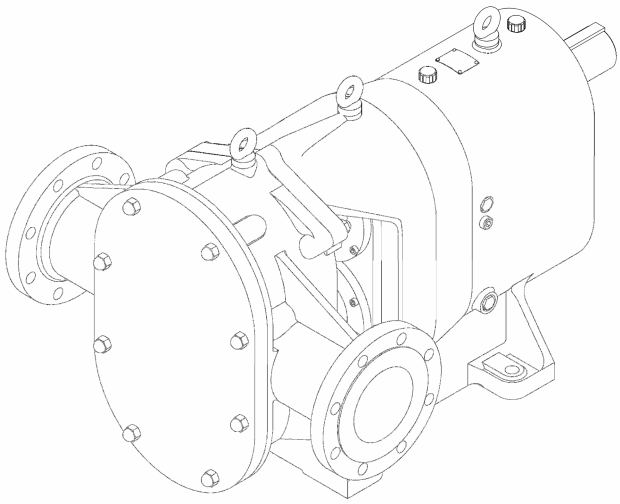
SSP Pumps

Series A&G 9

Stainless Steel and Ductile Iron
Positive Displacement Rotary Lobe Pumps

Operating Manual



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EC DECLARATION OF INCORPORATION

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.

EN294 : 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**

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EC DECLARATION OF CONFORMITY

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 Directive 73/23/EEC**

Electromagnetic Compatibility Directive 89/336/EEC

Applicable Standards/Specifications

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

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1.1 PUMP LIMITS OF APPLICATION OR USE

This range of pumps has been designed to offer a variety of duties including :-

Series G - general industrial, sewage and effluent sludge transfer.

Series A - for hygienic and anti-corrosive duties.

Pressures of up to 10 bar, speeds to 500 rpm and temperatures to 200°C can be obtained on this range of pumps depending on pump model/ size. These conditions cannot always be obtained simultaneously. The model type/size will be shown on the nameplate positioned on the pump.

The pump/pump unit will have been selected from the pump users specific application when known and the pump serial number will relate to this.

If the user has not specified the pumping application or needs to change it, it is important to confirm that the materials of construction and product seals are compatible with the pumping application and that adequate NPSH, speed, pressure etc is available.

It is therefore strongly recommended that the usercontact the supplierquoting:-pump model/ size, serial number and system details (eg product, pressure, flow rate etc).

1.2 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 for the pump. These details are stated on the original documentation and if not available may be obtained from yoursupplier quoting :- pump model and serial number.

1.3 NOISE LEVELS

Depending upon the pumping system and duty condition the pump noise levels may vary. The sound pressure level measurement stated is given fortypical pumps/pump units at maximum pressures/speeds, the results being taken on water at ambient temperature:-

Recorded sound pressure level :- 85 dB(A): (Ref 20uPa).

Note :- Readings taken in accordance with ISO3746.

1.4 UTILITY REQUIREMENTS

Electrical Supply :-

This pump may be supplied bareshaftorcoupled to a drive unit for which a drive unit/electrical supply will be required.

Note : The pump may be also driven by a diesel/petrol drive unit.

Water Supply :-

Additional watersupplies may be required if the pump is fitted with a product seal flushing arrangement. Consult your supplier for flush fluids compatible with products pumped.

1.5 SAFETY PRECAUTIONS

All warnings in this manual are summarised on this page.

Pay special attention to the instructions below so that severe personal injury or damage to the pump can be avoided.

Personnel performing installation, operation and maintenance of the pump must have the relevant experience required.

WARNING SIGNS :


General safety instructions are preceded by this symbol.


Electrical safety instructions are preceded by this symbol.


Take great care when using caustic agents.

INSTALLATION


: **Always** observe the technical data.


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


: **Never** start in the wrong direction of rotation with liquid in the pump.


: **Never** put your hands or fingers inside the port connections

OPERATION


: **Always** observe the technical data.


: **Never** touch the pump or the pipelines when pumping hot liquids.


: **Never** stand on the pump or pipelines.


: **Never** run the pump with the suction side or the pressure side blocked.


: **Always** handle toxic and acidic liquids with great care.


: **Never** put your hands or fingers inside the port connections.

MAINTENANCE


: **Always** observe the technical data.


: **Always** disconnect the pump from the drive unit and power supply when servicing the pump.


: The pump must **never** be hot when servicing it.


: The pump and pipelines must **never** be pressurised when servicing the pump.


: **Never** put your hands or fingers inside the port connections.

STUDY THIS MANUAL CAREFULLY

POTENTIAL SAFETY HAZARDS

The following section gives information on handling, storage and disposal of parts and materials used in the pumps which may be considered hazardous to health.

Please pass this information on to your Safety Officer, he may need it to comply with Health and Safety, and COSHH regulations.

Electric motors - the pump may have an electric motor fitted, ensure that the relevant fire equipment is available.

The information contained here is brief.

GENERAL FIRST AID

If potentially hazardous substances are accidentally inhaled, or skin or eyes contaminated, then the following basic precautions should be taken

Inhalation - Remove to fresh air

Skin - Wash with soap and water

Eyes - Flush with water, seek medical attention

In all cases, if symptoms persist, seek medical attention.

MATERIAL	USE	MAJOR HAZARD
SILICONE SEALANT	GEARBOX SEAL RETAINERS, REAR COVER, GENERAL SEALANT.	RELEASES VAPOUR AT ROOM TEMPERATURE.
SEALANT (RED HERMETITE)	GEARBOX SEAL RETAINERS, REAR COVER, GENERAL SEALANT.	RELEASES VAPOUR AT ROOM TEMPERATURE, HIGHLY FLAMMABLE, TREAT AS FIRE HAZARD.
ANTI-SEIZE COMPOUNDS	BEARINGS	APPLIED FROM AEROSOL. RELEASES VAPOUR. DISPOSE OF CONTAINER AS IF PRESSURISED.
ADHESIVES (E.G. PERMABOND)	BEARING NUTS, ADJUSTMENT NUTS.	RELEASES VAPOUR AT ROOM TEMPERATURE.
OIL AND GREASE	OIL - GENERAL LUBRICATION GREASE - PRODUCT SEALS, TIMING GEARS, GENERAL LUBRICATION.	SKIN AND EYE IRRITANT.
PLASTIC COMPOUNDS (PTFE, POLYPROPLYENE, PVC)	PTFE - 'O' RINGS, LIP SEALS, GLAND PACKING. POLYPROPLYENE - GLAND GUARDS. PVC - GLAND GUARDS.	RELEASES FUMES WHEN HEATED.
ELASTOMERIC COMPOUNDS (EP, VITON, NITRILE, NEOPRENE	ALL - 'O' RINGS, LIP SEALS. NITRILE, POLYURETHANE - ROTORS (KNOWN AS RUBBER AND URETHANE).	RELEASES FUMES WHEN HEATED.
ARAMID FIBRE	GLAND PACKING.	EMITS HARMFUL DUST. RELEASES FUMES WHEN HEATED.
PAINT	EXTERNAL PUMP SURFACES.	RELEASES DUST AND FUMES IF MACHINED. TREAT AS A FIRE HAZARD.

2.0 UNPACKING, HANDLING AND STORAGE

To avoid any problems, on receipt of your pump always use the following procedure:-

2.1 DOCUMENTS

1. Check the delivery note against the goods received.

2. If the pump has been delivered with an electric motor check that the motor instructions are available.

2.2 UNPACKING

Care must be taken when unpacking the pump, and the following stages must be completed:-

1. Inspect the packing for any possible signs of damage in transit.

2. Carefully remove the packing away from the pump.

3. Inspect the pump for any visible signs of damage.

4. Clean away the packing from the pump port connections.

5. Ensure that any additional equipment such as seal flushing pipework is not damaged.

2.3 HANDLING

Refer to the pump weights guide, prior to using any lifting gear. Use the correct lifting slings for the pump weight (or pump and drive if applicable).

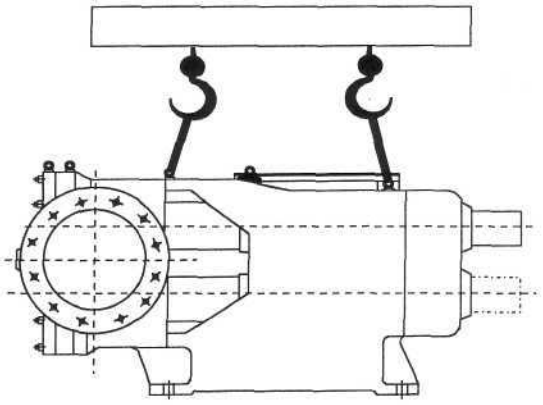
The following details show how the pumps should be lifted.

BARESHAFT PUMP :- A spreader beam together with the eye bolts can be used to lift the pump.

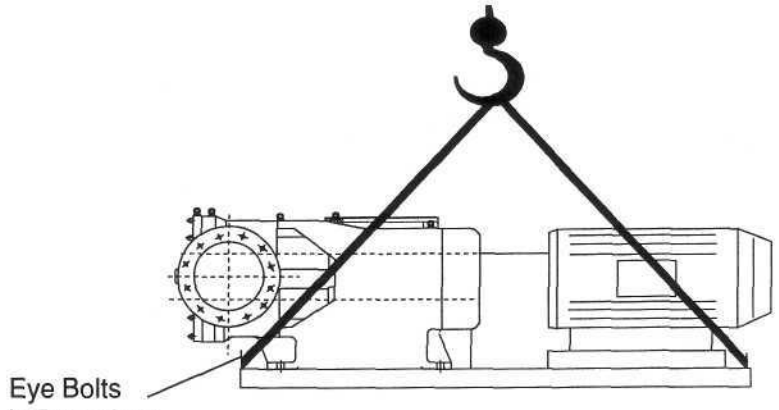
PUMP WITH DRIVE UNIT :- if the pump is in-line mounted the slings should be positioned as shown below.

NOTE :- To stop the slings slipping always cross the slings on the lifting hooks.

SPREADER BEAM



BARESHAFT PUMP



PUMP WITH IN-LINE DRIVE UNIT

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:-

1. Plastic or gasket type port covers should be left in place.

2. Pumps received wrapped with corrosion inhibiting treatment material should be rewrapped.

3. A clean, dry storage free from vibration location should be selected. When a moist dusty atmosphere must be used for storage, further protect the pump or unit with a moisture repellent cover until it is to be installed.

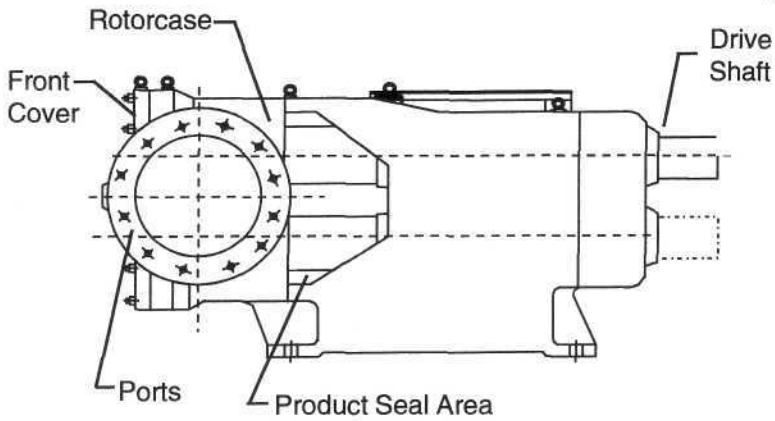
4. Rotate pump/drive unit by hand, weekly, to prevent bearing and gear damage.

5. All associated ancillary equipment should be treated similarly.

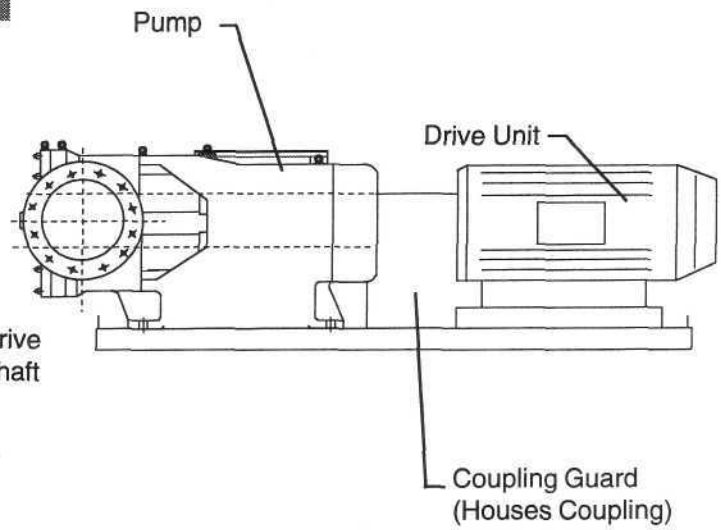
3.0 DESCRIPTION OF PUMP OR PUMP UNIT

3.1 GENERAL PUMP DESCRIPTION

The pump supplied is a positive displacement pump, which may be supplied with or without a drive unit (see below). The drawing below indicates various parts of the pump.



Bareshaft Pump

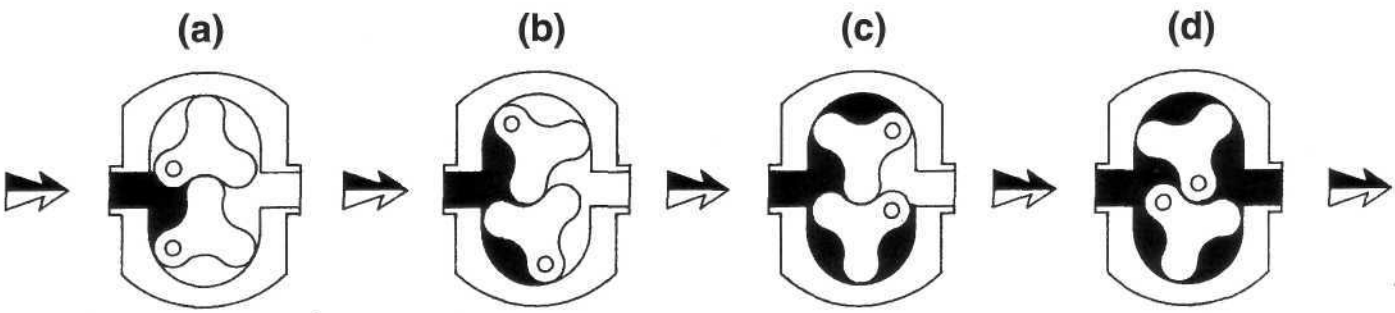


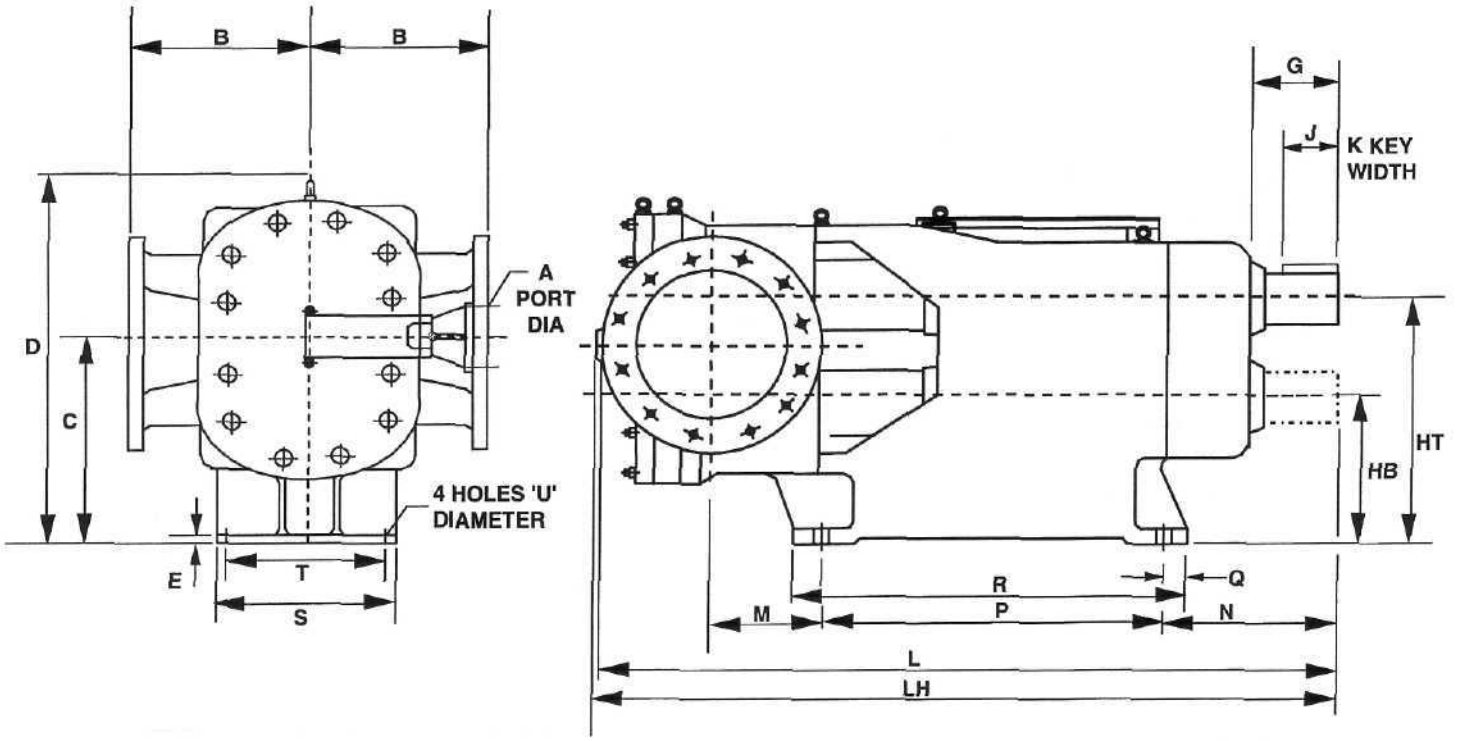
Pump with Drive Unit

3.2 PRINCIPLE OF OPERATION

The pumping principle is best explained with reference to the diagram below (a-d). In (a) the contra-rotating rotors have just come out of mesh creating a reduction in pressure within the chamber which is then filled with product. In (b) and (c) the product is trapped in the chambers and transferred around the outside of the rotorcase to the discharge. In (d) the rotors go into mesh and the product is discharged.

The rotors are synchronised by the timing gears, and mesh without contact occurring, thus when sealing system permits, dry running is possible. Pumps can be run in either direction of rotation.

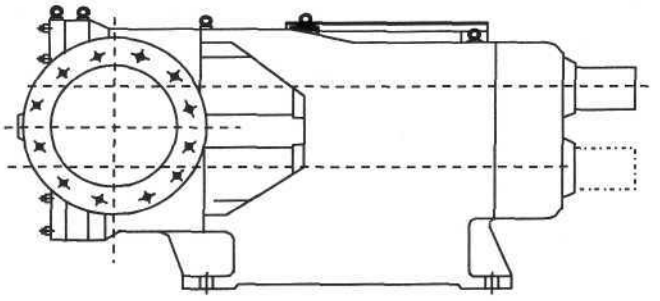




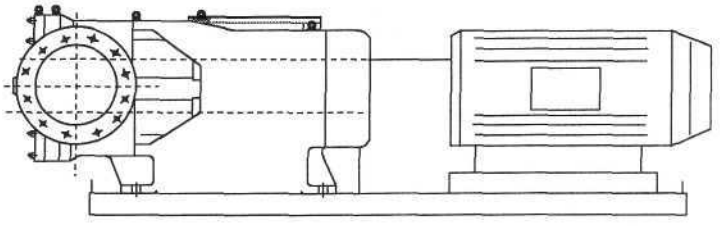
ALL DIMENSIONS IN MM

PUMP MODEL	A	B	C	D	E	F	G	HB	HT	J	K	L	LH	M	N	P	Q	R	S	T	U
A9/G9-1507	250	400	450	850	35	120	165	325	575	140	32	1536	1578	196	367	750	35	820	350	280	28
A9/G9-2270	305	400	450	850	35	120	165	325	575	140	32	1608	1663	246	367	750	35	820	350	280	28

The above dimensions are for guidance only and should not be used for installation purposes. Certified dimensions are available upon request.



BARESHAFT PUMP



PUMP UNIT - PUMP COMPLETE WITH DRIVE UNIT

PUMP MODEL	BARESHAFT PUMP KG	PUMP WITH TYPICAL DRIVE UNIT KG
A9/G9-1507	1362	2000
A9/G9-2270	1410	2100

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

The following table details the pump capacities for the pump models. This figure will change depending upon speed, pressure, temperature and product being pumped.

PUMP MODEL	DISPLACEMENT LITRES/REV	MAXIMUM SPEED WATER (RPM)	MAXIMUM CAPACITY AT MAXIMUM SPEED M^3/HR
A9/G9-1507	15.07	500	452
A9/G9-2270	22.70	500	681

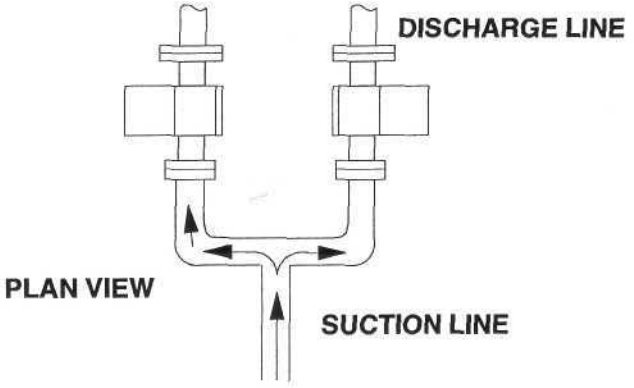
4.0 SYSTEM DESIGN AND INSTALLATION

4.1 SYSTEM DESIGN ADVICE

When designing the pumping system :-

DO - confirm with the supplier the Net Positive Suction Head (NPSH) requirements for the pump, as this is crucial for ensuring the smooth operation of the pump and preventing cavitation.

DO - avoid suction lifts and manifold/ common suction lines for two pumps running in parallel, as this may cause vibration or cavitation.



DO - 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, current monitoring device.

DO - Install a motor current sensing device which automatically reverses the pump when an overload or jam is detected.

Note : This is not recommended when non return valves are fitted.

DO - fit suction and discharge pressure gauges to monitor pressures for diagnostic purposes.

DO - install non-return valve to prevent turbining when high pressures are applied to the pump whilst it is not in use. Valves are also recommended if two pumps are to be used on manifold/common discharge lines.

DO - make the necessary piping arrangements if flushing is required for the seal.

DO - provide a hose cleaning facility to assist maintenance, ensuring the drive unit meets the specification for hose cleaning.

DO NOT - subject the pump to rapid temperature changes during C.I.P. (Cleaning in Place) procedures. **PUMP SEIZURE CAN RESULT FROM THERMAL SHOCK.** The differential pressure across the pump should be near zero when cleaning. A suitable by-pass is recommended.

Depending on your requirements the pump and drive (if supplied) may arrive mounted on a baseplate. Our standard baseplates have pre-drilled fixing holes to accept base retaining bolts.

To provide a permanent, rigid support for securing the pump unit a foundation is required, this will also absorb vibration, strain or shock on the pumping unit.

FOUNDATION SIZE

The foundation should be approximately 150mm longer and wider than the mounting base of the unit. The depth of the foundation should be proportional to the size of the pump unit (pump complete with drive and baseplate). The foundation depth should be at least 20 times the diameter of the foundation bolts.

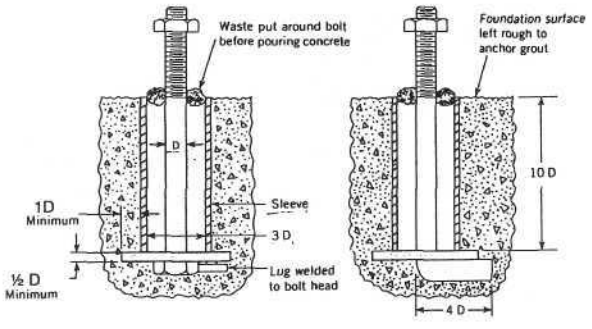
BOLT LOCATION DIMENSIONS

The location and sizes of the relevant bolting down holes can be provided on a certified drawing from your supplier.

TYPICAL FOUNDATION BOLTS

The drawing below shows two methods for foundation bolt retaining. The sleeve allows for 'slight' lateral movement of the bolts after the foundation is poured. Use rag or paper to prevent the concrete from entering the sleeve while the foundation is poured. A minimum of 14 days is required to allow the curing of the concrete prior to operation.

D = Diameter of foundation bolts

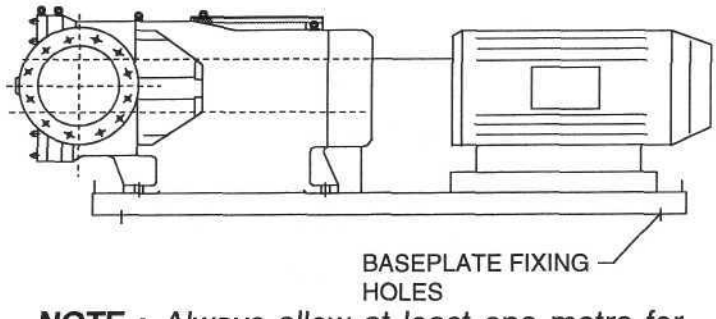


4.3 INSTALLATION

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. This will cause pump/motor shaft misalignment and pump/motor unit damage.

CHECK - **pump shaft** to **motor shaft alignment** once the baseplate has been secured and adjust as necessary.



NOTE : Always allow at least one metre for pump access/maintenance all around the pump.

WEIGHT - Consider the weight of the pump, drive and lifting gear requirements.

ELECTRICAL SUPPLY Ensure that there is an adequate electrical supply close to the pump drive unit. This should be compatible with the electric motor selected.

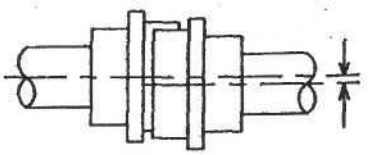
4.4 COUPLING MISALIGNMENT

When installing the pump and drive unit, it is **ESSENTIAL** to ensure that the coupling is **NOT** twisted during installation. The main cause of misalignment is by fitting the baseplate to an uneven surface.

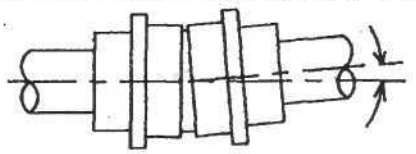
Check the maximum angular and parallel allowable misalignments for the couplings before operating the pump.

Details of coupling types will be available on request.

PARALLEL MISALIGNMENT



ANGULAR MISALIGNMENT



4.5 PIPEWORK

All pipework MUST be supported. The pump MUST NOT be allowed to support any of the pipework weight.

REMEMBER - Pipework supports must also support the weight of the product being pumped.

ALWAYS :-

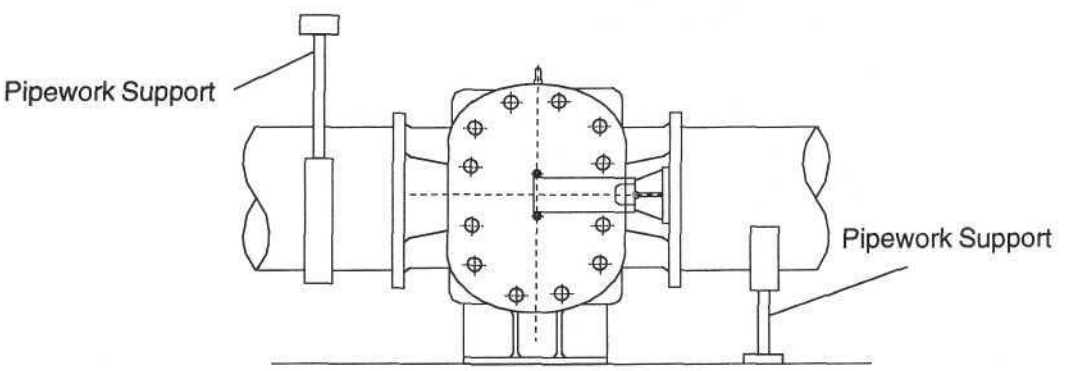
HAVE - Short straight suction lines to reduce friction losses in the pipework thereby improving the NPSH available.

AVOID - Tees and any restraints 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.

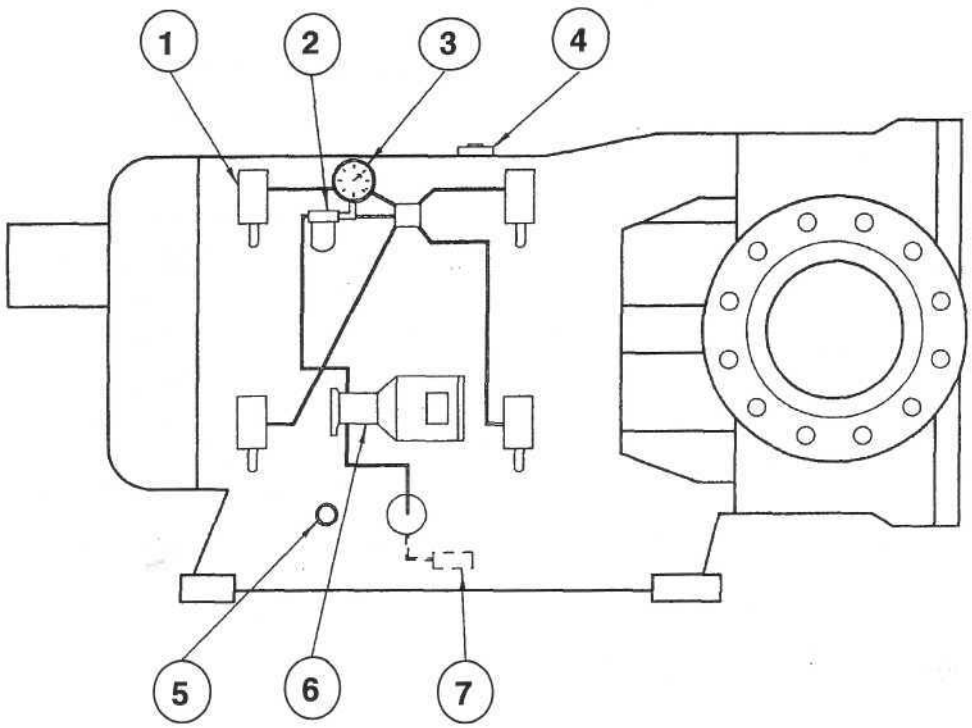
KEEP - Pipework horizontal where applicable to reduce air locks. Include eccentric reducers on suction lines.

CHECK - Coupling alignment during installation to highlight pipework alignment/support problems.



5.1 LUBRICATION

The bearings and timing gears are lubricated by an independent system attached to the side of the gearcase, using the gearcase to form an oil reservoir.



ITEM NUMBER	DESCRIPTION
1	ADJUSTABLE SIGHT FEED INDICATOR
2	HIGH PRESSURE FILTER
3	PRESSURE GAUGE
4	OIL FILLER/BREATHER
5	SIGHT GLASS
6	MOTORISED GEAR PUMP
7	SUCTION STRAINER

5.2 LUBRICATION SYSTEM MAINTENANCE

It is recommended that the following safety measures are incorporated into the lubrication system and maintenance.

1. A suitable electrical interlock device should be installed to ensure that :-

   - the motorised gear pumps come into operation approximately 15 seconds in advance of the main unit.

   - Main unit is stopped should the oil flow cease for any reason.

2. After first month of service drain the lubricating oil from the gearcase, flush with a suitable flushing oil and re-fill with a recommended grade of lubricant (approximately 32 litres), through the oil filler at the top of the pump.

3. Check that filler plug breather holes are clear.

4. Check gearcase lubricant level weekly and top up if necessary with the recommended grade of lubricant. Any substantial oil losses should be investigated.

5. Ensure that the oil pressure gauge shows that oil is being circulated. The reading should read between 0.3 - 3 bar. (5 - 45 PSI).

6. After 12 months or 5,000 working hours drain and flush gearcase and refill with recommended grade of interest.

7. If the pump is working in an extreme environment, then oil change frequency and lubrication grades may be changed, consult Alfa Laval Ltd for details.

8. Always ensure that the gearbox drive manufacturer's lubrication recommendations are carried out.

   If any of the recommended grades of lubricating oils are unobtainable locally then consult the supplier or distributor for alternative recommendations.

The lubrication capacity is approximately 32 litres.

RECOMMENDED LUBRICANTS
Mobilgear 626
BP Engergol C5150
Esso Spartan EP150
Omala 150
Texaco Regal Oil R & O 100

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

It is **IMPORTANT** that:-

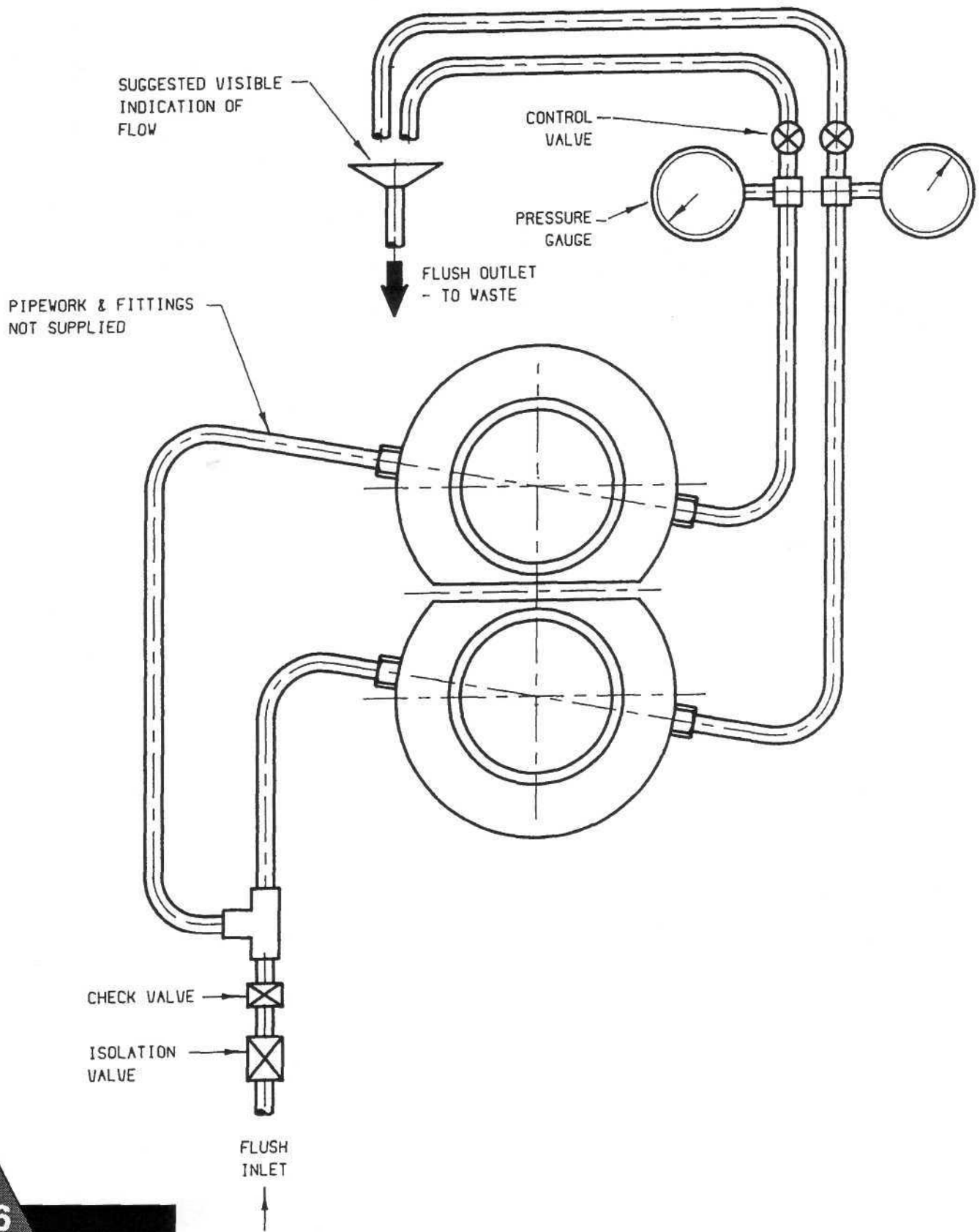
- The flush is correctly **CONNECTED.** (See overleaf).
- A **COMPATIBLE** flushing **FLUID** is used.
- The fluid is supplied at the **CORRECT PRESSURE** and **FLOW** rate.
- The flush is **TURNED ON** at the **SAME TIME/PRIOR** to **STARTING** the pump, and turned off at the same time/after stopping the pump.

5.4 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. (A constant flow valve can be used).
- **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 e.g. using a **TUN DISH.**

This suggested arrangement is for **FLUSHED PACKED GLANDS**. *If the pump is fitted with a different seal arrangement requiring a flushing system, consult the supplier for advice.*



The seal flushing connections are ¼" BSPT or NPT as specified at the time of order.

5.7 FLUSHING FLUID

The choice of flushing fluid is dependant upon the pumping media 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 the supplier.

5.8 FLUSHING PRESSURE AND FLOW RATE

To enable the flush to operate correctly, the flushing fluid must be supplied at the correct pressure. The flushing pressure for flushed packed glands should be 1 bar above the pumping pressure.

The flushing **FLOW RATE** must be adequate to ensure that the temperature limitation of the seals is not exceeded. Contact your supplier for further information on the recommended flow rate for the product seal fitted.

6.0 START UP, SHUT DOWN AND CLEANING IN PLACE

6.1 PUMP START-UP CHECK LIST

		YES	NO
1.	Is the location of the '**stop**' button clear?	☐	☐
2.	Has the pipework system been flushed through to purge welding slag and any other hard solids?	☐	☐
3.	Have all **obstructions** been removed from the pipework or pump?	☐	☐
4.	Are the pump**connections** and pipework joints **tight** and **leak-free**?	☐	☐
5.	Is there **lubrication** in the **pump** and **drive** unit?	☐	☐
6.	If your product **seals** require **flushing** has the flushing supply been fitted?	☐	☐
7.	Are the pipework **valves open**?	☐	☐
8.	Are **all safety guards** in place?	☐	☐
9.	Start then stop the pump, is the product **flowing** in the correct **direction**?	☐	☐
10.	Are the pump **speed/pressure** settings below the pump maximum limitations?	☐	☐

ALL ANSWERS SHOULD BE 'YES' BEFORE PROCEEDING

IF THERE ARE ANY PUMPING PROBLEMS REFER TO THE FAULT FINDING CHART

1. Turn the pump off.

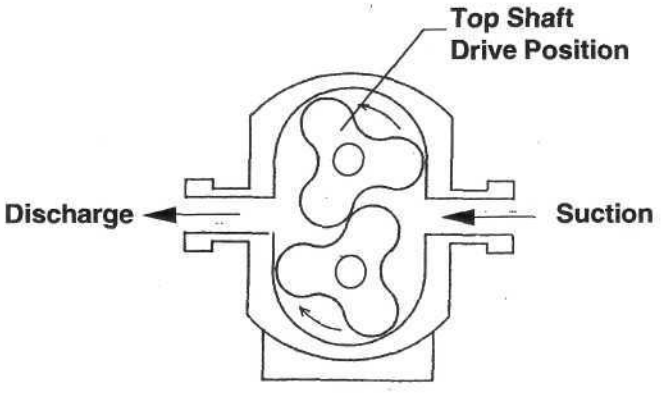
2. Isolate the pump/drive unit from all power and control supplies.

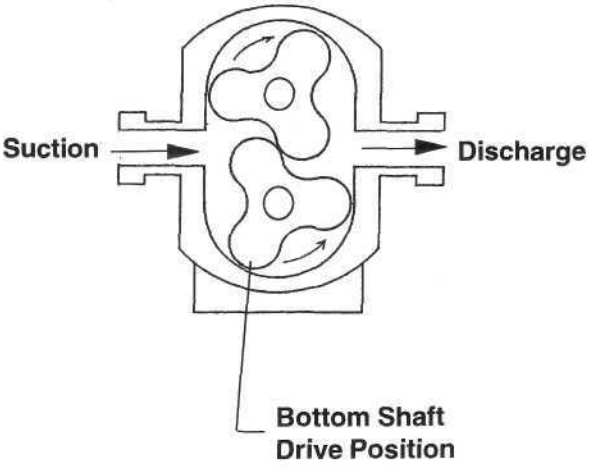
3. Close the pipework valves to isolate the pump.

4. If the pump is to be dismantled refer to the dismantling section.

6.3 DIRECTION OF ROTATION

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. Top and bottom shaft drive pumps have opposite flow directions as illustrated.

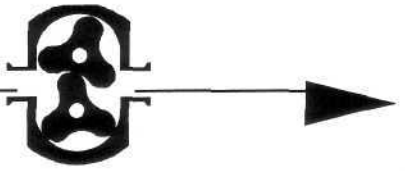




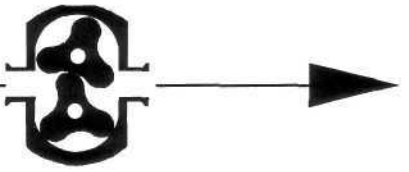
6.4 CLEANING IN PLACE (CIP)

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

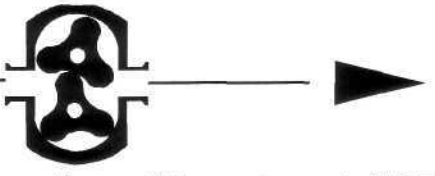
1. Flush through the system with cold water or bore water (6º C). See note at the bottom of this page.



2. Run hot caustic soda (70-80°C) at 2.5% dilution through the system for 20-30 minutes. See note at the bottom of the is page



3. Final flush through with cold water again. See note at the bottom of this page.



NEVER touch the pump or pipes as they will be extremely **HOT!**

DO NOT subject the pump to rapid temperature changes during C.I.P. procedures, as pump seizure can result from thermal shock. A suitable by-pass is recommended.

ALWAYS use rubber gloves and protective goggles when handling caustic agents.

ALWAYS rinse well with clean water after using a cleaning agent.

ALWAYS store/discharge cleaning agents in accordance with current rules/directives.

7.1 MAINTENANCE SCHEDULE

It is advisable to install pressure gauges either side of pump so that any problems within the pump/pipework will be highlighted.

YOUR WEEKLY SCHEDULE SHOULD INCLUDE:

- CHECKING THE **OIL LEVEL** IN THE GEARCASE
- CHECKING THE **MECHANICAL SEALS** (if fitted) FOR LEAKAGE AND REPLACING AS NECESSARY
- ADJUSTING THE **PACKED GLANDS** TO CONTROL LEAKAGE
- CHECKING THE **OIL SEALS** FOR LEAKAGE
- CHECKING **PUMPING PRESSURES**

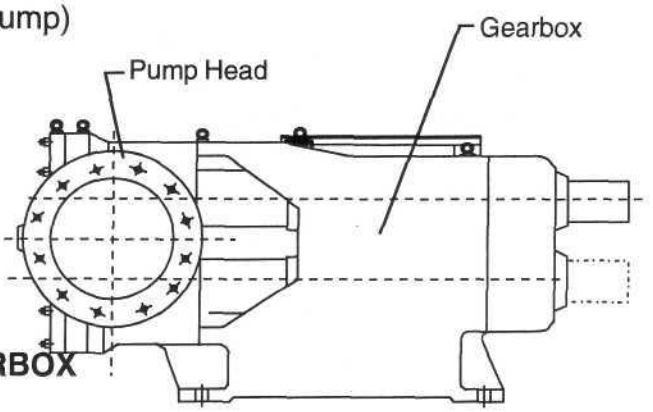
7.2 RECOMMENDED SPARE PARTS

The following table details the recommended spare parts which should be retained within your maintenance stock.

Part Description	Quantity
Lip Seal Drive End	2
'O' Ring Front Cover	1
Lip Seal Gland End	4
Rotors	2
Gasket Rotor Cap	2
Product Seals/Packing Sets	2

DISMANTLING AND ASSEMBLING OF THE PUMPHEAD

You will need - Lifting Gear
Allen keys
Spanners
Socket set
Wooden wedge
Soft mallet
Cleaning hose
Silicon grease
Torque wrench
Rotor clamp tool (not supplied with pump)

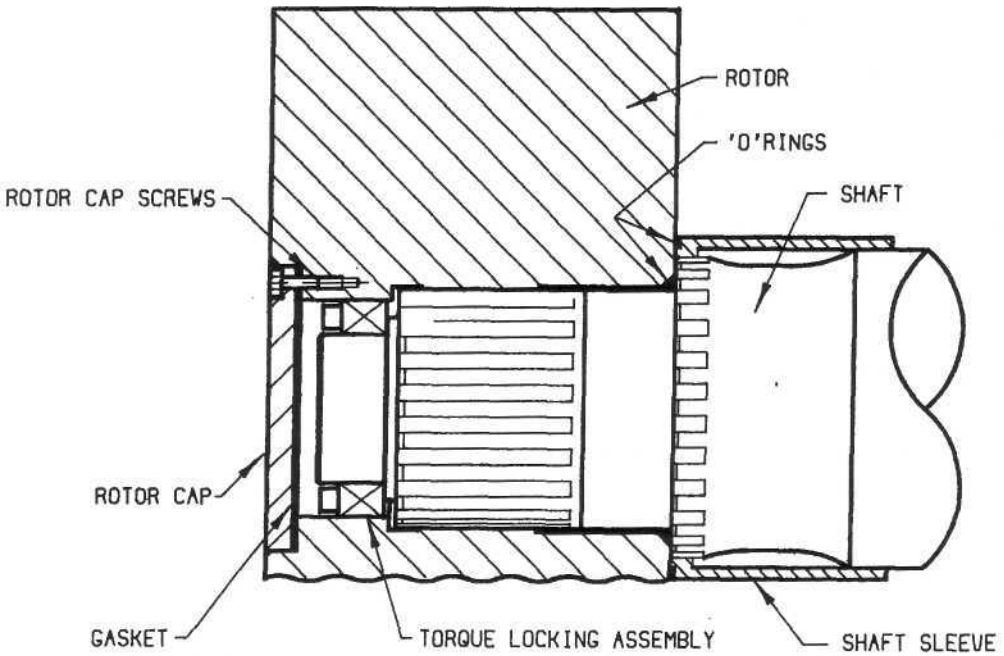


DISMANTLING AND ASSEMBLING OF THE GEARBOX

You will need - A Work Shop equipped with:

A heavy duty vice
A press and pressing tools
Lifting gear
Induction heater
A method of lubrication collection
Lever soft ended
Wooden wedge
'C' spanner
Liquid gasket
Permabond 145 (or equivalent)
Torque wrench

The rotors are retained to the shaft by Torque Locking Assemblies (TLA). Each rotor is sealed off at the end by a rotor cap and gasket which are in turn screwed to the rotor.



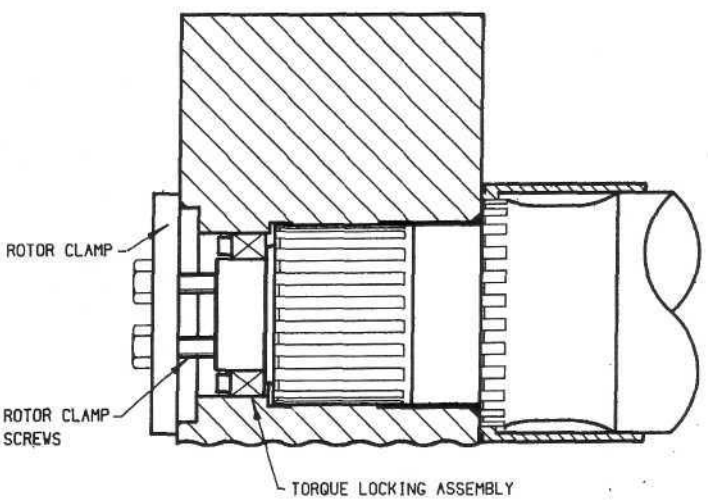
8.1 TORQUE LOCKING ASSEMBLY (TLA) FITTING INSTRUCTIONS

When fitting a TLA it is essential that :-

1. The TLA is lightly oiled on all surfaces to assist in achieving the correct torque value, and also to aid its release when removing.

2. Once fitted into its working position and before tightening, a temporary clamp and screw should be used to ensure the rotor with TLA is positively abutted against the shaft shoulder. This will ensure that rotor front and back clearances are maintained.

3. Lightly tighten the TLA screws, remove the rotor clamp and then tighten the screws up to the torque value detailed on page 40. To obtain best results it is recommended that the screws are tightened in a diametrically opposed pattern, repeating until correctly set.



NOTE :
ROTOR CLAMP (NOT SUPPLIED) THE RECOMMENDED CLAMP SIZE IS 25 X 25 X 170MM LONG DRILL 2 HOLES Ø 13.0 AT 38.0 PITCH

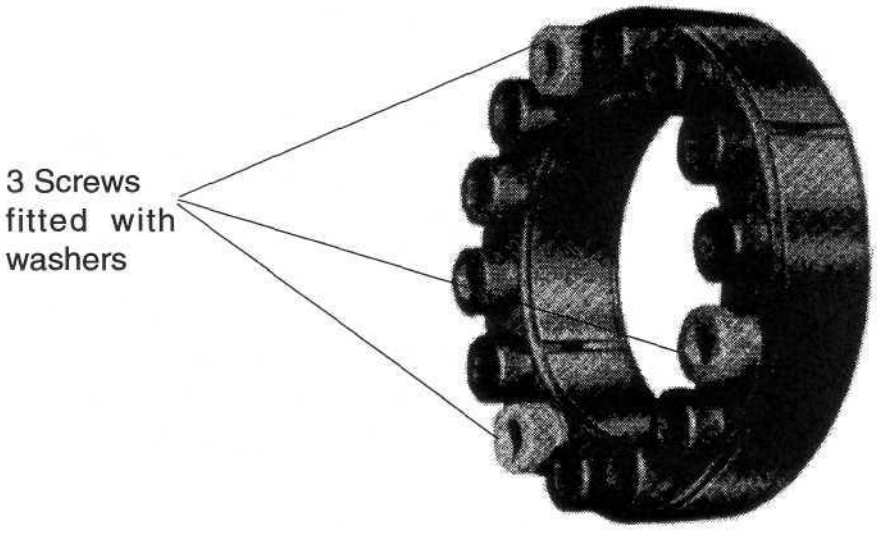
8.2 TORQUE LOCKING ASSEMBLY RELEASE INSTRUCTIONS

Remove the rotor cap screws and extract both rotor caps. Loosen all screws in the torque locking assembly. The TLA may be extracted by removing the three screws which protrude further than the remainder. Under these three screws are M12 tapped extraction holes, TLA may now be extracted by using the tapped holes. The rotor may now be removed from the rotorcase with suitable lifting equipment.

1. Remove the rotor cap screws and extract both rotor caps.

2. Loosen all screws in the torque locking assembly in several stages in a diametrically opposite sequence. The loosened TLA can now be removed.

3. To extract the TLA from the rotor, only remove the three screws which are fitted with washers. Carefully screw M12 bolts into the holes (these holes have only 3-5 threads, do not tighten) and pull out the TLA.



Torque Locking Assembly

9.1 BEFORE DISMANTLING THE PUMP

Before starting to dismantle the pump
ALWAYS:-

PURGE -

the pump and system if any noxious products have been pumped.

ISOLATE -

pump/drive unit from all power and control supplies.

CLOSE -

pipework valves to isolate the pump

DISCONNECT -

the pump from the drive unit.

READ THIS SECTION FIRST BEFORE CONTINUING TO DISMANTLE THE PUMP

9.2 REMOVING THE ROTORS

1 Before starting to dismantle the pumphead isolate the driver/pump from all power and control supplies, purge the system if any noxious products have been pumped.

2. Ensure isolating valves to the pump are closed.

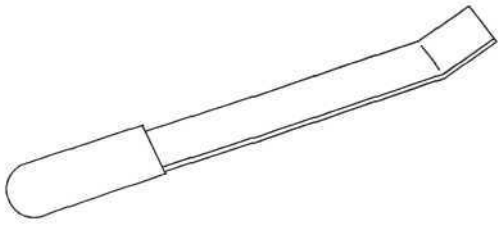
3. Carefully loosen the front cover retaining nuts, there may still be residual pressure in the system.

4. Remove the front cover retaining nuts. Using the hinge provided, remove the cover so it is clear of the rotorcase. Do not attempt to prise the front cover off with a screw driver or any metal implement.

5. At this point it may be advisable to flush out the pumphead before continuing.

6. Remove the rotor TLA's by following the torque locking assembly release instructions on page 25.

NOTE : Lifting equipment must be used to extract the rotors which should slide out from the splines. It may be necessary to use a suitable tool shown below to prise the rotors from the shaft splines. Always cover the end of the tool to prevent damage to the rotors.



9.3 REMOVING THE ROTORCASE

1. Remove rotors as described previously.

2. Before proceeding, disconnect the suction and discharge piping.

3. If the pump is fitted with a packed gland seal, loosen the gland followers.

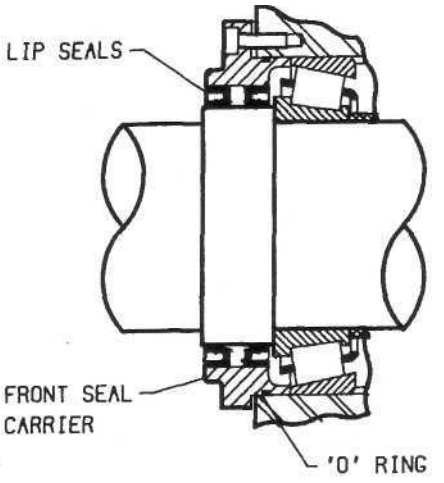
   If the pump is fitted with a flushed seal arrangement, remove the housing retaining nuts and ease the housing away from the rotorcase.

4. Remove the rotorcase/gearcase nuts.

5. Ensure the rotorcase is adequately supported by lifting equipment. The rotorcase can now be tapped forward with a soft mallet until it clears the locating dowels. If the pump is fitted with mechanical seals, care must be taken to support the rotorcase as it comes off the dowels other wise the seals may be damaged.

6. Once the rotorcase is removed the seals/ gland packing can be examined.

1. Follow the procedure for removal of rotors and rotorcase.
2. Remove the mechanical seal, or packed gland and ring slingers.
3. Three socket head screws retain the seal carrier, once removed the carrier can be extracted. As silicone sealant or a gasket is used to seal the faces the carrier may have to be eased off carefully with a lever.
4. Once the carriers are removed from the pump the seals can be pressed out and replacements pressed in using a suitable dolly.
5. Inspect and replace the carrier 'O' ring if necessary.
6. Ensure the surface area which the seal will run on is free from scratches, if the surface is scratched, clean up damaged area with a fine grade abrasive cloth. Ensure that all traces of abrasive material are cleaned away before refitting the new oil seals.
7. Before replacing the seal carriers, clean the old silicone sealant (if used) from the rear face of the carrier and from the front face of the gearcase. Coat the rear face of the carrier with new silicone sealant. Tighten the screws evenly to the recommended torque value.
8. Slide the carrier with the seals and 'O' ring into position and replace the three socket head screws. Replace ring slingers, reassemble the seals and rotorcase, see the relevant section for setting dimensions and refitting procedures.



9.5 REFITTING THE ROTORCASE

ALWAYS USE LIFTING EQUIPMENT WHEN REFITTING THE ROTORCASE

1. Remove and clean the shaft sleeve spacer as this determines the rotor alignment.

   Note : Ensure shaft sleeve spacers are replaced on the shaft that they have been removed from.

2. Fit seal according to relevant section and check the correct seal setting dimensions have been achieved.
3. Check that the seal assembly has been correctly fitted.
4. Locate the rotorcase/gearcase dowels carefully into position.
5. Replace and tighten the rotorcase/ gearcase nutsto the required torque value.

   Note: Care should be taken when sliding the rotorcase over the shafts not to damage the mechanical seals if fitted.

9.6 REMOVAL OF REAR GEARCASE COVER AND REPLACEMENT OF SEAL

1. Isolate the motor, remove any coupling or Vee belt guards.

2. If the pump is direct coupled, it will be necessary to disconnect the coupling and remove the pump from the baseplate to gain access to the rear oil seal.

3. The rear gearcase cover houses two identical seals fitted face to face and packed with grease between the two faces.

4. Make provisions to collect the lubricant from the pump on the removal of the rear cover. If a clean tray is used the lubricant can be reused.

5. As the end cover is sealed to the gearcase with a liquid gasket it may require a sharp tap with a mallet and punch on the side to break the joint.

6. Remove the end cover and press out the oil seal, and replace with a new seal. Pack the oil seals with Mobil grease Mobilplex 48 or equivalent.

7. Clean the faces of both the gearcase and the end cover, coat the faces with a suitable liquid gasket and refit the end cover. Replace the retaining screws then centralise the lipseal on the shaft before tightening to the recommended torque value.

8. Fill the pump gearcase with oil to the sight glass levels.

9.7 REFITTING THE ROTORS

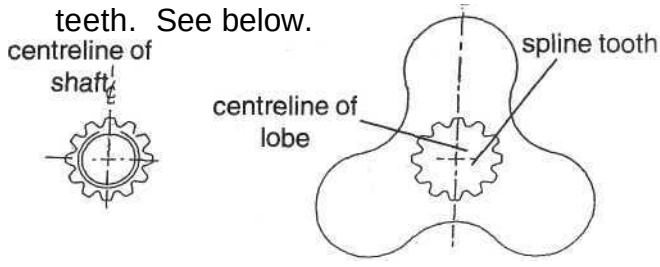
1. All rotors in Series A&G pump range have sealing 'O' rings as described previously. Check the condition of the 'O' rings and fit new rings if necessary.

2. The rotors are fully interchangeable. When refitting the rotors correct timing is achieved by replacing the rotors in exactly the same positions as when removed. If the gears have been removed or the gearbox dismantled the pump will have to be retimed as described in the timing adjustment section.

To refit the rotors the recommended procedure is as follows:-

rotate the drive shaft until the keyway's uppermost (not essential).

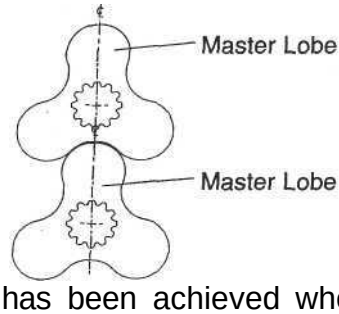
find the master lobe of the rotor which centreline is the same as that of the spline teeth. See below.



line the master lobe up with the shaft spline and slide the rotor onto the shaft.

find the master lobe of the remaining rotor as previously done.

slide the rotor on so that both rotors are in the position shown below.



Correct timing has been achieved when the pump rotates freely without contact taking place between the rotors, this should always be checked prior to running the pump.

3. Replace the 'torque locking assemblies', rotor cap and screws.

4. Before refitting the front cover examine the 'O' ring and replace it if damaged. Fit front cover and tighten the nuts up to the recommended torque values.

The following instructions detail the procedure for fitting stainless steel bilobe rotors.

1. Remove the front cover and existing bilobe rotors from the pump as detailed.

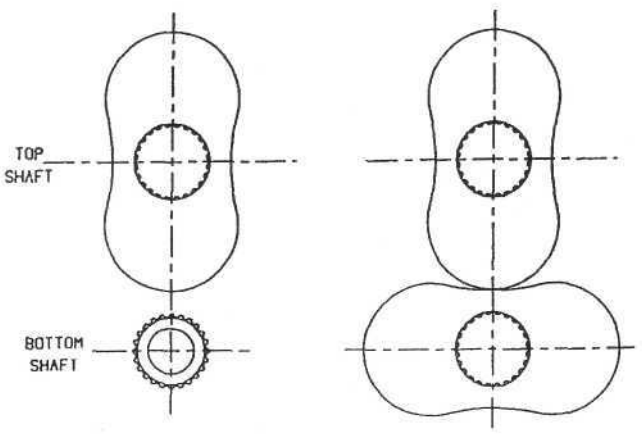
2. Rotate the drive shaft until the drive shaft keyway is in the upper most position.

3. Where applicable ensure all rotor 'O' rings are in place before locating the rotors onto the shaft.

4. Locate one of the rotors on the top shaft in the vertical position (6 o'clock - 12 o'clock plane). See below.

5. Fit the remaining rotor on the bottom shaft in the horizontal position (3 o'clock - 9 o'clock plane). See below

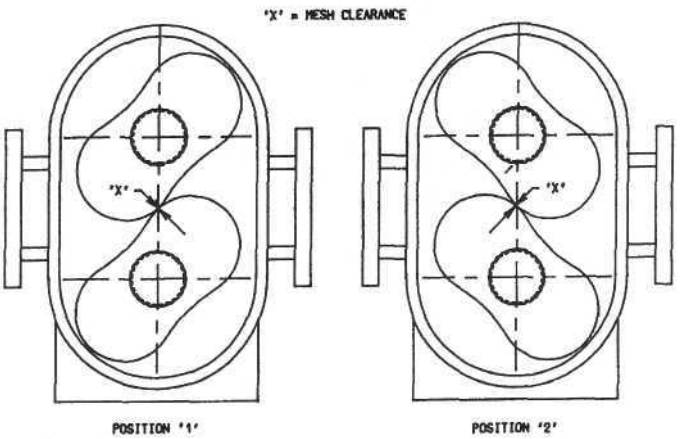
BILOBE ROTOR POSITIONS



6. Refit the TLA as detailed in the Torque Locking Assembly fitting instructions.

7. Rotate the pump shafts so that the rotors are in the new positions shown. See below.

CHECKING THE ROTOR CLEARANCES



8. Check and compare the mesh clearances at the points shown with those detailed in the clearance charts. (Charts available from the supplier.)

9. Rotate the pump shafts again until the second rotor position is achieved see above and repeat step 8.

10. Refer to the clearance charts and check all pump clearances. (Charts available from the supplier).

11. If the correct clearances have been achieved replace the rotor gasket, cap and screws followed by the front cover.

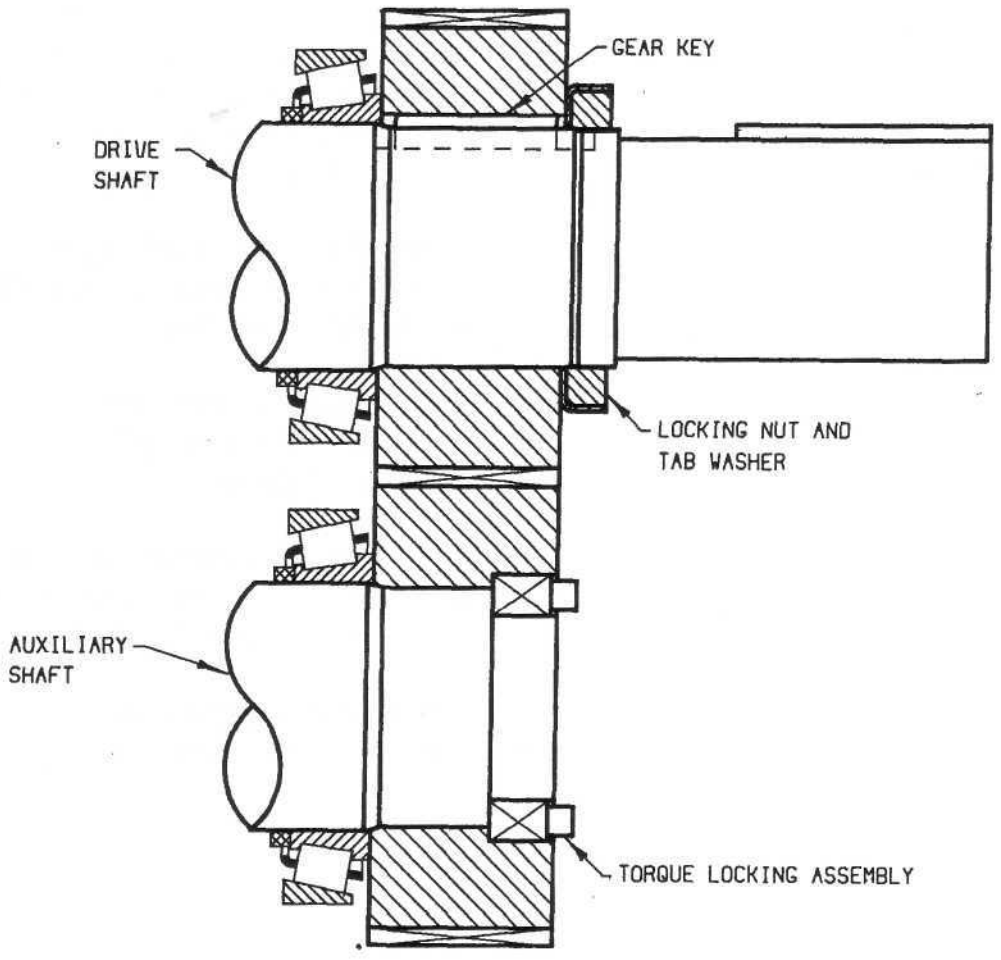
If the mesh clearance requires adjustment refer to the timing adjustment section.

10.0 GEARBOX COMPONENTS

10.1 TIMING GEARS

The pump is fitted with a pair of timing gears, which are located behind the gearcase cover. They provide synchronisation of the rotors, such that under normal working conditions the rotors will not contact one another.

One gear is keyed to the drive shaft and retained by a locking nut. The remaining gear has a torque locking assembly (TLA) within its bore providing both drive and retention for the timing gear.

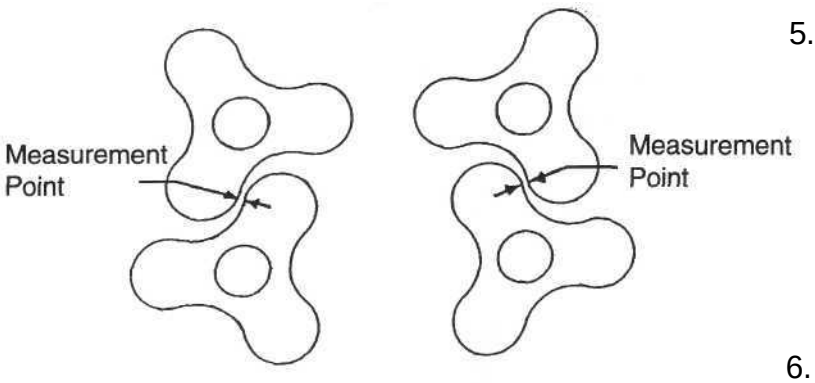


The **rotor** timing (synchronisation) is set-up in the factory. If the rotors become unsychronised, they may be retimed using the following procedure.

THE CAUSE OF THE FAULT SHOULD BE ESTABLISHED AND ELIMINATED BEFORE PROCEEDING.

To adjust the timing of the rotors, first remove the gearcase end cover. Once the cover is removed the timing gears will be exposed.

To retime the rotors, the torque locking assembly within the timing gear on the auxiliary shaft needs to be released sufficiently, to allow the rotors to be tapped into a position where they are synchronised. The rotors are correctly synchronised when the clearances at the measurement points are equal.



Use feeler gauges to measure the clearances at the positions illustrated and adjust until equal, the pump is then correctly timed. Tighten the screws for the timing gear torque locking assembly.

10.3 TIMING GEAR REMOVAL

To remove both timing gears the following procedure is recommended.

1. Drain the oil from the pump.

2. Remove gearcase cover.

3. Release the tab washer and locking nut from the drive shaft timing gear which is keyed in the shaft.

   Note : The shafts should be prevented from turning at this stage by using a soft wooden block to wedge between the gears.

4. The keyed gear may now be pulled off using the extraction holes provided.

5. Loosen all the torque locking assembly screws on the auxiliary shaft gear. Extraction holes are provided under the three screw heads, which protrude further than the remaining screws. Use the extraction holes to remove the torque locking assembly (TLA) followed by the gear from the shaft.

6. The keyed gear may now be pulled off using the extraction holes and a hydraulic puller. The gear is heated before fitting and will not slide off easily (it is an interference fit).

10.4 FITTING THE TIMING GEARS

1. Fit the rotors to the shafts to establish the timing.

2. Lubricate the timing gearwhich is retained by the torque locking assembly (TLA) and carefully slide it onto the respective shaft, use feeler gauges to ensure it is fully engaged against the bearing face.

3. Oil and insert the torque locking assembly (TLA) into the timing gear hole and loosely tighten the screws.

4. For the remaining keyed gear use an induction heater or hot oil bath to heat the gear up to 110°C. Carefully guide the gear over the key in the shaft and ensure it is fully engaged against the bearing face.

5. Coat the thread of the shaft with permabond 'thread lock', load the locking nut onto the drive shaft, and fully tighten, use Permabond nut lock on the thread.

6. Refer to timing adjustment section before fully tightening the torque locking assembly (TLA) on the auxiliary shaft gear.

10.5 LIP SEAL - REMOVAL AND REFITTING

The bearing lip seal fits behind the top shaft rear bearing housing. The lip seal runs on the back of the timing gears, and prevents the top chamber lubricant from draining into the bottom chamber.

If the lip seal is to be reused, care should be taken when extracting it not to damage the sealing edge, otherwise a new lip seal should be fitted. To refit a seal, it should be pressed evenly into the hole, and a flat plate or dolly used to drive it home.

10.6 SHAFT REMOVAL

To remove the shafts it is strongly recommended that a fixture is used to enable the pump to be turned from a horizontal to vertical position (see below) before proceeding with the following procedure.

1. Remove the rotorcase front cover, rotors and rotorcase.

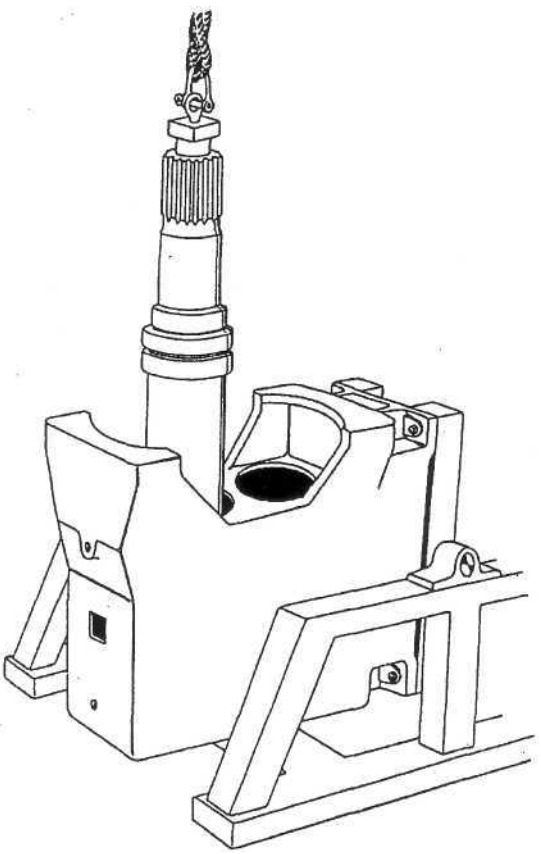
2. Remove product seals.

3. Remove the gearcase rear cover and timing gears.

4. With the pump in the vertical position remove the front seal retainer screws and retainers.

5. Fit a suitable lifting eye into the end of the shaft.

6. Carefully remove the shaft from within the gearcase using suitable lifting tackle.



The bearings are an interference fit on the shafts. The following procedure details the method for removing the bearings.

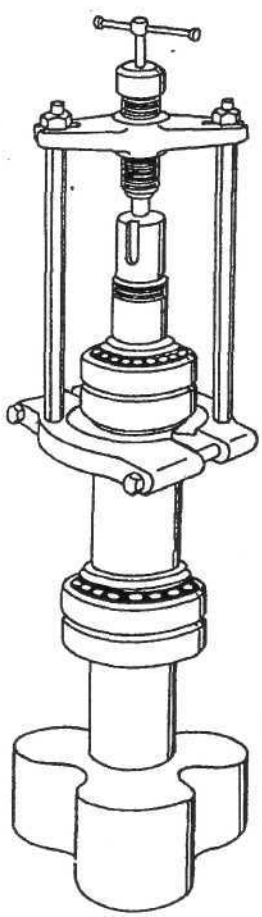
1. Remove the rear bearing using a hydraulic bearing puller with a capacity of at least 60 tons.

2. Pull off the bearing with pullers, loading the bearing through the inner cone, this will reduce the effort required to remove the bearing. Loading the shaft vertically into the rotor may assist the operation, see below.

3. The bearing spacers can now be removed from the shaft.

4. Remove the front bearings by the same method as the rear bearings.

   NOTE : It is important to note the part of the shaft from which each bearing has been removed.



10.8 BEARING ADJUSTMENT

The pumps are supplied with two sets of bearings for each shaft, one set for the front and back of the shaft. Care in dismantling will ensure no mix up of the different bearings when reassembled.

The bearings house a spacer. The front bearing spacer has been adjusted to give a specific amount of horizontal movement, known as bench end play. The correct setting must be obtained to ensure optimum performance of the bearing assembly.

If the front bearings are being replaced the following procedure should be used to determine the final spacer width.

NOTE : Always use a surface table to ensure accurate readings are recorded.

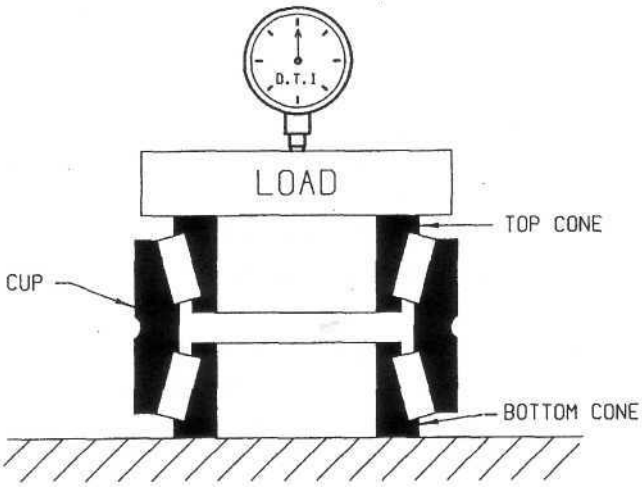
1. Place the complete front bearing assembly face down on the table without the inner bearing spacer. See below.

2. To simulate the conditions which the bearing will experience, the bearing should now be loaded with a weight of approximately 55kg.
   NOTE: Both timing gears may be used to gain the required load.

3. As measurements from a dial test indicator (DTI) are to be used, the load (or top face of the gear) should be marked 'O' with a marker pen. This will provide a target for the DTI such that a consistent reading is obtained. If using gears as the load, the gears should be marked to ensure they are also replaced in the correct position when used for further measurements. This will minimise run out errors.

4. With the bearing assembly loaded, rotate the bearing outer race until the bearing is seated. Correct seating may be checked by running the DTI around the load to check for any sizable deviations.

5. Locate the DTI on the mark 'O' and set the DTI to zero.

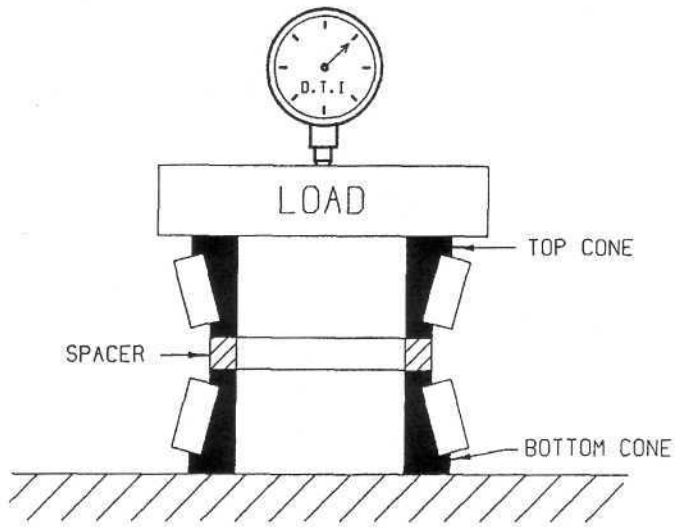


6. Carefully slide the load and bearing assembly from under the DTI.

7. Remove the load (or gears), top cone and cup (outer race). Replace new oversize cone spacer, top cone and weights, align marks where applicable.

8. Slide the loaded bearing assembly with spacer under DTI and take the reading . (See below).

9. The amount the spacer is required to be reduced may now be calculated as :-
(Last reading on the DTI) - (First reading on the DTI) + (The required bench end play).
NOTE : The bench end play required for the pump is 0.14mm (0.0056").



FRONT BEARINGS

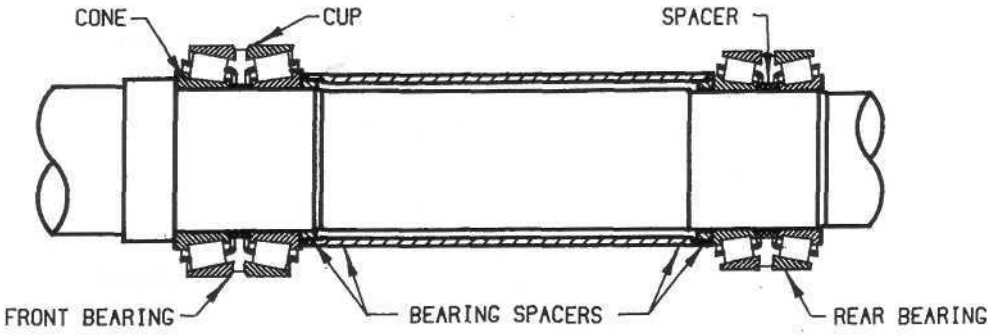
1. Remove any burrs present on shaft, and ensure shaft is conveniently supported for fitting the bearings. Stand the shaft in the rotor vertically.

2. Lightly oil shaft bearing journal.

3. Heat the cone assemblies to 120°C.

4. Assemble the bearing onto the shaft in the following order. (See below).
   - cone
   - spacer
   - cup
   - cone ("A" face uppermost)

   NOTE: "A" is marked on the end of one of the cones.



5. Allow to cool whilst ensuring that the cone is seated correctly against.

REAR BEARINGS

1. Fit bearing spacers.

2. Heat and assemble rear bearings as front bearings.

10.10 SHAFT REPLACEMENT

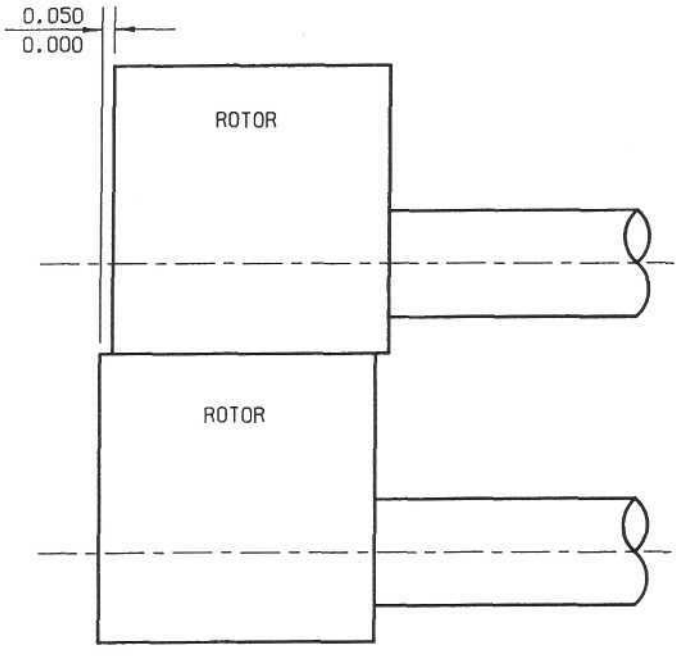
With both sets of bearings fitted onto the shaft, the shaft can now be loaded into the gearcase in a vertical mode, as previous diagram.

If new front bearings have been fitted, this will result in a change in the front and back clearance of the rotor within the rotorcase. To bring rotor clearances back to within the specified limits, adjustment is made by altering the size of the shaft sleeve spacers. The axial displacement can be in either direction as long as it is within 0.05mm (0.002") tolerance. See below.

NOTE:

a) Contact the supplier fro back clearance dimensions.

b) On non food applications always apply 'never seize[1] to the shaft before refitting the shaft sleeve.



10.11 CHECKING THE CLEARANCES

When refitting the original rotorcase or a replacement one, or having replaced the shaft bearings. The rotor clearances will need to be checked, against the rotor clearance sheet, and be adjusted as necessary.

To check the clearances the gearcases must be fully assembled with the shafts (14, 24) clamped into the gearcase by the front seal retainers (4). The shaft sleeves (8) and shaft sleeve spacers (10), must also be fitted.

The rotorcase (5) (less the mechanical seals packed gland and housing) and rotors must be fitted, with the rotors (6) locked back against the shaft sleeves (8). The clearances can now be checked.

Should the clearances need to be adjusted the shaft sleeve spacer (10) will need to be machined till the correct clearances have been achieved.

NOTE : () = Item number relating to sectional arrangement on page 38 of the maintenance manual.

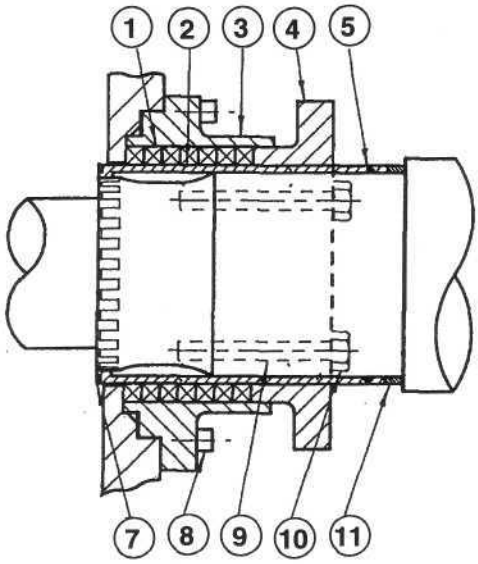
CLEARANCE SHEET

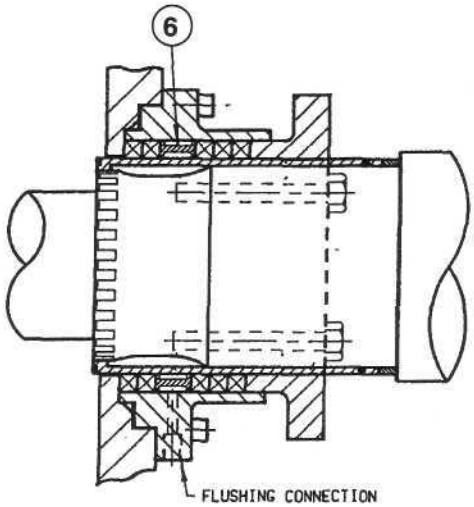
Please contact your supplier for a clearance sheet quoting the following details :

a) The pump model (e.g. A9-1507)
b) The pump serial number.

These details are included on the pump nameplate which is attached to the top of the pump.

11.1 PACKED GLAND ARRANGEMENTS





ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Gland Packing	7	Front Shaft Sleeve 'O' Ring
2	Shaft Sleeve	8	Gland Housing Screw
3	Gland Housing	9	Gland, Stud
4	Gland Follower	10	Gland Adjusting Nut
5	Shaft Sleeve 'O' Ring	11	Shaft Sleeve Spacer
6	Lantern Ring		

DRIP LEAKAGE IS ESSENTIAL TO PREVENT OVER HEATING OF THE GLAND AREA WHICH WILL CAUSE SEAL FAILURE

The packing rings are located within the gland area of the rotorcase and are tightened onto the shaft sleeve by adjusting the gland follower. On flushed packed glands a lantern ring replaces the middle ring of packing.

REMOVING THE PACKED GLAND

1. Release and pull back the gland follower.
2. Remove the rotorcase with packing still assembled.
3. Inspect and replace the packing and shaft sleeve if necessary.

FITTING THE PACKED GLAND

1. Insert the packing rings into the rotorcase and lantern ring (if flushed packed gland). Make sure they are in the correct order and positioned with the scarf joints 120° apart.
2. Loosely locate the gland follower and nuts.
3. Refit the rotorcase with packed assembly over the shaft sleeves.
4. Adjust the packed gland see next page.

11.2 ADJUSTING THE PACKED GLAND

DRIP LEAKAGE IS ESSENTIAL TO PREVENT OVER HEATING OF THE GLAND AREA WHICH WILL CAUSE SEAL FAILURE.

Important:
Stop and remove gland guard for checking temperature of housing and observing leakage. **ALWAYS REPLACE THE GUARD BEFORE RESTARTING.**

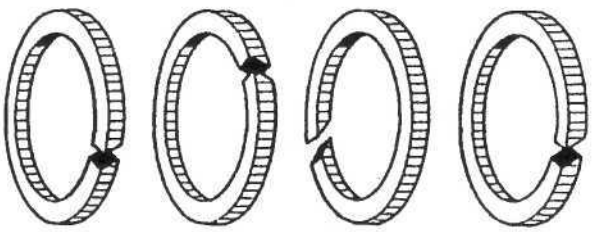
1. Lightly tighten up the gland follower.

2. Flood the pumphead and determine if the gland leakage is acceptable. Tighten the gland follower nuts until an acceptable leakage is achieved.

3. Start the pump and allow to run for 10 minutes. If the gland becomes significantly hotter than other parts of the pump, the gland is too tight.

4. Stop the pump and allow it to cool then repeat the above until the gland temperature is stable and gland slightly weeping.

5. Run the pump at 10 minute intervals tightening the gland follower nuts by *a%* of a turn until the leak is at an acceptable rate.



No Discharge	Under Capacity	Irregular Discharge	Prime lost after starting	Pump stalls when starting	Pump overheats	Motor overheats	Excessive power absorbed	Noise & vibration	Pump element wear	Excessive gland seal wear	Product loss through gland	Seizure	CAUSES		REMEDIES
•													Incorrect direction of rotation.	1	Reverse motor.
•													Pump un-primed.	2	Expell gas from supply line and pumping chamber and introduce liquid.
•	•	•	•					•					Insufficient NPSH available.	3	Increase supply line diameter. Increase suction head. Simplify supply line configuration and reduce length. Reduce speed
	•	•	•					•					Product vapourising in supply line.	4	Decrease product temperature - check effect of increased viscosity on available and permitted power inputs.
•	•	•	•					•					Air entering supply line.	5	Remake pipework joints. Adjust or repack gland.
	•	•	•					•					Gas in supply line.	6	Expell gas from supply line and pumping chamber and introduce liquid.
•	•	•	•					•					Insufficient head above supply vessel outlet.	7	Raise product level. Lower outlet position. Increase submergence of supply line.
		•	•					•					Foot valve strainer obstructed or blocked.	8	Service fittings.
	•		•	•	•	•	•	•					Product viscosity above rated figure.	9	Decrease pump speed. Increase product temperature.
	•												Product viscosity below rated figure.	10	Increase pump speed. Decrease product temperature.
					•			•	•			•	Product temperature above rated figure.	11	Cool the product pumping chamber.
				•		•	•						Product temperature below rated figure.	12	Heat the product pumping chamber. (Check with pump maker).
								•	•	•	•	•	Unexpected solids in product.	13	Clean the system. Fit strainer to supply line.
	•	•	•	•	•	•	•	•	•			•	Delivery pressure above rated figure.	14	Check for obstructions. Service system and revise to prevent problem recurring. Simplify delivery line.
					•	•	•			•		•	Gland over-tightened.	15	Slacken and re-adjust gland.
	•	•	•					•			•		Gland under-tightened.	16	Adjust gland. See not on packed glands under "Installation and Maintenance" heading.
										•	•		Gland flushing inadequate.	17	Check that fluid flows freely into gland. Increase flow rate.
	•					•	•	•					Pump speed above rated figure.	18	Decrease pump speed.
													Pump speed below rated figure.	19	Increase pump speed.
	•				•	•	•	•	•			•	Rotorcase strained by pipework.	20	Check alignment of pipes. Fit flexible pipes or expansion fittings. Support pipework.
					•	•	•	•					Belt drive slipping.	21	Re-tension to maker's recommendations.
								•					Flexible coupling misaligned.	22	Check flange alignment and adjust mountings accordingly.
					•	•	•	•	•			•	Insecure pump driver mountings.	23	Fit lock washers to slack fasteners and re-tighten.
				•	•	•	•	•	•			•	Shaft bearing wear or failure.	24	Refer to pump maker for advice and replacement parts.
					•	•	•	•				•	Worn un-synchronised timing gears.	25	Refer to pump maker for advice and replacement parts.
				•	•	•	•	•	•			•	Gearcase oil quantity incorrect.	26	Refer to pump maker's instructions.
•	•												Metal to metal contact of pumping element.	27	Check rated and duty pressures. Refer to pump maker.
	•				•								Worn pumping element.	28	Fit new components.

DIAGNOSIS WILL BE GREATLY ASSISTED BY TAKING ON-STREAM PRESSURE READINGS AT THE PUMPS INLET AND OUTLET PORTS

13.0 TECHNICAL DATA

13.1 PUMP INFORMATION CHART

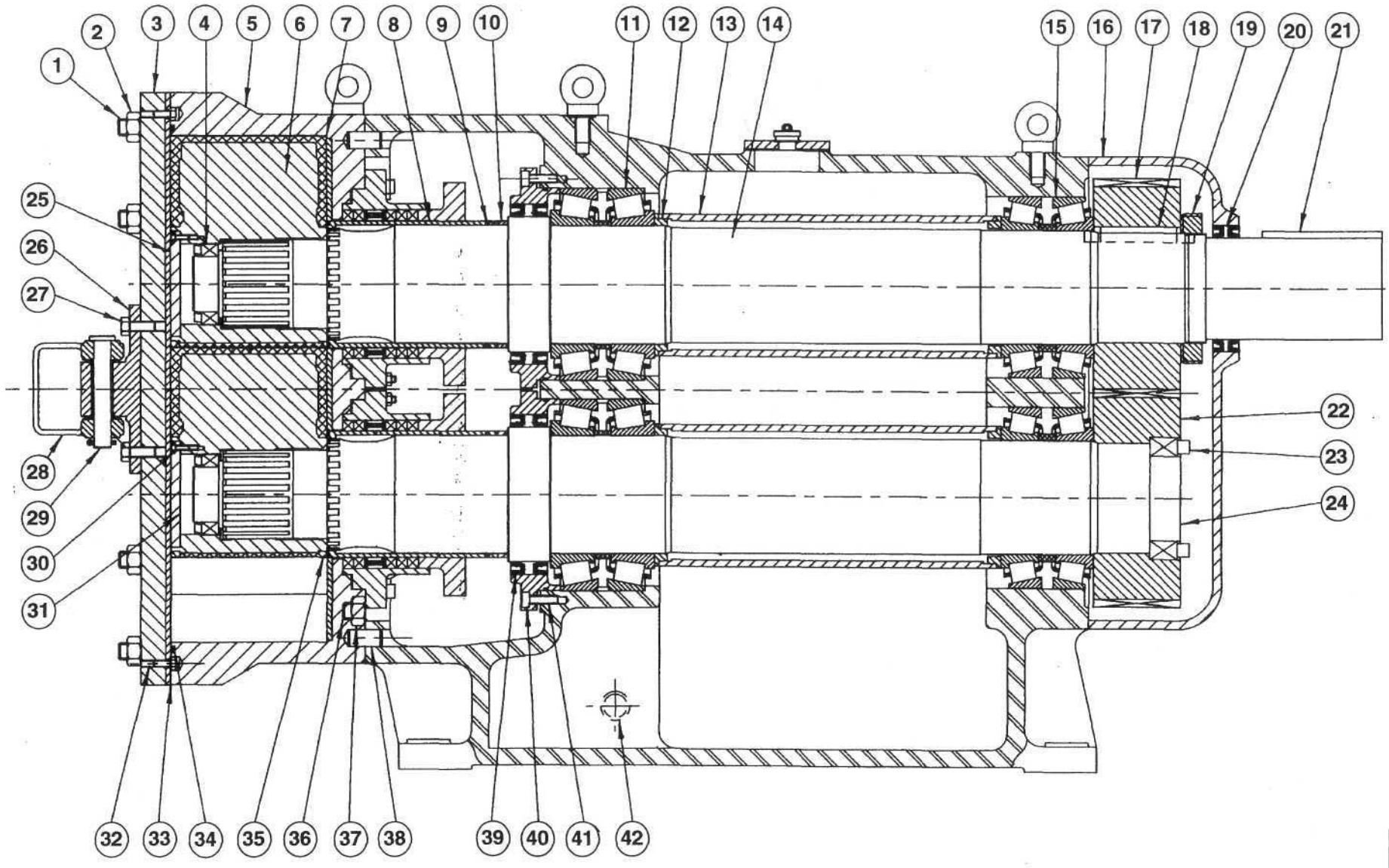
PUMP MODEL	DISPLACEMENT		SUCTION & DISCHARGE CONNECTIONS		MAXIMUM DIFFERENTIAL PRESSURE		MAX SPEED (WATER)	MAX CAPACITY (WATER)
			Connection Size international stds					
	Litres/ rev.	l gal/ 100 rev.	mm	inches	bar	lbf/in	rev/min	m^3/hr
A9/G9-1507	15.07	332	250	10	10	150	500	452
A9/G9-2270	22.70	500	300	12	10	150	500	681

13.2 TORQUE SPECIFICATION CHART

DESCRIPTION	TORQUE		KEY/SPANNER Size
	Nm	lbft	
FRONT COVER NUTS	273	188	30
GEARCASE NUTS	469	323	36
GEARCASE COVER NUTS	25	17	13
FRONT SEAL RETAINERS SCREWS	60	41	10
ROTOR TLA SCREWS	70	48	8
GEAR TLA SCREWS	125	86	10
ROTOR CAP SCREWS	10	7	5

14.0 SECTIONAL PUMP DRAWING AND PARTS LIST

ITEM	QTY	DESCRIPTION
1	12	ROTORCASE COVER STUD
2	12	ROTORCASE COVER NUT
3	1	ROTORCASE COVER
4	2	TORQUE LOCKING ASSEMBLY (ROTOR)
5	1	ROTORCASE
6	2	ROTOR
7	2	WEAR PLATE - ROTORCASE (OPTIONAL ON SERIES G)
8	2	SHAFT SLEEVE
9	2	SHAFT SLEEVE 'O' RING
10	2	SHAFT SLEEVE SPACER
11	2	FRONT BEARING
12	4	BEARING RING SPACER
13	2	BEARING SPACER
14	1	DRIVE SHAFT
15	2	REAR BEARING
16	1	GEARCASE COVER
17	1	TIMING GEAR (KEYED)
18	1	TIMING GEAR KEY
19	1	LOCKING NUT
20	2	LIP SEAL - GEARCASE COVER
21	1	KEY- DRIVE SHAFT
22	1	TIMING GEAR (TORQUE LOCKING ASSEMBLY)
23	1	TORQUE LOCKING ASSEMBLY (TIMING GEARS)
24	1	AUXILIARY SHAFT
25	2	ROTOR CAP
26	1	HINGE BRACKET
27	2	HINGE SCREW
28	1	HINGE ARM
29	1	HINGE PIN
30	6	ROTOR CAP SCREW
31	2	ROTOR CAP GASKET
32	2	FRONT COVER WEAR PLATE SCREW
33	1	FRONT COVER WEAR PLATE (OPTIONAL ON SERIES G)
34	1	FRONT COVER 'O[1] RING
35	2	SHAFT SLEEVE 'O' RING
36	4	ROTORCASE/GEARCASE STUD
37	4	ROTORCASE/GEARCASE NUT
38	2	GEARCASE DOWEL
39	4	RETAINER LIP SEAL
40	2	FRONT SEAL RETAINER
41	6	FRONT SEAL RETAINER SCREW
42	1	SIGHT GLASS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