PRM 601M
BY NEWAGE

WORKSHOP MANUAL

NEWAGE

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PRM GEARBOXES
BY NEWAGE

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

Newage 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.

COMPONENT IDENTIFICATION

In sections of this book relating to installation, operation and servicing, components are identified by a letter followed by a number (eg. item B10). The letter refers to the illustration in the spare parts list and the number corresponds to the item number on that illustration.
eg. item B10 is an 'O' ring.

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:

NEWAGE PRM COVENTRY
123456 A1234
601MVR2
USE RECOMMENDED LUBRICANTS ONLY

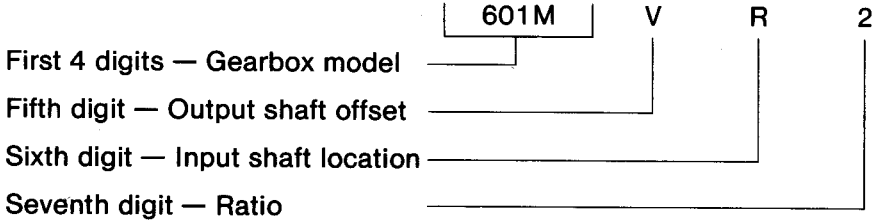
NEWAGE PRM COVENTRY
USE RECOMMENDED LUBRICANTS ONLY

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:-



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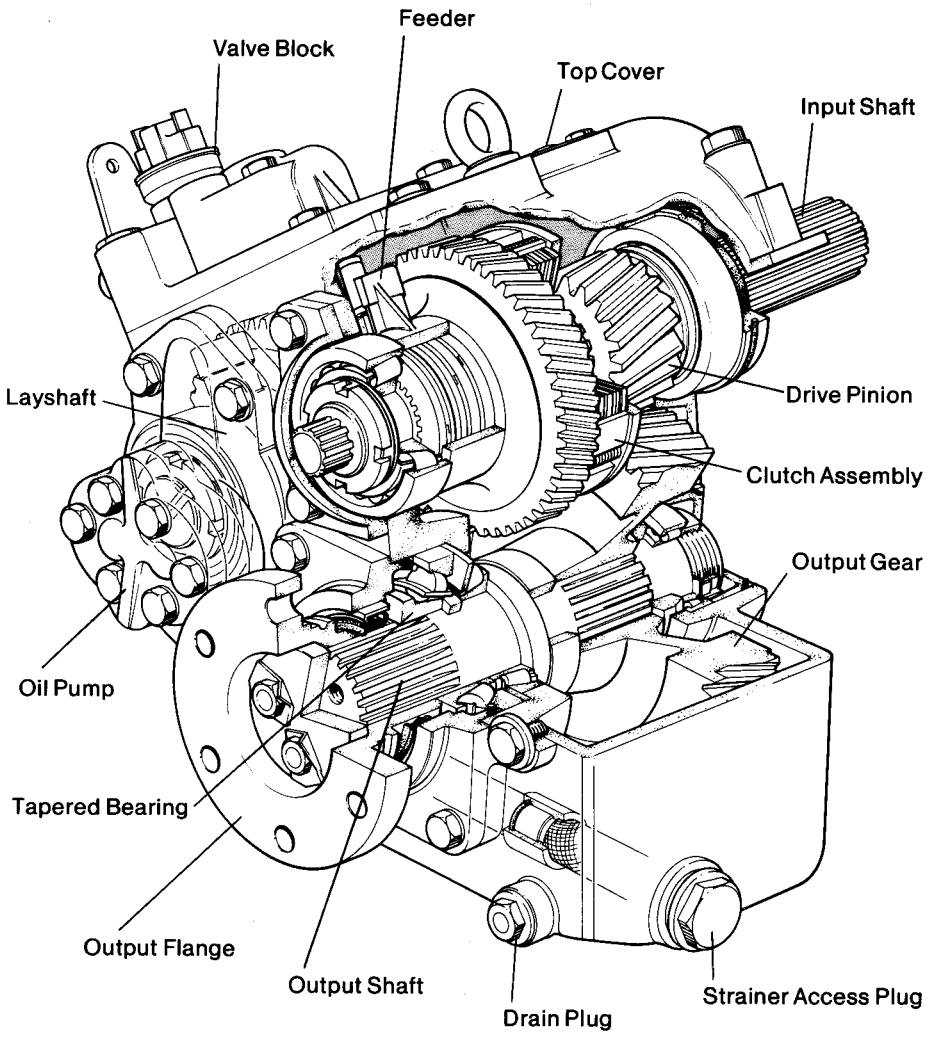


Fig. 1. Gearbox Cut-Away

1. GENERAL DATA

1.1 Specifications

Gear Ratios:

1.53:1, 2.03:1, 2.86:1 and 4.00:1

Power Rating:

1.53:1 up to 8.2kW (11.0hp) per 100 rev/min
2.03:1 up to 8.2kW (11.0hp) per 100 rev/min
2.86:1 up to 7.16kW (9.5hp) per 100 rev/min
4.00:1 up to 6.42kW (8.6hp) 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 3.6)

Output Rotation:

Clockwise or anti-clockwise as required.

Approximate Dry Weight:

All ratios excluding 4:1 - 86Kg (180lb) (excluding drive coupling, adaptor and cooler)

Additional weight: Power Take Off (direct drive)
Power Take Off (clutched)
Angle Drive 44Kg (97lb)

4:1 ratio - 93Kg (205lb) (excluding drive coupling, adaptor and oil cooler)

Additional Weight: Power Take Off (Direct Drive)
Power Take Off (Clutched)
Angle Drive 44Kg (97lb)

Oil Capacity:

3.25 litres (5.5 pints)
with Power Take Off : As above
with Angle Drive : 4 litres (6.8 pints)

Working Oil Pressure:

1790kPa (18.3Kg/cm^2 - 260lbf/in^2)

Working Oil Temperature:

50°C - 80°C
Maximum permissible temperature 90°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 9kW (12hp) capacity and a flow rate of 27 litres per hour per 1000 rev/min input should be adequate. Suitable coolers are available from Newage.

Input Drive Couplings:

Flexible drive coupling for flywheels of 11½in and 14in nominal diameter to SAE J620C.

Gearcase:

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

Input Shaft:

39.7mm (1.563in) diameter with 18 tooth involute spline, hardened alloy steel.

Propeller Thrust:

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

Output Flange:

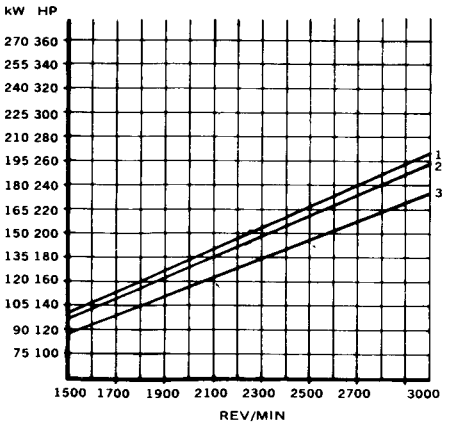
All ratios excluding 4:1
SAE 3 - 146mm (5.75in) diameter, with six holes 13.1mm (0.516in) diameter on a 121mm (4.75in) pitch circle diameter.

Ratio 4:1
SAE 4 - 184mm (7.25in) diameter, with six holes 16.3mm (0.614in) diameter on a 152mm (6.0in) pitch circle diameter.

Installation Angle:

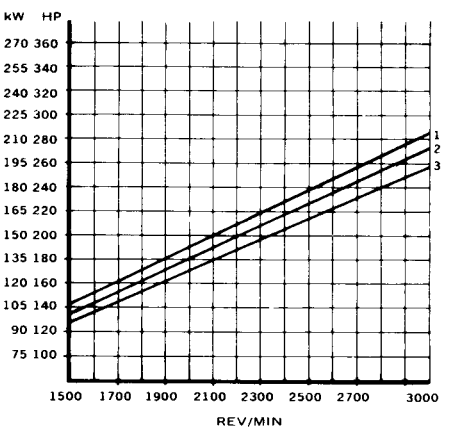
The maximum fore and aft installation angle permissible at rest is 15°.

1.2 Application Details



Class 1 Rating.
Workboats operating on continuous rating for more than 1,500 hours per year.

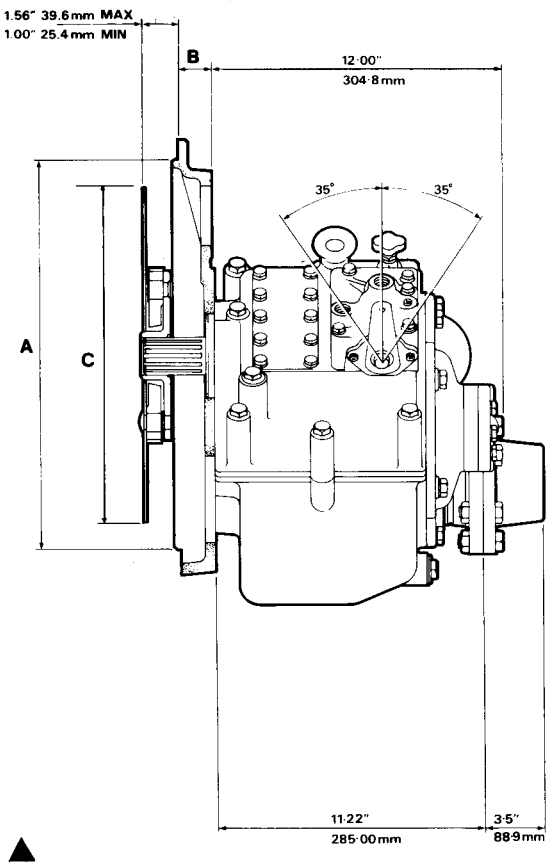
Power/Speed Ratios:
1. 1.5:1, 2:1 — 6.64kW (8.9hp) per 100 rev/min.
2. 3:1 — 6.42kW (8.6hp) per 100 rev/min.
3. 4:1 — 5.82kW (7.8hp) per 100 rev/min.

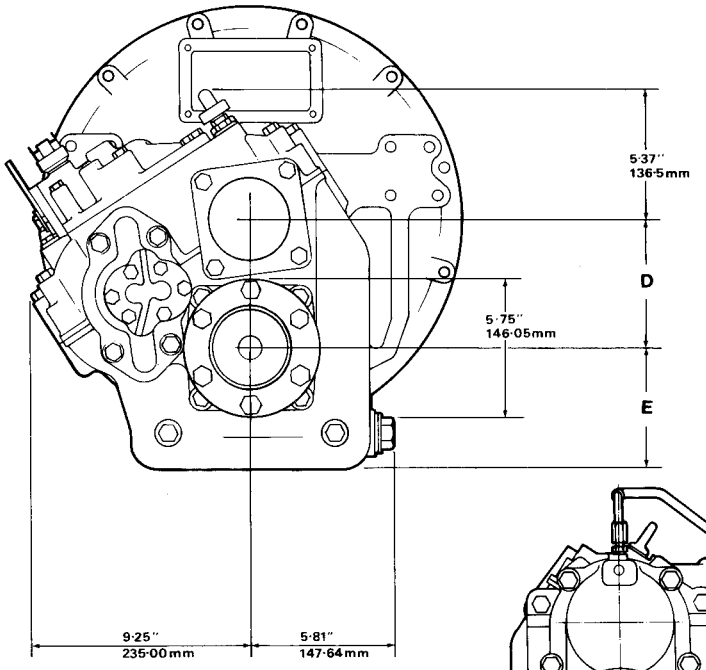


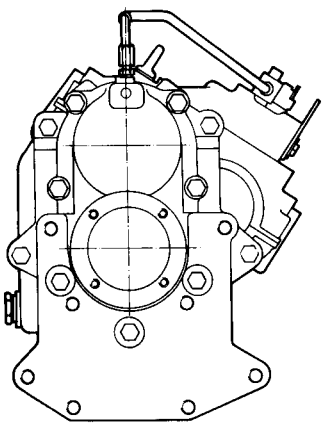
Class 2 Rating.
Workboats, fishing boats, passenger day boats and private craft operating less than 1,500 hours per year.

Power/Speed Ratios:
1. 1.5:1, 2:1 — 7.16kW (9.5hp) per 100 rev/min.
2. 3:1 — 6.79kW (9.1hp) per 100 rev/min.
3. 4:1 — 6.42kW (8.6hp) per 100 rev/min.

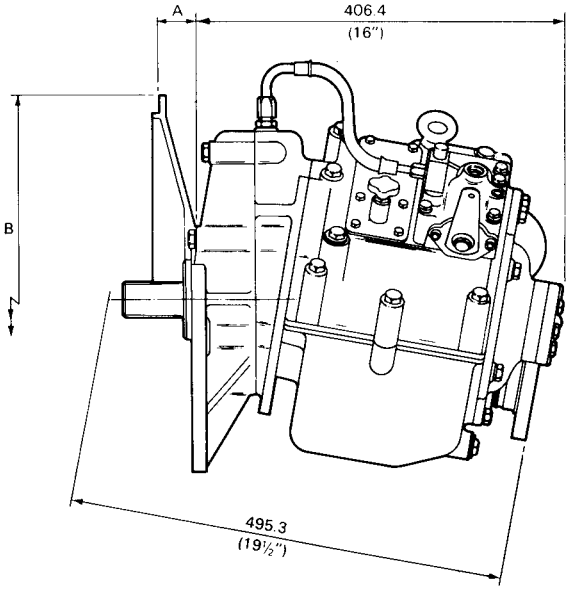
1.3 Installation Details







ADAPTOR	'A' DIMN.	'B' DIMN.
SAE 1	50.80mm (2.00")	511.17mm (20.125")
SAE 2	36.57mm (1.44")	447.55mm (17.625")
SAE 3	36.57mm (1.44")	409.55mm (16.124")



ADAPTOR PLATES	A	B
SAE 1	20.125" (511.17mm)	2.00" (50.80mm)
SAE 2	17.625" (447.67mm)	1.44" (36.57mm)
SAE 3	16.125" (409.57mm)	1.44" (36.57mm)

INPUT COUPLINGS	C
SAE 11½	13.875" (352.29mm)
SAE 14	18.375" (446.70mm)

DROP CENTRE DISTANCE	D	E
1.428:1 2.03:1 2.85:1	5.315" (135.00mm)	5.000" (127.00mm)
4:1	6.856" (174.00mm)	6.375" (162.00mm)

2. INTRODUCTION

Newage PRM 601M marine transmissions are oil-operated gearboxes of the countershaft type with separate oil-operated multi-disc clutches (which need no adjustment) for both ahead and astern drive. The design allows either left-hand or right-hand propeller rotation to be obtained in ahead drive with identical ratios and performance, and also permits full rated power to be transmitted in astern as well as ahead drive.

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

Note: engine and transmission rotation are described as seen when standing behind the gearbox output coupling, facing forwards towards the engine.

3. CONSTRUCTION

3.1 Gear cases

The cases of both the main gearbox and the angle drive are of heavy duty cast iron construction combining rigidity and strength with resistance to the marine environment.

The main gearcase, which is constructed in two parts for ease of servicing, is provided with a magnetic drain plug on its rear face. A second non-magnetic plug is provided alongside, and can be removed if a permanent sump drain pump is fitted.

The gearbox casing has been kept free from hydraulic pipes, cylinders, and associated components; the only items mounted externally on the PRM 601M are the oil pump, hydraulic control valve, and the operating lever. The PRM 601MA however, has external pipes connecting the angle drive to the oil supply of the main gearbox.

3.2 Gear Train — Main Gearbox

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

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), an emergency engaging device, 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.

The emergency drive acts on the layshaft assembly where the gearbox is fitted to an installation which includes an engine of left-hand crankshaft rotation and a left-hand propeller, or a right-hand rotating engine together with a right-hand propeller. With twin engine installations which includes one right-hand propeller and one left-hand propeller, the drive acts on the input shaft in one gearbox and the layshaft in the other gearbox.

The output shaft runs on taper roller bearings, so arranged as to enable propeller thrust to be absorbed, and the shaft carries the output gear of appropriate size and the output flange.

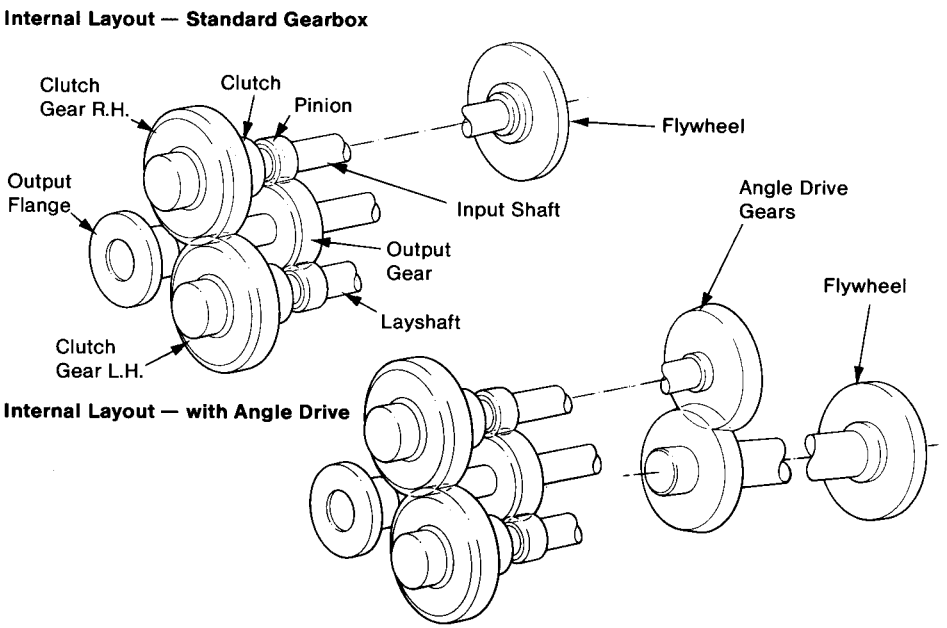


Fig. 2. Internal Layout Diagram

3.3 Gear Train — Angle Drive Unit

The angle drive unit incorporates a pair of conical involute gears so arranged that the output shaft runs at an angle of 10° 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 gear case 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.

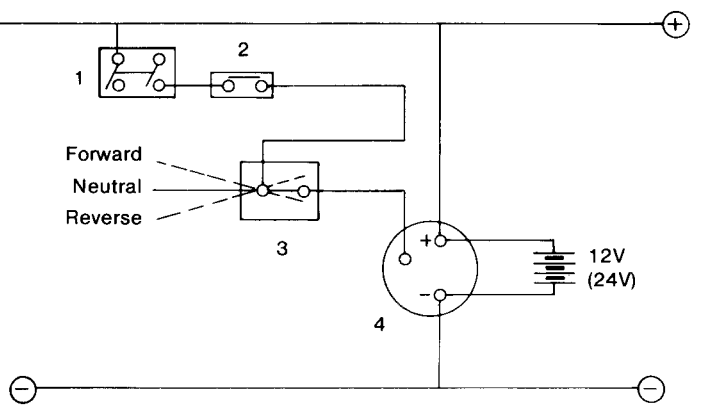
The control valve is fitted with a spring-loaded neutral detent; this provides a positive neutral position and ensures positive selection of either ahead or astern drive.

3.5 Neutral Safety Start Switch

Also provided is 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.

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.

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



1. Start key switch
2. Starter push switch
3. Neutral safety switch
4. Solenoid/starter motor

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

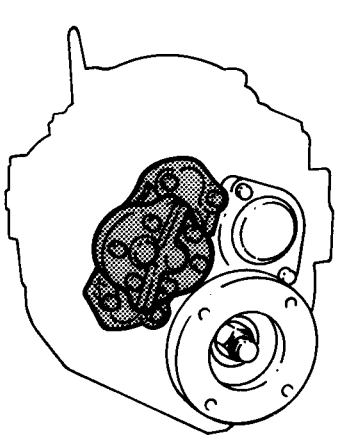
3.6 Oil Pump

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.

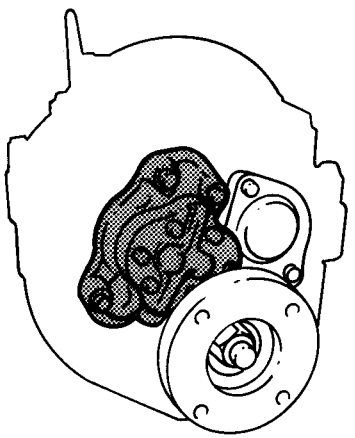
When the transmission is used with anti-clockwise engines, (looking at the flywheel) or, with clockwise engines when an angle drive unit is fitted, the oil pump is fitted in its standard position. For clockwise engines, or, anti-clockwise with angle drives, the pump is turned through 180° to standard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



Anti-clockwise engines (or clockwise engines when fitted with an angle drive unit).



Clockwise engines (or anti-clockwise engines when fitted with an angle drive unit).

Fig. 4. Oil Pump Mountings

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, hydraulic action causes the clutch on the appropriate shaft to engage and apply engine drive to the forward drive pinion. The pinion turns the gear on the output shaft and the propeller shaft and propeller rotate in the direction which corresponds with ahead movement of the vessel. Likewise, when the control lever is operated to the 'astern' drive position the clutch on the opposite shaft engages and engine drive is applied to the reverse pinion. The pinion turns the gear on the output shaft in the opposite direction and the propeller rotates 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 drawn from the gearbox sump through the internal supply pipe via a strainer 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.

4.3 Lubrication

Oil for lubrication purposes is also delivered via the internal supply pipe to the control block. Whether the gearbox is in ahead or astern drive, or in neutral, oil is diverted from the discharge side of the pressure relief valve to an external oil cooler. On returning from the cooler the oil is directed through the channels in the valve block to the feeders and thence through the layshaft and drive shaft to lubricate the clutch assemblies.

Oil surplus to requirement is diverted back to the sump.

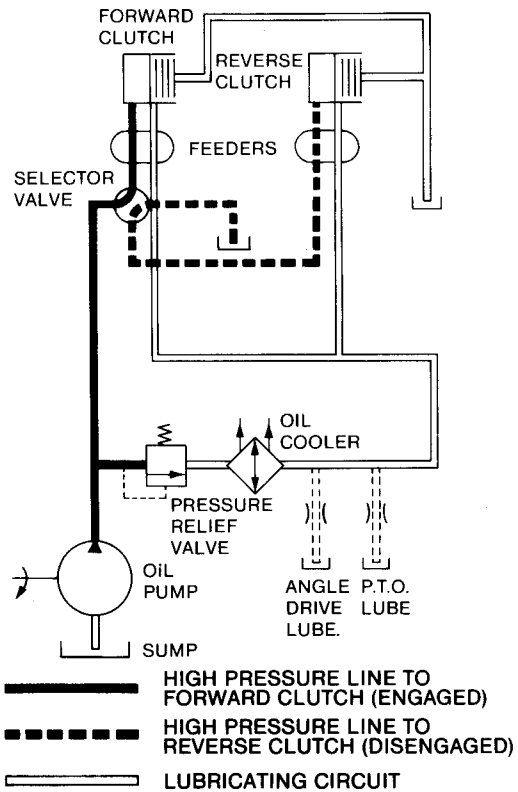


Fig. 5. Hydraulic and Lubricating Circuits.

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 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 willbe entertained if oil of the wrong specification is used.

5. INSTALLATION

5.1 General

The Newage PRM 601M marine gearbox is supplied with a choice of adaptor plates to SAE 1, SAE 2, or SAE 3 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 0.001in (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. 6.). Rotate the flywheel and check the deviation on the indicator over one complete revolution: this should not exceed 0.006in (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. 6.). Rotate the flywheel and check the deviation over one complete revolution; again, this should not exceed 0.006in (0.152mm) total indicator reading.

5.3 Checking the Engine Flywheel

Attach a dial test indicator, calibrated to 0.001in (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. 6.). Rotate the flywheel through one complete revolution and note the deviation: this should not exceed 0.005in (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 (face D on Fig. 6.). Rotate the flywheel through one complete revolution and note the deviation; this should not exceed 0.005in (0.125mm) total indicator reading.

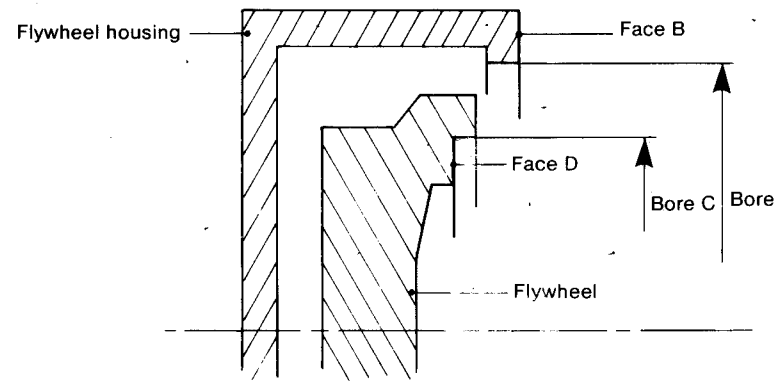


Fig. 5. Checking Engine Flywheel and Flywheel Housing

5.4 Mounting the Gearbox to the Engine

1. Mount the flexible input coupling to the flywheel, using an alignment mandrel if available; the outside diameter of the coupling should be a close fit in the register on the flywheel. Using the holes provided, bolt the coupling to 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 PRM 601M and PRM 601MA gearboxes must be fitted with an oil cooler to maintain correct working temperature range (50°C - 80°C). Two ⅜" BSP connections are provided on the valve block to enable a suitable cooler to be fitted; 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.

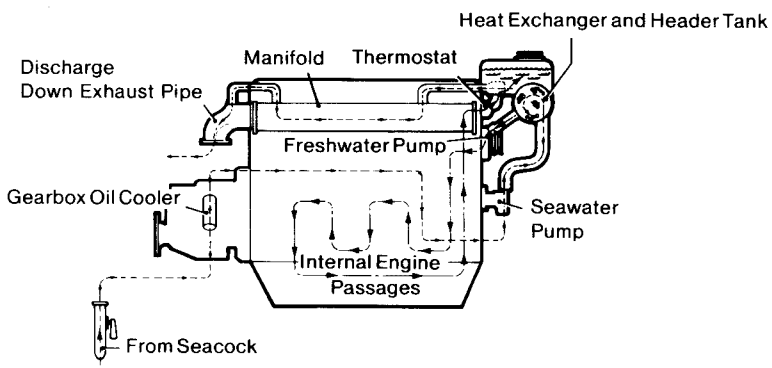


Fig. 7. Gearbox and Engine Cooling Circuit

Note: For the most efficient cooling, the system should be installed in such a way that oil and water flow through the cooler in opposite directions.

5.5.1 PRM 601M

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.

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.

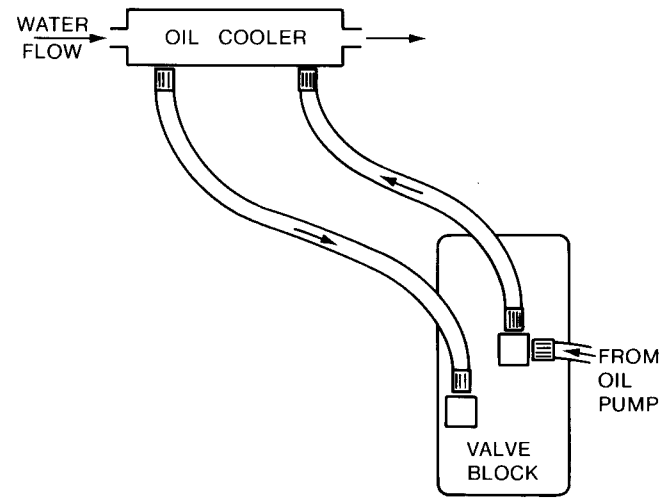


Fig. 8. Oil Cooler Connections — PRM 601M

5.5.2 PRM 601M 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:

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 PTO inlet.

d) 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.

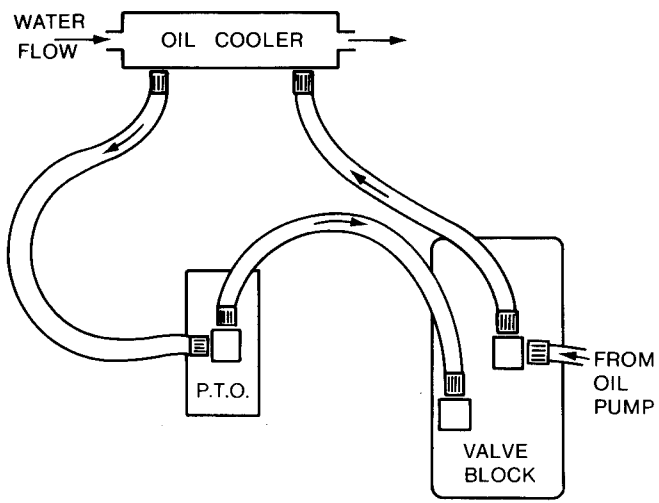


Fig. 9. Oil Cooler Connections — PRM 601M, with Power Take Off.

5.5.3 PRM 601MA with Angle Drive

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 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.

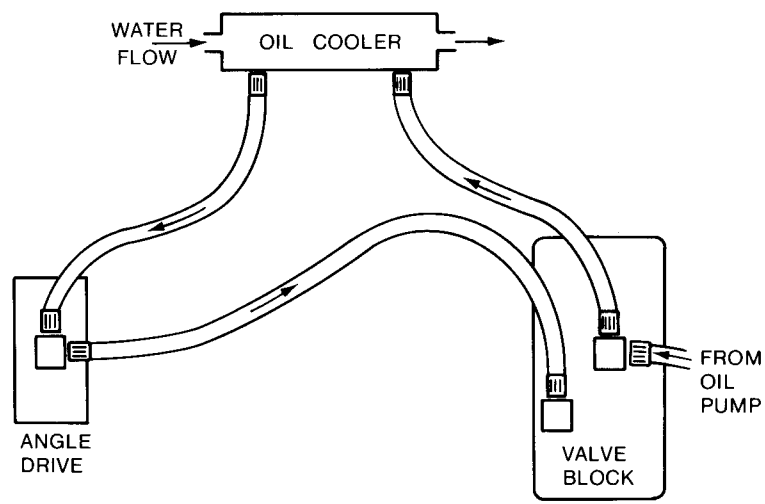


Fig. 10. Oil Cooler Connections — PRM 601MA, with Angle Drive.

Note: Operating oil temperature should not exceed 90°C under any circumstances. If, after carrying out the checks listed in the fault-finding chart without any fault being found, a gearbox consistently runs at a temperature higher than 80°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 15° with the boat at rest.

In the case of the Newage PRM 601MA (angle drive) the transmission provides a 10° 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 Installations

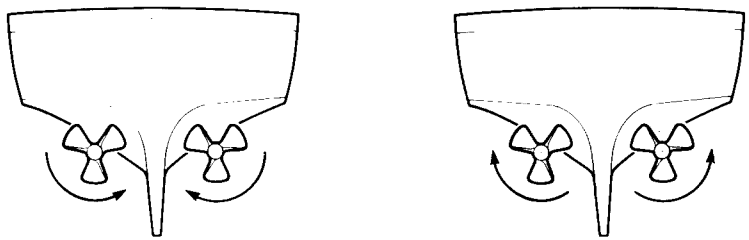
The rotation of a propeller, even in a single engine installation, tends to have a slight "turning" effect on the handling of the boat, but this can normally be corrected with very slight adjustments on the rudder.

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.

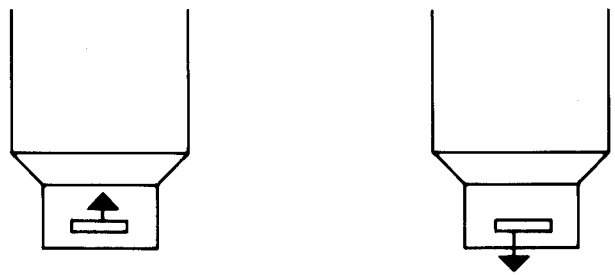
When connecting remote control units for twin engine/gearbox installations, it should be remembered that forward operation of the gearbox operating lever will produce output rotation as engine (generally left-hand, or anti-clockwise).

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. 11. Propeller Rotation — Twin Installations



PORT ENGINE
LEVER FORWARD
L.H. PROPELLER ROTATION

STARBOARD ENGINE
LEVER BACK
R.H. PROPELLER ROTATION

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

Fig. 12. Operating Lever Movement for Ahead Drive, Twin Installations

5.9. Remote Control Operating Unit

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 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

Newage PRM 601M gearboxes have been designed and tested to ensure that shifts from 'ahead' to 'astern' or vice-versa can in emergencies be operated at any engine speed up to the maximum recommended, and the gearbox will respond extremely rapidly in these circumstances.

Full power reversals, however do place abnormal, even if short lived, loading on the gearbox and transmission life will be increased if engine speed is brought down to approximately 1000 rev/min when changing direction; it is for this reason that we recommend the fitment of a proprietory 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 601M 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 601M 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 601M 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. The hexagonal key for operating the emergency device is held in a clip on the underside of the top cover.
3. Select the appropriate shaft. The majority of engines have a flywheel which rotates in an anti-clockwise direction when viewed from the stern of the boat. Therefore the appropriate shaft to 'lock-up' is as follows (looking from the stern):

   For left-hand propellers, use the left-hand shaft (right-hand shaft if Angle Drive is fitted).

   For right-hand propellers, use the right-hand shaft (left-hand shaft if Angle Drive is fitted).
4. Locate the clutch end plate (item D25). This has three tapped holes, angled to facilitate access. Rotate the shaft until one of the holes is uppermost and insert the hexagon key (or Allen key).
5. Tighten the grub screw (item D26) as tight as possible.
6. Rotate the shaft and similarly tighten the other two screws.
7. Ensure there is sufficient oil in the gearbox to avoid further damage and refit the top cover.
8. Select neutral on the operating lever and disconnect the operating cable.
9. The gearbox can now be run up to a maximum ⅓rd throttle.
10. If the clutch pack is not replaced, ensure that the grub screws are sufficiently tight in their holes, when disengaged, to prevent them shaking free under normal hydraulic operation. Replace if necessary.

Note:

a) When emergency drive is in operation, astern or neutral cannot be engaged and there is no means of stopping the boat using the gearbox.

b) After emergency drive has been used, qualified assistance should be sought to give the transmission a thorough check before the gearbox is used again.

c) Always disconnect the operating cable and ensure the gearbox operating lever is in neutral before engaging emergency drive.

d) 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 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

A) The gearbox oil should be changed at periods which correspond to the intervals at which engine oil changes are carried out.

B) The gearbox oil should also be changed if it has been contaminated by water or if the gearbox has suffered major mechanical damage.

8. FAULT FINDING

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

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

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

9. SERVICING AND REPAIRS

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

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

Exploded views of all internal components are contained in the parts list. Many servicing operations can be carried out with the gearbox still mounted to the engine (provided, of course, that there is sufficient space in the engine compartment to allow this); examples are the replacement or repair of valve block and oil pump.

The repair and maintenance of the input shaft, layshaft and output shaft will however require the gearbox to be removed from the boat.

Note: 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 safety start switch.
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 B13) 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 B10) and bearing (item B8), and replace if worn, damaged or defective. Check that the pressure relief valve spring (item B19) has retained its correct free length (0.812ins) and if not, replace.
6. To assemble and refit the valve blocks, simply reverse the above procedure.

9.2 Oil Pump Assembly

The oil pump assembly can also be removed with the gear box 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 oil 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 C1) must be replaced. If the pump body is in good condition, the oil pump can be repaired using the pump repair kit (MT0115).

The clutch shaft must be re-shimmed 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 Transmission from 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 through the eye-bolt on 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 Removal of Input Shaft and Layshaft Assemblies

1. Drain the gearbox oil into a suitable container.
2. Disconnect the oil cooler pipes and the cable or cables from the control lever or control equipment.
3. Remove the 10 bolts securing the adaptor plate and gearbox to the engine back end (12 bolts with SAE 2 adaptor) and lift the gearbox and adaptor plate clear of the engine.
4. Remove the 7 bolts securing the gearbox to the adaptor plate and separate.
5. 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 pump shims with pump assembly).
6. Remove the 4 bolts securing the shaft end cover and remove (Note: keep shims and 'O' ring with end cover).
7. Remove the 5 bolts and 1 nut retaining the valve block and remove.
8. Remove the 7 bolts securing the gearbox top half and lift clear.
9. Lift the input shaft assembly and front oil seal housing from the gearcase.
10. Lift the layshaft assembly and front end cover from the gearcase.

9.6 Removal of Clutch Shaft Components.

9.6.1 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 new seal (item A35) 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 and thrust bearing cone, 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 bearing and thrust washer, inspecting for wear and replacing where necessary.
5. Locate the new bearing (items D16 & D17) 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 9.10.

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 the 12 clutch securing bolts.
3. Withdraw the complete clutch from the shaft noting the position of the pull off springs and spring guide pins.
4. Position the shaft upright and locate the 3 spring guide pins in the clutch gear.
5. fit the clutch return plate over the spring guide pins and place the clutch return springs over the guide pins. Then, starting with one of the driven plates, build up the replacement clutch onto the clutch return plate.

6. Replace the end cover onto the pins and re-sit the 12 securing bolts and locking strips. Lightly tighten the bolts.
7. Ensure the pull off springs are correctly located and the clutch plates are free to travel in the clutch body.
8. Tighten the bolts with a torque spanner set at 12.2Nm (1.24Kgm - 9lbs ft), and close the locking strips over the bolt heads.
9. Replace the drive pinion by turning it slightly as it is inserted into the driven clutch plates until it touches the bottom thrust washer.
10. Place the thrust bearing, thrust washer and bearing onto the shaft and gently drive the bearing into position.

9.6.4 Clutch Gear

To fit a new clutch gear (item D35) remove the clutch as described in 9.6.3. and proceed as follows:

1. Withdraw the two thrust washers and one thrust bearinglocated in front of the piston.
2. Tap out the piston from the clutch gear. If it is found to be difficult to remove it may be left until a later stage.
3. Remove the locknut and tabwasher from the back end of the shaft.
4. Placing the shaft assembly such that the front face of the clutch body is supported face downwards on a plate. The shaft may then be driven out forwards through a suitable hole in the plate.
5. The clutch gear, feeder, piston and rear end bearing will now be free for inspection and replacement if necessary.
6. Refit clutch gear and feeder, examining the feeder piston rings and replacing where worn (for piston rings and feeder removal, refer to section 9.6.7).
7. Insert piston into clutch gear, examining the 'O' rings for wear or damage, replacing if necessary.
8. Place the bearing onto the shaft rear end and gently drive the bearing into position.
9. Refit the locknut and tabwasher.
10. Replace the clutch assembly as described in section 9.6.3.

Note: It is advisable to renew both clutch gears simultaneously since damage to one will often result in damage to the mating gear. It is also advisable and strongly recommended that piston seals and tabwashers should always be replaced.

9.6.5 Drive Pinion

To renew a drive pinion, follow the procedure as described in section 9.6.2.

Note: For shimming procedure please refer to Section 9.10.

9.6.6. Rear End Bearing

To renew a rear end bearing, follow the procedure as described in section 9.6.4.

9.6.7 Piston Rings and Feeder

Excessive wear or damage may necessitate renewal of the piston rings and feeder, and in the event the following procedure should be adopted:

1. Remove the feeder as described in section 9.6.4.
2. Use a special piston ring extractor, or a piece of thin steel to remove the rings from the clutch gear.
3. Raise one end of the top ring out of the groove and insert the steel strip between the ring and the clutch gear. Rotate the strip around the clutch gear, applying slight forward pressure to the raised portion of the ring until it rests on the land above the groove. It can then be eased off the clutch gear. Do likewise with the other two rings.
4. Remove the new piston rings (item D36) from the packing and clean off any grease or rust inhibitor.
5. If available, fit a ring loading tool around the clutch gear, load the rings on the tool, and locate in their approximate position. Gently withdraw the tool and allow the rings to locate in their grooves.

6. Where a loading tool is not available use a thin steelstrip, long enough to lay along the clutch gear above the grooves. Expand each ring just sufficiently to allow them to be placed in approximate position over the strip. Gently remove the strip and locate the rings in their respective grooves (see Fig. 13.).

7. Compress each ring in turn and carefully fit a new feeder (item D37).

Important: Ensure webs on feed necks are facing the gearcase outer walls when installed.

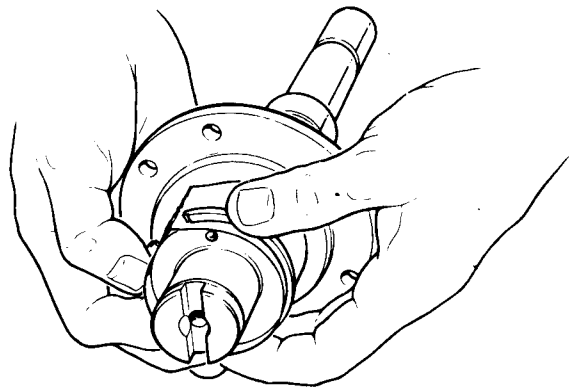


Fig. 13. Piston Ring Fitting Procedure

9.7 Replacement of Input Shaft and Layshaft Assemblies

1. Position the input shaft assembly in the casing and ensure that the front oil seal housing is located correctly in the groove. Examine the 'O' ring for wear or damage and replace if necessary.

2. Position the layshaft assembly in the casing ensuring that the front end cover is correctly located in the groove. Examine the 'O' ring for wear or damage and replace if necessary.

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 the direction of rotation required.

6. Refit the valve block, replacing gasket.

7. Refit the seven bolts securing the adaptor plate to the gearbox.

8. Offer-up the gearbox and adaptor plate to the engine and secure with the 10 bolts (12 bolts for SAE 2 adaptor).

9. Reconnect the oil cooler pipes and the control cable or cables.

10. Re-fill with one of the recommended lubricants and check the oil level.

11. Run the engine, check the oil pressure (⅛" BSP gauge tapping on valve block) and examine for leaks. Shut down, allow to settle and re-check the oil level.

Note: Shimming procedure is described in section 9.10.

9.8 Removal of Output Shaft Assembly

Removal of the output shaft will necessitate removing the gearbox from the installation in the following manner:

1. Follow the procedure as described in section 9.5 to remove input and layshaft assemblies.

2. Unlock tab strips and remove three bolts securing output shaft coupling.

3. Withdraw coupling, washer and 'O' ring (if fitted).

Note: 'O' ring only fitted to gearboxes built after January 1983.

4. Remove 4 bolts securing oil seal housing and withdraw housing.

5. Remove output shaft end cover. (This will be aided by the use of a magnet or rubber suction plunger).

6. Release tab and remove nut and washer at front end of gearbox.
7. To remove the shaft, drive or press shaft on front end, and the rear end bearings and shaft can be removed at the rear of the gearbox; leaving the front end bearing, spacer, gear and spacer behind.
8. Rear bearing cones can now be removed from the shaft and also front bearing outer-race removed from the gearcase.
9. Before re-assembly, examine the bearing, 'O' rings and rear oil seal for wear or damage.

Note: If a bearing has been damaged, also check the gear for damage.

10. To re-assemble, fit smaller of the two rear bearing cones to the shaft.
11. Push shaft from the rear through spacer (item F9), gear, spacer (item F23) and inner-race of front end roller bearing. Fit outer-race of front end bearing to housing.
12. Press or drive in cup of small rear end bearing, flush with housing shoulder. Fit cup spacer (item F17), cone spacer (item F16) and shims (items F18, F19, & F20).
13. Press or drive in cup of large rear bearing and push cone onto shaft.

IMPORTANT NOTE:

The rear end bearings, spacers and shims form a factory pre-set unit and if a bearing shows signs of wear or damage, the complete assembly must be replaced. ON NO ACCOUNT SHOULD INDIVIDUAL BEARINGS BE REPLACED.

14. Refit rear seal housing, having filled the gap between the two seal lips with grease.
15. Fit 'O' ring (if fitted), output flange, washer and tab washers, tighten screws and bend over tab washers. Tightening torques: 58.3Nm (5.95Kgfm - 43lbf.ft).
16. Fit washer, tab washer and nut at front end of gearbox and tighten nut. Tightening torques: 339Nm (34.58Kgfm - 250lbf).

Note: Tab washers at front and rear should always be replaced.

17. Fit end cover (item A38).

9.9 Output Shaft Oil Seal Replacement

Providing there is sufficient space and clearance when the propeller shaft coupling is disconnected to allow the output flange to be withdrawn the oil seal may be renewed without removing the gearbox from the installation. If there is not, before proceeding as instructed below, remove the gearbox as described in section 9.4.

1. Restrain the output coupling from turning by 'boring' it with a lever locked against bolts placed in the coupling flange holes. Remove the output coupling locking screws, tab washers and spacer.
2. Withdraw the coupling with pulley extractors, remove the output end housing (4 bolts) and extract the oil seal.
3. Examine the housing 'O' ring and if worn or damaged, renew.
4. Check the oil seal bearing surfaces for wear, and, if grooved, replace the output coupling.
5. Fit a new seal (item A43) ensuring it is driven square into the housing and refit the housing, taking care not to damage the 'O' ring (item A44).
6. Smear the oil seal diameter of the coupling with grease replace 'O' ring (item A44) and gently drive the coupling into position on the shaft.
7. Replace the washer, tab washers and three screws, tightening to a torque of 58.3Nm (5.95Kgfm - 43lbf.ft).

9.10 Shimming Procedures — Input Shaft and Layshaft

The allowable end float on the taper roller bearings is 0 - 0.075mm (0 - 0.003in) clearance, which should be checked with the aid of a depth micrometer.

1. Press the outer bearing cup firmly into position and measure between the face of the gearcase and the top of the bearing outer as shown in Fig. 14.
2. Measure the depth of the recess in the oil pump and in the input shaft end cover. Make up the difference between the two dimensions 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. Whilst rotating the input shaft or layshaft slowly tighten the 4 securing bolts until the shaft starts to bind. Care should be taken to ensure that the oil pump or end cover is tightened squarely to the gearbox face. This may be checked by testing the gap around the oil pump or end cover with shims or feeler gauges to ensure a uniform gap.
4. Measure the gap remaining at this point with shims or feeler gauges. This amount plus 0.075mm (0.003in) is then to be deducted 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 and refit the oil pump or end cover with the 'O' ring re-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).

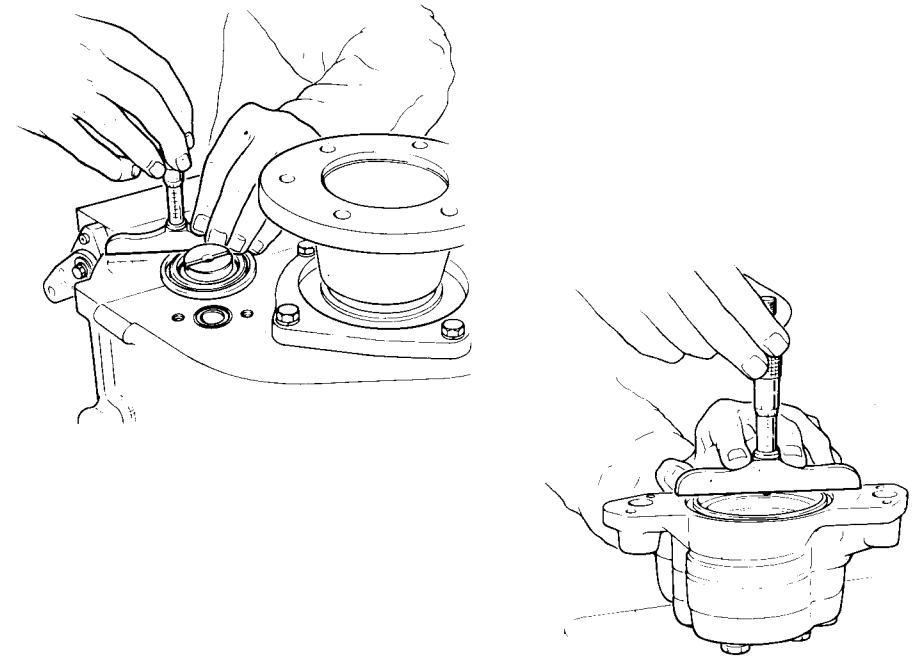


Fig. 14. Shimming Procedure

10. POWER TAKE OFF UNITS

10.1 'Direct Drive Power Take Off' (MT0128)

The P.T.O. is fitted on the rear face of the gearbox and is driven directly by the input shaft. It replaces the end cover which is normally fitted and also performs the cover function of sealing the gearbox case against oil loss and of correctly positioning the input shaft rear bearing. The P.T.O. unit provides the link between gearbox and pump. The pump will be directly driven with no disengage facility.

10.1.1 Specification

The Power Take Off is designed to accommodate hydraulic pumps which conform to SAE J744C, series 'B' two or four bolt fixing. Drive is via a muff coupling suitable for spline pump input shafts to the same SAE specification.

SAE J744C, series 'B' limits the permissible torques and horsepower, which are:-

217Nm (22.1kgfm - 160lbf.ft)
22kW (29.3hp) per 1000 rev/min.

Pumps of larger capacity than this are not permissible. The equipment is only designed to accommodate hydraulic pumps of gear, vane or piston type, which conform to SAE 'B' specification. IT EMPHATICALLY MUST NOT BE FITTED WITH ANY ADAPTION TO DRIVE AN OUTRIGGER PULLEY, as the mounting is not sufficient to support side loads.

While we cannot advise on the design of the ancilary power circuits, of which the PTO pump is part, we would expect that such circuits would be designed in accordance with the recommendations of the manufacturers hydraulic equipment, and be properly safeguarded against overloading.

10.1.2 Installation

1. Remove 4 bolts and washers fixing square end cover plate on rear face of gearbox and remove cover plate.
2. The body of the power take off acts as the gearbox input shaft bearing adjuster, in the same way as the end cover it replaces and must be measured for and fitted with shims in the following manner:-

   The allowable end float on the taper roller bearing is 0.0075mm (0" - 0.003") clearance, which should be checked with the aid of a depth micrometer.

   a) Press the bearing outer cup firmly into position and measure between the face of the gearbox case and top of the bearing outer.

   b) Measure the depth of the recess in the PTO body. Make up the difference between the two dimensions with shims to give the stated end float.

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

   c) Remove the 'O' ring from the PTO body.

   d) Fit sufficient shims so that the PTO body stands proud of the gearbox.

   e) Whilst rotating the gearbox input shaft slowly tighten up the 4 securing bolts until the shaft starts to bind. Care should be taken to ensure the PTO body is tightened squarely to the gearbox face. This may be checked by testing the gap around the body with shims or feeler gauges.

   f) Measure the gap remaining at this point with shims or feeler gauges. This amount plus 0.075mm (0.003") is then to be deducted from the shims already installed.

   g) Remove the necessary number of shims, replace the 'O' ring, tighten the securing nuts, and test by rotating the input shaft.

3. Insert the muff coupling into the body, pushing it carefully through the oil seal and engaging it with the spline on the end of the input shaft.
4. Offer the pump to the body. Rock the pump until the spline on the pump input shaft mates with the spline in the muff coupling. Press the pump flange fully into the mating flange in the PTO body and secure using M12 bolts.

WARNING: the pump will be engaged as soon as the engine is started.

5. Ensure that the pump is in the off-load position and start the engine.
6. Check that the pump and its associate machinery is working correctly.

10.2 Clutched Power Take Off (MTO132)

The PCT Power Take Off is fitted onto the rear face of the gearbox and is driven directly by the input shaft. It replaces the end cover which is normally fitted and also performs the cover function of sealing the gearbox case against oil loss and of correctly positioning the input shaft rear bearing. The PTO unit provides the link between gearbox and pump. Oil pressure is taken from the gearbox control valve from the point usually used for fitting an oil pressure gauge. This oil pressure engages the PTO clutch for driving the pump. When the lever is in the disengaged position, no pressure is applied

to the clutch plates, so no drive is effected. Low oil pressure from the return line of the oil cooler circuit is directed for lubrication purposes.

10.2.1 Specification

The Power Take Off is designed to accommodate hydraulic pumps which conform to SAE J744C, series 'B', two bolt fixing, splined input shaft.

SAE J744C, series 'B' limits the permissible torques and horsepower, which are:-

217Nm (22.1kgfm - 160lbf.ft)
22kW (29.3hp) per 1000 rev/min

Pumps of larger capacity than this are not permissible. The equipment is only designed to accommodate hydraulic pumps of gear, vane or piston type, which conform to SAE 'B' specification. IT EMPHATICALLY MUST NOT BE FITTED WITH ANY ADAPTION TO DRIVE AN OUTRIGGER PULLEY, as the mounting is not sufficient to support side loads.

While we cannot advise on the design of the ancilary power circuits, of which the PTO pump is part, we would expect that such circuits would be designed in accordance with the recommendations of the manufacturers of hydraulic equipment, and be properly safeguarded against overloading.

10.2.2 Installation

The following procedure must be followed when fitting a clutch operated PTO to an existing PRM 601. If the gearbox is part of an engine installation, fitting can be carried out with the gearbox in situ.

1. Remove the 4 bolts securing the oil pump and withdraw the oil pump, gasket, shims and 'O' ring, noting the position of the pump for refitting. Keep the shims, gasket and 'O' ring with the pump assembly.
2. Remove the 4 bolts securing the shaft end cover and remove, together with the shims and 'O' ring.
3. Insert the 4 studs (item H6) into the holes from which the end cover bolts were removed.
4. Take the 'O' ring (item A28) previously used with the shaft end cover and insert into the groove in the joint face of the PTO body.
5. Take the shims previously used with the end cover and locate in the recess in the PTO body joint face.
6. Offer up the PTO to the gearbox and locate on the 4 studs. Slide the PTO up to the joint face. If this is prevented by tooth misalignment on the drive spline, remove the PTO and rotate the clutch body (item H47) slightly and repeat.
7. Locate the 4 nuts (item H1) on the studs and tighten to a torque of 58.3Nm (6kgfm - 43lbf.ft).
8. Remove the cover plate (item H15) and joint (item H50) from the rear face of the PTO body.
9. Secure the clutch body to the gearbox shaft by inserting the cap screw (item H12) into the centre of the clutch body and tighten to a torque of 58.3Nm (6kgfm - 43lbf.ft). (A long series 8mm A/F Allen key is required for this operation).
10. Remove the pressure plug (item B22) from the valve block and replace with an unequal union (item H14) and bonded seal (item H13).
11. Fit identical components into the port situated directly behind the operating lever on the PTO body.
12. Fit the oil feed pipe from the valve block to PTO.
13. If an oil cooler is fitted, remove the oil return pipe from the cooler at the valve block.
14. Insert stud standpipe adaptor (item H4) and bonded seal (item H2) into the valve block and fit the tee piece (item H3) to the stud standpipe adaptor.
15. Refit the oil cooler return pipe into the tee piece. (The pipe connection should be made so that flow from the cooler is in line with the valve block port).
16. Insert the union s/assy (item H22) into the PTO body.
17. Fit the oil lubrication pipe (item H7) from the tee piece to PTO.
18. Refit the oil pump, replacing the 'O' ring if damaged. Ensure the pump is fitted the correct way around.

10.2.3 Pump Fitting

The adaptor flange is designed to accept any pump with a type 'B' flange to SAE J744C. (Within the capacity specified on the PTO)

1. Take the pump and offer up to the PTO flange, locating the pump shaft spline with the drive adaptor in the PTO and seating the pump in the spigot on the flange face.
2. Secure the pump by 2 off - M12 bolts on the flange face.
3. The pump is now ready for piping into an hydraulic circuit. Once fully installed, the gearbox should be run with the pump off loaded to check the PTO for correct hydraulic function and running.

10.2.4 Strip and Rebuild Procedures

Clutch Pack Replacement

A spares kit exists for replacing the PTO clutch. (MT0153).

1. Remove the pump from the PTO.
2. Remove the cap screw (item H12) securing the clutch body to the gearbox shaft (a long series 8mm A/F Allen key will be required for this operation).
3. Disconnect the pressure and lubrication pipes from the PTO.
4. Remove the gearbox oil pump as described in section 2.1.1.
5. Remove the 4 nuts (item H1) securing the PTO to the gearbox and withdraw the PTO from the studs and drive spline. (**N.B.** keep the shims and 'O' ring with the PTO body).
6. Remove the 4 cap screws (item H11) securing the bearing housing (item H31) and withdraw the bearing housing assembly from the PTO body.
7. The clutch body assembly can now be withdrawn from the PTO body for replacement of the clutch plates.
8. Unlock and remove the 6 clutch securing bolts.
9. Remove the clutch end cover (item H34) and withdraw the clutch plates, ferrules, pins and springs.
10. Stand the shaft in an upright position with the bolts refitted in the clutch body.
11. Locate the 3 spring guide pins (item H35) in the clutch body.
12. Fit the clutch return plate (item H34) over the spring guide pins and place the clutch return springs (item H39) over the guide pins.
13. Locate the 6 ferrules (item H36) on the 6 bolts and starting with one of the clutch friction plates (item H41) build up the replacement clutch with alternate plates onto the clutch return plate.
14. Replace the clutch end cover by locating on the guide pins and LIGHTLY tightening the 6 bolts.
15. Ensure the pull off springs are correctly located and the clutch plates are free to travel in the clutch body.
16. Tighten the 6 bolts with a torque spanner set at 15Nm (1.53kgfm - 11lbf.ft), and close the locking strips (MT351) over the bolt heads.
17. Refit the clutch body into the PTO taking care not to damage the piston rings on the feeder boss.
18. Refit the bearing housing assembly. The drive adaptor is best located on one clutch plate at a time. Once located, turn the adaptor until it engages with the next plate and so on.
19. Refit the cap screws in the bearing housing and tighten to a torque of 58Nm (6kgfm - 43lbf.ft).
20. Refit the PTO as described in section 2.

Bearing Replacement

The P.T.O. bearing can be replaced with the unit in situ on the gearbox.

To replace the bearing:-

1. Remove the pump from the PTO.
2. Remove the 4 cap screws (item H11) securing the bearing housing (item H31) and withdraw the bearing housing assembly from the PTO body. Taking care not to damage the gasket (item H49).

3. Remove the circlip (item H28) and press out the drive adaptor and bearing.
4. Remove the circlip (item H29) and press the drive adaptor off the bearing.
5. Inspect the bearing for wear or damage and replace if necessary. Refit the bearing and assemble in reverse order to the above.
6. When refitting the 4 cap screws, tighten to a torque of 58Nm (6kgfm - 43lbf.ft).

10.2.5 PTO Drive Replacement

If damage or excessive wear occurs on the splined drive extension from the main gearbox, it will be necessary to replace the input shaft.

The procedure for replacement is given in section 9.5 of the workshop manual. It will be necessary to remove the PTO for this operation.

11. ANGLE DRIVE UNIT

11.1 Identification

The original angle drive unit (MT0129) has been modified and re-numbered (MT0171); only a few very early gearboxes will have MT0129 fitted. Servicing instructions given below are for both units, but the instructions for retrofitting will of course only apply to MT0171.

11.2 Retrofitting Unit to an Existing 601M Gearbox

The following procedure must be followed when fitting an angle drive to an existing installation.

1. Remove the gearbox from the engine and separate from the adaptor plate as described in section 9.4.
2. Withdraw the output shaft front cover and 'O' ring (items A38 & A39). (This will be aided using a rubber suction plunger or magnet). These items can be discarded for this application.
3. When fitting an angle drive to the PRM 601M gearbox, the above items must be replaced by a spacer (item K26), supplied with the angle drive kit.
4. Remove the 4 bolts securing the oil pump, gasket, shims and 'O' rings.
5. Refit the oil pump assembly turned through 180° from its original position.

Note: See section 3.6 for pump fitting details.

6. Coat the input shaft of the main gearbox with an anti-fretting grease i.e."MOLYKOTE BR2 Plus".
7. Grease the joint (item K24) and fit it to the face of the main gearbox.
8. Offer up the angle drive unit to the gearbox locating the splines and secure with 6 studs and nuts (items K25 & K4), tightening to a torque of 95Nm (9.70kgfm - 70.11lbf.ft).
9. Screw the metering union (item K20) into the top of the angle drive unit and connect the oil pipe (item K27) into it.
10. Connect the free end of the oil pipe to the tee piece which should be fitted to the valve block in the line returning oil from the oil cooler.
11. Re-using the seven bolts originally removed to separate gearbox from adaptor, secure the adaptor to the angle drive gearbox.
12. Offer the complete assembly to the engine and secure with 10 bolts (12 bolts for SAE 2 adaptor).
13. Reconnect the pipes to the oil cooler and control cables.
14. Refill with recommended lubricant and replace the original dipstick with the new one supplied (item K28), discarding the original one. Check oil level.
15. Run the engine, check the oil pressure (⅛" BSP gauge tapping on valve block) and examine for leaks. Shut down engine, allow to settle and re-check the oil level. It should be noted there is no separate drain plug for the angle drive and a small amount of residual oil will remain when the whole assembly is drained.

Note: It should be remembered when running the installation after fitting the angle drive unit, the sense of forward/reverse direction is opposite and forward becomes reverse and reverse becomes forward.

11.3 Replacing Gears and Bearings

11.3.1 MT0171 Angle Drive

Care should be taken in dismantling this unit because of the converging shaft centres. Departure from the procedure below may result in damage to the gear teeth or bearings.

1. Removal of the angle drive from the main gearbox is carried out in the reverse order to that specified in section 11.2.
2. Remove the four socket head cap screws securing the input shaft front oil seal housing and shims and withdraw taking care not to misplace the shims. Tape the input shaft spline teeth during removal to prevent damage to the oil seal. Inspect the oil seal for wear or damage and replace if necessary.
3. Withdraw the spacer (item K23) and shims from the output bearing rear housing and remove the output bearing cup.
4. Remove the seven bolts securing the two case halves together.
5. With the unit layed on a horizontal surface, back face down, separate the two case halves and lift the front case half of the rear half. Two M8 tapped holes are provided in the front case half to assist in separating the case halves.
6. All bearings and gears are now free for inspection. If damage or excessive wear has occured the appropriate bearing must be replaced. If damage to a gear has resulted, then BOTH gears must be replaced.
7. To replace a damaged bearing, it will be necessary to remove the bearing cone from the gear using pulley extractors located behind the bearing roller.
8. If a bearing is to be replaced due to breakage, then it is likely that the remaining bearings and gears have also suffered damage as a result.

To re-assemble the unit proceed as follows:

1. Press bearings to input and output gears and fit bearing cups to case halves.
2. Locate the input gear on the rear case half and the output gear on the front case half.
3. Offer up the front case half to the rear. The dowel in the front output bearing housing must be aligned with the front case half. The two mating surfaces should be coated with a non-solidifying jointing compound.
4. Refit the seven bolts securing the case halves and tighten to a torque of 100Nm (10.2Kgfm - 73.8lbt.ft).
5. Refit four bolts securing front output bearing housing and tighten to a torque of 12Nm (1.22Kgfm - 9lbf.ft) ensuring that bonded washers are fitted.
6. To shim input shaft bearings proceed as follows:

Note: shimming is best done prior to fitting oil seal (item K18).

   a) Place sufficient shims in seal housing (item K19) so that housing stands approximately 0.125mm proud of gearcase when fitted.

   b) Fit screws (item K8) "finger tight", whilst rotating input shaft, to seat bearing (shaft should rotate freely).

   c) Measure gap below seal housing with feeler gauges and remove the measured amount of shims from the shim pack in the seal housing.

   d) Fit seal and replace seal housing.

7. To shim output shaft bearings, proceed as follows:

   a) Push in spacer (item K23).

   b) Apply hand pressure to spacer whilst rotating shaft, to seat bearings.

   c) Measure 'step' between gearcase face and end of spacer.

   d) Remove spacer and place shims of the above value between bearing cup and recess in spacer.

8. Refit angle drive to main gearbox as described in section 11.2.

11.3.2 MT0129 Angle Drive

Care should be taken in dismantling this unit because of converging shafts. Departure from this procedure below may result in damage to the gear teeth or bearings.

1. Remove the four socket head cap screws securing the input shaft front oil seal housing and remove. Tape the input shaft during removal to prevent damage to the oil seal. Inspect the oil seal for wear or damage and replace if necessary.
2. Remove the circlip (item J18) locating the front bearing on the input shaft.
3. Remove the seven bolts securing the two case halves together.
4. Remove the four bolts securing the front output bearing housing.
5. Gently but firmly separate the front case half from the rear half.
6. The input gear will now be located on the front case half and the output gear on the rear case half.
7. To remove the input gear, gently tap out through the front bearing from the spline end of the input shaft.
8. The front input bearing is now free for removal from the front case half.
9. To remove the output gear, remove the rear bearing circlip (item J19) and withdraw the output gear towards the front of the gearcase.
10. The rear output bearing is now free for removal from the rear case half.
11. Before rebuilding examine all bearings, gears and circlips for damage or excessive wear and replace if necessary.

To re-assemble the unit proceed as follows:

1. Locate the ball bearing and inner race of the roller bearing on the output gear and seat in the rear gearcase half. Locate the snap ring in the rear bearing and fit the circlip to locate the rear bearing to the output gear.
2. Locate the front output bearing housing on the front output bearing.
3. Locate the input shaft and rear bearing inner race into the rear bearing outer race. Ensure there is sufficient backlash in the mating gears.
4. Lift the front gearcase half onto the rear half. The dowel in the front output bearing housing must be aligned with the front case half. The two mating gearcase surfaces and bearing housing mating surfaces should be coated with a non-solidifying sealing compound.
5. Refit the seven bolts securing the case halves and tighten to "finger tight" only.
6. Locate the front input bearing into the bore on the front case half over the input shaft and ensure the bearing is seated up to the snap ring.
7. Tighten the seven case half bolts to a torque of 100Nm (10.2kgfm - 74lbf.ft). Rotate the input shaft and ensure the gears and bearings are running freely.
8. Refit the four bolts securing the front output bearing housing and tighten to a torque of 12.2Nm (1.24kgfm - 9lbf.ft) ensuring that the bonded washers are fitted.
9. Refit the circlip (item J18).
10. Refit the input shaft front oil seal housing taking care not to damage the oil seal. Coat the mating faces of the oil seal housing and gearcase with a non-solidifying sealing compound.
11. Coat both the input shaft male spline and the output gear female spline liberally with an anti-fretting grease, such as MOLYKOTE BR2 Plus.
12. Grease the joint (item J31) and fit to the front face of the gearbox.
13. Locate the spacer (item J28) onto the input bearing spigot and smear with grease.
14. Offer the angle drive unit to the main gearbox and proceed as described in section 11.2.

12. TIGHTENING TORQUES

	Nm	kgfm	lbf.ft
Upper to lower gearcase bolts	**58.3**	**6.0**	**43.0**
Valve block to upper gearcase			
Upper to lower gearcase bolts	**58.3**	**6.0**	**43.0**
Valve block to upper gearcase	**30.0**	**3.0**	**22.2**
Operating lever to valve block	**21.6**	**2.2**	**16.0**
End cover to valve block	**8.5**	**0.87**	**6.3**
Pump body to gearcase	**58.3**	**6.0**	**43.0**
End cover to gearcase	**58.3**	**6.0**	**43.0**
Pump cover to pump body	**30.0**	**3.0**	**22.2**
Coupling to output shaft	**58.3**	**6.0**	**43.0**
Locknut (output shaft)	**339.0**	**34.6**	**250.0**
Clutch pack (input and layshafts)	**12.2**	**1.2**	**9.0**
Locknut (input and layshafts)	**40 - 54**	**4.1 - 5.5**	**30 - 40**
Top cover to upper gearcase	**12.2**	**1.2**	**9.0**
Oil seal housing to gearcase	**58.3**	**6.0**	**43.0**
Adaptor plate to gearbox	**100.0**	**10.2**	**74.0**
PTO to rear of gearcase	**58.3**	**6.0**	**43.0**
Angle drive to front of gearcase	**95.0**	**9.7**	**70.0**

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

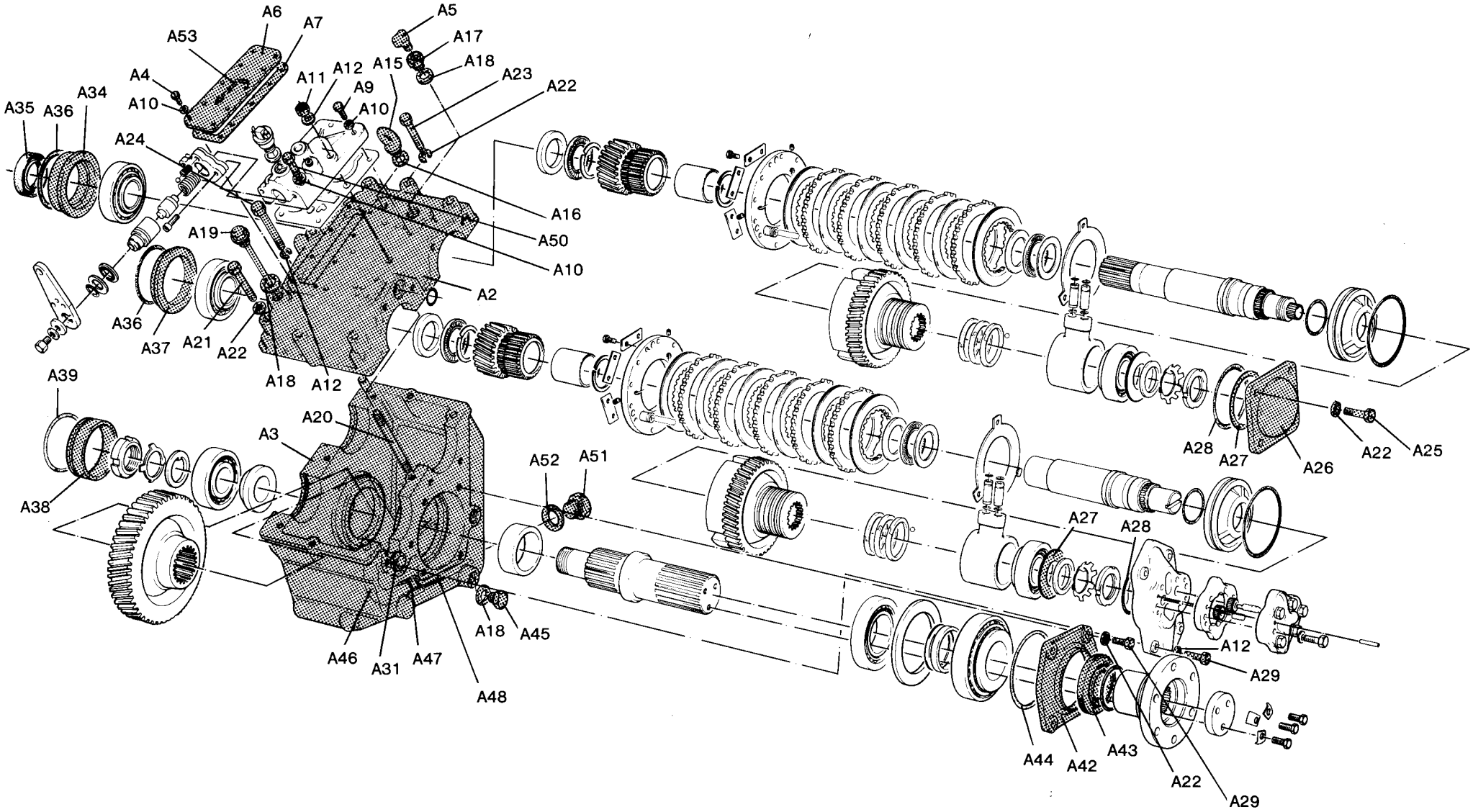
Tel: 0203 617141 Telex: 31333 Cables: 'SUPAGEARS' Coventry

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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A29

Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
A1	Gearcase Assembly Comprising:-	MT0173	1	Used on 1.5:1, 2:1 & 3:1 ratio gearboxes
A2	Gearcase top	MT4615	1	Not supplied separately
A3	Gearcase bottom	MT4661	1	Not supplied separately
A1	Gearcase assembly Comprising:-	MT0175	1	Used on 4:1 ratio gearboxes
A2	Gearcase top	MT4615	1	Not supplied separately
A3	Gearcase bottom	MT4662	1	Not supplied separately
A4	Screw - top cover	0040804	10	
A5	Breather	CP1057	1	
A6	Top cover	MT1121 S/A	1	
A7	Gasket - top cover	MT343	1	
A9	Screw	0040808	3	
A10	Washer	CP1223	15	
A11	Nut	0051001	1	
A12	Washer	0201706	17	
A15	Eyebolt	CP1339	1	
A16	Washer	0201609	1	
A17	Filler plug	MT4605	1	
A18	Washer	CP1068	4	
A19	Dipstick	0800687	1	
A19	Dipstick	MT1137	1	Used on 4:1 ratio gearboxes
A19	Dipstick	40M153		Used on gearbox fitted with Angle Drive
A20	Stud	MT4543	1	
A21	Bolt	0041021	4	
A22	Dowty washer	0201706	7	
A23	Bolt	0041017	2	
A24	Bolt	0041023	1	
A25	Bolt	0041008	4	
A26	Rear cover	MT4512	1	
A27	Shims	MT1076/02/10/31	AR	Only supplied as part of shimming kit MT0120

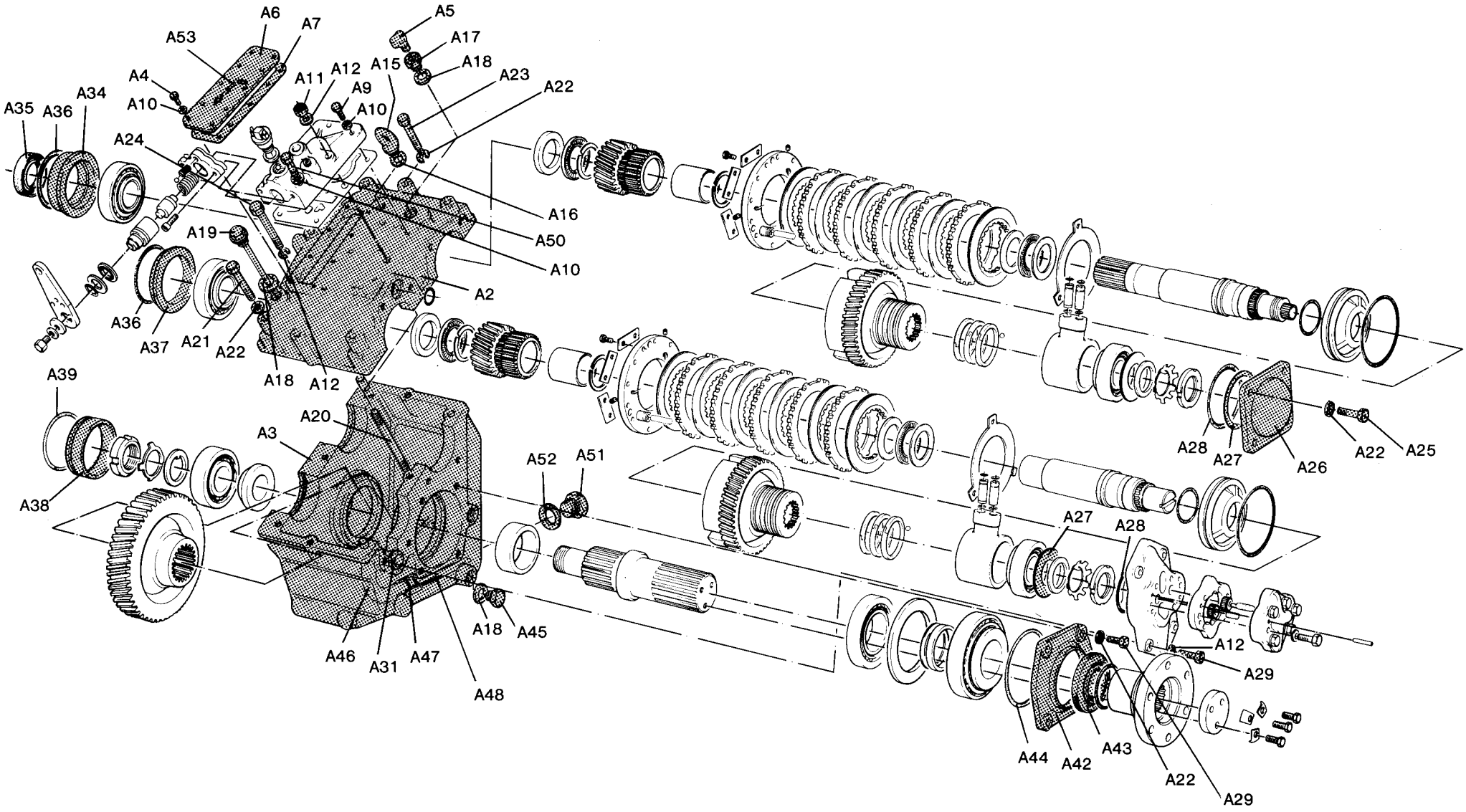
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Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
A28	O ring	004124	2	
A29	Screw	0041009	8	
A31	O ring	001254	2	
A32	Dowel	MT4540	2	Not illustrated
A33	Input cover assembly comprising:-	MT4514 S/A	1	
A34	Input cover	MT4514	1	
A35	Oil seal	0400403	1	
A36	O ring	003473	2	
A37	Layshaft cover	MT4515	1	
A38	Front cover	MT4668	1	Not required for 1.5:1, 2:1 & 3:1 ratio gearboxes fitted with angle drive, but are required on 4:1 ratio gearboxes with angle drive.
A39	O ring	003503	1	
A41	Seal housing assembly comprising:-	MT4664 S/A	1	
A42	Seal housing	MT4664	1	
A43	Oil seal	0400751	1	
A44	O ring	005002	1	
A45	Drain plug (magnetic)	CP1331	1	
A46	Oil pipe (internal)	MT4545	1	For 1.5:1, 2:1 & 3:1 ratio gearboxes
A46	Oil pipe (internal)	MT4546	1	For 4:1 ratio gearboxes
A47	O ring	000872	1	
A48	Strainer	MT4547	1	
A49	Bolt	0040812	1	Not illustrated

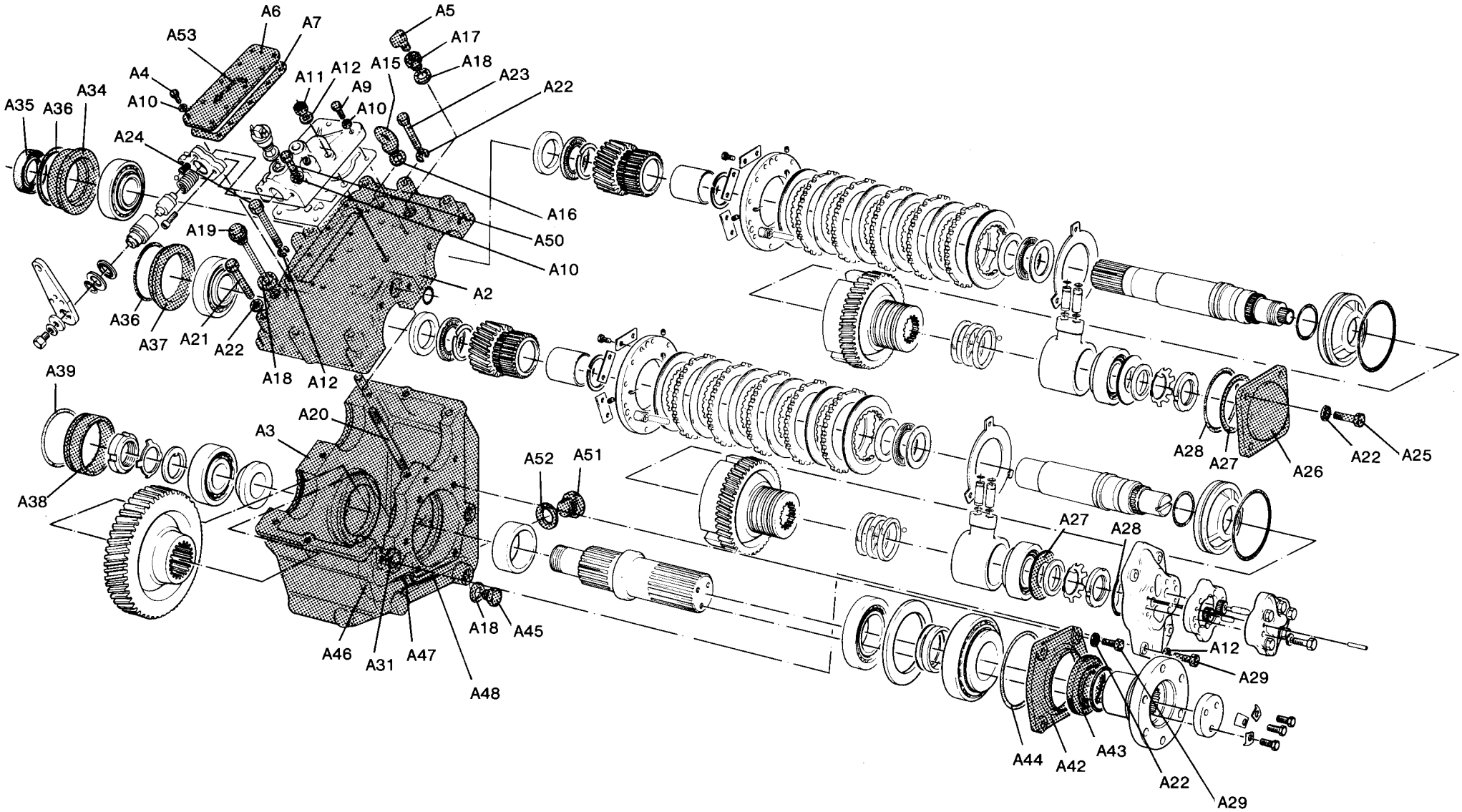
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Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
A50	Bolt	0040815	1	
A51	Plug	0150100	1	
A52	Dowty washer	0201720	1	
A53	Socket wrench	CP1352	1	
A54	Screw	0040807	2	Not illustrated

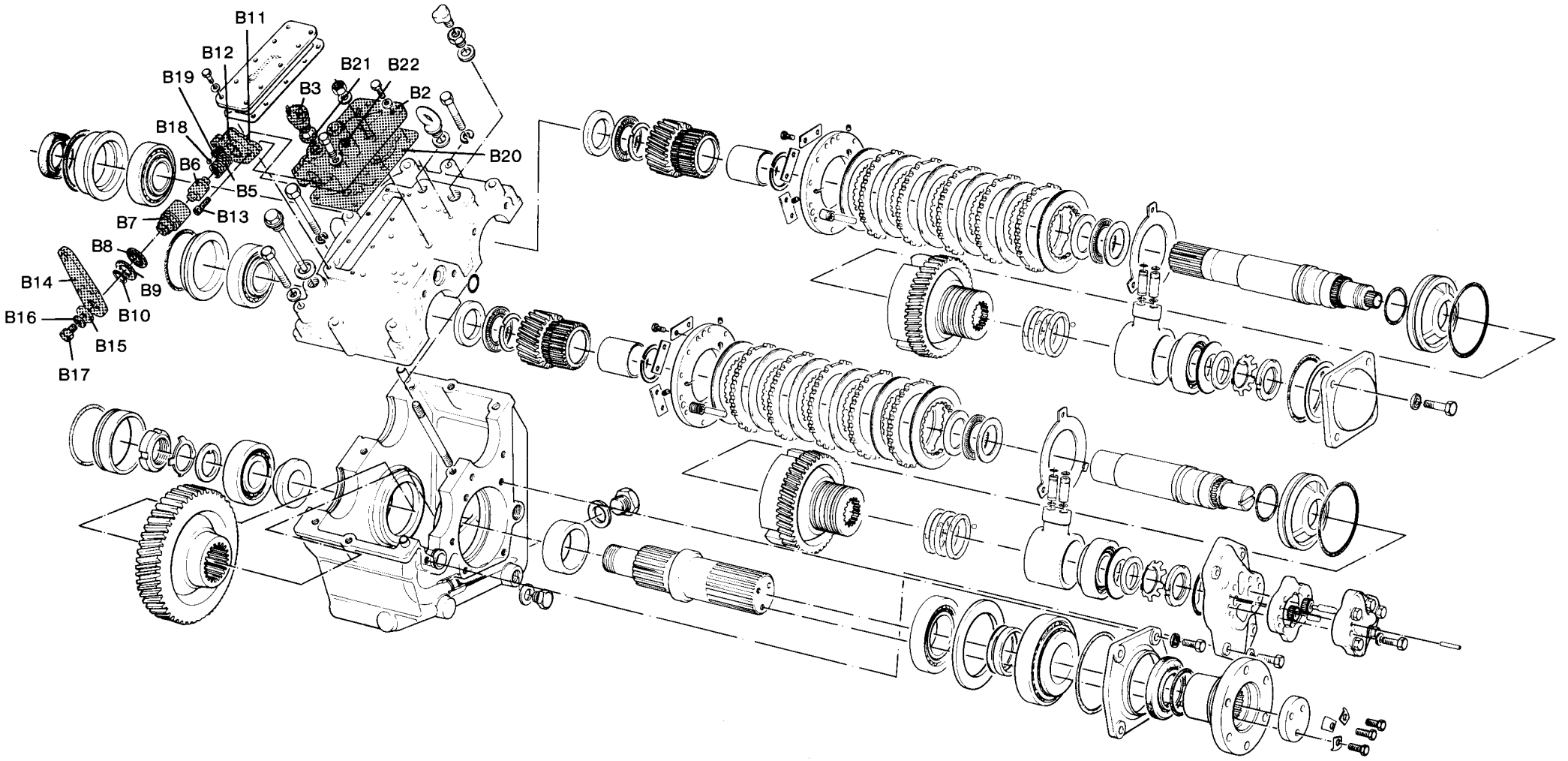
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Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
B1	Valve Block Assembly Comprising:-	MT0123	1	
B2	Valve block casing	MT4608	1	
B3	Microswitch	CP1358	1	
B5	Valve spring	MT1194	1	
B6	Relief valve	MT980	1	
B7	Control valve	MT4656	1	
B8	Thrust bearing	CP1307	1	
B9	Spacer	CP1308	1	
B10	O ring	000753	1	
B11	Gasket	MT1081	1	
B12	End plate	MT978	1	
B13	Screw	0081220	2	
B14	Operating lever	MT977	1	
B15	Washer	MT979	1	
B16	Spring washer	0191105	1	
B17	Screw	0040806	1	
B18	Ball	CP1077	2	
B19	Spring	MT305	1	
B20	Gasket	MT1073	1	
B21	Washer	0201715	1	
B22	Pressure plug	MT311	1	

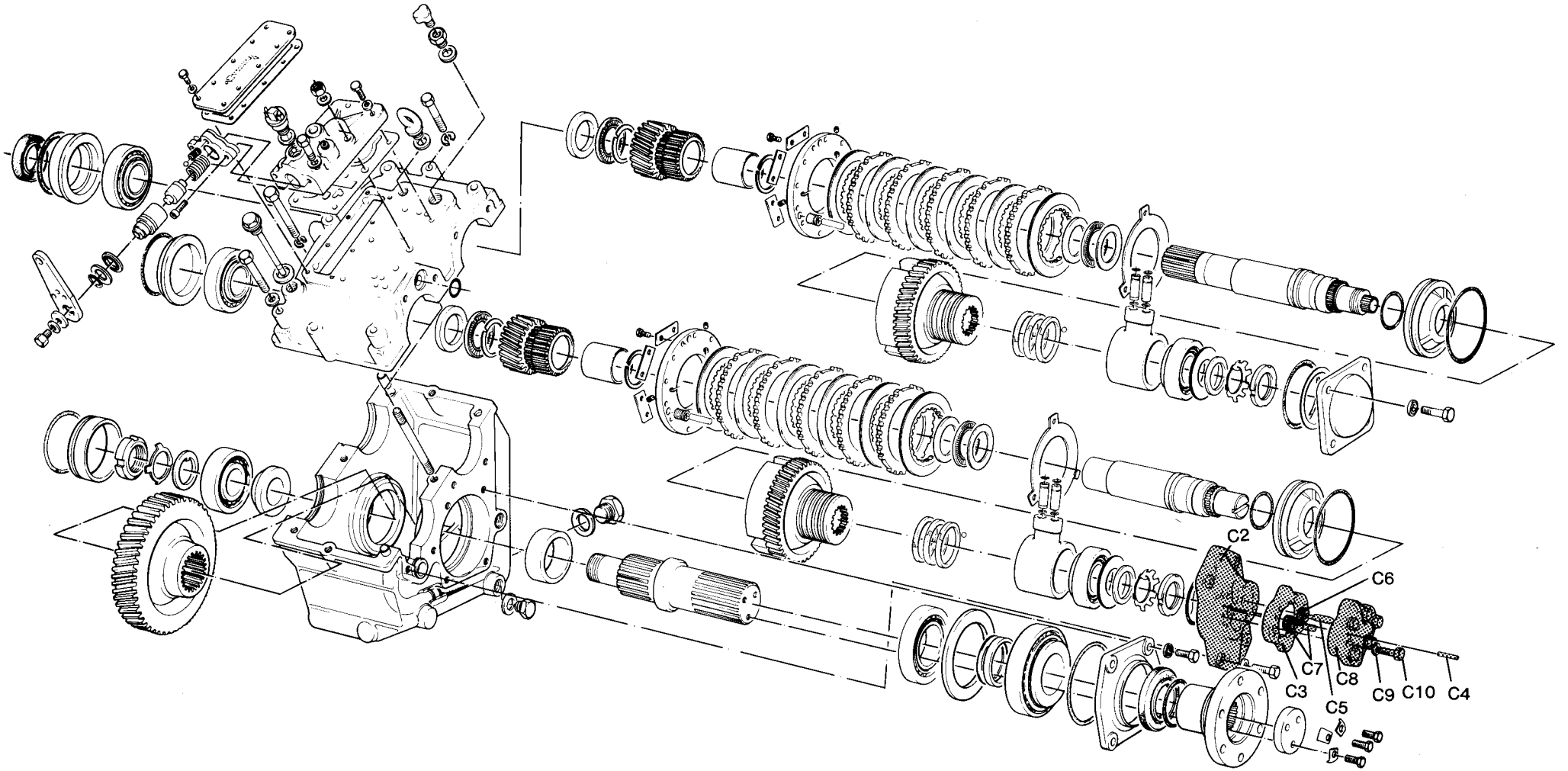
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Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
C1	Oil Pump Assembly Comprising:-	MT0101	1	
C2	Pump adaptor	MT4504	1	
C3	Pump plate	MT372	1	
C4	Dowel	MT417	2	
C5	Pump spindle	MT378	1	Supplied as part of MT0115
C6	Pump gear	MT379	1	Supplied as part of MT0115
C7	Spindle sub-assembly	MT4544 S/A	1	Supplied as part of MT0115
C8	Cover	MT321	1	
C9	Washer	CP1223	6	
C10	Bolt	004124	6	

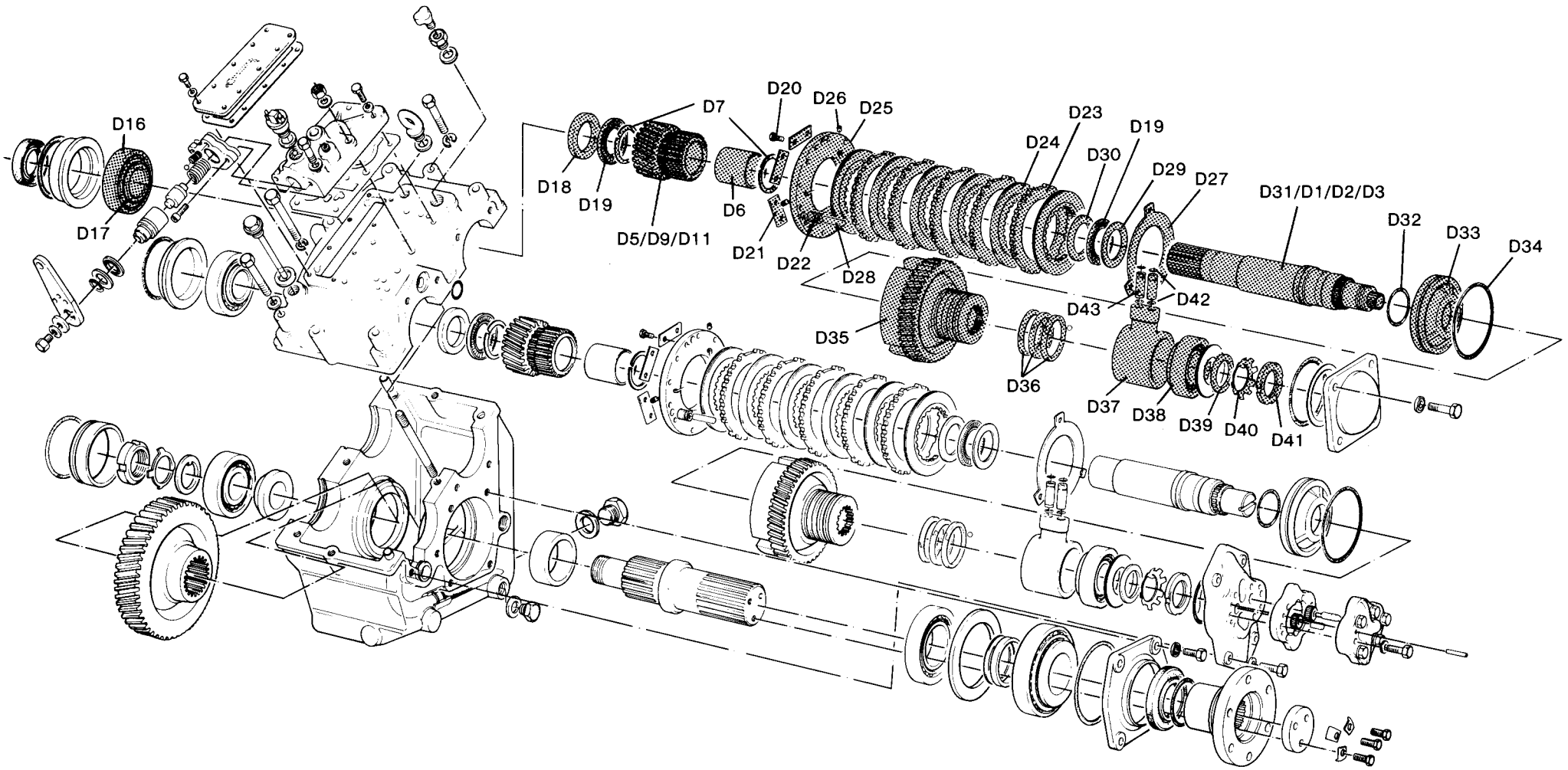
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Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
	Input Shaft Assembly			
D1	Short splined shaft 1.5:1	MT0106/1.5	1	
D2	Short splined shaft 2:1	MT0106/2	1	
D3	Short splined shaft 3:1 or 4:1	MT0106/3/4	1	
D4	Pinion sub-assembly 1.5:1	MT0100/1.5	1	
D5	Pinion	MT4521	1	
D6	Bush	MT4536	1	
D7	Spring ring	0320500	2	Locate in pinion bores
D8	Pinion sub-assembly 2:1	MT0100/2	1	
D9	Pinion	MT4523	1	
D6	Bush	MT4536	1	
D7	Spring ring	0320500	2	Locate in pinion bores
D10	Pinion sub-assembly 3:1 or 4:1	MT0100/3/4	1	
D11	Pinion	MT4520	1	
D6	Bush	MT4536	1	
D7	Spring ring	0320500	2	Locate in pinion bores
D16	Bearing cup	055U056	1	
D17	Bearing	055C025	1	
D18	Washer	MT4553	1	
D19	Thrust Bearing	CP1337	2	
D20	Bolt	0040607	12	

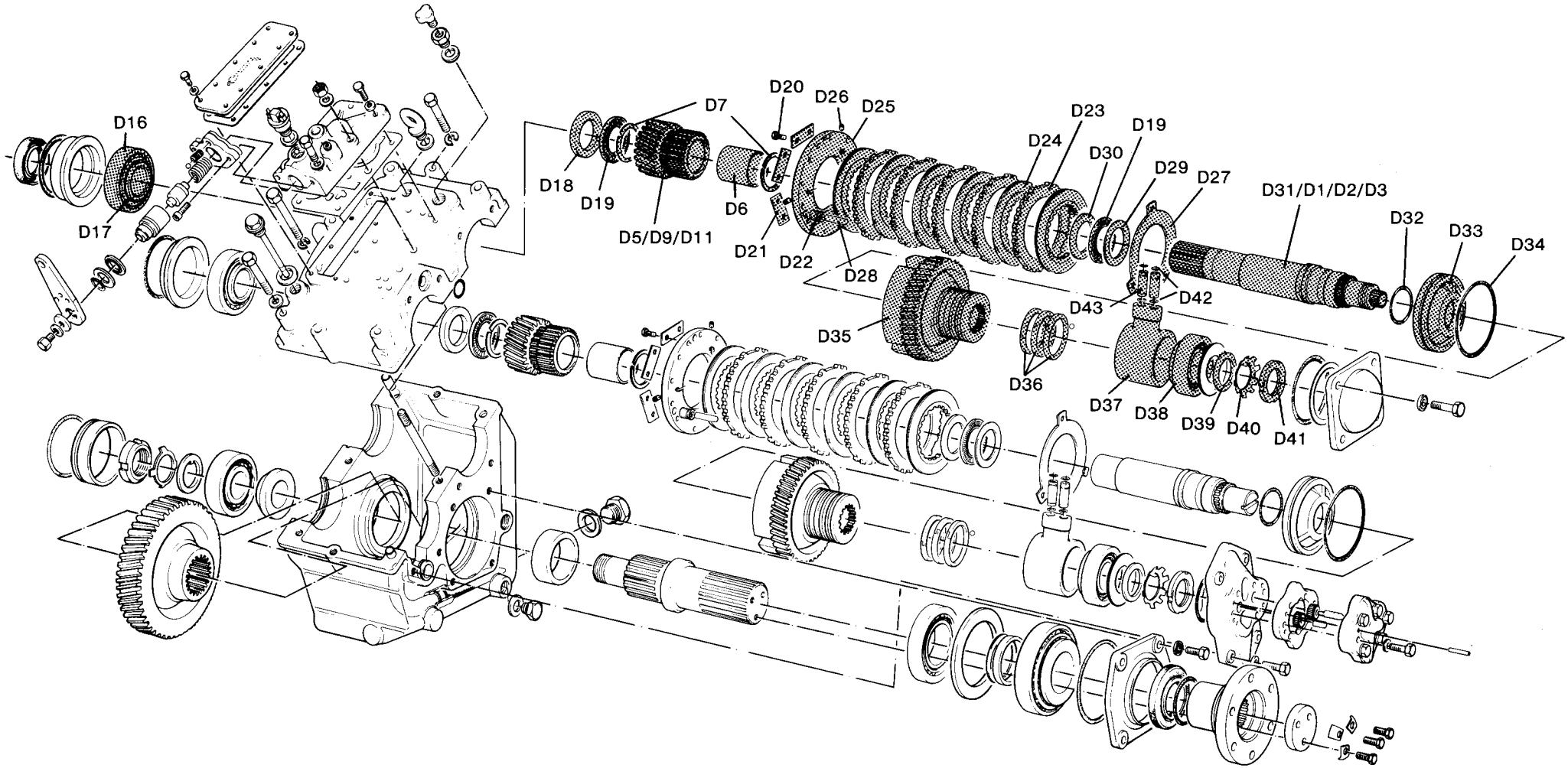
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Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
	Clutch pack comprising:-	MT0119	1	
D21	Tab washer	MT4555	6	
D22	Spring	MT4652	3	
D23	Clutch plate	MT4535	5	
D24	Clutch plate	MT4602	6	
D25	Clutch end plate	MT4554	1	Supplied as MT4554 S/A
D26	Grub screw	014K510L	3	Supplied as MT4554 S/A
D27	Clutch plate	MT4534	1	
D28	Guide pin	MT4541	3	
D29	Thrust washer	CP1338	1	
D30	Thrust washer	CP1363	1	
D31	Input shaft	MT4653	1	
D32	O ring	001873	1	
D33	Piston	MT4655	1	
D34	O ring	004254	1	
D35	Clutch gear	MT4529	1	
D36	Piston ring	MT4539	3	
D37	Feeder	MT4511	1	
D38	Bearing	0540452	1	
D39	Spacer	MT4518	1	
D40	Washer	010W401	1	
D41	Locknut	010N401	1	
D42	O ring	000372	4	
D43	Connector	MT1057	2	

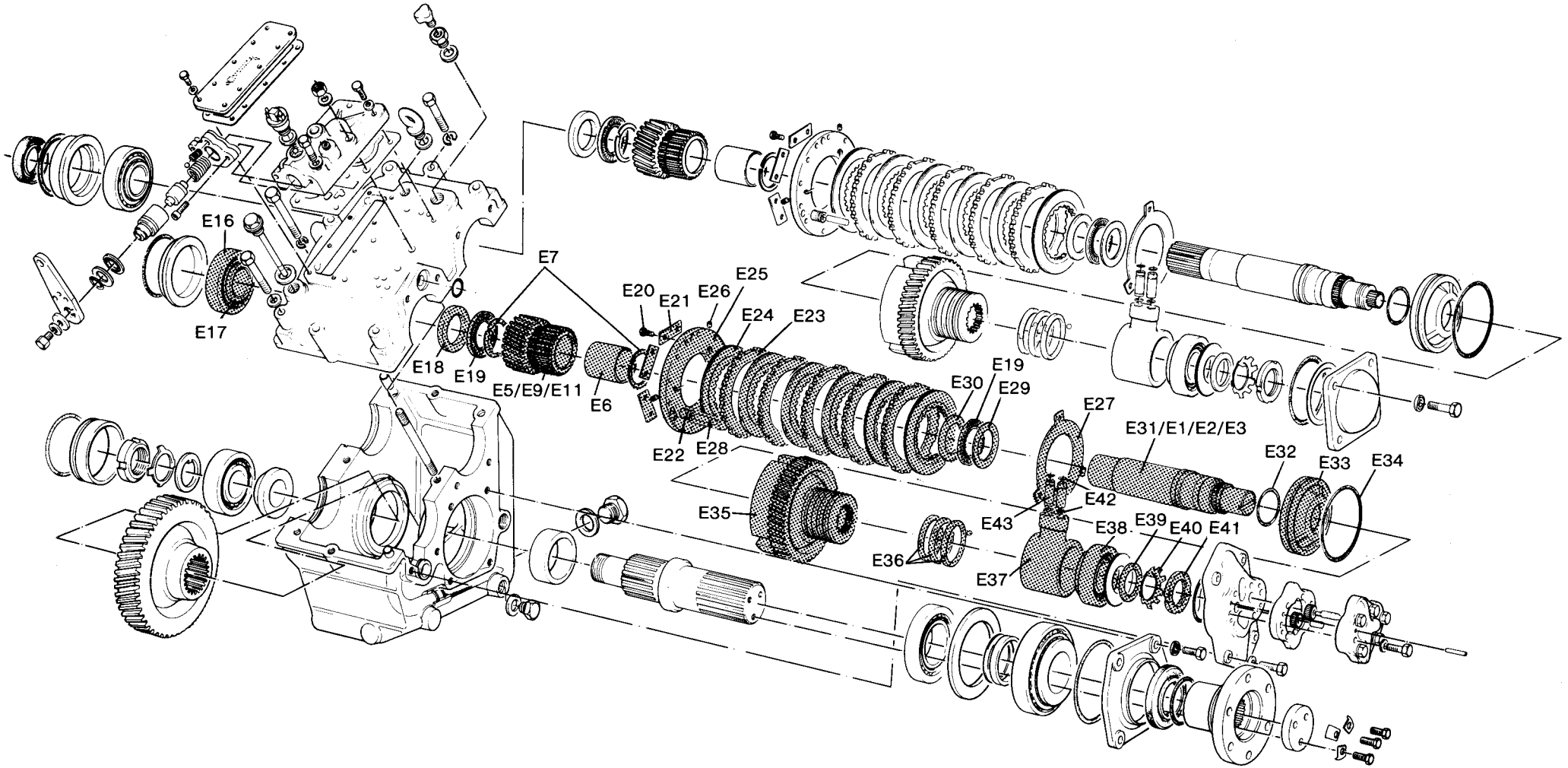
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Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
	Layshaft Assembly			
E1	Layshaft assembly 1.5:1 ratio	MT0107/1.5	1	
E2	Layshaft assembly 2:1 ratio	MT0107/2	1	
E3	Layshaft assembly 3:1 or 4:1 ratio	MT0107/3/4	1	
E4	Pinion sub-assembly 1.5:1	MT0100/1.5	1	
E5	Pinion	MT4628	1	
E6	Bush	MT4536	1	
E7	Spring ring	0320500	2	
E8	Pinion sub-assembly 2:1	MT0100/2	1	
E9	Pinion	MT4629	1	
E6	Bush	MT4536	1	
E7	Spring ring	0320500	2	
E10	Pinion sub-assembly 3:1 or 4:1	MT0100/3/4	1	
E11	Pinion	MT4520	1	
E6	Bush	MT4536	1	
E7	Spring ring	0320500	2	
E16	Bearing cup	055U056	1	
E17	Bearing	055C025	1	
E18	Washer	MT4553	1	
E19	Thrust Bearing	CP1337	2	
E20	Bolt	0040607	12	

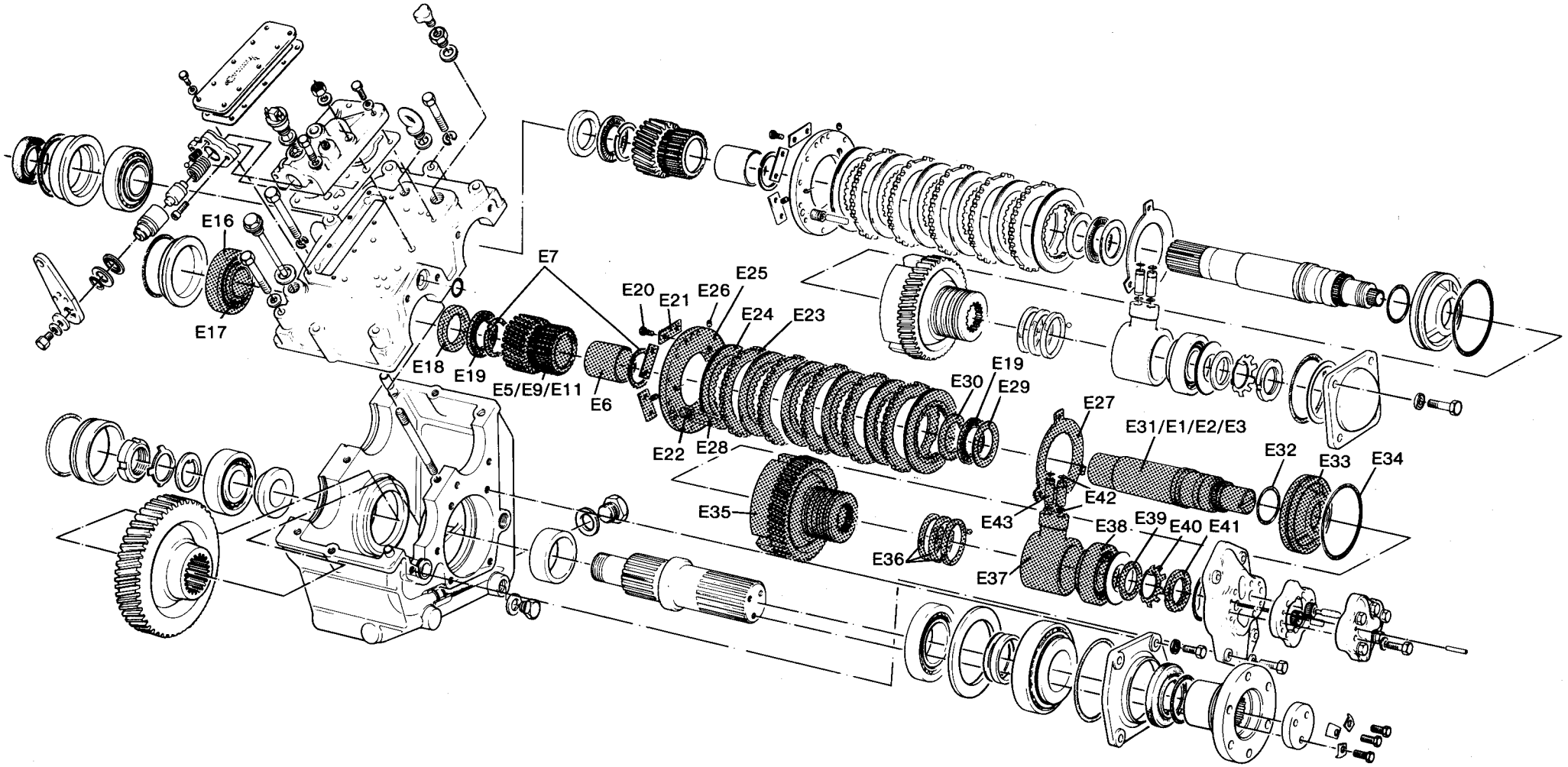
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Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
	Clutch pack comprising:-			
E21	Tab washer	MT4555	6	
E22	Spring	MT4652	3	
E23	Clutch plate	MT4535	5	
E24	Clutch plate	MT4602	6	
E25	Clutch end plate	MT4554	1	Supplied as MT4554 S/A
E26	Grub screw	014K510L	3	Supplied as MT4554 S/A
E27	Clutch plate	MT4534	1	
E28	Guide pin	MT4541	3	
E29	Thrust washer	CP1338	1	
E30	Thrust washer	CP1363	1	
E31	Layshaft	MT4654	1	
E32	O ring	001873	1	
E33	Piston	MT4655	1	
E34	O ring	004254	1	
E35	Clutch gear	MT4528	1	
E36	Piston ring	MT4539	3	
E37	Feeder	MT4511	1	
E38	Bearing	0540452	1	
E39	Spacer	MT4518	1	
E40	Washer	010W401	1	
E41	Locknut	010N401	1	
E42	O ring	000372	4	
E43	Connector	MT1057	2	

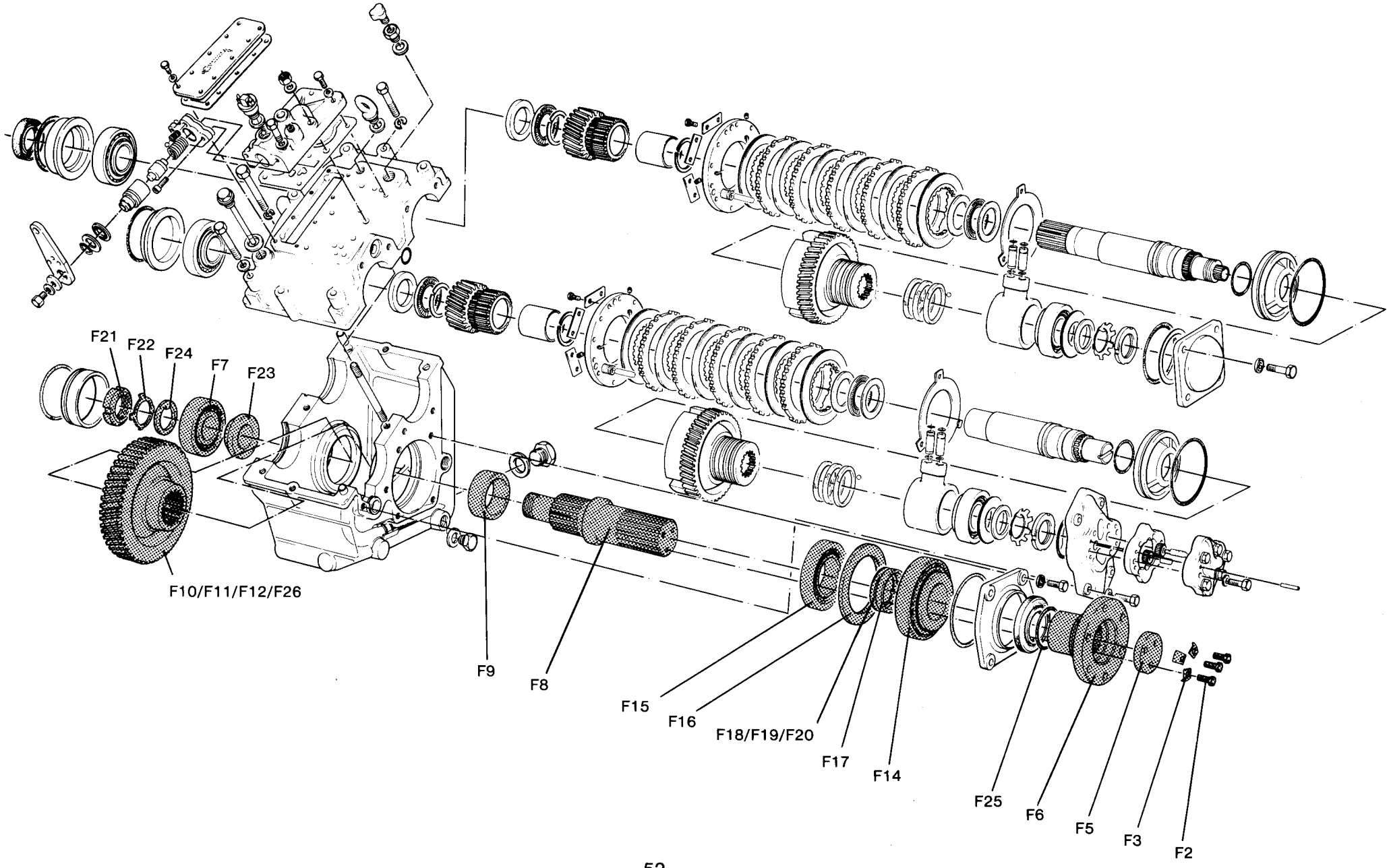
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Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
F1	Output Shaft Assembly Comprising:-			
F2	Screw	0041209 HT	3	
F3	Tab washer	MT4694	3	
F5	Washer	MT4693	1	
F6	Output flange	MT4666	1	For 4:1 gearbox ratio MT4667
F7	Bearing	0534011	1	
F8	Output shaft	MT4663	1	
F9	Spacer	MT4516	1	
F10	Output gear	MT4524	1	For 4:1 ratio gearboxes
F11	Output gear	MT4525	1	For 1.5:1 ratio gearboxes
F12	Output gear	MT4527	1	For 2:1 ratio gearboxes
F26	Output gear	MT4526	1	For 3:1 ratio gearboxes
F13	Bearing assembly comprising:-	MT0178	1	
F14	Bearing	0540601	1	
F15	Bearing	0540602	1	
F16	Spacer	MT4669	1	
F17	Spacer	MT4670	1	
F18	Shim	MT4671/A	2	
F19	Shim	MT4671/B	2	
F20	Shim	MT4671/C	1	
F21	Locknut	010N402	1	
F22	Tab washer	010W402	1	
F23	Spacer	MT4665	1	
F24	Tongue washer	MT4684	1	
F25	O ring	002563	1	Fitted to gearboxes after January 1983

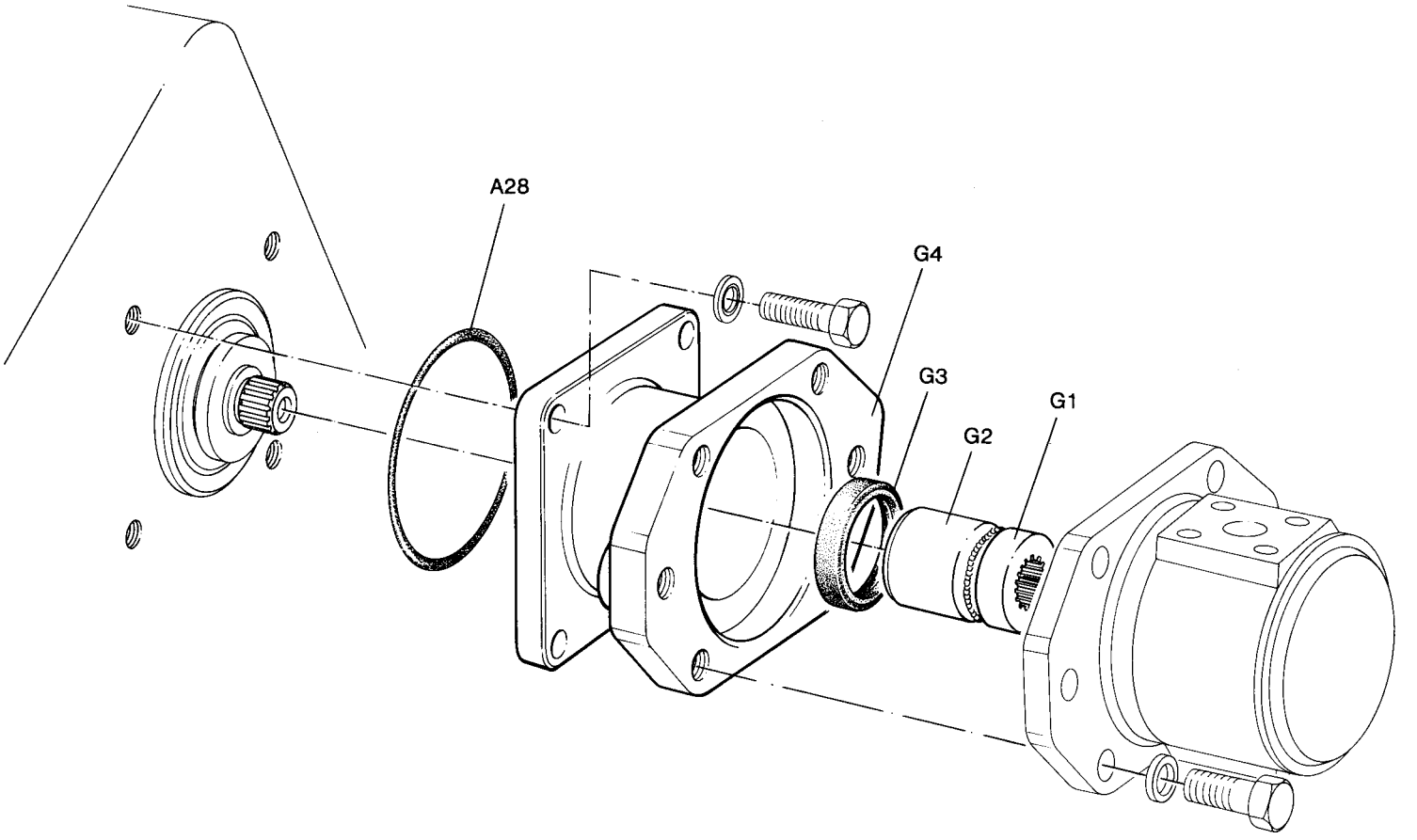
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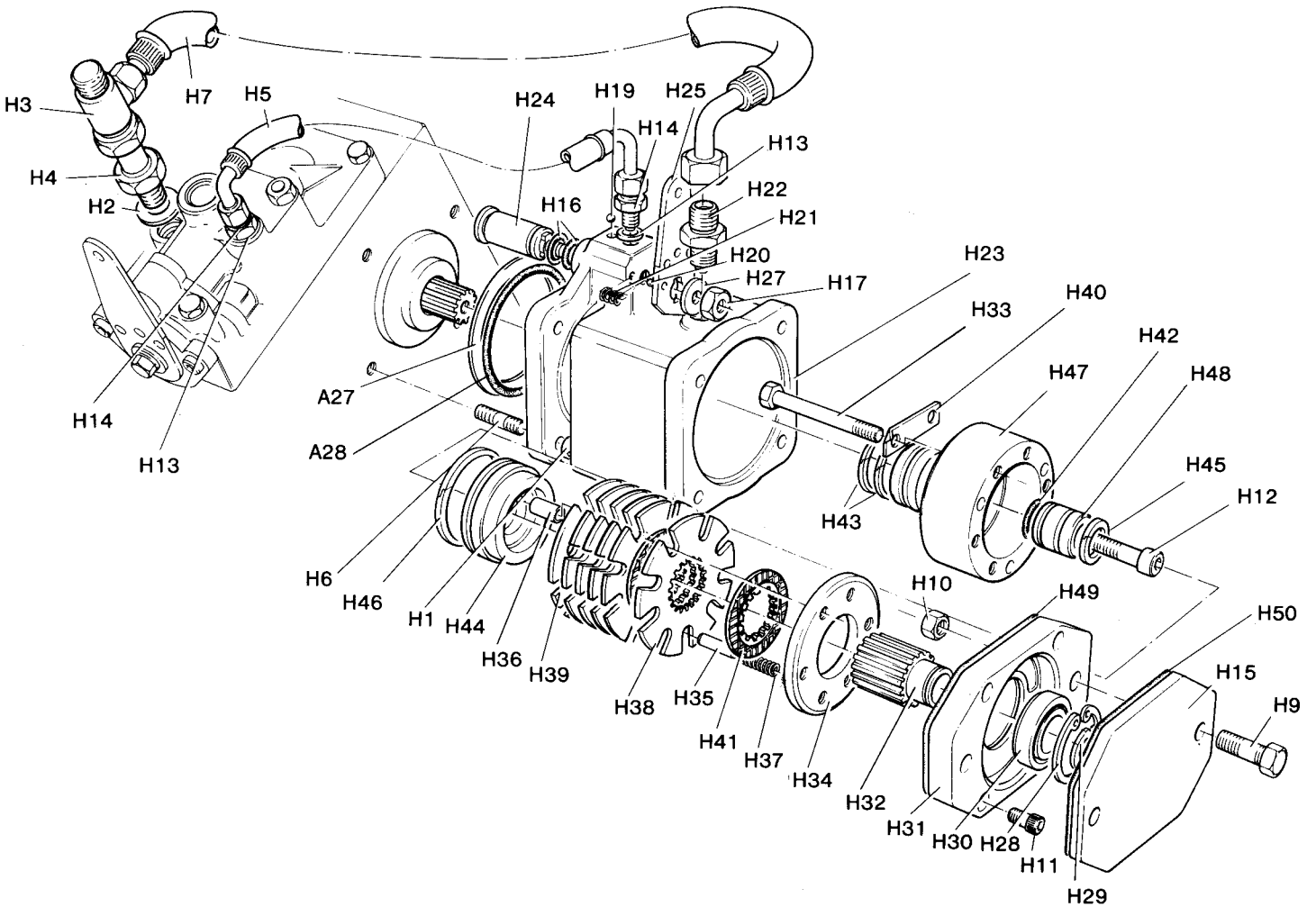
Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
A28	'O' ring	004124	1	
	Muff Coupling Sub-Assembly Comprising:-	MT5014 S/A		
G1	Half coupling	MT5014	1	
G2	Half coupling	MT5015	1	
	Adaptor Flange Assembly Comprising:	MT5016 S/A		
G3	Oil seal	0400463	1	
G4	Adaptor flange	MT5016	1	
G5	Shimming kit	MT0120	1	Not illustrated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Clutched Power Take Off

Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
H1	Nyloc nut	0051006	4	
H2	Dowty washer	0201715	1	
H3	Tee piece	CP1353	1	Only used together
H4	Pipe adaptor	CP1354	1	
H3	Tee piece	CP1367	1	Only used together, in place of CP1353 and CP1354
H4	Pipe adaptor	CP1255	1	
H5	Hose	MT5008	1	
H6	Stud	MT5009	4	
H7	Oil pipe	MT766 12" LONG	1	
	Shim	MT1076/02	AR	Not illustrated
H8	Shim	MT1076/10	AR	
	Shim	MT1076/31	AR	
H14	Union	CP1341	2	
H9	Bolt	0041211	2	
H10	Nut	0051205	2	
H11	Cap screw	0081520	4	
H12	Cap screw	0081535L	1	
H13	Seal	CP1224	2	
H16	'O' ring	000753	2	
H17	Nut	0050801	1	
H19	Ball	CP1180	1	
H20	Detent ball	CP1191	1	
H21	Spring	MT305	1	
H22	Union	MT4583	1	
H23	Body	MT5001	1	
H24	Lever	MT5006	1	
H25	Operating lever	MT5007	1	
H27	Washer	MT979	1	
H28	Circlip	0250550	1	
H29	Circlip	0330300	1	
H30	Ball bearing	0513010	1	
H31	Cover	MT5002	1	

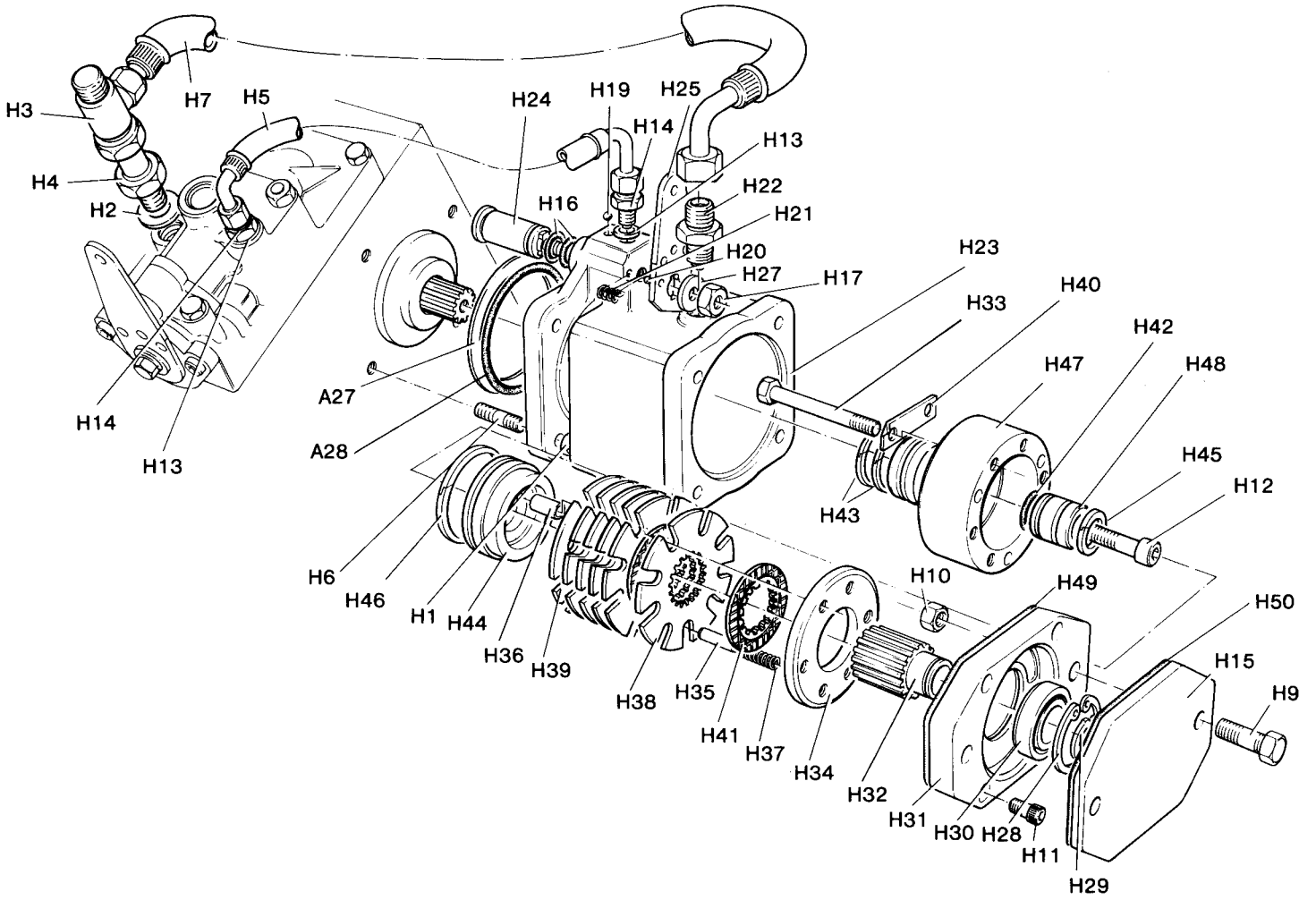
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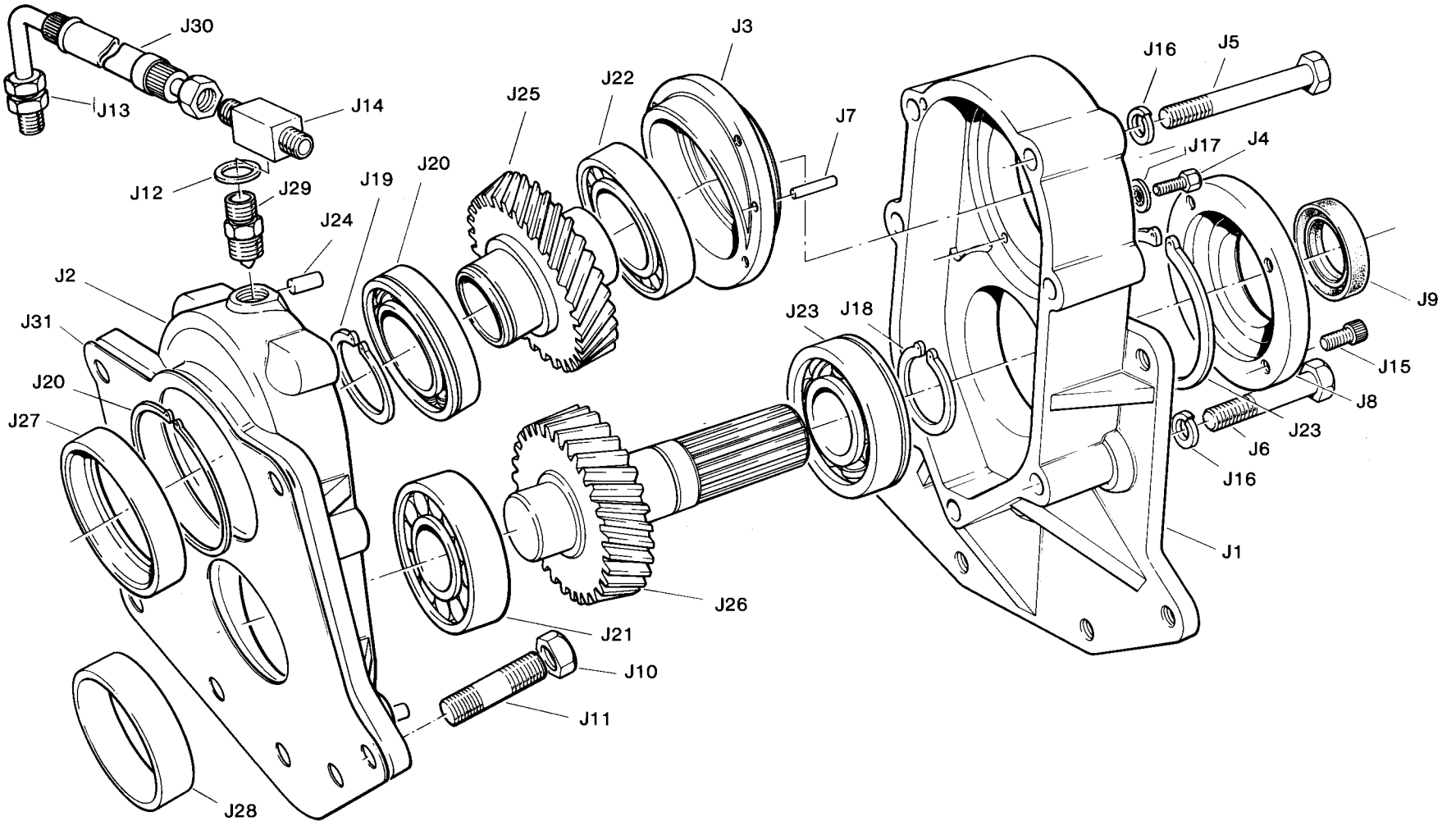
Plate Ref.	Description	PRM601M Part No.	Qty.	Remarks
H32	Drive adaptor	MT5004	1	
H15	Cover plate	MT5013	1	
	Clutch pack	MT0153		
H33	Bolt	0010420	6	
H34	Clutch end cover	MT1113	1	
H35	Pin	MT1155	3	
H36	Ferrule	MT1156	6	
H37	Spring	MT1157	3	
H38	Clutch plate	MT116	5	Not supplied separately
H39	Clutch end plate	MT117	1	
H40	Tab washer	MT351	3	
H41	Clutch plate	MT731	6	Not supplied separately
H42	'O' ring	001123	1	
H43	Piston ring	CP1192	2	
H44	Piston	MT345	1	
H45	Piston ring	MT358	1	
H46	Piston ring	MT359	1	
H47	Clutch body	MT5003	1	
H48	Plug	MT5005	1	
H49	Joint (gasket)	MT5011	1	
H50	Joint (gasket)	MT5012	1	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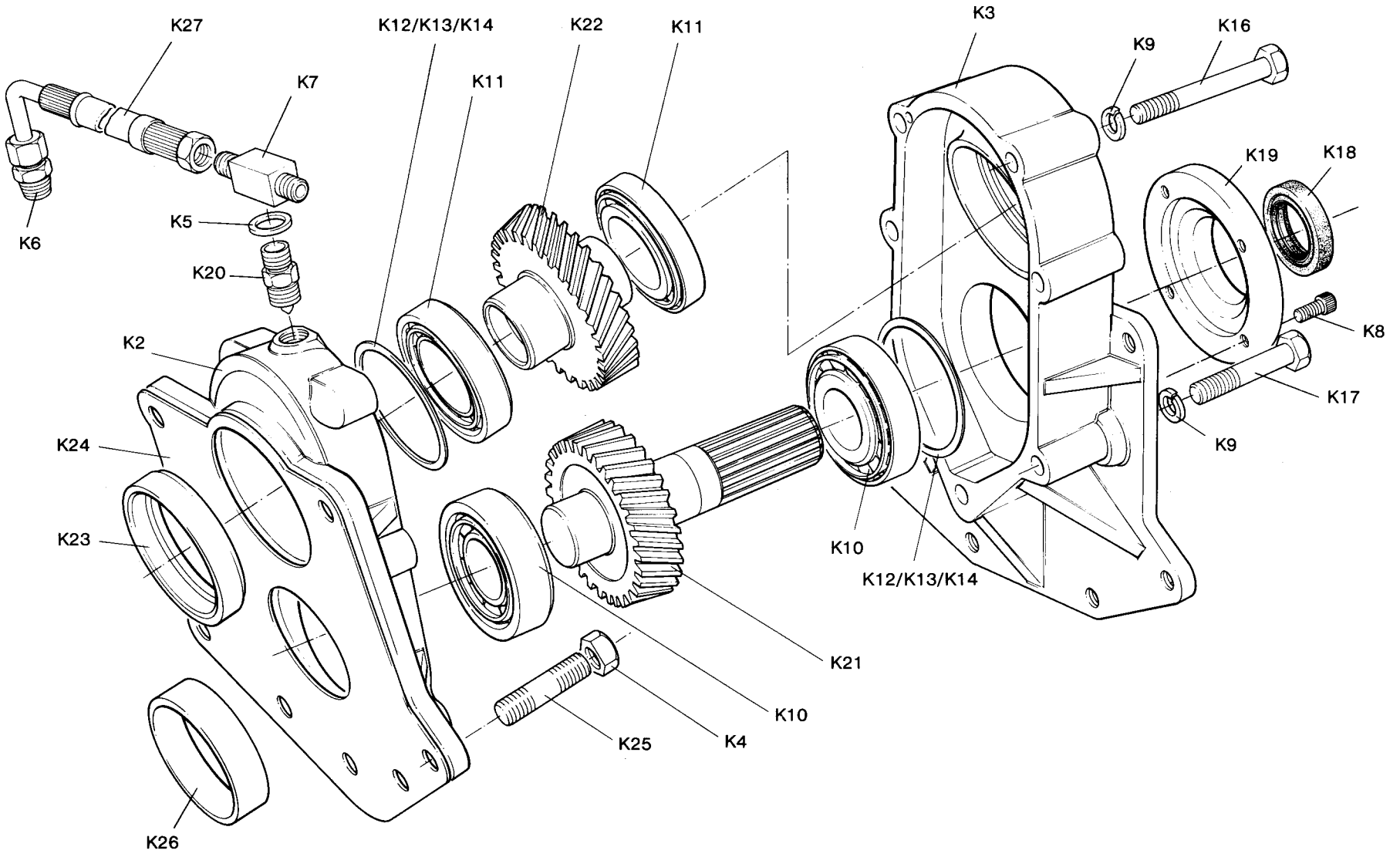
MT0129 Angle Drive Unit

Plate Ref.	Description	PRM601MA Part No.	Qty.	Remarks
	Gearcase S/A Comprising:	MT0122		
J1	Case half — front	MT4575	1	Not supplied separately
J2	Case half — rear	MT4576	1	Not supplied separately
J3	Bearing housing	MT4581	1	
J4	Screw	0040608	4	
J5	Bolt	0041217	4	
J6	Bolt	0041219	3	
J7	Dowel	CP1156	1	
	Seal Housing S/A Comprising:	MT4579 S/A		
J8	Oil seal housing	MT4579	1	
J9	Oil seal	0400402	1	
J10	Nyloc nut	0051205	6	
J11	Stud	MT4642	6	
J12	Dowty washer	0201715	1	
J13	Adaptor	CP1255	1	
J14	Tee piece	CP1367	1	
J15	Cap screw	0081316	4	
J16	Spring washer	0191107	7	
J17	Bonded seal	0191706	4	
J18	Circlip	0330400	1	
J19	Circlip	0330500	1	
J20	Ball bearing	0515026	1	
J21	Roller bearing	0534022	1	
J22	Roller bearing	0535021	1	
J23	Ball bearing	A48	1	
J24	Dowel	40M629	2	
J25	Output gear	MT4577	1	
J26	Input gear	MT4578	1	
J27	Locating ring	MT4580	1	
J28	Spacer	MT4672	1	
J29	Union assembly	MT4583	1	
J30	Oil pipe	MT766	1	
J31	Gasket	MT4599		
J32	Dipstick	40M153	1	Not illustrated


K27
K12/K13/K14
K22
K11
K3
K9
K16
K7
K11
K19
K18
K5
K6
K20
K2
K8
K17
K9
K24
K23
K10
K12/K13/K14
K21
K10
K25
K4
K26

MT0171 - Angle Drive

Plate Ref.	Description	PRM601MA Part No.	Qty.	Remarks
	Angle Drive	MT0171		
K1	Gearcase	MT0188	1	
K2	Case half (front)	MT4674	1	Not supplied separately
K3	Case half (Rear)	MT4675	1	Not supplied separately
K4	Nyloc nut	0051205	6	
K5	Dowty washer	0201715	1	
K6	Adaptor	CP1255	1	
K7	Tee piece	CP1367	1	
K8	Cap screw	0081316	4	
K9	Spring washer	0191107	7	
K10	Taper bearing	0540452	2	
K11	Taper bearing	0540501	2	
K12	Shim .002"	057353A	6	
K13	Shim .010"	057353C	6	
K14	Shim .031"	057353E	2	
K15	Dowel	40M629	2	Not illustrated
K16	Bolt	0041217	4	
K17	Bolt	0041219	3	
K18	Oil seal	0400402	1	
K19	Oil seal housing	MT4579	1	
K20	Union fitting	MT4583	1	
K21	Input gear	MT4658	1	
K22	Output gear	MT4659	1	
K23	Location ring	MT4676	1	
K24	Gasket	MT4599	1	
K25	Stud	MT4642	6	
K26	Spacer	MT4672	1	
K27	Oil pipe	MT766	1	
K28	Dipstick	40M153	1	Not illustrated

Service Kits of Parts

Plate Ref.	Description	PRM601M Part No.	Qty.
	'O' Ring Kit Comprising:-	**MT0238**	**1**
	Gasket - valve block	MT1073	1
A7	Gasket - top cover	MT343	1
	Gasket - valve block	MT1081	1
A28	'O' ring	004124	2
A31	'O' ring	001254	2
A36	'O' ring	003473	2
A39	'O' ring	003503	1
A44	'O' ring	005002	1
A47	'O' ring	000872	1
B10	'O' ring	000753	1
D32/E32	'O' ring	001873	2
D34/E34	'O' ring	004254	2
D42/E42	'O' ring	000372	8
A35	Oil seal - input shaft	0400403	1
A43	Oil seal - output shaft	0400751	1
	Shimming Kit Comprising:-	**MT0120**	**1**
A27	Shim	MT1076/02	3
A27	Shim	MT1076/10	3
A27	Shim	MT1076/31	2
F18	Shim	MT4671A	5
F19	Shim	MT4671B	5
F20	Shim	MT4671C	2
	Oil Pump Repair Kit Comprising:-	**MT0115**	**1**
C7	Spindle sub-assembly	MT4544 S/A	1
C6	Pump gear	MT379	1
C5	Pump spindle	MT378	1

Plate Ref.	Description	PRM601M Part No. MT0269	Qty.
	Clutch Pack Comprising:-	**~~MT0119~~**	**1**
D23/E23	Clutch plate	MT4535	5
D24/E24	Clutch plate	MT4602	6
D27/E27	Clutch end plate	MT4534	1
D22/E22	Spring	MT4652	3
D21/E21	Tabwasher	MT4555	6
D25/E25	End plate/Grub screw	MT4554 S/A	1
	Strip and Inspection Kit Comprising:-	**MT0246**	**1**
	'O' Ring kit	MT0238	1
D22/E22	Spring	MT4652	6
D21/E24	Tab washer	MT4555	12
	Ratio Change Kits:-		
	Conversion Kit to 1.5:1 Ratio	**MT0116**	**1**
D4/E4	Pinion sub-assembly	MT0100/1.5	2
F11	Output gear 1.5:1	MT4525	1
	'O' ring kit	MT0238	1
	Conversion Kit to 2:1 Ratio	**MT0117**	**1**
D8/E8	Pinion sub-assembly	MT0100/2	2
F12	Output gear 2:1	MT4527	1
	'O' ring kit	MT0238	1
	Conversion Kit to 3:1 Ratio	**MT0118**	**1**
D10/E10	Pinion sub-assembly	MT0100/3/4	2
F26	Output gear 3:1	MT4526	1
	'O' ring kit	MT0238	1

Plate Ref.	Description	PRM601M Part No.	Qty.
	Clutch Pack for Clutched PTO Comprising:-	**MT0153**	**1**
H33	Bolt	0010420	6
H34	Clutch end cover	MT1113	1
H35	Pin	MT1155	3
H36	Ferrule	MT1156	6
H37	Spring	MT1157	3
H38	Clutch plate	MT116	5
H39	Clutch end plate	MT117	1
H40	Tab washer	MT351	3
H41	Clutch plate	MT731	6

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