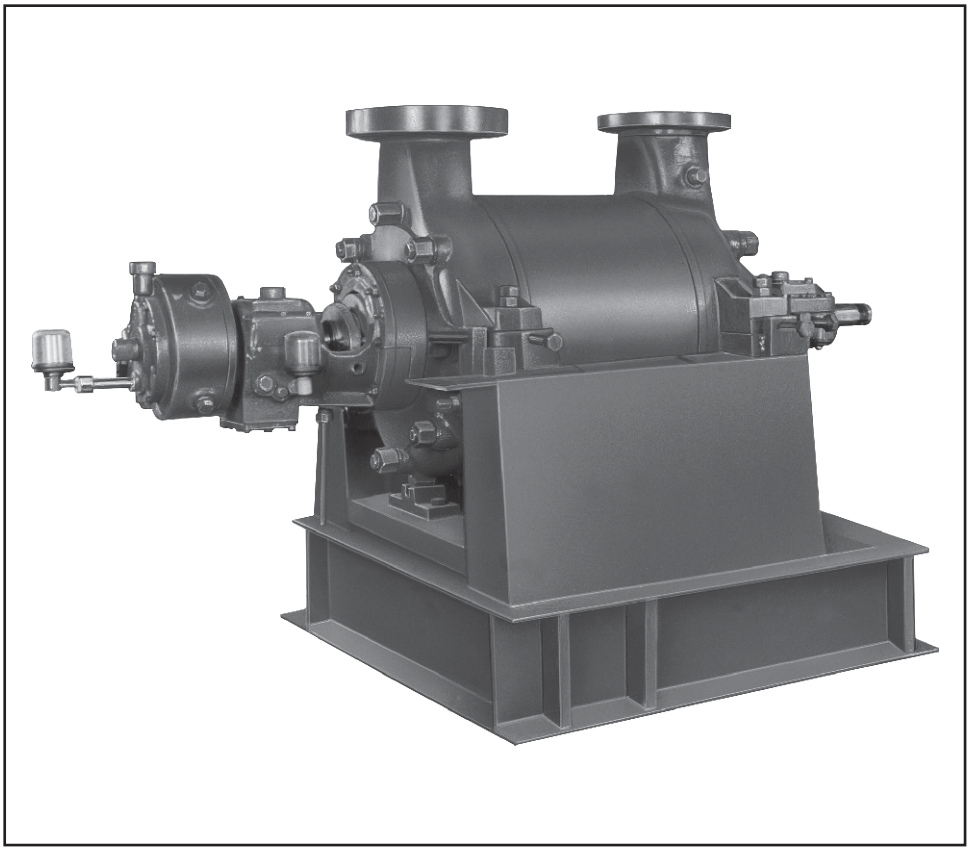
High Pressure Multistage Pump

HDA

Installation/Operating Manual



1 General

It is necessary that this Operating Instruction Manual is carefully read and understood by the person, who will be working on this pump set. Procedure laid down in this Manual should be strictly adhered so that risk of personal injury or damage to the equipment (particularly pump) is avoided.

We recommend that the erection and commissioning of the pump set is either done by KSB's Service Engineer, or at least under the supervision of our Service Engineer. When the erection and commissioning is done by our Service Engineer we guarantee the satisfactory performance and safety of the installed pump set.

YOU MUST CONFIRM TO ALL SAFETY REGULATIONS RELATED TO

- handling large pump set during transport, installation, assembly and dismantling.

PAY PARTICULAR ATTENTION TO THE CENTER OF GRAVITY

- operating this pump set high pressure, speed and temperature.

FAILURE TO COMPLY WITH THESE REGULATIONS CAN RESULT IN PERSONAL INJURY AND DAMAGE TO THE EQUIPMENT.

Centrifugal pumps will give satisfactory service if they are carefully installed and maintained.

The instructions in this Manual refer to the particular pump supplied under the order. The Manual does not cover all design details or possible eventualities which might occur during installation, operation or maintenance, nor local safety regulations.

The type series, size, main operating data and serial number are shown on the nameplate on the pump. For any information or instruction not given in this Manual, contact your nearest KSB office.

The pump should not be opened during the guarantee period unless a specific written authorisation is obtained in advance from KSB. If repairs do become necessary please contact KSB and request the visit of one of our Service Engineer.

ALL MEASURING INSTRUMENTS SUPPLIED WITH THE PUMP, SHOULD BE CALIBRATED BEFORE COMMISSIONING OF THE PUMP SET.

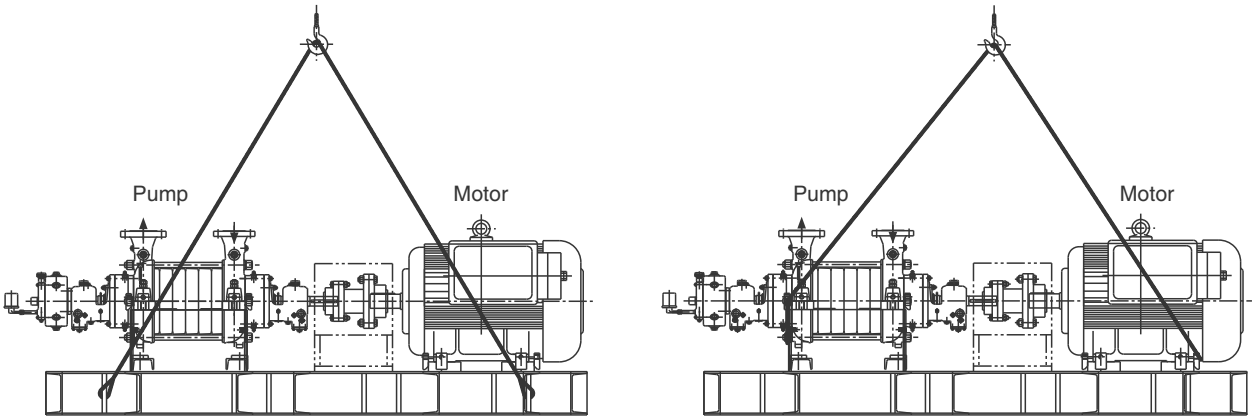
Caution :

The pumps equipped with plain bearings and ring oil lubrication, should under no circumstances be kept running (e.g. idling speed for turbine drive) below 1000 rpm. At lower speeds, lubricating ring will be ineffective to supply the oil to bearings, resulting into damages to bearings.

Set points, wherever conveyed through OPERATING INSTRUCTION MANUAL, of the instruments are only as guide line, and final values are to be set on the site as per observations and requirements.

1.1 Handling

If the pumping set is supplied as a complete unit bolted onto a combined baseplate, the hoisting ropes should be slung as illustrated in Fig. below (and not through the eyebolt of the driver).

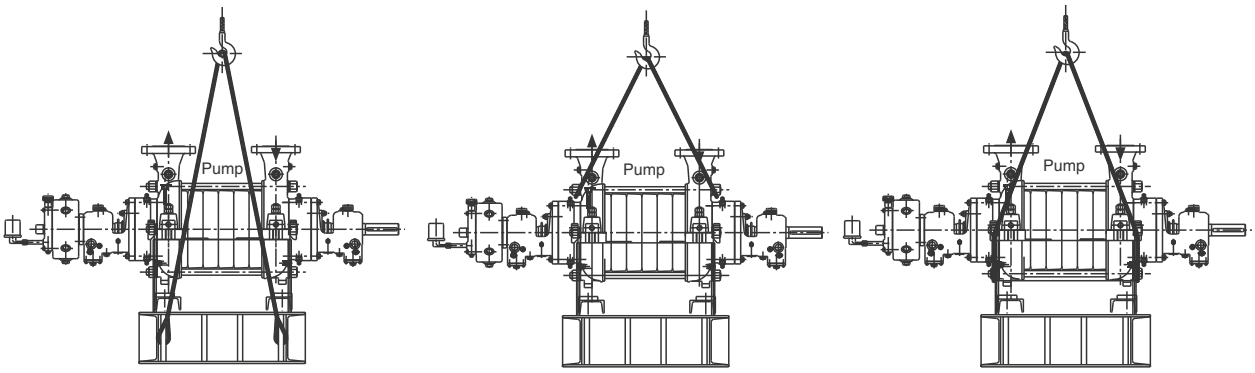


Pump and driver mounted on combined baseplate

In case of bare pumps or pumps mounted on a short baseplate, the hoisting ropes should be attached as illustrated in Fig. below

Caution :

Do not sling the ropes under the shaft stub ends or under the bearing housings of the pump.



Pump mounted on short baseplate

1.2 Procedure for Levelling & Grouting of Base Frame at Site

(for HDA Pumps only)

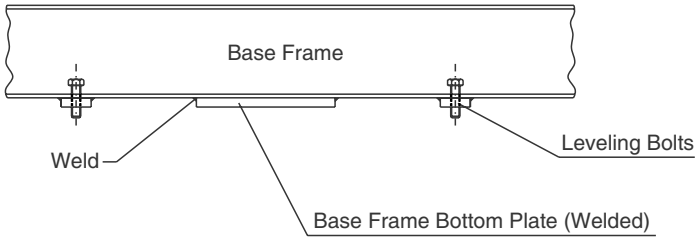


Fig. 1 : Base frame bottom pad

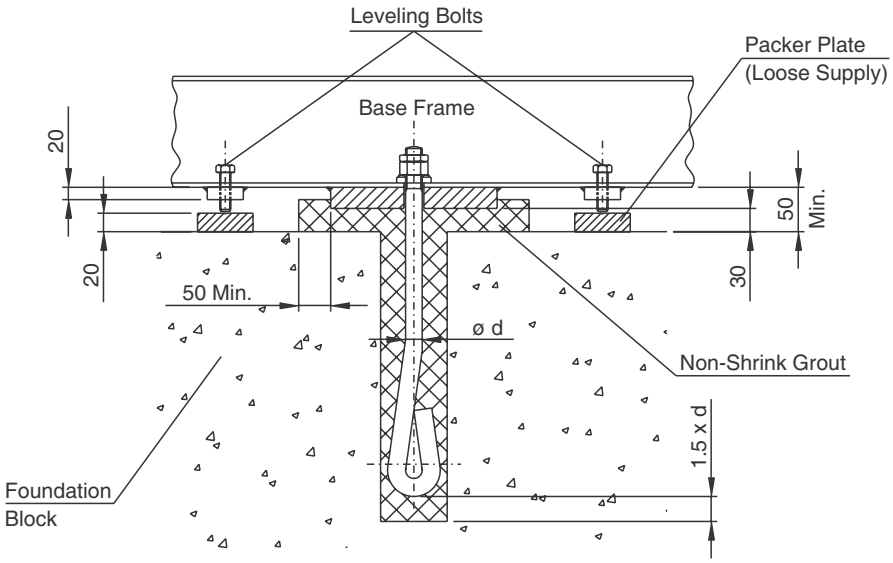


Fig. 2 : Arrangement of Foundation Bolts

Notes :

The foundation to be made of concrete on solid ground.
Foundation bolts to be grouted with non-shrink grout only.
Balance hollow portion of base frame to be grouted with portland cement, sand and aggregate in proportion of 1:2:2 gravel size should be <18 to 20 mm.
After final grouting, all surface should be finished with fine plaster and apply oil resistant paint.

Purpose

High speed rotary equipment need to be installed with maximum contact area between the base frame and the foundation. To achieve this conventionally, blue matching procedure is adopted to ensure contact between base frame, packer plate and foundation. Packer plates are supplied loose and located on the foundation individually. This calls for skilled mill - wright fitters to work on and consumes lot of time. Despite this, the contact area achieved is no where near to 100%.

Therefore, the following procedure is recommended which ensures -

1. Nearly 100% contact area between the foundation and the base frame bottom plates.
2. Considerable savings in time and manpower.

Preparation

The following preparation is followed.

- The base frame is provided with the pads, which are welded at the bottom, machined in one setting. (Ref. fig. 1)

Procedure

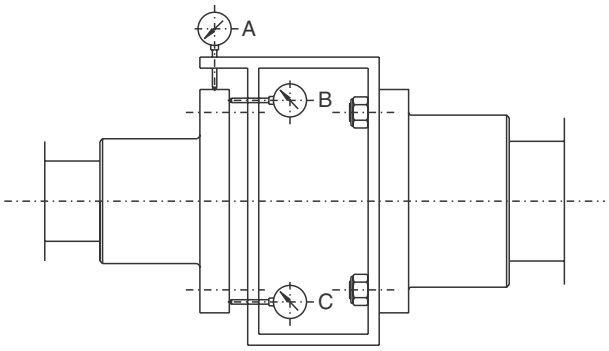
1. Bolt the pump on the base frame.
2. Packer plate to be provided under the jacking bolts to achieve required elevation. (Loose supply of 50 x 50 x 20 Thk. plates).
3. Place the unit on the foundation. Base frame shall be supported on the jacking bolt provided.
4. Suspend foundation bolts into the pockets provided on the foundation block.
5. Level the pump on the delivery flange or feet within 0.04 mm per meter, using jacking bolts provided across the length of the base frame.
6. Grout the foundation bolts and base frame bottom plate (welded) by using quick setting non-shrink cement, ACC make "SHRINKKOMP" or FORSROC make "CONBEXTRA-GP2" or equivalent (Ref. fig. 2)
7. Allow curing time to of 24 to 72 hours depending upon the grout used.
8. Tighten the foundation bolts and confirm the level.
9. Grout the complete base frame, including the hollow portion, if any, using conventional grouting mix i.e., Portland Cement, sand & aggregate in proportion 1:2:2 and gravel size not to exceed 20 mm.
10. Plaster the foundation and apply suitable oil resistant paint.

1.3 Alignment of the Pump and Driver

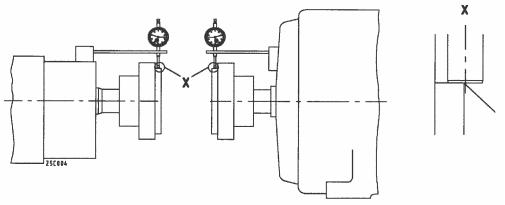
The pumpset can be considered correctly aligned when the gap between each shaft and a straight edge placed axially over the two half couplings is the same at all points on the circumference. Check this using a dial indicator (See fig.) below.

Caution !

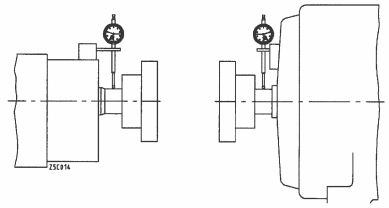
When mounting and aligning the pumpset make allowance for any level misalignment resulting from the driver warming up.



Aligning a spacer coupling using a dial indicator (example)



For coupling hub with outside step



For coupling hub without outside step

The axial and radial deviation between the two half couplings must not exceed 0.04 mm.

1.4 Checking the Direction of Rotation of the Driver with a non-primed pump

Prior to starting up the pump, check the driver's direction of rotation. If no rotary field indicator is available, disconnect the driver from the pump and check the direction of rotation.

Checking the Direction of Rotation

- Warning :
- Ensure that the motor cannot be inadvertently switched on (risk of accident).
- Dismantle spacer sleeve of the coupling.
- Startup the motor, run it briefly, shut it down.
- Check the direction of rotation; if it is wrong, have the terminals changed over by an electrician and then re-check the direction of rotation.
- Note : Suitably mark the connections in the terminal box.
- Warning :
- Until startup, ensure that the motor cannot be inadvertently switched on (risk of accident). Carry out final alignment of the coupling and connect it up.
- Fit coupling guard.

1.5 Connecting the Piping

Never use the pump as an anchorage point for the piping.

The suction line should be run with a dropping slope towards the pump. The pipes should be supported very near the pump and should be connected to the pump without transmitting any stresses and strains to it. The pump must not bear the weight of the piping. The nominal bores of the pipes should be the same as or greater than those of the pump nozzles.

We recommend installing non-return valves and shut-off valves, according to the type of installation. Thermal expansion of the pipework should be accommodated by suitable means so as not to impose any extra load on the pump.

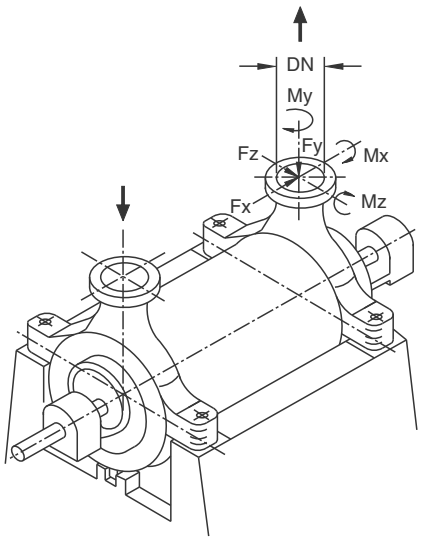
1.6 Forces and Moments

The piping forces and moments do not generally reach levels where the pump would be subjected to excessive mechanical loads.

Recalculation is not necessary provided the piping forces and moments lie within the values given in the appendix.

Dimensions : F in N
M in Nm
DN in mm

Forces and moments can simultaneously action discharge and suction nozzles. The suction and discharge nozzles are to be considered separately.



Fx, Fy and Fz indicate the directions in which the forces act, as follows :
Fx = horizontal parallel to the pump axis
Fy = horizontal at right angles to the pump axis
Fz = vertical at right angles to the pump axis

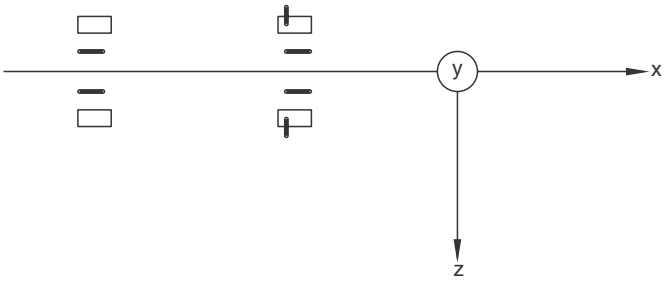
Mx, My and Mz indicate the directions in which the moments act, as follows :
Mx = around a horizontal axis parallel to the pump axis
My = around a horizontal axis at right angles to the pump axis
Mz = around the vertical nozzle axis

DN = normal diameter of the suction/discharge nozzle

1.7 Dowelling the Pump

In order to ensure that the alignment of the pump set will not be altered unduly after the pipelines have been connected and have warmed up, which might cause the pump to run rough and might lead to excessive wear of the pump and coupling, the pump should be dowelled on the baseplate as shown in the following figure. The pump should be dowelled a new after every dismantling operation.

The maximum admissible forces and moments at the pump nozzles as shown on the order specific general arrangement drawing must not be exceeded by the dowelling operation.



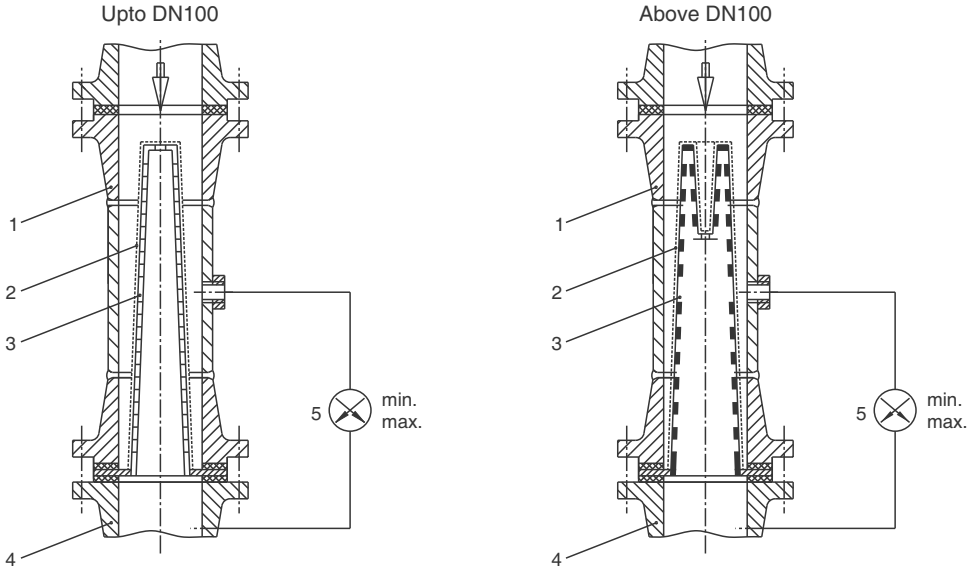
Dowelling the pump on the baseplate

1.8 Strainer in the Suction Line

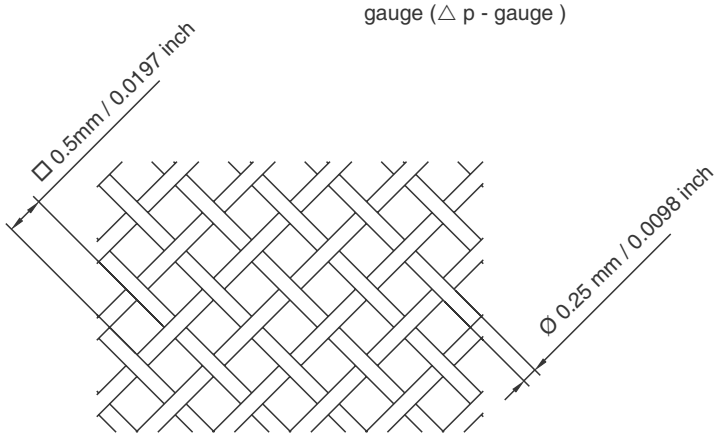
Before commissioning a new installation, thoroughly clean, flush and blow through all vessels, piping and connections. As welding beads, scale and other impurities frequently only become dislodged after a certain period of time, it is necessary to fit a strainer in the suction line, as close as possible to the suction nozzle, to stop these entering the pump. The total cross-section of the holes in the strainer should be three times the cross-section of the piping to prevent excessive pressure loss across the strainer caused by clogging. The pressure drop in the line must not exceed 3 m. We recommend the provision of Differential Pressure Gauge / Differential Pressure Switch, to monitor this pressure drop.

The conical strainer consists of a coarse strainer fronted by a fine strainer made of corrosion resistant material to AISI 304 / AISI 316 or similar qualities.

Mesh width 0.5 mm
Wire diameter 0.25 mm



1. Strainer holder / Strainer pipe
2. Fine strainer
3. Coarse strainer
4. Pump suction nozzle
5. Differential pressure gauge (△ p - gauge)



Conical strainer with pressure monitoring (example)

1.9 Auxiliary Connections

The size and location of all auxiliary connections (e.g. cooling liquid, balance liquid etc.) are shown in the installation plan.

1.10 Minimum Flow Q min

Minimum flow circulation by means of an automatic re-circulation valve. If this is provided to your pump see separate Operating Instructions.

1.11 Balance Liquid

The flow velocity in the balance liquid line should not exceed 5 m/s. If the balance liquid is led back into the suction vessel, the pressure of the balance liquid must be at least 0.5 bar higher than the suction pressure at the pump inlet, and the permissible damping pressure must not exceed 2.5 % max. of the pump discharge pressure.

If the balance liquid is led back into the suction vessel and the length of the balance liquid line exceeds 10 m, the return line should be sized one nominal size larger.

For connections 14A and 14E refer to the sectional drawing in the section 11.

1.12 Coupling Guard

Safety regulations stipulate that the pump must be fitted with a coupling guard.

2 Commissioning / Shutdown

Preparations for Commissioning Alignment

Re-check alignment. It must be possible to turn the rotor by hand at the coupling. If there are no deviations in alignment dowel the pump using cylindrical pins.

2.1 Lubrication

Check bearing and coupling lubrication and apply the required quantities of lubricant as stipulated. See Technical Appendix for details of lubricant grade and fill.

2.2 Shaft Seal

Check shaft seal. In case of gland packed pump, the gland packing are sent separately. The stuffing box / seal casing must be filled with these gland packing, in ring forms.

2.3 Priming the Pump and associated Checks

Vent and prime the pump and suction line before startup. The shut-off valve in the suction line must be fully open. Fully open also all auxiliary lines and check the flow.

2.4 Checking the Direction of Rotation with the Pump primed

The direction of rotation must match the arrow on the pump. Check this by switching the pump on and then off again immediately.

Warning : Prevent any contact of the non-guarded shaft stub by personnel. Fit coupling guard.

2.5 Pre-commissioning Checks

If commissioning takes place more than 5 months after the installation, the following checks must be repeated.

1. Ensure that the couplings are in perfect alignment.
2. The coupling casings of toothed couplings must be able to slide effortlessly in the axial direction.
3. Check the main piping is connected stress-free.
4. Check shaft seal.
5. Check operation of the measuring and monitoring equipment.
6. If the driver is an electric motor, check the direction of rotation with the pump primed by switching the pump on and then off again immediately. The direction must match the arrow on the pump.

Warning : Present any untensional contact of the non-guarded shaft stub by personnel.

Turbine drive : Follow start up instructions for the turbine, from Operating Instruction Manual of Turbine manufacturer.

2.6 Startup

Follow startup instructions of the driver !

a) Initial startup

Open the shut-off valve in the minimum flow line. Switch on the pump (motor) only if the discharge valve is closed.

Slowly open the discharge valve to obtain the required duty point after the pump has reached full speed. Check the pressure loss in the suction line by differential pressure measurements; this should not exceed 3 m.

b) Normal Operation

Switch on pump (motor).

Check the pressure loss in the suction line by differential pressure measurements; this loss must not exceed 3 m.

2.7 Shutdown

a) Normal operation

Switch off the driver checking that it runs down smoothly to a standstill.

It is essential that a non-return valve is fitted in the discharge line and that sufficient back pressure is available.

b) For overhaul

Close the shut-off valve in the discharge line.

Switch off the driver, check that it runs down smoothly to a standstill. Close the shut-off valves in the suction, minimum flow and supply lines. Allow the pump cooling down, make it pressure-less and drain it.

In case of frost and/or of prolonged shutdown periods, the pump must be drained or otherwise suitably safeguarded against freezing.

3 Maintenance

3.1 Supervision of Operation

The pump must run smoothly and evenly at all times. The pump must never run dry.

Prolonged operation against a closed discharge valve (> 250 hours per year) must be avoided even if the Automatic Recirculation valve is installed. (Part-load cavitation, wear to the Recirculation valve internals).

Check the quality and quantity of the bearing and coupling lubrication as per details in Technical Appendix.

The temperature of the bearing housing may exceed ambient temperature by 50°C, but should not exceed 80°C.

The shut-off valves in the supply lines must remain open during operation. For details of Shaft Seal monitoring see section Shaft Seal.

Check the suction pressure and temperature, the pump discharge pressure and temperature.

The suction and discharge nozzles of each pump should be equipped with a pressure gauge and thermometer having a suitable range for the pressure/temperature involved, plus a pressure gauge cock or valve.

Check cooling liquid flow and temperature.

The max. permissible diff. between inlet and outlet temperature is 10°C. We recommend recording this information in a logbook.

Standby pumps should be started up then immediately shut down once a week to keep them operational. Also check the integrity of the auxiliary connections.

3.2 Rotor position indicator

The axial position of the rotor, correspondingly the wear out of the balancing device is indicated by the rotor position indicator mounted on the discharge side of pump.

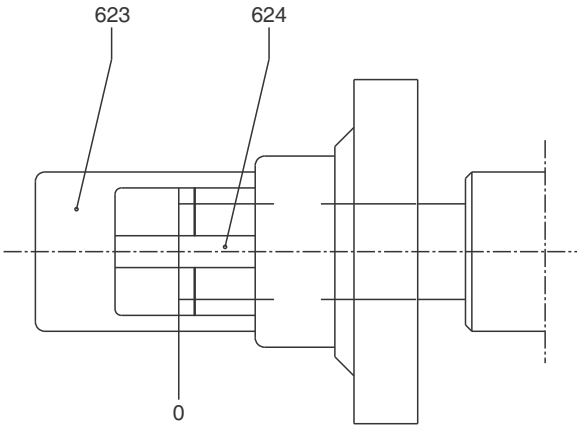
Rotor position indicator consists of the indicator bush (623.1) screwed on the bearing end cover, which is the stationary part, and the indicator (624) which is screwed in the shaft discharge end, which is the rotary part.

The bush has two scriber mark, at right angles to the shaft axis, which are 1.5 mm apart. The outer mark of this bush is aligned with the normal running position of the rotor, in the initial assembled condition.

During the running of the pump, as the balancing device wears out, the rotor begins to shift towards the suction side, which is indicated by the indicator shifting with respect to the outer mark on the indicator bush.

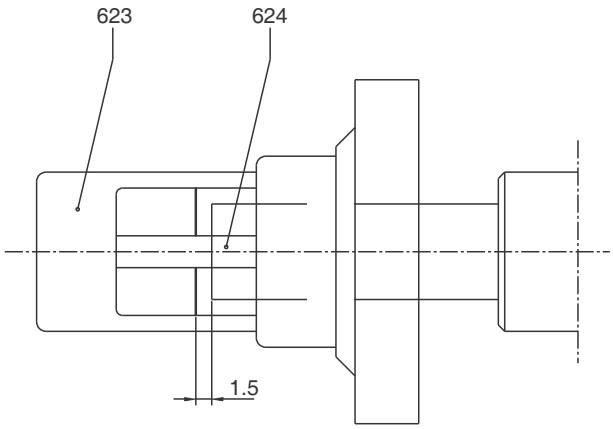
The spacing of 1.5 mm between the two marks on the indicator bush, corresponds to the maximum permissible wear out of the balancing device. As such, when the indicator indicates that the rotor is shifted by 1.5 mm towards the suction side, the pump should be stopped and the balancing device should be renewed.

Pump running normally



Rotor position indicator

Time to shut down the pump



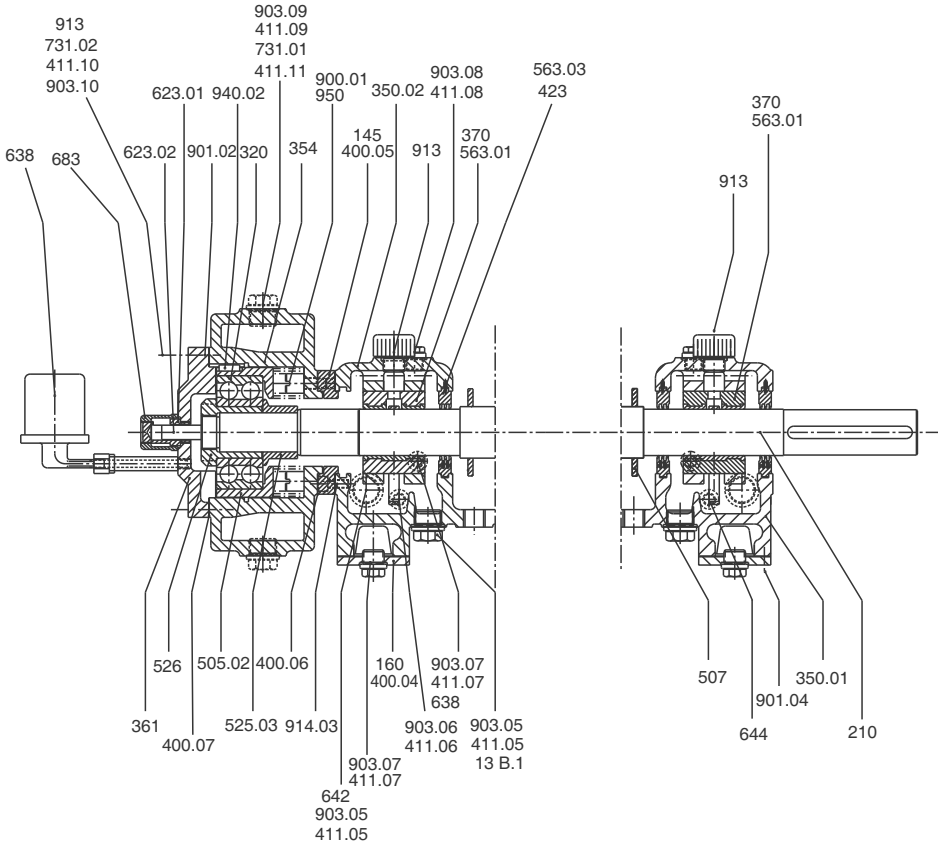
Rotor position indicator

4 Descriptions

4.1 Bearings

The shaft (210) is radially guided in two plain bearings (370). There is no need to take up the axial thrust because this is accommodated by the balance device (601 and 602). A lift-off device at the discharge end reliably disconnects the balancing disc from the counter balancing disc during low speeds, e.g. during startup or shutdown operation. Labyrinth rings (423) prevent leakage liquid entering the bearing housings (350.01).

For bearing sizes refer to Technical Appendix.



Part No.	Part designation	Part No.	Part designation	Part No.	Part designation
145	Adaptor	411.09	Sealing ring	731.01	Socket Male - Female
160	Cover	411.10	Sealing ring	731.02	Socket Male - Female
210	Shaft	411.11	Sealing ring	900.01	Screw
320	Angl. contact ball brg.	423	Labyrinth ring	901.02	Hex. bolt (Full threaded)
350.01	Bearing housing	505.02	Retaining ring	901.04	Hex. bolt (Full threaded)
350.02	Bearing housing	507	Splash ring	903.05	Hex. head plug
354	Thrust bearing housing	525.03	Spacer sleeve	903.06	Hex. head plug
361	Bearing end cover	526	Centering sleeve	903.07	Hex. head plug
370	Bearing shell	562.01	Parallel pin	903.08	Hex. head plug
400.04	Flat gasket	563.01	Parallel pin	903.09	Hex. head plug
400.05	Flat gasket	563.03	Parallel pin	903.10	Hex. head plug
400.06	Flat gasket	623.01	Bush for indicator	913	Vent plug
400.07	Flat gasket	623.02	Indicator	914.03	Hex. socket cap screw
411.05	Sealing ring	638	Constant level oiler	940.01	Key
411.06	Sealing ring	642	Oil level sight glass	950	Spring
411.07	Sealing ring	644	Lubricating ring		
411.08	Sealing ring	683	Hood		

4.2 Lubrication

Plain bearings :

Ring oil lubrication. For oil requirement see Technical Appendix / Lubrication Chart.

4.3 Oil specification

Heavy duty grade oils acc. to ISO class VG 46, L-TD acc. to DIN 51 515 or similar qualities.

4.4 Lubrication Schedules and Oil Change

First oil change after about 300 hours of operation.

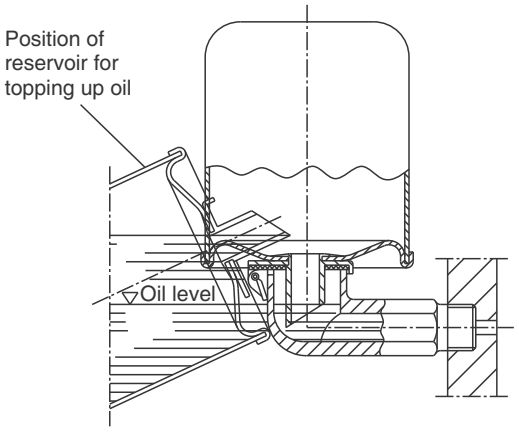
Oil change after every further 8,000 hours or one year, whichever is the sooner.

Check of oil fill is via constant level oiler (638).

Lubrication

The bearings are ring-lubricated by oil. The lubricating ring (644) is immersed to a sufficient depth in the oil fill to ensure correct and adequate lubrication.

The necessary oil level in the bearing housing (350) is automatically attained by a constant level oiler (638). A labyrinth ring (423) prevents any oil leakage between shaft and bearing housing. The bearing housing is to be vented by unscrewing the vent plug (913.01).



Constant level oiler

Procedure :

Unscrew vent plug (913.01). Turn down the constant level oiler (638). Pour in oil through the vent plug aperture after having hinged down the reservoir of the constant level oiler until oil appears in the vertical portion of the connection elbow of the constant level oiler (see fig.). Then fill the reservoir of the constant level oiler with oil and snap it back smartly into operating position. Screw vent plug in again. After a short time has elapsed, check whether the oil level in the reservoir has sunk. The reservoir should always remain filled.

Caution :

The oil level should always be situated below the level of the vent slot arranged at the top edge of the connection elbow, and this slot should always be perfectly dry.

4.5 Shaft Seal

4.5.1 Soft packed Stuffing Box

Stuffing box on either side is with jacket formed between the stuffing box housing (451) and cooling cover (165), with the provision of jacket cooling, whenever required.

The sealing along the axis of the shaft sleeve (OD) is achieved by means of 4 packing rings inserted and held tightly in the stuffing box compartment by means of stuffing box gland.

Cooling

When the temperature of the pumping liquid is up to 105°C jacket cooling is not necessary.

For pumping temperature between 105°C to 150°C cooling to the jacket is necessary (conn. 7E1/7A1), and in case of pumping temperature above 150°C additional cooling to the gland is necessary (conn. 7E2/7A2).

Packing the Stuffing Box

Always use new packing material to repack the stuffing box compartment, preferably the packing material that has been kept in store for certain time.

In case of suction pressure exceeding 15 bar, it is recommended to die-pressed individual packing rings in a press, before insertion in the stuffing box. The pressing pressure should be more than 50 bar.

Carefully clean the packing compartment and the shaft protection sleeve and coat them with molybdenum disulfide. Insert the packing rings individually and push them home into the packing compartment with the help of stuffing box gland. The ends of individual packing rings should be offset by approx. 90°, in relation to each other. Make sure to leave an adequate clearance at the end of the stuffing box for the positive guidance of the st. box gland. After insertion, the packing rings should be pressed lightly with the help of the gland and nuts. Then slacken the nuts and tighten them again by hand only. Use a feeler gauge to check that the stuffing gland seats evenly (i.e. not askew) when pump suction pressure is applied.

Caution :

The stuffing box should drip slightly whilst the pump is in operation. The rate of leakage should be between

2 to 3 lit/hr.

Gland packing sizes :

Pump size	No. of Rings	Packing cord / box (mm)
40 & 50	4	10 x 10 x 850
65 & 80	4	12 x 12 x 1000
100	4	12 x 12 x 1100
125	4	12 x 12 x 1300

4.5.2 Mechanical Seal

(Please refer Cross sectional drawing of Mechanical seal for appropriate part numbers)

In a mechanical seal, the sealing action takes place in the narrow axial clearance gap between the rotating seal ring and the stationary seal ring. The rotation of shaft generates a thin film of fluid between the rubbing faces of these two seal rings. The presence of this fluid film is vital for the length of life and operation reliability of the shaft seal. the film itself is influenced by the lubricating characteristics of the fluid pumped and by the effective removal of the frictional heat generated.

Mechanical seals of Flowserve Sanmar / Eagle Burgmann or recognized make can be provided. These seals are single acting, balanced. The cartridge arrangement will be given.

Mechanical seal size will be common for (i) HDA 40 & 50 (ii) HDA 65 & 80

HDA 100 & HDA 125 will have different sizes of Mechanical seals.

For the exact make / type of Mechanical Seal and details of flushing plan, please refer order specific datasheet and sectional drawing of Mechanical Seal.

5 General Instructions and Notices

Warning !

Before commencing dismantling, make sure that the pump is disconnected from the power supply and cannot be switched on accidentally.

The isolating valves in the suction line and in the discharge line respectively must be closed. The pump casing must have cooled down to ambient temperature. The pump casing must be drained and pressure less.

Cooling liquid and oil pipes must be closed if the relevant pump components must be handled. The bearings and the oil supply lines up to the oil supply plant must also to be drained.

Remove coupling guard. Disconnect the coupling and remove the spacer sleeve. Dismantle the auxiliary piping as far as necessary.

Remove gland packing, if the pump is gland packed.

Check pump alignment at the coupling, and make a written note of the readings (see section 'Alignment'). Always refer to the relevant sectional drawing during dismantling and reassembly.

6 Dismantling

6.1 Dismantling the Pump (mark all parts)

6.2 Pump with Plain bearings

At Suction side

1. Pull coupling hub off the shaft using proper device.

At Discharge side

2. Unscrew and remove indicator bush from End bearing cover.
3. Loosen hex bolts (901.02) and remove End bearing cover (361).
4. Unscrew the bearing sleeve (526). Pull out the angular contact ball bearing (320) and retainer ring (505.02).
5. Remove spacer sleeve (525.03) and springs (950).
6. Remove screw (900.03) and take of thrust bearing housing (354), as well as adaptor (145).

At Suction & Discharge sides

7. Unscrew and remove nuts fixing the upper bearing housing (350.01).
8. Remove upper bearing housings (350.01).
9. Remove top bearing shells (370), Lubricating rings (644) and bottom labyrinth rings (423).
10. Remove bottom bearing shells (370).
11. Unscrew nuts (920.03/04) of studs (902.03/04) on suction & discharge casings, and remove lower bearing housings (350.02).
12. Take off the splash rings (507).

Inspect the rubbing pattern in the bore and, if necessary remove any light pressure marks with scraper. Check the fits of the bearing shells (370) in bearing housings (350.1). When mounted in position the bearing shell should not be able to move in its seat. If the seat is too loose (i.e. if it is possible to move the bearing shell), the two joint faces of the bearing housing must be touched up evenly until the bearing shell can once more be clamped absoluting tight in its seat.

If new bearing shells are fitted, their seats should in principle be fitted in the manner described above.

6.3 Shaft Seal

6.3.1 Soft Packed Stuffing Box

1. Remove the stuffing box gland (452).
2. Extract the gland packing from the stuffing box compartment.

   (During the next assembly of the pumps, fresh gland packing should be used, since the used gland packing are generally deformed).
3. Force and remove stuffing box housing (451) together with cooling cover (165).

Sizes 40 and 50

4. Unscrew shaft protection sleeve (524.01/02) and pull them off the shaft (210). Remember the right-hand left-hand screw threads respectively.

Sizes 65 to 125

5. Remove circlip and pull shaft protection sleeves (524.01/02) off the shaft.
6. Pull off spacer sleeve (525.01) on the suction side.

6.3.2 Mechanical Seal with Cartridge arrangement

(Please refer Cross sectional drawing of Mechanical seal for appropriate part numbers)

1. Disconnect all the piping to gland (4) and plug all the holes and pipe ends.
2. Loosen the bolts (12) and locate the sliding washer (11) into the groove on shaft sleeve and then re-tighten the bolts.
3. Loosen the set screws (9) and dog point screw (10).
4. Unscrew and remove fixing screws of gland.
5. With the help of jacking bolts provided on gland remove cartridge off the shaft.

Follow the same procedure to pull out the mechanical seal cartridge on the discharge side.

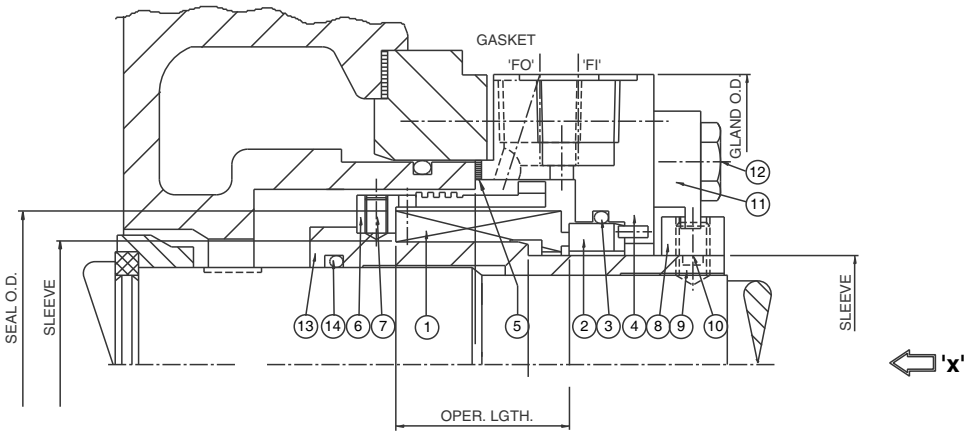
Dismantling of Cartridge (If required for inspection)

1. Remove bolts (12) and sliding washer (11). For removing of sliding washers slightly compress the springs (e) of mechanical seal.
2. Remove set screws (9) and dog point screws (10) from the drive collar (8).
3. Remove drive collar (8) from the sleeve (13).
4. Remove the mechanical seal rotary head assembly of the parts consisting of a, b, c, d, e, f, g.

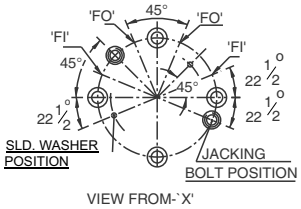
Damaged sleeve (13), seal ring (b), mating ring (2) and other mechanical seal components should be replaced by new ones.

In case of minor score marks on the rubbing faces of seal ring (b) and mating ring (2), they may be sent back to the manufacturer for lapping.

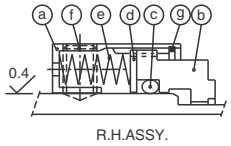
Below drawing is for reference only.



Notes :
CONNECTIONS 'FI' 1/2" B.S.P. FOR FLUSHING INLET
CONNECTIONS 'FO' 1/2" B.S.P. FOR FLUSHING OUTLET



VIEW FROM-`X'



R.H.ASSY.

14	'O' ring	1
13	Sleeve	1
12	Hex. bolt	2
11	Sld. washer	2
10	HF dog pt. scr.	1
9	Soc. set scr.	6
8	Drive collar	1
7	Soc. set scr	3
6	Pumping ring	1
5	Gasket	1
4	Gland	1
3	'O' ring	1
2	Mating ring	1
g	Circlip	1
f	Soc. set scr.	3
e	Spring	6
d	T. washer	1
c	'O' ring	1
b	Seal ring	1
a	Cup	1
	Consist of	
1	R. H. assy.	1

Note : Please refer Cross Section drawing of Mechanical Seal for appropriate part numbers.

6.4 Balancing Device

Sizes 40 and 50

Pull balancing disc (601) off the shaft with the aid of an extractor.

Sizes 65 - 125

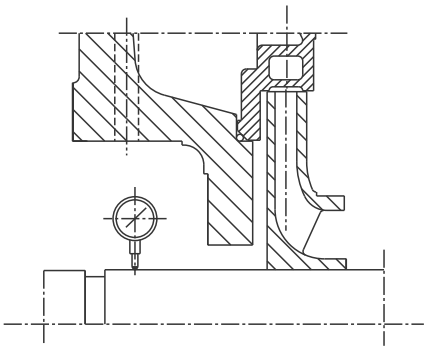
1. Pull off retainer ring (505.01) and remove split ring (501).
2. Pull off spacer ring (504.01).
3. Pull off balancing disc (601) with the aid of an extractor.
4. If necessary unscrew the fixing screws of counter balancing disc (602) and pull it out of the discharge casing (107), with the aid of an extractor.

Sizes 40 to 125

5. Pull spacer sleeve (525.2) on discharge side off the shaft.

Note :

If you do not intend to dismantle the body of the pump, measure the approximate total radial play. For this purpose, attach a dial indicator to a fixed support (e.g. flange or discharge nozzle) and place its tip against the seat of the balancing disc (See fig.). Carefully raise the shaft to its upper dead center, ensuring that there is no additional sagging of shaft, as this could give an incorrect measurement. The measured clearance must not exceed 0.8 mm.; if it does, the pump must be dismantled and overhauled. The accurate rotor measurement is possible only if the pump is dismantled.



Determining the rotor clearance

Balancing Device

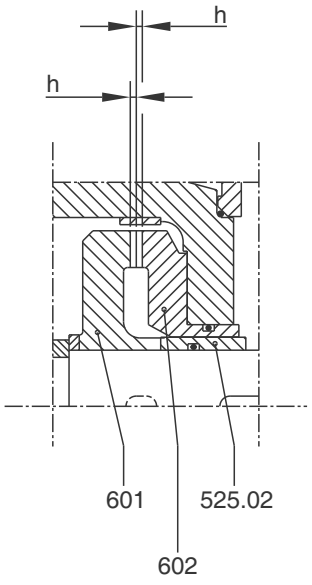
Check the balance disc (601), the counter balance disc (602) and the spacer sleeve (525.02) for damages.

If the balance disc (601) has touched the counter balance disc (602) re-machine the faces on the lathe with mandrel, this ensures the contact faces are then sufficiently true in relation to the bores. (Max. re-machining 2 h = 2 mm, see fig.). Individual grooves can be allowed to remain.

6.5 Re-machining the balance device

If re-machining causes 2 h to be exceeded you must fit a new balance device (601, 602). The total thickness of metal removed from the balancing disc (601) and from the counter balancing disc (602) must also be machined off the spacer sleeve (525.02) in order to maintain the previous rotor position in relation to the pump casing. When doing so make absolutely sure that the plane parallelism of the two end faces of spacer sleeve (525.02) is not impaired. The bottom of the re-machined balance disc (601) should not press against the key.

When eliminating fouling in the radial gap between the counter balance disc (602) and balancing disc (601) by machining, apply the clearance specified in the Technical Appendix.



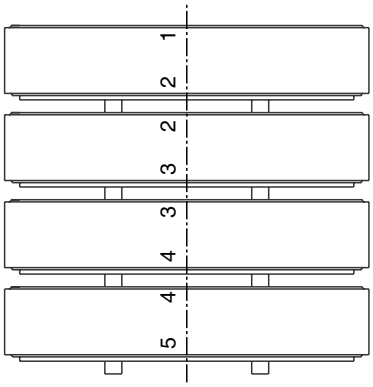
Re-machining the balance device

6.6 Pump Body

1. Loosen the nuts (920.01) on the discharge-side tie-rods (905.01) cross-wise until they are only slightly pre-tensioned.
2. Loosen holding down bolts on pump feet and lift the pump off the baseplate onto erection trestles.

   Note : Do not sling ropes under the pump shaft. Do not damage the sealing faces on the nozzles.
3. Unscrew nuts (920.01) on the discharge end of the pump and withdraw the tie rods (905.01).
4. Under pin the stage casings (108) with blocks of wood or a stand so that the next components are accessible.
5. Press discharge casing (107) together with diffuser (171) from the stage casing (108). Do not damage the sealing faces.
6. Pull last stage impeller (230) off the shaft.

   Note : Before dismantling, match-mark the stage casings (108) so they can be reassembled in the same order and position (see fig.) below.
7. Remove the stage casings (108) together with the diffusers (171), stage sleeves (521) and impellers (230) of the following stages. The impellers (230) and stage sleeves are secured against twisting by a common key on the shaft (210) and are stamped with matching numbers.
8. After the first (suction side) stage casing (108) has been dismantled, draw the shaft (210) with first stage impeller (230) out of the suction casing (106). Then pull the impeller (230) off the shaft (210).
9. Stack the stage casings (108) carefully so that the sealing faces cannot be damaged (see fig.)



Stacking the stage casings

6.7 Shaft (210)

Check true running between centers on a lathe. Max. permissible shaft whip : 0.03 mm. The shaft should never be straightened either warm or cold. If the maximum permissible shaft whip is exceeded, fit a new shaft.

Caution :

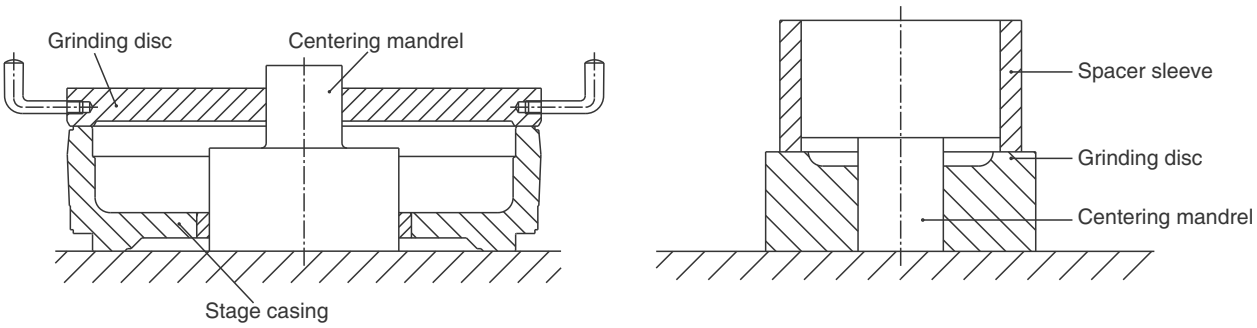
Make sure the shaft is accurately center on the lathe as otherwise the readings will be inaccurate.

Suction (106), Discharge (107) and Stage Casings (108), Impellers (230), Spacer Sleeves (525.01/.02), Casing Wear Rings (502).

Check all sealing faces are in perfect condition. Check the plane parallelism of the sealing faces at four points with a micrometer. The deviation should not exceed 0.02 mm. Touch up any damaged surfaces, preferably on a lathe. The surface roughness should not exceed 0.8 µm (super finish turning). If damaged faces cannot be touched up on a lathe they may be reground.

The pump casing has been adapted to match the sag of the shaft. The mating sealing faces on two adjoining stage casings are machined in such a way that the gap between the sealing faces at the top is narrower by a given amount that the gap at the bottom. These stage casings are marked with the word "TOP" at the top end of the periphery, and with the identification number of the stage casing concerned. When touching up the sealing faces of these stage casings, this difference in dimensions between top and bottom must be maintained at all costs.

The grinding equipment consists of a grinding disc and centering mandrel. Always use a very fine grinding compound.



Grinding the sealing faces

Never regrind a sealing face by using its mating face on the next stage casing as a grinding block, as this would open out the centering spigot.

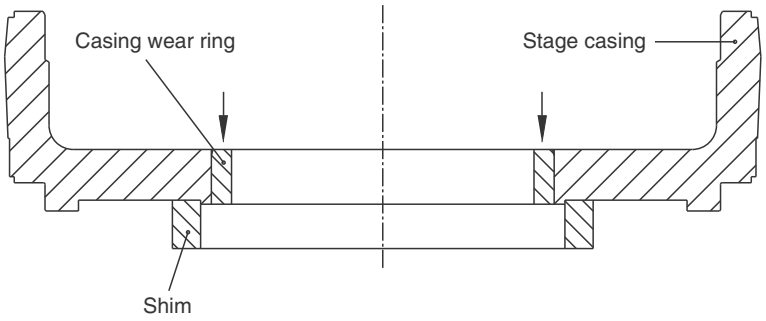
The stage casings (108) are equipped with renewable casing wear rings (502.02). Examine the wearing parts for signs of wear and check the rotor clearances as per Technical Appendix.

The wearing parts must only be re-machined in situ within the max. permissible clearance limits. The increase in clearance caused by machining must also be adjusted at all the wear points in the pumps.

If the rotor clearances exceed the max. values given in the Technical Appendix new wear part must be fitted to re-establish "as-new" clearances.

Example : Renewing the casing wear rings (502).

1. Push the casing wear rings out of their seats taking care not to damage the seats (see fig.).
2. Press the new oversized wear rings into the bore (cooling the rings makes this easier).
3. Smooth down all impellers (230) in the region of the suction throttle section to a common diameter, basing this on the most heavily scored section. Individual deep grooves can be left untouched.
4. Calculate the average actual diameter of all smoothed down impeller wear rings (if applicable). Adding this to the "as new" clearance as per Technical Appendix gives to bore diameter for the casing wear rings, tolerance + 0.04 mm.
5. Align the stage casing (108) and suction casing (106) with fitted casing wear ring to the outer fit and machine the wear ring in one machine tool setting.



Pushing out the casing wear rings

Rotor clearances

Description	As new clearances		Max. Permissible Clearance	
	Cast Iron	Chrome steel	Cast Iron	Chrome steel
	mm	mm	mm	mm
Casing Wear ring / Impeller neck	0.2	0.35	0.3	0.525
Casing Wear ring / Impeller ring (if applicable)	--	0.4	--	0.6
Diffuser / Stage sleeve	0.35	0.4	0.525	0.6
Stage bush (if applicable) / Stage sleeve	--	0.45	--	0.675
Counter balancing disc / Spacer sleeve	0.3	0.3	0.45	0.45
Suction casing / Spacer sleeve	1.2	1.2	1.8	1.8

6.8 Balancing the Rotor

Fitting new rotor components or re-machining existing ones, means rotor has to be dynamically balanced.

Maximum permissible residual unbalance is 5 microns.

Assembly of rotor for dynamic balancing.

Assembly from the suction side of the shaft.

Sizes 40 and 50

1. Insert key for first stage, and spacer sleeve (525.01) onto the shaft.

1.1 Screw shaft protection sleeve (524.01) onto the shaft without O rings.

Sizes 65 to 100

1. Slip spacer sleeve (525.01) onto the shaft, insert key, slip shaft protection sleeve (524.01) onto the shaft and fix it by means of circlip (932.03).

Size 125

1. Inset key, shaft sleeve (524.03) onto the shaft, and secure it with the circlip (932.3).

Sizes 40 and 125

2. Insert key for coupling hub in shaft (210) and mount coupling hub onto the shaft with the pusher device.

Further Assembly from discharge side of the shaft.

Sizes 65 to 125

3. Insert key for first stage impeller (230/231) in shaft (210).

Sizes 40 to 125

4. Slip the impellers and stage sleeves of the following stages onto the shaft in their correct sequence. Then slip on spacer sleeve (525.02) and balancing disc (601) without O-rings.

Sizes 40 and 50

5. Screw the shaft sleeve (524.02) onto the shaft and tighten it. Check that the axial clearance on the suction side [between first stage impeller (230) and spacer sleeve (525.01); alternately between spacer sleeve (525.01) and shaft protection sleeve (524.01)] is 0.3 mm. If necessary, obtain this clearance by touching up spacer sleeve (525.01).

Sizes 65 to 125

6. Slip spacer ring (504.01) onto the shaft, insert split ring (501) into the shaft groove and secure it against falling out by means of retainer ring (505.01). Check that the axial clearance between impeller (230) and spacer sleeve is 0.3 mm. for sizes 65 to 100 & 1.0 mm for size 125.

6.1 Insert key in shaft (210), mount shaft protection sleeve (524.02) without O ring and fix it by means of circlip (932.03).

Note :

In case the pumps are with segmental pads Lift off device, slip spacer sleeve (525.03) onto the shaft. Then insert key, slip thrust bearing plate (384) and spacer sleeve (525.04) onto the shaft, and tighten them with the bearing nut (920.08).

Sizes 40 to 125

7. Before dynamic balancing the rotor should be checked for run out at the impellers, stage sleeves, balancing disc and bearing seats. The maximum permissible run out 0.03 mm.

8. The rotor components are to be dismantled in the reverse order, prior to the assembly of the pump.

7 Assembly

7.1 Assembling the Pump

Assemble the pump in accordance with standard engineering practice. Coat the fits of the individual components with graphite or similar before assembly, and the same applies to the threads of screwed connections. Check all 0-rings and oil seals for damage and renew if necessary.

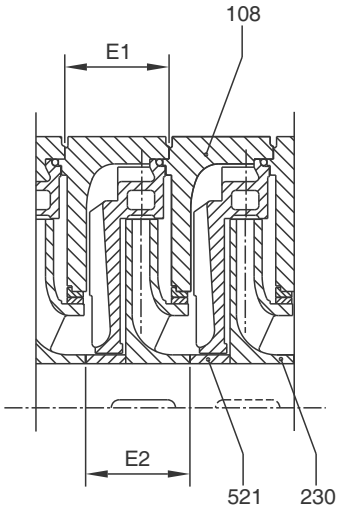
Note :

Always moisten O-rings before final assembly with silicon fluid or, if not available with soapy water. Never fit dry O-rings.

7.2 Preparations

Prior to assembly, measure the axial length "E" of the stage casing (108) and the associated impeller (230) and stage sleeve (521). Any differences in length must be compensated for solely by machining the stage sleeve (521) so that E1 = E2 (see fig.).

If re-machining is necessary, reduce the length of the stage sleeve at both end faces in a single machine tool setting. The permissible deviation from absolute plane parallelism is 0.05 mm.

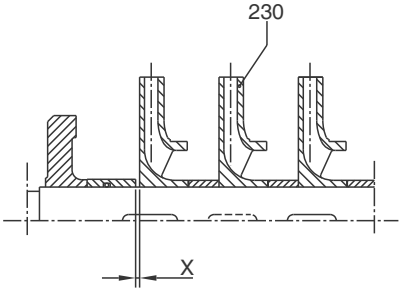


Measuring the stages

Check the axial clearance of the rotor components (x) before mounting the rotor (see fig.).

x = 0.3 mm for HDA 40-100 and 0.5 mm for HDA 125.

Value of 'x' to be ensured as above by machining (if required) the spacer sleeve (525.01), in case of size 40 and 50, and the spacer sleeve (525.02) in case of sizes 65 to 125.



Axial rotor clearance

Assembling the Pump

1. Coat shaft (210) with molybdenum disulphide or a similar approved liquid.

Sizes 40 and 50

1. Insert key for first stage Impeller, slip spacer sleeve (525.01) onto the shaft, tighten the shaft sleeve (524.01) together with 0 ring (412.05) onto the drive end of the shaft. Remember right hand / left hand screw threads.

Sizes 65 to 100

1. Slip spacer sleeve (525.01) from the suction side of the shaft, insert key, slip shaft protection sleeve (524.01) and fasten it with the aid of circlip (932.03). Check the axial clearance between the shaft shoulder and spacer sleeve (525.01), which should be 0.3 mm. if necessary, it should be established by machining the spacer sleeves.

Size 125

1. Place key on the suction side of the shaft, slip the shaft protection sleeve (524.01) and fasten it by means of circlip (932.03). Check that the axial clearance between shaft protection sleeve (524.01) and the shaft shoulder, which should be 1.00 mm.

Sizes 40 and 50

2. Slip the first stage impeller and stage sleeve (521) onto the shaft from the discharge side, and insert the shaft into suction casing (106).

Sizes 65 to 125

2. Insert key for first stage impeller, slip impeller (230/231) and stage sleeve (521) onto the shaft from discharge side, and insert the shaft into suction casing (106).

Sizes 40 to 125

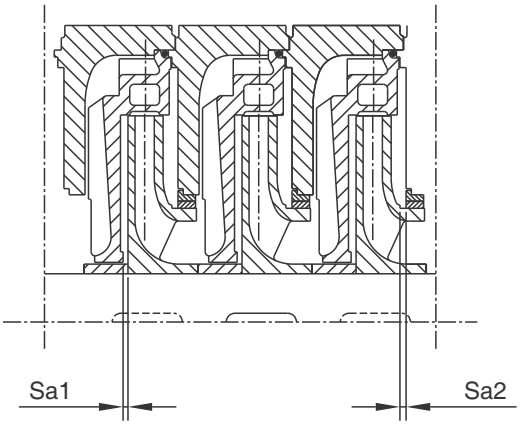
3. Insert diffuser (171.01) into stage casing (108), insert O ring (412.01) {HDA 125 will be without O ring}.

   Assemble the pre-assembled stage casing onto suction casing (106).

4. Assemble the subsequent stages, in their correct sequence, in the manner explained above. Each stage consists of the impeller, stage sleeve and stage casing, together with 0 ring.

   Underpin each stage casing in succession after assembly.

5. After assembly of each stage, check the total axial play Sa1, + Sa2, of the rotor, which should be min. 5 mm.



Total axial play

6. Insert final stage diffuser (171.02) into discharge casing (107).
7. Assemble discharge casing [with diffuser (171.02) and wear ring (512)] onto the stage casing last stage. {HDA 125 is without wear ring}.
8. Slip the washer (550.01) onto the suction end tie rod (905.01), screw the hex nut (920.01) up to the medium position on suction side threading of tie rod, and inset the tie rods into the casings from suction side.
9. On the discharge side, coat the threads and washers with molybdenum disulphide and tighten the nuts (920.01) by hand using standard short open-ended spanner to ensure metal-to-metal contact of the stage casings (108).
10. Place the pump on its baseplate, ensuring the pump feet flush on the base plate.
11. Tighten the nuts (920.01) on the discharge side of the tie rods (905.01) by number of divisions stamped on the top of the bearing housings designated as "SKT". Unscrew them again until loose and subsequently retighten them by hand using a short standard spanner. Mark the starting point on each nut and tie rod. Finally retighten the nuts by the amount indicated on the top of bearing housing.

7.3 Mounting the Balancing Device

Sizes 40 to 125

1. Insert Gasket (400.01), O ring (412.08) into the groove of the counter balancing disc, insert counter balancing disc (602) into discharge casing (107) and firmly tighten alien head screws (914.01).

Sizes 40 and 50

2. Slip spacer sleeve (525.02) onto the shaft until it abuts.
3. Insert key and push balancing disc (601) onto the shaft until it abuts against spacer sleeve (525.02).
4. Screw shaft sleeve (524.02) together with 0 ring (412.05) onto the shaft (210) and tighten it. Remember the right-hand or left-hand screw threads respectively.

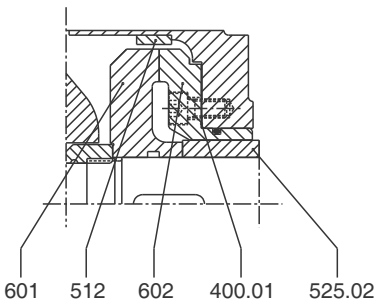
Sizes 65 to 125

2. Insert O ring (412.03), slip spacer sleeve (525.02) onto the shaft until it abuts against the impeller. The key of the final stage must engage in the key way of spacer sleeve (525.02).
3. Insert O ring (412.03) in the groove of balancing disc (601). Insert the key in the shaft key way and slip balancing disc onto the shaft until it abuts against spacer sleeve (525.02).

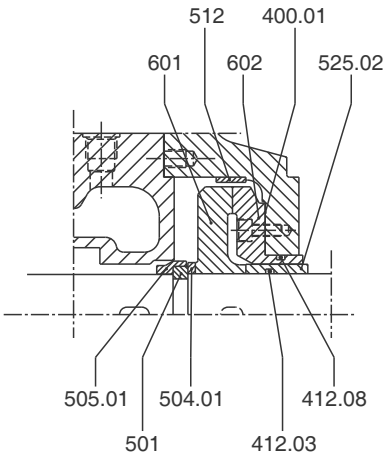
   Measure and shorten spacer ring (504.01) in accordance with section "Adjustment of Rotor position".
4. Slip spacer ring (504.01) onto the shaft, insert split ring (501) into the shaft groove, and slip retainer ring (505.01) over it.

Caution :

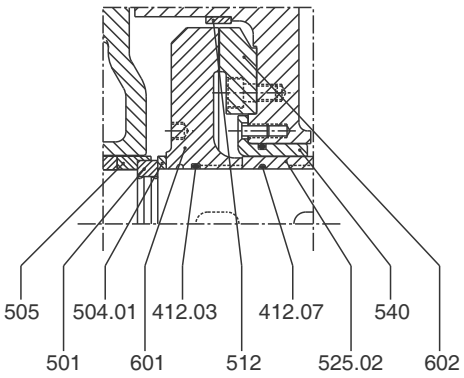
Follow the instructions of section "Checking the balancing device with bluing ink".



Pump sizes 40 and 50 Sizes



Pump sizes 65 to 100 Sizes



Pump sizes 125 to 150

7.4 Checking the Balance Device with Bluing Ink

After re-machining the balance device or fitting new components (601, 602) carry out a check with bluing ink.

Coat the axial contact face of the balance disc (601) thinly with bluing ink. Thoroughly clean the axial contact face of the counter balancing disc (602).

Assemble the balance device, shaft protecting sleeve, seal casing and bearings as described.

Note !

Do not fit the O-rings.

Slowly rotate the rotor pushing it towards the suction side.

Then pull the rotor back towards the discharge end of the pump and dismantle all components up to the balance counter disc (602).

The contact face of the counter balancing disc should bear an even impression of the bluing ink over its entire area or at least over the outer 3/4 of this area.

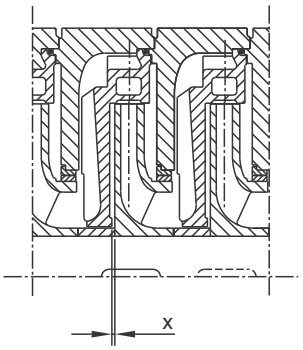
If not, the counter balancing disc (602) must be re-machined and the ink test should be repeated.

7.5 Adjusting the Rotor

The suction, discharge and stage casings are clamped together by means of Tie rods, and counter balancing disc (602), together with O-ring (412.08) is mounted in discharge casing (107) with gasket (400.01).

First shift the rotor towards discharge end of the pump, until it abuts against the casing, then shift it back towards the suction end. (See Fig.)

Caution : This rotor position must not be altered during the whole course of the measurements which follows :



Rotor position at start of measurements

Pump Size	With Lift off device **dimension x in mm.**	Without Lift off device **dimension x in mm.**
40 to 100	2.0	2.5
125	3.0	3.5

Rotor Adjustment

Measure distance "a" from wear face of counter balancing disc (602) to hub face of Last stage Impeller. (See Fig.)

Then measure the distance "b" from the wear face of balancing disc (601) {in dismantled condition} to the end face of spacer sleeve (525.02).

Machine Spacer sleeve (525.02) so that distances a = b.

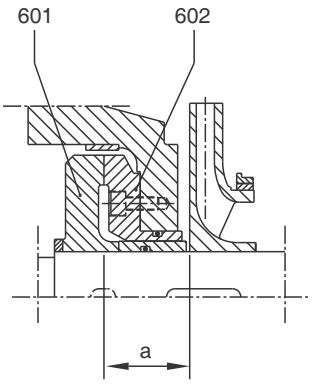
Sizes 40 and 50

Follow the instructions given in section 7.2

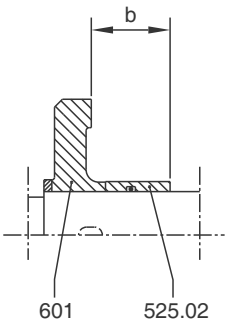
Sizes 65 to 125

Machine spacer ring (504), taking care not to impair the plain parallelism of its end faces, by an amount which will provide on axial clearance of 0.3 mm, on pump sizes 65-100 & 1.0 mm for size 125, between split ring (501) and spacer ring (504).

The deviation from absolute plane parallalison of the end faces must not exceed 0.02 mm. Refer "Mounting the Balancing Device".



Rotor adjustment, distance "a"



Rotor adjustment, distance "b"

7.6 Fitting the Shaft Seal (Gland Packing)

7.6.1 Gland Packing

Sizes 40 and 50

1. Mount stuffing box housing (451) including flat gasket (400.03).

Sizes 65 to 125

1. Insert key and slip shaft protection sleeve (524.01) together with O-ring (412.05) onto the shaft. Then mount the stuffing box housing (451) including flat gasket (400.03).

Sizes 40 to 125

2. Insert O-ring (412.04). Mount cooling cover (165) including flat gasket (400.02) and studs for stuffing box gland.
3. Slip stuffing box gland (452) over the shaft protection sleeve, but do not insert it into the stuffing box compartment.
4. Slip splash ring (507) onto the shaft.

Caution :

The stuffing box should be packed just before the commissioning, after the final alignment.

7.6.2 Mechanical Seal with Cartridge arrangement

(Please refer Cross Sectional drawing of Mechanical Seal for appropriate part numbers)

1. Fit Stuffing Box Housing (451) on to the suction / Discharge casings.
2. Fit Cooling Cover (165) on to the Stuffing Box Housings.
3. Place gasket (5) on the Stuffing Box Housings.
4. Slide mechanical seal cartridge on the shaft until the gland gets located on Stuffing Box Housings.
5. Tighten the screws to fix the glands to Stuffing Box Housings.
6. Tighten set screws (9) of drive collar (8) on the shaft.
7. Loosen hex bolts (12) and slide the sliding washer (11) outwards from the groove of the sleeve (13), so that it will not come in contact with the rotating components. Tighten hex bolts (12) to lock the sliding washers in that position.
8. Slip splash rings onto the shaft

Note : For reference drawing, please refer section 6.3.2

7.7 Mounting the Bearings

[Pump with plain bearings, Lift off device with Antifriction bearings]

1. Mount the bottom half of bearing housing (350.01)
2. Twist in the bearing shells (370) between shaft (210) and bearing housing. Mount the coupling hub with the aid of the pusher device.
3. Raise the rotor (see section "Raising the Rotor")
4. Mount top bearing shell (370), labyrinth ring (423), front end bearing cover (361) and top half of bearing housing.
5. On discharge side mount adaptor (145) and flat gasket (400.07) onto the bearing housing (350.02).
6. Mount thrust bearing housing (354) together with gasket (400.06) onto adaptor. The springs are to be inserted only after the complete measurement & necessary machining.
7. Slip spacer sleeve (525.03) onto the shaft (210) until it abuts.
8. Insert bearing (320) in the retainer ring (505.02) with the filling groove on outside, Heat both the components in an oil bath or oven up to approx. 80°C and slip both of them onto centering sleeve (526).
9. Carry out the measurement of the spring insertion length - required as 30 ± 1 mm - with the balancing/counter balancing discs in contact.

9.1 Measure dimension "a", the depth of thrust bearing housing (354) from the outer face to spring seat.

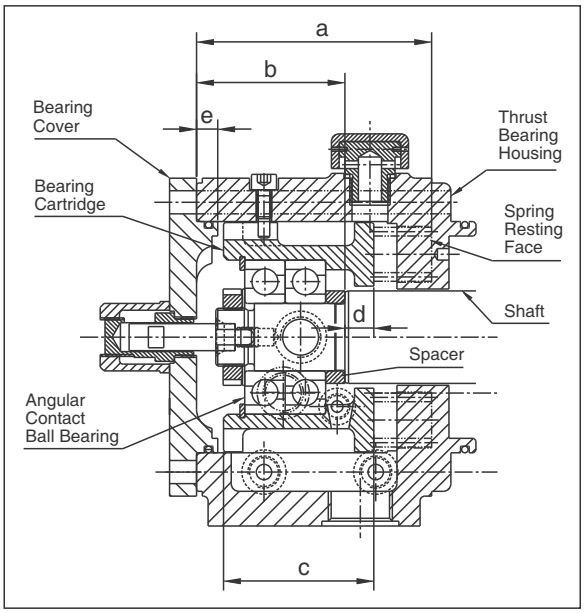
9.2 Measure dimensions "b", the total length of retainer ring.

9.3 Twist the subassembly of centering sleeve with bearing and retainer ring, together with key (940.11) onto the shaft, until it abuts against the spacer sleeve (525.03).

The freeness of retainer ring subassembly has to be ensured, within the thrust bearing housing.

9.4 Measure dimension "C" from the face of thrust bearing housing to retainer ring.

9.5 From these measurement the spring length will be = a - (b + c); which should be equal to 30 ± 1.0 mm. In case it is different either the back face ("A") of the retainer ring or the front face ("B") of the spacer sleeve should be machined.



10. Lift off dimension "X"

    This should be 1.0 ± 0.1 mm.

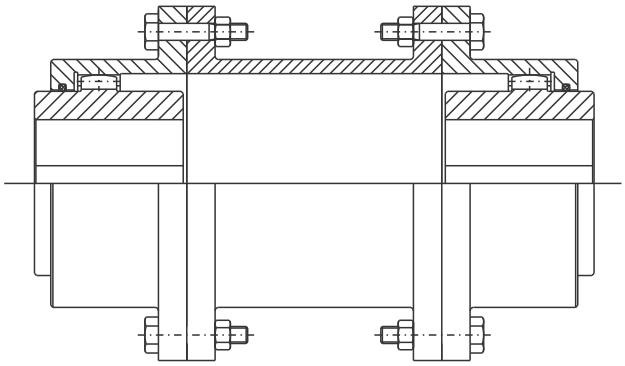
    Dimension "d" on the bearing end cover (361) plus thickness of gasket must be equal to "c" - (1.0 ± 0.1 mm). In case it is different, the bearing end cover must be machined accordingly.
11. Dismantle centering sleeve, together with bearing subassembly. Insert springs (950) and tighten the subassembly of bearing sleeves with bearing, onto the shaft, till it abuts against spacer sleeve. Insert key (940.11).
12. Mount rotor position indicator, consisting of indicator (623) and indicator bush (624); onto the bearing end cover.
13. Check the marking of the indicator (623) with the balancing disc (601) abutting against the counter balancing disc (602); if necessary, scribe a new marking on the indicator (see "Rotor Position Indicator").

7.8 Coupling

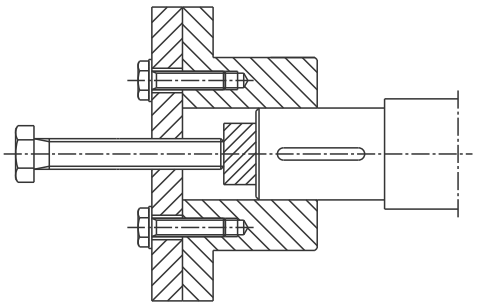
A geared coupling with spacer sleeve is used to connect the pump and drives (See fig.).

Wherever possible, use a special device to fit and pull off the couplings (See fig.).

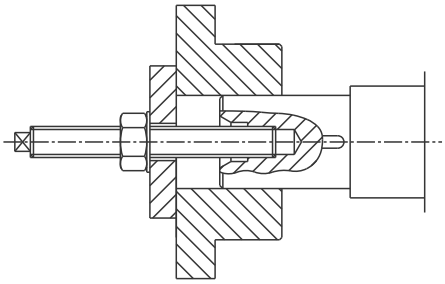
To mount the coupling hubs when warm, heat them in an oil bath or an electric hotplate between 80°C to 100°C.



Gear coupling with spacer sleeve



Pulling off the coupling hub



Mounting the coupling hub

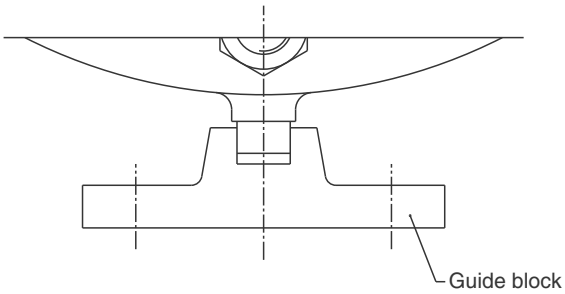
Caution :

It must be possible to manually slide the coupling hubs axially without effort, when the pump is stopped. In case of couplings with retainer rings, the axial freeness is to be checked with the retainer rings removed.

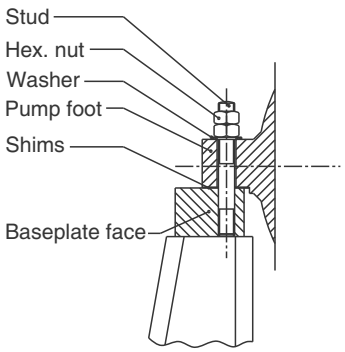
Fill grease before start up. For grease fill, grease quality, lubrication schedules and grease change refer manufacturers manual.

7.9 Alignment after Overhaul

After completion of overhaul and installation work, align the pump and driver at the coupling with dial indicators as per section 'Aligning the Pump and Driver'. Correct any differences in level by inserting shims between the pump feet and baseplate.



Lateral adjustment of pump (example)



Arrangement of the shims

After connecting all the pipework and checking the driver's direction of rotation (with the pump disconnected) re-check alignment. Enter the final measurements in the installation record pad graph.

Tightening the pump feet fastening bolts

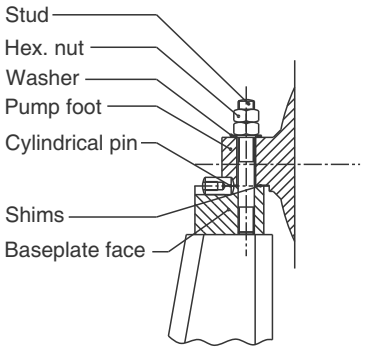
Discharge end

Tighten up the first nut so that the disc can only be moved by tapping it lightly with a hammer. Tighten up the second nut completely (lock), ensuring that the first one does not move at all.

Suction end

Tighten up the first nut against the disc and then tighten the lock nut. The feet on suction casing are dowelled Horizontly to the baseplate by cylindrical pins.

After completing alignment, fit the coupling spacer. Refer section "Dowelling the Pump".



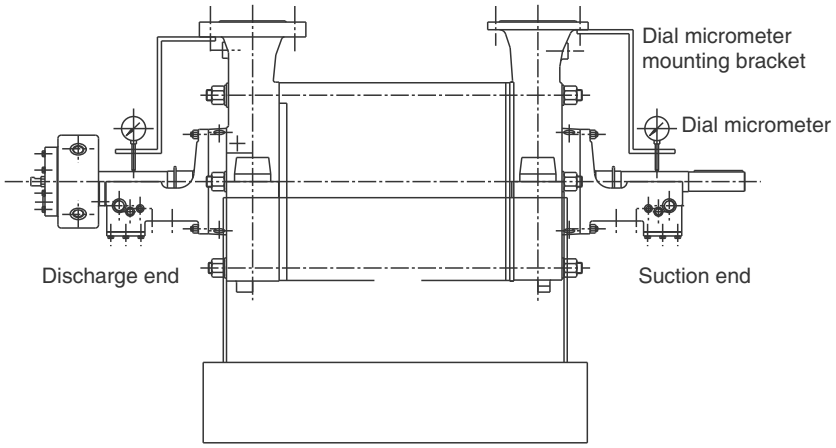
Dowelling the pump feet (suction end)

7.10 Raising the Rotor (Pump with plain bearings)

This check must only be carried out on the pump after it has cooled down & with the coupling hub mounted on the shaft. The temperature measured at the pump nozzle should not exceed 50°C.

Note :

Rotor raising values are stamped on the top valves of the bearing housings and designated by the word 'Lift-Up'. If any increases in clearances between pump rotor and pump casing, within the permissible limits, have been ascertained during the checking process, then the value for rotor raising stamped on the top half of the bearing housing must be increased by half the amount of the increase in radial clearance.



Placing the micrometers for raising the rotor

Place dial micrometers on shaft (210) at the suction and discharge end with the rotor in 'zero' position (the 'zero' position of the rotor means its position when both radial bearings and labyrinth rings have been removed. The rotor raising value is related to this 'zero' position). Then insert the bottom bearing shells (370) at the suction and discharge ends of the pump, and read off the vertical alteration in the rotor position on the dial micrometers and compare with the values for rotor raising stamped on the bearing housing. Correct any deviation by adjusting the bearing housings. To do this loosen bolts at bearing housings and carry out the precision adjustment using the fitted adjusting screws.

These measured values should be checked a second time by renewed removal and renewed reinsertion of the bottom bearing shells (370). The initial measurement reading must again be obtained during this renewed check. The bearing shells can be inserted more easily if the shaft is raised with the aid of a wooden slat. A written record should be made of the rotor raising values measured. Accurate sideways alignment of the bearing housings is to be carried out by the adjustment screws arranged on bearing housing flanges in the horizontal plane. Accurate sideways alignment can be considered to have been achieved when it is possible to twist the bottom bearing shell from either end without effort in its seat between shaft (210) and bottom half of bearing housing.

Re-tighten adjustment screws and nuts after rotor raising procedure has been carried out.

Re-check the rotor raising values.

8 Spare Parts

When ordering spare parts, always quote the part number and works serial number. The serial number is shown on the front page of this manual and on the pump name plate. When ordering spare parts for number of same pumps on one site, please refer VDMA 24296.

Following table gives complete list of recommended spares. For applicability of the same, please refer Cross Sectional Drawing and List Component for the particular order.

S = No. of stages

Part No.	Part Description	Quantity	Remarks
210	Shaft with Keys	1	
230	Impeller	S	
320	Angular Contact Ball Bearing	1 Set	
322	Cyl. Roller Brg. with Adapt. Sleeve	2	Pump with Anti. Fr. Brg.
370	Bearing Shell	2	Pump with Plain Brgs.
400	Gasket	1 Set	
412	O-Ring	1 Set	
433	Mechanical Seal complete	2	Pump with Mech. Seal
461	Gland Packing	2 Sets	Pump with gland pack
501	Split Ring	1	For sizes 65 - 125
502	Wearing Ring	S	
503	Impeller Ring	S	If applicable
504.1	Spacer Ring	1	For sizes 65 - 125
505.1	Retainer Ring	1	For sizes 65 - 125
505.2	Retainer Ring	1	
520	Sleeve	1	For sizes 65 - 125
521	Stage Sleeve	S-1	
523.1/2	Shaft Sleeve	2	Pump with Mech. Seal
524.1/2	Shaft Protection Sleeve	2	Pump with Gland Pack
525.1	Spacer Sleeve	1	For sizes 40 - 100
525.2	Spacer Sleeve	1	
525.3	Spacer Sleeve	1	
541	Stage Bush	S-1	If applicable
601	Balancing Disc	1	
602	Counter Balancing Disc	1	
932.3	Circlip	2	For sizes 65 - 100
950	Spring	1 Set	

9 Faults

Fault	Reference number Cause - Remedy
Pump delivers insufficient liquid	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 28
Driver overloaded	11, 12, 13, 14, 15, 23, 27, 28
Excessively high pump discharge pressure	15
Bearings overheating	22, 23, 24, 25, 26
Pump leaks	16, 29
Excessive shaft seal leakage	17, 18, 19, 20, 21, 22, 23
Rough pump running	3, 6, 11, 12, 22, 23, 25, 30, 31, 32
Excessive temperature rise inside the pump	3, 6, 32
Pressure quantity of balance liquid varies	3, 6, 11, 24, 33

Cause - Remedy 1)

1. The pump generates an excessively high differential pressure
   - Open discharge valve further until the duty point conditions have been attained
2. Excessively high back pressure
   - Fit larger impeller(s) 2)
   - Check installation for contaminations
3. The pump and/or piping are incompletely vented or primed
   - Vent or prime the pump and piping completely
4. Suction line or impeller(s) clogged
   - Remove deposits in the pump and / or piping
5. Formation of air pockets in the piping
   - Alter piping layout
   - If necessary, fit a vent valve
6. NPSH available is too low (on positive suction head installations) Check liquid level in suction vessel
   Open isolating valve in suction line fully
   Alter suction line if necessary, if the friction losses in the suction line are excessive
   Check suction line strainers
   Make sure that the permissible rate of pressure decrease is not exceeded
7. Excessively high suction lift
   Clean out suction strainer basket and suction piping
   - Check liquid level in the pit, correct if necessary
   - Alter the suction line
8. Ingress of air through the stuffing box
   - Fit a new shaft seal
9. Reverse rotation
   - Change over two phases of the power supply cable
10. Rotational speed is too low 2) 3)
    - Increase speed
    - Increase voltage
11. Excessive wear of the pump internals
    - Replace worn components by new ones
12. Pump back pressure is lower than specified in the purchase order
    - Adjust duty point accurately by means of the isolating valve in the discharge line
    - In case of persistent overloading, trim the impeller(s) if necessary 2)
13. Specific gravity or viscosity of the fluid pumped is higher than that specified in the purchase order
    - 2)
14. Gland cover too tight or tightened askew
    - Correct it
15. Excessive rotational speed
    - 2) 3)
16. Defective seal
    - Renew seal
17. Worn shaft seal
    - Check condition of shaft seal and renew it if necessary
18. Grooving, score marks or roughness on shaft sleeve surface
    - Fit new shaft protecting sleeve
19. Lack of cooling liquid or fouled and clogged cooling liquid compartment
    Increase the flow of cooling liquid
    Clean the cooling liquid itself
    Clean out the cooling compartment

20. Gland cover, end cover or seal cover plate incorrectly tightened, wrong packing material
    - Remedy the fault
21. The pump runs noisily
    Correct the suction conditions
    Check alignment of pump set and realign if necessary
    Re-balance the pump rotor
    Increase the suction pressure at pump suction nozzle.
22. Pump set misaligned
    - Check alignment at coupling and realign the set if necessary
23. The pump is warped
    - Check piping connections and pump fixing bolts
24. Excessive axial thrust 2)
    - Fit new casing wear rings
25. Too much, too little, or unsuitable lubricant
    - Reduce quantity of or top up lubricant, or change with suitable lubricant
26. The specified coupling gap has not been maintained
    - restore correct coupling gap in accordance with the data on the installation plan
27. Operating voltage is too low
28. The motor is running on two phases only
    - Replace the defective fuse
    - Check electrical connections
29. The connecting bolts are slack
    - Tighten the bolts
    - Fit new gaskets, if required
30. The rotor is out of balance
    - Clean the rotor
    - Re-balance the rotor dynamically
31. Defective bearings
    - Fit new bearings
32. Insufficient rate of flow
    - Increase the minimum rate of flow
33. Check balance liquid line for changes in cross-section, excessive pressure drops, combination of several lines too close to the pump, leaching out of balance counter disc, abrasive wear of balance device
    - Check mode of running of the pump
    - Check return line
    - Check pump pressures
    - Check rotor clearances and balancing device

1) The pump should be made pressure-less before attempting to remedy faults in parts under pressure.
2) Please contact KSB.
3) This fault can also be overcome by modifying the impeller diameter.

10 Long Time Storage

1.0 STORAGE

Adequate measures are taken at KSB works to safeguard the pump for short term storage between 3-4 months. However, following precautions are to be taken while storing the pump at site stores.

1.1.1 The pump should be stored in an enclosed room, which is, equipped with fire protection, free from roof leakage, water splashes or seepage from the floor. The pump should be protected from rain, sun heat, sand storm etc. Sufficient insurance cover may also be given.

1.1.2 In case if the pump is stored in the same packing box, as packed and supplied, from our works, the box should rest on anti-termite wooden beams or similar supporting structure at least 6" above the ground.

1.1.3 In case if the pump is stored in unpacked condition, it should be covered with at least 6 mil (0.15 mm) thick clear polyethylene sheet which should be fixed to resist winds; and should be with sufficient ventilation underneath.

1.1.4 The suction, discharge and other connections are blanked while dispatching the pump from works. Do not remove the blanks. Close open connections, if any, by metallic blanks.

1.2 For storage beyond 3-4 months, at stores or in installed condition, following measures in addition to above are required to be taken.

1.2.1 The packing box must be opened, if not opened earlier, and fill bearing housings of the pump with vapour phase inhibiting oil up to half of the bearing cavity, to avoid rusting of bearings and other components.

1.2.2 Lube oil, flushing and mech. seal piping, if provided, must be checked for rusting, clean if required, and fill with rust preventive oil.

1.2.3 The pump nozzles which are blanked with plugs or metallic blinds are to be opened and approx. 1/2" kg of vapour phase inhibiting crystals (e.g. Silica Gel), packed in a cloth bag are to be suspended in the pump nozzles and metallic blinds are to be placed back. (We recommend metallic blinds, bolted to the flange).

1.2.4 Following periodic checks are required to be performed.

Item	Periodicity	Checks
Vapour phase inhibiting crystals	Every 3 months	Checking of bags in nozzles and replenishment
Shaft	Every 3 months	Rotation through 180 degrees.
Bearing housing	At the end of first six months	Drain Bearing Housing and refill to half the level with vapour phase inhibiting preservative oil. Internal surfaces should be checked and recoated.
Internal surface of the pump	At the end of first six months	Checking through the nozzle openings and recoating the accessible area, except for stainless steel.
Coupling	At the end of first six months	Checking and recoating
External surfaces of the pump	At the end of the six months	Checking for the surface not painted, and recoating of them.
Mechanical seal	Every 6 months after completion of first year	The preservating oil should be injected into the seal faces through the flushing piping.
Soft packed stuffing box	Every 6 months after completion of first year	Cleanliness and dryness of accessible seal parts should be checked.

2.0 Preparations before Installation / Commissioning

Remove all coats applied during dispatching the pump from our works or during storage at site. Check the pump thoroughly. In case if you need assistance, please contact Customer Service Department of KSB.

2.1 While making use of petroleum products for cleaning, heat / sparks / flames etc., should be avoided.

2.2 Preservative grease should be washed off from the external surfaces, using some petroleum product (Kerosene / Diesel / Thinner).

2.3 All the auxiliary piping, as well as Bearing Housing, should be drained for the preservative oil.

2.4 Auxiliary piping and Bearing Housings should be flushed with a petroleum product, and the Bearing Housings should be cleaned and dried.

2.5 All the bearings should be removed before the flushing of bearing housing.

2.6 All the bearings should be cleaned, checked for acceptance for the use, and then only should be fitted in the bearing housing.

3.0 Storage of Accessories

3.1 Accessories

For major accessories, like driver / coupling / gear box / panels / main valves etc., basically manufacturer's recommendations are to be followed.

The smaller accessories covering piping/instrumentation/valves in piping/mountings etc., are generally mounted on the pumping unit, in their respective position, and as such will be taken care along with the precautions of the pump itself. However, if these are supplied loose, the same should be treated as spares.

3.2 Spares

While dispatching the spares whether project or subsequent these are properly packed, and treated before packing. These packing as long as they are not tampered can be directly stored in proper racks, for desired long time storage, however these racks must be located in such a position that they fulfill the conditions stipulated for pumps. Exception is to be made for the items which have their own shelf life such as rubber components, gaskets etc.

3.3 Pump Cartridge

Barrel type of pumps are many times supplied with a pump cartridge (which comprises a complete pump except the barrel), which is supplied in the assembled condition, clamped together with the clamping device.
The storage of this pump cartridge must fulfill all the conditions stipulated for the pump.

3.4 Tools

All the pumps are supplied with necessary Tools and Tackles for Dismantling / Assembly of pumps components. Though these do not demand any specific requirements for long time storage, these should be stored in such a manner that these are easily and readily accessible in emergencies.

Log Sheet

	PUMP TYPE		SERIAL NO.						
	CUSTOMER ITEM NO.								
No.		DESCRIPTION	UNIT	READING					
		PRESSURE AT							
1	-	Suction nozzle	kg/cm^2						
2	-	Differential across suction strainer	kg/cm^2						
3	-	discharge nozzle	kg/cm^2						
4	-	Balancing line	kg/cm^2						
5	-	Oil inlet to bearing (forced oil lubrication)							
	5.1	Suction side bearing	kg/cm^2						
	5.2	Discharge side bearing	kg/cm^2						
	5.3	Lift off / Thrust bearing	kg/cm^2						
		TEMPERATURE AT							
6	-	Suction nozzle	Deg C						
7	-	Discharge nozzle	Deg C						
8	-	Balancing line	Deg C						
9	-	**Bearings**							
	9.1	Suction side	Deg C						
	9.2	Discharge side	Deg C						
	9.3	Lift off / Thrust	Deg C						
10		**Oil Inlet** to bearing (forced oil lubrication)							
	10.1	Suction side	Deg C						
	10.2	Discharge side	Deg C						
	10.3	Lift off / Thrust	Deg C						
11		**Flushing liquid**							
	11.1	Shaft seal - Suction	Deg C						
	11.2	Shaft seal - Discharge	Deg C						
		Cooling Water Inlet / Outlet							
	11.3	Suction	Deg C						
	11.4	Discharge	Deg C						
	11.5	Lift off / Thrust	Deg C						
12		**ROTOR POSITION**							
13			Amplitude				RMS Velocity		
		VIBRATIONS AT	microns peak to pack)				mm / s		
			H	V	A		H	V	A
	13.1	Suction side bearing housing							
	13.2	Discharge side bearing housing							
	13.3	Lift off / Thrust bearing housing							
	13.4	Suction flange							
	13.5	Discharge flange							
	13.6	Suction side support foot							
	13.7	Discharge side support foot							
	13.8	Base Frame							
			H = Horizontal ;		V = Vertical ;		A = Axial.		
			DATE / TIME		SIGNATURE OF OPERATOR				

Pump Maintenance Plan

Maintenance Activity ➡ / Maintenance point ↓ (Whichever applicable)	Oil Change		Bearing Condition	Lubrication	Check
	First	Next			
Pump Bearing Housing	300 h	8000 h however at least once in a year	✪		
Pump Gland Packing					✝ *
Pump Mechanical Seal					✝ *
Coupling				@	Alignment * #

* = Only during stand still
✝ = In case of excessive leakage through shaft seal
@ = Refer Manufacturer's Manual
\# = In case of (i) higher vibrations; (ii) Restarting after long interval; (iii) Restarting after replacement of bearings; (iv) After overhaul
✪ = In case off (i) higher vibrations; (ii) higher bearing temperature; (iii) indication of misalignment

Pump Supervision Plan

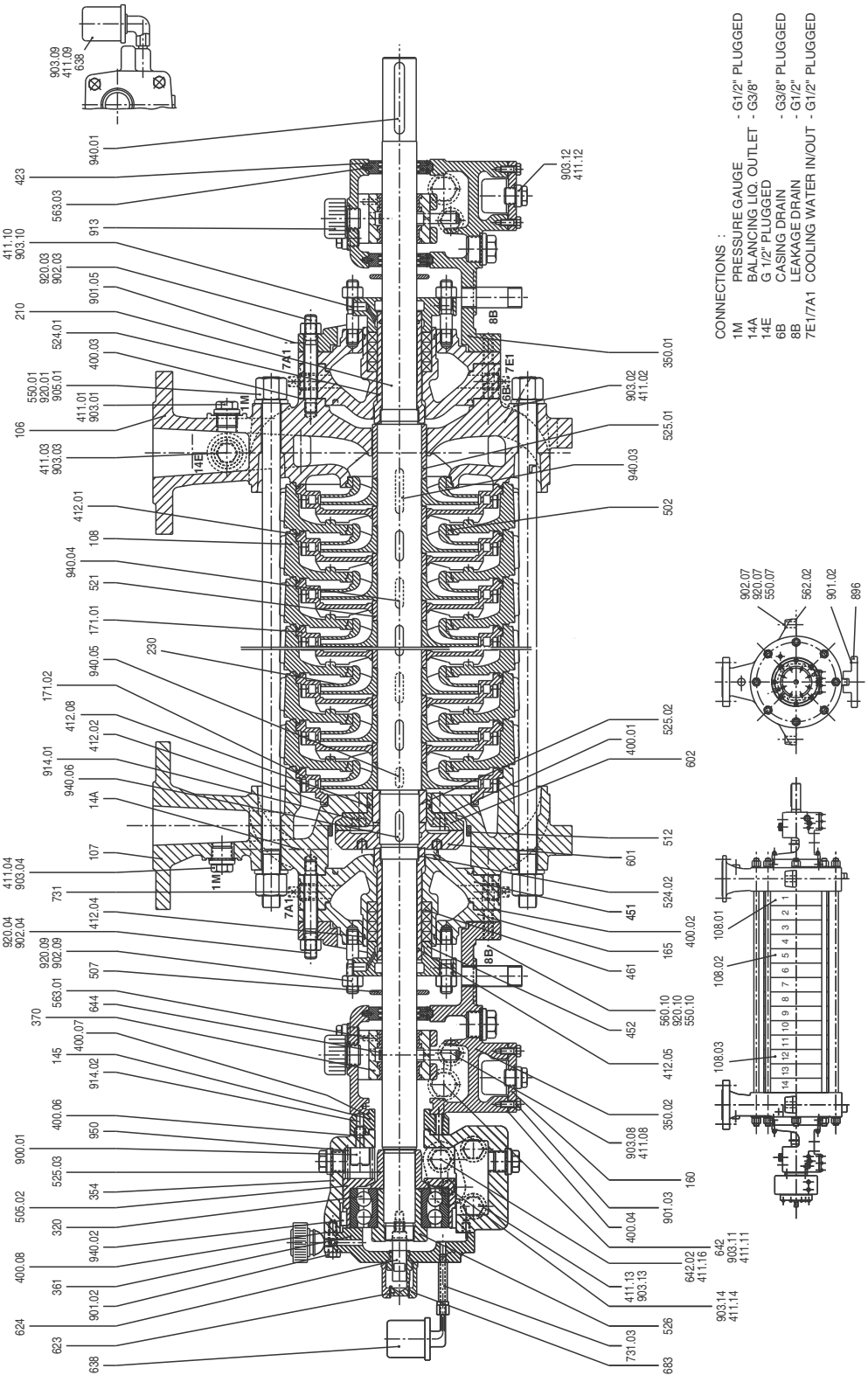
Type of Control ➡ / Control Area	Proper Condition	Damage	Leakage	Tightness	Noise	Smooth Running	Oil Level	Temperature	Pressure	Gland Packing Leakage @	Rotor Position	Oil / Water flow	Differential Pressure	Vibrations
Pump	W	W	S *	S *	S	S					W			
Suction Nozzle								S	S					
Discharge Nozzle								S	S					
Suction Strainer													S	
Min Flow Bypass									S					
Balancing Leak off									S			S		
Shaft Seal	R	R								S				
Bearing Housing	R	R			S		S	S	S					W
Flushing Inlet								S	S			S		
Lube oil Inlet								S	S			S		
Cooling Inlet								S	S			S		
Coupling	R	R												

* All threaded joints
@ Applicable only in case of Gland packed pump

S = Once a shift
W = Once a Week
M = Once a Month
R = Inspection at stand still

11 Sectional drawing and List of components

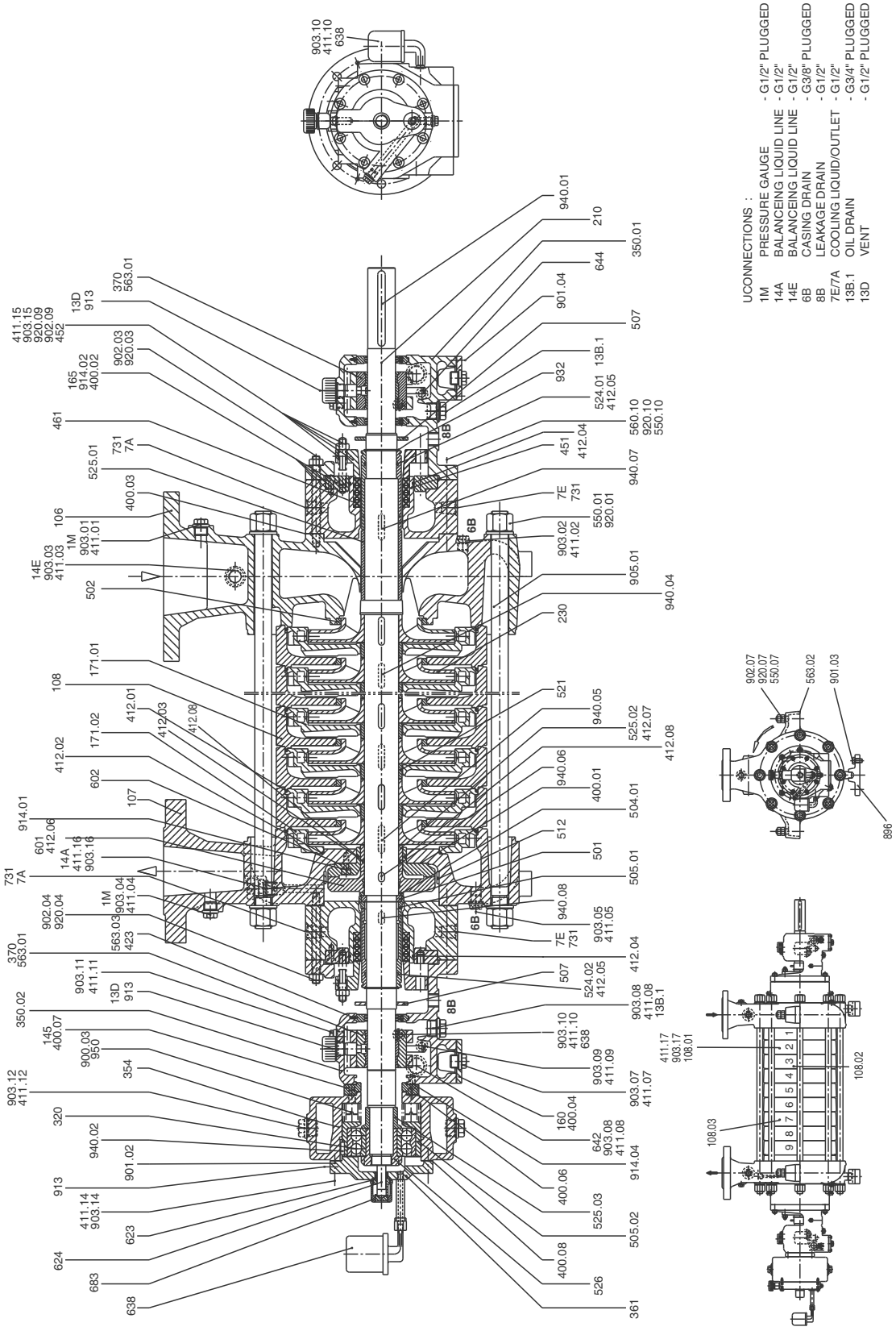
11.1 Sectional drawing for sizes 40 and 50



List of components

Part No.	Part Name	Part No.	Part Name	Part No.	Part Name
106	Suction casing	525.02	Spacer sleeve	940.05	Key
107	Discharge casing	525.03	Spacer sleeve	940.06	Key
108	Stage casings : Remaining	526	Centering sleeve	950	Spring
108.01	Stage casings for stage no. 1	550.01	Washer		
108.02	Taper stage casing	550.07	Washer		
108.03	Taper stage casing	550.10	Washer		
145	Adaptor	560.10	Taper pin		
160	Cover	563.01	Parallel pin		
165	Cooling cover	563.02	Parallel pin		
171.01	Diffuser	563.03	Parallel pin		
171.02	Diffuser last stage	601	Balancing disc		
210	Shaft	602	Counter balancing disc		
230	Impeller	623	Bush for indicator		
320	Angular contact ball bearing	624	Indicator		
350.01	Bearing housing	638	Constant level oiler		
350.02	Bearing housing	642	Oil level sight glass		
354	Thrust bearing housing	642.02	Oil level sight glass		
361	Bearing end cover	644	Lubricating ring		
370	Bearing shell	683	Hood		
400.01	Gasket	731	Square head plug		
400.02	Gasket	731.03	Extension piece		
400.03	Gasket	896	Guide piece		
400.04	Gasket	900.01	Screw		
400.06	Gasket	901.02	Hex. bolt (Full threaded)		
400.07	Gasket	901.03	Hex. bolt (Full threaded)		
400.08	Gasket	901.05	Hex. bolt (Full threaded)		
411.01	Sealing ring	902.03	Stud		
411.02	Sealing ring	902.04	Stud		
411.03	Sealing ring	902.07	Stud		
411.04	Sealing ring	902.09	Stud		
411.08	Sealing ring	903.01	Hex. head plug		
411.09	Sealing ring	903.02	Hex. head plug		
411.10	Sealing ring	903.03	Hex. head plug		
411.11	Sealing ring	903.04	Hex. head plug		
411.12	Sealing ring	903.08	Hex. head plug		
411.13	Sealing ring	903.09	Hex. head plug		
411.14	Sealing ring	903.10	Hex. head plug		
411.16	Sealing ring	903.11	Hex. head plug		
412.01	O-ring	903.12	Hex. head plug		
412.02	O-ring	903.13	Hex. head plug		
412.04	O-ring	903.14	Hex. head plug		
412.05	O-ring	905.01	Tie rod		
412.08	O-ring	913	Vent plug		
423	Labyrinth ring	914.01	Hex. soc. thin H. cap screw		
451	Stuffing box housing	914.02	Hex. soc. head cap screw		
452	Stuffing box gland	920.01	Hex. nut		
461	Gland packing	920.03	Hex. nut		
502	Wearing ring	920.04	Hex. nut		
505.02	Retaining ring	920.07	Hex. nut		
507	Splash ring	920.09	Hex. nut		
512	Wear ring	920.10	Hex. nut		
521	Stage sleeve	940.01	Key		
524.01/02	Shaft protection sleeve	940.02	Key		
525.01	Spacer sleeve	940.04	Key		

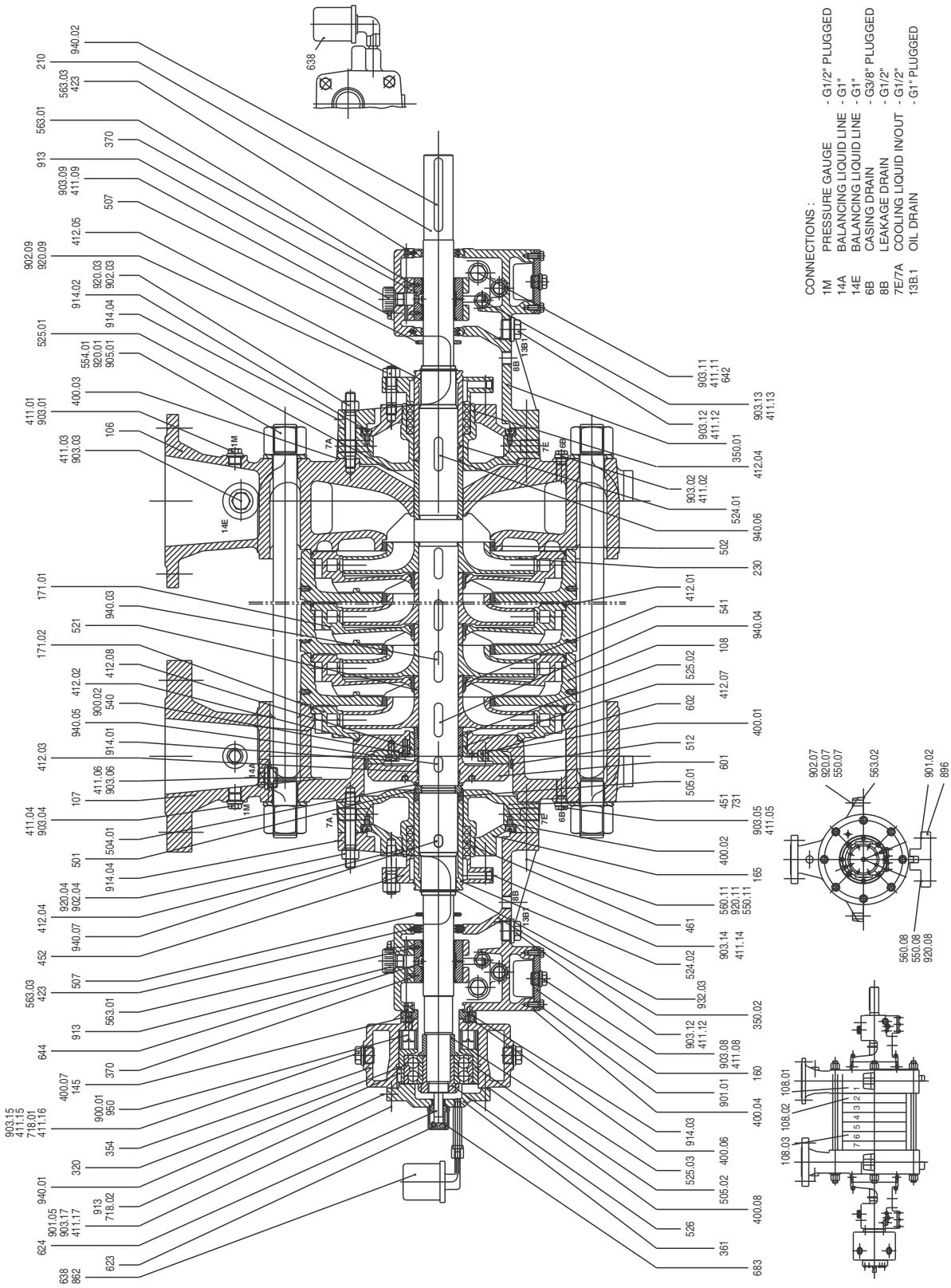
11.2 Sectional drawing for sizes 65, 80 and 100



List of components

Part No.	Part Name	Part No.	Part Name	Part No.	Part Name
106	Suction casing	501	Split ring	913	Vent plug
107	Discharge casing	502	Wearing ring	914.01	Hex. soc. Thin H. cap screw
108	Stage casings : Remaining	504.01	Spacer ring	914.02	Hex. soc. head cap screw
108.01	Stage casings for stage no. 1	505.01	Retaining ring	914.04	Hex. soc. head cap screw
108.02	Taper stage casing	505.02	Retaining ring	920.01	Hex. nut
108.03	Taper stage casing	507	Splash ring	920.03	Hex. nut
145	Adaptor	512	Wear ring	920.04	Hex. nut
160	Cover	521	Stage sleeve	920.07	Hex. nut
165	Cooling cover	524.01/02	Shaft protection sleeve	920.09	Hex. nut
171.01	Diffuser	525.01	Spacer sleeve	920.10	Hex. nut
171.02	Diffuser last stage	525.02	Spacer sleeve	932	Circlip (For shaft)
210	Shaft	525.03	Spacer sleeve	940.01	Key
230	Impeller	526	Centering sleeve	940.02	Key
320	Angular contact ball bearing	550.01	Washer	940.04	Key
350.01	Bearing housing	550.07	Washer	940.05	Key
350.02	Bearing housing	550.10	Washer	940.06	Key
354	Thrust bearing housing	560.10	Taper pin	940.07	Key
361	Bearing end cover	563.01	Parallel pin	940.08	Key
370	Bearing shell	563.02	Parallel pin	950	Spring
400.01	Gasket	563.03	Parallen pin		
400.02	Gasket	601	Balancing disc		
400.03	Gasket	602	Counter balancing disc		
400.04	Gasket	623	Bush for indicator		
400.06	Gasket	624	Indicator		
400.07	Gasket	638	Constant level oiler		
400.08	Gasket	642	Oil level sight glass		
411.01	Sealing ring	644	Lubricating ring		
411.02	Sealing ring	683	Hood		
411.03	Sealing ring	731	Square head plug		
411.04	Sealing ring	896	Guide piece		
411.05	Sealing ring	900.03	Screw		
411.07	Sealing ring	901.02	Hex. bolt (Full threaded)		
411.08	Sealing ring	901.03	Hex. bolt (Full threaded)		
411.09	Sealing ring	901.04	Hex. bolt (Full threaded)		
411.10	Sealing ring	902.03	Stud		
411.11	Sealing ring	902.04	Stud		
411.12	Sealing ring	902.07	Stud		
411.13	Sealing ring	902.09	Stud		
411.14	Sealing ring	903.01	Hex. head plug		
411.15	Sealing ring	903.02	Hex. head plug		
411.16	Sealing ring	903.03	Hex. head plug		
411.17	Sealing ring	903.04	Hex. head plug		
412.01	O-ring	903.05	Hex. head plug		
412.02	O-ring	903.07	Hex. head plug		
412.03	O-ring	903.08	Hex. head plug		
412.04	O-ring	903.09	Hex. head plug		
412.05	O-ring	903.10	Hex. head plug		
412.06	O-ring	903.11	Hex. head plug		
412.07	O-ring	903.12	Hex. head plug		
412.08	O-ring	903.14	Hex. head plug		
423	Labyrinth ring	903.15	Hex. head plug		
451	Stuffing box housing	903.16	Hex. head plug		
452	Stuffing box gland	903.17	Hex. head plug		
461	Gland packing	905.01	Tie rod		

11.3 Sectional drawing for size 125



List of components

Part No.	Part Name	Part No.	Part Name	Part No.	Part Name
106	Suction casing	504.01	Spacer ring	903.13	Hex. head plug
107	Discharge casing	505.01	Retaining ring	903.14	Hex. head plug
108	Stage casings : Remaining	505.02	Retaining ring	903.15	Hex. head plug
108.01	Stage casings for stage no. 1	507	Splash ring	903.17	Hex. head plug
108.02	Taper stage casing	512	Wear ring	905.01	Tie rod
108.03	Taper stage casing	521	Stage sleeve	913	Vent plug
145	Adaptor	524.01/02	Shaft protection sleeve	914.01	Hex. soc. Thin H. cap screw
160	Cover	525.01	Spacer sleeve	914.02	Hex. soc. head cap screw
165	Cooling cover	525.02	Spacer sleeve	914.03	Hex. soc. head cap screw
171.01	Diffuser	525.03	Spacer sleeve	914.04	Hex. soc. head cap screw
171.02	Diffuser last stage	526	Centering sleeve	920.01	Hex. nut
210	Shaft	540	Bush	920.03	Hex. nut
230	Impeller	541	Stage bush	920.04	Hex. nut
320	Angular contact ball bearing	550.07	Washer	920.07	Hex. nut
350.01	Bearing housing	550.08	Washer	920.08	Hex. nut
350.02	Bearing housing	550.11	Washer	920.09	Hex. nut
354	Thrust bearing housing	554.01	Grooved washer	920.11	Hex. nut
361	Bearing end cover	560.08	Taper pin	932.03	Circlip (For shaft)
370	Bearing shell	560.11	Taper pin	940.01	Key
400.01	Gasket	563.01	Parallel pin	940.02	Key
400.02	Gasket	563.02	Parallel pin	940.03	Key
400.03	Gasket	563.03	Parallel pin	940.04	Key
400.04	Gasket	601	Balancing disc	940.05	Key
400.06	Gasket	602	Counter balancing disc	940.06	Key
400.07	Gasket	623	Bush for indicator	940.07	Key
400.08	Gasket	624	Indicator	950	Spring
411.01	Sealing ring	638	Constant level oiler		
411.02	Sealing ring	642	Oil level sight glass		
411.03	Sealing ring	644	Lubricating ring		
411.04	Sealing ring	683	Hood		
411.05	Sealing ring	718.01	Socket Male-Female		
411.06	Sealing ring	718.02	Socket Male-Female		
411.08	Sealing ring	731	Square head plug		
411.09	Sealing ring	862	Extension piece		
411.11	Sealing ring	896	Guide casing		
411.12	Sealing ring	900.01	Hex. socket screw		
411.13	Sealing ring	900.02	Hex. socket screw		
411.14	Sealing ring	901.01	Hex. bolt (Full threaded)		
411.15	Sealing ring	901.02	Hex. bolt (Full threaded)		
411.16	Sealing ring	901.05	Hex. bolt (Full threaded)		
411.17	Sealing ring	902.03	Stud		
412.01	O-ring	902.04	Stud		
412.02	O-ring	902.07	Stud		
412.03	O-ring	902.09	Stud		
412.04	O-ring	903.01	Hex. head plug		
412.05	O-ring	903.02	Hex. head plug		
412.07	O-ring	903.03	Hex. head plug		
412.08	O-ring	903.04	Hex. head plug		
423	Labyrinth ring	903.05	Hex. head plug		
451	Stuffing box housing	903.06	Hex. head plug		
452	Stuffing box gland	903.08	Hex. head plug		
461	Gland packing	903.09	Hex. head plug		
501	Split ring	903.11	Hex. head plug		
502	Wearing ring	903.12	Hex. head plug		

Notes:

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