

Workshop Manual

A

Sail boat drive

2(0)

**130S-A, 130SR-A, 130S-B, 130SR-B,
130S-C, 130SR-C, 150S-A, 150SR-A,
150S-B, 150SR-B, 150S-C, 150SR-C**

Sail boat drive

130S-A, 130SR-A, 130S-B, 130SR-B, 130S-C, 130SR-C
150S-A, 150SR-A, 150S-B, 150SR-B, 150S-C, 150SR-C

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Safety information

Introduction

This workshop manual contains technical data, descriptions and repair instructions for the Volvo Penta products or product versions noted in the table of contents. Check that you have the correct Workshop Manual for your engine.

Read the available safety information, “General Information and Repair Instructions” in the workshop manual before you start to do any service work.

Important

In this book and on the product you will find the following special warning symbols.



WARNING! Warns for the risk of personal injury, major damage to product or property, or serious malfunctions if the instruction is ignored.



IMPORTANT! Is used to call attention to things which could cause damage or malfunctions to product or property.

NOTE! Is used to call attention to important information, to facilitate work processes or operation.

Below is a summary of the risks involved and safety precautions you should always observe or carry out when operating or servicing the engine.



Make it impossible to start the engine by cutting system current with the main switch(es) and lock it (them) in the off position before starting service work. Set up a warning notice at the engine control point.



As a general rule all service operations must be carried out with the engine stopped. Some work, such as adjustments, need the engine to be running, however. Approaching an engine which is operating is a safety hazard. Remember that loose clothing or long hair can fasten in rotating parts and cause serious personal injury.

If work is done adjacent to a running engine, a careless movement or a dropped tool can lead to personal injury in the worst case. Be careful with hot surfaces (exhaust pipes, turbos, charge air pipes, starting heaters etc.) and hot fluids in pipes and hoses on an engine which is running or which has just stopped. Reinstall all protective parts removed during service operations before starting the engine.



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



Never start the engine without installing the air cleaner filter. The rotating compressor turbine in the turbocharger can cause severe injury. Foreign objects entering the intake ducts can also cause mechanical damage.



Never use start spray or similar products as a starting aid. They may cause an explosion in the inlet manifold. Danger of personal injury.



Avoid opening the coolant filling cap when the engine is hot. Steam or hot coolant can spray out and the system pressure will be lost. Open the filler cap slowly, and release the pressure in the cooling system if the filling cap or tap has to be opened, or if a plug or coolant hose has to be removed when the engine is hot. It is difficult to anticipate in which direction steam or hot coolant can spray out.



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



Stop the engine and close the sea cocks before doing any work on the cooling system.



Only start the engine in a well-ventilated area. When operated in a confined space, exhaust fumes and crankcase gases must be ventilated from the engine bay or workshop area.



Always use protective glasses or goggles when carrying out work where there is a risk of splinters, grinding sparks, acid splashes or where other chemicals are used. Your eyes are extremely sensitive, injury could cause blindness!

-  Avoid getting oil on your skin! Repeated exposure to oil or exposure over a long period can result in the skin becoming dry. Irritation, dryness and eczema and other skin problems can then occur. Used oil is more dangerous than fresh oil from a health aspect. Use protective gloves and avoid oil soaked clothes and rags. Wash regularly, especially before eating. There are special skin creams which counteract drying out of the skin and make it easier to clean off dirt after work is completed.
-  Most chemicals intended for the product (e.g. engine and transmission oils, glycol, petrol (gasoline) and diesel oil) or chemicals for workshop use (e.g. degreasers, paints and solvents) are hazardous. Read the instructions on the product packaging with care! Always follow the safety precautions for the product (for example use of protective mask, glasses, gloves etc.). Make sure that other personnel are not inadvertently exposed to hazardous chemicals, for example in the air. Ensure good ventilation in the work place. Follow the instructions provided when disposing of used or leftover chemicals.
-  Exercise extreme care when leak detecting on the fuel system and testing the fuel injector nozzles. Use eye protection. The jet from a fuel injector is under very high pressure, and has considerable penetration ability; fuel can force its way deep into body tissues and cause serious damage. Danger of blood poisoning (septicemia).
-  All fuels, and many chemicals, are flammable. Do not allow naked flame or sparks in the vicinity. Petrol (gasoline), some thinners and hydrogen gas from batteries are extremely flammable and explosive when mixed with air in the correct ratio. No Smoking! Ensure that the work area is well ventilated and take the necessary safety precautions before starting welding or grinding work. Always ensure that there are fire extinguishers at hand when work is being carried out.
-  Make sure that oil and fuel soaked rags, and used fuel and oil filters are stored in a safe place. Rags soaked in oil can spontaneously ignite under certain circumstances. Used fuel and oil filters are polluting waste and must be handed to an approved waste management facility for destruction, together with used lubrication oil, contaminated fuel, paint residue, solvents,
- degreasers and wash residue.
-  Batteries must never be exposed to open flames or electric sparks. Never smoke close to the batteries. The batteries generate hydrogen gas when charged, which forms an explosive gas when mixed with air. This gas is easily ignited and highly volatile. A spark, which can be caused by incorrect battery connection, can cause a single spark which is sufficient to cause an explosion with resulting damage. Do not shift the connections when attempting to start the engine (spark risk) and do not lean over any of the batteries.
-  Always ensure that the Plus (positive) and Minus (negative) battery cables are correctly installed on the corresponding terminal posts on the batteries. Incorrect installation can result in serious damage to the electrical equipment. Refer to the wiring diagram.
-  Always use protective goggles when charging and handling the batteries. Battery electrolyte contains sulfuric acid which is highly corrosive. Should the battery electrolyte come into contact with unprotected skin wash off immediately using plenty of water and soap. If you get battery acid in your eyes, flush at once with a generous amount of water, and get medical assistance at once.
-  Turn the engine off and turn off the power at the main switch(es) before carrying out work on the electrical system.
-  Clutch adjustments must be carried out with the engine stopped.
-  The existing lugs on the engine/reversing gear should be used for lifting the assembly. Always check that the lifting devices are in good condition and that they have the correct capacity for the lift (the weight of the engine plus the reversing gear and extraequipment). The engine should be lifted with a customized or adjustable lifting boom for safe handling and to avoid damaging components on top of the engine. All chains or cables should be parallel to each other and should be as square as possible to the top of the engine.

 If other equipment connected to the engine has altered its center of gravity, special lifting devices may be needed to obtain the correct balance and safe handling.

Never do any work on an engine which just hangs from a lifting device. Never work alone when removing heavy engine components, even when using lifting devices such as locking tackle lifts. When using a lifting device two people are usually required to do the work, one to take care of the lifting device and another to ensure that components are lifted clear and not damaged during the lifting operations.

When you work aboard a boat, always make sure that there is enough space for disassembly where you are working, with no risk of personal injury or material damage.

 **WARNING!** Components in the electrical and fuel systems on Volvo Penta products have been designed to minimize the risks of explosion and fire. The engine must not be run in areas where there are explosive materials.

 **WARNING!** Fuel delivery pipes must not be bent or straightened under any circumstances. Damaged pipes must be replaced.

 Remember the following when washing with a high pressure washer: Never aim the water jet at seals, rubber hoses or electrical components. Never use a high pressure washer for engine cleaning.

 Only use the fuels recommended by Volvo Penta. Refer to the Instruction Book. Use of fuels that are of a lower quality can damage the engine. On a diesel engine poor quality fuel can cause the control rod to bind and the engine to overrev with resulting risk of damage to the engine and personal injury. Poor fuel can also lead to higher maintenance costs.

General information

About this Workshop Manual

This workshop manual contains technical data, descriptions and repair instructions for the standard version of sailboat drives 130S-A, 130SR-A, 130S-B, 130SR-B, 150S-A, 150SR-A, 150S-B and 150SR-B.

The workshop manual can illustrate tasks done on any of the drives noted above. This means that the illustrations and photographs which clarify certain details might not correspond with other drives in some cases. The repair methods are similar in all important respects, however. If this is not the case, this will be noted and important differences will be shown separately. The gear design, gear ratio and serial number are always noted on the type plate. The data on the type plate must always be given in all correspondence about a gear.

The Workshop Manual is produced primarily for the use of Volvo Penta workshops and service technicians. This assumes that people who use the Manual have basic knowledge of marine drive systems and can do the tasks of a mechanical or electrical nature associated with the trade.

Volvo Penta constantly improves its products, so we reserve the right to make modifications without prior notification. All information in this manual is based on product data which was available up to the date on which the manual was printed. Any material changes introduced into the product or service methods after this date are notified by means of Service Bulletins.

Spare parts

Spare parts for electrical and fuel systems are subject to various national safety requirements such as the US Coast Guard Safety Regulations. Volvo Penta Original Spares comply with these requirements. No damage whatever, occasioned by use of non-original Volvo Penta spares for the product, will be compensated by the warranty offered by Volvo Penta.

Repair instructions

The working methods described in the Workshop Manual apply to work carried out in a workshop. For this reason, the drive is removed from the boat and installed in a fixture. Renovation work which does not need the drive to be lifted out can be done in situ, with the same work methods, unless otherwise specified.

The warning signs which occur in the workshop manual (please refer to “Safety information” for their meanings)



NOTE! are not comprehensive in any way, since we can not of course foresee everything, because service work is done in highly varying circumstances. For this reason, all we can do is to point out the risks which we believe could occur due to incorrect work in a well-equipped workshop, using work methods and tools tested by us.

All operations described in the Workshop Manual for which there are Volvo Penta Special Tools available assume that these tools are used when carrying out the repair. Volvo Penta Special Tools have been specifically developed to ensure the most safe and rational working methods possible. It is therefore the responsibility of anyone using other tools or other working methods than we recommend to determine that there is no risk of personal injury or mechanical damage or malfunction as a result.

In some cases special safety precautions and user instructions may be required in order to use the tools and chemicals mentioned in the Workshop Manual. These rules must always be observed, so there are no special instructions about this in the workshop manual.

The majority of risks can be prevented by taking certain elementary precautions and using common sense. A clean work place and a clean drive will eliminate many risks of personal injury and engine malfunction.

Above all, when work on hydraulic systems, lubrication systems, bearing seals and sealed joints is done, it is extremely important that no dirt or foreign particles are able to get in, since this would otherwise cause malfunctions or shortened repair life.

Our common responsibility

Each engine and drive consists of a large number of collaborating systems and components. Any deviation of a component from its technical specification can dramatically increase the environmental impact of an otherwise good engine with attached drive. For this reason, it is extremely important that specified wear tolerances are maintained, that systems with adjustment facilities are correctly adjusted and that Volvo Penta Original Spares are used for the engine and drive. The times specified in the engine maintenance schedule must be followed, in the same way as the drive bellows, zinc anodes and oil changes etc. are changed.

Remember that most chemical products, incorrectly used, damage the environment. Volvo Penta recommends the use of biodegradable degreasers whenever drive components are de-greased, unless otherwise specified in the workshop manual. When working aboard a boat, be careful to ensure that oils, wash residue etc. are processed for destruction, and are not inadvertently discharged with bilge water into the environment.

Torque

The tightening torques for vital fasteners, which should be tightened with a torque wrench, are listed in the workshop manual, “**Technical data, Tightening torque**” and specified in the work descriptions in the book in bold face. All torque specifications apply to clean screws, screw heads and mating faces. Torque data stated apply to lightly oiled or dry threads. If lubricants, locking fluids or sealants are needed on a fastener, the type of preparation to be used will be noted in the job description.

Where the tightening torque for a fastener is printed in plain text, the general tightening torques should be used. The torque specification is a target value and the fastener does not need to be tightened with a torque wrench.

Torque-angle tightening

In torque/angle tightening, the fastener is tightened to the specified torque, and tightening then continues through a pre-determined angle. Example: for 90° angle tightening, the fastener is turned a further 1/4 turn in one sequence, after the specified tightening torque has been achieved.

Strength classes

Screws and nuts are sub-divided into different strength classes. Classification is indicated by markings on the screw head. A marking with higher number indicates stronger material. For example, a screw marked 10-9 is stronger than one marked 8-8. For this reason, it is important when screws are disassembled that the screws are put back in their original locations on re-assembly. If a screw must be replaced check in the spare parts catalogue to make sure the correct bolt is used.

Sealants etc.

Several different types of sealants, locking fluids and assembly compounds are used on the drive. The properties of the preparations differ, and they are intended for different strengths of fastener, temperature, resistance to oil and other chemicals, and for the different materials and gap thicknesses found in the engine.

To ensure service work is correctly carried out it is important that the correct sealant and assembly paste is used on the fasteners where the preparations are required.

In this Volvo Penta Workshop Manual the user will find that each section where these agents are applied in production states which type was used on the drive.

The same preparations should be used in service work.

When sealants and locking fluids are used, it is important that the surfaces are free from oil, grease, paint and rust-protection, and that they are dry.

Always follow the manufacturer's instructions for use regarding temperature range, curing time and any other instructions for the product.

Two different basic types of preparation are used on the drive. These are:

RTV preparations (Room Temperature Vulcanizing). These preparations are used when two flexible flanges, such as oil pan – engine block, are fitted together without a gasket. RTV is visible when a part has been disassembled; old RTV must be removed before re-sealing the joint. Old sealant should be removed with gasket scraper **885 516** and denatured alcohol.

Anaerobic agents. These agents cure in the absence of air. These preparations are used when two solid components, such as valve housing – engine block, are fitted together without a gasket. Common uses are also to lock and seal plugs, stud threads, taps, oil pressure monitors etc. Hardened anaerobic preparations are glassy and for this reason, the preparations are colored to make them visible. Hardened anaerobic preparations are highly resistant to solvents. Old sealant should be removed with gasket scraper **885 516**.

The surface should then be degreased with denatured alcohol.

The following anaerobic preparations are mentioned in the workshop manual:

Sealant (red), part no. **840 879**

Sealant (brown), part no. **116 1370**

Thread locking fluid, part number **116 1053**

The following assembly paste is used on the drive:

Grease, part number **828 250**. Used on seal rings and screws on the lower gear.

Safety rules for fluorocarbon rubber

Fluorocarbon rubber is a common material in seal rings for shafts, and in O-rings, for example.

When fluorocarbon rubber is exposed to high temperatures (above 300 °C), **hydrofluoric acid** can be formed, which is highly corrosive. Contact with the skin can result in severe chemical burns. Splashes in your eyes can result in severe chemical burns. If you breathe in the fumes, your lungs can be permanently damaged.

WARNING! Observe the greatest care in working on engines which might have been exposed to high temperatures, such as overheating during flame cutting or a fire. Seals must never be cut with a flame torch during disassembly, or burned in uncontrolled circumstances afterwards.

- Always use chloroprene rubber gloves (gloves for chemicals handling) and goggles. Handle the removed seal in the same way as corrosive acid. All residue, including ash, can be highly corrosive. Never use compressed air to blow anything clean.
- Put the remains in a plastic container, seal it and apply a warning label. Wash the gloves under running water before removing them.

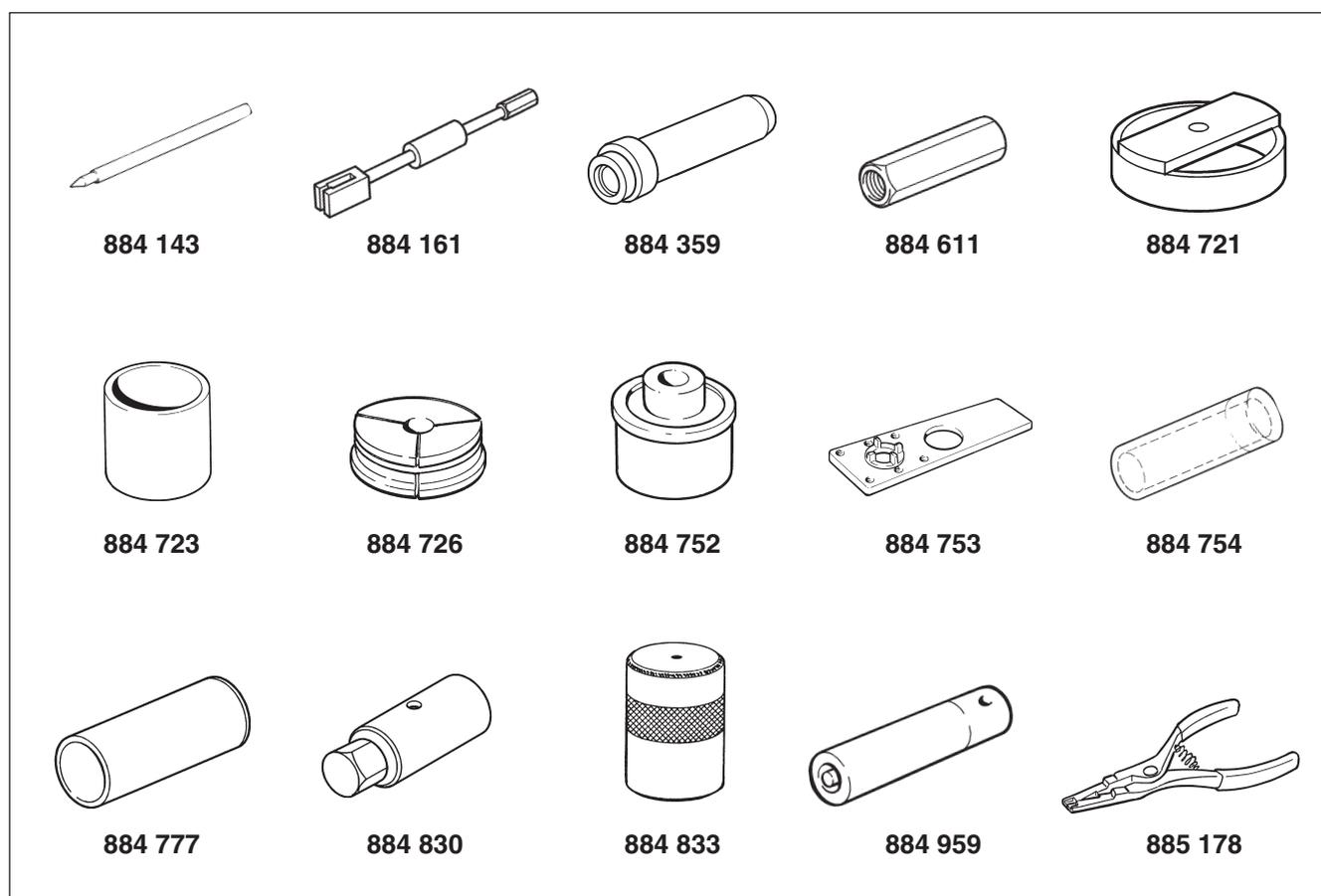
The following seals are most probably made from fluorocarbon rubber:

Seal rings for the crankshaft, camshaft, drive shafts.

O-rings, regardless of where they are installed. O-rings for cylinder liner sealing are almost always made of fluorocarbon rubber.

Please note that seals which have not been exposed to high temperature can be handled normally.

Special tools



884 143 ¹⁾ Standard extension

884 161 ¹⁾ Slide hammer for removing the propeller shaft

884 359 ¹⁾ Mandrel for installing bearing races in the upper gear

884 611 ¹⁾ Adapter for above slide hammer 884161

884 721 ¹⁾ Puller for bearing races, lower gear

884 723 ¹⁾ Counterhold for disassembling the bearing race, propeller shaft

884 726 ¹⁾ Expander for disassembling the bearing race, propeller bearing housing

884 752 ¹⁾ Mandrel for disassembling the gear wheel from the propeller shaft, installing seal rings in the propeller bearing housing.

884 753 ¹⁾ Plate for installing the gear wheel on the propeller shaft

884 754 ¹⁾ Mandrel for installing bearings, output shaft, upper gear

884 777 ¹⁾ Mandrel for installing bearing race, lower gear.

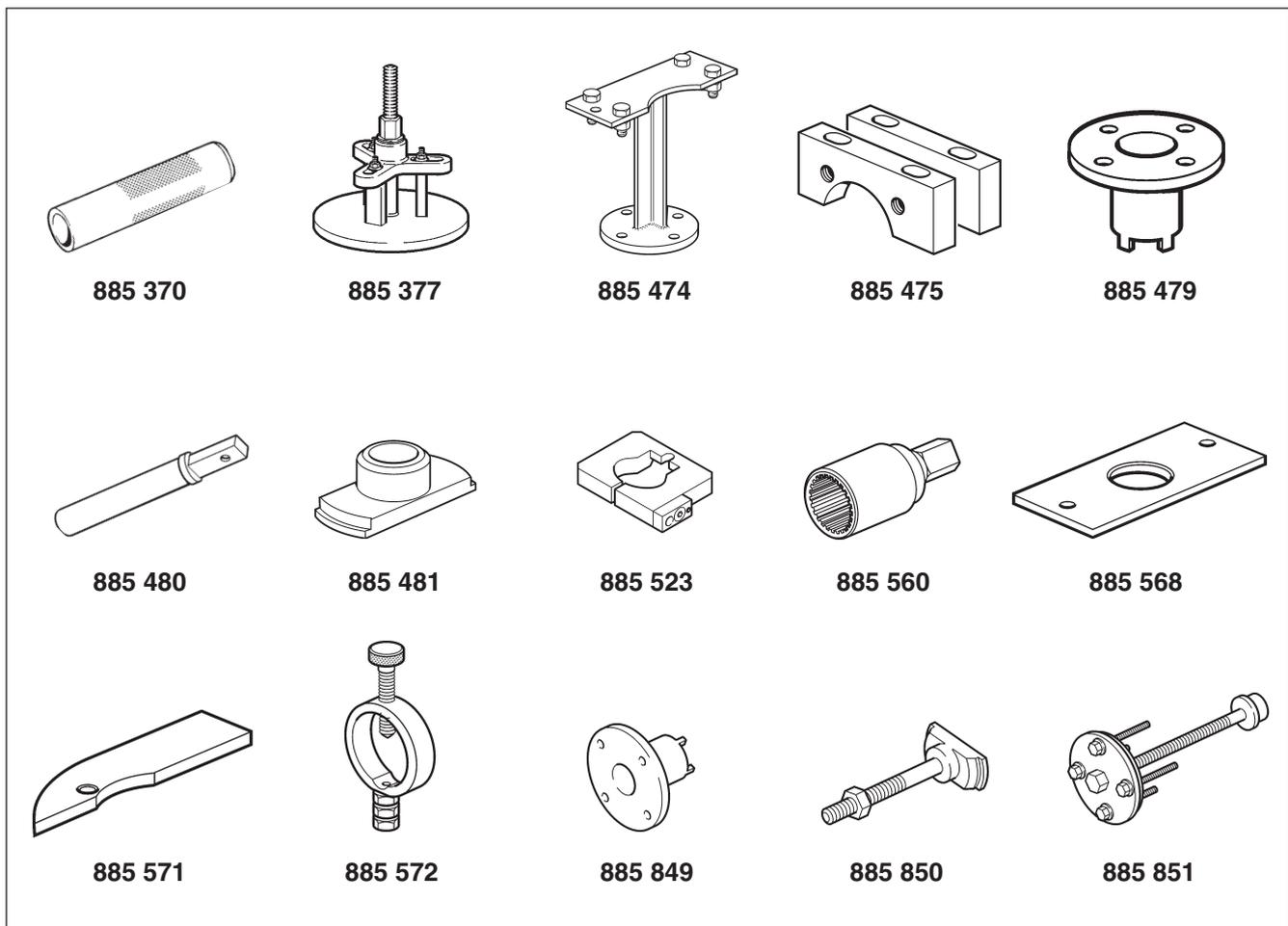
884 830 ¹⁾ Splined socket 130S

884 833 ¹⁾ Mandrel for removing the vertical shaft

884 959 ¹⁾ Mandrel for disassembling the bearings on the input shaft

885 178 ¹⁾ Circlip pliers

¹⁾ This tool is used with one or more of Volvo Penta's older products.



885 370 ¹⁾ Mandrel for disassembling the bearing on the input shaft

885 377 ¹⁾ Press tool for splitting the gear wheel unit

885 474 ¹⁾ Fixture for upper gear housing

885 475 ¹⁾ Clamp for fixing the input shaft upper gear

885 479 ¹⁾ Counterhold for removing the nut on the upper vertical shaft 130S

885 480 ¹⁾ Fixture for shim calculation, input shaft.

885 481 ¹⁾ Plate for removing bearing races in the upper gear

885 523 ¹⁾ Measurement fixture, cam shift mechanism

885 560 ¹⁾ Splined socket 150S

885 568 ¹⁾ Plate for puller halves

885 571 ¹⁾ Fixture for magnetic stand

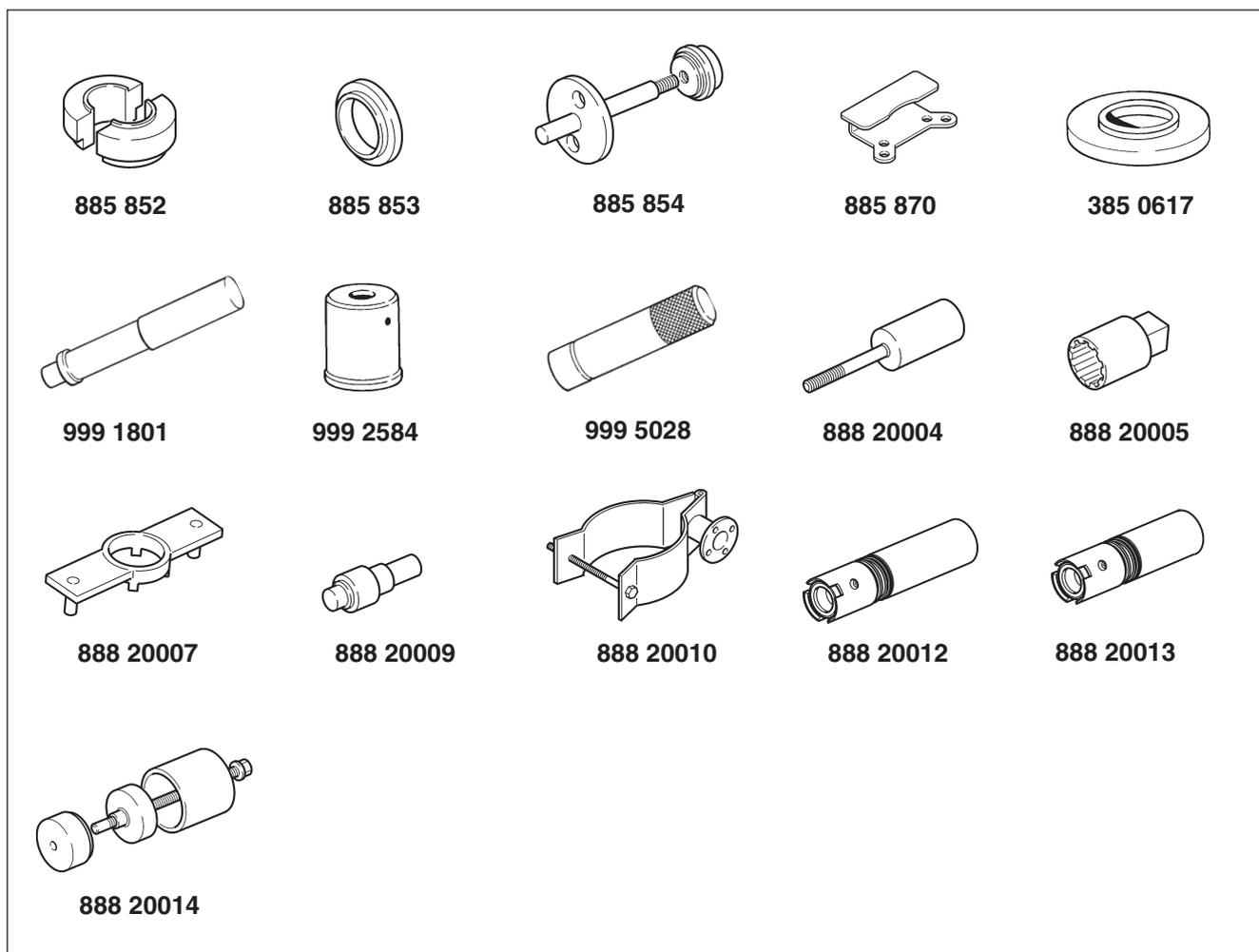
885 572 ¹⁾ Fixture for measuring gear flank clearance, lower gear.

885 849 Counterhold for removing the nut on the upper vertical shaft 130S

885 850 Counterhold for removing the nut on the upper vertical shaft 130S

885 851 Puller for needle roller bearing, lower gear

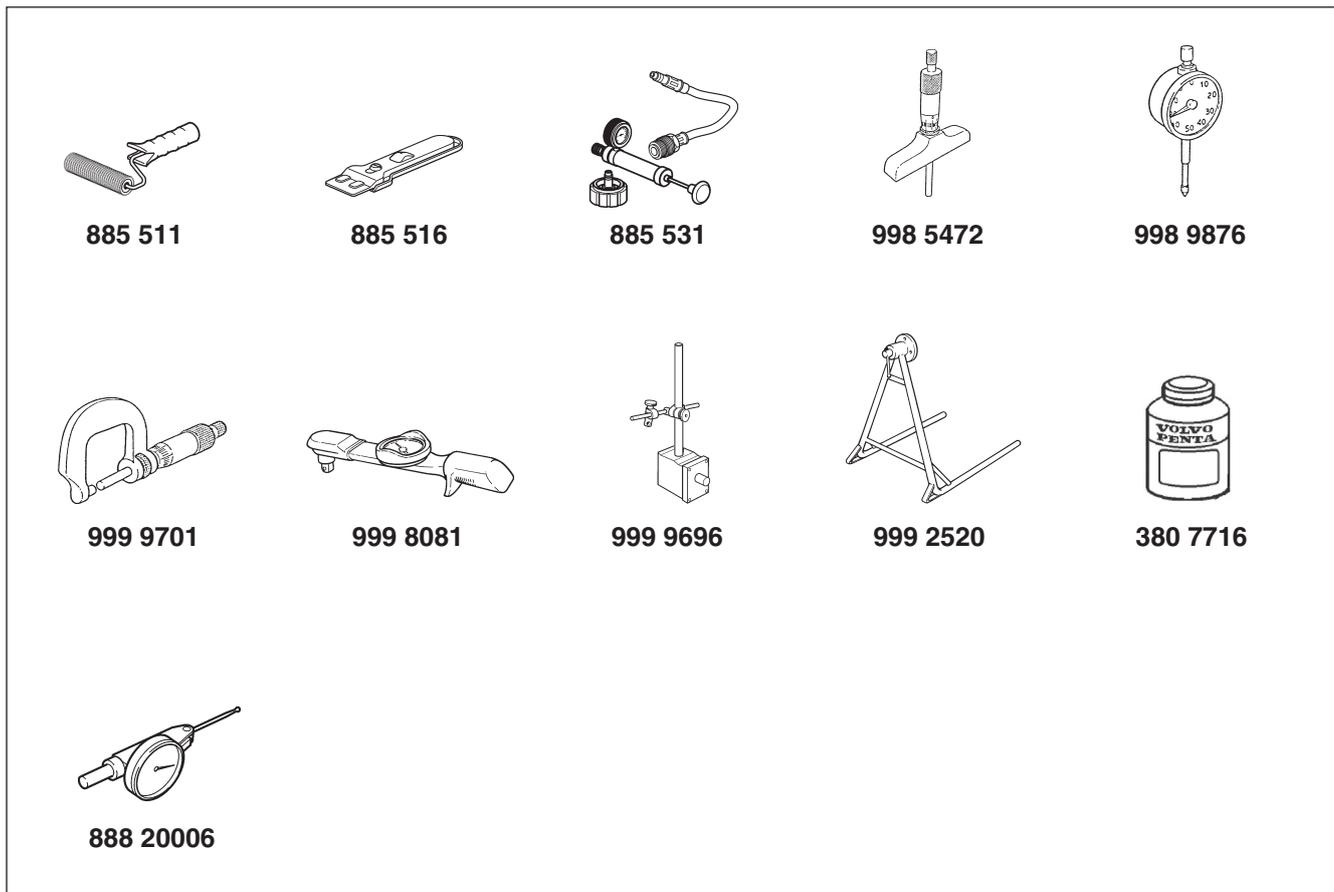
¹⁾ This tool is used with one or more of Volvo Penta's older products.



- | | | | |
|-------------------------------|--|------------------|--|
| 885 852 | Puller for bearing and needle roller bearing race, lower vertical shaft | 888 20004 | Puller for lower vertical shaft. |
| 885 853 | Counterhold for removing bearing on propeller shaft, 150S | 888 20005 | Splined socket |
| 885 854 | Mandrel for installing bearing race, lower gear (with plastic ring). | 888 20007 | Fixture for removing upper nut on lower vertical shaft |
| 885 870 | Alignment tool for shift mechanism | 888 20009 | Mandrel for installing seal ring in gear mechanism |
| 385 0617 ¹⁾ | Counterhold for removing bearing on input shaft, propeller shaft (only 130S) and for installing bearing and needle roller bearing on lower vertical shaft. | 888 20010 | Fixture for lower gear housing |
| 999 1801 ¹⁾ | Standard extension | 888 20012 | Measurement fixture, vertical shaft 130S |
| 999 2584 ¹⁾ | Counterhold for disassembling the gear wheel, propeller shaft | 888 20013 | Measurement fixture, vertical shaft 150S |
| 999 5028 ¹⁾ | Mandrel for removing output shaft, upper gear | 888 20014 | Press tool for changing rubber bushing, upper gear housing |

¹⁾ This tool is used with one or more of Volvo Penta's older products.

Other special equipment



885 511 ¹⁾ Roller for sealant

885 516 ¹⁾ Gasket scraper

885 531 Pressure testing kit

885 636 ¹⁾ Roller (spare part for 885 511)

998 5472 ¹⁾ Depth micrometer

998 9876 ¹⁾ Dial gage

999 9701 ¹⁾ Micrometer 0-25 mm

999 8081 ¹⁾ Torque wrench, for checking turning resistance

999 9696 ¹⁾ Magnetic stand

999 2520 ¹⁾ Stand for fixture

380 7716 ¹⁾ Marker dye for checking gear engagement pattern ²⁾

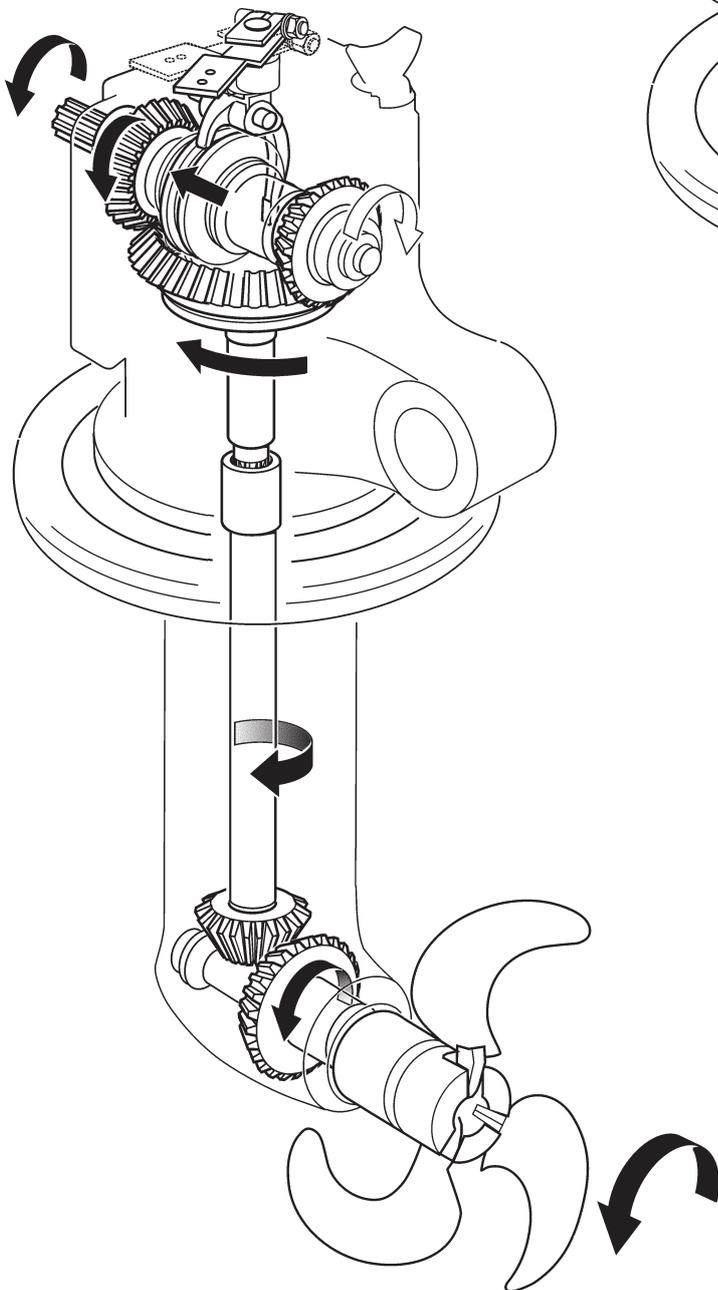
888 20006 Dial gage with long tip

¹⁾ This tool is used with one or more of Volvo Penta's older products.

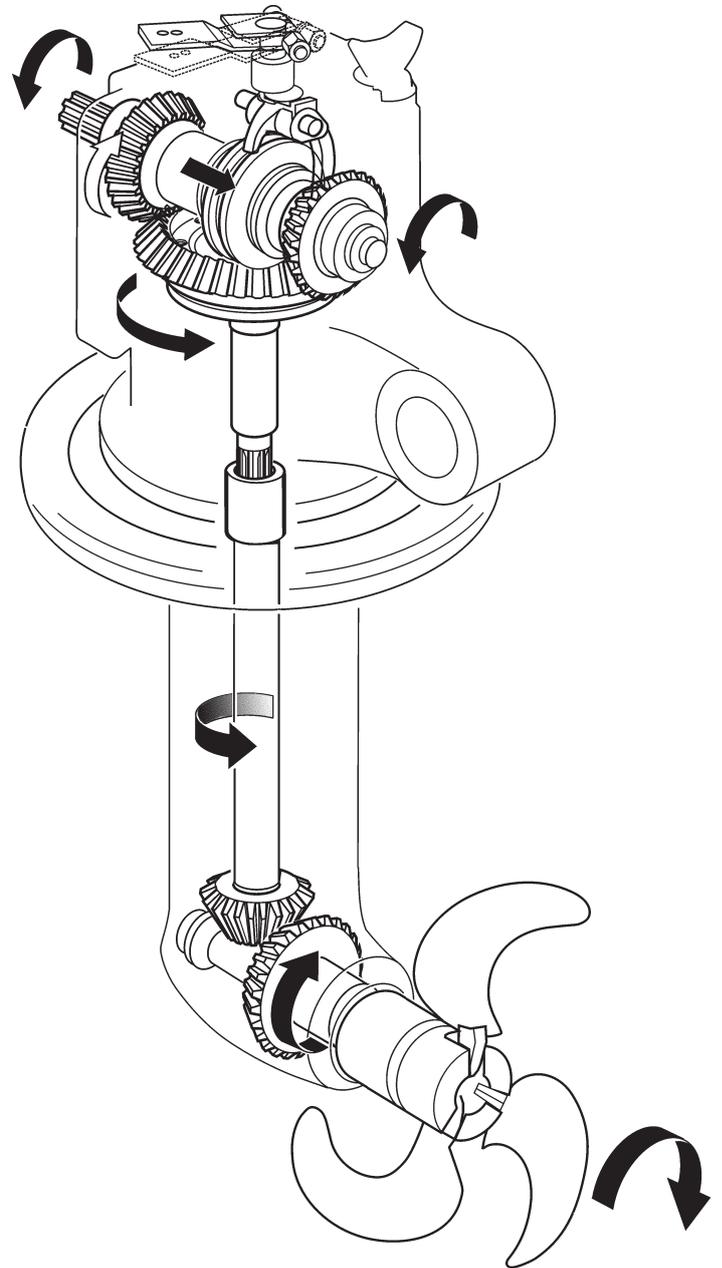
²⁾ The powder is mixed with a drop of oil to form a "dry" mixture.

Design and function

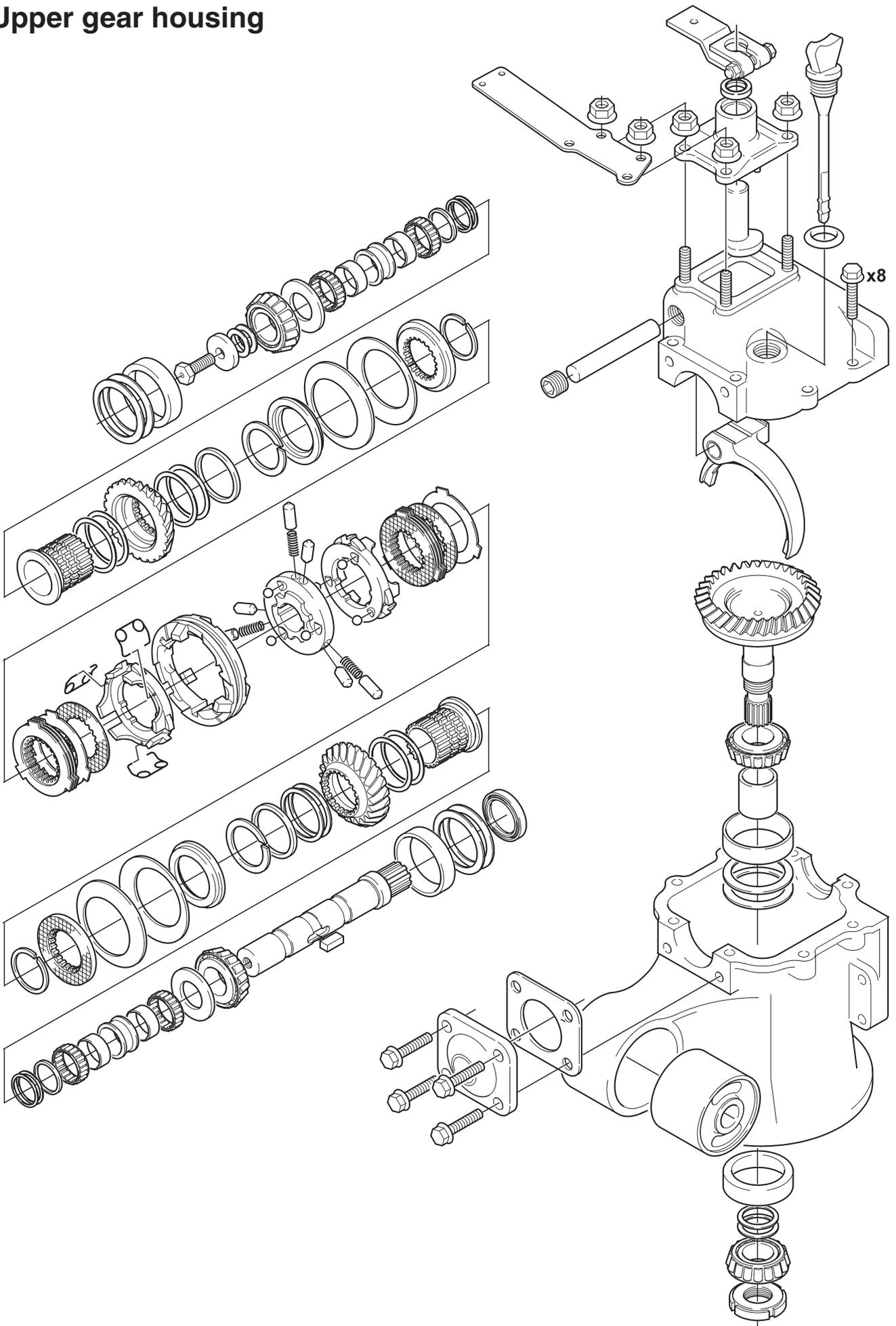
FORWARDS position for
left-hand rotating propeller



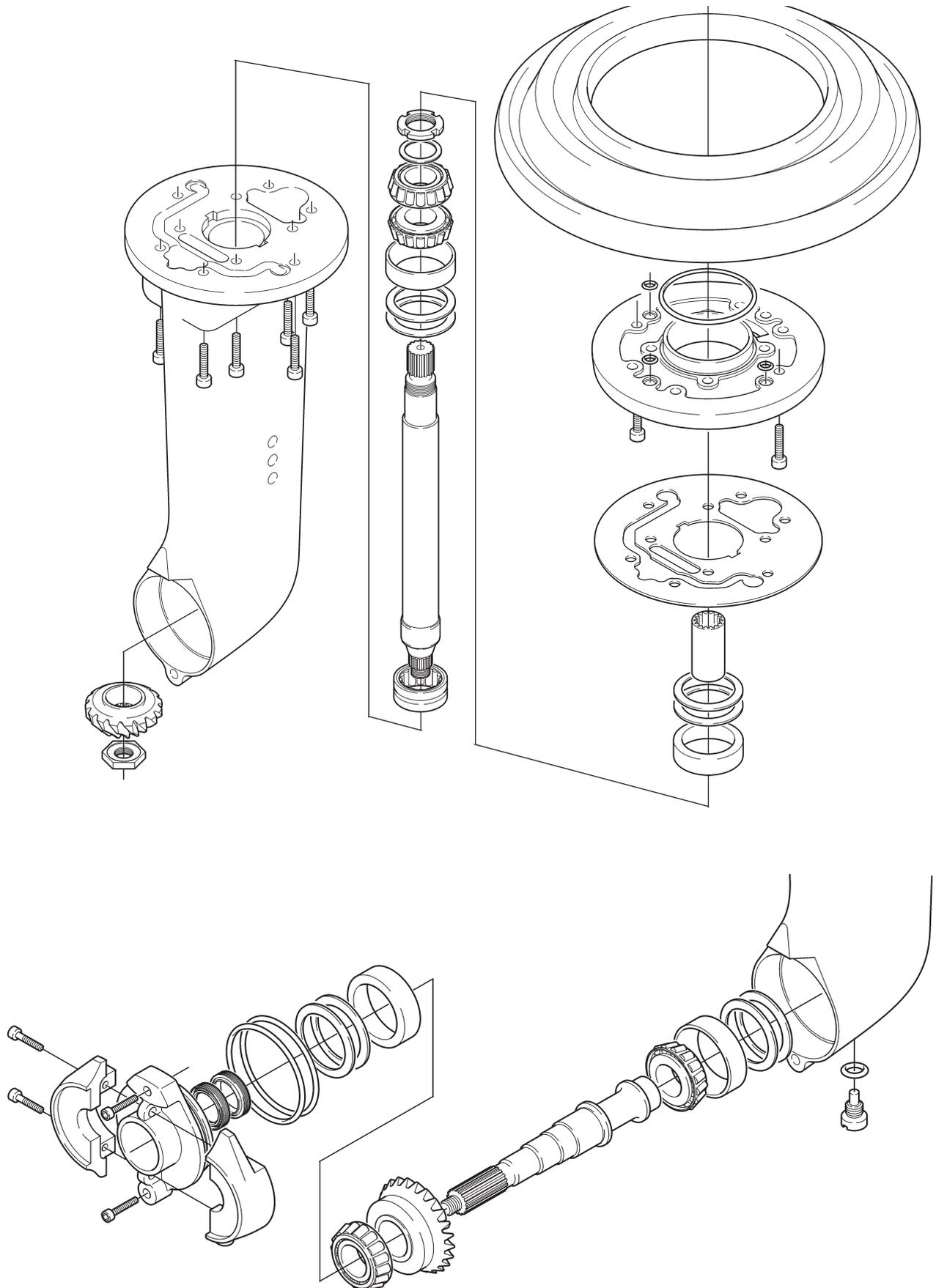
REVERSE position for
left-hand rotating propeller



Upper gear housing



Lower gear housing



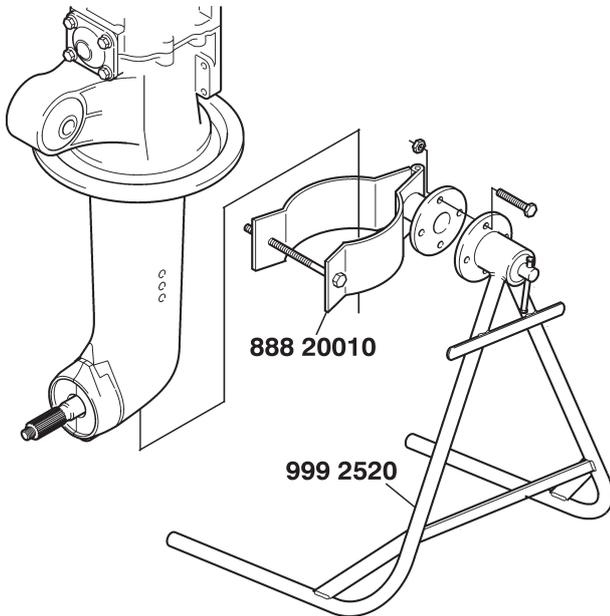
Repair instructions

Upper and lower gear housing, disassembly

1

Install fixture **888 20010** on drive.

Install fixture in stand **999 2520**.

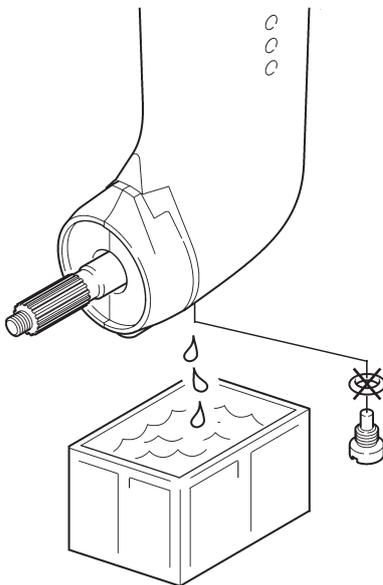


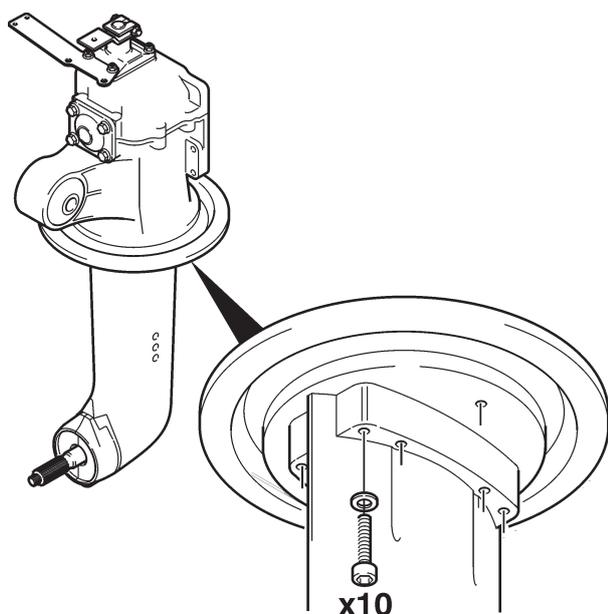
2

Clean the outside of the upper and lower gear housings.

Remove the drain plug and drain the oil.

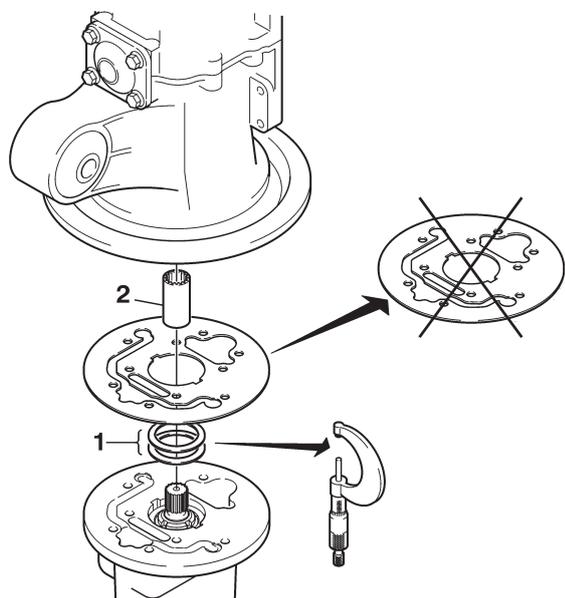
Scrap the O-ring.





3

Then remove all the screws, 10 pcs below the division line of the drive.

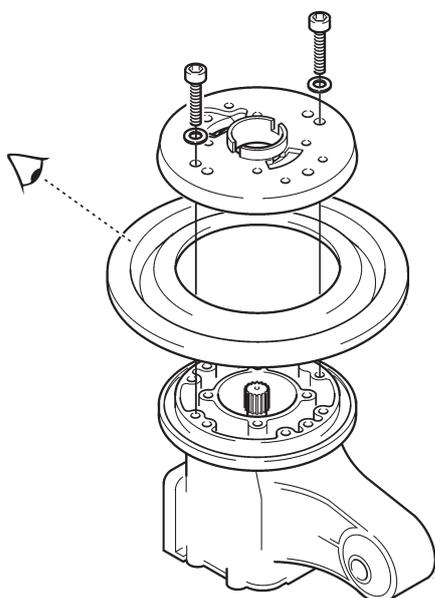


4

Split the drive.

Save the shims (1) and note the thickness of the shims.

Lift away the splined socket (2). Scrap the gasket.



5

Remove the adapter plate and remove the rubber seal.

Check the rubber seal for cracks and wear.

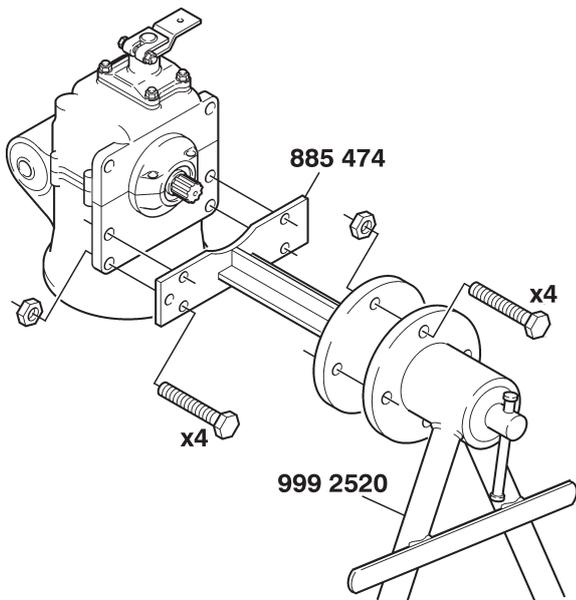
⚠ WARNING! The rubber seal should be changed every seven years, or earlier if defects are found.

Scrap the O-rings.

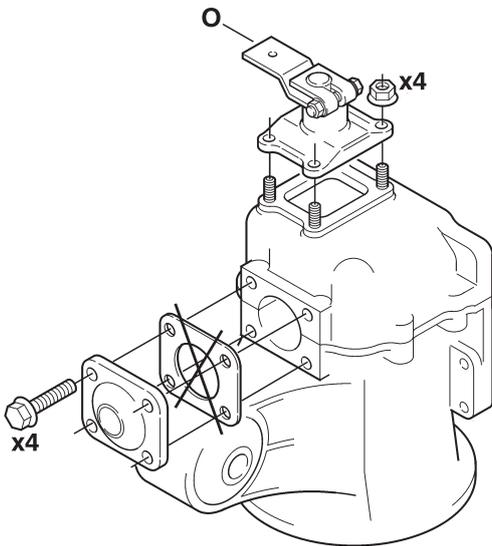
Upper gear, renovation

Disassembly

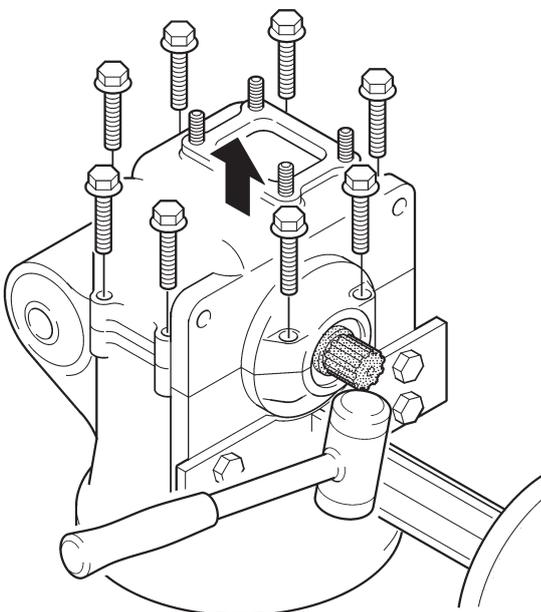
⚠ IMPORTANT! Mark the components when disassembled, to avoid mixing them up. Note the thickness and position of all the shims in the gear housing when you are working. There is a template for this at the end of the manual.



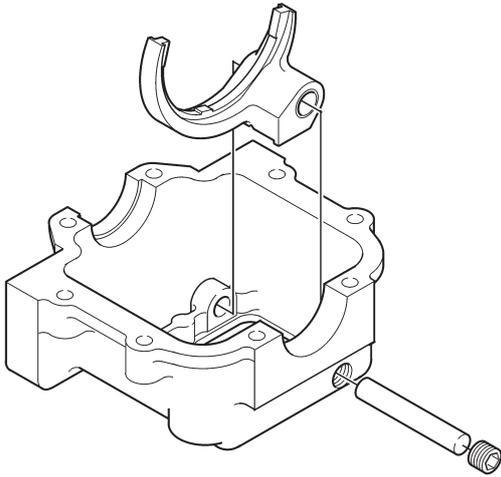
- 1
Install fixture **885 474** on the gear housing, if this has not been done previously.
Install fixture in stand **999 2520**.



- 2
Remove the rear cover. Scrap the gasket. Save the shims.
Put the gear selector in neutral and remove the gear mechanism.

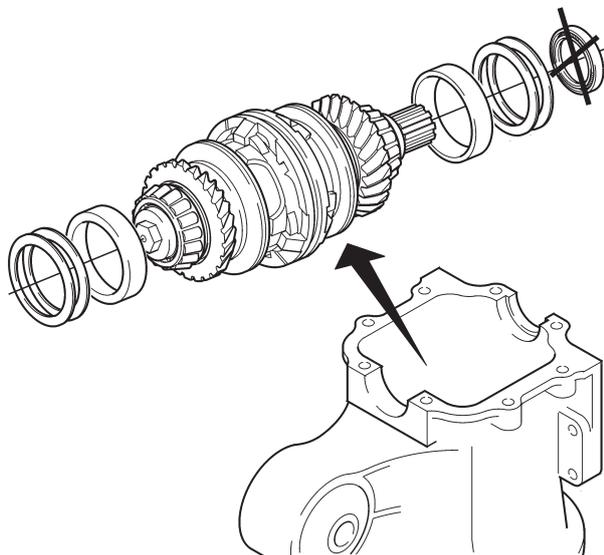


- 3
Remove the upper part of the gear housing. Tap the input shaft with a plastic-faced mallet to break the adhesive joint between the housing halves.



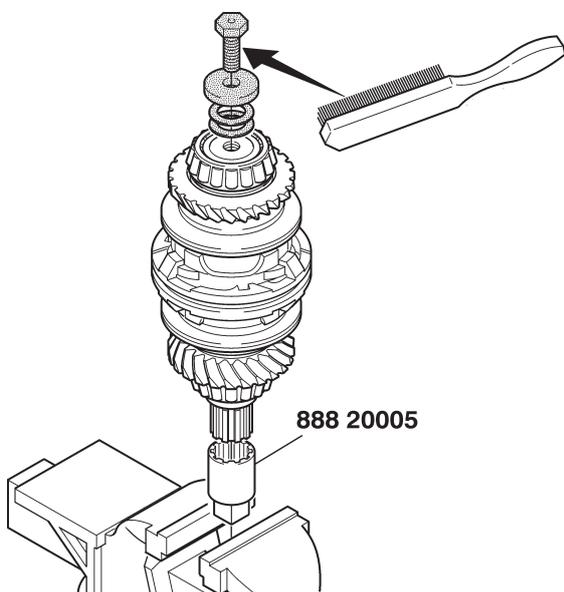
4

Remove the plug and slide the selector fork shaft out.



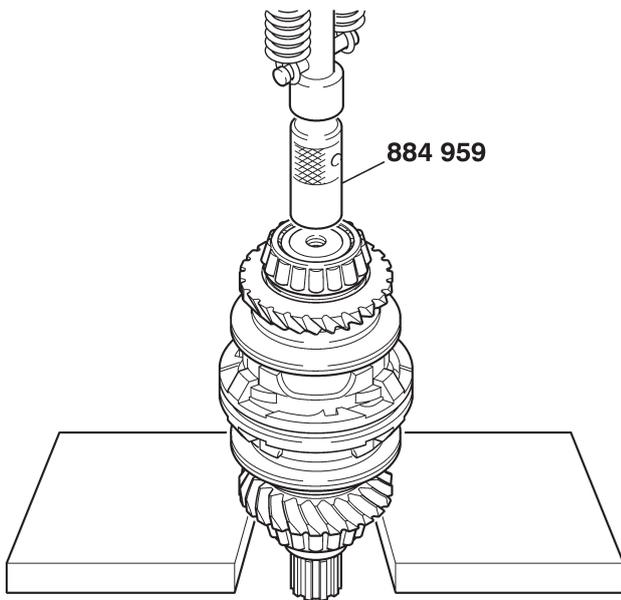
5

Lift the input shaft out.
 Scrap the seal ring.
 Save the shims and note the thickness of the shims.
 Remove the outer bearing races.



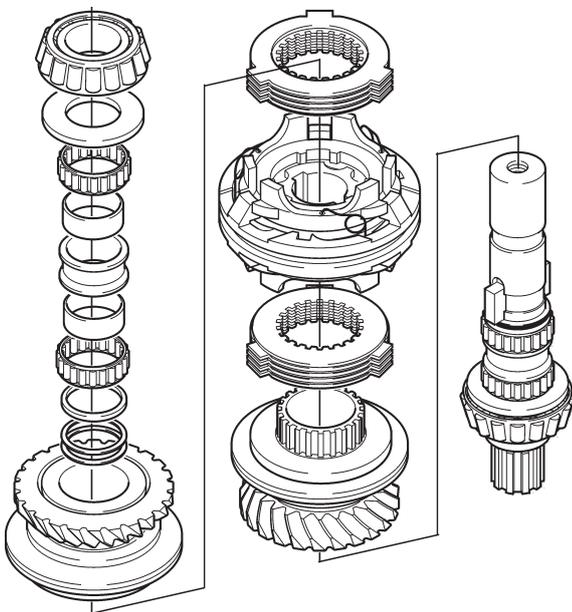
6

Install splined socket **888 20005** in the vice. Put the input shaft in the splined socket.
 Remove the screws and washer and shims. Note the thickness of the shims.
 Clean all traces of locking fluid off the threads.



7

Put the input shaft in a press, with the splines facing down.

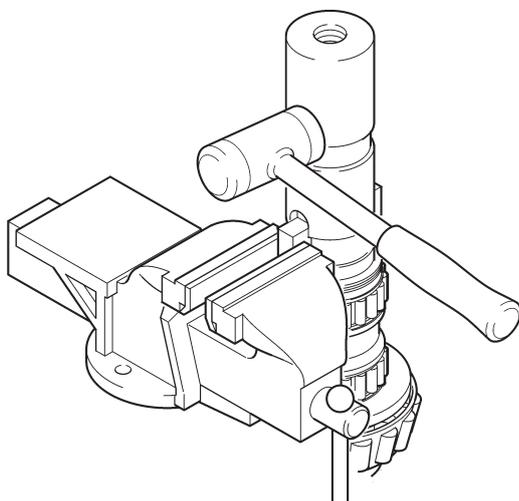


Press off, in one and the same operation:

- tapered roller bearing
- sintered washer
- needle roller bearing
- spacer sleeve
- needle roller bearing
- spacer ring
- shims
- rear gear wheel unit
- rear friction plate unit
- clutch unit
- front friction plate unit
- front gear wheel unit

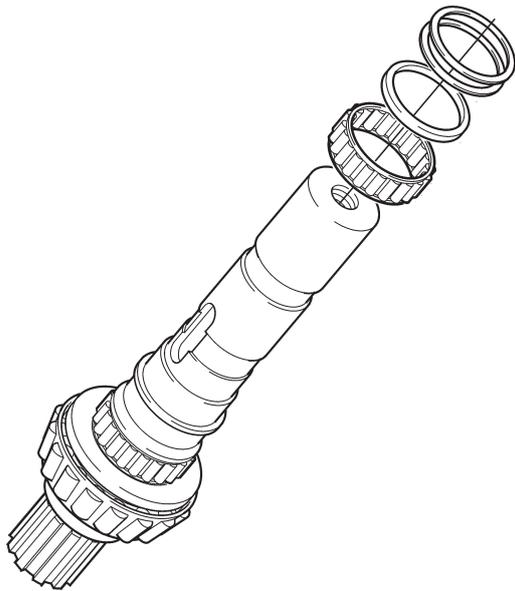
Use mandrel **884 959**.

Save the shims and note the thickness of the shims.



8

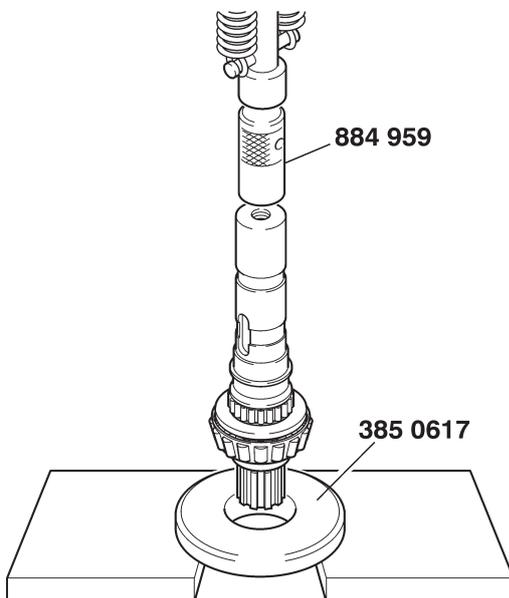
Remove the key from the shaft.



9

Lift off the shims, spacer ring and needle roller bearing.

Save the shims and note the thickness of the shims.

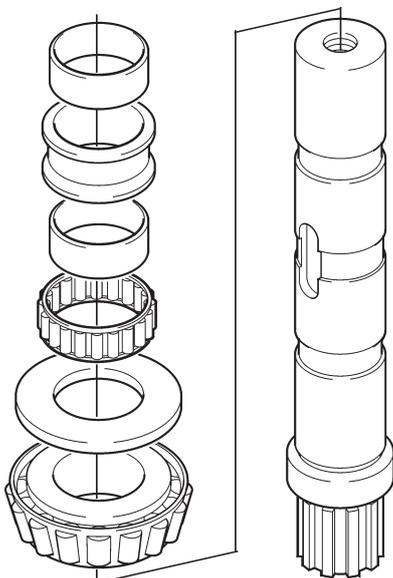


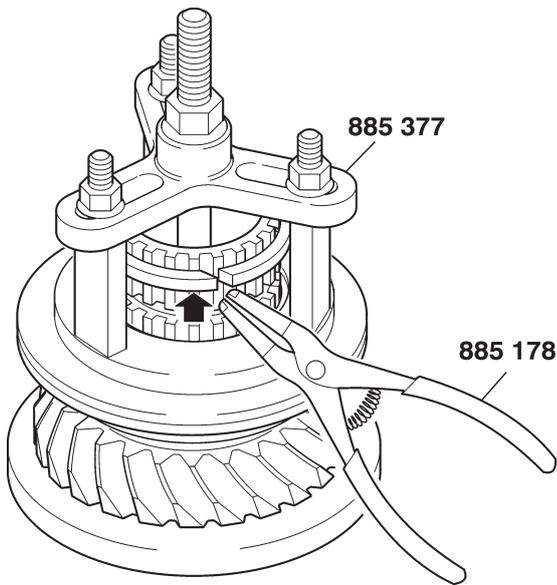
10

Press off:

- needle roller bearing race
- spacer
- needle roller bearing with needle roller bearing race
- sintered washer
- tapered roller bearing

Use mandrel **884 959** and counterhold **385 0617**.



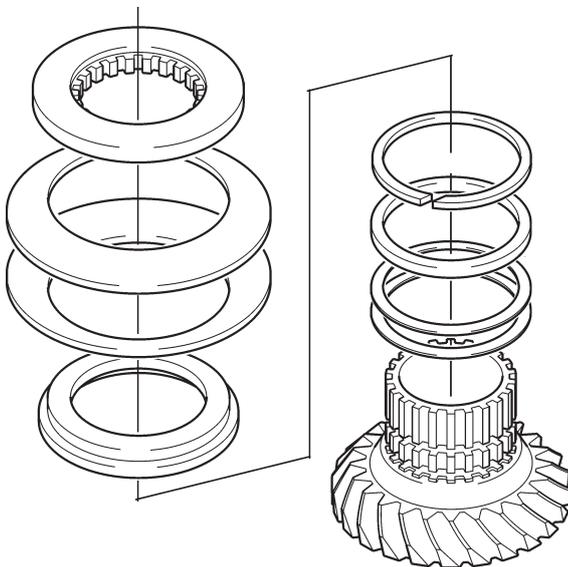


11

Remove the front and rear gear wheels from their flanges as follows:

Press the sintered washer down with press tool **885 377** as in the illustration.

Remove the circlip with circlip tong **885 178**.



12

Lift away:

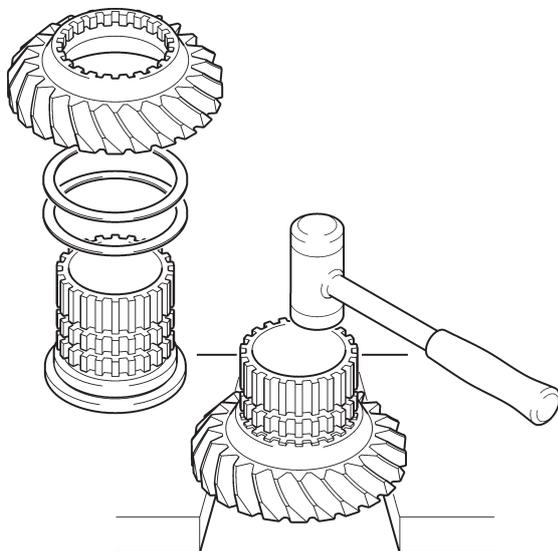
- sintered washer
- the two disc springs
- washer

Remove the circlip.

Lift away:

- spacer ring
- shim

Save the shims and note the thickness of the shims.



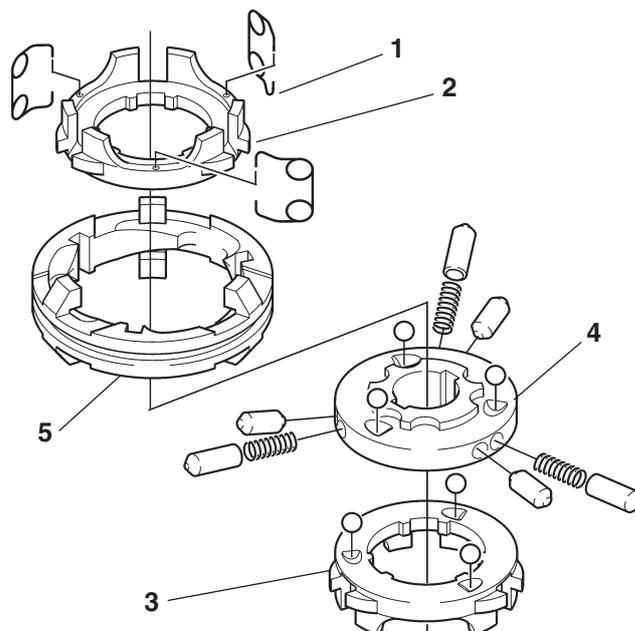
13

Tap the gear off the flange with a plastic faced hammer.

Save the shims and note the thickness of the shims.

14

Remove the three springs (1) and the two holders (2) and (3) from the clutch unit. Be careful to save the balls, three in each holder.



NOTE! Put the hub (4) with clutch plate (5) in a cloth etc. before separating them, to prevent pins and springs from flying away.

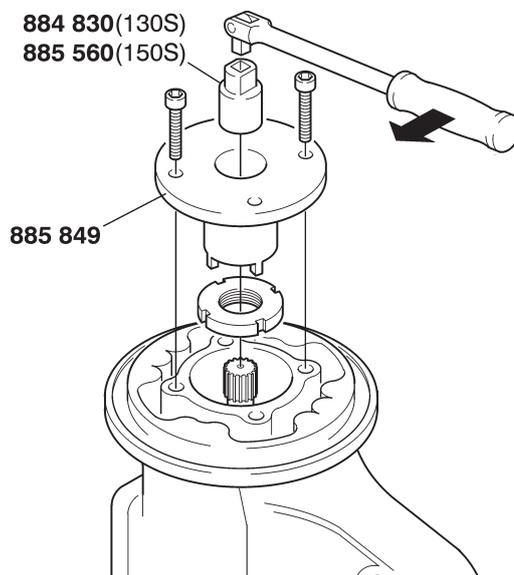
Carefully separate the hub and clutch plate.

Save the pins and springs.

15

Lock the slotted nut with counterhold **885 849** (130S-A/B) and **22296432**. Do not screw the screws in all the way, the counterhold must be able to move axially.

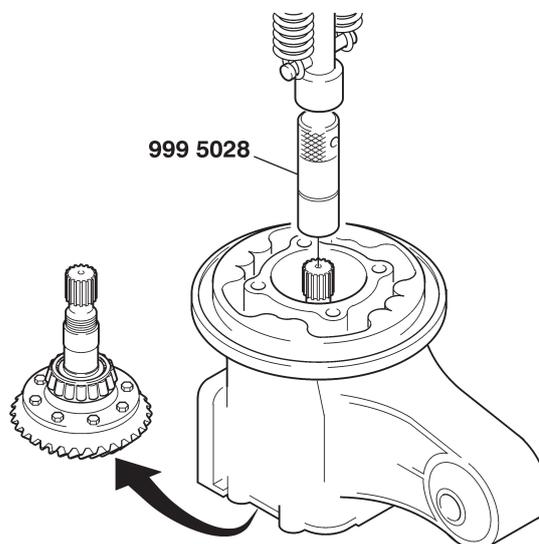
Undo the nut by turning the shaft clockwise with splined socket **884 830** (130S) or **885 560** (150S).

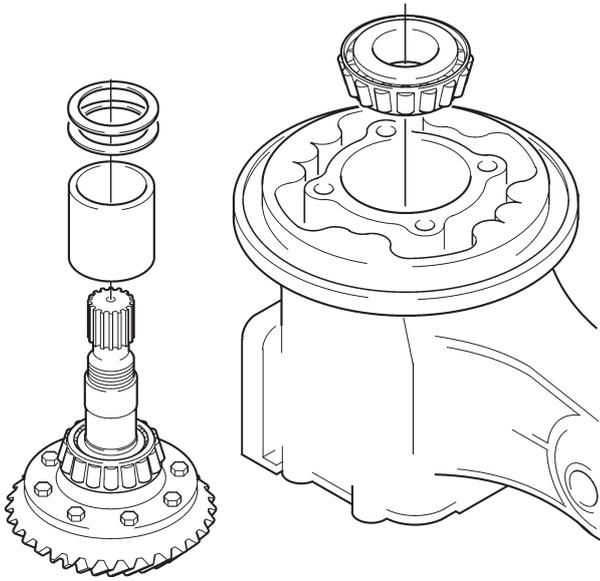


16

Remove counterhold and ring nut.

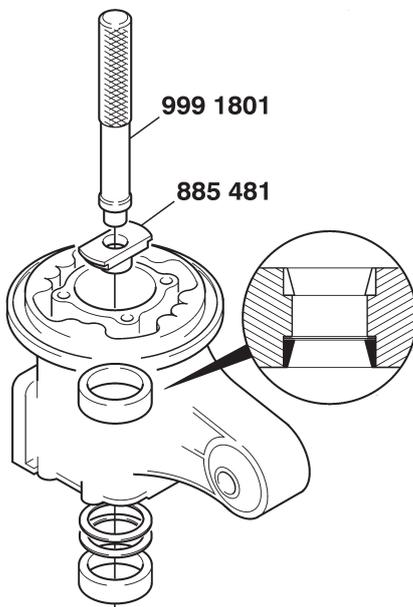
Press out the shaft, using mandrel **999 5028**.





17

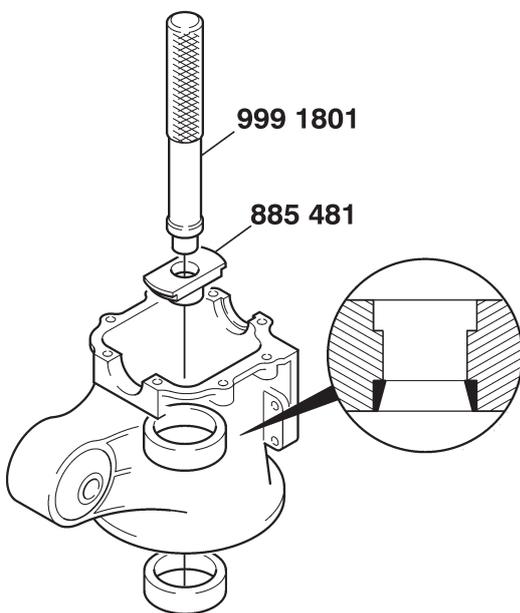
Remove the lower bearing, shims and spacer sleeve.
Save the shims and note the thickness of the shims.



18

Press out the upper bearing race with plate **885 481**
and standard shaft **999 1801**.

Save the shims and note the thickness of the shims.

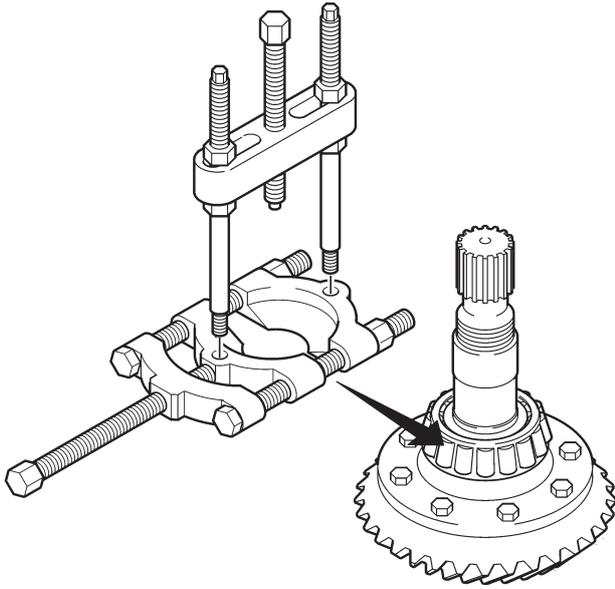


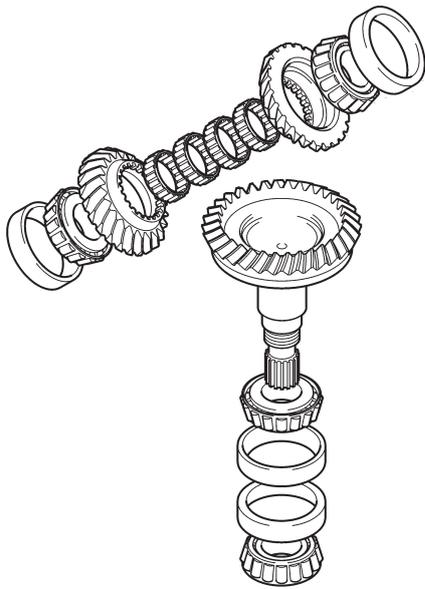
19

Turn the gear housing over and press the lower bearing race out. Use tool **885 481** and standard shaft **999 801**.

20

If the upper bearing needs to be changed, remove the bearing with a knife puller.





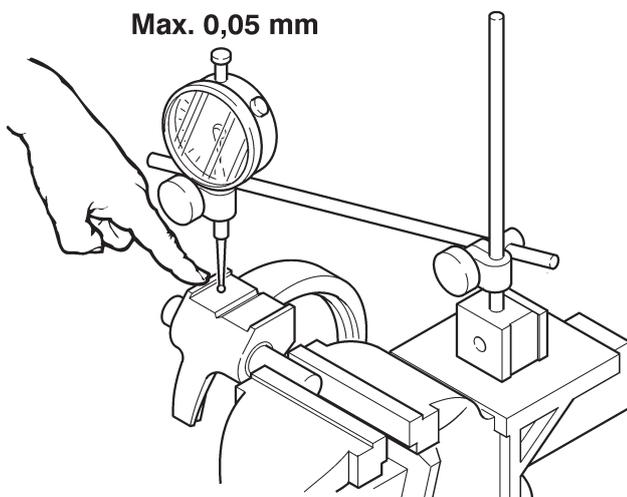
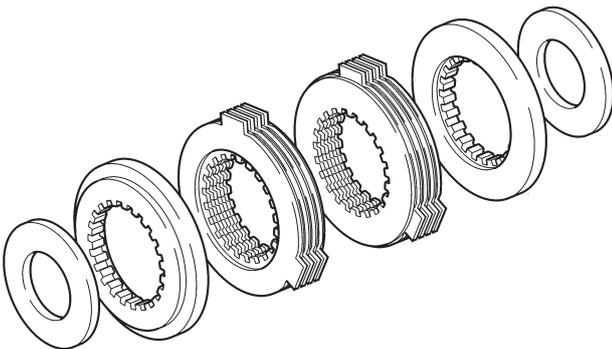
Inspection

1

Check all bearings and gear wheels.

2

If the sailboat drive is fully renovated, it is recommended that the front and rear friction plate packages and the four thrust washers should be changed.

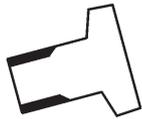


3

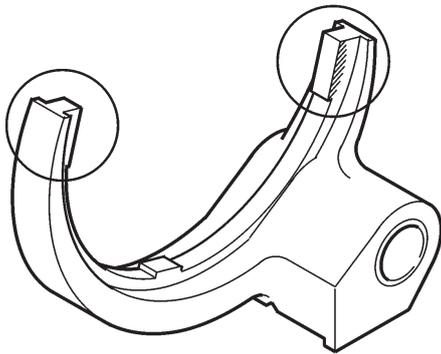
Check the clearance between the gear selector fork and shaft, as in the illustration.

Permissible clearance **0.05 mm**.

Change the gear selector fork if this clearance is exceeded.



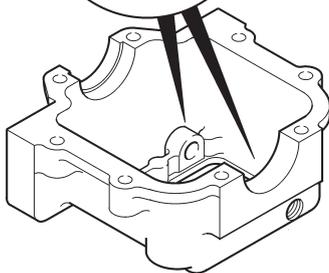
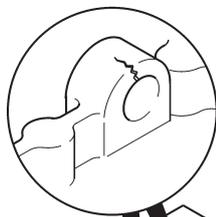
Max. 0,2 mm



4

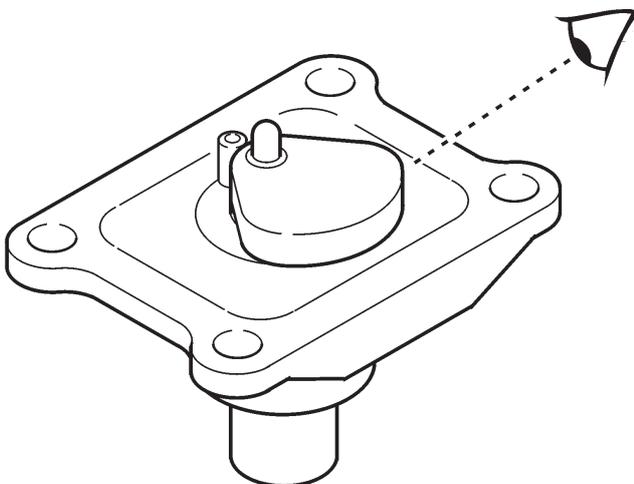
Measure the wear on the sliding surfaces of the gear selector fork.

Max permissible wear **0.2 mm**.



5

Check that there is no cracking between the lugs on the selector fork shaft.



6

Check the wear on the gear shift mechanism cam, please refer to "Gear mechanism, renovation".

Gear mechanism, renovation

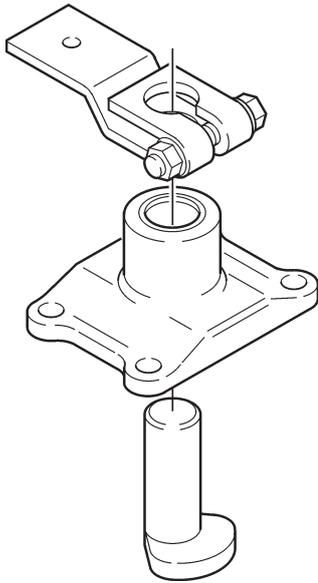
Special tool: 885 523

Removal

1

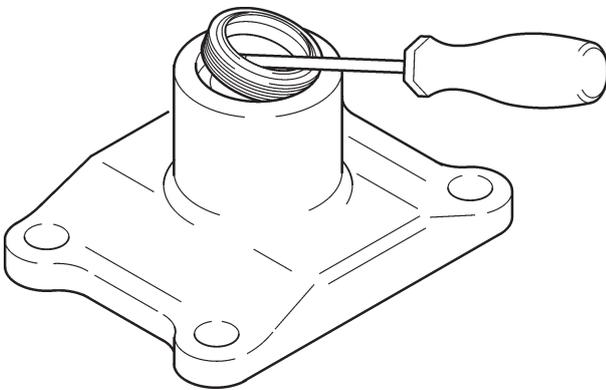
Undo the clamping screw and remove the selector arm.

Clean any paint residue off the shaft and then separate the shaft/cam from the housing.



2

Carefully prise out the seal ring with a screwdriver.

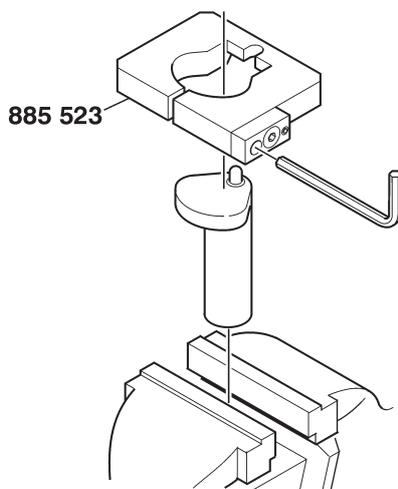


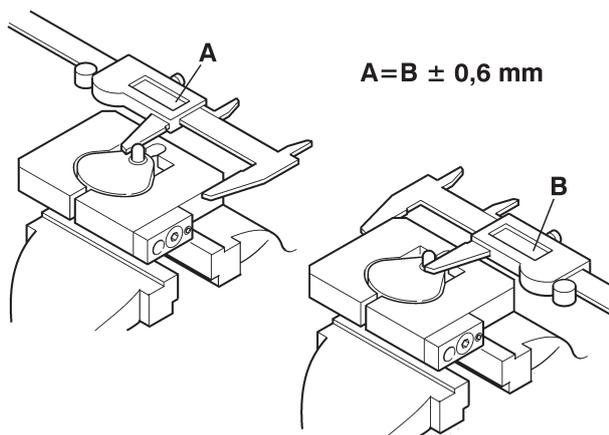
Inspection

3

Check the wear on the cam, using measurement fixture **885 523**.

Thread the fixture onto the cam. Tighten the socket cap screw slightly, to eliminate any clearance between the fixture and the cam.



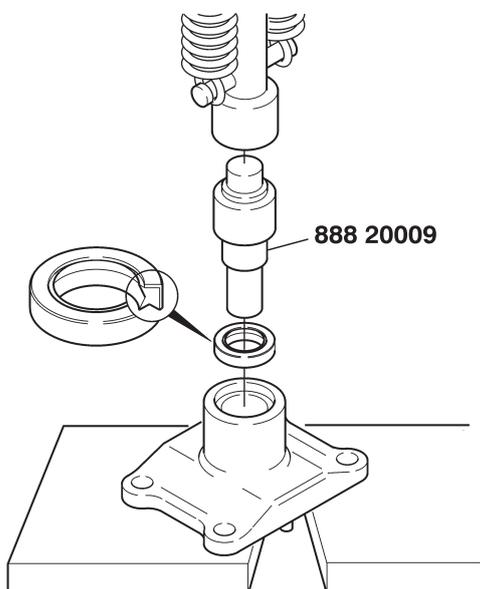


4

Measure as in the illustration.

Max permissible difference between the two measurements **0.6 mm**.

Change the cam if the difference exceeds the permissible value.

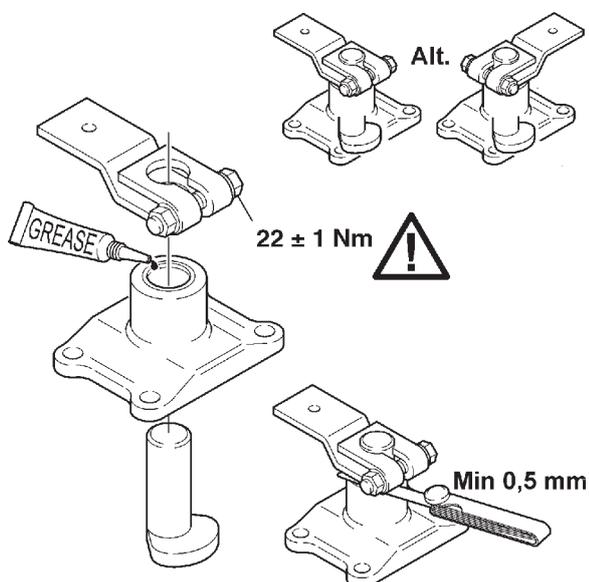


Assembly

5

Put the gear change mechanism on two plates (separated slightly so that the tension pin is free) and press the seal in with mandrel **888 20009**. Align the seal as in the illustration.

Align the mandrel as in the illustration, and press until the mandrel bottoms against the plates.



6

Grease the bore and the seal ring liberally with grease, VP part no. **828 250**.

Install the cam and the selector arm.

Angle the selector arm as in one of the two alternatives in the illustration (depending on what the boat installation looks like) and make sure that the clearance between the arm and the housing is at least **0.5 mm**.



IMPORTANT! Torque the clamping screw to: **22 ± 1 Nm**

Upper gear, assembly

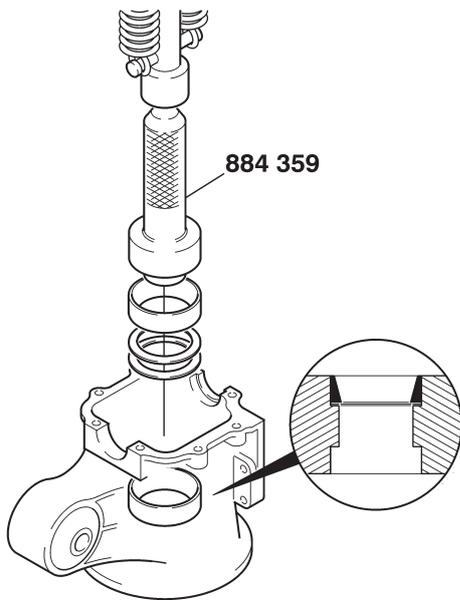
Output shaft

1

Place shims for the upper bearing race in the gear housing as follows:

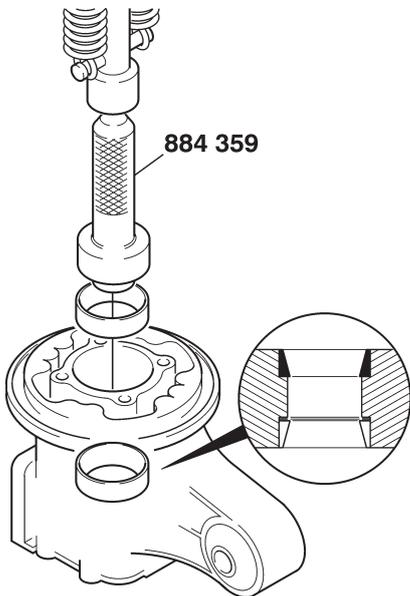
- if the original drive kit and bearings are to be used, use the original quantity of shims.
- if the drive kit and/or bearing has been changed, use 0.60 mm as a rough guide.

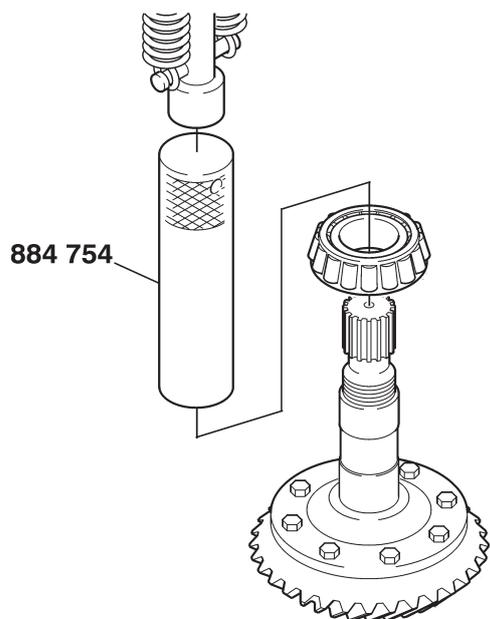
Press the bearing race in with mandrel **884 359**.



2

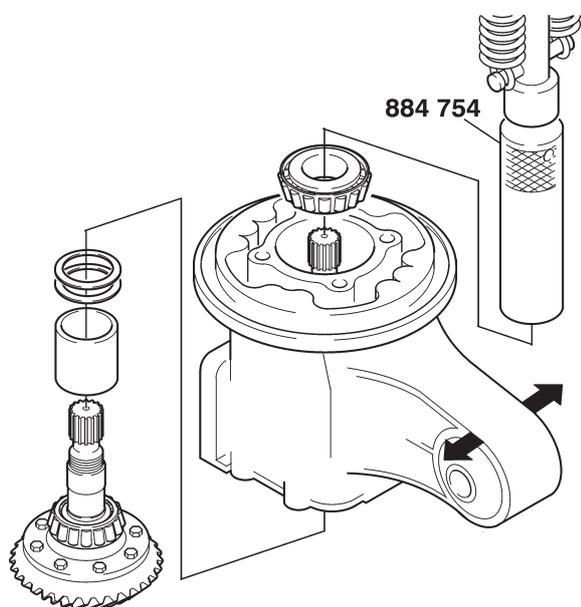
Turn the gear housing over and press the lower bearing race in with mandrel **884 359**.





3

Press the bearing onto the output shaft with mandrel **884 754**. Remember to protect the gear tooth tips.



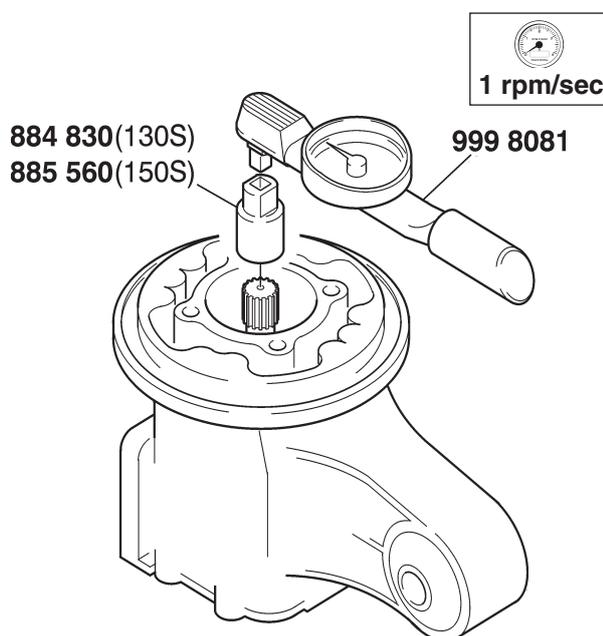
4

Put spacer sleeve (1) on the output shaft.

Put **the original** shim thickness on the shaft. If this value is not known, use 0.90 mm as rough guide.

Put the output shaft in the gear housing and press the lower bearing on with mandrel **884 754**. Press the gear until it bottoms against the shim.

⚠ IMPORTANT! Check that the bearings do not lock against each other, by turning the gear housing over during the press operation. Abandon the operation in this case, press the output shaft out and increase the shim thickness slightly.



5

Check the turning round torque with torque wrench **999 8081** and splined socket **884 830** (130S) or **885 560** (150S).

Correct value:

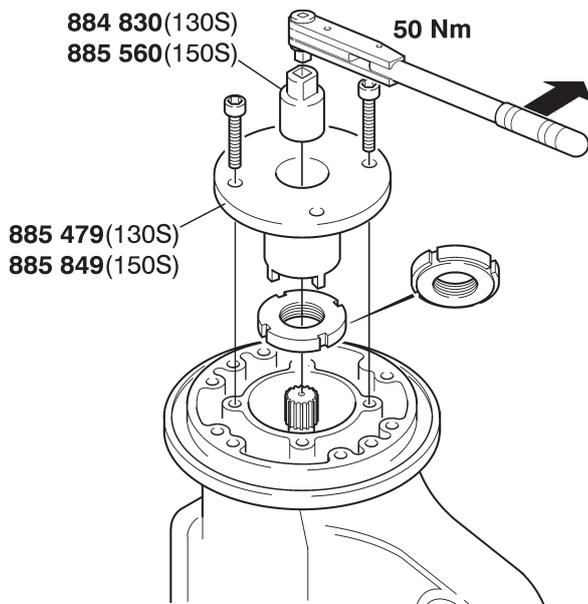
New bearings

Slack free–0.5 Nm

Run-in bearings

Slack free–0.5 Nm

If there is slack, press the output shaft out and reduce the shim thickness. If the turning round torque is too high, the shim thickness should naturally be increased.



6

When the correct value has been obtained, screw the hook nut on.

NOTE! Align the nut as in the illustration.

Fix the nut with counterhold **885 479** (130S-A/B) or **885 849**. Tighten the nut by turning the shaft anti-clockwise with splined socket **884 830** (130S) or **885 560** (150S).

Tightening torque **50 Nm**.

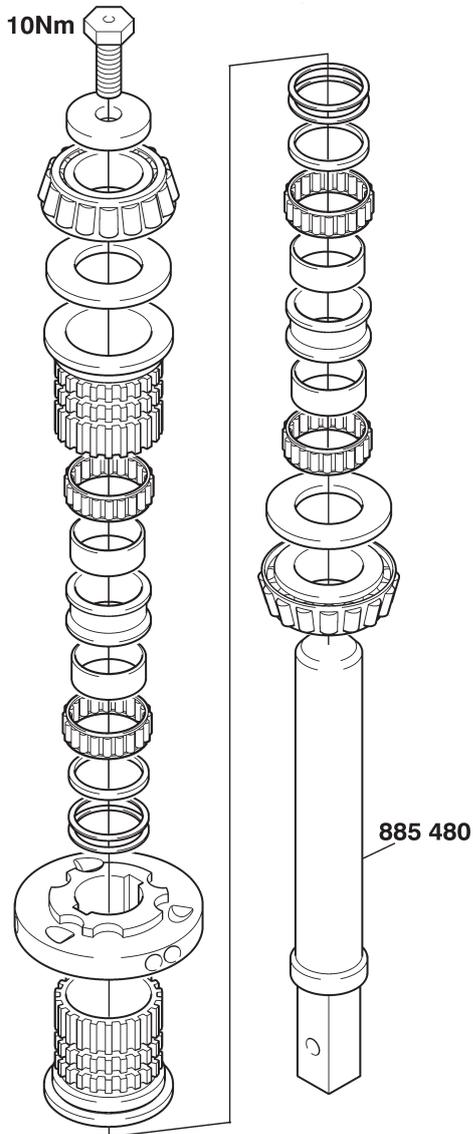
Shim calculation

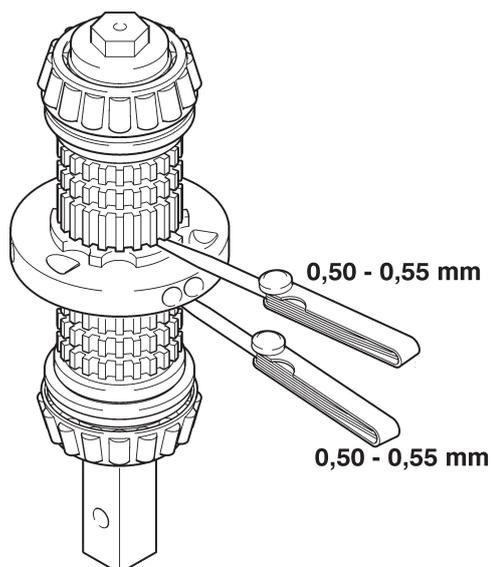
7

Put the following components on measurement fixture **885 480** in this order:

- tapered roller bearing
- sintered washer
- needle roller bearing
- spacer sleeve
- needle roller bearing
- spacer ring
- shims (**the original** thickness, if this is not known, use 0.50 mm as a rough guide)
- front flange
- hub
- shims (**the original** thickness, if this is not known, use 0.50 mm as a rough guide)
- spacer ring
- needle roller bearing
- spacer sleeve
- needle roller bearing
- rear flange
- sintered washer
- tapered roller bearing
- washer
- screw

Tighten the screw lightly, about 10 Nm.



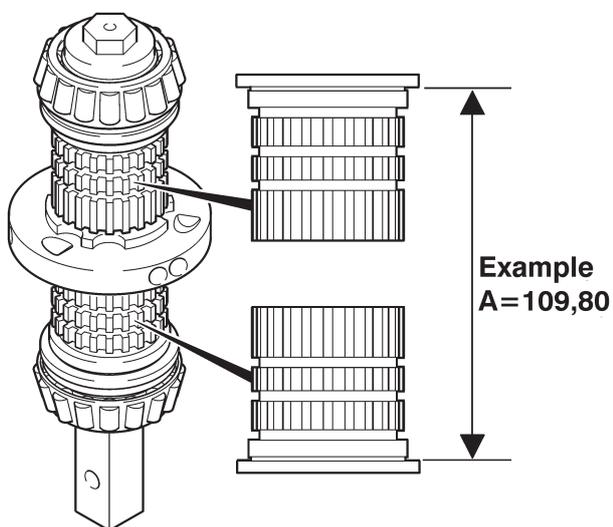


8

Measure the clearance between the hub and both flanges with a feeler gage.

The clearance should be equal on each side and should be **0.50–0.55 mm**.

Correct the shim thickness if necessary, to give the correct clearance.

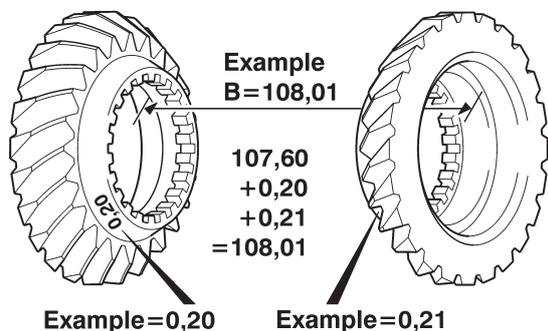


9

Slide the flanges apart and measure distance (A).

This distance indicates the distance that the front and rear gear wheels will be placed from each other.

Example: $A = 109.80 \text{ mm}$



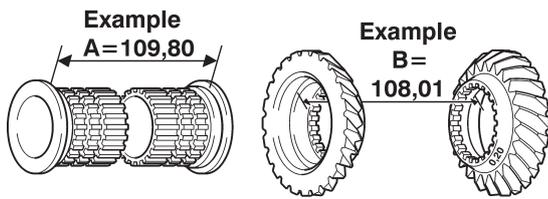
10

The gear wheels are made to be located 107.60 (2x53.8) mm away from each other.

This distance (B) should be corrected by the deviation in the gear wheels. The deviation in mm is engraved on the gear wheel, for example "0,15". The values are always positive.

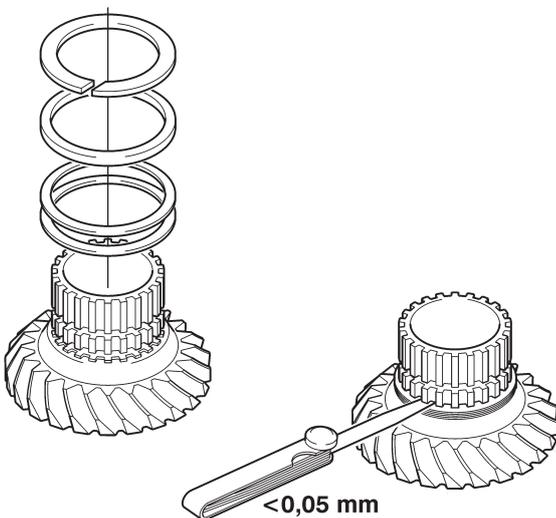
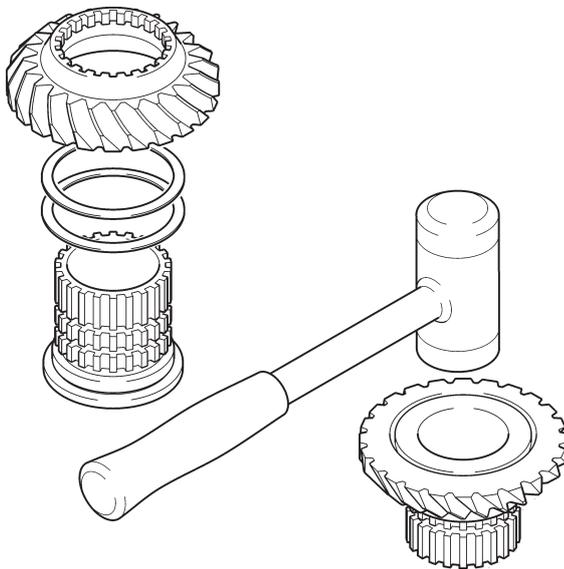
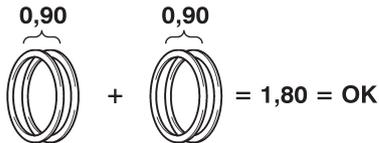
Read the distance on the gear wheel and correct dimension B.

Example: $B = 107.60 + 0.20 + 0.21 = 108.01$



109,80 (A)
-108,01 (B)
=1,79

1,79/2=0,895
0,895⇒0,90



11

If we now delete distance (B) (which we want to have between the gear wheels) from distance (A) (which is the actual distance between the flanges) and halve this amount, we get the shim thickness that needs to be put between each flange and gear wheel.

Example: Shim thickness = (A - B) x 0.5 = (109.80 - 108.01) x 0.5 = 0.895

Round the value off to 10/100 mm, which in this example gives us a shim thickness of 0.90 mm.

When shim calculation is completed, remove all components from the measurement fixture.

Input shaft, assembly

12

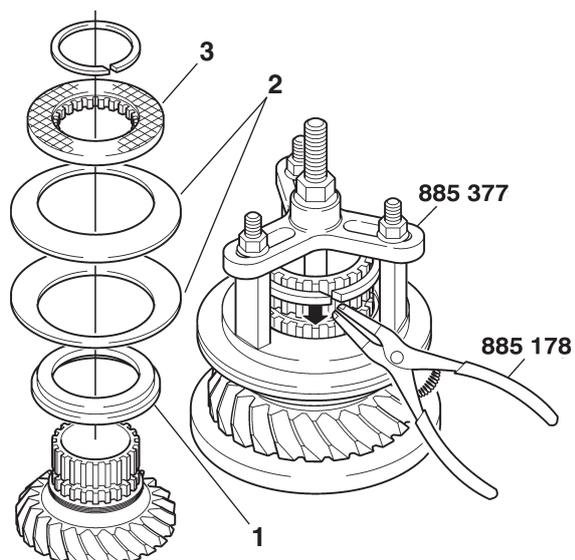
Put the calculated thickness of shims on each flange.

Install each gear wheel on its flange. Tap them together with a plastic faced mallet. Be careful to ensure that the flanges bottom properly.

13

Put the original shim thickness and spacer ring on the flange. Install the new circlip. Make sure that the circlip seat securely.

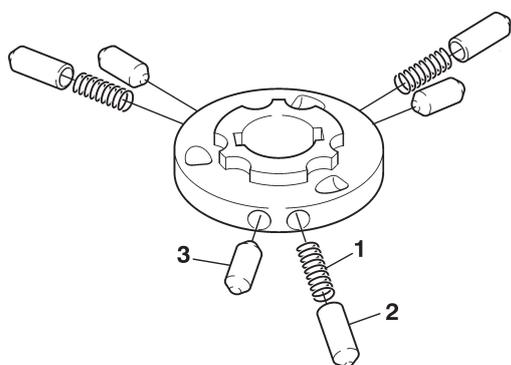
Check that there is no slack between the circlip and the spacer ring. Increase the shim thickness in this case.



14

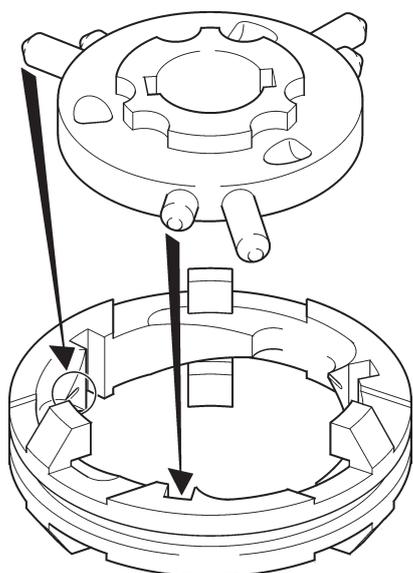
Put the washer (1), the two cup springs (2) and the sintered washer (3) on the appropriate flange. Align the components as in the illustration.

Compress the disc springs using press tool 885 377 and install the new circlip. Make sure that the circlip seats properly in its groove before the cup springs are unloaded.



15

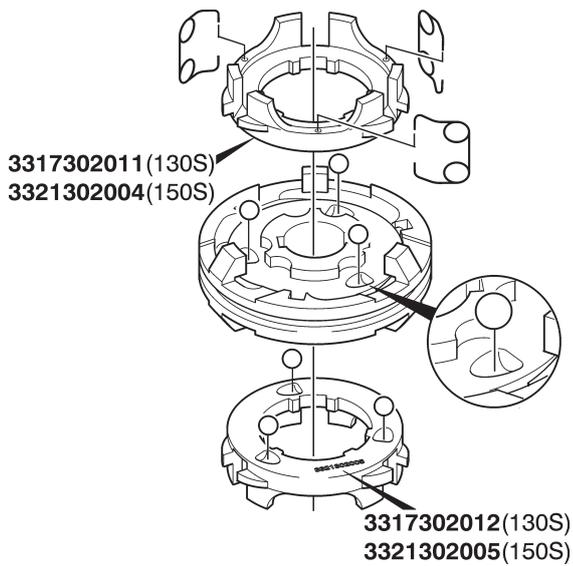
Install the springs (1), pin (2) and (3) in the hub as in the illustration.



16

Put the hub in the clutch plate. Align the components as in the illustration.

Press the pin in at the same time as the hub is pressed down into the clutch plate. Make sure that the pin engages in the groove for neutral gear.



17

IMPORTANT! Note the appearance of holder (A) as shown in fig (A). Place holder (A) on the workbench. Install:

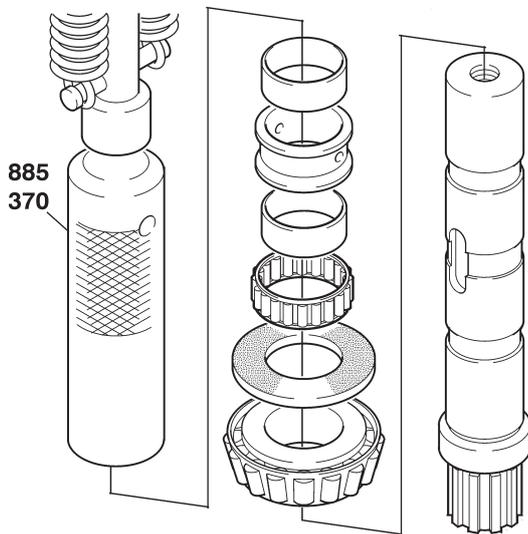
- the balls
- the assembled hub

IMPORTANT! Make sure that the inner part of the hub is aligned so that the ball seats face as shown in figure (B).

- the balls
- holder (C)

IMPORTANT! Note the appearance of holder (C) as shown in fig (C).

Install the springs, facing as in the illustration.

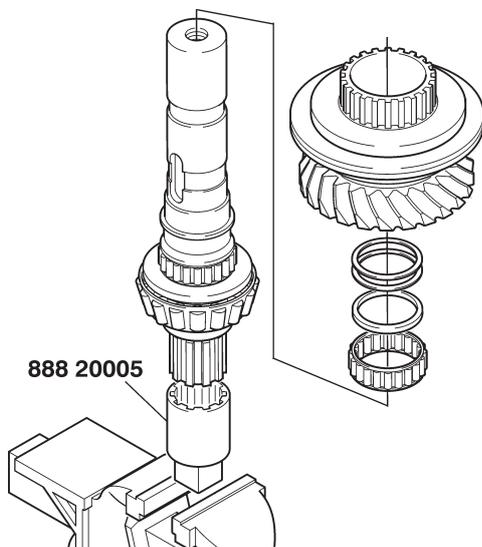


18

Press:

- bearing
- sintered washer (aligned as in the illustration)
- needle roller bearing
- spacer
- needle roller race

on the input shaft. Use mandrel **885 370**. Make sure that the components seat securely.



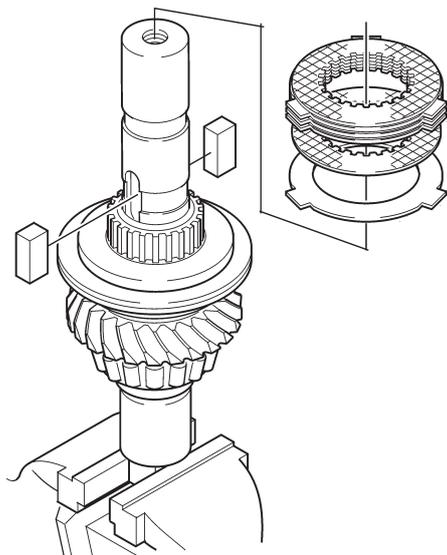
19

Put the input shaft in splined socket

888 20005. Thread on:

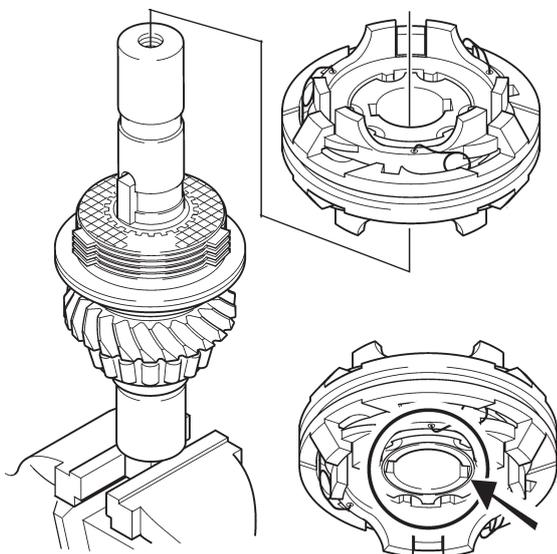
- needle roller bearing
- spacer ring
- shim (thickness as item 8)
- front gear wheel unit

on the input shaft.

**20**

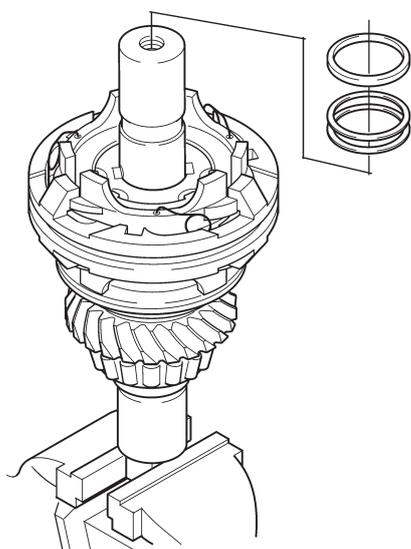
Install the two keys.

Install the front friction plate package. Put the steel plate at the bottom, and then alternate with coated friction plates. There is a total of three of each for the 130S, or four of each for the 150S.

**21**

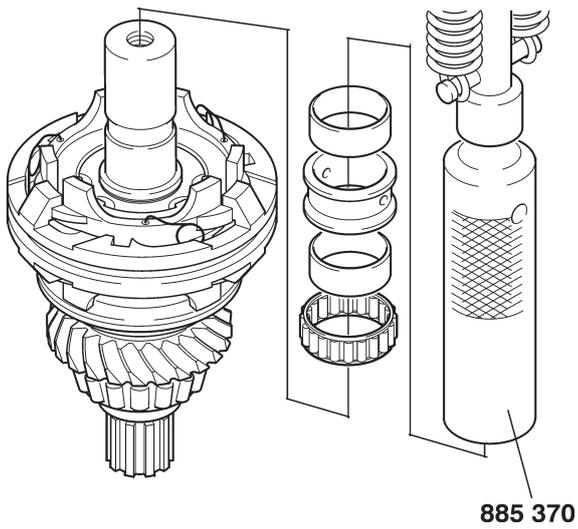
Thread the clutch hub onto the shaft. Align the steel clutch plate tags so that they enter the cutouts in the hub.

⚠ IMPORTANT! Make sure that the groove in the inner part of the hub is aligned as in the illustration.

**22**

Thread on:

- shim (thickness as item 8)
 - spacer ring
- on the input shaft.

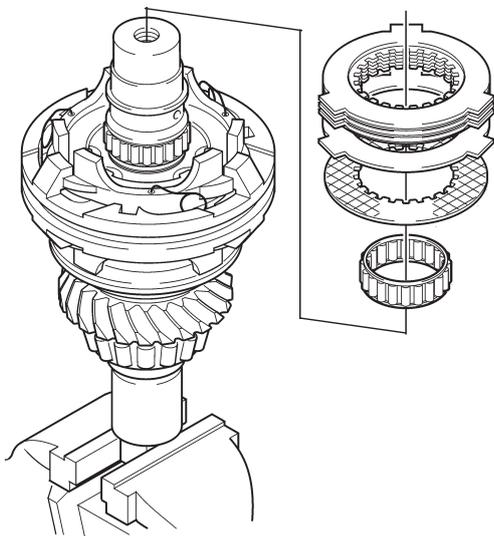


23

Press on:

- needle roller bearing
- spacer
- needle roller race

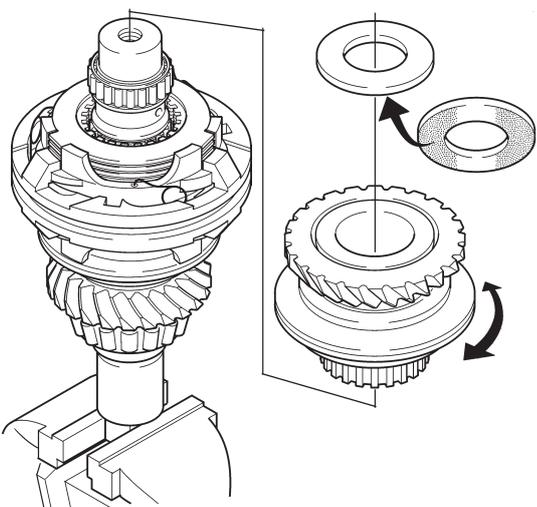
on the input shaft. Use mandrel **885 370**.



24

Thread the needle roller bearing on.

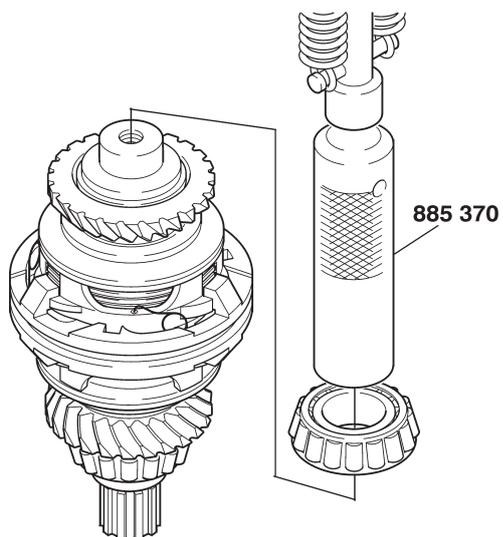
Install the rear friction plate package. Put a coated friction plate at the bottom, and alternate with steel discs. There is a total of three of each for the 130S, or four of each for the 150S.



25

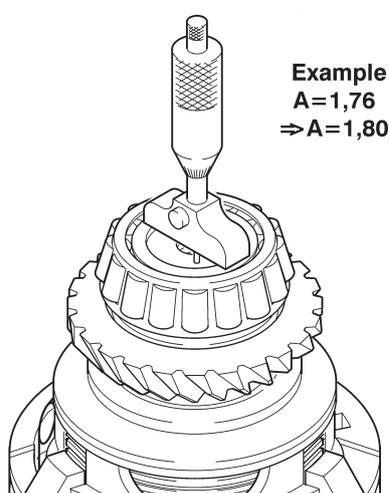
Install the rear gear wheel unit. Rock the gear wheel to centre the coated friction plates.

Thread the coated washer on, facing as in the illustration.



26

Press the bearing on. Use mandrel **885 370**.



27

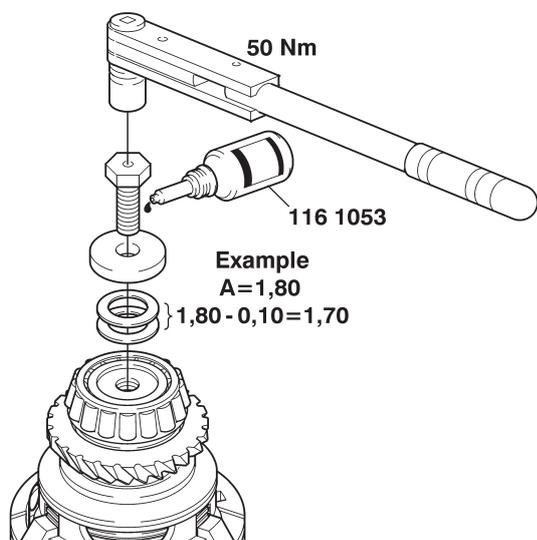
Measure distance (A) between the bearing race and the shaft with a depth micrometer.

Fill the distance up with shims as follows:

Round off to the nearest 10/100 mm. Then deduct 0.10 mm.

Example: $A = 1.76$ (rounded off to 1.80)

Shim thickness = $1.80 - 0.10 = 1.70$

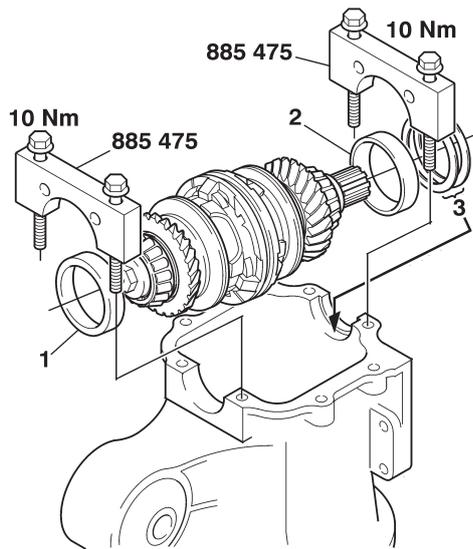


28

Put in the calculated thickness of shims.

Apply thread locking fluid, VP part number 114 1053 to the screw.

Install the washer and screw. Torque **50 Nm**.



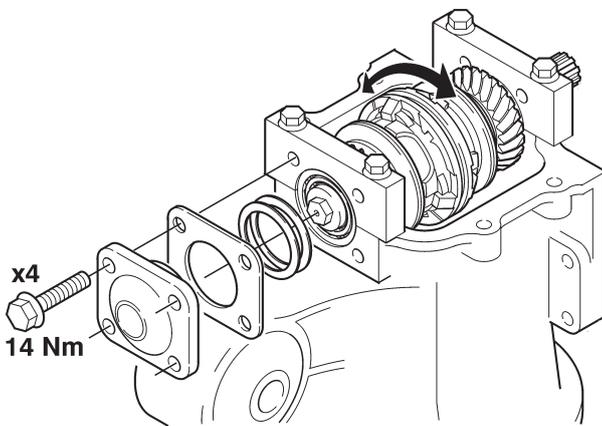
Input shaft, turning torque

29

Put the input shaft together with the rear bearing race (1), the front bearing race (2) and the original shim thickness (3) in the gear housing.

If the original shim thickness is not available, use 0.50 mm as a rule of thumb.

Fix the shaft with clamps **885 475**. Align the rear clamp flush with the gasket plane and tighten the screws lightly, app. 10 Nm.

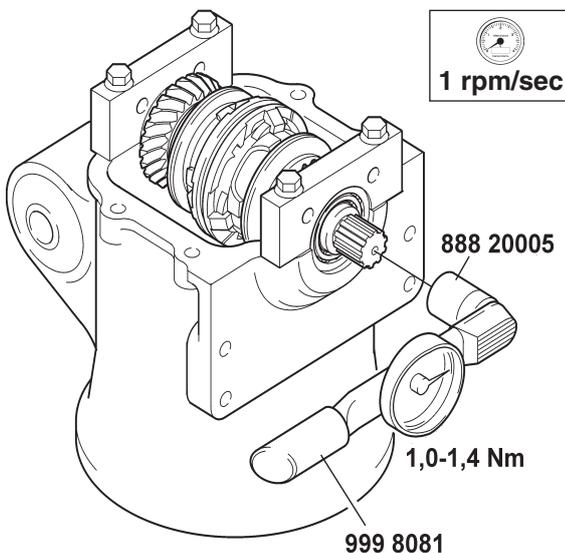


30

Install the rear cover together with the gasket and the original shim thickness.

If the original shim thickness is not available, use 0.50 mm as a rule of thumb.

Tighten the screw, about 14 Nm **at the same time** as the shaft is turned. This is to check that the turning torque is not so high that it "locks" the shaft.



31

Measure the turning torque with splined socket **888 20005** and torque wrench **999 8081**.

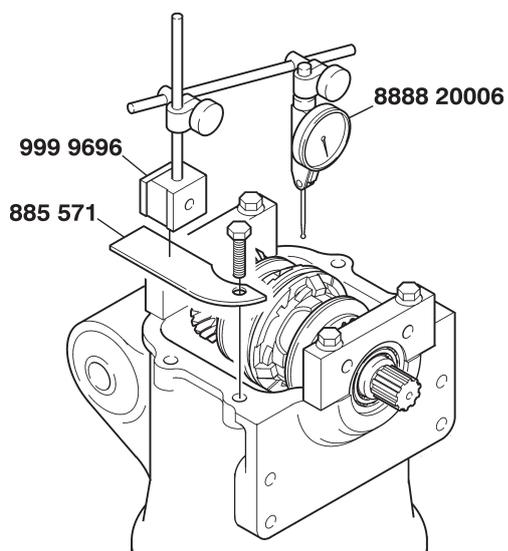
The correct turning torque should be:

1.0-1.4 Nm (new bearings)

1.0-1.4 Nm (run-in bearings)

If the turning torque is too low, increase the shim thickness inside the rear cover.

If, on the other hand, the value is too high, reduce the shim thickness.

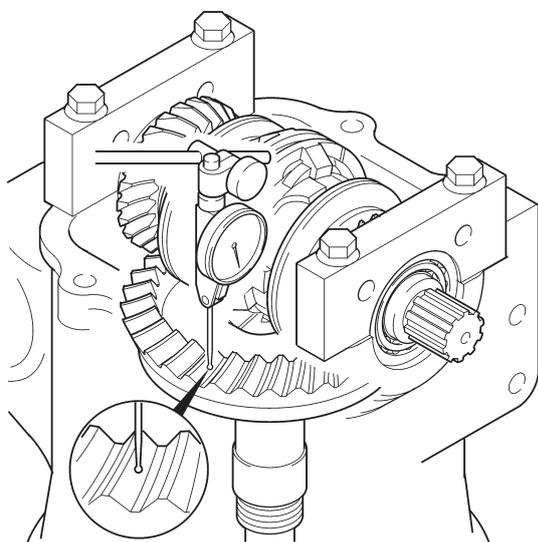


Flank clearance

32

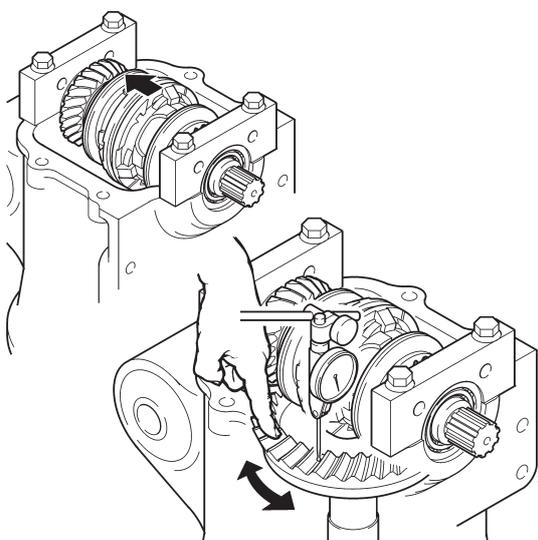
When the correct turning torque has been obtained, check the gear flank clearance.

Install fixture **885 571** on the gear housing. Put magnetic stand **999 9696** and dial gage **8888 20006** on the fixture.



33

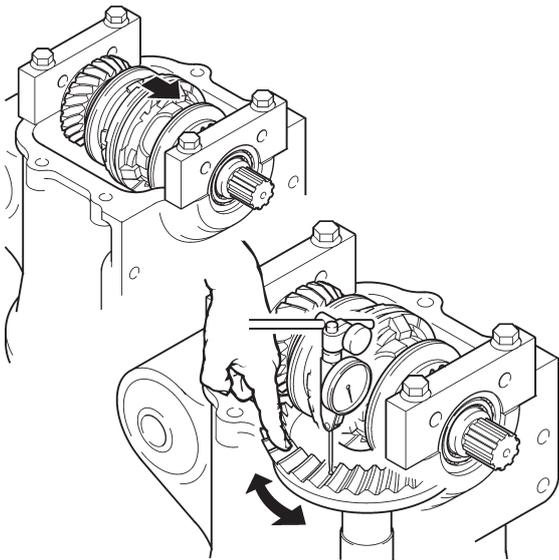
Put the dial gage measurement tip on the output gear wheel as in the illustration.



34

Slide the clutch plate backwards and read off the gear lash on the rear gear wheel by carefully rocking the **input gear wheel**.

Note the value.

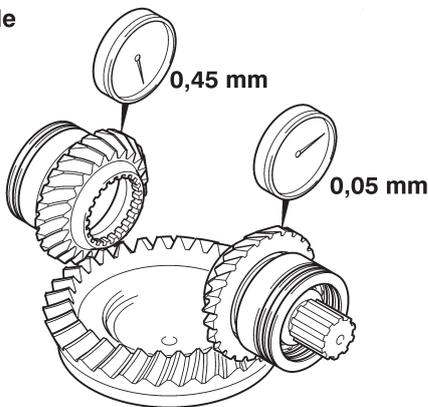


35

Slide the clutch plate forwards and read off the gear lash on the front gear wheel by carefully rocking the **input gear wheel**.

Note the value.

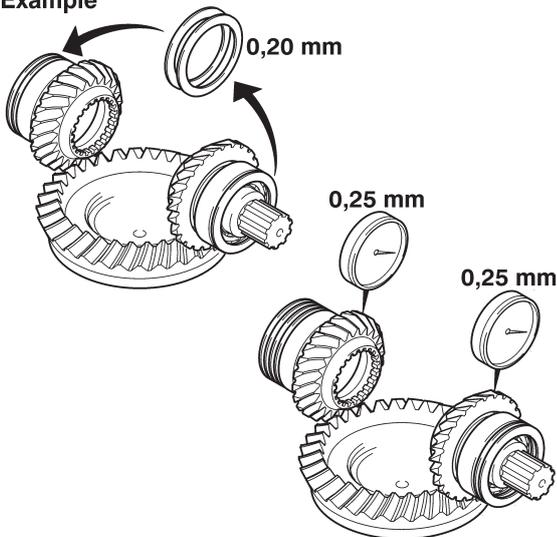
Example



36

Compare the two values. The flank clearance should be as equal as possible on each gear wheel.

Example

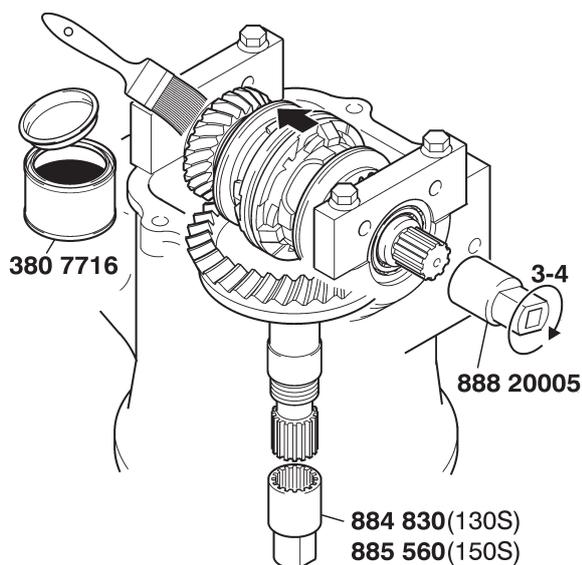


Adjust (center) the input shaft if necessary, by changing the shim thickness on the outer bearing races.

NOTE! Remember to remove the same amount on one side as you add on the other side, to avoid changing the turning torque.

Correct clearance after centering should be **0.12–0.27 mm** on each gear wheel.

Always check the gear engagement pattern before doing any adjustment to the clearance.



Marking pattern

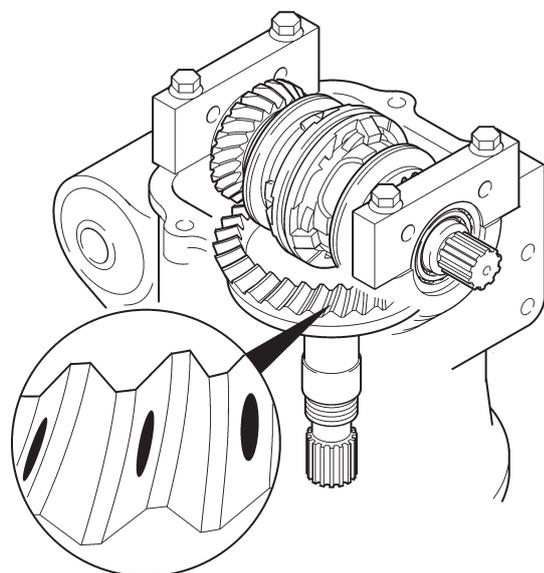
37

When the input shaft has been centered (equal clearance on each gear wheel) across the output gear wheel, check the gear engagement pattern.

Brush a **thin** layer of marker dye **380 7716** to 5-6 teeth on the rear gear wheel.

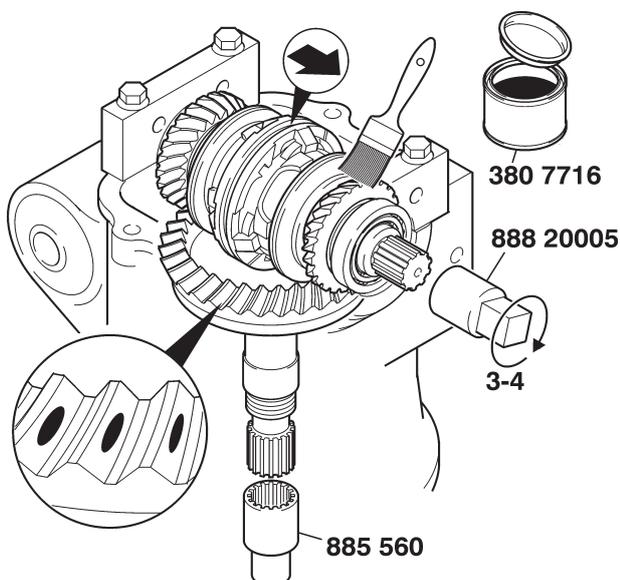
Slide the clutch plate backwards.

Put splined socket **888 20005** on the input shaft and turn it clockwise 3-4 turns at the same time as the output shaft is braked with splined socket **884 830** (130S) or **885 560** (150S).



It is easiest to check the gear engagement pattern on the concave outer side of the gear wheel.

The marking pattern on the lower gear wheel should be located centrally on the lower gear, in both the lengthways direction and in height.



38

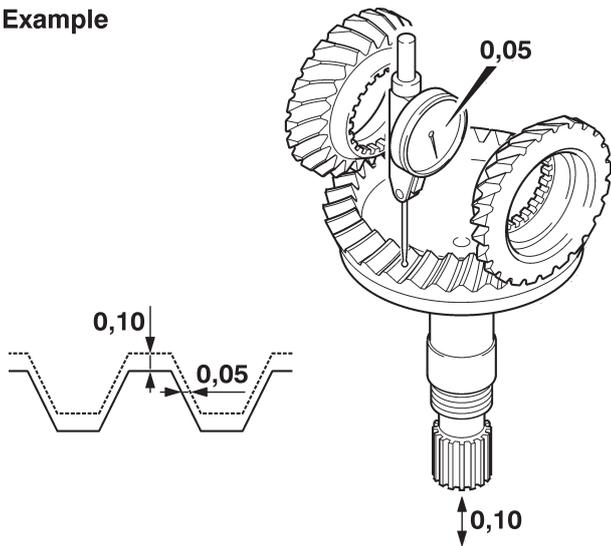
Brush a **thin** layer of marker dye **380 7716** to 5-6 teeth on the front gear wheel.

Slide the clutch plate forwards.

Repeat the procedure and check the location of the gear engagement pattern on the convex side of the output gear.

The marking pattern on the lower gear wheel should be located centrally on the lower gear, in both the lengthways direction and in height.

Example



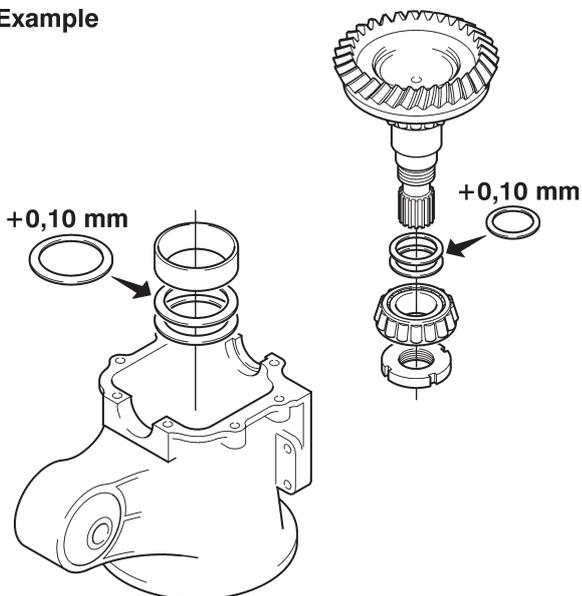
39

If you need to adjust the gear flank clearance in cases where the marking pattern is correct:

In most cases, the location of the front and rear gears is retained and the output gear is moved up or down.

If the output gear wheel is moved 0.10 mm, the gear flank clearance is changed about 0.05 mm.

Example



NOTE! Remember to compensate the shim thickness between bearings so as to retain the turning torque.

Put the current shim thickness, gear flank clearance and marking pattern locations in a copy of the “Shim table, upper gear housing” at the end of the book.

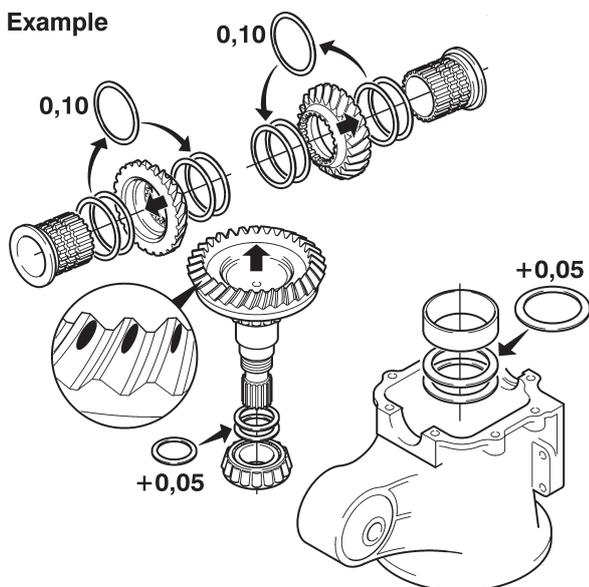
This considerably facilitates work if you should need to fine adjust the shim thicknesses.

If you need to adjust the marking pattern without changing the gear flank clearance:

The outgoing gear wheel, rear and front gear wheel are all moved.

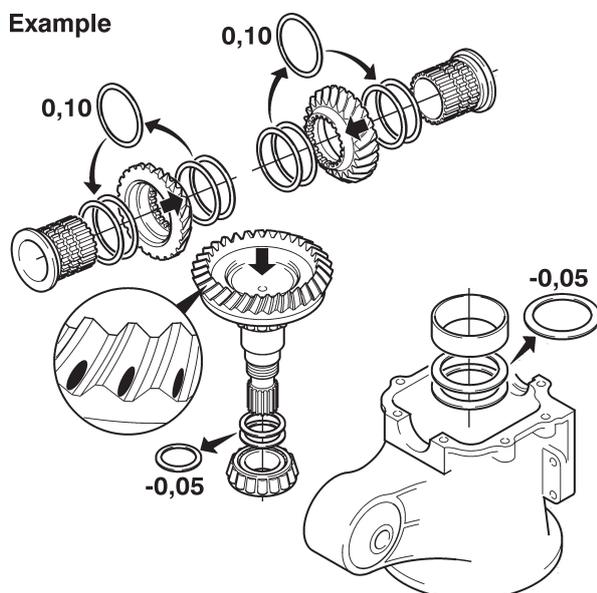
For example, if the output gear wheel is moved 0.05 mm, the front and rear gear wheels should be moved twice the distance, i.e. 0.10 mm to retain the gear flank clearance.

Example



If the marking pattern is as shown here, move the output gear wheel up, and the rear and front gear wheels outwards.

Example



If the marking pattern is as shown here, move the output gear wheel down, and the rear and front gear wheels inwards.

NOTE! Remember to compensate the shim thickness between the output shaft bearings so as to retain the turning torque.

NOTE! Remember to compensate the shim thickness between the flange and lock rings.

Put the current shim thickness, gear flank clearance and marking pattern locations in a copy of the "Shim table, upper gear housing" at the end of the book. This considerably facilitates work if you should need to fine adjust the shim thicknesses.

Upper gear housing, final assembly

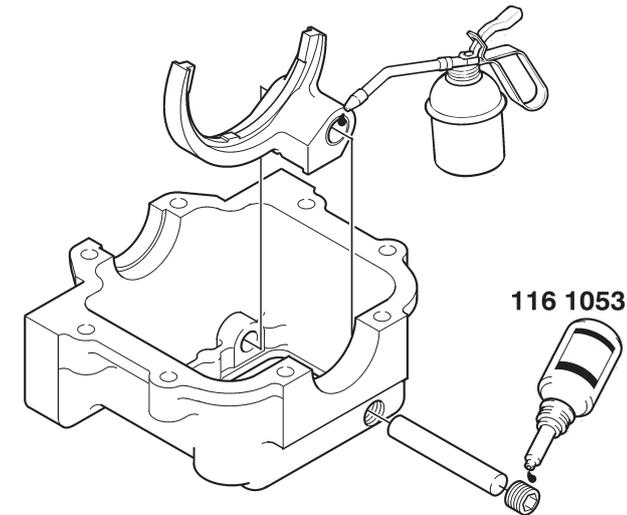
1

Oil the selector fork bearing bush. Put the gear in place and slide the shaft in.

Apply thread locking fluid, VP part number **116 1053** to the plug.

If the shaft design is as shown in (A), tighten the plug to 5 Nm.

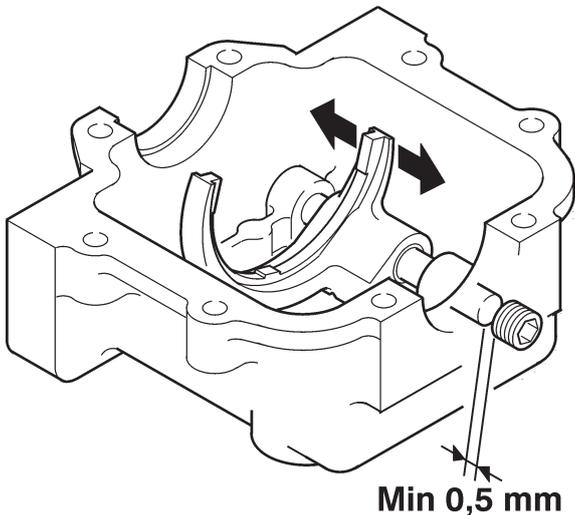
If the shaft design is as shown in (B), tighten the plug to 35 Nm.



2

Check that the clearance between the plug and the shaft is **min. 0,5 mm** and the selector fork can move easily.

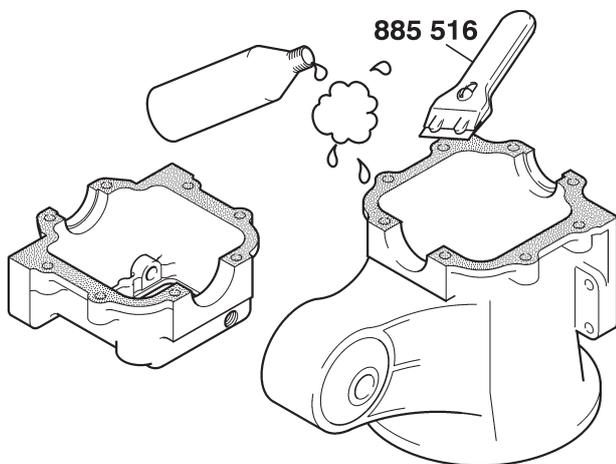
If the shaft design is as shown in (A) above, check that the clearance between the plug and the shaft is at least **0.5 mm** and that the selector fork moves freely.

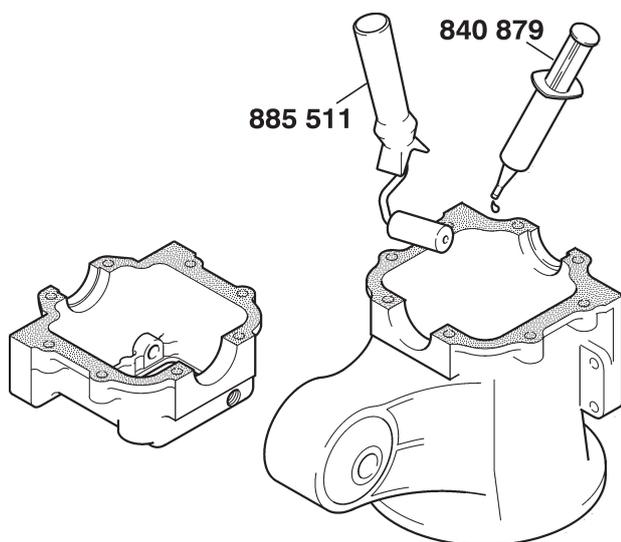


3

⚠ IMPORTANT! Clean all contact surfaces on both gear housing halves with denatured alcohol and a gasket scraper **885 516**.

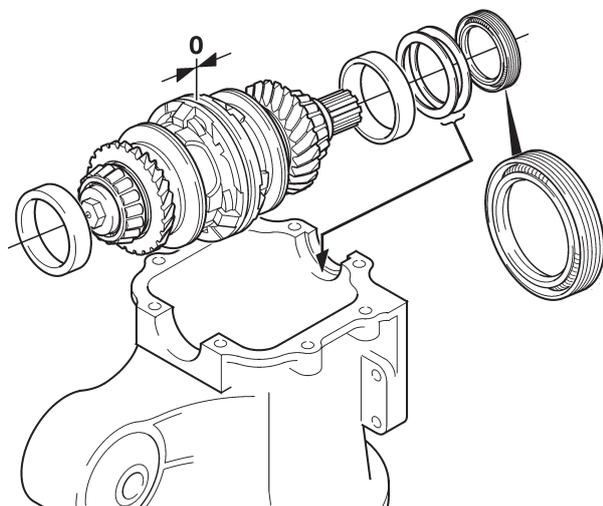
Old sealant residue must be completely removed, to promote successful re-sealing.





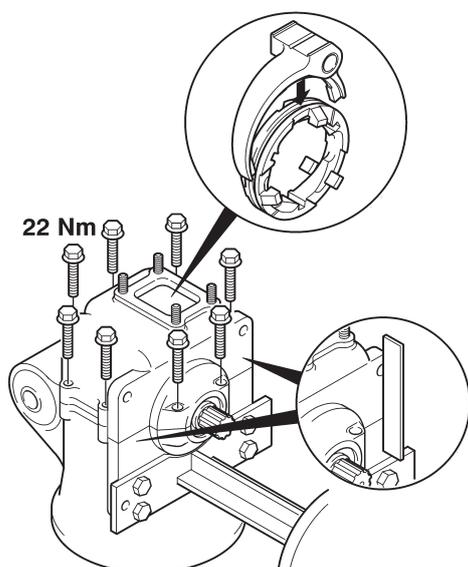
4

Apply a thin layer of sealant (red), part number **840 879**, to the top gear housing half as in the illustration. Use roller **885 511**.



5

Place the input shaft together with the bearing races, calculated shim thickness on the input side and the seal ring in the gear housing. Align the seal as in the illustration.



6

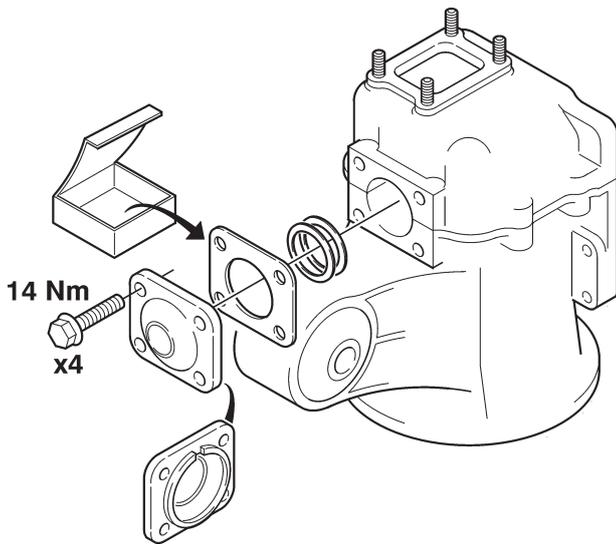
Install the upper gear housing half.

NOTE! Make sure that the clutch plate is in neutral.

NOTE! Make sure that the selector fork engages on the clutch plate.

NOTE! Align the front of the housing.

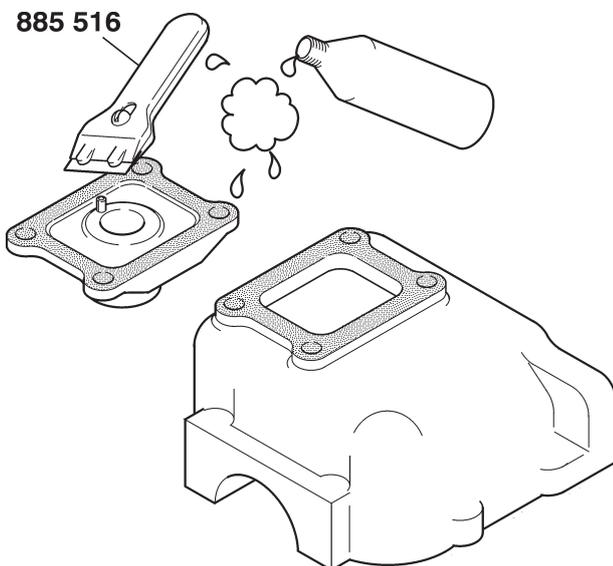
Tighten the bolts **diagonally** to 22 Nm.



7

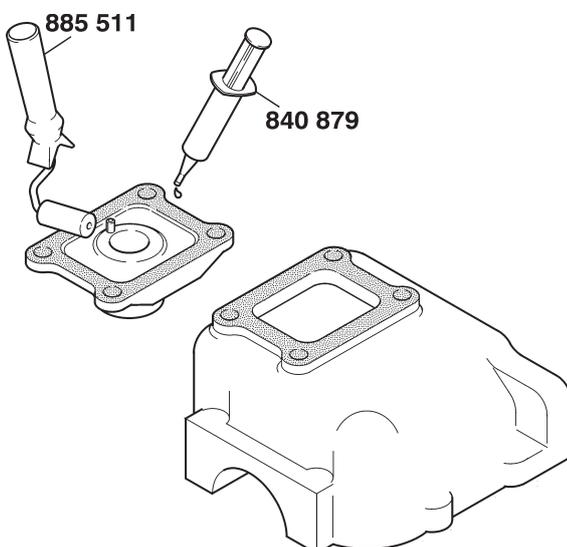
Install the rear cover together with the tested shim thickness and a new gasket.

Torque the screws to **14 Nm**.



8

⚠ IMPORTANT! Clean all contact surfaces on the gear housing and gear mechanism with denatured alcohol and a gasket scraper **885 516**. Old sealant residue must be completely removed, to promote successful re-sealing.

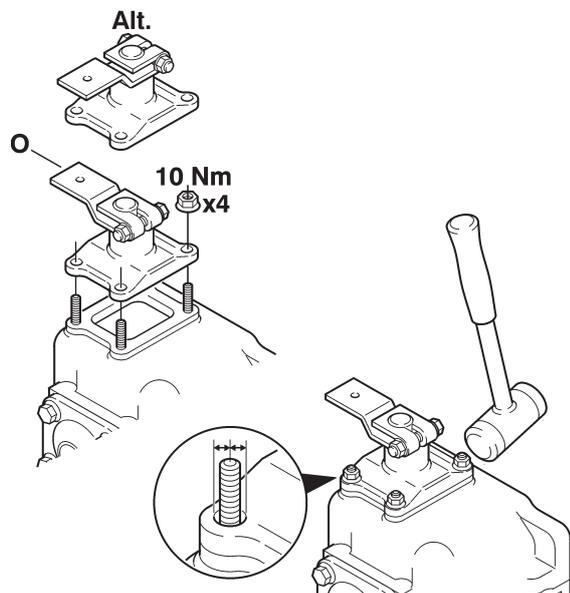


9

Apply a thin layer of sealant (red), part number **840 879** on the gear shift mechanism as in the illustration. Use roller **885 511**.

Shift mechanism, adjustment

Special tool: 885 870

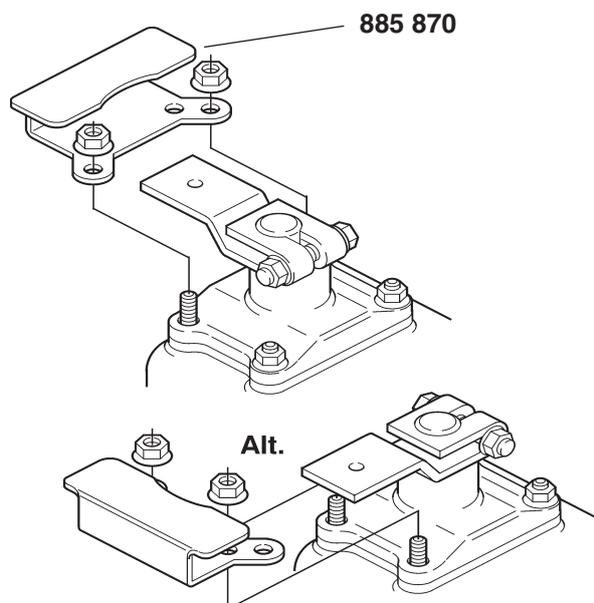


1

Check that the clutch plate is in neutral.

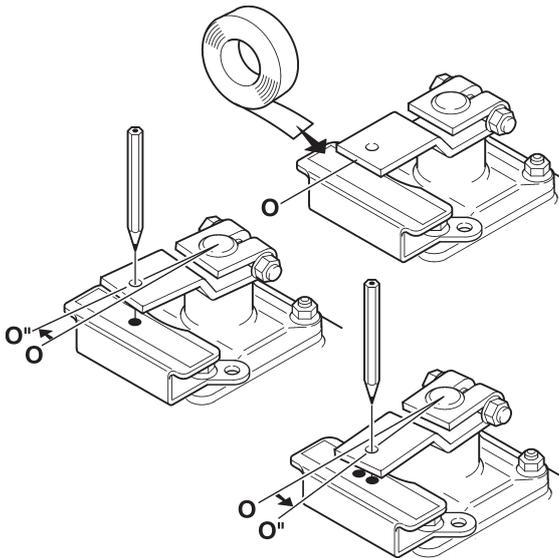
Install the shift mechanism as in the illustration. Roughly adjust the position by centering in the screw holes. Tighten the nuts to about 10 Nm (it should be possible to fine adjust the position of the gear mechanism by lightly tapping it with a plastic-faced mallet).

⚠ IMPORTANT! The position of the shift mechanism must be fine adjusted as in the points below, to reduce wear on the selector fork and clutch plate!



2

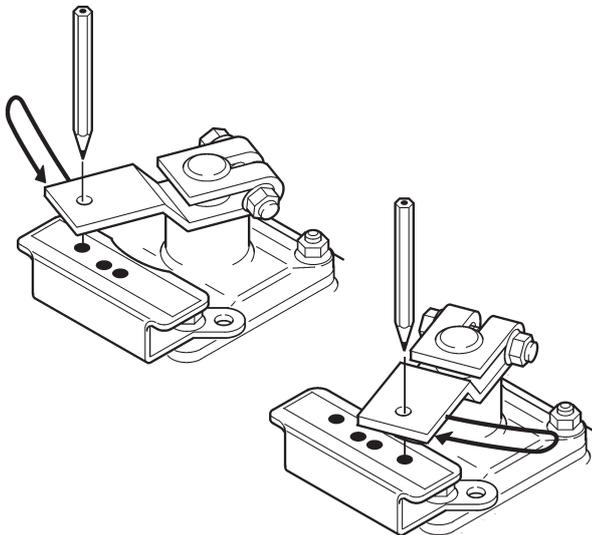
Install measurement fixture **885 870**. The fixture can be installed along or across the reversing gear, depending on how the gear shift arm is installed.



3

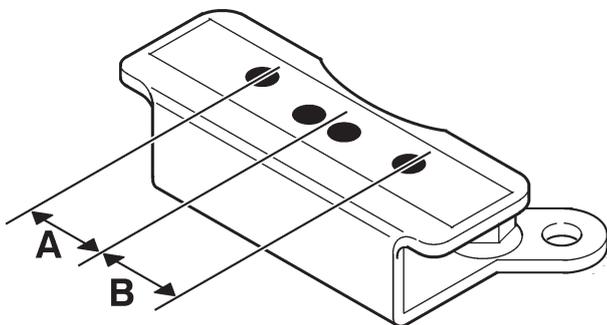
Put the shift mechanism in the neutral position. Find the shift arm “neutral position” by turning the mechanism carefully in each direction (without engaging a gear). Mark up the end positions as in the illustration.

NOTE! If you put masking tape on the measurement fixture, the markings are easier to see.



4

Find the end positions of the shift arm **with** the gear engaged by engaging a gear and by carefully turning the mechanism in each direction, until contact is made with the clutch plate. Mark up this position and repeat the procedure with the opposite gear position.



5

Measure the distances between A and B as in the illustration.

The permissible values of the A and B dimensions are not more than 24 mm. In addition, the difference between the two dimension must not exceed 3 mm.

Example:

$$A = 23.1 \text{ mm}$$

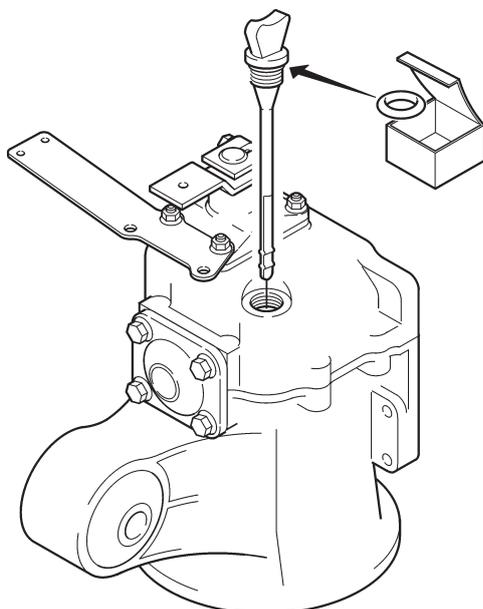
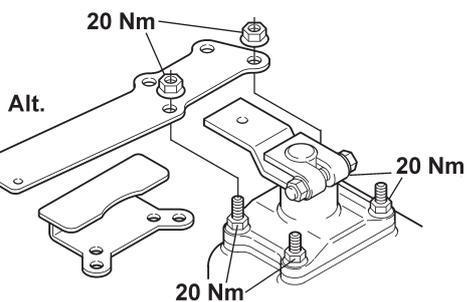
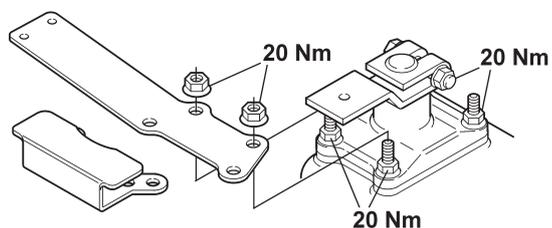
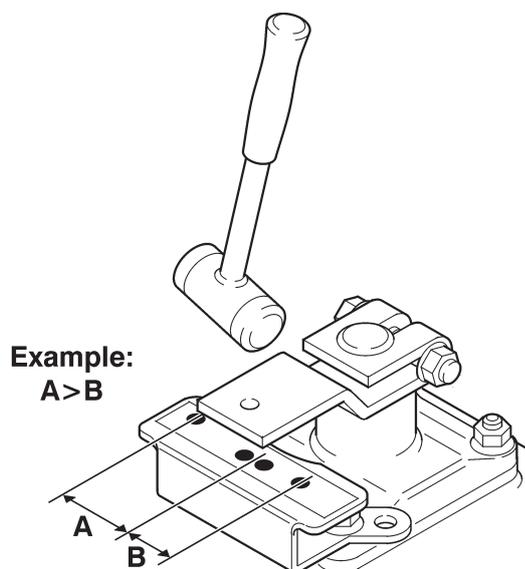
$$B = 22.3 \text{ mm}$$

$$A - B = 23.1 - 22.3 = 0.8 \text{ mm}$$

$$A = \text{max } 24 \text{ mm}$$

$$B = \text{max } 24 \text{ mm}$$

$$A = B \pm 3 \text{ mm}$$



6

If the values are outside the specified maximum dimensions, adjust the shift mechanism by carefully tapping it in the direction where the smallest value was measured.

Repeat the measurements and adjustments until you end up between the specified dimensions. If the specified dimensions are not achieved, the reversing gear must be changed.

7

When the correct dimension has been found, remove the fixture and install the bracket for the control cable. Torque all nuts to **20 Nm**.

8

Install the dipstick with a new O-ring.

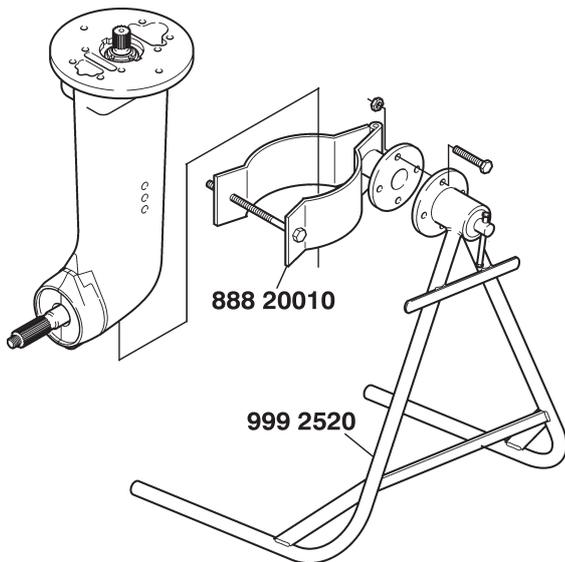
Lower gear, renovation

Disassembly

1

Install fixture **888 20010** on the gear housing, if this has not been done previously.

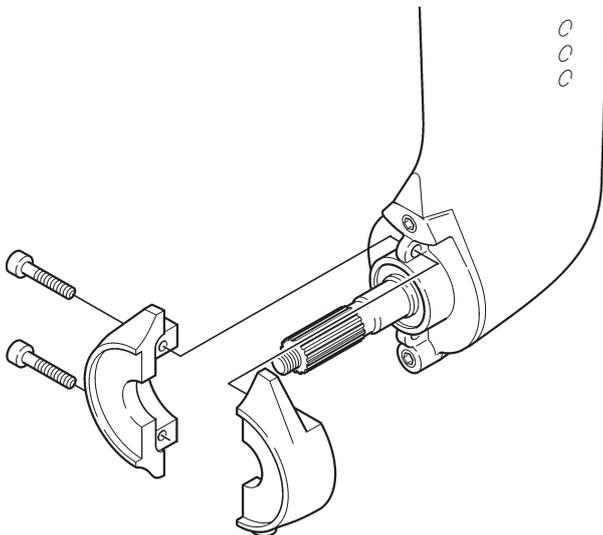
Install fixture in stand **999 2520**.



2

NOTE! Remove the oil drain plug.

Remove the zinc anode.

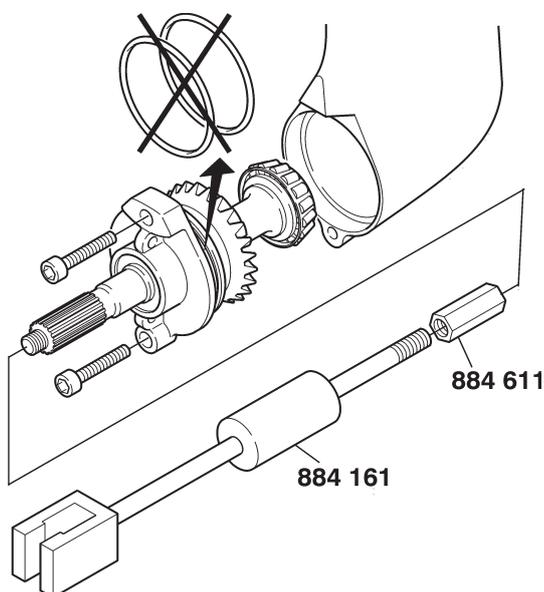


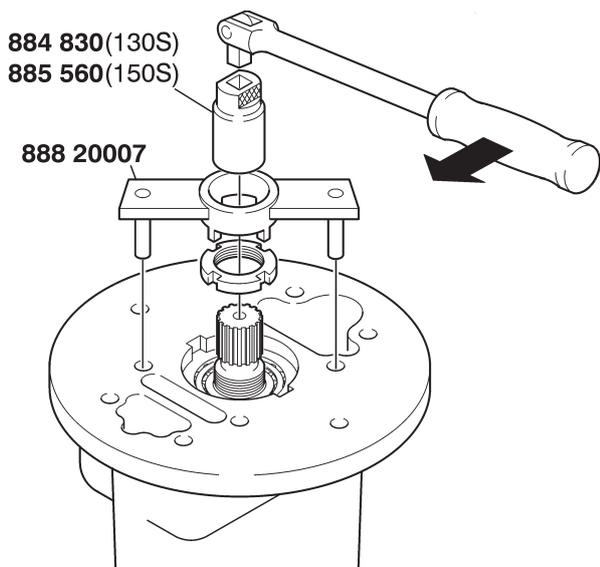
3

Remove the screws for the propeller seal housing.

Remove the propeller shaft and gear housing with a slide hammer **884 161** and adapter **884 611**.

Scrap the O-rings.

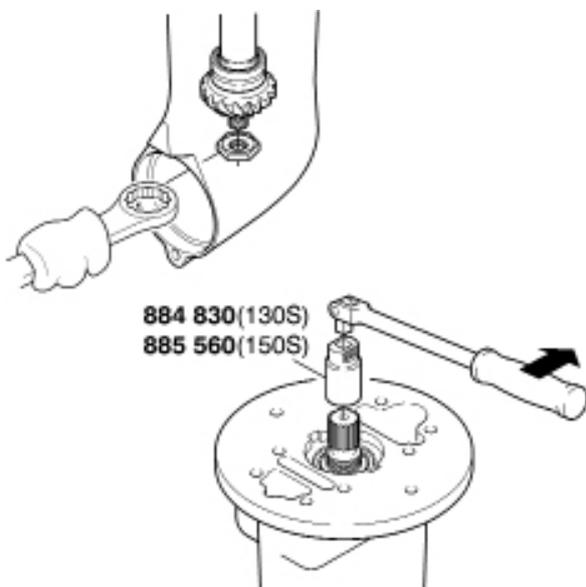




4

Fix the upper nut for the vertical shaft with fixture **888 20007**.

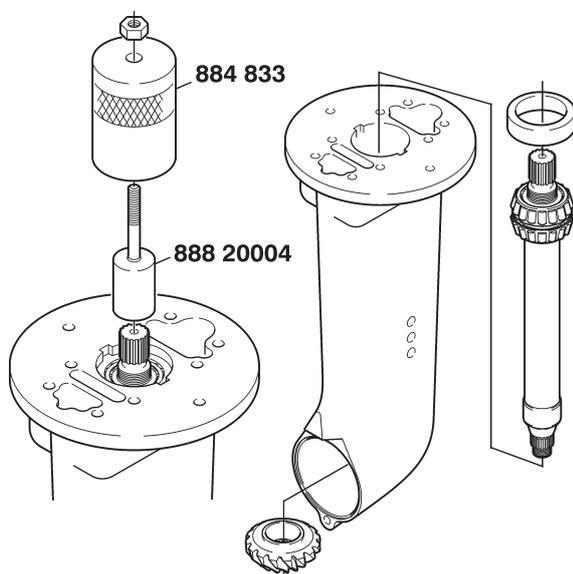
Undo the nut by turning the vertical shaft clockwise, with splined socket. **884 830** (130S) or **885 560** (150S).



5

Fix the pinion nut. Use a clean rag to protect the gear case.

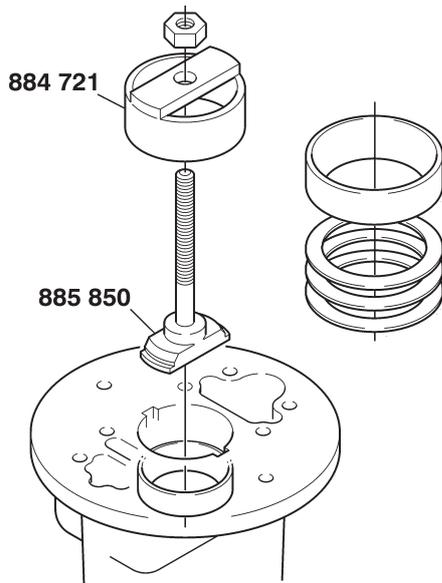
Undo the nut by turning the vertical shaft anti-clockwise with the splined socket. **884 830** (130S) or **885 560** (150S).



6

Pull up the vertical shaft puller **888 20004** and mandrel **884 833** as in the illustration.

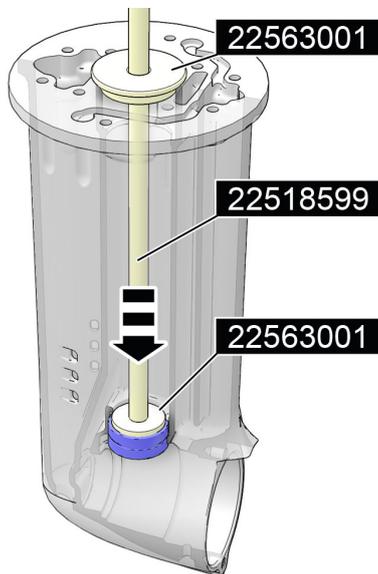
Catch the pinion gear.



7

Pull the bearing race up with puller **885 850** and **884 721**.

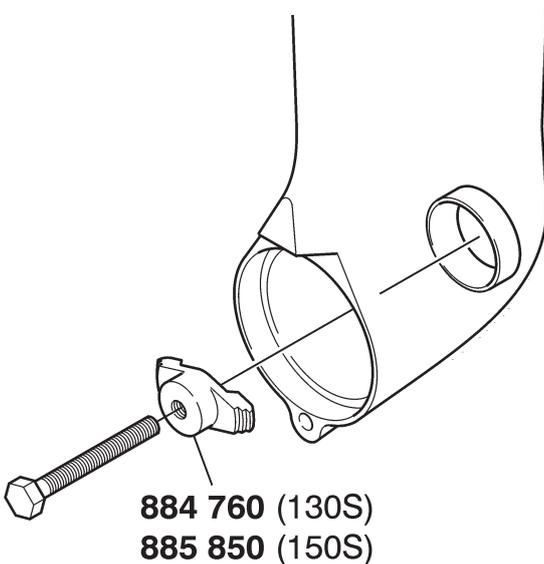
Save the shims and note the thickness of the shims.



8

Remove the needle roller bearing.

Use **22563001** and **22518599**.



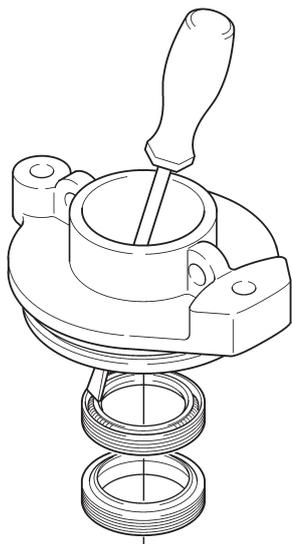
9

Pull out the bearing race for the front propeller shaft bearing with puller **884 760** (130S) or **885 850** (150S).

Save the shims and note the thickness of the shims.

10

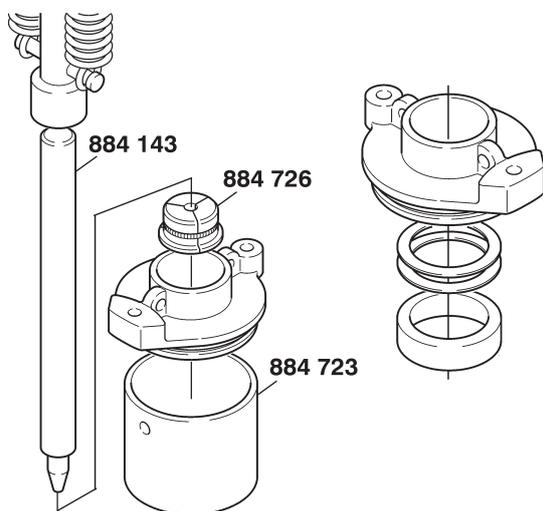
Tap the seal rings out of the propeller bearing housing, using a screwdriver.



11

Press the bearing race out with expander **884 726** and standard shaft **884 143**. Use ring **884 723** as a counterhold.

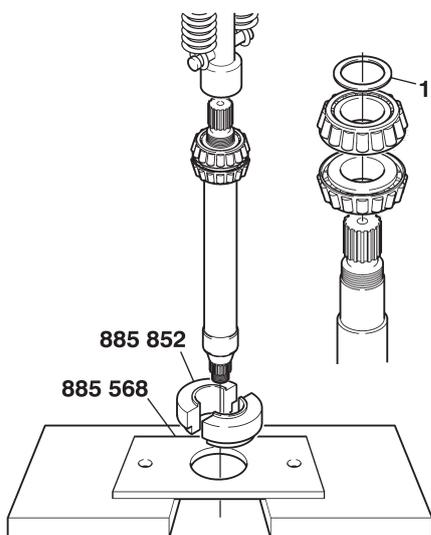
Save the shims and note the thickness of the shims.



12

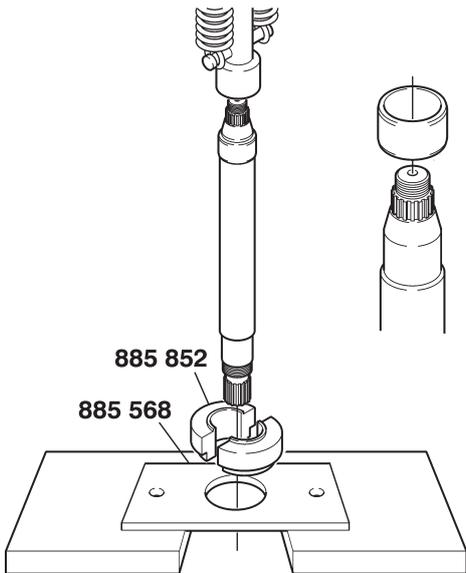
Press the bearings off with puller halves **885 852** and plate **885 568**.

Save the washer (1).



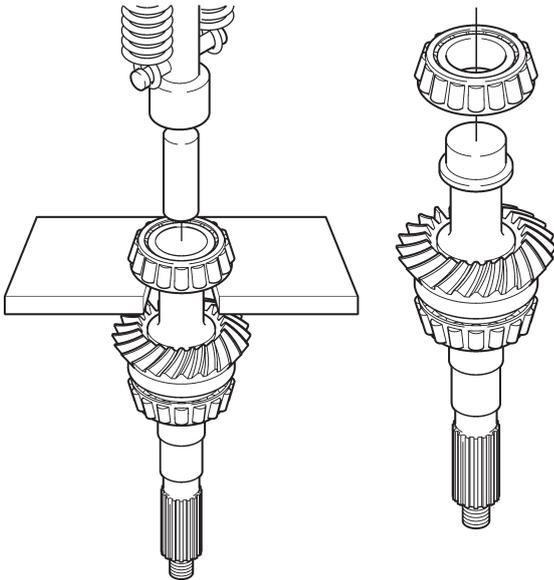
13

Press the needle roller bearings off with puller halves **885 852** and plate **885 568**.



14

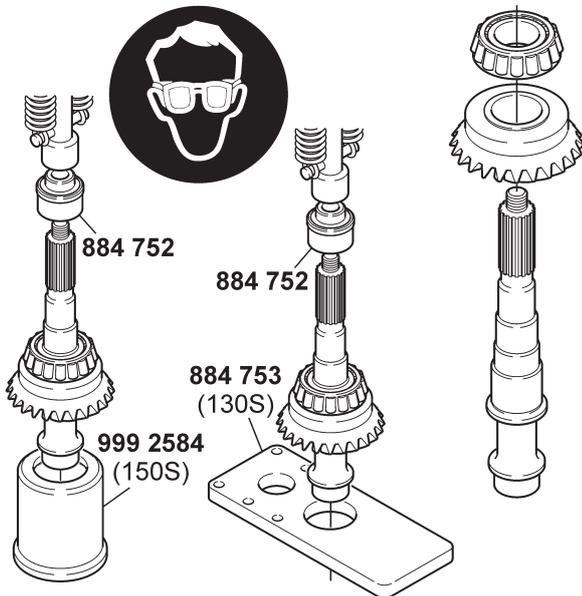
Press the inner bearing off the propeller shaft.



15

Press the gear wheel and outer bearing off. Use **884 753** (130S) or **999 2584** (150S) as a counterhold. Use something like mandrel **884 752** as a spacer to avoid damaging the threads on the shaft.

⚠ WARNING! Great pressure required (tapered joint). Wear goggles.



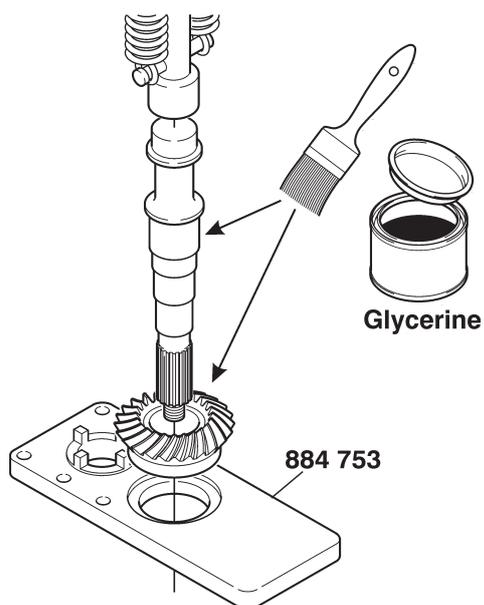
Assembly

1

NOTE! Brush a thin layer of glycerin on the tapered surface of the gear wheel and the propeller shaft (only 150S).

Press the propeller shaft down onto the gear wheel. Use plate **884 753** as a counterhold.

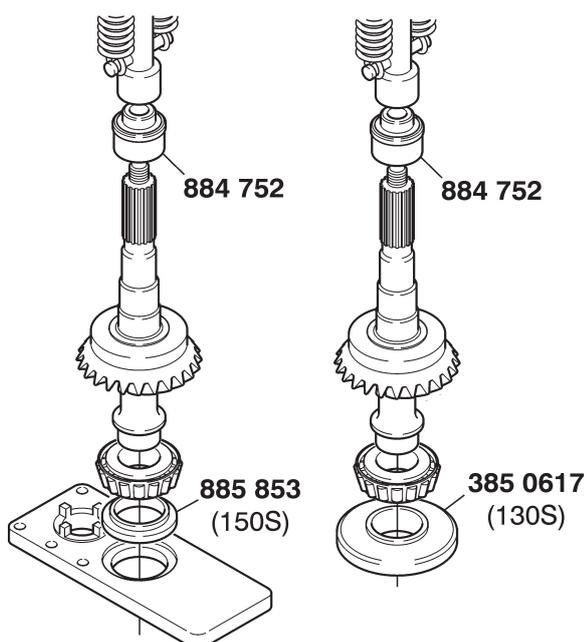
Press until the step bottoms solidly against the gear wheel.



2

Press the front bearing on. Use ring **385 0617** (130S) or **885 853** (150S) as a counterhold.

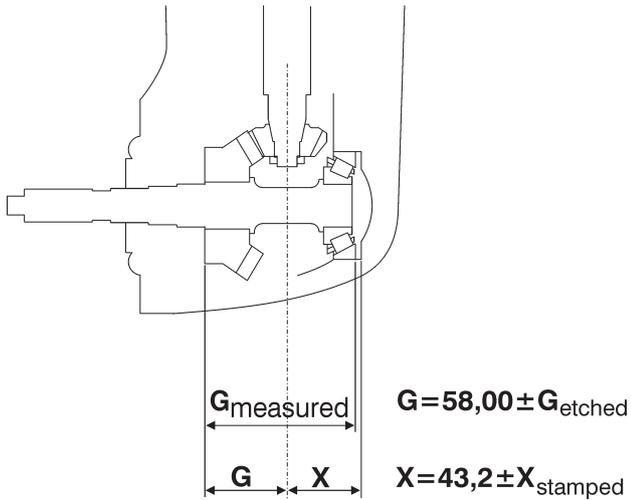
Use something like mandrel **884 752** as a spacer to avoid damaging the threads on the shaft.



Gear wheels 130S, shimming

3

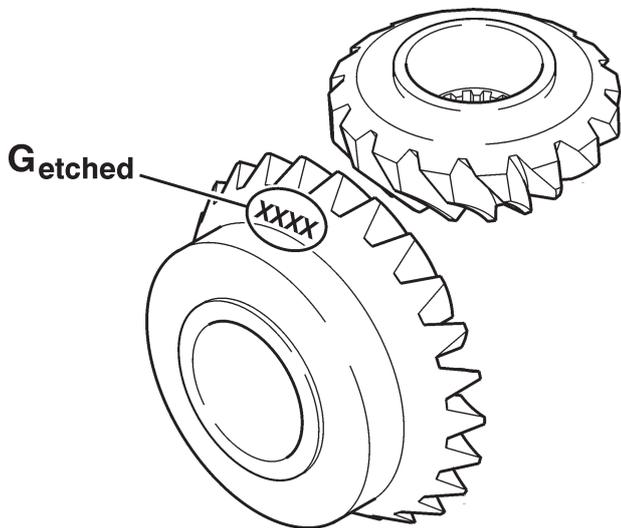
Gear wheel dimension (G_{etched}) is engraved on the gear wheel.



Read off the gear wheel deviation (G_{etched}) and compare this dimension with the table on the next page.

The deviation is noted in plain language.

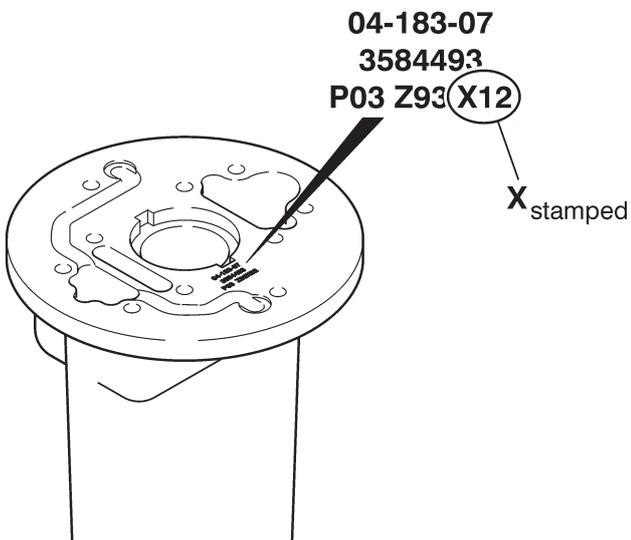
Example: 0.1 = 0.10 mm

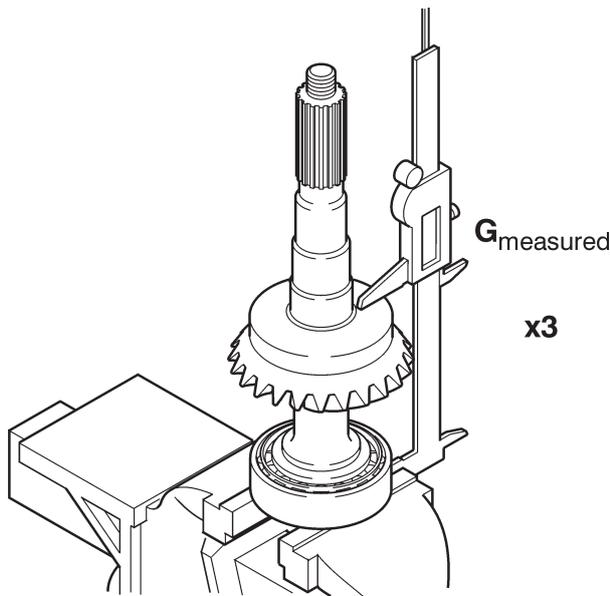


Read off the gear housing dimension deviation (X_{stamped}) and note this dimension in the table on the next page.

Only decimals of 1/100 mm are marked.

Example: X12 = 0.12 mm





Put the propeller shaft on the bearing race as in the illustration.

Press the shaft hard against the bearing race and measure the distance between the bearing race and the gear wheel. Do a number of measurements and prepare an average.

Example:

$$G_{\text{measured}} = \frac{100.27 + 100.25 + 100.23}{3} = 100.25 \text{ mm}$$

Gear nominal	58.00	
$G_{\text{etched}} \pm$	0,10	
=	58,10	
Housing nominal	43.20	
$X_{\text{stamped}} \pm$	0,12	
=	43,32	
	43,32	
+	58,10	
=	101,42	
G_{measured}	-	100,25
$G_{\text{shim}} =$		1,17

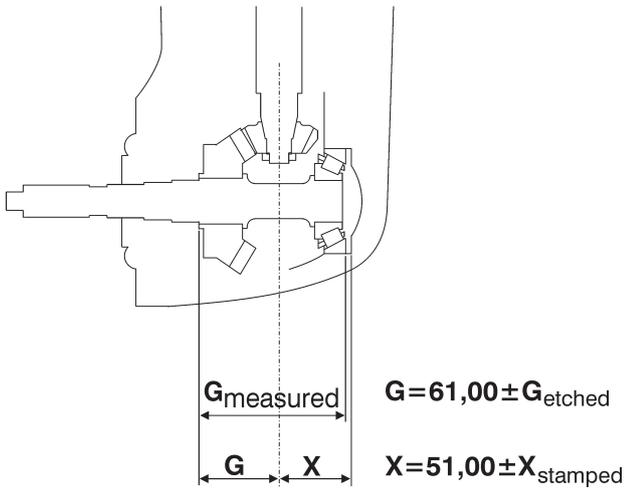
Put the calculated and measured dimensions into the table and calculate the shim thickness (G_{shim}).

Round off to the nearest 5/100 mm.

Gear wheels 150S, shimming

4

Gear wheel dimension (G_{etched}) is engraved on the gear wheel.

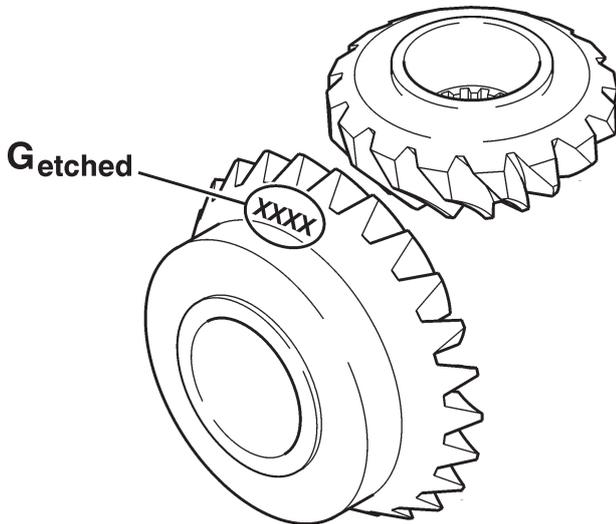


Read off the gear wheel deviation (G_{etched}) and compare this dimension with the table on the next page.

The deviation is noted in plain language.

Example:

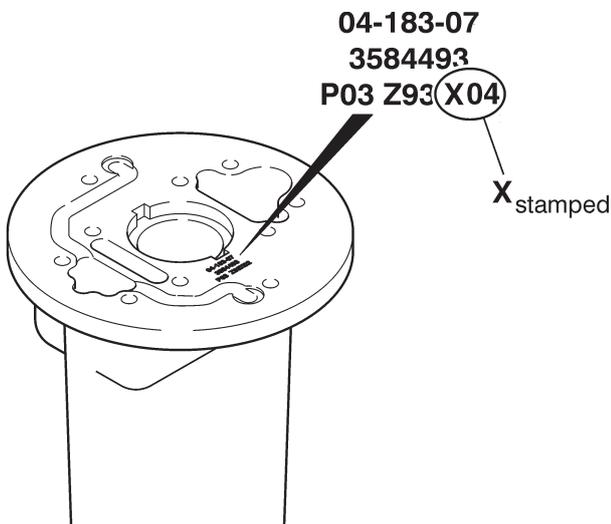
$$0.08 = 0.08 \text{ mm}$$

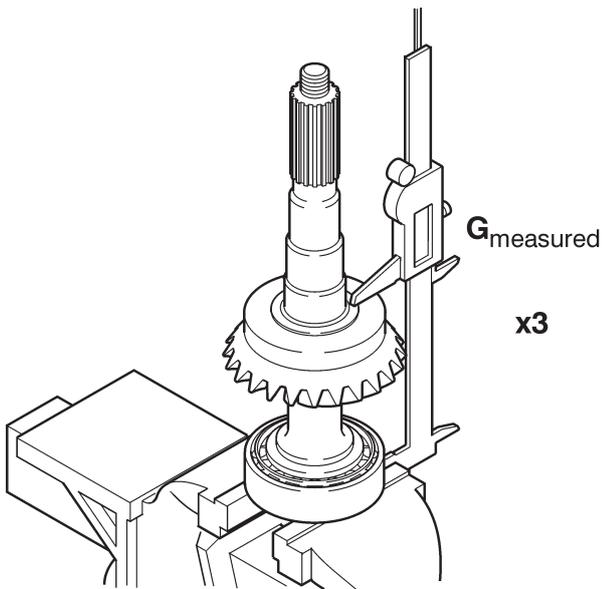


Read off the gear housing dimension deviation (X_{stamped}) and note this dimension in the table on the next page.

Only decimals of 1/100 mm are marked.

Example: X04 = 0.04 mm





Put the propeller shaft on the bearing race as in the illustration.

Press the shaft hard against the bearing race and measure the distance between the bearing race and the gear wheel. Do a number of measurements and prepare an average.

Example:

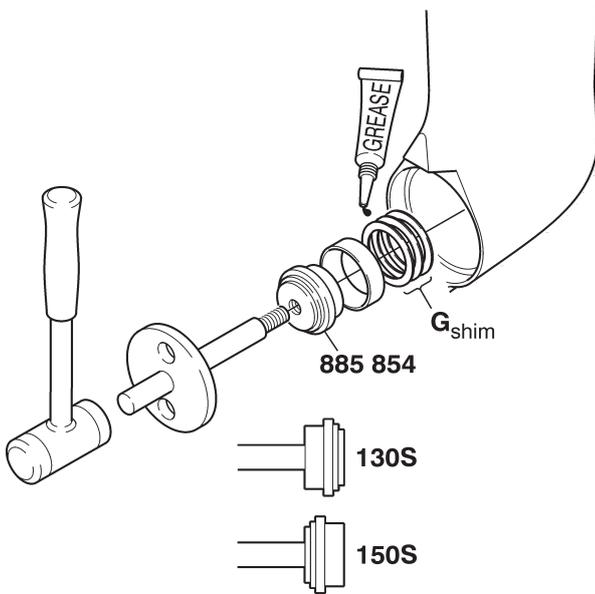
$$G_{\text{measured}} = \frac{111.27 + 111.31 + 111.29}{3} = 111.29 \text{ mm}$$

Gear nominal		61.00
G_{etched}	\pm	0,08
	=	61,08
Housing nominal		51.00
X_{stamped}	\pm	0,04
	=	51,04
		51,04
	+	61,08
	=	112,12
G_{measured}	-	111,29
G_{shim}	=	0,83

Put the calculated and measured dimensions into the table and calculate the shim thickness (G_{shim}).

Round off to the nearest 5/100 mm.

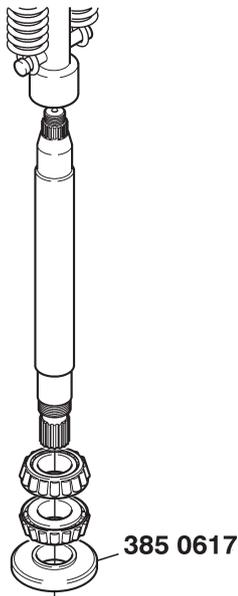
NOTE! If X_{stamped} value is close to 100, e.g. X96, housing nominal = 50.00 mm applies.



5

Put the calculated thickness of shims (G_{shim}) into the housing. Fix them with some grease.

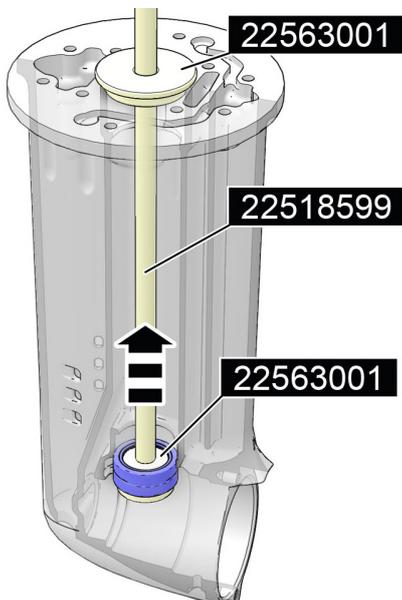
Install the bearing race with tool **885 854** and a plastic-faced mallet. Turn the lower part of the tool to suit the bearing race in question.



6

Press the bearing onto the vertical shaft with ring **385 0617**. Align the bearings as in the illustration.

NOTE! Be careful not to damage the threads for the pinion nut.



7

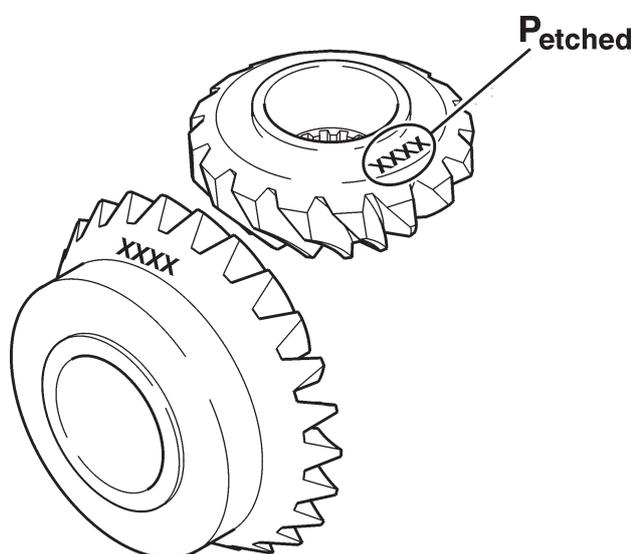
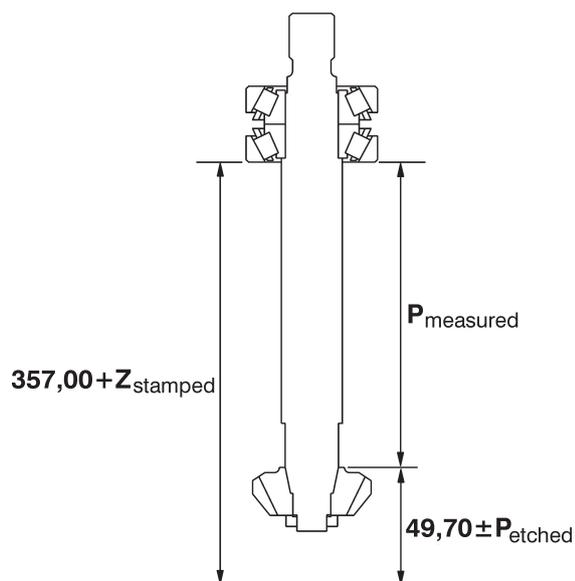
Align the needle roller bearing with the text side outwards (towards the tool). Knock the bearing up until it bottoms. Use 22563001 and 22518599.

Pinion gear 130S, shimming

8

Pinion gear nominal height = 49.70

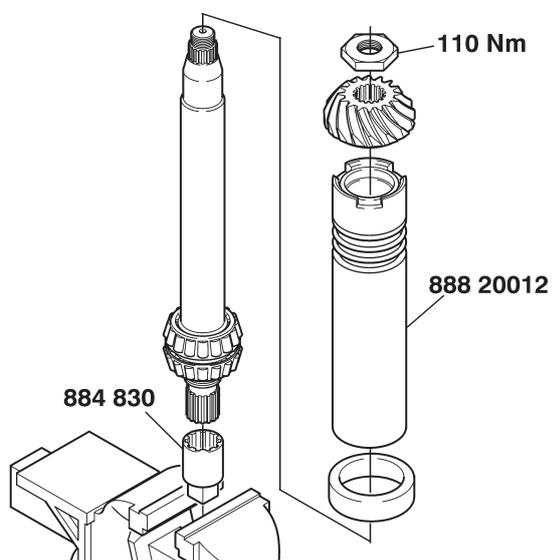
Lower gear housing nominal dimension = 357



The pinion gear deviation is engraved on the pinion gear. The deviation is noted in plain language.

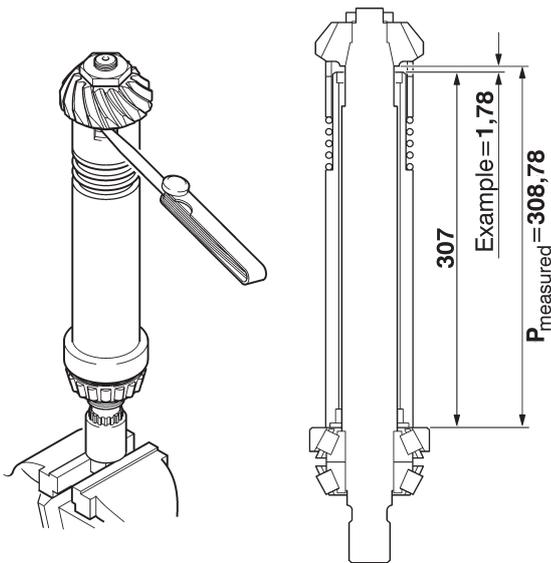
Example: 0,04 = 0.04 mm

Read off the pinion gear deviation (P_{etched}) and insert this into the calculation table "Shim calculation, lower gear housing 130S-A, 130SR-A". The table, intended to be copied, is at the end of the book.



Put splined socket **884 830** in a vise. Place the vertical shaft in the splined socket and thread on measurement fixture **888 20012**.

Install the pinion gear and the old pinion nut. Torque the nut to **110 Nm**.



Use a feeler gauge to measure the distance between the tool and the pinion gear. Measure the three cut-outs in the measurement fixture and take the average:

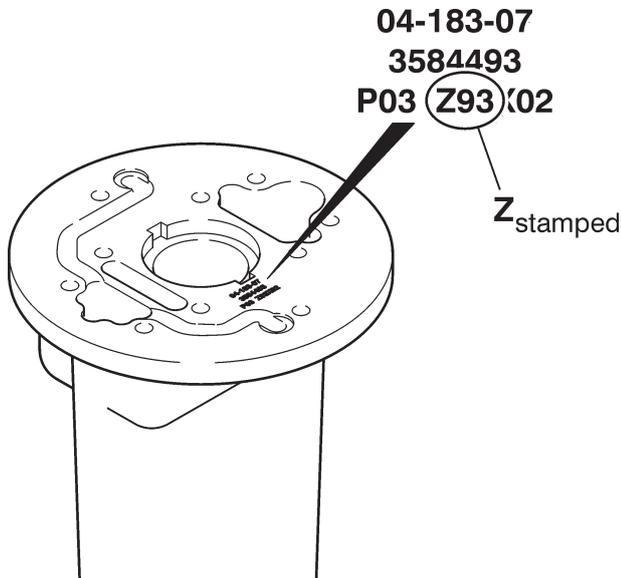
Example:

$$\frac{1.78 + 1.77 + 1.79}{3} = 1.78 \text{ mm}$$

Add the fixed length of the measurement fixture, which is 307,00 mm, and we obtain a dimension called:

$$P_{\text{measured}} = 1.78 + 307.00 = \mathbf{308.78 \text{ mm}}$$

Put this dimension into the table below.



Read off the gear housing deviation Z_{stamped} , only decimals of 1/100 mm are marked. Put this dimension into the table below.

Example: $Z93 = 0.93 \text{ mm}$

Pinjong nominal	49.70	
$P_{\text{ecthed}} \pm$	0,04	
=	49,74	
		←
	49,74	
$P_{\text{measured}} +$	308,78	
=	358,52	
		←
	358,52	
Housing nominal	357.00	
=	1,52	
		←
	1,52	
$Z_{\text{stamped}} -$	0,93	
$P_{\text{shim}} =$	0,59	

Put the calculated and measured dimensions into the table and calculate the shim thickness P_{shim} .

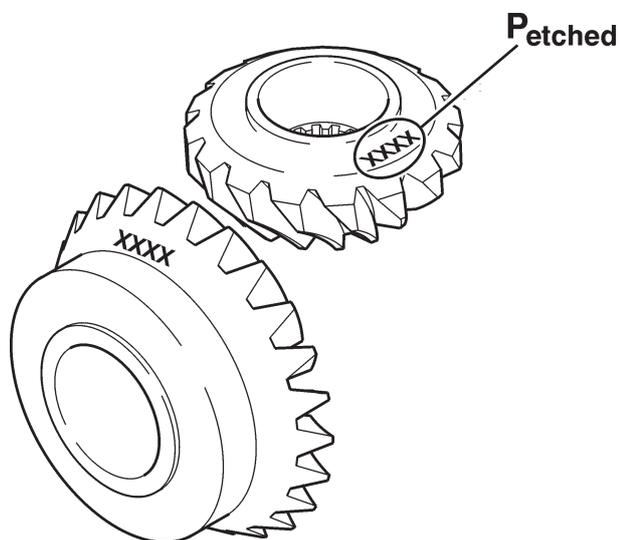
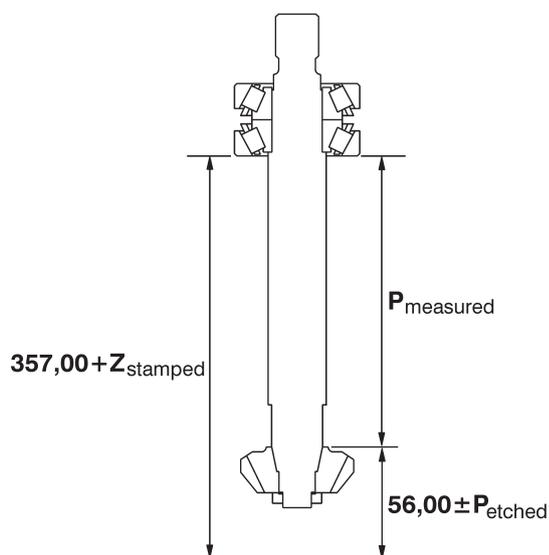
Round off to the nearest 5/100 mm.

Pinion gear 150S, shimming

9

Pinion gear nominal height = 56.00

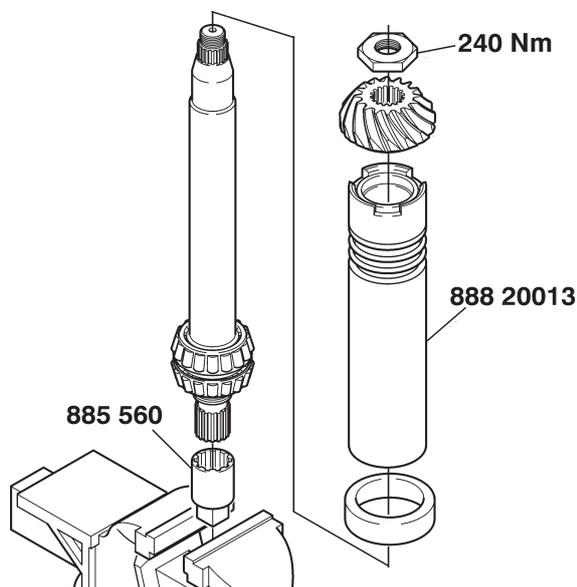
Lower gear housing nominal dimension = 357



The pinion gear deviation is engraved on the pinion gear. The deviation is noted in plain language.

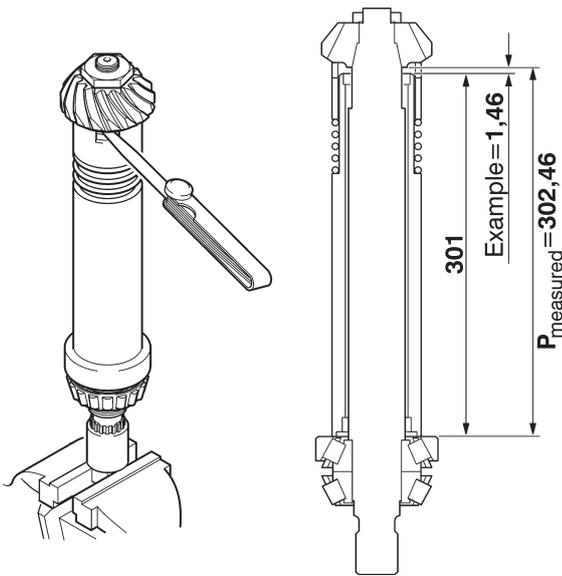
Example: 0,09 = 0.09 mm

Read off the pinion gear deviation (P_{etched}) and insert this into the calculation table "Shim calculation, lower gear housing 150S-A, 150SR-A". The table, intended to be copied, is at the end of the book.



Put splined socket **885 560** in a vise. Place the vertical shaft in the splined sleeve and thread measurement fixture **88 20013** on.

Install the pinion gear and the old pinion nut. Torque the bolts to **240 Nm**.



Use a feeler gauge to measure the distance between the tool and the pinion gear. Measure the three cut-outs in the measurement fixture and take the average:

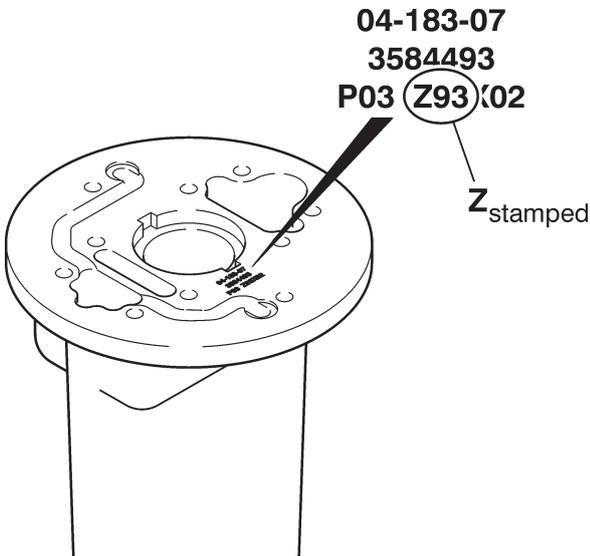
Example:

$$\frac{1.44 + 1.48 + 1.46}{3} = 1.46 \text{ mm}$$

Add the fixed length of the measurement fixture, which is 301.00 mm, and we obtain a dimension called:

$$P_{\text{measured}} = 1.46 + 301.00 = \mathbf{302.46 \text{ mm}}$$

Put this dimension into the table below.



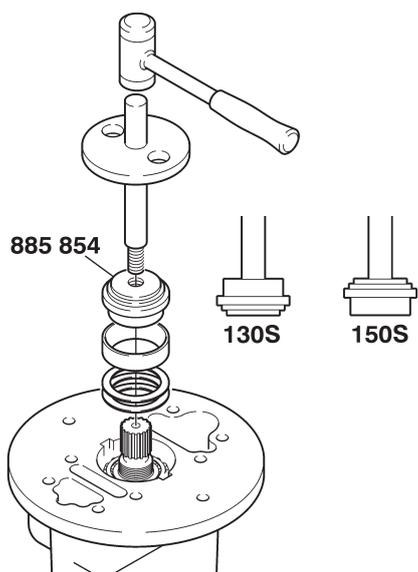
Read off the gear housing deviation Z_{stamped} , only decimals of 1/100 mm are marked. Put this dimension into the table below.

Example: $Z93 = 0.93 \text{ mm}$

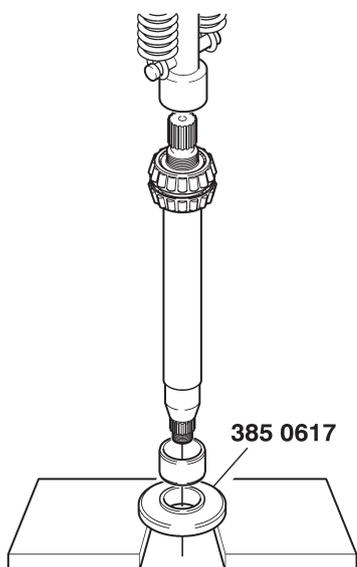
Pinjong nominal	-	56.00	
P_{etched}	\pm	0,09	
	=	56,09	←
		56,09	
P_{measured}	+	302,46	
	=	358,55	←
		358,55	
Housing nominal	-	357.00	
	=	1,55	←
		1,55	
Z_{stamped}	-	0,93	
P_{shim}	=	0,62	

Put the calculated and measured dimensions into the table and calculate the shim thickness P_{shim} .

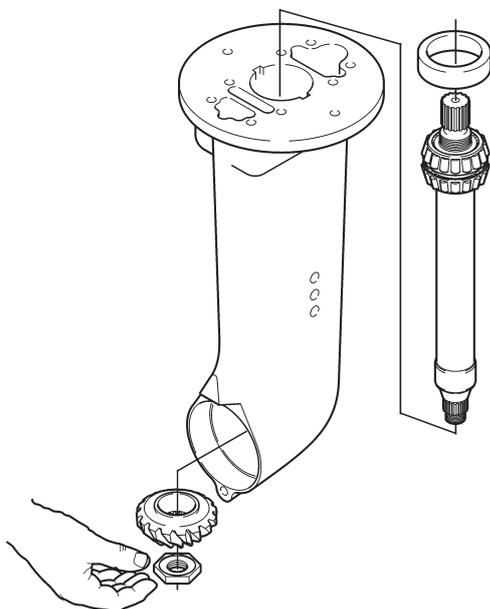
Round off to the nearest 5/100 mm.

**10**

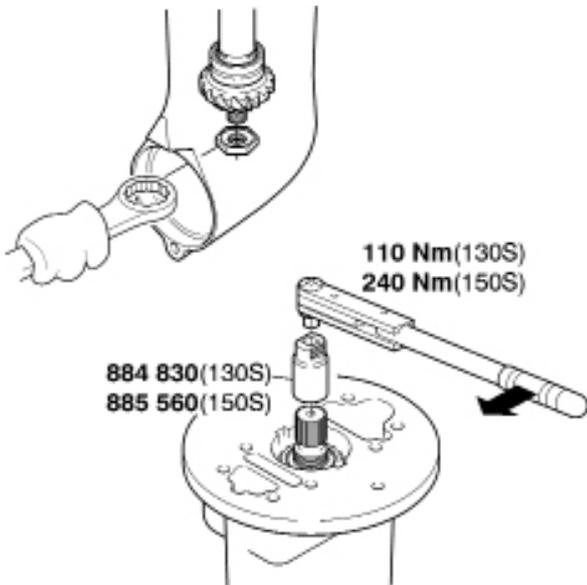
Install the calculated shim thickness in the gear housing and install the bearing race with tool **885 854** and a plastic-faced mallet. Turn the lower part of the tool to suit the bearing race in question.

**11**

Press the needle roller bearing onto the vertical shaft with ring **385 0617**.

**12**

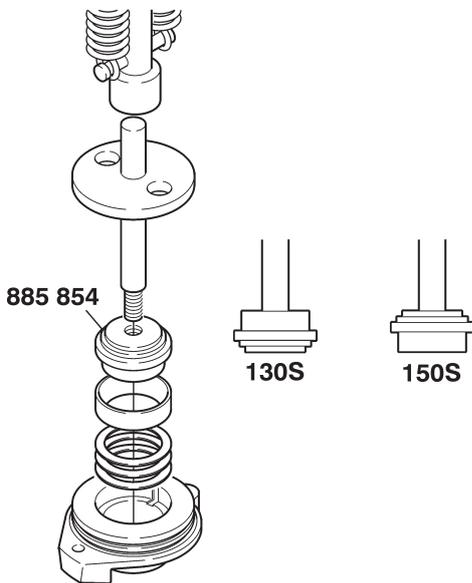
Put the vertical shaft in the gear housing. Install the pinion gear and screw the old nut on (aligned as in the illustration) by hand.



13

Fix the pinion nut. Use a clean rag to protect the gear case.

Tighten the nut by turning the vertical shaft with splined socket **884 830** (130S) or **885 560** (150S). Tightening torque **110 Nm** (130S) or **240 Nm** (150S) respectively.

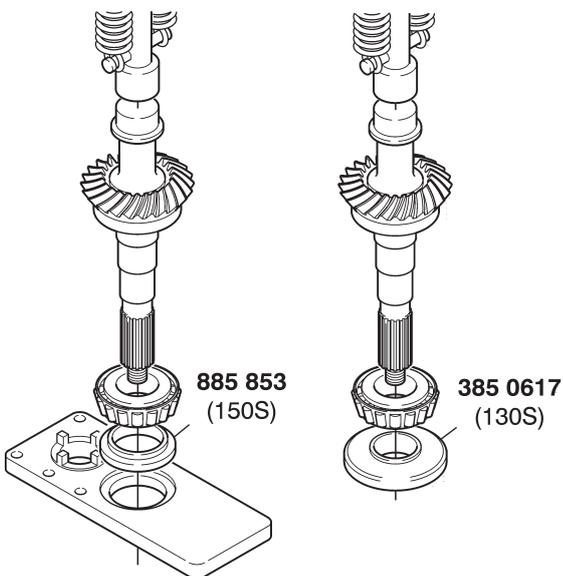


14

Put the original shim thickness in the propeller bearing housing.

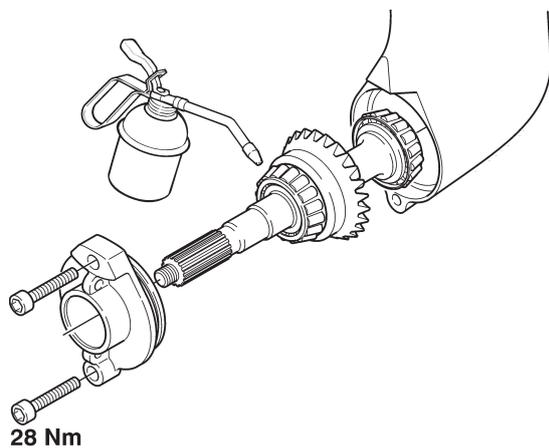
(Or adjust the shim thickness with the difference between the calculated and the original shim thickness for the **front** bearing race).

Press the bearing race in with tool **885 854**. Turn the lower part of the tool to suit the bearing race in question.



15

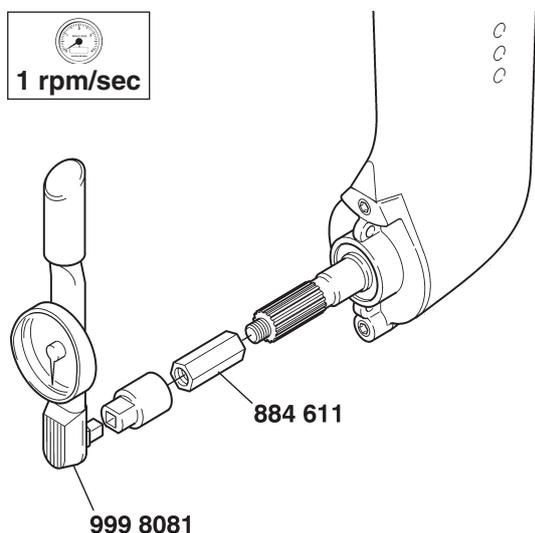
Press the rear bearing onto the propeller shaft. Use plate **884 753** and ring **385 0617** (130S) or **885 853** (150S) as a counterhold.

**16**

Oil the bearings lightly.

Put the propeller shaft in the gear housing.

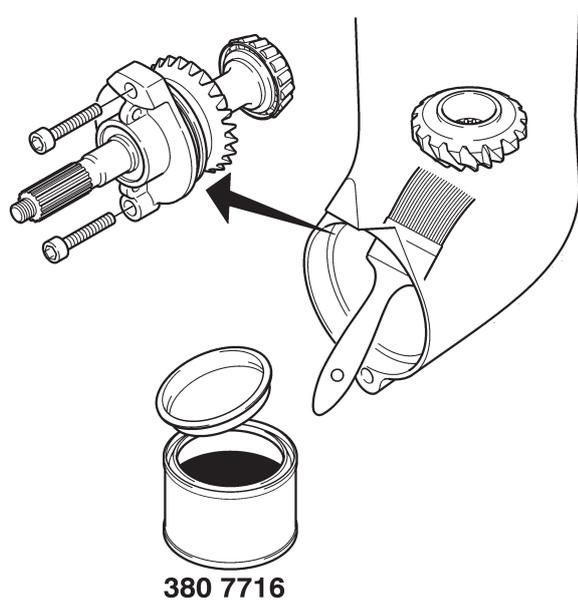
Install the propeller bearing housing without O-rings.
Torque the screws to **28 Nm**.

**17**

Check the turning round torque with adapter nut **884 611** and torque wrench **999 8081**.

Correct turning torque is **0.3 Nm – 1.6 Nm**

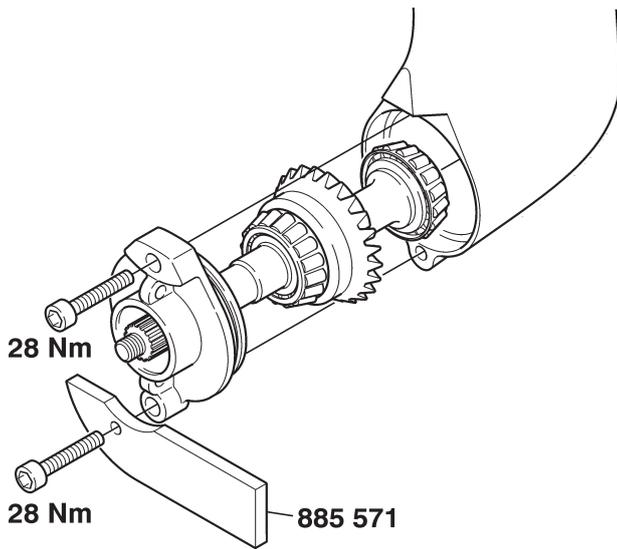
If the turning torque is too low, increase the thickness of shims under the bearing track in the propeller bearing housing, and if the turning torque is too high, reduce the thickness of shims.

**18**

When the correct turning torque has been obtained, the gear flank clearance and the marking pattern on the gear wheels should be checked.

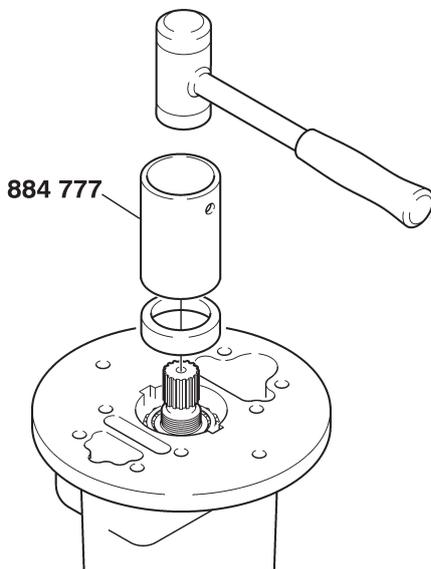
Remove the propeller bearing housing and propeller shaft.

Brush a **thin** layer of marker dye **380 7716** on 5-6 teeth on the pinion gear.



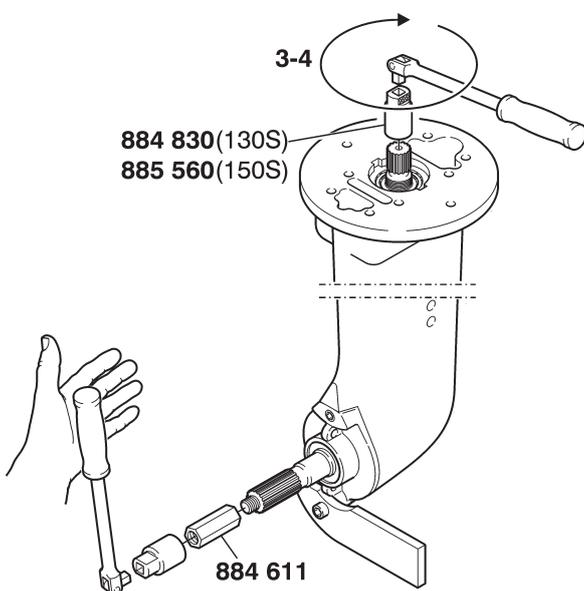
19

Put the propeller shaft back in the gear housing.
 Assemble the propeller bearing housing with fixture **885 571** as in the illustration. Torque the screws to 28 Nm.



20

Drive the upper bearing race down with a plastic-faced mallet and mandrel **884 777**.

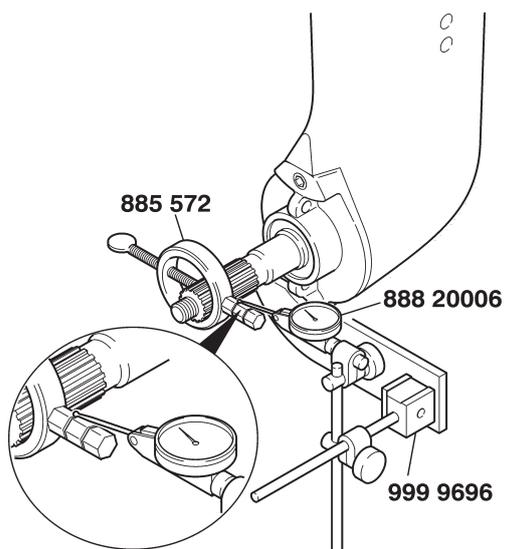


21

The shafts must be braked at the same time as the propeller shaft is turned, to permit the gear marking pattern to be checked.

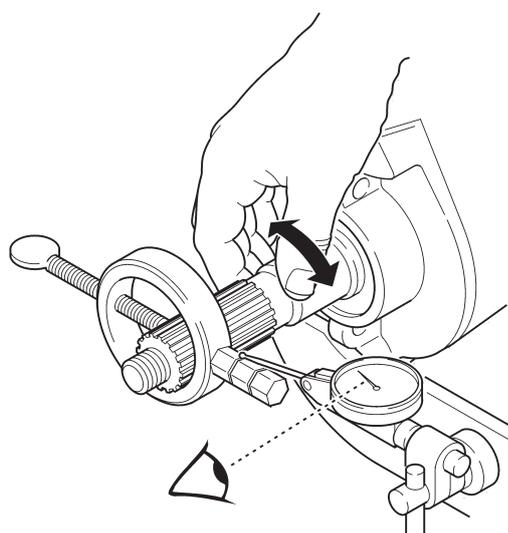
Install adapter nut **884 611** on the propeller shaft.
 Put splined socket **884 830** (130S) or **885 560** (150S) on the vertical shaft and turn it 3-4 turns clockwise at the same time as the propeller shaft is braked.

NOTE! Continue with the following points, to check the gear flank clearance, before disassembling to check the appearance of the marking pattern.

**22**

Install fixture **885 572**, magnetic stand **999 9696** and dial gage **888 20006** as in the illustration.

Put the measurement tip on the inner marking of the fixture.

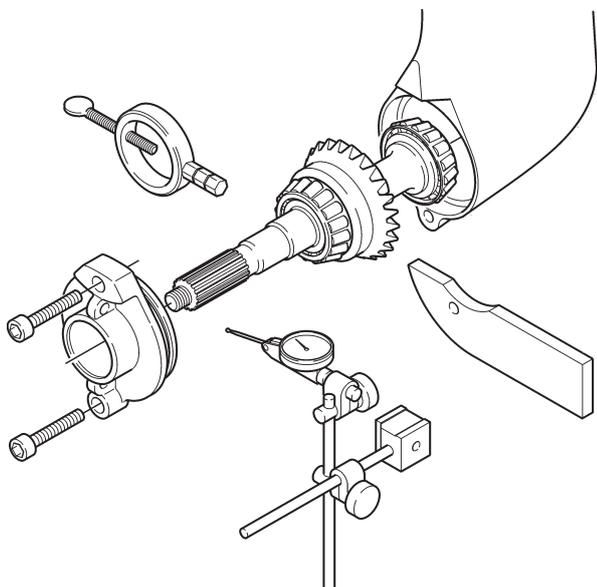
**23**

Fix the vertical shaft in a suitable manner.

Rock the propeller shaft forwards and backwards (avoid pressing in the radial direction) and read off the gear flank clearance.

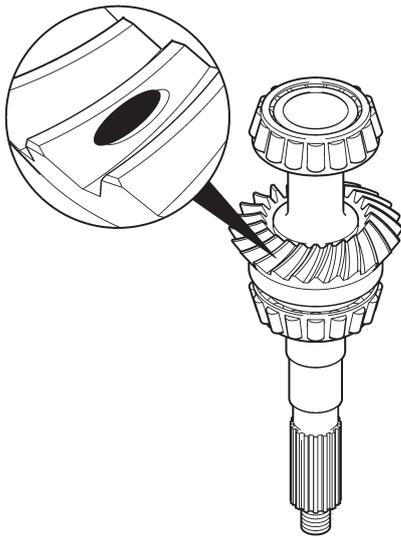
Correct value: **0.10 - 0.20 mm**

Note the measured value in the "Shim table, lower gear".

**24**

Remove all measurement tools and special tools.

Remove the propeller bearing housing and lift the propeller shaft out.

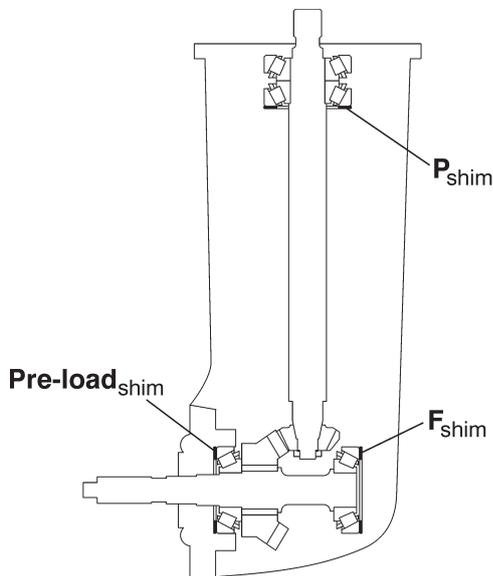


25

Check the position of the marking pattern.

The marking pattern on the gear wheel should be displaced slightly towards the “large end” and slightly towards the tooth tips.

During operation, the propeller forces will press the gear wheel forwards, which displaces the marking pattern and makes it centrally located in both height and lengthways direction.



26

If you need to adjust the gear flank clearance in cases where the marking pattern is correct:

In most cases, the pinion position is retained (P_{shim}) and the gear wheel is moved (F_{shim}).

If the gear wheel is moved 0.05 mm, the gear flank clearance is moved about 0.05 mm.

NOTE! Remember to compensate the shim thickness under the bearing race in the propeller bearing housing ($Pre-load_{shim}$) so that the turning torque is retained. Total of:

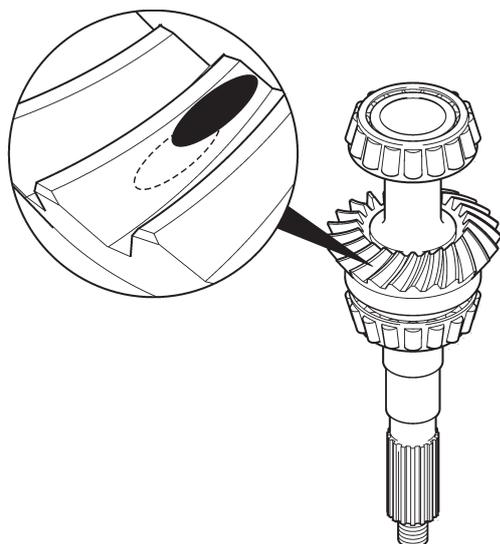
$$F_{shim} + Pre-load_{shim} \text{ is maintained unchanged.}$$

Put the current shim thickness, gear flank clearance, turning torque and marking pattern locations in a copy of the “Shim table, lower gear housing” at the end of the book. This considerably facilitates work if you should need to fine adjust the shim thicknesses.

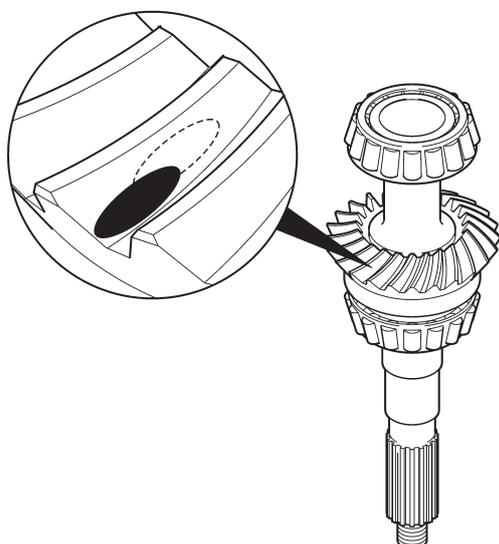
If you need to adjust the marking pattern without changing the gear flank clearance:

Move both the pinion and the gear wheel.

For example, if the gear wheels are moved 0.05 mm, the pinion should be moved twice the distance, i.e. 0.10 mm to retain the gear flank clearance.



If the gear engagement pattern is as follows, move the gear wheel in (F_{shim}) and the pinion outwards (P_{shim}).



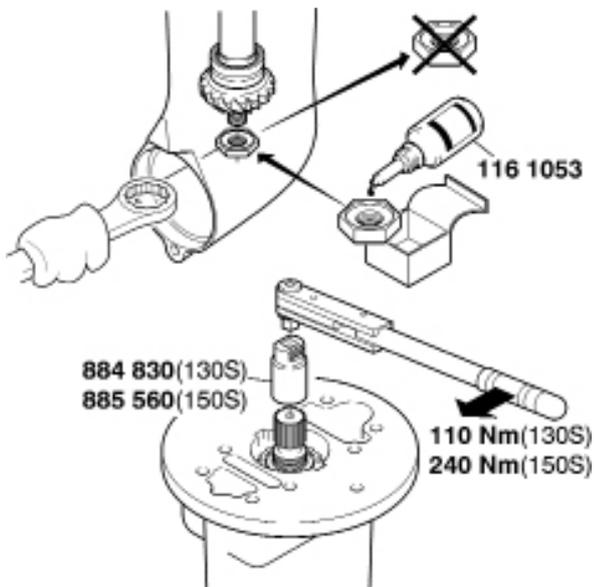
If the gear engagement pattern is as follows, move the gear wheel out (F_{shim}) and the pinion inwards (P_{shim}).

NOTE! Remember to compensate the shim thickness under the bearing race in the propeller bearing housing (**Pre-load_{shim}**) so that the turning torque is retained. Total of:

$$F_{shim} + \text{Pre-load}_{shim} \text{ is maintained unchanged}$$

Put the current shim thickness, gear flank clearance, turning torque and marking pattern locations in a copy of the “Shim table, lower gear housing” at the end of the book. This considerably facilitates work if you should need to fine adjust the shim thicknesses.

When correct turning torque, gear flank clearance and marking pattern have been obtained, remove the propeller bearing housing and propeller shaft.



Final assembly

25

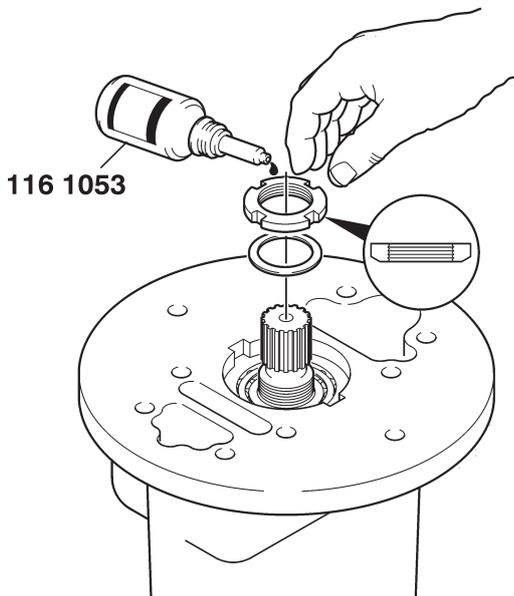
Remove the old pinion nut and scrap it.

Apply thread locking fluid, VP part number 116 1053 to the new pinion nut and screw it on by hand.

NOTE! Align the nut as in the illustration.

Fix the pinion nut. Use a clean rag to protect the gear case. Tighten the nut by turning the vertical shaft with splined socket **884 830** (130S) or **885 560** (150S).

Torque **110 Nm** (130S) or **240 Nm** (150S).

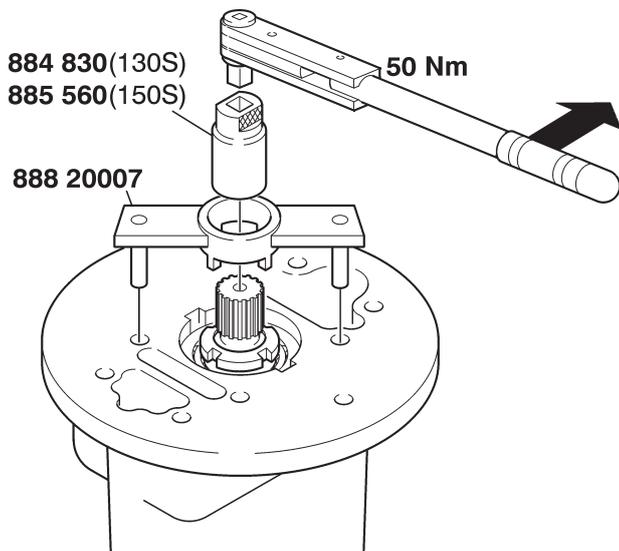


26

Thread the washer on.

Apply thread locking fluid, VP part number 116 1053 to the nut and screw it on by hand.

NOTE! Align the nut as in the illustration.

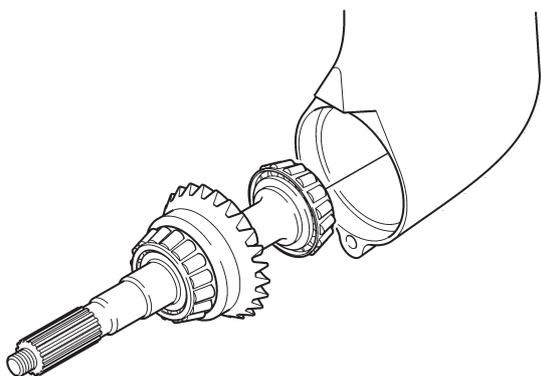


27

Fix the nut with fixture **888 20007**.

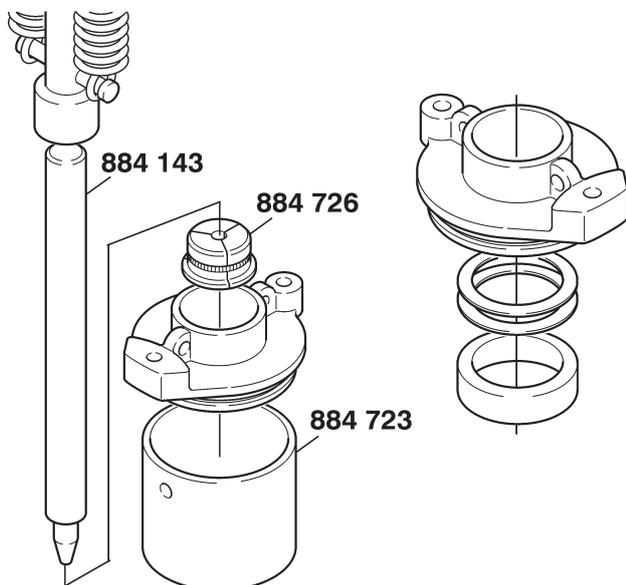
Tighten the nut by turning the vertical shaft anti-clockwise with the splined socket. **884 830** (130S) or **885 560** (150S).

Torque **50 Nm**.



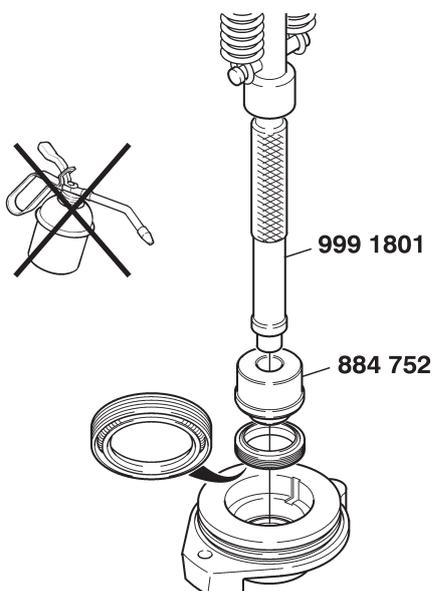
28

Put the propeller shaft in the gear housing.



29

Press the bearing race out of the propeller bearing housing with expander **884 726** and standard shaft **884 143**. Use ring **884 723** as a counterhold. Save the shims.

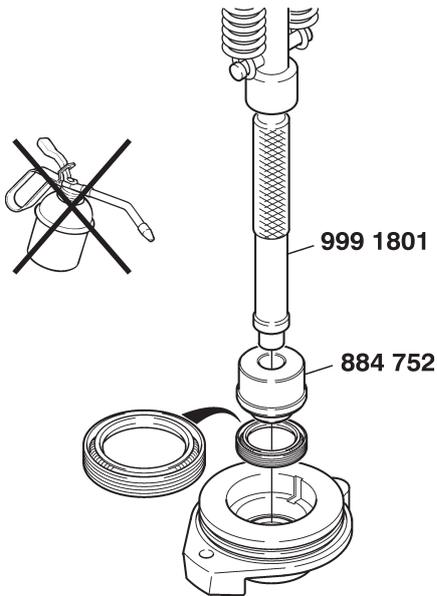


30

Install the outer seal ring with standard shaft **999 1801** and mandrel **884 752** in the propeller bearing housing.

NOTE! Install the seal ring **dry** and aligned so that the spring comes **outwards**.

Press until it meets the heel on the propeller bearing housing and retain the press force for a couple of seconds to allow the seal ring to “settle”.

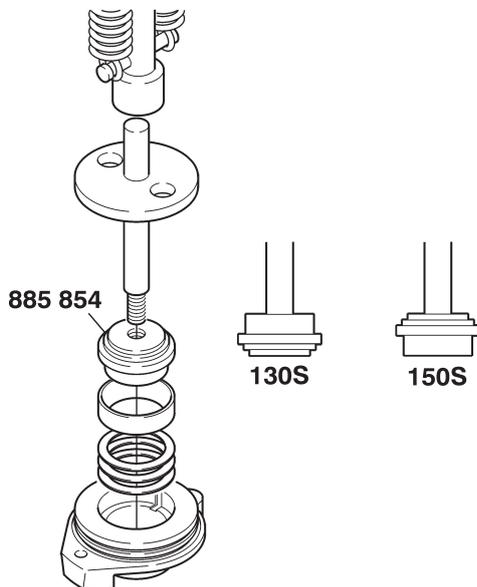


31

Install the inner seal ring with standard shaft **999 1801** and mandrel **884 752** in the propeller bearing housing.

NOTE! Install the seal ring **dry** and aligned so that the spring comes **inwards**.

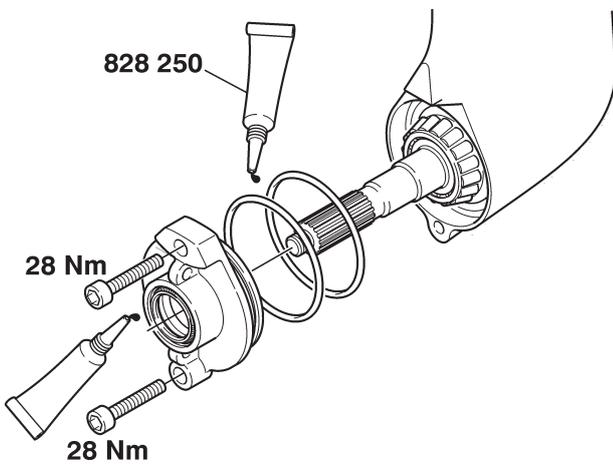
Press until it meets the heel on the propeller bearing housing and retain the press force for a couple of seconds to allow the seal ring to “settle”.



32

Place the tested shim thickness in the propeller bearing housing.

Press the bearing race in with tool **885 854**. Turn the lower part of the tool to suit the bearing race in question.



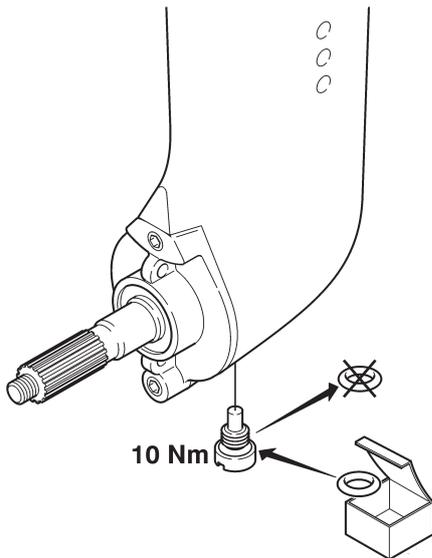
33

Install new O-rings on the propeller bearing housing.

Grease the seal rings and the O-rings liberally with grease, VP part no. **828250**.

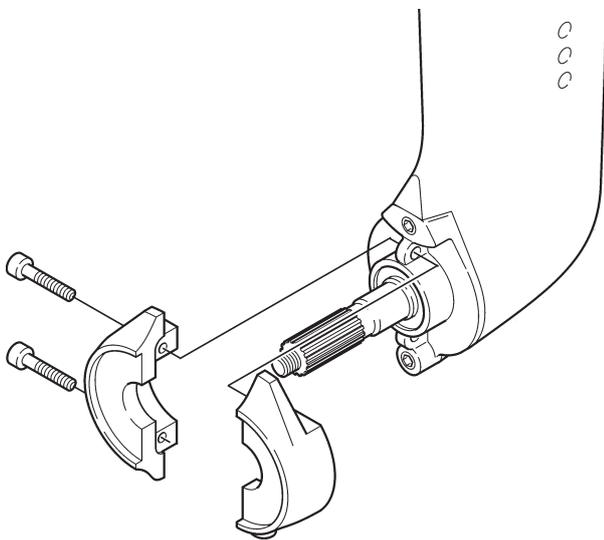
Put the propeller bearing housing in place. Be careful to ensure that the splines do not scratch the seal rings.

Tighten the screws. Torque **28 Nm**.



34

Install a new O-ring on the oil drain plug. Torque the plug to **10 Nm**.



35

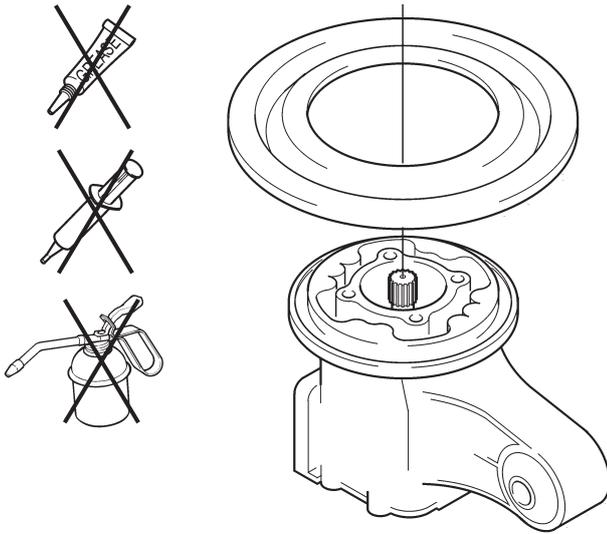
Scrape the mating surface clean and install the zinc anode. Tighten the bolts to 9 Nm

Upper and lower gear housing, assembly

1

Align the rubber sleeve on the upper gear as in the illustration.

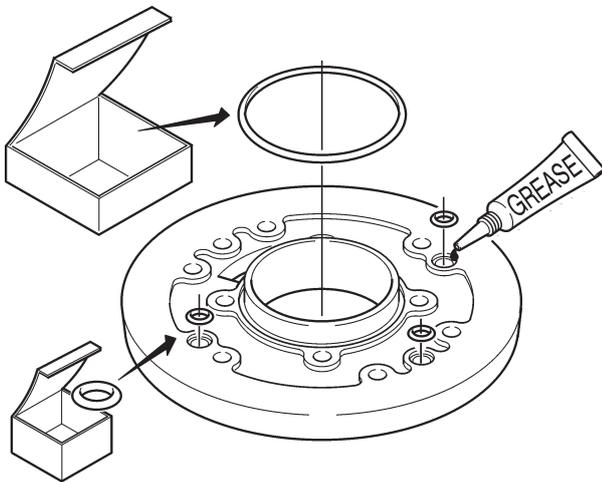
⚠ WARNING! The rubber sleeve must be installed dry. No kind of grease, silicone sealant or other sealant may be used.



2

Put the four O-rings on the adapter plate. Fix them with some grease.

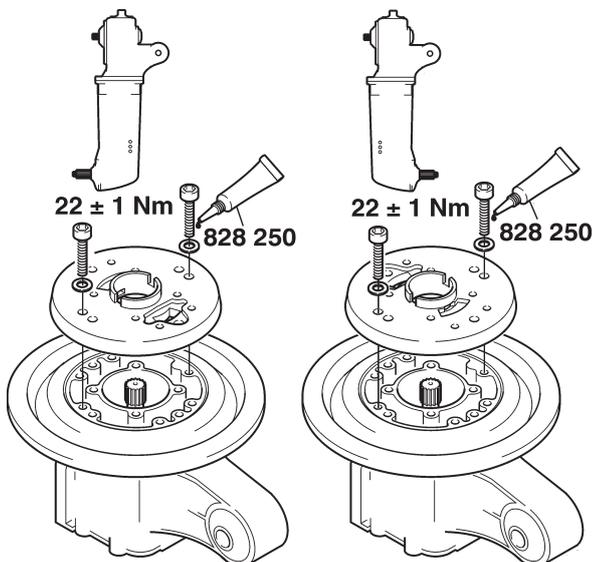
Install the adapter plate on the upper gear.

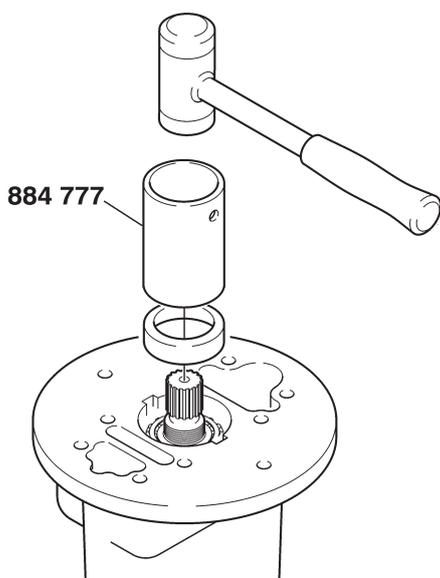


NOTE! Align the plate so it suits the type of drive in question. Depending on whether the drive should be located in front of or behind the engine, align the plate (and the lower gear) as in the illustration.

Apply grease, VP part number **828 250** to the screws.

Torque **22 ± 1 Nm**.





3

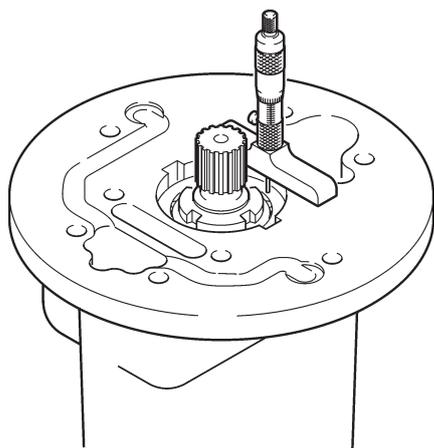
Check that there is no end float in the vertical shaft. If necessary, tap the upper bearing housing down with mandrel **884 777**.

Example:
C = 13,97 mm

4

Measure the depth (**C**) in the lower gear housing with depth micrometer **998 5472**.

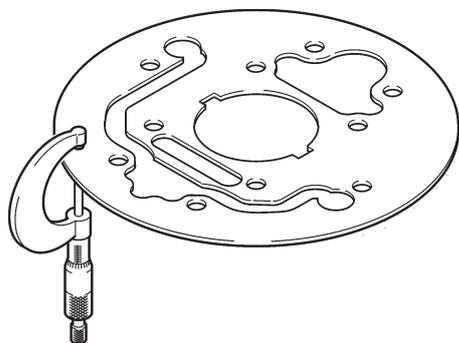
Example: **C = 13.97 mm**



5

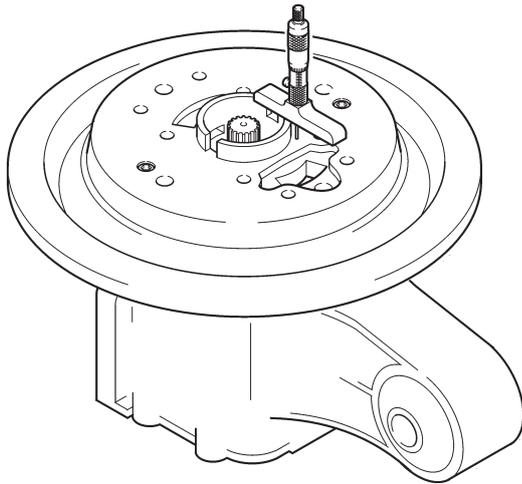
Measure the thickness (**G**) of a new gasket with micrometer **999 9701**.

Example: **G = 0.37 mm**



Example:
G = 0,37 mm

Example:
X = 12,36 mm



6

Measure the height (**X**) of the adapter plate flange, depth micrometer **998 5472**.

Example: **X = 12.36 mm**

$$S_{\min} = C + G - X$$

$$S_{\max} = C + G - X + 0,05$$

$$S_{\min} = 1,98$$

$$S_{\max} = 1,98 + 0,05 = 2,03$$

$$S = 2,00 = \text{OK}$$

7

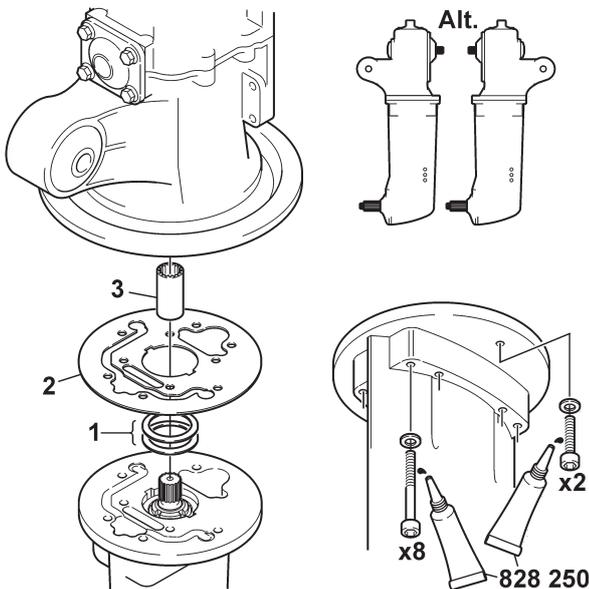
To calculate the clearance between the bearing race and the upper gear housing, you must add the gasket thickness (**G**) to dimension (**C**) and then deduct dimension (**X**).

Example:

$$\text{Clearance} = C + G - X = 13.97 + 0.37 - 12.36 = 1.98 \text{ mm}$$

To obtain the recommended gear pre-load **0.00-0.05 mm** shims must be put between the bearing race and the upper gear housing.

The example above leads to a shim thickness of 2.00 mm, which gives a bearing preload of 0.02 mm.



8

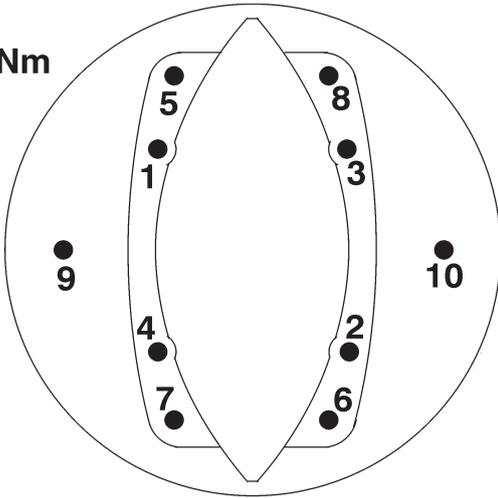
Put the calculated thickness of shims (1) in the lower gear housing.

Put a new gasket (2) on the lower gear housing. Align the gasket as in the illustration.

Install the splined socket (3) on the vertical shaft.

Carefully lift the upper gear housing/adapter plate into place.

Apply grease, VP part no. 828 250 to the screws.

$22 \pm 1 \text{ Nm}$ **9**

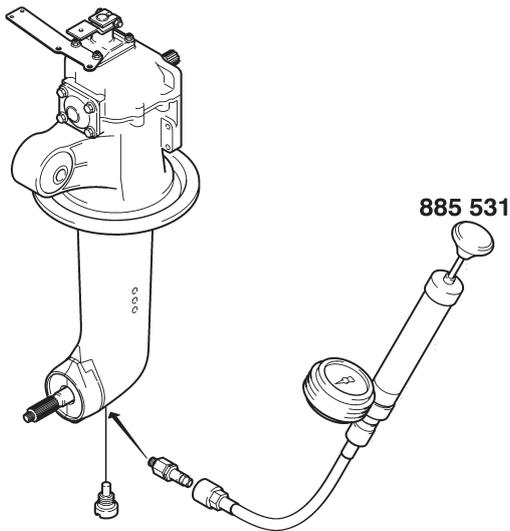
Tighten the screws as in the tightening torque schedule, to **$22 \pm 1 \text{ Nm}$** .

Pressure testing

Special tools: 885 531

Before the drive is filled with oil, it must be pressure tested to check that the drive has been made oil-tight after repair.

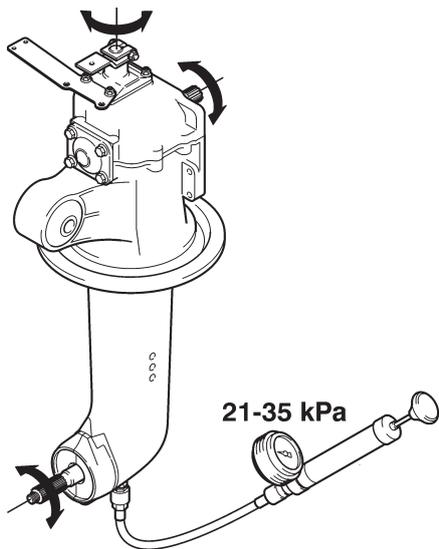
If a used drive is tested, the oil must be drained first. Note the appearance of the oil. Gray oil indicates leakage (water entry).



1

Remove the drain plug.

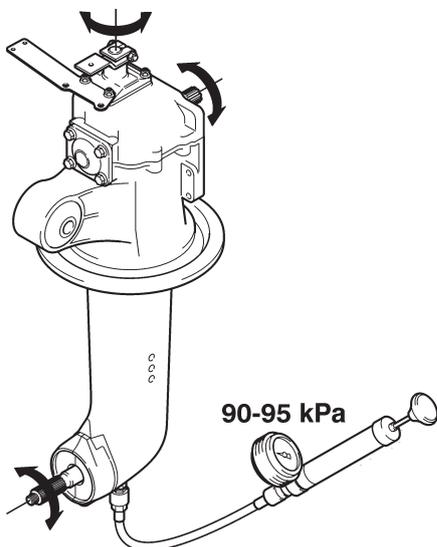
Install the nipple and pump from the pressure test kit **885 531**.



2

Pump the pressure up to 21–35 kPa.

Turn the propeller shaft, gear shift mechanism and input shaft, and check the sealing. If any pressure drop is noticed, use soapy water or immerse the drive completely in water to find the leakage. Carry out the necessary repairs and repeat the test.



If no pressure drop can be noticed, raise the pressure to 90–95 kPa. Use soapy water again or immerse the drive completely in water to find the leakage, if a pressure drop can be noticed. Permissible pressure drop max 7 kPa in 3 minutes.

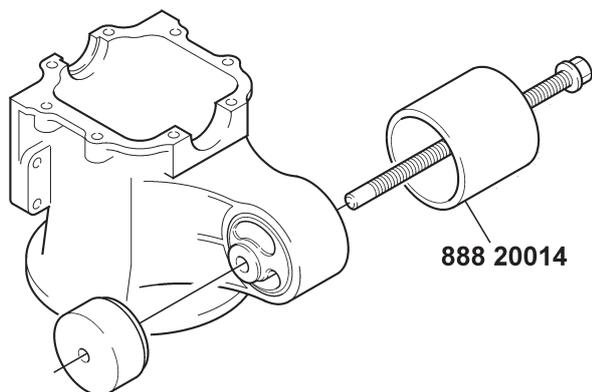
Rubber bushing, change

Special tools: 888 20014

1

130S-A/B, 150S-A/B:

Remove the rubber bush with press tool **888 20014**.

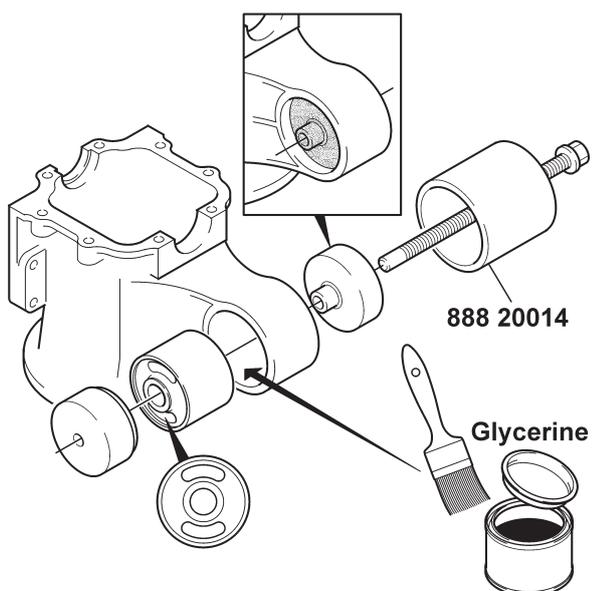


2

130S-A/B, 150S-A/B:

Brush glycerin in the cutout for the bushing in the gear housing.

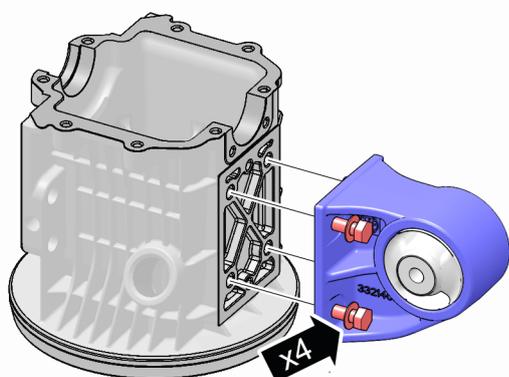
Align the new bushing as in the illustration. Press it in with the new press tool **888 20014**.



3

130S-C, 150S-C:

Åtdragningsmoment: 40 Nm



Painting

⚠ IMPORTANT! Read and carefully follow the instructions and warnings on the packaging.

1

Remove all marine fouling.

2

Remove all loose paint and corrosion residue by grit blasting or sandpaper.

If grit blasting is used, the grit should be aluminum oxide with a particle size of between 0.2 and 0.7 mm. Blow clean after grit blasting.

If sandpaper is used, it must be coated with aluminum oxide. Sand painted surfaces and the damaged/corroded raw aluminum surfaces to be touched up. Then clean with water or a good cleaning fluid.

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

⚠ IMPORTANT! Do not use emery cloth. Small pieces of iron oxide which are used in the emery cloth will become embedded in the aluminum and will cause severe corrosion damage.

3

When the primer coating is thin or the surface is unpainted, it must first be coated with primer, VP part number 1141562-7. The solvent in the primer must be given time to evaporate and the primer must harden before the top coat is applied. Allow 8 to 12 hours drying time.

4

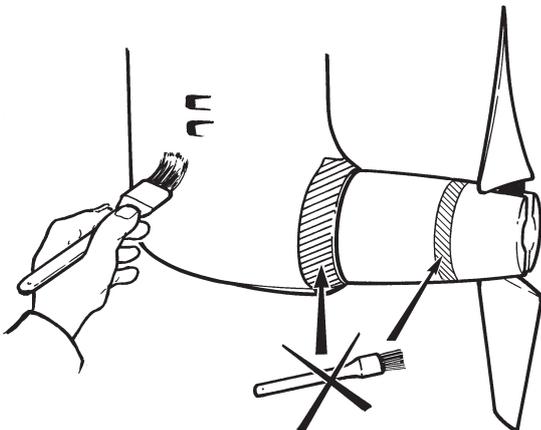
Apply the top coat. The spare parts catalogue and the "Penta accessories" catalogue specify the part numbers for surface treatment products.

5

Also apply anti-fouling.

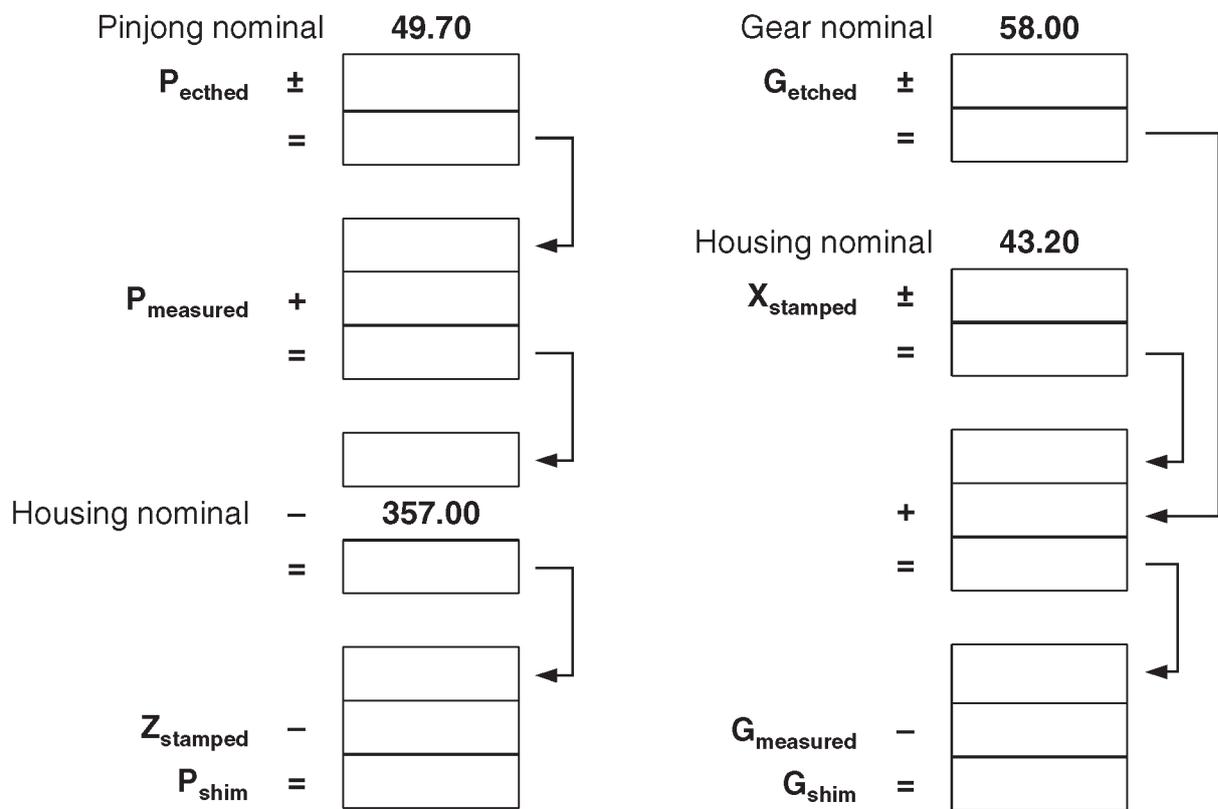
⚠ IMPORTANT! The sacrificial anodes on the drive and the propeller must not be painted.

⚠ IMPORTANT! Find out about current legislation for use of growth inhibiting paints / anti-fouling paints.

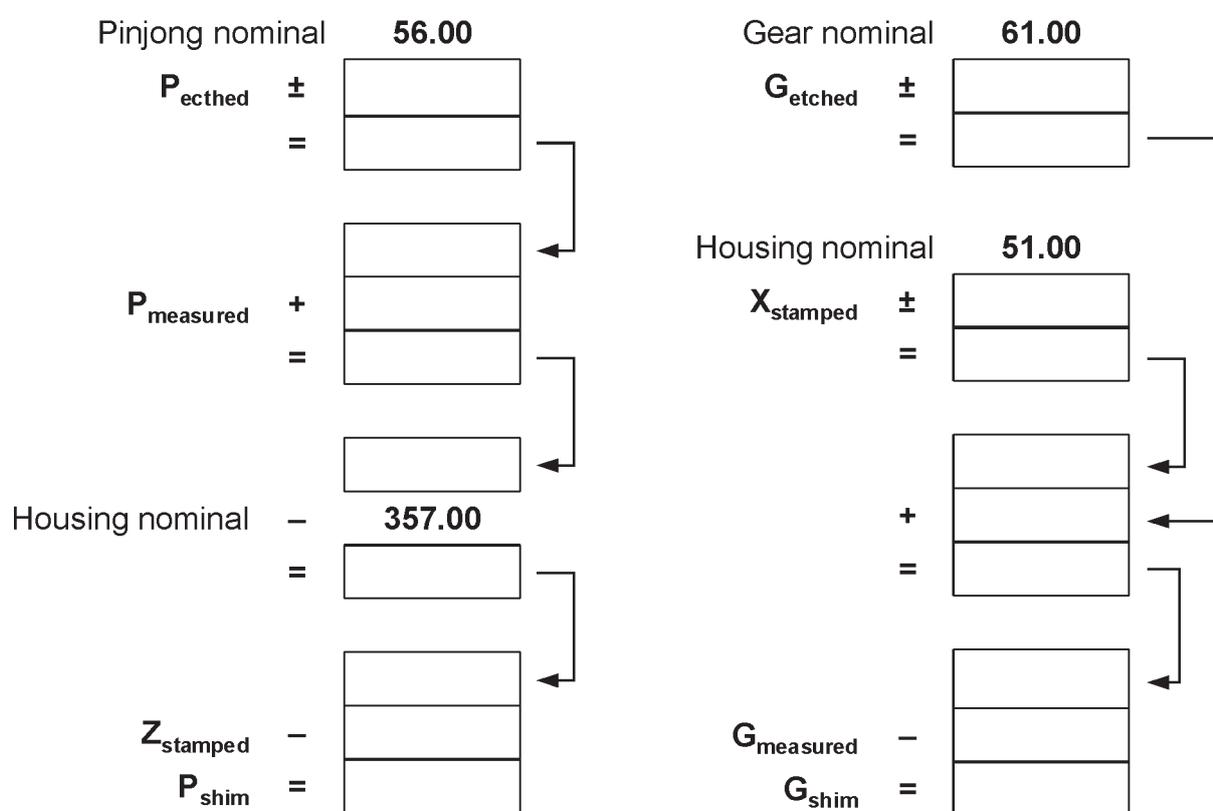


Shimming, quick reference guide

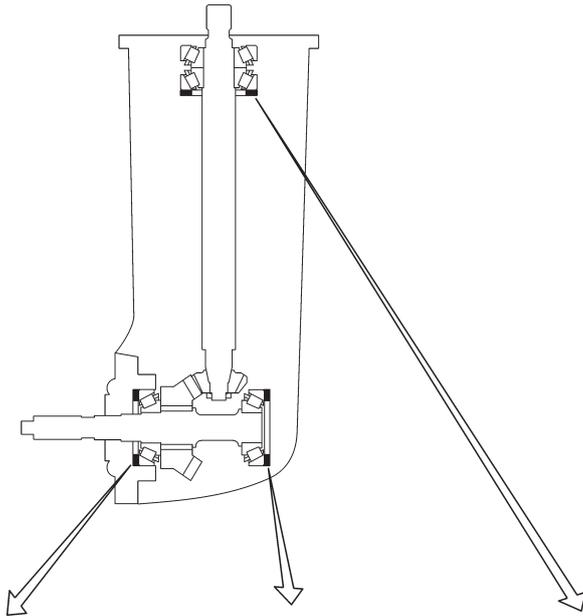
Shim calculation, lower gear housing 130S-A, 130SR-A

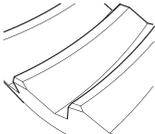
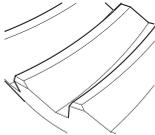
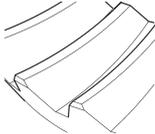
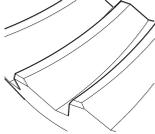


Shim calculation, lower gear housing 150S-A, 150SR-A



Shim calculation, lower gear housing



Original shim thickness			Turning torque	Back lash	Contact pattern
Shim thickness					
					
					
					
					

Troubleshooting

In case of a fault, first check if all items in the installation manual have been performed and that the operating instructions are being followed.

The table below will help you with fault tracing.

1 Oil leakage

Cause: Pores in castings.

Action: Change defective components.

Cause: Leaking oil seals.

Action: Change the defective oil seals.

Cause: Leakage at mating surface.

Action: Check that screws have been tightened to the correct torque. Clean the surfaces and apply new sealant.

Cause: Leakage at dipstick.

Action: Change the dipstick or the O-ring on the dipstick.

Cause: Oil level too high.

Action: Drain/suck out surplus oil.

2 High oil temperature

Cause: Oil level too high.

Action: Drain/suck out surplus oil.

Cause: Slipping clutch.

Action: See item 3.

3 Slipping clutch

Cause: Gear shift arm wrongly adjusted/installed.

Action: Adjust the gear shift mechanism.

Cause: Worn friction plates.

Action: Disassemble the sailboat drive, change the friction plates.

Cause: Wrong oil type.

Action: Drain the oil and re-fill with the correct type of oil.

Cause: Water in oil.

Action: Check and change the propeller shaft seals in the first instance. Then check the O-rings and seal between the upper and lower gear housings.

4 Noise, under load

Cause: Wrongly shimmed gear wheels and roller bearings.

Action: Check shimming and assembly of the sailboat drive.

Cause: Defective gear wheels.

Action: Change the relevant gear set (gear wheels are not sold separately).

5 The sailboat drive cannot be shifted

Cause: Gear shift arm wrongly installed.

Action: Adjust the gear shift arm.

Cause: Flexible coupling defective.

Action: Change the flexible coupling.

Cause: Gear shift arm loose.

Action: Check the gear shift arm and the tightening torque of the clamp screw.

Cause: Defective components as below.

Action: Check the cam on the gear shift mechanism, change if necessary.

Change the springs in the clutch package.

Change the friction disks.

Change the selector fork.

Adjust the gear shift mechanism.

6 Hard shifting

Cause: Idle speed too high.

Action: Adjust idle speed to the correct level.

7 Output shaft rotates in neutral position

Reason: Distorted clutch plates because of overheating.

Action: Change clutch plates and other damaged components.

Cause: Defective needle bearing on input shaft.

Remedy: Remove the sailboat drive and input shaft, change the appropriate bearing and other damaged components.

Technical data

General data

Type designation.....	130S-A, 130SR-A, 130S-B, 130SR-B, 150S-A, 150SR-A, 150S-B, 150SR-B
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Total gear ratio

130S-A, 130SR-A.....	2.19:1	2.47:1
130S-B, 130SR-B.....	2.19:1	
150S-A, 150SR-A, 150S-B, 150SR-B	2.19:1	

Weight

130S-A, 130SR-A, 130S-B, 130SR-B	26.5 kg
150S-A, 150SR-A, 150S-B, 150SR-B	27 kg

Flank clearance

Lower gear, Pinion gear– Gear wheels	0.10–0.20 mm
Upper gear input front gear - output gear wheel	0.12–0.27 mm
input rear gear - output gear wheel	0.12–0.27 mm

Pre-load (turning round torque)

Input shaft new bearings	1.0–1.4 Nm
used bearings.....	1.0–1.4 Nm
Output shaft (upper gear) new bearings	Slack free–0.5 Nm
used bearings.....	Slack free–0.5 Nm
Propeller shaft new bearings	0.3–1.6 Nm
used bearings.....	0.3–1.6 Nm

Lubrication system

Oil volume, app. 130S-A, 130SR-A, 130S-B, 130SR-B gear ratio 2.19:1	2.91 liter
130S-A, 130SR-A gear ratio 2.47:1.....	3.01 liter
150S-A, 150SR-A, 150S-B, 150SR-B	3.01 liter

Torque

General tightening torque values

	Nm
M6 standard screw 8.8	10
M8 standard screw 8.8	25
M10 standard screw 8.8	50
M12 standard screw 8.8	85
M14 standard screw 8.8	140

Special tightening torques

Upper gear housing, split plane	22
Gear shift mechanism.....	20
Clamp screw, gear shift arm	22 ± 1
Rear cover	14
Screw, input shaft	50
Nut, output shaft	50
Upper gear housing - adapter plate.....	22 ± 1
Upper gear housing - lower gear housing	22 ± 1
Nut, vertical shaft.....	50
Pinion nut	
130S, 130SR	110
150S, 150SR	240
Propeller bearing housing	28
Oil drain plug	10

Notes

A series of horizontal dotted lines for writing notes.

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 post it to us. The address is at the bottom of the page. We would prefer you to write in English or Swedish.

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