

Owner's Manual

- *Installation*
- *Use*
- *Maintenance*



NOTE: This Manual covers KE pumps with Serial Numbers starting at 09306001

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1. INTRODUCTION

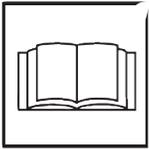
Please read this manual carefully before using your pump. It contains the necessary information for correct installation, use and maintenance as well as some practical suggestions for trouble shooting. Providing KE high pressure water plunger pumps are correctly installed and maintained, they will give trouble-free operation for a long time. The manufacturer declines all responsibility for damages arising from the misuse and non-observance of the instructions indicated in this manual.

On receiving the pump, please check that it is complete and in good state. Should you find anything out of order please contact your place of purchase before installing and starting the pump.

2. SYMBOL DESCRIPTIONS

**Warning**

Potential Danger



Read carefully and understand the manual before operating the pump

**Danger**

High Voltage

**Danger**

Wear protective mask

**Danger**

Wear goggles

**Danger**

Wear protective gloves

**Danger**

Wear protective boots

3. SAFETY

3.1 General safety instructions

The misuse of a high pressure water unit and the non-observance of the pump installation and maintenance instructions may cause serious damages and/or injuries to people or properties or both.

Any Manufacturer/Operator requested to assemble/use a high pressure water unit should be competent to do so, should have the necessary knowledge on every high pressure component installed in the unit and on the precautions to be taken in order to guarantee the largest safety margins during operation. No precaution, so far as is reasonably practical, should be left out in the interest of safety, both from the Manufacturer and the Operator.

3.2 High pressure unit safety requirements

1. A safety valve should be installed in any delivery line and should be sized to discharge or by-pass the entire pump flow rate
2. High pressure unit components, with particular regard for those units working outside, should be adequately protected against rain, frost and heat.
3. Electric components and wiring should be provided with an adequate degree of protection, able to protect them against spray coming from any direction. They should also be suitable for working in a wet environment.
4. High pressure hoses and any other accessory under pressure should be sized in accordance with the maximum unit working pressure and must always work within the safety margins indicated by the hose/accessory Manufacturer.
5. High pressure hose ends should be fastened to a steady object in order to prevent them from dangerous sweeping around, should they burst or come off their end fittings.
6. Proper safety guards should be provided to adequately cover transmission joints, pulleys, belts or auxiliary drives.



3.3 Safety of operation

The access into the area when a high pressure unit is working should be strictly prohibited to unauthorized personnel. The area should be suitably enclosed and its perimeter, so far as is reasonably practical, cordoned off and proper warning notices displayed in prominent positions.

Personnel authorized to enter that area should have been previously trained to do so and informed of the risks arising from failures, misuse and any foreseeable circumstance which may occur during operation. Before starting the pump unit and bringing it up to pressure the Operator is requested to carry out the following checks:

1. Make sure that a correct water supply to the pump is provided.
2. Make sure that water inlet filters are properly clean.
3. Electrical components and wiring, with special emphasis on connections, junction boxes, switches and supply cables should be free from external damage (i.e. exposed and broken wires) and adequately protected against water.
4. High pressure hose should not show apparent external wear and the fittings at both ends should be free from signs of erosion or corrosion.
5. Make sure that all fluids (lubricating oil for pump and engine, cooling water, hydraulic fluids) are at proper levels and in good condition.
6. Make sure the safety guards are in good condition.

The work should stop immediately and the pressure must be released in the event that leakage becomes apparent or if any person becomes aware of a change in condition or any hazard existing or being introduced. Any failure must be promptly reported and then checked personnel.



3.4 General procedures for high pressure gun/lance operation

1. The Operator should take reasonable care for the safety of himself and of other persons who may be affected by his acts or omission at work. His actions should always be governed by his good sense and responsibility.
2. The Operator should wear suitable waterproof protective clothing, having regard to the type of work being undertaken. The clothing set should include adequate hand protection, suitable boots able to ensure proper grip on wet floors, helmet provided with full face shield, waterproof garment providing full cover to the Operator, including his arms.
As most water jets produce noise levels in excess of 90 dB(A) suitable ear protection is advised.

NOTE: *It must be emphasized that whereas protective clothing provides adequate protection against spray and flying particles, it does not constitute complete protection against the direct impact of the water jet.*

Additional protections in the form of suitable metal shields or barriers may be necessary for certain jetting operation.

3. In most jetting operations it is an accepted practice to employ a team of Operators consisting of two members at least, in order to provide mutual assistance in case of need and to rotate their duties in case of long and heavy work. While the first Operator holds the gun, the second Operator attends the pump unit, keeping close watch on the first Operator for signs of difficulty or fatigue, and watching the surrounding area for intrusion by other persons or unsafe situations. If required, he will shut off the pressure unit until it is safe to continue.
4. The area in which the work is to proceed should be clear of loose items and debris to prevent tripping and slipping hazards.
5. The water jet should be directed only and always against the workpiece even during preliminary operating tests prior to starting work.
6. Where applicable, proper side shields should be suitable placed to safeguard personnel and equipment against contact with grit or particles removed by the water jet.
7. On no account must the Operator be distracted during operation until the jet has been stopped. Personnel having reason to enter the water jetting area should wait until the jet is stopped and his presence known.
8. Each team member must always be aware of the actions and intentions of other team members in order to prevent any dangerous misunderstanding occurring during jetting operation.
9. The pump unit should not be started and brought up to pressure unless each team member is in his designated position, the nozzle directed to the workpiece and the lance or gun securely held.

3.5 Safety of maintenance

Apart from the working pressure regulation no attempt should be made to adjust any nut, hose, fitting, etc., while that part of the system is under pressure. The pump should be stopped and any pressure in the line released prior to making any adjustments.

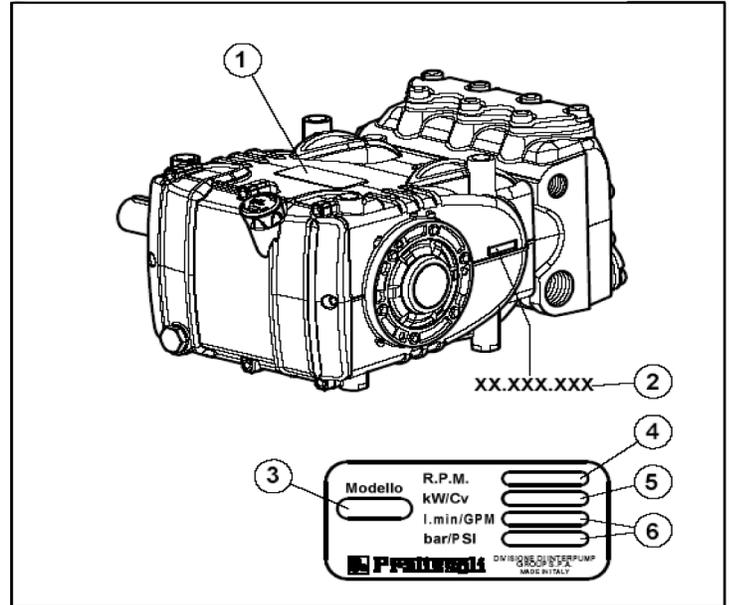
1. The high pressure water unit should be maintained in accordance with the Manufacturer's instructions.
2. The unit should be maintained only by competent personnel
3. Service and maintenance should be carried out with proper tools in order to prevent any damage on high pressure connections and fittings.
4. Use of other than original spare parts is strictly forbidden.

4. PUMP IDENTIFICATION

Each pump is fitted with a rating plate (see Fig. 1) containing the following information:

2. pump model and version
3. serial number
4. max RPM
5. max operating pressure (bar)
6. oil capacity (ltr) and oil specification
7. gear box ratio
8. max flow rate (l/min)

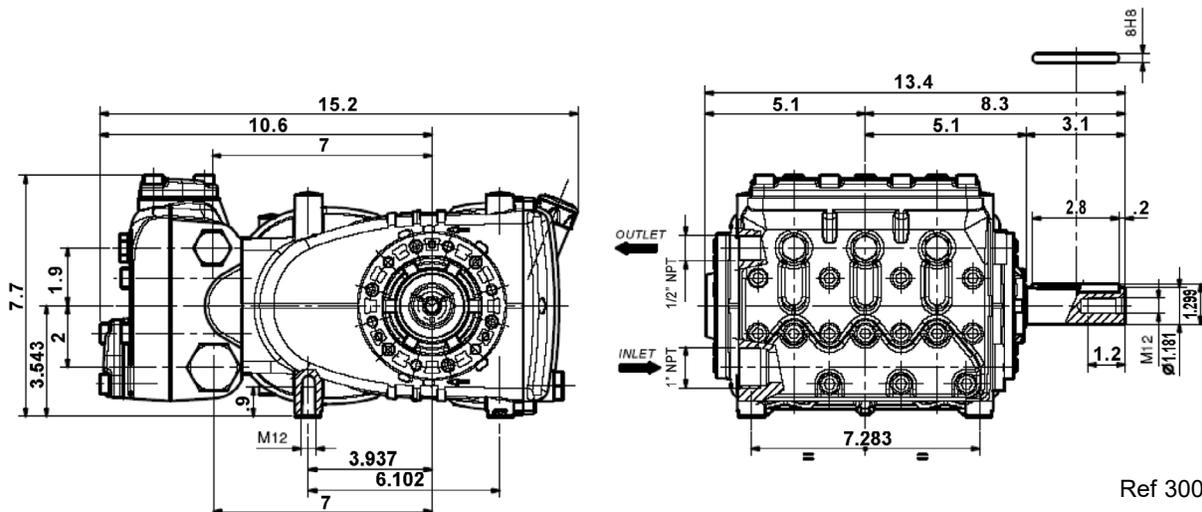
Pump model, pump version and serial number should be specified when ordering spare parts. Should the pump be modified (i.e by changing the original version) than any change should be mentioned on the rating plate for future reference.



5. TECHNICAL FEATURES

MODEL	RPM	FLOW RATE		PRESSURE		POWER	
		GPM	l/min	PSI	Bar	Hp	kW
KE20A	1450	8.0	31.4	4350	300	24.5	18
KE22A	1450	10.0	38	3625	250	24.7	18.16
KE24A	1450	11.9	45.2	3045	210	24.7	18.16
KE28AHA	1450	16.1	61.6	2175	150	24.0	17.6
KE30AHA	1450	18.5	70.7	1885	130	23.9	17.6
KE36HA	1450	26.4	100	1450	100	25.0	18.4

6. DIMENSIONS AND WEIGHT

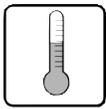


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7. GENERAL INFORMATION ABOUT PUMP USE



The KE pump has been designed to pump fresh and filtered (360 micron max.) water at room temperature. Special versions are available for pumping water up to 185°F and for reverse osmosis units.



7.1 Water temperature

The water temperature is critical for the pump life: the higher the water temperature, the more likely it is to create cavitation, resulting in premature seal and valve failures.

For such conditions, use HT series pumps.

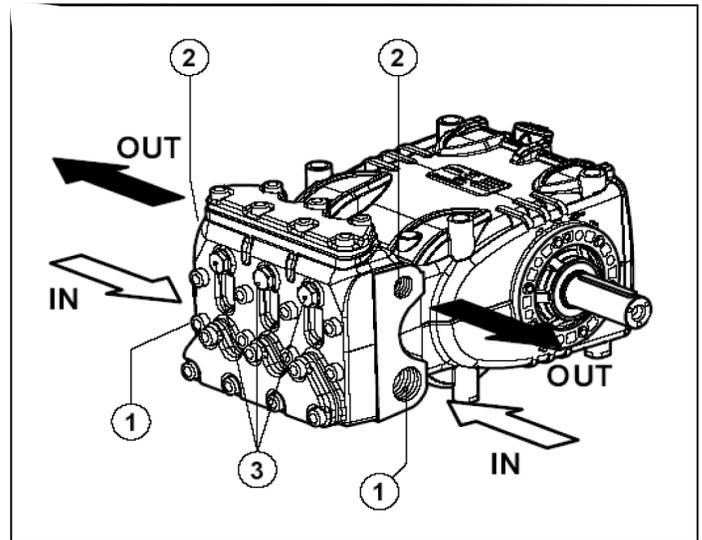
7.2 Max flow and pressure ratings

The performance data indicated in the catalog and on the rating plate refer to the maximum performance of the pump. The use of the pump below the rated performances does not allow the drop in power absorbed to be balanced by altering the pressure or volume of the pump above its maximum value.

7.3 Lowest operating RPM

The lowest operating speed **of the crankshaft** for all KE pumps (all versions) is 500 RPM.

8. CONNECTIONS AND PLUGS



KE pumps are provided with (Fig. 3):

1 - 2 inlet ports IN Ø 1" NPT

Suction line connection to either inlet port is acceptable, the port not being used should be sealed with the correct plug.

2 - 2 outlet ports OUT Ø 1/2" NPT

3 - 3 outlet ports OUT Ø 1/4" NPT (designed for pressure gauge and safety valve only)

9. PUMP INSTALLATION

9.1 Positioning

The pump must be installed on a rigid and perfectly flat and horizontal base by means of the proper four M12 threaded feet. The base should be rigid enough to avoid any misalignment or flexing on the pump/transmission coupling axis due to the torque involved during operation. The unit should not be rigidly fixed on the floor but be installed upon vibration dampeners.

The oil plug must absolutely be replaced by the oil stick and the oil level checked. Make sure that you can easily reach the oil stick even after the unit has been assembled.

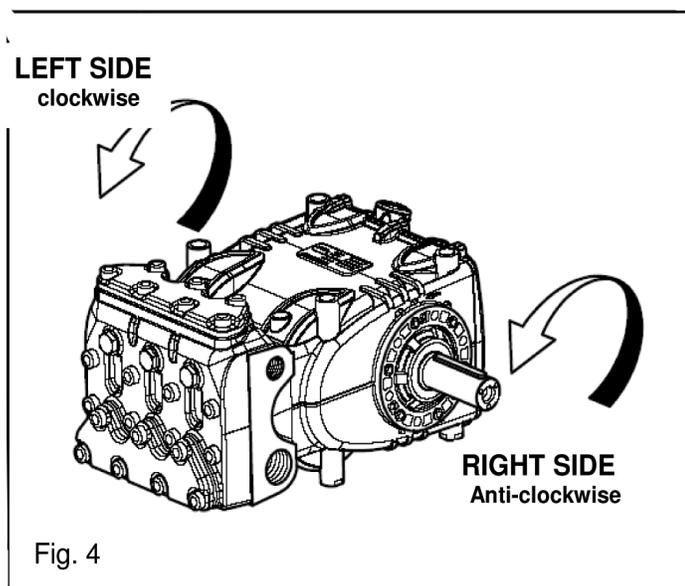
Never use rigid coupling on the shaft.

The following transmission types are suggested:

- Hydraulic by means of a flange.
- Pulleys.
- Cardan joint (within the max working angles indicated by the manufacturer).

9.2 Direction of rotation

An arrow situated on the crankcase near the shaft indicates the correct direction of rotation. Fig. 4 shows the direction of rotation looking at the pump from the fluid end side.



9.3 Water connections

In order to isolate the high pressure equipment from the pump vibrations it is suggested, where applicable, to use flexible hoses for both suction and delivery lines at least for the first length. The flexible hose must be rigid enough to prevent it from collapsing during the suction stroke, when a partial vacuum may occur.

9.4 Suction line

The pump life is considerably influenced by the effectiveness of the suction line which must have the following characteristics:

1. Internal diameter should be at least 1-1/2", in any point, possibly larger depending on the drop in pressure due to the length and shape of the line.
2. Should be as straight as possible minimizing changes in size and direction and positioned in such a way to allow air pockets and bubbles to escape.
3. Should be perfectly airtight.
4. Should be completely free from 90° elbows, diameter reductions, counter slopes, "T" connections and should not be connected to other pipelines.
5. Should be positioned in such a way to prevent the pipe emptying after the pump stops.
6. Do not use high pressure hydraulic fittings like 90° elbows, high pressure adapters, high pressure 3 or 4 way nipples and so on.
7. Do not install any kind of detergent injector along the suction line.
8. Do not install standing valves, check valves or other kind of one-way valves.
9. Make sure that the feed tank capacity and the water minimum level do not give rise to turbulence at the tank outlet port, which, in turn, might create cavitation at the pump.
10. Do not connect the by-pass line from the valve directly to the pump suction line.
11. Connect the by-pass line from the valve directly to the feed tank and make sure that both the by-pass and tank feeding flows could not give rise to turbulence at the tank outlet port, which, in turn, might create cavitation at the pump. Proper baffle plates should be provided inside the tank.
12. Before connecting the suction line to the pump inlet port make sure the pipe is perfectly clean inside.

9.5 Filtration

All pumps require a suitable filter. The filter should be installed as close as possible to the pump, should allow easy inspection and have the following characteristics:

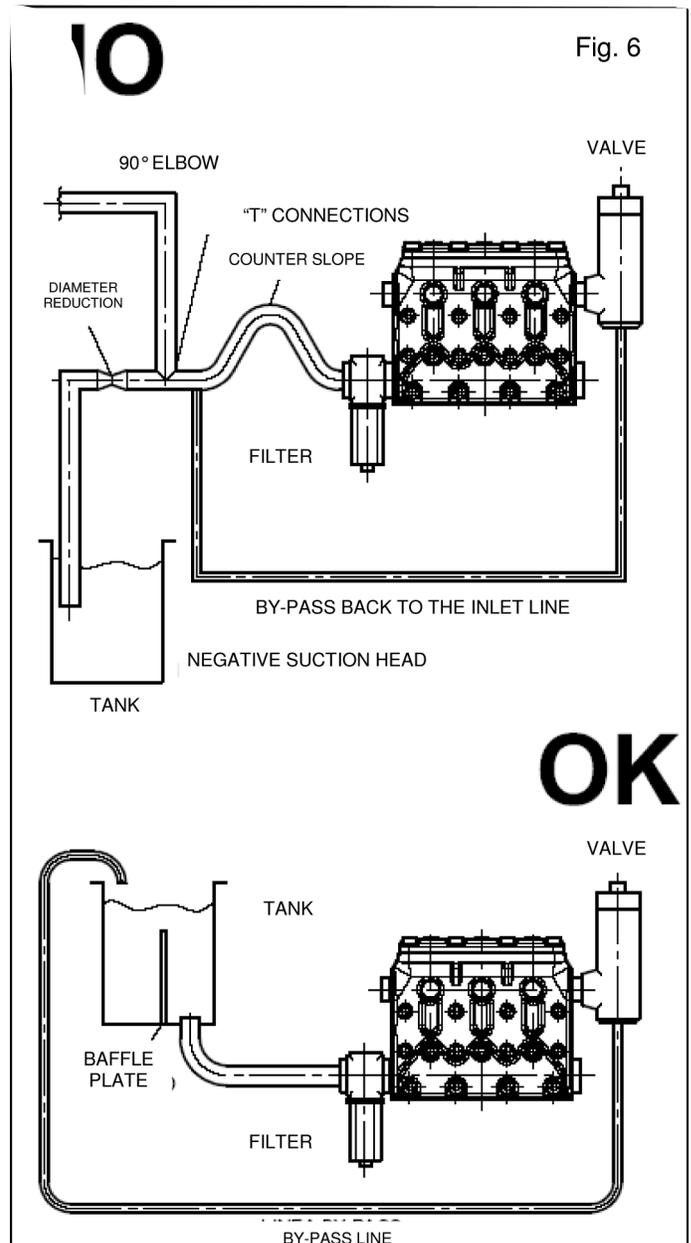
1. The filter capacity must be at least 3 times the rated pump volume.
2. Filter port diameters must not be smaller than the pump inlet ports.
3. Filtration degree in between 50 and 80 mesh (360 - 200 microns).

IMPORTANT NOTE: In order to properly safeguard the pump it is very important to plan cleaning of the filter with a frequency depending on the water quality, filtration degree and number of hours of each application.

9.6 Delivery line

For a correct delivery line comply with the following instructions:

1. The first length of delivery hose should be flexible in order to isolate the pump vibrations from the rest of the system.
2. Use only high pressure hoses and fittings able to guarantee the largest possible safety margins in any working conditions.
3. A suitable relief valve should be installed in the delivery line.
4. Use glycerine filled pressure gauges, as the most suitable for pulsating loads.
5. When designing the delivery line, take into proper account the unavoidable drop in pressure, due to its length and size.
6. If necessary, the effects of the pump pulsations can be reduced by installing a proper pulsation dampener on the pressure line.



9.7 Internal diameter of piping

To determine the internal diameter of the piping, follow the following diagram.

Example 1 (-----)

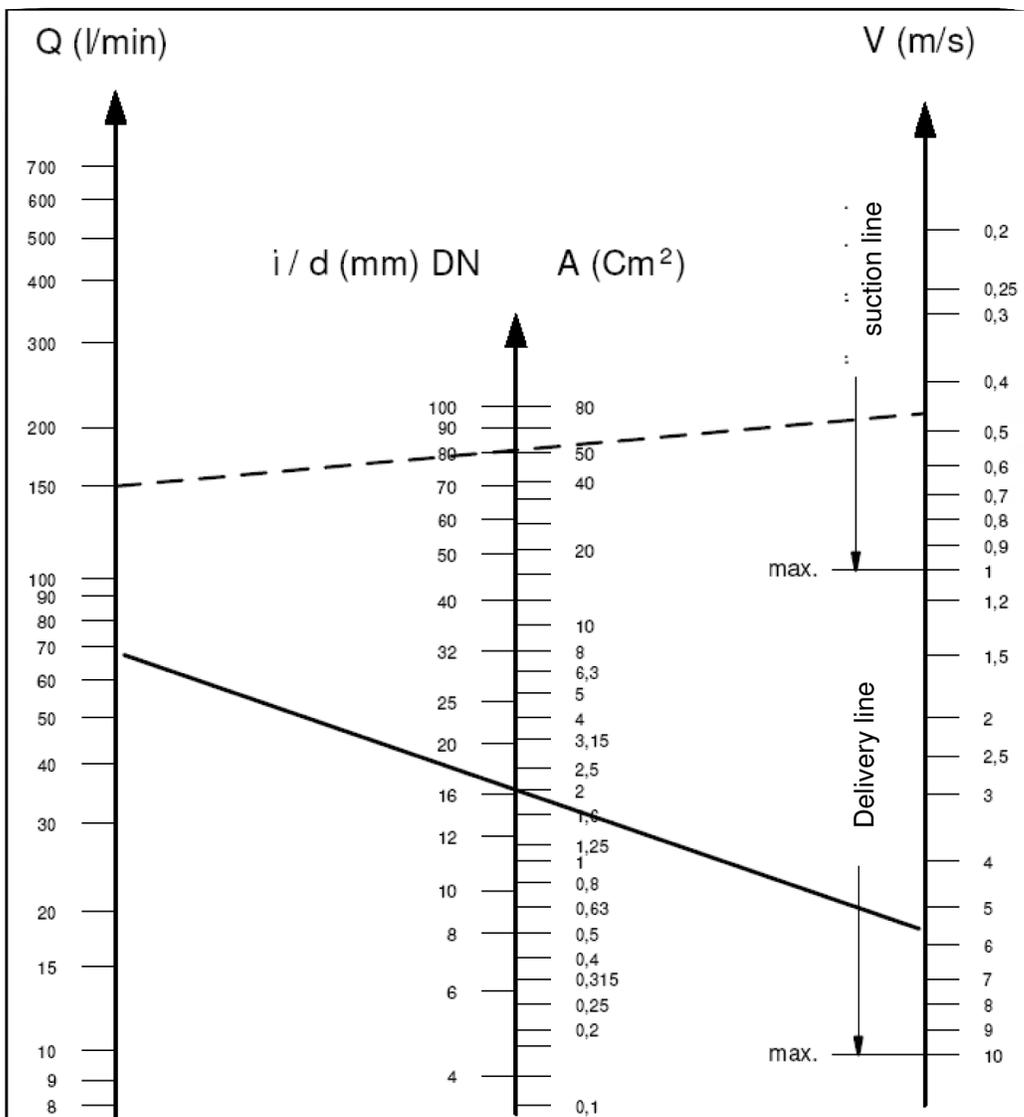
With a flow of 150 l/min and a water speed of 0.45 m/sec, the diagram line joining the 2 scales intersects the central scale, indicating the diameters, at a value of 80mm.

Example 2 (—)

With a flow of 70 l/min and a water speed of 5.5 m/sec, the diagram line joining the 2 scales intersects the central scale, indicating the diameters, at a value of 16mm.

Optimal speeds:

- suction: 0.5 m/sec
- delivery: 5 m/sec



The diagram does not take into consideration the pipe and valve resistance, drop in pressure, due to the pipe length, the viscosity of the pumped fluid, its temperature, etc.

10. START UP AND RUNNING PROCEDURES

10.1 Before start up

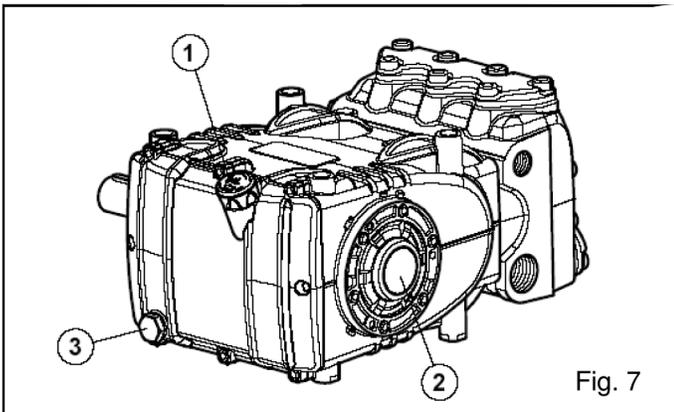
Before start up make sure that the following conditions have been complied with:

1. Suction line should be connected: **the pump must never run dry.**
2. Suction line must be perfectly airtight.
3. Any ON-OFF valve in between the pump and water source should be open and make sure the water gets into the pump freely.
4. Set the pressure line in dump mode in order to let the air in the pump get out easily thus facilitating the pump priming.
5. Make sure all suction/delivery line connections are fully tightened.
6. Joint alignment, belt tightening and PTO shaft inclination tolerances should remain within the values indicated by the transmission Manufacturer.
7. Make sure the oil level is correct using the dipstick (1, Fig. 7) and the oil sight glass (2, Fig. 7).

10.2 Starting up

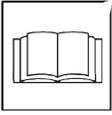
1. When starting the pump up for the first time check for proper direction of rotation.
2. Pump and motor/engine must start offload: set the regulating valve to zero or set the pressure line in dump mode by means of proper dumping devices.
3. During operation check the rotating speed, making sure the speed does not exceed the rated value.
4. Before putting the pump under pressure let it run for at least 3 minutes.
5. Before stopping the pump release the pressure from the system by operating the dump device or by releasing the regulating valve and reduce RPM to a minimum (diesel applications).

Note: in case of feeding by a centrifugal pump, make sure that the plunger pump starts only when the correct inlet pressure is provided.



Note: in case the pump has not run for a long period check the suction and delivery valves for scaling.

11. MAINTENANCE INSTRUCTIONS



11.1 Crank mechanism maintenance.

Check oil level through the oil level indicator (1, Fig. 8) at least on a weekly basis.

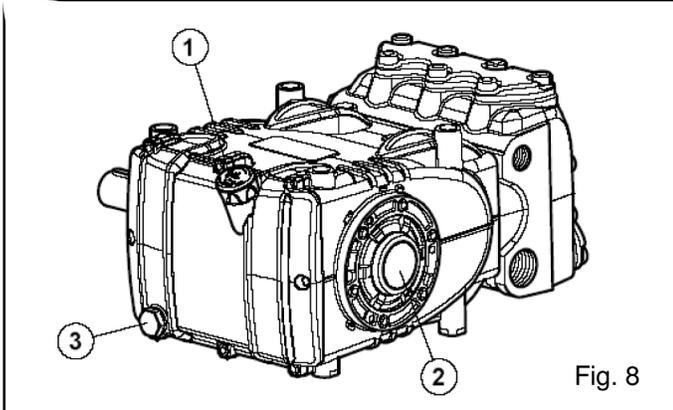


Fig. 8

If necessary add the missing oil through the oil plug (1 Fig. 8). Check oil level when the pump is at room temperature. When changing the oil (removing plug 3, Fig. 8), the pump should be at its working temperature.

Change oil every 1000 working hours, oil capacity is 67.6 ounces.

In any case the oil should be changed at least once a year, since oxidation deteriorates it.

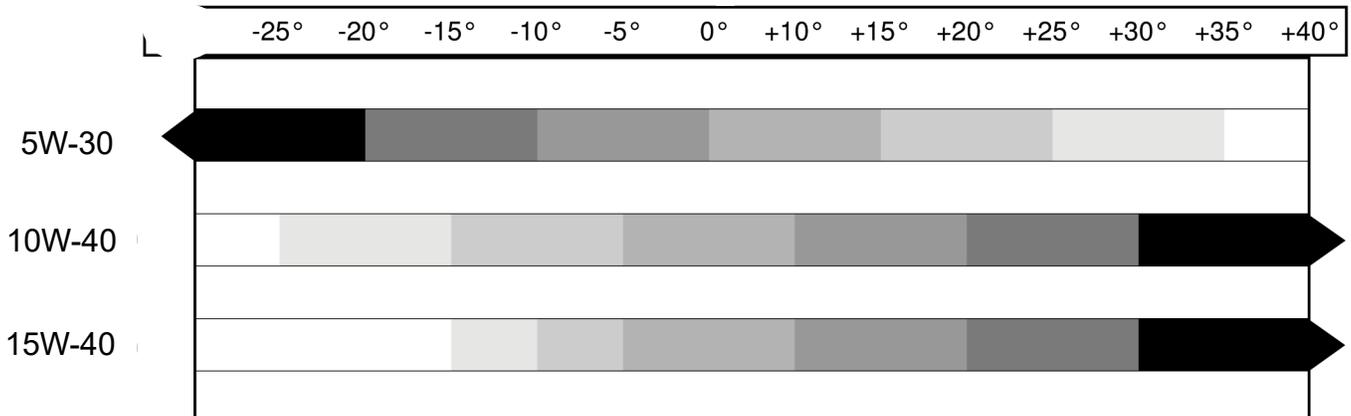
Recommended SAE 50W oils:

BRAND	TYPE
GENERAL PUMP	SERIES 220
ARAL	Aral Degol BG220
BP	ENERGOL HLP 220
CASTROL	Hyspin VG 220, Magna 220
ELF	POLYTELIS 220
ESSO	NUTO 220
FINA	Cirkan 220
FUCHS	RENOLIN 220
MOBIL	DTE OIL BB
SHELL	TELLUS C 220
TEXACO	RANDO HD 220
TOTAL	CORTIS 220

Mineral or synthetic oils can be used but they must be chosen according to the working environment temperature. Here below is a diagram indicating viscosity according to room temperature.

Oil grade SAE for engine oil

Recommended according to the room temperature (indicated in °C)



11.1.1 Crank mechanism disassembling

Do as follows:

- A) Drain the oil from the pump and remove:
- shaft key
 - back cover
 - connecting rod cap
 - side covers. To do so, put 3 screws M6 x 50 wholly threaded into the holes drilled for that purpose. See fig 9.



Fig. 9

- B) Push the piston guides and connecting rods forward so you can remove the pump crankshaft from the side.
Note: to extract the piston guide, it is necessary to remove the ceramic plunger and wiper first.
- C) Disassemble the crankshaft oil seals and the piston guides using standard tools.

11.1.2 Crank mechanism reassembling

After washing the crankcase, reassemble the power end as follows:

- A) Fit the piston guide seals into their seat thoroughly making sure they are correctly positioned.
- B) Introduce the units piston guide/connecting rod into their seats (to facilitate the tightening of the connecting rod cap position the connecting rod so you can easily read the number). To install the crankshaft, without key, it is necessary to push the unit piston guide/connecting rod backward.



Fig. 10

- C) Before reassembling the side covers, check the seal lips for wear. If they need replacing, fit the new ring following the indications in Fig. 11.

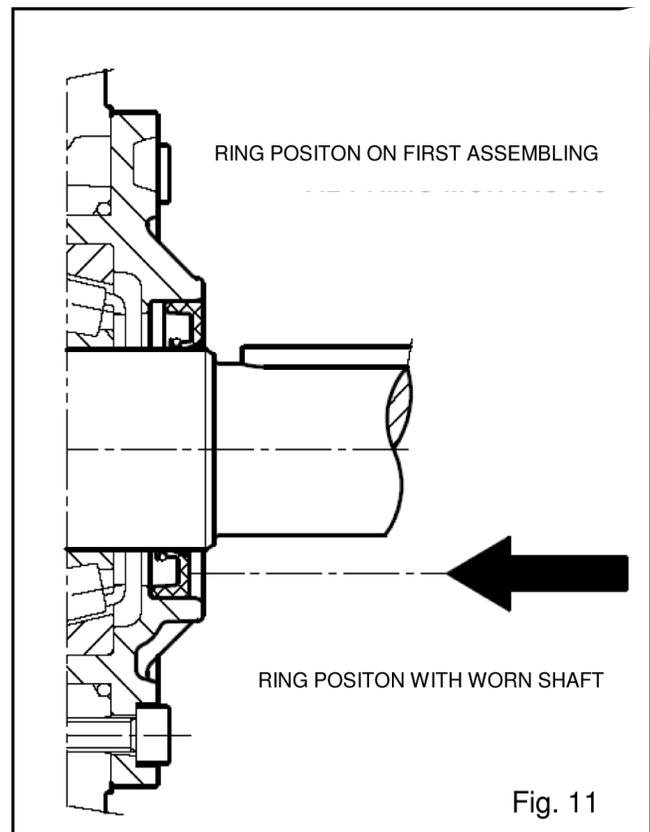


Fig. 11

Note: Should the shaft show diameter wear where there is the seal lip, it is possible to avoid grinding by fitting the seal further as indicated in Fig. 11. Before installing the cover (sight glass side) check that the shim rings have been placed. To help the covers fit on the crankcase, you can use 3 screws M6 x 40, and then finish screwing them with the original bolts M16 x 16.

D) Install the connecting rod cap taking care the numbers match and tighten the relevant bolts in 3 different stages:



1. Approach torque 6 - 8 Nm
2. Presetting torque 25-28 Nm
3. Tightening torque 38 Nm

Note: The screws must be greased on the thread and under the head.



D) Fit the back cover putting the dipstick hole upward.

11.1.3 Disassembling / Reassembling of the bearings and shims

The type of bearings (conical roller) ensures there is no end float on the crankshaft; the shims must be determined to reach that purpose. To disassemble, reassemble and if required replace them, it is absolutely necessary to do as indicated below.

Disassembling / Reassembling of the crankshaft without replacing the roller bearings

After removing the side covers, as indicated on point 11.11.1, check the rollers and races for wear; if they are in good shape, accurately clean the components with suitable degreaser and grease them again evenly with oil (same as the pump oil). The same shims can be used again taking care to fit them under the sight glass side cover. After installing the complete unit (glass sight side flange and crankshaft and motor side flange), check that the rolling couple - **with connecting rods free** - is at least 3 Nm, mas 6 Nm. To position the 2 side covers on the crankcase use 3 screws M6 x 40 first, and then the original screws to fix them.



Fig. 13

The rolling couple of the crankshaft (with connecting rods coupled) must not exceed 8 Nm.

Disassembling / Reassembling of the crankshaft with replacement of the bearings

After disassembling the side covers, as indicated on point 11.1.1, remove the outer ring nut of the bearings from their covers and the inner ring nut, together with the remaining part of the bearing, from the 2 shaft ends by means of a standard pin extractor or similar tool. See Fig. 14 - 15.



Fig. 14



Fig. 15

The new roller bearings can be mounted at room temperature with a press; it is necessary to hold them on the side surface of the ring nuts with suitable rings. The driving operation can be facilitated by heating the parts at a temperature between 250-300°F, making sure that the ring nuts are correctly fitted in their seats. Note: Take care not to invert the components of the 2 bearings (outer ring nut of bearing 1 instead of the one of bearing 2...).

To maintain the right axial load, the shim package has to be calculated again as follows:

- A) Install the crankshaft into the crankcase making sure that the PTO end comes out on the correct side.
- B) Fit the motor side flange on the crankcase with special attention to the seal lip as indicated on point 11.1.2.
- C) Position the sight glass side flange using the 3 screws M6 x 16 until the crankshaft cannot be turned freely by hand.



Fig.16

- D) By means of a thickness gauge (see Fig. 16) determine the shim set as indicated in the table below.

Measure	Shim Type	# of Pieces
From: 0.05 a: 0.10		
From: 1.00 a: 0.20	0.1	1
From: 0.21 a: 0.30	0.1	2
From: 0.31 a: 0.35	0.25	1
From: 0.36 a: 0.45	0.35	1
From: 0.46 a: 0.55	0.35	1
From: 0.56 a: 0.60	0.25	2
From: 0.61 a: 0.70	1.35	1

- E) Fit the shims under the sight glass cover tightening it on the crankcase with the screws, checking that the stall torque is between 4 Nm and 6 Nm.



Fig.17

- F) If the torque is correct, connect the rods to the crankshaft, otherwise, calculate the shims again as per point "C".

11.2 Fluid end maintenance

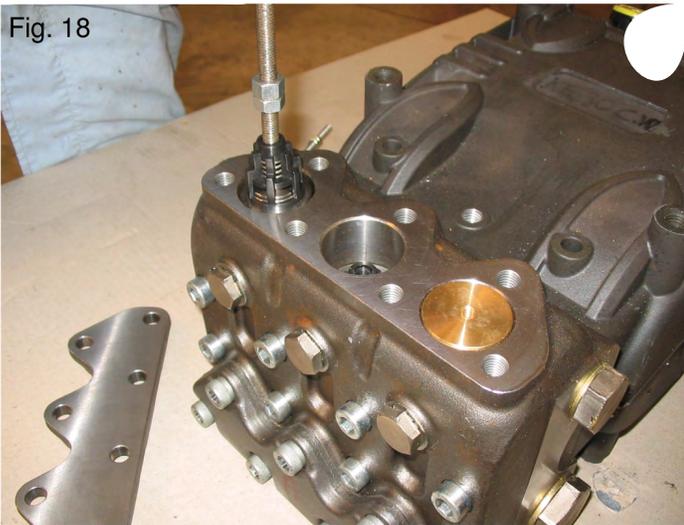
11.2.1 Pump head

The fluid end does not require periodical maintenance. Service operations are limited to the component inspection and/or replacement, when necessary.

V a l v e

U n i t s :

Fig. 18



- A) Loosen the valve cover screws.
- B) Extract the valve plugs with an extractor or a M8 threaded rod.
- C) Extract the valve unit with the same tool (See Fig. 18)

Valve components of each valve unit are pressed together and therefore they can be easily replaced and installed back in place by means of simple tools.



Fig. 19

Check the components for wear and replace if necessary. **Replace all o-rings of the valve units and plugs, at each inspection.**



IMPORTANT NOTE:
BEFORE REPOSITIONING THE VALVE UNITS AND O-RINGS CLEAN AND PERFECTLY DRY ALL VALVE HOUSINGS INSIDE THE FLUID END.

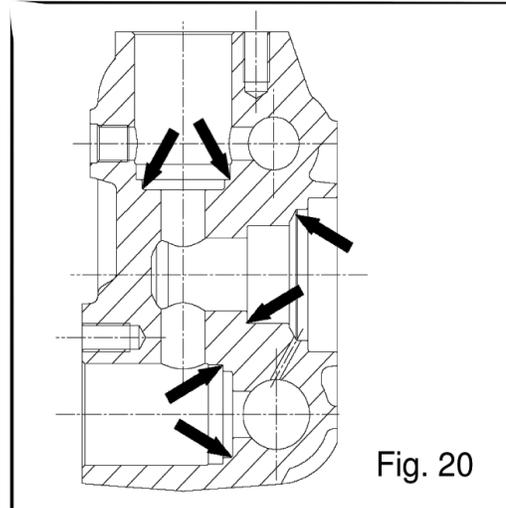


Fig. 20



D) To Reassemble the valves proceed the other way around, and tighten the cover screws with a torque wrench. The table on page 17 contains the screw tightening torque values and Fig. 24 indicated the sequence.

11.2.2 Seals

The replacement of the seals is necessary when water drips through the holes provided on the crankcase.

For replacement, do as follows:

- A) Remove the fluid end by loosening the 8 bolts (see Fig 21).

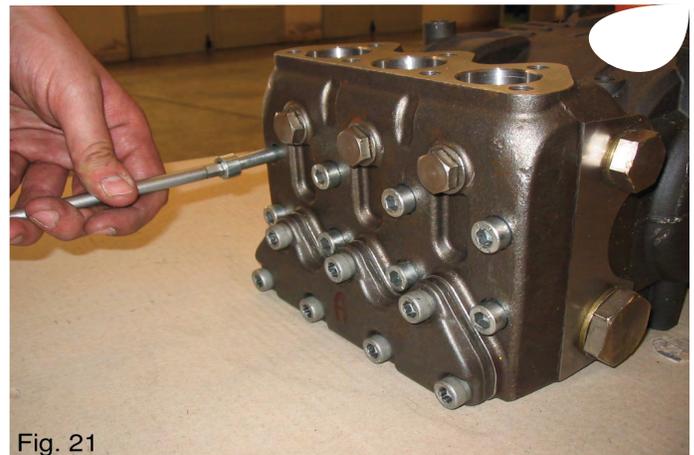


Fig. 21

B) Remove the high pressure packings from the fluid end and the low pressure ones from their support by means of standard tools, taking great care not to damage the seats. Fig. 22

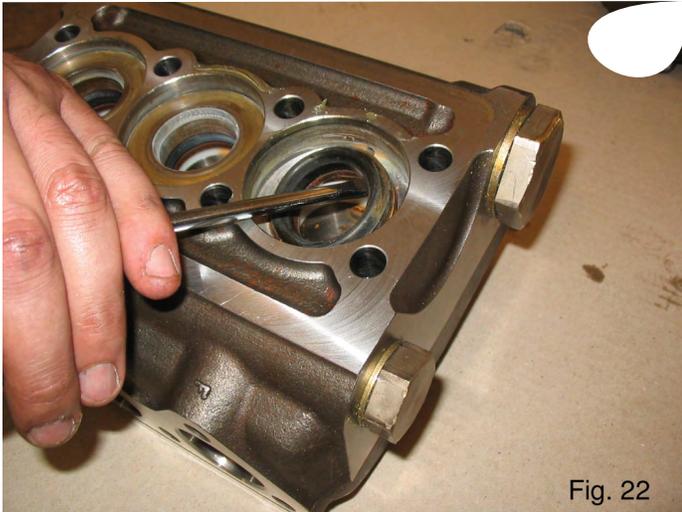


Fig. 22

Take note of the correct order of the entire package components when disassembling (Fig. 23):

1. Head ring
2. HP packing
3. "Restop" ring
4. Middle ring
5. LP packing
6. Back packing
7. O-ring

When reassembling, make sure of the correct order of the components.

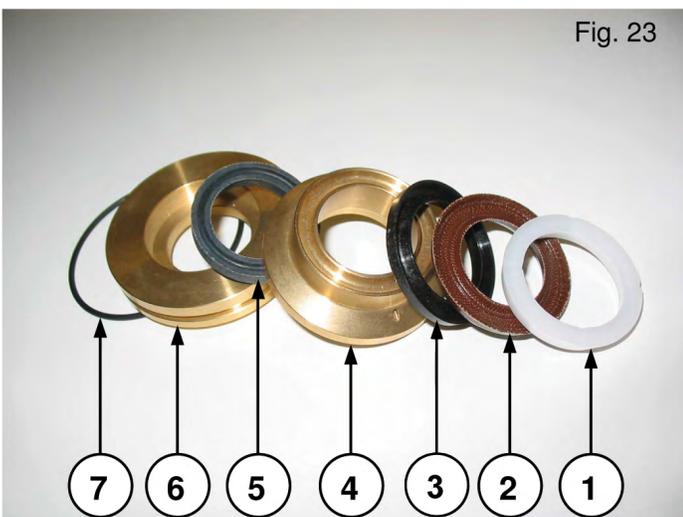


Fig. 23

C) Reassembling:

In order to carry out the replacement more easily, apply a very small quantity of silicone grease on the pressure packing lips and their seats on the fluid end. It is necessary to help the sealing lips settle on the plunger.



D) Fit the fluid end back in place and tighten the bolts with a torque wrench set for the value indicated in the table on page 17 and in the sequence indicated here below.

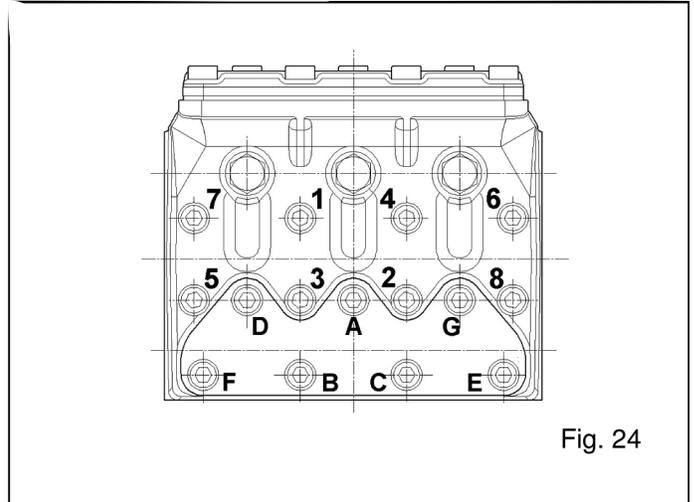


Fig. 24

11.2.3 Plunger

To replace the plunger, if necessary, do as follows:

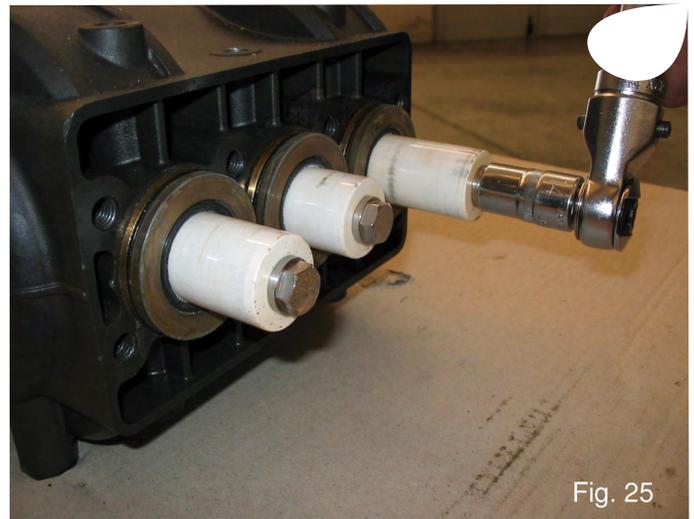


Fig. 25

A) Loosen and remove the plunger screw (1, Fig. 25).

When disassembling the pumping unit, the o-rings should always be replaced.



B) To fit back the replaced components invert the order using a torque wrench set for the values indicated in the table.

12. SCREW CALIBRATION



The following table contains the screw tightening torque values, to be set by means of a torque wrench only:

DESCRIPTION	Ft. Lbs.	N-m	Kgm.
Rear Cover Screws	7.3	10	1
Plunger Bolts	14.7	20	2
Connecting Rod Screws	28	38*	4
Valve Plate Screws	59	80**	8
Fluid End Bolts	29.5	40***	4
Suction Plug	73.7	100	10
Delivery Plug	88	120	12.2
Auxiliary Plug	29.5	40	4
<p>* The conrod screws must be tightened as indicated in point D, page 13.</p> <p>** The valve plate must be tightened following the sequence indicated in fig. 28.</p> <p>*** The fluid end screws must be tightened in 2 stages following the sequence indicated in fig 24: First stage: 20 N-m Second Stage</p>			

13. MAINTENANCE TOOLS



Standard tools are required for the pump maintenance but to facilitate the mounting and dismounting operations of some pump components, you will find the drawings to make some tools on page 21.

14. PUMP STOPPED FOR LONG TIME



Before starting the pump for the very first time after a long period from the date of shipment check for the correct oil level, check the valves as indicated in chapter 11 and then comply with the starting procedures indicated in chapter 10. When a long inactivity is scheduled drain the entire suction and delivery line and then run the pump dry **only for a few seconds** in order to drain out the water collected inside the fluid end.

15. PRECAUTIONS AGAINST FREEZING



In the risk of freezing the following precautions should be taken:

- After use drain the entire suction and delivery lines (filter included) by means of discharging devices, provided and positioned specifically for this purpose along the lowest point of the lines.
- Run the pump only for a few seconds in order to drain the water collected inside the fluid end.

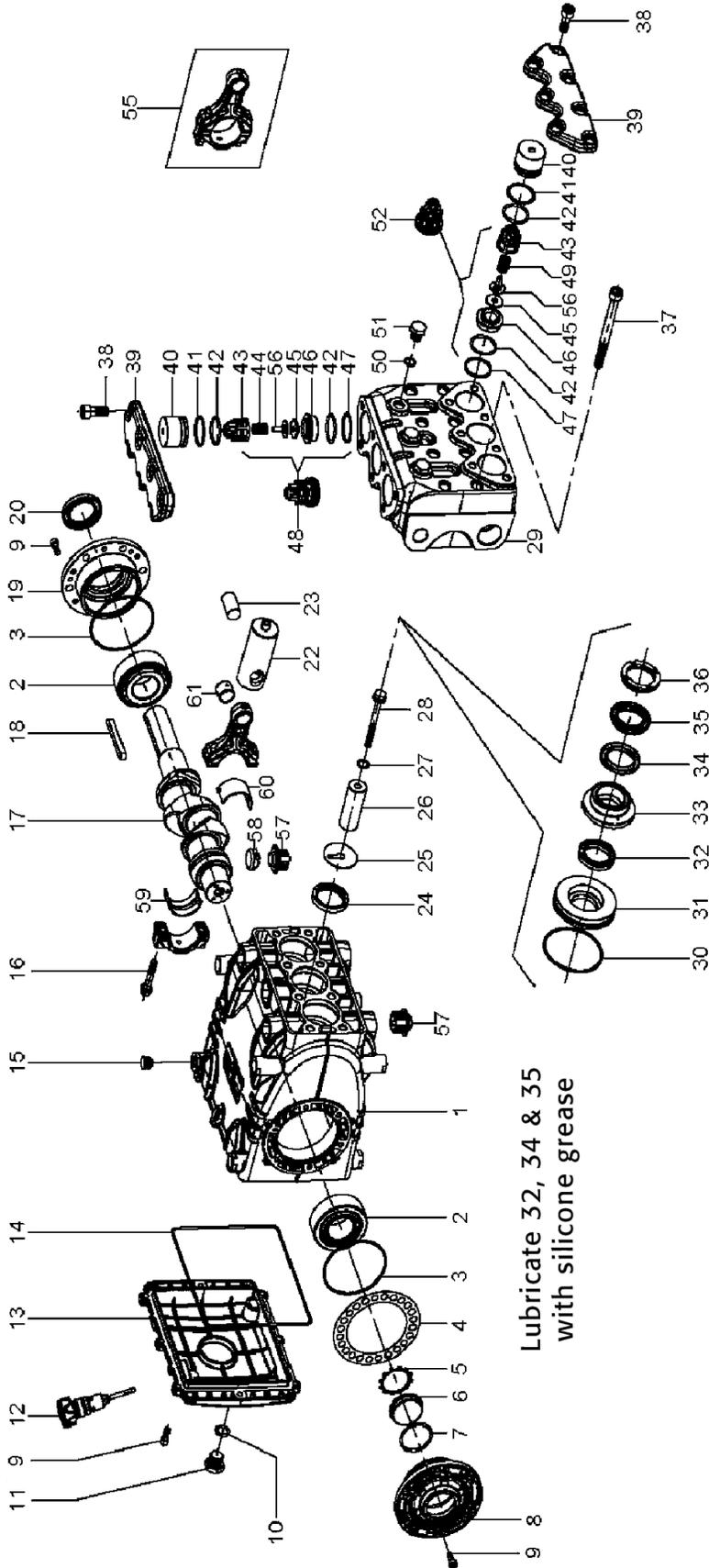
Or when applicable

- Add a recommended amount of anti-freeze into the water tank and run the pump until the anti-freeze works all through the system.

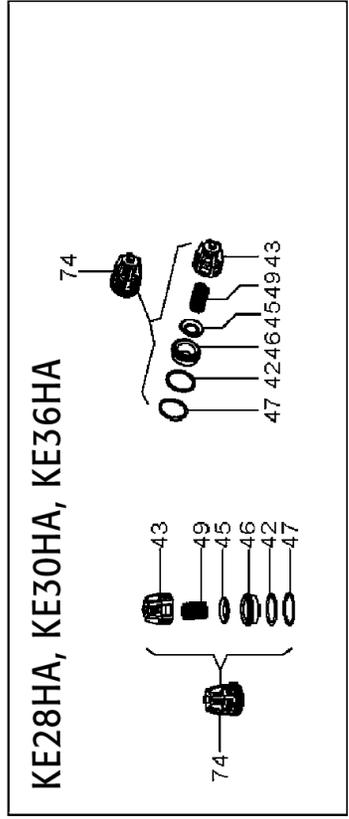


If a pump is frozen or appears frozen ON NO ACCOUNT SHOULD THE PUMP BE OPERATED until the entire system has been thawed out.

16. EXPLODED VIEW AND PARTS LIST



Lubricate 32, 34 & 35
with silicone grease



TORQUE SPECS

Pos.	Ft/lb	N-M
9	7.4	10
11	29.5	40
16	22.1	30
28	14.7	20
37	29.5	40
38	59.0	80
51	29.5	40

Item	Part #	Description	QTY.
1	70010022	Crankcase	1
2	91847700	Roller bearing	2
3	F90391500	O-ring Ø 80.6 x 2.62	2
4	F70220081	Shim 0.1	
	F70220381	Shim 25	
5	90075600	Retainer Clip	1
6	70211801	Oil level indicator	1
7	90387700	O-ring Ø 39.34 x 2.62	1
8	F70150122	Oil level indicator side bearing cover	1
9	F99185400	Bolt M6 x 16	20
10	F90383300	O-ring Ø 13.95 x 2.62	1
11	F98210050	Plug G3/8"	1
12	98211500	Dipstick	1
13	F70160022	Crankcase cover	1
14	F90394200	O-ring Ø 196.52 x 2.62	1
15	98200500	Plug for Ø 15 port	7
16	F99312300	Connecting rod screw	6
17	70020035	Crankshaft	1
18	F91490000	Crankshaft key	1
19	F70150022	Motor side bearing cover	1
20	90166800	Oil seal 35 x 52 x 7 Spec.	1
22	70050015	Piston guide	3
23	97742000	Pin Ø 18 x 36	3
24	F90167700	Seal 36 x 47 x 7	3
25	F96709900	Washer	3
26	F70040009	Plunger KE20	3
	F70040109	Plunger KE22	3
	F70040209	Plunger KE24	3
	F70040309	Plunger KE28HA	3
	F70040409	Plunger KE30HA	3
	70040509	Plunger KE36HA	3
27	90358400	O-ring Ø 10.82x1.78	3
28	F70224136	Plunger bolt	3
29	F70123036	Manifold, NPT, KE20A	1
	F70123136	Manifold, NPT, KE22A & KE24A	1
	F70125036	Manifold, NPT, KE28AHA & KE30AHA	1
	F70124836	Manifold, NPT, KE36HA	1
30	F90362600	O-ring Ø 50.52 x 1.78	3
31	F70080070	Packing retainer Ø 20	3
	F70080170	Packing retainer Ø 22	3
	F70080270	Packing retainer Ø 24	3
	F70080370	Packing retainer Ø 28	3
	F70080470	Packing retainer Ø 30	3
	F70081270	Packing retainer Ø 36	3
32	F90268800	L.P. packing, Ø 20	3
	F90271300	L.P. packing, Ø 22	3
	F90273700	L.P. packing, Ø 24	3
	F90275000	L.P. packing, Ø 28	3
	F90276000	L.P. packing, Ø 30	3
	F90280000	L.P. packing, Ø 36	3
33	F70216070	Middle ring, Ø 20	3
	F70216170	Middle ring, Ø 22	3
	F70216270	Middle ring, Ø 24	3
	F70216370	Middle ring, Ø 28	3
	F70216470	Middle ring, Ø 30	3
	F70222470	Middle ring, Ø 36	3

Item	Part #	Description	QTY.
34	90270400	Restop ring, Ø 20	3
	90273000	Restop ring, Ø 22	3
	F90274300	Restop ring, Ø 24	3
	F90275500	Restop ring, Ø 28	3
	F90277400	Restop ring, Ø 30	3
	F90281800	Restop ring, Ø 36	3
35	90270500	H.P. packing, Ø 20	3
	90272500	H.P. packing, Ø 22	3
	90274500	H.P. packing, Ø 24	3
	90275800	H.P. packing, Ø 28	3
	90277000	H.P. packing, Ø 30	3
	90282000	H.P. packing, Ø 36	3
36	F70100051	Front ring, Ø 20	3
	F70100151	Front ring, Ø 22	3
	F70100251	Front ring, Ø 24	3
	F70100351	Front ring, Ø 28	3
	F70100451	Front ring, Ø 30	3
	F71100251	Front ring, Ø 36	3
37	99381600	Screw, M10 x 110	8
38	99367100	Screw, M10 x 25 Spec.	14
39	F70210036	Valve cover	2
40	F70211570	Valve plug, KE20, KE22, KE24	6
	F70211670	Valve plug, KE28HA KE30HA, KE36HA	
41	F90518000	Back-up ring, Ø 32.4 x 36.5 x 1.5	6
42	90386500	O-ring, Ø 29.82 x 2.62	12
43	F36209751	Suction/delivery valve guide, KE20, KE22, KE24	6
	F36204705	Suction/delivery valve guide, KE28HA KE30HA, KE36HA	6
44	F94740100	Delivery valve spring	3
45	F36209966	Suction/delivery valve plate, KE20, KE24, KE24	6
	F36201076	Suction/delivery valve plate, KE28HA, KE30HA, KE36HA	6
46	F36203866	Suction/delivery valve seat	6
47	F90517800	Back-up ring, Ø 31 x 35.5 x 1.5	6
48	F36713401	Delivery valve assembly	3
49	F94739700	Suction valve spring, 11.4x20	3
	F94745000	Suction valve spring, 16v27.5	6
50	F90358500	O-ring Ø 10.82 x 1.78	3
	F90383300	O-ring Ø 13.95x2.62, KE36HA	3
51	F98204700	Plug G1/4" x 13	3
	F98209900	Plug G3/8" x 13, KE36HA	3
52	F36713301	Suction valve assembly	3
55	F70030501	Connecting rod assembly	3
56	F36210151	Internal Valve Guide	6
57	F70222551	Crankcase Plug	6
58	F71225951	Vented Cap	3
59	F90922000	Babbitt Bearing - Sup	3
	F90922100	Babbitt Bearing - Sup, +0.25	3
	F90922200	Babbitt Bearing - Sup, +0.50	3
60	F90922300	Babbitt Bearing - Inf	3
	F90922400	Babbitt Bearing - Inf, +0.25	3
	F90922500	Babbitt Bearing - Inf, +0.50	3
61	F90910000	Bronze Bushing	3
74	F36714301	Inlet Valve Assembly, KE28HA, KE30HA, KE36HA	6
	99426600	Feet Bolts, M12-1.75 x 25, Optional	4
	96719500	Feet Serrated Washer, M12, Optional	4

REPAIR KITS

	Items Included	KE20	KE22	KE24	KE28HA	KE30HA	KE36HA
Plunger Packing Kit	30-32-34-35	F2002	F2004	F2006	F2008	F2010	F2133
Suction Valve Kit	42-43-45-46-47-49-52		F2000			K2030	
Outlet Valve Kit	42-43-44-45-46-47-48		F2001				
Complete Seals Kit	3, 5, 7, 10, 14, 20, 24, 27, 30, 32, 34, 35, 36, 41, 42, 47, 50	F2003	F2005	F2007	F2009	F2011	F2134
Con-rod Bushing Kit	59, 60				F2156, F2157, F2158		

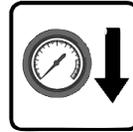


17. TROUBLE SHOOTING



THE PUMP DOES NOT PRODUCE ANY NOISE: the pump is not primed and is running dry!

- No water in the inlet line
- The valves are blocked
- The pressure line is closed and does not allow the air to get out the fluid end.



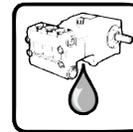
INSUFFICIENT PUMP PRESSURE:

- The nozzle is (or has become) too large.
- RPM are less than rated
- Excessive leakage from pressure packings
- Excessive amount of water by-passed by the pressure regulating valve or faulty valve operation.
- Worn out valves.



THE PUMP KNOCKS:

- Air suction.
- Insufficient feeding:
 - bends, elbows and fittings along the suction line throttle the amount of water which passed through.
 - Too small inlet filter.
 - Dirty inlet filter.
- The feeding pump, where provided is not of the suitable type or provides insufficient pressure or volume.
- The pump is not primed due to insufficient feeding or the delivery line is closed during start up.
- The pump is not primed because some valves are stuck (i.e pump inactivity for long time).
- Jammed or worn out valves.
- Worn out pressure packings.
- The pressure regulating valve does not work properly.
- Clearance in the drive system.
- RPM are higher than rated.



EXCESSIVE WATER LEAKAGE FROM THE PUMP:

- Pressure packing are excessively worn out (due to normal wear or excessive cavitation).
- Worn out plungers



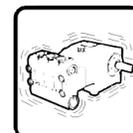
OVERHEATED PUMP:

- The direction of rotation is not correct.
- Pump is overloaded (pressure or RPM over the rated values).
- The oil level is too low or the oil is not of a suitable type or fully used
- Water in the oil
- Excessive belt tension or incorrect alignment of the joint (where provided).
- Excessive inclination of the pump during operation.



THE PUMP DOES NOT DELIVER THE RATED VOLUME:

- Insufficient feeding (due to the cause listed above).
- RPM are less than rated.
- Excessive amount of water by-passed by the pressure regulating valve.
- Worn out valves
- Excessive leakage from pressure packings



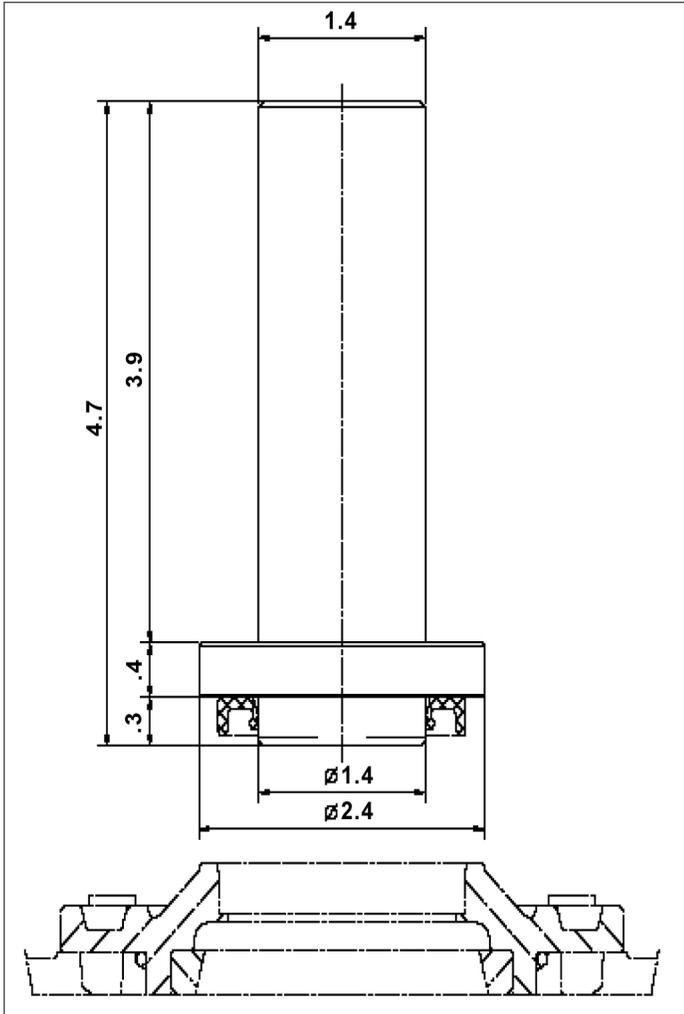
PIPE VIBRATIONS OR KNOCKING:

- Air suction.
- The pressure regulating valve does not work properly.
- The by-pass line is undersized.
- Jammed up valves.
- Drive transmission motion is irregular.

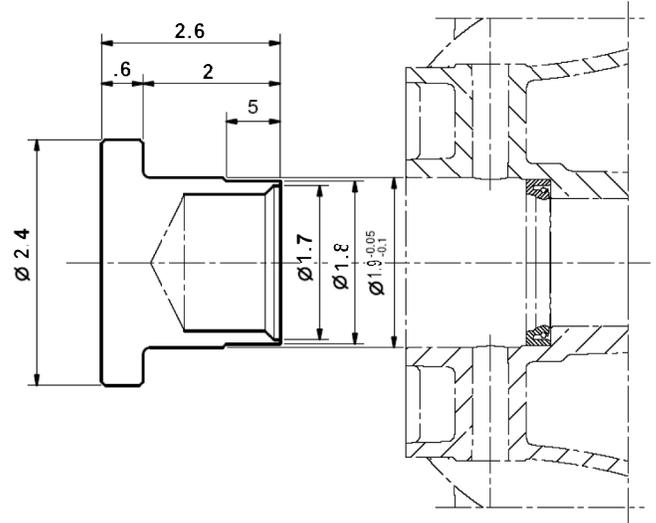
18. MAINTENANCE TOOLS

The pump maintenance can be carried out with simple tools for mounting and dismounting the components, but special tools can be made to facilitate the operations. The drawings here below will help the operator make tools if they chooses to.

18.1 Crankshaft oil seal assembling



19.2 Piston guide oil seal assembling



19. MAINTENANCE LOG

HOURS & DATE

OIL CHANGE							
GREASE							
PACKING REPLACEMENT							
PLUNGER REPLACEMENT							
VALVE REPLACEMENT							



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