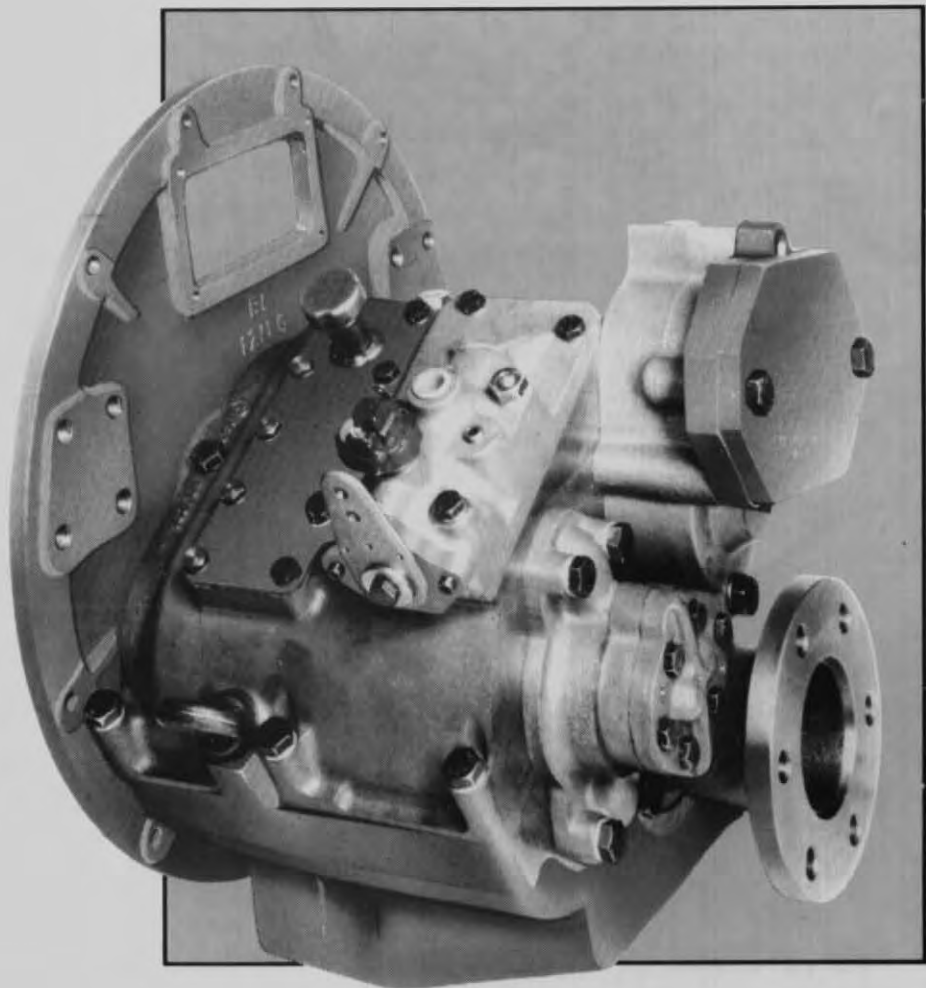


PRM 401 BY NEWAGE



WORKSHOP MANUAL

NEWAGE

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FORWARD

This workshop manual has been prepared to assist the operator or user of Newage PRM marine gearboxes and also to enable the skilled service engineer to undertake more detailed maintenance and overhaul.

GENERAL INFORMATION

PRM hydraulic marine gearboxes will give trouble-free service provided they are correctly installed, aligned and maintained. In the event of failure, the engine distributor who supplied the gearbox, or the local dealer, should be informed; where this is not possible, Newage Transmissions Limited, or the distributor for the area, should be notified. In all communications, verbal or otherwise, the model and serial number of the gearbox must be quoted in order to ensure correct identification and supply of parts.

CLAIMS UNDER WARRANTY

Claims for 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.

SERVICE PARTS

The comprehensive illustrated parts list gives full information and ordering procedure.

IDENTIFICATION PLATE

Every PRM gearbox is fitted with an identification plate on the top half of the gearcase before it leaves the factory; an example of such a plate is shown below.

| | |
|---------------------------------|----------|
| NEWAGE PRM | COVENTRY |
| 123456 | A1234 |
| 401VR3 | |
| USE RECOMMENDED LUBRICANTS ONLY | |

| | |
|---------------------------------|----------|
| NEWAGE PRM | COVENTRY |
| | |
| | |
| USE RECOMMENDED LUBRICANTS ONLY | |

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, and should always be quoted when ordering spare parts; this enables the factory to trace the history of the gearbox right back to its date of manufacture and the components and materials used in its production, thus ensuring that the correct components can be supplied as spare parts.

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

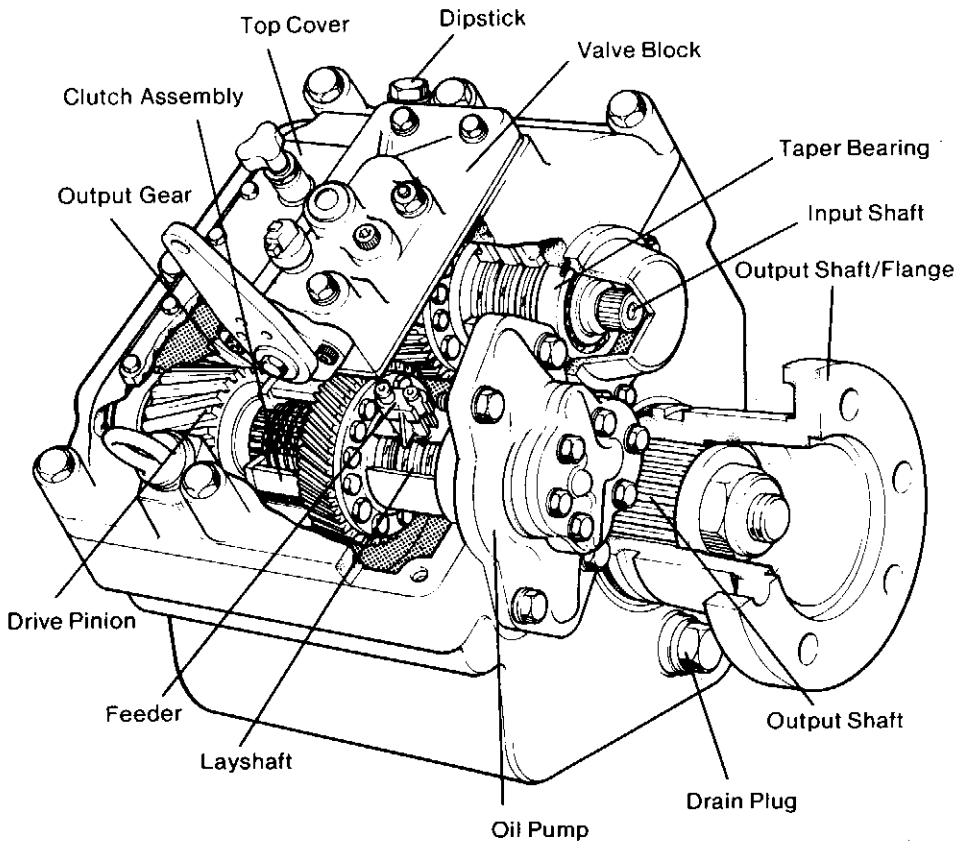
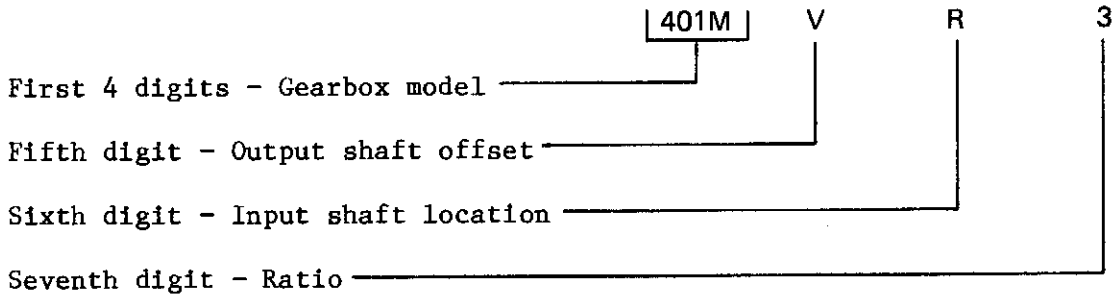


Fig. 1 Gearbox cut - away – typical arrangement

PRM401 SERVICE MANUAL

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1. GENERAL DATA

1.1 Specifications

Gear ratios

1.09:1, 1.459:1, 1.935:1, 2.904 :1 or 3.952:1

Power rating:

1.09 :1 up to 8.0 hp (5.97 kW) per 100 rev/min
1.459:1 up to 8.0 hp (5.97 kW) per 100 rev/min
1.935:1 up to 8.0 hp (5.97 kW) per 100 rev/min
2.565:1 up to 8.0 hp (5.97 kW) per 100 rev/min
2.904:1 up to 6.85 hp (5.11 kW) per 100 rev/min
3.952:1 up to 6.85 hp (5.11 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 3000 rev/min continuous
3600 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:

Ratios up to 2.904:- 72 Kg (158 lb)
Ratio 3.952 :- 80 Kg (176 lb)

(excluding drive coupling, adaptor and cooler).

Additional weight - Power take off: 12 Kg (26.4lb)
Angle drive: 17.5 Kg (38.5lb)

Oil capacity:

Ratios up to 2.904 : 3.25 litres (5.5 pints)
Ratio 3.952 : Available upon application
Power take off : As above
Angle drive unit : 4 litres (6.8 pints)

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

Working oil pressure:

2275 kPa (23.2 Kg/cm² - 330 lbf/in²)

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, but as a general guide, a cooler of 6.3 kW (8.5 hp) capacity and a flow rate of 27 litres per hour per 1000 rev/min input should be adequate. Suitable coolers are available from Newage Transmissions Ltd.

Input drive couplings:

Flexible drive coupling for flywheels of 10 in, 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:

29mm (1.14 in) diameter with $16/32$ DP involute spline.

Propeller thrust:

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

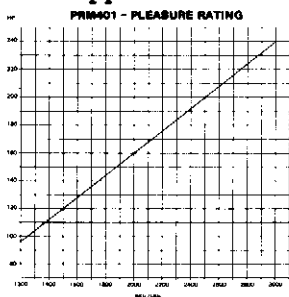
Output flange:

152.4mm (6 in) diameter, with 6 holes, 13mm (0.512 in) diameter on 121mm (4.5 in) PCD.

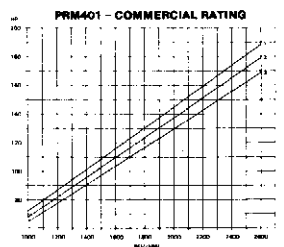
Installation angle:

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

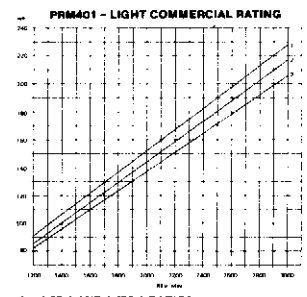
1.2 Application details



1.09:1, 1.459:1, 1.96:1 AND 2.565:1 RATIOS
THESE RATINGS ARE FOR PLEASURE CRAFT OPERATING FOR LESS THAN 500 HOURS PER YEAR WITH FULL THROTTLE USAGE LESS THAN 10 MINUTES IN ANY ONE HOUR.



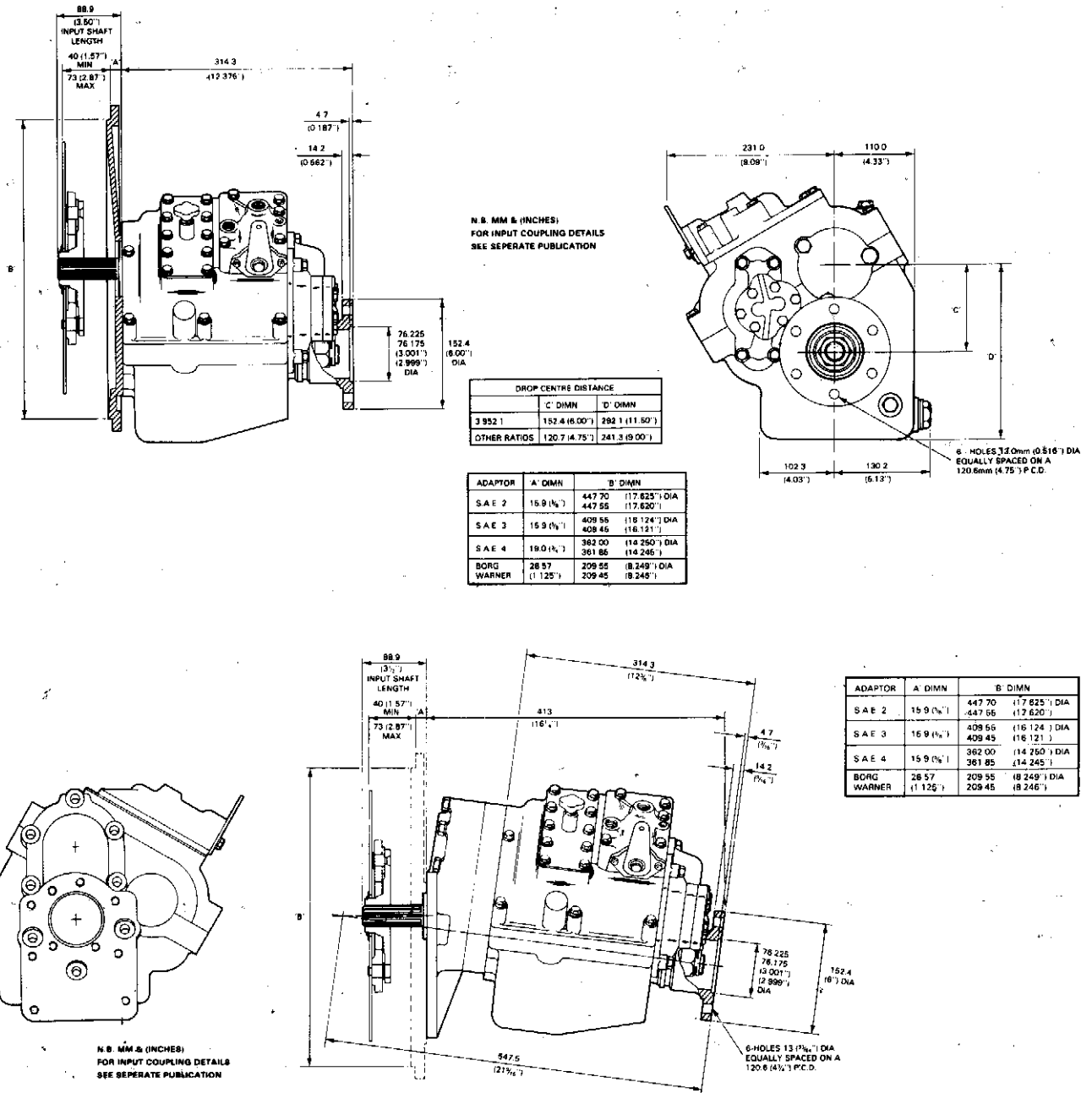
1 - 1.09:1 AND 1.459:1 RATIOS 2 - 1.96:1 RATIO
3 - 2.565:1, 2.904:1 AND 3.952:1 RATIOS
THESE RATINGS ARE FOR WORK BOATS AND FISHING BOATS OPERATING FOR MORE THAN 1,500 HOURS PER YEAR.



1 - 1.09:1 AND 1.459:1 RATIOS
2 - 1.96:1 RATIO
3 - 2.565:1, 2.904:1 AND 3.952:1 RATIOS
THESE RATINGS ARE FOR FISHING BOATS AND PLEASURE CRAFT OPERATING UP TO 1,500 HOURS PER YEAR.

NOTE: These ratings have been established in order to ensure the long and trouble-free life of the gearbox. However, operating conditions can vary widely with consequential effects on the gearbox and these ratings should therefore be used for general guidance only. If in any doubt, or for any particularly arduous duty, or for applications outside the powers and speeds shown here, please contact the factory or the distributor.

1.3 Installation details



TORSIONAL COMPATIBILITY

It is extremely important to ensure the torsional compatibility of the total propulsion system from engine through to propeller since disregarding this may result in gear chatter, particularly at low speeds, and in extreme cases component damage or even failure may occur.

It is the responsibility of the person assembling the drive and driven equipment to ensure that they are torsionally compatible; torsional vibration and analysis can be carried out by engine manufacturers, marine service societies, independent marine consultants, etc. Newage Transmissions Ltd will gladly provide all relevant information and assistance to help find solutions to potential torsional problems which may affect the transmissions.

2. INTRODUCTION

Newage PRM marine transmissions are oil-operated gearboxes of the counter-shaft 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 needle roller bearings), the forward (when used with a right-hand propeller) drive clutch assembly, the clutch gear and a hydraulic actuated piston to operate the clutch.

The layshaft is similarly supported by taper roller bearings and also incorporates a drive pinion of the same ratio (again running on needle roller bearings), 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.

Internal Layout (with Angle Drive)

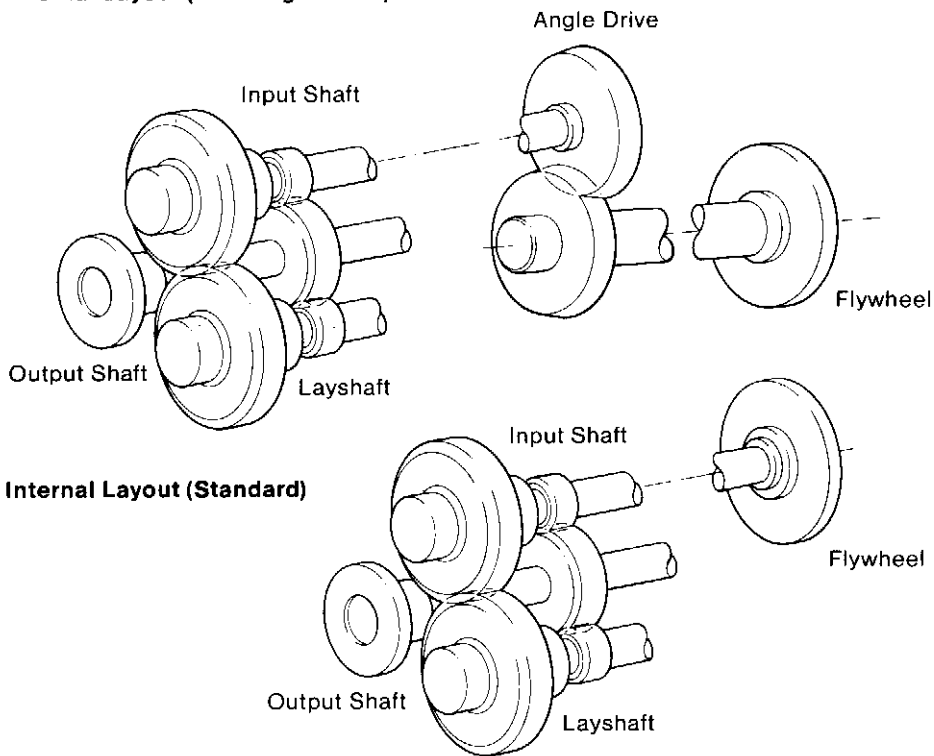


Fig. 2 Internal layout diagram

3.3 Gear train - Angle drive

The angle drive unit incorporates a pair of conical involute gears so arranged that the output shaft runs at an angle of 8° down relative to the input shaft; it also has the effect of reducing the centre line distance between the engine crankshaft and gearbox output shaft. The purpose of this is to enable the main gearbox to be mounted to the propulsion engine in such a way that the engine can be installed as near as possible to the horizontal whilst maintaining the required propeller shaft line.

Both input and output shafts are supported on bearings of adequate size for all Newage approved ratings.

3.4 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.

3.5 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.

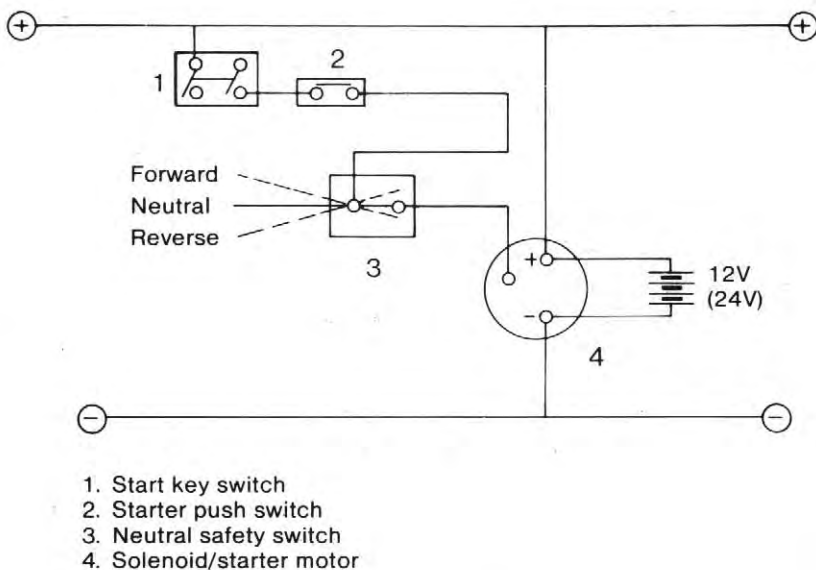


Fig. 3 Wiring diagram for neutral safety start device

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.

3.6 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) or with clockwise engines when an angle drive unit is fitted, the oil pump is fitted in its standard position. For clockwise engines, or anti-clockwise with angle drives the pump is turned through 180° to standard (see diagrams).

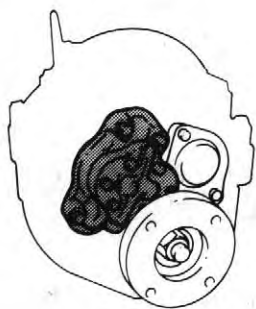


Fig. 4 Oil pump mounting
 - anti-clockwise engines
 (or clockwise with angle drive)

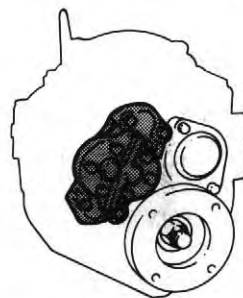


Fig. 5 Oil pump mounting
 - clockwise engines
 (or anti-clockwise with angle drive)

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

| | With Angle Drive | Without Angle Drive |
|----------------|---|---|
| Lever Backward |  |  |
| Lever Forward |  |  |

Engine Rotation Clockwise

| | With Angle Drive | Without Angle Drive |
|----------------|---|---|
| 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.

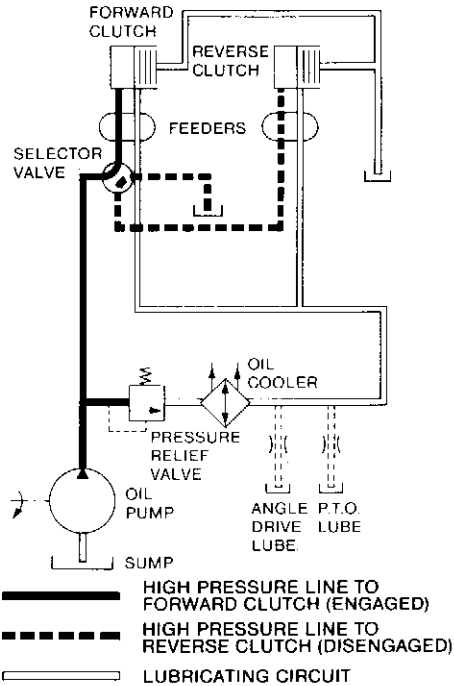


Fig. 6 Hydraulic and lubricating oil circuits

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 PRM401 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 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.

5.2 Checking the engine flywheel housing

Attach a dial test indicator, calibrated in units of 0.001 in. (0.025mm) 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 0.006 in. (0.152mm) 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 0.006 in. (0.152mm) total indicator reading.

5.3 Checking the engine flywheel

Attach a dial test indicator, calibrated to 0.001 in (0.025 mm) 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 0.005 in (0.125mm) 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 0.005 (0.125mm) total indicator reading.

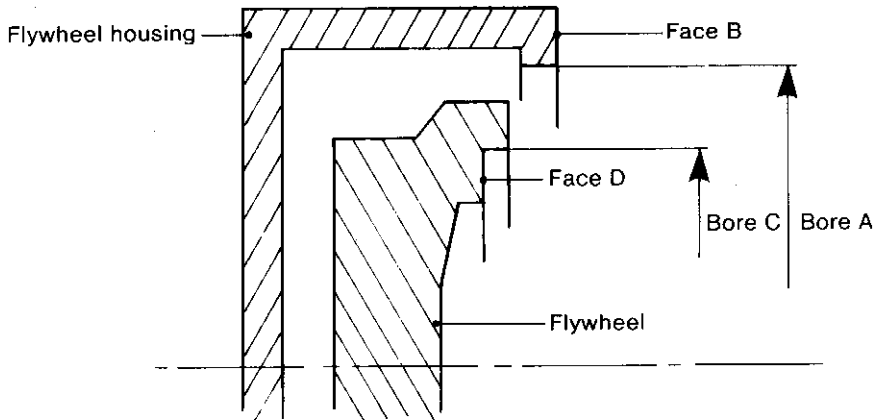


Fig. 7 Checking engine flywheel and flywheel housing

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 PRM401 gearboxes must be fitted with an oil cooler to maintain correct working temperatures. To permit a suitable cooler to be fitted, two 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.

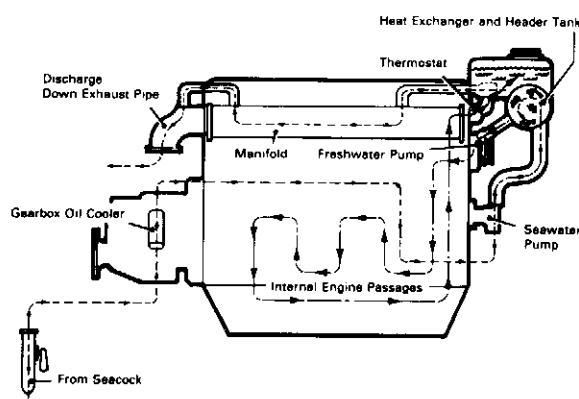


Fig. 8 Engine and gearbox cooling circuit

5.5.1 PRM401 standard gearbox

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.

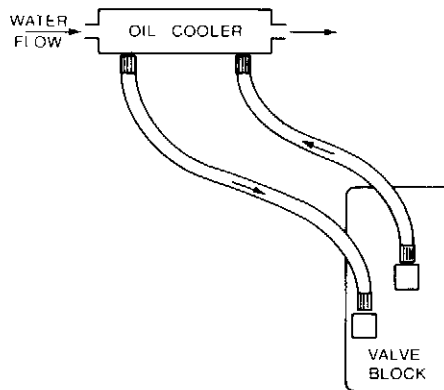


Fig. 9 Oil cooler connections PRM401

5.5.2 PRM401 with power take-off

Oil returned from the cooler to the valve block is first passed through the power take-off unit to provide lubrication and the method of connecting the cooling system is as follows:

- a) remove "Redcap" seals from the valve block.
- b) connect the valve block outlet to oil cooler inlet
- c) connect the oil cooler outlet to the P.T.O. inlet.
- d) complete the circuit by connecting the P.T.O. outlet to the valve block inlet.

The oil cooler can now be connected to the engine cooling system as outlined above.

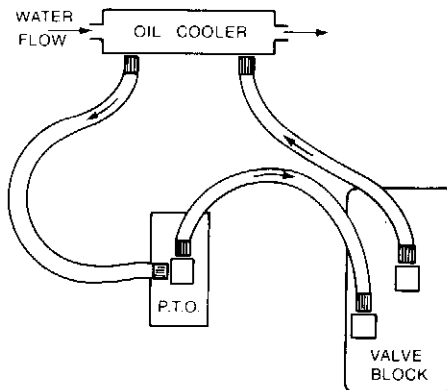


Fig. 10 Oil cooler connections PRM401 with power take-off

5.5.3 PRM401A (with angle drive)

Oil returned from the cooler to the valve block is first passed through the angle drive unit to provide lubrication and the method of connecting the cooling system is as follows:

- a) remove "Redcap" seals from the valve block.
- b) connect valve block outlet to oil cooler inlet.
- c) connect oil cooler outlet to the angle drive inlet.
- d) complete the circuit by connecting the angle drive outlet to the valve block inlet.

The gearbox oil cooler can now be connected to the engine cooling system as described above.

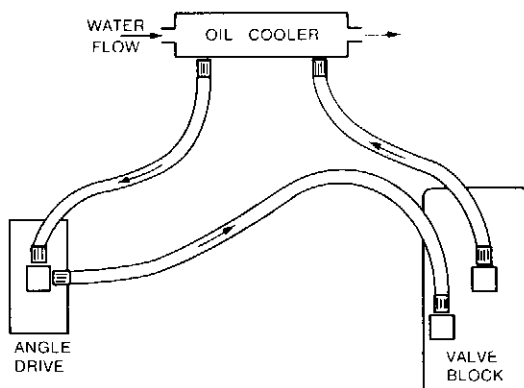


Fig. 11 Oil cooler connections PRM401A with angle drive

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, thereby enabling the correct alignment to 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.

In the case of the Newage PRM401A (angle drive) the transmission provides 8° down angle on the output shaft; it also has the effect of reducing the centre distance between the engine crankshaft and the gearbox output shaft, and enables the engine to be mounted nearer to the horizontal than would be the case with conventional in-line or drop centre transmissions. This has the effect of reducing the overall height required for installing the engine and will also help to prolong engine life.

5.8 Twin installation

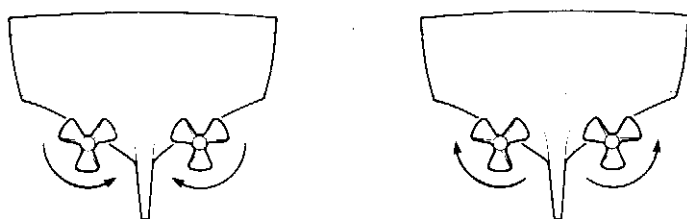
The rotation of a propeller, even in a single engine installation, tends to have a slight "turning" effect on the handling of the boat, but this can normally be corrected with very slight adjustments on the rudder.

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.

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

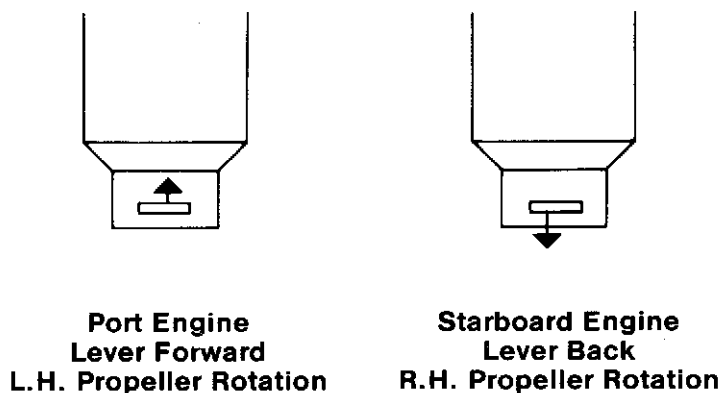
Therefore, in order to provide counter-rotation of the two propeller shafts in the correct direction for "ahead" drive, with both the remote control operating levers in the "ahead" position, the operating controls should be fitted so that the cable to the starboard gearbox moves the operating lever back,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



correct

incorrect

Fig. 12 Propeller rotation, twin installations



**Port Engine
Lever Forward**

L.H. Propeller Rotation

**Starboard Engine
Lever Back**

R.H. Propeller Rotation

Fig. 13 Operating cable entry, twin installations

Note: When an angle drive is fitted, lever movement will be reversed.

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: If the gearbox is fitted with an angle drive unit then the above operating lever movements are reversed.

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

6.2 Drive selection

The Newage PRM401 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 PRM401 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 PRM401 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 PRM401 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. Two different types of screws are used to secure the top cover; using one of the screws with the thinner head, screw it tightly into the threaded hole in the clutch plate directly below the groove.
4. Rotate the shaft through 180° and repeat the procedure as detailed in '3'.
5. Ensure that there is sufficient oil in the gearbox to avoid further damage and refit the top cover.
6. 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.
7. 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;
(right-hand shaft if angle drive is fitted).
 - for right-hand propeller rotation, the right-hand shaft;
(left-hand shaft if angle drive is fitted).

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 overleaf 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. |
| | | 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 boat.

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 9.10

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 fix 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. C14) has retained its correct free length (37.2mm, 1.463 ins) and if not, replace.
6. To assemble and refit the valve blocks, 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 6 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 Oil strainer

The gearbox oil strainer is situated in the sump and is attached to the end of the oil suction pump feeding the pump. It may be removed for inspection or cleaning, as follows:

1. Remove drain plug and washer in the bottom of gearbox, and withdraw strainer.
2. With the strainer removed, it may be washed in paraffin or suitable fluid to remove any debris which has become attached to the strainer.
3. To refit, reverse the procedure as described above.

9.4 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.

9.5 Removing the input shaft and layshaft assemblies

With normal installations, the layshaft assembly can be removed with the gearbox still installed in the boat, but the input shaft requires the gearbox to be removed from the engine. 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 3 bolts securing the drive shaft and 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. Lift the layshaft assembly and front end cover from the gearcase.

The input shaft assembly requires to be removed using the following procedure:

1. Remove gearbox from boat as described in section 9.4.
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.

9.6 Servicing Input Shaft and Layshaft Assembly Components

9.6.1 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 D27) in the housing and refit the housing.

9.6.2 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, thrust washer, thrust bearing, and end 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 thrust washer, thrust 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.
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.

9.6.3 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 and bearing as previously described.
2. Remove spacer, needle roller bearing, spacer, needle roller bearing.
3. Unlock and remove 3 nuts (item D33) securing the clutch end plate.
4. Withdraw the complete clutch assembly from the shaft noting the position of the pull off springs.
5. Remove snap ring, thrust washer, and thrust bearing and inspect for wear or damage and replace where necessary.

To rebuild the clutch assembly, the procedure is as follows:

6. Position shaft upright and locate the 3 assembly bolts through clutch gear.
7. Replace thrust bearing, thrust washer and snap ring.
8. Fit the clutch end plate (item D11) into the clutch gear and replace pull-off springs over the assembly bolts. Then, starting with one of the driven clutch plates (item D9), build up the replacement clutch onto the clutch end plate.
9. Replace the clutch end cover (item D7) onto the clutch pack, replace securing nuts and tighten with a torque spanner set a 12.2Nm (1.2Kgm, 9 lbf.ft).
10. Replace the drive pinion into the clutch pack until it touches the bottom washer.
11. Replace needle roller bearing, spacer, needle roller bearing and spacer.
12. Replace the thrust bearing, thrust washer and bearing inner cone on the shaft and gently drive the bearing into position.

9.6.4 Clutch gear

To fit a new clutch gear (item D18) first remove clutch pack as previously described in section 9.6.3, and proceed as follows:

1. Unlock and remove 12 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.

9.6.5 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 9.6.2.

9.6.6 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.

9.6.7 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. 13).
6. Compress each ring in turn and carefully fit the new feeders and spacers.

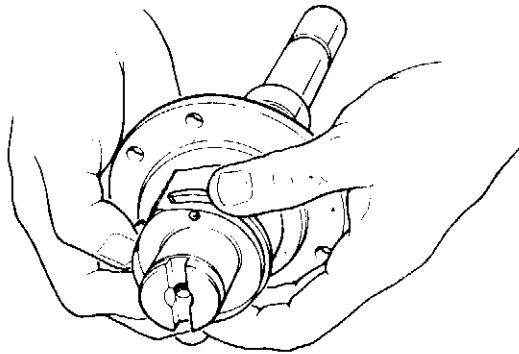


Fig. 14 Piston ring fitting procedure

9.7 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

9.8 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 nut (F15) at output coupling (F17) and remove coupling and 'O' ring (F18) if fitted.

NOTE 'O' ring (F18) only fitted on gearboxes built after January 1983.

3. Using a magnet, remove input end cover (F2), release tab washer (F4) and slacken nut (F3).
4. To remove shaft, drive or press shaft on front end, and rear end bearings and shaft can be removed at rear of gearbox leaving front end bearings, gear, spacers and centre bearing behind.
5. All bearings and rear oil seal (F14) can be removed and inspected for wear or damage.
6. If either of the thrust bearings are worn, remove both outer races, spacer and circlip from gearcase.

Note: The main thrust bearing assembly (F11) is supplied as a pre-adjusted unit, and if either bearing is worn or damaged, the complete assembly MUST be replaced.

7. If either of the bearings are worn, the output gear (F9) and mating pinions should also be inspected.
8. Assembly of the output shaft is the reverse of the above and is best carried out as follows:
9. Assemble the main thrust bearings (F11) to the gearcase, then assemble the shaft from the rear, through the thrust bearings. If necessary, tap the shaft on its end.
10. Feed spacer (F10), drive gear (F9), spacer (F8), bearing (F6), spacer (F5) and tab washer (F4) onto the shaft as it is pushed towards the input end.
11. Tighten nut (F3) to 339 Nm (34.58 Kgfm - 250 lbf ft), bend over tab washer (F4) and fit end cover (F2) together with 'O' ring (F1).
12. Fit new rear end oil seal (F14) and replace coupling (F17).

NOTE: If 'O' ring (F18) is fitted also renew.

13. Tighten rear end nut (F15) to 339 Nm (34.58 Kgfm - 250 lbf ft).

Note: 4:1 ratio only - when refitting shaft assembly into the gearbox, ensure match markings are re-aligned. Match markings are on shaft (F13) and output gear (F9).

9.9 Shimming procedures

The allowable end float on the taper bearing is 0.03 - 0.08mm (0.001 - 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. 15.
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.

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).

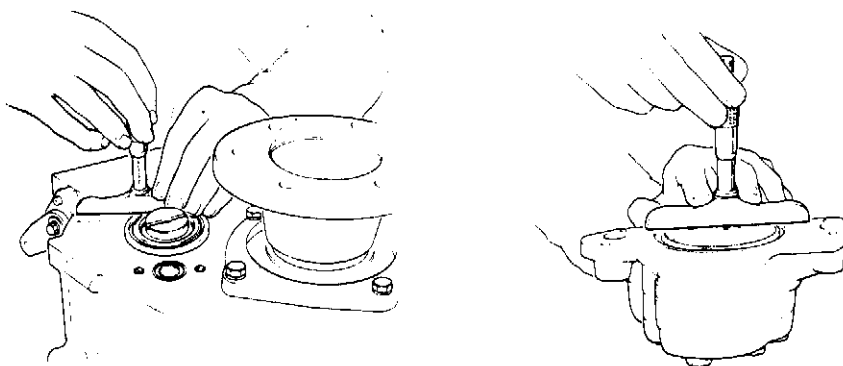


Fig. 15 Shimming procedure

10. POWER TAKE-OFF UNIT

10.1 To fit a P.T.O. unit to an existing gearbox

1. Remove end cover (A10) from rear face of gearbox, taking care not to lose shims, and replace shims against bearing outer race. (Use grease if required).
2. Fit spacer (H5) and drive gear (H4) to end of splined shaft, which protrudes from rear of gearbox.
3. Fit spacer (H7) into recess in gear and locking tab into hole in face of the gear.
4. Tighten screw (H9) to 101.5 Nm (10.35 Kgfm - 75 lbf.ft) and bend up locking tab.
5. Pass the P.T.O. unit over the gear (H4) and push against rear face of gearbox, ensuring that shims do not drop down and are located in recess in P.T.O. housing. Also ensure that 'O' ring remains in groove in P.T.O. housing and does not become trapped.
6. Tighten bolts (H11) into rear face of gearbox to 101.5 Nm (10.35 Kgfm - 75 lbf.ft).
7. Fit oil pipe assembly (H23) as shown on the installation drawing, between the 'T' piece on the P.T.O. housing and the connector on the valve block.
8. Fit hydraulic pump to P.T.O. unit.

10.2 To repair an existing P.T.O. unit

1. Removal of the unit is the reverse of that described in (10.1) above.
2. The output gear assembly (H2) can be removed without removing the P.T.O. unit from the gearbox. Remove hydraulic pump from P.T.O. and slacken screws (H19/H20). Pull out housing (H13/J13) and the gear (bearing assembly will remain with the housing).
3. To remove the output gear, (H2) remove circlip (H21) and tap gear on the end face to remove from bearing (H12).
4. The bearing (H12) can be removed by removing circlip (H15) and pressing or drifting out bearing.
5. If needle bearing (H3) is worn or damaged, it is best replaced when the P.T.O. housing is removed from the gearcase.
6. If the drive gear (H4) is removed from the gearbox shaft, then tab washer (H8) MUST be replaced.
7. Assembly is the reverse of all above and that described in (10.2) above.

11. 8° DOWN-ANGLE DRIVE UNIT

11.1 Retrofitting unit to an existing 40l gearbox

1. Remove the gearbox from the engine and separate from the adaptor plate as previously described.
2. Withdraw the output shaft front cover (F2) and input shaft seal housing (D28).
3. The output shaft cover (F2) must be replaced by spacer (G11) supplied with the angle drive unit. The spacer (G8) at the "top" of the angle drive locates in the front bore of the main gearbox.
4. Remove the oil pump assembly, turn through 180° and bolt in position, ensuring that the 'O' ring remains in its groove and the shims remain in the pump recess.
5. Grease gasket (G9) and fit to the front face of the main gearbox. Offer the angle drive up to the main gearbox, locate the splined shaft and tighten bolts (G10/G12) to 101.5 Nm (10.35 Kgfm - 75 lbf.ft).
6. Screw the metering union (G19) into the top of the angle drive, fit 'T' piece (G21) and oil pipe, (G20).
(see circuit and piping diagrams).
7. Connect the other end of the oil pipe to the fitting on the valve block.
8. Bolt the adaptor to the front face of the angle drive. Tighten bolts to 101.5 Nm (10.35 Kgfm - 75 lbf.ft).
9. Fit new dipstick to main gearbox and fill with oil.

Note: When an angle drive unit is fitted, the gearbox output rotation will be reversed. It is therefore necessary to reverse the control lever movement to give correct output rotation for 'ahead' or 'astern'.

11.2 Replacement of angle drive gears and bearings

1. Remove the unit from the main gearbox, as the reverse of that described in (11.1) above.
2. Remove bolt (G3) (1 off) and insert withdrawal screws to split the 2 halves of the gearcase.
3. Remove input seal housing (G17) and shims; also remove spacer (G8) and shims at the output gear rear face.

Note: Take care not to mix the input and output shims.

4. All bearings and gears are now free for "inspection". If damage or wear has taken place on any bearing, then it is recommended that all four are replaced. Also, the gears should be inspected if bearing wear has taken place. If gear replacement is required, it is advisable to replace both.
5. The bearing outer races can be easily pulled out of the housing, but a puller will be required to remove the inner races from the gears.

6. To re-assemble the unit, assuming new bearings and/or gears, first press the bearing inner races to the gears and push the outer races into the housing halves.
7. Locate the input gear on the rear case half and the output gear on the front half.
8. Coat the mating faces on the case-halves with "jointing" compound and bring the two halves together, ensuring dowels (G6) are properly located.
9. Tighten bolts (G3) (G12) to a torque of 101.5 Nm (10.35 Kgfm - 75 lbf.ft).
10. To shim input shaft bearings, proceed as follows:-

Note: Shimming is best done prior to fitting oil seal (G18) or 'O' ring; (G16) and with the unit horizontal on a flat surface.

- a) Push in seal housing (G17) against bearing outer race.
 - b) Apply hand pressure to spacer or place a weight of approximately 5 Kg on top of the spacer and turn shaft to seat the bearings.
 - c) Measure "step" between gearcase face and lower face of the housing with a depth micrometer or vernier.
 - d) Lift out housing and place shims of the value found in (c), below the housing.
 - e) Fit seal and 'O' ring to the housing and replace.
11. The output shaft bearings can be shimmed as follows:-
 - a) On a similar basis to the input shaft, apply hand pressure or a weight to the spacer, (G8) which is already located in the output bore.
 - b) Rotate the shaft to seat the bearings and measure the gap between the face of the gearcase and the face of the spacer which is just below the gearcase face. (Use a depth micrometer or vernier as before).
 - c) Lift out spacer, insert shims to value found in (b) and replace the spacer.
 12. Refit the angle drive unit to the main gearbox as described in the section on "retrofitting".

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 | 29.4 | 21.7 | 3.00 |
| End cover to valve block (loctite) | 9.5 | 7 | 0.97 |
| 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 | 339.0 | 250 | 34.58 |
| Top cover to upper gearcase | 30.0 | 22 | 3.04 |
| Adaptor plate to gearbox | 101.5 | 74.9 | 10.35 |
| Output shaft bearing retaining nut (input end) | 339.0 | 250 | 34.38 |
| Clutch securing nuts | 12.2 | 9 | 1.24 |
| P.T.O. to rear gearcase | 101.5 | 75 | 10.35 |
| Angle drive to front gearcase | 101.5 | 75 | 10.35 |

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

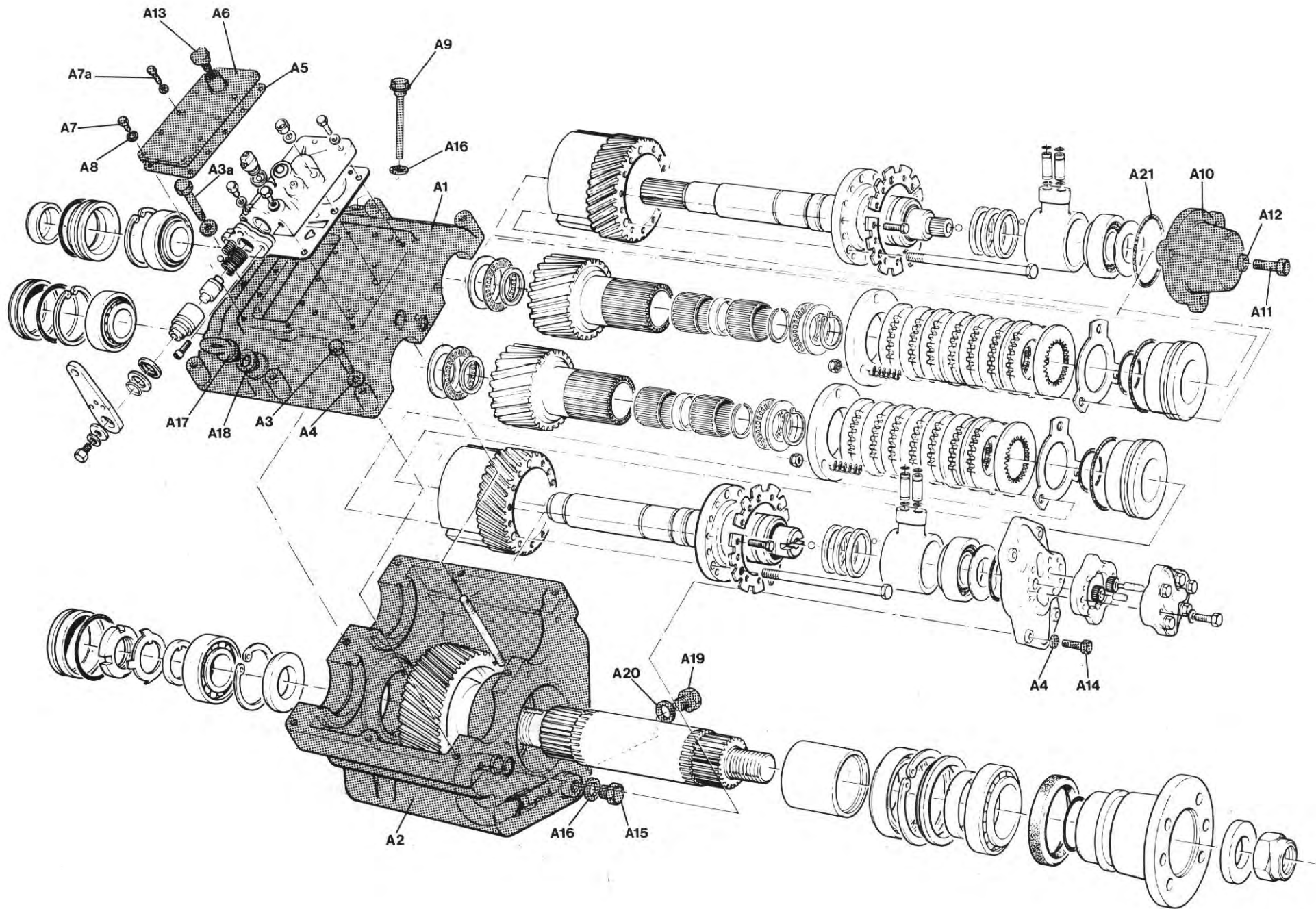
- 1 Individual items which form part of an assembly, or main components, are indented and may be supplied separately; if the assembly is ordered all components pertaining to that assembly are supplied. For example, if the 'clutch input shaft' assembly is ordered the shaft itself and every item called 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:

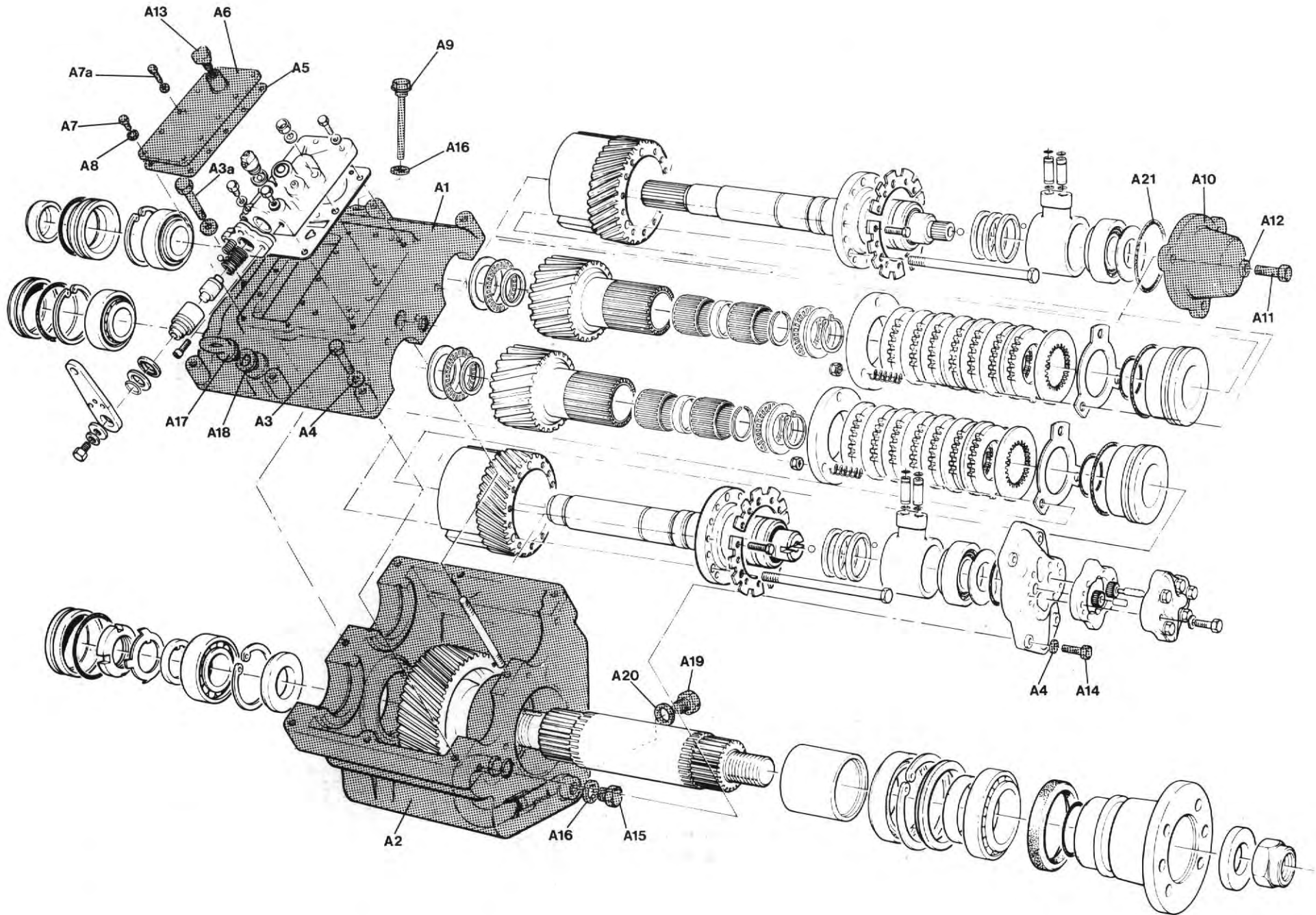
NEWAGE TRANSMISSIONS LIMITED
BARLOW ROAD
COVENTRY CV2 2LD
ENGLAND

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

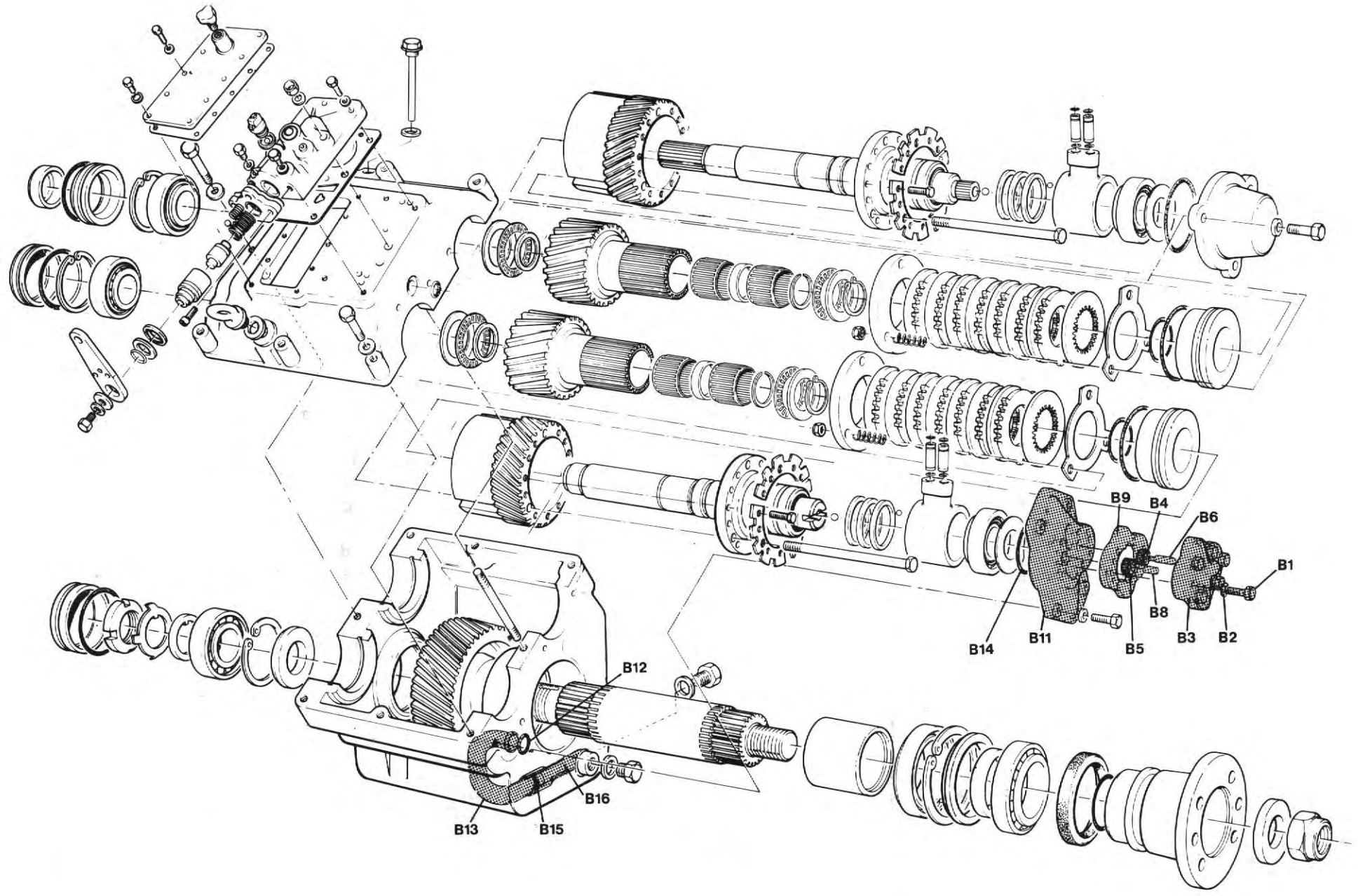
Spare Parts List



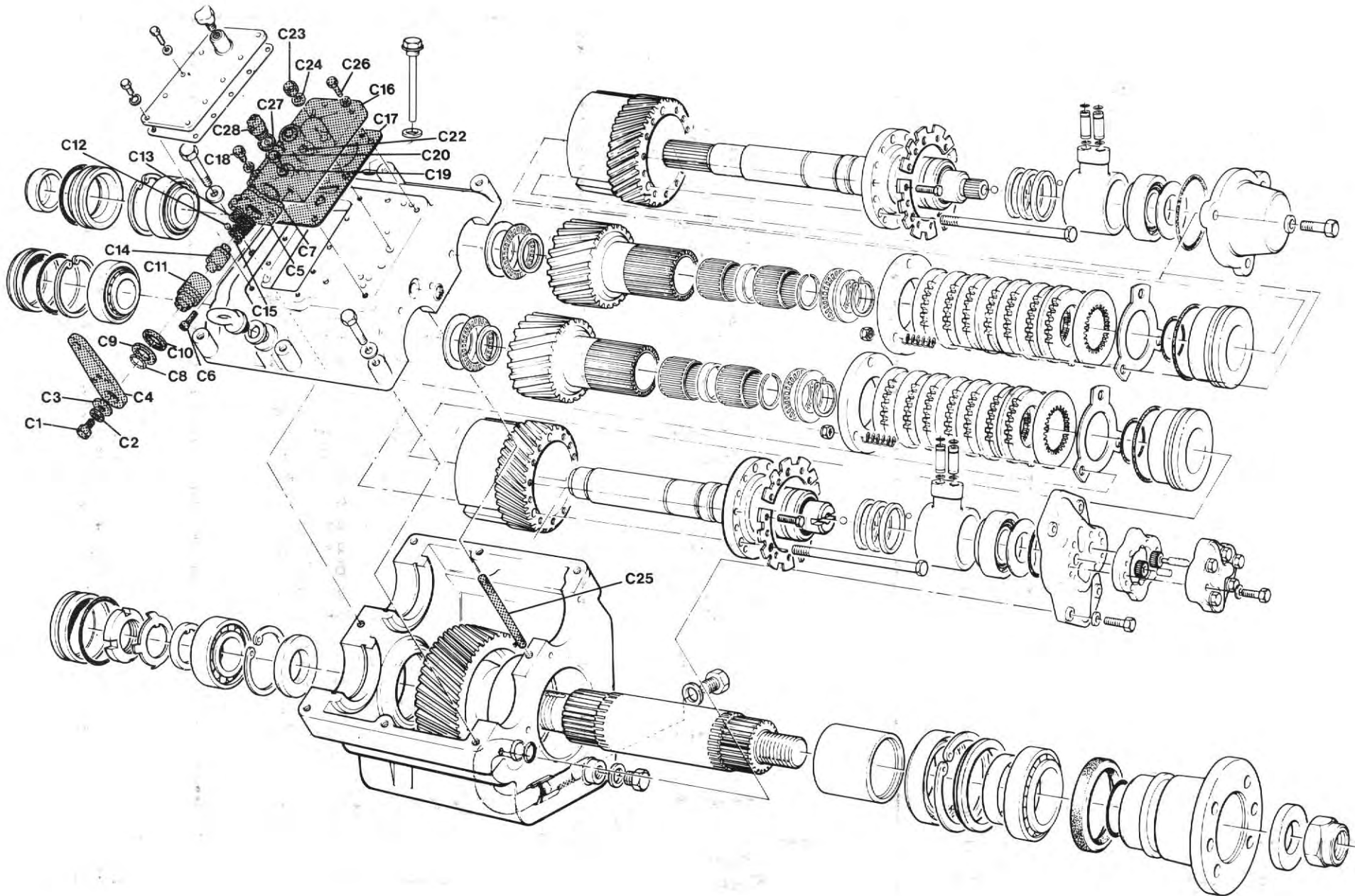
| Plate Ref. | Description | PRM401 Part No. | Qty. | Remarks |
|------------|-----------------------|--------------------|------|-------------------------|
| A | GEARCASE ASSEMBLY | | | |
| | Case sub-assembly | MT0204 | 1 | Supplied complete only |
| A1 | Gearcase - top | MT1284 | 1 | Not supplied separately |
| A2 | Gearcase - bottom | MT1244 | 1 | Not supplied separately |
| A3 | Bolt | 0041014 | 6 | |
| A3a | Bolt - case halves | 0041019 | 1 | |
| A4 | Washer | 0201706 | 11 | |
| A5 | Gasket (top cover) | MT343 | 1 | |
| A6 | Top Cover | MT1203 | 1 | |
| A7 | Screw | 0040804 | 8 | |
| A7a | Screw | MT1283 | 2 | |
| A8 | Washer | CP1223 | 10 | |
| A9 | Dipstick | MT472 | 1 | |
| A10 | End cover | MT1267 | 1 | |
| A11 | Screw | 0041208 | 3 | |
| A12 | Washer - spring | 0191107A | 3 | |
| A13 | Breather | CP1057 | 1 | |
| A14 | Bolt | 0041010 | 4 | |
| A15 | Drain plug - magnetic | CP1331 | 1 | |
| A16 | Washer (dipstick) | CP1068 | 2 | |
| A17 | Eyebolt | CP1339 | 1 | |
| A18 | Washer - eyebolt | 0201609 | 1 | |
| A19 | Drain plug | 0150100 | 1 | |
| A20 | Washer - drain plug | 0201720 | 1 | |
| A21 | 'O' Ring - rear cover | 0430771 | 1 | |



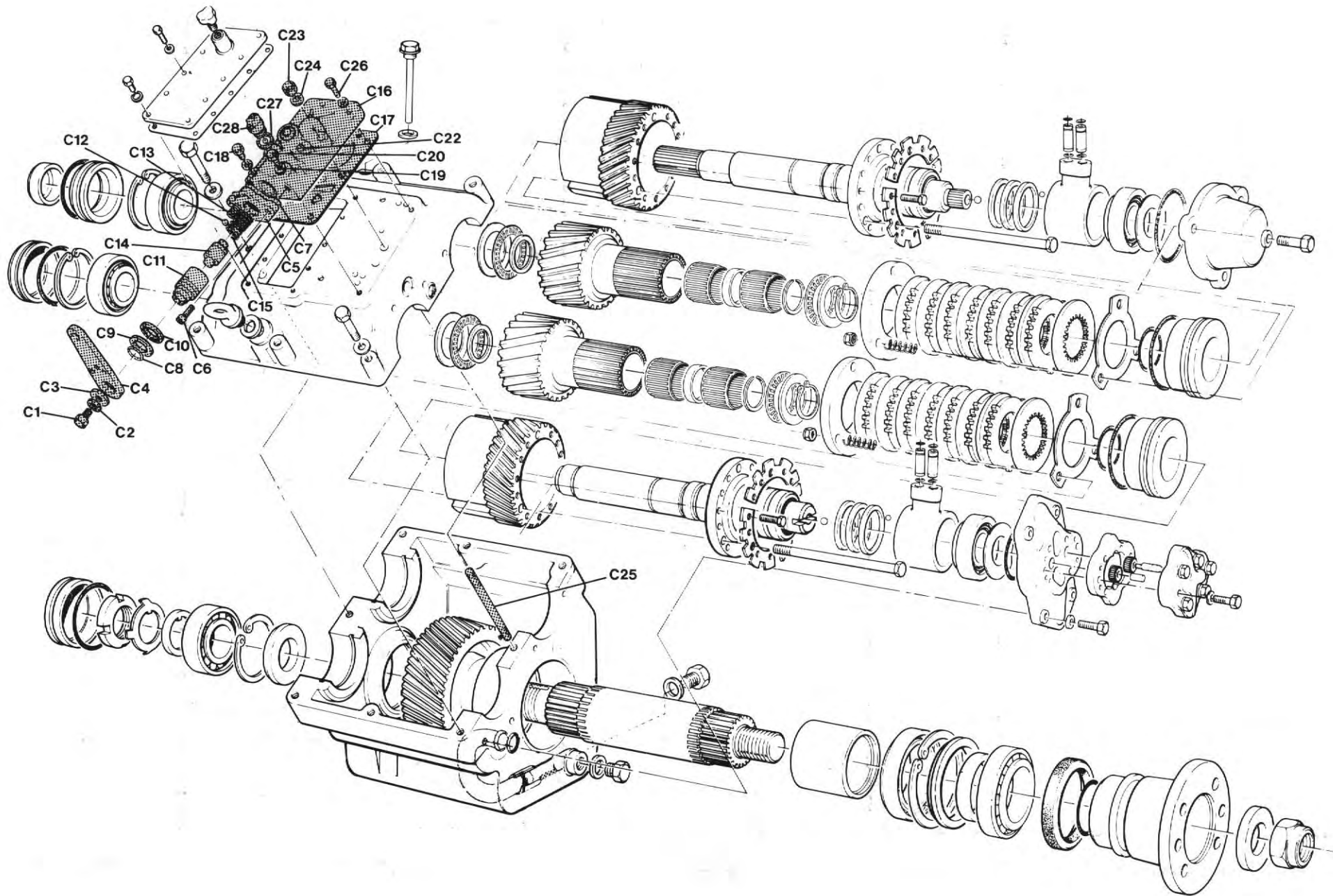
| Plate Ref. | Description | PRM401 Part No. | Qty. | Remarks |
|---|--|--|-------------------------------------|---|
| <p>Note:-</p> <p>A1</p> <p>A2</p> <p>A9</p> | <p>For 4:1 Ratio only:-</p> <p>Case sub-assembly</p> <p>Gearcse - top</p> <p>Gearcase - bottom</p> <p>Dipstick</p> | <p>MT0248</p> <p>MT1284</p> <p>MT1327</p> <p>0800925</p> | <p>1</p> <p>1</p> <p>1</p> <p>1</p> | <p>Supplied complete only</p> <p>Not supplied separately</p> <p>Not supplied separately</p> |



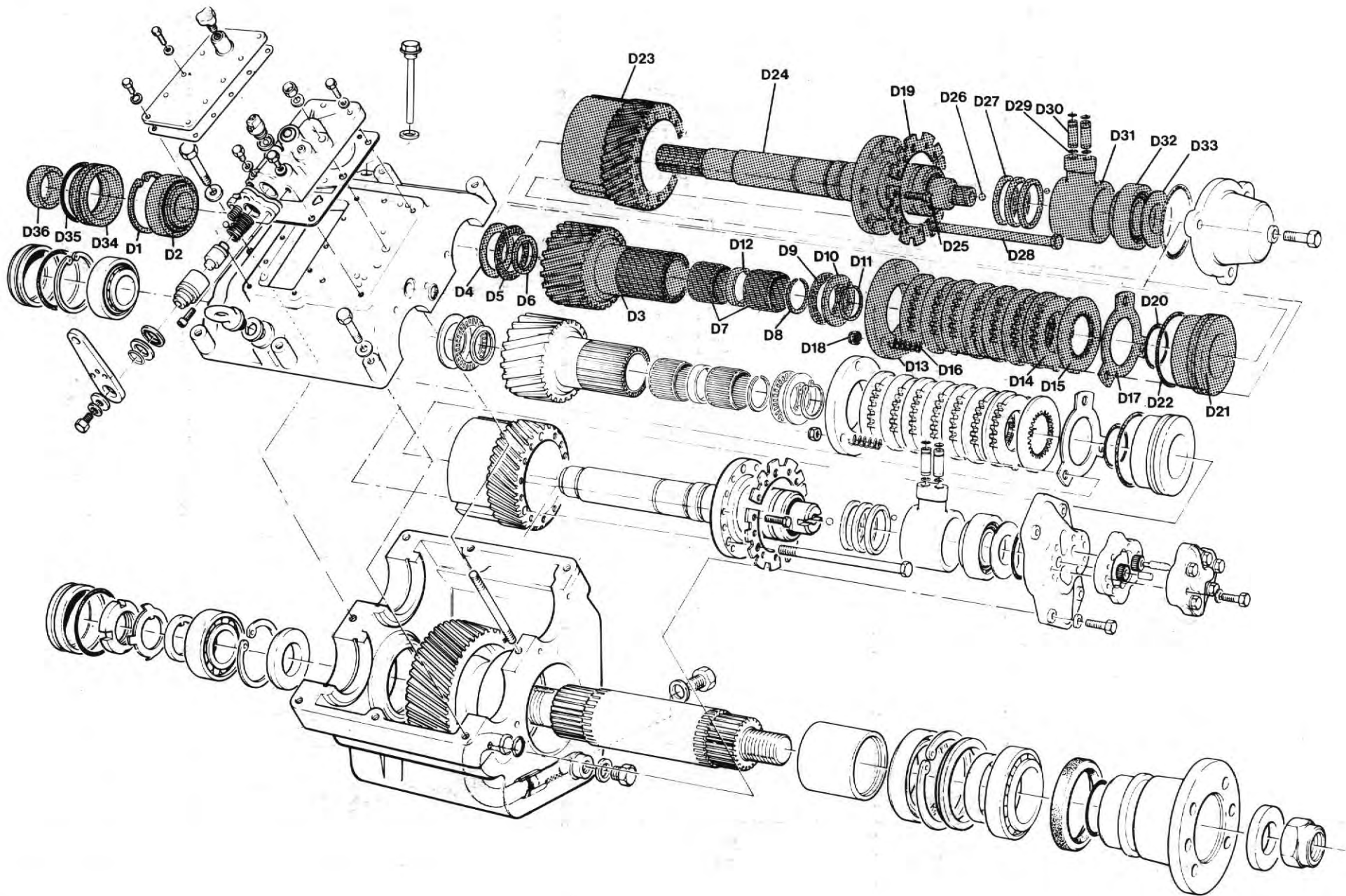
| Plate Ref. | Description | PRM401 Part No. | Qty. | Remarks |
|------------|-----------------------------|--|------|---------------------|
| B | OIL PUMP ASSEMBLY | MT0200 <i>MT0294 complete</i> | 1 | |
| B1 | Bolt | 0040811 | 6 | |
| B2 | Washer | CP1223 | 6 | |
| B3 | Pump cover | MT321 | 1 | |
| B4 | Pump gear driver | MT379 | 1 |)Part of MT4544 S/A |
| B5 | Pump gear driven | MT379 | 1 |)MT0115 |
| B6 | Pump spindle | MT4544 | 1 | Part of MT4544 S/A |
| B8 | Pump spindle | MT378 | 1 | MT0115 |
| B9 | Pump plate | MT372 | 1 | |
| B10 | Dowel | MT417 | 2 | |
| B11 | Adaptor | MT1256 | 1 | |
| B12 | O ring | 001254 | 2 | |
| B13 | Oil Pipe | MT1265 | 1 | |
| B14 | O ring | 003383 | 1 | |
| B15 | O ring | 000872 | 1 | |
| B16 | Strainer | MT4547 | 1 | |
| | Note:- For 4:1 Ratio only:- | | | |
| B13 | Oil pipe | MT1376 | 1 | |



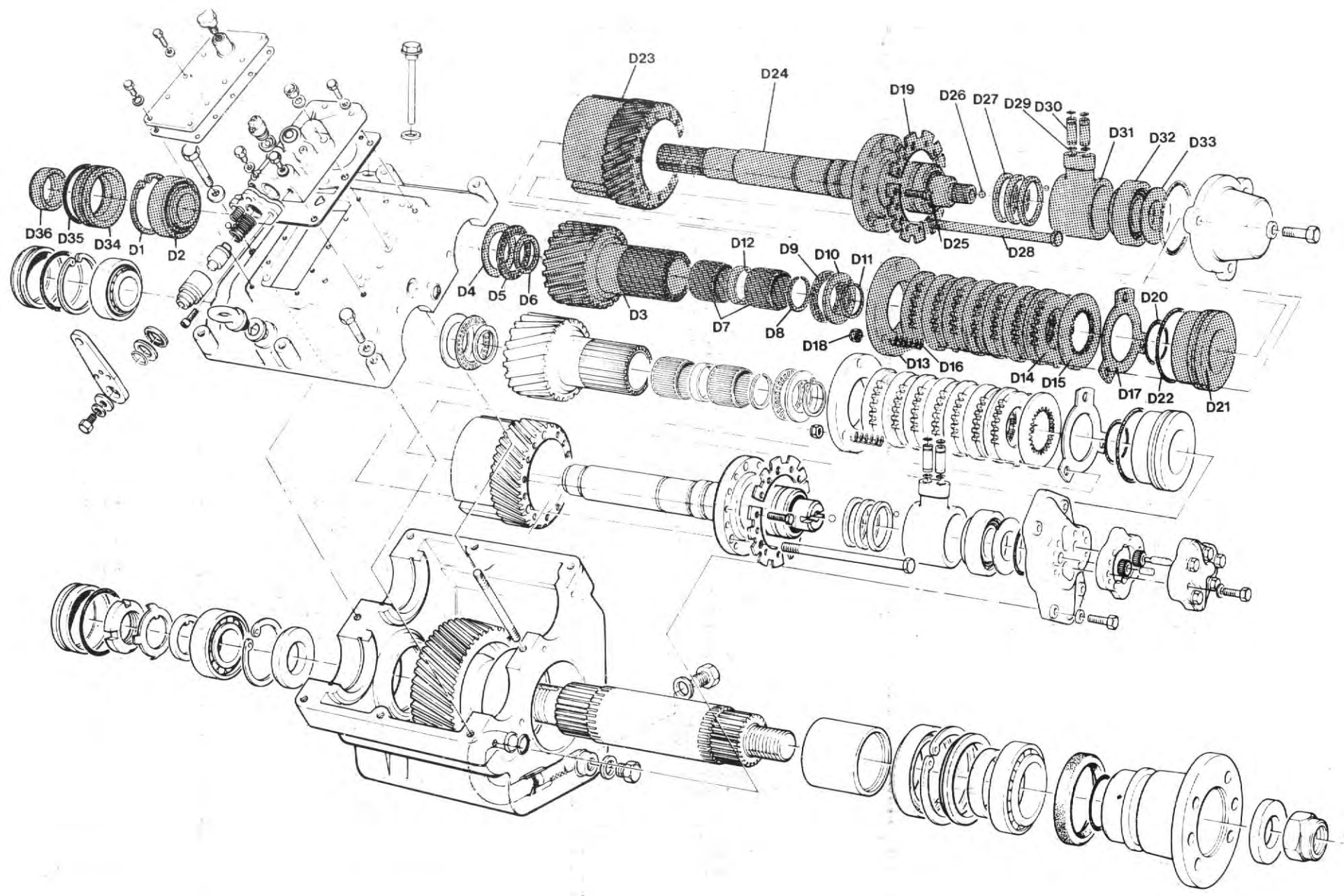
| Plate Ref. | Description | PRM401 Part No. | Qty. | Remarks |
|------------|----------------------|--------------------|------|---|
| C | VALVE BLOCK ASSEMBLY | MT0182 | 1 | MT0157 if Neutral Safety Switch fitted |
| C1 | Screw | 0040806 | 1 | |
| C2 | Spring washer | 0191105 | 1 | |
| C3 | Washer | 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 | Relief valve | MT980 | 1 | |
| C15 | Valve spring | MT4657 | 1 | |
| C16 | Valve block | MT4739 | 1 | |
| C21 | Redcap seal | MT477 | 2 | (Transit only) |
| C22 | Pressure plug | MT311 | 1 | |
| C17 | Gasket | MT1073 | 1 | |
| C18 | Bolt | 0040812 | 1 | |
| C19 | Washer | CP1223 | 5 | |
| C20 | Bolt | 0040815 | 1 | |
| C23 | Nut | 0051001 | 1 | |
| C24 | Washer | 0201706 | 1 | |
| C25 | Stud | MT1292 | 1 | |
| C26 | Screw | 0040808 | 3 | |
| C27 | Washer | 0201715 | 1 | Also used in MT0214 Neutral Safety Switch Retro-fit Kit |



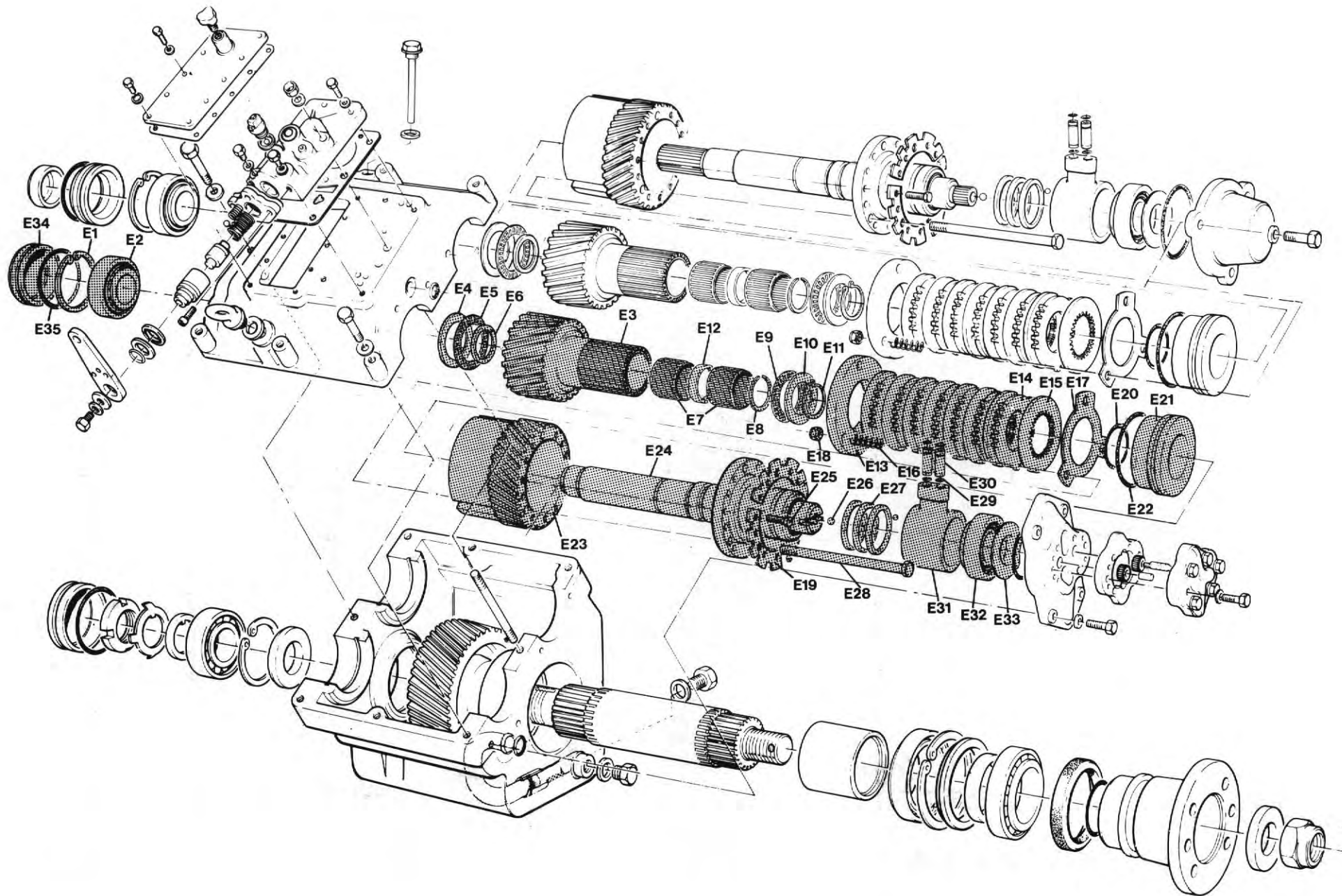
| Plate Ref. | Description | PRM401 Part No. | Qty. | Remarks |
|------------|----------------|--------------------|--------|---|
| C28 | Plug | CP1360 | 1 | |
| C28 | Switch Ball | CP1358 CP1077 | 1 1 |)Neutral Safety Switch)Retro-fit Kit MT0214 |
| | | | | |



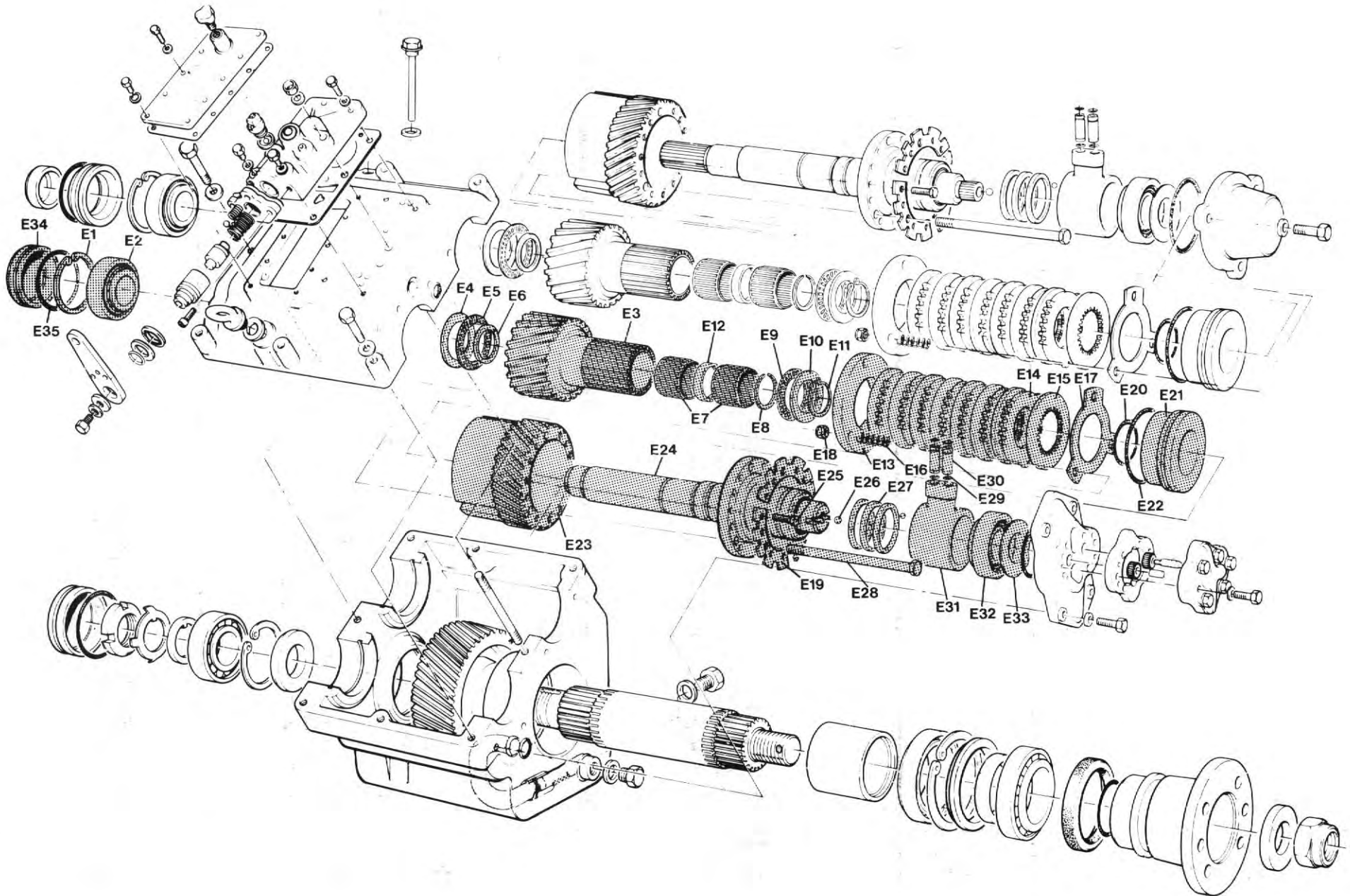
| Plate Ref. | Description | PRM401 Part No. | Qty. | Remarks |
|------------|---------------------------------|-----------------------------------|------|--|
| D | INPUT SHAFT ASSEMBLY <i>for</i> | <i>Inline variants see MT0279</i> | | |
| D1 | Circlip | CM2077 | 1 | |
| D2 | Taper roller bearing | 0540301 | 1 | |
| D3 | Drive Pinion | MT1473 | 1 | 1:1 43 teeth |
| | | MT1474 | 1 | 1.5:1 37 teeth |
| | | MT1475 | 1 | 2:1 31 teeth |
| | | MT1476 | 1 | 2.5:1 23 teeth |
| | | MT1477 | 1 | 3:1 21 teeth |
| | | MT1477 | 1 | 4:1 21 teeth |
| D4 | Thrust washer | 0673801 | 1 | |
| D5 | Thrust bearing | 0603801 | 1 | |
| D6 | Spacer | MT1471 | 1 | |
| D7 | Needle roller bearing | 0563501 | 2 | |
| D8 | Snap ring | 0300350 | 1 | |
| D9 | Thrust bearing | 0603501 | 1 | |
| D10 | Thrust washer | 0673502 | 1 | |
| D11 | Circlip | 0330350 | 1 | |
| D12 | Spacer | MT1472 | 1 | |
| | Clutch pack | MT0298 | 1 | |
| D13 | Clutch end cover | MT1282 | 1 | |
| D14 | Clutch plate driven | MT982 | 7 | |
| D15 | Clutch plate driver | MT725/S | 8 | |
| D16 | Spring | MT1067 | 3 | Not supplied separately |
| D17 | End plate | MT983 | 1 | |
| D18 | Nut | 0050606HT | 3 | |
| D19 | Tab washer | MT1289 | 3 | |
| D20 | Piston O ring | 0421503 | 1 | |
| D21 | Piston | MT1264 | 1 | |
| D22 | Piston O ring | 003504 | 1 | |
| D23 | Clutch gear | MT1286 | 1 | |
| D24 | Input shaft | MT1321 | 1 | Supplied as MT1321S/A including 066MO50 |



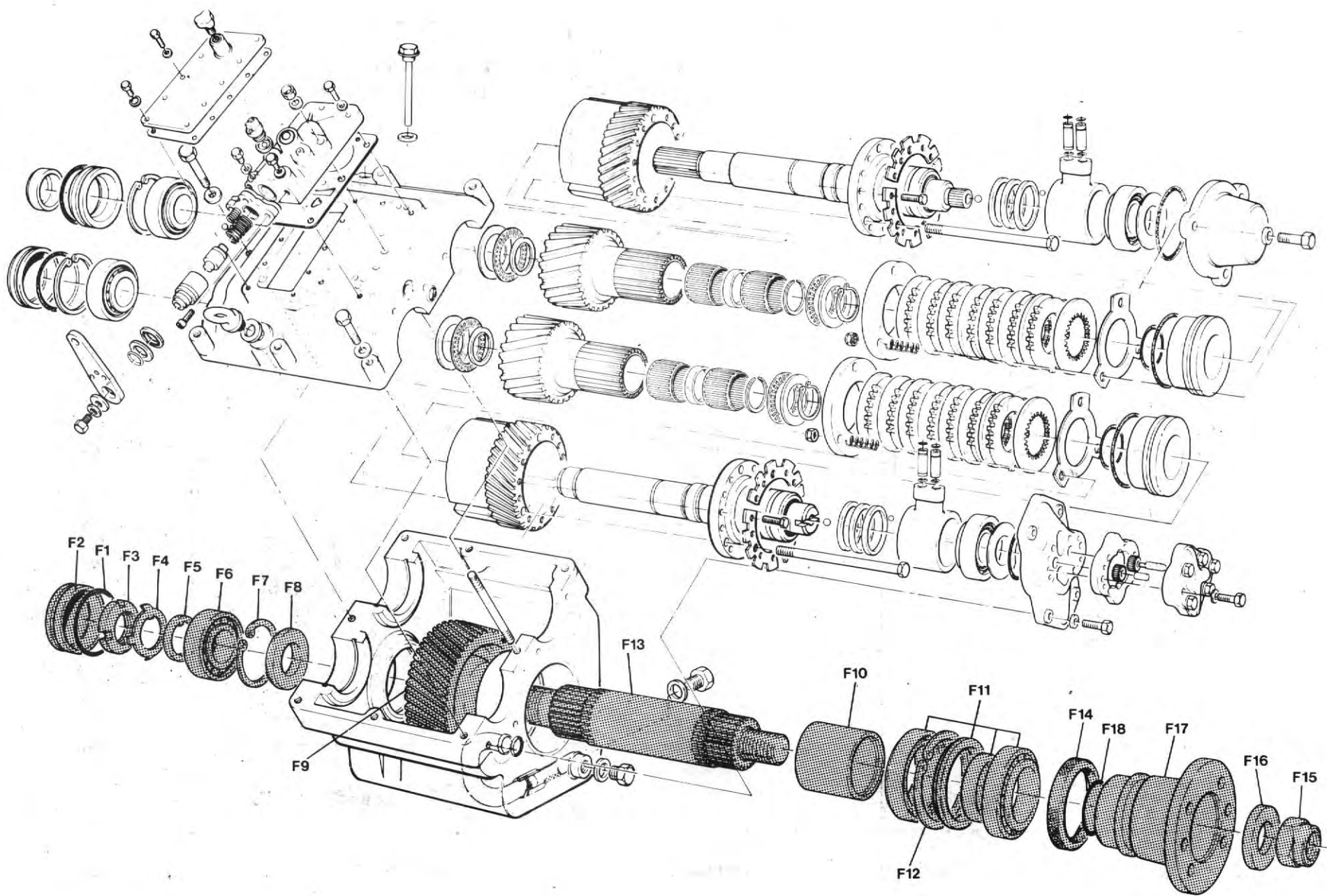
| Plate Ref. | Description | PRM401 Part No. | Qty. | Remarks |
|------------|----------------------|--------------------|------|------------------|
| D25 | Bolt | 0040609HT | 12 | |
| D26 | Ball | 066M050 | 1 | |
| D26a | Ball | CP1191 | 1 | |
| D27 | Piston ring | MT292 | 3 | |
| D28 | Bolt | MT1290 | 3 | |
| D29 | O ring | 000372 | 4 | |
| D30 | Connector | MT1057 | 2 | |
| D31 | Feeder | MT380 | 1 | |
| D32 | Taper roller bearing | .0540351 | 1 | |
| D33 | Shim 0.002" | MT1077/02 | | As required |
| D33 | Shim 0.010" | MT1077/10 | | As required |
| D33 | Shim 0.031" | MT1077/31 | | As required |
| D34 | End cover | MT1068 | 1 | Not used |
| D35 | O ring | 002874 | 1 | when angle drive |
| D36 | Oil seal | MT251 | 1 | is fitted |



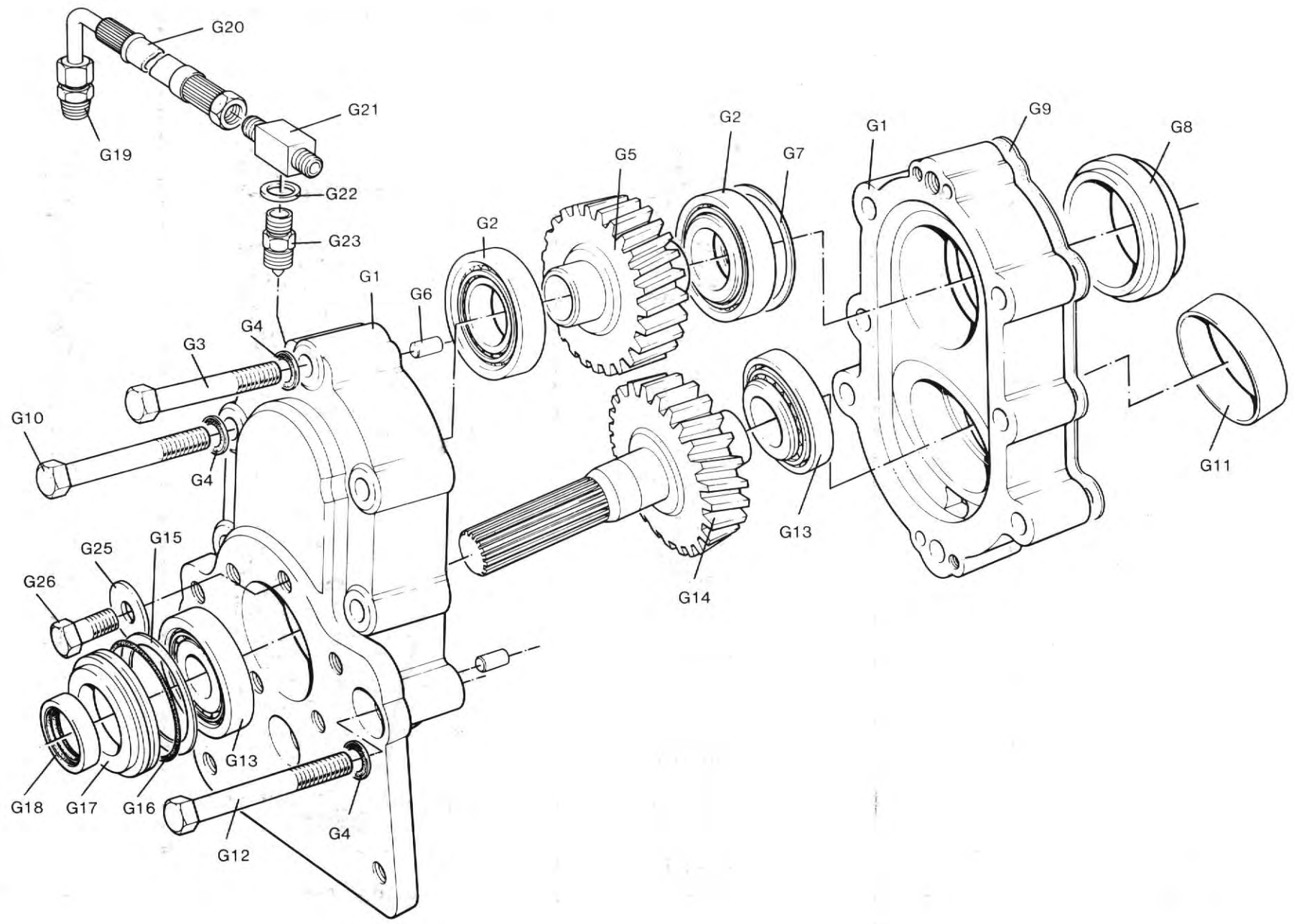
| Plate Ref. | Description | PRM401 Part No. | Qty. | Remarks |
|------------|-----------------------|--------------------|------|--|
| E | LAYSHAFT ASSEMBLY | | | |
| E1 | Circlip | CM2077 | 1 | |
| E2 | Taper roller bearing | 0540301 | 1 | |
| E3 | Drive Pinion | MT1473 | 1 | 1:1 43 teeth |
| | | MT1474 | 1 | 1.5:1 37 teeth |
| | | MT1475 | 1 | 2:1 31 teeth |
| | | MT1476 | 1 | 2.5:1 23 teeth |
| | | MT1477 | 1 | 3:1 21 teeth |
| | | MT1477 | 1 | 4:1 21 teeth |
| E4 | Thrust washer | 0673801 | 1 | |
| E5 | Thrust bearing | 0603801 | 1 | |
| E6 | Spacer | MT1471 | 1 | |
| E7 | Needle roller bearing | 0563501 | 2 | |
| E8 | Snap ring | 0300350 | 1 | |
| E9 | Thrust bearing | 0603501 | 1 | |
| E10 | Thrust washer | 0673502 | 1 | |
| E11 | Circlip | 0330350 | 1 | |
| E12 | Spacer | MT1472 | 1 | |
| | Clutch pack | MT0298 | 1 | |
| E13 | Clutch end cover | MT1282 | 1 | |
| E14 | Clutch plate driven | MT982 | 7 | |
| E15 | Clutch plate driver | MT725/S | 8 | |
| E16 | Spring | MT1067 | 3 | Not supplied separately |
| E17 | End plate | MT983 | 1 | |
| E18 | Nut | 0050606HT | 3 | |
| E19 | Tab washer | MT1289 | 3 | |
| E20 | Piston O ring | 0421503 | 1 | |
| E21 | Piston | MT1264 | 1 | |
| E22 | Piston O ring | 003504 | 1 | |
| E23 | Clutch gear | MT1286 | 1 | |
| E24 | Laysahft | MT1260 | 1 | Supplied as MT1260S/A including 066M050 |



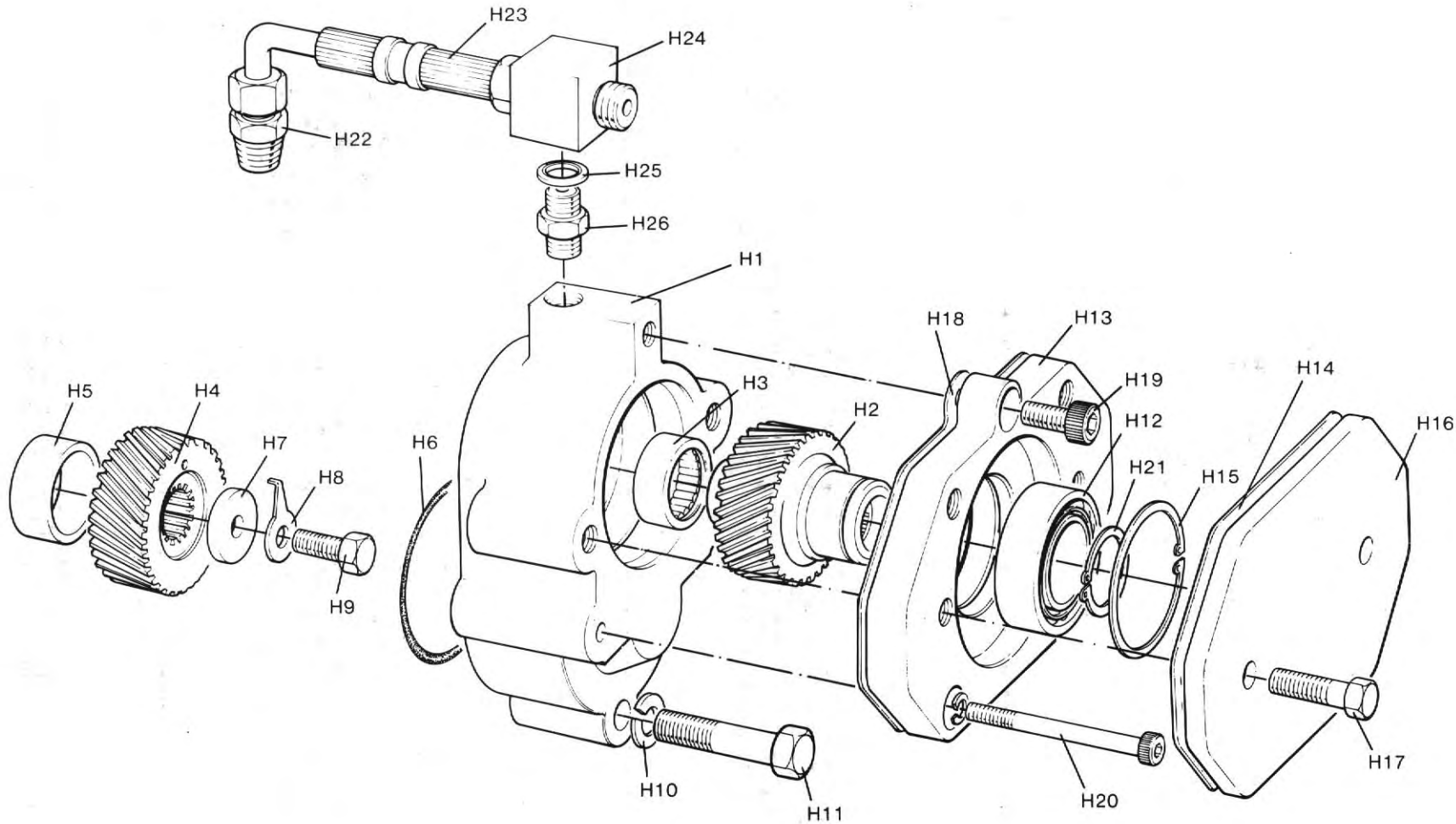
| Plate Ref. | Description | PRM401 Part No. | Qty. | Remarks |
|------------|----------------------|--------------------|------|-------------|
| E25 | Bolt | 0040609HT | 12 | |
| E26 | Ball | 066M050 | 2 | |
| E27 | Piston ring | MT292 | 3 | |
| E28 | Bolt | MT1290 | 3 | |
| E29 | O ring | 000372 | 4 | |
| E30 | Connector | MT1057 | 2 | |
| E31 | Feeder | MT380 | 1 | |
| E32 | Taper roller bearing | 0540351 | 1 | |
| E33 | Shim 0.002" | MT1077/02 | | As required |
| E33 | Shim 0.010" | MT1077/10 | | As required |
| E33 | Shim 0.031" | MT1077/31 | | As required |
| E34 | End cover | MT1069 | 1 | |
| E35 | O ring | 002874 | 1 | |



| Plate Ref. | Description | PRM401 Part No. | Qty. | Remarks | |
|---|-------------------------|-----------------|------|---|----------------|
| F | OUTPUT SHAFT ASSEMBLY | | | | |
| F1 | O ring | 002874 | 1 | Not used when Angle Drive is fitted | |
| F2 | End cover | MT1333 | 1 | | |
| F3 | Locknut | *CP1314 | 1 | | |
| F4 | Tab washer | CP1315 | 1 | | |
| F5 | Tongue washer | MT1331 | 1 | | |
| F6 | Roller bearing | 0533531 | 1 | | |
| F7 | Circlip | CM2077 | 1 | | |
| F8 | Spacer | MT1332 | 1 | | |
| F8 | Spacer (4:1 only) | *MT1405 | 1 | | |
| F9 | Output gear | MT1324 | 1 | | 1:1 47 teeth |
| F9 | | MT1064 | 1 | | 1.5:1 54 teeth |
| F9 | | MT1254 | 1 | | 2:1 60 teeth |
| F9 | | MT1419 | 1 | | 2.5:1 59 teeth |
| F9 | | MT1316 | 1 | 3:1 61 teeth | |
| F9 | | MT1403 | 1 | 4:1 83 teeth. Only supplied as MT0270/4 | |
| F10 | Spacer | MT1326 | 1 | | |
| F10 | Spacer (4:1 only) | *MT1408 | 1 | | |
| F11 | Bearing assembly | MT1317 | 1 | | |
| F12 | Circlip | 0250952 | 1 | | |
| F13 | Output shaft | MT1325 | 1 | | |
| F13 | Output shaft (4:1 only) | MT1404 | 1 | Only supplied as MT0270/4 | |
| F14 | Oil seal | MT252 | 1 | | |
| F15 | Locknut | *400-2200 | 1 | | |
| F16 | Coupling washer | *MT1251 | 1 | | |
| F17 | Output coupling | MT1250 | 1 | | |
| F18 | O ring | 001873 | 1 | | |
| <p>Note: 4:1 Ratio only Items marked * can be ordered separately, but if output gear MT1403 or output shaft MT1404 requires replacing, then output shaft assembly MT0270/4 must be ordered, which includes output shaft and items marked *.</p> | | | | | |



| Plate Ref. | Description | PRM401 Part No. | Qty. | Remarks |
|------------|-----------------------|--------------------|------|-------------------------|
| G | DOWN ANGLE DRIVE UNIT | MT0210 | 1 | |
| G1 | Gearcase S/A | MT0189 | 1 | |
| | Half case (front) | MT1273 | 1 | Not supplied separately |
| | Half case (rear) | MT1274 | 1 | Not supplied separately |
| G2 | Taper roller bearing | 0540351 | 2 | |
| G3 | Bolt | 0041216 | 1 | |
| G4 | Dowty seal washer | 0191107 | 8 | |
| G5 | Output gear | MT1320 | 1 | |
| G6 | Dowel | 0210815 | 2 | |
| G7 | Shim | MT1077 | | As required |
| G8 | Location ring | MT1277 | 1 | |
| G9 | Gasket | MT1281 | 1 | |
| G10 | Bolt | 0041222 | 4 | |
| G11 | Spacer | MT1271 | 1 | |
| G12 | Bolt | 0041221 | 3 | |
| G13 | Taper roller bearing | 0540301 | 2 | |
| G14 | Input gear | MT1319 | 1 | |
| G15 | Shim | MT1077 | | As required |
| G16 | O ring | 002874 | 1 | |
| G17 | End cover | MT1068 | 1 | |
| G18 | Oil seal | MT251 | 1 | |
| G19 | Adaptor | CP1255 | 1 | |
| G20 | Oil pipe | MT766 | 1 | |
| G21 | Tee piece | CP1367 | 1 | |
| G22 | Washer | 0201715 | 1 | |
| G23 | Metering union | MT4583 | 1 | |
| G25 | Washer | CM2123 | | Transit only |
| G26 | Screw | 0041206 | | Transit only |



| Plate Ref. | Description | PRM401 Part No. | Qty. | Remarks |
|------------|-------------------------|--------------------|------|---------------------------|
| H | POWER TAKE OFF ASSEMBLY | MT0193 | 1 | SAE B Flange, 2 or 4 bolt |
| H1 | PTO housing | MT1300 | 1 | |
| H2 | Driven gear | MT1297 | 1 | |
| H3 | Needle bearing | 0563003 | 1 | |
| H4 | Driving gear | MT1296 | 1 | |
| H5 | Spacer | MT1295 | 1 | |
| H6 | O ring | 0430771 | 1 | |
| H7 | Washer | MT1301 | 1 | |
| H8 | Tab washer | MT1302 | 1 | |
| H9 | Screw | 0041008 | 1 | |
| H10 | Spring washer | 0191107 | 3 | |
| H11 | Bolt | 0041216 | 1 | |
| H12 | Ball bearing | 40M433 | 1 | |
| H13 | Adaptor flange | MT1299 | 1 | |
| H14 | Gasket | MT1307 | 1 | 4 bolt |
| H14 | Gasket | MT5012 | 1 | 2 bolt |
| H15 | Circlip | 0250620 | 1 | |
| H16 | Cover plate | MT1293 | 1 | Transit only |
| H17 | Screw | 0041208 | 2 | |
| H18 | Gasket | MT1303 | 1 | |
| H19 | Cap screw | 0081520 | 1 | |
| H20 | Cap screw | 0081685 | 2 | |
| H21 | Circlip | CM2067 | 1 | |
| H22 | Adaptor | CP1255 | 1 | |
| H23 | Oil pipe | MT766 | 1 | |
| H24 | Tee piece | CP1367 | 1 | |
| H25 | Washer | 0201715 | 1 | |
| H26 | Metering union | MT4583 | 1 | |

KITS OF PARTS

| Part No. | Description | Qty | Part No. | Description | Qty |
|------------|-----------------------|-----|------------|------------------------|-----|
| MT0115 | Pump Repair Kit | | MT251 | Oil seal | 1 |
| MT378 | Pump spindle | 1 | MT252 | Oil seal | 1 |
| MT379 | Pump gear | 1 | MT343 | Gasket | 1 |
| MT4544 S/A | Spindle assembly | 1 | | | |
| | | | MT0068 | Shimming Kit | |
| MT0214 | Starter Cut-Out Kit | | MT1077/02 | Shim | 6 |
| 0201715 | Dowty washer | 1 | MT1077/10 | Shim | 10 |
| CP1077 | Detent ball | 1 | MT1077/31 | Shim | 2 |
| CP1358 | Switch | 1 | | | |
| | | | MT0253 | Conversion Kit 1.09:1 | |
| MT0247 | Clutch Pack | | MT0196/1 | Pinion S/A | 2 |
| 0050606 HT | Nyloc nut | 3 | MT0251 | 'O' ring kit | 1 |
| 0270350 | Snap ring | 1 | MT1324 | Output gear | 1 |
| MT1067 | Clutch ring | 3 | | | |
| MT1282 | Clutch end cover | 1 | MT0254 | Conversion Kit 1.459:1 | |
| MT1289 | Tab washer | 3 | MT0196/1.5 | Pinion S/A | 2 |
| MT725 | Clutch plate (driven) | 8 | MT0251 | 'O' ring kit | 1 |
| MT983 | Clutch end plate | 1 | MT1064 | Output gear | 1 |
| | | | | | |
| MT0251 | 'O' Ring Kit | | MT0255 | Conversion Kit 1.935:1 | |
| 000372 | 'O' ring | 8 | MT0196/2 | Pinion S/A | 2 |
| 000753 | 'O' ring | 1 | MT0251 | 'O' ring kit | 1 |
| 000872 | 'O' ring | 1 | MT1254 | Output gear | 1 |
| 001254 | 'O' ring | 2 | | | |
| 001873 | 'O' ring | 1 | MT0281 | Conversion Kit 2.565:1 | |
| 002123 | 'O' ring | 1 | MT0196/2.5 | Pinion S/A | 2 |
| 002433 | 'O' ring | 1 | MT0251 | 'O' ring kit | 1 |
| 002874 | 'O' ring | 3 | MT1419 | Output gear | 1 |
| 003383 | 'O' ring | 1 | | | |
| 003504 | 'O' ring | 2 | MT0256 | Conversion Kit 2.904:1 | |
| 004754 | 'O' ring | 1 | MT0196/3 | Pinion S/A | 2 |
| 0421503 | 'O' ring | 2 | MT0251 | 'O' ring kit | 1 |
| 0430771 | 'O' ring | 1 | MT1316 | Output gear | 1 |
| MT1073 | Gasket | 1 | | | |
| MT1081 | Gasket | 1 | | | |