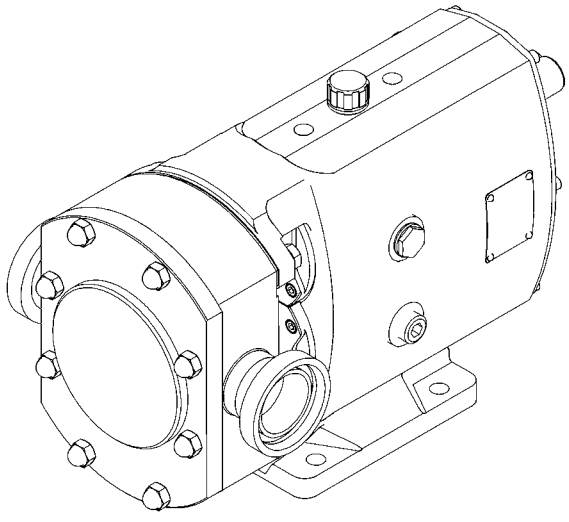
Series S

Stainless Steel Positive Displacement Rotary Lobe Pumps

Operating Manual



M/101/0211

EC Declaration of Incorporation

The designating company

Alfa Laval

Company Name

Birch Road, Eastbourne, East Sussex BN23 6 PQ

Address

Phone: (01323) 412555 Fax: (01323) 412515

Phone and Fax No.

We hereby declare that the following machinery is intended for installation into a machine or to be assembled with other machines into a machine. It must **not** be put into service until the machinery into which it is incorporated has been declared in conformity with the provisions of the Machinery Directive 89/392/EEC, amendments 91/368/EEC, 93/44/EEC, 93/68/EEC.

Machine Description: **Rotary Lobe Pump**

Type/Size:

Serial Number:

This machinery has been designed and manufactured in accordance with the following transposed harmonised European Standards:

EN292: **Parts 1 and 2: 1991 Safety of Machinery - Basic Concepts, general principles for design.**

EN 294: **1992 Safety distances to prevent danger zones being reached by the upper limbs.**

ISO9001: **2000 Quality Management System.**

A technical construction file for this machinery is retained at the above address.

Signed _____ Date _____

(Authorised Person)

Name **P. Sweet** Position **Quality Manager**

EC Declaration of Conformity

The designating company

Alfa Laval
Company Name

Birch Road, Eastbourne, East Sussex BN23 6 PQ
Address

Phone: (01323) 412555 Fax: (01323) 412515
Phone and Fax No.

We hereby declare that the following machinery conforms to the machinery directive 89/392/EEC as amended by 91/368/EEC, 93/44/EEC and 93/68/EEC and to the following other relevant directives. The machinery has been designed and manufactured in accordance with the transposed harmonised European standards; European and national standards as listed:

Machine Description: **Rotary Lobe Pump - Motorised**

Type/Size: _____ Serial Number: _____

Other Applicable Directives: **Electrical Equipment Low Voltage 73/23/EEC**

Electromagnetic Compatibility 89/336/EEC

This machinery has been designed and manufactured in accordance with the following transposed harmonised European Standards:

EN292: **Parts 1 and 2: 1991 Safety of Machinery - Basic concepts, general principles for design.**

EN294: **1992 Safety distances to prevent danger zones being reached by the upper limbs.**

EN60204: **Part 1: 1993 Safety of Machinery - Electrical equipment of machines - specification for general requirements.**

BS5304: **1988 Code of Practice for Safety of Machinery.**

ISO9001: **2000 Quality Management System.**

A technical construction file for this machinery is retained at the above address.

Signed _____ Date _____
(Authorised Person)

Name **P. Sweet** Position **Quality Manager**

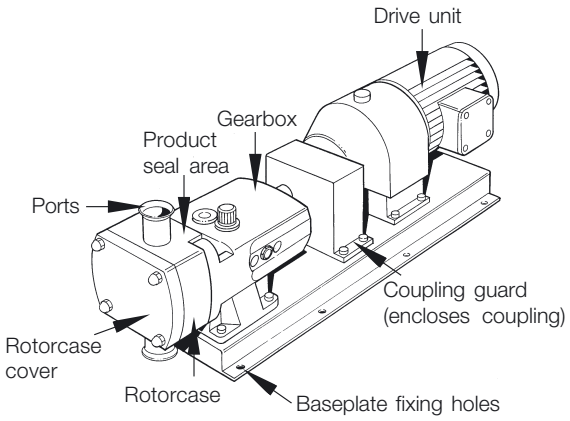
CE

The information contained herein is correct at the time of issue but may be subject to change without prior notice.

The Series S pump supplied is a positive displacement rotary lobe pump; it may be supplied with or without a drive unit (see drawing). The drawing shown indicates various parts of the pump unit.

The Series S range has a universal gearbox design in models S1 - 4. This enables the flexibility of mounting pumps with the inlet and outlet ports in either a vertical or horizontal plane. The port orientation, vertical or horizontal, may be changed by moving one of two available bolt-on feet on the gearbox. Port orientation should be specified when ordering, but the alternative foot design allows pumps that are already installed being changed should the need arise.

Models S5 & 6 pumps can also have the inlet and outlet ports in either horizontal or vertical plane. This is achieved by the use of dedicated gearbox castings having either horizontal or vertical shaft arrangements.



Pump duty conditions

The pump should only be used for the duty for which it has been specified. The operating pressure, speed and temperature limits have been selected at the time of order and MUST NOT be exceeded. These details are stated on the original order documentation and if not available may be obtained from your supplier quoting pump model and serial number.

Noise levels

Under certain operating conditions pumps and/or drives and/or the systems within which they are installed can produce sound pressure levels in excess of 85dB[A]. When necessary, protection against noise should be taken.

Unsafe practices and other important information are emphasized in this manual.
Warnings are emphasized by means of special signs.

Always read the manual before using the pump!

WARNING!
Indicates that special procedures **must** be followed to avoid severe personal injury.

CAUTION!
Indicates that special procedures **must** be followed to avoid damage to the pump.

NOTE!
Indicates important information to simplify or clarify practices.

General warning:

Dangerous electrical voltage:

Caustic agents:

All warnings in the manual are summarised on this page.
Pay special attention to the instructions below so that severe personal injury or damage to the pump are avoided.

Installation

- **Always** observe the technical data (see chapter 5).
- **Never** start in the wrong direction of rotation with liquid in the pump.
- **Never** put your hands or fingers inside the port connections or anywhere close to rotating shafts.

The pump **must** be electrically connected by authorised personnel (see the motor instructions supplied with the drive unit).

Operation

- **Always** observe the technical data (see chapter 5).
- **Never** touch the pump or the pipelines when pumping hot liquids or when sterilising.
- **Never** stand on the pump or pipelines.
- **Never** run the pump with both the suction side and the pressure side blocked.
- **Never** put your hands or fingers inside the port connections or anywhere close to rotating shafts.

Only handle toxic and acidic liquids in accordance with their manufacturers instructions and recommendations.

Maintenance

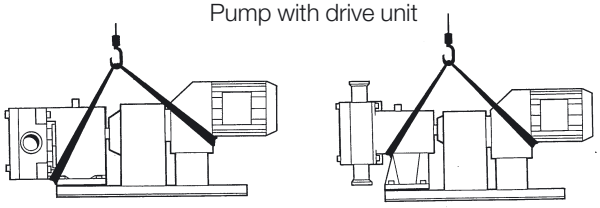
- **Always** observe the technical data (see chapter 5).
- The pump must **never** be serviced when hot.
- The pump and the pipelines must **never** be pressurised when the pump is being serviced.
- **Never** put your hands or fingers inside the port connections or anywhere close to rotating shafts.

Always disconnect the power supply when the pump is being serviced.

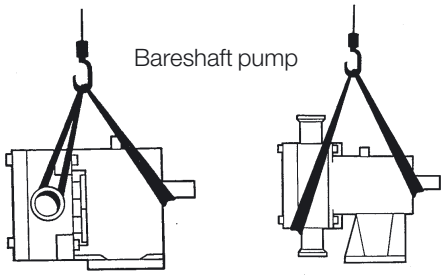
Step 1
Refer to the pump weights guide (chapter 5) before selecting and using any lifting gear. The drawings show how the pump should be lifted.

Ensure that lifting equipment is correctly rated and used within these limits.

Pump with drive unit



Bareshaft pump

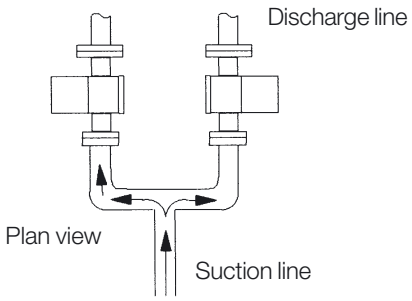


Step 2
On receipt always:
- Check the delivery note against the goods received.
- If motorised, check that the drive instructions are available.
- Inspect the packing for signs of damage in transit.
- Carefully remove the packing away from the pump.
- Inspect the pump for any visible signs of damage.
- Clean away the packing from the pump port connections.
- Report any damage immediately to the carrier.

Step 3
After receipt and inspection, if the pump is not to be installed immediately, the pump should be repacked and placed in suitable storage. The following points should be noted:

- Plastic or gasket type port covers should be left in place.
- Pumps received wrapped with corrosion inhibiting treatment material should have wrapping replaced.
- A clean, dry storage location free from vibration should be selected. If a moist or dusty atmosphere is used for storage, further protect the pump or unit with a suitable cover.
- Rotate the pump/pump unit by hand weekly, to prevent bearing damage.
- All associated ancillary equipment should be treated similarly.

Step 1
When designing the pumping system:
- Confirm the Net Positive Suction Head requirements of the pump (NPSHr) are met by the system, as this is crucial for ensuring the smooth operation of the pump and preventing cavitation.
- Avoid suction lifts and manifold/common suction lines for two pumps running in parallel, as this may cause vibration or cavitation.
- Protect the pump against blockage from hard solid objects e.g. nuts, bolts etc. Also protect the pump from accidental operation against a closed valve by using one of the following methods: - relief valves, pressure switch, and current limiting device.



Step 2
Before the pump is installed it is advisable to consider the following:

Always
- ensure that the mounting surface is flat to avoid distortion of the baseplate, as this will cause pump/motor shaft misalignment and pump / motor unit damage.

Check
- pump shaft to motor shaft alignment is within manufacturers limits once the base plate has been secured.

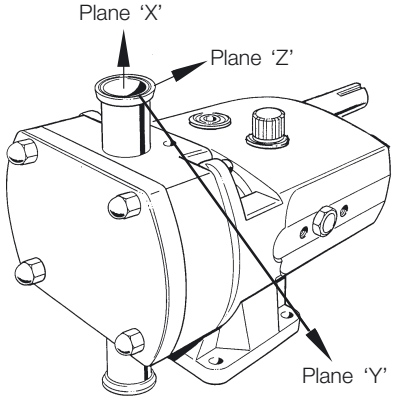
Always allow at least 1 m for pump access / maintenance all around the pump.

- Fit suction and discharge pressure monitor points for diagnostic purposes.
- Fit valves if two pumps are to be used on manifold/common discharge lines.
- Make the necessary piping arrangements if flushing is required for the seal or if media is required for heating/cooling jackets.
- **Do not** subject the pump to rapid temperature changes. Pump seizure can result from thermal shock.

Step 3
All pipework must be supported. The pump must not be allowed to support any of the pipework weight beyond the limits set in the following table.

Remember:
Pipework supports must also support the weight of the product being pumped.

Always:
- Design short straight suction lines to reduce friction losses in the pipework thereby improving the NPSH available from the system.
- Avoid bends, tees and any restrictions close to either suction or discharge side of pump. Use long radius bends wherever possible.
- Provide isolating valves on each side of the pump to isolate the pump when necessary.
- Keep pipework horizontal where applicable to reduce air locks. Include eccentric reducers on suction lines.



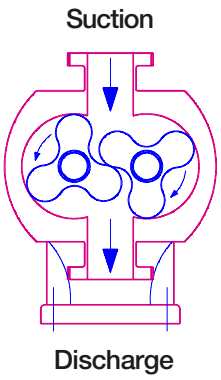
Step 3 - continued

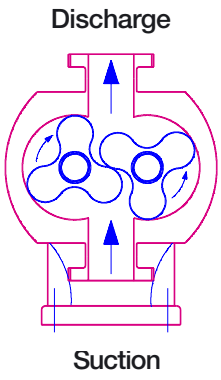
Table of Maximum Forces and Moments

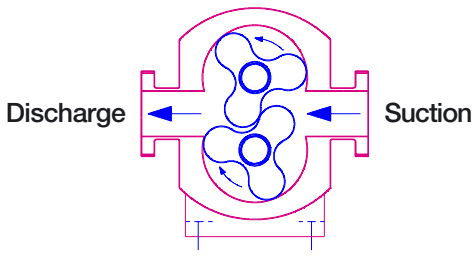
Pump Model			Forces				Moments			
			FZ	FY	FX	EF	MZ	MY	MX	EM
S1	Forces	N *lbf*	80 *18*	60 *13*	70 *16*	120 *27*				
	Moments	Nm *lbft*					75 *55*	90 *66*	115 *85*	165 *122*
S2	Forces	N *lbf*	125 *28*	100 *22*	110 *25*	195 *44*				
	Moments	Nm *lbft*					90 *66*	105 *77*	130 *96*	190 *140*
S3/4	Forces	N *lbf*	165 *37*	135 *30*	150 *34*	260 *58*				
	Moments	Nm *lbft*					100 *74*	115 *85*	140 *103*	205 *151*
S5/6	Forces	N *lbf*	300 *67*	250 *56*	250 *56*	460 *103*				
	Moments	Nm *lbft*					125 *92*	145 *107*	175 *129*	260 *192*

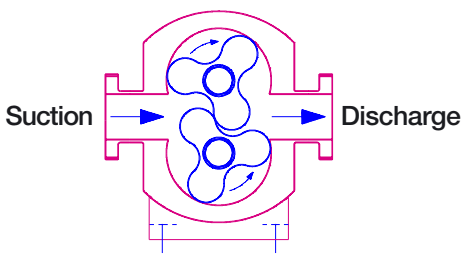
Step 4

The direction of flow is dictated by the direction of rotation of the drive shaft. Reversing the direction of rotation will reverse the flow direction.









Step 5
The pump will not be supplied pre-filled with oil therefore this table must be used to select recommended oil.

Oil changing: Oil level must be checked with the pump static.

First change: After 150 hours of operation, thereafter every 3000 hours of operation.

Oil filling: Fill with oil through the filler plug to the level indicated in the sight glass.

NOTE!
On horizontally ported pumps the sight glass must be fitted to the upper hole on the side of the gearcase.
Refer to technical data (chapter 5) for oil quantities required.

Pump Operating Temperature	
-20°C to +130°C (-4°F to +266°F	**+130°C to 200°C** (+266°F to 392°F)
BP Energol GR - XP150	BP GRS15
Castrol Alpha SP150	Castrol Alpha SN150
Mobil Gear 629	Mobil Glycoyle 30
Shell Omala 150	Shell Tivela WA
Texaco Meropa 150	Texaco Synlube SAE90
Esso Spartan EP150	Esso IL1947

Step 1

A flushed seal arrangement is fitted in order to cool or clean the seal area.

It is important that:

- The flush is correctly connected (see below).
- A compatible flushing fluid is used and supplied at the correct pressure and flow rate.
- The flush is turned on at the same time/prior to starting the pump, and turned off at the same time/after stopping the pump.

Step 2

Connecting the flush

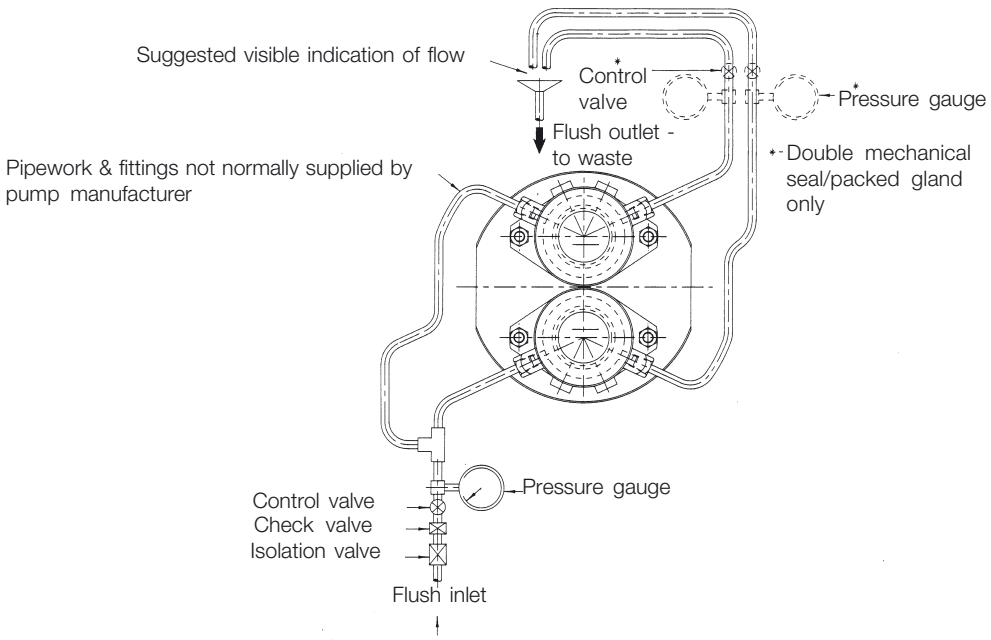
The following equipment is strongly recommended when using a flushing system:

- Control valve and pressure gauge, to enable the correct flushing pressure to be obtained and monitored.
- Isolation valve and check valve, so that the flush can be turned off, and to stop any unwanted substances flowing in the wrong direction.
- A method of visibly indicating flushing fluid flow.

Step 3

Flusing pipework

This suggested arrangement is for single mechanical seals. If the pump is fitted with double mechanical seals or packed glands the pressure gauges and control valves should be fitted on the outlet side of the system.



Step 4

Flushing fluid

The choice of flushing fluid is dependent upon the fluid being pumped and duty conditions i.e. pressure and temperature. Usually water is used for cooling or flushing water soluble products. For advice on selecting a suitable flushing fluid please contact pump supplier.

Step 5

Flusing pressure and flow rate

Single mechanical seal 0.5 bar *(7 psi)* maximum. Any further increase in pressure will result in lip seal failure.
Double mechanical seal/flushed packed gland 1.0 bar *(14 psi)* higher pressure than the discharge of the pump. If the discharge pressure fluctuates set the pressure to suit maximum condition.

The flushing flow rate must be adequate to ensure that the temperature limitation of the seals is not exceeded. Contact your pump supplier for further information on the recommended flow.

Step 6

Pre-start up checks

- Check the pipework system has been purged to remove debris.
- Check all obstructions have been removed from pipework and pump.
- Check pump connections and pipework joints are tight.
- Check lubrication levels are correct.
- Check seal flushing is connected if applicable.
- Check all safety guards are in place.

The pump can be manually cleaned or cleaned in place (CIP). The following is an example of a typical CIP procedure. However specific advice for each application should be sought from the pump supplier.

Typical CIP procedure

1. Flush through the system with cold water or bore water (6°) *(43°F)*.
2. Run hot caustic soda (70-80°C) *(158-176°F)* at 2.5% dilution through the system for 20-30 minutes.
3. Final flush through with cold water again.

Warnings

- **Never** touch the pump or the pipelines as they will be extremely **hot!**
- **Do not** subject the pump to rapid temperature changes during CIP procedures, as pump seizure can result from thermal shock. A suitable by-pass is recommended.
- **Always** rinse well with clean water after using a cleaning agent.

- **Always** use rubber gloves and protective goggles when handling caustic agents.
- **Always** store/discharge cleaning agents in accordance with current rules/directives.

It is advisable to install pressure gauges on both sides of the pump so that any problems within the pump/pipework can be monitored.

Maintenance schedule
Your weekly schedule should include:
- Checking the oil level in the gearcase with the pump stationary.
- Checking the seals for leakage and replacing as necessary.
- Checking the oil seals for leakage.
- Check pumping pressures.

In certain operational circumstances the pump will pose a thermal hazard and as such should not be touched during operation. After shutdown the pump unit should be allowed time to cool.

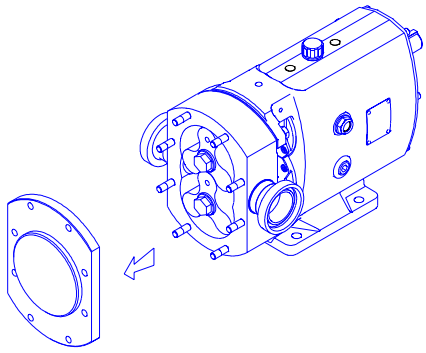
Oil should be changed every 3000 hours of operation or a period of 2 years, whichever is the soonest.

Recommended Spare Parts
The table shows recommended spare parts that should be retained within your maintenance schedule.

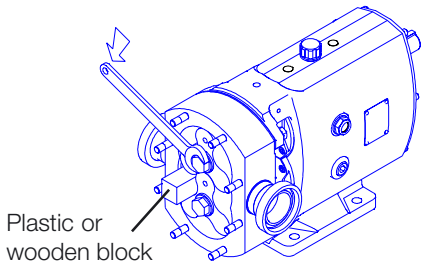
Part description	Quantity
Lip seal drive end	1
O-ring rotorcase cover	1
Lip seal gland end	2
O-ring rotor sealing shaft end	2
O-ring rotor sealing nut end	2
Primary seals	2

Step 1
Before disassembling the pump refer to safety precautions. See exploded view drawings (chapter 6).

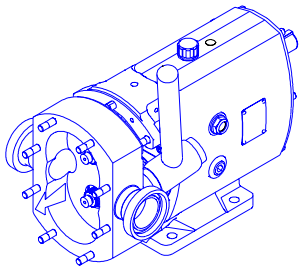
Removing rotorcase cover
Remove rotorcase cover nuts (13) and cover (12).



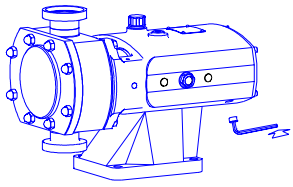
Step 2
Removing rotors
1. Insert a plastic/wooden block between the two rotors (17) to stop them turning.
2. Remove rotor retention nuts (22) and rotors. Pump models S6 rotors are retained by torque locking assemblies, TLA's (19) and can be removed by:
   - Loosening each TLA screw in several stages in a diametrically opposite sequence.
   - Use bolts to screw into two of the TLA holes (fitted with washers) and extract the TLA's.

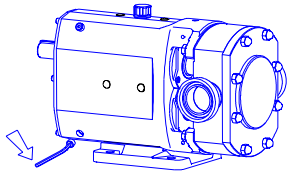


Step 3
Removing rotorcase
1. For packed gland seals loosen the gland followers to relieve the packing pressure on the shaft.
   For flushed mechanical seal arrangements, remove the seal housing retaining nuts and ease the seal housings from the rotorcase.
2. Remove rotorcase retaining nuts (4) and washers (4A).
3. Tap both sides of the rotorcase (9) with a soft mallet.
4. **Take care not to damage mechanical seals.** The rotorcase must not be allowed to drop onto the shafts (24 and 25) during the removal process.
5. Shims (8) should not be removed unless rotor clearances require resetting.



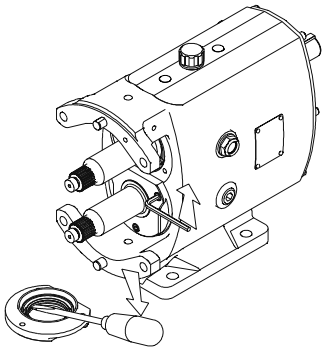
Step 4
Draining pump lubrication
1. Place a tray under the gearcase to collect the waste lubricating oil.
2. Remove the lower drain plug (45) at the side of the gearcase (1).





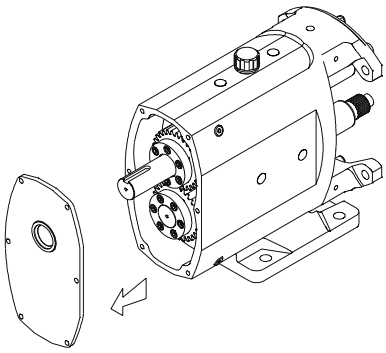
Step 5
Removing seal retainers

1. Remove screws (15).
2. Then remove seal retainers (14) - as a liquid sealant has been used a lever may be required to remove retainers.
3. The lip seals (16) can be removed using a screwdriver/ lever once the seal retainers are removed. It is essential to renew the lip seals and it is recommended that new gaskets or sealant be used prior to reassembly.



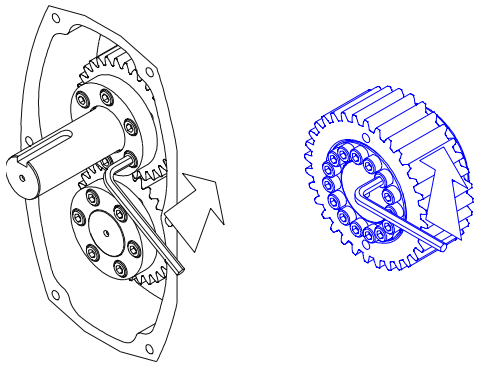
Step 6
Removing Gearcase Cover

1. Remove screws (6).
2. Remove gearcase cover (5) after breaking the gasket seal then press out the lip seal (7). It is essential to renew the lip seal prior to reassembly.



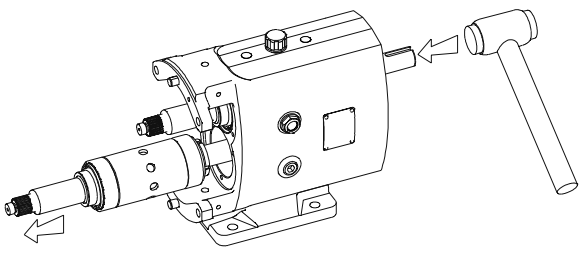
Step 7
Removing timing gears

1. Release clamp plate screws (40) on pump models S1, 2 and 3. Release the torque locking assembly screws in several stages on pump models S4, 5 and 6.
2. Remove gears (36) using the tapped extraction holes provided, or remove shaft assembly as shown in step 8 below.



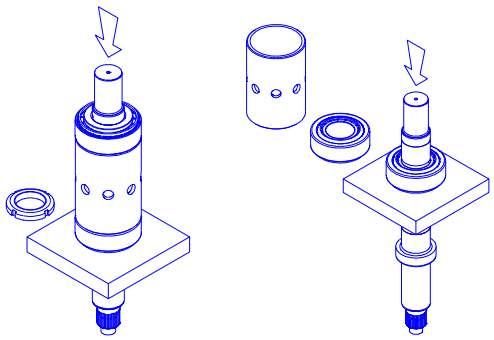
Step 8
Shaft assembly removal

1. Using a soft mallet gently tap the rear end of each shaft (24 and 25), to remove through the front of the gearcase (1).
2. Support each shaft during removal from the gearcase.
3. Remove the shaft abutment spacer (27) from:
   - On models S1, 2, 3 and 4 and horizontally ported 5 and 6 pumps, the bearing bore opposite the rotorcase mounting face with the additional machining mark.
   - On models S5 and 6 vertically ported pumps, the right hand bearing bore when viewed from the front of the pump.



Step 9
Bearing removal

1. Hold the shafts (24 and 25) in a vice using soft jaws to protect the areas where the seals will be located.
2. Remove the bearing nuts (30) with a ‘sharp tap’ on a ‘C’ spanner. The nuts may be tight all the way off as they are fitted with thread locking adhesive.
3. Mount the shaft vertically in a press with a tool positively located against the bearing inner as shown and apply pressure to the top of the shaft so that the shaft moves through the bearings (26 and 31).
4. Remove each bearing set (inner and outer). Good engineering practice suggests that if bearings are removed from the shafts for any reason they should be renewed.



Clean and examine all components for wear or damage. Renew where necessary.

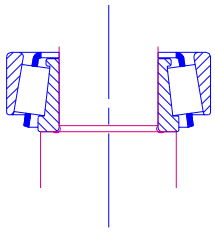
4.4.1 Fitting bearings to shafts

Take care not to damage shaft surfaces, in particular where the seals will be located.
Ensure all fasteings are tightened to torque settings as shown in Technical Data (chapter 5).

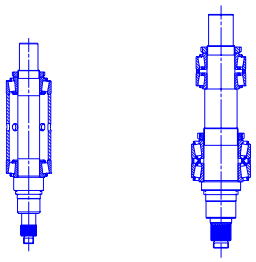
On models S1, 2 and 3 pumps, bearings do not require heating. For models S4, 5 and 6 pumps, heat the bearing inner cones to 110°C *(230°F)*.
Do not use any form of live flame when heating, as this will damage bearings.

Step 1
Position shaft (24 and 25) vertically in a vice using soft jaws and apply anti-seize compound to the bearing diameters.

Step 2
Place the inner cone on the shaft ensuring a positive fit against the shaft shoulder.



Step 3
Locate outer cup, bearing spacer (32) and rear bearing cup.



Step 4
Allow bearings to cool (models S4, 5 and 6 pumps only). Failure to do so will result in incorrectly set bearings.

1. Apply Permabond Grade 145 or equivalent locking compound to the bearing nut thread.
2. Tighten the bearing nut (30), whilst at the same time rotating the bearings (26 and 31) and spacer (32). The bearings are correctly adjusted when the spacer can only be moved with a light tap of a mallet.
3. Repeat the above for double bearing assemblies.
4. Apply oil to the bearings.

4.4.2 Fitting Shaft Assemblies

Step 1

Replace the shaft abutment spacer (27) in:

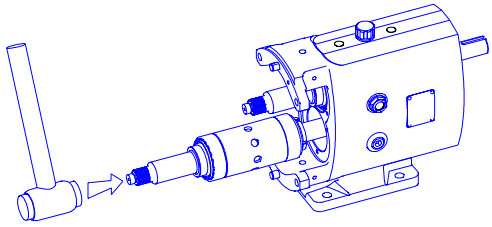
- On models S1, 2, 3 and 4 and horizontally ported 5 and 6 pumps, the bearing bore opposite the rotorcase mounting face with the additional machining mark.
- On models S5 and 6 vertically ported pumps, the right hand bearing bore when viewed from the front of the pump.

Step 2

Identify drive and auxillary shaft positions according to gearcase cover (5) orientation.

Step 3

1. Using a soft faced mallet tap the shafts (24 and 25) into the gearcase (1).
2. If the bearings have been replaced, a new abutment spacer will probably be needed. It is vital to ensure the rotor alignments is within the limits set in section 4.4.4.



4.4.3 Fitting seal retainers

Step 1

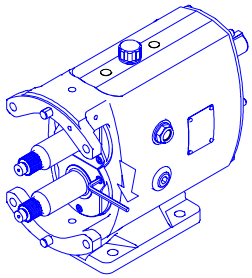
Clean the rear face of the seal retainers (14), fit in position and tighten.

Step 2

1. Check rotor alignment is correct by reffering to the rotor abutment alignment in section 4.4.4.
2. When rotor alignment is correct remove seal retainers and press new lip seals (16) into seal retainers.
3. Apply liquid sealant onto the front of the gearcase (1) and push the seal retainers into position. Make sure lip seals are not damaged when sliding them onto the shafts.

Step 3

Replace and tighten the screws (15).



4.4.4 Checking rotor abutment alignment

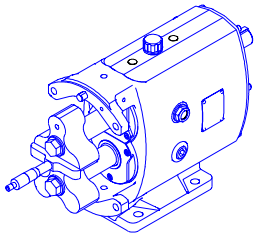
Step 1

Incorrect setting of rotor alignment will damage the pump.

Fit rotors onto shafts (24 and 25) and tighten rotor retention nuts (22).

Step 2

1. Using a depth micrometer ensure axial alignment is within tolerance of 0.012mm *(0.0005 in)*.
2. If the alignment is incorrect, the shaft abutment spacer (27) must be replaced/machined.



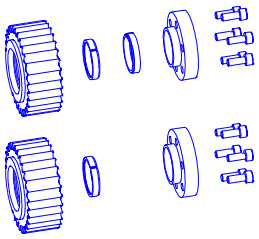
4.4.5 Fitting timing gears

Step 1

Slide timing gears (36) onto shafts (24 and 25), realigning timing marks.

Step 2

1. Before fitting the torque locking devices (38) lubricate them with gear oil. Models S1, 2 and 3 high pressure pumps have two sets of elements.
2. Models S4, 5 and 6 pumps have torque locking assemblies.



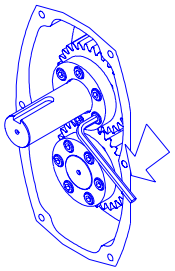
Step 3

Fit timing gear clamp plates (39) - models S1, 2 and 3 only.

Step 4

Timing adjustment is now required:

Tighten one clamp plate/torque locking assembly only, allowing rotation of the shaft in the other gear for timing adjustment. See Adjusting Rotor Timing section 4.4.6.



4.4.6 Adjusting rotor timing

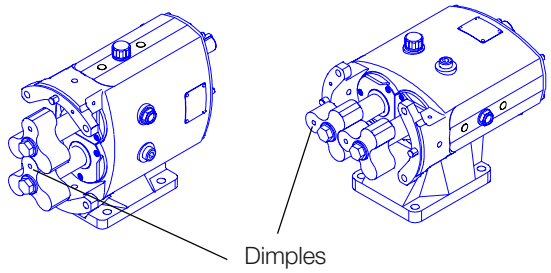
Step 1

If the rotor timing requires adjustment (and assuming the pump has not yet been re-built), it is important to establish the cause for the rotors mistiming before proceeding.

To allow timing adjustment ensure that one shaft is able to rotate within the torque locking assembly/element. The other torque locking assembly/element should be tightened to the recommended torque.

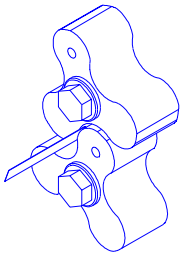
Step 2

Set the rotors (17) to the positions shown with the rotor dimples in the 6-12 o'clock plane (horizontally ported pumps) or 3-9 o'clock plane (vertically ported pumps).



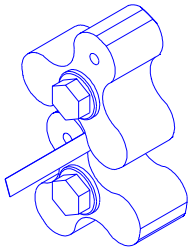
Step 3

Turn the shaft so that the rotors are in the new positions as shown.



Step 4

Using feeler gauges measure between the points indicated, turning the shaft as required.



Step 5

If the measurement points are unequal tap the rotor which is on the free turning shaft until equal measurement through 6 points is achieved.

Step 6

Tighten the torque locking assemblies or clamp plate screws. Confirm timing is still correct. Remove the rotors.

4.4.7 Fitting gearcase cover

Step 1

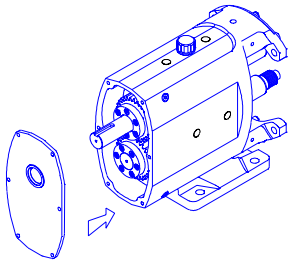
Clean the gearcase cover bore and remove all gasket material from the face. Press a new lip seal (7) into the cover (5).

Step 2

Apply liquid gasket to the face of the cover where it mates with the gearcase.

Step 3

Carefully slide the cover over the shaft ensuring the lip seal is centred and not cut or damaged. Tighten the screws (6).



4.4.8 Fitting and shimming rotorcase

The rotorcase may require re-shimming if new components have been fitted. Back clearances must be checked before operating the pump.

NOTE!

Your supplier can advise the correct clearances from the pump serial number. Should they need adjustment follow steps below. Any incorrect setting of clearances is likely to damage the pump in operation. Shims vary in colour for different thickness, and are grouped in equal packs at the top and bottom of the rotorcase held in place by shim retainers.

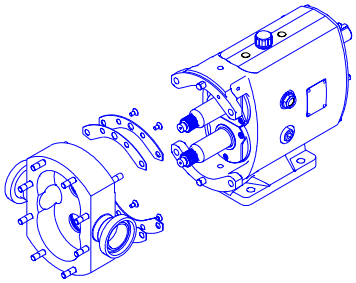
Step 1

1. Remove the shim retainers (8A) and fit one of the thinnest shims (8) to top and bottom position.
2. Replace shim retainers and screws (8B).
3. Fit the rotorcase (9) to the gearcase (1), tighten the rotorcase retaining nuts (4) and fit the rotors (17).

The back clearances can now be measured using feeler gauges. The additional shimming required to bring the clearances within tolerance can be determined, fit additional shims and re-check the clearances.

Step 2

Remove the rotorcase to allow fitting of product seals.



4.4.9 Fitting primary seals

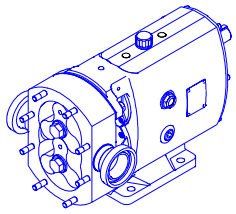
Step 1

Refer to section 4.5 for seal fitting instructions.

4.4.10 Fitting rotors

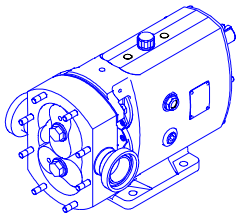
Step 1

1. Fit new rotor O rings (18).
2. Fit rotors (17) onto the shafts (24 and 25) with both dimpled rotor master lobes in the 6 -12 o'clock position (horizontally ported pumps) or 3-9 o'clock position (vertically ported pumps).



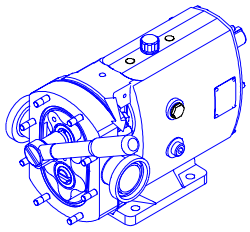
For Bi-lobe rotors:

Fit one rotor in the 6 - 12 o' clock plane onto the top shaft and the remaining rotor in the 3 - 9 o'clock plane on the bottom shaft. Rotate pump one full revolution ensuring there is no rotor contact.



Step 2

Fit new O rings (20) to rotor retention nuts (22).
Use a wooden/plastic block between the rotors to stop them turning whilst tightening the rotor retention nuts to the recommended torque settings shown in Technical Data (chapter 5).

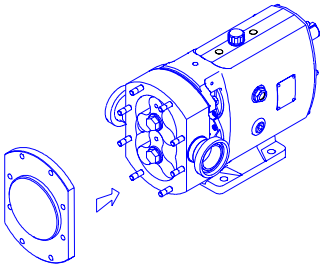


Step 3

To check rotors are correctly synchronised turn the drive shaft (24) by hand and check meshing clearances with feeler gauges against recommended clearance figures.

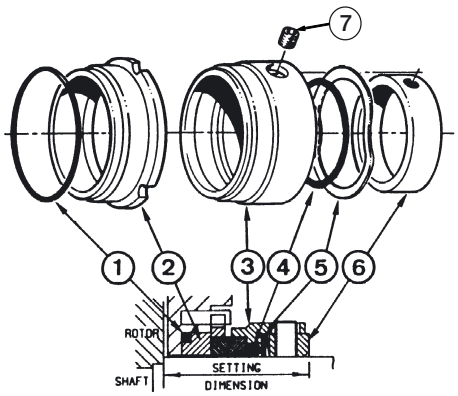
4.4.11 Fitting rotorcase cover

1. Lightly smear new O-ring (11) in grease and fit to rotorcase cover (12).
2. Fit rotorcase cover onto rotorcase (9) and tighten rotorcase cover nuts (13).
3. Refer to pump start up checks prior to operation.



4.5.1 R90 Single mechanical seal

Mechanical seals are fragile. Take extreme care when handling. Clean components before fitting, checking there is no damage to sealing faces. New elastomeric parts should be fitted during assembly.



Pump	Setting Dimension	
	mm	*in*
S1	33.6	*1.32*
S2	35.6	*1.40*
S3	38.1	*1.50*
S4	39.6	*1.56*
S5	47.6	*1.87*
S6	50.7	*2.00*

Item	Description
1	Stationary seal ring O-ring
2	Stationary seal ring
3	Rotary seal ring
4	Rotary seal ring O-ring
5	Wave spring
6	Drive ring
7	Grub screw

Seal removal

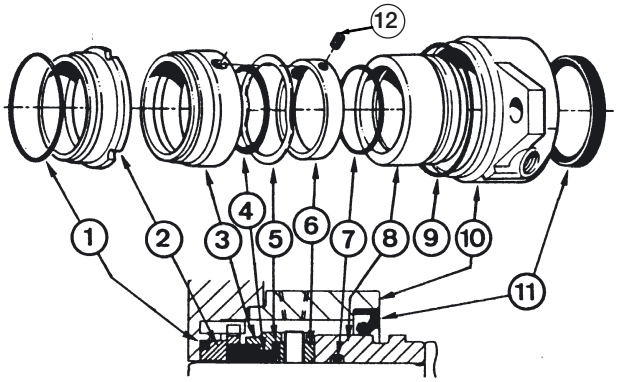
1. Loosen the screws (7).
2. Remove the rotorcase.
3. Extract stationary seals (2) from rotorcase.
4. Remove the rotary seal (3) from the shaft (and abutment spacer if fitted).

Seal fitting

1. Mark the shaft to indicate the seal setting length.
2. Lightly lubricate O-rings (4 and 1) and fit to rotary and stationary seals (3 and 2).
3. If fitted replace abutment spacers. Fit rotary seals to shafts until aligned with the setting mark.
4. Tighten the screws (7).
5. Fit stationary seals to rotorcase.
6. Wipe clean the sealing faces with solvent.
7. Refit the rotorcase.

4.5.2 R90 Single flushed/quench mechanical seal

Item	Description
1	Stationary seal ring O-ring
2	Stationary seal ring
3	Rotary seal ring
4	Rotary seal ring O-ring
5	Wave spring
6	Drive ring
7	Spacer O-ring
8	Spacer
9	Gasket
10	Seal housing
11	Lip seal
12	Grub screw



Seal removal:

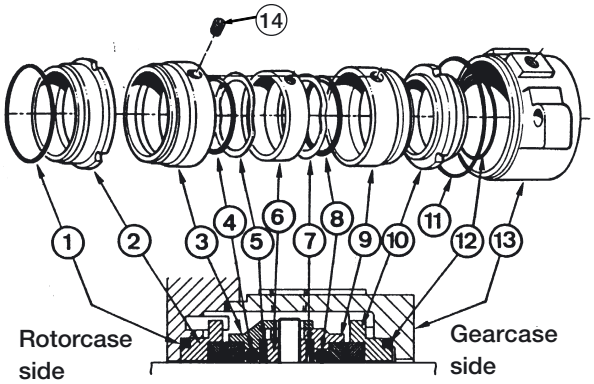
1. Turn off the flush and disconnect the flushing pipework.
2. Loosen screws (12) through the flushing connections.
3. Remove seal housing nuts and separate housing (10) from rotorcase.
4. Remove rotorcase.
   Extract stationary seals (2) from rotorcase and rotary seal (3) from the shaft.
5. Remove seal housing (10), lip seal (11) and spacer (8).

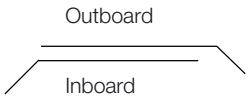
Seal fitting:

1. Lightly lubricate O-rings (4 and 1) and fit to rotary and stationary seals (3 and 2).
2. Lubricate and fit O-rings (7) to spacers (8) and fit to shafts.
3. Fit new lip seals (11) to seal housings (10) and locate over spacers.
4. Fit rotary seals to shafts and stationary seals to rotorcase.
5. Wipe clean the sealing faces with solvent.
6. Fit new seal housing gasket (9).
7. Refit rotorcase.
8. Locate seal housing and tighten nuts.
9. Tighten screws (12) through the flushing connections.

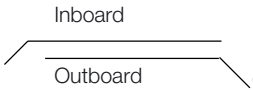
4.5.3 R90 Double flushed mechanical seal

Item	Description
1	Stationary seal ring O-ring
2	Stationary seal ring
3	Rotary seal ring
4	Rotary seal ring O-ring
5	Wave spring
6	Drive ring
7	Wave spring
8	Rotary seal ring O-ring
9	Rotary seal ring
10	Stationary seal ring
11	Gasket
12	Stationary seal ring O-ring
13	Seal housing
14	Grub screw





Model S1, the outboard seal fits over the inboard seal.



Models S2-6, the inboard seal fits over the outboard seal.

Seal removal:

1. Turn off the flush and disconnect the flushing pipework.
2. Loosen screws (14) through the flushing connections.
3. Remove seal housing nuts and separate housing (13) from rotorcase.
4. Remove rotorcase.
5. Extract stationary seals (2) from rotorcase and rotary seal (3) from the shaft.
6. Remove seal housings complete with stationary seals.

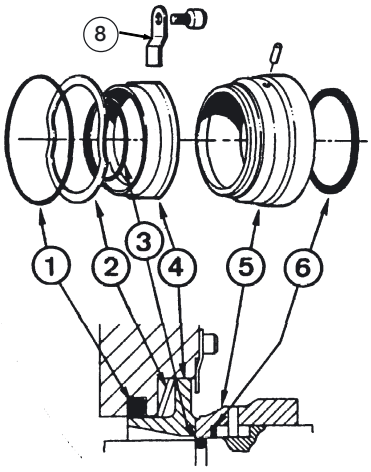
Seal fitting:

Ensure seal orientation is correct.

1. Lightly lubricate O-rings.
2. Fit o-rings (1 and 12) to stationary seals (2 and 10), and fit to seal housings (13) and rotorcase.
3. Locate seal housings over shafts.
4. Wipe clean the sealing faces with solvent.
5. Fit O-rings (4 and 8) to rotary seals (3 and 9) and fit to shafts.
6. Fit new seal housing gasket (11).
7. Refit rotorcase.
8. Locate seal housing and tighten nuts.
9. Tighten screws (14) through the flushing connections.

4.5.4 Hyclean single mechanical seal

Item	Description
1	Rotorcase O-ring
2	Wave spring
3	Shaft O-ring
4	Stationary seal ring
5	Rotary seal ring
6	Washer
7	Clip

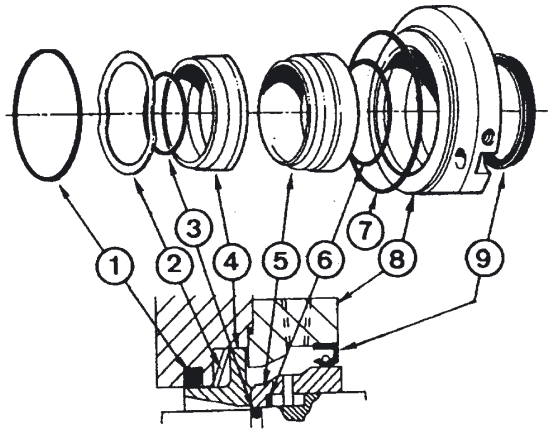


Seal removal:
1. Remove the rotorcase.
2. Remove clips (7) and stationary seals (4) from rotorcase.
3. Remove rotary seals (5) and O-rings (3) from shafts.

Seal fitting:
1. Lightly lubricate the O-rings (3 and 1) and fit to shafts and rotorcase.
2. Fit washers (6) to rotary seals (5) and locate on shafts.
3. Fit wave springs (2) to stationary seals (4), locate in rotorcase and retain with clips (7).
4. Wipe clean the sealing faces with solvent.
5. Refit the rotorcase.

4.5.5 Hyclean single flushed/quench mechanical seal

Item	Description
1	Rotorcase O-ring
2	Wave spring
3	Shaft O-ring
4	Stationary seal ring
5	Rotary seal ring
6	Washer
7	O-ring
8	Seal housing
9	Lip seal



Seal removal:

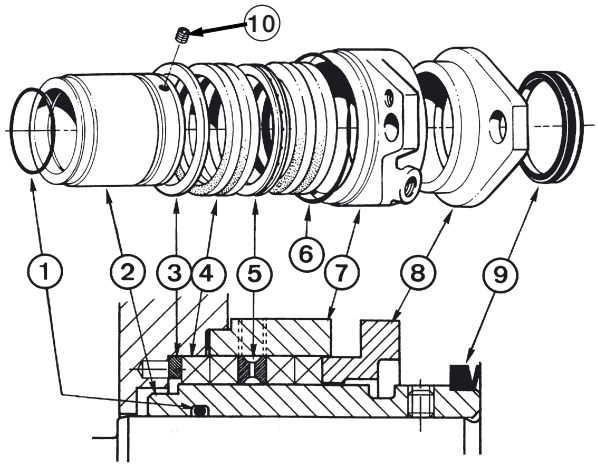
1. Turn off the flush and disconnect the flushing pipework.
2. Remove the rotorcase.
3. Remove seal housings (8), stationary seals (4) and O-rings (1) from rotorcase.
4. Remove rotary seals (5) and O-rings (3) from shafts.

Seal fitting:

1. Lightly lubricate the O-rings (3 and 1) and fit to shafts and rotorcase.
2. Fit washers (6) to rotary seals (5) and locate on shafts.
3. Fit new lip seals (9) into seal housings (8).
4. Fit wave springs (2) to stationary seals (4) and locate in rotorcase.
5. Fit seal housings to rotorcase with new O-rings (7) and tighten nuts.
6. Wipe clean the sealing faces with solvent.
7. Refit the rotorcase.

4.5.6 Packed gland

Item	Description
1	Shaft sleeve O-ring
2	Shaft sleeve
3	Spacer
4	Packing rings
5	Lantern ring (if fitted)
6	Gasket
7	Gland housing
8	Gland follower
9	Ring slinger
10	Screw



Packed gland removal:
1. Loosen gland follower nuts.
2. Remove rotorcase with gland housing (7), packing (4) and gland follower (8) still assembled.
3. Loosen shaft sleeve screws (10) and remove sleeves (2) from shafts.

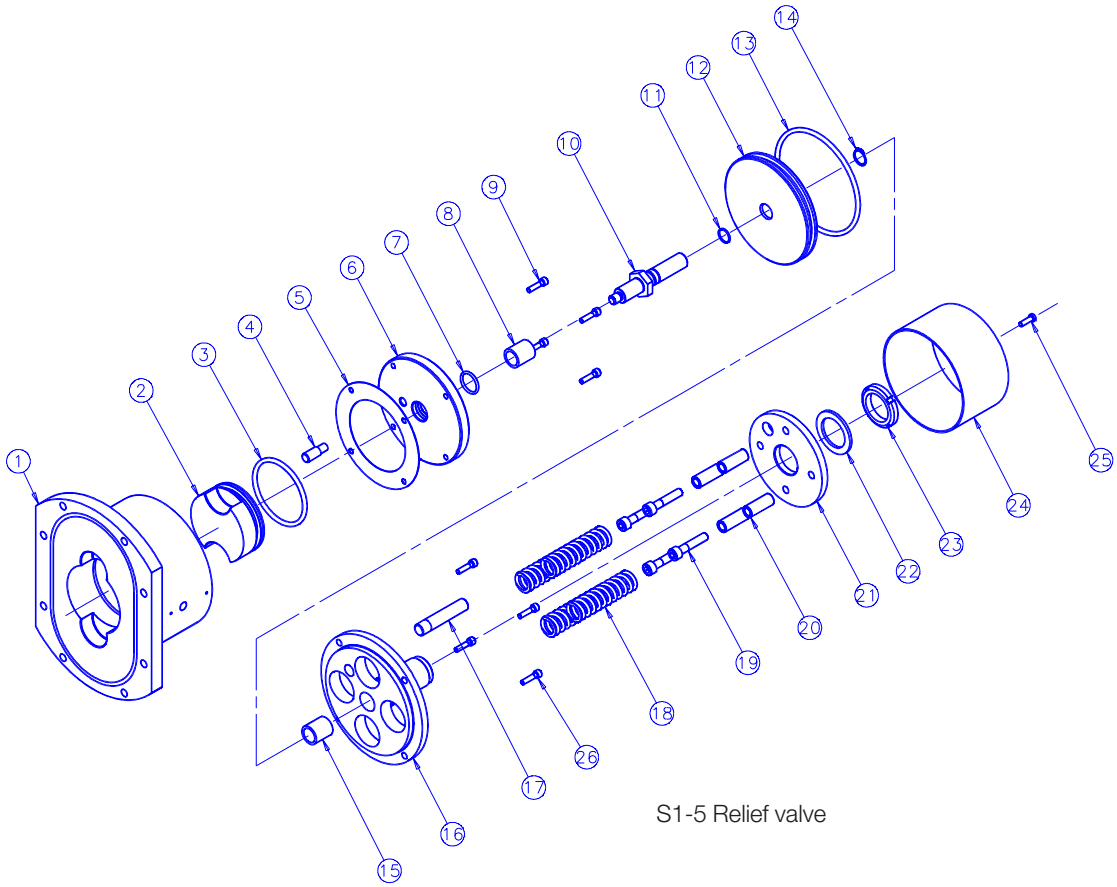
Packed gland fitting:
Check condition of all components replacing as necessary.
1. Lubricate the O-rings (1), fit to shaft sleeves (2) and locate on shafts.
2. Tighten screws (10) and fit slingers (9).
3. Fit gland spacer (3), gasket (6) and gland housing (7) to rotorcase.
4. Insert the packing rings (4), and lantern ring (5) if fitted, as shown ensuring joints are correctly spaced.
5. Loosely locate the gland follower (8) and nuts.
6. Refit rotorcase with packed assemblies over shaft sleeves.
7. Adjust the packed gland.

Packed gland adjustment:
Important: To prolong gland life some leakage is necessary.
1. Lightly and evenly tighten gland follower nuts.
2. Start pump. Run for 10 minutes, monitoring gland housing temperature and leakage. Gland housing temperatures should be equal.
3. Adjust gland follower nuts by a $^{1}/_{6}$ of a turn until leakage is at an acceptable rate.

Always replace gland guard after adjustment.

The relief valve must not be disassembled whilst the pump is in operation. Always observe the safety precautions detailed at the front of this manual.

Take extreme care when removing the springs as they may be compressed.



S1-5 Relief valve

Item	Description	Item	Description
1	Rotorcase cover	14	Circlip
2	Hydraulic piston	15	Bush
3	O-ring, hydraulic piston	16	Valve guide
4	Valve pin	17	Valve pin
5	Shim	18	Spring
6	Backstop disc	19	Screw
7	O-ring, backstop disc	20	Valve spring guide
8	Bush	21	Spring adjuster
9	Screw, backstop disc	22	Washer
10	Valve shaft	23	Notched nut
11	O-ring, pneumatic piston	24	Valve housing
12	Pneumatic piston	25	Screw
13	O-ring, pneumatic piston	26	Screw, spring adjuster

Relief Valve Disassembly

1. Remove manual override lever if fitted.
2. Remove screws (25) and valve housing (24).
3. Remove notched nut(s) (23) and spring adjuster (21). If springs are still compressed when the notched nut reaches end of thread, release the spring adjuster screws (26).
4. Remove springs (18) (models S1-5), spring stacks (models S6), screws and valve guide (16).
5. Remove circlip (14) and pneumatic piston (12).
6. Remove screws, backstop disc (6) and hydraulic piston (2).
7. Unscrew hydraulic piston (2) from valve shaft (10) and remove O-rings (3, 7, 11 and 13).

Relief Valve Assembly

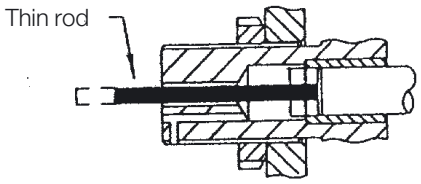
New o-rings should be fitted during assembly.
Clean components before fitting; check there is no damage to faces.

1. Lubricate all o-rings.
2. Fit O-ring (7) to backstop disc (6) and fit backstop disc to valve shaft (10).
3. Fit O-ring (3) to hydraulic piston (2) and screw onto valve shaft.
4. Locate assembly into rotorcase cover, replace backstop disc screws (9).
5. Fit pneumatic piston o-rings (11 and 13) and locate assembly on valve shaft. Replace circlip (14) and springs (18). (Models S6 pumps only - each spring stack should contain an equal amount of springs, noting correct orientation). Place valve guide (16) over springs and replace screws (26).
6. Fit spring adjuster (21) and notched nut (23), valve housing (24) and screw (25).
7. Replace manual override lever if applicable.

Valve Adjustment

The relief valve will require setting to suit duty requirements.
Note: A gauge is required to measure discharge pressure during adjustment

1. Stop the pump
2. Remove valve housing (24).
3. Release notched nut(s) (23) to end of thread.
4. Insert a thin rod into valve guide (16) and mark to indicate closed position.
5. Start pump and increase pressure noting pressure gauge reading when the rod starts to move. This indicates the valve is beginning to open.
6. Tighten the notched nut gradually until desired system pressure is achieved. (Model S6 pump only - evenly tighten the spring stack nuts after adjusting the notched nut).
7. Apply thread locking adhesive to the notched nut after relief valve is set.
8. If pneumatic override is required connect air supply and adjust pressure until valve opens. Check piston reseats when air supply is disconnected.
9. Replace valve housing and screws.



Problem																Probable Causes	Solutions
No flow	Under capacity	Irregular discharge	Low discharge pressure	Pump will not prime	Prime lost after starting	Pump stalls when starting	Pump overheats	Motor overheats	Excessive power absorbed	Noise and vibration	Pump element wear	Syphoning	Seizure	Mechanical seal leakage	Packed gland leakage		
✓				✓												Incorrect direction of rotation.	Reverse motor.
✓																Pump not primed.	Expel gas from suction line and pumping chamber and introduce fluid.
✓	✓	✓	✓		✓					✓						Insufficient NPSH available.	Increase suction line diameter. Increase suction head. Simplify suction line configuration and reduce length. Reduce pump speed.
	✓	✓	✓		✓					✓						Fluid vaporising in suction line.	Increase suction line diameter. Increase suction head. Simplify suction line configuration and reduce length. Reduce pump speed.
✓	✓	✓		✓	✓					✓						Air entering suction line.	Remake pipework joints.
	✓	✓		✓	✓					✓						Strainer or filter blocked.	Service fittings.
	✓				✓	✓	✓	✓	✓	✓					✓	Fluid viscosity above rated figure.	Increase fluid temperature. Decrease pump speed. Check seal face viscosity limitations.
✓	✓		✓													Fluid viscosity below rated figure.	Decrease fluid temperature. Increase pump speed.
							✓			✓	✓		✓	✓		Fluid temp. above rated figure.	Cool the pump casing. Reduce fluid temperature. Check seal face and elastomer temp. limitations.
						✓		✓	✓							Fluid temp. below rated figure.	Heat the pump casing. Increase fluid temperature.
										✓	✓		✓	✓		Unexpected solids in fluid.	Clean the system. Fit strainer to suction line. If solids cannot be eliminated, consider fitting double mechanical seals.
✓	✓	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	Discharge pressure above rated figure	Check for obstructions i.e. closed valve. Service system and change to prevent problem recurring. Simplify discharge line to decrease pressure.
							✓	✓	✓				✓			Gland over-tightened	Slacken and re-adjust gland packing.
	✓	✓			✓					✓					✓	Gland under-tightened	Adjust gland packing.
														✓	✓	Seal flushing inadequate.	Increase flush flow rate. Check that flush fluid flows freely into seal area.
	✓							✓	✓	✓						Pump speed above rated figure.	Decrease pump speed.
✓	✓															Pump speed below rated figure.	Increase pump speed.
	✓						✓	✓	✓	✓	✓		✓			Pump casing strained by pipework.	Check alignment of pipes. Fit flexible pipes or expansion fittings. Support pipework.
							✓			✓	✓		✓			Flexible coupling misaligned.	Check alignment and adjust mountings accordingly.
							✓	✓	✓	✓	✓		✓			Insecure pump driver mountings.	Fit lock washers to slack fasteners and re-tighten.
							✓	✓	✓	✓	✓		✓	✓	✓	Shaft bearing wear or failure.	Refer to pump maker for advice and replacement parts.
							✓	✓	✓	✓	✓		✓			Insufficient gearcase lubrication.	Refer to pump maker's instructions.
✓	✓						✓	✓	✓	✓	✓		✓			Metal to metal contact of pumping element.	Check rated and duty pressures. Refer to pump maker.
✓	✓		✓													Worn pumping element.	Fit new components.
✓	✓									✓						Rotorcase cover relief valve leakage.	Check pressure setting and re-adjust if necessary. Examine and clean seating surfaces. Replace worn parts.
✓										✓						Rotorcase cover relief valve chatter.	Check for wear on sealing surfaces, guides etc. - Replace if necessary.
✓	✓															Rotorcase cover relief valve incorrectly set.	Re-adjust spring compression - valve should lift approx. 10% above duty pressure.
✓				✓												Suction lift too high.	Lower pump or raise liquid level.
														✓	✓	Fluid pumped not compatible with materials used.	Use optional materials.
												✓				No barrier in system to prevent flow passing.	Ensure discharge pipework higher than suction tank.
														✓	✓	Pump allowed to run dry.	Ensure system operation prevents this. Fit single or double flushed mechanical seals. Fit flushed packed gland.
									✓	✓						Faulty motor.	Check and replace motor bearings.
✓																Pumping element missing	Fit pumping element.

5.1.1 Oil capacities

Pump model	Port orientation		*Port orientation*	
	Vertical litres	Horizontal litres	*Vertical US pints*	*Horizontal US pints*
S1	0.28	0.38	*0.60*	*0.80*
S2	0.55	0.65	*1.20*	*1.40*
S3	1.05	1.48	*2.20*	*3.10*
S4	1.50	2.00	*3.20*	*4.20*
S5	5.00	0.62 (top chamber) 1.38 (bottom chamber)	*10.60*	*1.30 (top chamber)* *2.90 (bottom chamber)*
S6	8.50	1.30 (top chamber) 2.30 (bottom chamber)	18.00	2.80 (top chamber) 4.90 (bottom chamber)

5.1.2 Weights

Pump model	Bare Shaft Pump kg *(lb)* Port Orientation		Pump with drive unit kg *(lb)* Port Orientation	
	Horizontal	Vertical	Horizontal	Vertical
S1-0005	15 *(33)*	16 *(35)*	45 *(99)*	46 *(101)*
S1-0008	17 *(37)*	18 *(40)*	55 *(121)*	56 *(123)*
S2-0013	28 *(62)*	30 *(66)*	75 *(165)*	77 *(170)*
S2-0018	29 *(64)*	31 *(68)*	80 *(176)*	82 *(181)*
S3-0027	53 *(117)*	56 *(123)*	145 *(320)*	148 *(326)*
S3-0038	56 *(123)*	59 *(130)*	150 *(331)*	153 *(337)*
S4-0055	105 *(231)*	111 *(245)*	260 *(573)*	266 *(586)*
S4-0079	110 *(243)*	116 *(256)*	265 *(584)*	271 *(597)*
S5-0116	152 *(335)*	152 *(335)*	400 *(882)*	400 *(882)*
S5-0168	160 *(353)*	160 *(353)*	415 *(915)*	415 *(915)*
S6-0260	260 *(573)*	260 *(573)*	525 *(1157)*	525 *(1157)*
S6-0353	265 *(584)*	265 *(584)*	545 *(1202)*	545 *(1202)*

The above weights are for guidance purposes only and will vary dependent upon specification of pump, baseplate and drive unit.

5.1.3 Tool requirements

Description	Tool required	Pump Model					
		S1	S2	S3	S4	S5	S6
Rotorcase cover nut (13)	Socket Size (mm)	13	17	17	17	17	19
	Torque Setting (Nm)	*20*	*39*	*39*	*39*	*39*	*105*
	Torque Setting (lbft)	*14.8*	*28.8*	*28.8*	*28.8*	*28.8*	*77.4*
Rotor retention nut (22)	Socket Size (mm)	17	24	24	36	36	36
	Torque Setting (Nm)	*14*	*77*	*120*	*161*	*161*	*161*
	Torque Setting (lbft)	*10.3*	*56.8*	*88.5*	*118.8*	*118.8*	*118.8*
Rotor TLA (19)	Key Size (mm)	-	-	-	-	-	5
	Torque Setting (Nm)	-	-	-	-	-	*14*
	Torque Setting (lbft)	-	-	-	-	-	*10.3*
Rotorcase retaining nut (4)	Spanner Size (mm)	13	17	17	19	19	24
	Torque Setting (Nm)	*20*	*40*	*40*	*64*	*64*	*175*
	Torque Setting (lbft)	*14.8*	*29.5*	*29.5*	*47.2*	*47.2*	*129.1*
Seal retainer screw (15)	Key Size (mm)	5	5	5	6	6	6
	Torque Setting (Nm)	*10*	*10*	*10*	*25*	*25*	*25*
	Torque Setting (lbft)	*7.4*	*7.4*	*7.4*	*18.4*	*18.4*	*18.4*
Gearcase cover screw (6)	Key Size (mm)	5	5	5	6	6	6
	Torque Setting (Nm)	*10*	*10*	*10*	*25*	*25*	*25*
	Torque Setting (lbft)	*7.4*	*7.4*	*7.4*	*18.4*	*18.4*	*18.4*
TLA/Clamp plate screw (40)	Key Size (mm)	5	5	5	5	6	6
	Torque Setting (Nm)	*12*	*17*	*12*	*14*	*35*	*35*
	Torque Setting (lbft)	*8.9*	*12.5*	*8.9*	*10.3*	*25.8*	*25.8*
Drain plug (45)	Key *Size (in)*	*¼*	*¼*	*¼*	*¼*	*½*	*½*
Foot bolt (58)	Key Size (mm)	5	6	6	8	-	-
	Torque Setting (Nm)	*15*	*30*	*30*	*60*	-	-
	Torque Setting (lbft)	*11.1*	*22.1*	*22.1*	*44.3*	-	-

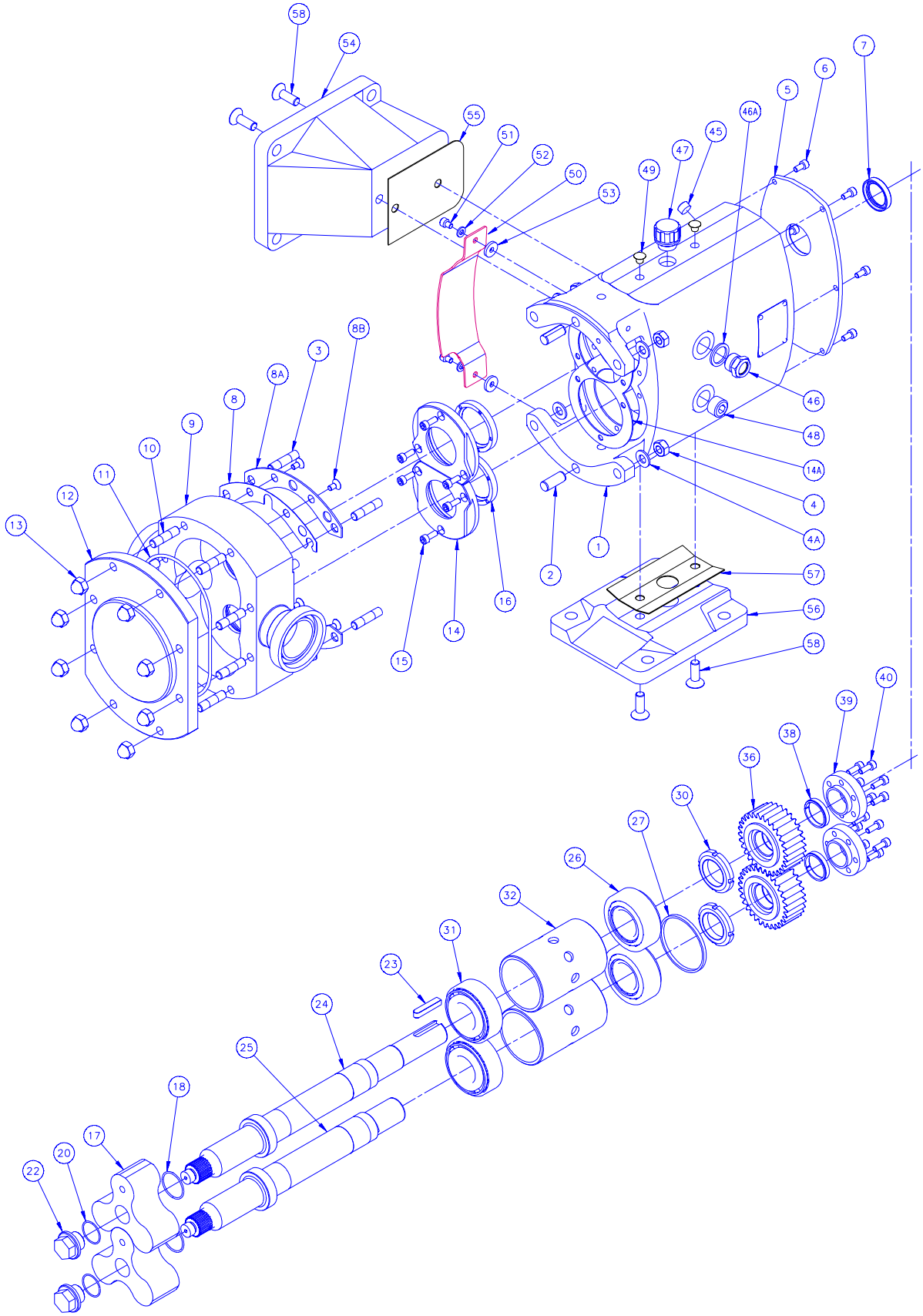
Parts List

Pos.	Description
1	Gearcase - universal mounting
2	Dowel
3	Stud, rotorcase retention
4	Nut, rotorcase retention
4A	Washer, rotorcase retention
5	Cover, gearcase
6	Screw, gearcase cover
7	Lip seal, drive end
8	Shim
8A	Shim retainer
8B	Shim retainer screws
9	Rotorcase
10	Stud, rotorcase/cover retention
11	'O' Ring, cover
12	Cover, rotorcase
13	Dome nut, rotorcase cover
14	Retainer, seal
15	Screw, seal retainer
16	Lip seal, gland end
17	Rotors
18	'O' Ring, rotor sealing shaft end
20	'O' Ring, rotor sealing nut end
22	Nut, rotor retention
23	Key
24	Shaft, drive
25	Shaft, auxiliary
26	Bearing, rear
27	Spacer, shaft abutment
30	Nut, bearing
31	Bearing, front
32	Spacer, bearing
36	Timing gear
38	Torque locking element
39	Clamp plate
40	Screw, clamp plate
45	Drain plug
46	Sight glass
46A	Washer, sight glass
47	Filler plug
48	Plug
49	Blanking plug
50	Gland guard
51	Screw, gland guard
52	Washer, gland guard
53	Washer, gland guard
54	Foot, vertical port
55	Foot gasket, vertical port
56	Foot, horizontal port
57	Foot gasket, horizontal port
58	Bolt, Foot

This page shows an exploded drawing of S1-3.

The drawing includes all items of the pump.

Exploded Drawing



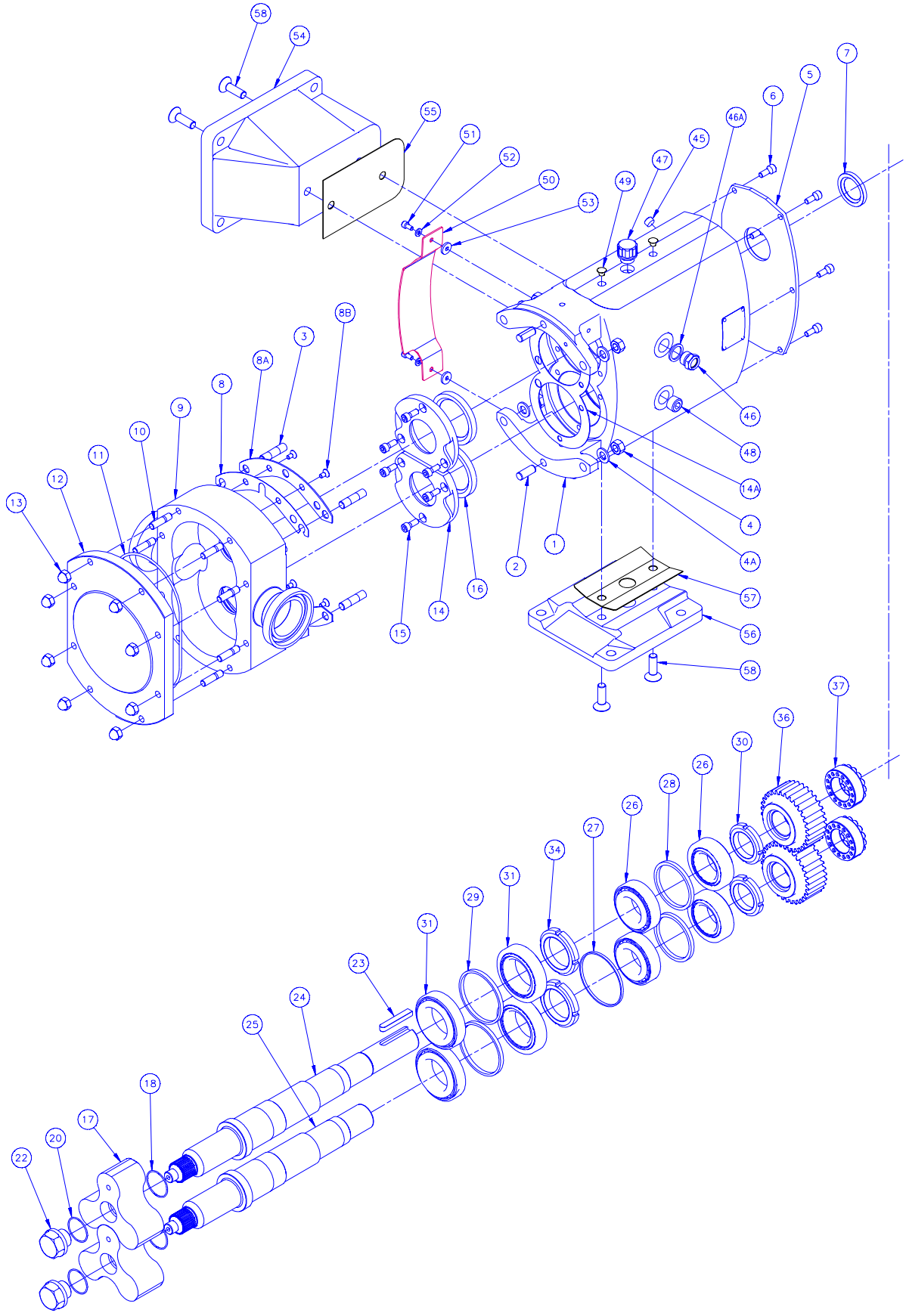
Parts List

Pos.	Description
1	Gearcase - universal mounting
2	Dowel
3	Stud, rotorcase retention
4	Nut, rotorcase retention
4A	Washer, rotorcase retention
5	Cover, gearcase
6	Screw, gearcase cover
7	Lip seal, drive end
8	Shim
8A	Shim retainer
8B	Shim retainer screws
9	Rotorcase
10	Stud, rotorcase/cover retention
11	'O' Ring, cover
12	Cover, rotorcase
13	Dome nut, rotorcase cover
14	Retainer, seal
15	Screw, seal retainer
15A	Screw, seal retainer
16	Lip seal, gland end
17	Rotors
18	'O' Ring, rotor sealing shaft end
20	'O' Ring, rotor sealing nut end
22	Nut, rotor retention
23	Key
24	Shaft, drive
25	Shaft, auxiliary
26	Bearing, rear
27	Spacer, shaft abutment
28	Spacer, bearing drive end
29	Spacer, bearing gland end
30	Nut, bearing rear
31	Bearing, front
34	Nut, bearing front
36	Timing gear
37	Torque locking assembly
45	Drain plug
46	Sight glass
46A	Washer, sight glass
47	Filler plug
48	Plug
49	Blanking plug
50	Gland guard
51	Screw, gland guard
52	Washer, gland guard
53	Washer, gland guard
54	Foot, vertical port
55	Foot gasket, vertical port
56	Foot, horizontal port
57	Foot gasket, horizontal port
58	Bolt, Foot

This page shows an exploded drawing of S4.

The drawing includes all items of the pump.

Exploded Drawing



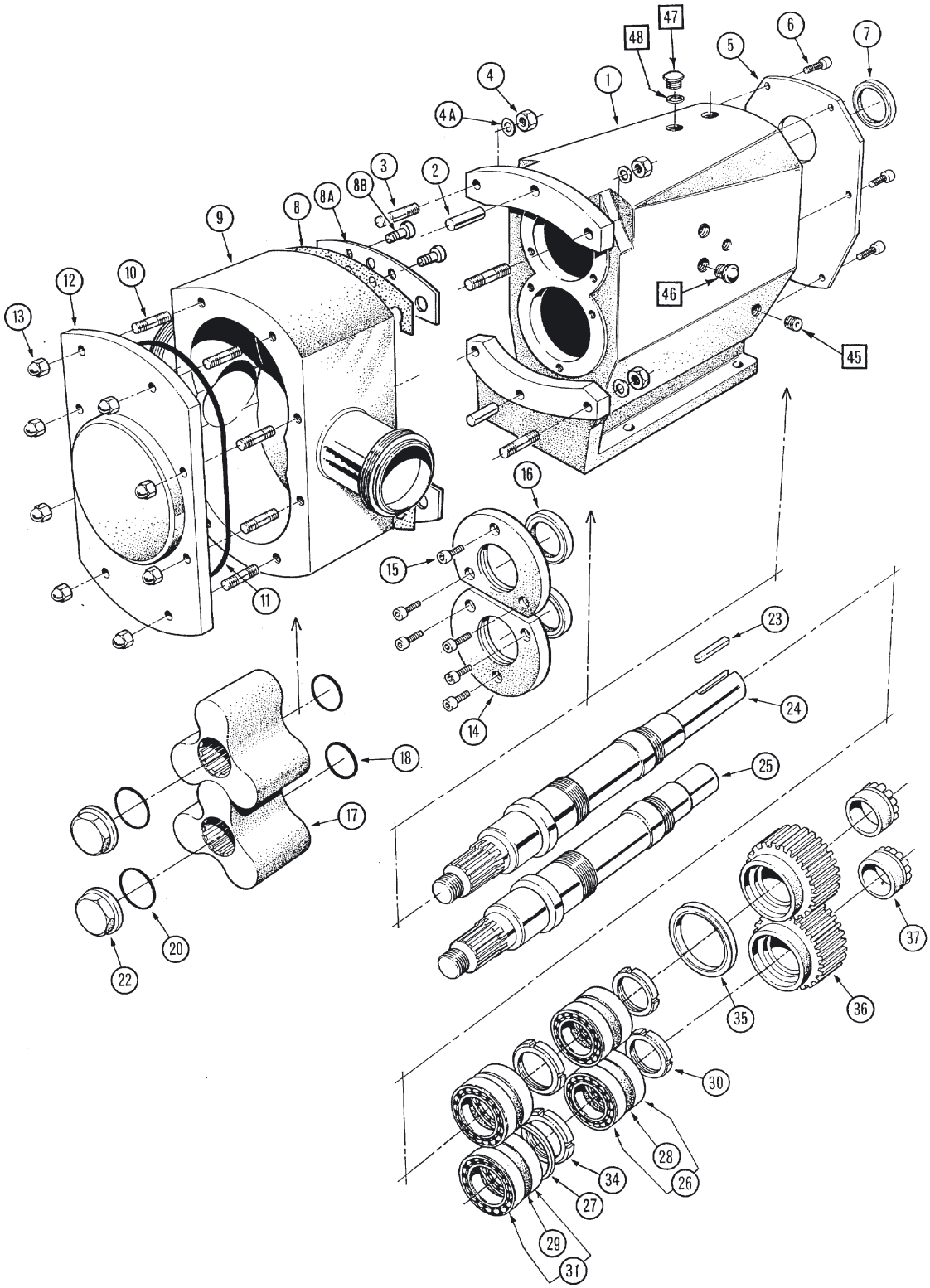
Parts List

Pos.	Description
1	Gearcase
2	Dowel
3	Stud, rotorcase retention
4	Nut, rotorcase retention
4A	Washer, rotorcase retention
5	Cover, gearcase
6	Screw, gearcase cover
7	Lip seal, drive end
8	Shim
8A	Shim retainer
8B	Shim retainer screws
9	Rotorcase
10	Stud, rotorcase/cover retention
11	O-ring, cover
12	Cover, rotorcase
13	Dome nut, rotorcase cover
14	Retainer, seal
15	Screw, seal retainer
16	Lip seal, gland end
17	Rotors
18	O-ring, rotor sealing shaft end
20	O-ring, rotor sealing nut end
22	Nut, rotor retention
23	Key
24	Shaft, drive
25	Shaft, auxiliary
26	Bearing, rear
27	Spacer, shaft abutment
28	Spacer, bearing drive end
29	Spacer, bearing gland end
30	Nut, bearing rear
31	Bearing, front
34	Nut, bearing front
35	Lip seal, upper chamber
36	Timing gear
37	Torque locking assembly
45	Drain plug
46	Sight glass
46A	Washer, sight glass
47	Filler plug

This page shows an exploded drawing of S5 - horizontally ported.

The drawing includes all items of the pump.

Exploded Drawing

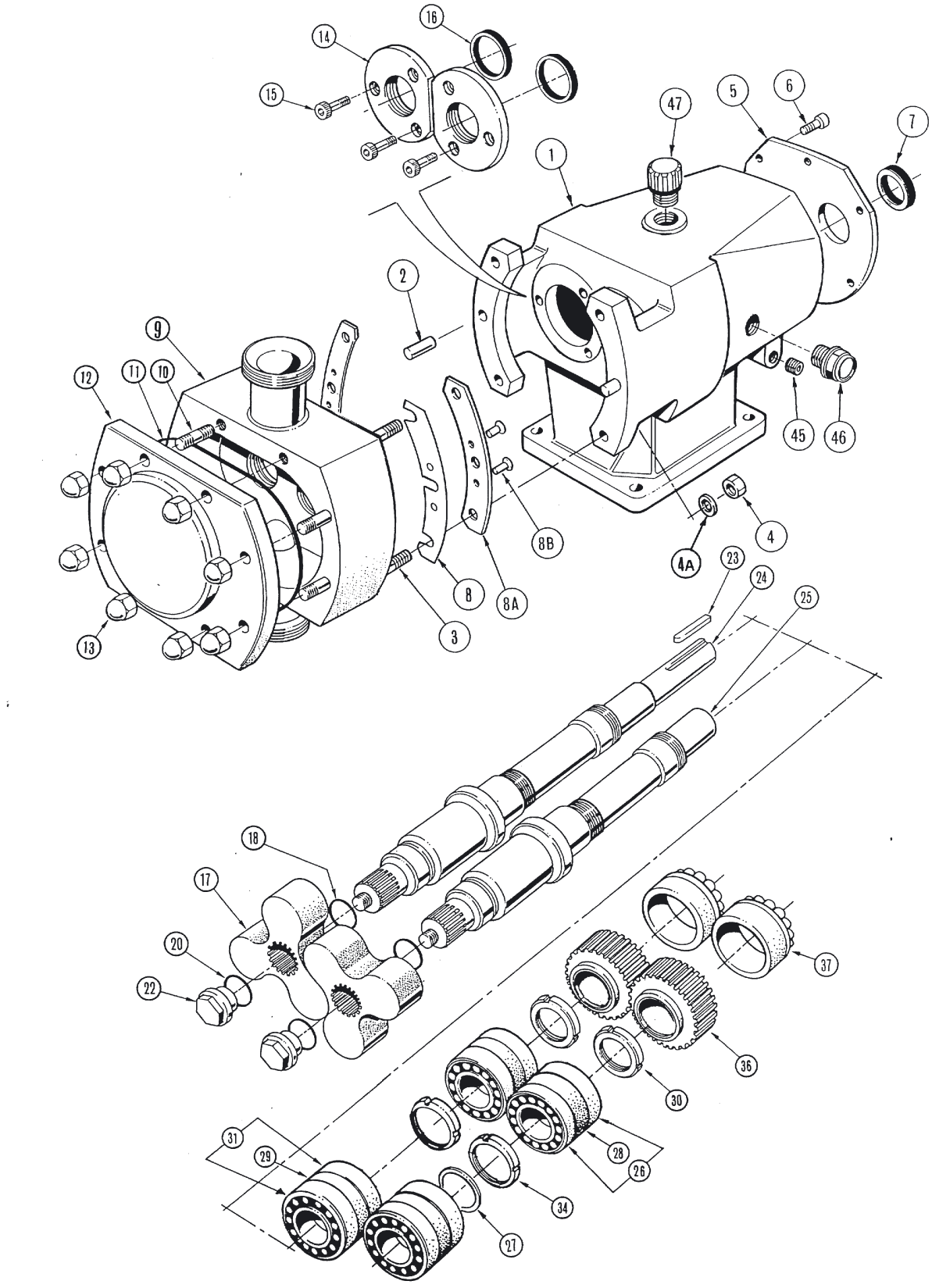


Parts List

Pos.	Description
1	Gearcase
2	Dowel
3	Stud, rotorcase retention
4	Nut, rotorcase retention
4A	Washer, rotorcase retention
5	Cover, gearcase
6	Screw, gearcase cover
7	Lip seal, drive end
8	Shim
8A	Shim retainer
8B	Shim retainer screws
9	Rotorcase
10	Stud, rotorcase/cover retention
11	O-ring, cover
12	Cover, rotorcase
13	Dome nut, rotorcase cover
14	Retainer, seal
15	Screw, seal retainer
16	Lip seal, gland end
17	Rotors
18	O-ring, rotor sealing shaft end
20	O-ring, rotor sealing nut end
22	Nut, rotor retention
23	Key
24	Shaft, drive
25	Shaft, auxiliary
26	Bearing, rear
27	Spacer, shaft abutment
28	Spacer, bearing drive end
29	Spacer, bearing gland end
30	Nut, bearing rear
31	Bearing, front
34	Nut, bearing front
36	Timing gear
37	Torque locking assembly
45	Drain plug
46	Sight glass
46A	Washer, sight glass
47	Filler plug

This page shows an exploded drawing of S5 - vertically ported. The drawing includes all items of the pump.

Exploded Drawing



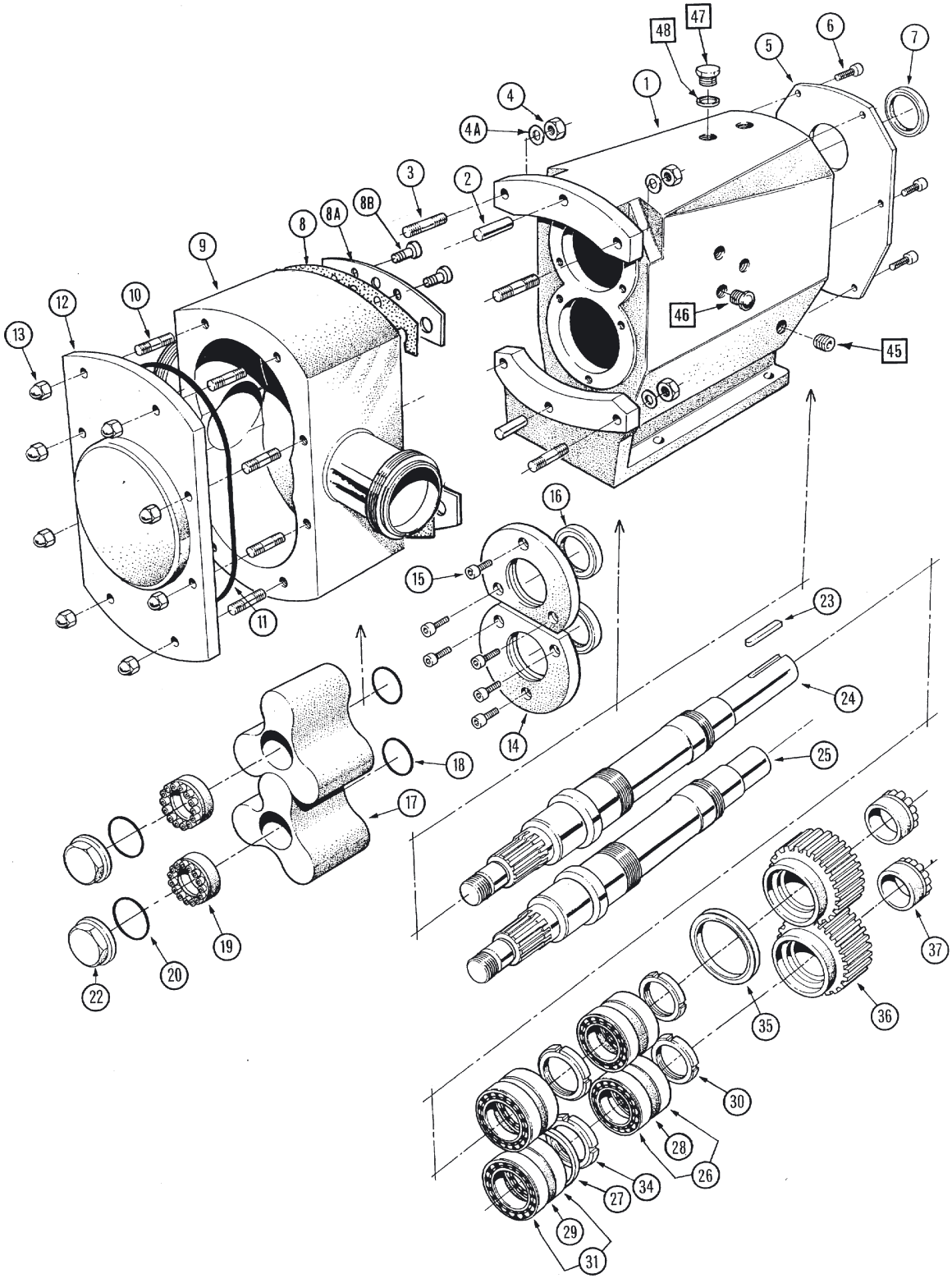
Parts List

Pos.	Description
1	Gearcase
2	Dowel
3	Stud, rotorcase retention
4	Nut, rotorcase retention
4A	Washer, rotorcase retention
5	Cover, gearcase
6	Screw, gearcase cover
7	Lip seal, drive end
8	Shim
8	Shim retainer
8B	Shim retainer screws
9	Rotorcase
10	Stud, rotorcase/cover retention
11	O-ring, cover
12	Cover, rotorcase
13	Dome nut, rotorcase cover
14	Retainer, seal
15	Screw, seal retainer
16	Lip seal, gland end
17	Rotors
18	O-ring, rotor sealing shaft end
19	Torque locking assembly
20	O-ring, rotor sealing nut end
22	Nut, rotor retention
23	Key
24	Shaft, drive
25	Shaft, auxiliary
26	Bearing, rear
27	Spacer, shaft abutment
28	Spacer, bearing drive end
29	Spacer, bearing gland end
30	Nut, bearing rear
31	Bearing, front
34	Nut, bearing front
35	Lip seal, upper chamber
36	Timing gear
37	Torque locking assembly
45	Drain plug
46	Sight glass
46A	Washer, sight glass
47	Filler plug

This page shows an exploded drawing of S6 - horizontally ported.

The drawing includes all items of the pump.

Exploded Drawing

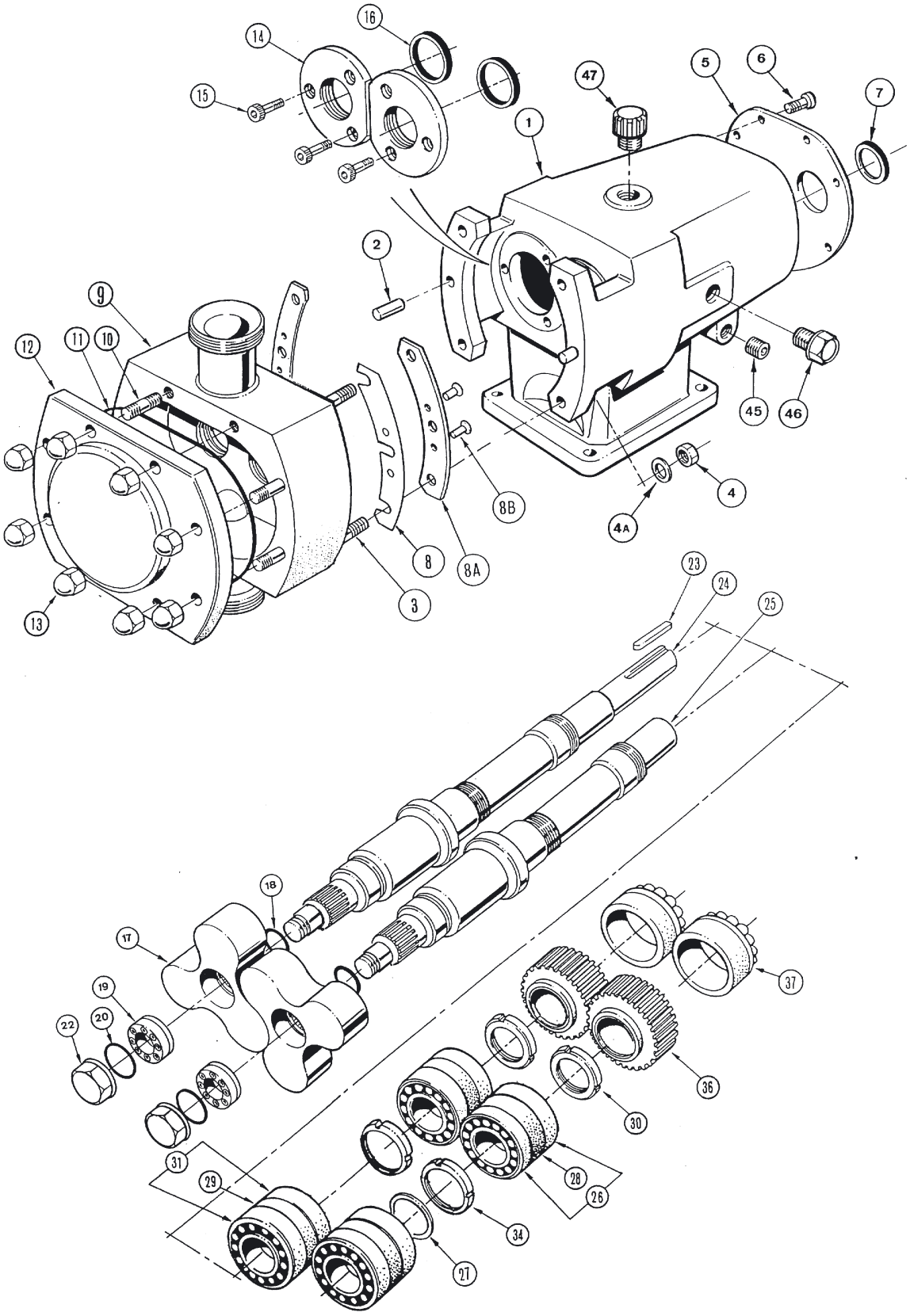


Parts List

Pos.	Description
1	Gearcase
2	Dowel
3	Stud, rotorcase retention
4	Nut, rotorcase retention
4A	Washer, rotorcase retention
5	Cover, gearcase
6	Screw, gearcase cover
7	Lip seal, drive end
8	Shim
8A	Shim retainer
8B	Shim retainer screws
9	Rotorcase
10	Stud, rotorcase/cover retention
11	O-ring, cover
12	Cover, rotorcase
13	Dome nut, rotorcase cover
14	Retainer, seal
15	Screw, seal retainer
16	Lip seal, gland end
17	Rotors
18	O-ring, rotor sealing shaft end
19	Torque locking assembly
20	O-ring, rotor sealing nut end
22	Nut, rotor retention
23	Key
24	Shaft, drive
25	Shaft, auxiliary
26	Bearing, rear
27	Spacer, shaft abutment
28	Spacer, bearing drive end
29	Spacer, bearing gland end
30	Nut, bearing rear
31	Bearing, front
34	Nut, bearing front
36	Timing gear
37	Torque locking assembly
45	Drain plug
46	Sight glass
46A	Washer, sight glass
47	Filler plug

This page shows an exploded drawing of S6 - vertically ported. The drawing includes all items of the pump.

Exploded Drawing



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