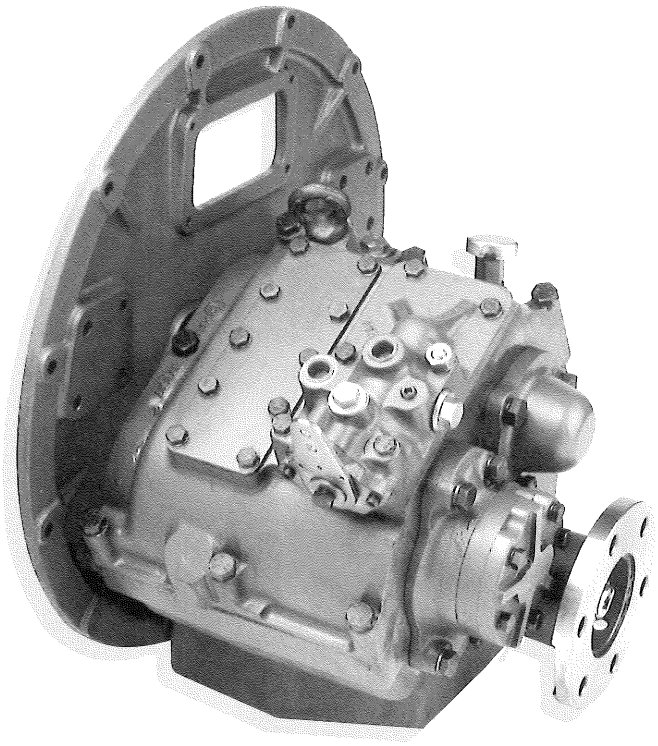
NEWAGE

PRM

PRM402 MARINE GEARBOX



WORKSHOP MANUAL

Publication No. 402Man/3/96

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BSI REGISTERED FIRM

Certificate No. Q10728

FOREWORD

Provided it is correctly installed, aligned and maintained, the PRM402 gearbox should have a long and trouble-free life. This workshop manual contains important instructions to ensure that this is so, and it is of the utmost importance that these are carefully followed. Newage Transmissions Ltd can accept no responsibility under warranty or otherwise for any loss or damage resulting from failure to observe these instructions.

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

CLAIMS UNDER WARRANTY

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

SERVICE PARTS

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

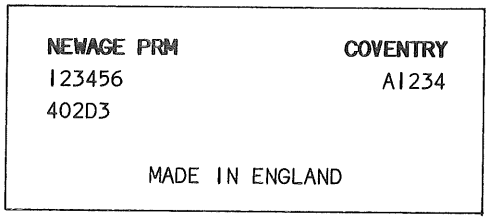
PRE-DELIVERY TEST

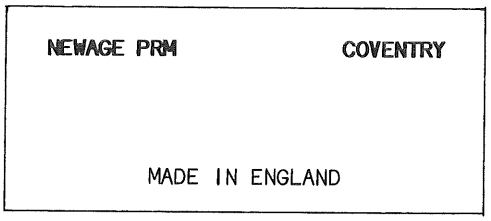
Before it leaves the factory, every gearbox is subjected to a final test and inspection which includes the following:-

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

IDENTIFICATION PLATE

Before it leaves the factory, every PRM402 is fitted with an identification plate on the top half of the gearcase which looks something like this:-.



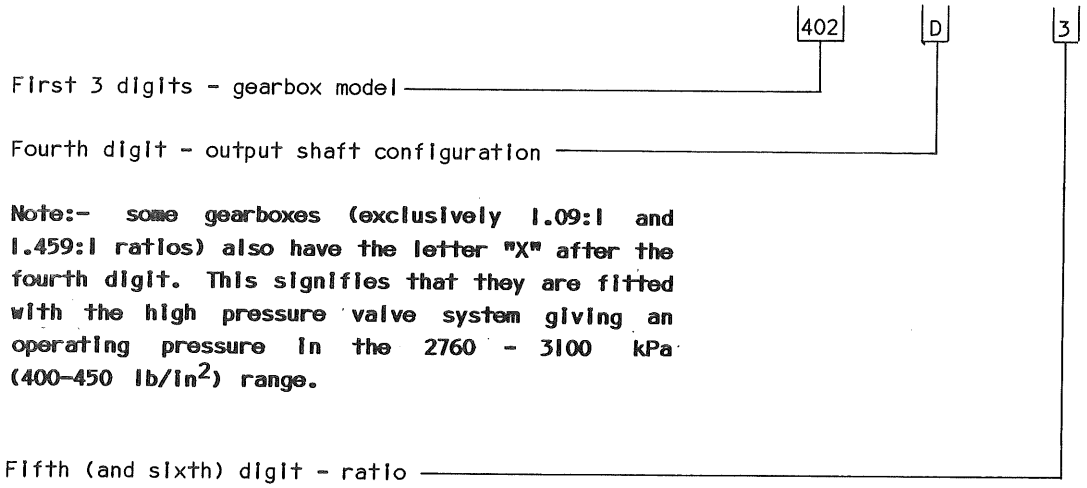


For reference, please record the model and serial number of your gearbox here.

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

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

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



Note:- some gearboxes (exclusively 1.09:1 and 1.459:1 ratios) also have the letter "X" after the fourth digit. This signifies that they are fitted with the high pressure valve system giving an operating pressure in the 2760 - 3100 kPa (400-450 lb/in^2) range.

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

CONTENTS

LIST OF ILLUSTRATIONS

1. GENERAL DATA

1.1 Specifications

Gear ratios

1.09:1, 1.459:1, 1.935:1, 2.565:1, 2.904:1 or 3.952:1.

Power rating:

RATIO	PLEASURE		LIGHT COMMERCIAL		HEAVY COMMERCIAL	
	BHP	kW	BHP	kW	BHP	kW
1.09:1, 1.459:1	9.62	7.17	7.62	5.68	7.23	5.39
1.935:1	8.76	6.53	7.23	5.39	6.85	5.11
2.565:1	8.00	5.97	7.23	5.39	6.85	5.11
2.904:1, 3.953:1	7.62	5.68	6.85	5.11	6.47	4.85
MAXIMUM OPERATING SPEEDS: 4000 rev/min intermittent, 3,600 rev/min continuous						

Note: these ratings refer to diesel engines; powers are expressed in BHP and kW per 100 rev/min engine operating speed, and are measured at the engine flywheel. Ratings have been established to ensure the long and trouble-free life of the gearbox which must not be used at powers greater than 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 use of the PRM402 gearbox at this rating in any commercial boat, or in sport-fishing charter boats or long-range pleasure cruisers, is **not** approved.

LIGHT COMMERCIAL:- planing or semi-displacement craft used 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:- all displacement and semi-displacement craft used in any commercial application should be classified according to the heavy commercial rating. In vessels of this type (including trawlers, purse seiners, lobster and crab boats, tugs, ferries, offshore supply boats etc.) the gearbox is expected to work at full rated engine power and speed. The engine's power setting must be known, and must be within permitted heavy commercial rating of the gearbox.

IMPORTANT NOTE:

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

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

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

APPROXIMATE WEIGHTS AND OIL CAPACITIES

DRY WEIGHT			OIL CAPACITY	
PRM402D	72kg (158lb)	excluding drive coupling, adaptor and cooler.	2.5 litres (4.40 pints)	plus the amount needed to fill the cooling circuit.
PRM402D4	80kg (176lb)		3.5 litres (6.16 pints)	
PRM402A	90kg (198lb)		3.0 litres (5.28 pints)	
PRM402C	93kg (205kg)		3.0 litres (5.28 pints)	
Additional weight, power take off: 12 Kg (26.4lb)				

Input rotation:

May be either clockwise or anti-clockwise (see section 2).

Output rotation:

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

Hydraulic operating system:

Working oil pressure	1.09:1/1.459:1:-	minimum--2760 kPa (400 lb/in^2) maximum--3100 kPa (450 lb/in^2)
	other ratios :-:	minimum--2275 kPa (330 lb/in^2) maximum--2655 kPa (385 lb/in^2)

Note:- the above pressures do NOT apply to gearboxes fitted with trolling valves, for which specific instructions are provided separately.

Oil pressures should be measured at a gearbox operating temperature of 70°C and an input speed of not less than 1500 rev/min. Normal operating oil temperature should be between 50°C - 70°C with a maximum of 80°C permissible for very short periods only.

In order to ensure that correct operating temperatures are maintained an oil cooler is required, and there are two 3/8 in. connections on the valve block so that a suitable unit may be fitted. The capacity of the cooler needed depends on a number of factors, including transmitted power, operating speed, duty cycle, inlet water temperature and ambient temperature. Suitable coolers are available from Newage Transmissions Ltd.

Input drive couplings:

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

Gearcase:

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

Input shaft:

402D, 402A: 29mm (1.14 in) diameter with $^{16}/_{32}$ DP involute spline.
402C : 33mm (1.30 in) diameter with $^{20}/_{40}$ DP 26 tooth involute spline.

Propeller thrust:

Ahead and astern thrust carried by the output shaft bearings which are of adequate capacity for all factory-approved ratings.

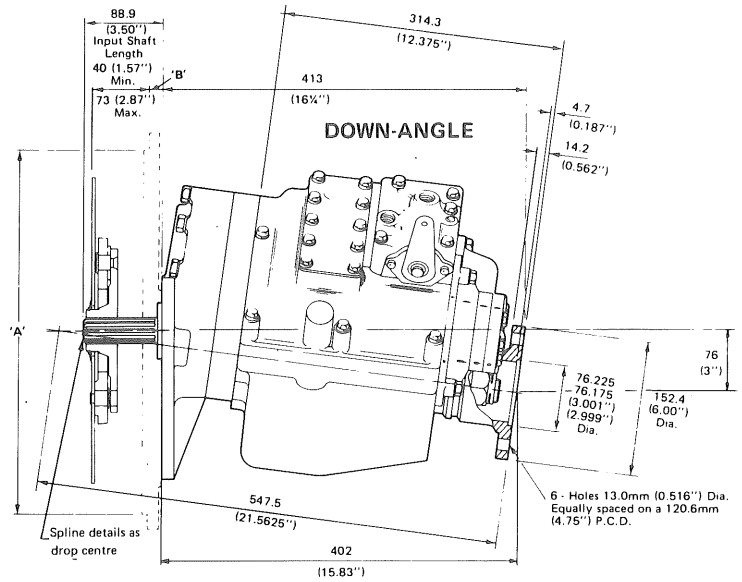
Output flange:

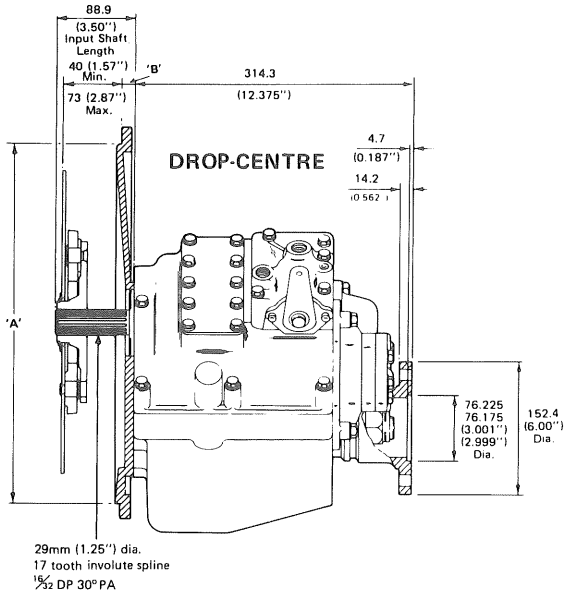
152.4mm (6 in) diameter, with 6 holes, 13mm (0.512 in) diameter on 121mm (4.5 in) PCD, and female spigot, 76.2 mm (3.0 in) diameter.

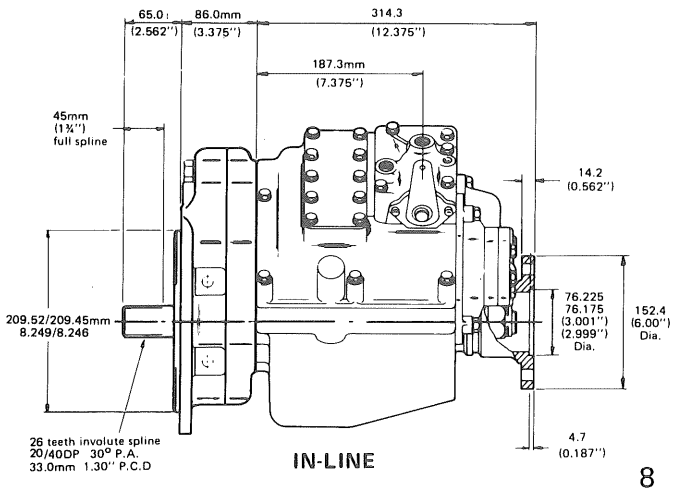
Installation angle:

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

1.2 Installation details



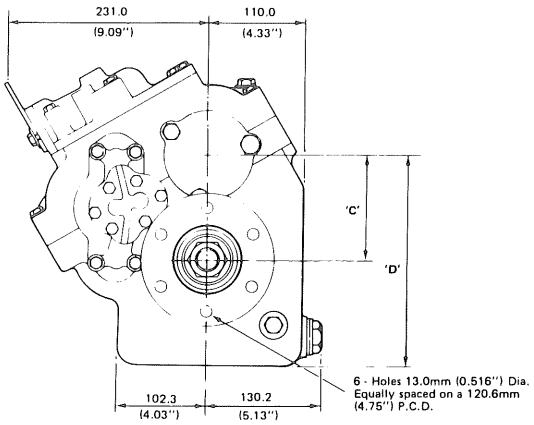




OUTLINE DIMENSIONS - PRM402

Adaptors	'A'		'B' (Nominal)	
	mm	inches	mm	inches
SAE2	447.68	17.625	15.90	0.625
SAE3	409.58	16.125	15.90	0.625
SAE4	361.95	14.250	19.00	0.750
B/W	209.50	8.250	28.57	1.125

DROP CENTRE DISTANCE				
	'C'		'D'	
	mm	inches	mm	inches
3.925:1	152.4	6.00	292.1	11.50
other ratios	120.7	4.75	241.3	9.00



2. INTRODUCTION

The PRM402 marine transmission is an oil-operated gearbox 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 allows right hand or left hand propeller rotation in ahead drive with identical ratios in both directions.

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

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

3. CONSTRUCTION

3.1 Gearcase

The gearcase is free of 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; if required, this can be removed and a hand-operated drain pump connected.

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

3.2 Gear train

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

The input shaft, which is supported by a taper roller bearing at either end, incorporates a drive pinion of the required ratio (running on needle roller bearings), an emergency operating device (see section 6.4), the forward (when used with a right-hand propeller) drive clutch assembly, the clutch gear and a hydraulically actuated piston to operate the clutch.

The layshaft is similarly supported by taper roller bearings and also carries 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 the opposite hand rotation to that on the input shaft, and a hydraulically actuated piston to operate the clutch.

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

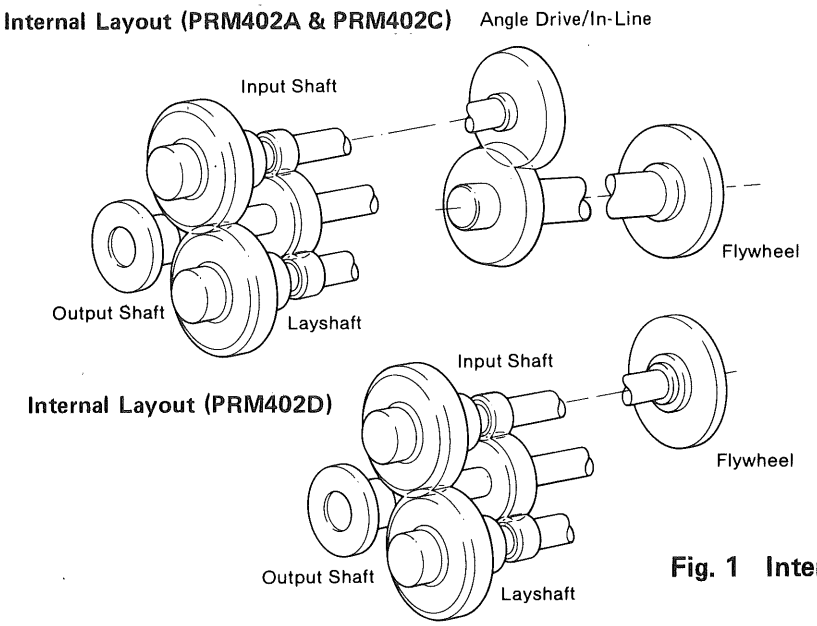


Fig. 1 Internal layout diagram

3.3 Geartrain - Angle drive

The angle drive unit incorporates a pair of conical involute gears (supported on bearings of adequate size for all factory approved ratings) so arranged that the output shaft runs at an angle of 8° down relative to the input shaft and reducing the centre line distance between the engine crankshaft and the gearbox output shaft. This allows the engine to be installed as near to the horizontal as possible whilst maintaining the required propeller shaft line.

3.4 Geartrain - In-line

The in-line gearbox incorporates a matching pair of conical involute gears (supported on bearings of adequate size for all factory approved ratings) so arranged that the input shaft of the main gearbox is stepped down to the same centre line as the output shaft, bringing the propeller shaft into line with the engine crankshaft.

3.5 Valve block

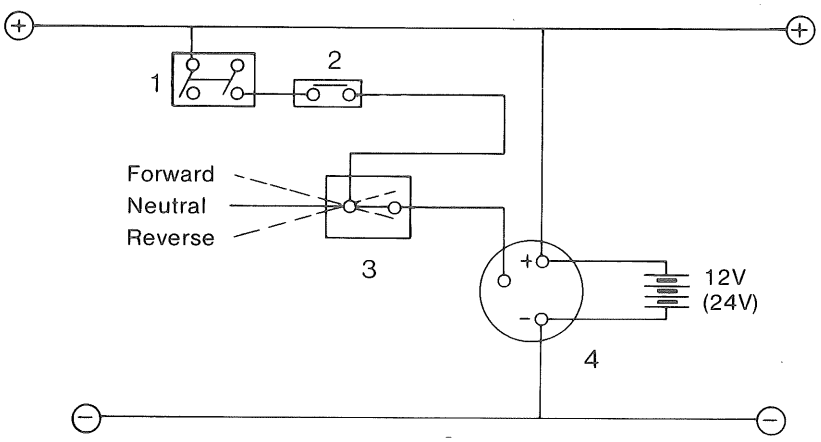
The valve block, located on top of the gearcase, contains the main control valve, which in turn incorporates the high pressure valve which controls oil supply to the clutch assemblies. Any oil surplus to clutch operation requirements is used for lubrication purposes.

The control valve is fitted with a spring-loaded neutral detent which provides a positive "feel" to the neutral position to facilitate the setting-up of the remote control operating unit and help ensure positive shifting.

3.6 Neutral safety switch

A neutral safety start switch, which prevents the engine from being 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. Newage Transmissions Ltd strongly recommends the use of this device.

When fitted, the switch is located on the valve block (see item C on the parts list) and should be wired into the starter circuit as shown in Fig. 2.



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

Fig. 2 Wiring diagram for neutral safety start device

3.7 Oil pump

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

When the gearbox is used with anti-clockwise engines (looking at the flywheel) or with clockwise engines in the case of the PRM402A and PRM402C, the oil pump is fitted in its standard position. For clockwise engines, (anti-clockwise in the case of the PRM402A and PRM402C), the pump is mounted at 180° to its standard position (see diagrams).

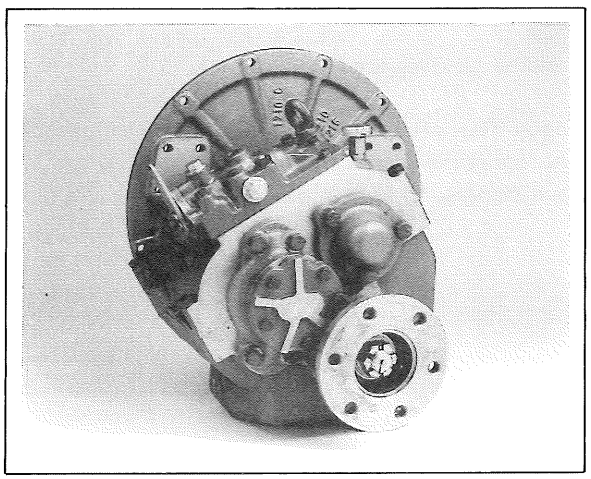


Fig. 3 Oil pump mounting
(anti-clockwise engines)

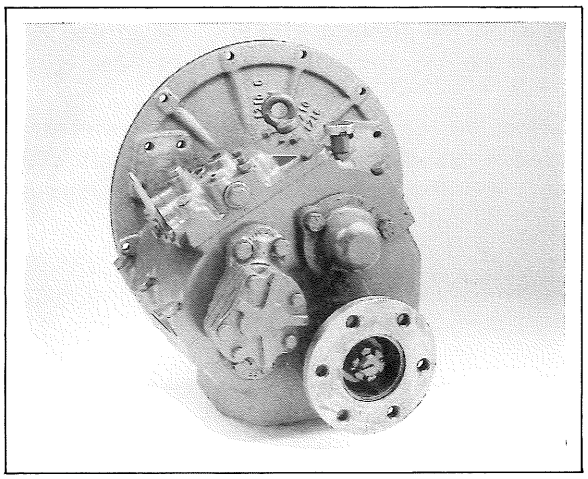


Fig. 4 Oil pump mounting
(clockwise engines)

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 input shaft and clutch gear rotate at engine speed. The clutch gear is in constant mesh with the layshaft clutch gear, which is therefore also driven at engine speed but in the opposite direction. Since neither clutch is engaged, the drive pinions do not rotate.

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

Moving the control lever to the 'astern' position engages the clutch on the other shaft causing the reverse pinion to drive the output shaft gear in the opposite direction so that the propeller shaft and propeller turn in the direction affording astern movement of the vessel.

Gearbox Output Rotation

Engine Rotation Anti-clockwise

	PRM402A & PRM402C	PRM402D
Lever Backward		
Lever Forward		

Engine Rotation Clockwise

	PRM402A & PRM402C	PRM402D
Lever Backward		
Lever Forward		

Note: (I) Rotations are as seen looking from the propeller forward to the gearbox.

(II) Anti-clockwise engines are by far the most common, and the standard gearbox build therefore assumes an anti-clockwise input.

4.2 Hydraulic system

Oil is pumped from the gearbox sump through the internal supply pipe to the control block. This incorporates a high pressure valve which ensures that the correct operating pressure is maintained.

When the operating lever is moved, oil is delivered under pressure via a feeder on the input shaft or the layshaft to a piston which actuates the clutch appropriate to the desired propeller rotation. Excess oil not needed for hydraulic actuation is used for lubricating the gearbox.

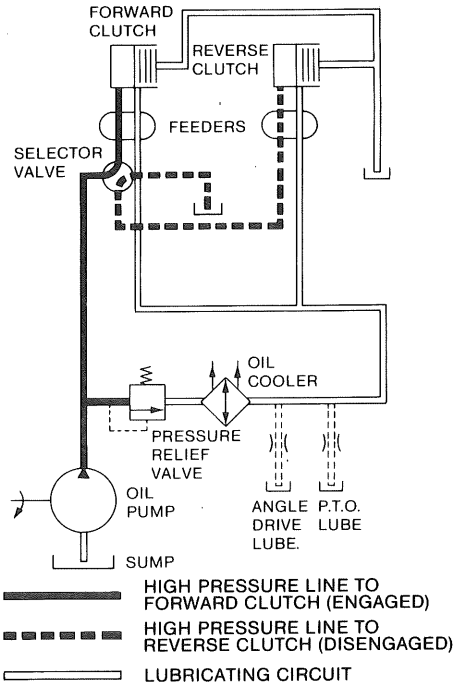


Fig. 5 Hydraulic and lubricating oil circuits

4.3 Lubrication

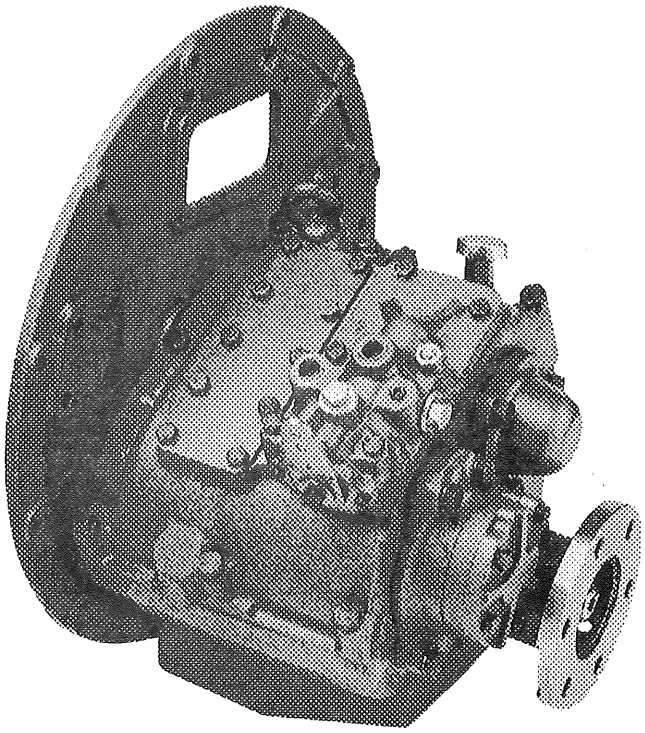
Oil for lubrication purposes is also delivered via the internal supply pipe to the control block. Irrespective of whether ahead or astern is engaged, oil is diverted from the discharge side of the pressure relief valve to an external oil cooler. After passing through the cooler, the oil is directed through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

4.4 APPROVED OILS

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.



PRM402 MARINE GEARBOX BY NEWAGE

5. INSTALLATION

5.1 General

A variety of adaptor plates to SAE2, SAE3, SAE4 and other dimensions is offered for use with the PRM402, so that it may be mounted to engines with flywheel housings of equivalent dimensions.

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. This coupling enjoys a degree of torsional flexibility, which helps to dampen down engine torsional or cyclic vibrations and prevent them being passed to the gearbox.

The strongest engine vibrations are generally those caused by firing in the cylinders; diesel engines, with their high compression ratios, usually generate stronger vibration pulses than petrol (gasolene) engines, and it is often the case that of two engines of roughly equivalent size, the one having the greater number of cylinders will tend to run more smoothly than the one with fewer cylinders, although this is by no means always the case.

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

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

Newage Transmissions Ltd will provide all possible information to help solve existing or potential torsional problems, but ultimately it is the responsibility of the person who assembles the drive and driven equipment to ensure that they are torsionally compatible.

5.2 Checking the engine flywheel housing

Attach a dial test indicator, calibrated in units of 0.001 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. 6). 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 indicator still attached to the flywheel, re-position the stylus so that it is perpendicular to the face of the flywheel housing (face B on Fig. 6). Rotate the flywheel and check the deviation over one complete revolution: again, this should not exceed 0.006 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 flywheel register (bore C on Fig 6). Rotate the flywheel through one complete revolution and note the deviation, which should not exceed 0.005 in (0.125mm) total indicator reading.

With the indicator still attached to the flywheel housing, reposition the stylus so that it is perpendicular to the face of the flywheel register (D on Fig 6). Rotate the flywheel through one complete revolution and note the deviation, which should not exceed 0.005 (0.125mm) total indicator reading.

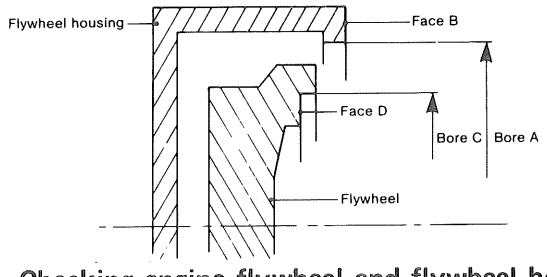


Fig. 6 Checking engine flywheel and flywheel housing

5.4 Mounting the gearbox to the engine

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

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

   If no mandrel is available, tighten the mounting bolts, just sufficiently to prevent free movement, assemble the gearbox to the coupling, and rotate the engine two or three revolutions by hand to align the plate. Tighten up two or three opposite bolts, using the inspection window provided on the gearbox adaptor flange.

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

4. Offer up the gearbox and adaptor (at the correct attitude to provide the output shaft offset) to the input coupling and engine flywheel housing, and insert the input shaft into the centre of the coupling (you may need to rock the shaft slightly to ensure that the shaft enters). Press the assembly fully into position, align the mounting holes in the adaptor flange with those on the flywheel housing, and bolt securely.

Note: for tightening torques see section 13.

5.5 Oil cooler

All PRM402 gearboxes must be fitted with an oil cooler to maintain correct working temperatures (50-70°C). To permit a suitable cooler to be fitted, two $^{3}/_{8}$ in. BSP connections are provided on the valve block; these are blanked off with "Redcap" seals for delivery from the factory.

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

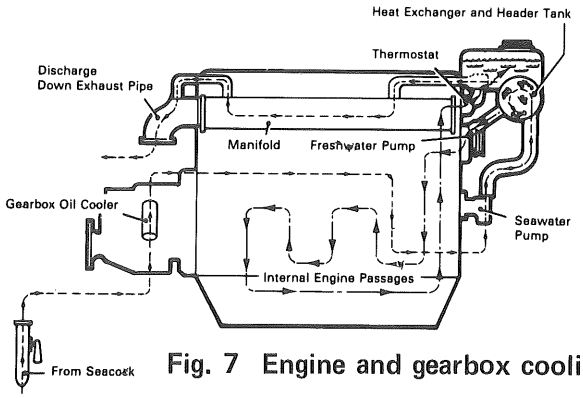


Fig. 7 Engine and gearbox cooling circuit

5.5.1 PRM402 standard gearbox

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

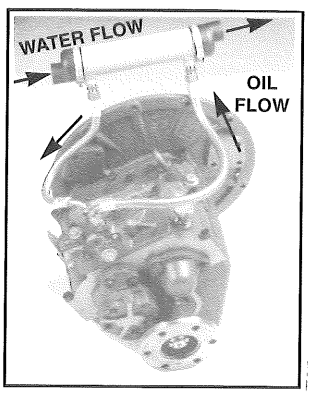


Fig. 8 Oil cooler connections - PRM402D

5.5.2 PRM402 with power take-off

The cooling system should be connected so that oil returning from the cooler to the valve block first passes through the power take-off, 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.

The oil cooler can now be connected to the engine cooling system as outlined on page 16.

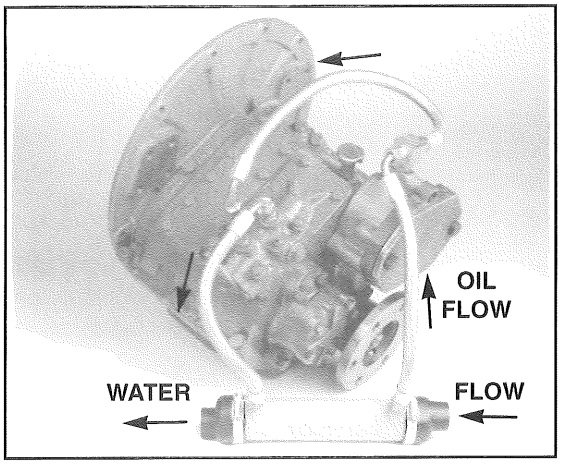


Fig. 9 Oil cooler connections - PRM402 with power take-off

5.5.3 PRM402A (with angle drive)

The cooling circuit should be connected so that oil returning from the cooler to the valve block first passes through the angle drive unit, 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.

The gearbox oil cooler can now be connected to the engine cooling system as described on page 16.

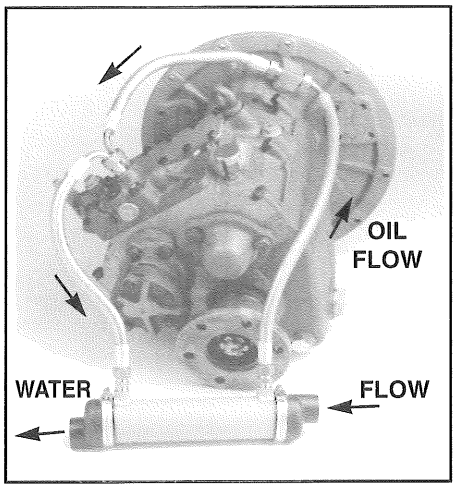


Fig. 10 Oil cooler connections - PRM402A (with angle drive)

5.5.4 PRM402C (in-line)

The cooling system should be connected so that oil returning from the cooler to the valve block first passes through the in-line unit, 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 in-line inlet.

d) connect the in-line outlet to the valve block inlet.

The gearbox oil cooler can now be connected to the engine cooling system as described on page 16.

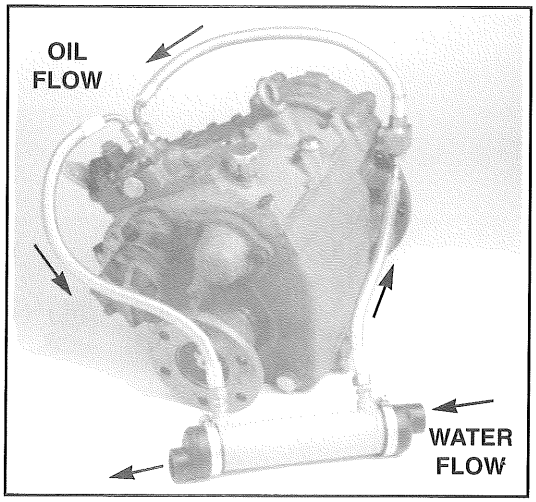


Fig. 11 Oil cooler connections - PRM402C (in-line)

***NOTE: The in-line unit is provided with two connector positions. Either can be used to suit installation requirements.**

5.5.5 PRM402A/PRM402C with power take-off

The cooling system should be connected so that oil returning from the cooler to the valve block first passes through the power take-off and then through the angle drive/in-line unit, 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 power take-off inlet.

d) connect the power take-off outlet to the angle drive/in-line inlet.

e) connect the angle drive/in-line outlet to the valve block inlet.

The gearbox oil cooler can now be connected to the engine cooling system as described on page 16.

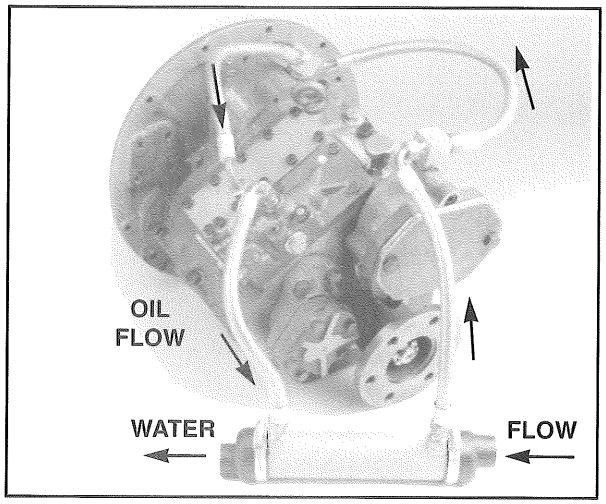


Fig. 12 Oil cooler connections - PRM402A/PRM402C - with power take-off

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

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

5.6 Propeller shaft alignment

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

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

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

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

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

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

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

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

ii) the two halves of the coupling must be carefully aligned. This should be done by bringing the two flanges close enough together so that a feeler gauge can be used to check the vertical and horizontal alignment.

Since the propeller shaft line is normally fixed in the boat, alignment is usually obtained by adjusting the number of shims under the engine mounts.

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

5.7 Installation angle

The PRM402 should not normally be installed at a fore and aft angle of more than 17° relative to the water line with the boat at rest.

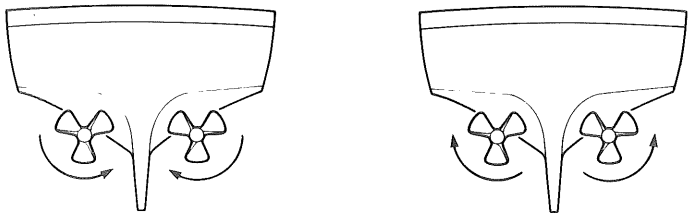
The PRM402A version provides 8° down angle on the output shaft, and also has the effect of reducing the centre distance between the engine crankshaft and the gearbox output shaft. This enables the engine to be mounted nearer to the horizontal than would be the case with conventional in-line or drop centre transmissions, effectively reducing the overall height needed to instal the engine; it may also help to prolong engine life.

5.8 Twin Installation

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

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

It is preferable for the starboard (right-hand) propeller to rotate clockwise and the port (left-hand) propeller anti-clockwise rather than the other way around since in the latter case, when the propeller blades are at the lowest point of their rotational arc, they tend to create a vacuum which reduces the flow of water to the other propeller; furthermore, when the boat is making a tight turn with one gearbox in "ahead" and the other in "astern", the thrust side of one propeller will be acting diametrically opposite to the other one, causing the boat to be deflected off line and thus delaying completion of the manoeuvre.

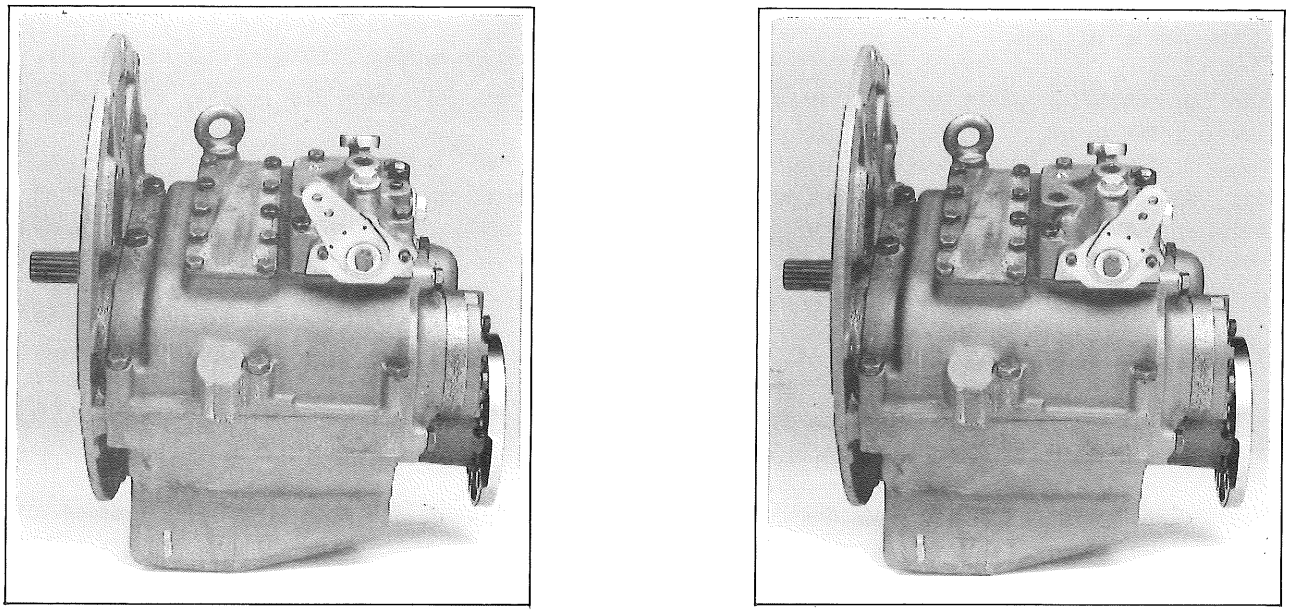


Normal Applications Special Applications

Fig. 13 Propeller rotation, twin installations

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

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



Port engine
Lever forward
L.H. propeller rotation

Starboard engine
Lever back
R.H. propeller rotation

Fig. 14 Operating cable entry, twin installations

Note: Lever movement is reversed for PRM402A and PRM402C gearboxes.

5.9 Remote control operating systems

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

The following points should be noted:

(I) the gearbox operating lever has a positive neutral position, which greatly assists in setting up the remote control unit.

(II) care should be taken to ensure that the cable moves the gearbox operating lever approximately 1/16" (2mm) short of its maximum forward or backward travel to prevent the lever being brought hard up against the end stop with every gear shift.

The remote control equipment should in all cases be installed in accordance with the manufacturer's recommendations.

6. OPERATION

6.1 First time usage

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

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

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

Note:- Using the gearbox with insufficient oil will lead to low oil pressure, unsatisfactory operation, overheating and eventual failure. Equally, over-filling the gearbox may cause overheating and oil leaks; the owner/operator must therefore ensure that the oil level is correct at all times.

6.2 Drive selection

The PRM402 has been designed and tested to ensure rapid shifting from ahead to astern and vice versa at full horsepower ratings and speeds should the need arise. However, full power reversals do place abnormal, even if short-lived, loads on the gearbox and should therefore only be used in an emergency.

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

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

If the gearbox is used with a less common right-hand (clockwise engine), the opposite occurs: moving the gearbox operating lever backwards produces left hand propeller rotation whilst forwards produces right-hand rotation.

Note: In the case of the PRM402A and PRM402C, the effect of moving the gearbox operating lever is the reverse of that described above; engine and propeller rotations are described as seen looking forward from the propeller to the gearbox.

6.3 Trailing (free-wheeling) the propeller

The bearings used in the PRM402 have been carefully selected to ensure that prolonged trailing (free-wheeling) of the propeller does not harm the gearbox. Because the propeller can turn freely with the engine shut down the gearbox is particularly well suited for use in auxiliary sailboats, motor sailers or multi-engine installations where the boat may be operated with one or more engines shut down.

It is not necessary to provide any propeller shaft locking device to protect the gearbox, although in the case of racing yachts and other high performance sailing boats with two bladed propellers it may be thought desirable to lock the propeller behind the deadwood by means of a propshaft lock to reduce drag.

A free-wheeling propeller can be a useful source of free auxiliary power; a flat pulley fitted to the propeller shaft will enable a small battery-charging generator to be belt driven (although care must be taken not to apply excessive side-load which would cause vibration and misalignment).

6.4 Emergency operation

Included as standard in every PRM402 gearbox is a "get you home" device which in the unlikely event of hydraulic clutch failure enables the gearbox to be mechanically locked in 'ahead' allowing the boat to be brought to safety.

To operate, **first switch off the engine, disconnect the operating cable, make sure that the gearbox operating lever is in the neutral position,** and then proceed as follows:

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

2. Select the shaft to provide the required propeller rotation (see note (a) below) and rotate until the spring clip holding the two screws in position is accessible.

3. Remove the spring clip and tighten the two clamping screws: this locks up the clutch pack and provides drive.

4. Ensure that sufficient oil remains in the gearbox to avoid further damage, refit the top cover and tighten the bolts (for torque, see section 13).

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

The engine can now be run, but the gearbox operating lever must not be moved or reconnected to the operating cable; to minimise the possibility of further damage being caused to the gearbox, we also recommend that engine speed is limited to a maximum of 1/3 full throttle.

Note:

a) Assuming an anti-clockwise rotating engine, the shaft to select is:

- **for left-hand propeller rotation, the left-hand shaft; (right-hand shaft for PRM402A and PRM402C).**

- **for right-hand propeller rotation, the right-hand shaft; (left-hand shaft for PRM402A and PRM402C).**

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

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

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

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

7. ROUTINE MAINTENANCE

7.1. Initial maintenance (after 25 hours running)

Switch off the engine, drain all oil from the gearbox and refill with one of the recommended lubricants. Operate the engine and gearbox, allowing the oil to circulate, then stop the engine to let the oil settle. Re-check the level and top up to the maximum mark on the dipstick.

7.2 Daily check

1. Check the gearbox oil level

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

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

7.3 Annual checks

At the beginning of each season:-

1. Drain all oil from the gearbox, flush thoroughly, and refill with fresh oil to the correct specification. **Note:-** The gearbox oil should also be changed if it has been contaminated by water or if the gearbox has suffered major mechanical damage.

2. Check all oil cooler connections and correct/replace if necessary.

3. Check propeller shaft alignment and correct if necessary.

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

5. Check that all fasteners are correctly tightened (see section 13).

7.4 Winter storage

Drain all water from the cooling system to avoid freezing or the collection of harmful deposits.

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.	Replace oil pump.
		Broken input coupling.	Replace coupling.
		Insufficient oil.	Check level and top up as necessary.
		Oil leaks.	Search for leaks and rectify.
Propeller speed does not increase with engine speed, ahead and astern.	Low oil pressure to both clutches.	Damaged oil pump.	Replace oil pump.
		Oil strainer clogged.	Remove, clean and replace if necessary.
		Remote control cable or linkage does not allow gearbox operating lever to move correct distance.	Remove cable and operate lever by hand to check movement. Adjust cable if necessary.
		Pressure relief valve spring defective.	Remove valve block and replace spring.
Propeller speed does not increase with engine speed in one direction only.	Low oil pressure to one clutch.	Worn piston rings or feeder.	Remove appropriate clutch shaft and replace worn feeder or piston rings.
		Damaged 'O' ring in hydraulic circuit.	Check 'O' rings in feeder connectors and replace if necessary.
		Blocked hydraulic passage in valve block.	Remove valve block, examine and clean.
		Damaged clutch plates.	Remove and examine clutch on appropriate shaft and replace if necessary.
Excessive noise from gearbox at low speeds.	Engine idle speed set too low.	Faulty adjustment.	Increase idling speed.
	Torsional vibration.	Torsional incompatibility of elements in driveline.	If not cured by increasing engine idling speed, refer to engine supplier.
Excessive noise throughout operating range.	Defective input coupling.	Input coupling worn or damaged.	Remove, examine and replace if necessary.
	Propeller shaft misalignment.	Hull flexing or faulty installation.	Check the alignment of the propeller shaft coupling; if necessary rectify by adjusting the shims under the engine mounts or the engine mounts themselves.
	Propeller out of balance.	Propeller damaged or badly machined.	Remove the propeller and check that the weight, pitch, diameter and balance of all the blades are equal and rectify if necessary.
	Engine/gearbox misalignment.	Faulty installation.	Remove the transmission and check that the flywheel face is flat and that the flexible input coupling is aligned correctly.
	Defective bearing.	Bearing worn or damaged.	Isolate defective bearing, remove and replace
Excessive oil temperature.	Cooling system fault.	Defective oil cooler.	Replace oil cooler.
		Oil cooler too small.	Fit larger capacity cooler.
		Defective pressure relief valve.	Remove and examine relief valve and replace if necessary.
		System blocked.	Check and flush out oil cooler and hoses.
		Oil pipes too small.	Fit larger diameter hoses.
Oil level needs constant topping-up.	Oil leaks.	Defective oil seal, gasket or 'O' ring.	Clean the outside of the gearcase, particularly around the ends of the shafts, including the output shaft. Run the engine and inspect the gearbox for leaks. Replace any defective seals as required.
		Defective oil cooler or hoses.	Check for traces of water in the gearbox oil or oil in the cooling water system. Replace cooler or hoses as necessary.
Excessive internal pressure.	Escape of pressure from gearbox when dipstick is removed.	Defective breather causing leaks past oil seals.	Contact distributor or factory for advice.
Difficult to move single lever control.	Control lever on valve block too stiff.	Defective valve or detent spring.	Contact distributor or factory for advice.
	Faulty installation.	Remote control operating cable badly installed.	Check the installation and eliminate all tight bends in the cable.

9. SERVICING AND REPAIRS

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

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

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

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

N.B. The input shaft and layshaft are supported by taper roller bearings. Each time a shaft is stripped for inspection, component repair or replacement it will be necessary to recalculate the number of shims required to load the bearings correctly as described in Section 9.10

9.1 Valve block

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

1. Disconnect the oil cooler pipes, and the control cable from the gearbox operating lever.

2. Disconnect the wiring from the neutral switch (C28), if fitted.

3. Remove the 5 bolts (C18, C20 & C26) and one nut (C23) securing the valve block to the gearcase.

4. To remove the control valve (C11) and high pressure valve (C14), simply remove the two cap screws (C6) and withdraw the valves from the valve body. **Take care not to lose the detent ball (C12) and springs (C13, C15)!**

5. Inspect the 'O' ring (item no. C8) and bearing (item no. C10), and replace if worn, damaged or defective. Check that the pressure relief valve spring (item no. C14) has retained its correct free length (64mm, 2.52 ins) if not, replace it.

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

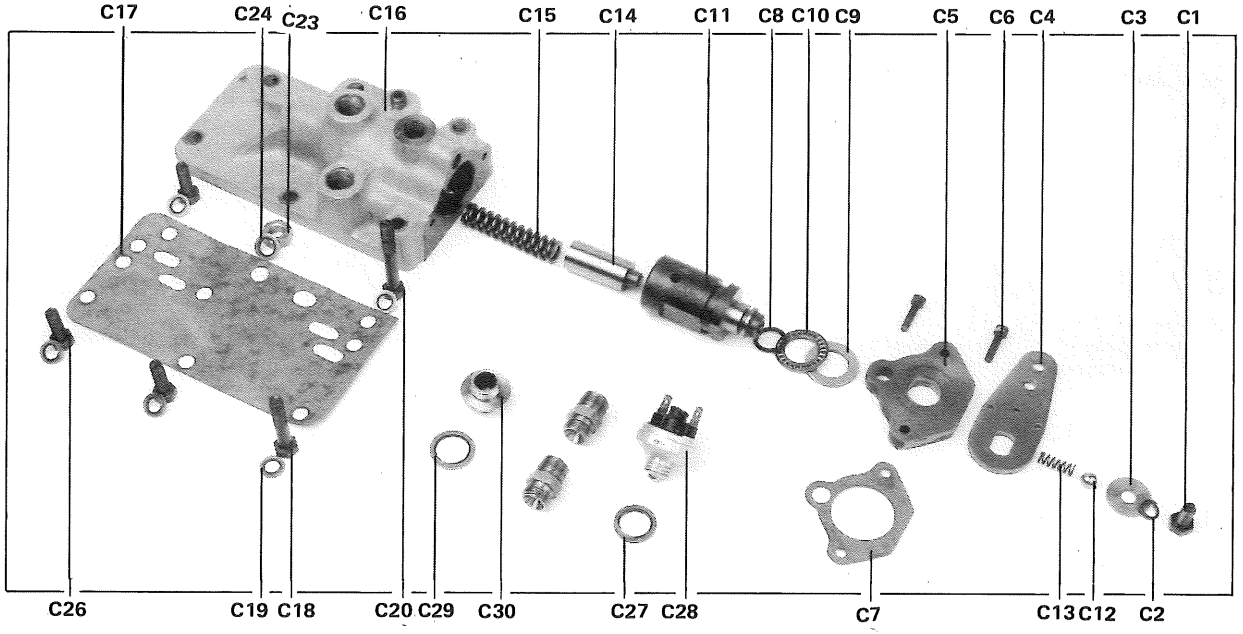


Fig. 15 Servicing and repairs - valve block

9.2 Oil pump

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

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 (B7) and shims (E23).

3. Replace the 'O' rings.

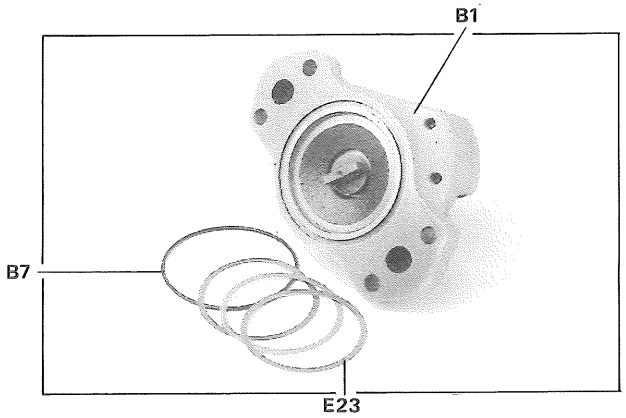


Fig. 16 Servicing and repairs - oil pump

If the oil pump is in any way damaged the complete pump assembly (B1) must be replaced.

Note: 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 end of the oil suction pump which feeds the pump and is situated in the sump. It may be removed for inspection or cleaning, as follows:

1. Remove the drain plug and washer in the bottom of the gearbox, and remove the strainer.

2. Wash the strainer in paraffin or other suitable fluid to remove any debris which may have become attached to it.

3. Ensure that the baffle is correctly located, then refit the strainer.

4. Refit the drain plug and washer in the bottom of the gearcase.

9.4 Removing the gearbox 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 oil from the gearbox into a suitable container and disconnect the cooler pipes.

3. Undo and withdraw the bolts which connect the gearbox output flange to the flexible coupling or mating half coupling on the propeller shaft.

4. To provide support whilst the gearbox is being removed from the engine, either thread a rope through the eyebolt provided or place a jack under the gearcase.

5. Remove the bolts securing the adaptor flange to the flywheel housing.

6. Withdraw the gearbox, if necessary rocking it slightly to disengage the input shaft spline from the internal spline in the coupling, which remains mounted to the flywheel.

9.5 Removing the input shaft and layshaft assemblies

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

2. Undo the 4 bolts securing the oil pump to the gearcase and withdraw the oil pump, shims and 'O' rings, noting the position of the pump for refitting **(note: keep the pump shims with the pump assembly)**.

3. Remove the 3 bolts securing the input shaft end cover and remove **(note: keep the shims and 'O' rings with the end cover)**.

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

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

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

7. Lift the input shaft assembly, front seal housing and thrust washer from the gearcase.

9.6 Servicing input shaft and layshaft assembly components

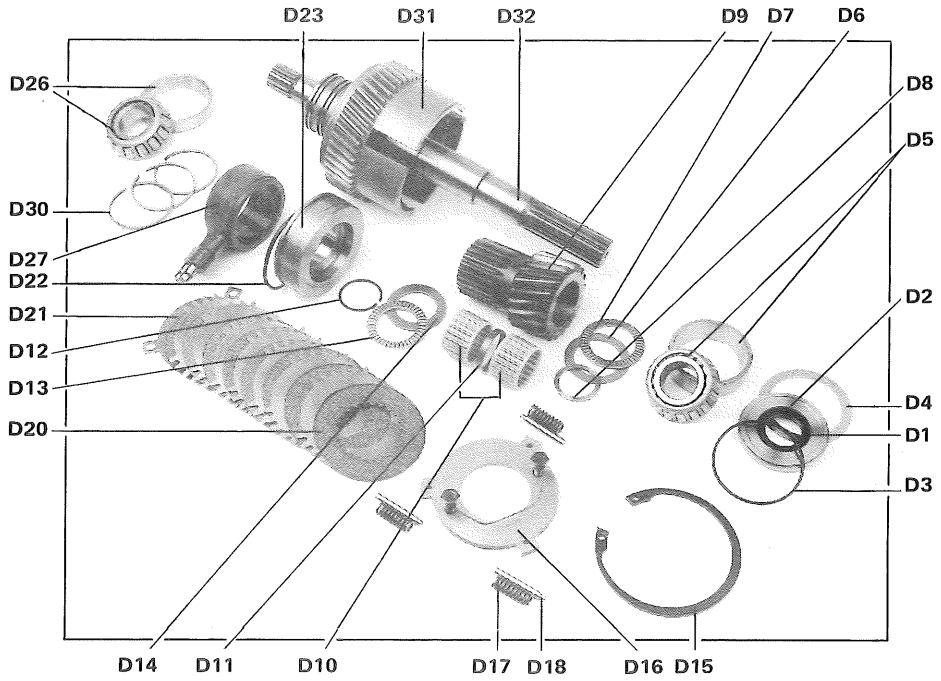


Fig. 17 Servicing and repairs - input shaft and layshaft

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 (D2) from the shaft and press the seal (D1) from the housing.

Taking care not to damage it, fit a new seal (D1) in the housing and refit the housing.

9.6.2 Drive end bearing

To renew a damaged or worn bearing:-

1. Support the shaft in a vice, and remove the input seal housing (D1) and thrust washer (D4) (this applies to the input shaft only).

2. Using a pulley extractor with its jaws located behind the pinion (D9), withdraw the clutch pinion, thrust washer (D6), thrust bearing (D7), and end bearing (D5).

3. Refit the clutch pinion to the shaft.

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

5. Locate the new bearing (D5) on the shaft and, using either a hand press or a hardwood drift and hammer, gently drive the assembly into position. **Take care not to damage the bearing rollers or raceways during this operation.**

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

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

9.6.3 Clutch assembly

Clutch plates which are discoloured by overheating, or worn down so much that they have lost their grooving patterns, will tend to slip. If either of these conditions occurs, the clutch assembly will have to be replaced as follows:

1. Remove the drive pinion and bearing as previously described.

2. Remove the spacer (D8), needle roller bearing (D10), spacer (D11), and needle roller bearing (D10).

3. Remove the large circlip (D15).

4. Withdraw the complete clutch assembly from the shaft, noting the position of the pull-off springs (D17) and assembly pins (D18).

5. Remove the small snap ring (D12), thrust bearing (D13) and thrust washer (D14); inspect for wear or damage and replace them if necessary.

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

6. Position the shaft upright and locate the 3 assembly pins into the clutch gear.

7. Replace the thrust washer, thrust bearing and the small snap ring.

8. Fit the clutch end plate (D21) into the clutch gear and replace the pull-off springs over the assembly pins. Then, starting with one of the driver clutch plates (D20), build up the replacement clutch on to the clutch end plate.

9. Replace the clutch end cover (D16) on to the clutch pack, locating the 3 pins and ensuring that one of the tapped holes in the clutch end plate aligns with the dimple on the body of the clutch gear.

10. Replace the large circlip (D15).

11. Reposition the drive pinion into the clutch pack so that it touches the bottom washer.

12. Replace the needle roller bearing (D10), spacer (D11), needle roller bearing (D10) and spacer (D8).

13. Replace the thrust bearing (D7), thrust washer (D6) and bearing inner cone (D5) on the shaft and gently drive the bearing into position.

9.6.4 Clutch gear

It is recommended that the clutch gear (D31) is not separated from the shaft (D32) unless either is damaged; if it is necessary to split them, this can only be accomplished by means of a power press, as follows:-

1. Position the shaft assembly so that the front face of the clutch gear is supported face downwards on a plate, and press the shaft out through a suitable hole in the plate.

2. The clutch gear, piston (D23), feeder (D27) and rear end bearing (D26) will now be free for inspection and replacement if necessary.

To reassemble:

3. Fit new "O" rings (D22, D24) and insert the piston into the clutch gear.

4. Fit new piston rings (D30) to the feeder (for piston rings and feeder removal refer to section 9.6.7). Refit the clutch gear to the feeder, and replace the assembly on to the shaft. Ensure that the spline on the shaft has engaged with the clutch gear.

5. Place the rear end bearing on to the shaft and gently drive the bearing into position.

6. Replace the clutch as described in 9.6.3.

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

9.6.5 Drive pinion

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

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

9.6.6 Rear end bearing, piston rings and feeder

1. Place the shaft assembly in a vice so that the front face of the clutch gear is face down and, using pulley extractors with their jaws located underneath the feeder, pull off the rear end bearing (D26) together with the feeder (D27). This provides access to the piston rings and feeder.

2. Using a special piston ring extractor, remove the piston rings (D30) from the shaft. If you do not have an extractor, you can use a thin piece of steel as follows:-

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

Any piston rings which are worn or damaged will have to be replaced, as follows:-

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

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

6. Compress each ring in turn and carefully fit the feeder.

7. Position the rear end bearing onto the shaft and drive it carefully into place.

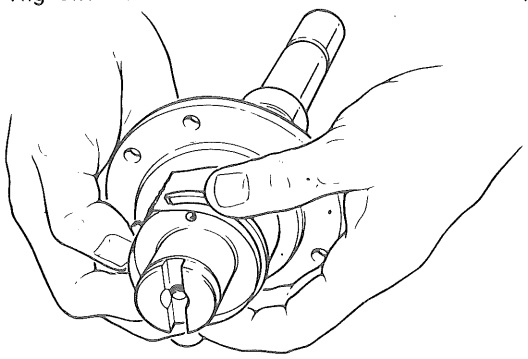


Fig. 18 Piston ring fitting procedure

9.7 Replacement of input shaft and layshaft assemblies

1. Having fitted a new O' ring (D3) and oil seal (D1), position the input shaft assembly in the gearcase, ensuring that the thrust washer (D4) is correctly located in the groove in the lower half of the gearcase, and that the seal housing (D2) is correctly positioned.

2. Position the layshaft in the gearcase, fit a new "O" ring (E1) into the end cover (E2) and carefully position the end cover in the groove in the lower half of the gearcase.

3. Fit two new "O" rings (E27) to each feeder connector, then coat the mating surfaces of the two case halves with a jointing compound. Pass a length of wire through the holes in the top half of the gearcase into the feeder connectors to ensure that they are correctly located, and fit the top half of the gearcase to the lower.

4. Replace the two front gearcase bolts and ensure the gearcase halves are square.

5. Replace the remaining gearcase bolts and tighten them to the correct torque.

6. Replace the 'O' ring (A21) in the input shaft end cover (A10), shim, and refit.

7. Replace the three oil pump 'O' rings (B6, B7), then shim and refit the oil pump ensuring that it is fitted in the correct position for the hand of engine rotation required.

8. Using a new gasket (C17), refit the valve block.

9. Carefully ensuring correct alignment (section 5.4), refit the adaptor plate to the gearbox, tightening the bolts to the correct torque (section 13).

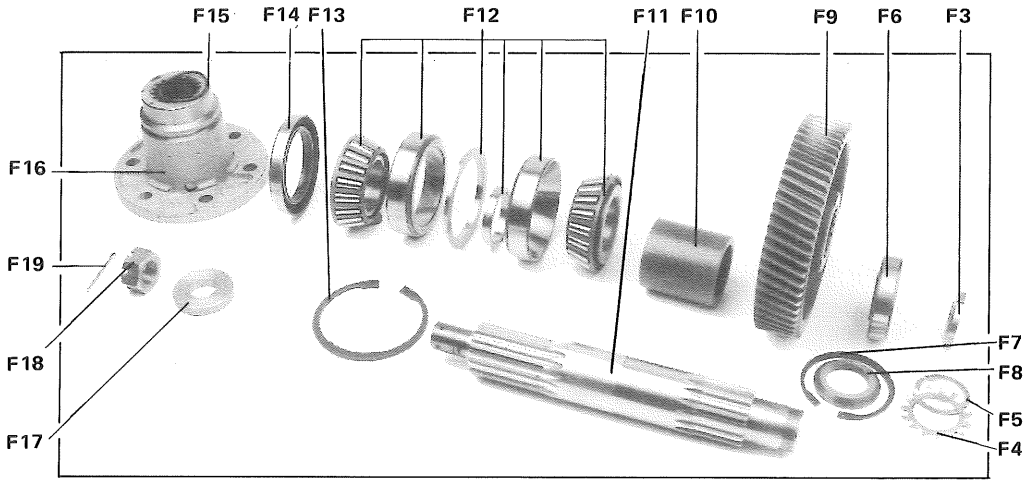
10. Offer up the gearbox and the adaptor plate to the engine, locating the input shaft in the centre of the coupling, and secure.

11. Reconnect the oil cooler pipes and control cables.

Note: Shimming procedures are described in section 9.10

9.8 Servicing the output shaft assembly

Fig. 19 Servicing and repairs - output shaft



To remove the output shaft, first take the gearbox out of the boat (see section 9.4), then proceed as follows:-

1. Remove the input shaft and layshaft assemblies (see section 9.5).

2. Extract the split pin (F19) and slacken the nut (F18) at the output coupling (F16), and remove the coupling, washer (F17) and 'O' ring (F15).

3. Remove the output shaft end cover (F1), release the tab washer (F4), slacken and remove the nut (F3), tab washer and tongue washer (F5).

4. To remove the shaft from the gearbox, drive or press on the front end, allowing the rear end bearings (F12) and oil seal (F14) to be removed and leaving the front and centre components behind.

5. Inspect all bearings and oil seals, and replace if worn or damaged.

6. If either of the thrust bearings (F12) is worn, remove both outer races, the spacer and the circlip (F13) from the gearcase.

Note: The main thrust bearing assembly (F12) is supplied as a pre-adjusted unit, and if either bearing is worn or damaged, the complete assembly MUST be replaced.

7. If either of the bearings is worn, the output gear (F9) and mating pinions should also be inspected and replaced if worn or damaged.

9.9 Re-assembling the output shaft assembly

1. Position the gearcase on the bench front face down, then place the output gear into position and fit the inner thrust bearing, supporting it in position with the large spacer (F10).

2. Place the distance piece on top of the inner bearing and relocate the outer thrust bearing.

3. Feed the output shaft through the bearing assembly, spacer and output gear.

3. Feed the spacer (F8), front end bearing (F6), tongue washer (F5), tab washer (F4) and lock nut (F3) on to the shaft.

4. Tighten the nut (F3) to 339 Nm (250 lbf ft), bend over the tab washer (F4) and fit the end cover (F1) and the 'O' ring (F2).

5. Fit a new rear oil seal (F14), and replace 'O' ring (F15), coupling (F16), and washer (F17).

6. Tighten the rear end nut (F18) to 339 Nm (250 lbf.ft) and refit the split pin.

Note: 4:1 ratio only - when refitting the shaft assembly into the gearbox, make sure that the match markings on the shaft (F11) and output gear (F9) are aligned.

9.10 Shimming procedures

The allowable end float on the taper bearing is 0.03 - 0.08mm (0.001 - 0.003in) clearance: this should be checked with the aid of a depth micrometer as follows:

1. Press the bearing outer cup firmly into position and measure between the face of the gearcase and the top of the bearing outer as shown in Fig. 20.

2. Measure the depth of the recess in the oil pump and in the input shaft end cover, as shown in Fig 21. 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, fit sufficient shims to cause it to stand proud when re-installed, and re-fit it to the gearcase.

2. Rotate the shaft, slowly tightening the securing bolts until the shaft starts to bind. Note: use feeler gauges or shims around the pump or end cover to ensure that the gap is uniform and that they are positioned squarely on the rear face of the gearcase.

3. Use feeler gauges or shims to measure the gap, as shown in Fig 22, and add 0.05mm (0.002 in) to this measurement.

4. Remove shims to the value of (3), re-fit and tighten the oil pump or end cover, and rotate the shaft to check that it moves freely.

5. 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).

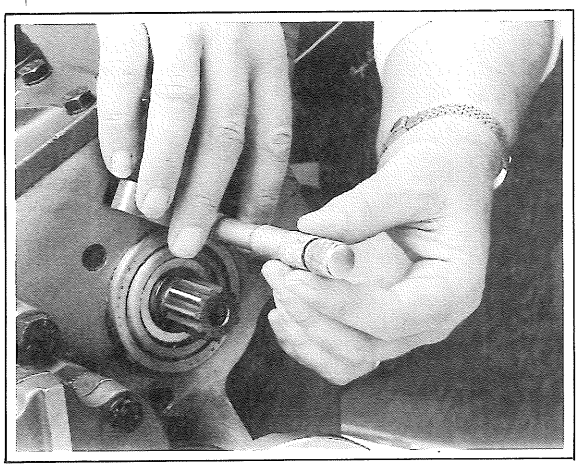


Fig. 20

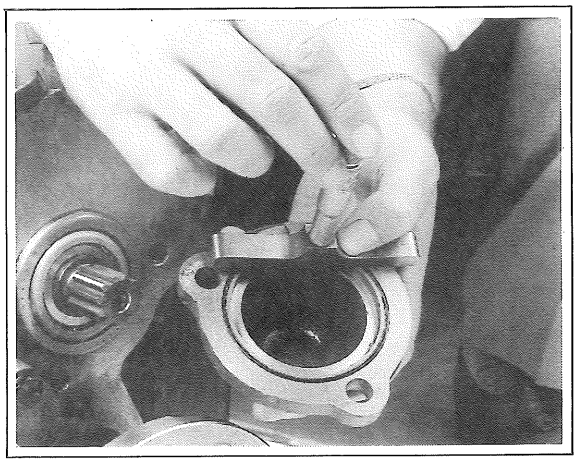


Fig. 21

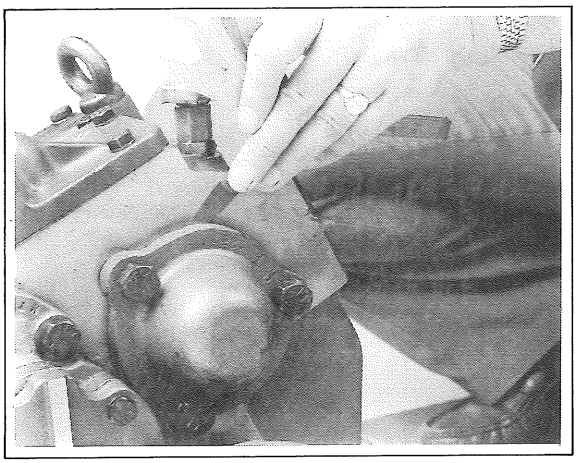


Fig. 22

10. POWER TAKE-OFF UNIT

10.1 Fitting a PTO to an existing gearbox

1. Taking care not to lose the shims (D25), remove the end cover (A10) from the rear face of the gearbox, and replace the shims against the bearing outer race, using grease if required.

2. Fit the spacer (H5) and drive gear (H4) on to the splined shaft which protrudes from the rear of the gearbox.

3. Fit the spacer (H7) into the recess in the gear, and the locking tab (H8) into the hole in the face of the gear.

4. Tighten the screw (H9) to 101.5 Nm (75 lbf.ft) and bend up the lock tab.

5. Remove cover plate (H16) from PTO housing.

6. Pass the PTO unit over the gear (H4) and push it up to the rear face of the gearbox. **Ensure that the shims do not drop down but locate in the PTO housing recess, and that the 'O' ring remains in the PTO housing groove and does not become trapped.**

7. Tighten the bolt (H11) into the rear face of the gearbox to 101.5 Nm (75 lbf.ft).

8. Replace cover plate (H16).

9. Fit the oil pipe assembly (H23) between the 'T' piece on the PTO housing and the connector on the valve block as shown in fig. 9.

10. **In accordance with the manufacturer's instructions,** fit the hydraulic pump to the PTO.

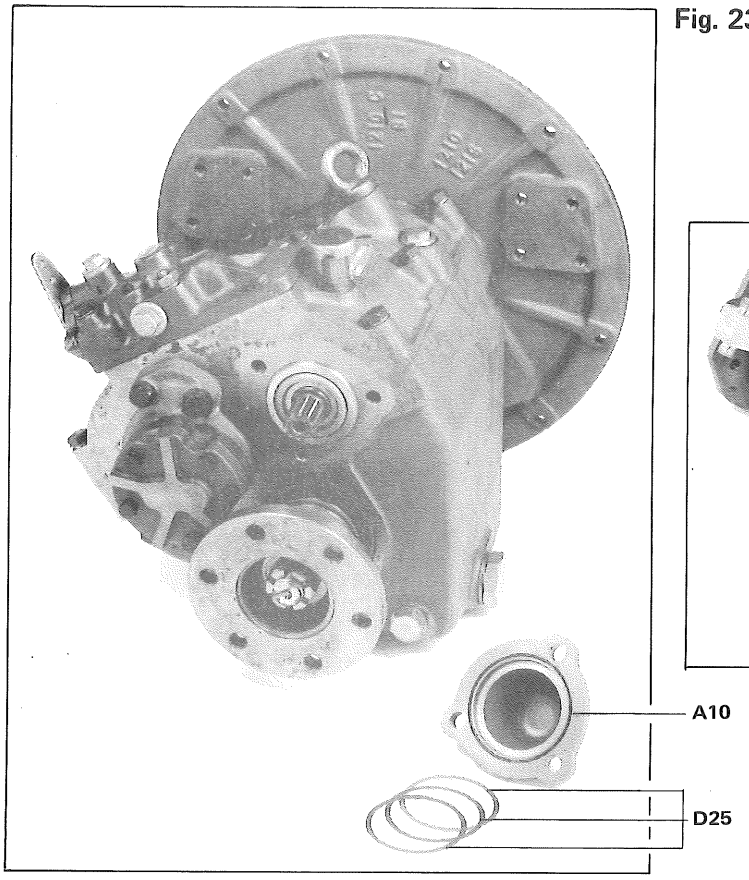


Fig. 23

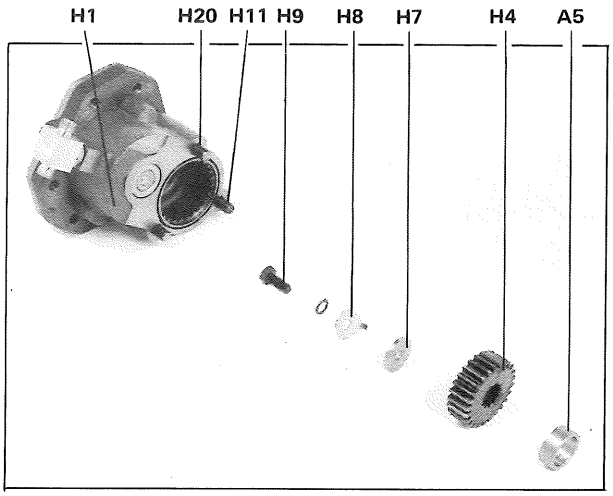


Fig. 24

10.2 Repairing the power take-off

1. To remove the PTO from the gearbox the procedure is the reverse of that described in section 10.1 above.

2. The output gear assembly (H2) can be removed without removing the PTO from the gearbox, as follows:-
   Remove the hydraulic pump from the PTO and slacken the screws H19/H20.
   Pull out the housing (H13) and the gear; the bearing assembly will remain with the housing).

3. To remove the output gear, (H2) remove the circlip (H21) and tap the gear on the end face to remove it from the bearing (H12).

4. The bearing (H12) can be removed by removing the circlip (H15) and pressing or drifting out the bearing.

5. If the needle bearing (H3) is worn or damaged, it is best replaced whilst the PTO is removed from the gearcase.

6. If the drive gear (H4) is removed from the gearbox shaft, then the tab washer (H8) MUST be replaced.

7. Re-assembly procedure is the reverse of that described in sections 10.1 and 10.2 above.

11. 8° DOWN-ANGLE DRIVE UNIT (MT0210)

11.1 Retrofitting to an existing PRM402

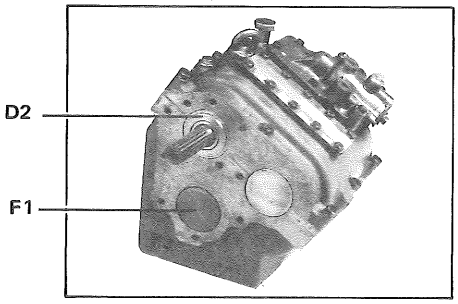


Fig. 25

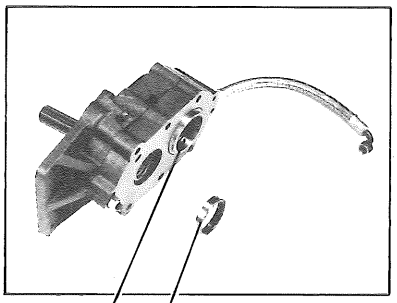


Fig. 26

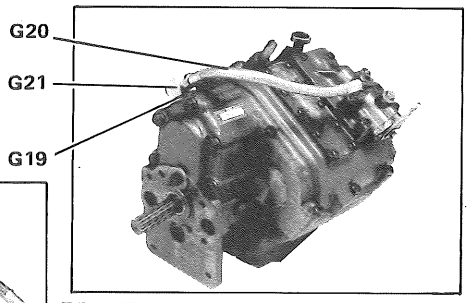


Fig. 27

1. Drain all oil from the gearbox, remove it from the engine, and take off the adaptor plate as previously described.

2. Remove and discard the output shaft front cover (F1) and the input shaft seal housing (D2) from the main gearbox.

3. Remove and discard the transit washer, screw and nut retaining the angle drive rear spacers.

4. Fit the spacer (G11) supplied with the angle drive unit in the location formerly occupied by the front cover (F1).

5. Locate the other spacer (G8) supplied with the angle drive in the front bore of the main gearbox (i.e. in place of the input shaft seal housing D2.)

6. Taking care not to damage or lose the shims or 'O' rings, remove the oil pump from the gearbox, rotate it through 180° and bolt it back in position, ensuring that the 'O' rings are correctly located in the grooves and that the shims are properly seated in the pump recess.

7. Position the gasket (G9) on the front face of the main gearbox and offer the angle drive up to the gearbox. Insert the gearbox shaft into the splined gear and fit the bolts (G10/G12), tightening them to 101.5 Nm (75 lbf.ft) torque.

8. Screw the metering union (G19) into the top of the angle drive, fit the 'T' piece (G21) and connect the oil pipe (G20).

9. Connect the other end of the oil pipe to the low pressure fitting on the valve block.

10. Fit a new dipstick to the main gearbox, fill it with a reccomended oil, and check the level.

11. The adaptor plate can now be fitted to the front face of the angle drive. Tighten the bolts to 101.5 Nm (75 lbf.ft).

12. The complete gearbox/angle drive assembly may now be mounted on the engine as described in section 5.4.

Note: fitting an angle drive causes the gearbox output rotation to be reversed relative to the movement of the operating lever (see section 4).

11.2 Replacement of angle drive gears and bearings

1. Remove the unit from the main gearbox; the procedure is the reverse of that described in section 11.1 above.

2. Remove the bolt (G3) and insert withdrawal screws to split the 2 halves of the gearcase.

3. Remove the input seal housing (G17) and shims, and the spacer (G8) and shims at the rear face of the output gear.

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

4. All bearings and gears may now be inspected; if any one bearing is damaged or worn, it is recommended that all four be replaced, and the gears should also be inspected. If either gear has to be replaced, you should replace both.

5. The bearing outer races are easily removed from the housing, but a puller will be required to remove the inner races from the gears.

11.3. Re-assembling the angle drive

1. Press the bearing inner races to the gears and push the outer races into the halves of the housing.

2. Locate the input gear in the rear half and the output gear in the front half of the gearcase.

3. Coat the mating faces with "jointing" compound and bring the two halves together, ensuring that the dowels (G6) are correctly located.

4. Tighten the bolts (G3 and G12) to a torque of 101.5 Nm (75 lbf.ft).

11.4. Shimming the angle drive input shaft bearings

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

1. Push in the seal housing (G17) against the bearing outer race.

2. Seat the bearings by applying hand pressure to the spacer or placing a weight of approximately 5 Kg on top of the spacer and turning the shaft.

3. Using a depth micrometer or a vernier gauge, measure the step between the gearcase face and the lower face of the housing..

4. Lift out the housing and place shims to the value found in (3) under it.

5. Fit the seal and 'O' ring to the housing and replace.

11.5. Shimming the angle drive output shaft bearings

1. As with the input shaft, apply hand pressure or a weight to the spacer (G8) which is already located in the output bore.

2. Rotate the shaft to seat the bearings and, using a depth micrometer or vernier gauge as before, measure the gap between the face of the gearcase and the face of the spacer which is just below it.

3. Lift out the spacer, insert shims to the value measured in (2) above, and replace.

The procedure for refitting the angle drive to the main gearbox is as described in section 11.1.

12. IN-LINE GEARBOXES

Unlike the angle drive unit, the in-line unit is a factory-fitted item and **CANNOT** be retro-fitted. Servicing and repair of the main gearbox is identical to servicing a standard drop-centre gearbox. Servicing the in-line unit is as follows:

12.1 Removing the in-line unit

1. Drain all oil from the gearbox and remove it from the engine as described in section 9.3.

2. Disconnect the oil pipes connecting the in-line unit to both the cooler and the main gearbox.

3. Remove the bolts (K21 - 3 off), (K23 - 2 off) and (K24 - 2 off), and split the unit into two halves.

4. The two gears (K7 and K14) can now be removed from the rear half.

5. To detach the rear case half from the main gearcase, remove the cap screw (K15) and four bolts (K17). **Take care not to misplace the spacer and shims from either shaft.**

12.2 Removal of in-line unit components

1. Once the in-line unit has been taken apart as described above, all bearings and gears are free for inspection for damage or wear. If one gear requires replacing, it is advisable to replace both.

2. The bearing outer races can be easily removed from the housing, but a puller or press will be required to remove the inner races from the gears.

12.3 Shimming the in-line unit

Before the in-line unit can be reassembled and refitted to the main gearbox, it is essential that the two shafts be shimmed. The procedure is as follows:

1. Push the bearing outer races into the in-line case halves and fit the bearing inner races on to the gears and shafts.

2. Fit the two case halves together and secure with bolts (K21 and K24).

3. Using a depth micrometer measure the depth from the front face of the main gearcase to the thrust washer on the input shaft.

4. Ensuring that the outer races of the two rear bearings are correctly located in the rear half of the in-line case, measure the distance from the bearing to that rear face.

5. Subtract the value of (4) from (3); the result is the thickness of shims required. Shimming tolerance is 0.00 to 0.002" (0.00 to 0.05mm).

6. To shim the main gearbox output shaft, place the spacer (K12) in the output shaft bore of the main gearcase and, using a depth micrometer, measure the distance from the front face of the main gearcase to the face of the spacer.

7. With the lower rear bearing outer race correctly located in the rear case of the in-line unit, measure the step between the face of the rear case half and the outer race, seated in the bore.

8. The result of (6) plus (7) is the value of the shims required. Shimming tolerance is 0.00 to 0.002in (0.00 to 0.05mm).

12.4 In-line unit rebuild

Once the shimming process is completed, the in-line unit can be refitted to the main gearbox as follows:

1. Position shims to the correct thickness in both the input and the output shaft bore of the main gearcase.

2. Fit the spacer (K12) in the output shaft bore of the main gearcase.

3. Offer the rear half of the in-line unit, complete with outer bearing races, to the main gearcase and secure with bolts (K17) and cap screw (K15).

4. Refit the two gears (K7 and K14), together with the bearing inner races, into the rear half of the in-line unit.

5. The front case half and bearing cups can now be secured to the rear half using bolts K21, K23 and K24.

6. Taking care not to damage it, press the oil seal (K22) into the bore, .

7. Reconnect the oil pipes to the cooler and the main gearbox.

13. TIGHTENING TORQUES

	Nm	lbf.ft	Kgfm
Upper to lower gearcase bolts	56.0	41.5	5.7
Upper to lower gearcase studs	56.0	41.5	4.0
Upper to lower gearcase nuts	56.0	41.5	5.7
Valve block to upper gearcase	28.0	21.0	2.9
Operating lever to selector valve	28.0	20.6	2.9
End cover to valve block (Loctite)	9.5	7.0	0.9
Top cover to upper gearcase	28.0	21.0	2.9
Pump body to gearcase	56.0	41.5	5.7
Pump cover to pump body	28.0	21.0	2.9
End cover to gearcase	98.0	72.5	10.0
Oil seal housing to gearcase	56.0	41.5	5.7
Output bearing retaining bolts	11.7	8.6	1.2
Output coupling to output shaft	340.0	250.0	34.8
Adaptor plate to gearbox: bolts/nuts	98.0	72.5	10.0
: studs	68.6	50.6	7.0
Adaptor plate to angle drive: bolts/nuts	98.0	72.5	10.0
: studs	68.6	50.6	10.0
Power take-off to rear gearcase	98.0	72.5	10.0
In-line case halves	98.0	72.5	10.0
In-line unit to main gearbox	98.0	72.5	10.0
Angle drive case halves	98.0	72.5	10.0
Angle drive to front gearcase	98.0	72.5	10.0

SPARE PARTS ORDERING

When ordering spare parts the following should be quoted:

a) Gearbox model and serial number

b) Description(s) and part number(s) of the component(s) required

c) Quantity required

Orders and enquiries for spare parts should be addressed to:

NEWAGE TRANSMISSIONS LTD
BARLOW ROAD
COVENTRY CV2 2LD
ENGLAND

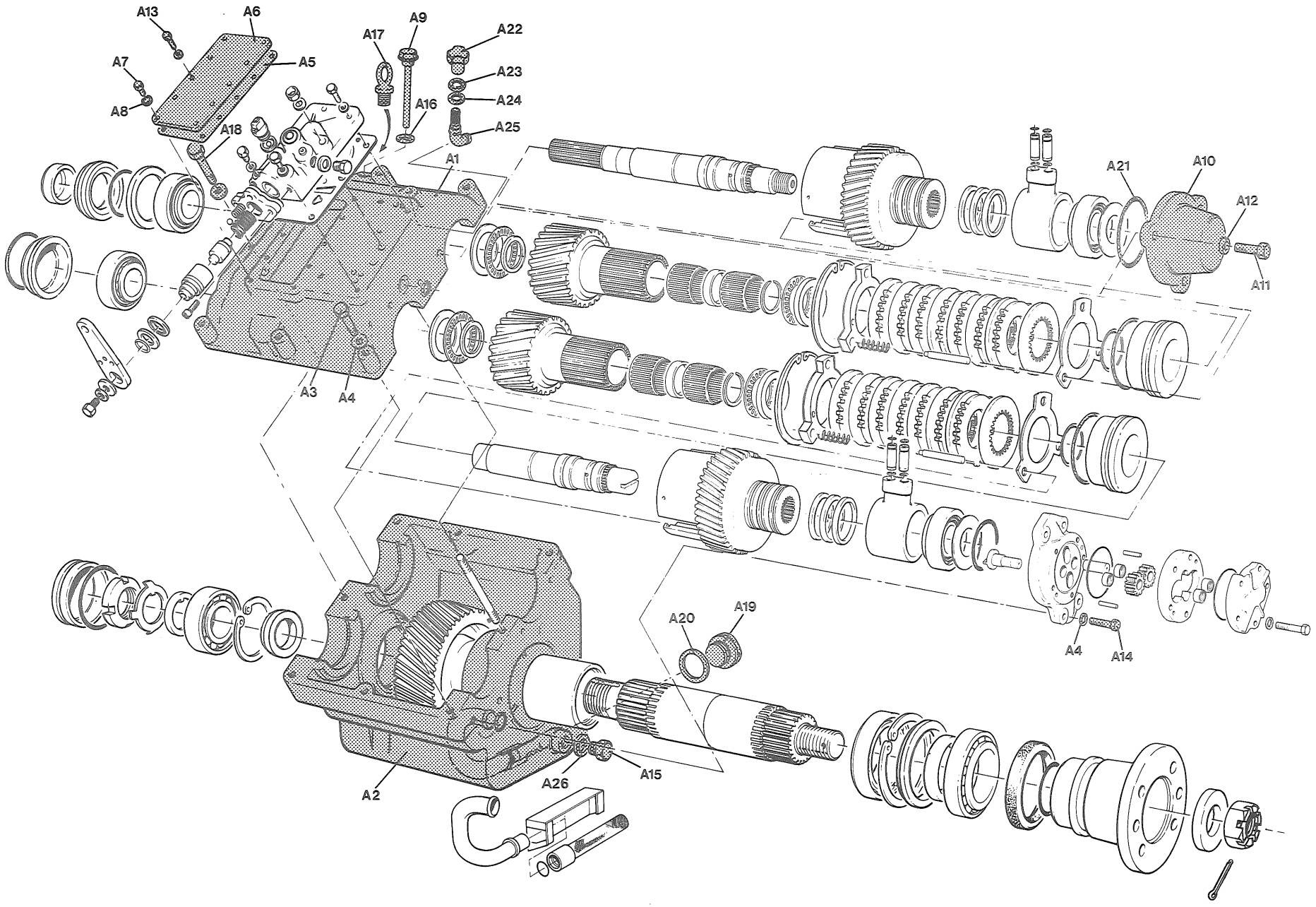
Tel: 0203 617141 Telex: 31333
Fax: 0203 611845

METRIC DIMENSIONS

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

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

SPARE PARTS LIST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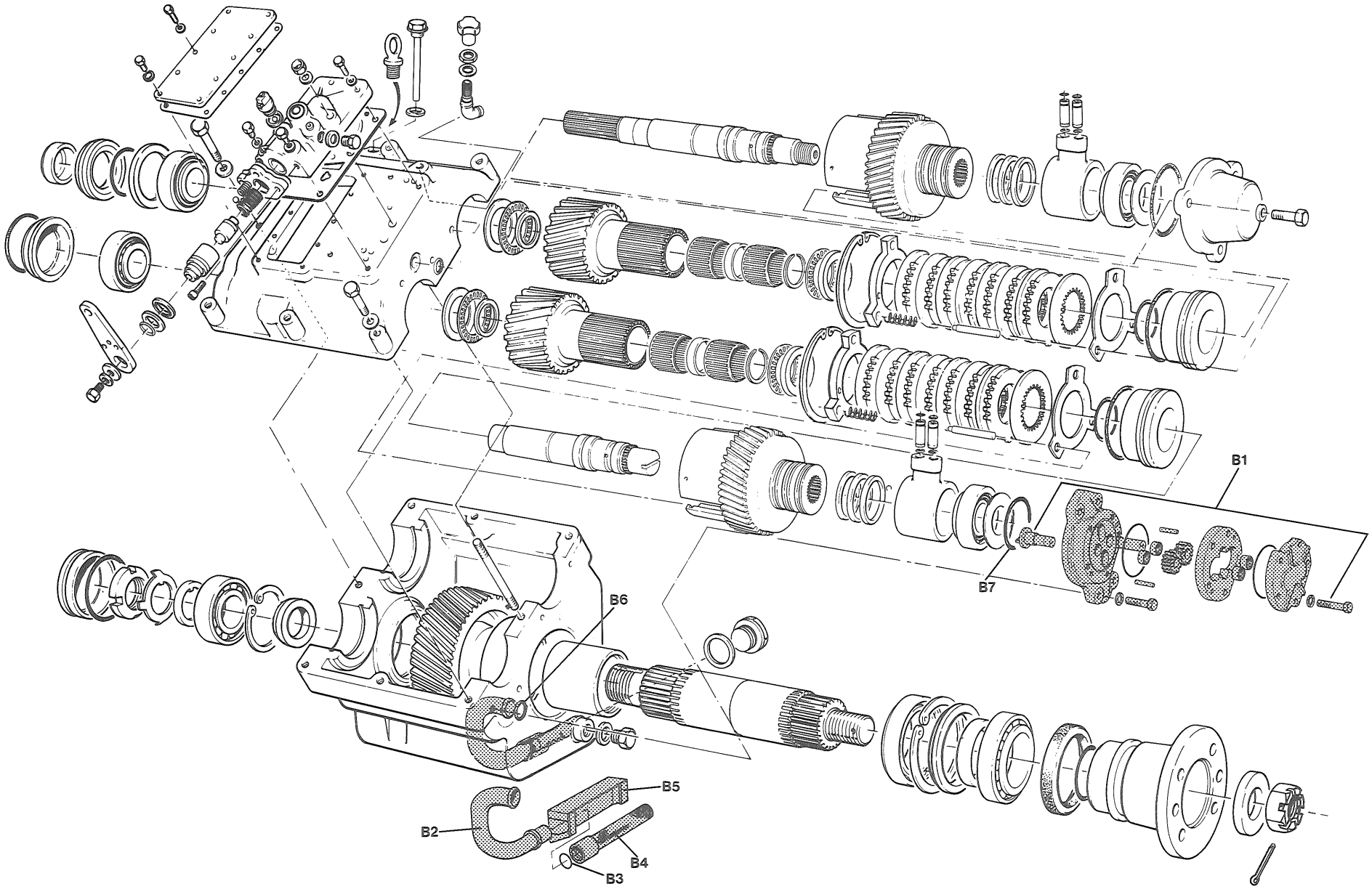
A2
A26
A15

PRM 402

Plate Ref.	Description	Part No.	Qty.	Remarks
A	**GEARCASE ASSEMBLY**			
A1 & A2	Case sub-assembly	MT0307	1	Supplied complete only
A3	Bolt	0041014	6	
A4	Washer	0191710	11	
A5	Gasket (top cover)	MT343	1	
A6	Top Cover	MT1467	1	
A7	Screw	0040804	10	
A8	Washer	CP1223	10	
A9	Dipstick	MT472	1	
A10	End cover	MT1267	1	
A11	Screw	0041208	3	
A12	Spring washer	0191107A	3	
A14	Bolt	0041010	4	
A15	Drain plug - magnetic	CP1331	1	
A16	Washer	CP1068	1	
A17	Eye bolt	CP1339	1	
A18	Bolt	0041019	1	
A19	Drain plug	0150100	1	
A20	Washer	0201720	1	
A21	'O' Ring	0430771	1	Supplied as part of seal kit
A22	Breather	CP1383	1	
A23	Locknut	CP1385	1	
A24	Washer	CP1204	1	
A25	Breather tube assembly	CP1382 S/A	1	
A26	Bonded washer	0201714	1	
4:1 Ratio only:-				
A1 & A2	Case sub-assembly	MT0312	1	Supplied complete only
A9	Dipstick	0800925	1	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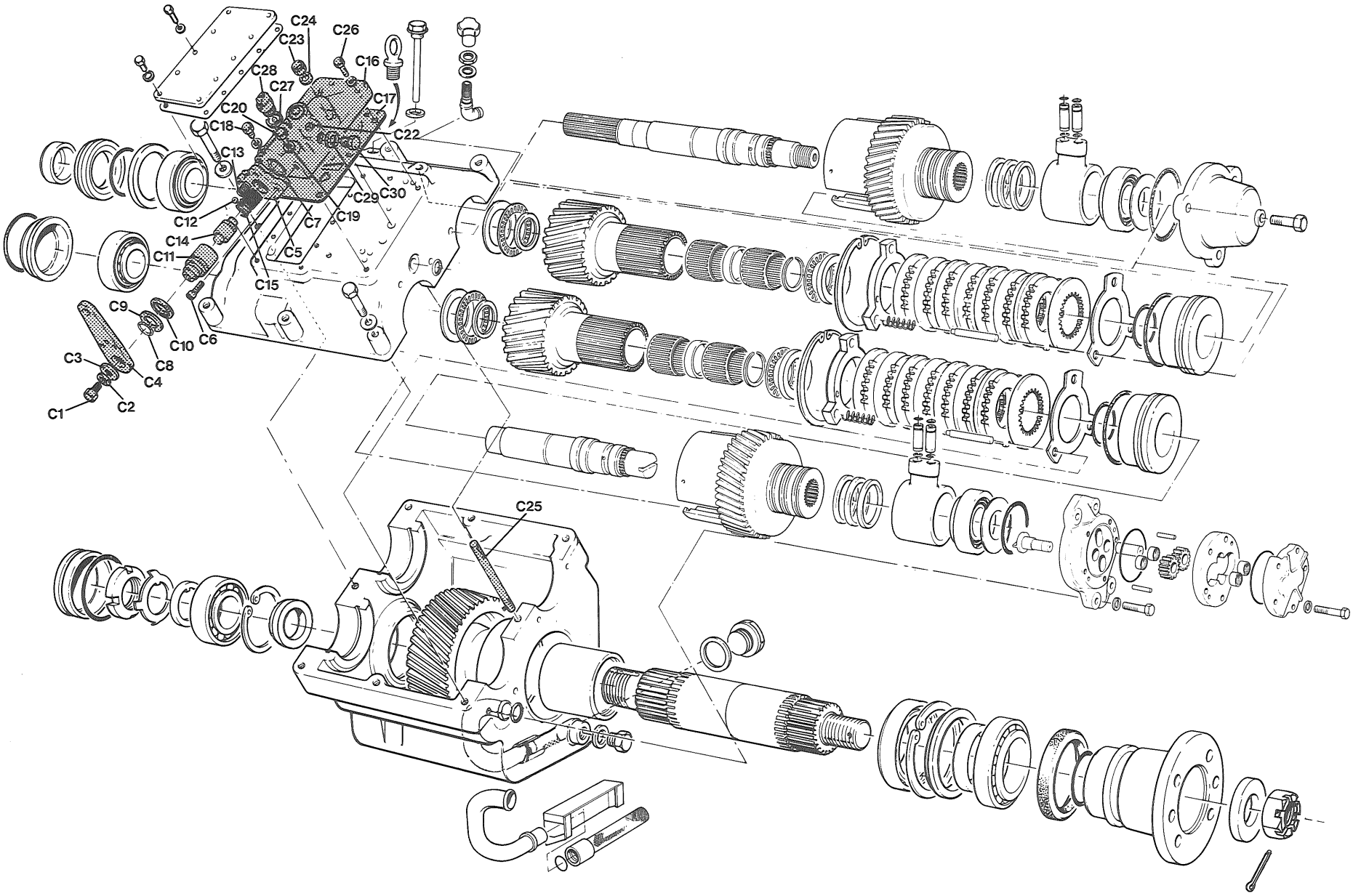
B5
B2
B4
B3

Plate Ref.	Description	Part No.	Qty.	Remarks
B	**OIL PUMP ASSEMBLY**			
B1	Oil pump assembly	MT0294	1	Supplied complete only
B2	Oil pipe	MT1265	1	
B3	'O' ring	000872	1	Supplied as part of seal kit.
B4	Strainer	MT4547	1	
B5	Baffle	MT1504	1	
B6	'O' ring	001254	2	Supplied as part of seal kit
B7	'O' ring	003383	1	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C14
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C5
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C9
C10
C6
C8
C3
C4
C1
C2
C25

Plate Ref.	Description	Part No.	Qty.	Remarks
C	**VALVE BLOCK ASSEMBLY**			
	1:1 and 1.5:1 ratios only	MT0348	1	
	2:1, 2.5:1, 3:1 and 4:1 ratios only	MT0319	1	
C1	Screw	0040806	1	
C2	Spring washer	0191105	1	
C3	Washer	MT979	1	
C4	Operating lever	MT977	1	
C5	End plate	MT978	1	
C6	Cap screw	0081220	2	
C7	Gasket	MT1081	1	
C8	O ring	000753	1	
C9	Thrust race	CP1308	1	
C10	Thrust bearing	CP1307	1	
C11	Control valve	MT4656	1	
C12	Detent ball	CP1077	1	
C13	Detent spring	MT305	1	
C14	Relief valve	MT4751	1	
C15	Valve spring	MT4752	1	
C16	Valve block	MT4753	1	
C17	Gasket	MT1073	1	
C18	Bolt	0040812	1	
C19	Washer	CP1223	5	
C20	Bolt	0040815	1	
C22	Pressure plug	MT311	1	
C23	Nut	0051001	1	
C24	Washer	0191710	1	
C25	Stud	MT1292	1	
C26	Screw	0040808	3	

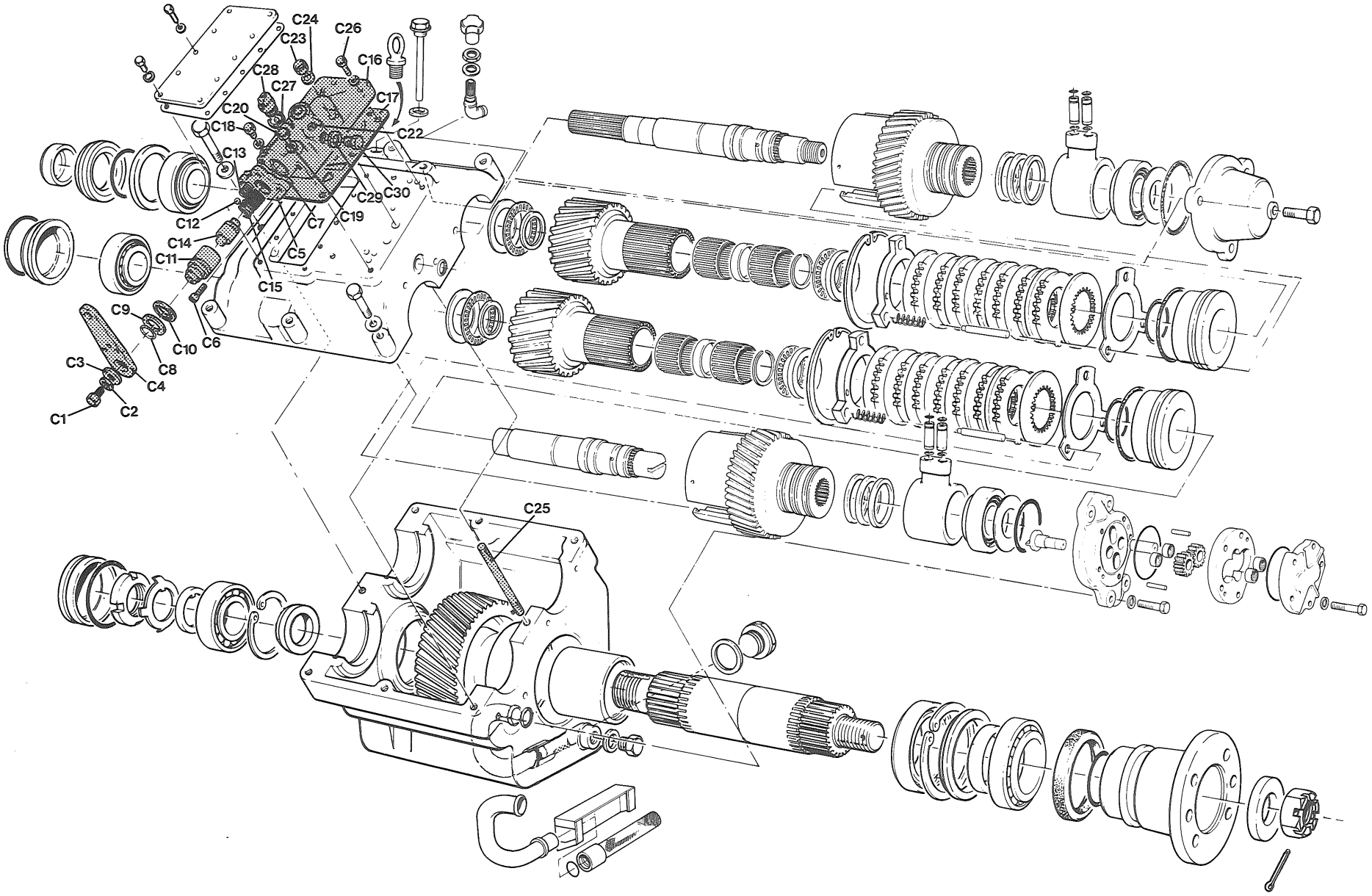
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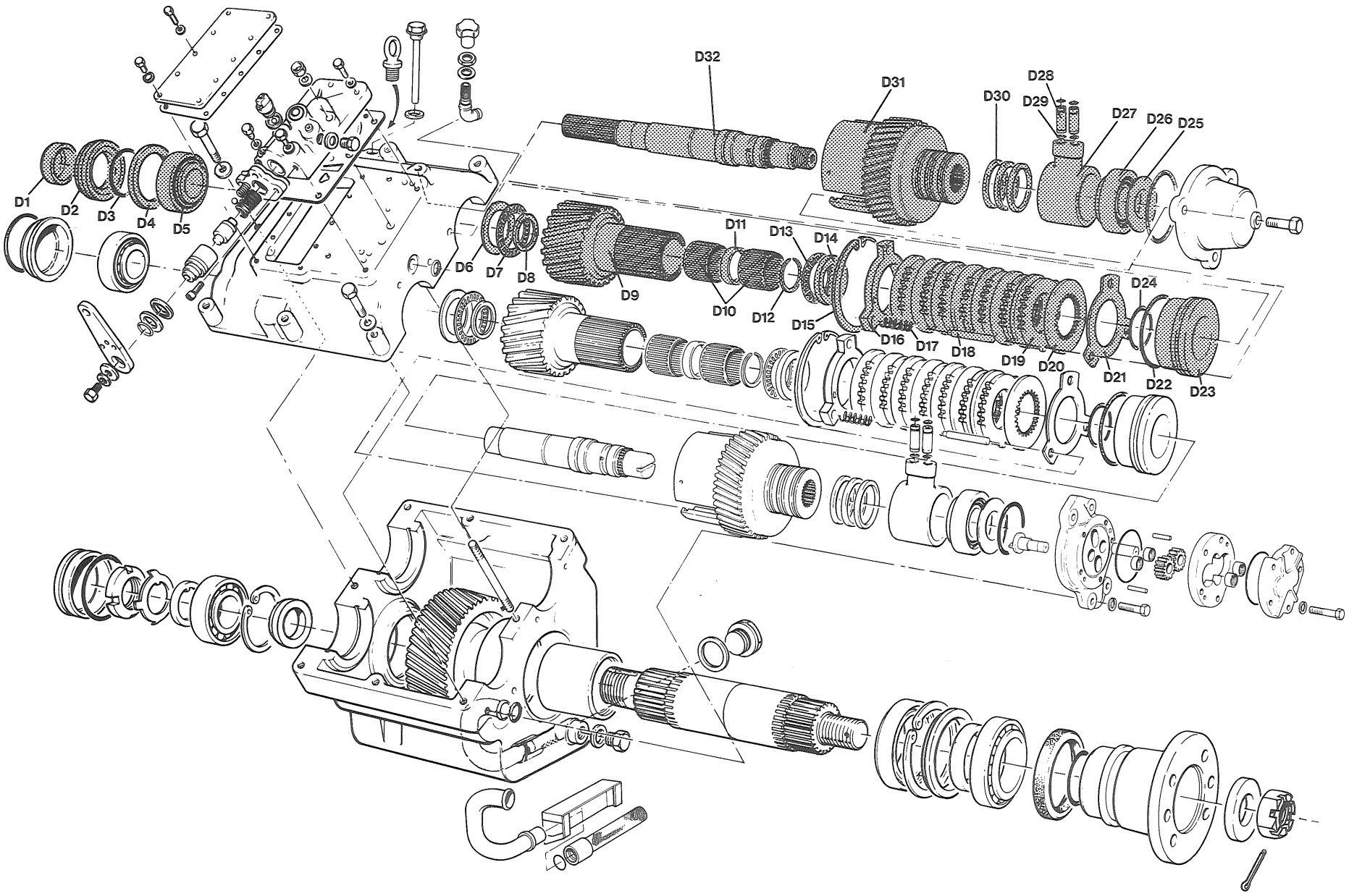
Plate Ref.	Description	Part No.	Qty.	Remarks
C27	Washer	0201715	1	Also used in MT0214
C28	Plug	CP1360	1	
	OR			
C28	Switch	CP1358	1	)Neutral Safety Switch
	Ball	CP1077	1	)Retro-fit Kit MT0214
C29	Washer	0191718	1	
C30	Plug (18mm oil pressure sender)	0150318	1	
1:1 and 1.5:1 ratios only				
C31	Spring	MT1559	1	(Not illustrated)
C32	Spring Guide	MT1557	1	(Not illustrated)
C15	Spring	MT4752	1	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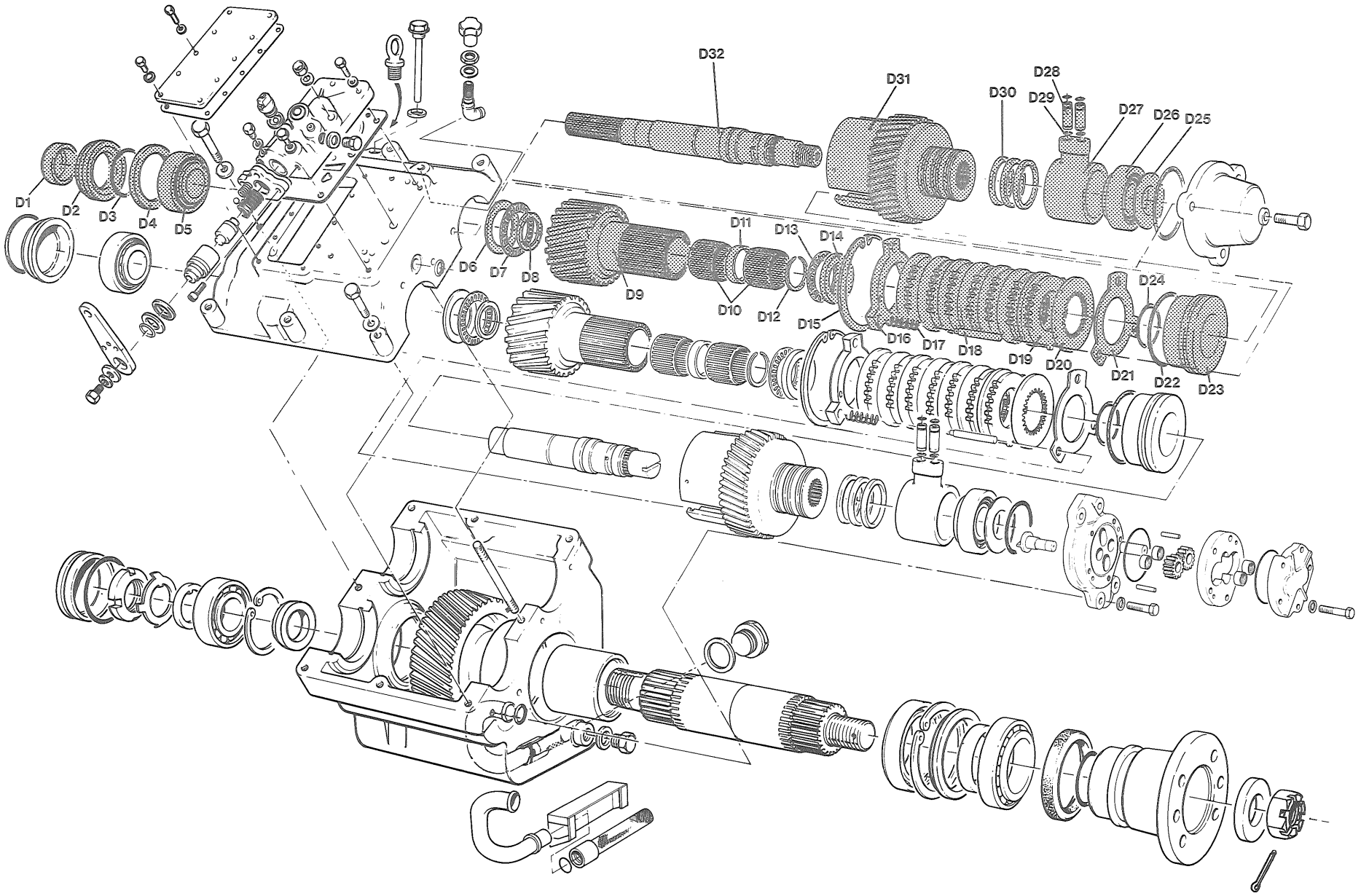
PRM402

Plate Ref.	Description	Part No.	Qty.	Remarks
D	**INPUT SHAFT ASSEMBLY**			
D1	Oil Seal	MT251	1	)Not used with PRM402A or
D2	Oil seal housing	MT1514	1	)PRM402C
D3	'O' ring	04306725	1	
D4	Thrust washer	MT1516	1	
D5	Bearing	055U044	1	
	Bearing cup	055C019	1	
D6	Thrust washer	0673801	1	
D7	Thrust bearing	0603801	1	
D8	Spacer	MT1471	1	
D9	Pinion	MT1582	1	1:1 43 teeth
		MT1583	1	1.5:1 37 teeth
		MT1475	1	2:1 31 teeth
		MT1476	1	2.5:1 23 teeth
		MT1477	1	3:1 21 teeth
		MT1477	1	4:1 21 teeth
D10	Needle roller bearing	0563501	2	
D11	Spacer	MT1472	1	
D12	Snap ring	0300350	1	
D13	Thrust bearing	0603501	1	
D14	Thrust washer	0673503	1	
	Clutch pack	**MT0349**	1	
D15	Circlip	0251020	1	
D16	Clutch end cover	MT1484S/A	1	
D17	Spring	MT1067	3	
D18	Assembly pins	MT1485	3	
D19	Clutch plate - driven	MT982	7	
D20	Clutch plate - driver	MT725/S	8	
D21	End plate	MT983	1	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PRM 402

Plate Ref.	Description	Part No.	Qty.	Remarks
D22	Piston 'O' ring	003504	1	Part of seal kit
D23	Piston	MT1264	1	
D24	Piston 'O' ring	0421503	1	Part of seal kit
D25	Shims		1	Order shim kit MT0068
D26	Bearing	0540302	1	
D27	Feeder	MT380	1	
D28	Feeder connectors	MT1057	2	
D29	Feeder '0' ring	000372	4	
D30	Piston rings	MT292	3	
D31	Clutch gear	MT1483	1	
D32	Input shaft	MT1482	1	
Special note	Input shaft (In-line Gearbox only)	MT1519	1	

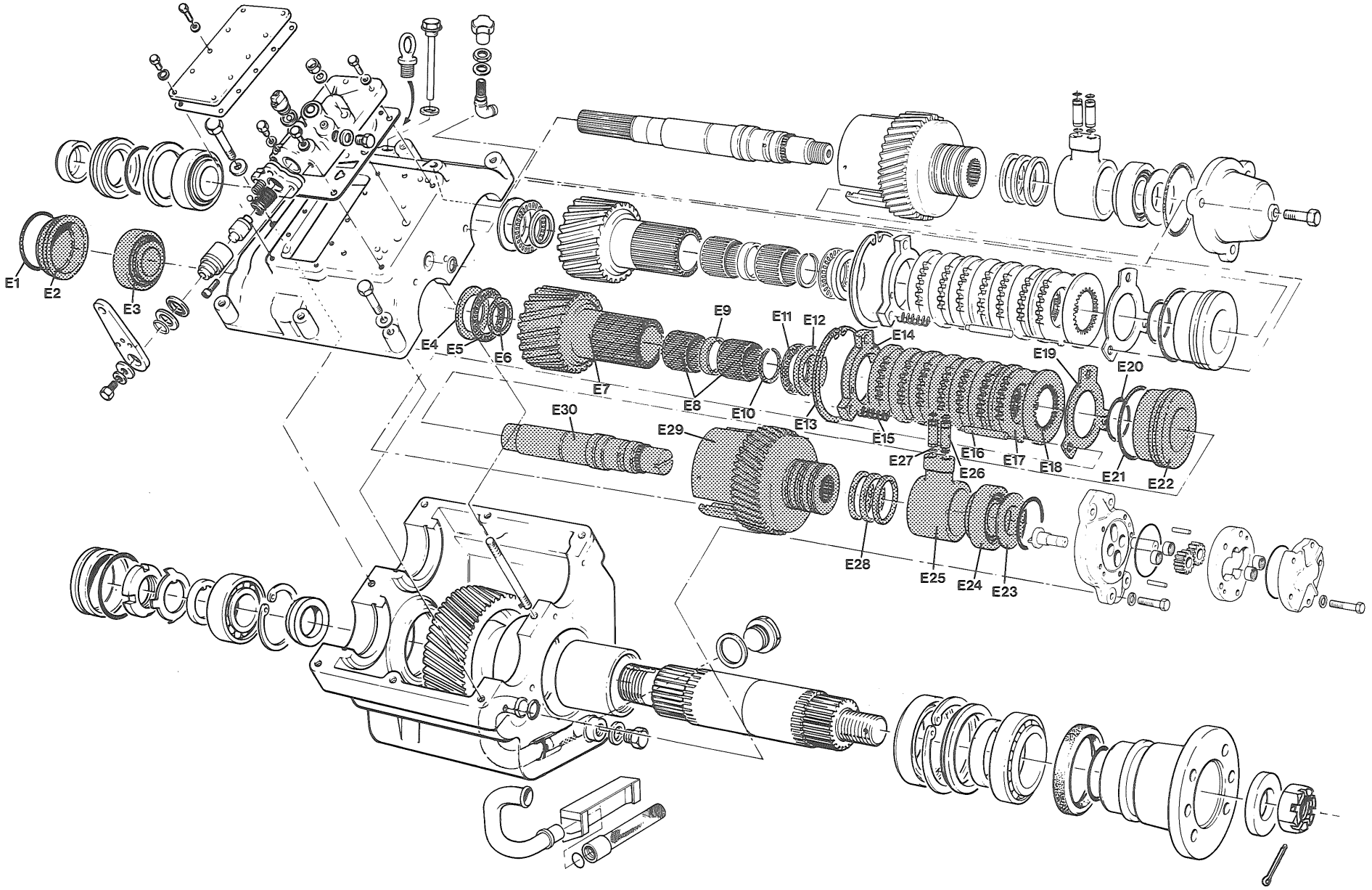
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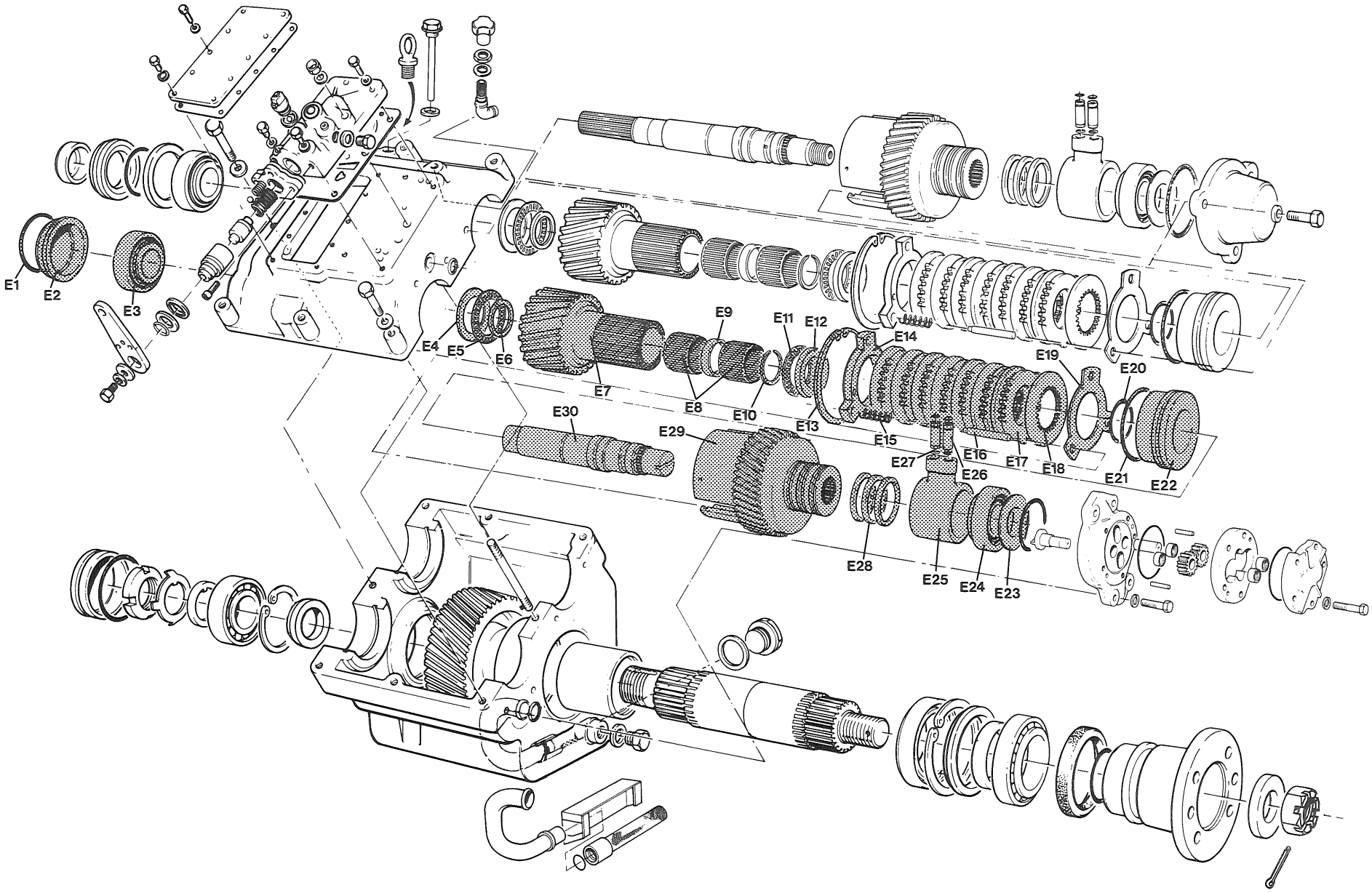
Plate Ref.	Description	Part No.	Qty.	Remarks
E	**LAYSHAFT ASSEMBLY**			
E1	'O' ring	04306725	1	
E2	End cover	MT1515	1	
E3	Bearing	055U044	1	
	Bearing cup	055C019	1	
E4	Thrust washer	0673801	1	
E5	Thrust bearing	0603801	1	
E6	Spacer	MT1471	1	
E7	Pinion	MT1582	1	1:1 43 teeth
		MT1583	1	1.5:1 37 teeth
		MT1475	1	2:1 31 teeth
		MT1476	1	2.5:1 23 teeth
		MT1477	1	3:1 21 teeth
		MT1477	1	4:1 21 teeth
E8	Needle roller bearing	0563501	2	
E9	Spacer	MT1472	1	
E10	Snap ring	0300350	1	
E11	Thrust bearing	0603501	1	
E12	Thrust washer	0673503	1	
	Clutch pack	**MT0349**	1	
E13	Circlip	0251020	1	
E14	Clutch end cover	MT1484S/A	1	
E15	Spring	MT1067	3	
E16	Assembly pins	MT1485	3	
E17	Clutch plate - driven	MT982	7	
E18	Clutch plate driver	MT725/S	8	
E19	End plate	MT983	1	
E20	Piston 'O' ring	0421503	1	Part of seal kit
E21	Piston 'O' ring	003504	1	Part of seal kit
E22	Piston	MT1264	1	
E23	Shims			Order shim kit MT0068
E24	Bearing	0540302	1	
E25	Feeder	MT380	1	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PRM 402

Plate Ref.	Description	Part No.	Qty.	Remarks
E26	Feeder connectors	MT1057	2	
E27	Feeder 'O' rings	000372	4	Part of seal kit
E28	Piston rings	MT292	3	
E29	Clutch gear	MT1501	4	
E30	Layshaft	MT1500	1	

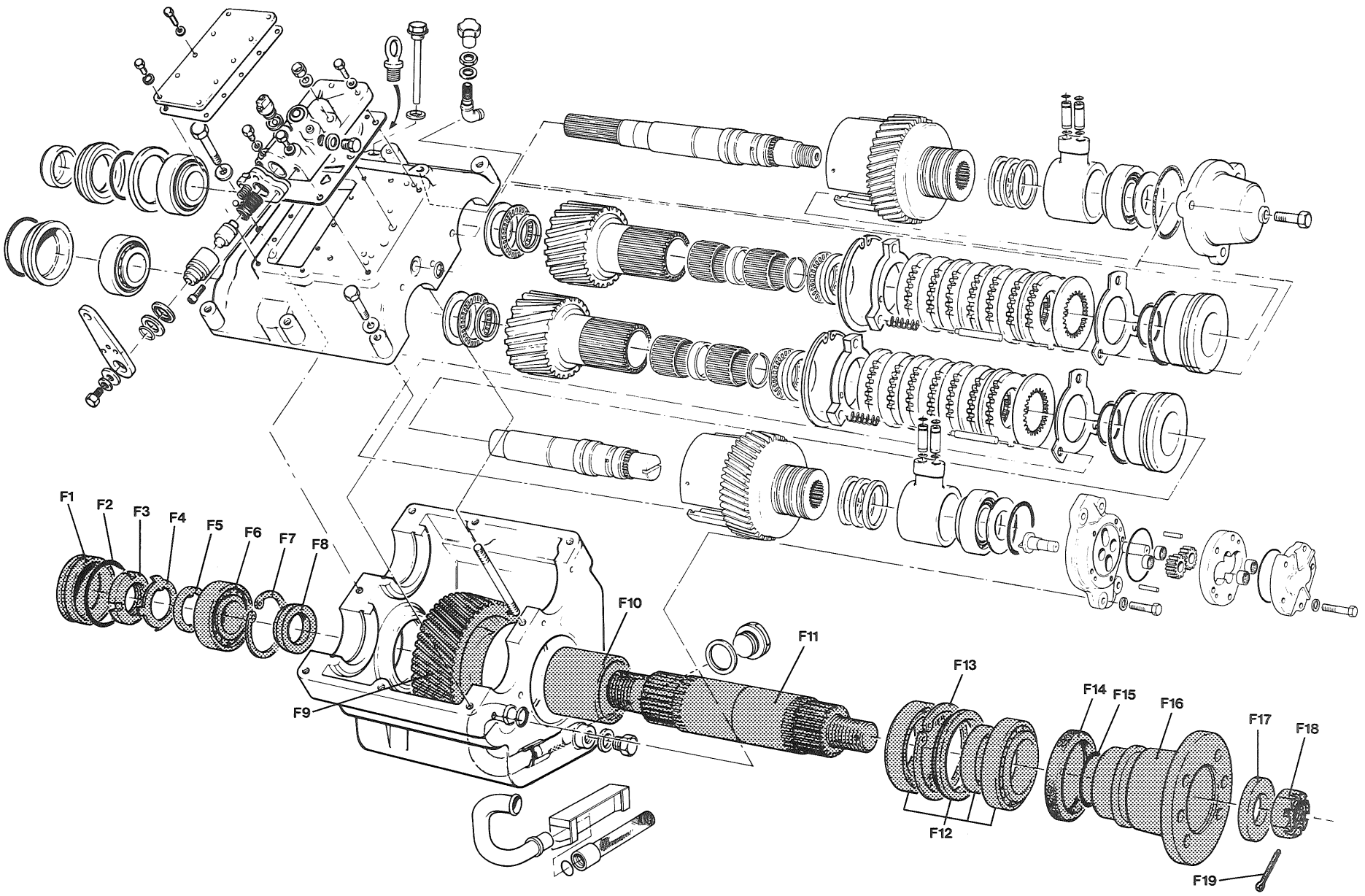
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Plate Ref.	Description	Part No.	Qty.	Remarks
F	**OUTPUT SHAFT ASSEMBLY**			
F1	End cover	MT1524	1	)Not used with PRM402A or
F2	'O' ring	04306725	1	)PRM402C
F3	Locknut	*CP1314	1	
F4	Tab washer	CP1315	1	
F5	Tongue washer	MT1331	1	
F6	Roller bearing	0533531	1	
F7	Circlip	CM2077	1	
F8	Spacer	MT1332	1	
F8	Spacer (4:1 only)	*MT1405	1	
F9	Output gear	MT1584	1	1:1 47 teeth
F9		MT1585	1	1.5:1 54 teeth
F9		MT1254	1	2:1 60 teeth
F9		MT1419	1	2.5:1 59 teeth
F9		MT1316	1	3:1 61 teeth
F9		MT1403	1	4:1 83 teeth. Only supplied as MT0313/4
F10	Spacer	MT1326	1	
F10	Spacer (4:1 only)	*MT1408	1	
F11	Output shaft	MT1486	1	
	Output shaft (4:1 only)	MT1523	1	Only supplied as MT0313/4
F12	Bearing assembly	MT1317	1	
F13	Circlip	0250952	1	
F14	Oil seal	MT252	1	
F15	'O' ring	001873	1	Part of seal kit
F16	Output coupling	MT1487	1	
F17	Coupling washer	*MT1251	1	
F18	Castle nut	*MT1488	1	
F19	Split pin	*024M345	1	

Note: 4:1 Ratio only
Items marked * can be ordered separately, but if output gear MT1403 or output shaft MT1523 requires replacing, then output shaft assembly MT0313/4 must be ordered, which includes output gear, output shaft and items marked *.

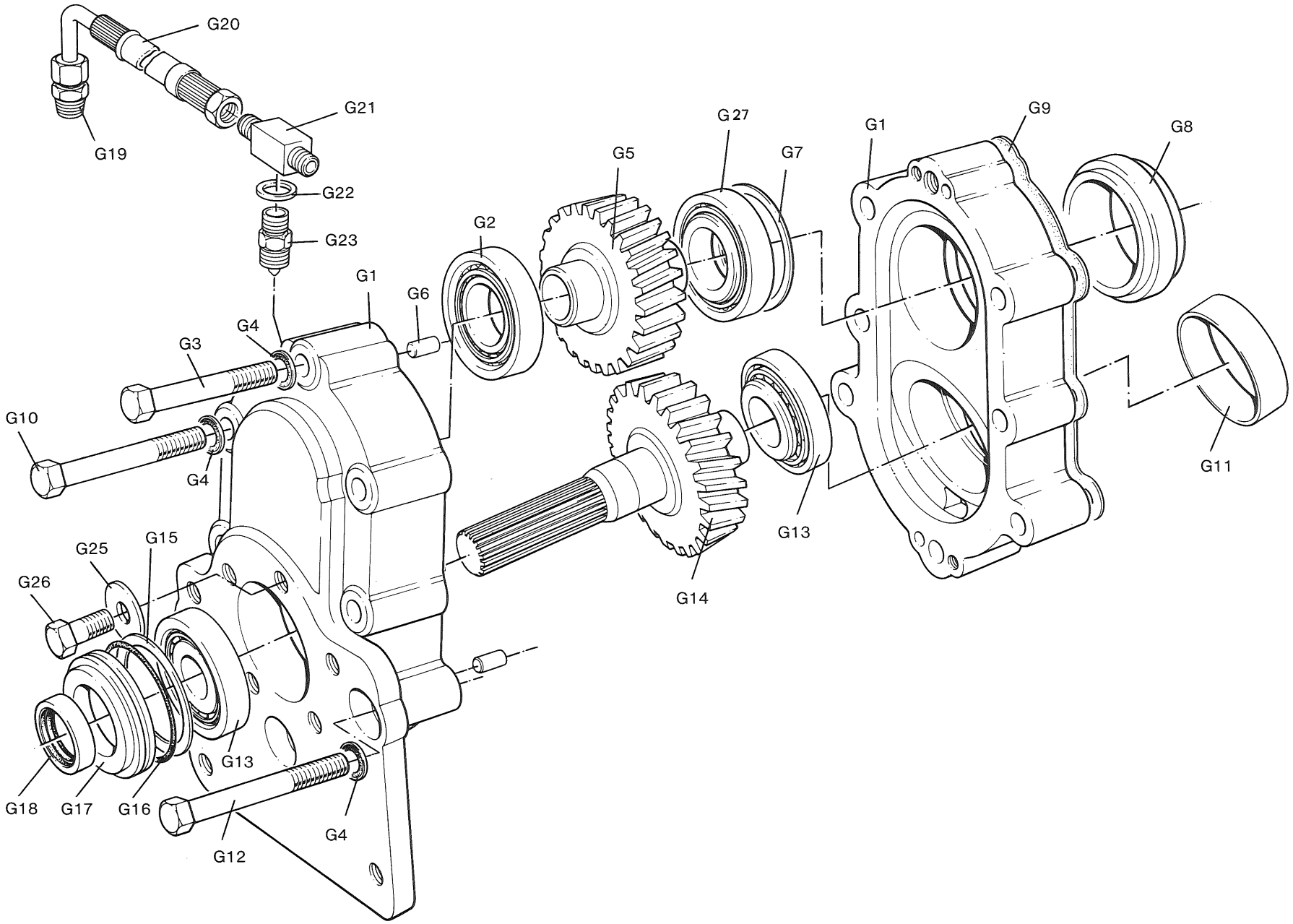
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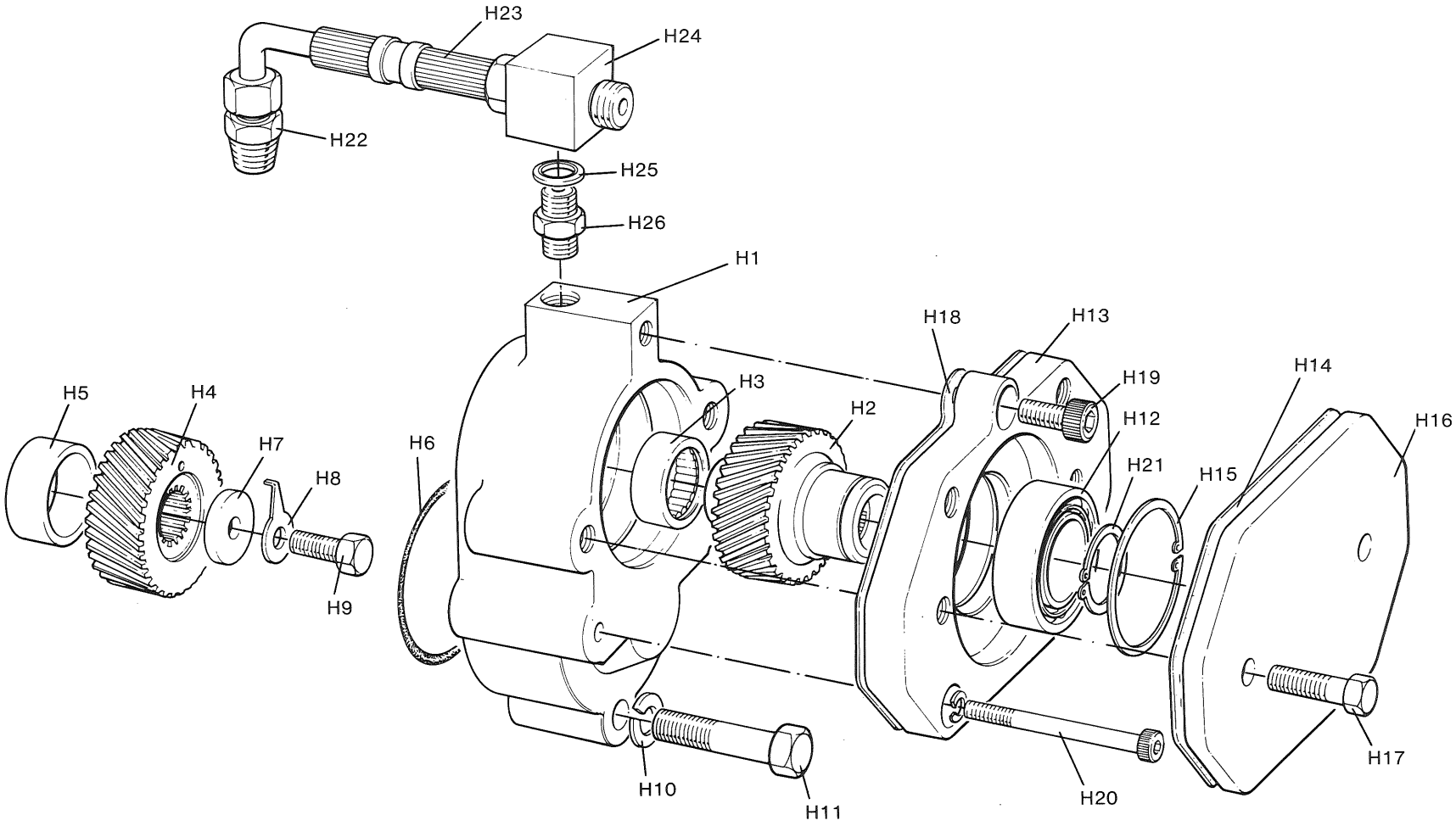
Plate Ref.	Description	Part No.	Qty.	Remarks
G	**DOWN ANGLE DRIVE UNIT**	MT0210	1	
G1	Gearcase S/A	MT0189	1	
	Half case (front)	MT1273	1	Not supplied separately
	Half case (rear)	MT1274	1	Not supplied separately
G2	Taper roller bearing	0540351	1	
G3	Bolt	0041216	1	
G4	Dowty seal washer	CP1204	8	
G5	Output gear	MT1527	1	
G6	Dowel	0210815	2	
G7	Shim	057313A/C/E		As required
G8	Location ring	MT1512	1	
G9	Gasket	MT1281	1	
G10	Bolt	0041222	4	
G11	Spacer	MT1271	1	
G12	Bolt	0041221	3	
G13	Taper roller bearing	0540302	2	
G14	Input gear	MT1525	1	
G15	Shim	MT1077		As required
G16	O ring	002874	1	
G17	End cover	MT1068	1	
G18	Oil seal	MT251	1	
G19	Adaptor	CP1255	1	
G20	Oil pipe	MT766	1	
G21	Tee piece	CP1367	1	
G22	Washer	0201715	1	
G23	Metering union	MT4583	1	
G25	Washer	CM2123		Transit only
G26	Screw	0041206		Transit only
G27	Taper bearing	0540353	1	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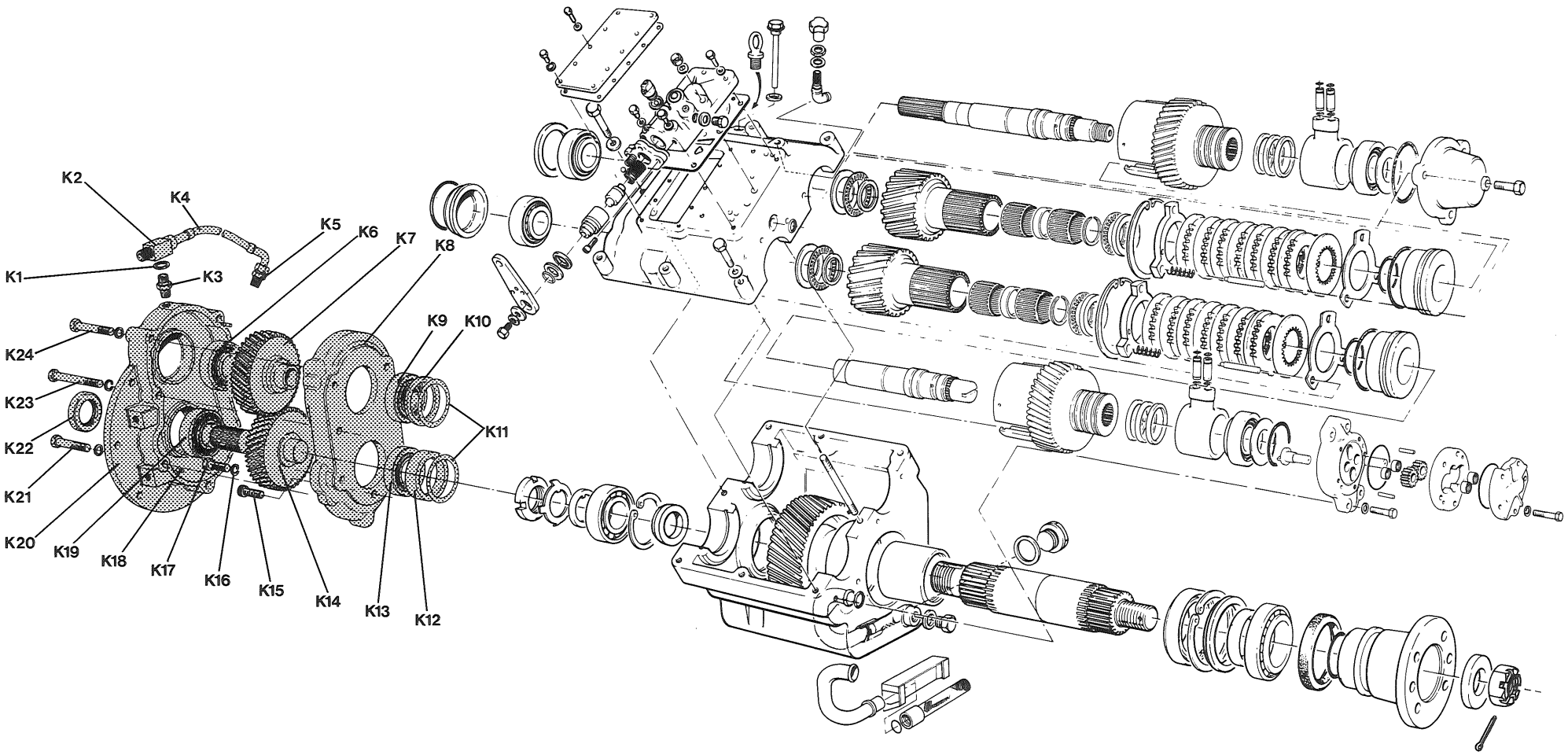
PRM 402

Plate Ref.	Description	Part No.	Qty.	Remarks
H	**POWER TAKE OFF ASSEMBLY**	MT0193	1	SAE B Flange, 2 or 4 bolt
H1	PTO housing	MT1300	1	
H2	Driven gear	MT1297	1	
H3	Needle bearing	0563003	1	
H4	Driving gear	MT1296	1	
H5	Spacer	MT1589	1	
H6	O ring	0430771	1	
H7	Washer	MT1301	1	
H8	Tab washer	MT1302	1	
H9	Screw	0041008	1	
H10	Spring washer	0191107	3	
H11	Bolt	0041216	1	
H12	Ball bearing	40M433	1	
H13	Adaptor flange	MT1299	1	
H14	Gasket	MT1307	1	4 bolt
H14	Gasket	MT5012	1	2 bolt
H15	Circlip	0250620	1	
H16	Cover plate	MT1293	1	Transit only
H17	Screw	0041208	2	
H18	Gasket	MT1303	1	
H19	Cap screw	0081520	1	
H20	Cap screw	0081685	2	
H21	Circlip	CM2067	1	
H22	Adaptor	CP1255	1	
H23	Oil pipe	MT766	1	
H24	Tee piece	CP1367	1	
H25	Washer	0201715	1	
H26	Metering union	MT4583	1	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PRM 402

Plate Ref.	Description	Part No.	Qty.	Remarks
K	**IN-LINE UNIT**	MT0279	1	
K1	Dowty washer	0201715	1	
K2	Tee piece	CP1367	1	
K3	Metering union	MT4583	1	
K4	Oil pipe	MT767	1	
K5	Adaptor	CP1255	1	
K6	Bearing	0540354	1	
K7	Gear	MT1435	1	45T LH
K8	Gearcase	MT1433	1	
K9	Bearing	0540351	1	
K10	Spacer	MT1465	1	
K11	Shim 0.002	MT1077/02		As required
K11	Shim 0.010	MT1077/10		As required
K11	Shim 0.031	MT1077/31		As required
K12	Spacer	MT1440	1	
K13	Bearing	0540301	1	
K14	Gear and shaft	MT1434	1	45T RH
K15	S.H. Screw	0081620	1	
K16	Spring washer	0191107	11	
K17	Bolt	0041208	4	
K18	Dowel	0210614	2	
K19	Bearing	0540402	1	
K20	Gearcase	MT1432	1	
K21	Bolt	0041217	3	
K22	Oil seal	0400351	1	
K23	Bolt	0041222	2	
K24	Bolt	0041215	2	
Special note	Input shaft of main gearbox becomes MT1519			

KITS OF PARTS

Part No.	Description	Qty.
MT0214	**Starter Cut-Out Kit**	
0201715	Dowty washer	1
CP1077	Detent ball	1
CP1358	Switch	1
MT0349	**Clutch Pack**	
0251020	Int. circlip	1
MT1067	CL spring	3
MT1484	Clutch end plate	1
MT1485	Clutch pin	3
MT1554	Spring clip	1
MT1555	Screw	2
MT725/S	Clutch plate - sintered	8
MT982	Clutch plate	7
MT983	CL end plate	1
MT0068	**Shimming Kit**	
MT1077/02	Shim	6
MT1077/10	Shim	10
MT1077/31	Shim	2

Part No.	Description	Qty.
MT0381	**Sealing Kit**	
000372	'O' ring	8
000623	'O' ring	1
000872	'O' ring	1
001254	'O' ring	2
001313	'O' ring	1
001873	'O' ring	1
002123	'O' ring	1
002433	'O' ring	1
002874	'O' ring	4
003383	'O' ring	2
003504	'O' ring	2
004754	'O' ring	1
0400351	Oil seal	1
0421503	'O' ring	2
04305725	'O' ring	1
04306725	'O' ring	3
0430771	'O' ring	1
MT1073	Gasket	1
MT1081	Gasket	1
MT251	Oil seal	1
MT252	Oil seal retainer	1
MT313	Gasket	1
MT343	Gasket	1
MT8082	Seal NU-LIP	1