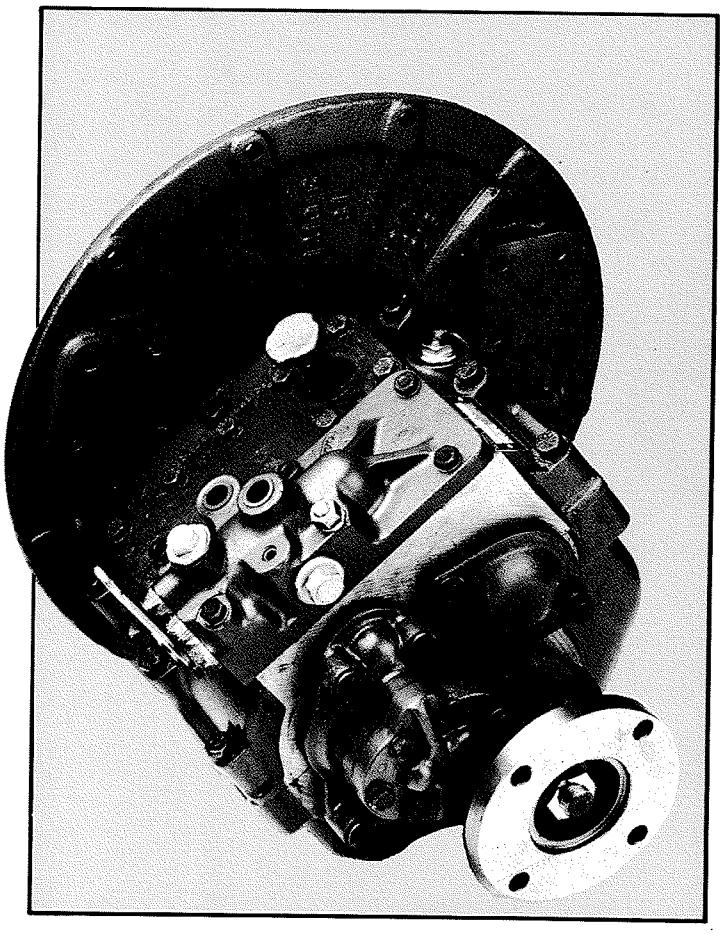
NEWAGE

PRM 160
Marine Gearbox

Workshop Manual



- **NEWAGE TRANSMISSIONS LTD**
- Barlow Road
- Coventry CV2 2LD
- England
- Telephone: (0203) 617141
- Fax: (0203) 611845
- Telex: 31333

Registered in England, Reg. No. 345283
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FOREWORD

Provided it is correctly installed, aligned and maintained, the PRM160 gearbox should have a long and trouble-free life. This workshop manual contains important instructions to ensure that this is so, and it is of the utmost importance that these are carefully followed. Newage Transmissions Ltd can accept no responsibility under warranty or otherwise for any loss or damage resulting from failure to observe these instructions.

To avoid prejudicing your rights under warranty, do not undertake any repair or other work on the gearbox during the warranty period without first contacting Newage Transmissions Ltd or an authorised distrubutor or dealer for advice. In the event of failure, you should do this via the engine distributor who supplied the gearbox, or his local dealer; if this is not possible, you should notify the local Newage distributor/dealer or Newage Transmissions Ltd direct.

CLAIMS UNDER WARRANTY

Claims for the replacement of parts under warranty must always be submitted to the distributor who supplied the gearbox; if this is not possible, application may be made to the nearest distributor or dealer, who must, however, be advised of the supplier's name and address ofthe company who originally supplied the gearbox.

SERVICE PARTS

The comprehensive illustrated parts list at the rear of this manual also contains full information on ordering procedures.

PRE-DELIVERY TEST

Before it leaves the factory, every gearbox is subjected to a final test and inspection which includes the following:-

1. Flush clean
2. Check time to reach operating temperature
3. Pressurise case, check for leaks
4. Check noise level
5. Check for drag in neutral
6. Check valve lever operating force
   - 6A Neutral to forward
   - 6B Neutral to reverse
7. Check operating temperature
8. Check operating oil pressure at 2000 rev/min
9. Check output nut torque
10. Check input spline dimensions
11. Check bolt torques
12. Check coupling concentricity
13. Check for conformity with details on serial number plate

IDENTIFICATION PLATE

Before it leaves the factory, every PRM gearbox is fitted with an identification plate on the top half of the gearcase which looks something this:-

NEWAGE PRM	COVENTRY
123456	A1234
160D3	
MADE IN ENGLAND	

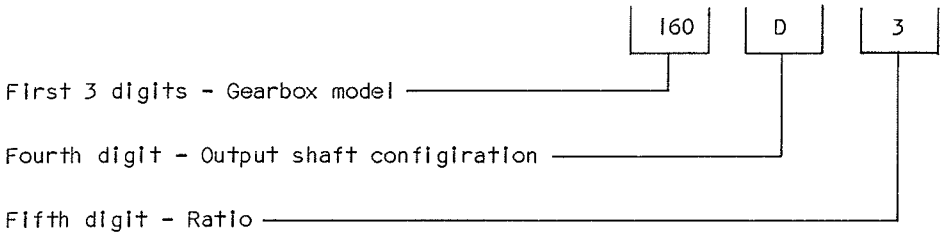
NEWAGE PRM	COVENTRY
MADE IN ENGLAND	

Please complete the above box with serial number and specification of your own gearbox.

It will be noted that there are two lines of numbers.

The top line is the gearbox serial number enables the factory to trace the history of the gearbox right back to its date of manufacture and the components and materials used to make it.

The lower line is the gearbox specification; in the example given this translates as follows:-



NOTE

Throughout this manual, engine, gearbox and propeller rotations are always described as seen looking forward from the propeller to the engine.

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1. GENERAL DATA

1.1 SPECIFICATIONS

Gear ratios:	1.96:1, 2.94:1	
Power rating:	Pleasure/light commercial:	3.43 bhp (2.56 kW) per 100 rev/min
	Heavy commercial:	3.05 bhp (2.27 kW) per 100 rev/min
Maximum input speed:	4000 rev/min intermittent,	3600 rev/min continuous.

Note: these ratings refer to diesel engines; powers are expressed in BHP and kW per 100 rev/min engine operating speed, and are measured at the engine flywheel. Ratings have been established to ensure the long and trouble-free life of the gearbox which must not, therefore, be used at powers in excess of those shown.

SERVICE CLASSIFICATION DEFINITIONS

Pleasure: limited to planing hull pleasure craft; operation at full engine throttle not to exceed 5% of total operating time with balance of usage at 90% or less of full throttle engine speed, and total operating time not more than 500 hours per year. The use of the PRM160 marine gearbox at this rating in any commercial boat or in sport-fishing charter boats or long-range pleasure cruisers is **not** approved.

Light commercial: planing or semi-displacement craft used for pleasure or commercial applications may qualify for light commercial rating if their annual usage is less than 1500 hours and full throttle operation is limited, most operating time being at partial throttle.

Heavy commercial: all displacement and semi-displacement craft used in any commercial application should be classified according to the heavy commercial rating. In vessels of these types (including trawlers, purse seiners, lobster and crab boats, tugs, ferries, offshore supply boats and so on) the gearbox is expected to work continuously at full rated engine power and speed. The power setting of the engine must be known and must be within the the permitted heavy commercial rating of the gearbox.

IMPORTANT NOTE

(1) It is vital that the engine, gearbox model, reduction ratio and propeller size should be correctly matched so that the engine can without labouring attain the rated speed appropriate to the service classification at which it is to be used. Neglecting to observe this requirement will place undue strain on both the engine and the gearbox and may eventually lead to their failure.

(2) It is also essential to ensure the torsional compatibility of the complete propulsion system from the engine to the propeller, otherwise gear noise may result (particularly at low engine speeds); if ignored, this may eventually lead to damage of either transmission or engine components.

Newage Transmissions Ltd will provide all possible information to help find solutions to existing or potential torsional problems, but it is the ultimate responsibility of whoever assembles the driving and driven equipment to ensure that they are torsionally compatible.

Input rotation:	May be either 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: 1 Litre (1.76 pints). **Note:** this does **not** include the oil needed to fill the cooling circuit (see section 6.1).

Working oil pressure **minimum** :-1790 kPa (260 lbf/in^2 - 18.3 kg/cm^2)
maximum :-2170 kPa (315 lbf/in^2 - 22.1 kg/cm^2)

(Oil pressures should be measured at a gearbox operating temperature of 70°C and an input speed of not less than 1500 rev/min.)

Operating oil temperature: between 50°C-70°C with a maximum of 80°C permissible for very short periods only.

(In order to ensure that the correct operating temperatures are maintained an oil cooler is required, there are two 3/8"BSP connections on the valve block so that a suitable unit can be fitted. The capacity of the cooler needed will vary according to ambient temperature, engine horsepower and other factors. Suitable coolers are available from Newage Transmissions Ltd).

Input drive couplings: Flexible drive couplings are available to suit flywheels of 7.5 in, 10 in and 11.5 in nominal diameter to SAE J620C, and to other dimensions.

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

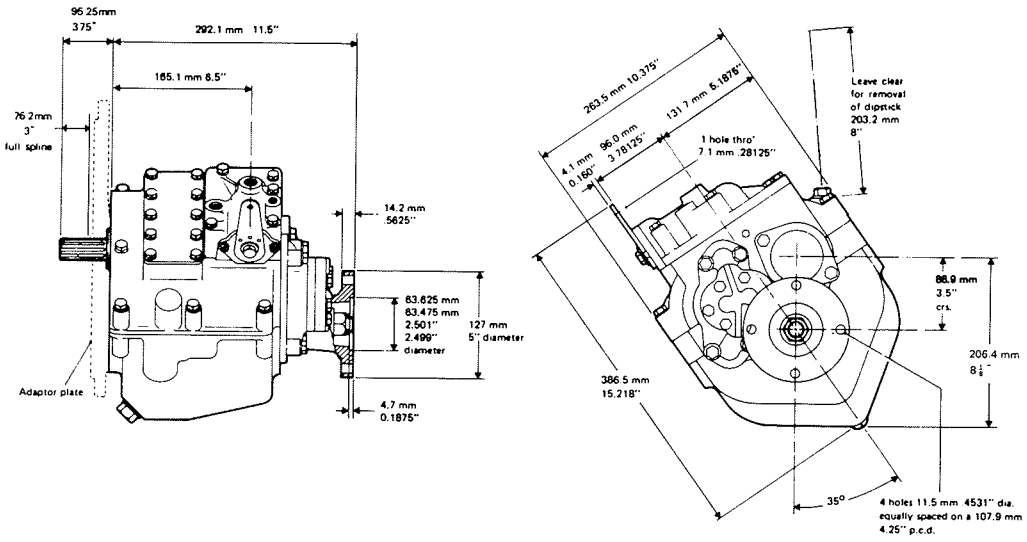
Input shaft: 25.4mm (1 in) diameter with SAE 10 spline.

Propeller thrust: Ahead and astern thrust is 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, and female spigot, 63.5mm (2.50 in) diameter.

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

1.2 INSTALATION DETAILS



2. INTRODUCTION

The PRM160 marine transmission is an oil-operated gearbox 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 both directions.

Both left-hand (anti-clockwise) and right-hand (clockwise) rotating engines can be accommodated (see section 3.5).

Note: throughout this manual, engine, gearbox and propeller rotations are described as seen when standing behind the boat, facing forwards towards the engine and transmission.

3. CONSTRUCTION

3.1 Gearcase

The gearcase has been kept free from hydraulic pipes, cylinders and associated components, the only items mounted externally being 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 to allow a hand-operated drain pump to be fitted via suitable pipework if required.

Connections are provided on the valve block for the oil cooler pipes and an oil 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 needle roller bearings, an emergency operating device (see section 6.4), the forward (when used with a right-hand propeller) drive clutch assembly, the clutch gear and a hydraulically actuated piston to operate the clutch.

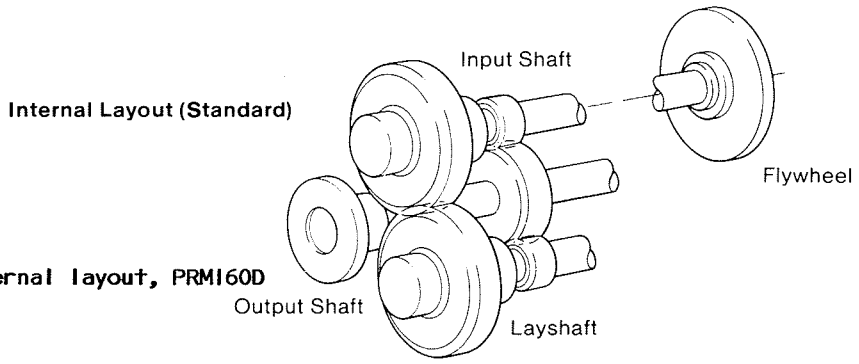


Fig. 1 Internal layout, PRM160D

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

The output shaft runs on amply proportioned bearings, so arranged as to absorb the thrust developed by the propeller, and 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 controlling the supply of oil 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 "feel" to the neutral position, facilitating the setting-up of the remote operating cable and helping to ensure positive shifting.

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 accidental damage caused by a boat moving ahead or astern on engine start-up in a crowded marina or other area. Newage Transmissions Ltd strongly recommends the use of this device.

When fitted, 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. 2.

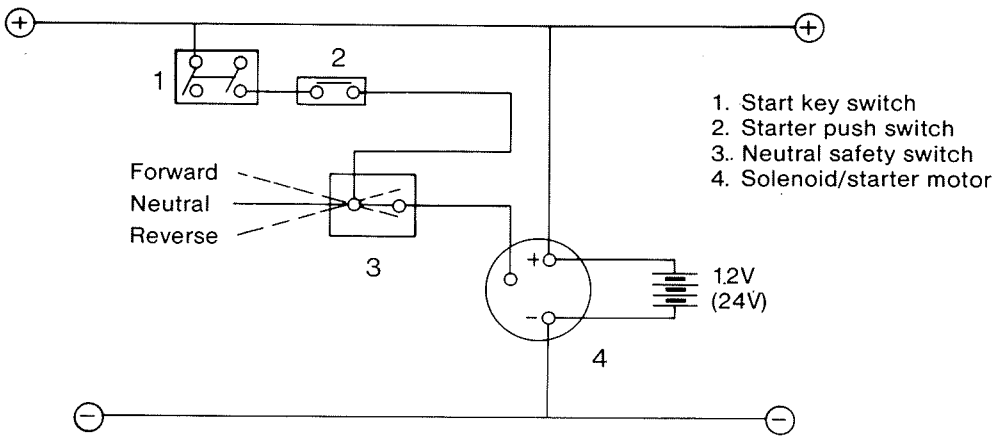


Fig. 2 Wiring diagram, neutral safety start switch

3.5 Oil pump

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

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 Figs. 3 and 4).

Fig. 3
Pump mounting position
anti-clockwise engines

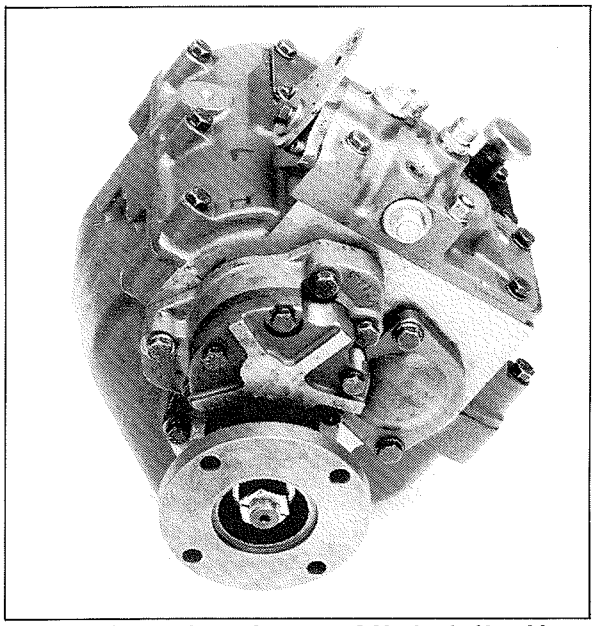
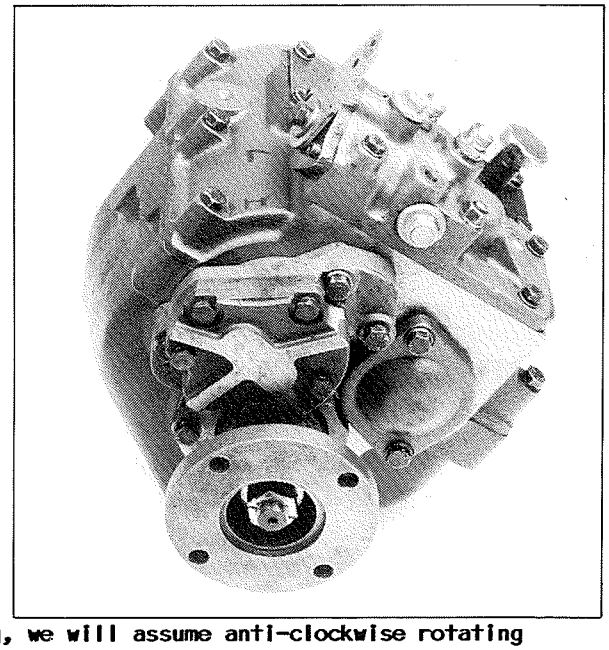


Fig. 4
Pump mounting position
clockwise engines



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 engine running and the control lever at the mid-point of travel or neutral position, 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 direction. Since neither clutch is engaged, the drive pinions do not rotate.

Moving the control lever to the 'ahead' position actuates the hydraulic system which directs oil at high pressure to the clutch on the appropriate shaft; the clutch engages and transmits engine drive to the forward drive pinion. The pinion drives the output shaft gear, causing the propeller shaft and propeller to turn in the direction corresponding to ahead movement of the vessel.

Similarly, moving the control lever to the 'astern' position engages the clutch on the other shaft and transmits drive to the reverse pinion, driving the output shaft gear in the opposite direction so that the propeller shaft and propeller turn in the direction affording 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 to the control block. This incorporates a high pressure valve which ensures 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 the 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.

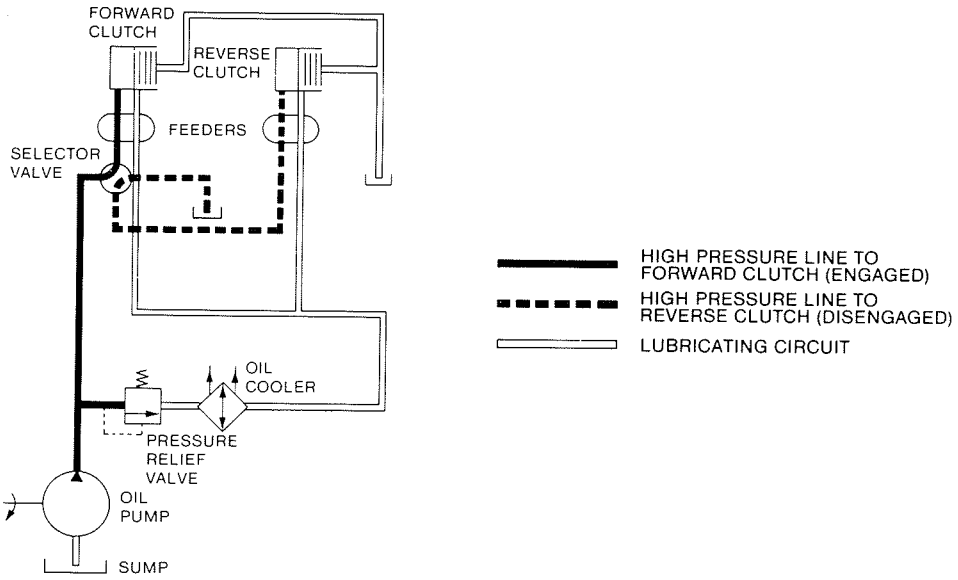


Fig. 5 Hydraulic and lubricating oil circuits

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 SAE3, SAE4, SAE5 and BW specifications enabling it to be fitted to engines having flywheel housings of equivalent specification.

Drive is transmitted from the engine to the gearbox via a flexible input coupling which bolts to the engine flywheel, and has the gearbox input shaft inserted into its centre.

The coupling enjoys a degree of torsional flexibility, which helps 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, with their 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 so).

In all marine installations, correct alignment is vital:- misalignment can cause noise, vibration and premature failure. It is essential, therefore, that all the procedures detailed in this manual are carefully followed.

It is also necessary to ensure the torsional compatibility of the complete propulsion system from the engine to the propeller otherwise gear noise may result, particularly at low engine speeds; if ignored, this may eventually lead to the failure of both engine and gearbox components.

Newage Transmissions Ltd will provide all possible information and assistance to help solve existing or 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. 6). 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 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. 6). Rotate the flywheel and check the deviation over 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 6).

Rotate the flywheel through one complete revolution and note the deviation, which should not exceed 0.125mm (0.005 in.) total indicator reading. With the 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 6). Rotate the flywheel through one complete revolution and note the deviation, which again should not exceed 0.125mm (0.005 in.) total indicator reading.

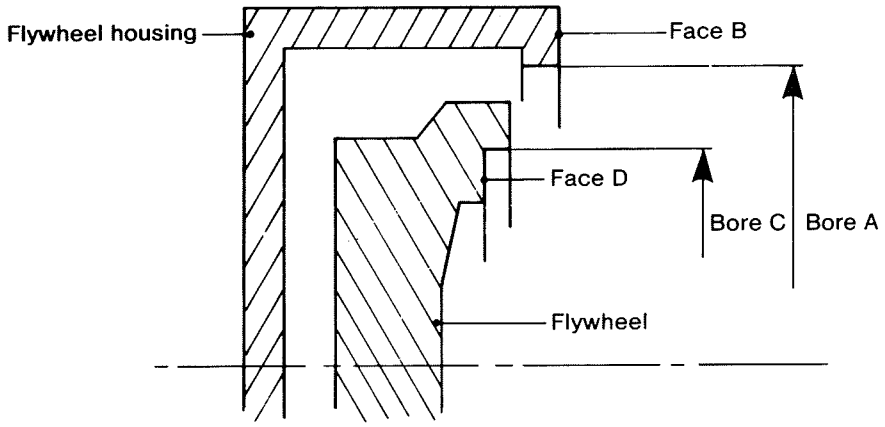


Fig. 6 Checking engine flywheel and flywheel housing

5.4 Mounting the gearbox to the engine

1. Taking care to ensure correct alignment, bolt the adaptor flange to the front of the gearbox; the maximum misalignment allowable between the adaptor and the gearbox is 0.002in (0.05mm).

2. Using an alignment mandril if available, mount and bolt the flexible input coupling to the flywheel via the holes provided. If the flywheel and coupling are to SAE standard, the outside diameter of the coupling should be a close fit in the flywheel register.

   If no mandril is 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.

3. Remove the gearbox and fully tighten the flexible input coupling bolts.

4. Offer up the gearbox and adaptor to the input coupling and engine flywheel housing at the correct attitude to provide the output shaft offset and insert the gearbox input shaft into the centre of the coupling (you may need 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.

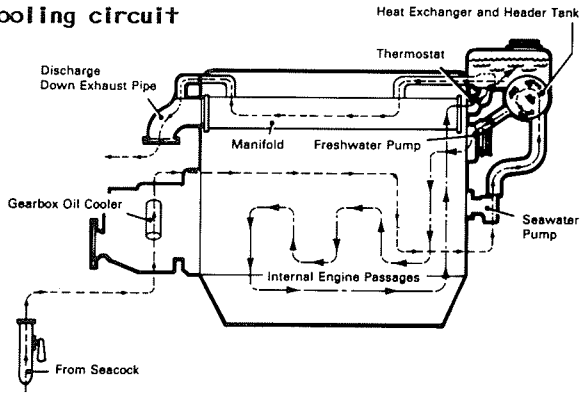
Note: for tightening torques see section 10.

5.5 Oil cooler

All Newage PRM160 gearboxes **must** be fitted with an oil cooler to maintain correct working temperature (50-70°C). To permit a suitable cooler to be fitted, two 3/8 in. BSP connections are provided on the valve block; these are blanked off with "Redcap" seals for delivery from the factory.

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

Fig. 7 Engine and gearbox cooling circuit



Remove the "Redcap" seals from the valve block, and, using suitable hoses, connect it to the oil cooler inlet and plumb it into the engine cooling system as outlined below.

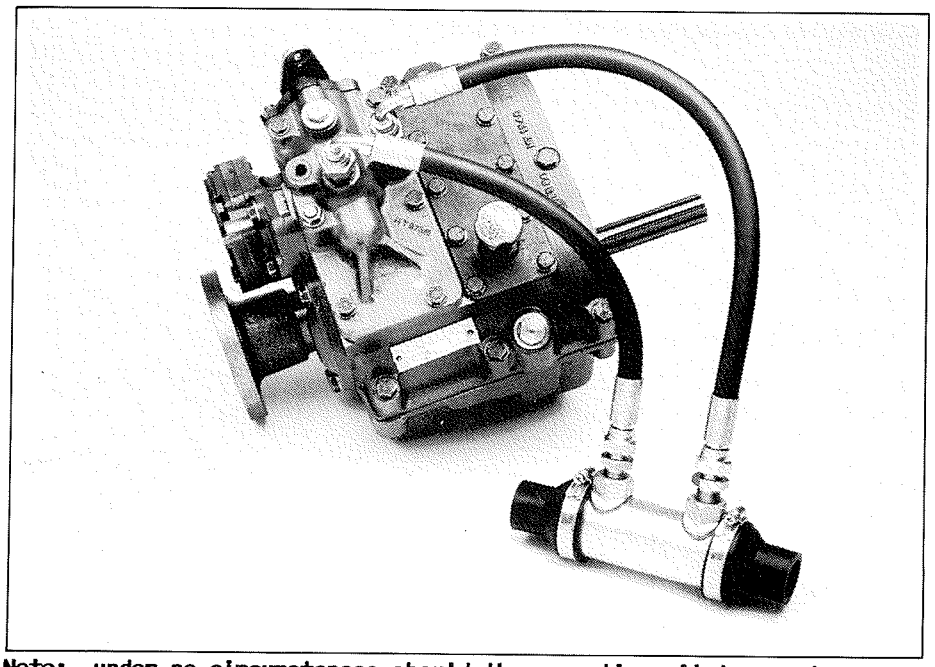


Fig. 8 Oil cooler connections, PRM160D

Note: under no circumstances should the operating oil temperature exceed 80°C. If the gearbox consistently runs at temperatures above 70°C, and the checks listed in the fault-finding chart have been carried out with no fault found, a larger capacity oil cooler should be fitted.

In those installations where the gearbox oil cooler is plumbed into the main engine cooling system it is recommended that, to ensure adequate transmission cooling, the gearbox cooler should be so connected to the circuit that it receives coolant water before, and not after, it enters the engine cooler.

5.6 Propeller shaft alignment

Correct alignment of the propeller shaft and the gearbox output flange is essential since misalignment may cause excessive vibration and stress leading to damage and perhaps even failure.

In the majority of boats whose hulls are rigid enough to prevent excessive flexing in heavy sea conditions, (which could cause the engine and transmission to shift relative to the propeller shaft), it is generally considered preferable to couple the propeller shaft direct to the gearbox output flange by means of a rigid coupling.

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

a) in boats whose hulls are not rigid enough to prevent the flexing referred to above, and

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

In both cases, the flexible coupling helps isolate engine vibration or other movement from the propeller shaft, thus also helping to maintain correct alignment with the propeller shaft and the stern tube.

Whether a solid or flexible coupling is used, it is essential to check the following points carefully:-

i) the coupling must be a tight press fit on the shaft and the keyway machined accurately to the correct size, and

ii) the two halves of the coupling must 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 in the boat is normally fixed, alignment is usually obtained by adjusting the number of shims under the engine mounts.

Note: Whenever possible, the engine and gearbox should be installed whilst the hull is afloat, otherwise there is a risk that the hull may distort because its surface is not supported adequately, which in turn may well affect the alignment. If the engine and gearbox are fitted before the hull is launched, alignment should be very carefully re-checked after launching.

5.7 Installation angle

The PRM160 should not normally be installed at a fore and aft angle of more than 17° relative to the water-line with the boat at rest.

5.8 Twin installation

Even in a single engine installation, the rotation of a propeller has a slight "turning" effect on the handling of the boat, which can normally be corrected by very slight rudder adjustments .

In twin installations, if both propellers rotate in the same direction the turning effect is much more pronounced. The solution is to use "handed" (i.e. counter-rotating) propellers, which is why PRM gearboxes have been designed to provide either hand of output rotation at any of the available gear ratios.

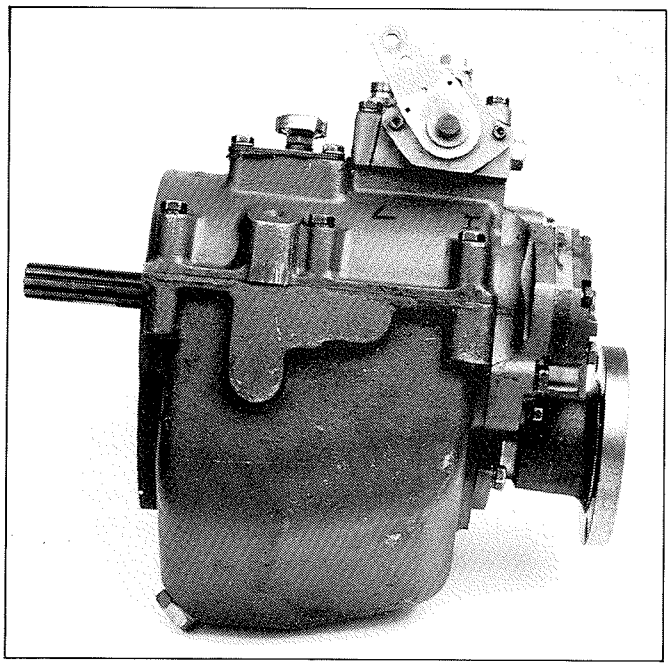
It is also usually preferable for the starboard (right-hand) propeller to rotate clockwise and the port (left-hand) propeller anti-clockwise rather than the other way around since in the latter case, when the propeller blades are at the lowest point of their rotational arc they tend to create a vacuum which reduces the flow of water the other propeller; 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 the completion of the manoeuvre.

Normal applications **Special applications**

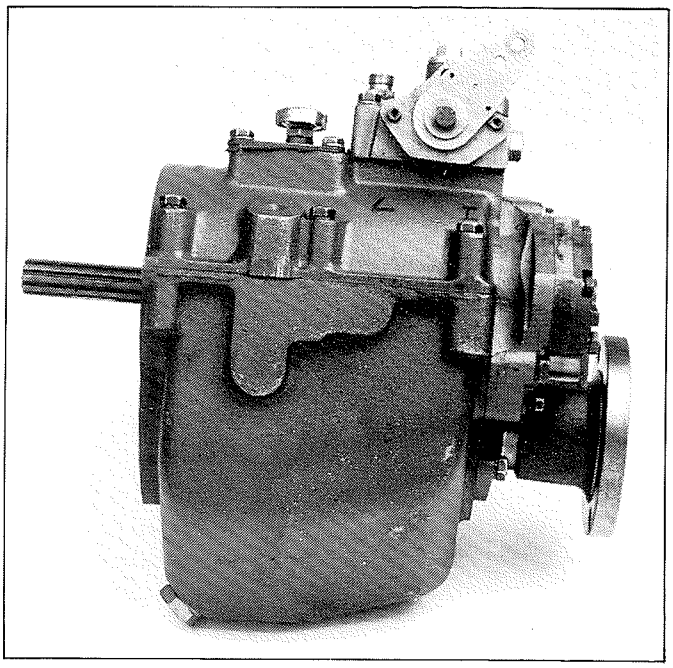
Fig. 9 Propeller rotations, twin installations

When connecting remote control units for twin engine/gearbox installations, please remember that moving the gearbox operating lever forwards will produce output rotation as engine (generally left-hand, or anti- clockwise).

Therefore, in order to ensure that the propeller shafts counter-rotate outwards in "ahead" , the operating cables should be connected so that the operating lever on the starboard gearbox moves back when the remote control operating levers are in the "ahead" position providing right-hand rotation.



Port engine
Lever forward
L.H. Propeller rotation



Starboard engine
Lever back
R.H Propeller rotation

Fig. 10 Operating cable entry, 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 linking the engine throttle to the gearbox operating lever is highly recommended.

The following points should be noted:

(i) The gearbox operating lever has a positive neutral position, which greatly assists in setting up 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 remote control equipment should in all cases be installed in accordance with the manufacturer's recommendations.

6. OPERATION

6.1 First time usage

Before starting the engine, remove the dipstick and fill the gearbox with one of the recommended lubricants (see section 4.4) to the dipstick maximum mark.

Ensure that the gearbox is in neutral (it is recommended that the optional neutral safety start switch should be wired into the starter circuit to avoid uncontrolled boat movement on start up). Start and run the engine and gearbox for a few minutes to allow the oil to circulate through the cooling circuit. Stop the engine to let the oil settle, then re-check the level and "top up" to the maximum mark on the dipstick.

When checking the oil level, always screw the dipstick fully down into place.

Note: using the gearbox with insufficient oil will lead to low oil pressure, unsatisfactory operation, overheating and eventual failure. Equally, over-filling the gearbox may cause overheating and oil leaks; it is the duty of the owner/operator to make sure that the oil level is correct at all times.

6.2 Drive selection

The Newage PRM160 has been designed and tested to ensure rapid shifts from ahead to astern or vice versa at full horsepower ratings and speeds should the need arise. However, full power reversals do place abnormal, even if short lived, loads on the gearbox and should therefore only be used in an emergency.

Newage recommends that when changing direction the engine speed be brought down to approximately 1000 rev/min. We therefore strongly recommend the fitment of a proprietary single lever remote control operating system linking the engine throttle control to the gearbox operating lever, **which must be installed strictly in accordance with the manufacturer's instructions.**

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

If the gearbox is used with the less common right-hand (clockwise) rotating engines, the operation is then reversed, i.e. moving the gearbox operating lever backwards produces left-hand propeller rotation and forwards produces right-hand propeller rotation.

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

6.3 Trailing (free-wheeling) the propeller

The bearings used in the PRM160 have been carefully selected to ensure that prolonged trailing (free-wheeling) of the propeller has no detrimental effect on the transmission. Because the propeller can turn freely with the engine shut down the gearbox is particularly well 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 necessary to provide any propeller shaft locking device to protect the transmission, although in the case of racing yachts and other high performance sailboats fitted with two bladed propellers it may be desirable to fit a propshaft lock to lock the propeller behind the deadwood, reducing drag.

A free-wheeling propeller can be a useful low-cost source of auxiliary power; a flat pulley fitted to the propeller shaft will enable a small battery-charging generator to be belt driven (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 PRM160 gearbox is a "get you home" device which, in the unlikely event of hydraulic failure, allows the gearbox to be mechanically locked in 'ahead' drive. To operate, first switch off the engine, select neutral on the operating lever disconnect the operating cable, then:

1. Remove the top cover (located alongside the valve block).

2. Select the shaft which provides 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 into the threaded hole in the clutch plate directly below the groove (thereby clamping the clutch and providing drive).

4. Ensure that sufficient oil remains in the gearbox to avoid further damage and refit the top cover, tightening the bolts to a torque of 28 Nm (21 lbf.ft - 2.9 Kgfm).

5. Check that the dipstick does not foul the head of either clamping screw: if it does, remove the dipstick and plug the hole with a clean cloth.

The engine can now be run, but to minimise the possibility of further damage being caused to the transmission, we recommend that engine speed is limited to 1/3 full throttle.

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;

(as seen looking forward from the propeller to the gearbox).

b) When emergency drive is engaged, neither astern nor neutral is available and there is no means of stopping the boat using the gearbox. You must therefore handle the boat with great care, particularly during docking.

c) After emergency drive has been used, you must seek qualified assistance to check the transmission thoroughly before it is used again.

d) Never use the top cover for topping up the oil.

7. ROUTINE MAINTENANCE

7.1. Initial maintenance (after 25 hours running)

Switch off the engine, 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 to let the oil settle. Re-check the level and top up to the maximum mark on the dipstick.

7.2 Daily check

1. Check the gearbox oil level.

2. Make a visual inspection of the general condition of the gearbox and check for oil leaks, especially around the output shaft seal and at gasket sealing surfaces.

3. Listen for any unusual noises and check their cause.

7.3 Annual checks

At the beginning of each season:

1. Check oil cooler connections and correct/replace if necessary.

2. Check propeller shaft alignment and correct if necessary.

3. Ensure that the remote control operating linkage is accurately adjusted to give correct travel on the gearbox operating lever.

4. check that all fasteners are correctly tightened (see section 10).

7.4 Winter storage

Drain all 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 you should check these 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.

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The fault finding chart is designed to help diagnose some of the problems which might be encountered. It asumes 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 distributer or dealer, for advice.

SYMPTOM	CAUSE	REASON	REMEDY
No drive ahead or astern	No oil pressure	Damaged oil pump	Replace oil pump
		Broken input coupling	Replace coupling
		Oil leaks	Check for evidence and rectify
Propeller speed does not increase with engine speed, ahead and astern	Low oil pressure to both clutches	Damaged oil pump	Replace oil pump
		Remote control cable or linkage not allowing F-N-R lever to move correct distance	Remove cable and operate lever by hand to check movement. Adjust cable if necessary
		Pressure relief valve spring defective	Remove valve block and replace spring
Propeller speed does not increase with engine speed in one direction only	Low oil pressure to one clutch	Piston rings or feeder worn	Remove appropriate clutch shaft and and replace worn feeder or piston rings
		Damaged 'O' ring in hydraulic circuit	Check 'O' rings in feeder connectors and piston; replace if necessary
		Blocked hydraulic passage in valve block	Remove valve block, examine and clean
		Damaged clutch plates	Remove and examine clutch on appropriate shaft and replace if necessary
Excessive noise from gearbox at low speeds	Engine idle speed set too low	Faulty adjustment	Increase idling speed
	Torsional vibration	Torsional incompatibility of elements in driveline	If not cured by increasing engine idling speed, refer to engine supplier
Excessive noise throughout operating range	Defective input coupling	Input coupling worn or damaged	Remove, examine and replace if necessary
	Propeller shaft misalignment	Hull flexing or faulty installation	Check the alignment of the propeller shaft coupling; if necessary rectify by adjusting the shims under the engine mounts themselves
	Propeller out of balance	Propeller damaged or badly machined	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	Faulty installation	Remove the transmission and check that the flywheel face is flat and that the flexible input coupling is aligned correctly
	Defective bearing	Bearing worn or damaged	Isolate defective bearing, remove and replace
Excessive oil temperature	fault in cooling system	defective oil cooler	Replace oil cooler
		Oil cooler too small	Fit larger capacity cooler
		Defective pressure relief valve	Remove and examine relief valve and replace if necessary
		System blocked	Check and flush out oil cooler and hoses
		Oil pipes too small	Fit larger diameter hoses
Oil level needs constant topping up	Oil leaks	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 inspect the gearbox for leaks. Replace seals as required
		Defective oil cooler or hoses	Check for traces of water in the gearbox oil or oil in the cooling water system. Replace cooler or hoses as necessary
Escape of high pressure from gearbox when dipstick is removed	Defective breather causing leaks past oil seals		Contact distributor or factory for advice
Difficulty in moving single lever control	Control lever on valve block too stiff	Defective valve or detent spring	Contact distributor or factory for advice
	Faulty installation	Remote control operating cable badly installed	Check the installation and eliminate all tight bends in the cable

IMPORTANT: The above operations should be carried out by suitably qualified personnel and strictly in accordance with the procedures detailed in the appropriate workshop manual. Before carrying out any service work always make sure that the engine is switched off, and disconnect the operating cable from the gearbox.

9. SERVICING AND REPAIRS

WARNING: do not undertake any servicing or repair work without first switching off the engine and disconnecting the operating cable.

The servicing, repair and replacement of the input shaft and layshaft assemblies and components is simplified 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.

Repair may be further simplified by fitting complete replacement shaft assemblies, and if skilled service personnel or reasonable workshop facilities are not readily available, or labour costs are high, you may find it best to adopt this procedure.

Some servicing operations can be carried out with the gearbox still mounted to the engine (provided, of course, that the engine compartment is sufficiently large to allow this); examples are the replacement or repair of valve block and oil pump. To repair or replace the input shaft, layshaft or output shaft, however, you will need to remove the gearbox from the engine.

N.B. The input shaft and layshaft are supported by taper roller bearings. Each time a shaft is stripped for inspection, component repair or replacement it will be necessary to recalculate the number of shims required to load the bearings correctly. Shimming procedures are described in section 9.8.

9.1 Valve block

The complete valve block is easily removed for inspection and servicing with the gearbox still in the boat, as follows:-

1. Disconnect the control cable(s) from the lever on the remote control unit.

2. Disconnect the oil cooler pipes and the wiring from the neutral switch, if fitted.

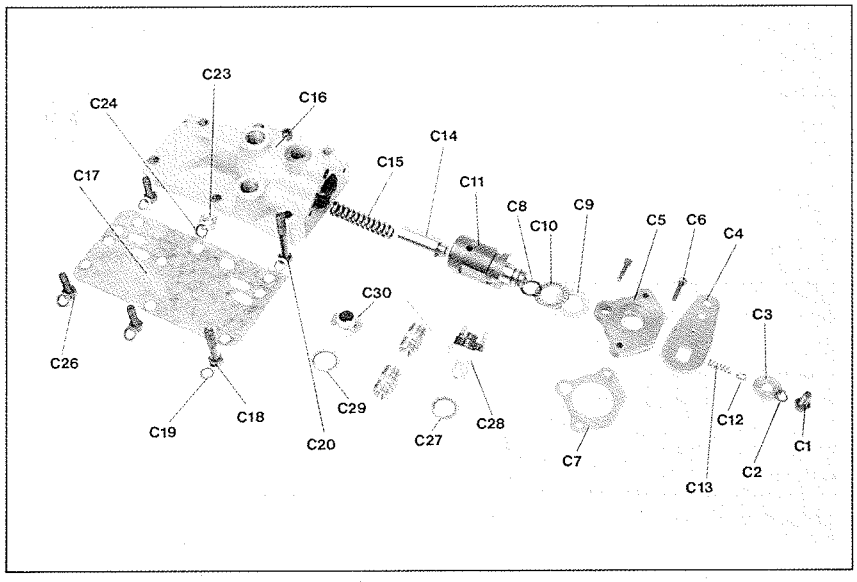
3. Remove the 5 bolts and one nut securing the valve block to the gearcase.

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. **Take care not to lose the detent ball and springs!**

5. Inspect the 'O' ring (item no. C8) and bearing (item no. C10), and 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):- if not, replace it.

6. To assemble and refit the valve block, simply reverse the above procedure.

Fig. 11 Valve block components



9.2 Oil pump

The oil pump assembly is also easy to remove 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 store carefully until required for refitting.

If the pump is damaged in any way, the complete pump assembly (item No. B) must be replaced.

N.B. If a new pump assembly is fitted the clutch shaft must be reshimmed.

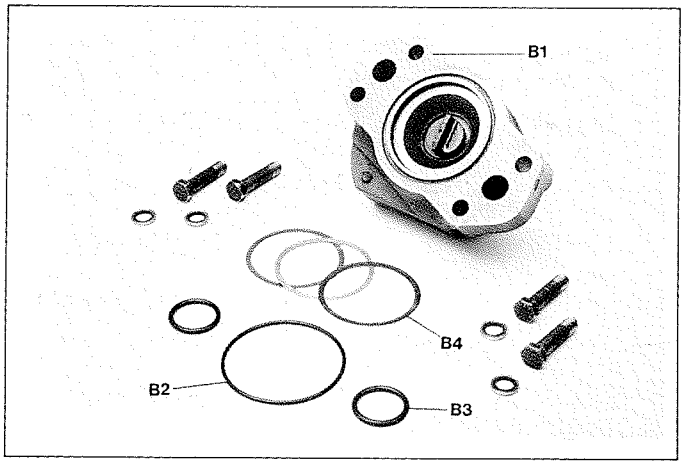


Fig. 12 Oil pump

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 from it.

2. Drain the gearbox oil into a suitable container and disconnect the oil cooler pipes.

3. Undo and withdraw the bolts which connect the gearbox output flange to 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. Remove the bolts securing the adaptor flange to the flywheel housing.

6. Slacken the bolts which secure the input coupling to the flywheel.

7. Withdraw the gearbox, if necessary rocking the unit slightly in order to disengage the input shaft spline from the internal spline in the coupling, and lift clear.

9.4 Removing the input shaft and layshaft assemblies

1. Remove the gearbox from the boat as decribed in section 9.3.

2. Undo 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 the shims and 'O' rings with the cover).**

4. Remove the 5 bolts and 1 nut retaining the valve block and remove it.

5. Remove the 7 bolts securing the gearcase top half and lift it clear.

6. Lift the input shaft assembly and front seal housing from the gearcase.

7. Lift the layshaft assembly and front end cover from the gearcase.

9.5 Servicing input shaft and layshaft assembly components

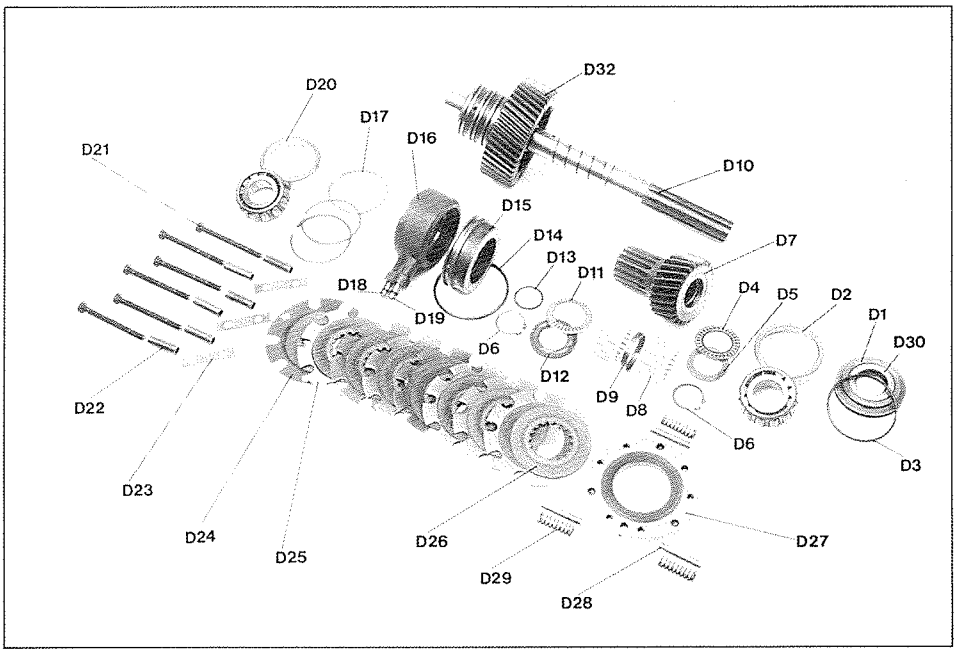


Fig. 13 Input and layshaft components

9.5.1 Input shaft oil seal

In the event of an oil leak caused by a damaged seal, remove the input shaft oil seal housing from the shaft and, using 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:-

1. Support the shaft in a vice and remove the input seal housing (this applies only to the input shaft).

2. Using a pulley extractor with its jaws located behind the pinion, withdraw the clutch pinion, thrust washer, thrust bearing and end bearing.

3. Refit the clutch pinion to the shaft.

4. Replace the thrust washer and thrust bearing, inspecting for wear and replacing where necessary.

5. Locate the new bearing (item D2) on the shaft and, using either a hand press or a hardwood drift and hammer, gently drive the assembly into position. **Take care not to damage the bearing rollers or raceways during this operation.** Note:- if the bearing is correctly located the pinion will be able to move slightly fore and aft along the shaft.

6. Reposition the input seal housing on the shaft (input shaft only.)

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

9.5.3 Clutch assembly

Clutch plates which are discoloured by overheating, or worn down so much that they have lost their grooving patterns, will tend to slip. If either of these conditions occurs, the clutch assembly will have 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-off springs.
4. Stand the shaft upright and locate the retaining pins in the clutch gear.
5. Fit the clutch end plate (D24) over the pins and then, starting with one of the driver clutch plates (D25), 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 on to 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 (9 lbf.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 (D32) first remove the clutch pack as previously described in section 9.5.3, and proceed as follows:

1. Position the shaft assembly so that the front face of the clutch gear is supported face downwards on a plate, and press the shaft out through a suitable hole in the plate.
2. The clutch gear, piston (D23), feeder (D16) and rear end bearing (D20) will now be free for inspection and replacement if necessary.

To reassemble:

3. Fit new "O" rings (D13, D14) and insert the piston into the clutch gear.
4. Fit new piston rings (D17) to the feeder (for piston rings and feeder removal refer to section 9.5.7). Refit the clutch gear to the feeder, and replace the assembly on to the shaft. Ensure that the spline on the shaft has engaged with the clutch gear.
5. Place the rear end bearing on to the shaft and gently drive the bearing into position.
6. Replace the clutch as described in 9.5.3.

Note: It is advisable to renew both clutch gears simultaneously since damage to one will often result in damage to its mating gear. It is also strongly recommended that the piston seals and tab washers are also replaced.

9.5.5 Drive pinion

As with the clutch gears it is advisable to renew both drive pinions at the same time. To ensure that the drive pinion of the correct ratio is used, please refer to the parts list at the back of this manual. If a different ratio from that originally supplied is required, 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 shows any sign of damage.

9.5.7 Piston rings and feeder

If they are damaged or excessively worn, the piston rings and feeder will need replacing. The procedure is as follows:-

1. Remove the non drive end bearing as described and remove the feeder and spacer.

2. Using a special piston ring extractor, remove the piston rings from the shaft. If you do not have an extractor, you can use a thin piece of steel as follows:-

   raise one end of the top ring out of the groove and insert the steel strip between the ring and the shaft. Apply a slight forward pressure to the raised portion of the ring, and rotate the strip around the shaft until it rests on the land above the groove, where it can be eased off. Repeat this with the other two rings.

3. Remove the new rings from their packing, and clean off any grease or inhibitor.

4. Using a ring loading tool fitted around the shaft, load the rings on the tool and locate them in their approximate position. Gently withdraw the tool, allowing the rings to locate in their respective grooves.

5. If you do not have a loading tool, lay a thin metal strip along the shaft above the grooves. Expand each ring just enough to allow it to be placed in its approximate position over the strip, then gently remove the strip, leaving the rings located in their respective grooves. (see Fig. 14).

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

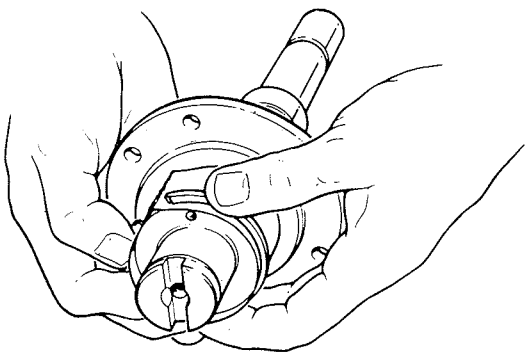


Fig. 14 Fitting piston rings

9.6 Replacement of input shaft and layshaft assemblies

1. Position the input shaft assembly in the gearcase, ensuring that the seal housing is in its correct position.

2. Position the layshaft in the casing ensuring the end cover is correctly located.

3. Coat the mating surfaces of the two gearcase halves with a jointing compound and, to ensure that the feeder connectors are located correctly, pass some wire through the holes in the top half of the gearcase and the feeder connectors and fit the top half of the gearcase to the lower, checking that the two halves are square to each other. The connector 'O' rings should be examined for damage or wear and renewed if necessary.

4. Refit the 7 gearcase bolts and tighten them to the correct torque (see section 10)

5. Shim and refit the input shaft end cover, replacing the 'O' ring if damaged.

6. Shim and refit the oil pump, replacing the 'O' rings if damaged. Take care that the oil pump is fitted in the correct position to provide the required direction of rotation.

7. Refit the valve block, replacing the gasket.

8. Taking care to ensure correct alignment (section 5.4), refit the adaptor to the gearbox, tightening the 7 bolts to a torque of 58.3 Nm (43 lbf ft - 5.95 Kgfm).

9. Taking care to ensure correct alignment section 5.4), refit the input coupling to the engine flywheel and tighten the securing bolts.

10. Reconnect the oil cooler pipes and the control cable as described in sections 5.5 and 5.9.

11. Reconnect the gearbox output flange to the propeller shaft coupling and carefully realign as described in section 5.6.

Note: shimming procedures are described in section 9.8

9.7 Servicing the output shaft assembly

To remove the output shaft assembly, first remove the gearbox from the boat (see section 9.3), then proceed as follows:-

1. Remove the input shaft and layshaft assemblies (see section 9.4).

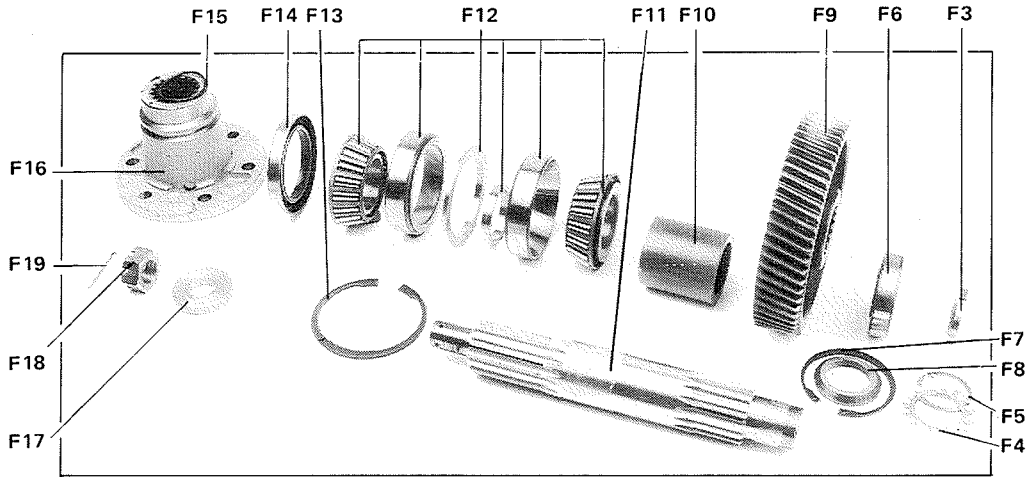
2. Undo the nut (F18) and washer (F17),and remove the output coupling (F9).

3. Remove the output shaft front end cover (F1).

4. Undo the three screws (A21), and remove the rear seal housing (F12) and the shims located between the seal housing and the bearing.

5. To remove the shaft from the gearbox, drive or press the shaft on the front end, allowing the rear bearing (F10) and shaft (F8) to be removed from the rear end of the gearbox, leaving the front bearing inner race, output gear and spacers behind.

Fig. 15 output shaft components



9.7.1 Front bearing and output gear

1. Once the output shaft has been taken out of the gearbox, the output gear (F9) can be lifted from the gear case.

2. Remove the circlip (F3) from the bearing bore; this allows the bearing outer race (F4) to be removed from its bore by means of a press or a hardwood drift and hammer.

3. Check the bearing and output gear for any defect or damage and replace them if necessary.

9.7.2 Rear bearing and oil seal

1. If the oil seal (F13) is damaged, press it out from its housing (F12) and renew.

2. If the rear bearing (F10) is damaged, remove it from the shaft by means of a soft hammer or hand press.

Note: all 'O' rings, oil seals and circlips should be renewed whenever the output shaft is stripped.

9.7.3 Re-assembling the 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 the circlip (F3) into the groove in the bore of the gearcase.

3. Press the rear bearing inner race (F10) on to the shaft until it seats on the shoulder provided on the output shaft.

4. Assemble the shaft from the rear. Feed the spacer (F7), 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 up to the the circlip in the bore.

5 Locate the rear bearing outer race in the rear bore and it press home.

6. Re-calculate and fit the number of shims required (see section 9.8), fit a new 'O' ring (F11) to the oil seal housing (F12) and secure the housing to the gearcase.

8. Fit the 'O' ring to the front cover and refit the cover in the front bore.

7. Refit the 'O' ring (F16), output coupling (F9), washer (F17), and nut (F18). Tighten the nut to 163 Nm (120 lbf.ft).

9.8 Shimming procedures

9.8.1 Input shaft and layshaft

The allowable end float on the taper bearing is 0 - 0.075mm (0 - 0.003in) 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. 16.

2. Measure the depth of the recess in the oil pump and in the output shaft end cover as in Fig. 17, and make up the difference between the two dimensions with shims.

If no depth micrometer is available, the following method may be used:-

1. Remove the '0' ring from the oil pump or end cover.

2. Fit enough shims to cause the oil pump or end cover to stand proud.

3. Rotate the shaft, slowly tightening the securing bolts until the shaft starts to bind. Use feeler gauges or shims around the pump or end cover (Fig. 18) to ensure that the gap is uniform and that they are positioned squarely on the rear face of the gearcase.

4. Measure the gap by means of feeler gauges or shims, and deduct shims to this figure plus 0.075mm (0.003in) from the shims already installed.

5. Remove the requisite 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 '0' ring installed.

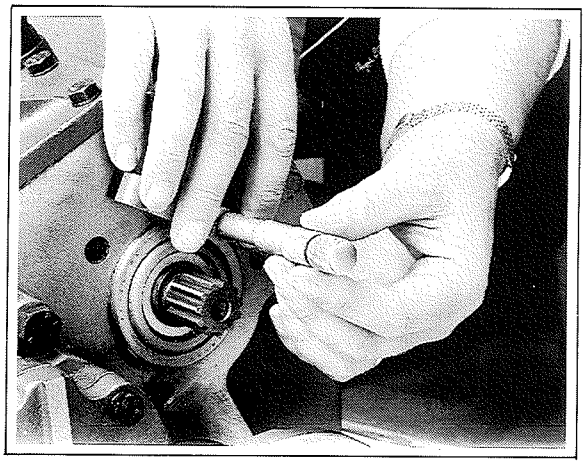


Fig. 16

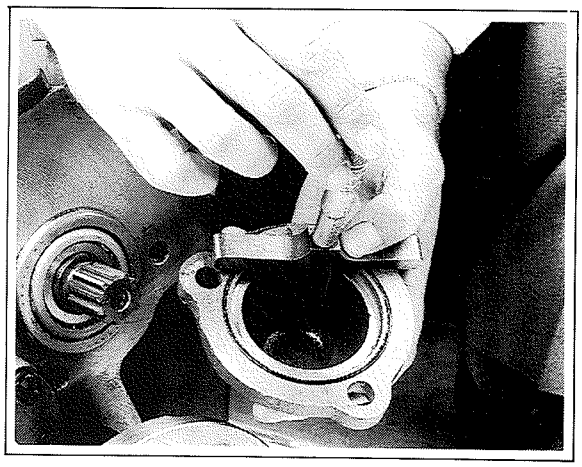


Fig. 17

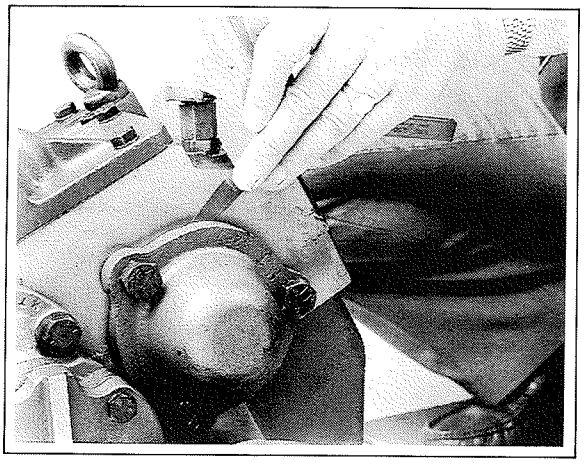


Fig. 18

9.8.2 Output shaft

1. With the output shaft fitted in the gearcase and the bearing driven into position, press the bearing outer cone firmly into place 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 you get an end float reading of 0.548mm (0.023in), you should use two shims of 0.254mm (0.010in) and one of 0.05mm (0.002in), giving a final end float or clearance of 0.025mm (0.001in).

10. TIGHTENING TORQUES

	Nm	lbf.ft	Kgfm
Upper to lower gearcase bolts	54.2	40.0	5.5
Valve block to upper gearcase	28.5	21.0	2.9
Operating lever to selector valve	27.9	20.6	2.9
End cover to valve block (loctite)	9.5	7.0	1.0
Pump body to gearcase	56.3	41.5	5.7
Oil seal housing to gearcase	54.0	40.0	5.5
Pump cover to pump body	28.0	21.0	2.9
Coupling to output shaft	163.0	120.0	16.6
Top cover to upper gearcase	28.0	21.0	2.9
Adaptor plate to gearbox	58.3	43.0	6.0

REPLACEMENT PARTS ORDERING

When ordering replacement 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 LTD,
BARLOW ROAD
COVENTRY CV2 2LD
ENGLAND

Tel: 0203 617141 **Telex: 31333** **Fax: 0203 611845**

METRIC DIMENSIONS

Where metric dimensions are shown in the description column, or without brackets in the remarks column, i.e. bearing dimensions, these are the actual dimensions of that item.

Where metric dimensions are shown within brackets in the remarks column, these are the metric equivalents of imperial dimensions and are given solely to help in the identification of components.

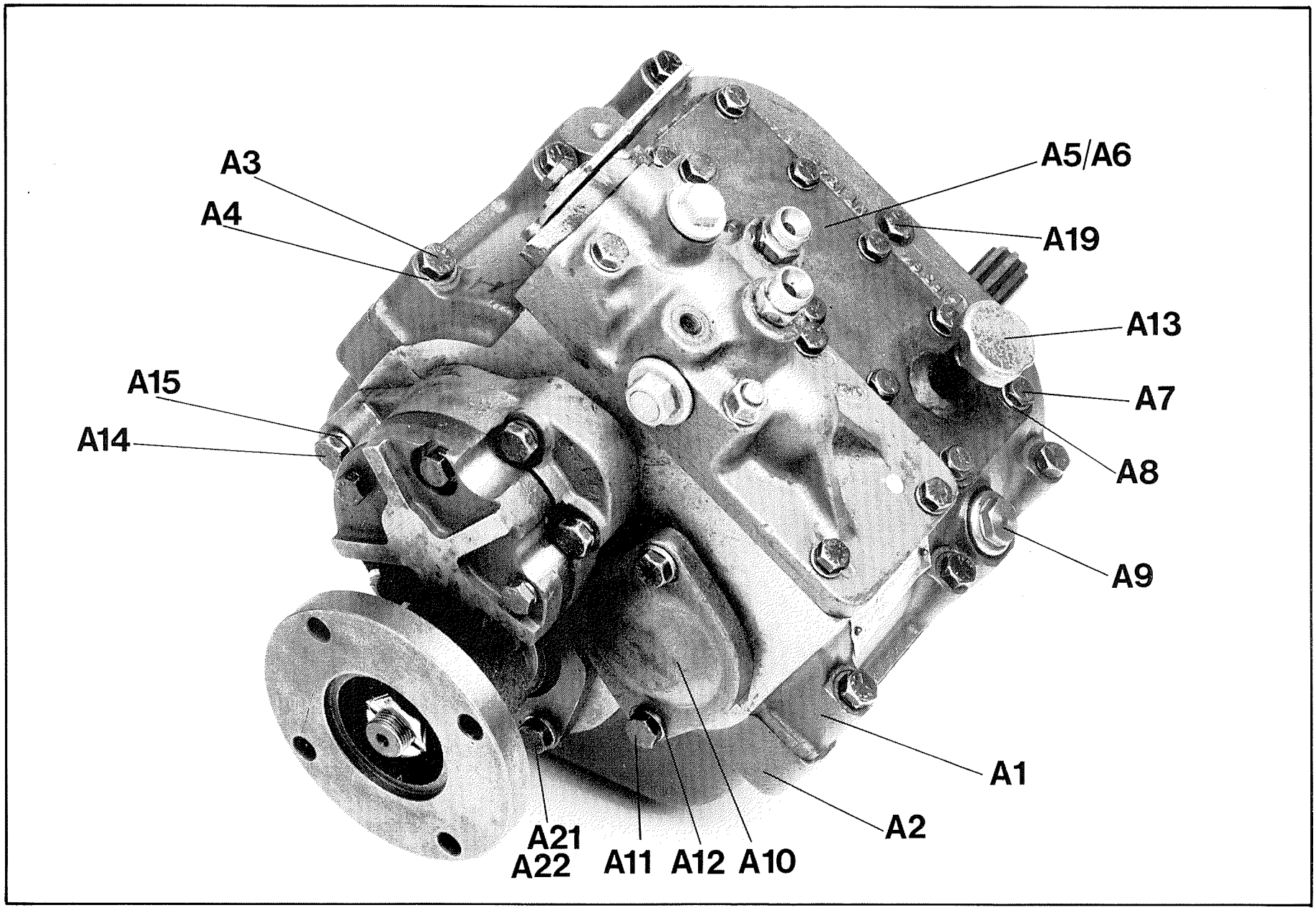

A3
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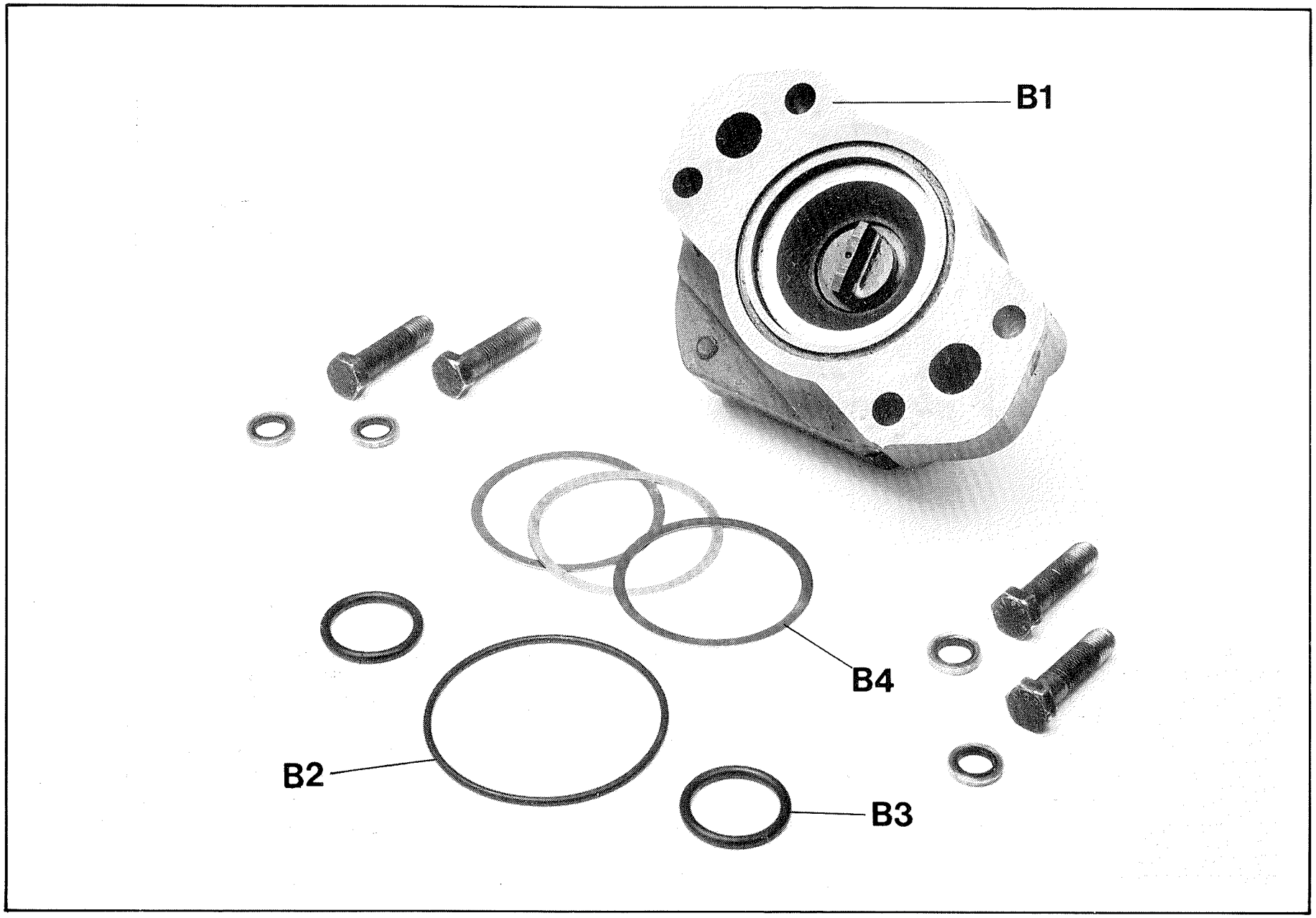
Plate Ref.	Description	PRM 160 Part No.	Qty.	Remarks
A	**GEARCASE ASSEMBLY**			
	Case sub-assembly	MT0371	1	Supplied complete only
A1	Gearcase - top	MT1119	1	Not supplied separately
A2	Gearcase - bottom	MT1427	1	Not supplied separately
A3	Bolt	UBF113	6	
A4	Washer	W108	6	
A5	Gasket	MT343	1	
A6	Top cover	MT1203	1	
A7	Screw	USF32	10	
A8	Washer	CP1223	10	
A9	Dipstick	MT471	1	
A10	End cover	MT318	1	
A11	Screw	USF33	2	
A12	Washer	CP1224	2	
A13	Breather	CP1057	1	
A14	Bolt	UBF93	4	
A15	Washer	CP1224	4	
A16	Drain plug	CP1331	1	Not illustrated
A17	Washer (drain plug)	0201714	1	Not illustrated
A18	Washer (dipstick)	CP1068	1	Not illustrated
A19	Case half bolt	UBF173	1	Not illustrated
A20	O ring (End cover)	002873	1	With item A10
A21	Bolt	USF53	3	
A22	Washer	W108	3	


B1
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B3

Plate Ref.	Description	PRM 160 Part No.	Qty.	Remarks
B1	**OIL PUMP ASSEMBLY**	MT0296	1	Supplied complete only
B2	O ring	002873	2	
B3	O ring	001254	2	
B4	Shims	MT1075/02	A/R	
B4	Shims	MT1075/10	A/R	
B5	Oil pipe	MT736	1	Not illustrated

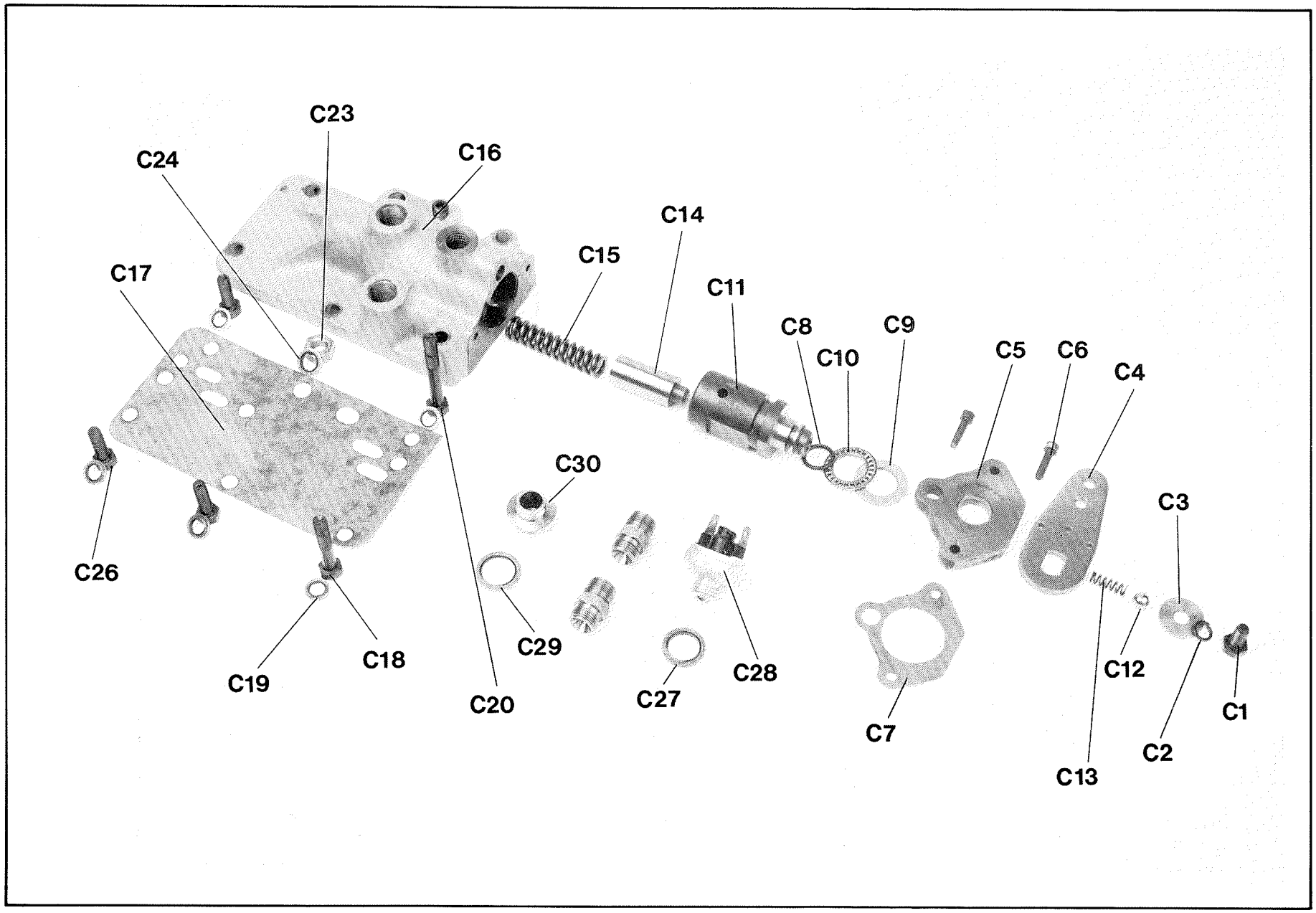
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Plate Ref.	Description	PRM 160 Part No.	Qty.	Remarks
C	**VALVE BLOCK ASSEMBLY**	**MT0354**	**1**	
C1	Screw	0040806	1	
C2	Spring washer	0191105	1	
C3	Washer	MT979	1	
C4	Operating lever	MT977	1	
C5	End plate	MT978	1	
C6	Cap screw	0081220	2	
C7	Gasket	MT1081	1	
C8	O ring	000753	1	
C9	Thrust race	CP1308	1	
C10	Thrust bearing	CP1307	1	
C11	Control valve	MT4656	1	
C12	Detent ball	CP1077	1	
C13	Detent spring	MT305	1	
C14	Control valve	MT4751	1	
C15	Valve spring	MT4772	1	
C16	Valve block	MT4780	1	
C17	Gasket	MT1073	1	
C18	Bolt	UBF102	1	
C19	Washer	CP1223	5	
C20	Bolt	UBF122	1	
C21	Redcap seal (transit only)	MT477	2	
C22	Pressure plug	MT311	1	
C23	Nut	UN505	1	
C24	Washer	W108	1	
C25	Stud	MT1079	1	
C26	Screw	USF52	3	
C27	Plug	CP1360	1	Not illustrated
C27	OR Neutral safety switch	MT0214	1	
	Switch	CP1358	1	Not illustrated
	Ball	CP1077	1	Not illustrated
C28	Washer	0201715	1	Not illustrated
C29	Plug	0150318	1	Not illustrated
C30	Bonded seal	0191718	1	Not illustrated
C31	Dowty washer	0201715	1	Not illustrated with C27

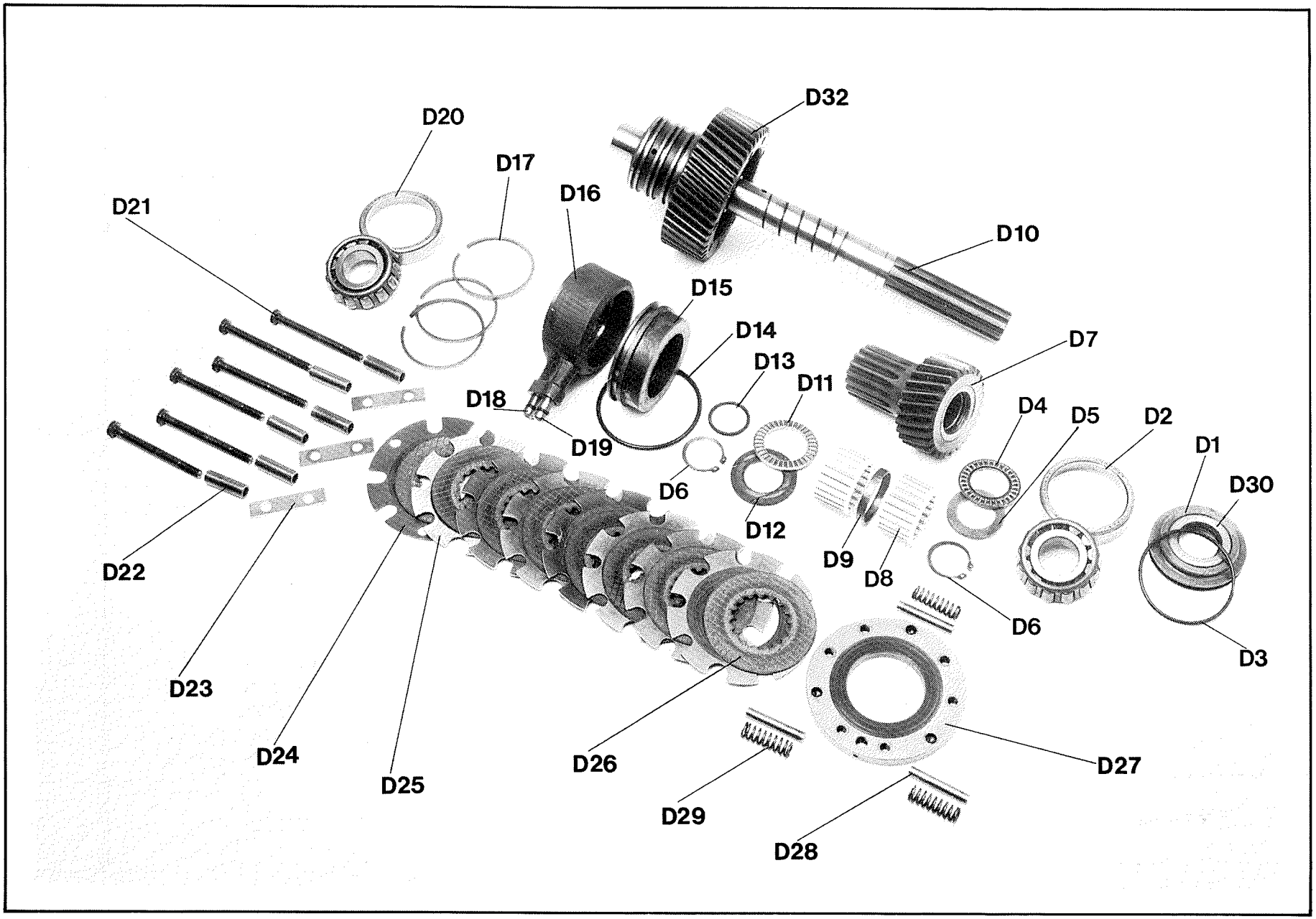
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Plate Ref.	Description	PRM 160 Part No.	Qty.	Remarks
D	**INPUT SHAFT ASSEMBLY**			
D1	Oil seal housing	MT1615	1	
D2	Taper roller bearing	0540251	1	
D3	O ring	002433	1	
D4	Thrust bearing	0602801	1	
D5	Thrust washer	0592502	1	
D6	Spring ring	0300250	2	
D7	Pinion 1.96:1	MT1598	1	27 teeth
D7	Pinion 2.94:1	MT1599	1	17 teeth.
D8	Needle roller bearing	0562504	2	
D9	Needle bearing spacer	MT1600	2	
D10	Input shaft	MT1596	1	
D11	Thrust bearing	CP1388	1	
D12	Thrust washer	0592501	1	
D13	O ring	001123	1	
D14	O ring	002874	1	
D15	Piston	MT1347	1	
D16	Feeder	MT1601	1	
D17	Piston ring	MT292	3	
D18	Connector	MT1057	2	
D19	O ring	000372	4	
D20	Bearing	0540251	1	
D21	Bolt	MT452	6	
	Clutch Pack	MT0079	1	
D22	Ferrule	MT730	6	
D23	Tab strip	MT351	3	
D24	End plate	MT117	1	
D25	Clutch plate driven	MT116	7	
D26	Clutch plate driver	MT731/S	8	
D27	Clutch end cover	MT1113	1	
D28	Pin	MT357-2	3	
D29	Spring	MT120	3	
D30	Input shaft oil seal	MT165	1	
D31	Shim	MT1075/02	A/R	Not illustrated
D31	Shim	MT1075/10	A/R	Not illustrated
D32	Clutch gear	MT1591	1	

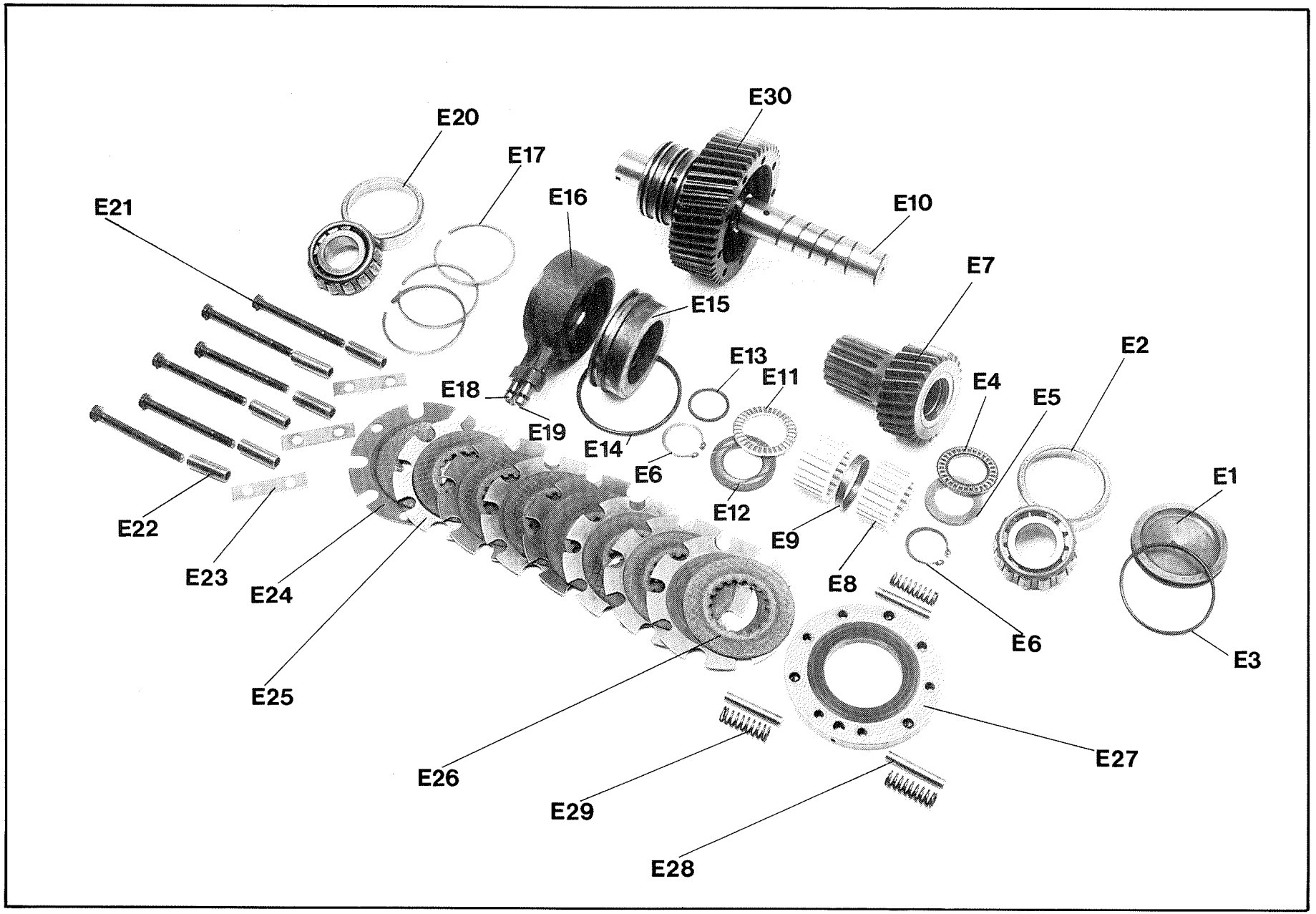
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Plate Ref.	Description	PRM 160 Part No.	Qty.	Remarks
E	**LAYSHAFT ASSEMBLY**			
E1	End Cover	MT1614	1	
E2	Taper bearing	0540251	1	
E3	O ring	002433	1	
E4	Thrust bearing	0602801	1	
E5	Thrust washer	0592502	1	
E6	Spring ring	0300250	2	
E7	Pinion 1.96:1	MT1598	1	27 teeth
E7	Pinion 2.94:1	MT1599	1	17 teeth
E8	Needle roller bearing	0562504	2	
E9	Needle bearing spacer	MT1600	2	
E10	Layshaft	MT1597	1	
E11	Thrust bearing	CP1388	1	
E12	Thrust washer	0592501	1	
E13	O ring	001123	1	
E14	O ring	002874	1	
E15	Piston	MT1347	1	
E16	Feeder	MT1601	1	
E17	Piston ring	MT292	3	
E18	Connector	MT1057	2	
E19	O ring	000372	4	
E20	Bearing	0540251	1	
E21	Bolt	MT452	6	
	Clutch Pack	MT0079	1	
E22	Ferrule	MT730	6	
E23	Tab strip	MT351	3	
E24	Clutch end plate	MT117	1	
E25	Clutch plate driven	MT116	7	
E26	Clutch plate driver	MT731/S	8	
E27	Clutch end cover	MT1113	1	
E29	Spring	MT120	3	
E28	Pin	MT357-2	3	
E30	Clutch gear	MT1593	1	

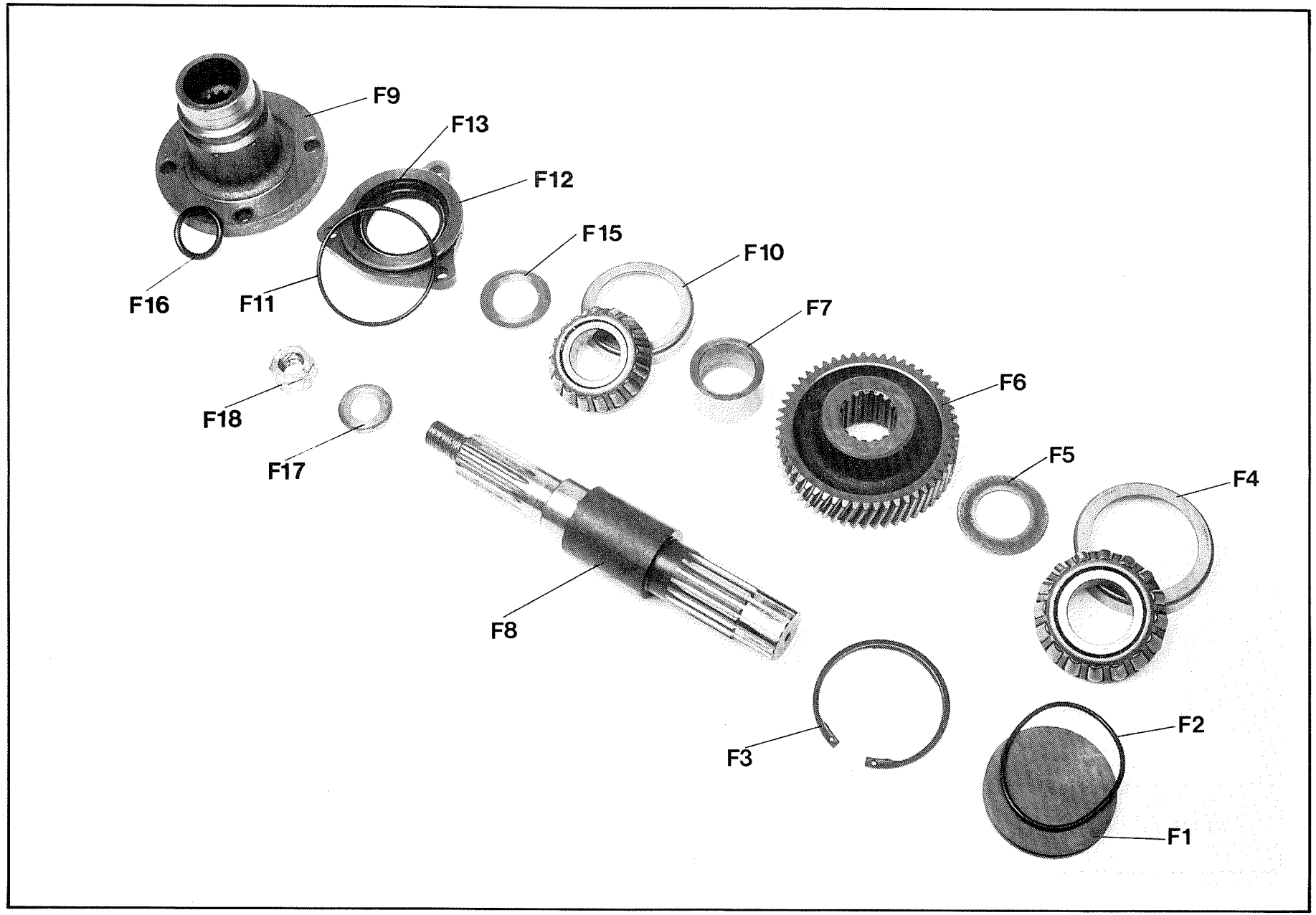
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Plate Ref.	Description	PRM 160 Part No.	Qty.	Remarks
F	**OUTPUT SHAFT ASSEMBLY**			
F1	End cover	MT996	1	
F2	O ring	003124	1	
F3	Circlip	0250800	1	
F4	Bearing	0540352	1	
F5	Spacer	MT995	1	
F6	Output gear 1.96:1	MT1100	1	53 teeth.
F6	Output gear 2.94:1	MT1098	1	50 teeth.
F7	Spacer	MT1102	1	
F8	Output shaft	MT1097	1	
F9	Output coupling	MT753	1	
F10	Bearing	0540401	1	
F11	O ring	003504	1	
F12	End cover	MT319	1	
F13	Oil seal	MT349	1	
F14	Shim	MT1076/02	AR	
F14	Shim	MT1076/10	AR	
F15	Spacer	MT1082	1	
F16	O ring	001506	1	
F17	Washer	MT600	1	
F18	Nut	0061210	1	

KITS OF PARTS

Part No.	Description	Qty
MT0025	**O ring kit**	
000372	O ring Feeder connection	8
000753	O ring Control valve	1
001254	O ring Oil pump	2
001506	O ring Output shaft	1
002433	O ring End cover	2
002873	O ring Oil pump	2
003124	O ring End cover	1
003504	O ring Output shaft	1
MT165	Oil seal Input shaft	1
MT343	Gasket Top cover	1
MT349	Oil seal Output shaft	1
MT1073	Gasket Valve block	1
MT1081	Gasket Valve end plate	1
MT0067	**Shimming kit**	
MT1075/02	Shim	6
MT1075/10	Shim	6
MT1076/02	Shim	4
MT1076/10	Shim	4

Part No.	Description	Qty
MT0079	**Clutch pack kit**	
CP1102	Circlip	1
MT1113	Clutch end cover	1
MT116	Clutch plate Driven	7
MT117	Clutch end plate	1
MT120	Spring	3
MT344	Spacer	1
MT351	Tab washer	3
MT357	Pin	3
MT730	Ferrule	6
MT731/S	Clutch plate Driver	8
USF32	Screw	1
	2:1 Conversion kit	
MT1598	Pinion 2:1	2
MT1100	Output gear 2:1	1
	3:1 Conversion kit	
MT1599	Pinion 3:1	2
MT1098	Output gear 3:1	1