



Tri-Clover[®] T Series TSK Positive Rotary Pump

Service & Installation Manual

omd ■ 800-648-3326
oliver m. dean, inc. ■ www.omdean.com



Tri-Clover Inc.

CONTENTS

Thank you for purchasing a Tri-Clover Product! This manual contains disassembly and assembly instructions, maintenance procedures, troubleshooting, and a complete parts list for all TSK Positive Rotary Pumps designed and manufactured for Tri-Clover Inc., Kenosha, Wisconsin.

READ THIS MANUAL carefully to learn how to service these pumps. Failure to do so could result in personal injury or equipment damage.

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SAFETY

DO'S AND DON'TS

DO read and understand these instructions before installing or using the pump.

DO NOT modify the pump. Modifying the pump creates unsafe conditions and voids all warranties.

DO NOT place the pump in an application where the service ratings are exceeded.

DO NOT service the pump while it is running.

DO ENSURE POWER TO THE UNIT HAS BEEN LOCKED OUT/TAGGED OUT PRIOR TO PERFORMING ANY PUMP MAINTENANCE OR CLEANING.

SAFETY PRECAUTIONS WHEN INSTALLING PUMP

DO have authorized personnel electrically connect the pump. (See the motor instructions supplied with the drive unit.)

DO NOT start in the wrong direction of rotation with liquid in the pump.

DO NOT put your hands or fingers inside the port connections.

SAFETY PRECAUTIONS WHEN OPERATING PUMP

DO NOT touch the pump or the pipelines when pumping hot liquids or when sterilizing.

DO NOT stand on the pump or pipelines.

DO NOT run the pump with the suction side or the pressure side blocked.

DO handle toxic and acidic liquids with great care.

DO NOT put your hands or fingers inside the port connections.

SAFETY PRECAUTIONS WHEN SERVICING PUMP

DO disconnect the pump from the drive unit and power supply when servicing the pump.

DO NOT put your hands or fingers inside the port connections.

DO NOT service the pump when it is hot.

DO NOT service the pump when the pump or pump lines are pressurized.

These instructions contain operating and service information for the pump only. Motor information is provided separately by the motor manufacturer.

SAFETY

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.

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

Material	Use	Major Hazard
Silicone Sealant	gearbox seal retainers, rear cover, general sealant	Releases vapor at room temperature.
Sealant (Red Hermetite)	gearbox seal retainers, rear cover, general sealant	Releases vapor at room temperature, highly flammable, treat as fire hazard.
Anti-Seize Compounds	bearings	Applied from aerosol. Releases vapor. Dispose of container as if pressurized.
Adhesives (e.g., permabond)	bearing nuts, adjustment nuts	Releases vapor at room temperature.
Oil and Grease	oil - general lubricant grease - product seals	Skin and Eye irritant.
Plastic Compounds (PTFE, Polypropylene, PVC)	<i>PTFE</i> - o-rings, lip seals, gland packing. <i>Polypropylene</i> - gland guards <i>PVC</i> - gland guards	Releases fumes when heated.
Elastomeric Compounds (EP, Viton, Nitrile, Neoprene)	<i>all</i> - o-rings, lip seals, nitrile, <i>polyurethane</i> - rotors (known as rubber and urethane)	Releases fumes when heated.
Paints	external pump surfaces	Releases dust and fumes if machined. Treat as a fire hazard.

SAFETY

IMPORTANT INFORMATION

The following DANGER, WARNING, AND CAUTION signs and their meanings are used within these instructions.

	 DANGER
	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. The word Danger is used in the most extreme cases.

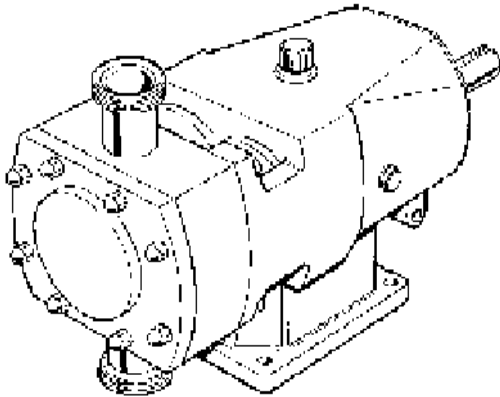
	 WARNING
	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. May also be used to alert against an unsafe operating or maintenance practice.

	 CAUTION
	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

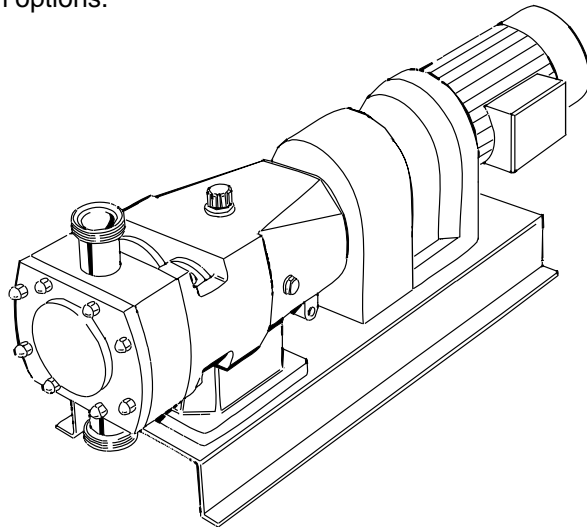
INTRODUCTION

GENERAL PUMP DESCRIPTION

The TSK pump is a positive displacement pump, which may be supplied with or without a drive unit (see below). The drawing below displays both options.



Bareshaft Pump



Pump with Drive Unit

PRINCIPLE OF OPERATION

The rotors are timed such that when they rotate no contact occurs. The direction of flow is reversed by changing the direction of rotation of the pump drive shaft. The pumping principle is as follows :

1. The rotors have just come out of mesh creating a reduction in pressure in the chamber which is then filled with product (Figure 1).
2. The product is contained in the rotor case chamber (Figure 2).
3. As the rotors continue to rotate the product is transferred around the rotor case to the discharge side. The rotors lobes go into mesh and the product is discharged from the pump (Figure 3).

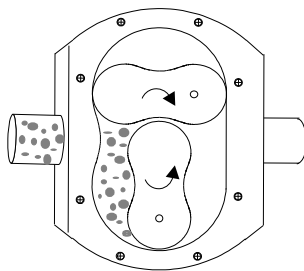


Figure 1

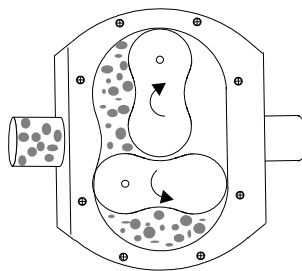


Figure 2

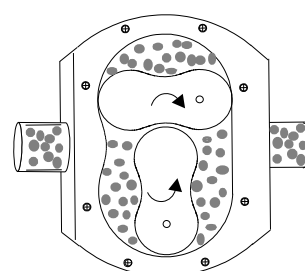


Figure 3

INTRODUCTION

PUMP LIMITS OF APPLICATION OR USE

This range of pumps has been designed for pumping the most hygienic - critical positive transfer duties throughout biotechnology, food, pharmaceutical and similar manufacturing processes.

Pressures of up to 145 psi (10 bar), speeds to 650rpm and temperatures to 266 (130°C) can be obtained on this range of pumps depending on pump model/size. The model type/size is shown on the nameplate positioned on the pump.

It is important that the pump user confirms that the materials of construction and product seals are compatible with the pumping application.

For specific guidelines contact your supplier quoting: pump model/size, serial number and system details (e.g. product, pressure, flow rate).

Important : Where the application requires, the pump should be mounted to ensure self draining e.g. food media. This must be requested at the time of order, as the pump build specification will change.

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 your supplier quoting: pump model and serial number.

NOISE LEVELS

Under certain operating conditions pumps and / or drives and / or the systems in which they are installed can produce sound pressure levels in excess of 85 dB (A). When necessary personal protection against noise should be taken to safeguard the hearing of persons who are likely to be in close proximity to the equipment.

NOTE : Readings taken in accordance with ISO3746.

UTILITY REQUIREMENTS

Electrical Supply

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

Water Supply

Additional water supplies may be required if the pump has a product seal flushing arrangement. Consult Tri-Clover for flush fluids compatible with products pumped.

Steam Supply

A supply of steam will be required if heating saddles and jackets are installed.

TECHNICAL INFORMATION

TECHNICAL DATA

PUMP INFORMATION CHART

The following table details technical data regarding the pump range, for further details contact your supplier. The technical data below must not be used for pump selection purposes.

TSK Model	Displacement		Suction and Discharge Connections		Differential Pressure		Max Speed	Maximum Flow at 100% Volumetric Efficiency	
	US g/100rev	L/rev	Normal Bore Diameter		See Note Below				
			inches	mm	in-lb ²	bar	rev/min	GPM	M/hr
TSK1WLD	2.25	0.085	1	25.4	72.5	5	650	14.6	3.31
TSK2WLD	4.78	0.180	1½	38.1	145	10	650	31	7.04
TSK3WLD	10.15	0.384	2	50.8	145	10	650	65.9	14.45
TSK4WLD	20.87	0.790	2½	63.5	145	10	650	135.6	30.78
TSK5WLD	44.39	1.680	3	76.2	145	10	650	288.5	65.48

Note: The pressure shown indicate the pump's maximum capability. Seal selection can reduce these figures. Please refer to Tri-Clover.

TORQUE SPECIFICATION CHART

Pump Model	Tightening Torques								Wrench Size			
	Front cover Nuts		Rotor Clamp Screws		Gearcase Nuts		Timing Gears Screws		Front Cover Nuts	Rotor Clamp Screws	Gearcase Nuts	Timing Gear Screws
	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	mm	mm	mm	mm
TSK1WLD	15	20	0.75	1	15	20	10	14	13	2.5	13	5
TSK2WLD	29	39	0.75	1	30	40	12.5	17	17	2.5	17	5
TSK3WLD	29	39	1.75	2.4	30	40	9	12	17	3	17	5
TSK4WLD	29	39	1.75	2.4	47	64	10	14	19	3	19	5
TSK5WLD	29	39	1.75	2.4	47	64	26	35	19	3	19	5

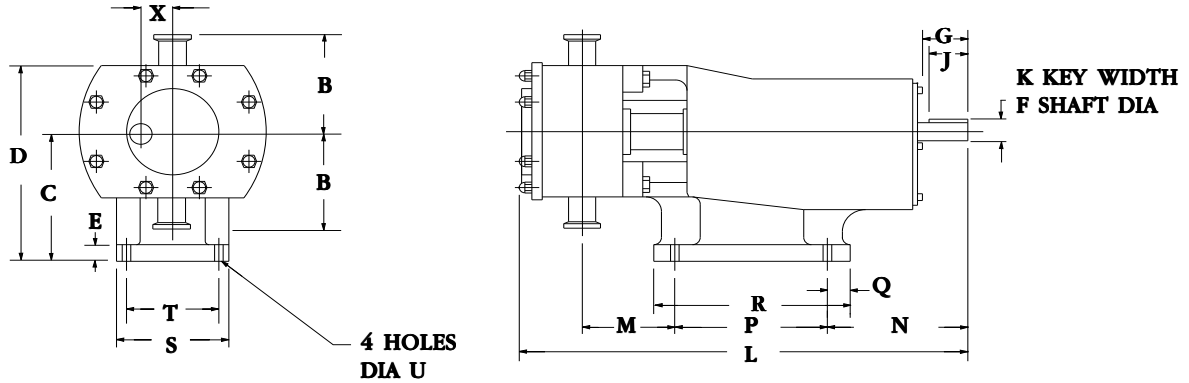
Front Seal and Rear Seal Covers

TSK1, TSK2 & TSK3: Torque 10 Nm (7lbft) - Wrench Size 5mm

TSK4, TSK5: Torque 25 Nm (19 lbft) - Wrench Size 6mm

TECHNICAL INFORMATION

PUMP DIMENSIONS

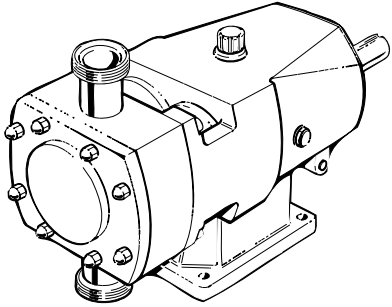


TSK PORT	STD.	B		C		D		E		F		G		J		K		L	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	
1WL	1"	3 ³ / ₄	95.3	4 ⁷ / ₁₆	112.7	6 ¹ / ₂	165.1	2 ¹ / ₃₂	16.7	—	16.0	1 ⁹ / ₁₆	39.7	1 ³ / ₁₆	30.1	—	5.0	11 ¹ / ₂	292.1
2WL	1 ¹ / ₂ "	4 ¹ / ₈	104.8	5 ²⁵ / ₃₂	146.8	8 ¹¹ / ₃₂	211.8	2 ⁷ / ₃₂	21.4	—	22.0	1 ³¹ / ₃₂	50.0	1 ¹ / ₄	31.8	—	6.0	13 ¹³ / ₁₆	350.8
3WL	2"	4 ²⁹ / ₃₂	124.6	6 ⁷ / ₈	174.6	10 ¹ / ₃₂	254.8	2 ⁹ / ₃₂	23.0	—	28.0	2 ⁹ / ₃₂	58.0	1 ⁹ / ₁₆	39.7	—	8.0	17 ¹¹ / ₁₆	449.3
4WL	2 ¹ / ₂ "	5 ²⁹ / ₃₂	150.0	8 ³ / ₈	212.7	12 ⁵ / ₁₆	312.7	3 ¹ / ₃₂	24.6	—	38.0	3 ⁵ / ₃₂	80.2	2 ¹⁵ / ₃₂	62.7	—	10.0	21 ⁷ / ₈	555.6
5WL	3"	6 ⁷ / ₈	174.6	10 ³ / ₃₂	256.4	14 ¹ / ₂	368.3	1 ³ / ₁₆	30.1	—	45.0	4 ¹¹ / ₃₂	110.3	2 ³ / ₄	70.0	—	14.0	25 ⁵ / ₈	651.0
TSK PORT	STD.	M		N		P		Q		R		S		T		U		X	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	
1WL	1"	2 ⁵ / ₃₂	54.8	4 ¹⁹ / ₃₂	116.7	3 ⁵ / ₃₂	80.2	1 ⁵ / ₃₂	12.0	4 ³ / ₃₂	104.0	4 ³ / ₃₂	104.0	3 ⁹ / ₃₂	80.2	1 ³ / ₃₂	10.3	7 ⁷ / ₈	22.2
2WL	1 ¹ / ₂ "	2 ²⁵ / ₃₂	70.6	4 ⁷ / ₈	123.8	3 ¹⁵ / ₁₆	100.0	1 ⁵ / ₃₂	12.0	4 ⁷ / ₈	123.8	4 ⁷ / ₈	123.8	3 ¹⁵ / ₁₆	100.0	1 ⁵ / ₃₂	12.0	1 ³ / ₁₆	30.1
3WL	2"	2 ²⁷ / ₃₂	72.2	6 ¹¹ / ₃₂	161.1	6 ³ / ₃₂	154.8	1 ⁹ / ₃₂	15.1	7 ⁹ / ₃₂	185.0	6 ¹ / ₁₆	154.0	4 ²⁹ / ₃₂	124.6	1 ⁵ / ₃₂	12.0	1 ¹⁵ / ₃₂	37.3
4WL	2 ¹ / ₂ "	3 ¹ / ₂	89.0	7 ²⁵ / ₃₂	197.6	7 ⁷ / ₈	200.0	2 ¹ / ₃₂	16.7	9 ⁷ / ₃₂	234.2	7 ¹ / ₄	184.2	5 ²⁹ / ₃₂	150.0	9 ⁹ / ₁₆	14.3	1 ⁷ / ₈	47.6
5WL	3"	4 ¹ / ₁₆	103.2	10 ³ / ₃₂	264.3	7 ⁷ / ₈	200.0	2 ⁵ / ₃₂	20.0	9 ⁷ / ₁₆	239.7	8 ²¹ / ₃₂	220.0	7 ³ / ₃₂	180.2	9 ⁹ / ₁₆	14.3	2 ⁵ / ₈	60.3

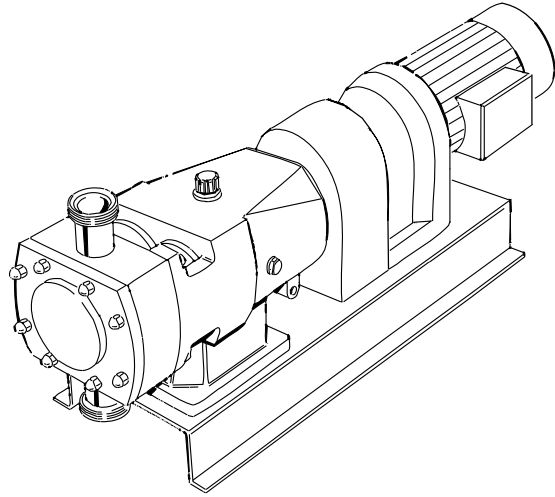
Note: Unless otherwise specified or requested, the drive shaft location will always be on the left side of the pump when looking from the wet end.

TECHNICAL INFORMATION

PUMP AND PUMP UNIT WEIGHTS



Bare shaft Pump



Pump Unit - Pump Complete

PUMP REFERENCE	BARESHAFT PUMP		PUMP WITH DRIVE UNIT	
	LBS	KG	LBS	KG
TSK1WLD	38	17	110	50
TSK2WLD	64	29	177	80
TSK3WLD	115	52	320	145
TSK4WLD	225	102	585	265
TSK5WLD	349	158	915	415

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

INSTALLATION

UNPACKING EQUIPMENT

UNPACKING

Care must be taken when unpacking the pump. Follow these steps:

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.

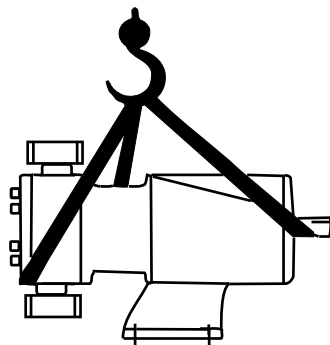
HANDLING

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.

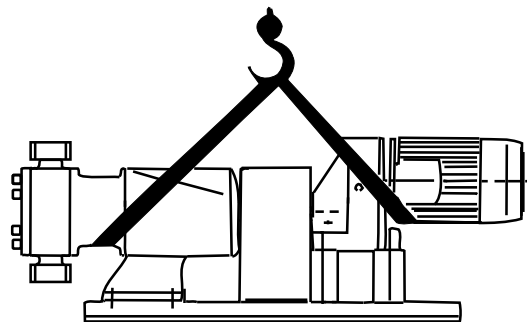
Bareshaft Pump : the slings should be wrapped around the ports across the front of the pump and the drive shaft.

Pump with Drive Unit : the slings should be positioned around the pump rotor case and under the motor.

NOTE: To keep the slings from slipping, always cross the slings on the lifting hooks.



Bareshaft Pump



Pump with Drive Unit

PUMP STORAGE

If the pump will not be installed immediately, it should be repacked and placed in suitable storage. Use the following guidelines:

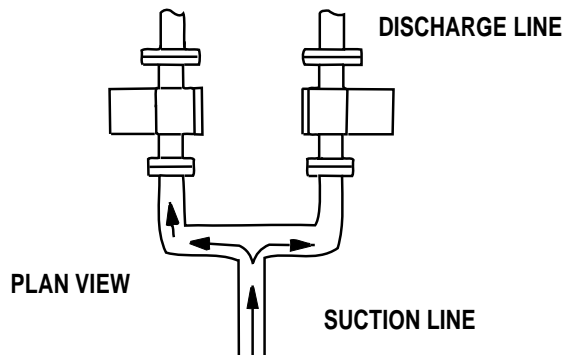
- Plastic or gasket type port covers should be left in place.
- Pumps received wrapped with corrosion inhibiting treatment material should be rewrapped.
- Store the pump/pumping equipment in a clean, dry area, vibration free area. When a moist, dusty atmosphere must be used for storage, further protect the pump or unit with a moisture repellent cover until it is to be installed.
- Rotate pump/pump unit by hand, weekly, to prevent bearing damage.
- All associated ancillary equipment should be treated similarly.

INSTALLATION

SYSTEM DESIGN ADVICE

When designing the pumping system :

- Confirm with the supplier the Net Positive Suction Head (NPSH) requirements for 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.



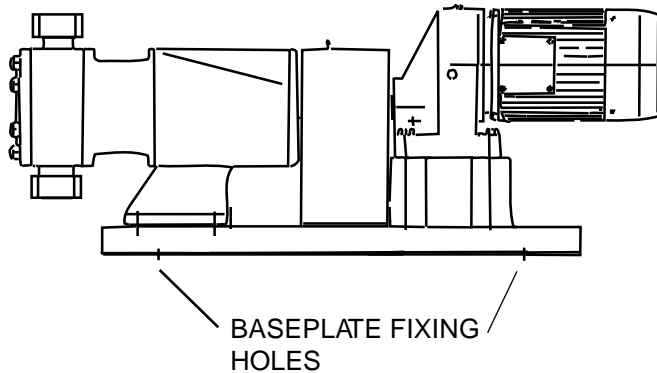
- Protect the pump against blockage from hard solid objects e.g. nuts, bolts etc. Also protect the pump from accidental operation against a closed valve by using one of the following methods : relief valves, pressure switch, current monitoring device.
- Install suction and discharge pressure gauges to monitor pressures for diagnostic purposes.
- Install non-return valve to prevent turbining when high pressures are applied to the pump while it is not in use. Valves are also recommended 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 steam is required for heating jackets.
- DO NOT subject the pump to rapid temperature changes during CIP (Clean in Place) procedures. Pump seizure can result from thermal shock. The differential pressure across the pump should be near zero when cleaning. A suitable bypass is recommended.

INSTALLATION

INSTALLATION GUIDELINES

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

- 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 3¼ feet (one meter) 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.

INSTALLATION

COUPLING MISALIGNMENT

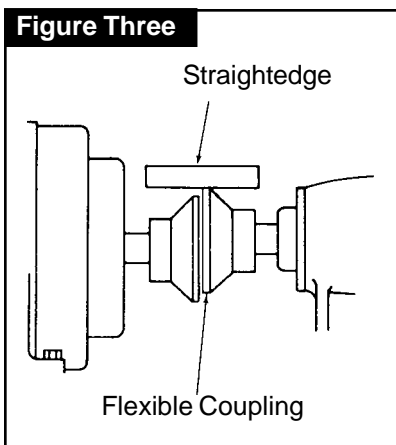
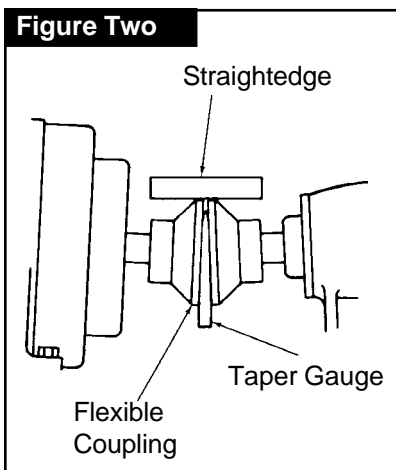
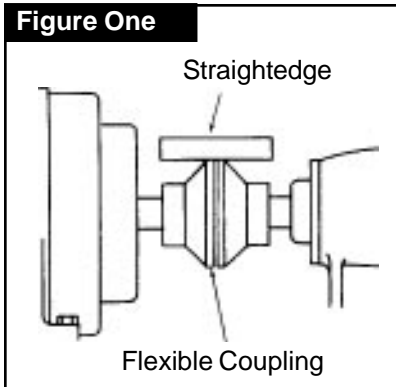
FLEXIBLE COUPLINGS

The purpose of a flexible coupling is to compensate for temperature changes and allow end movement of the pump and motor shafts without interference with each other while transmitting power from the motor to the pump. A flexible coupling should not be used to compensate for shaft misalignment.

When properly aligned, the flexible couplings should appear as shown in *figure one*.

The faces of the coupling halves should be far enough apart so that they do not touch each other when the motor shaft is moved toward the pump.

The tools required for checking flexible coupling alignment are a straightedge and a taper gauge or set of feeler gauges.



FLEXIBLE COUPLING ALIGNMENT

There are two types of misalignment encountered with flexible couplings: angular misalignment and parallel misalignment. To check for angular misalignment, (see *figure two*), insert a taper gauge or feeler gauge at four places located 90° degrees apart around the coupling as shown. Coupling halves will be aligned when the measurements are the same at all check points.

To check parallel misalignment, (see *figure three*), place a straightedge across the coupling half rims at the top, bottom, and both sides, making sure that the straightedge is parallel to the motor and pump shafts. The coupling will be properly aligned when the straightedge rests evenly on the coupling rims at all check points.

Correct alignment is obtained by use of shims under the motor mounting feet. It must be remembered that adjustment made in one direction may affect alignment in another direction. Therefore several checks of both angular and parallel alignment should be made.

Connect the flexible coupling, start the pump and operate it until temperatures are stabilized. The unit should then be shut down, and the alignment immediately rechecked.

If the pump is required to be side mounted, or inverted, then must be stated at the time of order. Alternatively, if the orientation of an existing pump is to be changed, Tri-Clover Inc. must be contacted for details of the necessary modifications.

INSTALLATION

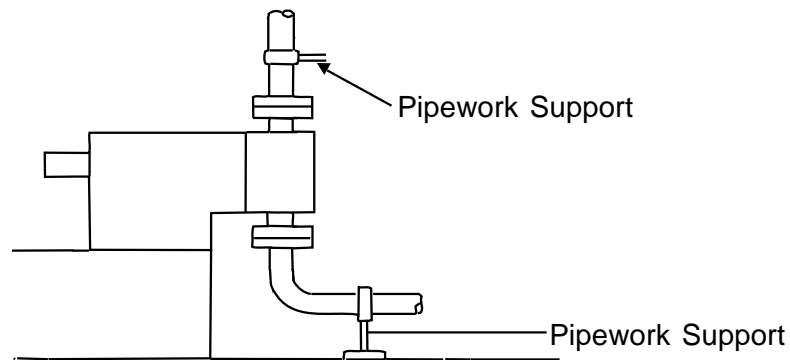
PIPEWORK

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 straight suction lines to reduce friction losses in the pipework thereby improving the NPSH available.
- Avoid bends, 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 where necessary.
- Check coupling alignment during installation to highlight pipework alignment/support problems.



INSTALLATION

COMMISSIONING

RECOMMENDED LUBRICANTS

Pumps specified oil filled :

The pump will NOT be supplied prefilled with oil therefore the table below must be used to select a recommended oil.

Oil Filled	
-61° F to 266° F	
-20° C to +130° C	
BP	Energol (GR-XP150)
Castrol	Alpha SP120
Esso	Spartan EP150
Mobil	SHC 630
Shell	Omata 150
Texaco	Meropa 150
Jax	SynGear 220

LUBRICATING THE PUMP

Oil Filling:

Fill oil through the filter plug to the level indicated in the sight glass.

Changing the Oil:

The pump will NOT be supplied oil filled.

First change: After 150 hours of operation.

Next changes: Every 3000 hours of operation.

Only use the oil types recommended by your supplier.

Lubrication Capacities

PUMP REF	QUARTS	LITERS
TSK1	0.35	0.33
TSK2	0.80	0.75
TSK3	1.50	1.40
TSK4	3.00	2.75
TSK5	4.75	4.50

INSTALLATION

FLUSHED SEAL ARRANGEMENTS

A flushed seal arrangement is installed in order to cool/clean the seal area.

It is important that:

- The flush is correctly connected.
- 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.

CONNECTING THE FLUSH

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

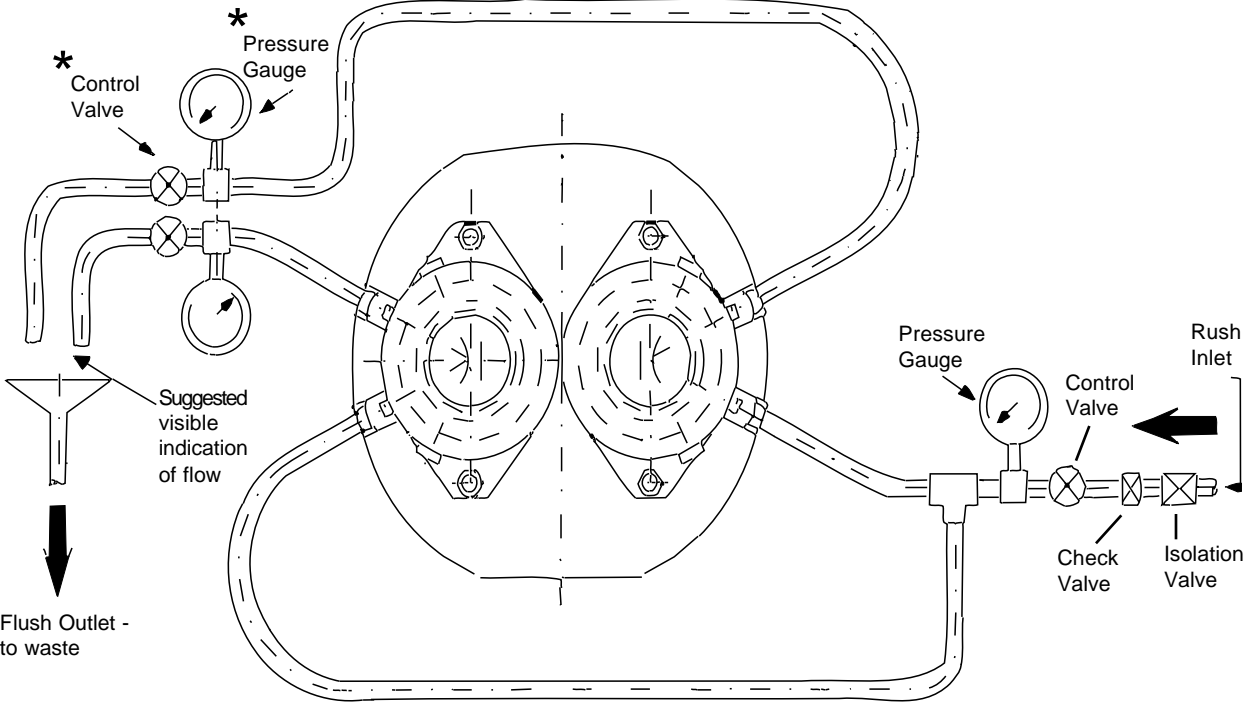
- **control valve** and **pressure gauge**, to enable the correct flushing pressure to be obtained and monitored. (A constant flow valve can be used).
- **isolation valve** and **check valve**, so that the flush can be turned off, and to stop any unwanted substances flowing in the wrong direction.
- A method of visibly indicating flushing fluid flow, such as a site glass.

INSTALLATION

FLUSHING PIPEWORK LAYOUT

Suggested seal arrangements:

- * Double mechanical seal/packed gland only.



Note: The pipework and fittings are not supplied with pump.

INSTALLATION

FLUSHED SEAL HOUSING CONNECTIONS

Pump Model	Single with Flush Mechanical Seal
TSK1WLD	1/8"
TSK2WLD	
TSK3WLD	
TSK4WLD	
TSK5WLD	1/4"

All connections NPT as specified at the time of order.

FLUSHING FLUID

The choice of flushing fluid is dependent 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 Tri-Clover.

FLUSHING PRESSURE AND FLOW RATE

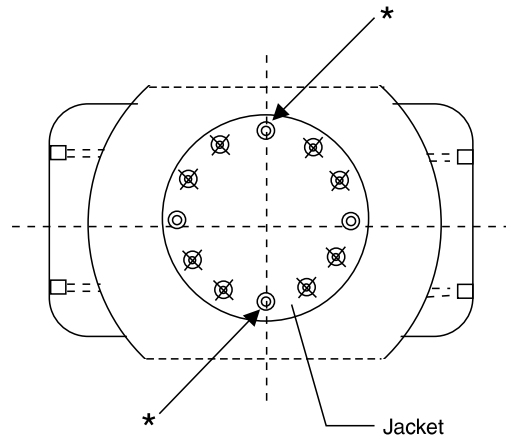
Single Mechanical Seal - **7.3 psi (0.5 Bar) maximum.**
Any further increase in pressure will result in lip seal failure.

The flushing FLOW RATE must be adequate to ensure that the temperature limitation of the seals is not exceeded. Contact Tri-Clover for further information on the recommended flow rate for the product seal installed.

INSTALLATION

STEAM JACKETS

Careful attention should be taken when piping up and connecting to steam jackets. (See below.)



- * CONNECTION FOR STEAM, HOT/COLD FLUID ENTRY AND EXIT.

If new steam jackets are being installed use Loctite Multigasket 576 (or equivalent).



⚠ WARNING

For safety, prior to operation, a hydraulic test should be completed on the new steam jacket if it has to be replaced.

Hydrostatic test pressure (water): 85.4 psi (6 Bar)

Maximum working pressure: 49.8 psi (3.5 Bar)

OPERATION

PUMP START-UP CHECK LIST

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

All answers should be **YES**.

If there are pumping problems, refer to the *Troubleshooting* section of this manual.

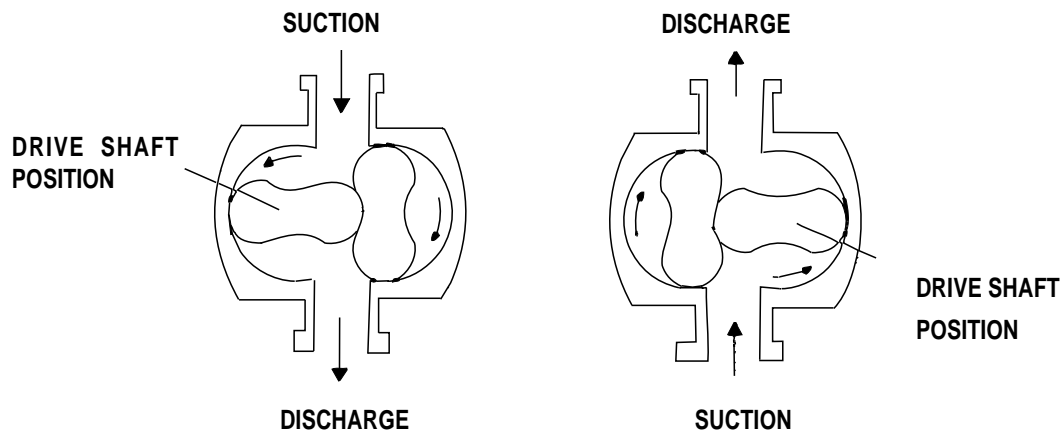
OPERATION

PUMP SHUT DOWN PROCEDURE

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 Disassembly section of this manual.

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. Left and right shaft drive pumps have opposite flow directions as illustrated.



MAINTENANCE

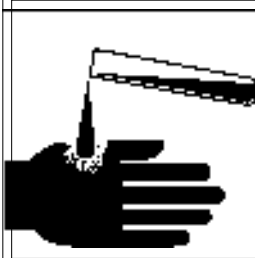
CLEANING IN PLACE (C.I.P.)

The pump can be manually cleaned or clean 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 Tri-Clover.



⚠ WARNING

Never touch the pump or pipes as they are extremely hot!



⚠ WARNING

Always use rubber gloves and protective goggles when handling caustic acids and rinse well with clean water after using a cleaning agent..

⚠ CAUTION

Do not subject the pump to rapid temperature changes during CIP procedures, as pump seizure can result from thermal shock. A suitable bypass is recommended.

⚠ CAUTION

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

1. Observe all cautions and warnings above.
2. Flush through the system with cold water (43°F or 6°C).
3. Run hot caustic soda (158°-176°F or 70-80°C) at 2.5% dilution through the system for 20 - 30 minutes.
4. Finally, flush trough with cold water again.

MAINTENANCE

MAINTENANCE AND INSPECTION

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 mechanical seals for leakage and replacing as necessary
- Checking the lip seals for leakage
- Check pumping pressures

RECOMMENDED SPARE PARTS

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

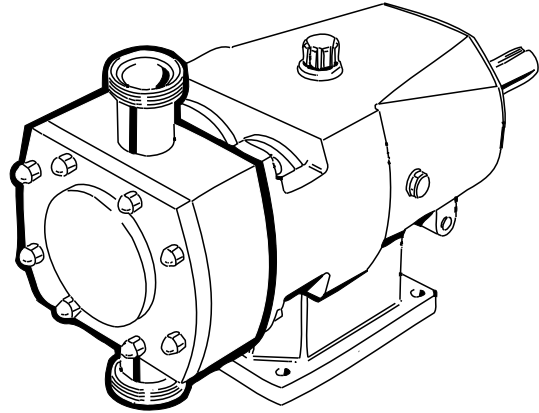
PART DESCRIPTION	QUANTITY
Lip Seal Drive End	1
'O' Ring Front Cover	1
Lip Seal Gland End	2
Rotors	2
'O' Ring Rotor Sealing	2
'O' Ring Rotor Nuts	2
Product Seals	2

MAINTENANCE

MAINTENANCE TOOLS

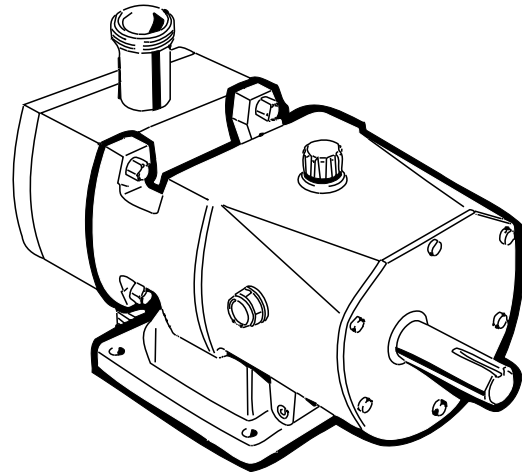
Removing the Pump Head

- You will need:
- Allen wrenches
 - wrenches
 - socket set
 - wooden wedge
 - soft mallet
 - cleaning hose



Dismantling the Gear Box

- You will need:
- heavy duty vice
 - press and pressing tools
 - lifting gear
 - induction heater
 - method of lubrication collection
 - soft ended lever
 - wooden wedge
 - 'C' Spanner
 - liquid gasket
 - RTV Silicon



MAINTENANCE

DISASSEMBLY

Important: Read this section first, before continuing to dismantle the pump.

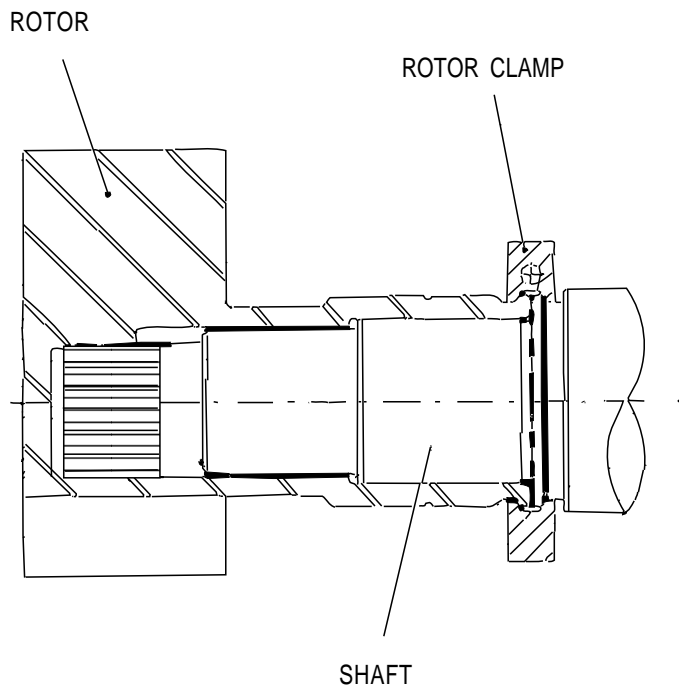
BEFORE DISMANTLING THE PUMP

Before starting to dismantle the pump, observe the following precautions:

- Isolate the pump/drive unit from all power and control supplies.
- Close the pipework valves to isolate the pump.
- Purge the pump and system if any noxious products have been pumped.
- Disconnect the pump from the drive unit.

ROTOR RETENTION

The TSK range of pumps uses a single method of rotor retention. The rotors are retained on the shaft externally by a three part circular rotor clamp. This method ensures that the product does not come in contact with the spline area. The pump is permitted to run in either direction. For recommended torque values for the rotor clamp screws see below.



Torque Values for Rotor Clamp Screws

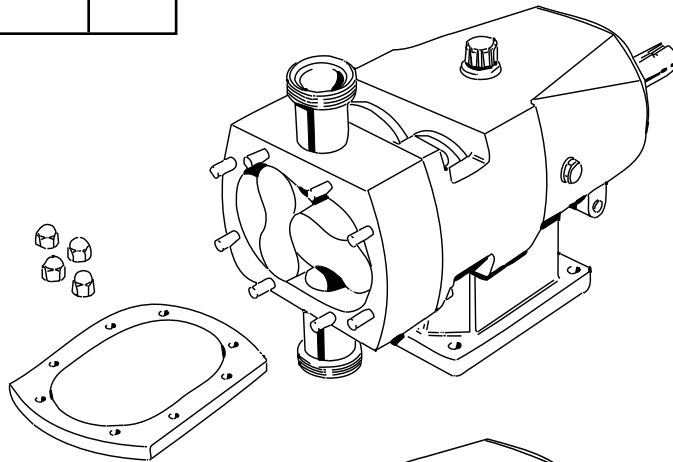
Pump Model	Torque Nm (lbft)	Wrench mm
TSK1 TSK2	1.0 (0.75)	2.5
TSK3 TSK4 TSK5	2.4 (1.75)	3.0

MAINTENANCE

Front Cover Nut Wrench Size in mm	TSK1	TSK2	TSK3	TSK4	TSK5
	13	17	17	17	17

REMOVING THE FRONT COVER

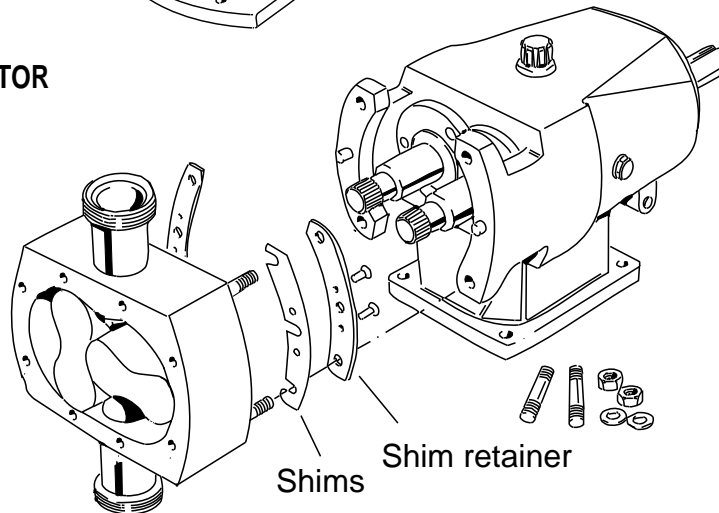
1. Carefully loosen the front cover retaining nuts as there may still be residual pressure in the system. Release lower nuts first, any product will be directed down.
2. Remove the front cover nuts and take off the cover.
3. Flush out the pump head before continuing.



REMOVING THE ROTORS AND ROTOR CASE

Before proceeding remove suction and discharge pipes

1. Slacken the rotor clamp screws and ease clamp towards rotor case allowing it to sit on rotor hub.
2. Remove gear case nuts and gently ease rotor case off with rotors intact using a soft mallet. Place rotor case assembly face down on a protective surface with rotor hubs sitting vertically.
3. Between the rotor case and gear case shim retainers are used to adjust rotor clearances. These must be replaced exactly as removed, failure to note correct position of shims may result in rotor to rotor case contact possibly damaging both. The shims are preshaped plastic.
4. Remove circlip.
5. Slacken the set screws which hold the seals onto the rotor hubs.
6. Slide seals off making sure not to damage seal faces.
7. Rotors can now be withdrawn from rotor case.



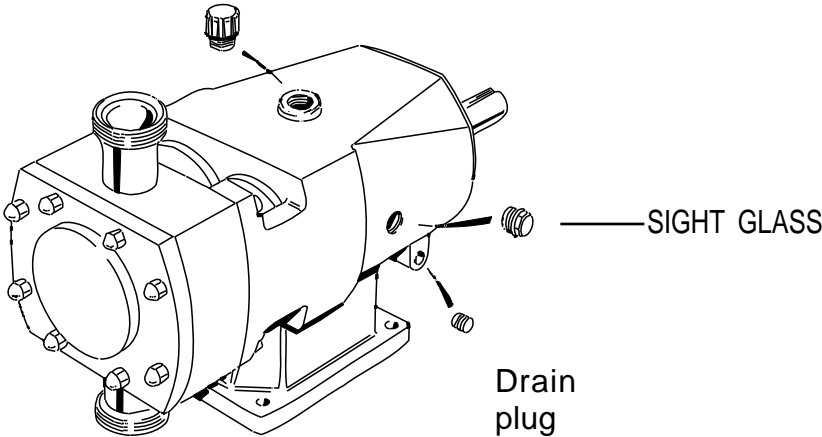
MAINTENANCE

DRAINING THE PUMP LUBRICATION

Drain the pump lubrication before continuing.

Oil Filled Gearbox

- Remove drain plug

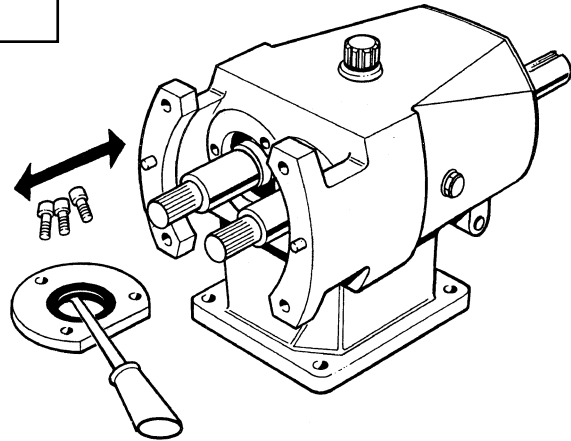


MAINTENANCE

Retainer Screw Key	TSK1	TSK2	TSK3	TSK4	TSK5
Size in mm	5	5	5	6	6

REMOVING THE FRONT SEAL RETAINERS

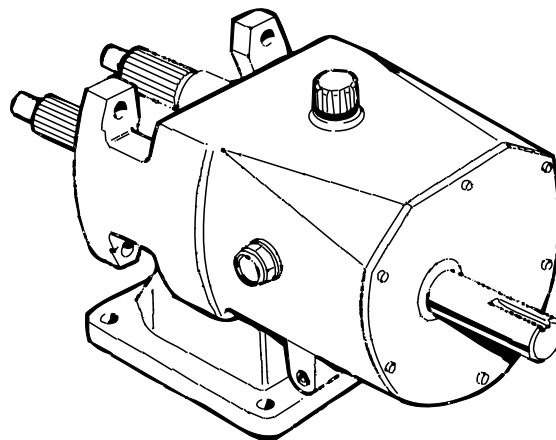
1. Remove the socket head cap screws
2. Use a lever to remove the seal retainers as a sealant is used as a gasket to the gear case.
3. The lip seals can be removed using a screwdriver/lever. It is essential to renew the lip seals prior to reassembly.



REMOVING THE GEAR CASE COVER

Cover Screw Key	TSK1	TSK2	TSK3	TSK4	TSK5
Size in mm	5	5	5	6	6

1. Remove the socket head cap screws.
2. Tap the gear case cover (which is sealed with liquid gasket) sharply in the center between the socket head screw holes using a soft mallet to break the sealant joint.
3. Slide the cover from the shaft and press out the lip seal. It is essential to renew the lip seals prior to reassemble.

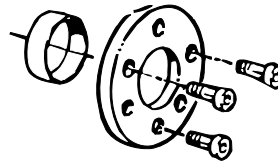


MAINTENANCE

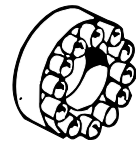
Plate Screw Key	TSK1	TSK2	TSK3	TSK4	TSK5
Size in mm	5	5	5	5	6

REMOVING THE GEARS

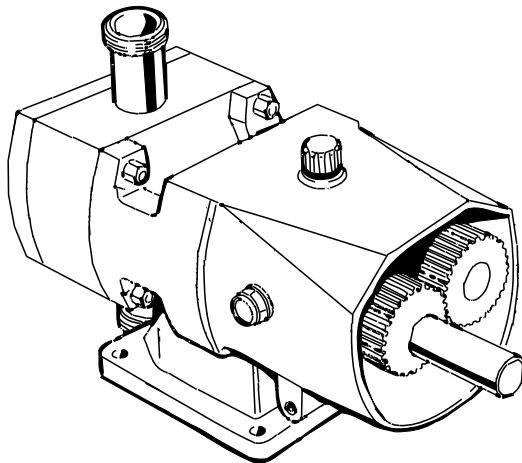
1. Release the clamp plate socket head cap screws (TSK1, TSK2, TSK3). Release the torque locking assembly screws in several stages (TSK4, TSK5).
2. Remove the torque locking elements or assemblies.
3. Pull off the timing gear using the tapped extraction holes provided, or tap the shafts through the gears.



1, 2, 3

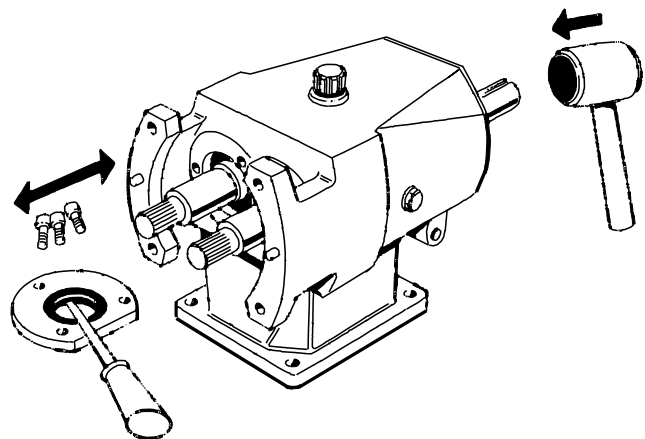


4, 5



SHAFT ASSEMBLY REMOVAL

1. Using a soft mallet gently tap the rear end of each shaft, to remove it through the front of the gear case.
2. Support each shaft during removal from the gear case.
3. A shaft abutment spacer is located in
SINGLE BEARING ASSEMBLIES -
Rear left bearing bore -
DOUBLE BEARING ASSEMBLIES -
Front left bearing bore -
and must be retained for reassembly.



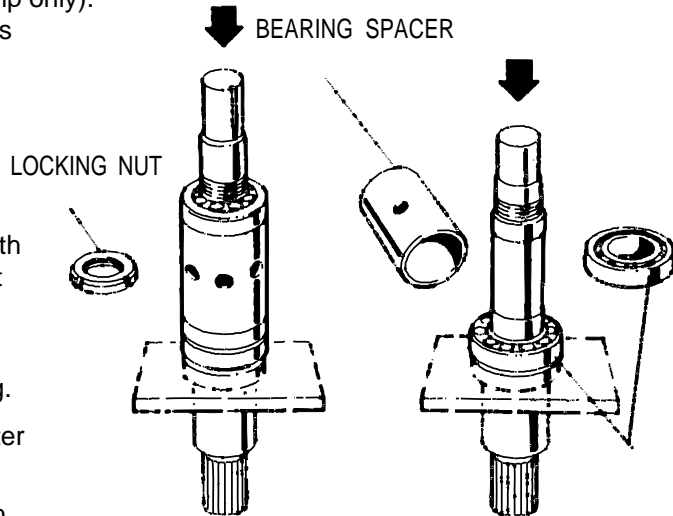
MAINTENANCE

BEARING REMOVAL

To keep the shaft from turning, put a rotor over the spline, and put the rotor in a vise (brass clamp only). Be careful not to damage the rotor during this procedure.

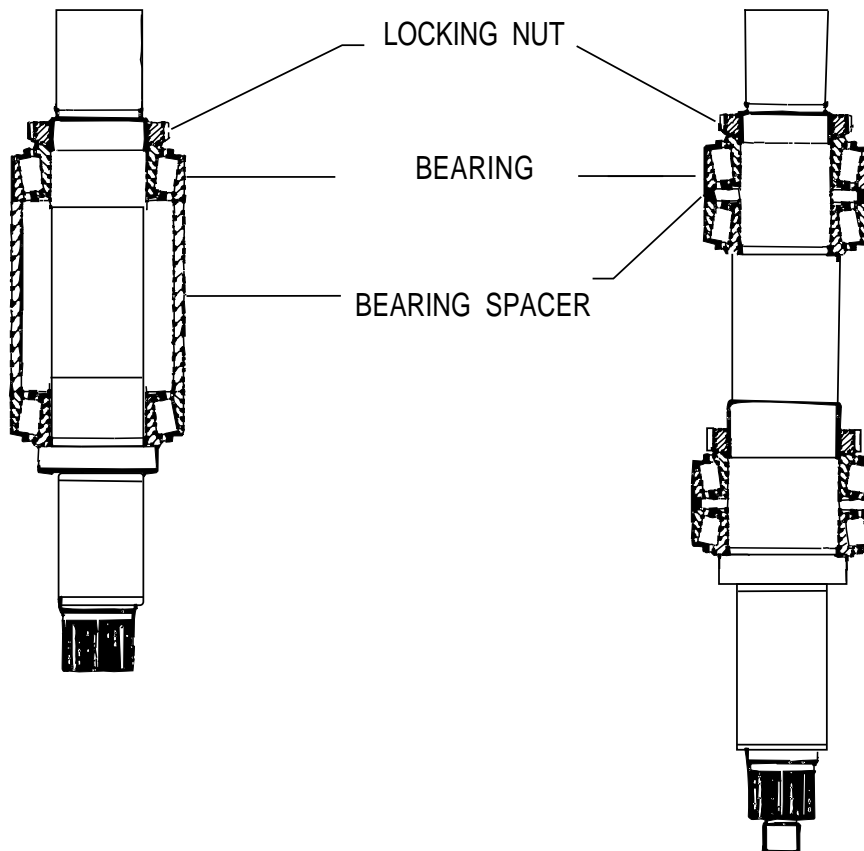
1. Remove the locking nuts, which have thread locking adhesive on them, with a 'sharp tap' on a 'C' spanner.
2. Mount the shaft vertically in the press with a pressing tool positively located against the bearing inner as shown.
3. Apply pressure to the top of the shaft so that the shaft moves through the bearing.
4. Remove each bearing set (inner and outer cones) and **maintain in sets**.

To assist assembly note the positions on the shaft from which the bearings were pressed.



Single Bearing Assembly

Double Bearing Assembly



MAINTENANCE

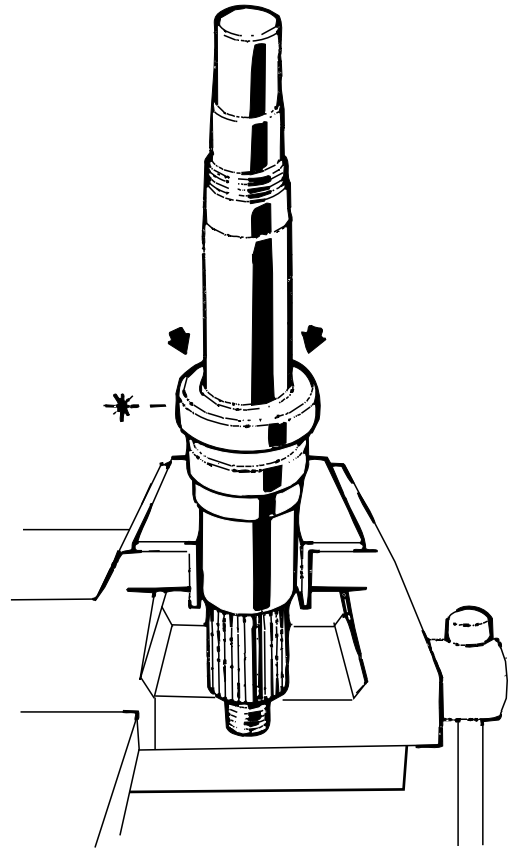
ASSEMBLY

INSTALLING BEARINGS TO THE SHAFT

1. Position shaft vertically into the vice and apply anti-seize compound to the bearing diameters.
2. Use an approved "C" Spanners induction heater to heat the front inner cone bearing to 230°F (110°C) on pumps TSK4 and TSK5. (Pumps TSK1, TSK2 and TSK3 do not require heating.)

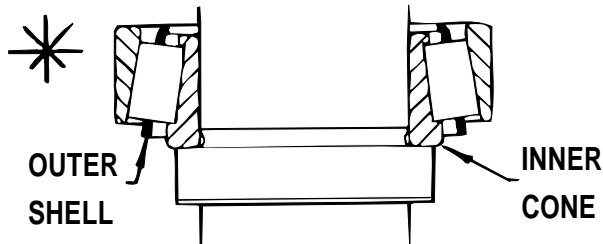
⚠ CAUTION

Do not use any sort of flame when heating, as this will damage the bearings.



NOTE : TAKE CARE NOT TO DAMAGE SHAFT SURFACES

3. Pass the heated/unheated bearing on the shaft ensuring a positive fit against the shaft shoulder.
4. Locate outer shell.



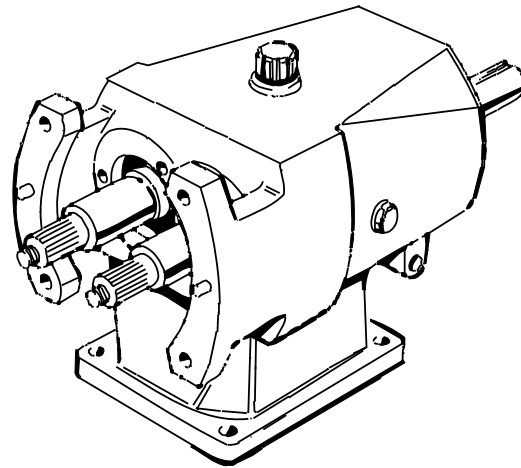
5. Locate bearing spacer.
6. Locate rear bearing shell.
7. Heat (**TSK4, TSK5 pumps only**) rear inner bearing cone and drop onto rear bearing shell.
8. Allow bearings to cool. (TSK4, and TSK5 pumps only) NOTE : Failure to do so will result in incorrectly set bearings.
9. Apply RTV silicon to the shaft lock nut thread and screw on the lock nut.
10. Continue to tighten the locking nut while at the same time rotating the bearings and spacer. The bearings are correctly seated when the spacer can only be moved with a light tap of a mallet.
11. Repeat the above for double bearing assemblies.
12. Apply oil to the bearings.
13. Pass the heated/unheated bearing on the shaft ensuring a positive fit against the shaft shoulder.

MAINTENANCE

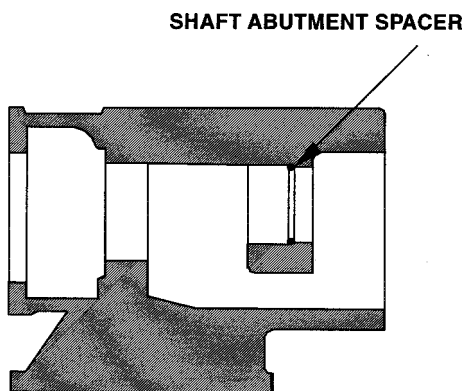
INSTALLING THE SHAFT ASSEMBLIES

1. Replace the shaft abutment spacer located in:
Single Bearing Assemblies - Rear left bearing bore.
Double Bearing Assemblies -Front left bearing bore.
2. Identify if pump is to be built right or left shaft drive
3. Install auxiliary shaft into the gear case.
4. Install drive shaft into the gear case.

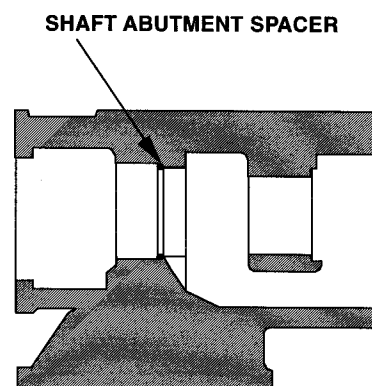
NOTE: If the bearings have been replaced the new abutment spacer will need adjustment. See Checking the Rotor Abutment Alignment section later in this manual.



Single Bearing Assemblies



Double Bearing Assemblies



NOTE : The position of the shaft abutment spacer does not alter with right or left shaft drive pumps.

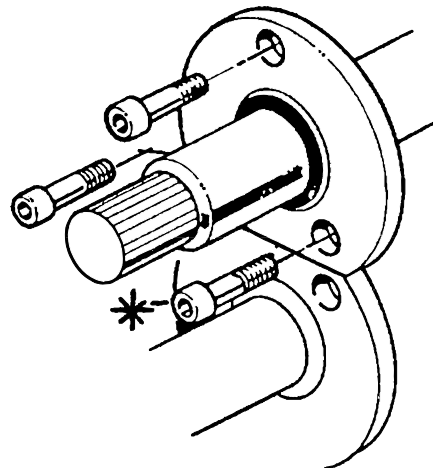
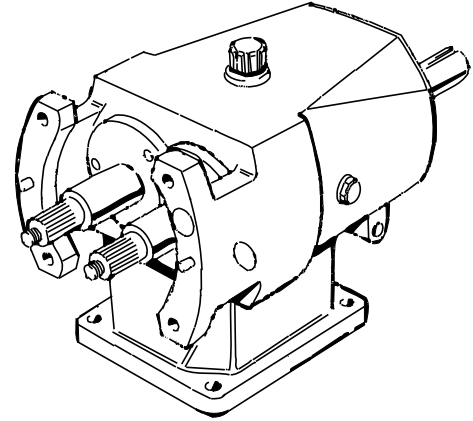
MAINTENANCE

INSTALLING THE FRONT SEAL RETAINERS

Socket Screws Key Size (mm)	TSK1	TSK2	TSK3	TSK4	TSK5
		5	5	5	6
Torque (Nm)	10	10	10	25	25
(ft-lb)	7	7	7	18	18
(ft-lb)	89	89	89	221	221

1. Clean and examine for grooving the surfaces where the lip seals will seat on the shafts, and remove the old sealant from the rear face.
2. Press the new lip seal into the seal retainer.
3. If the rotor abutment **alignment** is set apply sealant to the retainer face, otherwise refer to the Checking Rotor Abutment Alignment section.
4. Push the retainers onto the shaft. Make sure the lip seals do not distort by using a suitable tool to guide the lip seals onto the shaft.
5. Replace and tighten the socket head cap screws. As shown.

NOTE : Use the longest screw for this hole position.



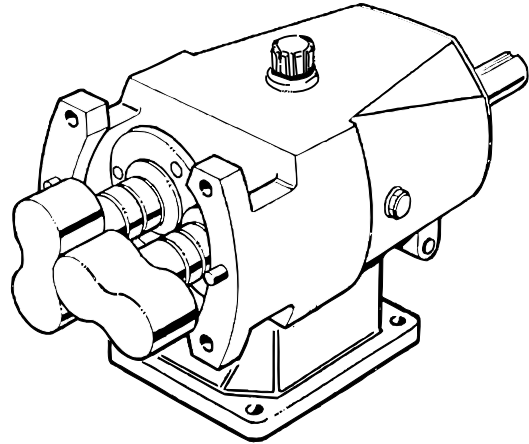
* = longest screw

MAINTENANCE

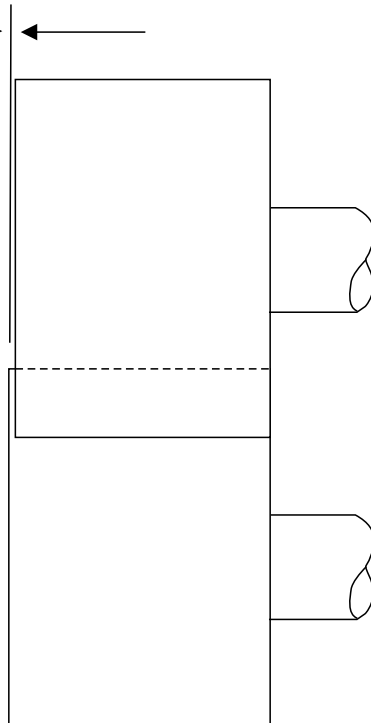
CHECKING THE ROTOR ABUTMENT ALIGNMENT

Incorrect setting of the rotor abutment alignment will damage the pump.

1. Install the rotors onto the shafts and tighten the rotor clamps.
2. Using a depth micrometer ensure the axial alignment is within tolerance 0.0005 inches (0.012mm).
3. If the tolerance is not achieved the shaft abutment spacer must be replaced/ reground to give the correct tolerance.



MAX 0.0005 inches to
0.0000 inches
(0.012mm to 0.00mm)



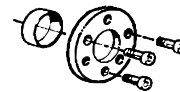
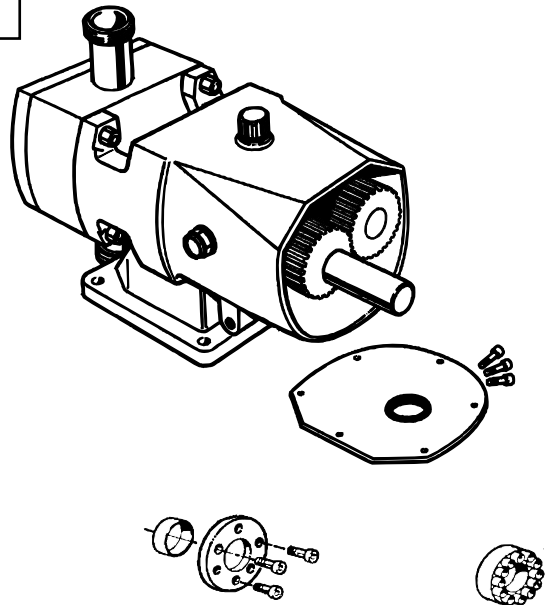
MAINTENANCE

FITTING THE TIMING GEARS

TLA/Clamp Screws Key Size (mm)	TSK1	TSK2	TSK3	TSK4	TSK5
		5	5	5	5
Torque (Nm)	12	17	12	14	35
(lb-ft)	9	13	9	10	26
(lb-in)	106	150	106	124	310

1. Slide each timing gear onto the shafts, realign marks if gears were previously marked in pairs.
2. Install the torque locking elements (TSK1, TSK2, TSK3), (high pressure pumps have two sets) or torque locking assemblies (TSK4, TSK5).
3. Install the timing gear clamp plates. (TSK1, TSK2 & TSK3 only).
4. Timing adjustment is now required:

Tighten one of the clamp plates/torque locking assemblies only, therefore allowing rotation of the shaft in the remainder for timing adjustment. See Adjusting the Rotor Timing Section later in this manual.



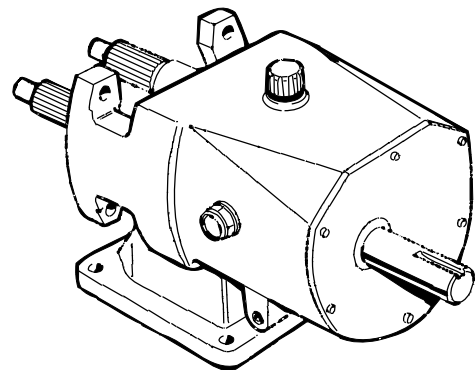
1, 2, 3

4, 5

INSTALLING THE GEAR CASE COVER

Cover Screws Key Size (mm)	TSK1	TSK2	TSK3	TSK4	TSK5
		5	5	5	6
Torque (Nm)	10	10	10	25	25
(lb-ft)	7	7	7	18	18
(lb-in)	89	89	89	221	221

1. Clean the gear case cover bore and press the lip seal into the cover.
2. Clean the faces of the cover removing all the liquid gasket.
3. Coat liquid gasket on the inner face of the cover that will mate with the gear case edge.
4. Carefully push the cover over the shaft and tighten the socket head cap screws ensuring lip seal is centralized.

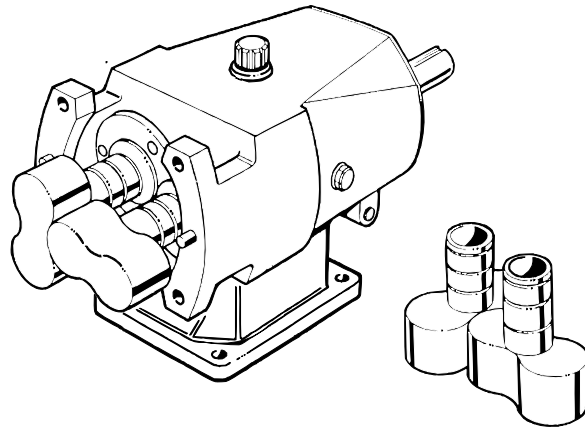


MAINTENANCE

ADJUSTING THE ROTOR TIMING

If the rotor timing requires adjustment it is important to establish the cause for the rotors becoming mis-timed before proceeding.

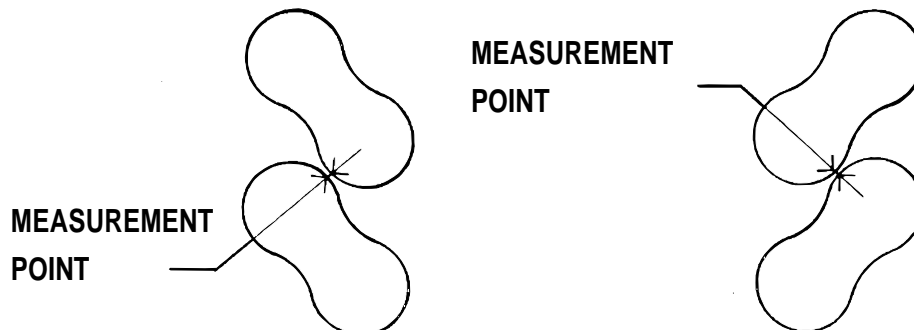
1. To allow rotor timing adjustment ensure that one shaft is **'free'** to move within the torque locking assembly/clamp plate.
2. Set the rotors to the positions shown with the rotor dimple at the 12 o'clock plane.
3. Turn the shaft so that the rotors are in the new positions below.
4. Using feeler gauges measure between the points shown below turning the shaft as required.
5. If the measurement points are unequal tap the rotor which is on the free turning shaft until equal measurement through 4 points is achieved as far as possible.
6. Tighten the torque locking assemblies (TLA) and clamp plate screws.
7. Remove the rotors.



ROTOR MEASUREMENT POINTS

Timing Gear TLA/Clamp Screws Key Size (mm)	TSK1	TSK2	TSK3	TSK4	TSK5
	5	5	5	5	5
Torque (Nm)	12	17	12	14	35
(lb-ft)	9	13	9	10	26
(lb-in)	106	150	106	124	310

Note: Refer to the Dimension and Tolerance table on the following page for specific information about each TSK model.



MAINTENANCE

PUMP	TEMPERATURE	ROTOR LEGNTH		FRONT CLEARANCE		ROTOR DIAMETER		RADIAL CLEARANCE		MINIMUM MESH		Back Clearance mm
		inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	
TSK1 (73 psi)	129°F (70°C)	1.050	26.66	(min)	(min)	2.550	64.76	(min)	(min)	0.010	0.25	0.05 to 0.13
		1.048	26.63	0.003	0.08	2.548	64.72	0.004	0.09			
	237°F (130°C)	1.048	26.63	(min)	(min)	2.550	64.76	(min)	(min)	0.01	0.25	
		1.047	26.6	0.004	0.11	2.548	64.72	0.004	0.09			
TSK2 (73 psi)	129°F (70°C)	1.262	32.05	0.004	0.10	3.400	86.36	0.005	0.12	0.010	0.25	0.06 to 0.14
		1.261	32.02	0.007	0.18	3.399	86.36	0.009	0.22			
	237°F (130°C)	1.261	32.02	0.005	0.13	3.398	86.32	0.005	0.12	0.010	0.25	
		1.259	31.99	0.008	0.21	3.398	86.32	0.009	0.22			
TSK2 (145 psi)	129°F (70°C)	1.258	31.95	(min)	(min)	3.394	86.20	(min)	(min)	0.019	0.48	0.10 to 0.18
		1.257	31.92	0.007	0.18	3.392	86.16	0.008	0.20			
	237°F (130°C)	1.257	31.92	(min)	(min)	3.394	86.2	(min)	(min)	0.019	0.48	
		1.256	31.89	0.008	0.21	3.392	86.16	0.008	0.20			
TSK3 (73 psi)	129°F (70°C)	1.704	43.28	(min)	(min)	4.254	108.0	(min)	(min)	0.011	0.28	0.08 to 0.16
		1.699	43.15	0.004	0.10	4.252	108.0	0.005	0.12			
	237°F (130°C)	1.698	43.14	(min)	(min)	4.254	108.0	(min)	(min)	0.011	0.28	
		1.697	43.11	0.006	0.14	4.252	108.0	0.005	0.12			
TSK3 (145 psi)	129°F (70°C)	1.693	43.00	(min)	(min)	4.246	107.8	(min)	(min)	0.018	0.46	0.12 to 0.20
		1.692	42.97	0.009	0.24	4.244	107.8	0.009	0.22			
	237°F (130°C)	1.691	42.96	(min)	(min)	4.246	107.8	(min)	(min)	0.018	0.46	
		1.690	42.93	0.011	0.28	4.244	107.8	0.009	0.22			
TSK4 (73 psi)	129°F (70°C)	2.169	55.1	0.004	0.11	5.447	138.3	0.004	0.10	0.013	0.32	0.07 to 0.15
		2.168	55.07	0.007	0.19	5.445	138.3	0.009	0.24			
	237°F (130°C)	2.168	55.07	0.006	0.14	5.447	138.3	0.004	0.10	0.013	0.32	
		2.167	55.04	0.009	0.22	5.445	138.3	0.009	0.24			
TSK4 (145 psi)	129°F (70°C)	2.166	55.02	(min)	(min)	5.437	138.1	(min)	(min)	0.017	0.42	0.08 to 0.16
		2.165	54.99	0.007	0.18	5.435	138.0	0.009	0.23			
	237°F (130°C)	2.165	54.99	(min)	(min)	5.437	138.1	(min)	(min)	0.017	0.42	
		2.164	54.96	0.008	0.21	5.435	138.0	0.009	0.23			
TSK5 (73 psi)	129°F (70°C)	2.924	74.26	(min)	(min)	6.809	172.9	(min)	(min)	0.009	0.24	0.08 to 0.16
		2.922	74.23	0.006	0.14	6.807	172.9	0.004	0.10			
	237°F (130°C)	2.922	74.22	(min)	(min)	6.809	172.9	(min)	(min)	0.009	0.24	
		2.921	74.19	0.007	0.18	6.807	172.9	0.004	0.1			
TSK5 (145 psi)	237°F (130°C)	2.920	74.16	(min)	(min)	6.801	172.7	(min)	(min)	0.016	0.4	0.10 to 0.18
		2.918	74.13	0.009	0.23	6.799	172.7	0.008	0.2			
	129°F (70°C)	2.918	74.12	(min)	(min)	6.801	172.7	(min)	(min)	0.016	0.4	
		2.917	74.09	0.011	0.27	6.803	172.8	0.008	0.20			

MAINTENANCE

FITTING AND SHIMMING THE ROTOR CASE

Rotor Case/ Gear Case Wrench Size (mm)	TSK1	TSK2	TSK3	TSK4	TSK5
	13	17	17	19	19
Torque (Nm)	20	40	40	64	150
(lb-ft)	15	30	30	47	111
(lb-in)	177	354	354	566	1327

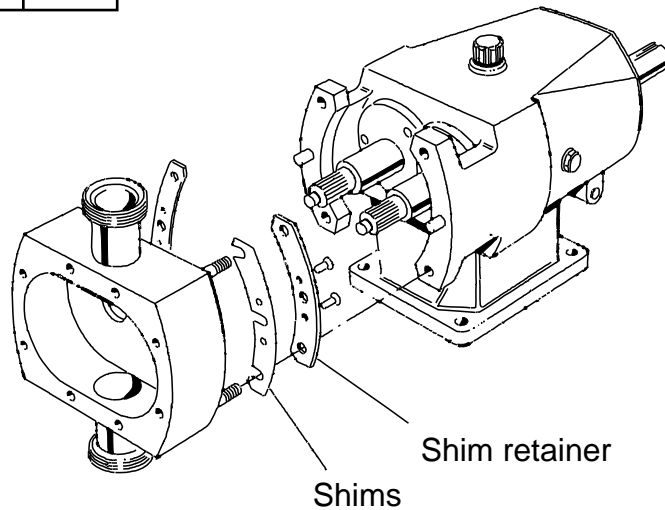
If the rotor case has previously been shimmed, the shims should not be removed.

The rotor case may require re-shimming if new components have been installed on the shaft assemblies or the gearbox changed.

The back clearances should be checked before operating the pump.

New shims should be installed using the following procedure:

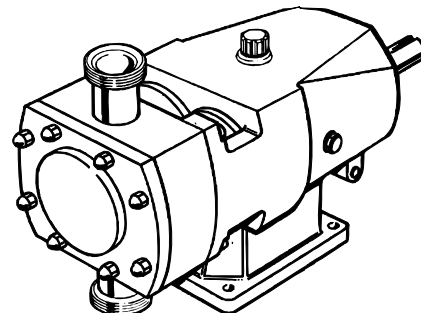
1. Insert the smallest thickness shim between the right and left side of the rotor case and gear case and rotors.
2. Install the rotor case to the gear case, tighten the gear case nuts and install the rotors.
3. The back clearance can now be measured using feeler gauges. The additional shimming required to bring the clearances within tolerance can be determined. (See the Dimension and Tolerance table on the previous page.)
4. Install the additional shims and re-check the clearances and if necessary repeat the re-shimming procedure.
5. Remove the rotor case with the shims (secured by the shim retainer) ready for fitting the product seal.



FITTING THE PUMP SEALS

Refer to the type of seal to be installed for further instructions.

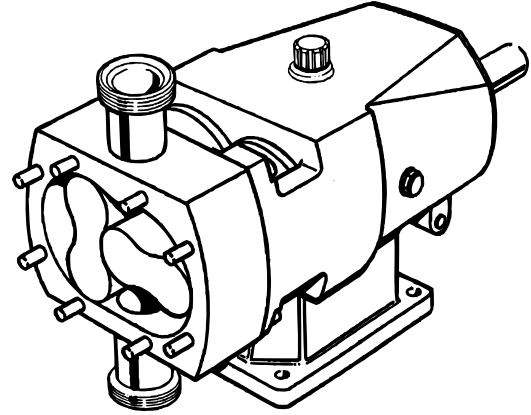
<p>⚠ CAUTION</p>
<p>Seal faces are brittle. Any marks on the seal faces will cause failure. Take extreme care when handling.</p>



MAINTENANCE

INSTALLING THE ROTORS

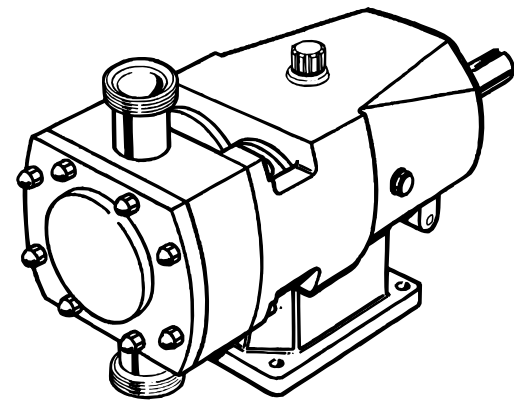
1. If the pump is has mechanical seals, flushed mechanical seals or lip seals the rotor case including rotors and seal assembly should be guided onto the shaft spline.
2. Care and a minimum amount of force should be used in correctly aligning the rotor spline with the shaft spline, to avoid damaging the seals the assembly should be placed onto the shaft as square as possible.
3. To identify if the pump has been correctly timed, turn the drive shaft by hand and check if any contact between the rotors takes place.
4. To check that the rotors are correctly synchronized turn the drive shaft by hand and check the meshing clearances with feeler gauges against clearance charts. (Available on request from your supplier.)



INSTALLING THE FRONT COVER

Rotor Case/ Gear Case Wrench Size (mm)	TSK1	TSK2	TSK3	TSK4	TSK5
Torque (Nm)	20	40	40	64	150
(lb-ft)	15	30	30	47	111
(lb-in)	177	354	354	566	1327

1. Place new 'O' ring on front cover. (If necessary, lubricate with food grade lubricant.)
2. Place cover in correct orientation.
3. Place the cover onto the rotor case studs and tighten the front cover nuts.
4. The pump can now be mounted with its drive unit.
5. Prior to start up the pump must be oil filled.



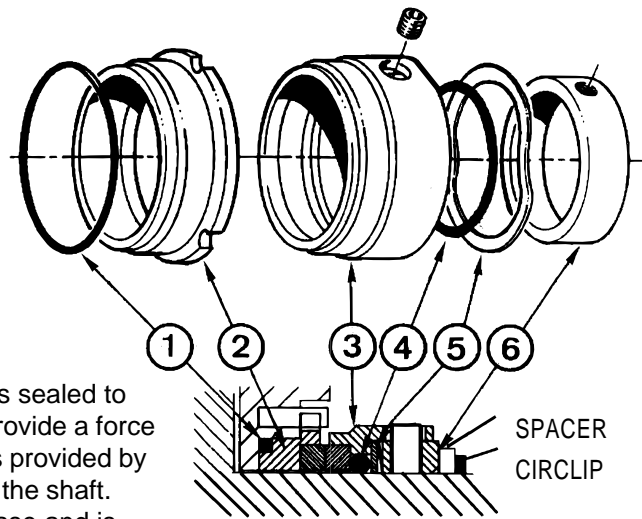
Read the start-up check list before proceeding to start the pump.

MAINTENANCE

SEALS - REMOVAL AND INSTALLING

SINGLE MECHANICAL SEAL

ITEM	DESCRIPTION
1	STATIONARY FACE 'O' RING
2	STATIONARY FACE
3	ROTARY FACE
4	SHAFT 'O' RING
5	WAVE SPRING
6	DRIVE RING



The seal comprises of a rotary face which is sealed to the shaft by an 'O' ring. A wave spring(s) provide a force to maintain face to face contact. Rotation is provided by socket set screws which are tightened onto the shaft. The stationary face is located in the rotor case and is prevented from rotating by three pins.

⚠ CAUTION
Seal faces are brittle. Take extreme care when handling.

REMOVING THE MECHANICAL SEAL

1. Remove circlip and spacer.
2. Pull seal off rotor sleeve.
3. Remove stationary face from rotor case bore.

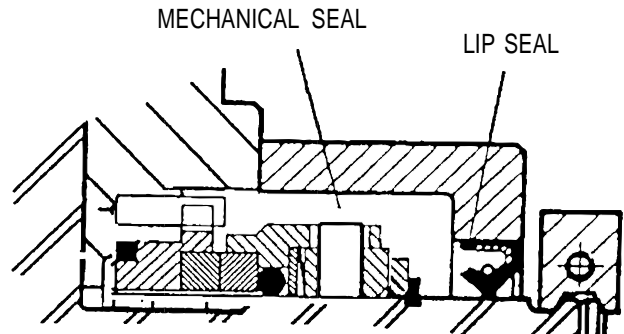
INSTALLING THE MECHANICAL SEAL

1. Use a solvent to wipe the lapped surface of the seal faces until perfectly clean. Be extremely careful not to scratch the faces.
2. Firmly press the stationary face 'O' ring onto the stationary face edge and locate within the rotor case bore over the roll pins.
3. Place the rotors in the rotor case. Lay the assembly face down on the bench with rotor hubs are pointing vertically upward. Place a soft piece of material under rotor faces so the backs of rotor lobes are in intimate contact with the rotor case and the front of rotor case is clear of the bench.
4. Slacken all set screws and slide circlip along shaft until it drops into its groove.
5. The set screws should now be progressively tightened in sequence.
6. Install the rotors.

MAINTENANCE

SINGLE FLUSHED MECHANICAL SEAL

ITEM	DESCRIPTION
1	STATIONARY FACE O-RING
2	STATIONARY FACE
3	ROTARY FACE
4	SHAFT O-RING
5	WAVE SPRING
6	DRIVE RING



The seal comprises of a rotary face which is sealed to the shaft by an 'O' ring. A wave spring(s) provide a force to maintain face to face contact. Rotation is provided by socket set screws which are tightened onto the shaft. The stationary face is located in the rotor case and is prevented from rotating by three pins. A seal housing with lip seal encloses the seal and runs on the rotor nuts.

▲ CAUTION

Seal faces are brittle. Take extreme care when handling.

REMOVING THE SINGLE FLUSHED MECHANICAL SEAL

1. The rotors, rotor case and seals must be removed as a single assembly.
2. Release and remove the flush seal housing retaining screws and remove the housing. The lip seals should be inspected and replaced if necessary.
3. With the seal housings removed, the six set screws should be slackened and the circlip released.
4. The seals can now be carefully removed from the rotor hubs.

INSTALLING THE SINGLE FLUSHED MECHANICAL SEAL

1. Press the lip seal into the seal housing.
2. Use a solvent to wipe the lapped surface of the faces until perfectly clean, being extremely careful not to scratch the faces.
3. Lightly lubricate the stationary face 'O' ring and firmly press the stationary face 'O' ring onto the stationary face and locate them within the rotor case bore over the roll pins.
4. Slide rotary face seal over lubricated rotor hub and install spacers and circlips.
5. Place housing centrally over rotor hub and tighten.

TROUBLESHOOTING

TROUBLESHOOTING

The troubleshooting chart applies to problems which may arise during pump operation. The chart assumes that the pump is correctly installed and is the correct size for the application.

Contact Tri-Clover if assistance is required.

Refer to the motor manufacturer's operating and maintenance manual for motor troubleshooting

PROBLEM	PROBABLE CAUSE	REMEDY
No Discharge	<ul style="list-style-type: none"> a. Incorrect direction of rotation. b. Pump un-primed. c. Insufficient NPSH available. d. Air entering supply line. e. Insufficient head above supply vessel outlet. f. Metal to metal contact of pumping element. 	<ul style="list-style-type: none"> a. Reverse motor b. Expel gas from supply line and pumping chamber and introduce liquid. c. Increase supply line diameter. Increase suction head. Simplify supply line configuration and reduce length. Reduce speed. d. Remake pipework joints. Adjust or repack gland. e. Raise product level. Lower outlet position. Increase submergence of supply line. f. Check rated and duty pressure. Contact Tri-Clover.
Irregular Discharge	<ul style="list-style-type: none"> a. Insufficient NPSH available. b. Product vaporizing in supply line. c. Air entering supply line. d. Gas in supply line. e. Insufficient head above supply vessel outlet. f. Food valve strainer obstructed or blocked. 	<ul style="list-style-type: none"> a. Increase supply line diameter. Increase suction head. Simplify supply line configuration and reduce length. Reduce speed. b. Decrease product temperature. Check effect of increased viscosity on available and permitted power inputs. c. Remake pipework joints. Adjust or repack gland. d. Expel gas from supply line and pumping chamber and introduce liquid. e. Raise product level. Lower outlet position. Increase submergence of supply line. f. Service fittings.

TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	REMEDY
Irregular Discharge (cont.)	<ul style="list-style-type: none"> <li data-bbox="500 359 894 422">g. Product viscosity above rated figure. <li data-bbox="500 453 894 516">h. Delivery pressure above rated figure. <li data-bbox="500 642 813 674">l. Gland under tightened. 	<ul style="list-style-type: none"> <li data-bbox="1011 359 1455 422">g. Decrease pump speed. Increase product temperature. <li data-bbox="1011 453 1438 579">h. Check for obstructions. Service system and revise to prevent problem from reoccurring. Simplify delivery line. <li data-bbox="1011 642 1373 737">l. Adjust gland. See note on packed glands under Maintenance heading.
Under Capacity	<ul style="list-style-type: none"> <li data-bbox="500 772 870 804">a. Insufficient NPSH available. <li data-bbox="500 898 878 961">b. Product vaporizing in supply line. <li data-bbox="500 1056 821 1087">c. Air entering supply line. <li data-bbox="500 1161 764 1192">d. Gas in supply line. <li data-bbox="500 1318 902 1381">e. Insufficient head above supply vessel outlet. <li data-bbox="500 1444 894 1507">f. Product viscosity above rated figure. <li data-bbox="500 1539 894 1602">g. Product viscosity below rated figure. <li data-bbox="500 1633 894 1696">h. Delivery pressure above rated figure. <li data-bbox="500 1791 813 1822">l. Gland under tightened. 	<ul style="list-style-type: none"> <li data-bbox="1011 772 1438 898">a. Increase supply line diameter. Increase suction head. Simplify supply line configuration and reduce length. Reduce speed. <li data-bbox="1011 930 1422 1056">b. Decrease product temperature. Check effect of increased viscosity on available and permitted power inputs. <li data-bbox="1011 1087 1438 1150">c. Remake pipework joints. Adjust or repack gland. <li data-bbox="1011 1182 1438 1276">d. Expel gas from supply line and pumping chamber and introduce liquid. <li data-bbox="1011 1308 1455 1402">e. Raise product level. Lower outlet position. Increase submergence of supply line. <li data-bbox="1011 1434 1455 1497">f. Decrease pump speed. Increase product temperature. <li data-bbox="1011 1528 1455 1591">g. Increase pump speed. Decrease product temperature. <li data-bbox="1011 1623 1438 1749">h. Check for obstructions. Service system and revise to prevent problem from reoccurring. Simplify delivery line. <li data-bbox="1011 1780 1373 1875">l. Adjust gland. See note on packed glands under Maintenance heading.

TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	REMEDY
<p>Under Capacity (cont.)</p>	<ul style="list-style-type: none"> j. Pump speed above rated figure. k. Rotor case strained by pipework. l. Metal to metal contact of pumping element. m. Worn pumping element. n. Front cover relief valve leakage. o. Relief Valve chatter. 	<ul style="list-style-type: none"> j. Decrease pump speed. k. Check alignment of pipes. Install flexible pipes or expansion fittings. Support pipework. l. Check rated and duty pressure. Contact Tri-Clover m. Install new components. n. Check pressure setting and re-adjust if necessary. Examine and clean seating surfaces. Replace worn parts. o. Check for wear sealing surfaces, guides etc. Replace if necessary.
<p>Prime Lost After Starting</p>	<ul style="list-style-type: none"> a. Insufficient NPSH available. b. Product vaporizing in supply line. c. Air entering supply line. d. Gas in supply line. e. Insufficient head above supply vessel outlet. 	<ul style="list-style-type: none"> a. Increase supply line diameter. Increase suction head. Simplify supply line configuration and reduce length. Reduce speed. b. Decrease product temperature. Check effect of increased viscosity on available and permitted power inputs. c. Remake pipework joints. Adjust or repack gland. d. Expel gas from supply line and pumping chamber and introduce liquid. e. Raise product level. Lower outlet position. Increase submergence of supply line.

TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	REMEDY
Prime Lost After Starting (cont)	<ul style="list-style-type: none"> f. Food valve strainer obstructed or blocked. g. Product viscosity above rated figure. h. Delivery pressure above rated figure. i. Gland under tightened. 	<ul style="list-style-type: none"> f. Service fittings. g. Decrease pump speed. Increase product temperature. h. Check for obstructions. Service system and revise to prevent problem from reoccurring. Simplify delivery line. i. Adjust gland. See note on packed glands under Maintenance heading.
Pump Stalls When Starting	<ul style="list-style-type: none"> a. Product viscosity above rated figure. b. Product temperature below rated figure. c. Delivery pressure above rated figure. d. Shaft bearing wear or failure. e. Gear case oil quantity incorrect. 	<ul style="list-style-type: none"> a. Decrease pump speed. Increase product temperature. b. Heat the product pumping chamber. (Contact Tri-Clover.) c. Check for obstructions. Service system and revise to prevent problem from reoccurring. Simplify delivery line. d. Contact Tri-Clover for advice and replacement parts. e. Contact Tri-Clover.
Pump Overheats	<ul style="list-style-type: none"> a. Product viscosity above rated figure. b. Product temperature above rated figure. c. Delivery pressure above rated figure. 	<ul style="list-style-type: none"> a. Decrease pump speed. Increase product temperature. b. Cool the product pumping chamber. c. Check for obstructions. Service system and revise to prevent problem from reoccurring. Simplify delivery line.

TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	REMEDY
Pump Overheats (cont.)	<ul style="list-style-type: none"> d. Gland over tightened. e. Rotor case strained by pipework. f. Belt drive slipping. g. Insecure pump driver mountings. h. Shaft bearing wear or failure. i. Worn un-synchronized timing gears. j. Gear case oil quantity incorrect. k. Worn pumping element. 	<ul style="list-style-type: none"> d. Slacken and re-adjust gland. e. Check alignment of pipes. Install flexible pipes or expansion fittings. Support pipeworks. f. Re-tension to Tri-Clover's recommendations. g. Install lock washers to slack fasteners and re-tighten. h. Contact Tri-Clover for advice and replacement parts. i. Contact Tri-Clover for advice and replacement parts. j. Contact Tri-Clover for instructions. k. Install new components.
Motor Overheats or Excessive Power is Absorbed	<ul style="list-style-type: none"> a. Product viscosity above rated figure. b. Product temperature below rated figure. c. Delivery pressure above rated figure. d. Gland over-tightened. e. Pump speed above rated figure. f. Rotor case strained by pipework. g. Belt drive slipping. 	<ul style="list-style-type: none"> a. Decrease pump speed. Increase product temperature. b. Heat the product pumping chamber. (Consult Tri-Clover.) c. Check for obstructions. Service system and revise to prevent problem from reoccurring. Simplify the delivery line. d. Slacken and re-adjust gland. e. Decrease pump speed. f. Check the alignment of the pipes. Install flexible pipes or expansion fittings. Support pipework. g. Re-tension to Tri-Clover's recommendations.

TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	REMEDY
Motor Overheats or Excessive Power is Absorbed (cont.)	<ul style="list-style-type: none"> <li data-bbox="581 390 889 453">h. Insecure pump driver mountings. <li data-bbox="581 485 889 548">i. Shaft bearing wear or failure. <li data-bbox="581 579 899 642">j. Worn un-synchronized timing gears. <li data-bbox="581 674 889 737">k. Gear case oil quantity incorrect. 	<ul style="list-style-type: none"> <li data-bbox="1005 390 1398 453">h. Install lock washers to slack fasteners and re-tighten. <li data-bbox="1005 485 1398 548">i. Contact Tri-Clover for advice and replacement parts. <li data-bbox="1005 579 1398 642">j. Contact Tri-Clover for advice and replacement parts. <li data-bbox="1005 674 1317 737">k. Contact Tri-Clover for instructions.
Noise and Vibration	<ul style="list-style-type: none"> <li data-bbox="581 772 959 804">a. Insufficient NPSH available. <li data-bbox="581 930 964 993">b. Product vaporizing in supply line. <li data-bbox="581 1087 906 1119">c. Air entering supply line. <li data-bbox="581 1182 849 1213">d. Gas in supply line. <li data-bbox="581 1308 906 1371">e. Insufficient head above supply vessel outlet. <li data-bbox="581 1434 889 1497">f. Food valve strainer obstructed or blocked. <li data-bbox="581 1539 911 1602">g. Product viscosity above rated figure. <li data-bbox="581 1623 954 1686">h. Product temperature above rated figure. <li data-bbox="581 1728 873 1791">i. Unexpected solids in product. <li data-bbox="581 1812 915 1875">j. Delivery pressure above rated figure. 	<ul style="list-style-type: none"> <li data-bbox="1005 772 1442 898">a. Increase supply line diameter. Increase suction head. Simplify supply line and reduce length. Reduce speed. <li data-bbox="1005 930 1430 1056">b. Decrease product temperature. Check effect of increased viscosity on available and permitted power inputs. <li data-bbox="1005 1087 1442 1150">c. Remake pipework joints. Adjust or repack gland. <li data-bbox="1005 1182 1442 1276">d. Expel gas from supply line and pumping chamber and introduce liquid. <li data-bbox="1005 1308 1393 1402">e. Raise product level. Lower outlet position. Increase submergence of supply line. <li data-bbox="1005 1434 1239 1465">f. Service fittings. <li data-bbox="1005 1539 1417 1602">g. Decrease pump speed. Increase product temperature. <li data-bbox="1005 1623 1365 1686">h. Cool the product pumping chamber. <li data-bbox="1005 1728 1360 1791">i. Clean the system. Install strainer to supply line. <li data-bbox="1005 1812 1442 1938">j. Check for obstructions. Service system and revise to prevent problem from reoccurring. Simplify delivery line.

TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	REMEDY
Noise and Vibration (cont.)	<ul style="list-style-type: none"> k. Gland under tightened. l. Pump speed above rated figure. m. Rotor case strained by pipework. n. Belt drive slipping. o. Flexible coupling misaligned. p. Insecure pump driver mountings. q. Shaft bearing wear or failure. r. Worn un-synchronized timing gears. s. Gear case all quantity incorrect. t. Front cover relief valve leakage. u. Relief Valve chatter. 	<ul style="list-style-type: none"> k. Adjust gland. See note on packed glands under Maintenance heading. l. Decrease pump speed. m. Check alignment of pipes. Install flexible pipes or expansion fittings. Support pipework. n. Re-tension to Tri-Clover's recommendations. o. Check flange alignment and adjust mountings accordingly. p. Install lock washers on slack fasteners and re-tighten. q. Contact Tri-Clover for advice and replacement parts. r. Contact Tri-Clover for advice and replacement parts. s. Contact Tri-Clover for instructions. t. Check pressure setting. Re-adjust if necessary. Examine and clean seating surfaces. Replace worn parts. u. Check for wear sealing surfaces, guides etc. Replace if necessary.
Pump Element Wear	<ul style="list-style-type: none"> a. Product temperature above rated figure. b. Unexpected solids in product. c. Delivery pressure above rated figure. d. Rotor case strained by pipework. e. Insecure pump driver mountings. 	<ul style="list-style-type: none"> a. Cool the product pumping chamber. b. Clean the system. Install strainer on supply line. c. Check for obstructions. Service system and revise to prevent problem from reoccurring. Simplify delivery line. d. Check alignment of pipes. Install flexible pipes or expansion fittings. Support pipework. e. Install lock washers on slack fasteners and re-tighten.

TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	REMEDY
Pump Element Wear (Cont.)	<ul style="list-style-type: none"> f. Shaft bearing wear or failure. g. Gear case oil quantity incorrect. 	<ul style="list-style-type: none"> f. Contact Tri-Clover for advice and replacement parts. g. Contact Tri-Clover for instructions.
Excessive Gland Seal Wear	<ul style="list-style-type: none"> a. Unexpected solids in product. b. Gland over tightened. c. Gland flushing inadequate. 	<ul style="list-style-type: none"> a. Clean the system. Install strainer on supply line. b. Slacken and re-adjust gland. c. Check that fluid flows freely into gland. Increase for rate.
Product Loss Through Gland	<ul style="list-style-type: none"> a. Unexpected solids in product. b. Gland under tightened. c. Gland flushing inadequate. 	<ul style="list-style-type: none"> a. Clean the system. Install strainer on supply line. b. Adjust gland. See note on packed glands under the Maintenance heading. c. Check that fluid flows freely into gland. Increase for rate.
Seizure	<ul style="list-style-type: none"> a. Product temperature above rated figure. b. Unexpected solids in product. c. Delivery pressure above rated figure. d. Gland over-tightened. e. Rotor case strained by pipework. f. Insecure pump driver mountings. g. Shaft bearing wear or failure. h. Worn un-synchronized timing gears. i. Gear case oil quantity incorrect. 	<ul style="list-style-type: none"> a. Cool the product pumping chamber. b. Clean the system. Install strainer on the supply line. c. Check for obstructions. Service system and revise to prevent problem from reoccurring. d. Slacken and re-adjust gland. e. Check alignment of pipes. Flexible pipes or expansion fittings. Support pipework. f. Install lock washers to slack fasteners and re-tighten. g. Contact Tri-Clover for advice and repair parts. h. Contact Tri-Clover for advice and repair parts. i. Contact Tri-Clover for instructions.

PARTS LIST

ORDERING INFORMATION

All orders for repair parts must contain the following:

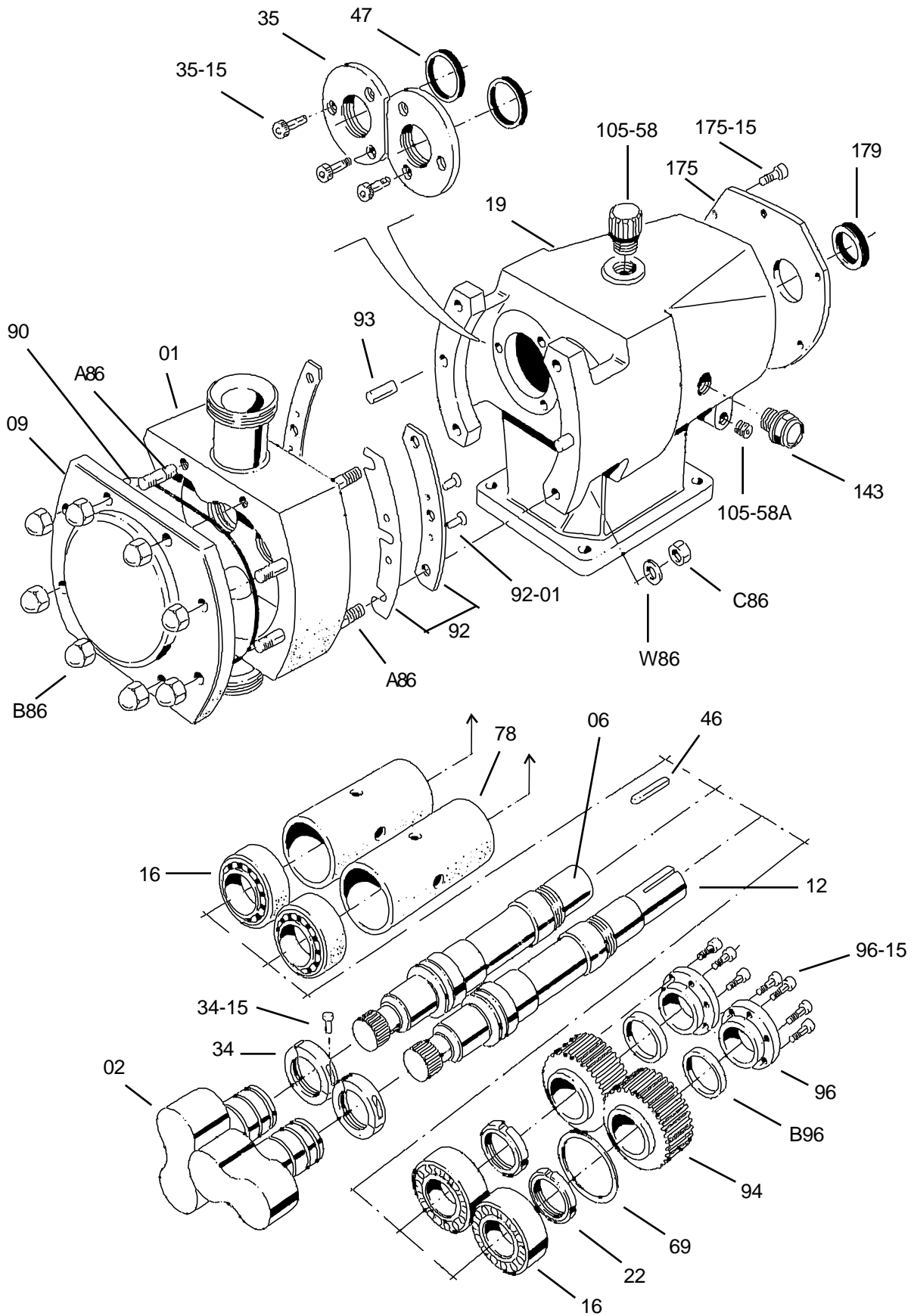
1. Complete model number (located on nameplate).
2. Pump serial number (located on nameplate).
3. Description and part key number from the parts list.

The exploded view and parts key facilitate ordering repair parts from Tri-Clover. All parts for the CL pump are keyed to the parts list.

PARTS LIST - TSK1, TSK2, AND TSK3

Key #	DESCRIPTION	Key	DESCRIPTION
34	Rotor Clamp	35-15	Screws, Front Seal Carrier
34-15	Screws, Rotor Clamp	46	Key
01	Rotor Case	47	Lip Seals, Gland End
02	Rotors	69	Spacer, Shaft Abutment
06	Shaft Auxiliary	78	Spacer, Shaft
09	Cover, Rotor Case	A86	Stud, Rotor Case
105-58	Filter Plug (oil)	90	'O' Ring Front Cover
105-58A	Drain Plug (oil)	92	Shim
12	Shaft Drive	92-01	Stud, Gear Case
143	Sight Level (oil)	93	Dowel
16	Bearings	94	Timing Gear
175	Cover, Gear Case	96	Clamp Plate
175-15	Screw, Rear Cover	96-15	Caphead Screws, Clamp Plate
179	Lip Seal Drive End	B86	Dome Nuts, Front Cover
19	Gear Case	B96	Torque Locking Element
22	Nut, Bearing	C86	Nut, Gear Case Stud
35	Retainer, Seal	W86	Washer, Gear Case Stud

EXPLODED VIEW - TSK1, TSK2, & TSK3

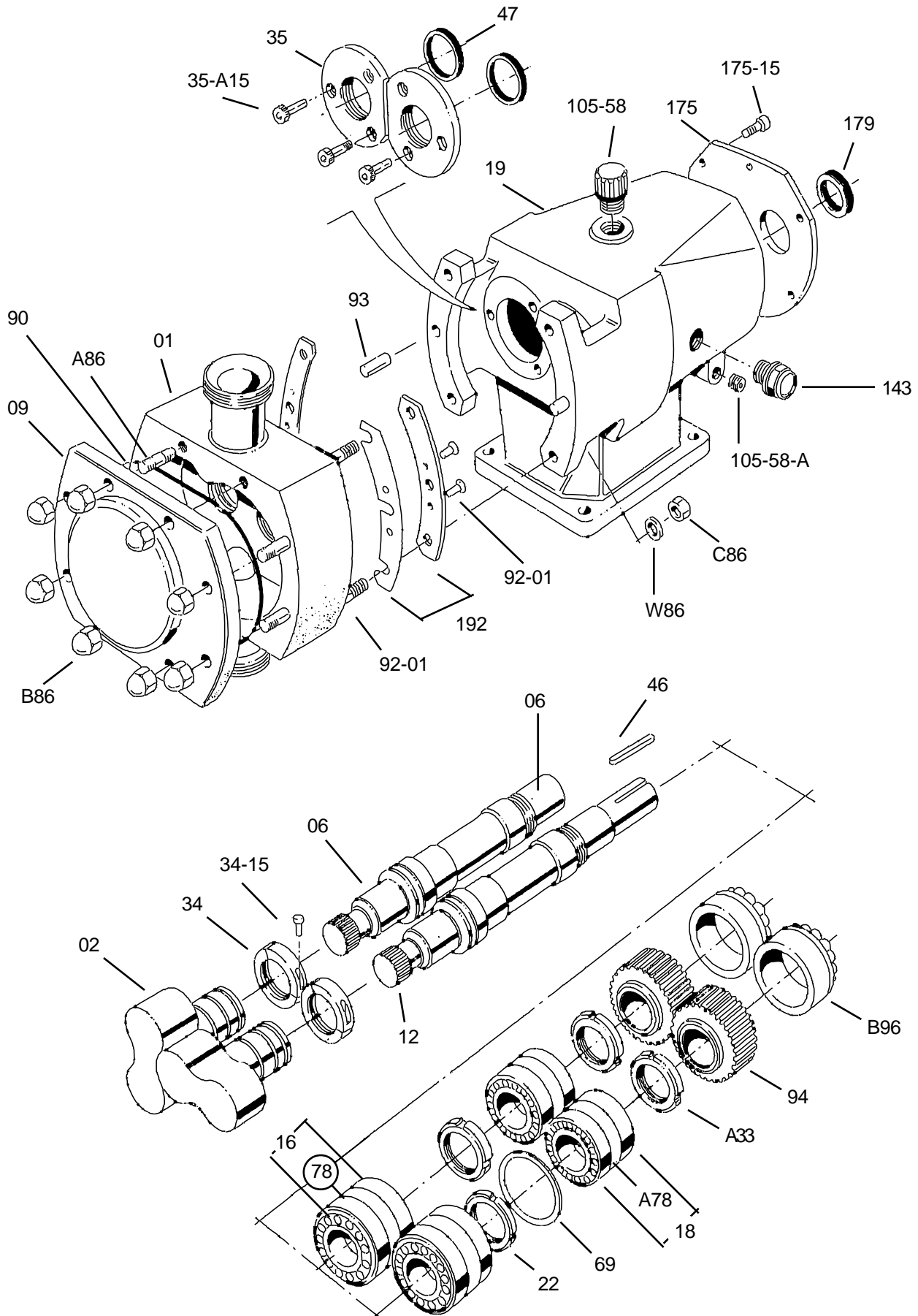


PARTS LIST

PARTS LIST - TSK4 AND TSK5

Key	DESCRIPTION	Key	DESCRIPTION
34	Rotor Clamp	35	Retainer, Seal
34-15	Screws, Rotor Clamp	35-A15	Screws, Front Seal Carrier
01	Rotor Case	46	Key
02	Rotors	47	Lip Seals, Gland End
06	Shaft, Auxiliary	69	Spacer, Shaft Abutment
09	Cover, Rotor Case	90	O-ring
105-58	Filter Plug (oil)	92	Shim
105-58A	Drain Plug (oil)	92-01	Stud, Gear Case
12	Shaft, Drive	93	Dowel
143	Sight Level Oil	94	Timing Gear
16	Nut, Bearing	A78	Spacer, Bearing
175	Cover, Gear Case	A22	Spacer, Bearing
175-15	Screw, Rear Cover	A86	Stud, Rotor Case
179	Lip Seal Drive End	B86	Dome Nuts, Front Cover
18	Bearings, Rear	B96	Torque Locking Assembly
19	Gear Case	C86	Nut, Gear Case Stud
22	Bearings, Front	W86	Washer, Gear Case Stud

EXPLODED VIEW - TSK4 & TSK5



Tri-Clover

manufactures

a complete line of

TRI-WELD® fittings

TRI-CLAMP® fittings

BEVEL SEAT fittings

POSITIVE PUMPS

CENTRIFUGAL PUMPS

AUTOMATIC Air Actuated VALVES

STAINLESS STEEL TUBING

AUTOMATED FLOW CONTROL SYSTEMS

Terms, Warranty Provisions, Notice of Claims and Limitation of Liability

Prices and all terms and conditions of sale are established in current price sheets and are subject to change without notice. All orders are subject to acceptance by Tri-Clover Inc. at its Kenosha, Wisconsin or Distribution Center* offices only. No assignment of the purchaser's rights may be made without consent of Tri-Clover Inc.

Each Tri-Clover item is warranted to be free from manufacturing defects for a period of one (1) year from the date of shipment, providing it has been used as recommended and in accordance with recognized piping practice, and providing it has not been worn out due to severe service, such as encountered under extremely corrosive or abrasive conditions.

This warranty is expressly in lieu of any other warranties, express or implied, including but not limited to, any implied warranty of merchantability or fitness for a particular purpose.

All claims must be in writing and must be mailed or delivered by purchaser within thirty (30) days after purchaser learns of the facts upon which such claim is based. Any claim not made in

writing and within the time period specified above shall be deemed waived.

Purchaser's sole and exclusive remedy and Tri-Clover Inc.'s maximum liability for claims arising hereunder or for negligence for any and all losses and damages resulting from any cause shall be either the repair or replacement of defective items or, at Tri-Clover Inc.'s option, the refund of the purchase price for such items. In no event, including in the case of a claim for negligence, shall Tri-Clover be liable for incidental or consequential damages including loss of profits.

No person, including any representative, employee or agent of Tri-Clover, is authorized to assume on behalf of Tri-Clover Inc., any liability or responsibility in addition to or different from that described in this provision. Any and all representations, promises, warranties or statements that are in addition to or different from the terms of this provision are of no force or effect.

**Distribution Centers in Union City, California and St. Charles, Missouri.*



Tri-Clover Inc.

Food & Dairy Division
9201 Wilmot Road
Kenosha, Wisconsin 53141-1413
PHONE: 1-800-242-4000
FAX: 414-694-7104

Distribution Centers
St Charles, MO
PHONE: 1-800-238-0142
Union City, CA
PHONE: 1-800-852-3178

Bio-Pharm Division
PHONE: 1-800-511-5444
FAX: 414-694-2454

Tri-Clover Canada
101 Milner Avenue
Scarborough, Ontario M1S4S6
PHONE: 416-297-3400
FAX: 416-299-5095

Export Division
PHONE: +1-414-697-3170
FAX: +1-414-694-8188

Tri-Clover Mexico
Recursos Petroleros No. 7
Fracc. Ind. La Loma
54060 Tlalnepantla, Edo. de Mexico
PHONE: 52-5-397-0601
FAX: 52-5-362-3246

