Contents

- These are standard operating instructions.
- User should identify the type of execution of the pump purchased and then follow the instructions specifically.
- Specify W.O. No. and pump type in case of any question to KSB.

0. General

Your WL pump will give trouble free satisfactory service if it is properly installed and maintained.

Follow the instructions in the manual carefully. Do not run the pump under operating conditions which differ from those specified by us.

This manual does not take into account any site safety regulations which may apply. The site manager or site operator is responsible for notifying the erection staff of any such regulations and ensuring they are complied with.

The type series, pump size, main operating data and works serial number are all stamped on the name plate attached to the pump. Please quote this information whenever you have queries or repeat orders and in particular when ordering spares.

0.1 Handling

When handling a complete pump set attach ropes to the pump and primemover as shown (do not use the eye bolt on the driver).

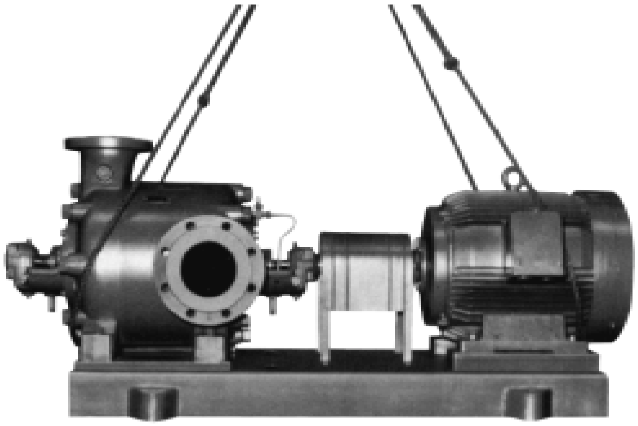


Fig. 1 Slinging the ropes under the pump and driver mounted on a combined baseplate.

See certified installation drawing for details of weights. If the pump is supplied with a short baseplate or without a baseplate, the ropes should be slung under the connection rods as illustrated in Fig. 1.1

Caution : When slinging the ropes for transport, never sling them under the pump stub shafts or under the bearing housings.

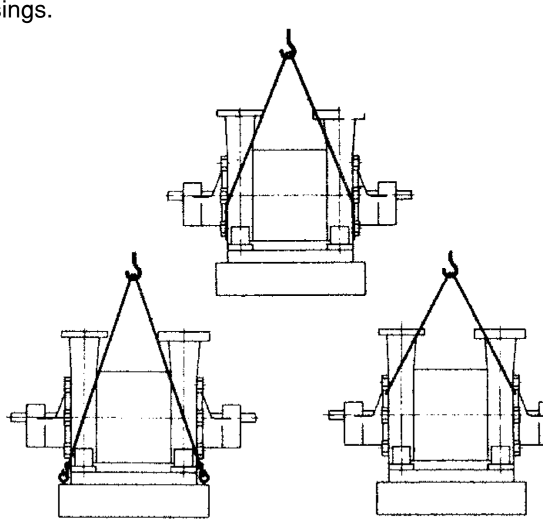


Fig. 1.1 Slinging the ropes on a pump with short baseplate.

1. Installation

(Installation on Site)

1.1 Foundation

Make sure that the concrete foundation has set firmly before placing the pumping set on it. The surface of the foundation should be truly horizontal and perfectly flat. The foundation bolts should be suspended in the baseplate.

1.1.1 Installation

After placing the pump on the foundation, level it up with the aid of a spirit level placed on the shaft/discharge nozzle. The correct gap between the two coupling halves specified on the installation drawing must be observed. Shims should always be inserted to the left and right of the foundation bolts in close proximity to the bolts themselves between the baseplate or foundation frame and the foundation itself if the spacing between adjoining anchor bolt holes exceeds 800 mm. additional shims should be inserted half way between the adjoining holes. All shims must be perfectly flush.

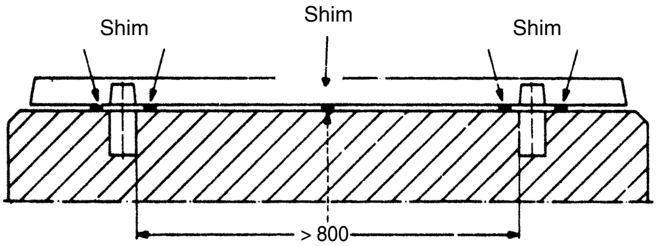


Fig. 2 Provision of necessary shims.

Grout the foundation bolts. After the mortar has set hard uniformly tighten up the foundtion bolts.

On baseplate with no grouting aperture, only the foundation bolts are to be grouted in.

After alignment grout the baseplate (non-shrinking mortar is highly recommended), ensuring that no cavities remain.

1.2 Aligning the Coupling

If the bare pump only is supplied, i.e. the motor or gearbox are not mounted, the flexible coupling should be preheated to 100-120°C approx. in an oil bath before mounting on the stub shafts. The flexible elements should be removed before hand.

Caution : Never drive the half coupling onto the shaft by hammer blows. Always use a pusher device to mount it on the shaft (see Fig. 2.1).

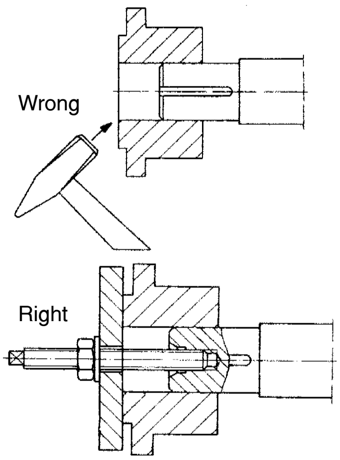


Fig. 2.1 Mounting the coupling.

In order to align the shafts, the pump and drive should be pushed towards each other until the two coupling halves are separated by the axial gap specified in the foundation or installation drawing. The preliminary alignment of the coupling is effected by means of a short steel straight edge and feeler gauge.

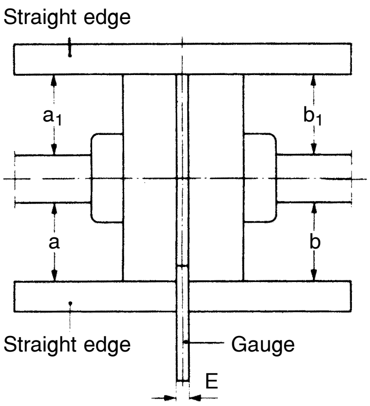


Fig. 2.2 Align the coupling by means of a straight edge and gauge.

Check the axial gap "E" at various points around the periphery, with the aid of a feeler gauge, and place a short straight edge across the outer diameter of the two coupling havles, forming a bridge. If the straight edge lies flush at all points, the preliminary alignment can be considered satisfactory. (see Fig. 2.2)

The accurate coupling alignment requires the manufacture of a coupling alignment jig. This can be made from 20 x 20 flat bar steel or similar, the jig should be attached to the shafts. (see Fig. 2.3)

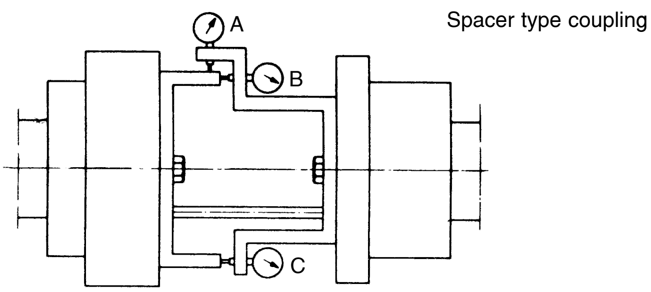


Fig. 2.3

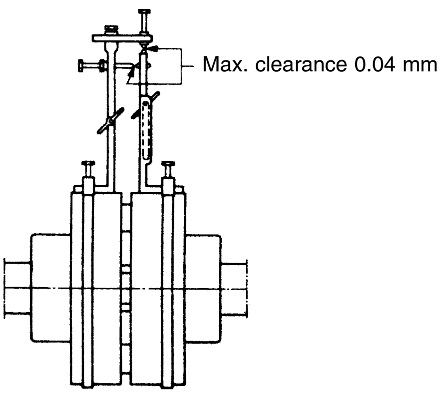


Fig. 2.4 Coupling alignment jig.

The coupling can be considered correctly aligned with the aid of the jigs illustrated if the difference measured does not exceed 0.04 mm. both in the radial and axial directions, measurements being taken in 4 planes at 90^0 intervals. The coupling alignment checking should be repeated after the piping has been connected to the pump.

1.2.1 Grouting in the Baseplate

After alignment of the coupling the holes for the foundations bolts and the baseplate should be grouted in with a quick-setting cement mortar in 1:2 ratio (1 part of cement to 2 parts of standard gravel). Make sure that all the boxes in the baseplate are completely filled with the cement mortar and that no cavities remain.

The foundation bolts should be tightened evenly and firmly after the grout has set firmly. Then check with the aid of a dial micrometer that the alignment is still correct.

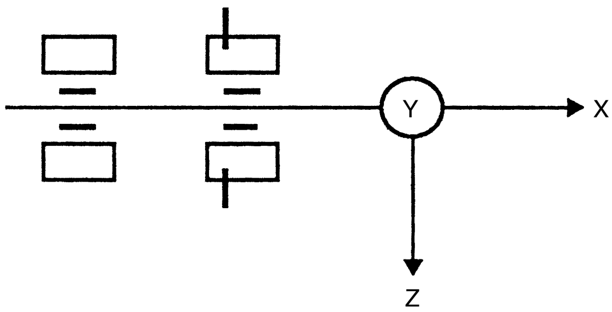
1.2.2 Final Alignment

After all the pipelines have been carried and the direction of rotation check has been carried out (with the pump disconnected from the driver), the final alignment of the pumping set should be effected. The same procedure would be followed as for the preliminary alignment, i.e. the relevant alignment jigs with 3 dial micrometers should be used and the measurements previously described should be carried out at the various shaft positions.

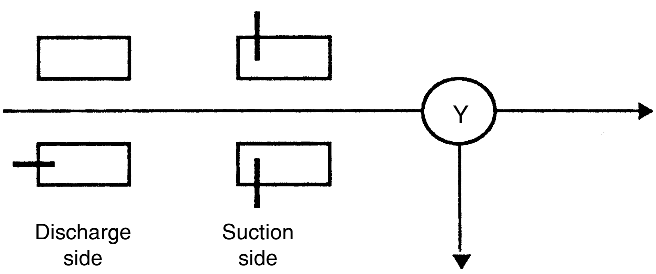
Caution :

The pump feet must be pulled tight against their seating on the baseplate. The alignment can be considered satisfactory if the dimensional deviations do not exceed 0.04 mm. both in the case of the radial measurements and in the case of the axial difference measurement.

The final measurement readings should be entered in the system of coordinates on the erection check list. Any necessary height adjustment should be effected by inserting shims of appropriate thickness under the feet of the individual machines. After each dismantling of the pump, the suction and pump feet must be dowelled a new.



Dowelling of pump on base plate
(for pump with centre feet)



Dowelling of the pump on base frame
(for pump with bottom feet)

1.3 Connecting the Piping

The main piping should be connected to the pump without transmitting any stresses or strains onto the latter. Any appreciable piping forces which are transmitted to the baseplate via the pump can detrimentally affect the alignment and the running of the pump. Such forces should therefore be kept to a minimum at all costs.

1.3.1 Suction Lift Line and Positive Suction Head Line

The pipe line connected to the suction casing (106) is called either a suction lift line or a (positive) suction head line, depending on whether the pressure at the pump inlet is below or above atmospheric pressure. This line should be kept as short as possible. (see Figs. 4 and 5)

Suction lift lines should rise all the way towards the pump, they should also be absolutely leak tight and be laid in such a way as to prevent the formation of air pockets at any point. (see Fig. 4)

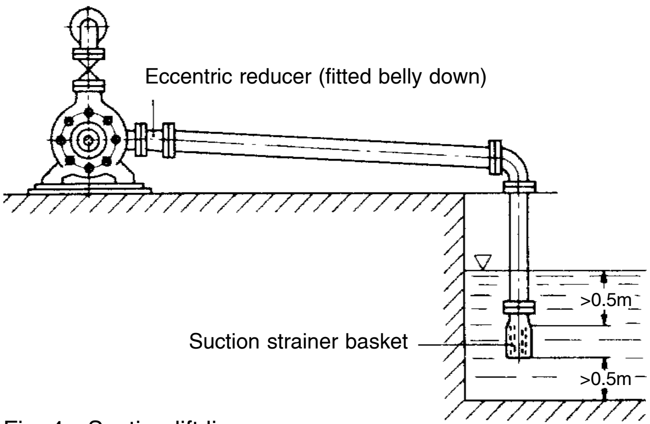


Fig. 4 Suction lift line

The nominal size of the pump suction flange is no accurate guide to the size of the suction lift line. The latter should be sized, as a first approximation to give a velocity of 2m/sec. approx. In principle, every pump should be equipped with its own individual suction lift line. If this is not feasible for particular reasons, the common suction lift line should be sized for as low a velocity as possible and preferably for a constant velocity right up to the last pump on the line. (see Fig. 6)

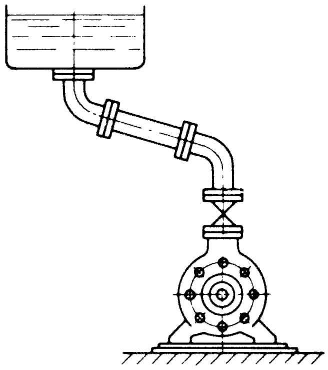


Fig. 5 Suction head line

In addition, pumps connected to a common suction lift line should be equipped with VSM stuffing boxes.

If the suction lift line is buried, it should be hydrostatically tested at 3 to 4 bar before burial.

The same remarks as above apply to the nature and laying of (positive) suction head lines. Horizontal lengths of suction head lines should however be laid with a slightly rising slope towards the suction vessel. It it is not feasible to avoid apexes in the suction head line, each apex should be equipped with a vent cock. It is also advisable to avoid any appreciable length of horizontal suction head line laid close beneath the suction vessel because of the danger of evaporation. (see Fig. 5)

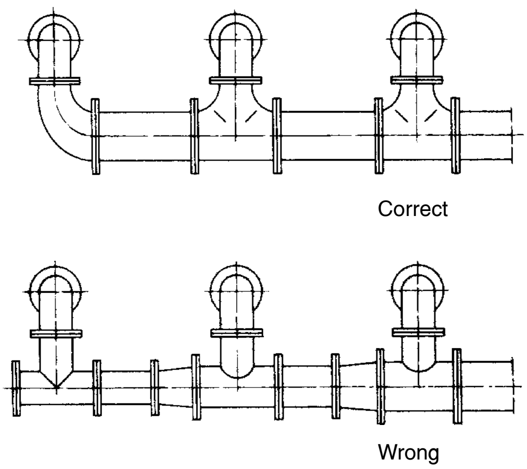


Fig. 6 Common suction lift line for several pumps

1.3.2 Strainers in Suction Head Line/Suction Lift Line

Before a new pumping installation is commissioned, all the vessels, piping and connections should be thoroughly cleaned, flushed through and blown through. It often happens that welding beads, pipe scale and other dirt only become detached from inside the piping after a considerable period of service; hey must therefore be prevented from penetrating inside the pump by the provision of a strainer in the suction head or suction lift line. This strainer should have a free are of holes equal to 3 times the pipe cross section area approx., in order to avoid an excessive pressure drop when foreign bodies tend to clog the strainer.

Conical (hat shaped) strainers have given good results in service they should have a woven wire insert to corrosion resistant material with a 1.0 mm. mesh width of 0.5 mm. diameter wire. The fine strainer should precede the coarse strainer in respect to direction of flow of the fluid. During the initial period of commissioning, the suction pressure should be kept under frequent observation. If the NPSH available is found to decrease, this may be due to clogged strainers (the pressure drop across the strainer should be measured with the aid of a differential pressure gauge). The strainers should then be cleaned. (see Figs. 7 and 8)

Unless anything to the contrary has been specified, the max. permissible pressure drop across the strainer should not exceed 3 meters.

1. Strainer holder
2. Fine strainer
3. Coarse strainer
4. Pump

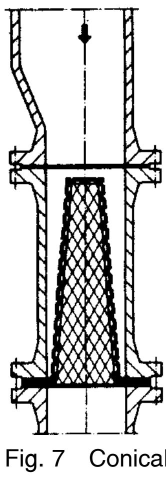


Fig. 7 Conical strainer for suction head line

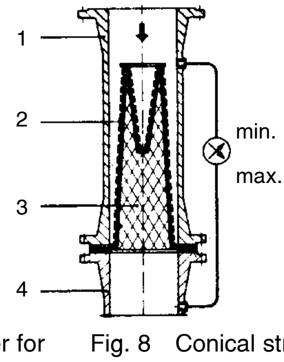


Fig. 8 Conical strainer with monitoring of pressure drop.

1.3.3 Valves

1.3.3.1 Isolating Valves

An isolating valve (gate valve) should be provided in the suction lift line, to enable the supply of fluid to a pump to be shut off if necessary. An isolating valve should also be incorporated in the discharge line of every pump, as close as possible to the pump itself. This valve can be used to adjust the operating point (rate of flow) apart from its function of isolating the discharge line. Isolating valves in Suction head lines should only be used to isolate the line. (in the event of repairs etc.) They must always remain fully open when the pump is running. If the pump operates under vacuum or suction lift, the isolating valve should be provided with a sealing liquid connection or with a closed water seal, to prevent any ingress of air into the stuffing box of the valve stem. To facilitate venting the isolating valves should be fitted in the line with their stems horizontal.

1.3.3.2 Non-Return Valves (in the discharge line)

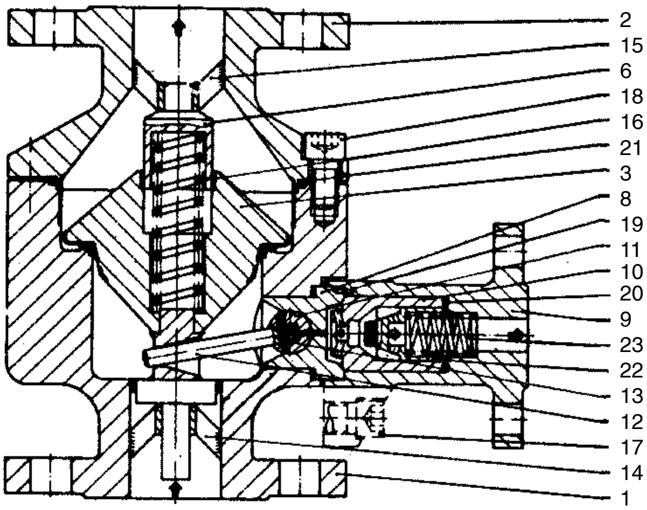
A check valve or non-return valve should be incorporated between the pump and the isolating valve. Depending on the circumstances, this can be either a check valve, or a non-return valve or an automatic recirculation valve. The object of the non-return valve is to prevent a reflux of fluid through the pump when the latter stops suddenly.

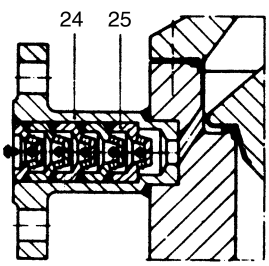
A blocked or leaky non-return valve may cause the pump to rotate in reverse, slackening the shaft protection sleeves and damaging the pump.

1.3.3.3 Automatic Recirculation Valve

The automatic recirculation valve (minimum flow device) is a safety device. It should always be installed immediately downstream of the pump, always upstream of the isolating valve, and always vertical, with the direction of flow from bottom to top. (see Fig. 9)

Each automatic recirculation valve is supplied in accordance with the operating conditions of the pump concerned.





"Construction with manual operation nozzle"

Fig. 9 Automatic recirculation valve

Part No.	Designation	Part No.	Designation
1	Bottom half of body	16	Cylindrical helical spring
2	Top half of body		
3	Valve cone	17	Socket head cap screws
6	Guide shank	18	Socket head cap screws
8	Slide valve head	19	Taper grooved dowell pin
9	Nozzle		
10	Throttle	20	O-ring
11	Rotary slide valve	21	O-ring
12	Lever	21*)	Valve
13	Taper grooved dowel pin	22	Cylindrical helical spring
14	Bottom spider	23	Manual operation
15	Top spider	24	Nozzle
		25	Multistage throttle

*) Not applicable for temperatures above 130ºC and valve pressure rating above PN 100 (metal to metal sealing provided).

Parts 8-13 (Complete leak-off nozzle) can be replaced individually.

The greater the flow of fluid, the higher the valve cone is lifted by the fluid pumped. A connecting rod in the shape of a lever the slide valve lever is connected at one end to the valve cone and at the rotor end to the shut-off valve (slide valve) on the bypass (leak-off) outlet. As the valve cone rises and falls, the shut-off valve is actuated by this lever, and the opening of the bypass is controlled in such a way that the bypass closes when the rate of flow has attained a given value, and opens when it drops below this value. The minimum flow rate is calculated and adjusted so as to avoid any excessive overheating inside the pump. (see Fig. 10)

Fig. 10

1.4 Final Coupling Check

After completion of the piping assemly, the coupling alignment should be checked once more (Ref. point No. 1.2). It must be possible to rotate the pump rotor without effort by hand at the coupling, when the stuffing boxes are not packed. If the alignment is satisfactory (no misalignment having taken place), the drive can be dowelled with cylindrical dowel pins. (Ref. Fig. 3)

1.5 Measuring Instruments

Each pump should be equipped with two pressure gauges, one at suction nozzle and the other at the discharge nozzle; and one more pressure gauge if the balancing line is connected to deaerator tank their measuring range should be suitable for the prevalent pressure conditions, and they should be provided with a stop valve, if the suction conditions demand it (e.g. suction lift operation), the gauge on the suction nozzle should be pressure vacuum gauge.

2. Commissioning, Start up / Shut down

2.1 Preliminary Remarks regarding Commissioning

If the initial start up does not take place immediately after the etection of the pumping set, but only weeks or even months later, it will be necessary to carry out the following checks once again before start up :

1. Check direction of rotation of driver after disconnecting the pump.

   Even a relatively short start up run in reverse rotation may result in damage to the pump. The overspeed trip check of the turbine or turbine driven pumps should also be carried out with the turbine disconnected from the pump.
2. Check correct coupling alignment again.
3. Dismantle pump bearings, clean them and reassemble them (as described in section 4.2 "Dismantling the Pump").
4. Fill-in oil, or check grease fill respectively.
5. Pack the stuffing boxes (see section 2.1.2.1 "Stuffing Boxes").

2.1.1 Oil Lubrication

Standard construction WL pumps are provided with oil splash lubrication. The antifriction bearings are slightly submerged in the oil sump, ensuring satisfactory lubrication at all times. The max. oil level is automatically attained during topping up when oil starts pouring out of the over flow holes in the bearing covers 360/361).

On request, we can fit constant level oilers (638), which will necessitate the sealing of the shaft against the bearing housing by means of felt rings. (422.1)

Oil Quality : Machinery oil possessing good air release properties and corrosion prevention characteristics; kinematic viscosity 36 cSt approx. = 4.8°E at 50°C; flash point 155°C minimum; pour point lower than - 20°C.

2.1.2 Shaft Seal

The shaft is sealed at its exists through the casings by soft packed stuffing boxes or by mechanical seals. If the pump is fitted with special stuffing boxes, mechanical seals can be fitted in lieu of soft packing (or vice versa) at any time during the service lift of the pump, with a minimum of machining of the cooling compartment covers. On the other hand, the fitting of mechanical seals to pumps equipped with standard or hot water type soft-packed stuffing boxes necessitates the fitting of new pump components. Particulars can be ontained from the pump manufacturer.

2.1.2.1 Stuffing Boxes

Soft-packed stuffing boxes reduce the flow of leakage liquid at the clearance gap between casing and shaft protection sleeve when the pressure inside the pump is higher than atmospheric. Conversely, on pumps which operate on suction lift, the soft-packed stuffing box prevents the ingress of air into the pump. Sealing is effected by means of soft packing (461.1) arranged in a number of rings in the annular space betwen the stuffing box housing (451) and the shaft protection sleeve (524.1/2) and lightly compressed by the stuffing box gland (452).

Caution :

On pumps which have a high discharge pressure, the stuffing box at the discharge end is relieved of pressure, via a balance liquid line, down to the suction pressure, provided that the differential pressure across the pump exceeds 2 bar. This ensures that the stuffing boxes at the suction and discharge ends of the pump have the same admission pressure. This arrangement applies to pump sizes 40 to 65 if the discharge pressure exceeds 20 bar and to pump sizes 80 to 150 if the discharge pressure exceeds 15 bar.

Single stage pumps require no special pressure relief even at high discharge pressures. The pressure is relieved via the balance holes in the impeller.

Soft-packed stuffing box, "Standard" (N) construction.

Standard construction with 4 packing rings (461.1) used for temperatures of the fluid pumped up to 105°C, the stuffing box compartment cannot be cooled.

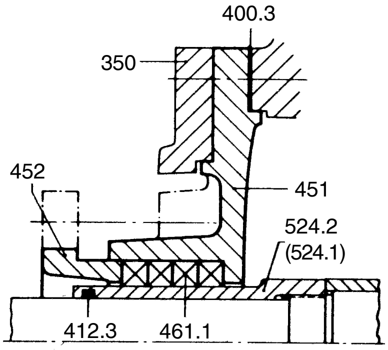


Fig. 11 "Standard" (N) construction stuffing box.

Soft-packed stuffing box, "Hot Water (HW) construction.

Construction with 4 packing rings (461.1) and cooling of the stuffing box compartment. Used for temperatures of the fluid pumped in excess of 105°C up to 230°C max.

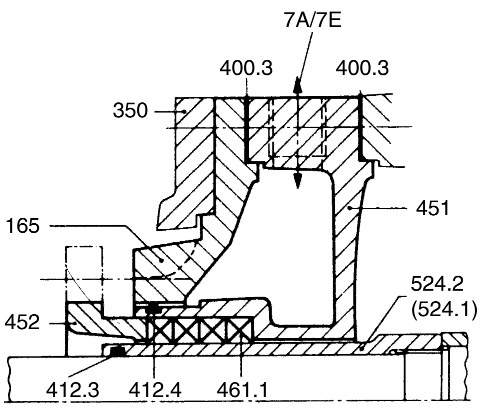


Fig. 12 "Hot Water" (HW) construction stuffing box.

Special stuffing box, "Extra-deep" (V) construction.

Construction with 7 packing rings (461.1) and cooling of the stuffing box compartment. Used mainly in process industry applications.

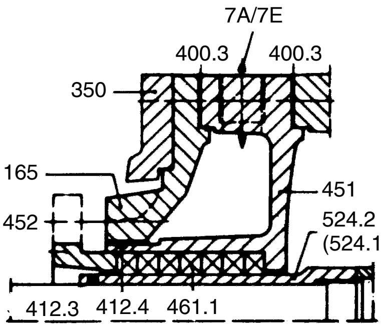
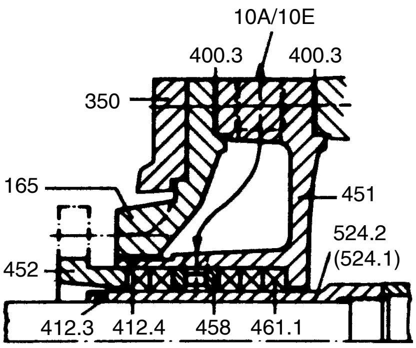


Fig. 13 Special soft packed stuffing box "Extra deep" (V).

Special stuffing box, "VSM" Construction

VSM is the abbreviation (in German) of "Extra deep with lantern ring at the centre".

Construction with 5 packing rings (461.1) and one lantern ring (458) arranged at the centre of the packing compartment; used mainly for operation under vacuum or suction lift, and where malodorous fluids are pumped. For operation under vacuum, the lantern ring (458) is fed with a sealing liquid, and it prevents the ingress of air into the pump.



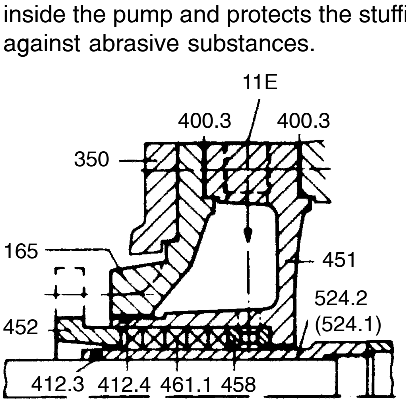
Fluids pumped :
Operation under vacuum or pumping of malodorous fluids (ammonia and solvents).

Sealing liquid consumption 1 to 3 litres/hours approx.

Fig. 14 Special stuffing box VSM.

Special stuffing box, "VSH" Construction

VSH is the abbreviation (in German) for "Extra deep with intern ring at the bottom of the box". This construction with 5 packing rings (461.1) and a lantern ring (458) arranged at the bottom of the packing compartment is used where fluids containing abrasive particles are pumped. The flushing liquid, which should be fed through the lantern ring (458) at a pressure of atleast 1 to 4 bar (max.) above the suction pressure, penetrates inside the pump and protects the stuffing box packing (461.1) against abrasive substances.



Fluids :

Products containing abrasive particles, which must be kept away from the stuffing box packing, so as not to erode the latter (oils containing diatomite (kieselguhr), fractions from catalytic cracking containing abrasive catalyst particles). Flushing liquid consumption 300 to 500 litres/hour approx.

Fig. 15 Special stuffing box VSH.

2.1.2.2 Cooling Liquid for Stuffing Boxes

Treated cooling water which does not tend to pericipate salts causing hardness out of solution should be used as cooling liquid. The cooling water should be allowed to flow out freely and visibly, so that it can be checked at any time in respect of rate of flow and temperature. The temperature differential between cooling water inlet and outlet should not exceed 10°C. The max. permissible cooling water outlet temperature should not exceed 50°C. The cooling water pressure should be situated between 1 bar min. and 10 bar max.

An isolating valve should be incorporated in the cooling water supply line, to enable the rate of flow of cooling water to be adjusted, and the supply of cooling water to be turned off when the pump is shutdown. The cooling water should only be turned off after the temperature of the fluid inside the pump has dropped to below 80°C.

2.1.2.3 Packing the Stuffing Boxes

Caution :

The pump is despatched from our works with the stuffing boxes unpacked. An adequate quantity of packing material is supplied loose with the pump. The stuffing box will only be able to perform its vital function satisfactorily on condition that it is carefully packed and properly maintained as prescribed.

Before packing, thoroughly clean stuffing box gland (452), packing compartment and shaft protection sleeve (524.1/.2).

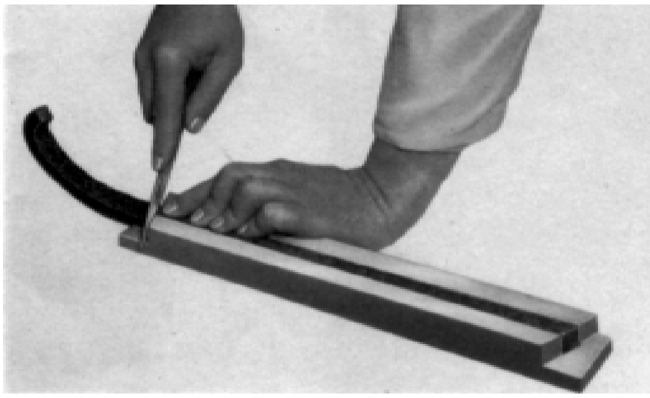


Fig. 16 Cutting the packing rings to length.

To cut the packing rings to correct length, use a suitable wooden cutting jig (we can supply same on request), to ensure that the packing rings are of the correct length and that their ring butts come into correct contact with one another. (see Fig. 16)

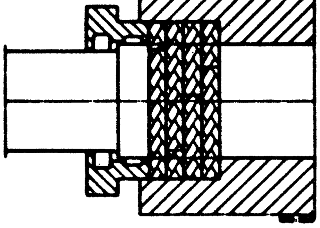


Fig. 17 Stuffing box packing.

If the packing rings are either too long or too short, the stuffing box will not be aboe to perform its function properly. In the case of asbestos-graphite packing material, the rubbing faces of the individual rings should be lightly coated with molybdenum disulphide before insertion in the packing compartment. The first packing ring is then inserted and pushed home into the compartment with the aid of the stuffing box gland.

The following packing rings are then inserted into the packing compartment one by one, making sure that the butt joint of each ring is offset 90° approx. in relation to the buss joint of the preceding ring; the individual rings are pushed home into the packing compartment with the aid of the stuffing box gland (see Fig. 17 and 18). The packing rings should only be pressed lightly against one another. They should not be inserted in the packing compartment in such a way that a clear gap of 6 to 8 mm is left at the outer end of the compartment for the positive guidance of the stuffing box gland.

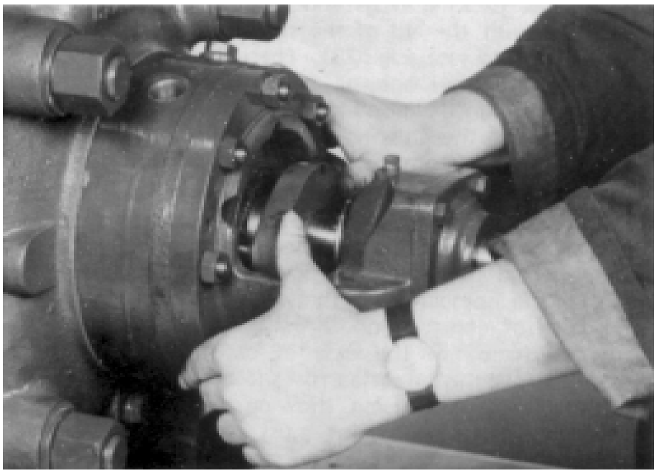


Fig. 18 Insertion of packing rings with the aid of the stuffing box gland.

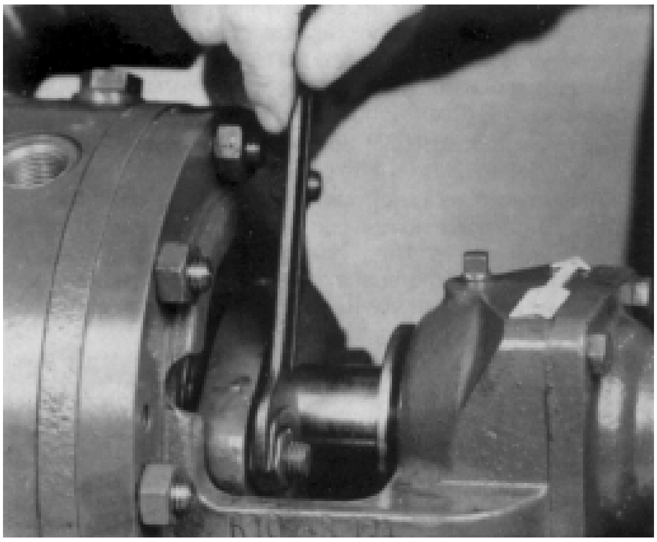


Fig. 19 Tightening the stuffing box gland.

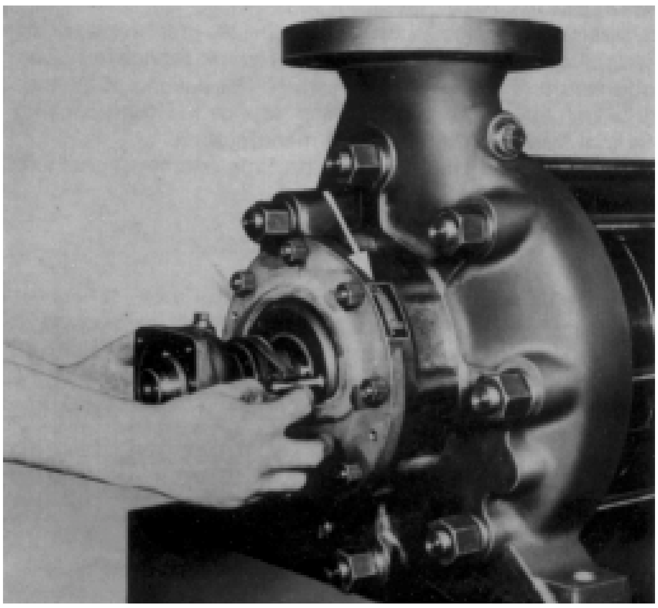


Fig. 20 Information plate regarding lantern ring.

The inserted packing rings should then be compressed moderately with the aid of the stuffing box gland (452) and the nuts (see Fig. 19). Then the nuts should be slackened again by one to two complete turns, and thereafter tightened lightly by hand. The correct and even seating of the stuffing box gland (452) should be checked with the pump is subjected to suction pressure, by inserting a feeler gauge between the gland (452) and the shaft protection sleeve (524.1/.2).

In the case of the special stuffing boxes, a lantern ring is also inserted in the packing compartment, viz. at the centre of the compartment (between the packing rings) in the case of construction "VSM", and at the bottom of the compartment in the case of construction "VSH". In these cases, an information plate (see Fig. 20) is affixed to the stuffing box housing, showing the position of the lantern ring. The lantern ring must register beneath the drilled hole in the stuffing box housing, to enable the sealing or flushing liquid to flow through the hole and the ring. The sealing or flushing liquid pressure should be 1 to 4 bar above the pressure reigning in the packing compartment of the stuffing box.

The packing of the stuffing boxes should be carried out with great care, to avoid an excessively high radial pressing force of the packing rings against the shaft protection sleeve, which might damage the latter. If the shaft protection sleeve is scored or grooved, even a new packing cannot be expected to last very long in service.

A newly packed stuffing box should leak profusely at first. If this leakage does not cease of its own accord after a relatively short period of operation, the nuts on the gland should be tightened slowly and evenly while the pump is running, until the stuffing box only drips slightly. Make sure that stuffing box glands (452) are tightened evenly and not askew, as otherwise the shaft protection sleeves (524.1/.2) might be damaged. (see Fig. 19)

The leakage rate in service of a soft-packed stuffing box should amount to 3 to 5 liters/hours approx.

If the newly packed stuffing boxes start to smoke when the pump is started up for the first time, the pump should be switched off. If the smoking persists after the pump has been started up again and operated several times in succession, the nuts on the gland should be slackened slightly, or the stuffing box should be inspected if necessary.

2.1.2.4 Packing Material

When selecting the packing material, make sure it is compatible with the fluid pumped. (consult the manufacturer in case of doubt)

In steam generating plants, the asbestos-graphite packing material specially developed for hot water service has given good results. Packing material which has been kept in store for a certain period has a longer service life than packing material fresh from the packing manufacturer.

2.1.3 Priming the Pump

The pump must be completely primed with the product pumped. Before it is started up for the first time, the pump should be vented through the connection on the discharge pressure gauge, or through the vent valves, if provided. The discharge line should also be vented through valves situated at the apex of the line.

2.2 Start-up

1. Check oil level in pump bearings, if necessary top up the oil fill until oil starts pouring out of the over flow hole.
2. Check condition of stuffing boxes (451.1/451.2). The stuffing box gland should penetrate deep enought in the stuffing box to ensure positive guidance, and must not be tightened askew (see section 2.1.2.1 “Stuffing Boxes”).
3. In the case of a mechanical seal with internal circulation, open flow controller fully (only applies to the initial start-up).
4. Turn on cooling liquid supply and check that it flows away freely.
5. Open suction valve fully.
6. Leave isolating valve in discharge line closed for the time being.
7. Open the shut off valve on the minimum flow line of the automatic recirculation valve and lock it open, to prevent unintentional closure. If the automatic recirculation valve is equipped with a manual operation line, open the valve in this line.

   If the pump is only equipped with a manually controlled minimum flow (by pass) line, open the isolating valve in this line.

   If a check valve or non return valve is incorporated and if the pump is to be started up against an open discharge valve, make sure that the non return valve is closed as a result of the back pressure (e.g. the boiler pressure). If the full back pressure does not reign at the time of start up the pump should only be started up against a closed discharge valve.
8. Check suction pressure and temperature. Check whether the saturation condition of the fluid pumped reigns inside the pump with the aid of the saturation curve. No vapour formation must be allowed to take place inside the pump.
9. When starting up for the first time, and also after a prolonged plant shutdown, start up the driver with the pump coupled to it, then switch off the driver again immediately. Check that the rotor runs down to a standstill smoothly and lightly, and check that the pump bearings are being supplied with oil. The pump rotor must not stop with a sudden jerk.
10. In the case of a turbine drive pump, run the pump up to full speed rapidly.
11. Watch the discharge pressure, to make such the pump attains the prescribed discharge pressure.
12. If applicable, close the manually operated minimum flow line when the operating rotational speed has been attained. Check whether minimum flow line becomes warm.
13. Adjust rate of flow of cooling liquid for the mechanical seal by means of the flow controller. The temperature at the mechanical seals should not exceed 70⁰C.
14. Open isolating valve in the discharge line.

Caution :

If the pump is commissioned on hot fluid, the casing will heat up more rapidly than the tie rods (905) because of its direct contact with the fluid pumped. The casing will become longer as a result of thermal expansion. The prestressing of the tie rods will increase and the surface pressure (contact pressure) on the glat gaskets will attain a maximum value. Under such stress conditions, the gaskets which are still new will bed themselves down. When the pump has warmed up all over, the tie rods (905) may sutter such a reduction in prestressing that the pump may start leaking at the stage casings, especially in the case of pumps with a large number of stages. In order to avaoid such leakage, the tie rods (905) should be tightened up after the first few “hot” starts on a new or reconditioned pump.

2.3 Shut-down

1. Close isolating valve (gate valve or globe valve) in the discharge line. If applicable, check the opening point of the minimum flow device from time to time.
2. Switch off driver and watch the pump run down smoothly to a standstill. The pump rotor should not stop with a sudden jerk.
3. If applicable, turn off the sealing, circulation or flushing liquid.
4. The cooling liquid supply can be partially throttled, but it should only be turned off completely when the temperature inside the pump, measured at the pump nozzle, has dropped below 80⁰C. The suction valve should remain open unless the pump is being taken our of service for a prolonged period and is being drained.

3. Maintenance and Lubrication

3.1 Supervision of Operation

1. Pumps operating at constant speed may usually be operated at the point of optimum efficiency, at total heads up to 90% of design head. Provided that suction head and the motor horsepower are adequate.
2. Pumps operating at variable (controlled) speed may only be operated within the rage indicated in the pump operating diagram below. It should be noted that the throughput which can be achieved decreases with decreasing speed and pressure. (see Fig. 21)

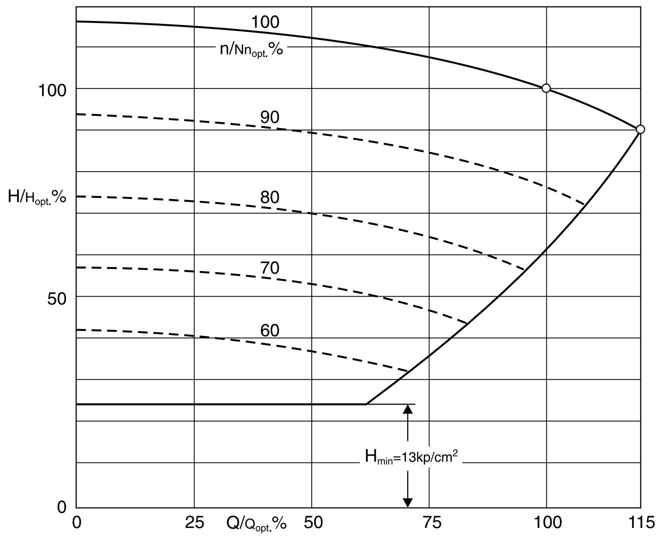


Fig. 21 Pump operating diagram.

3. When filling the boiler, the operating limits specified in 1 and 2 above should not be exceeded i.e. the discharge valve should be partially closed to ensure tha the pressure does not fall below the minimum discharge pressure corresponding to the particular speed or capacity at which the pump is operated at the time. If the rate of flow drops below the minimum flow, the minimum flow device starts operating. Any prolonged operation within the response range of the minimum flow device should be avoided as far as possible, because this will cause permature wear on the control and throttling organs.

3.2 Lubrication and oil change

Lubrication times : First oil change after the first 500 hours of operation, subsequent oil changes after every 3000 hours of operation appeox., but at least once a year.

Topping up of the oil fill at least once a month.

The bearing temperature may be allowed to rise up to 40°C above room temperature, but should not exceed 80°C.

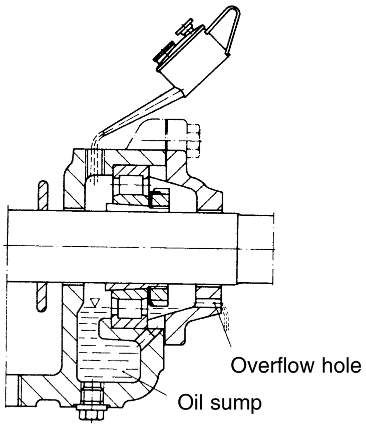


Fig. 22 Sump Oil Lubrication.

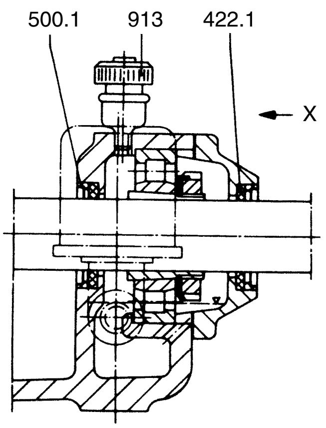


Fig. 23 Construction with constant level oiler and sealing of the bearing housing.

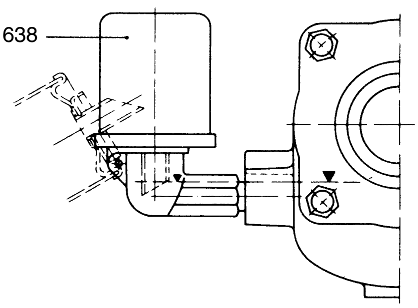


Fig. 24 Constant level oiler, viewed from X.

3.3 Preservation

If the pump is taken out of service for a prolonged period, it is advisable to dismantle it completely. Proceed as described in section 4.2 “Dismantling”. All components should be thoroughly cleaned, dried and all bright parts coated with grease. Thereafter the pump should be reassembled. All apertures on the pump should be plugged with wooden stoppers soaked in oil or blanked off with wooden cover plates fitted with O-rings. A sachet filled with silicagel (silicagel absorbs moisture) should be attached to the inside faces of the oil soaked wooden cover plates on the suction and discharge nozzles (i.e. inside the nozzles).

The packing should be removed from the stuffing box compartment and these should be sealed by oil-soaked wooden half tubes, each provided with two O-rings, in order to prevent the penetration of moisture (not applicable to pumps fitted with mechanical seals).

Caution :

Only use acid free oils and greases when preserving the pump.

4. Special Instructions & Recommendations

4.1 Dismantling and Reassembly

4.1.1 General

1. Close all isolating valves in the suction and discharge lines, and also, if applicable, in the cooling liquid, sealing liquid or flushing liquid lines, and drain the pump via the drain apertures (6B) in the suction and discharge casings. (106 and 107)
2. Dismantle and remove cooling liquid, sealing liquid or flushing liquid lines.
3. Pull out stuffing box gland (452) and remove stuffing box packing. (461.1)
4. Disconnect coupling (see section 1.6 “Couplings”). Check pump alignment at the coupling and make a note of the measurements. (see section 1.2.1)
5. If the pump is to be dismantled completely, unscrew the fixing bolts on the suction and discharge lines and on the pump feet, and remove the pump from the baseplate.
6. Drain off the oil fill in the bearing housing by unscrewing drain plug (903.4/.5).

4.2 Dismantling

4.2.1 Dismantling the End side Bearing

A. Dismantling the End side Bearing

1. Pull off the half coupling with the aid of an extractor. (see Figs. 25 and 26)

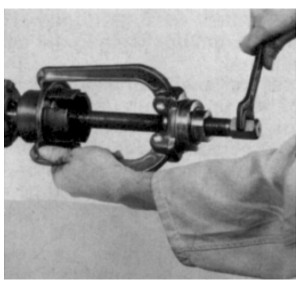


Fig. 25 Coupling puller.

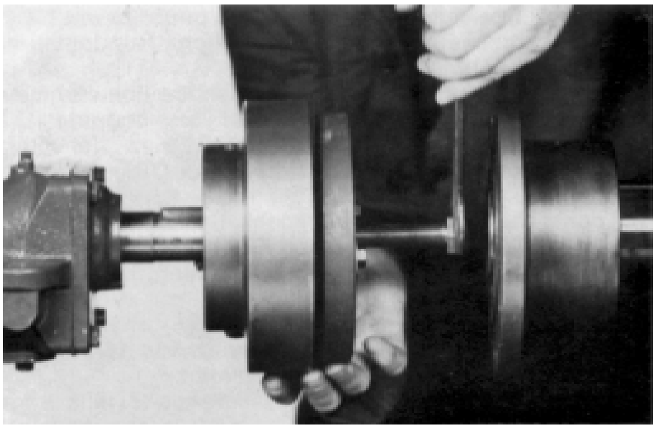


Fig. 26 Pulling off the coupling hub.

2. Remove bearing cover (361).
3. Bend back tab washer between ring nut of adaptor sleeve and cylindrical roller bearing (322). (see Fig. 27).

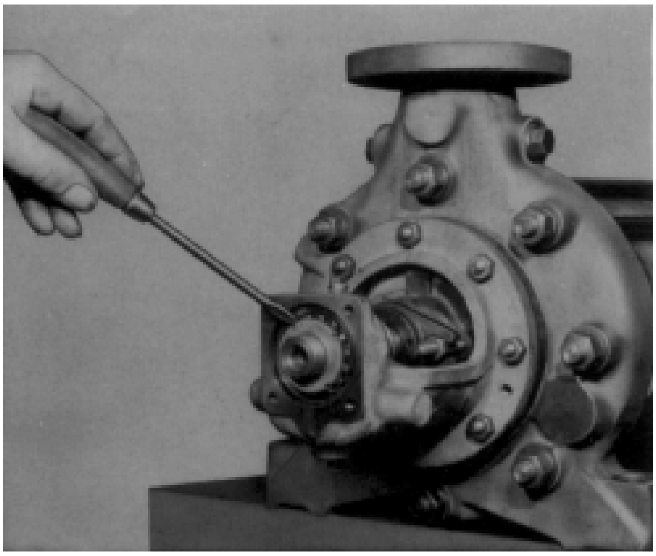


Fig. 27 Bending back the locking washer.

4. Slacken withdrawal nut of adaptor sleeve (52.1) by a few turns. (see Fig. 28)

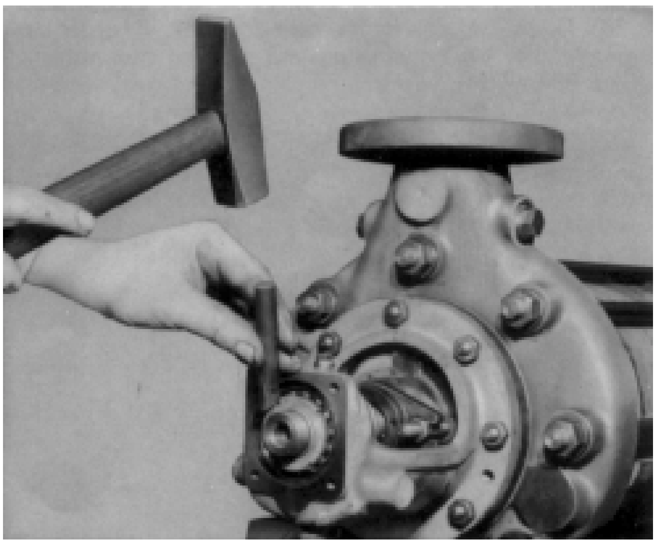


Fig. 28 Slackening the withdrawal nut.

5. Loosen adaptor sleeve (52.1) on shaft (210) by gentle taps on the end face of the withdrawal nut.

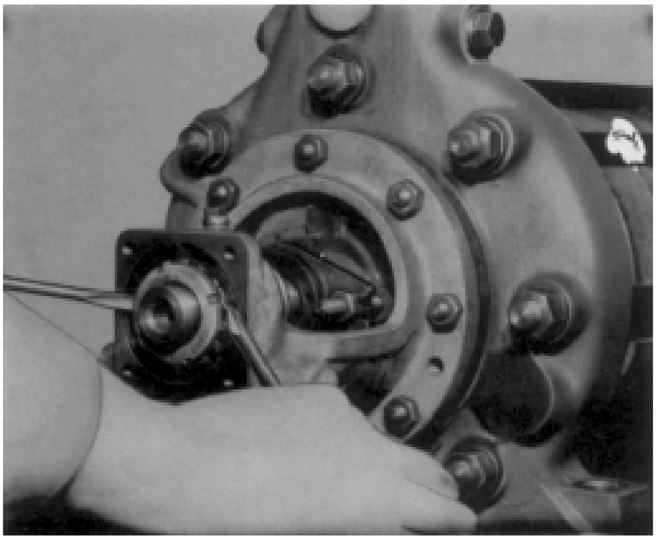


Fig. 29 Forcing out the inner components of the cylindrical roller bearing.

6. Pull out inner race of cylindrical roller bearing (322) together with adaptor sleeve (52.1) from bearing housing (350). (see Fig. 29 & 30)

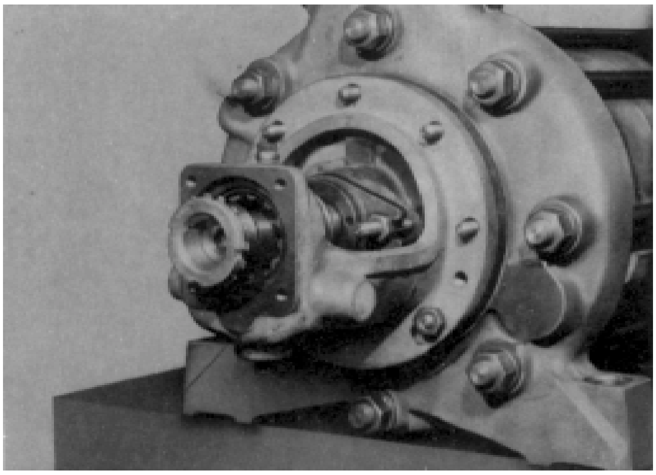


Fig. 30 Dismantled inner components of cylindrical roller bearing.

7. Unscrew and remove hex. nuts (920.2) from studs (902.1) in the suction casing (106) in order to dismantle the bearing housing and stuffing box housing. (see Fig. 31 and 32)

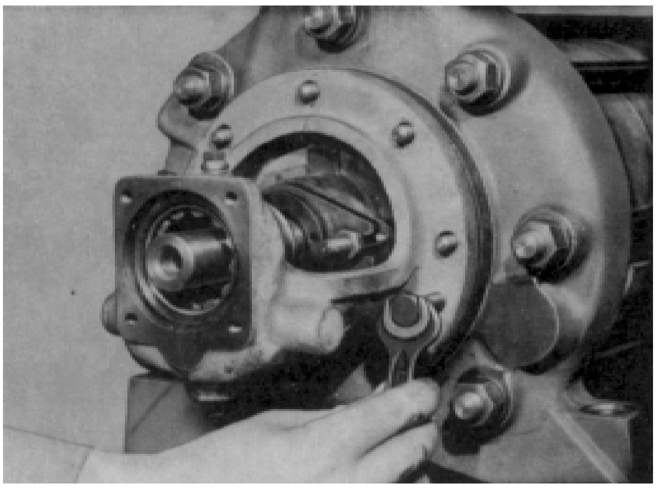


Fig. 31 Forcing off the bearing housing.

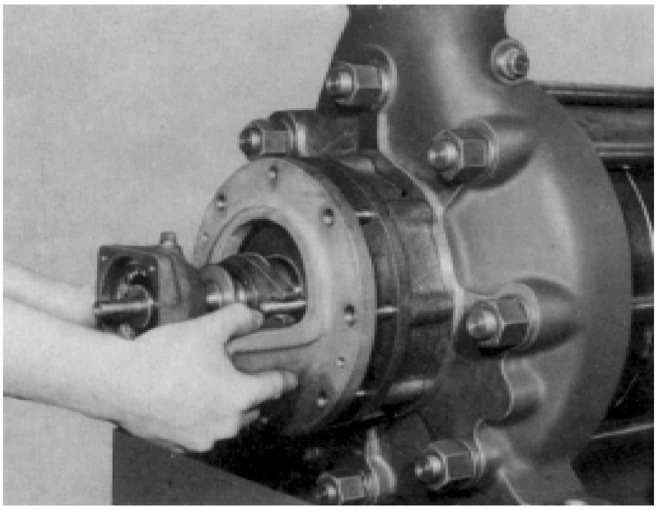


Fig. 32 Removing the bearing housing (350) together with outer race of cylindrical roller bearing (322).

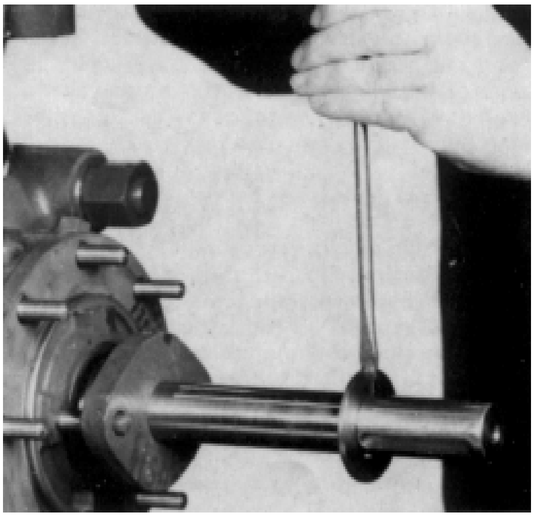


Fig. 33 Stripping off the splash ring.

8. On pump size 150 which is fitted with a cylindrical roller bearing without adaptor sleeve, the bearing housing (350), including the outer race of the bearing and the spacer bush (543) are removed after unscrewing the hex. nuts (920.4), then the inner race of the bearing and the spacer sleeve (525.4) are pulled off the shaft, and the circlip (932) removed.

Dismantling the End side Bearing

Standard Bearing Construction

Remove bearing end cover (361) together with sleeve (623.1) of rotor position indicator.

All further steps are as from 3 to 8 of the section 4.2.1 A (the previous one)

4.2.1.1 Dismantling the Balancing Device

1. Pull off the balancing disc (601). Use the tapped holes and puller studs for this purpose.
2. Remove key from shaft (210).
3. Unscrew and remove fixing screws of counter balancing disc (602).
4. Dismantle counter balancing disc (602). Use the tapped holes and puller studs to pull it out.
5. On pump size 150, pull spacer sleeve (525.2) off the shaft.

4.2.2 Removing the Shaft Seal

4.2.2.1 Soft-packed Stuffing Box Construction

1. Pull stuffing box gland (452) off the shaft.
2. Force off and remove stuffing box housing (451). On pumps eqipped with cooled stuffing boxes, force off and remove the stuffing box housing (451) including cooling cover (165) (see Fig. 34).

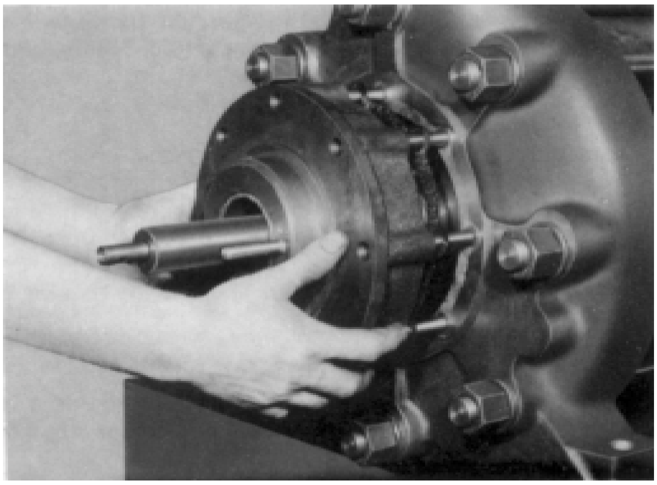


Fig. 34 Removing the stuffing box housing (451).

3. Slacken shaft protection sleeve (524.2) and remove it from shaft (210). (see Fig. 35)

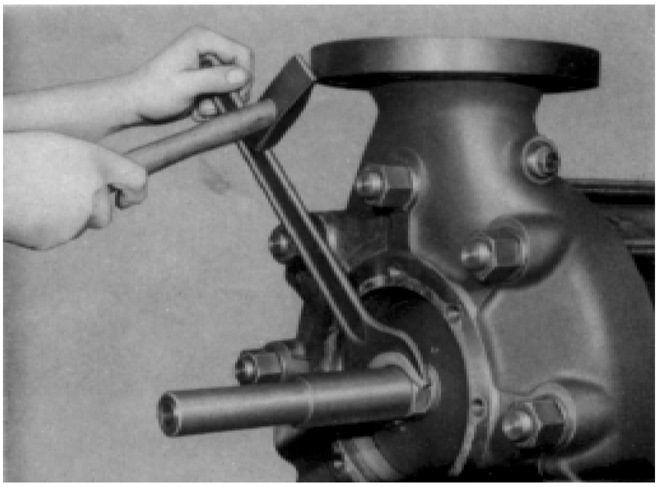


Fig. 35 Slackening shaft protection sleeve (524.2).

4.2.3 Dismantling the Pump Body

1. The stage casings (108) should be numbered consecutively in respect of their positions in relation to one another before dismantling, to ensure that the suction casing (106), the stage casing (108) and the discharge casing (107) are all reassembled in the correct sequence and orientation in relation to one another during reassembly. (see Fig. 36)

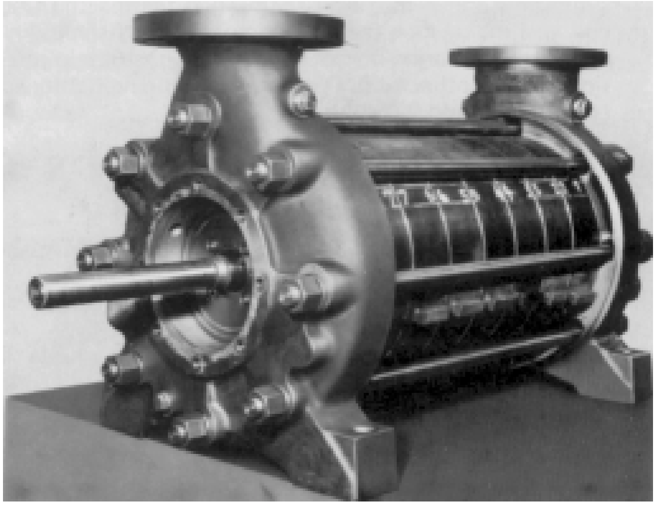


Fig. 36 Identification of casing components and removal of tie rods.

2. Unscrew nuts (920.1) at discharge end or tie rods (905) and pull the tie rods out of the suction and discharge casings.
3. Underpin the pump at the stage casing (108) with wooden blocks or an erection trestle, so as to free the component with is to be dismantled next.
4. Force discharge casing (107) together with diffuser/last stage (171.2) off stage casing (108) and lift it off. (see Fig. 37 and 38)

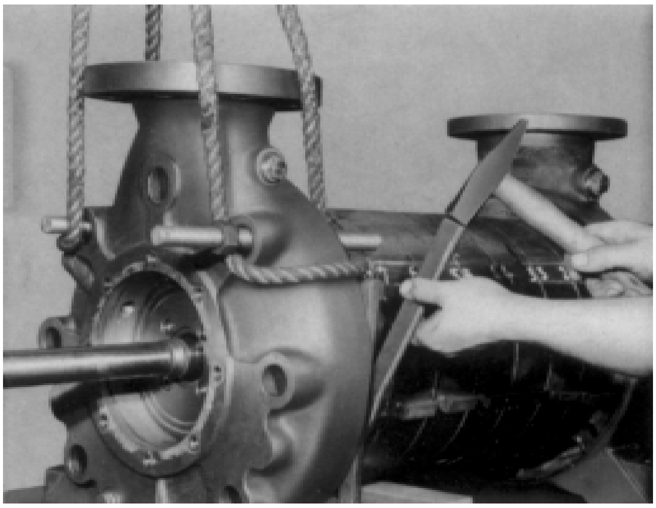


Fig. 37 Forcing off the discharge casing.

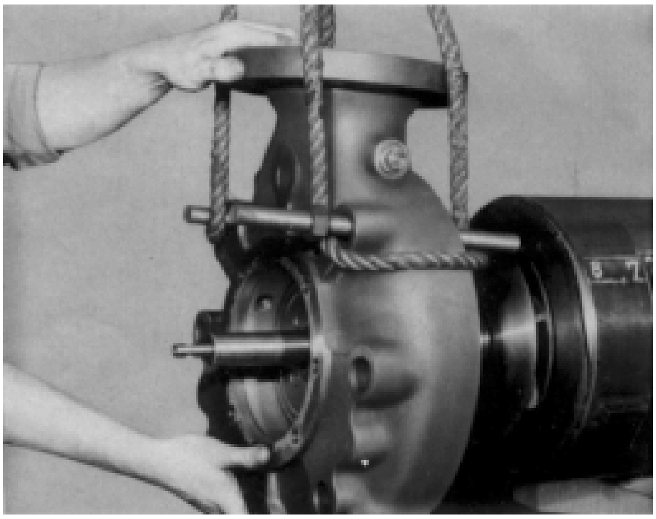


Fig. 38 Lifting off the discharge casing.

5. Dismantle in sequence impellers (230), stage casings (108) together with diffusers (171.1), keys and stage sleeve (521). (see Fig. 39 and 40)

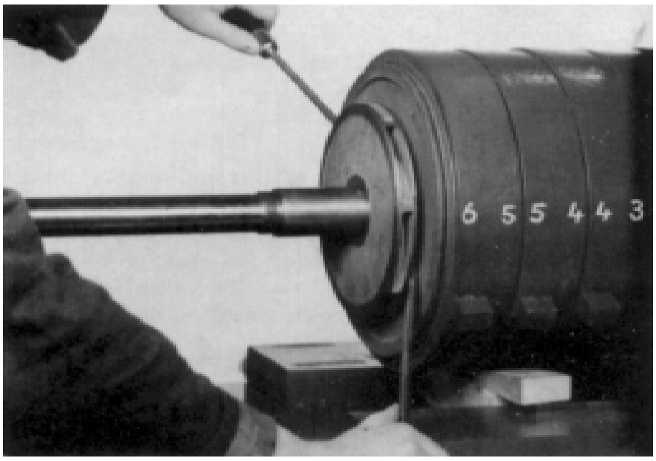


Fig. 39 Forcing off the impeller.

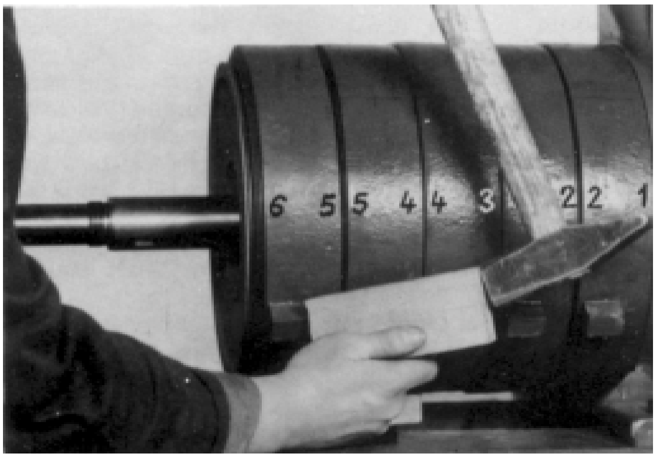


Fig. 40 Slackening and removing the stage casing.

6. When the last stage casing (108) has been dismantled, pull shaft (210) together with last impeller (230), spacer sleeve (525.1) and shaft protection sleeve (524.1) out of the suction casing. (see Fig. 41)

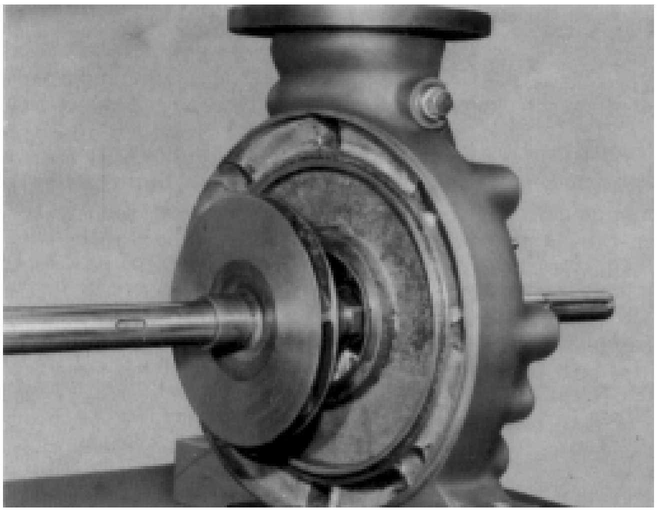


Fig. 41 Removing the shaft together with first stage impeller.

7. Pull impeller (230), spacer sleeve (525.1) and shaft protection sleeve (524.1) off the shaft. (see Fig. 42)

Fig. 42 Dismantled shaft with impeller spacer sleeve and shaft protection sleeve.

8. Stack the stage casings on top of one another in correct order. The contact faces should be protected by wooden strips or thick cardboard during stacking, to avoid any damage. (see Fig. 43)

Fig. 43 Stacking the stage casings on top of one another.

4.3 Bearing Arrangement

The shaft (210) is supported on two cylindrical roller bearings (322) attached to the shaft by means of the adaptor sleeves (52.1); the shaft is free to slide axially. The bearings do not have to absorb any axial forces because the axial thrust is compensated by the balancing device (601 and 602). (see Figs. 45 and 46)

Splash rings (507) mounted on shaft (210) prevent the ingress of leakage liquid from the stuffing box into the bearing housing (350).

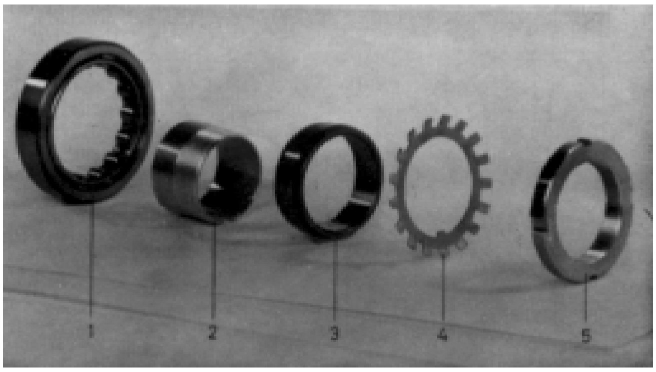


Fig. 44 Individual bearing components (drive end).

Part 1 = Outer race with cage and rollers
Part 2 = Adaptor Sleeve
Part 3 = Inner bearing race
Part 4 = Locking Washer
Part 5 = Withdrawal Nut

End Side Drive Side

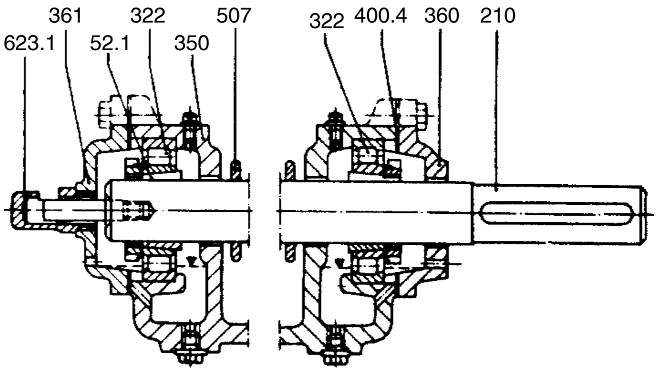


Fig. 45 Standard bearing arrangement.

End Side Drive Side

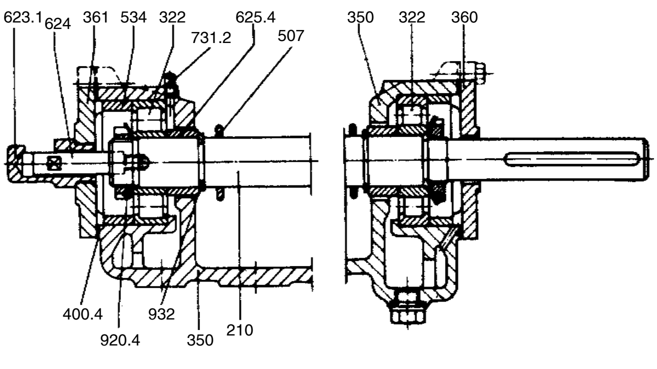


Fig. 46 Bearing arrangement on pump size 150.

4.3.1 Bearing & Oil Requirement

Pump Size	40	50	65	80	100	125	150
Bearing designation in accordance with DIN 5412	NU 206 K-C3	NU 207 K-C3	NU 207 K-C3	NU 208 K-C3	NU 208 K-C3	NU 210 K-C3	NU 410-C3
Adaptor sleeve in accordannce with CIM 5415	H 206	H 207	H 207	H 208	H 208	H 210	
Oil fill per pump (litres)	0.16	0.18	0.18	0.25	0.25	0.28	0.45
Approx. annual oil consumption (litres)	1.5	1.5	1.5	2.0	2.0	2.0	2.5

Fig. 47 Table of bearing sizes and oil requirements.

4.4 Reassembly

4.4.1 Preparations prior to Reassembly

Before reassembly of ring section pumps, the axial face-to-face length 'E' of each stage casing (108) and of the corresponding impeller (230) with stage sleeve (521) must be measured. Any discrepancy in lengths must be compensated by machining the stage sleeve (521) only, and the end result must be E1 = E2 taking the thickness of flat gasket (400.2) into account. (see Fig. 48)

If machining of the stage sleeve is required, it should be shortened at both end faces in one and the same clamping on the machine tool. The permissible end face wobble (deviation from plane parallelism) is 5 m. Make sure not to damage the conatact faces on the casing components, diffusers impellers, stage bush and stage sleeve before and during assembly. All pump components, particularly the end contact faces, should be thoroughly cleaned. If new impellers are fitted, or if the old ones are touched up, the rotor must be balanced dynamically.

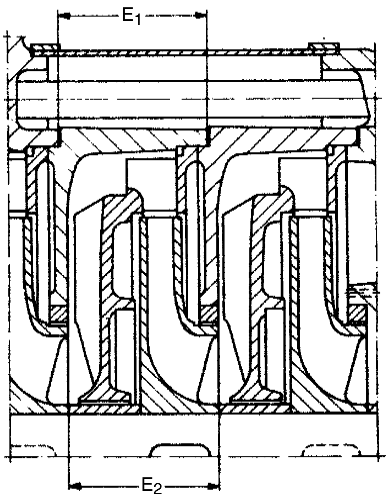


Fig. 48 Measuring the stages.

4.4.2 Assembling the Pump Body

1. Before assembly of the rotor components, coat the shaft (210) with molybdenum disulphide.

2. Slip the shaft protection sleeve (524.1) onto shaft (210) after inserting O-ring (412.3) and pull it tight against the shaft shoulder. Mount spacer sleeve (525.1), key and first stage impeller (230) onto shaft (210). (see Fig. 49)

Fig. 49 Shaft with first stage impeller.

3. Insert shaft (210) together with spacer sleeve (525.1) and impeller (230) into suction (106). (see Figs. 50 and 51)

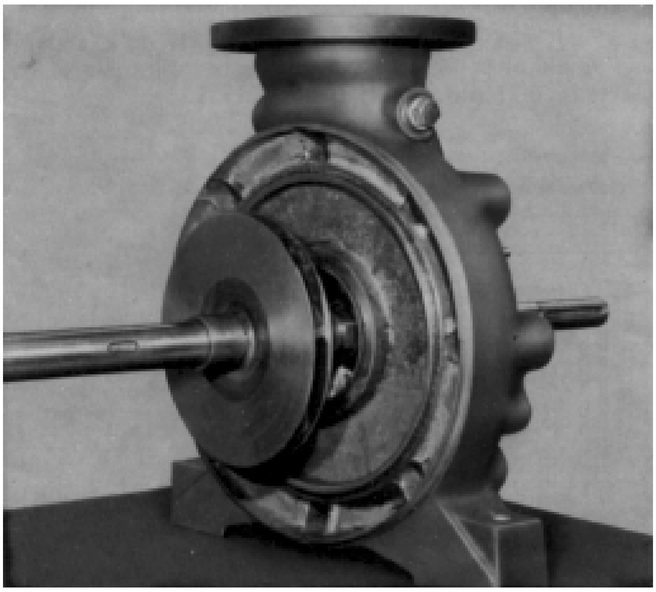


Fig. 50 Shaft with first stage impeller inserted into suction casing.

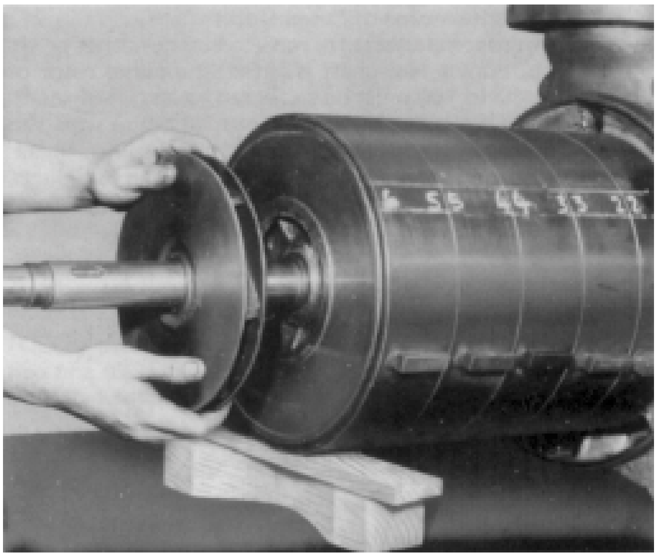


Fig. 51 Mounting the impeller.

4. Mount stage casing (108) together with inserted diffuser (171.1) and flat gasket (400.2), and slip stage sleeve (521) onto the shaft. (see Fig. 52)

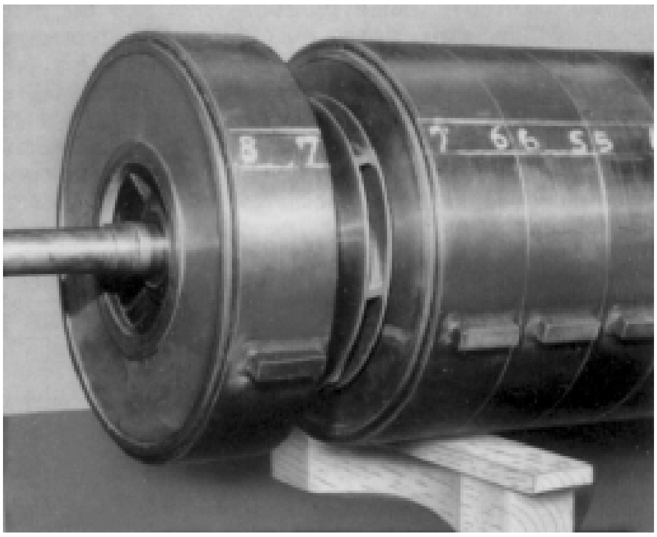


Fig. 52 Mounting the stage casing.

5. Mount all the following stages in similar fashion each stage consists of stage casing (108), diffuser (171.1), casing wearing ring (502), flat gasket (400.2), impeller (230), key and stage sleeve (521). Underpin the stage casings (108) in turn after assembly.

6. After assembly of each individual stage, check the total axial clearance "Sa1 + Sa2" of the pump rotor. (approx. 6 mm., see Fig. 53)

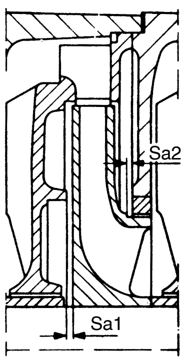


Fig. 53 Checking the total axial clearance.

7. Mount discharge casing (107) with inserted final stage diffuser (171.2) and O-ring (412.2). (see Figs. 54 and 54.1)

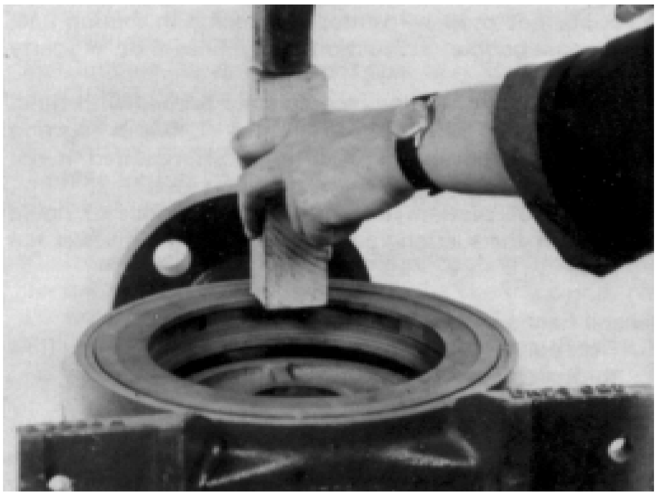


Fig. 54 Inserting the diffuser in the discharge casing.

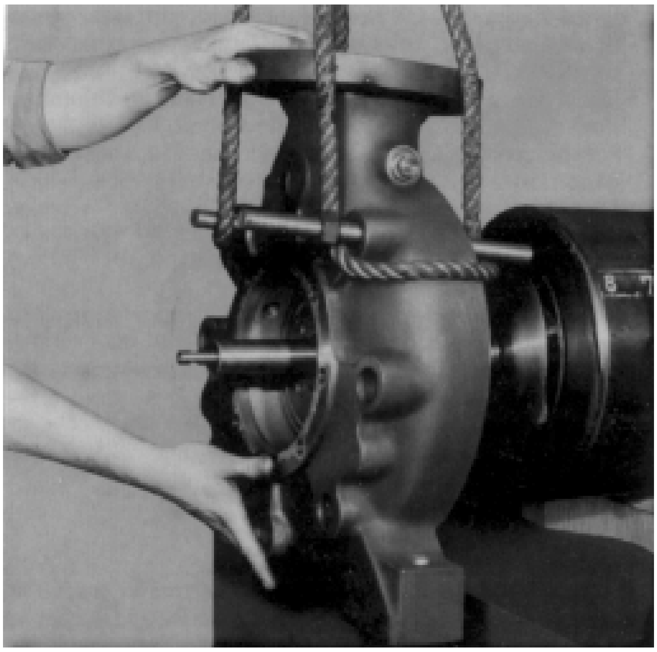
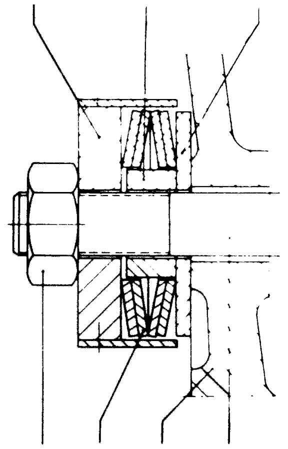


Fig. 54.1 Mounting the discharge casing.

8. Insert tie rods (905) with nuts (920.1) and washers (550) from the suction end.

9. At the suction end, screw on at the hex. nuts (920.1) on tie rods (905) and screw them down to median position. Insert the tie rods (905) from the suction end, after having slipped on the washers.

9a. Pumps which operate under conditions of extreme temperature fluctuations (in excess of 50^{0}C within a 30 minutes interval) can be subjected to unequal thermal expansion at the casings and tie rods, which can result in leakage. In order to compensate these expansions, a stack of cup springs should be inserted between the nut and suction casing on each tie rod. The number of cup springs in the stack will depend on the compression pressure required, and is determined by the pump manufacturer. (see Fig. 55)



Part No.	Designation
106	Suction casing
483	Spring cage
520.1	Sleeve
550.1	Washer
905	Tie rod
920.1	Hex. nut
950	Stack of cup springs

Fig. 55 Stack of cup springs.

Size	Number of stages	Torque	Number of stages	Torque
40	1-10	7.5 kpm	11-16	8.0 kpm
50	1-10	8.5 kpm	11-15	10.0 kpm
65	1-10	12.0 kpm	11-14	15.0 kpm
80	1-8	20.0 kpm	9-12	23.0 kpm
100	1-8	25.0 kpm	9-11	27.0 kpm
125	1-6	30.0 kpm	7-10	32.0 kpm
150	1-6	35.0 kpm	7-8	37.0 kpm

1 kpm = 1 kgm

Fig. 56 Tightening torque for the tie rod.

9b. The washer (550.1), sleeve (520.1), stack of cup springs (950) and spring cage (483) are all mounted on the tie rods (905) between the suction casing (106) and the hex. nut (920.1). The cup springs should be lightly coated with oil before insertion. The hex. nut (920.1) should be screwed on by hand. The tie rods (905) should be fitted as described under point 10 below. The hex. nut (920.1) at the suction end should be tightened until abutment is achieved.

If the pump should become slightly distorted by uneven tightening, the hex. nuts (920.1) at the suction end should be slackened slightly.

10. At the discharge end, the screw threads of the tie rods and the washers should be coated with molybdenum disulphide. The hex. nuts (920.1) should be tightened by hand with a standard short spanner to ensure intimate contact of the stage casings (108) at their sealing faces.

11. Slip the stage sleeve onto the shaft until it abuts against the hub of the final stage impeller.

12. Place the pump on the base plate. The pump feet must seat flush on the baseplate. Tighten hex. nuts (920.1) on the tie rods at the discharge end evenly on the cross.

13. Tighten nuts (920.1) on the tie rods (905) at the discharge end. Then slacken the nuts at the discharge end again until the seating is loose, and tighten them again by hand with the aid of a short hammering spanner until contact is established. Then tighten the nuts firmly with the aid of a torque spanner. (see Fig. 56)

14. Mount bearing housing (drive end) (350) together with outer race of cylindrical roller bearing (322) and tighten hex. nuts (920.2) uniformly. (see Fig. 57)

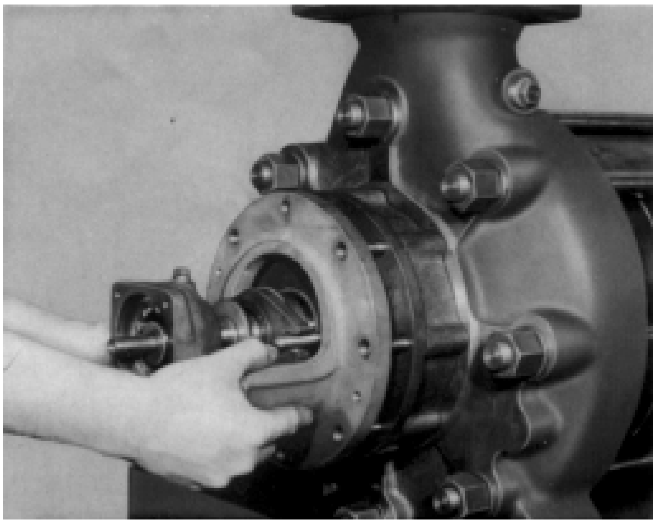


Fig. 57 Mounting the bearing housing.

15. Slip adaptor sleeve (52.1) together with inner race of bearing, lock washer and withdrawal nut onto shaft (210) until the rear end face of the bearing inner race lies in the same plane as the outer end face of the outer race of cylindrical roller bearing (322). Then tighten the withdrawal nut and make sure that the components of the cylindrical roller bearing do not slide out of position in relation to each other whilst the withdrawal nut is being tightened. (see Figs. 58 and 59)

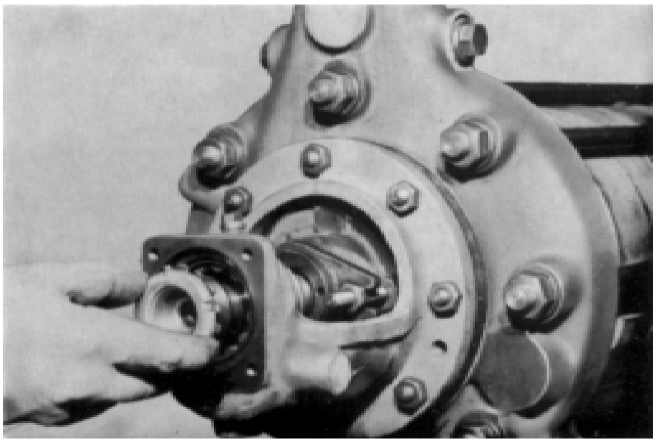


Fig. 58 Mounting the inner race of the cylindrical roller bearing with adaptor sleeve.

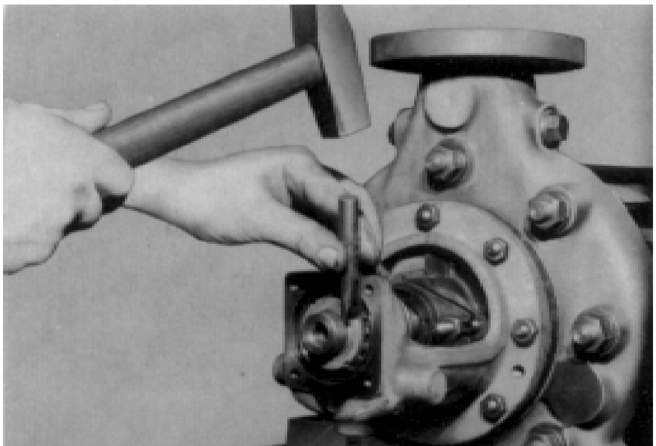


Fig. 59 Tightening the withdrawal nut.

16. Bend down the tabs on the lock washer. (see Fig. 60)

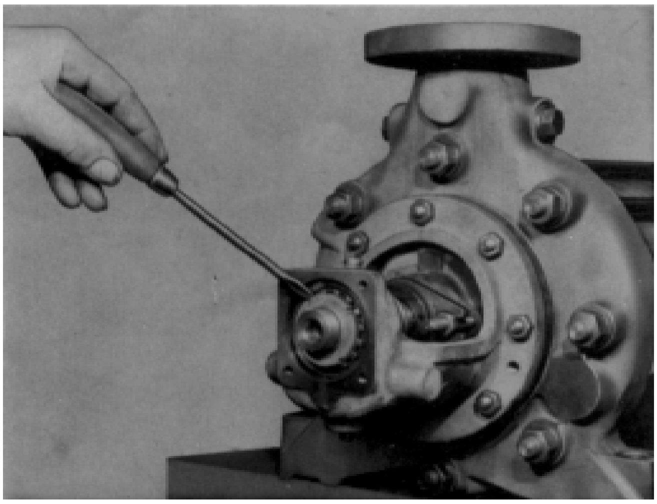


Fig. 60 Bending down the tabs on the lock washer.

17. After this mount the counter balancing disc (602) with flat gasket (400.1) in discharge casing (107) and tighten it firmly with the aid of the allen head screws.

    Then slide the rotor towards the suction end of the pump until it abuts, then slide it towards the discharge end until it abuts, and measure the total axial play. There after slide the rotor back towards the suction end by one third of the measured total play. Measure distance "X" between hub of last stage impeller and rubbing face of counter balancing disc (602). (see Fig. 61)

Caution : Do not alter the position of the rotor during this measurement.

Then shorten the hub of balancing disc (601) at its suction end face so as to obtain the same distance "X" between the rubbing face of the balancing disc and the end face of the hub.

On pump size 150, the spacer sleeve (525.2) should be shortened correspondingly. (see Fig. 62)

Make sure not to impair the plane paralelism of the end faces during the machining. The deviation from absolute plane parallelism must not exceed 0.05 mm.

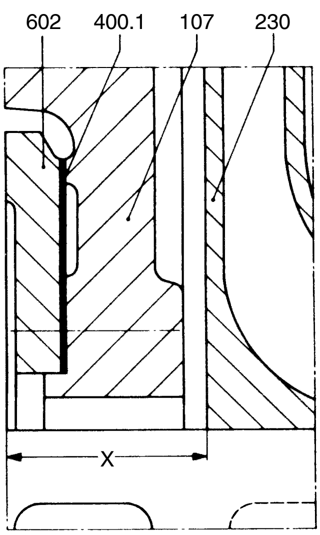


Fig. 61 Measurement of rotor adjustment.

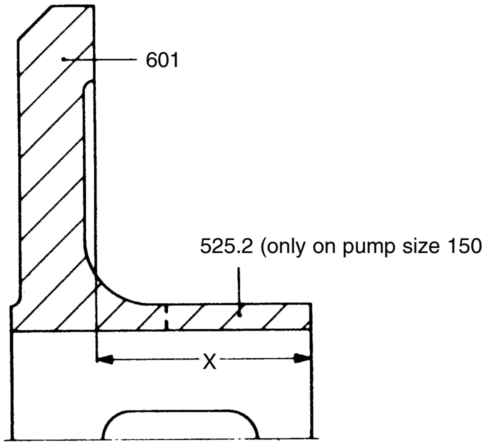


Fig. 62 Measurement of balancing disc.

18. Reassembly of Balancing Device.

a. Clean all components throughly, and lightly coat the rubbing faces of the balancing device (601 and 602) with molybdenum disulphide or clean machinery oil. Inspect all components in respect of flawless condition.

b. Mount counter balancing disc (602) with flat gasket (400.1) in discharge casing (107) and tighten the allen head screws very firmly. (see Fig. 63 and 64)

c. Insert key for balancing disc (601) in shaft (210).

d. Slip balancing disc (601) onto shaft (210) and onto the key. In the case of pump size 150, first mount spacer sleeve (525.2).

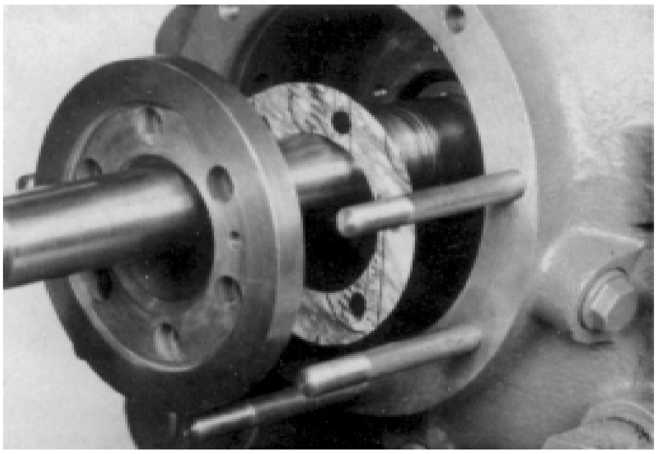


Fig. 63 Insertion of counter balancing disc.

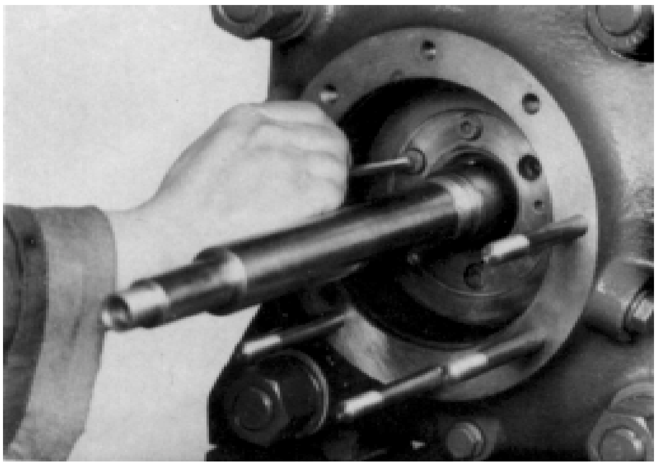


Fig. 64 Fastenning the counter balancing disc.

19. Assembly of Shaft Seal

Pump Construction with Soft-packed Stuffing Box

1. Slip shaft protecting sleeve (524.2) onto shaft (210) after insertion of O-ring (412.3), and pull it tight against spacer sleeve (525.2). (see Fig. 65)

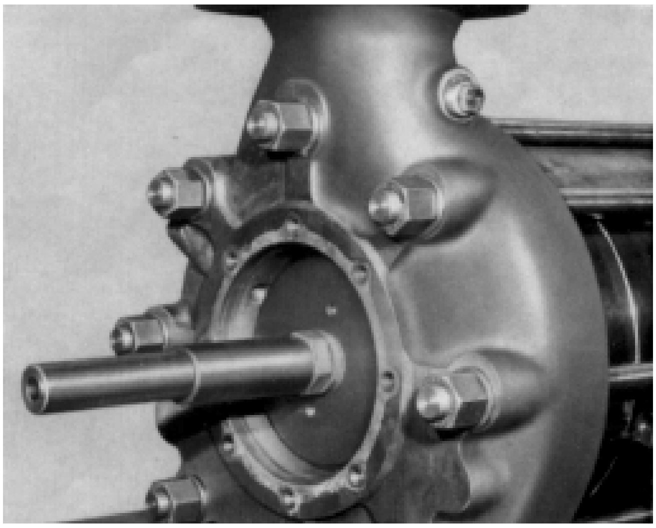


Fig. 65 Mounting the shaft protection sleeve.

2. Mount stuffing box housing (451) with flat gasket (400.3). In the case of pumps equipped with cooled stuffing boxes, mount the stuffing box housing (451) together with cooling compartment cover (165). (see Fig. 66)

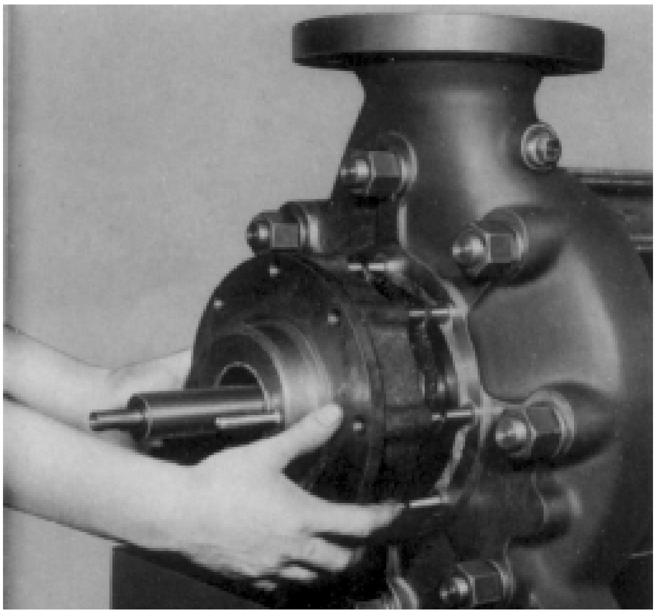


Fig. 66 Mounting the stuffing box housing.

3. Slip the stuffing box gland (452) loosely on shaft (210) but do not insert it in the stuffing box compartment.
4. Slip splash ring (507) onto the shaft.
5. Mount end side bearing cover (361) together with flat gasket (400.4) and indicator bush (623.1) of the rotor position indicator.
6. Check the scribed marking on indicator bush (623.1) of the rotor position indicator, with the balancing disc (601) in conatact with counter balancing disc (602), and if necessary scribe a new marking on the sleeve.
7. Check pump alignment at the coupling, and realign pump if necessary.
8. Pack the stuffing boxes.
9. Fill bearing housing (350) with oil.
10. Open isolating valve in suction line fully, and also, if applicable, isolating valve in the balance liquid line.
11. Start up the pump.

4.5 Spare Parts

4.5.1 Spares ordering

Please quote the following information when ordering spares.

Part :

Type : WL Pump size / Number of stages.

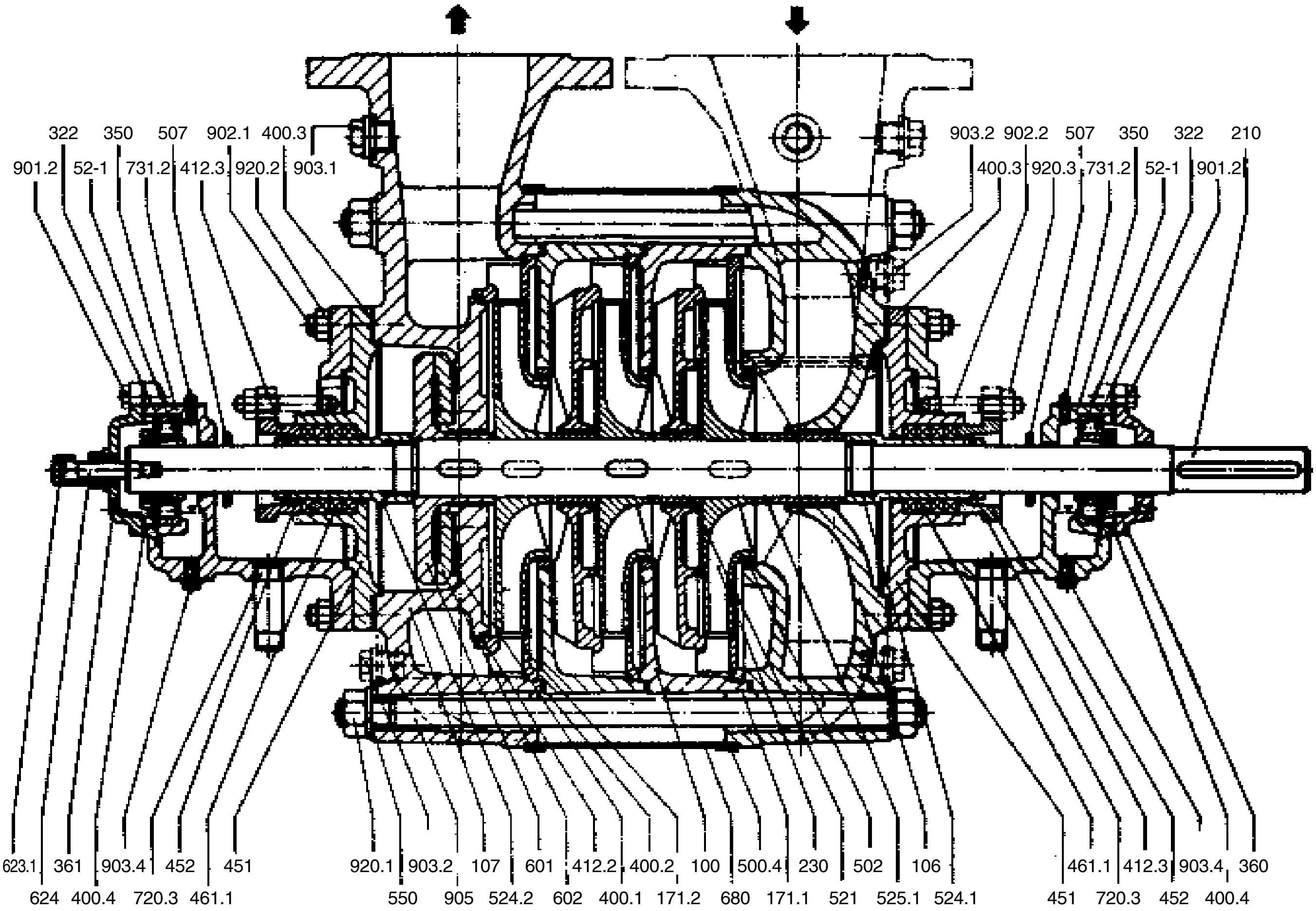
Product No. :

Serial No. :

Part No.		Quantity for pump construction with: Standard stuffing box	Special stuffing boxes HW V, VSM, VSH	Mechanical seal	Remark
210	Shaft with keys	1	1	1	*)
230	Impeller	S	S	S	*)
322	Cylindrical roller bearing	2	2	2	
400.1	Flat gasket	1	1	1	
400.2	Flat gasket	S	S	S	
400.3	Flat gasket	2	4	4	
400.4	Flat gasket	2	2	2	
400.6	Flat gasket	-	-	2	
412.2	O-ring	1	1	1	
412.3	O-ring	2	2	2	*)
412.4	O-ring	-	2	2	
422.1	Felt ring	1	1	1	Only when bearing is sealed
461.1	Stuffing box packing (in metres)	2	2	-	
472	Machanical seal, complete	-	-	2	
502	Casing wearing ring	S	S	S	
521	Stage sleeve	S-1	S-1	S-1	
523.1	Shaft protection sleeve	-	-	1	*)
523.2	Shaft protection sleeve	-	-	1	*)
524.1	Shaft protection sleeve	1	1	-	*)
524.2	Shaft protection sleeve	1	1	-	*)
525.1	Spacer sleeve	1	1	1	*)
525.2	Spacer sleeve	1	1	1	*)
540.1	Stage bush	1	1	1	Only on pump size 150
540.2	Stage bush	1	1	1	Only on material alternative Chrome Steel
540.3	Stage bush	1	1	1	Only on material alternative Chrome Steel
541	Stage bush	S-1	S-1	S-1	Only on material alternative Chrome Steel
52.1	Adaptor sleeve complete	1	1	1	
601	Balancing disc	1	1	1	*)
602	Counter balancing disc	1	1	1	

S = Number of stages
*) Parts for complete pump rotor.
The latter should be assembled and dynamically balanced, and kept in stock as a complete spare parts.

4.6 Sectional Drawing & List of Components



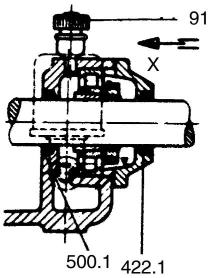
Part No.	Designation	Qty. Per Pump
106	Suction casing	1
107	Discharge casing	1
108	Stage casing	S-1
165	Cooling cover	2
171.1	Diffuser	S-1
171.2	Diffuser last stage	1
(210)	Shaft	1
(230)	Impeller	S
(322)	Cylindrical roller bearing	2
350	Bearing housing	2
360	Bearing cover	1
(400.1)	Flat gasket	
(400.2)	Flat gasket	
(400.3)	Flat gasket	
(400.4)	Flat gasket	Set
(412.2)	O-ring	
(412.3)	O-ring	
(412.4)	O-ring	
421.1	Oil seal	3
422.1	Felt ring	3
451	Stuffing box housing	2
452	Stuffing box gland	2
458	Lantern ring	2

Part No.	Designation	Qty. Per Pump
(461.1)	Stuffing box packing	Set
500.1	Spacer ring	2
500.4	Spacer ring	2
(502)	Casing wearing ring 1)	S
503	Impeler wearing ring 1) 4)	S
507	Splash ring	2
(521)	Stage sleeve	S-1
(524.1)	Shaft prot. sleeve	1
(524.2)	Shaft prot. sleeve	1
(525.1)	Spacer sleeve	1
525.4	Spacer sleeve 3)	+
(540.2)	Stage bush 1)	1
(540.3)	Stage bush 1)	1
(541)	Stage bush 1)	S-1
543	Spacer bush 3)	1
550	Washer	16
52.1	Adapter sleeve	
(601)	Balancing disc	1
(602)	Counter balanding disc	1
623.1	Indicator bush	1
624	Indicator	1
636	Grease nipple	

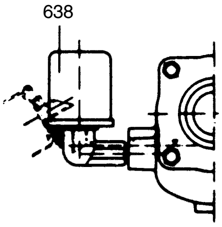
Part No.	Designation	Qty. Per Pump
638	Constant level oiler	2
680	Cover sheet	1
720.3	Double nipple	2
731.2	Plug	Set
901.2	Hex. bolt	Set
902.1	Stud	Set
902.2	Stud	Set
903.1	Plug	Set
903.2	Plug	Set
903.4	Plug	Set
905	Plug	Set
913	Veng plug	Set
920.1	Hex. nut	Set
920.2	Hex. nut	Set
920.3	Hex. nut	Set
920.4	Shaft nut 3)	1
932	Circlip 3)	2
7A	Cooling liquid outlet	
7E	Cooling liquid inlet	
10A	Sealing liquid outlet	
10E	Sealing liquid inlet	
11E	Flushing liquid inlet	

1) For complete chrome steel execution (i.e. Impeller, Diffuser, Stage and Wearing Ring, all of Chrome Steel).
2) For out door execution felt ring Part No. 422.1/2 or Oil seal 421.1/2.
3) For WL 150
4) Only supplied in conjunction with Part No. 230 (Impeller)
( ) Recommended spare parts
S Number of stage

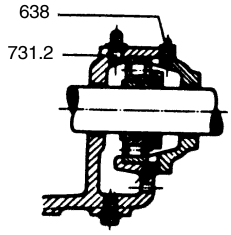
Construction with constant level oiler and bearing housing seal



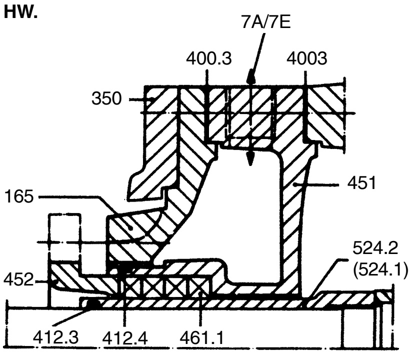
Constant level oiler (viewed from X)



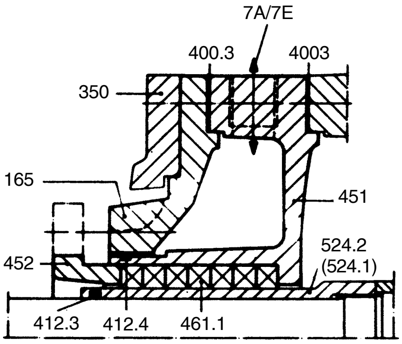
Grease-lubricated construcion



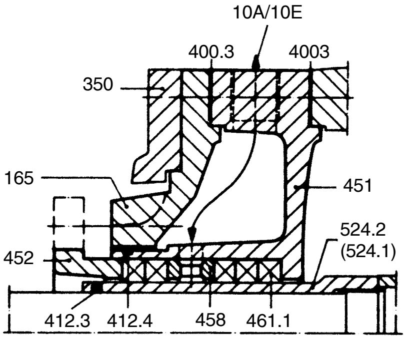
Hot water stuffing box HW.



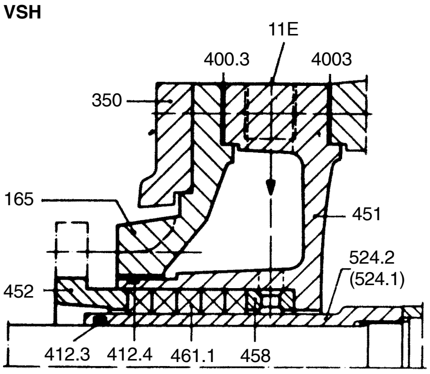
Special stuffing boxes V



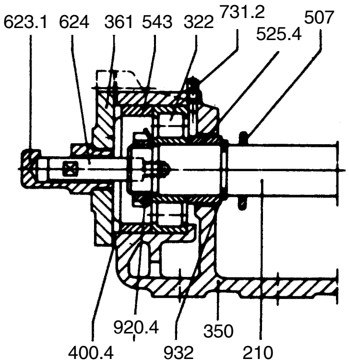
VSM



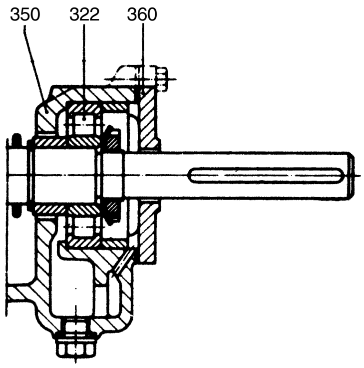
VSH



WL 150 bearing construction

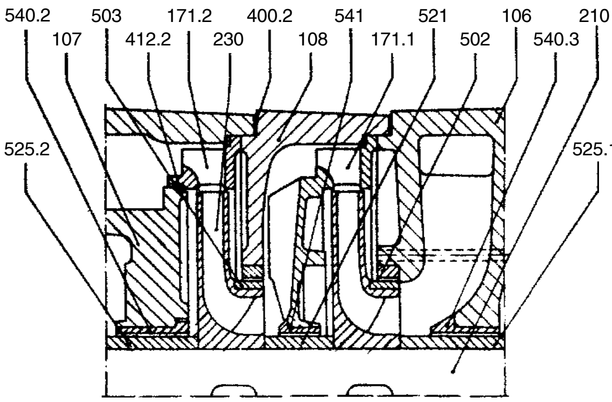


Front end



drive end

Construction with Complete Chrome Steel



Impeller wear rings and bushes

5. Faults

Caution : Before remedying operation troubles check all measuring instruments used for reliability and accuracy.

Faults	Code Number Cause-Remedy
1. Pump fails to deliver liquid	1, 2, 3, 4, 5, 7, 8, 12, 13
2. Pump delivers insufficient liquid	1, 2, 3, 4, 5, 8, 12, 13, 13, 20, 21
3. Total head is too low	3, 4, 5, 7, 8, 10, 12, 19, 20, 21
4. Sudden interruption of delivery shortly after start up	1, 2, 3, 4, 9, 11, 13
5. Absorbed power is excessively high	6, 7, 9, 10, 17, 19
6. Excessive leakage at stuffing box	14, 16, 18, 22, 23, 24, 25, 28, 29
7. Life of packing is too short	14, 16, 18, 22, 23, 24, 25, 26, 27, 28, 29
8. Pump vibbrates or runs noisily	2, 3, 4, 11, 13, 14, 15, 16, 17, 18, 20, 24, 32 33
9. Life of bearings is too short	14, 16, 17, 25 31, 32, 33, 34
10. Excessively high temperature inside the pump. Rotor fouls the inlet, outlet covers or sizes	1, 3, 4, 7, 9, 11, 13, 14, 16, 18, 19, 20, 24, 30, 32
11. Fluctuations in pressure or rate of flow of the balance liquid	2, 4, 13, 17, 19, 20, 21, 30, 35
12. Too high a rate of leakage liquid at the mechanical seal, or too short a mechanical seal life	14, 16, 18, 24, 25, 35, 36, 37, 38, 39, 40, 41

5.1 Cause of Damage : (the numbers listed below correspond with the code numbers of section 5).

Faults at the Suction End

1. Pump not properly vented, air pocket in suction line, vapour bubble at suction end, lines not properly vented.
2. Pump or suction line incompletely primed with fluid.
3. Insufficient pressure differential between suction pressure and vapour pressure. NPSH required is not attained (observe rate of pressure decrease).
4. Mouth of suction line too close to surface of liquid level in the suction vessel, or liquid level in vessel too low.

General Faults in the Installation

5. Rotational speed too low, or rate or minimum flow through by-pass excessive.
6. Rotational speed too high.
7. Reverse rotation.
8. Total head required for the system is higher than total head generated by the pump at duty point (back pressure too high).
9. Total head required for the system is lower than total head generated by the pump (pump operates beyond the performance limit curve).
10. Specific gravity of fluid pumped is different from figure specified originally (different operating temperature).
11. Operation at very low rate of flow (fault in minimum flow device, rate of minimum flow is too low).
12. Pumps cannot possibly operate in parallel under these conditions.

Mechanical Faults

13. Foreign bodies lodged in impeller.
14. Pump misaligned or incorrectly aligned, or shifting of foundation.
15. Resonance, or interference by other machines via the foundation.
16. Shaft is bent.
17. Rotating elements foul the stationary elements, pump runs very rough.
18. Bearing badly worn.
19. Casing wearing rings badly worn.
20. Impeller damaged or disintegrated.
21. Faulty casing seal (excessive internal loss at throttling gap, rotor clearances exceeded due to wear), so that an excessive loss arises or water leaks through the casing partition. Water leaks out of metallic sealing face to atmosphere.
22. Shaft or shaft protection sleeves worn or scored, O-ring damaged.
23. Stuffing box badly packed. Packing material of unsuitable quality.
24. Shaft chatters because bearings are worn or because shaft is misaligned.
25. Rotor vibrates.
26. Stuffing box gland is tightened excessively, no fluid available to lubricate the packing.
27. Defect in cooling liquid supply to water-cooled stuffing box gland.
28. Excessive clearance gap between stuffing box gland and shaft protection sleeve. Packing is squeezed into gap beneath the gland.
29. Dirt or sand in cooling liquid fed to stuffing box gland causes scoring of shaft protection sleeve.
30. Excessively high axial thrust.
31. Insufficient quantity of oil in bearing housing, unsuitable oil quality, dirty oil, water in the oil.
32. Faulty bearing assembly (damage during assembly, wrong assembly).
33. Dirt in the bearings.
34. Ingress of water into bearing housing.
35. Change in cross-section of balance liquid return line. Abrasive wear on balancing device. Leaching out of stationary components of balancing device. The balance liquid line has too great a pressure drop characteristic. The balance liquid lines of several pumps are tied into close to the pump.
36. Rubbing faces of mechanical seal worn or scored, O-rings damaged.

37. Seal incorrectly assembled. Materials unsuitable.
38. Surface pressure in sealing gap too high, no fluid available for lubrication and cooling.
39. Fault in cooling liquid supply system to mechanical seal.
40. Excessively large gap between cooling housing and spacer sleeve. Temperature in the cooling circuit rises excessively.
41. Dirt in cooling circuit of mechanical seal leads to scoring of mechanical seal rubbing faces.

5.2 Suggested Remedies

If, after a breakdown has occurred, one of the cause listed in section 5.1 has been established as the cause, and the matter has been put right or the cause of the trouble eliminated, it is recommended, prior to recommissioning, the set, to check the balancing device and the effortless rotation of the pump rotor by hand, with the driver disconnected (unless the pump had to be dismantled in any case, because of the damage). Check that the pump runs smoothly and quietly after recommissioning.

Cause 1. Open vent valves or pressure gauge vent screws, open isolating valves in minimum flow device circuit. (The balance liquid lines must be open). Check layout of pipelines to ensure that fluid flows smoothly.

Cause 2. Prime pumps and piping again, and vent them thoroughly. Check layout of pipelines.

Cause 3. Check isolating valves and strainers in suction line. The instrument reading taken must be accurate. Consult manufacturer.

Cause 4. Check liquid level in reservoir and examine possibility of altering it. Raise liquid level, alter mouth of suction line. The nozzle should not project too high inside the reservoir, and it should be shaped so as to promote favourable flow characteristics.

Cause 5. Increase speed if pump is turbine-driven. Refer to manufacturer, if pump is motor-driven. Check operation of minimum flow device.

Cause 6. Decrease speed, if pump is turbine-driven. Refer to manufacturer, if pump is motor-driven.

Cause 7. Transpose (cross over) two phase leads on the motor.

Cause 8. Increase rotational speed. Fit larger diameter impellers. Increase number of stages. Refer to manufacturer.

Cause 9. Adjust pressure conditions by means of discharge valve. Alter rotational speed, alter impeller diameter. Refer to manufacturer.

Cause 10. Check temperature of fluid pumped, take steps outlines in 9, above.

Cause 11. Check operation of minimum flow device. Refer to manufacturer.

Cause 12. Check condition of individual machines. Refer to manufacturer.

Cause 13. Clean out pump, check condition of suction system (check suction line and strainers).

Cause 14. Realign pumping set when cold.

Cause 15. Refer to manufacturer.

Cause 16. Fit a new shaft. On no account straighten out a bent shaft.

Cause 17. Check balancing device, and dismantle pump if necessary.

Cause 18. Check quiet running of pumps. Check coupling alignment (when cold). Check oil quality and cleanliness.

Cause 19. Fit new casing wearing rings, Check out-of-round true running of rotor. Check presence of foreign bodies in the pump. (see also item 5.3)

Cause 20. Fit new impeller. Check suction head (cavitation). Check system for presence of foreign bodies. (see also item (5.3)

Cause 21. Replace damaged components by new ones.

Cause 22. Replace damaged components by new ones. Check shaft protection sleeves for true running (out-of-round). Check suitability of packing material used. Check that gland is not tightened askew and observe rate of leakage.

Cause 23. Carefully repack stuffing box. Check suitability of packing material used.

Cause 24. Realign coupling (when cold). Fit new bearings. Check rotor for signs of damage.

Cause 25. Check suction pressure (cavitation). Check coupling alignment. Check pump internals for presence of foreign bodies.

Cause 26. Repack stuffing box. Tighten gland lightly only. Allow slightly higher rate of gland leakage. Check suitability of packing material used.

Cause 27. Check unobstructed flow through cooling water feed line.

Cause 28. Fit an throttle bush or a new stuffing box gland. Check condition of shaft protection sleeve.

Cause 29. Use treated cooling liquid. Fit filters in cooling liquid lines.

Cause 30. Check balancing device and rotor clearances. Check axial adjustment (position) of rotor.

Cause 31. Check oil quality and quantity.

Cause 32. Check bearing components for signs of damage and assemble them correctly.

Cause 33. Thoroughly clean bearings, bearing housing and check condition of bearing oil seal.

Cause 34. Remove all rust from bearings and bearing housings. Change the oil fill.

Cause 35. Check mode of running of set. Check balance liquid line. Check suction and discharge pressures. Check balancing device and rotor clearances.

The balance liquid pressure should not exceed the suction pressure by more than 3% of the total head, measured at the operating (duty) point. Refer to manufacturer.

Cause 36. Replace damaged components by new ones. Check rotating components for out-of-round. Check suitability of materials used. Make sure all seal components seal accurately, and look out for leakage.

Cause 37. Carefully insert seal. Check materials for suitability.

Cause 38. Measure the seal anew. Refer to manufacturer.

Cause 39. Check unobstructed flow through cooling liquid supply line.

Cause 40. Fit a new bush or spacer sleeve in the cooling housing.

Cause 41. Use treated cooling liquid. Incorporate filters in the cooling liquid line.

5.3 Check List

5.3.1 Pre-requisites for Initial Commissioning

Check direction of rotation of driver with pump disconnected. Check correct alignment of pumping set with appropriate alignment jigs and dial micrometers.

Check that the stuffing box gland seats squarely and has sufficient guidance (with the aid of a feeler gauge, check that the gap between the shaft protection sleeve and the stuffing box gland remains the same around the circumference). If mechanical seals are fitted, check that the circulation lines are vented at the apex.

Check that the valves in the minimum flow line are opened. Check that the valve in the manually-operated line of the minimum flow device is opened.

Check that oil has been filled in the bearing housing and that the required oil level has been attained (by oil pouring out of the overflow holes).

Observe the start-up procedure for the driver.

If the operating temperature exceed 105^{0}C, check that the main valve in the cooling liquid supply line is fully open, and that the fluid flows through freely, also check that the throttling valves in the cooling liquid lines are fully open.

Check that the isolating valve in the suction head line is fully open.

Check that the isolating valve in the discharge line is closed.

5.3.2 Initial Start-up with Cold Water

Switch on driver for a short instant, and switch it off again immediately. Check that rotor runs down smoothly and evenly to a standstill.

Switch driver on again. Check quiet running of pump.

Observe the stuffing boxes (they should not run too hot).

Make sure that the pump runs smoothly and quietly, and that the stuffing boxes function correctly.

On pumps fitted with mechanical seals, keep a check on the temperature in the circulation lines.

Keep a check on the pressure gauge indications (suction and discharge pressures).

If the pump is turbine driven, run up turbine to full operating speed as rapidly as possible, and make sure the pump runs quietly during this time.

5.3.3 Priming the Boiler

Crake the isolating valve in the discharge line open slowly (remember lag of servo-actuated valves). Run the pump within the confines of the limitation curve of the operating diagram (see section 5.3.5 "Pump Operation and Supervision").

5.3.4 Initial Operation with Hot Fluid

When the nominal temperature of the fluid pumped has been attained, adjust the flow rate of the cooling liquid supply. This should be done by throttling the individual valves in the internal cooling liquid piping system in such a way that a temperature differential of 10^{0}C max. is set up between the cooling liquid inlet and outlet.

During operation, check the pressure drop across the strainer in the suction lift or suction head line. When the max. permissible pressure drop value has been reached, switch off the pumping set and clean the strainer.

5.3.5 Supervision of Operations & Maintenance

During operation, the pump should be kept under careful observation. The following measurement values should be checked at frequent intervals :

Suction pressure

Suction temperature

Pump discharge pressure

Temperature at pump discharge nozzle

Bearing temperature

Stuffing box leakage

Temperature of mechanical seals

Cooling liquid temperature at cooler outlet
(Max. temperature differential 10^{0}C)

Check that the pump runs smoothly and quietly at all times, and check the pressure drop across the suction head line by differential pressure measurement.

We recommend keeping a log book on pump operation, to supervise the pumps more closely; the following data should be entered in this log book at hourly intervals : rate of flow, suction pressure, discharge pressure, temperature of fluid pumped, rotational speed and axial rotor position. The times of start-up and shutdown should also be recorded, so that the total number of hours of operation of the feed pump can be ascertained at any time.

The oil level and oil quality should be checked, respectively tested, after the first 200 hours of operation. Thereafter, the oil level and oil quality should be checked at least once a month.

Balancing Liquid Piping

1. Field of Application

Balancing liquid piping is required for WK/WKs/WL pumps, whenever the discharge pressure exceeds 20 bar for sizes 40 to 65 and for sizes 80 to 150 when this pressure exceeds 15 bar.

2. Requirement and Connection

In case of WK/WKs pumps, the balancing of major portion of axial thrust is achieved by means of balancing liquid holes provided on each stage impeller. With this, the pressure equalization on either side of impeller is attained. Due to this, a certain quantity of liquid being pumped flows towards the pressure side, which ultimately enters the balancing chamber, formed between the walls of stuffing box housing and discharge casing. This balancing liquid quantity has to be drawn off from the balancing chamber, which otherwise will accumulate there and hamper the performance of the pump. For this purpose a pipeline is provided, which connects this high pressure chamber to the low pressure region of suction casing (fig. A). By this the pressure relieving of the discharge side stuffing box housing is also achieved.

In case of WL pumps, the balancing of major portion of axial thrust is achieved by means of balancing device. This also involves the flow of balancing liquid into the balancing chamber, which again has to be drawn off. In case of WL pumps, this piping is either connected back to the suction casing (fig A.) or to the feed water tank (fig. B) depending on the temperature and differential head of the pumped liquid.

3. Size

The tapping sizes provided on the balancing chamber of discharge casing the recommend pipeline sizes are given in the following table :

Pump Size	Tapping on Bal. Chamber	Pipeline size mm
40, 50, 65	GI"	16 x 1.5
80, 100	GH"	20 x 2
125, 150	G 1"	25 x 2

4. Accessories

Whenever the balancing liquid piping is connected back to the suction casing, no accessories are required.

When this connection is given back to feed water tank (Fig. C) then the following accessories are necessary.

The sizes of the valves are to be considered as the corresponding size of the pipeline given in article 3 above.

5. Precautionary Notes

i) Connection of balancing liquid piping whether to suction casing or to the feed water tank is indicated on the front page (Technical Data Sheet) of the order acceptance. This is to be strictly adhered to.

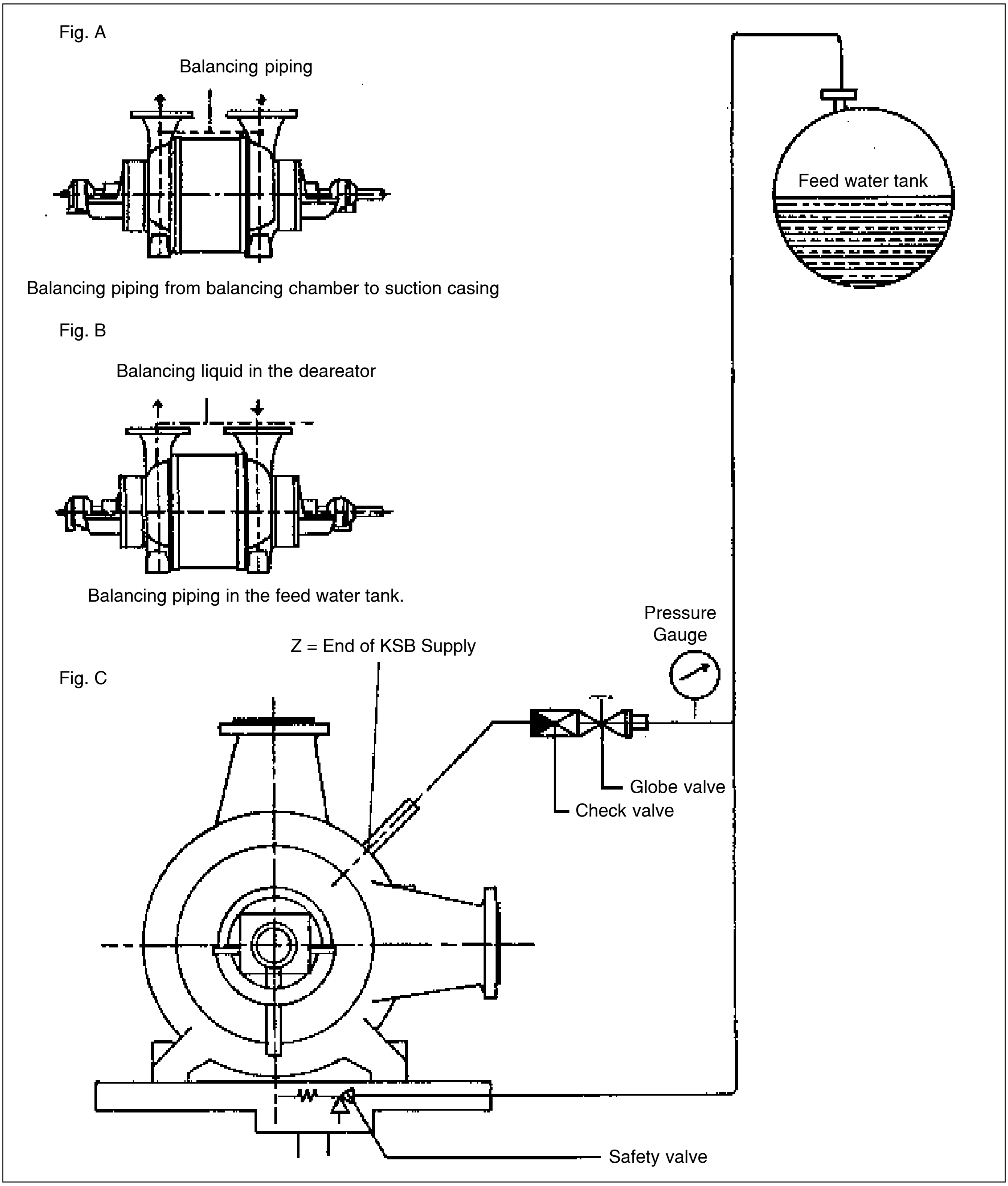
ii) Size of the balancing liquid piping should be exactly as given in article 3 above.

iii) Whenever the balancing liquid line is fed back to feed water tank, and if more pumps than one are operating in parallel, the individual balancing liquid lines should be independently connected to the feed water tank, without joining them together or even putting them into a common header.

iv) The globe valve in the balancing liquid line back to feed water tank should always remain in fully open condition, and on no account should it be closed even by accident.

v) Check valve and globe valve in the balancing line [back to deaeroter] should always be mounted on the horizontal pipe branch [i.e. should not be mounted with their inlet/outlet nozzles in vertical position].

Accessory	Purpose	Pressure Rating
Pressure gauge	Indication of balancing line pressure	0-6 or 0-10 kg/cm2 reading
Check valve	Restriction of back flow of bal. liquid	PN 40
Globe valve	Isolation of balancing piping for the purpose of maintenance.	PN 40
Safety valve	To safeguard the balancing device	PN 40 x 10



6. Illustrations

i) Balancing liquid fed back to suction casing. Fig. A
ii) Balancing liquid fed back to feed water tank. Fig. B
iii) Arrangement of valves in balancing line. Fig. C

Operating Instructions for Lift-off Device

The lift-off device is designed to absorb the relatively low axial thrust of the pump rotor which is generated when the rotational speed of the pump drops below a given limit value, and simultaneously to lift the balancing disc off the counter balancing disc.

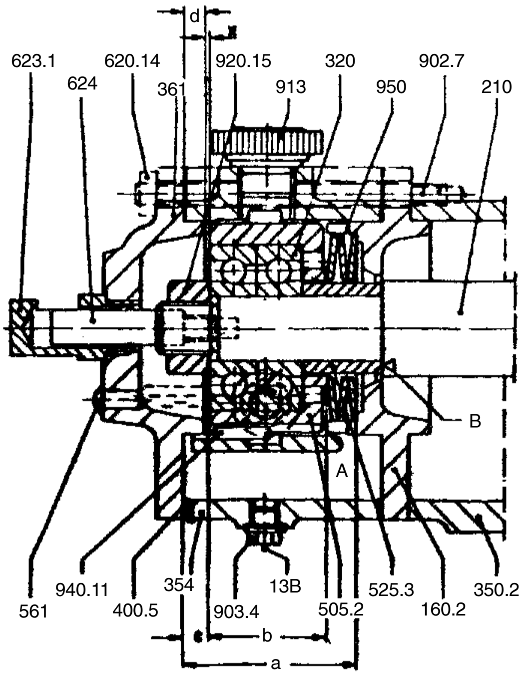


Fig. 1 Lift-off device : Antifriction bearing Pump construction : Antifriction bearing.

Part No.	Part designation
160.2	Cover
210	Shaft
320	Antifriction bearing
350.2	Bearing housing
354	Thrust bearing housing
361	Bearing end cover
400.5	Flat gasket
505.2	Retainer ring
525.3	Spacer sleeve
561	Grooved pin
623.1	Indicator bush
624	Indicator
902.7	Stud
903.4	Hex. head plug
913	Vent plug
920.14	Hex. nut
920.15	Hex. nut
940.11	Key
950	Cup spring
13B	Oil drain

1. Dismantling of Lift off Device :

1. Drain off oil. Unscrew fixing nuts (920.14) of bearing end cover (361).
2. Remove bearing end cover (361) together with indicator bush (623.1).
3. Carefully unscrew and remove hex. nut (920.15). Caution : Remember the spring tension.
4. Force cover (160.2) together with thrust bearing housing (354) and complete inner bearing body, consisting of retainer ring (505.2), antifriction bearing (320) and cup spring (950) off the bearing housing (350.2) and carefully pull them off the shaft (210). Caution : Do not damage bearing (320).
5. Pull spacer sleeve (525.3) off the shaft (210).
6. If required, dismantle antifriction bearing (320) and clean with kerosene or petrol and spray it with oil immediately after cleaning.

   In the event of even slight scoloration (orr speaks of rust) or signs of damage, fit a new bearing.
7. Thoroughly clean all the remaining components, examine them for signs of damage and replace them by new ones if necessary.

Pump sizes	Lift off device Angular contact ball bearings DIN 628	Oil fill for lift off device-lift.
80	7305 BUA	0.2
100		
125	7305 BUA	0.3

Fig. 2 Bearing sizes and oil requirements.

2. Assembly and Adjustment of Lift off Device

Before assembly, examine all the components clean them thoroughly and de-burr them if necessary. Flat gaskets should in principle be replaced by new ones, making sure that the thickness of the new gasket is exactly the same as that of the old one. The set of springs should only be inserted after all the checks measurements have been carried out and the components have been adjusted.

1. Attach cover (160.2) and flat gasket (400.5) to the bearing (350.2).
2. Adjust thrust bearing housing (354) together with flat gasket (400.5) to the studs (902.7) on cover (160.2).
3. Slip spacer sleeve (525.3) over shaft (210) until it abuts.
4. Carry out measurement of the spring insertion leength, 13 ± 1 mm. with the balancing disc in contact with the counter balancing disc face.

4.1 Measure dimension “a” from the end face of the axial bearing housing (354) to the spring seating face on cover (160.2).

4.2 Measure dimension “b” viz. the length of retainer ring (505.2) from end face to end face.

4.3 Insert bearing (320) into retainer ring (505.2) (O-arrangement in accordance with Fig. 3) heat them up in an oil bath up to 80°C approx. and slip them onto shaft (210) and tighten with the aid of hex. nut (920.15).

Check the axial slideability of the complete inner bearing body in the thrust bearing housing (354). The retainer ring (505.2) must not come into contact with the thrust bearing housing during this check.

4.4 Measure dimension "c" from end face of retainer ring (505.2) to end face of thrust bearing housing (354).

4.5 Spring tension length = a - (b + c) = 13 ± 1.0 mm. desired (specified) dimension. In the case of deviation from the desired (specified) dimension, the end face A on retainer ring (505.2) or the end face B on spacer sleeve (523.3) should be machined accordingly.

5. Adjustment of lift off limitation X (Fig. 1). Desired (specified) dimension = 1.0 ± 0.1 mm. Dimension "d" on bearing end cover (361) plus thickness of gasket (400.5) must amount to "c" - 1.0 ± 0.1 mm. If there is any significant deviation, the bearing end cover (361) must be machined accordingly.

6. Unscrew hex. nut (920.15) and dismantle retainer ring (505.2) together with bearing (320). Insert the cup spring (950) and retainer ring (505.2) and slip again the complete set onto the shaft (as described in section 4.3) until it abuts against the spacer sleeve (525.3) and fasten hex. nut (920.15). Insert key (940.11).

7. Screw in the indicator (624).

8. Attach bearing end cover (361) together with indicator bush (623.1) and gasket (400.5) to thrust bearing housing (354). See operating instruction of pump for description of the indicator bush.

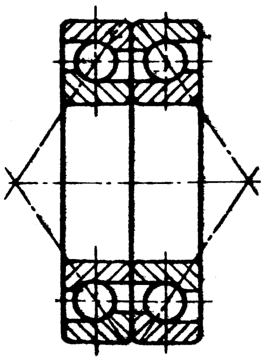


Fig. 3 O-arrangement of angular contact ball bearings.

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Manufactured in technical collaboration with KSB Aktiengesellschaft., Germany by :

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WL

High Pressure Centrifugal Pumps

Works Order No. : ____________________

Pump Type & Size : ____________________

⚠ These operating instructions contain fundamental information and precautionary notes. Please read the manual thoroughly prior to installation of unit, electrical connection and commissioning.
It is imperative to comply with all other operating instructions referring to components of individuals units.