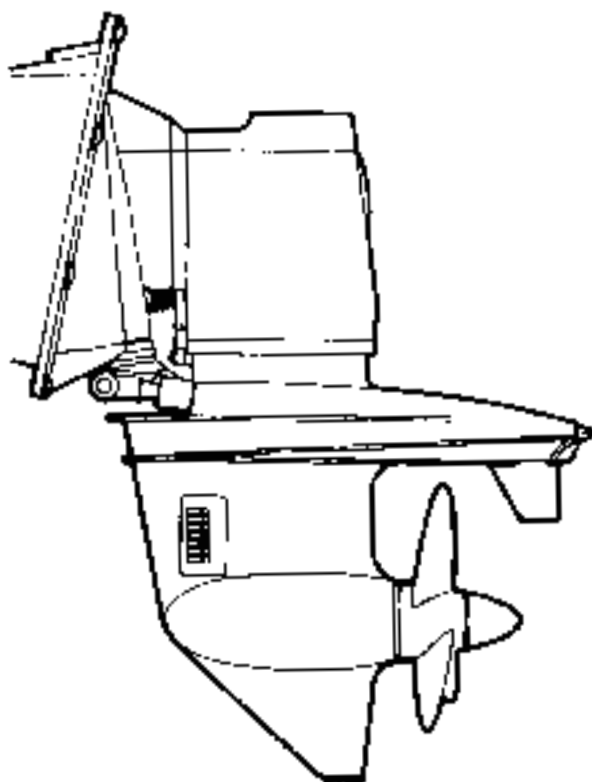


# Workshop Manual

# BMW Stern Drive



**BMW Marine Engines**

V12 Engine

[www.bmwmarine.com](http://www.bmwmarine.com)

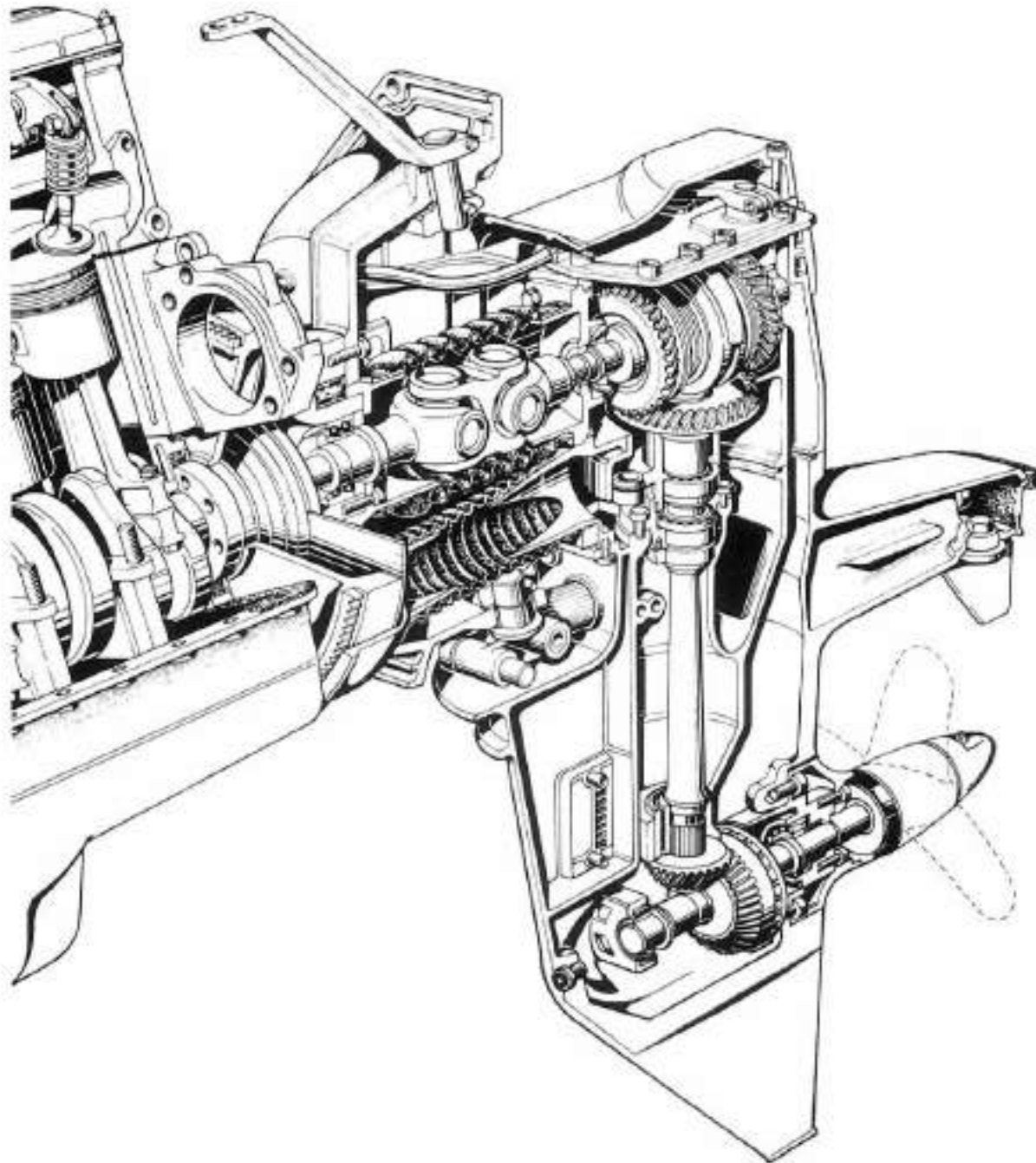
<https://www.boat-manuals.com/>



**This Workshop Manual describes the total dismantling and reassembling of a BMW Stern Drive.**

**In cases where just one or only a few assemblies needs attending to, the headings "Dismantling" and "Overhaul" of the previous sections should be ignored, and the main instructions followed to the point of the actual job.**

**Specifications are given directly in connection with each working stage, and to some extent also in the "Technical Data" section.**



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# Specifications

Upper driven gear bearing and play	0,03 - 0,06 mm (0,0011" - 0,0023")
Upper gear clearance	0,10 - 0,16 mm (0,004" - 0,006")
Clutch shaft end play	0,01 - 0,03 mm (0,0004" - 0,0011")
Drive shaft end play	0,02 - 0,04 mm (0,0008" - 0,0016")
Lower driven gear press distance onto propeller shaft	4,3 - 4,5 mm (0,17" - 0,18")
Propeller shaft end play	0,03 - 0,05 mm (0,0011" - 0,0020")
Lower gear clearance	0,10 - 0,16 mm = = ,025 - 0,045 measured on propeller shaft splines (0,004 - 0,006" - 0,0010 - 0,0018")
Piston rod pivots max. allowed out of concentricity	0,05 mm (0,002")
Oil capacity	6,5 liter - 6,86 US quart - 11,4 imp. pints
Oil specification	ATF Dexron
Reduction ratio	1,81 : 1, 1,95 : 1 or 2,2 : 1

## Torque specifications

Drive pivot pin lock screws	2,1 kpm	( 15 ft. lbs)
Steering arm lock screw	1,0 kpm	( 7 ft. lbs)
Upper cover screws	2,1 kpm	( 15 ft. lbs)
Shift cable tube to transom shield	2,1 kpm	( 15 ft. lbs)
Piston rod pivot pin lock screws	2,1 kpm	( 15 ft. lbs)
Trim tab lock screw	4,1 kpm	( 30 ft. lbs)
Sacrificial anode	2,1, kpm	( 15 ft. lbs)
Upper gear housing to lower gear housing	2,1 kpm	( 15 ft. lbs)
Clutch shaft lock nut	20 kpm	(145 ft. lbs)
Clutch shaft front bearing housing	2,1 kpm	( 15 ft. lbs)
Shift cover to upper gear housing	2,1 kpm	( 15 ft. lbs)
Drive gear assy to upper gear housing	2,1 kpm	( 15 ft. lbs)
Drive shaft assy to lower gear housing	2,1 kpm	( 15 ft. lbs)
Pinjon lock nut	18,5 kpm	(134 ft. lbs)
Lower gear bearing cage	7,2 kpm	( 52 ft. lbs)
Piston rod pivot to be secured with		Loctite 242
Piston lock screws to be secured with		Loctite 242
Upper gear housing studs		Loctite 270
Banjo bolt hydraulic lines	2,1 kpm	( 15 ft. lbs)

# Removal of Stern Drive

## Preparation

Make it a habit to always clean the drive and transom shield before you start removing the drive.



- remove the three Allen screws (6 mm) securing the top cover and remove the same (1A).
- remove the dip stick (1B).
- tilt the drive and drain the oil by removing the drain plug at the front end of lower gear housing. While waiting for the oil to drain, remove hose clamps for water intake and exhaust bellow at the drive end.
- lower the drive without squeezing the loosened hose and bellow.

## Removal



- disconnect shift cable.
- remove the three Phillips screws securing the cover of the power trim transmitter unit on the starboard side of the gimbal ring.
- pry off the cover using two screw drivers (2A) placed between the adjustment slots.
- remove the propeller by removing the cotter pin securing the cone, the cone itself, propeller lock nut (30 mm), spacer and finally the propeller.

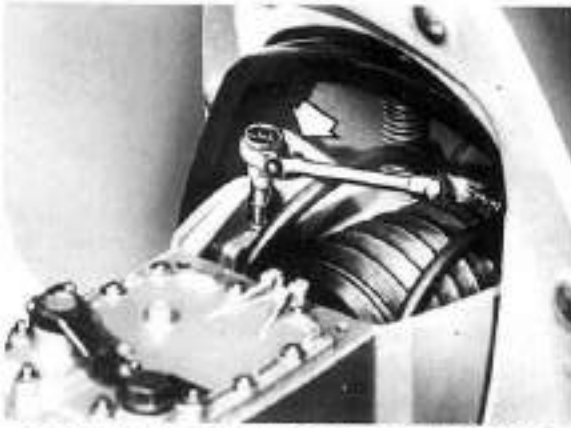


- remove the hydraulic hoses at the drive end (17 mm) and collect the oil in a suitable can (3A).
- remove the rear hose clamp of the joint's protective boot.



- remove the piston rod pivot lock screws (6 mm) (4A) and remove the pivot pin.





- remove the clamp screws (6 mm) securing the drive pivot pins (5).

**NOTE!** The screws must be fully removed before any attempt to remove the pivot pins is made.

- remove the drive pivot pins while supporting the drive to keep the alignment. The pins can normally be pushed out with thumb pressure (6).



- pull out the drive.
- plug the power trim hose connections, install dip stick and drain plug to prevent dirt to enter into the drive.

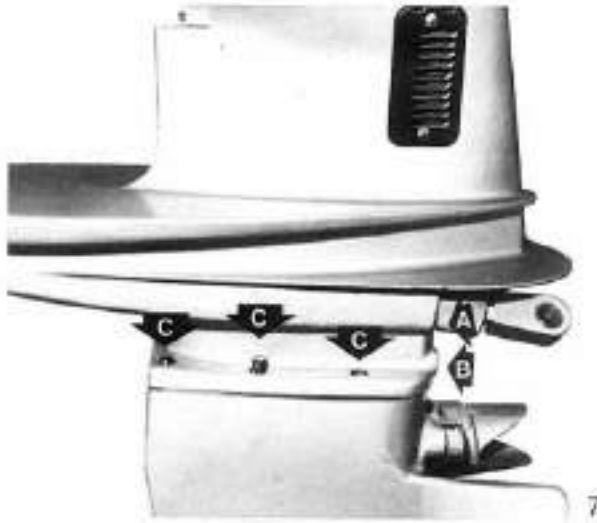


## Separating upper and lower gear

### Preparation

- remove the stern drive from the boat.

### Separation



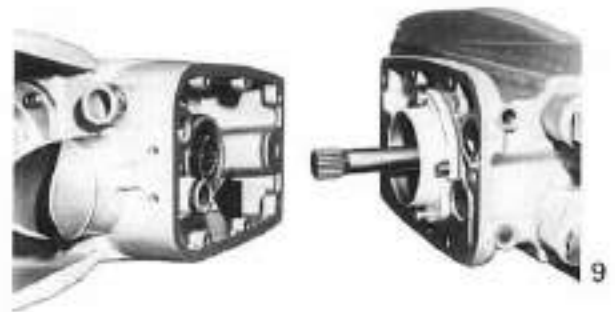
- remove the upper sacrificial anode (7A).
- remove the seven Allen screws (6 mm) holding upper and lower unit together (7C). Begin with the screw located behind the sacrificial anode (7B).
- pull upper and lower units apart (8).



## Upper gear overhaul

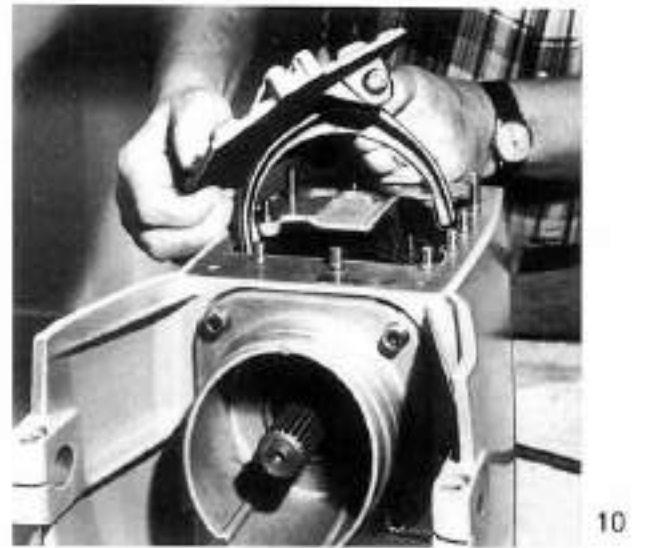
### Preparation

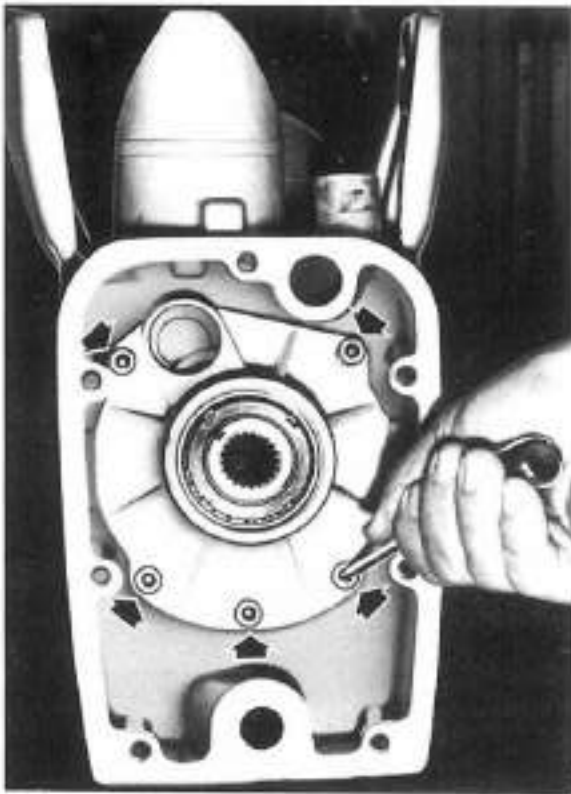
- separate upper and lower unit.
- remove oil return pipe at bottom of upper unit (9A).



### Disassembly

- remove oil dip stick (24 mm).
- remove the nuts (13 mm) securing the shift cover and remove the same (10).

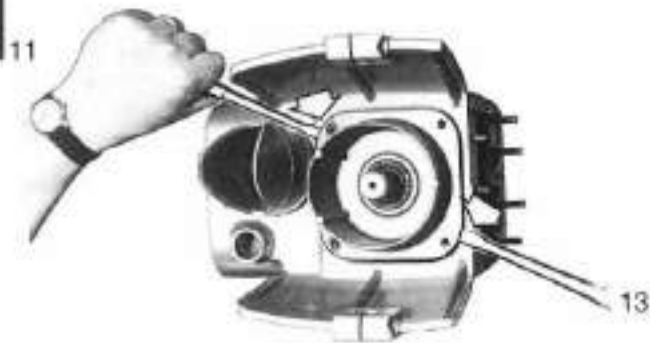




11 - loosen the five screws (6 mm) securing driven gear and lift out the same (11).



12 - loosen the four screws securing the clutch shaft bearing housing and pry it out using two screw drivers (13).



13 - pull out the clutch shaft assy (14).



14

# Overhauling driven gear assy

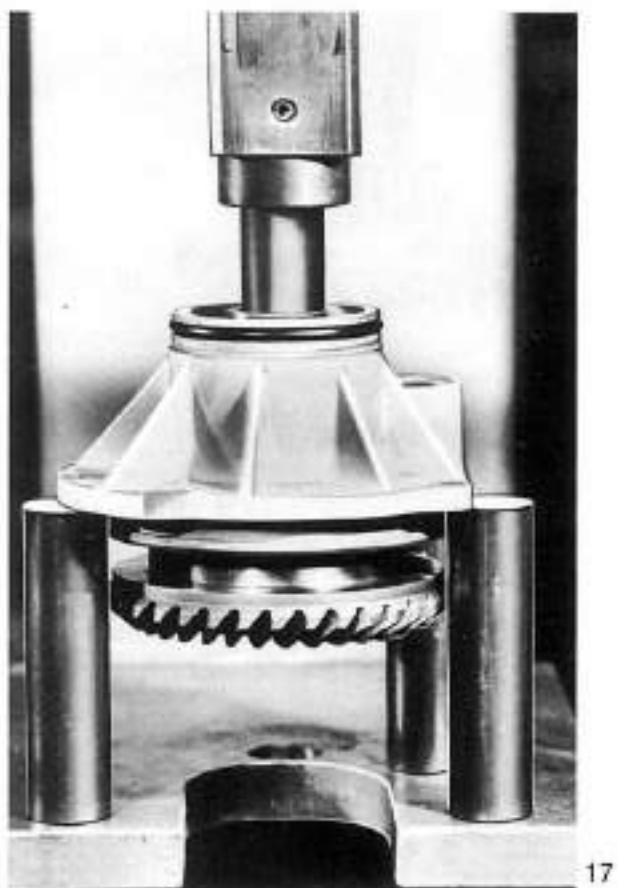
## Preparation

- disassemble upper gear.

## Disassembly



- break the lock nut (15) and remove the same (16).



- press shaft and gear assy out of the housing (17).
- pull upper bearing off the shaft with a bearing puller.
- clean and inspect the parts.



**NOTE!** The driven gear cannot be changed separately, but must be changed as a gear set.



## Assembly



- press the upper bearing into it's gear end position (19A).



- turn the nut to adjust the shaft end play (21) to correct value (0,03-0,06 mm).

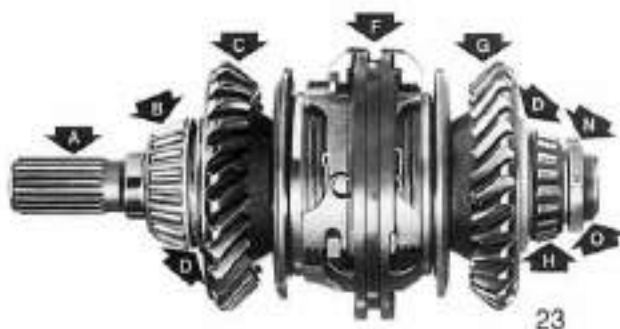


- install the lower bearing at shaft end (20).

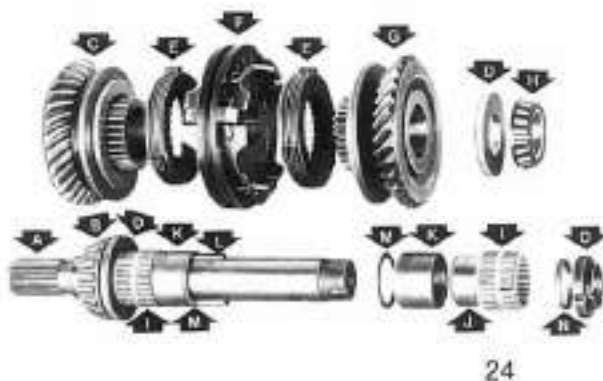


- when the end play is correct, make a notch in the nut collar with a chisel to secure the nut to the shaft (22).

## Overhauling clutch shaft



- A. Input shaft
- B. Front cone & roller assy
- C. Front gear assy
- D. Thrust washer
- E. Internal & external splined clutch plates
- F. Clutch assy
- G. Rear gear assy
- H. Rear cone & roller assy
- I. Needle bearing cage
- J. Needle bearing race
- K. Spacer
- L. Keys
- M. Shims
- N. Washer
- O. Lock nut



### Preparation

- disassemble upper gear.
- install shaft retaining tool in a vice.
- insert the shaft assy in the tool (25).



### Disassembly

- break the lock nut (25A) and remove the same.  
Use tool No. 74 64 1 330 938



74 84 1 330 939



### Inspection

- clean and check all parts for wear and damage.

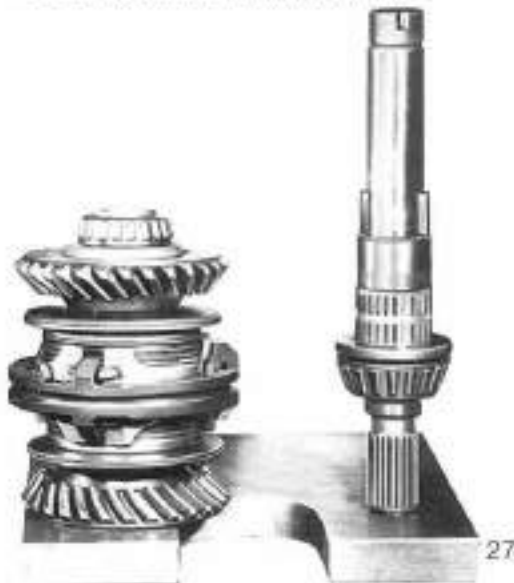
### Remark

Disassembly and assembly of clutch and gear assy's will be covered in the following sections.

### Assembly

- install the front cone & roller assy. The installation will be easier if the bearing is warmed up in hot oil (max 80°C) before pressed into place.
- fit the thrust washer with the steel side against the bearing (bronze side facing the gear that follows).
- press the needle bearing race into place (should be preheated in hot oil to facilitate the installation).
- fit the spacer and shim(s).
- install the needle bearing halves, oiled.
- install the pre-assembled gear.
- fit the clutch plates. The complete pack consist of five internally and four externally splined clutch plates.
- install the keys.
- align the keys (28C) and the clutch using the tool (28A) as guide and press the clutch assy into place.

- rig the shaft assy in a press (26).
- carefully press out the shaft (26) (27).



- remove the two keys from the shaft (24L).
- remove shim (24M) spacer (24K) and needle bearing cage (24I) in the order mentioned.
- pull off bearing (24B), thrust washer (24D) and needle bearing race (24J) with a bearing puller,

74 84 1 330 937



## Clutch overhaul

**IMPORTANT 1:** When installing the clutch it is of the utmost importance that it is mounted such that the thinner lugs (28B) of the plate carriers lead before the thicker ones in the direction of rotation (28D). If turned the other way around, the clutch will slip under load.

74 64 1 330 940



29

**IMPORTANT 2:** The clutch plates should not seize or bind, but move freely, while clutch is pressed into place. Check frequently that the externally splined (steel) plates fit smoothly into the plate carriers of the clutch (29A).

- press the clutch fully home.
- install shim and spacer to the rear side of the clutch.
- press the needle bearing race fully home (don't forget to warm it up).
- fit the complete pack of plates for the rear clutch.
- install the pre-assembled rear gear assy.
- install the needle bearing cage halves, well oiled.
- fit the thrust washer with the bronze side facing the gear.
- install the rear cone & roller assy.
- fit the washer and nut. Torque the nut to 200 Nm.
- secure the nut by tapping part of the nut collar into the groove of the shaft.

### Preparation

- disassemble clutch shaft assy.

### Disassembly



30

- remove the three hairpin springs (30).



31

- lift out the clutch plate carriers (31A) and the steel balls (31B).



32

- separate shift ring (32A) and hub (32B).

**NOTE:** Wrap a rag around the parts when doing this to prevent springs and detents from being lost.

## Assembly

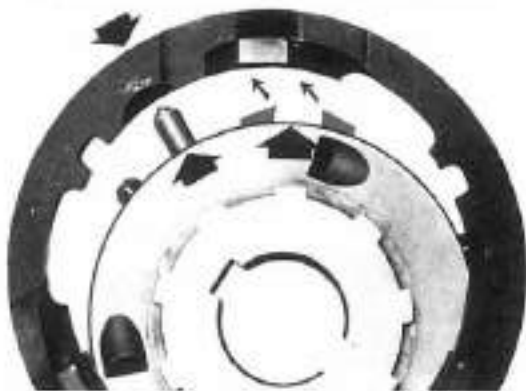
- match one of the plate carriers to it's correct side of the hub. The ball slots should be opposite each other as in picture 33.



33

**NOTE:** This is very important as the clutch, if incorrectly assembled, will be inoperative.

- put the plate carrier on the work bench with the ball recesses facing upwards.
- insert the three balls.
- put the hub with the correct side down on top of the plate carrier.
- install the three detents and their springs.
- install the shift ring according to picture 34, while holding the detents in place with your fingers.



34

- push the shift ring to neutral position.
- turn the sub-assy upside down.
- put the remaining three balls in the hub slots and put the second plate carrier on top.
- install the three hairpin springs.

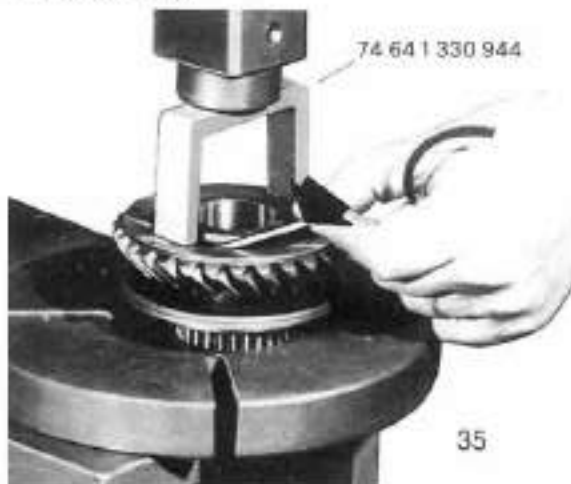


## Gear assy overhaul

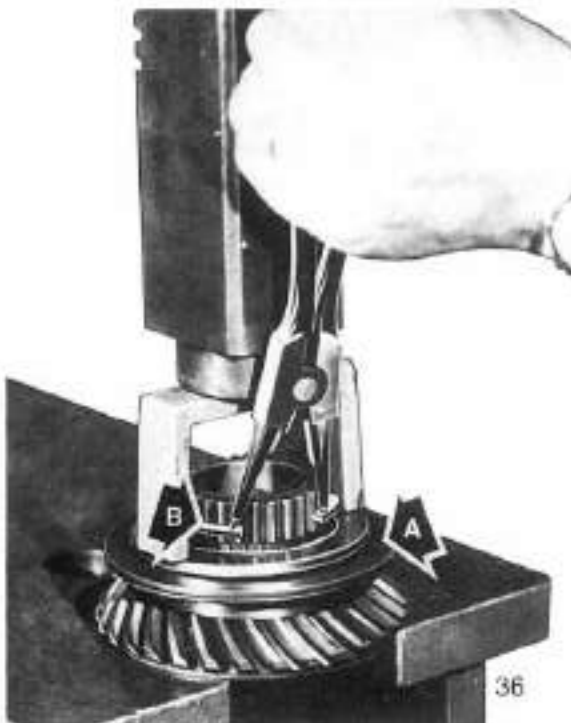
### Preparation

- disassemble clutch shaft.

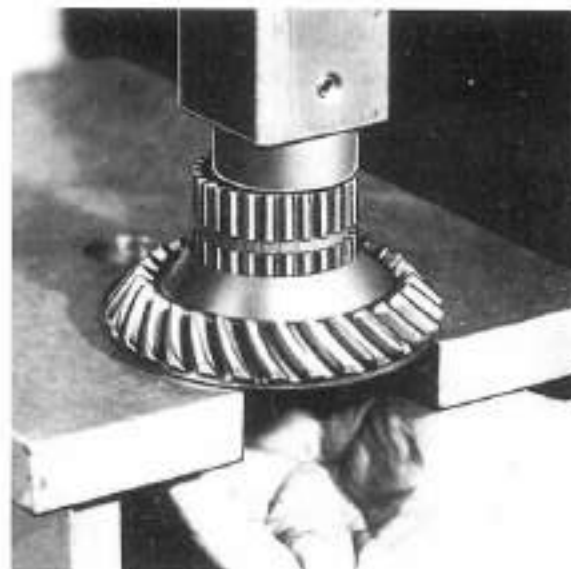
### Disassembly



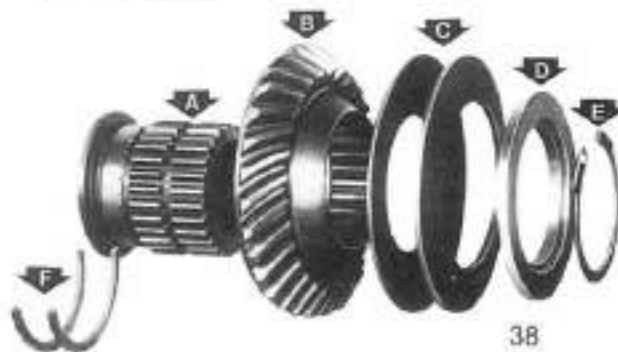
- press down on the gear and remove the split shim (35).



- turn the gear over and press down on the pressure plate (36A).
- remove the circlip (36B) with a plier.
- release the pressure and lift out the pressure plate and the two belleville springs.



- turn the gear over again and press the gear off the gear carrier (37).



- A. Gear carrier
- B. Gear
- C. Belleville springs (2 pcs)
- D. Pressure plate
- E. Circlip
- F. Split shims

### Assembly

- press the gear onto the gear carrier.
- install the belleville springs.

**NOTE:** Two different types of belleville springs are used. The one with the smallest hole is to be installed next to the gear.

- fit the pressure plate.
- press down on the pressure plate and secure it with the circlip.

## Adjustment

The clutch plate clearance (distance between clutch plate carrier and pressure plate of gear assy), is of great importance to the function of the clutch. If the clearance is too small the clutch will overheat due to internal friction, and could also cause a drag in neutral position. An excessive clearance can, on the other hand, allow the clutch to slip under load.

To prevent such a condition the following shimming procedure must be adopted.



- place the thrust washer with the bronze side facing upwards on a flat and even surface (39A).
- put the gear assy (39B) on top.
- insert, in the order mentioned, the needle bearing race (39C) and spacer (39D) into the gear centre.

**NOTE:** make certain that the race is properly seated in recess on the bronze side of the thrust washer (39E).

- adjust with shims (39F) on top of the spacer until a distance of 16,1–16,2 mm from top of shim to top surface of gear assy pressure plate has been reached (40).



From now on, the parts used to obtain this measurement are matched and must always be kept together as a set, and not be mixed up with similar parts from other gear assies.

## Assembling and shimming upper gear

When assembling the upper gear a number of factors, which can influence durability and noise level of the unit, must be taken into consideration.

1. Clutch shaft end play
2. Gear backlash on front and rear gear
3. Gear tooth pattern,

Before going into specific details it must also be mentioned that preceding assemblies and subassemblies must be correct in order to succeed with the assembly.

### Preparation

- assemble clutch shaft,
- assemble driven gear,



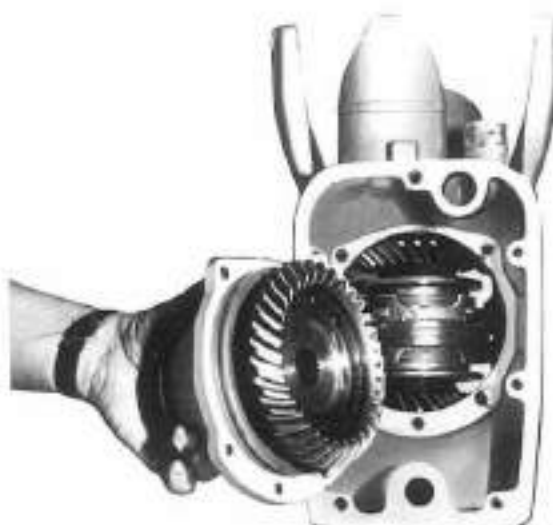
41

- install a 0,4 mm thick shim behind the bearing in the front bearing retainer (41).



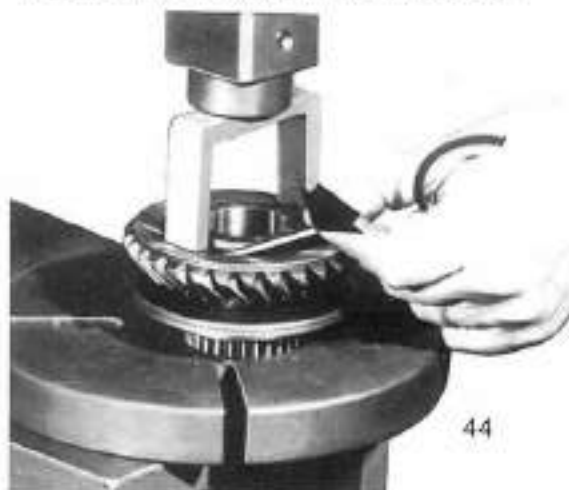
42

- install a 0,25 mm thick shim behind the rear bearing in upper housing (42).



43

- choose a 0,35 mm thick shim to be installed between driven gear housing and upper gear housing (43).



44

- install 1,7 mm shim between gear and gear carrier (44). This can be done also when the input shaft is completely assembled.
- leave all o-rings and sealing rings aside as they can make measurements more difficult and could be damaged.

**NOTE 1:** The above mentioned shims will in most cases provide adequate clearances to all concerned parts. It is however recommended to check frequently during the assembly, that clearances do exist to avoid pre-loading of gears and bearings.

**NOTE 2:** Make certain that the shift ring is, and remains, in neutral position while the readings are taken.



## Checking and adjusting clutch shaft end play

- install the clutch shaft assy in the gear housing.
- fit the front bearing housing (without sealing rings).
- install the four Allen screws (6 mm) while turning the shaft to make sure it's free to rotate.
- torque the Allen screws.



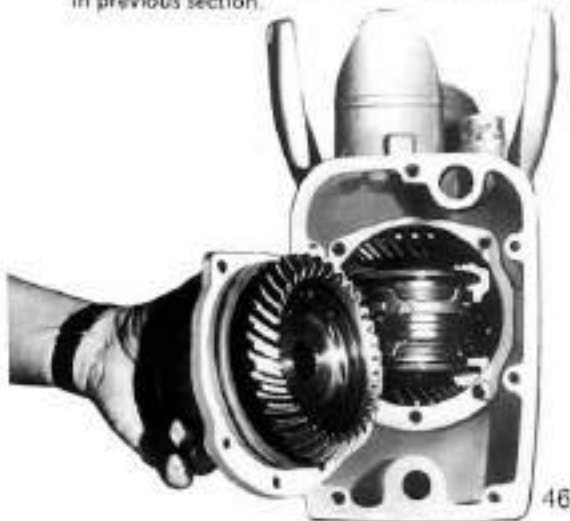
- rig a dial indicator and check the shaft end play (45) (should be 0,01–0,03 mm).
- adjust with shims in the front bearing retainer if deviations are observed.



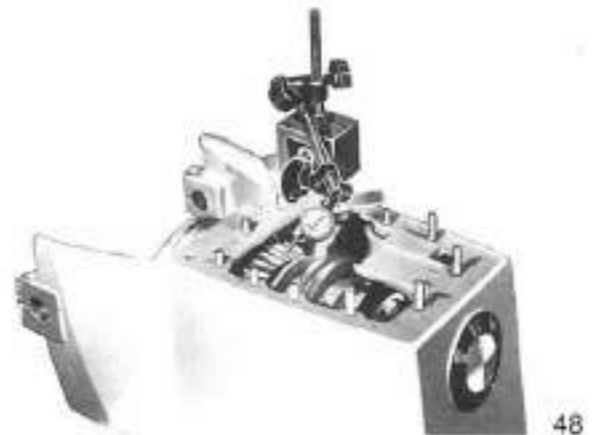
- block the driven gear (can be done with a wedge of hardwood, tapped in between the bearing lock nut and housing) (47).

## Checking gear backlash

- adjust clutch shaft end play according to instruction in previous section.



- Install driven gear assy together with mentioned shim (0,35 mm) (46).



- rig a dial indicator to measure the gear backlash on the front gear (48). Rock the gear back and forth and note the reading. (The greatest care must be exercised to avoid false readings due to unintentional movement of driven gear).
- repeat the procedure on the rear gear.
- the correct backlash should be 0,10–0,16 mm.



## Adjusting gear backlash

Two conclusions can be drawn from the readings taken

- whether the clutch shaft has to be repositioned (forward or backward).
- whether the driven gear has to be moved (outwards or inwards).

The shaft has to be repositioned if the difference in backlash between the gears exceeds 0,05 mm.

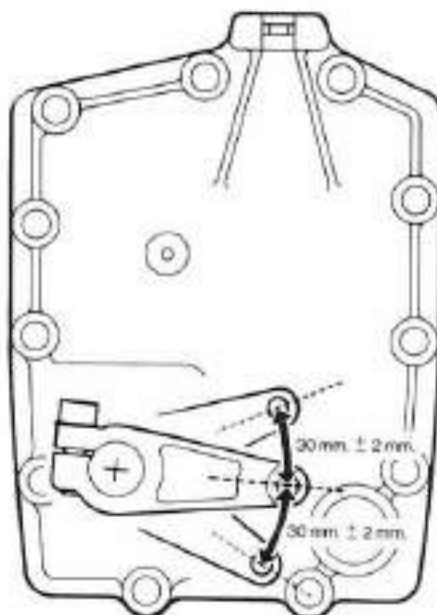
The shaft is repositioned by moving shims from one bearing cup to another. To maintain the previously set end play of the shaft the total amount of shim behind the cups must always remain the same.

The amount of shim to be moved in relation to measured difference in gear backlash can be found in the table below:

Difference in backlash	Shim thickness adjustment
less than 0,05	0
0,05 – 0,10	0,05
0,11 – 0,17	0,10
0,18 – 0,24	0,15
0,25 – 0,31	0,20

When the clutch shaft has been re-shimmed, it is always advisable to recheck the actual backlash.

When the clutch shaft has been centered the driven gear must be adjusted to bring the backlash within the given tolerances. If the measured backlash exceeds the given tolerance the gear must be brought further inwards by removing shims. If the backlash is too small shims must be added.



## Adjusting gear tooth pattern

As a final check the gear tooth pattern should be examined.

- loosen the driven gear assy.
- smear some prussian blue to the gear teeth.
- install the driven gear.
- turn the input (clutch) shaft back and fourth while braking the driven gear.
- remove the driven gear again and check the contact surfaces.
- should adjustments be necessary, they should be made by changing the split shim between gear and gear carrier on the clutch shaft.

## Final assembly of upper gear

When the backlash and gear tooth pattern is correct, the final assembly of the upper gear can take place.

- install all sealing rings and O-rings.
- grease the O-ring sealing areas with water resistant grease.
- torque the Allen screws to 21 Nm.
- clean shift cover and housing carefully to remove any trace of the old gasket.
- install a new gasket.
- fit the shift cover, assuring that shift ring and shift fork both are in neutral position. Otherwise problems with neutral position alignment could arise.
- install the cover with two nuts
- adjust the cover in any direction until the travel of the shift lever from neutral to engaged gear is  $30 \pm 2$  mm, see figure

**NOTE!** This is very important to enable the clutch to fully engage as well as prevent friction and wear between shift ring and shift fork

- tighten the nuts to 21 Nm.





## Overhauling lower gear

### Preparation

- separate upper and lower gear.

### Disassembly

- remove the sacrificial anode,
- remove propeller bearing cage (49A).



49

- pull out the propeller shaft (50).



50

- set up the driveshaft in the tools (51A) (51B).
- loosen the pinion lock nut (19 mm) (51C).
- remove the washer and discard the lock nut.
- remove the lower unit from the tools.



51

- loosen the four Allen screws (52A) (5 mm) securing the drive shaft bearing cage.
- pull out the shaft and remove the pinion (52).



52

- remove the bearing that supports the pinion by using a hammer and a long mandrel (53).



53



## Overhauling propeller shaft

The propeller shaft gear is force fitted to the propeller shaft. It, as well as the propeller shaft, can not be changed separately, but makes up a set together with the pinion gear. Among the parts fitted to the propeller shaft, only the bearing and the oil pump can be changed separately.

### Disassembly

- remove the bearing with a bearing puller. Notice the shims fitted at the front bearing.
- heat the oil pump impeller with a torch to approx 200°C and pry it off using two screwdrivers.

### Assembly

- heat the oil pump impeller with a torch to 200°C and tap it into place with the wings facing forwards.

**IMPORTANT!** Never attempt to force it onto the gear when cold, as it then might come loose during operation.



54

- press the rear bearing into place (no shims; the shims are fitted behind the cup in the bearing cage) (54).
- install the front cone & roller assy with a 0,4 mm thick shim (this shim will provide a basic setting for correct shimming of lower gear).

## Drive shaft overhaul

### Preparation

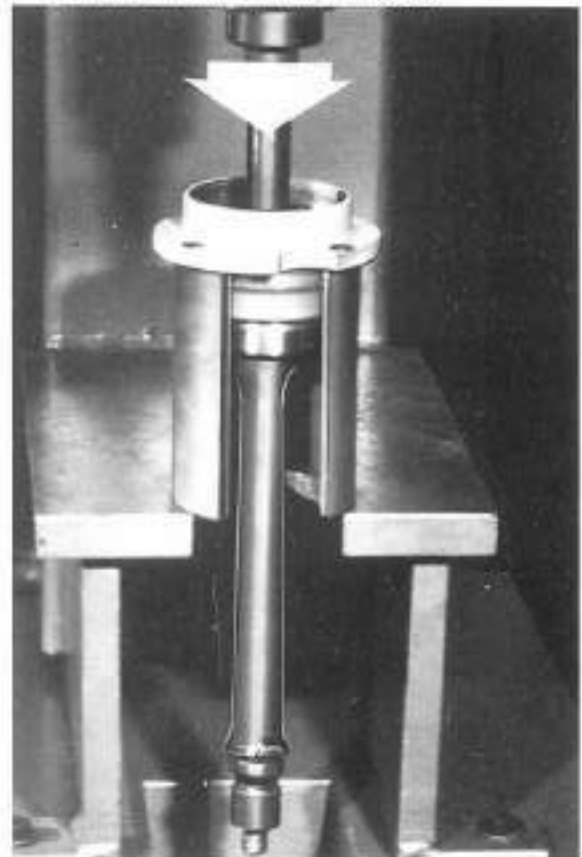
- disassemble lower gear.

### Disassembly



55

- insert the shaft assy in the special tool (55A).
- break the lock nut and remove it (55B).



56

- rig the shaft in a press and press it out (56).

**NOTE!** Care should be exercised, so that the four springs between housing and lower bearing cup are not lost.

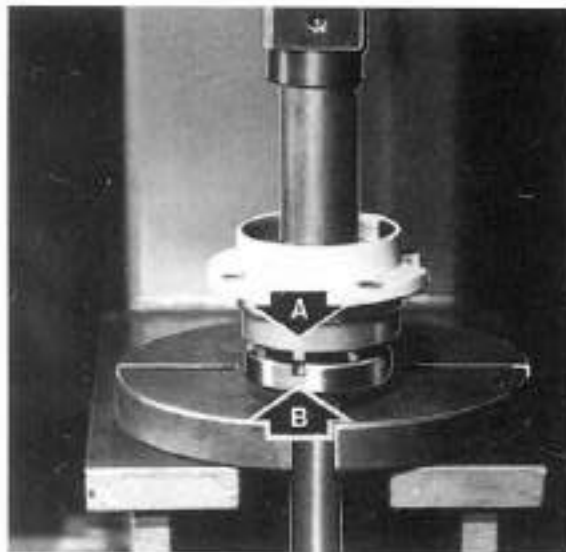


- A. Drive shaft
- B. Lower cone & roller assy
- C. Lower cup
- D. Springs (4x)
- E. Bearing housing
- F. Upper cup (hidden)
- G. Upper cone & roller assy

- remove the upper bearing cup with a bearing puller.
- remove the lower cone & roller assy with a puller.

### Assembly

- press the lower cone & roller assy (57B) onto the drive shaft.
- install the upper cup (57F) in the bearing housing.
- install the lower cup (57C) on the lower bearing and insert the four springs (57D).
- slide the bearing housing (57E) onto the shaft.



- press down on upper cone & roller assy (57G) while aligning the stud (58A) on housing with the groove (58B) in lower cup.
- install the lock nut and tighten the nut until an end-play of 0,02–0,04 mm has been achieved.
- secure the nut by tapping the nut collar into the shaft groove.

## Assembling and shimming lower unit

- install the propeller shaft front cup.
- fit the pinion needle bearing.
- fit the drive shaft assy with 0,35 mm shims installed between lower unit and retainer, to get a basic setting for the shimming procedure.

**NOTE!** Do not fit the sealing rings yet. This is done only when the required amount of shims has been established.

- install pinion. Fit the washer and lock nut and tighten the nut to 185 Nm.

**NOTE!** The nut is of self-locking type and should never be used twice. It can however be used at this initial assembly, but don't forget to use a new one at the final assembly.

- insert the propeller shaft.
- fit the bearing cage with a 0,25 mm shim placed between rear bearing cup and cage.

**NOTE!** Sealing rings are not yet installed. This is done when the shimming is completed.

## Shimming of lower gear

- rig a dial indicator and check the propeller shaft end play.
- adjust the end play to 0,03–0,05 mm by removing or adding shim between rear bearing cup and cage.
- rig a dial indicator with the tip against a propeller shaft spline.
- block the drive shaft.
- turn the propeller shaft back and fourth and note the dial indicator reading which indicates the gear backlash.

**NOTE:** As the measurement is taken on a radius which is smaller than that of the propeller shaft gear, the reading will consequently be lower. When gear backlash is correct, the reading should be 0,025–0,045.

- if the reading is too low, shim should be removed at the rear cup and the same amount of shim added at the front propeller shaft bearing. If the reading is too high, shim should be removed at the front propeller shaft bearing and the same amount added at the rear cup. The relation between shim to be added or removed and deviations in gear backlash is shown in table below.
- adjust the shimming accordingly and recheck the gear backlash.
- check the gear tooth pattern by smearing prussian blue to the propeller shaft gear.
- brake the drive shaft while turning the propeller shaft back and fourth.
- remove the propeller shaft again and check the gear tooth pattern.
- adjust if necessary with shim between drive shaft bearing cage and lower unit.
- install the o-rings and propeller shaft seal. Don't forget to fill the propeller shaft seal with water-resistant grease before installing the bearing cage.

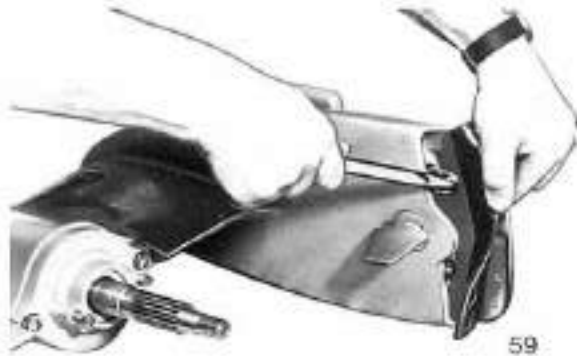
**IMPORTANT!** The bearing cage must be installed with the lip upward.



## Replacing power Trim hydraulic cylinders

### Removal

- loosen the bolt (17 mm) at the drive exhaust outlet.
- knock the cylinder out with a mandrel and a hammer.



### Installation

- install new o-rings on cylinder in lower unit housing and on the securing bolt.
- insert the cylinder in the lower unit.
- tighten the bolt to 160 Nm.



## Mark II Sterndrive

The procedures to disassemble, inspect and reassemble the Mark II drive are with a few exceptions similar to the Mark I sterndrive.

The following section describes the deviating procedures.

### Upper gearhousing

#### Removal of universal joint

- Remove vertical drive as explained on page 5.
- Place vertical drive in holding fixture.
- Remove plug at tapered side of joint.
- Connect oil press tool. We recommend the use of SKF oilpress kit 729 101 B and press of universal joint.

#### Installation of universal joint

- Preheat joint (only tapered side) to 200 °C (400 °F).
- Install taper of joint on clutch shaft with a short hammer tap. Joint will shrink fit on shaft.
- Install sterndrive to transom.

### Lower gearhousing

#### Disassembly

- Drain lubricating oil. Check lubricant for metal particles or water.
- Separate upper and lower gearhousing.
- Place gearhousing in holding fixture.
- Remove propellernut, lockplate, propeller and thrustplate.
- Remove retaining ring and pull out seal cover. Remove screws holding retainer.
- Unscrew threaded retainer and remove bearing cover.
- Remove propeller shaft.
- Remove pinion gear and drive shaft (see page 23).

#### Inspection procedures

- Clean parts in solvent and dry with compressed air.
- Inspect gears for pitting, chipped or broken teeth and excessive or uneven wear.
- Inspect tapered roller bearings and bearing cup for grooves, uneven wear or overheating.
- Inspect oil seals and „O-rings“
- Inspect drive shaft- and propeller shaft splines. Check for wear and straightness.

### Overhauling propeller shaft (see page 25)

The propeller shaft gear can be removed from the shaft.

#### Disassembly

- Remove tapered bearings.
- Connect oilpress to threaded hole in front of propeller shaft. Use SKF oil press 729 101 B.
- Press off gear. Gear will move to proppside off shaft.

#### Assembly

- Heat gear to 220 °C (430 °F).
- Place distances bushing part-number 74 64 1 330 970 on bench.
- Place propeller shaft, front side first in tool.
- Install gear, teeth facing down on shaft until front face of gear touches tool. If gear slides not down completely help with hydraulic press.
- Install oilpump impeller and bearings as described on page 25.

### Drive shaft overhaul see page 25, 26

#### Assembly of lower gearhousing

See page 27.

- Install drive shaft and pinion.
- Insert propeller shaft.
- Install bearing cover and screw in threaded retainer.
- Adjust with threaded retainer shaft endplay. This should be 0,03 – 0,05 mm.
- Tighten retainer with 2 screws.
- Install seal cover and retaining ring.

**NOTE:** Adjust gear backlash as described on page 27 "shimming of lower gear".



## Stern drive special tools

<b>Part no.</b>	<b>Description</b>
74 64 1 330 936	clutch shaft holder
74 64 1 330 937	key alignment tool
74 64 1 330 938	spanner clutchshaft nut
74 64 1 330 939	remover
74 64 1 330 940	installer bushing
74 64 1 330 941	spanner bevel gear nut
74 64 1 330 942	spanner drive shaft nut
74 64 1 330 943	bushing
74 64 1 330 944	press-in mandrel
74 64 1 330 969	square profil
74 64 1 330 970	distance bushing propeller shaft gear (only Mark II)



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