Vertical Spindle Well Pumps B

Serial No.: _____

Type series: _____

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

This manual shall always be kept close to the unit's location or directly on the pump set.

Introduction

KSB has supplied you with equipment that has been designed and manufactured with the most advanced technology. Due to its simple and tough construction it will not need much maintenance. With the aim of providing our clients with a satisfactory, trouble free operation, we recommend to install and care our equipment according to the instructions contained in this service manual.

This manual has been prepared to inform the end user about the construction and operation of our pumps, describing the adequate procedures for handling and maintenance. We recommend that this manual should be handled by the maintenance supervision.

This equipment should be used in the operational conditions for which it was selected as to: flow rate, total head, speed, voltage, frequency, and temperature of pumped liquid.

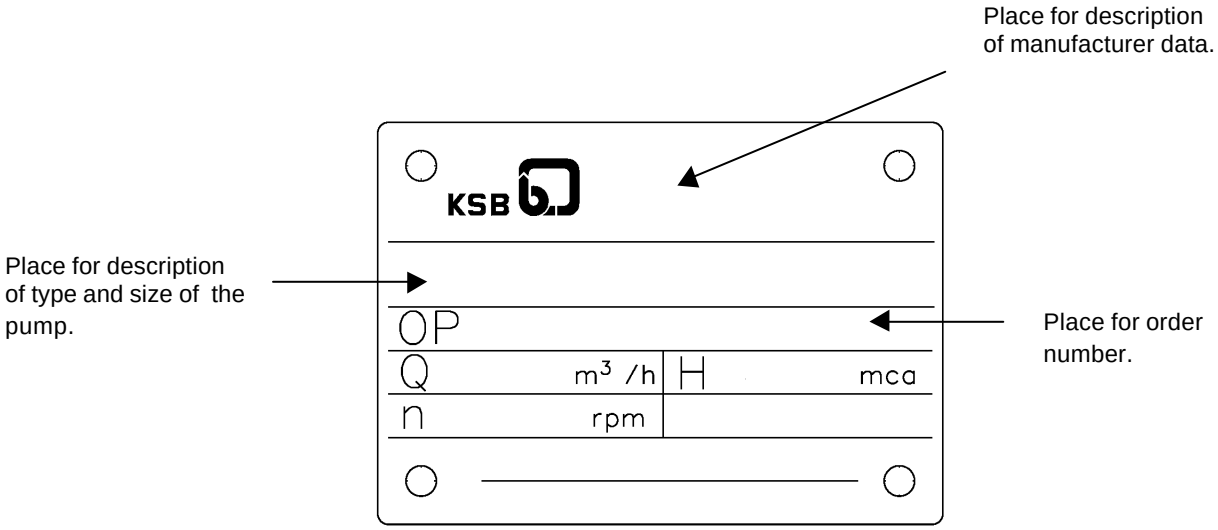


Fig.1 – Nameplate

For requests about the product, or when ordering spare parts, please indicate the type of pump and the Production Order nº (serial nº). This information can be obtained from the nameplate on the actual pump. If the nameplate is not available, the PO nº is engraved in low relief on the suction flange and on the discharge flange you may find the impeller diameter.

Attention: This manual contains very important instructions and recommendations. Its careful reading is an obligation **before installation, electrical connections, first starting and maintenance.**

Contents

0. General

Your centrifugal pump will only give you trouble-free service if it is carefully erected and correctly maintained. We cannot accept responsibility for failure to observe the Instructions contained in the present Instruction Manual. The same applies if the pumps are used for operating conditions, which differ from those specified in our Confirmation of Order.
During the guarantee period the pump should not be dismantled without our previous consent, neither should any parts of it be dismantled.
The rating plate on the pump features the most important operating data and the Works serial number. Always please specify this Works serial number in the event of queries or when ordering spare parts.
The local site Management is responsible for acquainting our erection staff of any local safety regulations before erection commences.

1. Construction of Pump

1.1 Casing

B-Pumps are vertical single or multistage pumps with a radially split casing. The casing consists of the suction casing (106) a number of guide vane casings (112) and a discharge casing (107). The individual casing components are connected to one another by stud bolts and sealed off from one another by flat gaskets. The suction and discharge casings also fulfil the function of bearing housings for the pump shaft bearings.
The individual stages are sealed internally by means of renewable case wear rings on the suction casing and on the guide vane casings. These rings are arranged in the region of the impeller neck.
Double curvature vanes are integrally cast into each guide vane casing, and a recess is provided for the bearing bushes. The number of guide vane casings equals the number of pump stages.
The suction pipe or the suction strainer basket (143) is flanged on or screwed on with pipe screw thread to the suction casing (106) optionally.
The discharge casing can be provided as required with a bell and spigot joint or with a flanged connection for the rising main.

1.2 Rotor

The complete rotor comprises all the rotating components attached to pump shaft (211). Pump shaft (211) transmits the torque generated by the driver to the impellers, which are attached radially on the pump shaft by means of keys. Axially, the impellers (230) are attached to the shaft by means of stage sleeves (521).
The impellers are of the single-entry type, of mixed flow type and they are not balanced hydraulically. The hydraulic axial thrust, which is generated, is absorbed by a support bearing (thrust bearing).
The pump shafts, intermediate shafts and drive shafts of all pump executions are not protected against the medium pumped. Therefore the shaft materials must be selected in accordance with the aggressiveness of the medium pumped.

1.3 Bearing Arrangement

1.3.1 Pump Bearings

The pump shaft is guided in two plain bearings and in addition in a bearing bush arranged in each guide vane casing. These bearings cannot absorb any axial forces. The bearing at the suction end, which is arranged inside the suction casing, is totally enclosed and provided with a grease fill as permanent lubrication or pumped liquid depending on bush material. The pump bearing at the discharge end is lubricated by the product pumped and is arranged inside the discharge casing, with the exception of pump size B 22. On this size there is no plain bearing in discharge casing.

1.3.2 Intermediate Shaft Bearings

(Rising Main Bearings)
The intermediate shafts are guided in bearing spiders with built bearing bushes fitted between the individual lengths of rising main. The construction of the intermediate bearings is dependent on the type of connection of the rising mains, on the product pumped and on the mode of lubrication of the bearings. The number of bearing spiders is equal to the number of normal lengths of rising main on all pump sizes, with the exception of size B 22. The uppermost length of rising main should not be taken into account when determining the number of bearing spiders. The intermediate shaft protection, the bearing material combination and the lubrication provided at the bearing points are listed in table 1. The bearing sleeves are keyed to the shafts. Rubber bearing bushes are accommodated in supporting shells.

Bearing	Lubrication	Shaft protection
Rubber	By product pumped (standard construction). By a fluid from an outside source.	Bearing sleeve of bronze TM23.
Metal	Grease: no shaft protecting pipe provided.	Bearing sleeve of AISI420.

Table 1 – Correlation between bearing construction, lubrication and shaft protection

1.3.3 Support Bearing

The support bearing arranged inside the drive stool absorbs the hydraulic axial thrust generated, also the weight of the complete pump rotor including the intermediate shafts, and the radial forces, and transmits these to the drive stool via the bearing pedestal. Depending on the pump size, the loading on the bearing and the rotational speed, either a BUA antifriction bearing pedestal or a DS segmental pad thrust bearing pedestal is fitted. The pump manufacturer decides which type of bearing pedestal will be fitted.

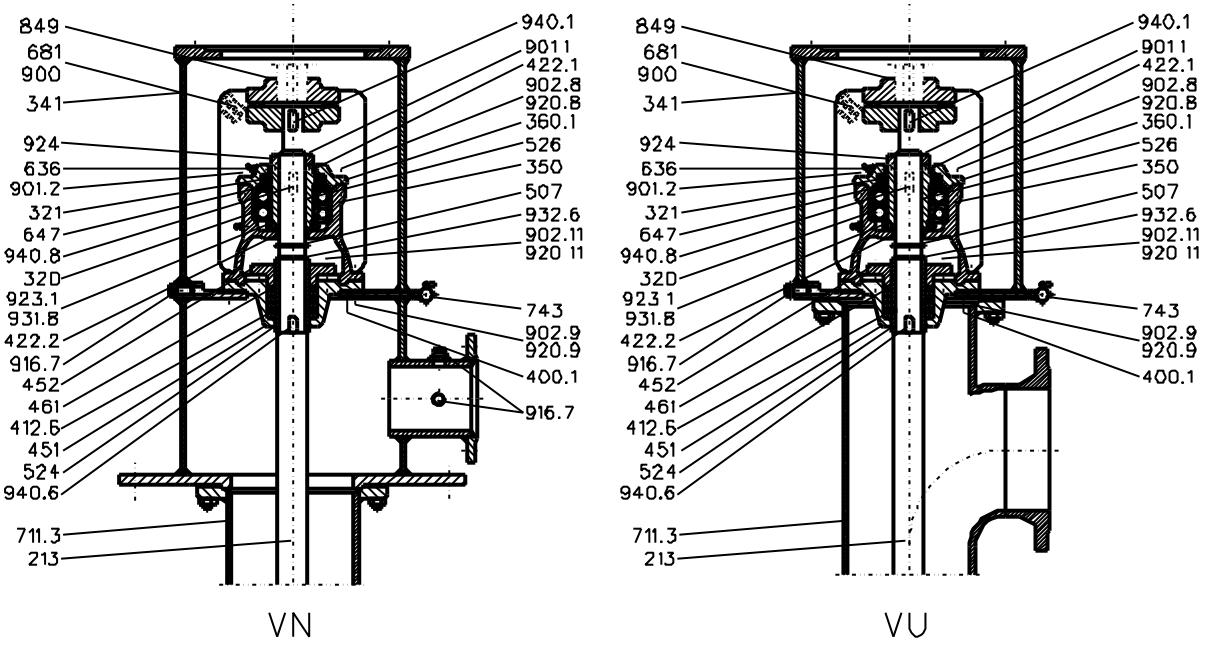
1.3.3.1 BUA Bearing Pedestal

The following pair of matched bearings are incorporated in the BUA bearing pedestal:
2 angular contact ball bearings DIN 628 in tandem arrangement and 1 deep groove ball bearing DIN 625.
The antifriction bearings are packed with grease for lubrication. See table 4 for relevant grease fills.

See table 2 for correlation of bearing pedestals to bearing sizes.
The construction of the support bearing fitted with BUA bearing pedestal, for the VN and VU constructions is illustrated in Fig.2.

Bearing Pedestal		BUA				
		25	35	45	60	75
Bearing arrangement	**Bearing designation**	**Bearing size**				
Tandem	2 angular contact ball bearings, series BUA	7309	7312	7315	7318	7322
	1 deep groove ball bearing in acc. with DIN 625/C3	6010	6013	6016	6021	6226

Table 2 – Correlation between antifriction bearings and BUA bearing pedestals



List of components – VN

Item No.	Designation	Item No.	Designation
320	Antifriction bearing	901.2/1	Hexagon head bolt
321	Radial ball bearing	902.8/9/11	Stud
341	Drive lantern	916.7	Plug
350	Bearing housing	920.8/9/11	Nut
360.1	Bearing cover	923.1	Bearing nut
400.1	Flat gasket	924	Adjusting nut
412.6	O-ring	931.8	Lock washer
422.2/1	Felt ring	932.6	Circlip
451	Stuffing box housing	940.8/6/1	Key
452	Gland cover		
461	Gland packing		
507	Thrower		
524	Shaft protecting sleeve		
526	Centering sleeve		
636	Grease nipple		
647	Grease regulator		
681	Coupling guard		
743	Cock		
849	Sleeve coupling		
900	Screw		

List of components - VU

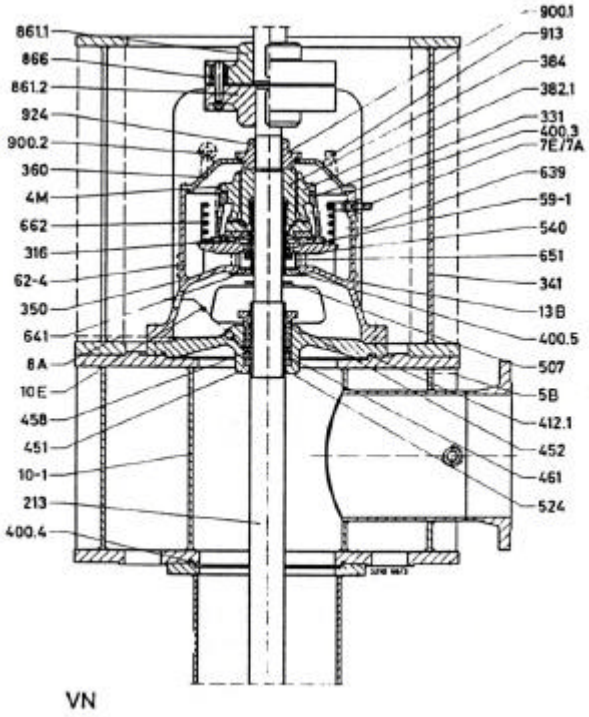
Item No.	Designation	Item No.	Designation
213	Drive shaft	849	Sleeve coupling
320	Antifriction bearing	900	Screw
321	Radial ball bearing	901.2/1	Hexagon head bolt
341	Drive lantern	902.8/9/11	Stud
350	Bearing housing	916.7	Plug
360.1	Bearing cover	920.8/9/11	Nut
400.1	Flat gasket	923.1	Bearing nut
412.6	O-ring	924	Adjusting nut
422.2/1	Felt ring	931.8	Lock washer
451	Stuffing box housing	932.6	Circlip
452	Gland cover	940.8/6/1	Key
461	Gland packing		
507	Thrower		
524	Shaft protecting sleeve		
526	Centering sleeve		
636	Grease nipple		
647	Grease regulator		
681	Coupling guard		
711.3	Riser pipe		
743	Cock		

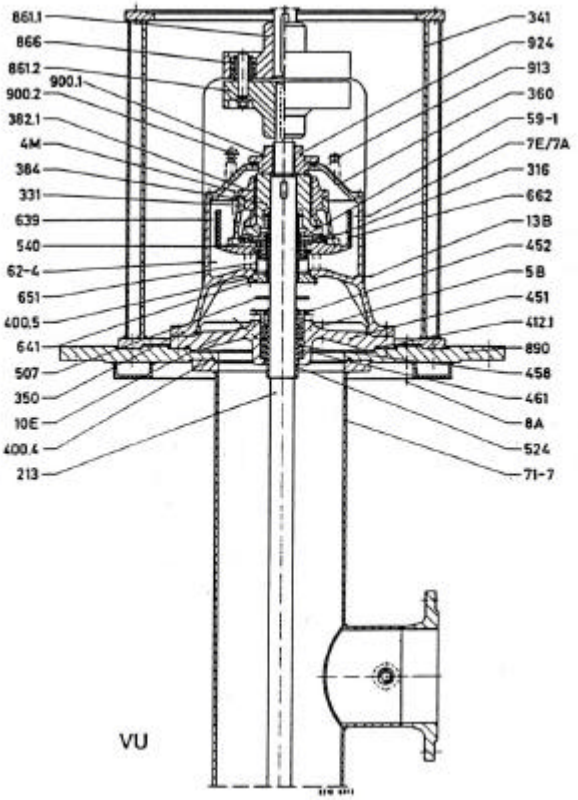
Fig.2 – Drive stool for V1 motors, fitted with BUA antifriction bearing pedestal

1.3.3.2 DS Segmental Pad Thrust Bearing Pedestal

In cases where appreciable axial bearing loadings are generated, a DS segmental thrust pad bearing pedestal is fitted as support bearing.

The axial load is transmitted to the drive stool via the thrust bearing disc (384), the single-acting thrust bearing (316) and the bearing housing (350). A bearing body (382.1) attached to the bearing bracket (331) ensures the radial guidance of the drive shaft. The combined thrust and radial bearing is lodged in a totally enclosed bearing housing (350) and is splash-lubricated by oil. The lubricating oil is fed to all the moving parts of the bearing by a conveyor screw (59-1) attached to the thrust bearing disc, and cooled down to the appropriate operating temperature by the built-in cooling pipe coil (662). The construction of the DS bearing arrangement is illustrated in Fig. 3





Item No.	Designation	Item No.	Designation	Item No.	Designation
10-1	Distribution header	451	Stuffing box housing	890	Baseplate
59-1	Conveyor screw	452	Stuffing box gland	900.1/.2	Screw
62-4	Thermometer	458	Lantern ring	913	Vent screw
71-7	Distribution pipe	461	Stuffing box packing	924	Adjusting nut
213	Drive shaft	507	Thrower	4 M	Connection for remote indicating thermometer
316	Single-acting thrust bearing	524	Shaft protecting sleeve		
331	Bearing bracket	540	Bush	5 B	Air vent
341	Drive stool	639	Oil level indicator	7 A	Cooling liquid outlet
350	Bearing housing	641	Oil level pipe	7 E	Cooling liquid inlet
360	Bearing cover	651	Oil strainer	8 A	Leakage outlet
382.1	Bearing body	662	Cooling pipe coil	10 E	Sealing liquid inlet
384	Thrust bearing disc	861.1	Half coupling/motor end	13 B	Oil drain
400.3/.4/.5	Flat gasket	861.2	Half coupling/pump end		
412.1	O-ring	866	Coupling		

Fig.3 – Drive stool with segmental shoe thrust bearing pedestal (An N or VSM shaft seal can be fitted if required)

1.3.4 Bearing Temperature

The permissible bearing temperatures are listed below; they apply to temperatures t of the liquid pumped not exceeding 105º C and to an ambient temperature of 20º C.

Bearing pedestal:
BUA 25 – 45 70º C [1)]
BUA 60 – 75 90º C [1) 1)] measured at bearing housing
DS 60 – 80V 70º C [2) 2)] measured in the oil bath

If the local conditions necessitate it, the bearing temperatures listed above may be exceeded by no more than 10º C.
Either local indicating instruments or remote indicating thermometers (connection 4M) can be provided for the monitoring of the bearing temperature.

1.4 Lubrication

The lubrication of the individual bearing points on the pump, intermediate shaft and motor stool is effected simultaneously by different methods. The selection of the correct mode of lubrication will depend on the operating conditions, including nature of fluid pumped, type of drive, rotational speed and bearing construction.

1.4.1 Oil lubrication

The DS segmental thrust pad bearings are oil-lubricated (splash lubrication). The bearing housing should be filled with lubricating oil up to the level mark on the oil level indicator. All the bearing parts are adequately fed with oil by the conveyor screw (59-1) attached to the thrust bearing disc. A built-in cooling pipe coil with a separate coolant line cools the oil fill down to the temperature prescribed in section 1.3.4.
On request, the temperature monitoring can be provided with a remote indicating thermometer.
The lubricanting oil should have the following characteristics (approx.):
Viscosity at 40ºC: 29 to 50 cSt – ISO VG32 or 46.

Oil Fill

Bearing pedestal DS	60	80V
Oil quantity (litres)	20	30
Rate of coolant flow (m^3/hr)	0,4	0,5

Table 3 – Oil and coolant requirements for DS bearings

Lubrication intervals for DS bearing pedestals
a) First oil change after 500 hours of operation
b) Subsequent oil changes after every 4000 hours of operation, but at least once every 6 to 8 months.

Lubrication data concerning pumps equipped with oil - lubricated intermediate shafts are given in a separate instruction leaflet.

1.4.2 Grease Lubrication

Antifriction bearings in BUA bearing pedestals and the pump bearing at the suction end are packed with grease for lubrication. For this purpose, a high quality lithium soap bearing grease, free of resin and acid, and possessing good rust preventive properties, good stability at high temperatures and low sensitivity to water should be employed. Its drop point should not be less than 160º C, and its worked penetration at 25º C should lie between 265 and 295 mm/10 mm.

Caution: Do not overfill the bearing compartment with grease. Too much grease will result in an excessively high bearing temperature during operation.

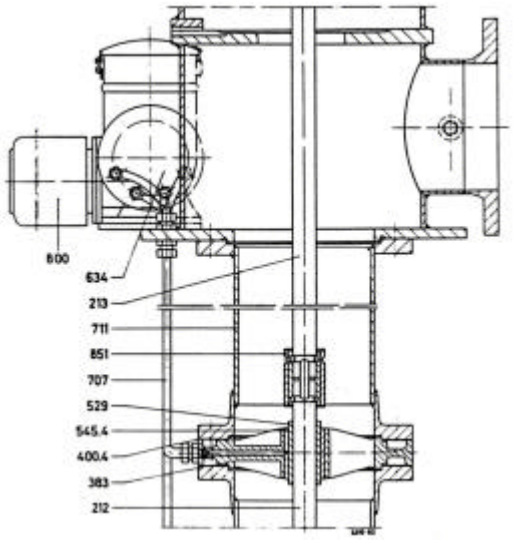
BUA bearing pedestal		**25**	**35**	**45**	**60**	**75**
First fill (grammes)	Tandem	120	190	300	450	1000
Topping up quantitiy (grammes)	Tandem	35	40	50	70	100

Table 4 – Grease requirements in grammes

Topping up quantities and lubrication intervals for BUA bearing pedestals

The topping up quantities will depend on the bearing size and on the lubrication intervals:
a) First topping up after 24 hours of operation, using 3 times the grease quantity specified in table 4.
b) Second topping up after a further 24 hours of operation, using 3 times the grease quantity specified in table 4.
c) Subsequent toppings-up once every 1500 hours of operation. Using the normal quantity of grease prescribed.

The grease fill in the pump bearing at the suction end is a permanent lubrication fill, and should only be renewed on the occasion of overhauls. For the lubrication of the driver bearings, see operating instructions relating to the driver.
In the case of intermediate shafts equipped with metal bearings (special execution), these bearings are grease - lubricated from a separately driven externally mounted grease pump. This lubrication is an overflow type of lubrication, which means that small amounts of grease from the continuous (adjustable) grease feed penetrate into the stream of fluid pumped. This type of lubrication can be adopted on untreated water pumps, which handle appreciable amounts of solids in the water (VSM type stuffing box). The pressure of the grease ensures that on foreign bodies will penetrate inside the bearings.

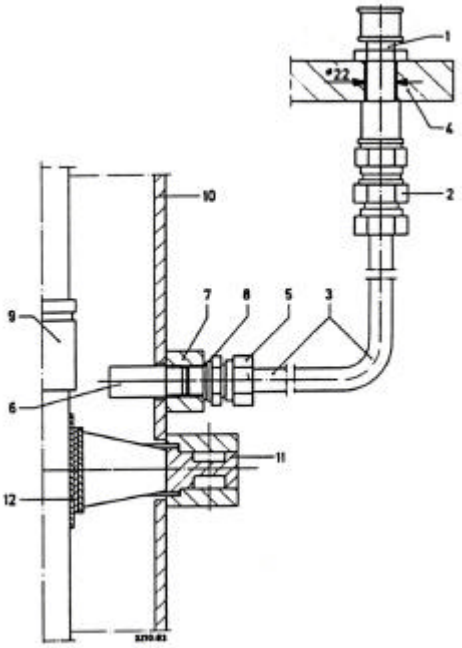


Item No.	Designation
212	Intermediate shaft
213	Drive shaft
383	Bearing spider
400.4	Flat gasket
529	Bearing sleeve
545.4	Bearing bush
634	Grease pump
707	Lubrificating pipe
711	Riser pipe
800	Motor
851	Coupling

Fig.4 – Arrangement of grease pump for intermediate shaft with grease lubricated metal bearings and rising main with flanged connection.

1.4.3 Lubrication by Pumped Liquid

Rubber bearings in the guide vane casings and on the intermediate shafts which are exposed to the liquid pumped, as well as the pump bearing on the discharge side are all lubricated by the liquid pumped. Rubber bearings have no emergency running characteristics. It is therefore essential to ensure that all the bearings are flooded by the liquid pumped when the pump is started up. If there is any danger of the rising pipe running dry (either no foot valve provided or a defective foot valve), the pump should be started up at least once a day. If it is shut down for prolonged periods, it will be necessary to prelubricate the bearings. For this purpose, a reservoir with a content of 50 litres approx. is arranged at the level of the drive stool. Before the pump is started up, a quantity of liquid from this reservoir is fed to the topmost bearing through a pipe which can be isolated, and this liquid then runs along the shaft, thus also prelubricating the remaining bearings.
Optionally this device can be supplied by KSB.



Item No.	Designation
1	Long thread socket end
2	Non-return valve
3	Pipe
4	Distributor header
5	Screwed connection
6	Double pipe nipple
7	Welded on boss
8	Sealing ring
9	Coupling
10	Wall of rising main
11	Bearing spider
12	Bearing sleeve

Fig.5 – Arrangement of pre-lubrication device

1.5 Shaft Seal

Soft-packed stuffing boxes are used to seal the shaft at the motor stool.
It is also possible to use mechanical seals and specific installation and maintenance instructions should be verified with mechanical seal manufacturer. If it is desired at a later date to replace a soft-packed stuffing box by a mechanical seal, the pump manufacturer should be first consulted.

1.5.1 Soft-packed Stuffing Boxes

Soft-packed stuffing boxes prevent any leakage of fluid through the clearance gap between the shaft and the pump casing.
The sealing is effected by means of a soft packing (461), which is inserted in several layers in the annular space between the drive shaft (213) or the shaft protecting sleeve (524) respectively and the stuffing box housing (451), and which is lightly compressed by the stuffing box gland (452). In the case of operation under vacuum, the ingress of air is prevented by feeding sealing fluid via the lantern ring (458). The following alternative stuffing boxes are used:
N = standard construction and VSM = extended depth stuffing box with lantern ring at the centre (see Fig. 6).

Standard Construction Soft-packed Stuffing Box (N)
The N construction, which is provided with from 3 to 6 packing rings (461), depending on bearing pedestal size, is adopted on all pumps for temperatures of the fluid pumped not exceeding 105ºC. See table 5 for precise number of rings.

“VSM” Construction Soft-packed Stuffing Box
The fitting of a lantern ring is only recommended in cases where an ingress of air must be prevented and for executions with protecting tube. The quantity of sealing fluid will depend on the condition of the packing and will amount to between 30 and 200 l/h at a sealing fluid pressure varying from 1 to 3 bar. A non return valve should be incorporated in the sealing fluid line, to prevent the stuffing box pressure from being released via the lantern ring during operation of the pump, which would result in the top packing rings running dry. If the sealing fluid is tapped from the main discharge line, a magnetic filter can be installed, which should be closed during operation.

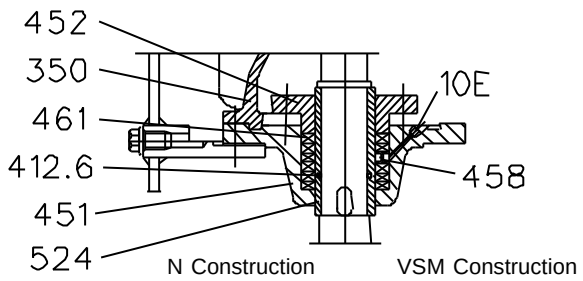


Fig.6 – Stuffing box constructions

If the guide bearings of the intermediate shafts are grease-lubricated, the lantern ring in the stuffing box housing of VU construction pumps or of pumps not provided with a foot valve should be connected to the lubrication system of the grease pump.

1.5.1.1 Packing Material

The material of the packing rings must in all cases be selected with regard to its compatibility with the fluid pumped and with the temperature of the latter. The large number of packing varieties and packing manufactures available on the market make it undesirable as a general rule to recommend specific manufacturers.

Bearing pedestal		Packing compartment d_{ws}/d_a	Packing rings			
			Number			Overall length of packing coil
			N	VSM	mm	
BUA	25	34 / 50	3	5	8	700
	35	44 / 65	4	5	10	900
	45	55 / 80	5	5	12	1100
	60	70 / 95	5	5	12	1400
	75	80 / 105	5	6	12	1800
DS	60	80 / 105	5	5	12	1750
	80 V	105 / 130	5	5	12	2100

Table 5 – Packing compartment and packing size in mm

1.5.1.2 Packing of Stuffing Box

Caution: The pump is despatched with the stuffing box unpacked. The necessary packing material is supplied loose with the pump.
The stuffing box can only fulfil its important duty on condition that it is carefully packed and properly maintained. Before packing the stuffing box, thoroughly clean the stuffing box gland (452), the packing compartment and the shaft protecting sleeve (524).
Use a suitable wooden jig to cut the packing rings to size; we can supply such a jig on request; it is essential to use a jig in order to cut the rings to the correct length and to ensure that their butt joint faces register accurately against one another (see Fig.7).
If the packing rings are cut too long or too short, the stuffing box will not be able to fulfil its duty properly.
If asbestos graphite packing rings are used, the rubbing faces of the individual rings should be thinly coated with molybdenum disulphide before insertion. The first packing ring is inserted and pushed home with the aid of the stuffing box gland.

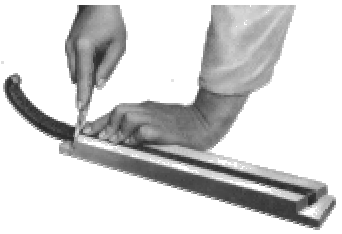


Fig.7 – Cutting the packing rings to length

Each subsequent packing ring is inserted offset 90º approx. in relation to the butt joint of the previous ring, and pushed home individually into the packing compartment with the aid of the stuffing box gland.
Make sure that the packing rings are only compressed lightly against each other. Only insert a sufficient number of packing rings to leave a clear gap of 6 to 8 mm at the outside end 01 the packing compartment, for the guidance of the stuffing box gland (see Fig.8).

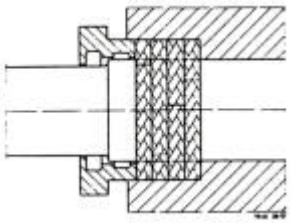


Fig.8 – Stuffing box packing

The inserted packing rings should be moderately compressed with the aid the stuffing box gland (452) and the nuts. Then the nuts should be slackened by 1 to 2 complete turns, and thereupon lightly tightened by hand. Check that the stuffing box gland (452) seats evenly.
The stuffing box should be packed very carefully in order to ensure that the shaft or the shaft protecting sleeve is not damaged by too great a radial compression pressure of the packing rings. No packing can be expected to have an adequate life if the shaft or the shaft protecting sleeve is scored or grooved.
Soft-packed stuffing boxes must leak to a certain extent in operation, and this rate of leakage should be more considerable during the initial period of operation. If the leakage does not decrease after a given period of time, the stuffing box gland (452) should be tightened evenly with the aid of the nuts during the operation of the pump.
If is therefore impossible to give a precise indication of the rate of leakage at the stuffing box. It should however amount to at least 6 l/h.
II the newly packed stuffing box starts to smoke immediately after commissioning, the nuts should be slackened evenly to a slight extent. If the smoking does not cease, the pump should be stopped and the stuffing box inspected.
If pre-pressed packing rings are used, these should be pre-pressed at a pressure of 50 bar approx.

1.6 Rising Pipe

When the pump is installed at a given depth, the distance between the pump and the distribution header or the drive stool is bridged by means of rising pipes and intermediate shafts. The intermediate shafts are guided in bearing spiders between the individual lengths of rising main, and are connected to each other by means of screwed or split (muff) couplings. Depending on the depth of installation, the lenghts of rising pipe within a given size range are fitted with either flanged or bell and spigot joint connections (see Fig.9). During operation, the rising pipe is under pump discharge pressure. It is sealed off by means of flat gaskets between the rising pipe flange and the bearing spider or the distributor header or distribution pipe respectively.

When selecting the required length for the individual piping lengths, the erection facilities must be taken into account. Remember that for the mounting of a length of rising pipe , 1.5 times this length must be available as free height from the pump foundation to the lower edge of the crane hook.

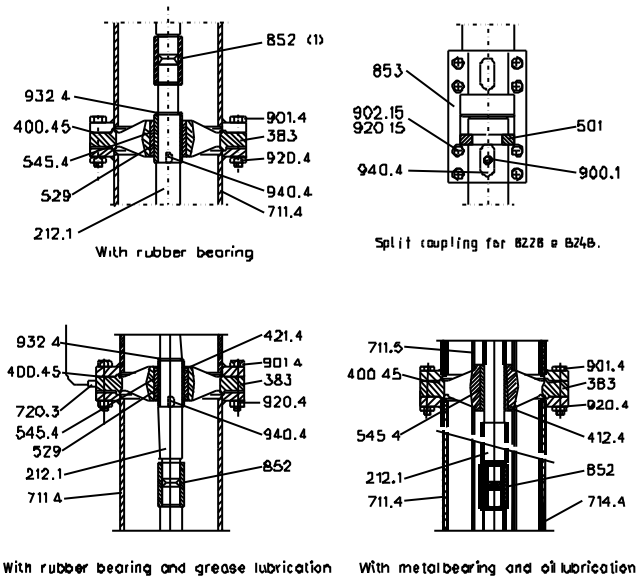


Fig.9 – Rising mains without and with shaft protecting pipe

Item No.	Designation
212.1	Intermediate shaft
383	Bearing spider
400.45	Flat gasket
412.4	O Ring
421.4	Radial shaft seal ring
501	Multiple ring
529	Bearing sleeve
545.4	Bearing bush
711.4/5	Rising main
714.4	Shaft protecting pipe
720.3	Pipe
852	Screwed coupling
853	Split (muff) coupling
900.1	Screw
901.4	Hexagon head bolt
902.15	Stud
920.4/15	Nut
932.4	Circlip
940.4	Key

Rising pipes with shaft protecting pipe are applied in case of column bearings lubricated by oil or clear water. Some components like threaded bush (545.4), bearing spiders (383) and stuffing box are special machined to accomodate o'rings to seal the inside region of the protective tubes.

Distribution Pipe (VU Construction)

Distribution pipes can be accommodated within the arrangement of the standard and top lengths of rising pipe. As the pipe socket is welded on, certain minimum dimensions must be taken into account, e.g. cover joists or girders should not be allowed to interfere with a hydraulically favorable laying of the discharge line below floor level. If possible, the distribution pipe should always be laid as top length of the rising pipe. If it is laid lower down the rising pipe (exceptionally), steps must be taken to ensure that the pump is not pushed out of vertical alignment by piping forces or thermal expansion. This could lead to seizure of the pump and intermediate shaft bearings.

The rising main must be properly vented above the discharge nozzle of the distribution pipe.

Caution: The pump should be installed in accordance with one of the permissible modes of installation, and the permissible temperature limits must be observed (see Fig. 21).

1.7 Couplings

1.7.1 Rigid Couplings for intermediate Shafts

Depending on the shaft diameter, rotational speed, switching frequency and type of driver, either rigid screwed couplings, or split (muff) couplings are used to connect the intermediate shafts to one another and to transmit the driving torque.

In order to prevent the unscrewing (slackening) of screwed couplings during reverse rotation pumping sets fitted with such couplings must be provided with a reverse rotation stop device.

Hollow shaft motors and hollow shaft bevel gears are equipped with such a reverse rotation stop device. Electric motors of V1 type series are however not so equipped, and the direction of rotation of such motors should therefore be checked before connection to the shafting. It is therefore preferable to use split (muff) couplings in conjunction with V1 type series electric motors. The type of coupling applying to your installation can be ascertained from the data sheet attached to the Order Confirmation.

See Figs.10 to 11 for construction and arrangement.

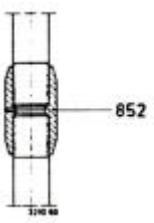


Fig. 10 – Screwed coupling

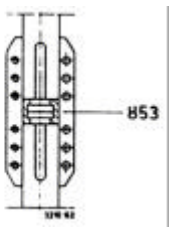


Fig. 11 – Split (muff) coupling

Item No.	Designation
851	Cone coupling
852	Screwed coupling
853	Split (muff) coupling
863	Tapered coupling shell
864	Coupling sleeve

1.7.2 Flexible Couplings — Drive Stool

The pump and driver are connected to one another by a flexible coupling. Usually claw couplings or pin couplings of non-spacer type are fitted (see Figs. 12 and 13).
Every coupling demands careful and accurate alignment of the pump and driver shafts, because any axial or angular misalignment of the shafts (lack of concentricity or parallelism) can only be compensated to a limited extent by the flexibility of the coupling at the high rotational speeds which prevail, and will in due course result in damage to the transmission elements and to the pump itself.
During operation, the coupling requires no special maintenance.

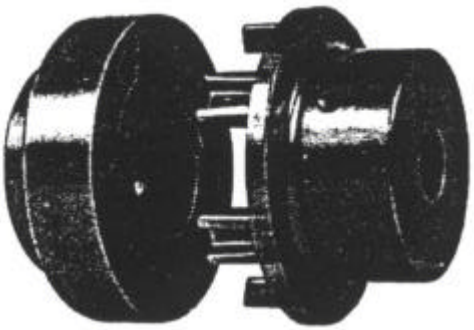


Fig.12 – Claw coupling

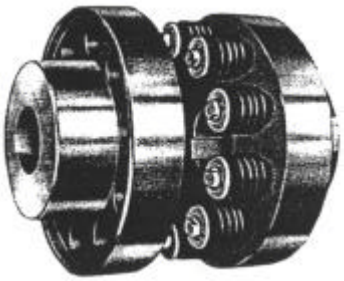


Fig.13 – Flexible pin coupling

1.8 Drive and Drive Stool

1.8.1 Drive

Usually electric motors of type V1 or hollow shaft motors are used (see Fig. 14).
In the case of a quill drive (hollow shaft), the axial thrust generated by the pump is absorbed by the motor or by the gearbox bearing. These additional loadings, as well as the rotor and intermediate shaft weights, should be indicated to the motor supplier.

If a bevel gear drive is fitted, the driver can be either an electric motor, a turbine or an IC engine.
In the case of an IC engine drive, the pump and driver must in all cases be installed on separate foundations. The minimum distance between the two stub shafts should never be less than 1 meter. A torsionally flexible cardan shaft is a suitable coupling in this case.
The absorbed power is determined by the duty point (operating point) of the pump. The frictional losses of the shaft seal and of the rising main bearings must be added to the absorbed power of the pump proper.
The following power margins should be incorporated when sizing the rating of the driver:
For a pump absorbed power

up to 25 kW	25% at least
from 25 to 75 kW	15% at least
above 75kW	10% at least

Table 6

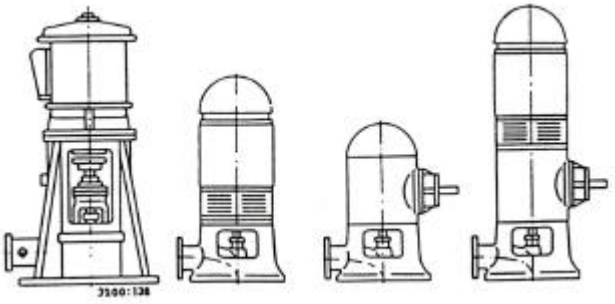


Fig.14 – Types of drive

V1 Direct drive by vertical electric motor
ET Direct drive by vertical hollow shaft electric motor
KT Indirect drive by IC engine via a bevel gear transmission
EK Combined drive, either by vertical hollow shaft electric meter (direct drive) or by IC engine via a bevel gear transmission (indirect drive)

Direction of Rotation

Anticlockwise direction of rotation viewed from driver onto pump.

Safeguard against reverse Rotation

Hollow shaft motors and gearboxes (quill drives) are always equipped with a stop device against reverse rotation. This device protects the pump against reverse rotation originating either from the driver or from the reflux of the water fill in the piping through the pump (pump running as a turbine).
The driver is fully described in a separate operating instruction manual issued by the manufacturer of the driver.

1.8.2 Drive Stool

The drive stool, onto which the top length of rising main is attached, supports the weight of the pump, of the rising main (filled with liquid) and of the driver. The drive stool sizes are classified in accordance with IEC standard motor sizes. Non-standard meter sizes require a special construction of drive stool.
The drive stools are distinguished by the arrangement of the discharge nozzle

VN = discharge nozzle above floor level, arranged on the distributor housing (header)
VU = discharge nozzle below floor level, arranged on the distributor pipe
(Connection flange machined according to ANSI; special executions can be supplied machined according to DIN or ISO on request).
The drive stool for V1 type motors is a welded structure. Apart from the weights previously mentioned, it also absorbs the hydraulic axial thrust via the thrust bearing and it supports the weight of the rotating assembly.
The shaft seal is located in the drive stool.
In the case of the VN construction, drive stools up to BUA 60 inclusive have a distributor housing and drive stool lantern welded together to form a single unit, viz. the support bearing lantern, whereas drive stools for 75 BUA and DS have a distributor housing bolted onto, but basically detachable from the drive stool lantern (see Figs. 2 and 3).

In the case of the standard construction the discharge flange is a slip-on flange, machined to ANSI B16.5 - 150#RF.
Flanges of other pressure ratings are available on request.
In the case of quill drives (ET, KT, EK), the bearing in the drive unit absorbs the weight of the rotating assembly, the weight of the liquid column in the rising main and the hydraulic axial thrust.
The drive stools for quill drives are made of ASTM A48CL30 grey cast iron and available only in VN construction.
VN construction: distributor housing and drive stool lantern cast in one piece.
Integrally cast discharge flange, machined to ANSI B16.1 - 125#FF
Distributor housing attached above floor level.

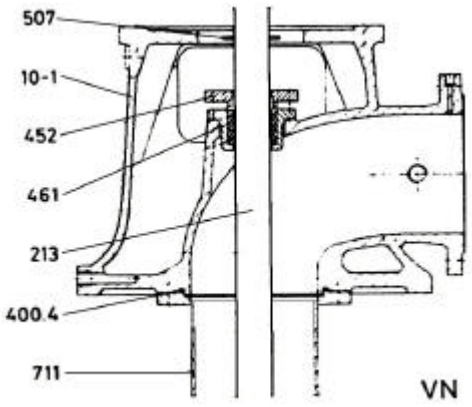


Fig.15 – Drive stool for quill drive

Item No.	Designation
10-1	Distributor housing
213	Drive shaft
400.4	Flat gasket
452	Stuffing box gland
461	Stuffing box packing
507	Thrower
711	Top length of rising main

2. Mode of Operation of Pump

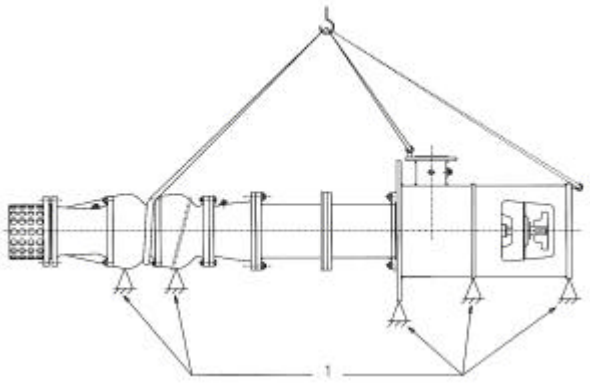
The fluid pumped flows at a given pressure through the suction casing towards the first stage impeller which relates with the shaft. The impeller transmits kinetic energy to the fluid pumped and this kinetic energy is converted into pressure. The fluid pumped then flows from the impeller into the adjoining guide vane casing where its pressure increases still further as a result of partial conversion of the kinetic energy into potential energy. This process is repeated from stage to stage, and the pressure increases by the same amount in each stage, i. e. by the stage pressure.
At its exit from the final guide vane casing, the fluid pumped flows through the discharge casing into the rising main and discharge line attached to the latter. A throttling gap arranged between the impeller neck and the casing wear ring (502) on the suction side of each impeller ensures that there is no equalization of pressure between the suction and discharge sides of the impeller. The discharge pressure generates an axial thrust on the pump rotor of single and multistage centrifugal pumps, which is absorbed by the support bearing in the drive stool. The support bearing is also used to locate the rotor in the axial direction.

3. Transport

Assembled Pumping Set
(See under 5. State of Equipment as Supplied)
The pumping set should be transported and stored horizontally as far as possible. Always attach ropes to the pump bowl and to the motor stool/discharge head as shown below.

Attach the ropes to the pump body and nozzle as shown in the figure. Eventual hoisting tackles should be provided by the user.

Caution: Fastening of the ropes on riser pipes, bearing housing and shaft end is not permitted.



1 = Suitable locations for horizontal support

Caution: Lower the loads at the lowest lowering speed of the hoist

Support the pump on the discharge head and the pump bowl. For suitable locations for support see figure.

Caution: Supporting of the pump on riser pipes, bearing housing and shaft end is not permitted.

Secure the pump against lateral rolling away

For installation in the pump pit, attach the ropes to the drive stool and carefully raise the pumping set vertically.

Individual Parts of Pumping Set

(Pump bowl, rising main, drive stool)
Apart from the drive stool, transport and store all the parts horizontally as far as possible.
Caution: Do not attach the transport ropes to the stub shafts. Do not damage the paintwork.

4. Painting

Pumps of standard construction have all their components above and below floor level painted with one coat of primer followed by one lop coat of synthetic resin base blue enamel paint (RAL 5002).
Special paints can be provided on request in accordance with the Purchase Order and the Order Confirmation. All not painted machined surfaces of the pump are protected with oil Castrol Rustilo DWRL301.

5. State of Equipment as supplied

For all pump executions the following despatch rules apply:
Despatch length up to 4 m:
Pump body, drive stool, rising main assembled together. Motor, suction pipe, suction strainer basket and accessories packed separately.
Despatch length exceeding 4 m:
Pump bowl, drive stool, rising main, meter, suction pipe, suction strainer basket and accessories all packed separately.

Caution:

1. Bearing pedestals with oil lubrication: the bearings are not filled with oil on despatch.
2. Bearing pedestals with grease lubrication: the bearings are packed with grease at our Works before despatch.
3. The stuffing boxes are not packed on despatch. Sensitive indicating instruments such as pressure gauges, thermometers etc., are despatched loose with the pump. All apertures are sealed.
4. Pumps are protected for 6 months of storage in indoor installations. For different conditions, please consult KSB.

6. Accessories

It is recommended to keep a stock of the following standard and special
accessories respectively, which we can supply on request.

Standard Accessories:

+ Support and erection clamps for rising main piping
+ Mounting/pulling off device for impellers. In the case of impellers mounted with the aid clamping sleeves (up to size B12) — sleeve driver (drift)
Suction strainer basket with foot valve or
Suction strainer basket without foot valve
+ = Essential for erection and dismantling

Special Accessories:

Water level indicator, mechanical, pneumatic, electrical
Wooden cutting jig for packing rings
Pressure gauge
Oil level gauge
Grease lubricator
Thermometer
Pressure vacuum gauge
Foot cum elbow
Isolating valve
Filter
Check valve
Flow monitor
Flowmeter
Pressure monitor
Adapter pieces for piping
Foundation frame
Foundation bolts
Chain pipe wrench
(for bell and spigot joint type of rising main)
Tools
Switchgear and control gear

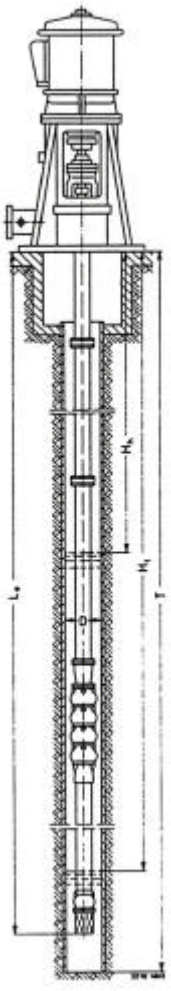


Fig.16 – Installation sketch

7. Assembling of Pumping Set

7.1 Preparations

The local site management has the responsibility of acquainting our erection staff with any local safety regulations before erection commences

The site of the well installation must have been cleared; i. e. released for erection by the local site management or the local authorities before erection commences. The foundation, the well and its surroundings must be in a condition fit for the uninterrupted and unimpeded erection of the pumping set. The design and construction of the well installation, and of the intake chambers in particular, have an important bearing on the optimal pump availability and performance the type of installation selected (see Fig. 21) must already be decided on at the planning stage of the installation, and the intake must be designed in such a way that there is no likelihood or dirt, sand, algae, shells etc accumulating.

Before installation of the pump, the well sinker shall have checked the well in respect of required clear diameter (bore), linearity (straightness) and depth, and shall have tested it in respect of freedom from sand and yield, preferably with the aid of a test pump. If the new pump is used for this purpose, it must be allowed to pump under throttled delivery conditions **without interruption** for as long as necessary until the well is free of sand. The bottom end of the suction pipe should lie at a depth at least 1.0 times the nominal bore of the suction pipe below the lowest water H_t (see Fig. 16).

The checked values must correspond with the data on the certified installation drawing.

A hoist is required for the installation of the pumping set. Its lifting capacity must be in excess of the total weight of the complete pumping set including water fill. There must be a clearance gap between foundation and crane hook equal to at least 1.5 times the length of one length of rising main piping. The crane hook must have an easily rotatable pivot, especially in the case of bell-and-spigot joint piping.

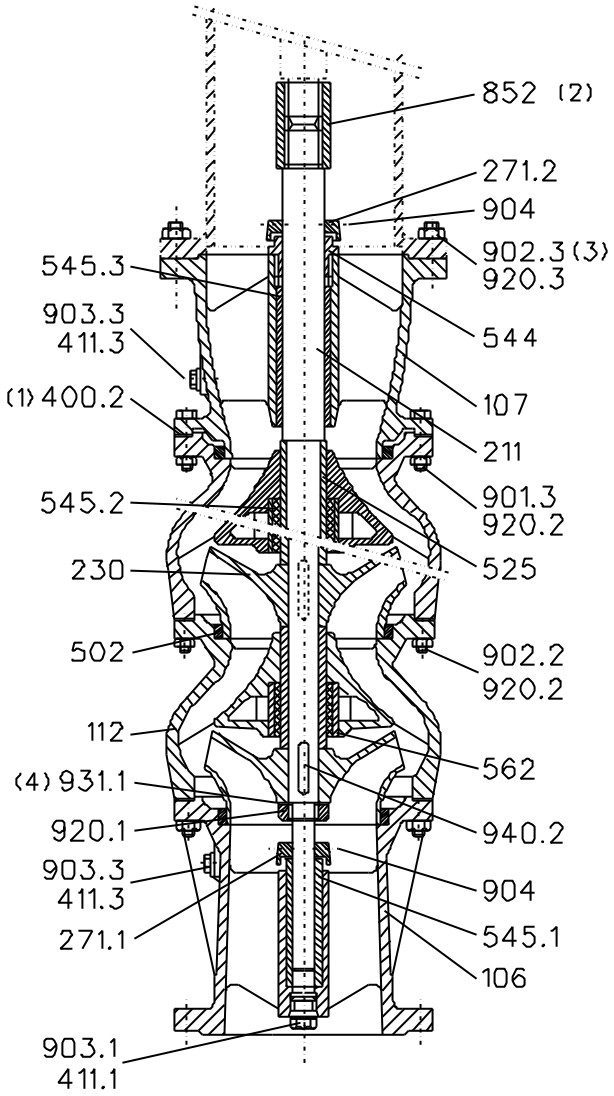
Guideline values concerning weight and length are given on the certified installation drawing.

The following tools should be available (see also list of standard accessories)

2 sets of pipe clamps	flat tongs
pipe wrench, chain pipe wrench	screwdriver
	wire brush
hook wrench (pin wrench)	several short lengths of rope
open-jawed spanner	
monkey wrench (shifting spanner)	oil, grease, sealing compound
	pound, paint, brushes
copper drift	cleaning rags
hammer	puller devices (extractors)
crowbar (jemmy)	

Before erection commences, all the component parts of the pumping set which must be assembled together, such as suction strainer basket, suction pipe, pump body, lengths of rising main with bearing spiders and couplings, drive stool with distributor housing or distributor pipe and driving motor should be checked for completeness and laid out on wooden planks in their sequence of assembly, facing towards the well. Take care not to damage the screw threads, sealing faces and fits on the shafts and rising main piping.

7.2 Pump Bowl



(1) 412.2 O Ring for B22B e B24B.
(2) 853 Shell coupling for B22B e B24B.
(3) 901.31 Hexagon head bolt for B12B/D; B22B e B24B.
(4) Not avaible for B6B.

Pump bowl
Rising pipe with bell-and-spigot joints

Item No.	Designation	Item No.	Designation
106	Suction casing	544	Threaded bush
107	Discharge casing	545.1	Bearing bush
112	Guide vane casing	545.2	Bearing bush / rubber
211	Pump shaft	545.3	Bearing bush
230	Impeller	562	Cylindrical pin
271.1	Sand guard	852	Screwed coupling
271.2	Sand guard	901.3	Hexagon head bolt
400.1	Flat gasket	902.2/3	Stud
400.2	Flat gasket	904	Thread pin
411.1	Gasket	903.1/3	Screwed plug
411.3	Gasket	920.1/2/3	Nut
502	Casing wear ring	931.1	Tab washer only on sizes B14 and over
525	Spacer sleeve	940.2	Key

7.2.1 Pump Bowl - Construction with Keys (see figure on pg. 13)

1. Coat pump shaft (211) with molybdenum disulphide.
2. Slip cylindrical pin (562) onto pump shaft (211) from the front end, until it abuts against the shaft shoulder.
3. Slip guide vane casing (112) of last stage ever the shaft , without the casing wear ring, but with the flat gasket (400.2).
4. Lay key and slip impeller (230) of last stage onto shaft (211) until it abuts against stage sleeve (521).
5. Slip discharge casing (107) including threaded bush (544) onto shaft from the drive end. Boll the discharge casing (107) to the guide vane casing (112).
6. Mount the cylindrical pin (562), keys (940.2), impellers (230), flat gaskets (402) and guide vane casings (112) of the remaining stages onto the shaft. Bolt the guide vane casings together.
7. After having mounted the first stage impeller (suction impeller), mount the tab washer (931.1) and the nut with 2 flats (920.1) on the shaft. Firmly tighlen the nut with 2 flats and lock it.
8. Determine the seat of the sand guard (271.1) at the suction end, and secure it on shaft (211) with a set screw.

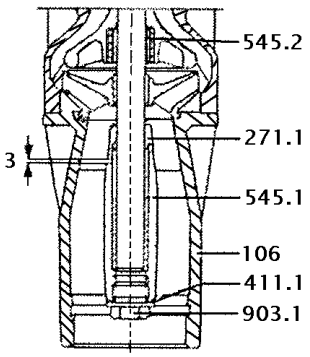


Fig.27 – Installation dimension for the sand guards

9. Mount suction casing (106) (545.1) and bolt it on.
10. Slip on sand guard (271.2) at the discharge end and fasten it onto the shaft with a set screw.
    See Fig. 27 for correct distance between threaded bush (545.1) and sand guard (271.1).
11. See section 7.2. for assembly of pump body onto suction piping and rising main.

7.3 Assembly of Bearings

7.3.1 Intermediate Shaft Bearings

1. In the case of flanged connections, press the bearing bush (545.4) into the bearing spider.
2. Lay the flat gaskets (400.4), slip the complete bearing spider over the intermediate shaft and mount it between the rising main flanges.
3. In the case of bell-and-spigot jointed rising main piping, the bearing bush (545.4) is pressed into the bearing body (932.2) and secured in position. The bearing body (932.2) acts simultaneously as connection sleeve for the piping.
5. Special type bearing bushes, e. g. asbestos or plastic bearing bushes are secured against twisting by means of a two-component adhesive.

7.3.2 Support Bearing — BUA Bearing Pedestal Bearings in Tandem Arrangement — (see Fig. 2)

1. Thoroughly clean centering bush (526) and coat it with molybdenum disulphide.
2. Slip on grease feed regulator (647) until it abuts against the centering sleeve.
3. Heat up angular contact ball bearing (320) in an oil bath to 80ºC approx., and mount it on the centering sleeve in tandem arrangement.
   Caution: Do not drive the bearing onto the sleeve with hammer blows.
4. Slip on tab washer (931.8), firmly tighten lock nut (920.8) and lock it with the aid of the tab washer.
5. Heat up deep groove ball bearing (321) in an oil bath and slip it onto centering bush (526) from the drive end it should not abut against the grease feed regulator (647). A clearance of 0,3 mm should be kept.
6. Insert oil soaked felt ring (422.1) into bearing housing (350).
7. Insert oil soaked felt ring (422.2) into bearing cover (360).
8. See section 7.2.4. for the erection of the bearing pedestal - drive shaft.
9. Put bearing cover (360) avoiding to cause a stress on outer race of the tandem bearings (320); It should be kept a alearance from 0 to 0,15 mm.

7.3.3 DS Bearing Pedestal

1. Mount oil strainer (651), oil level pipe (641) and bush (540) into bearing housing (350).
2. Fit conveyor screw (59-1) onto thrust bearing disc (384).
3. Insert the single acting thrust bearing (316) in bearing housing (350). The cylindrical pin must engage in the bore in the bearing housing.
4. Slip thrust bearing disc (384) including conveyor screw (59-1) over the oil level pipe (641).
5. Place bearing bracket (331) in position and fasten it to bearing housing (350).

6. Slip bearing body (382.1) over the thrust bearing disc, adjust it and fasten it to bearing bracket (331). The axial bearing clearance between bearing body (382.1) and thrust bearing disc (384) which amounts to 0.5 mm should be checked, or suitably adjusted by fitting shims or by touching up work (see Fig. 28). The radial bearing clearance in accordance with Table 15 should be checked or suitably adjusted.
7. Mount cooling pipe coil (662).
8. Mount bearing cover (360) and flat gasket (400.3).
9. Adjust the adjusting nut (924) and lock it in position with the aid of the tab washer.
10. See section 7.2.4. for assembly of bearing pedestal drive shaft.

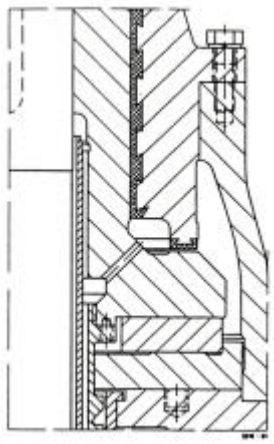


Fig.28 – Axial clearance in segmental shoe thrust bearing

Bearing Pedestal	DS	60	80V
Clearances (mm)	min.	0,072	0,085
	max.	0,161	0,188

Table 11 – Radial clearance in the neck bearing of the segmental shoe thrust bearing pedestal

7.4 Suction Strainer Basket and Suction Pipe

The suction strainer basket can be attached to the suction pipe or direct onto the suction casing (see installation drawing).

Caution: Remove the locking pin from strainer baskets fitted with a foot valve.

Bell and spigot joint: Clean the screw thread with a wire brush and coat it with molybdenum disulphide or with a non-sticking liquid sealing compound.

Flange connection: Clean the raised face and lay a flat gasket. Attach a pipe clamp approximately 0.5 m below the top end of the suction pipe and lower the suction line down the well until the pipe clamp rests on the foundation.

When raising the suction pipe upright, do not damage the suction strainer basket.

7.5 Pump Bowl and Rising Pipe

The complete pump is preferably assembled with the adjoining length of rising main piping, before raising it upright, as follows:

1. Connect the intermediate shaft to the free shaft end of the pump with the aid of a screwed coupling, a cone coupling or a split (muff) coupling, depending on the construction (see Section 7.2.3 Rising Pipe).
2. Carefully slip the first length of rising main piping over the shaft and attach it to the pump. Insert a flat gasket in between.
3. Attach a second pipe clamp onto the rising main, and carefully bring the pump together with the pipe in position above the well.
4. Screw the pump onto the suction pipe.
   Bell and spigot joint: Clean the screw thread and coat it with molybdenum disulphide or with a non-sticking liquid sealing compound.
   Flanged connection: Clean the raised face and lay a flat gasket.
6. Unscrew and remove the pipe clamp on the suction pipe and carefully lower the pump down the well, until the pipe clamp on the rising main rests on the foundation.

7.6 Rising Pipe

Caution: The top length of rising pipe is shorter than the other lengths, and is equipped with a flange for connection to the distributor casing, even in the case of a bell-and-spigot joint pipe. On VU constructions, the top length of pipe is usually combined with the distributor pipe, and has a welded-on discharge nozzle.

The top shaft [drive shaft (213)] has 2 different shaft ends, depending on the type of coupling. The top shaft end is usually fitted with a keyway for the key of the flexible coupling. If the clearance height of the hoist is adequate, the intermediate shaft and the rising pipe can be mounted separately. On the other hand, if the clearance height is inadequate, the intermediate shaft should be suspended inside the rising pipe with the aid of a double rope loop in such a way that it rests eccentrically on one side (see Fig. 17).

Attach the free pipe clamp approximately 0.5 m beneath the top end of the pipe, and carefully bring the pipe with the suspended shaft in position above the borehole (well).

Carefully clean the raised faces and the screw threads. Place an intermediate shaft guide bearing together with a gasket on the length of rising main suspended in the well (see Fig. 17). Connect the intermediate shafts to one another with the aid of , a screwed coupling or a split (muff) coupling, depending on the construction.

Bell-and-spigot joint: the female threaded element should be placed face upwards, and the screw threads should be coated with molybdenum disulphide or with a non-sticking liquid sealing compound.

Flange connection: Clean the raised faces and lay a flat gasket. Place the length of rising pipe on the guide bearing, and fasten it.

Fig.17 – Rising main with suspeded shaft

Fig.18 – Screwing the shafts together (left-handed screw thread)

Screwed Coupling (852)

1. Screw the screwed coupling (852) onto the bottom intermediate shaft (212).
2. Screw the top intermediate shaft into the screwed coupling. (Use a lathe dog or similar implement for this purpose (see Fig. 18).

Split (muff) Coupling (853)

1. Push the two intermediate shafts together and lay the keys.
2. Fix the axial position of the intermediate shafts with the clamping sleeve.
3. Fit the coupling shells and fasten them.

Lower the upper length of rising main and fasten it to the lower length.

Flanged Connection

Insert a flat gasket beforehand.

Bell-and-spigot joints

Coat the screw threads with molybdenum disulphide or with a non-sticking liquid sealing compound. Unscrew and remove the bottom pipe clamp, and carefully lower the assembled components down the well, until the upper pipe clamp comes to rest.

The remaining lengths of rising main piping should be assembled in the sequence described above, including the top length of rising main, or the distributor pipe in the case of the VU construction. In the case of the top length of rising main or the distributor pipe, the drive shaft (213) is inserted instead of an intermediate shaft (212).

7.7 Drive Stool

7.7.1 VN Construction with BUA Bearing Pedestal

1. Lay a flat gasket on the top rising main flange.
2. Pull the complete support bearing, consisting of the main elements centering sleeve (526), angular contact ball bearing (320), lock nut (920.8), grease feed regulator (647), deep groove ball bearing (321), bearing cover (360.1), out of the bearing housing (350).
3. Lower the support bearing lantern including stuffing box housing (451), bearing housing (350), felt ring (422.1) over the drive shaft (213) with the aid of a hoist, up to the point where the shaft end in the lower region of bearing housing (350) becomes visible.
4. Slip the stuffing box gland (452) and the thrower (507) onto the drive shaft (213). Lower the support-bearing lantern until it rests on the top length of rising main, and attach it to the rising main flange.
5. Unscrew and remove pipe clamp, lower the pumping set down the well until the support bearing lantern rests on the levelled up foundation; check the alignment again, and pull the foundation bolts tight.
6. Lay the key in drive shaft (213) and insert the complete support bearing (see point 2.) after having packed it with grease into the carefully cleaned bearing housing (350).
7. Fit bearing cover (360.1) including oil soaked felt ring (422.2) and attach it to bearing housing (350).
8. Screw adjusting nut (924) onto drive shaft (213) and pull it tight by hand only.

VN Construction with DS Bearing Pedestal

1. Lay flat gasket on the top rising main flange.
2. Pull the complete support bearing, consisting of the main elements bearing cover (360), thrust bearing disc (384) with conveyor screw (59-1), bearing body (382.1), bearing bracket (331) and single-acting thrust bearing (316) out of the bearing housing (350).
3. Lower the remainder of the drive stool, consisting of the main elements distributor housing (10-1), drive stool lantern (341), stuffing box housing (451) and bearing housing (350) over the drive shaft (213) with the aid of a hoist, up to the point where the shaft end in the lower region of the bearing housing (350) becomes visible.
4. Slip the stuffing box gland (452) and the thrower (507) onto the drive shaft (213). Lower the drive stool until it rests on the top length of the rising main, and attach it to the rising main flange.
5. Unscrew and remove pipe clamp, lower the pumping set down the well until the drive stool rests on the levelled up foundation; check the alignment again, and pull the foundation bolts tight.
6. Lay the keys in drive shaft (213) and insert the complete support bearing (see point 2.) into the carefully cleaned bearing housing (350).
7. Fit bearing cover (360) and fasten it to bearing housing (350).
9 Screw adjusting nut (924) onto the drive shaft and pull it tight by hand only.

VN Construction with Hollow Shaft Drive

1. Lay a flat gasket on the top rising main flange.
2. Lower the distributor housing (10-1) without the stuffing box gland (452) carefully over the drive shaft (213) with the aid of a hoist, until it rests on the top rising main, and fasten it to the rising main flange.

Caution: Do not damage the stub end of the drive shaft.

3. Slip stuffing box gland (452) and thrower (507) onto drive shaft (213).
7. Unscrew and remove pipe clamp, lower the pumping set down the well, until the distributor housing (10-1) rests on the leveled up foundation. Check alignment once again and pull the foundation bolts tight.

7.7.2 VU Construction with BUA Bearing Pedestal

1. Lay flat gasket on the top flange of the distributor pipe.
2. Pull the complete support bearing, consisting of the main elements centering sleeve (526), angular contact ball bearing (320), tock nut (920.8), grease feed regulator (647), deep groove ball bearing (321), bearing cover (360.1), out of the bearing housing (350).
3. Lower the motor stool lantern (341) including stuffing box housing (451), bearing housing (350), felt ring (422.1) over the drive shaft (213) with the aid of a hoist, up to the point where the shaft end in the lower region of bearing housing (350) becomes visible.
4. Slip the stuffing box gland (452) and the thrower (507) onto the drive shaft (213). Lower the drive stool lantern (341) until it rests on the distributor pipe (71-7) and attach it to the flange of the distributor pipe.
5. Unscrew and remove pipe clamp, lower the pumping set down the well until the drive stool lantern (341) rests on the leveled up foundation; check the alignment again and pull the foundation bolts tight.
6. Lay the key in drive shaft (213) and insert the complete support bearing (see point 2.) after having packed it with grease into the carefully cleaned bearing housing (350).
7. Fit bearing cover (360) including oil soaked felt ring (422.2) and fasten it to the bearing housing (350).
8. Screw adjusting nut (924) onto drive shaft (213) and pull it tight by hand only.

VU Construction with DS Bearing Pedestal

1. Lay flat gasket on the top flange of the distributor pipe.
2. Pull the complete support bearing, consisting of the main elements bearing cover (360), thrust bearing disc (384) with conveyor screw (59-1), bearing body (382.1), bearing bracket (331) and single-acting thrust bearing (316) out of the bearing housing (350).
3. Lower the remainder of the drive stool, consisting of the main elements drive stool lantern (341), stuffing box housing (451) and bearing housing (350) over the drive shaft (213) with the aid of a hoist, up to the point where the shaft end in the lower region of the bearing housing (350) becomes visible.
4. Slip the stuffing box gland (452) and the thrower (507) onto the drive shaft (213). Lower the drive stool lantern (341) until it rests on the distributor pipe (71-7) and attach it to the flange on the distributor pipe.
5. Unscrew and remove pipe clamp, lower the pumping set down the well, until the drive stool lantern (341) rests on the levelled up foundation; check the alignment once again, and pull the foundation bolts tight.
6. Lay the key in drive shaft (213) and insert the complete support bearing (see point 2.) into the carefully cleaned bearing housing (350).
7. Fit bearing cover (360) and fasten it to the bearing housing (350).
8. Screw adjusting nut (924) onto the drive shaft and pull it tight by hand only.

VU Construction with Hollow Shaft Drive

1. Lay a flat gasket on the top flange of the distributor pipe.
2. Lower the motor stool lantern (341) without the stuffing box gland (452) carefully over the drive shaft (213) with the aid of a hoist, until it rests on the distributor pipe (71-7), and attach it to the distributor pipe flange.

Caution: Take care not to damage the stub end of the drive shaft.

3. Slip stuffing box gland (452) and thrower (507) onto drive shaft (213).
4. Unscrew and remove pipe clamp, lower the pumping set down the well until the drive stool lantern (341) rests en the levelled up foundation. Check alignment once again and pull the foundation bolts tight.

7.7.3 Adjustment of Pump Rotor

7.7.3.1 Pump Construction with BUA and DS Bearing Pedestals

After completion of erection of the drive stool, and before the driver coupling is mounted, the pump rotor must be pre-set in the axial position.

With the aid of adjusting nut (924), the pump rotor is lowered to its bottom position, where the impellers come to rest against the pump casing. Then the rotor should be slightly raised again and the precise location of the bottom abutment should be ascertained by careful renewed lowering (the rotor sticks when it is rotated). Now the rotor should be raised by 3 mm and the adjusting nut should be locked. It must be possible to rotate the rotor by hand without effort.

Caution: For each complete turn of adjusting nut (924) the pump rotor is raised by 1.5 mm in the case of bearing pedestal sizes 25, 35, and 45 (this is the diameter of the shaft at the stuffing box) and by 2 mm in the case of bearing pedestal sizes 60 and above.

The nearest adjoining tapped holes in centering sleeve (526) or in thrust bearing disc (384) should be sought for the locking screws (900), and the adjusting nut should be twisted accordingly and locked in position with the aid of 2 screws.

7.7.3.2 Pump Construction with Hollow Shaft Drive

In the case of hollow shaft motors, the adjustment of the rotor position is carried out after erection of the driving motor. The motor cowl is not yet mounted. The pump rotor is lowered to its bottom position with the aid of the adjusting nut, until the impellers come to rest against the pump casing. Then the rotor should be raised again slightly and the precise location of the bottom abutment should be ascertained by careful renewed lowering (the rotor sticks when it is rotated). Now the rotor should be raised by 3 mm and the adjusting nut should be locked. It must be possible to rotate the rotor by hand without effort.

Caution: For each complete turn of adjusting nut (924) the pump rotor is raised by 1.5 mm in the case of bearing pedestal sizes 25, 35, and 45 (this is the diameter of the shaft at the stuffing box), and by 2 mm in the case of bearing pedestal sizes 60 and above.

On motors provided with a reverse rotation step device, the direction of rotation should now be checked; the correct direction of rotation is anticlockwise viewed from above; if the motor rotates in reverse, two of the phase leads should be crossed over.

Put on the motor cowl and secure it.

7.7.4 Mounting the Coupling

Thoroughly clean the stub shafts on the pump and motor shafts and the coupling hubs and coat them with molybdenum disulphide. Lay the key in the shaft keyway. Remove the flexible inserts from the coupling hub, heat the coupling hub in an oil bath to 80ºC approx., and slip it onto the stub shaft.

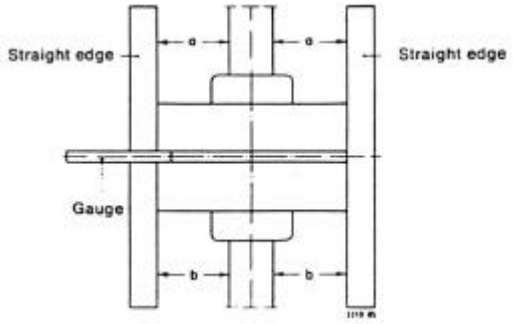


Fig.19 – Aligning the coupling with the aid of a straight edge and gauge

Caution: Do not drive the coupling hub onto the shaft with hammer blows to avoid damage the bearings. Check the condition of the flexible inserts and fit them in after having checked the direction of rotation; mount the driver, align the coupling with the aid of a straight edge and gauge or a dial micrometer and secure it in position on the key with the aid of a fillister head screw.

8 Piping

(See certified installation drawing for dimensions of connections.)

8.1 Suction Line (suction pipe)

Wet Pit Installation

In normal operation, the pump bowl is submerged in the fluid pumped; the suction pipe including suction strainer basket with flanged connection is fastened directly onto the suction casing. Suction pipes are available in fixed lengths of 1500 and 3000 mm. They can however also be supplied in shorter lengths, if a precisely specified installation depth has to be observed. The bottom end of the suction pipe should be installed at a depth at least 1.0 times the nominal diameter of the suction pipe below the lowest water level H_t (see Fig. 16).

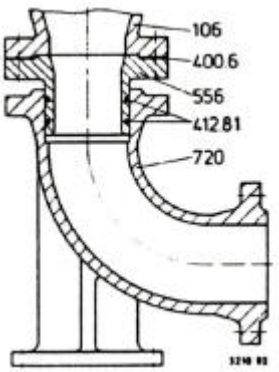
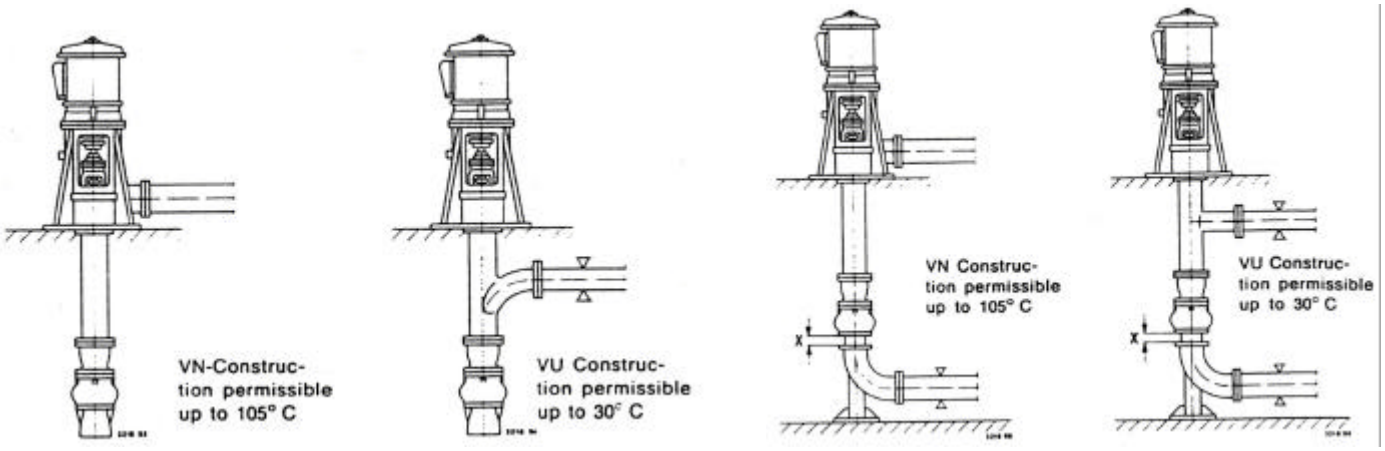


Fig.20 – Foot-cum-elbow with adapter piece



∇ Required fixed point (situated as close to the flange as possible)
Δ

X Axial compensation length (see certified installation drawing)

Fig.21 – Permissible modes of installation and temperatures of fluid pumped

Pump is installed dry outside the pumped liquid. For this purpose, a foot-cum-elbow (720) and a special adapter piece (556) are fitted between the pump body and the suction pipe. The foot-cum-elbow (720) and the adapter piece (556) prevent any radial displacement of the pump, and simultaneously provide a possibility of expansion in the axial direction when the temperature fluctuates.
Caution: Observe the temperature limitations and the permissible modes of installation shown in Fig. 21.

Mounting the Foot-cum-Elbow

1. Put the adapter piece (556) including O-rings (41 2.81) and flat gasket (400.6) onto the suction casing.
2. Insert the foundation belts in the footplate and set the foot-cum-elbow upright(the foundation bolts must hang vertically).
3. Lower the pumping set and guide it into the foot-cum-elbow, preset dimension “X” in accordance with the installation drawing and align the pumping set including the foot-cum-elbow accurately in the vertical direction.
4. Fill the foundation bolt holes with mortar. The foundation bolts should remain vertical while being grouted in.
5. When the grout has set firm, pull the nuts on the foundation bolts tight and check the alignment.
   X = See certified installation drawing.
   In principle, a straight length of piping equal to 20 D at least should be provided upstream of the foot-cum-elbow. The NPSH available values should be reduced by 0.5 to 1.0 m approx. depending on the arrangement of the approach flow.

Suction Strainer Basket without Foot Valve

Coarse dirt is kept away from the pump by the suction strainer basket. When the suction strainer basket is clogged or completely filled, the pump may run dry or fail. The first signs of this are a drop in the total head and in the capacity of the pump.
If the suction strainer basket is procured by the operator, it should be borne in mind that the free cross-sectional area of the holes in the basket should amount to 4 to 5 times the cross-sectional area of the pipe.
Suction strainer baskets without foot valve have roughly 1/3 of the flow resistance of suction strainer baskets with foot valve.

Suction Strainer Basket with Foot Valve

As regards clogging by dirt, the same applies as mentioned above for suction strainer baskets without foot valve. There is the added danger with foot valves that the valve cone no longer seats leaktight as a result of fine deposits.
Water hammer problems must also be taken into account, because the foot valve normally closes before the check valve.
Wherever possible, a foot valve should be dispensed with and the rising main bearings should be pre-lubricated.
When this solution is adopted, the first stage impeller must be submerged under water during start-up. If it is impossible to dispense with a foot valve because of the low water level, additional safety devices must be installed in conjunction with the check valve.

8.2 Discharge Line (see Fig. 21)

VN Construction: The discharge line is connected to the distributor housing or to the support bearing lantern, depending on the type of drive stool.

VU Construction: The discharge line is connected to the topmost length of rising main below floor level (distributor pipe with connection nozzle).
The discharge nozzle is usually provided with a flange and with connection bosses for measuring instruments or measuring lines.

8.3 Auxiliary Lines

(see certified installation drawing for dimensions of connections).

8.3.1 Leakage Liquid Line

A connection (8 A) is provided at the bottom of the drive stool lantern for the draining of the seal leakage, and this can be fitted with a discharge line leading to a drain collecting duct or to a dewatering reservoir with free discharge.

8.3.2 Sealing Liquid Line

(only required when the shaft seal is fitted with a lantern ring).
The sealing fluid is fed to the stuffing box via connection (10 E) and lantern ring (458), in order to prevent the ingress of air when the pump is stopped.

8.3.3 Cooling Liquid Line

Two connections for the cooling liquid inlet and outlet (7 E and 7 A) are provided on bearing housing (350) for the cooling of the bearing lubrication system of DS bearing pedestals. In a closed circuit system, both these lines should be provided with an isolating valve.

8.3.4 Priming Line

The rising pipe and the pump bowl must be primed with liquid before the pump is commissioned. The necessary priming line is connected to the pump discharge nozzle. An isolating valve should be incorporated in the line.

8.4 Forces acting on the piping

Pumps are subjected to internal pressures, dynamic forces, the weight of piping and of valves and also to forces and moments which arise from the thermal expansion. These loadings are characterized by bending and twisting deformations, and to a certain extent also by axial and thrust deformations. It is therefore necessary for the installation contractor to lay the piping in such a way that the leading it exerts on the pump nozzles remains within acceptable limits. The following points are of great importance in this connection:

1. The suction and discharge lines should not be too rigid.
2. The provision of fixed bearings should in no way counteract the flexibility of the pipe bends.
3. Expansion joints should be provided at suitable places, e. g. by the provision of well-proven compensators such as smooth or creased pipe bends, lyre bends etc.
4. The piping must be correctly guided and supported.
5. Loadings which may arise should be reduced by pre stressing the piping.
6. Never use the pump as an anchorage point for the piping.
7. In the case of the VU construction, make sure to install the pump as illustrated in Fig. 21.

It is possible to predict the permissible loading on the pump, but this is of no great practical use to the installation contractor, because all the forces and moments in all 3 planes of action must be taken into account and these may in some cases have a resultant of zero in practice.
It is therefore necessary to check the permissible loadings on the nozzles on the basis of the values which arise in practice.

8.5 Isolating Valves

It is only necessary to provide an isolating valve in the suction line if the pump is installed in a dry pit. This valve is only used to isolate the pipeline (e. g. in the case of repairs or overhauls) and it must remain fully open while the pump is running.
Each pump should be equipped with an isolating valve in the discharge tine, located as close to the pump as possible. Apart from isolating the discharge line, this valve can also be used to adjust the operating point (capacity) of the pump.

Non-Return Valves

A non-return valve should be fitted between the pump and the isolating valve in the discharge line. Depending on the operating conditions this can be either a check valve or a non-return valve.
The object of the non-return valve is to prevent a reflux of fluid through the pump when the latter is suddenly stopped.

8.6 Measuring instruments

Every pump should be equipped with a pressure gauge on the discharge nozzle having a suitable measuring range for the applicable pressure, and equipped with a pressure gauge cock or valve.

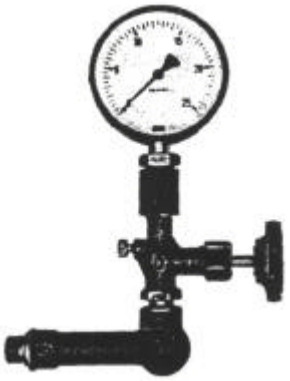


Fig.22 – Arrangement of measuring device

8.7 Pneumatic Water Level Indicator

The pneumatic water level indicator is designed to measure the water level in the well at any moment. it consists of a pressure gauge, an adapter piece, a wall bracket, a foot operated air pump and a measuring tube. The pressure gauge is a spring tube pressure gauge, of 160mm dia., 1/2" BSPT, and its dial is graduaded in metres. The adapter piece has a built-in valve with protective cap. and 1/2" BSPT female thread at the top, into which the pressure gauge is screwed and a 3/8"BSPT male thread at the bottom onto which the measuring tube is screwed. The wall bracket has a 100mm overhang and is fixed to the wall (well foreshaft); the adapter piece is attached to it. The foot operated air pump is designed for an operating pressure of 10 bar and is provided with a 1.0m long hose with plug-on nipple and with a fstening lever.

A 3/8" gas pipe is used as measuring tube and is conected to the adapter piece;it is led down to the top edge of the pump in the well. When all the water is pumped out of the measuring tube with the aid of the foot operated air pump, the indicator needle of the pressure gauge is deflected. This deflection "b" indicates by how many metres the water level lies above the top flange of the pump. The depth of the water level below floor level is given by a = c – b. As the water tends to absorb the air in the measuring tube gradually, the foot operated air pump must be operated on the occasion of each measurement until the pressure gauge needle no longer rises.

9. Commissioning

9.1 Preliminary Remarks Relating to Commissioning

If the initial commissioning does not take place immediately after completion of erection, but only weeks or months later, the checks listed below must be carried out once again:

1. Renewed direction of rotation check of the driver with the pump disconnected.
   Even a very short run in reverse rotation may result in damage to the pump.
2. Check correct alignment of coupling.
3. Check the pump bearings.
4. Fill in oil, check the grease fill.
5. Pack the stuffing boxes (see section 1.5.1. Stuffing Boxes).

9.2 Start-up

1. Check lubricant in the bearing pedestal and in the motor, if necessary top it up. See section 1.4. Lubrication for the quantity of lubricant.
2. Check shaft seal. The stuffing box gland should have sufficient positive guidance and should not be tightened askew. If a lantern ring is fitted, open the valve in the sealing fluid line.
3. On pumps fitted with a mechanical seal, open the valve (if applicable) in the circulation or flushing line fully (only applicable on the initial start-up).
4. Turn on the cooling fluid supply to the DS bearing pedestal and check that the water runs away freely.
5. Open the suction valve fully.
6. The isolating valve in the discharge line should remain closed for the time being.
7. Prime the pump, rising pipe and distributor housing with fluid (only in the case of a suction strainer basket with foot valve) and thoroughly vent them via connection B 5.
8. On the occasion of the initial start-up or if the pump has been shut down for a prolonged period, start the pump up with the driver coupled to it for a short instant, then switch the driver off again immediately.
   Check that the rotor runs down to a stand still smoothly and evenly, and that it does not stop with a sudden jerk.
9. Switch on driver. Slowly open the isolating valves in the discharge line and adjust the operating point. Observe the prescribed discharge pressure of the pump. The output and current intensity data stamped on the motor rating plate must not be exceeded.
10. Regulate the flow of cooling liquid to the mechanical seal with the aid of the valve. The temperature at the mechanical seal should not exceed 70ºC.
11. Check the sand content of the water pumped. If the fluid pumped is contaminated, operate the pump under throttled conditions for as long as necessary to obtain water completely free of sand. On no account should the pump be switched off before this happens.

9.3 Pump Operation and Supervision

The pump should only be operated in the overload region up to the limit where the NPSH available (positive suction head of installation less pipe friction losses) is at least equal to the NPSH required (indispensable minimum suction head of pump). On no account should the pump operate under cavitating conditions, nor should the water column be allowed to break away. The pump bearings and the intermediate bearings will suffer damage if the pump runs dry or if it runs out of balance as a result of partial admission only of liquid to the impellers.

The bearing temperature in the bearing pedestal should be kept under continuous observation during the initial stages. It should not exceed 70º C or 90º C respectively (see 1.3.4.) in continuous operation. This temperature relates to the outer wall of the bearing housing in the case **of antifriction bearing pedestals** and to the oil bath in the case of **segmental thrust pad bearing pedestals.**

The pump, shaft and rising pipe require no maintenance under normal operating conditions. The stuffing box should drip slightly during operation (see section 1.5.1.2.).

Lubricate the installation as described in section 1.4. Old grease should be drained away when the bearing is warm, and replaced by new grease; do not overgrease the bearing.

Refer to the special instruction Manual concerning the maintenance of the driver, in particular the prescriptions relating to lubrication, which should be carefully followed.

Check the current absorbed by the driver (overcurrent release). It is recommended to keep a record of the total operating hours in connection with the intervals for maintenance.

9.4 Shutting Down the Pump

1. Close isolating valve (gate valve or globe valve) in the discharge line.
2. Switch off driver and observe the pump running down smoothly to a standstill. The pump rotor should not stop with a sudden jerk.
3. If applicable turn off the sealing liquid, circulation liquid or flushing liquid supply.
4. Turn off the cooling liquid supply.
5. The suction valve should remain open, unless the pump is taken out of service for a prolonged period, and has to be drained.

9.5 Preserving the Pump during Prolonged Shutdowns

If the pump is shut down for a prolonged period, it is advisable to dismantle it completely. Proceed as described under section 10. “Dismantling” for this purpose.
Pumps supplied by KSB are preserved for 6 months after delivery if stored in a dry and indoor installation. For other conditions, please consult KSB.

All the components should be carefully cleaned, dried and bright parts should be coated with grease or protective oil. The pump is then reassembled. All apertures should be sealed. A sachet of silicagel should be attached to the underface of the pump suction and discharge nozzles (silicagel absorbs moisture).
Caution: Only use oils and greases free of acid for preservation purposes.

10. Dismantling the Pumping Set

10.1 Preparations

1. Switch off pump as described in section 9.4. “Shutting down the Pump”, and safeguard the driver against accidental switching on.
2. Close the isolating valve in the discharge line and the valves in the cooling liquid, sealing liquid or flushing liquid lines, and drain the rising pipe by opening the vent.
3. Remove the cooling, sealing or flushing liquid lines.
4. Pull out stuffing box gland (452) and remove stuffing box packing (461).
   Observe the special prescriptions relating to mechanical seals if your pump is fitted with a mechanical seal.
5. If applicable, close isolating valve in the suction line.
6. Disconnect discharge line at the distributor housing.
7. Install an adequate hoist and provide tools in accordance with section 7.1. Have the auxiliary equipment for erection handy.

10.2 Dismantling

10.2.1 Drive

V1 Motor

1. Unscrew fixing screws of motor on drive stool, and lift off motor including coupling hub with the aid of the hoist.
2. Unscrew fillister head screw on the pump end coupling hub, and pull the coupling off with the aid of an extractor, from drive shaft (213) (see Fig. 23). Check the flexible coupling inserts for signs of damage and if necessary replace them by new ones.

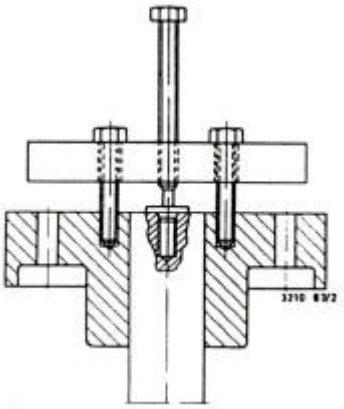


Fig.23 – Pulling off the coupling

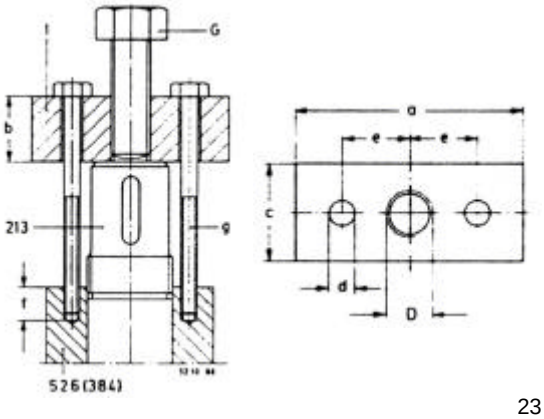
Hollow Shaft Drive (ET, KT and EK)

1. Unscrew and remove motor cowl.
2. Unscrew lock nut, lower the rotor with the aid of adjusting nut (924) until it abuts and remove adjusting nut.
3. Unscrew the motor fixing screws on the distributor housing (10-1) or on the drive stool lantern (641) and carefully lift the motor (including the gearbox if applicable) over the drive shaft. Take care to not damage the stub end of the shaft while doing this.
4. Remove key from keyway on the shaft and check it for signs of damage.

10.2.2 Drive Stool

10.2.2.1 VN Construction with BUA Bearing Pedestal

1. Remove locking screws from adjusting nut (924) and lower the rotor with the aid of adjusting nut (924) until it abuts against the pump casing. Then unscrew the adjusting nut.
2. Unscrew and remove bearing cover (360).
3. Pull the complete support bearing off the drive shaft (213) (see Fig. 24), with the aid of a puller device attached to centering sleeve (526).
   The tandem arrangement support bearing consists of:
   Centering sleeve (526), 2 angular contact ball bearings (320), grease feed regulator (647), 1 deep groove ball bearing (321), lock nut (920.2) and tab washer (931.2).



Item No.	Designation
1	Puller device
213	Bearing shaft
526	Centering sleeve
(384)	Thrust bearing disc

Fig.24 – Puller device

Bearing Pedestal	a	min. b	min. c	d Ø	D	e	f	g	G
25	60	20	25	6	M12	17,5	11	M5	M16
35	75	20	25	7	M16	25	18	M6	M16
45	85	25	30	7	M16	30	18	M6	M20
60	110	30	40	9	M20	40	18	M8	M24
75	140	35	45	10	M24	54	18	M8	M24

Table 7 – Puller device

If there is no possibility of manufacturing a puller device, the adjusting nut itself can be used to pull off the bearing.
In this case, lay a flat iron across the end face of the drive shaft; this should be at least as wide as the shaft diameter, and the adjusting nut should be laid on top of it, then 2 threaded pins should be pushed through the holes in the adjusting nut and screwed into the tapped holes of the centering sleeve. These threaded pins should be sufficiently long for the nut and washer to project above the adjusting nut.

The nuts should be screwed onto the threaded pins and tightened evenly until the centering sleeve can be easily removed from the shaft.

4. The subsequent dismantling of the support bearing proceeds as follows:

Tandem Arrangement Support Bearing: Underpin the inner race of the deep groove ball bearing (e. g. in an open vice), lay a length of pipe or a drift on the end face of the centering sleeve and drive it through the bearings with uniform hammer blows.

5. Unscrew the foundation bolts, raise the complete pumping set and fasten the first pipe clamp in an accessible position on the top length of rising main (711). Then lower the pumping set until the pipe clamp rests on the foundation.
6. Pull the remainder of the drive stool, consisting of distributor housing (10-1), stuffing box housing (451) and bearing housing (350), including thrower (507) and stuffing box gland (452) off the drive shaft (213).

VN Construction with DS Bearing Pedestal

1. Remove locking screws from adjusting nut (924) and lower the rotor with the aid of adjusting nut (924) until it abuts against the pump casing. Then unscrew the adjusting nut.
2. Unscrew and remove bearing cover (360).
3. Unscrew the fixing bolts on bearing bracket (331) and pull the complete support bearing at the thrust bearing disc (384) off the shaft with the aid of a puller device (Fig. 41).

The DS bearing consists of: thrust bearing disc (384) with conveyor screw (59-1), bearing bracket (382.1) and bearing bracket (331).

4. Remove single-acting thrust bearing (316) and examine it for signs of damage.
5. Pull thrust bearing disc (384) out of bearing bracket (382) and examine both components for signs of galling (seizure).
6. Unscrew the foundation bolts, raise the complete pumping set and attach the first pipe clamp in an accessible position on the top length of rising main (711). Then lower the pumping set until the pipe clamp rests on the foundation.
7. Pull the remainder of the drive stool consisting of distributor housing (10-1) drive stool lantern (341), stuffing box housing (451) and bearing housing (350) including thrower (507) and stuffing box gland (452) of the drive shaft (213).

VN Construction with Hollow Shaft Drive

1. Unscrew foundation bolts, raise the complete pumping set and attach the first pipe clamp in an accessible position on the top length of rising main (711). Then lower the pumping set until the pipe clamp rests on the foundation.
2. Pull the drive stool consisting of distributor housing (10-1) and stuffing box housing (451) including thrower (507) and stuffing box gland (452) off the drive shaft (213).

10.2.2.2 VU Construction with BUA or DS Bearing Pedestal and Hollow Shaft Drive

Proceed as in the case of the VN Construction, but attach the first pipe clamp to the distributor pipe (71-7).

10.2.3 Dismantling the Rising Main

1. Lift the rising pipe and the pump bowl out of the borehole (well) with the aid of a hoist sufficiently high to allow the second pipe clamp to be attached to the rising pipe approximately 50 cm beneath the next rising main pipe joint.
2. Firmly fasten the pipe clamp and lower the pumping set again until the pipe clamp rests on the foundation.
3. Unscrew the pipe joint of the rising pipe and lift the top length of the rising pipe (711) or the distributor pipe (71-7) respectively over the drive shaft.
4. Unscrew the intermediate shaft coupling and remove the drive shaft.

Use a puller device in the case of cone couplings (fig.25)

Fig.25 – Dismantling the cone coupling with the aid of a puller device

5. Force off the complete intermediate shaft bearing and pull it off over the shaft.
   Inspect the bearing and shaft for signs of galling (seizure).
6. Raise the pumping set by a further length of rising pipe, attach a free pipe clamp as described under item 1, and lower the pumping set again until the pipe clamp rests on the foundation.
7. Proceed as described above for the following lengths of rising pipe, the pump body and the suction pipe or suction strainer basket (if applicable), i. e. pull them out of the borehole and dismantle them.

10.2.4 Dismantling the Pump Bowl

1. Unscrew flanged connection on suction casing (106) and pull suction casing including bearing bush (545.1) off the pump shaft (211).
2. Unscrew locking screw and pull off sand guard (271.1).
3. Impellers (230) are fastened onto pump shaft (211) with the aid of keys then loosen the nut with two flats (920.1), pull impeller (230) off pump shaft (211).
4. Unscrew guide vane casing (112) and remove it. The following stages are dismantled in similar fashion to that described above.

When the last impeller has been loosened, the pump shaft (211) can be pulled out of the discharge casing (107) in the direction of the drive end, together with the sand guard (271.2).

Caution:
After a considerable operating time, it may happen that the individual components of the rotor can only be pulled with difficulty off the shaft (these components include the impellers, the stage sleeves, the sand guards or the bearings). In this event, never use force to remove the components i.e. never drive them off with hammer blows. First try using a solvent and a puller device. If this does not lead to the desired result, the components concerned can be warmed up slightly, then pulled off or forced off. The shaft should remain as cold as possible when warming up the components.
If rotor components have been dismantled by heating them up, the shaft should be checked for true running (out-of-round).

10.3 Examination of Individual Components

1. Guide vane casing (112) with bearing bush (545.2) and casing wear ring (502), impeller (230), stage sleeve (521), suction casing (106) and discharge casing (107). Inspect impellers (230) and guide vane casings (112) for signs of damage by solid contents.

Inspect impeller necks and casing wear rings (502), stage sleeve (521), bearing bush (545.2) and suction casing (106) and discharge casing (107) for signs of radial galling (seizure).
If there is any sign of galling, which can be removed by touching up on a lathe, the increase in clearance which results from such touching up should not exceed the maximum permissible values listed in Table 8 “Rotor Clearances” and in Tables 9, 10 and 11 “Bearing Clearances”. On the other hand, if these values are exceeded as a result of the touching up work on the components, it will be necessary to fit new components and to re-establish the specified “as new” clearances.
All the throttling gaps should be touched up in such a way that the increase in clearance amounts to the same value on each one.
In principle, if the clearances have been exceeded at one or more points within the pump bowl, thus requiring new wear parts, it will be necessary to renew all the other wear parts as well.

2. Shafts (211, 212, 213)
   Check the bearing sleeves (529) for signs of galling. Slightly damaged spots can be remedied by grinding within the permissible clearances (see Tables 9 and 14). If this touching up work exceeds the permissible clearances, new bearing bushes (529) should be provided.
   Carry out an out-of-round check on a lathe between lathe centres. The max. permissible shaft run-out should not exceed 0.03 mm.

Caution: Make sure the shaft is centered correctly on the lathe, to avoid an erroneous measurement.
If certain components of rotor are replaced by new ones, touched up or if a new shaft is fitted, the pump rotor should be checked for true running (out-of-round), and the pump rotor on pump sizes 14 to 24 inclusive should also be subjected to a dynamic balancing at the max. operating speed if possible, but at least at 1000 1/min. the max. residual eccentricity must not exceed 5 µm(see section 10.4.).

3. Antifriction bearings (320, 321)
   The bearings should be replaced by new ones even in the case of slight discoloration (also in the case of rust spots) or in the case of damage to the rubbing surfaces.
   Always observe the greatest cleanliness when mounting the bearings. Gasoline can be used to clean existing bearings. After washing, the bearings should be immediately sprayed with oil or packed with grease.
4. Thrust bearing (Segmental thrust pads bearing) inspect the rubbing pattern on thrust bearing disc (384) and on single-acting thrust bearing (316). Deep grooves can be removed by machining (permissible run-out 0.015 mm, quality of surface finish R_a = 0.4µm).
   If the thrust bearing pads are replaced by new ones or if there is any extensive scraping work done on the white metal rubbing faces, these components should be subjected to an indian ink check in the assembled condition together with the thrust bearing disc (384).
5. Radial Guide Bearings (plain bearings)
   Inspect the rubbing pattern in the bore and remove any light pressure marks with a scraper if necessary.
   Caution: M-G-F radial journal bearings (M-G-F **=** multiple rubbing face bearing).
   These bearings are recognizable by their 4 symmetrical grooves arranged around the periphery of the bore, and they should in principle not be scraped by hand, because the bore is machine-profiled.

6. Intermediate shaft bearings
   Inspect the bearing bushes for signs of galling. Carbon or metal bushes can be touched up within the limits of the permissible clearances (see Fig. 46). If the max. permissible clearances are exceeded, new bushes should be fitted, as in the case of rubber bearings

	As new clearance for material alternative		Max. permissible clearance for material alternative	
	Cast iron, Nodular iron, bronze mm on dia	Full chrome steel mm on dia	Cast iron, Nodular iron, bronze mm on dia	Full chrome steel mm on dia
Casing wear ring – impeller neck	0,3	0,5	1,0	

Table 8 – Rotor clearances

Bearing Clearances
The bearing clearances in the table of Tables 9 and 10 below are related to the diameter and to the “as new” condition of the components.

Caution: We recommend fitting new bearing bushes if the value measured on the diameter exceeds the corresponding max. “as new” clearance value by 0,2mm (Tables 9 and 10).

Pump

Pump size				**6 to 8**	**10 to 12**	**14 to 16**	**18**	**20**	**22**	**24**
Suction casing	M	Clearances	min.	0,065	0,080	0,105	0,130	0,130	0,130	0,130
			max.	0,228	0,279	0,290	0,350	0,350	0,260	0,280
Guide vane casing	G		min.	0,200	0,200	0,340	0,350	0,370	0,470	0,336
			max.	0,383	0,389	0,730	0,740	0,790	0,890	0,571
Discharge casing	M		min.	0,065	0,080	0,130	0,130	0,130 [1)]	0,100	0,130 [2)]
			max.	0,228	0,279	0,234	0,234	0,234	0,274	0,280

M = Metal
G = Rubber
[1)] for intermediate shafts larger than 60Ø
[2)] for intermediate shafts larger than 80Ø
the clearances are related to the intermediate shaft

Table 9 – Clearance on diameter of pump bearings in mm

Rising Pipe

Standard construction without shaft protecting pipe

Intermediate shaft dia. (mm)			**20**	**25**	**30**	**35**	**40**	**45**	**60**	**70**	**80**	**90**	**100**	**110**
Rubber bearing	Clearances	min.	0,31	0,32	0,33	0,33	0,34	0,35	0,37		0,37	0,48		0,50
		max.	0,59	0,63		0,64	0,69	0,73	0,74		0,79	0,90		0,95
Metal bearing		min.	0,080	0,100				0,120			0,144			0,170
		max.	0,146	0,178				0,212			0,252			0,292

Table 10 – Clearance on dia. of intermediate shaft bearings in mm

7. Shaft seal
   Soft-packed stuffing boxes
   Insert new packing every time the pump is overhauled. The shaft protecting sleeve (524) should only be touched up by grinding very lightly. If it is extensively damaged, it should be replaced by a new shaft protecting sleeve. See special instructions relating to mechanical seals.
8. Pin couplings and claw couplings
   The flexible transmission elements should be inspected for signs of wear and replaced by new ones, if necessary.

10.4 Dynamic Balancing of Pump Rotor

For this purpose, the pump rotor should be assembled as follows:

Assembly from the drive end: Slip the sand guard (271.2) onto the shaft and secure it with the aid of a set screw.

Assembly from the front end: Slip the stage sleeve (521) onto pump shaft (211) until it abuts against the shaft shoulder.

Lay the key and slip the last stage impeller (230) onto the shaft until it abuts.

Mount the stage sleeves (521), keys and impellers (230) of the remaining stages in their correct sequence.

Caution: Make sure to mount the impellers on the shaft in their correct stage sequence.

Slip on the tab washer and fasten the assembled components on shaft (211) with the aid of the nut with two flats (920.1). Before dynamic balancing, the pump rotor should be checked for true running (out-of-round) at the impellers (230) and at the bearings. The max. permissible out-of-round should not exceed 0.03 mm. Then the rotor should be balanced dynamically, if possible at max. operating speed, but at least at 1000 1/min. The max. residual eccentricity should not exceed 5µm. The pump rotor should be dismantled again before final reassembly and this dismantling is carried out in reverse sequence to the assembly previously described.

11 Operating Faults, Causes and Remedies

Fault	Code No. – Cause / Remedy
Insufficient rate of flow of pump	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 28
The driver is overloaded	11, 12, 13, 14, 15, 27, 28
Excessive pump discharge pressure	15
Excessive bearing temperature	22, 23, 24, 25, 26
The pump leaks	16, 29
The shaft seal leaks excessively	17, 18, 19, 20, 21, 22, 23, 33, 34
The pump runs rough	3, 6, 11, 22, 23, 25, 30, 31
The temperature inside the pump is excessive	3, 6, 32

Table 12

Cause — Remedy [1]

1. The pump operates against too high a delivery pressure
   - Open discharge valve wider until the operating point is correctly adjusted.
2. The back pressure is too high
   - Fit larger diameter impeller(s) [2]
   - Increase rotational speed (turbine or IC engine-driven pump)
   - Check system for dirt
3. The pump and piping are not completely vented or primed
   - Vent or prime thoroughly
4. The positive suction head line or the impeller(s) are clogged
   - Remove deposits in the pump and/or in the piping
5. Formation of air pockets in the piping
   - Change piping layout
   - Fit a vent valve
6. NPSH availabie is too low (suction side)
   - Correct lhe liquid level
   - Fully open the isolating valve in the positive head suction line
   - Change layout of positive head suction line if necessary, if the pressure drop in the line is too high
   - Check condition of strainers in the line
   - Observe the permissible rate of pressure drop
7. Suction lift is too high
   - Clean the suction strainer basket and the suction line
   - Correct the height of the liquid level
   - Alter the layout of the suction lift line
8. Air is sucked in at the stuffing box
   - Clean the sealing fluid duct, if necessary feed in sealing fluid from an outside source, or increase pressure of sealing fluid
   - Fit a new shaft seal
9. Reverse rotation
   - Cross over 2 phase leads of the current supply
10. Rotational speed is Ice lew [2] [3]
    - Increase rotational speed
    - Increase voltage
11. Excessive wear of pump internals
    - Fit new wear parts
12. The back pressure of the pump is lower than that specified in the purchase order
    - Adjust the operating pressure accurately by means of the isolating valve in the discharge line
    - If there is continuous overloading, trim the impeller(s) if necessary [2]
13. The density or viscosity of the fluid pumped is higher than that specified in the purchase order
    - [2]
14. The stuffing box gland is tightened excessively or askew [2]
    - Remedy the fault
15. The rotational speed is too high
    - Decrease the rotational speed (on a turbine or IC engine — driven pump [2] [3]
16. Defective seal
    - Renew the seat
17. Worn shaft seal
    - Inspect shaft seal and renew it if necessary
    - Check pressure of flushing/sealing fluid
18. Scoring or roughness of shaft protecting sleeve
    - Fit a new shaft protecting sleeve
19. Lack of cooling fluid or dirt in the cooling fluid compartment
    - Increase rate of flow of cooling fluid
    - Clean out the cooling fluid compartment
    - Clean the cooling fluid itself
20. Stuffing box gland, end cover, seat coverplate wrongly tightened, wrong packing material used
    - Remedy the fault

21. The pump runs rough
    - Correct the suction conditions
    - Realign the pump
    - Balance the rotor dynamically
    - Increase the pressure at the pump suction nozzle
22. The pumping set is misaligned
    - Check coupling and realign it if necessary
23. The pump is warped
    - Check piping connections and pump mounting
24. Excessive axial thrust [2)]
    - Clean out balance holes in the impeller
    - Fit new casing wear rings
25. Too much, too little or unsuitable lubricant
    - Top up lubricant, reduce quantity of lubricant or use a different lubricant
26. The correct coupling gap has not been observed
    - Correct the gap in accordance with the installation drawing
27. The operating voltage is too low
28. The motor runs on 2 phases only
    - Fit new fuses to replace the defective ones
    - Check cable connections
29. Connecting bolts slack
    - Pull them tight
    - Fit new gaskets
30. Rotor is unbalanced
    - Clean the rotor
    - Re-balance the rotor dynamically
31. Damaged bearings
    - Fit new bearings
32. Insufficient rate of flow
    - Increase the minimum rate of flow
33. Defects in the circulation fluid feed tine
    - Increase the free cross-sectional area
34. Excessive surface pressure in the sealing gap, lack of lubricating or circulation fluid
    - Check the installation dimensions [2)]

[1)] The pump should be made pressureless before remedying defects on components subjected to pressure
[2)] Refer to KSB
[3)] This fault can also be remedied by altering the impeller diameter

12. Spare Parts

When ordering spare parts, always please specify the item numbers, designations of the components concerned, and the Works serial number of the pump. This will avoid any delays in delivery and possible queries. The Works number of the pump is given on the title page of present Instruction Manual, and is also stamped on the pump rating plate.
We recommend keeping the following spare parts in stock in order to be in a position to quicky remedy any faults which may arise in service. This list is in accordance with DIN 24296 (recommended spares).

Item No.	Designation	Quantity required for construction with Bearing Pedestal BUA	Bearing Pedestal DS	Remarks
211	Pump shaft with keys	1	1	+) keys
212	Intermediate shaft			
213	Drive shaft	1	1	
230	Impeller	1	1	
271.1	Sand guard	1	1	
271.2	Sand guard	1	1	
320	Angular contact ball bearing	2	-	
321	Deep groove ball bearing	1	-	
382.1	Bearing body	-	1	
384	Thrust bearing disc	-	1	
400.1	Flat gasket	1	1	
400.2	Flat gasket	S	S	
400.3	Flat gasket	1	1	
400.4	Flat gasket	2	2	
400.5	Flat gasket	1	1	
412.1	O-ring	1	1	
422.1	Felt ring	1	-	
422.2	Felt ring	1	-	
461	Stuffing box packing (in meters)	2	2	
502	Casing wear ring	S	S	
525	Spacer sleeve	S-1	S-1	
524	Shaft protecting sleeve	1	1	
526	Centering sleeve	1	-	
529	Bearing sleeve	1	1	
540	Bush	1	1	
541	Stage bush	S-1	S-1	Not applicable to sizes 6, 7, 14 and above
544	Threaded bush	1	1	
545.1	Bearing bush	1	1	
545.2	Bearing bush / rubber	S	S	
545.3	Bearing bush	1	1	
851	Cone coupling	Z + 1	Z + 1	
852	Screwed coupling	Z + 1	Z + 1	
920.1	Nut with 2 flats	1	1	
931.1	Tab washer	1	1	
931.2	Tab washer	2	-	

S = Number of stages Z = Number of intermediate shafts

Table 13

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