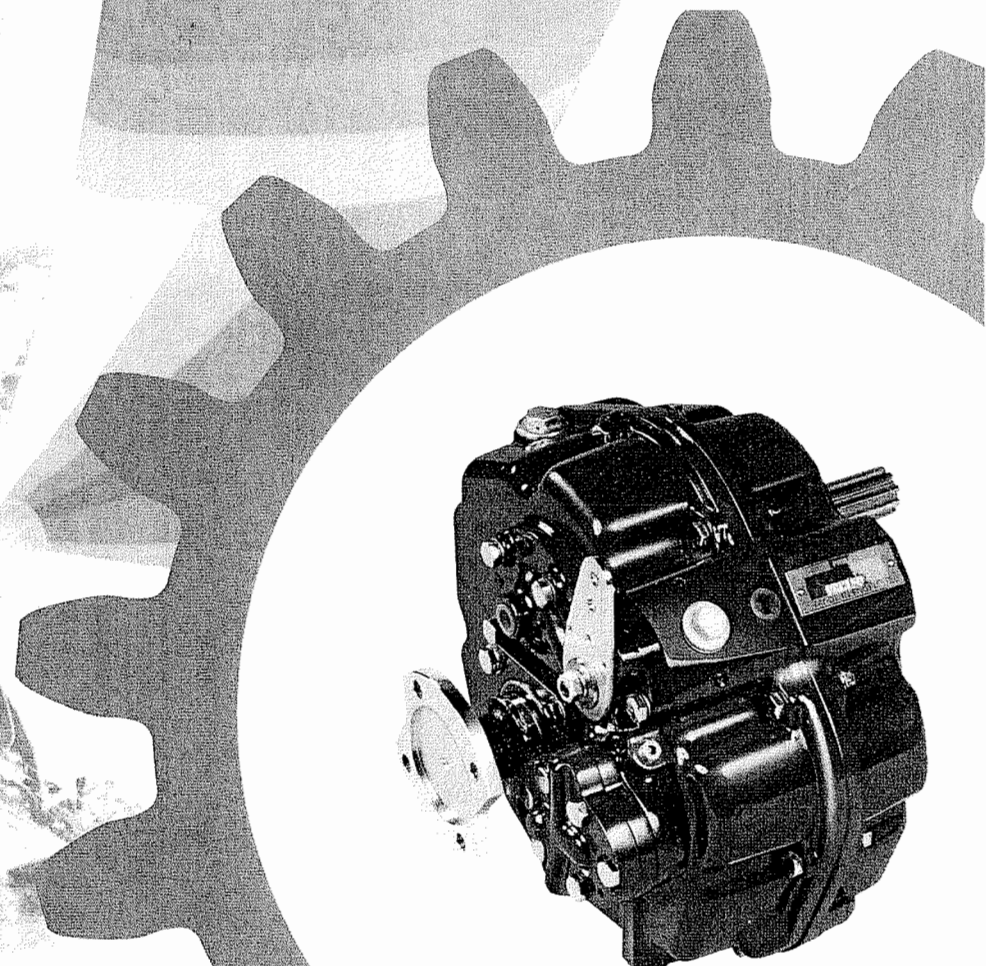




Marine Transmissions

PRM 150

Workshop Manual



The following international symbols are used in this service manual.



WARNING: THIS SYMBOL WARNS OF POSSIBLE PERSONAL INJURY



CAUTION: THIS SYMBOL WARNS OF POSSIBLE DAMAGE TO TRANSMISSION

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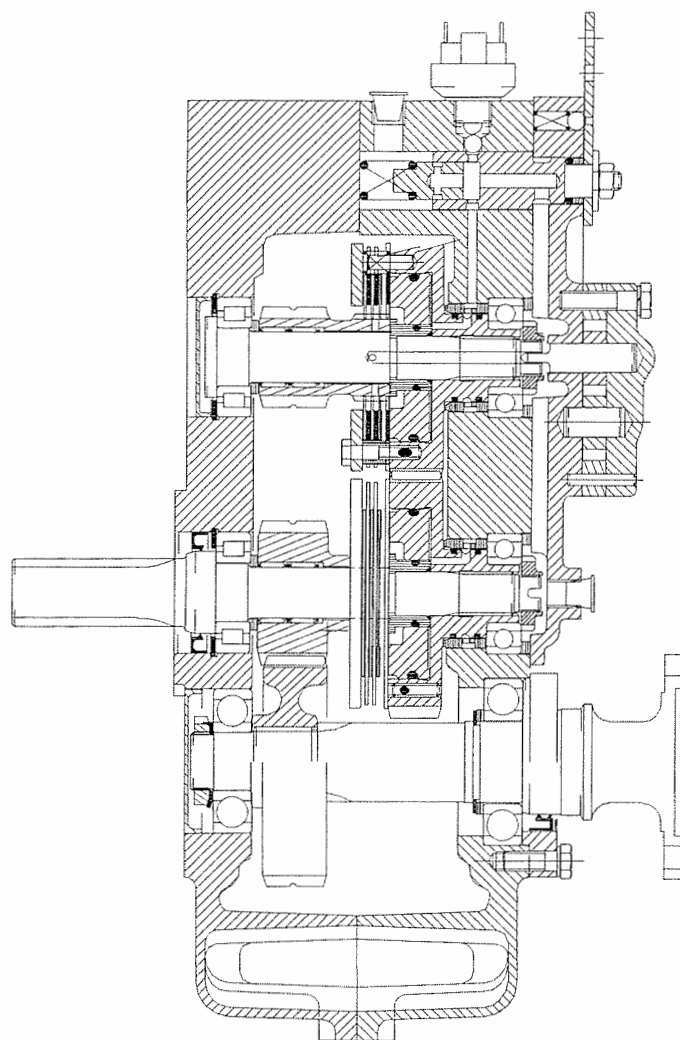


Fig. 1 PRM150 Sectional View

FOREWORD

Provided it is correctly installed, aligned and maintained, the PRM150 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 distributor 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, quoting the serial number.

CLAIMS UNDER WARRANTY

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

SERVICE PARTS

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

PRE-DELIVERY TEST

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

1. Flush clean.
2. Fill with oil to correct level.
3. Pressurise the case, and check for oil leaks.
4. Check for noise levels.
5. Check for drag in neutral.
6. Check input spline dimensions.
7. Check bolt torques.
8. Check for conformance to customer spec.
9. Record box temperature (Deg. C).
10. Record valve block force N to F (lbf).
11. Record valve block force N to R (lbf).
12. Record oil pressure @ 3000rpm (lb/sq.in).

IDENTIFICATION PLATE

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

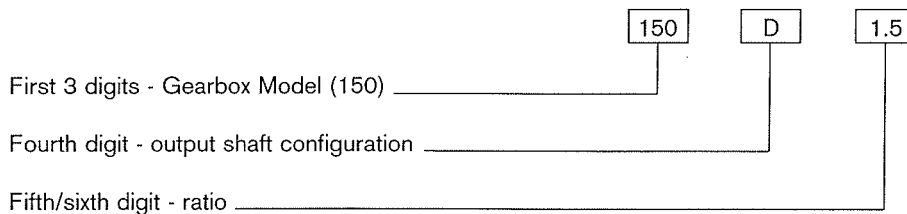
NEWAGE	PRM	COVENTRY
123456		R1234
150D1.5		
MADE IN ENGLAND		

NEWAGE	PRM	COVENTRY
MADE IN ENGLAND		

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

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

The top line is the gearbox serial number, and should always be quoted when ordering spare parts; the lower line is the gearbox specification, in the example given this translates as follows:-



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

1. GENERAL DATA

1.1 Specifications

Gear ratios

1.53:1, 2.09:1, 2.82:1

POWER RATING

GEAR RATIOS	PLEASURE		COMMERCIAL	
	BHP	kW	BHP	kW
1.53:1	2.1	1.6	1.5	1.1
2.09:1	2.1	1.6	1.5	1.1
2.82:1	2.1	1.6	1.5	1.1

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

Input speed:

Maximum operating speed 4500 rev/min continuous
5000 rev/min intermittent

Input rotation:

For engines of left-hand (anti-clockwise) rotation as viewed looking on the flywheel from behind the engine.

Output rotation:

Either hand.

Approximate dry weight:

21kg (46lb) (excluding drive coupling, adaptor flange and oil cooler)

Oil capacity:

1.4 litres (2.5 pints)

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

Operating pressure:

Minimum:- 2500kPa (370 lb/in²)] These pressures relate to input speed of approximately
Maximum:- 2895kPa (420 lb/in²)] 1500rpm, and 70°C oil temperature

NOTE: Pressure may vary at different operating speeds; it is likely that, on start up, when the gearbox is cold, significantly higher pressures may occur. A 600psi pressure gauge is available as an option to check clutch pressures. See page 15 Fig. 8 for pressure position.

Working oil temperature:

The normal operating temperature should be in the range 50°C to 80°C and should not be permitted to exceed 90°C

Transmission cooling:

An oil cooler is necessary to ensure that correct operating temperatures are maintained and the gearbox is provided with two 1/4 inch BSP connectors to allow it to be fitted. The size of the cooler depends on a number of factors including the engine horse power, operating speed, duty cycle, inlet temperature and ambient temperature.

Suitable coolers are available from Newage Transmissions Ltd.

Engine mounting adaptors:

Available in SAE5, Velvet Drive (Borg Warner) and special patterns.

Input drive couplings:

Flexible centre damper plate SAE 6.5" or SAE 7.5"

Gearcase:

Made from heavy duty aluminium alloy for use in a marine environment, and ribbed internally for strength and rigidity. Made in two halves to facilitate servicing.

Input shaft:

29mm diameter with 10 tooth spline to DIN5464.

Propeller thrust:

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

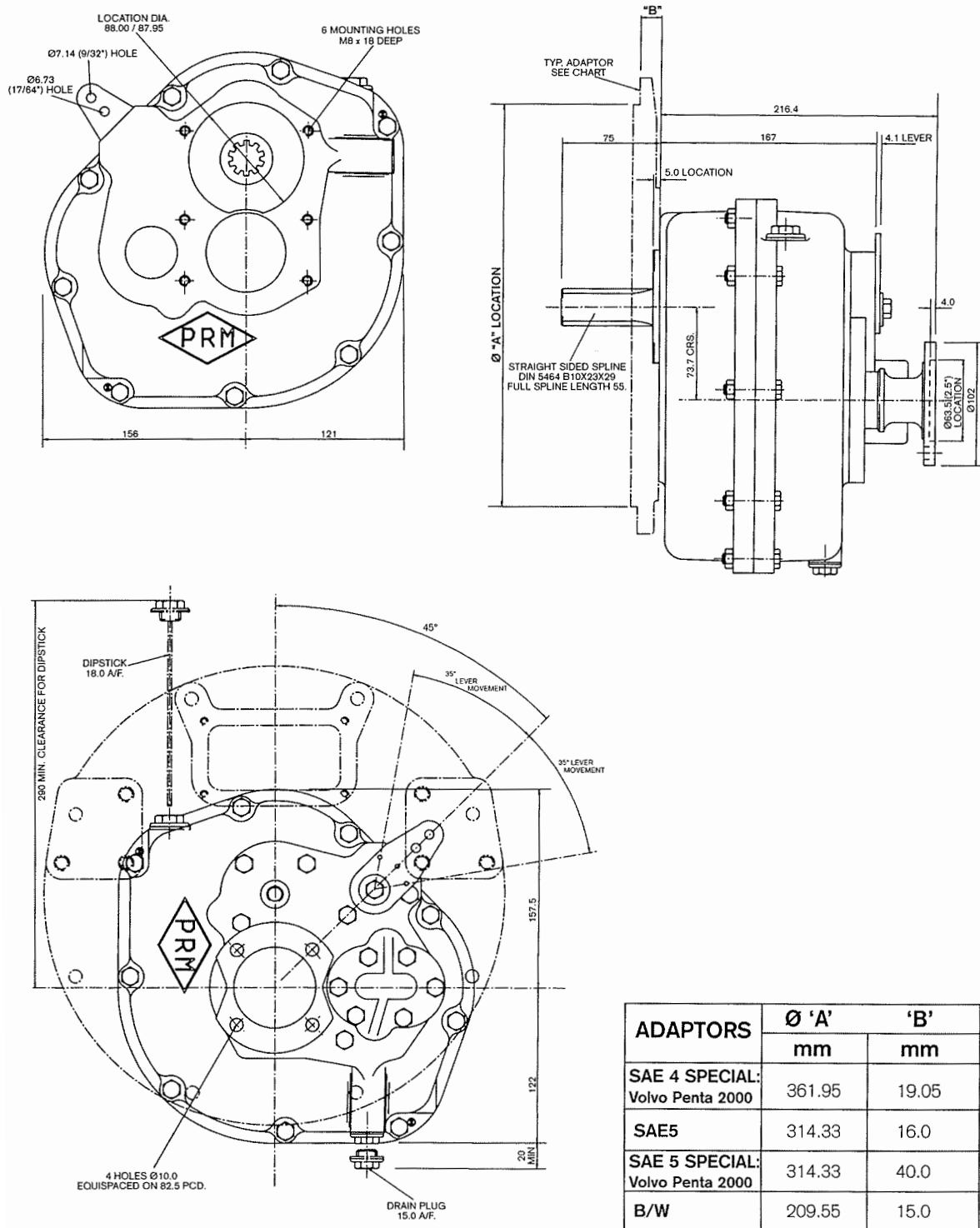
Output flange:

102mm (4 in.) diameter, with 4 holes 10mm (0.4 in.) diameter on 82.5mm (3.25 in.) pitch circle diameter.

Installation angle:

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

BASIC INSTALLATION DETAILS - PRM150



IMPORTANT NOTE

INSTALLATION ANGLE

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

All information given in this manual is correct at the time of going to press. However, in the interests of technical progress, design specifications are subject to change without notice. Accordingly, data given herein should be regarded as a general guide only and does not form part of any contract. Any specific performance requirements must be made known to us in writing with customer orders for goods. Illustrations are approximate only and do not form part of any contract with us; certified installation drawings are available on request. All goods are supplied in accordance with our standard terms and conditions of sale.

Fig 2

2. INTRODUCTION

Newage Transmissions Ltd. PRM150 marine transmission are oil-operated gearboxes of the counter-shaft type with oil-operated multi-disc clutches (which need no adjustment) for both ahead and astern drive. This design permits full power to be transmitted in astern as well as ahead, and also allows right-hand or left-hand propeller rotation in ahead drive, with identical ratios in ahead and astern.

Note: the PRM150 can only be installed on to engines that rotate left-hand (anti-clockwise) as viewed when standing behind the gearbox output coupling facing towards the engine flywheel.

3. CONSTRUCTION

3.1 Gearcase

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

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

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

3.2 Gear train

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

The input shaft is supported by roller and ball bearings which incorporates a drive pinion of the required ratio mounted on needle bearings. This also incorporates the clutch gear, and the hydraulically actuated piston which operates the clutch assembly.

The layshaft is similarly supported by roller and ball bearings and incorporates the hydraulic clutch and gear assembly as described for the above input shaft.

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 incorporates the output flange.

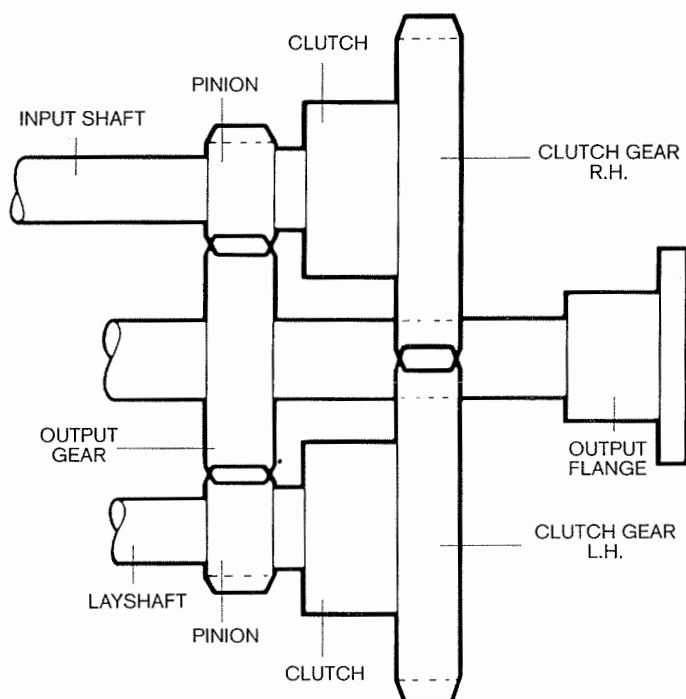


Fig 3 Internal layout

3.3 Oil pump

A cast iron gear-type pump externally mounted at the rear of the gearcase driven by the layshaft, supplies oil at high pressure for actuation of the clutch assemblies, and at lower pressure for lubrication. It should be noted that pressure may vary at different operating speeds. It is also likely that, on start up, when the gearbox is cold, significantly higher pressure may occur.

3.4 Valve block

The valve block, located on the rear 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 neutral position ensuring correct selection of either ahead or astern drive.

3.5 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.

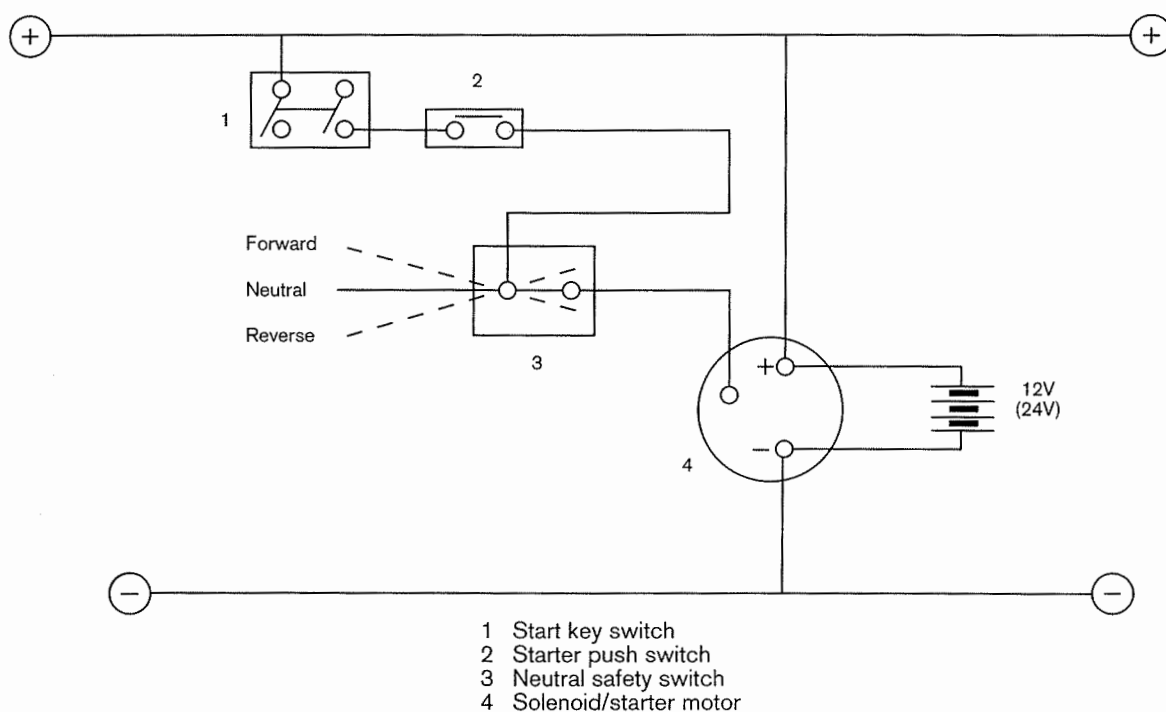


Fig 4 Wiring diagram for neutral safety switch

When used, the switch is located on top of the rear gearcase half, immediately in front of the control lever, and should be wired into the starter circuit as shown in Fig. 4.

4. OPERATING SYSTEM

4.1 Output rotations

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

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

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

4.2 Hydraulic system

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

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

Excess oil is then used for lubricating the gearbox.

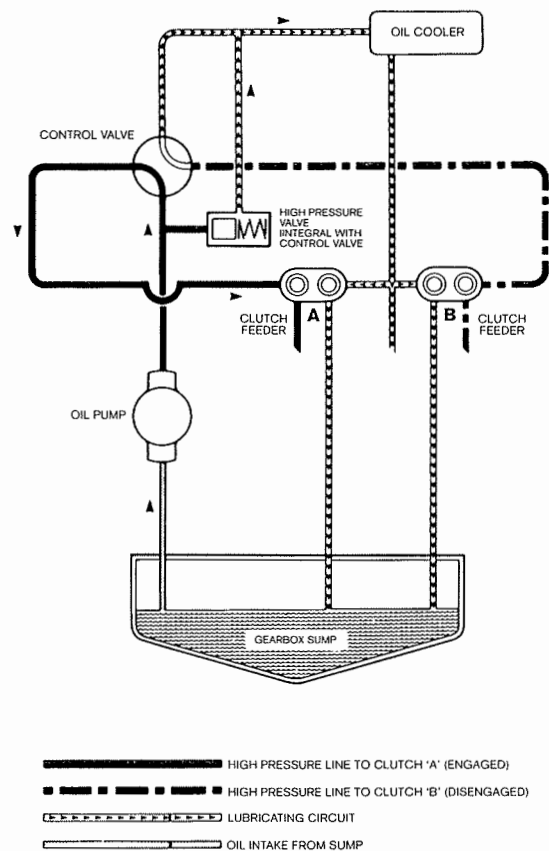


Fig 5 Hydraulic and lubricating oil circuits

4.3 Lubrication

Lubrication oil is delivered via the internal supply 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 in the valve block and thence through the layshaft and drive shaft to lubricate the clutch assemblies.

4.4 Approved oils

TEMP	TYPE OF OIL
Below Zero	10W30 or 20W engine oil to AP1 designation CD
0°C to 30°C	10W30 or 15W40 engine oil to AP1 designation CD
Above 30°	10W30 or 40W engine oil to AP1 designation CD
Note: Gearboxes are despatched from the factory without oil.	

It is essential that only good quality engine oil, supplied by a recognised and well known manufacturer, is used in the PRM150. Do not mix different brands, types or grade of oil.



CAUTION: 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.

5. INSTALLATION

5.1 General

Drive is transmitted from the engine to the gearbox via a flexible centre drive plate (damper plate) which bolts to the engine flywheel. The gearbox input shaft is driven from the centre spline.

These drive plates have a degree of torsional flexibility, the purpose being to reduce engine torsional or cyclic vibrations and prevent them being passed to the transmission.

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

In all marine installations, correct alignment of the engine, gearbox and propeller shaft is extremely important - misalignment can cause noise, vibration and premature failure - and it is strongly recommended that all the procedures detailed in this manual are carefully followed.



CAUTION: It is particularly important to ensure the torsional compatibility of the complete propulsion system from engine through to propeller since disregarding this may result in gear noise at low speed operation and in extreme cases damage or failure of components. Newage Transmissions Ltd. will provide all possible information and assistance to help find solutions to potential torsional problems, but it is the ultimate responsibility of the person assembling the drive and driven equipment to ensure that they are torsionally compatible.

5.2 Checking the engine flywheel housing

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

With the dial test indicator still attached to the flywheel, re-position the stylus so that it is perpendicular to the face of the flywheel housing (face B on Fig. 6). Rotate the flywheel and check the deviation over one complete revolution; again, this should not exceed 0.152mm (0.006in.) total indicator reading.

5.3 Checking the engine flywheel

Attach a dial test indicator, calibrated to 0.025mm (0.001in.) or less, to the engine flywheel housing so that the measuring stylus of the indicator is perpendicular to the bore of the register in the flywheel (bore C on Fig. 6). Rotate the flywheel through one complete revolution and note the deviation, this should not exceed 0.125mm (0.005in.) total indicator reading.

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

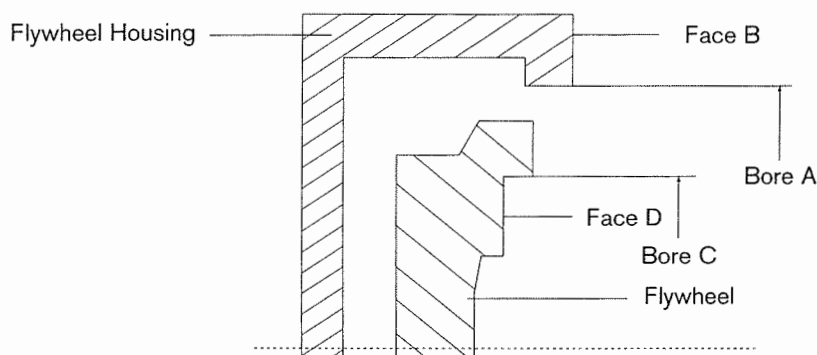


Fig. 6. Checking the flywheel and flywheel housing

5.4 Mounting the gearbox to the engine



CAUTION: Failure to carry out the following mounting instructions correctly can cause vibration that could result in component or gearbox failure.

1. Fit adaptor plate to the gearbox, tightening to a torque of 30Nm (22 lbf.ft).
2. Mount the drive plate to the flywheel, using an alignment mandrel if available, and bolt to the flywheel. Where components to SAE standard are used, the outside diameter of the drive plate should be a close fit in the register on the flywheel.

If a mandrel is not available, tighten the bolts just sufficiently to prevent free movement, assemble the gearbox to the drive plate and rotate the engine two or three revolutions by hand to align the plate.

Tighten up two or three opposite bolts. Remove the gearbox and fully tighten all the drive plate bolts.

3. Offer the gearbox and adaptor up to the drive plate and flywheel housing. Insert the gearbox input shaft into the centre of the drive plate (it may be necessary to rock the shaft slightly to ensure the splines align). Press the assembly fully into position, align the holes in the adaptor with those on the flywheel housing and tighten fully. See fastening torque chart page 28.

5.5 Oil Cooler

All Newage PRM150 gearboxes must be fitted with an oil cooler to maintain correct working temperatures. To permit a suitable cooler to be fitted, two 1/4 in. BSP connections are provided on the valve block. Note: these are blanked off with plastic "Redcap" plugs on delivery from the factory.



CAUTION: Failure to correctly install an oil cooler into the lubrication circuit can result in damage to the gearbox see Fig. 8 for correct circuit. After a gearbox failure it is extremely important to flush cooler and hoses completely to remove any contamination. Failure to do so could result in the new/repaired gearbox failing prematurely.

The gearbox oil cooler is normally mounted on the gearbox adaptor flange or the bulkhead of the boat, and then connected into the cooling system on the engine; one method of arranging the engine and gearbox cooling circuit is shown at Fig. 7.

NOTE: Cooling water must pass through gearbox cooler before engine cooler.

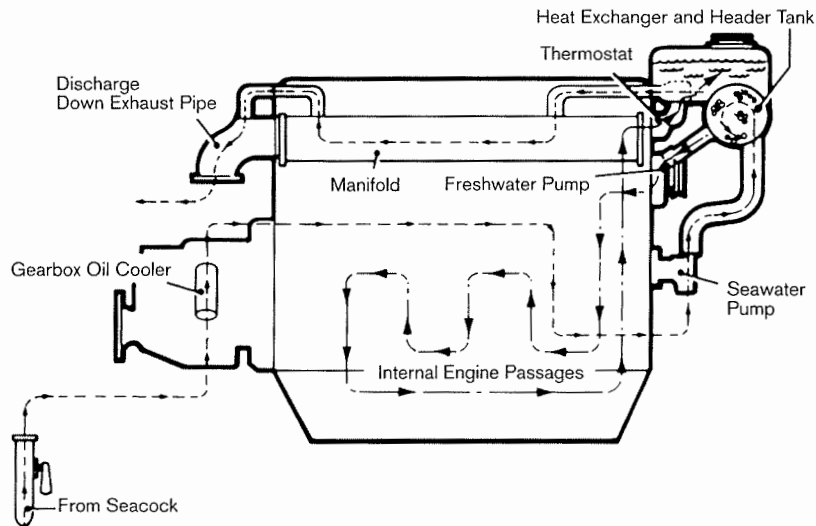


Fig. 7. Engine and gearbox cooling circuit



CAUTION: Remove the "Redcap" plugs from the valve block and gearbox prior to the installation of the cooler. Connect suitable hoses to the connections on the oil cooler and valve block, which can then be incorporated into the engine cooling system as outlined above.



CAUTION: Operating oil temperature should not exceed 90°C under any circumstances. If the checks listed in the fault-finding chart have been carried out without any fault being found and the gearbox consistently runs at a temperature higher than 80°C, Newage strongly recommends that a larger capacity oil cooler be fitted.

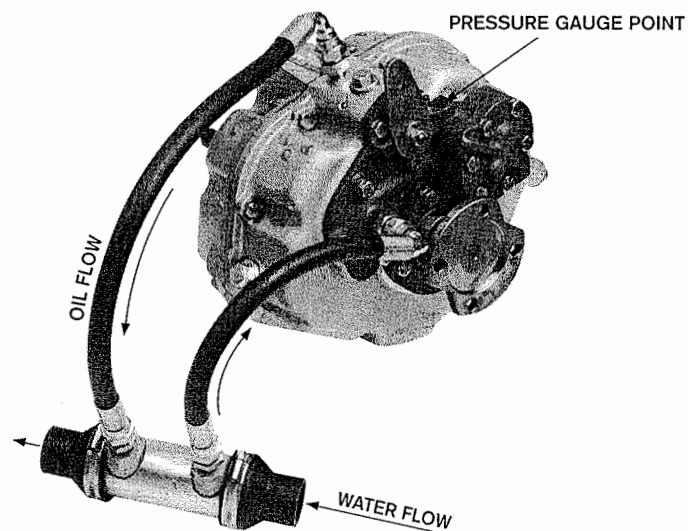


Fig. 8. Oil cooler connections

5.6 Alignment to propeller shaft



CAUTION: Alignment between the propeller shaft and the mating flange on the gearbox output shaft is extremely important since excessive vibration and stress may lead to premature failure if correct alignment is not achieved.

In the majority of boats whose hulls are rigid enough to prevent excessive flexing in heavy sea conditions, (which would cause the engine and transmission 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 sufficiently rigid to prevent the flexing referred to above,
- b) in cases where the engine is mounted on flexible mounts.

In both instances, the flexible coupling helps to isolate engine vibration or other movement from the propeller shaft thus enabling correct alignment with the propeller shaft and stern tube to be maintained.

Whether a solid or flexible coupling is used, it is extremely important that the following points are carefully checked:

- i) the coupling should be a tight press fit on the shaft and the keyway accurately made to the correct size, and
- ii) the two halves of the coupling should be carefully aligned. This should be done by bringing the two flanges close enough together so that a feeler gauge can be used to check the vertical and horizontal alignment.
- iii) alignment should only be carried out with the boat afloat. The maximum permissible misalignment being 0.05mm.

Since the propeller shaft line is normally fixed in the boat, alignment is usually obtained by adjusting engine mount shims on the mounts themselves.

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

In designing PRM150, SAE standards were adhered to as far as possible. However, other manufacturers of similar sized transmissions have a different, but common, output coupling spigot, which is not to SAE. This spigot size has become the industry standard and most proprietary flexible output couplings are made to suit.

5.7 Installation angle

The transmissions should normally be installed so that the maximum fore and aft angle relative to the water line does not exceed 15° with the boat at rest. Please consult Newage Transmissions Ltd. if installation angles greater than this are required.

5.8 Twin installation

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

In twin installations, the turning effect on the handling of the boat will be much more pronounced if both propellers rotate in the same direction. It is therefore desirable that "handed" (i.e. counter-rotating) propellers be fitted. For this reason PRM gearboxes are capable of providing either hand of output rotation with any of the available gear ratios.

It is also preferable for the starboard (right-hand) propeller to rotate clockwise and the port (left-hand) anti-clockwise rather than the other way about. In the latter case, when the propeller blades are at the lowest point of their rotational arc they tend to create a vacuum which affects the other propeller by reducing the flow of water to it. 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, causing the boat to be deflected off line which delays completion of the manoeuvre.

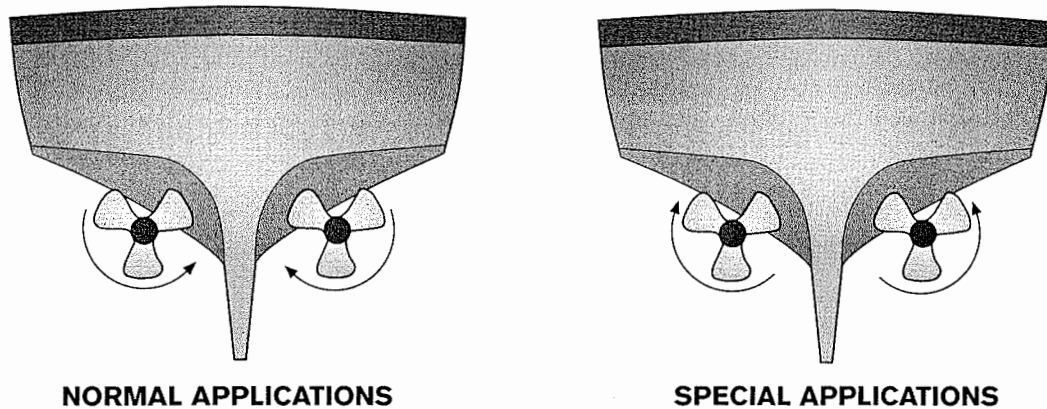


Fig. 9. Propeller rotation twin installations

Moving the gearbox operating lever to the right will provide left-hand (anti-clockwise) propeller shaft rotation, moving it to the left gives right-hand (clockwise) rotation, as seen looking forward from propeller to gearbox. Either rotation can be used for ahead drive according to propeller fitted.

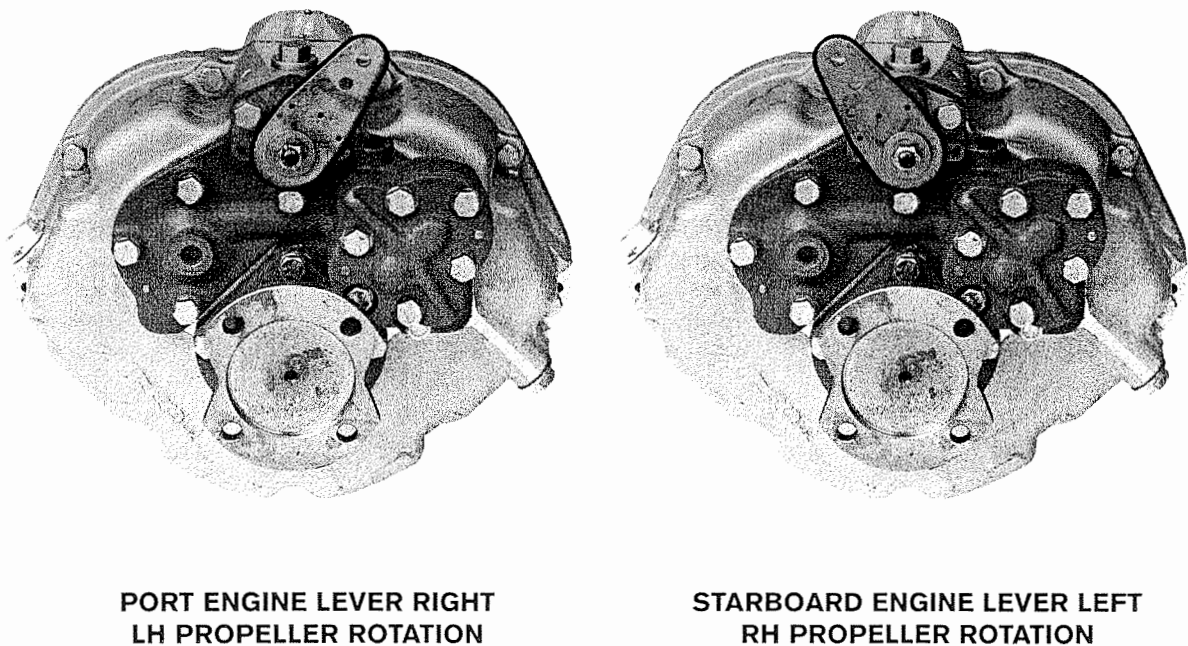


Fig. 10. Operating lever movement for ahead drive, twin installations

5.9 Remote control operating systems

The PRM150 can be used with remote control operating systems which links the engine throttle to the gearbox operating lever e.g. Morse Controls single lever type.

The following points should be noted:

- i) The gearbox operating lever is provided with a positive neutral position, which greatly assists the setting up of the remote control unit.



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

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

6. OPERATION

6.1 First time usage



CAUTION: Before starting the engine fill the gearbox to the correct level with a suitable oil (refer to recommended list, section 4.4 Page 13).

Ensure 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 and allow the oil to settle, re-check the level and top up to the maximum mark on the dipstick.

NOTE: Screw dipstick fully down when checking oil level.

6.2 Drive selection

The PRM150 has been designed and tested to ensure rapid shifts from ahead to astern or vice versa and can be operated at full horsepower ratings and speeds. In these circumstances the transmission will respond rapidly.



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

Newage Transmissions Ltd. recommend that when changing direction the engine speed be brought down to approximately 1000 rev/min. For this reason it is recommended that a proprietary single lever remote control operating system is fitted which links the engine throttle control to the gearbox operating lever.

6.3 Trailing (free wheeling) the propeller

The bearings used in the Newage PRM150 gearbox have been carefully selected to ensure that prolonged trailing (free wheeling) of the propeller will not have any detrimental effect on the transmission. This allows the propeller to turn freely with the engine shut down and makes the Newage PRM150 particularly suited for use in auxiliary sailboats, motor sailers or multi-engine installations where the boat may be operated with one or more engines shut down.

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

Where propellers are allowed to free-wheel they can be a useful source of free auxiliary power; if a flat pulley is fitted to the propeller shaft a small generator can be belt driven for charging batteries



CAUTION: Care must be taken not to apply excessive side-load which would cause vibration and misalignment.

6.4 Emergency operation

Included as standard in every Newage PRM150 gearbox is a "Get You Home" device allowing the gearbox to be mechanically locked in 'ahead' drive in the unlikely event of hydraulic clutch failure.

The method of operation is as follows:

1. Undo the 9 hexagon bolts securing the rear manifold to the gearcase and, taking care not to lose the small socket wrench which is located inside it, remove the manifold complete with oil pump. (See Fig. 11 Page 19)
2. Rotate the input shaft until two socket screws in the clutch gear align with the two holes in the rear of the gearcase.
3. Insert socket wrench through the holes in the gearcase and tighten the two screws; this locks the clutch plates together and provides drive for a right hand rotation propeller.
4. Reposition rear manifold and secure. Tighten to correct torque see chart page 28
5. Ensure that sufficient oil remains in the gearbox to prevent further damage.
6. Select neutral on the operating lever and disconnect operating cable; the engine can now be run.



CAUTION: Disconnection of the operating cable is very important in order to prevent accidental selection of direction whilst the clutch is mechanically locked.

When the mechanical lock-up device is engaged it is important to remember:

- a) right hand propeller rotation only is available;
- b) when emergency drive is in operation, astern or neutral cannot be engaged and there is no means of stopping the boat using the gearbox.
- c) the engine should not be run above $\frac{1}{3}$ full throttle.
- d) after emergency drive has been used, qualified assistance should be sought to give the transmission a thorough check before it is used again.

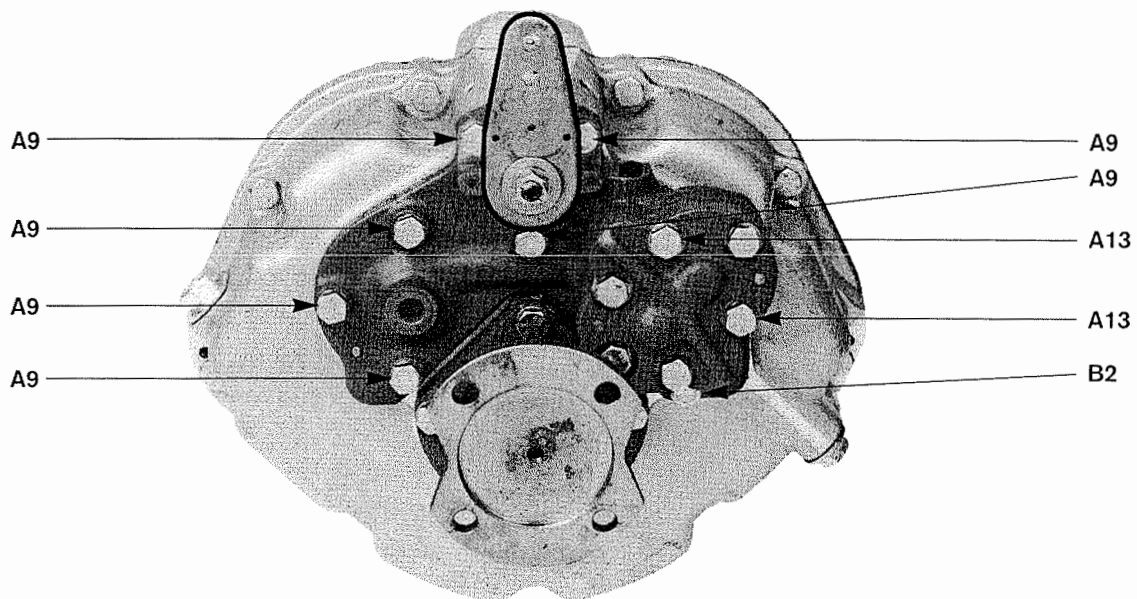


Fig. 11. Removal of bolts for emergency operation

7. ROUTINE MAINTENANCE



WARNING: Hot oil can cause burns. Do not work on the gearbox with the engine running.

7.1. Initial maintenance (after 25 hours running)

Drain all oil from the gearbox, the drain plug is located in the rear of the casing on the right-hand side of the transmission. This requires a 15mm A/F spanner to remove. Refill with one of the recommended lubricants (see page 13). Operate the engine and gearbox, allowing the oil to circulate, then stop the engine and allow to settle. Re-check the oil level and top up if necessary to the maximum mark on the dipstick. Refit drain plug and washer.

7.2 Daily checks

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

7.3 Annual check

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

7.4 Winter storage

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

7.5 Other maintenance operations

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

8. FAULT FINDING CHART

The following 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. or an authorised distributor or dealer for advice.

SYMPTOM	CAUSE	REASON	REMEDY
No drive ahead or astern	No oil pressure	Damaged oil pump Broken input drive plate Broken input shaft Broken output shaft	Remove oil pump and replace complete or with pump repair kit. Replace input drive plate. Replace input shaft. Replace output shaft.
Intermittent or complete loss of drive	Oil leaks	Damaged oil seals or gaskets	Check leakage area and replace relevant gasket or seal. Re-fill to correct level on dipstick.
Propeller speed does not increase with engine speed ahead or astern	Low oil pressure to both clutches	Damaged or worn oil pump Remote control cable not allowing correct gearlever movement Pressure relief valve defective	Replace oil pump complete or with pump repair kit. Remove cable and operate lever by hand adjust cable if necessary. Remove valve block and replace spring.
Propeller speed does not increase with engine speed in one direction only	Low oil pressure to one clutch	Piston rings worn Feeder worn Damaged 'O' ring in hydraulic circuit Blocked hydraulic feed in valve block Damaged clutch plates	Remove appropriate clutch shaft replace worn feeder or piston rings. Check 'O' rings in feeder connectors and piston. Remove valve block and examine. Remove and examine appropriate clutch and replace if necessary.
Excessive noise from gearbox at low speeds	Engine idle speed too low Torsional vibration	Faulty adjustment Torsional incompatibility of driveline components	Increase idling speed. If not cured by increasing engine idling speed refer to engine supplier.
Excessive noise throughout operating range	Defective input coupling Propeller shaft misalignment	Input coupling worn or damaged Hull flexing or faulty installation	Remove, examine and replace input coupling if necessary. Check the alignment of the propeller shaft coupling. If necessary rectify by adjusting shims under the engine mounts or engine mounts themselves.
Excessive vibration throughout operating range	Propeller out of balance Engine/gearbox misalignment	Propeller damaged or badly machined Defective bearing	Check pitch, weight, diameter and balance of propeller. Remove transmission and check flywheel face is flat or flexible coupling is correctly aligned (see section 5.3). Isolate defective bearing and replace.

NOTE: See Fig. 8 page 15 for clutch pressure position using 600psi gauge.

SYMPTOM	CAUSE	REASON	REMEDY
Excessively high oil temperature	Power too high Defective oil cooler or cooler too small Oil level too high/low Incorrect oil type Defective oil pressure relief valve Slipping clutches	Incorrect engine rating for gearbox Damaged or blocked oil cooler, incorrectly specified cooler size Damaged or collapsed relief valve spring Worn clutches, low oil pressure	Re-assess engine power. Replace oil cooler or re-specify cooler size. Fill to correct oil level on dip stick. Fill with correct oil type. Remove and examine valve spring. Replace if necessary. Replace defective clutch, see remedy for low oil pressure.
Oil level needs constant topping up	Oil leaks	Defective oil seals, 'O' rings, or gaskets Defective oil cooler and hoses	Clean the outside of the gear box particularly around output shaft and valve block, inspect for leaks. 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 Faulty installation	Defective valve or detent spring Remote control operating cable badly installed or kinked	Contact distributor or factory for advice. Check the installation and eliminate all tight bends in the cable.
No neutral	Control system not moving gear lever correctly Seized or dragging clutch	Incorrect control cable set-up Clutches badly worn or seized causing permanent engagement of a direction	Check cable installation. Check clutch and replace as necessary.



WARNING: Before carrying out any service work always ensure that the engine is switched off and disconnect the operating cable from the gearbox.



CAUTION: The above operations should be carried out by suitably qualified personnel and strictly in accordance with the procedures detailed in the workshop manual.

9. SERVICING AND REPAIRS - GENERAL



WARNING: Before removal of the gearbox for service, repair or overhaul, switch off the engine and carefully study the following procedures. Use proper hand tools, slings or hoists for the job - **WORK SAFELY**

Keep all work areas, tools and gearbox clean. Wipe up any spilled oil or fluids to prevent accidents. Wear correct safety equipment i.e. safety glasses and safety shoes to guard against personal injury.

Remember **WORK SAFELY - USE COMMON SENSE.**

Drawings showing all internal components are contained in the parts lists. See page 29.

9.1 Seals

Remove oil seals carefully to prevent damage if they are to be re-used, however it is best to replace these items. Carefully examine all cast iron piston rings for wear and corresponding wear/damage in the bores. Take care not to break these rings.

9.2 Bearings

If removing roller bearings for re-use keep them in matched sets and protect all bearings from contamination.

9.3 Cleaning



WARNING: If using cleaning solvents these can be toxic, flammable, a skin irritant or give off harmful fumes. Avoid prolonged contact, vapour inhalation, or smoking. Failure to take care can result in injury or death.

Rinse all metal parts in solvent to remove dirt, grease and oil.

Be careful to remove solvent from items before re-fitting.

9.4 Inspection

9.4.1 Gearcase

Inspect for cracks. Check sealing surfaces for any scratches, damage etc. which will lead to oil leaks.

9.4.2 Gears

Inspect for any chipped broken or cracked gear teeth, also for any excessive wear, i.e. gear pitting

9.4.3 Bearings

Inspect for any damage, pitting or over-heating.

9.4.4 Clutch plates

Inspect all clutch plates for signs of overheating and/or distortion. Check friction surfaces for wear. Replace if oil grooves have worn away.

9.4.5 Clutch components

Inspect clutch components for wear, damage, overheating or debris. Check all oil feed holes are clear.

9.4.6 Threaded parts

Inspect for stripped or damaged threads.

10. SERVICING AND REPAIR PROCEDURES



CAUTION: When re-assembling the gearbox all threaded fasteners must be tightened to the torques listed in table, page 28 to prevent premature failure.

The servicing, repair and replacement of components and assemblies on the input/output shaft and layshaft is made simple because the gearbox is constructed in two separate halves, the rear half being easily removable to give access to all shafts once the gearbox has been removed from the engine. Cross sectional views of all internal components are contained in the parts list page 29.

If the details outlined below are carefully followed no difficulty will be found in stripping and rebuilding the gearbox. It is most important that all components are perfectly clean and in good condition before re-assembly.

10.1 Selector valve assembly

The selector valve operating lever and where fitted the neutral safety switch are integral parts of the gearbox design. The removal, inspection and replacement of the components may be carried out without removal of the gearbox from the engine.

1. Disconnect the oil cooler pipes and the control cable or cables from the gearlever.
2. Disconnect the wiring from the neutral switch if fitted, unscrew the switch and washer and remove the steel ball (C7) from its recess.
3. Remove the nut and end washer (C2 and C3) from the selector valve (C10) and withdraw the operating lever (C4) taking care not to lose or misplace the detent ball and spring (C5 and C6).
4. Remove the nine bolts securing the pump adaptor and manifold to the gearbox (see fig. 11) and withdraw the unit from the gearbox. Take care not to damage the gaskets or lose the 3mm A/F socket wrench located in the pump adaptor. If the spacer and 'O' ring (C1 and C12) have remained in the pump adaptor and manifold carefully remove these items.
5. The selector valve assembly can now be withdrawn from the gearbox together with the high pressure valve and spring (C9 and C8).
6. If the spacer and 'O' ring (C1 and C12) have remained on the end of the selector valve, these should now be removed. Taking care not to damage 'O' ring bore and valve diameter. Note: it is recommended that a new 'O' ring and gasket is fitted when re-assembling.
7. Inspect the valve components for damage or wear. Check that the valve spring has retained its correct free length (31.75mm) and if necessary replace.

To fit selector valve assembly proceed as follows:-

8. With the high pressure valve and spring (C9 and C8) fitted in the selector valve (C10), slide the selector valve into the housing until the spring seats on the bottom.
9. Assemble the manifold gasket (A20) ensuring that the 3mm A/F socket wrench is housed in its recess in the pump manifold. A liberal coating of grease on the wrench will retain it in the housing when refitting.
10. Refit the pump manifold taking care to align the pump drive tang (B8) into the drive slot in the end of the layshaft (E25).
11. Tighten the nine bolts to the correct torque (see chart page 28)
12. Make sure the 'O' ring (C12) is undamaged and replace if necessary. When re-fitting into the bore coat with grease to ensure 'O' ring is not damaged.
13. Insert the spacer (C1) into the recess in the pump manifold until the spacer is flush with the rear face.
14. Refit the detent springs and ball (C6 and C5), fit the operating lever (C4) tightening the lever nut (C2) to correct torque see chart page 28.
15. If re-fitting the neutral safety switch (A19) ensure the steel ball (C7) is in place and refit the cooler pipes and cable.

16. Start up the engine and run until operating temperature is reached and check for leaks, correct operation of the clutches and oil pressure. A $\frac{1}{8}$ " BSP tapping is provided on the pump adaptor and manifold for fitment of an oil pressure gauge. See section 1.1 for correct operating pressure.

The following section will assist when fitting the neutral safety switch. See Fig. 4 for wiring diagram

17. Connect the switch terminals to a battery and a bulb circuit. Move the operating lever to the forward or astern position insert the steel operating ball and fit the bonded seal to the switch.
18. Screw the switch into the housing with the circuit connected, the bulb should now light. Continue screwing the switch until the bulb goes out.
19. Move the operating lever to the neutral position, the bulb should now light. Check switch function in all three lever positions. The switch can now be connected into the solenoid circuit on the engine starter motor.

10.2 Oil pump assembly

The oil pump assembly can be removed with the gearbox in position on the engine.

1. Follow the procedure as described in 10.1 - 1, 4 and 5.
2. The pump can now be stripped by removing the 4 fixing bolts (B1/2) in the cover plate. The assembly splits into its three component parts exposing the body, gears and shafts.
3. If the pump body is damaged, the complete pump assembly must be replaced. If the pump body is in good condition, the oil pump can be repaired using the pump repair kit (see page 33)

10.3 Removing the transmission from the boat



CAUTION: Before commencing work see section 9. The following instructions must be complied with to avoid damage to the gearbox.

1. Ensure that the gearbox operating lever is in the neutral position and disconnect the operating cable or cables, and disconnect the wiring from the neutral safety switch, if fitted.
2. Drain the gearbox oil into a suitable container and disconnect oil cooler pipes.
3. Unscrew and withdraw the bolts connecting the gearbox output flange from the flexible coupling or mating half coupling on the propeller shaft.
4. Remove the bolts securing the adaptor and gearbox to the engine and lift the gearbox and adaptor plate clear of the engine. Remove the 6 nuts and studs securing the gearbox to the adaptor and separate.

10.4 Removing the input shaft and layshaft assemblies

1. Remove the seal (F1) and locknut (F10) and washer (F2) from the front end of the output shaft.



CAUTION: Note: it will be necessary to punch a hole in the seal (F1) to remove it taking care not to damage the gearbox face or the bearing.

2. Remove the output shaft following stages 1-4 in section 10.6.
3. Remove the 9 bolts and washers (A7 and A8) securing the front and rear gearcase halves. With a suitable punch tap the two dowels (A3) clear of one half of the casing.
4. Lift the front gearcase half clear of the clutch shafts and rear gearcase. This operation will be easier if the gearcase is supported with the rear face down.

Where inspection or replacement of the clutch gear, feeder or rear bearing is required continue as below.

5. Remove the pump adaptor and manifold as described in section 10.1.

10.5 Clutch assemblies

Clutch plates which have discoloured and/or distorted by overheating or if the groove pattern on the friction plates have been worn away they need to be changed as follows, these instructions apply to both directional clutches:-

1. Remove the clutch assemblies from the rear gearcase (A2) after first supporting the joint face on wood or similar material to prevent damage. This will need to be of sufficient height as the clutch assemblies are to be tapped out of the bearings (D/E14).
2. Remove staked portion of locknut (D/E16) taking care not to damage the shaft thread.
3. Using a piece of tube to locate over the thread of the shaft (D/E25) and inside bearing (D/E14) gently tap clutch gear (D/E20) through bearing (D/E14) and feeder (A21) taking great care not to break piston rings (D/E13).
4. When these assemblies have been removed from the gearcase it will be possible to tap the shafts through the clutch gears (D/E20).
5. Position assembly upright, remove the bolts (D/E23) securing the clutch pack and withdraw the complete assembly noting the position of the springs (D/E7) ferrules (D/E23A) and guide pins (D/E8).

10.5.1 Re-assembly of clutch

1. Fit the clutch end plate (D/E9) over the spring guide pins (D/E8) and place the return springs (D/E7) over the spring guide pins (D/E8) also fit the ferrules (D/E23A). Starting with one of the driven friction plates (D/E21) followed by steel plate (D/E22) build up the replacement clutch on the clutch end plate (D/E9).
2. Fit the clutch end plate (D/E6) onto the clutch pack refit the new securing bolts (D/E23) through the ferrules (D/E23A). **Finger tighten these bolts only at this stage.**



CAUTION: It is important that new bolts are always fitted when the clutch is re-worked as they can only be used once to maintain correct locking effectiveness.

3. Ensure the springs are correctly located and the clutch plates are free to travel in the clutch assembly.
4. Tighten these bolts (D/E23) to 14Nm. Press in shaft (D/E25) through the sealing collar (D/E18) and clutch gear (D/E20) after first fitting a new 'O' ring (D/E17) to sealing collar. It will be found easier if grease is applied to the sealing collar to hold 'O' ring in place.

10.5.2 Clutch gear

If a clutch gear has been damaged or badly worn, both clutch gears must be replaced.

1. Follow stages 1-3 in Section 10.5.
2. It will now be possible to remove the piston (D/E11) sealing collar (D/E17) and 'O' rings (D/E10, 12 and 17) fit new 'O' rings on re-build. Note: to remove the piston, gently tap the clutch gear onto a piece of wood or similar material, this will dislodge the piston and sealing collar.
3. Replace 'O' rings (D/E10 and 17) and carefully examine piston and clutch gear for damage in their bores.
4. Re-build the clutch gear assembly taking care when re-fitting the piston that the 'O' rings are not damaged. Lubricate the piston and seals with clean gearbox oil prior to re-fitting.

10.5.3 Drive pinion

As with the clutch gears it is advisable to renew both drive pinions together. To ensure the correct ratio is used refer to the parts list page 29. If it is required to alter the gear ratio from the original build then both pinions (D/E5) and output gear (F4) must be changed. To replace the drive pinion refer to section 10.4, 10.5.

Note: If spacer (D/E4) is removed it must be fitted with grooved face to pinion gear.

10.5.4 Rear bearing

To replace a damaged or worn rear bearing:

1. Remove the clutch shaft assembly as described in section 10.5.
2. Remove spacer (D/E15). Withdraw the bearing (D/E14) from the rear case half (A2) using a suitable extractor.
3. Using a drift or hand press, fit the new bearing into the casing (A2) up to the shoulder.
4. Refit the clutch assembly.

10.5.5 Clutch feeder

1. Remove the clutch shaft assembly as described in section 10.5.
2. Remove the bearing as described in section 10.5.4.
3. Using a hand press and suitable bung on the bearing end, remove the feeder (A21) from the rear case (A2).
4. Refit the feeder by laying the case (A2) on its joint face and press the feeder (A21) into its bore making sure the chamfered end enters first i.e towards the clutch gear (D/E20). Press flush with bearing shoulder face.

10.5.6 Piston rings

Excessive wear or damage may necessitate renewal of the piston rings (D/E13) as follows:

1. Remove the clutch assembly as previously described.
2. Use a piston ring extractor or a piece of thin steel to remove the rings from the clutch gear.
3. Raise one end of the top ring out of the groove and insert the steel strip between the ring and the clutch gear. Rotate the strip around the clutch gear, applying slight forward pressure to the raised portion of the ring until it rests on the land above the groove. The ring can then be eased off the gear. Repeat for the second ring.
4. Clean off any grease or rust inhibitor from the new rings.
5. If a ring loading tool is available, fit this around the shaft, load the rings onto the tool and locate in their approximate position. Gently withdraw the tool and allow the rings to locate in their respective grooves.
6. Where a loading tool is not available, use a thin metal strip, long enough to lay along the shaft above the grooves. Expand each ring just sufficiently to allow it to be placed in its approximate position over the strip. Gently withdraw the strip and locate the rings in their respective grooves.

10.5.7 Replacement of input and layshaft assemblies

1. Position the rear case (A2) back face down onto a firm surface, with rear bearing (D/E14) removed, see section 10.5.4.
2. Position the clutch shaft assembly into the feeder (A21) taking great care when fitting the piston rings (D/E13) into the bore. Press the rear clutch shaft bearing (D/E14) into the casing up to the shoulder, fit spacer (D/E15) and NEW locknut (D/E16) and tighten to correct torque - see torque chart page 28



CAUTION: Remember to stake the locknut into the shaft slot and use Loctite 270.

10.6 Removing output shaft

1. Split the gearcase assembly as described in section 10.4.
2. Remove the locknut (F10) and washer (F2) from the front end of the output shaft (F5). Pull off bearing (F3) and remove output gear (F4).
3. Remove the four bolts (A9) holding the seal housing (A18) in the casing.
4. Using a soft faced mallet drive the output shaft through the rear gearcase.
5. Examine the output gear and if it is worn or damaged replace it together with two new pinion gears of the same ratio as it is likely they may have suffered damage also.
6. If the bearings (F3/8) are found to be worn or damaged replace them, but also ensure the gears have not been damaged due to dirt or debris.

10.6.1 Rear bearing and oil seal replacement

1. Remove the circlip (F6) and spacer (F7). Remove bearing (F8) and oil seal housing (A18) from the shaft (F5).
2. If the oil seal (F9) is to be replaced extract it from the housing (A18). Ensure that the new oil seal is pressed squarely into the housing.
3. Reposition the oil seal housing onto the shaft having first lubricated the seal running surface with clean gear box oil.
4. Re-fit the output bearing (F8) spacer (F7) and circlip (F6). Reassemble the output shaft into the rear case.
5. Coat the surface of the oil seal housing (A18) with silicon RTV sealing compound and insert the four bolts (A9) tightening to the correct torque (see torque chart page 28)
6. Re-assemble output gear (F4) bearing (F3) locknut (F10) and washer (F2). Tighten nut to correct torque (see torque chart page 28) making sure the tab washer is correctly fitted into the nut slot.

10.6.2 Replacement of input shaft oil seal

1. Remove gearbox from the boat as instructed in section 10.3, 1-4.
2. The input seal (D1) can now be removed with the use of a suitable lever to extract the seal. Be careful not to damage either the shaft seal diameter or the outer case diameter.
3. Coat the shaft seal diameter with clean gearbox oil and gently tap in new seal to a depth of 7.0mm from the gearbox face, (see drawing section A).

10.6.3. Replacement of front case seals - layshaft/output shaft

1. These two seals can easily be removed by punching a hole through them with a screwdriver and gently levering out.
2. Fit new seals, gently tapping into the case by using a flat piece of material in conjunction with a soft mallet to be flush with the case surface. Make sure the seals are fitted square so that they do not "spring" out.

11. SPECIAL TOOLS

Output shaft nut tube spanner PR23131

11.1 Tool kit

Dipstick 18mm A/F
Drain plug 15mm A/F
Spanners 10mm A/F
 13mm A/F

11.2 Tightening torques (Note: These figures are for dry threads only).

RECOMMENDED TIGHTENING TORQUES		
	Nm	lbf.ft
Front to rear gearcase bolts	30.0	22.0
Pump adaptor/manifold to gearcase	30.0	22.0
Oil seal housing to gearcase	30.0	22.0
Output shaft locknut (tabbed)	135.6	100.0
Operating lever to selector valve	22.0	16.0
Clutch pack	14.0	10.3
Adaptor plate to gearcase	30.0	22.0
Input shaft/layshaft locknut	80.0	59.0

12. REPLACEMENT PARTS ORDERING

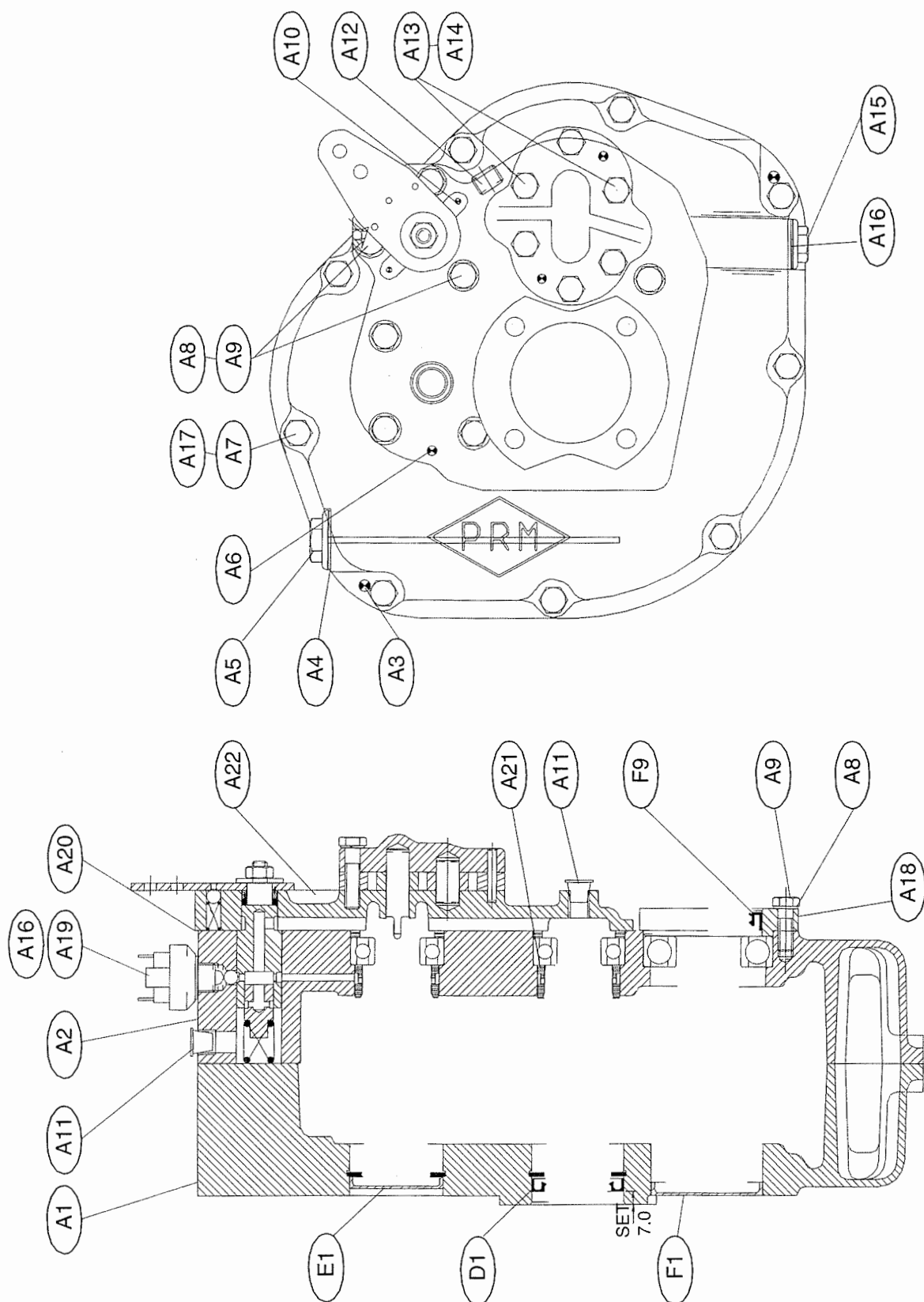
When ordering replacement parts the following should be quoted:

- a) Gearbox model and serial number
- b) Description(s) and part number(s) of the component(s) required
- c) Quantity required
- d) Orders and enquiries for replacement parts must be made through Newage distributor/dealer network

NOTE: Enquiries relating to a technical or service nature can be made direct to:

NEWAGE TRANSMISSIONS LTD.
BARLOW ROAD
COVENTRY CV2 2LD
ENGLAND
TEL: +44 (0)1203 617141
FAX: +44 (0)1203 611845
EMAIL: mail@newage-prm.co.uk
WEBSITE: http://www.newage-prm.co.uk

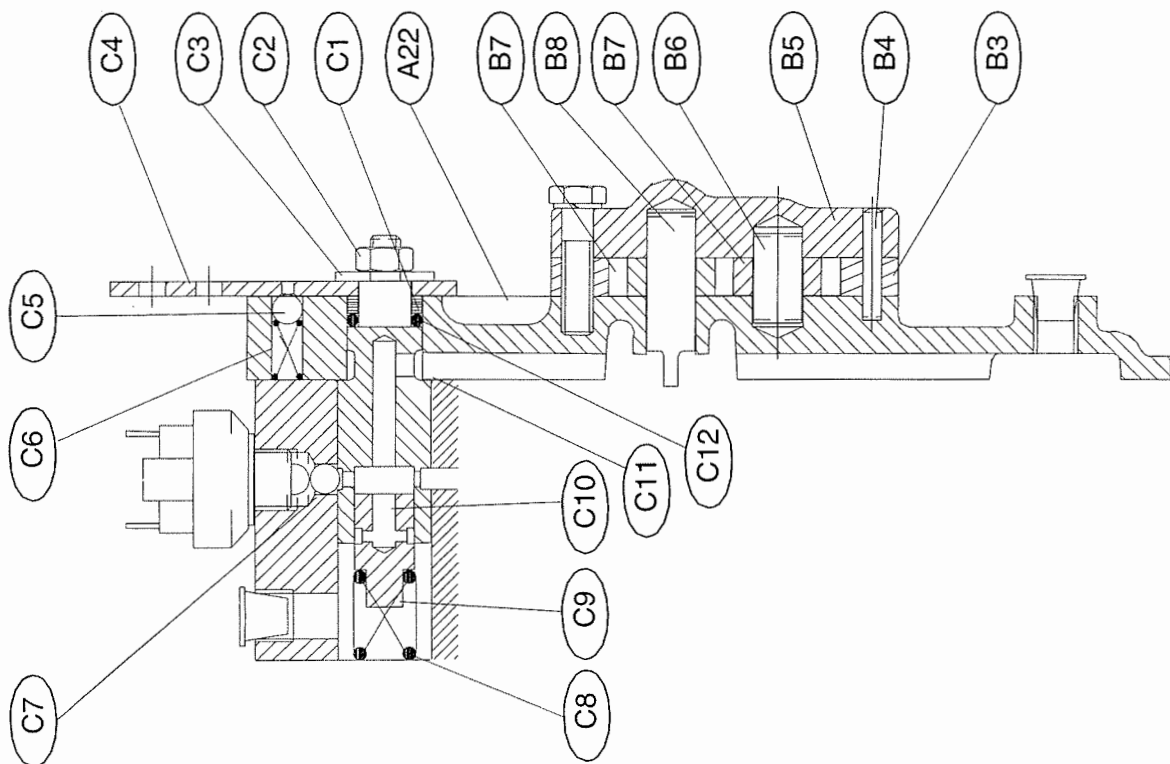
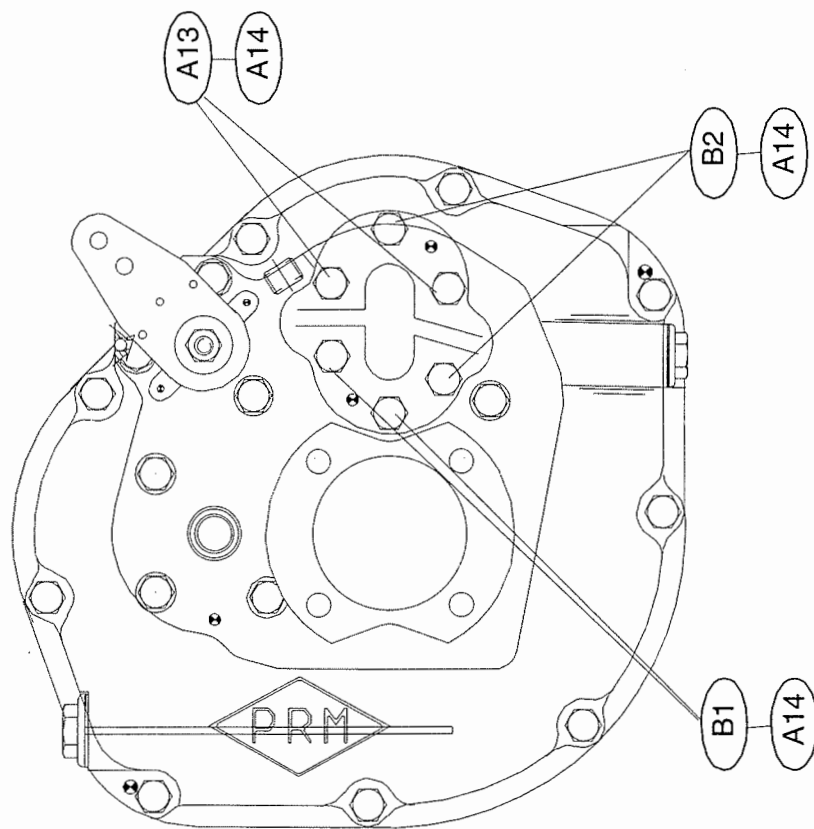
PARTS LIST



SECTION A - GEARCASE ASSEMBLY			
ITEM NO.	DESCRIPTION	PART NO.	QTY
A1	Front gearcase	MT4898	1
A2	Rear gearcase	MT4899	1
A3	Dowel 6 dia x 20 long	0210620	2
A4	Bonded seal 1/2" BSP	0201714	1
A5	Dipstick	0800550	1
A6	Dowel 3/16" dia x 1/2" long	022D304	2
A7	Bolts M8 x 45	0040812ZP	9
A8	Spring washer	0191105ZP	11
A9	Screw M8 x 25 long	0040808ZP	11
A10	Spirol Pin 3 dia x 8 long	028S308	2
A11	Protection cap (for transit)	0161012	2
A12	Pressure plug 1/8 BSP	MT311	1
A13	Bolt M8 x 60 long	0040815ZP	2
A14	Bonded seal 5/16" dia	CP1223	2
A15	Drain plug M16	CP1360	2
A16	Bonded seal M16	0191716	2
A17	Nut M8	0050810	9
A18 + F9	Seal housing sub assy	MT3173S/A	1
A19 *	Switch (if fitted)	CP1358	1
A20	Gasket**	MT3177	1
A21	Feeder	MT3175	2
A22	Manifold	MT3176	1
Not illustrated	Socket wrench	CP1362	1

* If switch and ball are not fitted then tapping will be blanked off with plug CP1360

** Modification 11382 was Part No. MT3029 introduced at Serial No. C914601 February 1998 onwards.



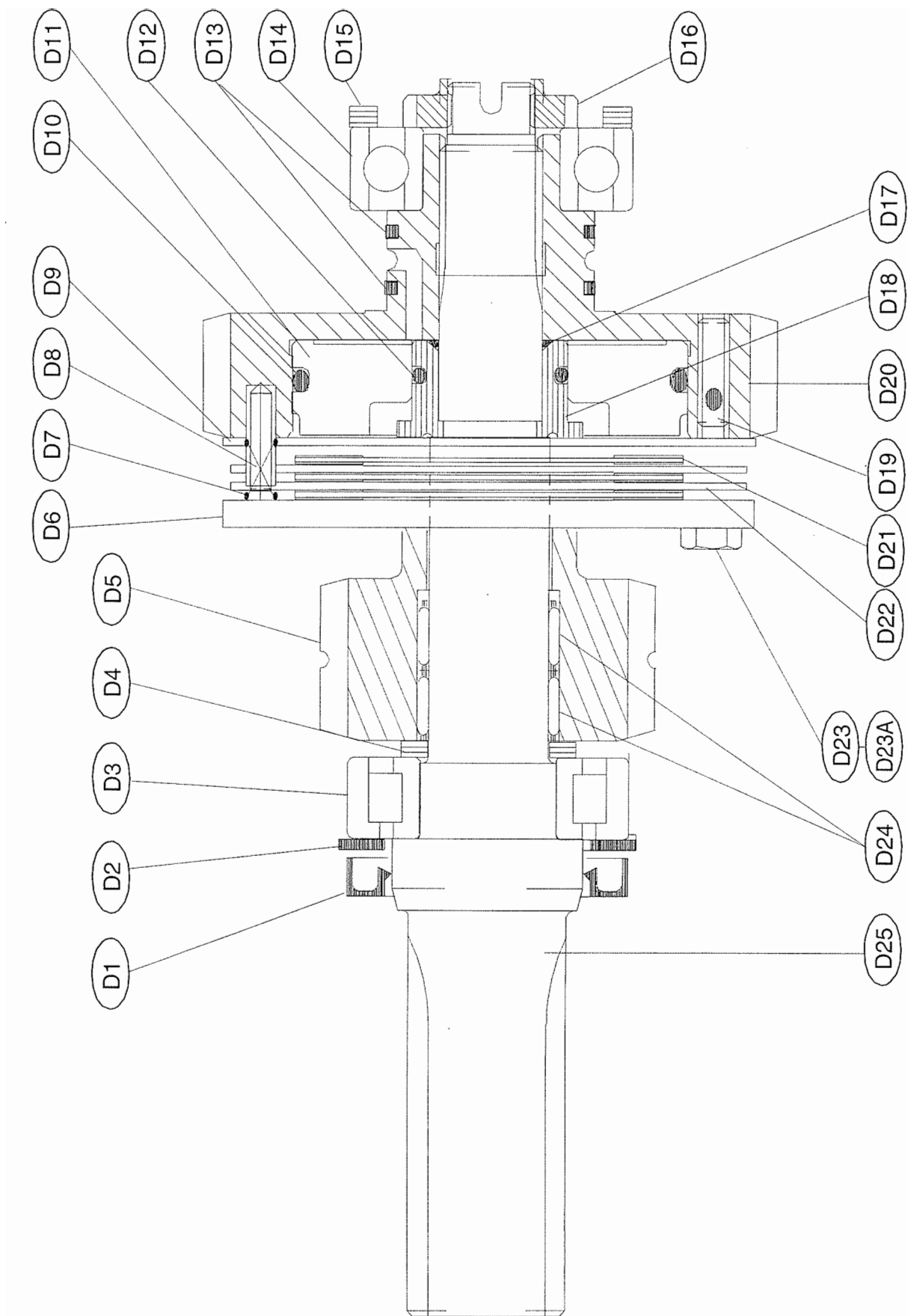
SECTION B - OIL PUMP ASSEMBLY			
ITEM NO.	DESCRIPTION	PART NO.	QTY
B1	Bolt M8 x 30 long	0040809ZP	2
B2	Bolt M8 x 35 long	0040810ZP	2
A14	Bonded seal $\frac{5}{16}$ " dia	CP1223	4
B3	Pump plate	MT320	1
B4	Dowel $\frac{3}{16}$ " x 1. $\frac{1}{8}$ " long	MT356	2
B5	Pump cover	MT3049	1
B6	* Pump spindle	MT325	1
B7	* Pump gear	MT323	2
B8	* Spindle	MT3028	1
B7/B8	* Spindle sub assembly	MT3028S/A	1

Pump repair kit MT0163 comprising items as indicated*. These are not supplied separately.

Pump assembly kit MT0421 - kit

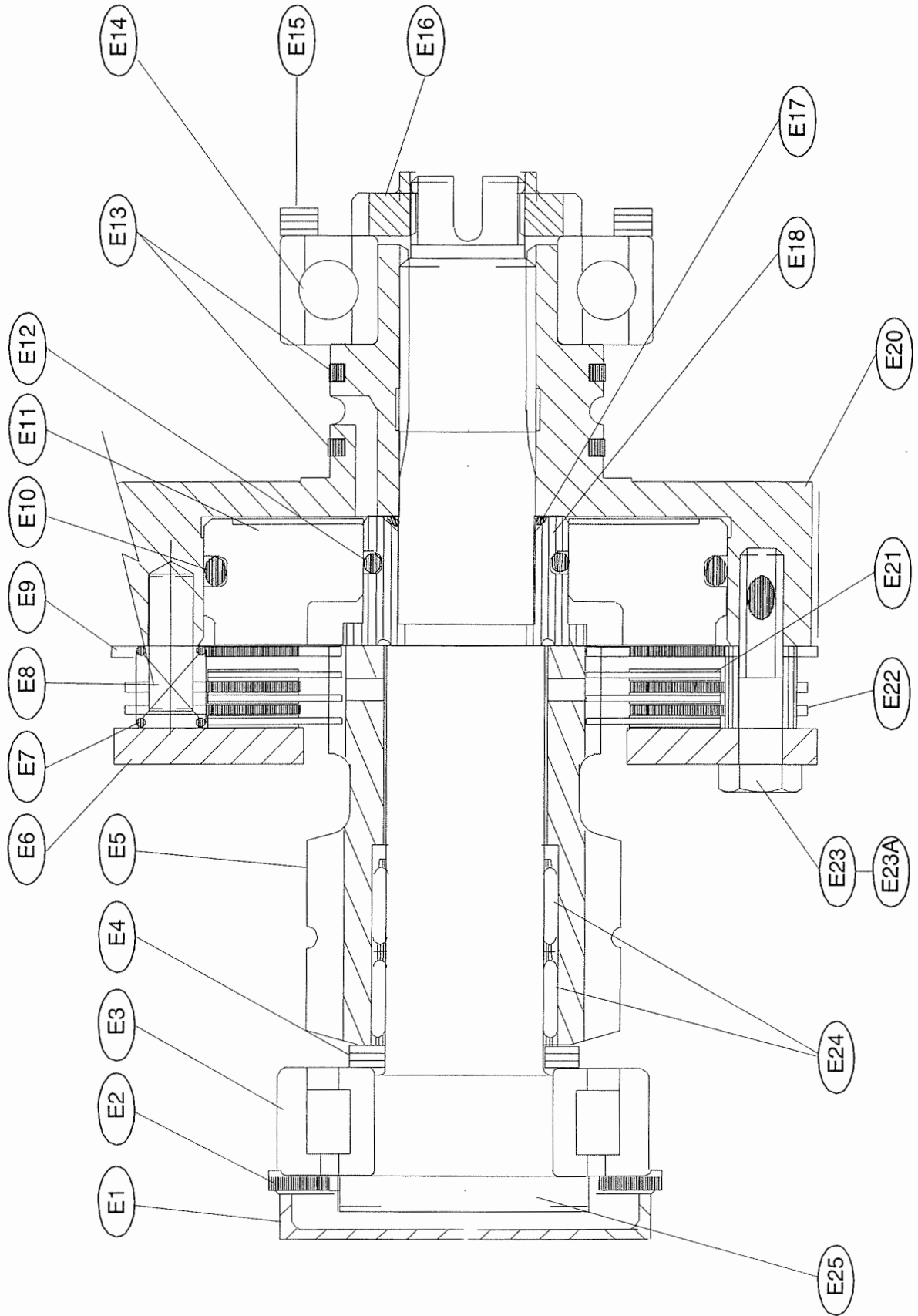
SECTION C - SELECTOR VALVE ASSEMBLY			
ITEM NO.	DESCRIPTION	PART NO.	QTY
C1	Spacer	MT3052	1
C2/A17	Nut M8	0050810	1
C3	Washer	MT979	1
C4	Operating lever	MT977	1
C5	Steel ball 8mm	066M080	1
C6	Spring	MT3045	1
C7	Steel ball 8mm (if fitted)	066M080	1
C8	Spring	MT3051	1
C9	Relief valve	MT3026	1
C10	Selector valve	MT3025	1
C11/A20	Gasket** (see page 31)	MT3177	1
C12	'O' ring**	04301525	1

Valve block 'O' ring gasket kit MT0391 comprising items as indicated**.



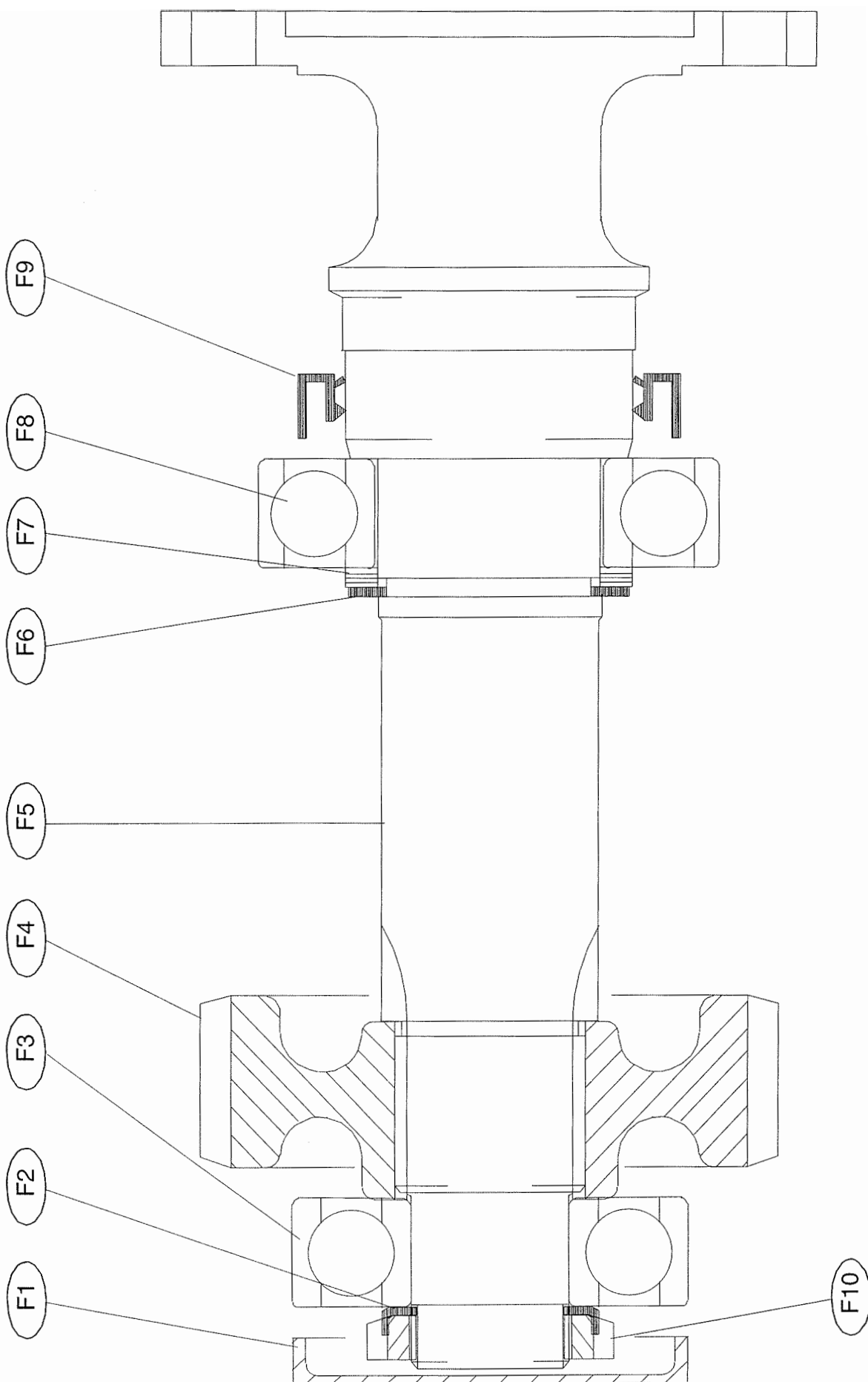
SECTION D - INPUT SHAFT ASSEMBLY			
ITEM NO.	DESCRIPTION	PART NO.	QTY
D1	Oil seal	0400354	1
D2	Circlip (internal)	0250520	1
D3	Bearing	0532522	1
D4 *	Thrust washer	MT3022	1
D5	Pinion and bearing sub-assy (1.5:1)	MT3166 S/A	1
	Pinion and bearing sub-assy (2.0:1)	MT3167S/A	1
	Pinion and bearing sub-assy (3.0:1)	MT3168S/A	1
D6 *	Clutch end plate	MT3165	1
D7 *	Spring	MT3024	3
D8 *	Guide pin	MT3021	3
D9 *	Clutch end plate	MT117	1
D10	'O' ring	002874	1
D11	Piston	MT3170	1
D12	'O' ring	001123	1
D13	Piston ring	MT369	2
D14	Ball bearing	0512528	1
D15	Spacer	MT3174	1
D16 *	Special locknut	MT8118	1
D17	'O' ring	000872	1
D18	Sealing collar	MT3172	1
D19	Grub screw	014F420L	2
D20	Clutch gear	MT3164	1
D21	Clutch plate	MT731/S	3
D22 *	Clutch plate	MT116	2
D23 *	Screw M6 x 30	0040609HTP	6
D23A *	Ferrule	MT3066	6
D24	Needle bearing	0562213	2
D25	Input shaft	MT3160	1

Clutch repair kit - Part No. MT0436 comprising items as indicated *. Clutch plates not sold separately.



SECTION E - LAYSHAFT ASSEMBLY			
ITEM NO.	DESCRIPTION	PART NO.	QTY
E1	Shamban seal	069050206	1
E2	Circlip (internal)	0250520	1
E3	Bearing	0532522	1
E4 *	Thrust washer	MT3022	1
E5	Pinion and bearing sub-assy (1.5:1)	MT3166S/A	1
	Pinion and bearing sub-assy (2.0:1)	MT3167S/A	1
	Pinion and bearing sub-assy (3.0:1)	MT3168S/A	1
E6 *	Clutch end plate	MT3165	1
E7 *	Spring	MT3024	3
E8 *	Guide pin	MT3021	3
E9 *	Clutch end plate	MT117	1
E10	'O' ring	002874	1
E11	Piston	MT3170	1
E12	'O' ring	001123	1
E13	Piston ring	MT369	2
E14	Ball bearing	0512528	1
E15	Spacer	MT3174	1
E16 *	Special locknut	MT8118	1
E17	'O' ring	000872	1
E18	Sealing collar	MT3172	1
E20	Clutch gear	MT3163	1
E21 *	Clutch plate	MT731/S	3
E22 *	Clutch plate	MT116	2
E23 *	Screw M6 x 30	0040609HTP	6
E23A *	Ferrule	MT3066	6
E24	Needle bearing	0562213	2
E25	Layshaft	MT3161	1

Clutch repair kit - Part No. MT0436 comprising items as indicated *. Clutch plates not sold separately.

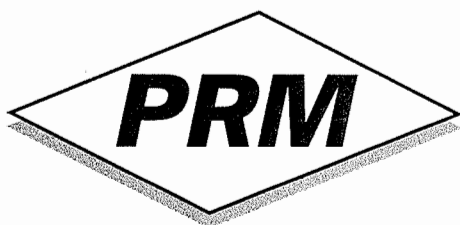


SECTION F - OUTPUT SHAFT ASSEMBLY			
ITEM NO.	DESCRIPTION	PART NO.	QTY
F1	Shamban seal	06906208	1
F2	Lockwasher	010W251	1
F3	Bearing	AM161	1
F4	Wheel (1.5:1)	MT3012	1
	Wheel (2:1)	MT3010	1
	Wheel (3:1)	MT3171	1
F5	Output shaft	MT3162	1
F6	Circlip	0330350	1
F7	Spacer	MT3089	1
F8	Bearing	CM2017	1
F9	Seal	0400454	1
F10	Locknut	010N251	1
	'O' ring/seal kit containing all gaskets seals etc. for complete gearbox	MT0433	1

REPAIR KITS AVAILABLE

Piston ring kit	MT0437
Clutch pack kit	MT0436
Pump repair kit	MT0163
'O' ring/seal kit	MT0433
Pump assembly kit	MT0421 - kit
Valve block 'O' ring gasket kit	MT0391

NOTES



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Certificate No. Q10728

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Newage Transmissions Ltd. is a member of BI Group Plc.
Registered in England - No 345283
Registered Office - Neville House, 42-46 Hagley Road,
Birmingham B16 8PZ
Printed in England by Beechwood Litho (024) 7671 3792