rear propeller.



7. Install the rear propeller nut, chamfered edge forward.

***NOTICE!*** **Be sure the chamfered edge of the propeller nut is facing forward. Failure to install the propeller nut correctly could result in a propeller coming loose and damge to the lower unit and/or propeller.**



8. Torque nut to 50 ft. lb. (70 N•m).
   Use prop nut tool **3862808** or 30 mm socket and torque wrench.

***NOTICE!*** **Failure to install the propellers as indicated could result in a propeller coming loose and damge to the lower unit and/or propeller.**

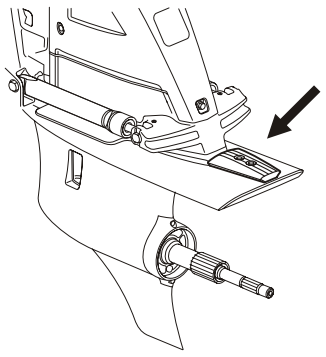
Remove dipstick and oil level plug (under shift cover) so sterndrive will vent and drain completely

9. Shift the drive in to **neutral**.
   Both propellers should turn freely.

## Anodes

The drive anode is located on the top of the caviatation plate.

### Replacing



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Anode erosion or disintegration in salt or brackish water indicates the anode is functioning correctly. Anodes should be inspected and/or replaced at regular intervals, or corrosion of the drive will increase.

***NOTICE!*** **Replace anode when it is reduced to two-thirds of original size (one-third eroded).**

Replacement anode kits contain new mounting screws. The new screws have pre-applied Locktite ™ and should always be used when installing new anodes.

Torque anode screws to 15-20 ft. lb. (20-28 N•m)

**Materials** Anodes are offered in three materials (metals);

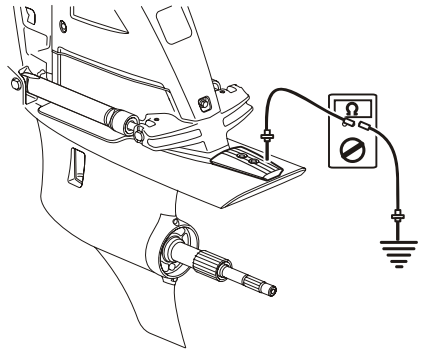
**Aluminum** - for use when the boat (drive) will be used in multiple water types; fresh, salt or brackish. Also best when the water type where the boat will be operated is not known.

**Zinc** - for use in salt water

**Magnesium** - for use in fresh water

Check the Parts Catalog for the anode part numbers.

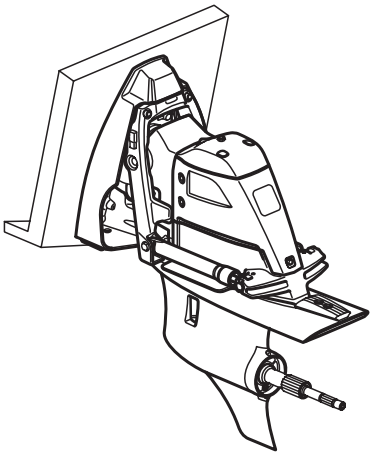
**Testing**



Test for proper installation of the anode.
Set an ohmmeter to the low ohms scale.
Connect one ohmmeter lead to a good ground, and the other to the anode. Be sure anode surface is clean to make good contact.
Ohmmeter should indicate a very low reading (zero).
If not, remove the anode and clean the mounting screws, the surface of the anode and gearcase where the anode is installed.
Install and retest the anode.

***NOTICE!*** **Do not paint or otherwise coat the anodes. This will prevent them from functioning properly. If anode appears to be corroded on its surface, but is not deteriorating, it should be replaced.**

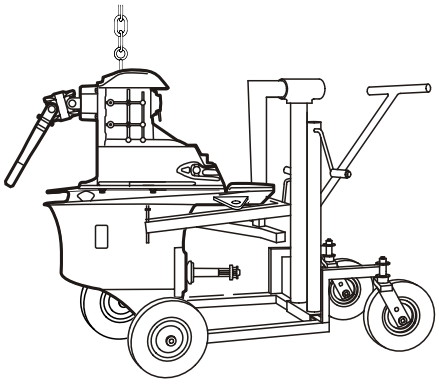
## Sterndrive Removal



⚠ **WARNING! Make sure the engine can not start during work on sterndrive;**
**remove ignition key(s)**
**shift control to forward or reverse to engage neutral safety**

⚠ **WARNING! Boat must be out of the water and safely supported on trailer or storage racks before removing sterndrive.**

**Preparation**

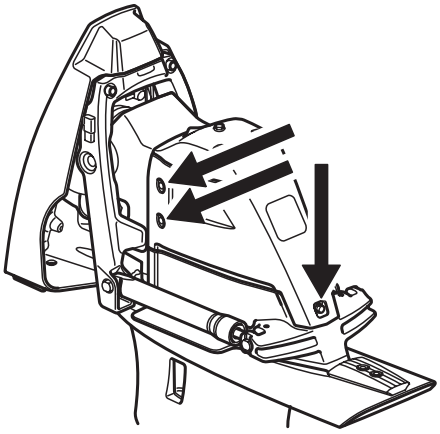


⚠ **CAUTION! Sterndrives are heavy and awkward to handle. Before beginning sterndrive removal, plan for supporting the sterndrive with a drive cart or overhead hoist, before proceeding with removal.**

Remove propellers. See section titled “Propeller Removal” in this chapter.

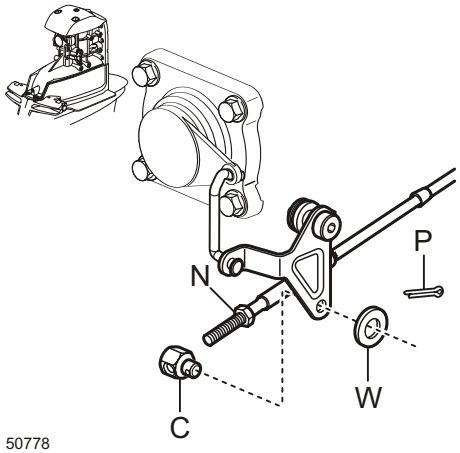
Trim sterndrive to full down position

### Remove Upper Cover



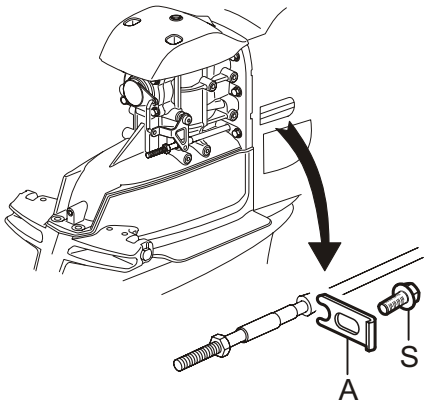
1. Remove five screws securing cover. Use 12mm socket.
2. Remove cover.

### Disconnect Shift Cable




50778

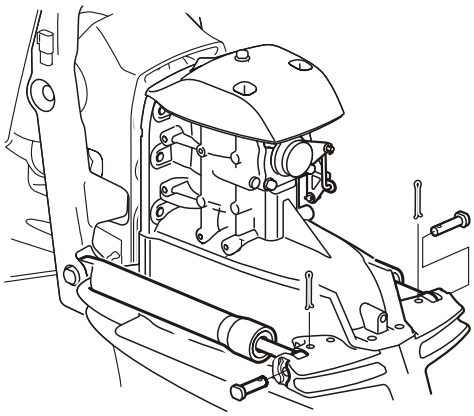
1. Remove cotter pin (P) and then washer (W) from cube (C).
2. Remove cube and cable from bracket.
   Loosen jam nut (N).
   Thread cube off of cable.
   Remove seal from cable. Save seal.




50779

3. Loosen screw (S) securing anchor (A). Use 10mm box wrench
   Slide anchor outwards to release cable.

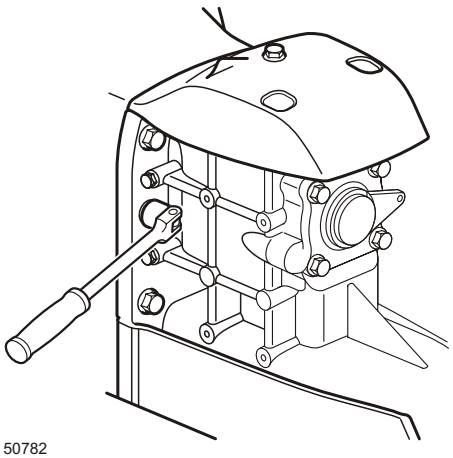
### Disconnect Trim Cylinders



1. Straighten bottom of cotter pins.
   Pull cotter pins up and out of housing.
2. Pry in housing slots behind pin heads to start pins, protect painted surfaces from damage by tools.
   After pin head is exposed, use pliers to pull pins from housing and cylinders.
3. Pull ends of cylinders up and out of housing.
   Secure cylinders out of the way during drive removal.

### Remove Sterndrive

⚠ **CAUTION! Sterndrives are heavy and awkward to handle. Before disconnecting sterndrive from transom, secure the sterndrive to a drive cart or overhead hoist capable of supporting at least 500 lbs (227kgs).**

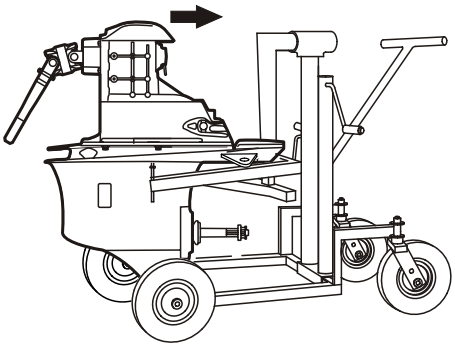


50782

1. Remove six locknuts securing upper housing to transom shield.
   Use 5/8” swivel socket or 5/8” box wrench.
   Protect painted surfaces from damage by tools.
   Discard nuts.

2. Pull sterndrive straight back.

***NOTICE!*** **It may be necessary to slightly rock the sterndrive up and down on the cart or hoist to disengage the u-joint shaft from the transom shield.**



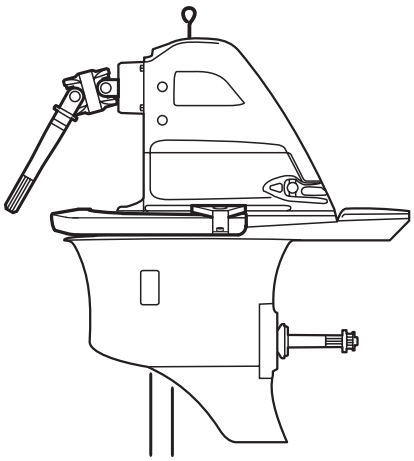
## Sterndrive Service

Service and disassembly procedures for the upper and lower gear housings follow in the next three chapters, see the main Table of Contents for details.

The following sections cover separating the upper housing from the lower housing, reassembling the housings, testing the sterndrive for proper sealing and then reinstalling the sterndrive on the transom shield.

***NOTICE!*** **All references to oil or gear oil in all assembly steps are referring to the same oil used to fill the sterndrive; Volvo Penta GL5 Synthetic gear lubricant, SAE 75W90.**

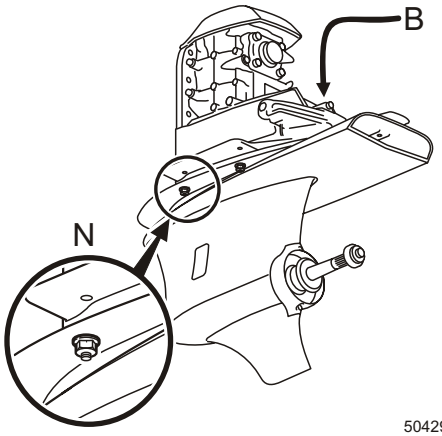
### Disassemble



1. Mount the sterndrive in a suitable holding fixture and clamp it securely.

***NOTICE!*** **Fixture is not shown in the following images to provide clearer illustration of parts.**

2. Drain the oil from sterndrive. See section titled “Draining Oil from Sterndrive”.
3. Remove four spiral locknuts (N) from underside of lower gearcase. Use 15mm box wrench.

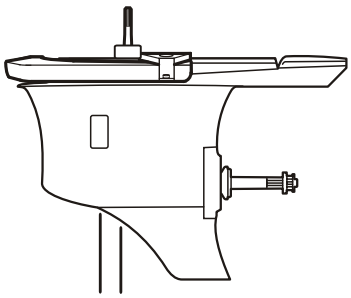



***NOTICE!*** **Save spiral locknuts, they can be re-used up to 50 times.**

**Do not substitute other types of lock nuts for the spiral locknuts. Other nut types will not torque correctly, causing damage to the sterndrive. If spiral locknuts are lost or damaged replace with locknut part number specified in the Parts Catalog.**

4. Remove two bolts (B) securing upper to lower housings. Use 17mm socket.
5. Lift upper housing off of lower housing.
6. Remove and discard seals between housings.

## Reassemble



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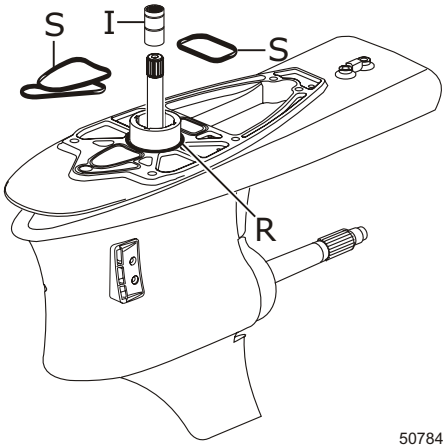
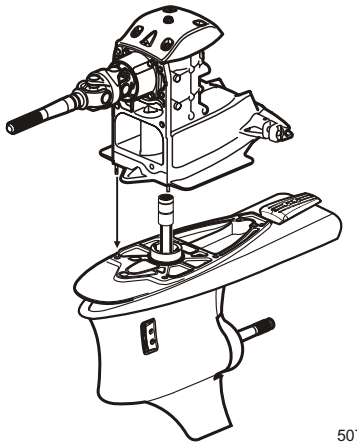
1. Mount the lower housing in a suitable holding fixture and clamp it securely.

***NOTICE!*** **Fixture is not shown in the following images to provide clearer illustration of parts.**




50784

2. Lightly oil new seals (S) and insert in grooves in lower housing. Also oil o-ring (R) on retainer.
3. Place intermediate shaft (I) on lower vertical shaft.
   Oil splines on both shafts.
   Groove should be oriented up.



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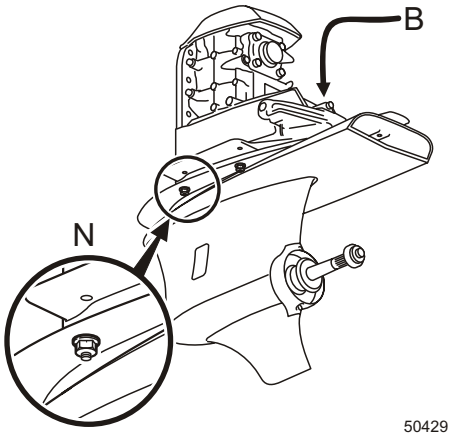
4. Place upper gear housing on lower.
   Engage intermediate shaft in upper vertical shaft, if needed rotate propeller shaft or u-joint shaft to engage.
   Line up studs in mounting holes in lower.
   Protect painted surfaces from damage by studs and tools.
   Make sure seals are seated properly.



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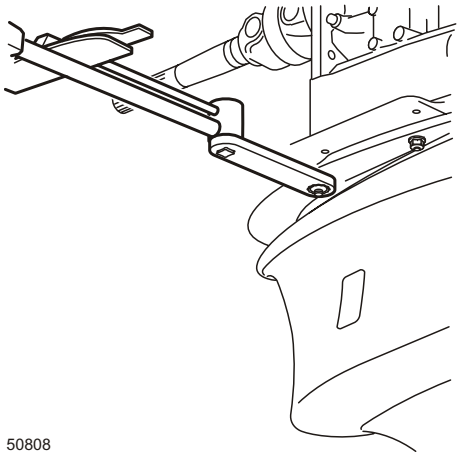
5. Install and hand tighten four spiral locknuts (N).

***NOTICE!*** **Do not substitute other types of lock nuts for the spiral locknuts. Other nut types will not torque correctly, causing damage to the sterndrive. If spiral locknuts are lost or damaged replace with locknut part number specified in the Parts Catalog.**

6. Install and hand tighten two bolts (B) through upper housing.


50808

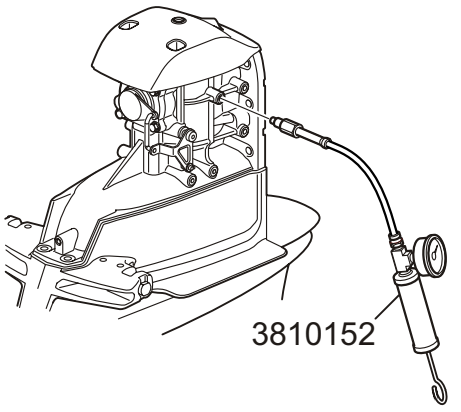
7. Torque the fasteners in a crossing patter, starting in the middle.
   Use wrench **3849655** and torque wrench to torque nuts**.**
   Use 17mm socket and torque wrench to torque nuts**.**
   Nuts = 30-38 ft.lbs (41-51N•m)
   Bolts = 30-38 ft.lbs (41-51N•m)

**Pressure and Vacuum Testing**

Before filling sterndrive with gear oil, it must be pressure and vacuum tested to verify proper sealing.

Remove the oil level plug at the gear housing.
Make sure o-rings are installed on other plugs and dipstick.
Install and tighten all other plugs and dipsticks.

**Pressure Test**



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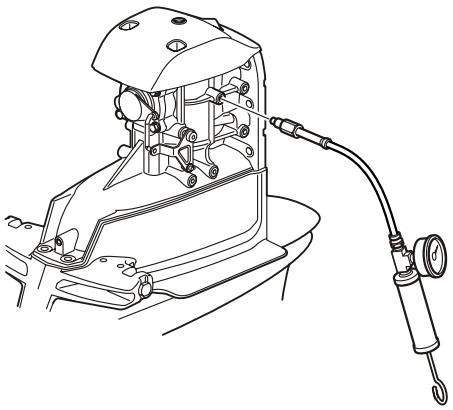
1. Attach pressure tester **3810152** (or Stevens S-34) to oil level hole.
   Pressurize sterndrive to 3-5 PSI (20,7-34,5 kPa).
   Rotate propeller shaft and u-joint shaft to check sealing.
   If pressure loss is indicated, use a soapy water solution to find source of leak.
   Make necessary repairs then repeat test.
2. If pressure loss is not indicated, increase pressure to 16-18 PSI (110-124 kPa).
   If pressure loss is indicated, use a soapy water solution to find source of leak.
   Make necessary repairs then repeat test.
   Drive must not loose more than 1 PSI (6,9 kPa) in 3 minutes.
   Drive must pass pressure test before making vacuum test.

### Vacuum Test



50791

1. Attach vacuum tester (such as Stevens V-34) to the oil level hole.
   Pull vacuum to 3-5 inches of mercury (10-16,8 kPa).
   Rotate propeller and u-joint shaft to check sealing.
   If drive does not hold vacuum, apply gear oil to seal surfaces to find source of leak.
   Make necessary repairs then repeat test.
   No loss of vacuum should occur on low vacuum test.
2. If vacuum loss is not indicated, increase vacuum to 14-16 inches of mercury (47-54 kPa).
   Rotate propeller and u-joint shaft to check sealing.
   If drive does not hold vacuum, apply gear oil to seal surfaces to find source of leak.
   Make necessary repairs then repeat test.
   Drive must not loose more than 1 inch of mercury (3,4 kPa) in 3 minutes.

# Installing the Sterndrive

Proper installation is important for the safe, reliable operation of all mechanical products. In these instructions we recommend and describe effective procedures you should follow when installing Volvo Penta sterndrive products. Some of these methods require the use of tools especially designed for the purpose. These tools should be used whenever recommended.

Follow the steps and procedures described in this section—in the order listed—to perform a complete installation of a Volvo Penta engine and sterndrive assembly.

1. Prepare for installation
2. Install drive unit
3. Install shift cable
4. Check shift cable installation

### Prepare for Installation

Read installation instructions completely, and collect all tools, instruments, and parts needed for the job before you start work.

**Required Special Tools**

- Volvo Penta “Solo” Drive Unit Cart[1] **9990001**
- Lifting Eye (½ in.- 13 threads)
- Grease Gun
- Alignment Tool **3851083**
- Universal Handle **3850609**

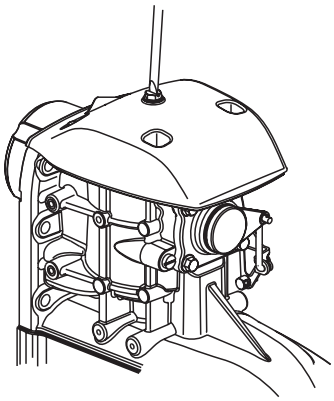
**Sealants and Lubricants Required**

- Volvo Penta Water Resistant Grease **828250**
- Volvo Penta GL 5 Synthetic Gear Lubricant 75W90

1. Although a drive unit cart is not required, we strongly recommend its use when moving the sterndrive.

### Preparing Drive

1. Remove and retain oil level dipstick and gasket.



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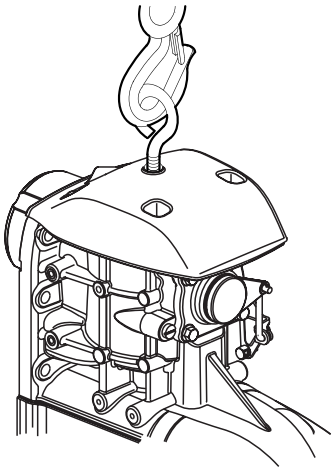
2. Thread lifting eye into oil level dipstick hole.
3. Use a suitable hoist to remove drive unit from work area and holding fixture.



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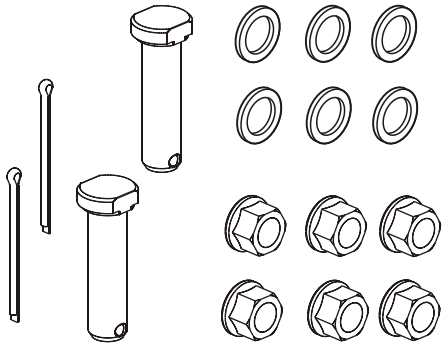
4. Make sure all attaching hardware is readily available.
   6 lock nuts
   6 washers, narrow
   2 trim/tilt pins
   2 cotter pins



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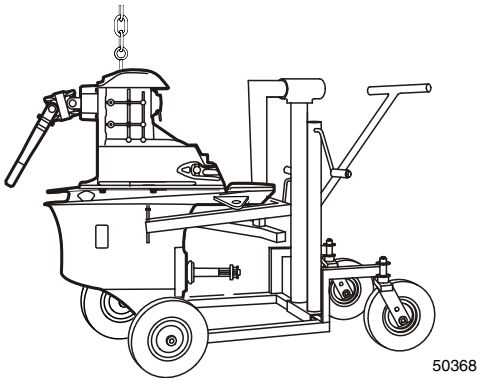
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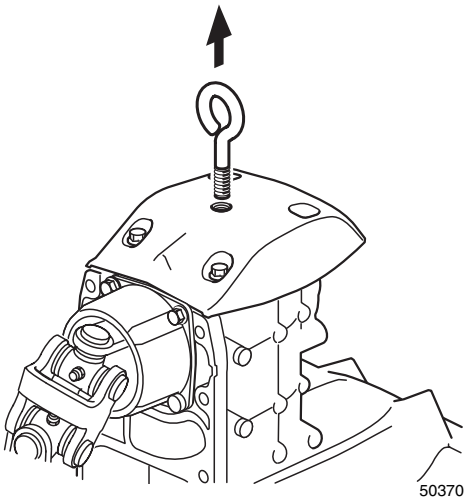
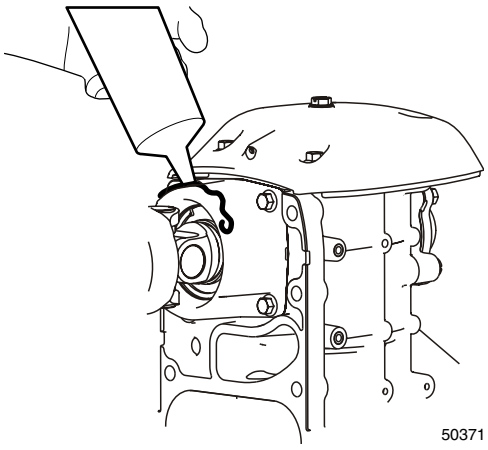
5. If the boat transom design requires the transfer of the drive unit from a hoist onto a drive unit cart, do so now.


50370

6. Remove lifting eye bolt from upper housing.
7. Reinstall dipstick and o-ring. Tighten dipstick.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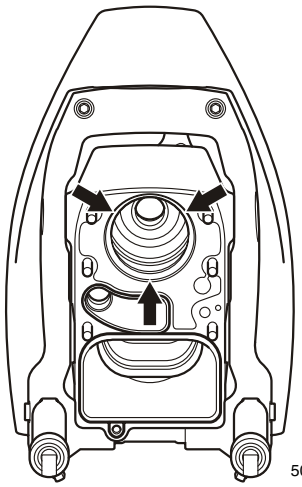
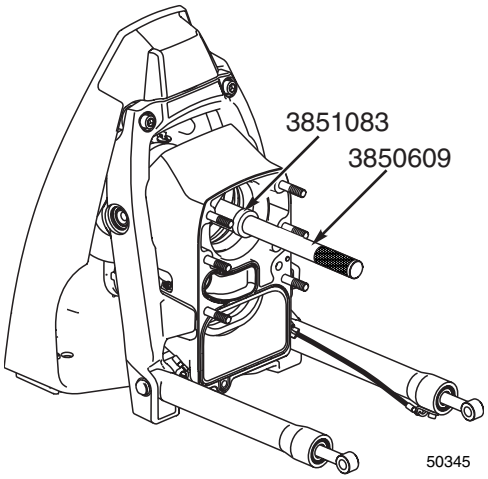
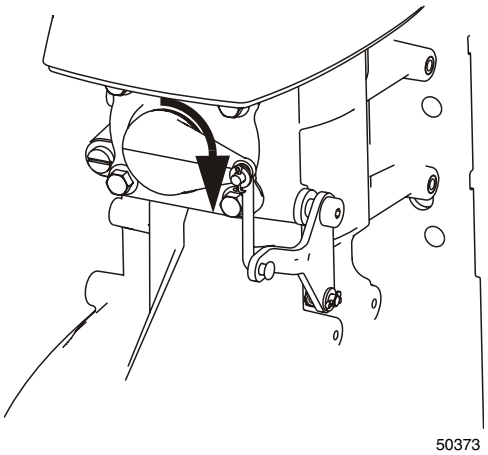
8. Inspect the tapered end of the bearing housing to ensure it is free of nicks and dents.
   Apply a light coat of grease **828250** to tapered end of bearing housing.
   Lubricate shaft splines, o-rings, and water passage seal with grease.



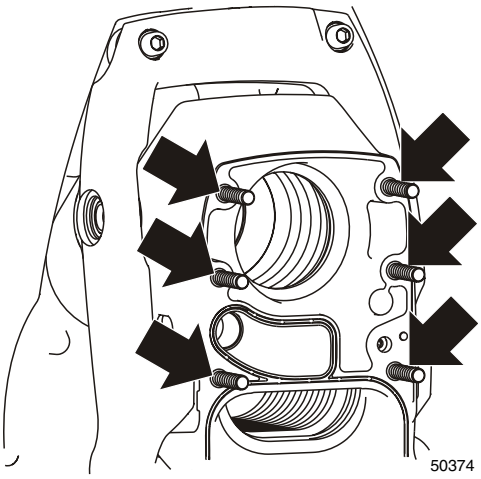

9. Inspect seal ring for proper fit in its groove.
   Inspect and lightly lubricate u-joint bellows lip with grease **828250**.



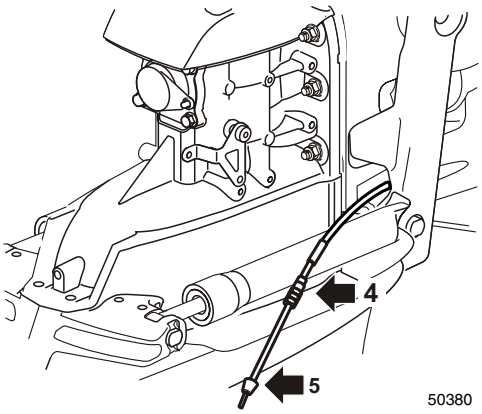

10. Using handle **3850609**, slide alignment tool **3851083** through gimbal bearing. Alignment tool must easily slide through gimbal bearing and into engine coupler.
    If alignment tool binds going into coupler, the front engine mount(s) must be adjusted either “up” or “down,” until alignment tool easily slides in and out of coupler.




11. Shift sterndrive into gear by rotating the eccentric piston arm.

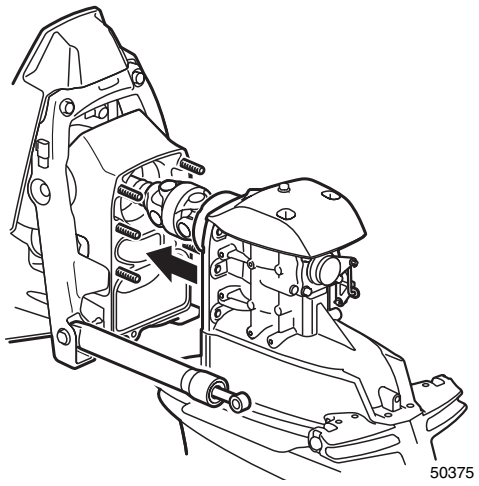



12. Apply grease **828250** to the six studs.



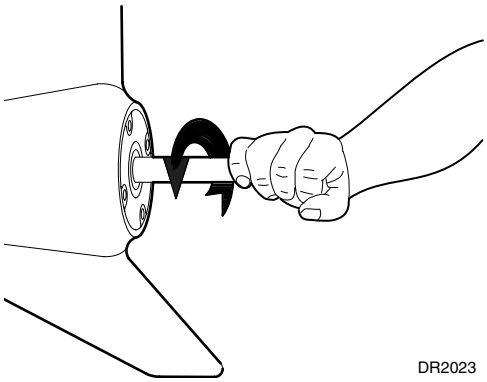

13. Reinstall the large seal **4** and small seal **5** onto the shift cable.

**Installing Drive Unit**




1. Tilt the trim cylinders up above the upper gear splash plate.
2. Slide u-joint shaft through gimbal bearing.
   Guide shift cable through opeining in sterndrive.

***NOTICE!*** **Be careful not to damage the cable when installing the sterndrive.**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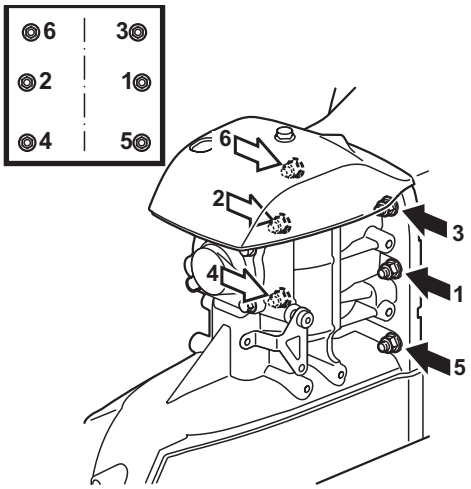
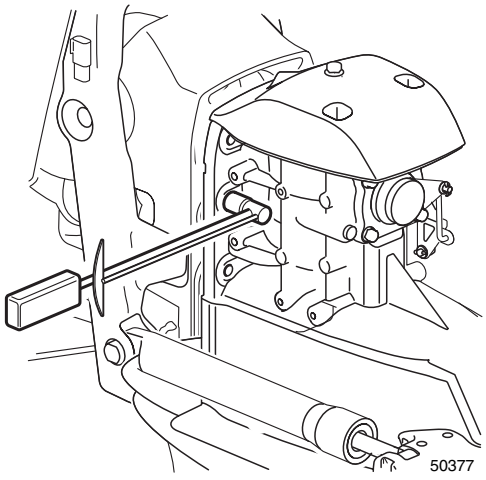
3. To align u-joint shaft splines, rotate propeller shaft(s) until the shaft splines engage the coupler.

⚠ **CAUTION!Wear gloves or use a shop cloth to protect your hands. Propeller shaft splines may be sharp.**



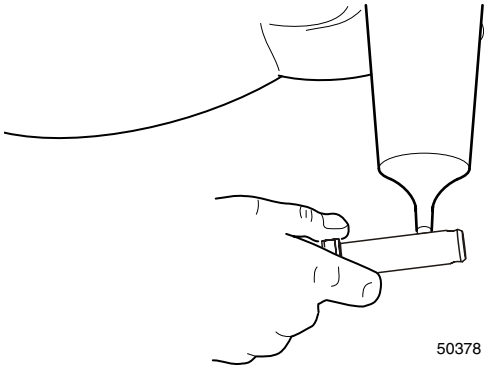

4. Slide sterndrive onto six studs until it is completely seated against the pivot housing.
   Install six washers and lock nuts (three on each side).


50377

5. Tighten the nuts in two steps.
   Torque nuts to an initial setting of 25 ft. lb. (34 N•m).
   Start with the center nut **1** and work in a crisscross pattern (**2**, **3**, **4**, **5**, **6**) to secure the sterndrive to pivot housing.
   Use the same crisscross pattern to torque all six lock nuts to a final setting of 50 ft. lb. (68 N•m).

***NOTICE!*** **Do not use pneumatic or electric impact type tools on drive attachment nuts. The threads of the nut and stud will be damaged.**

6. If a drive unit cart has been used, remove it at this time for installation of the trim/tilt cylinders.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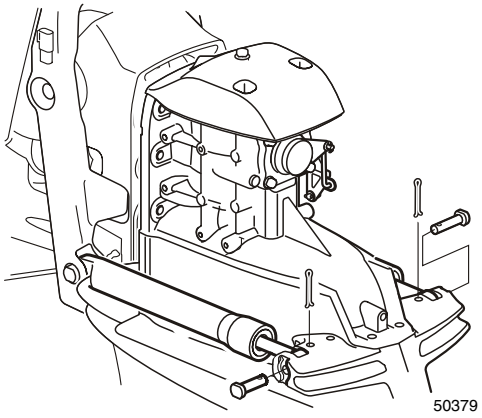
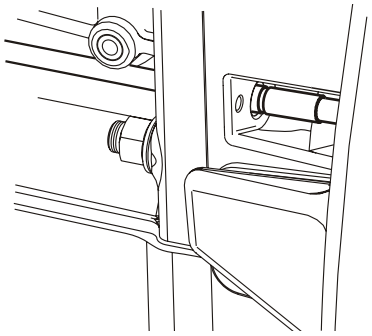
7. Apply grease **828250** to the trim/tilt pivot pin.

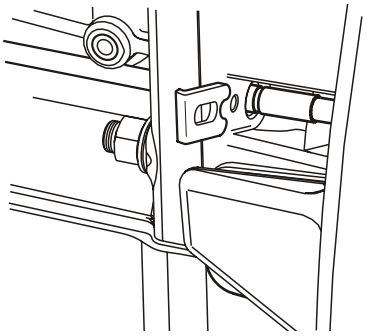



8. Align trim/tilt cylinder end with upper gear housing boss.
   Slide trim/tilt pivot pins into upper gear housing.
9. Use the flats on pin heads to align the trim pins with the cotter pin holes in the gear housing.
   Install the cotter pins.
   Bend the cotter pin ends to lock in place.
10. Trim sterndrive to down position.
    Check oil level, see procedure title “Checking Gear Oil Level” in this chapter.

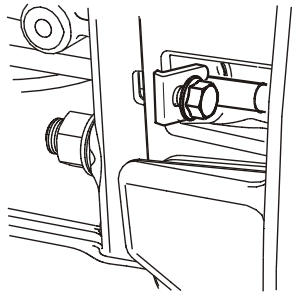
**Install Shift Cable**



1. Cable should be routed through hole in pivot housing and upper gear housing, with the end of the cable behind the shift bracket.



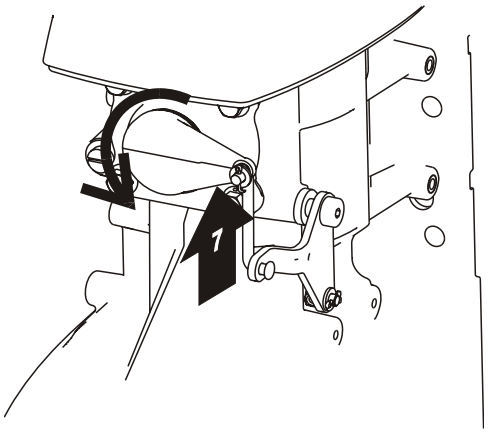
2. Slide anchor in, engaging slot in end of anchor with the anchor groove in the shift cable.
   Lip on the anchor should face forward.



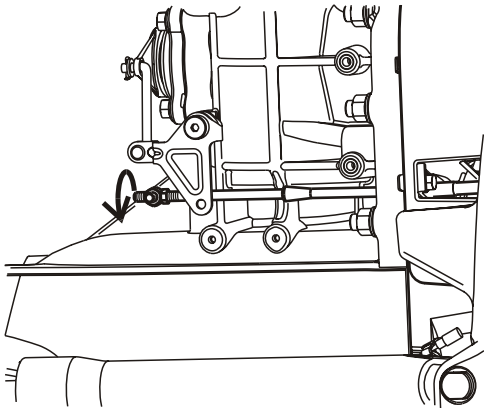
3. Torque anchor clamp screw to 7.4ft. lb. (10 N•m).
   Use 10mm socket and torque wrench.

**WARNING! The anchor must completely capture the shift cable and be securely attached to the housing. Failure to secure cable and anchor will result in the shift cable coming loose and result in loss of shift control.**

4. Rotate eccentric piston arm **7** to extend bellcrank.




5. Move the gear shift to reverse to extend the shift cable.
   Thread cube halfway onto cable end.
   Rotate eccentric piston arm back to neutral detent position, then move gear shift to its neutral detent position.



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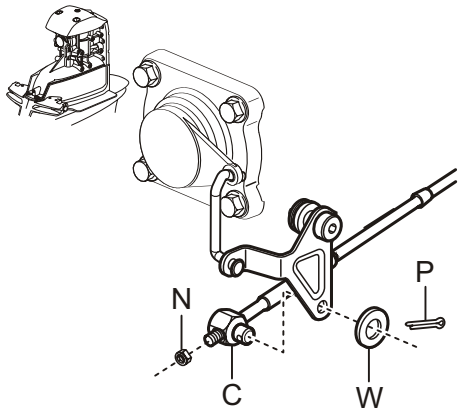
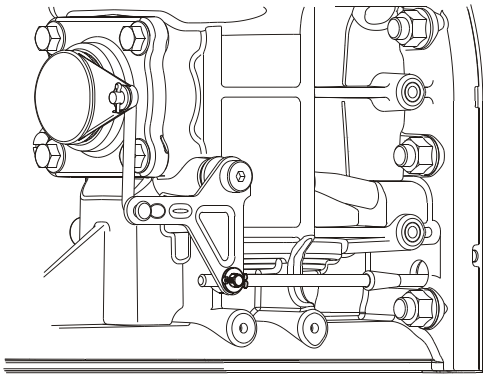
6. Thread cube (C) in or out on cable until it aligns with center of hole in shift bracket.
7. Push shaft of cube (C) through hole in shift bracket.
   Install washer (W) on shaft, secure with cotter pin (P).
   Bend ends of cotter pin.
8. Install jam nut (N) and tighten securely against cube to keep cable from turning in cube.




50792



⚠ **WARNING! The cube must be securely attached to the bracket and the cable. Failure to secure cable and cube will result in the shift cable coming loose and result in loss of shift control.**

**Start-in-Neutral-Only Test**

⚠ **WARNING! The remote control should be designed to allow starting in NEUTRAL only. If control handle is in an "in gear" position, engine should not crank. Test to make certain engine will not crank in forward or reverse gear positions, and will crank only when control handle is in neutral position.**

⚠ **WARNING! Explosion hazard, operate bilge blower as required by regulations before starting engine, to clear and fuel fumes. Open engine cover or hatch before starting engine if the boat is not equipped with a blower. Leave it open until after engine has started.**

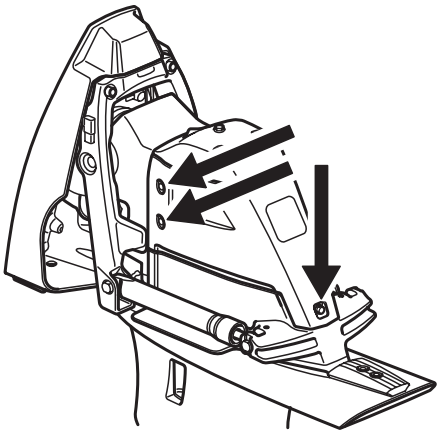
***NOTICE!*** **Make sure sterndrive is properly filled with oil before running engine/sterndrive. See procedure above.**

**Shift System Test**

With engine running, shift unit into forward and reverse gear several times. Ensure full forward and reverse gear engagement occurs. Boat must move in direction of selected gear (i.e., with control handle in forward, boat moves forward). Refer to the remote control manufacturer's service manual to correct any problems **before** operation of the boat.

***NOTICE!*** **When shifting from neutral into forward and reverse gear, the movement of remote control handle required to obtain gear engagement should be approximately equal in both directions. If not, the shift cable cube has to be readjusted to obtain a centered shift stroke.**

## Install Shift Cover



1. After shift system tests are performed, all adjustments are made, and after final gear oil level check:
   Reinstall the shift cover.
   Carefully thread five screws in to housing.
   Use 12mm socket and rachet to hand tighten,
   then torque to 13-17 ft.lbs (17-23N•m)

# NOTES

# Upper Gear Housing

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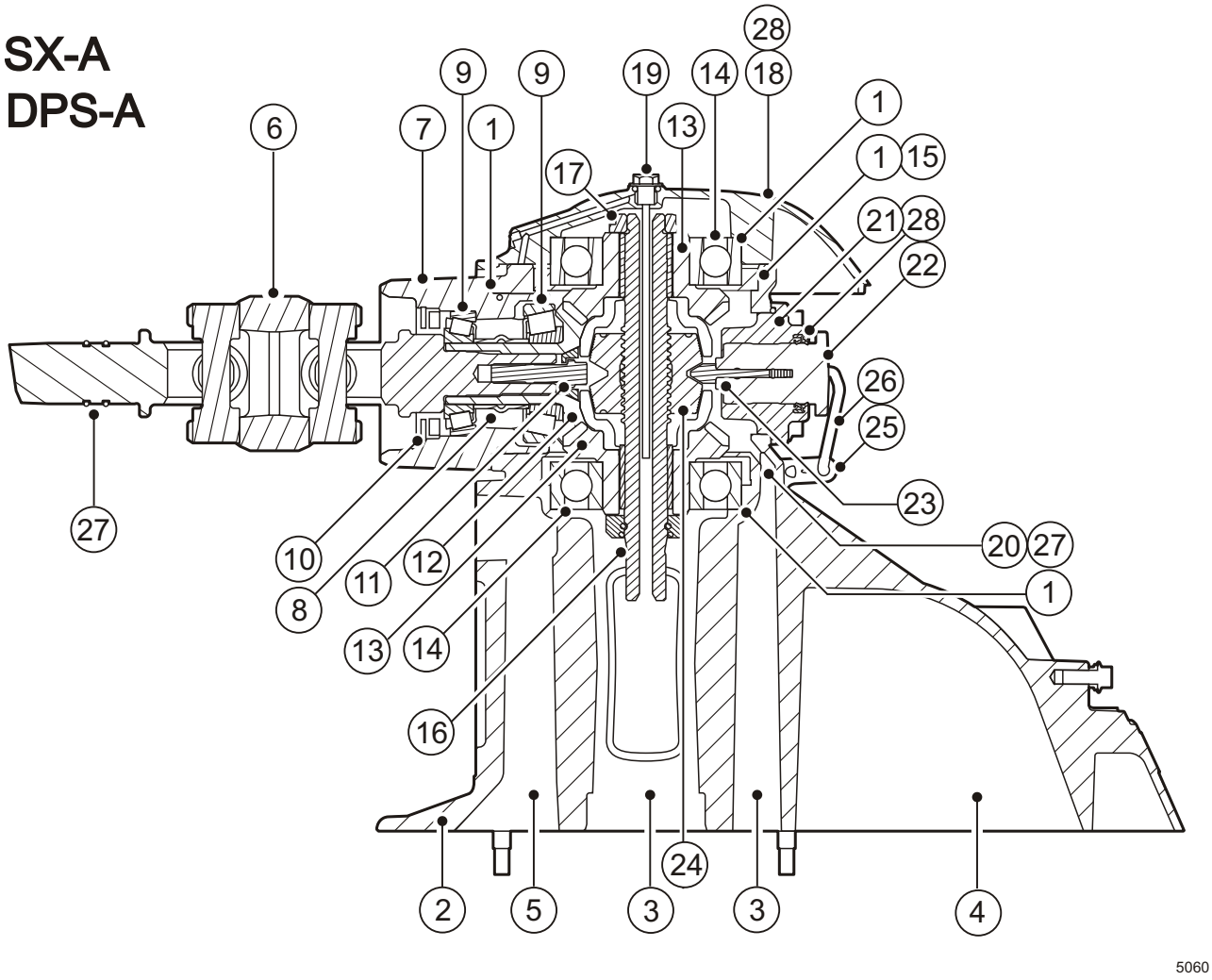
## Safety Messages

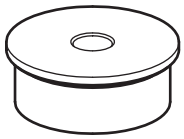
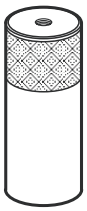
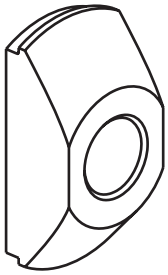
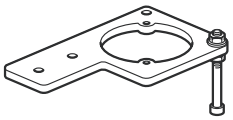
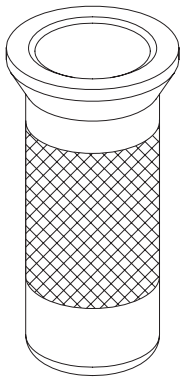
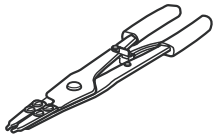
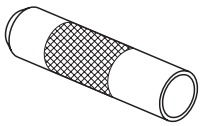
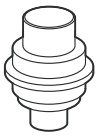
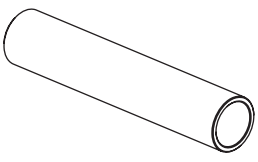
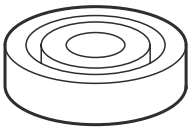
Before working on any part of a Volvo Penta sterndrive, read the section called “Safety Messages” in the first chapter of this manual.

## Upper Gearcase - cross section



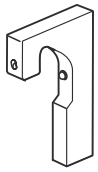
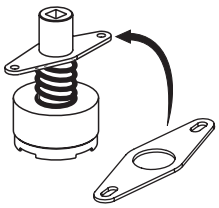
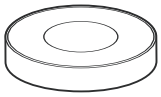
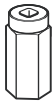
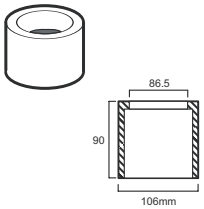
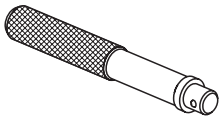
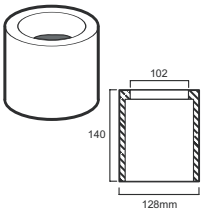
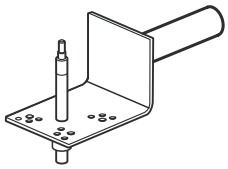
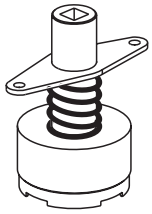

1. Shim position
2. Pitot passage
3. Oil passage
4. Exhaust passage
5. Water passage
6. U-joint
7. Pinion bearing housing
8. Crush sleeve
9. Bearings, pinion
10. Seal, pinion
11. Reatiner and screw, pinion
12. Pinion
13. Drive gear
14. Bearing, drive gear
15. Ring, upper gear
16. Vertical shaft
17. Top nut
18. Top cover
19. Dipstick
20. Plug, oil drain
21. Shift housing
22. Shift eccentric
23. Shift shoe
24. Shift cone
25. Shift bracket
26. Shift rod
27. O-ring
28. Seal

## Special Tools

| Tool Name | Part No. | View | Tool Name | Part No. | View |
|---|---|---|---|---|---|
| Assembly Tool | 884932 |  | Drift | 884789 |  |
| Dis-assembly Tool | 884933 |  | Holding Fixture | 3849658 |  |
| Drift | 884168 |  | Retaining Ring Pliers | 3850608 (331045) |  |
| Drift | 884263 |  | Seal Installer | 885557 |  |
| Drift | 884266 |  | Seal Installer | 3850607 |  |

(Early versions may have the OMC part no.)

**Special Tools, cont'd**

| Tool Name | Part No. | View | Tool Name | Part No. | View |
|---|---|---|---|---|---|
| Shim Tool | 3849650 |  | Plate (Replaces original plate on 3860604) | 3861651 |  |
| Shim Tool | 3850600 |  | Spline Socket | 3850598 |  |
| Sleeve | 884938 |  | Shaft | 9991801 |  |
| Sleeve | 3862673 |  | Upper Gear Housing Holder | 3849651 |  |
| Spanner Wrench | 3850604 |  | | | |

**Volvo Penta Tools** All tools by Volvo Penta are listed in text by name and **part number.**

**Sealants, Lubricants and Adhesives**

Cleaning solvent

Volvo Penta GL5 Synthetic gear lubricant, 75W90

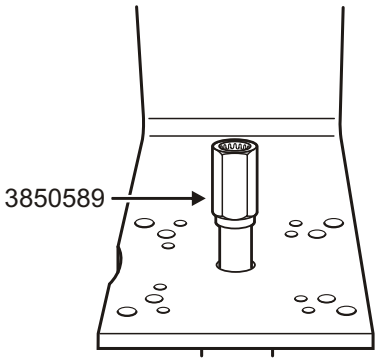
Loctite primer

Volvo Penta thread locking compound p/n **1161053**

Volvo Penta grease p/n **828250**

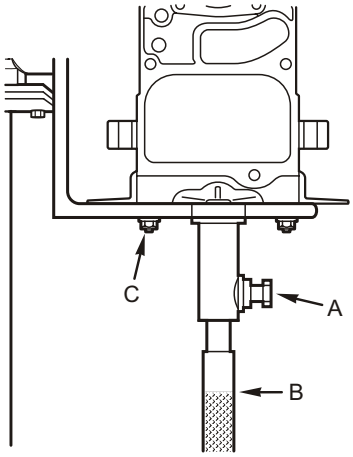
## Sterndrive Removal and Disassembly

To service components of the upper gear housing, remove sterndrive from transom shield and separate upper housing from lower. Follow the procedures in the **Sterndrive, General Information** chapter of this manual.




1. Attach spline socket **3850598** to holding fixture **3849651**.

   Tighten set screw securely.




2. Mount upper gear housing on holding fixture.

***NOTICE!*** **Rotate upper gear housing if fixture holes do not align with holding fixture.**

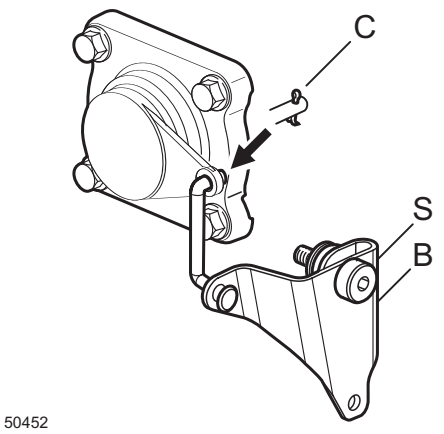
Loosen locking screw (A).

Rotate and lift fixture shaft (B) to engage upper driveshaft splines.

Install and securely tighten four nuts on studs(C).

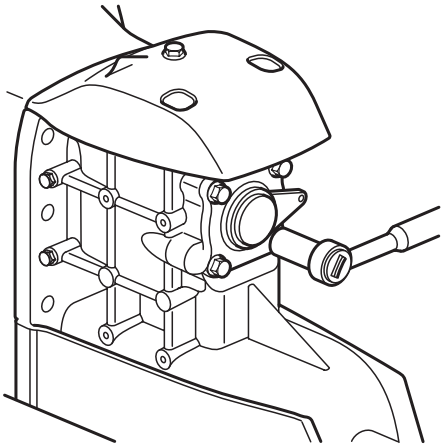
# Upper Gear Housing Disassembly

### Shift Mechanism Removal



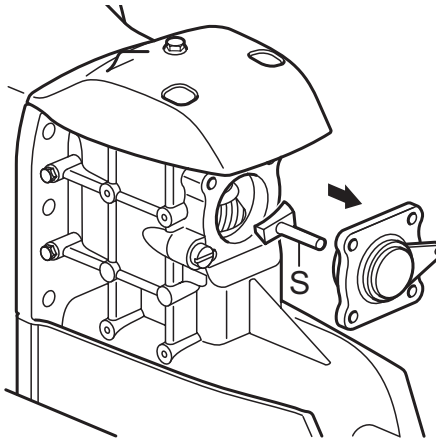
50452

1. Remove cotter pin (C) securing rod to eccentric.
2. Remove screw (S) and washer attaching shift bracket.
3. Remove bracket (B) and rod.



4. Remove four screws securing shift housing.

***NOTICE!*** **Shift housing is spring loaded and may pop out when screws are loosened.**

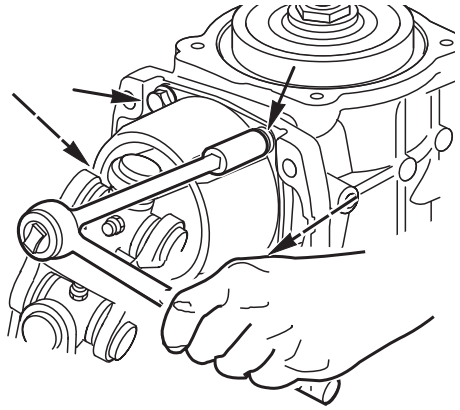



5. Remove shift housing from upper gear housing.

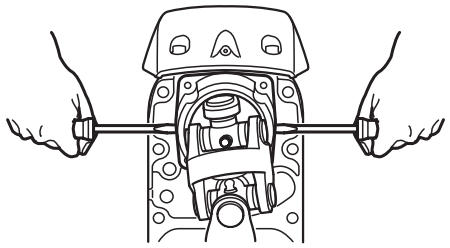
   Note the position of shift shoe (S) during removal.

   It must be re-installed in the same orientation or shift system will not function correctly.

### Pinion Bearing Carrier Removal

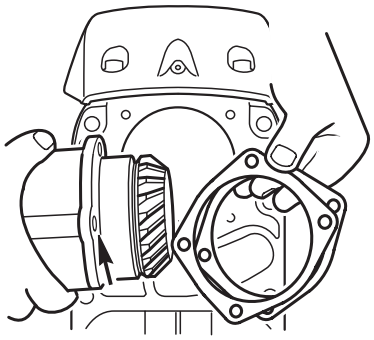


1. Remove four screws securing pinion bearing carrier to upper housing.



2. Remove pinion bearing carrier and u-joint using two screwdrivers.

   Be careful not to damage upper housing or bearing carrier mounting surfaces.



3. Save any undamaged shims, they can be reused.
   Remove and discard O-ring.

### Output Gear Removal

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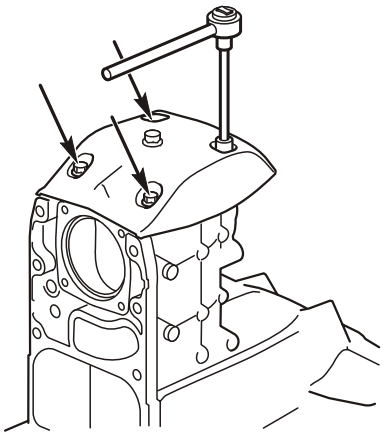
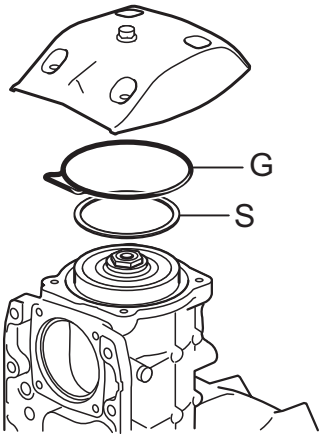
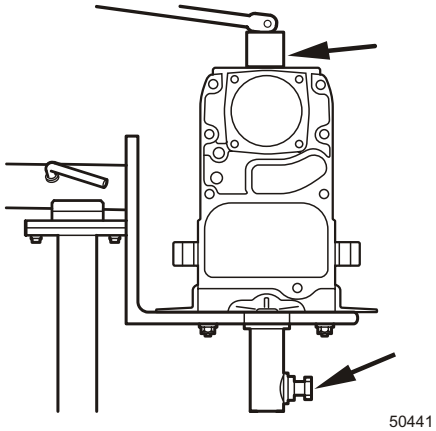


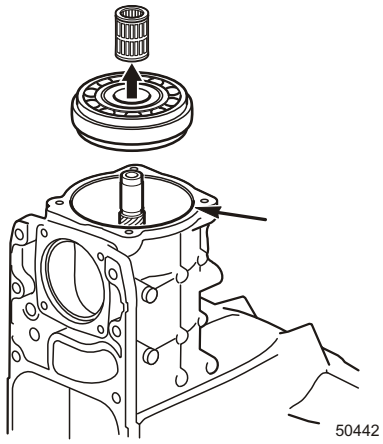
1. If present, remove and save dipstick, discard O-ring.
2. Remove four screws securing upper cover.
   Use 12mm socket.
   Remove cover.




3. Save any undamaged shims (S) under cover, they can be reused. Remove and discard cover seal (G).

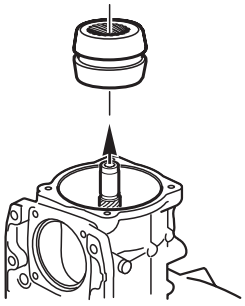



4. Push holding fixture shaft up to engage upper driveshaft splines. Align flat part of fixture shaft with locking screw. Tighten locking screw to prevent upper drive shaft from turning. Remove **Left-Hand** threaded top nut with 30 mm socket.

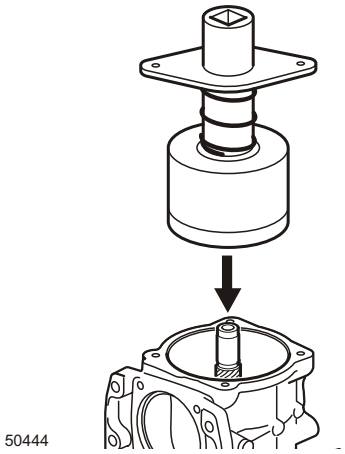



5. Lift upper gear/bearing/ring assembly out of housing. Note and mark needle bearing orientation (top-to-bottom), then remove needle bearings from center of gear. Remove and save shims. They can be reused if not damaged.

***NOTICE!*** **Needle bearings should be reinstalled in same gear/ bearing and in same orientation, top to bottom, as they were removed. Do not switch needle bearings between lower and upper gear/bearing assemblies. Premature failure will result if they are switched or installed in different orientation.**



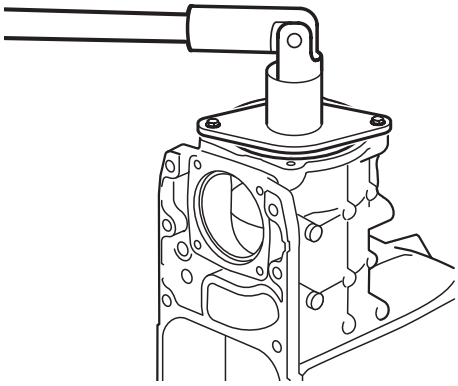
6. Remove cone clutch.



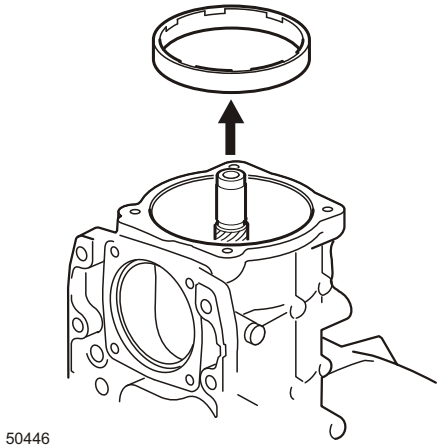
50444

7. Use spanner wrench **3850604** to remove retainer ring that holds lower gear/bearing assembly in place.
   Spanner must be updated with new plate **3861651**, original plate will not mate to housing.
   Insert tool into housing.
   Use two upper housing cover screws to secure spring loaded arm to top of gear housing. As screws are turned down, alternate between two screws every two turns.

⚠ **CAUTION! The retainer ring is tightened to a high torque, all parts and fixtures must be tightened securely before the ring can be safely removed. Seat screws completely, then tighten them securely. Tighten the holding fixture securely.**



8. Attach a 3/4 in. breaker bar to spanner wrench and loosen retainer ring.

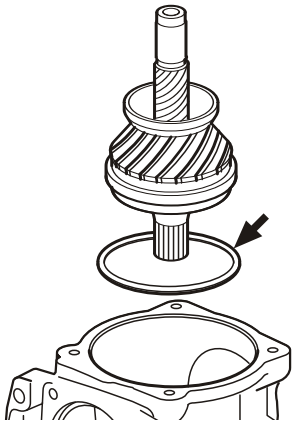


50446

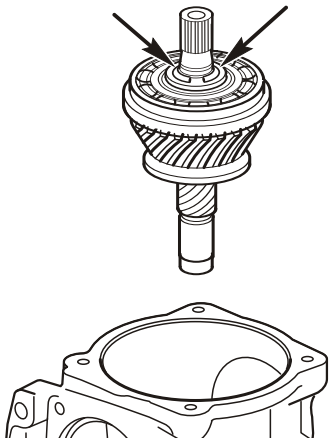
9. After it turns easily, detach spring-loaded arm from top of housing. Unscrew retainer ring and lift it out.

⚠ **CAUTION! Be careful removing screws. Arm is under tension.**

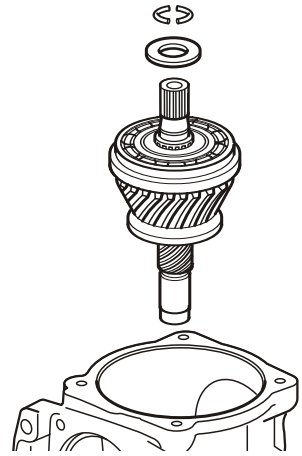
10. Remove lower bearing and shaft assembly. Remove and save shims. They can be reused if not damaged.


50447

11. Turn lower bearing and shaft assembly over. Remove O-ring. Push up on shaft to disengage shaft c-clips from spacer.


50448

12. Remove upper driveshaft c-clips and spacer from shaft.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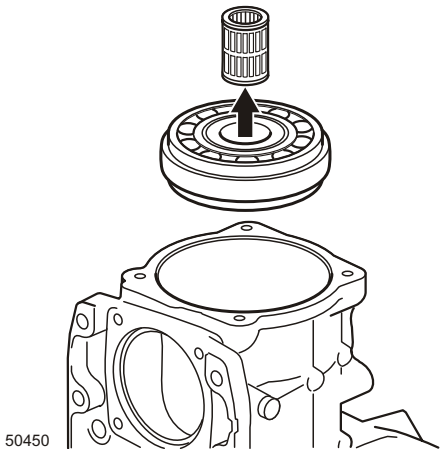
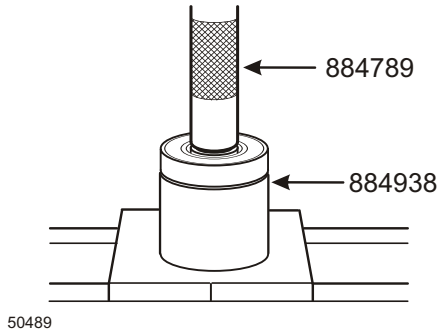



13. Remove lower gear/bearing assembly. Note and mark needle bearing orientation (top-to-bottom), then remove needle bearings from center of gear/bearing assembly.

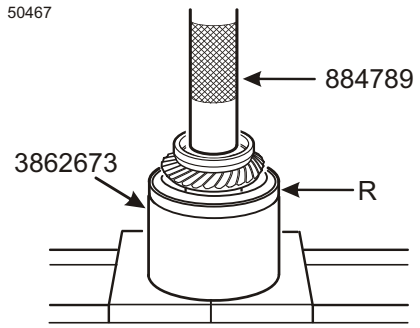
**Lower Output Gear Disassembly**

***NOTICE!*** **Only remove bearing from gear if bearing is defective. Bearing cannot be re-used if pressed off gear.**

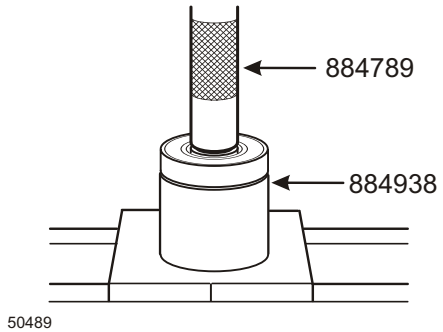



1. Place sleeve **884938**, large end up, in a press. Place rag in tool to protect gear. Place gear/bearing assembly into sleeve with gear facing down. Press gear from bearing using drift **884789**.

**Upper Output Gear Disassembly**

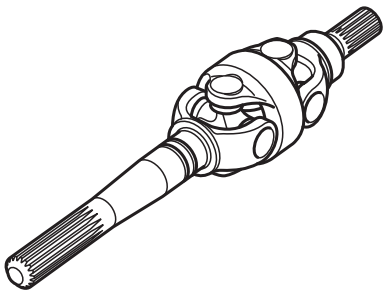



1. Remove bearing/gear from ring (R);
2. Place remover/installer **3862673**, large diameter end up, in a press. Place rag in tool to protect gear.
3. Place ring/gear/bearing assembly into tool with gear facing up.
4. Press gear/bearing through ring, use drift Volvo Penta p/n **884789**.




5. Place sleeve **884938**, large end up, in a press. Place rag in tool to protect gear.
6. Place gear/bearing assembly into sleeve with gear facing down.
7. Press gear from bearing using drift **884789**.

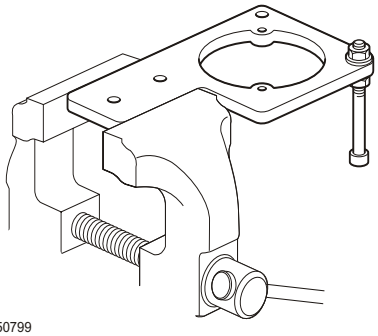
### Universal Joint Service



***NOTICE!*** **The universal joint is not servicable. No parts are offered for the u-joint. Testing has shown that when any part of the u-joint fails the other parts are also compromised.**
**The complete u-joint must be replaced.**

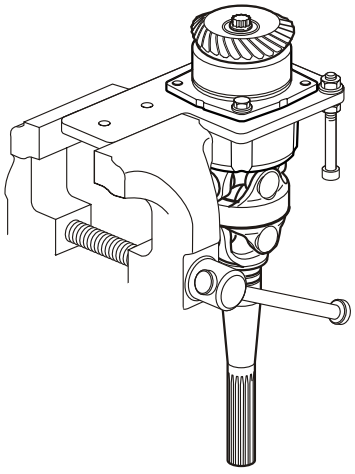
### Pinion Bearing Carrier Disassembly

1. Secure holding fixture **3849658** in vise as shown.



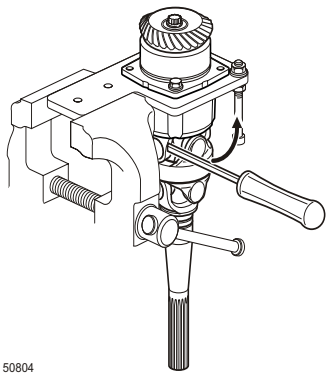
50799

2. Place bearing carrier in fixture as shown.
3. Use top cover screws to secure housing to fixture.
4. Tighten screws to secure housing in fixture.

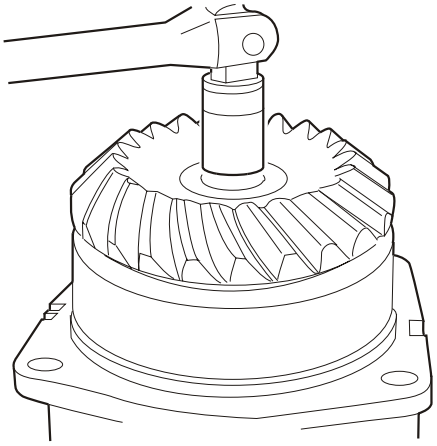


50800

5. Use prybar or large screwdriver through u-joint and against bolt on fixture to prevent u-joint from turning

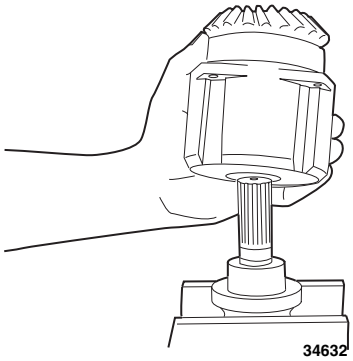


50804

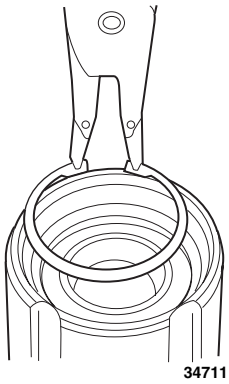


6. Remove pinion gear retainer screw using 11mm 12 point socket. Discard screw.
7. Remove the pinion gear retainer.

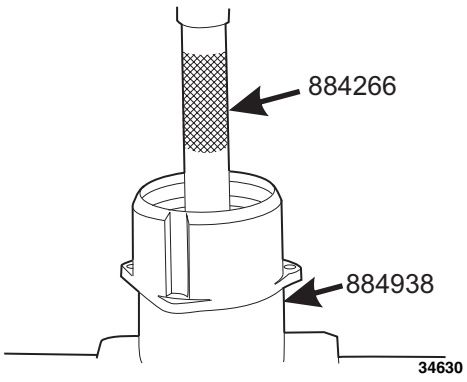
***NOTICE!*** **Pinion gear screw must not be reused. Proper torque cannot be achieved with a used screw.**



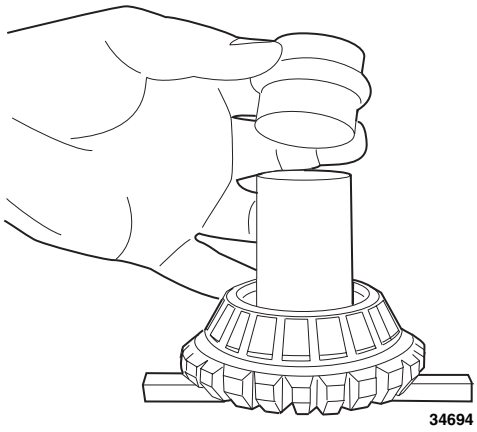

8. Carefully remove pinion bearing carrier from universal joint shaft. If pinion bearing carrier is stuck, a press may be used to remove universal joint shaft from pinion bearing carrier.




9. **Wear eye protection.** Remove seal retaining ring from pinion bearing carrier by using retaining ring pliers **3850608**.

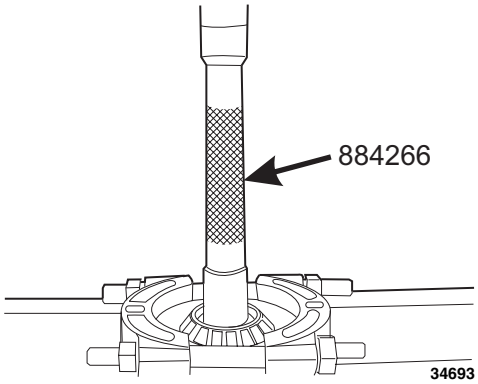



10. Place sleeve **884938**, large diameter up, in press. Place a rag inside tool to protect gear.
11. Place pinion bearing carrier into tool, gear side down.
12. Press out gear using drift **884266**.



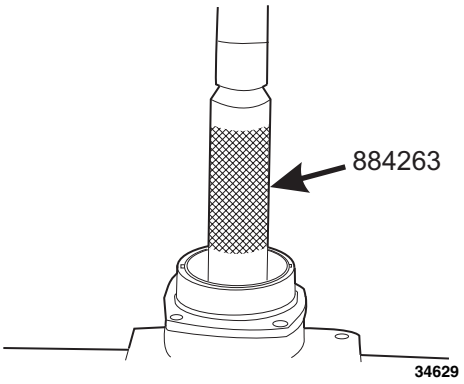

13. Remove pretension sleeve from input gear shaft and discard.

***NOTICE!*** **Pretension sleeves must not be reused. Proper rolling torque cannot be achieved with a used pretension sleeve.**

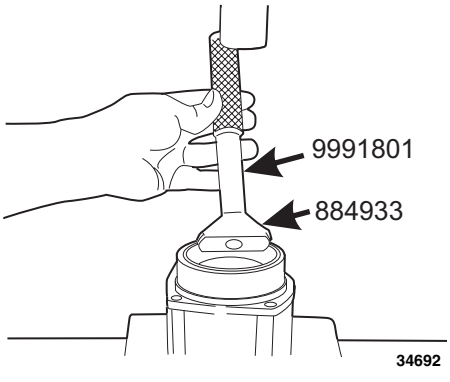



14. Clamp input gear and bearing in bearing separator, placing curved side of jaws behind bearing.
15. Remove gear from bearing using drift **884266**.

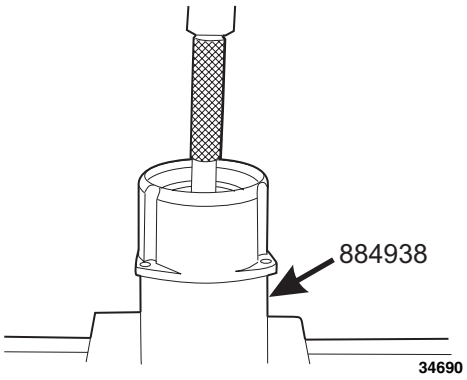
***NOTICE!*** **Do not remove bearing from input gear unless it is damaged. Removal destroys bearing. When replacing any tapered roller bearing, corresponding race must also be replaced.**




16. Place pinion bearing carrier in press with seal facing down. Press out seal and roller bearing using drift **884263**.



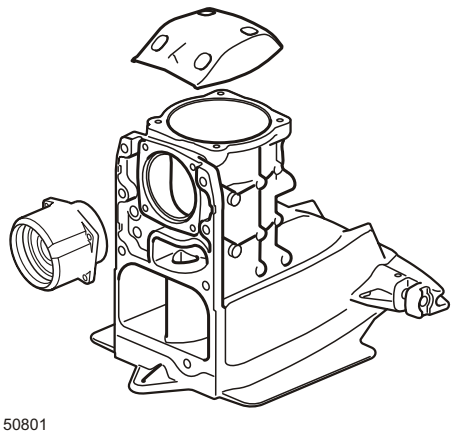

17. Install disassembly tool **884933** on end of shaft **9991801**.
18. Place pinion bearing carrier in press, large diameter down.
19. Press out small bearing race.




20. Place sleeve **884938** in press.
21. Turn pinion bearing carrier over and place it on tool.
22. Press large bearing out using tools in previous step.

### Gearhousing Cleaning and Inspection

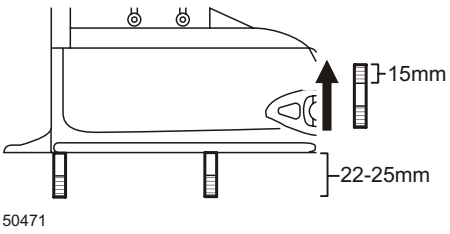
Clean housings in solvent to remove all sealer from screw holes, gasket surfaces, and O-ring bores. Dry housing thoroughly.




***NOTICE!*** **Most threaded holes in gearhousing have Heli-Coil® inserts. Do not use a thread tap to clean screw holes. Tap will damage Heli-Coil insert and make replacement necessary. Do not replace with standard non-locking Heli-Coils.**

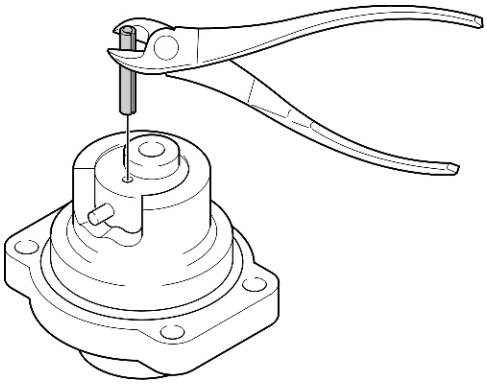
- **Retainer Threads** - lock ring must turn freely for full depth.
- **Cooling Passages** - check for corrosion build-up that would restrict water circulation.
- **Shaft and Gear Bore** - remove all sharp edges that would cut O-rings or seals.
- **Gears, Shafts and Bearings** - inspect gear teeth for cracks and chips or discoloration. If any gear is damaged all must be replaced. They are replaced as a set.
  Screw threads on end of shafts must be undamaged. Replace shaft if lock patch is excessively worn. Check for pitting, corrosion and discoloration.

### Upper Housing Stud Replacement

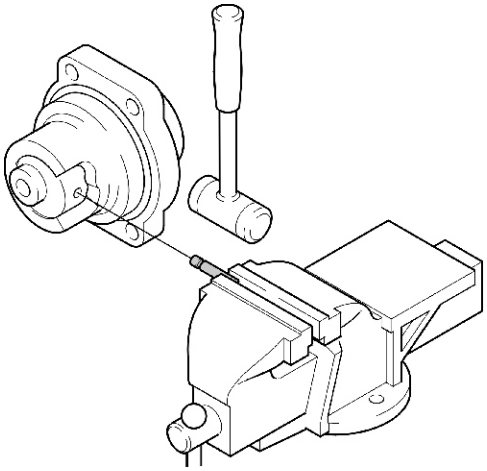



1. Remove stud(s) only if damaged.
2. Clean hole(s) of debris and sealer, do not use tap in hole.
3. Apply Loctite primer to threads on short end of stud and let air dry.
4. Apply thread locking compound **1161053** to threads.
5. Thread short end of stud (15mm) in hole until it bottoms.
   Mount studs to **height of 22-25mm** from bottom of housing**.**

### Shift Mechanism Overhaul

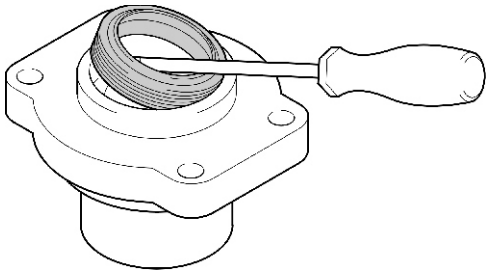


1. Inspect cone clutch and shift shoe, replace if excessively worn.
2. Remove shift shoe and spring. Scrap the O-ring.
3. Pull spring pin out with side cutting pliers.



4. Fix the pin in a vise.
5. Tap housing with a plastic faced mallet until it comes off pin.
6. Pull eccentric piston out of housing.

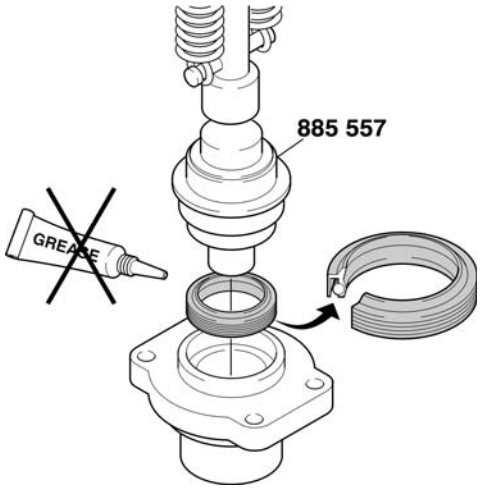
***NOTICE!*** **Take care not to damage the pin. A new pin must be used if the pin is damaged, do not reuse a damaged pin.**



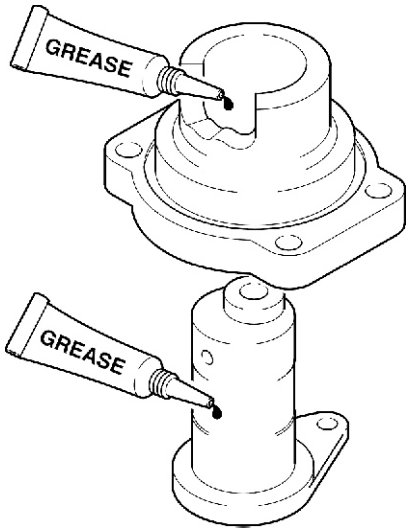
7. Pry the seal ring out with a screwdriver.

***NOTICE!*** **Take care not to damage the seal bore. If the bore is damaged during seal removal, a leak could develop when the drive is reassembled. Repace the shift housing if the seal bore is damaged.**

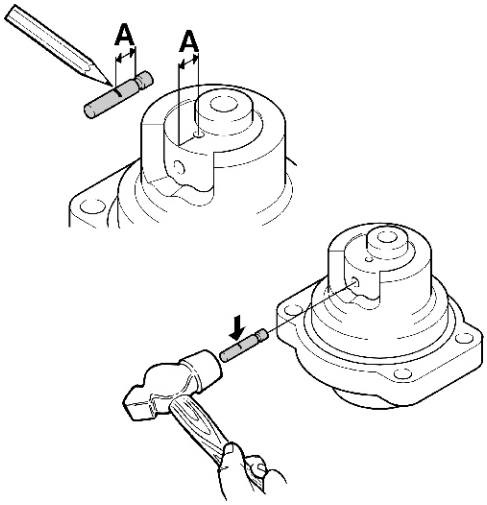
8. Clean and inspect all components in the gear shift mechanism.



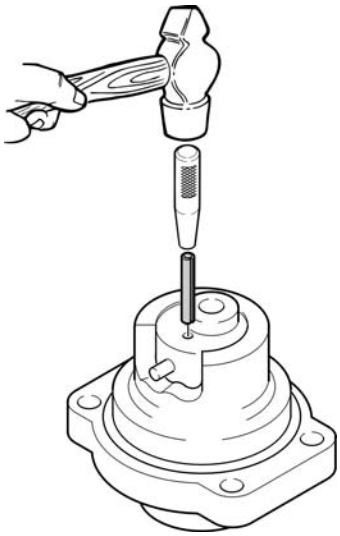

9. Thread a new seal onto mandrel **885557**.
10. Align the seal as in the illustration.
11. The seal must be pressed in dry (not greased).
12. Press the seal until it bottoms and maintain the press force for a few seconds to give the seal time to settle.




13. Grease the seal ring, eccentric piston and its seat in the gear shift mechanism.
14. Install the eccentric piston. Make sure not to damage the seal ring.




15. Tap the pin in so far that the milled cutout is level with the hole for the spring pin.

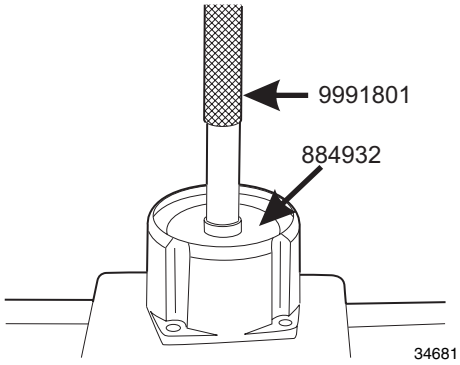


16. Tap the spring pin all the way.

***NOTICE!*** **The spring pin will project a couple of mm, when installed. Be careful not to damage the edge of the eccentric piston.**

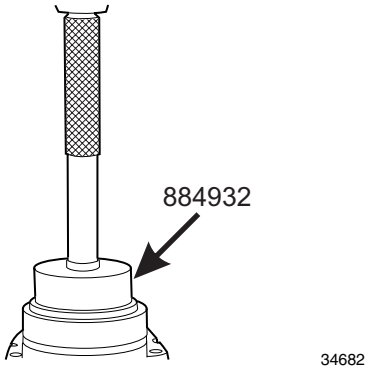
17. Do **not** install shift mechanism in housing at this time.

### Pinion Bearing Carrier Assembly

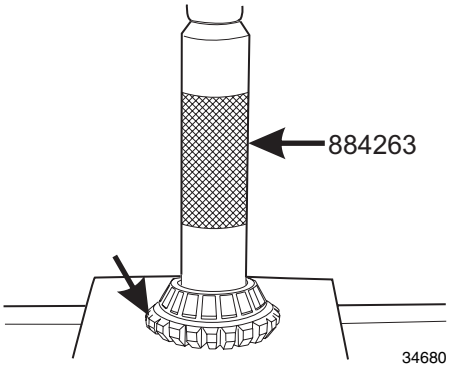



***NOTICE!*** **All references to gear oil in all assembly steps are referring to the same oil used to fill the drive; Volvo Penta GL5 Synthetic gear lubricant, SAE 75W-90.**

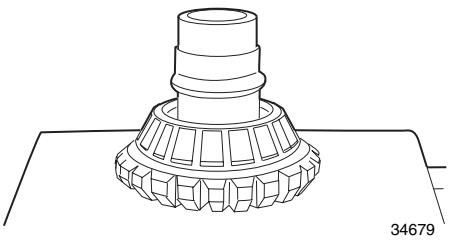
1. Place pinion bearing carrier in press with large opening up.
2. Lightly oil outside diameter of small bearing race with gear oil and set it in carrier.
3. Press race in until it seats, using assembly tool **884932**, large diameter up, and shaft **9991801**.




4. Turn pinion bearing carrier over and set it in press.
5. Lightly oil outside of large bearing race with gear oil and set it in carrier.
6. Assemble special tools used in previous step with large diameter of assembly tool **884932**, facing down.
7. Press race in until it seats.

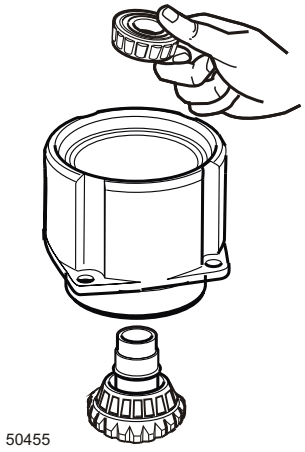



8. Coat pinion gear shaft with gear oil and set it in press.Protect gear teeth.
9. Position large tapered roller bearing on input gear and press it until it seats, using drift **884263**.

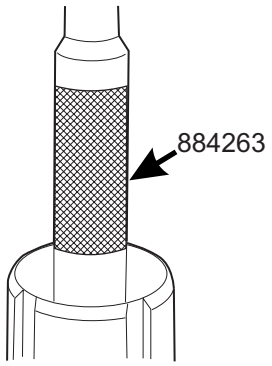



10. Place a new pretension sleeve on input shaft.

***NOTICE!*** **A new pretension sleeve must be used to achieve proper rolling torque.**


50455

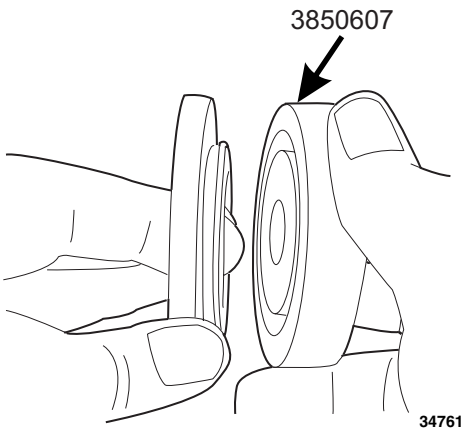
11. Oil large and small roller bearings with gear oil.
12. Place pinion bearing carrier on top of input gear.
13. Place small bearing on top of input bearing shaft.



34676

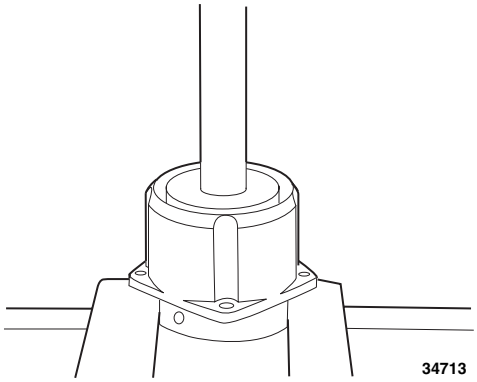
14. Press small bearing onto shaft using drift **884263**, until all end play is removed.

***NOTICE!*** **This is the starting point for determining rolling torque of the pinion bearing carrier. Use caution. Do not press the bearing on too far. If the pretension sleeve is distorted by pressing the bearing on too far, proper rolling torque cannot be achieved. The carrier will have to be disassembled and pretension sleeve replaced.**

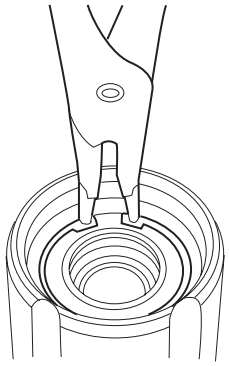


34761

15. Place protruding lip of seal into recess of seal installer **3850607**.


34713

16. Press seal into pinion bearing carrier until it seats.

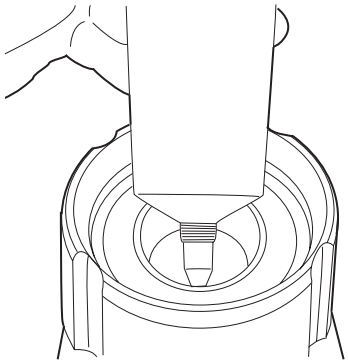


34712

**⚠ WARNING! Always wear eye protection when removing or installing snap rings.**

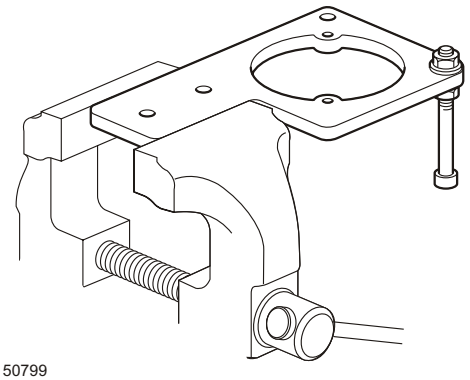
17. Install seal retaining ring in its groove in pinion bearing carrier using retaining ring pliers **3850608**. Make sure retaining ring seats completely.

18. Coat seal lips with grease **828250**.



34704

19. Secure holding fixture **3849658** in vise.



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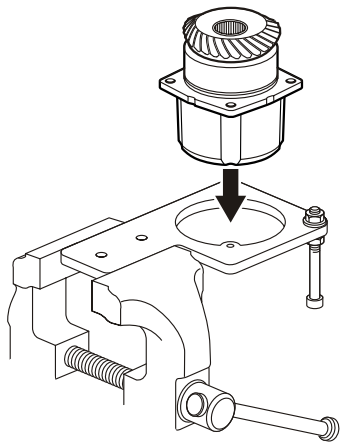
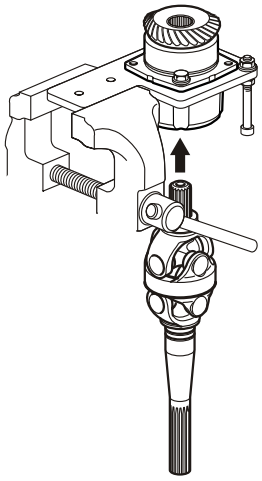
20. Place bearing carrier in fixture as shown.
21. Use top cover screws to secure housing to fixture.
22. Tighten screws to secure housing in fixture.

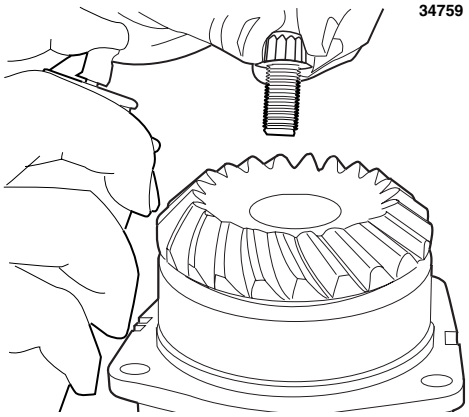


50802



50803

23. Carefully insert universal joint shaft through seal and engage splines of input gear.

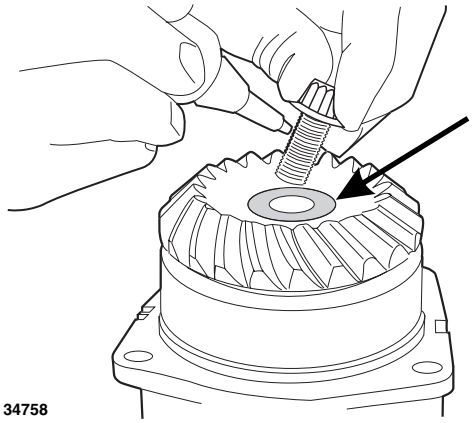


34759

24. Spray threads of universal joint shaft and new pinion gear retainer screw with Loctite primer “N” and allow to air dry.

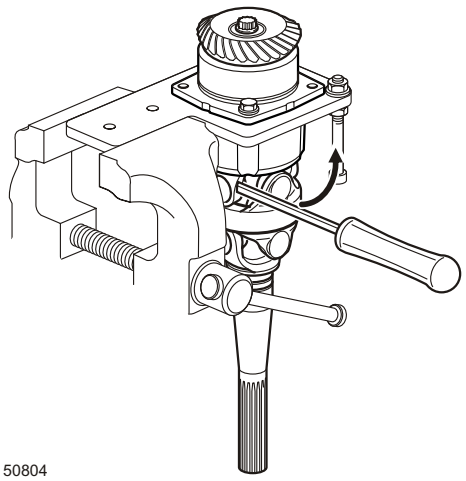
***NOTICE!*** **Pinion gear screw must not be reused. Use new screw supplied with u-joint or order new screw from Parts. Proper torque cannot be achieved with a used screw.**

⚠ **CAUTION! Follow the manufacturer’s safety precautions when applying Loctite Primer N from an aerosol container.**



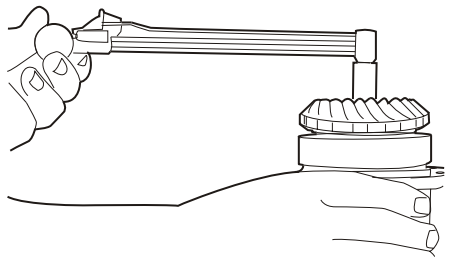
34758

25. Place pinion gear retainer on top of input gear.
26. Apply thread locking fluid **1161053** to screw threads.



50804

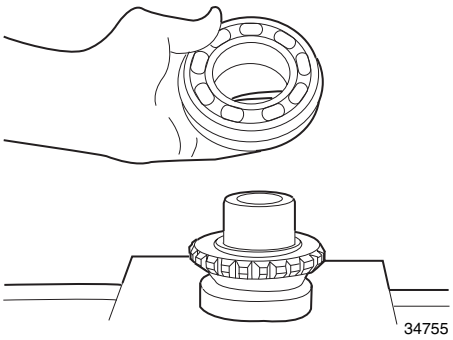
27. Use prybar or large screwdriver through u-joint and against bolt on fixture to prevent u-joint from turning



28. Install screw, tighten a little at a time using 11mm 12 point socket.
29. Turn pinion bearing carrier while tightening screw to seat bearings.
30. Frequently remove assembly from vise to check rolling torque. Stop when rolling torque reaches **9-14 in. lb. (1,0-1,6 N·m)**.

***NOTICE!*** **If the rolling torque is exceeded, the pinion bearing carrier will have to be disassembled and a new pretension sleeve installed.**

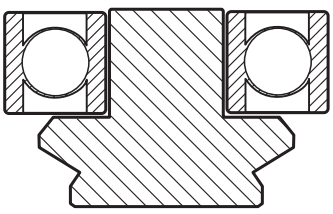
### Lower Output Gear Assembly



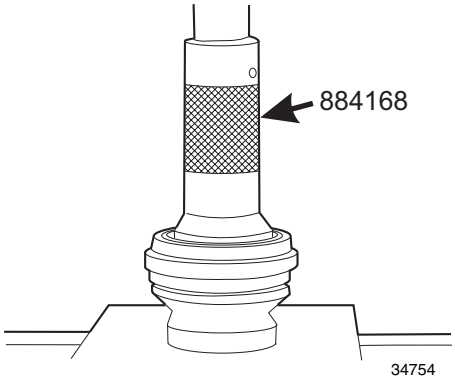
34755

1. Place lower gear in a press. Protect gear face. Lightly oil inside diameter of bearing with gear oil.

2. Place bearing on top of gear.



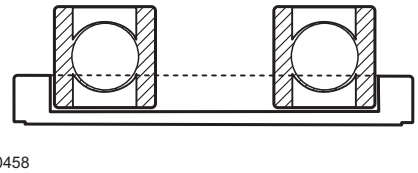
50457



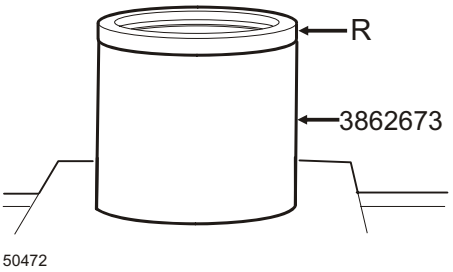

3. Press bearing in place until it seats, using drift **884168**.

**Upper Output Gear Assembly**

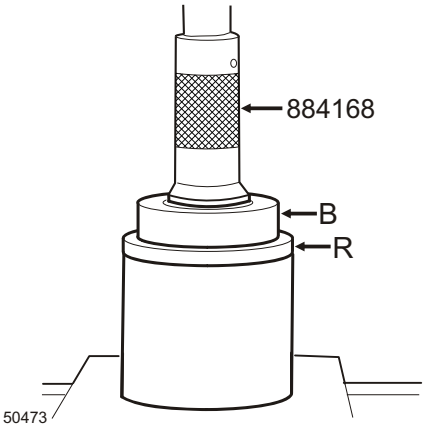
1. Press bearing in to ring;



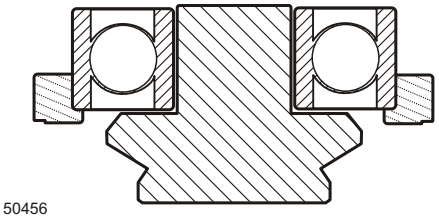

2. Place sleeve **3862673**, large diameter end up, in a press.
3. Lightly oil inside diameter of ring with gear oil.
4. Place ring (R) on top of the sleeve, inner lip down.

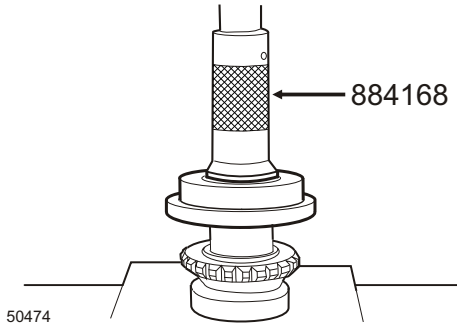



5. Place bearing (B) in ring (R).
6. Press bearing in place until it seats, using drift **884168**.




7. Press bearing/ring on to gear;



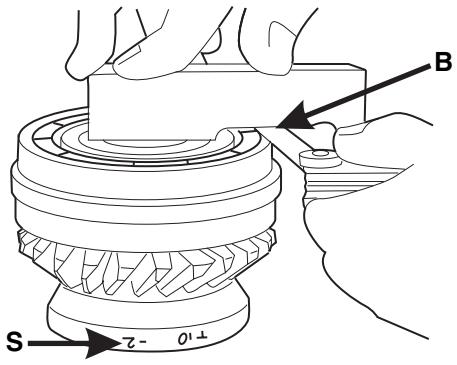



8. Place upper gear in a press. Protect gear face.
9. Lightly oil inside diameter of bearing with gear oil.
10. Place bearing/ring on top of gear.
11. Orient bearing/ring as shown above.
12. Press bearing in place until it seats, using drift **884168**.

***NOTICE!*** **The following procedures will set gear position for the input, lower and upper output gears. Record all measurements for future reference.**

***NOTICE!*** **All mating, thrust and bearing faces must be clean. Shims to be used during assembly must be clean and undamaged. No less than one shim but no more than six shims should be used.**

### Lower Output Gear Shimming




1. Place gear/bearing assembly, gear down, on flat surface.

   Protect gear cup surface.

   Place shim tool **3849650**, on assembly as shown.

   Apply light pressure to hold shim fixture properly on gear. Fixture should be level across top of gear shaft.
2. Take a feeler gauge measurement (B) at outer edge of bearing.

   Record this measurement, in inches.
3. Find etching on gear, +/- number is shimming allowance (S).

   Number represents thousandths of an inch (0.00X”).

   2 in picture = 0.002”

   Add or subtract (S) from measurement (B).

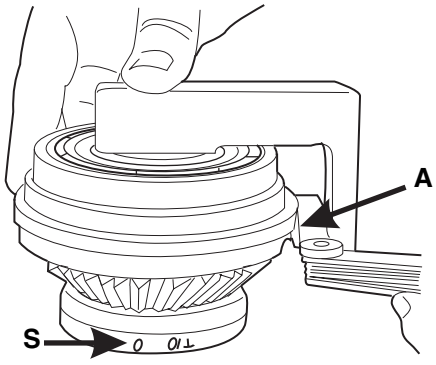
   This is shim thickness required to properly position lower output gear in upper gear housing.

***NOTICE!*** **For lower gear, use the following information when adding or subtracting etching (S) from measurement (M).**

**Example;**

- If etched number is +2, **SUBTRACT** 0.002 in. from the feeler gauge measurement (B).
- If etched number is -2, **ADD** 0.002 in. to the feeler gauge measurement (B).
- If etched number is zero (0), use feeler gauge measurement (B) to determine shims.

### Upper Output Gear Shimming




1. Place gear/bearing/ring assembly, gear down, on flat surface.

   Protect gear cup surface.

   Place shim tool **3849650**, on assembly as shown.

   Apply light pressure to hold shim fixture properly on gear. Fixture should be level across top of gear shaft.

2. Take feeler gauge measurement (A) at **outer, lower edge of ring**.

   Record this measurement, in inches.

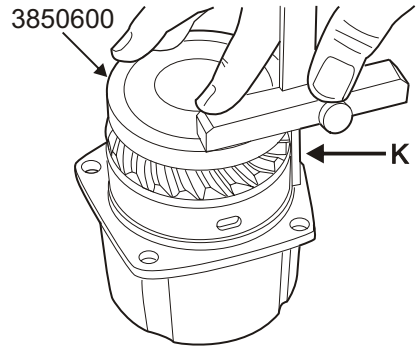
3. Find etching on gear, +/- number is shimming allowance (S). Number represents thousandths of an inch (0.00X”).
   5 in picture = 0.005”
   Add or subtract (S) from measurement (A).
   This is shim thickness required to properly position lower output gear in upper gear housing.

***NOTICE!*** **For upper gear, use the following information when adding or subtracting etching (S) from measurement (M).**

**Example;**

- If etched number is +5, **ADD** 0.005 in. to the feeler gauge measurement (A).
- If etched number is -5, **SUBTRACT** 0.005 in. from the feeler gauge measurement (A).
- If etched number is zero (0), use feeler gauge measurement (A) to determine shims.

### Pinion Bearing Carrier Shimming




50477

1. Position shim fixture **3850600** on top of pinion gear, recessed side facing up.
   Using a vernier caliper or depth micrometer that reads in inches, measure actual dimension from top of tool to surface of pinion bearing carrier (H). Measure in at least three places, then take an average (A).
   Stay away from the bolt holes to get an accurate reading.
   Subtract 0.500 in. from this measurement.

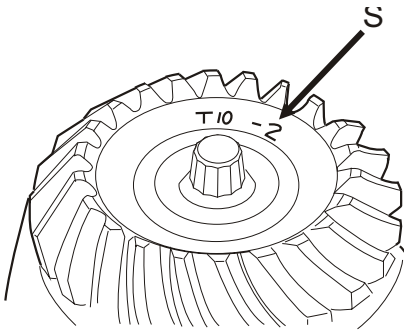
**Example;**

H = 2.692”, 2.688”, 2.687’, average (A) = 2.689

2.689” average dimension

- 0.500” , thickness of shim fixture

2.189” actual dimension (D), save for next step.




50479

2. Find etching on gear, +/- number is shimming allowance (S). Number represents thousandths of an inch (0.00X").
   2 in pucture = 0.002"
   Add or subtract (S) from actual dimension (D).

***NOTICE!*** **For pinion gear, use the following information when adding or subtracting etched allowance figure from dimension (D).**

**Example;**

- If etched number is +5, **ADD** 0.005 in. to the dimension (D).
- If etched number is -5, **SUBTRACT** 0.005 in. from the dimension (D).
- If etched number is zero (0), use dimension (D) in next step.

**Example;**

2.189 in. - dimension (D)

- 0.002 in. - shimming allowance (S)

2.187 in. - Total (T)

3. **SX 1.79:1, 1.97:1, 2.18:1 and DPS 2.11:1 and 2.32:1 Ratios Only:** Subtract the nominal figure 2.171" from the (T).
   **All Other Ratios:** Subtract the nominal figure 2.244" from (T).
   This figure is thickness of shims required to properly position pinion gear in upper gear housing.

**Example;**
Subtract

2.187 in. - Total (T)

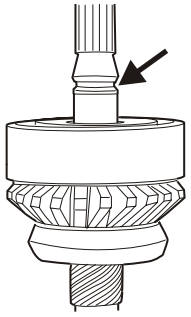
- 2.170 in. - nominal figure

0.017 in. - Thickness of shims needed

***NOTICE!*** **Shims are to be placed between the bearing carrier and the upper gear housing. No less than one shim but no more than five shims should be used. Shims to be used must be clean and undamaged.**

# Upper Gear Housing Assembly

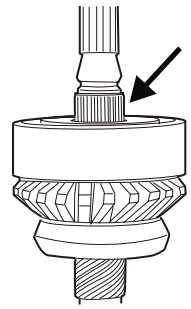
### Lower Output Gear and Shaft Assembly



50481

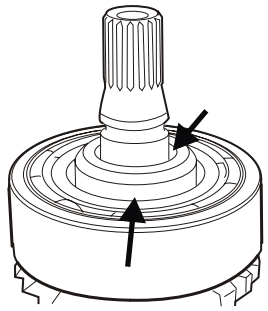
*NOTICE!* **All references to gear oil in all assembly steps are referring to the same oil used to fill the drive; Volvo Penta GL5 Synthetic gear lubricant, SAE 75W-90.**

1. Place upper shaft through lower output gear/bearing assembly. Groove must be on same side as bearing.



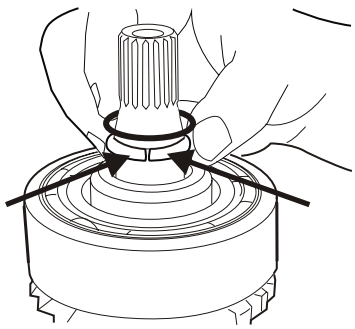
50482

2. Lightly oil lower needle bearings with gear oil.
3. Install needle bearings onto upper driveshaft with same top-to-bottom orientation as when disassembled.
4. New bearings can be installed with either end up.
5. Push bearing all the way into gear.



50483

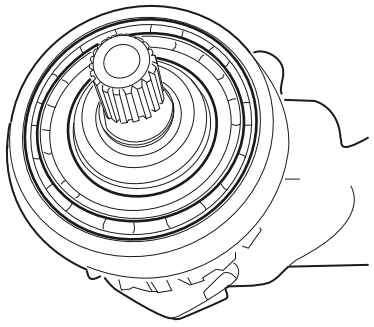
6. Place spacer on upper shaft with recess facing up.



50484

7. Place two c-clips into groove on upper shaft.
8. Place O-ring over clips, in groove inside spacer.

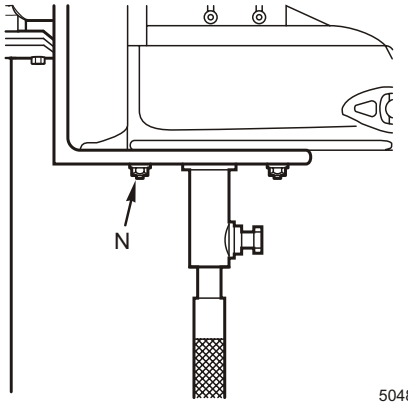
9. Move shaft down to capture c-clips in recess of spacer.



50485

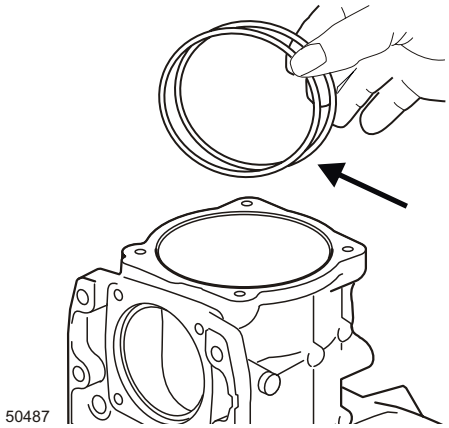
### Lower Output Gear Installation

1. Mount upper gear housing on holding fixture **3849651.** Secure housing to fixture with 4 nuts (N) on studs.

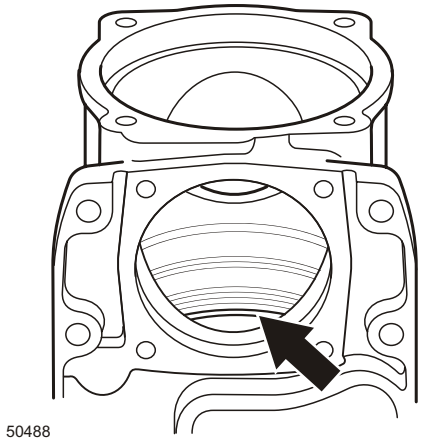



50486

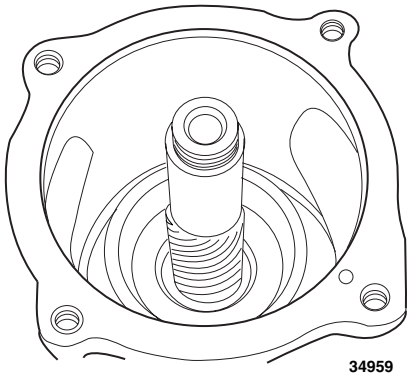
2. Place required amount of shims for lower gear/bearing into upper gear housing.



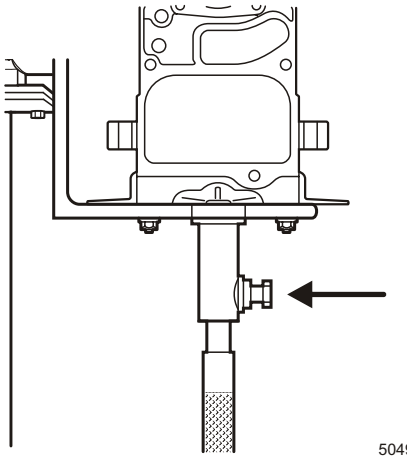
50487


50488

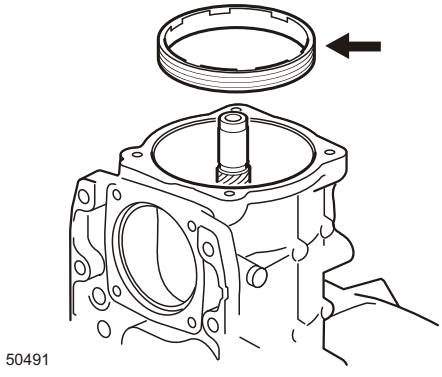
3. Place shims on bottom bore as shown. Shims go on surface where bearing is mounted.


34959

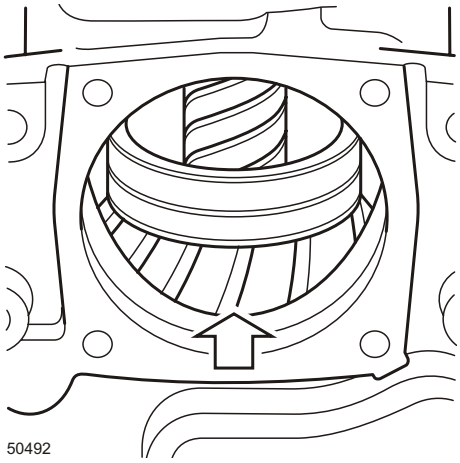
4. Place lower gear/bearing assembly, bearing down, on shims.


50490

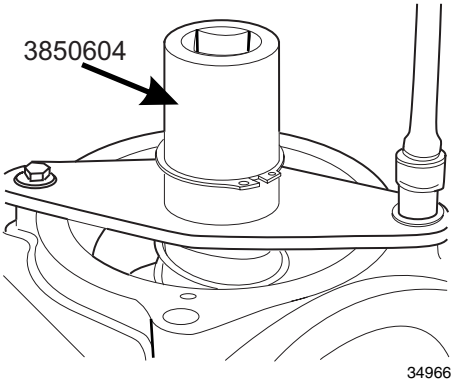
5. Loosen locking screw and adjust fixture shaft until there is a small amount of vertical play in drive shaft. Re-tighten fixture bolt.


50491

6. Lightly oil retainer ring with gear oil.
7. Install ring in housing, teeth upwards.
8. Thread ring in by hand until it seats on bearing.

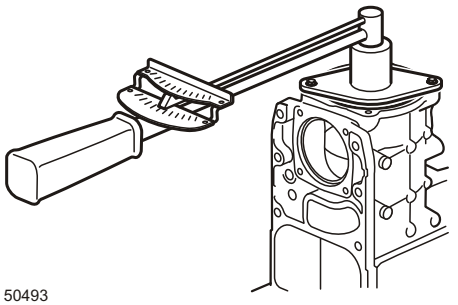

50492

9. When fully seated, retainer ring will be below bottom edge of pinion bearing carrier opening.



34966

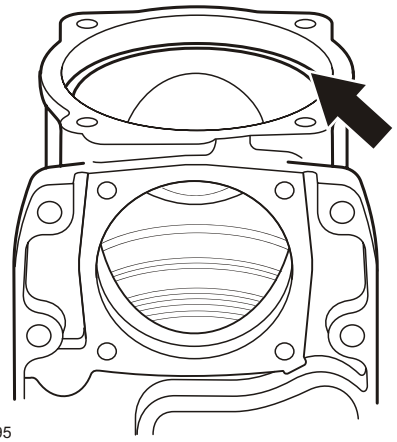
10. Install spanner wrench **3850604**, and secure tension arm with two top cover screws. Spanner must be updated with new plate **3861651**, original plate will not mate to housing.
11. Tighten cover screws down evenly, alternating every two turns.
12. Tighten cover screws securely.


50493

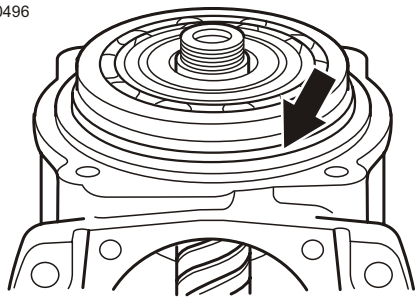
13. Torque retainer ring to 145-165 ft. lb. (196-225 N·m).
14. Remove two screws from tension arm, then remove spanner.

⚠ **CAUTION Use caution when removing screws from tension arm, arm is under spring tension.**

### Upper Output Gear Installation

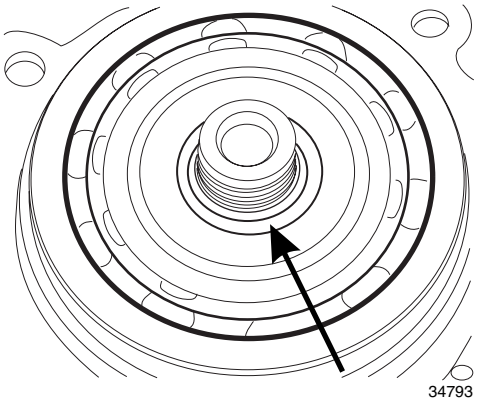

50495

1. Place required amount of shims for upper gear/bearing/ring in upper gear housing. Place shims on upper bore as shown. Shims go on surface where bearing ring is mounted. Bearing ring sits in machined surface at top of housing.


50496

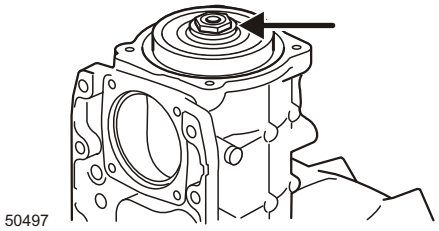
2. Place upper gear/bearing/ring in top of housing and over shaft. If needed, **lightly** tap bearing ring to seat it in housing. Be careful not to disturb the shims when installing bearing ring.

***NOTICE!*** **You may have to loosen the four nuts that secure the upper housing to the holding fixture, to center the housing and shaft. This will make installation of the upper output bearing assembly easier.**


34793

3. Apply gear oil to upper needle bearings.
4. Place needle bearing on top of shaft. Maintain same top-to-bottom orientation as during disassembly. New bearings can be installed with either end up.
5. Push needle bearing all the way into gear.

### Shimming Vertical Movement Of Upper Driveshaft

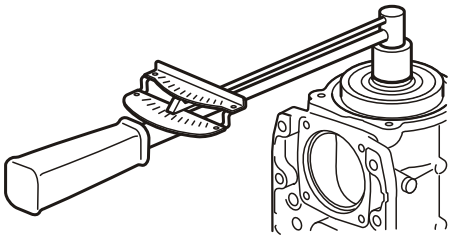

50497

Correct vertical clearance (up and down movement of the upper driveshaft) is controlled by the top nut that secures shaft.
There are four top nuts, with shoulders of different thicknesses.

1. Apply gear oil to shaft threads to prevent galling.
   Install a top nut on shaft.

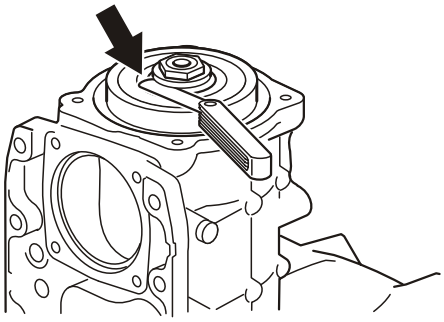
***NOTICE!*** **Nut has a left-hand thread.**

50498



2. Torque nut to 96-110 ft. lb. (130-150 N.m).

50499



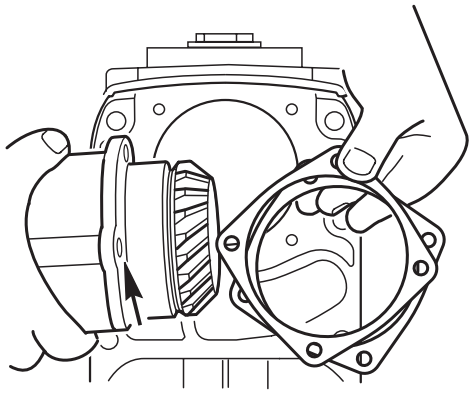
3. Push up on holding fixture shaft to remove end play in shaft. Measure clearance between the top nut and upper gear. Vertical clearance should be **0.002-0.010 in. (0,05-0,25 mm)**. If clearance is high, install thicker nut. If clearance is low, install a thinner nut. Thickness of nut is determined by number on top of nut.

| Number Marking | Thickness | | Part Number |
|---|---|---|---|
| 0 | 0.000 in. | 0.00 mm | 3852301 |
| 2 | 0.008 in. | 0.20 mm | 3852302 |
| 4 | 0.016 in. | 0.40 mm | 3852303 |
| 6 | 0.024 in. | 0.60 mm | 3852375 |

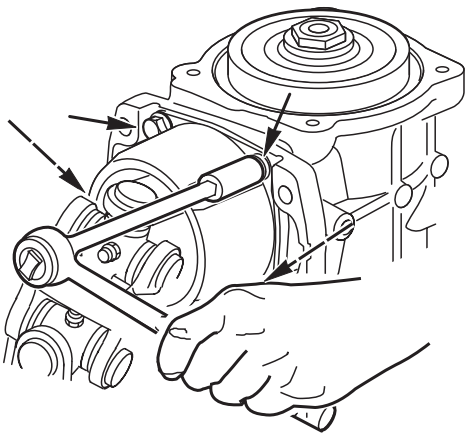
4. Retighten top nut to specified torque, measure clearance again.

***NOTICE!*** **If proper clearance is not obtainable with any of the four nut sizes, make sure the upper gear, bearing and ring are correctly assembled. If no problems are found in upper gear, also check lower gear.**

### Pinion Bearing Carrier Installation

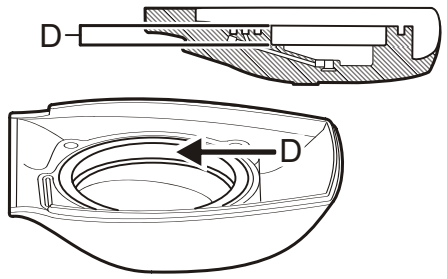


1. Place required amount of shims for pinion gear position on pinion bearing carrier. Do not install an O-ring at this time.



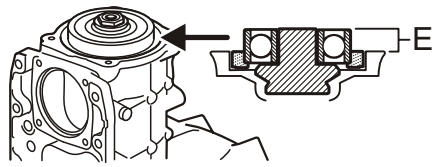
2. Install pinion bearing carrier into gear housing and secure with four screws.
3. Torque screws, in a crossing pattern, to 15-20 ft. lb. (20-28 N•m).

**Top Cover Shimming**




50501

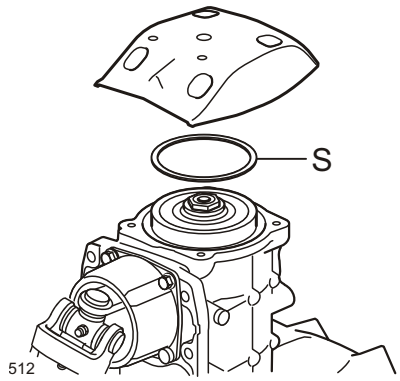
1. Measure in inches, depth of bearing seat in top cover. Save as measurement D.




50502

2. Measure in inches, height of installed bearing above gear housing. Save as measurement E.
3. Subtract E from D. Add 0.005” to determine shim thickness.

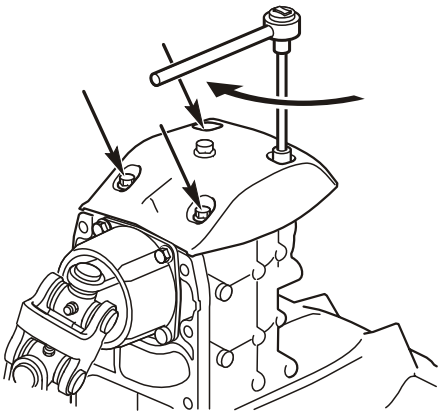
**Top Cover Installation**




512

1. Install cover and shims over bearing. Do not install seal.

50511

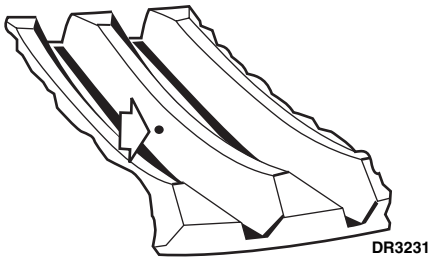


2. Install 4 screws in cover.
3. Torque screws, in a crossing pattern, first pass to 6-9 ft. lb. (8-12 N•m). final pass to 15-20 ft. lb. (20-28 N•m).

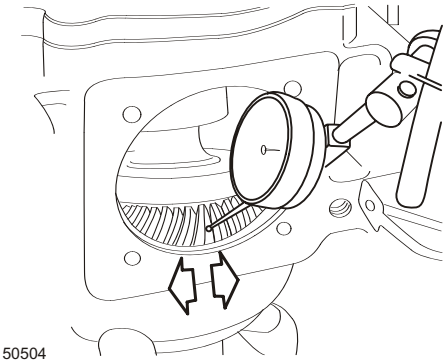
## Checking Gear Lash

This procedure will check the relative clearance between the pinion gear and the upper and lower output gears.

### Lower Gear



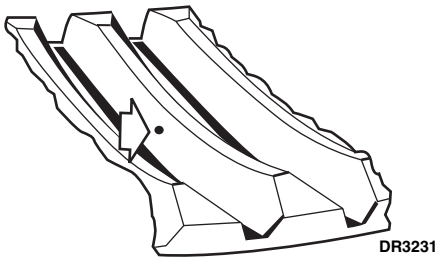

1. Attach a dial indicator to gear housing.
2. Place indicator tip at midpoint of a lower gear tooth.
3. Proper indicator placement is important for an accurate reading.



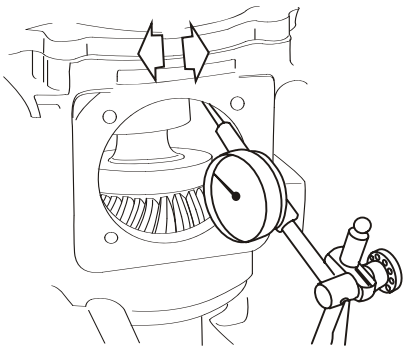
50504

4. Zero indicator.
5. With your finger, gently rotate gear first in one direction until tooth contact is felt, then in other direction. Do not turn gear far enough to rotate universal joint, just far enough to contact pinion gear in both directions.
6. Correct gear lash is **0.006-0.011 in. (0,15-0,28 mm)**.
7. Record your measurements.

### Upper Gear



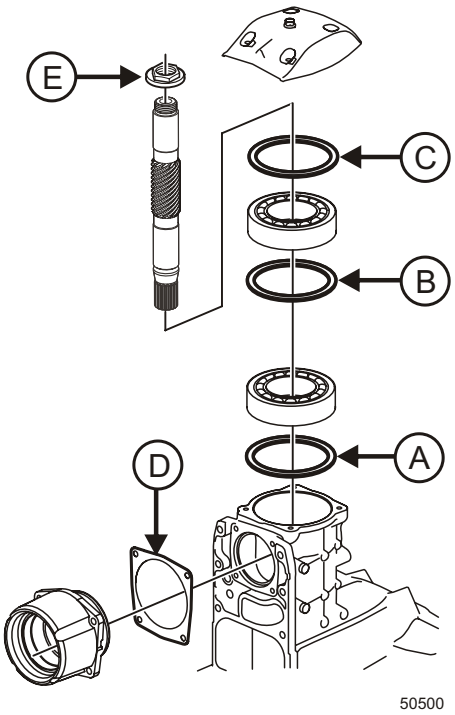

1. Reposition indicator tip to contact midpoint of an upper gear tooth.



50505

2. Zero indicator.
3. With your finger, gently rotate gear first in one direction until tooth contact is felt, then in other direction. Do not turn gear far enough to rotate universal joint, just far enough to contact pinion gear in both directions.
4. Correct gear lash is **0.006- 0.011 in. (0,15-0,28 mm)**.
5. Record your measurements.

**Correcting Gear Lash**




50500

If both readings are different, yet within each gear's specified range, gear lash is correct.

Gear lash measurements that are incorrect will fall into one of the categories below. Refer to chart and drawing when determining how to change gear lash. Make all shim changes at Position (A) first, then at (B), (C), (D) and (E) in that order.
Determine amount of change by either subtracting range mid-point from reading, or by subtracting reading from range mid-point.

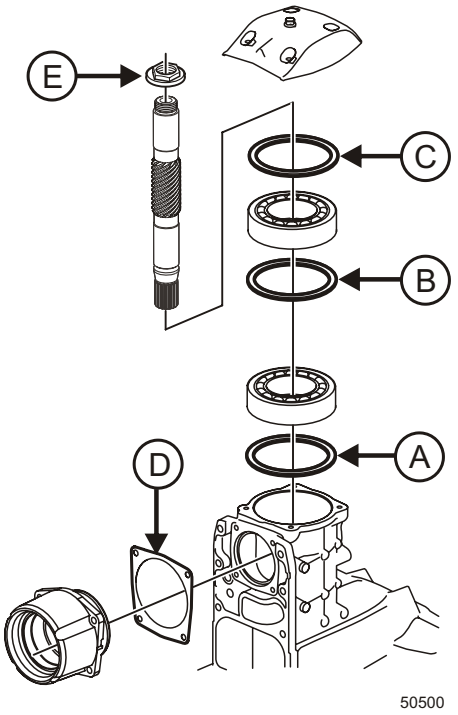
A change to shim (D) affects gear lash of both upper and lower output gears.

A change to shim (B) affects gear lash of upper output gear only.

A change to shim (A) affects gear lash of lower output gear only.

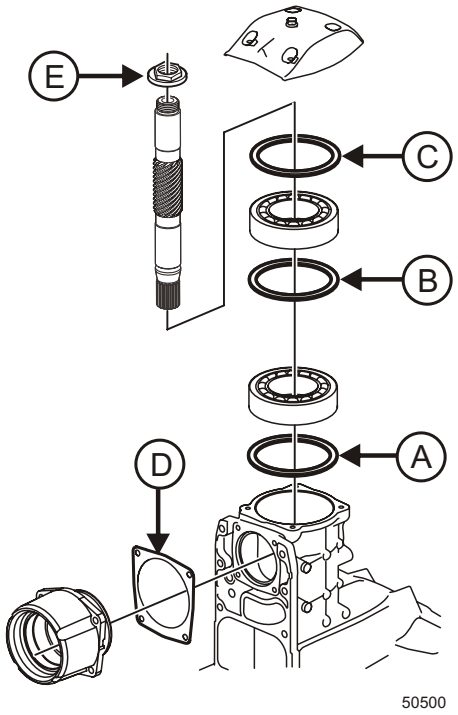
**One Gear Correct, One Gear Requires Change**
Add or subtract **same amount of shims** at each location indicated.

| | Positions Requiring Shim Change | | | | |
|---|---|---|---|---|---|
| **Condition** | **A** | **B** | **C** | **D** | **E** |
| Lower gears less than range min.<br>Upper gear within range | Subtract | * | * | * | Re-shim |
| Lower gear greater than range max.<br>Upper gear within range | Add | * | * | * | Re-shim |
| Upper gear less than range min.<br>Lower gear within range | * | Add | Re-shim | * | Re-shim |
| Upper gear greater than range max.<br>Lower gear within range | * | Subtract | Re-shim | * | Re-shim |
| * No Change Required | | | | | |




**Both Gears Incorrect By Same Amount**
Add or subtract same amount of shims at each location indicated

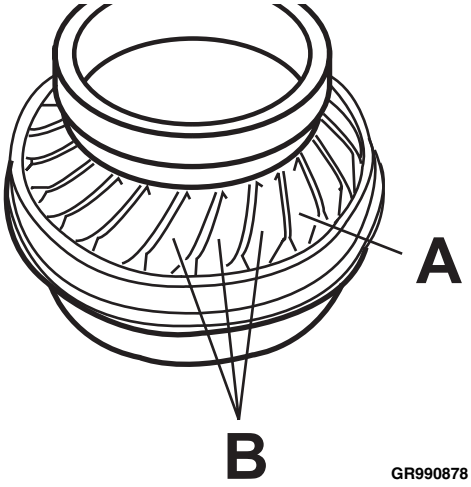
| | Positions Requiring Shim Change | | | | |
|---|---|---|---|---|---|
| **Condition** | **A** | **B** | **C** | **D** | **E** |
| Upper gear greater than range max.<br>Lower gear less than range min. | Subtract | Subtract | Re-shim | * | Re-shim |
| Lower gear greater than range max.<br>Upper gear less than range min. | Add | Add | Re-shim | * | Re-shim |
| Lower gear less than range min.<br>Upper gear less than range min. | * | * | * | Add | * |
| Lower gear greater than range max.<br>Upper gear greater than range max. | * | * | * | Add | * |
| * No Change Required | | | | | |




**Both Gears Incorrect By Different Amount**
Add or subtract same amount of shims at each location indicated

| | Positions Requiring Shim Change | | | | |
|---|---|---|---|---|---|
| **Condition** | **A** | **B** | **C** | **D** | **E** |
| Upper gear greater than range max.<br>Lower gear less than range min. | Subtract | Subtract | Re-shim | * | Re-shim |
| Lower gear greater than range max.<br>Upper gear less than range min. | Add | Add | Re-shim | * | Re-shim |
| Lower gear less than range min.<br>Upper gear less than range min. | Subtract | Add | Re-shim | * | Re-shim |
| Lower gear greater than range max.<br>Upper gear greater than range max. | Add | Subtract | Re-shim | * | Re-shim |
| * No Change Required | | | | | |

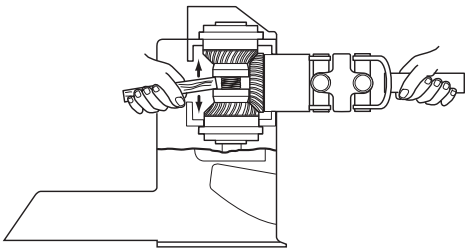
### Checking Gear Teeth Contact Pattern



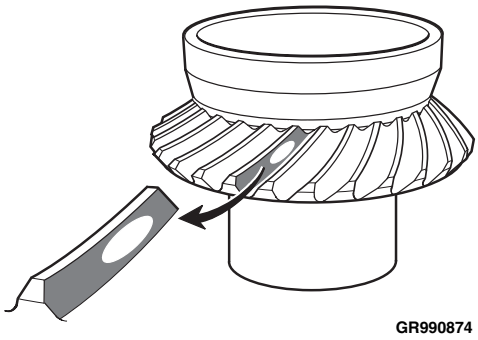
GR990878

1. In order to achieve long gear life and smooth running with minimum noise, you **MUST** obtain proper gear tooth contact pattern. The contact pattern will give you a visual clue as to where the teeth are meshing with each other. The proper pattern on the upper gear unit will be checked on the driven gears, (upper and lower) on their respective convex sides.
2. Paint three teeth (B) on both the upper and lower driven gears on their convex sides (A) with gear marking compound as shown. You can access the gears through the shift mechanism hole. The convex side of the gear teeth should be lightly covered from heel to toe and from crest to root.

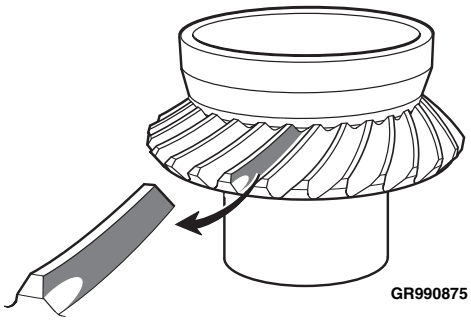
***NOTICE!*** **The clutch cone should not be installed during this procedure.**



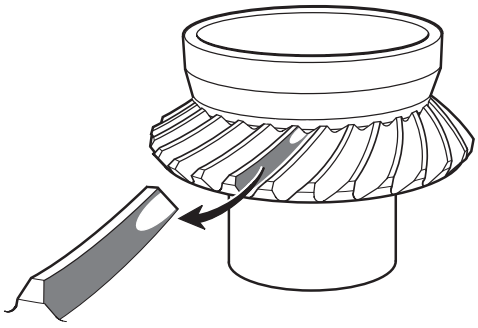
3. Insert a piece of wood, approximate size 1 in. x 2 in. x 6 in. (25mm x 50mm x 150mm) through the shift mechanism hole between the upper and lower gear cups. Load the gears with the piece of wood while turning the input gear at least six times in the direction of engine rotation (clockwise as viewed from the front of the drive. This procedure will require the assistance of another person to turn the input gear.


GR990874

4. Dismantle the gear set and compare the contact pattern to that of the picture. This picture shows the desired contact pattern for the drive side of the forward and reverse gear. The drive side is the convex side of the gear. The dye pattern should be nearly oval in form and be positioned half way up on the gear tooth. It should be displaced towards the small end of the tooth.


GR990875

5. If the dye pattern shows contact as shown in picture, shim thickness behind pinion carrier housing must be reduced (i.e. move the drive gear toward the driven gears.) The driven gears must be shimmed outward the same amount to maintain correct backlash



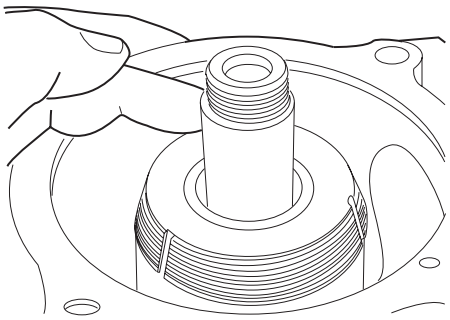
GR990876

6. If the dye pattern shows contact as shown in this picture, shim thickness behind pinion carrier housing must be increased, (i.e. the drive gear is moved away from the driven gears.) The driven gears must be shimmed inward to maintain correct backlash.

**Final Assembly of Upper Gear Housing**

After gear lash and contact pattern are correct, remove the follwing parts, see disassembly steps earlier in this section;

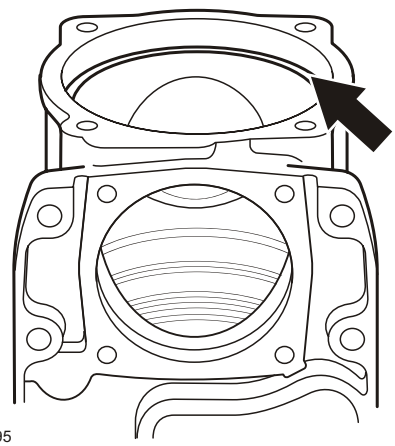
1. Remove pinion bearing carrier.
   Save shims for final assembly.
2. Remove top cover from housing.
   Save shims for final assembly.
3. Remove top nut from upper gear.
4. Remover upper gear/bearing/ring assembly.
   Save shims for final assembly.
5. Install cone clutch on shaft with the word “TOP” facing **UP**.
   Slowly let cone clutch spin down shaft helix.



34970

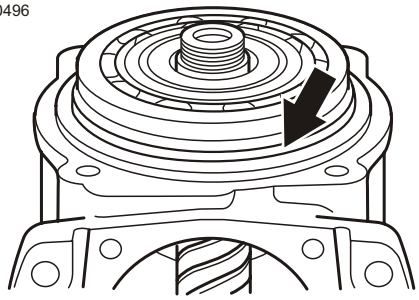
**Upper Gear Installation**

1. Place required amount of shims for upper gear/bearing/ring in upper gear housing.
2. Place shims on upper bore as shown. Shims go on surface where bearing ring is mounted.



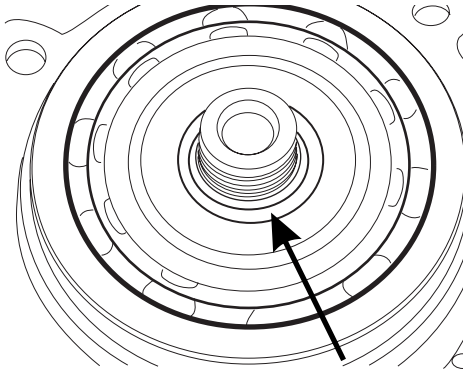
50495

50496



3. Place upper gear/bearing/ring in top of housing and over shaft. If needed, **lightly** tap bearing ring to seat it in housing. Be careful not to disturb the shims when installing bearing ring.

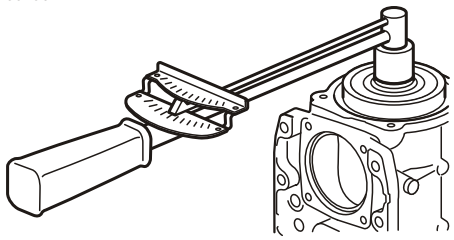
***NOTICE!*** **You may have to loosen the four nuts that secure the upper housing to the holding fixture, to center the housing and shaft. This will make installation of the upper output bearing assembly easier.**



34793

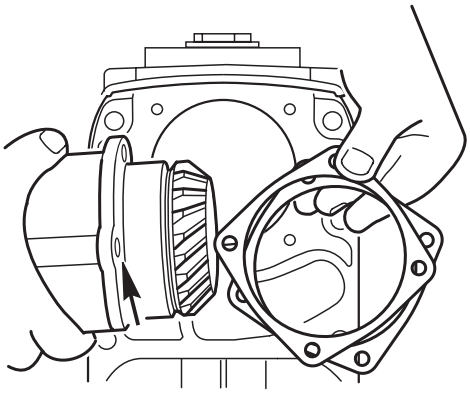
4. Apply gear oil to upper needle bearings.
5. Place needle bearing on top of shaft. Maintain same top-to-bottom orientation as during disassembly. New bearings can be installed with either end up.
6. Push needle bearing all the way into gear.

50498

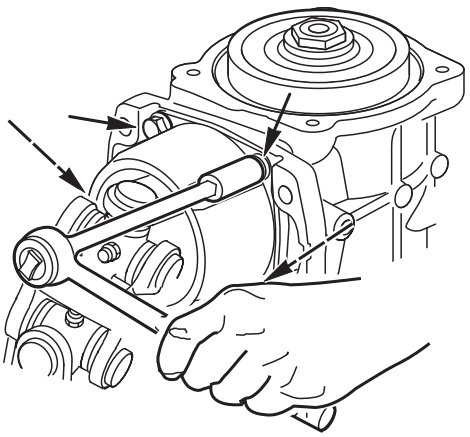


7. Re-install top nut on shaft.
8. Torque nut to 96-110 ft. lb. (130-150 N.m).

**Pinion Bearing Carrier Installation**

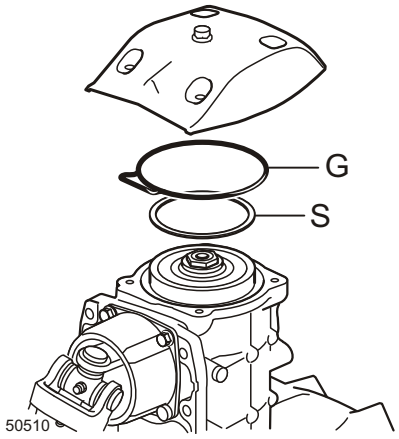


1. Place required amount of shims for pinion gear position on pinion bearing carrier.



2. Install pinion bearing carrier into gear housing and secure with four screws.
3. Torque screws, in a crossing pattern, to 15-20 ft. lb. (20-28 N•m).

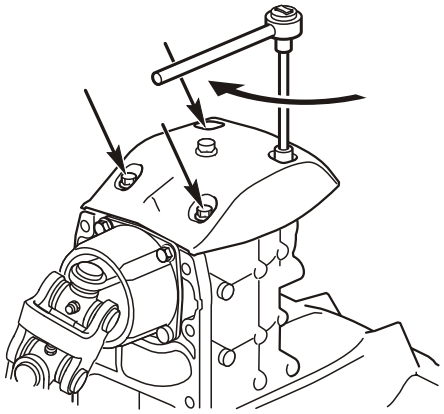
**Top Cover Installation**




50510

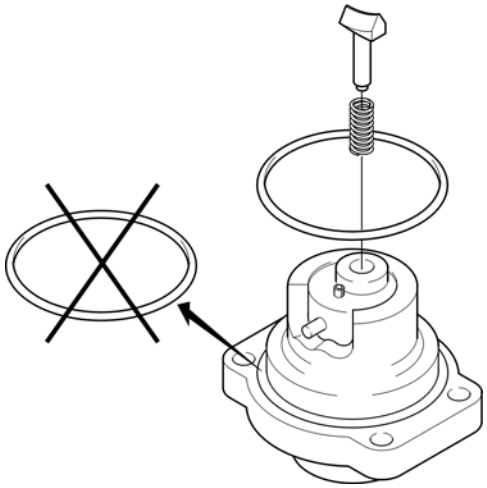
4. Make sure correct shims are under cover and shims are positioned correctly.
5. Lightly coat gasket with gear oil.
6. Place gasket around upper output gear assembly. Orient opening in gasket as shown.

50511

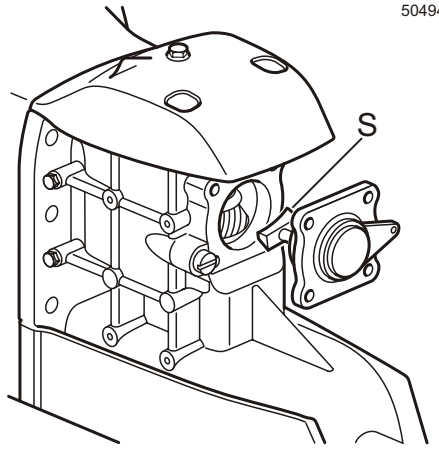


7. Install top cover on upper housing.
8. Install 4 screws in cover.
9. Torque screws, in a crossing pattern. First pass to 6-9 ft. lb. (8-12 N•m). Final pass to 15-20 ft. lb. (20-28 N•m).

### Shift Mechanism Installation



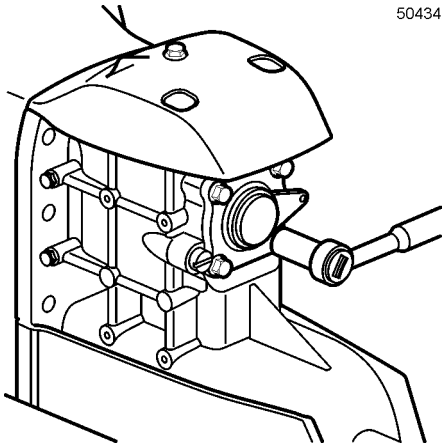
1. Install new O-ring on housing. Do not re-use old O-ring.
2. Install spring and shift shoe in piston.




50494

3. Place shift mechanism in mounting hole.

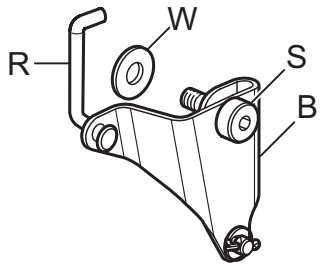
   **Make sure shift shoe is oriented as shown, with “UP” marking facing up.**



50434

4. Install four bolts, hand tighten in a crossing patter.
   Torque bolts, in a crossing pattern, to 15-20 ft. lb. (20-28 N•m).

**Shift Linkage Assembly**

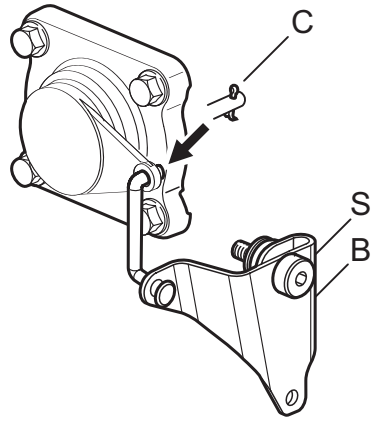



50464

1. Install bracket (B) to housing with washer (W) and **new** screw (S).

   **Screw has locking patch, if screw is removed it must be replaced.**

2. Torque screw to 15-20 ft. lb. (20-28 N•m)
   Make sure bracket moves freely.




50452

3. Install rod in hole in eccentric.
4. Secure with cotter pin (C).

## Gearhousing Installation

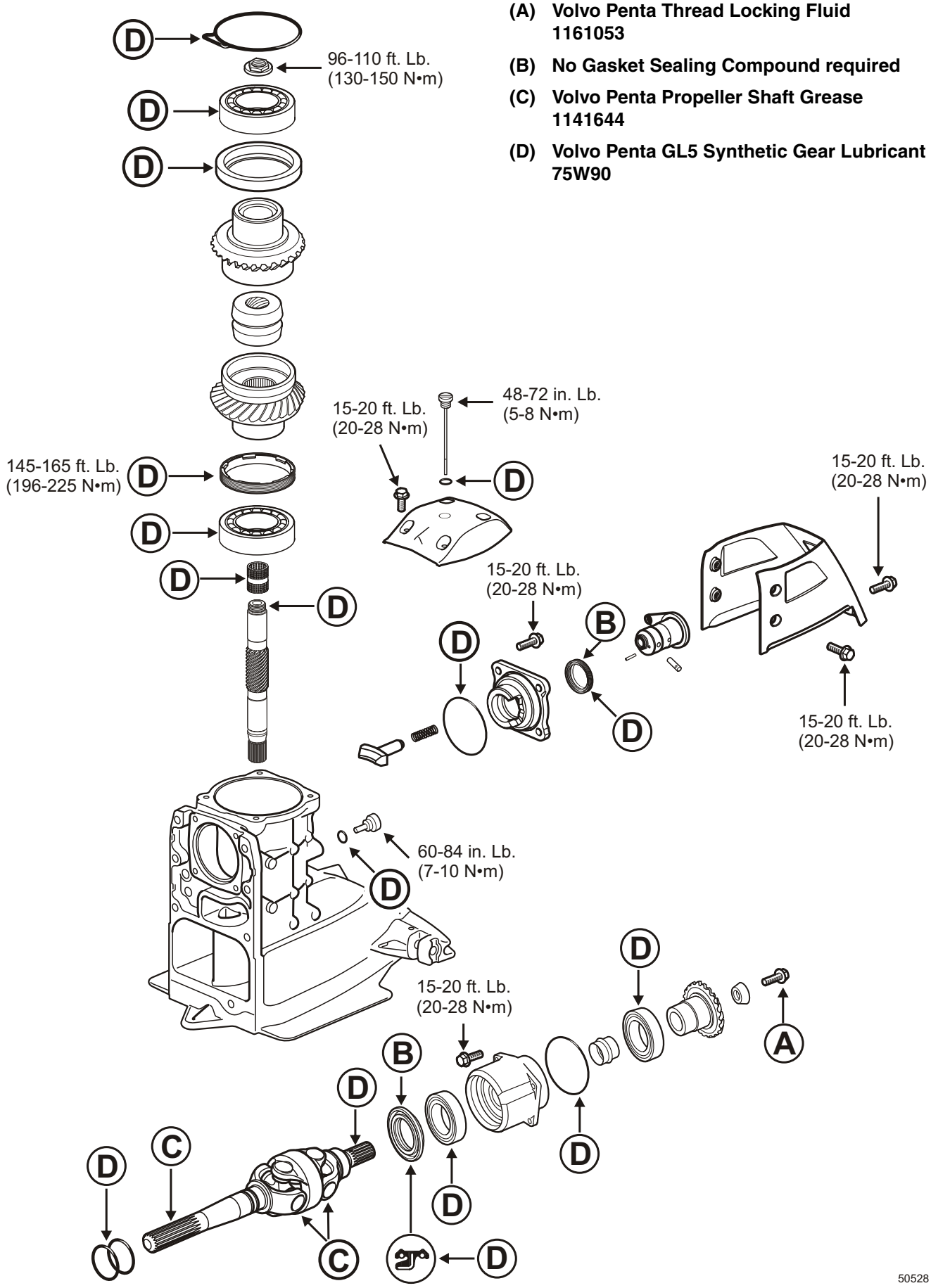
**Proceed to Chapter 2 to;**

- Reassemble gearcase to the upper housing
- Pressure and Vacuum test the assembled drive
- Install the drive on the transom
- Install the propeller

## Specifications

| Description | U.S. | Metric |
|---|---|---|
| Bearing retainer ring | 145-165 ft. lb. | 196-225 N•m |
| Nut, upper driveshaft | 96-110 ft. lb. | 130-150 N•m |
| Plugs, drain and oil level | 60-84 **in.** lb. | 7-10 N•m |
| Dipstick | 48-72 **in.** lb. | 5-8 N•m |
| Studs, upper housing | 22-25 mm height | 22-25 mm height |
| Nuts, upper to lower housings | 30-38 ft. lb. | 41-51 N•m |
| Screws, upper to lower housings | 30-38 ft. lb. | 41-51N•m |
| Screws, top cover | 15-20 ft. lb. | 20-28 N•m |
| Screws, pinion bearing carrier | 15-20 ft. lb. | 20-28 N•m |
| Screws, shift housing | 15-20 ft. lb. | 20-28 N•m |
| Screw, shift bracket | 15-20 ft. lb. | 20-28 N•m |
| Screws, shift cover | 15-20 ft. lb. | 20-28 N•m |

## Service Chart



# NOTES

# SX-A Lower Gearcase

Table of Contents

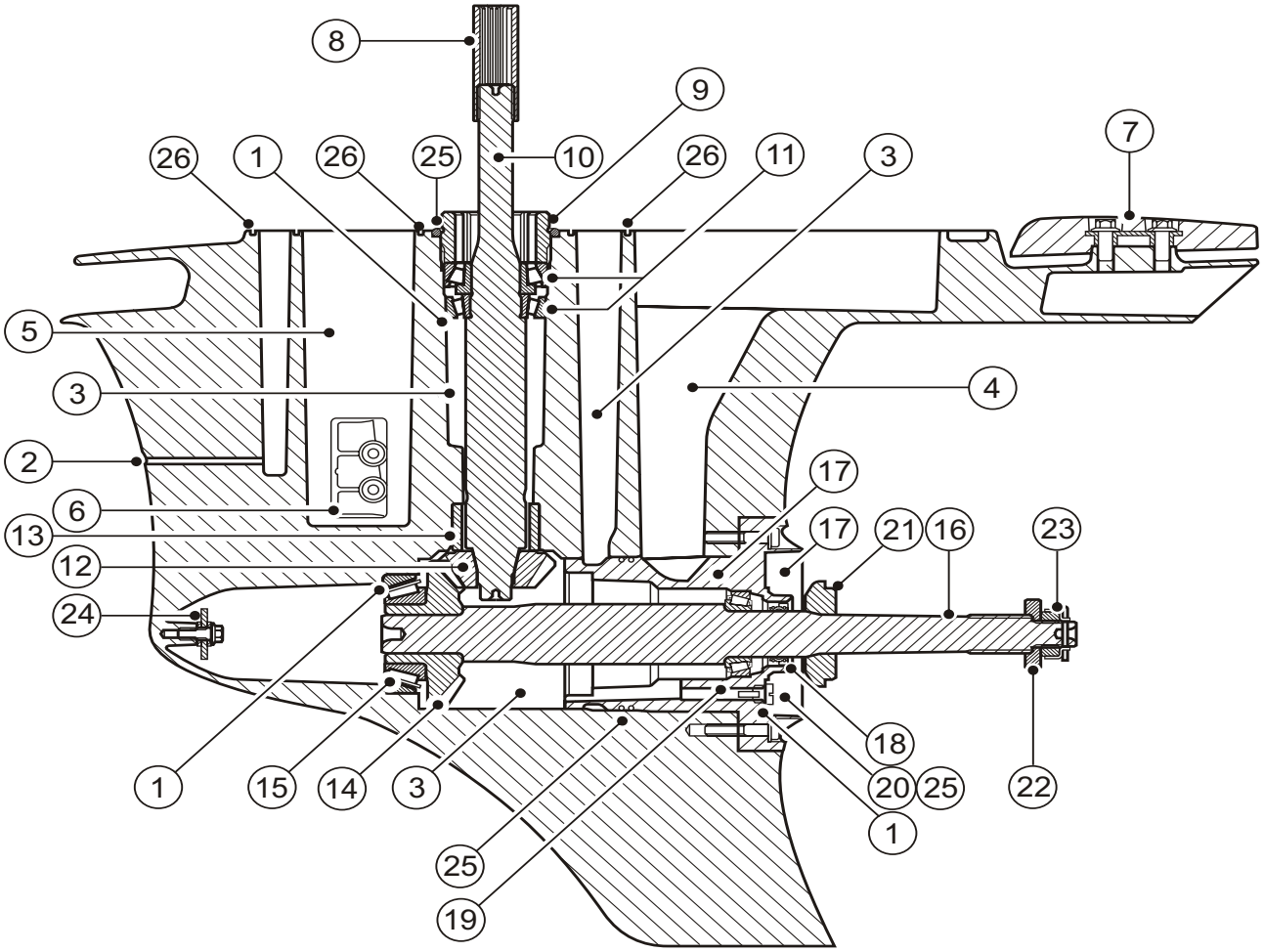


## Safety Messages

Before working on any part of a Volvo Penta sterndrive, read the section called “Safety Messages” in the first chapter of this manual.

## Lower Gearcase - cross section

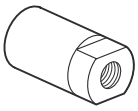
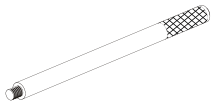
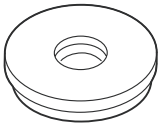
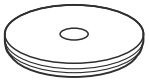
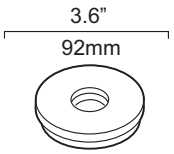
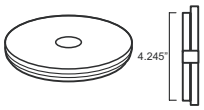
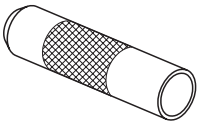
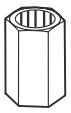
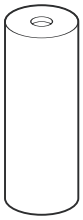
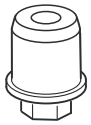
SX-A




50605

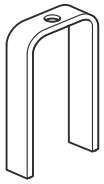
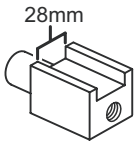
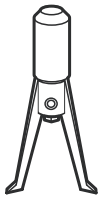
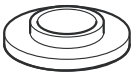
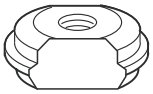
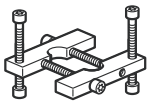
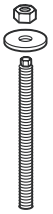
1. Shim position
2. Pitot passage
3. Oil passage
4. Exhaust passage
5. Water passage
6. Water intake
7. Anode
8. Splined sleeve - Drive Saver
9. Retainer, vertical shaft
10. Vertical shaft
11. Bearing, vertical shaft
12. Pinion
13. Bearing, pinion
14. Drive gear
15. Bearing, drive gear
16. Propshaft
17. Propshaft bearing housing
18. Seal, propshaft
19. Bearing, propshaft
20. Plug, oil drain
21. Thrust washer, prop
22. Spacer, prop
23. Nut and cotter pin, prop
24. Magnet
25. O-ring
26. Seal

## Special Tools

| Tool Name | Part No. | View | Tool Name | Part No. | View |
|---|---|---|---|---|---|
| Adapter/Puller | 3849652 |  | Handle | 3850609 (311880) |  |
| Bearing Cup Installer | 3850616 (914695) |  | Guide Plate | 3850619 (914700) |  |
| Bearing Cup Installer | 3850621 (914703) |  | Guide Plate | 3849656 |  |
| Drift | 884263 |  | Holding Socket | 884830 or 3850618 (914699) |  |
| Drift | 3855866 |  | Pinion Bearing Installer | 3850620 (914701) |  |

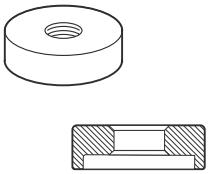
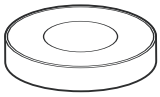
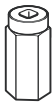
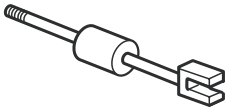
(Early versions may have the OMC part no.)

**Special Tools, cont'd**

| Tool Name | Part No. | View | Tool Name | Part No. | View |
|---|---|---|---|---|---|
| Pinion Bearing remover | 3884360 |  | Puller Bridge | 3850611 (432127) |  |
| Pinion Nut Holder | 3854864 (914694) |  | Puller Jaws | 3850612 (432129) |  |
| Pinion Shim Fixture | 3855098 |  | Pusher/Puller | 3850623 (914706) |  |
| Propshaft Bearing Installer | 3850617 |  | Remover Tip | 3855859 |  |
| Puller | 3855923 |  | Rod<br>Nut<br>Washer | 3855860 |  |

(Early versions may have the OMC part no.)

**Special Tools, cont'd**

| Tool Name | Part No. | View | Tool Name | Part No. | View |
|---|---|---|---|---|---|
| Seal Installer | 3588103 |  | Spanner Wrench | 3850601 |  |
| Shimming Fixture | 3850600 |  | Spline Socket | 3850598 |  |
| Slide Hammer | 884161 |  | | | |

(Early versions may have the OMC part no.)

**Volvo Penta Service Tools** All tools by are listed in text by name and **part number.**

**Sealants, Lubricants and Adhesives**

Cleaning solvent

Volvo Penta GL5 Synthetic gear lubricant, 75W90

Loctite primer

Volvo Penta thread locking compound **1161053**

Volvo Penta grease **828250**

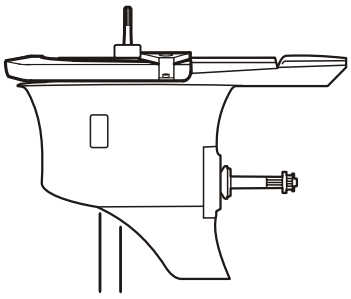
## Sterndrive Removal and Disassembly

To service components of the lower gear housing, separate lower housing from upper housing. Follow the procedures in the **Sterndrive, General Information** chapter of this manual.

If only the lower housing is being serviced, do not remove the sterndrive from the transom shield. Tilt the drive up and then follow the procedure for separating the uppper and lower housings.

5. Mount the gearcase in a suitable holding fixture and clamp it securely.

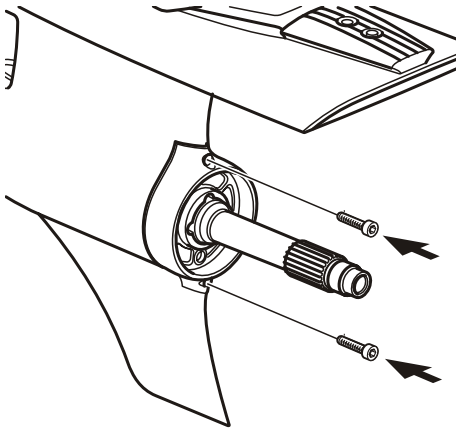
***NOTICE!*** **The gearcase should be held in fixture throughout rebuild process. Fixture is not shown in following steps to provide clearer illustrations of the steps.**



50503

# Lower Gearcase Disassembly

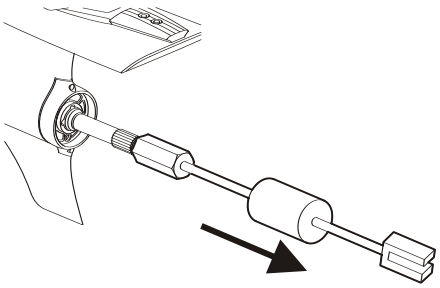
### Propshaft and Bearing Housing Removal



50506

1. Remove and retain the two screws securing propshaft bearing housing.

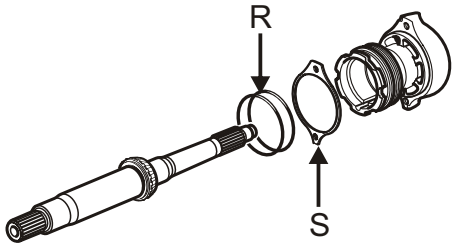
***NOTICE!*** **Use the same type of screw that was removed if any require replacement. If a socket head screw was removed, a socket head screw must be used to replace it. Flange type screws are not compatible with early propshaft bearing housings.**



50507

2. Thread adapter **3849652** on end of propshaft.
3. Attach slide-hammer **884161** to adapter.

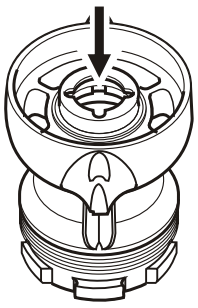
   **Use slide-hammer to remove propshaft and housing from gearcase.**




50508

4. Remove shaft/bearing from housing.
5. Remove shims (S), they can be reused if not damaged.
6. Remove and discard o-rings (R).

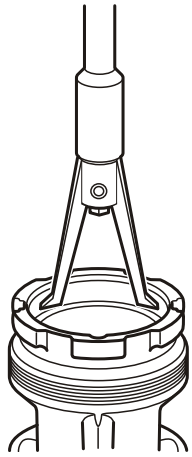
### Seal and Bearing Removal



50513

1. Use a punch and hammer to remove seal from housing.

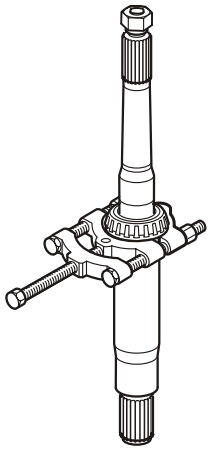
   **Seal will be damaged during removal and must be replaced.**



50514

2. Attach threaded rod from tool **3850611** to two jaw puller **3850612**.
3. Insert puller into housing, expand jaws tightly behind bearing cup. Pull up on rod to pull out cup.

**Propshaft Bearing Removal**

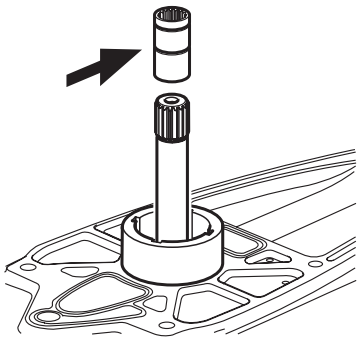


50515

1. Screw propeller nut on shaft to prevent thread damage.
2. Support bearing in bearing splitter and press propshaft down and out of bearing.

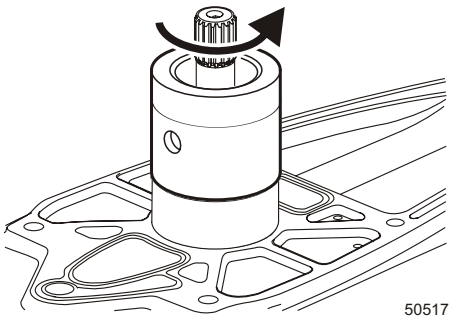
   **Be ready to catch shaft when pressed out of bearing.**

**Vertical Shaft and Pinion Removal**



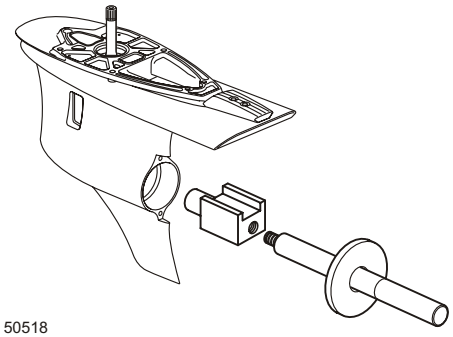
50516

1. Remove intermediate shaft and inspect splines.
2. Inspect intermediate shaft for twisting. If damaged replace.

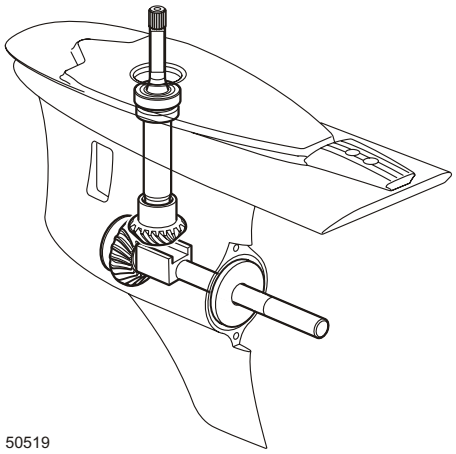

50517

3. Using spanner wrench **3850601** unscrew retainer.
4. Remove retainer and o-ring, discard o-ring.

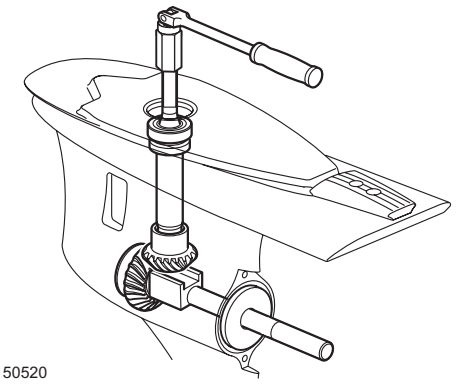
**Pinion nut removal**


50518

5. Screw pinion nut holder, **3854864** onto handle **3850609**.
6. Slide guide plate **3849656** over handle.

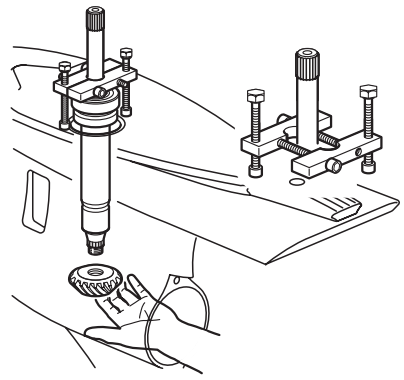

50519

7. Insert pinion nut holder in to drive gear.
8. Turn vertical shaft to align pinion nut with holder.


50520

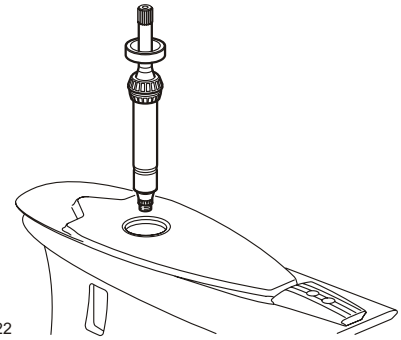
9. Slide socket **3850598** on to vertical shaft.
10. Attach pull bar to socket.
11. Hold pinion nut holder in place with handle and turn socket (and shaft) counter-clockwise to loosen pinion nut.
12. Remove and retain pinion nut.

### Vertical shaft removal

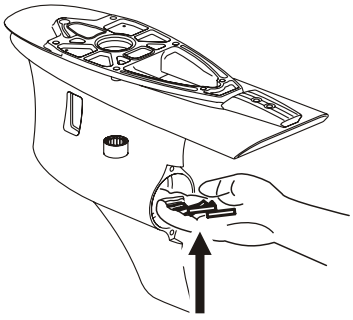

50521

1. Pinion gear may slip off shaft, if not, Install puller **3855923** on vertical shaft.
2. Pull shaft and bearings up by tightening vertical screws.

   **Hold the pinion gear while lifting shaft.**
3. Remove pinion gear.

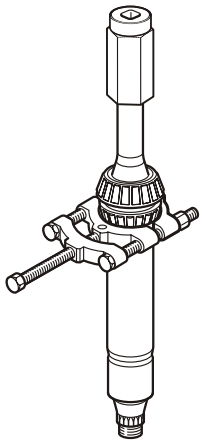

50522

4. Lift out vertical shaft, bearings and upper cup.


50524

5. The pinion roller bearings may fall out of retainer.

   **Remove and retain roller bearings.**


50523

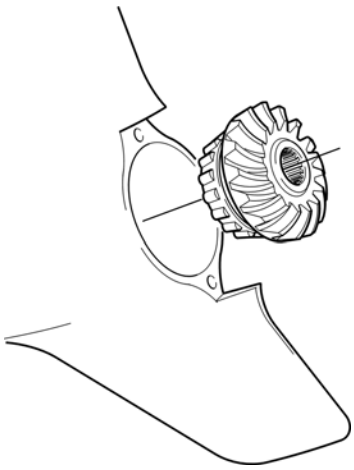
***NOTICE!*** **Do not remove vertical shaft bearings unless you intend to replace them. Removal process may damage bearings.**

1. Place socket **3850598** over splines to protect shaft.
2. Using a bearing separator and press, remove bearings.

   **Be ready to catch shaft when pressed out of bearings.**

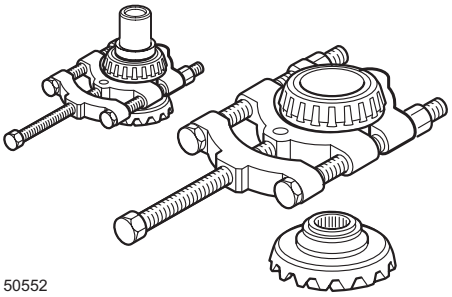
## Propshaft Gear Removal

### Gear and Bearing Removal



1. Remove gear and bearing.

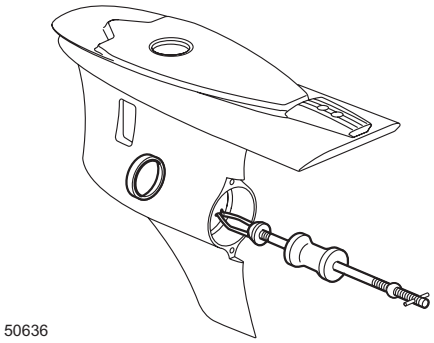
***NOTICE!*** **Do not remove bearing from propshaft gear unless you intend to replace bearing. Removal process may damage bearing.**



50552

2. Use bearing separator to support bearing.
3. Use drift **3861653** to press gear out of bearing.

   **Be ready to catch gear when it is pressed out of bearing.**

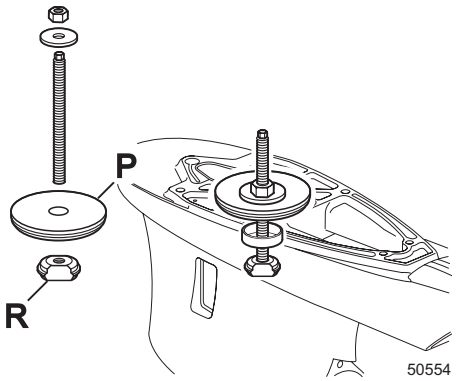


50636

4. Use a two jaw puller and slide hammer to remove drive bearing cup and shims.

***NOTICE!*** **The shims will be damaged during removal and must be replaced on reassembly.**

### Lower Bearing Cup Removal

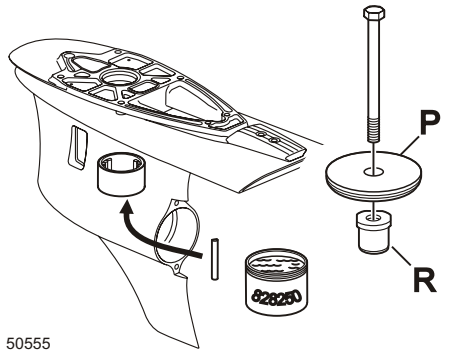



1. Assemble cup remover **3855859** (R), rod, nut and washer **3855860** and guide plate **3850619** (P).
2. Place remover in to cavity under lip of bearing cup.

   **Place smallest step of plate in retainer bore.**
3. Tighten nut to remove cup and shims.

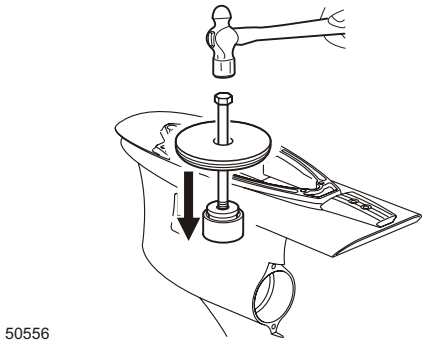
***NOTICE!*** **Shims may be damaged during removal and should be replaced.**

### Pinion Bearing Removal



50555

4. To remove pinion bearing, apply grease **828250** to bearing rollers. Place **all** rollers in bearing case. Tool presses on rollers.
5. Assemble pusher/puller **3850623**, guide plate **3850619** (P), and remover **3884360** (R).


50556

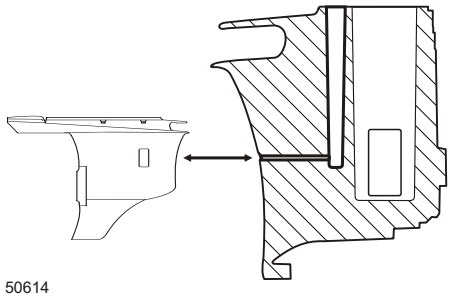
6. Install remover into pinion bearing.
7. Place smallest step of plate in retainer bore.
8. Using a hammer, drive pinion bearing down and out of gearcase.

### Gearcase Cleaning and Inspection

Clean housing in solvent to remove all sealer from screw holes, gasket surfaces, and o-ring bores. Dry housing thoroughly.

### Passages for Pitot

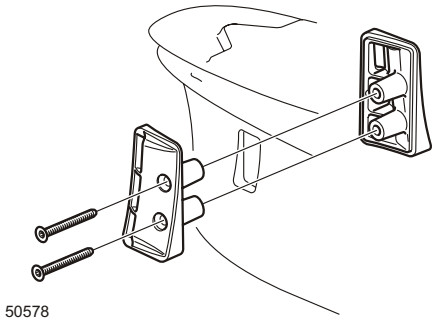
If pitot (speedometer) is clogged, use compressed air to clear the passages. Apply air at opening to smaller passage on leading edge of gearcase.


50614

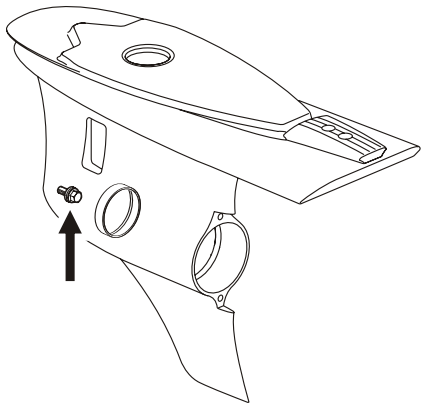
### Water Intakes

If needed, water intakes can be removed.

Remove two screws from port intake.


50578

### Gearcase Magnet



50615

There is a magnet mounted in the front of the gearcase, forward of the propshaft gear. No service is needed and the magnet should not be removed during routine gearcase service.

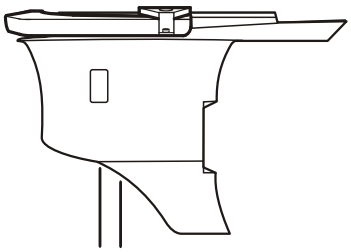
If the magnet is removed, when reinstalling, **torque screw to 5-7 ft. lb. (7-9 N•m) .**

***NOTICE!*** **Most threaded holes in gearcase have Heli-Coil® inserts. Do not use a thread tap to clean screw holes. Tap will damage Heli-Coil insert and make replacement necessary. Do not replace with standard non-locking Heli-Coils.**

- **Retainer Threads** - lock ring must turn freely for full depth.
- **Cooling Passages** - check for corrosion build-up that would restrict water circulation.
- **Propshaft Bearing Carrier Bore** - remove all sharp edges that would cut o-ring.
- **Gears, Shafts and Bearings** - inspect gear teeth for cracks and chips or discoloration. If any gear is damaged all must be replaced. They are replaced as a set.
  Screw threads on end of shafts must be undamaged. Replace shaft if lock patch is excessively worn. Check for pitting, corrosion and discoloration.

# Lower Gearcase Assembly

### Gearcase

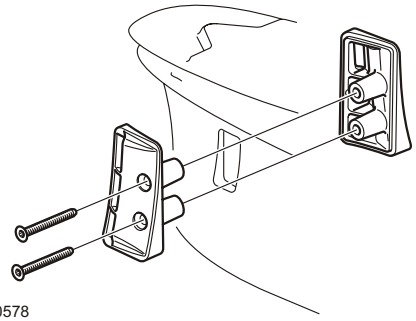


50611

Mount the gearcase in a suitable holding fixture and clamp it securely.

***NOTICE!*** **The gearcase should be held in fixture throughout rebuild process. Fixture is not shown in following steps to provide clearer illustrations of the steps.**

### Water Intakes



50578

1. Reinstall water intakes if removed.
2. Place each intake in hole on correct side of gearcase.

   **Openings must face forward.**
3. Install two screws from port intake side.

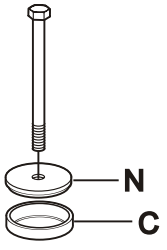
   **Torque screws to 44-62 in. lb. (5-7 N•m).**

The following steps assemble the gearcase so that gear shimming, gear lash and wear contact patterns can be set. Complete assembly is covered in see Final Assembly on page 119.

***NOTICE!*** **All references to gear oil in all assembly steps are referring to the same oil used to fill the drive; Volvo Penta GL5 Synthetic gear lubricant, SAE 75W-90.**

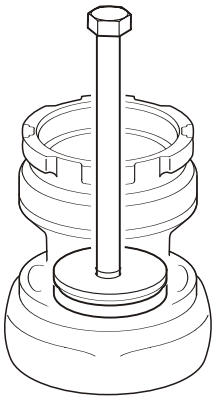
### Propshaft and Bearing Housing

#### Propshaft Bearing Cup




50559

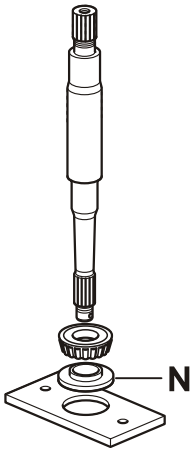
1. Apply gear oil to bearing cup (C).
2. Assemble pusher/puller **3850623** and cup installer **3850621**(N).
3. Place cup in installer.



50560

4. Press cup in to housing until it seats
5. Do not install seal at this step.

### Propshaft Bearing

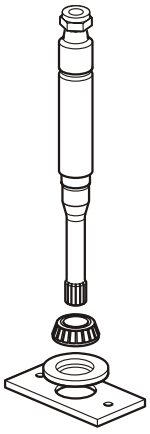



50561

1. Apply gear oil to inner diameter of bearing.
2. Slide bearing on shaft with taper facing prop end.
3. Place bearing installer **3850617** (N) on open jaws of a press support.

   **Position raised lip of installer up; it must contact rear of bearing.**
4. Insert shaft in installer, and press shaft into bearing until it seats.

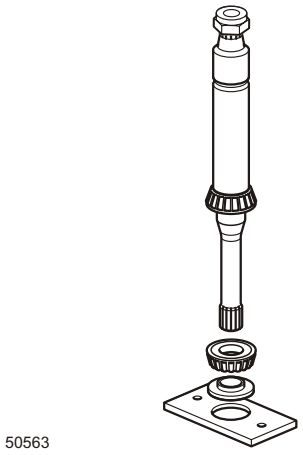
### Vertical Shaft Bearings



50562

1. Apply gear oil to inner diameter of small bearing.
2. Protect threads of shaft by installing a pinion nut on shaft.
3. Slide bearing on shaft with taper facing pinion end.
4. Place bearing installer **3850617** on open jaws of a press support.

   **Position raised lip of Installer down**
5. Insert shaft and bearing in installer, and press shaft in bearing until it seats.


50563

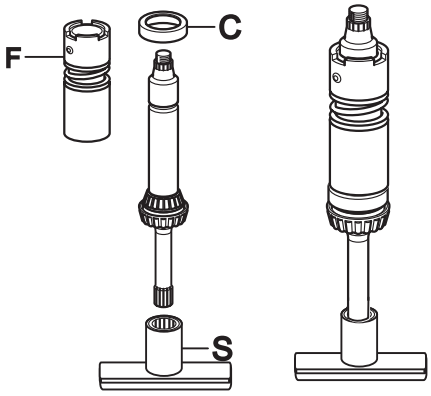
6. Apply a light coat of gear oil to inner diamter of large bearing.
7. Slide bearing on shaft with taper facing away from small bearing.
8. Place bearing installer **3850617** on open jaws of a press support.

   **Position raised lip of installer up; it must contact nose of bearing.**
9. Insert shaft into installer, and press shaft in bearing until it seats.

## Pinion Shimming

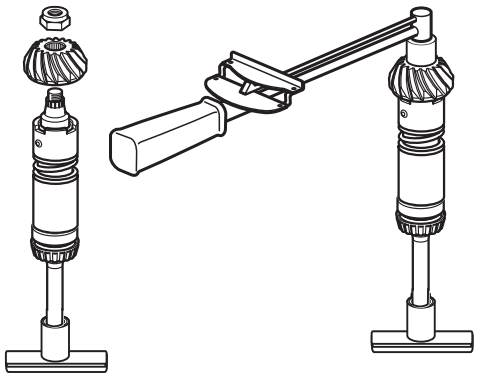
***NOTICE!*** **This procedure determines the amount of shims required to properly position the pinion in relation to the propshaft gear. Record the following shimming measurement for the final gear lash check.**

### Measure for Shims




1. Clamp special tool **884830** (S) in a vice and place vertical shaft in socket. Place cup (C) on small bearing.

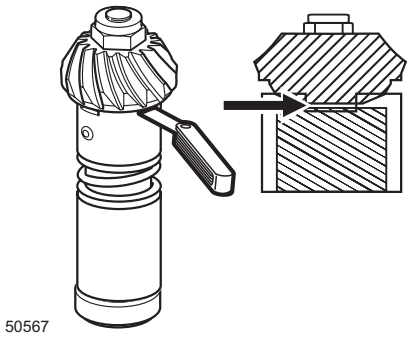
   **Slide shim fixture 3855098 (F) on shaft with three slots facing threaded end of shaft.**



2. Install pinion and pinion nut.

   **Torque nut to 150-160 ft. lb. (203-217 N.m).**

   **Rotate shim fixture to seat bearing for shimming purposes.**


50567

3. Check all three slots with feeler gauge and record each reading. Measure between inner ring of fixture and horizontal gear surface. Average feeler gauge readings.

Example:

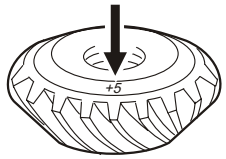
**Table 1: Pinion Shims**

| Add: | Divide: |
|---|---|
| Slot no. 1 = 0.011 in. | 0.028 in. ÷ 3 = 0.0093 in. |
| Slot no. 2 = 0.009 in. | (Round off to 0.009 in.) |
| Slot no. 3 = 0.008 in. | |
| Total 0.028 in. | |

4. Remove pinion nut and discard.

   **Remove gear.**

5. Add or subtract shimming allowance number etched on gear from number found in Step 3



34792

If number is **+5**, you would **add 0.005 in.** to number in 3.
If number is **-5**, you would **subtract 0.005 in.** from number in 3.
If the number is **zero (0)**, use number in 3.

Example:

Add/Subtract:

0.009 in., number from Step 3

+ 0.005 in. number etched on gear

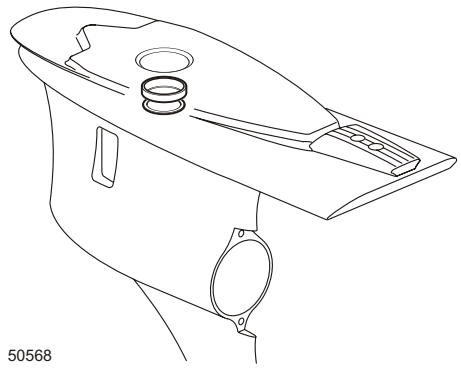
0.014 in. shims needed

6. Use this thickness of shims for pinion gear shimming.

***NOTICE!*** **No less than one shim but no more than five shims should be used to obtain needed shim thickness.**

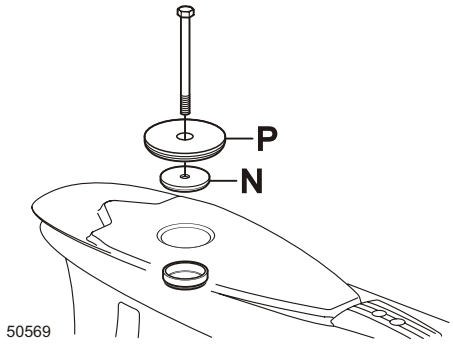
7. Record shim measurement for rolling torque correction in see Gear Lash on page 115.

### Install Shims

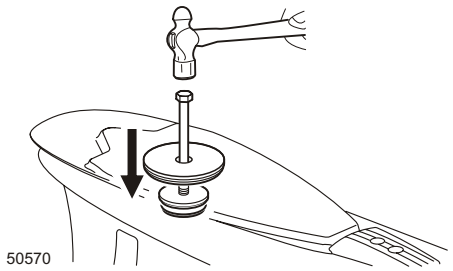

50568

1. Install pinion shims in gearcase where lower bearing cup seats.
2. Apply gear oil to bearing cup.

   **Install cup on top of shims with cup taper facing up.**



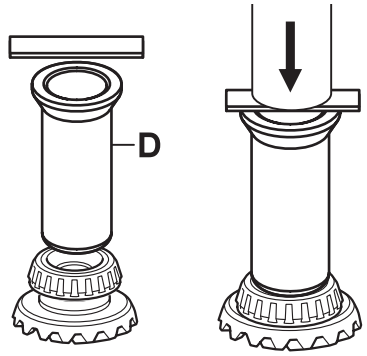

3. Use pusher/puller **3850623**, guide plate **3850619** (P), and cup installer **3850621** (N) to install cup.




4. Place installer on cup.
5. Place smallest step of plate in retainer bore.
6. Use a hammer to seat bearing cup.

**Propshaft Gear**

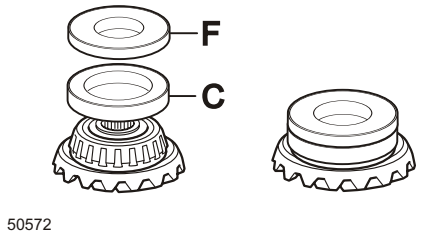
**Bearing Installation**




1. Apply gear oil to inner diameter of bearing.
2. Slide bearing on gear with taper facing away from gear.
3. Position drift **884168** (D) upside down on inner ring of bearing with a sutible press plate, and press bearing on gear until it seats.

***NOTICE!*** **This procedure determines the amount of shims required to properly position the propshaft gear in relation to the pinion.**

**Shimming**

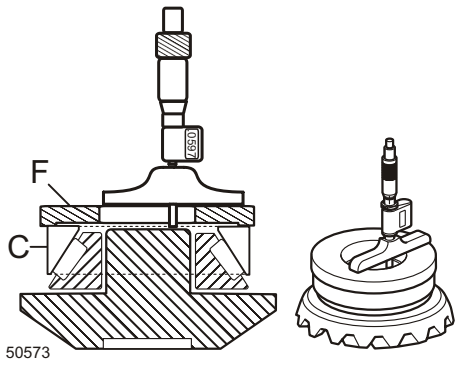



1. Place gear and bearing on flat surface.

   **Place bearing cup (C) on top of bearing.**

   **Rotate cup to seat bearings.**

   **Position shim fixture 3850600 (F) on top of gear and bearing, recessed side facing down.**



50573

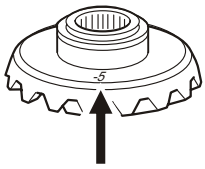
2. Using a depth micrometer, measure the distance from top of shim fixture to end of gear shaft. **Subtract 0.500 in.** from this measurement.

Example:

0.557 in. measurement to end of gear shaft

- 0.500 in. thickness of shim fixture

0.057 in. actual dimension



50586

3. Add or subtract the shimming allowance number etched on gear from actual dimension in Step 2.
   If etched number is **-5**, you would **subtract 0.005 in**. from dimension in Step 2.
   If etched number is +**5**, you would **add 0.005 in.** to dimension in Step 2.
   If the etched number is **zero (0)**, use the dimension in Step 2.

Example:

Add/Subtract:

0.057 in. actual dimension in Step 2

-0.005 in. etched number (0) on gear

0.052 in. total

4. Subtract number in Step 3 from a nominal dimension of 0.079 in.

Example:

Subtract:

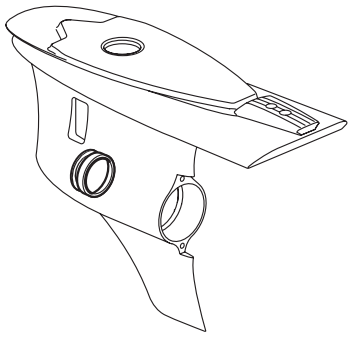
0.079 in. nominal dimension

- 0.052 in. total from Step 3

**0.027** in. shims needed

5. Use this thickness of shims for propshaft gear shimming
6. Record shim measurement for rolling torque correction in see Gear Lash on page 115.

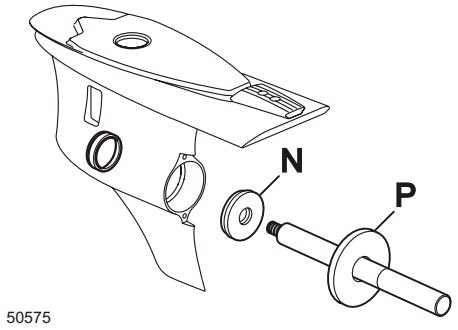
**Bearing Cup and Shim Installation**


50574

1. Place needed thickness of shims in recess of bearing cup bore.

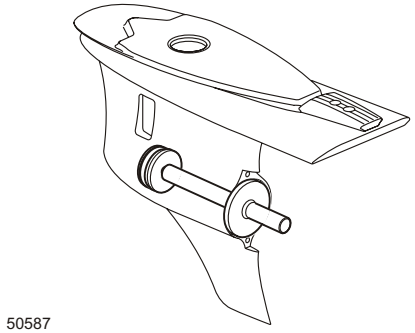
***NOTICE!*** **No less than one shim but no more then three shims should be used.**

2. Apply gear oil to the bearing cup.
3. Place cup on top of shims in gearcase.



50575

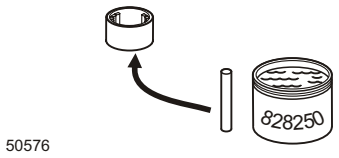
4. Screw cup installer **3850616** (N) on handle **3850609**.
5. Slide alignment plate **3849656** (P) on handle.


50587

6. Make sure cup is straight in bore.
7. Place installer in cup and drive cup in until seated.

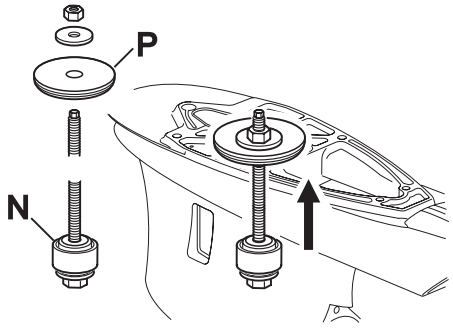
## Vertical Shaft and Gear Installation

### Pinion Bearing Installation



50576

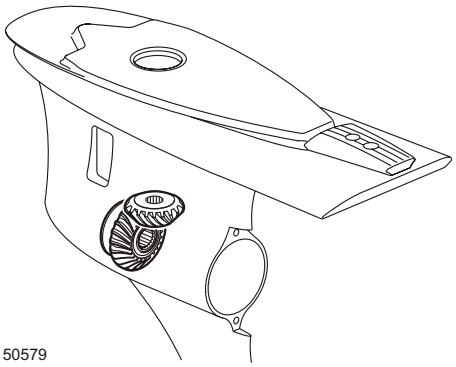
1. Apply grease **828250** to roller bearings.
2. Install bearings in pinion cup.




3. Apply gear oil to pinion bearing.
4. Install pinion bearing onto installer **3850620** (N).
5. Slide guide plate **3850619** (P), on rod, nut, and washer **3855860**.
6. Insert rod in gearcase and screw in to installer.
7. Place smallest step of plate in retainer bore.
8. Turn nut until pinion bearing is seated, then unscrew and remove tools.

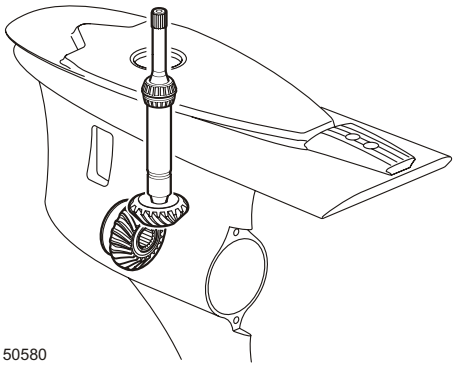
***NOTICE!*** **If installer turns in bearing, screw pinion nut holder 3854864 on handle 3850609. Slide alignment plate 3849656 onto handle. Insert into geasrcase and hold pinion installer.**

### Gear Installation


50579

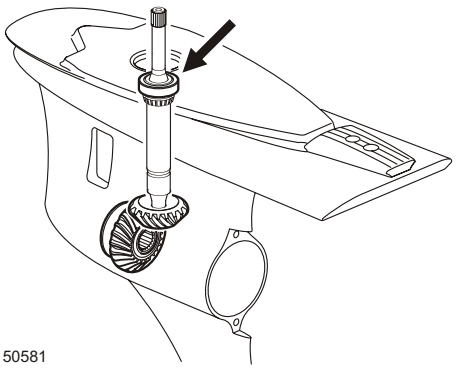
1. Install propshaft gear/bearing in gearcase.
2. Position pinion above gear in gearcase pinion pocket.
3. Engage pinion teeth with propshaft gear teeth.

### Vertical Shaft Installation

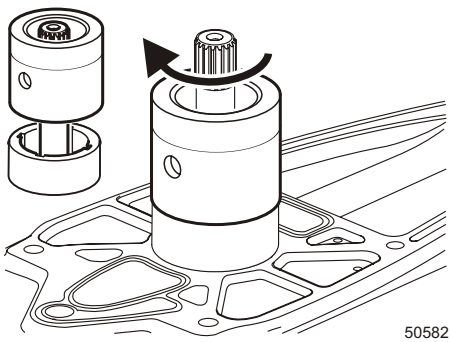

50580

4. Install vertical shaft in gearcase and engage pinion splines.
5. Seat lower bearing in cup.
6. Seat shaft in pinion bearing.

***NOTICE!*** **Insert vertical shaft carefully so pinion bearing rollers aren't dislodged.**


50581

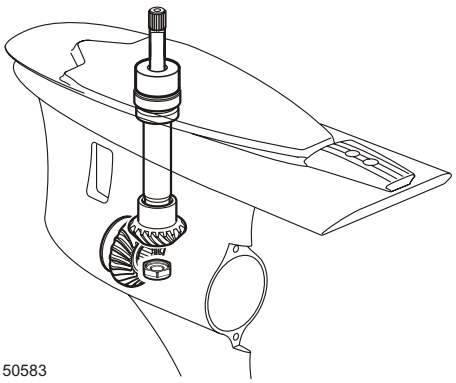
7. Apply gear oil to upper bearing cup.
8. Place cup in housing, and push down until it seats on bearing.


50582

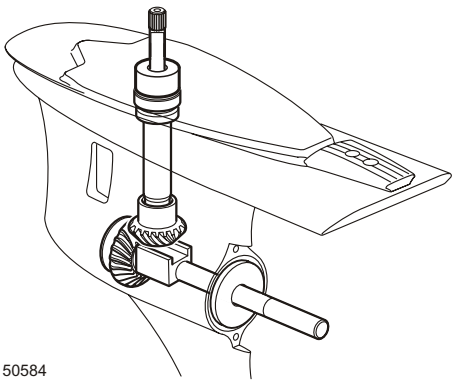
9. Place retainer over shaft and bearing cup, start threads. Screw in shaft retainer using spanner wrench **3850601**, to seat upper shaft bearing cup.

### Pinion Nut Installation

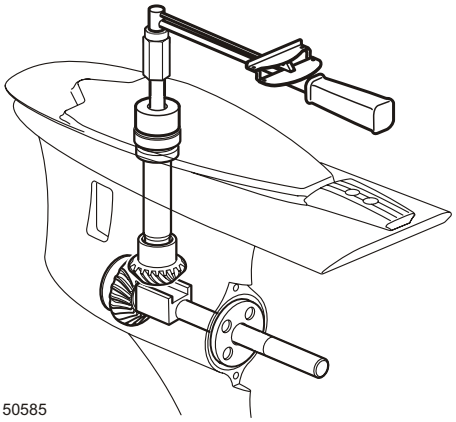
10. Apply Loctite primer to pinion threads on shaft and let air dry.
11. Apply thread locking compound **1161053** to threads.
12. Install a new pinion nut onto shaft.


50583

13. Assemble pinion nut holder **3854864** on handle **3850609**.
14. Slide alignment plate **3849656** on handle.
15. Insert pinion nut holder in to drive gear.
16. Turn vertical shaft to align pinion nut with holder.


50584

17. Slide socket **3850598** on to vertical shaft.
18. Attach torque wrench to socket.
19. Hold pinion nut holder in place with handle and turn socket (and shaft) to tighten pinion nut.
20. Torque pinion nut to 150-160 ft. lb. (203-217 N.m).

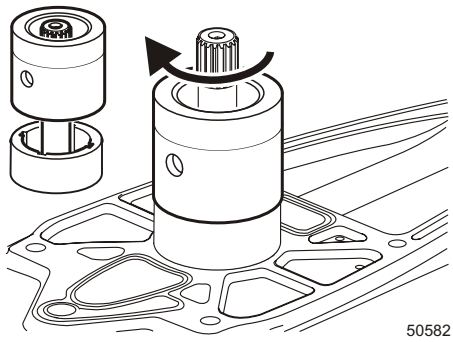

50585

### Setting Rolling Torque

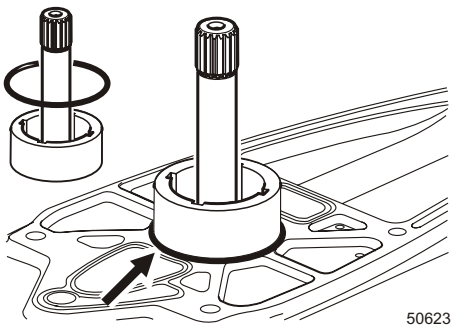
***NOTICE!*** **This procedure will ensure bearing life by setting vertical shaft rolling torque. Turn gearcase so that propshaft bore is vertical and gear is down. This will ensure the propshaft gear will not interfere with the pinion rolling torque measurement.**

**Vertical Shaft**

1. Turn vertical shaft several times to ensure bearing is seated before each torque reading.




2. Tighten retainer to achieve a vertical shaft rolling torque of 2-4 in. lb. (0,22-0,45 N•m).
3. **Record rolling torque setting.**

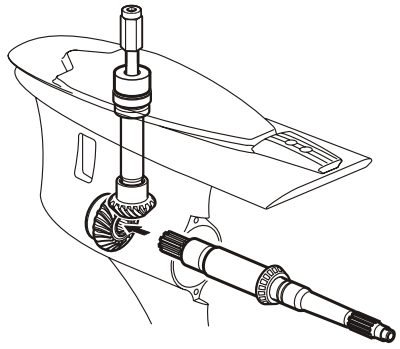



4. Apply gear oil to o-ring for retainer.
5. Install o-ring over retainer.
6. Return gearcase to normal position, propshaft bore slightly above horizontal.

### Propshaft Bearing Housing, Shimming and Rolling Torque

***NOTICE!*** **This procedure determines the amount of shims required to preload the propshaft bearings, and also ensures bearing life by setting the vertical shaft and propshaft rolling torque.**

1. Install propshaft/bearing in gear.



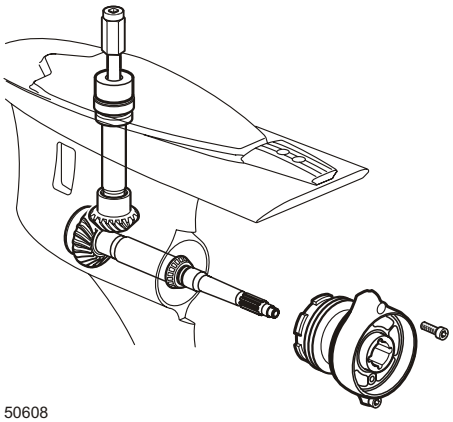
50607

2. Install bearing housing (no seal).

   **Do not install o-rings or shims.**

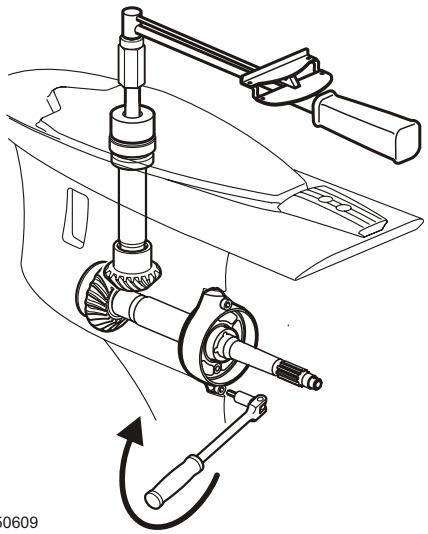
3. Place bearing housing over shaft and in to bore in gearcase.
4. Install housing, use original screws removed during disassembly.

***NOTICE!*** **Use the same type of screw that was removed if any require replacement. If a socket head screw was removed, a socket head screw must be used to replace it. Flange type screws are not compatible with early propshaft bearing housings.**

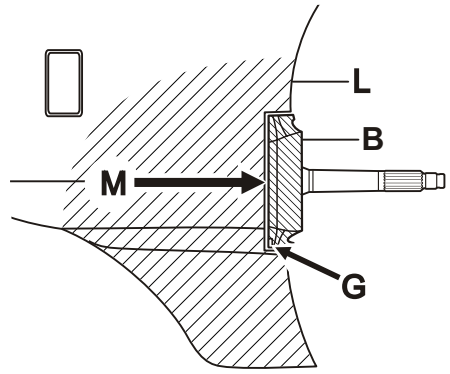


50608

5. Tighten screws in small steps, alternating top and bottom, until vertical shaft rolling torque is;
   - for ratios 1.43, 1.51, 1.60, 1.79, 1.89: 1**4-23 in.lb.** (**1,58-2,60 N.m).**
   - for ratios 1.66, 1.97, 2.18: **11-18 in. lb. (1,24-2,03 N.m)**



50609




50610

6. Measure (M) gap between bearing housing (B) and gearcase (L).

   Record in two places, in the middle on each side.

   Average the measurements.

***NOTICE!*** **Do not measure at gap (G) at bottom and top of housing.**

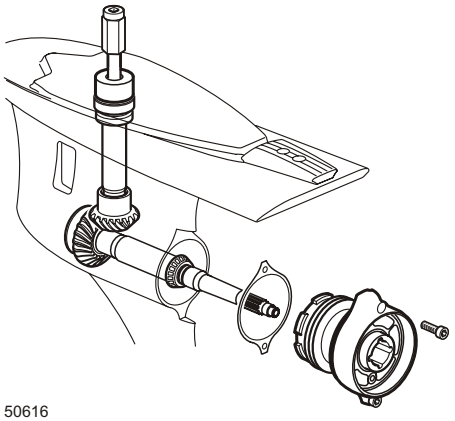
7. Round off the average amount.

   **This is the shim amount for the propshaft bearing housing.**

Example:

| Add: | Divide: |
|---|---|
| no. 1 = 0.014 in. | 0.031 in. / 2= 0.0151 in. |
| no. 2 = 0.017 in. | round to 0.015 in. |
| Total 0.031 in. | |

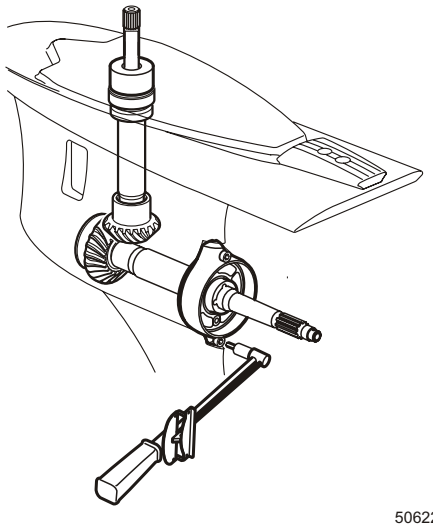
8. Remove bearing housing.
9. Install shims and re-install bearing housing.



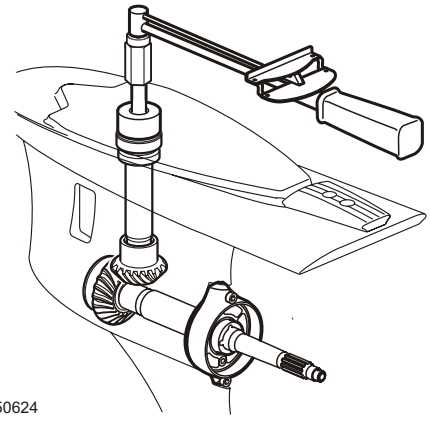
50616

10. Install original screws and torque to 10 ft. lb. **(13,5 N'm)**. Then tighten screws another 70° of rotation.

***NOTICE!*** **Use original screws for all shimming, rolling torque and other pre-assembly work. Use two NEW screws for final assembly and final torque.**



50622


50624

11. Check for correct rolling torque, see step 5 above.
12. Correct as needed;

    **rolling torque is too high, add shim.**

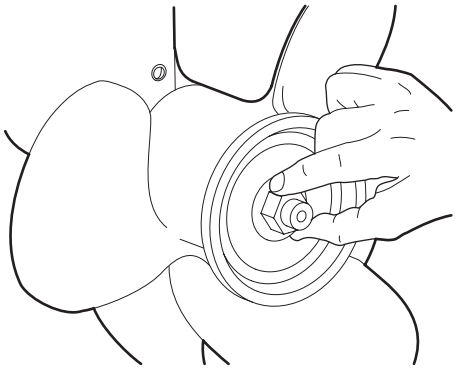
    **rolling torque is too low, subtract shim.**

**Gear Lash**

This procedure will check the relative clearance between the pinion gear and the propshaft gear.

Gear lash and contact pattern must be corrected in consecutive steps. The lash **MUST** be correct before checking the contact pattern. If adjustment is made to the shims to correct the gear contact pattern, then the lash must be rechecked before final assembly.

**Checking**

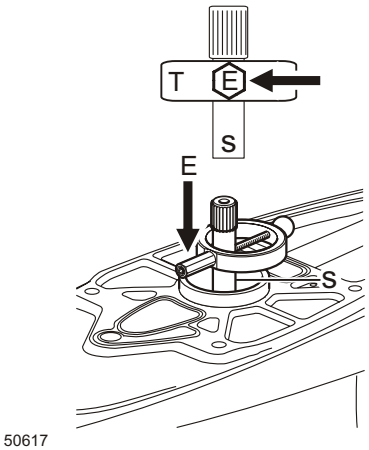


1. The propshaft must not turn during gear lash check.

   **If propshaft is hard to turn by hand, no additional steps are necessary, go to step 2.**

   **If propshaft turns freely, install a propeller without thrust washer. Install the brass spacer and prop nut.**

   **Tighten prop nut by hand until propshaft does not rotate freely.**

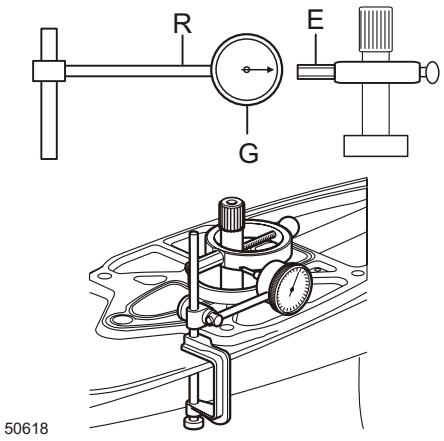


50617

2. Slide gear lash tool **3855873** (T) on to vertical shaft.

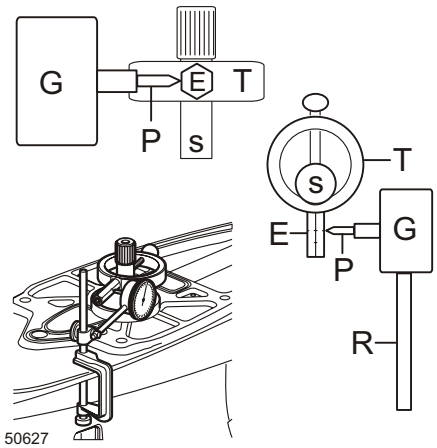
   **Extension (E) on tool must be perpendicular to shaft (S) and parallel to mating surface of gearcase.**

   **Rotate extension so that one flat surface is perpendicular to gearcase mounting surface (see upper arrow in picture).**



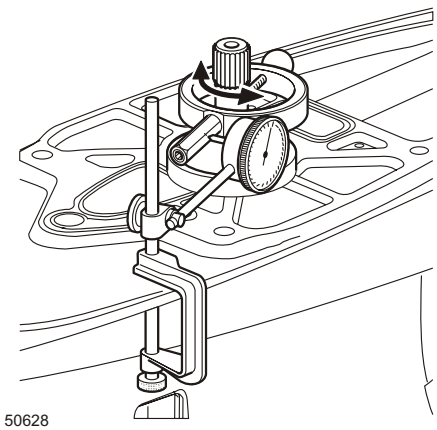

3. Mount dial indicator on gearcase.

   **Position dial indicator so rod (R) holding gauge (G) is at same height as extension (E) and parallel to extension. See illustration.**




4. Dial indicator pointer (P) must contact middle of flat surface of extension (E) at inner most groove for an accurate reading.

   **Pointer (P) must be perpindicular to extension (E). See illustration.**




5. The propshaft must not turn during gear lash check. See step 1.

   **Rotate tool (shaft) in one direction until gear teeth make contact.**

   **Zero the dial indicator.**

   **Rotate tool (shaft) in other direction until gear teeth make contact.**

   **Read dial indicator.**

   **Correct gear lash range = 0.005-0.012 in. (0,13-0,30 mm).**

   **Optimum gear lash range = 0.0085 in. (0,22mm).**

6. If reading is in range, remove propeller and go to .see Gear Contact Pattern on page 118.

   **If reading is out of range, follow steps in Correcting below.**

**Correcting**

1. Gear shimming must be remeasured.

   **Disassemble gearcase.**

2. Recalculate shim for propshaft gear (see Shimming on page 107) and pinion gear (see Pinion Shimming on page 105).

3. Compare shim measurements to measurements done earlier. If different shim dimensions are calculated the second time, reassemble the drive train with the new shims and recheck rolling torque.

4. If new gear lash is in range, continue to see Gear Contact Pattern on page 118. If lash is still out of range recalculate shims again.
5. If the second shim calcualtion produces the same shim values as the first calculation, and the recorded gear lash is still out of range, continue with the following procedure:

**When Gear Lash Measurement Is Less Than 0.005 in.**

Subtract the actual gear lash measurement from 0.0085 in. (optimum gear lash measurement), and divide by two.

Example Only:

0.0085 in. Optimum gear lash measurement

- 0.003 in. Gear lash measurement

0.0055 in. Result

Divide:

0.0055 in. ÷ 2 = 0.00275 in. correction needed

Round off to nearest thousandths of an inch (i.e. 0.003 in.) if needed. This example requires the **addition of 0.003 in. shim** under the lower vertical shaft bearing cup, and **0.003 in. shim removed from** behind the propeller gear bearing cup.

**When Gear Lash Measurement Is More Than 0.012 in.**

Subtract 0.0085 in. (optimum gear lash measurement) from the actual gear lash measurement, and divide by two.

Example Only:

0.0148 in. Gear lash measurement

- 0.0085 in. Optimum gear lash measurement

0.0063 in. Result

Divide:

0.0063 in. ÷ 2 = 0.00315 in. correction needed

Round off to nearest thousandths of an inch (i.e. 0.003 in.) if needed. This example requires the **removal of 0.003 in. shim** from under the lower vertical shaft bearing cup, and **adding 0.003 in.** behind the propeller gear cup.

Re-assemble the drive train and check rolling torque.
If reading is between 0.005-0.012 in. (0,13-0,30 mm), continue to .see Gear Contact Pattern on page 118.

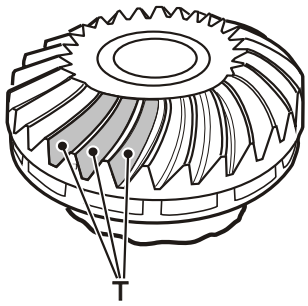
## Gear Contact Pattern

Gear lash and contact pattern must be corrected in consecutive steps. The lash **MUST** be correct before checking the contact pattern.

***NOTICE!*** **If adjustment is made to the shims to correct the gear contact pattern, then the lash must be rechecked before final assembly.**

In order to achieve long gear life and smooth running with minimum noise, you must obtain proper gear contact pattern. The contact pattern will give you a visual clue as to where the gear teeth are meshing with each other.

### Checking



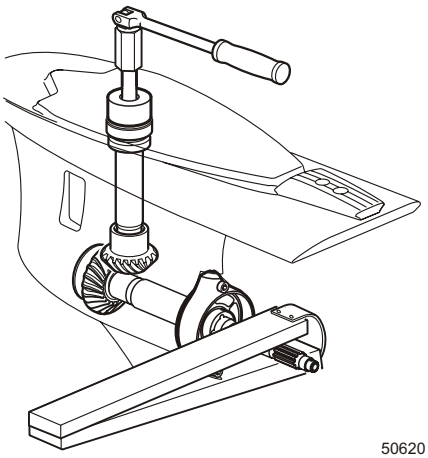

50619

1. Paint three gear teeth (T) with marking compound as shown.

   **Teeth should be completely covered with marking compound, (light coating) from heel to toe and crest to root.**

   **For right hand rotation applications, use the convex side of gear.**

   **For left hand applications, use the concave side of gear.**



50620

2. Reassemble gearcase according to earlier procedures;

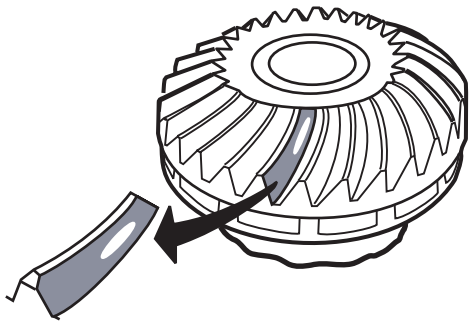
   **Install propshaft/bearing.**

   **Install bearing housing and shims.**

3. Turn vertical shaft in direction of rotation.

   **While turning, brake the propshaft movement to simulate a propeller load.**

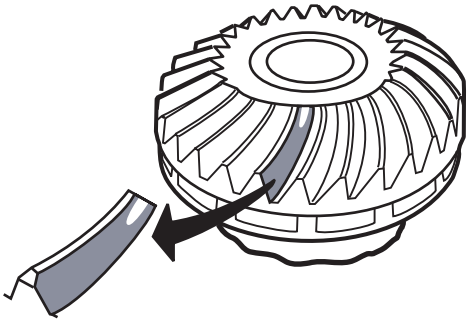
⚠ **CAUTION! If you must load the propshaft with your hands, wear leather gloves. The propshaft has sharp edges and may cut or injure your hands.**



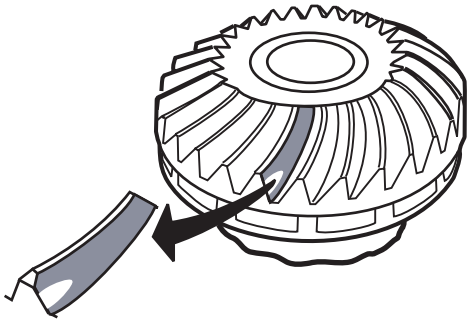
4. Remove the bearing carrier and the propshaft. Inspect the propshaft gear contact pattern.
5. Check that the contact pattern matches Illustration.

   **The pattern should be positioned in the middle of the tooth but displaced towards the toe.**

### Correcting



6. If the contact pattern is running off the toe, **add** equal amounts of shim thickness to the propshaft and vertical shaft bearings.



7. It the contact pattern is running off the heel, **subtract** equal amounts of shim thickness from the propshaft and vertical shaft bearings.

8. If shims were changed to correct the gear contact pattern, then the lash must be rechecked before final assembly.

   **Go to see Gear Lash on page 115.**

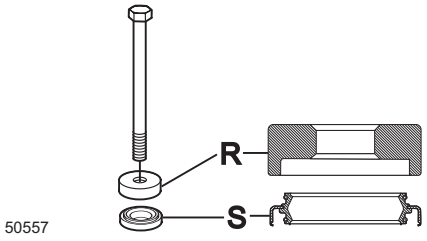
9. After gear lash and contact pattern are both correct, clean all marking compound from gears and proceed to final assembly.

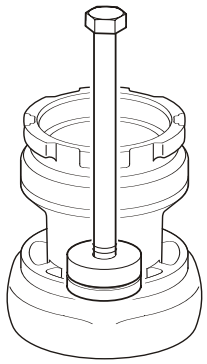
## Final Assembly

### Propshaft Seal

1. Assemble pusher/puller **3850623** and seal installer **3588103** (R).

   **Place seal in installer, lip towards tool, as shown.**



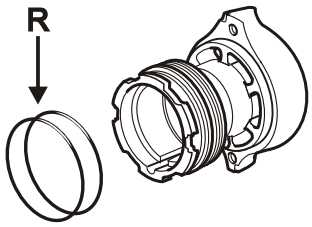


50558

**Propshaft Bearing Housing**

2. Press seal in to housing until it seats.

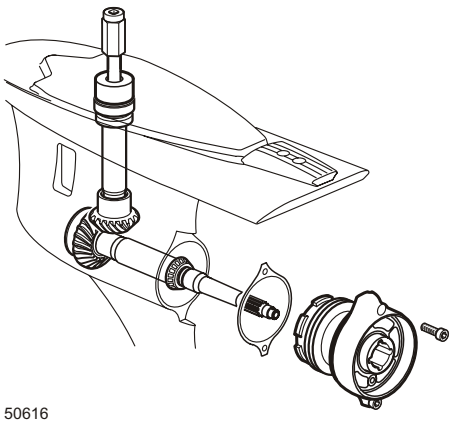
   **Apply gear oil to seal lip.**




50621

3. Install o-rings on housing.

   **Apply gear oil to o-rings.**

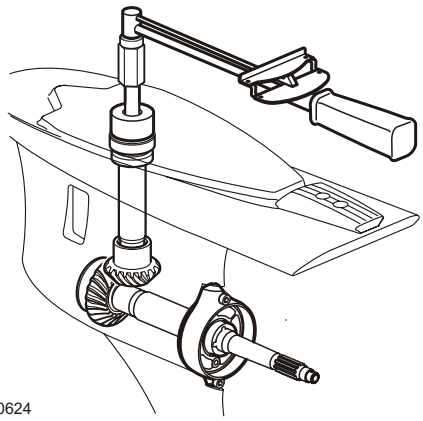


50616

4. Install shims and re-install bearing housing.
   Install NEW screws and torque to 10 ft. lb. **(13,5 N'm)**.
   Then tighten screws another 70° of rotation.

***NOTICE!*** **Use original screws for all shimming, rolling torque and other pre-assembly work. Use two NEW screws for final assembly and final torque.**

**Check Rolling Torque**



50624

5. Check for correct rolling torque;

   **for ratios 1.43, 1.51, 1.60, 1.79, 1.89: 14-23 in. lb. (1,58-2,60 N.m).**

   **for ratios 1.66, 1.97, 2.18: 11-18 in. lb. (1,24-2,03 N.m)**

6. Correct as needed;

   **rolling torque is too high, add shim.**

   **rolling torque is too low, decrease shim.**

## Lower Gearcase Installation

**Proceed to Chapter 2 to;**

- Reassemble gearcase to the upper housing
- Pressure and Vacuum test the assembled drive
- Install the drive on the transom
- Install the propeller

## Specifications

| Description | U.S. | Metric |
|---|---|---|
| Nut, pinion gear | 150-160 ft. lb. | 203-217 N•m |
| Screws, anode | 15-20 ft. lb. | 20-28 N•m |
| Plug, drain | 60-84 **in.** lb. | 7-10 N•m |
| Nuts, upper to lower housing | 30-41 ft. lb. | 40-56 N•m |
| Screws, upper to lower housing | 30-41 ft. lb. | 40-56 N•m |
| Screws, propshaft bearing housing | 10 ft. lb.<br>+ 70° rotation | 13.5 N•m<br>+ 70° rotation |
| Screws, water intakes | 44-62 **in**. lb. | 5-7 N•m |

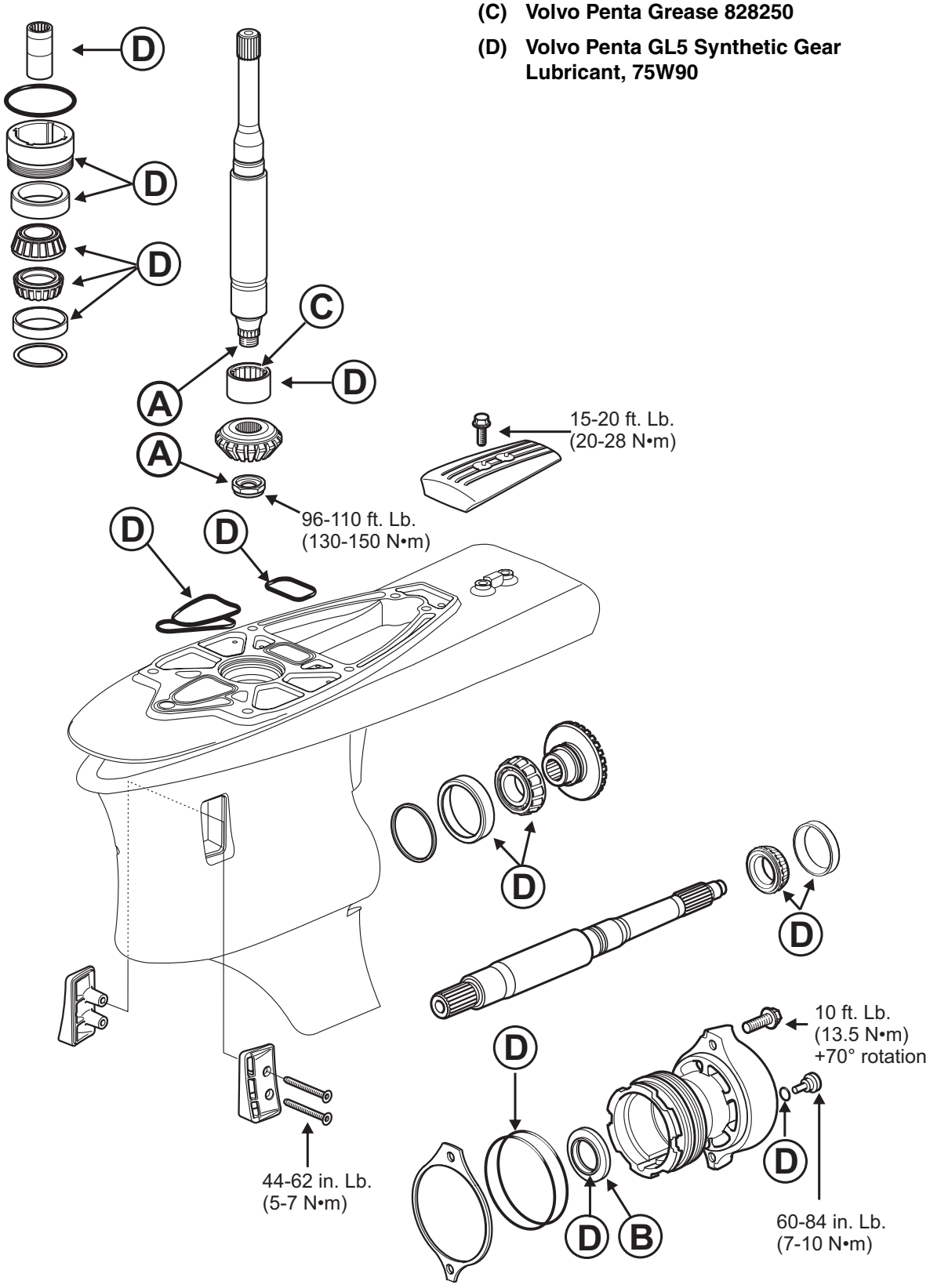
## Service Chart

**(A) Volvo Penta Thread Locking Fluid 1161053**

**(B) NO Gasket Sealing Compound required**

**(C) Volvo Penta Grease 828250**

**(D) Volvo Penta GL5 Synthetic Gear Lubricant, 75W90**



# DPS-A Lower Gearcase

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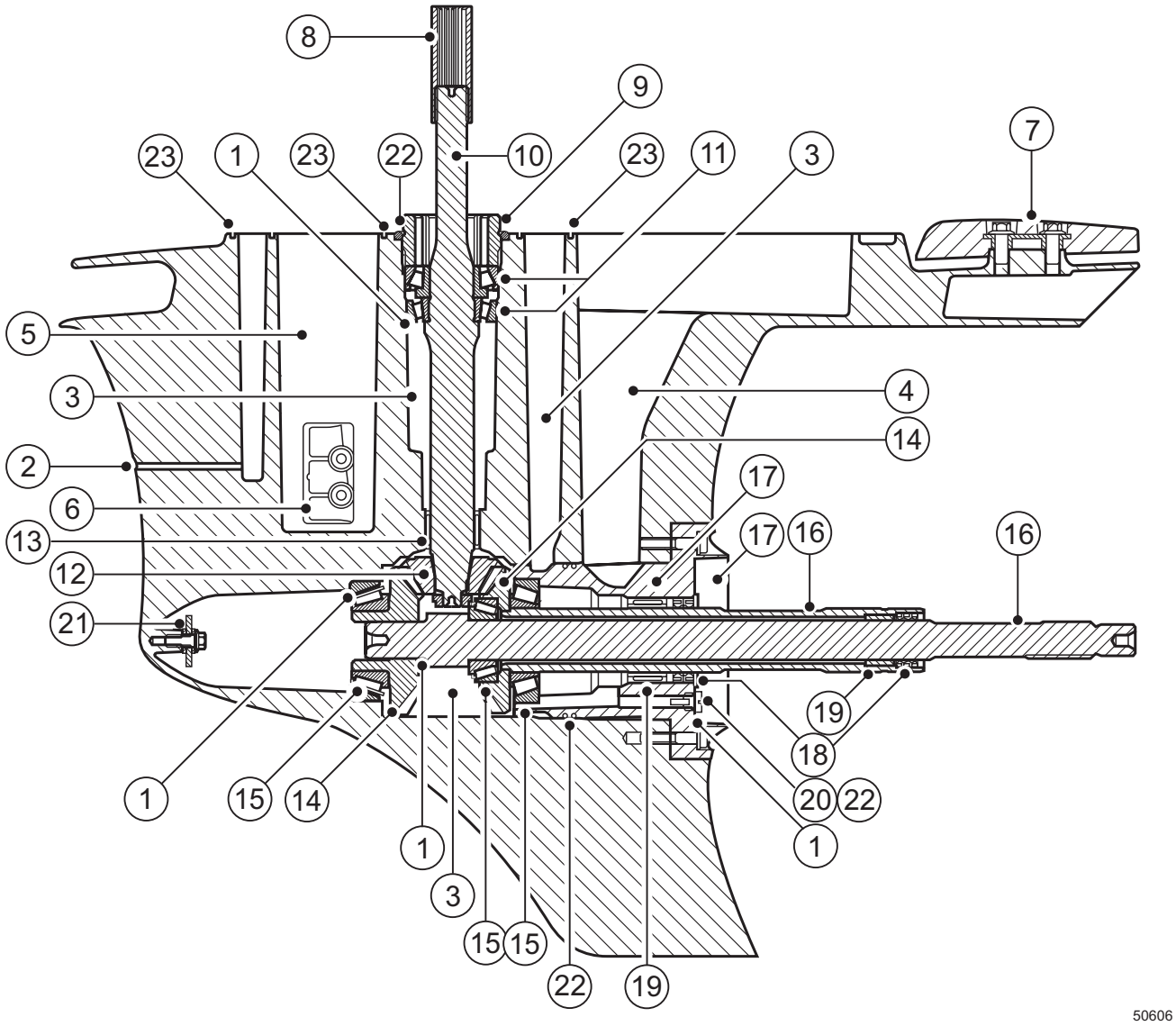
## Safety Messages

Before working on any part of a Volvo Penta sterndrive, read the section called “Safety Messages” in the first chapter of this manual.

## Lower Gearcase - cross section

DPS-A




1.Shim position16. Propshaft
2.Pitot passage17.Propshaft bearing housing
3.Oil passage18.Seals, propshaft
4.Exhaust passage19.Bearing, propshaft
5.Water passage20.Plug, oil drain
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7.Anode22.O-ring
8.Splined sleeve - Drive Saver23.Seal
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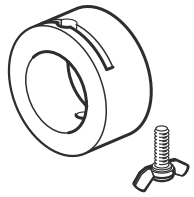
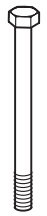
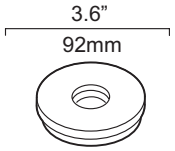
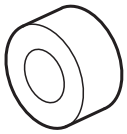
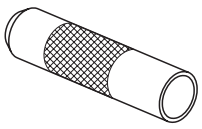
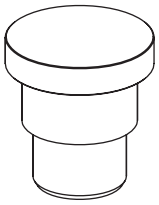
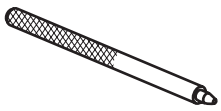
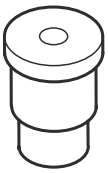
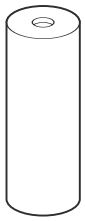
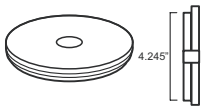
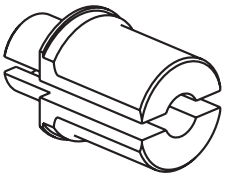
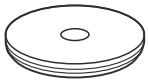
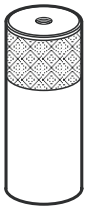
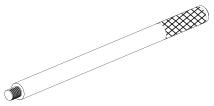
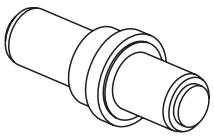
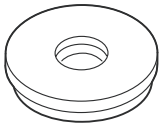
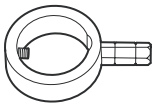
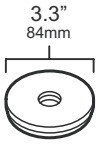
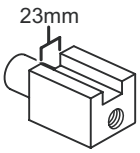
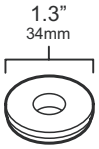
10.Vertical shaft
11.Bearing, vertical shaft
12.Pinion
13.Bearing, pinion
14.Drive gear
15.Bearing, drive gear

## Special Tools

| Tool Name | Part No. | View | Tool Name | Part No. | View |
|---|---|---|---|---|---|
| Attachment Tool | 884940 |  | Bolt | 3850623 |  |
| Bearing Cup Installer | 3850621 |  | Dismantling Tool | 884803 |  |
| Bearing Installer | 3850617 |  | Drift | 884263 |  |
| Bearing Installer | 3855928 |  | Drift | 884143 |  |
| Bearing Installer | 3849670 |  | Drift | 3855866 |  |

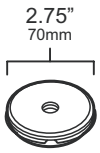
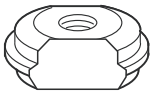
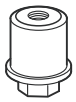
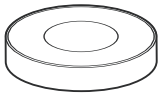
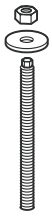
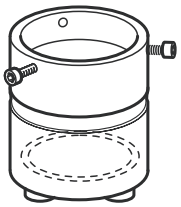
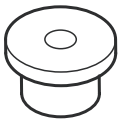
(Early versions may have the OMC part no.)

**Special Tools, cont'd**

| Tool Name | Part No. | View | Tool Name | Part No. | View |
|---|---|---|---|---|---|
| Guide Plate | 3849656 |  | Puller | 884832 |  |
| Guide Plate | 3850619 (914700) |  | Puller | 884789 |  |
| Handle | 3850609 (311880) |  | Puller | 3850623 |  |
| Installation Tool | 884975 |  | Race Installer | 3850616 (914695) |  |
| Lash Tool | 3855873 |  | Race Installer | 3855864 |  |
| Pinion Nut Holder | 3849660 |  | Race Installer | 3855865 |  |

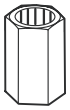
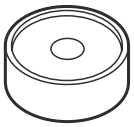
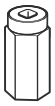
(Early versions may have the OMC part no.)

**Special Tools, cont'd**

| Tool Name | Part No. | View | Tool Name | Part No. | View |
|---|---|---|---|---|---|
| Race Remover | 3855862 |  | Seal Protector | 884807 |  |
| Remover Tip | 3855859 |  | Seal Protector | 884976 |  |
| Remover/ Installer Tip | 3855868 |  | Shim Fixture | 3850600 |  |
| Remover Tool | 3849659 |  | Shim Fixture | 3849662 |  |
| Rod, Nut and Washer | 3855860 |  | Shim Fixture | 3849663 |  |
| Seal Installer | 3849661 |  | Shim Spacer | 3849653 |  |

(Early versions may have the OMC part no.)

**Special Tools, cont'd**

| Tool Name | Part No. | View | Tool Name | Part No. | View |
|---|---|---|---|---|---|
| Socket | 884830 or 3850618 (914699) |  | Spanner Wrench | 3850601 |  |
| Spacer | 3849672 |  | Spline Socket | 3850598 |  |

(Early versions may have the OMC part no.)

**Volvo Penta Service Tools** All tools by are listed in text by name and **part number.**

**Sealants, Lubricants and Adhesives**

Cleaning solvent

Volvo Penta GL5 Synthetic gear lubricant, 75W90

Loctite primer

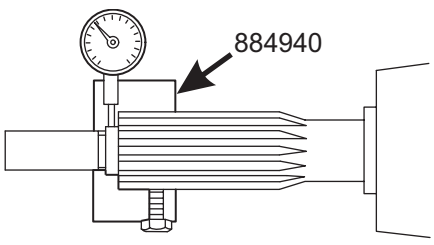
Volvo Penta thread locking compound **1161053**

Volvo Penta grease **828250**

## Inner Propshaft Runout

Inner propshaft runout and play must be measured before the gearcase is disassembled.

***NOTICE!*** **If either runout or play exceeds the limits in the steps below the inner propshaft is worn or bent and must be replaced. All related bearings and seals must also be replaced.**

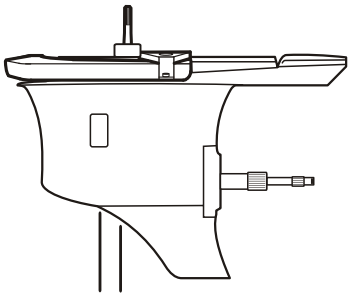



1. Attach a dial indicator to tool **884940**.
   Attach to outer propshaft with tip resting on inner propshaft, as close to edge of outer propshaft as possible.
2. Rotate shafts one turn and read dial indicator.
   The reading should not exceed 0.0027 in. (0,07 mm).
3. To measure play in inner propshaft move inner propshaft toward and away from dial indicator.
   Check shaft in several different positions.
4. The play between shafts should not exceed 0.0012 in. (0,03 mm).

## Sterndrive Removal and Disassembly

To service components of the lower gear housing, separate lower housing from upper housing. Follow the procedures in the **Sterndrive, General Information** chapter of this manual.

If only the lower housing is being serviced, do not remove the sterndrive from the transom shield. Tilt the drive up and then follow the procedure for separating the uppper and lower housings.



50631

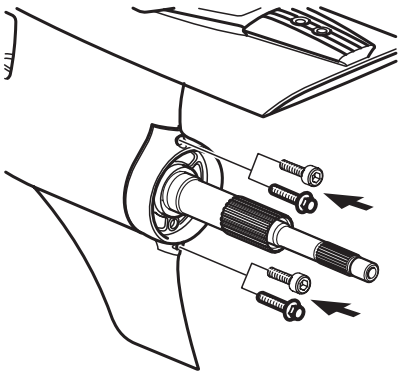
1. Mount the gearcase in a suitable holding fixture and clamp it securely.

***NOTICE!*** **The gearcase should be held in fixture throughout rebuild process. Fixture is not shown in following steps to provide clearer illustrations of the steps.**

## Lower Gearcase Disassembly

### Propshafts and Bearing Housing Removal

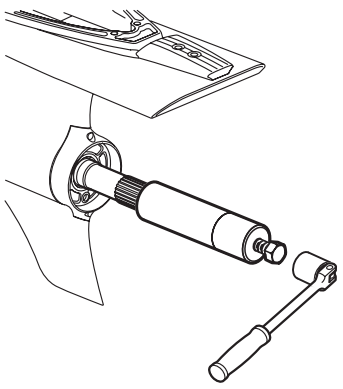
**Bearing housing**



50630

1. Remove two screws securing propshaft bearing housing.

***NOTICE!*** **Use the same type of screw that was removed if any require replacement. If a socket head screw was removed, a socket head screw must be used to replace it. Flange type screws are not compatible with early propshaft bearing housings.**



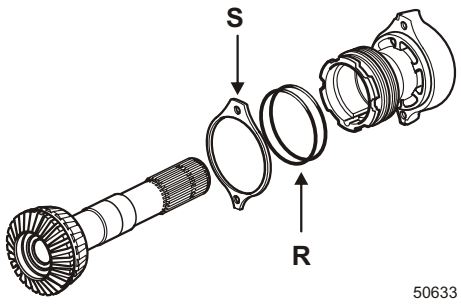
50632

2. Thread puller **884789** on end of outer propshaft.

   Thread a 5/8-11 bolt in to end of adapter.

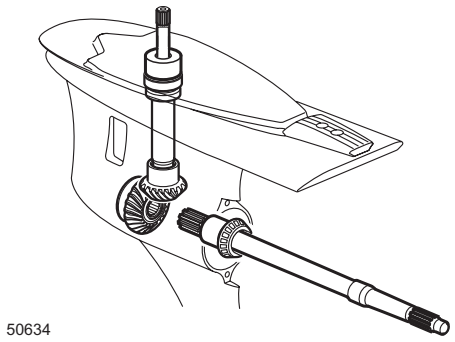
   Use socket and ratchet to turn bolt to loosen outer propshaft and housing.

   Remove shaft and housing from gearcase.



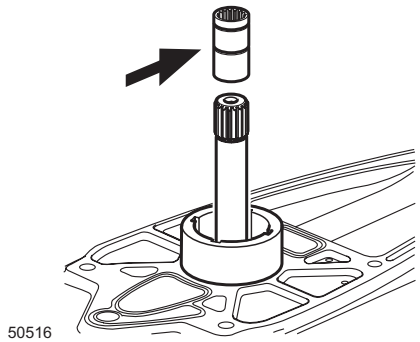
50633

3. Remove shims (S), they can be reused if not damaged.
   Remove and discard o-rings (R).
4. Remove tube gear/bearing from housing.

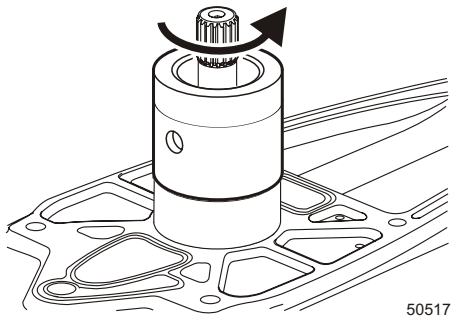

50634

5. The inner propshaft is a slide fit, not pressed.
   Remove innner propshaft.
   Save shims.

**Vertical Shaft and Pinion Removal**

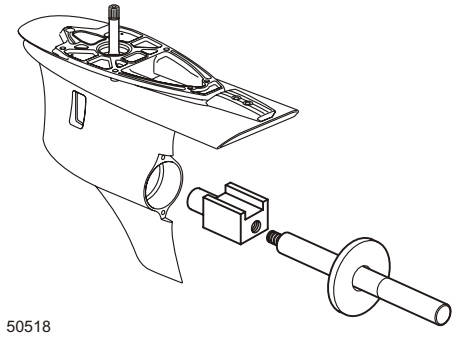

50516

1. Remove intermediate shaft and inspect splines.
   Inspect intermediate shaft for twisting.
   If damaged replace.


50517

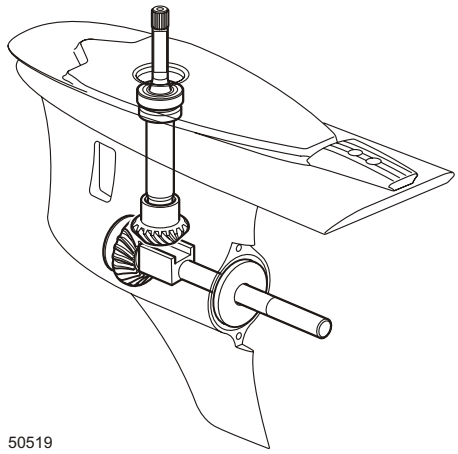
2. Using spanner wrench **3850601** unscrew retainer.
   Remove retainer and o-ring, discard o-ring.

### Pinion nut removal



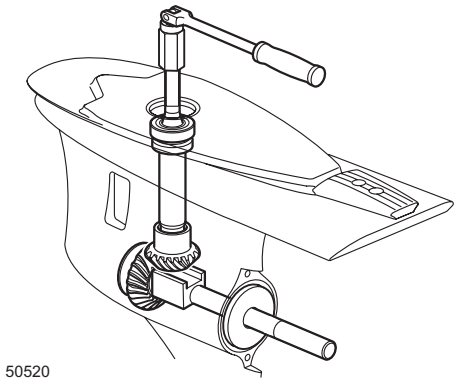
50518

1. Screw pinion nut holder **3849660** on to handle **3850609**.
   Slide guide plate **3849656** over handle.



50519

2. Insert pinion nut holder in to drive gear.
   Turn vertical shaft to align pinion nut with holder.



50520

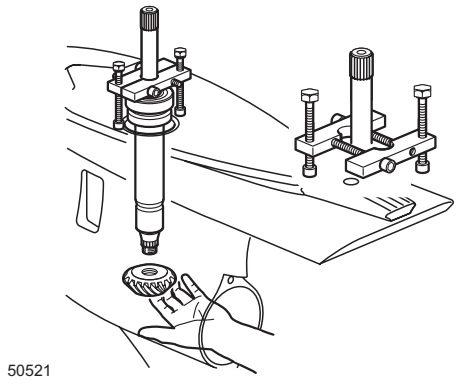
3. Slide socket **3850598** on to vertical shaft.

   Attach pull bar to socket.

   Hold pinion nut holder in place with handle and turn socket (and shaft) counter-clockwise to loosen pinion nut.

   Remove and retain pinion nut.

### Vertical shaft removal

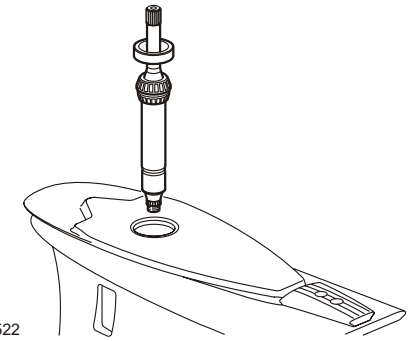


50521

1. Pinion gear may slip off shaft, if not;
   Install puller 3855923 on vertical shaft.
   Pull shaft and bearings up by tightening vertical screws.

***NOTICE!*** **Hold the pinion gear while lifting shaft.**

2. Remove pinion gear.

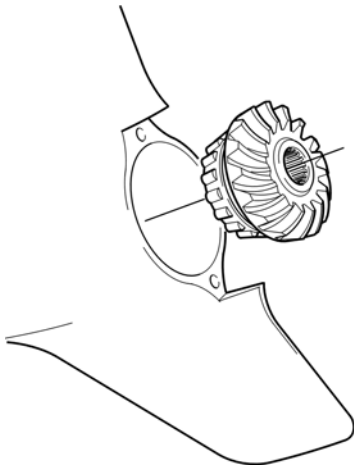

50522

3. Lift out vertical shaft, bearings and upper race.

***NOTICE!*** **Do not remove vertical shaft bearings unless you intend to replace them. Removal process may damage bearings.**

**Gear and Bearing Removal**

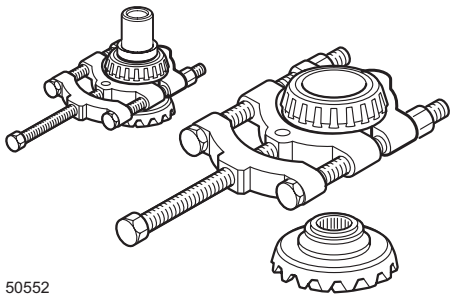
1. Remove forward gear and bearing.



**Forward Gear Service**

**Bearing Removal**

***NOTICE!*** **Do not remove bearing from forward gear unless you intend to replace bearing. Removal process may damage bearing.**

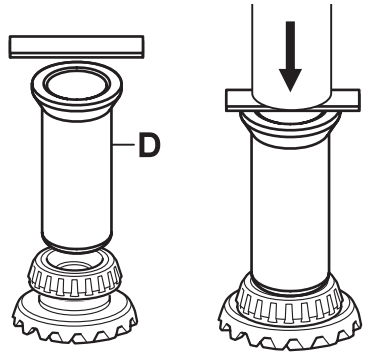

50552

1. Use bearing separator to support bearing.
   Use drift **884263** to press gear out of bearing.

***NOTICE!*** **Be ready to catch gear when it is pressed out of bearing.**

**Installation**

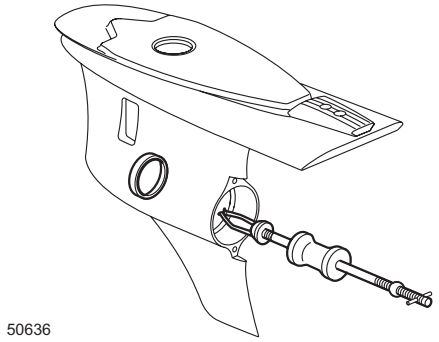
### Bearing Installation




1. Apply gear oil to inner diameter of bearing.

   Slide bearing on gear with taper facing away from gear.

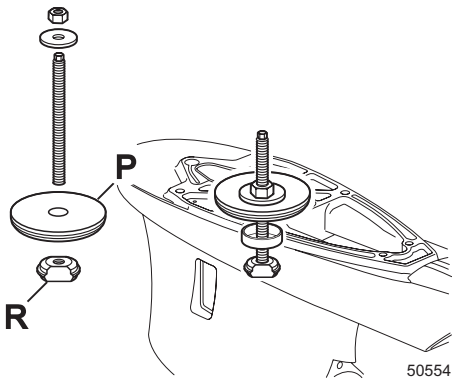
   Position drift **884168** (D) upside down on inner ring of bearing with a sutible press plate, and press bearing on gear until it seats.




2. Use a two-jaw puller and slide hammer to remove bearing race and shims.
   There are two slots in the housing forward of the race seat to accept the puller jaws.

***NOTICE!*** **The shims may be damaged during removal and must be replaced on reassembly.**

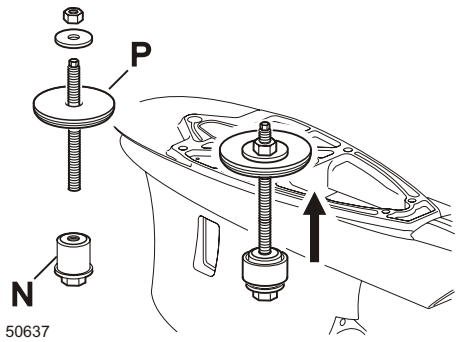
### Lower Bearing Race Removal




1. Assemble race remover **3855859** (R), rod, nut and washer **3855860** and guide plate **3850619** (P).
   Place remover in to cavity under lip of bearing race.
   Place smallest step of plate in retainer bore.
2. Tighten nut to remove race and shims.
   Shims may be damaged during removal and should be replaced.

### Pinion Bearing Removal

***NOTICE!*** **Remove the pinion bearing only if it is to be replaced. The bearing may be damaged during removal.**




1. Place smallest step of plate **3850619 (P)** in retainer bore.
   Insert rod/nut/washer **3855860** through plate.
2. Place remover tip **3855868** (N) in to pinion bearing from below.
   Thread rod **3855860** in to remover tip.
3. Tighten the nut to remove the pinion bearing.

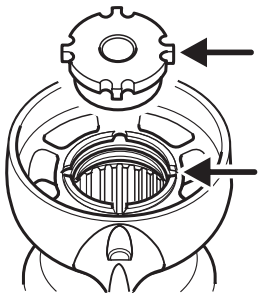
***NOTICE!*** **All references to gear oil in all assembly steps are referring to the same oil used to fill the drive; GL5 Synthetic gear lubricant, SAE 75W-90.**

## Bearing Housing Service

### Bearing and seal removal

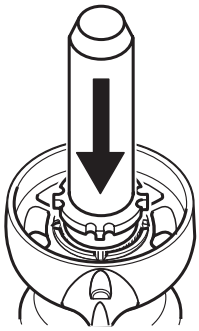
***NOTICE!*** **Bearings should not be removed unless they are to be replaced. Removal will damage the bearings.**

1. Place housing in press, seal end up.
2. Place tool **3849659** on seal.
   Line up high spots on tool (arrow) with slots on housing.



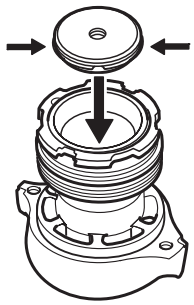
50810

3. Install drift **884263** on tool.
   Press out and discard the bearing and seals.

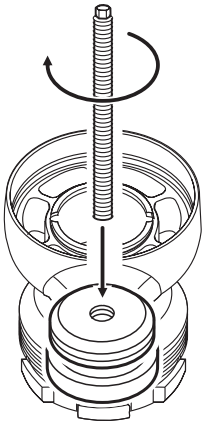


50811

4. Turn housing over, bearing race facing up.
   Insert race remover **3855862** with the tapered side facing up in housing and press behind race.

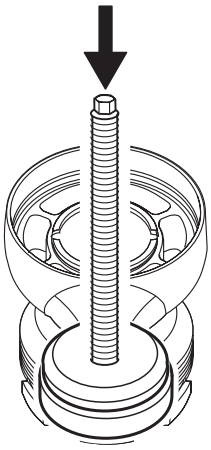


50817



50947

5. Turn housing over again, bearing race facing down.
   Thread rod from **3855860** in to remover **3855862**.



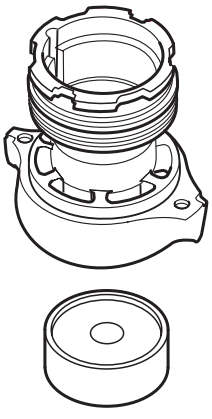
50948

6. Place housing over press or vise.
   Lightly tap or press on rod to remove race.
7. Clean housing in solvent to remove all oil, sealer and other debris from holes, gasket surfaces, and bores. Dry housing thoroughly..

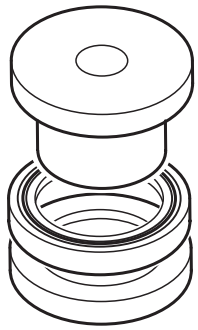
**Seal, bearing installation**

***NOTICE!*** **Correct alignment of bearing and seals in housing bore is needed to insure proper installation. The use of a hand press or other small press is recommended.**

1. Place tool **3849672** on press.
   Place housing over tool as shown.
   Center housing over tool.
   The tool acts as a stop for the depth of the seals and bearing.

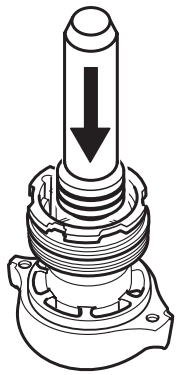


50812



50813

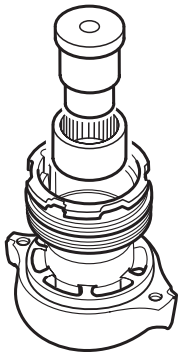
2. Apply oil to outer surface of seals.
   Place seals, back to back (springs facing outward) on tool **3849661**.
   Apply white sealing compound to outer edges of seals.



50814

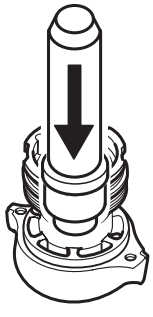
3. Insert tool and seals in to housing
   Use mandrel **884263** against tool, lightly press seals in to place.

***NOTICE!*** **If outer propshaft is grooved where seals contact shaft, do not press seals all the way against the end of housing. Stop seals approxiamtely 5mm from end of housing.**
**When bearing is seated it will position seals.**



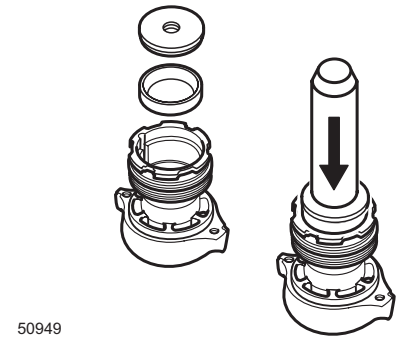
50815

4. Apply oil to outer surface of bearing.
   Place bearing in housing.
   Place press tool **3849670** in bearing.



50816

5. Use mandrel **884263** against tool, lightly press bearing in housing until tool **3849670** stops on tool **3849672** (see above).


50949

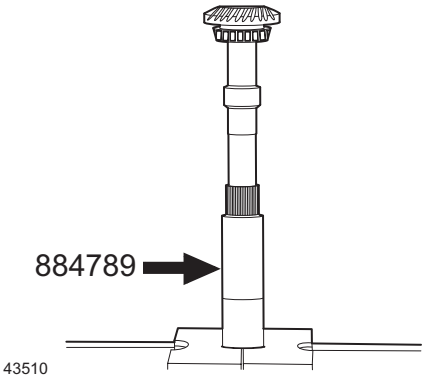
6. Lightly oil outside edge of of bearing race, insert race in housing.
   Place installer **3855864** over race.
   Place mandrel **884263** on installer.
   Lightly press race in to housing.

7. Do not install o-rings at this step.

## Outer Propeller Shaft Service

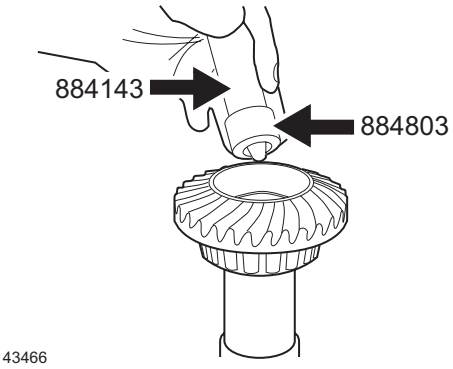
### Bearing, seal removal

***NOTICE!*** **Bearings should not be removed unless they are to be replaced. Removal will damage the bearings.**



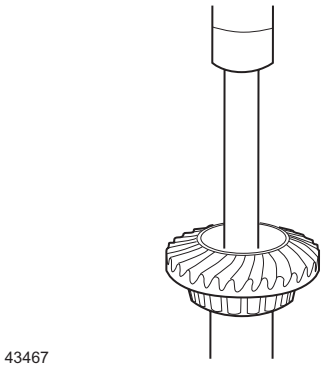
43510

1. Screw puller **884789** on to end of propshaft to protect threads.
   Place assembly in a press.



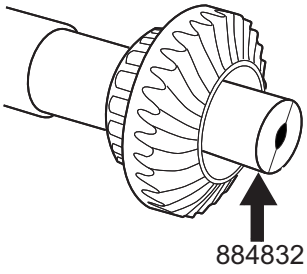
43466

2. Slide dismantling tool **884803** and drift **884143** in propshaft.



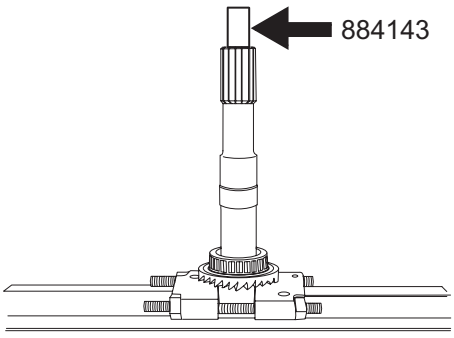
43467

3. Press bearing and seals out of propshaft.
Remove puller **884789** and discard bearing and seals.



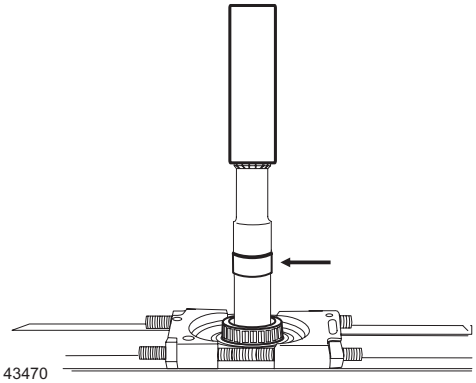

43468

4. Position both parts of puller **884832** so flanges of puller catch inside lip of bearing race.




43469

5. Place drift **884143** in position through propshaft.
Support assembly in a press and press out race.



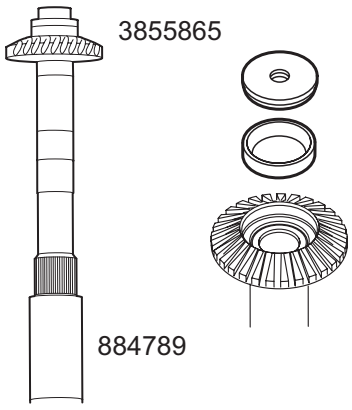
43470

***NOTICE!*** **Do not remove the bearing on the propshaft unless it needs to be replaced. The bearing will be damaged if removed, plus the needle bearing race (arrow) on the propshaft will also have to be removed and replaced to remove the bearing.**

6. Clamp a bearing separator in position to hold bearing.
Thread puller **884789** on propshaft to protect threads.
Position propshaft in a press and press out bearing, then use bearing to press off inner race for needle bearing.

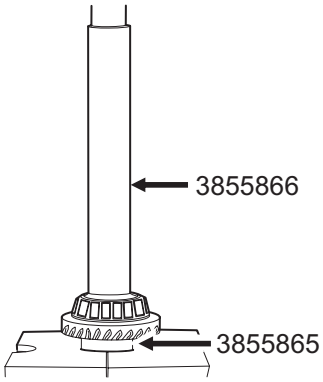
***NOTICE!*** **Needle bearing race is epoxied to the propshaft, modearte heat may be needed to remove race.**

**Bearing, seal installation**



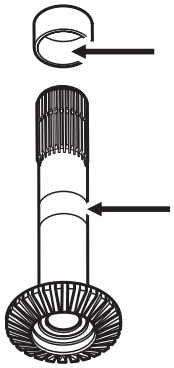
43511

1. Screw puller **884789** on propshaft to protect threads.
   Position in a press. Apply gear oil to the bearing race.
   Press race into gear face using installer **3855865**.

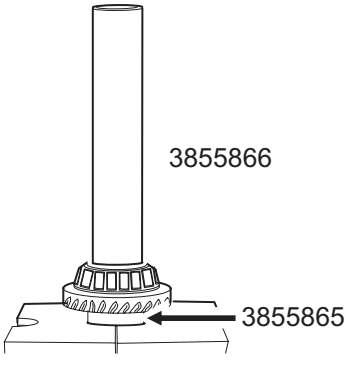


43536

2. Place installer **3855865** on a press, bevel up.
   Place race in propshaft gear over installer.
   Lightly oil inside surface of bearing and place it on propshaft, tapered side away from gear.
   Press bearing in place using installer **3855866**.

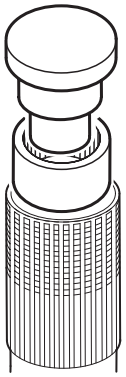

50953

3. Apply Loctite primer to inside of sleeve and its position on propshaft, Allow to air dry.
   Apply a small amount of Loctite 609 to propshaft.



50954

4. Place installer **3855865** on a press, bevel up.
   Place race in propshaft gear over installer.
   Position race on propshaft
   Press in position using Installer **3855866**. Race is seated at proper depth when installer bottoms out on bearing.

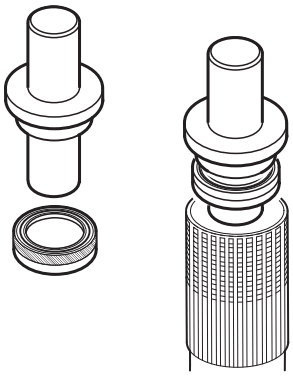


43676

5. Apply gear oil to outside surface of needle bearing and position it in end of propshaft.

   Use installer **3855928** to press bearing in position.

   Press until tool lip seats on end of propshaft.

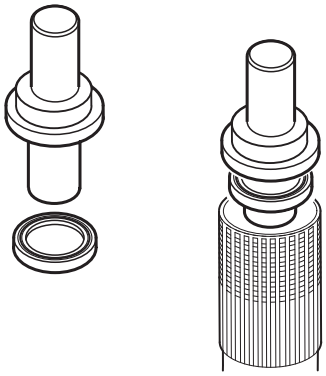


43473

6. Place double lipped seal on installer **884975** with rubber side facing stepped side of the installer.

   Apply white sealing compound to outer edges of seal.

   Press seal in place until tool seats on end of propshaft.



43474

7. Turn installation tool over so that the stepped side is facing up.

   Position single lipped seal on installation tool **884975** with open side of seal facing installer.

   Apply white sealing compound to outer edges of seal.

   Press seal in place until tool seats on end of propshaft.

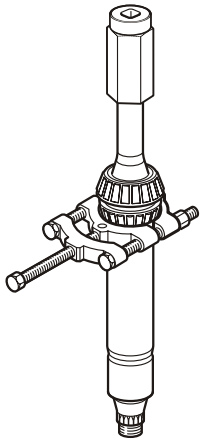
8. Remove tool.

   Apply gear oil to seal lips.

**Vertical Shaft Service**

***NOTICE!*** **Do not remove vertical shaft bearings unless you intend to replace them. Removal process may damage bearings.**

### Bearing removal

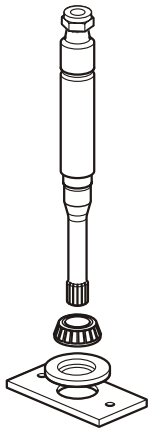


50523

1. Place socket **3850598** over splines to protect shaft.
   Using a bearing separator and press, remove bearings.

***NOTICE!*** **Be ready to catch shaft when pressed out of bearings.**

### Installation



50562

1. Apply gear oil to inner diameter of small bearing.

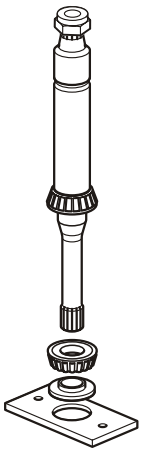
   Protect threads of shaft by installing a pinion nut on shaft.

   Slide bearing on shaft with taper facing pinion end.

   Place bearing installer **3850617** on open jaws of a press support.

   Position raised lip of Installer down

   Insert shaft and bearing in installer, and press shaft in bearing until it seats.



50563

2. Apply a light coat of gear oil to inner diamter of large bearing.

   Slide bearing on shaft with taper facing away from small bearing.

   Place bearing installer **3850617** on open jaws of a press support.

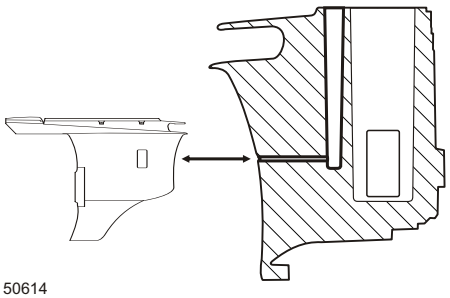
   Position raised lip of installer up; it must contact nose of bearing.

   Insert shaft into installer, and press shaft in bearing until it seats.

**Gearcase Cleaning and Inspection**

Clean housing in solvent to remove all oil, sealer and other debris from holes, gasket surfaces, and bores. Dry housing thoroughly.

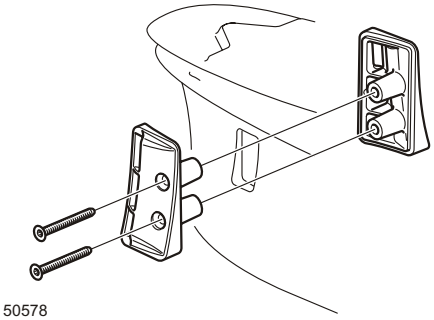
### Passages for Pitot



50614

If pitot (speedometer) is clogged, use compressed air to clear the passages. Apply air at opening to smaller passage on leading edge of gearcase.

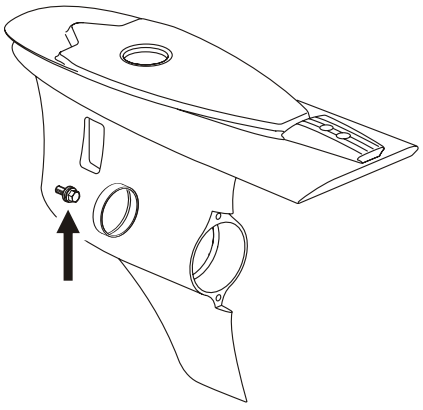
### Water Intakes



50578

If needed, water intakes can be removed.
Remove two screws from port intake.

### Gearcase Magnet



50615

There is a magnet mounted in the front of the gearcase, forward of the propshaft gear. No service is needed and the magnet should not be removed during routine gearcase service.

If the magnet is removed, when reinstalling, torque screw to 5-7 ft. lb. (7-9 N•m) .

***NOTICE!*** **Most threaded holes in gearcase have Heli-Coil inserts. Do not use a thread tap to clean screw holes. Tap will damage Heli-Coil insert and make replacement necessary. Do not replace with standard non-locking Heli-Coils.**

- **Retainer Threads** - lock ring must turn freely for full depth.
- **Cooling Passages** - check for corrosion build-up that would restrict water circulation.
- **Propshaft Bearing Carrier Bore** - remove all sharp edges that would cut o-ring.
- **Gears, Shafts and Bearings** - inspect gear teeth for cracks and chips or discoloration. If any gear is damaged all must be

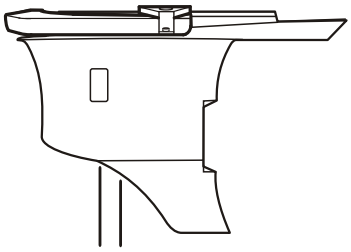
replaced. They are replaced as a set.
Screw threads on end of shafts must be undamaged. Replace shaft if lock patch is excessively worn. Check for pitting, corrosion and discoloration.

## Lower Gearcase Assembly

### Gearcase

Mount the gearcase in a suitable holding fixture and clamp it securely.

***NOTICE!*** **The gearcase should be held in fixture throughout rebuild process. Fixture is not shown in following steps to provide clearer illustrations of the steps.**



50611

### Water Intakes

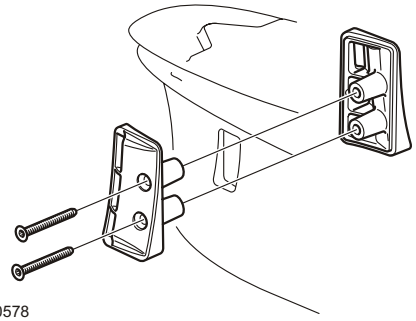
Reinstall water intakes if removed.

Place each intake in hole on correct side of gearcase.

Openings must face forward.

Install two screws from port intake side.

Torque screws to 44-62 **in.** lb. (5-7 N•m).



50578

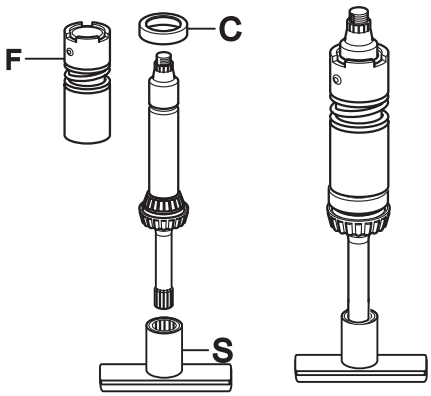
The following steps assemble the gearcase so that gear shimming, gear lash and wear contact patterns can be set.

***NOTICE!*** **All references to gear oil in all assembly steps are referring to the same oil used to fill the drive; Volvo Penta GL5 Synthetic gear lubricant, SAE 75W-90.**

### Pinion Shimming

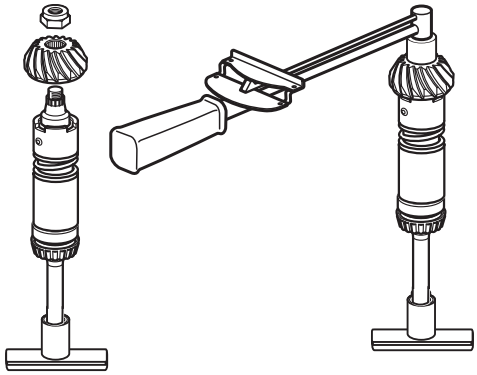
***NOTICE!*** **This procedure determines the amount of shims required to properly position the pinion in relation to the propshaft gears. Record the following shimming measurement for the final gear lash check.**

### Measure for Shims

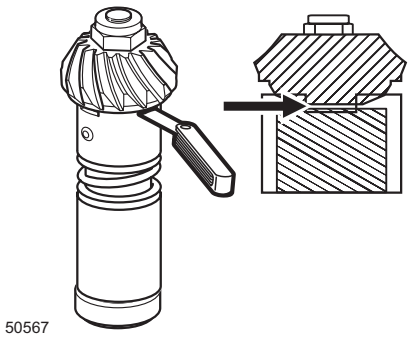



1. Clamp socket **884830** (S) in a vice and place vertical shaft in socket. Place race (C) on small bearing.
   Slide shim fixture **3849662** (F) on shaft with three slots facing threaded end of shaft.

***NOTICE!*** **The shim fixture for the DPS is similar to the SX shim fixture. Make sure you use the correct ficture; 3849662.**



2. Install pinion and pinion nut.
   Torque nut to 78-87 ft. lb. (105-118 N.m).
   Rotate shim fixture to seat bearing for shimming purposes.


50567

3. Check all three slots with feeler gauge and record each reading.
   Measure between inner ring of fixture and horizontal gear surface.
   Average feeler gauge readings.

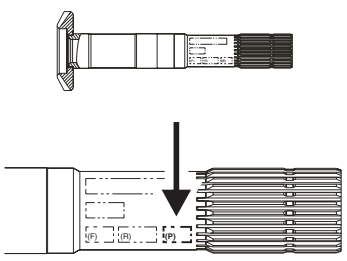
Example:

**Table 1:**

| Add: | Divide: |
|---|---|
| Slot no. 1 = 0.011 in. | 0.028 in. ÷ 3 = 0.0093 in. |
| Slot no. 2 = 0.009 in. | (Round off to 0.009 in.) |
| Slot no. 3 = 0.008 in. | |
| Total 0.028 in. | |

4. Remove pinion nut and discard.
   Remove gear.
5. The pinion gear markings/etchings are on the outer propshaft.
   Pinion gear mark is in the box marked **P**.
6. Add or subtract shimming allowance number etched on gear from number found in Step 3.
   If number is +5, you would add 0.005 in. to number in 3.
   If number is -5, you would subtract 0.005 in. from number in 3.
   If the number is zero (0), use number in 3.

50955



**Example:**
Add/Subtract:

0.009 in., number from Step 3

+ 0.005 in. number etched on gear

0.014 in. shims needed

7. Use this thickness of shims for pinion gear shimming.

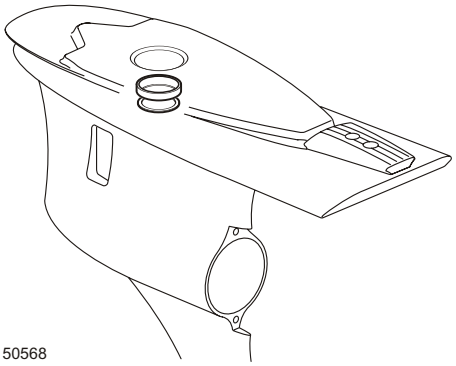
***NOTICE!*** **No less than one shim but no more than five shims should be used to obtain needed shim thickness.**

8. Record shim measurement for rolling torque correction chapter.

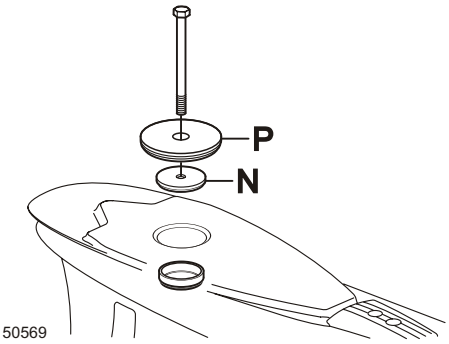
### Install Shims

1. Install pinion shims in gearcase where lower bearing race seats.
2. Apply gear oil to bearing race.

   Install race on top of shims with race taper facing up.


50568

3. Use pusher/puller **3850623**, guide plate **3850619** (P), and race installer **3850621** (N) to install race.



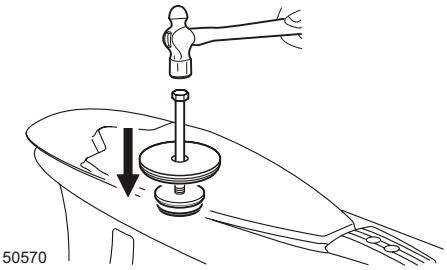
50569

4. Place installer on race.

   Place smallest step of plate in retainer bore.

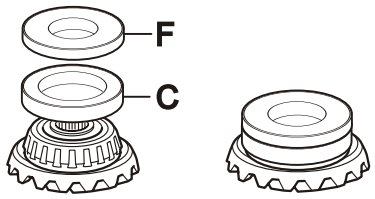
⚠ **CAUTION! Wear safety glasses.**

Use a hammer to seat bearing race.


50570

***NOTICE!*** **This procedure determines the amount of shims required to properly position the propshaft gear in relation to the pinion.**

## Forward Gear Shimming



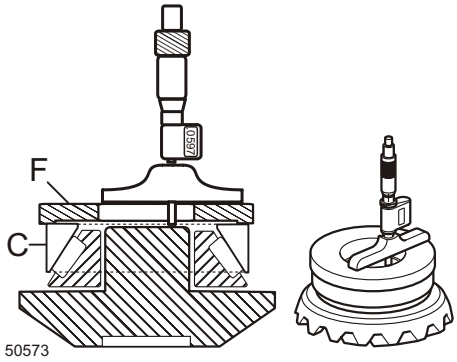

50572

1. Place gear and bearing on flat surface.

   Place bearing race (C) on top of bearing.

   Rotate race to seat bearings.

   Position shim fixture **3850600** (F) on top of gear and bearing, recessed side facing down.




50573

2. Using a depth micrometer, measure the distance from top of shim fixture to end of gear shaft.

   Subtract 0.500 in. from this measurement.

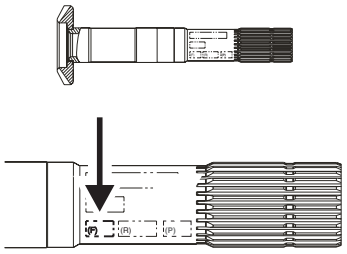
Example:

0.552 in. measurement to end of gear shaft

- 0.500 in. thickness of shim fixture

0.052 in. actual dimension

50956



3. The forward gear markings/etchings are on the outer propshaft. Forward gear mark is in the box marked **F**.
4. Add or subtract shimming allowance number etched on gear from number found in Step 2.
   If etched number is -5, you would subtract 0.005 in. from dimension in Step 2.
   If etched number is +5, you would add 0.005 in. to dimension in Step 2.
   If the etched number is zero (0), use the dimension in Step 2.

Example:

Add/Subtract:

0.052 in. actual dimension in Step 2

-0.005 in. etched number (0) on gear

0.047 in. total

5. Subtract number in Step 3 from a nominal dimension of **0.079** in.

Example:

Subtract:

0.079 in. nominal dimension

- 0.047 in. total from Step 3

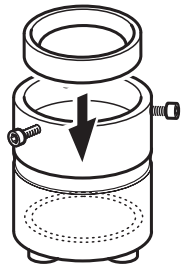
0.032 in. shims needed

6. Use this thickness of shims for front gear shimming
7. Record shim measurement for bearing race installation later in procedure and rolling torque correction in “Gear Lash” section later in manual.

## Outer Propeller Shaft Shimming

***NOTICE!*** **This procedure determines the amount of shims required to properly position the outer propeller shaft**

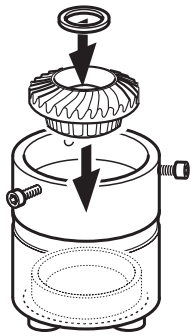
**in relation to the pinion. Record the following shimming measurement for the final gear lash check.**



50971

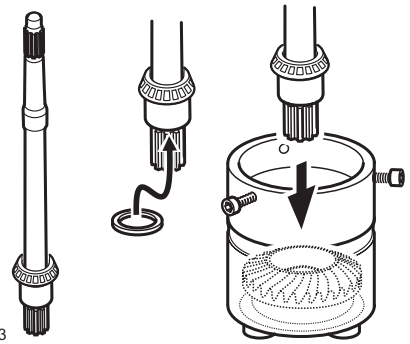
1. Place shim fixture, **3849663** on a flat surface.

   Place forward gear bearing race (taper up) inside fixture.



50972

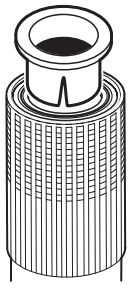
2. Place forward gear/bearing inside the fixture and position on race.
3. Set shim spacer, **3849653** on forward gear face



50973

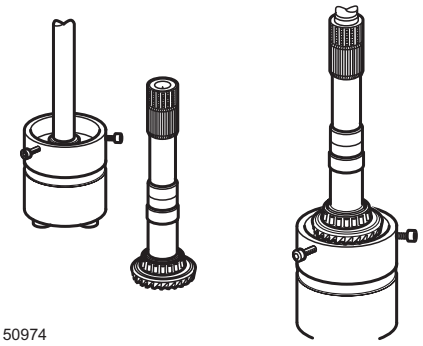
4. Insert inner propshaft/bearing in forward gear.

   Make sure spacer is seated between gearface and boss on propshaft.



50959

5. Place seal protector, **884976** over outer propshaft seals.

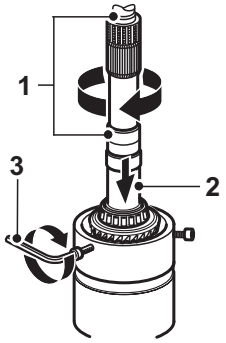


50974

6. Place the outer propshaft over inner propshaft

   Position outer propshaft in shim fixture.

   Make sure race in gear face seats on bearing on inner propshaft.

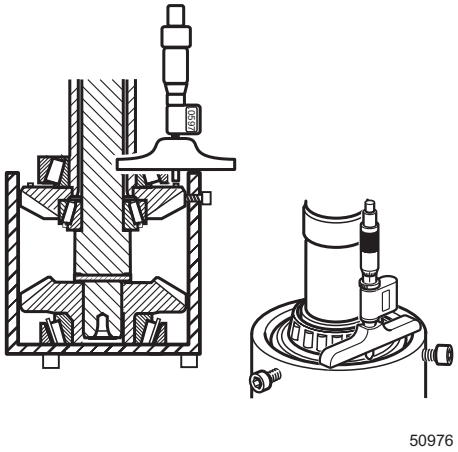



50975

7. Spin both shafts to seat the gears.

   Load the assembly by pressing down on outer propshaft.

   Finger tighten the three set screws to capture outer propshaft.



50976

8. Use a depth micrometer to measure from the top of the shim fixture to the machined ring on the outer propshaft.

   Take a measurement by each of the three set screws.

   Average the measurements.

Example:

**Table 2:**

| Add: | Divide: |
|---|---|
| No. 1 = 0.249 in. | 0.759 in. ÷ 3 = 0.253 in. |
| No. 2 = 0.253 in. | |
| No. 3 = 0.257 in. | |
| Total 0.759 in. | Average 0.253 in. |

9. Subtract the amount of shims required to position the forward gear from the average depth measurement from step 8.

Example:

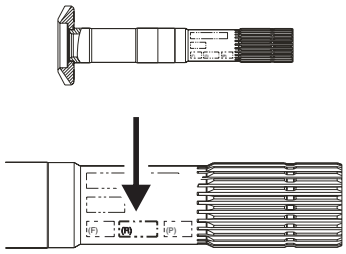
Subtract:

0.253 in. average depth from step 8

<u>0.032 in.</u> forward gear shims

0.221 in. total

50957



10. The rear gear markings/etchings are on the outer propshaft. Forward gear mark is in the box marked **R**.
11. Add or subtract shimming allowance number etched on gear from number found in Step 9.;

    If the etched number is **+5**, you would **ADD 0.005 in.** to actual dimension in Step 9.

    If the etched number is **-5**, you would **SUBTRACT 0.005 in.** from actual dimension in Step 9.

    If the etched number is -0-, use the actual dimension from Step 9.

Example:

Add/Subtract:

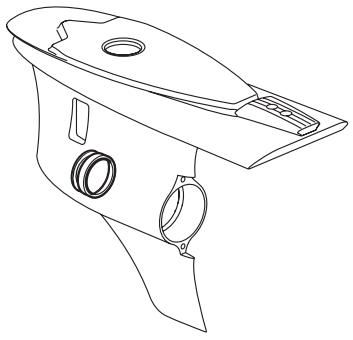
0.221 in. actual dimension in Step 9

0.002 in. etched number (+2) on gear

0.223 in. total shims required

12. Record dimension (example: 0.223 in.) for the outer propeller shaft shims required.
13. Remove parts from shim fixture.

**Bearing Race and Shim Installation**



50574

***NOTICE!*** **Use the least number of shims possible to obtain the required shim thickness.**

1. Place needed thickness of shims in recess of bearing race bore.

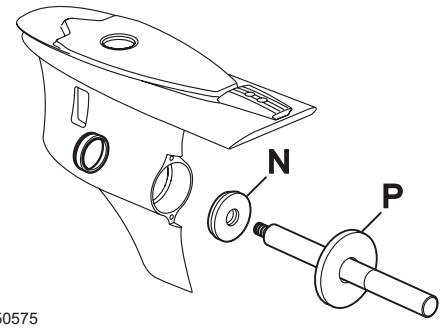
***NOTICE!*** **No less than one shim but no more then three shims should be used.**

2. Apply gear oil to the bearing race.

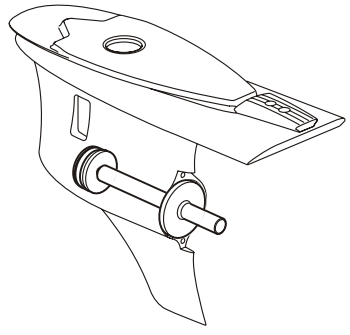
   Place race on top of shims in gearcase.

3. Screw race installer **3849657** (N) on handle **3850609**.

   Slide guide plate **3849656** (P) on handle.




50575



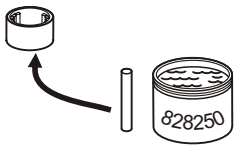
50587

4. Make sure race is straight in bore.

   Place installer in race and drive race in until seated.

## Vertical Shaft and Gear Installation

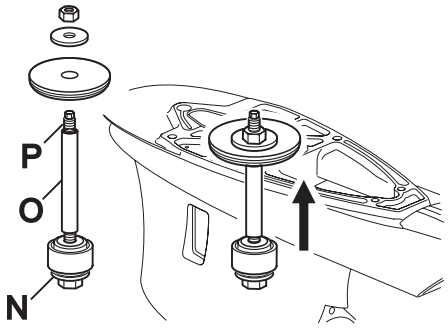
### Pinion Bearing Installation




50576

1. Apply grease **828250** to roller bearings.

   Install bearings in pinion race.




2. Apply gear oil to pinion bearing.

   Install pinion bearing onto installer **3849660** (N).

   Slide spacer **3849668** (O) guide plate **3850619** (P), on rod, nut, and washer **3855860**.

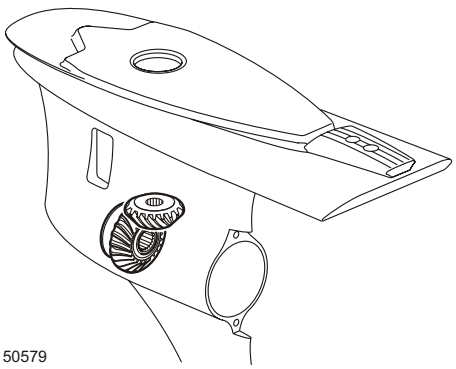
   Insert rod in gearcase and screw in to installer.

   Place smallest step of plate in retainer bore.

3. Turn nut until pinion bearing is seated, then unscrew and remove tools.

***NOTICE!*** **If installer turns in bearing, screw pinion nut holder 3849660 on handle 3850609. Slide guide plate 3849656 onto handle. Insert into gearcase and hold pinion installer.**

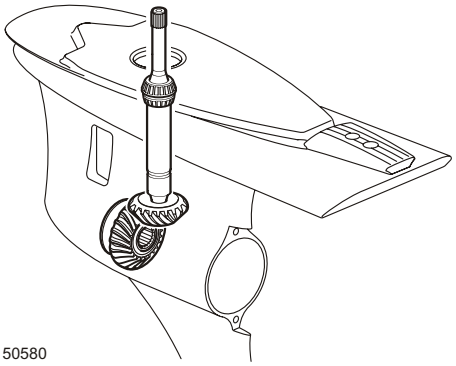
### Pinion Installation



50579

1. Install front gear/bearing in gearcase.
   Position pinion above gear in gearcase pinion pocket.
   Engage pinion teeth with propshaft gear teeth.

### Vertical Shaft Installation

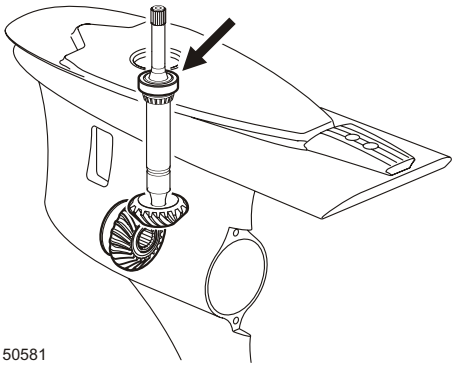

50580

2. Install vertical shaft in gearcase and engage pinion splines.

   Seat lower bearing in race.

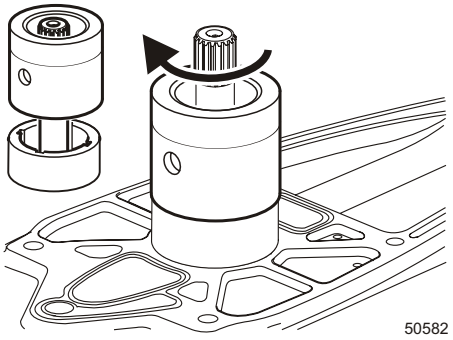
   Seat shaft in pinion bearing.

***NOTICE!*** **Insert vertical shaft carefully so pinion bearing rollers aren't dislodged.**


50581

3. Apply gear oil to upper bearing race.

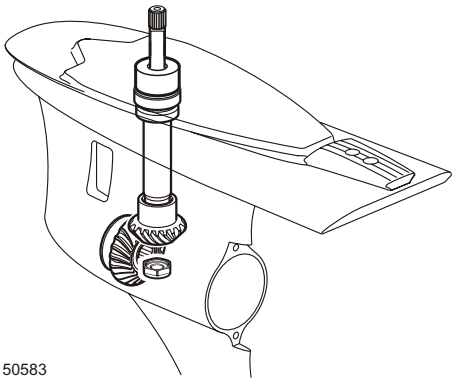
   Place race in housing, and push down until it seats on bearing.


50582

4. Place retainer over shaft and bearing race, start threads.

   Screw in shaft retainer using spanner wrench **3850601**, to seat upper shaft bearing race.

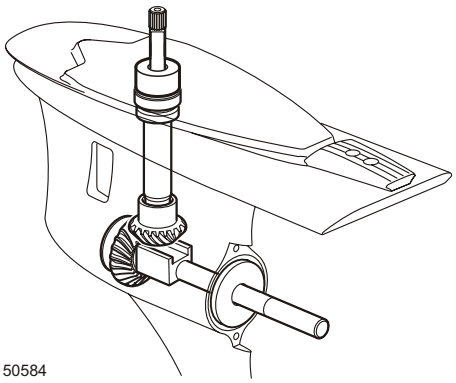
### Pinion Nut Installation


50583

5. Apply Loctite primer to pinion threads on shaft and let air dry.

   Apply thread locking compound **1161053** to threads.

   Install a new pinion nut onto shaft.



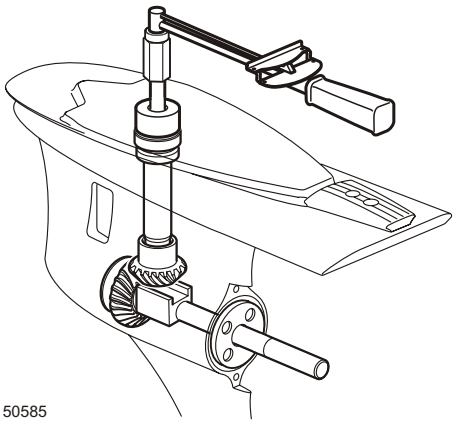
50584

6. Assemble pinion nut holder **3849660** on handle **3850609**.

   Slide guide plate **3849656** on handle.

   Insert pinion nut holder in to drive gear.

   Turn vertical shaft to align pinion nut with holder.



50585

7. Slide socket **3850598** on to vertical shaft.

   Attach torque wrench to socket.

   Hold pinion nut holder in place with handle and turn socket (and shaft) to tighten pinion nut.

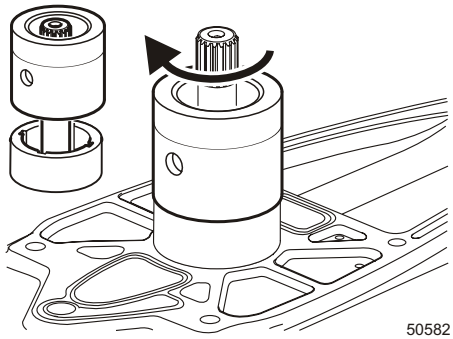
   Torque pinion nut to 78-87 ft. lb. (105-118 N.m).

## Setting Rolling Torque

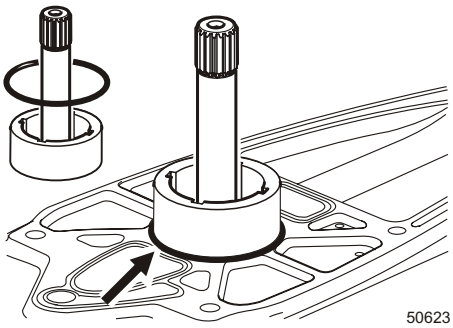
***NOTICE!*** **This procedure will ensure bearing life by setting vertical shaft rolling torque. Turn gearcase so that propshaft bore is vertical and gear is down. This will ensure the propshaft gear will not interfere with the pinion rolling torque measurement.**

### Vertical Shaft

1. Before each torque reading, turn vertical shaft several times to ensure bearing is seated.
2. Tighten retainer to achieve a vertical shaft rolling torque of 2-4 in. lb. (0,22-0,45 N•m).
   **Record rolling torque setting.**


50582

3. Apply gear oil to o-ring for retainer.
   Install o-ring over retainer.
4. Return gearcase to normal position, propshaft bore slightly above horizontal.

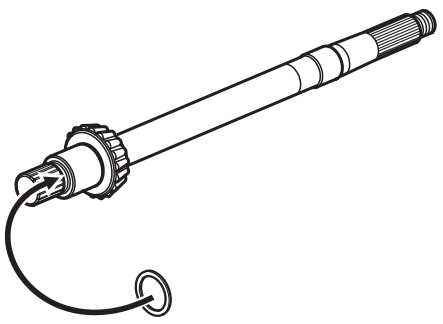

50623

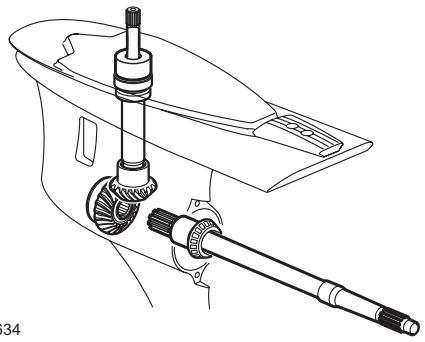
## Propshaft Bearing Housing, Shimming and Rolling Torque

***NOTICE!*** **This procedure determines the amount of shims required to preload the propshaft bearings, and also ensures bearing life by setting the vertical shaft and propshaft rolling torque.**

1. Place needed thickness of shims on inner propshaft.

***NOTICE!*** **Use as few shims as possible and sandwich the thinnest shims in between the thickest shims.**


50958

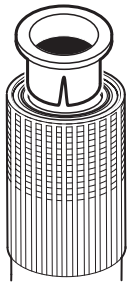


50634

2. Insert spline of inner propshaft in to spline in forward gear.

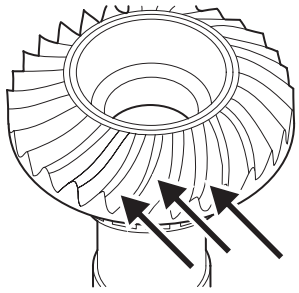
***NOTICE!*** **Seal Protectors must be used whenever propshaft seals are slid over splines on the propshafts. Seal damge, then drive failure are possible if seals are damaged by the splines.**

3. Place seal protector, **884976** into seals in outer propshaft.



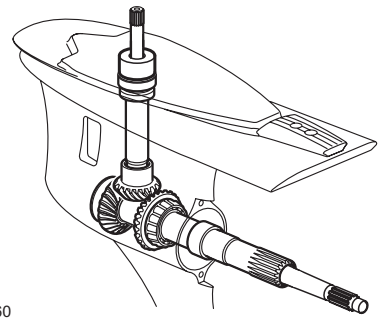
50959

4. Apply gear marking compound to at least three teeth on outer propshaft gear.

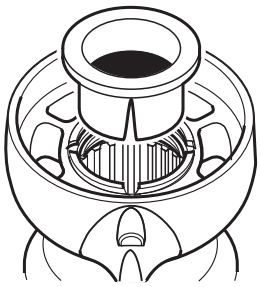


43616

5. Slide the outer propshaft gear into place over inner propshaft. Remove the seal protector when seals are past prop splines. Seal protector will affect rolling torque if left in place.

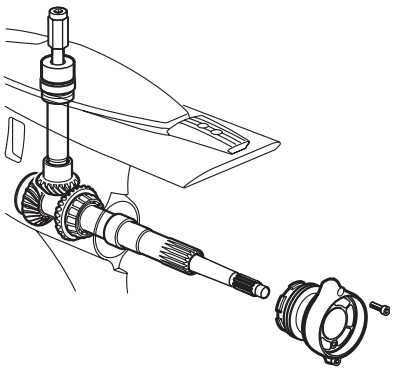


50960



50961

6. Place seal protector, **884807** into seals in propshaft bearing housing.
   Do not install o-rings on housing.



50962

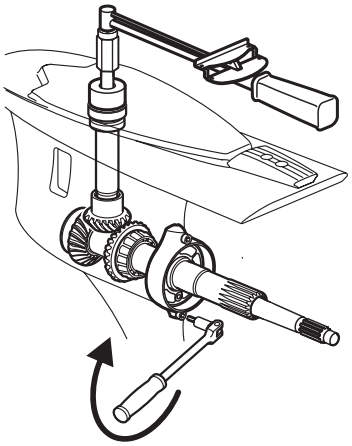
7. Remove any shims that may be on the propshaft housing.

   Slide housing into position over outer propshaft.

   Remove the seal protector when seals are past propshaft splines.

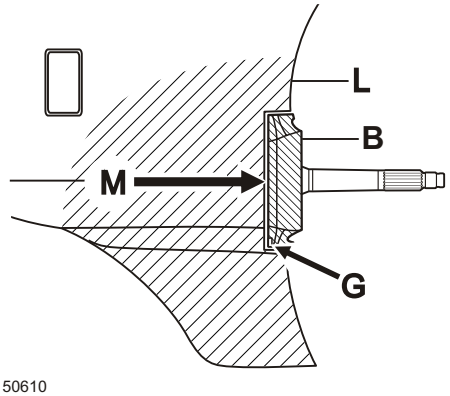
8. Install original screws removed during disassembly.

***NOTICE!*** **Use original screws for all shimming, rolling torque and other pre-assembly work. Use two NEW screws for final assembly and final torque.**



50963

9. Tighten screws in small steps, alternating top and bottom until vertical shaft rolling torque is;
   for ratios 1.95, 2.14, 2.32: 18-26 in. lb. (2,0-2,9 N.m)
   for ratios 1.68, 1.78 and 2.11: 26-35 in. lb. (2,9-4,0 N.m)




50610

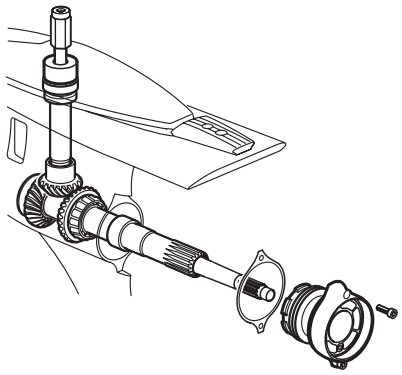
10. Measure (M) gap between bearing housing (B) and gearcase (L). Record in two places, in the middle on each side. Average the measurements.

***NOTICE!*** **Do not measure at gap (G) at bottom and top of housing.**

11. Round off the average amount.
    This is the shim amount for the propshaft bearing housing.

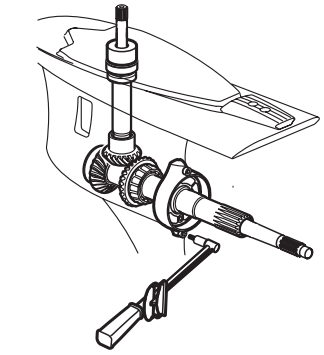
Example:

| Add: | Divide: |
|---|---|
| no. 1 = 0.014 in. | 0.031 in. / 2= 0.0151 in. |
| no. 2 = 0.017 in. | round to 0.015 in. |
| Total 0.031 in. | |



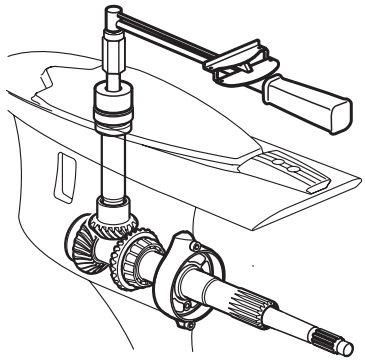
50964

12. Place seal protector, **884807** into seals in propshaft bearing housing.
    Remove bearing housing.
    Install shim amount from step 10 and re-install bearing housing.
    Do not install o-rings at this step.
    Remove seal protector.



50965

13. Install original screws and torque to 10 ft. lb. **(13,5 N'm)**.
    Then tighten screws another 70° of rotation.

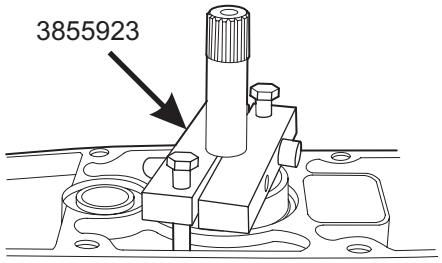


50966

14. Check for correct rolling torque, see step 9 above.
    Correct as needed;
    rolling torque is too high, add shim.
    rolling torque is too low, decrease shim.

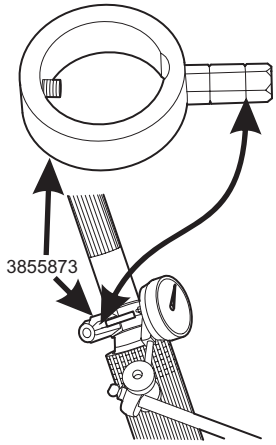
## Gear Lash

***NOTICE!*** **Verify that there is no end play on the vertical shaft and both propeller shafts before attempting to check gear lash.**



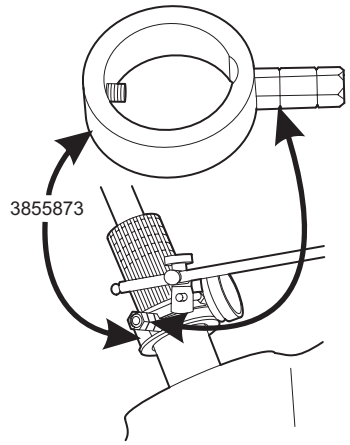

43617

1. Lock vertical shaft in place using puller **3855923**.
   Tighten Allen head screws to lock tool to shaft.
   Lightly tighten screws to keep the shaft from moving.




43621

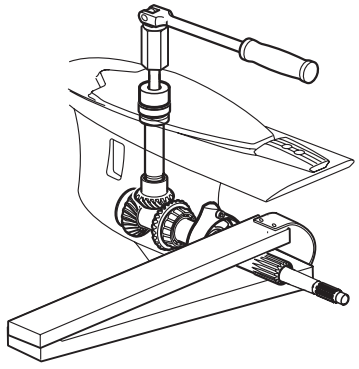
2. Place lash tool **3855873** on inner propshaft.
   Stay away from the splines.
3. Set up a dial indicator to read forward gear lash, by setting the indicator tip on outer lash tool line.
4. Rotate inner prop shaft back and forth to check the amount of lash for the forward gear.
   Lash should be 0.006-0.012 in. (0,15-0,30 mm).
5. Record your measurements.




43622

6. Reposition Lash Tool **3855873** onto outer propshaft.
   Stay away from the propeller splines.
7. Set up a dial indicator to read rear gear lash, by setting the indicator tip on inner lash tool line.
8. Rotate the outer propshaft back and forth to check the amount of lash for the rear gear.
   Lash should be 0.006-0.014 in. (0,15-0,35 mm).
9. Record your measurements.

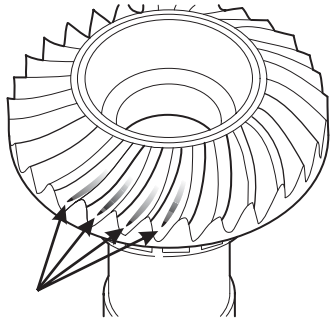
### Checking Tooth Contact Pattern


50983

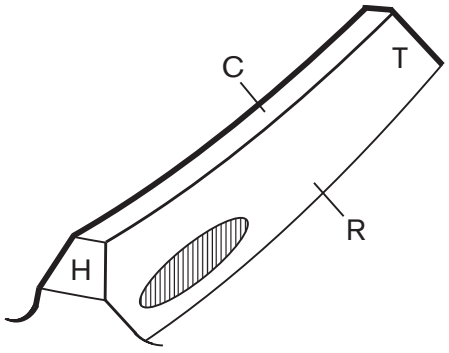
1. Turn vertical shaft.
   While turning, brake the propshaft movement to simulate a propeller load.

***NOTICE!*** **If you must load the propshaft with your hands, wear leather gloves. The propshaft has sharp edges and may cut or injure your hands.**

2. Remove the outer propshaft and propshaft bearing housing following the instructions found elsewhere in this section.


43624

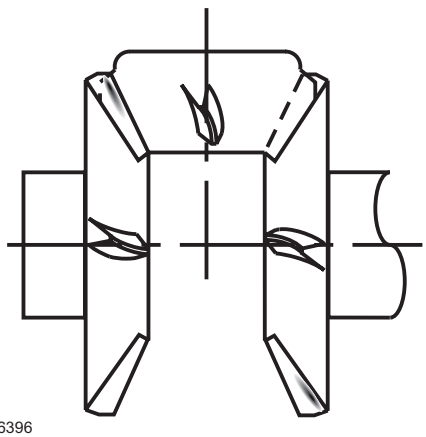
3. Check the tooth contact pattern on the outer propshaft gear.
   Check the tooth contact pattern on the forward propshaft gear.



drc7524

4. The contact pattern should be located towards the heel (H) with a slight displacement towards the root (R) of the tooth.

   **H = Heel**
   **R = Root**
   **T = Toe**
   **C = Crest**


drc6396

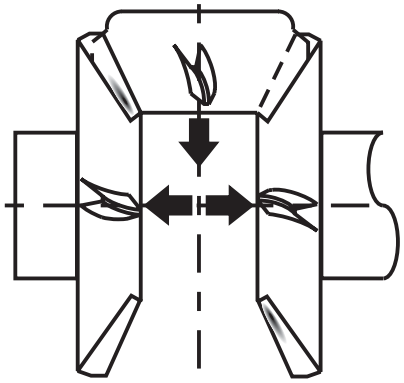
5. If the tooth contact pattern and gear lash are within specifications, proceed to the **Final Assembly** section below.
   If either the pattern or the lash are out of specifications, proceed with **Adjusting Tooth Contact Pattern and Gear Lash**.

## Adjusting Tooth Contact Pattern and Gear Lash

***NOTICE!*** **Correcting the gear contact pattern and/or gear lash will require disassmbly of the drive train. Proceed from the beginning of this chapter.**

### Tooth Contact Pattern

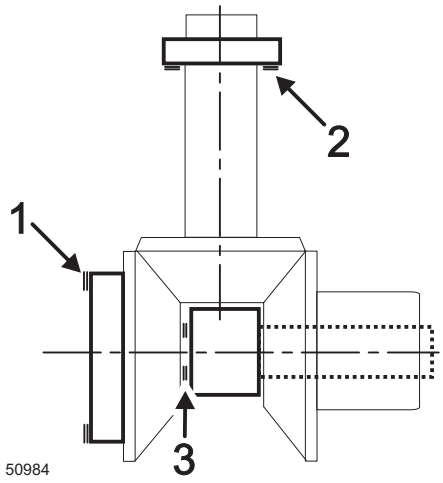
***NOTICE!*** **Contact pattern must be corrected before attempting to correct gear lash.**



drc6397

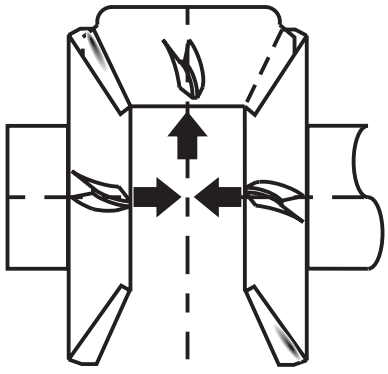
If the contact pattern is too far towards the crest of the tooth and towards the toe of the gear, change the shims as follows:

- Subtract shims from position (1)
- Subtract shims from position (2)
- Add shims to position (3)



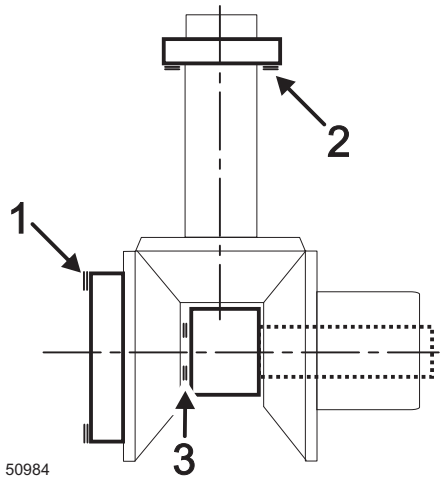

50984

If the contact pattern is too far towards the root of the tooth and towards to heel of the gear, change the shims as follows:



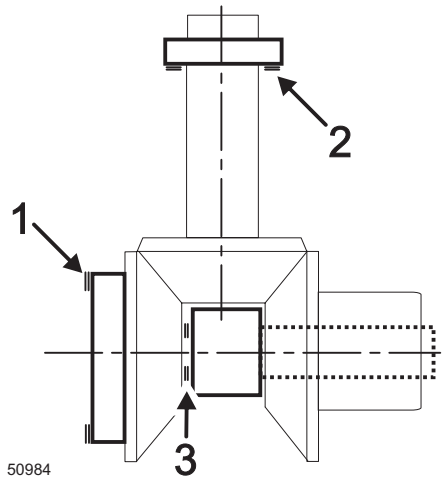
drc6398

- Add shims to position (1)
- Add shims to position (2)
- Subtract shims from position (3)




50984

### Gear Lash



50984

***NOTICE!*** **Contact pattern must be correct before attempting to correct gear lash. If the contact pattern on the outer propshaft gear is correct, the outer propshaft gear lash will also be within specifications. Therefore, only forward gear lash will generally need to be corrected.**

If the forward gear lash must be increased without changing the tooth contact pattern, change the shims equally as follows:

- Subtract shims from position (1)
- Add shims to position (3)

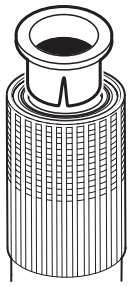
If the forward gear lash must be decreased without changing the tooth contact pattern, change the shims equally as follows:

- Add shims to position (1)
- Subtract shims from position (3)

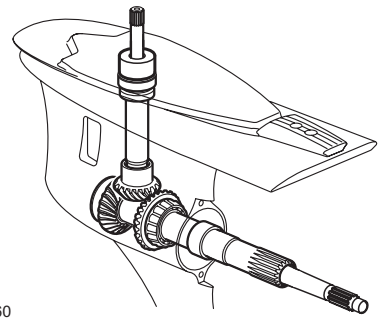
Reassemble the gearcase and recheck the gear lash and contact pattern according to the instructions above. When both are correct, proceed with **Final Assembly.**

## Final Assembly

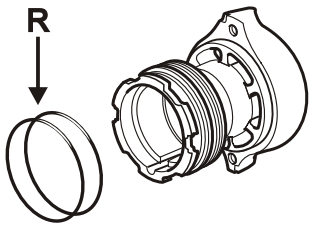
***NOTICE!*** **All references to gear oil in all assembly steps are referring to the same oil used to fill the drive; Volvo Penta GL5 Synthetic gear lubricant, SAE 75W-90.**


50959

1. Place seal protector, **884976** into seals in outer propshaft.

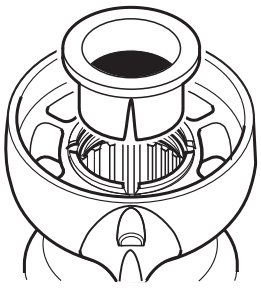

50960

2. Install outer propshaft over inner shaft and in to gearcase. Remove the seal protector when seals are past prop splines.



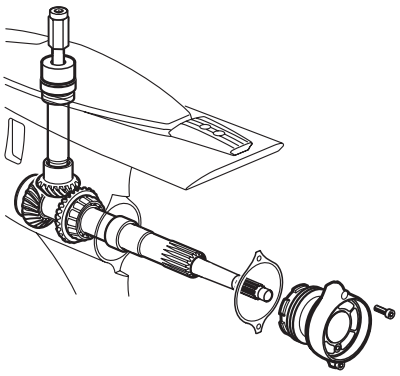
50621

3. Apply gear oil to o-rings and install them on housing. Coat the flange of the propshaft housing with gear oil.



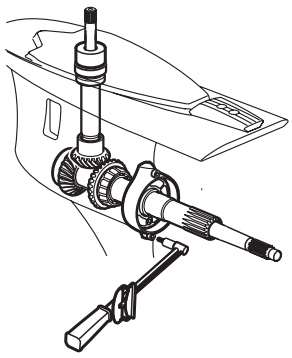
50961

4. Place seal protector, **884807** into seals in propshaft bearing housing.



50964

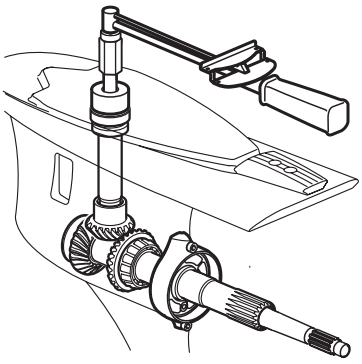
5. Slide housing and shims into position over outer propshaft. Remove the seal protector when seals are past prop splines. Seat the housing into the gearcase.



50965

6. Install NEW screws and torque to 10 ft. lb. **(13,5 N'm)**. Then tighten screws another 70° of rotation.

***NOTICE!*** **Use original screws for all shimming, rolling torque and other pre-assembly work. Use two NEW screws for final assembly and final torque.**



50966

7. Check for correct rolling torque, see procedure above. Correct as needed;
   rolling torque is too high, add shim.
   rolling torque is too low, decrease shim.

***NOTICE!*** **Failure to reset the rolling torque to the figure established in earlier procedure will change gear lash and tooth contact pattern.**

## Lower Gearcase Installation

**Proceed to Chapter 2 to;**

- Reassemble gearcase to the upper housing
- Pressure and Vacuum test the assembled drive
- Install the drive on the transom
- Install the propellers

## Specifications

| Description | U.S. | Metric |
|---|---|---|
| Nut, pinion gear | 78-87 ft. lb. | 105-118 N•m |
| Screws, anode | 15-20 ft. lb. | 20-28 N•m |
| Plug, drain | 60-84 **in.** lb. | 7-10 N•m |
| Nuts, upper to lower housing | 30-41 ft. lb. | 40-56 N•m |
| Screws, upper to lower housing | 30-41 ft. lb. | 40-56 N•m |
| Screws, propshaft bearing housing | 10 ft. lb.<br>+ 70° rotation | 13.5 N•m<br>+ 70° rotation |
| Screws, water intakes | 44-62 **in**. lb. | 5-7 N•m |

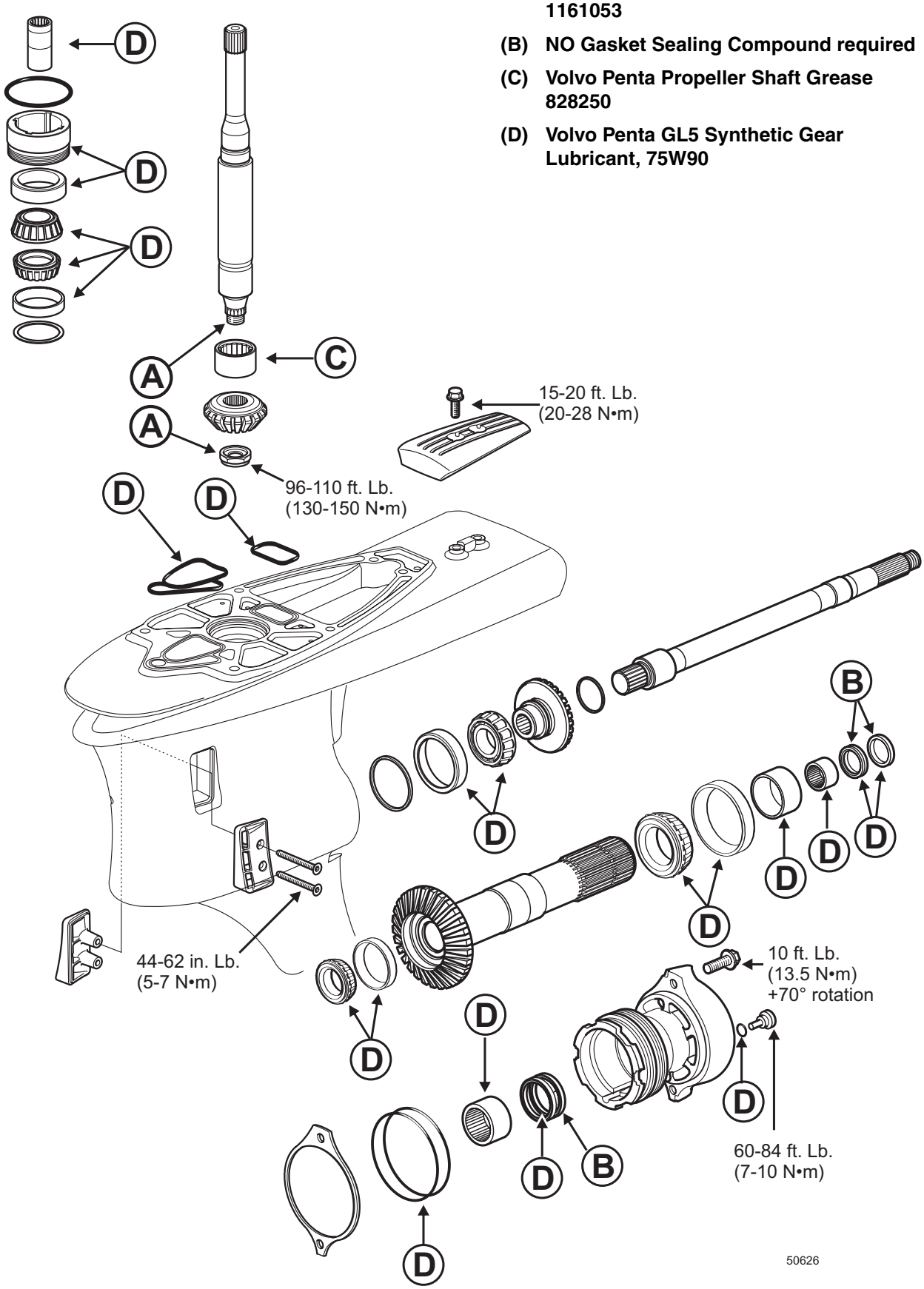
## Service Chart

**(A) Volvo Penta Thread Locking Fluid 1161053**

**(B) NO Gasket Sealing Compound required**

**(C) Volvo Penta Propeller Shaft Grease 828250**

**(D) Volvo Penta GL5 Synthetic Gear Lubricant, 75W90**



# NOTES

# Transom Shield Assembly

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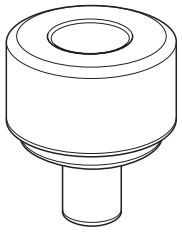
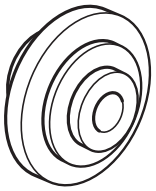
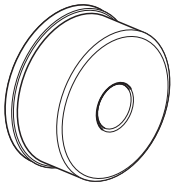
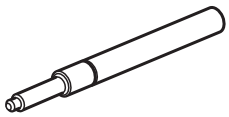
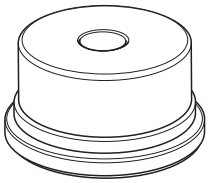
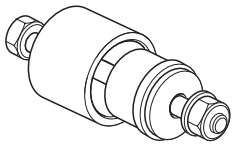
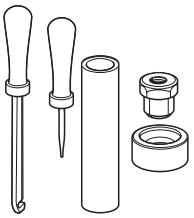
**Safety Messages**

**Before working on any part of a Volvo Penta sterndrive, be sure to read the Safety Messages chapter at the beginning of this manual. Pay special attention to safety messages that appear throughout the text.**

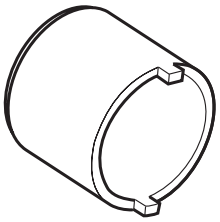
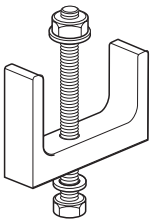
When replacement parts are required, use genuine Volvo Penta parts or parts with equivalent characteristics including type, strength, and material. Failure to do so may result in product malfunction and possible injury to the operator and/or passengers.

Some screw holes have special Heli-Coil inserts that provide a thread-locking feature. Do not clean Heli-Coil holes with a thread tap. This will damage the Heli-Coil inserts and necessitate their replacement.

## Special Tools

| Tool Name | Part No. | View | Tool Name | Part No. | View |
|---|---|---|---|---|---|
| Drive Handle | 3850609 |  | Gimbal ring steering shaft bushing installer | 3849654 |  |
| Gimbal bearing/ seal Installer | 3850038 (OMC 912279) |  | Upper steering shaft bushing remover | 3849666 |  |
| O-ring and cup installation tool | 3849674 |  | Upper steering shaft bushing installer | 3849646 |  |
| Gimbal ring pivot pin remover | 3849647 |  | Trim cylinder tilt spacer installation tools | 3849636 |  |

## Special Tools

| | | | | | |
|---|---|---|---|---|---|
| Water inlet fitting remover/installer | 3849648 |  | Steering shaft remover | 3849649 |  |

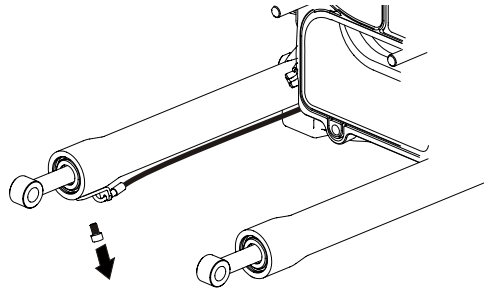
**Remove Sterndrive**

Remove the Sterndrive see Sterndrive Removal on page 28. If the complete transom shield assembly is being rebuilt or replaced, remove engine following procedure in the *Engine and Sterndrive Installation Manual.*

**Trim/Tilt Cylinder Removal**

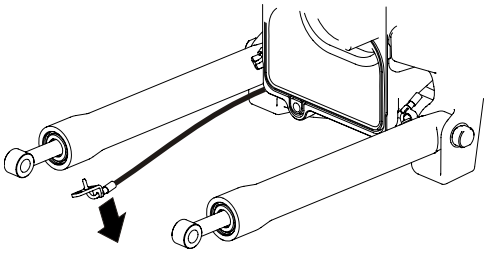
⚠ **CAUTION! If replacing a trim cylinder, check the trim cylinder for trim limiting spacers before replacement of the trim cylinder. Installation of a limited trim cylinder and a non-limited trim cylinder on the same drive will cause damage to the trim system, transom shield and sterndrive.**

1. Remover hydraulic line retaining screw and keeper.



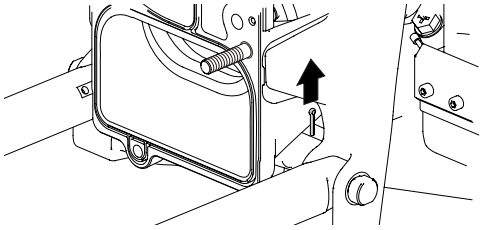
***NOTICE!*** **The hydraulic lines should only be disconnected if replacing a trim cylinder. Any other service of the transom shield does not require the removal of the hydraulic lines from the trim cylinders.**

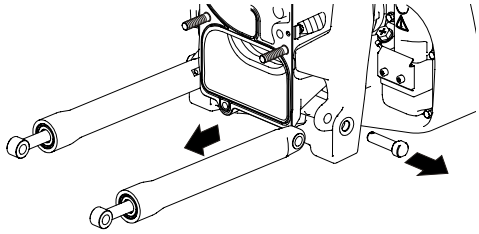
2. **Wear safety glasses.** Cover fittings with a shop cloth and disconnect trim/tilt lines.
3. Cut tie straps holding the front of the hydraulic lines to the forward trim cylinder hydraulic line connector.



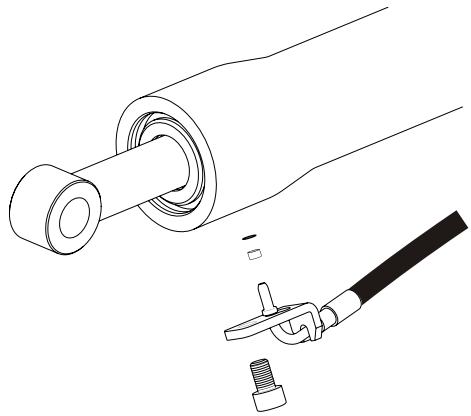
***NOTICE!*** **The tie strap must be replaced when reinstalling the cylinder to prevent the hydraulic line from pinching between the pivot housing and gimbal ring.**

4. Remove cotter pin from the trim cylinder pivot pins.





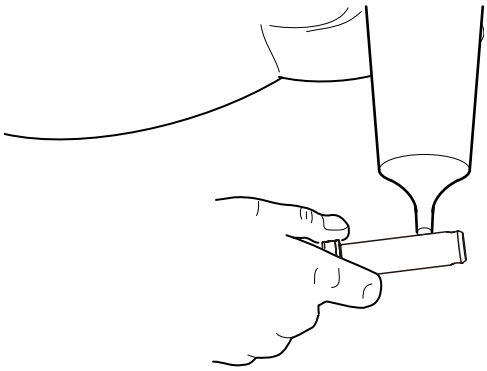
5. Remove trim cylinder pivot pin.
6. Remove the trim cylinder.



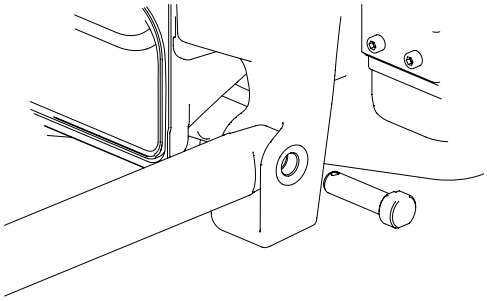
7. Remove and discard trim/tilt line O-rings and retainers only if they are leaking, otherwise, leave the O-rings and retainers in the trim cylinders.

***NOTICE!*** **New O-rings and retainers come installed on new trim cylinders.**

**Trim/Tilt Cylinder Installation**

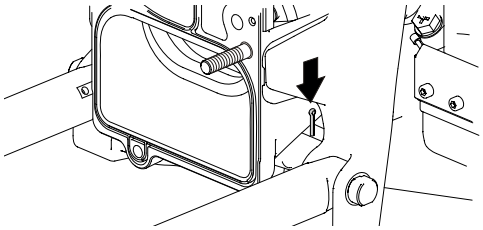


1. Coat the pivot pins with grease **828250**.

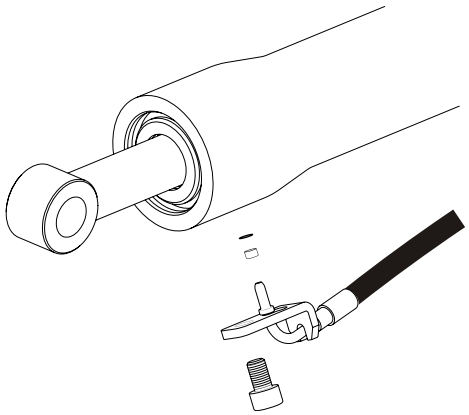


***NOTICE!*** **If trim cylinder bushings are damaged, replace them. Align trim tilt cylinders with gimbal ring.**

2. Slide pivot pin through cylinders and gimbal ring



3. Install and spread cotter pin ends.

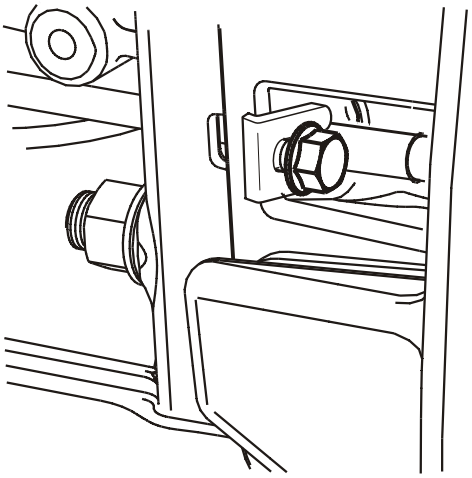


4. Place a new O-ring and retainer on trim/tilt cylinder line fittings and attach lines to cylinder. Tighten line fittings to 8 ± 0.5 Nm (70 ± 5 in. lb.).

***NOTICE!*** **To fill and bleed the trim cylinders and trim motor reservoir, see *Filling and Bleeding Dry System* in *Trim/Tilt Hydraulic System* section of this manual.**

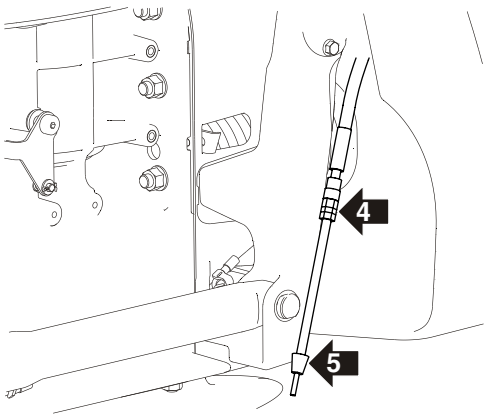
**Gimbal Ring Removal**

Remove trim/tilt cylinders and pivot housing following instructions elsewhere in this section.

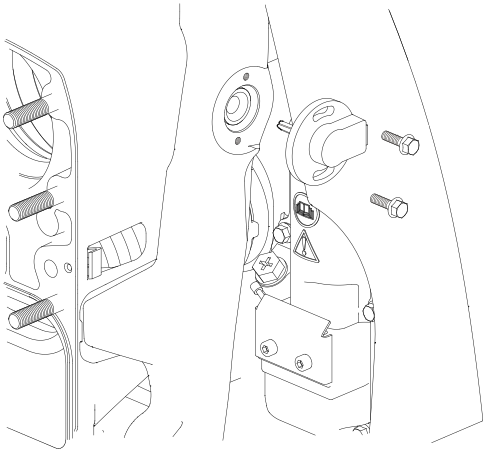


***NOTICE!*** **Proceed to step 3 if shot cable has already been disconnected.**

1. Turn sterndrive to port. Loosen anchor clamp screw and slide clamp to starboard disengaging the remote control shift cable.

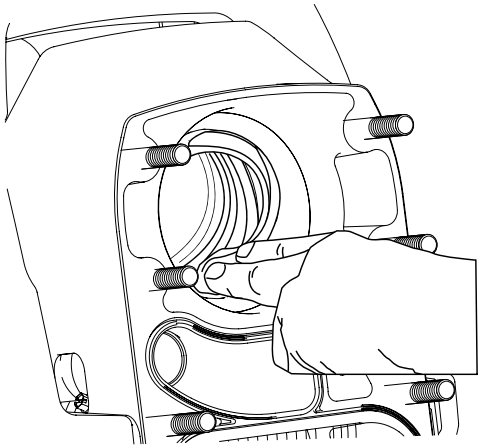



2. Remove shift cable from pivot and gimbal housing. Remove small and large seals. From inside of boat, pull shift cable out of sleeve and connector assembly.

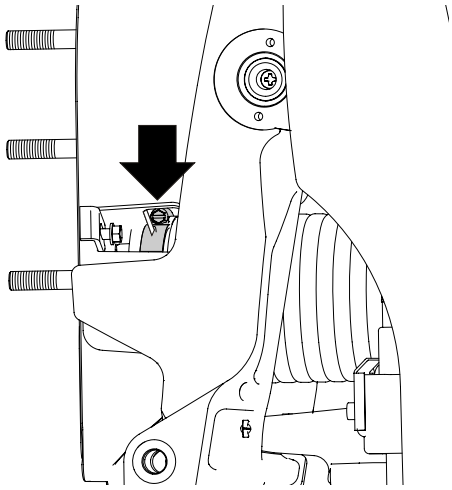


3. Turn gimbal to port and remove two screws holding trim sender. Remove the trim sender from the gimbal ring.

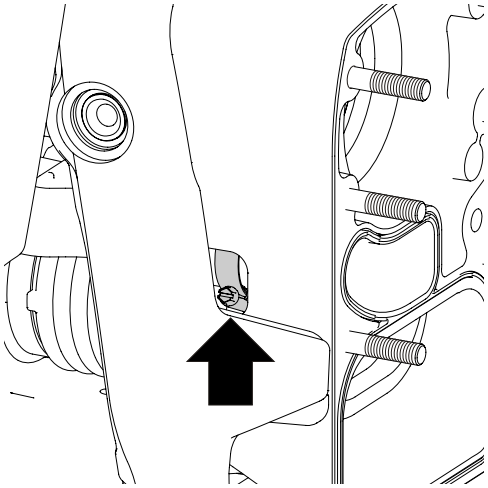
⚠ **CAUTION! Do not attempt to pull the sender out of the transom shield as its leads are secured to transom shield.**



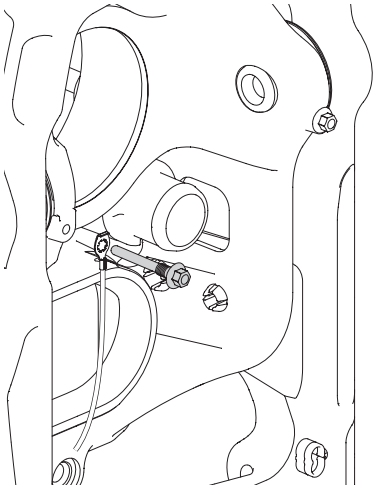
4. Disengage U-joint bellows from lip of pivot housing and push it inside.



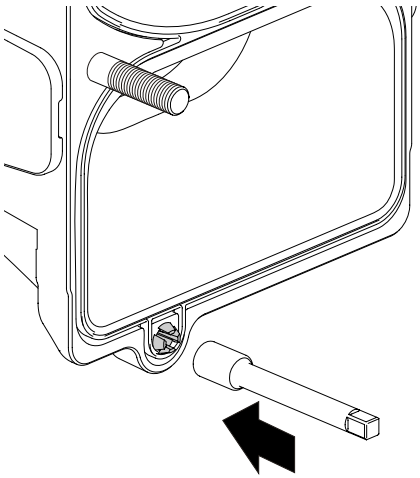
5. Loosen hose clamp securing the exhaust bellows to the pivot housing through the access hole on the starboard side of the pivot housing
6. Disconnect exhaust bellows from the pivot housing.



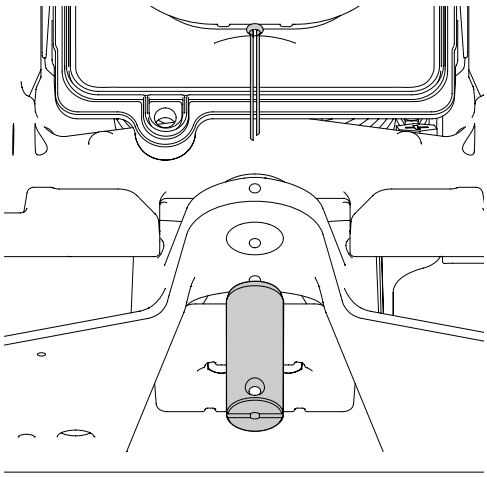
7. Loosen the hose clamp securing the water inlet hose to the pivot housing water nipple through the port side access hole.
8. Disconnect water inlet hose from the nipple.



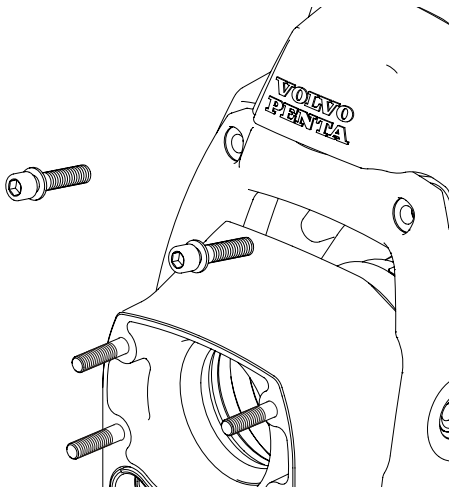
9. Turn the gimbal ring to port as far as possible and remove the starboard pivot pin locking pin and ground terminal.



10. Using the socket end of a ¼ in socket extension, gently push the pitot connector through the pivot housing mounting hole.

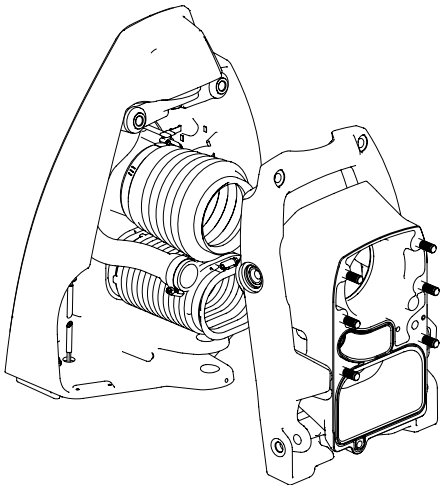


11. Remove cotter pin from the lower gimbal ring steering pivot pin.
12. Remove the lower gimbal ring steering pivot pin.




13. Using a 10 mm allen wrench, remove the two gimbal ring retaining screws from the steering shaft.

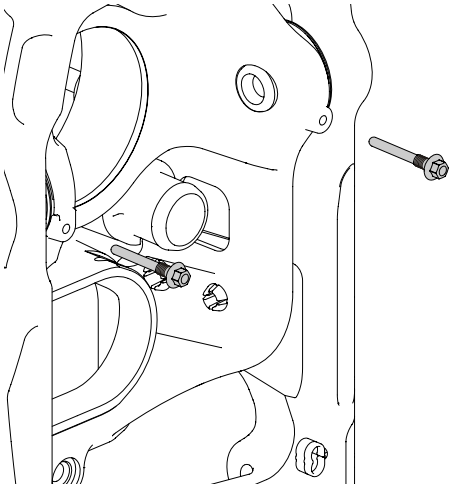
***NOTICE!*** **The screws use threadlocking compound to prevent loosening. A small amount of heat may be necessary to loosen the screws. If heat is used, do not heat the part more than 250°F (121°C).**



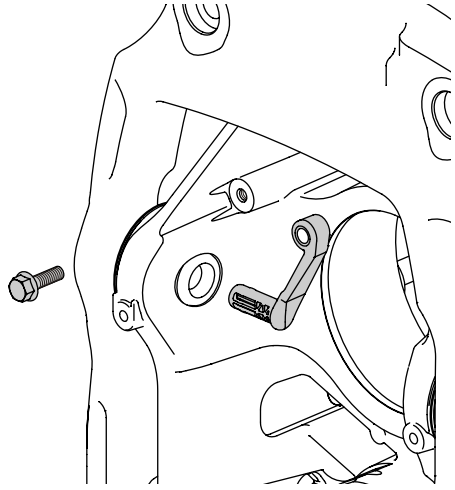
14. Remove the gimbal ring and pivot housing as an assembly.

**Pivot Housing Removal**

Remove the sterndrive following the procedure in *Sterndrive Removal and Installation* section in this manual.

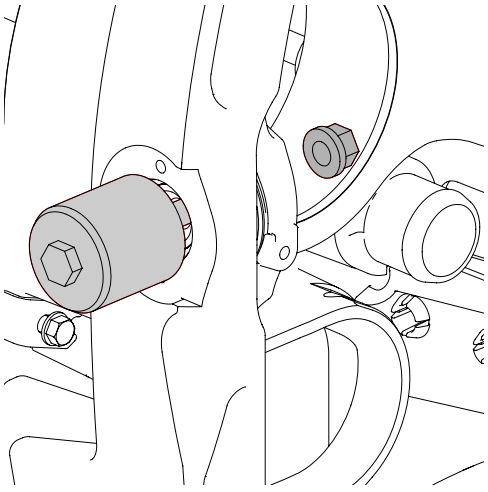


1. Remove the port pivot pin locking screw.



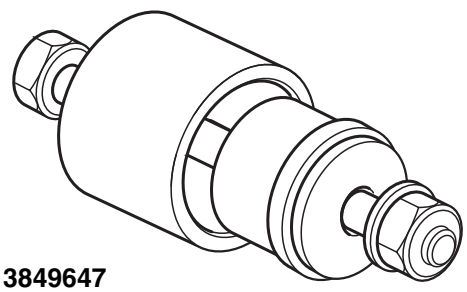
2. Remove the Trim Sender driver screw and driver arm from the pivot housing.

**Pivot Housing Disassembly**

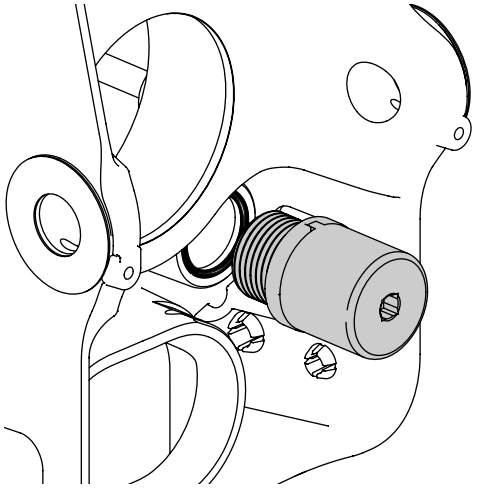


1. Using the large cup and nut from special tool 3849647, press out the pivot pins.

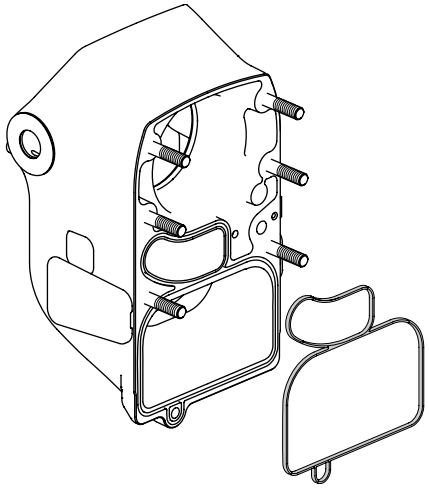
***NOTICE!*** **Do not use the bushing puller/installer to remove the pivot pins.**



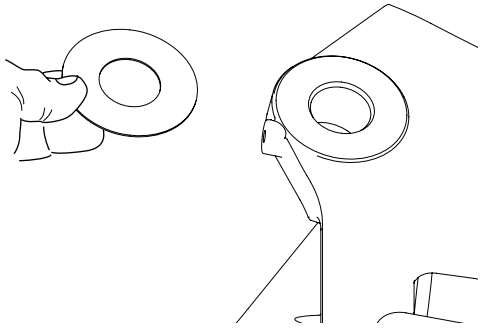
**3849647**



2. Using special tool 3849648, remove the water inlet nipple from the pivot housing. Remove and discard the water nipple O-ring.



3. Remove and discard cooling and exhaust passage seal.



4. Inspect the nylon friction washer on pivot bosses. Peel them off and discard if they're damaged. Remove and inspect thrust washer underneath.

**Cleaning and Inspection**

Clean housing in solvent and dry thoroughly. Remove sealer and/or adhesive from cooling passage opening, U-joint bellows opening, and pivot bosses.

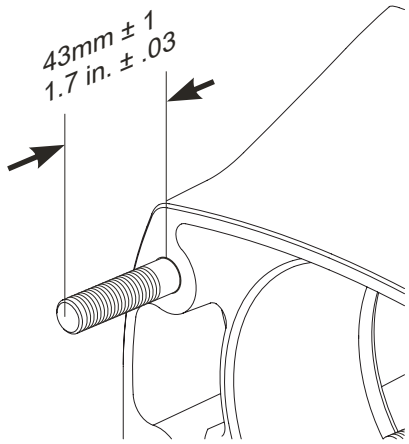
***NOTICE!*** **Clean screw holes with solvent only. A thread tap would damage the Heli-Coil inserts and necessitate their replacement.**

- **O-ring Seal Groove** - Check for sharp edges that would prevent O-ring sealing water passage.
- **Mounting Studs** - Look for damaged threads and looseness.

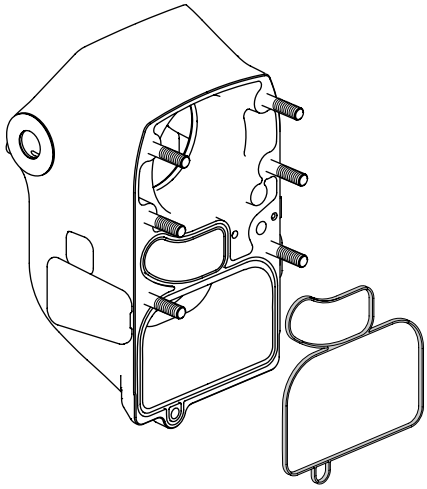
- **Ground Wire** - Check wire ends for frayed or loose connections.

Repair or replace all suspect components.

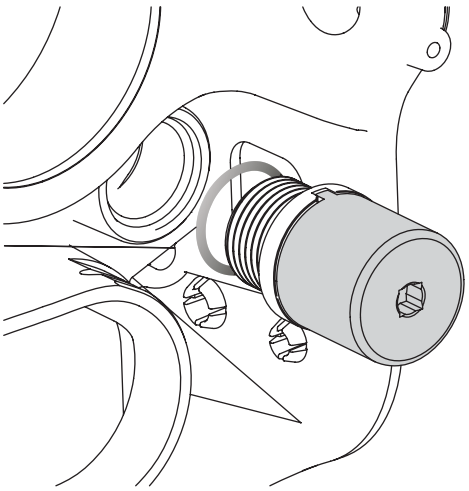
**Pivot Housing Assembly**



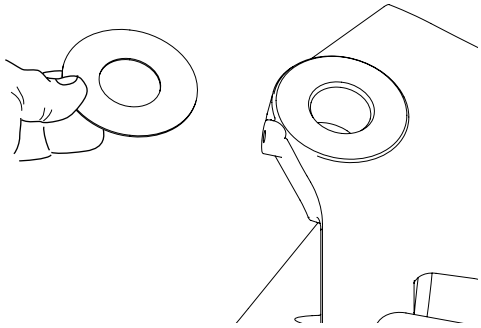

1. If a drive stud is damaged and requires replacement, install the new stud to a depth of 43 mm ± 1 (1.7 in ±.03).



2. Install a new cooling and exhaust passage seal.

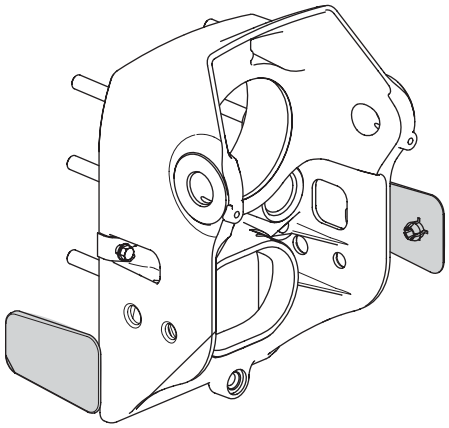


3. Apply grease **828250** to a new O-ring and install water nipple with special tool **3849648**. Torque fitting 11-19 Nm (8-14 ft. lb.).



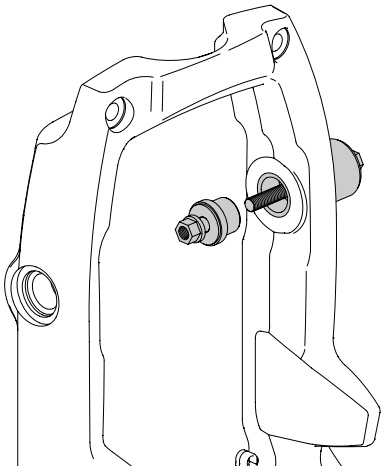
4. If the old pivot boss friction washers were removed, make sure a thrust washer, coated with grease **828250**, is installed in each pivot.

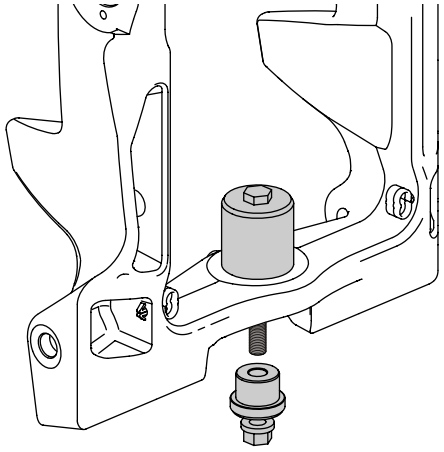
5. Replace the wear pads if damaged, cracked or worn through.



**Gimbal Ring Disassembly**

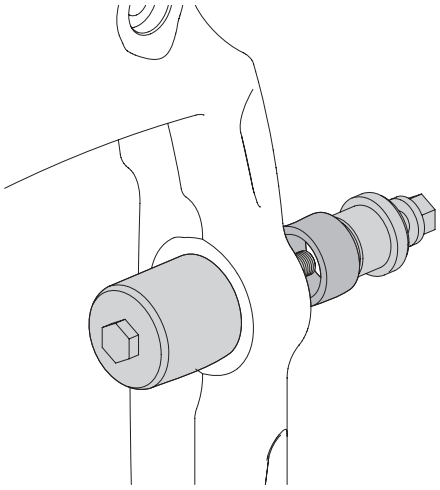
1. Using special tool **3849647**, press out the pivot pin bushings.



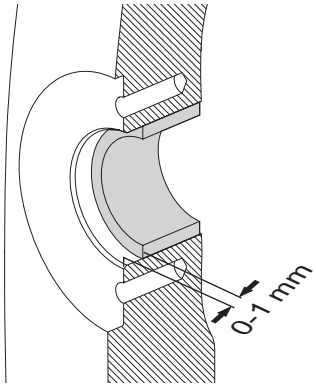


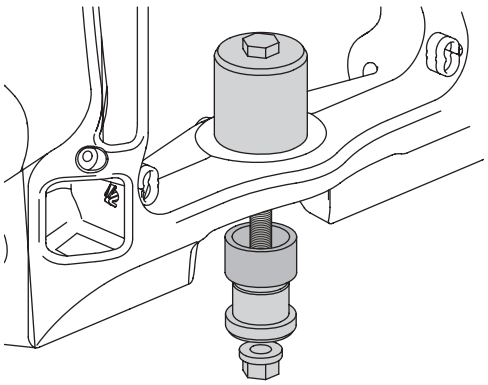
2. Use special tool 3849647 to press out the gimbal ring steering pivot bushing.

**Gimbal Ring Assembly**

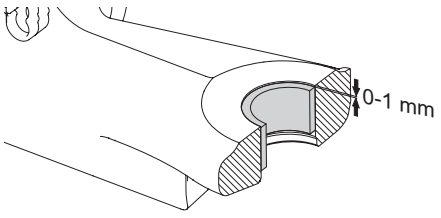


1. Lightly oil outside of a new pivot bushing and place it in bore. Use installer **3889647** to seat bushing 0-1mm (0 - .03 in) into the gimbal ring.

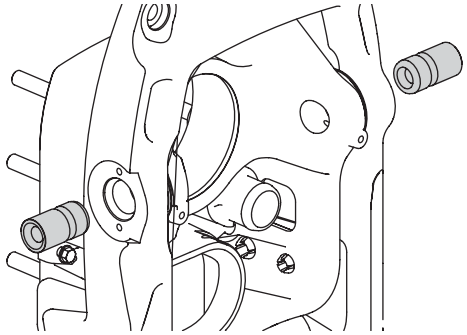


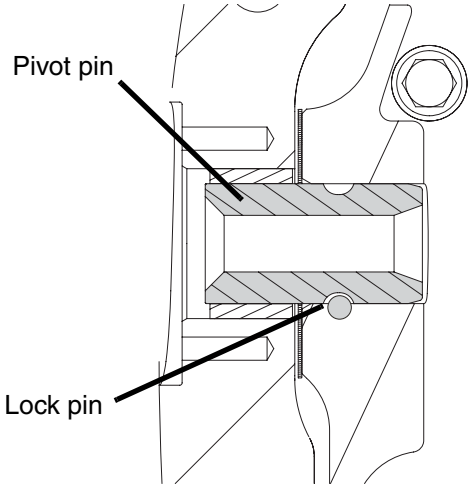
2. Lightly oil the outside of a new steering pivot bushing and place it in bore. Use installer 3889647 to seat bushing 0-1mm (0 - .03 in) into the gimbal ring.



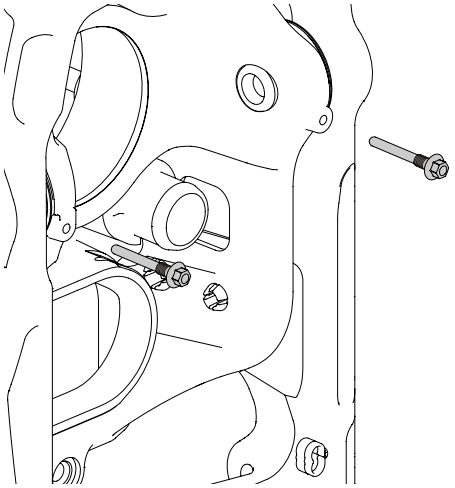
### Pivot Housing Installation



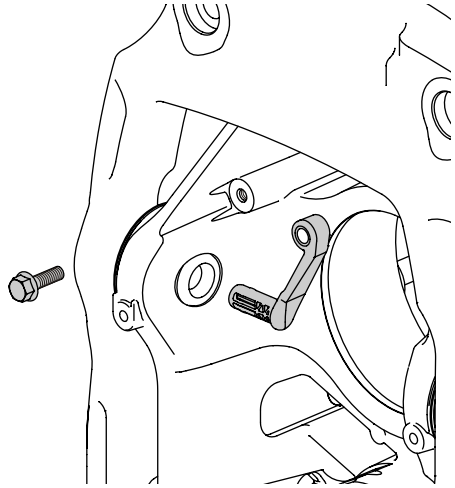
1. Position pivot housing in gimbal ring.




2. Align one gimbal ring pivot pin hole with hole in pivot housing. Look inside to see if thrust washer is still in position and not blocking hole.
3. Apply grease **828250** to pivot pin.
4. Align and install the pivot pins. Drive pivot pins in until the groove aligns with the locking pin hole.



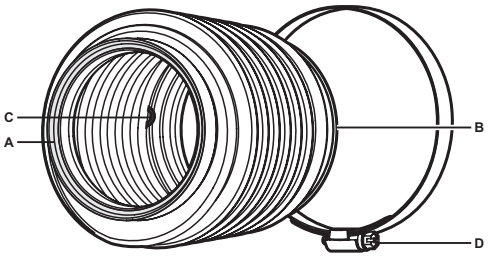
5. Install pivot pin locking pins and torque to 10 ± 1.5 Nm (88 ± 13 in. lb).



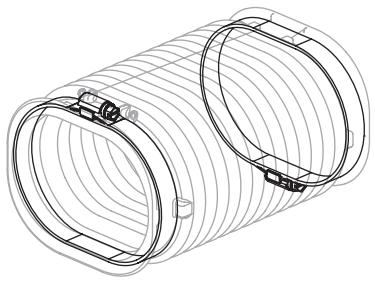
6. Install the trim sender driver and torque screw to 10 ± 1.5 Nm (88 ± 13 in. lb)

**U-joint and Exhaust Bellows Installation**

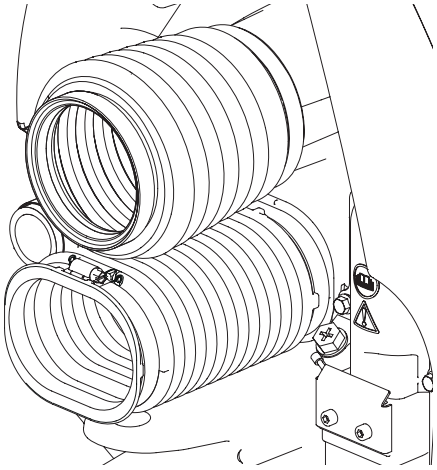
***NOTICE!*** **Clamp's screw position is important. If not properly positioned, steering radius will be reduced because of gimbal ring contacting clamp head when turning.**




7. Place clamp on small end of U-joint bellows. There is an internal rib that must engage a corresponding groove around opening's surface. Push bellows on and engage groove, then rotate clamp until screw fitting (A) is in the two o'clock position. Slide ground strap clip under hose clamp. Tighten clamp securely.



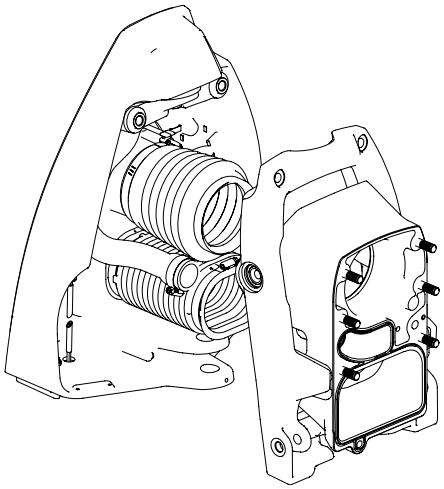
8. Place clamp on bellows in recessed area and align with locating tabs on the bellows. Place one clamp with the worm screw at the top and the other camp worm screw at the bottom.



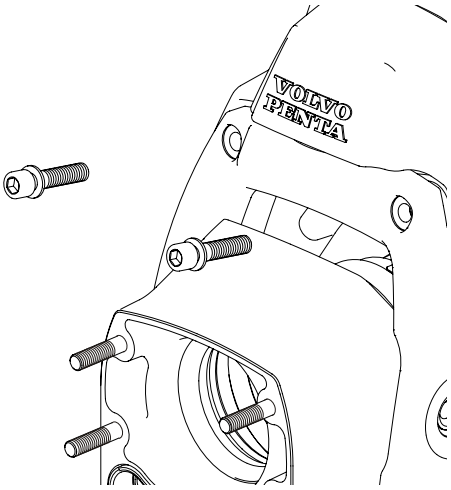
9. Push the exhaust bellows onto exhaust tube until it engages groove. Slide ground strap clip under hose clamp and tighten clamp securely.

***NOTICE!*** **The exhaust bellows does not have a specific position. Mounting the worm screw on top allows access through an opening in the pivot housing.**

**Gimbal Ring Installation**

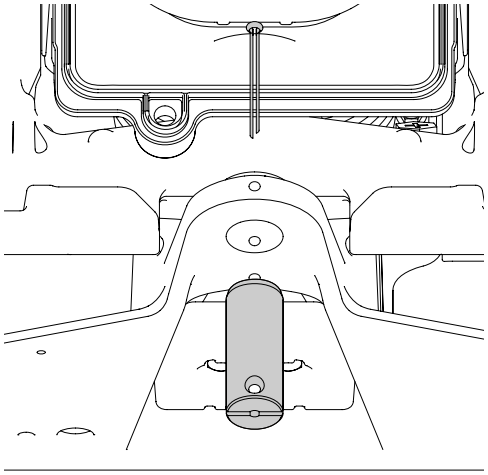


1. Install the gimbal ring and pivot housing assembly to the steering shaft and align the lower steering pivot.

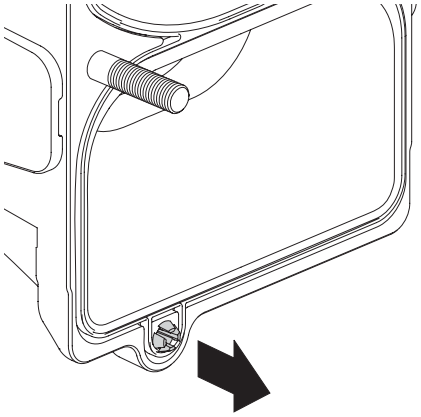



2. Install the gimbal ring to steering shaft screws and torque to 85 ± 15 Nm (62 ± 11 ft. lb).

***NOTICE!*** **If reusing existing screws, apply Loctite 241 before installation.**



3. Apply grease 828250 to the steering pivot pin.
4. Align gimbal ring with gimbal housing steering pivot hole and install the steering pivot pin.
5. Install a new cotter pin and spread ends.

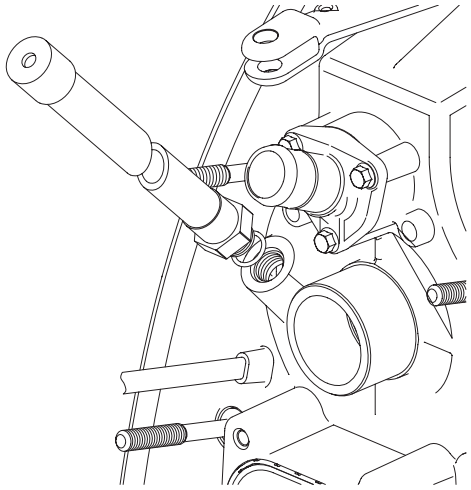


6. Reinstall the pitot sensor port connector.

# Gimbal Housing Disassembly

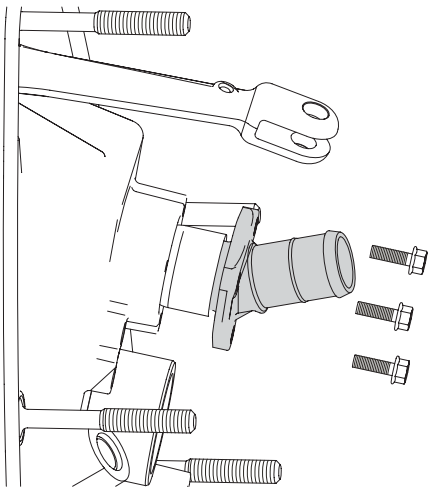
Remove trim/tilt cylinders (see Trim/Tilt Cylinder Removal on page 167), and gimbal ring (see Gimbal Ring Removal on page 169).

### Shift Cable Hose Removal



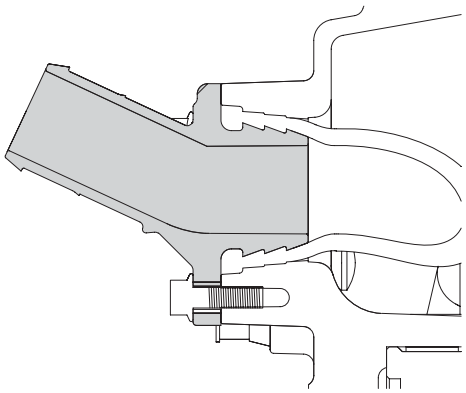
1. If not already removed, cut tie straps that attach the speedometer hose to the shift cable tube.
2. Use a 29 mm (1-1/8 in) box end wrench and remove the shift cable tube from the transom shield.

### Water Tube Removal



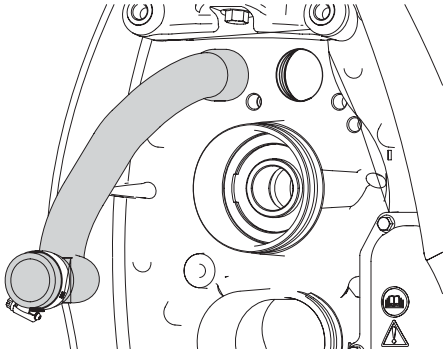
1. Loosen clamp on upper end of water inlet hose and remove hose from water tube.
2. Remove the three retaining screws using a 10 mm socket.

***NOTICE!*** **The water hose is trapped between grooved in the transom shield port and ribs molded into the water tube.**



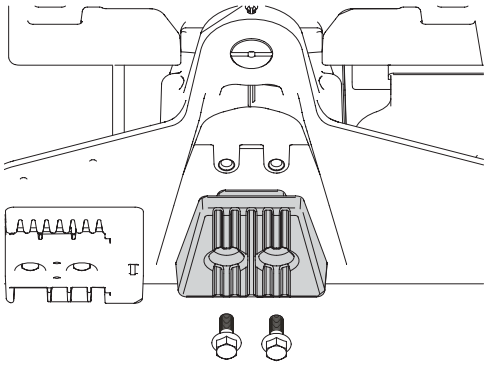
3. Remove the water inlet nipple from the water hose by flexing and twisting the water tube.

### Water Hose Removal



4. Once the water inlet nipple is removed, pull the water hose through the port toward the rear of the transom shield.

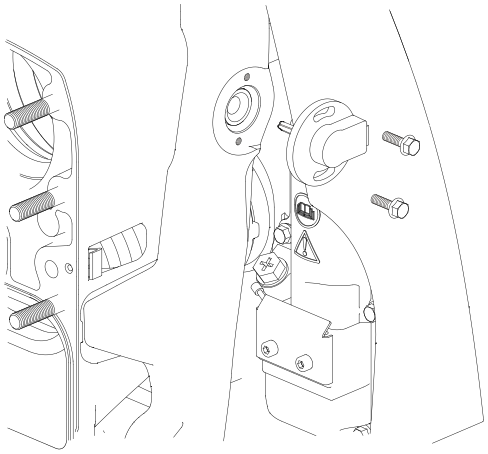
### Anode Replacement



***NOTICE!*** **The sacrificial anode need not be removed unless it is 2/3 deteriorated and needs to be replaced.**

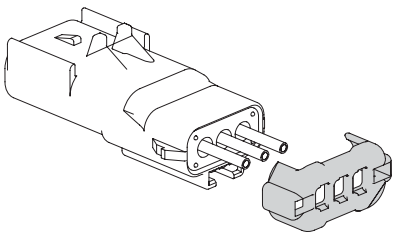
1. Remove two screws, lock washers, flat washers, and anode.
2. Clean mounting surface, then install new anode and attaching hardware. Tighten screws to 24 ± 4 Nm (18 ± 3 ft. lb).

### Trim Sender Removal

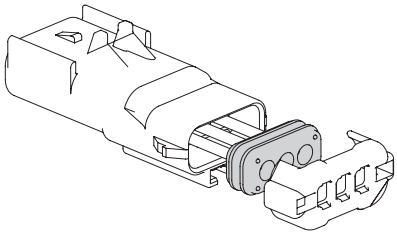


1. Disconnect trim sender connector at wiring harness on engine. Record position of sending unit wires before removing. Use socket removal tool **3854350** to push terminals out of rubber plug.

***NOTICE!*** **The use of alcohol or equivalent will make socket installation into rubber plug easier.**

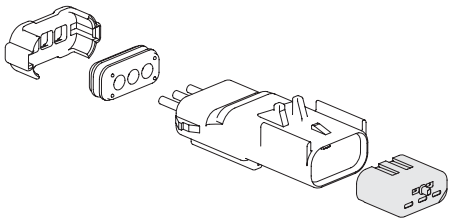


2. Use a small straight tip screwdriver and pry the weatherpak retaining clip from locking tabs on the connector.

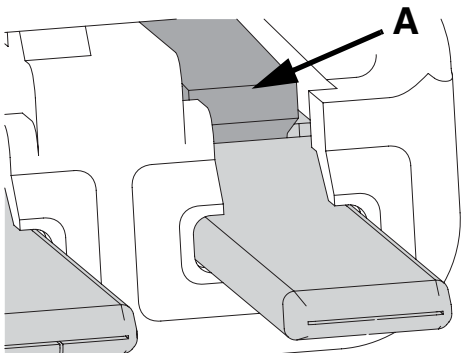


3. Use a small straight tip screwdriver and pry weatherpak gasket back from connector.

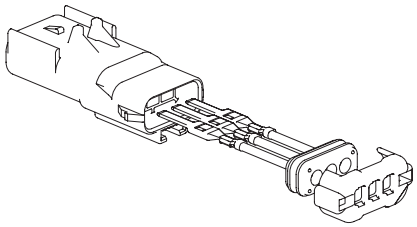
***NOTICE!*** **The material is very soft. be careful not to tear or damage the gasket. If the gasket is torn or damaged, the terminal must be replaced.**



4. Use a small pair of needle nose pliers, grab the small knob on the face of the terminal support block and pull the support out of the connector.

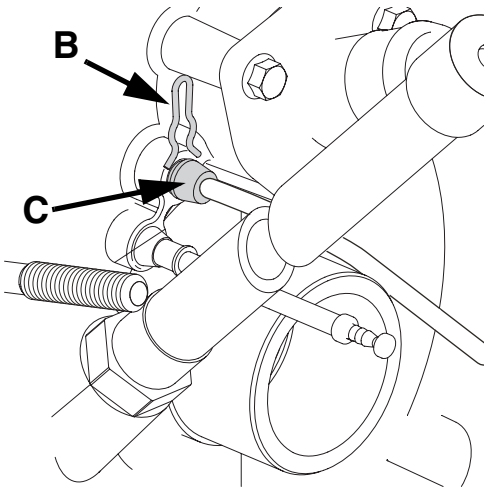



5. Lift the locking tab (A) with a scribe or very small screwdriver. Pull terminals from the rear of the connector to clear the housing.



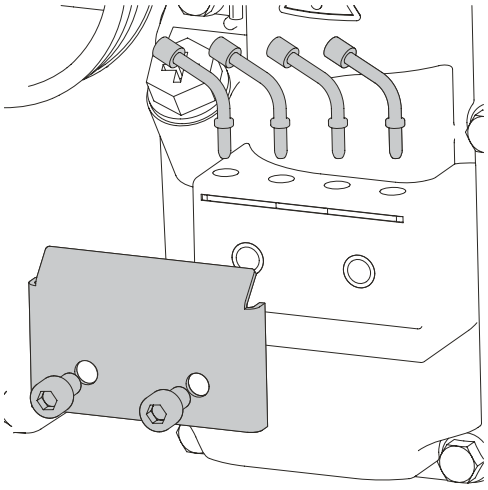
6. Remove terminals for the trim sender connector. Pull wires and terminals through weatherpak gasket and retainer.

***NOTICE!*** **Take care not to damage the gasket with the terminals when pulling through the gasket. If the gasket is torn or damaged, it must be replaced with a new gasket during installation.**




7. Remove the spring clip (B) from the trim sender through fitting (C) and pull the wires and fitting through the hole toward the rear of the transom shield.

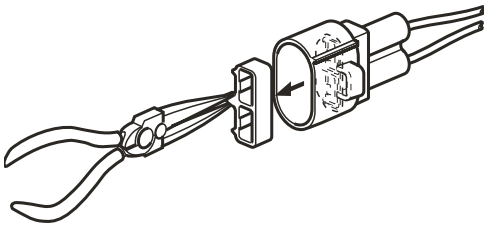
### Hydraulic Lines Removal



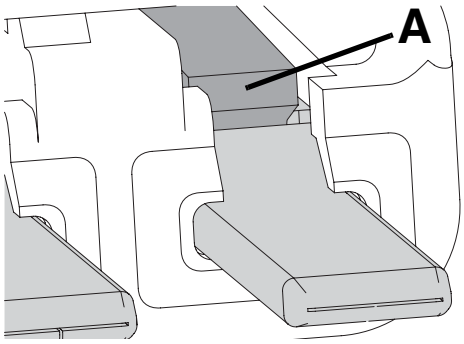
***NOTICE!*** **The trim system is a hydraulic system and is extremely sensitive to dirt and debris. Only remove the hydraulic lines and/or trim pump if you have a problem with the trim system.**

1. Remove two screws that secure the hydraulic line retainer to the trim pump.
2. Remove the hydraulic lines from the trim pump

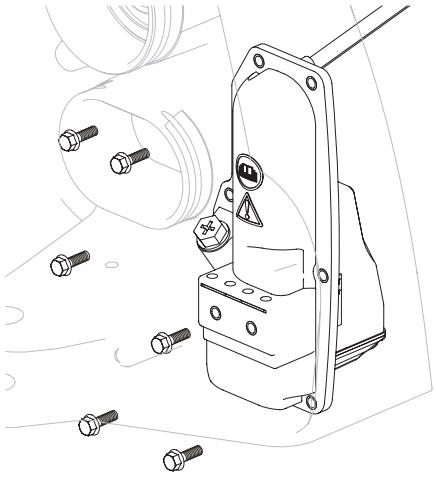
### Trim Pump Removal



1. Mark the connector for the positive (+) and negative (-) wires.
2. Using a pair of needle nosed pliers, remove the red plastic insert in the connector.



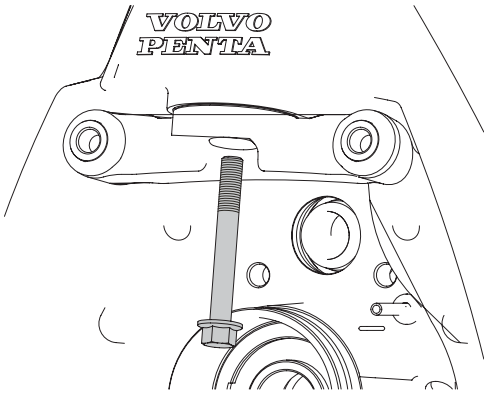

3. Using a probe, lift the locking tab (A) for the connector terminals and remove the terminals through the rear of the connector.



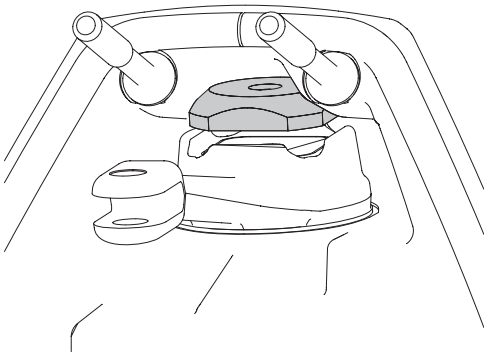
4. Disconnect hydraulic lines from trim pump. See “Hydraulic Lines Removal” on page 185.
5. Remove the six retaining screws on the trim pump housing.
6. Remove pump from transom shield.
7. Pull the power feed wires through the transom shield.

***NOTICE!*** **Use caution when pulling the trim pump wires through the transom shield. The wires connected to the electric motor may pull loose. Push the wires through the transom shield while removing the trim pump.**

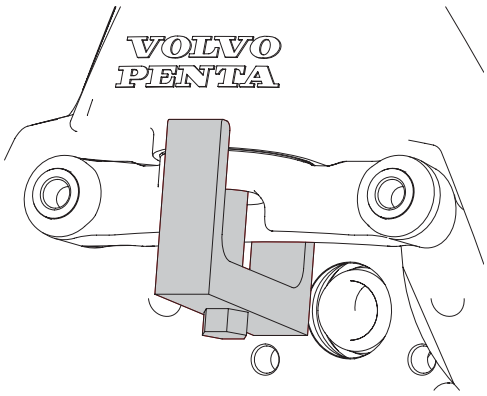
### Steering Bearing, Gimbal Bearing and Seal Removal



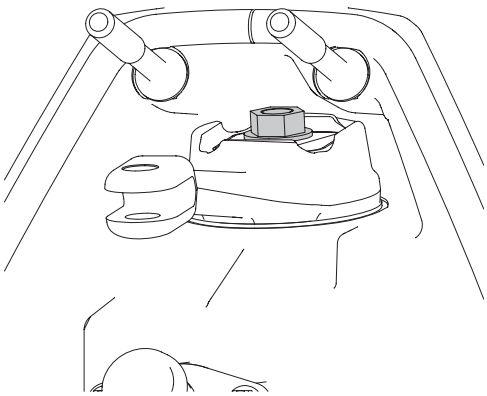

1. Using a 5/8 socket wrench, remove the steering shaft bolt.



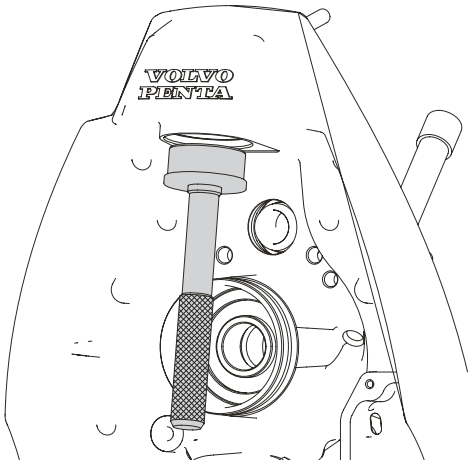
2. Remove the steering shaft to tiller arm retainer nut.



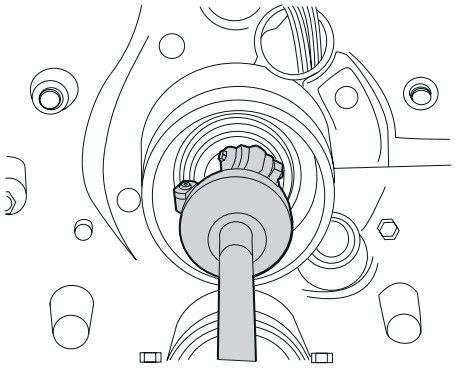

3. Install special tool **3591637** with the longer leg facing outward toward the rear of the transom shield.



4. Screw the flange nut onto the special tool bolt and remove the steering shaft from the tiller arm.




5. Assemble special tool **3849666** on handle **9991801**. Install the special tool into the steering bushing. Using a hammer, drive the bushing out.



6. Use a two jaw puller such as **Owatonna Tool 1176** to pull out the gimbal bearing. Spread the tool jaws between the bearing and inner seal and expand the jaws tightly behind the bearing. Remove and discard the bearing.
7. Pull the inner seal out in a similar manner and discard it.

**Gimbal Housing Cleaning and Inspection**

Clean grease and sealer from bearing cavity, seal seat, and manifold cavity. Check inner bore diameter for scoring or discoloration that indicates a spinning bearing.

- **Pivot Bearing** - Inspect Teflon surface for wear or corrosion.
- **Gimbal Bearing** - Rollers must spin freely and hub must pivot in all directions; inner diameter must be free of corrosion.
- **Hydraulic Manifold** - O-ring grooves must be free of nicks and burrs; all fluid passages must be clear.
- **Hydraulic Lines -** must be clear and fittings undamaged.
- **Mounting Studs** - must be tight and have no thread damage.
- **Seal Grooves** - Check for corrosion, burrs and damaged edges.
- **Anode** - Check amount of deterioration.

Clean parts in solvent and dry thoroughly.

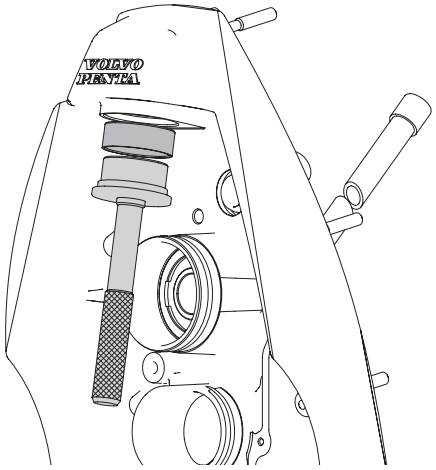
Some screw holes have special Heli-Coil inserts that provide a thread-locking feature.

⚠ **CAUTION! Do not clean Heli-Coil holes with a thread tap. This will damage the Heli-Coil inserts and force their replacement.**

Use only Locking Heli-Coils available from Volvo Penta Parts. See your parts catalog.

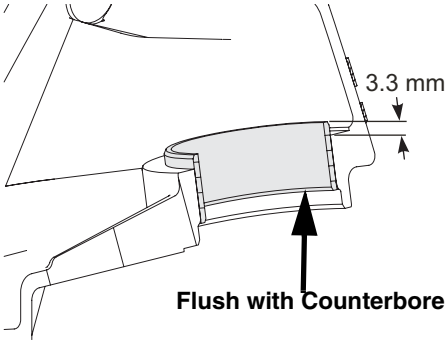
# Gimbal Housing Assembly

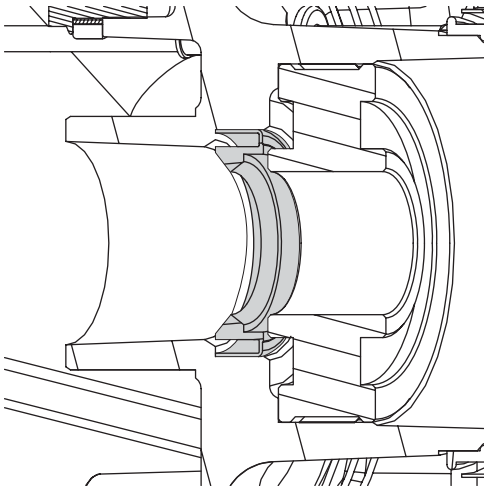
### Steering Bearing, Gimbal Bearing and Seal Installation



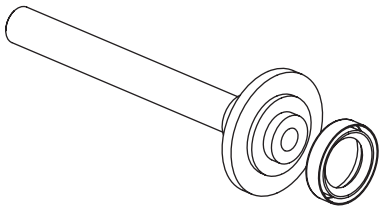

1. Assemble special tool **3849646** onto drive handle **9991801**. Face chamfered end of a new steering shaft bearing up and install on the special tool. Drive the bearing into the shield until the tool bottoms. The installer will act as a stop to seat the bearing.

***NOTICE!*** **The bushing should protrude 3.3 mm above the transom shield and the bushing should be flush with the counterbore.**

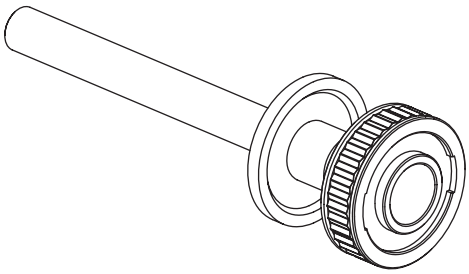


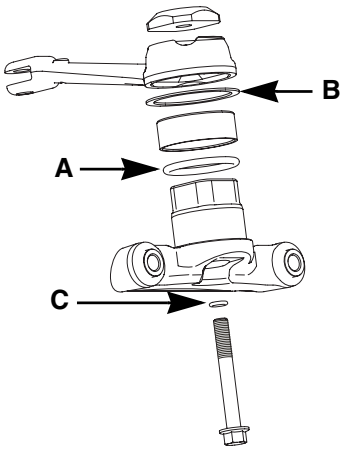



2. Screw installer **3850038** onto drive handle **3850609**. Drive seal into housing until it seats. Coat seal lip with grease **828250**.

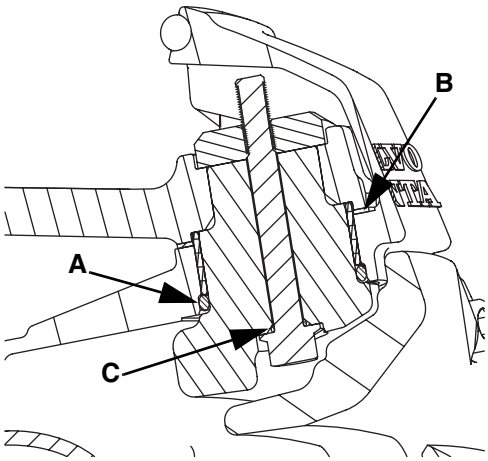


3. Reverse the gimbal bearing/seal installer **3850038** on the drive handle **3850609**. Position the gimbal bearing with the ring slots facing in toward shield. Drive the gimbal bearing into the shield until the tool bottoms.



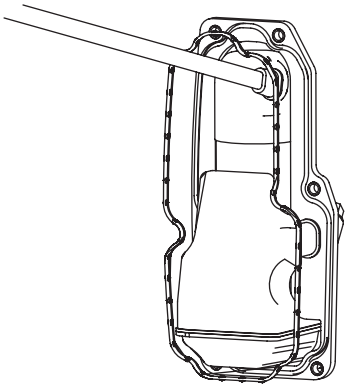


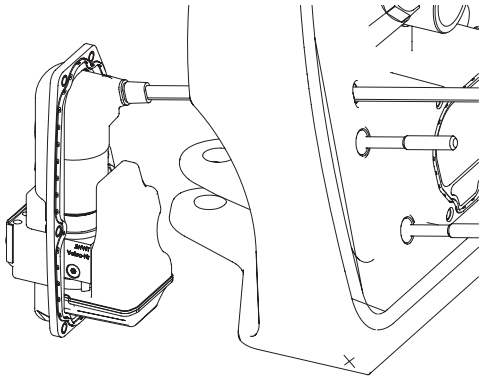

4. Install new O-ring (**A**) onto steering shaft. Place new thrust washer (**B**) over the steering shaft bushing in the transom shield. Install the steering shaft into the steering shaft bushing and align the tiller arm with the square post on the steering shaft. Place the tiller arm nut on top of the tiller arm. Install a new O-ring (**C**) on the steering shaft bolt. Apply Loctite 271 to the steering shaft bolt. Thread the steering shaft bolt into the tiller arm nut and tighten to 81 ± 14 Nm (60 ± 10 ft. lb).



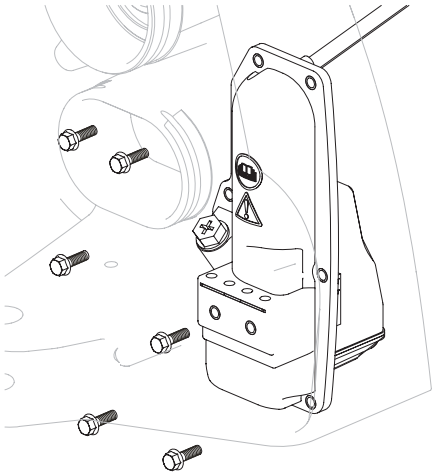

**Trim Pump Installation**

1. Inspect the trim pump sealing surface of the transom shield for nicks, cuts, or corrosion that may cause leaking past the gasket. If defects are found, the transom shield housing may need to be replaced.
2. Install a new gasket part no. 3841015 in the trim pump groove.

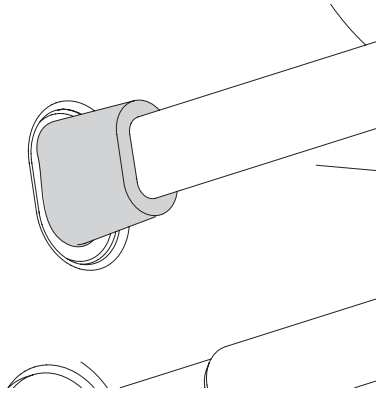




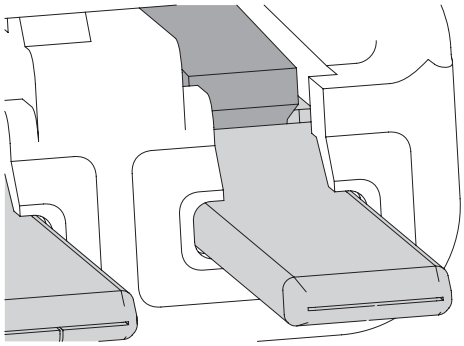
3. Feed wire through opening in transom shield.



4. Install pump into transom shield and install six bolts. Tighten the bolts to 10 ± 1.5 Nm (88 ± 13 in. lb.).

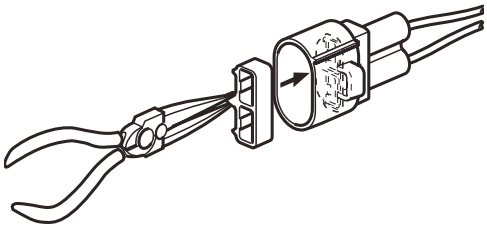


5. Make certain the grommet is completely seated in the opening.



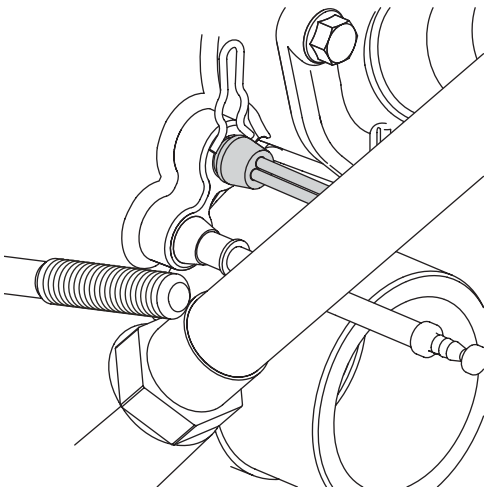
6. Insert the wires in the correct openings of the connector. Slide the terminals in until the locking tab engages the stop on the terminals.

***NOTICE!*** **The lock tab will “click” when the terminal is fully engaged.**



7. Install the terminal support into the connector.
8. Fill trim pump reservoir, See General Information section of this manual.

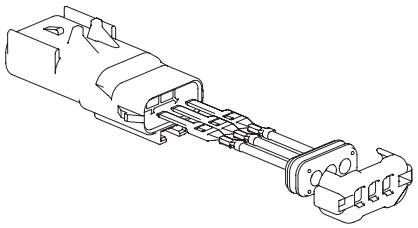
**Trim Sender Installation**



1. Apply grease **828250** to trim/tilt sender lead grommet. Feed wires through opening in transom shield and out through transom plate. Push grommet into hole until it seats.

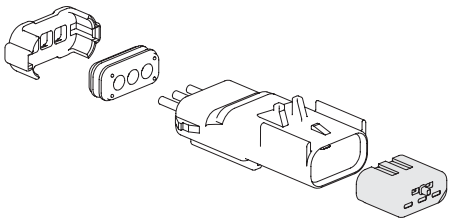
***NOTICE!*** **Do not route trim/tilt sender leads under extension tube or hydraulic lines. Leads must be free to move when drive unit steers, otherwise sender or wire will be damaged.**

2. Attach retaining clip to grommet inside transom plate.

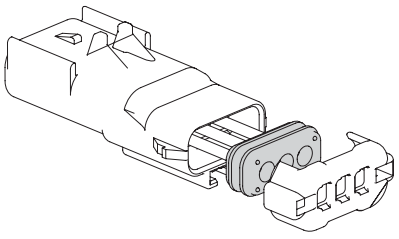


3. Install Black/Brown wire in position “1”, Green/Red wire in position “2” and Black wire in position “3”.

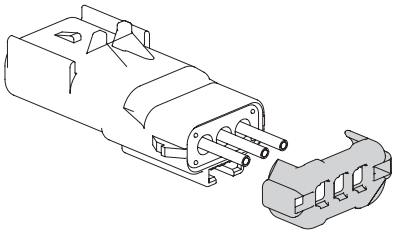
***NOTICE!*** **The terminal numbers are moulded into the connector.**



4. Install terminal support block.

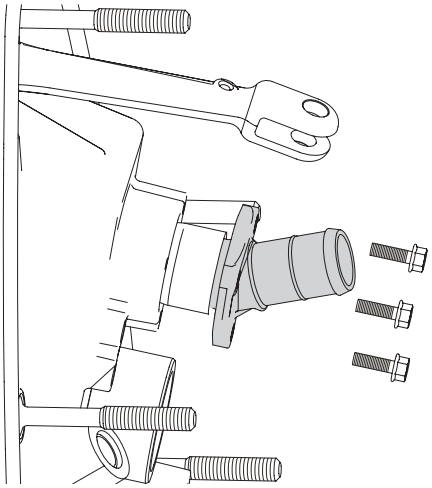


5. Slide gasket into the back of the connector.

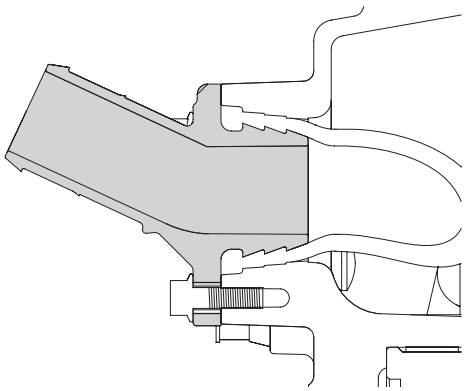


6. Slide the gasket retainer onto the connector.

### Water Tube Installation



1. Install water hose though transom shield opening.
2. Push the water tube into the water hose until the water hose stop against the water tube mounting flange.

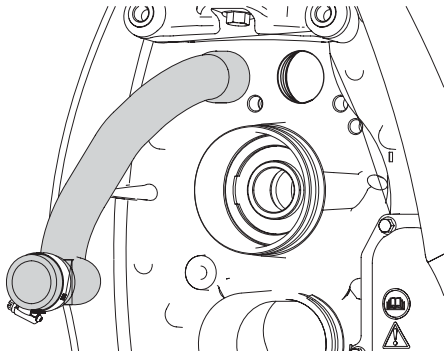


3. Push the water hose and water tube assembly into the transom shield.

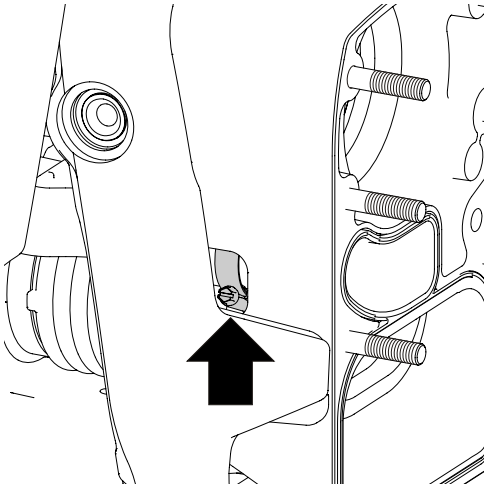
***NOTICE!*** **You will not be able to fully seat the water tube by hand, but you will have to insert it enough to get the mounting screws started.**

4. Install the mounting screws and tighten evenly to 10 ± 1.5 Nm (88 ± 13 in. lb.)

### Water Hose Installation

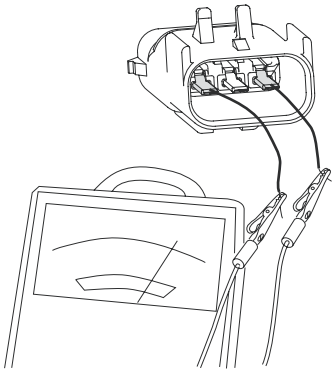


1. Place a hose clamp on the water hose.
2. Slide the water hose onto the water hose fitting in the Pivot housing.

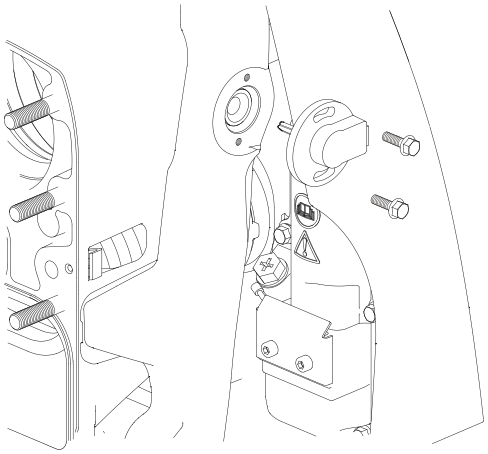


3. Tighten hose clamp through the access window of the pivot housing.
4. Check the water hose travel for kinking, pinching or binding in all pivot housing positions.
5. Slide the other end of the exhaust bellows over the exhaust opening of the pivot housing.
6. Push bellows onto exhaust port until it engages groove.
7. Turn the clamp to the 12 o'clock position.
8. Tighten the clamp through the pivot housing access window.

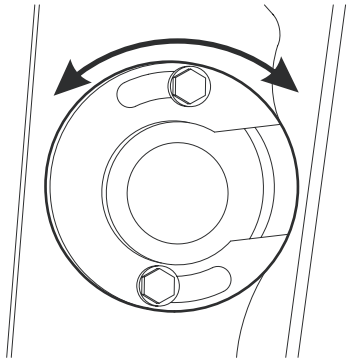
**Trim Sender Adjustment**



1. Connect an ohm meter to the black and brown/black wire on the sending unit connector. Turn sending unit control nut until meter reads 11 ± 1 ohm.



2. With lower edge of pivot housing pushed in towards gimbal housing, insert sending unit control nut into pivot bolt head. Install two trim sender mounting screws finger tight.

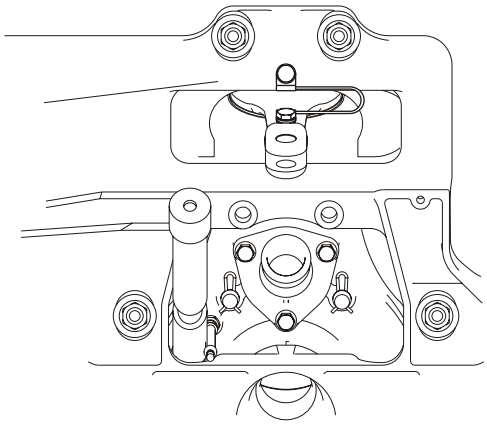


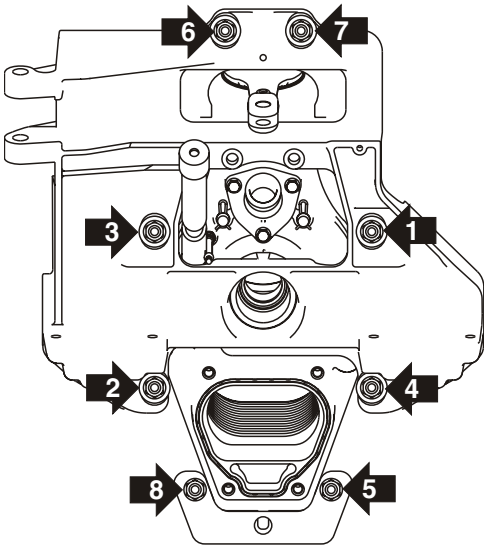
3. With pivot housing pushed in towards gimbal housing, check adjustment of sending unit between pins “1” and “3” of sending unit connector. Rotate sending unit to obtain a 11 ± 1 ohm reading on the meter, then tighten mounting screws to 21 ± 3 in. lb. (1.75 ± 0.25 Nm).

## Transom Shield Removal

Remove engine, lower exhaust pipe, and steering cylinder following instructions in *Stern Drive Engine Removal* and installation section in the *Engine Service Manual*.

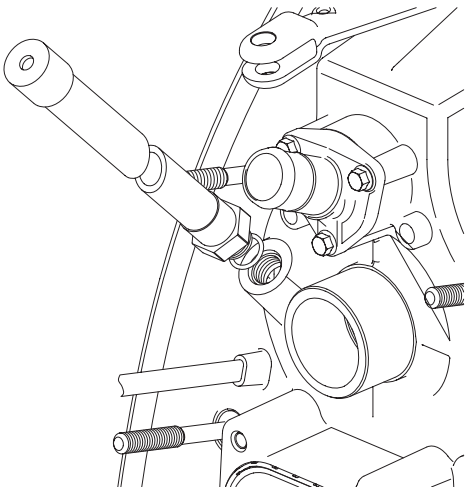
1. Remove screw and washer securing transom plate ground strap to steering arm.



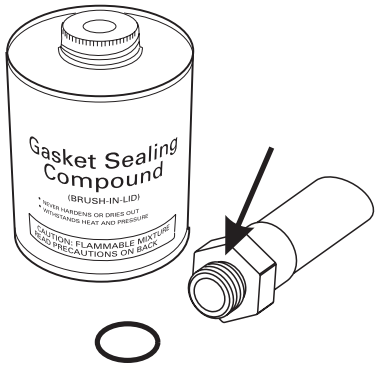



2. Remove six nuts and washers securing transom plate inside boat. Lift plate off studs.
3. Remove two remaining nuts, washers (**5, 8**), and transom bearing plate. Pull gimbal housing off transom.

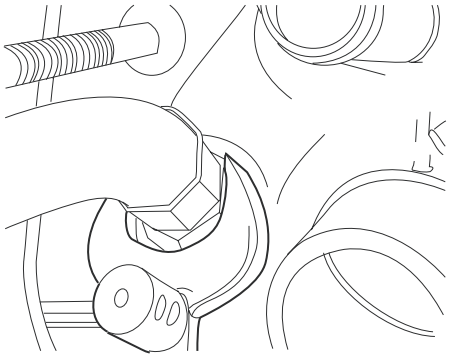
### Shift Cable Sleeve Replacement



1. Unscrew shift cable sleeve and connector assembly. Discard connector O-ring.

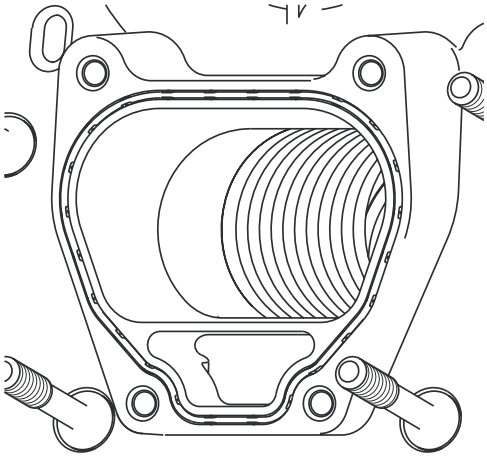



2. Apply gasket sealing compound to a new O-ring. Slide it onto connector and position it against hex, then coat connector threads with sealer.

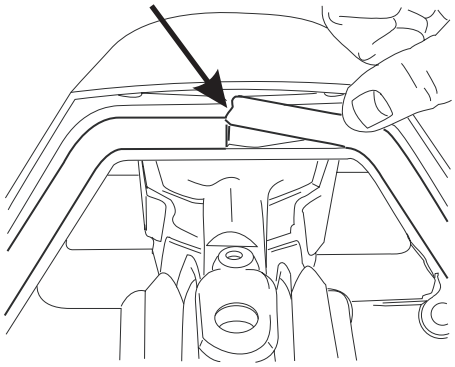


3. Install sleeve and connector assembly and use a crowfoot adapter to tighten connector to 44 ± 4 ft. lb. (60 ± 5 Nm).

### Transom and Exhaust Seal Replacement

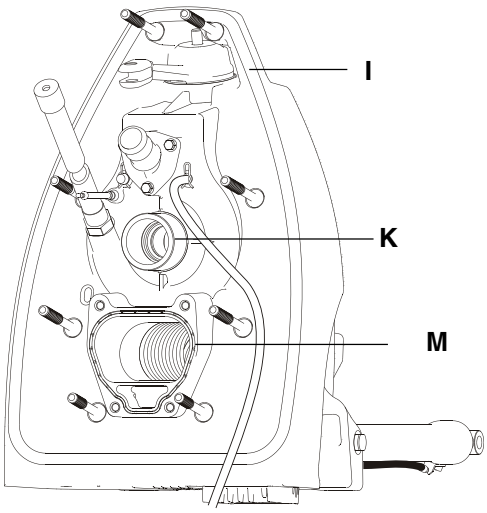


1. Remove and discard exhaust O-ring seal and large rubber transom seal.
2. Apply 3M Scotch Grip Rubber Adhesive 1300 in exhaust groove and install new O-ring seal.

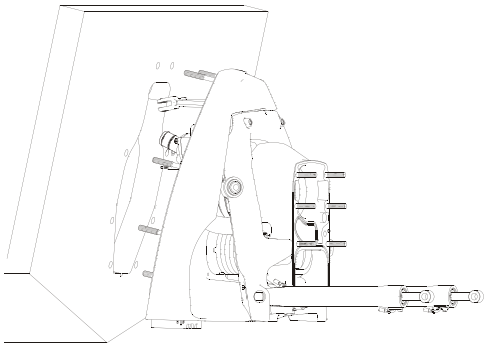


3. Apply 3M Scotch Grip Rubber Adhesive 1300 to entire transom seal groove around gimbal housing. Start at top and firmly push new seal into groove. Also apply 3M Scotch Grip Rubber Adhesive 1300 to the seal ends and butt them together to form a watertight junction at top of gimbal housing.

## Transom Shield Installation

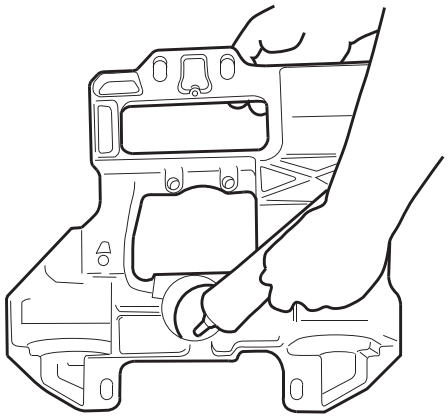



1. Thoroughly clean outer transom surface where gimbal housing seal makes contact.
2. Make sure the outer transom seal **I** and exhaust outlet seal **M**, are properly seated in their grooves. Check the transom shield alignment tube **K** for nicks or burrs that would make installation difficult.

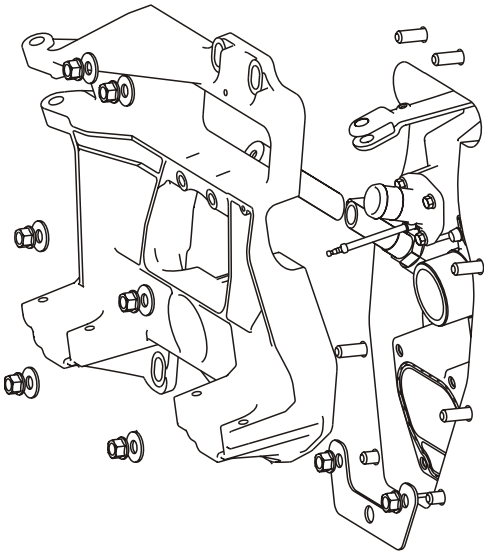


3. Lightly coat the eight gimbal housing studs with gasket sealing compound.
4. Install outer transom shield into transom. Guide studs through drilled holes in transom.

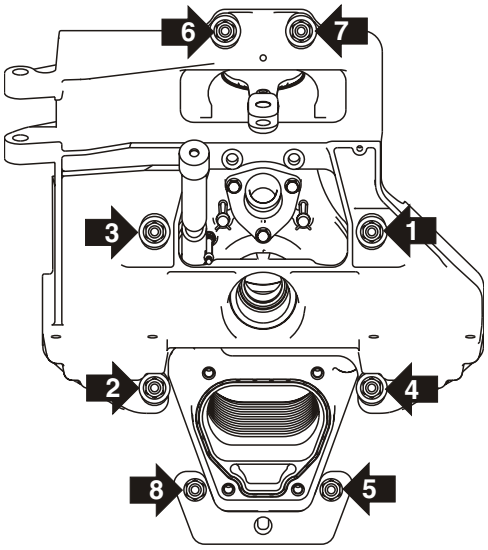
⚠ **CAUTION! Ensure the wires are not caught under the transom seal. Failure to follow this instruction will result damage to wires and seal. This may result in water leaking into the boat.**



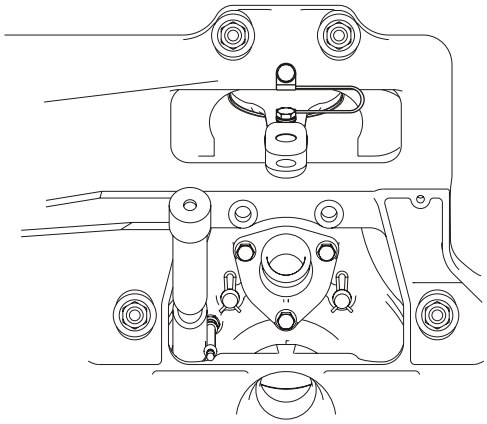
5. Apply a light coat of grease **828250** to inside of transom plate alignment tube.



6. Install inner transom plate over steering arm and water tube. Install (PN 828250) Do not tighten at this time.




7. Tighten the eight lock nuts in a cross pattern, starting with the two center nuts. Tighten them to of 20–25 ft. lb. (27–34 Nm).



8. Attach transom plate ground strap to steering arm and secure with screw and washer. Tighten screw securely.

## Torque Specifications

| Description | U.S. | Metric |
|---|---|---|
| Anode | 18 ± 3 ft. lb. | 24 ± 4 Nm |
| Shift Cable Sleeve | 44 ± 4 ft. lb. | 60 ± 5 Nm |
| Trim Pump Fill Cap | 23 ± 4 in. lb. | 2.7 ± 0.5 Nm |
| Trim Line to Cylinder/Pump | 70 ± 5 in. lb. | 8 ± 0.5 Nm |
| Tilt Pivot Pin Lock Screw<br>Trim Sensor Screw | 88 ± 13 in. lb. | 10 ± 1.5 Nm |
| Shift Cable Attachment | 88 ± 13 in. lb. | 10 ± 1.5 Nm |
| Steering Shaft Assembly to Gimbal Rin | 62 ± 11 ft lb. | 85 ± 15 Nm |
| Transom Shield Mounting Studs | 59 ± 7 ft. lb. | 80 ± 10 Nm |
| Tiller Arm to Steering Shaft | 60 ± 10 ft. lb. | 81 ± 14 Nm |
| Trim Pump Mounting | 88 ± 13 in. lb. | 10 ± 1.5 |
| Trim Sender | 21 ± 3 in. lb. | 1.75 ± 0.25 Nm |
| Water Outlet | 88 ± 13 in. lb. | 10 ± 1.5 Nm |
| Water Nipple | 8–14 ft. lb. | 11–19 Nm |

## Sealants, Lubricants, and Adhesives

| Adhesives | Where used |
|---|---|
| *Loctite® 271* Thread Locking Fluid | Stud, Gimbal Housing<br>Stud, Transom Shield<br>Screw, Steering Shaft to Gimbal Ring<br>Screw, Steering Shaft to Tiller Arm<br>Screw, Pivot Pin lock<br>Screw, Trim Sender driver |
| 3M Scotch Grip Rubber Adhesive 1300 | Transom Seal<br>Exhaust Seal |
| **Lubricants** | **Where Used** |
| Volvo Penta Grease **828250** | Alignment Tube, Inner Transom Plate<br>Bushing, Upper Steering Post<br>Washer, Pivot Housing<br>Grommet, Trim Sender Lead<br>Grommet, Trim Pump Power Lead<br>O-ring, Upper Steering shaft<br>Water Nipple<br>Pivot Pin, Trim/Tilt Cylinders<br>Seal Lip, Gimbal Housing<br>Thrust Washer, Lower Steering Post<br>Thrust Washer, Pivot Pin<br>Thrust Washer, Upper Steering Bearing<br>Pivot Housing Lip, U-joint Bellows |
| **Sealants** | **Where Used** |
| Volvo Penta Gasket Sealing Compound **1161099** | O-ring, Shift Cable Tube<br>Studs, Gimbal Housing |

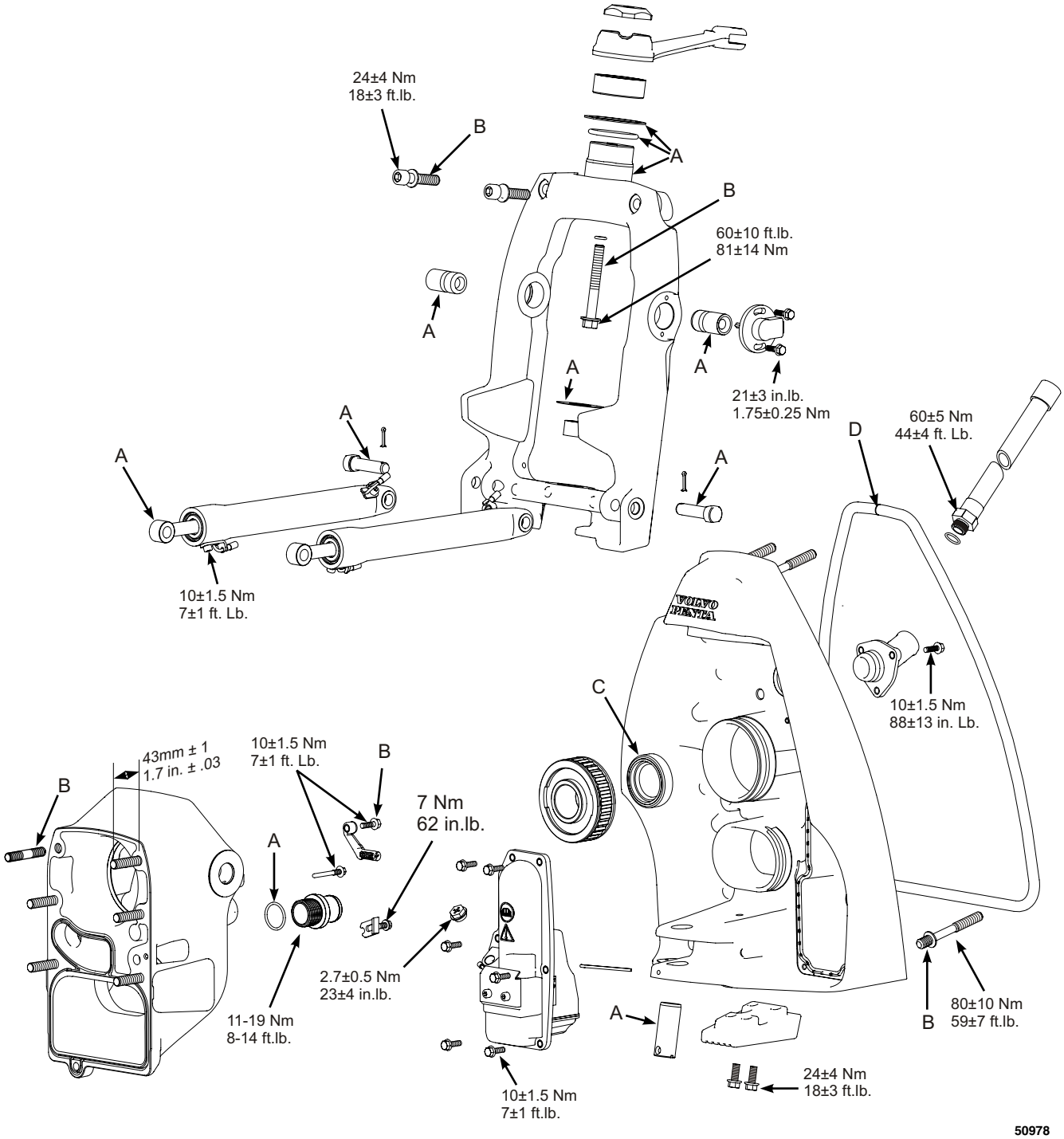
## Service Chart

**(A) Volvo Penta P/N 828250 grease**

**(B) Loctite® 271 Thread Locking compound**

**(C) Perfect Seal gasket sealing compound**

**(D) 3M Scotch Grip rubber adhesive 1300**



# NOTES

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