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1. GENERAL DATA

1.1 Specifications

Gear ratios

1.96:1, 2.94:1

Power rating:

1.96:1 up to 3.43 hp (2.56 kW) per 100 rev/min

2.94:1 up to 3.43 hp (2.56 kW) per 100 rev/min

Note: All ratings are for guidance and will vary according to application and duty cycle. Further details available from Newage Transmissions Ltd. or local distributor.

Input speed:

Up to 3600 rev/min continuous

4000 rev/min intermittent

Input rotation:

Clockwise or anti-clockwise (see section 2).

Output rotation:

Clockwise or anti-clockwise as required (see section 4.1).

Approximate dry weight:

48 Kg (106lb)

(excluding drive coupling, adaptor and cooler).

Oil capacity:

Both ratios: 1 Litre (1.76 pints)

Note: above capacities do not include oil required to fill the cooling circuit.

Working oil pressure:

1790 kPa (2601bf/in² - 18.3 kg/cm²)

Working oil temperature

50°C - 70°C

Maximum permissible temperature 80°C

Transmission cooling:

Transmission cooler must be fitted; provision made for connecting unit to operating valve block.

Capacity of cooler required will vary according to ambient temperature, engine horsepower and other factors. Suitable coolers are available from Newage Transmissions Ltd.

Input drive couplings:

Flexible drive coupling for flywheels of 6.5 in, 7.5 in, 8 in, 10 in and 11.5 in nominal diameter to SAE J620C.

Gearcase:

Heavy duty cast iron for use in marine environment, constructed in two halves for ease of servicing; ribbed internally for rigidity and strength.

Input shaft:

25.4mm (1 in) diameter SAE 10 spline.

Propeller thrust:

Ahead and astern thrust carried by output shaft bearings of adequate capacity for all Newage approved ratings.

Output flange:

127mm (5 in) diameter, with 4 holes, 12mm (0.453 in) diameter on 108mm (4.25 in) PCD.

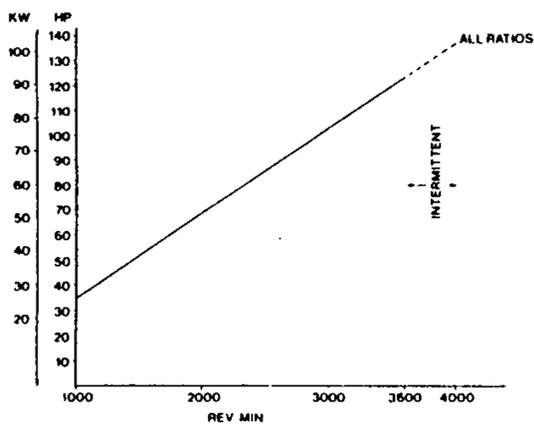
Installation angle:

The maximum fore and aft installation angle permissible at rest is 17°.

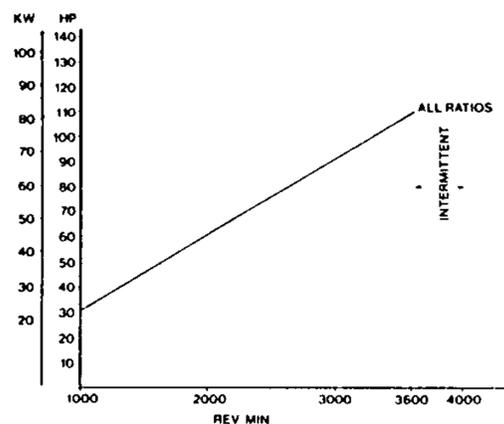
1.2 Application details

PRM160

Pleasure boats

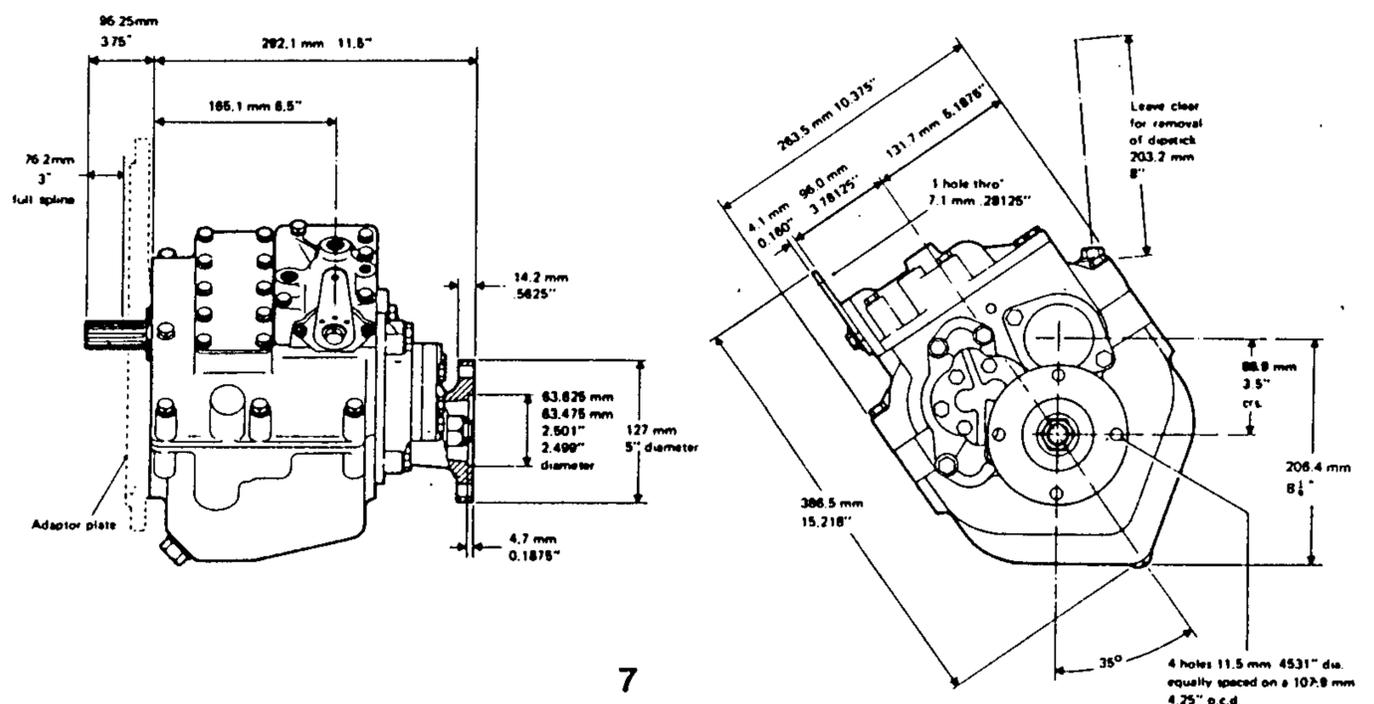


Workboats



Note: Pleasure boat ratings are generally also acceptable for light commercial boat applications up to 1500 hours per year. However, all ratings are given for general guidance; if in any doubt or for special application requirements please refer to factory or distributor.

1.3 Installation details



2. INTRODUCTION

Newage PRM marine transmissions are oil-operated gearboxes of the countershaft type with separate oil-operated multi-disc clutches (which need no adjustment) for both ahead and astern drive. This design permits full power to be transmitted in astern as well as ahead, and also allows right-hand or left-hand propeller rotation in ahead drive, with identical ratios in ahead and astern.

Both left-hand (anti-clockwise) and right-hand (clockwise) rotating engines can be accommodated.

Note: when describing engine rotations, face the engine on which the transmission is to be mounted and describe the rotation accordingly. Similarly, describe the transmission output rotation as clockwise or anti-clockwise as seen when standing behind the gearbox output coupling facing towards the input or engine end of the transmission.

3. CONSTRUCTION

3.1 Gearcase

The gearcase has been kept free from hydraulic pipes, cylinders and associated components, and the only items mounted externally are the oil pump, hydraulic control block and operating lever.

A magnetic drain plug is provided at the front of the gearcase; this can be removed if required to allow suitable pipework to be connected to a hand-operated drain pump.

Connections are provided on the valve block for the oil cooler and pressure gauge.

3.2 Gear train

The transmission comprises an input shaft assembly, a layshaft assembly and an output shaft.

The input shaft, which is supported by a taper roller bearing at either end, incorporates a drive pinion of the required ratio (running on a special self-lubricating bearing), the forward (when used with a right-hand propeller) drive clutch assembly, the clutch gear and a hydraulic actuated piston to operate the clutch.

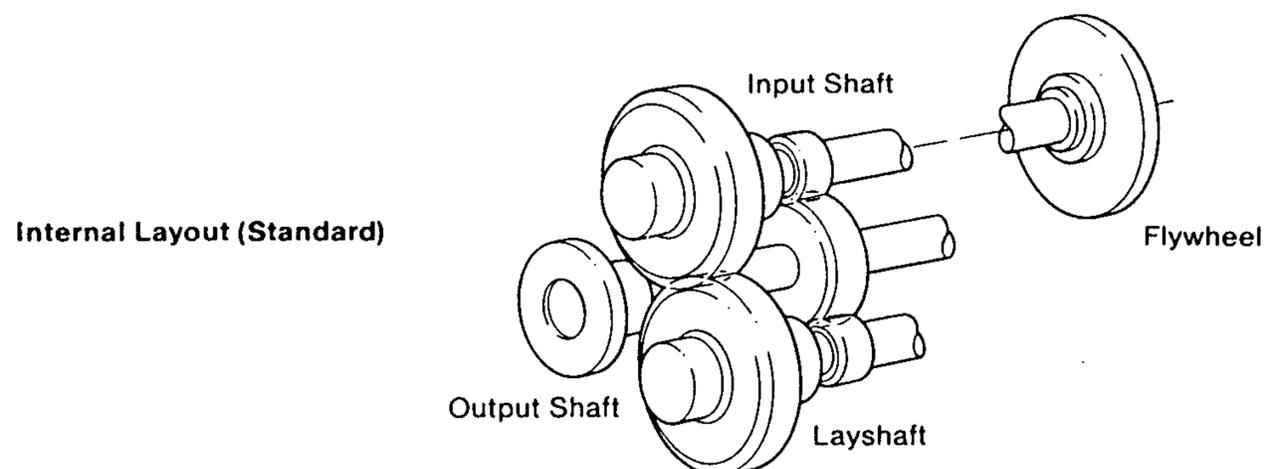


Fig. 2. Internal Layout

The layshaft is similarly supported by taper roller bearings and also incorporates a drive pinion of the same ratio (again running on a special self-lubricating bearing), the reverse (when used with a right-hand propeller) drive clutch assembly, a clutch gear of opposite hand rotation to that on the input shaft, and a hydraulically actuated piston to operate the clutch.

The output shaft runs on amply proportioned bearings, arranged in such a way that propeller thrust can be satisfactorily absorbed; it also carries the output gear and the output flange.

3.3 Valve block

The valve block is located on the top of the gearcase and contains the main control valve, integral with which is the high pressure valve which controls the supply to the clutch assemblies. Oil which is surplus to clutch operation requirements is used for lubrication purposes.

The control valve is fitted with a spring-loaded neutral detent; this provides a positive neutral position and ensures positive selection of either ahead or astern drive.

3.4 Neutral safety switch

A neutral safety start switch, which ensures that the engine to which the gearbox is fitted cannot be started unless the gearbox is in neutral, is available as an optional extra.

This device is of obvious benefit, since it will help prevent accident or damage caused by a boat moving ahead or astern on engine start-up in a crowded marina or other area.

When used, the switch is located on the valve block (see item C on the parts list) and should be wired into the starter circuit as shown in Fig. 3.

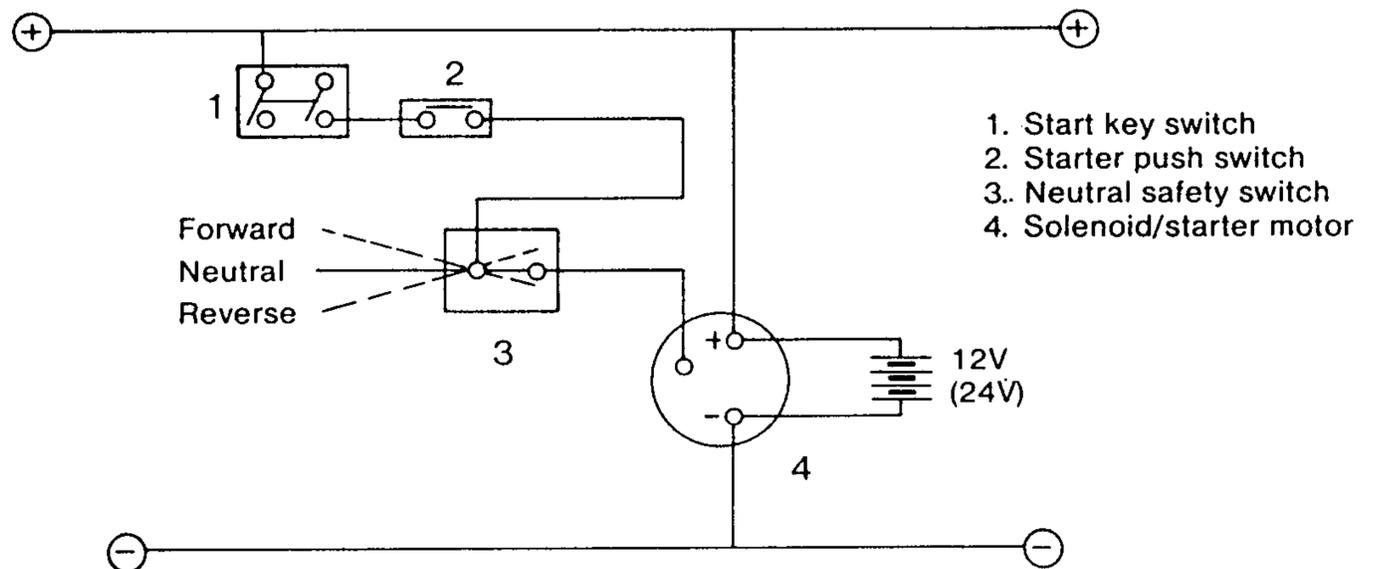


Fig. 3. Wiring Diagram for Neutral Safety Start Device.

3.5 Oil pump

A cast iron gear-type pump externally mounted at the rear of the gearcase and normally driven by the layshaft, supplies oil at high pressure for actuation of the clutch assemblies, and at lower pressure for lubrication circuits.

When the transmission is used with anti-clockwise engines (looking at the flywheel), the oil pump is fitted in its standard position. For clockwise engines, the pump is turned through 180° to standard (see diagrams).

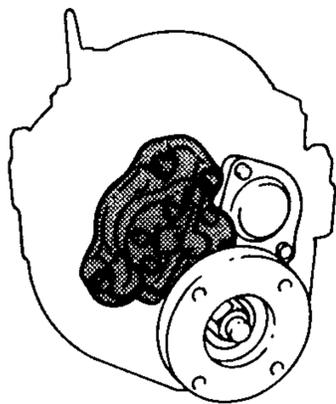


Fig. 4. Oil Pump Mounting — anti-clockwise engines

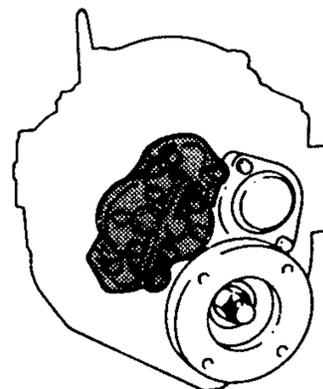


Fig. 5. Oil Pump Mounting — clockwise engines

Note: Unless otherwise specified at the time of ordering, we will assume anti-clockwise rotating engine and the oil pump will be mounted accordingly.

If a clockwise input rotation is specified when the order is placed, the pump will automatically be mounted in the appropriate position.

4. OPERATING SYSTEM

4.1 Output rotations

With the control lever at the mid-point of travel or neutral position and the engine running, the splined input shaft and the clutch gear rotate at engine speed. The clutch gear is in constant mesh with the clutch gear on the layshaft which is therefore also driven at engine speed, but in the opposite rotation. Since neither clutch is engaged, the drive pinions do not rotate.

When the control lever is moved to the 'ahead' position the hydraulic system is actuated and oil is directed at high pressure to the clutch on the appropriate shaft; the clutch engages and engine drive is directed to the forward drive pinion. The pinion turns the gear on the output shaft and the propeller shaft and propeller are rotated in the direction corresponding to ahead movement of the vessel.

Similarly, when the control lever is moved to the 'astern' position, the clutch on the opposite shaft is engaged and drive applied to the reverse pinion. This turns the output shaft gear in the opposite direction; and the propeller shaft and propeller rotate in the direction corresponding to astern movement of the vessel.

Gearbox output rotation

Engine rotation anti-clockwise	
Lever Backward	
Lever Forward	

Engine rotation clockwise	
Lever Backward	
Lever Forward	

Note: (i) Rotations are as seen looking from the propeller forward to the gearbox.

(ii) Anti-clockwise engines are by far the most common, and the standard gearbox build therefore assumes an anti-clockwise input.

4.2 Hydraulic system

Oil is pumped from the gearbox sump through the internal supply pipe and is delivered to the control block, which incorporates a high pressure valve to ensure that the correct operating pressure is maintained.

When the operating lever is moved, oil is delivered under pressure to a feeder on either the input shaft or layshaft and thence to a piston which actuates the appropriate clutch for either ahead or astern drive.

Oil in excess of that required for hydraulic actuation is used for lubricating the gearbox.

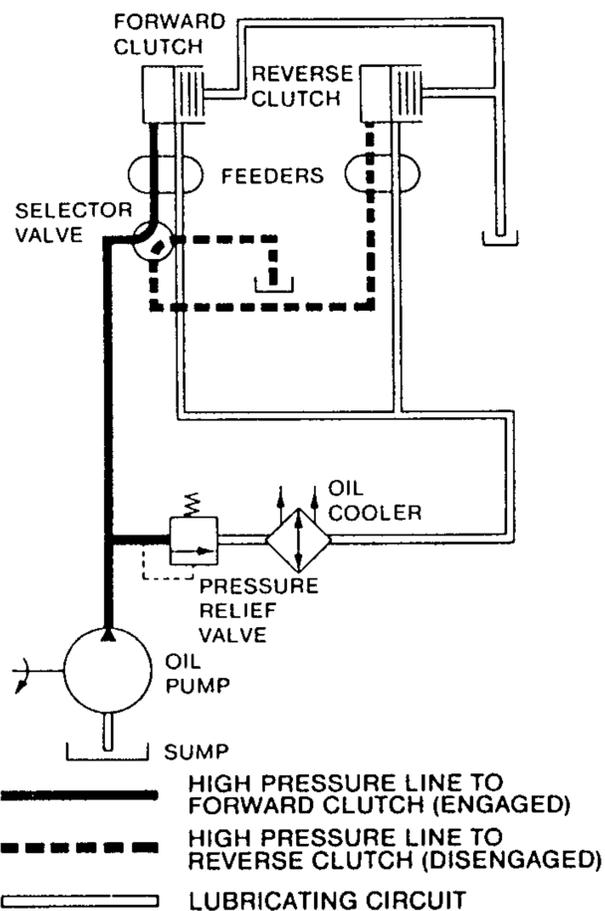


Fig. 6. Hydraulic and Lubricating Oil Circuits.

4.3 Lubrication

Oil for lubrication purposes is also delivered via the internal supply pipe to the control block. Irrespective of whether ahead or astern is engaged oil is diverted from the discharge side of the pressure relief valve to an external oil cooler. After passing through the cooler, the oil is directed through channels on the valve block to the feeders and thence through the layshaft and drive shaft to lubricate the clutch assemblies.

4.4 Approved oils

APPROVED LUBRICANTS – PRM MARINE GEARBOXES

Company	Ambient Temperature Below 0°C	Ambient Temperature 0°C – 30°C	Ambient Temperature Above 30°C
BP	BP Vanellus M20-50	BP Vanellus M20-50	BP Vanellus M20-50
Castrol	Castrol GTX or Deusol CRB 20W/50	Castrol GTX or Deusol CRB 20W/50	Castrol GTX or Deusol CRB 20W/50
Century	Century Supreme 20W/50 or Centlube Supreme 10W/30	Century Supreme 20W/50 or Centlube Supreme 10W/30	Century Supreme 20W/50
Chevron	Chevron Delo 100 10W or Chevron Delo 200 10W	Chevron Delo 100 20W/20 or Chevron Delo 200 20W/20	Chevron Delo 100 30 or Chevron Delo 200 30
Conoco	Conoco 20W/50 or Conoco HD 10W/30	Conoco 20W/50 or Conoco HD 10W/30	Conoco 20W/50
Duckhams	Fleetol Multilite	Q Motor Oil or Fleetol Multi-V	Q Motor Oil or Fleetol Multi-V
Elf	Cougar 15W/30	Cougar 15W/30	Cougar 15W/30
Esso	Esso Superlube or Essolube HDX Plus 10W-30 or Essolube XD-3 10W	Esso Superlube or Essolube HDX Plus 30 or Tromar HD30	Essolube HDX Plus 30 or Tromar HD30 or Essolube XD-3 30
Fina	Fina Dilano 20 or Fina 20W/50	Fina Dilano 30 or Fina 20W/50	Fina Dilano 40 or Fina 20W/50
Gulf	G.M.O. XHD 10W/30 or G.M.O. XHD 10W	G.M.O. XHD 10W/30 or G.M.O. XHD 20W/20	G.M.O. XHD 10W/30 or G.M.O. XHD 30
Mobil	Mobil Super 15W-50 or Delvac Special 10W-30 or Delvac Super 15W-40	Mobil Super 15W-50 or Delvac Special 10W-30 or Delvac Super 15W-40	Mobil Super 15W-50 or Delvac Special 10W-30 or Delvac Super 15W-40
Shell	Shell Super Motor Oil or Rotella TX 20W/40	Shell Super Motor Oil or Rotella TX 20W/40	Shell Super Motor Oil or Rotella TX 20W/40
Silkolene	Chatsworth 10 Engine Oil or Permavisco 20W650 Engine Oil	Chatsworth 20 Engine Oil or Permavisco 20W/50 Engine Oil	Chatsworth 30 Engine Oil or Permavisco 20W/50 Engine Oil
Texaco	Ursatex 20W-50 or Ursa Extra Duty 20W-40	Ursatex 20W-50 or Ursa Extra Duty 20W-40	Ursatex 20W-50 or Ursa Extra Duty 20W-40
Total	GTS or HD2.M 20W/50	GTS or HD2.M 20W/50	GTS or HD2.M 20W/50
Valvoline	Super HPO 10W or HDS HDM 10W Grades	XLD 15W 50	XLD 15W 50 or All Climate 20W-50

Customers wishing to use any oil not listed above should send the relevant details to Newage for prior approval. Failure to do so may result in the forfeiture of warranty cover since no claims under warranty will be entertained if oil of the wrong specification is used.

5. INSTALLATION

5.1 General

The Newage PRM160 marine gearbox is supplied with a choice of adaptor plates to SAE2, SAE3, or SAE4 specifications thus allowing the transmission to be mounted to engine flywheel housings of equivalent specification.

Drive is transmitted from the engine to the gearbox via either a spring centre drive plate or a flexible input coupling which bolts to the engine flywheel with the gearbox input shaft inserted into its centre.

These components enjoy a degree of torsional flexibility, the purpose of which is to damp down engine torsional or cyclic vibrations and prevent them being passed to the transmission.

The strongest engine vibrations are usually those caused by firing in the cylinders; diesel engines which have high compression ratios, usually generate stronger vibration pulses than petrol (gasolene) engines; and it is often the case that of two engines of roughly equivalent size, the one having the greater number of cylinders will tend to run more smoothly than the one with fewer cylinders, although this is by no means always the case.

In all marine installations, correct alignment is of the utmost importance - misalignment can cause noise, vibration and premature failure - and we strongly recommend that all the procedures detailed in this manual are carefully followed.

Note: It is particularly important to ensure the torsional compatibility of the complete propulsion system from engine through to propeller since disregarding this may result in gear noise at low speed operation and in extreme cases damage or failure of components.

Newage Transmissions Ltd. will provide all possible information and assistance to help find solutions to potential torsional problems, but it is the ultimate responsibility of the person assembling the drive and driven equipment to ensure that they are torsionally compatible.

5.2 Checking the engine flywheel housing

Attach a dial test indicator, calibrated in units of 0.025mm (0.001 in.) or smaller, to the flywheel so that the measuring stylus of the indicator is perpendicular to the bore of the flywheel housing (bore A on Fig. 7). Rotate the flywheel and check the deviation on the indicator over one complete revolution: this should not exceed 0.152mm (0.006 in.) total indicator reading.

With the dial test indicator still attached to the flywheel, re-position the stylus so that it is perpendicular to the face of the flywheel housing (face B on Fig. 7). Rotate the flywheel and check the deviation over the one complete revolution; again, this should not exceed 0.152mm (0.006 in.) total indicator reading.

5.3 Checking the engine flywheel

Attach a dial test indicator, calibrated to 0.025mm (0.001 in.) or less, to the engine flywheel housing so that the measuring stylus of the indicator is perpendicular to the bore of the register in the flywheel (bore C on Fig 7).

Rotate the flywheel through one complete revolution and note the deviation, this should not exceed 0.125mm (0.005 in.) total indicator reading. With the dial test indicator still attached to the flywheel housing, reposition the stylus so that it is perpendicular to the face of the flywheel register (D on Fig 7). Rotate the flywheel through one complete revolution and note the deviation, this should not exceed 0.125mm (0.005 in.) total indicator reading.

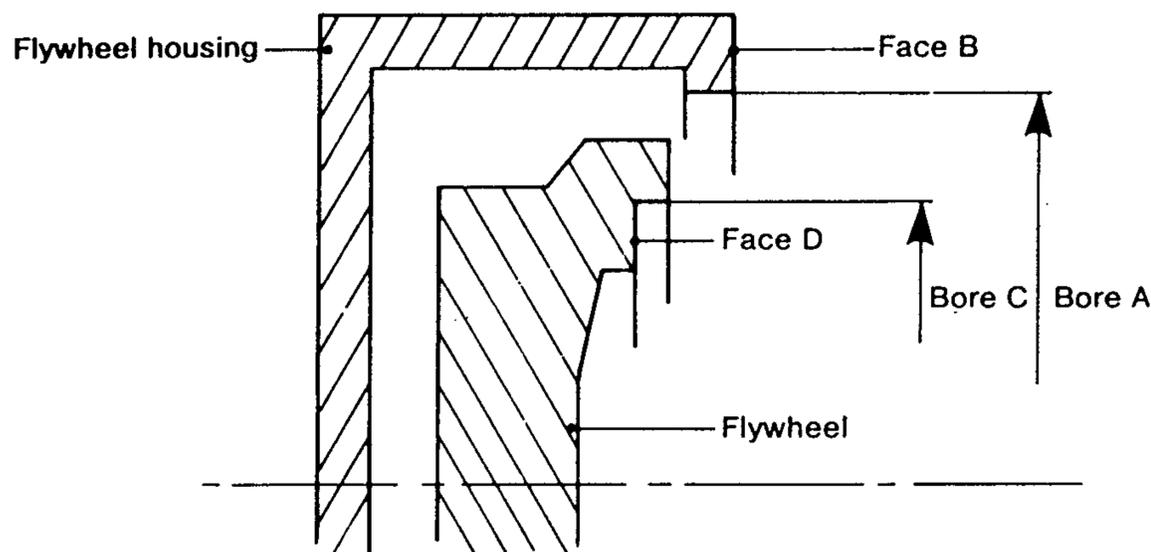


Fig. 7. Checking engine flywheel and flywheel housing.

5.4 Mounting the gearbox to the engine

1. Mount the flexible input coupling to the flywheel, using an alignment mandrel if available, and bolt it to the flywheel using the holes provided. Where components to SAE standard are used, the outside diameter of the drive plate or coupling should be a close fit in the register on the flywheel.

If a mandrel is not available, tighten the mounting bolts, just sufficiently to prevent free movement, assemble the gearbox to the coupling, and rotate the engine two or three revolutions by hand to align the plate. Tighten up two or three opposite bolts, using the inspection window provided on the gearbox adaptor flange.

2. Remove the gearbox and fully tighten the flexible input coupling bolts.
3. Taking care to ensure correct alignment, mount the adaptor flange to the front of the gearbox.
4. Offer up the gearbox and adaptor to the input coupling and engine flywheel housing at the correct angle of inclination to obtain the shaft offset and insert the gearbox input shaft into the centre of the coupling (it may be necessary to rock the shaft slightly to ensure that the shaft enters). Press the assembly fully into position, align the mounting holes in the adaptor flange with those on the flywheel housing and bolt securely.

5.5 Oil cooler

All Newage PRM160 gearboxes must be fitted with an oil cooler to maintain correct working temperatures. To permit a suitable cooler to be fitted, two $\frac{3}{8}$ in. BSP connections are provided on the valve block, and these are blanked off with "Redcap" seals on delivery from the factory.

The gearbox oil cooler is normally mounted on the gearbox adaptor flange or the bulkhead of the boat, and then connected into the cooling system on the engine; one method of arranging the engine and gearbox cooling circuit is shown below.

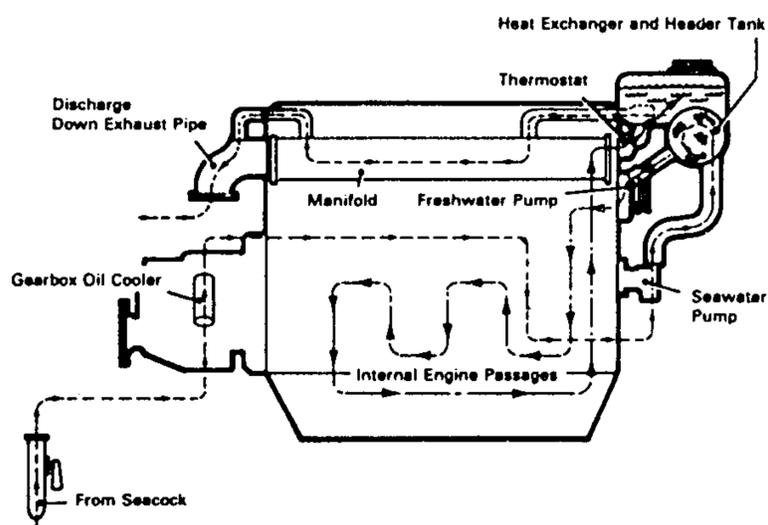


Fig. 8. Gearbox and Engine Cooling Circuit

Remove the "Redcap" seals from the valve block and connect, via suitable hoses, to inlet connections on the oil cooler, which can then be incorporated into the engine cooling system as outlined above.

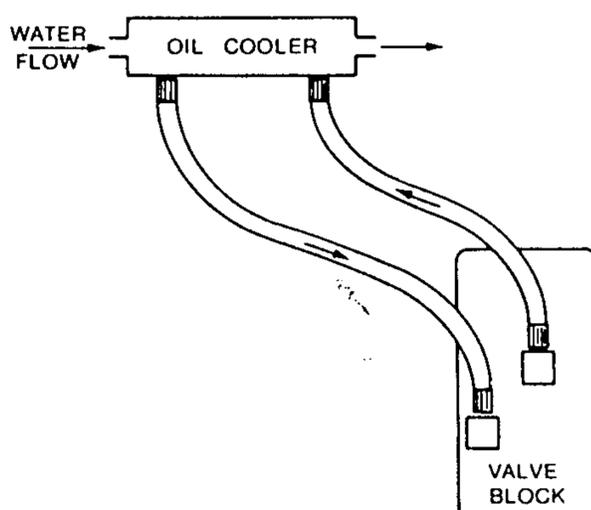


Fig. 9. Oil Cooler Connections PRM 160

Note: Operating oil temperature should not exceed 80°C under any circumstances. If the checks listed in the fault-finding chart have been carried out without any fault being found and the gearbox consistently runs at a temperature higher than 70°C, Newage strongly recommends that a larger capacity oil cooler be fitted.

5.6 Alignment to propeller shaft

Alignment between the propeller shaft and the mating flange on the gearbox output shaft is extremely important since excessive vibration and stress leading to damage and perhaps even failure can occur if correct alignment is not achieved.

It is generally considered preferable to couple the propeller shaft direct to the gearbox output flange using a rigid coupling particularly in the majority of boats whose hulls have sufficient rigidity as not to allow flexing in heavy sea conditions, which could cause the engine and transmission to shift in relation to the propeller shaft.

The two main conditions when a flexible coupling should be used are:

- a) in boats whose hulls are insufficiently rigid to prevent the flexing referred to above, and

b) in cases where the engine is mounted on flexible mounts.

In both instances, the flexible coupling will isolate engine vibration or other movement from the propeller shaft and the stern tube to be maintained.

Whether a solid or flexible coupling is used, it is extremely important that the following points are carefully checked:

- i) the coupling should be a tight press fit on the shaft and the keyway accurately made to the correct size, and
- ii) the two halves of the coupling should be carefully aligned. This should be done by bringing the two flanges close enough together so that a feeler gauge can be used to check the vertical and horizontal alignment.

Since the propeller shaft line is normally fixed in the boat, alignment is usually obtained by adjusting engine mount shims on the mounts themselves.

Note: Whenever possible, the engine and gearbox should be installed whilst the hull is afloat, otherwise there is a danger of the hull distorting because of insufficient support over its surface. If the engine and transmission are fitted before the hull is in water, the installation should be very carefully re-checked for alignment after launching.

5.7 Installation angle

The transmissions should normally be installed so that the maximum fore and aft angle relative to the water line does not exceed 17° with the boat at rest.

5.8 Twin installation

The rotation of a propeller, even in a single engine installation, tends to have a slight "turning" effect on the handling of the boat, but this can normally be corrected with very slight adjustments on the rudder.

In twin installations, the turning effect on the handling of the boat will be much more pronounced if both propellers rotate in the same direction. It is therefore desirable that "handed" (i.e. counter-rotating) propellers be fitted, and it is for this reason that PRM gearboxes are capable of providing either hand of output rotation at any of the available gear ratios.

It is also preferable for the starboard (right-hand) propeller to rotate clockwise and the port (left-hand) anti-clockwise rather than the other way about since in the latter case, when the propeller blades are at the lowest point of their rotational arc they tend to create a vacuum which affects the other propeller by reducing the flow of water to it; furthermore, when the boat is making a tight turn with one gearbox in "ahead" and the other in "astern", the thrust side of one propeller will be acting diametrically opposite to the other one, causing the boat to be deflected off line and thus delaying completion of the manoeuvre.

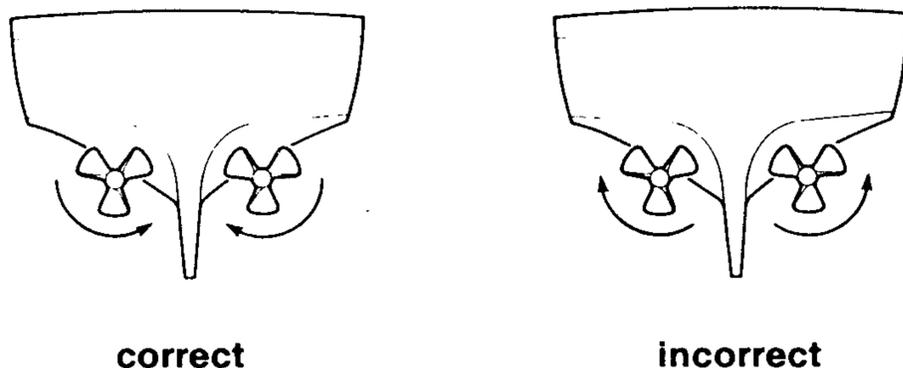


Fig.10. Propeller Rotation — Twin Installations

When connecting remote control units for twin engine/gearbox installations; should be remembered that forward operation of the gearbox operating lever will produce output rotation as engine (generally left-hand, or anti-clockwise).

Therefore, in order to provide counter-rotation of the two propeller shafts in the correct direction for "ahead" drive, with both the remote control operating levers in the "ahead" position, the operating controls should be fitted so that the cable to the starboard gearbox moves the operating lever back, to provide right-hand rotation.

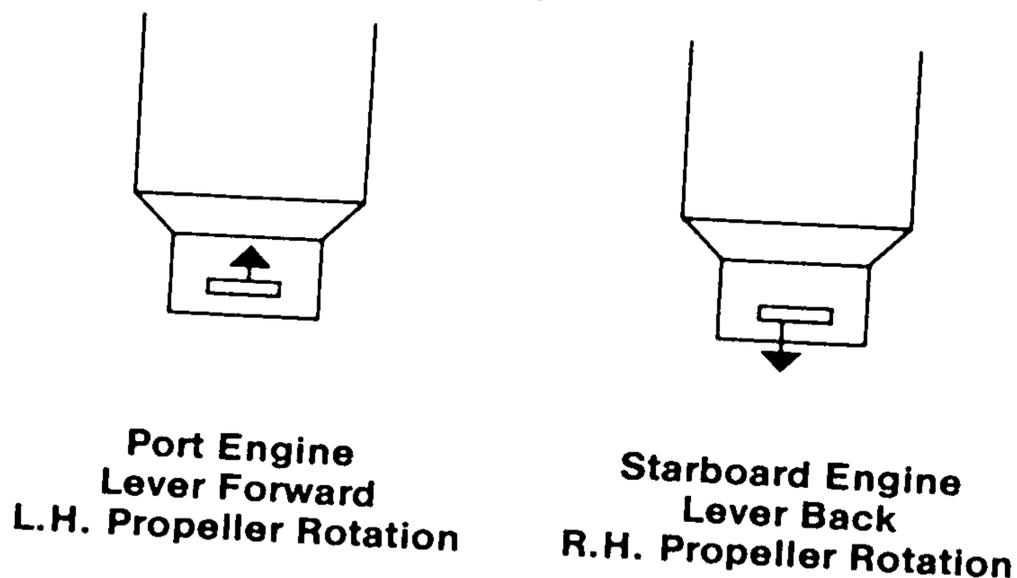


Fig. 11. Operating Lever Movement for Ahead Drive, Twin Installations

5.9 Remote control operating systems

All PRM gearboxes can be used with remote control operating systems and indeed the use of the single lever type of remote control, which links the engine throttle to the gearbox operating lever, is highly recommended.

The following points should be noted:

- (i) The gearbox operating lever is provided with a positive neutral position, which greatly assists the setting up of the remote control unit.
- (ii) care should be taken to ensure that the cable moves the gearbox operating lever approximately 1/16" (2mm) short of its maximum forward or backward travel to prevent the lever being brought hard up against the end stop with every gear shift.

The control equipment should in all cases be connected in accordance with the manufacturer's recommendations.

6. OPERATION

6.1 First time usage

Before starting the engine fill the gearbox to the correct level with a suitable oil (refer to recommended list, section 4.4).

Ensure the gearbox is in neutral, it is recommended that the optional neutral safety switch (if fitted) be wired into the starter circuit to avoid uncontrolled boat movement on start up.

Start the engine and gearbox, allowing the oil to circulate, then stop the engine and allow to settle. Re-check the gearbox oil and top up if necessary to the maximum mark on the dipstick.

With the more common left-hand (anti-clockwise) rotating engines, moving the gearbox operating lever backwards will provide right-hand propeller rotation, and moving the lever forward will provide left-hand propeller rotation.

If the gearbox is used with the less common right-hand (clockwise) rotating engines, the operation is then reversed:-

Moving the gearbox operating lever backwards provides left-hand propeller rotation and forwards provides right-hand propeller rotation.

Note: Engine and propeller rotations are described as seen looking forward from the propeller to the gearbox.

6.2 Drive selection

The Newage PRM160 has been designed and tested to ensure rapid shifts from ahead to astern or vice versa can be operated at full horsepower, ratings and speeds, and the transmission will respond rapidly in these circumstances.

Full power reversals, however, do place abnormal, even if short-lived, loads on the gearbox, and operating life will be prolonged if full power reversals are reserved for emergency use only.

Newage recommend that when changing direction the engine speed be brought down to approximately 1000 rev/min. For this reason we also recommend the fitment of a proprietary single lever remote control operating system which links the engine throttle control to the gearbox operating lever.

6.3 Trailing (free-wheeling) the propeller

The bearings used in the Newage PRM160 gearbox have been carefully selected to ensure that prolonged trailing (free-wheeling) of the propeller will not have any detrimental effect on the transmission. This allows the propeller to turn freely with the engine shut down and makes the Newage PRM160 particularly suited for use in auxiliary sailboats, motor sailers or multi-engine installations where the boat may be operated with one or more engines shut down.

It is not therefore necessary to provide any propeller shaft locking device to protect the transmission, although in the case of sailing yachts and other high performance sailboats fitted with two bladed propellers, it may be desirable to fit a propshaft lock so that the propeller can be locked behind the dead-wood to reduce drag.

Where propellers are allowed to free-wheel they can be a useful source of free auxiliary power; if a flat pulley is fitted to the propeller shaft a small generator can be belt driven for charging batteries (although care must be taken not to apply excessive side-load which would cause vibration and misalignment).

6.4 Emergency operation

Included as standard in every Newage PRM160 gearbox is a "Get You Home" device allowing the gearbox to be mechanically locked in 'ahead' drive in the unlikely event of hydraulic clutch failure.

The method of operation is as follows:

1. Remove top cover (located alongside the valve block).
2. Select the shaft to provide the appropriate propeller rotation (see note (a) below) and rotate until one of the grooves on the outer edge of the clutch plate is uppermost.
3. Take one of the top cover screws and screw it tightly into the threaded hole in the clutch plate directly below the groove (thereby clamping the clutch and providing drive).
4. Ensure that there is sufficient oil in the gearbox to avoid further damage and refit the top cover.
5. Check that the dipstick does not foul the head of the screw now fitted in the clutch end plate; if necessary remove the dipstick and plug the hole with a clean rag.
6. Select neutral on the operating lever and disconnect the operating cable.

The engine can now be run. Newage recommends a maximum 1/3 full throttle to minimise the possibility of further damage to the transmission.

Note:

- a) Assuming an anti-clockwise rotating engine, the shaft to select is:
 - for left-hand propeller rotation, the left-hand shaft;
 - for right-hand propeller rotation, the right-hand shaft;

When looking forward from the propeller to the gearbox.

- b) When emergency drive is in operation, astern or neutral cannot be engaged and there is no means of stopping the boat using the gearbox.
- c) After emergency drive has been used, qualified assistance should be sought to give the transmission a thorough check before the gearbox is used again.
- d) Always disconnect the operating cable and ensure the gearbox operating lever is in neutral before engaging emergency drive.
- e) Never use the top cover for topping up with oil.

7. ROUTINE MAINTENANCE

7.1. Initial maintenance (after 25 hours running)

Drain all oil from the gearbox and refill with one of the recommended lubricants. Operate the engine and gearbox, allowing the oil to circulate, then stop the engine and allow to settle. Re-check the oil level and top up if necessary to the maximum mark on the dipstick.

7.2 Daily check

1. Check the gearbox oil level

2. Make visual inspection of the general condition of the transmission and check for oil leaks, especially at the output shaft seal and at gasket sealing surfaces.
3. Listen for any unusual noises and check their cause.

7.3 Annual checks

1. Check oil cooler connections.
2. Check propeller shaft alignment.
3. Check remote control operating linkage is accurately adjusted to give correct travel on the gearbox operating lever.

7.4 Winter storage

Drain water from the transmission oil cooler to avoid freezing or the collection of harmful deposits.

7.5 Other maintenance operations

1. The gearbox oil should be changed at periods which correspond to the intervals at which engine oil changes are carried out.
2. The gearbox oil should also be changed if it has been contaminated by water or if the gearbox has suffered major mechanical damage.

8. FAULT FINDING

The fault finding chart below is designed to help diagnose some of the problems which might be encountered. It assumes that the installation and operating instructions in this manual have been followed and we advise that these are checked before proceeding to fault finding.

To avoid prejudicing warranty rights, no repair or other work should be done on the gearbox during the warranty period without first contacting NEWAGE TRANSMISSIONS LTD., COVENTRY, or an authorised distributor or dealer, for advice.

SYMPTOM	NOTICEABLE EFFECT	CAUSE	REMEDY
No oil pressure	No drive ahead or astern	Damaged oil pump	Remove oil pump and examine. If possible replace gears and shafts with repair kit. If body damaged replace complete unit.
		Broken input drive plate.	Replace drive plate.
Loss of drive		Oil leaks	Check for evidence of leakage and rectify.
Low oil pressure to both clutches	Propeller speed does not increase with engine speed ahead and astern	Damaged or worn oil pump	Repair with kit or replace.
		Remote control cable or linkage not allowing F-N-R lever to move correct distance	Remove cable and operate lever by hand. Adjust cable if necessary.
		Pressure relief valve spring defective	Remove valve block and replace spring.
Low oil pressure to one clutch	Propeller speed does not increase with engine speed in one direction only	Piston rings worn. Feeder worn	Remove appropriate clutch shaft Replace worn feeder or piston rings.
		Damaged 'O' ring in hydraulic circuit	Check 'O' rings in feeder connectors and piston.
		Blocked hydraulic passage in valve block	Remove valve block and examine.
		Damaged clutch plates	Remove and examine clutch on appropriate shaft and replace if necessary.
Gearbox noise	Excessive noise from gearbox	Input coupling defective	Remove, examine and replace if necessary.
		Gear rattle at low speed	Increase engine idling speed.
	Excessive noise from gearbox	Propeller shaft misalignment	Check the alignment of the propeller shaft coupling (see section 5.7); if necessary rectify by adjusting the shims under the engine mounts or the engine mounts themselves.
		Out-of-balance propeller	Remove the propeller and check that the pitch, weight, diameter and balance of all the blades are equal and rectify if necessary.
		Engine/gearbox misalignment	Remove the transmission and check that the flywheel face is flat and that the drive plate or flexible input coupling is correctly aligned.
		Defective bearing	Isolate defective bearing noise, remove and replace.
Excessively high oil temperature	Gearcase too hot to touch	Defective oil cooler	Replace oil cooler.
		Defective pressure relief valve	Remove and examine relief valve. Replace if necessary.
Gearbox oil consumption excessive	Oil level requiring constant topping up	Defective oil seal, gasket or 'O' ring	Clean the outside of the gearcase, particularly around the ends of shafts including the output shaft. Run the engine and observe the gearbox for leaks. Replace seals as required.
		Defective oil cooler	Check for traces of water in the gearbox oil or oil in the cooling water system. Replace cooler if necessary.
	Escape of high pressure in gearbox when dipstick is removed	Defective breather (causing leaks past oil seals)	Contact distributor or factory for advice.
Control lever on valve block stiff	Difficult to move single lever control	Defective valve or detent spring	Contact distributor or factory for advice.

9. SERVICING AND REPAIRS

The servicing, repair and replacement of components and assemblies on the input shaft and layshaft is made simple by the fact that the gearcase is constructed in two separate halves, the top half being easily removable to give access to the two top shafts.

This can be further simplified by fitting complete replacement shaft assemblies, and where skilled service personnel or reasonable workshop facilities are not readily available, or where time and labour costs are of greatest importance, it may be found advantageous to adopt this procedure.

Exploded views of all internal components are contained in the parts list. Many servicing operations can be carried out with the gearbox still mounted to the engine (provided, of course, that there is sufficient space in the engine compartment to allow this); examples are the replacement or repair of valve block and oil pump. It may also be possible to work on the layshaft and even the input shaft. The repair and maintenance of items on the output shaft will require that the gearbox is removed from the engine.

N.B. The input shaft and layshaft are supported by taper roller bearings. It will be necessary to recalculate the number of shims required to correctly load the bearings each time a shaft is stripped for inspection, component repair or replacement.

Shimming procedure is described in Section 9.8.

9.1 Valve block

The complete valve block is easily removed for inspection and servicing with the gearbox still installed in the boat.

1. Disconnect the oil cooler pipes and the control cable or cables from the lever on the control equipment.
2. Disconnect the wiring from the neutral switch - if fitted.
3. Remove the 5 bolts and one nut which secure the valve block to the gearcase.
4. To remove the control valve and high pressure valve, simply remove the two cap screws (item no. C6) and withdraw the valves from the valve body. Care should be taken not to lose the detent ball and springs.
5. Inspect the 'O' ring (item no. C8) and bearing (item no. C10): replace if worn, damaged or defective. Check that the pressure relief valve spring (item no. C15) has retained its correct free length (36.5mm, 1.437 ins) and if not, replace.
6. To assemble and refit the valve block, simply reverse the above procedure.

9.2 Oil pump

The oil pump assembly can also be easily removed with the gearbox in situ.

1. Note the mounting position of the pump (for refitting).
2. Remove the four bolts securing the oil pump to the main case and withdraw the pump assembly complete with 'O' rings and shims.

3. Inspect the 'O' rings and replace if necessary. If in good condition carefully store until required for refitting.

The pump can now be stripped by removing the 4 fixing bolts in the cover plate. The assembly splits into its three component parts exposing the body, gears and shafts.

If the pump body is damaged, the complete pump assembly (item No. B) must be replaced. If the pump body is in good condition, the oil pump can be repaired using the pump repair kit (items No. B4 to No. B8 inclusive).

N.B. The clutch shaft must be reshimmed if a replacement pump body or complete pump assembly is fitted. If the old pump casing is re-used, refitting the original shims will be adequate.

9.3 Removing the transmission from the boat.

1. Ensure that the gearbox operating lever is in the neutral position and disconnect the operating cable or cables.
2. Drain the gearbox oil into a suitable container and disconnect oil cooler pipes.
3. Unscrew and withdraw the bolts connecting the gearbox output flange from the flexible coupling or mating half coupling on the propeller shaft.
4. Sling ropes around the gearbox to provide support while it is being removed from the engine.
5. Unscrew and withdraw the bolts securing the adaptor flange to the engine flywheel housing.
6. Slacken the bolts which secure the input coupling to the flywheel.
7. Withdraw the gearbox, if necessary by rocking the unit slightly in order to disengage the input shaft spline from the opposing spline in the coupling.

9.4 Removing the input shaft and layshaft assemblies

With some installations, both the input shaft and layshaft assemblies can be removed with the gearbox still installed in the boat. The procedure is as follows:

1. Drain the gearbox oil into a suitable container.
2. Disconnect oil cooler pipes and the cable from the gearbox control lever.
3. Remove the 4 bolts securing the oil pump to the gearcase and withdraw the oil pump, gasket, shims and 'O' rings, noting the position of the pump for refitting (note: keep pump shims with pump assembly).
4. Remove the 2 bolts securing the drive shaft end plate.
5. Remove the 5 bolts and 1 nut retaining the valve block and remove.
6. Remove the 7 bolts securing the gearcase top half and lift clear.

7. Slacken the bolts securing the input coupling to the flywheel, to allow slight movement. Withdraw the input shaft spline. (On units incorporating 2.94:1 ratio it is recommended that all bolts but one be removed so that the coupling will pivot on the remaining bolt to permit the input shaft to be lifted with the gearbox case).
8. Lift the input shaft, if necessary rotating slightly so that the spline can be withdrawn from the flexible coupling.
9. Once the spline is cleared, lift the complete shaft assembly from the casing. Lift and remove the layshaft and front cover from the casing.

If, however, the installation is abnormal, or more than 50% of the input shaft spline is engaged in the coupling, then the gearbox must be removed from the boat, procedure as follows:

1. Remove gearbox from boat as described in section 9.3.
2. Remove the 4 bolts securing the oil pump and withdraw the oil pump, gasket, shims and 'O' rings, noting the position of the pump for refitting (note: keep the pump shims with the pump assembly).
3. Remove the 3 bolts securing the shaft end cover and remove. (note: keep shims and 'O' rings with end cover).
4. Remove 5 bolts and 1 nut retaining the valve block and remove valve block.
5. Remove 7 bolts securing the gearcase top half and lift clear.
6. Lift input shaft assembly and front seal housing from the gearcase.
7. Lift layshaft assembly and front end cover from the gearcase.

9.5 Servicing input shaft and layshaft assembly components

9.5.1 Input shaft oil seal

In the event of an oil leak due to a damaged seal, remove the input shaft oil seal housing from the shaft and with the aid of a hardwood drift and hammer, force the seal from the housing.

Fit a new seal (item D29) in the housing and refit the housing.

9.5.2 Drive end bearing

To renew a damaged or worn bearing, proceed as follows:

1. Support the shaft in a vice and remove the input seal housing (this applies only to the input shaft).
2. Withdraw the clutch pinion, spacer and bearing using pulley extractors with the jaws of the extractor located behind the pinion.
3. Refit the clutch pinion to the shaft.
4. Replace the spacer and bearing, inspecting for wear and replacing where necessary.

5. Locate the new bearing (item D2) on the shaft and gently drive (either handpress or use hardwood drift and hammer) the assembly into position. Take care not to damage the bearing rollers or raceways during this operation. The pinion should always be able to move a small amount fore and aft on the shaft, once the bearing is fully in position.
6. Reposition the input seal housing on the shaft (input shaft only.)

Note: If new bearings are fitted, bearings must be shimmed as described in section 9.8.

9.5.3 Clutch assembly

Clutch plates which are discoloured by overheating, or worn down to the extent of having lost their grooving patterns, will tend to slip. If either of these conditions occur, the clutch assembly will need to be replaced as follows:

1. Remove the drive pinion bearing as previously described.
2. Unlock and remove the 6 clutch securing bolts taking care not to lose any of the locating ferrules..
3. Withdraw the complete clutch from the shaft noting the position of the pull of springs.
4. Position shaft upright and locate the retaining pins in the clutch gear.
5. Fit the clutch end plate (item D10) over the pins and then, starting with one of the driver clutch plates (item no. D7), build up the replacement clutch on to the end plate.
6. Position the ferrules in the spaces between the driven clutch plates and fit the pull-off springs over the pins.
7. Replace the end cover onto the pins, locating them in the blind holes in the cover.
8. Refit the securing bolts and locating strips by feeding them through the flange on the clutch shaft and lightly tighten.
9. Turn the shaft upside down and ensuring that the pull-off springs are correctly located tighten the bolts to 12.2 Nm (91bf.ft, 1.24 Kgm) and close the lock strips over the bolt head.
10. Replace the drive pinion, turning slightly so that it is inserted into the driver clutch plates until it touches the bottom washer.
11. Replace the thrust washer bearing and circlip as described.

9.5.4 Clutch gear

To fit a new clutch gear (item D18) first remove clutch pack as previously described in section 9.5.3, and proceed as follows:

1. Unlock and remove 6 screws (item D25) bolting the clutch gear to the shaft.
2. Extract the piston retaining spacer (item D12) and circlip (item D13) to allow the clutch gear and piston to be removed from the shaft.

3. Separate the clutch gear from the piston, and check that the inner and outer piston seals show no sign of wear or damage.
4. Refit the new clutch gear around the piston and replace onto the shaft.
5. Refit new circlip and spacer and re-assemble the clutch, drive pinion and bearing as previously described.

Note: It is advisable to renew both clutch gears simultaneously since damage to one will often result in damage to its mating gear.

Note: It is also advisable and strongly recommended that piston seals and tab washers should always be replaced.

9.5.5 Drive pinion

As with the clutch gears it is advisable to renew both drive pinions simultaneously. To ensure that the drive pinion of the correct ratio is used please refer to the parts at the back of this manual. It is required to fit a ratio which is different to that which was originally supplied, the output gear as well as both pinions will need to be changed.

To replace the drive pinion, follow the procedure set out in section 9.5.2.

9.5.6 Non drive end bearing

Withdraw sufficient clutch securing bolts to permit light bearing pullers to be located behind the feeder, and pull off the bearing. Before refitting, examine the bearing carefully and replace it if it exhibits any sign of damage.

9.5.7 Piston rings and feeder

Excessive wear or damage may necessitate replacement of the piston rings and feeder in the following manner:-

1. Remove the non drive end bearing as described and remove the feeder and spacer.
2. Remove the piston rings from the shaft with the aid of a special piston ring extractor or a piece of thin steel. Raise one end of the top ring out of the groove and insert the steel strip between the ring and the shaft. Rotate the strip around the shaft applying slight forward pressure to the raised portion of the ring and until it rests on the land above the groove, where it can be eased off. Repeat this with the other two rings.
3. Take out the new rings from the packing and clean off any grease or inhibitor.
4. If a ring loading tool is available, fit this around the shaft, load the rings onto the tool and locate in their approximate position. Gently withdraw the tool and allow the rings to locate in their respective grooves.
5. Where a loading tool is not available use a thin metal strip, long enough to lay along the shaft above the grooves. Expand each ring just sufficiently to allow it to be placed in its approximate position over the strip. Gently withdraw the strip and locate the rings in their respective grooves. (see Fig. 11).

6. Compress each ring in turn and carefully fit the new feeders and spacers.

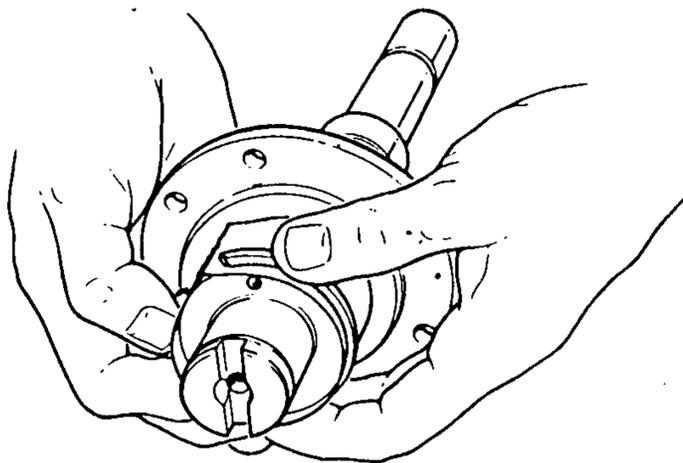


Fig.12. Piston Ring Fitting Procedure

9.6 Replacement of input shaft and layshaft assemblies

1. Position the input shaft assembly in the gearcase and ensure that the circlip is correctly located in the lower half of the gearcase, and the seal housing is in the correct position. If the gearbox is still mounted in the boat, engage the input shaft onto the splined centre of the drive plate or input coupling.
2. Position the layshaft in the casing ensuring the end cover is correctly located.
3. Fit the top half of the gearcase and secure with 7 bolts, ensuring the feed connectors are located correctly. To simplify this operation wire placed in the feeder connectors and passed through the holes in the top half of the gearcase will ensure they are approximately located when the gearcase top half is lowered onto them. The 'O' rings on the connectors should be examined for damage or wear and renewed if necessary.
4. Shim and refit the input shaft end cover, replacing the 'O' ring if damaged.
5. Shim and refit the oil pump replacing the 'O' rings if damaged. Ensure the oil pump is fitted in the correct position, to suit direction of rotation required.
6. Refit the valve block, replacing gasket.
7. Tighten the bolts securing the drive plate or input coupling to the engine flywheel.
8. If gearbox has been removed from the engine, re-align and reconnect the propeller shaft coupling, oil cooler and operating system as described in sections 5.5, 5.6, 5.7 and 5.9 (installation).

Note: Shimming procedure is described in section 9.8

9.7 Servicing the output shaft assembly

Removal of the output assembly will necessitate removing the gearbox from the boat (see section 9.3). Then proceed as follows:-

1. Remove input shaft and layshaft assemblies as described in section 9.4.

2. Slacken and remove nut (F22) and washer (F21) at output coupling (F8B), and remove.
3. Using a magnet, remove output shaft front end cover (F1).
4. Remove four screws (F16), and remove rear seal housing (F14) and shims which are located between the seal housing and bearing.
5. To remove the shaft from the gearbox, drive or press the shaft on the front end, and the rear bearing (F12) and shaft (F8A) can be removed from the rear end of the gearbox leaving the front bearing inner race, output gear and spacers behind.

9.7.1 Front bearing and output gear

1. Having removed the output shaft from the gearbox, the output gear (F9) can be lifted from the gear case.
2. Remove the circlip (F3) from the bearing bore and the bearing outer race (F4) can be removed from its bore using a press or a hardwood drift and hammer.
3. Check both bearing and output gear for any defects or damage and replace if necessary.

9.7.2 Rear bearing and oil seal

1. If the oil seal (F15) is damaged, press out from seal housing (F14) and renew.
2. If the rear bearing (F12) is damaged, it can be removed from the shaft using a soft hammer or a hand press.

Note: Whenever the output shaft is stripped, it is always advisable to renew all 'O' rings, oil seal, and circlips.

9.7.3 Re-assembling output shaft assembly

- 1 Press the outer race of the new bearing into the gearcase until it just clears the circlip groove in the bore.
- 2 Fit circlip (F3) into groove in bore of gearcase.
3. Press rear bearing inner race (F12) onto the shaft until it seats on the shoulder provided on the output shaft.
4. Assemble the shaft from the rear. Feed spacer (F7A), drive gear (F6), spacer (F5) and front bearing inner race (F4) onto the shaft. Press the shaft home until the inner race is fully loaded onto the shaft and outer race is seated upto the the circlip in the bore.
- 5 Locate the rear bearing outer race in the rear bore and press home.
6. Re-calculate and fit the number of shims required (see shimming procedures), refit new 'O' ring (F13) to oil seal housing (F14) and secure seal housing to the gearbox case.
8. Replace the 'O' ring on the front cover and refit the cover into the front bore.

7. Refit the 'O' ring (F20) output coupling (F8B) washer (F21) and nut (F22). Tighten nut to 162.7Nm (16.60 Kgfm - 120 lbf.ft).

9.8 Shimming procedures

9.8.1 Input shaft and layshaft

The allowable end float on the taper bearing is 0 - 0.05mm (0 - 0.002in) clearance: this should be checked with the aid of a depth micrometer as follows:

1. Press the bearing outer cup firmly into position and measure between the face of the gearcase and the top of the bearing outer as shown in Fig. 13.
2. Measure the depth of the recess in the oil pump and in the output shaft end cover. Make up the difference with shims.

Where a depth micrometer is not available, the following method may be used:-

1. Remove the 'O' ring from the oil pump or end cover.
2. Fit sufficient shims so that the oil pump or end cover stands proud of the gearbox.
3. Rotate the input shaft or layshaft whilst slowly tightening the four securing bolts until the shaft starts to bind. Note: care must be taken to ensure that the oil pump or end cover is tightened squarely on to the gearbox face: this can be checked by feeler gauges or shims around the pump end cover to ensure a uniform gap.
4. Now measure the gap with the aid of feeler gauges or shims. Deduct shims to this figure plus 0.05mm (0.002in) from the shims already installed.
5. Remove the necessary number of shims, tighten the oil pump or end cover, and test by rotating the shaft.
6. Remove the oil pump or end cover and refit with the 'O' ring installed.

9.8.2 Output shaft

1. When the output shaft is fitted in the gearcase and the bearing driven into position, press the bearing outer cone firmly into position and measure from the gearcase to the top of the bearing outer.
2. Measure the height of the spigot on the seal housing from the face which is fitted to the gearcase.
3. Make up the difference between the two dimensions with shims.

Note: Shims are available in two thicknesses, 0.254mm (0.010in) and 0.05mm (0.002in). As an example of their use, if an end float reading of 0.548mm (0.023in) is obtained, two shims of 0.254mm (0.010in) and one of 0.05mm (0.002in) should be used, giving a final end float or clearance of 0.025mm (0.001in).

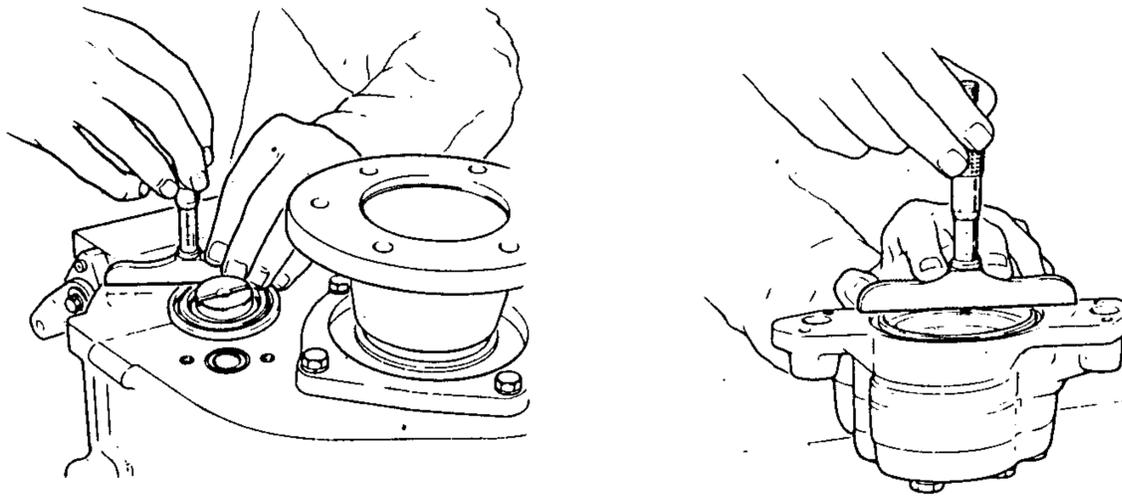


Fig.13. Shimming Procedure

12. TIGHTENING TORQUES

	Nm	lbf.ft	Kgfm
Upper to lower gearcase bolts	54.2	40	5.53
Valve block to upper gearcase	30.0	22	3.04
Operating lever to valve block	30.0	22	3.04
End cover to valve block (loctite)	54.2	40	5.53
Pump body to gearcase	54.2	40	5.53
End cover to gearcase	54.2	40	5.53
Pump cover to pump body	30.0	22	3.04
Coupling to output shaft	162.7	120	16.60
Top cover to upper gearcase	30.0	22	3.04
Oil seal housing to gearcase	54.2	40	5.53
Adaptor plate to gearbox	62.7	43	6.40

SPARE PARTS ORDERING

When ordering spare parts the following should be quoted:

- a) Gearbox model and serial number
- b) Description(s) and part number(s) of the component(s) required
- c) Quantity required

NOTES

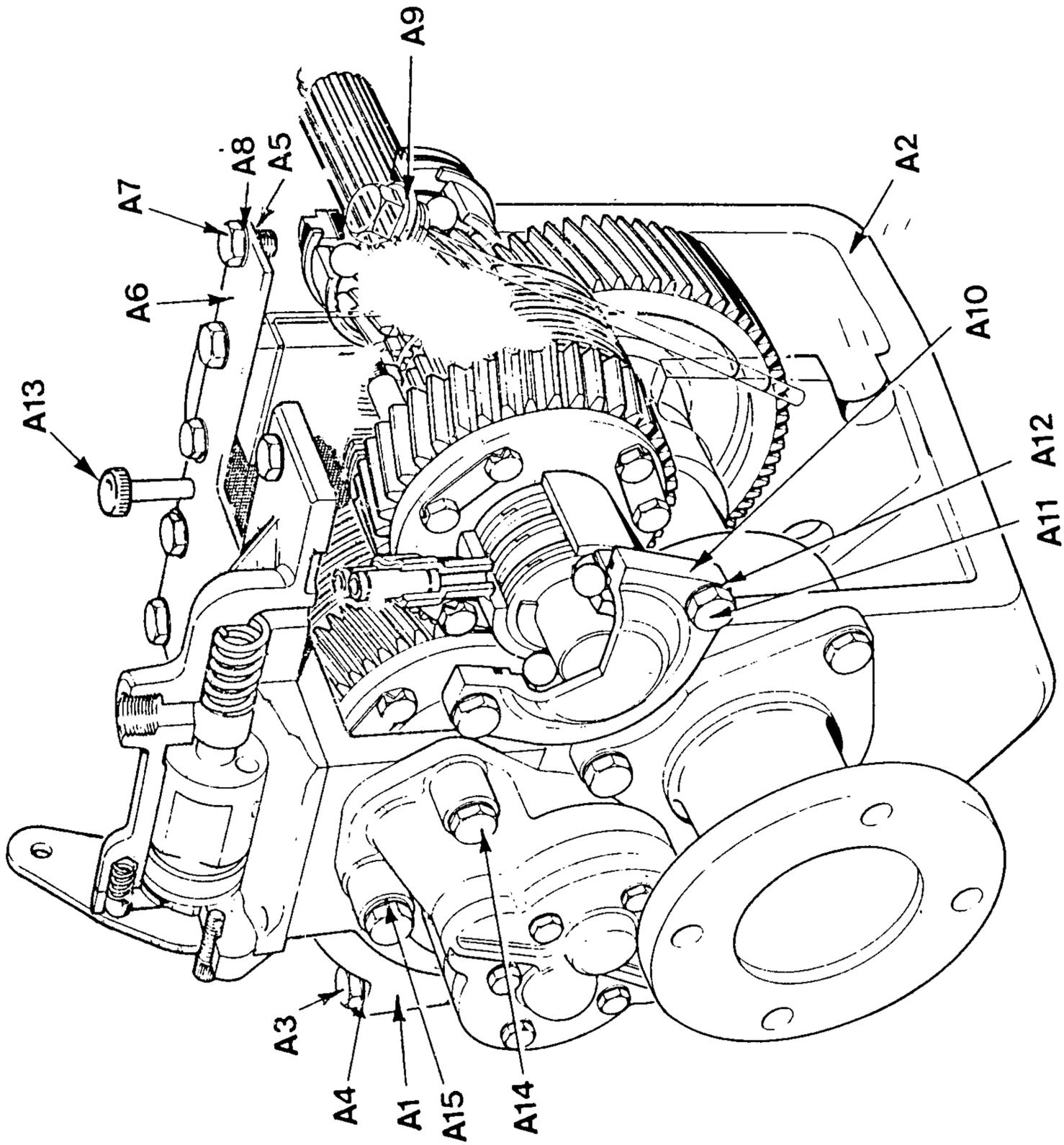
- 1 Individual items which form part of an assembly, or main components, are indented and may be supplied separately; if the assembly is ordered all components pertaining to that assembly are supplied. For example, if the 'clutch input shaft' assembly is ordered the shaft itself and every item called up and shown on the corresponding illustration will be supplied, with the exception of the end housing and oil seal. The same applies to the layshaft.
- 2 Clutch plate assemblies, i.e. end plates, driven plates and driver plates are supplied in sets.

Orders and enquiries for spare parts should be addressed to:

NEWAGE TRANSMISSIONS LIMITED
BARLOW ROAD
COVENTRY CV2 2LD
ENGLAND

Tel: 0203 617141 Telex: 31333 Cables: 'SUPAGEARS' Coventry

Spare Parts List



PRM 160

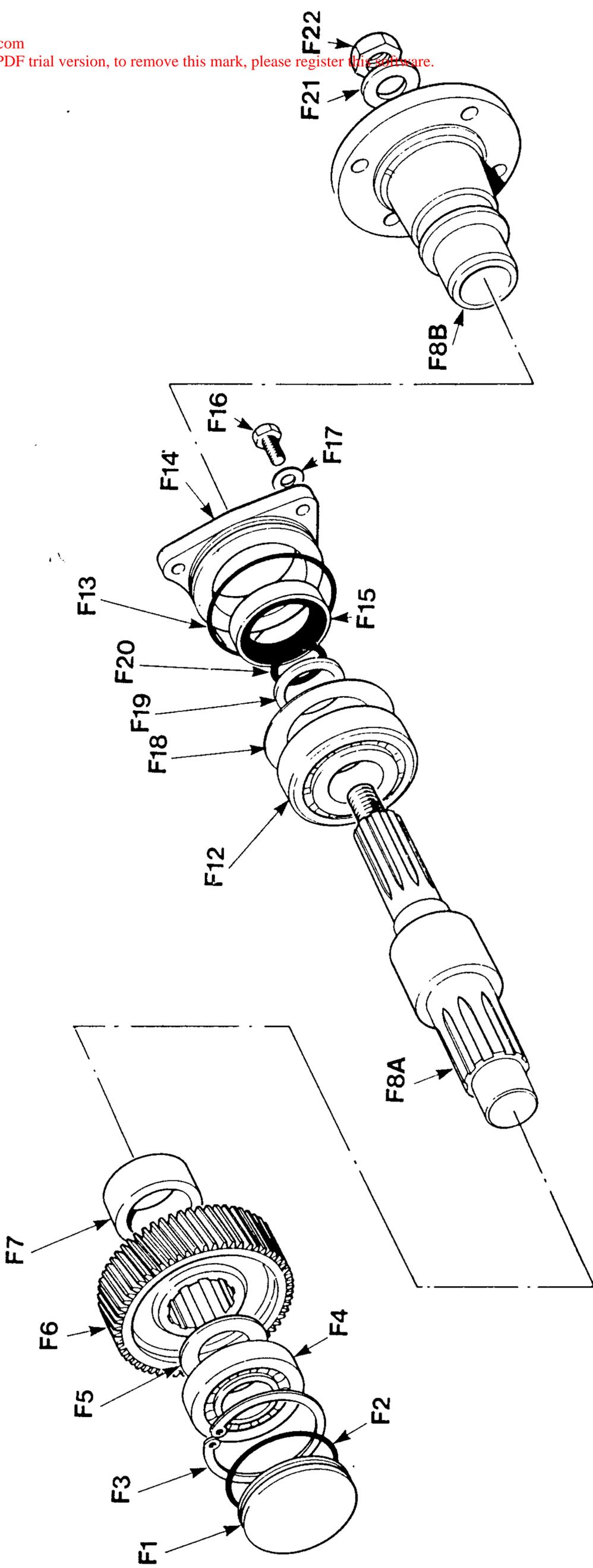


Plate Ref.	Description	PRM 160 Part No.	Qty.	Remarks
E19	Ball	CP1180	1	
E20	Ball	CP1191	1	
E21	Piston ring	CP1192	3	
E22	Feeder	MT315	1	
E25	Bolt	MT452	6	
E26	Layshaft	MT1125	1	
E27	Shim .002"	MT1075/02	AR	
E27	Shim .010"	MT1075/10	AR	
E29	End Cover	MT999	1	
E30	O ring	002433	1	
E31	Circlip	0250620	1	
E32	O ring	000372	4	
E33	Connector	MT1057	2	
E34	Bearing	0540251	1	

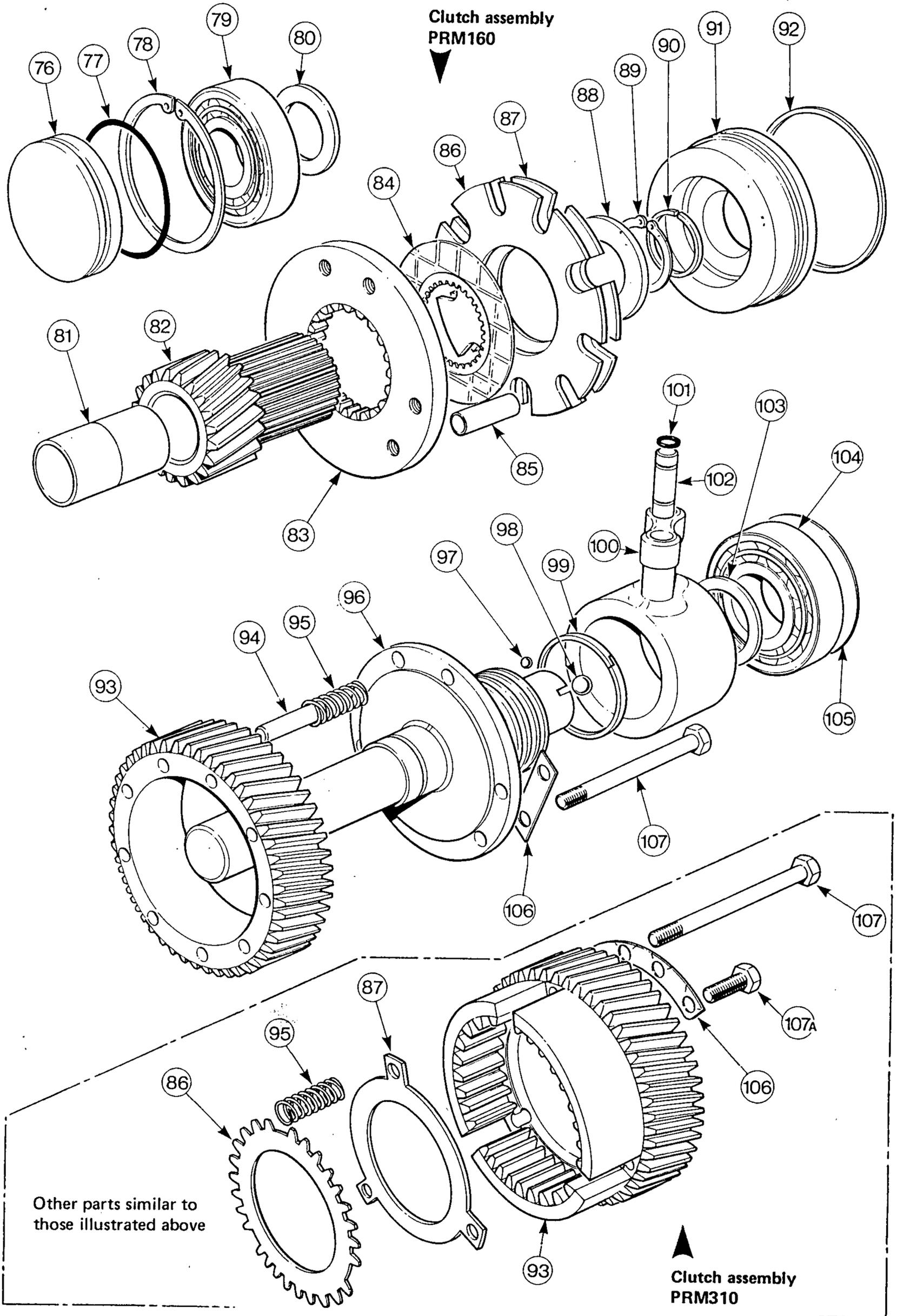


Fig. 17 Layshaft Assemblies

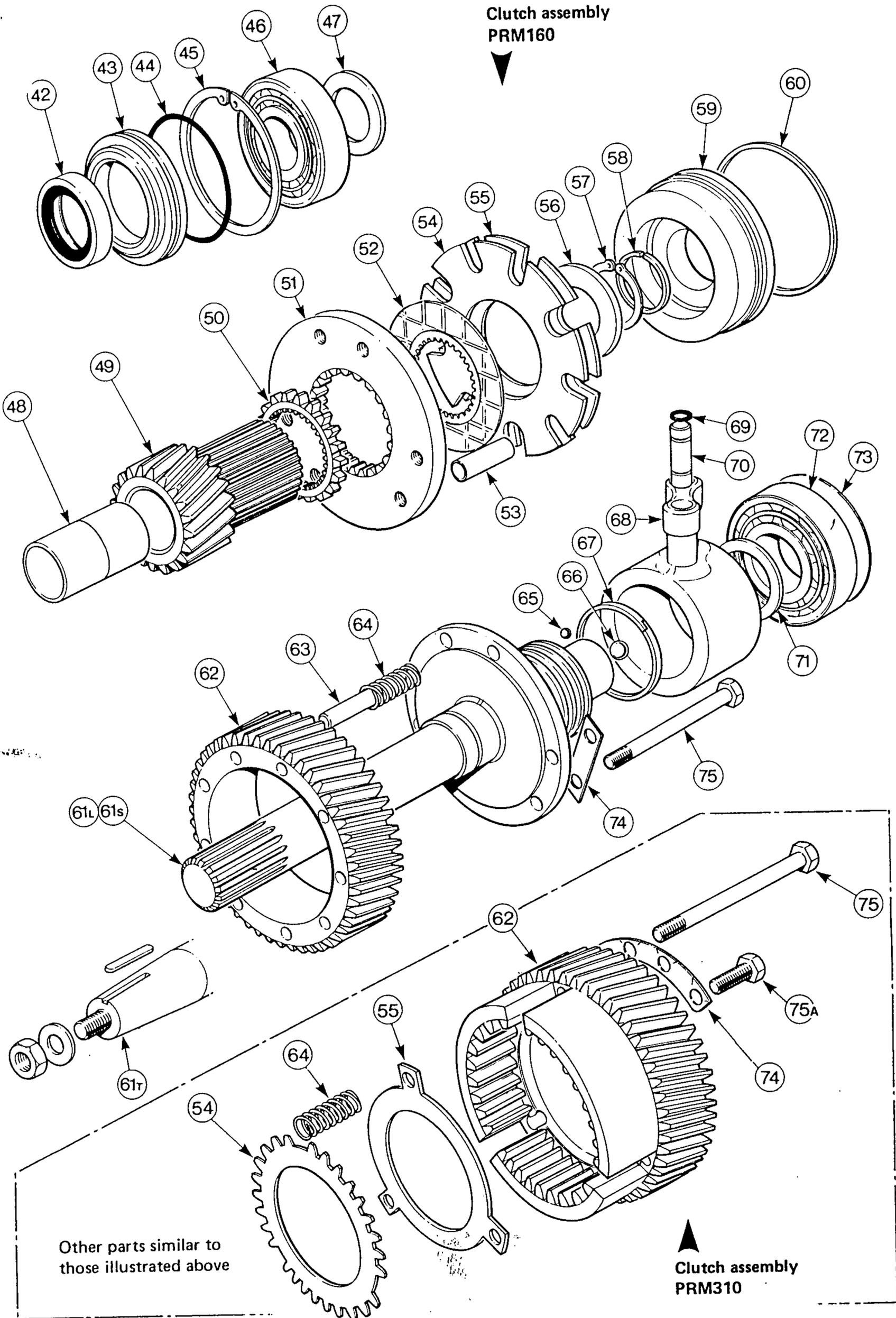


Fig. 16 Input Shaft Assemblies