

manual for:

PRM601



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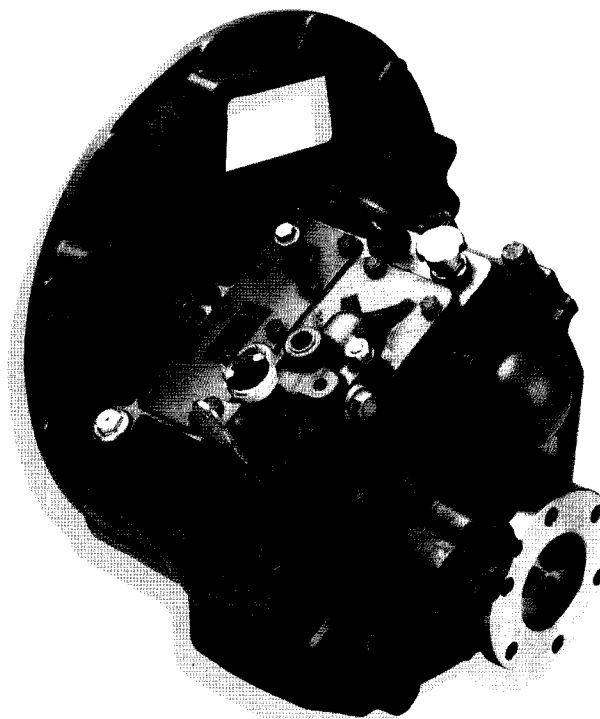


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NEWAGE

PRM

PRM601 MARINE GEARBOX



WORKSHOP MANUAL

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Certificate No. Q10728

FOREWORD

Provided it is correctly installed, aligned and maintained, the PRM601 gearbox should have a long and trouble-free life. This workshop manual contains important instructions to ensure that this is so, and it is of the utmost importance that these are carefully followed. Newage Transmissions can accept no responsibility under warranty or otherwise for any loss or damage resulting from failure to observe these instructions.

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

CLAIMS UNDER WARRANTY

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

SERVICE PARTS

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

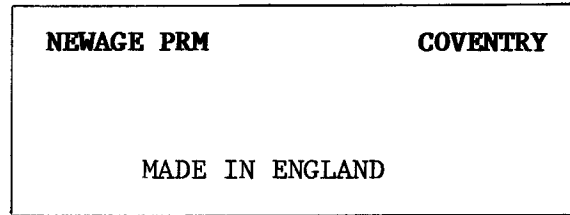
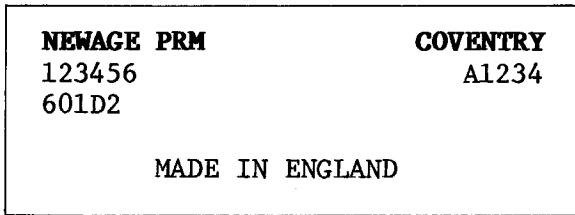
PRE-DELIVERY TEST

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

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

IDENTIFICATION PLATE

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



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

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

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

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

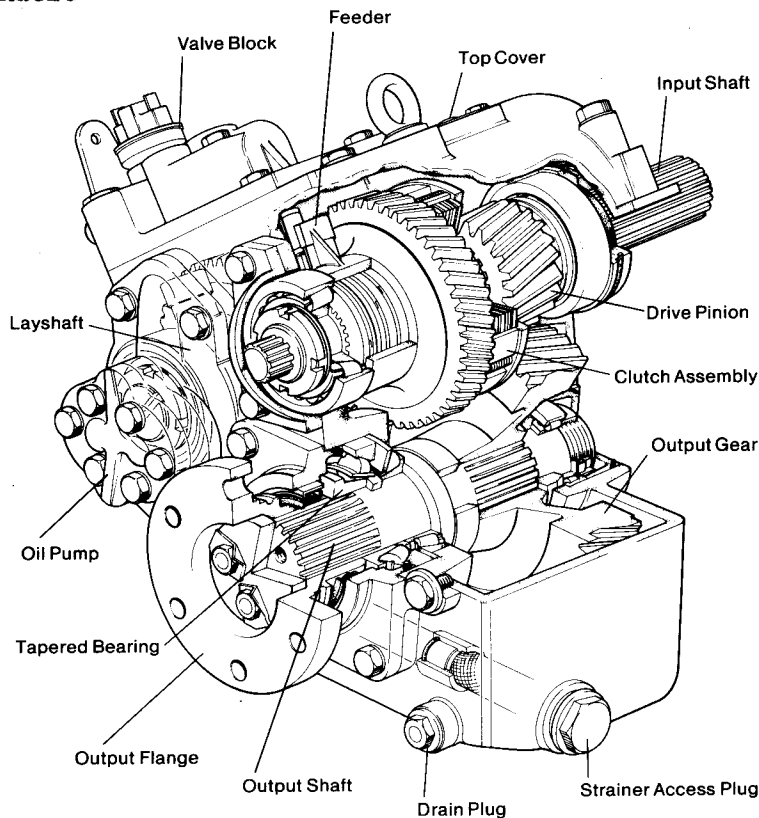
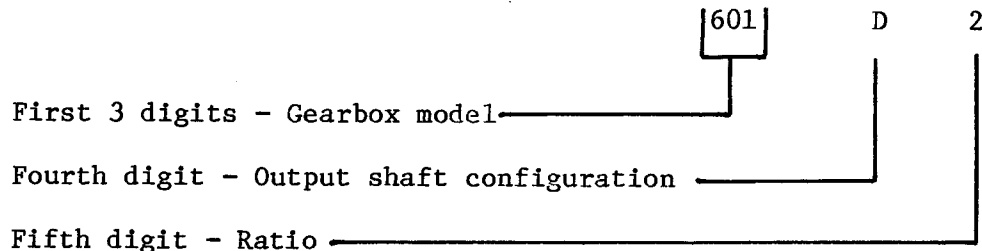


Fig. 1 Gearbox cut-away

PRM601 SERVICE MANUAL

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1. GENERAL DATA

1.1 Specifications

Gear ratios

1.19:1, 1.53:1, 2.03:1, 2.86:1, or 4.00:1 .

Power rating:

| RATIO | PLEASURE | | LIGHT COMMERCIAL | | HEAVY COMMERCIAL | |
|----------------|----------|------|------------------|------|------------------|------|
| | BHP | kW | BHP | kW | BHP | kW |
| 1.19:1, 1.53:1 | 12.95 | 9.66 | 9.52 | 7.10 | 8.95 | 6.67 |
| 2.03:1 | 12.19 | 9.09 | 9.52 | 7.10 | 8.95 | 6.67 |
| 2.86:1 | 10.28 | 7.67 | 9.14 | 6.82 | 8.57 | 6.39 |
| 4.00:1 | 10.28 | 7.67 | 9.14 | 6.82 | 8.57 | 6.39 |

MAXIMUM OPERATING SPEEDS: 3200 REV/MIN INTERMITTENT, 2800 REV/MIN CONTINUOUS

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

SERVICE CLASSIFICATION DEFINITIONS

PLEASURE: limited to planing hull pleasure craft; operation at full engine throttle not to exceed 5% of total time, with balance of usage at 90% or less of full throttle engine speed, and maximum operating time 500 hours per year. The selection of PRM marine transmissions according to this classification for any commercial boat, or in sport-fishing charter boats or long-range pleasure cruisers, is not approved.

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

HEAVY COMMERCIAL: Newage Transmissions Ltd recommends that all displacement and semi-displacement craft used for commercial applications should be classed as Heavy Commercial Duty. In vessels of this type (including trawlers, purse seiners, lobster and crab boats, tugs, ferries, offshore supply boats etc) the marine gearbox is expected to work at full governed engine speed. The power setting of the engine must be known, and must be within the permitted heavy commercial rating of the gearbox.

IMPORTANT NOTE:

(1) It is important that the engine, transmission model, reduction ratio and propeller size should be correctly matched so that the engine can attain its rated speed appropriate to the relevant service classification without labouring.

(2) It is also very important to ensure the torsional compatibility of the complete propulsion system from engine to propeller, since disregarding this may result in gear noise, particularly at low speed operation, and may even result in damage to engine as well as transmission components.

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

APPROXIMATE WEIGHTS AND OIL CAPACITIES

| DRY WEIGHT | | OIL CAPACITY |
|------------------------------------|---------------------------------|--|
| PRM601D | 86kg (190lb) (excluding drive | 3.0 litres (5.28 pints) |
| PRM601D4 | 93kg (205lb) (coupling, adaptor | 4.0 litres (7.04 pints) |
| PRM601A | 118kg (260lb) (and cooler. | 3.5 litres (6.16 pints) |
| CLUTCHED PTO:11.2kg (24.7lb) extra | | plus amount required to fill cooling circuit. |
| LIVE PTO:3.2kg (7.1lb) extra | | |

Input rotation:

Clockwise or anti-clockwise (see section 2).

Output rotation:

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

Working oil pressure:

Minimum: 2310 kPa (335 lb/in²) - **Maximum:** 2655 kPa (385 lb/in²).

Working oil temperature:

50°C - 70°C.

Maximum permissible temperature 80°C.

Transmission cooling:

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

The size of cooler required depends on a number of factors including transmitted horsepower; operating speed duty cycle, inlet water temperature and ambient temperature. Suitable coolers are available from Newage Transmissions Ltd

Input drive couplings:

Flexible drive coupling for flywheels of 11.5in and 14in nominal diameter to SAE J620C.

Gearcase:

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

Input shaft:

39.7mm (1.563in) diameter with 18 tooth involute spline.

Propeller thrust:

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

Output flange:

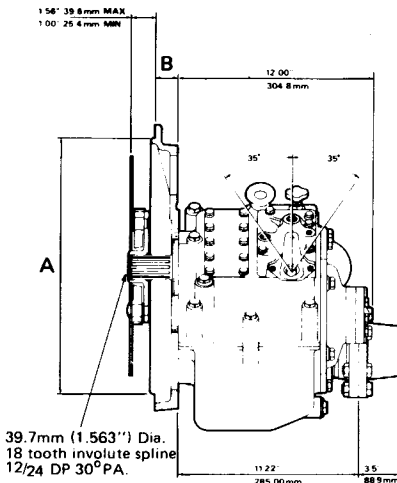
All ratios **except** 4:1:- 146mm (5.75in) diameter, with 6 holes, 13mm (0.512 in) diameter on 121mm (4.75in) PCD.

4:1 ratio only:- 184mm (7.25in) diameter, with 6 holes 16.3mm (0.614in) diameter on 152mm (6.0in) PCD.

Installation angle:

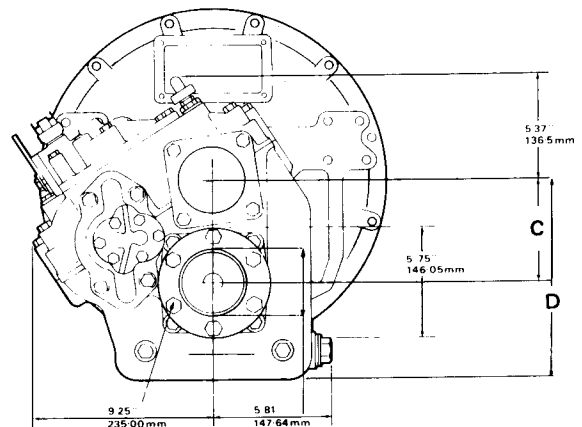
The maximum fore and aft installation angle permissible at rest is 17°.

1.2 Installation details



| Adaptor | 'A' | | 'B' (Nominal) | |
|---------|--------|--------|---------------|--------|
| | mm | inches | mm | inches |
| SAE 1 | 511.17 | 20.125 | 50.80 | 2.00 |
| SAE 2 | 447.67 | 17.625 | 36.57 | 1.44 |
| SAE 3 | 409.57 | 16.125 | 36.57 | 1.44 |

| | DROP CENTRE DISTANCE | | | |
|--------------|----------------------|--------|-------|--------|
| | 'C' | | 'D' | |
| | mm | inches | mm | inches |
| 4:1 | 174.0 | 6.856 | 336.0 | 13.23 |
| other ratios | 135.0 | 5.315 | 262.0 | 10.31 |

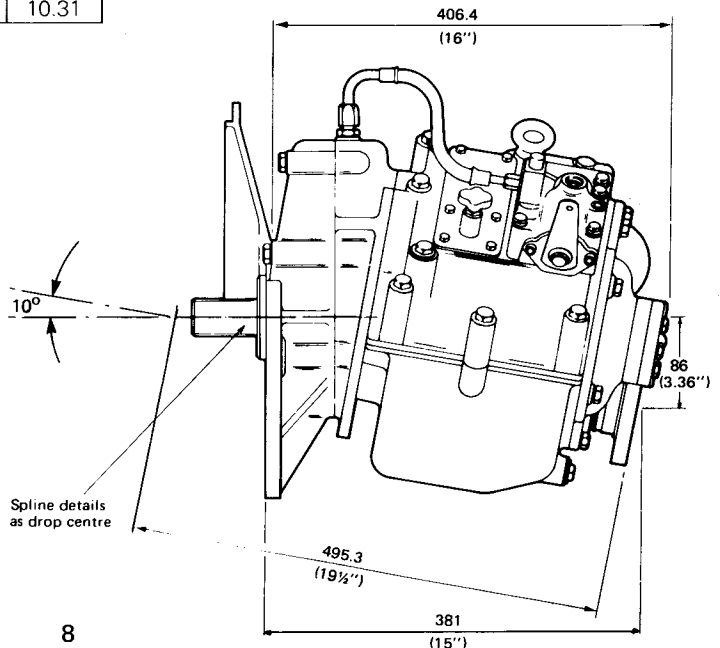
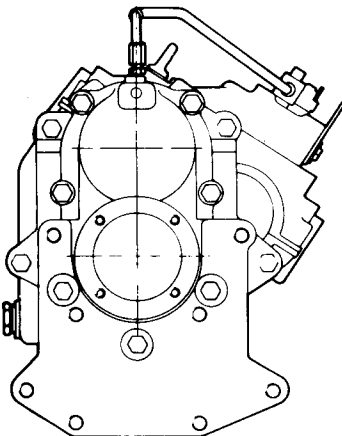


4:1 Ratio - 3.75" (95.25mm)
Other Ratios - 3.00" (76.20mm)

4:1 Ratio - 6 Holes 0.64" (16.25mm)
on a 6.00" (152.4mm) PCD
Other Ratios - 6 Holes 0.515" (13.00mm)
on a 4.75" (120.7mm) PCD

Installation angle

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



2. INTRODUCTION

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

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

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

3. CONSTRUCTION

3.1 Gearcase

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

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

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

3.2 Gear train

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

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

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

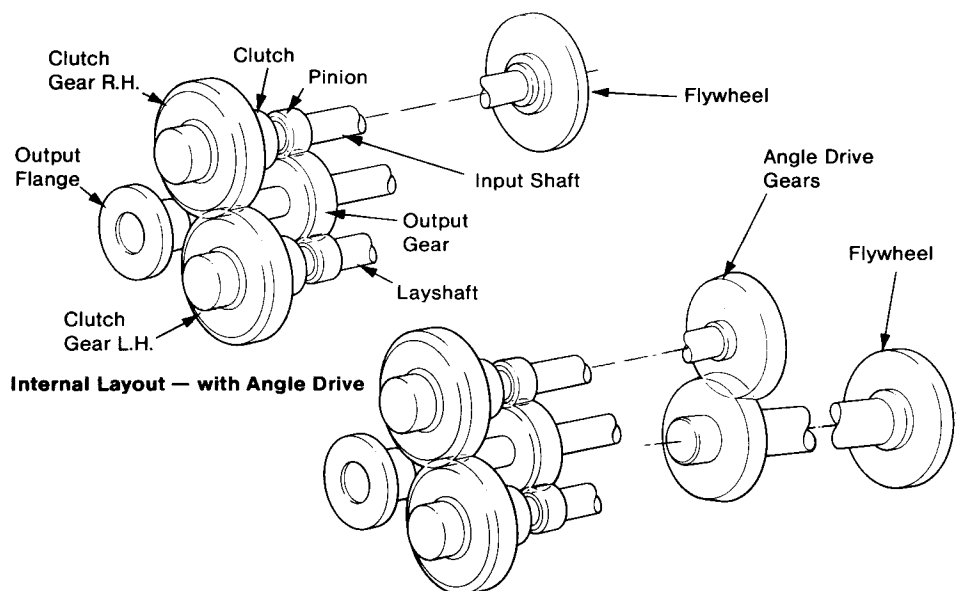


Fig. 2 Internal layout diagram

3.3 Gear train - angle drive

The angle drive unit incorporates a pair of conical involute gears so arranged that the output shaft runs at an angle of 10° down relative to the input shaft; it also has the secondary 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 engine in such a way that the latter can be installed as near as possible to the horizontal whilst maintaining the required propeller shaft line.

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

3.4 Valve block

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

The control valve is fitted with a spring-loaded neutral detent; this provides a positive "feel" to the neutral position, to facilitate the setting-up of the remote control operating cable and ensuring positive shifting.

3.5 Neutral safety switch

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

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

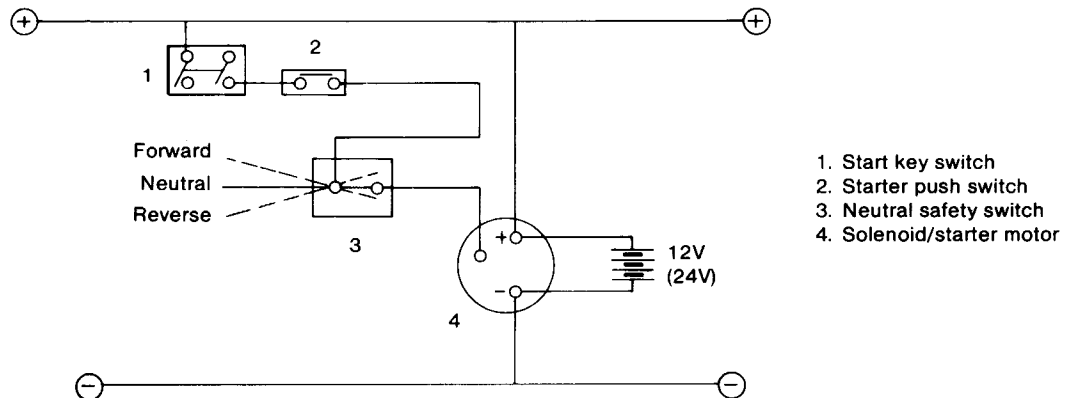


Fig. 3 Wiring diagram for neutral safety start device

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

3.6 Oil pump

A cast iron gear-type pump, externally mounted at the rear of the gearcase and normally driven by the layshaft, supplies oil at high pressure to actuate the clutches, and at lower pressure to the 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 (PRM601A), the oil pump is fitted in its standard position. For clockwise engines, or anti-clockwise with angle drive (PRM601A), the pump is mounted at 180° from its standard position (see diagrams).

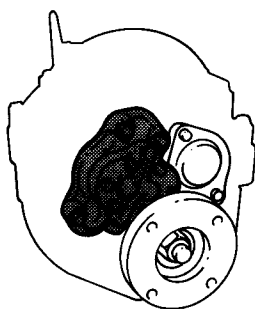


Fig. 4 Oil pump mounting –
anti-clockwise engines
(or clockwise with Angle Drive)

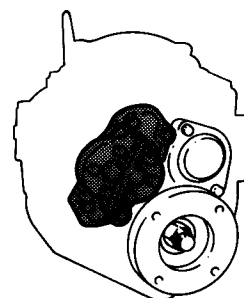


Fig. 5 Oil pump mounting –
clockwise engines
(or anti-clockwise with Angle Drive)

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

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

4. OPERATING SYSTEM

4.1 Output rotations

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

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

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

Gearbox output rotation

Engine rotation anti-clockwise

| | PRM601A | PRM601D |
|----------------|---------|---------|
| Lever Backward | ↺ | ↻ |
| Lever Forward | ↻ | ↻ |

Engine rotation clockwise

| | PRM601A | PRM601D |
|----------------|---------|---------|
| 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; the standard gearbox build therefore assumes an anti-clockwise input.

4.2 Hydraulic system

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

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

Oil in excess of that needed to operate the clutches is used for lubricating the gearbox.

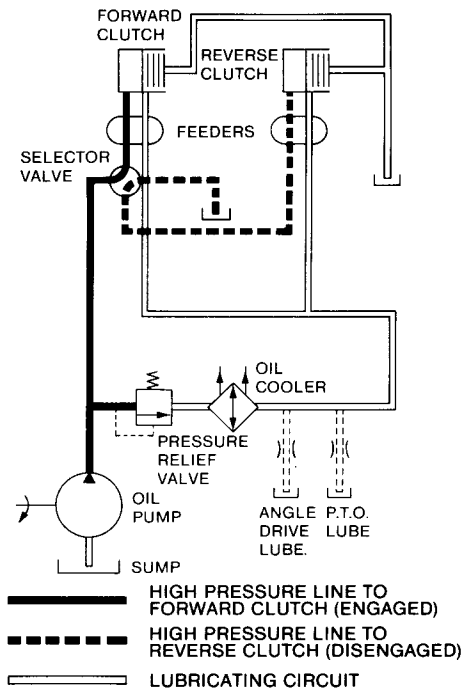


Fig. 6 Hydraulic and lubricating oil circuits

4.3 Lubrication

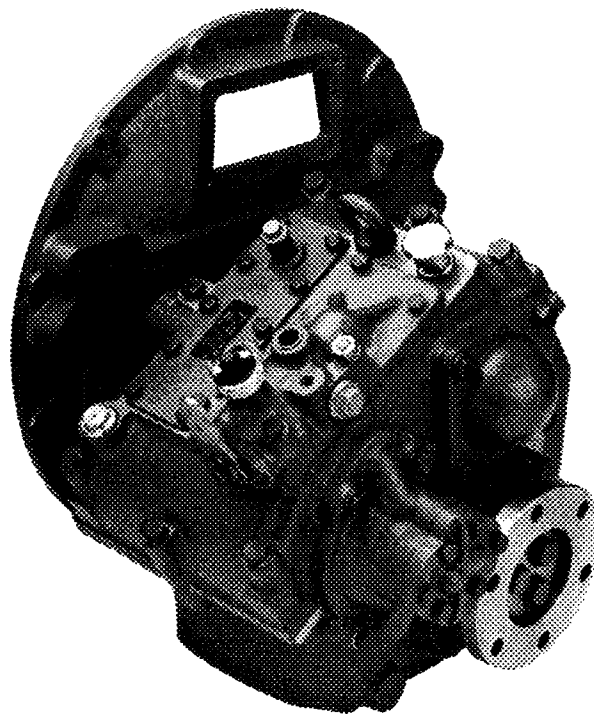
Oil for lubrication purposes is also delivered via the internal supply pipe to the control block. Irrespective of whether ahead or astern is engaged oil is diverted from the discharge side of the pressure relief valve to an external oil cooler. After passing through the cooler, the oil is directed through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

4.4 APPROVED OILS

| | | |
|-------------|---|---|
| Below Zero | : | 10W30 or 20W. Engine oil to AP1 designation CD. |
| 0°C to 30°C | : | 10W30 or 30W. Engine oil to AP1 designation CD. |
| Above 30°C | : | 10W30 or 40W. Engine oil to AP1 designation CD. |

It is essential that only **good quality** engine oil, supplied by a **recognised and well known manufacturer**, is used in Newage marine transmissions.

Failure to comply with the above oil types may result in the forfeiture of warranty cover since no claims under warranty will be entertained if oil of the wrong specification is used.



PRM601 MARINE GEARBOX BY NEWAGE

5. INSTALLATION

5.1 General

The Newage PRM601 marine gearbox is supplied with a choice of adaptor plates to SAE1, SAE2, or SAE3 specifications enabling the gearbox to be mounted to engines having flywheel housings of equivalent specification.

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

The coupling enjoys a measure of torsional flexibility, which helps to damp down engine torsional or cyclic vibrations and prevent them being passed to the transmission.

The strongest engine vibrations are usually those caused by firing in the cylinders; diesel engines, 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 horsepower, 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 therefore that all the procedures detailed in this manual are carefully followed.

5.2 Checking the engine flywheel housing

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

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

5.3 Checking the engine flywheel

Attach a dial test indicator, calibrated to 0.001 in (0.025 mm) or less, to the engine flywheel housing so that the measuring stylus of the indicator is perpendicular to the bore of the register in the flywheel (bore C on Fig 7). Rotate the flywheel through one complete revolution and note the deviation, this should not exceed 0.005 in (0.125mm) total indicator reading.

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

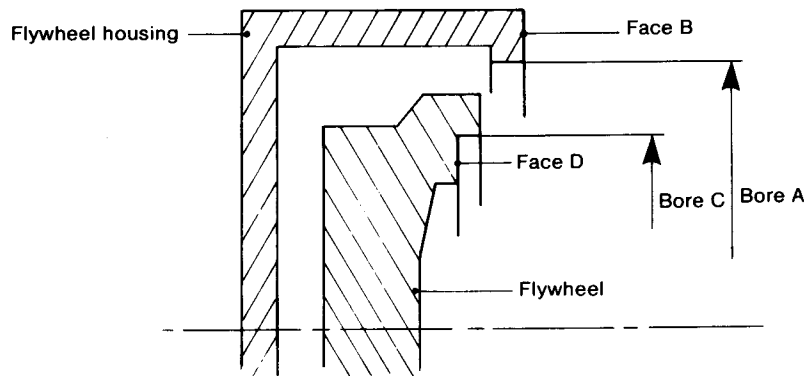


Fig. 7 Checking engine flywheel and flywheel housing

5.4 Mounting the gearbox to the engine

1. Taking care to ensure correct alignment, bolt the adaptor flange to the front of the gearbox. **Note:** the maximum permissible misalignment of adaptor and gearbox is 0.002in (0.05mm).
2. Mount the flexible input coupling to the flywheel, using an alignment mandrel if available, and bolt it to the flywheel using the holes provided. If the flywheel and coupling are to SAE standard, the outside diameter of the coupling should be a close fit in the flywheel register.

If 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.

3. Fully tighten the input coupling bolts.
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 PRM601 gearboxes must be fitted with an oil cooler to maintain correct working temperature (50°C - 70°C). To permit a suitable cooler to be fitted, two $\frac{3}{8}$ in. BSP connections are provided on the valve block; these are blanked off with "Redcap" seals on delivery from the factory.

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

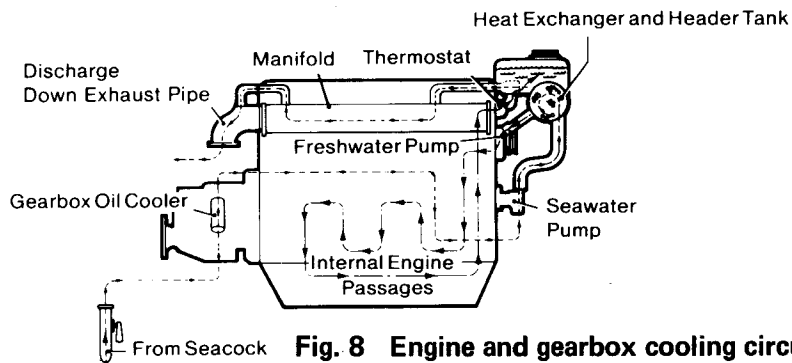


Fig. 8 Engine and gearbox cooling circuit

5.5.1 PRM601D - standard gearbox

- a) Remove the "Redcap" seals from the valve block.
- b) using suitable hydraulic hoses, connect the valve block outlet to the inlet connection on the oil cooler, and the cooler outlet to the valve block inlet.
- c) incorporate the cooler into the engine cooling system as shown above.

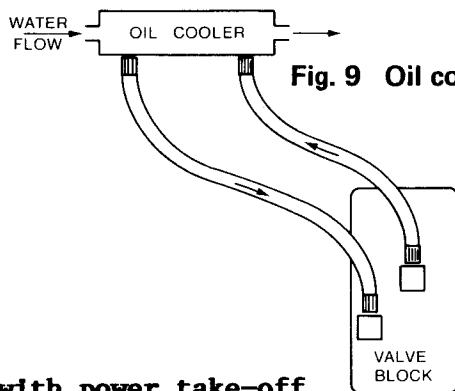


Fig. 9 Oil cooler connections PRM601

5.5.2 PRM601D - with power take-off

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

- a) remove the "Redcap" seals from the valve block.
- b) connect the valve block outlet to the 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.
- e) incorporate the oil cooler in the engine cooling system as shown above.

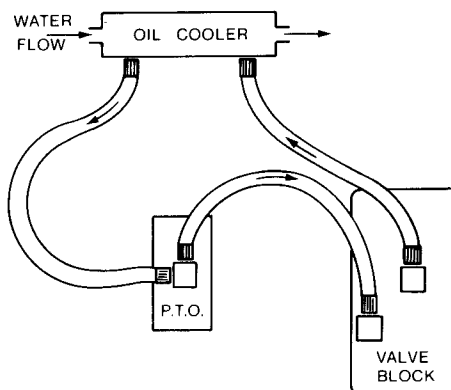


Fig. 10. Oil cooler connections PRM601D with power take-off

5.5.3 PRM601A - with angle drive

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

- a) remove the "Redcap" seals from the valve block.
- b) connect the valve block outlet to the oil cooler inlet.
- c) connect the oil cooler outlet to the angle drive inlet.
- d) complete the circuit by connecting the angle drive outlet to the valve block inlet.
- e) incorporate the oil cooler in the engine cooling system as shown above.

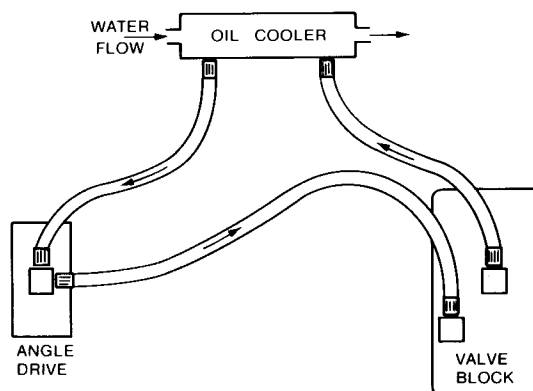


Fig. 11 Oil cooler connections PRM601A with angle drive

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

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

5.6 Alignment to propeller shaft

Correct alignment of the propeller shaft and gearbox output shaft is extremely important since excessive vibration and stress leading to damage and perhaps even failure can occur if good alignment is not achieved.

In the majority of boats whose hulls are sufficiently rigid as not to allow excessive flexing in heavy sea conditions, (which could cause the engine and transmission to shift relative to the propeller shaft), it is generally considered preferable to couple the propeller shaft to the gearbox output flange by means of a rigid coupling

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

- a) in boats whose hulls are insufficiently rigid to prevent the flexing referred to above, and
- b) in cases where the engine is mounted on flexible mounts.

In both cases, the flexible coupling helps to isolate engine vibration or other movement from the propeller shaft, thus by enabling correct alignment with 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 the number of shims on the engine mounts.

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

5.7 Installation angle

The 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 PRM601A (angle drive) the transmission provides 10° down angle on the output shaft; it also reduces the centre distance between the engine crankshaft and the gearbox output shaft, enabling the engine to be mounted nearer to the horizontal than in-line or drop-centre transmissions will allow and reducing the overall height required for installing the engine. This will also help to prolong engine life.

5.8 Twin installation

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

In twin installations, the effect on the handling of the boat is much more pronounced if both propellers rotate in the same direction. It is therefore desirable that "handed" (i.e. counter-rotating) propellers be fitted, which is why PRM gearboxes have been designed to provide either hand of output rotation at any of the available gear ratios.

It is also usually preferable for the starboard (right-hand) propeller to rotate clockwise and the port (left-hand) 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 a vacuum tends to be created which affects the other propeller by reducing the flow of water to it; moreover, when the boat makes a tight turn with one gearbox in "ahead" and the other in "astern", the thrust side of one propeller will act diametrically opposite to the other, causing the boat to be deflected off line and thus delaying the completion of the manoeuvre.

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

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

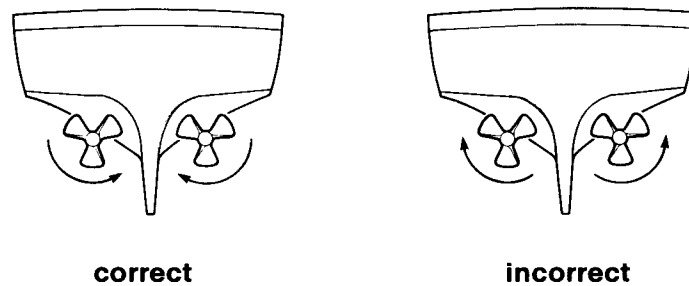


Fig. 12 Propeller rotation, twin installations

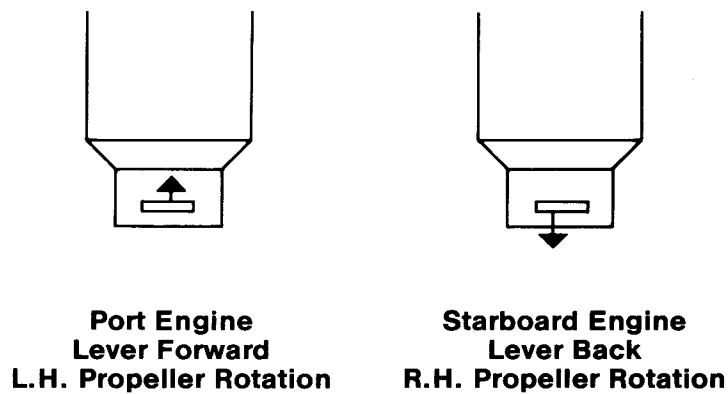


Fig. 13 Operating lever movement for ahead drive, twin installations

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

5.9 Remote control operating systems

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

The following points should be noted:

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

The 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 recommendation, section 4.4).

Ensure that the gearbox is in neutral. (It is recommended that the optional neutral safety switch be wired into the starter circuit to avoid inadvertent movement of the boat on start up).

Start the engine and gearbox, allowing the oil to circulate, then stop the engine to let the oil settle. Remove and wipe the dipstick, then screw it fully down into the gearcase and remove it again to read the oil level.

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 and moving the gearbox operating lever backwards provides left-hand propeller rotation whilst moving it forwards provides right-hand propeller rotation.

Note: If the gearbox is fitted with an angle drive unit (PRM601A), then the operating lever movements described above are reversed.

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

6.2 Drive selection

The Newage PRM601 has been designed and tested to ensure rapid shifts from ahead to astern or vice versa; it can be operated at full horsepower ratings and speeds, and will respond rapidly in these circumstances.

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

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

6.3 Trailing (free-wheeling) the propeller

The bearings used in the Newage PRM601 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, making the gearbox particularly well suited for use in auxiliary sailboats, motor sailers or multi-engine installations where the boat may be operated with one or more engines shut down.

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

Propellers which are allowed to free-wheel 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 PRM601 gearbox is a "Get You Home" device which, in the unlikely event of hydraulic clutch failure allows the gearbox to be mechanically locked in 'ahead' drive.

To operate, first switch off the engine, select neutral on the operating lever, disconnect the operating cable and then proceed as follows:-

1. Remove top cover (located alongside the valve block). The hexagonal key for operating the emergency device is held in a clip on the underside of the top cover.
2. Decide which shaft has to be locked up. Since the majority of engines have left-hand (anti clockwise) rotating flywheels as viewed from the stern of the boat, the appropriate shaft to "lock-up", also viewed from the stern, is as follows:-

For left-hand propeller rotation, use the left-hand shaft (right-hand shaft if angle drive (PRM601A) is fitted).

For right-hand propeller rotation, use the right-hand shaft (left-hand shaft if angle drive (PRM601A) is fitted).

3. Locate the clutch end plate (item D9). This has three tapped holes, angled to facilitate access. Rotate the shaft until one of the holes is uppermost and insert hexagon key (allen key).
4. Screw the grub screw (item D10) as tight as possible.
5. Rotate the shaft and similarly tighten the other two screws.
6. Ensure that sufficient oil remains in the gearbox to avoid further damage and refit the top cover.

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

NOTE:

- a) 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 to let the oil settle. Re-check the level and top up if necessary to the maximum mark on the dipstick.

7.2 Daily check

1. Check the gearbox oil level
2. Visually inspect the general condition of the gearbox and check for oil leaks, especially at the output shaft seal and at gasket sealing surfaces.
3. Listen for any unusual noises and check their cause.

7.3 Annual checks

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

7.4 Winter storage

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

7.5 Other maintenance operations

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

8. FAULT FINDING

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

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

9. SERVICING AND REPAIRS

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

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

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

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, layshaft and output shaft will however require the gearbox to be removed from the boat.

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

Exploded views of all internal components are contained in the parts list.

9.1 Valve block

The complete valve block can easily be removed for inspection and servicing without taking the gearbox out of the boat, as follows:-

1. Disconnect the oil cooler pipes and the control cable or cables from the lever on the valve block.
2. Disconnect the wiring from the neutral switch (if fitted).
3. Remove the 5 bolts and one nut securing the valve block to the gearcase.
4. To remove the control valve and high pressure valve, simply remove the two cap screws (item no. B13) and withdraw the valves from the valve body. **Take care not to lose the detent ball and springs!**
5. Inspect the 'O' ring (item no. B10) and bearing (item no. B8): replace if worn, damaged or defective. Check that the pressure relief valve spring (item no. B5) has retained its correct free length (62mm, 2.441 in):- if not, replace.
6. To assemble and refit the valve block, simply reverse the above procedure.

9.2 Oil pump

The oil pump assembly is also easy to remove with the gearbox in situ:-

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

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

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

N.B. The clutch shaft must be reshimmed if a new pump assembly is fitted.

9.3 Oil strainer

The gearbox oil strainer is attached to the intake end of the oil suction pipe which feeds oil from the sump to the pump. It may be removed for inspection or cleaning, as follows:-

1. Remove the drain plug and washer from the bottom of the gearbox, and withdraw the strainer.
2. In order to remove any debris which may have become attached to the strainer, wash the strainer in paraffin or other suitable fluid.
3. To refit, simply reverse the above procedure.

9.4 Removing the transmission from the boat.

1. Ensure that the gearbox operating lever is in the neutral position and disconnect the operating cable from it.
2. Drain the gearbox oil into a suitable container and disconnect the 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 rocking the unit slightly in order to disengage the input shaft spline from the internal spline in the coupling.

9.5 Removing the input shaft and layshaft assemblies

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

6. Lift input shaft assembly and front oil seal housing from the gearcase.
7. Lift layshaft assembly and front end cover from the gearcase.

9.6 Servicing input shaft and layshaft assembly components

9.6.1 Input shaft oil seal

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

Fit a new seal (item 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 to the input shaft only).
2. Using pulley extractors with the jaws of the extractor located behind the pinion, withdraw the clutch pinion, spacer and bearing.
3. Refit the clutch pinion to the shaft.
4. Refit the spacer and bearing, inspecting for wear and replacing where necessary.
5. Locate the new bearing (items D1 & D2) on the shaft and, using a handpress or if this is unavailable, a hardwood drift and hammer, gently drive the assembly into position. Take care not to damage the bearing rollers or raceways during this operation. Note:- with the bearing correctly located, the pinion should be able to move a small amount fore and aft on the shaft.
6. Reposition the input seal housing on the shaft (input shaft only.)

Note: If new bearings are fitted, they must be re-shimmed as described in section 9.9.

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 occurs, 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 (item D7).
3. Withdraw the complete clutch from the shaft, noting the position of the pull-off springs.
4. Stand the shaft upright and locate the 3 assembly bolts in the clutch gear.
5. Fit the clutch end plate (item D14) into the clutch gear and replace the pull-off springs over the assembly bolts. Then, starting with one of the driven clutch plates (item D12), build up the replacement clutch onto the clutch end plate.

6. Replace the clutch end cover (item D9) on the clutch pack, replace the securing bolts, and using a torque spanner, tighten them to 12.2Nm (1.2 Kgm, 9 lbf.ft).
7. Replace the drive pinion into the clutch pack until it touches the bottom washer.
8. Position the thrust bearing, thrust washer and bearing on the shaft and gently drive the bearing into position. With the bearing correctly located, the drive pinion should be able to move a small amount fore and aft.

9.6.4 Clutch gear

To fit a new clutch gear (item D23) first remove the clutch pack as previously described in section 9.6.3, and then proceed as follows:-

1. Withdraw the two thrust washers and one thrust bearing located in front of the piston.
2. Tap out the piston from the clutch gear. If difficult to remove, this may be left until a later stage.
3. Remove the lock nut and tabwasher from the rear end of the shaft.
4. Position the shaft assembly such that the front face of the clutch body is supported face downwards on a plate; the shaft may now 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 the clutch gear and feeder, examining the feeder piston rings and replacing if worn (for piston rings and feeder removal, refer to section 9.6.7).
7. Insert the piston into the clutch gear, examining the 'O' rings for wear or damage, and replacing if necessary.
8. Position the bearing on the rear end of the shaft and gently drive into position.
9. Refit the lock nut 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 its mating gear. It is also strongly recommended that piston seals and tabwashers should always be replaced.

9.6.5 Drive pinion

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

To replace the drive pinion, follow the procedure set out in section 9.6.2.

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 replacement of the piston rings and feeder in the following manner:-

1. Remove the non drive end bearing as described and remove the feeder and spacer.
2. Using a special piston ring extractor remove the piston rings from the shaft. If no extractor is available, a thin piece of steel may be used, as follows:-

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

3. Remove the new rings (D24) from their packing and clean off any grease or inhibitor.
4. Using a ring loading tool fitted around the clutch gear, load the rings on to the tool and locate in their approximate position. Gently withdraw the tool, allowing the rings to locate in their respective grooves.
5. If no loading tool is available, use a thin metal strip, long enough to lay along the clutch gear above the grooves. Expand each ring just sufficiently to allow it to be placed in its approximate position over the strip, then gently withdraw the strip, locating the rings in their respective grooves. (see Fig. 13).
6. Compress each ring in turn and carefully fit the new feeder.

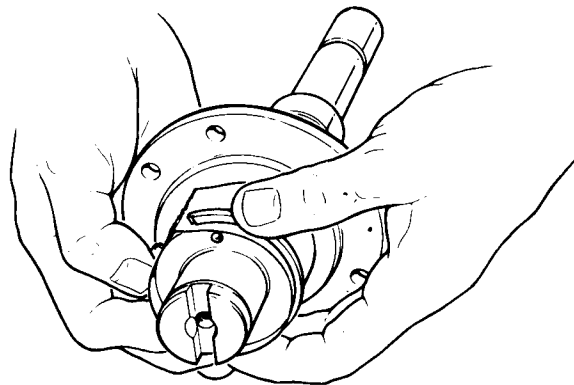


Fig. 14 Piston ring fitting procedure

9.7 Replacement of input shaft and layshaft assemblies

1. Position the input shaft assembly in the gearcase, ensuring that the oil seal housing is correctly located in the groove. Examine the 'O' ring for wear or damage and replace if necessary.
2. Position the layshaft in the casing, ensuring that the end cover is correctly located in the groove. Examine the 'O' ring for wear or damage and replace if necessary.
3. Coat the mating surfaces of the two gearcase halves with a jointing compound and, ensuring that the feeder connectors are correctly located, fit the top half of the gearcase to the lower. To simplify this operation, wire placed in the feeder connectors and passed through the holes in the top half of the gearcase will ensure that they are in approximately the correct location when the gearcase top half is lowered on to them. The 'O' rings on the connectors should be examined for damage or wear and renewed if necessary.
4. Replace the two front gearcase bolts and make sure that the two gearcase halves are square .
5. Fit the remaining gearcase bolts and tighten all 7 to the correct torque.
6. Shim and refit the input shaft end cover, replacing the 'O' ring if damaged.
7. Shim and refit the oil pump, replacing the 'O' rings if damaged. Take care that the oil pump is fitted in the correct position to ensure the required direction of rotation .
6. Refit the valve block, replacing the 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 SAE2 adaptors).
9. Reconnect the oil cooler pipes and the control cable or cables.

Note: Shimming procedure is described in section 9.8

9.8 Servicing the output shaft assembly

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

1. Remove the input shaft and layshaft assemblies as described in section 9.5.
2. Unlock the tab strip (F17), remove the three bolts (F18) securing the output coupling, and remove the coupling (F15) and 'O' ring (F14).
3. Remove the output shaft end cover (A38), release the tab washer (F2), and slacken and remove the locknut (F1) together with the tab washer and tongue washer (F3)
4. Remove the four screws (A29) and remove the rear seal housing (A42).

5. To remove the shaft from the gearbox, drive or press the shaft on the front end, allowing the rear bearing assembly and shaft (F8) to be removed from the rear end of the gearbox, leaving the front bearing, output gear and spacers behind.
6. The rear bearing assembly can now be removed from the shaft and the front bearing outer-race removed from the gearcase.

IMPORTANT NOTE: If either the output gear or output shaft has been damaged, a complete output shaft assembly, comprising locknut (F1), spacer (F5), output gear (F6), spacer (F7), output shaft (F8) and sleeve (transit only), must be replaced.

7. Before re-assembly, examine the bearing, 'O' rings and rear oil seal for wear or damage, and replace if necessary.

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

8. To re-assemble, fit the smaller of the two rear bearing cones to the shaft.
9. Push the shaft from the rear through the spacer (F7), gear, spacer (F5) and inner-race of the front end roller bearing. Fit the front end bearing outer-race to the housing.
10. Press or drive in the cup of the small rear end bearing until it is flush with the housing shoulder, then fit the cup, spacer, (F12), cone, spacer, (F10), and shims (F11).
11. Press or drive in the cup of the large rear end bearing and push the cone on to the 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.**

12. Refit the rear seal housing, having filled the gap between the two seal lips with grease.
13. Fit the 'O' ring (F14), output flange, washer and tab washers, tighten the screws to 98 Nm (10 Kgfm - 72.5 lbf.ft) and bend over the tab washers.
14. Fit the washer, tabwasher and nut at the front end of the gearbox, tighten the nut to 339Nm (34.58Kgfm - 250lbf) and bend over the tabwasher.

Note: Both front and rear tab washers should always be replaced.

15. Fit the end cover (A38).

9.9 Output shaft oil seal replacement

If there is enough 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 boat. If not, first remove the gearbox as described in section 9.4, and then proceed as follows:-

1. Prevent the output coupling from turning by 'boring' it with a lever locked against bolts placed in the coupling flange holes and remove the output coupling locking screws, tab washers and spacer.
2. Using pulley extractors, withdraw the coupling, remove the output end housing (4 bolts), and extract the oil seal.
3. Examine the housing 'O' ring and renew if worn or damaged.
4. Check the oil seal bearing surfaces for wear, and, if grooved, replace the output coupling.
5. Fit a new seal (A43) ensuring it is driven square into the housing and refit the housing, taking care not to damage the 'O' ring (A44).
6. Smear the oil seal diameter of the coupling with grease, replace the 'O' ring (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 (5.95Kgf.m - 431bf.ft).

9.10 Shimming procedures - input shaft and layshaft

The allowable end float on the taper bearing is 0 - 0.075mm (0 - 0.003in) clearance: this should be checked with the aid of a depth micrometer as follows:

1. Press the bearing outer cup firmly into position and measure between the face of the gearcase and the top of the bearing outer as shown in Fig. 14.
2. Measure the depth of the recess in the oil pump and in the output shaft end cover, and make up the difference between the two dimensions with shims.

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

1. Remove the 'O' ring from the oil pump or end cover.
2. Fit sufficient shims to cause the oil pump or end cover to stand proud of the gearbox.
3. Rotate the input shaft or layshaft and slowly tighten the four securing bolts until the shaft starts to bind. Note: care must be taken to ensure that the oil pump or end cover is tightened squarely on to the gearbox face: this can be checked by feeler gauges or shims around the pump end cover to ensure a uniform gap.
4. Measure the gap by means of feeler gauges or shims, and deduct shims to this figure plus 0.075mm (0.003in) from the shims already installed.
5. Remove the correct number of shims, tighten the oil pump or end cover, and test by rotating the shaft.
6. Remove the oil pump or end cover and refit with the 'O' ring installed.

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

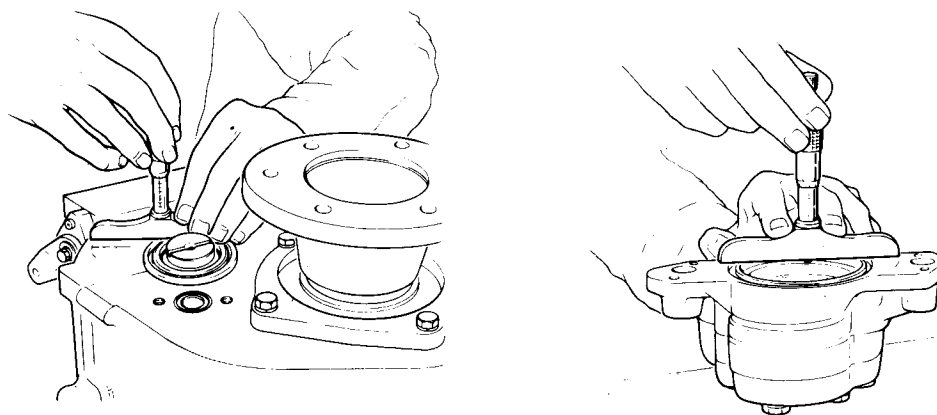


Fig. 15 Shimming procedure

10. POWER TAKE-OFF UNIT

10.1 'Direct Drive Power Take Off'

The Direct Drive PTO 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 function of the cover in sealing the gearbox case against oil loss and correctly positioning the input shaft rear bearing. The PTO is the link between the gearbox and the hydraulic pump, which will be directly driven with no disengage facility.

10.1.1 Specification

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

SAE J744C, series 'B' specification limits the permissible torques and horsepower which may be transmitted, as follows:-

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

Pumps of larger capacity than this must **not** be used. The PTO is designed to accommodate hydraulic pumps of the gear, vane or piston types, which conform to SAE J744C, series 'B' specification **only**. **IT EMPHATICALLY MUST NOT BE FITTED WITH ANY ADAPTION TO DRIVE AN OUTRIGGER PULLEY**, as the mounting provided is not adequate to support side loads.

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

10.1.2 Installation

1. Remove the 4 bolts and washers which secure the square end cover plate to the rear face of the gearbox and remove the plate.

2. Since the body of the power take off performs the function of the gearbox input shaft bearing adjuster, in the same way as the end cover it replaces, it must be measured for and fitted with shims as follows:-

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

- 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.

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

- c) Remove the 'O' ring from the PTO body.
 - d) Fit sufficient shims to cause the PTO body to stand proud of the gearbox.
 - e) Rotate the gearbox input shaft and slowly tighten up the 4 bolts until the shaft starts to bind. Be sure to ensure that 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 (0.003in) 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 of the PTO and push it carefully through the oil seal to engage with the spline on the end of the input shaft.
 4. Offer the pump to the body and rock 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 associated machinery is working correctly.

10.2 Clutched power take off

The Clutched PTO mounts 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 function of the cover in sealing the gearbox case against oil loss and correctly positioning the input shaft rear bearing. The PTO unit is the link between the gearbox and the hydraulic pump.

Oil pressure taken from the gearbox control valve at the point usually used for fitting an oil pressure gauge is used to engage the PTO clutch for driving the hydraulic pump. With the lever in the disengaged position, no pressure is applied to the clutch plates, so no drive is effected. Low pressure oil from the return line of the oil cooler is directed to the PTO for lubrication purposes.

10.2.1 Specification

The Clutched PTO is designed to accommodate hydraulic pumps, with splined input shaft, conforming to SAE J744C, series 'B' specification, two or four bolt fixing.

SAE J744C, series 'B' specification limits the torques and horsepower which may be transmitted by the PTO as follows:-

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

Pumps of larger capacity than this must **not** be used. The PTO is designed to drive hydraulic pumps of the gear, vane or piston type, conforming to SAE J744C, series "B" specification **only**. **IT EMPHATICALLY MUST NOT BE FITTED WITH ANY ADAPTION TO DRIVE AN OUTRIGGER PULLEY**, as the mounting is not adequate to support side loads.

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

10.2.2 Installation

The following procedure must be followed when fitting a clutched PTO to an existing PRM601 gearbox. If the gearbox is already installed on an engine or in a boat, it can be performed with the gearbox in situ.

1. 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. Keep the shims, gasket and 'O' ring with the pump assembly.
2. Remove the 4 bolts securing the shaft end cover and remove the cover 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 it into the groove in the joint face of the PTO body.
5. Take the shims previously used with the end cover and locate them in the recess in the PTO body joint face.
6. Remove transit bung from PTO body (this operation requires 8mm long series allen key).
7. Offer up the PTO to the gearbox and locate it 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.

8. Locate the 4 nuts (item H1) on the studs and tighten to a torque of 58.3Nm (6kgfm - 431bf.ft).
9. Remove the cover plate (item H15) and joint (item H50) from the rear face of the PTO body.
10. 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 - 431bf.ft). (This operation requires a long series 8mm A/F Allen key).
11. Remove the pressure plug (B22) from the valve block and replace it with a union (H14) and bonded seal (H13).
12. Fit identical components into the port which is situated directly behind the operating lever on the PTO body.
13. Fit the oil feed pipe (H5) from the valve block to the PTO.
14. Remove the oil return pipe which connects the oil cooler to the valve block.
15. Insert the union (H22) into the PTO and fit the tee piece (H3) and bonded seal (H2) into the union.
16. Refit the oil cooler return pipe into the tee piece.
17. Insert the pipe adaptor (H4) into the valve block.
18. Fit the oil lubrication pipe (H7) from the tee piece on the PTO to the pipe adaptor on the valve block.
19. Refit the oil pump, replacing the 'O' ring if damaged. Take care that the pump is fitted in the correct position to provide the required propeller rotation.

10.2.3 Fitting the hydraulic pump.

The adaptor flange is designed to accept any hydraulic pump which has a flange to SAE J744C, series 'B' specification, two-bolt fixing.

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 the hydraulic circuit as specified by the pump manufacturer. Once fully installed, the gearbox should be run with the pump off-load to check the PTO for correct hydraulic function and running.

10.2.4 Strip and Rebuild Procedures

Clutch pack replacement

A replacement parts kit exists for replacing the PTO clutch (see back page).

1. Remove the pump from the PTO.

2. Remove the cap screw (H12) securing the clutch body to the gearbox shaft (This operation requires a long series 8mm A/F Allen key).
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 (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 (H11) securing the bearing housing (H31) and withdraw the bearing housing assembly from the PTO body.
7. The clutch body assembly can now be withdrawn from the PTO body allowing the clutch plates to be replaced.
8. Unlock and remove the 6 clutch securing bolts.
9. Remove the clutch end cover (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 (H35) in the clutch body.
12. Fit the clutch return plate (H34) over the spring guide pins and place the clutch return springs (H39) over the guide pins.
13. Locate the 6 ferrules (H36) on the 6 bolts and, starting with one of the clutch friction plates (H41), build up the replacement clutch with alternative plates on to the clutch return plate.
14. Replace the clutch end cover, locating it on the guide pins, and LIGHTLY tighten the 6 bolts.
15. Ensure that the pull-off springs are correctly located and that 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-111bf.ft), and close the locking strips (H40) 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 - 431bf.ft).
20. Refit the PTO as described in section 2.

Bearing Replacement

The PTO 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 (H11) securing the bearing housing (H31) and withdraw the bearing housing assembly from the PTO body. Take care not to damage the gasket (H49).
3. Remove the circlip (H28) and press out the drive adaptor and bearing.
4. Remove the circlip (H29) and press the drive adaptor off the bearing.
5. Inspect the bearing for wear or damage and replace it 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. The Angle Drive unit has been modified again making the gears wider and introducing longer life bearings. The part number has changed to MT0345. Servicing instructions given below are for all units, but the instructions for retrofitting will of course only apply to MT0345.

11.2 Retrofitting Unit to an Existing PRM601D Gearbox

The following procedure must be followed when retrofitting an angle drive to an existing gearbox:-

1. Drain all oil from the gearbox.
2. Remove the output shaft front cover (A38) and 'O' ring (A39) from the main gearbox discard and replace with spacer L26. Remove input seal (A35) and discard.
3. Taking care not to lose the gasket, shims or 'O'rings, remove the oil pump from the gearbox, rotate it through 180 degrees and bolt it back into position, ensuring that the 'O'ring is correctly located in its groove and that the shims are properly located in the pump recess.
4. Coat the input shaft of the main gearbox with an anti-fretting grease (e.g. "Molycote BR2 Plus").
5. Grease the gasket (L24), illustrated on P.76 and fit to the front face of the main gearbox.

6. Remove the tape, securing the spacer (L23) and offer up the angle drive to the main gearbox, locating the gearbox input shaft in the splined gear and the spacer in the bore formerly occupied by the gearbox output shaft cover and 'O' ring (A38 and A39).
7. Secure the two assemblies with 6 studs (L25) and nuts (L4), tightening to a torque of 101.5 Nm (10.35 Kgf.m - 75 lbf.ft).
8. Screw the metering union (L20) into the top of the angle drive unit, fit tee piece (L7), sealing washer (L5) and loosely connect the oil pipe (L27) to it.
9. Connect the free end of the oil pipe to the valve block in the line returning oil from the oil cooler, and tighten the oil pipe connections.
10. The dipstick **MUST** be replaced by the new one supplied with the angle drive unit as the oil level rises with angle drive facility.
11. Refill the gearbox with a recommended oil and check the level. Re-check oil level after initial start up to allow for oil in cooler system.
12. Fit the adaptor plate to the front face of the angle drive, and tighten the bolts to 101.5Nm (10.35kgf.m - 75lbf.ft) torque.

The complete unit can be fitted to the engine as described in section 5.4.

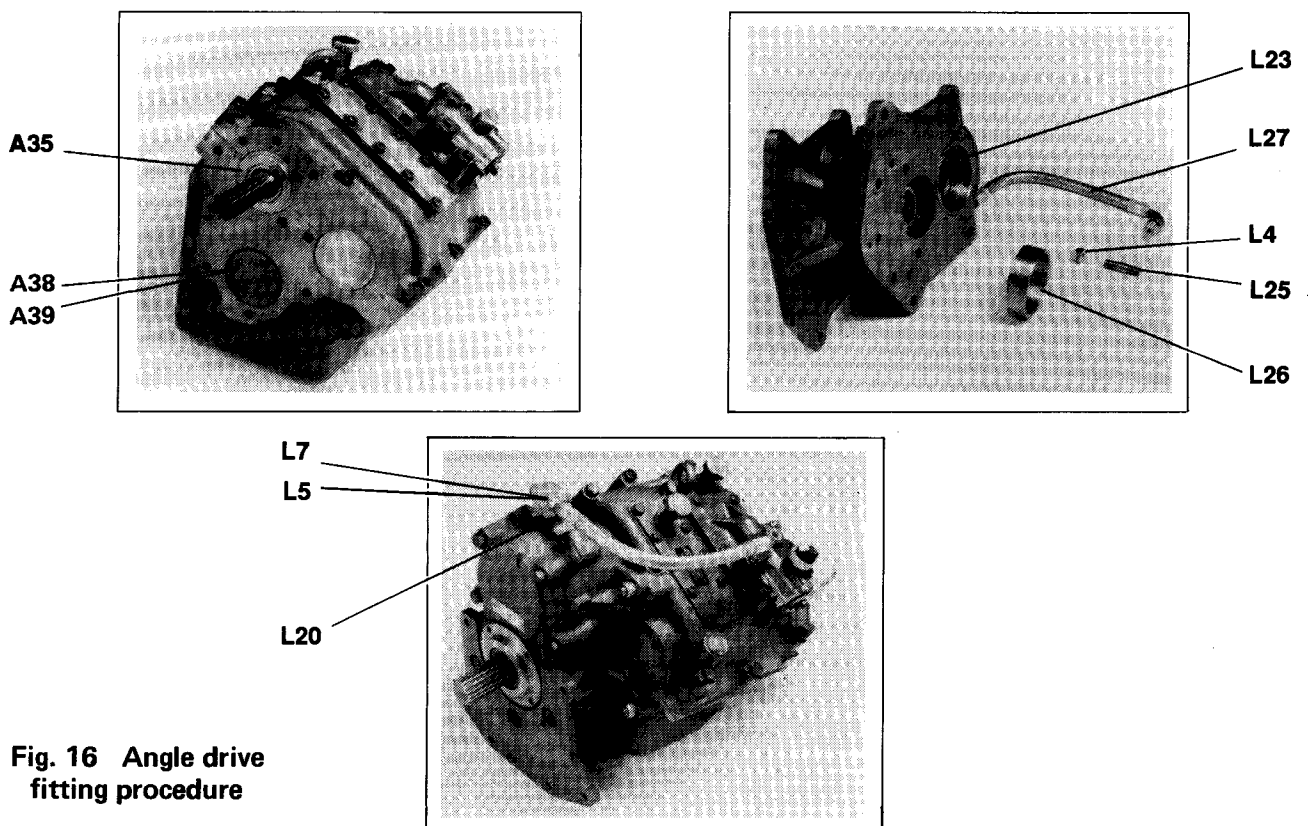


Fig. 16 Angle drive fitting procedure

Note: when running the installation after fitting the angle drive unit, it should be remembered that the sense of forward/reverse direction on the operating lever is now different (see section 5.8).

If in any doubt about your ability to carry out the above procedure correctly, return both angle drive and gearbox to the factory for fitting.

NOTE: it is essential that the above instructions are followed **PRECISELY**, otherwise serious damage may occur when the unit is operated. Newage Transmissions Ltd. will not accept responsibility for claims under warranty or otherwise in respect of loss or damage caused by failure to follow these instructions.

11.3 Replacing gears and bearings

11.3.1. MT0171/MT0345 angle drive

Because of the converging shaft centres, care should be taken when dismantling this unit; departure from correct procedure may result in damage to the gear teeth or bearings.

1. Remove the angle drive from the main gearbox in the reverse order to the procedure described in section 11.2.
2. Tape the input shaft spline teeth to prevent damage to the oil seal during removal. Remove the four socket head cap screws securing the input shaft front oil seal housing and shims and withdraw the housing, taking care not to misplace the shims. Inspect the oil seal for wear or damage and replace if necessary.
3. Withdraw the spacer (K23) and shims from the output bearing rear housing and remove the output bearing cup.
4. Remove the seven bolts which secure the two case halves .
5. With the unit laid on a horizontal surface, rear face down, separate the two case halves and lift the front case half off 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 occurred the appropriate bearing must be replaced. If damage to either gear is apparent, 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.

NOTE: If any bearing has to be replaced due to breakage, then it is likely that the remaining bearings and the gears have also suffered damage as a result. They should therefore be carefully inspected and if necessary replaced.

To re-assemble the unit proceed as follows:

1. Press the bearings to the input and output gears and fit the bearing cups to the case halves.
2. Locate the input gear on the rear case half and the output gear on the front case half.
3. Coat the mating surfaces of the two gearcase halves with a jointing compound and, aligning the dowel in the front output bearing housing with the front case half, offer the top half of the gearcase to the lower.
4. Refit the seven bolts securing the case halves and tighten to a torque of 100.5Nm (10.2 Kgfm - 73.8 lbf.ft).

5. Refit the four bolts securing the front output bearing housing and tighten to a torque of 12Nm (1.22 Kgfm - 91bf.ft), ensuring that the 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) Position sufficient shims in the seal housing (item K19) to cause it to stand approximately 0.125mm proud of gearcase when fitted.
- b) Fit screws (item K8) "finger tight", whilst rotating the input shaft, to seat the bearing (the shaft should rotate freely).
- c) Measure the gap below the seal housing with feeler gauges, and remove from the shim pack in the seal housing the amount of shims corresponding to that measurement
- d) Fit the seal and replace the seal housing.

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

- a) Insert spacer (item K23).
- b) Apply hand pressure to the spacer and rotate the shaft, to seat the bearings.
- c) Measure the step between the gearcase face and the end of the spacer.
- d) Remove the spacer, and position shims of equivalent value between the bearing cup and the recess in the spacer.

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

11.3.2 MT0129 Angle Drive

Because of converging shafts, care should be taken when dismantling this unit; departure from the correct procedure may result in damage to the gear teeth or bearings.

1. Tape the input shaft to prevent damage to the oil seal during removal. Remove the four socket head cap screws securing the input shaft front oil seal housing and remove the housing. Inspect the oil seal for wear or damage and replace if necessary.
2. Remove the circlip (item J18) which locates the front bearing on the input shaft.
3. Remove the seven bolts securing the two case halves.
4. Remove the four bolts securing the front output bearing housing.
5. Gently but firmly separate the front case half from the rear half; the input gear will now be located on the front case half and the output gear on the rear case half.
6. To remove the input gear, gently tap it out through the front bearing from the splined end of the input shaft.

7. The front input bearing is now free for removal from the case halves.
8. To remove the output gear, remove the rear bearing circlip (item J19) and withdraw the output gear towards the front of the gearcase.
9. The rear output bearing is now free for removal from the rear case half.
10. 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 the inner race of the roller bearing on the output gear and seat it 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 that 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 that the bearing is seated against 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 that the gears and bearings are running freely.
8. Ensuring that the bonded washers are fitted, refit the four bolts securing the front output bearing housing and tighten to a torque of 12.2Nm (1.24kgfm - 9lbf.ft)
9. Refit the circlip (item J18).
10. Coat the mating faces of the oil seal housing and gearcase with a non-solidifying sealing compound and taking care not to damage the oil seal, refit the input shaft oil seal housing.
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 it to the front face of the gearbox.
13. Locate the spacer (item J28) on 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 | lbf.ft | Kgfm |
|--|-------|--------|-------|
| Upper to lower gearcase bolts | 56.0 | 41.5 | 5.7 |
| Stud - upper and lower gearcase | 56.0 | 41.5 | 5.7 |
| Valve block to upper gearcase | 28.0 | 21.0 | 2.8 |
| Operating lever to valve block | 28.0 | 21.0 | 2.8 |
| End cover to valve block (loctite) | 9.5 | 7.0 | 0.97 |
| Pump body to gearcase | 56.0 | 41.5 | 5.7 |
| End cover to gearcase | 56.0 | 41.5 | 5.7 |
| Pump cover to pump body | 28.0 | 21.0 | 2.8 |
| Coupling to output shaft | 98.0 | 72.5 | 10.0 |
| Top cover to upper gearcase | 28.0 | 21.0 | 2.8 |
| Adaptor plate to gearbox | 98.0 | 72.5 | 10.0 |
| Output shaft bearing retaining nut (input end) | 339.0 | 250.0 | 35.58 |
| Clutch securing nuts | 11.7 | 8.6 | 1.2 |
| P.T.O. to rear gearcase | 56.0 | 41.5 | 5.7 |
| Angle drive to front gearcase | 98.0 | 72.5 | 10.0 |

REPLACEMENT 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 itself is ordered all components pertaining to that assembly are supplied. For example, if the 'clutched 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 replacement parts should be addressed to:

**NEWAGE TRANSMISSIONS LTD
BARLOW ROAD
COVENTRY CV2 2LD
ENGLAND**

Tel: 01203 617141

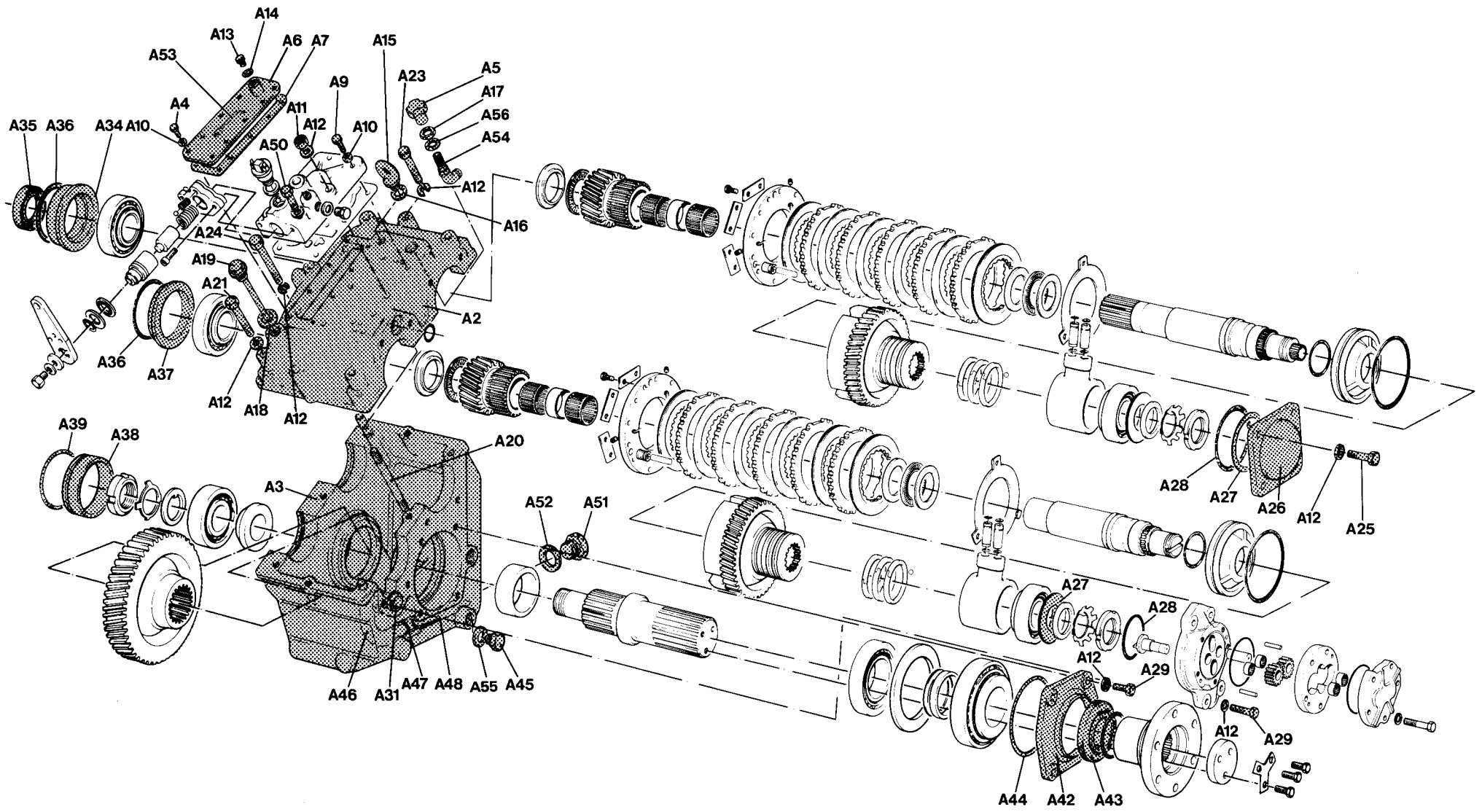
Fax: 01203 611845

METRIC DIMENSIONS

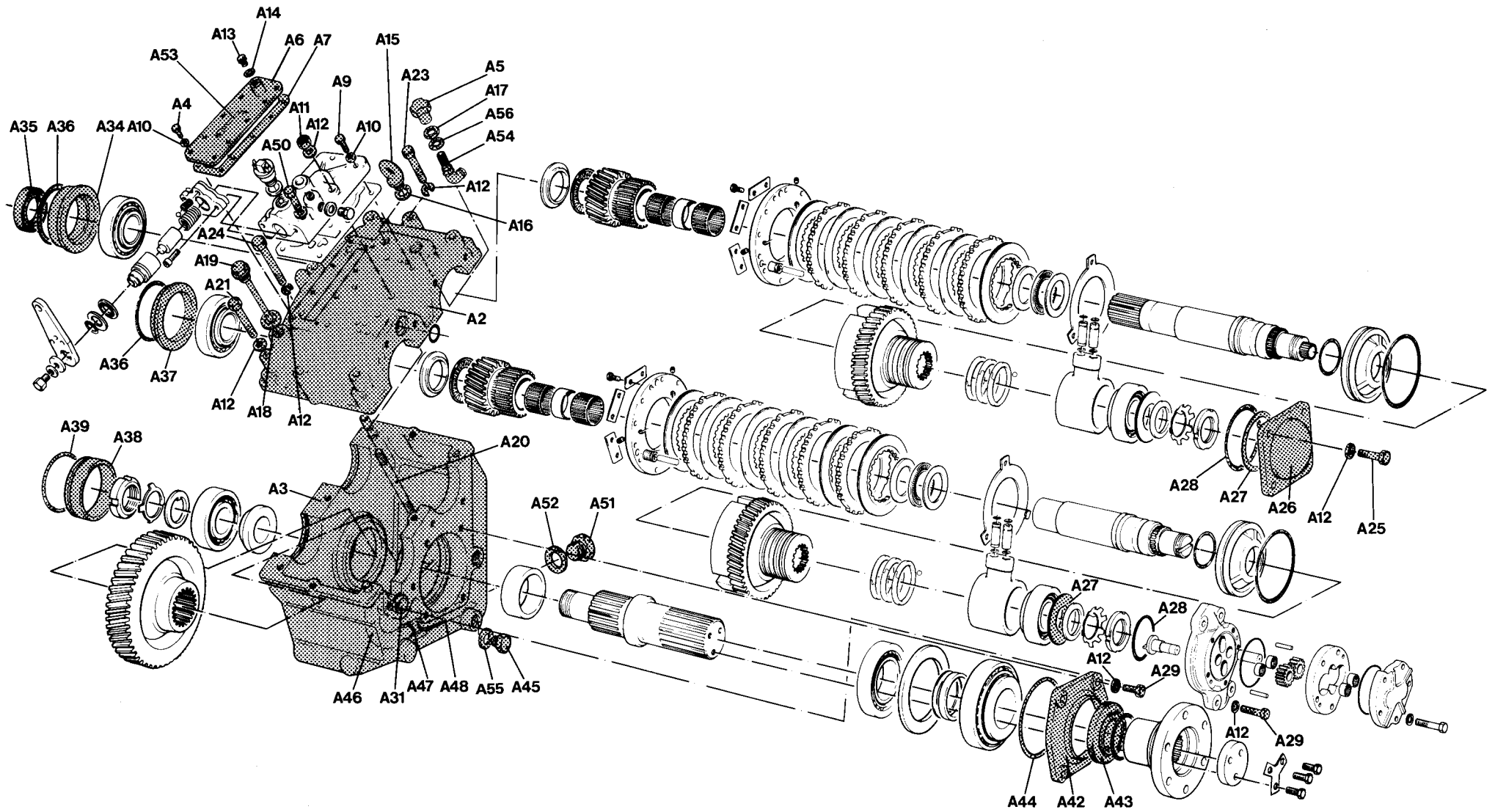
Where metric dimensions are shown in the description column, or without brackets in the remarks column, i.e. bearing dimensions, these are actual dimensions.

Where metric dimensions are shown within brackets in the remarks column, these have been converted from the original imperial measurements and are solely intended to assist in component identification .

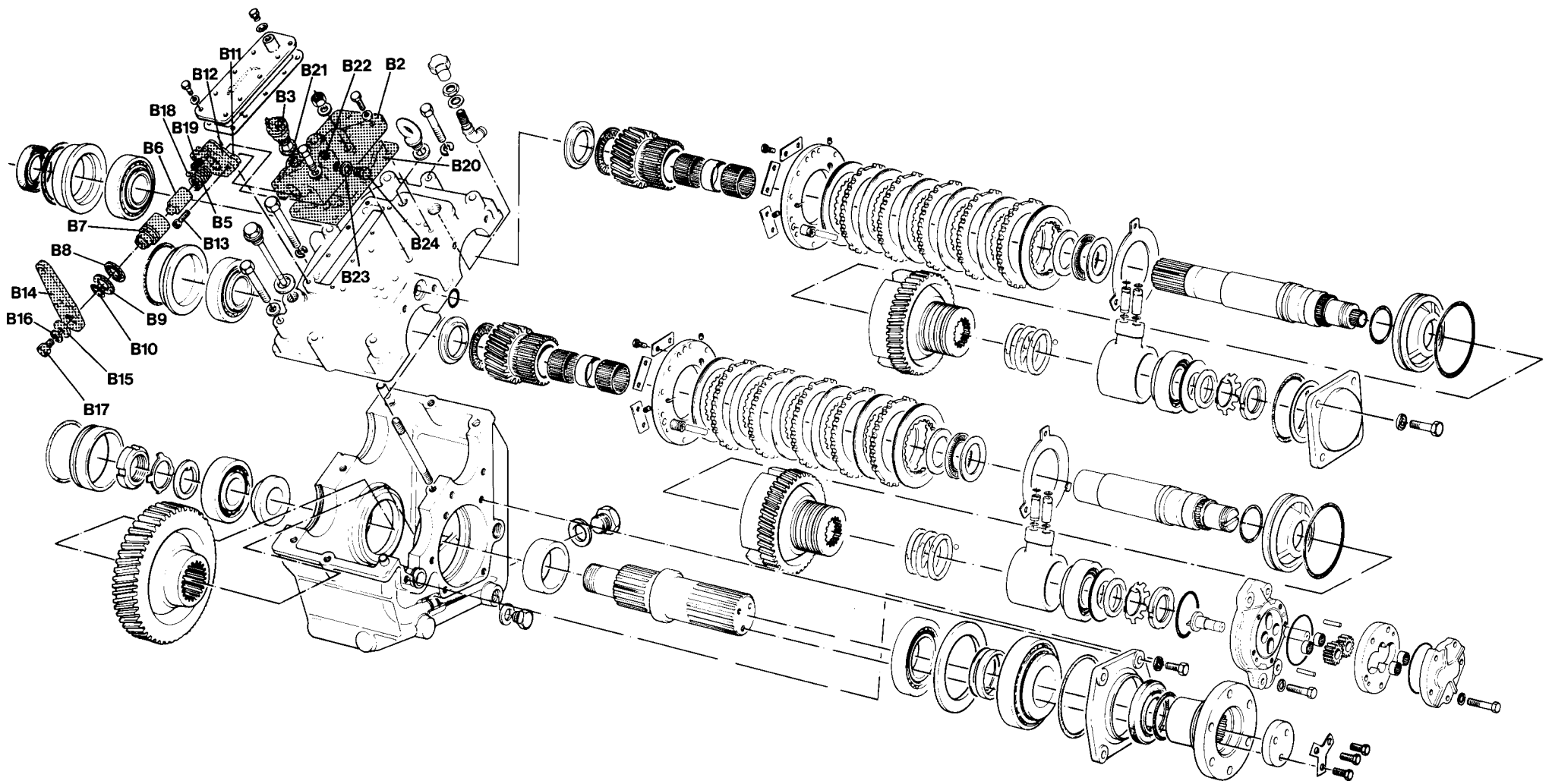
PARTS LIST



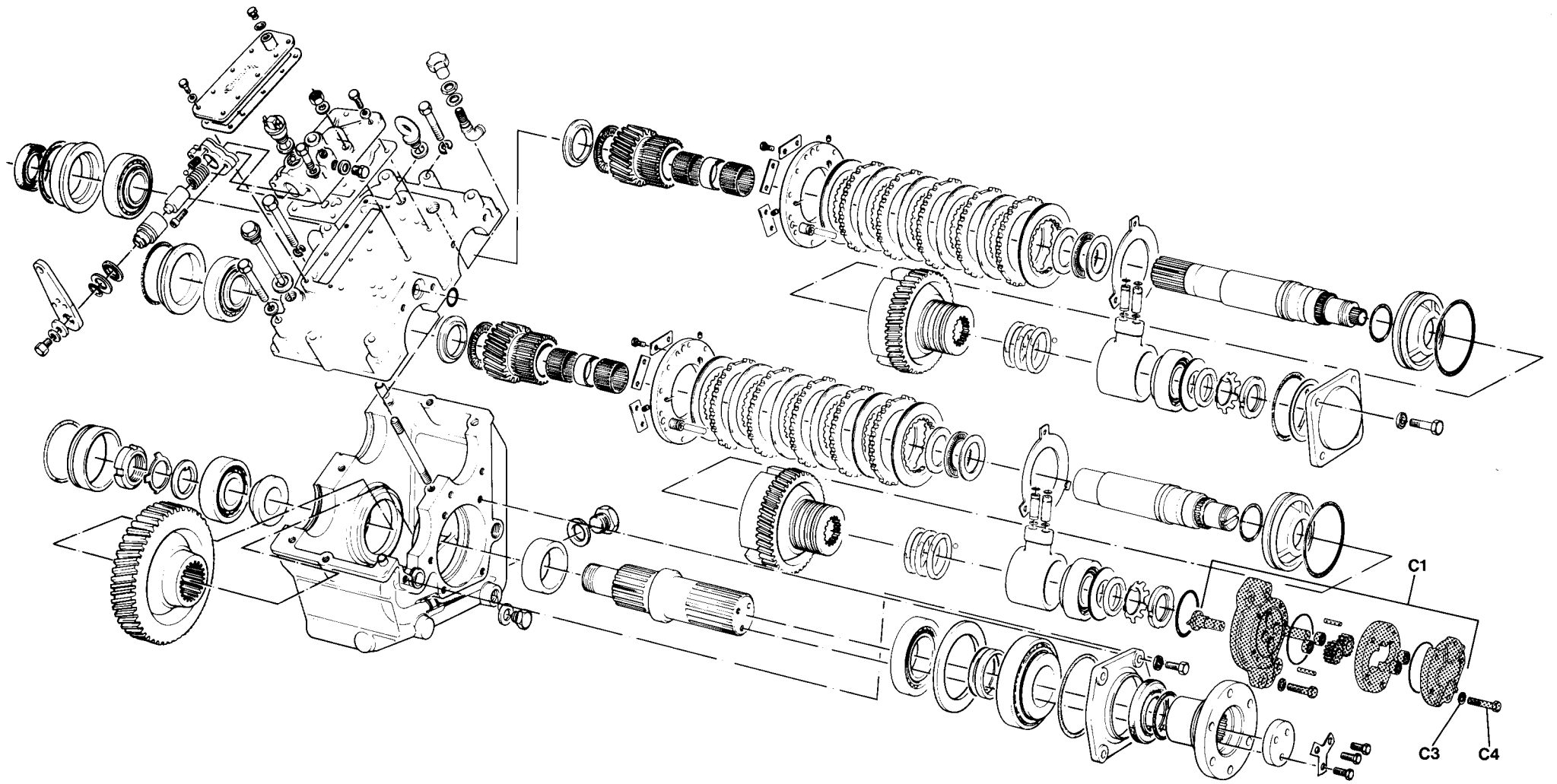
| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|--------------------------|---------------------|-----|-------------------------|
| A | GEARCASE ASSEMBLY | | | |
| | Case sub-assembly | MT0173 | 1 | All ratios except 4:1 |
| A2 | Gearcase - top | MT4615 | 1 | Not supplied separately |
| A3 | Gearcase - bottom | MT4661 | 1 | Not supplied separately |
| A | GEARCASE ASSEMBLY | | | |
| | Case sub-assembly | MT0175 | 1 | 4:1 ratio only |
| A2 | Gearcase - top | MT4615 | 1 | Not supplied separately |
| A3 | Gearcase - bottom | MT4662 | 1 | Not supplied separately |
| A4 | Screw - top cover | 0040804 | 10 | |
| A5 | Breather | CP1383 | 1 | |
| A6 | Top cover | MT4743 S/A | 1 | |
| A7 | Gasket (top cover) | MT343 | 1 | |
| A9 | Screw | 0040808 | 3 | |
| A10 | Washer | CP1223 | 15 | |
| A11 | Nut | 0051001 | 1 | |
| A12 | Dowty washer | 0201706 | 21 | |
| A13 | Plug 1/4 BSP | CP1123 | 1 | |
| A14 | Washer 1/4 BSP | CP1139 | 1 | |
| A15 | Eyebolt | CP1339 | 1 | |
| A16 | Washer | 0201609 | 1 | |
| A17 | Filler plug | CP1385 | 1 | |
| A18 | Washer | CP1068 | 1 | |
| A19 | Dipstick | 0800687 | 1 | |
| A19 | Dipstick | MT1137 | 1 | 4:1 ratio G/box only |
| A19 | Dipstick | 40M153 | 1 | G/box with angle drive |
| A20 | Stud | MT4543 | 1 | |
| A21 | Bolt | 0041021 | 4 | |
| A23 | Bolt | 0041017 | 2 | |
| A24 | Bolt | 0041023 | 1 | |
| A25 | Bolt | 0041008 | 4 | |
| A26 | Rear cover | MT4512 | 1 | |



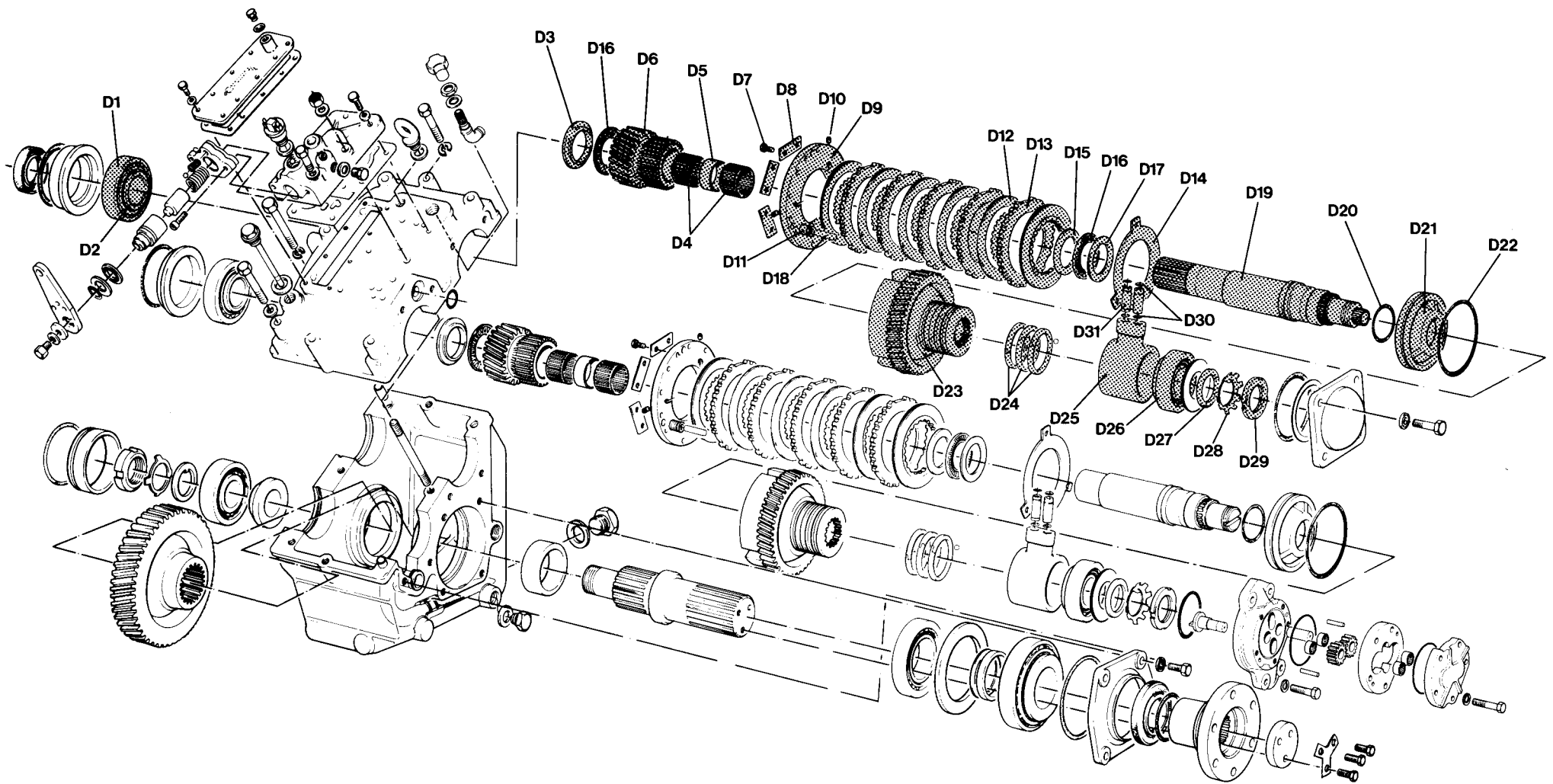
| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|---------------------------------------|---------------------|-----|--|
| A27 | Shims | MT1076/02/10 | AR | Only supplied as part of shimming kit MT0120 |
| A28 | 'O' ring | 004124 | 2 | |
| A29 | Screw | 0041009 | 8 | |
| A31 | '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, all ratios except 4:1 with angle drive but is required on 4:1 ratio 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 | All ratios except 4:1 |
| A46 | Oil pipe (internal) | MT4546 | 1 | 4:1 ratio only |
| A47 | 'O' ring | 000872 | 1 | |
| A48 | Strainer | MT4547 | 1 | |
| A49 | Bolt | 0040812 | 1 | Not illustrated |
| A50 | Bolt | 0040815 | 1 | |
| A51 | Plug | 0150100 | 1 | |
| A52 | Dowty washer | 0201720 | 1 | |
| A53 | Socket wrench | CP1352 | 1 | |
| A54 | Breather tube | CP1382 S/A | 1 | |
| A55 | Bonded washer | 0201714 | 1 | |
| A56 | Washer - breather | CP1204 | 1 | |



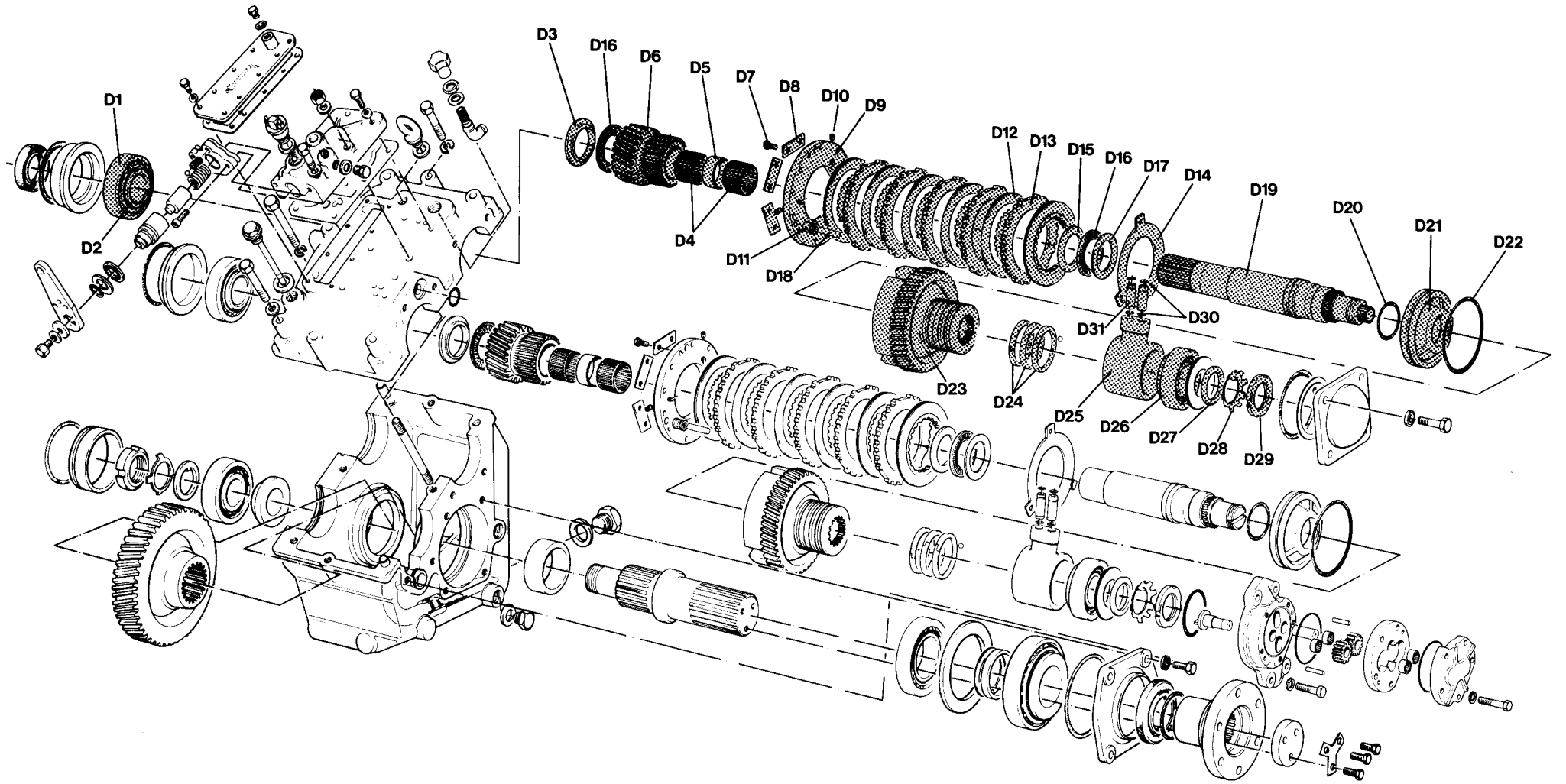
| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|----------------------|---------------------|-----|---------|
| B1 | VALVE BLOCK ASSEMBLY | MT0319 | 1 | |
| B2 | Valve block casing | MT4780 | 1 | |
| B3 | Microswitch or | CP1358 | 1 | |
| B3 | Plug | CP1360 | 1 | |
| B5 | Valve spring | MT4752 | 1 | |
| B6 | Relief valve | MT4751 | 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 | 1 | |
| B19 | Spring | MT305 | 1 | |
| B20 | Gasket | MT1073 | 1 | |
| B21 | Washer | 0201715 | 1 | |
| B22 | Pressure plug | MT311 | 1 | |
| B23 | Bonded washer | 0191718 | 1 | |
| B24 | Plug M18 | 0150318 | 1 | |



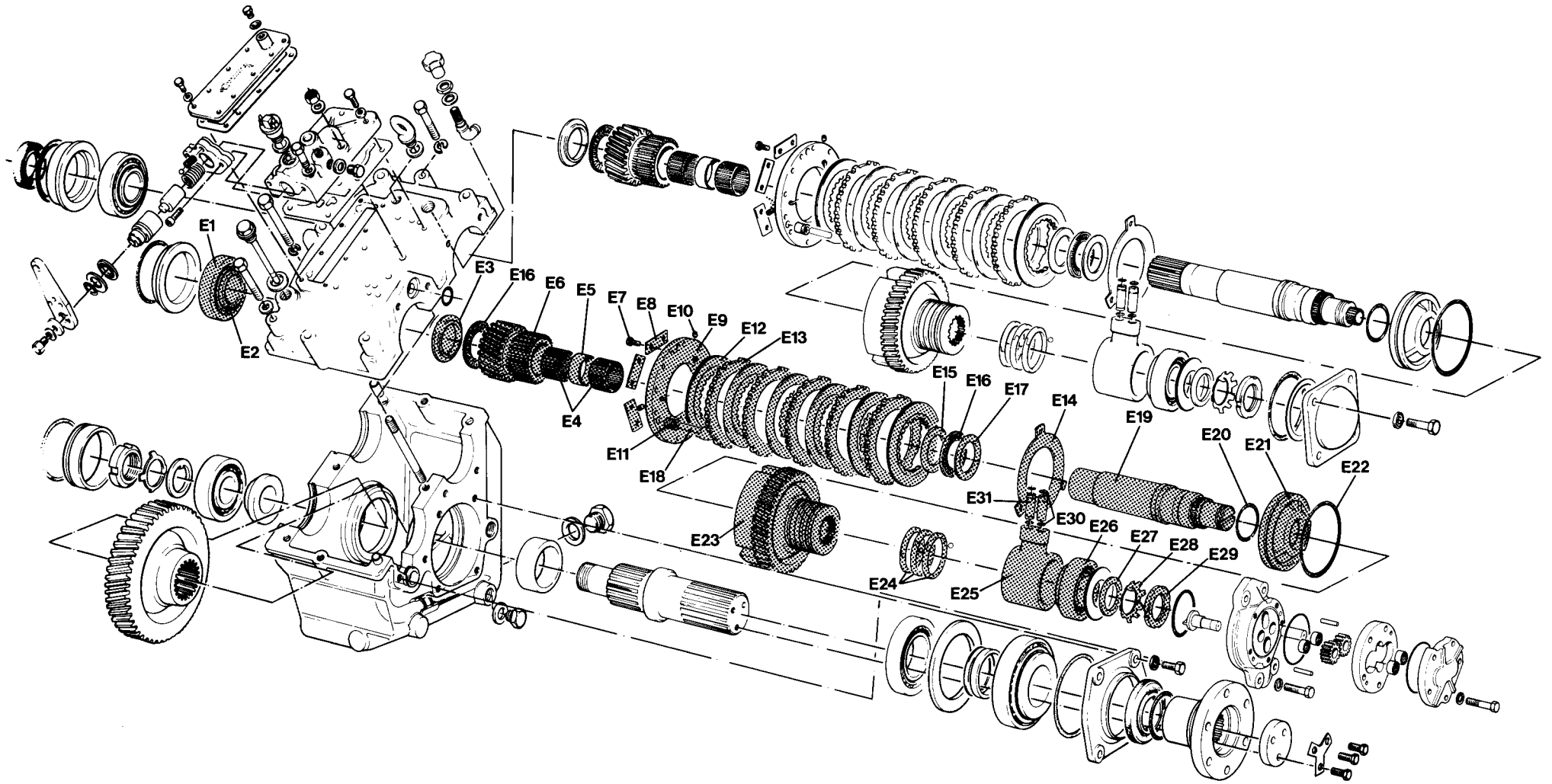
| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|-------------------|---------------------|-----|---------|
| C1 | OIL PUMP ASSEMBLY | MT0304 | 1 | |
| C3 | Washer | 0191105 | 5 | |
| C4 | Bolt | 0040811 | 5 | |



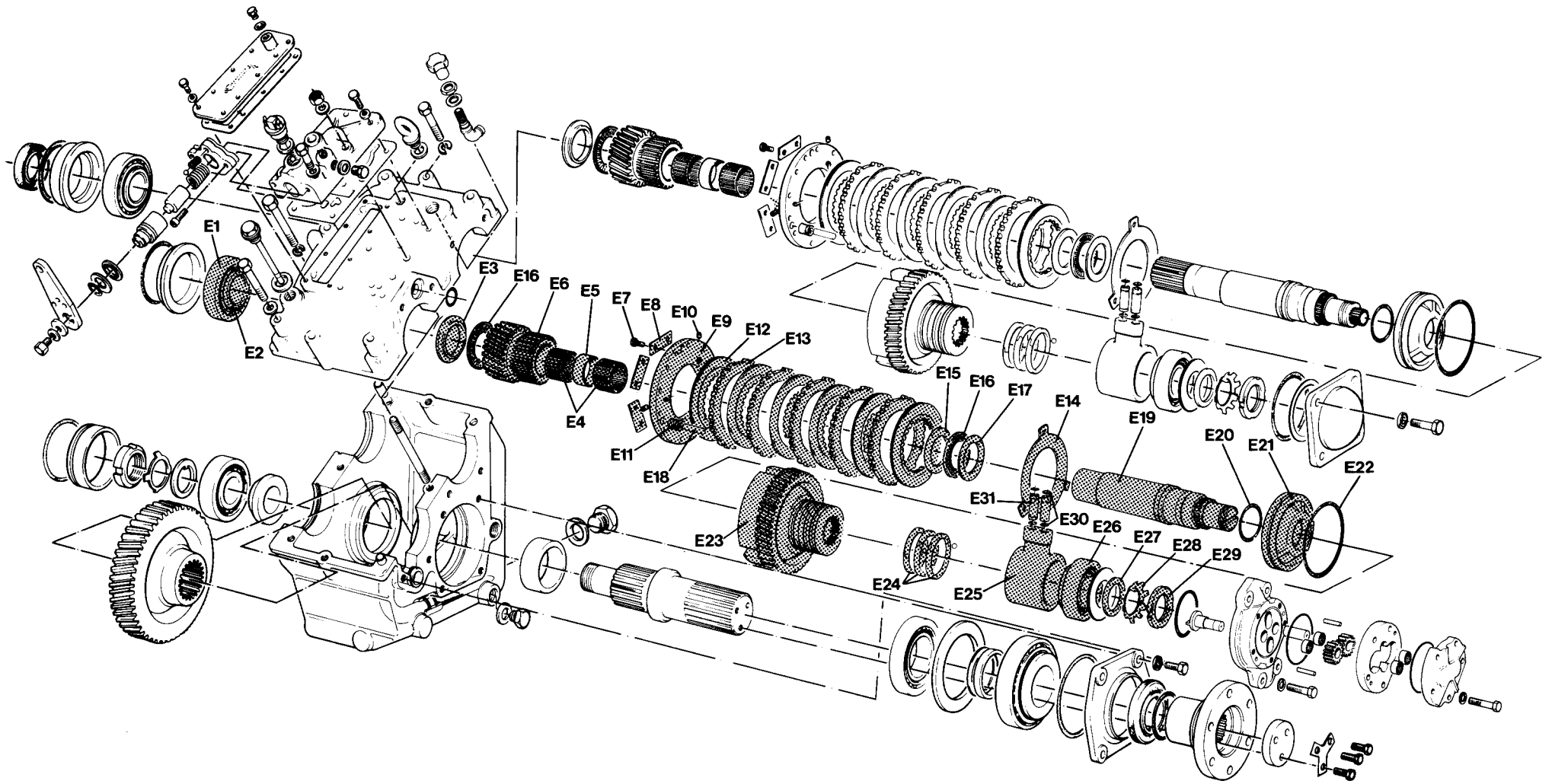
| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|-----------------------------|---------------------|-----|--------------------|
| D | INPUT SHAFT ASSEMBLY | | 1 | |
| D1 | Bearing cup | 055U056 | 1 | |
| D2 | Bearing cone | 055C025 | 1 | |
| D3 | Spacer | MT4715 | 1 | |
| D4 | Needle roller bearing | 0564201 | 2 | |
| D5 | Spacer | MT4723 | 1 | |
| D6 | Pinion 1.19:1 ratio | MT4724 | 1 | |
| | 1.5:1 ratio | MT4725 | 1 | |
| | 2.0:1 ratio | MT4726 | 1 | |
| | 3:1 & 4:1 ratio | MT4718 | 1 | |
| D7 | Screw | 0040608 | 12 | |
| | Clutch pack comprising: | | 1 | |
| D8 | Tab washer | MT4555 | 6 | |
| D9 | Clutch end cover | MT4554 | 1 | Part of MT4554 S/A |
| D10 | Grub screw | 014K510L | 3 | Part of MT4554 S/A |
| D11 | Spring | MT4649 | 3 | |
| D12 | Clutch plate | MT4602/S | 7 | |
| D13 | Clutch plate | MT4535 | 6 | |
| D14 | Clutch end plate | MT4534 | 1 | |
| D15 | Thrust washer | CP1363 | 1 | |
| D16 | Thrust bearing | CP1337 | 2 | |
| D17 | Thrust washer | CP1338 | 1 | |
| D18 | Guide Pin | MT4648 | 3 | |
| D19 | Input shaft | MT4716 | 1 | |
| D20 | 'O' ring | 001873 | 1 | |
| D21 | Piston | MT4655 | 1 | |
| D22 | 'O' ring | 004254 | 1 | |
| D23 | Clutch gear | MT4647 | 1 | |
| D24 | Piston ring | MT4539 | 3 | |
| D25 | Feeder | MT4511 | 1 | |



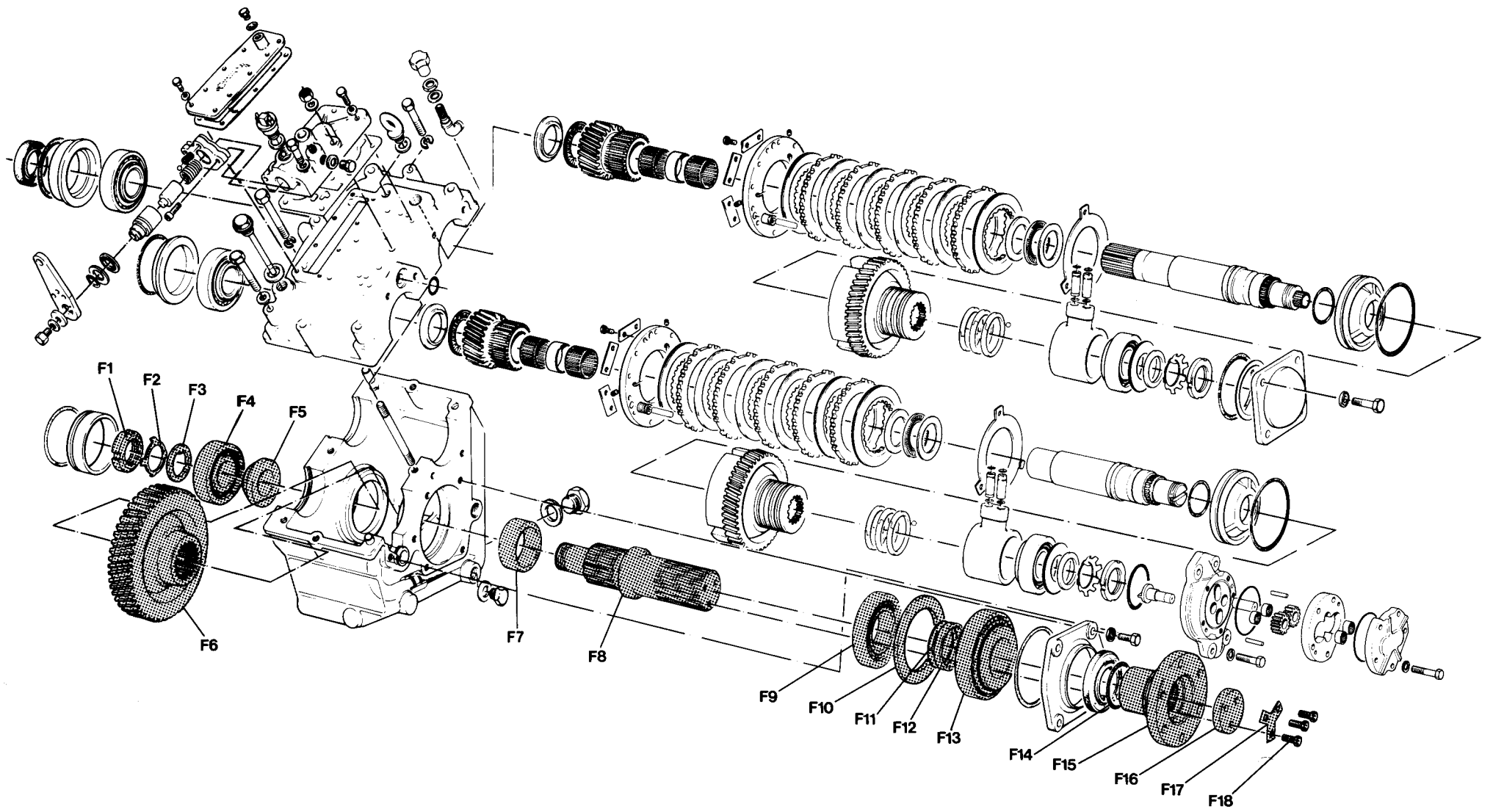
| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|-------------|---------------------|-----|---------|
| D26 | Bearing | 0540452 | 1 | |
| D27 | Spacer | MT4518 | 1 | |
| D28 | Lockwasher | 010W401 | 1 | |
| D29 | Locknut | 010N401 | 1 | |
| D30 | 'O' ring | 000372 | 4 | |
| D31 | Connector | MT1057 | 2 | |



| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|--------------------------|---------------------|-----|--------------------|
| E | LAYSHAFT ASSEMBLY | | 1 | |
| E1 | Bearing cup | 055U056 | 1 | |
| E2 | Bearing | 055C025 | 1 | |
| E3 | Spacer | MT4715 | 1 | |
| E4 | Needle roller bearing | 0564201 | 2 | |
| E5 | Spacer | MT4723 | 1 | |
| E6 | Pinion 1.19:1 ratio | MT4724 | 1 | |
| | 1.5:1 ratio | MT4725 | 1 | |
| | 2.0:1 ratio | MT4726 | 1 | |
| | 3:1 & 4:1 ratio | MT4718 | 1 | |
| E7 | Screw | 0040608 | 12 | |
| | Clutch pack comprising: | | 1 | |
| E8 | Tab washer | MT4555 | 6 | |
| E9 | Clutch end cover | MT4554 | 1 | Part of MT4554 S/A |
| E10 | Grub screw | 014K510L | 3 | Part of MT4554 S/A |
| E11 | Spring | MT4649 | 3 | |
| E12 | Clutch plate | MT4602/S | 7 | |
| E13 | Clutch plate | MT4535 | 6 | |
| E14 | Clutch end plate | MT4534 | 1 | |
| E15 | Thrust washer | CP1363 | 1 | |
| E16 | Thrust bearing | CP1337 | 2 | |
| E17 | Thrust washer | CP1338 | 1 | |
| E18 | Guide Pin | MT4648 | 3 | |
| E19 | Layshaft | MT4717 | 1 | |
| E20 | 'O' ring | 001873 | 1 | |
| E21 | Piston | MT4655 | 1 | |
| E22 | 'O' ring | 004254 | 1 | |
| E23 | Clutch gear | MT4646 | 1 | |
| E24 | Piston ring | MT4539 | 3 | |
| E25 | Feeder | MT4511 | 1 | |

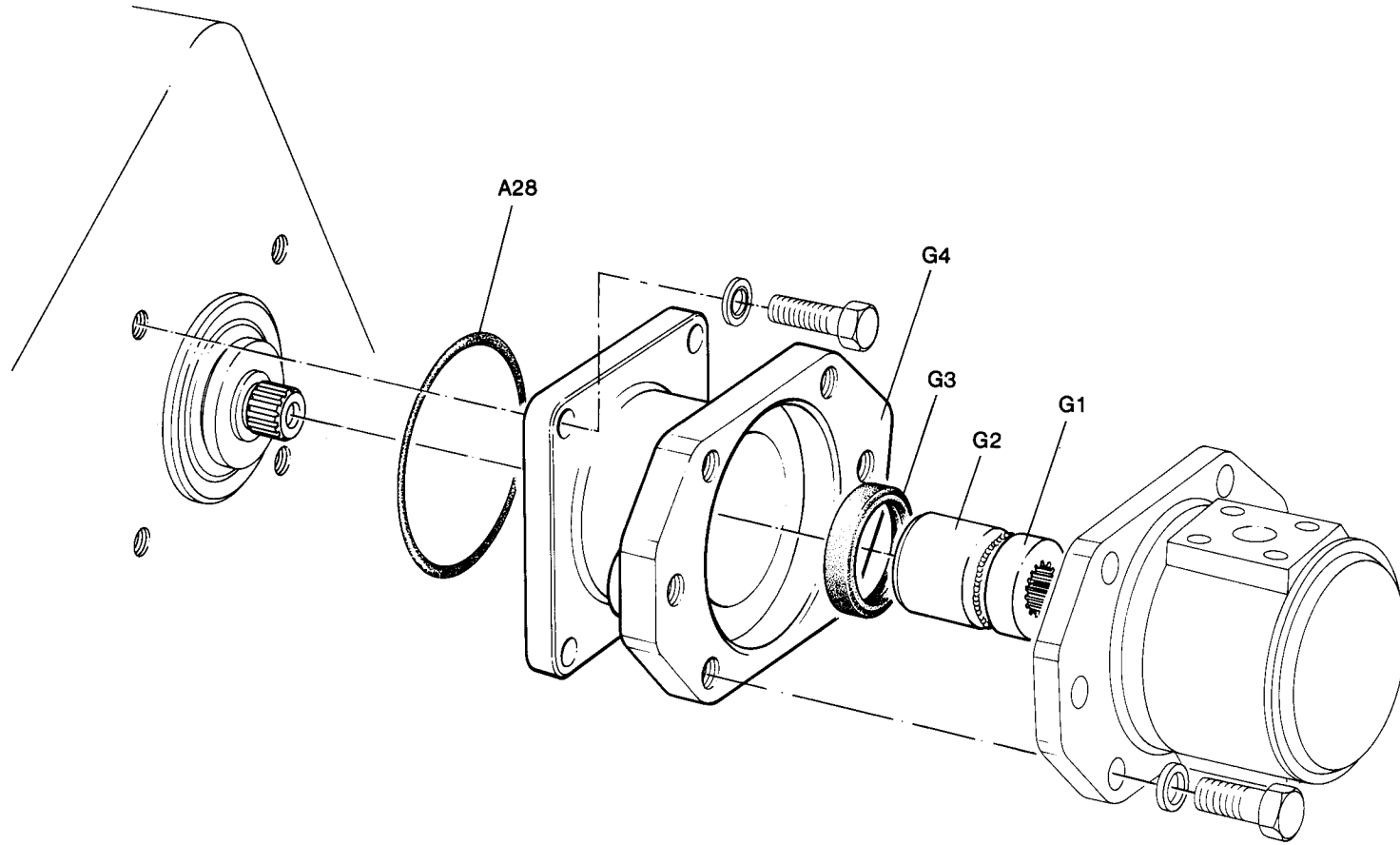


| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|-------------|---------------------|-----|---------|
| E26 | Bearing | 0540452 | 1 | |
| E27 | Spacer | MT4518 | 1 | |
| E28 | Lockwasher | 010W401 | 1 | |
| E29 | Locknut | 010N401 | 1 | |
| E30 | 'O' ring | 000372 | 4 | |
| E31 | Connector | MT1057 | 2 | |

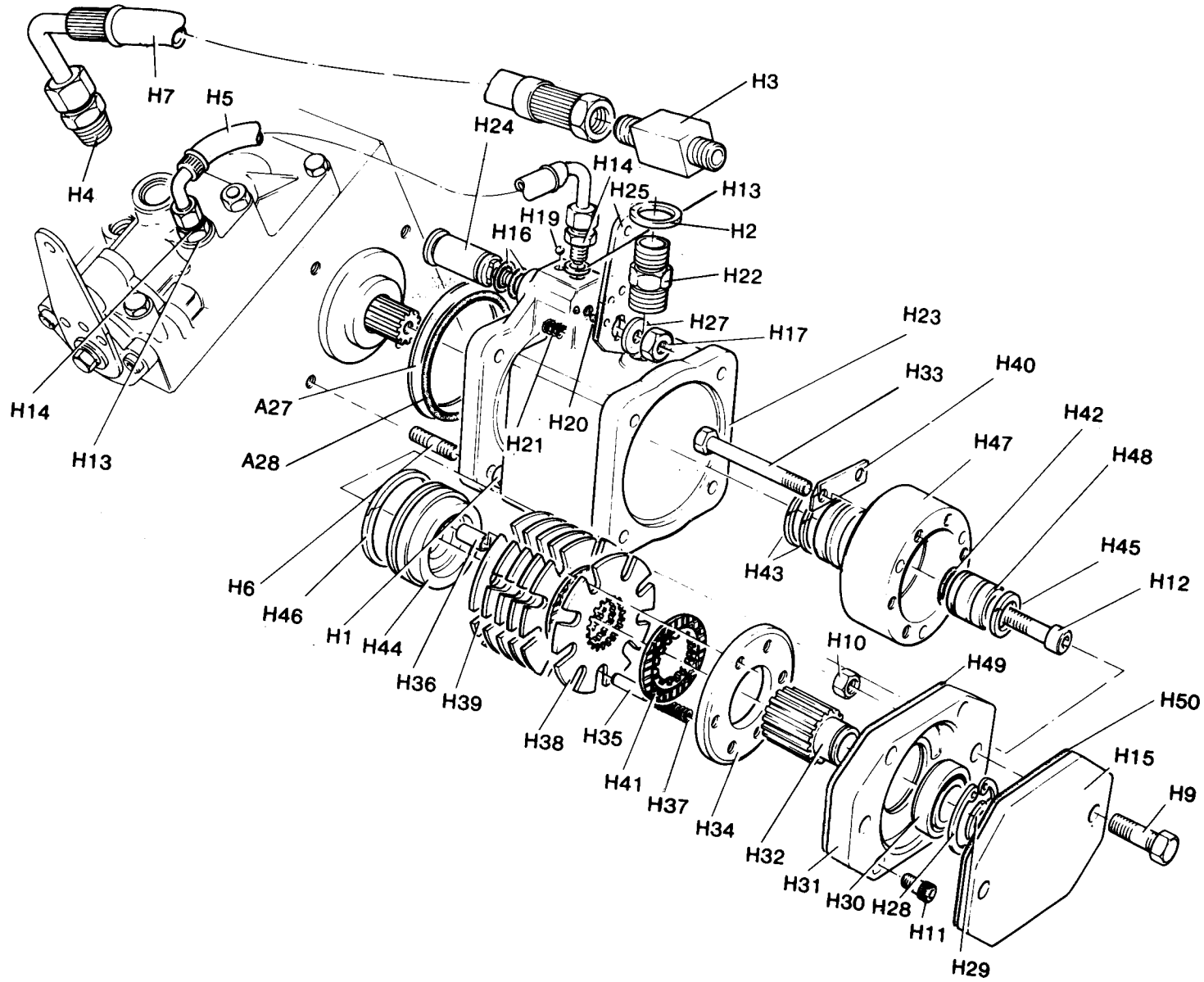


| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|-----------------------|---------------------|-----|---------|
| F | OUTPUT SHAFT ASSEMBLY | | | |
| F1 | Locknut | 010N402 | 1 | |
| F2 | Lockwasher | 010W402 | 1 | |
| F3 | Tongue washer | MT4684 | 1 | |
| F4 | Bearing | 0534011 | 1 | |
| F5 | Spacer | MT4701 | 1 | |
| F6 | Output gear 1.19:1 | MT4704 | 1 | |
| | 1.5:1 | MT4705 | 1 | |
| | 2:1 | MT4706 | 1 | |
| | 3:1 | MT4719 | 1 | |
| | 4:1 | MT4720 | 1 | |
| F7 | Spacer | MT4722 | 1 | |
| F8 | Output shaft | MT4703 | 1 | |
| | Bearing assembly | MT0178 | 1 | |
| | comprising: | | | |
| | Bearing | | 1 | |
| | Spacer | | 1 | |
| | Shims | | AR | |
| | Spacer | | 1 | |
| | Bearing | | 1 | |
| | 'O' ring | 002563 | 1 | |
| F15 | Output flange | | | |
| | all ratios except 4:1 | MT4666 | 1 | |
| | 4:1 | MT4667 | 1 | |
| | Washer | MT4693 | 1 | |
| | Tab washer | MT7032 | 1 | |
| | Screw | 0041209HT | 3 | |

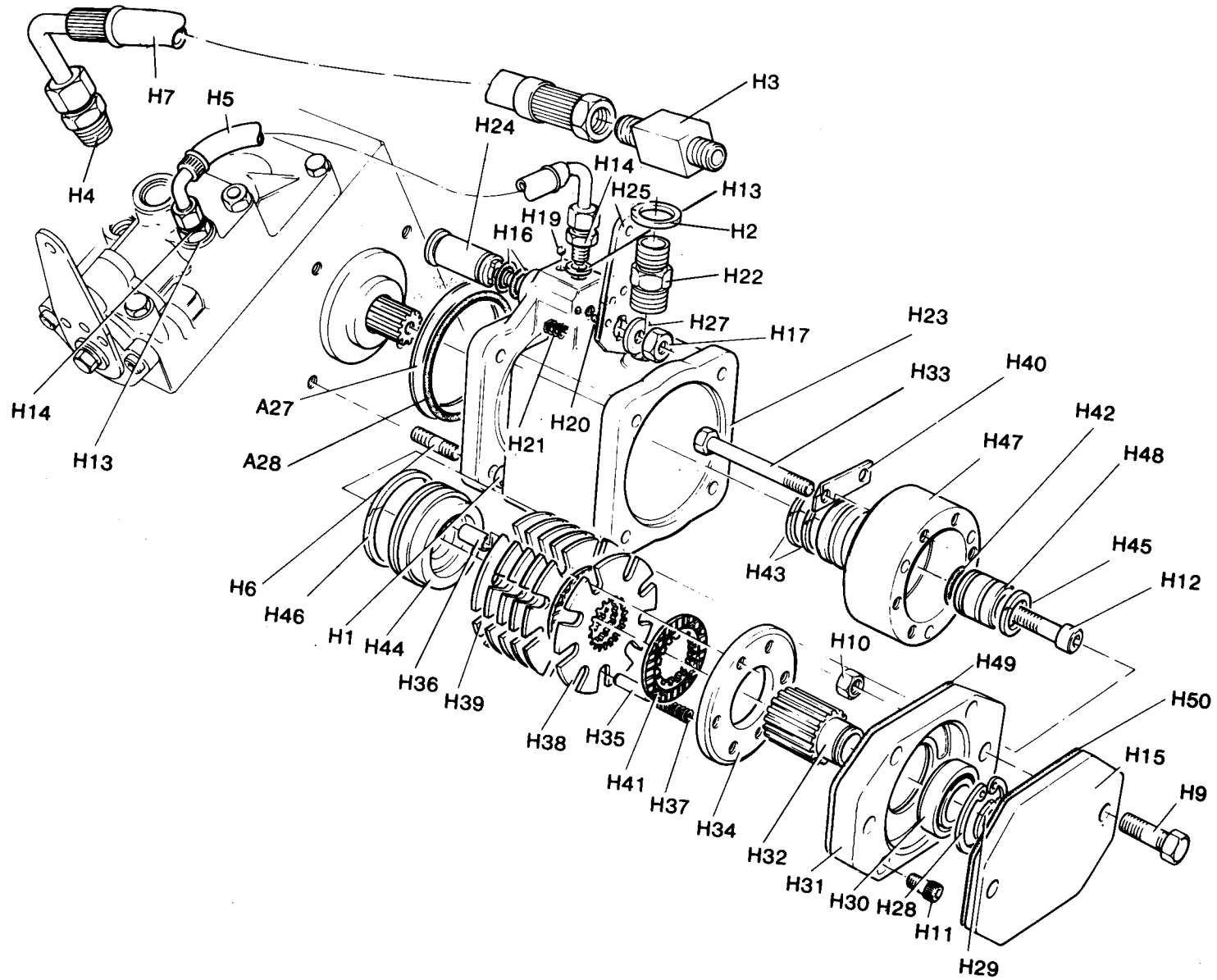
Fitted to g/boxes after
Jan 1983



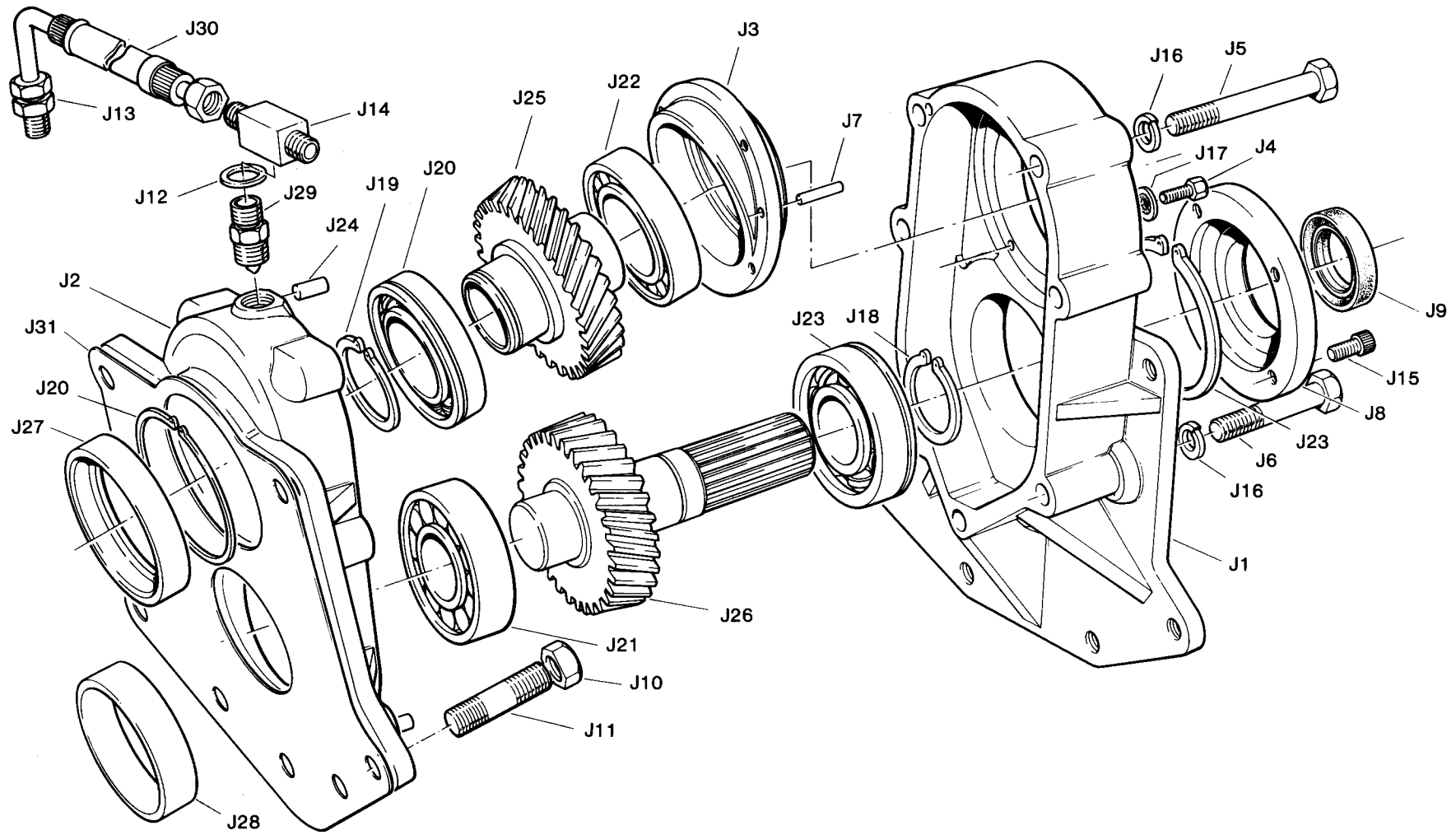
| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|---|---|---|-----------------|
| A28 | DIRECT DRIVE-POWER TAKE OFF 'O' ring Muff coupling S/A comprising: G1 Half coupling G2 Half coupling Adaptor flange assembly comprising:- G3 Oil seal G4 Adaptor flange G5 Shimming kit | MT0128 004124 MT5014 S/A MT5014 MT5015 MT5016 S/A 0400403 MT5016 MT0120 | 1 1 1 1 1 1 1 | Not illustrated |



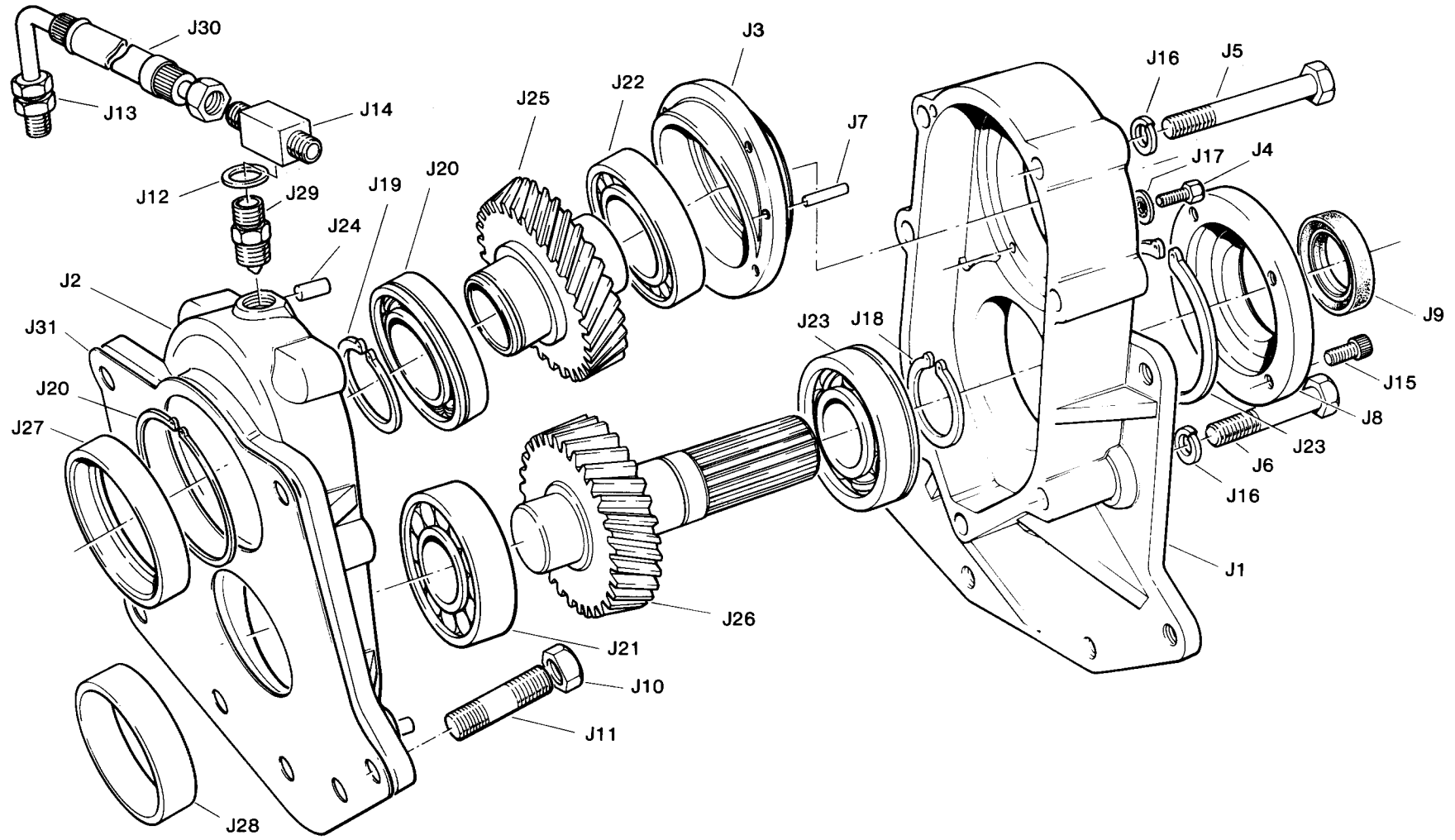
| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|-------------------------|---------------------|-----|-----------------|
| H | CLUTCHED POWER TAKE-OFF | MT0205 | | |
| H1 | Nyloc nut | 0051006 | 4 | |
| H2 | Dowty washer | 0201715 | 1 | |
| H3 | Tee piece | CP1367 | 1 | |
| H4 | Pipe adaptor | CP1255 | 1 | |
| H5 | Hose | MT5008 | 1 | |
| H6 | Stud | MT5009 | 4 | |
| H7 | Oil pipe | MT766 | 1 | |
| H8 | Shimming kit | MT0120 | AR | Not illustrated |
| H9 | Bolt | 0041208 | 2 | |
| H11 | Cap screw | 0081620 | 4 | |
| H12 | Cap screw | 0081535L | 1 | |
| H13 | Seal | CP1224 | 2 | |
| H14 | Union | CP1341 | 2 | |
| H15 | Cover plate | MT1293 | 1 | |
| H16 | 'O' ring | 00753 | 2 | |
| H17 | Nut | 0050801 | 1 | |
| H19 | Ball | CP1180 | 1 | |
| H20 | Detent ball | CP1191 | 1 | |
| H21 | Spring | MT305 | 1 | |
| H22 | Union | MT4583 | 1 | |
| H23 | Body | MT1310 | 1 | |
| H24 | Selector valve | MT1626 | 1 | |
| H25 | Operating lever | MT5007 | 1 | |
| H27 | Washer | MT979 | 1 | |
| H28 | Circlip | 0250550 | 1 | |



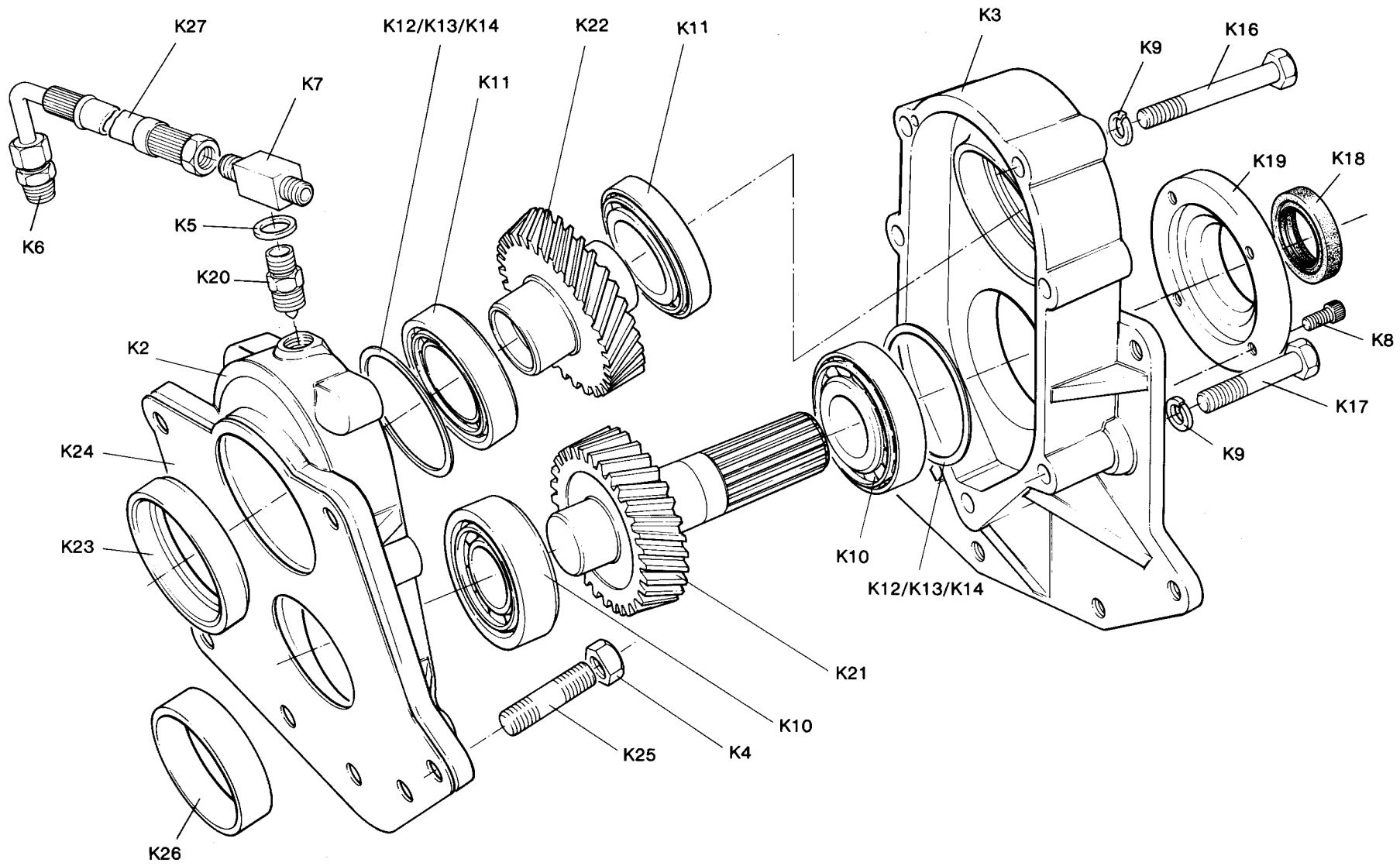
| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|------------------|---------------------|-----|-------------------------|
| H29 | Circlip | 0330300 | 1 | |
| H30 | Ball bearing | 0513010 | 1 | |
| H31 | Cover | MT1309 | 1 | |
| H32 | Drive adaptor | MT5004 | 1 | |
| | Clutch pack | | | |
| 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/S | 6 | Not supplied separately |
| H42 | 'O' ring | 001123 | 1 | |
| H43 | Piston ring | 0071722 | 2 | |
| H44 | Piston | MT1347 | 1 | |
| H45 | Piston ring | 001123 | 1 | |
| H46 | Piston ring | 002874 | 1 | |
| H47 | Clutch body | MT5003 | 1 | |
| H48 | Plug | MT1549 | 1 | |
| H49 | Joint (gasket) | MT5011 | 1 | |
| H50 | Joint (gasket) | MT5012 | 1 | |
| H51 | End cap | MT1625 | 1 | Not illustratrđ |
| H52 | Cap screw | 0081312L | 1 | Fitted next to H24 |



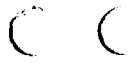
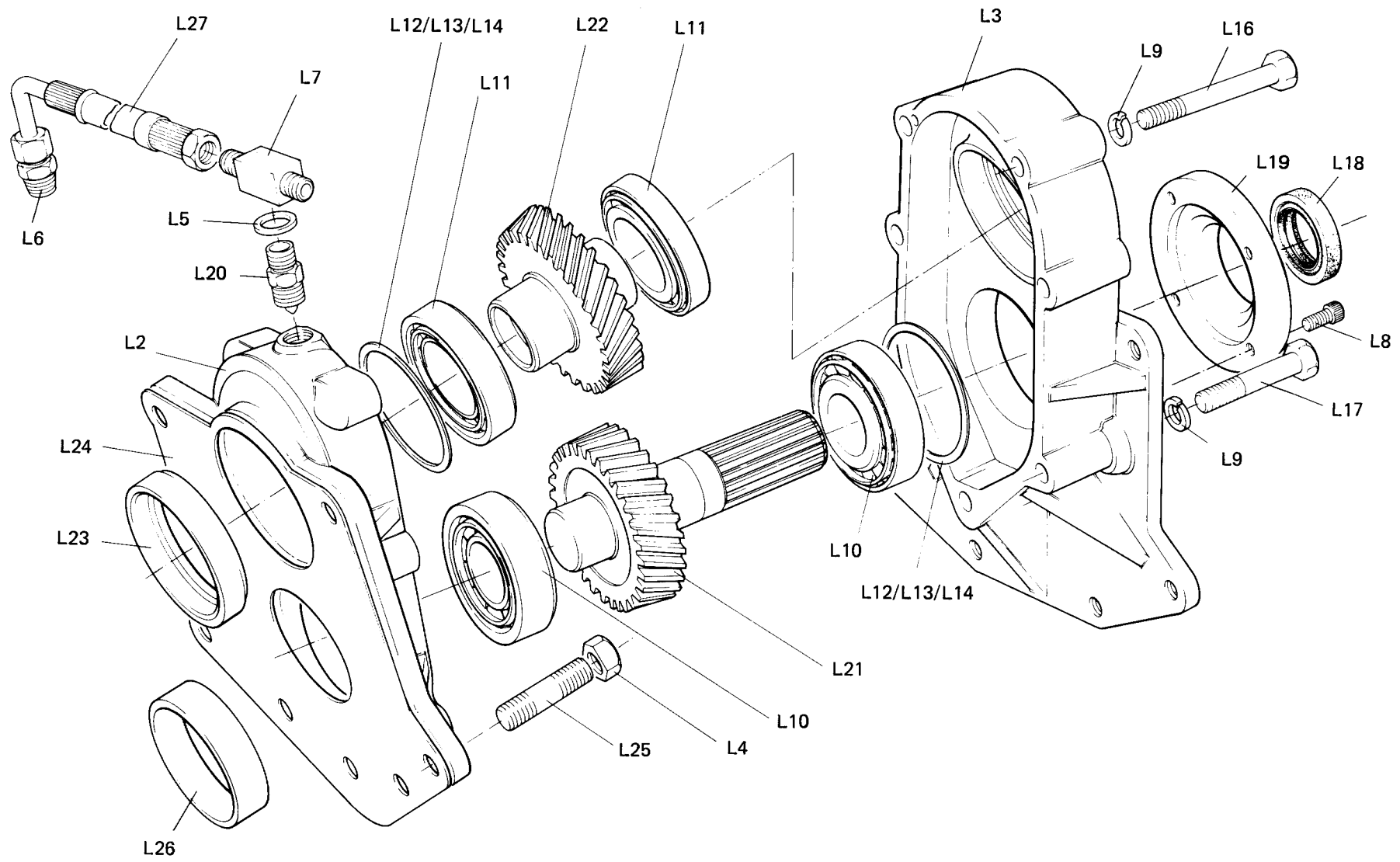
| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|-------------------|---------------------|-----|-------------------------|
| J | ANGLE DRIVE UNIT | MT0129 | | |
| | Gearcase | MT0122 | | |
| J1 | Case half (front) | MT4575 | 1 | Not supplied separately |
| J2 | Case half (rear) | 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 | MT4579 S/A | | |
| | comprising:- | | | |
| 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 | |



| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|----------------|---------------------|-----|-----------------|
| 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 |



| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|-------------------|------------------|-----|-------------------------|
| K | ANGLE DRIVE UNIT | 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 | 0400403 | 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 |



| Plate Ref | Description | PRM601D Part No. | Qty | Remarks |
|-----------|-------------------|---------------------|-----|-------------------------|
| L | ANGLE DRIVE UNIT | MT0345 | | |
| L1 | Gearcase | MT0344 | 1 | |
| L2 | Case half (front) | MT4776 | 1 | Not supplied separately |
| L3 | Case half (rear) | MT4775 | 1 | Not supplied separately |
| L4 | Nyloc nut | 0051205 | 6 | |
| L5 | Dowty washer | 0201715 | 1 | |
| L6 | Adaptor | CP1255 | 1 | |
| L7 | Tee piece | CP1367 | 1 | |
| L8 | Cap screw | 0081316 | 4 | |
| L9 | Spring washer | 0191107 | 7 | |
| L10 | Taper bearing | 0540551 | 2 | |
| L11 | Taper bearing | 0540401 | 2 | |
| L12 | Shim .002" | 057353A | 6 | |
| L13 | Shim .010" | 057353C | 6 | |
| L14 | Shim .031" | 057353E | 2 | |
| L15 | Dowel | 40M629 | 2 | Not illustrated |
| L16 | Bolt | 0041217 | 4 | |
| L17 | Bolt | 0041219 | 3 | |
| L18 | Oil seal | 0400403 | 1 | |
| L19 | Oil seal housing | MT4778 | 1 | |
| L20 | Union fitting | MT4583 | 1 | |
| L21 | Input gear | MT4658 | 1 | |
| L22 | Output gear | MT4779 | 1 | |
| L23 | Location ring | MT4777 | 1 | |
| L24 | Gasket | MT4599 | 1 | |
| L25 | Stud | MT4642 | 6 | |
| L26 | Spacer | MT4672 | 1 | |
| L27 | Oil pipe | MT766 | 1 | |
| L28 | Dipstick | 40M153 | 1 | Not illustrated |
| L29 | Shims | 057390A/C/E | 3 | Not illustrated |

KITS OF PARTS

| Part No. | Description | Qty |
|---------------|--|----------|
| MT0115 | Pump Repair Kit - before Dec 87 | 1 |
| MT378 | Pump spindle | 1 |
| MT379 | Pump gear | 1 |
| MT4544 S/A | Spindle assembly | 1 |
| MT0238 | 'O' Ring Kit | 1 |
| MT1073 | Gasket - valve block | 1 |
| MT343 | Gasket - top cover | 1 |
| MT1081 | Gasket - valve block | 1 |
| 000372 | 'O' ring | 8 |
| 000753 | 'O' ring | 1 |
| 000872 | 'O' ring | 1 |
| 001254 | 'O' ring | 2 |
| 001873 | 'O' ring | 2 |
| 002563 | 'O' ring | 1 |
| 003473 | 'O' ring | 2 |
| 003503 | 'O' ring | 1 |
| 004124 | 'O' ring | 2 |
| 004254 | 'O' ring | 2 |
| 005002 | 'O' ring | 1 |
| 0400403 | Oil seal - input shaft | 1 |
| 0400751 | Oil seal - output shaft | 1 |
| MT0120 | Shimming Kit | 1 |
| MT1076/02 | Shim | 3 |
| MT1076/10 | Shim | 3 |
| MT1076/31 | Shim | 2 |
| MT4671A | Shim | 5 |
| MT4671B | Shim | 5 |
| MT4671C | Shim | 2 |

| Part No. | Description | Qty |
|---------------|-------------------------------------|----------|
| MT0264 | Clutch pack | 1 |
| MT4535 | Clutch plate | 6 |
| MT4602/S | Clutch plate | 7 |
| MT4534 | Clutch end plate | 1 |
| MT4652 | Spring | 3 |
| MT4555 | Tab washer | 6 |
| MT4554 S/A | End plate/grub screw | 1 |
| MT4649 | Spring | 3 |
| MT0153 | Clutch pack for clutched PTO | 1 |
| 0010420 | Bolt | 6 |
| MT1113 | Clutch end cover | 1 |
| MT1155 | Pin | 3 |
| MT1156 | Ferrule | 6 |
| MT1157 | Spring | 3 |
| MT116 | Clutch plate | 5 |
| MT117 | Clutch end plate | 1 |
| MT351 | Tab washer | 3 |
| MT731/S | Clutch plate | 6 |