Workshop Manual

Drive

C
2(0)

Aquamatic 270

Workshop Manual

Outboard drive unit
AQ270B,C,D

Index

Safety Precautions

Introduction

This Workshop Manual contains technical data, descriptions and repair instructions for Volvo Penta products or product versions contained in the contents list. Ensure that the correct workshop literature is being used.

Read the safety information and the Workshop Manual "General Information" and "Repair Instructions" carefully before starting work.

Important

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

⚠ **WARNING!** If these instructions are not followed there is a danger of personal injury, extensive damage to the product or serious mechanical malfunction.

⚠ **IMPORTANT!** Used to draw your attention to something that can cause damage, product malfunction or damage to property.

NOTE! Used to draw your attention to important information that will facilitate work or operations.

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

⚠ Immobilize the engine by turning off the power supply to the engine at the main switch (switches) and lock it (them) in the OFF position before starting work. Set up a warning notice at the engine control point or helm.

⚠ Generally, all servicing should be carried out with the engine switched off. Some work (carrying out certain adjustments for example) requires the engine to be running. Approaching a running engine is dangerous. Loose clothing or long hair can fasten in rotating parts and cause serious personal injury.
If working in proximity to a running engine, careless movements or a dropped tool can result in personal injury. Avoid burns. Take precautions to avoid hot surfaces (exhausts, turbochargers, charge air pipes and starter elements etc.) and liquids in supply lines and hoses when the engine is running or has been turned off immediately prior to starting work on it. Reinstall all protective parts removed during service operations before starting the engine.

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

⚠ Engine with turbocharger: Never start the engine without installing the air cleaner (ACL). The rotating compressor in the Turbo can cause serious personal injury. Foreign objects entering the intake ducts can also cause mechanical damage.

⚠ Never use start spray or similar to start the engine. The starter element may cause an explosion in the inlet manifold. Danger of personal injury.

⚠ Avoid opening the filler cap for engine coolant system (freshwater cooled engines) when the engine is still hot. Steam or hot coolant can spray out. Open the coolant filler cap carefully and slowly to release pressure before removing the cap completely. Take great care if a cock, plug or engine coolant line must be removed from a hot engine. 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 commencing work on it. Never start or operate the engine with the oil filler cap removed, otherwise oil could be ejected.

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

⚠ Only start the engine in a well-ventilated area. If operating the engine in an enclosed space, ensure that exhaust gases and crankcase ventilation emissions are ventilated out of the working area.

⚠ Always use protective goggles where there is a danger of pieces of metal, sparks from grinding, acid or other chemicals being thrown into your eyes. Your eyes are very sensitive, injury can lead to loss of sight!

⚠ Avoid skin contact with oil. Long-term or repeated contact with oil can remove the natural oils from your skin. The result can be irritation, dry skin, eczema and other skin problems. Used oil is more dangerous to health than new oil. Use protective gloves and avoid using oil-soaked clothes and rags. Wash regularly, especially before meals. Use the correct barrier cream to prevent dry skin and to make cleaning your skin easier.

⚠ Most chemicals used in products (engine and transmission oils, glycol, petrol and diesel oil) and workshop chemicals (solvents and paints) are hazardous to health Read the instructions on the product packaging carefully! Always follow safety instructions (using breathing apparatus, protective goggles and gloves for example). Ensure that other personnel are not unwittingly exposed to hazardous substances (by breathing them in for example). Ensure that ventilation is good. Handle used and excess chemicals according to instructions.

⚠ Be extremely careful when tracing leaks in the fuel system and testing fuel injection nozzles. Use protective goggles! The jet ejected from a fuel injection nozzle is under very high pressure, it can penetrate body tissue and cause serious injury There is a danger of blood poisoning.

⚠ All fuels and many chemicals are inflammable. Ensure that a naked flame or sparks cannot ignite fuel or chemicals. Combined with air in certain ratios, petrol, some solvents and hydrogen from batteries are easily inflammable and explosive. Smoking is prohibited! Ensure that ventilation is good and that the necessary safety precautions have been taken before carrying out welding or grinding work. Always have a fire extinguisher to hand in the workplace.

⚠ Store oil and fuel-soaked rags and fuel and oil filters safely. In certain conditions oil-soaked rags can spontaneously ignite. Used fuel and oil filters are environmentally dangerous waste and must be deposited at an approved site for destruction together with used lubricating oil, contaminated fuel, paint remnants, solvent, degreasing agents and waste from washing parts.

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

⚠ Never mix up the positive and negative battery terminals when installing. Incorrect installation can result in serious damage to electrical equipment. Refer to wiring diagrams.

⚠ Always use protective goggles when charging and handling batteries. The battery electrolyte contains extremely corrosive sulfuric acid. If this comes into contact with the skin, wash immediately with soap and plenty of water. If battery acid comes into contact with the eyes, immediately flush with copious amounts of water and obtain medical assistance.

⚠ Turn off the engine and turn off power at main switch(es) before carrying out work on the electrical system.

⚠ Clutch adjustments must be carried out with the engine turned off.

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

To ensure safe handling and to avoid damaging engine components on top of the engine, use a lifting beam to raise the engine. All chains and cables should run parallel to each other and as perpendicular as possible in relation to the top of the engine.

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

Never carry out work on an engine suspended on a hoist.

⚠ Never remove heavy components alone, even where secure lifting equipment such as secured blocks are being used. Even where lifting equipment is being used it is best to carry out the work with two people; one to operate the lifting equipment and the other to ensure that components are not trapped and damaged when being lifted.
When working on-board ensure that there is sufficient space to remove components without danger of injury or damage.

⚠ Components in the electrical system, ignition system (gasoline engines) and fuel system on Volvo Penta products are designed and constructed to minimize the risk of fire and explosion. The engine must not be run in areas where there are explosive materials.

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

General information

About the workshop manual

This workshop manual contains technical specification, descriptions and instructions for repairing the standard versions of the drives AQ270B, C, D. The product designation and number should be given in all correspondence about the drive.

This Workshop Manual has been developed primarily for Volvo Penta service workshops and qualified personnel. Persons using this book are assumed to have a grounding in marine drive systems and be able to carry out related mechanical and electrical work.

Volvo Penta is continuously developing their products. We therefore reserve the right to make changes. All the information contained in this book is based on product data available at the time of going to print. Any essential changes or modifi cations introduced into production or updated or revised service methods introduced after the date of publication will be provided in the form of Service Bulletins.

Replacement parts

Replacement parts for electrical and fuel systems are subject to statutory requirements (US Coast Guard Safety Regulations for example). Volvo Penta Genuine parts meet these requirements. Any type of damage which results from the use of non-original Volvo Penta replacement parts for the product will not be covered under any warranty provided by Volvo Penta.

Repair instructions

The working methods described in the Service Manual apply to work carried out in a workshop. The engine has been removed from the boat and is installed in an engine fixture. Unless otherwise stated reconditioning work which can be carried out with the engine in place follows the same working method.

Warning symbols occurring in the Workshop Manual (for their meaning see *Safety information*)

WARNING!

IMPORTANT!

NOTE!

are not in any way comprehensive since it is impossible to predict every circumstance under which service work or repairs may be carried out. For this reason we can only highlight the risks that can arise when work is carried out incorrectly in a well-equipped workshop using working methods and tools developed by us.

All procedures for which there are Volvo Penta special tools in this Workshop Manual are carried out using these. Special tools are developed to rationalize working methods and make procedures as safe as possible. It is therefore the responsibility of any person using tools or working methods other than the ones recommended by us to ensure that there is no danger of injury, damage or malfunction resulting from these.

In some cases there may be special safety precautions and instructions for the use of tools and chemicals contained in this Workshop Manual. These special instructions should always be followed if there are no separate instructions in the Workshop Manual.

Certain elementary precautions and common sense can prevent most risks arising. A clean workplace and engine eliminates much of the danger of injury and malfunction.

It is of the greatest importance that no dirt or foreign particles get into the fuel system, lubrication system, intake system, turbocharger, bearings and seals when they are being worked on. The result can be malfunction or a shorter operational life.

Our joint responsibility

Each engine consists of many connected systems and components. If a component deviates from its technical specification the environmental impact of an otherwise good engine may be increased significantly. It is therefore vital that wear tolerances are maintained, that systems that can be adjusted are adjusted properly and that Volvo Penta Genuine Parts as used. The engine Maintenance Schedule must be followed.

Some systems, such as the components in the fuel system, require special expertise and special testing equipment for service and maintenance. Some components are sealed at the factory for environmental reasons. No work should be carried out on sealed components except by authorized personnel.

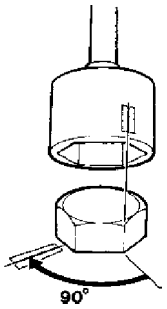
Bear in mind that most chemicals used on boats are harmful to the environment if used incorrectly. Volvo Penta recommends the use of biodegradable degreasing agents for cleaning engine components, unless otherwise stated in a workshop manual. Take special care when working on-board, that oil and waste is taken for destruction and is not accidentally pumped into the environment with bilge water.

Tightening torques

Tightening torques for vital joints that must be tightened with a torque wrench are listed in workshop manual “Technical Data”: “Tightening Torques” and are contained in work descriptions in this Manual. All torques apply for cleaned threads, screw heads and mating surfaces. Torques apply for lightly oiled or dry threads. If lubricants, locking fluid or sealing compound are required for a screwed joint this information will be contained in the work description and in “Tightening Torques” Where no tightening torque is stated for a joint use the general tightening torques according to the tables below. The tightening torques stated are a guide and the joint does not have to be tightened using a torque wrench.

Dimension	**Tightening Torques**	
	Nm	**lbt.ft**
M5	6	4.4
M6	10	7.4
M8	25	18.4
M10	50	36.9
M12	80	59.0
M14	140	103.3

Tightening torques – protractor (angle) tightening



Tightening using both a torque setting and a protractor angle requires that first the recommended torque is applied using a torque wrench and then the recommended angle is added according to the protractor scale. Example: a 90° protractor tightening means that the joint is tightened a further 1/4 turn in one operation after the stated tightening torque has been applied.

Locknuts

Do not re-use lock nuts that have been removed during dismantling as they have reduced service life when re-used – use new nuts when assembling or reinstalling. For lock nuts with a plastic insert such as Nylock® the tightening torque stated in the table is reduced if the Nylock® nut has the same head height as a standard hexagonal nut without plastic insert. Reduce the tightening torque by 25% for bolt size 8 mm or larger. Where Nylock® nuts are higher, or of the same height as a standard hexagonal nut, the tightening torques given in the table apply.

Tolerance classes

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

Sealants

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

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

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 engine.

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

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

Tow different basic types of agent are used on the engine and these are:

RTV agent (Room temperature vulcanizing). Use for gaskets, sealing gasket joints or coating gaskets. RTV agent is clearly visible when a component has been dismantled; old RTV must be removed before the joint is resealed.

The following RTV agents are mentioned in the Service Manual: Loctite® 574, Volvo Penta 840879-1, Permatex® No. 3, Volvo Penta P/N 1161099-5, Permatex® No. 77. Old sealant can be removed using methylated spirits in all cases.

Anaerobic agents. These agents cure in an absence of air. They are used when two solid parts, for example cast components, are installed face-to-face without a gasket. They are also commonly used to secure plugs, threads in stud bolts, cocks, oil pressure switches and so on. The cured material is glass-like and it is therefore colored to make it visible. Cured anaerobic agents are extremely resistant to solvents and the old agent cannot be removed. When reinstalling the part is carefully degreased and then new sealant is applied.

The following anaerobic agents are mentioned in the Workshop Manual: Loctite® 572 (white), Loctite® 241 (blue).

NOTE! Loctite® is the registered trademark of Loctite Corporation, Permatex® is the registered trademark of the Permatex Corporation.

Part 1 Description

General description, Aquamatic 270

Outboard model AQ270 is compact unit suspended in a shield on the boat's transom. The unit can be steered horizontally using a steering rod on the inside of the shield and can be raised with an electro-mechanical lift operated from the driving position. All exterior components are manufactured from corrosion resistant materials. In order to further increase the corrosion resistance all components which are subject to corrosion are carefully surface treated. Zinc electrodes, which protect the drive unit from damage caused by galvanic currents are fitted on the lower gear housing behind the propeller and to the shield. See Figs 3 and 4. The engine cooling water is sucked in through the two cooling water inlets on the lower gear housing. See 21, Fig 1. The exhaust gases and cooling water are taken through the exhaust channel of the outboard drive and released under the rear edge of the cavitation plate. The shift mechanism consists of the Volvo Penta patented cone clutch, of "Silent-Shift" type. The mechanism is fitted with servo disengagement and self-adjusting friction cones and is quiet in engagement and easy to operate.

Power transmission

Power from the engine is transmitted to the upper gear housing through the vibration damper (27), Fig. 1, the shaft (25) and the double universal joint (5). From the universal joint the power is transmitted to the input gear (7) for forward and reverse, which is in constant mesh with "Forward" and "Reverse" gears (8). These gears are carried on the countershaft so that they can rotate independently of the shaft. Between the gears (8) there is a cone clutch which makes possible disengagement and reversal of the direction of rotation of the vertical drive shaft (14). The lower end of this shaft drives the propeller shaft (18) through the propeller gearing. The total reduction ratio for the drive 270B is 1.61:1, for the drive 270C it is 1.89:1 and for the 270D 2.15:1.

Manoeuvering

The countershaft is fitted with a thread between the forward and reverse gears (8), and it is on this thread that the engaging sleeve (11) can be moved up and down by means of the control mechanism (12). Both ends of the engaging sleeve are tapered so that when the sleeve is moved upwards or downwards, the tapered surfaces engage with the corresponding outer tapers 9 which are screwed onto the forward and reverse gears. Since the engaging sleeve (11) is journalled on the countershaft thread, increased transmission torque from the engine assists in more positive engagement and increased frictional power between the engaging sleeve and the gear tapers.

When the control lever is moved to the "Forward" position, the engaging sleeve (11) engages with the taper of the lower gear, whereby the vertical drive shaft (14) is locked in engagement with the gear. The propeller will then rotate for running forward. When the control lever is moved to the "Reverse" position, the engaging sleeve is moved upwards until it engages with the taper (9)on the upper gear, thus producing the opposite direction of rotation. In the neutral position, the engaging sleeve is retained in an intermediate position so that both the gears rotate freely. The gearing described above gives standard rotation to the propeller shaft, that is, a propeller with a left-hand thread.

In the case of propeller rotation in the opposite direction (starboard drive in case of double installation), then the upper gear (8) functions as forward gear and the lower gear (8) as reverse.

When running in reverse, the outboard drive is kept in its normal position by means of a retaining pawl (22).

Steering

The outboard drive is steered by the movements of the steering wheel which are transmitted through an internally located steering rod (1) which is fitted on the steering yoke (3). The action of the steering rod is independent of the degree to which the drive is tipped up. The lower parts of the yoke arms are carried in a steering casing (6) which is, in its turn, bolted to the upper gear housing of the outboard drive. The steering angle of the drive is about 30° from the neutral position.

Lift device

In order to facilitate tipping-up of the outboard drive, it is fitted with an electrical-mechanical lift device (2), which is operated from the steering seat. The lift device is fitted on the inside of the transom shield and consists of an electric motor which operates a push rod on the pivot yoke through the medium of a worm gear. This releases the retaining pawl and lifts out the drive to its tipped-up position. The electric motor cuts out automatically as soon as the drive has attained its fully tipped-up or fully lowered positions. When the drive is being lowered, it is automatically centred independent of the position of the steering wheel. The maximum tipped-up angle is about 60°. The outboard drive remains in the required tipped-up position and for this reason the unit can be run when partly tipped up during shorter periods and at low speed.

Lubrication

The outboard drive is fitted with an oil system which is common to both the upper and lower gear housing. The oil is circulated through all the gears and bearings by means of an oil circulation pump (17) which is fitted on the gear in the lower gear housing. The oil is cooled by the water flowing past the lower part of the outboard drive. A dipstick for checking the oil level is fitted in the cover above the upper gear housing. The double universal joint is lubricated for life and requires no periodical servicing.

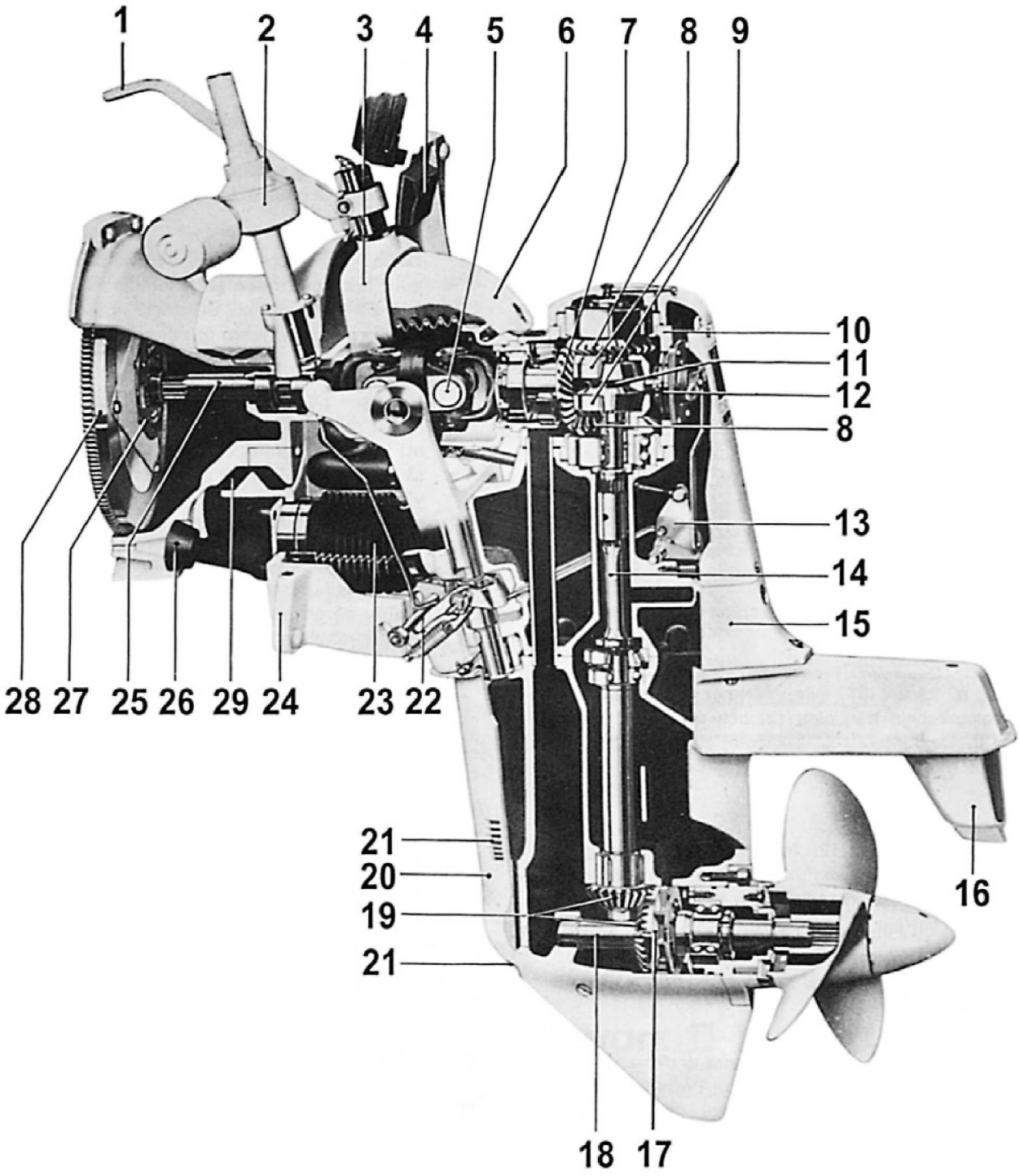


Fig. 1. Cross-section through the Aquamatic 270

1. Steering rod
2. Lift device
3. Steering yoke
4. Rubber block
5. Universal joint
6. Steering casing
7. Input gear
8. “Forward”/“Reverse” gears
9. “Forward”/“Reverse” gear taper
10. Upper gear housing
11. Engaging sleeve
12. Control mechanism
13. Shift fork
14. Vertical drive shaft
15. Intermediate housing
16. Trimming tab
17. Oil circulation pump
18. Propeller shaft
19. Propeller gear
20. Lower gear housing
21. Water intake
22. Retaining pawl
23. Bellows for exhaust system
24. Mounting collar
25. Drive shaft
26. Supporting rubber pad
27. Vibration damper
28. Flywheel
29. Rubber element

Part II Removing the outboard drive unit

⚠ **IMPORTANT!** It is of the greatest importance to ensure that the workbench and tools are kept clean when working on the outboard drive unit to prevent impurities from getting into bearings, bushes, etc. Make a habit of always washing the unit externally before removing. The figures included in the text below refer to the exploded drawings at the end of this book.

1. Remove the propeller by knocking up the tabs on the lock washer 2, Fig. 2 for the propeller taper 1 and unscrewing the taper. Take off the propeller and the spacing sleeve (33, Fig. 59).

2. Remove the two crosshead screws 1, Fig 3, for the zinc ring and remove the ring.

3. Drain off the oil from the outboard drive. To do this slacken the dipstick (71, Fig 57) and the oil drain plug (36, Fig. 59). Fit new packing and O-rings (later drive).

4. Remove the casing (76, Fig 57) from over the control mechanism and disconnect the control cable from the yoke (2, Fig. 58) and unscrew the securing block (39). Remove the control cable locking plate (35), which is mounted on the front edge of the intermediate housing.

5. Loosen the steering casing (12, Fig. 56) from the upper gear housing, the rubber bellows for the universal joint, the exhaust bellows from the intermediate housing and the water hose from the cooling-water connection (28, Fig 58) on the yoke.

6. Unscrew both the lock screws (32, Fig. 56) which retain the pivot pins (31) in the mounting collar. Place a block under the drive end and knock out the pivot pins and lift off the drive unit.
NOTE: Do not lose the two bushes (38, Fig. 58) on the yoke.

7. Loosen the control rod (18) from the yoke, unscrew the bolts (15) and loosen the nuts (17) retaining the upper gear housing to the intermediate housing. Strike carefully with a rubber mallet on one of the housings until they separate.

8. Count the number of shims between the different housings and on all the gear assemblies in case there is no need to replace the gears, housings, or bearings since, in this case, the same number of shims must be re-fitted when assembling.

9. Unscrew the seven bolts retaining the lower gear housing to the intermediate housing and strike carefully with a rubber mallet on one of the housings until they separate from each other. Lift off the splined sleeve (41, Fig.59).

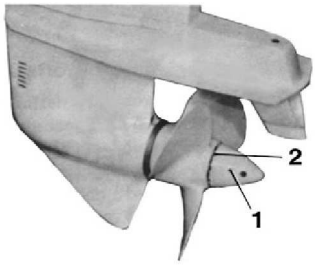


Fig. 2.

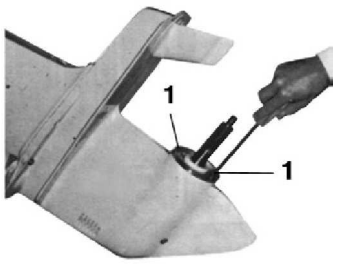


Fig. 3.

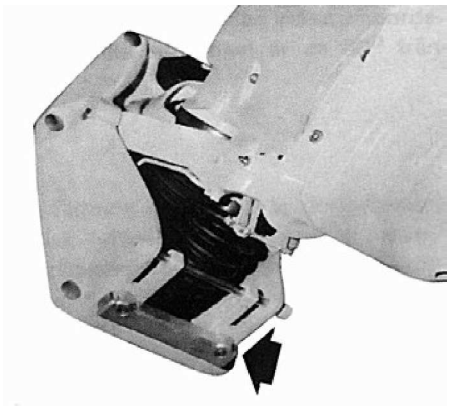


Fig. 4.

Part III Reconditioning the upper gear housing

A. REMOVING

1. Place the upper gear housing in tool 884264.

2. Unscrew the bolts (66, Fig. 57) for the shift mechanism and remove the mechanism. Note that the friction lug (56) goes with the mechanism.

3. Unscrew the internal hexagon screws for the clamp ring (36) and pull out the universal joint with the double bearing box. Note: Take care of the shims.

4. Unscrew the four bolts on the gear housing cover (4) and take off the cover. Note: The front right bolt is hollow with an O-ring sealing 1, Fig. 5. Take care of the shims 2.

5. Slacken the nut 3, Fig. 5 (52, Fig. 57) at the top of the countershaft. Note: It has a left-hand thread. Use tool 884264 as a counterhold on the splines when the nut is released. Lift out the upper gear with the bearing box and engaging sleeve. Remove the lower gear

assembly by taking off the divided lock ring (51) and washer (50). Make line-up marks on the gears to ensure they are re-fitted in the same place.
NOTE! Be very careful with the engaging sleeve and the gear tapers that they do not get scratched.

6. Remove the needle bearings and the spacer rings (48 and 49) from the upper and lower gear assemblies. Note that the needle bearings are matched in pairs, and must not get mixed up. Press the upper and lower gears loose from the bearings (39). Use tools 884386 and 884259 for this purpose.

7. Press the bearings (39) out of the bearing sleeves (40). Use tools 884386 and 884265 for this purpose.

8. Remove the twelve-sided bolt (34), 1/2" width across flats, a hexagonal socket screw is fitted on later drives as of and including PZ No. 272 1099 and the stop washer (35) in the center of the universal joint stem and pull out the joint. Then press the double bearing box (12) out of the clamp ring (36). Use a rubber mallet if necessary.
NOTE: Take care of the shims.

9. Remove the stop washer (18) from the double bearing box.
NOTE: Take care of the shims. Then remove the lock ring (17). After this take off the seal (16), which is always replaced by a new one. Press out the input drive (11) with the help of tools 884386 and 884259, see Fig. 6.

10. If necessary, press the roller bearing (12) from the drive with the help of a "knife puller". The bearings (12) can be replaced separately. With replacement of the outer races for the bearings, the races must be tapped out evenly all round. The oil deflector washer must always be replaced in connection with changing the bearing races.

11. Wash the parts thoroughly and check for wear. If necessary, replace parts.
NOTE: Gears with tapers are sold in sets in order to ensure the proper tooth contact.

B. ADJUSTING THE UPPER GEAR

When assembling the upper gear housing, it is extremely important to ensure that the drive and gears are in their proper position relative to each other. This concerns not only the clearance between the gears but also the engagement of the gear teeth. Correct tooth contact means mat the stresses to which the gears are subjected while the unit is running, are distributed over a large part of the tooth surface. This helps to prevent tooth failure and abnormal gear wear while contributing to smooth shifting at the same time.

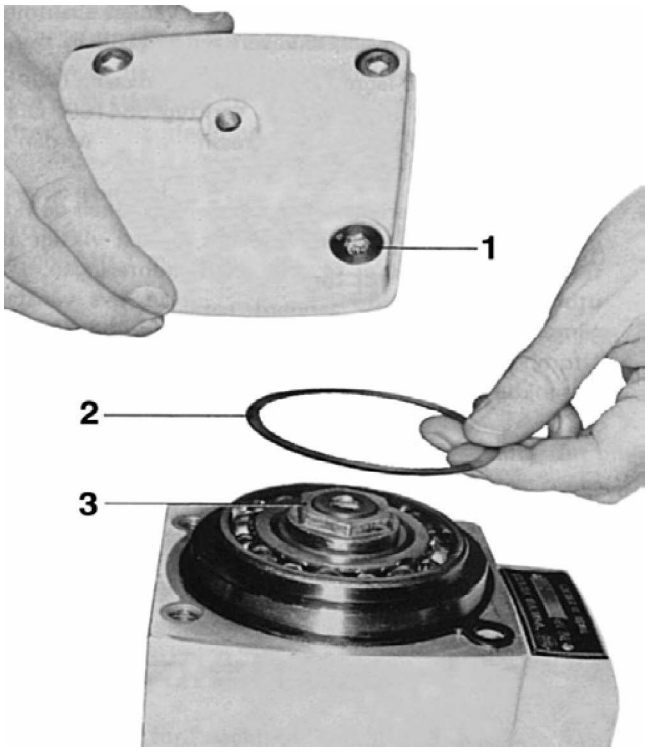


Fig. 5.

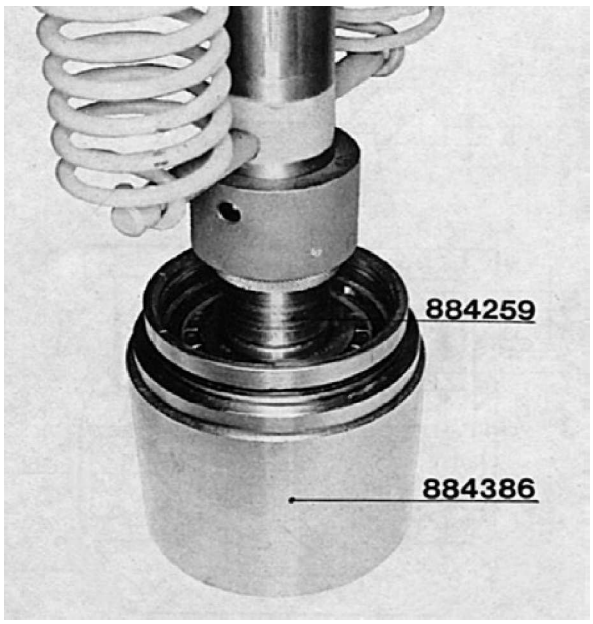


Fig. 6.

Input drive (double bearing box)

1. Press onto the drive the large roller bearing 1, Fig. 7, which is included in the complete double bearing box (12, Fig. 57) on the drive 2. Use here tool 884263.

2. Fit the input drive into the double bearing box 3 and press on the small roller bearing 4 so that light tension is obtained. Use tool 884263, Fig 8.
NOTE: Protect the tops of the gears. Rotate the drive a few turns to ensure that the bearings bed down properly. Check the tension by using a spring balance and a cord, which is wound round the bearing housing, see Fig. 9. The tension should be 0.5–1.0 kp (1.1–2.2 lb.). If the tension is too low, carefully apply a little more pressure to the roller bearing; and if it is too high, ease the pressure on the roller bearing slightly.
NOTE: With run-in bearings the tension should be 0.4–0.7 kp (0.9–1.6 lb.).

3. Determine the measurement ”B”, see Fig. 7. Use a depth gauge micrometer and read off measurement ”C” between the edge of the double bearing box and the bearing inner ring, see Fig. 10, and then measurement ”D” between the edge of the double bearing box and the drive neck. Thereafter calculate the difference.

4. Measure the depth of the recess in the washer E, Fig. 7 (18) and add to this measurement so many shims 5 (20) that measurement ”B” is obtained according to point 3.

5. Then place the washer in position and draw together the gear assembly in the double bearing box with the help of tool 884483 and bolt (34), which is tightened to a torque of 12.5 kpm (90 lb. ft.). On drives as of and including PZ no 272 1099 with a hexagonal socket screw the tightening torque is 8 kpm (60 lb.ft). Rotate a couple of turns and re-check the tension, which should be 0.5–1.0 kp (1.1–2.2 lb.). If the tension is too high, remove the washer and press back the drive slightly, after which try one more shim under the washer. If the tension is too low, try remedying this by removing a shim. Then draw the double bearing box together with tool 884483. Again check the tension.

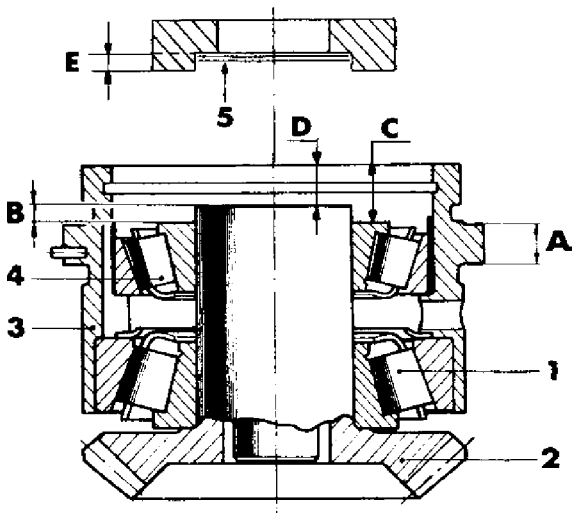


Fig. 7.

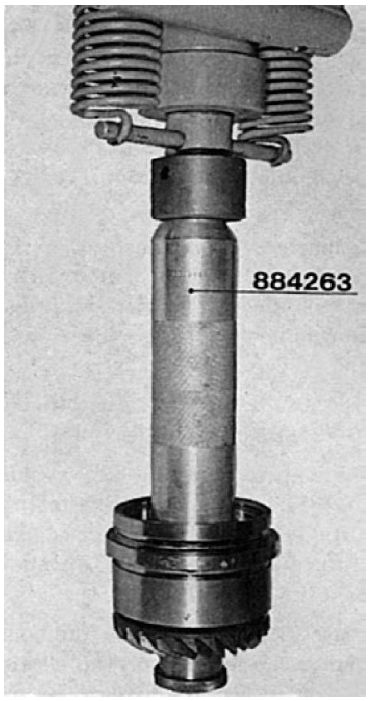


Fig. 8.

”Forward” and ”Reverse” gears

1. Lubricate the ball bearings (39) and press them into their respective bearing boxes, (40).
NOTE: Turn the bearings so that the recesses in the bearing races for fitting the balls face away from the gears. Use, for example, tool 884168.

2. Then press the bearings (39) and bearing boxes, (40) on the gears (11), Use, for example, tool 884168.
NOTE: Protect the taper from being deformed when pressing together.

3. Always start the adjusting with the adjustment of the ”Forward” gear. Should the previously removed gears be used again, it is important that the ”Forward” and ”Reverse” gears are not confused when fitting. For an outboard drive with standard rotation, i.e., a propeller with a left-hand thread, the ”Forward” gear is the lower gear. An outboard drive with opposite rotation has the upper gear as ”Forward” gear.

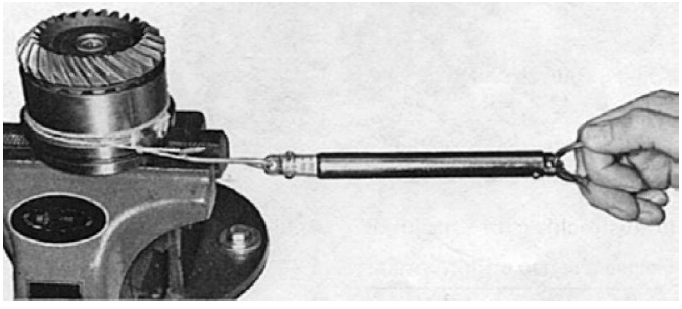


Fig. 9.

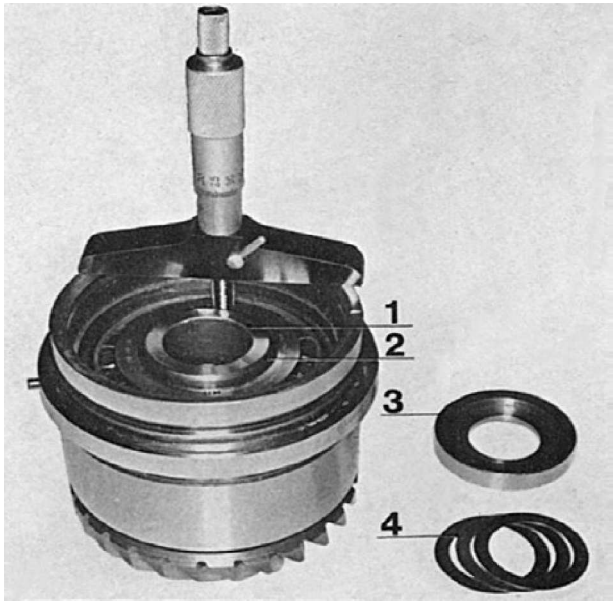


Fig. 10.

1. Drive neck
2. Bearing inner ring
3. Stop washer
4. Shims

C SHIMMING ”FORWARD”/”REVERSE” GEARS, METHOD I

Forward Gear

The ”A” measurement, Fig. 11, is a nominal figure predetermined to 62.05 mm (2.46").

Due to tolerances in manufacture, the gears can be marked with either a plus or a minus figure. As far as the gear housing is concerned, it will have two stamped-in figures denoted ”C” and ”B”, Fig. 61, page 40.

In order to simplify the manufacturing, only the three last digits will be found on the housing (the ”B” and ”C” figures). However, when calculating the shim thickness, the digit six must be used, see the calculating examples below.

The marking figure on the gear is in the same way as on the housing shortened, and only the last digit, if any, is shown. For both forward and reverse gear, take the plus or the minus figure on the gear and add or subtract this figure depending on its + or – symbol, from the nominal figure 62.05 as shown below.

From this calculated figure, subtract the figure denoted ”C”, and the result is the thickness of the shim needed.

	Meas. in mm (in.).	
Meas. ”A”	62.05 (2.46)	fixed
Gear ± marking, e.g. +	0.05 (0.002)	marked[1)]
	62.10 (2.462) . . 62.10 (2.462)	
Gear housing marking ”C”, e.g.	–61.65 (2.444)	stamped[2)]
	0.45 (0.018)	

Shim thickness for ” Forward” gear = 0.45 (0.018)

[1)] Only 5 marked, [2)] Only 1.65 stamped

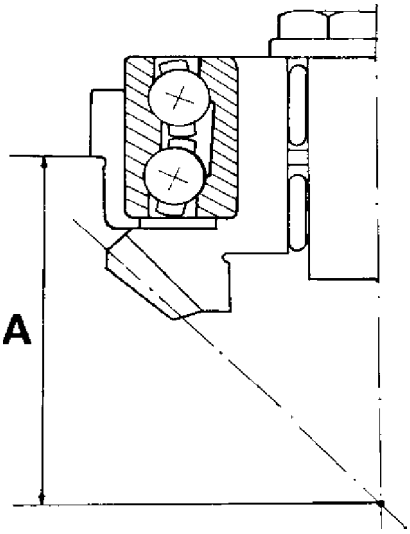


Fig. 11.

Reverse Gear

Repeat the above-stated shimming procedure for the reverse gear. However, for the calculation, take the stamped-in figure denoted ”B” and use this in the calculation in order to get the shim thickness for the reverse gear.

	Meas. in mm (in.).	
Meas. ”A”	62.05 (2.46)	fixed
Gear ± marking, e.g. –	0.05 (0.002)	marked [1)]
	62.00 (2.458) . . 62.00 (2.458)	
Gear housing marking ”B”, e.g.	–61.65 (2.444)	stamped[2)]
	0.35 (0.014)	

Shim thickness for ”Reverse” gear = 0.35 (0.014)

Then continue according to points 1–11 below.

METHOD II

Begin by adding 0.2 mm (0.08") shims, which is about the best size to start off with, under the bearing boxes (40, Fig. 57).

Then continue in accordance with points 1–11 below.

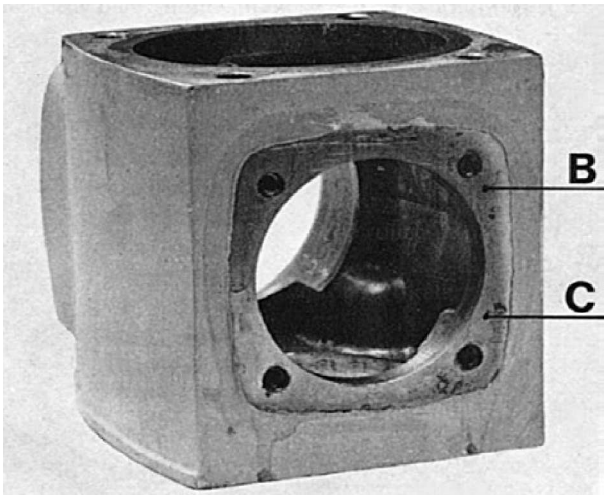


Fig. 12.

1. In order to get a clear picture of the tooth contact pattern, smear the teeth of the input gear and meshing gear with a thin coating of marking paint. Then fit the ”Forward” gear in the gear housing (2) with the measured shims.

2. Fix the tool 884387 for the upper gear housing in a vice.

3. Fit the upper gear housing so that the bearing coincides with the corresponding recess in the tool.

4. Fit the assembled double bearing box (12) with 0.3 mm (0.012") shims.

NOTE: The guide pin in the double bearing box should face downwards and fit in the corresponding slot.

5. Fit the clamp ring together with enough shims that the ring actually presses in the double bearing box. There must be a clearance between the gear housing and the clamp ring.

6. Measure the backlash with a rocker arm indicator. See Fig. 13. The backlash should be 0.15–0.25 mm (0.0060–0.0098") on B models. On other models C and D the backlash should be 0.08–0.18 mm (0.003–0.007"). If the backlash is too small, more shims should be placed between the double bearing box (12) and the upper gear housing (2). If the backlash is too large, reduce the thickness of shims. Note point 5.

7. Rotate the gear in its correct direction of rotation (clockwise) while braking the gear hard at the same time by pushing against the taper on the gear with a wooden handle. See Fig. 14. The marking paint on the gear teeth is then pressed off from the surfaces where the teeth mesh and this gives a picture of the tooth contact pattern and its position.

8. Remove the gear assembly and compare the contact pattern on the teeth with the pattern shown in Fig. 15 (A). This shows the ideal tooth contact on the drive side which should be aimed at for both the input drive 1 (the double bearing box) and gears 2 and 3 (”forward” and ”reverse” gears respectively). The contact pattern is practically oval in shape and, on the drive side, is on the centre of the tooth vertically but displaced towards the toe.

9. If the contact pattern is like (B), Fig. 15, the thickness of shims should be reduced under drive 1 (the double bearing box), so that the drive 1 is moved towards the centre.

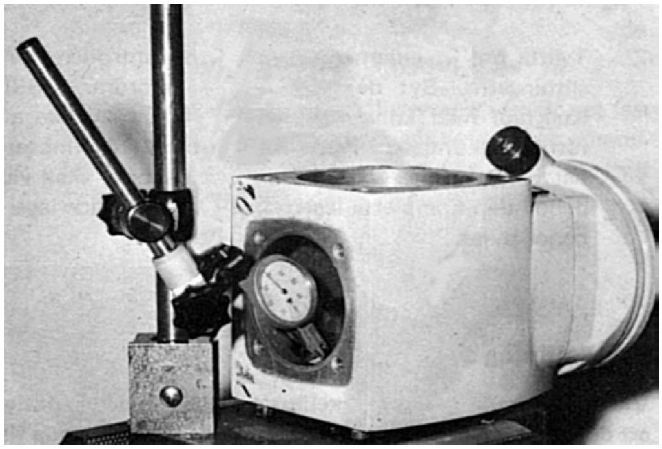


Fig. 13.

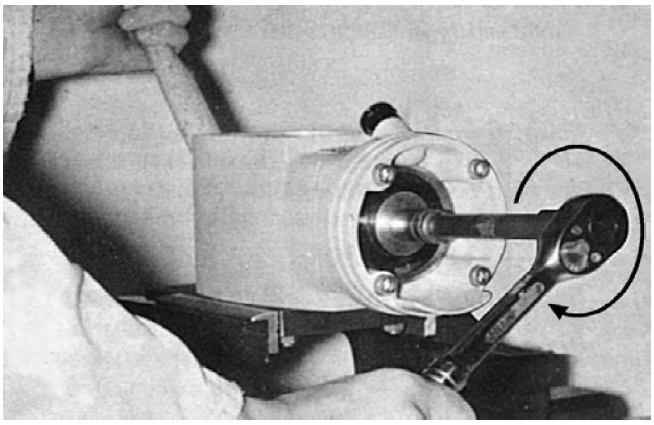


Fig. 14.

If the contact pattern is like (C), the thickness of shims under drive 1 (the double bearing box) should be increased, so that the drive 1 is moved from the centre.

NOTE: Should the drive 1 be moved in or out, gear 2 must be moved correspondingly out or in so as to keep the backlash unchanged.

10. When the correct backlash and tooth contact pattern have been obtained for the ”forward” gear, adjust the ”reverse” gear as follows: Coat drive 1 and the ”reverse” gear 3 with a thin coating of marking paint. Then fit the ”reverse” gear in the gear housing (2) with measured shims. Tool 884387 fits only the lower gear. In order to keep the upper bearing in position, use a cover with too many shims fitted.

11. Measure the backlash according to point 6. Then compare the contact pattern in accordance with points 7–9.

NOTE: Shims may only be altered under ”reverse” gear 3, since otherwise the adjustment for the ”forward” gear is altered.

D. RECONDITIONING THE UNIVERSAL JOINT

Dismantling the universal joint

1. Remove the snap rings (24, Fig. 57) which hold the needle bearings in the yokes.

2. Use a hammer and drift to drive out the needle bearings, see Fig. 16. Remove the spider.

Inspecting the universal joint

Check the spider and needle bearings for looseness and scoring in the bearing races. If there are any faults, replace the spider complete with the needle bearings.

Also make sure that the needle bearing cages are not loose in the yokes. If there is looseness, fit new yokes.

Assembling the universal joint

1. Fit new seal washers on the spider trunnions. Insert the spider in the flange yoke.

2. Push the spider so far in one direction that the needle bearing can be slid into the trunnion. Then press in the needle bearing so far that the snap ring can be fitted.

3. Fit the other needle bearing and snap ring in the same way.

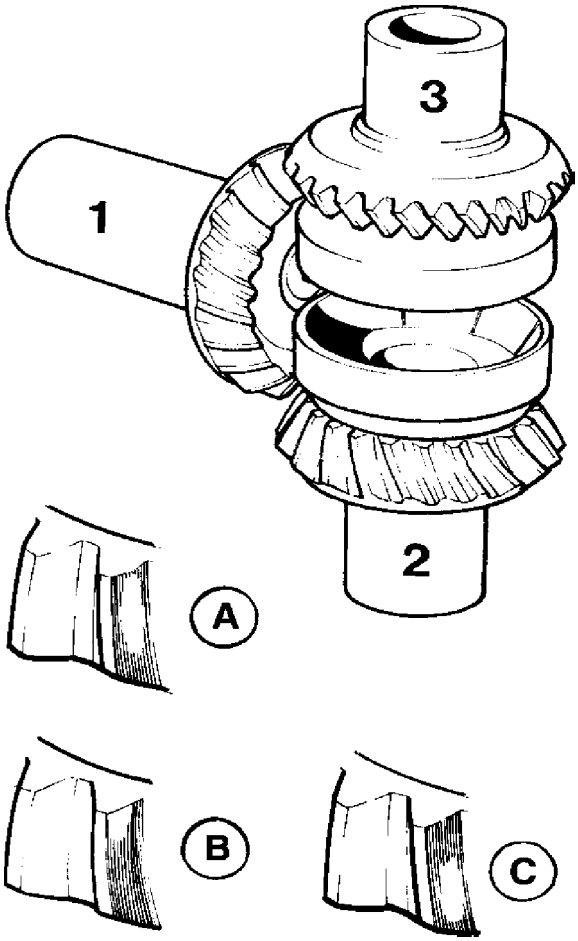


Fig. 15.

(A) Correct pattern

(B) Reduce shim thickness (drive 1)

(C) Increase shim thickness (drive 1)

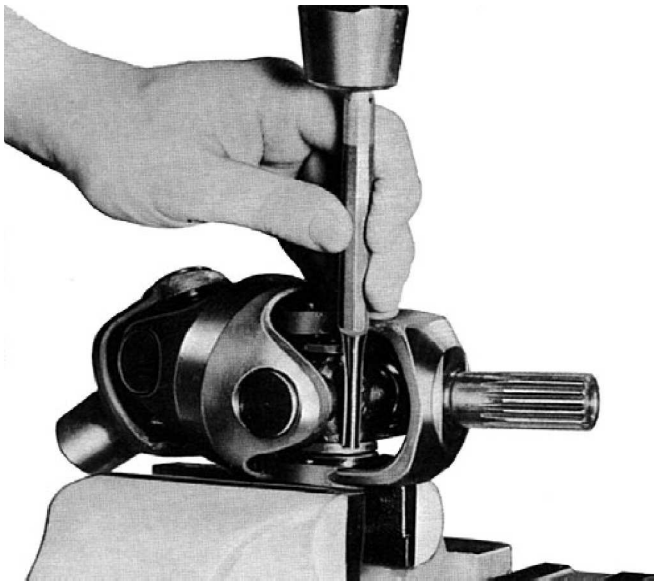


Fig. 16.

E. FITTING THE UPPER GEAR

Before fitting, clean the marking colour from all the gears and lubricate all bearings and bolts.

1. Fit the ”Lower” gear together with the measured shims.

2. Fit the snap ring (47, Fig. 57), the washer (46), the spring (45), the needle bearings (48) and the engaging sleeve (44) with the drilled recess facing upwards, on the shaft (43). Place the shaft in the lower gear.

3. The engaging sleeve (44) should weigh lightly on the spring (45). Feel by hand if this is the case. See Fig. 17.

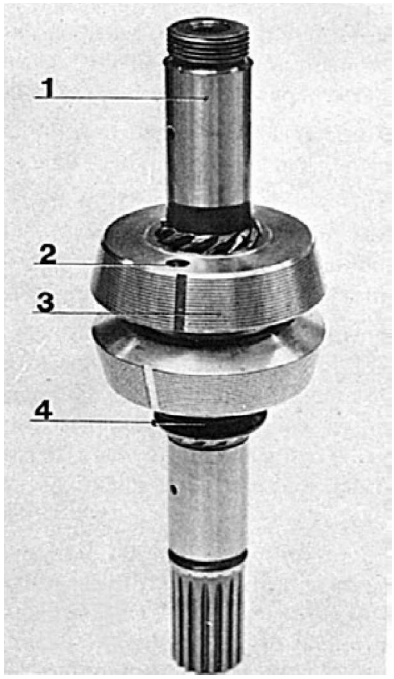


Fig. 17.

1. Vertical shaft
2. Drilled marking
3. Engaging sleeve
4. Spring

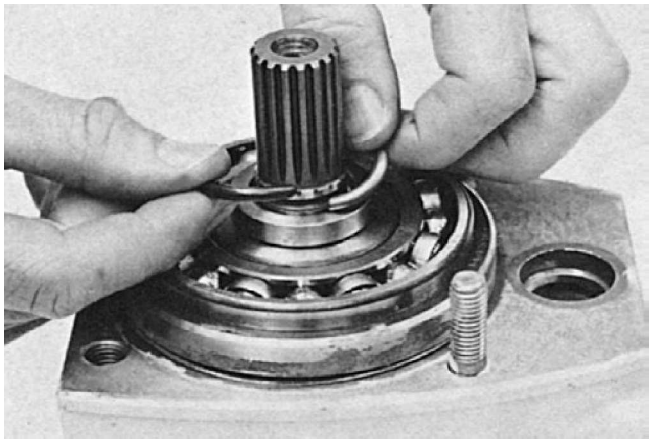


Fig. 18.

4. Place the upper gear together with its shims in the gear housing. Fit the needle bearings (43) with the spacer ring (49) between the bearings and the shaft's lower circlips (50 and 51), Fig. 18.
NOTE: The needle bearings are classed in pairs and must not be mixed up.

5. In order to obtain the correct axial clearance on the shaft (43), a choice can be made between three nuts (52) with flats of different thicknesses. Begin by fitting the nut with part No. 897311.

Tighten the nut (52) on top of the countershaft to a torque of 6 kpm (45 lb. ft.). A new type of nut is fitted on later drives. This nut is of steel with a wear face of brass, classified to three thickness: 2.0; 2.37 and 2.65 mm (0.0785; 0.093 and 0.104"). Tightening torque for the new nut is 12 kpm (90 lb. ft.).
NOTE: The nuts have left-hand threads. Use tool 884264 as a counterhold.

Then measure the clearance between the nut (52) and the bearing (39). The axial clearance should be between 0.1–0.5 mm (0.004–0.020").

If the clearance is greater (max. 0.75 mm = 0.030"), fit the nut with part No. 814360. Where the clearance exceeds 0.75 mm (0.030"), but max. 1.05 mm (0.041"), fit the nut with part No. 814361. Should the clearance exceed 1.05 mm (0.041"), the bearings (39) are defective.

6. Measure the thickness of shims between the clamp ring (36) and the gear housing as follows: Place the double bearing box with the measured shims (15) in position. Add so many shims to the clamp ring that there is a clearance of max. 0.10 mm (0.004") between the clamp ring and gear housing. Press the clamp ring into position with the hand and then measure with a feeler gauge all round. See Fig. 19.

7. Again remove tool 884483 from the double bearing box. Remove the stop washer (18) and the shims. Press the new sealing ring (16) up against the shoulder on the double bearing box, with the open part facing downwards. Use tools 9991801 and 884312, see Fig. 20. Fit the circlip (17) and the stop washer (18) with shims.

8. Fix the O-ring (19) on the stop washer (18) with grease.

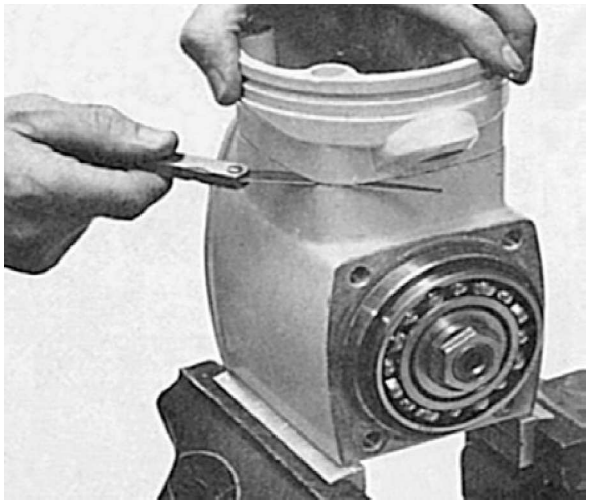


Fig. 19.

9. Fit the shims and the two new O-rings (14) on the double bearing box.

10. Place the clamp ring (36) and the double bearing box on the universal joint.
NOTE: The guide pin should fit in the slot on the clamp ring. Fit the stop washer (35) and the bolt (34). A new bolt (34) should be used for the final fitting. Use VP 1161053-2 or Loctite 270 adhesive on this bolt. Tighten the bolt to a torque of 12.5 kpm (90 lb. ft.) or 8 kpm (60 lb. ft) for respectively screw.

11. As a protection against corrosion, smear the surfaces between the clamp ring and the gear housing with sealing compound VP 1141570-0 or Permatex 679, before fitting.

12. Fit the double bearing box with the universal joint in the gear housing. The guide pin in the double bearing box should face downwards. Stick the bolts with VP 1161053-2 or Loctite 270 and tighten to a torque of 3.5 kpm (25 lb. ft.).

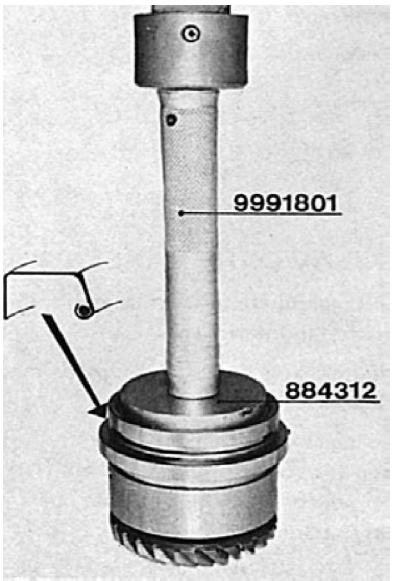


Fig. 20.

Fitting the cover on the upper gear housing

1. Fit a sufficient number of shims under the cover so that there is a clearance of max. 0.1 mm (0.004") between the cover and gear housing. Place the cover in position and press it in the right way. Measure the clearance all round with a feeler gauge. See Fig. 21.

2. Apply sealing compound and place the sealing ring (10) so that the seal for the front, right bolt fits into the recess in the cover provided for this purpose. Then fit the measured shims and tighten the cover. **NOTE:** The front, right bolt is hollow and should have an O-ring under its head. Tightening torque for the bolts, 1.4–1.7 kpm (10–12.3 lb.ft.).

F. RECONDITIONING CONTROL MECHANISM

Removing

1. Knock out the tension pin (64, Fig. 57), see Fig. 22, and pull out the pin (65). Remove the locking wire (60), the spring (59) and the ball (58) and pull out the eccentric plunger (55). Remove the sealing ring (63).

2. Clean the parts and check for wear, replace if necessary.

FITTING

Lubricate all movable parts and bolts before fitting

1. Fit the sealing ring (63) in the cover (54), the side with the spring being turned inwards.

2. Install the eccentric plunger (55). Fit the pin (65) and lock it with the tension pin (64). Make sure that the tension pin is centrally located in the eccentric plunger.

3. Fit the ball (58) and the spring (59). Insert a locking wire (60) in the slot in the cover and use this to

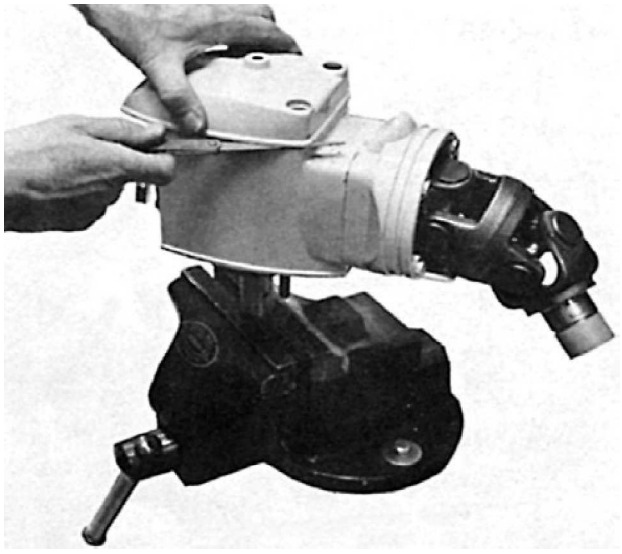


Fig. 21.

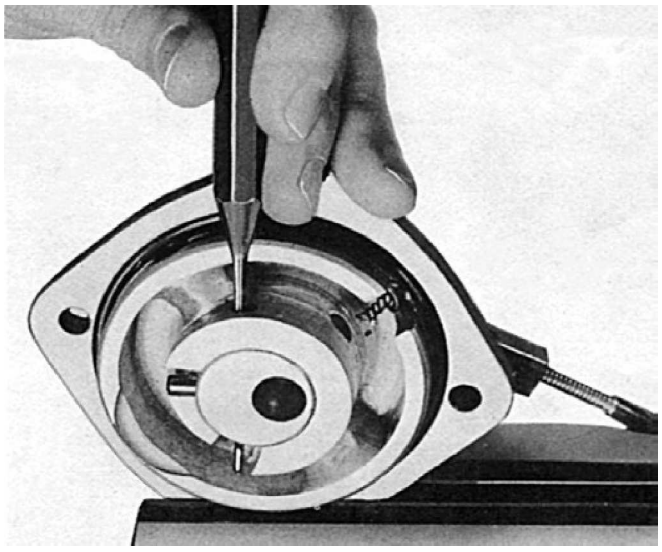


Fig. 22.

compress the spring. Clip the wire and turn down the end in the cover recess. The only function of the locking wire is to hold in the spring while the control mechanism is being fitted in the gear housing.

4. Fit the spring and friction lug (56) as well as the O-ring (67). Coat the contact surfaces with VP 1141570-0 or Permatex 679. Tighten the control mechanism in the gear housing so that the bolt (61) in the cover (54) is displaced towards the starboard. See Fig. 23.

5. Set the control mechanism to neutral position and remove all the shims (62) under the bolt (61). Now it will not be possible to rotate the shaft (43). Then fit the shims one at a time until the shaft can be rotated without resistance. After adjusting, apply sealing agent to the shims and bolt. Final fitting then follows.

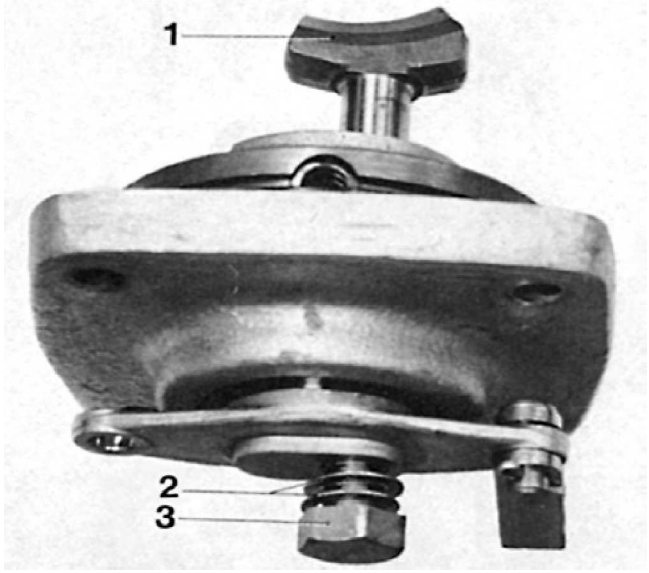


Fig. 23.

1. Friction lug
2. Shims
3. Bolt

OVERHAULING THE CONTROL MECHANISM, MODIFIED MODELS

The control mechanism on later drives has a modified design.

The ball, spring (and locking wire) which mark the neutral position have been deleted. The bearing housing has been complemented with a neutral position groove for the pin.

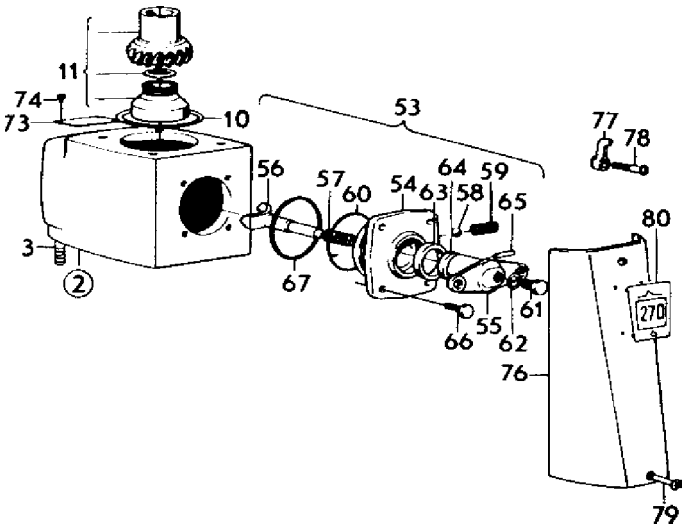


Fig. A.

DISASSEMBLY

1. Knock out the tension pin (64) fig. A, and fig B and pull out the pin (65) and the excenter piston (55). Remove the sealing ring (63).

2. Wash the parts clean and check for wear and replace parts when necessary.

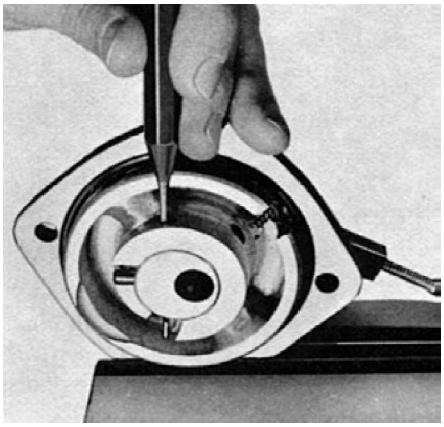


Fig. B.

ASSEMBLY

Oil all moving parts and screws before assembly.

1. Fit the sealing ring (63) in the cover with the side having the spring turned inwards.

2. Push in the excenter piston (55). Fit the pin (65) and lock the pin with the tensioning pin (64). Make sure that the tensioning pin is in the middle of the excenter piston.

3. Fit the spring and the sliding shoe (56) and the O-ring (67). Apply VP 1141570-0 or Permatex 679 on the mating faces. Screw the control mechanism tight in the gear housing so that the screw (3) fig. C in the cover is pushed towards starboard side.

4. Set the control mechanism in the position between forward and neutral or between reverse and neutral and remove all the adjusting shims (2) fig. C under the screw (3). In this position the shaft cannot be turned. Then replace one shim at a time until the shaft can be turned without resistance. After adjustment sealing compound is spread on the shim and the screw after which final assembly takes place.

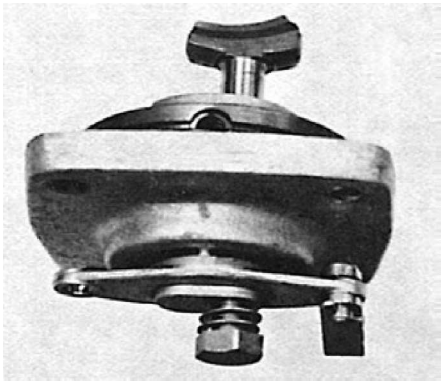


Fig. C.

Part IV Reconditioning the intermediate housing

A. REMOVING

1. Slacken the two screws (30, Fig. 58) holding the hose attachment (28) to the yoke. Remove the hose attachment and packing.

2. Remove the yoke by knocking out the guide spindle (23). Use tools 884311 and 9991801, see Fig. 24.

3. Remove the plugs (14), the retaining pawl and plastic washers (16 and 60) as well as the wear washer (25).

4. Remove the two sealing rings (13) and the needle bearing (12) with the help of tools 884259 and 9991801, press out the bush (11).

5. Remove the shaft (4) for the shift yoke (2) and pull out the yoke.

6. Drive out the bearing race (13, Fig. 59) for the axial bearing. Use tools 884140 and 884143, see Fig. 25.

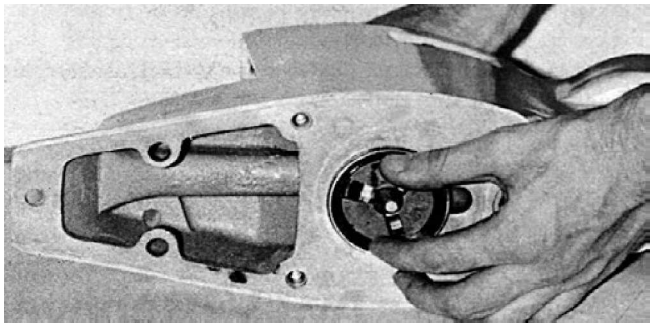


Fig. 25.

7. **If necessary, the retaining pawl can be removed as follows:**

Remove the shaft pins, Fig. 27 (48, Fig. 58). Take off the spring (57) as well as the spring (49) and release the springs (58).
NOTE: Grip the spring shaft (50) so that it does not fly off. Unscrew the nuts (55), remove the spring hooks (52 and 54) and spacer washers (44), also the retaining pawl (42). Lift off the journalling (43), the shaft (53) and the thrust rod (45).

8. Clean the parts, check for wear and replace if necessary.

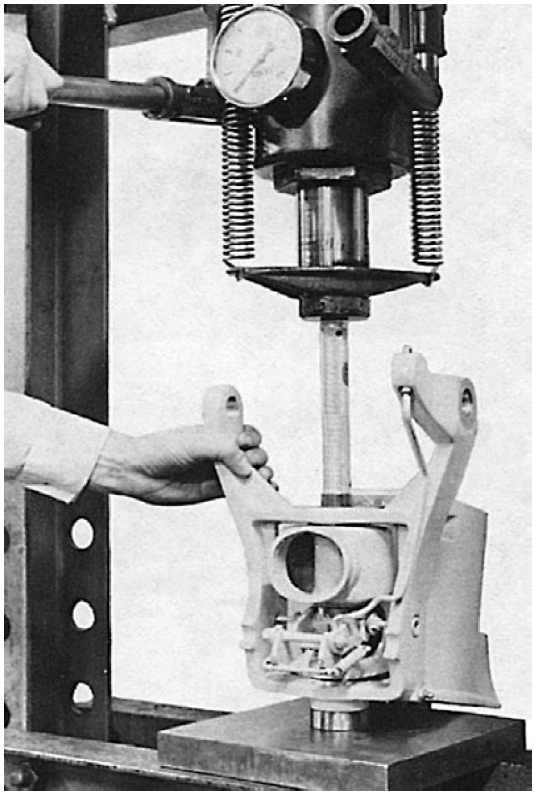


Fig. 24.

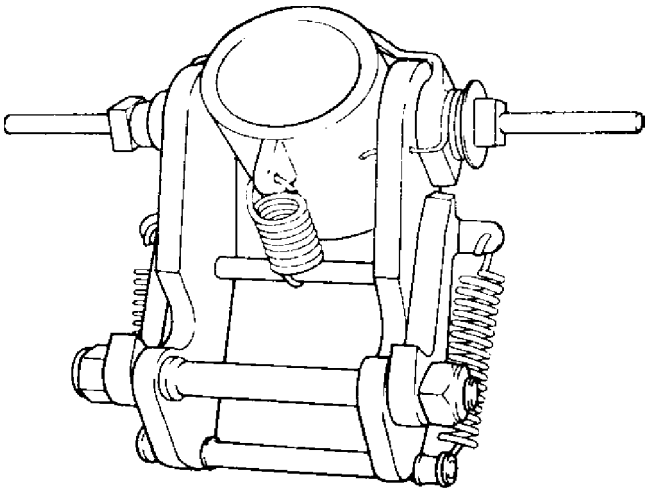


Fig. 26.

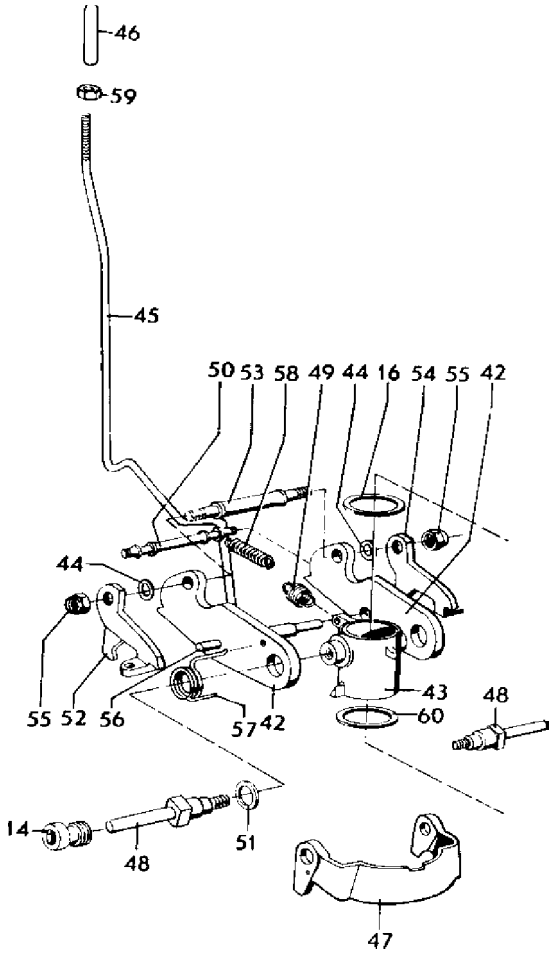


Fig. 27.

B FITTING

Lubricate all the movable parts and bolts before fitting

1. Fit the shaft, Fig. 27 (53), on one of the retaining pawls (42) and the spacer washer (44) as well as the spring hook (52). Screw one of the nuts (55) onto the shaft. Then place the thrust rod (45) on the stop shaft (56) and fit the journalling (43) in the retaining pawl half. After this place the thrust rod (45) and the stop shaft (56) in the retaining pawl half. Now fit the other retaining pawl (42) and the spring hook (54) with the spacer washer (44) on the shaft (53) and the journalling (43). Screw tight the other nut (55).
NOTE: Tighten the nuts (55) fully, then slacken them about 1/8 of a turn so that the spring hooks move without being loose. Now fit the lock clamp (47), and the shaft pins (48) with spring (57) and washer (51), in the journalling (43). Place the spring shaft (50) in position with the help of the springs (58) and fit the spring (49) between the journalling (43) and the stop shaft (56). Paint the retaining pawl with a thin coating of genuine VP touch-up paint. Concerning assembled retaining pawl, see Fig. 26.

2. Grease the needle bearing (12) with universal grease and drive the bearing into the yoke with tools 884259 and 9991801. Press in both the sealing rings (13) with the help of the same tools.
NOTE: The sealing rings must be able to prevent water from seeping in, see Fig. 28. Apply bushing installation adhesive on the bush (11) and fit the bush in the yoke with the flange facing down towards the retaining pawl.

3. Fit the retaining pawl in the yoke (earlier model) and screw tight the guide plugs (14).

4. Fit the yoke with the retaining pawl on the intermediate housing and press in the guide spindle until the collar bottoms.
NOTE: Do not forget the wear washer (25) between the lower attachment of the yoke and the intermediate housing, also the two plastic washers (16 and 60) on each side of the journalling (43). Observe due care when fitting the guide spindle not to damage the sealing ring.

5. Fit the hose attachment and packing on the yoke. Coat the surfaces with VP 1141570-0 or Permatex 679.
NOTE. On the 270T drive the hose fixture is turned to port.

6. Fit the shift yoke and push in the shaft (4) and lock with a split pin.
NOTE: A washer (5) should be fitted on each side of the split pin.

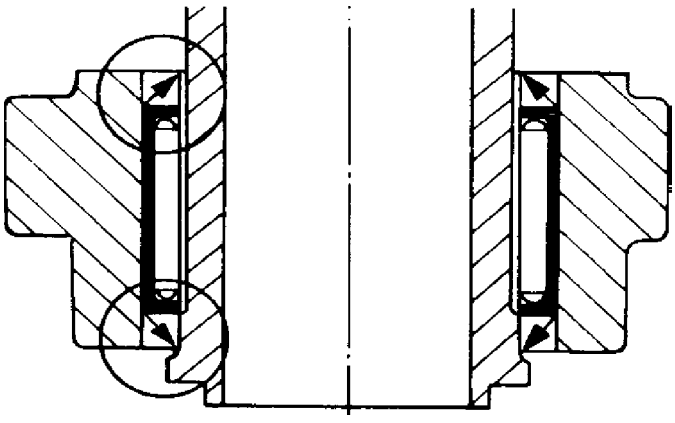


Fig. 28.

Part V Reconditioning the lower gear

A. REMOVING

1. Lift the oil strainer up out of the oil channel. Invert the lower gear housing in tool 884264.

Propeller shaft

2. Remove the two screws (7, Fig. 59) retaining the propeller bearing housing (3). Remove the propeller shaft (11) and the propeller bearing housing with the help of tool 884161, see Fig. 29. When the propeller bearing housing has been removed, unscrew the tool and pull out the housing by hand. If the above tool is not available, removal can be done by holding the propeller shaft and striking the gear housing with a rubber mallet until the propeller shaft together with the propeller bearing housing loosens from the gear housing.

3. Unscrew the washer (26) and the 6 nuts from the propeller bearing housing, tap the propeller shaft out of the bearing housing.

4. Bend up the lock washer (20) and unscrew the round nut (21) on the propeller shaft.

5. Press the gear (22) and bearing (19) off the propeller shaft at the same time. Use tools 884265 and 884168, see Fig. 30,

6. Remove the lock washer (23) and the pump impeller (25) from the gear.
NOTE: Lever next to the two drive pins in order not to damage the impeller during removal.

7. Tap the two sealing rings (32) out of the propeller bearing housing.

Vertical drive shaft

1. Bend up the lock washer (18) for the nut (17) holding the drive on the vertical shaft and unscrew the nut.

2. Bend up the lock washer (15) and unscrew the round nut (16). Remove the lock washer and spacer ring (14).

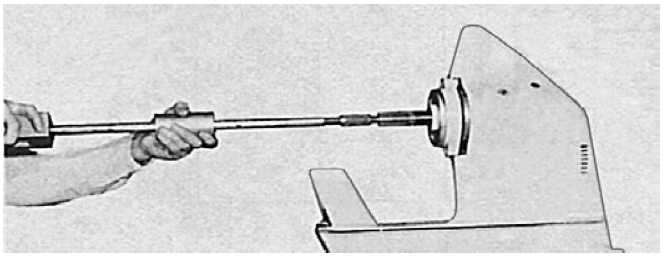


Fig. 29.

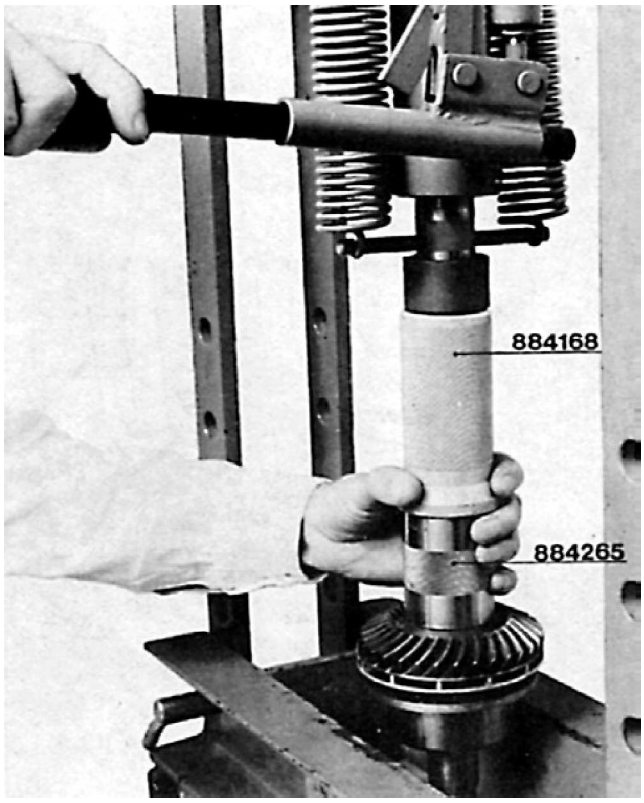


Fig. 30.

3. Remove the drive with the help of tools 884267 and 884264, see Fig. 31.

4. Lift out the drive (22).
NOTE: Take care of the washer for the needle bearing (6). The needle bearing (6) is a complete needle bearing with loose needles. Make sure that all 27 needles are taken out.

5. Carefully remove the lower gear housing from the vertical drive shaft.
NOTE: Take care of the shims.

6. Press (tap out) the outer ring for the needle bearing with tools 884143 and 884381.

7. Press the ball and roller bearings off the vertical drive shaft (against the base of the press). See Fig. 32.
NOTE: Do not forget the shims between the bearings.

8. If the needle bearing (12) for the propeller shaft is damaged, remove it with the help of tools 884169 and 9991821. Place puller 9991821 in the needle bearing so that it hooks round the back of the needles. Then screw in extractor 884316 and tension the hooks apart to enable the bearing to be removed. The needle bearing race on the propeller shaft is then removed by splitting it.

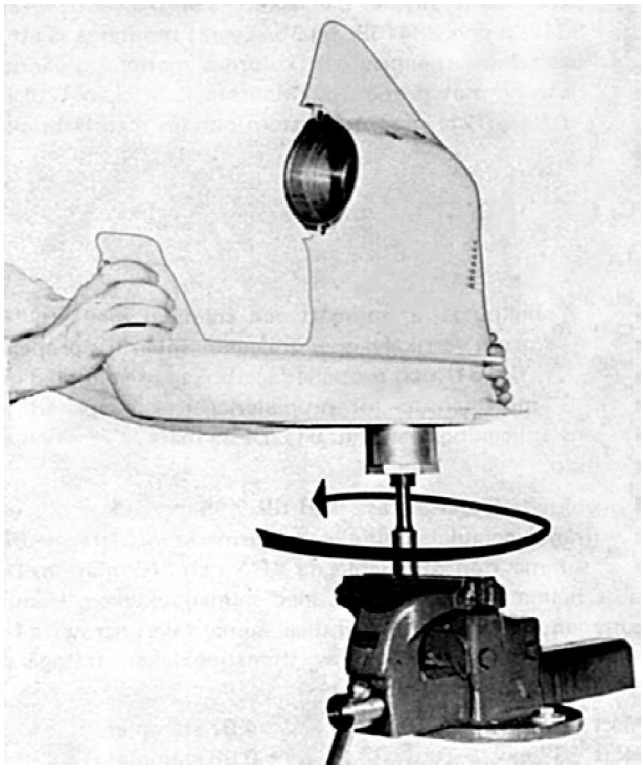


Fig. 31.

Then screw in extractor 884316 and tension the hooks apart to enable the bearing to be removed. The needle bearing race on the propeller shaft is then removed by splitting it.

9. Check all parts for wear and replace if necessary.
NOTE: The gears are sold in pairs in order to keep the proper tooth contact.

B. FITTING

Lubricate all movable parts and bolts before fitting.

1. Lubricate and fill both the sealing rings (32) with grease and press them into the propeller bearing housing with the help of tools 884283 and 9991801.
NOTE: Turn the sealing rings so that they seal against oil in the gear housing and against water. See Fig. 33.

2. Fit the needle bearing (12) for the propeller shaft. The side of the bearing on which the designation is stamped should face inwards. Use tools 884283 and 9991801.

3. Pull in the roller bearing outer ring (6) for the vertical drive shaft (8). Use tools 884241 and 884385.
NOTE: Face the open side downwards and make sure the 27 needles are fitted. Grease the needles. See Fig. 34.

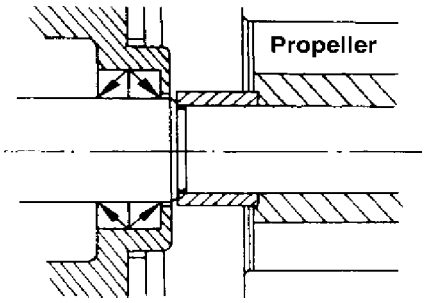


Fig. 33.

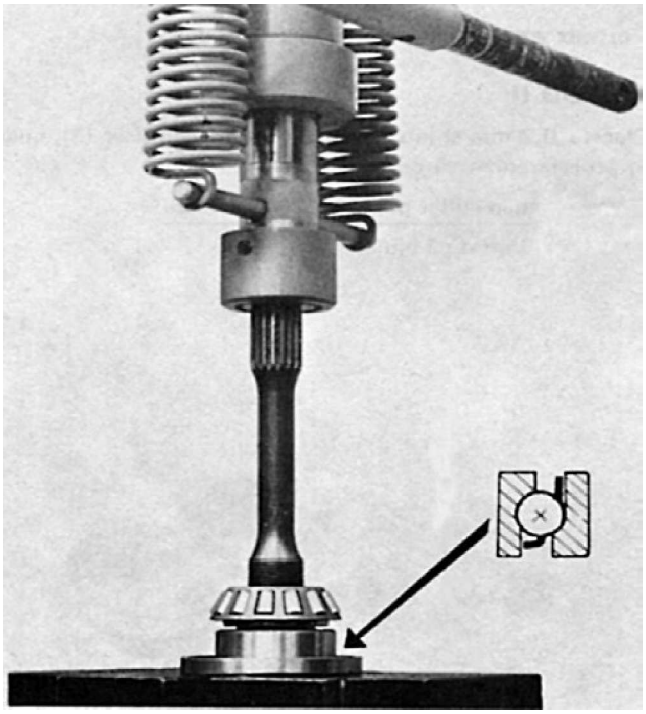


Fig. 32.

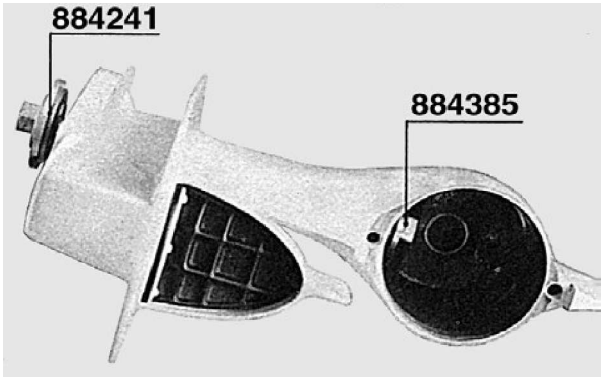


Fig. 34.

Vertical drive shaft

1. Press the ball bearing (9) the distance piece (38) and the roller bearing (13) on to the shaft.
NOTE! Observe the position of the bearings.
See Figs. 32 and 43. Use tool 884266.

2. Fit the distance rings (14), lock-washer (15) and nut (16). Tighten the nut, but do not lock it yet.

3. Place the gear (22) and washer in its position in order that it will be a guide for the vertical shaft.

4. Before installing the vertical shaft into housing place a shim set, consisting of one paper shim thickness 0,25 mm (0,01") between two metal shims having a thickness of 0,05 mm (0,002") into the recess for the ball bearing (9).

5. Fit the washer (18) and nut (17). Tighten the nut to a torque of 16 kpm (115 lb.ft.). Use tool 884264 in the splined end as a counterhold.
NOTE: Do not lock at this torque.

6. Fit the tensioning tool 884348 over the bearing (13).

Propeller shaft

1. Fit the pump impeller (25) and the lock ring (23) on the gear (22).

2. Press the bearing race for the propeller shaft needle bearing (12) on the propeller shaft.

3. Fit the gear and lock washer (26) on the propeller shaft and press on the bearing (19). Use tools 884265 and 884168, Fig. 35. Fit the bearing so that the recess in the bearing races for the balls face in the direction of the propeller. Fit the lock washer (20) and the nut (21). Tighten the nut and lock with the lock washer.

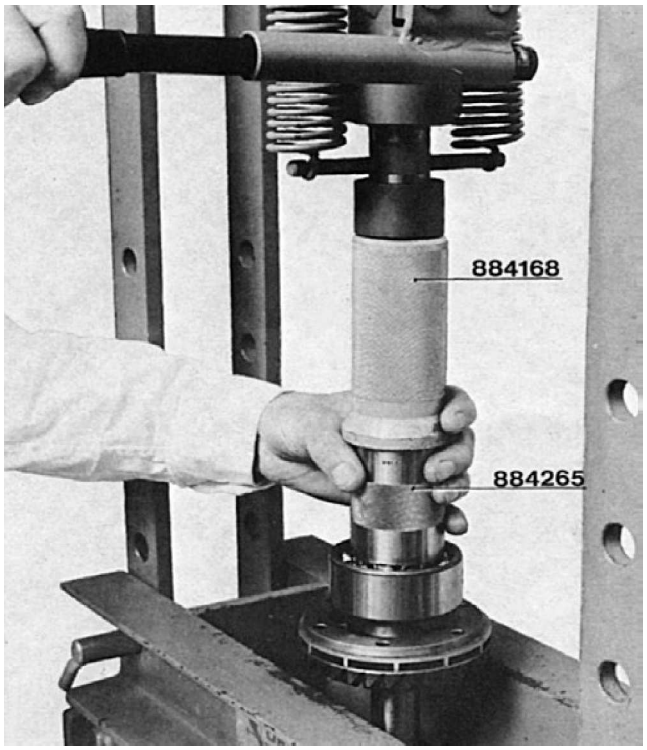


Fig. 35.

C. SHIMMING THE LOWER GEAR

METHOD I

The procedure is very much the same as for gears in the upper gear housing. Here the gear (22 Fig. 59) has a nominal measurement predetermined to 5,85 mm (0.230"). The lower housing will have a stamped in figure denoted ”F” and the propeller bearing box a figure denoted ”G”. See Figs. 36 and 61.

Begin the calculation by adding or subtracting the figure marked on the gear which depends on if it has a plus or minus symbol, see example shown below.

Add the two figures denoted ”F” and ”G” together and subtract from this figure the calculated gear measurement as shown below.

Meas. in mm (in.)

Meas. ”F”, e.g.	4.97 (0.197) stamped	
Meas. ”G”, e.g.	+ 0.98 (0.038) stamped	
	5.95 (0.235)	5.95 (0.235)
Gear	5.85 (0.230) fixed	
Gear marking, e.g.	+ 0.04 (0.002) marked[1)]	
	5.89 (0.232)	–5.89 (0.232)
		0.06 (0.002)

The sum obtained will always be positive provided everything is in order.

In this example, 0.05 mm (0.002") shim is placed between propeller bearing box and propeller thrust bearing. **Then continue according to paragraphs 1-8 below.**

METHOD II

Start the shimming procedure by putting a 0.2 mm (0.008") thick shim (39, Fig. 59) underneath the bearing housing (3).

This shim figure is given as the best known from experience.

Then continue according to paragraphs 1-8 below.

[1)] Only 4 marked

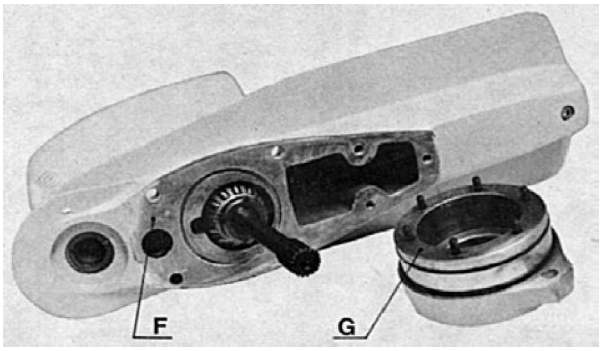


Fig. 36.

1. Then fit the propeller shaft with bearing in the housing. Take care when fitting that the bearing is not located at a slant in the bearing housing or that the sealing rings are not damaged.

2. Fit the propeller shaft with bearing box in the gear housing. Tighten the bolt to a torque of 4 kpm (29 lb.ft.)

3. Check the backlash, which is measured directly on the vertical drive shaft splines. Here the clearance should be 0.06–0.10 mm (0.0023–0.0040"), which gives a backlash of 0.15–0.25 mm (0.006–0.010") on the gears. See Fig. 37. If the backlash does not agree, adjust it as follows.

If method I, page 16, has been chosen: Should the clearance be too small, increase the thickness of shims under the ball bearing (9), and if it is excessive, reduce the shim thickness.

If method II, page 16, has been chosen: Should the clearance be too small, reduce the thickness of shims in the propeller bearing housing (3) and if it is excessive, increase the shim thickness.

4. Undo the screws and pull out the propeller shaft.

5. Coat marking paint on the gears and drive.

6. Fit the propeller shaft with bearing box in the gear housing. Tighten the screws to a torque of 4 kpm (29 lb.ft.).

7. Fit tool 884264 on the end of the splines and rotate the shaft in its proper direction of rotation, clockwise for a left-hand threaded propeller and anti-clockwise for a right-hand threaded propeller, while braking the propeller shaft hard at the same time. See Fig. 39.

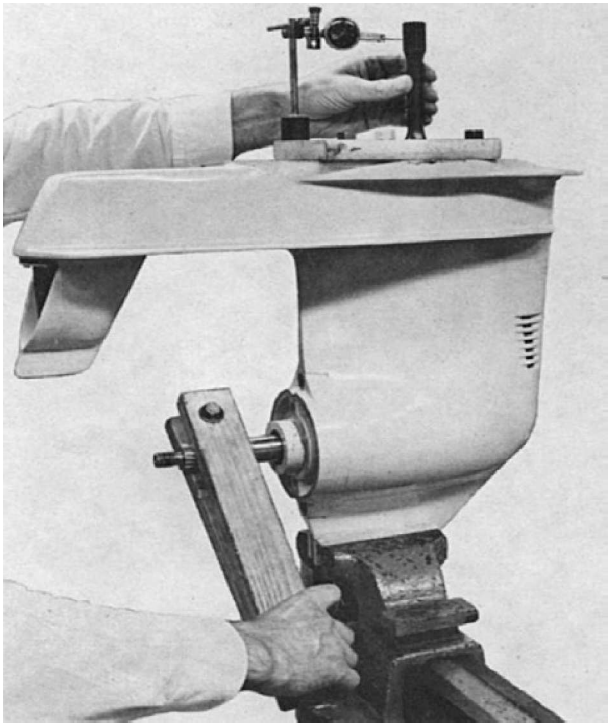


Fig. 37.

8. Check that the contact pattern on the tooth surfaces of the drive side agree with the contact pattern (A), Fig. 38. The pattern should be in the center of the tooth vertically but towards the toe. If the contact pattern is like (B), reduce the shim thickness on the vertical shaft and on the propeller shaft. If the contact pattern is like (C), increase the shim thickness for the vertical shaft and for the propeller shaft.
NOTE: If the drive is moved, adjust the gear accordingly in order not to disturb the backlash.

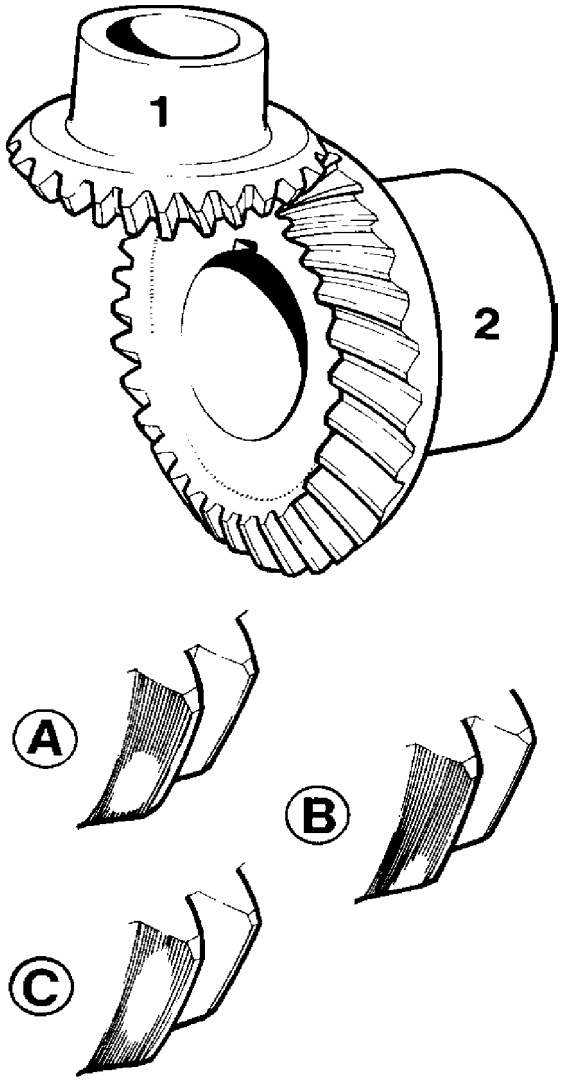


Fig. 38.

(A) Correct tooth pattern

(B) Reducing shim thickness on drive 1 and on gear 2

(C) Increasing shim thickness on drive 1 and on gear 2

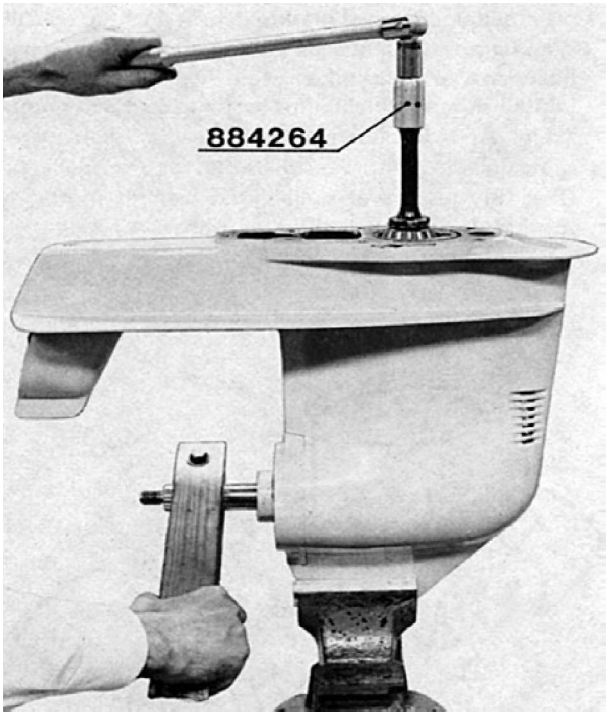


Fig. 39.

Fitting

1. Separate drive and gear and wash off the contact paint. Re-fit with measured shims.

2. Fit the spacer ring (14), the lock washer (15) and the nut (16) on the vertical drive shaft. Tighten the nut and lock with the lock washer (15).

3. Tighten the nut (17) holding the drive in position to a torque of 16 kpm (115 lb.ft.) and then lock the nut with the lock washer (18). Use tool 884264 on the end of the splines as a counterhold. See Fig. 40.

4. Place both the O-rings (29) on the propeller shaft bearing housing. Coat VP 1141570-0 or Permatex 679 on the contact surfaces and screws. Fit the bearing housing with shaft in the lower gear housing and tighten both the internal hex screws to a torque of 4 kpm (29 lb.ft.).

D. SHIMMING, INTERMEDIATE HOUSING AND LOWER GEAR HOUSING

1. Place the outer ring of the axial bearing on the bearing (13, Fig. 59) and hold it firmly in position. With a depth micrometer measure ”A”, Figs. 41 and 43 and ”B”, Fig. 42.

Deduct measurement ”A” from measurement ”B”, and fill up the difference with shims. A tolerance of 0.07 mm (0.0028") is permitted. Of this figure –0.05 mm (0.0020") is max. clearance and +0.02 mm (0.0080") max. clamping. A clearance of 0.02 mm (0.0080"), nominal value, should be aimed at.

For calculation of shim thickness, see example below.

Meas. ”B” e.g.	8.00 (0.3150)
Meas. ”A” e.g.	–7.93 (0.3122)
	0.07 (0.0028)

A shim thickness of 0.05 mm (0.0020") should be fitted on the axial bearing outer ring (13), which gives in this example a clearance of 0.02 mm (0.0008").

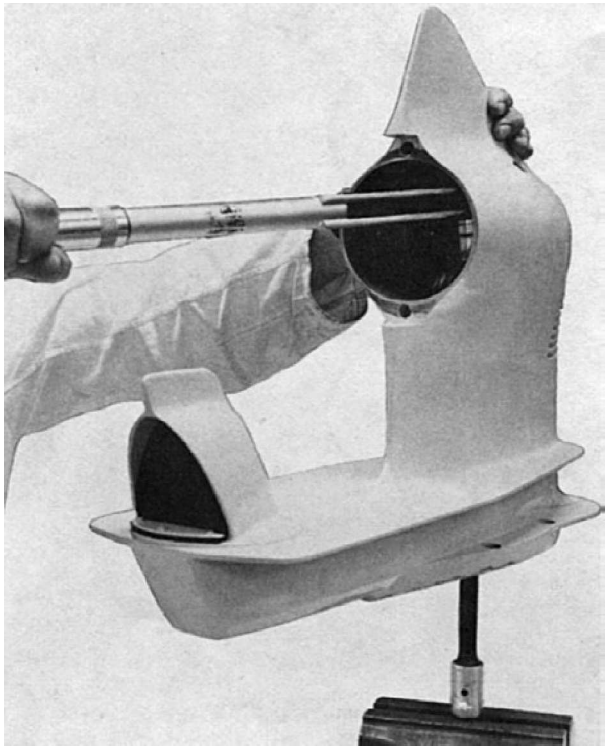


Fig. 40.

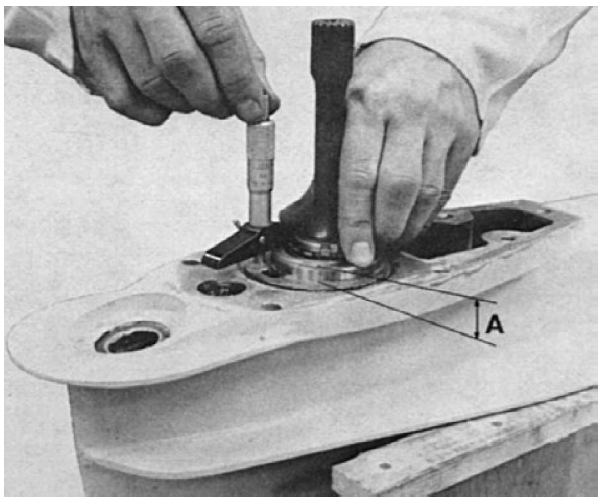


Fig. 41.

2. Press in the axial bearing's outer race (13) with the measured shims in the intermediate housing. Use, for example, drift 884263.

3. Place the oil strainer and pipe in the oil channel. Assemble the intermediate and lower gear housings. Use three new O-rings (29, 40) and coat the contact surfaces with VP 1141570-0 or Permatex 679. Tighten the screws to a torque of 1.5 kpm (11 lb.ft.) in diagonal sequence.

4. Fit the oil drain plug in the gear housing (tightening torque 1 kpm = 7 lb.ft.).
NOTE: Do not forget the packing.

E. SHIMMING, INTERMEDIATE HOUSING AND UPPER GEAR HOUSING

1. On the upper gear housing measure the distance from the outer bearing race on the lower ball bearing (39, Fig. 57) to the face of the gear housing.
See Fig. 44.

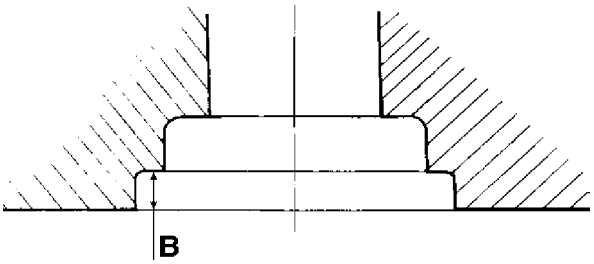


Fig. 42.

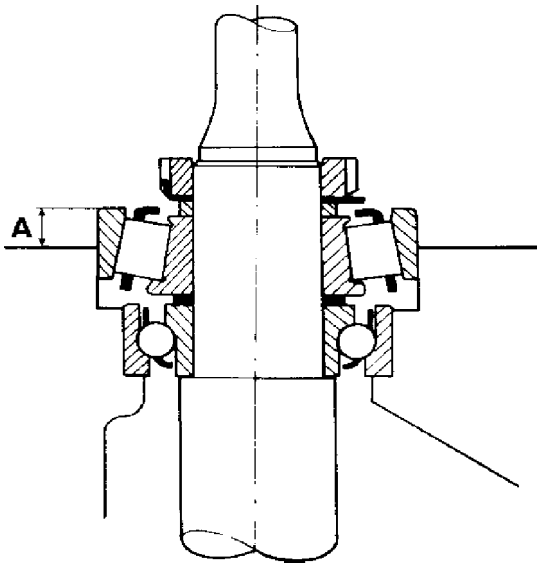


Fig. 43.

2. Determine the depth of the corresponding recess for the bearing race in the intermediate housing Fig. 45 and add to the measurement under point 1 above enough shims so that the depth of the intermediate housing is exceeded by max. 0.1 mm (0.004").

3. Fit the spline sleeve (41, Fig. 59) on the vertical drive shaft and the two O-rings (7, 34, Fig. 58) and shims (8) calculated under point 2 on the intermediate housing. Coat VP 1141570-0 or Permatex 679 on the dividing surface. Fit the upper gear housing on the intermediate housing. Tighten the screws evenly all round and in diagonal sequence to a torque of 2 kpm (14 lb. ft.).

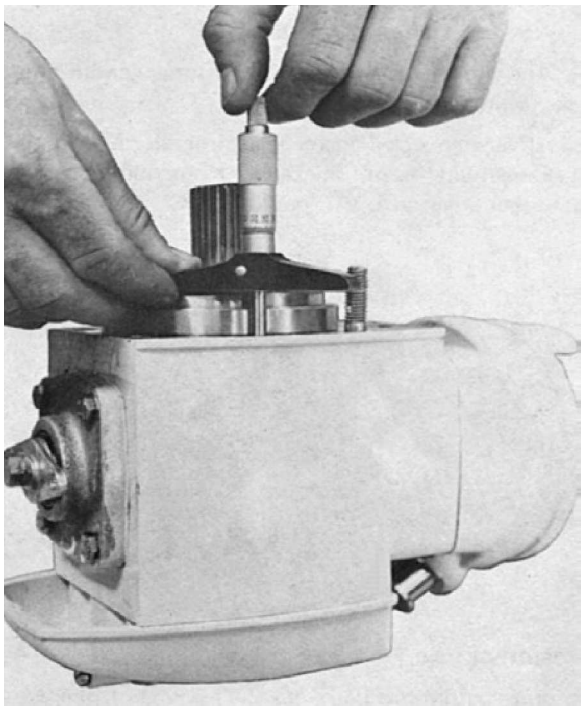


Fig. 44.

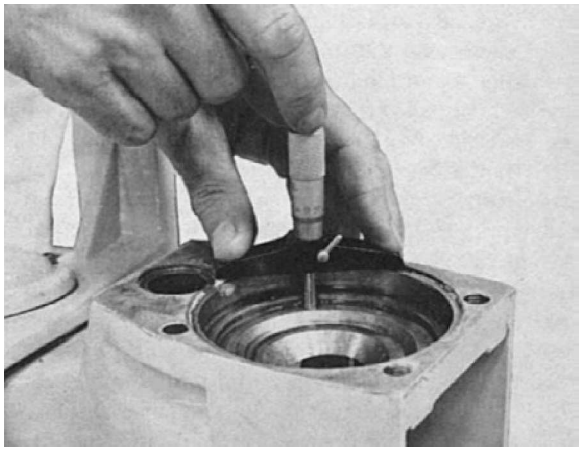


Fig. 45.

F. CHANGING PROPELLER ROTATION

The gears in the upper gear housing are so designed that they do not need to be changed when shifting from left-hand to right-hand threaded propeller.

For standard rotation, that is, using a left-hand threaded propeller, the lower gear functions as the forward drive gear and the shift rod is located according to ”A”, Fig. 46. With a right-hand threaded propeller, the upper gear functions as the forward drive gear and the shift rod is placed according to ”B”.

In order to obtain rotation in the opposite direction, the shift rod between the yoke 3 and lever 1 on the shift mechanism is moved as follows:

1. Remove the cover from the shift mechanism.

2. Move the shift rod 2 from position ”A” to position ”B”.

NOTE: The rotation must not be altered by inverting the control levers.

For both a left-hand and right-hand threaded propeller, the control cable has a ”push” motion for engaging the forward gear. Check and adjust the shift control according to Part VII, points 8–14.

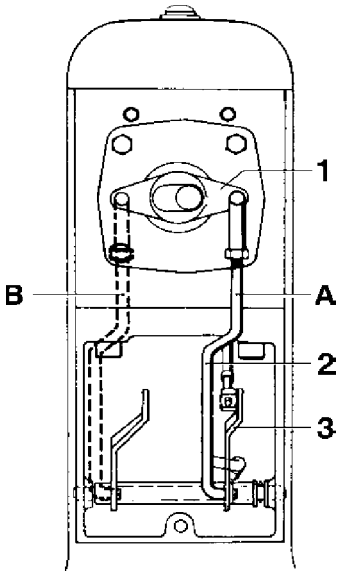


Fig. 46.

Part VI Anti-corrosion

Before installing the drive unit in the boat, check it for any corrosion damage. Check the contact surfaces of the zinc protectors. If these are worn down to more than 50%, they should be replaced. Paintwork which is exposed to mechanical abrasion should be touched-up where damaged. The damaged spot must first be rubbed clean. Sandpaper with grain thicker than 220 must not be used. Wash clean with white spirit or thinner. If the light-alloy parts are damaged so that pores have arisen, these should be filled up with, for example, Plastic Padding or Spar Var Filling-up. Concerning hardening and drying times, see the instructions given on the containers for the respective materials. Polish the surface smooth. Paint the spot concerned with primer, Spar Var EXP (2-component) in those cases where the polishing has penetrated to the light-alloy. The drying time for the primer is approx. 24 hours. This drying time can be shortened by raising the temperature (max 65°C = 140°F). The primer does not need to be polished. If polishing is carried out after all, there must be no polishing **through** to the metal. Touch-up the spot concerned with VP genuine touching-up paint, twice with a drying interval of 24 hours between each application. If it is desired to shorten the drying time, the temperature can be raised to max 65°C (140°F). Wet-polish with 220-paper between applications.

Primer, Spar Var EXP, can be applied with a brush or sprayed on to the drive unit. When thinning out the paint, thinner must be used, it contains xylene.

In room temperature, the drying time is about 24 hours but the time can be shortened by raising the temperature (max. 65°C = 140°F).

If the outside of the drive unit is in such a condition that touching up of affected spots does not give fully satisfactory results, the entire drive unit should be repainted.

Attn.! The zinc protectors must not be painted.

In order to protect the drive unit against marine growth, the entire outboard drive, including the retaining pawl, cooling water inlet and mounting collar must be painted with anti-marine growth paint. It must not contain bronze or copper.

Attn! This paint should not be sprayed on since it contains chemicals which are dangerous to inhale.

After the touching-up paint has dried, before painting with anti-marine growth paint, polish the surface slightly with wet-polishing paper 400. In order to be effective, the painting should be done twice, allowing each coat to dry overnight. The boat should be launched at the earliest 12 hours after the final application.

Part VII Fitting the outboard drive on the transom

1. Fit new bellows (21, Fig. 56 and 68, Fig. 57) for the exhaust installation and universal joint. Connect the cooling-water hose (49, Fig. 56) between the drive and mounting collar.
NOTE: The cooling-water hose is marked with the word ”Engine” on the end to be fitted to the connection in the mounting collar.

2. Lift the outboard over to the mounting collar and prop it up under the fin so that it comes up to the right height. See Fig. 47.

3. Hang the hose clip (69, Fig. 57) for the universal joint rubber bellows on the neck of the gear housing. Smear the universal joint and shaft splines with grease. Move the drive towards the drive shaft while turning the universal joint at the same time so that the splines on the drive shaft can engage with the splines on the universal joint.
NOTE: Make sure when fitting that no burr comes on the splines as this would make assembling difficult.

Lubricate the shaft pins with grease or Molykote or similar.

4. Move the outboard drive mounting yoke (9, Fig. 58) into the mounting collar and line it up so that the shaft pins (31, Fig. 56) can be pushed into the holes in the yoke.
NOTE: Do not forget to fit the two plastic bushes (38, Fig 58) in the yoke holes. Turn the pins so that the locking bolts can be fitted. Tighten the locking bolts firmly. Tighten securely the tapered lock bolt (75, Fig. 57) in the steering casing (12, Fig. 56) to a torque of 5 kpm (36 lb.ft).

5. Fit the rubber bellows of the universal joint. Place the clip so that its tightening screw is on the underside of the bellows. Make sure that the bellows are correctly fitted and that both the clips are tightened to prevent leakage.

6. Hang up the hose clips (22, 50, Fig. 56) for the exhaust and cooling-water hoses. Connect up the hoses and tighten the hose clips. The tightening screws should be placed on the side of the hose. The hose clips for the exhaust hose should be turned as shown in Fig. 48. It is extremely important that the clips are fitted properly, otherwise they may damage adjacent hoses as well as hinder the movements of the drive.

7. Fit the locking plate (35, Fig. 58) for the shift cable so that it locks in the cable slot.

8. Check to make sure that the control lever and the drive shaft lever are in neutral. Slacken the locknut for the yoke 11, Fig. 49 and turn the yoke on the thread of the control rod 10 so that when it is connected to the shift lever, the position of the reverse check rod 6 is such that the rod comes in contact with (without force being used) the bracket of the retaining pawl at ”A”. Lock the yoke 11 with the locknut in this position. **(In other words, there must be no axial play on the reverse inhibitor rod 6.)**

9. Screw the locknut and the securing block on the control cable and adjust the shift cable 7 securing block 9 so that the block can easily be inserted in the hole in the gear yoke. Move the control lever to ”Forward” and check that corner ”C” on the gear yoke 8 does not catch in the housing.

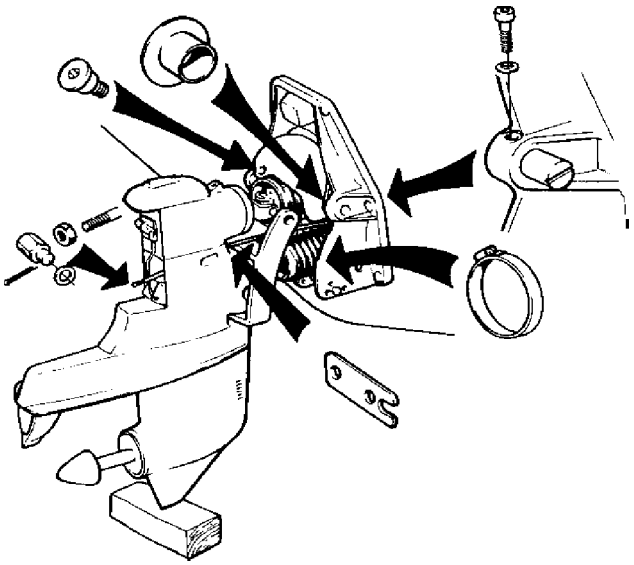


Fig. 47.

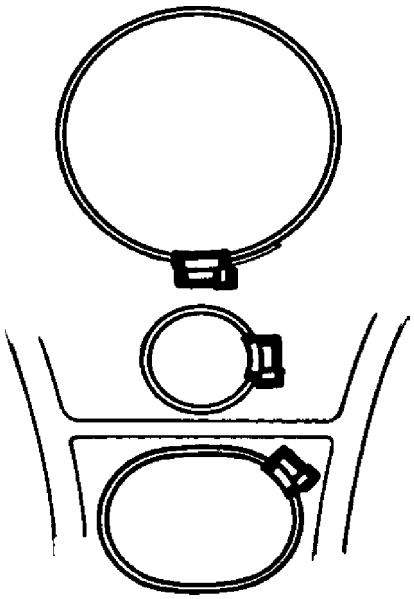


Fig. 48.

10. Pull down the retaining pawl against the stop (the stop lugs) on the journalling (43) and release the locknut for the thrust sleeve 2, Fig. 49. Adjust the thrust sleeve with the retaining pawl still down so that the sleeve comes to the level of or max. 0.5 mm (0.02") below the contour of the yoke, see B, Fig 49. Lock the thrust sleeve with the counternut. Then press the drive forwards towards the locating pin and check that the upper end of the thrust rod 3 is not in contact with the thrust plate of the lift. When the lift 1 is tilted up, the retaining pawl releases.

11. Check the hooking of the retaining pawl on the locating pin by pulling the drive first backwards and then in both the outer steering positions. Then check that the electro-mechanical lift 1 releases the retaining pawl from the locating pin when the drive tips up. With the drive released fully downwards and the locating pin in the very inside hole, clearance should be assured between the thrust plate of the lift and the release rod of the retaining pawl.

12. Check the free travel of the retaining pawl. Press the drive forwards and secure the retaining pawl in this position. Then move the drive backwards and check that the retaining pawl does not hook on the locating pin.

13. Fit the protective cover 12, over the shift mechanism, and fill the drive unit with oil. The unit has a capacity of about 2.2 litres oil (2.3 US quarts). See Part X, "Specifications". Lubricate the steering rod journalling.

Checking the retaining pawl when test running

14. Pull the drive backwards so that the spring hooks of the retaining pawl grip the locating pin.

a Check that the retaining pawl rests against the underside of the locating pin. If it does not do so, then probably the counternut of the thrust sleeve is incorrectly adjusted or the thrust rod is deformed.

b Check that there is full overlapping between the tabs of the locking brackets and the connecting surfaces of the spring hooks 5 Fig. 50 when "Reverse" is engaged.

c The clearance between the tabs of the locking bracket and the contact surfaces of the spring hook in "Neutral" should be approx. 2 mm (0.08"). See measurement at F, Fig. 50.

FITTING THE PROPELLER

Fit the spacer sleeve (fish line guard) (33, Fig. 59) on the propeller shaft. Coat the propeller shaft with water-resistant grease and slide on the propeller. Fit the lock washer (35) and the propeller cone (34), also lock the cone by peening all the lock teeth on the lock washer.

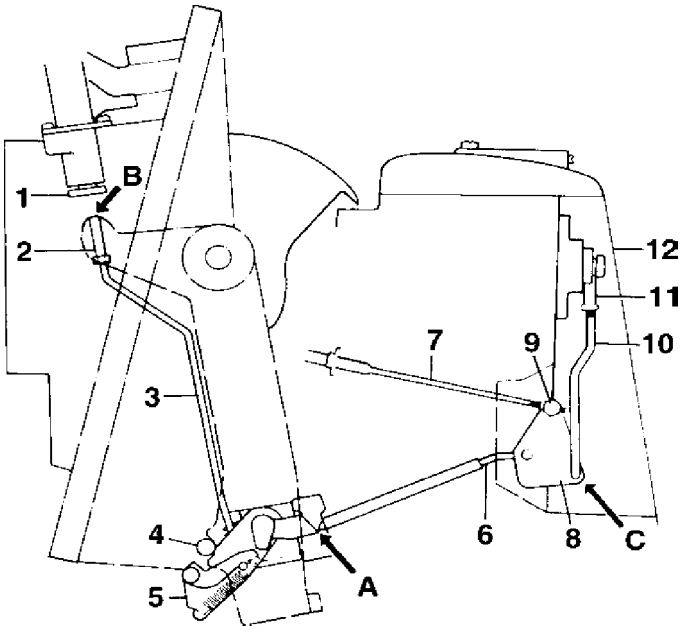


Fig. 49.

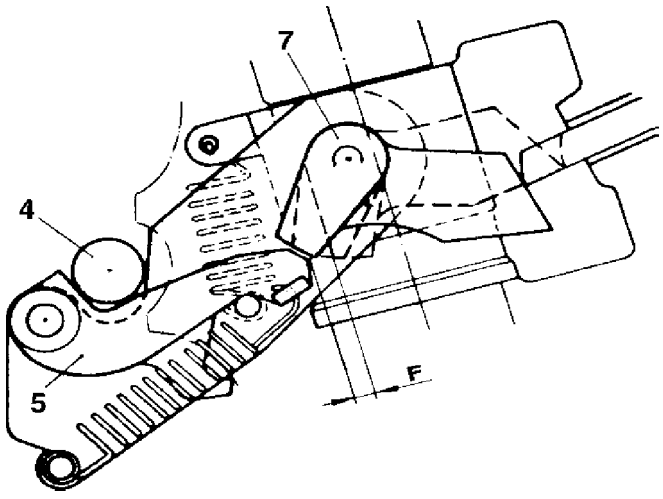


Fig. 50.

Part VIII Extending the outboard drive unit

General

When installing the Aquamatic unit in boats with a deep V-bottom, it can happen that the engine lies rather deep in relation to the water level when the boat is loaded.

As a maximum limit to which the engine and the drive may be installed, the following applies:

When the boat is loaded, the water level may not be higher than to the bottom edge of the rubber pad on the upper edge of the mounting collar.

By fitting an extension to the drive unit, the engine and mounting collar can be mounted higher up on the transom.

The S-measurement (AQ270), which is given in the publication ”Transom Template”, should be increased by the same height measurement as that of the extension unit.

The following are the extensions for the Aquamatic 270 drive unit:

25 mm (1"), part No. 814133.

100 mm (4"), part No. 814318.

INSTALLATION INSTRUCTIONS

1. Drain the oil from the outboard drive unit. See Part II, point 3.

2. Remove the protective casing from the gear mechanism, also the shift rod and the bolts and nuts securing the upper housing to the intermediate housing. With a rubber mallet tap carefully on the housings until they can be separated.
NOTE: Keep account of the number of shims between the housings.

3. Unscrew the bolts securing the lower gear housing to the intermediate housing. With a rubber mallet tap carefully on the housings until they can be separated. Lift off the spline sleeve.

4. Remove the outer bearing race for the axial bearing from the intermediate housing. Use tools 884140 and 884143.

5. Clean the contact surfaces of the various housings thoroughly. Check the O-rings and replace them with new ones if necessary,

6. Press the outer bearing race for the bearing into the extension. See ”Shimming, intermediate housing and lower gear housing”.

7. Fit the extension on the lower gear housing. Smear the contact surfaces with sealing agent. Fit the three new O-rings and the oil pipe supplied with the extension kit. Tighten the bolts evenly and in diagonal sequence.

8. Fit the lock ring in the spline sleeve. Turn (applies to 1" and 4" extensions) the end with the lock ring downwards and then fit the sleeve on the lower vertical shaft.

9. Place the intermediate housing on the extension. Smear the contact surfaces with VP 1141570-0 or Permatex 679.
NOTE: Do not forget the O-rings. Tighten the bolts evenly and in diagonal sequence.

10. Fit the spline sleeve (41, Fig. 59). Mount the upper gear housing with O-ring on the intermediate housing after having first coated the contact surfaces with sealing agent. Tighten the bolts and nuts in diagonal sequence.
NOTE: Do not forget the shims between the housings.

11. Fit the shift rod and the protective casing.

12. Touch up any damaged spots on the paintwork with genuine Volvo Penta touching-up paint.

13. Fill the lubricating system with oil. Concerning the oil capacity and grade, see ”Specifications”. Check the oil level with the drive down and after the boat has been stationary for a moment by pushing the oil dipstick down as far as it can go, but do not screw it down. Lift up the dipstick and read off the level. Top up if necessary.
NOTE: Do not forget the small seal under the dipstick head.

Part IX Reconditioning the lift

1. Remove the protective cover and take off the switch (26, Fig. 55) as well as the bracket with relays (23 and 24).

2. Slacken the nuts and remove the electric motor (22).

3. Knock up the lock washer (11) and unscrew the limiting screw (10) and the sealing nut (9).

4. Screw off the upper section (4) and lift out the worm rod (5), the spring (12), the bearings (17) and the worm gear (7).

5. Pull out the guide ring (15) and the worm (8) with the bearing (18).

6. Clean the parts and check for wear. Replace any parts if necessary.

7. Fit the lift in the reverse order to removal. Before fitting, grease the parts with universal grease and fill the upper part of the housing with grease. Connect up the ground cable as shown in Fig. 52.

CHECK AFTER RECONDITIONING

After reconditioning, check that the drive tip-up and retaining pawl mechanism function satisfactorily. During tilting, the lift should clear the retaining pawl completely from the setting pin before the drive tilts up. The length of the push rod is adjusted according to point 10, Part VII.

When the outboard drive is lowered, the lift motor should be run until it automatically cuts out and the warning light goes out.

If the drive does not straighten out, this means that the spring (12, Fig. 55) has poor tension. Place a washer (part No. 955901) under the spring. If the drive cannot be pressed down by hand (approx. 75 kg = 165 lb. at the fin), slacken the upper section (4) slightly. It is not necessary to lock the upper section since the spring thrust latches it.

Wiring diagram for lift

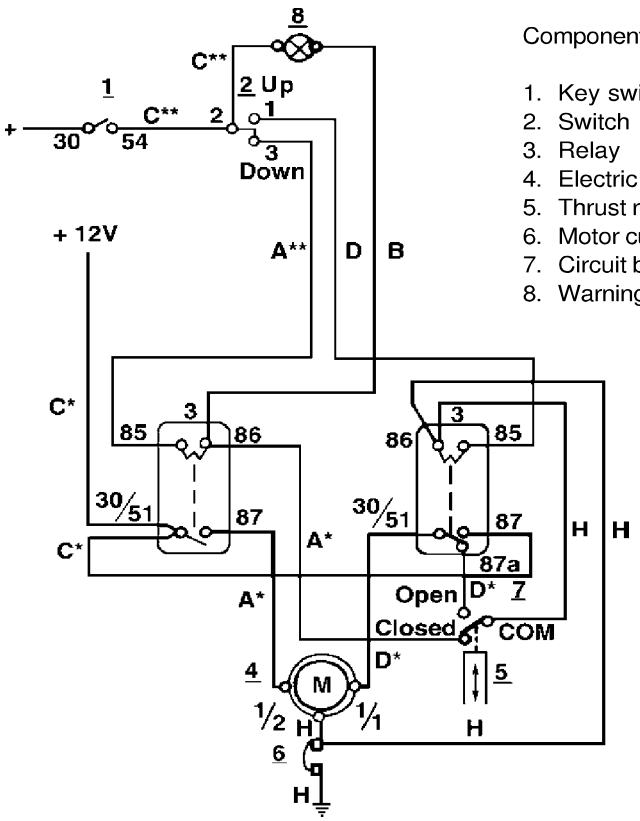


Fig. 51.

Component	Cable markings			
	Des.	Colour	mm²	AWG
1. Key switch	A'	Ivory	2.5	13
2. Switch	A"	Ivory	1.5	15
3. Relay	B	Black	1.5	15
4. Electric motor	C'	Red (+)	2.5	13
5. Thrust rod, retaining pawl	C"	Red (+)	1.5	15
6. Motor cut-out	D*	Green	2.5	13
7. Circuit breaker	D	Green	1.5	15
8. Warning lamp	H	Blue	2.5	13

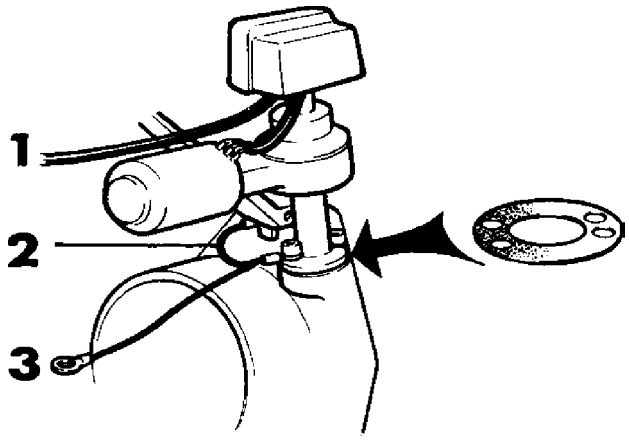


Fig. 52.

1. Cable harness for control switch
2. Ground cable between screw for steering arm and screw for lift
3. Ground cable, connected to flywheel casing

Part X Specifications

General description, Aquamatic 270

Type designation	Aquamatic 270
Shift mechanism	”Silent Shift”, self-adjusting cone clutch with servo-disengagement. Adjustable for twin installation.
Maximum propeller diameter	16"
Tip-up angle, approx.	60°
Lift unit, type	Electro-mechanical
Steering angle, maximum	30°

Overall reduction ratio

Type 270B	1.61:1
Type 270C	1.89:1
Type 270D	2.15:1

Backlash

Upper gear, measured directly on the gear wheels,	0.15–0.25 mm (0.006–0.010")
Lower gear, measured on the drive shaft splines	0.06–0.10 mm = 0,15–0.25 mm (0.0024–0.0040 = 0.006–0.010") backlash in gear

Lubricating system

Pump, type	Circulation pump for supplying oil to all the lubricating points
Oil grade	Engine oil for Service MS
Viscosity	Multigrade oil SAE 10 W-30 or 20 W-40
Oil capacity, approx. litres (US quarts)	2.2 (2.3)
Oil capacity with 1" extension, approx. litres (US quarts)	2.2 (2.3)
Oil capacity with 4" extension, approx. litres (US quarts)	2.4 (2.5)
Oil capacity between Max and Min marks, approx. litre (US quart)	0.15 (0.16)

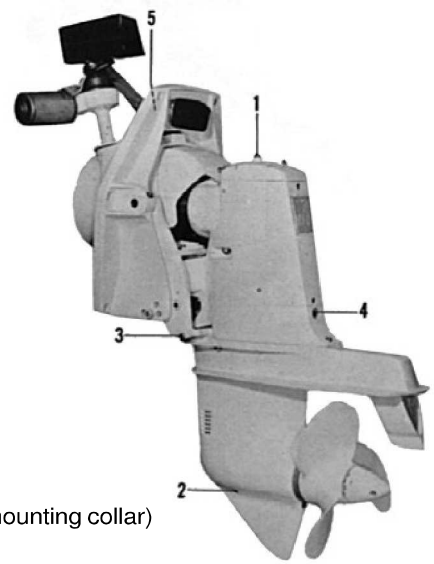


Fig. 53.

1. Oil dipstick
2. Drain hole
3. Lubricating nipple, steering shaft
4. Oil filter hole
5. Lubricating nipple, steering arm (inside mounting collar)

Part XI Special tools

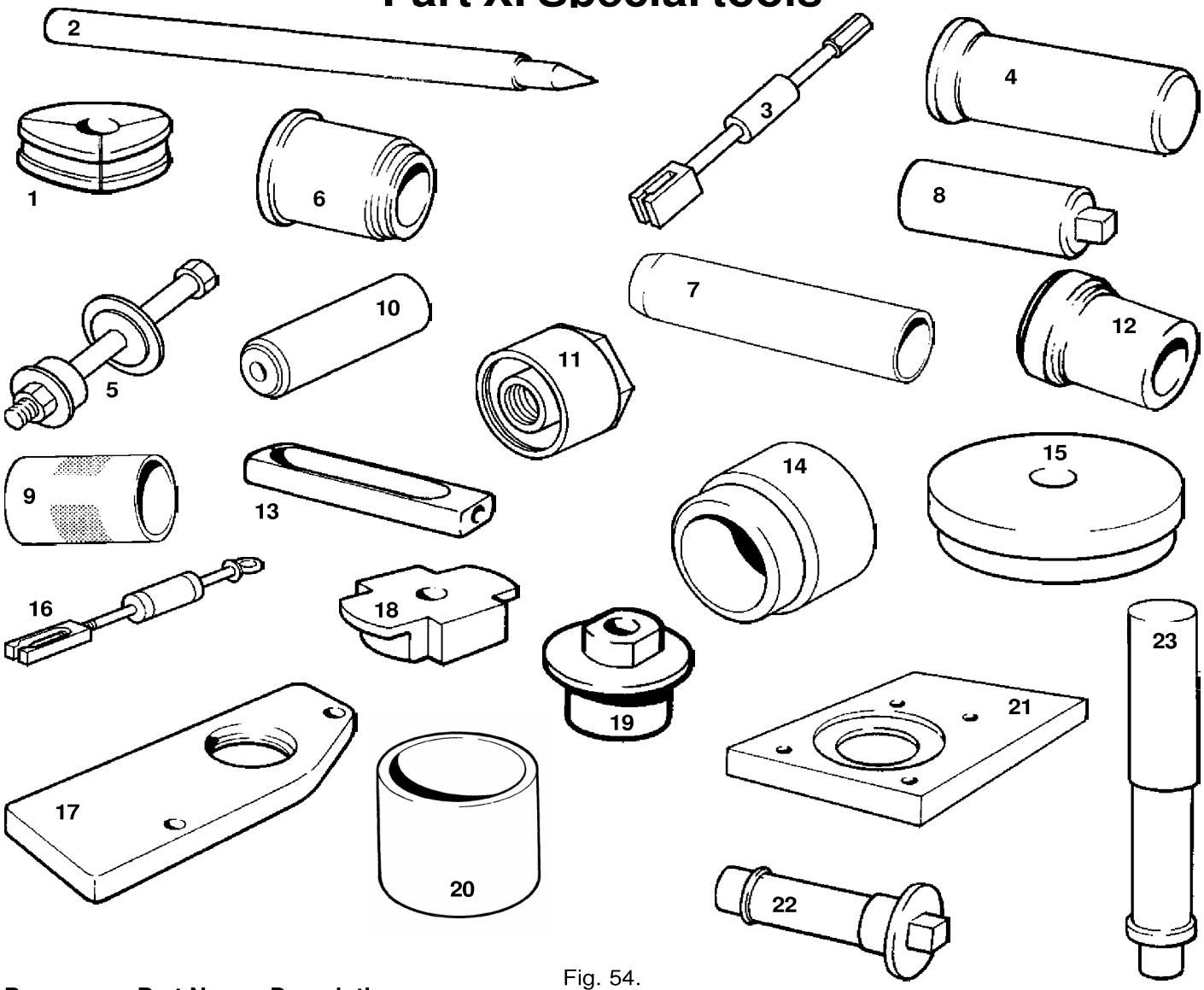


Fig. 54.

Pos.	Part No.	Description
1	884140	Expander for removing bearing race of axial bearing in intermediate housing
2	884143	Drift for tools 884140 and 884381
3	884161	Tool for removing propeller bearing housing and lower intermediate shaft
4	884168	Drift (large diameter)
5	884241	Tool for 884345
6	884259	Drift for removing gear wheel in upper gear and removing and fitting bearing and sealing rings in yoke
7	884263	Drift for fitting bearing on propeller shaft and input drive in upper gear
8	884264	Sleeve for countershaft
9	884265	Sleeve for removing gear wheel and bearing on propeller shaft
10	884266	Drift for fitting bearing on vertical drive shaft
11	884267	Tool for removing vertical drive shaft
12	884283	Drift for fitting sealing rings in propeller shaft bearing housing and fitting needle bearings for propeller shaft
13	884298	Puller for propeller shaft needle bearings
14	884311	Tool for fitting and removing steering spindle in yoke
15	884312	Tool for fitting seal in double bearing box
16	884316	Tool for 884298
17	884348	Tensioning tool for tapered roller bearing on countershaft
18	884381	Tool for removing vertical drive shaft needle bearings
19	884385	Tool for fitting vertical drive shaft needle bearings
20	884386	Sleeve for removing and fitting gears in upper gear
21	884387	Attaching plate for upper gear housing
22	884483	Tensioner bolt for fitting double bearing box
23	9991801	Standard handle for drifts

Part XII Assembly drawings

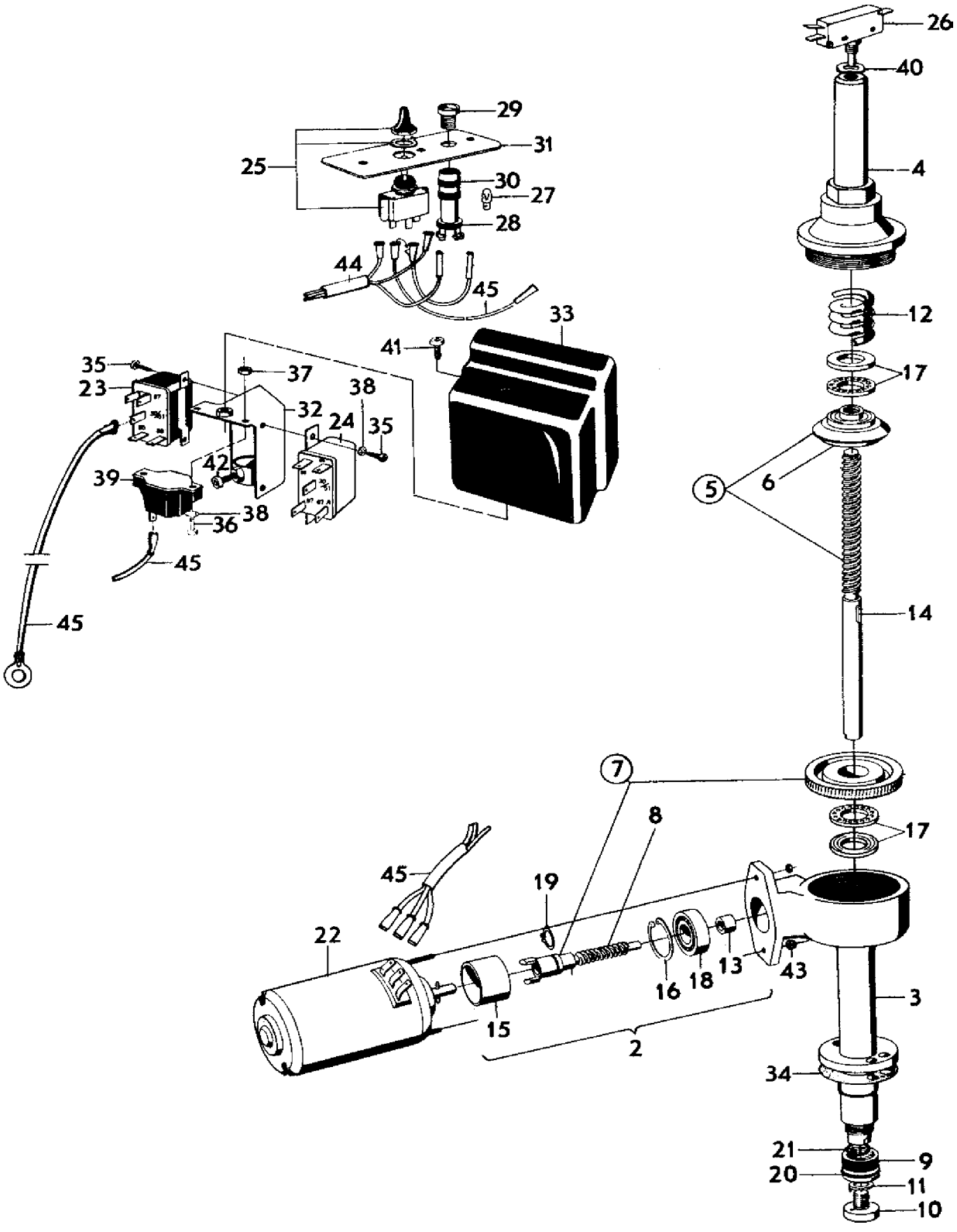


Fig. 55. Electro-mechanical lift unit

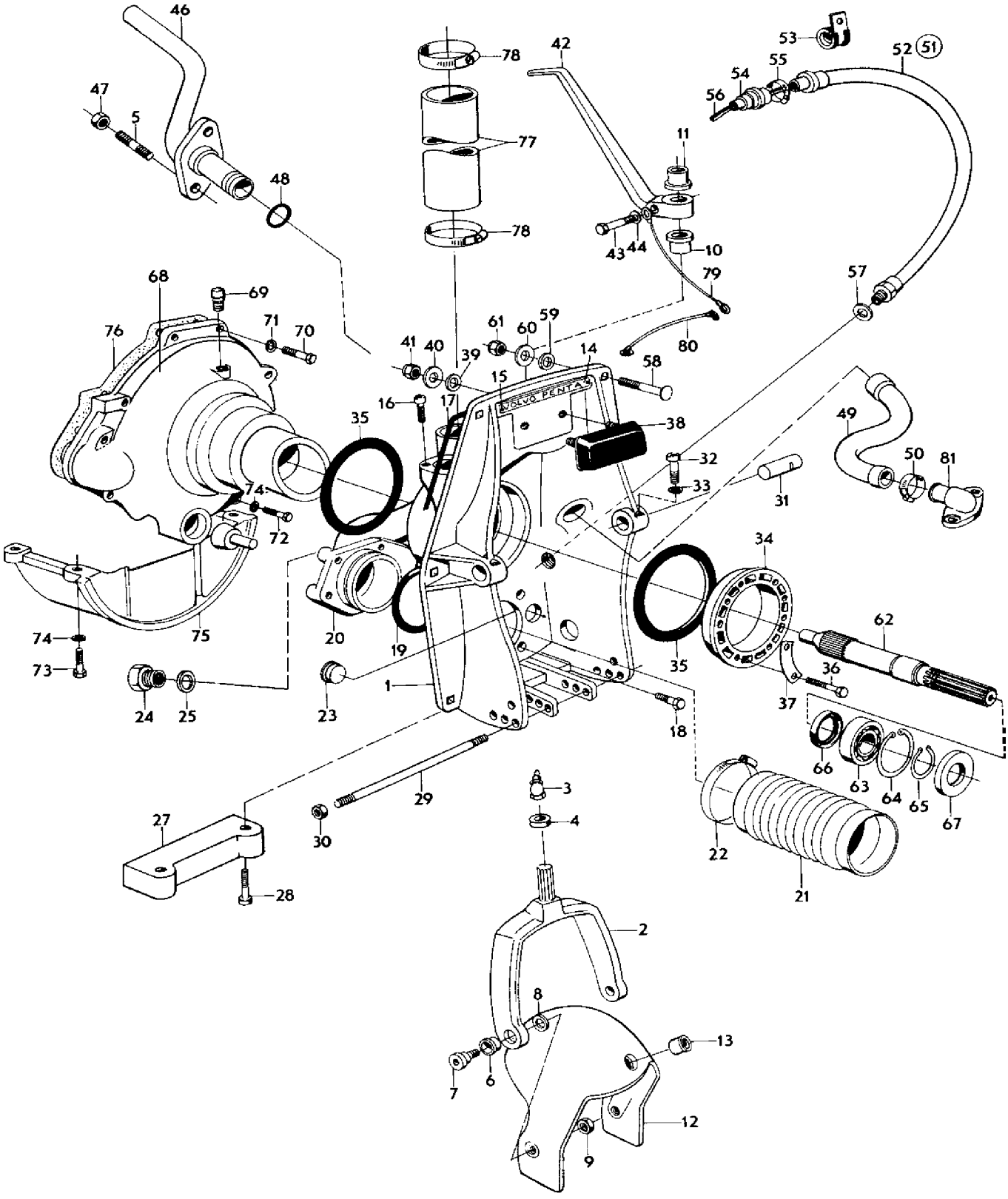


Fig. 56. Mounting collar.

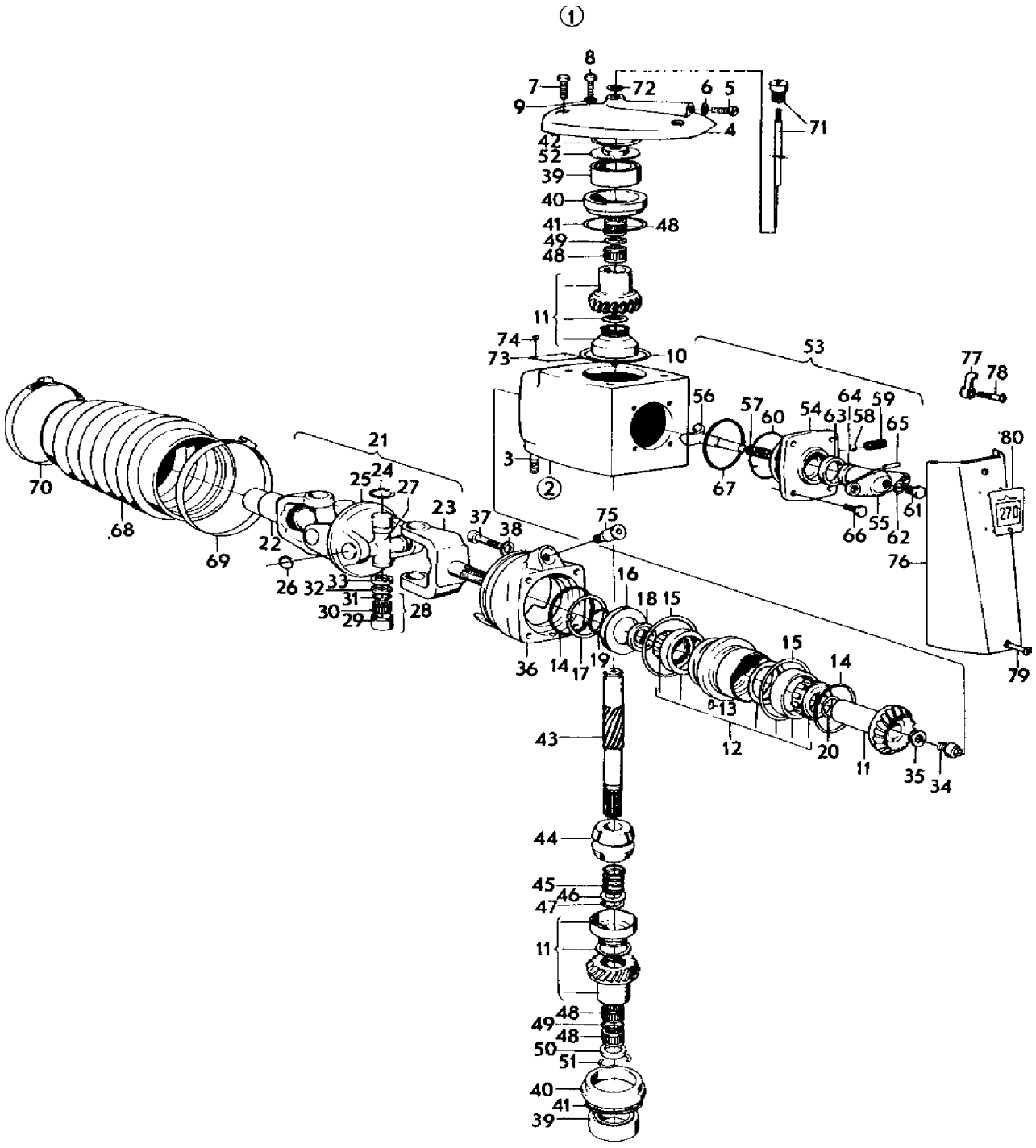


Fig. 57. Upper gear housing

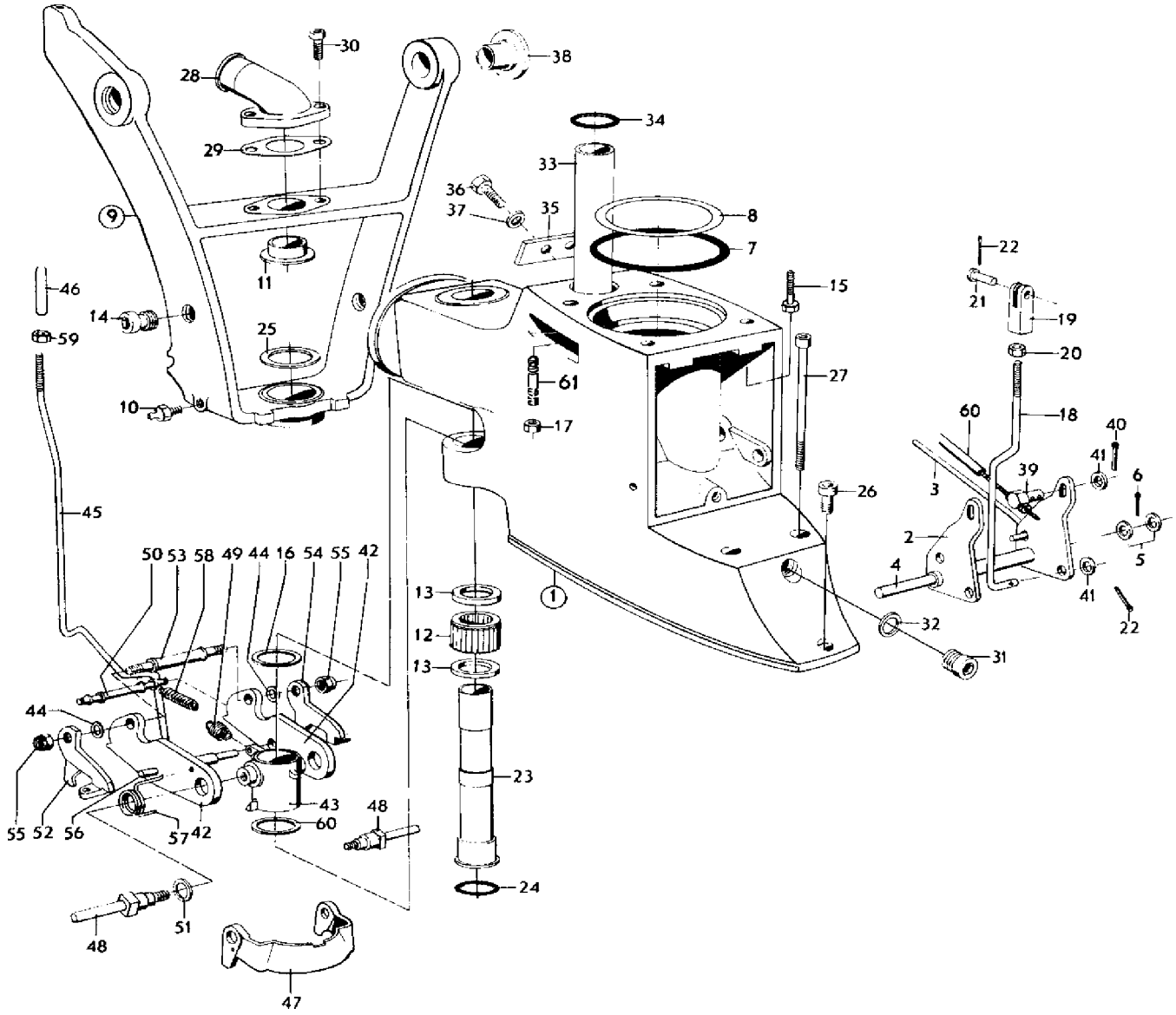


Fig. 58. Intermediate housing.

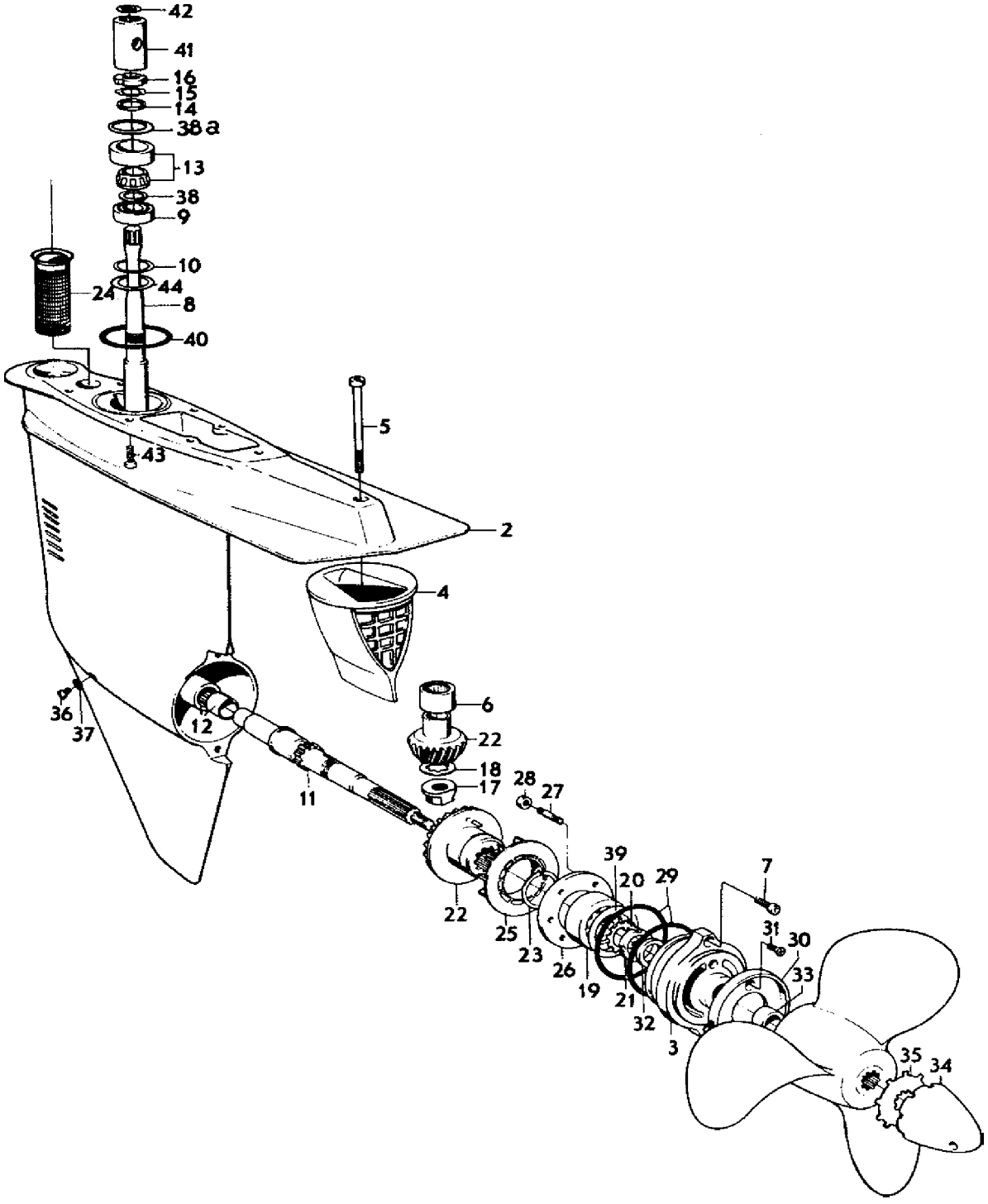


Fig. 59. Lower gear housing.

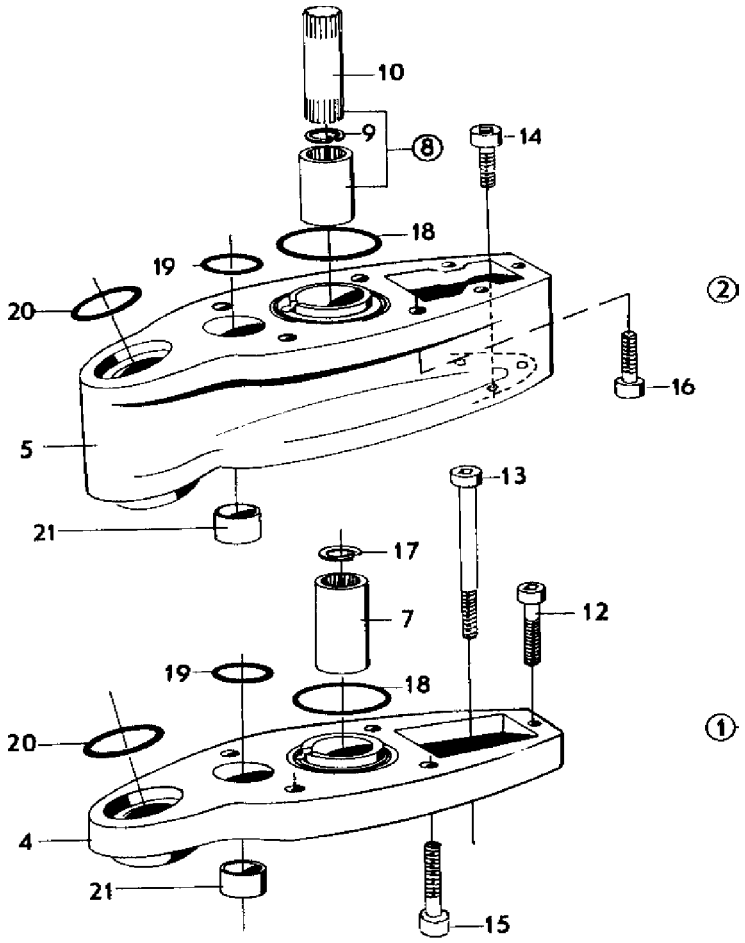


Fig. 60. Extensions.
(1) 1" extension
(2) 4" extension

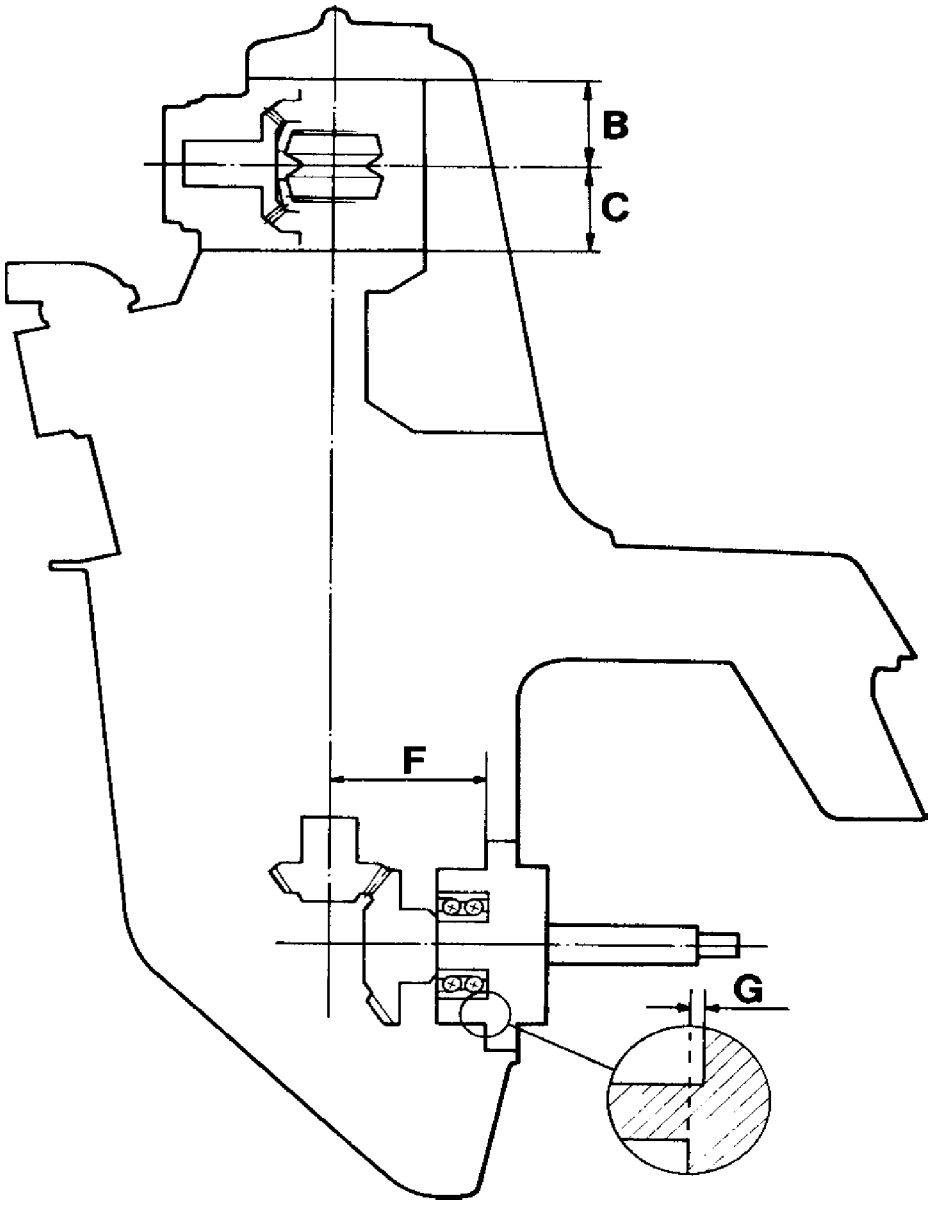


Fig. 61. B, C, F and G – Measurement location.

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Dept. 42200
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