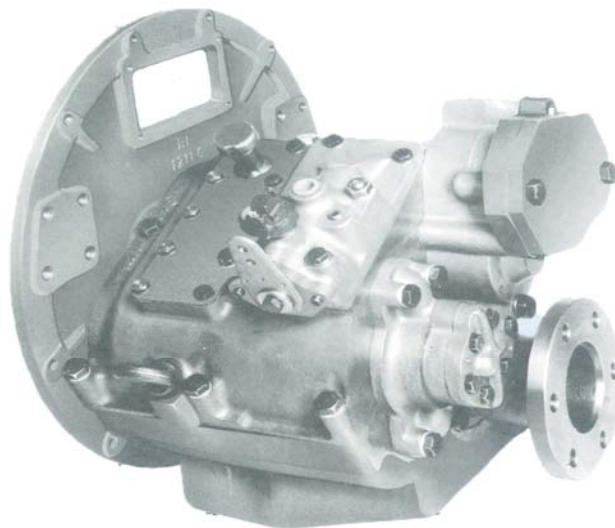


**manual for:**

**PRM401**



**this manual is offered to you by:**



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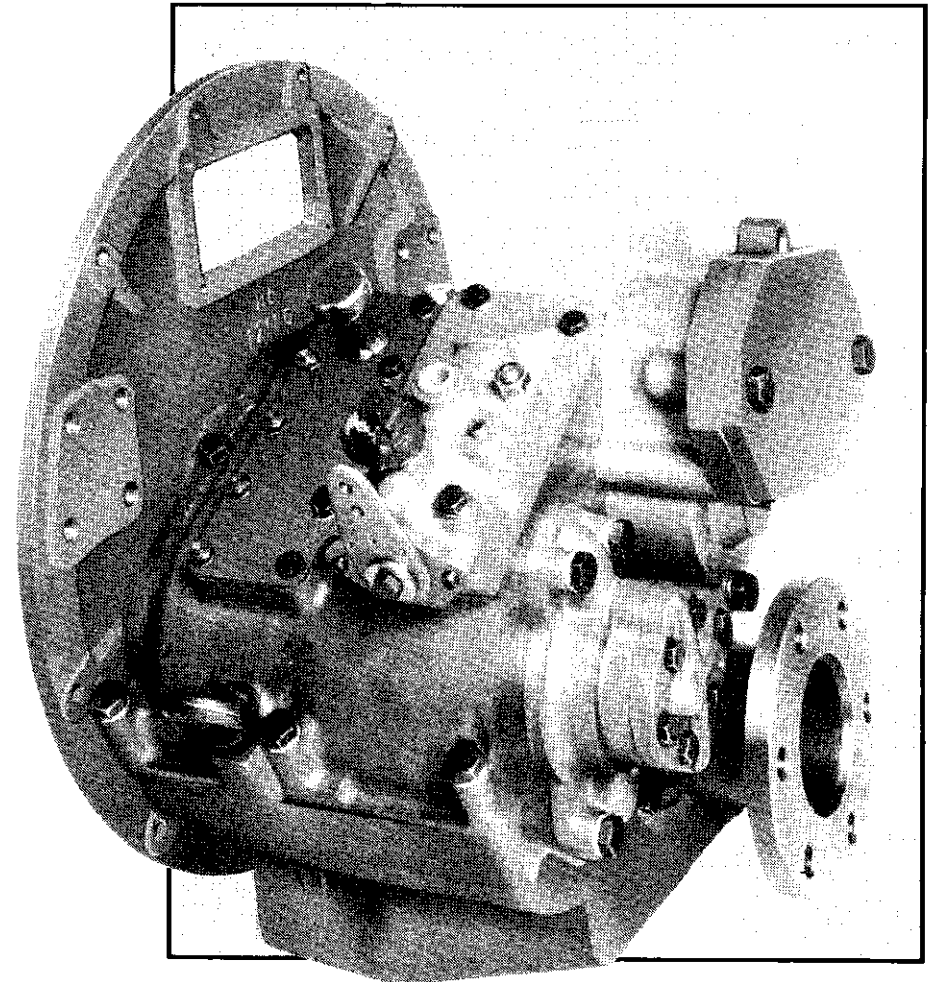
# PRM 401 BY NEWAGE

*DINTRA*

## WORKSHOP MANUAL

# NEWAGE

NEWAGE TRANSMISSIONS LIMITED  
Barlow Road, Coventry, CV2 2LD, England  
Telephone: (0203) 617141 Telex: 31333





## FOREWORD

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 his 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

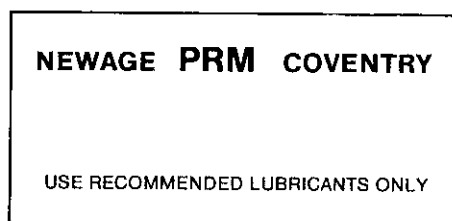
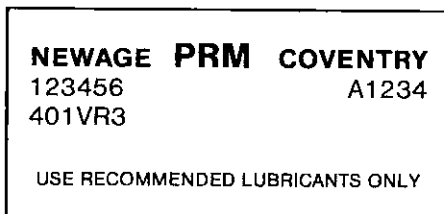
Claims for replacement of parts under warranty must always be submitted to the distributor who supplied the gearbox; if this is not possible, application may be made to the nearest distributor or dealer, who must, however, be advised of the supplier's name and address.

## SERVICE PARTS

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

## 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

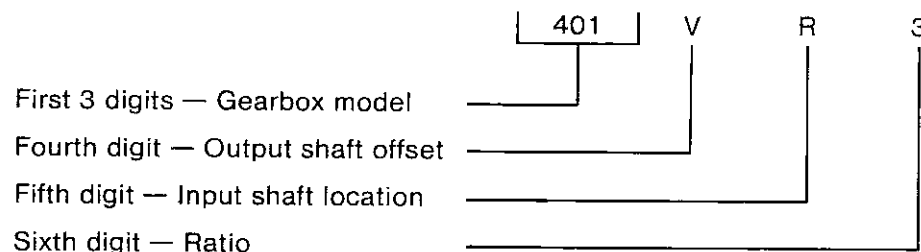


Please complete the above box with serial number and specification of your own gearbox.

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:-



Reprinted November 1983 — includes modifications upto and including MOD 8730 — 23rd November 1983

Reprinted October 1984 — includes modifications from MOD 8731 upto and including MOD 10047.

# 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:**

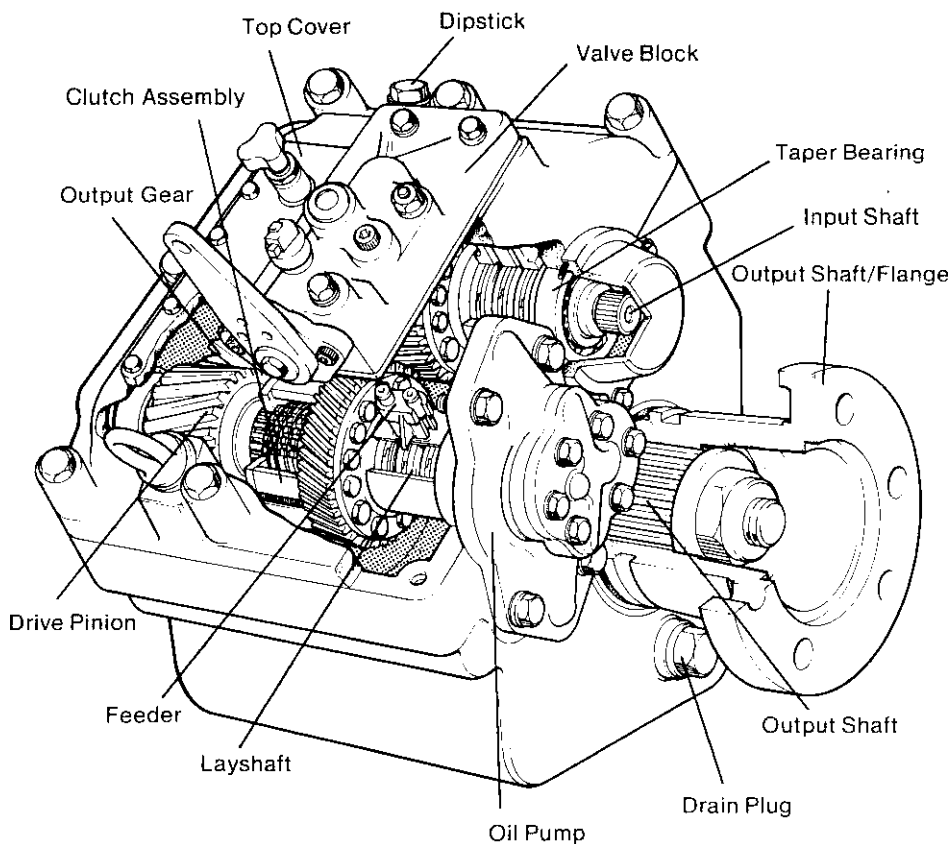
Ratios up to 2.904:- 72Kg (158lb)  
Ratio 3.952 :- 80Kg (176lb)  
(excluding drive coupling, adaptor and cooler).

Additional weight - Power Take Off: 12Kg (26.4lb)  
Angle Drive: 17.5Kg (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.



**Fig. 1. Gearbox Cut-Away — Typical Arrangement**

**Working Oil Pressure:**

2275 kPa (23.2 Kg/cm<sup>2</sup> - 330 lbf/in<sup>2</sup>)

**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 (8.5hp) 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. and 1 1/2 in. nominal diameter to SAE J620C.

**Gearcase:**

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

**Input Shaft:**

29 mm (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.

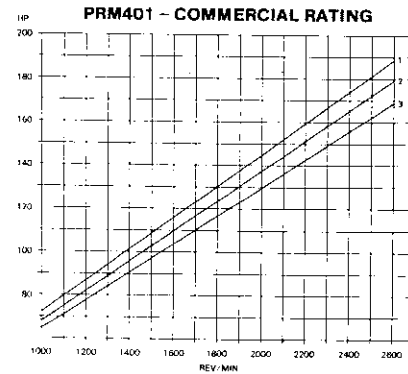
**Output Flange:**

152.4mm (6in.) diameter, with 6 holes, 13mm (0.512in.) diameter on 121 mm (4.75in.) PCD.

**Installation Angle:**

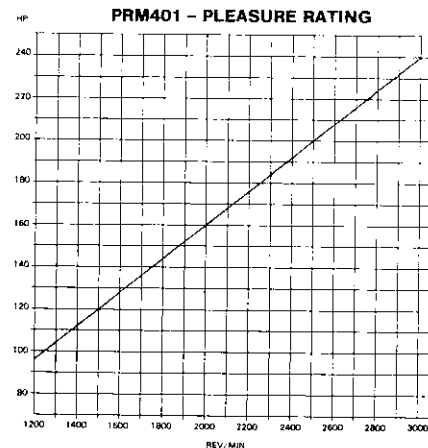
The maximum fore and aft installation angle permissible at rest is 17°.

**1.2 Application Details**



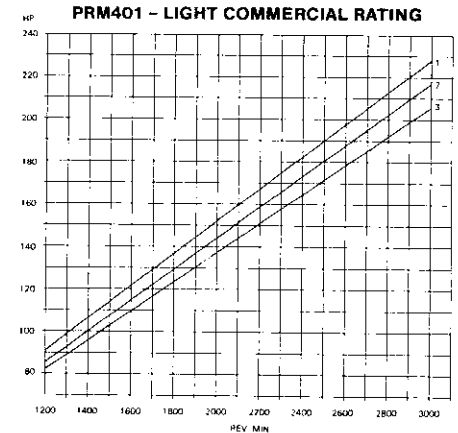
1 - 1.09:1 AND 1.459:1 RATIOS 2 - 1.96:1 RATIO  
3 - 2.565:1, 2.904:1 AND 3.952:1 RATIOS

THESE RATINGS ARE FOR WORK BOATS AND FISHING BOATS OPERATING FOR MORE THAN 1,500 HOURS PER YEAR.



1.09:1, 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.



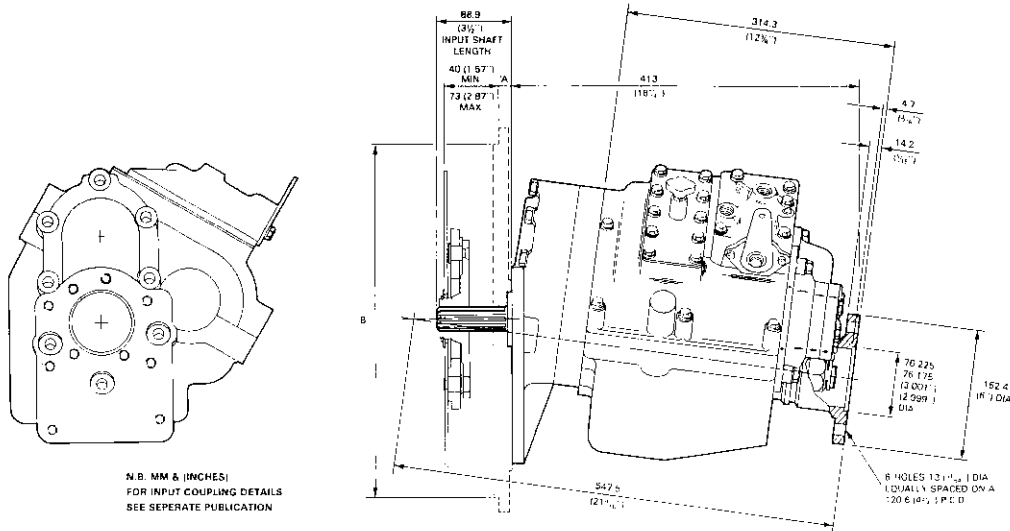
1 - 1.09:1 AND 1.459:1 RATIOS  
2 - 1.96:1 RATIO  
3 - 2.565:1, 2.904:1 AND 3.952:1 RATIOS

THESE RATINGS ARE FOR 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 particularly arduous duty, or for applications outside the powers and speeds shown here, please consult the factory or distributor.



### 1.3 Installation Details



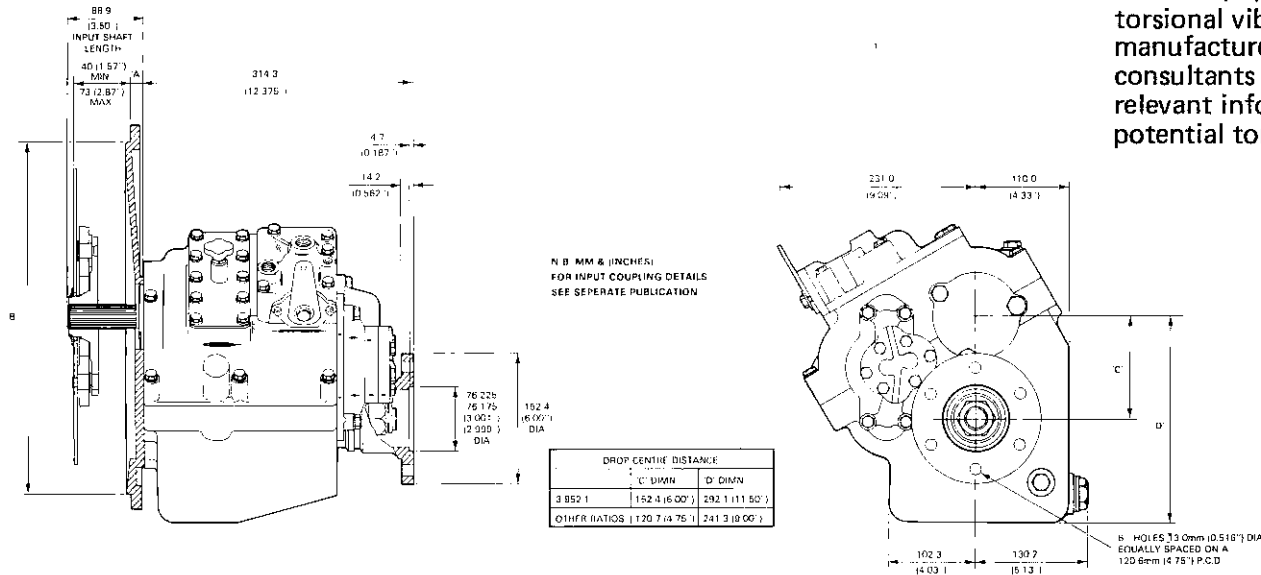
ADAPTOR	A' DIM	B' DIM
SAE 2	15.9 (5/8)	447.70 (17.625) DIA 447.55 (17.620)
SAE 3	15.9 (5/8)	409.55 (16.124) DIA 409.45 (16.121)
SAE 4	15.9 (5/8)	362.00 (14.250) DIA 361.85 (14.245)
BORG WARNER	28.5 (1.125)	209.55 (8.249) DIA 209.45 (8.246)

N.B. MM & (INCHES) FOR INPUT COUPLING DETAILS SEE SEPERATE PUBLICATION

### 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 transmission.



ADAPTOR	A' DIM	B' DIM
SAE 2	15.9 (5/8)	447.70 (17.625) DIA 447.55 (17.620)
SAE 3	15.9 (5/8)	409.55 (16.124) DIA 409.45 (16.121)
SAE 4	15.9 (5/8)	362.00 (14.250) DIA 361.85 (14.245)
BORG WARNER	28.5 (1.125)	209.55 (8.249) DIA 209.45 (8.246)

## 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 rear of the gearcase; this can be removed if required to allow suitable pipework to be connected to a hand-operated drain pump.

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

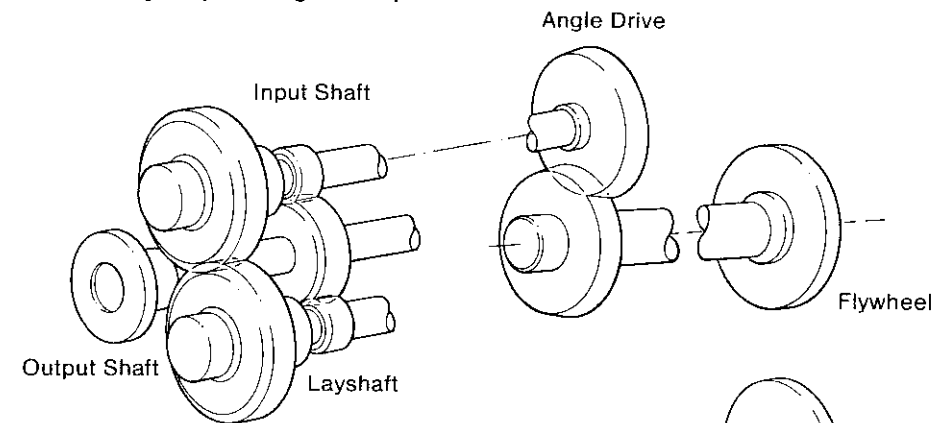
### 3.2 Gear Train

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

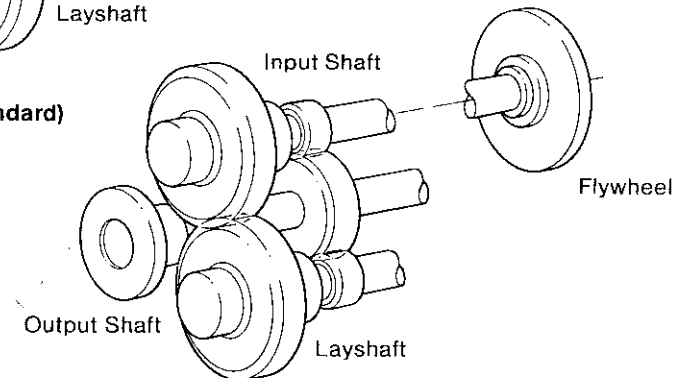
The input shaft, which is supported by a taper roller bearing at either end, incorporates a drive pinion of the required ratio (running on a special self-lubricating bearing), the forward (when used with a right-hand propeller) drive clutch assembly, the clutch gear and a hydraulically actuated piston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

### Internal Layout (with Angle Drive)



### Internal Layout (Standard)



**Fig. 2. Internal Layout**

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

### 3.3 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  $8^\circ$  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 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.

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

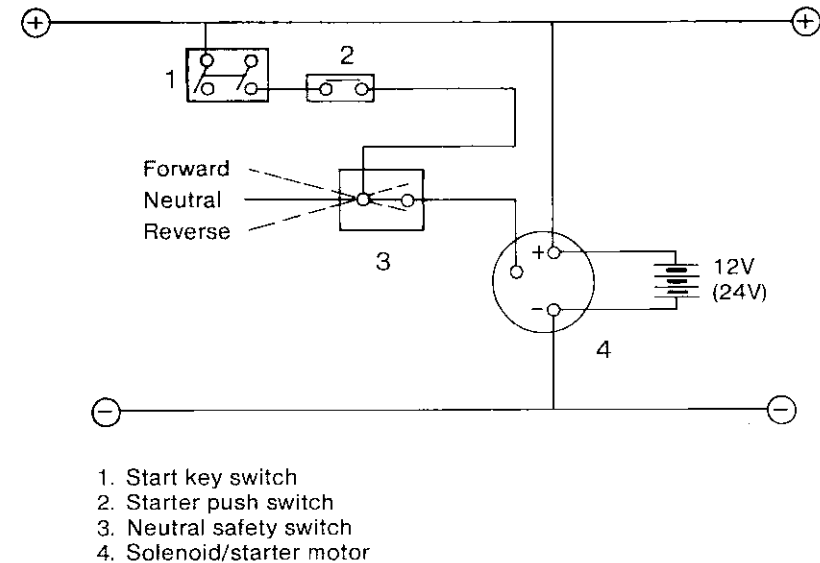


Fig. 3. Wiring Diagram for Neutral Safety Start Device.

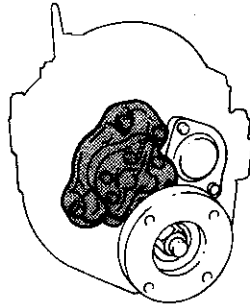
### 3.6 Oil Pump

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.

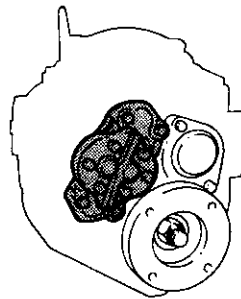
When the transmission is used with anti-clockwise engines (looking at the flywheel) or with clockwise engines when an angle drive unit is fitted, the oil pump is fitted in its standard position. For clockwise engines, or anti-clockwise with angle drives the pump is turned through  $180^\circ$  to standard (see diagrams).

**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.



**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)**

## 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 via a strainer 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.

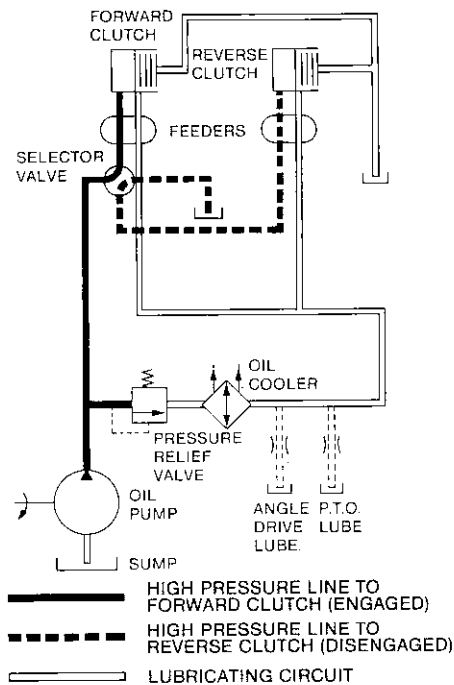


Fig. 6. Hydraulic and Lubricating Oil Circuits.

## 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

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 Centilube Supreme 10W/30	Century Supreme 20W/50 or Centilube 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 Supertube 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

Company	Ambient Temperature Below 0° C	Ambient Temperature 0° C — 30° C	Ambient Temperature Above 30° C
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 PRM 401 marine gearbox is supplied with a choice of adaptor plates to SAE 2, SAE 3, or SAE 4 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 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. (0.025mm) 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, re-position 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 in. (0.125mm) total indicator reading.

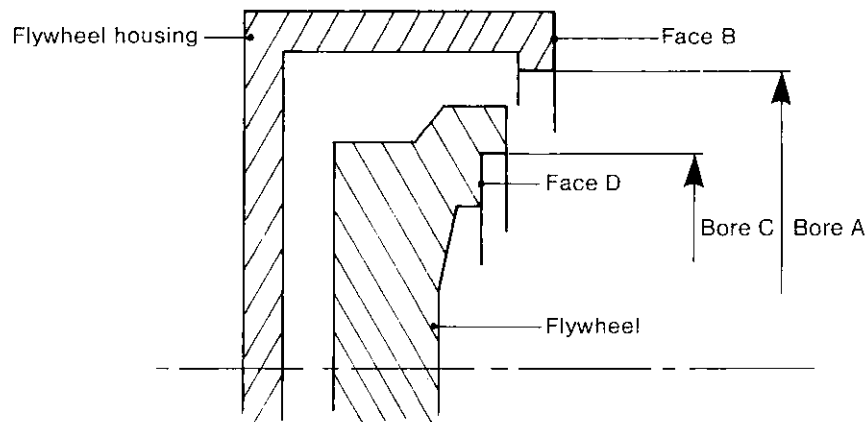


Fig. 7. Checking engine flywheel and flywheel housing.

### 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  $\frac{3}{8}$  in. BSP connections are provided on the valve block, and these are blanked off with "Redcap" seals on delivery from the factory.

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

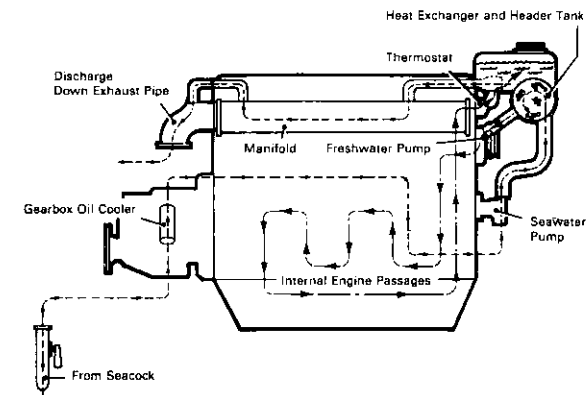
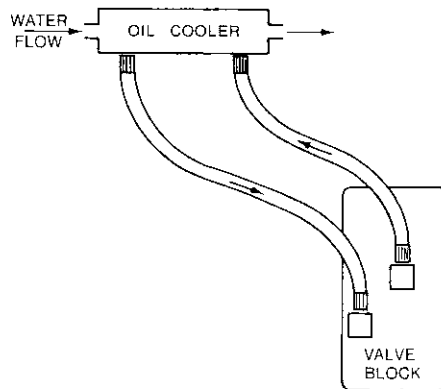


Fig. 8. Gearbox and Engine Cooling Circuit

### 5.5.1 PRM 401

Capacity of oil cooler required 6.3 kW (8.5 hp) with an oil flow rate of 27 litres (6 gallons) per minute and a seawater flow rate of 40 litres (9 gallons) per minute at an inlet temperature of 20° C.

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



**Fig. 9. Oil Cooler Connections PRM 401**

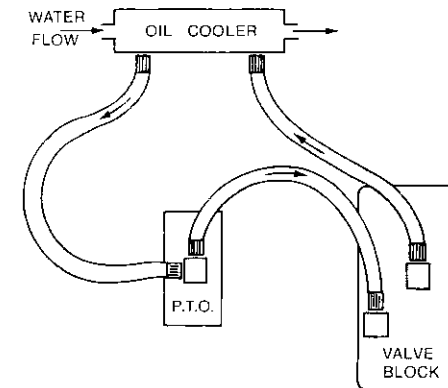
### 5.5.2 PRM 401 with Power Take Off

Capacity of oil cooler required 9kW (12hp) with an oil flow rate of 27 litres (6 gallons) per minute and a seawater flow rate of 40 litres (9 gallons) per minute at an inlet temperature of 20° C.

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:

- remove “Redcap” seals from the valve block.
- connect the valve block outlet to oil cooler inlet.
- connect the oil cooler outlet to the PTO inlet.
- complete the circuit by connecting the PTO 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 — PRM 401 with Power Take Off.**

### 5.5.3 PRM 401A (with Angle Drive)

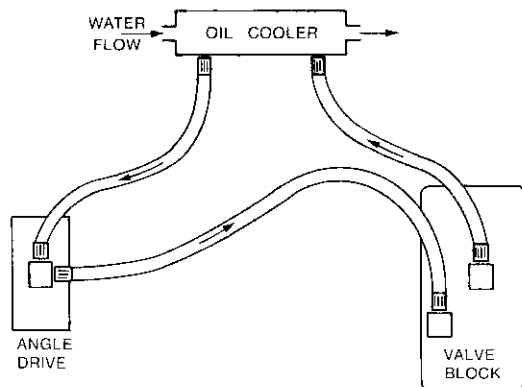
Capacity of oil cooler required 9 kW (12 hp) with an oil flow rate of 27 litres (6 gallons) per minute and a seawater flow rate of 40 litres (9 gallons) per minute at an inlet temperature of 20° C.

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:

- remove “Redcap” seals from the valve block.
- connect valve block outlet to oil cooler inlet.
- connect oil cooler outlet to the angle drive inlet.
- 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 — PRM 401A — 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 flange 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 fitted whilst the hull is afloat, otherwise there is a danger of distorting the hull because insufficient support being provided 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 transmission 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 PRM 401A (angle drive) the transmission provides an 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

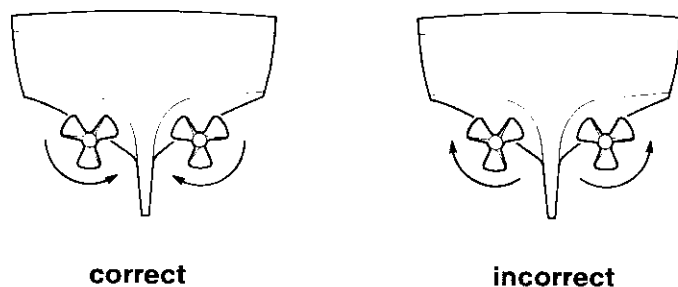
The rotation of a propeller, even in a single engine installation, tends to have a slight “turning” effect on the handling of the boat, but this can normally be corrected with very slight adjustments on the rudder.

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.

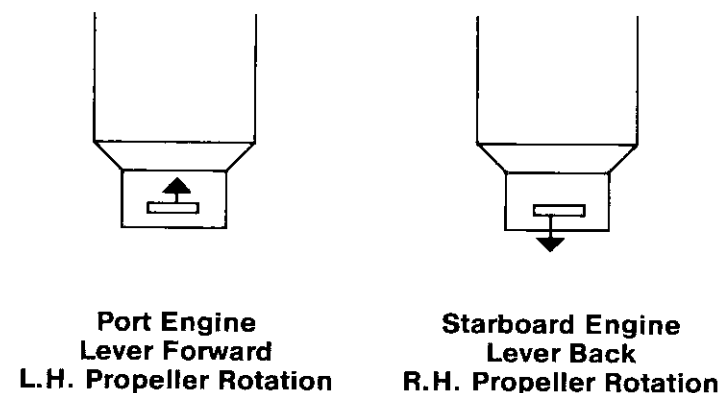
It is also preferable for the starboard (right-hand) propeller to rotate clockwise and the port (left-hand) anti-clockwise rather than the other way about since in the latter case, when the propeller blades are at the lowest point of their rotational arc they tend to create a vacuum which affects the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



**Fig. 12. Propeller Rotation — Twin Installations**



**Note:** When an Angle Drive is fitted, lever movement will be reversed.

**Fig. 13. Operating Lever Movement for Ahead Drive, Twin Installations**

### 5.9 Remote Control Operating Systems

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

The following points should be noted:

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

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

## 6. OPERATION

### 6.1 First Time Usage

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

Ensure the gearbox is in neutral (if fitted) it is recommended that the optional neutral safety switch 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 PRM 401 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 PRM 401 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 PRM 401 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 PRM 401 gearbox is a "Get You Home" device allowing the gearbox to be mechanically locked in 'ahead' drive in the unlikely event of hydraulic or 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 of 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 below is designed to help diagnose some of the problems which might be encountered. It assumes that the installation and operating instructions in this manual have been followed and we advise that these are checked before proceeding to fault finding.

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

SYMPTOM	NOTICEABLE EFFECT	CAUSE	REMEDY	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.			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.
		Broken input drive plate.	Replace drive plate.			Defective bearing	Isolate defective bearing noise, remove and replace.
Loss of Drive		Oil leaks	Check for evidence of leakage and rectify.	Excessively high oil temperature	Gearcase too hot to touch	Defective oil cooler	Replace oil cooler.
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.			Defective pressure relief valve	Remove and examine relief valve. Replace if necessary.
		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.	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.
		Pressure relief valve spring defective.	Remove valve block and replace spring.			Defective oil cooler	Check for traces of water in the gearbox oil or oil in the cooling water system. Replace cooler if necessary.
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.		Escape of high pressure in gearbox when dipstick is removed	Defective breather (causing leaks past oil seals)	Contact distributor or factory for advice.
		Damaged 'O' ring in hydraulic circuit.	Check 'O' rings in feeder connectors and piston.	Control lever on valve block stiff	Difficult to move single lever control	Defective valve or detent spring	Contact distributor or factory for advice.
		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.				

## 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, 1.463ins.) 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 'O' rings and replace if necessary. If in good condition carefully store until required for refitting.

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

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

**N.B.** The clutch shaft must be reshimmied 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, both the input shaft and layshaft assemblies can be removed with the gearbox still installed in the boat. The procedure is as follows:

1. Drain the gearbox oil into a suitable container.
2. Disconnect oil cooler pipes and the cable from the gearbox control lever.
3. Remove the 4 bolts securing the oil pump to the gearcase and withdraw the oil pump, gasket, shims and 'O' rings, noting the position of the pump for refitting (note: keep pump shims with pump assembly).
4. Remove the 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. Slacken the bolts securing the input coupling to the flywheel, to allow slight movement. Withdraw the input shaft spline. (On units incorporating 2.904:1 and 3.952:1 ratios, it is recommended that all bolts but one be removed so that the coupling will pivot on the remaining bolt to permit the input shaft to be lifted with the gearbox case).
8. Lift the input shaft, if necessary rotating slightly so that the spline can be withdrawn from the flexible coupling.
9. Once the spline is cleared, lift the complete shaft assembly from the casing. Lift and remove the layshaft and front cover from the casing.

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

1. Remove gearbox from boat as described in section 9.3.
2. Remove the 4 bolts securing the oil pump and withdraw the oil pump, gasket, shims and 'O' rings, noting the position of the pump for refitting (note: keep the pump shims with the pump assembly).

3. Remove the 3 bolts securing the shaft end cover and remove. (note: keep shims and 'O' rings with end cover).
4. Remove 5 bolts and 1 nut retaining the valve block and remove valve block.
5. Remove 7 bolts securing the gearcase top half and lift clear.
6. Lift input shaft assembly and front seal housing from the gearcase.
7. Lift layshaft assembly and front end cover from the gearcase.

### 9.6 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, spacer and bearing using pulley extractors with the jaws of the extractor located behind the pinion.
3. Refit the clutch pinion to the shaft.
4. Replace the spacer and bearing, inspecting for wear and replacing where necessary.
5. Locate the new bearing (item D2) on the shaft and gently drive (either handpress or use hardwood drift and hammer) the assembly into position. Take care not to damage the bearing rollers or raceways during this operation.
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 bearing as previously described.
2. Unlock and remove 3 nuts (item D33) securing the clutch end plate.
3. Withdraw the complete clutch from the shaft noting the position of the pull of springs.
4. Position shaft upright and locate the 3 assembly bolts through clutch gear.
5. 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.
6. Replace the clutch end cover (item D7) onto the clutch pack, replace securing nuts and tighten with a torque spanner set at 12.2Nm (1.2Kgm, 9 lbf ft).
7. Replace the drive pinion into the clutch pack until it touches the bottom washer.
8. Place the spacer 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 9.5.3., 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 recommend 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 list at the back of this manual. If it is required to fit a ratio which is different to that which was originally supplied, the output gear as well as both pinions will need to be changed.

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

### 9.6.6 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.

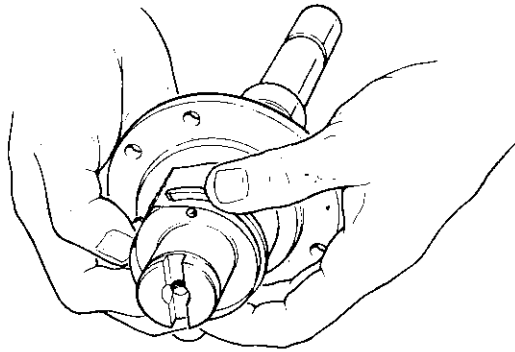
### 9.6.7 Piston Rings and Feeder

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 into 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 shaft 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 bearing (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 339Nm (34.58Kgfm - 250lbf.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 339Nm (34.58Kgfm - 250lbf.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

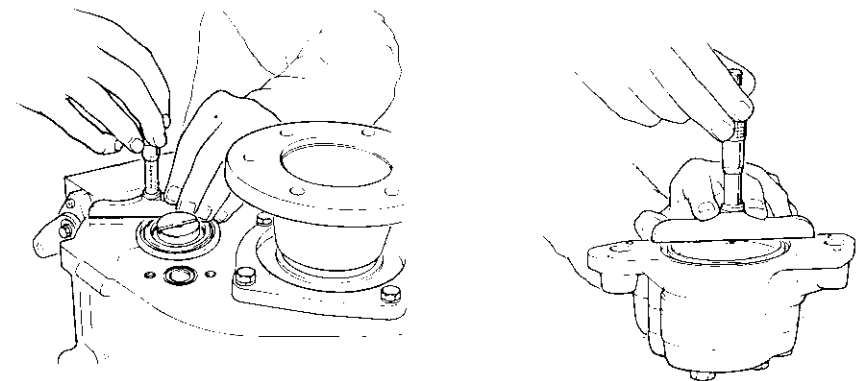
The allowable end float on the taper bearing is 0 - 0.05mm (0 - 0.002in) clearance: this should be checked with the aid of a depth micrometer as follows:-

1. Press the bearing outer cup firmly into position and measure between the face of the gearcase and the top of the bearing outer as shown in Fig. 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 or 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 401 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 halves together, ensuring dowels (G6) are properly located.
9. Tighten bolts (G3) (G12) to a torque of 101.5Nm (10.35Kgfm - 75lbf.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 5Kg 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	34.58
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

### **METRIC DIMENSIONS**

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

**Where metric dimensions are shown within brackets in the remarks column, these are equivalent metric dimensions to imperial and are intended to assist identification of components only.**

# **SPARE PARTS LIST**

PRM 401

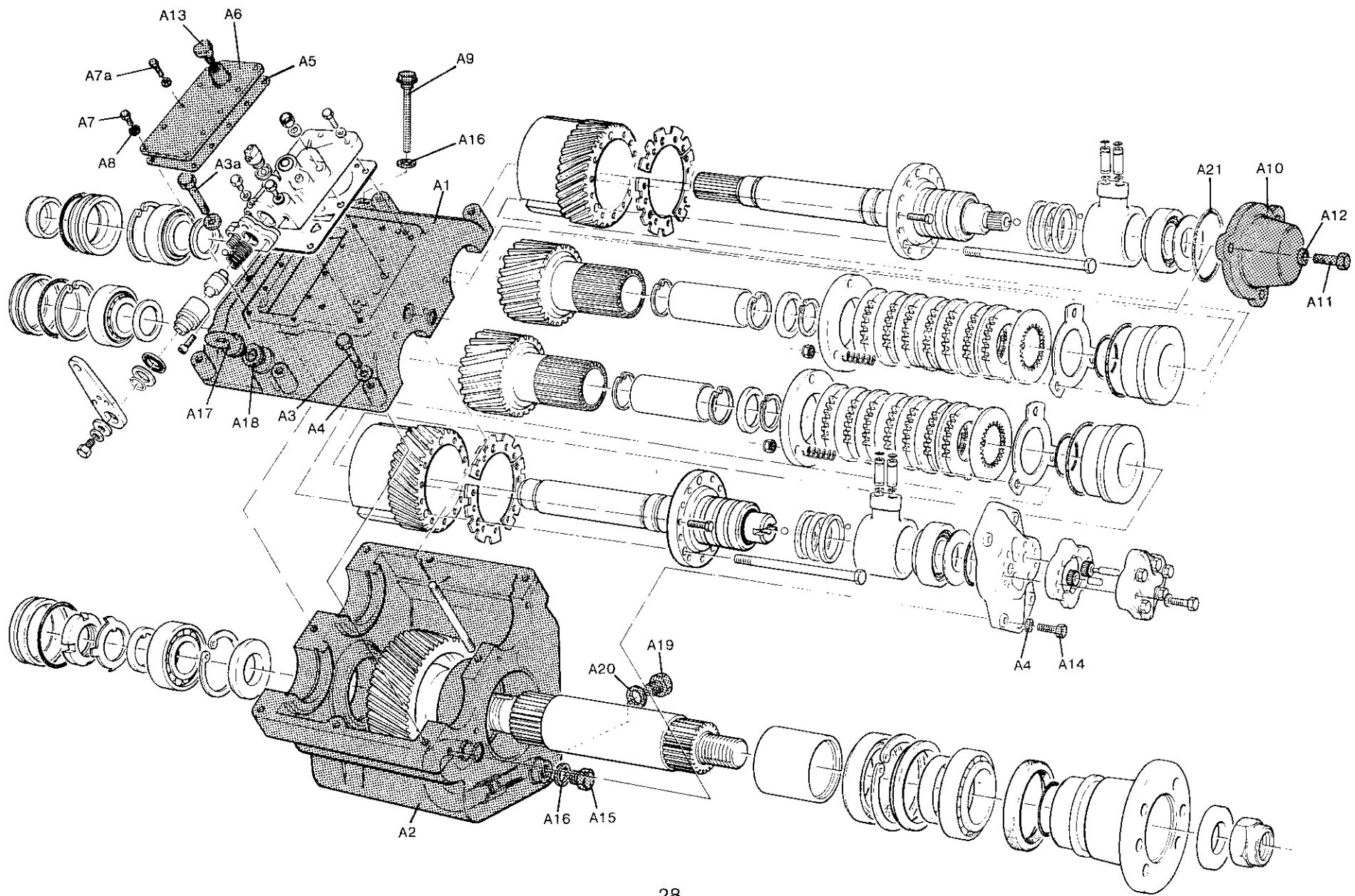


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
A.	Gearcase Assembly comprising:			
	Case sub-assembly	MT0204	1	Supplied complete only
A1	Gearcase — top	MT1284	1	Not supplied separately
A2	Gearcase — bottom	MT1244	1	Not supplied separately
A3	Bolt	0041014	6	
A3a	Bolt - case halves	0041019	1	
A4	Washer	0201706	11	
A5	Gasket (topcover)	MT343	1	
A6	Top cover	MT1203	1	
A7	Screw	0040804	8	
A7a	Screw	MT1283	2	
A8	Washer	CP1223	10	
A9	Dipstick	MT472	1	0800687 when fitted with Angle Drive
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/drain plug	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	



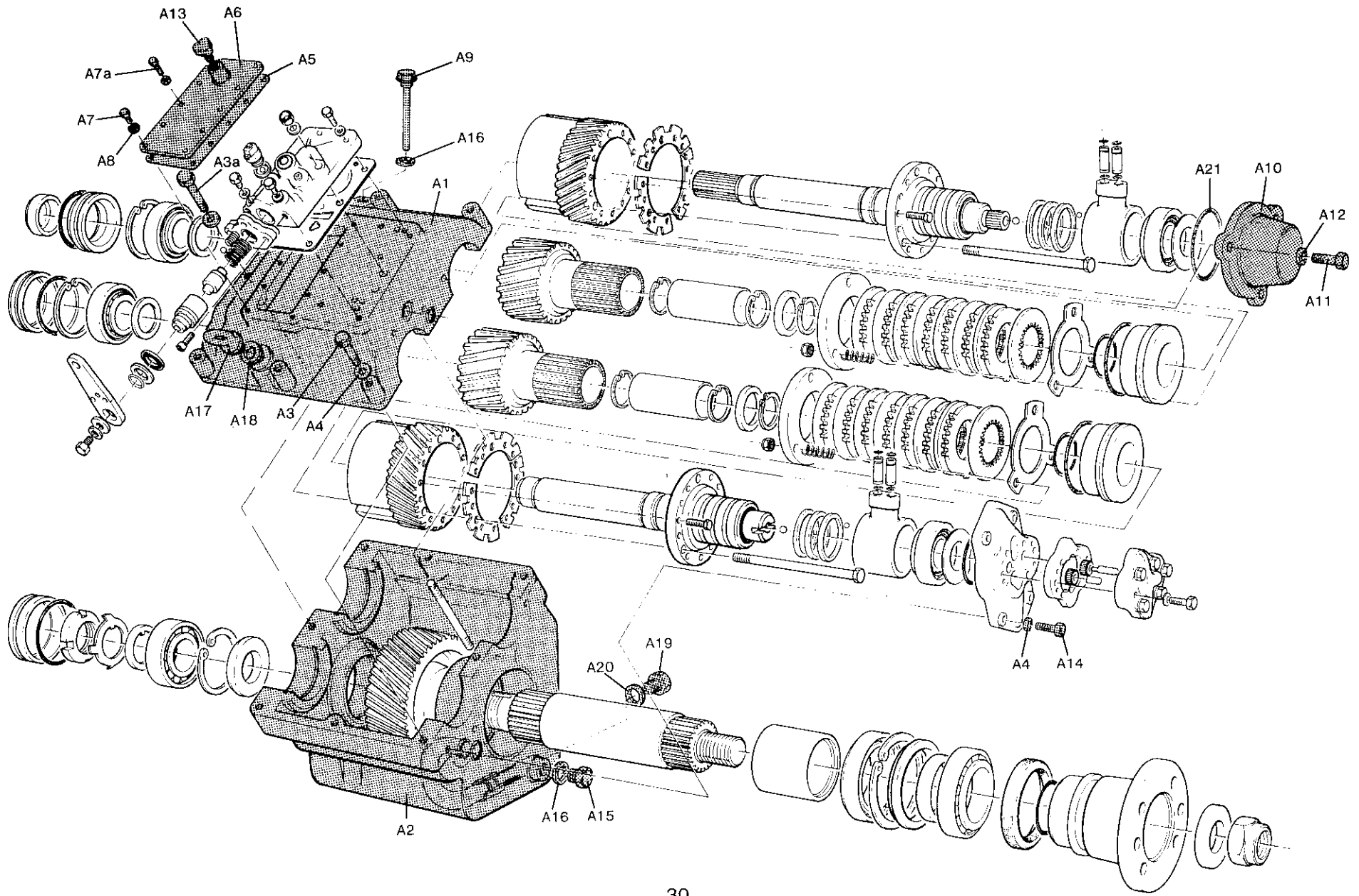


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
A1 A2 A9	<p><b>Note:-</b> For 4:1 Ratio only:-</p> <p>Case sub-assembly</p> <p>    Gearcase — top</p> <p>    Gearcase — bottom</p> <p>Dipstick</p>	<p>MT0248</p> <p>MT1284</p> <p>MT1327</p> <p>0800925</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>Supplied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

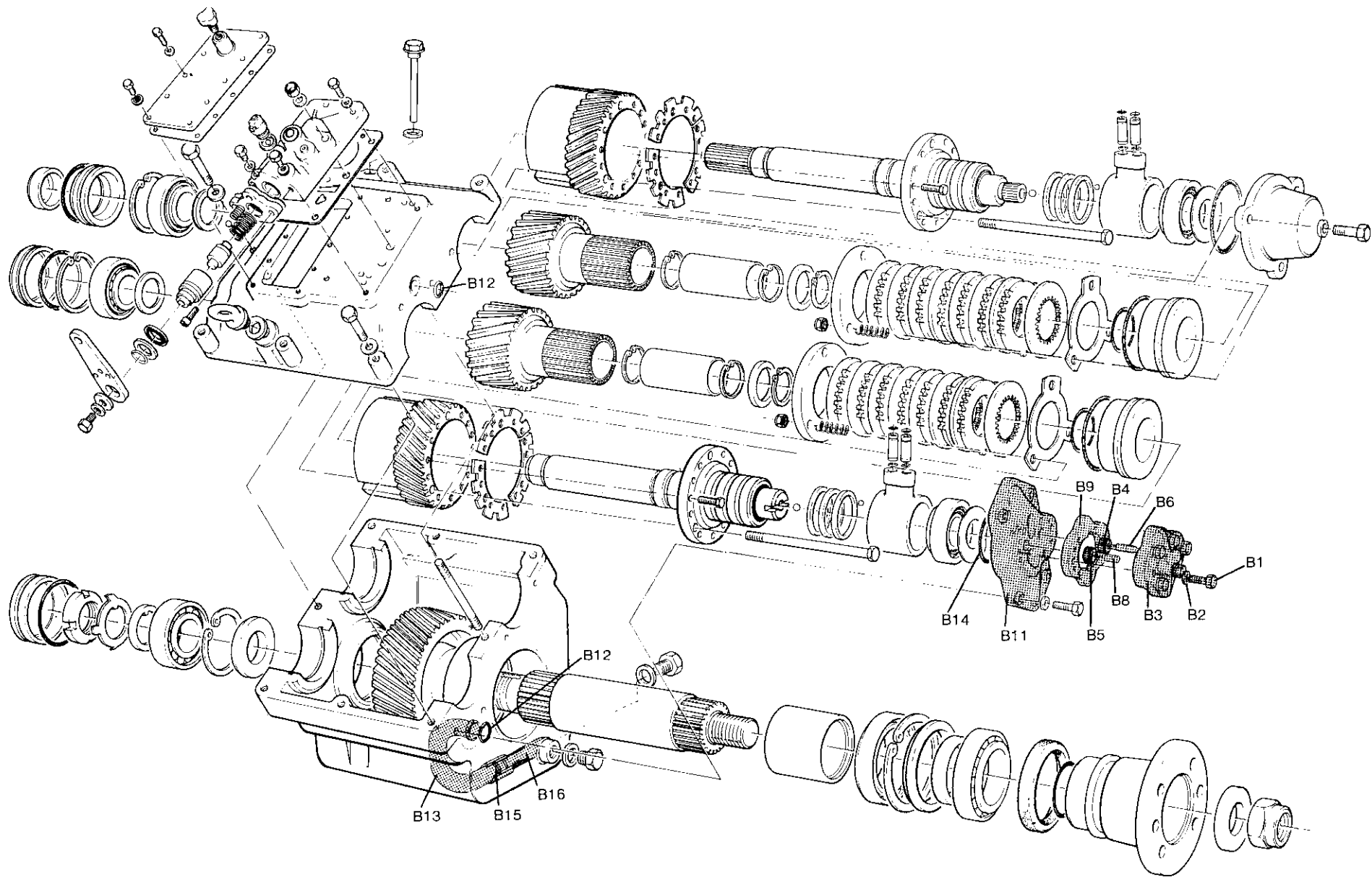


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
B.	Oil Pump Assembly comprising:	MT0200	1	
B1	Bolt	0040811	6	
B2	Washer	CP1223	6	
B3	Pump cover	MT321	1	
B4	Pump gear driver	MT379	1	} Part of MT4544 S/A MT0115
B5	Pump gear driven	MT379	1	
B6	Pump spindle	MT4544	1	} Part of MT4544 S/A MT0115
B8	Pump spindle	MT378	1	
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	
	<b>Note:-</b> For 4:1 Ratio only:-			
B13	Oil pipe	MT1376	1	

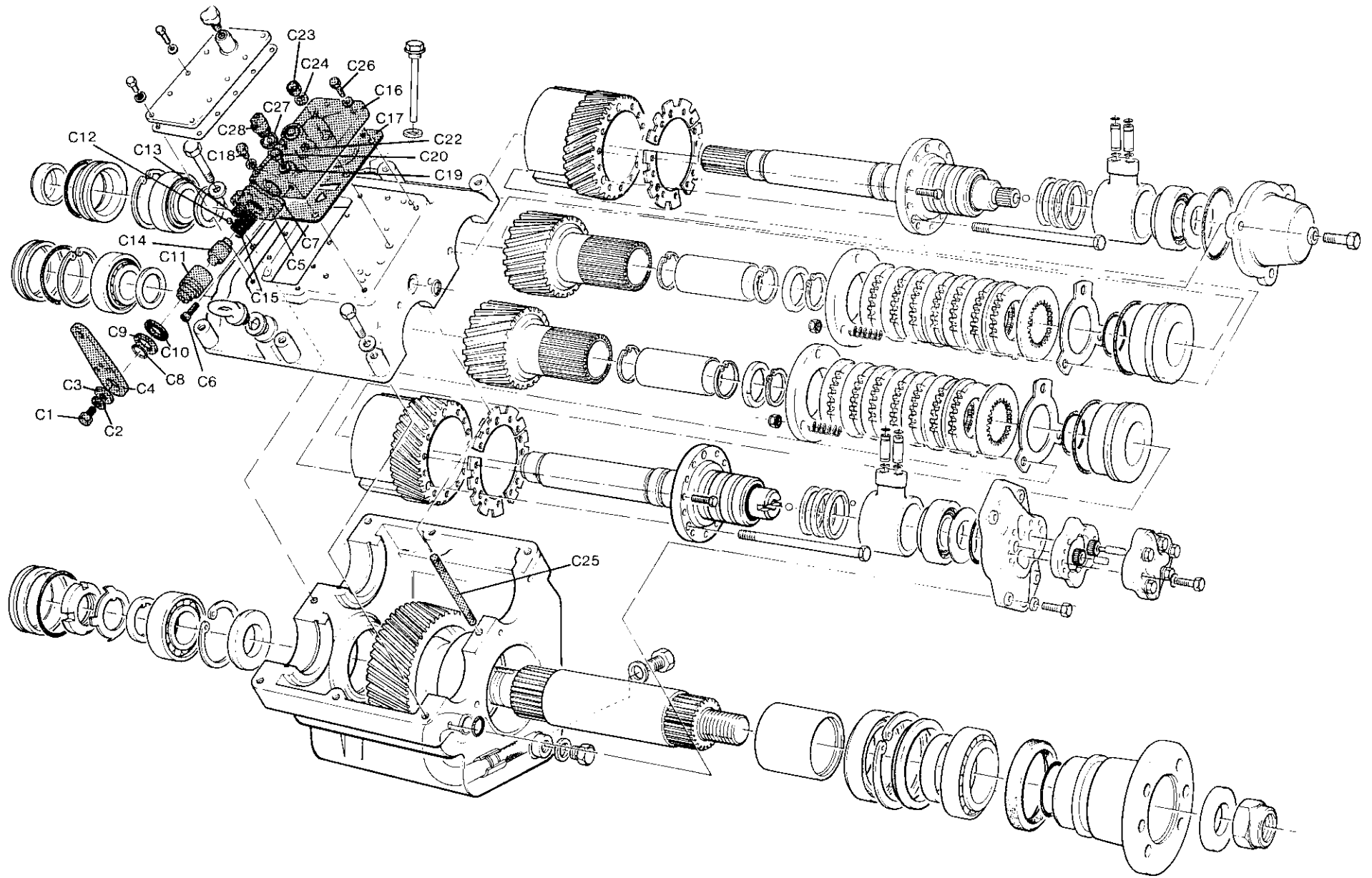


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
C.	Valve Block Assembly comprising:	MT0182	1	MT0157 if Neutral Safety Switch fitted
C1	Screw	0040806	1	
C2	Spring washer	0191105	1	
C3	Washer	MT979	1	
C4	Operating lever	MT977	1	
C5	End plate	MT978	1	
C6	Cap screw	0081220	2	
C7	Gasket	MT1081	1	
C8	O 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	MT4608	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

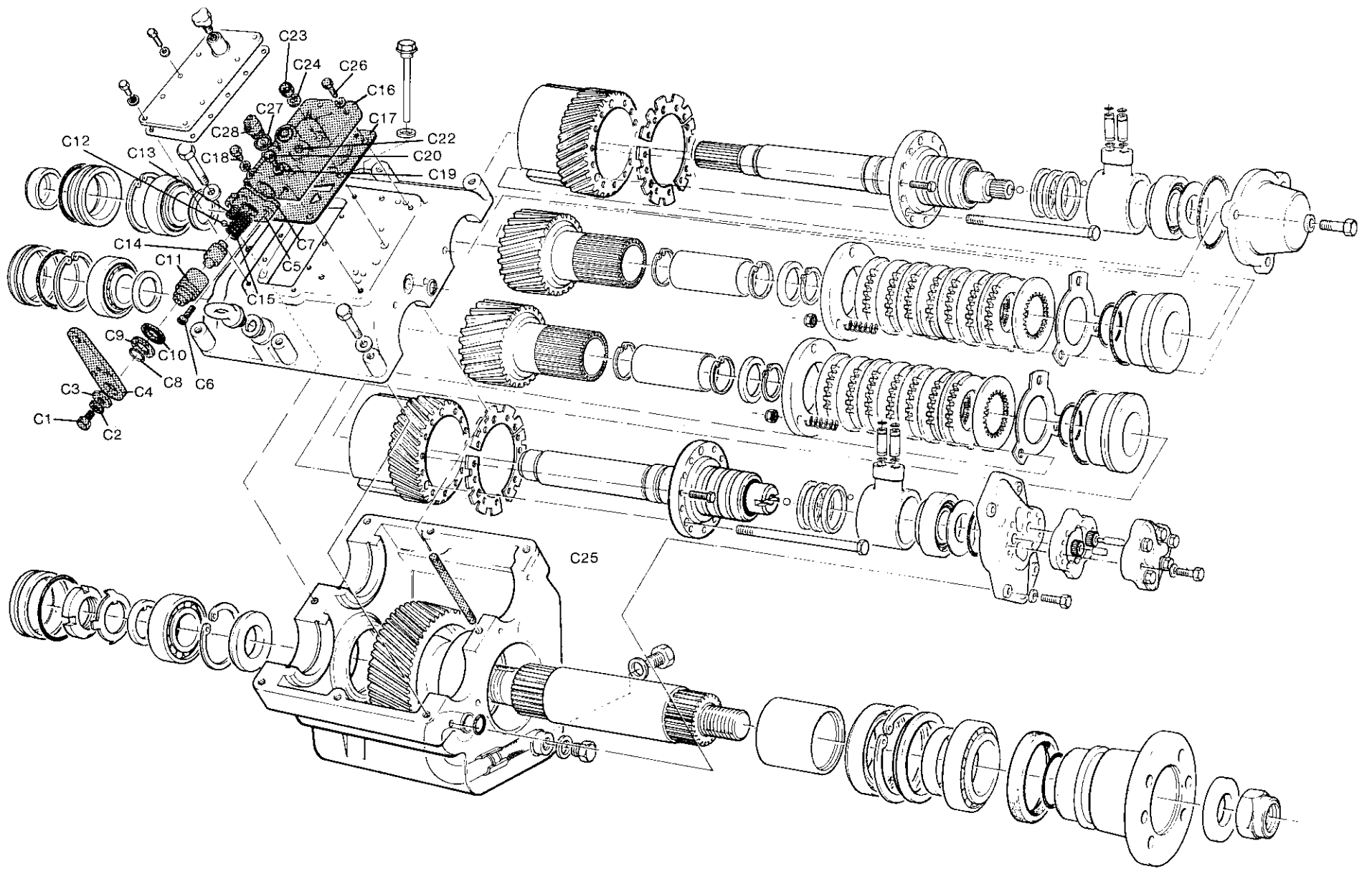


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
C28	Plug	CP1360	1	
C28	OR Switch Ball	CP1358 CP1077	1 1	} Neutral Safety Switch Retro-fit Kit MT0214



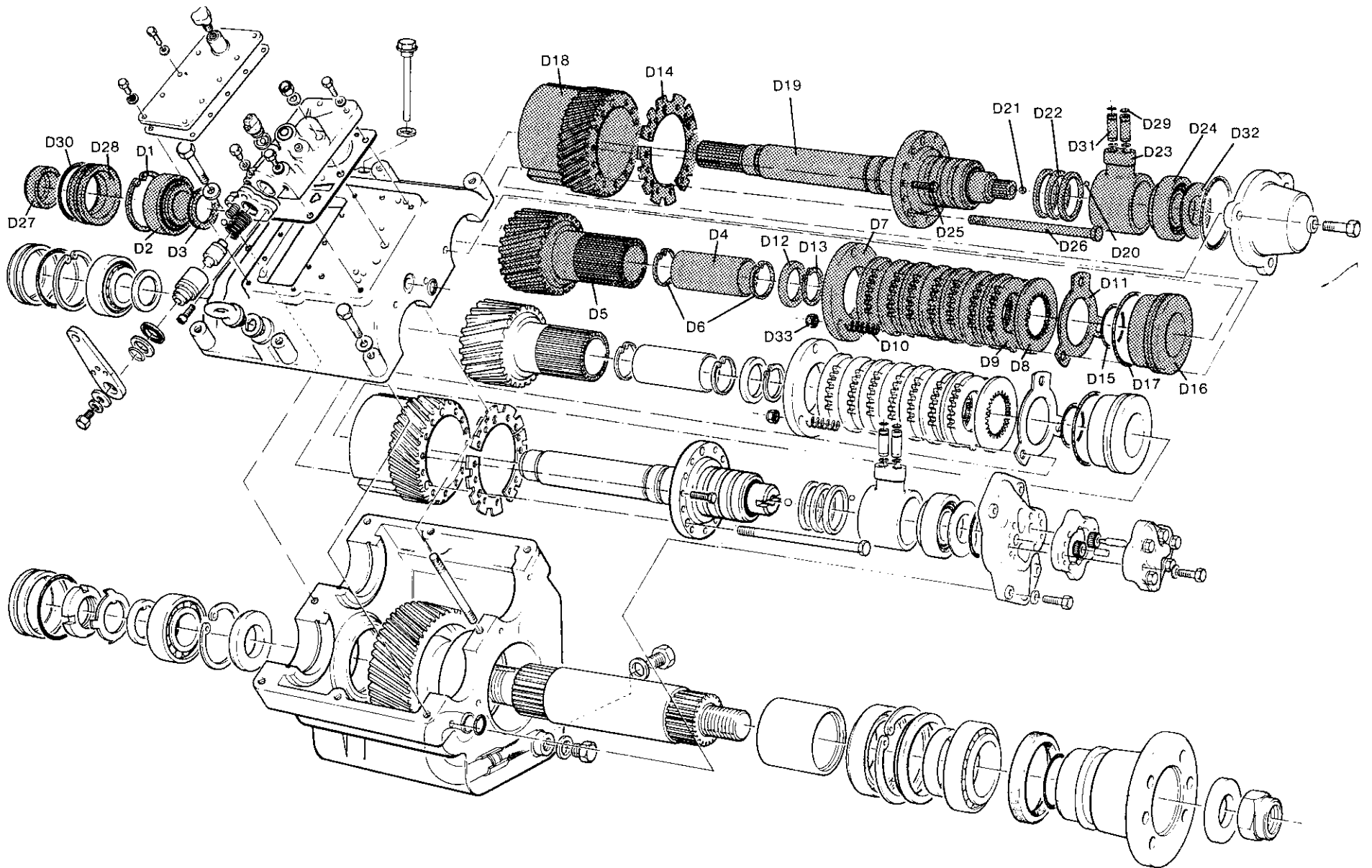


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
D.	Input Shaft Assembly			
	Input shaft 1:1	MT0198/1	1	
	Input shaft 1.5:1	MT0198/1.5	1	
	Input shaft 2:1	MT0198/2	1	
	Input shaft 2.5:1	MT0198/2.5	1	
	Input shaft 3:1	MT0198/3	1	
	Input shaft 4:1	MT0198/3	1	
	comprising:			
D1	Circlip	CM2077	1	
D2	Taper roller bearing	0540301	1	
D3	Spacer	MT1090	1	
	Drive Pinion S/A	MT0196/1	1	
D4	Bush	MT416	2	
D5	Pinion 1:1	MT1323	1	Supplied complete only Not supplied separately 43 teeth. Not supplied separately
	Drive Pinion S/A	MT0196/1.5	1	
D4	Bush	MT1266	1	
D5	Pinion 1.5:1	MT1261	1	Supplied complete only Not supplied separately 37 teeth. Not supplied separately
D6	Snap ring	0320390	2	Not supplied separately
	Drive Pinion S/A	MT0196/2	1	
D4	Bush	MT1266	1	
D5	Pinion 2:1	MT1262	1	Supplied complete only Not supplied separately 31 teeth. Not supplied separately
D6	Snap ring	0320390	2	Not supplied separately
	Drive Pinion S/A	MT0196/2.5	1	
D4	Bush	MT1266	1	
D5	Pinion 2.5:1	MT1418	1	Supplied complete only Not supplied separately 23 teeth. Not supplied separately
D6	Snap ring	0320390	1	Not supplied separately

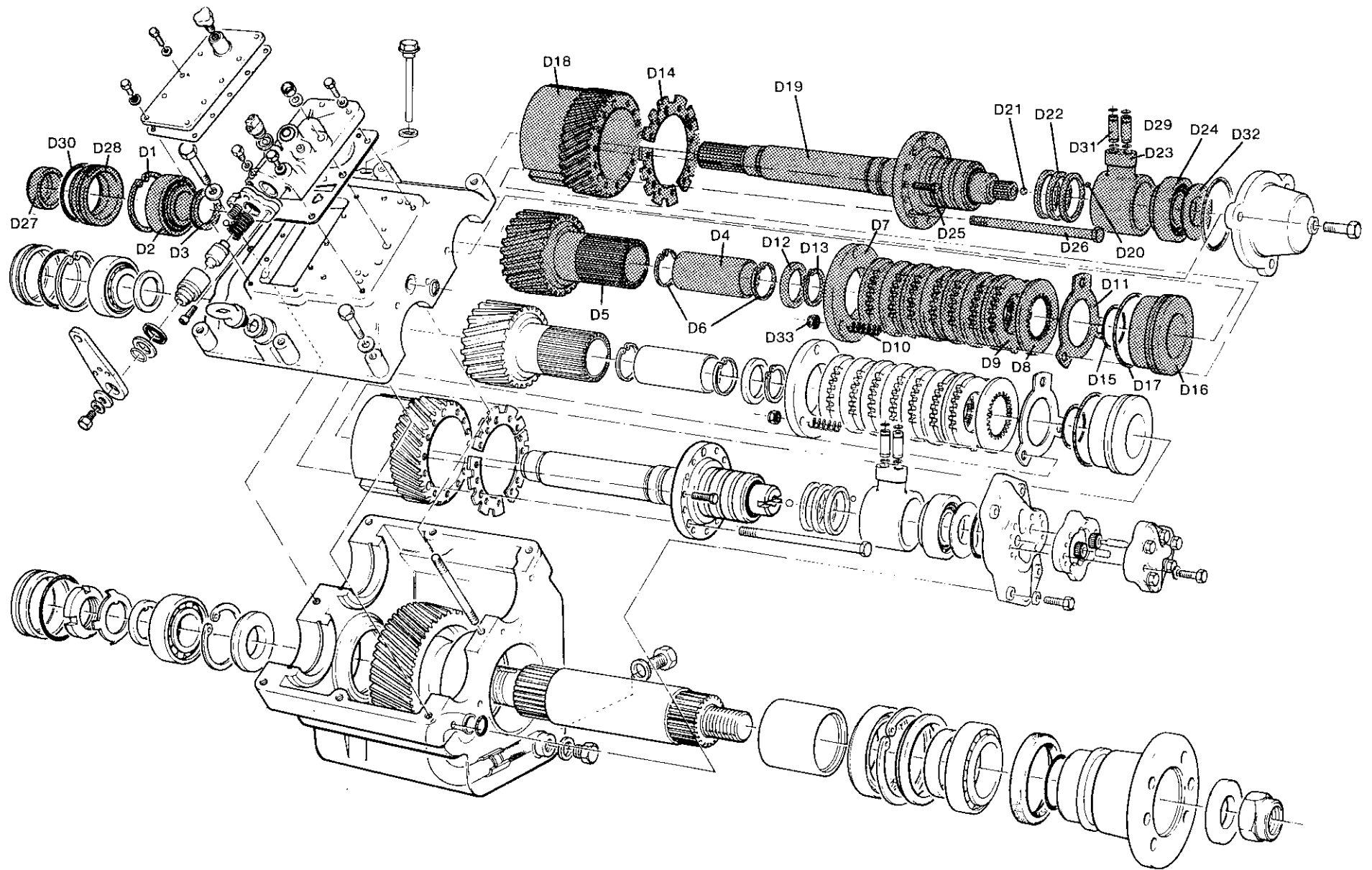


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks	
	Drive Pinion S/A	MT0196/3	1	Supplied complete only Not supplied separately	
D4	Bush	MT1266	1		
D5	Pinion 3:1	MT1263	1		
D6	Snap ring	0320390	2	Not supplied separately	
	Drive Pinion S/A	MT0196/3	1	Supplied complete only Not supplied separately	
D4	Bush	MT1266	1		
D5	Pinion 4:1	MT1263	1		
D6	Snap ring	0320390	2	Not supplied separately	
	Clutch Pack	MT0247	1	} Not supplied separately	
D7	Clutch end cover	MT1282	1		
D8	Clutch plate driver	MT725	8		
D9	Clutch plate driven	MT982	7		
D10	Spring	MT1067	3		
D11	End plate	MT983	1		
D12	Spacer	MT939	1		
D13	Circlip	0270350	1		
D14	Tab strip	MT1289	3		
D33	Nut	0050606 HT	3		Part of MT0247
D15	Piston O ring	0421503	1	} Not supplied separately	
D16	Piston	MT1264	1		
D17	Piston O ring	003504	1		
D18	Clutch gear	MT1286	1		
D19	Input shaft	MT1321	1		Supplied as MT1321 S/A (including CP1180 and CP1191)
D20	Ball	CP1180	1		} Not supplied separately
D21	Ball	CP1191	1		
D22	Piston ring	MT292	3		

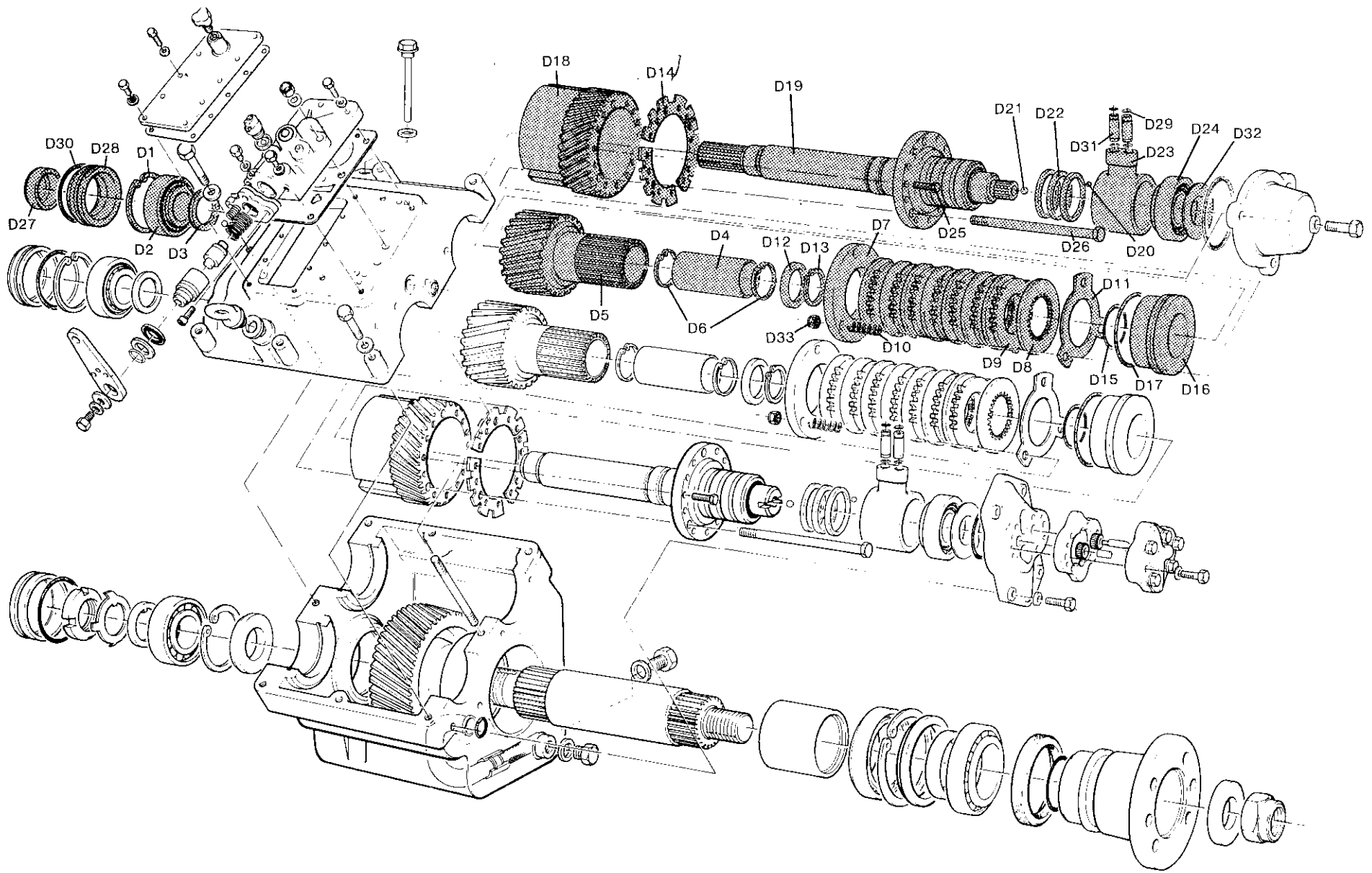


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
D23	Feeder	MT380	1	
D24	Taper roller bearing	0540351	1	
D25	Screw	0040609 HT	12	
D26	Bolt	MT1290	3	
D27	Oil seal	MT251	1	Not used when Angle Drive is fitted
D28	End cover	MT1068	1	Not used when Angle Drive is fitted
D29	O ring	000372	4	
D30	O ring	002874	1	Not used when Angle Drive is fitted
D31	Connector	MT1057	2	
D32	Shim .002"	MT1077/02	AR	
D32	Shim .010"	MT1077/10	AR	
D32	Shim .031"	MT1077/31	AR	

**Note:-** For 4:1 ratio Input Shaft Assembly is MT0198/3

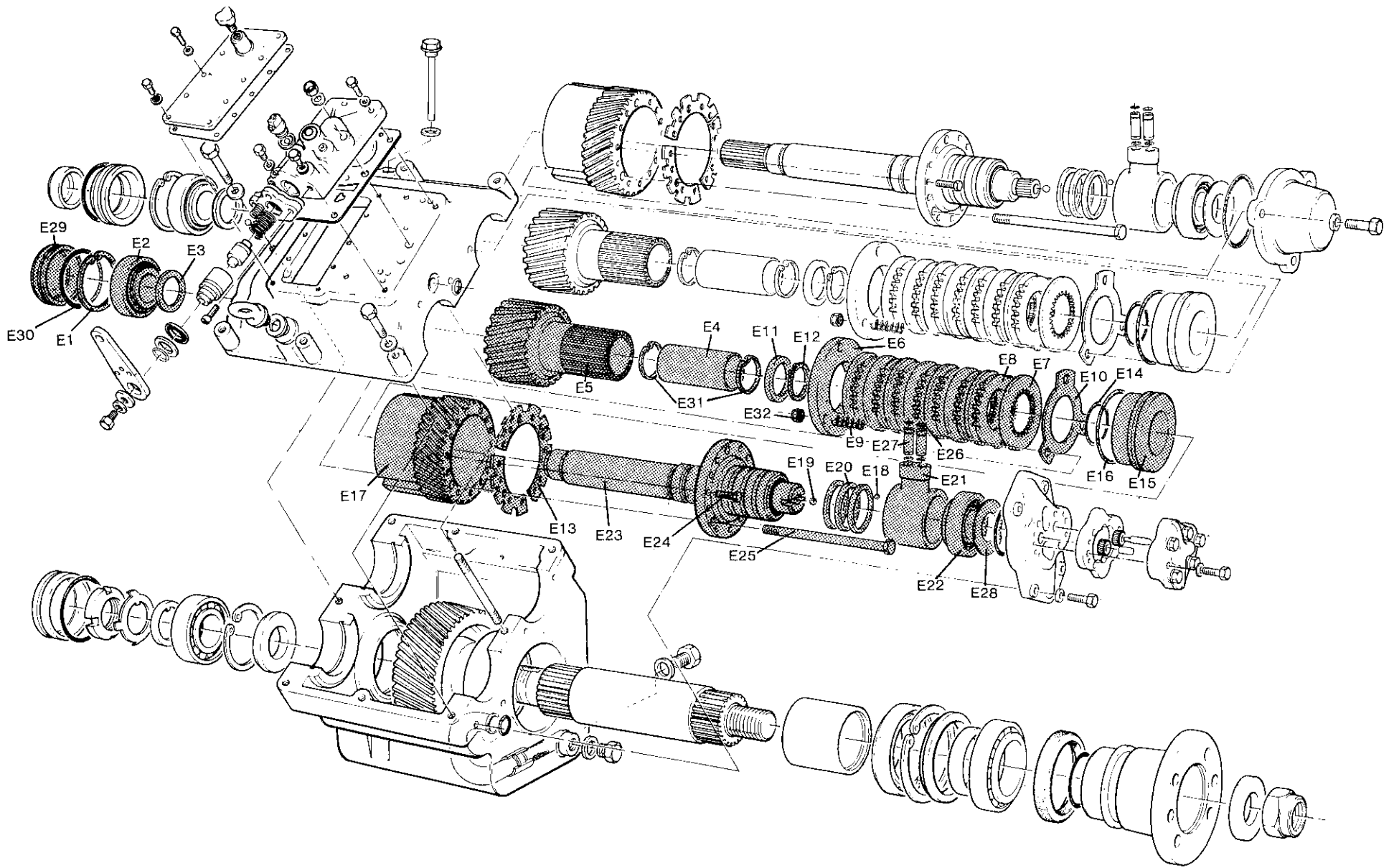


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
E	Layshaft Assembly Layshaft assembly 1:1 Layshaft assembly 1.5:1 Layshaft assembly 2:1 Layshaft assembly 2.5:1 Layshaft assembly 3:1 Layshaft assembly 4:1	MT0197/1 MT0197/1.5 MT0197/2 MT0197/2.5 MT0197/3 MT0197/3	1 1 1 1 1 1	
	comprising:			
E1	Circlip	CM2077	1	
E2	Taper bearing	0540301	1	
E3	Spacer	MT1090	1	
E4	Drive Pinion S/A	MT0196/1	1	Supplied complete only not supplied separately
E5	Bush	MT416	2	
E5	Pinion 1:1	MT1323	1	43 teeth. Not supplied separately
E4	Drive Pinion S/A	MT0196/1.5	1	Supplied complete only Not supplied separately
E5	Bush	MT1266	1	
E5	Pinion 1.5:1	MT1261	1	37 teeth. Not supplied separately
E4	Drive Pinion S/A	MT0196/2	1	Supplied complete only Not supplied separately
E5	Bush	MT1266	1	
E5	Pinion 2:1	MT1262	1	31 teeth. Not supplied separately
E31	Snap ring	0320390	2	Not supplied separately
E4	Drive Pinion S/A	MT0196/2.5	1	Supplied complete only Not supplied separately
E5	Bush	MT1266	1	
E5	Pinion 2.5:1	MT1418	1	23 teeth. Not supplied separately
E31	Snap ring	0320390	2	Not supplied separately



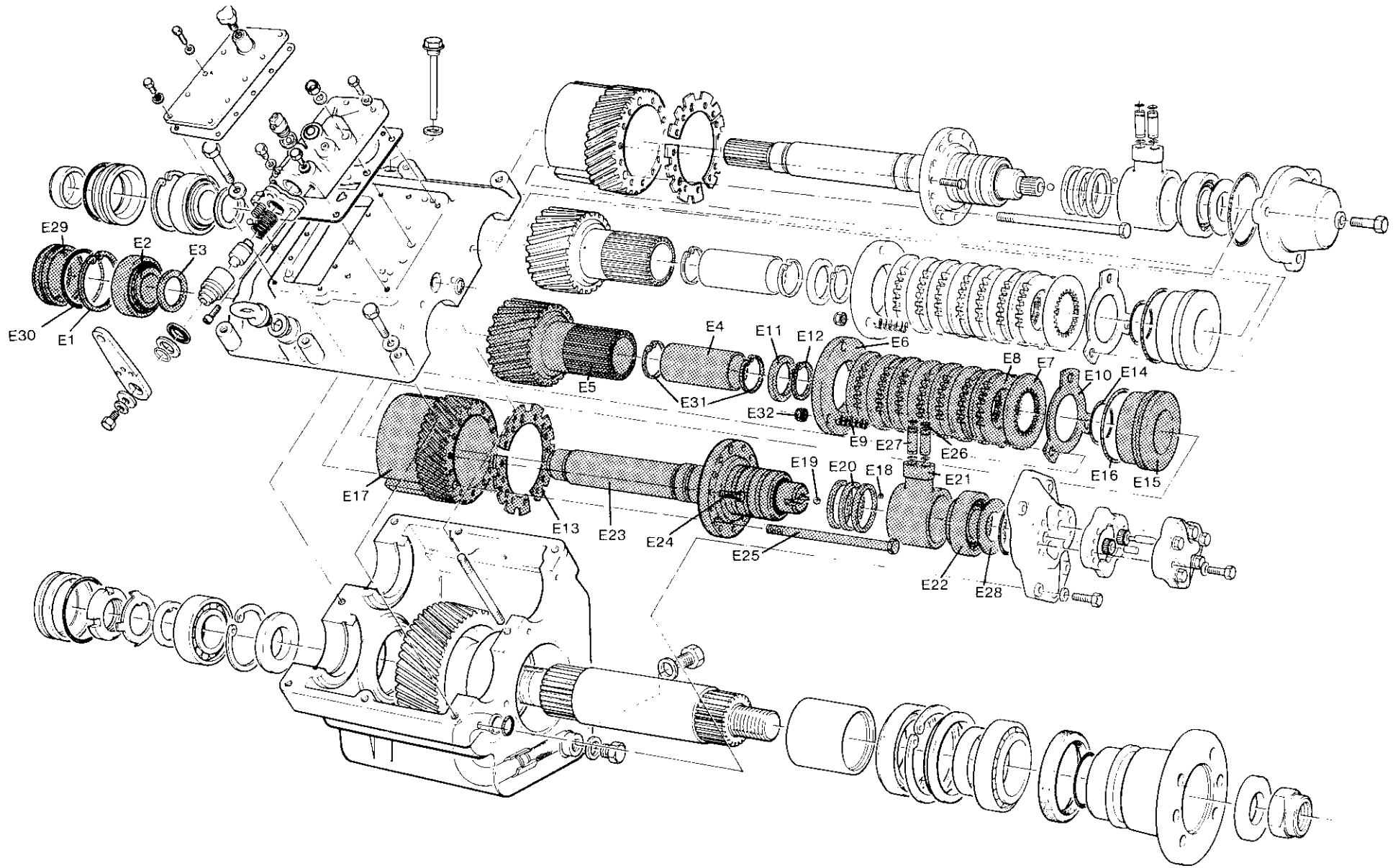


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
E4	Drive Pinion S/A	MT0196/3	1	Supplied complete only Not supplied separately
E5	Bush	MT1266	1	
E5	Pinion 3:1	MT1263	1	
E31	Snap ring	0320390	2	Not supplied separately
E4	Drive Pinion S/A	MT0196/3	1	Supplied complete only Not supplied separately
E5	Bush	MT1266	1	
E5	Pinion 4:1	MT1263	1	
E31	Snap ring	0320390	2	Not supplied separately
E6	Clutch Pack	MT0247	1	Not supplied separately
E7	Clutch end cover	MT1282	1	
E7	Clutch plate driver	MT725	8	
E8	Clutch plate driven	MT982	7	
E9	Spring	MT1067	3	
E10	Clutch end plate	MT983	1	
E11	Spacer	MT939	1	
E12	Circlip	0270350	1	
E13	Tabstrip	MT1289	3	
E32	Nut	0050606HT	3	
E14	Piston O ring	0421503	1	Part of MT0247
E15	Piston	MT1264	1	
E16	Piston O ring	003504	1	
E17	Clutch gear	MT1287	1	
E18	Ball	CP1180	1	
E19	Ball	066MO50	1	
E20	Piston ring	MT292	3	
E21	Feeder	MT380	1	
E22	Bearing	0540351	1	

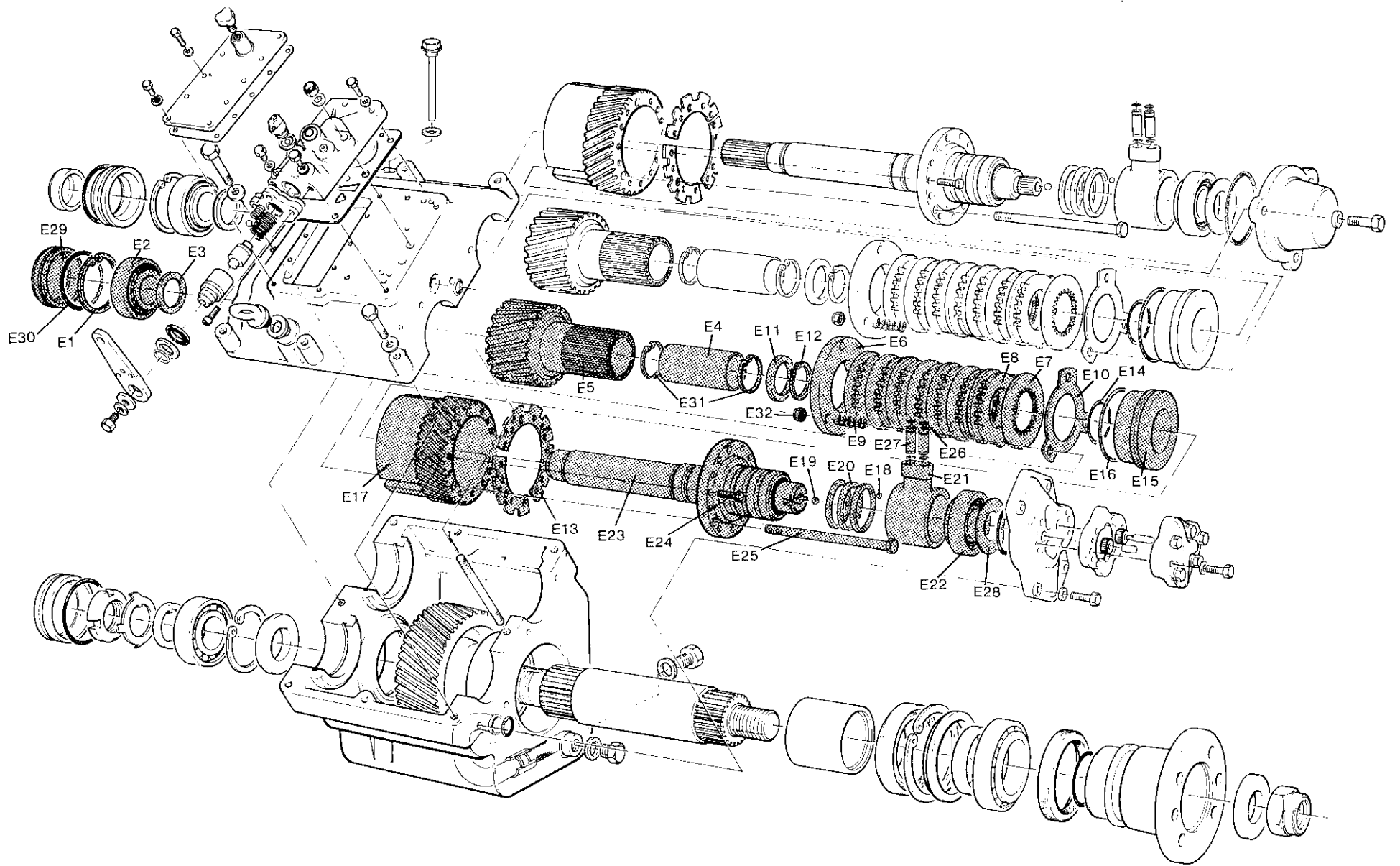


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
E23	Layshaft	MT1260	1	Supplied as MT1260 S/A (including CP1180 and 066MO50
E24	Screw	0040609 HT	12	
E25	Bolt	MT1290	3	
E26	O Ring	000372	4	
E27	Connector	MT1057	2	
E28	Shim .002"	MT1077/02	AR	
E28	Shim .010"	MT1077/10	AR	
E28	Shim .031"	MT1077/31	AR	
E29	End cover	MT1069	1	
E30	O ring	002874	1	

**Note:-** For 4:1 ratio Layshaft Assembly is MT0197/3

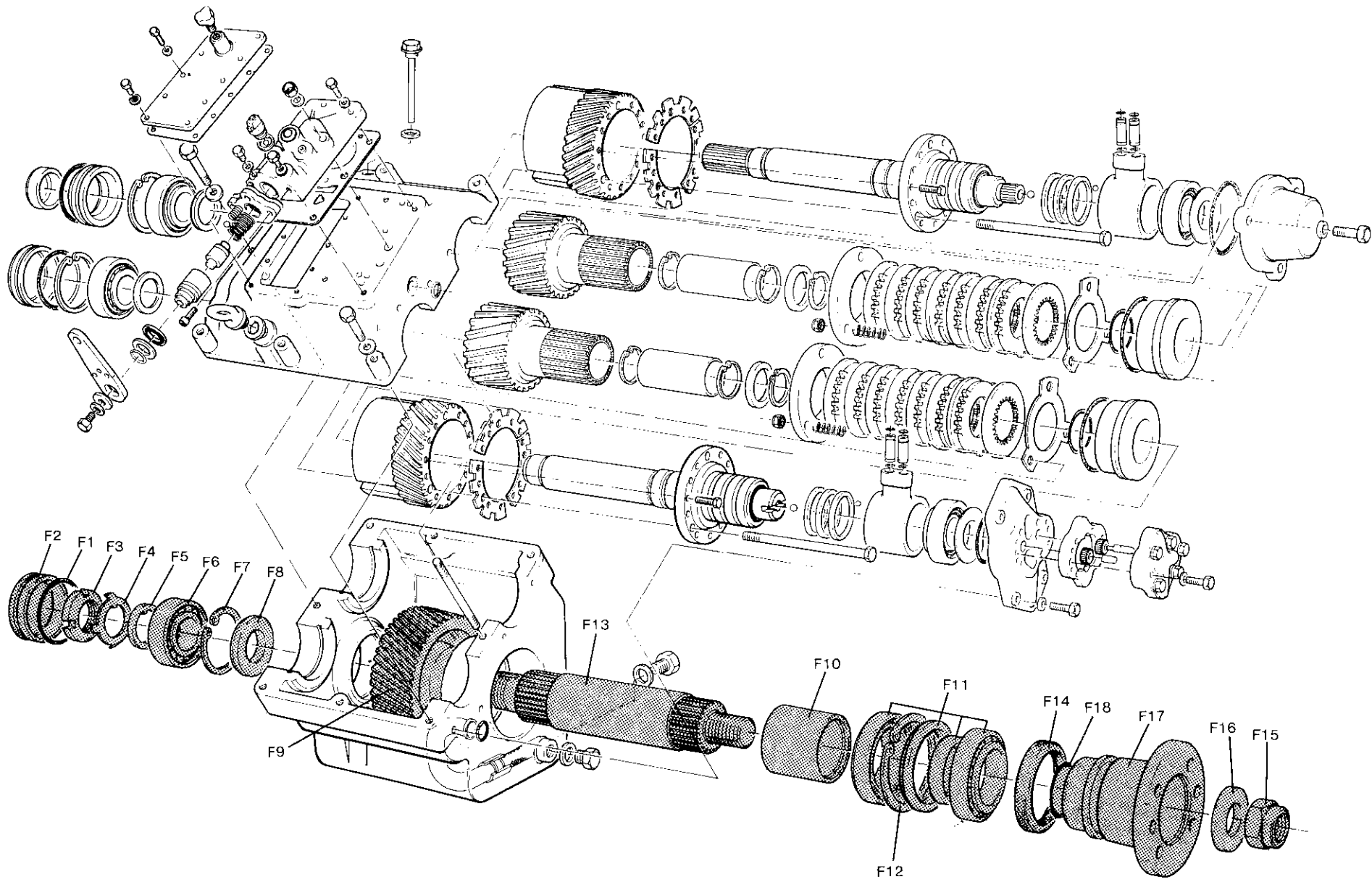


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
F.	Output Shaft Assembly comprising:			
F1	O ring	002874	1	Not used when Angle Drive is fitted
F2	End cover	MT1333	1	Not used when Angle Drive is fitted
F3	Locknut	*CP1314	1	
F4	Tab washer	CP1315	1	
F5	Tongue washer	MT1331	1	
F6	Roller bearing	0533531	1	
F7	Circlip	CM2077	1	
F8	Spacer	MT1332	1	
F8	Spacer (4:1 only)	*MT1405	1	
F9	Output gear 1:1	MT1324	1	47 teeth
F9	Output gear 1.5:1	MT1064	1	54 teeth
F9	Output gear 2:1	MT1254	1	60 teeth
F9	Output gear 2.5:1	MT1419	1	59 teeth
F9	Output gear 3:1	MT1316	1	61 teeth
F9	Output gear 4:1	MT1403	1	83 teeth. Only supplied as assembly 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 assembly MT0270/4
F14	Oil seal	MT252	1	
F15	Locknut	*400-2200	1	
F16	Coupling washer	*MT1251	1	
F17	Output coupling	MT1250	1	Fitted to gearboxes after January, 1983
F18	O ring	001873	1	

**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 gear, output shaft and items marked\*.

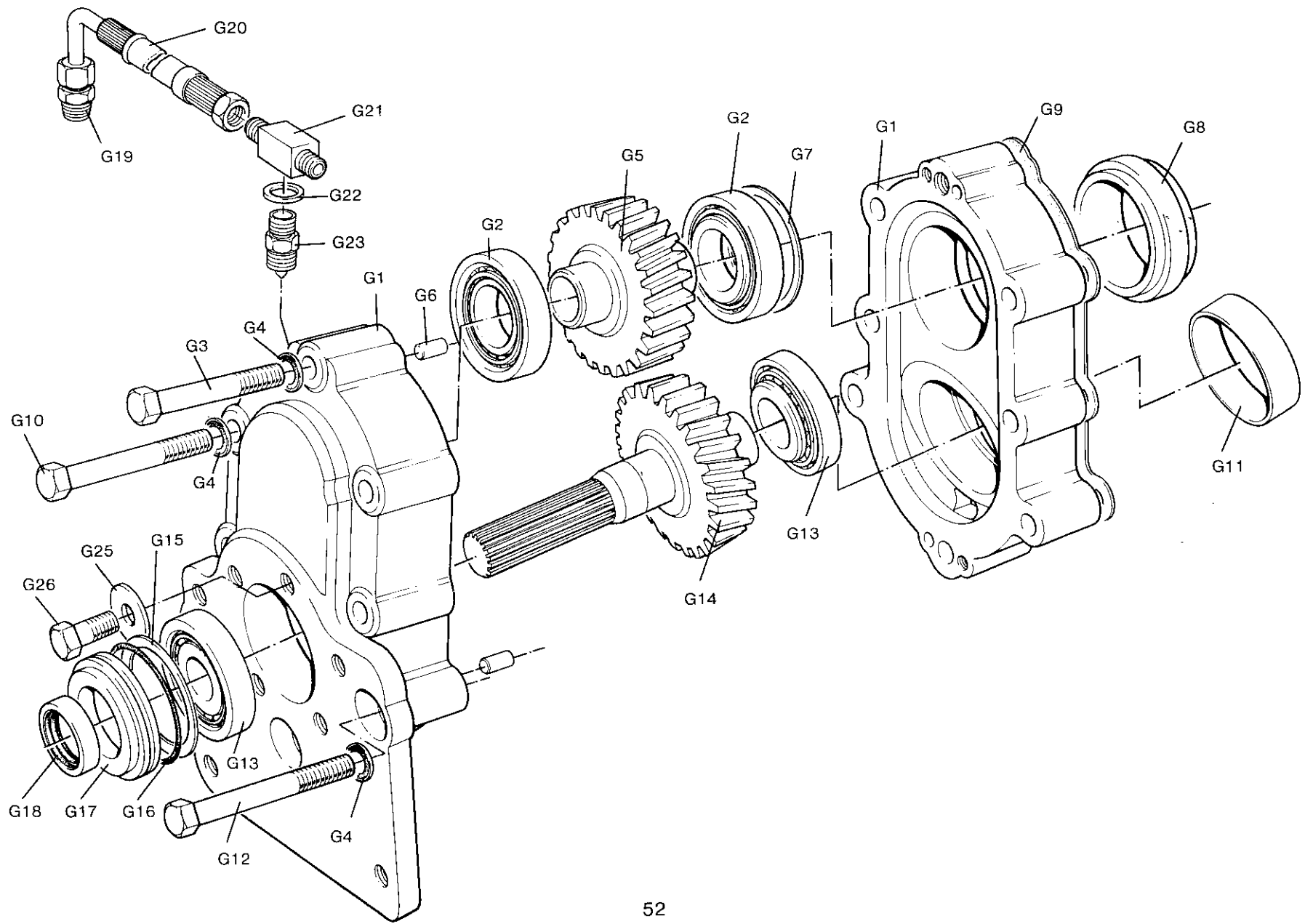


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
G.	Down Angle Drive Unit comprising:	MT0210		
G1	Gearcase S/A	MT0189	1	Not supplied separately
	Half case (front)	MT1273	1	
	Half case (rear)	MT1274	1	Not supplied separately
G2	Taper roller bearing	0540351	2	
G3	Bolt	0041216	1	
G4	Dowty seal washer	0191107	8	
G5	Output gear	MT1320	1	
G6	Dowel	0210815	2	
G7	Shim	MT1077	AR	
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	AR	
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	
G24	Dipstick	0800687	1	Not illustrated
G25	Washer	CM2123		Transit only
G26	Screw	0041206		Transit only



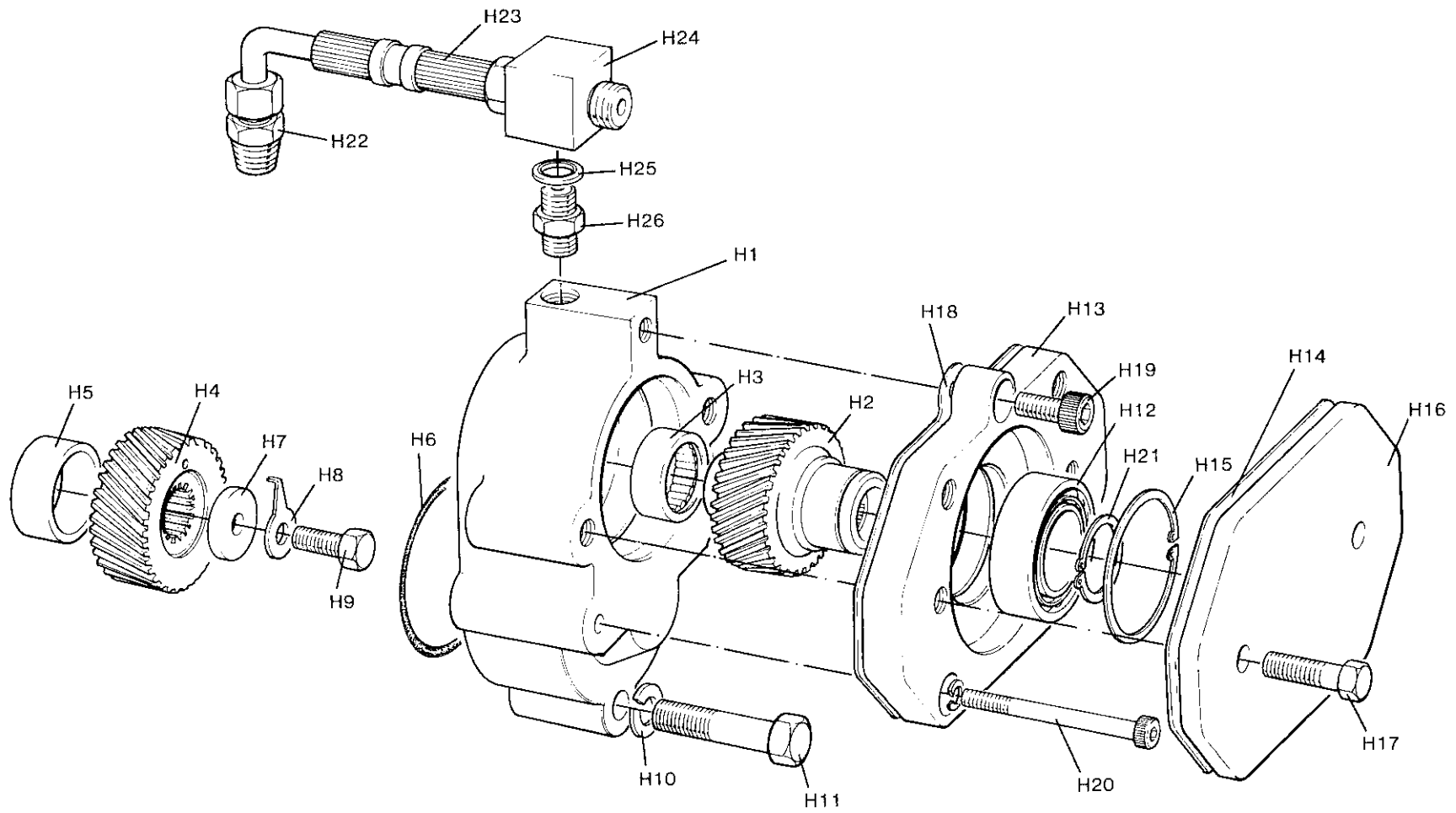


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
H.	Power Take Off Assembly comprising:	MT0193	1	SAE B Flange, 2 or 4 bolt
H1	PTO housing	MT1300	1	
H2	Driven gear	MT1297	1	
H3	Needle bearing	0563003	1	
H4	Driving gear	MT1296	1	
H5	Spacer	MT1295	1	
H6	O ring	0430771	1	
H7	Washer	MT1301	1	
H8	Tab washer	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	Not illustrated
H22	Adaptor	CP1255	1	
H23	Oil pipe	MT766	1	
H24	Tee piece	CP1367	1	
H25	Washer	0201715	1	
H26	Metering union	MT4583	1	

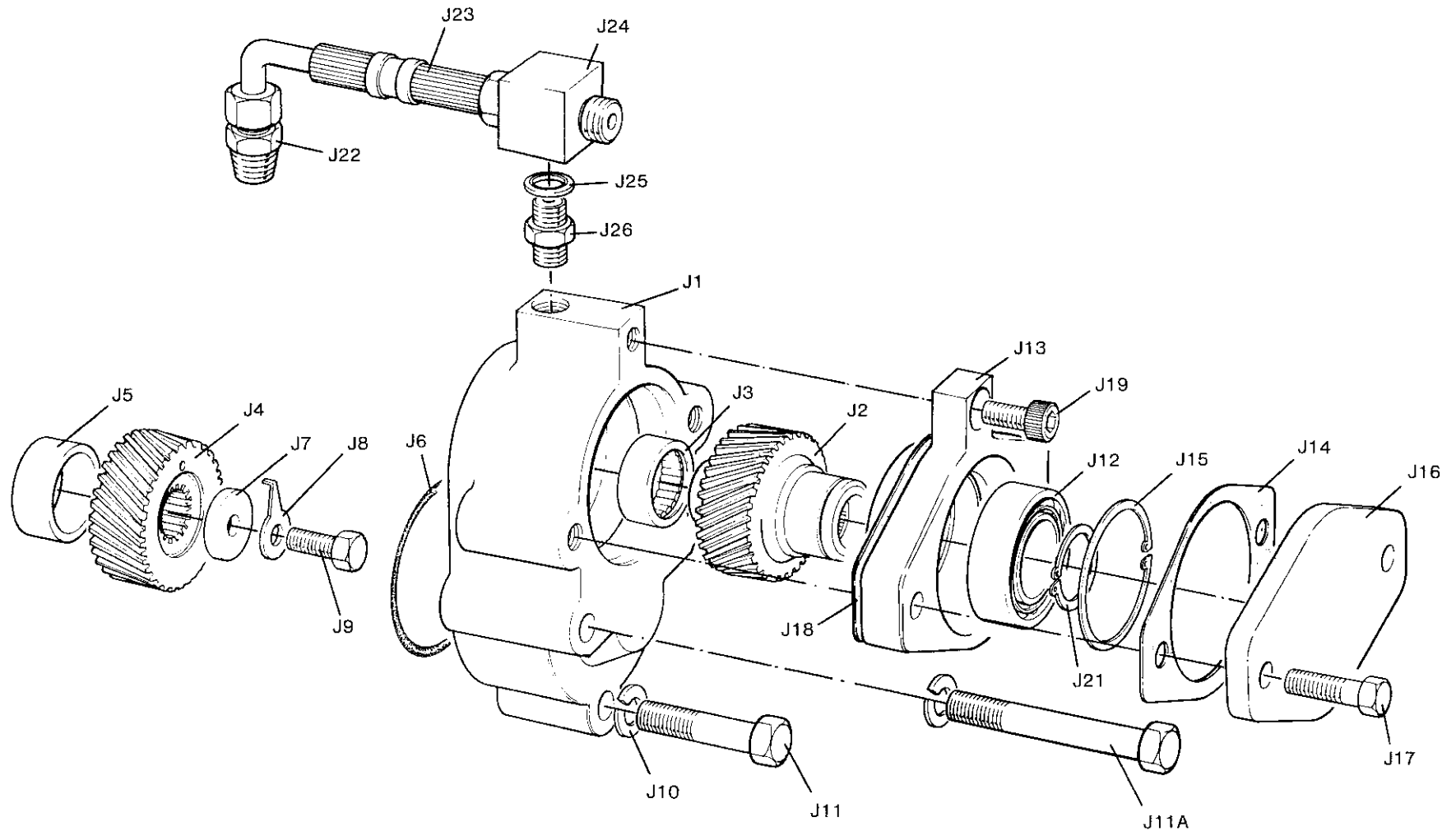


Plate Ref.	Description	PRM401 Part No.	Qty.	Remarks
J.	Power Take Off Assembly comprising:	MT0194	1	SAE A Flange
J1	PTO housing	MT1300	1	
J2	Driven gear	MT1305	1	
J3	Needle bearing	0563003	1	
J4	Driving gear	MT1296	1	
J5	Spacer	MT1295	1	
J6	O ring	0430771	1	
J7	Washer	MT1301	1	
J8	Tab washer	MT1302	1	
J9	Screw	0041008	1	
J10	Spring washer	0191107	3	
J11	Bolt	0041216	1	
J11A	Bolt	0041219	2	
J12	Ball bearing	40M433	1	
J13	Adaptor flange	MT1298	1	
J14	Gasket	MT1234	1	
J15	Circlip	0250620	1	
J16	Cover plate	MT1294	1	
J17	Screw	0041012	2	Transit only
J18	Gasket	MT1304	1	
J19	Cap screw	0081520	1	
J21	Circlip	CM2067	1	
J22	Adaptor	CP1255	1	
J23	Oil pipe	MT766	1	
J24	Tee piece	CP1367	1	
J25	Washer	0201715	1	
J26	Metering union	MT4583	1	
J27	Nut	0051001	2	Not illustrated

**Kits of Parts.**

<b>Part No.</b>	<b>Description</b>	<b>Quantity</b>	<b>Part No.</b>	<b>Description</b>	<b>Quantity</b>
<b>MT0115</b>	<b>Pump Repair Kit</b>		0421503	'O' ring	2
MT378	Pump spindle	1	043077	'O' ring	1
MT379	Pump gear	1	MT1073	Gasket	1
MT4544 S/A	Spindle assembly	1	MT1081	Gasket	1
			MT251	Oil seal	1
			MT252	Oil seal	1
			MT343	Gasket	1
<b>MT0214</b>	<b>Starter Cut-Out Kit</b>		<b>MT0252</b>	<b>Strip and Inpection Kit</b>	
0201715	Dowty washer	1	0050606 HT	Nyloc nut	3
CP1077	Detent ball	1	0270350	Snap ring	2
CP1358	Switch	1	MT0251	'O' ring kit	1
			MT1067	Clutch spring	3
			MT1289	Tab washer	3
<b>MT0247</b>	<b>Clutch Pack</b>		<b>MT0253</b>	<b>Conversion Kit 1.09:1</b>	
0050606 HT	Nyloc nut	3	MT0196/1	Pinion S/A	2
0270350	Snap ring	1	MT0251	'O' ring kit	1
MT1067	Clutch ring	3	MT1324	Output gear	1
MT1282	Clutch end cover	1			
MT1289	Tab washer	3	<b>MT0254</b>	<b>Conversion Kit 1.459:1</b>	
MT725	Clutch plate (driver)	8	MT0196/1.5	Pinion S/A	2
MT939	Spacer	1	MT0251	'O' ring kit	1
MT982	Clutch plate (driven)	7	MT1064	Output gear	1
MT983	Clutch end plate	1			
<b>MT0250</b>	<b>Borg Warner Adaptor Kit</b>		<b>MT0255</b>	<b>Conversion Kit 1.935:1</b>	
0041206	Screw	2	MT0196/2	Pinion S/A	2
0051205	Nut	5	MT0251	'O' ring kit	1
0191107	Special washer	2	MT1254	Output gear	1
MT1279	Adaptor	1			
MT1382	Stud	5	<b>MT0256</b>	<b>Conversion Kit 2.904:1</b>	
MT1383	Retaining spring	1	MT0196/3	Pinion S/A	2
			MT0251	'O' ring kit	1
			MT1316	Output gear	1
<b>MT0251</b>	<b>'O' Ring Kit</b>				
000372	'O' ring	8			
000753	'O' ring	1			
000872	'O' ring	1			
001254	'O' ring	2			
001873	'O' ring	1			
002874	'O' ring	3			
003383	'O' ring	1			
003504	'O' ring	2			



