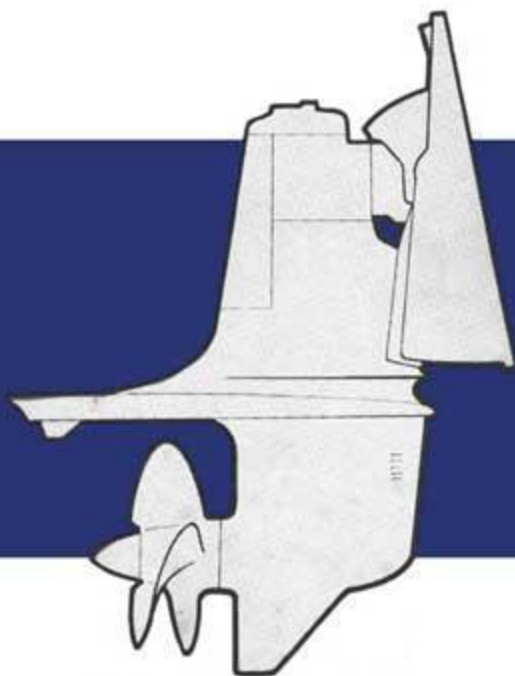


**WORKSHOP MANUAL**

***AQUAMATIC***

***280 280-DP 285 290 290-DP***



**VOLVO PENTA**

# **Workshop Manual**

**Drives**

<b>B C</b>
<b>2(0)</b>

**280, 280-DP, 285, 290, 290-DP  
SP-A, SP-C, DP-A, DP-B, DP-C**



---

# Drives

## **AQ 280, AQ 280-DP, AQ 285, AQ 290, AQ 290-DP SP-A, SP-C, DP-A, DP-B, DP-C**

### Contents

<b>General Information</b> .....	<b>3</b>	Reconditioning the universal joint .....	62
Safety Information .....	3	Reconditioning the shift mechanism .....	64
Introduction .....	3	Types of shift mechanisms .....	64
Important .....	3	Shift mechanism type 1 .....	64
General Information .....	6	Shift mechanism type 2 .....	66
About the Workshop Manual .....	6	Shift mechanism type 3 .....	68
Spare parts .....	6	Intermediate housing .....	73
Repair Instructions .....	7	Reconditioning the intermediate housing, model 280, 285 and 285A .....	73
Our joint responsibility .....	7	Assembly .....	75
Tightening torques .....	7	Reconditioning the intermediate housing, model 290 and 290A .....	77
Angular torque .....	8	Assembly .....	79
Lock nuts .....	8	Reconditioning the intermediate housing, models SP and DP .....	82
Strength classes .....	8	Lower gear .....	86
Sealant .....	8	Reconditioning the lower gear, models 280, 285, 290 and SP .....	86
Safety instructions for fluororubber .....	9	Disassembly .....	86
<b>Special tools</b> .....	<b>10</b>	Assembly .....	90
Chemicals .....	14	The propeller shaft .....	93
<b>Drive models and generations</b> .....	<b>15</b>	Shimming .....	94
<b>Design and function</b> .....	<b>19</b>	Final assembly .....	98
Model 280 .....	19	Reconditioning the lower gear, models 280-DP, 290-DP and DP .....	99
Models 290-DP, DP-A, DP-B, DP-C .....	20	Disassembly .....	99
<b>Removing the sterndrive</b> .....	<b>21</b>	Inner propellershaft .....	102
Models 280, 285 and 290 .....	21	Outer propeller shaft .....	102
Models SP and DP .....	25	Propeller shaft bearing box .....	103
<b>Repair instructions</b> .....	<b>29</b>	Forward gear .....	104
Upper gear housing .....	29	Vertical shaft .....	104
Removal .....	29	Assembly .....	105
Disassembly, models 280, 285 and 290 .....	30	Shimming the lower gear to the intermediate housing .....	120
Assembly, models 280, 285 and 290 .....	35	Shimming the upper gear to the intermediate housing .....	122
Disassembly, models 290A, SP and DP .....	46	Pressure and vacuum testing .....	124
Assembly, models 290A, SP and DP .....	50		

<b>Installing the sterndrive .....</b>	<b>125</b>	Installing the electric motor .....	157
Models 280 and 285 .....	125	Replacing adapter and pump assembly .....	157
Checking and adjusting controls .....	127	The relief valve assemblies .....	158
Checking the retaining pawl when		Installing the trim pump in the boat .....	158
test running .....	127	Venting system .....	158
Oil filling .....	128	Test .....	158
Propeller installation .....	128	Adjusting the trim instrument .....	158
Installing a 'long hub' type of propeller .....	128	Checking the trim figure .....	159
Installing a 'short hub' type of propeller .....	128	Adjusting the trim figure .....	159
The duoprop (earlier model) .....	129	<b>Sterndrive extensions .....</b>	<b>160</b>
Changing the direction of the propeller		Installation instructions for 1" and 4" extensions ....	160
rotation .....	129	The 4" extension .....	160
The electro-mechanical sterndrive		The 1" extension .....	161
tilting device (model 280) .....	130	<b>Welding .....</b>	<b>162</b>
Repair instructions .....	130	Parts that cannot be welded .....	162
Reconditioning the tilting device .....	131	Parts which can be welded .....	162
Model 290, SP and DP .....	132	Repair instructions .....	162
Adjusting the retaining pawl (model 290) .....	137	<b>Painting .....</b>	<b>163</b>
Oil filling .....	137	Preparing the sterndrive .....	163
Propeller installation .....	138	Painting the underwater hull .....	163
Installing a 'long hub' type of propeller .....	138	<b>Electrical wiring diagrams .....</b>	<b>164</b>
Installing a 'short hub' type of propeller .....	138	Model 280 Tilting device .....	164
Changing the direction of the propeller		Model 280, Power trim .....	165
rotation .....	139	Model 290, Power trim (earlier model) .....	166
Adjustment of the trim fin .....	140	Models 290, SP and DP, Power trim (later model) ..	167
Twin engine installation .....	140	<b>Technical data .....</b>	<b>168</b>
<b>Transom shield .....</b>	<b>142</b>	Models 280, 280T, 280PT, 285, 285A and 290 .....	168
Changing trim cylinders, model 290, SP and DP ...	142	Models 280-DP, 280-DP/PT, 290-DP	
Changing steering helmet .....	147	and 290A-DP .....	170
Removal .....	147	Models SP-A, SP-A1, SP-A2 and SP-C .....	173
<b>Trim system .....</b>	<b>150</b>	Models DP-A, DP-A1, DP-A2, DP-B, DP-B1,	
Changing the sending unit .....	150	DP-C and DP-C1 .....	174
Changing the trim system gear rack .....	151	<b>References to Service Bulletin .....</b>	<b>176</b>
Changing the trim system gear wheel .....	153		
The power trim pump .....	155		
Removing the trim pump from the boat .....	156		
Removing the oil reservoir .....	156		
Replacing filters .....	156		
Removing the electric motor .....	157		

---

# Safety Information

## Introduction

The Workshop Manual contains technical data, descriptions, and repair instructions for the designated Volvo Penta products or product versions. Make sure that the correct workshop literature is used.

**Read the following safety information and the *General Information and Repair Instructions* in the Workshop Manual carefully before starting service work.**

## Important

The following special warning symbols are used in the Workshop Manual and on the product.



**WARNING!** Warns of risk of bodily injury, serious damage to product or property, or that a serious malfunction can occur if the instructions are not followed.



**IMPORTANT!** Used to attract attention to things that can cause damage or malfunction to product or property.

**NOTE!** Used to attract attention to important information, to simplify work procedures or handling.

The following list provides an overview of the risks and cautionary procedures that should always be observed.



Prevent the engine from being started by disconnecting the power with the main switch (switches) and locking it (them) in disconnected mode before the service work is begun. Attach a warning sign in the cabin.



As a rule, all service work should be performed on an idle engine. Some work, e.g. certain adjustments, require the engine to be running. Approaching an engine that is running is a safety risk. Remember that loose clothes or long hair can fasten in rotating parts and cause severe injury.

A careless movement or dropped tool while working in the vicinity of an engine that is running, can in the worst case lead to injury. Observe caution on hot surfaces (exhaust pipe, turbo, charge air pipe, starter element etc.) and hot fluids in the lines and hoses of an engine that is running, or has just been started. Refit all guards dismantled during service work before starting the engine.



Make sure that the warning or information decals on the product are always clearly visible. Replace labels that have been damaged or painted over.



Never start the engine unless the air filter is fitted. The rotating compressor wheel in the turbo can cause severe injury. Foreign objects in the inlet pipe can also damage the machine.
















Never use starter spray or the like. Explosion risk in the inlet pipe. Risk of personal injury.









Avoid opening the coolant filler cap when the engine is hot. Steam or hot coolant can spray out, and built up pressure will be lost. Open the filler cap slowly and release the overpressure in the cooling system if the filler cap or cock must be opened, or if a plug or coolant pipe must be removed when the engine is hot. Steam or hot coolant can flow out in an unpredicted direction.



Hot oil can cause burn injuries. Avoid skin contact with hot oil. Make sure that the oil system is not pressurised before working on it. Never start, or run the engine with the oil filler cap removed in view of the risk of ejecting oil.

-  Stop the engine and close the bottom valve before working on the cooling system.
-  Only start the engine in a well-ventilated area. Exhaust fumes and crankcase gases should be led out of the engine compartment or workshop when working in closed environments.
-  Always use protective glasses for work where there is a risk of splintering, sparks, or splashing of acid or other chemicals. The eyes are extremely sensitive, and an injury can cause blindness!
-  Avoid skin contact with oil! Prolonged or frequent skin contact with oil can degrease the skin, resulting in irritation, drying out, eczema, and other skin complaints. Used oil is more dangerous than new oil from the health care point of view. Use protective gloves and avoid oil drenched clothes and rags. Wash your hands regularly, especially before meals. Use special hand cream to counteract drying out, and to simplify cleaning the skin.
-  The majority of chemicals intended for the product (e.g. engine and timing gear oils, glycol, petrol and diesel oil) or chemicals for workshop use (e.g. degreasing agent, enamels and solvents) are hazardous to health. Read the instruction on the pack carefully. Always follow the given safety instructions (e.g. the use of breathing protection, protective glasses, or gloves, etc.) Make sure that other personnel are not exposed to hazardous substances, e.g. by inhaling the air. Make sure there is adequate ventilation. Handle consumed and surplus chemicals in the prescribed manner.
-  Observe extreme caution when tracing fuel leaks in fuel systems and when testing fuel nozzles. Wear protective glasses. The jet from a fuel nozzle has a very high pressure and penetrating force. The fuel can penetrate deeply into bodily tissue and cause serious injury. Risk of blood poisoning.
-  All fuels, in similarity with chemicals, are inflammable. Make sure that naked flames, or sparks, cannot lead to ignition. Petrol, certain thinners, and hydrogen from batteries, are extremely inflammable and explosive when mixed with air. Smoking is prohibited! Ventilate well and take the necessary precautions before conducting welding or grinding work in the immediate vicinity. Always have a fire extinguisher handy in the workshop.
-  Make sure that rags drenched in oil and petrol, including old fuel and lubricant filters, are stored safely. Oil drenched rags can in certain conditions self-ignite. Old fuel and oil filters are environmentally hazardous waste, and together with spent lubricant, contaminated fuel, paint residue, solvent, degreasing agent and suds, should be handed in to a waste handling unit for destruction.
-  Batteries must never be exposed to naked flames or electrical sparks. Never smoke in the vicinity of batteries. Hydrogen develops when batteries are charged, which in combination with air forms an explosive gas. This gas is highly inflammable and very explosive. One spark from connecting the batteries incorrectly is sufficient to cause the battery to explode and cause injury. Do not touch the connection when starting (risk of spark) and do not lean over the batteries.
-  Never confuse the plus and minus terminals when fitting the batteries. This can cause serious damage to the electrical equipment. Check the wiring diagram.
-  Always use protective glasses when charging and handling batteries. The battery electrolyte contains strongly corrosive sulphuric acid. On skin contact, wash with soap and plenty of water. If battery acid gets into the eyes, rinse immediately with water, and contact a doctor without delay.
-  Stop the engine and switch off the power with the main switch (switches) before working on the electrical system.
-  Adjustment of the clutch should be conducted when the engine is idle.

-  Use the lifting hooks mounted on the engine/reverse gear when lifting the drive unit. Always check that the lifting equipment is in good condition and has the correct capacity for the lift (weight of engine plus reverse gear and extra equipment where appropriate). For safe handling, and to avoid damaging the components mounted on top of the engine, the engine should always be lifted with a lifting bar adjusted to the engine. All chains or wires should run in parallel with each other and as perpendicular to the top of the engine as possible. Special lifting equipment may be required to ensure the right balance and safe handling if other equipment connected to the engine alters its centre of gravity. Never carry out work on an engine only supported by lifting equipment.
-  Never work alone when heavy components are to be dismantled, even when safe lifting (e.g. lockable block and tackle) equipment is used. In most cases, two persons are required even when lifting equipment is used: one to handle the equipment and one to make sure that components are not damaged. When working on-board a boat always make sure in advance that there is sufficient space to allow dismantling in situ, without the risk of personal injury or damage to materials.
-  **WARNING!** The components in the electrical system and in the fuel system on Volvo Penta products are designed and manufactured to minimise the risks of explosion and fire. The engine must not be run in environments surrounded by explosive media.
-  When cleaning with high-pressure wash, observe the following: Never point the jet of water at seals, rubber hoses, or electrical components. Never use the high-pressure function when washing the engine.
-  **NOTE!** Pressure pipes must not bent, turned, or exposed to other strain. Replace damaged pressure pipes.
-  Always use Volvo Penta recommended fuel. See the instruction handbook. The use of inferior quality fuel can damage the engine. The use of inferior fuel in a diesel engine can cause the control rod to jam and the engine to overspeed, with the risk of personal injury or damage to the machine. Inferior fuel can also lead to higher maintenance costs.



---

# **General Information**

## **About the Workshop Manual**

This Workshop Manual contains technical information, descriptions, and repair instructions for the standard versions of the drive units 280, 280T, 280PT, 285, 285A, 290, 290A, 280-DP, 280-DP/PT, 290-DP, 290A-DP, SP-A, SP-A1, SP-A2, SP-C, DP-A, DP-A1, DP-A2, DP-B, DP-B1, DP-C and DP-C1.

The Workshop Manual can show operations carried out on any of the drives listed above. As a result the illustrations and pictures in the manual that show certain parts on the drives, do not in some cases apply to all the drives listed. However the repair and service operations described are in all essential details the same. Where they are not the same this is stated in the manual and where the difference is considerable the operations are described separately. The Drive Designations and Series Number (PZ-No.) can be found on the product plate. Please always include both the drive designation and the PZ number in all correspondence.

The Workshop Manual is primarily produced for Volvo Penta service workshops and their qualified personnel. It is therefore assumed that persons using this manual have a basic knowledge of marine drive systems, and can perform the relevant work of a mechanical and electrical nature.

Volvo Penta continuously develops its products, and therefore reserves the right to introduce modifications. All the information in this manual is based on product data available prior to publication. Any amendments or service methods of essential importance that have been introduced for the product after this date are confirmed in the form of Service Bulletins.

## **Spare parts**

Spare parts for the electrical and fuel systems are subject to different national safety requirements, e.g. U.S. Coast Guard Safety Regulations. Volvo Penta Genuine Spare Parts comply with these requirements. All types of damage resulting from the use of non genuine Volvo Penta spare parts for the product in question will not be regulated by the warranty undertakings of Volvo Penta.

---

# Repair Instructions

The work methods described in the Workshop Manual are applicable for a workshop environment. The drive has removed from the boat and is installed in an overhaul fixture. Unless otherwise stated reconditioning work which can be carried out with the drive in place follows the same working method.

The warning symbols used in the Workshop Manual (see Safety Information for implication),

 **WARNING!**

 **IMPORTANT!**

**NOTE!** By no means cover everything since the service work is conducted under a wide range of different conditions, and it is obviously impossible to foresee everything. All that can be done is to point out the risks that can occur from incorrect handling when working in a well-equipped workshop with work methods and tools approved by Volvo Penta.

Where Volvo Penta special tools can be used for work procedures, these are described in the Workshop Manual. The object of special tools is to ensure the safest and most rational work method possible. If other tools or work methods are used than those recommended by Volvo Penta, then it is incumbent on the person using them to ensure that there is no risk of personal injury, damage, or malfunction.

In some cases, there are special directions and user instructions for the tools and chemicals named in the Workshop Manual. These directions should always be followed even if there is no special mention of them in the Workshop Manual.

Most risks can be prevented by means of taking elementary precautions and using common sense. A clean workplace and a clean drive will eliminate many risks of both personal injury and drive malfunction.

Above all when working with bearing unions and sealing unions, it is extremely important to prevent dirt or foreign objects from getting in, since this can result in malfunction or reduce the life span of the repair.

## Our joint responsibility

Every engine consists of a large number of co-ordinated systems and components. The deviation of one component from the technical specification can dramatically increase the impact on the environment from what is otherwise a good engine. It is therefore extremely important to maintain the given tolerances, to implement the correct adjustments where applicable, and to use Volvo Penta Genuine Parts. The time schedule in the engine's maintenance schedule must be followed.

Certain systems, e.g. components in the fuel system, may require special competence and special testing equipment. For environmental reasons certain components are sealed at the factory and must not be worked on by unauthorised persons.

Remember that most chemical products when incorrectly used can be damaging to the environment. Volvo Penta recommends the use of biologically decomposing degreasing agents for all cleaning of engine components, unless otherwise stated in the Workshop Manual. When working onboard boats special care must be observed to prevent oils and suds etc. unintentionally ending up the nature, e.g. via the bilge water.

## Tightening torques

Tightening torque for vital unions, which should be tightened with a torque multiplier, are indicated in the Workshop Manual, **Technical data, Tightening torques** and the manual's work descriptions. All torque readings are applicable for clean threads, screw heads and mating surfaces. The torque readings refer to lightly oiled or dry thread. If lubricants, locking fluids or sealant are required for screw union, then the type is indicated in the work description. For unions where special torque denotations are not indicated, the general tightening torque is applicable according to the table below. The torque readings are guide values, and unions do not need to be tightened with a torque multiplier.

Size	Tightening torque, Nm (lb.ft)	
M5 .....	6	(4.4)
M6 .....	10	(7.4)
M8 .....	25	(18.4)
M10 .....	50	(36.9)
M12 .....	80	(59.0)
M14 .....	140	(103.3)

## Angular torque

For angular tightening the screw union is first tightened with a given torque, after which tightening continues at a predetermined angle. Example: for 90° angular torque the union is tightened an addition ¼ turn after the given tightening torque has been achieved.

## Lock nuts

Dismantled lock nuts should not be reused but replaced with new ones, since the locking properties become inferior or non-existent after multiple use. For lock nuts with plastic inserts, e.g. Nylock®, the tightening torque indicated in the table should be reduced if the Nylock® nut has the same nut height as a standard solid metal hex nut. The tightening torque is reduced by 25 % for screw sizes of 8 mm or more. For Nylock® nuts with higher nut size, where the solid metal thread is the same height as a standard hex nut, the tightening torque as per the table is applicable.

## Strength classes

Screws and nuts are divided into different strength classes. Their classification is indicated on the screw head. A high number on the marking represents a stronger material, e.g. a screw marked 10-9 is stronger than a screw marked 8-8. It is therefore important when a screw union is dismantled to return the screws to their original positions. See the spare parts catalogue when replacing screws to ensure that the correct version is used.

## Safety instructions for fluororubber

Fluororubber is a common material used in sealing rings for shafts and O-rings.

**Hydrofluoric acid** is formed when fluororubber is exposed to high temperatures (over 300°C/572°F), and is strongly corrosive. Contact with the skin, eyes, or respiratory passages, can lead to severe injury.



**WARNING!** Observe extreme caution when working on engines that may have been exposed to high temperatures, e.g. overheating during seizing or fire. Seals must never be burned off during dismantling, or burned up in uncontrolled circumstances.

- Always use chloroprene gloves (for handling chemicals) and protective glasses.
- Handle the removed seal in the same way a corrosive acid. All residue, including ash, can be strongly corrosive. Never use compressed air to blow clean.
- Place the remains in a sealed plastic container with warning label. Wash gloves under running water before taking off.

The following seals are in all probability manufactured of fluororubber.

Sealing rings for crankshaft, camshaft, and intermediate shafts.

O-rings, irrespective of position. O-rings for cylinder lining seals are almost always made of fluororubber.

**Note that seals that have not been exposed to high temperatures can be handled normally.**

## Sealant

A number of different types of sealant and locking fluids are used on the engine. The sealant has different properties for different union strengths, temperature ranges, resistance to oil and chemicals, and for the different materials and slot sizes in the engine.

It is therefore important to use the correct type of sealant and locking fluid for those unions that require them, in order to ensure satisfactory service work.

The Workshop Manual indicates in the relevant chapters the compounds used when the drives were manufactured.

The same compound, or a compound with equivalent properties but of other manufacture, should be used during the service work.

When using sealant and locking fluids it is important that the surfaces are free from oil, grease, paint and anti-rust agent, and that they are dry.

Always follow the manufacturer's instructions concerning application temperature and hardening times etc. for the product.

Different basic types of sealant are used on the drive and are characterised by:

**RTV compound** (Room Temperature Vulcanising). Often used together with gaskets, e.g. sealing of gasket joints or applied on gaskets. RTV compound is clearly visible when the part has been dismantled, and old RTV compound must be removed before the union is sealed again.

The following RTV compounds are mentioned in the Workshop Manual:

Volvo Penta part no. 1161099-5  
(alternative Permatex® no. 3).

Old sealant is removed with denatured spirit.

**Anaerobic compounds.** These compounds harden on the absence of air. The compound is used when two solid parts, e.g. cast components, are fitted together without a gasket. A common application is also to secure and seal plugs, thread on studs, cocks, and oil pressure sensors etc. Hardened anaerobic compound is transparent and therefore the compounds are dyed to make them visible. Hardened anaerobic compounds are very resistant to solvents and old compound cannot be removed. Before refitting they are carefully degreased, after which new sealant is applied.

The following anaerobic compounds are mentioned in the Workshop Manual:

Volvo Penta part no. 1161053-2 (alternative Loctite® 243)  
Volvo Penta part no. 1161351-0 (alternative Loctite® 603).

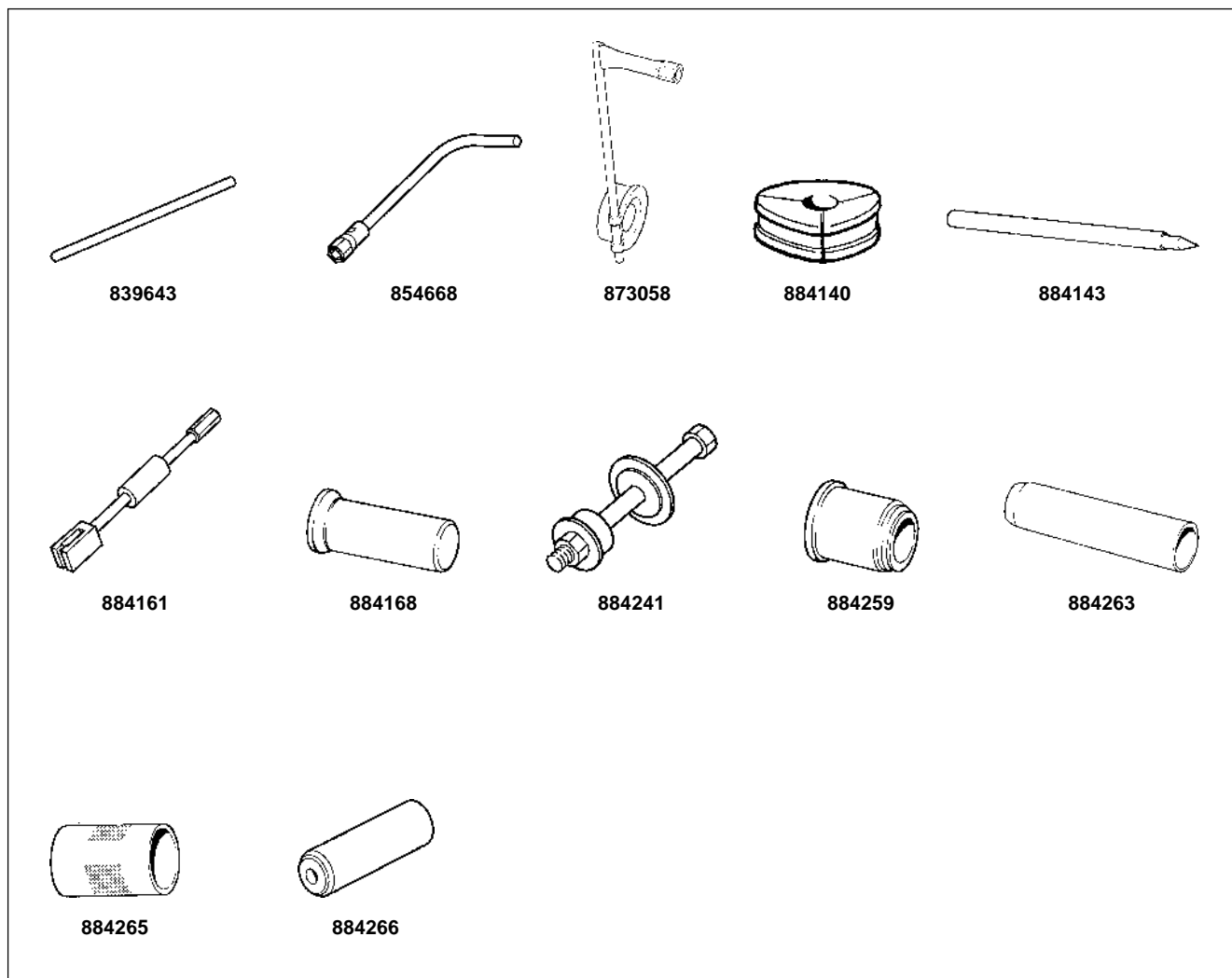
**Polymeric compounds.** The following polymeric compounds are mentioned in the Workshop Manual:

Volvo Penta part no. 1141570-0, Sealant.

**NOTE!** Permatex® is a registered trademark for Permatex Corporation.  
Loctite® is a registered trademark for Loctite Corporation.

# Special tools

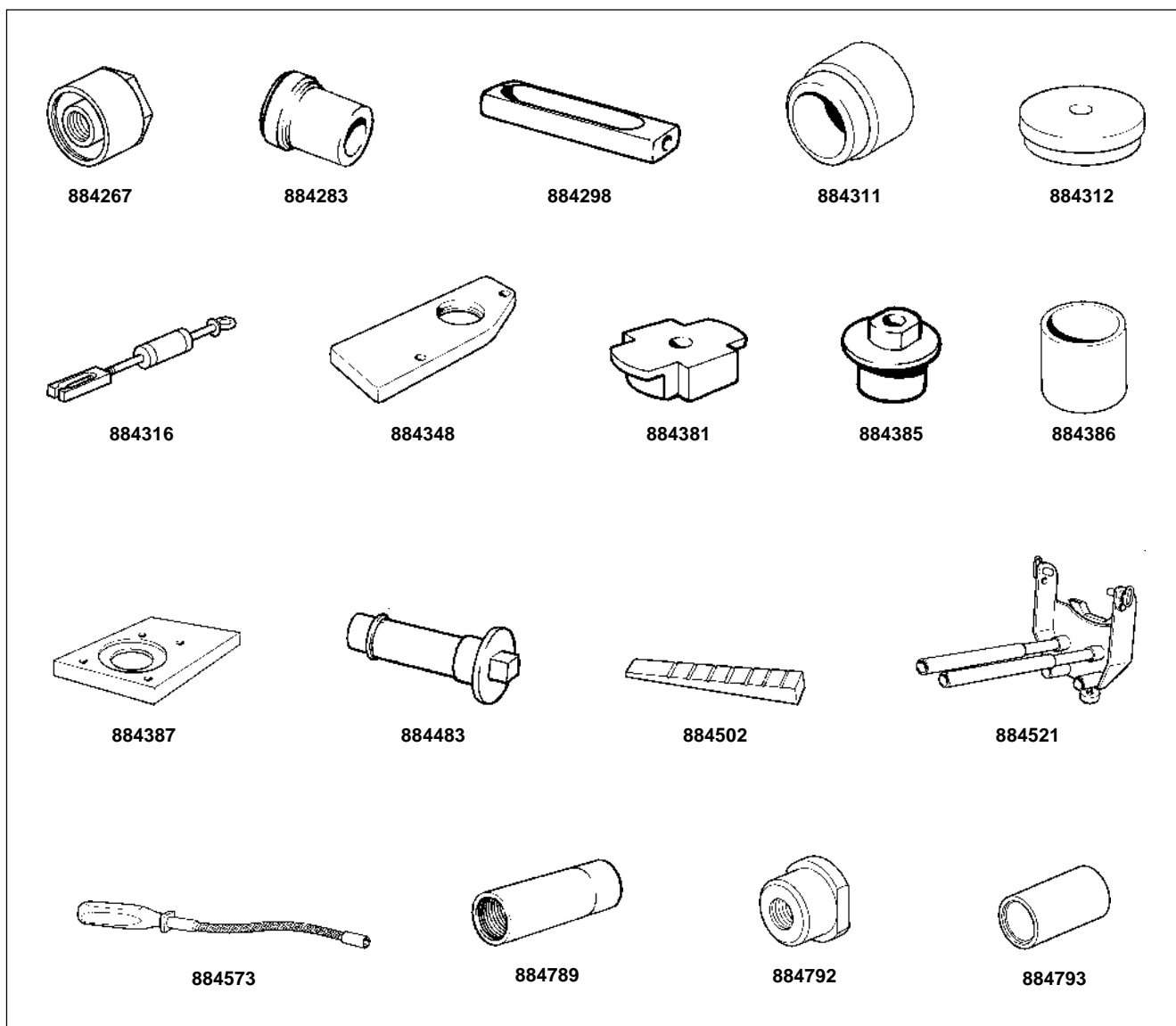
In all cases where it has been practically possible tools have been punched with their tool number, excluding the last digit. The last digit (after the hyphen) is a check number.



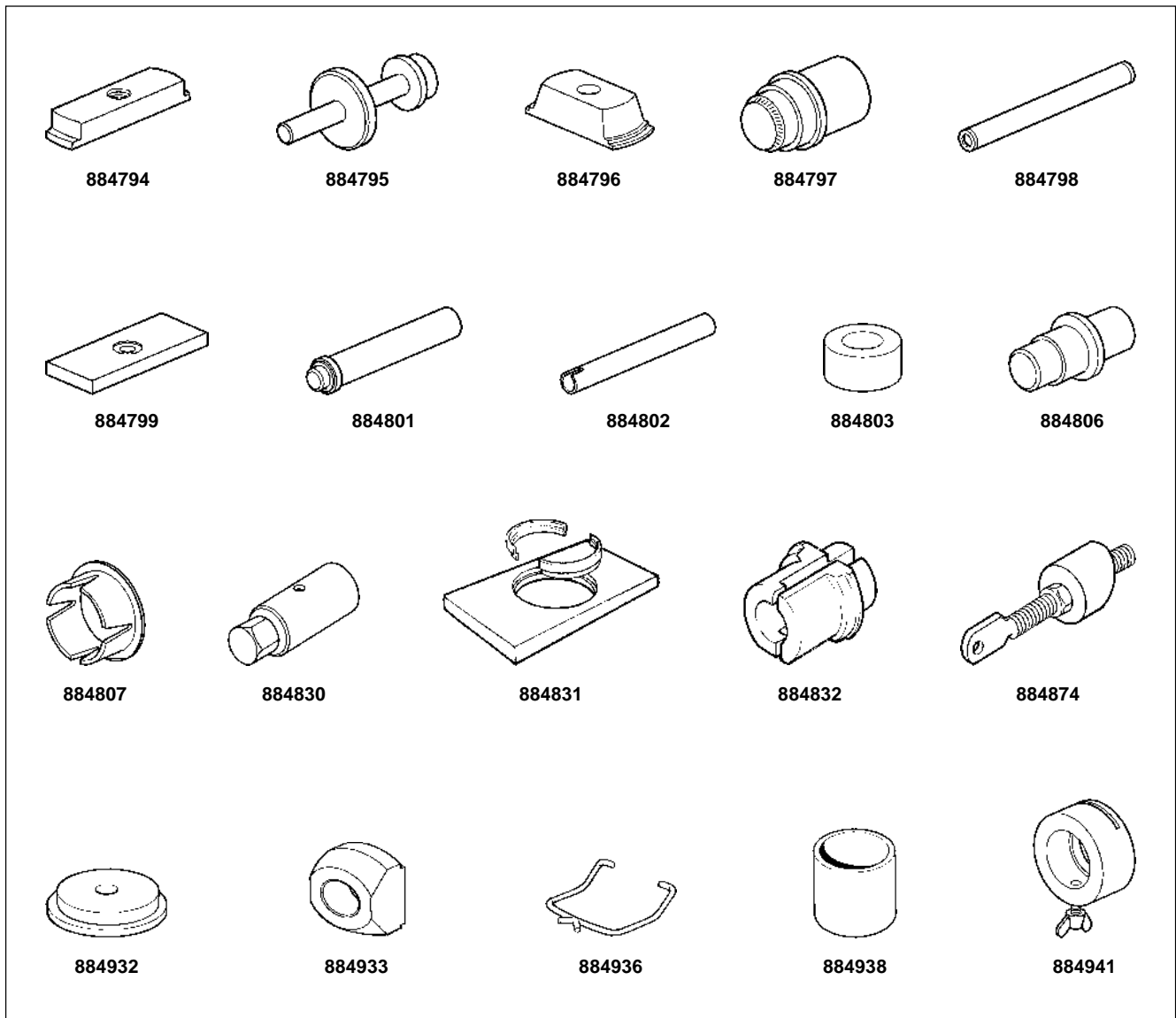
- 839643-4** Drive repair welding rod (aluminum electrode)
- 854668-1** Prop wrench for 16 mm bolt cone
- 873058-2** Prop wrench for 20 mm bolt cone
- 884140-5** Expander, dismantling of bearings – intermediate
- 884143-9<sup>1)</sup>** Standard handle, pointed – lower and intermediate
- 884161-1** Tool to remove propeller bearing and lower intermediate shaft
- 884168-6** Bearing press drift – upper, intermediate and lower

- 884241-1** Tool to install the needle bearing of the vertical shaft – lower
- 884259-3** Drift, bearing installer/remover – intermediate
- 884263-5** Drift for the assembly of bearings on propeller shaft and input gear wheel in upper gear
- 884265-0** Sleeve for removing gear wheel and bearing on propeller shaft
- 884266-8** Drift for the assembly of bearing on vertical shaft

<sup>1)</sup> Used together with special tools 884281, 884140 and 884381



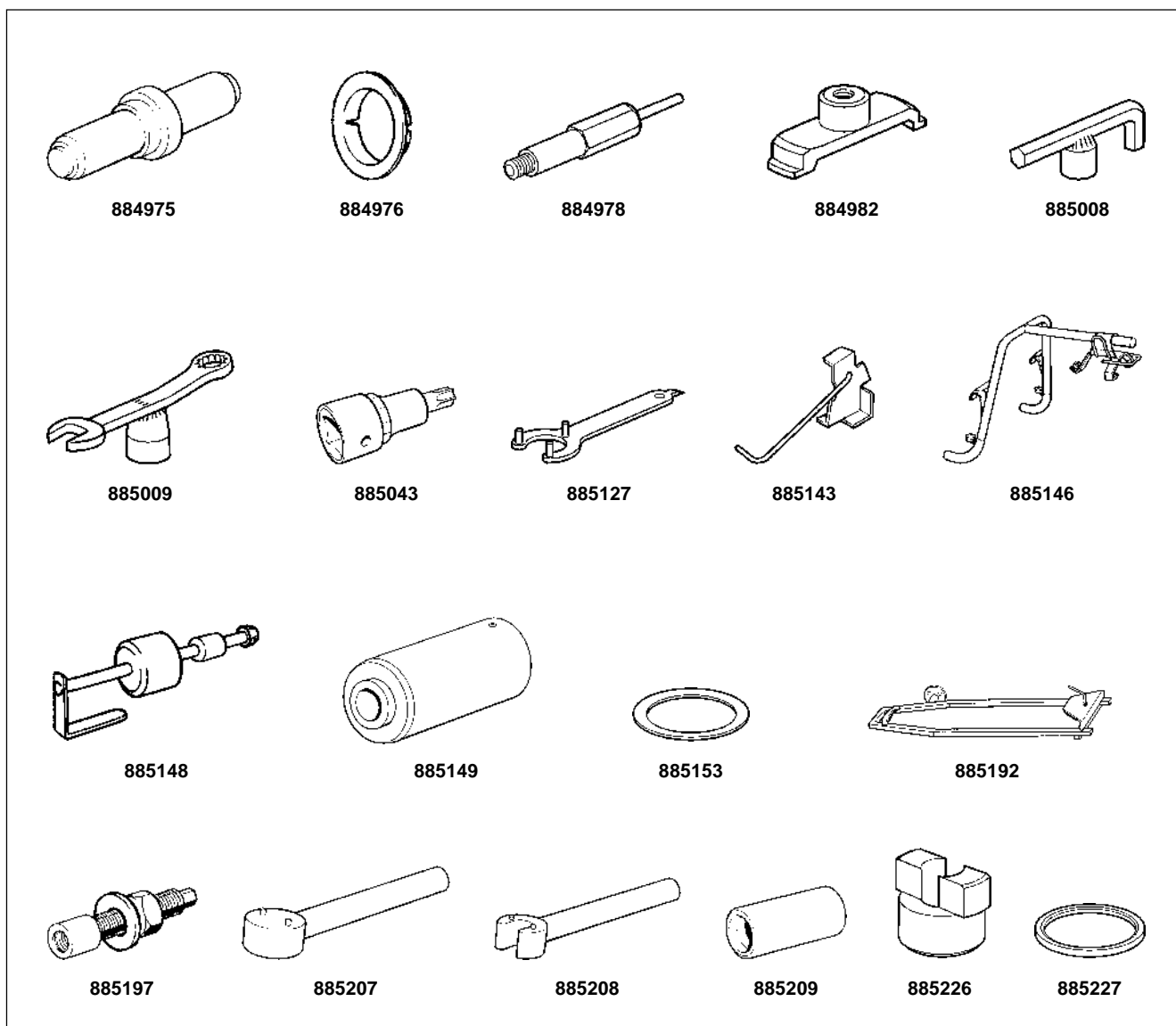
- |                 |  |                 |  |
|-----------------|--|-----------------|--|
| <b>884267-6</b> | Tool, dismantling vertical shaft   | <b>884386-4</b> | Sleeve, dismantling and installing gear wheels in upper gear |
| <b>884283-3</b> | Drift for the installation of sealing rings in propeller bearing housing and of propeller shaft needle bearing | <b>884387-2</b> | Attachment plate for upper gear housing                      |
| <b>884298-1</b> | Puller, propeller shaft needle bearing. Included in complete tool <b>884316-1</b>                              | <b>884483-9</b> | Clamp bolt for the collaring of the double bearing box       |
| <b>884311-2</b> | Tool for dismantling and installing the steering spindle   | <b>884502-6</b> | Alignment wedge, engine to transom shield                    |
| <b>884312-0</b> | Drift for sealing ring, double bearing box   | <b>884521-6</b> | Tool for installation of sterndrive to transom shield        |
| <b>884316-1</b> | Puller, complete, propeller shaft needle bearing   | <b>884573-7</b> | Socket wrench for the tightening of hose clamps              |
| <b>884348-4</b> | Spanner tool for taper roller bearing, vertical shaft  | <b>884789-9</b> | Puller   |
| <b>884381-5</b> | Dismantling tool for vertical shaft needle bearing   | <b>884792-3</b> | Bearing install tool, lower                                  |
| <b>884385-6</b> | Installation tool vertical shaft needle bearing  | <b>884793-1</b> | Seal install tool, upper                                     |



- 884794-9** Puller, forward bearing race remover, lower
- 884795-6** Bearing install tool, lower
- 884796-4** Drift, bearing remover, lower
- 884797-2** Press tool, bearing & seal, lower
- 884798-0** Install tool, prop shaft bearing
- 884799-8** Installer, lower press fixture, lower
- 884801-2** Press tool, bearing & seal installer, lower
  
- 884802-0** Shaft puller, duoprop – lower
- 884803-8** Drift, tube gear bearing & seal remover – lower unit
- 884806-1** Drift, tube gear bearing installer – lower
- 884807-9** Large protective sleeve/ring, black – lower
- 884830-1<sup>1)</sup>** Socket – vertical shaft

- 884831-9** Press fixture, bearing race remover, lower
- 884832-7** Drift set, tube gear race remover, lower
- 884874-9** Support, dismantling the sterndrive from the transom shield
- 884932-5** Disassembly tool for the outer bearing races of the double bearing box
- 884933-3** Assembly tool for the outer bearing races of the double bearing box
- 884936-6** Yoke, holding the sterndrive while installing the clamps for the bellows. Models 280 & 285
- 884938-2** Sleeve for the disassembling of gear wheels in upper gear
- 884941-6** Attachment, duoprop prop shaft runout, lower

<sup>1)</sup> Earlier part no. 884264



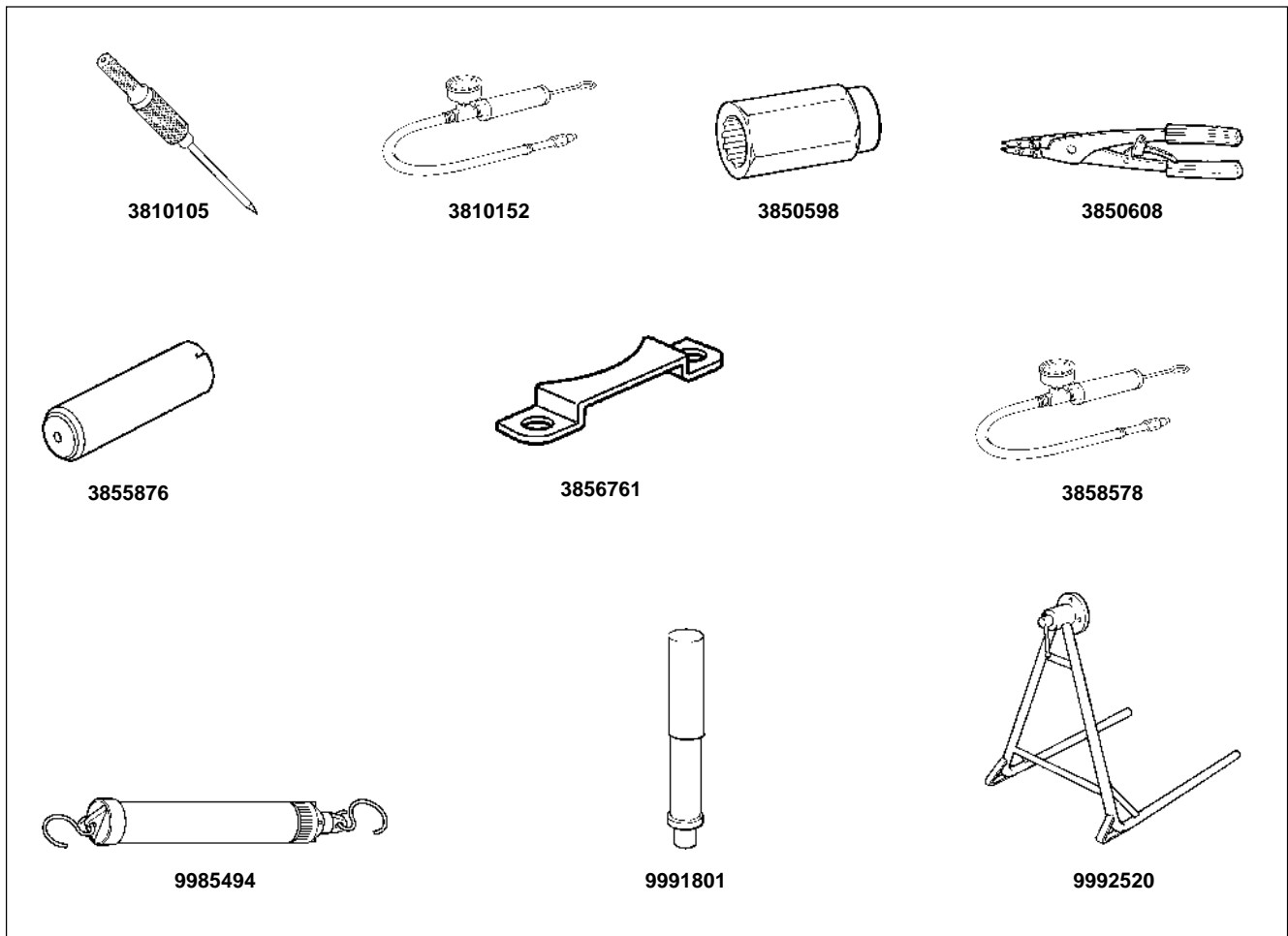
- 884975-4<sup>1)</sup>** Installation tool
- 884976-2<sup>1)</sup>** Protection sleeve
- 884978-8** Trim cylinder removal tool, intermediate
- 884982-0** Disassembly tool for outer bearing race. Intermediate housing, extension.
- 885008-3** Allen wrench, upper, intermediate & lower gears
- 885009-1** Cap wrench
- 885043-0** Torx 50 bit – Input gear
- 885127-1** Installation/dismantling tool – propellers
- 885143-8** Yoke, holding the sterndrive while installing the clamps for the bellows. Models 290, SP, DP
- 885146-1<sup>2)</sup>** Suspension tool
- 885148-7** Pin remover, intermediate
- 885149-5** Drilling jigg, duoprop, lower
- 885152-9** Kit containing tools **884387** and **885153**
- 885153-7** Spacer ring, mounting plate, upper
- 885192-5** Suspension fixture
- 885197-4** Tool, duoprop, threaded screw, lower
- 885207-1<sup>3)</sup>** Hook spanner, power steering cylinder
- 885208-9<sup>3)</sup>** Hook spanner, power steering cylinder
- 885209-7<sup>3)</sup>** Sleeve, power steering cylinder
- 885226-1** Drift, bearing remover, lower
- 885227-9** Spacer ring

<sup>1)</sup> Included in kit no. 884977

<sup>2)</sup> Earlier part no. 884862

<sup>3)</sup> These special tools have been designed for the overhaul of the power steering cylinder. The overhaul procedure is described in the **Installation instruction**, publ. no. 7734865-4, included in the overhaul kit part no. 872697-8. The tool can be ordered on the usual parts form.





**3810105-1** Pin installer, intermediate

**3810152-3** Drive pressure tester

**3850598-8** Splined socket, upper & lower

**3850608-5** Snap ring pliers, upper

**3855876-3** Tool, new type of propeller nut

**3856761-6** Holding plate, shift mechanism

**3858578-2** Drive vacuum tester

**9985494-5** Spring gauge/scale, upper

**9991801-3** Standard shaft

**9992520-8** Stand

## Chemicals

Volvo Penta  
part no.:

**1141570-0** Sealant for drives

**1161053-2** Thread locking compound

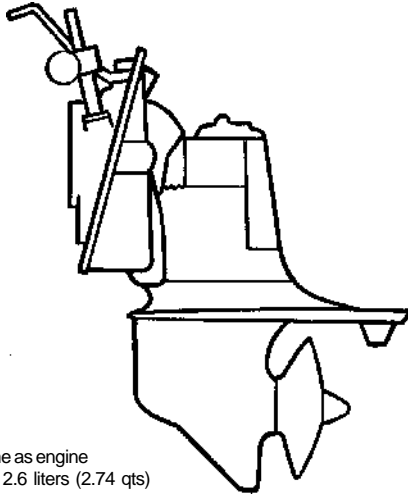
**1161099-5** Sealing compound

**1161351-0** Bushing installation adhesive

---

# Drive models and generations

## AQ 280

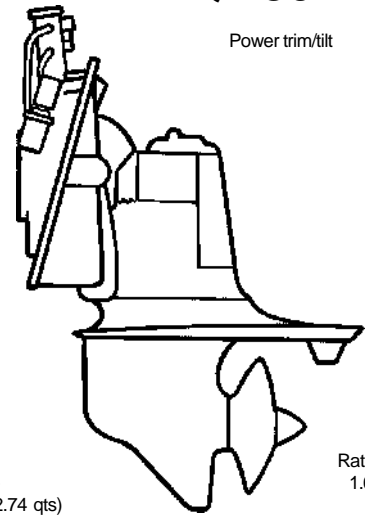


Oil:  
Same as engine  
Qty: 2.6 liters (2.74 qts)

Ratio:  
1.61:1  
1.89:1  
2.15:1

## AQ 280T

Power trim/tilt



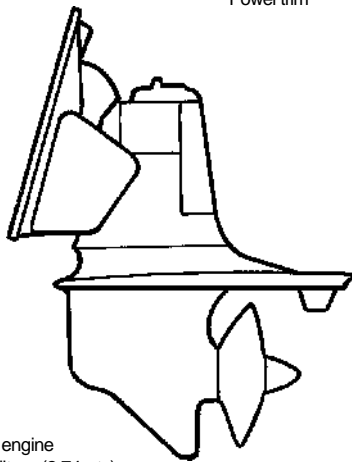
Oil:  
Same as engine  
Qty: 2.6 liters (2.74 qts)

Ratio:  
1.61

---

## AQ 280 PT

Power trim

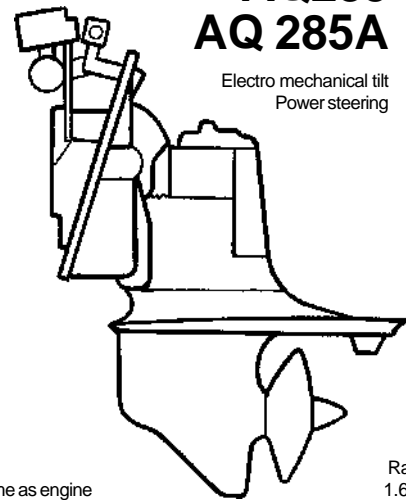


Oil:  
Same as engine  
Qty: 2.6 liters (2.74 qts)

Ratio:  
1.61:1  
1.89:1

## AQ285 AQ 285A

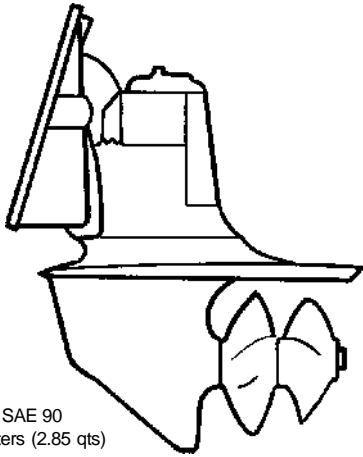
Electro mechanical tilt  
Power steering



Oil:  
Same as engine  
Qty: 2.6 liters (2.74 qts)

Ratio:  
1.61:1

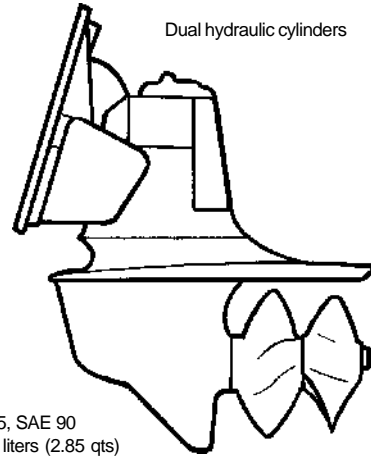
### AQ 280-DP



Oil: <sup>1)</sup>  
API GL-5, SAE 90  
Qty: 2.7 liters (2.85 qts)

Ratio:  
1.95:1  
2.30:1

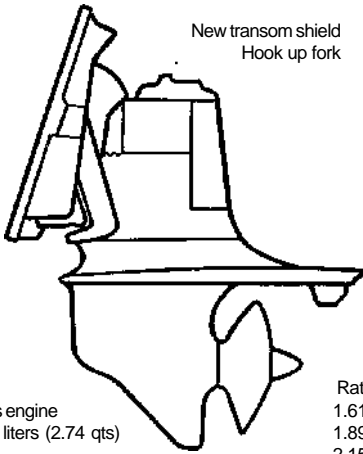
### AQ 280-DP/PT



Oil: <sup>1)</sup>  
API GL-5, SAE 90  
Qty: 2.7 liters (2.85 qts)

Ratio:  
1.95:1  
2.30:1

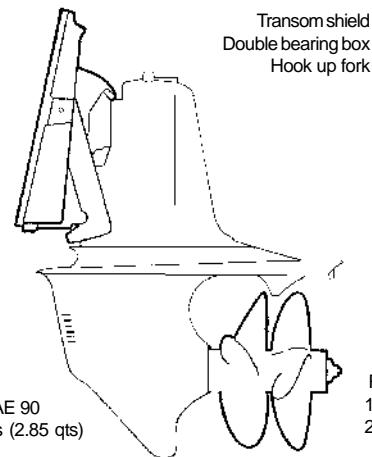
### AQ 290 AQ 290A



Oil:  
Same as engine  
Qty: 2.6 liters (2.74 qts)

Ratio:  
1.61:1  
1.89:1  
2.15:1

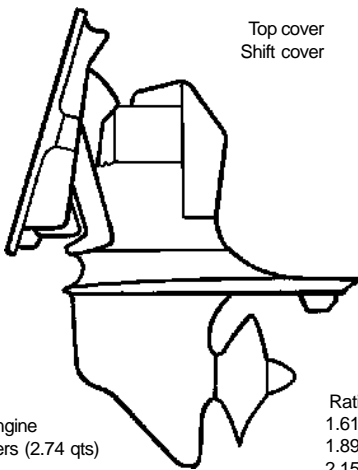
### AQ 290-DP AQ 290A-DP



Oil: <sup>1)</sup>  
API GL-5, SAE 90  
Qty: 2.7 liters (2.85 qts)

Ratio:  
1.95:1  
2.30:1

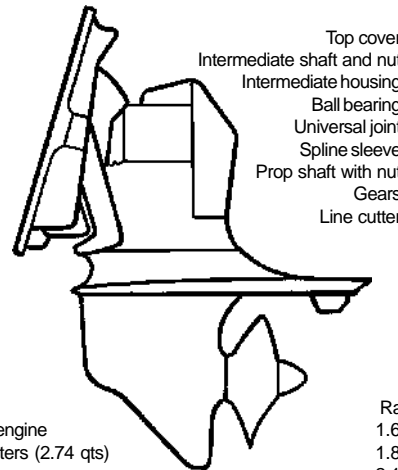
### SP-A



Oil:  
Same as engine  
Qty: 2.6 liters (2.74 qts)

Ratio:  
1.61:1  
1.89:1  
2.15:1

### SP-A1

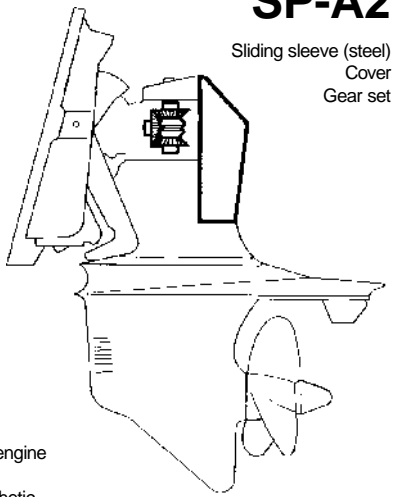


Oil:  
Same as engine  
Qty: 2.6 liters (2.74 qts)

Ratio:  
1.61:1  
1.89:1  
2.15:1

<sup>1)</sup> **NOTE!** If the drive was manufactured before 1986, for a 30- or 40-engine and has previously been operated with engine oil in the drive, then engine oil should also be used in the future.

### SP-A2

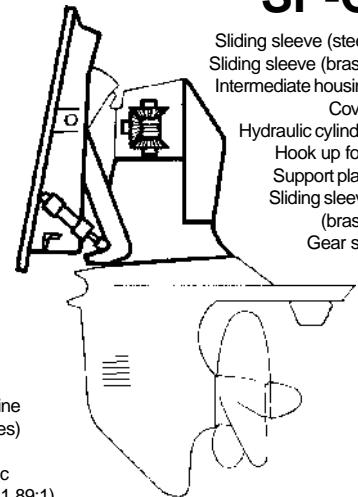


Sliding sleeve (steel)  
Cover  
Gear set

Oil:  
Same as engine  
or  
Fully synthetic  
API GL-5 SAE 75W-90  
Qty: 2.6 liters (2.74 qts)

Ratio:  
1.61:1  
1.89:1

### SP-C

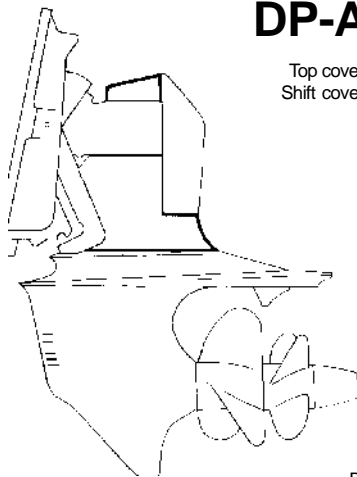


Sliding sleeve (steel)  
Sliding sleeve (brass)  
Intermediate housing  
Cover  
Hydraulic cylinder  
Hook up fork  
Support plate  
Sliding sleeve (brass)  
Gear set

Oil:  
Same as engine  
(all SP-C drives)  
or  
Fully synthetic  
(ratio 1.61:1, 1.89:1)  
API GL-5 SAE 75W-90  
Qty: 2.6 liters (2.74 qts)

Ratio:  
1.61:1  
1.89:1  
2.15:1

### DP-A

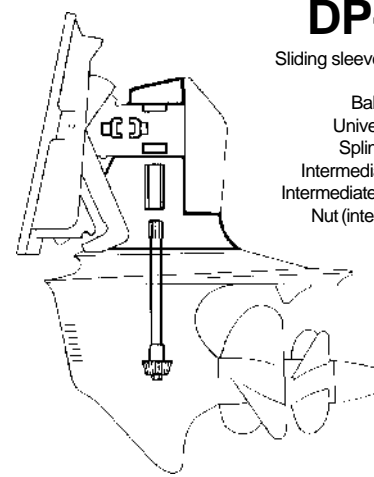


Top cover  
Shift cover

Oil: <sup>1)</sup>  
API GL-5, SAE 90  
Qty: 2.7 liters (2.85 qts)

Ratio:  
1.95:1  
2.30:1

### DP-A1

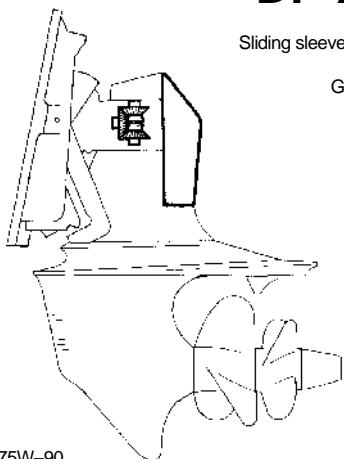


Sliding sleeve (brass)  
Cover  
Ball bearing  
Universal joint  
Spline sleeve  
Intermediate shaft  
Intermediate housing  
Nut (intermediate shaft)

Oil: <sup>1)</sup>  
API GL-5, SAE 90  
Qty: 2.7 liters (2.85 qts)

Ratio:  
1.78:1  
1.95:1  
2.30:1

### DP-A2

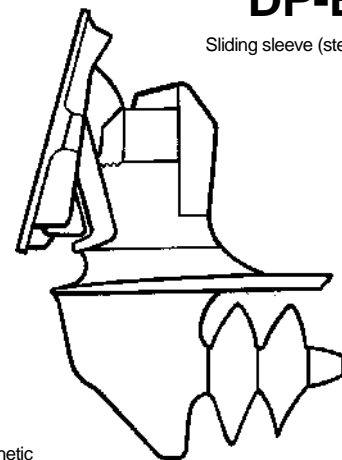


Sliding sleeve (steel)  
Cover  
Gear set

Oil:  
Fully synthetic  
API GL-5 SAE 75W-90  
Qty: 2.7 liters (2.85 qts)

Ratio:  
1.78:1  
1.95:1  
2.30:1

### DP-B



Sliding sleeve (steel)

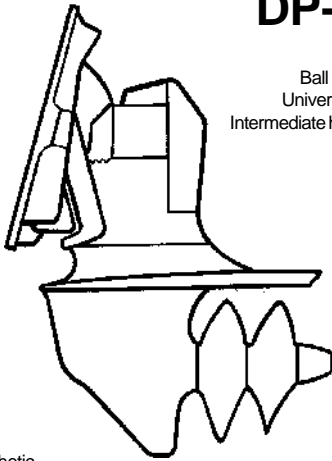
Oil:  
Fully synthetic  
API GL-5 SAE 75W-90  
Qty: 2.7 liters (2.85 qts)

Ratio:  
1.78:1  
1.95:1  
2.30:1

<sup>1)</sup> **NOTE!** If the drive was manufactured before 1986, for a 30- or 40-engine and has previously been operated with engine oil in the drive, then engine oil should also be used in the future.

### DP-B1

Cover  
Ball bearing  
Universal joint  
Intermediate housing

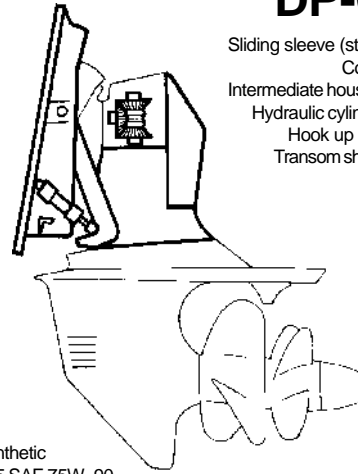


Oil:  
Fully synthetic  
API GL-5 SAE 75W-90  
Qty: 2.7 liters (2.85 qts)

Ratio:  
1.78:1  
1.95:1  
2.30:1

### DP-C

Sliding sleeve (steel)  
Cover  
Intermediate housing  
Hydraulic cylinder  
Hook up fork  
Transom shield

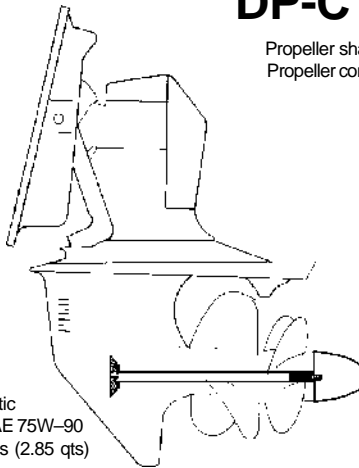


Oil:  
Fully synthetic  
API GL-5 SAE 75W-90  
Qty: 2.7 liters (2.85 qts)

Ratio:  
1.78:1  
1.95:1  
2.30:1

### DP-C1

Propeller shaft  
Propeller cone



Oil:  
Fully synthetic  
API GL-5 SAE 75W-90  
Qty: 2.7 liters (2.85 qts)

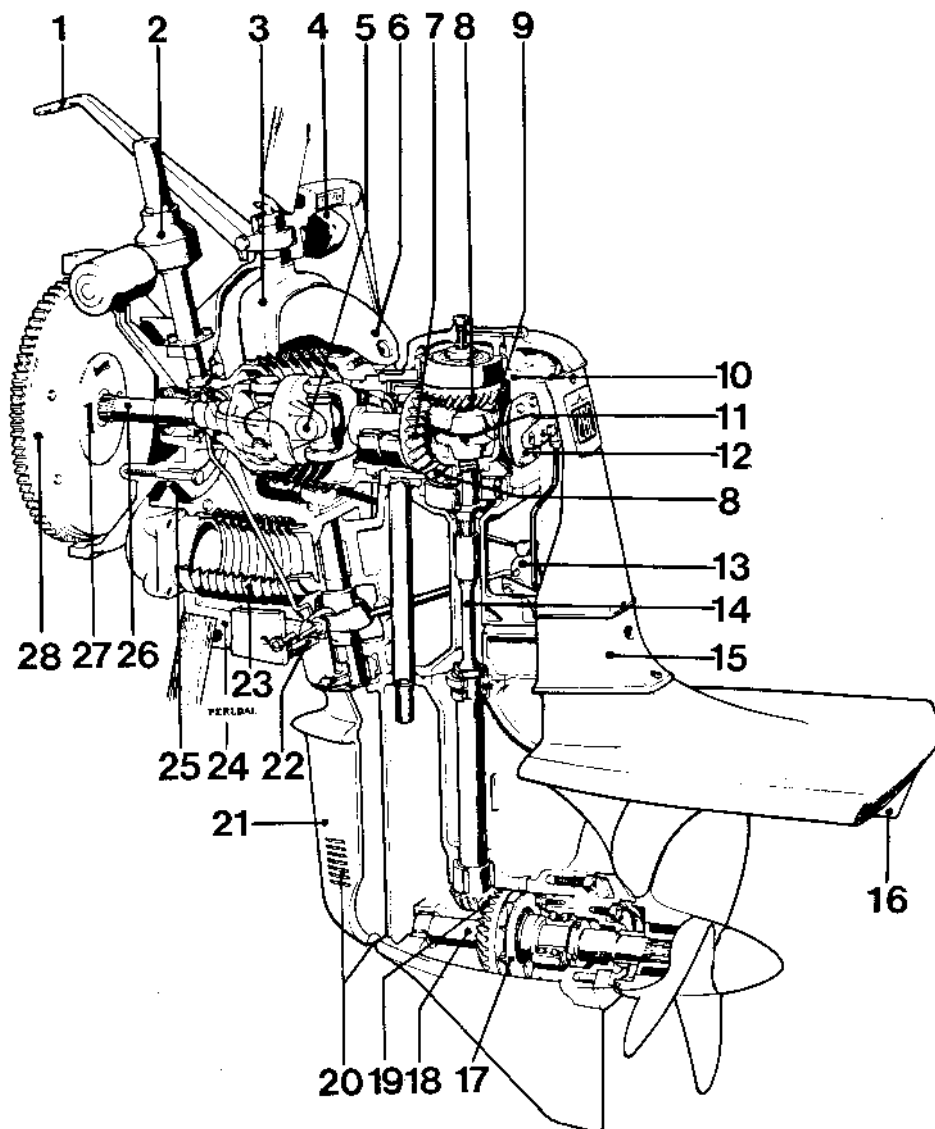
Ratio:  
1.78:1  
1.95:1  
2.30:1

# Design and function

## Model 280

### Section through the sterndrive

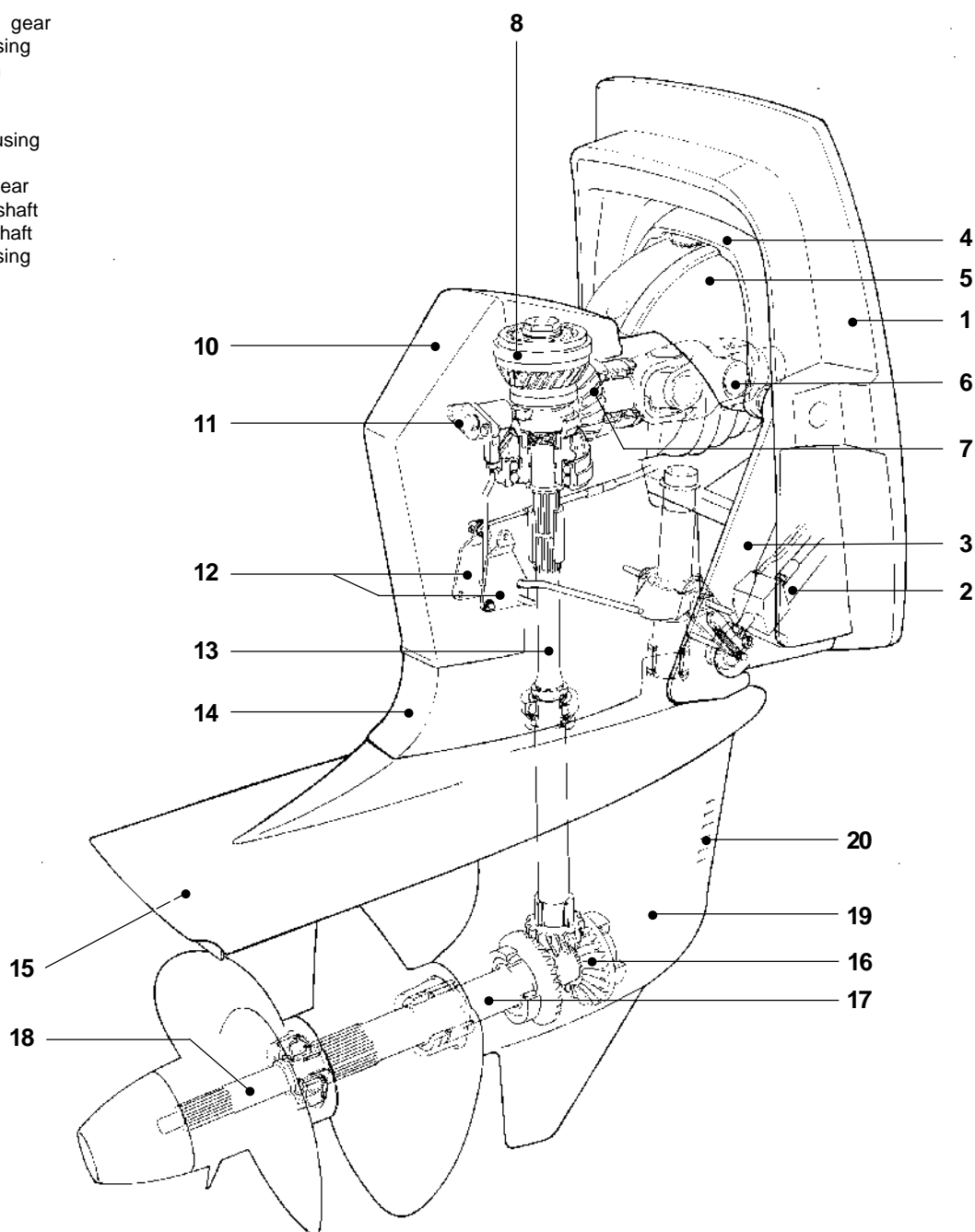
1. Steering arm
2. Electro-mechanical tilting device
3. Steering yoke
4. Rubber cushion
5. Universal joint
6. Steering helmet
7. Input gear
8. Forward/reverse gear
9. Forward/reverse cone
10. Upper gear housing
11. Coupling box
12. Shift mechanism
13. Shift plate
14. Vertical shaft
15. Intermediate housing
16. Trim tab
17. Circulation pump
18. Propeller shaft
19. Propeller shaft gear
20. Water intake
21. Lower gear housing
22. Retaining pawl
23. Exhaust bellows
24. Transom shield
25. Supporting rubber cushion
26. Drive shaft
27. Damper plate
28. Flywheel



## Models 290-DP, DP-A, DP-B, DP-C

Section through the sterndrive, showing model DP

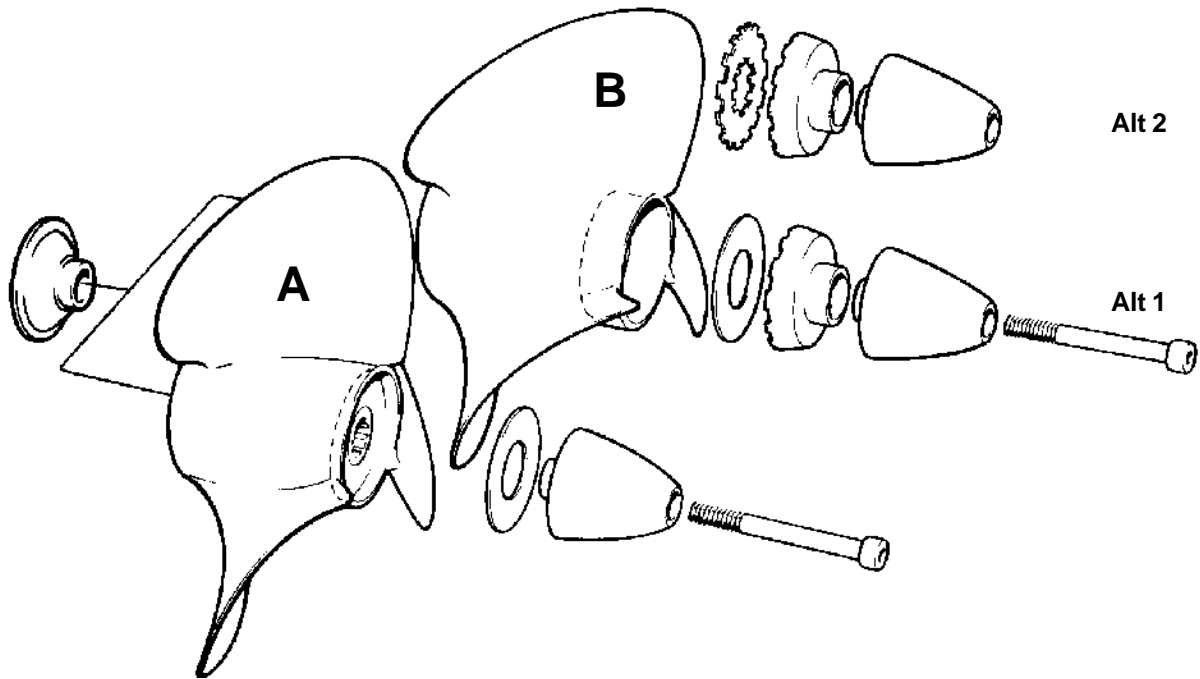
1. Transom shield
2. Trim cylinder
3. Hook up fork
4. Steering yoke
5. Steering helmet
6. Universal joint
7. Input gear
8. Forward/reverse gear
10. Upper gear housing
11. Shift mechanism
12. Shift plate
13. Vertical shaft
14. Intermediate housing
15. Trim tab
16. Propeller shaft gear
17. Outer propeller shaft
18. Inner propeller shaft
19. Lower gear housing
20. Water intake



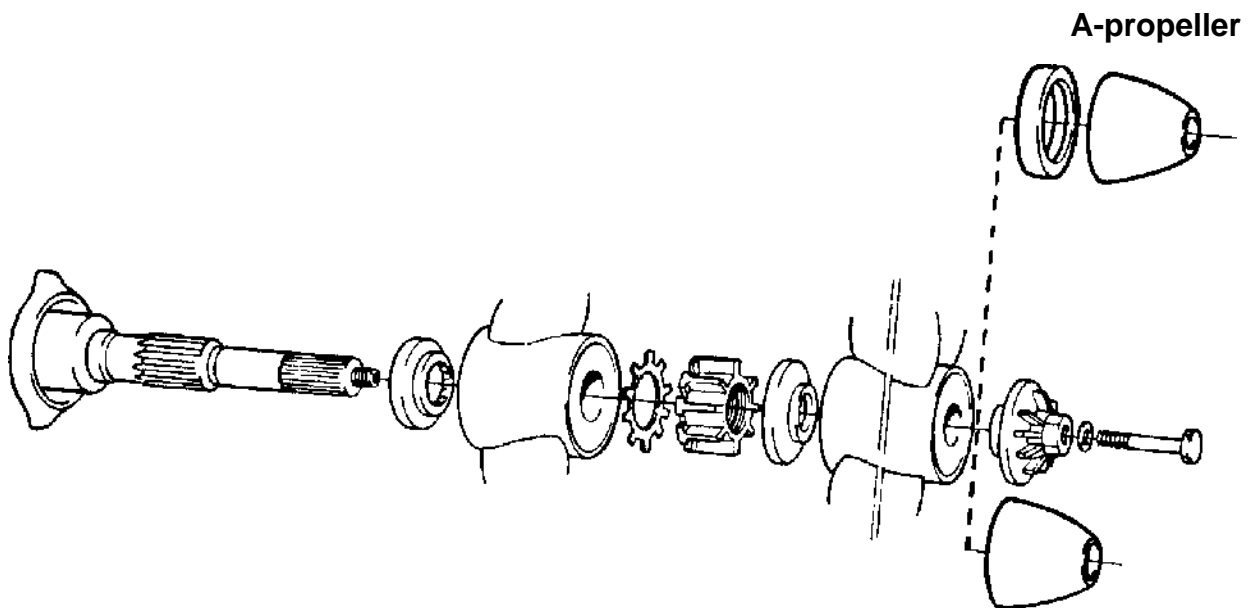
---

# Removing the sterndrive

## Models 280, 285 and 290



1. Remove the propeller of the Singleprop sterndrive according to the picture.

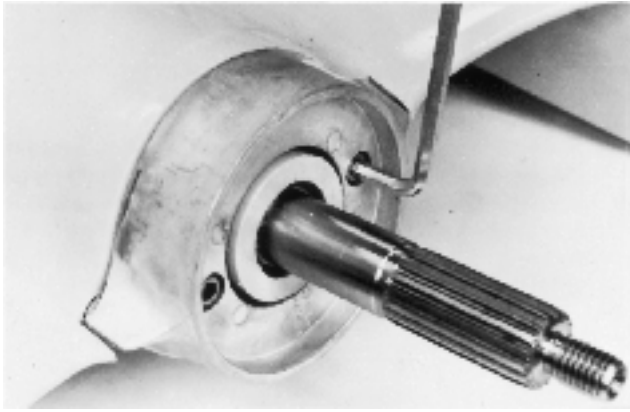


2. Remove the propellers of the Duoprop sterndrive according to the picture. (The picture shows the earlier model.)

**B-propeller**

**NOTE!** Never mix propellers from different drives.

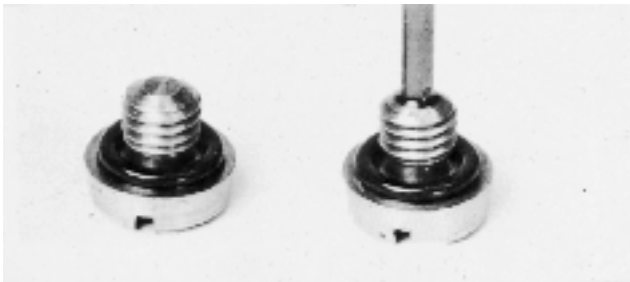




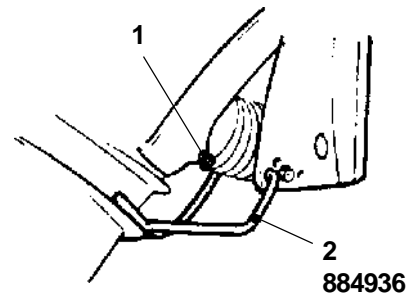
3. Remove the Allen-head bolts holding the zinc ring and remove it.



5b. Sterndrive model 290: Remove the cover over the shift mechanism and disconnect the shift cable from the shift plate and remove the swivel. Remove the screws holding the locking plate, then push the locking plate down.



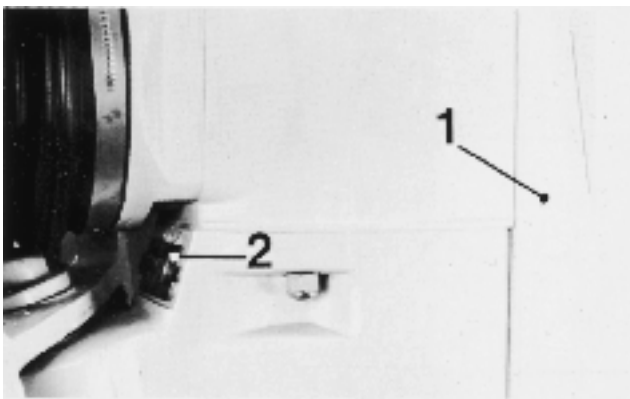
4. Remove the oil drain plug and drain off the oil. Also remove the oil dipstick to facilitate the oil drainage. Replace the O-ring on the drain plug and on the oil dipstick.



6a. Sterndrive models 280 and 285:

**⚠ IMPORTANT!** Carefully check the rubber bellows for possible damage and also check that the hose clamps are properly tightened.

**NOTE!** The universal joint bellows and its hose clamps should be replaced every other year. Contact an authorized service workshop and let them do the checking and replacing of the rubber bellows.



5a. Sterndrive models 280 and 285: Remove the cover (1) over the shift mechanism and disconnect the shift cable from the shift plate and remove the swivel. Then remove the shift cable locking plate (2).

**⚠ WARNING!** Never start working on the rubber bellows of the sterndrive until you have secured it in its raised position and then in a way which definitely keeps it up. A sterndrive 'falling' down can cause severe bodily injuries.

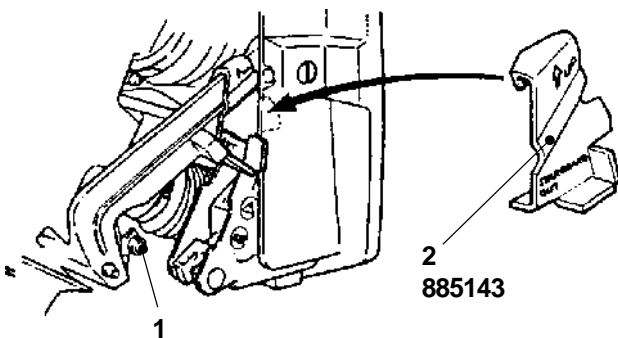
The suspension tool **884936**, when properly installed, prevents the sterndrive from 'falling' down. The suspension tool locks the sterndrive in its raised position. Install the suspension tool as follows:

Press the retaining pawl (1) by hand downwards and lift the sterndrive, also by hand, to its fully raised position. Hold the sterndrive in this position while installing the suspension tool (2) as indicated in the picture.

**NOTE!** Do not overload the suspension tool by for example standing on the raised sterndrive!

It is also possible to raise the sterndrive by operating the sterndrive tilting motor sufficiently to allow the disassembly and assembly respectively of the rubber bellows.

**NOTE!** Secure the sterndrive in its raised position to prevent it from 'falling' down!



#### 6b. Sterndrive models 290 and 290A:

**⚠ IMPORTANT!** Carefully check the rubber bellows for possible damage and also check that the hose clamps are properly tightened.

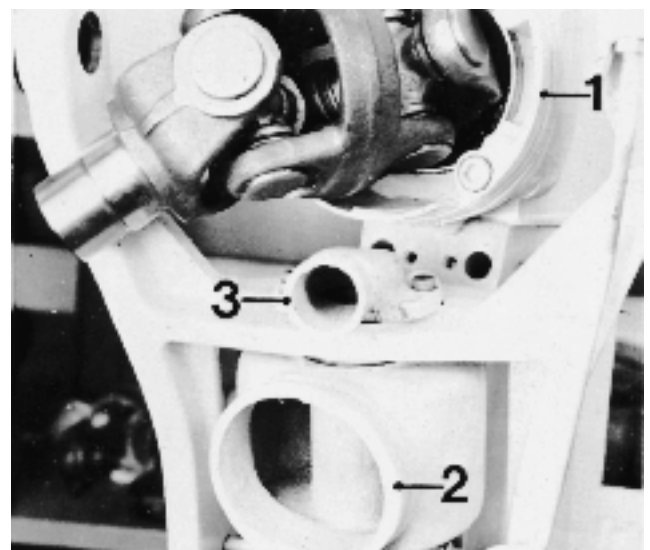
**NOTE!** The universal joint bellows and its hose clamps should be replaced every other year. Contact an authorized service workshop and let them do the checking and replacing of the rubber bellows.

**⚠ WARNING!** Never start working on the sterndrive rubber bellows or on the hydraulics until the sterndrive is securely locked in its raised position in a way that it cannot 'fall' down. A sterndrive 'falling' down can cause severe bodily injuries. The suspension tool when properly installed, prevents the sterndrive from 'falling' down.

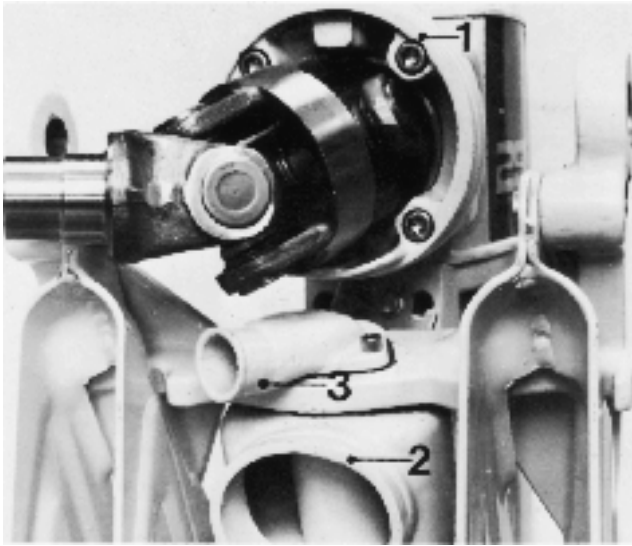
The suspension tool **885143** locks the sterndrive in its raised position. Install the suspension tool as follows:

Press the retaining pawl (1) by hand downwards and lift the sterndrive, also by hand, to its fully raised position. Hold the sterndrive in this position and install the suspension tool (2) on the starboard side in accordance with the picture.

**NOTE!** Do not overload the suspension tool by for example standing on the raised sterndrive!



**7a. Sterndrive models 280 and 285:** Remove the steering helmet and the universal joint rubber bellows from the upper gear housing (1), the exhaust bellows from the intermediary housing (2) and the cooling water hose from the cooling water connection (3). The universal joint rubber bellows must be replaced every other year.

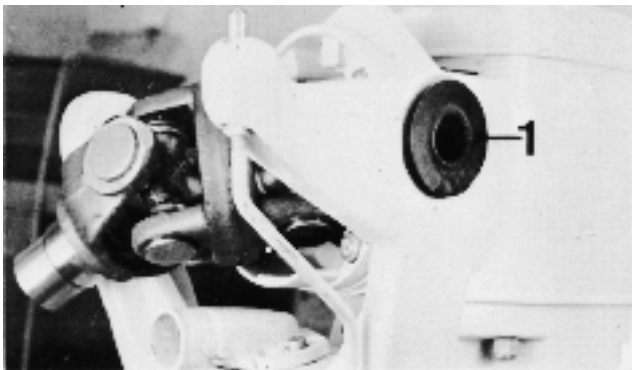


**7b. Sterndrive model 290:** Remove the steering helmet and the universal joint rubber bellows from the upper gear housing (1), the exhaust bellows from the intermediate housing (2) and the cooling water hose from the cooling water connection (3). The universal joint rubber bellows must be replaced every other year.



**8b. Sterndrive model 290:** Remove the two locking screws holding the shaft journals in the transom shield. Support the sterndrive from underneath and knock out the shaft journals using a brass drift or some similar tool. Lift off the sterndrive and place it in a suitable cradle.

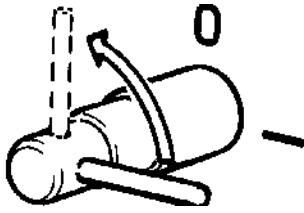
**NOTE!** Always replace the bushings (1).



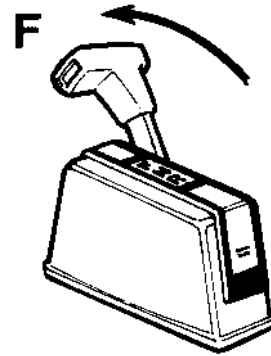
**8a. Sterndrive models 280 and 285:** Remove the two locking screws holding the shaft journals in the transom shield. Support the sterndrive from underneath and pull out the shaft journals, using special tool **884874**. A brass drift can also be used. Lift off the sterndrive and place it in a suitable cradle.

**NOTE!** Always replace the bushings (1).

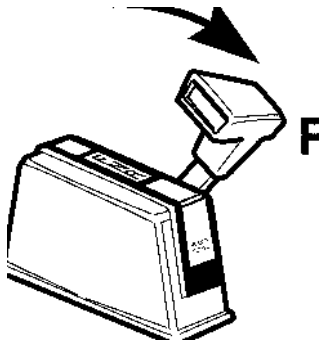
## Models SP and DP



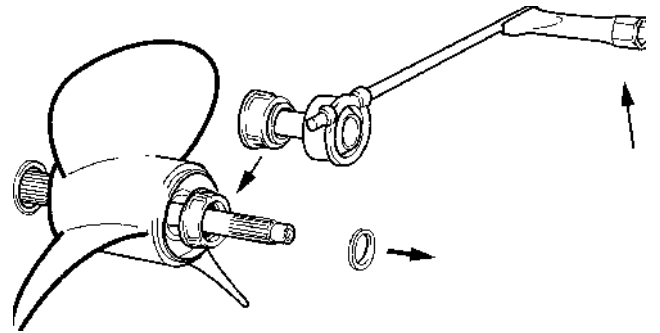
1. Disconnect power to prevent accidental starting.



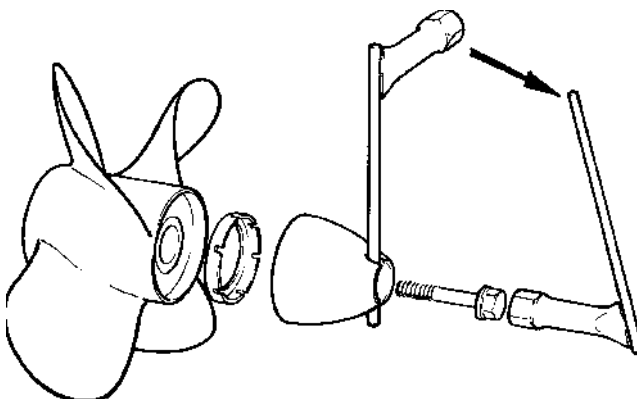
4. Move control to forward gear.



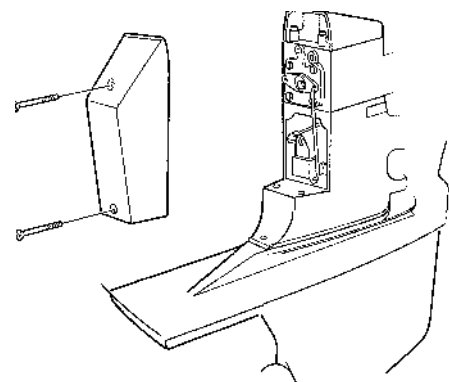
2. Move control to reverse.



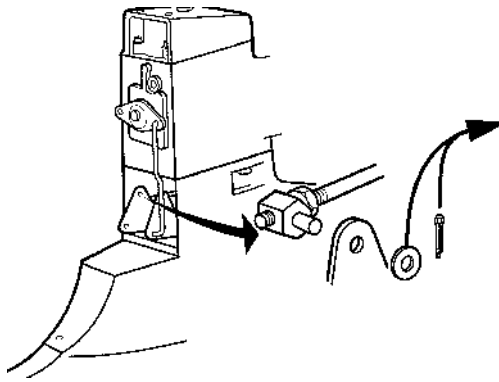
5. Remove the aft line cutter, forward propeller nut, and forward propeller. Return the shift control to neutral.



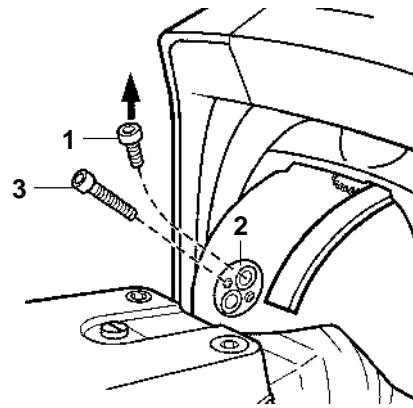
3. Loosen propeller cone lock bolt.  
Remove the aft propeller cone.



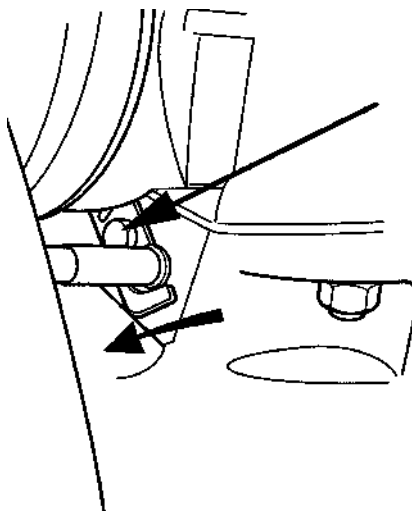
6. Remove the shift linkage cover.



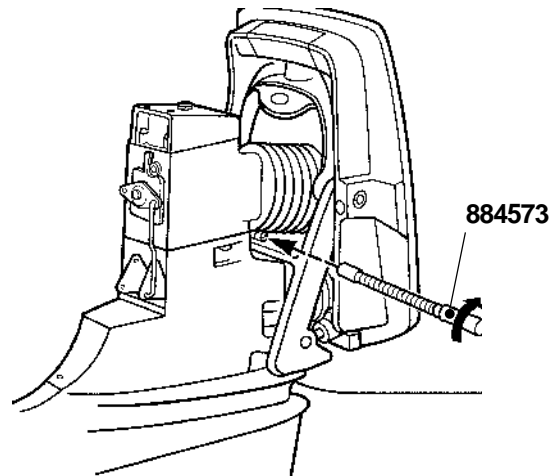
7. Remove the cotter pin and washer from the shift cable end. Remove the end pivot pin from the cable.



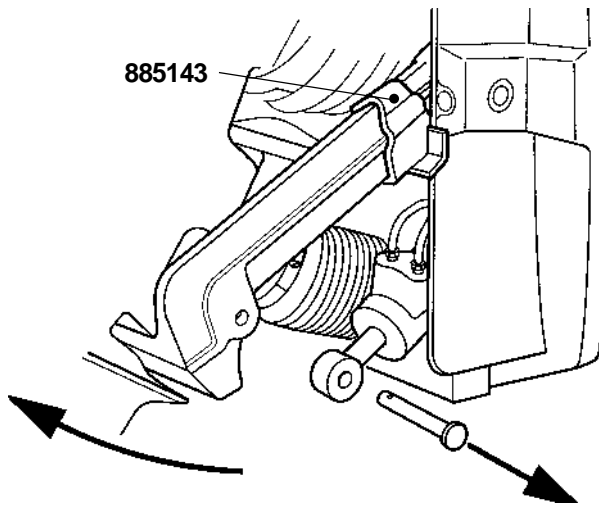
9. Remove the two screws (1) holding the steering pin to the upper gear head (2). Using two M6 screws (3) 30 mm or longer, install into the threaded holes of the steering pin. As the screws are turned in, the steering pin will be forced out of the steering pin socket and steering helmet bushing.



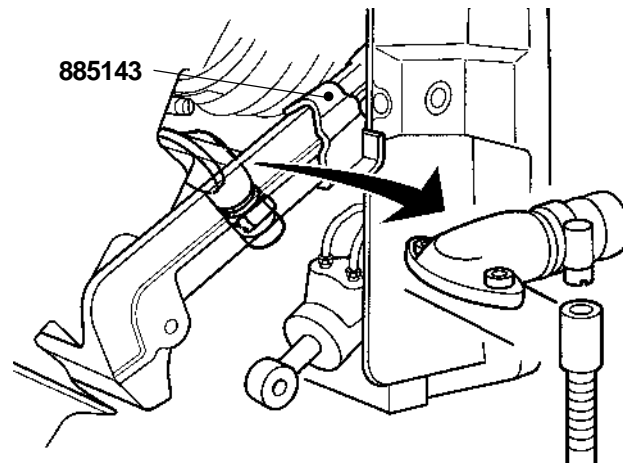
8. Loosen screw holding the shift cable clamp and release shift cable.



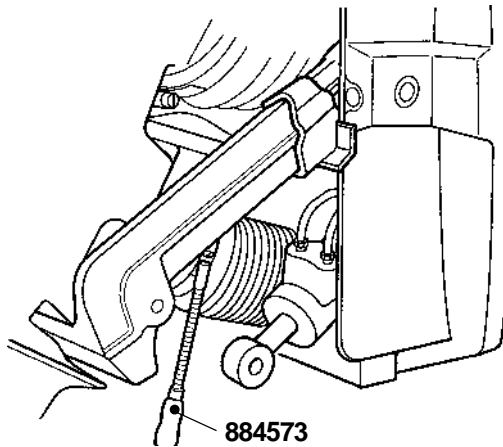
10. Using special tool **884573**, remove the clamp around the u-joint bellows.



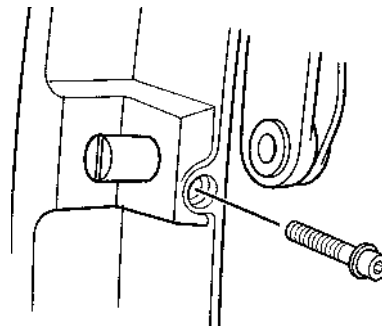
11. Remove the cotter pin on the trim cylinder pin. Remove the trim cylinder pin. Raise the drive manually and insert special tool **885143**.



13. Remove the clamp on the raw water hose. Remove the raw water hose. Remove special tool **885143** and carefully lower the drive.

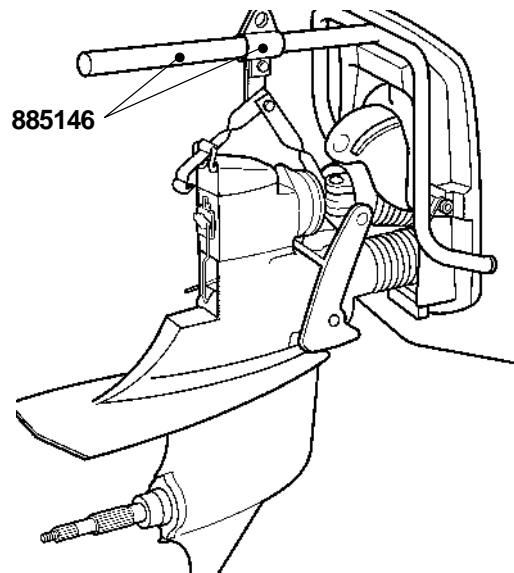


12. Using special tool **884573**, disconnect the exhaust bellows.



14. Remove the hook-up fork pin lock bolt. Using Pin removal tool **885148**, pull the pin half way out of the transom shield.

**⚠ WARNING!** Do not remove the pins completely, the sterndrive will fall off the boat.



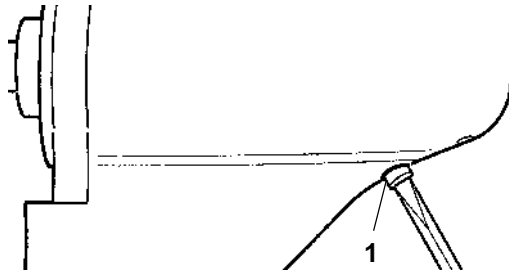
**15.** Install special tool **885146** and remove the stern-drive from the transom shield.

---

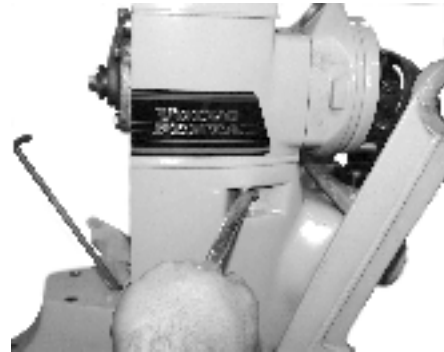
# ***Repair instructions***

## ***Upper gear housing***

### **Removal**



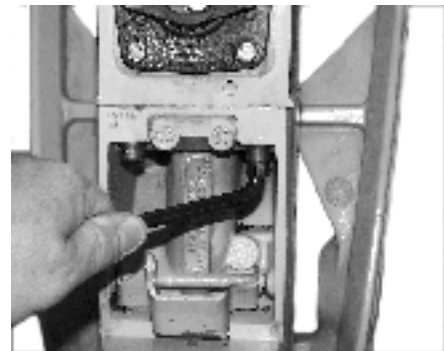
**1.** Place a drain pan under the sterndrive. Remove the drain plug (1) and drain oil from drive. Reinstall the drain plug after the oil has drained.



**3.** Remove two retaining nuts from upper gear head studs.



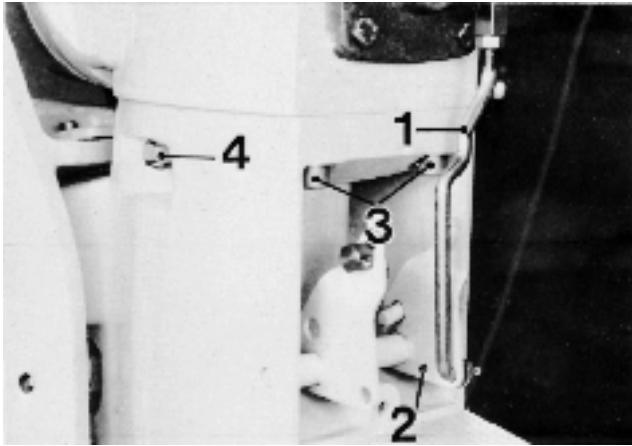
**2.** Remove cotter pin and washer from gear shift linkage, and remove the linkage.



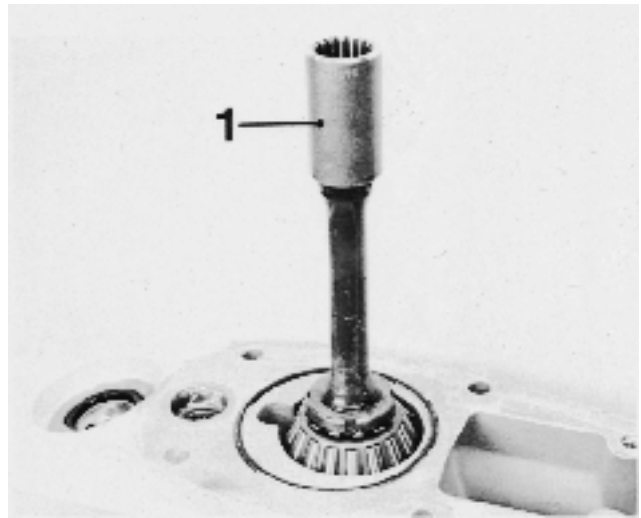
**4.** Remove two allen head retaining bolts. Remove the gear head.



## Disassembly, models 280, 285 and 290

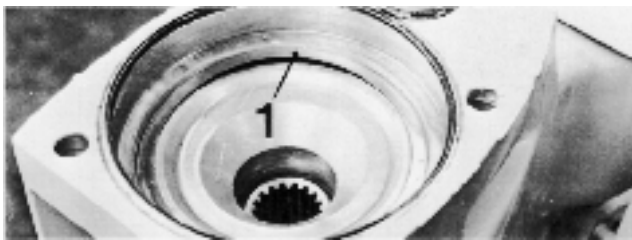


1. Remove the shift rod (1) from the shift plate (2). Remove the screws (3) and the nuts (4) holding the intermediate housing to the upper housing. Use a rubber mallet to knock the housings apart. Knock carefully.

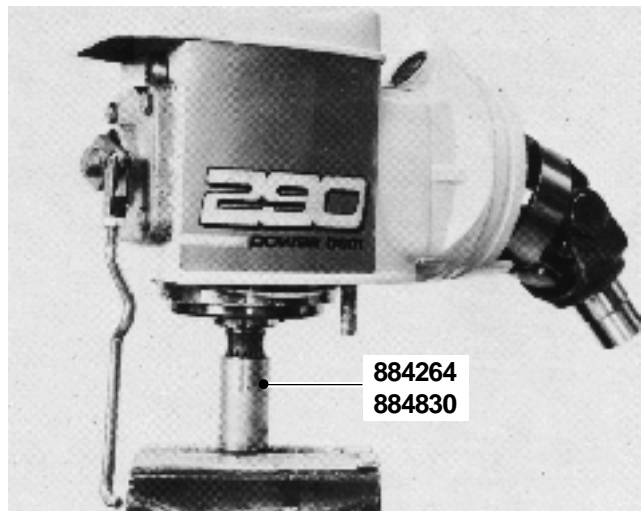


3. Remove the 7 screws holding the lower gear housing to the intermediate housing. Use a rubber mallet and knock the housings carefully apart. Lift off the splines sleeve (1).

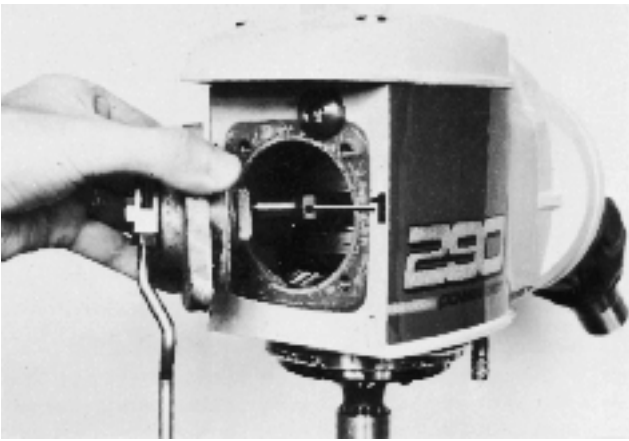
**NOTE!** On sterndrives of later manufacture the 4 bigger-sized screws are installed with stainless steel washers. Take care of these washers.



2. Keep check on the number of shims (1) between the different housings and for all the gear sets in case neither the gears, housing nor the bearings need to be replaced. In this case the same shim thickness is to be used.

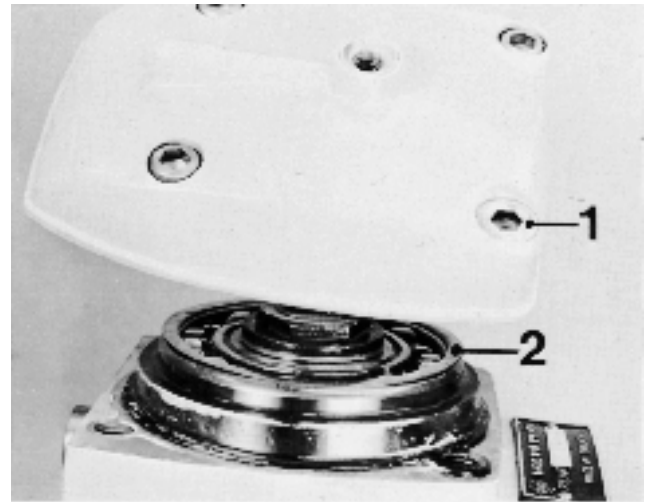


4. Install the upper gear housing in the special tool **884264**. This tool, of later manufacture, carries the part number **884830**.



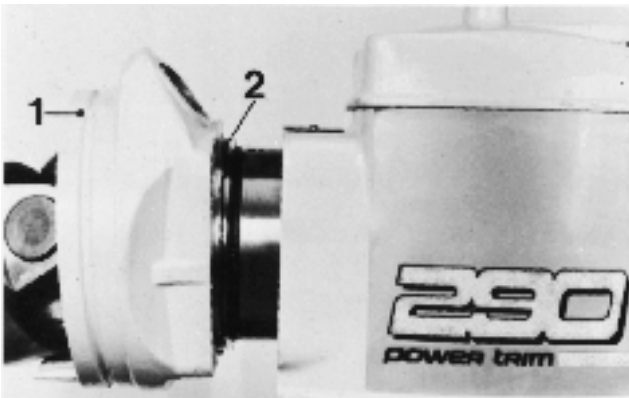
5. Remove the 4 screws holding the shift mechanism and remove the mechanism.

**NOTE!** Be sure to remove the shift shoe (1) with the shift mechanism.



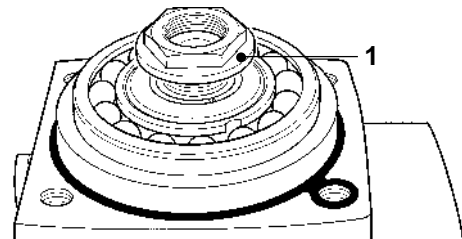
7. Remove the 4 screws holding the gear housing cover and remove the cover.

**NOTE!** The front right hand screw (1) is a hollow screw with an O-ring seal. Take care of the shims (2).

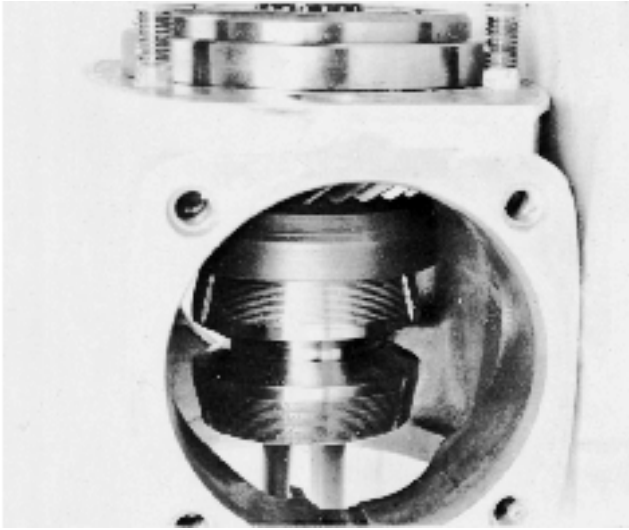


6. Remove the 4 Allen-head screws holding the clamping ring (1) and pull out the universal joint and the double bearing box.

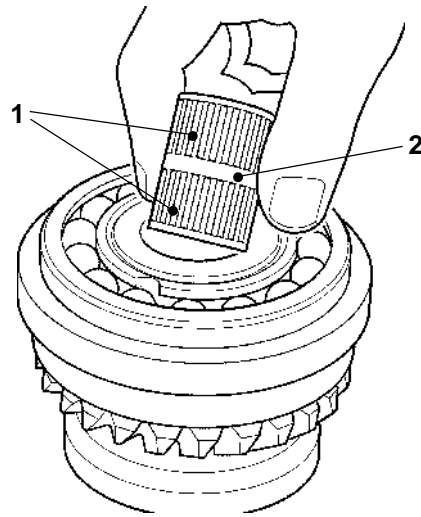
**NOTE!** Take care of the shims (2).



8. Remove the left hand threaded nut (1) on the vertical shaft. Use special tool **884830** as a counter-hold on the splines shaft when removing the nut.

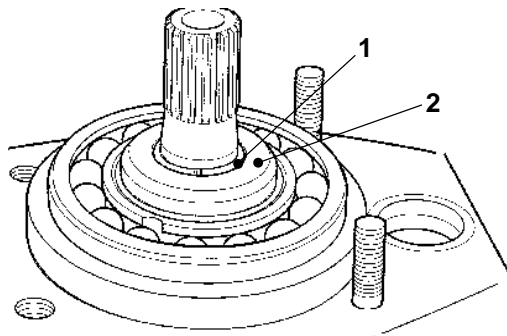


9. Lift out the upper gear and the bearing box as well as the engagement sleeve.



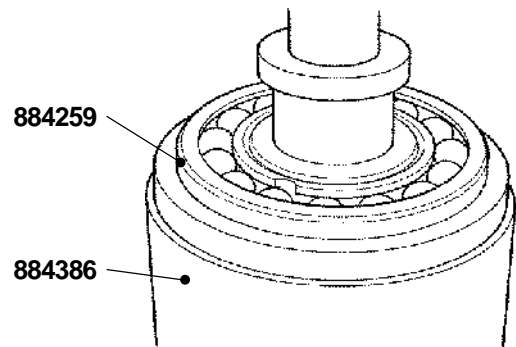
11. Remove the needle bearings (1) and the spacer rings (2) from the upper and lower gear sets.

**NOTE!** The needle bearings are matched in pairs and must not be mixed!

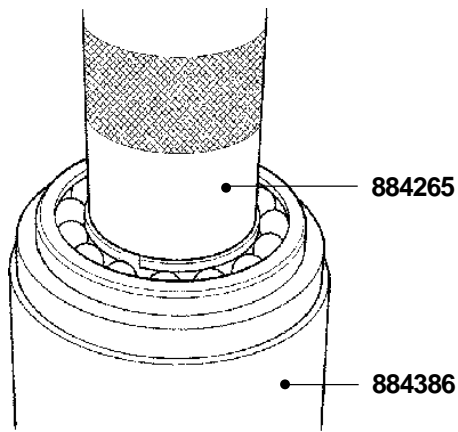


10. Lift off the upper gear housing from the special tool. Dismantle the lower gear set and the shaft by removing the split locking ring (1) and the washer (2). Mark the gears to ensure the same location when assembling.

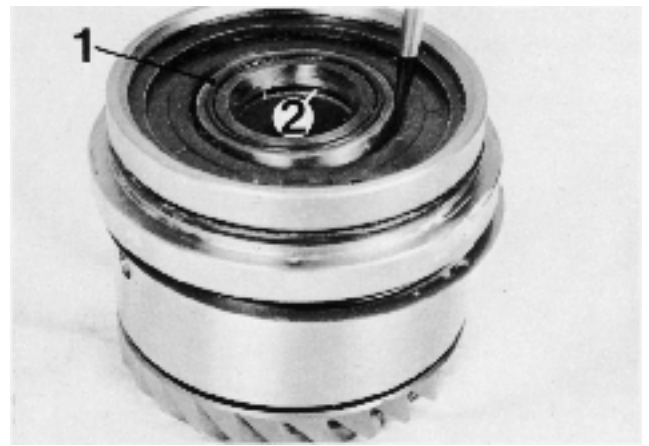
**NOTE!** Handle the engagement sleeve and gear wheel cones with utmost care to avoid scratching them.



12. Remove by pressing out the upper and lower of the bearing sleeves. Use special tools **884386** and **884259**.



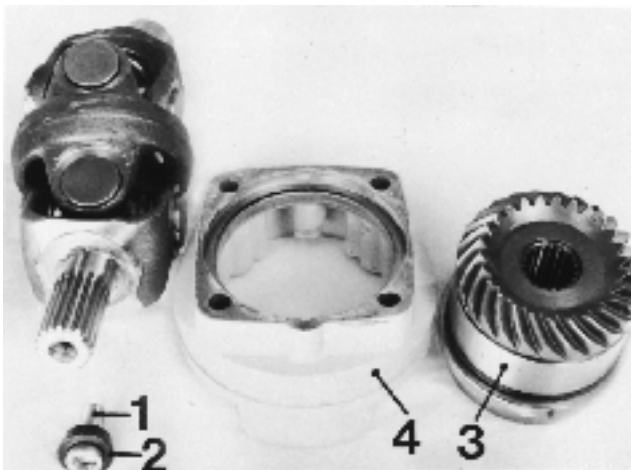
13. Press out the bearings of the bearing sleeves. Use special tools **884386** and **884265**.



15. Remove the collar washer (1) from the double bearing box.

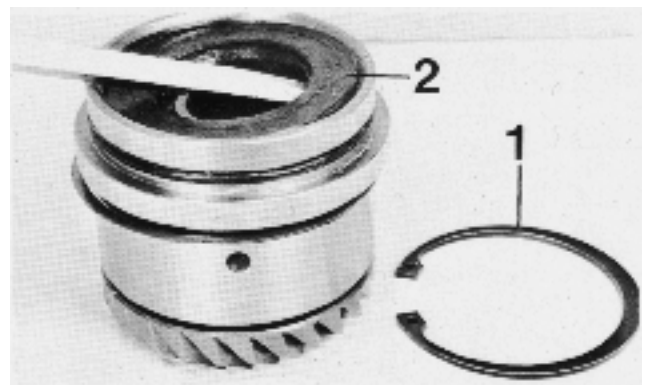
**NOTE!** Take care of the shims (2).

### Input gear (Double bearing box)



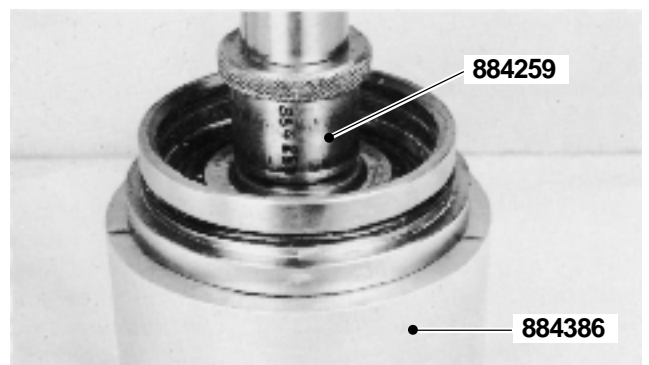
14. Remove the Allen-head screw (1) and the collar washer (2) in the center of the universal joint shaft. Pull out the universal joint and push out the double bearing box (3) from the clamping ring (4). Use a rubber mallet if necessary.

**NOTE!** Do not damage or lose the shims!

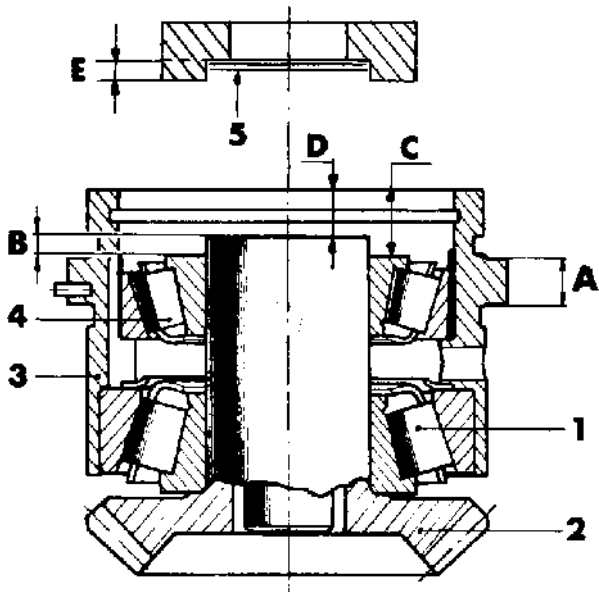


16. Remove the locking ring (1) and the sealing (2).

**NOTE!** Always replace the sealing!



17. Press out the input gear. Use special tools **884386** and **884259**.



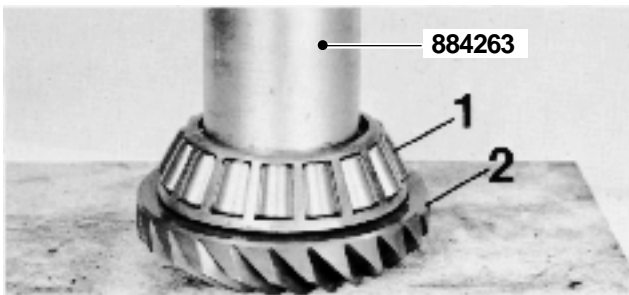
**18.** If required press off the roller bearing (1) from the gear using a knife puller. The bearings (1) and (4) can be changed separately. When changing the outer races of the bearings, these must be "knocked" off. Knock evenly all around. Always replace the oil deflector washer together with the outer races.

Wash the parts and check for wear. Replace parts when necessary.

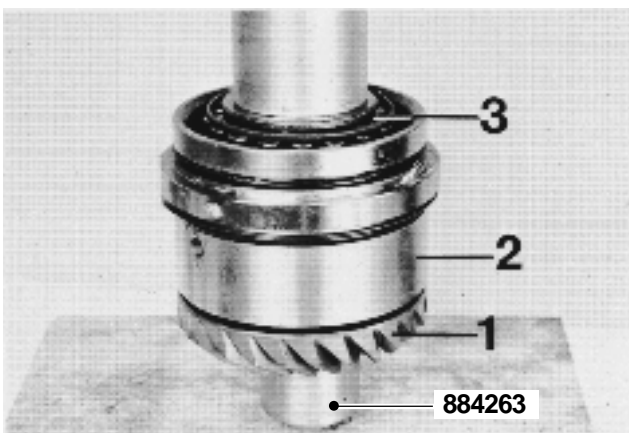
**NOTE!** Gears with cones are sold in sets in order to obtain the correct gear contact.

## Assembly, models 280, 285 and 290

**NOTE!** When assembling the upper gear housing it is very important that the gears are correctly positioned in relation to each other. This applies not only to the backlash between the gear teeth but also to the gear teeth contact. Correct gear teeth contact spreads the load to which the gears are subjected over a larger area of the gear tooth. This preventing gear break-down and abnormal wear and at the same time providing a quiet operation.

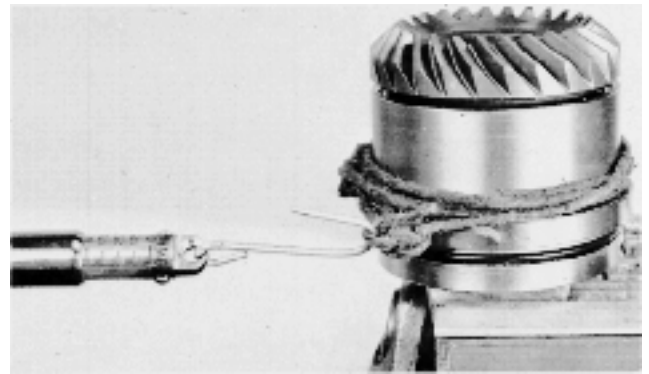


1. Press the larger roller bearing (1) onto the gear (2). Use special tool **884263**.



2. Install the input gear (1) in the double bearing box (2) and press on the smaller roller bearing (3) in a way that a slight prestressing is obtained. Use special tool **884263**.

**NOTE!** Protect the tips of the gear teeth.

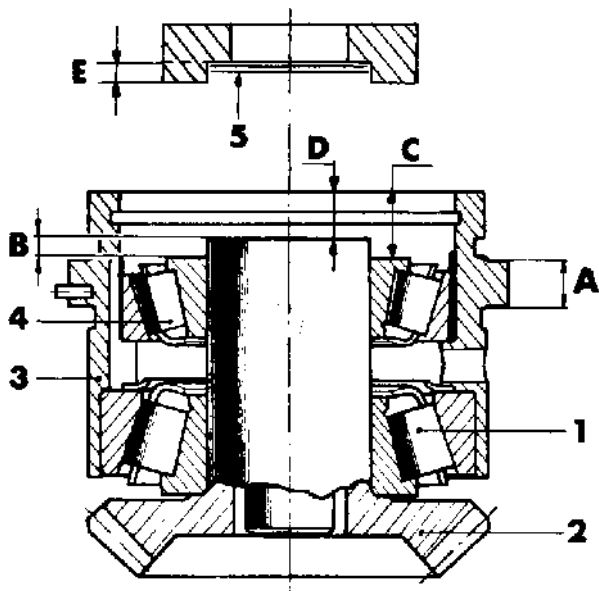


3. Rotate the bearings a couple of turns to allow them to "set". Check the prestressing with a spring scale and a piece of string, tied around the bearing housing. The prestressing should be **5–10 Nm (3.69–7.38 lb.ft.)**. Should the prestressing be too low, press the roller bearing carefully a bit harder and if the prestressing is too high, release the roller bearing somewhat.

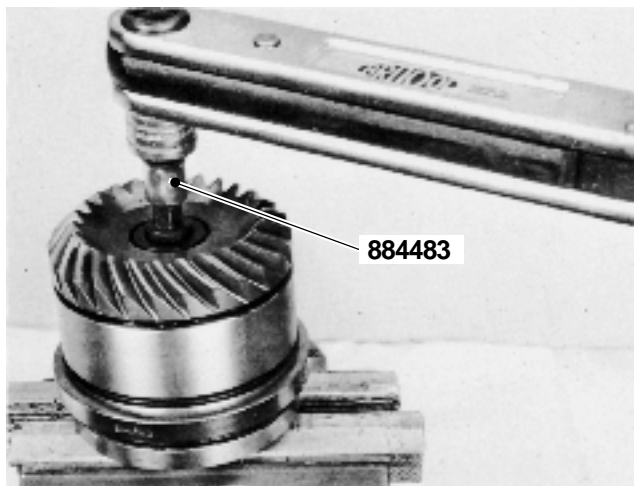
**NOTE!** With run-in bearings the prestressing should be **2.5–5 Nm (1.84–3.69 lb.ft.)**.



4. Determine the measurement "B" (fig. under point 5) as follows: Use a depth micrometer and read the measurement "C" between the edge of the double bearing box and the inner ring of the bearing and measurement "D" between the edge of the double bearing box and the edge of the gear. Then calculate the difference.



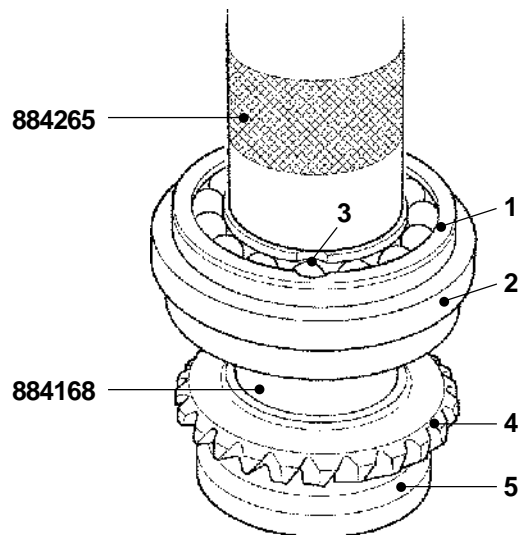
5. Measure the depth of the recess in the collar washer "E" and add to this measurement a number of shims (5) that the measurement "B" is obtained.



6. Place the collar washer in position and tighten the double bearing box. Use special tool **884483** and the universal joint screw.

**NOTE!** Coat the screw with Loctite locking fluid or its equivalent. The tightening torque should be **75 Nm (55 lb.ft.)**. Rotate the double bearing box a few turns and check once more the prestressing (**5–11 Nm, 3.69–8.11 lb.ft.**). Should the prestressing be too high, remove the recessed washer and press back the gear wheel somewhat. Then add more shims underneath the recessed washer. On the other hand should the prestressing be too low, reduce the number of shims. Then tighten the double bearing box again with the screw and the special tool **884483** and check the prestressing.

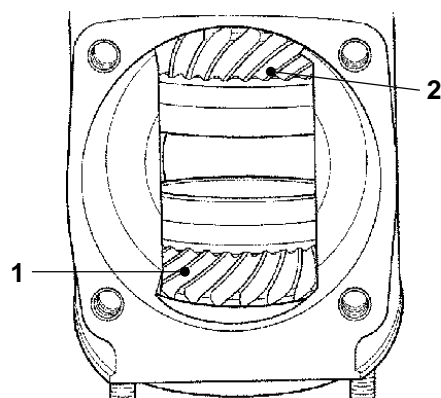
## Forward and reverse gears



7. Lubricate the bearings (1) and press the bearings into their respective bearing boxes (2).

**NOTE!** Turn the bearings with the recesses in the bearing races (3), for the assembly of the balls, facing away from the gear wheels. Use special tool **884168**. Then press on the bearings and the bearing boxes onto the gear wheels (4). Use special tool **884265**.

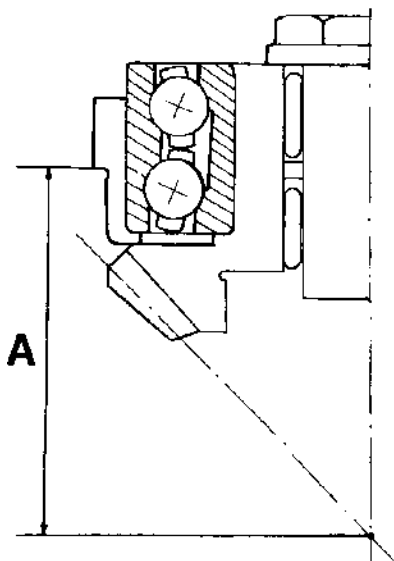
**NOTE!** Protect the gear cup (5) during the compression to avoid that it is being deformed.



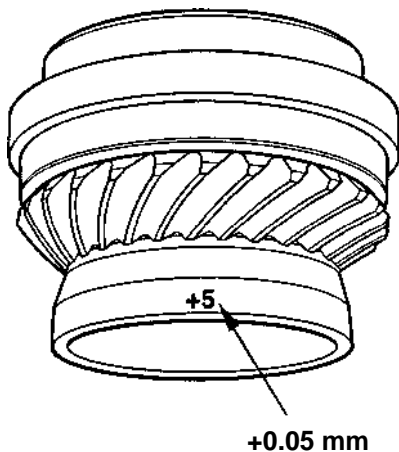
8. Always start by adjusting the forward gear. If the previously dismantled gears are to be used, it is important not to mix forward and reverse gears with each other when assembling. On sterndrives having left hand rotating propeller as standard, the lower gear is the 'forward' gear (1). Sterndrives having right hand rotating propeller as standard, the upper gear is the 'forward' gear (2).

## Shimming the forward and reverse gears

### Method 1

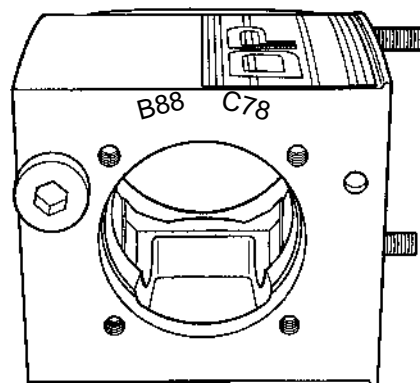


9. Measurement "A" is fixed at 62.05 mm (2.443").



10. Add or subtract the plus or minus marking (1) of the gear.

**NOTE!** a + 5 marking = +0.05 mm (0.002").



11. Only the decimal values of the "B" and "C" dimensions are stamped into the upper gear housing. The nominal value for both "B" and "C" is 61.00 mm (2.40"). Add this value to the value stamped into the gear to calculate shims for the forward and reverse gears.

The shim calculations can be seen in the example below:

Measurement "A":	62.05 mm	(Fixed Dimension)
	+ 0.05 mm	(Gear Etching <sup>1)</sup> )
	<u>62.10 mm</u>	
"C" Stamping:	- 61.78 mm	(Stamped <sup>2)</sup> )
	<u>0.32 mm</u>	<b>(0.013")</b>

The shim thickness for the forward gear is 0.32 mm (0.013").

The shim thickness for the reverse gear is calculated the same way, only using the "B" stamping.

<sup>1)</sup> Only +5 is etched.

<sup>2)</sup> Only 88 (B) respectively 78 (C) is stamped.



**NOTE!** When calculating the shim thickness for the forward and reverse gears, remember:

**The upper gear housing nominal dimension has two values.**

If the stamped number is **50 or more**, use the lower nominal value, 61.00 mm.

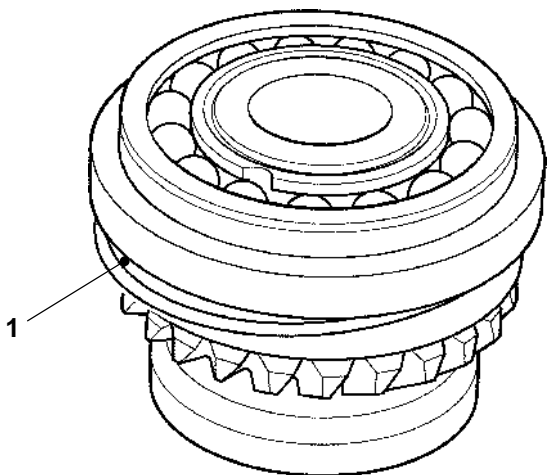
If the stamped number is **49 or less**, use the higher nominal value, 62.00 mm.

**Example:**                      **Stamping 50 or more**  
"C" stamping: 78            = 00.78 mm  
Use Nominal Dimension = 61.00 mm  
   61.78 mm

**Example:**                      **Stamping 49 or less**  
"C" stamping: 43            = 00.43 mm  
Use Nominal Dimension = 62.00 mm  
   62.43 mm

Then follow the procedure in chapter **Checking the gear backlash and contact pattern.**

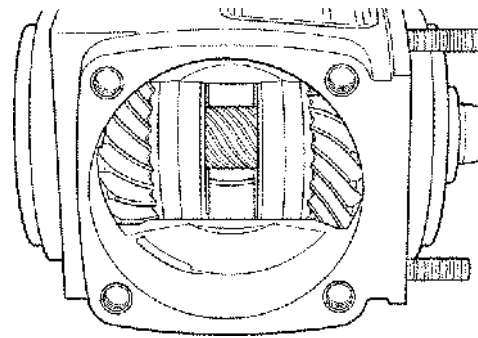
### Method 2



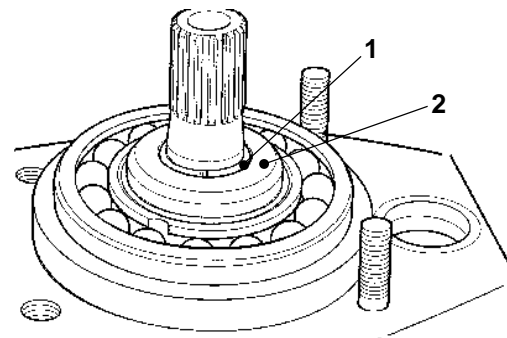
**12.** Insert a 0.2 mm (0.008") shim (1) under both forward and reverse gears as a starting point. The shim value is a number derived from experience.

Then follow the procedure in chapter **Checking the gear backlash and contact pattern.**

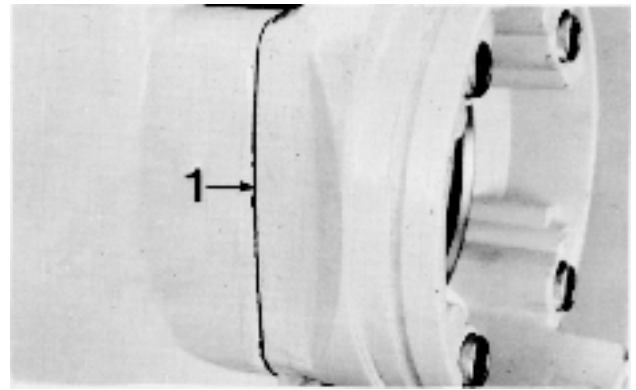
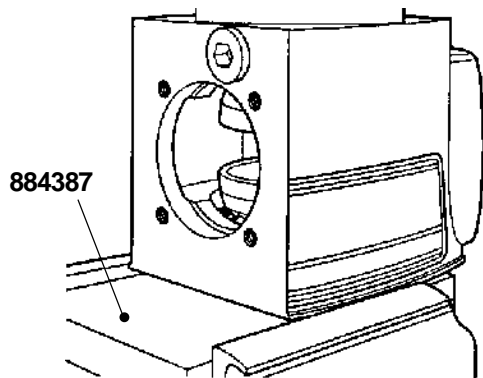
## Checking the gear backlash and contact pattern



**13.** Install the forward gear with the calculated shims into the gear housing. Insert the needle bearings and the vertical shaft. Install reverse gear into the gear housing using the needle bearings as a guide.

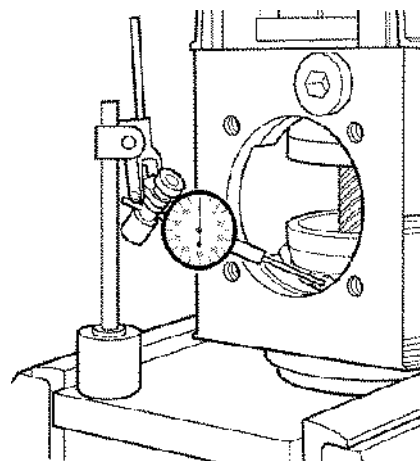
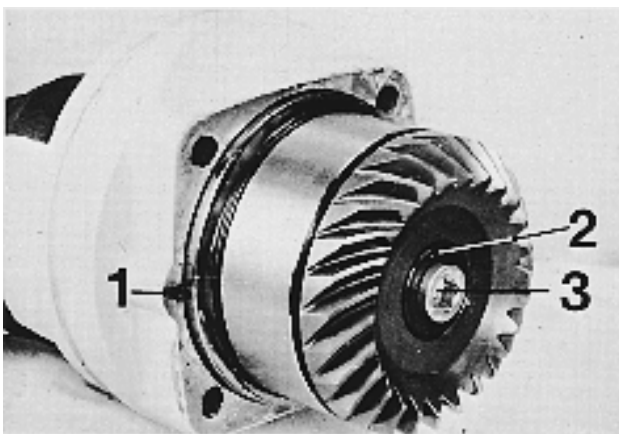


**14.** Install the washer (2) and the split locking ring (1) and tighten the nut at the opposite end of the vertical shaft.



15. Brace the special tool **884387** in a vice and install the gear housing in the tool.

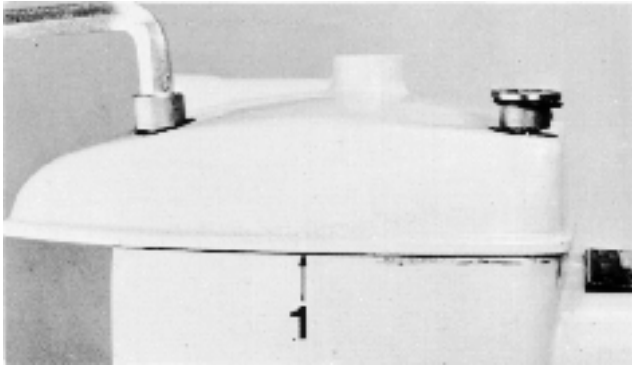
17. Install the clamp ring and the cover with sufficient number of shims to ensure a proper compression of the bearings. There must be a clearance (1) between the housing and the clamp ring. See also the picture under point 19.



16. Install the preassembled double bearing box with 0.4 mm (0.016") shims.

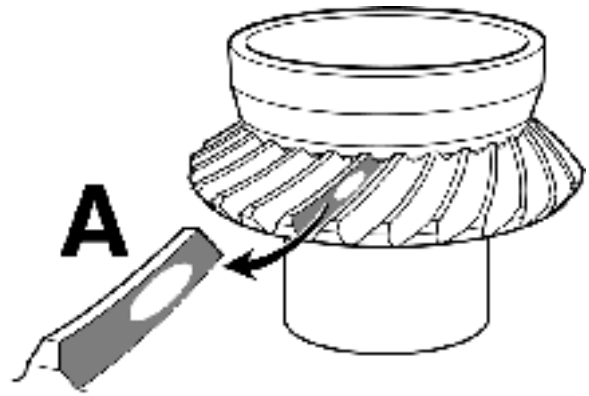
**NOTE!** The guide pin (1) in the double bearing box must be turned to face downwards and pressed into the corresponding groove in the clamp ring. Special tool **884483** is still being used.

18. Install a dial indicator to measure backlash. The correct backlash should be **0.15–0.25 mm (0.006–0.010")**. Should the backlash be too small, more shims must be added between the double bearing box and the gear housing. If the backlash is excessive, shims must be removed. A shim thickness of 0.10 mm (0.004") is a safe adjustment value.

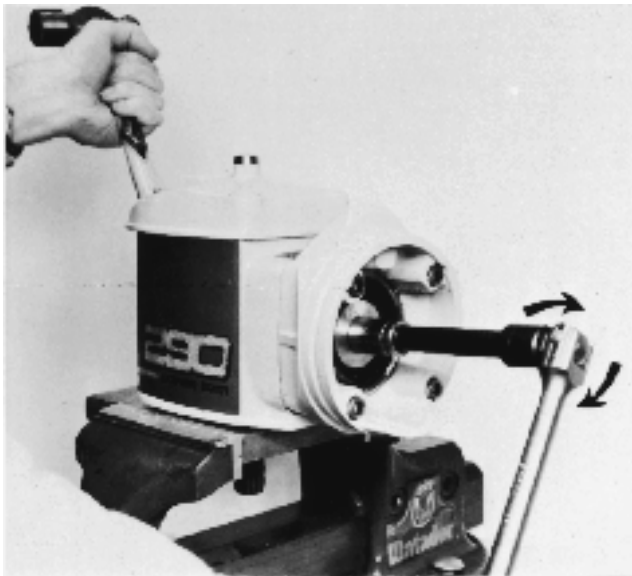


19. When the correct backlash has been obtained, dismantle the double bearing box and the clamp ring. In order to obtain a clear picture of the contact pattern, the gear teeth are coated with a thin coating of marking dye. Once again assemble the double bearing box and the clamp ring.

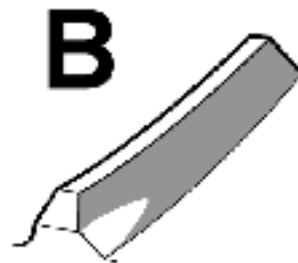
**NOTE!** The cover must still be installed with an excess number of shims (1).



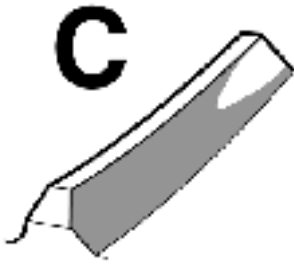
21. Dismantle the gear set and compare the contact pattern to that of the picture "A". This picture shows the desired pattern for the drive side of the forward and reverse gear. The drive side is the convex side of the gear. The dye pattern should be nearly oval in form and be positioned half way up on the gear tooth. It should be displaced towards the small end of the tooth (towards the gear cup) but not running off the end of the tooth.



20. Rotate the gear in the correct direction of rotation (clockwise) while at the same time braking the gear forcefully by wedging a wooden brace against the gear cone. The marking dye is then pressed away from the contact surface thus giving a picture of the width and location of the teeth contact.



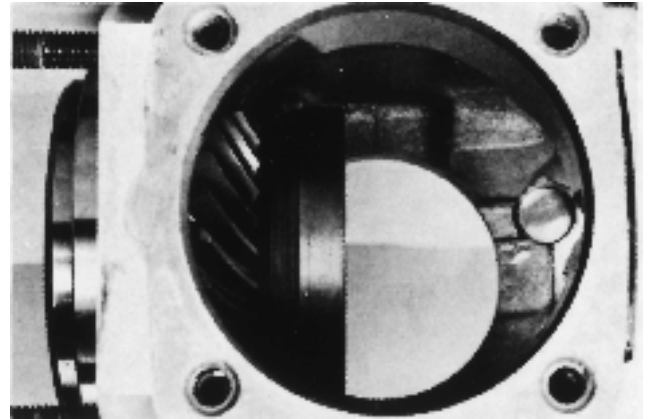
22. If the dye pattern reflects a contact pattern as shown in picture "B" the shim thickness underneath the drive gear (double bearing box) must be reduced. The drive gear then moves towards the driven gears. The driven gears must then be shimmed out the same amount to maintain the correct backlash.



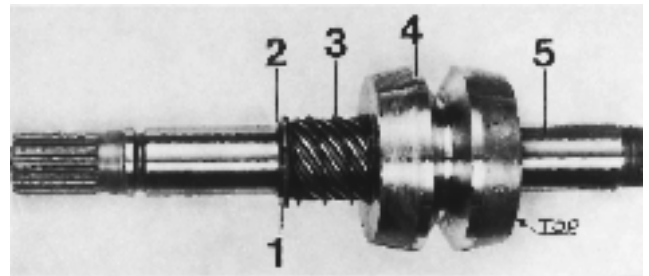
23. If the dye pattern reflects a contact pattern as shown in picture "C" the shim thickness underneath the drive gear (double bearing box) must be increased. The drive then moves away from the center.

**NOTE!** If the drive is moved in or out respectively, also the gears must be moved in or out in order to maintain the correct backlash. Having obtained the correct backlash and dye pattern, the upper gear must be dismantled and the marking dye removed. All bearings and screws must be lubricated prior to assembly, which is carried out after the reconditioning of the universal joint.

## Final assembly

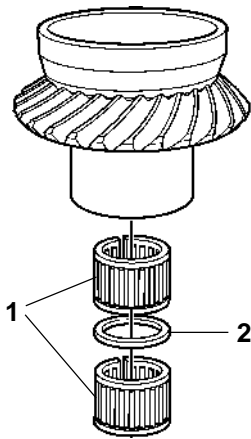


1. Install the lower gear along with the calculated number of shims.



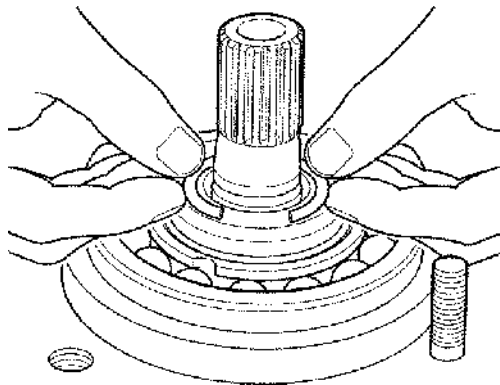
2. Install the washer (1), the locking ring (2), the spring (3) and the engagement sleeve (4) onto the shaft (5).

**NOTE!** The end of the engagement sleeve marked 'TOP' must be facing upwards on the shaft. On earlier models there is a drilled recess, which must be turned upwards. The engagement sleeve must rest lightly on the spring. Feel by hand to make certain.



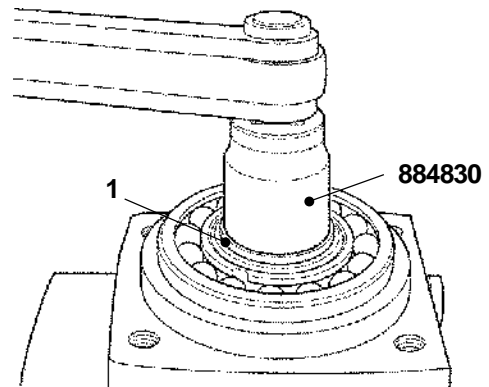
3. Install the needle bearings (1) and the spacer ring (2) between the bearings in the lower gear and insert the shaft in the gear.

**NOTE!** The needle bearings are matched in pairs and must not be mixed up.



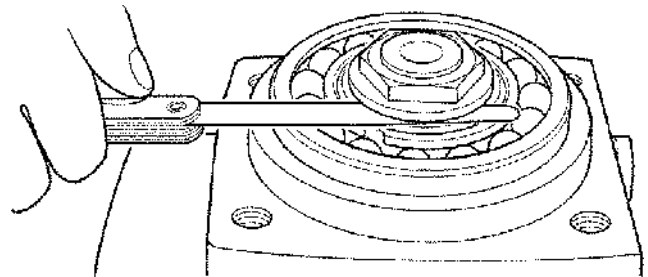
4. Install the upper gear wheel with its calculated number of shims in the gear housing. Install the needle bearings with the spacer ring in between and the lower locking ring on the shaft.

**NOTE!** Carefully inspect the condition of the brass washer and replace if necessary.



5. In order to obtain the correct axial shaft clearance there are 3 left hand threaded nuts (1) with different steps available. Select a nut and tighten it (tightening torque: **120 Nm (88.5 lb.ft.)**). Use special tool **884830** as a counter hold.

**NOTE!** Lubricate the treads to prevent the nut from galling.



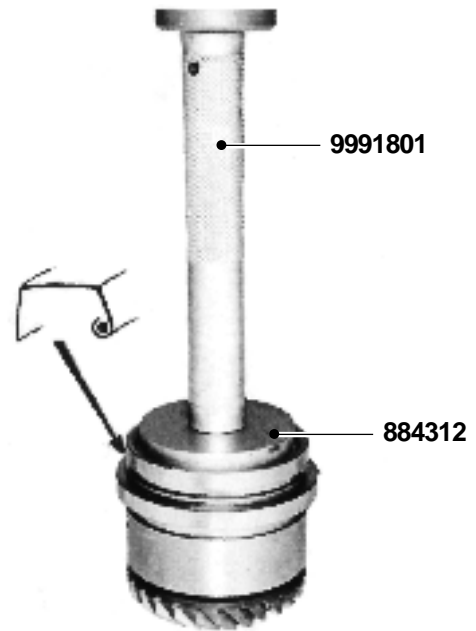
6. Measure the clearance between the nut and the bearing. The axial clearance should be between **0.1–0.5 mm (0.004–0.020")**. Should it prove impossible to obtain the correct clearance with either of the nuts, the bearing is probably defective.



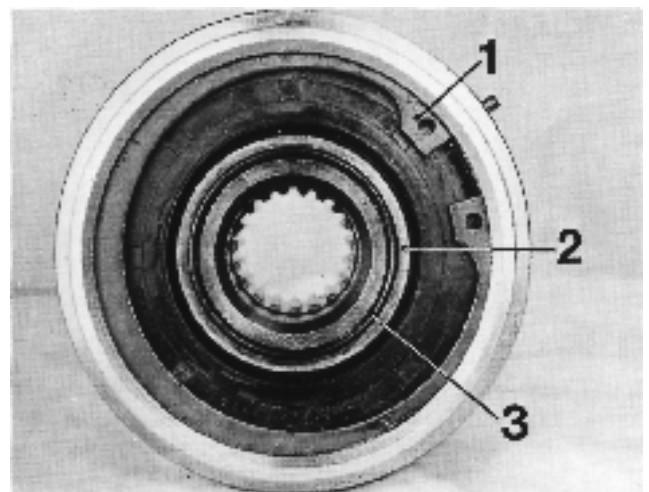
7. Measure the shim thickness between the clamp ring and the gear housing as follows:

Hold the double bearing box as indicated in the picture with its calculated number of shims (see point 16, page 39).

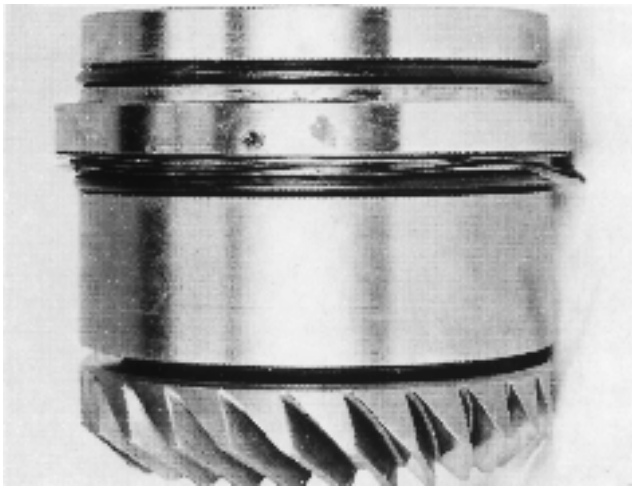
**NOTE!** The guide pin! Add a sufficient number of shims to the clamp ring to obtain a clearance of max. 0.10 mm (0.004") between the clamp ring and the gear housing. Push the clamp ring into its position by hand and use a feeler gauge and measure the clearance all around.



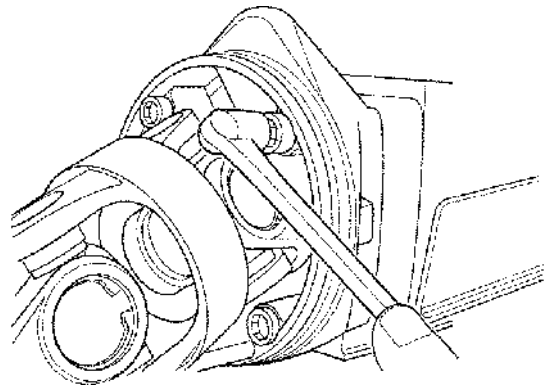
8. Remove the recessed washer and the shims in it. Press the new sealing ring against the collar in the double bearing box, with the open part against the bearing. Use special tools **9991801** and **884312**.



9. Install the locking ring (1) and the recessed washer (2) along with shims and install the O-ring (3) in the groove of the recessed washer. Use grease to get attachment.



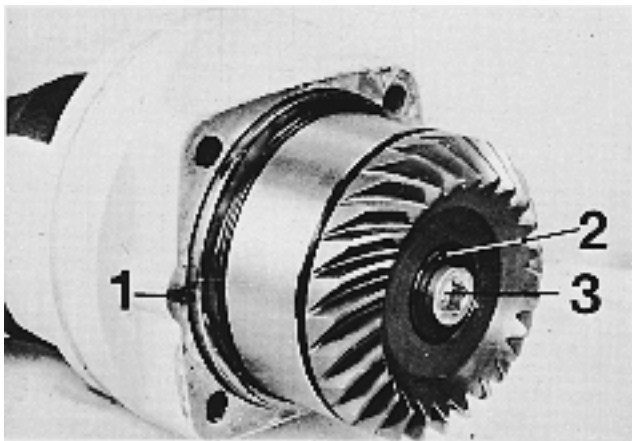
10. Install the shims and the 2 new O-rings on the double bearing box.



12. Apply Volvo Penta part no. 1161099-5, Permatex® no. 3 on the surfaces between the clamp ring and gear housing.

Install the double bearing box along with the universal joint in the gear housing. The guide pin in the double bearing box should be turned downwards. Lock the screws with thread locking compound, Volvo Penta part no. 1161053-2 and tighten them with a torque of **35 Nm (25.8 lb.ft.)**.

If necessary, recondition the universal joint. See chapter **Reconditioning the universal joint**, pages 62–63.

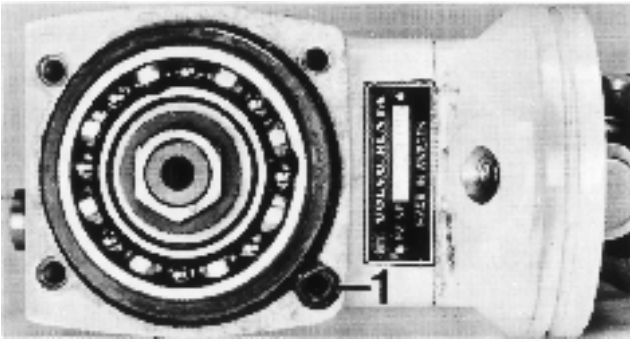


11. Install the clamp ring and the double bearing box on the universal joint.

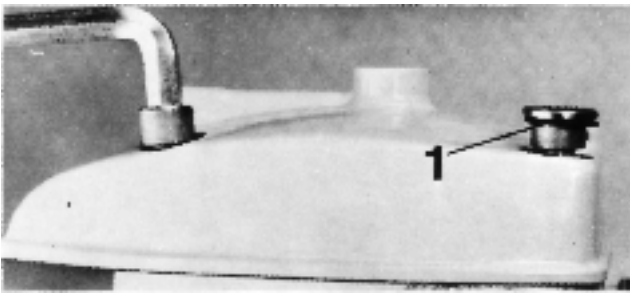
**NOTE!** The guide pin (1) must fit the groove in the clamp ring. Install the washer (2) and the screw (3). At final assembly always use a new screw! Coat the screw with Volvo Penta part no. 1161053-2, locking fluid and tighten with a torque of **75 Nm (55 lb.ft.)**.



13. Install shims under the cover to obtain a clearance of **max 0.1 mm (0.004")** between the cover and the gear housing. Install the cover and push it into its position and measure the clearance with a feeler gauge all around.



14. Coat the contact surface with Volvo Penta part no. 1141570-0 sealant and install the sealing ring (1) in a way that the sealing for the front right hand screw aligns with the corresponding recess in the cover.



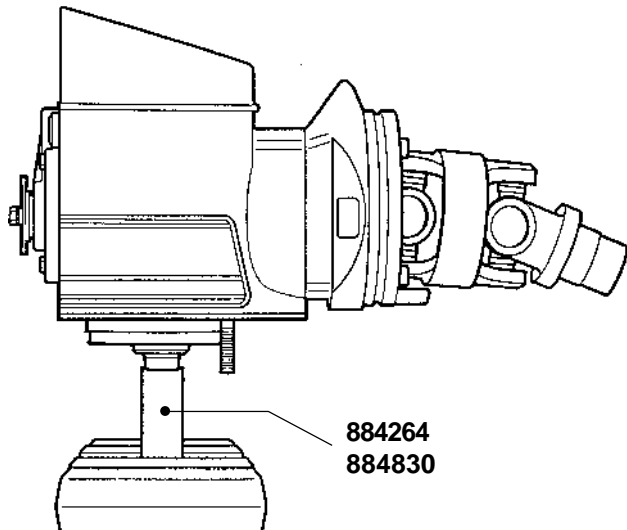
15. Install the calculated number of shims and tighten the cover.

**NOTE!** The front right hand screw is a hollow screw and shall be provided with an O-ring (1) under its head. Tighten the screws with a torque of **15 Nm (11 lb.ft.)**. **Tighten diagonally!**

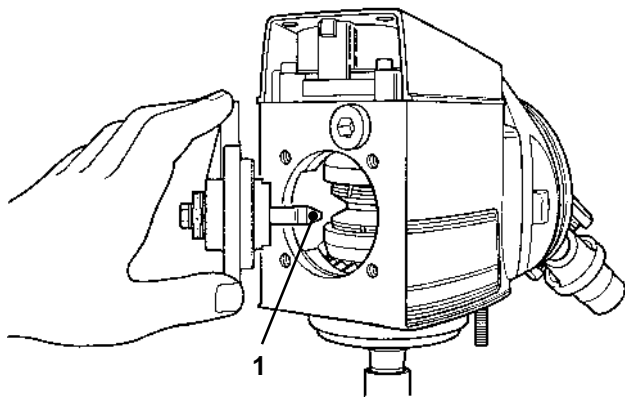


## Disassembly, models 290A, SP and DP

**NOTE!** The illustrations show drives model DP, but the working methods are the same as for models 290A and SP.

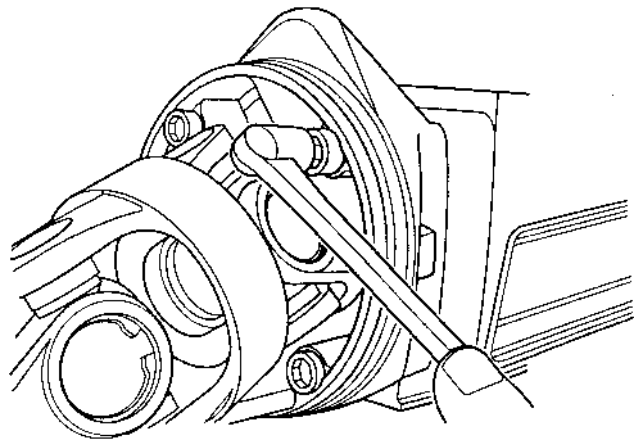


1. Install the upper gear housing on special tool **884830**. This special tool, of earlier manufacture, also carries the part no **884264**.

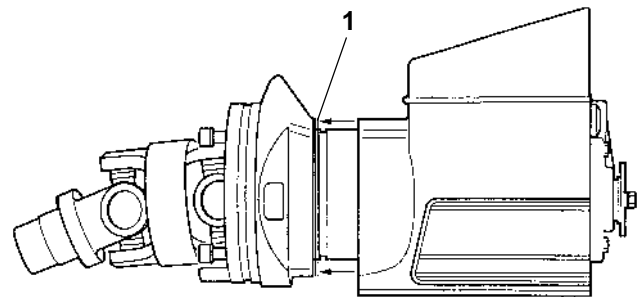


2. Remove the 4 screws holding the shift mechanism and remove the mechanism.

**NOTE!** Be sure to remove the shift shoe (1) with the shift mechanism.

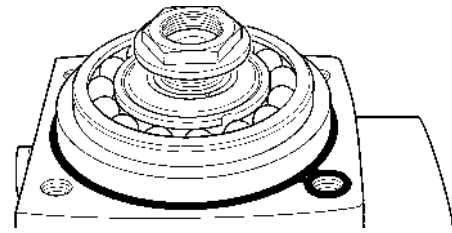
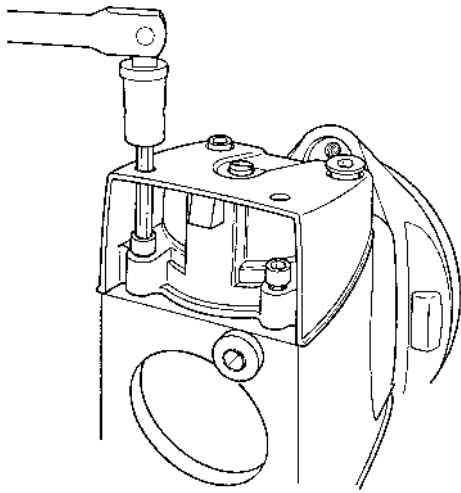


3. Loosen and remove the 4 allen head bolts holding the double bearing box.



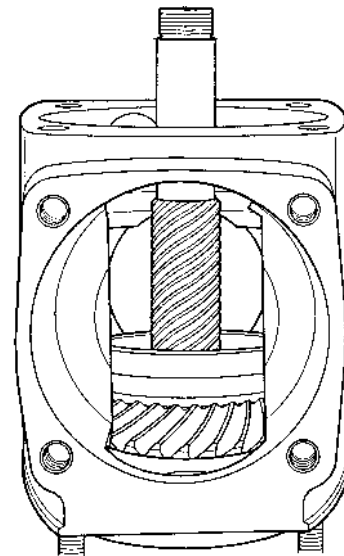
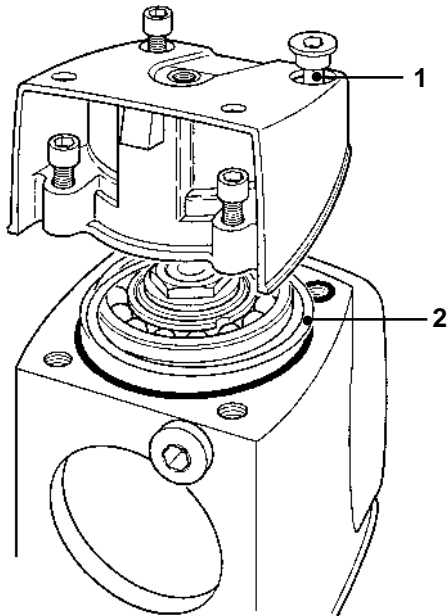
4. Pull out the double bearing box by pulling and turning simultaneously. Use strap wrench **9999179** to rotate the double bearing box.

**⚠ IMPORTANT!** Do not damage or lose the shims.



7. Remove the **left hand thread** nut on the vertical shaft. Use special tool **884830** and the spline shaft as a counter-hold while removing the nut.

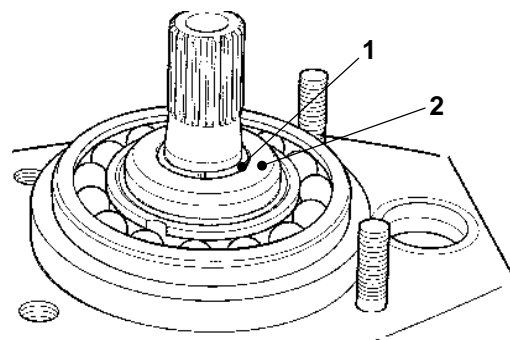
5. Remove the 4 screws holding the gear housing cover.



8. Lift out the upper bearing assembly along with the sliding sleeve and the spring.

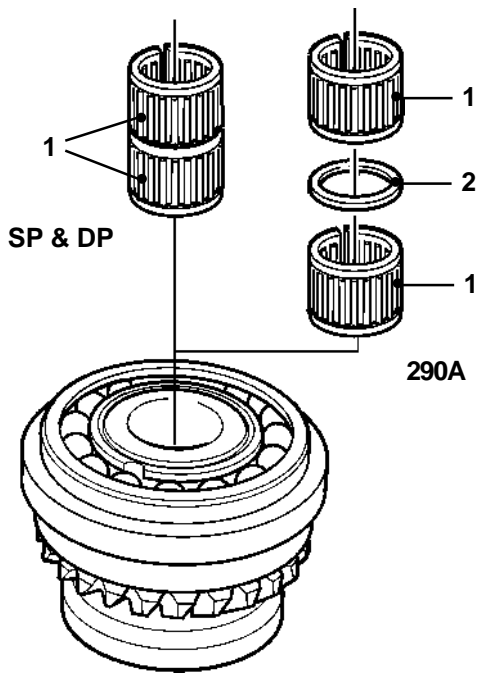
6. Remove the cover.

**NOTE!** The front right hand screw (1) is a hollow screw with an O-ring. Do not damage or lose the shims (2) for the cover.



9. Lift out the upper gear housing from the special tool. Disassemble the bearing assembly and shaft by lifting the shaft enough to remove the split locking ring (1), then the thrust washer (2).

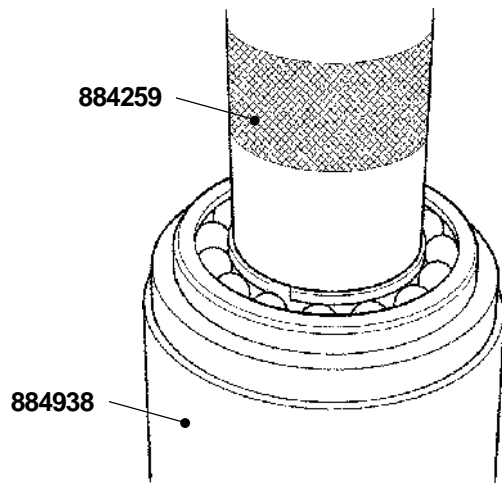
**NOTE!** Do not scratch the sliding sleeve or the gear cups while removing them.



10. Remove the needle bearings (1) from the upper and lower gear cup assemblies.

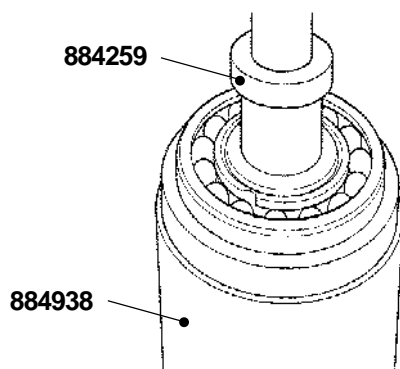
**Model 290A only:** Also remove the spacer ring (2).

**NOTE!** Do not mix upper and lower needle bearings.



**11b. Drives without integrated bearings:**

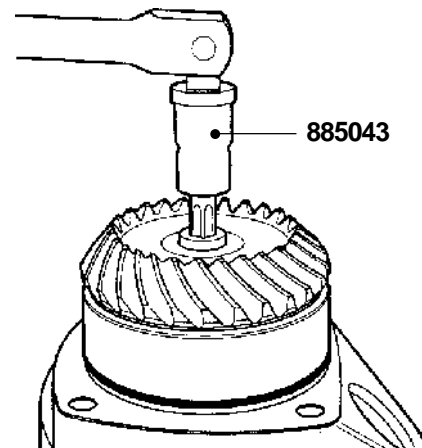
Press out the bearings from the bearing sleeves. Use special tools **884938** and **884265**.



**11a. Drives with integrated bearings (SP-A1, DP-A1, DP-B1):**

Press out the upper and lower gear wheels from the bearings. Mount the bearing and gear assembly in holding fixture **884938**, use special tools **884259** with handle **9991801**.

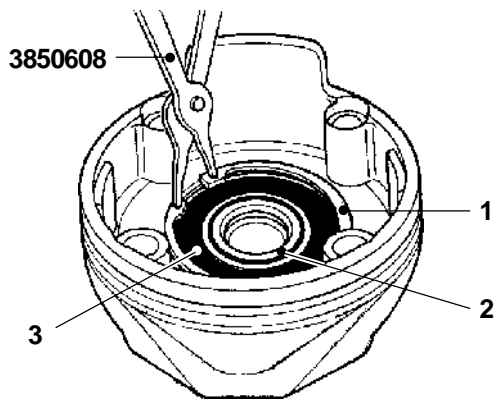
## Input gear (Double bearing box)



12. Brace the universal joint in a vice. Use soft jaws to protect the universal joint. Use special tool **885043** to remove the TX50 torx head screw and the tapered washer; discard the screw.

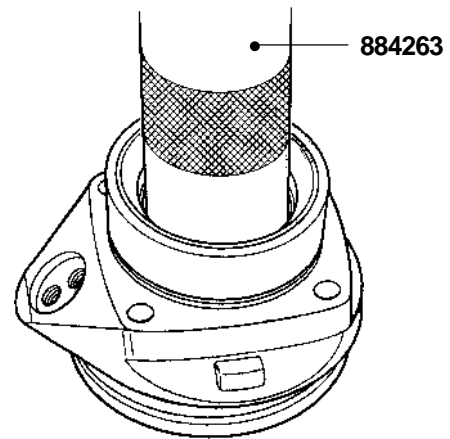
**NOTE!** Sterndrives model 290A have an Allen head screw instead of a TX50 torx head screw.

Remove the double bearing box from the universal joint.



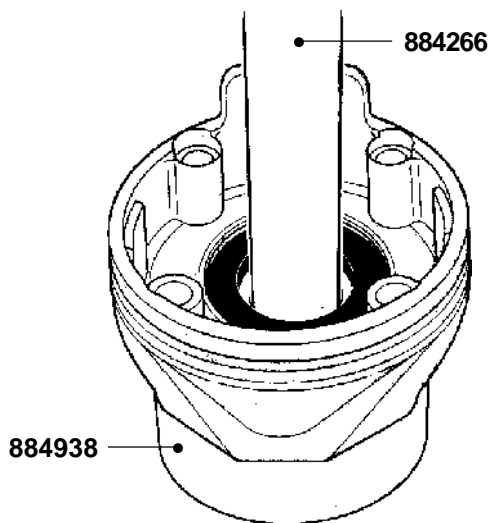
13. Use special tool **3850608** to remove the locking ring (1), remove the shoulder washer (2).

**NOTE!** The seal ring (3) can be removed at a later time.

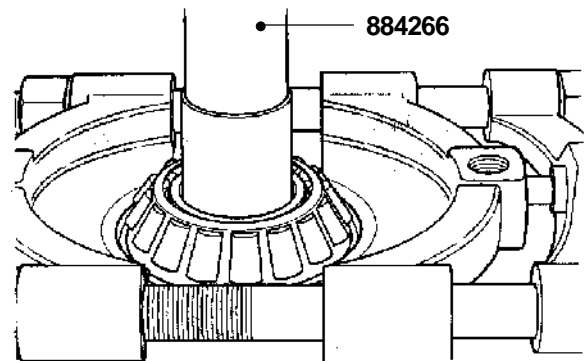


15. Turn over the double bearing box and press out the seal ring along with the roller bearing. Use special tool **884263**.

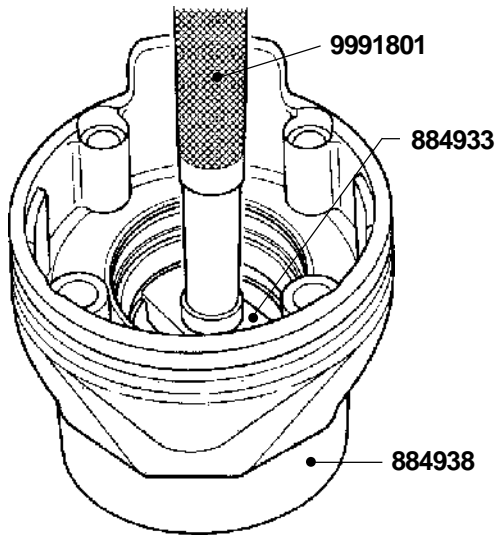
**NOTE!** The bearing will be damaged if removed, only remove if a new bearing will be installed.



14. Press out the input gear. Use special tools **884938** and **884266**. Remove the crush sleeve and discard.



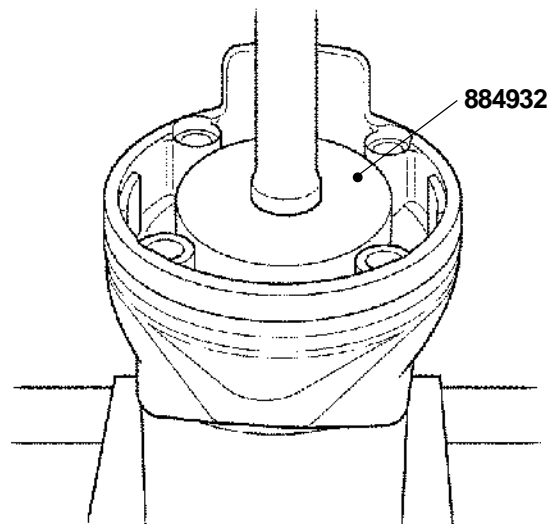
16. Use a "knife puller" to remove the roller bearing from the gear (if necessary). Also use special tool **884266**.



## Assembly, models 290A, SP and DP

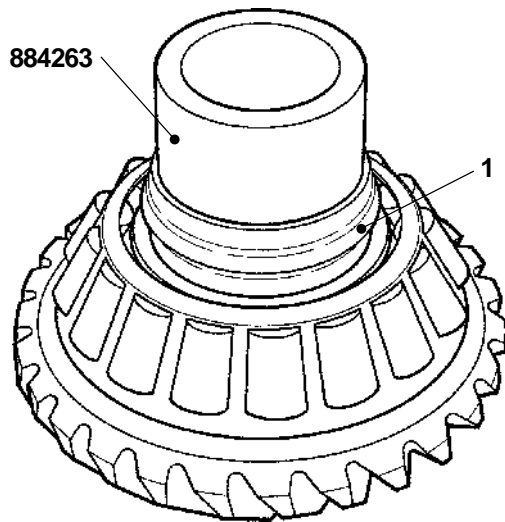
**NOTE!** When assembling the upper gear housing it is very important that the gears are correctly positioned in relation to each other. This applies not only to the backlash between the gear teeth but also to the gear teeth contact. Correct gear teeth contact spreads the load to which the gears are subjected over a larger area of the gear tooth. This preventing gear break-down and abnormal wear and at the same time providing a quiet operation.

17. When replacing the outer bearing races, the bearing races must be **pressed** out. Use special tool **9991801** handle with **884938** and **884933** holding fixture. If necessary, recondition the universal joint. See chapter **Reconditioning the universal joint**, pages 62–63.



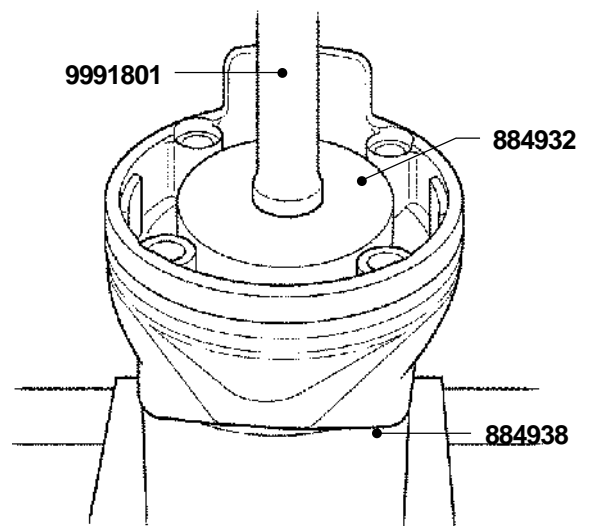
1. Install the outer bearing race. Use special tool no **884932**.

**NOTE!** Make sure that the double bearing box is positioned horizontally. Turn the special tool when installing the other bearing race.

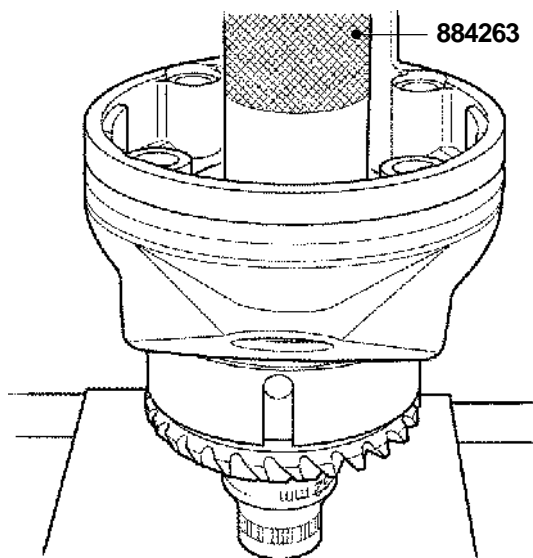


2. Install the bigger roller bearing on the gear wheel by pressing it on. Use special tool **884263**.

**NOTE! Protect the gear teeth.** Then install a new clamping sleeve (1).

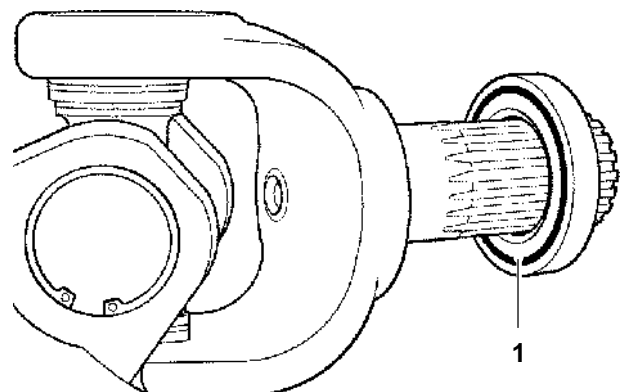


4. Press down the sealing ring to the shoulder. Use special tool **884932** with handle **991801** and special tool **884938**. Then install the locking ring with special tool **3850608**.

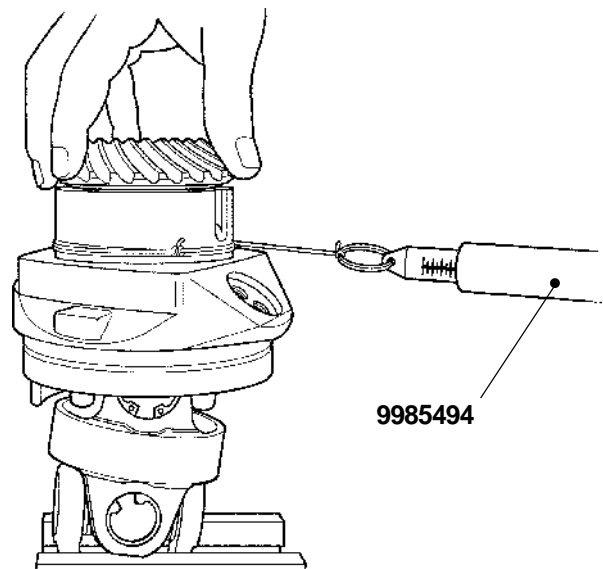
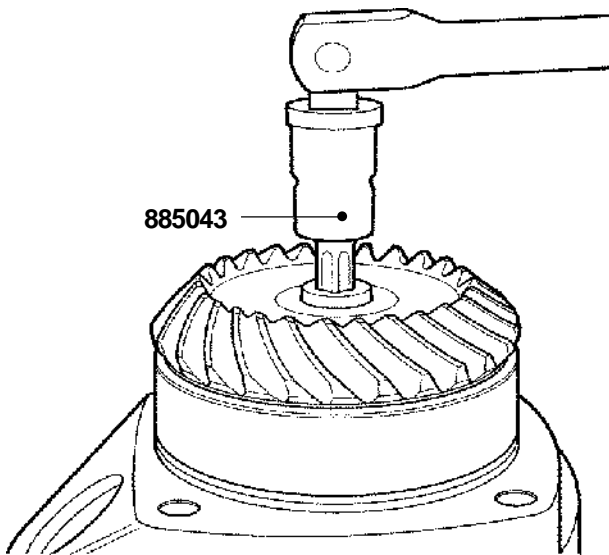


3. Install the input gear in the double bearing box and press on the smaller roller bearing in a way that a 1 mm (0,0394"), approximately, clearance is obtained. Use special tool **884263**.

**NOTE! Protect the gear teeth.**



5. Coat the O-ring (1) with grease and insert it in its location. Push the shoulder washer into its location against the universal joint.



6. Insert the universal joint into the double bearing box and brace the universal joint in a vice. Install the conical washer and tighten the screw by hand.

**NOTE!** Apply thread locking compound, Volvo Penta part no. 1161053-0 or Loctite® 243 on the screw. Use a new screw. Use special tool **885043** to tighten the TX50 torx head screw with short intervals. Check the pre-stressing between each interval, see under the following point) and rotate the bearings continuously to allow them to 'set'.

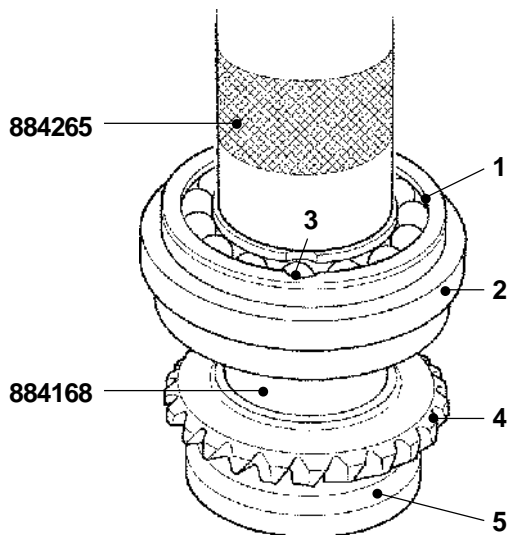
Model 290A has an Allen head screw instead of a TX50 torx head screw.

7. Check the pre-stressing of the bearings between the tightening intervals and then use a spring type of scale, special tool **9985494**. Pre-stressing new bearings: **10–15 N (2,20–3,30 lbs)**.

Prestressing used bearings: **7,5–10 N (1,6–2,2 lbs)**.

**NOTE!** If the screw is tightening to much and the pre-stressing becomes too high, the double bearing box must be disassembled and the crush sleeve replaced.

## Forward and reverse gears



### 8a. Drives without integrated bearings:

Lubricate the bearings (1) and press the bearing into their respective bearing boxes (2).

**NOTE!** Turn the bearings with the recesses in the bearing races (3), for the assembly of the balls, facing away from the gear wheels. Use special tool **884168**. Then press on the bearings and the bearing boxes onto the gear wheels. Use special tool **884265**.

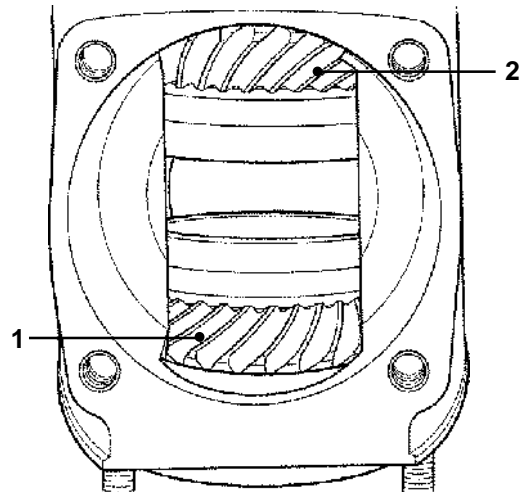
**NOTE!** Protect the gear cup during the compression to avoid that it is being deformed.

### 8b. Drives with integrated bearings.

From models SP-A1, DP-A1 on

Lubricate the bearings with synthetic gear lube API GL-5. Press the bearing onto their respective gears. Use special tool **884168**.

**NOTE!** Protect the gear cup during the compression to avoid that it is being deformed.



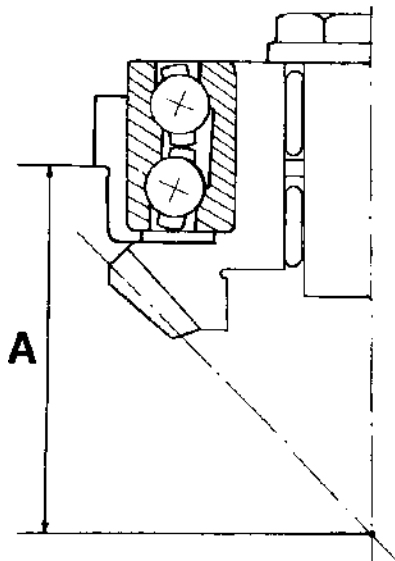
**9.** Always start by adjusting the forward gear. If the previously dismantled gears are to be used, it is important not to mix forward and reverse gears with each other when assembling.

On sterndrives having left hand rotating propeller as standard, the lower gear is the forward gear (1). On sterndrives having right hand rotating propeller as standard, the upper gear is the forward gear (2).

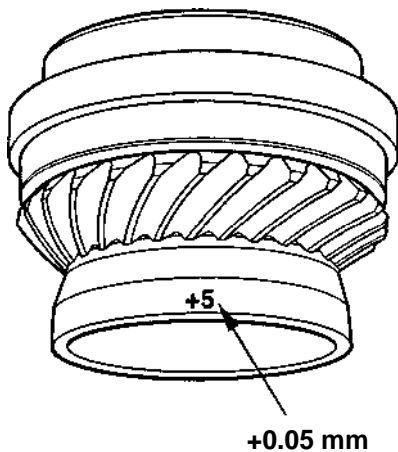


## Shimming the forward and reverse gears

### Method 1

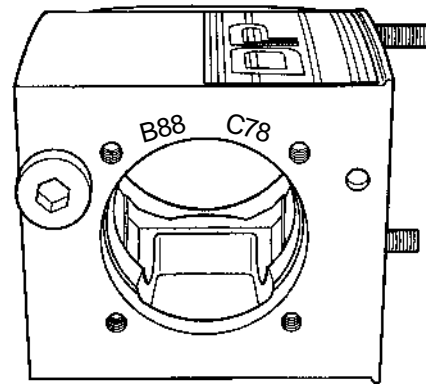


10. Measurement "A" is fixed at 62.05 mm (2.443").



11. Add or subtract the plus or minus marking (1) of the gear.

**NOTE!** a + 5 marking = +0.05 mm (0.002").



12. Only the decimal values of the "B" and "C" dimensions are stamped into the upper gear housing. The nominal value for both "B" and "C" is 61.00 mm (2.40"). Add this value to the value stamped into the gear to calculate shims for the forward and reverse gears.

The shim calculations can be seen in the example below:

Measurement "A":	62.05 mm	(Fixed Dimension)
	+ 0.05 mm	(Gear Etching <sup>1)</sup> )
	62.10 mm	
"C" Stamping:	- 61.78 mm	(Stamped <sup>2)</sup> )
	<b>0.32 mm</b>	<b>(0.013")</b>

The shim thickness for the forward gear is 0.32 mm (0.013").

The shim thickness for the reverse gear is calculated the same way, only using the "B" stamping.

<sup>1)</sup> Only +5 is etched.

<sup>2)</sup> Only 88 (B) respectively 78 (C) is stamped.

**NOTE!** When calculating the shim thickness for the forward and reverse gears, remember:

**The upper gear housing nominal dimension has two values.**

If the stamped number is **50 or more**, use the lower nominal value, 61.00 mm.

If the stamped number is **49 or less**, use the higher nominal value, 62.00 mm.

**Example:**                      **Stamping 50 or more**  
 “C” stamping: 78              = 00.78 mm  
 Use Nominal Dimension =  $\frac{61.00 \text{ mm}}{61.78 \text{ mm}}$

**Example:**                      **Stamping 49 or less**  
 “C” stamping: 43              = 00.43 mm  
 Use Nominal Dimension =  $\frac{62.00 \text{ mm}}{62.43 \text{ mm}}$

Then follow the procedure in **chapter Checking the gear backlash and contact pattern.**

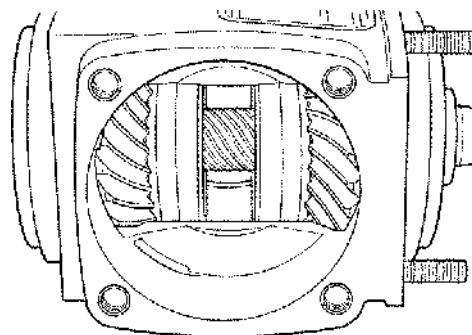
**Method 2**



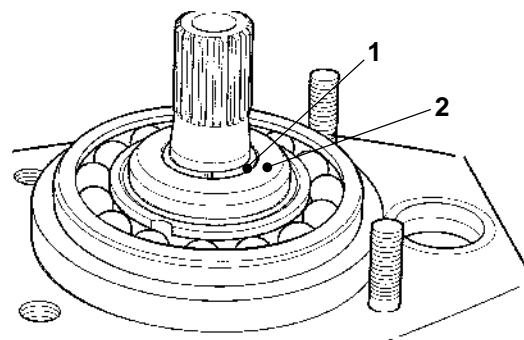
**13.** Insert a 0.2 mm (0.008") shim (1) under both forward and reverse gears as a starting point. The shim value is a number derived from experience.

Then follow the procedure in chapter **Checking the gear backlash and contact pattern.**

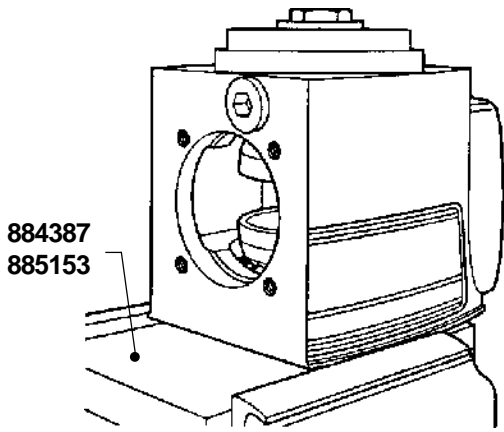
**Checking the gear backlash and contact pattern**



**14.** Install the forward gear with the calculated shims into the gear housing. Insert the needle bearings and the vertical shaft. Install reverse gear into the gear housing using the needle bearings as a guide.



**15.** Install the washer (2) and the split locking ring (1) and tighten the **left hand nut** at the opposite end of the vertical shaft. Use special tool **3850598**.

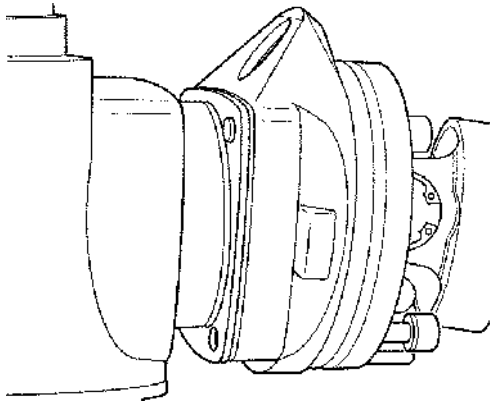


**16 a. Drives with integrated bearings  
From models SP-A1 and DP-A1 on**

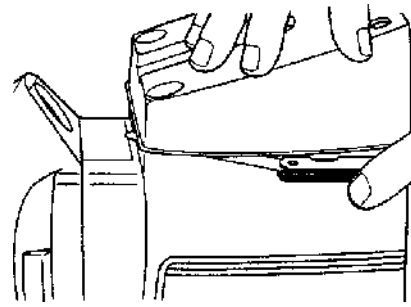
Brace the special tool **884387** plate and ring **885153** (tool kit **885152**) in a vise and install the gear housing in the tool.

**16 b. Drives without integrated bearings  
Up to models SP-A1 and DP-A1**

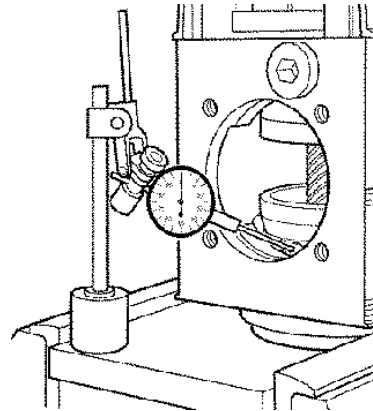
Brace the special tool **884387** plate in a vise and install the gear housing in the plate.



**17.** Install the preassembled double bearing box with **0.4 mm (0.0157")** shims. Make sure not to squeeze the shims in the O-ring groove. Tighten the 4 Allen-head screws.

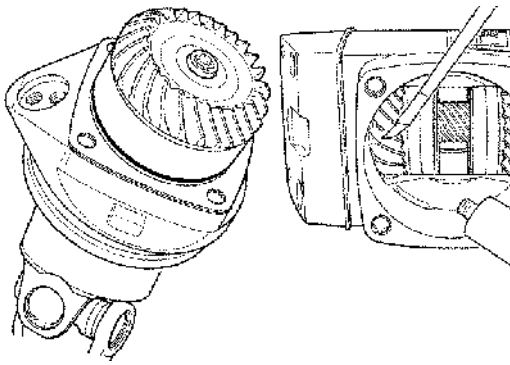


**18.** Use sufficient number of shims to create clearance of max. **0.1 mm (0.004")** between the top cover and the upper gear housing as shown in the picture. Install the cover and tighten the cover screws.



**19.** Install a dial indicator to measure backlash. The correct backlash should be 0.15–0.25 mm (0.006–0.010"). On 2.15 and 2.30 ratio drives (only model 290A) the backlash should be 0.08–0.18 mm (0.003–0.007").

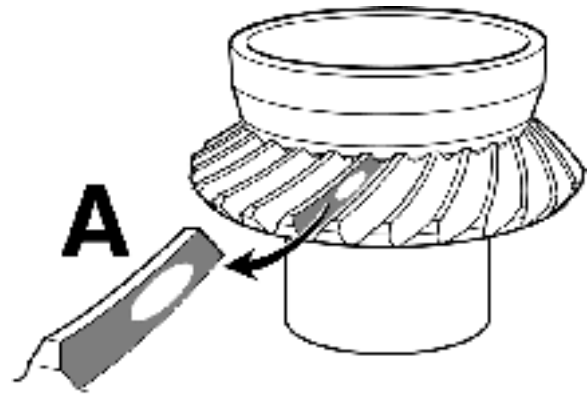
If the backlash is too tight, shims must be added between the double bearing box and the gear housing. If the backlash is too loose, shims must be removed from the double bearing box. A shim thickness of 0.10 mm (0.004") is a safe adjustment step.



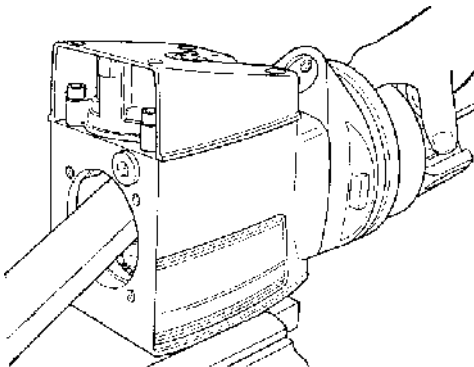
**20.** Remove the double bearing box when the correct backlash has been obtained.

To gain a clearer picture of the contact pattern, coat the gear teeth with a thin coating of marking dye. Then install the double bearing box again.

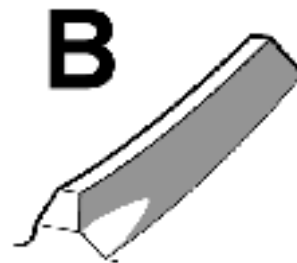
**NOTE!** The cover is still installed with an excessive number of shims!



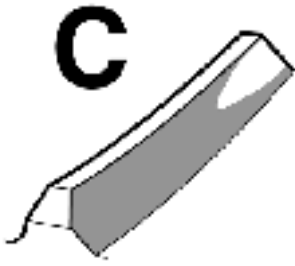
**22.** Dismantle the gear set and compare the contact pattern to that of the picture "A". This picture shows the desired pattern for the drive side of the forward and reverse gear. The drive side is the convex side of the gear. The dye pattern should be nearly oval in form and be positioned half way up on the gear tooth. It should be displaced towards the small end of the tooth (towards the gear cup) but not running off the end of the tooth.



**21.** Rotate the gears in the normal direction of rotation (clockwise) while at the same time braking the gear forcefully by wedging a wooden brace against the gear cups. The marking dye will be pressed away from the point of contact on the gear tooth face, which will show a picture of the contact pattern.



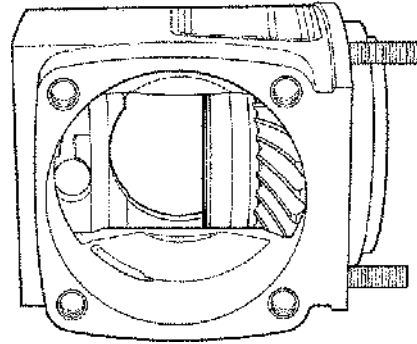
**23.** If the dye pattern reflects a contact pattern as shown in picture "B" the shim thickness underneath the drive gear (double bearing box) must be reduced. The drive gear then moves towards the driven gears. The driven gears must then be shimmed out the same amount to maintain the correct backlash.



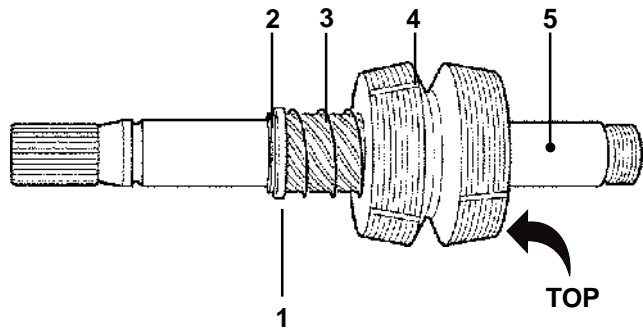
24. If the dye pattern reflects a contact pattern as shown in picture "C" the shim thickness underneath the drive gear (double bearing box) must be increased. The drive then moves away from the center.

**NOTE!** If the drive is moved in or out respectively, also the gears must be moved in or out in order to maintain the correct backlash. Having obtained the correct backlash and dye pattern, the upper gear must be dismantled and the marking dye removed. All bearings and screws must be lubricated prior to assembly, which is carried out after the reconditioning of the universal joint.

## Final assembly

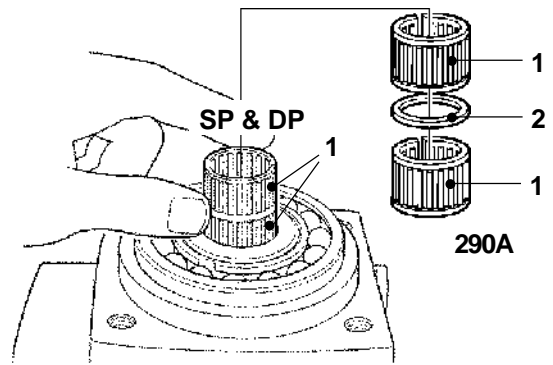
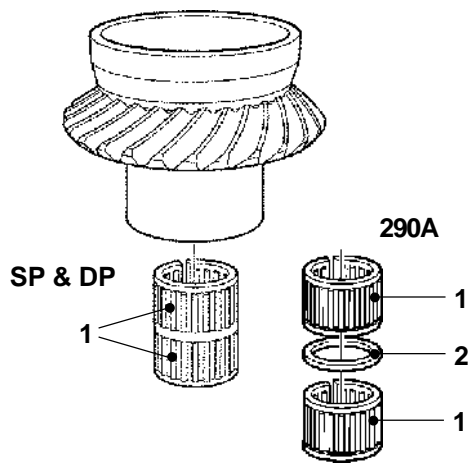


1. Install the lower gear along with the calculated number of shims.



2. Install the washer (1), the locking ring (2), the spring (3) and the engagement sleeve (4) onto the shaft (5).

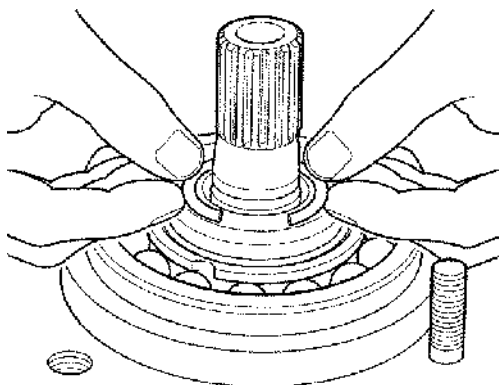
**NOTE!** The end of the engagement sleeve marked 'TOP' must be facing upwards on the shaft. On earlier models there is a drilled recess, which must be turned upwards. The engagement sleeve must rest lightly on the spring. Feel by hand to make certain.



3. Install the needle bearings (1) and the spacer ring (2, **model 290A only**) between the bearings in the lower gear and insert the shaft in the gear.

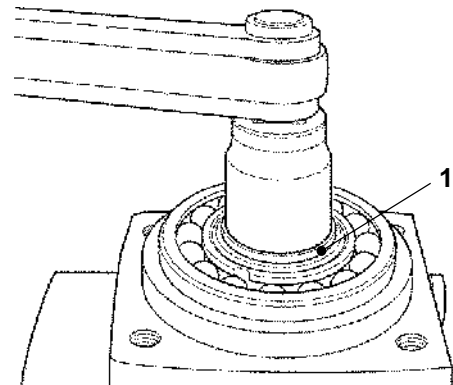
**NOTE!** The needle bearings are matched in pairs and must not be mixed up.

5. Place the upper gear wheel with the calculated shims in the gear housing. Install the needle bearings (1) along with the spacer ring (2, **model 290A only**) between the bearings.



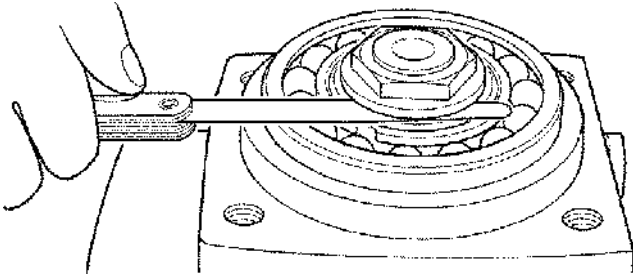
4. Install the brass washer and the split locking ring. Then place the gear housing in the splines sleeve **884830**.

**NOTE!** Carefully inspect the condition of the brass washer and replace if necessary.

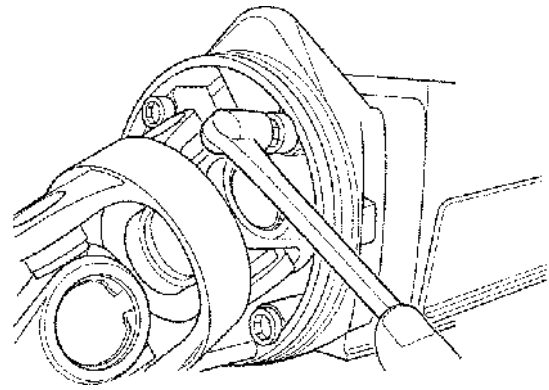


6. In order to obtain the correct axial clearance, there are three left hand threaded nuts with shoulders of different thicknesses (1). Select a nut and tighten it with a tightening torque of **120 Nm (88.3 lb.ft.)**.

**NOTE!** Lubricate the threads to prevent the nut from galling.



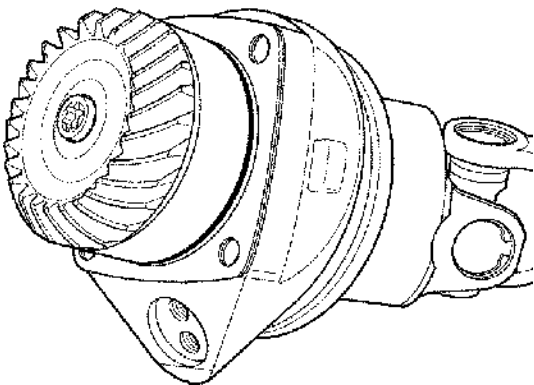
7. Measure the clearance between the nut and the bearing. The axial clearance should be **0.1–0.5 mm, 0.00394–0.0197"**). If it should not be possible to obtain the correct clearance with any of the nuts, most probably the bearing is defective.



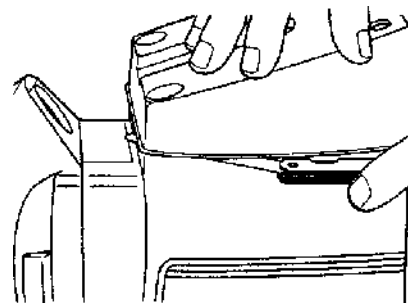
9. Coat the surfaces between the double bearing box and the gear housing with sealing compound, Volvo Penta part no. 1161099-5 or Permatex® no. 3.

Install the double bearing box with the universal joint in the gear housing.

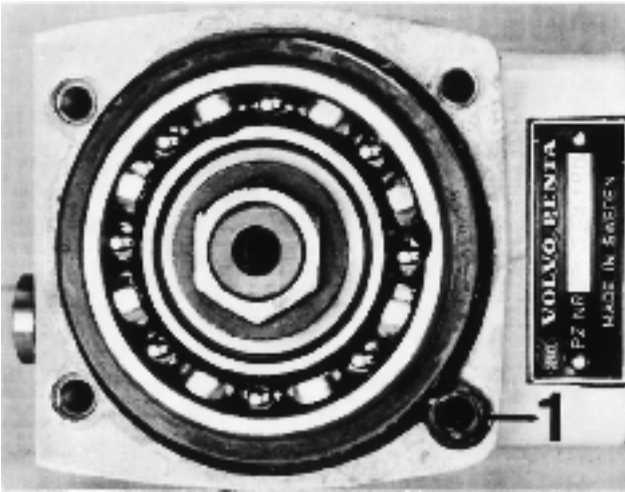
Coat the screws with thread locking compound, Volvo Penta part no. 1161053-2 or Loctite® 243 and tighten them with a torque of **35 Nm (25.8 lb.ft.)**.



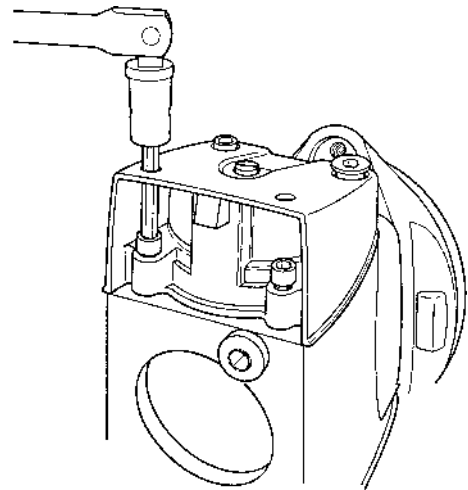
8. Install the shims and the new O-ring on the double bearing box.



10. Install a sufficient number of shims underneath the cover to obtain a clearance of **max 0.1 mm (0.004")** between the cover and the gear housing. Locate the cover and push it lightly into position and measure the clearance all around with a feeler gauge.



11. Coat the cover with sealant, Volvo Penta part no. 1141570-0 and install the sealing ring (1) so that the sealing for the front, right hand screw ends up in the recess of the cover, provided for it.

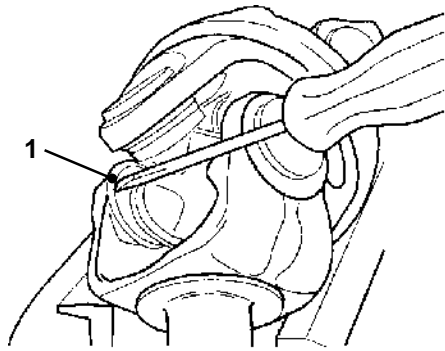


12. Insert the calculated shims and tighten the cover.

**NOTE!** The front, right hand screw is a hollow screw, to be installed with an O-ring underneath the head of the screw. Tighten the screws with a torque of **15 Nm (11.04 lb.ft.)** in diagonal sequence.

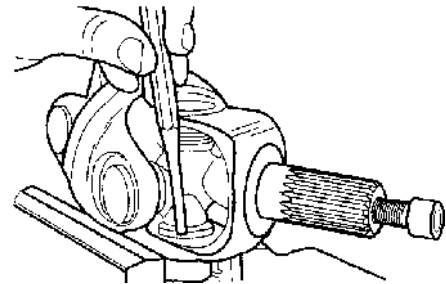


## Reconditioning the universal joint

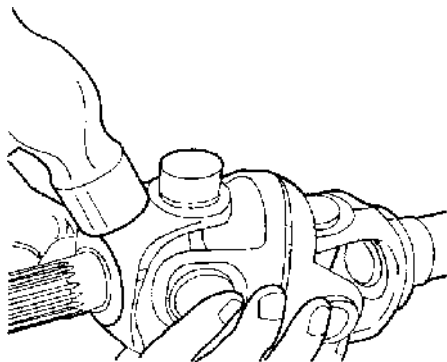


1. Remove the locking rings (1) holding the needle bearing in the yoke.

**NOTE!** To avoid having the locking rings “jump out” and getting lost, hold a rag over the universal joint when removing the locking rings.

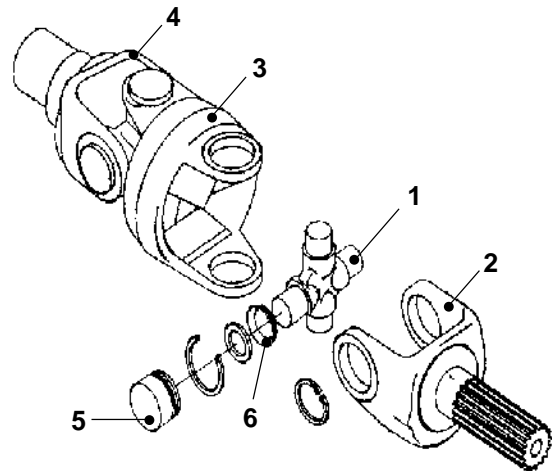


3. Try to ease out the bearing using a pair of pliers or Channel Lock® pliers. If this is unsuccessful the bearing can be driven out by using a hammer and a drift punch. Once the bearings are removed, remove the spider from the yoke.



2. Hold the universal joint in your hand and strike with a hammer until the bearing emerges from the yoke.

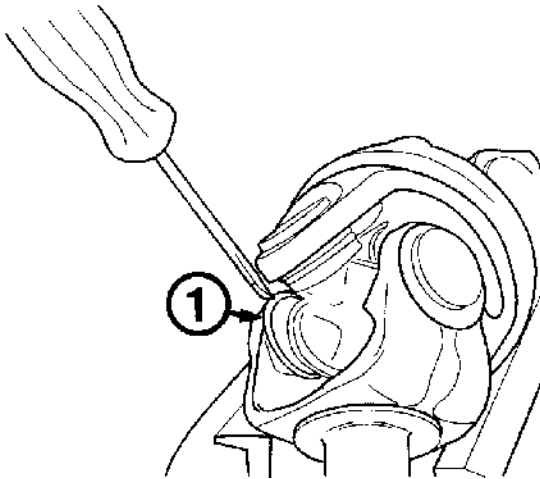
**⚠ WARNING!** Do not strike the splines or sealing surfaces. The universal joint will be damaged and must be replaced.



4. Inspect the spider (1) and needle bearings for play in the yokes (2, 3, and 4) and possible wear marks in the bearing races (5). If faulty, the spider (1) and needle bearing caps (5) must be replaced as a complete unit.

**NOTE! DO NOT** install new bearings and caps onto a used spider or vice-versa.

If the bearing caps (5) are found to have play in the yokes (2, 3, and 4), the yokes must also be replaced. Install new seal washers (6) on the spider. Feed the spider in the yoke.



5. Use a small amount of water resistant EP bearing grease, Volvo Penta part no. 1161246-2, to retain the needle bearings in the cap. Push the spider through the yoke in one direction to allow the needle bearing to align with the spider. Push the needle bearing cap into the yoke with the spider inside the needle bearing cap to keep the needle bearings in place. Press the needle bearing cap into the yoke far enough to allow the lock ring to be installed. Install the remaining needle bearing caps in the same manner.

**⚠ WARNING!** Be extremely careful when pressing the needle bearing caps into place. The needle bearings may come loose and fall to the bottom of the bearing cap. **DO NOT** force the needle bearing caps onto the spider. If the locking groove for the needle bearings caps do not readily align, a bearing may have come loose and fallen to the bottom of the cap.

# Reconditioning the shift mechanism

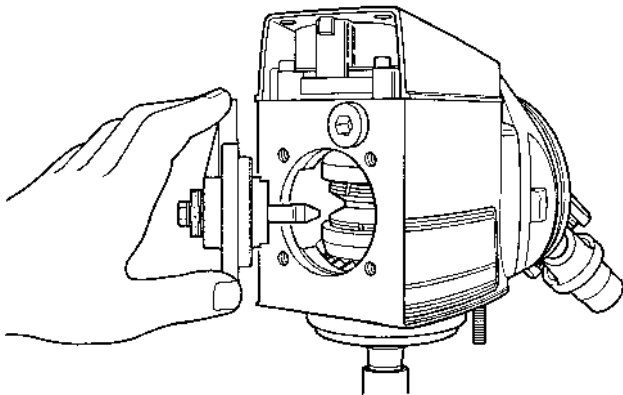
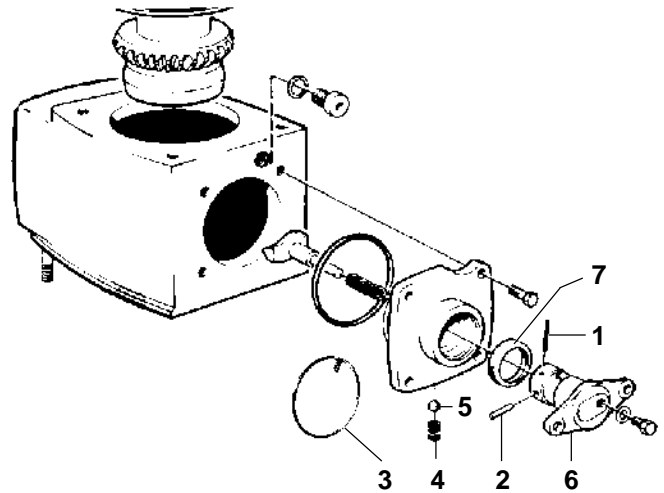
## Types of shift mechanisms

For the models 280, 290, 285, 285A and 290A there are 3 different types of shift mechanism. The first type was installed up to and including serial no PZ 2829528. As from serial number PZ 2829529 the second type – where the ball, spring and the locking wire were removed – was installed. There is a somewhat different dismantling and assembly sequence for each type.

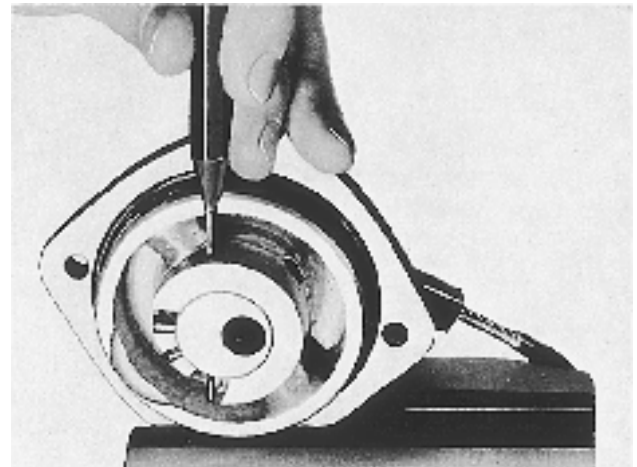
The third type and the shift mechanism for models DP and SP are described on pages 68–72.

**NOTE!** The upper gear head does not have to be removed from the intermediate housing, nor the stern-drive from the transom shield, to replace the shift mechanism.

## Shift mechanism type 1



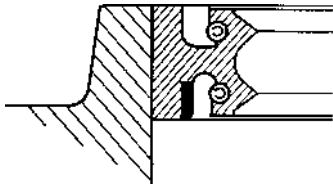
1. Remove the shift mechanism from the upper gear head.



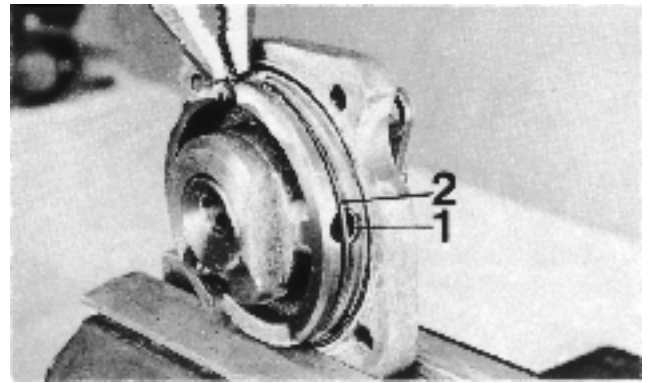
2. Knock out the load pin (1, figure above) and pull out the pin (2). Remove the locking wire (3), the springs (4) and the balls (5) and pull out the eccentric piston (6). Remove the sealing ring (7). Wash the parts and check for wear and replace parts where necessary.

## Assembly

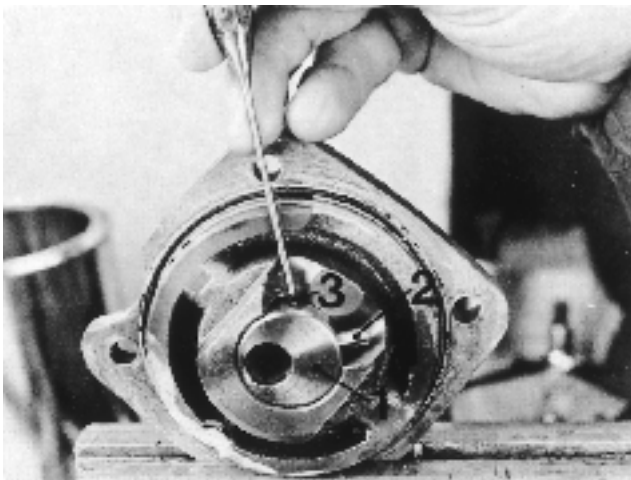
Oil all moving parts prior to the assembly.



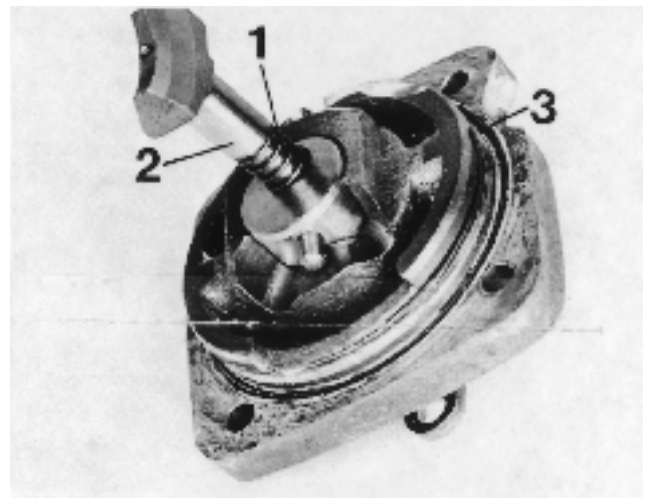
3. Lubricate the sealing ring abundantly and install it with the steel edge (small clearance) facing inwards the gear housing.



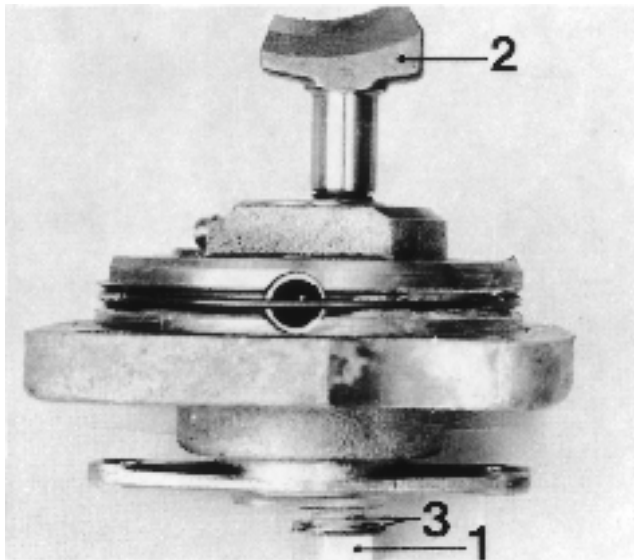
5. Install the balls and the springs (1). Insert a locking wire (2) in the groove of the cover and compress the springs as indicated in the picture. Cut off and turn down the end into the cover recess. The only function of the locking wire is to hold the spring in position while the shift mechanism is being installed in the gear housing.



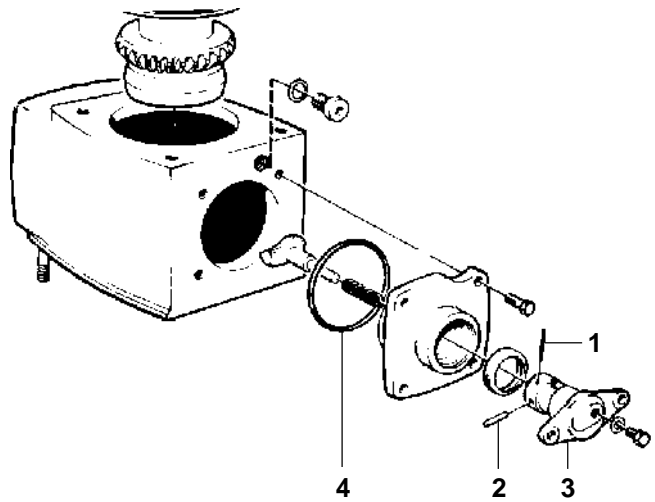
4. Insert the excentric piston (1). Install the pin (2) and lock it with the load pin (3). Make sure that the load pin centers in the excentric piston.



6. Install the spring (1), the shift shoe (2) and the O-ring (3) and coat the contact surfaces with sealing compound, Volvo Penta part no. 1161099-5 or Permatex® no. 3.



## Shift mechanism type 2



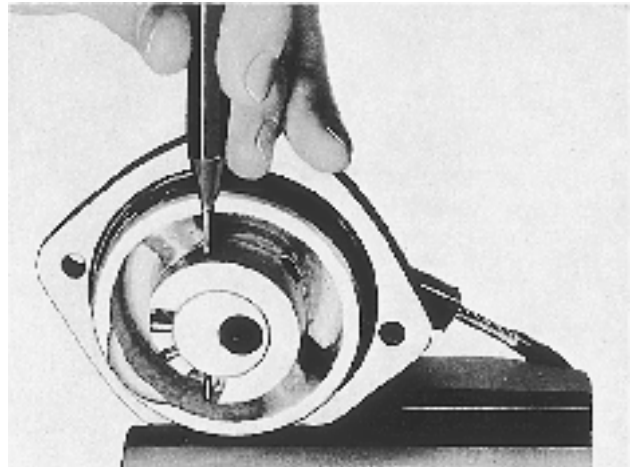
7. Install the shift mechanism in the gear housing in a way that the screw (1) will be displaced towards star-board.

**NOTE!** Make sure that the sliding shoe (2) is turned to a position corresponding the one in the picture. The shift mechanism will not function if the sliding shoe is turned the opposite way. Now install the shift mechanism in the sterndrive.

Set the shift mechanism in neutral and remove all adjustment pads (3) and tighten the screw. Now the vertical shaft in the upper gear housing cannot be turned. Insert a shim at the time on the screw until it is possible to turn the shaft.

**Models 290 and 290A:** Add **one more** shim to the screw (1).

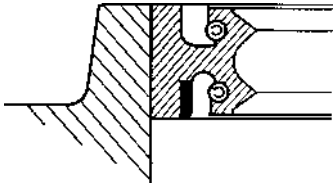
Coat the shim/shims and the screw with sealing compound, Volvo Penta part no. 1161099-5, or Permatex® no. 3 when the adjustment is done and then tighten the screw.



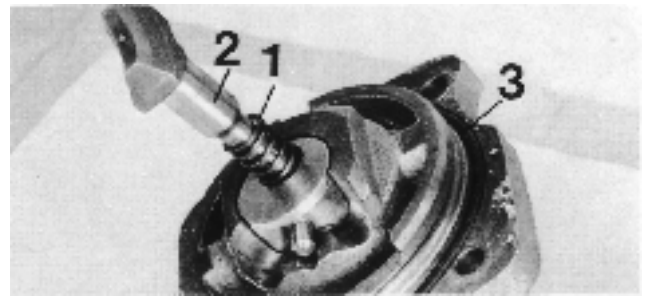
8. Knock out the load pin (1, figure above) and pull out the pin (2) and the excentric piston (3). Remove the sealing ring (4). Wash the parts and check for wear. Replace parts if necessary.

## Assembly

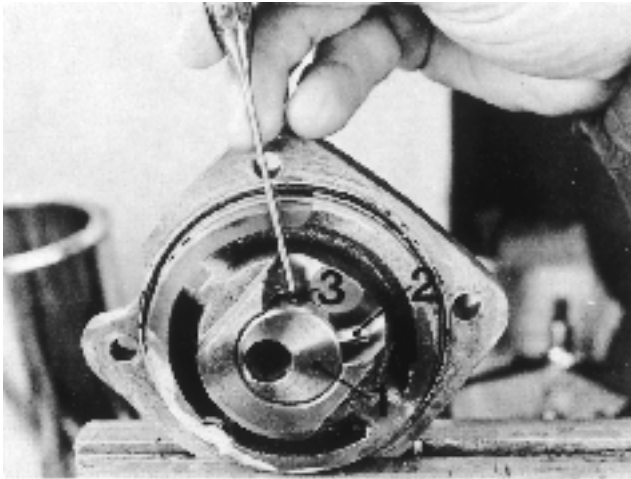
Oil all moving parts prior to assembly.



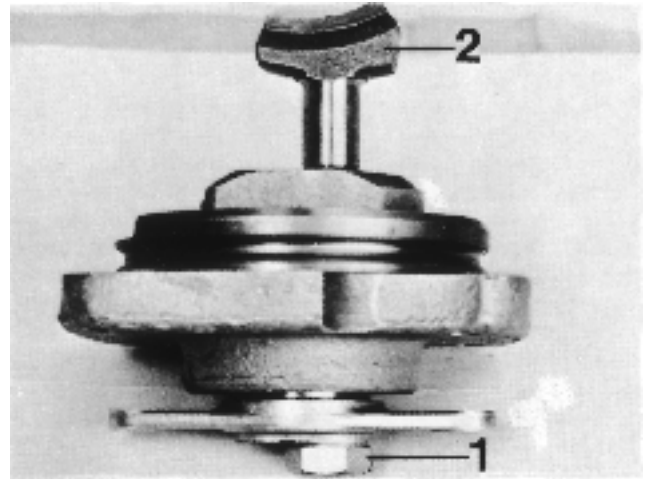
9. Lubricate the sealing ring abundantly and install it with the steel edge (small clearance) facing inwards the gear housing.



11. Install the spring (1), the sliding shoe (2) and the O-ring (3) and coat the contact surfaces with sealing compound, Volvo Penta part no. 1161099-5, or Permatex® no. 3.

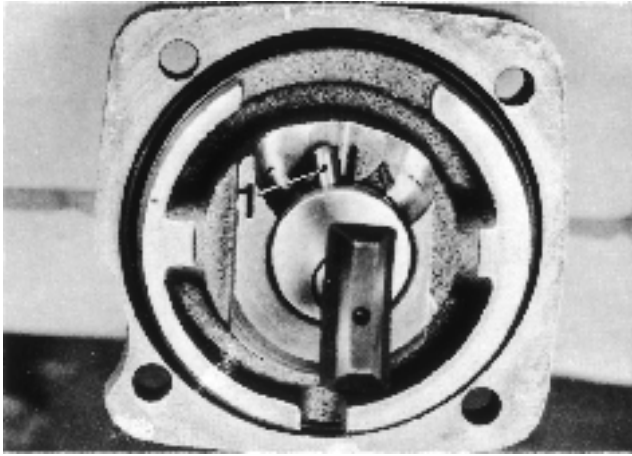


10. Install the excentric piston (1). Install the pin (2) and lock it with the load pin (3). Make sure that the load pin centers in the excentric piston.



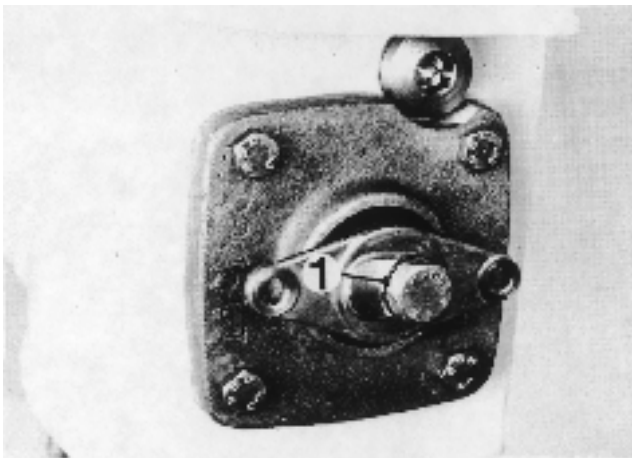
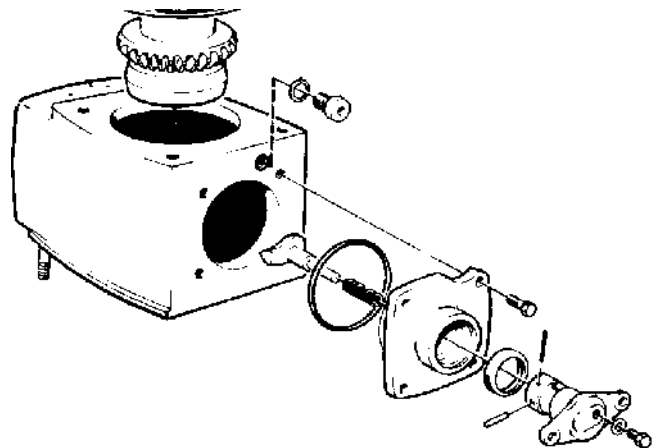
12. Install the shift mechanism in the gear housing in a way that the screw (1) is displaced towards star-board.

**NOTE!** Make sure that the sliding shoe (2) is turned to a position corresponding the one in the picture. The shift mechanism will not function if the sliding shoe is turned the opposite way.



13. Set the shift mechanism in a position between forward and neutral or between reverse and neutral. The pin (1) should be positioned on one of the 'cams'. Install the shift mechanism in the sterndrive.

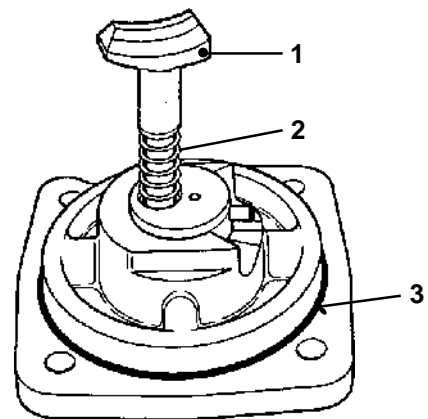
### Shift mechanism type 3



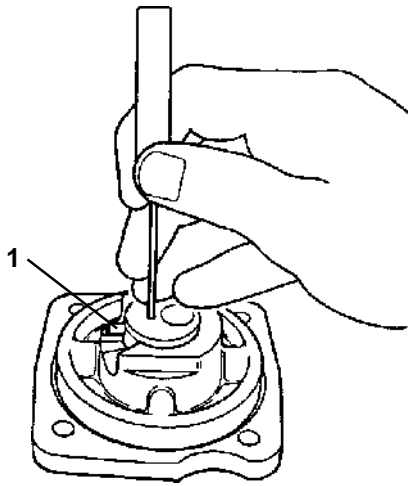
14. Remove all adjustment shims (1) and tighten the screws. Now it is not possible to turn the vertical shaft in the upper gear housing. Insert an adjustment shim at the time on the screw until the shaft can be turned again without any sort of resistance.

**Models 290 and 290A:** Add **one more** shim to the screw (1).

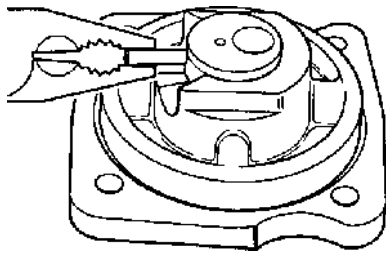
When the adjustment is done, coat the shims and the screw with sealing compound, Volvo Penta part no. 1161099-5, or Permatex® no. 3 and tighten the screw.



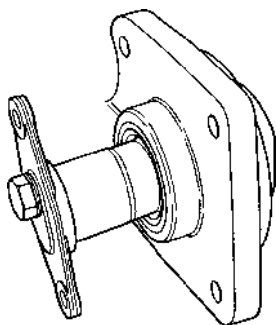
15. Remove the sliding shoe (1) and the spring (2) and the O-ring (3).



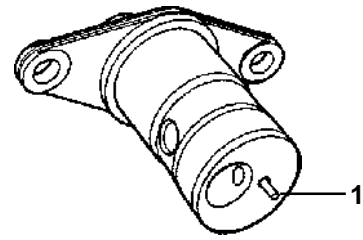
16. Knock in the load pin as far as necessary to free the pin (1).



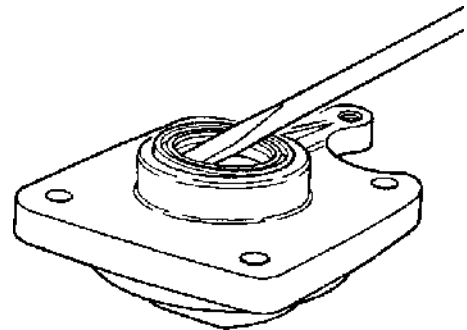
17. Pull out the pin.



18. Pull out the excentric piston.



19. Tap the eccentric piston lightly on a wooden surface to remove the spring pin (1). Inspect the eccentric piston for scoring, distortion, or damage that may cause it to leak or bind in the housing.

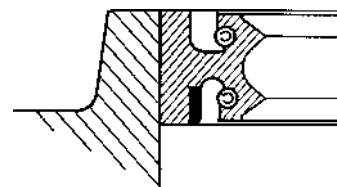


20. Using a screwdriver, pry out the eccentric piston seal. Clean all surfaces and check for damage that may cause leaks. Replace parts as necessary.

### Assembly, models

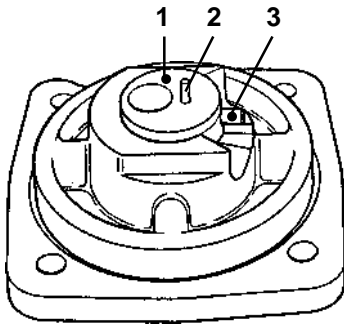
280, 285, 285A, 290 and 290A

Oil all moving parts prior to assembly.

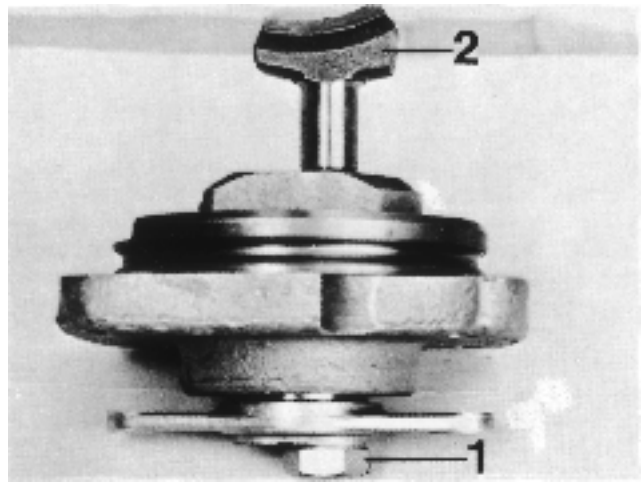


21. Install a new eccentric piston seal with the steel edge facing inward, as shown. Use special tool 884793.



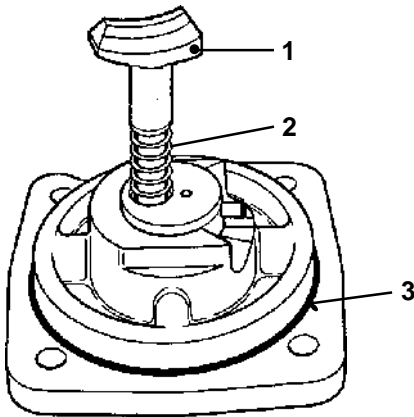


**22.** Install the eccentric piston (1) in the housing. Do not damage the seal! Push in the locating pin (2). Align the hole with the housing. Lock it in place with a new spring pin (3).

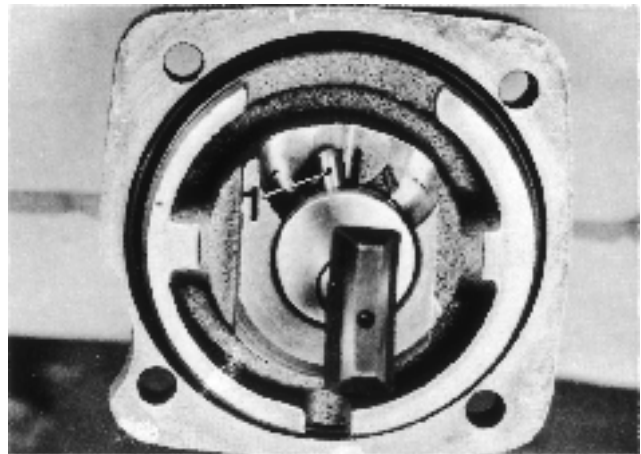


**24.** Install the shift mechanism in the gear housing in a way that the screw (1) is displaced towards star-board.

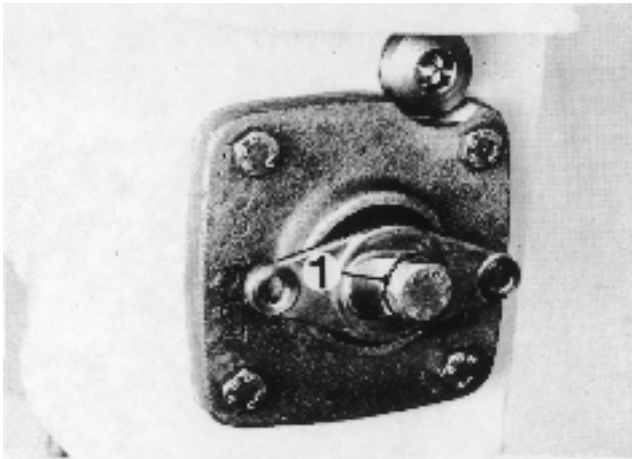
**NOTE!** Make sure that the sliding shoe (2) is turned to a position as indicated in the picture. The shift mechanism will not function if the sliding shoe is turned in the opposite direction.



**23.** Install a new O-ring (3) and insert the spring (2) and the sliding shoe (1). Coat the contact surface with Volvo Penta part no. 1141570-0 sealant.



**25.** Set the shift mechanism in a position between forward and neutral or between reverse and neutral. (The pin (1) shall rest on one of the 'cams'). Install the shift mechanism in the sterndrive.



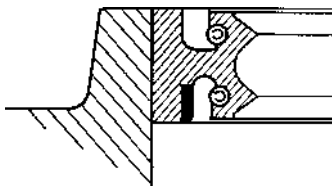
**26.** Remove all adjustment shims (1) and tighten the screw. Now it is no longer possible to turn the vertical shaft in the upper gear housing. Insert an adjustment shim at the time on the screw until the shaft can be turned again without any sort of resistance.

**Models 290 and 290A:** Add **one more** shim to the screw.

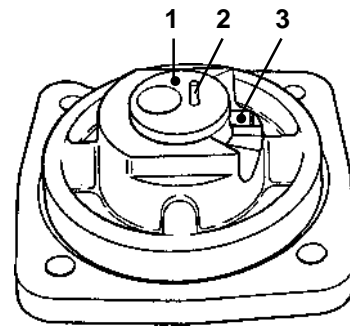
When the adjustment is done, coat the shims and the screw with sealing compound, Volvo Penta part no. 1161099-5, or Permatex® no. 3 and then tighten the screw.

### Assembly, models SP and DP

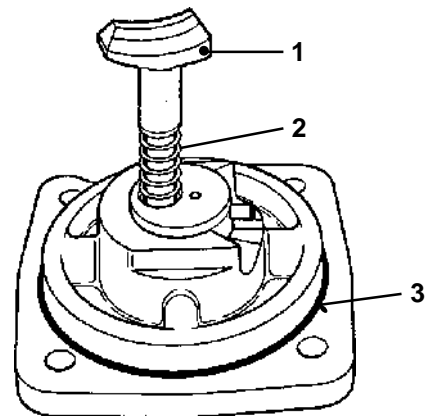
Oil all moving parts prior to assembly.



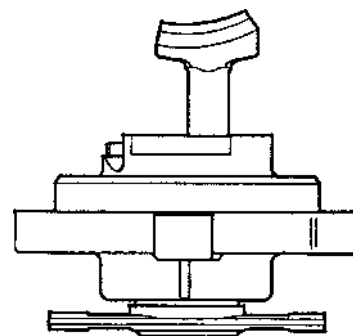
**27.** Install a new eccentric piston seal with the steel edge facing inward, as shown. Use special tool **884793**.



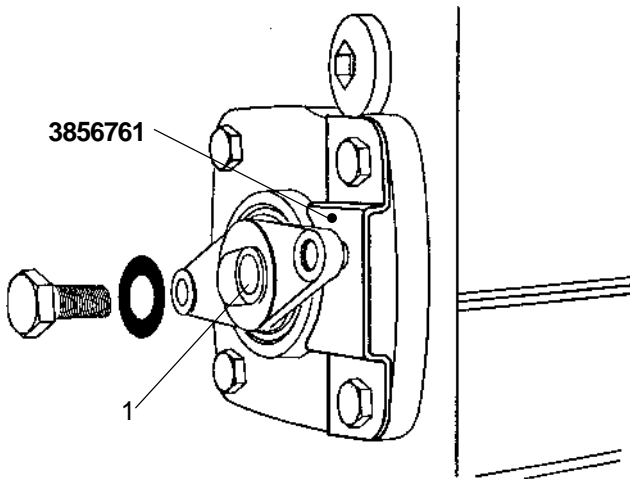
**28.** Install the eccentric piston (1) in the housing. Do not damage the seal! Push in the locating pin (2). Align the hole with the housing. Lock it in place with a new spring pin (3).



**29.** Install a new O-ring (3), then insert the spring (2) and shift shoe (1). Coat the contact surface with Volvo Penta part no. 1141570-0 sealant.



**30.** Remove the shim screw and install the assembly in the upper gear head. Make sure the long edge of the shift shoe is toward the right side of the housing as viewed from the top.



**31.** Do not attempt to mount the special tool **3856761** on any raised portion or raised lettering on the shift housing. The tool shall be mounted closed to the housing.

Install the special tool under the two starboard side retaining screws, as shown.

**NOTE!** Alternatively the special tool can be mounted on the port side, but after the gear shift rod is dismantled.

With the special tool installed, add one shim to the shimming screw (**1**) and install finger tight while rotating the propeller shaft **by hand**. If propeller shaft binds, repeat this step, adding one shim at a time, until no resistance is felt through 360° of rotation.

**NOTE!** Do not attempt to rotate the propeller shaft with any leverage devices (e.g., propellers or pliers). This will damage the sliding sleeve and/or the shift shoe.

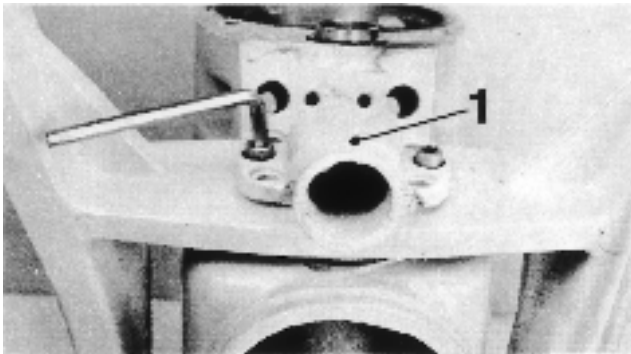
After the proper amount of shims have been established add one more shim to the shimming screw.

Coat the shimming screw threads with Volvo Penta sealing compound, part no. 1161099-5, and install. Tighten the shimming screw to **14–16 Nm (10–12 lb.ft.)**.

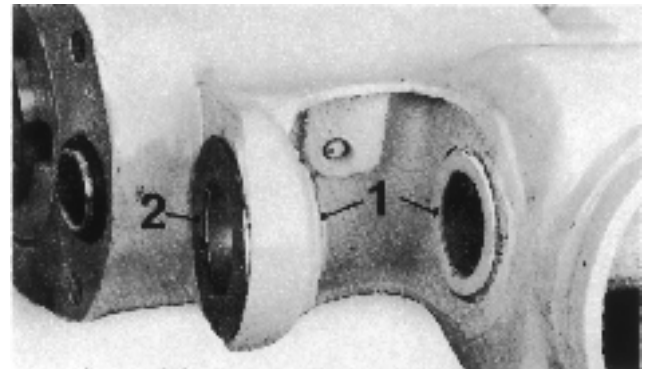
**32.** Remove the special tool and install the shift linkage.

## Intermediate housing

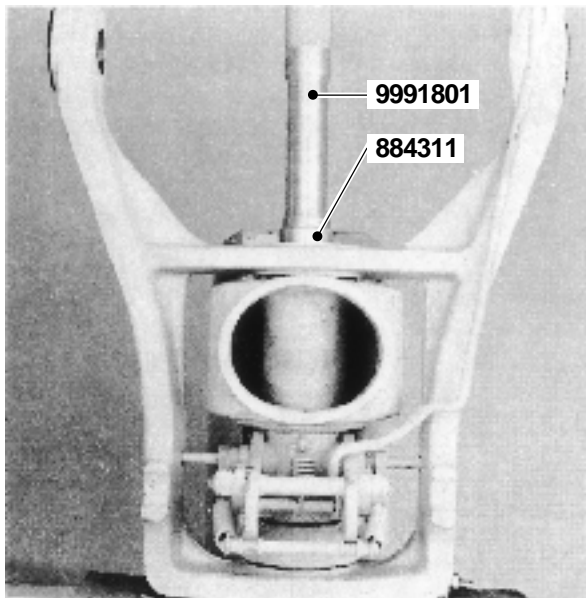
### Reconditioning the intermediate housing, model 280 and 285



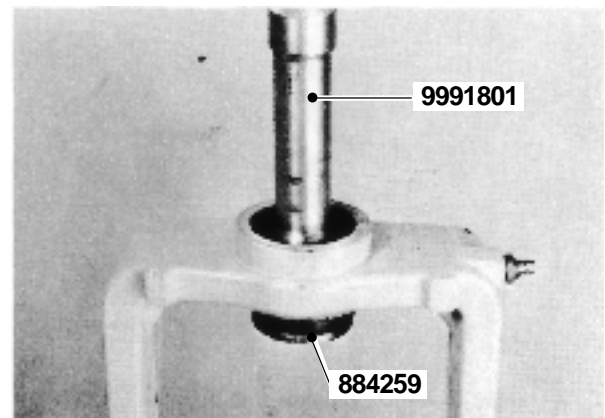
1. Remove the 2 screws holding the hose connection (1) on the yoke. Remove the hose connection and the gasket.



3. Remove the plastic washers (1) and the wear washer (2).

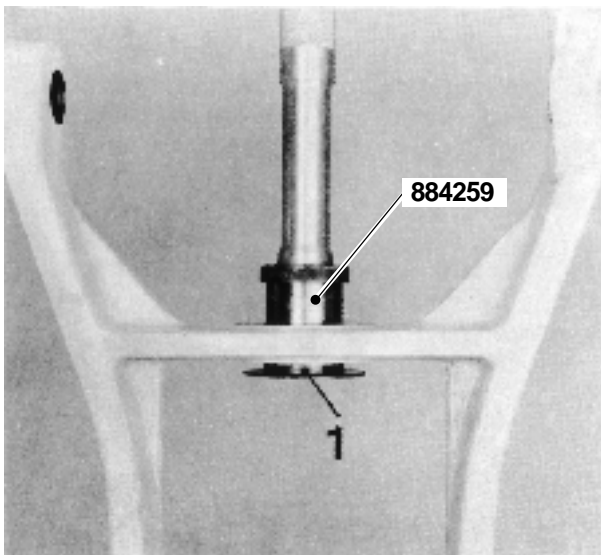


2. Dismantle the yoke by driving out the steering spindle. Use special tools **884311** and **9991801**. Then remove the retaining pawl from the yoke.

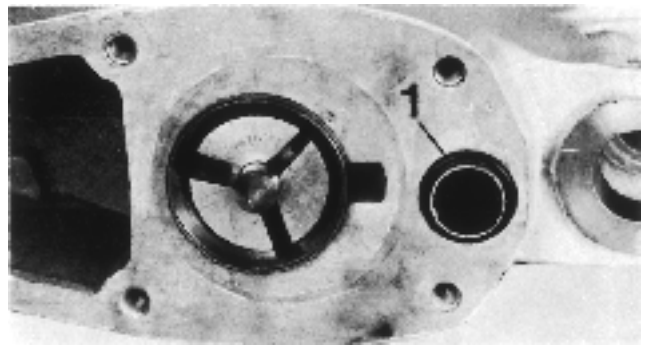


4. Press out the sealing rings and the needle bearing. Use special tool **884259** and **9991801**.

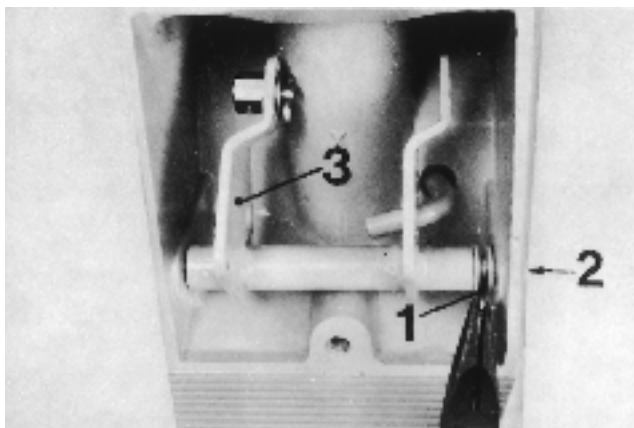
**NOTE!** There is a sealing ring on each side of the needle bearing.



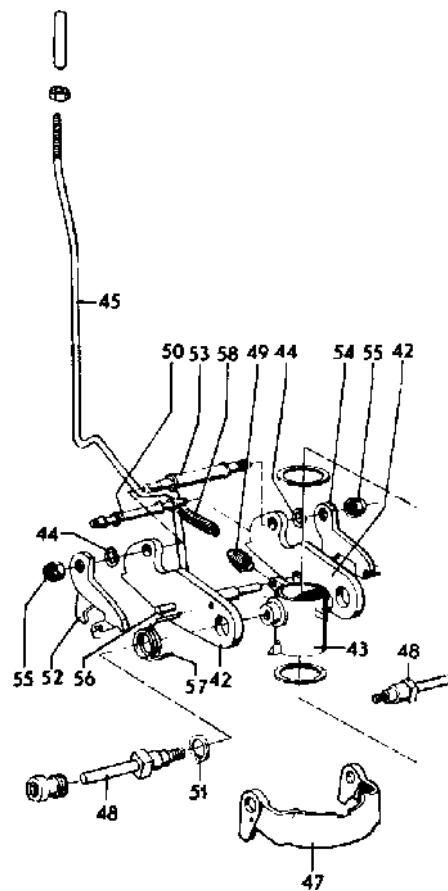
5. Press out the bushing (1). Use special tool **884259**.



7. Dismantle the axial bearing race. Use special tools **884140** and **884143**. Also replace the O-rings (1). One at each end of the tube.



6. Should the shift yoke need to be replaced, remove the cotter pin (1). Then it is possible to pull out the shaft (2) and the shift yoke (3).



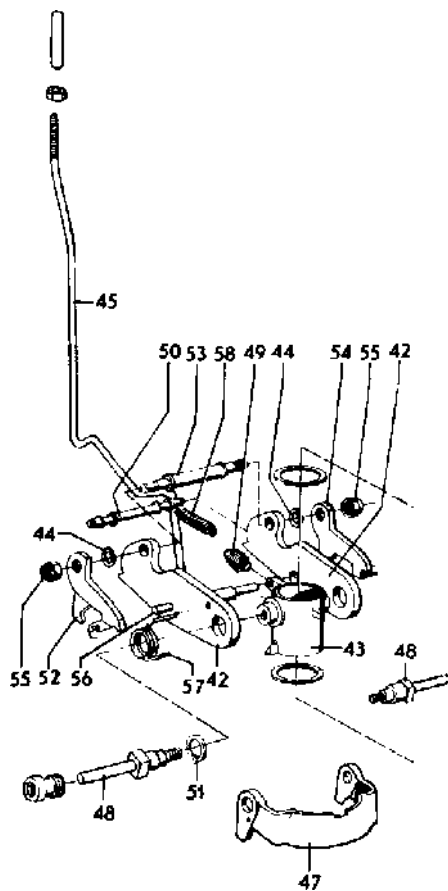
8. The retaining pawl is dismantled, when necessary, as follows:

Remove the shaft journals (48). Remove the spring (57), the spring (49) and the springs (58).

**NOTE!** Hold the spring shaft (50). Remove the nuts (55) and the spring catches (52) and (54) and the spacer washers (44) and the retaining pawl (42). Lift out the bearing (43) and the shaft (53) and the push rod (45). Wash the parts and check for wear. Replace parts if necessary.

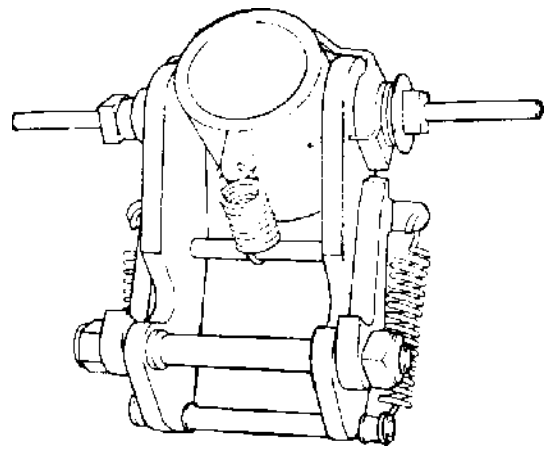
## Assembly

Oil all moving parts and the screws prior to assembly.



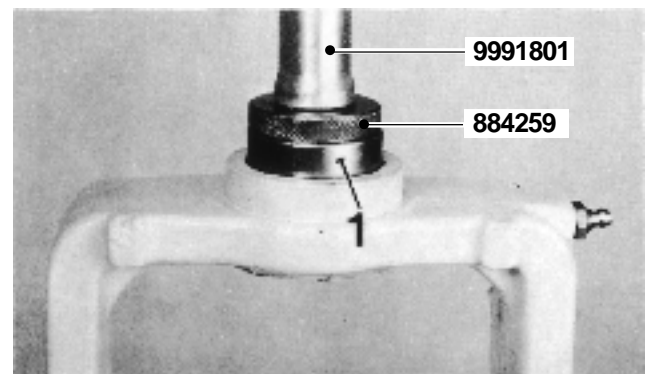
9. Install the shaft (53) on one of the retaining pawls (42) and the spacer washer (44) and the spring catch (52). Install one of the nuts (55) on the shaft. Then place the push rod (45) on the stop shaft (56) and insert the bearing (43) in the retaining pawl half. Then install the remaining retaining pawl (42) and the spring catches (54) along with the spacer washer (44) on the shaft (53) and the bearing (43). Install the remaining nut (55).

**NOTE!** Tighten the nuts (55) completely. Then ease them off approx.  $\frac{1}{8}$  turn in order to make the spring catches movable without adding a play. Then install the locking yoke (47) and the shaft journals (48) along with the spring (57) and the washer (51) in the bearing (43). Install the spring shaft (50) with the assistance of the springs (58) and install the spring (49) between the bearing (43) and the stop shaft (56).

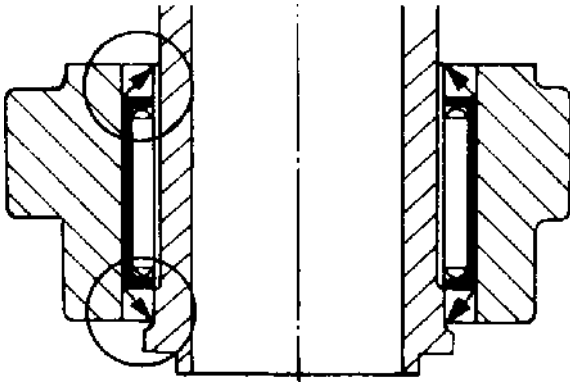


10. Paint the retaining pawl with a thin layer of 'touch-up paint'. Painting is hard to do when the pawl is assembled.

The picture reflects an assembled retaining pawl.

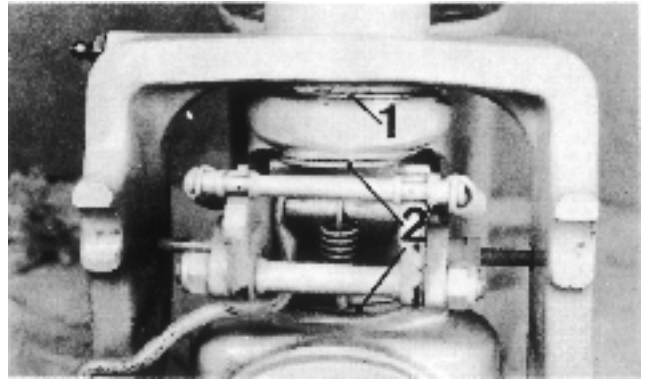


11. Grease the needle bearing (1) with an universal type of grease and press it into the center of the yoke. Use special tool 884259 and 9991801. Turn the bearing in a way that the tool is pressing against the side where the material is at the thickest, (where the text is stamped into the material).



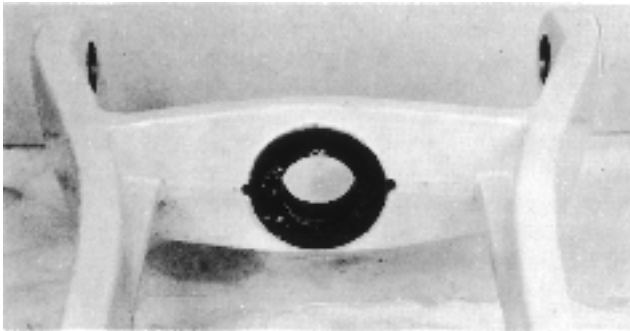
**12.** Press in both sealing rings. Use special tool **884259**.

**NOTE!** The sealing rings are to seal against water and thus have to be installed "facing" each other.

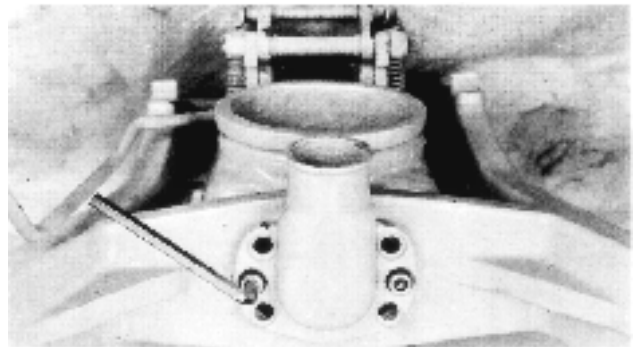


**14.** Install the retaining pawl in the yoke and place the yoke with the retaining pawl in its location in the intermediate housing.

**NOTE!** Insert the wear washer (1) between the lower attachment of the yoke and the intermediate housing and the two plastic washers (2) with one on each side of the bearing. Then press in the steering spindle until the collar bottoms. Be very careful during the installation of the steering spindle in order to avoid damaging the lower sealing ring.

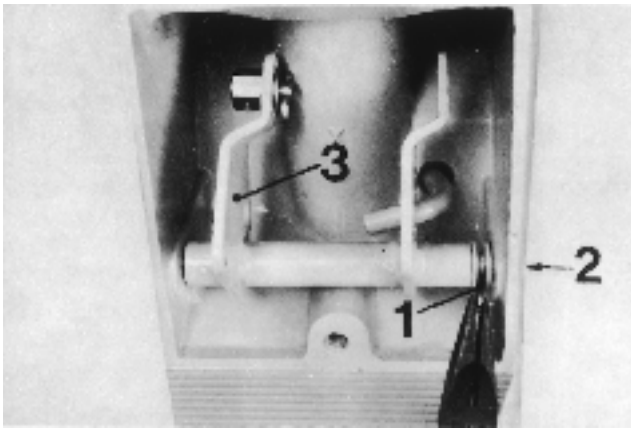


**13.** Glue the bushing to the yoke. Use bushing installation adhesive, Volvo Penta part no. 11161351-0 or Loctite® 603 . The flange must be turned downwards against the retaining pawl.



**15.** Install the hose connection with its gasket on the yoke. Coat the sealing surfaces with sealing compound, Volvo Penta part no. 1161099-5 or Permatex® no. 3.

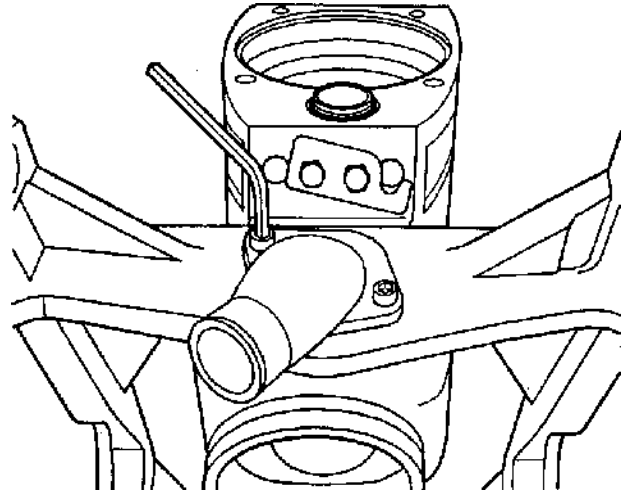
**NOTE!** On sterndrive model 280 the hose connection must be pointing straight forwards.



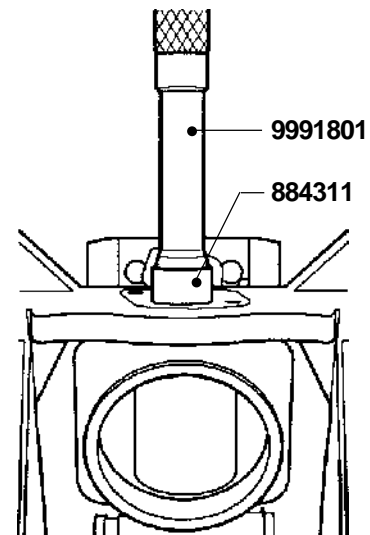
16. Install the shift yoke (3) and push in the shaft (2) and lock it with the cotter pin (1).

**NOTE!** A washer must be installed on either side of the cotter pin.

## Reconditioning the intermediate housing, model 290 and 290A

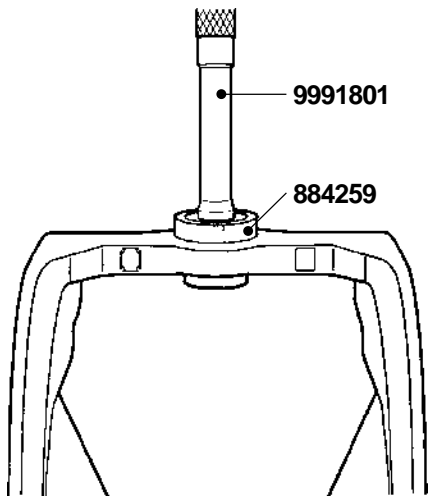


1. Remove the 2 screws holding the hose connection. Remove the hose connection and the gasket.



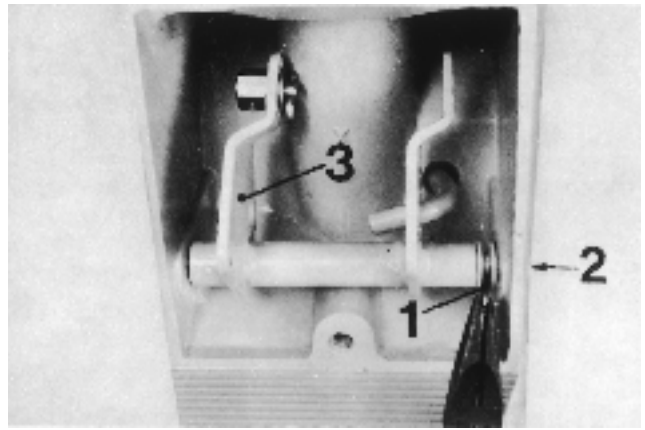
2. Remove the yoke by driving out the steering spindle. Use special tools **884311** and **9991801**. Lift up the attachment device of the trim cylinders and remove the retaining pawl, the two wear washers, the plastic washer and the guide washer from the steering yoke.



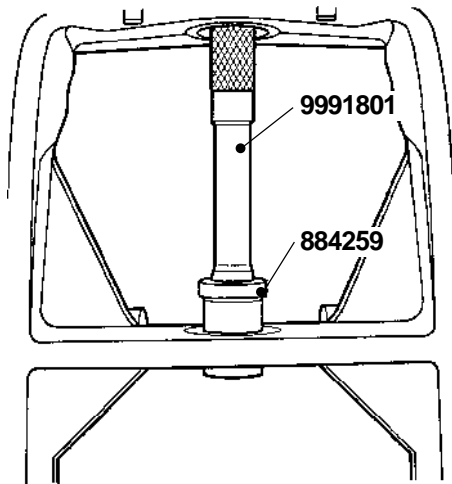


3. Press out the sealing rings and the needle bearing. Use special tools **884259** and **9991801**.

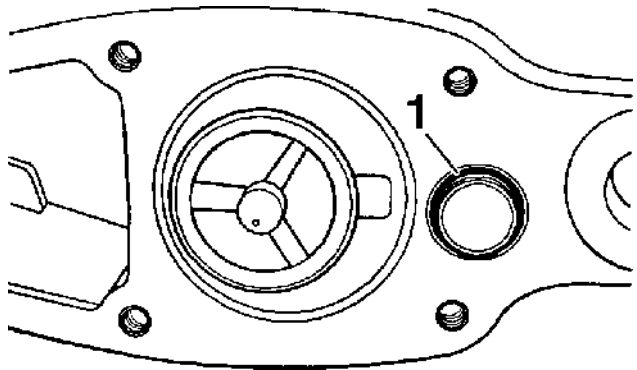
**NOTE!** There is a sealing ring on each side of the needle bearing.



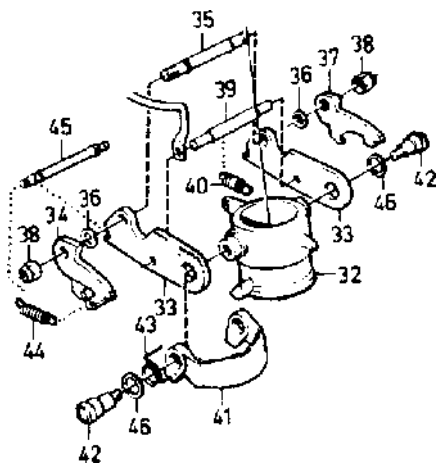
5. Should the shift yoke be in need of being replaced, remove the cotter pin (1). Then pull out the shaft (2) and remove the shift yoke (3).



4. Press out the bushing. Use special tools **884259** and **9991801**.



6. Remove the bearing race of the axial bearing. Use special tools **884140** and **884143**. Also replace the O-rings (1). One in each end of the oil tube.



7. If necessary the retaining pawl is dismantled as follows:

Remove the shaft journals (42). Remove the spring (43) the spring (40) and the springs (44).

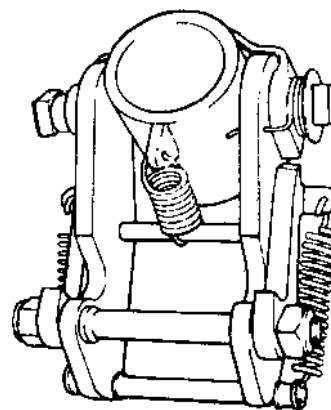
**NOTE!** Hold the spring shaft (45). Remove the nuts (38) and spring catches (34) and (37) and the spacer washers (36) as well as the retaining pawl (33). Remove the bearing (32) and the shaft (35). Clean the parts and check for wear. Replace parts if necessary.

## Assembly

Oil all moving parts and the screws prior to assembly.

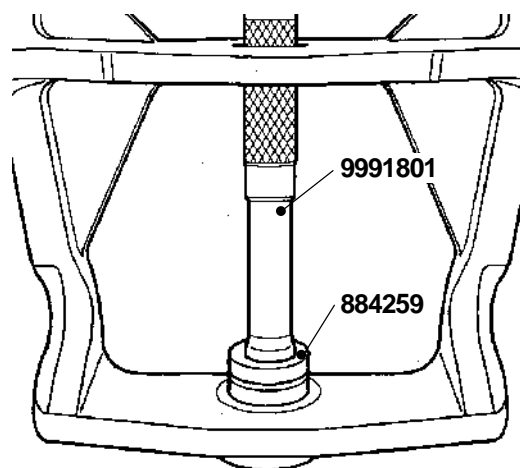
8. Install the shaft (35, picture above) on one of the retaining pawls (33) and install the spacer washer (36) and the spring catch (34). Install one of the nuts (38) on the shaft. Then place the stop shaft (39) and the bearing (32) in the retaining pawl half. Then install the remaining retaining pawl (33) and the spring catch (37) the spacer sleeve (36) on the shaft (35) and the bearing (32). Install the second nut (38).

**NOTE!** Tighten the nuts (38) completely. Then ease off a 1/8 turn to allow the spring catches to move without adding a play. Then install the locking yoke (41) and the shaft journals (42) with the spring (43) and the washer (46) in the bearing (32). Install the spring shaft (45) in its location with the assistance of the springs (44) and install the spring (40) between the bearing (32) and the stop shaft (39).

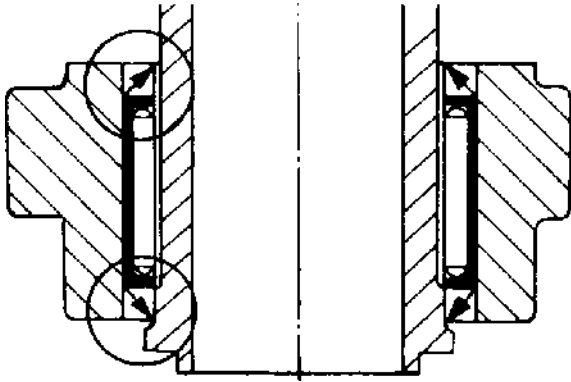


9. Paint the retaining pawl with a thin layer of "touch-up paint". Painting is hard to do when the pawl is assembled.

The picture reflects an assembled retaining pawl.

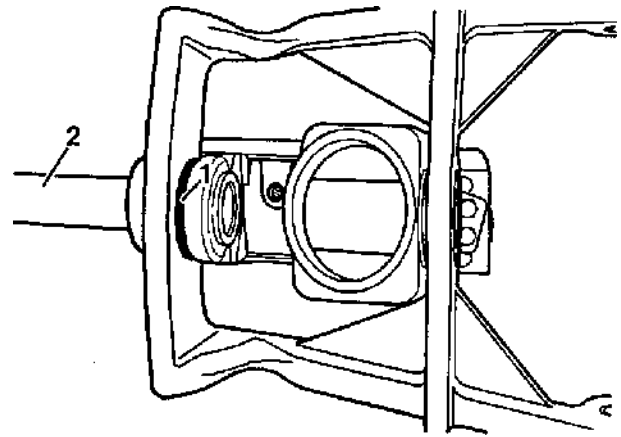


10. Grease the needle bearing with an universal type of grease and press it into the center of the yoke. Use special tools 884259 and 9991801. Turn the bearing in a way that the tool is pressing against the side where the material is at the thickest (where the text is stamped into the material).



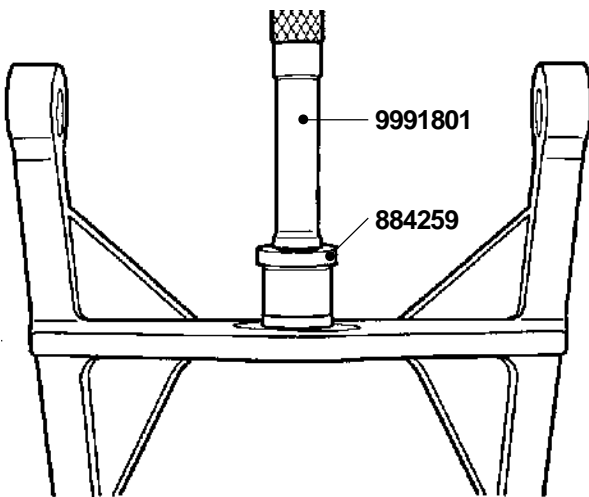
11. Press in both sealing rings. Use special tool **884259**.

**NOTE!** The sealing rings are to seal against water and thus have to be installed "facing" each other.

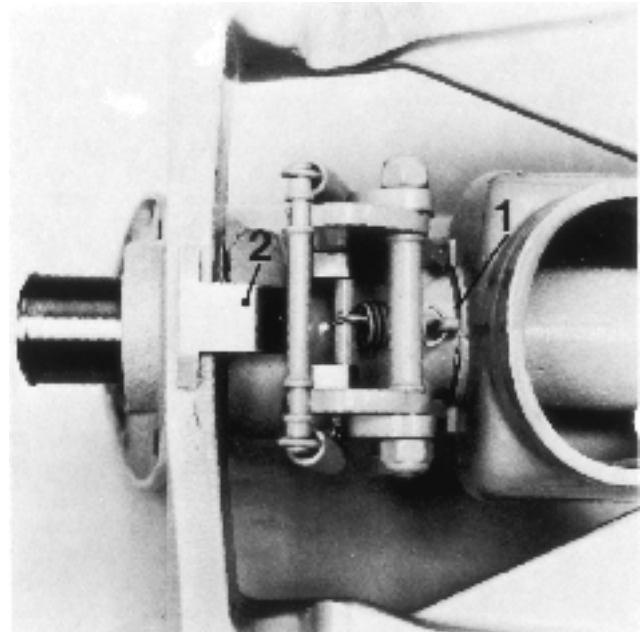


13. Place the yoke and the wear washer (1) on the intermediate housing and push in the steering spindle (2) as far as to hold the wear washer.

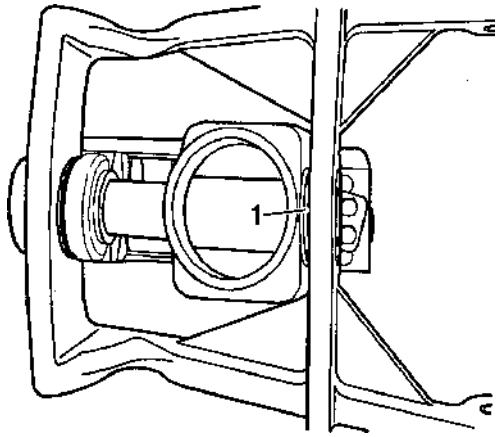
**NOTE!** Be careful not to damage the lower sealing rings.



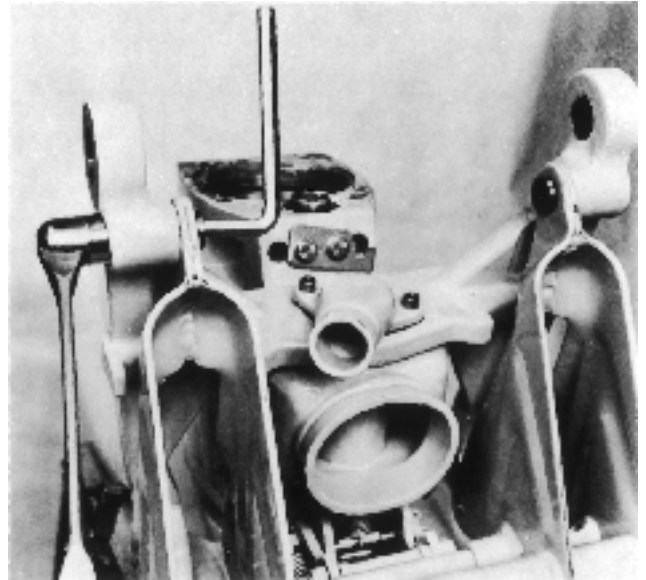
12. Press the bushing into the yoke. Use special tool **884259** and **9991801**.



14. Insert the retaining pawl into the intermediate housing. Then insert the plastic washer (1) and the guide washer (2) between the retaining pawl and the intermediate housing. Then push in the steering spindle as far as to hold the plastic washer.

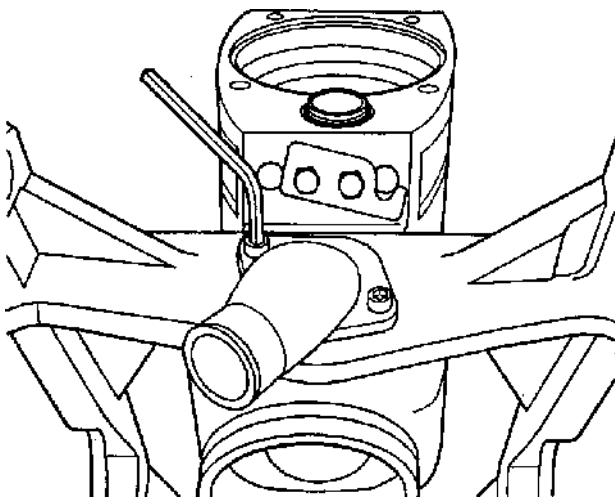


15. Insert the wear washer (1) between the steering yoke and the intermediate housing and push in the steering spindle until the collar bottoms.

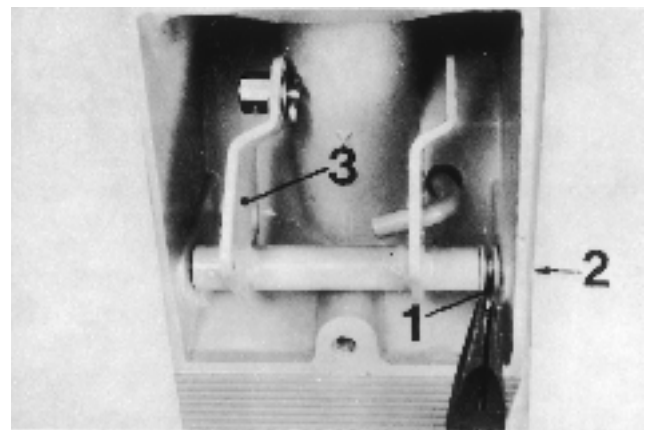


17. If the trim cylinder attachment is in need of repair or in need of being replaced, remove the 2 collar screws. Use a socket wrench (17 mm) as a counter hold. Then install the new cylinder attachment.

**NOTE!** Use the same screws, washers and nuts unless they are damaged.



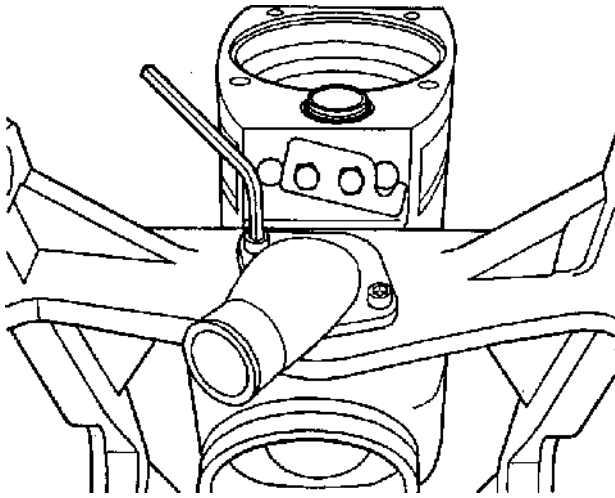
16. Install the hose connection and the gasket on the yoke. Coat the surfaces with sealing compound, Volvo Penta part no. 1161099-5 or Permatex® no. 3.



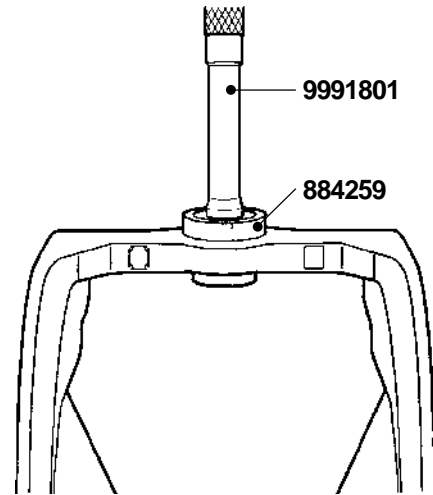
18. Install the shift yoke (3) and push in the shaft (2) and lock it with the cotter pin (1).

**NOTE!** Install a washer on each side of the cotter pin!

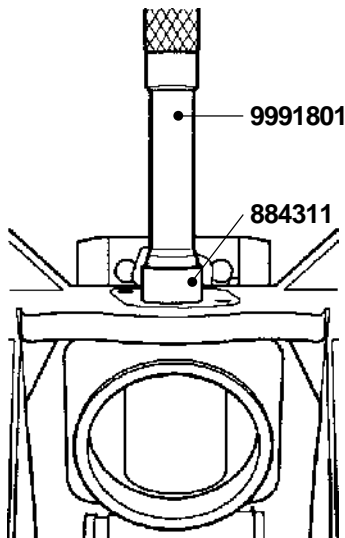
## Reconditioning the intermediate housing, models SP and DP



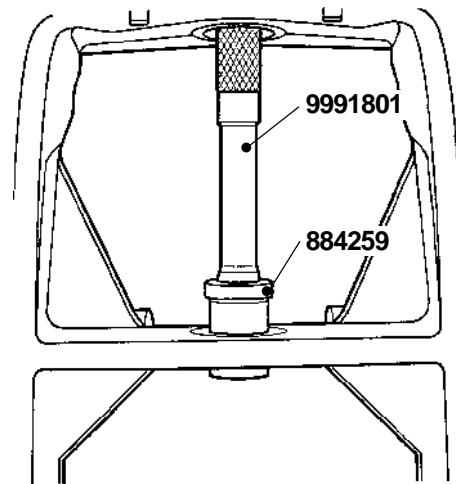
1. Remove the 2 screws holding the hose connection. Remove the hose connection and the gasket.



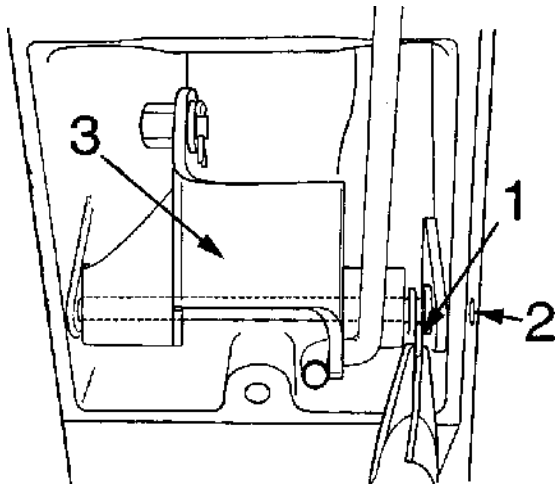
3. Press out the lower steering spindle bushing. Use special tools **884259** and **9991801**.



2. Remove the hook up fork by driving out the steering spindle. Use special tools **884311** and **9991801**.

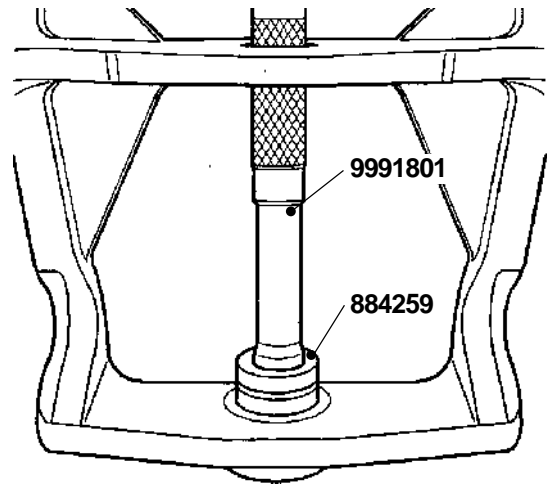


4. Press out the upper steering spindle bushing using special tool **884259** and **9991801**.

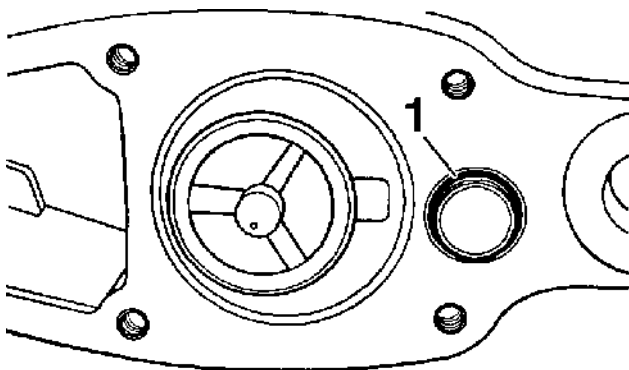


5. Should the shift fork require replacement, remove the cotter pin (1). Remove the shaft (2) and remove the shift yoke (3). To install reverse procedure.

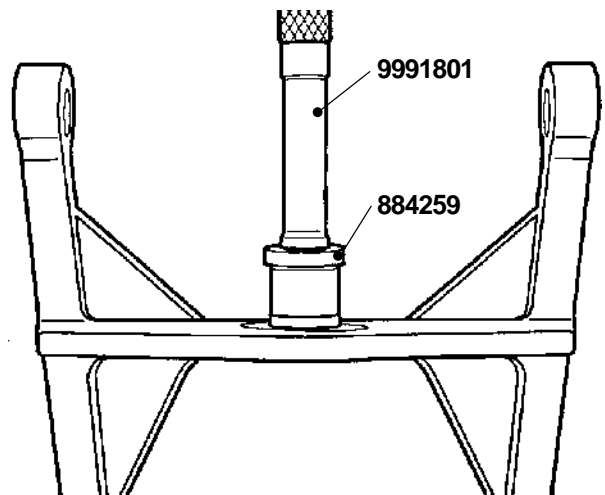
**NOTE!** Always use a new cotter pin when reinstalling.



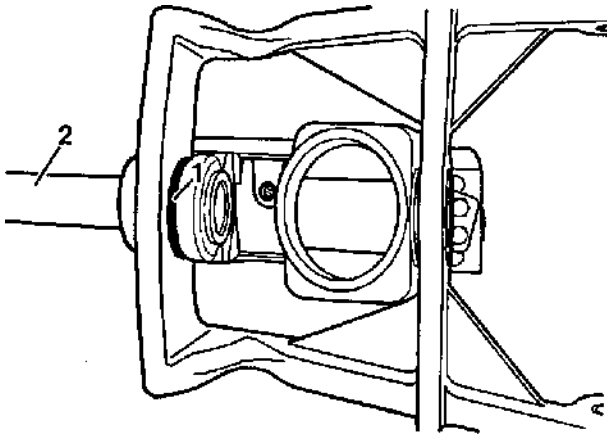
7. Grease the lower hook up fork bushing with Volvo Penta part np. 828250-1 water resistant grease. Using special tool **884259** and **9991801**, press in the bushing.



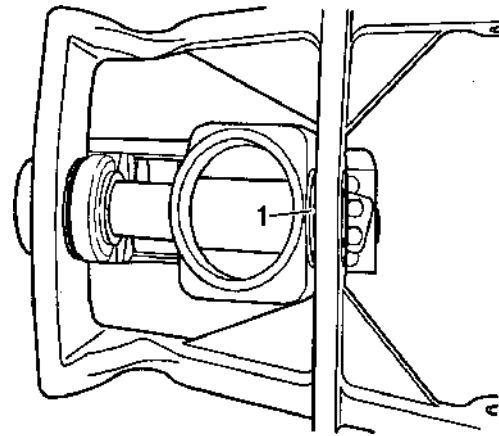
6. Remove the bearing race of the axial bearing. Use special tool **884140** and **884143**. Also replace the O-rings (1). One on each side of the oil tube.



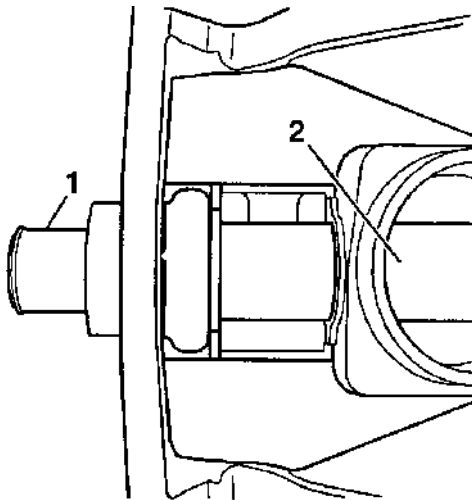
8. Press the bushing into the hook up fork. Use special tools **884259** with handle **9991801**.



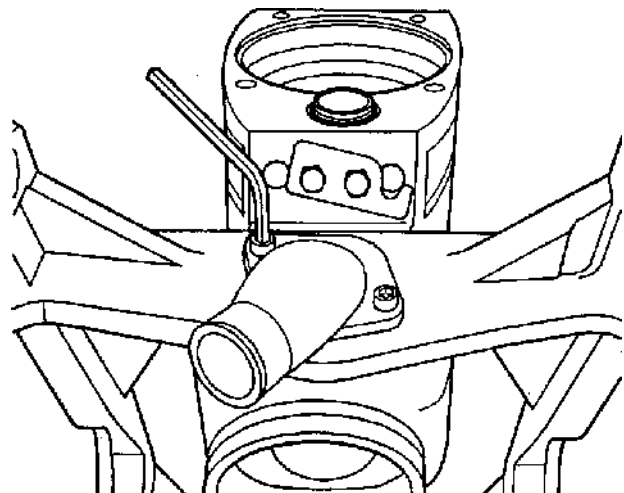
**9.** Place the wear washer (1) on the intermediate housing and push the steering spindle (2) in far enough to hold the wear washer.



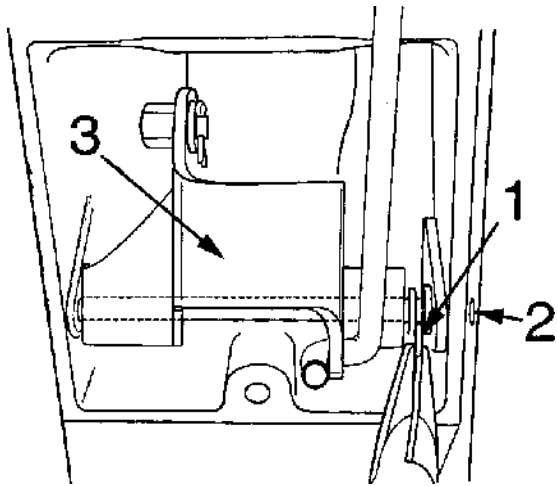
**11.** Insert the plastic wear washer (1) between the intermediate housing and the hook up fork. Push the steering spindle in until the collar bottoms.



**10.** Push the steering spindle (1) through the intermediate housing exhaust port (2) stopping short of the upper hook up fork bushing.



**12.** Install the O-ring and the hose connection on the yoke. Use a small amount of Volvo Penta part no. 828250-1 water resistant grease to hold the O-ring in place while installing the hose connection.



**13.** Install the shift yoke (3). Align the shift yoke with the shaft hole in the intermediate housing. Push the shaft (2) through and lock it with a new cotter pin (1).

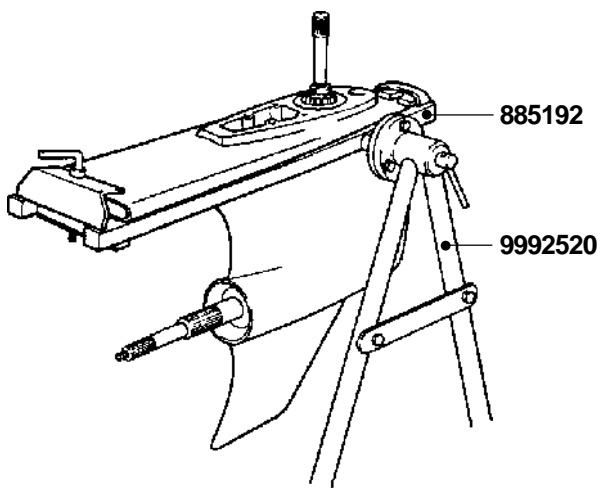


## Lower gear

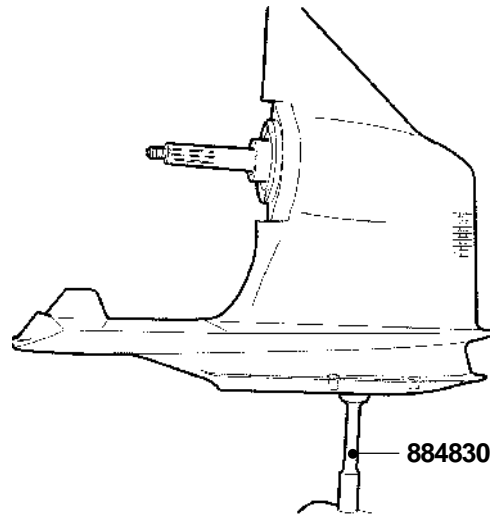
### Reconditioning the lower gear, models 280, 285, 290 and SP

#### Disassembly

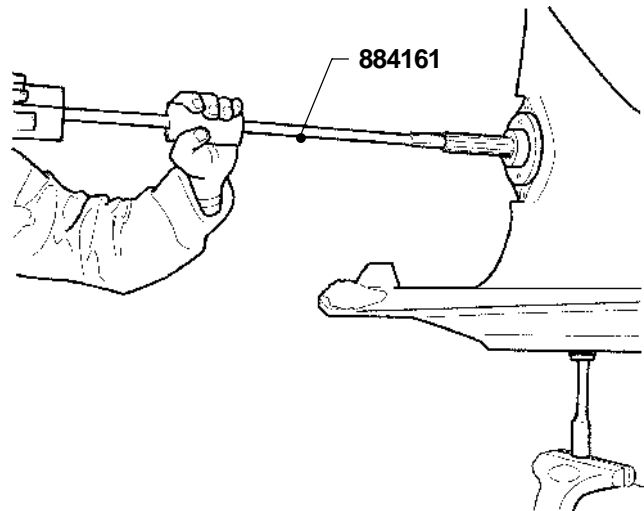
##### The propeller shaft



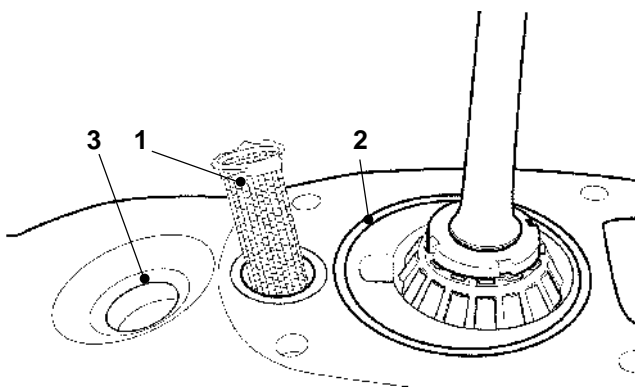
1. Install the suspension fixture **885192** in stand **9992520** and brace the lower unit in the stand.



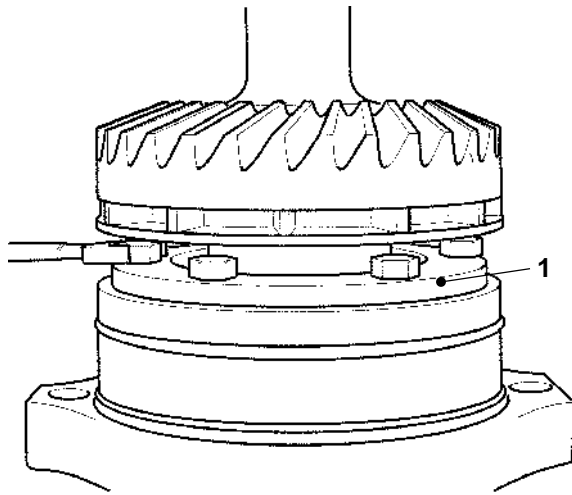
3. Use special tool **884830** and install the lower gear upside down.



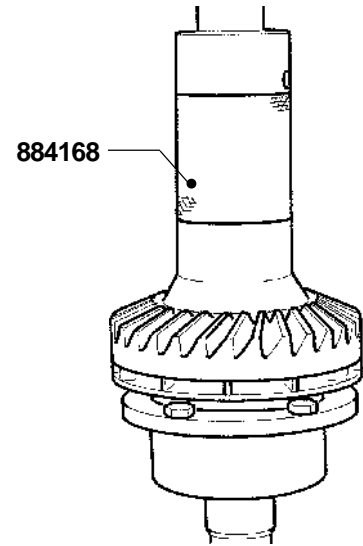
4. Remove the 2 screws holding the propeller bearing housing. Remove the propeller shaft and the propeller bearing housing. Use special tool **884161**. Remove the special tool once the propeller bearing housing is free and pull out the bearing housing by hand.



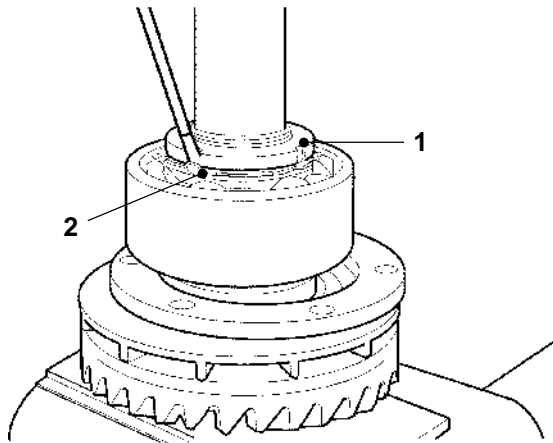
2. Remove the oil strainer (1) and the O-rings (2 and 3, only models 280, 285 and 290).



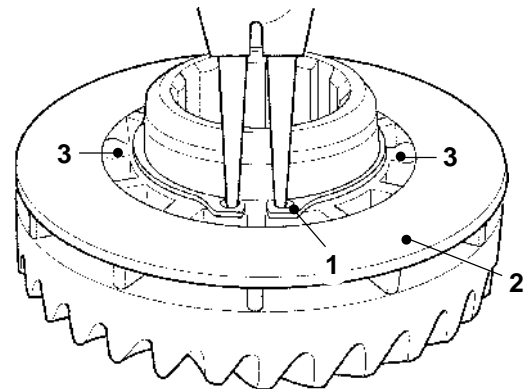
5. Remove the 6 nuts holding the washer (1) and knock the propeller shaft out of the bearing housing. Use a copper mallet or its equivalent in order not to damage the threads.



7. Press off the gear wheel and the bearing from the propeller shaft simultaneously. Use special tool **884168**.

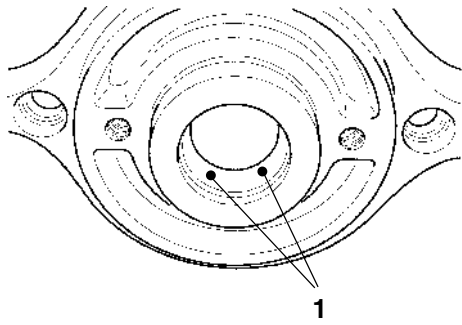


6. Fold down the locking washer (1) remove the round nut (2).

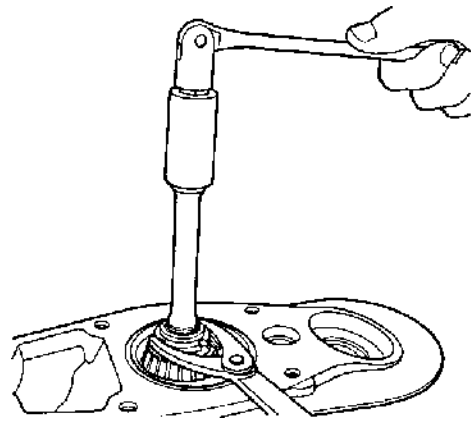


8. Remove the locking ring (1) and the oil deflector (2) from the gear wheel.

**NOTE!** In order not to damage the oil deflector during the dismantling, apply the bending tool close to the 2 carrier pins (3). (This is valid for sterndrives of earlier manufacture). On sterndrives of later manufacture the carrier pins have been replaced by a load pin.

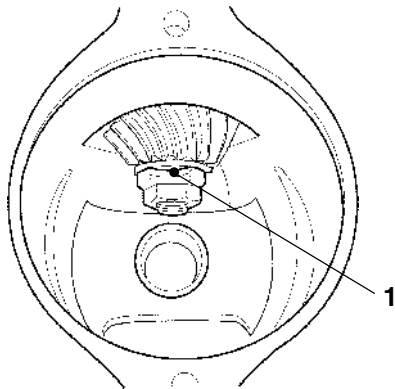


9. Knock out the 2 sealing rings (1) off the propeller bearing housing.

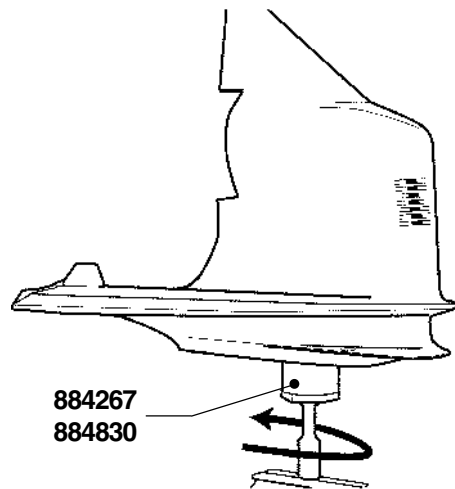


11b. Models 280, 290 of later manufacture: Lift the gear housing off the special tool and place it back in the work stand. Remove the nylock® nut with a hook spanner wrench.

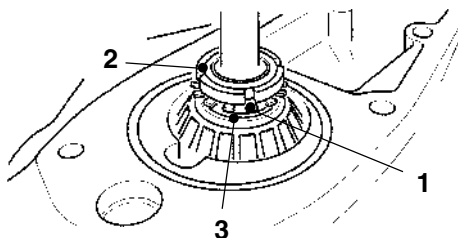
### The vertical shaft



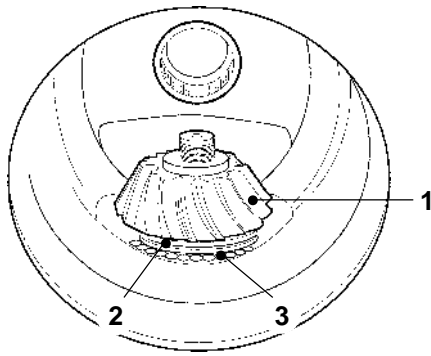
10. Fold down the tab on the locking washer (1) and remove the nut holding the pinion to the vertical drive shaft.



12. Use special tools 884267 and 884830 to remove the pinion.

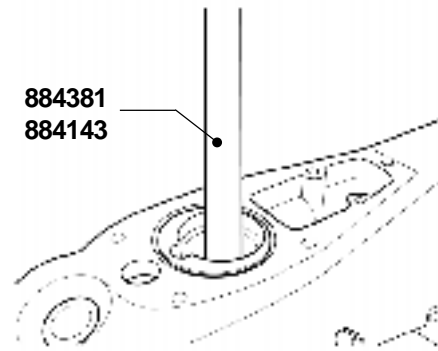


11a. Models 280 and 290 of earlier manufacture and model SP: Fold down the tab of the locking washer (1) and remove the round nut (2). Remove the locking washer and the spacer ring (3).

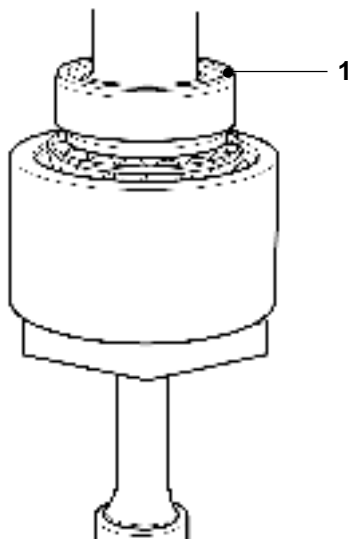


**13.** Lift out the pinion (1) and the needle bearing washer (2).

**NOTE!** The needle bearing is a full needle type of bearing with loose needles (3). Remove all 27 needles.

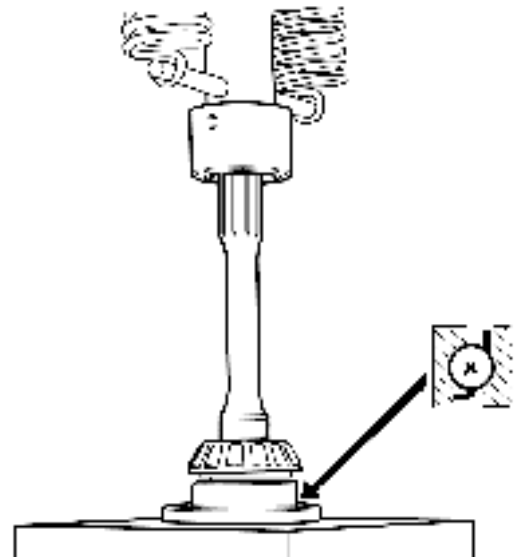


**15.** Press (knock) off the outer ring of the needle bearing. Use special tools **884381** and **884143**. Insert the tool from underneath and the shaft from above.



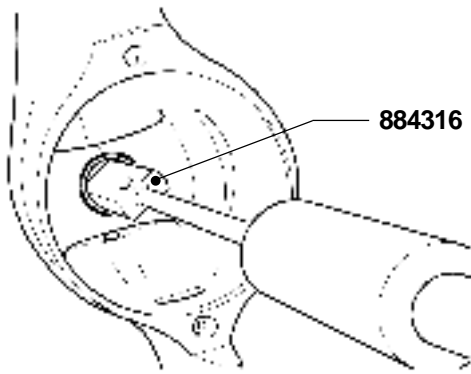
**14.** Carefully lift off the lower gear housing from the vertical drive shaft.

**NOTE!** Take care of the shims (1).

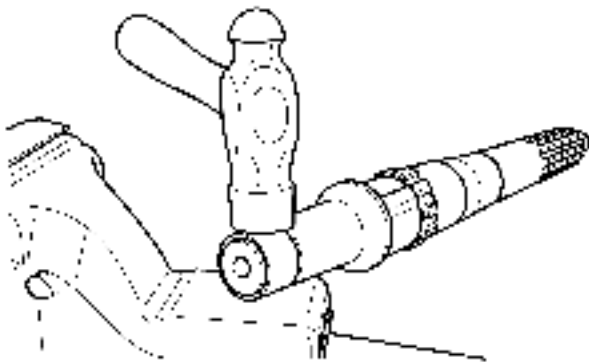


**16.** Press off the ball and roller bearings from the vertical shaft (against the frame of the press).

**NOTE!** There are spacer pads between the bearings.



17. Should the needle bearing of the propeller shaft be damaged, use special tool **884316** to remove it. Insert the puller into the needle bearing in a way that the barbs of the puller end up at the backside of the needles. Then tighten the puller forcing the barbs apart and pull out the bearing.

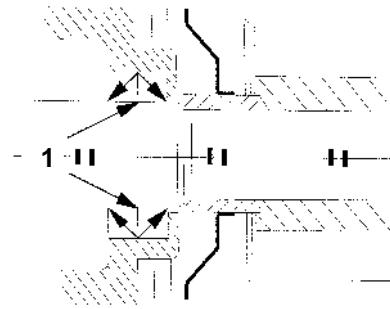


18. Remove the bearing race on the propeller shaft by cracking it. Clean all parts and check them for wear. Replace parts if necessary.

**NOTE!** The gear wheels are sold in matched pairs in order to obtain the correct contact pattern.

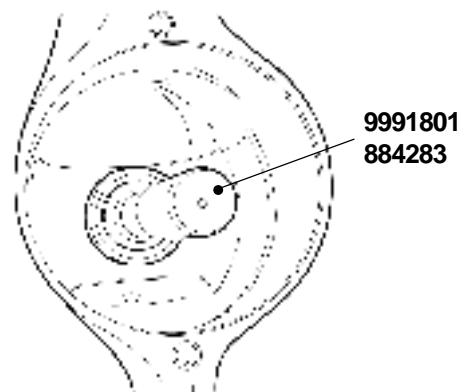
## Assembly

Oil all moving parts and the screws prior to assembly.

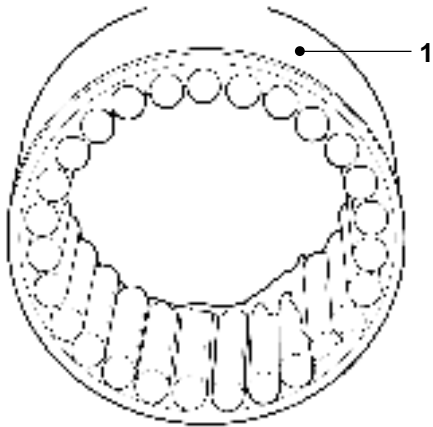


1. Fill up with grease between the two sealing rings (1) and press them home in the propeller bearing housing. Use special tools **884283** and **9991801**.

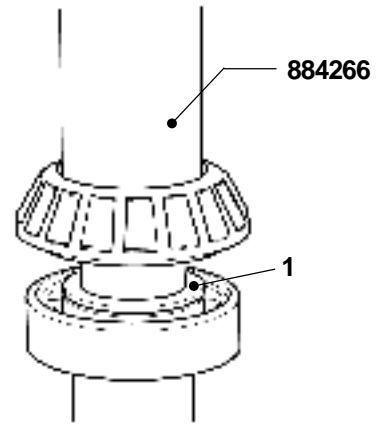
**NOTE!** Turn the sealing rings correctly. They are to seal against the oil in the gear housing as well as against water.



2. Install the needle bearings for the propeller shaft. The side of the needle bearing carrying the description must be turned facing aft. Use special tools **884283** and **9991801**.

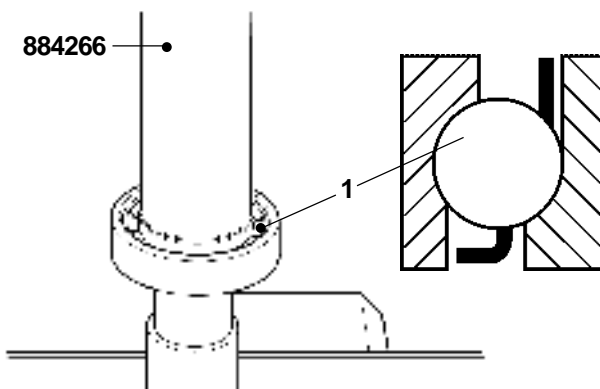


3. Grease abundantly the outer race (1) with grease and insert the 27 needles, well cleaned, into the ring letting the grease hold them. Insert special tool **84385** in the bearing and insert the bearing from underneath into the gear housing. Then install the special tool **884241** from above and pull the bearing into its seat in the gear housing.



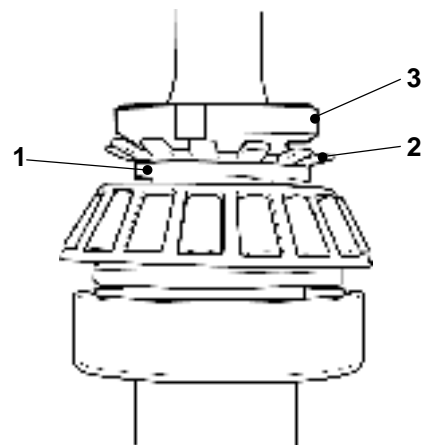
5. Install the spacer pad (1) on the ball bearing and press on the roller bearing. Use special tool **884266**.

### The vertical shaft



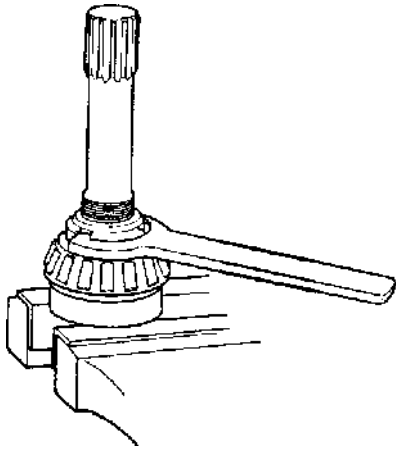
4. Press on the ball bearing on the vertical shaft. Use special tool **884266**.

**NOTE!** Install the ball bearing according to figure in a way that the balls (1) become visible.

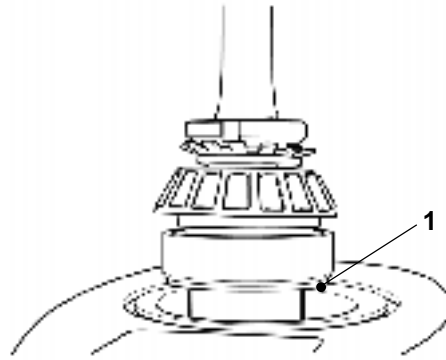


6a. **Models 280 and 290 of earlier manufacture and model SP:** Install the spacer ring (1), the locking washer (2) and the round nut (3) on the vertical shaft. Tighten the nut.

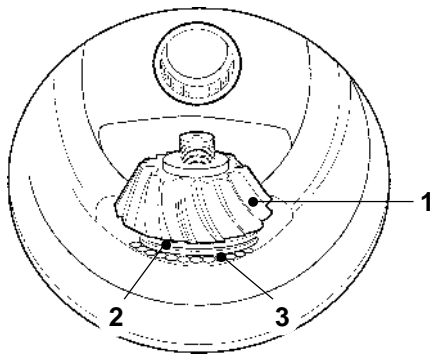
**NOTE!** Don't lock the nut with the washer just yet.



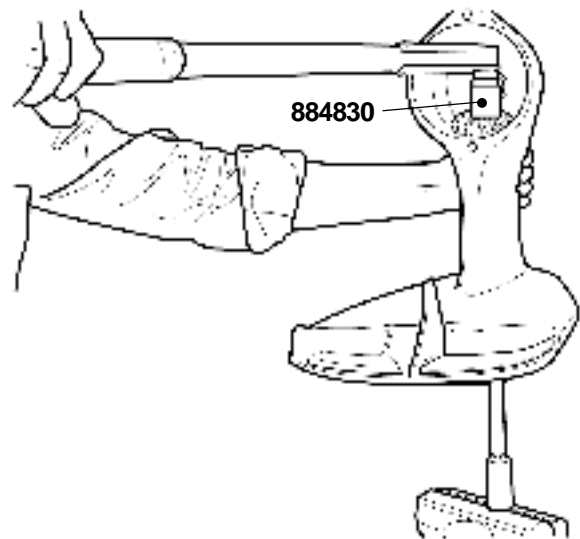
**6b. Models 280, 290 of later manufacture:** Install the thick spacer ring and tighten the plastic insert locknut. Use a hook spanner wrench.



**8.** Install the vertical shaft with a 0.35 mm (0.14") thick shims package (1) consisting of a paper shim 0.25 mm (0.01") between two metal shims 0.05 mm (0.002") each.

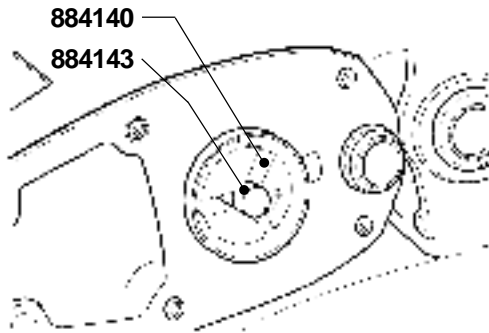


**7.** Insert the pinion (1) along with the washer (2) for the needle bearing (3) into the gear housing.

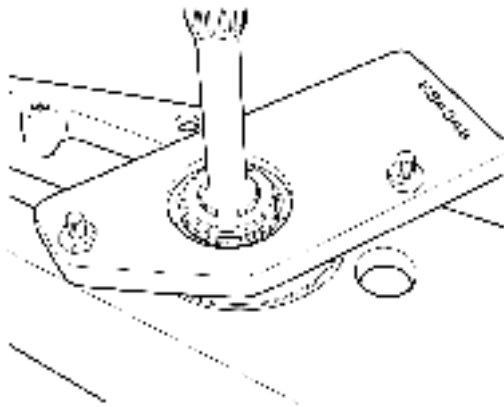


**9.** Install the washer and the nut. Tighten the nut with a torque of **160 Nm (118 lbf.ft.)**. Use special tool **884830** on the splined end as a counter hold.

**NOTE!** Don't lock just yet.

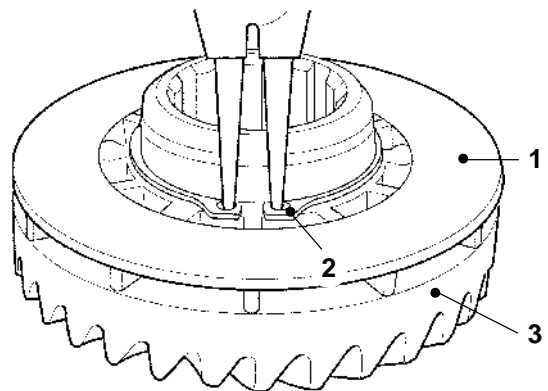


10. Remove the conical roller bearing race in the intermediate housing (if the old bearing can still be used). Use special tools **884140** and **884143**.



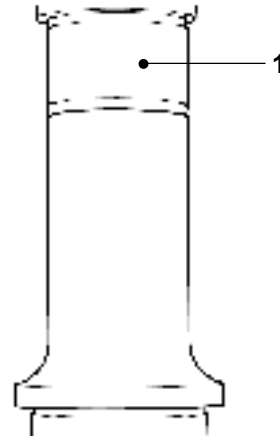
11. Insert the bearing race on the roller bearing on the lower gear housing and install the spanner tool **884348**. Insert if necessary shims between the bearing race and the tool to prevent the vertical shaft from moving axially. Tighten the spanner tool with two screws and nuts.

## The propeller shaft



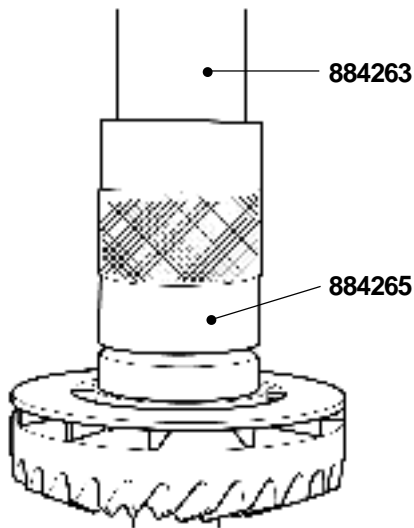
12. Install the oil deflector (1) and the locking ring (2) on the gear wheel (3).

**NOTE!** Make sure that the two holes on the oil deflector coincide with the carrier pins (on sterndrives of earlier manufacture). On sterndrives of later manufacture a load pin acts as carrier of the oil deflector.

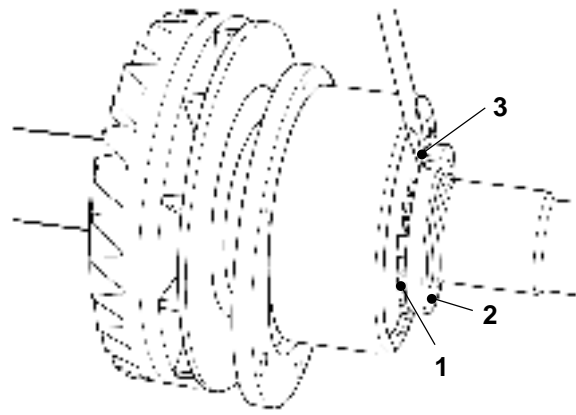


13. Press on the bearing race (1) on the propeller shaft (in case it has been dismantled).





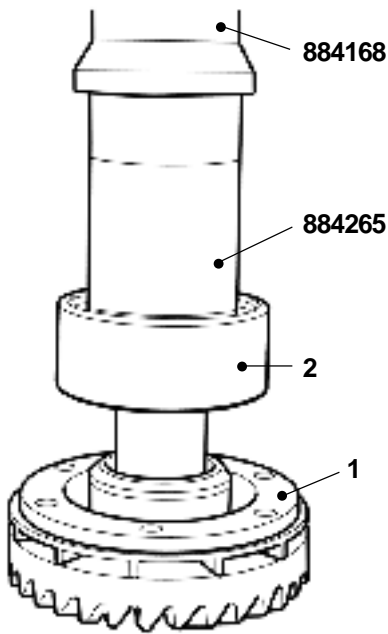
14. Press on the gear wheel on the propeller shaft. Use special tools **884265** and **884263**.



16. Install the locking washer (1) and the round nut (2). Tighten the nut and lock it with the locking washer (3).

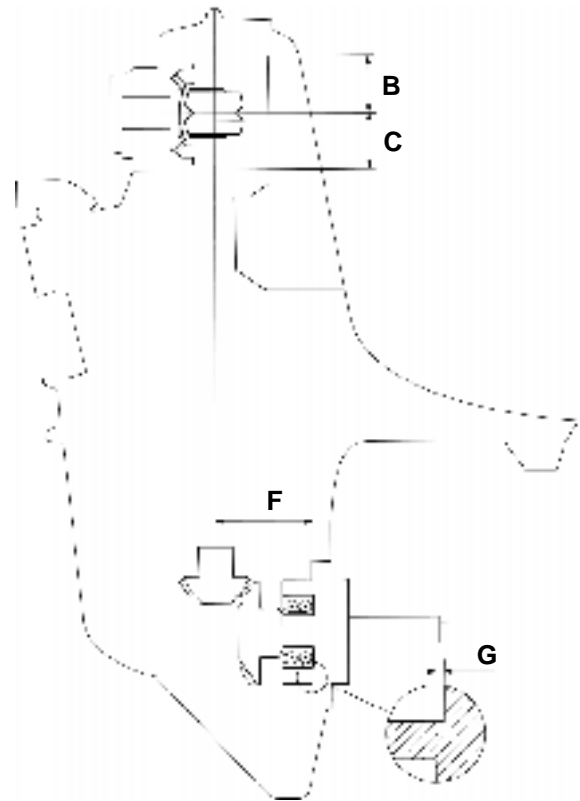
## Shimming

### Method 1

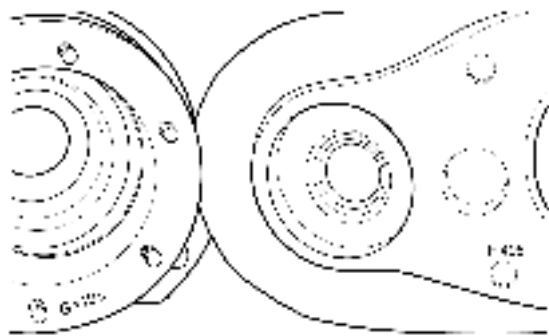


15. Install the locking washer (1) and press on the ball bearing (2). Use special tools **884265** and **884168**.

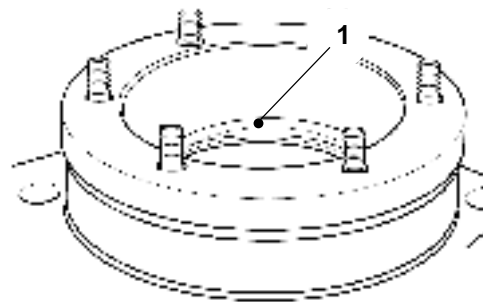
**NOTE!** Install the bearing in a way that the recess in the bearing races (for the insertion of the balls) is turned facing the propeller.



1. The lower gear housing is stamped with a 'F'-measurement (center vertical shaft – contact surface of the propeller bearing box), the propeller bearing box is stamped with a 'G'-measurement (shoulder of the propeller bearing – contact surface of the propeller bearing box). Add these measurements together.



## Method 2



2. The gear length is fixed at 5.85 mm (0.230"). Add or subtract the plus or minus marking of the gear wheel. Subtract from this sum the sum of the 'F' and 'G' measurements. The sum thus obtained denotes the thickness of the shim.

**NOTE!** On some gear housings for instance the figures 03 can be stamped or some other figure. In these cases add the number 5.00 to that of the 'F'-measurement and the figure 1.00 to that of the 'G'-measurement. Then the 'F'-measurement ends up being for instance 5.03 or some other measurement above 5 mm and the 'G'-measurement for instance 1.03 or some other measurement above 1.0 mm\*.

If the sum obtained does not coincide with available shims, select the closest five – or ten – number. How to calculate the shim thickness can be seen in the following example:

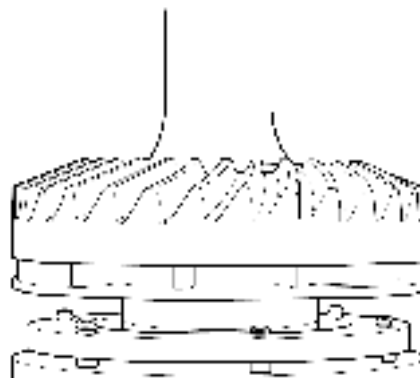
Measurement 'F'	4.97 (0.195")	stamped	
Measurement 'G'	+0.98 (0.039")	stamped	
	<u>5.95 (0.234")</u>		5.95
Gear wheel	5.85 (0.230")	fixed	
Gear wheel marking	+0.04 (0.002")	etched**	
	<u>5.89 ....</u>		5.89
<b>Calculated sum always positive!</b>			<b>0.06 (0.002")</b>

As per this example a 0.05 mm (0.002") shim is inserted between the propeller bearing box and the propeller thrust bearing. Carry on according to points 4–12 below!

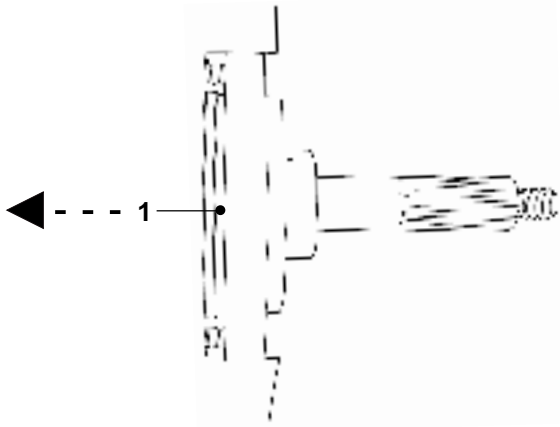
\* These measurements are examples.

\*\* Only the figure 4 is etched on the gear wheel

3. Insert the 0.2 mm (0.008") shim (1) in the propeller bearing housing. This is a value of experience.

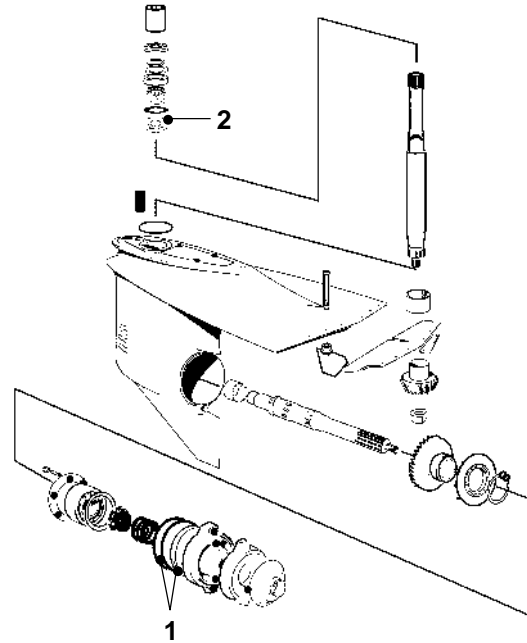


4. Install the propeller shaft along with bearings in the gear housing. Be careful so that the bearing does not end up obliquely in the bearing housing or that the sealing rings are damaged. Make sure that the six holes in the washer coincide with the screws. Insert the nuts before the bearing is pushed home completely in the bearing box. Tighten the six nuts.



5. Install the propeller shaft with its bearing box in the gear housing. Tighten the screws with a torque of **40 Nm (29.5 lb.ft.)**.

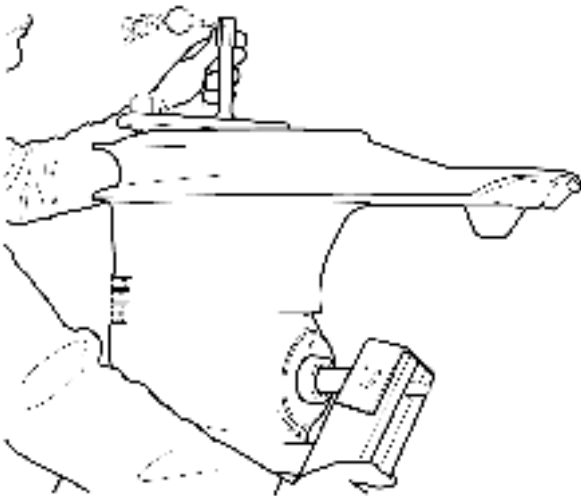
**NOTE!** The two O-rings (1) on the bearing housing should not be installed.



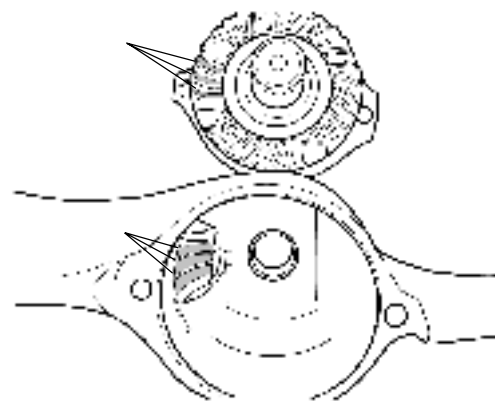
7. If the backlash is found not to be correct, adjust as follows:

**If the method 1 has been used:** If the backlash is too small, increase the shim thickness underneath the ball bearing (1) and if the backlash is too big, decrease the shim thickness.

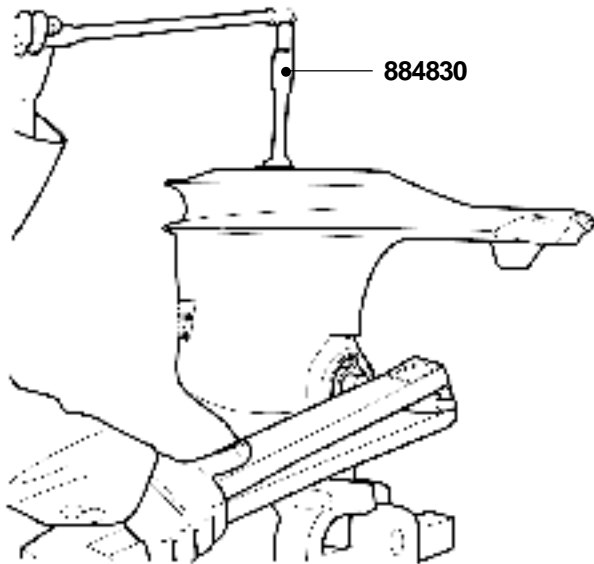
**If method 2 has been used:** If the backlash is too small decrease the shim thickness in the propeller bearing housing (2) and if the backlash is too big, increase the shim thickness.



6. Check the gear backlash and measure it directly against the vertical splines shaft. The clearance should be **0.06–0.10 mm (0.002–0.004")** resulting in a gear backlash of **0.15–0.25 mm (0.006–0.020")**.

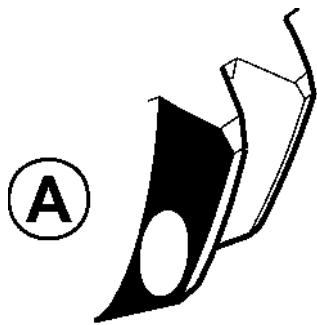


8. Remove the screws and pull out the propeller shaft. Coat the gear teeth of the gear wheel and the pinion with marking dye. Then install the propeller shaft with the bearing box in the gear housing. Tighten the screws with a torque of **40 Nm (29.5 lb.ft.)**.

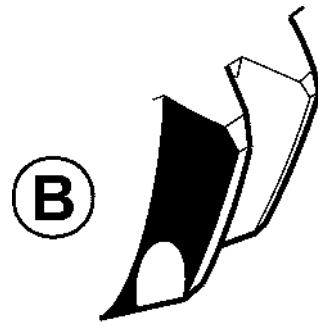


9. Install special tool **884830** onto the splines end and turn the gear in the set direction of rotation, clockwise for left handed propeller. At the same time brake the movement on the propeller shaft, as forcefully as possible.

### Contact pattern



10. Check that the contact pattern on the teeth surfaces of the drive side coincide with that of the picture "A", which is correct. The contact pattern should be positioned in the middle of the tooth but displaced towards the small end.



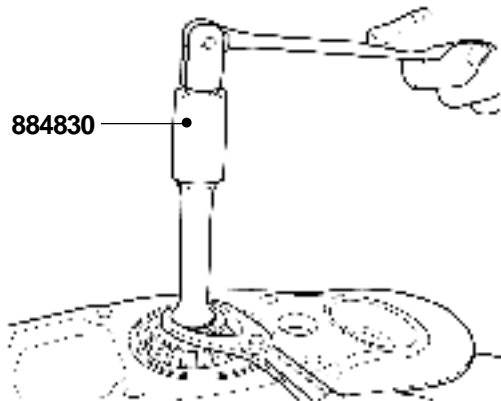
11. Should the contact pattern correspond to that of picture "B", reduce the shim thickness for the vertical shaft and the propeller shaft.



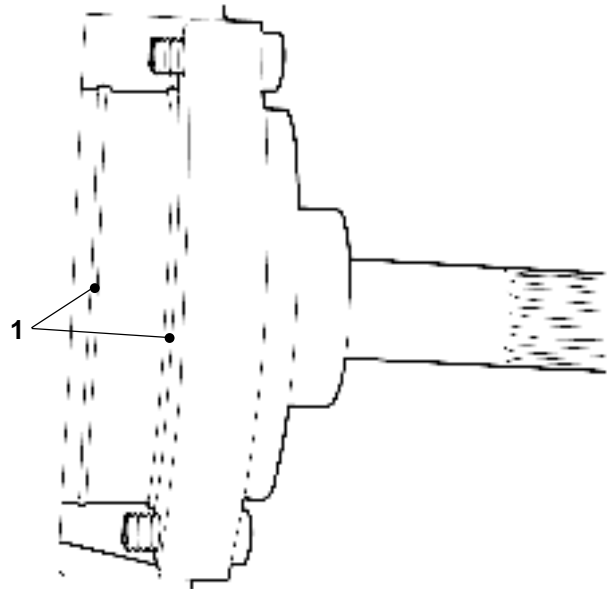
12. Should the contact pattern correspond to that of picture "C", increase the shim thickness for the vertical shaft and the propeller shaft.

**NOTE!** If the pinion is moved the gear wheel must be moved correspondingly in order not to alter the gear backlash.

## Final assembly

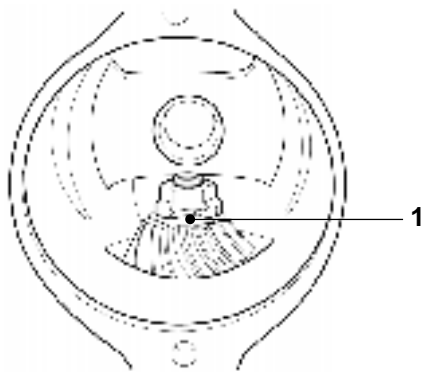


1. Dismantle pinion and gear and clean parts from marking dye and then assemble with the calculated shims. Then install the spacer ring, the locking ring and the nut on the vertical shaft. Tighten the nut and lock with the locking washer. Use special tool **884830** as a counter hold.



3. Install the O-rings (1) in the propeller bearing housing. Coat the contact surfaces and the screws with sealing compound, Volvo Penta part no. 1161099-5 or Permatex® no. 3. Install the propeller bearing housing in the gear housing and tighten the 2 Allen-head screws.

**NOTE!** Turn the vertical shaft somewhat to allow the gears to engage. Tightening torque **40 Nm (29.5 lb.ft.)**.

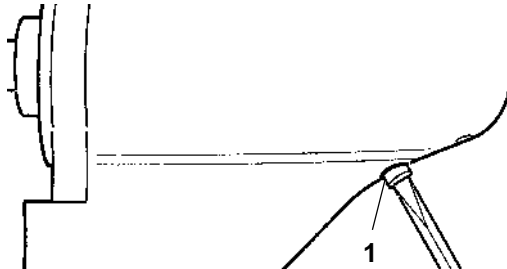


2. Tighten the pinion nut with a torque of **160 Nm (118 lb.ft.)**. Then lock the nut with the locking washer (1). Use special tool **884830** applied at the splines shaft end as a counter hold.

## Reconditioning the lower gear, models 280-DP, 290-DP and DP

### Disassembly

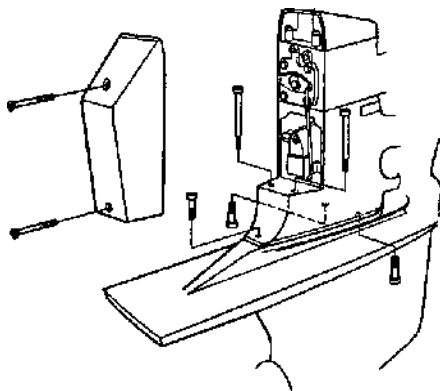
1. Clean the sterndrive externally.



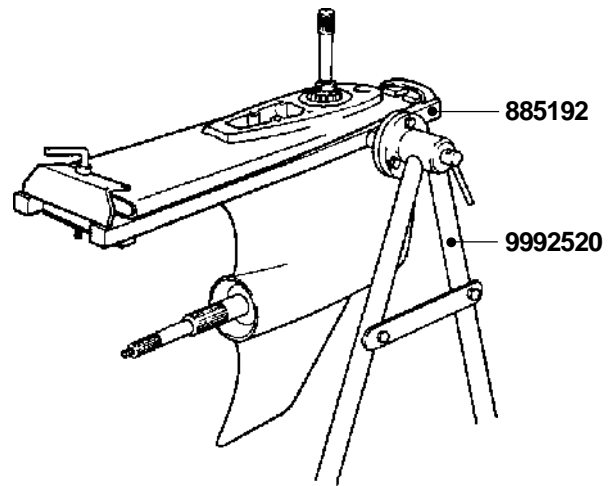
2. Drain the oil by removing the screw (1), if not already drained in previous steps.

**NOTE!** Place a drain pan under the sterndrive. Tilt the sterndrive all the way down to allow all the oil to drain.

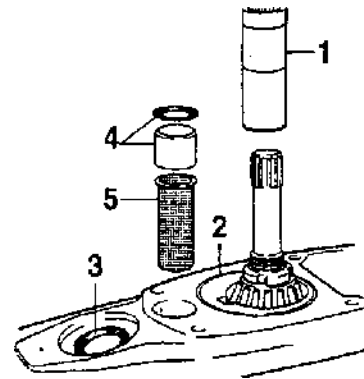
3a. **Models 280-DP and 290-DP:** Remove the lower gear from the intermediate housing (7 screws).



3b. **Model DP:** Remove the shift mechanism cover and remove the 5 bolts holding the lower unit on the intermediate housing. (Two bolts are inside the shift mechanism cover.)

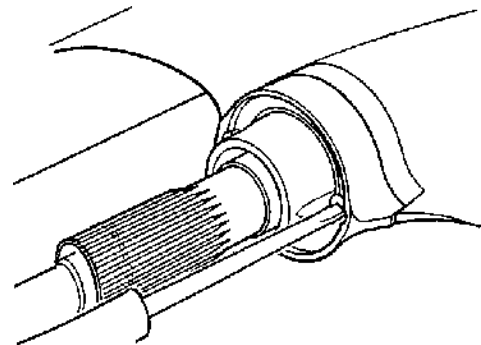


4. Install the suspension fixture **885192** in stand **9992520** and brace the lower unit in the stand.

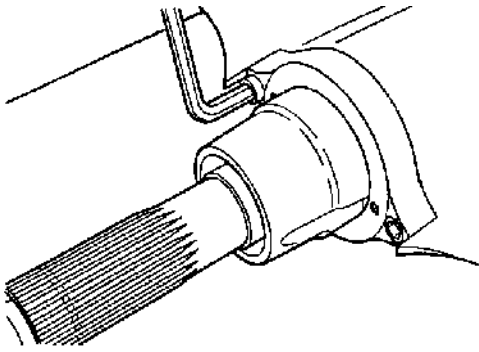


5a. **Models 280-DP and 290-DP:** Take care of the spline sleeve (1), the oil strainer (5) and the -ring (2).

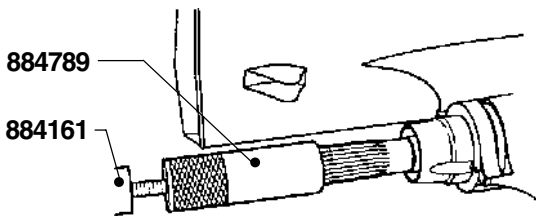
5b. **Model DP:** Remove the spline sleeve (1) and the O-rings (2 and 3). Remove the spacer sleeve along with the O-ring (4) and the oil strainer (5).



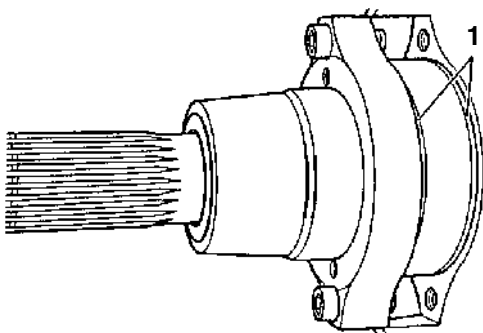
6. Remove the two screws holding the anode to the lower unit.



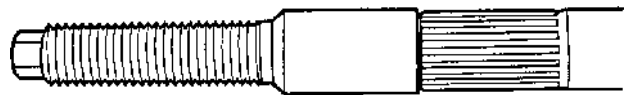
7. Remove the two Allen-head screws from the propeller bearing housing. Key width:  $\frac{3}{8}$ ".



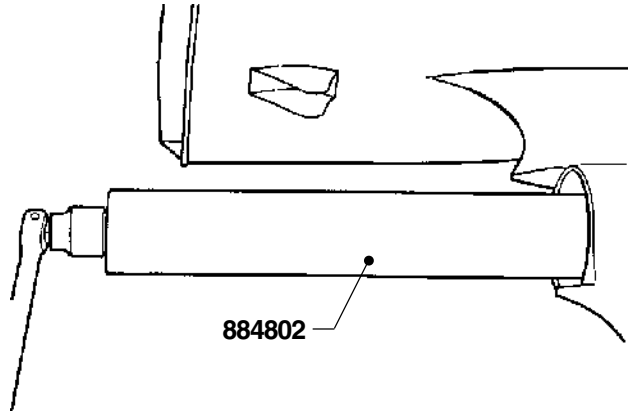
8. Install special tool **884789** on the outer propeller shaft. Using special tool **884161** with a slide hammer, remove the outer propeller shaft and bearing housing.



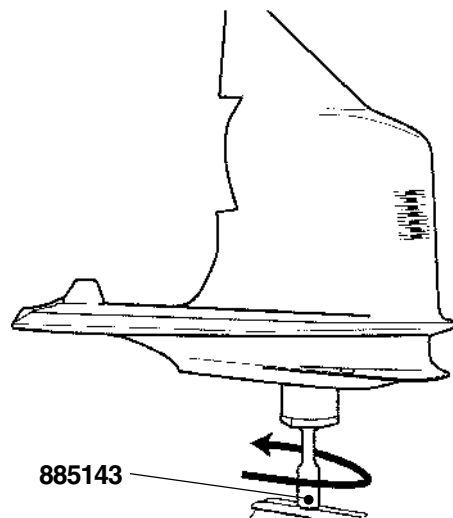
9. Remove the 2 O-rings (1) from the propeller shaft housing. Discard the O-rings.



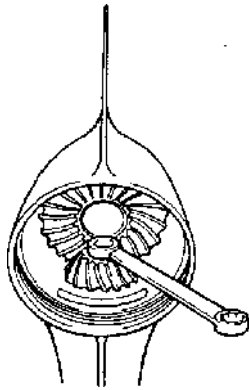
10. Install special tool **885197** on the inner propeller shaft.



11. Install special tool **884802** over the inner propeller shaft. Add the washer and nut from tool 885197. The slot in the end of the tool should face the pinion gear. Tighten the nut until the shaft is extracted from the forward gear. Use a 30 mm wrench.



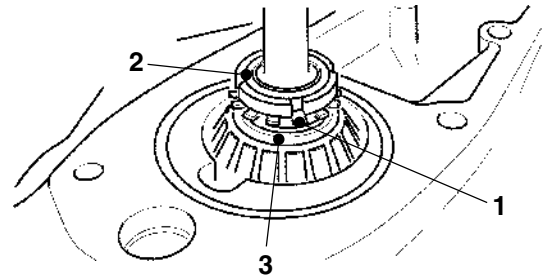
12. Brace special tool **884830** in a vise and place the lower unit upside down in the tool.



**13.** Remove the nut from the pinion gear.

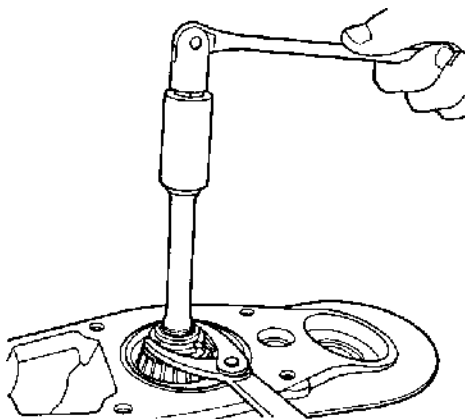
Use a 23 mm wrench.

**NOTE!** Do not discard the nut. Put it aside for use in the shimming procedure later.

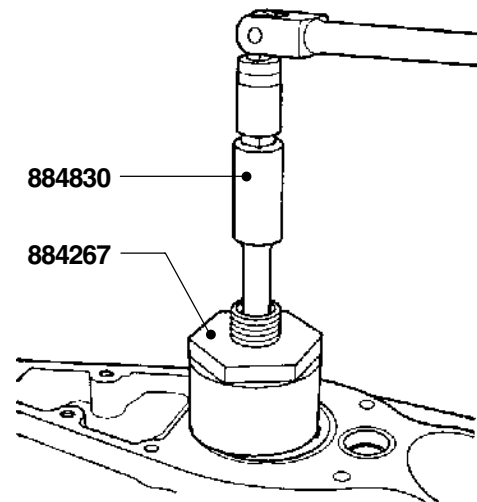


**14b. NOTE!** Sterndrives model 280 and 290 of earlier manufacture have a lock washer (1) and a round nut (2) instead of a Nylock® nut. Knock down the locking tab of the washer and remove the round nut with a hook spanner wrench.

Remove the lock washer and the spacer ring (3).



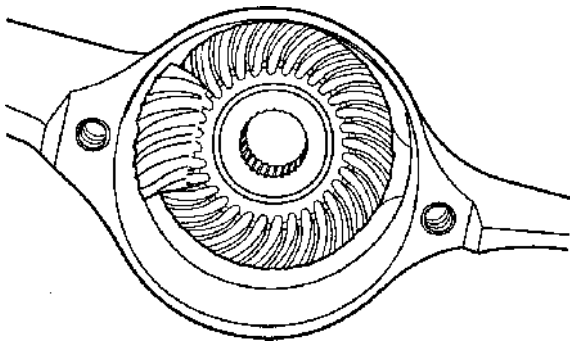
**14a.** Lift the gear housing off the special tool and place it back in the work stand. Remove the Nylock® nut with a hook spanner wrench.



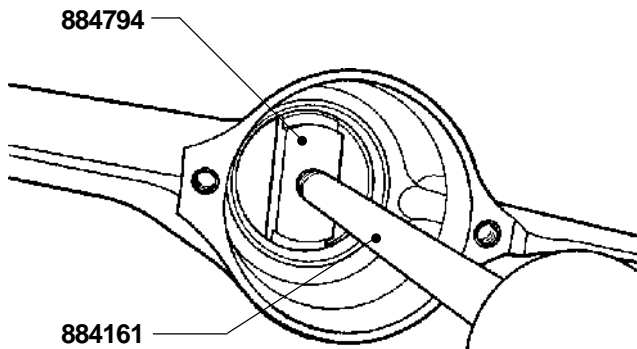
**15.** Install special tool **884267** on the vertical shaft. Attach special tool **884830**, and turn counter clockwise until the shaft can be lifted out of the lower unit gear housing. Remove the tool from the shaft. Remove the shims from under the vertical shaft bearing.

**NOTE!** Be sure not to damage the shims! Save them for use later in the assembly process.



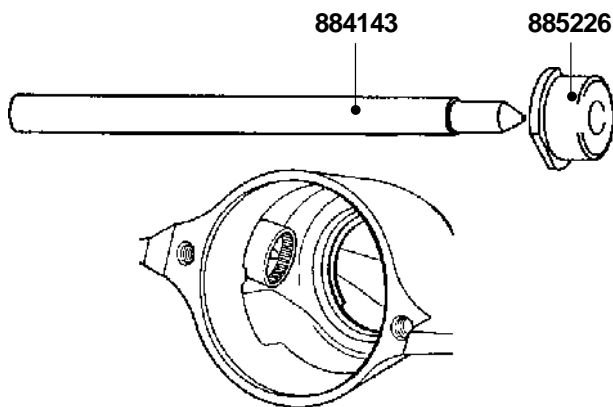


16. Remove the pinion gear and the front gear from the lower unit housing. The forward gear should be free to remove from the housing with the forward bearing attached to the gear.



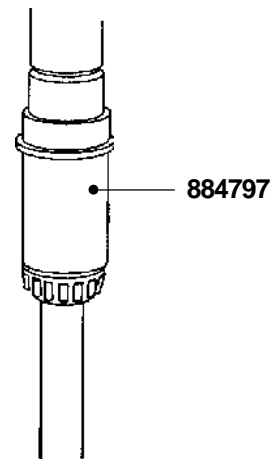
17. Remove the forward gear bearing outer race from the lower unit, using special tool **884794** and slide hammer **884161**. Remove the shims from the housing.

**NOTE!** Be careful not to damage the shims! Save them for use later.



18. Use special tool **885226** with handle **884143**. Drive the needle bearing from the lower unit gear housing.

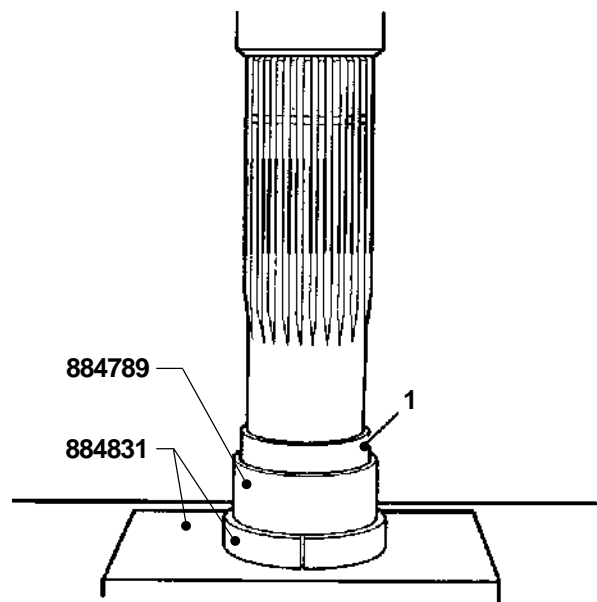
### Inner propeller shaft



19. Press off the roller bearing from the propeller shaft, using special tool **884797**.

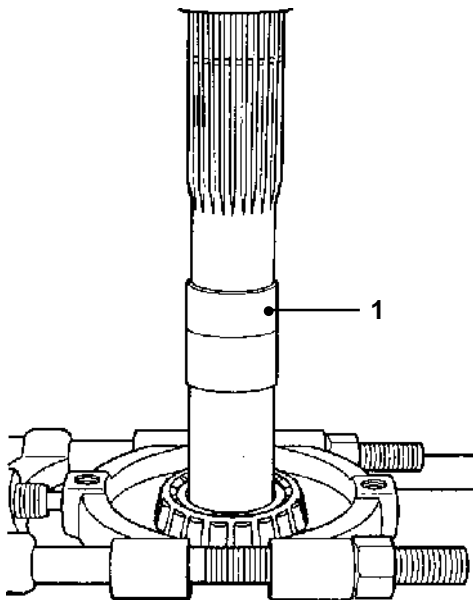
**NOTE!** Take care of the shims.

### Outer propeller shaft



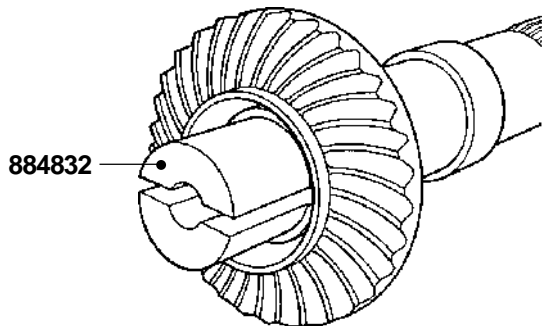
20. Insert the shaft in special tool **884831**. Install puller halves between the shaft and the special tool. Install special tool **884789** on the shaft to protect the shaft during pressing operations. Press off the bearing race.

**⚠ WARNING!** Do not use a knife puller or other, similar tool to remove this bearing race. Such tools may scratch the sealing surfaces of the shaft (1) and result in water leaking into the sterndrive.

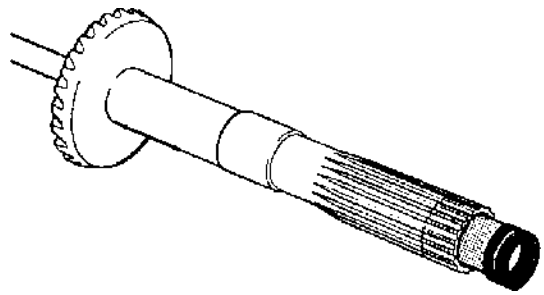


21. Install a knife puller on the outer propeller shaft roller bearing. Using a press, remove the roller bearing.

**⚠ IMPORTANT!** Make sure the sealing surfaces (1) of the shaft are not damaged during the process!



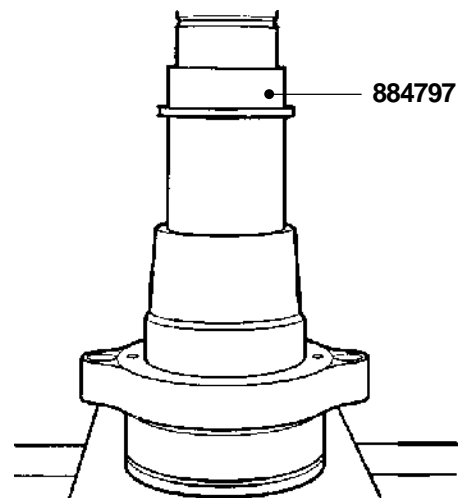
22. Install special tool **884832** under the intermediate bearing outer race. Insert handle **884143** to expand the bearing tool. Press out the intermediate bearing outer race from the rear propeller shaft gear.



23. Remove the inner needle bearing and seals using special tools **884803** and **884143**. Install special tool **884789** to protect the propeller shaft threads.

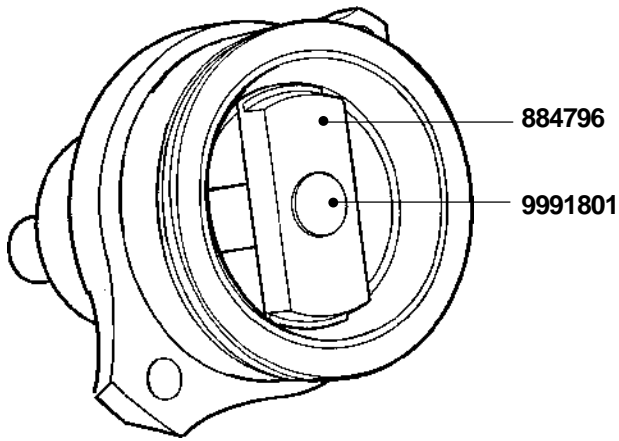
**NOTE!** If you only want to replace the seals, it is still easier to remove the seals along with the bearings.

### Propeller shaft bearing box



24. Remove the O-rings from the propeller shaft bearing housing and discard. Using special tool **884797** to press out the seals and needle bearings.

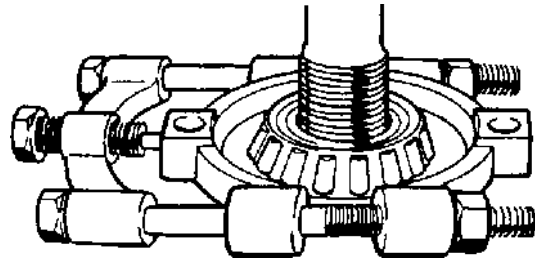
**⚠ WARNING!** Center the tool carefully. Locate a pair of wooden blocks underneath the bearing box to protect the bearing box. Always use new seals and O-rings during final assembly.



25. Remove the outer bearing race using special tools **884796** and handle **9991801**.

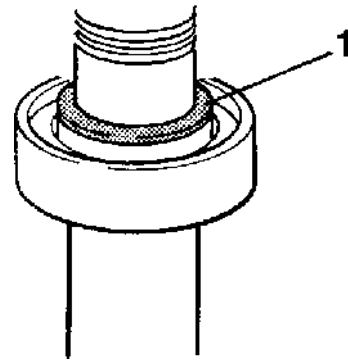
**⚠ IMPORTANT!** Center the tool carefully. Locate a pair of wooden blocks underneath the bearing box to protect the bearing box while pressing out the bearing race.

### Vertical shaft

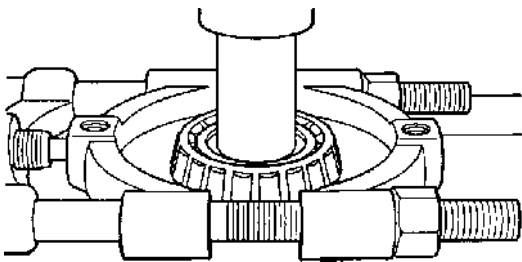


27. Use a knife puller to remove the bearings one by one or together.

**⚠ IMPORTANT!** Use spline socket **3850598** to protect the splines when pressing off the bearings

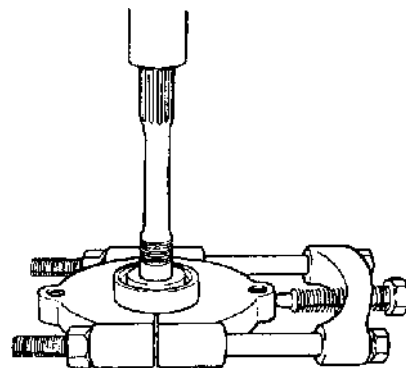


### Forward gear

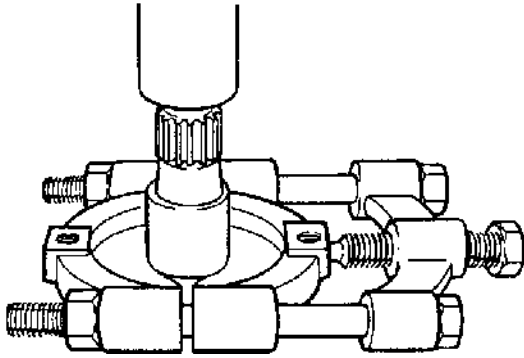


26. Use a knife puller to press off the front roller bearing from the gear.

28. **NOTE!** There is a spacer pad (1) located between the roller bearing and the ball bearing. This spacer pad, however, is smaller than the spacer ring located above the roller bearing. See point 14b.



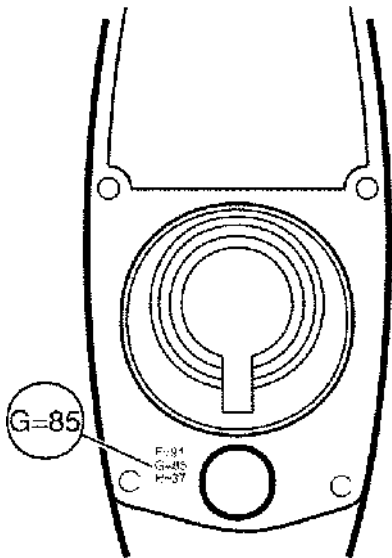
29. Remove the ball bearings. Use a knife puller.



30. Check the bearing race. Replace as necessary, using a knife puller. Clean and check all parts for wear.

## Assembly

### Shimming the front bearing



1. Find the "G"-marking on the parting plane of the lower gear housing.

Only the decimals of the "G"-marking are stamped into the gear housing. In this case, the "G"-stamping is 85. The nominal value of the "G"-measurement is 60.00 mm. Add 60.00 and 0.85, which yields 60.85.

**NOTE!** When calculating the shim thickness for the lower unit gears, remember:

**The lower unit gear housing nominal dimension has two values:**

If the stamped number is **50 or more**, use the **lower** nominal value: 60.00 mm.

If the stamped number is **49 or less**, use the **higher** nominal value: 61.00 mm.

**Example:**

**Stamping is 50 or more:**

"G"-stamping: 85 =	00.85 mm
Use Nominal Dimension =	<u>+60.00 mm</u>
"G"-measurement	<b>60.85 mm</b>

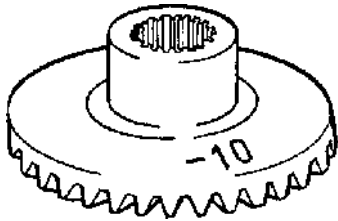
**Stamping 49 or less:**

"G"-stamping: 02 =	00.02 mm
Use Nominal Dimension =	<u>+61.00 mm</u>
"G"-measurement	<b>61.02 mm</b>



2. The nominal height of the bearing is 20.85 mm (0.821").

**NOTE!** The front and rear roller bearings are different and must not be mixed.



3. The nominal measurement of the forward gear is 39.50 mm. The tolerance ( $\pm$ ) is engraved on the gear. All engraved numbers are decimal millimeters. In this instance, "-10" equals -0.10 mm. The real measurement of the gear is  $39.50 - 0.10 = 39.40$  mm.

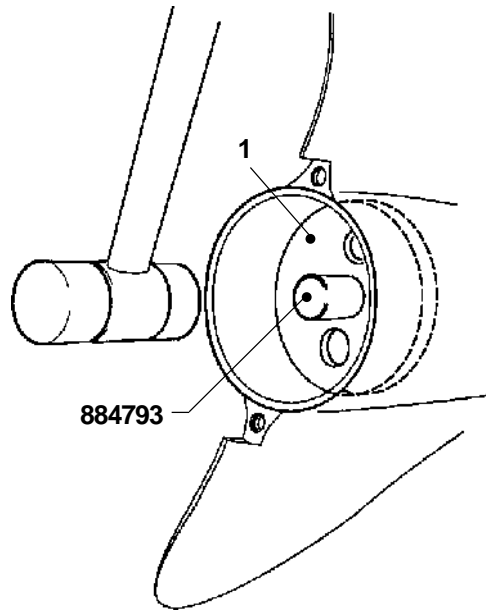
**Add** the height of the forward roller bearing to the real measurement of the forward gear:

**Add:**

Roller Bearing =	20.85 mm
Forward Gear =	+ 39.40 mm
Total forward gear length	<u>60.25 mm</u>

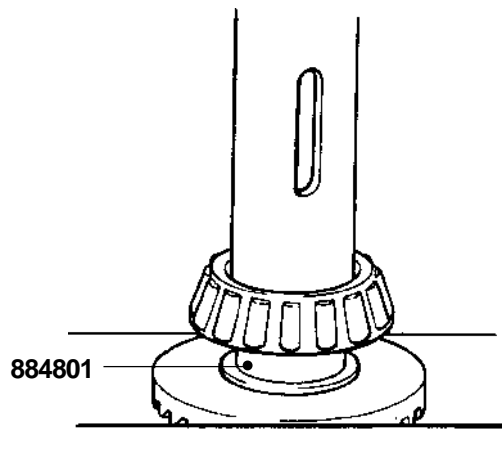
This sum should be **subtracted** from the "G"-stamping resulting in a shim thickness for the front bearing:

G-measurement	60.85 mm
Total forward gear length	- 60.25 mm
Shim Thickness =	<u>00.60 mm</u>

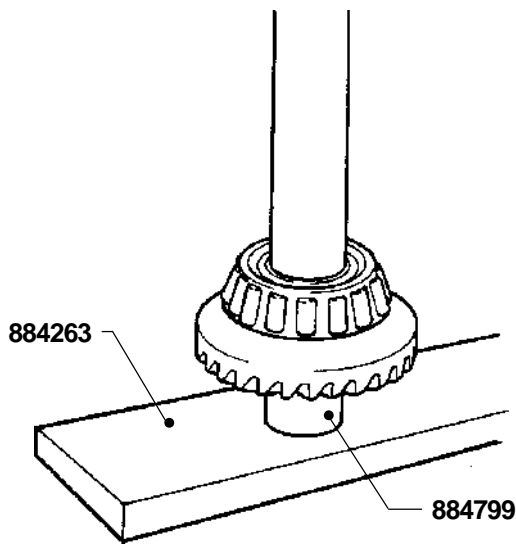


4. Lubricate the bearing position before assembly. Place the calculated shim thickness in the gear housing and install the outer bearing race (marked 30209) with special tool **884795**.

**NOTE!** The plastic disk (1) should be pressed as far in as possible on the tool.



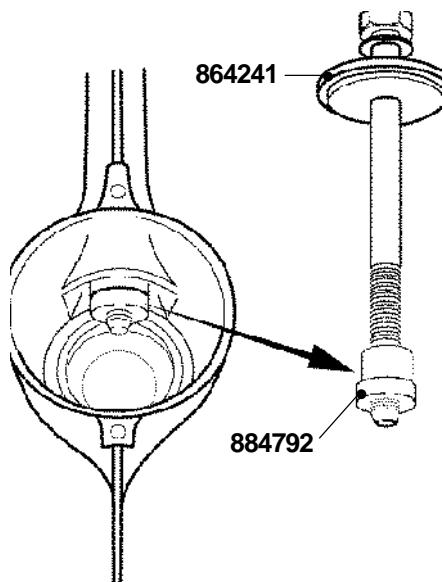
5. Press on the front roller bearing onto the forward gear. Use special tool **884801**. Use special tool **884797** to protect gear teeth.



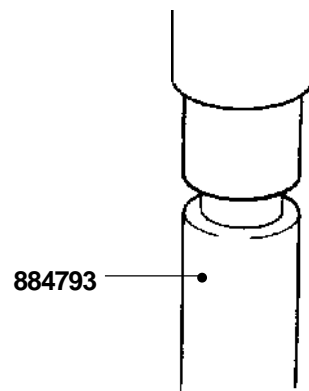
6. Use special tool **884263** to press the gear and bearing assembly onto the propeller shaft. Use special tool **884799** to protect the bearing.

**⚠ WARNING!** Do not press on by using the bearing race!

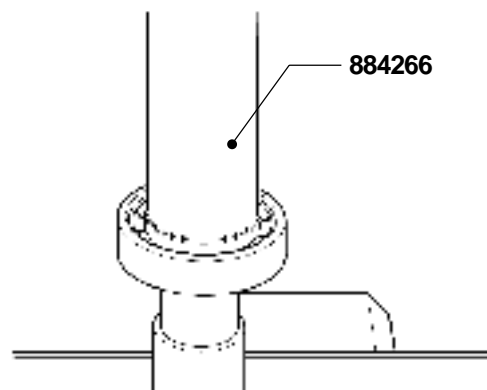
### Shimming the vertical shaft



7. Grease the bearing location. Carefully align the needle bearing when installing it in the gear housing. Use special tool **884792** in combination with **884241**. Turn the bearing to allow the tool **884792** to press against the text on the bearing. Tighten the screw until the bearing bottoms.

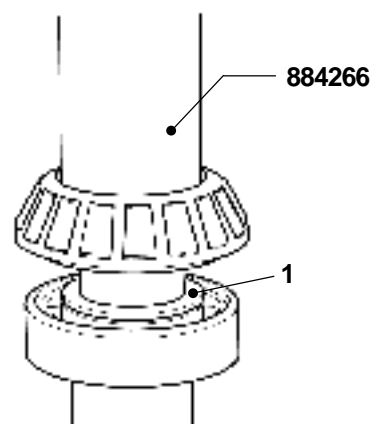


8. Press a new inner bearing race onto the vertical shaft. Use special tool **884793**.

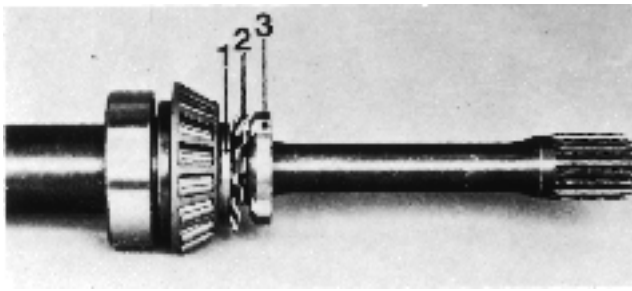


9. Press a new ball bearing onto the vertical shaft special tool **884266**.

**NOTE!** Install the bearing so that the thick part of the inner race faces up.



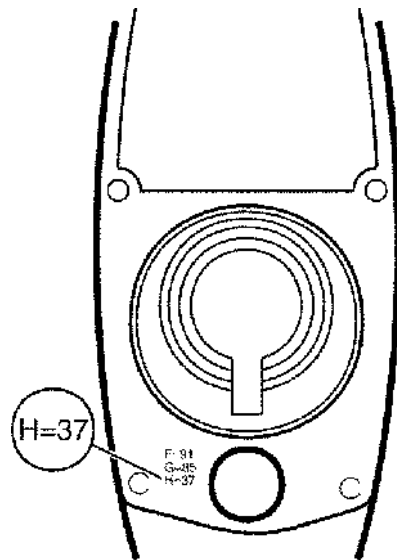
10. Place the thin spacer pad (1) on the ball bearing press on the roller bearing. Use special tool **884266**.



**11a. Sterndrives model 280 and 290 of earlier manufacture:**

Install the thick spacer ring (1), the locking washer (2) and the round nut (3) on the vertical shaft.

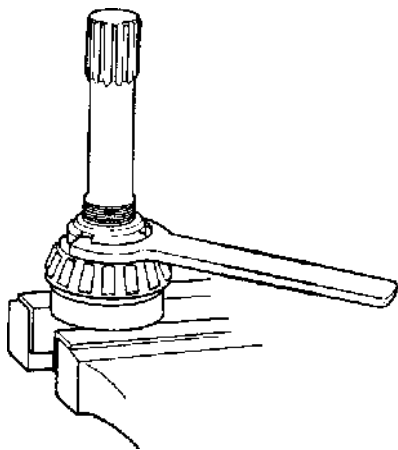
**NOTE!** Install the nut with the even side facing upwards. Tighten the nut but don't lock it with the washer. Use a hook spanner wrench.



**12.** Find the "H"-marking on the parting plane of the lower gear housing. The "H"-stamping in this instance is 37. Remember, the stamping is in hundreds of millimeters. The **nominal** "H"-measurement is 277. Add the "H"-stamping to the nominal dimension of 277. The sum will be 277.37 mm.

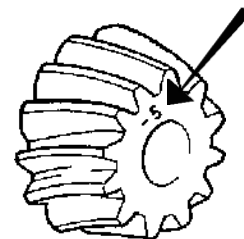
**Add:**

"H"-Nominal	277.00 mm
"H"-Stamping	+00.37 mm
"H"-Measurement	277.37 mm



**11b. Sterndrives model 280 and 290 of later manufacture and sterndrives model DP:**

Install the thick spacer ring and tighten the plastic insert locknut. Use a hook spanner wrench.



**13.** Find the marking on the pinion gear. In this instance the pinion etching is -5. Remember, the etching is in hundreds of millimeters. This etching is -0.05 mm. The nominal measurement of the pinion gear is 60.00 mm. Subtract the pinion gear etching from the nominal measurement for a difference of 59.95 mm.

**14.** The nominal measurement of the vertical shaft is 217.75 mm. This measurement is added to the calculated pinion measurement of 59.95 mm. This combined distance equals 277.70 mm, as illustrated below:

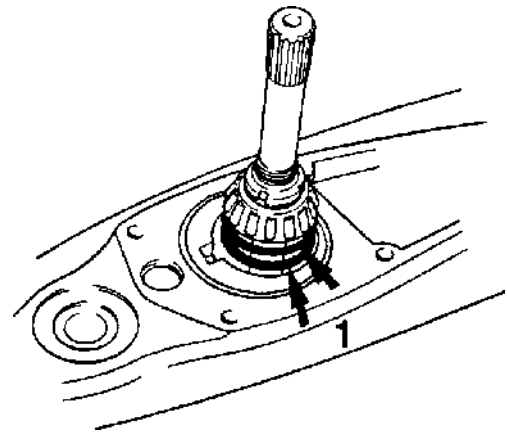
**Add:**

Vertical Shaft Nominal	217.75 mm
Pinion Calculated	+59.95 mm
Vertical Shaft Calculated	<u>277.70 mm</u>

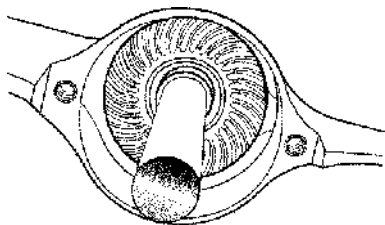
Subtract the “H”-stamping dimension from the Vertical Shaft Calculated (277.70 mm) to arrive at the shim thickness:

**Subtract:**

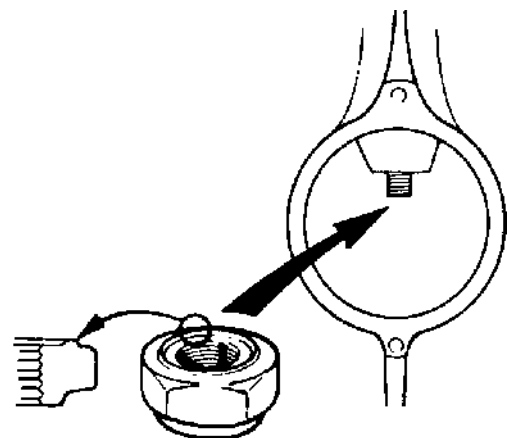
Vertical Shaft Calculated	277.70 mm
“H”-Measurement	- 277.37 mm
Calculated Shims	<u>0.33 mm</u>



**16.** Place the calculated shim thickness (1) in the gear housing. In this case, it is 0.33 mm. With one hand, hold the pinion gear and the original pinion gear nut in the gear together in the housing.



**15.** Place the propeller shaft with gear installed in the gear housing.



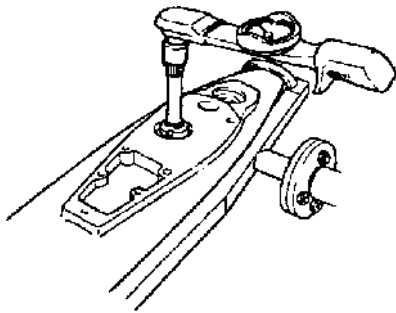
**17.** Center the pinion gear and nut carefully; then, with the other hand, install the vertical shaft.

**NOTE!** The groove of the nut must face the pinion gear.

Install the nut on the vertical shaft.

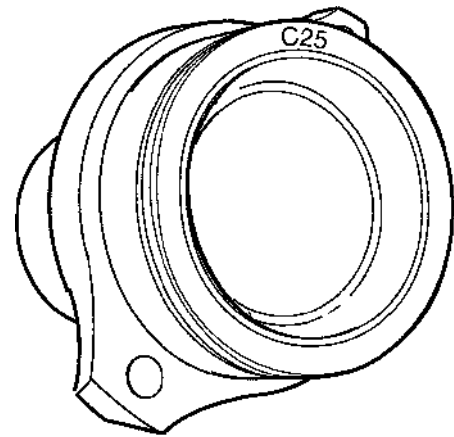
**NOTE!** A new nut must be used for final assembly.





18. Hold the pinion nut with a 23 mm socket. Use special tool **884830**, or **3850598** as an alternative, and a torque wrench. Torque the vertical shaft to **110 Nm (81.5 lb.ft.)**.

**⚠ WARNING!** Be careful not to allow the counter-hold wrench to damage the lower gear housing. Use a piece of soft wood to brace the wrench and protect the housing while applying torque to the pinion nut.

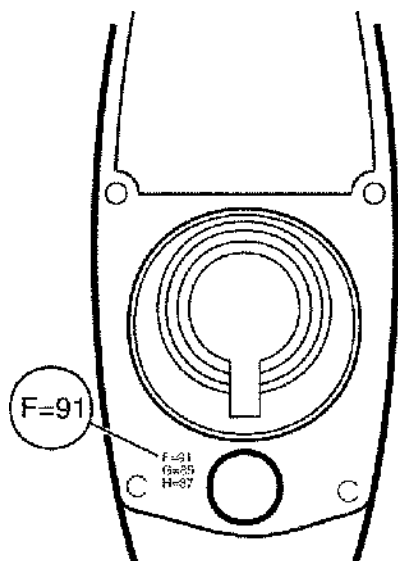


20. Find the stamping “C” on the bearing box. In this case, “C”=25. Again, the stamping is in decimal millimeters. The nominal dimension for the bearing box is 19.00 mm. Add the “C”-stamping to the nominal dimension to get the “C”-measurement.

**Add:**

“C”-nominal	19.00 mm
“C”-stamping	+ 0.25 mm
“C”-measurement	<u>19.25 mm</u>

## Shimming the bearing box



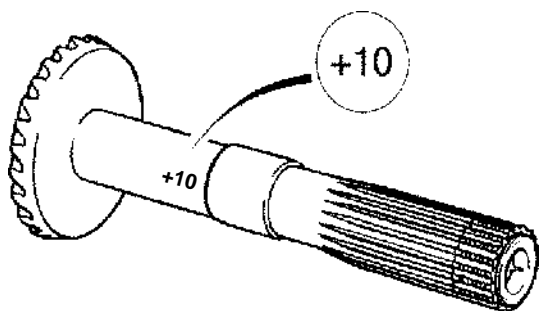
19. The nominal dimension of the “F”-measurement is 80.00mm ±0.10 mm. Figures between 90 and 99 are stamped into the lower gear housing indicating the amount of variation from nominal that the housing is machined. When the “F”-stamping is between 90 and 99, add 79.00 mm to the figure. If the “F”-stamping is between 00 and 10, add 80.00 mm to the figure. In this case, the “F”-stamping is 91. Add 0.91 to the nominal figure of 79.00. The sum for the “F”-measurement is 79.91.

Now subtract the “C”-measurement from the “F”-measurement.

**Subtract:**

“F”-measurement	79.91 mm
“C”-measurement	- 19.25 mm
Aft gear bearing location	<u>60.66 mm</u>

## Shimming the outer propeller shaft



**21.** The nominal measurement of the aft gear is 39.50 mm. Find the variation marking on the gear. In this case it is +10. Remember, hundreds of millimeters only!

**Add:**

Gear nominal	39.50 mm
Gear marking	+0.10 mm
Gear measurement	<u>39.60 mm</u>



**22.** The nominal bearing height is 20.75 mm.

**NOTE!** The forward and aft gear bearings have different nominal dimensions by 0.10 mm. **DO NOT** mix them up.

For the aft bearing, make sure that the inner bearing race is marked **BK-358X** and the outer bearing race is marked **K354X**.

Installing the bearings in the wrong location will cause incorrect lower unit gear contact patterns, incorrect bearing preload, and shorten gear life.

**23.** Add the gear measurement to the bearing nominal dimension.

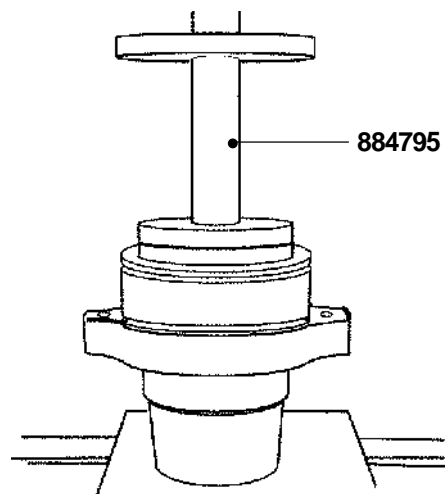
**Add:**

Gear measurement	39.60 mm
Nominal bearing height	+ 20.75 mm
Total aft gear dimension	<u>60.35 mm</u>

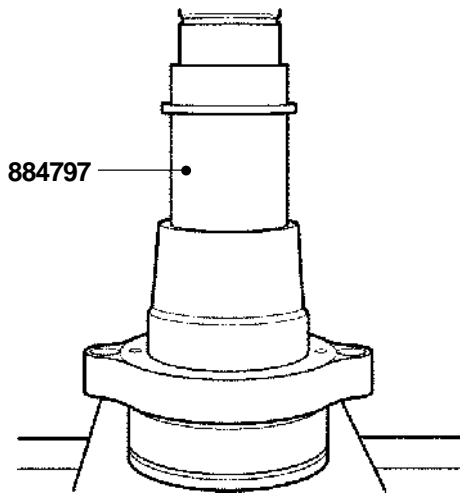
Now subtract the total aft gear dimension from the bearing box location.

**Subtract:**

"C"-measurement	60.66 mm
Gear dimension	- 60.35 mm
Bearing box shims	<u>0.31 mm</u>



**24.** Grease the bearing location with propeller shaft grease and insert the calculated bearing box shims from the previous step (0.31 mm). Install the bearing race using special tool **884795**.



25. Turn the bearing box over. Use special tool **884797**, install the needle bearing in the bearing box. Make sure the bearing marking is facing the tool.

27. Now add the front and rear gear shims.

**Add:**

Forward gear shims	0.60 mm
Aft gear shims	+ 0.31 mm
	<hr/> 0.91 mm
Add nominal value	+ 120.00 mm
	<hr/> 120.91 mm

The shim thickness is obtained by subtracting:

**Subtract:**

	121.51 mm
	- 120.91 mm
Intermediate bearing shim	<hr/> 0.60 mm

**Shimming the intermediate bearing**

26. Start by adding the "F"-measurement and "G"-measurement.

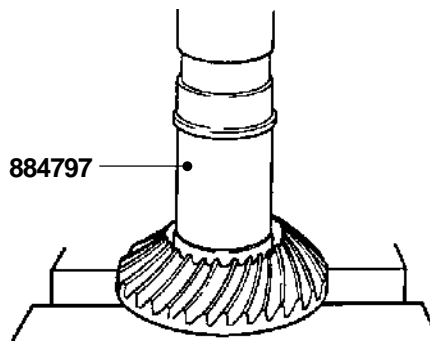
**Add:**

"G"-measurement	60.85 mm
"F"-measurement	+ 79.91 mm
	<hr/> 140.76 mm

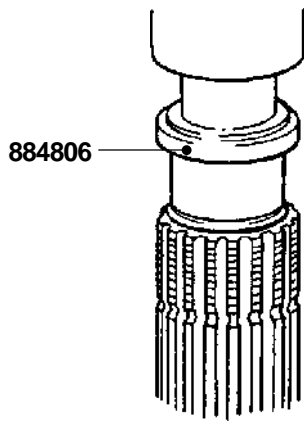
Now subtract the "C"-measurement of the propeller bearing box.

**Subtract:**

"F" and "G" combined	140.76 mm
"C"-measurement	- 19.25 mm
	<hr/> 121.51 mm

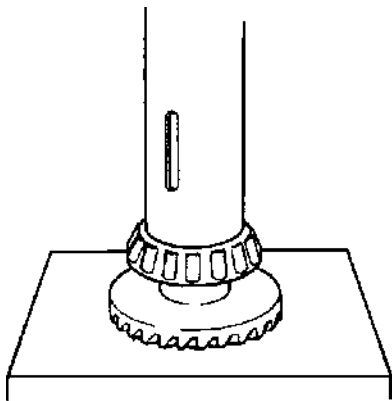


28. Press the bearing race into the aft gear. Use special tool **884797**.

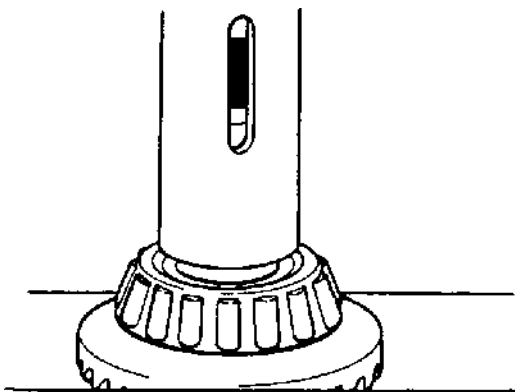


29. Press the needle bearing into the propeller shaft with the text on the bearing turned facing the tool. Use special tool **884806**. Press the tool until it bottoms.

**NOTE!** Do not install the seal rings, wait until the gear tooth clearance and contact pattern are checked.



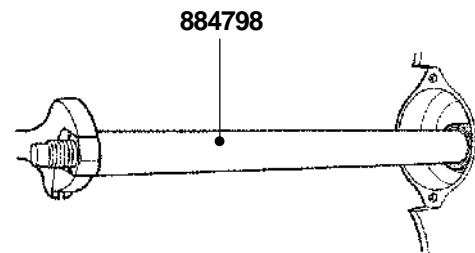
30. Press the roller bearing onto the propeller shaft. Use special tool **884801**.



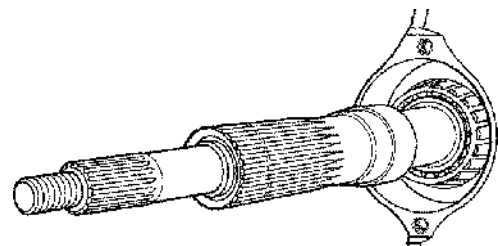
31. Press the inner needle bearing race onto the propeller shaft. Use special tool **884801**.



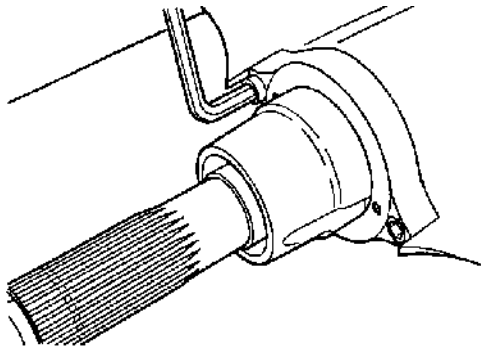
32. Apply marking dye on the convex side of the aft gear. Place the calculated shims for the intermediate bearing and the intermediate bearing on the inner propeller shaft. Install special tool **885197** onto the threads until the tool bottoms.



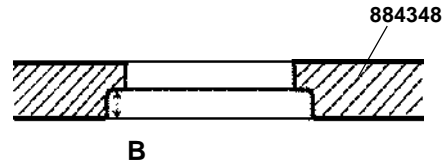
33. Install special tool **884798** on the propeller shaft with the washer and nut. Using a 30 mm wrench, tighten the nut until the intermediate bearing bottoms. Use special tool **884830** or **3850598** and a wrench as a counter hold on the vertical shaft. After the intermediate bearing is pressed on completely, remove the special tools from the propeller shaft.



34. Coat the convex side of the aft gear with marking dye. Insert the gear assembly onto the inner propeller shaft.



35. Grease the bearing box and install on the lower unit. Tighten the allen bolts to **40 Nm (29 lb.ft.)**.



37. Using a depth gauge, measure "B" in special tool **884348**. Subtract measurement "A" from measurement "B".

B – A = positive result ( clearance dimension)

B – A = negative result (preload)

Tolerances: Max. allowed clearance dimension  
0.05 mm (0.002")

Max. allowed preload 0.02 mm (0.0008")

A clearance dimension of 0.02 mm (0.0008") shall be aspiring to attain. When a clearance dimension is reached, shims shall be added according to the following example:

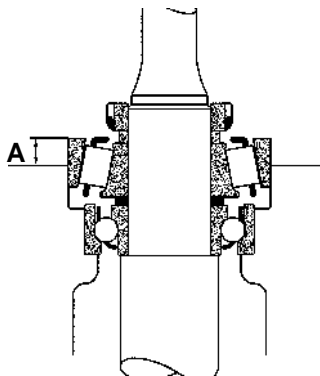
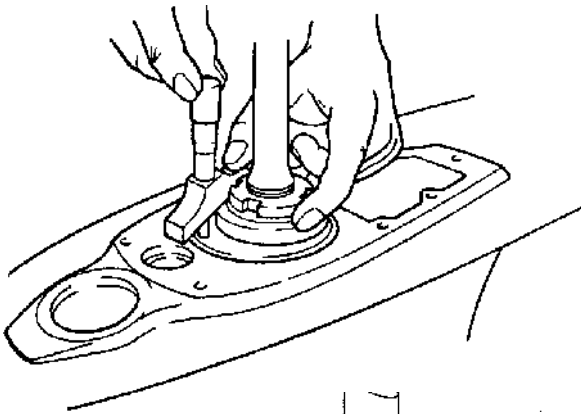
**Example:**

Measurement "B" 10.02 mm

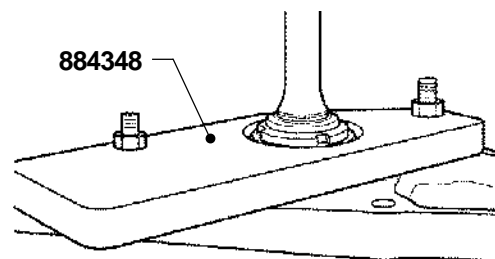
Measurement "A" – 9.78 mm

+ 0.24 mm

( clearance dimension)

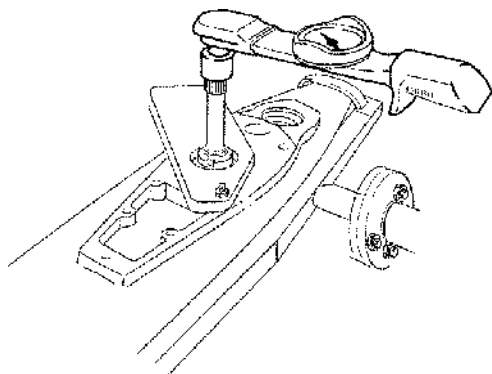


36. Place the outer bearing race on the vertical shaft roller bearing and hold it steady in position. Use a depth gauge to measure the height of the bearing assembly "A." Note this dimension.



38. Insert the bearing race on the vertical shaft roller bearing. Install shims between the bearing race and the special tool to prevent the bearing from moving axially. Install special tool **884348**. Tighten the special tool with two screws and nuts finger tight to prevent axial movement but not enough to preload the vertical shaft.

## Checking preload

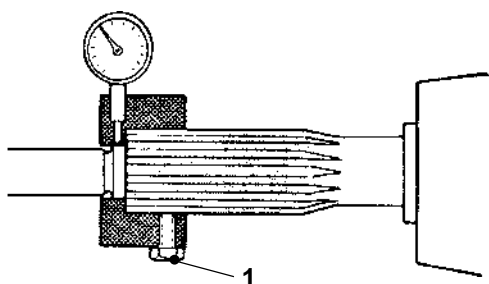


**39.** After calculating the shims required according to points "A" and "B", place the calculated shim on top of the bearing race and install special tool **884830** on the vertical shaft. Use torque gauge **9999177** and turn the shaft one revolution per second. The minimum preload value should be **1.2 Nm (10.6 lb.ft.)** and maximum preload value should be **2.3 Nm (20.3 lb.ft.)**.

If the preload is too **high**, the shim thickness on top of the bearing race should be **reduced**.

If the preload is too **low**, the shim thickness on top of the bearing race should be **increased**.

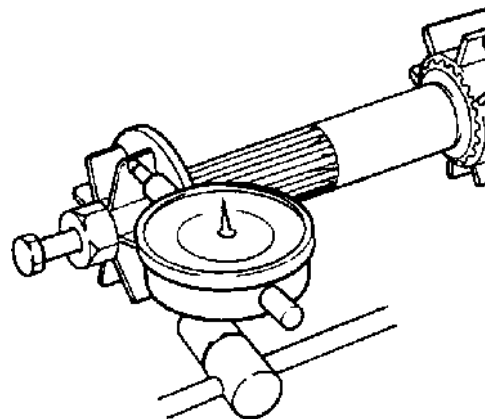
## Slack in the propeller shaft



**40.** Install tool **884941** on the tubular shaft (until it bottoms on the shaft). Tighten screw **(1)** on the tool and then slide a dial gauge into the tool. Turn the shaft one turn and read the run-out on the dial gauge. The run-out must not exceed 0.07 mm (0.0027"). To measure slack in the propeller shaft, press the shaft towards and away from the dial gauge while you read off the bearing slack. Turn the shaft to different positions and read off each time. Bearing slack must not exceed 0.03 mm (0.0012").

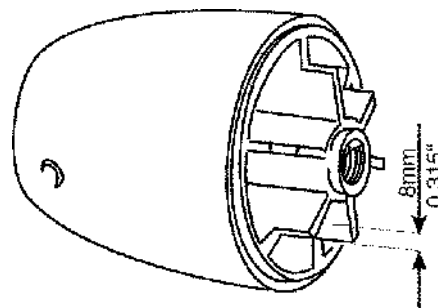
## Checking backlash

### Propeller Nut



**41.** Lock the vertical shaft to prevent it from being turned. Install Duoprop propeller nuts and or cone on the propeller shafts. Rig a dial indicator gauge against the wings of the rear nut as far out on the wing as possible. Check the flank clearance of the front gear by turning the propeller shaft (both ways) by hand to check the backlash. The clearance at the wing should be **0.08–0.17mm (0.003–0.007")**, which results in a clearance of **0.15–0.30mm (0.006–0.013")** at the gear.

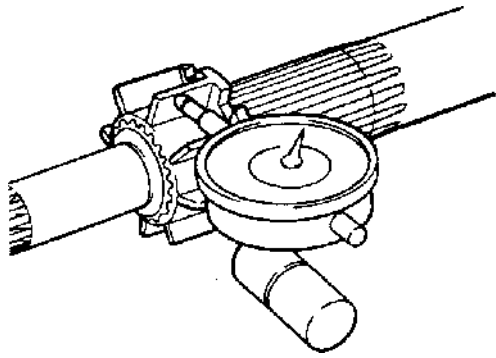
### Propeller Cone



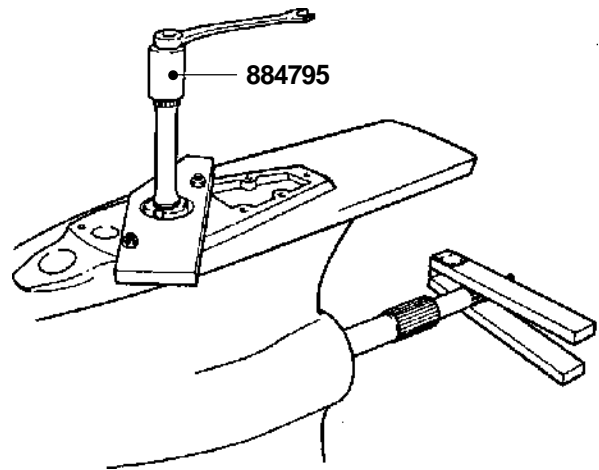
**42.** If the rear propeller is locked with a propeller cone, measuring the gear backlash must be done the same way as when measuring using the propeller nut.

The only difference is that the measuring must be done 8 mm (0.315") in from any of the tips of the cone's wings, and towards the propeller shaft center.

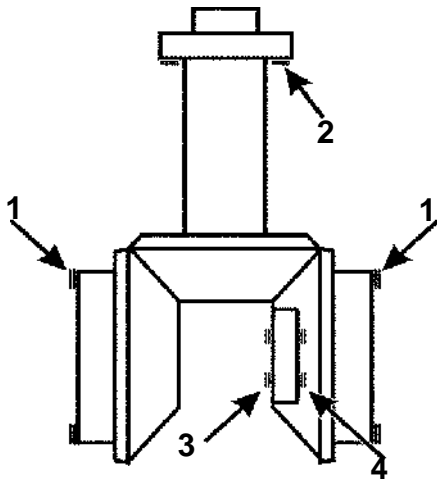
The measuring is done at the same radius from the propeller shaft center as when measuring is done on the propeller nut.



43. Move the dial indicator gauge to the outer nut. Measure the backlash of the rear gear the same way as the front gear. The clearance should be **0.15–0.27 mm (0.006–0.010”)**, which is **0.20–0.35 mm (0.008–0.014”)** at the gear.



45. Turn the vertical shaft both ways. Use the spline sleeve **884830** while applying braking action.



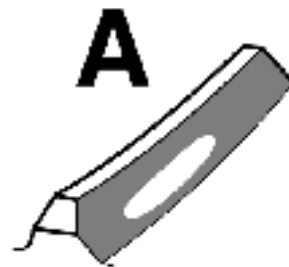
44. If it is necessary to increase the backlash without changing the contact pattern, shims must be removed from the front and rear gears (1) and shims must be added under the vertical shaft (2) to compensate the play.

Add the shim thickness corresponding to that removed from gears (1) to the bearing (3) to maintain preload.

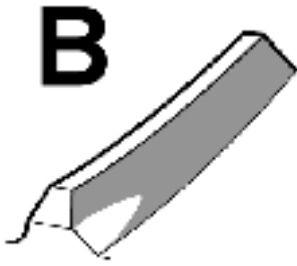
If the backlash needs to be reduced remove shims from gear (3) and add corresponding shim thickness to gears (1). Compensate by reducing shim thickness under the vertical shaft (2).

**Earlier models:** If new shims are installed, place shims underneath the bearing (3). If old shims are re-installed place the shims under the bearing race in position (4).

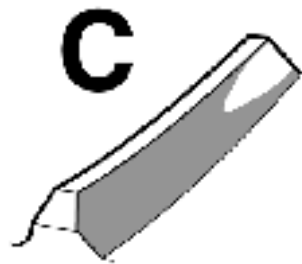
## Contact Pattern



46. Remove the special tool and propeller shaft bearing box. Check the contact pattern on the gear wheel. Also check the front gear wheel inside the gear housing. The contact pattern should be located towards the big end with a slight displacement toward the root of the tooth (“A”).

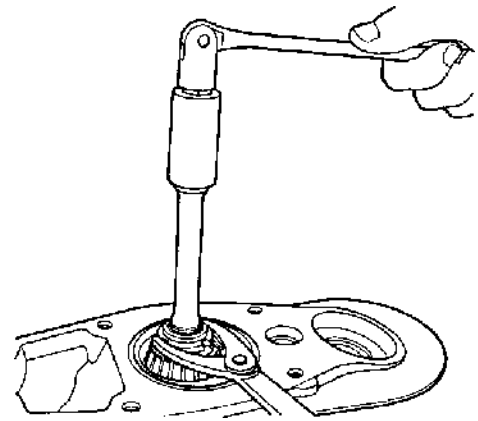


**47.** If the contact pattern is toward the root of the tooth and at the big end, the shims should be increased under the front and rear roller bearing (1, **figure under point 44**). To maintain correct bearing preload, reduce the shims under the intermediate bearing (3) by a corresponding amount. To maintain the correct backlash, increase the shims under the vertical shaft ball bearing (2).

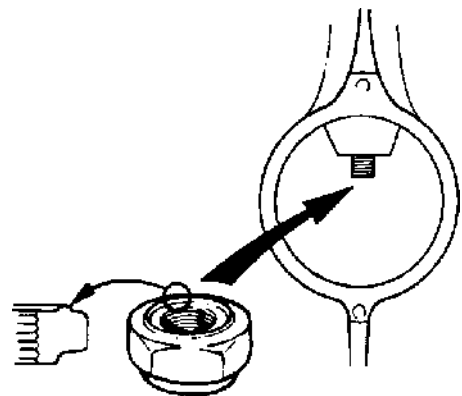


**48.** If the contact pattern is too far toward the top of the tooth and toward the small end, reduce the shim thickness for under the front and rear roller bearing (1, **figure under point 44**). To maintain proper bearing preload, increase the shim thickness correspondingly under the intermediate bearing (3). To maintain the correct backlash, decrease the shim thickness under the vertical shaft ball bearing (2).

## Final assembly

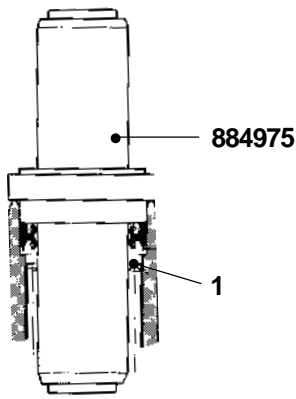


**1.** After the correct preload, backlash, and contact pattern have been obtained, remove the preload tool and tighten the vertical shaft nut. Remove the bearing box and outer propeller shaft.

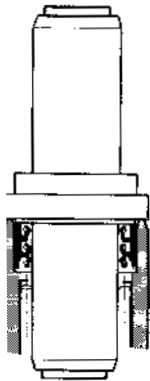


**2.** Remove and discard the old pinion gear nut. Grease the threads of the vertical shaft. Install a new nut with the groove against the pinion gear. Tighten to **110 Nm (81 lb.ft.)**.

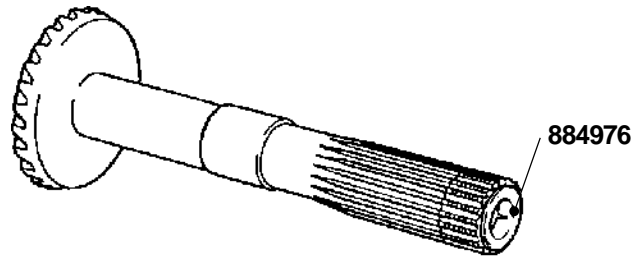




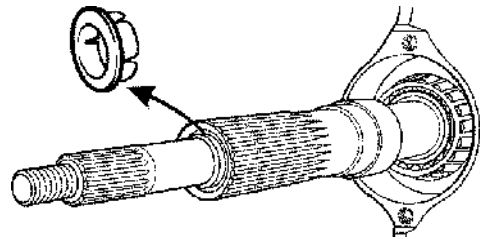
3. Grease the new seal rings and install in the propeller shaft. Turn the steel edge (1) facing forward. Use special tool **884975**. Turn the broad shoulder against the seal ring. Press until it bottoms.



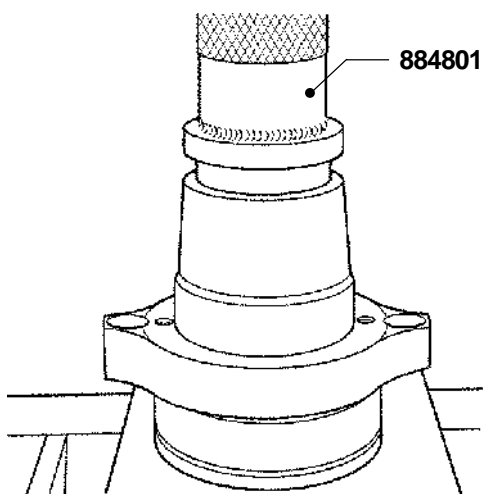
4. Turn the tool over and press in the "single lip" seal ring. Turn the spring facing aft. Press until it bottoms.



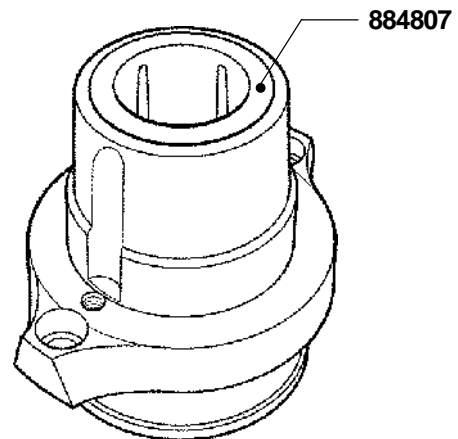
6. Insert the protective ring **884976** into the outer propeller shaft seals so that the seal lips are protected during installation.



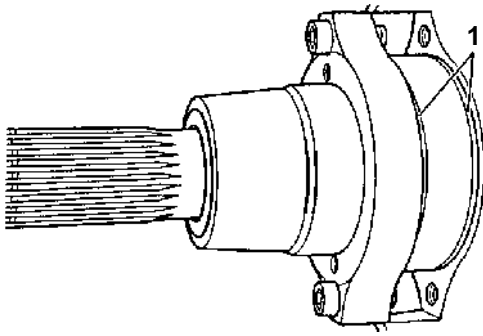
7. Carefully insert the outer propeller shaft in the gear housing. Remove the seal protector.



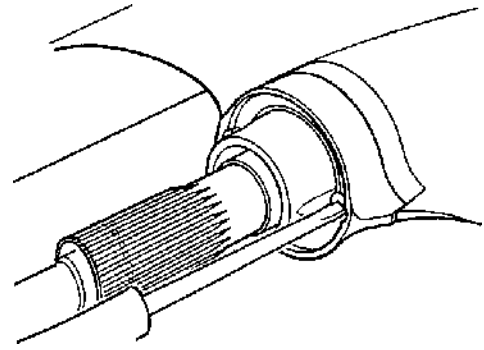
5. Grease the seal rings and install in the bearing box with the springs facing away from each other. Use special tool **884801**. Press until it bottoms.



8. Install seal protector **884807** in the bearing box to protect the seal during installation.



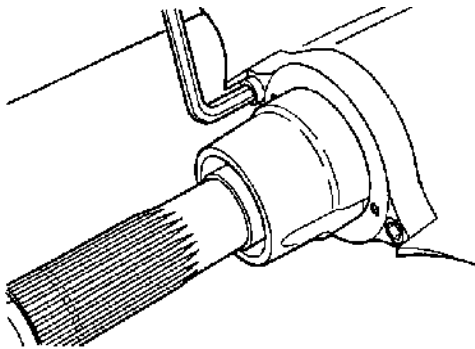
9. Install new O-rings (1) on the bearing box. Coat the entire sealing surface and O-rings with Volvo Penta part no. 1141570-0 sealant. Install the bearing box in the gear housing.



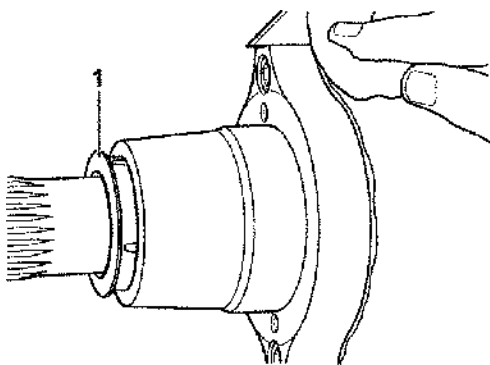
12. Install the zinc ring on the lower gear housing. Check to make sure that the contact surfaces are clean and there is a good electrical contact.

An ohmmeter may be used to ensure there is little or no resistance between the zinc ring and the lower unit housing.

For more detailed information about Electrochemical Corrosion, what causes it and how to prevent it, consult publication 7733534-7, **Marine Electrical Systems** available from Volvo Penta.

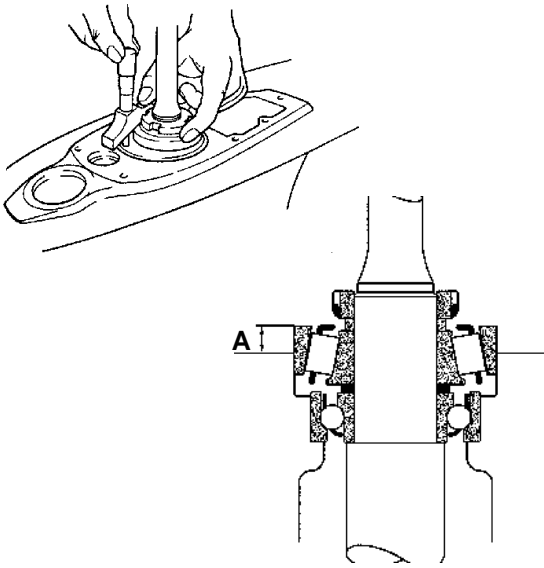


10. Tighten the bolts to **40 Nm (30 lb.ft.)**.

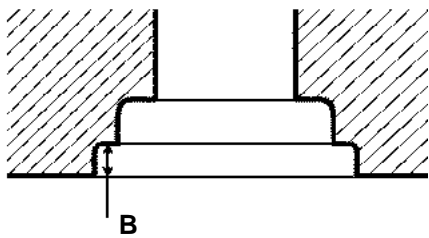


11. Remove the seal protector (1) when the bearing box has been installed and tightened. Clean off any excess sealing compound.

## **Shimming the lower gear to the intermediate housing**



1. Place the bearing race on the bearing and hold in position. Using a depth gauge, measure the bearing height above the lower unit parting plane "A".



2. Using the depth gauge, measure the measurement "B" in the intermediate housing .

Subtract measurement "A" from measurement "B".

$B - A =$  positive result ( clearance dimension)

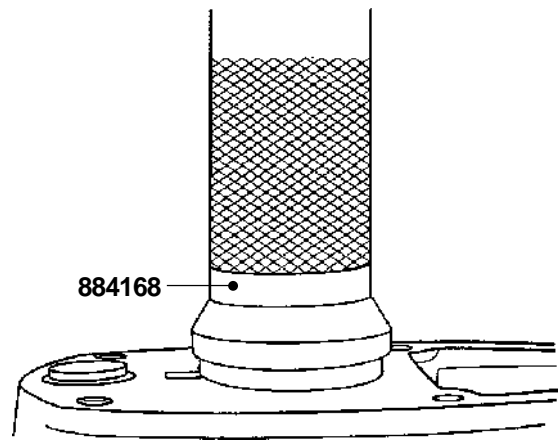
$B - A =$  negative result (preload)

Tolerances: Max. allowed clearance dimension

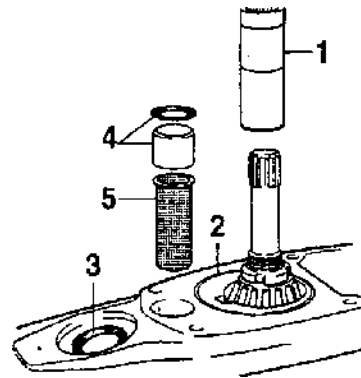
0.05 mm (0.002")

Max. allowed preload 0.02 mm (0.0008").

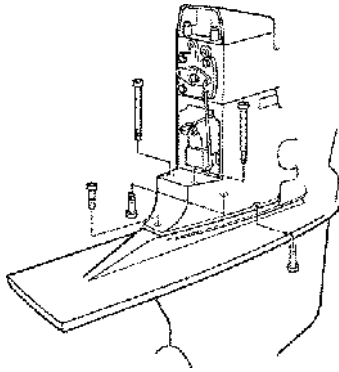
For calculation of shims see point 37 on page 114.



3. Press the outer race of the vertical shaft bearing with the calculated shims into the intermediate housing. Use special tool **884168**.



4. Insert the oil strainer (5) into the lower gear housing. Check that the spacer sleeve (4) is provided with an O-ring. Use new O-rings (3) and (4). Install the spline sleeve (1) on the vertical shaft with the groove in the up position. Coat the contact surfaces with a thin coating of Volvo Penta part no. 1141570-0 sealant.



5. Use new screws and washers. Coat the screw threads with thread locking compound, Volvo Penta part no. 1161053-2, or Loctite® 243.

Tighten the 4 larger screws diagonally and in sequence with a torque wrench to **38 Nm (28 lb.ft.)**. Use special tool **885008**. Tighten the 3 smaller screws to **15 Nm (11 lb.ft.)**.

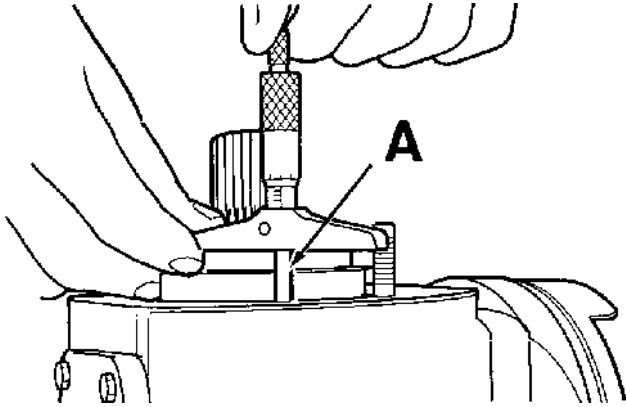
**280 drives:**

Earlier 280 drives do not have washers while later versions do. Both versions of the 280 drive shall always have washers fitted to all bolts between the lower and intermediate housing when overhauling. Tightening torque; see above.

**290 drives:**

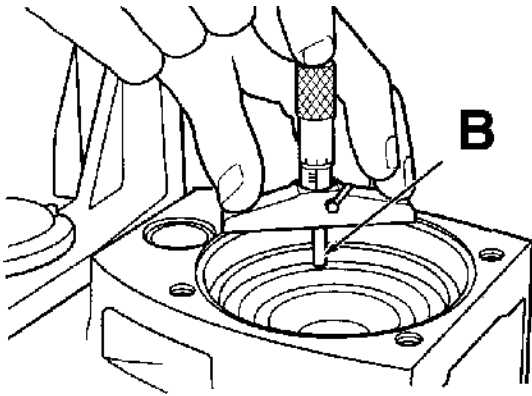
All production 290 drives have washers fitted. Tightening torque; see above.

## Shimming the upper gear to the intermediate housing



1. Measure the distance from the bottom of the upper gear housing to the top of the outer bearing race (**A**). Record the measurements in the table below.

**NOTE!** The shift mechanism must be in neutral (if installed) to achieve an accurate measurement.

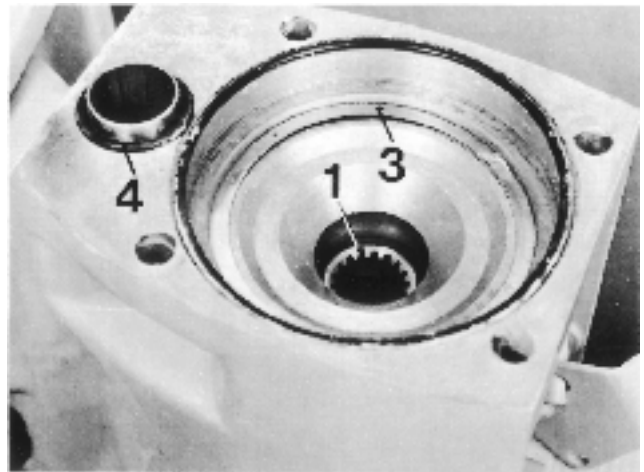


2. Measure the distance from the top of the intermediate housing and the upper gear head lower bearing outer race seat. (**B**). Record the measurement in the table below.

<b>B</b>		<b>mm</b>
<b>- A</b>		<b>mm</b>
<b>Clearance</b>		<b>mm</b>
<b>+ 0.06</b>		<b>mm</b>
<b>Shims Required</b>		<b>mm</b>

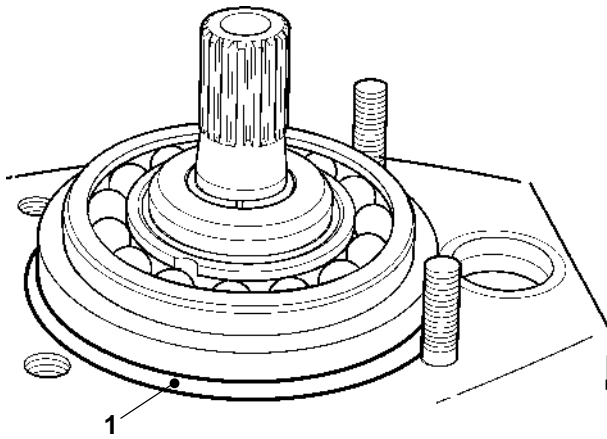
3. Subtract the upper gear head bearing thickness (**A**, figure under point 1) from the intermediate housing measurement to find the bearing clearance. Add enough shims to take up the clearance plus 0.06 mm shim to preload the upper gear head bearing.

Apply a light coating of Volvo Penta part no. 1141570 sealant to the mating surfaces of the intermediate housing and the upper gear head. Install the upper gear head on the intermediate housing with the calculated shims in place.



4. Install the splines sleeve (**1**) on the vertical drive shaft and the O-ring (**2**) plus the shims calculated under point 2 (**3**) on the intermediate housing.

Check to make sure that the O-ring (**4**) for the spacer sleeve is properly in its location. The contact surfaces have to be coated with sealing compound, Volvo Penta part no. 1161099-5 or Permatex® no. 3.

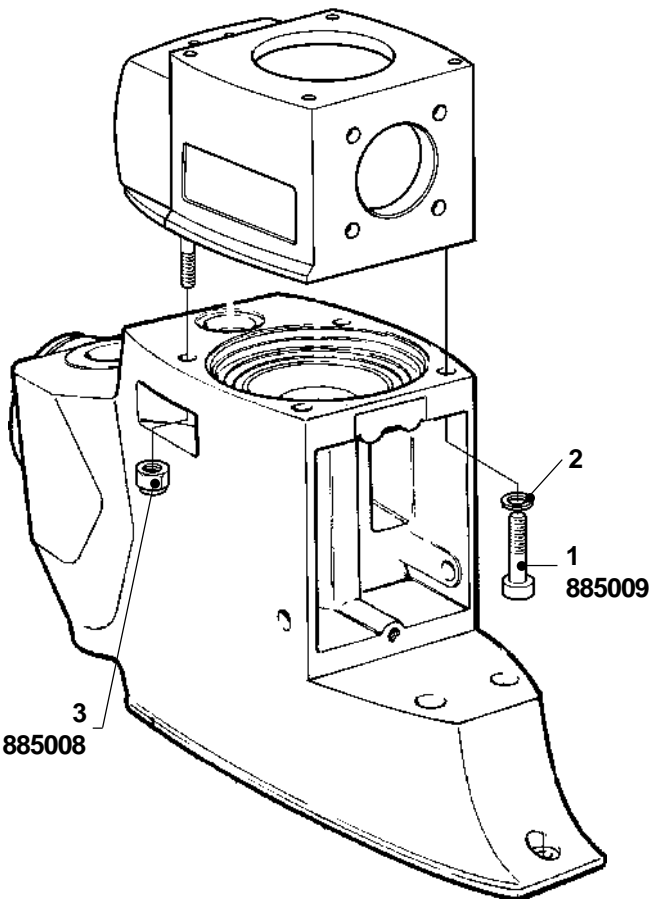


5. Install the O-ring (1) on the upper gear.



7. Install the shift linkage rod, washer and cotter pin.

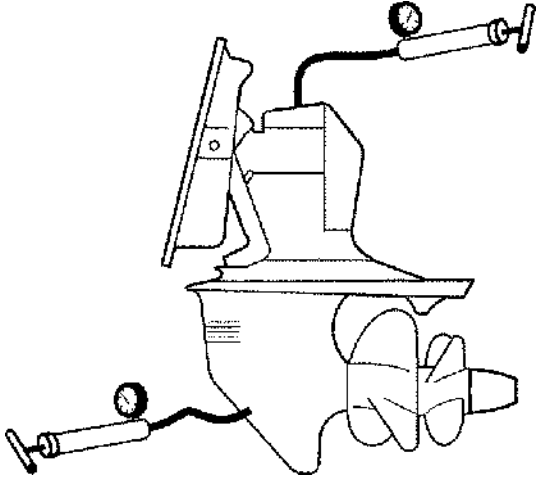
**⚠ WARNING!** Always use a new cotter pin. Never reuse a cotter pin that has been removed.



6. Install the upper gear housing on the intermediate housing. Use new Allen bolts (1, 2 pcs), washers (2, 2 pcs) and nyloc nuts (3). Many drives do not have washers under the bolt heads. When overhauling however, washers shall always be fitted. This applies to all drives. Apply some grease to the Allen bolt and stud threads, and to the contact faces of the nuts and washers. Tighten the screws and nuts in diagonal sequence and evenly all around and with a torque of **38 Nm (28 lb.ft)**. Use tool **885008** and **885009**.

## Pressure and vacuum testing

Before filling the drive with gear oil, it must be pressure and vacuum tested to verify proper sealing during assembly.



### Pressure/vacuum test the drive as follows:

1. Remove the drain plug and drain the oil from the drive. If the drive has not been used for some time, a small amount of water can run out (a few drops). If the drive has been used in the previous few days, it can be more difficult to observe a small amount of water.
2. Please refer to chapter **Technical Data** for the correct tightening torques for the upper gear housing, intermediate housing and lower gear housing.
3. Remove the drain plug and screw the dipstick with O-ring back into the upper housing.

a) Connect a pressure tester **3810152** to the drain hole and pressurise the drive to **21–35 kPa**. Turn the propeller shaft(s) and the drive shaft universal joint to check for tightness. If any pressure loss is indicated, use a soapy water solution, or dip the drive into water to find the leakage point. Do the necessary repairs and then repeat the test.

b) If no pressure loss is indicated, increase the pressure to 110–124 kPa. Again use a soapy water solution or dip the drive to find the leakage point if the drive loses pressure. Do the necessary repairs and then repeat the test. The drive must hold its pressure before the vacuum test is done, and must not lose more than 7 kPa in 3 minutes.

c) Connect a vacuum tester **3858578** to the drain hole and evacuate the drive to 10–17 kPa (75–125 mm Hg). Turn the propeller shaft(s) and the drive shaft universal joint to check for tightness. If the drive can not hold its vacuum, apply thick oil along the joint surfaces to find the leakage point. The oil is sucked in at the leakage point and when the joint is subsequently taken apart, the oil is visible on the sealing surface (gasket). Do the necessary repairs and then repeat the test. No loss of vacuum must occur during the test.

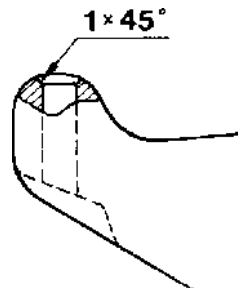
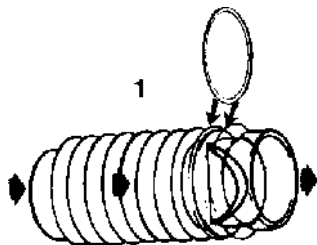
d) If no vacuum loss is indicated, increase the vacuum to 47–54 kPa (355–405 mm Hg). Apply a new film of thick oil to find the leakage point if the drive does not hold vacuum. Do the necessary repairs and then repeat the test. The drive must not lose more than 25 mm Hg (3.4 kPa) during 3 minutes.

Repair the leak and retest the unit.

**NOTE!** Do not fill the drive with oil unless it passes both the pressure test and the vacuum test.

# Installing the sterndrive

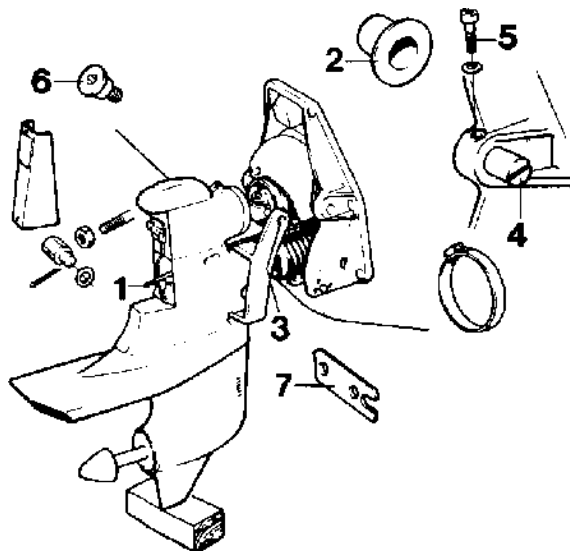
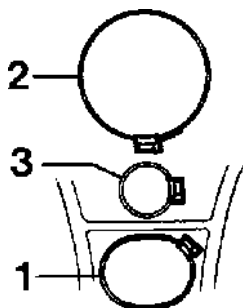
## Models 280 and 285



There are 2 types of exhaust bellows. One type with an exhaust valve and one without. The exhaust bellows with an exhaust valve installed should be used on sterndrives not having a rubber exhaust flap installed on the exhaust outlet in the cavitation plate. Otherwise exhaust bellows without exhaust valve should be installed.

**⚠ IMPORTANT!** When using an exhaust bellows with built-in flaps, make sure that the flaps are opening/closing horizontally. Furthermore check that the bellows is installed with the drainage hole pointing downwards.

**2.** Check to make sure that the hole in the suspension yoke for the push rod is chamfered. The chamfer should be 1 mm x 45° (0.004" x 45°) to prevent the thrust washer of the lifting device to deform the edges of the hole when tilting the sterndrive. In case the thrust rod is jamming in the hole, the sterndrive will kick up when put in reverse. Should this happen, push down the push rod and adjust the chamfer.



**1.** Install new rubber bellows for the through-hull exhaust (1) and the universal joint (2). Use special tool **884936**. Connect the cooling water hose (3) between the transom shield and the sterndrive.

**NOTE!** The cooling water hose is marked 'engine' at the end to be connected to the transom shield. Check to make sure that the hose clamps are well tightened to avoid water leaking into the boat. Use the flexible screwdriver **884573** to tighten the clamps.

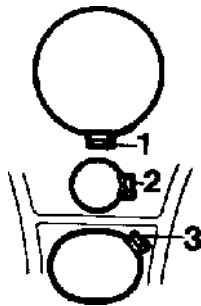
**3.** Put the sterndrive in front of the transom shield. Block it from underneath to align it heightwise with the transom shield. As an alternative the special tool **884521** can be used. Insert the shift cable (1) in the sterndrive.



4. Hang the hose clamp for the rubber bellows of the universal joint on the “neck” of the gear housing. Grease the splines of the universal joint and those of the shaft with grease. Push the sterndrive gently against the drive shaft. Turn simultaneously the universal joint to allow the shaft splines to find the corresponding female splines of the joint more easily.

**NOTE!** Be careful during the assembly not to damage either splines thus making the mating more difficult. Install the two plastic bushings (2, figure under point 1) in the holes of the suspension yoke. Grease the shaft journals (4) with grease or Molycote.

Insert the sterndrive suspension yoke into the transom shield and align it to allow the shaft journals to be pushed into the holes of the yoke. Turn the shaft journals to allow the locking screws (5) to be installed. Tighten the locking screws.

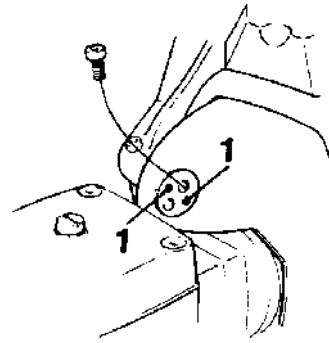


5. Attach the universal joint bellows to the sterndrive. Locate the hose clamp in such a way that its tightening screw (1) ends up on the underside of the bellows. Check to make sure that the bellows is correctly installed and tighten the clamp. Use a flexible screwdriver, special tool **884573**.

Tighten the clamp so as to avoid water leaking into the boat. Hang on the hose clamps for the exhaust bellows and the cooling water hose. The tightening screw on the cooling water hose must be located two o'clock of the hose (2).

The tightening screw for the exhaust bellows must be turned pointing at 6 o'clock, (3). The picture reflects the correct positioning of the hose clamps.

Test by turning the sterndrive from one side to the other and check thereby that the clamps do not interfere with the sterndrive nor that they chafe against and thus damage close by hoses.



**6a. Sterndrives of later manufacture:**

Lower the steering helmet and grease the ‘attachment bolt’ with grease. Turn the recessed holes facing outwards.

Then push home the ‘attachment bolt’ into the helmet and center it so that the two Allen-head screws can be tightened.

Tightening torque: **35 Nm (26.25 lb.ft.)**.

Prior to the tightening, grease the threads of the screws with grease. In order to be able to turn and center the ‘attachment bolt’ screw holes, the screws must be installed in the holes marked (1). Then the ‘attachment bolt’ can be turned.

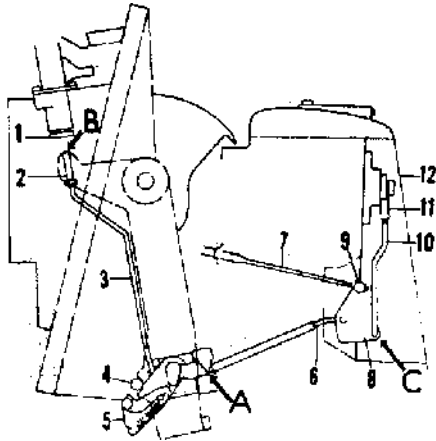
**6b. Sterndrives of earlier manufacture:**

Lower the steering helmet and tighten the tapered locking screw (6) in figure under point 3, in the upper gear housing.

Tightening torque: **50–60 Nm (37.5–45 lb.ft.)**.

Install the locking plate (7) in figure under point 3, for the shift cable in a way that it is locking in the groove of the cable.

## Checking and adjusting controls



7. Check that the control lever and the shift lever of the sterndrive both are in a neutral position. Remove the locking nut for the shift yoke (11) and turn the yoke on the thread of the shift rod (10) in a way that it gives the retaining pawl rod (6) at the connection to the shift lever such a position that it will touch (without pressing against) the yoke of the retaining catch at "A".

Lock the yoke (11) with the locking nut in this position.

**NOTE!** The retaining pawl rod (6) is not permitted to have an axial play.

Install the locking nut and the swivel on the shift cable. Adjust the swivel (9) of the shift cable (7) so that it easily will enter the hole on the shift plate.

Push the control lever to the forward position and check that the corner "C" on the shift plate (8) does not touch the housing.

Pull down the retaining pawl against the stop shoulders on the bearing and remove the stop nut on the thrust sleeve (2).

Adjust the sleeve with the retaining pawl still pulled down so that the sleeve becomes level or maximum 0.5 mm (0.020") under the contour "B" of the yoke.

Lock the thrust sleeve and the counter nut with locking compound, Volvo Penta part no. 1161053-2.

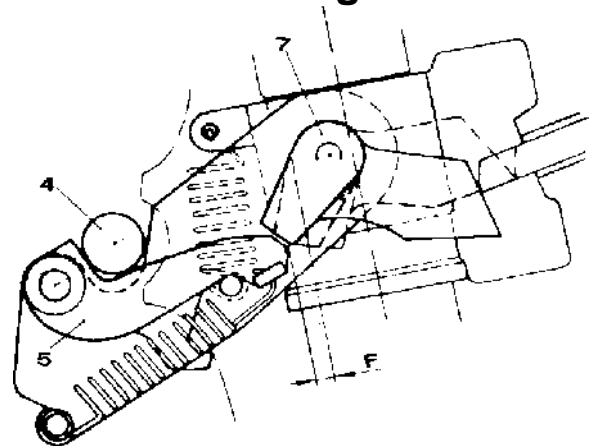
**NOTE!** Earlier the thrust sleeve was locked only with the counter nut. However, from sterndrive serial no. PZ 2813853 it is also locked with locking compound, Volvo Penta part no. 1161053-2. Adjustment afterwards is seldom necessary as the retaining pawl is adjusted at the time of delivery.

Then push the sterndrive forwards against the adjusting pin and check that the upper end of the push rod (3) does not touch the thrust plate of the lift device. The lifting device (1), when tilting, will disengage the retaining pawl. The retaining in the adjusting pin of the retaining pawl is checked by first pulling the sterndrive backwards and then in the two outer positions.

Then check that the electromechanical lifting device (1) when tilting the sterndrive will release the retaining pawl from the adjusting pin. With the sterndrive fully lowered and with the adjustment pin in the innermost position there should be a safe clearance between the thrust plate of the lifting device and the retaining pawl push rod.

8. Check the retaining pawl clearance as follows: Push the sterndrive forwards and hold the retaining pawl in this position. Then push the sterndrive backwards and check that the retaining pawl does not hook up on the adjustment pin.

## Checking the retaining pawl when test running



9. Pull the sterndrive backwards so that the spring catches of the retaining pawl engages the adjusting pin.

- Check that the retaining pawl touches the underside of the adjusting pin. If it doesn't probably the counter nut of the thrust sleeve is incorrectly adjusted or the push rod might be deformed.
- Check to make sure that there is a full overlap between the shoulders of the locking yoke and the stopping surface of the spring catches (5) when the shift is in the reverse position.
- The clearance between the shoulders of the locking yoke and the stop surface of the spring catch in neutral position should be approx. 2 mm (0.08") "F".

## Oil filling

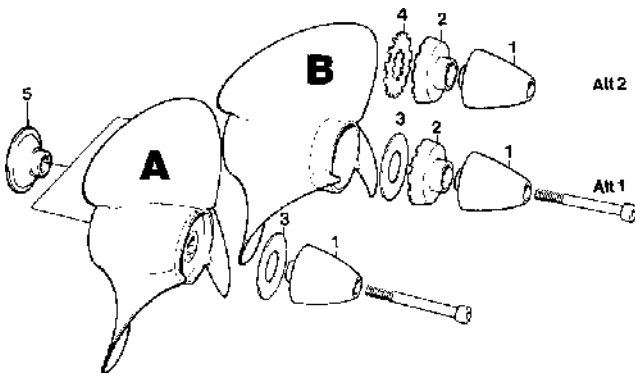
1. Install the oil drain plug with a new O-ring.
2. Tilt the sterndrive to the full up position. Remove the fill plug and fill with approx. 2.2 liters of gear oil. See **Technical Data**. Install the fill plug with a new gasket.

Tighten the fill plug to **35 Nm (26 lb.ft.)**.

Lower the sterndrive and check the oil level with the dipstick. If necessary, Top off the sterdrive with oil through the dip stick hole.

3. Install the shift mechanism cover.

## Propeller installation



On propellers of earlier manufacture the propeller cone is locked by a folding washer and on propellers of later manufacture the cone is locked by a locking screw through the center of the cone.

### Installing a 'long hub' type of propeller (A)

1. Grease the propeller shaft with a thin layer of grease.
2. Install the fishing line deflector (5).
3. Install the propeller.
4. Install the plastic washer.
5. Install the propeller cone (1) and tighten it.
6. Install and tighten the center screw.

### Installing a 'short hub' type of propeller (B)

1. Grease the propeller shaft with a thin layer of grease.
2. Install the fishing line deflector (5, figure on previous page).
3. Install the propeller.
4. **Alternative 1:** (Threaded hole in the propeller shaft center). Insert the plastic washer (3).  
**Alternative 2:** (No threaded hole in the propeller shaft center). Insert the folding washer (4).
5. Install the spacer ring, (2).
6. Install and tighten the propeller cone (1).
7. **Alternative 1:** Install and tighten the center screw.  
**Alternative 2:** Fold the washer (4) against the spacer ring (2).

**NOTE!** The sterndrive model 280B, ratio 1.61:1, is different from model 280D and model 270, ratio 2.15:1. The difference is to be found in the fact that the propellers have 'long hubs' and 'short hubs' respectively. See the picture.

**NOTE!** Short hub propellers (folding washer and cone) will be replaced by long hub propellers (plastic washer, cone, center bolt). When installing long hub propellers on older sterndrives, the propeller shaft must be drilled and tapped for use of cone with center bolt.

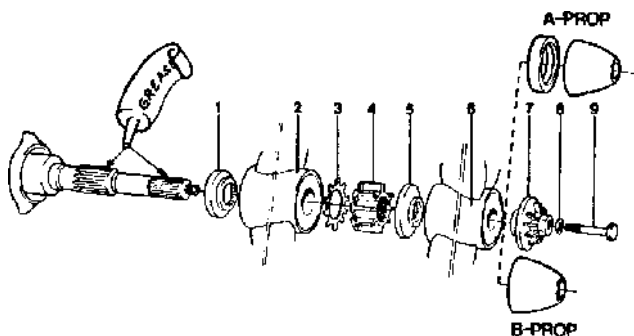
Use drill jig **885149** to drill the propeller shaft eliminating the need to remove the shaft from the drive unit as follows:

1. Install drill jig on propeller shaft.
2. Drill a 6.5 mm (0.255") hole to a depth of 20 mm (0.787"). Use cutting oil to cool shaft. Clean thoroughly.
3. Usa a 5/16"-18 UNC taps to thread shaft. Clean thoroughly.
4. Install propeller, plastic washer, cone and center bolt. Torque: cone = **110 Nm (81 ft.lb.)**, bolt = **22 Nm (16 ft.lb.)**.

## The Duoprop, earlier model

Check the speed range of the relevant boat and select the correct propeller. See *Propeller recommendations*.

**NOTE!** The propellers are supplied matched in pairs and must not be mixed.

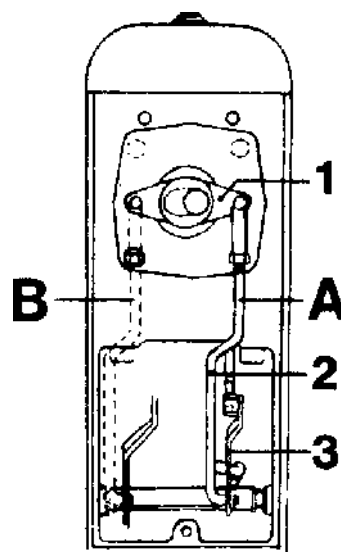


Install the propellers as follows: Grease the propeller shaft and install the fishing line deflector (1) and the propeller (2). Then install the folding washer (3) and the nut (4). Tighten the nut in a way that any of the tabs of the folding washer can be folded into the corresponding recesses of the nut. Then install the second fishing line deflector (5) and the propeller (6), which is locked with the nut (7). Insert a washer (8) on the screw (9) and tighten the screw in the propeller shaft center.

### Marking:

The propellers are marked on the hub side with the part number and a size code from A1 to A10.

## Changing the direction of the propeller rotation



The upper gear is designed in a way it does not have to be changed if you want to change the propeller rotation.

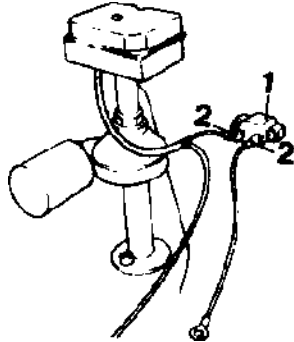
With the standard rotation – left hand rotating propeller – the lower gear wheel is operating as ‘forward’ gear and the shift rod is located in accordance with “A” on the picture. With a right hand rotating propeller the upper gear wheel is operating as “forward” gear and the shift rod is located in accordance with “B” on the picture.

In order to reverse the rotation the shift rod between the yoke (3) and the lever (1) on the shift mechanism must be moved as follows:

- a) Remove the cover over the shift mechanism.
- b) Move the shift rod 2 from position “A” to “B”.

**NOTE!** Changing the direction of rotation by reversing the levers in the control is strictly forbidden. With a left hand as well as with a right hand rotating propeller, the shift cable movement is “pushing” in position “forward”. Check and adjust the control in accordance with chapters *Checking and adjusting controls*, page 127 and *Checking the retaining pawl when test running*, page 127!

## The electro-mechanical sterndrive tilting device, model 280/285



### Repair instructions

Operating failures of the sterndrive tilting device can be caused either by electrical or mechanical faults. Below we deal with 2 examples of electrical faults and 1 mechanical fault.

#### 1a. Overheating the electrical motor

Avoid running the sterndrive up and down repeatedly. Such operation can cause over-heating of the electrical motor. The built-in overheating cut-out switch is being released when the motor temperature reaches a certain value. If the over-heating switch has been released, the electrical motor has to cool down (approx. ½ an hour) before the tilting device can be operated again.

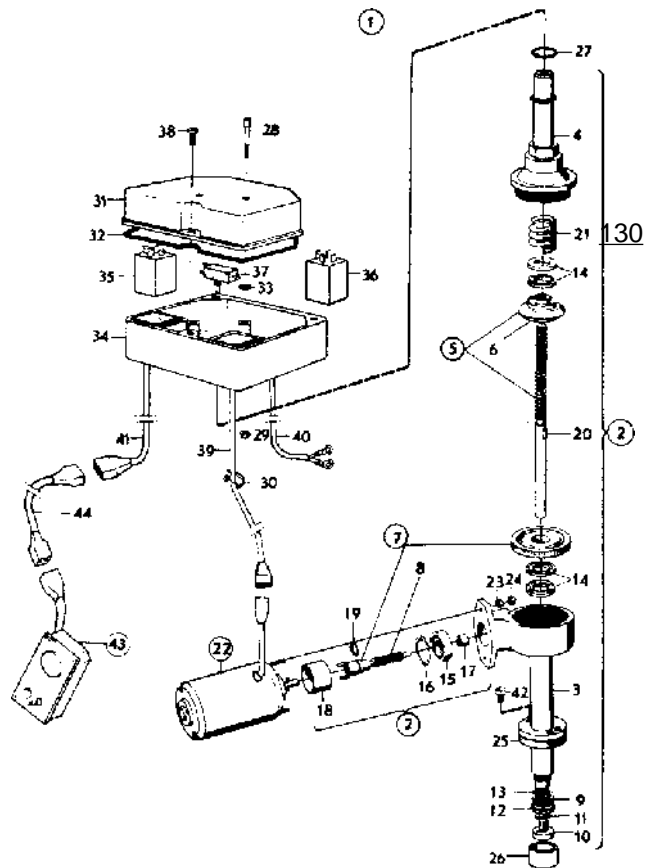
#### 1b. Burnt electrical motor

If the tilt motor is operated too long after the sterndrive has reached its top position, the motor can burn. To avoid this an overload circuit breaker can be installed on the transom.

**NOTE!** On sterndrives of later manufacture this overload circuit breaker is standard equipment.

Install the overload circuit breaker as follows:

Install the overload circuit breaker (1) on the transom, close to the sterndrive tilting device. Remove the minus wire (earth), (blue), from the flywheel housing sufficiently to allow the wire to be connected to the overload circuit breaker and then back to the flywheel housing. Cut the wire and connect two terminals (2). Install the minus wire (earth) to the flywheel housing.

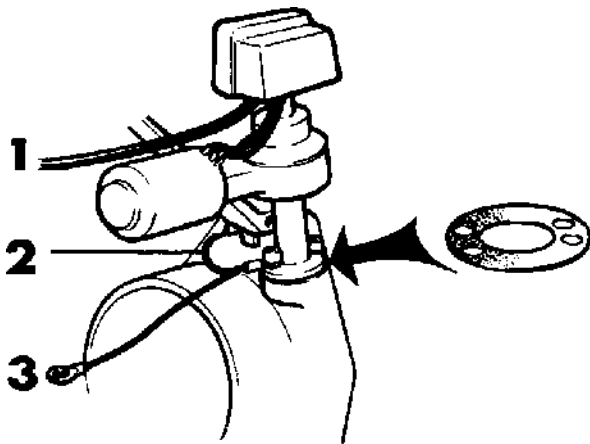


## 1c. Mechanical fault

Check to make sure that the cover does not press against the limit switch by removing the cover and testing the function of the tilting device. If the tilting device functions with the cover removed but not with the cover installed, remove part of the cover over the limit switch, pressing on the switch. Check the clearance between the cover and the limit switch.

## Reconditioning the tilting device

1. Remove the cover and remove the limit switch (37, fig. on previous page) and the bracket with the relays (35) and (36).
2. Remove the nuts and the electrical motor (22).
3. Remove the locking washer (11) and the shoulder screw (10) and the sealing nut (9).
4. Remove the upper part (4) and lift out the gear rod (5) the spring (21), the bearings (14) and the worm gear (7).
5. Pull out the guide sleeve (18) and the worm screw (8) along with the bearing (15).
6. Wash the parts and check the wear. Replace parts if necessary.



7. Assemble the tilting device in the reversed order. Grease the parts in an universal type of grease at the assembly. Also fill the upper housing with grease. Connect the minus (earth) wire (2) and (3) as indicated in the picture and the wire harness (1) to the control switch.

## Checking after reconditioning

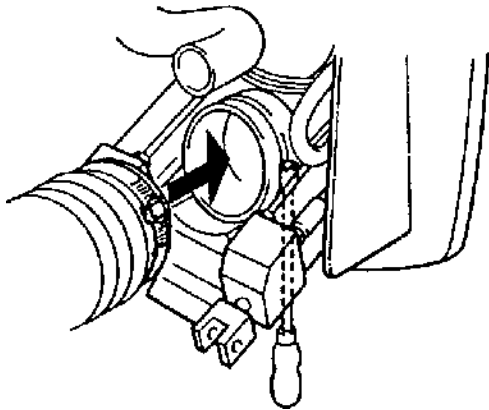
Check after the installation that the tilt and retaining pawl mechanism function properly. When tilting, the tilting device should release the retaining pawl completely from the adjusting pin prior to tilting the stern-drive. Adjust the push rod length in accordance with point 7 page 127.

When lowering the sterndrive, run the tilt motor until it is automatically cut off and the warning light goes out.

In case the sterndrive should not stay in the 'up' position, the spring (21, fig. on previous page) is not stretched sufficiently. Insert a washer underneath the spring. Should it not be possible to depress the sterndrive by hand (approx. 75 Kilos, 145 lbs) at the trim tab, the upper part (4) must be eased off a bit.

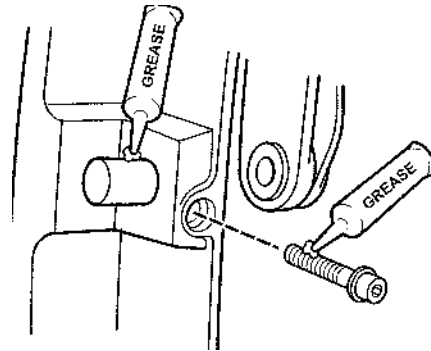
**NOTE!** There is no need to lock the upper part. The spring pressure is locking it.

## Models 290, SP and DP

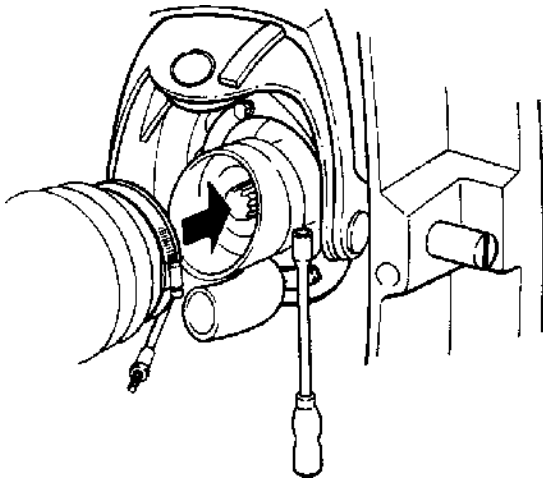


1. Install the exhaust bellows on the transom shield. Turn the hose clamp so that the tightening screw ends up at two o'clock with the head pointing downwards.

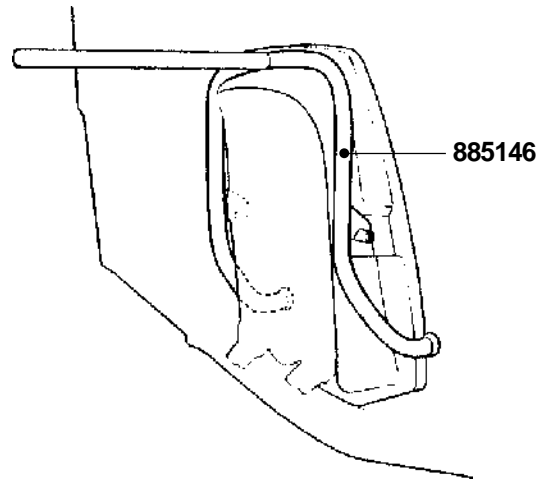
**NOTE!** Turn the drainage hole in the bellows facing downwards.



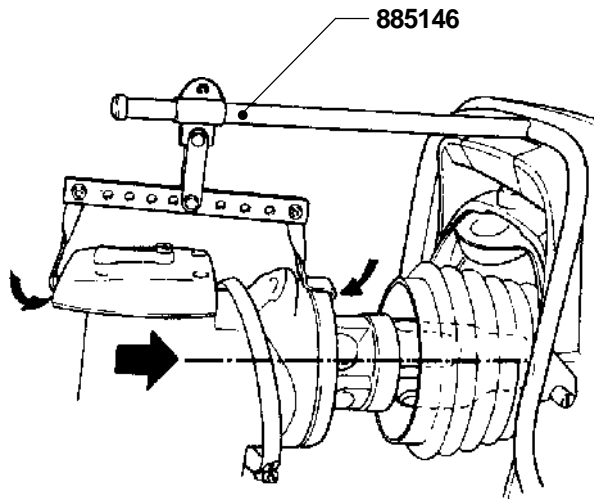
3. Remove the locking screw and remove the suspension pin. Grease the suspension pins with Volvo Penta low temperature grease 1161417-9 and install in the transom shield flush with the interior face to the shield. Grease the locking bolt with Volvo Penta low temperature grease 1161417-9. Put the locking bolts aside for installation later.



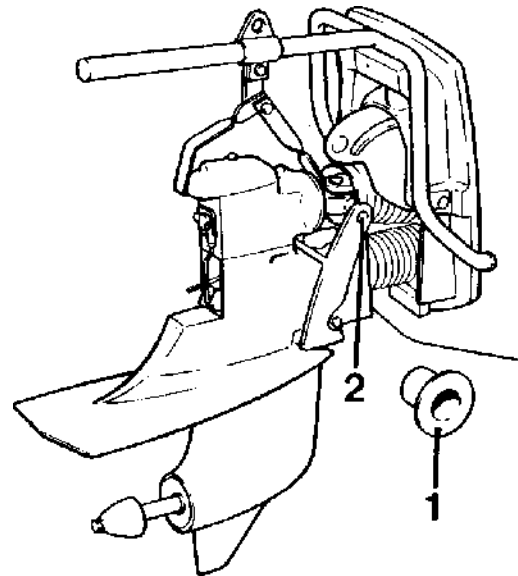
2. Hang on the hose clamp and install the universal joint bellows. Locate the tightening screw at 3 o'clock.



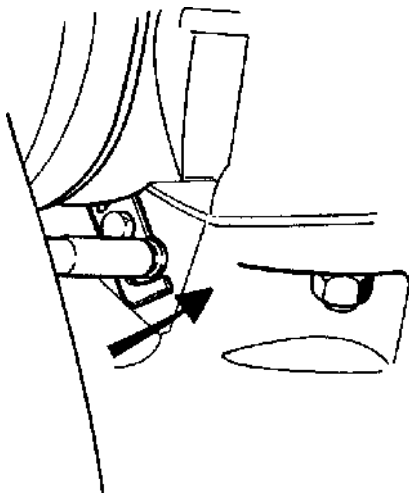
4. Install the yoke **885146** in the transom shield.



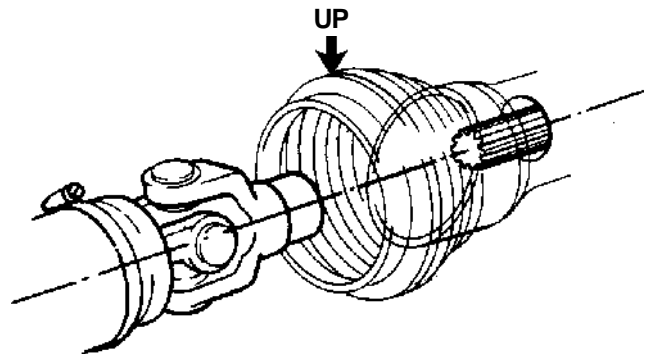
5. Remove the cover over the shift mechanism. Hang a hose clamp on the sterndrive and install the yoke on the sterndrive. Then lift up the sterndrive and hang it in the tool **885146**.



7. Install the plastic bushings (1) in the holes (2) of the suspension yoke.



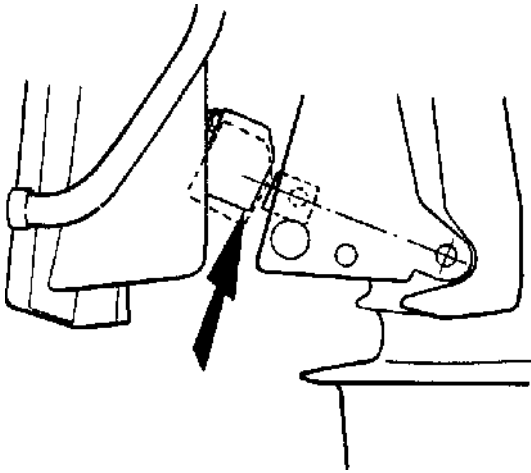
6. Push the shift cable as far into the sterndrive as to allow the locking to lock the cable in its groove in the cable cover. Tighten the locking plate with the 2 stainless steel screws. Key width **11 mm**.



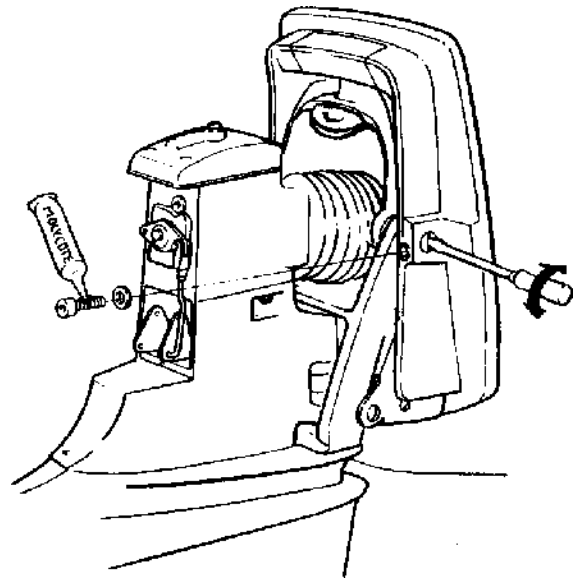
8. Push the sterndrive forwards against the engine primary shaft and turn the universal joint simultaneously to better allow the primary shaft splines to enter the universal joint. A small guide in the joint facilitates the finding of the correct position.

**NOTE!** Install the bellow with the "UP" marking up.





9. Push the stern drive forwards. Lift up the trim cylinders simultaneously and continue to push the stern drive forwards.

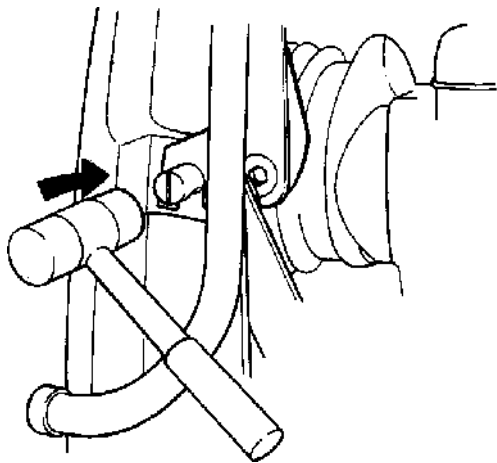


11. Use a screwdriver to turn the dowels so that the locking grooves coincide with the locking screw holes in the ears of the transom shield. Tighten the locking screws. Prior to the tightening of the screws, grease them with low temperature grease, Volvo Penta part no. 1141644-3.

**NOTE!** Don't forget the washer under the screw heads.

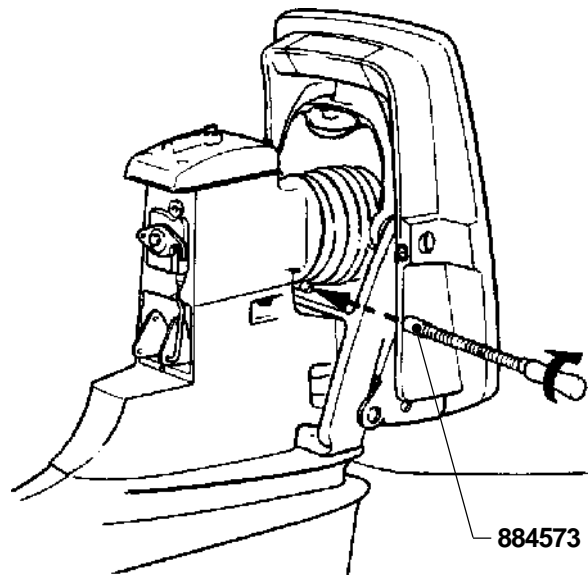
Tighten torque: **24 Nm (17 lb.ft)**.

Remove the installation tool.

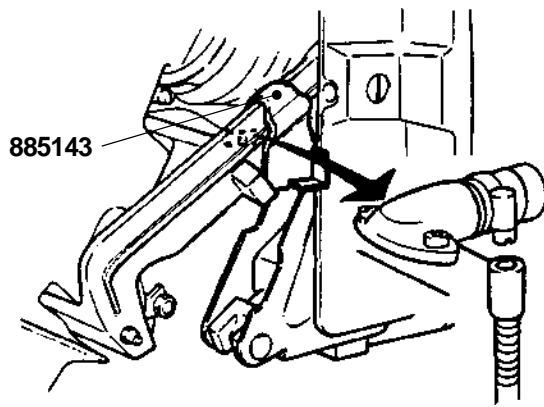


10. Push the stern drive suspension yoke into the transom shield and align the yoke with the suspension dowels in the shield. Knock the dowels into position and use a rubber mallet.

**NOTE!** Don't use a hammer in order to avoid damaging the dowels thus not making the future dismantling more difficult.



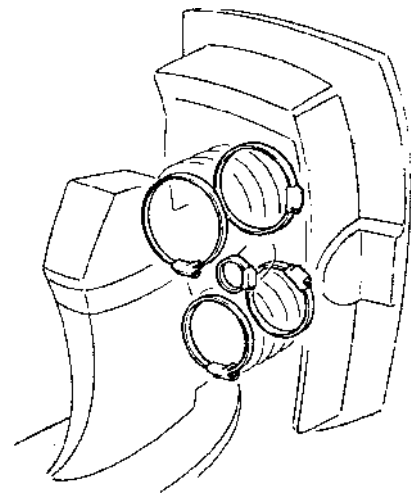
12. Push the rubber bellows on to the neck of the upper gear housing. Check to make sure that the bellows is installed correctly and push on the hose clamp and tighten it with the tightening screw located on the underside of the bellows. Use special tool **884573**.



**13.** Pull down the retaining pawl and lift up the stern-drive sufficiently to allow the installation of special tool **885143** between the transom shield and the suspension yoke.

Hang the hose clamp on to the cooling water hose and connect the hose to the hose attachment on the suspension yoke.

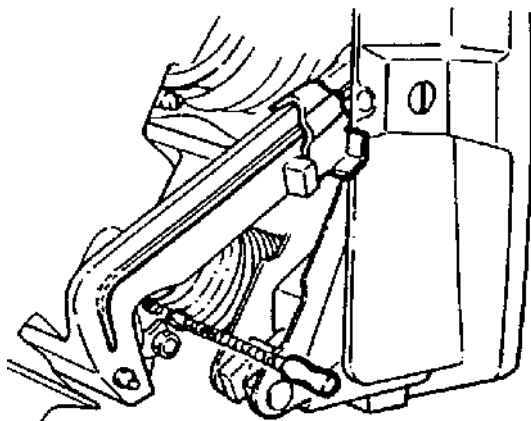
**⚠ IMPORTANT!** Turn the hose clamp so that the tightening screw ends up at two o'clock on the starboard side. This is important. Should the hose clamp be installed incorrectly, this can damage any of the other bellows.



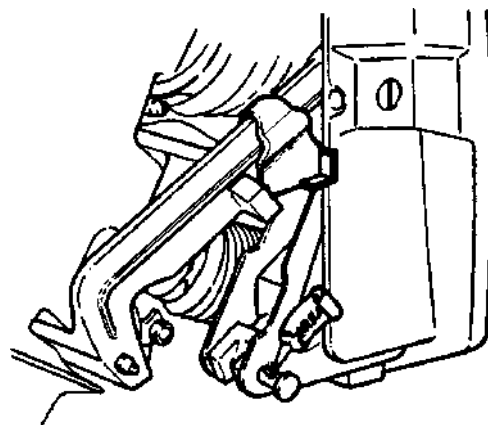
**15.** Check to make sure that all bellows and hoses have been installed correctly and well tightened.

Tilt the stern-drive and turn it fully both ways and check simultaneously that the tightening screws of the bellows do not touch neither the stern-drive, the transom shield nor the bellows. Adjust if necessary. Use special tools **885143** and **884573**.

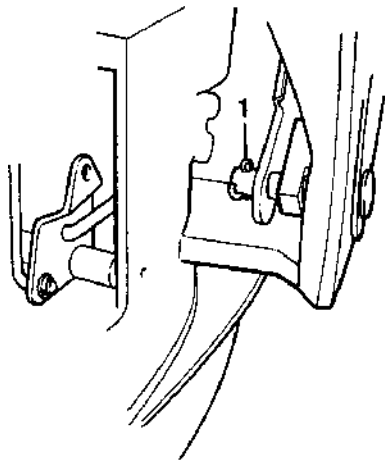
The above picture reflects the correct positioning of the hose clamps.



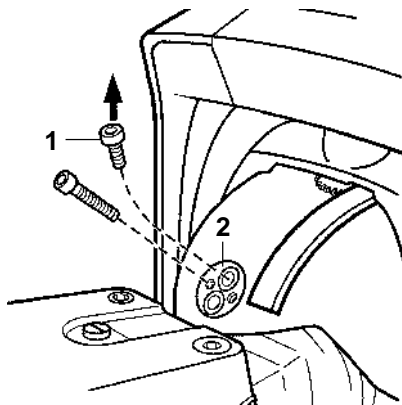
**14.** Hang on the hose clamp for the exhaust bellows and push it onto the neck of the stern-drive. Turn the hose clamp into the position indicated by the picture. See also point 15.



**16.** Center the cylinder attachment holes and the cylinders. Grease the trim cylinder bolts and install them.



17. Install the cotter pins (1). Fold the 'legs' backwards carefully.

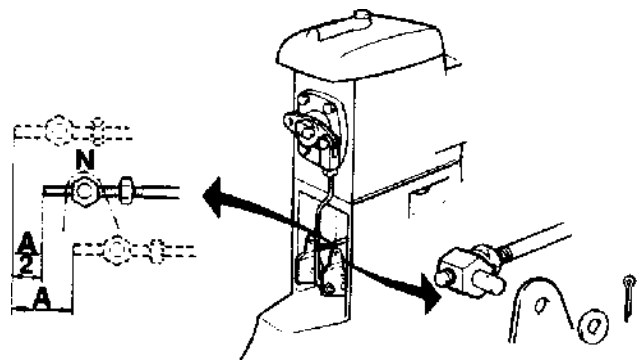


18. Lower the steering helmet and align the helmet bushing with the recessed hole of the upper gear head. Grease the attachment (2) with low temperature grease, Volvo Penta part no. 1161417-9.

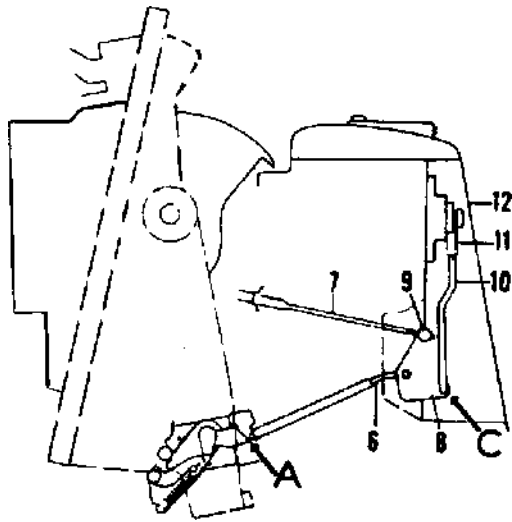
Install the attachment in the helmet bushing with the recessed holes vertical (one hole over the other). While moving the sterndrive slightly from side to side, push home the attachment until it bottoms in the upper gear head recessed hole. Install the two allen head bolts (1).

Tightening torque: **35 Nm (25 lb.ft)**.

**⚠ WARNING!** Be sure the attachment is aligned in the upper gear recess before tightening the allen head bolts.



19. Before connecting the shift cable be sure that if the remote control moves forward, the shift cable extends from the cable housing, (i.e. cable pushes for forward gear, pulls for reverse gear). Set the stern-drive shift lever to horizontal making shure that it is in the neutral detent position. Set the remote control shift lever to neutral. Push the shift cable in as far as possible. Using a fiber tip marker or suitable substitute, mark the position of the cable at the cable housing (A). Pull the control cable as far out as possible. Note the distance between the cable housing and the marked position on the cable. Push the cable into the housing half the distance to the mark (A2). Install the swivel onto the shift cable to the point it will attach to the shift lever without moving the lever for attachment. Install the washer and cotter pin. Bend the tabs backwards onto the swivel.



## Adjusting the retaining pawl, model 290

- a) Set the control lever in the 'Forward' position and check that the lever (8) does not touch the housing. See position "C" on the picture.

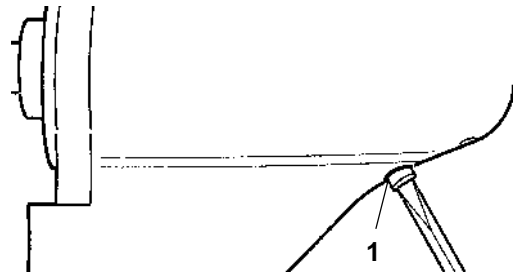
Check with the control lever in 'Forward', 'Reverse' and in 'Neutral' that the swivel (9) and the cable attachment (7) does not strain in the shift plate (8).

Adjust by easing off the locking nut and then by altering the position of the swivel (9) on the shift cable. Tighten the nut after the adjustment.

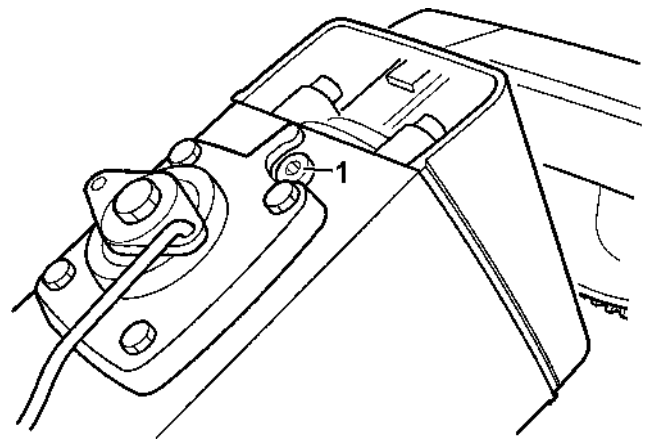
- b) Set the control lever in 'Neutral' and check that the rod (6) has a position that it will touch the yoke of the retaining pawl at "A". However, without pressing against it.

Adjust if necessary the yoke (11). If a second adjustment is made, also point a) has to be adjusted once again.

## Oil filling



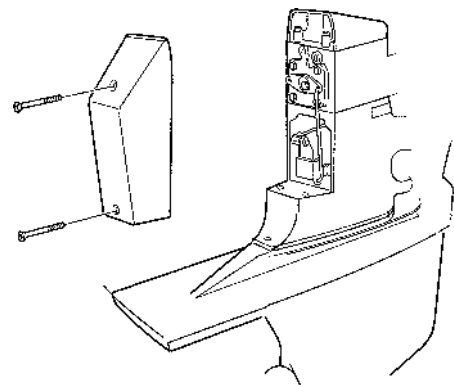
1. Install the oil drain plug with a new O-ring (1).



2. Tilt the sterndrive to the full up position. Remove the fill plug (1) and fill with approx. 2.2 liters of GL-5 synthetic gear oil. See **Technical Data**. Install the fill plug with a new gasket.

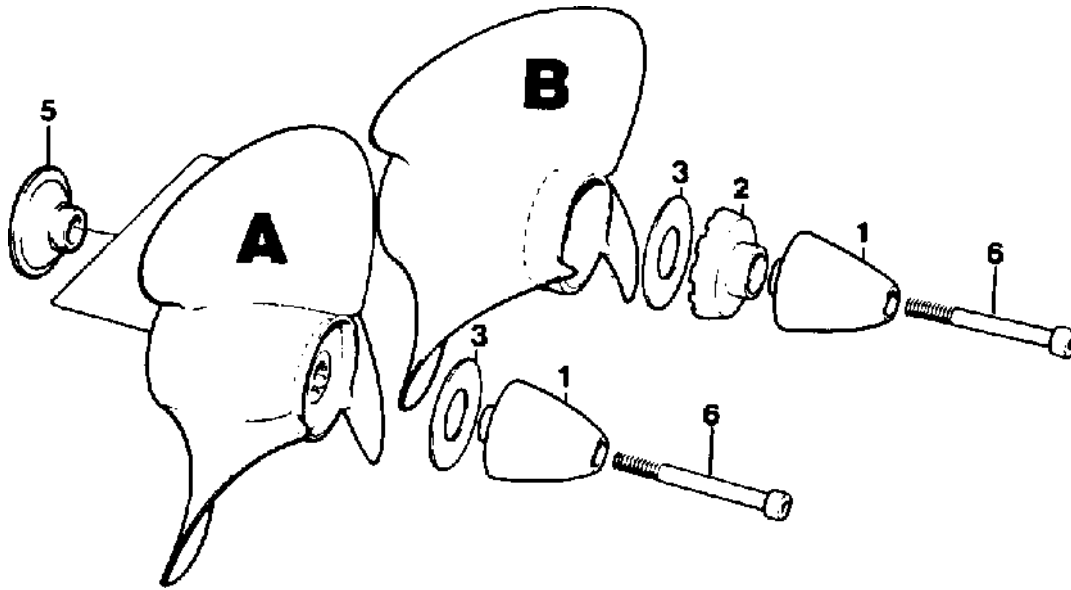
Tighten the fill plug to **35 Nm (26 lb.ft.)**.

Lower the sterndrive and check the oil level with the dipstick. If necessary, Top off the sterndrive with oil through the dip stick hole.



3. Install the shift mechanism cover.

## Propeller installation



Locking the propeller cone on sterndrives of earlier manufacture is done by a folding washer and on sterndrives of later manufacture by a locking screw through the cone center.

### Installing a 'long hub' type of propeller (A)

1. Grease the propeller shaft with a thin layer of grease.
2. Install the fishing line deflector (5).
3. Install the propeller.
4. Insert the plastic washer (3).
5. Install and tighten the propeller cone (1).
6. Install and tighten the center bolt, (6).

### Installing a 'short hub' type of propeller (B)

1. Grease the propeller shaft with a thin layer of grease.
2. Install the fishing line deflector (5).
3. Install the propeller
4. Insert the plastic washer (3).

5. Install the spacer ring (2).
6. Install and tighten the propeller cone (1).
7. Install and tighten the center bolt (6).

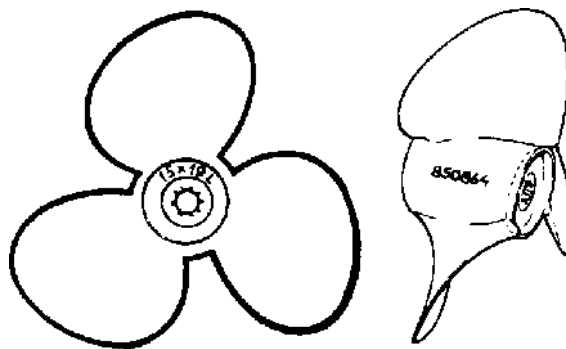
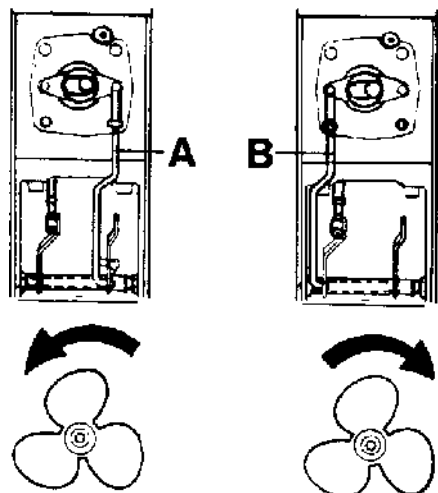
**NOTE!** Sterndrive model 290B ratio 1.61:1 is different from sterndrive model 290D ratio 2.15:1. The difference consists of propellers with long and short hub respectively. See the picture!

**NOTE!** Short hub propellers (folding washer and cone) will be replaced by long hub propellers (plastic washer, cone, center bolt). When installing long hub propellers on older sterndrives, the propeller shaft must be drilled and tapped for use of cone with center bolt.

Use drill jig **885149** to drill the propeller shaft eliminating the need to remove the shaft from the drive unit as follows:

1. Install drill jig on propeller shaft.
2. Drill a 6.5 mm (0.255") hole to a depth of 20 mm (0.787"). Use cutting oil to cool shaft. Clean thoroughly.
3. Use a 5/16"-18 UNC taps to thread shaft. Clean thoroughly.
4. Install propeller, plastic washer, cone and center bolt. Torque: cone = **110 Nm (81 ft.lb.)**, bolt = **22 Nm (16 ft.lb.)**.

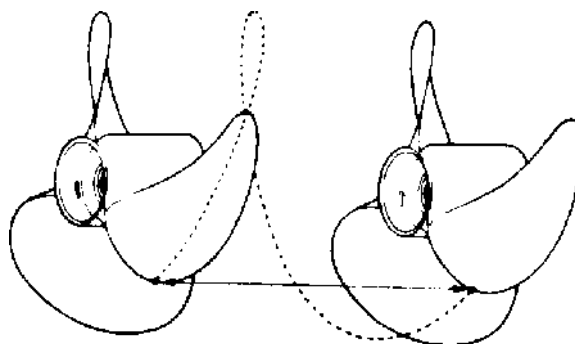
## Changing the direction of the propeller rotation, SP drives



On the propeller hub there is a 'L' for left hand rotating and a 'R' for right hand rotating propeller. Also the size of the propeller is stamped into the hub, for instance 15x19 where 15 denotes the diameter in inches and 19 the pitch, also in inches. This is not valid for Duo-prop propellers.

The sterndrives are supplied adjusted for left hand rotation 'A'. In some cases, however, it can be of advantage in a twin installation to have right hand rotating starboard propeller 'B'. It's possible, by a rather simple adjustment, to change from standard left hand rotating propeller to a right hand rotating one by simply moving the shift rod from 'A' to 'B'. Check to make sure that the adjustment of the retaining pawl and the shift mechanism is still intact. Install the shift mechanism cover.

**NOTE!** There is no need to alter the direction of rotation on the Duo-prop sterndrive in a twin installation.

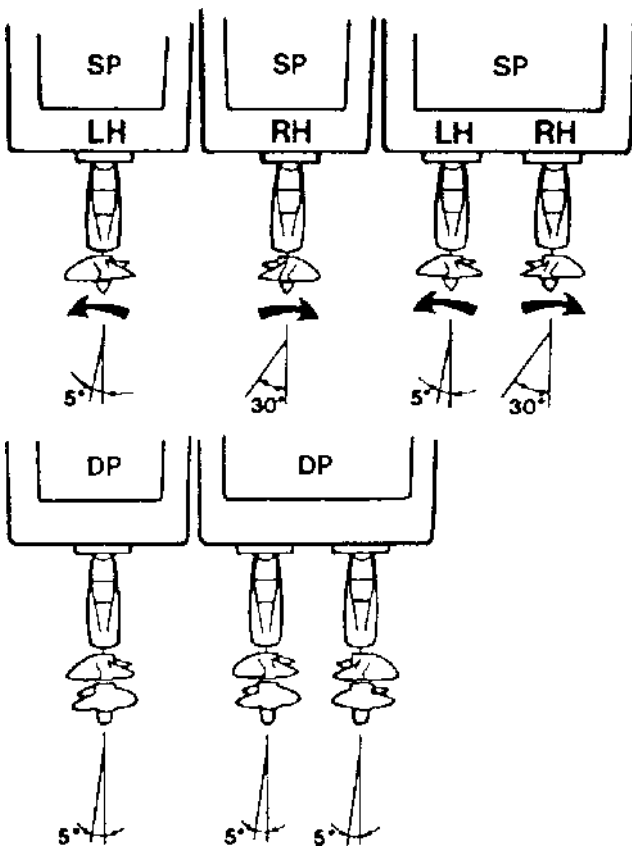
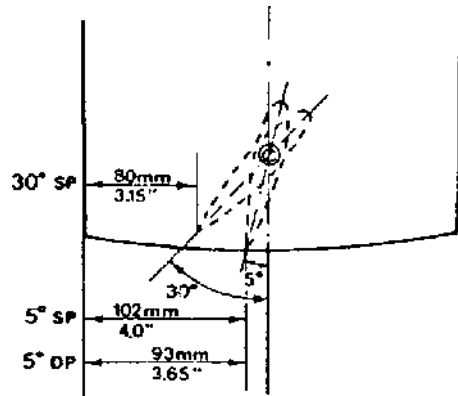


The pitch is the theoretical lengthwise movement of the propeller during one full turn.

## Adjustment of trim fin

The trim fin is factory set at 5° towards port side. After installation the adjustment of the trim fin should be checked and, if necessary, corrected according to figures below. This is a basic adjustment. An exact adjustment can only be done after a test run with the servo unit disconnected.

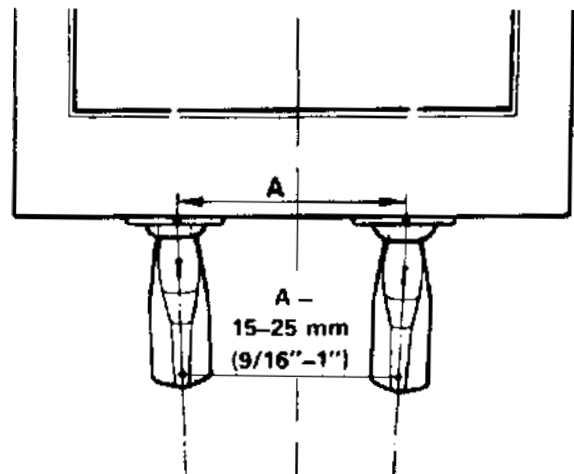
SP = Single prop  
 DP = Double prop  
 LH = Left hand  
 RH = Right hand



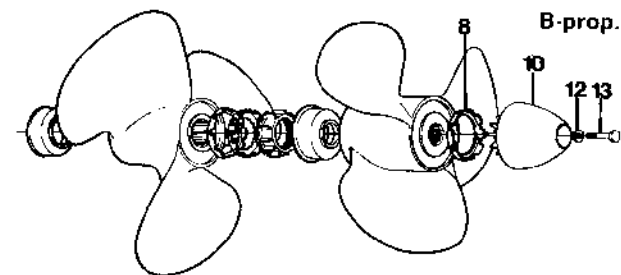
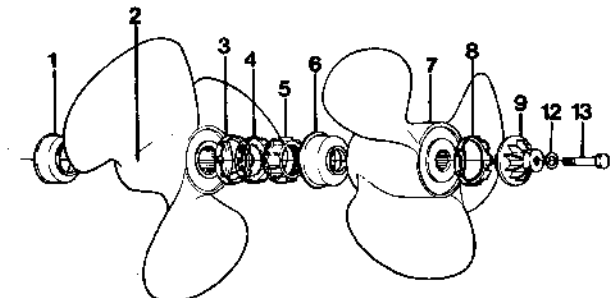
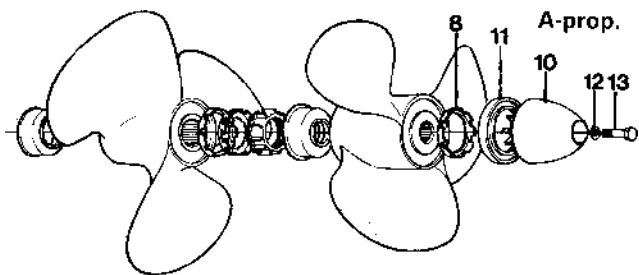
## Twin engine installation

In a twin installation the 'Toe-out' angle between the sterndrives must be adjusted until an operation free from cavitation has been obtained. Increase the angle between the sterndrives on a boat with a deeper V-hull. Adjust the sterndrives in accordance with the picture. If the measurement at the transom shield is 'A', the measurement at the screw head of the trim tab must be 'A' minus 15–25 mm (9/16"–1").

**NOTE!** Push the sterndrives apart by hand when measuring.



**NOTE!** The figures show the boat drive from above. Tightening torque: 14–17 Nm (10–12 lbf.ft.).



Duoprop propellers are available in two versions as follows:

**A-marked** propellers shall only be used with diesel engines.

**B-marked** propellers shall only be used with petrol/gasoline engines.

**⚠ WARNING!** A and B propellers must never be mixed.

**Markings:**

Earlier propellers are only marked on the side of the hub with the part No. and size code, from A1 to A10 or from B1 to B8.

On later propellers the part No. and propeller size marking on the side of the hub is complemented with the following data stamped on the rear end of the hub:

- 1 = Part No.
- 2 = Propeller size
- 3 = Date of vulcanizing
- 4 = Final manufacture date of the propeller
- 5 = Tool No. used for the vulcanizing

**NOTE!** that later propellers, both A and B propellers, are painted black. To identify the two types, the rear propeller has a sticker on the front end of the hub.

Propellers with a green/yellow sticker (A propellers) shall only be used with diesel engines.

Propellers with a red/yellow sticker (B propellers) shall only be used with petrol/gasoline engines.

**Duoprop (later model)**

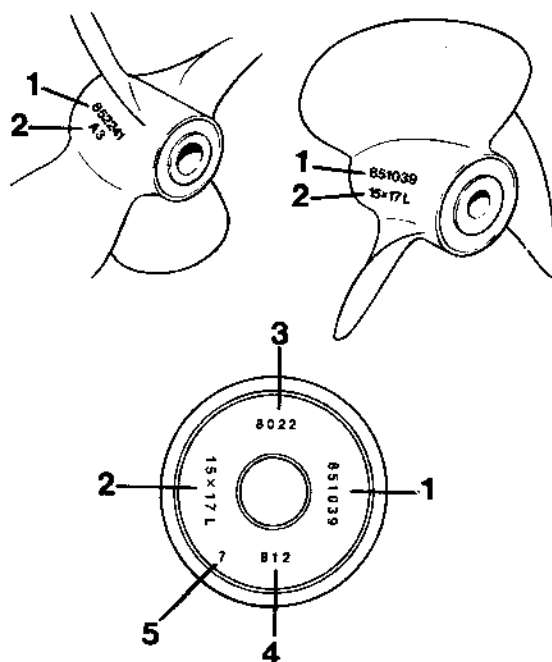
Check which speed range the boat in question operates in, and select the correct propeller. Refer to propeller recommendations.

**NOTE!** The propellers are supplied in pairs and must not be mixed. Use special tool **885127**. Install the propellers as follows: grease the propeller shaft and fit the fishing line protection (1) and the propeller (2).

**⚠ WARNING!** The line cutters (1 and 6) have very sharp edges. Be careful to avoid cuts. Then fit the plastic washer (3), the tab washer (4) and nut (5). Tighten the nut so that the locking washer's tabs can be bent into the nut's recesses. Thereafter, install the other fishing line protection (6) and the propeller (7). Place a plastic washer (8) on the nut (9) or propeller cone (10) and tighten the propeller with the nut. When the locking cone (10) is fitted, a spacer ring (11) shall be fitted for **A**-propellers. The spacer ring shall not be used for **B**-propellers. Place a washer (12) on bolt (13) and tighten the propeller shaft centre bolt.

**NOTE!** The line cutters (1 and 6) are now replaced by thrust washers. Never mount line cutters together with thrust washers.

Propeller identification



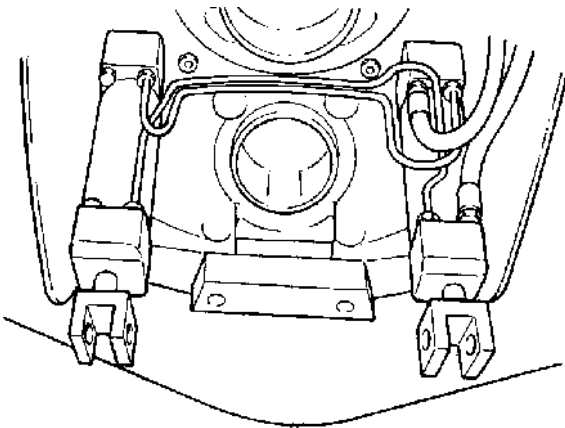


# Transom shield

## Changing trim cylinders, models 290, SP and DP

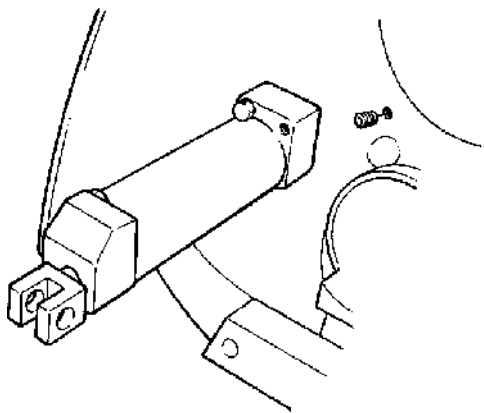
1. Remove the sterndrive when the boat is on land. Also remove the exhaust bellows and the universal joint bellows. Remove if necessary barnacles etc and clean the shield.

### Trim cylinders, earlier models



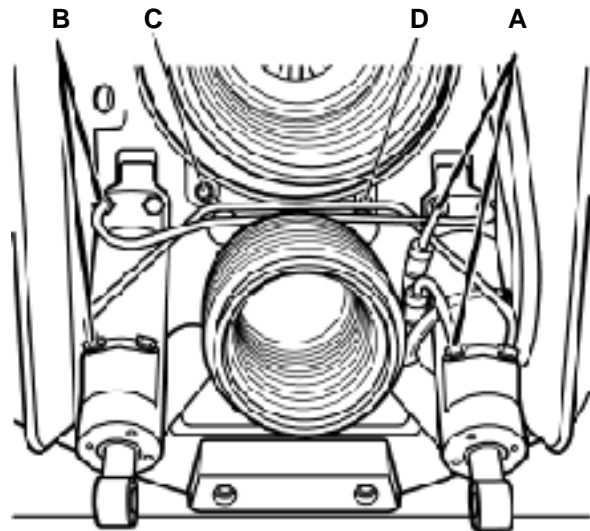
2. Remove the 2 hoses and the pipes from the starboard cylinder. If only the port trim cylinder is to be replaced, remove the pipe connections. Watch out for oil running out.

**⚠ WARNING!** Be sure to catch any oil which will leak when the hydraulic lines are disconnected.



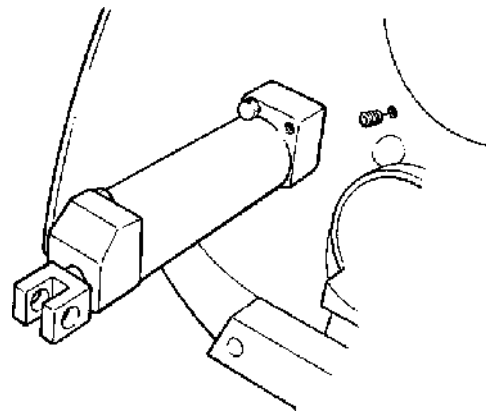
3. Remove the plastic plug with a 5 mm Allen-head key.

### Trim cylinders, later models



4. Remove the 2 hoses (A) from the starboard cylinder. If only the port cylinder is to be replaced, remove the pipe connections on that cylinder (B).

**⚠ WARNING!** Be sure to catch any oil which will leak when the hydraulic lines are disconnected.



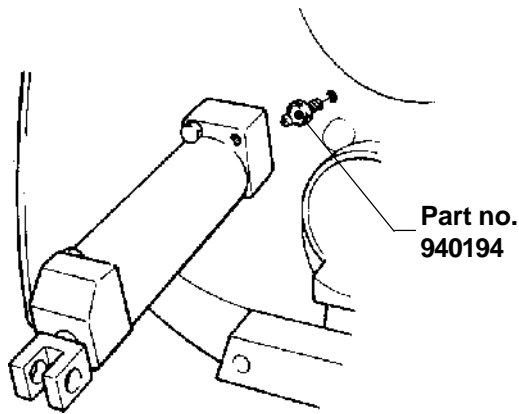
#### 5a. Port Cylinder:

If the port cylinder is to be removed, remove the ground strap terminal (C, figure above) and insert from the transom shield.

#### 5b. Starboard Cylinder:

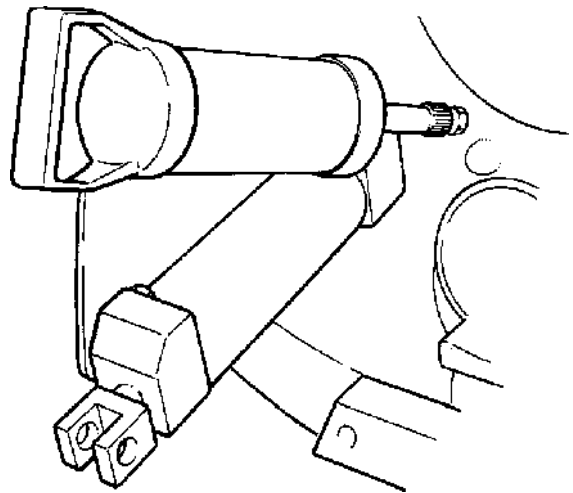
Remove the plastic plug (D, figure above) adjacent to the trim cylinder attachment pin.

Trim cylinders, all models

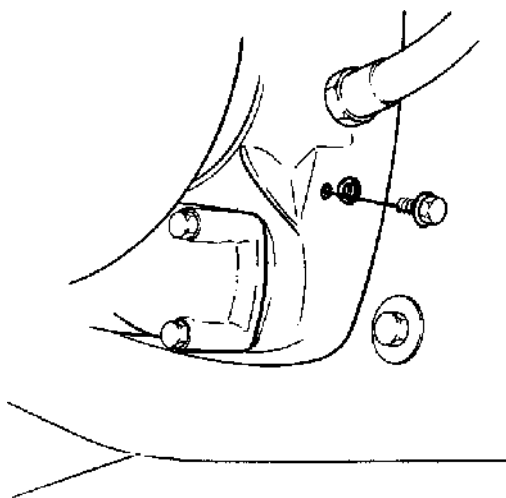


6. Install a grease nipple where the ground terminal bushing (late models) or plastic plug (early models) was removed.

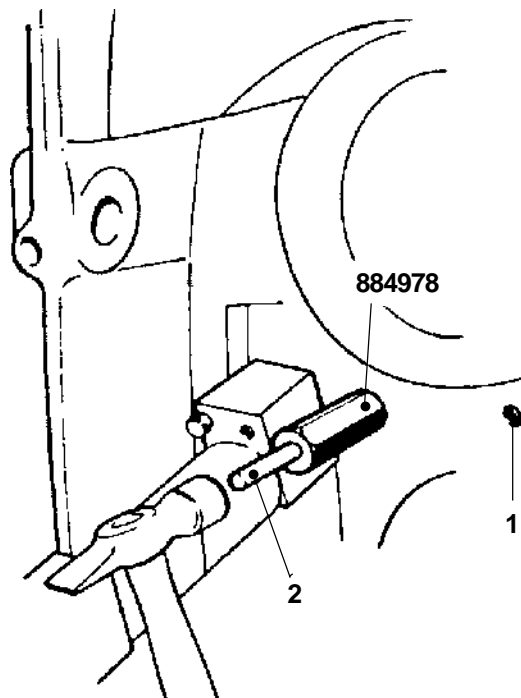
Use grease nipple, Volvo Penta part no. 940194.



8. Use a grease gun and inject grease into the grease nipple. The dowel pin will then be pushed out and the trim cylinder can be removed.



7. Remove the locking bolt for the trim cylinder dowel pin. Key width 10 mm.



9. If the dowel pin will not come out by using a grease gun, special tool **884978** should be used as follows:

Remove the grease fitting.

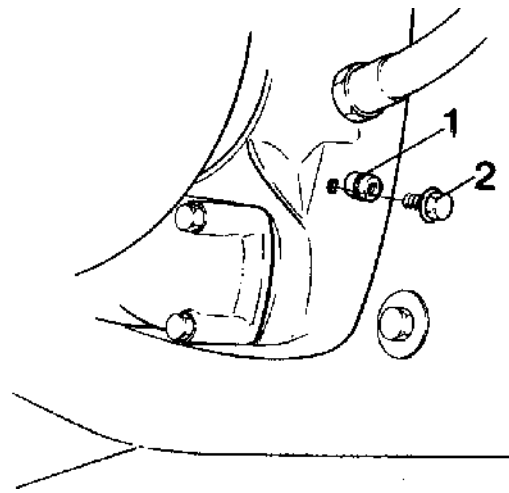
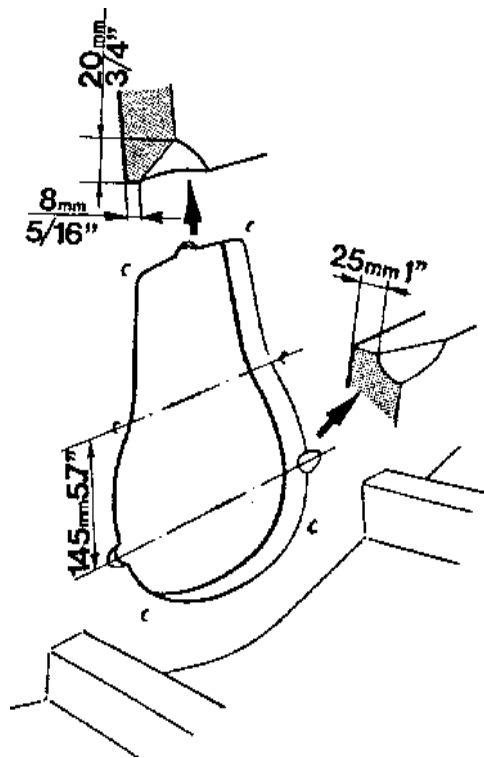
Fill the tool with grease.

Screw the tool into the transom shield and carefully tighten.

Unscrew the locking trim cylinder pin locking bolt (1) approx. 10 mm (1/4").

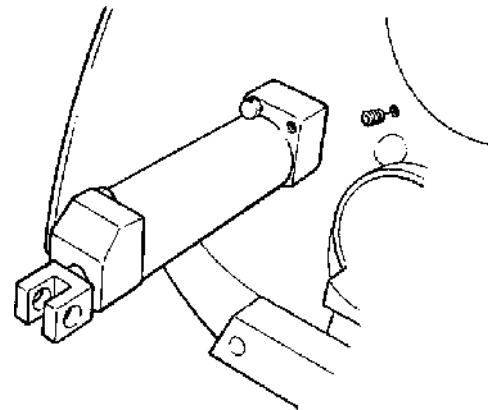
Hit the tool piston (2) with a hammer so that the trim cylinder pin is forced against the locking bolt.

Unscrew the locking bolt completely. Force the pin the rest of the way out of the hole.



11. Always use a new O-ring (1) on the dowel pin during reassembly. Check the pin hole and pin for scratches or other damage. Position (2) is the locking bolt.

**⚠ IMPORTANT!** The transom must have cutouts called for on the transom template to allow sufficient clearance for the pins to be removed. If the cutouts are not made, the transom shield must be removed from the boat to enable trim cylinder pin removal.

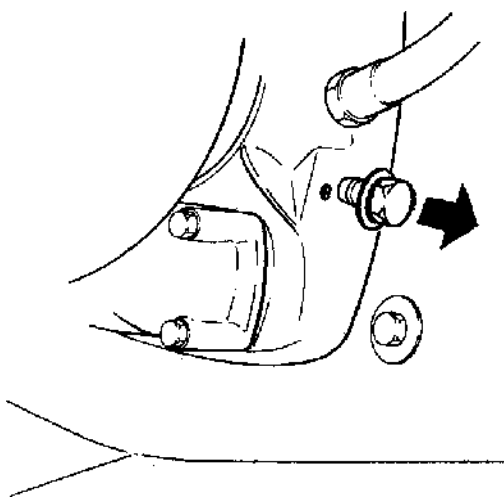


12. Remove the grease fitting that was used to remove the attachment pin.

Grease and install the trim cylinder dowel pin.

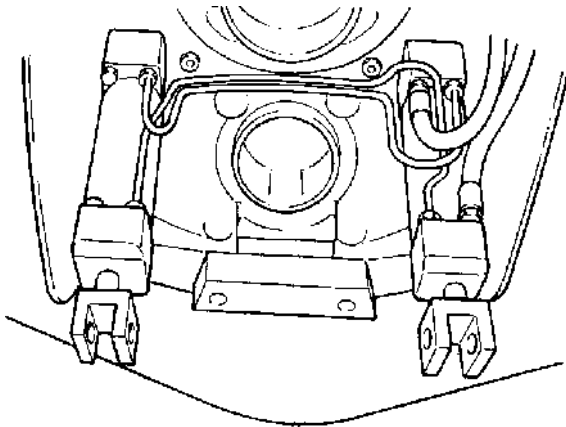
Install the new trim cylinder.

Remove the attachment bolt from the end of the pin and lock the pin in position with the bolt.



10. **NOTE!** The locking bolt can be installed in the dowel pin. Then apply a pair of pliers and pull out the dowel pin.

## Trim cylinders, earlier models



13. Remove any shipping plugs installed in the new trim cylinder.

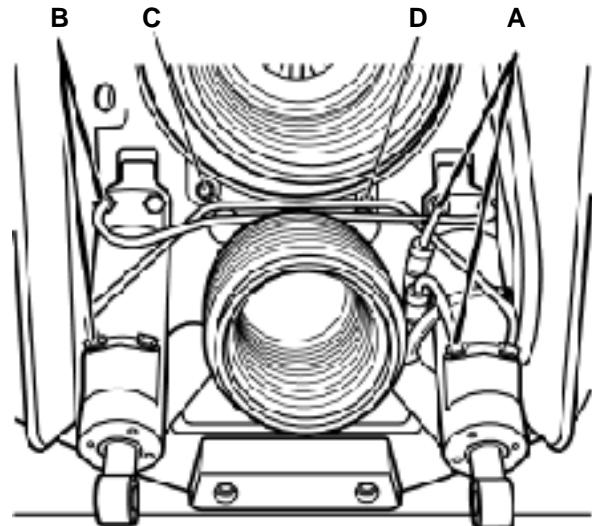
Install the pipes and the hoses on the new trim cylinder.

**⚠ WARNING!** Make sure all the pipes and hose fittings are attached finger tight before torquing any of the fittings. Final tightening of any of the fittings before all fittings are started could cause cross-threaded fittings and damage the cylinder.

Install the sterndrive according to chapter *Installing the Sterndrive*.

Raise and lower the sterndrive several times to bleed any air trapped in the hydraulic system.

## Trim cylinders, later models



14. Remove any shipping plugs installed in the new trim cylinder.

Install the pipes and the hoses on the new trim cylinder. Hoses to starboard cylinder (A) and port cylinder (B).

**⚠ WARNING!** Make sure all the pipes and hose fittings are attached finger tight before torquing any of the fittings. Final tightening of any of the fittings before all fittings are started could cause cross-threaded fittings and damage the cylinder.

## 15a. Port cylinder:

Remove the block off plugs from the old cylinder and install in the same holes of the new cylinder.

Install the ground strap insert (C), attach the ground strap to the insert.

**⚠ WARNING!** Be sure there is good electrical contact (low resistance) between the trim cylinders and the transom shield. High resistance between the transom shield and the trim cylinders will result in corroded trim cylinders. For more information on electrochemical corrosion, consult publication 7733534-7 *Marine Electrical Systems* available from Volvo Penta parts.

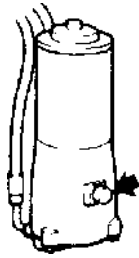
## 15b. Starboard cylinder:

Install the plastic plug (D).

Install the sterndrive according to chapter *Installing the Sterndrive*.

Raise and lower the sterndrive several times to bleed any air trapped in the hydraulic system.

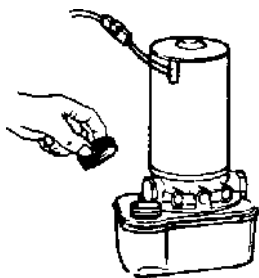
Trim cylinders, all models



Trim pump, earlier model

**⚠ IMPORTANT!** The hydraulic pump must be installed vertically, as reflected by the picture.

16. Remove the oil filler/indicator plug to check the oil level. Top up if necessary. Install the sterndrive in the transom shield. Raise and lower the drive simultaneously to facilitate the topping up and to make sure that the system is properly filled up. The oil level should be level with the oil filler hole. Use the same oil quality as for the engine or ATF oil. See below.



Trim pump, later model

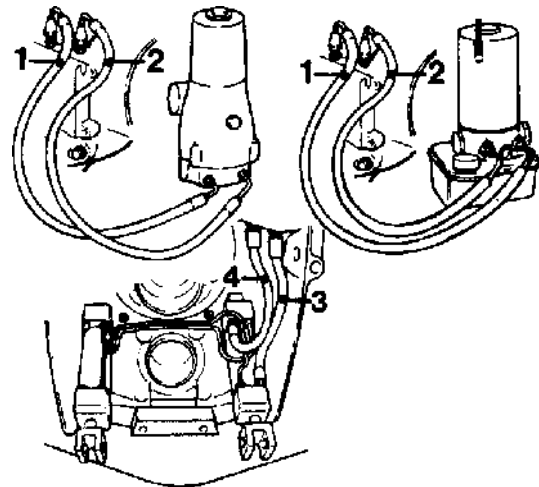
17. Oil level, hydraulic pump – power trim:  
Trim in the drive as far as possible. Check that the oil level is between the max and min. marks on the reservoir. Top up if necessary with ATF oil.

**NOTE!** Early production drives were filled with engine oil and have that recommendation in the Owner's Manual. Late production drives have ATF oil filled.

**⚠ IMPORTANT!** We recommend the use of ATF oil. Observe strict cleanliness so that dirt is not drawn in by the oil.  
**ATF oil and engine oil must never be mixed.** If ATF oil is to be used, the engine oil must first be drained from the system. If the system has been drained, fill up with new oil and trim the drive 6 to 10 times in and out to purge air from the system. Check the oil level and top up if necessary.

Trim pump, earlier model

Trim pump, later model

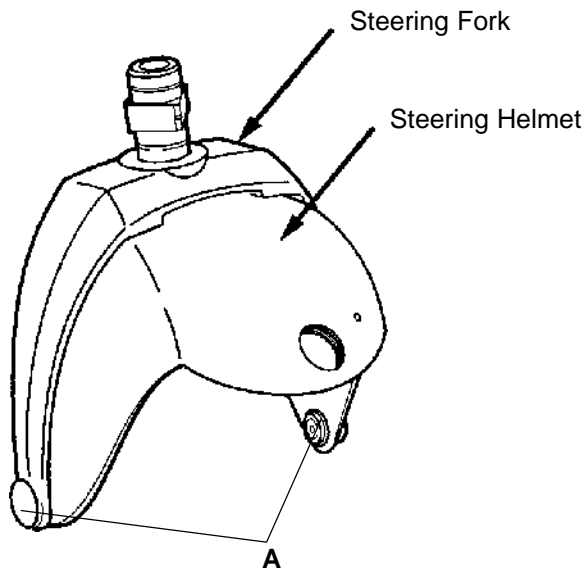


18. Should the low pressure hoses (1) and high pressure hoses (2) need to be disconnected for any reason it is vital that they be reconnected to the correct hose connection.

The figures above show how the hoses shall be connected on the inside and outside of the transom shield.

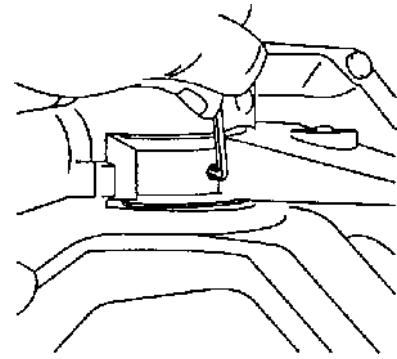
**NOTE!** The outer low pressure hose (3) is marked white and the outer high pressure hose (4) is marked red.

## Changing steering helmet

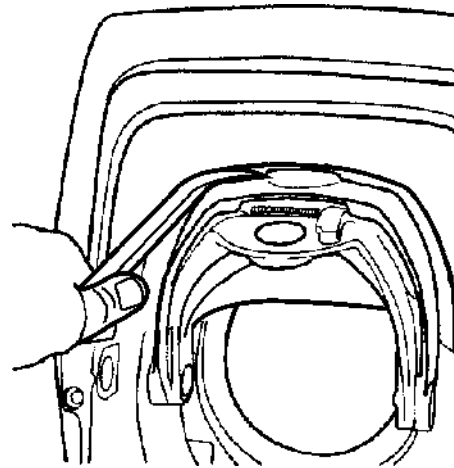


To ensure the integrity of the steering system the steering helmet is not serviceable as a separate part from the steering fork. If there is a problem with the steering helmet or the steering fork, they must be replaced as a unit.

**⚠ WARNING!** The bolted joints steering helmet – steering fork (A) shall not be dismantled.



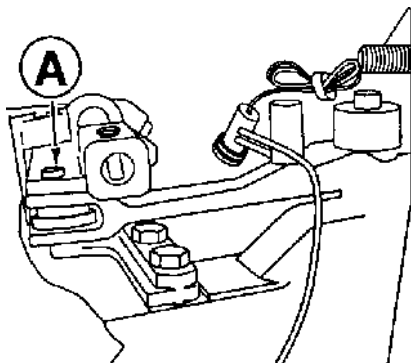
21. Loosen the tiller arm set screw using a 5/32 allen wrench.



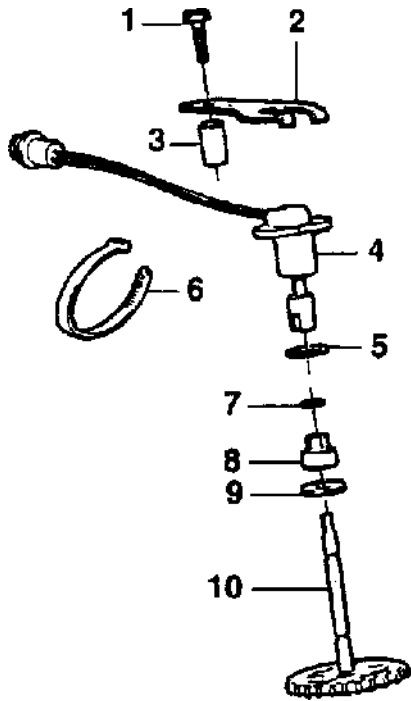
22. Gently pry the steering fork down from the transom shield.

## Removal

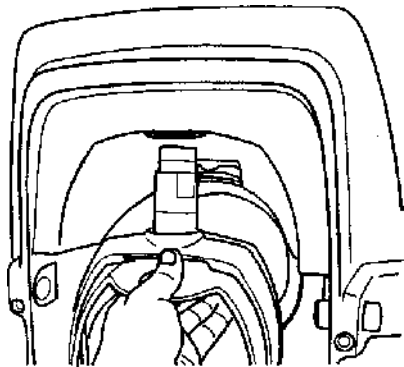
19. Remove the sterndrive according to procedure elsewhere in this book.



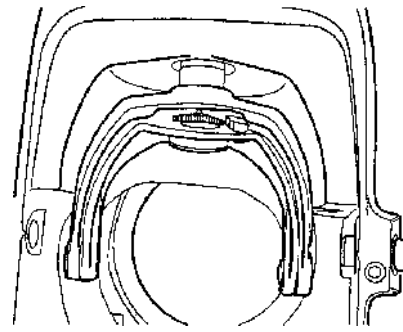
20. Disconnect the power steering (A) if equipped. Disconnect and remove the trim sending unit.



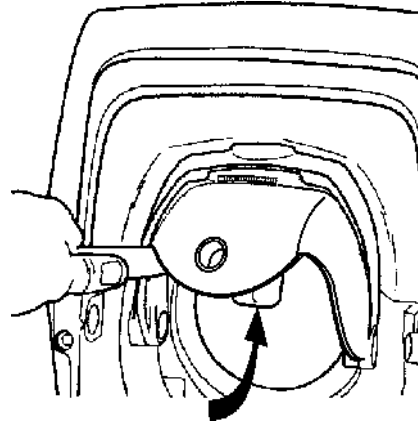
23. Install a new bushing (8) into the new steering fork.



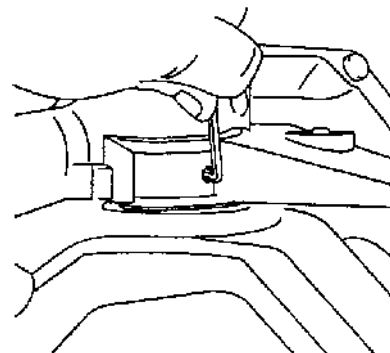
24. Align the square/the splines on the steering fork with the square in the tiller arm and install into the transom shield.



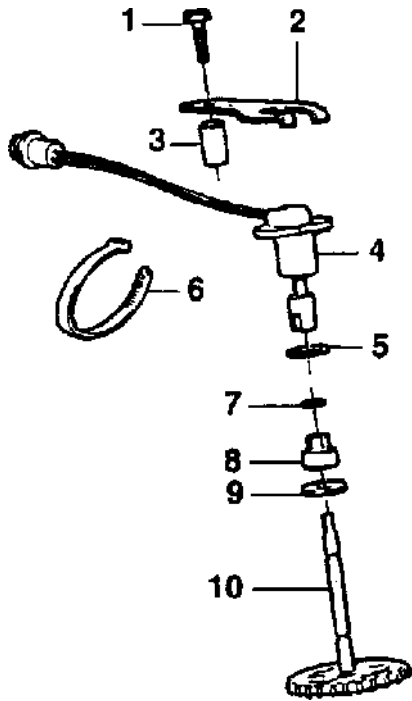
25. Make sure the square/the splines on the steering fork and the tiller arm are aligned.



26. Using a rubber mallet tap on the steering fork into position



27. Lock the setscrew with a 5/32 in. allen wrench.



**28.** Install a new seal (9) and O-ring (7) on the gear wheel.

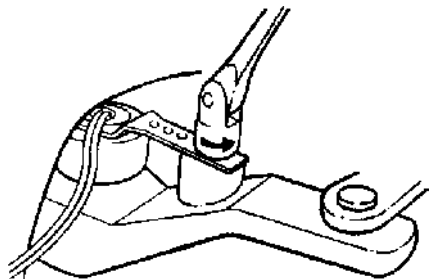
Install the trim sending unit, gear wheel and gear rack.  
See chapter **Trim System**.



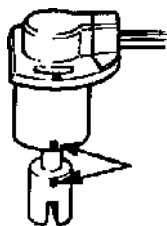
---

# Trim system

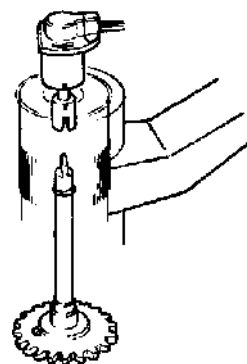
## Changing the sending unit



1. Lower the sterndrive to the full down position. Turn the helm full starboard. Using a 13 mm wrench, remove the trim sender holding bracket and the trim sender. Unplug the sender from the wiring harness.



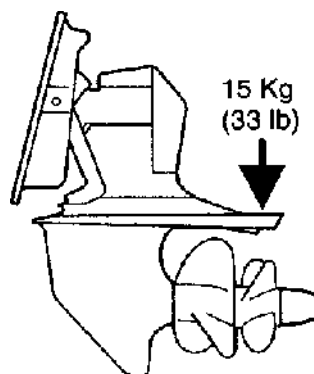
2. Plug the new sending unit into the wiring harness. Align the white notch on the drive coupling with the white notch on the sending unit housing.



3. Install the sending unit housing into the steering shaft on the transom shield. Rotate the sending unit slightly to align the drive coupling with the gear wheel.

**NOTE!** Do not force the sending unit into the hole. This may damage the sending unit and/or the gear wheel.

Install the trim sender bracket and hold down screw. Finger tight only, do not tighten until all adjustments have been made.

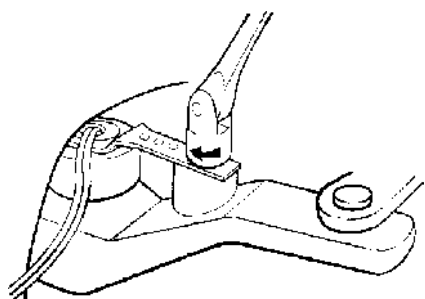


4. Lower the sterndrive to its bottom position. Ensure the sterndrive is at its lowest position, place a 15 kg load on the rear of the sterndrive.



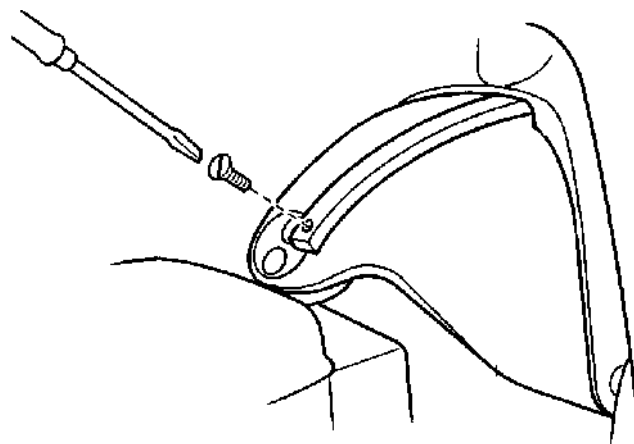
5. -4 should be shown in the instrument window for a 12° transom angle. Move the sending unit in either direction until the correct number is displayed on the trim gauge. Other transom angle settings are as follows:

Transom angle	Instrument indication
10°	- 2
11°	- 3
12°	- 4
13°	- 5
14°	- 6
15°	- 7

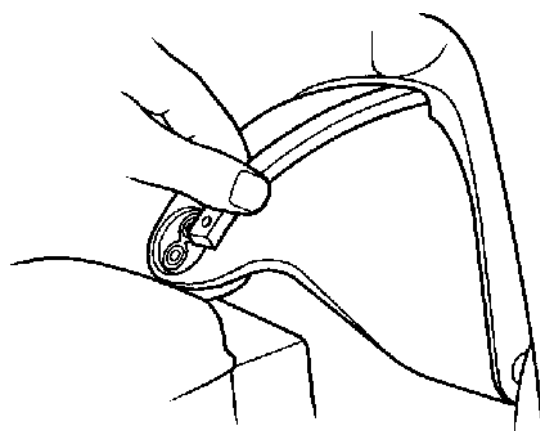


6. Tighten the trim sender bracket hold down screw. Be sure the sending unit does not move when the bracket is tightened.

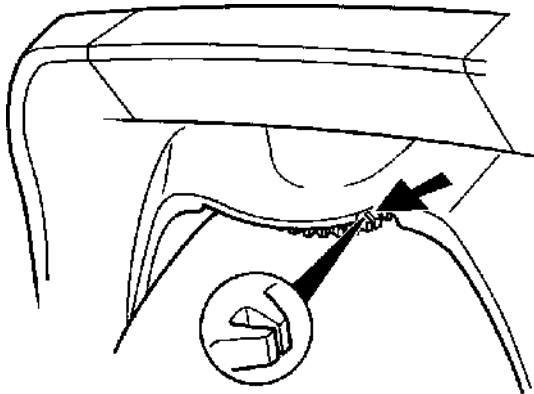
## Changing the trim system gear rack



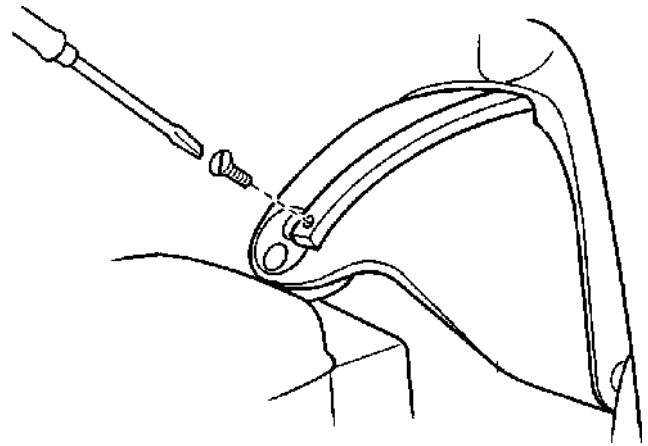
1. Remove the damaged gear rack by removing the screw.



2. Bend the gear rack up slightly to clear the nut and pull it out from the steering helmet.



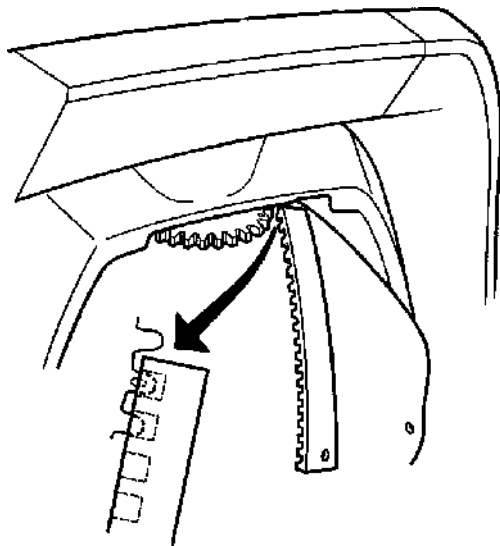
3. Turn the gear wheel until the tooth with a white recessed marking appears.



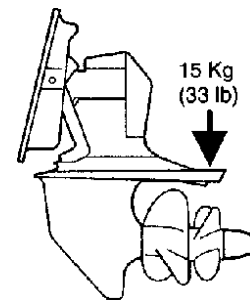
6. Install the screw and carefully tighten.

**NOTE!** It is recommended that a new screw be used whenever the gear rack is removed.

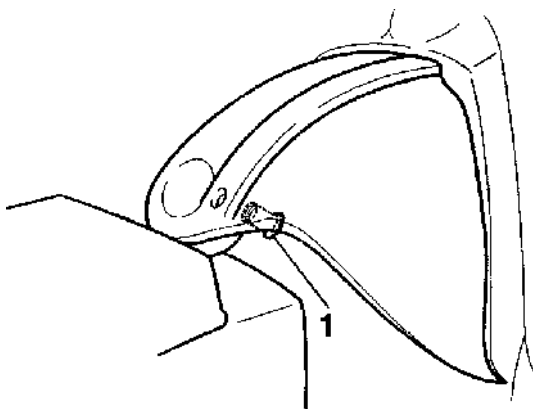
**⚠ WARNING!** Do not overtighten the screw. Use extreme caution to prevent stripping the threads from the screw.



4. Install the new gear rack with the marked tooth of the gear wheel in the first slot of the gear rack.



7. Lower the sterndrive to its bottom position. Ensure the sterndrive is at its lowest position, place a 15 kg load on the rear of the sterndrive.

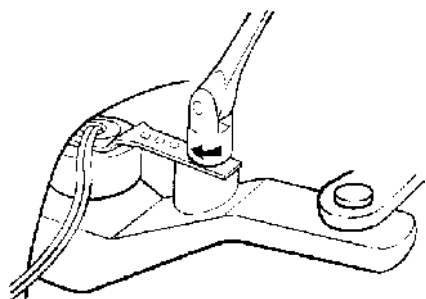


5. Align the gear rack with the hole in the steering helmet. Push the nut (1) through the helmet and into the gear rack.



8. -4 should be shown in the instrument window for a 12° transom angle. Move the sending unit in either direction until the correct number is displayed on the trim gauge. Other transom angle settings are as follows:

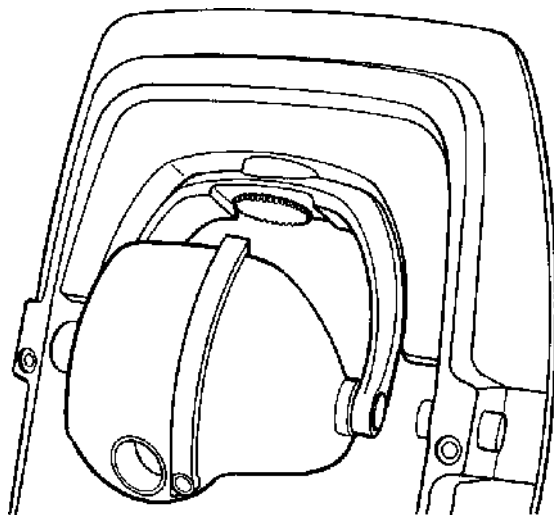
Transom angle	Instrument indication
10°	- 2
11°	- 3
12°	- 4
13°	- 5
14°	- 6
15°	- 7



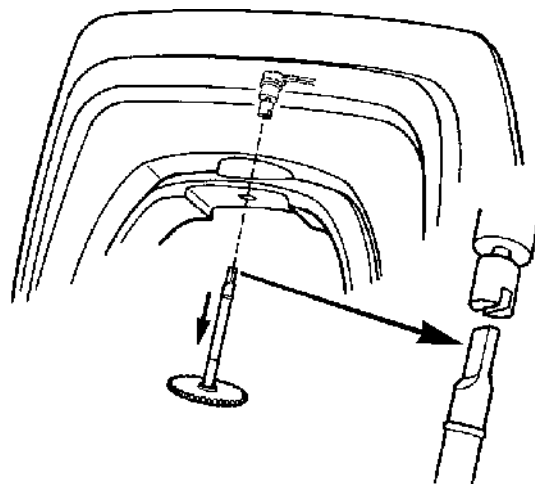
9. Tighten the trim sender bracket hold down screw. Be sure the sending unit does not move when the bracket is tightened.

## Changing the trim system gear wheel

1. Remove the sterndrive according to the section installation and removal.

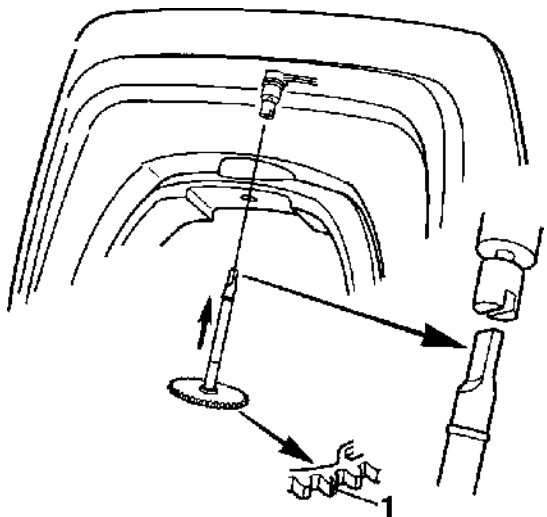


2. Pull the steering helmet aft far enough to clear the gear wheel. Turn the gear wheel so that the digital trim instrument indicates -4.

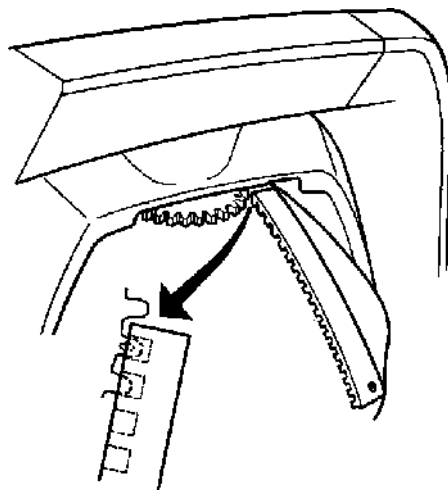


3. Pull the gear wheel straight down. There will be some resistance because of the retaining pawl in the bushing. Note the position of the drive end of the shaft when removing it. This will ease installation of the new shaft in the same position.

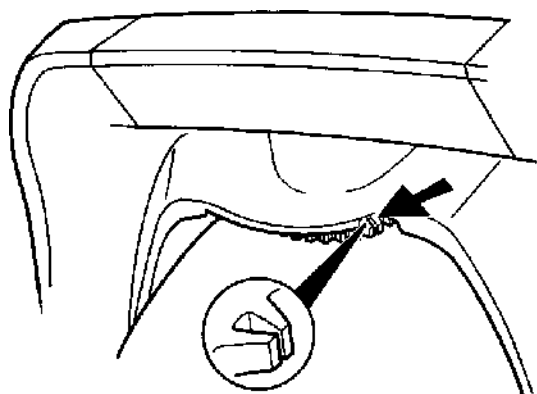
**NOTE!** Always use a new O-ring whenever the gear wheel is removed.



4. Grease the new gear wheel shaft and O-ring liberally with Volvo Penta Propeller shaft grease 828250-1. Install the new gear wheel with the marked tooth pointing starboard just enough aft to be visible from under the steering fork. If the shaft will not fit easily into place, rotate the gear wheel slightly in either direction to engage the gear wheel shaft and the trim sender coupling. Be sure the gear is completely seated before trying to engage the gear rack on the steering helmet.



6. Push the steering helmet into position with the marked tooth of the gear wheel engaging the first notch of the gear rack. Push the steering helmet as far forward as possible. Install the sterndrive according to the installation section earlier in this chapter. Check the trim adjustment according to adjusting the trim instrument section.

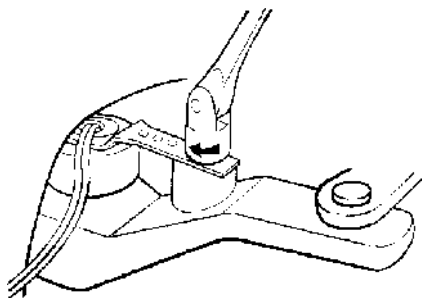


5. Position the gear wheel as shown.



7. -4 should be shown in the instrument window for a 12° transom angle. Move the sending unit in either direction until the correct number is displayed on the trim gauge. Other transom angle settings are as follows:

Transom angle	Instrument indication
10°	-2
11°	-3
12°	-4
13°	-5
14°	-6
15°	-7



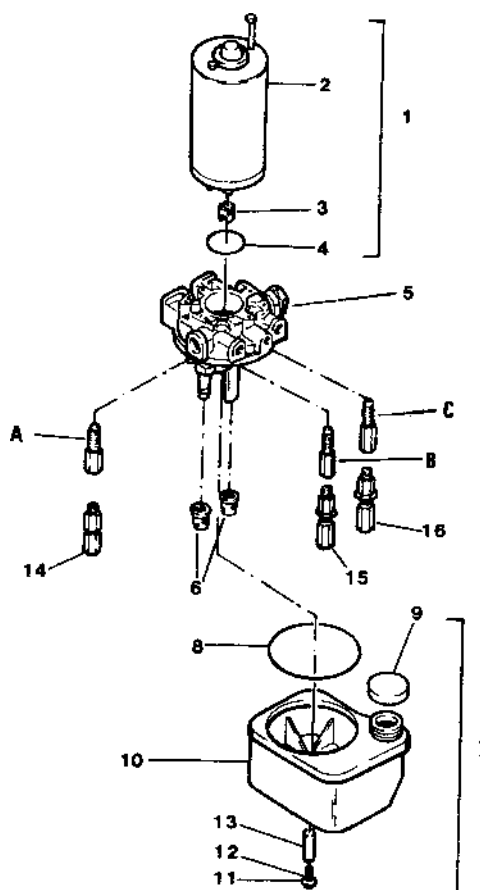
8. After all adjustments are made, tighten the trim sender bracket hold down screw. Be sure the sending unit does not move when the bracket is tightened.

## The power trim pump

The parts illustrated are those available as replacement parts or complete assemblies. The following instructions cover the replacement of parts making up the trim pump unit.

- 1 Motor assembly
- 2 Motor, incl. mounting studs
- 3 Coupling
- 4 O-ring
- 5 Adapter and basic pump assembly<sup>1)</sup>
- 6 Filter
- 7 Reservoir assembly
- 8 Reservoir seal
- 9 Reservoir cap
- 10 Reservoir
- 11,12,13 Screw, spacer, O-ring assy
- 14 Thermal relief valve<sup>1)</sup>
- 15 High pressure relief valve<sup>1)</sup>
- 16 Low pressure relief valve<sup>1)</sup>
- A B C Original factory fitted valve assy

<sup>1)</sup> Non-serviceable part. Replace as complete unit.

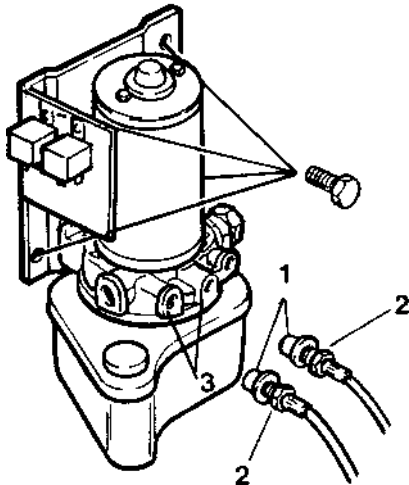


**Note!** Do not disassemble the valve or adapter assemblies, as this will disturb the factory settings and may cause pump malfunction.

**⚠ WARNING!** Use great care when working with this hydraulic system. Be sure your work area is clean. Do not allow dirt to enter the system. Use lint-free rags. Fill with clean recommended oil only.

## Removing the trim pump from the boat

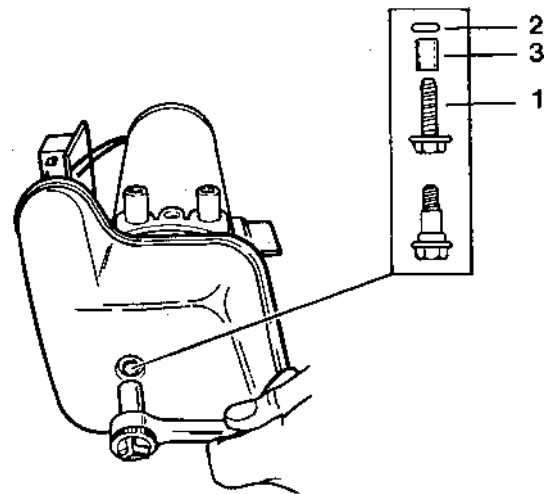
**Turn off the main battery switch.** Disconnect the trim pump wiring harness, ground cable from the flywheel housing, and the positive (+) cable from the starter motor.



Note how the hydraulic hoses are connected to the pump. Place a clean drain pan under the pump assembly. Disconnect the hydraulic hoses. Install protective caps (1) over the hoses (2) and pump (3) to prevent dirt from entering. Unbolt the oil pump mounting bracket. Hold the pump upright to avoid oil spillage. Drain the oil from the pump.

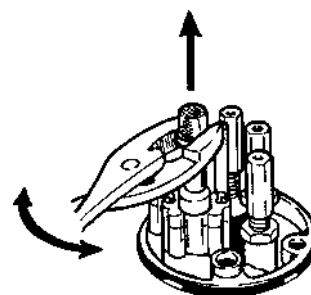
**⚠ WARNING!** Always exercise great cleanliness when working with hydraulic systems. Do not allow dirt or other impurities to enter the system. Use lint-free rags when cleaning parts. Always fill with clean oil of the recommended quality.

## Removing the oil reservoir

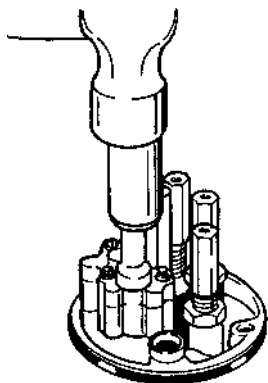


Remove the center bolt (1), together with the O-ring (2) and sleeve (3) that holds the plastic reservoir, using an 8 mm socket. Remove the reservoir and the rubber seal (8) (fig. showing the exploded view).

## Replacing filters

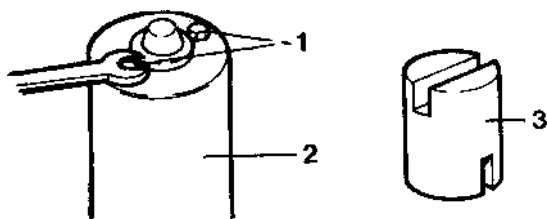


Grip the filter ring with pliers and pull upward while twisting.



To install a new filter, place a 5/8" socket over the filter and gently tap it down using a hammer.

## Removing the electric motor

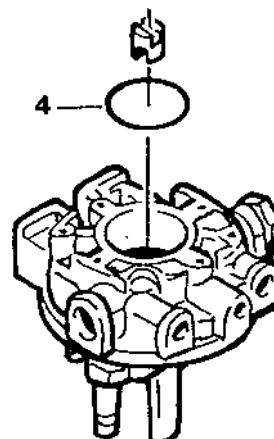


Remove the two studs (1) using an 8 mm socket (see exploded view on page 155). Lift the motor off the adapter assembly. Be sure the coupling (3) is positioned on the pump shaft with the wide groove up. See exploded view, pos (3), on page 155.

## Installing the electric motor

Apply water resistant grease to the coupling (3, fig. above). Be sure that coupling is installed correctly. Inspect the O-ring and replace if necessary (see exploded view, pos (4), on page 155). Place the O-ring on the motor. Install the motor on the adapter assembly, ensuring the drive shaft engages the coupling. Tighten the two studs.

## Replacing adapter and pump assembly



The adapter and pump assembly contain no serviceable parts and are replaced as a complete unit.

Remove the oil reservoir, motor and coupling.

Remove the valve assemblies using a 7/16" wrench. **The original factory fitted valves cannot be installed in a new adapter/pump assembly.**

Install new replacement valve assemblies, from the factory, on the new adapter/pump assembly. See **Relief valve assemblies**.

Install the oil reservoir.

Apply water resistant grease to the pump shaft and install coupling on the shaft. (Be sure the wide groove is facing the motor.) Inspect the O-ring. Replace, if necessary (4). Tighten using a 8 mm wrench.

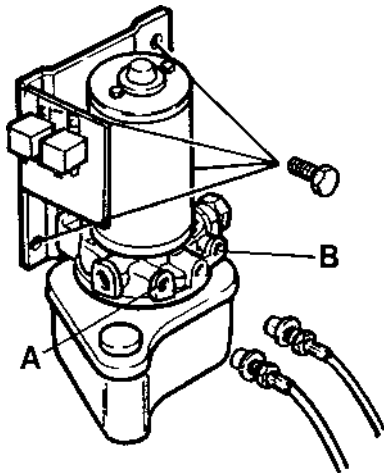
**NOTE!** The electric motor does not need to be removed to replace the thermal, high and low pressure relief valve assemblies.



## The relief valve assemblies

If the original factory fitted valves have to be removed, this will alter the factory setting, and new valves will have to be installed.

**NOTE!** Replacement valves are set from the factory and must not be opened.



The replacement relief valves have a different design than the original factory installed valves. See exploded view, pos (A, B, C), on page 155. Use a 7/16" wrench to remove and install valves.

**⚠ WARNING!** Place wrench on lower part of valve to avoid altering the setting when tightening.

## Installing the trim pump

Mount trim pump and bracket. Remove the protective plugs from the pump and hoses. Connect the hoses to their respective connections on the pump. (A, fig. above) is the high pressure connection and (B, fig. above) is the low pressure connection.

Connect the wiring harness, the ground (-) and positive (+) cables.

Fill the reservoir with recommended oil to the proper level (between MIN and MAX marks).

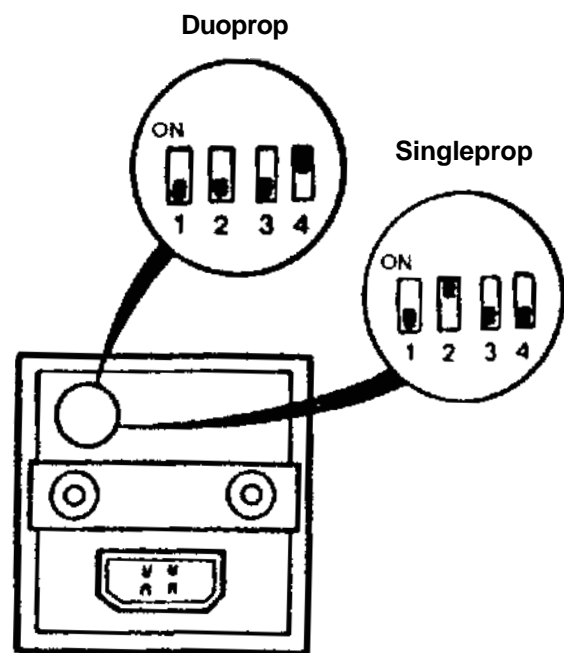
## Venting system

Reconnect main battery switch and operate the trim pump (system is self-bleeding). Re-check the oil level and add if necessary.

## Test

Once the system has been vented, operate the trim pump for proper operation. Check pump and hose connections for leaks.

## Adjusting the trim instrument



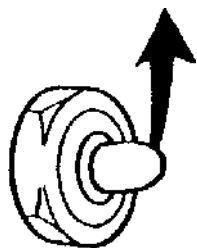
The trim instrument is always delivered together with Duoprop drives. It is set to a trim limit of 6° and the switch is sealed. Refer to the enlarged view for the Duoprop drive where switch 4 in ON.

**NOTE!** No other trim limit is permitted for the Duoprop drive. The seal must **not** be broken.

However, if the instrument is mounted to a Singleprop drive, the seal must be broken and the instrument reset to 12° trim limit. Refer to the enlarged view for the Singleprop drive where switch 4 down and switch 2 is ON.

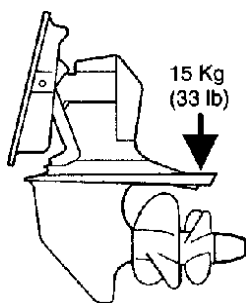
## Checking the trim figure

1. Turn the ignition key to the ignition position (the lights are on).



2. Trim down the drive to its bottom position.

**NOTE!** Push the switch upwards.



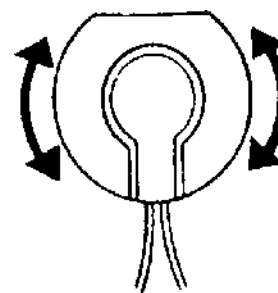
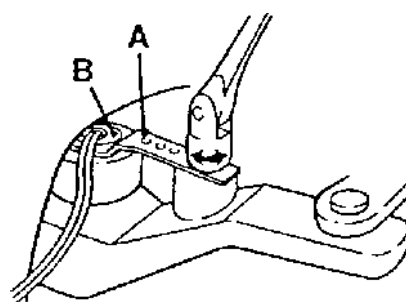
3. To ensure that the drive rests against the adjusting rod it should be loaded with approx. 15 kp (33 lb.).

4. The instrument, when trimmed down and with a known transom angle, shows the following figures, see table below:

Transom angle	Instrument indication
10°	- 2
11°	- 3
12°	- 4
13°	- 5
14°	- 6
15°	- 7

5. If the instrument shows a different figure than that stated in the table, then action as described below must be taken.

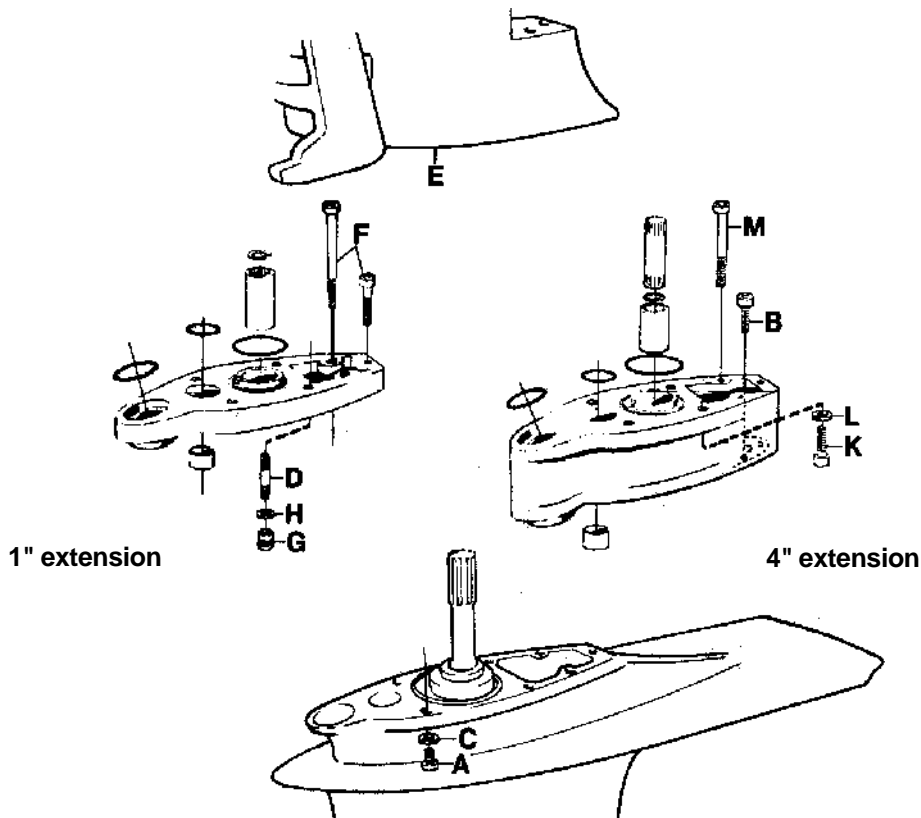
## Adjusting the trim figure



6. Loosen the trim sender's fixing bracket (A) and turn the trim sender housing (B) until the instrument shows the correct figure according to the table.

Then retighten the fixing bracket for the sender and remove the load from the drive.

# Sterndrive extensions



## Tightening torques:

A-G-K = 33 Nm

B-F-M = 18 Nm

## Installation instructions for 1" and 4" extensions:

Drain the oil from the sterndrive.

Remove the cover over the shift mechanism.

Remove the screws (and washers) holding the lower gear housing to the intermediate housing. Use a rubber mallet and carefully knock the housing apart. Remove the splines sleeve.

**NOTE!** When installing a 1" extension the washers will be used again and on the 4" extension the screws as well as the washers.

Use special tool **884982** in combination with special tool **884316** to remove the outer bearing race of the axial bearing from the intermediate housing.

Clean the contact surfaces of the housing carefully. Check the O-ring and replace it if necessary.

Press in the outer bearing race of the axial bearing in the extension. See under **Shimming the intermediate housing and the lower gear housing**.

**NOTE!** Measure the measurement 'B' on the extension!

## The 4" extension

Coat the contact surface with a sealant, Volvo Penta part no. 1141570-0. Use the 3 new O-rings and the oil pipe from the extension kit. Install the extension on the lower gear housing. Tighten the bolts 'A' and 'B' in diagonal sequence. Tightening torques – see the picture!

**NOTE!** Use washers 'C' underneath the 4 larger screws. Then install the existing splines sleeve on the lower vertical shaft and then the extension shaft and the new splines sleeve.

## The 1" extension

Coat the contact surfaces with a sealant. Use the 3 new O-rings and the oil pipe from the extension kit. Install the extension on the lower gear housing.

Install the locking ring in the splines sleeve. Turn the end with locking ring downwards and then install the sleeve on the lower vertical shaft.

Install the stud screws 'D' in the intermediate housing 'E'.

Coat the contact surfaces with a sealant and place the intermediate housing on the extension.

**NOTE!** Do not forget the O-rings! Tighten the bolts 'F' and nuts 'G' (1" extension) evenly and in diagonal sequence. Use the existing washers 'H' on the nuts. On the 4" extension the screws 'K' and the washers 'L' are used instead of nuts and washers.

Tightening torques – see the picture!

Install the cover over the shift mechanism.

If the paint has been damaged, use touch-up paint to repair. See under **Accessories – Aquamatic**.

Fill up with lubrication oil. Regarding oil quantity and oil quality, see chapter **Technical Data**. Check the oil level with the sterndrive fully lowered. Let a few minutes pass after you have shut down the engine before you start checking the oil level. Push down the oil dipstick as far as possible, however, without tightening it. Lift up the oil dipstick and register the oil level. Top-up if necessary.

**NOTE!** Do not forget the small O-ring underneath the oil dipstick head.

# Welding

Welding on certain parts of the sterndrive and the transom shield is allowed. Extreme caution must be used to prevent damage to the precision machined surfaces or precision parts used in the sterndrive (i.e. near bearing locations). Always use Volvo Penta welding electrode 839643-4 when making any welding repairs to the sterndrive or transom shield.

## Parts that cannot be welded

**⚠ WARNING!** The following parts are safety related and are not allowed to be welded.

The steering fork, steering helmet, clamp ring, tiller arm, suspension yoke and exhaust elbows, trim cylinders, trim cylinder attachment, power steering cylinder attachment, power steering cylinder, and the area around the suspension pins. On or around precision machined surfaces or precision parts.

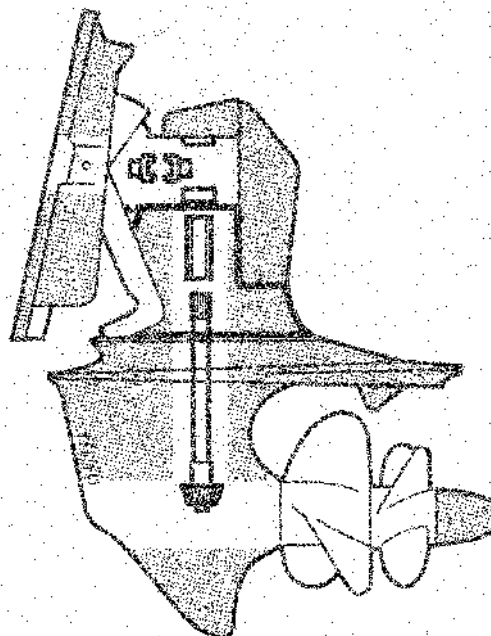
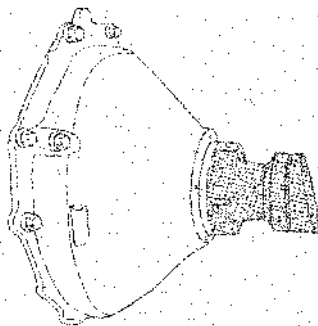
## Parts which can be welded

1. The neck of the flywheel housing for the attachment of the rubber bellows. Grind the neck smooth after welding to get an even surface.
2. The transom shield except on and around the suspension ears, steering journals, around the suspension pins and the attachment of the trim cylinders.
3. The shift mechanism cover.

4. The exhaust channel in the intermediate housing except at the steering spindle and around the upper and lower bearing positions of the vertical shaft.
5. The lower unit housing on the cavitation plate and the exhaust channel except around the bearing positions. The lower fin provided no more than 2/3 of it is missing measured vertically. The water intake channel at the front of the housing, however, it is important to maintain the channel profile. The correct profile is important to prevent restricted water flow to the engine. The exhaust outlet, trim tab and propeller cone may be welded. It is important to protect the rubber exhaust flap during welding.
6. Pressurize the housing after repair. See chapter **Pressure and vacuum testing**.

## Repair instructions

Dismantle and clean the damaged part of the sterndrive. Grind the area to be welded according to industry standard for welding aluminum. The welding should not be done at less than 20 °C (68 °F). If a part has been broken off and hasn't been lost, it should be used. Even if the surfaces are to be welded, there should be a V groove approximately 45° on both sides of the joint. Make the repair using Argon welding and Volvo Penta electrode **839643-4**. Always pressure and vacuum test the sterndrive as an assembly before returning to service. The shaded portions of the sterndrive and flywheel housing indicate where welding is permitted except where noted above.




---

# Painting

## Painting the sterndrive and underwater hull

### General

Most countries have introduced legislation controlling the use of anti-fouling agents. In some cases these agents are completely forbidden for use on leisure craft. **In these cases ask your Volvo Penta dealer for advice about alternative methods.**

 **IMPORTANT!** Find out what regulations apply to the use of anti-fouling agents.


### Sterndrive

The paintwork is part of the drive's anti-corrosion protection and it is therefore important that any paintwork damage is remedied.

Sand down metal surfaces lightly using a 120 grade paper and a finer grade for painted surfaces. Wash off using thinners or similar. Any pores in the surface should be filled and sanded down.


Paint using Volvo Penta original primer and topcoat. Let the paint dry.

The drive should be painted with Volvo Penta anti-fouling to prevent fouling. Apply according to the instructions on the packaging.

 **IMPORTANT!** The sacrificial anodes on the drive must not be painted.

### Underwater hull

Anti fouling agent containing **copper oxide** can increase the risk of galvanic corrosion and therefore should never be used.

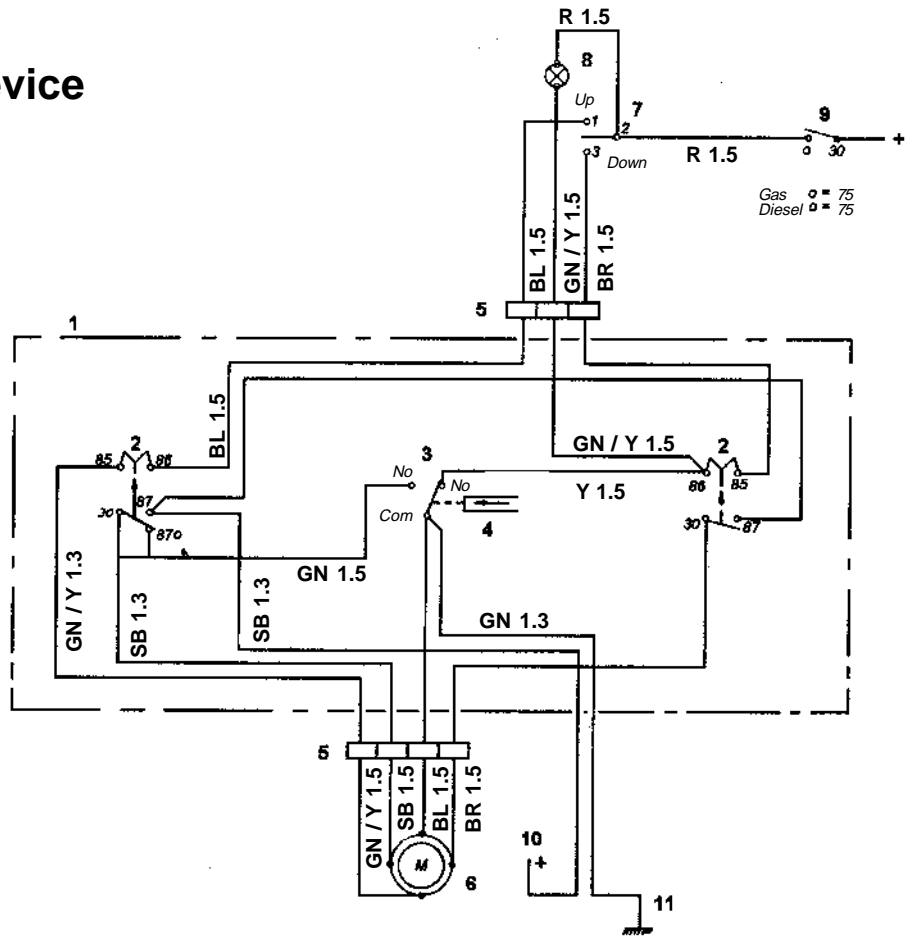
 **IMPORTANT!** Never paint all the way forward to the shield, this can increase the risk of galvanic corrosion. Leave an area of 10 mm (1/2") around the shield unpainted.

# Electrical wiring diagrams

## Model 280, tilting device

### References:

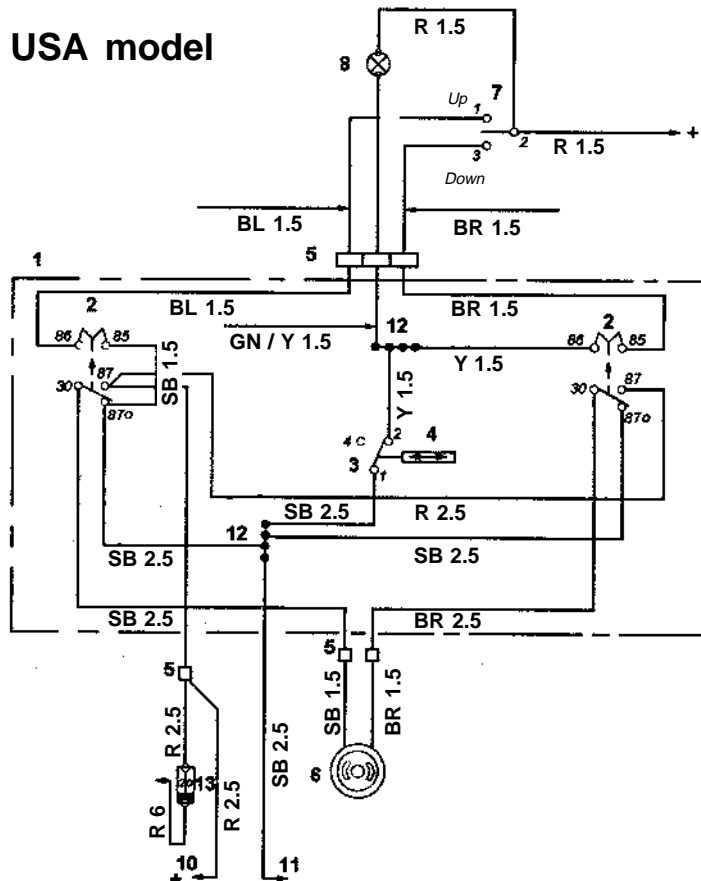
1. Relay box
2. Relay
3. Limit switch
4. Push rod, retaining pawl
5. Connector
6. Electrical motor
7. Switch
8. Warning light
9. Key switch
10. Connected to 30 (+) on the starter motor
11. Connected to engine (-)
12. Connector
13. Fuse, 20 Amps



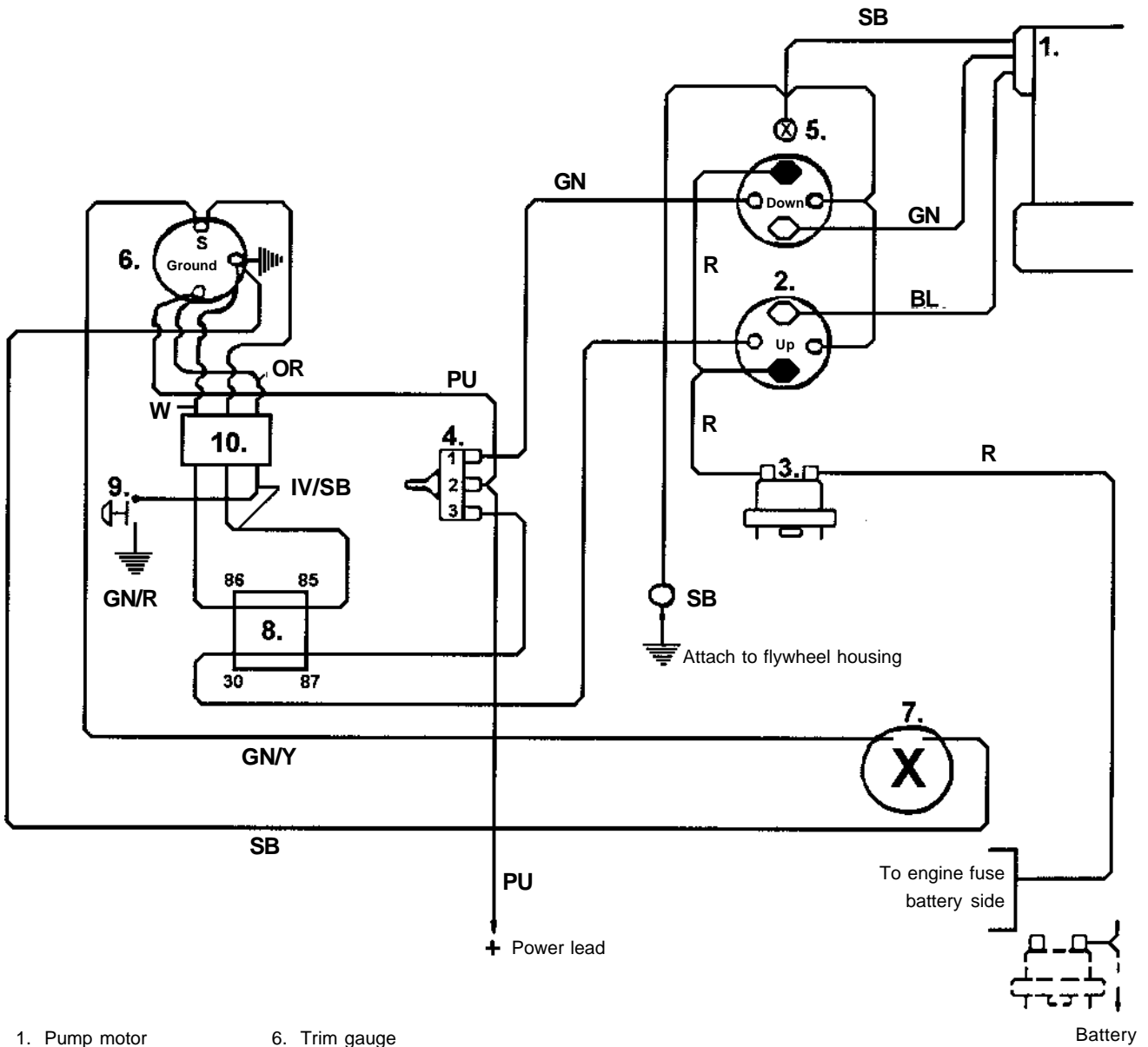
## USA model

### Cable colour codes

- R = red  
 SB = black  
 GN = green  
 BL = blue  
 BR = brown  
 GN/Y = green/yellow  
 Y = yellow



## Model 280, Power trim



- |               |                       |
|---------------|-----------------------|
| 1. Pump motor | 6. Trim gauge         |
| 2. Relay      | 7. Sender             |
| 3. Fuse       | 8. Relay              |
| 4. Switch     | 9. Bypass switch      |
| 5. Body       | 10. Trim limit switch |

### Cable colour codes

R = red  
 SB = black  
 GN = green  
 BL = blue  
 W = white  
 GN/R = green/red  
 GN/Y = green/yellow  
 IV/SB = ivory/black  
 PU = purple  
 Cable area 1,5 mm<sup>2</sup>



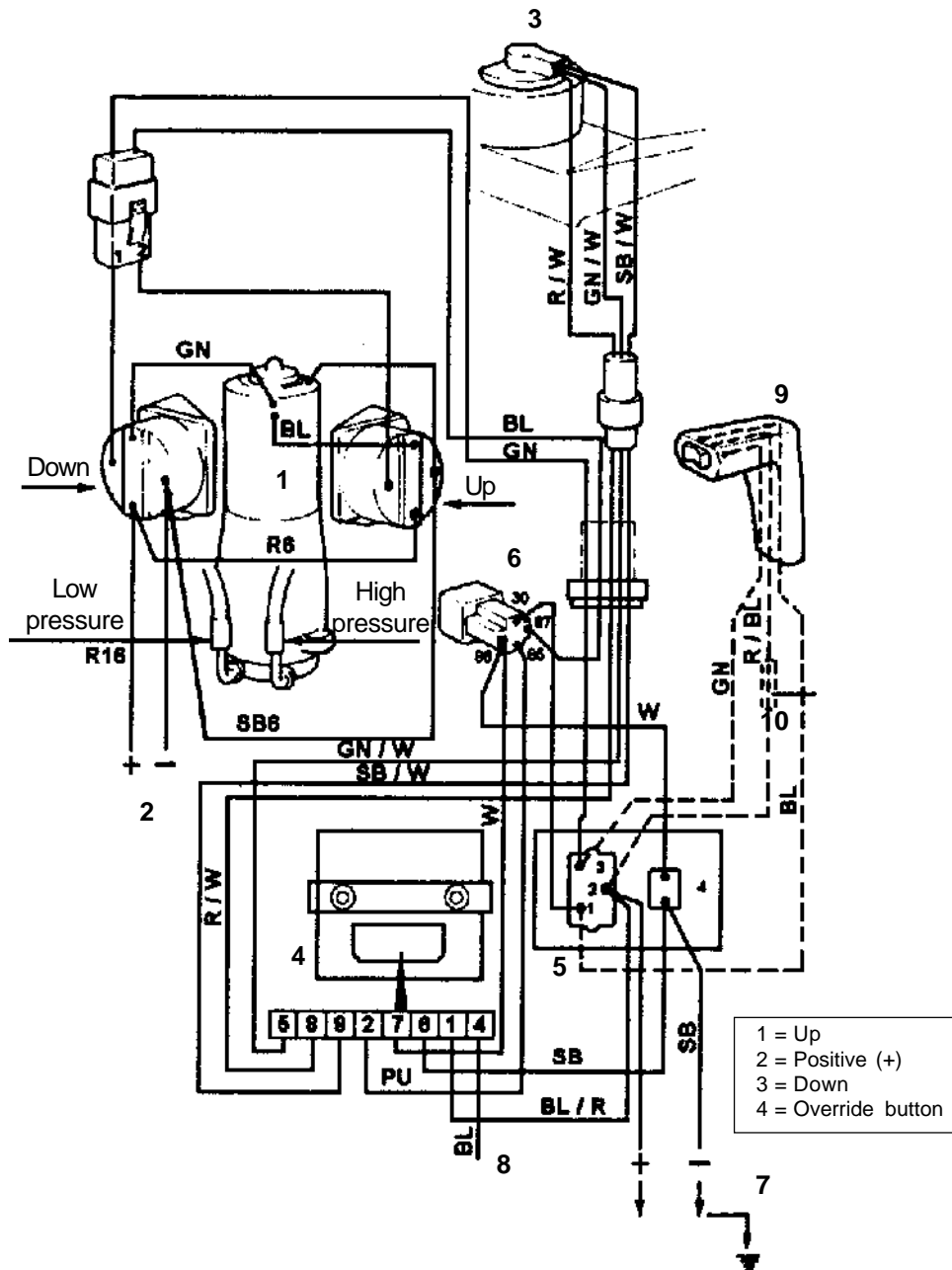
# Model 290, Power trim Earlier model

1. Oil pump
2. Fuse 55 amps
3. Trim sender
4. Trim indicator
5. Switch
6. Switch-relay, position "Beach"
7. Connection instrument panel
8. Instrument lighting
9. Throttle hook-up (optional)
10. Fuse 5 amps

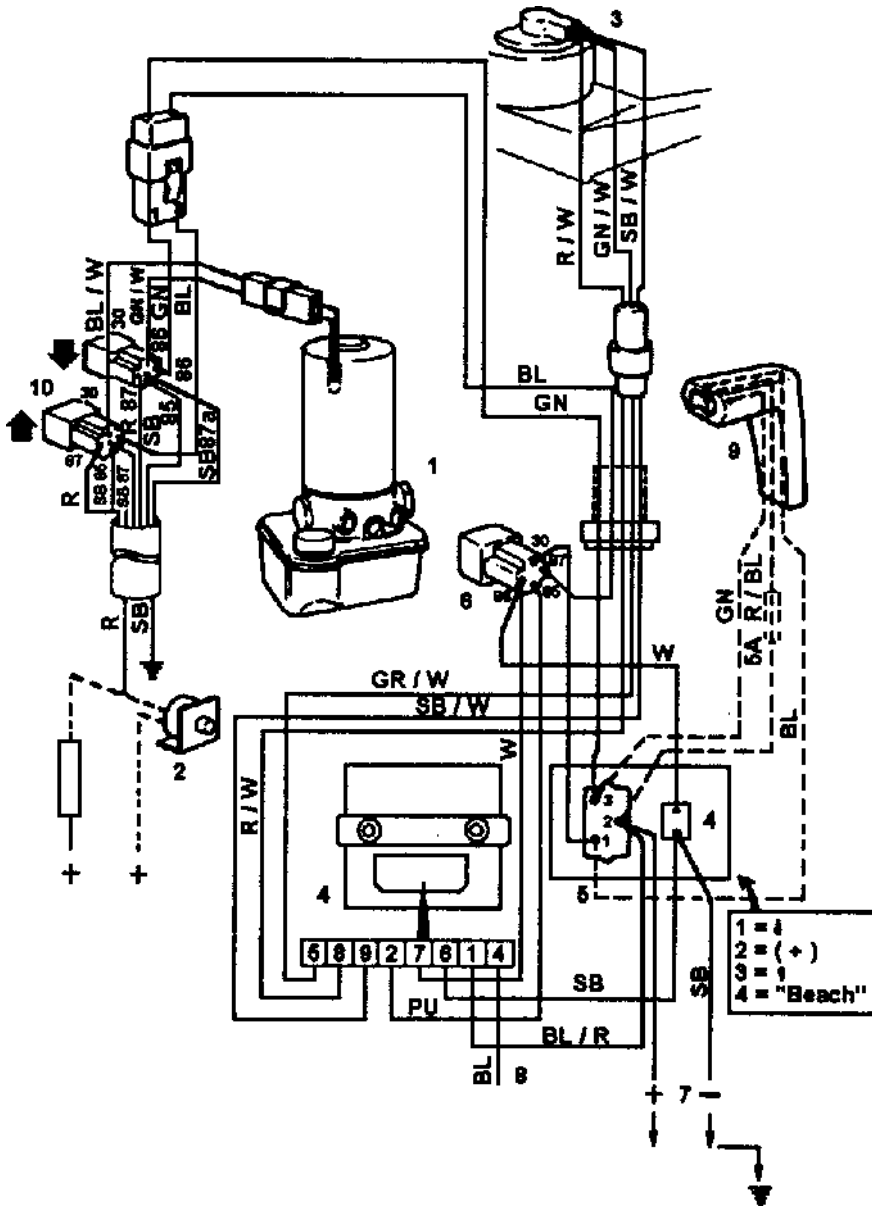
### Cable colour codes

- R = red
- SB = black
- GN = green
- BL = blue
- W = white
- R/W = red/white
- GN/W = green/white
- SB/W = black/white
- BL/R = blue/red
- PU = purple
- BL/W = blue/white

Cable area 1,5 mm<sup>2</sup>



# Models 290, SP and DP, Power trim Later model



1. Oil pump
2. Fuse 55 amps
3. Trim sender
4. Trim indicator
5. Switch
6. Switch-relay, position "Beach"
7. Connection instrument panel
8. Instrument lighting
9. Throttle hook-up (optional)
10. Relays the arrows in the electric wiring diagram refer to the trimming function up/down.

### Cable colour codes

- R = red
  - SB = black
  - GN = green
  - BL = blue
  - W = white
  - R/W = red/white
  - GN/W = green/white
  - SB/W = black/white
  - BL/R = blue/red
  - PU = purple
  - BL/W = blue/white
- Cable area 1,5 mm<sup>2</sup>

---

# Technical data

## Models 280, 280T, 280PT, 285, 285A and 290

### General Data

Type designation .....	Aquamatic 280, 285 & 290
Shift Mechanism .....	Self adjusting Silent Shift type of cone clutch, servo assisted disengagement. Direction of rotation adjustable.
Maximum propeller diameter .....	16"
Tilting angle .....	60°
Tilting device, model 280, 280T, 285 & 285A .....	Electro mechanical tilting device
Power trim & tilting device, models 280PT, 285PT & 290 .....	"Power Trim"
Steering angle, max .....	30°

### Overall gear ratio

Model 280, 280 B <sup>1)</sup> , 290 .....	1.61:1
Model 280, 280 C <sup>1)</sup> , 290 .....	1.89:1
Model 280, 280 D <sup>1)</sup> , 290 .....	2.15:1
Model 280T .....	1.61:1
Model 280PT .....	1.61:1, 1.89:1
Model 285, 285A .....	1.61:1
Model 290A .....	1.61:1
Model 290A .....	2.15:1

### Weight

Model 280 .....	52 kg (114.6 lb.)
Model 290 .....	54 kg (119 lb.)

### Gear backlash

Upper gear, measured directly on the gear wheels,

ratio 1.61:1 .....	0.15–0.25 mm (0.006–0.010")
ratios 1.89:1 and 2.15:1 .....	0.08–0.18 mm (0.003–0.007")

Lower gear, measured on the intermediate shaft splines joint .. 0.06–0.10 = 0.15–0.25 mm gear backlash in the gear (0.002–0.004")

<sup>1)</sup> On certain 280 drives the gear ratio is given by the marking B, C, or D.

## Lubricating system

Pump, type .....	Circulation pump for distribution of oil to all lubrication points
Oil quality .....	Engine oil
Viscosity .....	Multigrade SAE 10W-30 aft. 10W-40 <sup>1)</sup>
Oil quantity, approx .....	2.6 liters (US Qts. 2 3/4)
Oil quantity, 1" extension, approx. ....	2.6 liters (US Qts. 2 3/4)
Oil quantity, 4" extension, approx. ....	2.8 liters (US Qts. 3.0)
Oil capacity between min. and max. marks, approx. ....	0.15 liters (US Qts. 0.16)
Power Trim,	
oil quality .....	ATF oil <sup>2)</sup>
oil quantity .....	1.0 liters (1.1 US Qts.)

## Tightening torques

	<b>Nm</b>	<b>Lb. ft.</b>
Upper nut vertical shaft (upper gear) .....	125	92
Tightening universal joint .....	125 <sup>3)</sup>	92 <sup>3)</sup>
Assembly double bearing box – gear housing .....	35	26
Assembly of top cover to upper gear housing .....	15	11
Lower nut vertical shaft .....	160	118
Bearing box with propeller shaft in gear housing .....	40	30
Intermediate housing – lower gear housing .....	38 <sup>4)</sup>	28 <sup>4)</sup>
Oil drain plug .....	10	7.5
Oil filler plug .....	35	25
Intermediate housing – upper gear housing .....	38	28
Steering helmet ‘attachment bolt’, Earlier model .....	50–60	36–44
Steering helmet ‘attachment bolt’, Later model .....	35	25

## Pre-stressing

Input gear in double bearing box, 280–290 .....	5–10 N (1.102–2.205 lb.)
Input gear in double bearing box, run-in gears, 280–290 .....	2.5–5 N (0.55–1.102 lb.)
Input gear in double bearing box, 290A .....	10–15 N (2.20–3.30 lb.)
Input gear in double bearing box, run-in gears, 290A .....	7.5–10 N (1.65–2.2 lb.)

<sup>1)</sup> Alt. Volvo Penta oil for petrol or diesel engines. See Owners Manual.

<sup>2)</sup> Early production drives were filled with engine oil and have that recommendation in the Owner's Manual. Late production drives have ATF oil filled. We recommend the use of ATF oil. Observe strict cleanliness so that dirt is not drawn in by the oil.

**NOTE!** Never mix ATF oil with engine oil, as this will cause foaming and possible pump failure.

<sup>3)</sup> As from PZ number 2721099 the following tightening torque should be applied: **75 Nm (55.2 lb. ft.)**

<sup>4)</sup> The tightening torque for the three thinner bolts (two long and one short) is **15 Nm (10 lb. ft.)**. This applies to all drives.

## Models 280-DP, 280DP/PT, 290DP and 290A-DP

### General Data

Type designation .....	Aquamatic DuoProp
Shift mechanism .....	Self adjusting Silent Shaft type of cone clutch, servo assisted disengagement. Direction of rotation adjustable.
Maximum propeller diameter .....	16"
Maximum tilt angle, approx .....	60°
Power Trim & tilting device .....	"Power Trim"
Steering angle, max .....	30°

### Overall gear ratio

Model 280-DP, 280DP G <sup>1)</sup> , 290-DP .....	1.95:1
Model 280-DP, 280DP H <sup>1)</sup> , 290-DP .....	2.30:1
Model 280-DP/PT .....	1.95:1, 2.30:1
Model 290A-DP .....	1.78:1, 1.95:1, 2.30:1

### Weight

Model DuoProp .....	58 kg (127.9 lb.)
---------------------	-------------------

### Gear backlash

Lower gear,	
measured on the wings of the inner propeller shaft nut .....	0.08–0.17 = 0.15–0.30 mm backlash in the gear (0.003–0.007")
measured on the wings of the outer propeller shaft nut .....	0.11–0.34 = 0.20–0.35 mm backlash in the gear (0.008–0.014")
Upper gear, measured directly on the gear,	
ratio 1.95:1 and 1.78:1 .....	0.15–0.25 mm (0.006–0.010")
ratio 2.30:1 .....	0.08–0.18 mm (0.003–0.007")

<sup>1)</sup> On certain 280DP drives the gear ratio is given by the marking G or H.

## Lubricating system

Pump, type .....	Circulation pump for distribution of oil to all lubricating points
Oil quality .....	API GL5 <sup>1)</sup>
Viscosity .....	SAE 90 or 80W90
Oil quantity, approx .....	2.7 liters (2.8 US Qts.)
Oil quantity, 1" extension, approx. ....	2.7 liters (2.8 US Qts.)
Oil quantity, 4" extension, approx. ....	2.9 liters (3.0 US Qts.)
Oil quantity between min. & max. marks .....	0.15 liters (0.16 US Qts.)
Power Trim,	
oil quality .....	ATF oil <sup>2)</sup>
oil quantity .....	1.0 liters (1.1 US Qts.)

## Tightening torques

	Nm	Lb. ft.
Upper nut on vertical shaft (upper gear) .....	125	92
Tightening universal joint .....	75	55
Assembly double bearing box – gear housing .....	35	26
Assembly of top cover to upper gear housing .....	15	11
Lower nut on vertical shaft .....	110	81
Bearing box with propeller shaft in gear housing .....	40	30
Interm. housing – lower gear housing .....	38 <sup>3)</sup>	28 <sup>3)</sup>
Oil drain plug .....	10	7.5
Oil filler plug .....	35	25
Interm. housing – upper gear housing .....	38	28
Steering helmet attachment bolt .....	35	25

## Pre-stressing

Input gear in double bearing box 280–290 .....	5–10 N (1.102–2.205 lb.)
Input gear in double bearing box run-in gears, 280–290 .....	2.5–5 N (0.55–1.102 lb.)
Input gear in double bearing box, 290A .....	10–15 N (2.20–3.30 lb.)
Input gear in double bearing box, run-in gears, 290A .....	7.5–10 N (1.65–2.2 lb.)
Lower gear .....	1.2–2,3 N (0.265–0.507 lb.)

<sup>1)</sup> Synthetic oil 75W90 is recommended for commercial duty (corresponding to the requirements for GL5 oil).

<sup>2)</sup> Early production drives were filled with engine oil and have that recommendation in the Owner's Manual. Late production drives have ATF oil filled. We recommend the use of ATF oil. Observe strict cleanliness so that dirt is not drawn in by the oil.

**NOTE!** Never mix ATF oil with engine oil, as this will cause foaming and possible pump failure.

<sup>3)</sup> The tightening torque for the three thinner bolts (two long and one short) is **15 Nm (10 lb. ft.)**. This applies to all drives.

## Models SP-A, SP-A1, SP-A2 and SP-C

### GeneralData

Type designation .....	Aquamatic SP-A, SP-A1, SP-A2 & SP-C
Shift mechanism .....	Self adjusting Silent Shaft type of cone clutch, servo assisted disengagement.
Maximum Propeller diameter .....	16"
Maximum tilt angle, approx. ....	60"
Power Trim & tilting device .....	"Power Trim"
Steering angle, max. ....	30°

### Overall gear ratio

Model SP-A .....	1.61:1, 1.89:1, 2.15:1
Model SP-A1 .....	1.61:1, 1.89:1, 2.15:1
Model SP-A2 .....	1.61:1, 1.89:1
Model SP-C .....	1.61:1, 1.89:1, 2.15:1

### Weight

Models SP .....	58 kg (127.9 lb.)
-----------------	-------------------

### Gear backlash

Upper gear, measured directly on the gear wheel,

ratio 1.61:1 .....	0.15-0.25 mm (0.006-0.010")
ratio 1.89:1 .....	0.08–0.18 mm (0.003–0.007")
ratio 2.15:1 .....	0.08–0.18 mm (0.003–0.007")

Lower gear, measured on the intermediate shaft spline joint .... 0.06-0.10 = 0.15-0.25 mm gear backlash in the gear (0.002-0.004 in)

### Lubrication System

Pump, type .....	Circulation pump for distribution of oil to all lubricating points
Oil quality .....	API-GL5 <sup>1)</sup>
Viscosity .....	SAE 90 or 80W90
Oil quantity, approx. ....	2.6 liters (2.75 US Qts.)
Oil quantity, 1 in. extension, approx. ....	2.6 liters (2.75 US Qts.)
Oil quantity, 4" extension, approx. ....	2.8 liters (3.0 US Qts.)
Oil quantity between min. & max. marks .....	0.15 liters (0.16 US Qts.)
Power Trim, oil quality .....	ATF oil

<sup>1)</sup> Synthetic oil grade 75W90 corresponding to API GL5 requirements is recommended for commercial use.

<b>Tightening torques</b>	<b>Nm</b>	<b>Lb. ft.</b>
Upper nut on vertical shaft (upper gear) .....	125	92
Tightening universal joint .....	75	55
Assembly double bearing box - gear housing .....	35	26
Assembly of top cover to upper gear housing .....	15	11
Lower nut on vertical shaft .....	110	81
Bearing box with propeller shaft in gear housing .....	40	30
Interm. housing - lower gear housing .....	15	11
Oil drain plug .....	10	7.5
Oil filler plug .....	35	25
Interm. housing - upper gear housing .....	20	15
Steering helmet 'attachment bolt' .....	35	25

**Pre-stressing**

Input gear in double bearing box .....	5-10 N (0.5-1.0 kp/1.102-2.205 lb.)
Input gear in double bearing box, run-in gears .....	2.5-5 N (0.25-0.5 kp/0.55-1.102 lb.)



## Models DP-A, DP-A1, DP-A2, DP-B, DP-B1, DP-C and DP-C1

### General Data

Type designation .....	Aquamatic DUOPROP
Shift mechanism .....	Self adjusting Silent Shaft type of cone clutch, servo assisted disengagement.
Maximum tilt angle, approx .....	60"
Power Trim & tilting device .....	"Power Trim"
Steering angle, max .....	30°

### Overall gear ratio

Model DP-A .....	1.95:1, 2.30:1
Models DP-A1, DP-A2, DP-B, DP-B1, DP-C and DP-C1 .....	1.95:1, 2.30:1, 1.78:1

### Weight

Models DP-A, DP-A1, DP-A2, DP-B, DP-B1, DP-C, DP-C1 ....	58 kg (127.9 lb.)
--	-------------------

### Gear backlash

Lower gear, measured on the wings of the inner propeller shaft nut .....	0.08-0.17 = 0.15-0.30 mm (0.003-0.007 in.) backlash in the gear
Lower gear, measured on the wings of the outer propeller shaft nut .....	0.11-0.34 = 0.20-0.35 mm (0.008-0.014 in.) backlash in the gear
Upper gear, measured directly on the gear, ratio 1.95:1 and 1.78:1 .....	0.15-0.25 mm (0.006-0.010")
ratio 2.30:1 .....	0.08-0.18 mm (0.003-0.070")

### Lubrication System

Pump, type .....	Circulation pump for distribution of oil to all lubricating points
Oil quality .....	API-GL5 <sup>1)</sup>
Viscosity .....	SAE 90 or 80W90
Oil quantity, approx. ....	2.7 liters (2.8 IS Qts.)
Oil quantity, 1 in. extension, approx .....	2.7 liters (2.8 US Qts.)
Oil quantity, 4" extension, approx. ....	2.9 liters (3.0 US Qts.)
Oil quantity between min. & max. marks .....	0.15 liters (0.16 US Qts.)
Power Trim, oil quality .....	ATF oil

<sup>1)</sup> Synthetic oil grade 75W90 corresponding to API GL5 requirements is recommended for commercial use.

**Tightening torques**

	<b>Nm</b>	<b>Lb. ft.</b>
Upper nut on vertical shaft (upper gear) .....	125	92
Tightening universal joint .....	75	55
Assembly double bearing box - gear housing .....	35	26
Assembly of top cover to upper gear housing .....	15	11
Lower nut on vertical shaft .....	110	81
Bearing box with propeller shaft in gear housing .....	40	30
Interm. housing - lower gear housing .....	15	11
Oil drain plug .....	10	7.5
Oil filler plug .....	35	25
Interm. housing - upper gear housing .....	20	15
Steering helmet 'attachment bolt' .....	35	25

**Prestressing**

Input gear in double bearing box .....	5-10 N (1.102-2.205 lb.)
Input gear in double bearing box, run-in gears .....	2.5-5 N (0.55-1.102 lb.)
Lower gear .....	1.2-2.3 N (0.265-0.507 lb.)



# Report form

Do you have any complaints or other comments about this manual. Please make a copy of this page, write your comments down and send them to us. The address is at the bottom. We would prefer you to write in English or Swedish.

From: .....  
.....  
.....  
.....

Refers to publication: .....

Publication No.: ..... Date of issue: .....

Proposal/motivation: .....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....

Date: .....

Signed: .....

AB Volvo Penta  
Technical Information  
Dept. 42200  
SE-405 08 Göteborg  
Sweden

