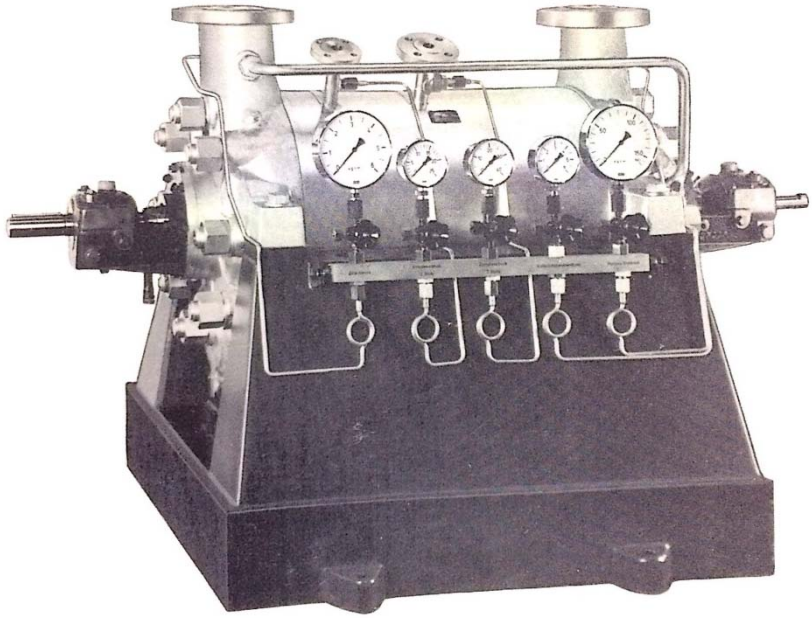
KSB HDB

High-pressure centrifugal pump



1. Application

The KSB HDB series is recommended for boiler feedwater and power plants, production under pressure at pressure and descaling.

2. General Description

Horizontal, multistage, with radially split suction, discharge and stage casings. The sealing between the stage casings is metallic and the union of the components with tie bolts keeps the junction of metallic surfaces under pressure. The stage casings and tie bolts are covered with a jacket.
The pump is supported at the shaft centerline.

3. Description

KSB HDB 100 / 7

Brand — KSB
Model — HDB
Discharge nozzle diameter (mm) — 100
Number of stages — 7

4. Operation Data

Sizes	- DN 40 up to 150
Flow	- up to 700 m^3/h
Head	- up to 2.500 m
Temperature	- up to 230ºC
Speed	- up to 5.500 rpm
Final pressure	- up to 230 bar

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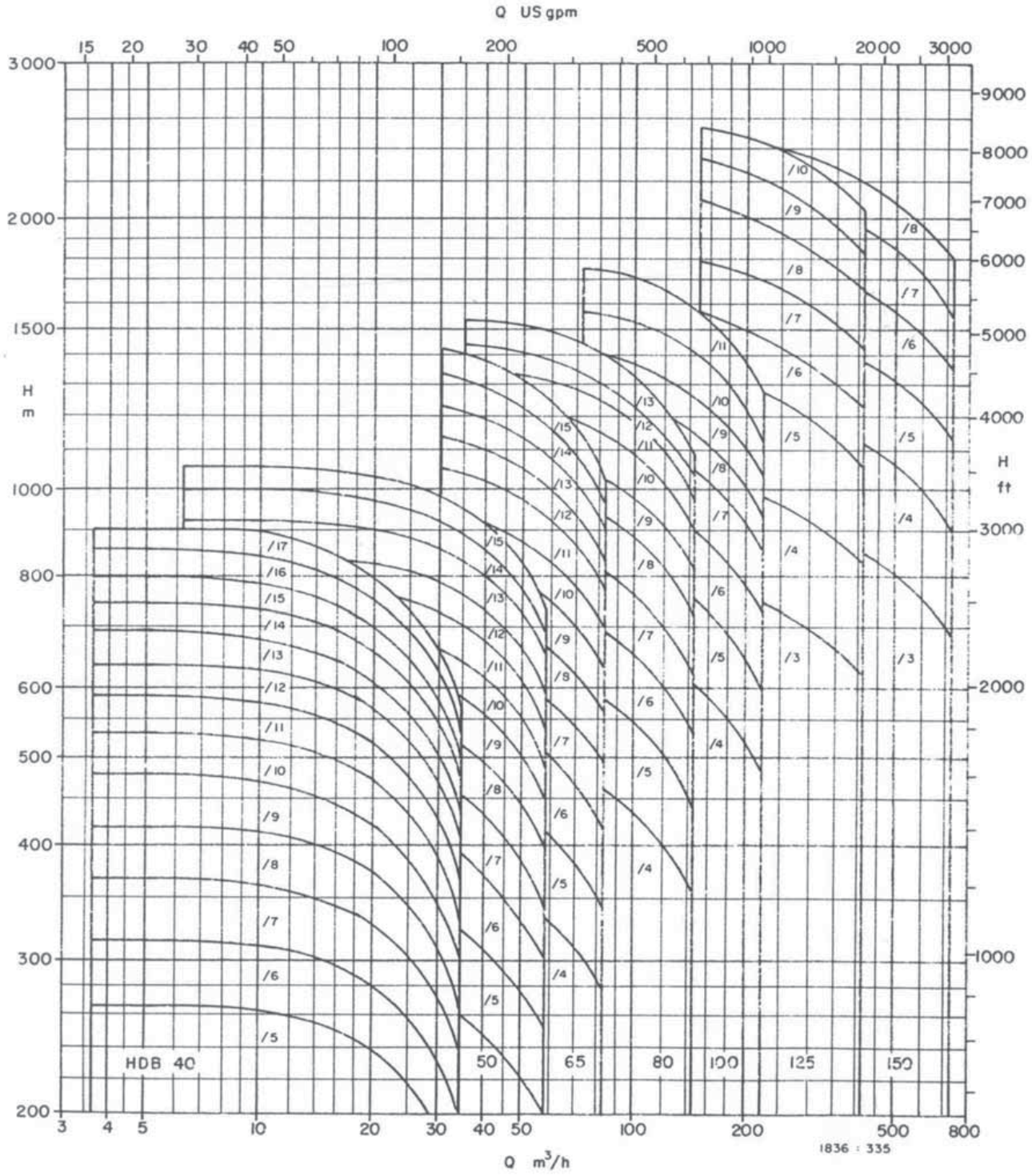
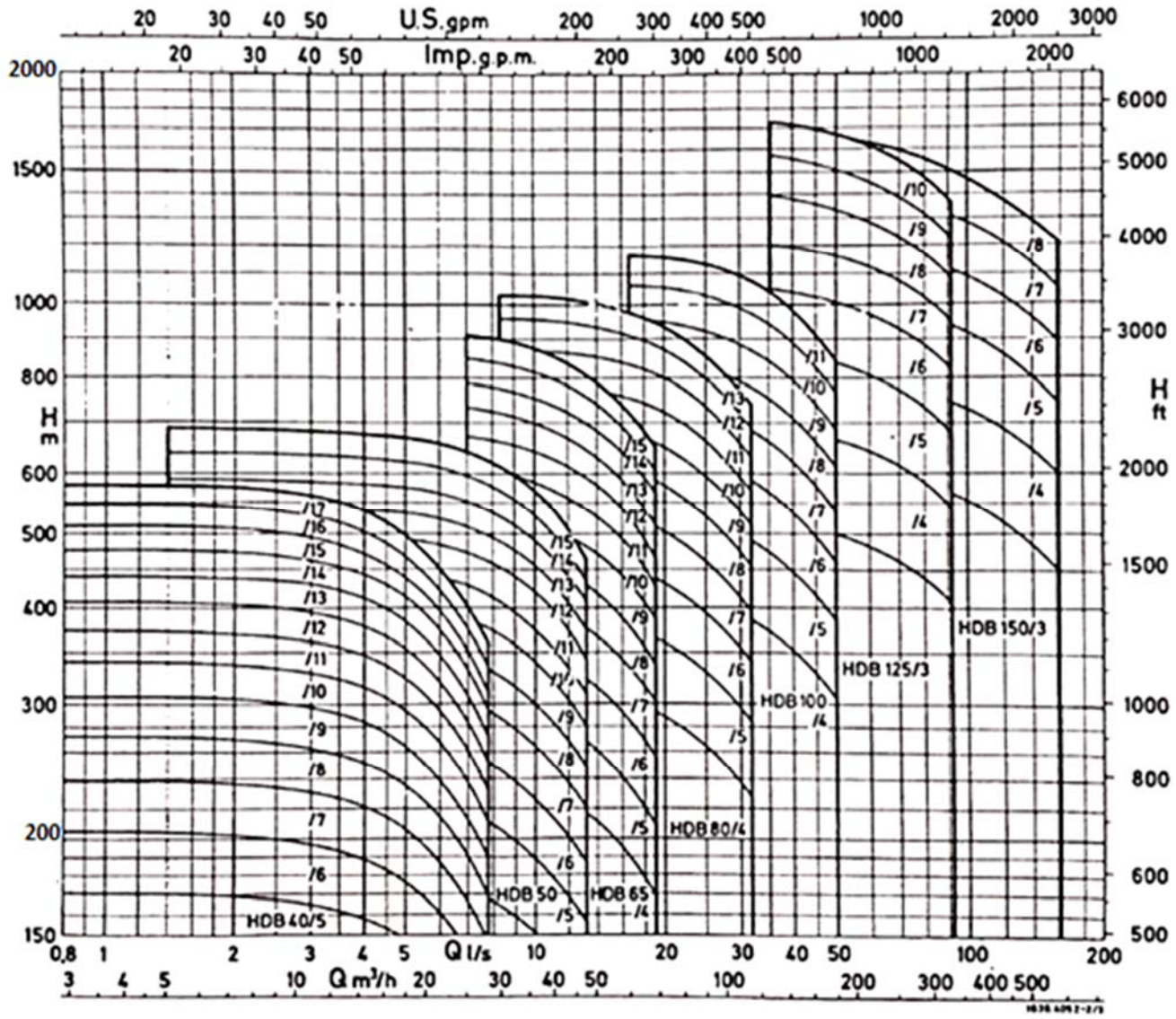
5. Selection chart – 60 Hz



Speed: 3550 rpm

6. Selection chart – 50 Hz



Speed 2900 rpm

7. Constructive Data

Design Data \ Pump Size			40	50	65	80	100	125	150
Suction maximum pressure (bar)			30					25	
Delivery maximum pressure (bar)	Material variant	01	160						
		02	230						
Max differential pressure per stage (bar)	Material variant	01 and 02	26					28	35.5
Max pressure Hydrostatic test (bar)	1st stage	01 and 02	60						
	Other stages – Material variant	01	230					200	
		02	275						
Minimum flow			0.5 x Qopt						
Maximum flow			1.15 x Qopt.						
Min/Max temperature (ºC)			See item 8.2						
Speed direction			Driving on suction side: clockwise (viewed from drive side)						
Flanges ANSI B16.5(1)	Suction		300 # RF	ANSI B16.5 - 150 # RF / ANSI B16.5 - 300 # RF					
	Delivery		ANSI B16.5 - 900 # RF / ANSI B16.5 - 1500 # RF						
Plain bearings DxL (mm)			35x50		45x60		50x60	65x75	75x85
Oil volume per plain bearing (lts)			0.4				0.5	0.7	1.3
Oil flow for forced feed lubrication (l/s) per bearing			0.033		0.05		0.066	0.1	0.133
Additional oil quantity required for axial thrust balance device lubrication (l/s)			0.1				0.133	0.166	
Axial thrust balance device, execution with roller bearings	Double row angular-contact roller bearings		3309-C3		3310-C3				
	Oil volume		0.2		0.4				
Max allowable P/n, shaft (kW/rpm) – Material	SAE 1045		0.0635		0.1405		0.1833	0.6000	0.9500
	AISI 6F3		0.1022		0.1714		0.2415	0.6210	0.9780

Bearing type (2)		GR	GD	GR	GD	GR	GD	GR	GD	GR	GD coupling > 50kg	GD coupling ≤ 50kg	GR	GD	GR	GD
Maximum speed per stages number (3)	3	-	-	-	-	-	-	-	-	-	-	-	3000	3600	3000	3600
	4	-	-	3600	5500	3600	5000	3600	4500	3000	3000	4500	3000	3600	3000	3600
	5	3600	5500	3600	5500	3600	5000	3600	4500	3000	3000	4500	3000	3600	3000	3600
	6	3600	5500	3600	5500	3600	5000	3600	4500	3000	3000	4500	3000	3600	3000	3600
	7	3600	5500	3600	5500	3600	5000	3600	4500	3000	3000	4500	3000	3600	3000	3600
	8	3600	5500	3600	5500	3600	5000	3600	4500	3000	3000	4500	3000	3600	3000	3600
	9	3600	5500	3600	5500	3600	5000	3600	4500	3000	3000	4400	3000	3600	-	-
	10	3600	5500	3600	5500	3600	5000	3600	4300	3000	3000	4200	3000	3600	-	-
	11	3600	5500	3600	5500	3600	4800	3600	4250	3000	3000	4000	-	-	-	-
	12	3600	5500	3600	5300	3600	4700	3600	4200	-	-	-	-	-	-	-
	13	3600	5500	3600	5100	3600	4600	3600	4100	-	-	-	-	-	-	-
	14	3600	5200	3600	4900	3600	4400	-	-	-	-	-	-	-	-	-
	15	3600	4800	3600	4700	3600	4300	-	-	-	-	-	-	-	-	-
	16	3600	4400	-	-	-	-	-	-	-	-	-	-	-	-	-
	17	3600	4000	-	-	-	-	-	-	-	-	-	-	-	-	-

Minimum number of stages		5	4				3	
Inertia moments J=GD²/4 (Kgm²) with water	1st stage	0.00715	0.01210	0.02185	0.03180	0.06605	0.25455	0.50000
	Each additional stage	0.00415	0.00750	0.01575	0.02110	0.04415	0.14525	0.26250

Pump final weight per stages, in kg								
	3	-	-	-	-	-	1200	1735
	4	-	279	374	564	780	1300	1900
	5	214	300	401	605	830	1400	2065
	6	228	321	428	664	880	1500	2230
	7	242	342	455	687	930	1600	2395
	8	256	363	482	728	980	1700	2560
	9	270	384	509	769	1030	1800	-
	10	284	405	536	810	1080	1900	-
	11	298	426	563	851	1130	-	-
	12	312	447	591	892	-	-	-
	13	326	468	618	933	-	-	-
	14	340	489	645	-	-	-	-
	15	354	510	672	-	-	-	-
	16	368	-	-	-	-	-	-
	17	382	-	-	-	-	-	-

Table 1 – Technical data

Pressure shall not be lower than 25% of pressure at operation point, neither lower than 15 bars·

(1) Other flanges standards, upon request.
(2) Bearing types:
GR - plain bearings with lubrication by oil ring
GD – plain bearing with forced feed lubrication
(3) Speed can be exceeded by 10% for a short period of time, considering the allowable pressure limitations according to figure3.

8. General Description

8.1 Casing

Top suction and discharge flanges. Flanges on the stage casing for extraction of one or more partial flows of feedwater for use elsewhere.

8.2 Impeller

Radial, closed, single suction impeller

8.3 Shaft

Pump shaft is provided with shaft protection sleeve and spacer sleeve.

8.4 Shaft sealing

The shaft is sealed by packing. Option for shaft sealing by mechanical seal is available.
Cooling chamber is necessary for temperatures above 105ºC.

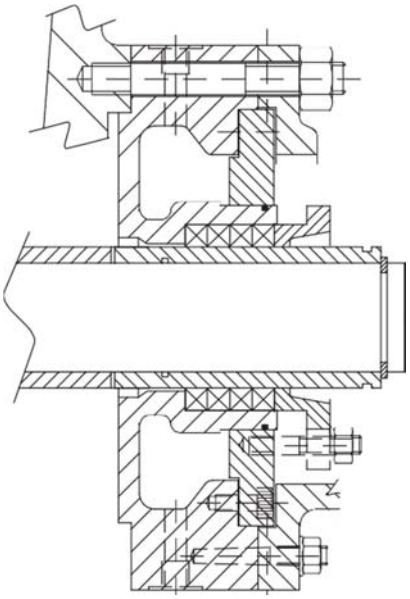


Fig.1 - Shaft sealing by gasket with cooling chamber

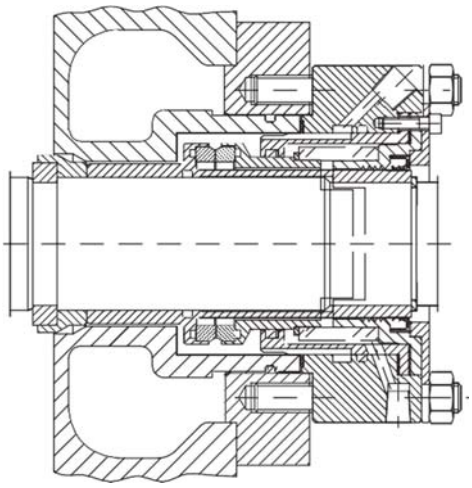


Fig.2 - Shaft sealing by mechanical seal

8.5 Axial thrust balance

Axial thrust balance by balance disc, with balance line piping towards the suction casing or suction tank.

8.5.1 Description and principle of operation of the axial thrust balance device

The pumped medium flows through the suction casing (106) to the first impeller. It leaves the impeller (230), pressurizes its shoulders and flows to the diffuser (171.1) and from diffuser to the next impeller inlet.
This process is repeated on each stage, while the pressure is increased by an equal value successively, i.e. by the capacity of head of the stage.
From the last impeller, the medium flows to the balance disc chamber and to last stage diffuser (171.2). From the last stage diffuser to the pressure casing and to the discharge piping
An axial force A, which is caused by the differential pressure from the area between DSP (wear ring inner diameter) and e Da (stage sleeve diameter) acts on each impeller. See Figure 3. This axial thrust tends to displace the impeller to pump suction side.

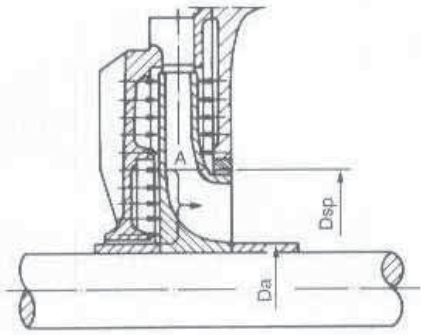


Fig.3 – Rotor axial thrust

A specific balance device is necessary to balance the axial thrust. This device consists of a balance disc (601), balance disc seat (602) and balance line piping, acting through the radial clearance between the throttle bushing of the balance disc seat (602) and the spacer sleeve (525.2) - clearance “B” – and the axial clearance between disc and balance disc seat – clearance “C”.
For example, if clearance “C” is very small, roughly the pump final pressure will act on disc chamber, displacing the rotor to the discharge side, and clearance C will increase. If the clearance C is too big, there will be a pressure relief on the disc chamber, reducing the axial thrust and returning the rotor to the suction side. During the operation, an average clearance will be set and pump will be axially balanced. See Figure 4.

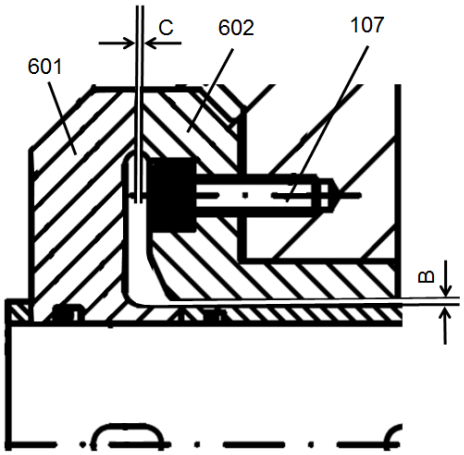


Fig.4 – Axial thrust balance device

On the back of the balance disc, between the discharge casing (107) and gland packing (451) there is a chamber where the balance piping is installed and can be returned to suction casing or tank, depending on specific conditions. See Figures 6 and 10.

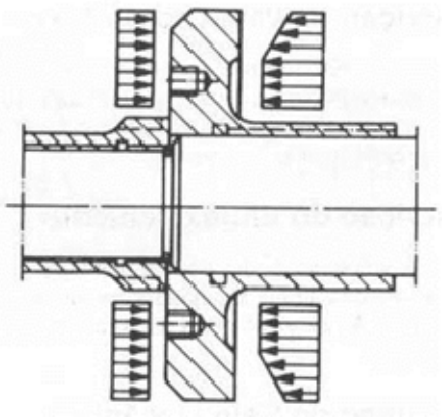


Fig.5 – Axial forces on the balance disc

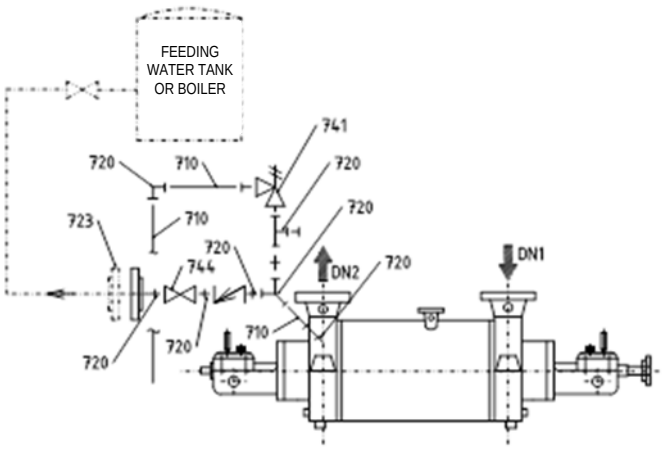


Fig.6 – Balance line piping sketch with return to the suction tank

Caution: Minimum differential pressure to displace disc is 15 bar. For lower values, the clearance "C" in Figure 4 will not exist and the balance device will be violently worn by friction.

8.6 Bearings

The bearings are installed in two flanged bearing brackets on both ends of the pump. Bearings can be rolling bearings, or plain bearings with lubrication by oil rings or forced feed lubrication.

8.7 Accessories (optional)

8.7.1 Drive

Direct drive by flexible coupling or indirect drive by means of gearbox, electric motor, turbine, diesel motor, etc.

8.7.2 Coupling

Flexible coupling sleeve to allow shaft axial displacement.

8.7.3 Coupling guard

KSB standard

8.7.4 Baseplate

KSB standard of steel

8.7.5 Suction strainer

Suction strainer must always be installed on the suction piping in order to protect the pump.

8.7.6 Temperature sensors (PT100)

The temperature sensors are installed on the bearings to monitor their temperature

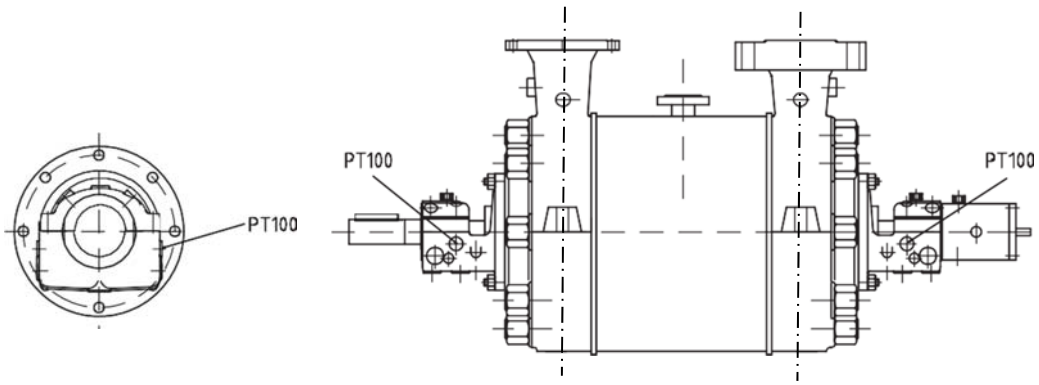


Fig.7 – Temperature sensors positioning

8.7.7 Vibration sensors

They can be installed on the bearings with features depending of customer's specification and bearing type.

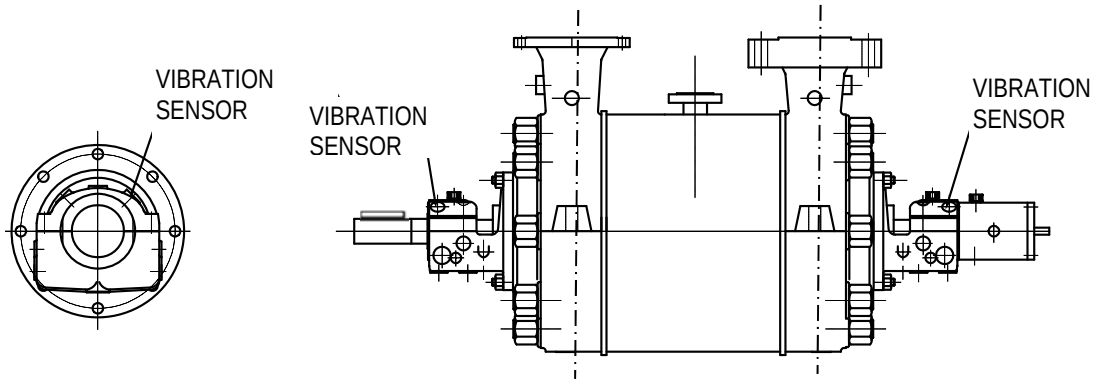


Fig.8 – Vibration sensors position

9 Technical Data

9.1 Discharge flow for axial thrust balance

The flows of discharge Q_E are average values resulting from various measurements shown on Figure 9. These flows refer to a pump speed n = 3550 rpm, 60 Hz and may be linearly transformed to other speeds.

The discharge flow returns to the pump suction flange or to the boiler which feeds the pump, according to the flow temperature and the number of stages (see Figure 10). Conditions: Q min = 20% de $Q\eta_{opt}$ and NPSHavailable ≅ NPSHrequired.

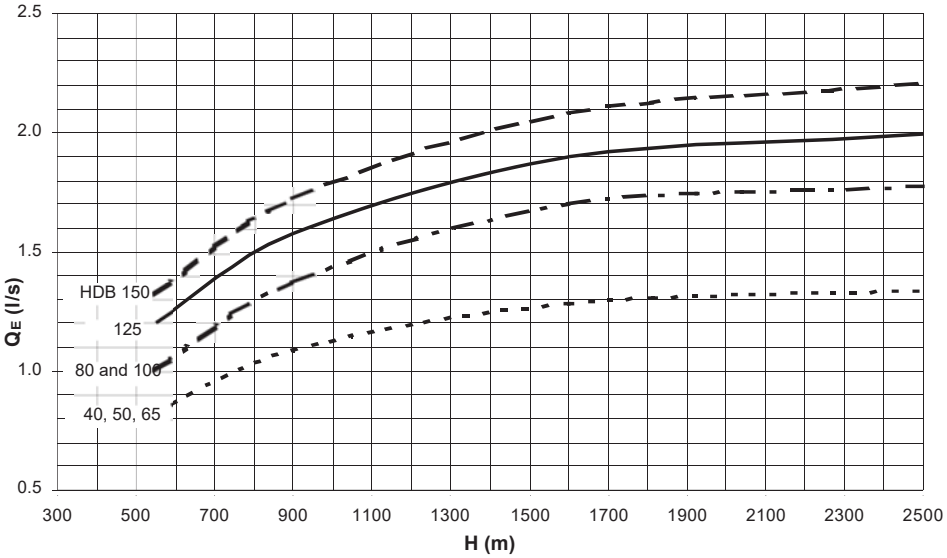


Figure 9 – Flows of discharge Q_E in l/s for a speed of 3550 rpm.

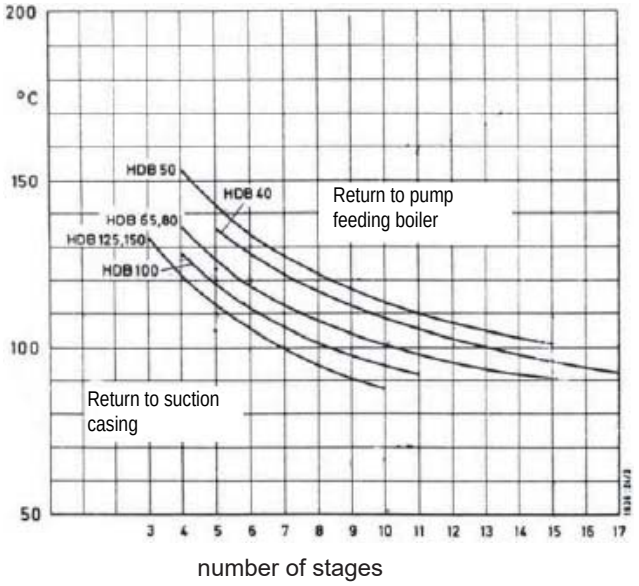


Figure 10 – Values for flow return

The balance disc liquid piping requires sizing according to table below:

Size	Diameter of balance disc liquid piping for pipe length < 10 m	Diameter of balance disc liquid piping for pipe length ≥ 10 m
40 to 65	DN 25	DN 40
80 to 150	DN 40	DN 50

9.2 Pressure and temperature limits

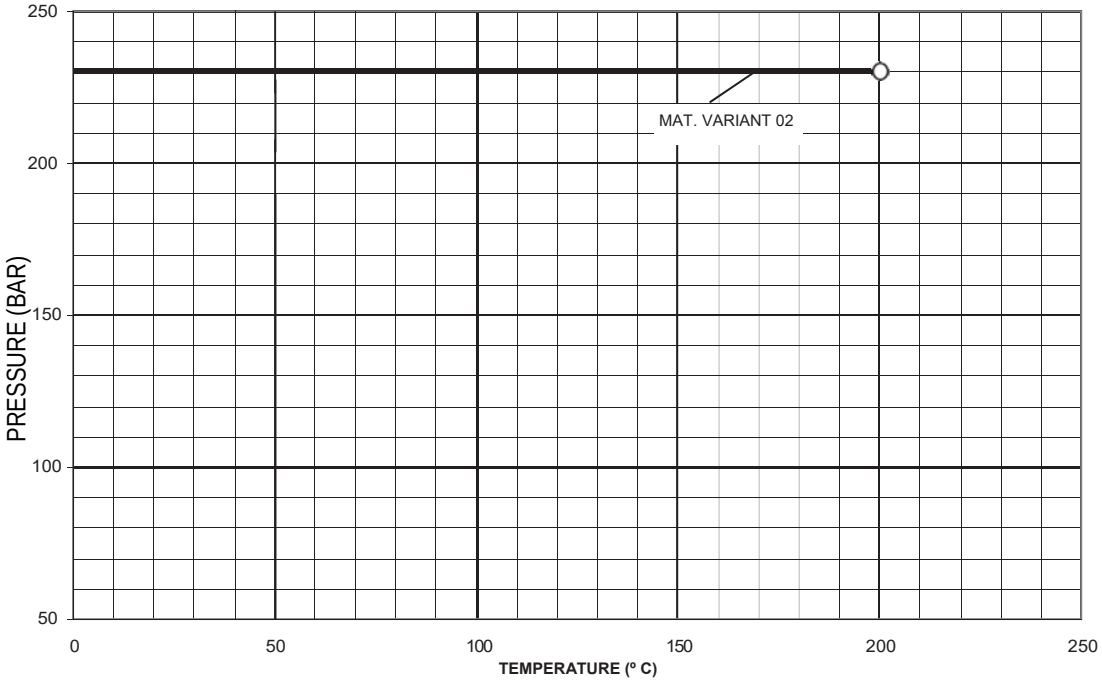


Figure 11- Pressure and temperature limits (with pre-warming)

Figure 11 sets pressure limitations valid for pumps whose temperatures differences between operating condition of pump and medium are small, for example.

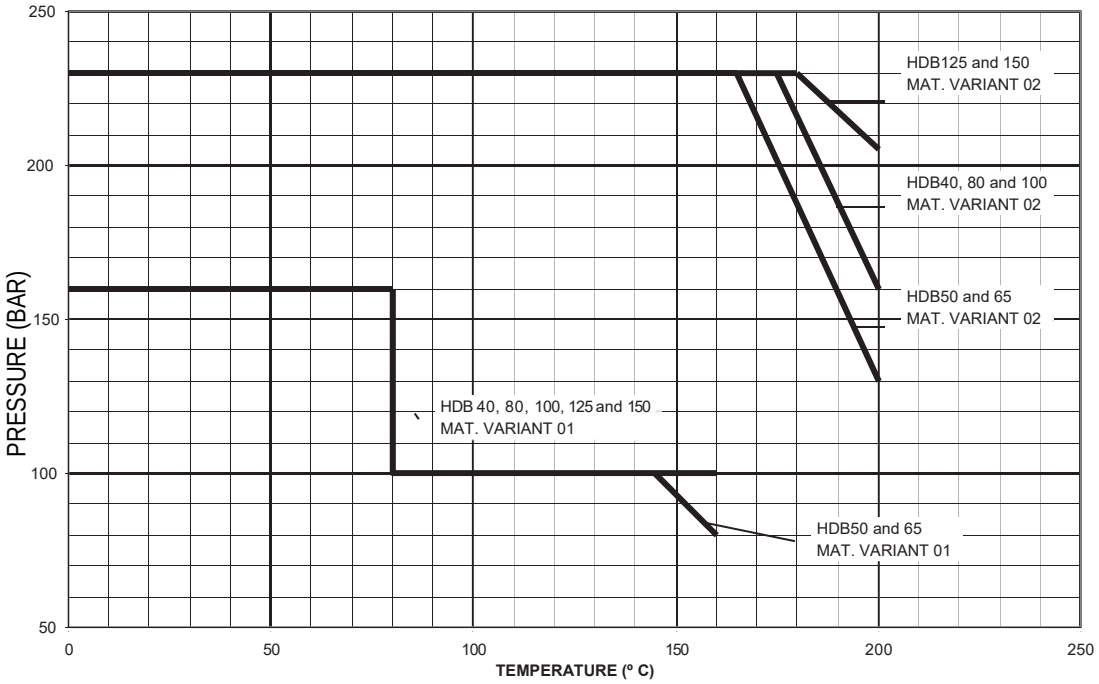


Figure 12 – Pressure and temperature limits (cold start-up)

9.3 Speed limits according to impeller diameter and material

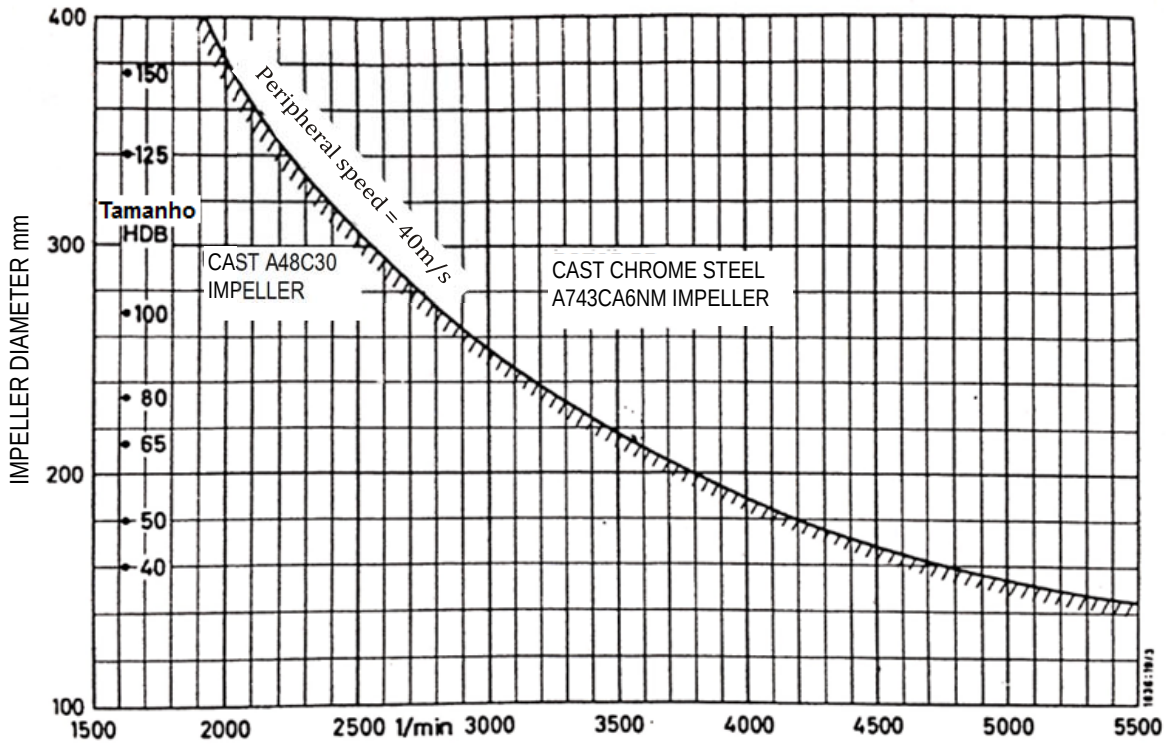


Figure 13 – Speed limits according to impeller material

For sizes 125 and 150 only chrome steel impellers can be used

9.4 Critical speeds

Figure 14 shows critical speeds, which are defined according to hydraulic features.

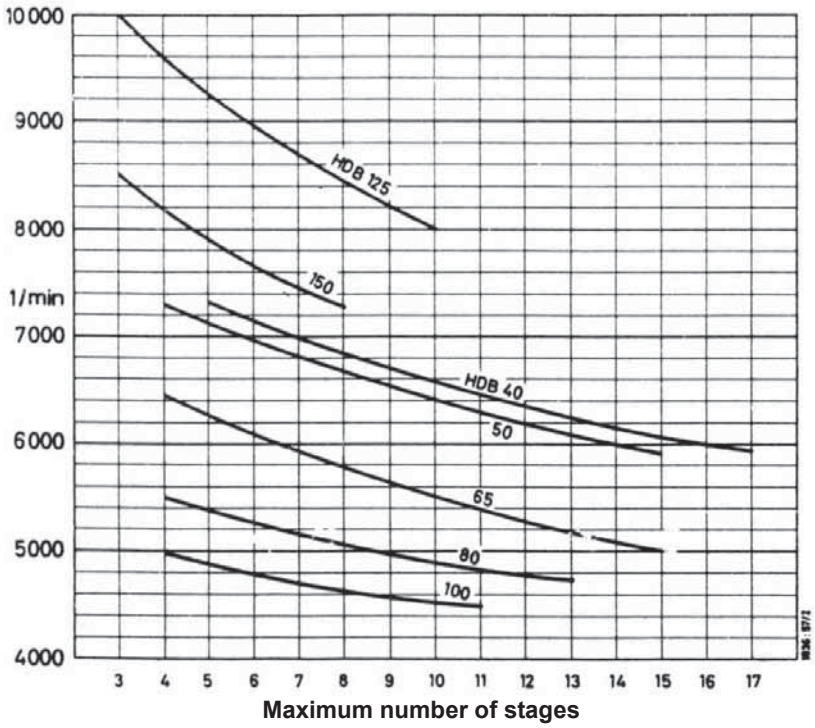
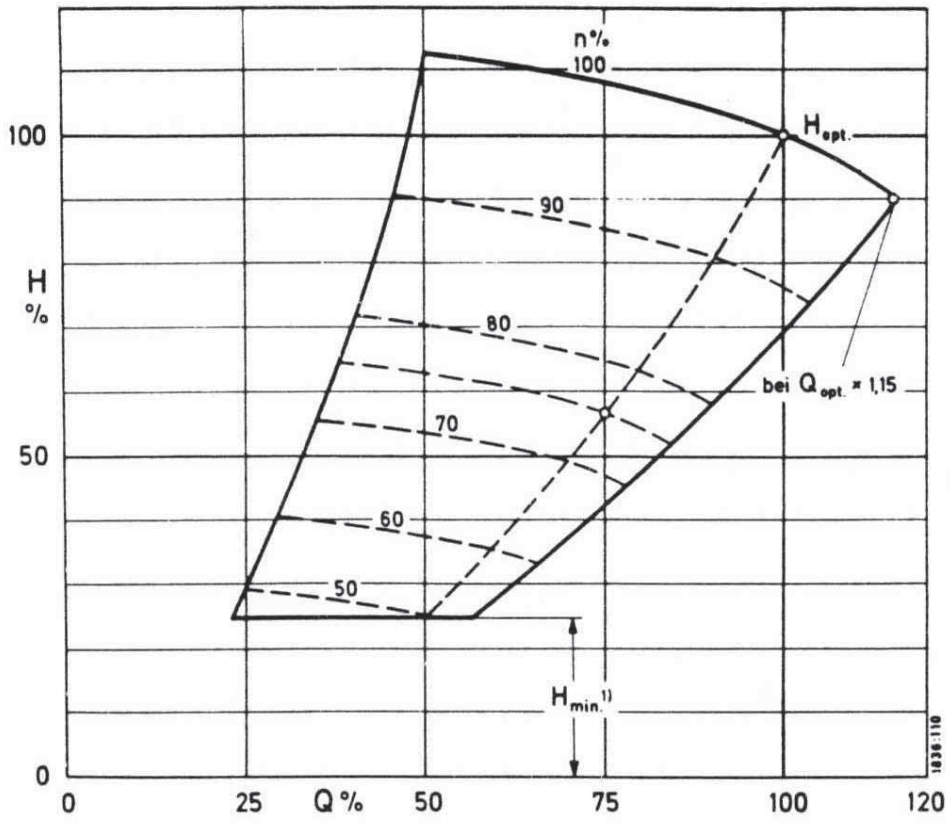


Figure 14 – Critical speeds according to the number of stages

9.5 Speed regulation

For driving machines with speed regulation (turbine, reducer, frequency inverter, etc.) there will be other values for manometric height, shown on chart in Figure 15.

For example, if pump speed corresponds to 75% of nominal speed, when pump works with ¾ of load, we receive only 56% of pump manometric height, compared to 100% of load and nominal speed.



See item 6 – Technical Data

Figure 15 – Speed regulation

9.6 NPSH required

In order to avoid cavitation, the NPSH available shall always be higher than NPSH required (safety margin and tolerances for construction and dimensions are not considered on the catalogues).
The graph on Figure 16 shows the relations between factors.
For constant pressure of the water in suction tank, the safety margin for Qmax shall be of at least 1 m.
In case the strainer is installed inside the suction piping, the loss on the strainer is approximately 2 m for maximum Q, assuming that free area of the strainer is three times bigger than free suction piping area. For detailed information about the losses on the suction strainer, please contact KSB.
If HDB pump receives inlet pressure required by a pre-pump (BOOSTER type), the pressure provided by this pre-pump shall be considered to determine the NPSH required of HDB.

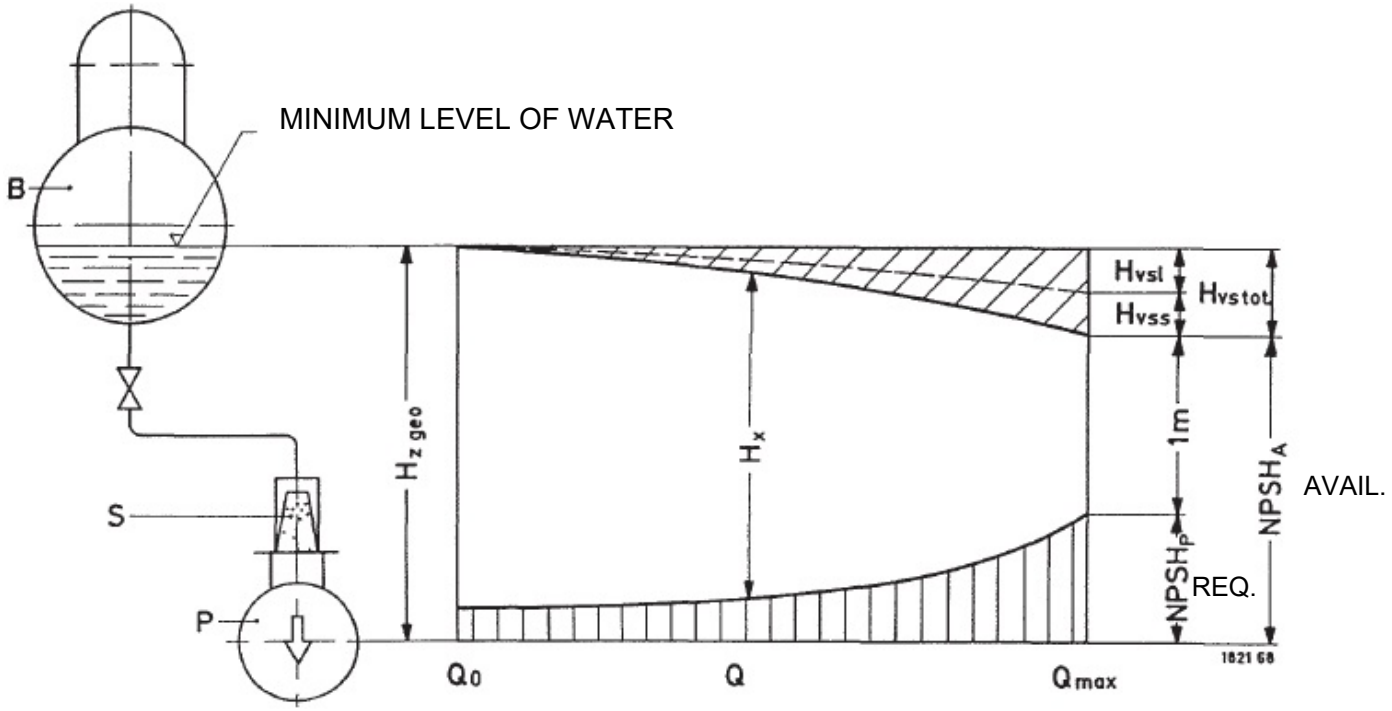


Figure 16

NPSH req.	=	Required NPSH [m]
NPSH avail.	=	Available NPSH [m]
Hz geo	=	Geodesic height of pump flow inlet [m]
Hvstot	=	Losses due to friction inside inlet piping, including strainer losses [m]
Hvsl	=	Losses at boiler outlet and piping up to pump, without strainer losses [m]
Hvss	=	Strainer losses [m]
Hx	=	Safety heights
B	=	Boiler feedwater pump
P	=	Pump
S	=	Strainer

10 Design

High pressure horizontal multistage centrifugal pump.
The casings of various stages and tie bolts are installed inside a cover. The suction and discharge casings have top flanges. The pump feet are supported on shaft centerline position to avoid thermal expansion.

10.1 Assembly of set and work environment

In most cases pumps and motors including other accessories are installed on a common baseplate on most of the cases, and inside closed areas.

For hot water pumps it is possible to pre warm the pump by the flow during operation (see figure 17).

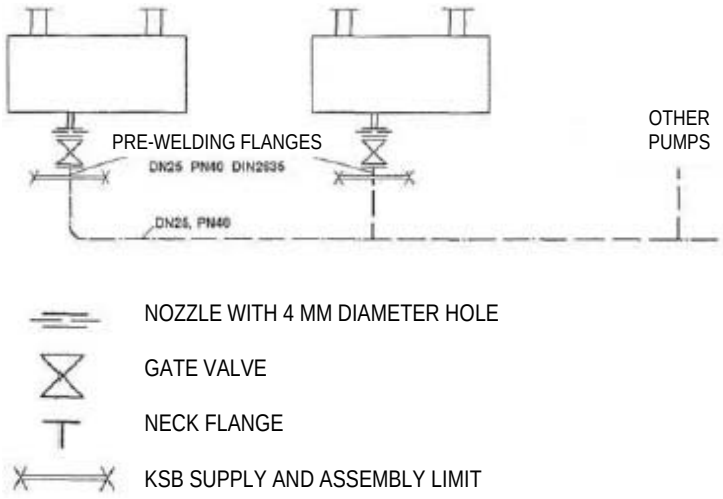


Figure 17 – Cold water pumps installation outdoors

It is possible to install heating coil between the pump casing and baseplate outdoor during low temperature period on cold water pumps installed (figure 18).

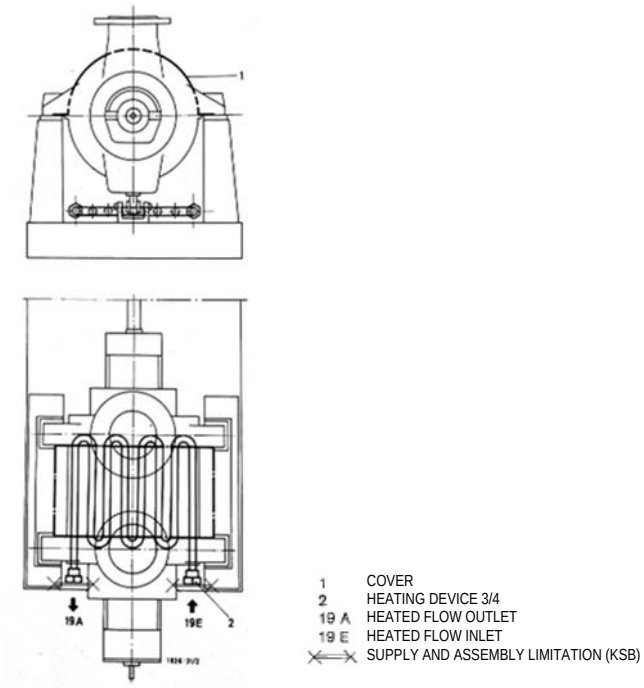


Figure 18 – Pump with heating device

10.1 Casing
HDB pumps are provided with suction and stage casings and gland installed radially to the shaft.
The casings are assembled with metal-to-metal joints (without sealing gasket) to avoid leakage.
Diffusers are installed inside the stages and pressure casings. Wear rings are installed inside suction and stage casings.
Standardized pressure classes according to ANSI standard, other standards may be applied upon request.

Pump Size	Suction	Pressure casing
40	ANSI B16.5 - 300 # RF	ANSI B16.5 - 900 # RF ANSI B16.5 - 1500 # RF
50 65 80 100 125 150	ANSI B16.5 - 150 # RF ANSI B16.5 - 300 # RF	

Table 2 – Flange nominal pressure, according to ANSI standard.

For flanges connections, see item Dimensions.

10.2 Impellers
HDB pumps are provided with radial impellers, with clockwise direction and single suction. Impellers are fastened to shaft with keys; the distance between the impellers is made through stages spacer sleeve, and spacer sleeves on suction side and discharge side.

10.3 Shaft
Made from a single piece in different materials, shafts are protected by shaft protection sleeves and spacer sleeves, according to specified variant. In standard variant, on shell and impellers fastening regions, it is provided with chrome surface treatment.1
Shaft mechanical strength depends on shaft and coupling sleeve material.
Remark: Couplings that do not allow axial flotation (E.g.: Steelflex from “Falk”) do not apply to this pump type, due to rotor axial displacement during start-up.

10.4 Bearings and Lubrication Types

10.4.1 Bearings
HDB pumps bearings do not need to handle axial forces, as these forces are balanced by the hydraulic balance thrust device.
For bearings sizes and oil quantity on bearings housings, see Tables 1, 3, 4, 5 and 6.
The maximum bearings housing temperature considered is 45ºC above ambient temperature, and shall not exceed 80ºC.
For applications with ambient temperatures above 45ºC and pumped water temperature from 150ºC to 200ºC it is necessary to cool the bearing housing when plain bearings are used, see figure 20. It is not necessary to cool the bearings if the bearings lubrication is by forced feed lubrication.
For pumped fluid temperature above 200 ºC, forced feed lubrication is required.
Plain bearings clearance is approximately 0.001 x shaft Ø

Pump Size	Plain bearings inner Ø x length (mm)	Oil volume per bearing (l)
40 and 50	35 x 50	0.4
65	45 x 60	0.4
80	45 x 60	0.4
100	50 x 60	0.5
125	65 x 75	0.7
150	75 x 85	1.3

Table 3 – Pumps with plain bearings and lubrication by oil ring, without axial thrust device

Pump Size	Plain bearings internal Ø x length (mm)	Oil flow for radial bearing forced feed lubrication (l/sec)	Oil additional quantity when axial thrust device is used (l/sec)
40 and 50	35 x 50	0.033	0.10
65	45 x 60	0.050	0.10
80	45 x 60	0.050	0.10
100	50 x 60	0.066	0.133
125	65 x 75	0.100	0.166
150	75 x 85	0.133	0.166

Table 4 – Pumps with plain bearings and forced feed lubrication

Pump Size	Axial thrust balance device, with roller bearings execution:	
	Angular-contact roller bearing	Oil volume for axial thrust balance device (l)
40 and 50	3309-C 3	0.2
65	3310-C 3	0.4
80		
100		
125		
150		

Table 5 – Pumps with plain bearings and axial thrust balance device with roller bearing

When the pump is installed outdoors the bearings have extra protection by felt rings to avoid dust contamination. Oil level is constantly controlled by a constant level oiler.

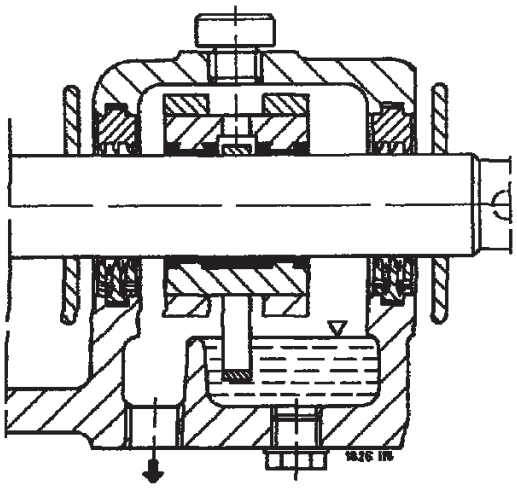
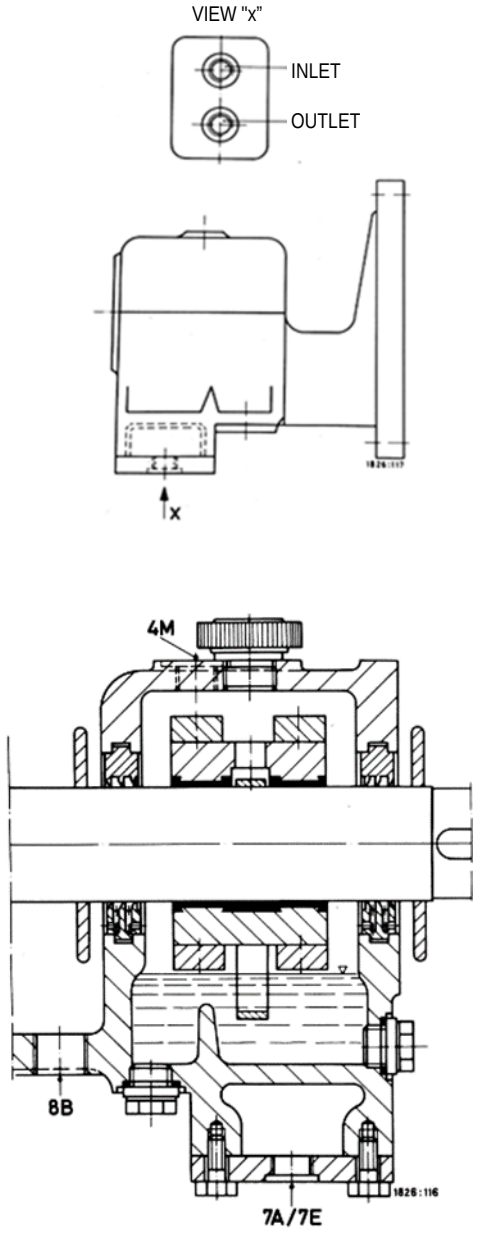


Figure 19 – Plain bearings sealing for outdoors installation (standard execution)



CONNECTIONS	DESIGNATION
4M	TEMPERATURE MEASUREMENT POINT
7A	COOLING WATER OUTLET
7E	COOLING WATER INLET
8B	DRIPPING WATER DRAIN

Figure 20 – Bearing housing cooling

10.4.2 Axial thrust balance device

11 For speeds below 50% of nominal speed, with discharge pressure below 25% of pressure at operating point or below 15 bar, the axial thrust balance device (balance disc and balance disc seat) is roughly without any effect i.e. disc and balance disc seat would have metallic contact. In order to avoid the wear of these parts it is necessary to limit the pump speed to a minimum speed in case of automatic regulation. During start-up and shutdown it is unavoidable to cross the speed ranges mentioned above (for example more than one time a day in case of electric motor, or in case of turbine driven pump, when the turbine operates for a long time period of time in low speed) it is recommended to use a lift-off device.

12 The aim of this device is to avoid metallic contact between disc and balance disc seat and to balance axial hydraulic thrust which occurs in low speeds.

13 Depending on the pump size and speed there are two types of lift-off device i.e. execution with roller bearings (figures 21 and 22) and with segment bearings (figures 23 and 24). For plain bearings with forced feed lubrication the device shall be used as shown on figures 23 and 24.These executions require pressurized oil and consumption according to Table 8.

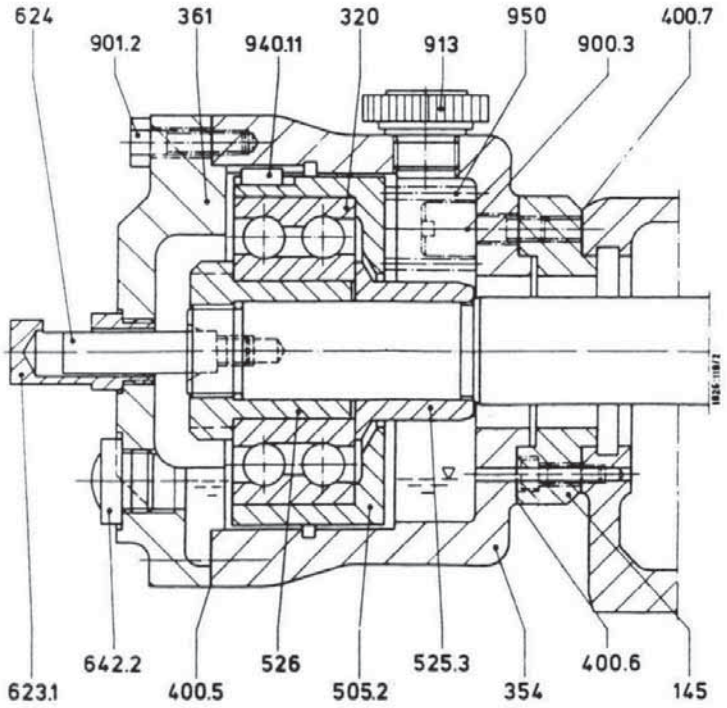


Figure 21 – Lift-off device with roller bearings for pumps with plain bearings for sizes 40 to 100

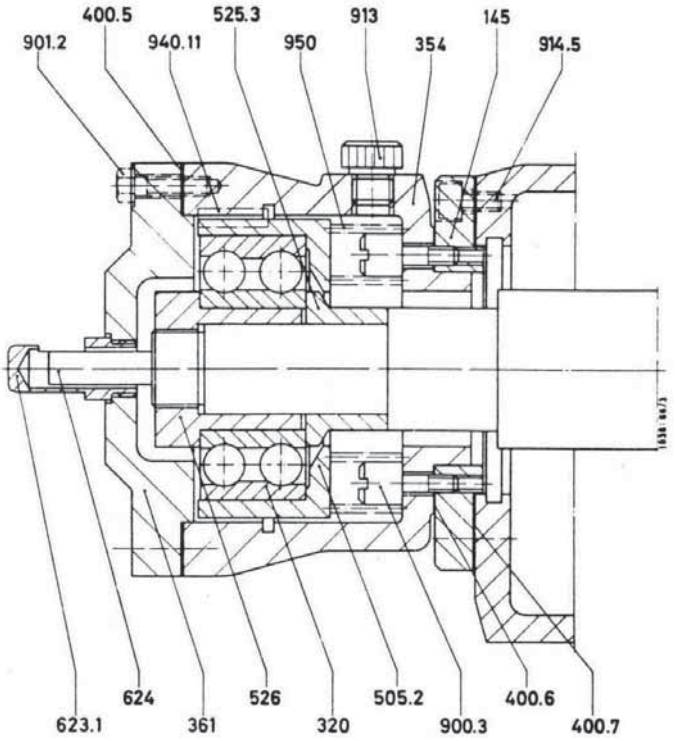


Figure 22 – Lift-off device with roller bearings for pumps with plain bearings for sizes 125 and 150

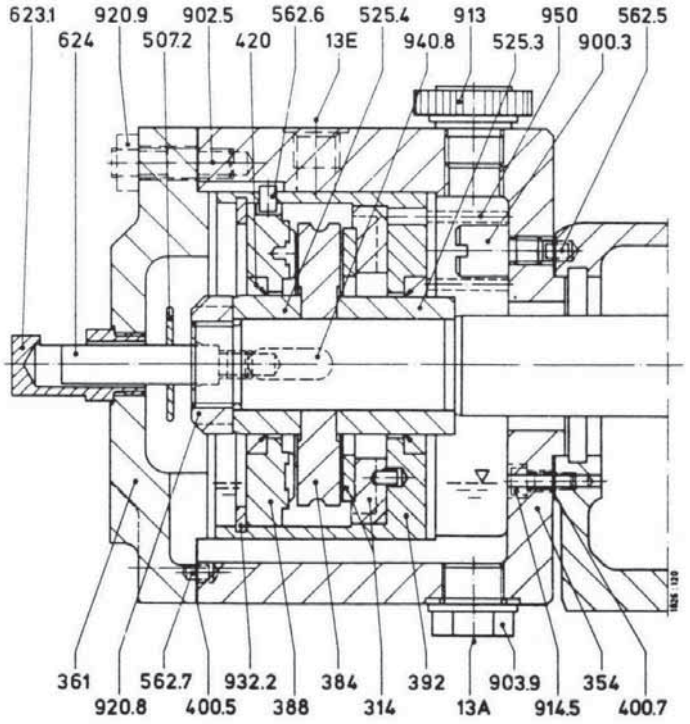


Fig. 23 – Lift-off device with forced feed lubrication for pumps with plain bearings for sizes 40 to 100

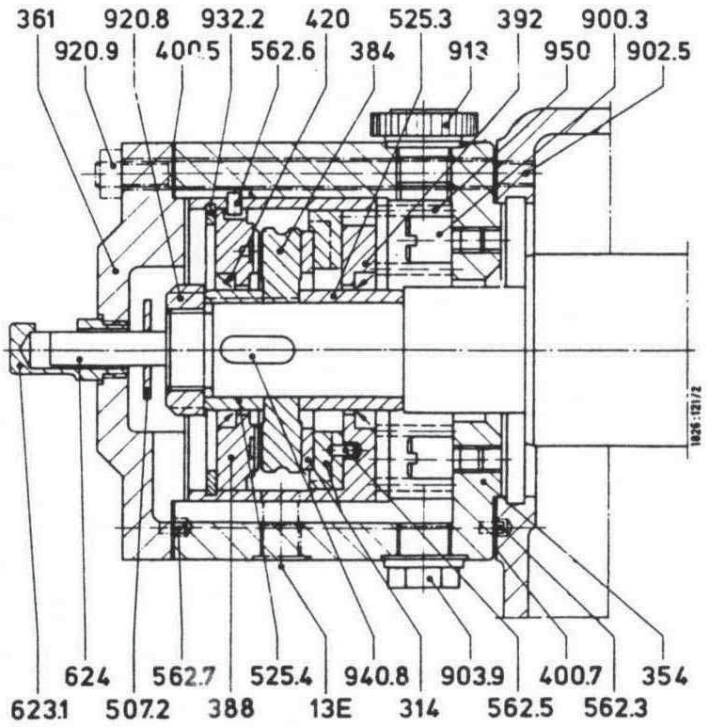


Fig. 24 – Lift-off device with forced feed lubrication for pumps with plain bearings for sizes 125 and 150

Qty. of parts per pump	Part no.	Description	Lift-off device	
			Execution with bearing	Execution with segment bearings
			Fig. 21 and 22 Material	Fig. 23 and 24 Material
1	145	Union part	SAE 1045	-
1	314	Thrust bearing	-	St/Lg Sn 80
1	320	Roller bearing	Steel	-
1	354	Thrust Bearing housing	A48 CL30	A48 CL35
1	361	Bearing end cover	A48 CL30	A48 CL35
1	384	Thrust bearing plate	-	AISI 420
1	388	Balance disc seat plate	-	St/Lg Sn 80
1	392	Bearing segment carrier	-	SAE 1045
1	400.5[1)]	Gasket	Hydraulic Cardboard	Hydraulic Cardboard
1	400.6	Gasket	Hydraulic Cardboard	-
1	400.7	Gasket	Hydraulic Cardboard	Hydraulic Cardboard
2	420	Shaft seal ring	-	Steel/NB
1	505.2	Loose collar	AISI 420	-
1	507.2	Thrower	-	AISI 316
1	525.3	Spacer sleeve	AISI 420	AISI 420
1	525.4	Spacer sleeve	-	AISI 420
1	526	Centering sleeve	Steel	-
1	562.5	Cylindrical pin	-	SAE 1045
1	562.6	Cylindrical pin	-	SAE 1045
1	562.7	Cylindrical pin	-	SAE 1045
1	623.1	Shaft position indicator	Brass	Brass
1	624	Pin wear indicator	SAE 1020	SAE 1020
1	642.2	Oil level sight glass	Brass/Glass	-
1	913	Venting device	Aluminum	Aluminum
8	900.3	Screw	SAE 1045	SAE 1045
8	901.2	Hexagon head bolt	SAE 1045	-
4	902.5	Stud	-	SAE 1045
1	903.9	Screwed plug	-	Steel
8	914.5	Socket head cap screw	SAE 1045	SAE 1045
4	920.8	Nut	-	SAE 1045
4	920.9	Nut	-	SAE 1045
1	932.2	Circlip	-	Spring Steel
1	940.8	Key	-	SAE 1045
1	940.11	Key	SAE 1045	-
8	950	Spring	Spring Steel	Spring Steel

1) For pressure segment bearings 2 parts
Recommended spare parts

13A Oil outlet
13E Oil inlet

Table 6 – Materials list for lift-off device

13.1.1 Lubrication types

10.5.3.1 Execution with plain bearings = lubrication with oil ring or forced feed lubrication

For bearings with forced feed lubrication it is recommended to change the oil every 8000 hours of operation or after maximum two years. For plain bearing and oil ring it is recommended to carry out first oil change after 500 hours of operation, and the next oil changes after 8000 hours or within maximum 1 year.

The oil control in the reservoir or the strainer control of the lube oil system must be performed monthly.

Figure 25 and table 7 show the size and the position of the connections of the plain bearing housing.

In case of pump driven by steam turbine, a lube oil system only for the turbine must be provided separately, which includes an oil reservoir and gear pump driven by electric motor, with heat exchanger, oil filter, internal piping, pressure switches, accessories and instrumentation.

In case of pump driven by electric motor, a lube oil system only for the turbine must be provided separately, which includes an oil reservoir and gear pump driven by electric motor, with heat exchanger, oil filter, internal piping, pressure switches, accessories and instrumentation. The lube oil system installation is set to turn on the main electric motor with the pressure switch right after the oil pump motor starts to operate.

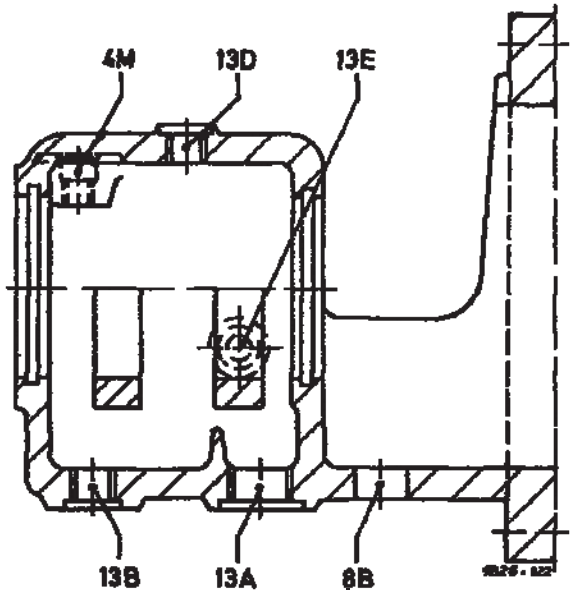


Figure 25 – Connections

Pump Size	Oil			Connection for temperature control 4M	Vent plug cover 13D	Dripping outlet 8B
	Inlet 13E	Outlet 13A	Drain 13B			
40	R ¼"	R ¾"	R ½"	R $^{3}/_{8}$"	R ½"	R ½"
50	R ¼"	R ¾"	R ½"	R $^{3}/_{8}$"	R ½"	R ½"
65	R ¼"	R ¾"	R ½"	R $^{3}/_{8}$"	R ½"	R ½"
80	R ¼"	R ¾"	R ½"	R $^{3}/_{8}$"	R ½"	R ½"
100	R $^{3}/_{8}$"	R ¾"	R ½"	R $^{3}/_{8}$"	R ½"	R ½"
125	R $^{3}/_{8}$"	R 1"	R ½"	R $^{3}/_{8}$"	R ½"	R ½"
150	R $^{3}/_{8}$"	R 1"	R ½"	R $^{3}/_{8}$"	R ½"	R ¾"

Table 7 – Connections for lube oil system for bearing housing of plain bearings housing

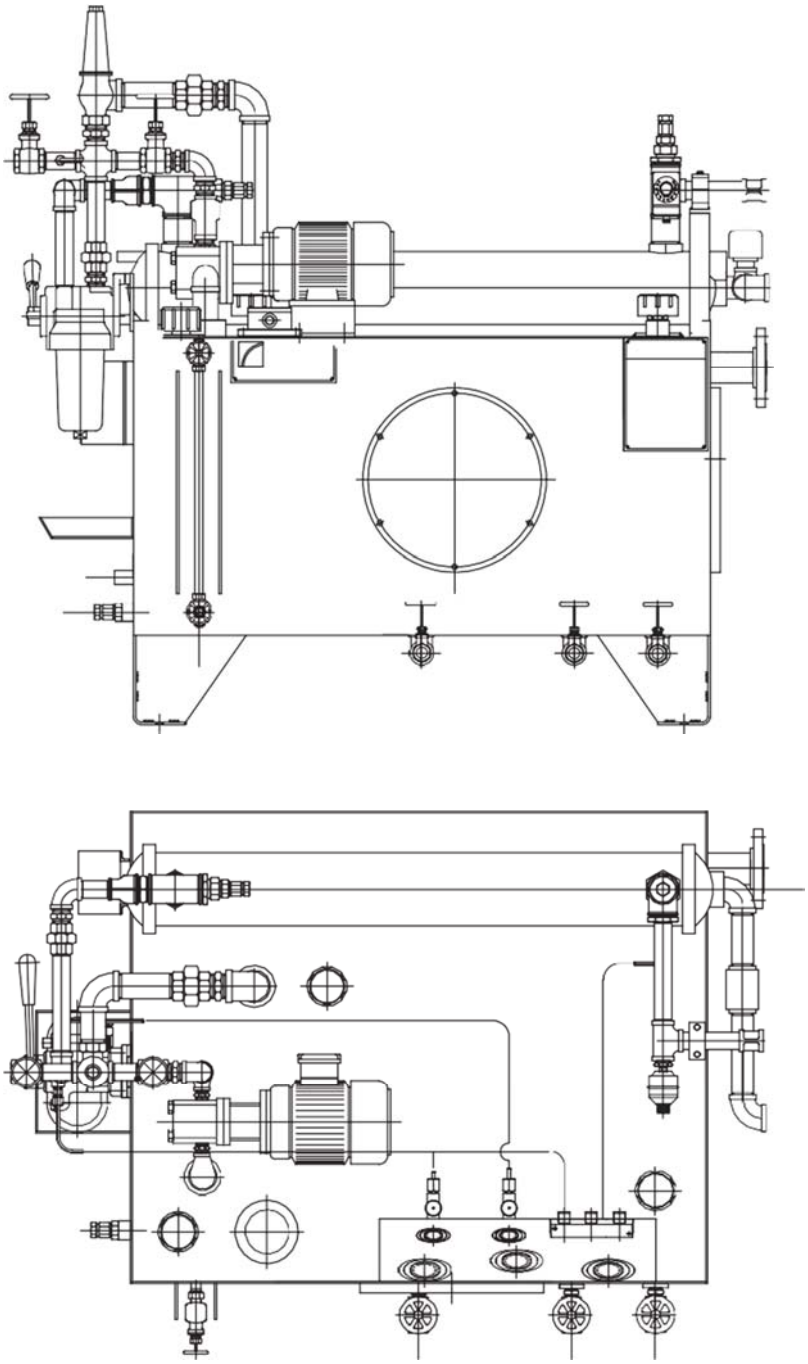


Figure 26 – Lube oil system (example)

Pump Size	Oil flow consumption in l/sec	
	Without lift-off device	With lift-off device
40, 50, 65 and 80	0.083	0.166
100, 125 and 150	0.166	0.333

Table 8 – Oil distribution according to pump size and execution

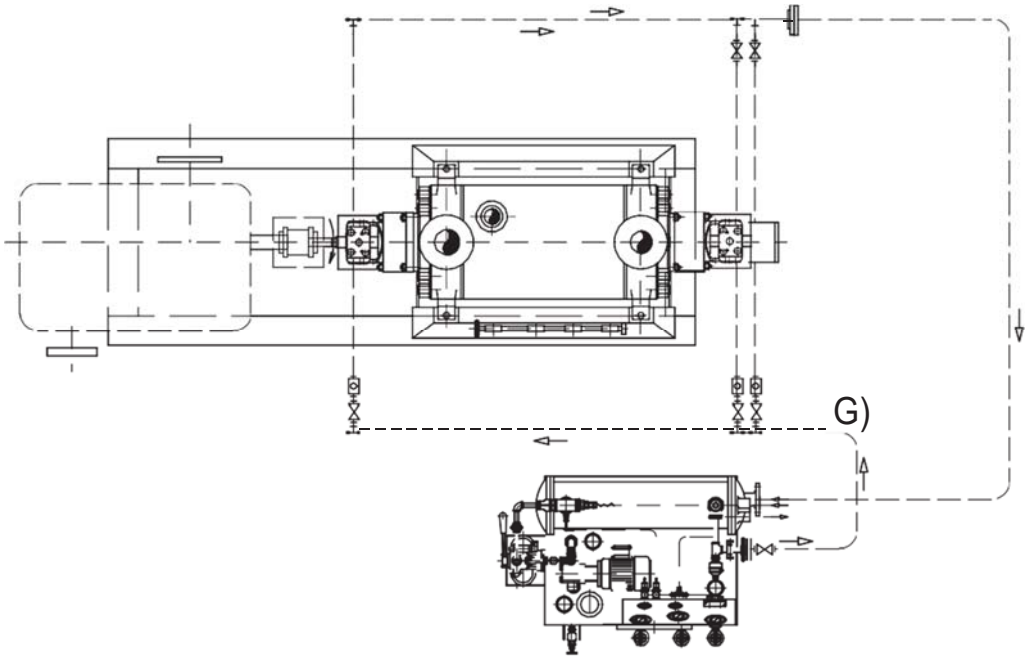


Figure 27 – Lube oil system at the side of the pump for pump lubrication only

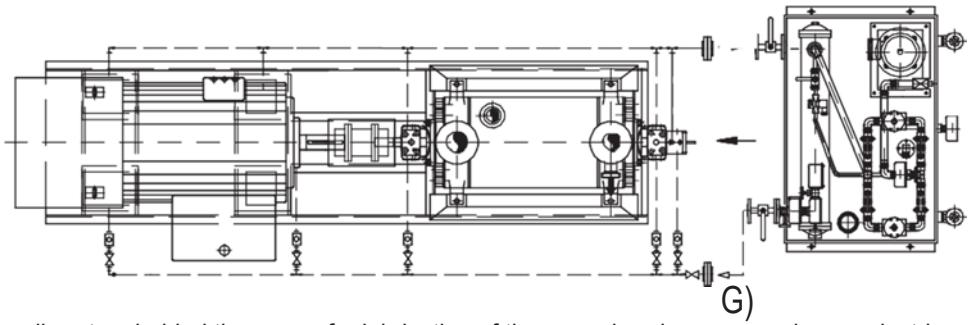


Figure 28 – Lube oil system behind the pump, for lubrication of the pump bearings, or gearbox or electric motor

Pump Size	For maximum oil flow consumption	Connections for oil piping PN 6 ①	Connections for oil return piping PN 6 ②
40 e 50	0.133 l/sec	R ¾”	R 2”
65 e 80	0.150 l/sec	R ¾”	R 2”
100	0.200 l/sec	R 1”	R 2”
125	0.266 l/sec	R 1”	R 2”
150	0.300 l/sec	R 1”	R 2”

① The numbers 1 and 2 refer to positions of the connections shown on Figures 29 and 30.

Table 9 – Oil piping

10.6 Shaft sealing

10.6.1 Gland packing

The standard material for gland packing material for hot water is PTFE with graphite. Rings number is 4 on each side.
The gland packing leakage shall be of approximately 10 to 20 ml/min, depending on sealing conditions.

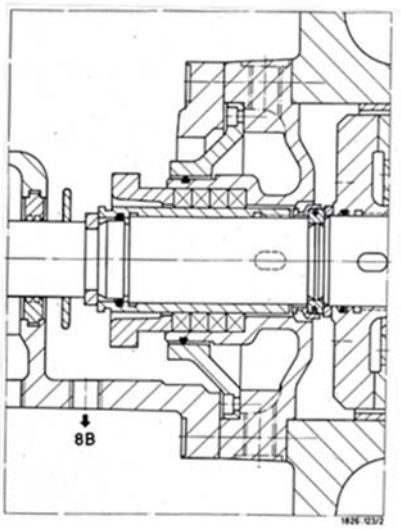


Figure 29 – Standard execution with gland packing
(from -50ºC to 105ºC)

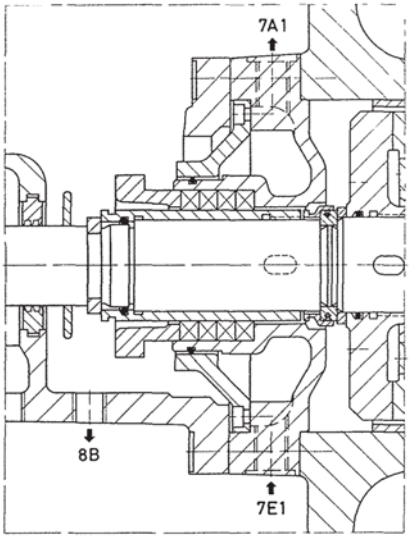


Figure 30 – Standard execution with gland packing
(from 105ºC up to 150ºC)

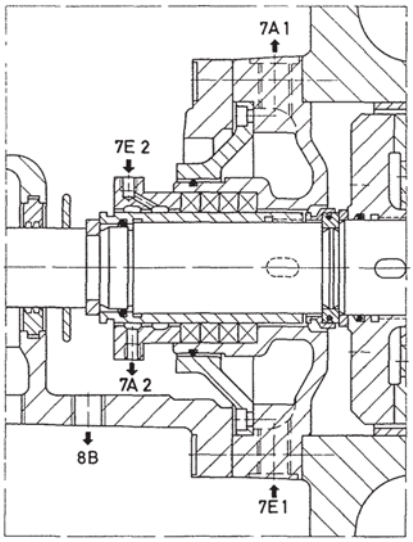


Figure 31 – Gland packing execution w/ cooling
for temperatures ≥ 150ºC

Pump Size	Seal chamber dimensions (mm)	Gland packing rings		Length	
		Quantity	mm	per ring (mm)	total (mm)
40 e 50	Ø 45/ 65 x 45	4	10	180	720
65 e 80	Ø 66/ 90 x 50	4	12	250	1000
100	Ø 70/ 95 x 50	4	12	265	1060
125	Ø 91/ 115 x 53	4	12	330	1320
150	Ø 101/ 125 x 53	4	12	365	1460

Table 10 – Seal chamber and gland packing dimensions

Gland packing friction losses

The gland packing losses are determined by the acceleration power shown on Figure 32.

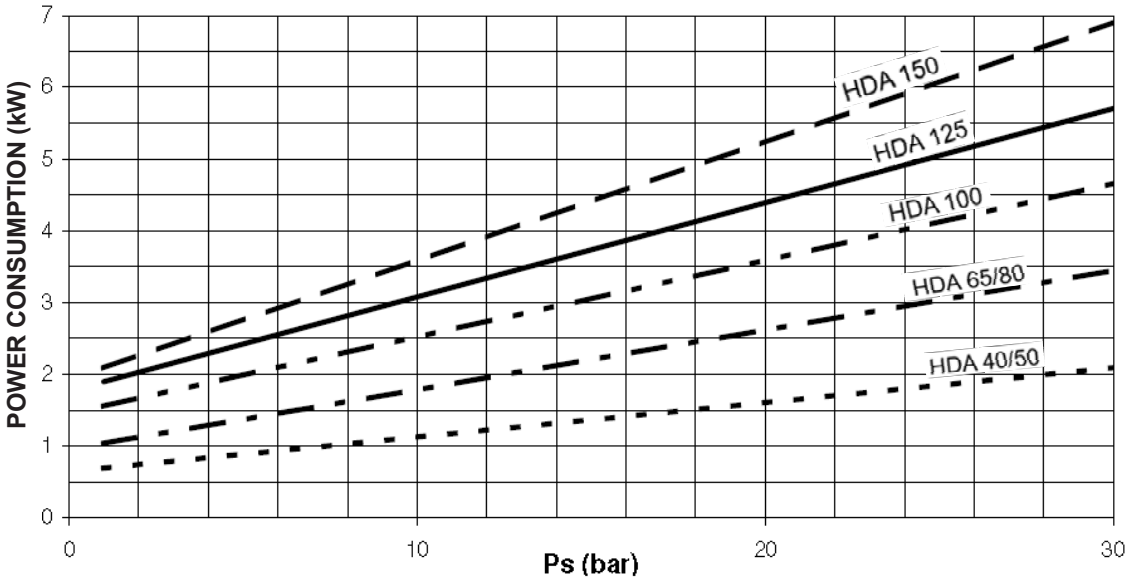


Figure 32 – Power losses by gland packing (per pump)

Caution: For other speeds the losses are calculated according to the speed ratio.

10.6.2 Mechanical Seal

The shaft sealing by mechanical seal and sealing plan shall be agreed between KSB, the customer and the seal supplier.
As a reference, the table below indicates its common applications:

Pumped medium	Temperature	Seal plan	Seal type
Water	165ºC	23	EU5--VV
Water	122ºC	02	01-H75G115 BdB
Water	140ºC	54	J.C. SB2A

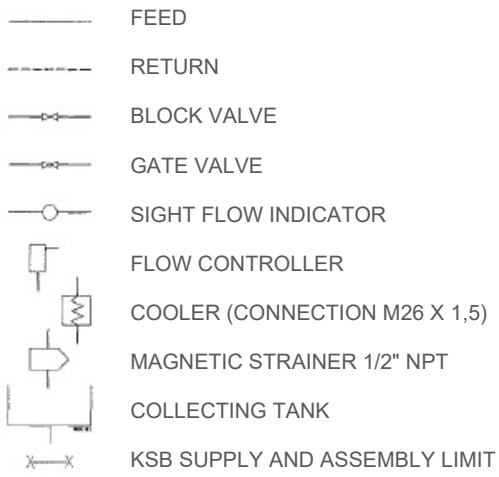
Table 11

Cooling

10.6.3 Shaft sealing by gland packing

Clean water is required for gland packing cooling. It shall not contain solids that may cause pipe clogging with time, for example: condensate.

Legend:



Open system

Pump Size	Stop valve 1) internal thread	Collecting container 2) of waste water
40	R1"	R1"
50	R1"	R1"
65	R1¼"	R1"
80	R1¼"	R2"
100	R1¼"	R2"
125	R1½"	R3"
150	R1½"	R3"

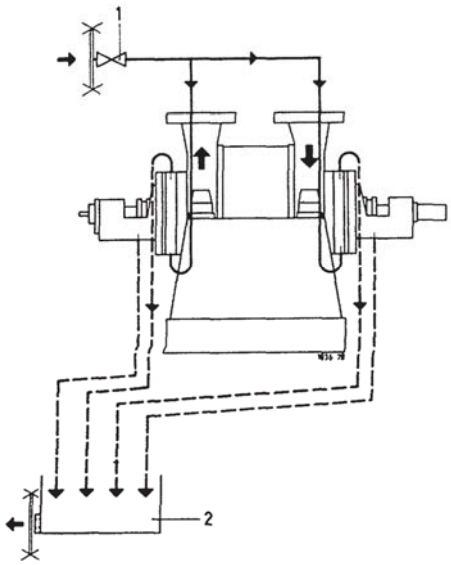
Closed system

Pump Size	Stop valve 1) internal thread	Collecting container 2) of waste water
40	R1"	R1"
50	R1"	R1"
65	R1¼"	R1"
80	R1¼"	R1"
100	R1¼"	R1"
125	R1½"	R1"
150	R1½"	R1"

Table 12 – Connections for cooling

10.7.1.1 Pumped medium temperature between 106 to 150ºC

OPEN SYSTEM



CLOSED SYSTEM

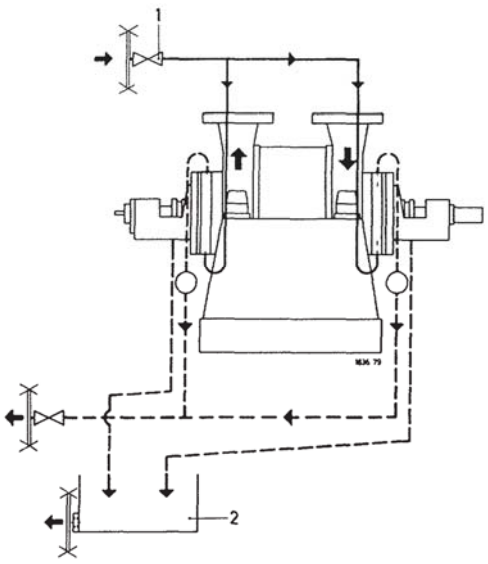


Figure 33 – Stuffing box cooling

10.7.2 Shaft sealing by Mechanical Seal

The required and suitable cooling must be agreed between KSB, the customer and the seal supplier. There are the following cooling arrangements as a reference:

10.7.2.1 With seal flushing plan and without cooler (from -5ºC up to +70 ºC)

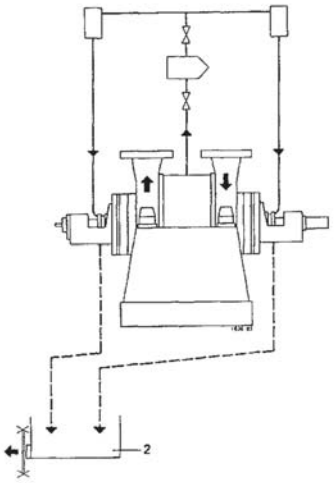


Figure 34 – Cooling with extraction and seal flushing plan

10.7.2.2 Without seal flushing plan and sealing chamber cooling (from 70ºC up to 120 ºC)

OPEN SYSTEM

CLOSED SYSTEM

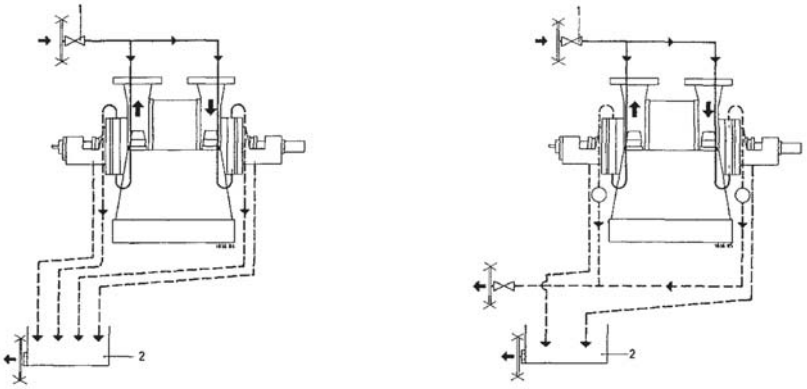


Figure 35

10.7.2.3 With seal chamber cooling and mechanical seals in parallel (from 121º up to 180 ºC)

OPEN SYSTEM

CLOSED SYSTEM

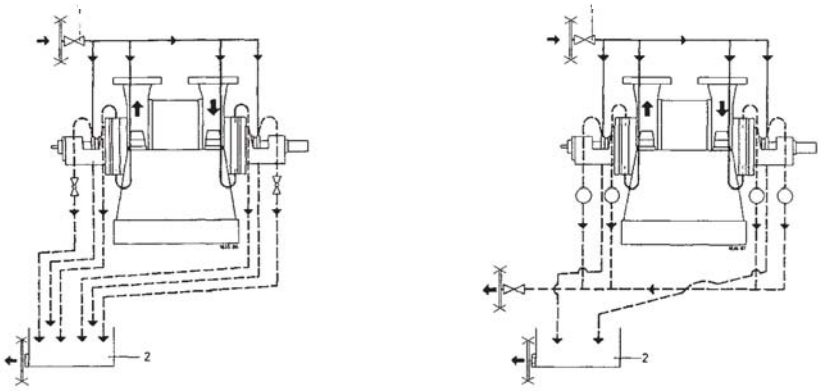
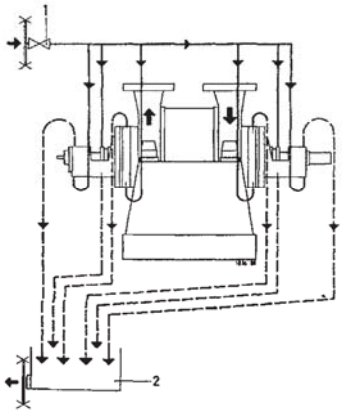


Figure 36

10.7.2.4 For ambient temperature > 45 ºC and pumped medium temperature > 150ºC to 180 ºC the bearing housings shall be cooled (see Figure 37).

OPEN SYSTEM



CLOSED SYSTEM

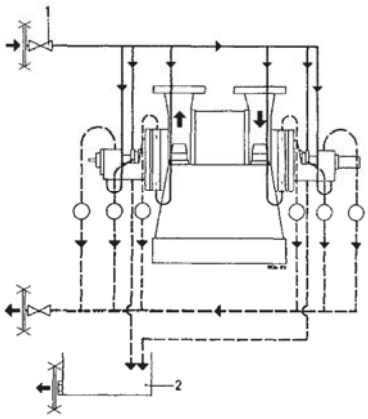


Figure 37

10.7.2.5 With seal flushing plan with one heat exchanger for each mechanical seal and seal chamber cooling at the following temperature conditions:

For HDB 40 up to 100, T = 181 up to 230 ºC, See Figure 38
For HDB 125 and 150, T = 181 up to 200 ºC, See Figure 38
For ambient temperature > 45 ºC the bearing housings shall be cooled. See Figure 39.

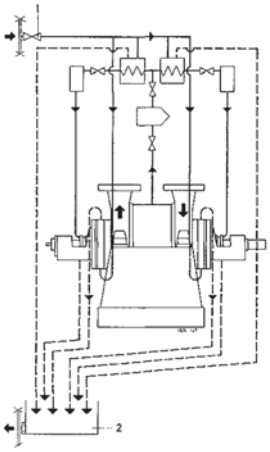


Figure 38

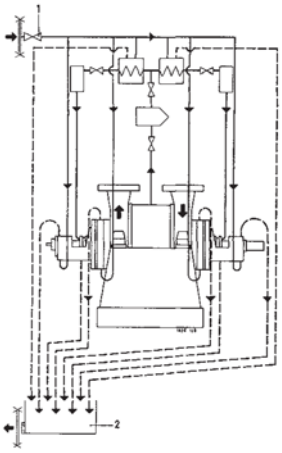


Figure 39

The required cooling water flow is indicated on Figure 40. In this diagram the heating of a cooling liquid of Δt = 10 ºC was considered. When the temperature Δt changes, the cooling liquid quantity can be calculated with this formula:

$$\frac{10.Q}{\Delta t} = \text{effective cooling liquid quantity}$$

Cooling liquid temperature at the outlet shall not exceed 50ºC. The values on the diagram shall have an increase of approximately 10% for the gland follower cooling.
Add 10% for bearing cooling.

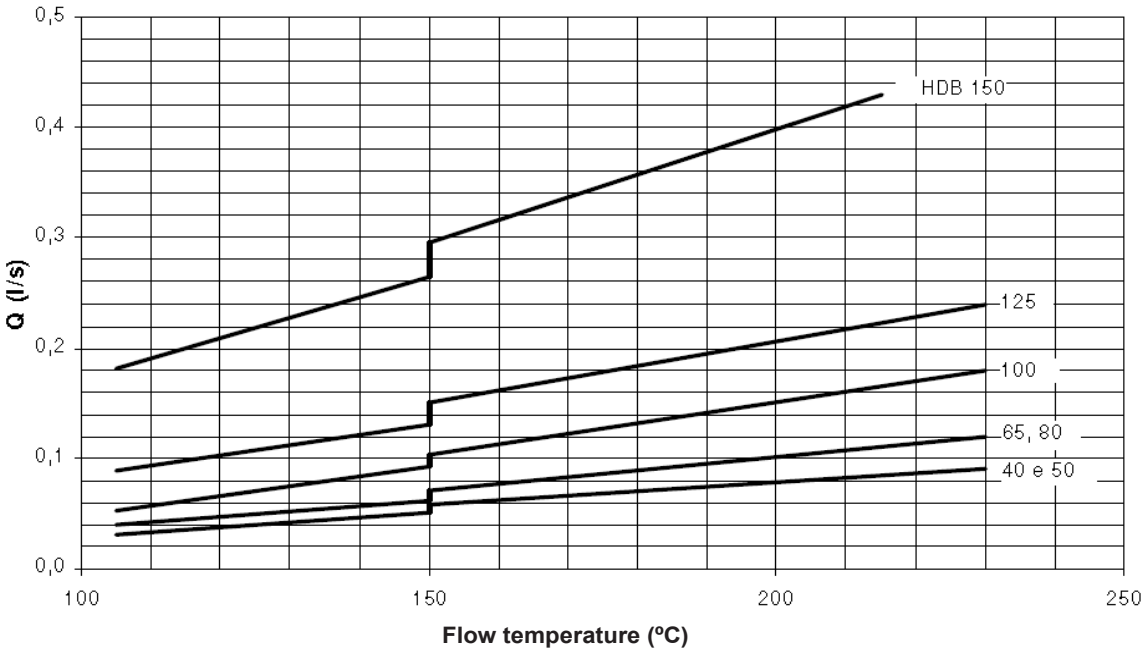


Figure 40 – Cooling liquid

10.8 Heating chamber

Stuffing box, execution with hot water

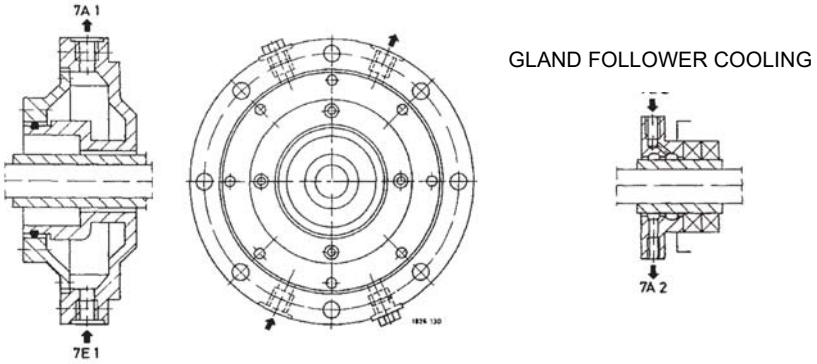


Figure 41

10.9 Inertia

Figure 43 shows the moment of inertia curve during start-up with closed valve. The moment of inertia during start-up shall be of 10% of the nominal moment of inertia.

A – pump start-up to maximum speed
B – valve opening
C – valve open

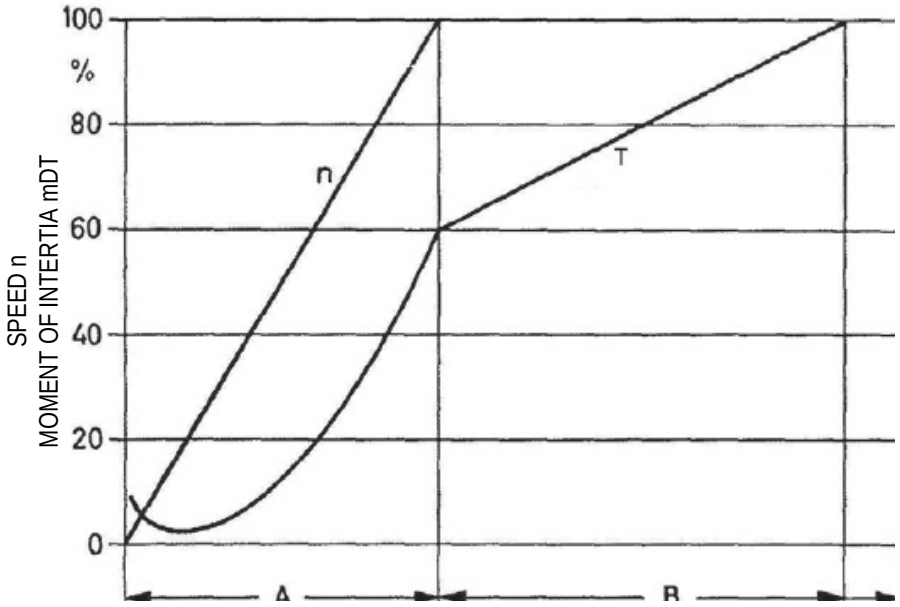


Figure 42 – Moment of inertia curve during start-up

10.10Drive

The transmission can be direct with flexible coupling or indirect with gearbox and flexible coupling connected to the electric motor, steam turbine or internal-combustion motor. The power margin shall be 15% for power of up to 50 kW and of 10% for power above 50 KW.

10.11Couplings

Usually flexible couplings with spacer shall be used with HDB pumps. It avoids the need of dismantling the pump or driver from the baseplate to check the bearings or the shaft protection sleeve.
Required length for spacer is indicated in Table 13.

Pump Size	Spacer length
40	140
50	
65	180
80	
100	
125	210
150	250

Table 13 – Minimum length required for spacer

10.11.1 Coupling guard

Coupling guard size depends on coupling size and shall be fastened on the baseplate.

10.11.2 Baseplates

With robust construction they are usually designed to support the pump and the driver on the same skid. They are designed according to the project.

14 Materials

The standardized materials variants are provided on Table 15, according to the pumped medium type.

14.1 DIRECTIVES FOR MATERIALS SELECTION FOR BOILER FEEDWATER PUMPS

14.1.1 General Rules

- Pressure limit
Above 100 bar at operating point cast chrome steel material shall be used for casing and internal parts (variant 02).

- Speed limit
Up to n = 3600 rpm (for HDB 125 and 150 up to 3000 rpm). For higher speeds, material variant 04 shall be used.

- Water for boiler feed
Water shall be free of abrasive solids.

- pH value
Feedwater with pH values between 7.0 and 10.5 (referring to 20 ºC)

- Feedwater temperature
The maximum temperature of feedwater is 230 ºC

- Water preparation
There are two processes for feedwater preparation:
- total desalination: demineralized boiler feedwater
- partial desalination: boiler water (prepared with low hardness residue, maximum chlorine content of 150 ppm, sulphate maximum content of 100 ppm).

Remark: The feedwater pumps material for nuclear plants is usually cast chrome steel.

- Oxygen content

The maximum oxygen content shall be is 0,03 ppm O_2, for continuous operation of 0,02 ppm O_2, these values shall not be exceeded.
The maximum oxygen content shall be accurately considered for all operating conditions before the pump inlet (start-up and shutdown). Higher oxygen contents are more corrosive, especially for feedwater with partial desalinations.

Maximum dissolved oxygen content		< 0.02 ppm (short time ≤ 0.03 ppm)	<0,03 ppm (short time ≤ 0.04 ppm)	
Preparation		Partial desalination	Total desalination	
		Sizes 40 up to 150	Sizes 40 up to 100	Sizes 125 and 150
pH for 20 ºC	≥ 9.3	01	01	01
	≥ 8.5			
	≥ 7.0		01	01 or 02

Table 14 – Materials selection, based on dissolved oxygen concentration

Caution: For unfavorable operation (intermittent, high switching-frequency, etc.) or when the oxygen content and pH-value are not controlled, due to the lack of equipment/instruments, or lack of overview of personnel surveillance, superior material variant must be selected.

Dimension:
1 ppm (part per million) = 1 mg/l (for density = 1)

- Operation type
Intermittent operation (many start-ups), with shutdown during the weekend (risk of oxygen enrichment inside the installations with thermal degassing) and when the unit will operate many times with partial load, there is a risk of erosion-corrosion.
Continuous operation with spare pump to start operation immediately (approximately 1 time/month) is the preferred operation type.
For start-up in new installations the feedwater pumps must be protected against corrosion after a long time without operation (operation disturbances during start-up allow oxygen presence in the system).

15 Material Variants

Part	Description	Qty	01	02
106	Suction casing	1	A216 Gr. WCB	A743 CA6NM
107	Pressure casing	1	A216 Gr. WCB	A743 CA6NM
108.1	Stage casing	S-1	A216 Gr. WCB	A743 CA6NM
165	Cooling chamber cover	2	A748CF8M	A743 CA6NM
171.1	Diffuser	S-1	A748CF8M	A743 CA6NM
171.2	Last stage diffuser	1	A743CF8M	A743 CA6NM
210	Shaft 1)	1	SAE 1045/hard chrome	AISI 6F3/ hard chrome
230	Impeller	S-1	A743CF8M	A743 CA6NM
231	Suction impeller	1	A743CF8M	A743 CA6NM
400.1	Gasket	1	Klingersil	Klingersil
400.2	Gasket	2	Klingersil	Klingersil
411.3	Joint ring	2	Cu	Cu
412.1	O' Ring	S	Viton70	Viton70
412.2	O' Ring	1	Viton70	Viton70
412.3	O' Ring	2	Viton70	Viton70
412.4	O' Ring	2	NB80	NB80
412.5	O' Ring	2	Viton70	Viton70
451	Stuffing box housing	2	A216 Gr. WCB	A743 CA6NM
452.1	Gland follower w/o cooling	2	G-CUSN10N	G-CUSN10N
461	Gland packing	2	Teflon with graphite	
501	Split ring	1	AISI 420	AISI 420
502.1	Casing wear ring / suction stage	1	AISI 420	RWA 350
502.2	Casing wear ring	S-1	AISI 420	RWA 350
504.1	Spacer ring	1	AISI 420	AISI 420
505.1	Loose collar	1	AISI 420	AISI 420
507.1	Thrower	2	AISI 316	AISI 316
512	Wear ring for balance disc and balance disc seat assembly	1	AISI 316	AISI 420
521	Stage sleeve	S-1	AISI 420	
524.1	Shaft protecting sleeve / suction side	1	AISI 420	AISI 420
524.2	Shaft protecting sleeve / pressure side	1	AISI 420	AISI 420
525.1[2)]	Spacer sleeve / suction side	1	AISI 420	1.4024.09
525.2	Spacer sleeve / pressure side	1	AISI 420	1.4024.09
550.1	Washer	16	SAE 1045	SAE 4140
601	Balance disc	1	1.4024.09	1.4024.09
602	Balance disc seat	1	RWA 350	RWA 350
680	Guard	1	SAE 1020	SAE 1020
702	Balance line piping	1	Steel	Steel
902.1	Stud	16	SAE 1045	SAE 1045
902.2	Stud	4	AISI 316	AISI 316
905	Tie bolt	8	SAE 4140	1.6772 (Monix 3K)
914.1	Hexagon head cap screw	8	AISI 316	AISI 316
920.1	Nut	16	1.7709.05	1.7709.05
920.2	Nut	16	SAE 1020/6	A194 GR.2H
920.3	Nut	4	AISI 304	AISI 304
932.3	Circlip	2	Spring Steel	Spring Steel

1) = Check P/n. If required, use other material

= Recommended spare parts

S = no. of stages

2) = It does not apply to sizes 125 and 150

Table 15 – Material variants

15.1 Clearances

Indications about output and manometric height referring to characteristic curves concern a clearance between rotor and wear ring equal to 0.3 mm (material variant 01).

Chrome-steel wear rings (material variant 02) require a clearance increase to 0.4mm, and output reduction (η):

- HDB 40 up to 80: -2%
- HDB 100 up to 150: -1%

16 Forces and Moments

Piping forces and moments shall not overload the pump. When required on specific cases a pre-calculation has to made for all forces and moments and its possible combinations, which shall meet the following formula:

$$\sqrt{(3F_x)^2 + (F_y)^2 + (3F_z)^2} + \frac{0,3}{D}\sqrt{(1,3Mx)^2 + (2My)^2 + (2Mz)^2} \begin{cases} \leq 400.000.D\ (DN \leq 80) \\ \leq 320.000.D\ (DN \geq 100) \end{cases}$$

Dimensions:
F in N
M in Nm
D in m

Remark: Forces and moments may simultaneously load suction flange and pressure flange.

Size	40	50	65	80	100	125	150
Suction flange							
Fx	1500	2000	2500	3000	3500	4000	5000
Fy	2500	4000	7000	10000	14000	16000	17000
Fz	1500	2000	2500	3000	3500	4000	5000
Mx	750	1200	1500	2000	5000	6000	6000
My	750	1200	1200	1200	1500	2500	3000
Mz	750	1200	1500	1800	2400	3500	4000
Delivery flange							
Fx	1000	1500	2000	2500	3000	3500	4000
Fy	2000	2500	4000	7000	10000	14000	16000
Fz	1000	1500	2000	2500	3000	3500	4000
Mx	500	750	1200	1500	2000	5000	6000
My	500	750	1200	1200	1200	1500	2500
Mz	500	750	1200	1500	1800	2400	3500

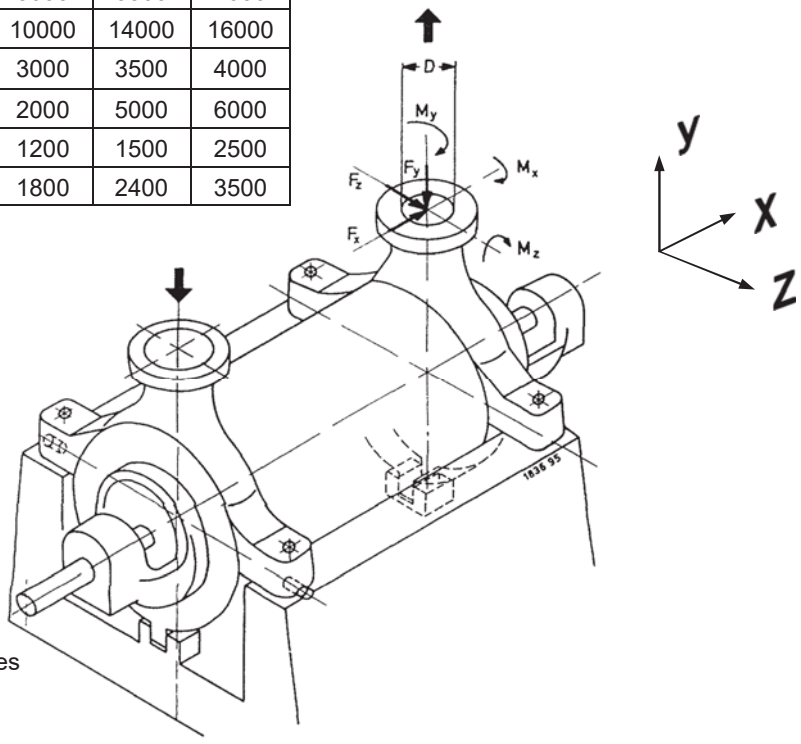


Figure 43 – Forces and moments on pump flanges

Letter F indicates the direction of the forces and letter M indicates the direction of the moments of inertia, and letter D indicates the suction and discharge flanges diameter.

It is not recommended to fasten pump after heating the connections and pipes, as this may cause vibrations and high wear on the pump and coupling wear. The pump positioning and fastening of the pump and its accessories with pins shall only be made in cold condition as shown on Figure 44.

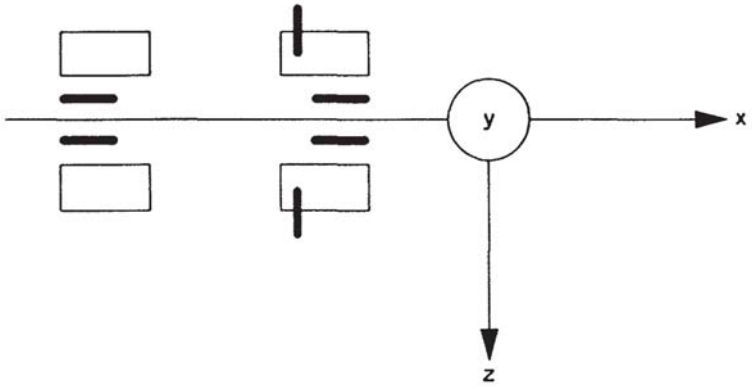


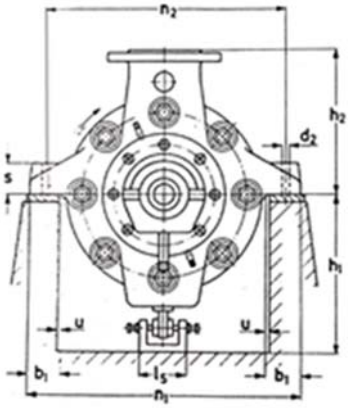
Figure 44 – Pump fastening to the baseplate by pins

13.1. Center of gravity position
The pump center of center position is approximately at the half of the pump.

17 Spare parts

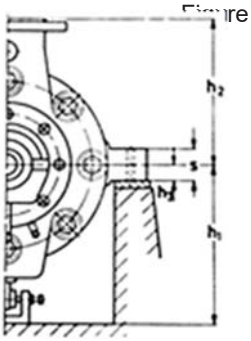
Recommended spare parts are indicated on the materials variants table.

18 Dimensions

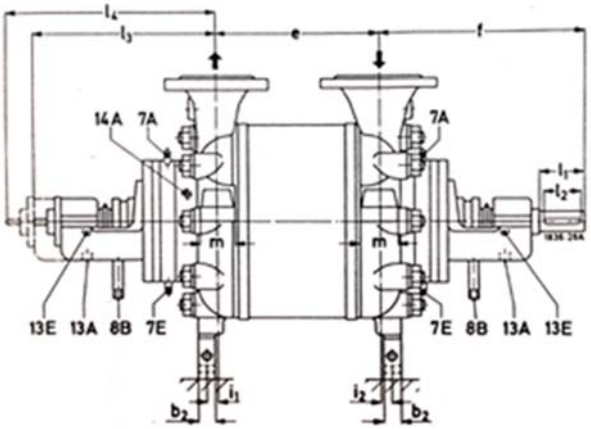


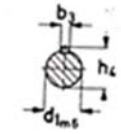
Sizes 40 thru 100

Figure 45

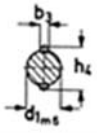


Sizes 125 and 150

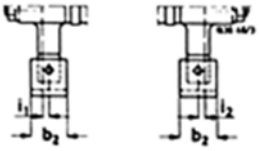




Execution with
one key
Sizes 40 thru 100



Execution with
two keys
Sizes 125 and 150



Sizes 125 and 150

dimensions in mm

Pump size	Suction flange	Pressure flange	Pump dimensions																						
						e (for each stage)																			
	DN_1	DN_2	b_1	b_2	d_2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	f	h_1	h_2	h_3
40	50	40	65	40	23	--	--	283	331	379	427	475	523	571	619	667	715	763	811	859	400	275	275	--
50	65	50	70	40	23	--	256	308	360	412	464	516	568	620	672	724	776	828	--	--	405	305	315	--
65	80	65	75	40	26	--	300	360	420	480	540	600	660	720	780	840	900	960	--	--	460	340	350	--
80	100	80	80	40	26	--	315	380	445	510	575	640	705	770	835	900	--	--	--	--	465	375	400	--
80	125	80	80	40	26	--	345	410	475	540	605	670	735	800	865	930	--	--	--	--	495	375	400	--
100	125	100	110	40	33	--	364	434	504	574	644	714	784	854	--	--	--	--	--	--	510	425	465	--
100	150	100	110	40	33	--	364	434	504	574	644	714	784	854	--	--	--	--	--	--	510	425	465	--
125	150	125	110	40	36	405	510	615	720	825	930	1035	1140	--	--	--	--	--	--	--	615	415	525	35
150	200	150	125	40	36	470	595	720	845	970	1095	--	--	--	--	--	--	--	--	--	645	460	575	40

Table 16

Pump Size	Dimensions										Shaft end					Connections				
	i_1	i_2	l_3	l_4 [1]	l_5	m	n_1	n_2	s	u	b_3	d_1 m_6	h_4	l_1	l_2	Stuffing box cooling	Stuffing box drain	Balance line outlet	Oil under pressure	
																			inlet	outlet
																7A/7E	8B	14A	13E	13A
40	12	16	375	484	130	65	480	410	60	5	10	34	37,3	80	70	R3/8	R1/2	R1/2	R1/4	R3/4
50	10	17	380	489	130	65	540	470	60	5	10	34	37,3	80	70	R3/8	R1/2	R3/4	R1/4	R3/4
65	22	27	435	611	130	70	600	520	70	5	12	44	47,1	110	90	R1/2	R1/2	R3/4	R1/4	R3/4
80	25	35	460	636	130	75	660	580	70	5	12	44	47,1	110	90	R1/2	R1/2	R1	R1/4	R3/4
80	25	35	460	636	130	75	660	580	70	5	12	44	47,1	110	90	R1/2	R1/2	R1	R1/4	R3/4
100	40	45	475	654	130	100	800	700	80	5	14	48	51,5	120	110	R1/2	R1/2	R1	R3/8	R3/4
100	40	45	475	654	130	100	800	700	80	5	14	48	51,5	120	110	R1/2	R1/2	R1	R3/8	R3/4
125	25	25	495	650	130	105	920	850	70	5	18	64	72	140	130	R3/4	R1/2	R1	R3/8	R1
150	25	25	530	695	130	110	1060	950	80	5	20	74	83	140	130	R3/4	R3/4	R1 1/4	R3/8	R1

1) With lift-off device

Table 17

19 Cross sectional drawing and Parts List

19.1 Sizes 40 and 50

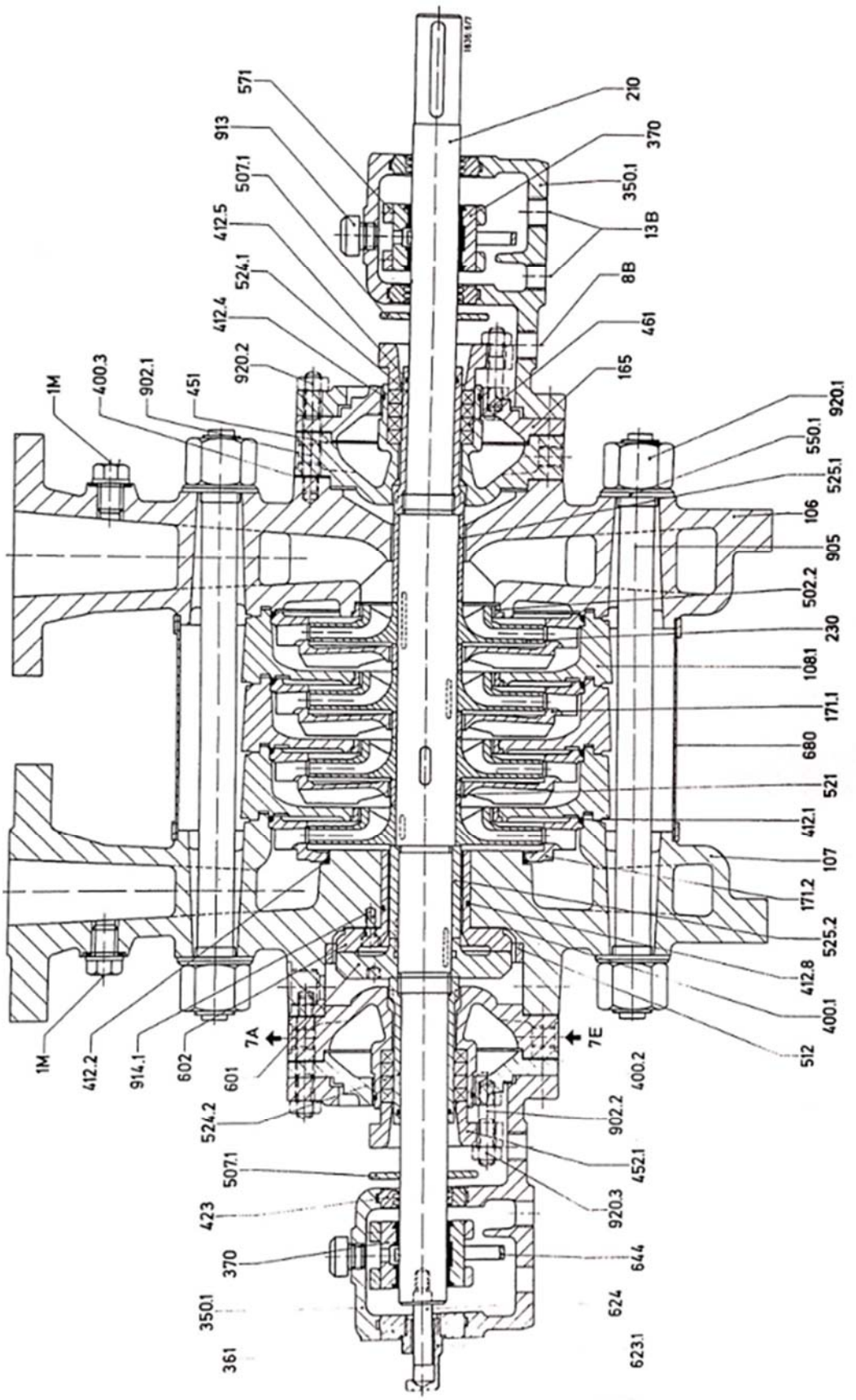


Figure 46

19.2 Sizes 65, 80 and 100

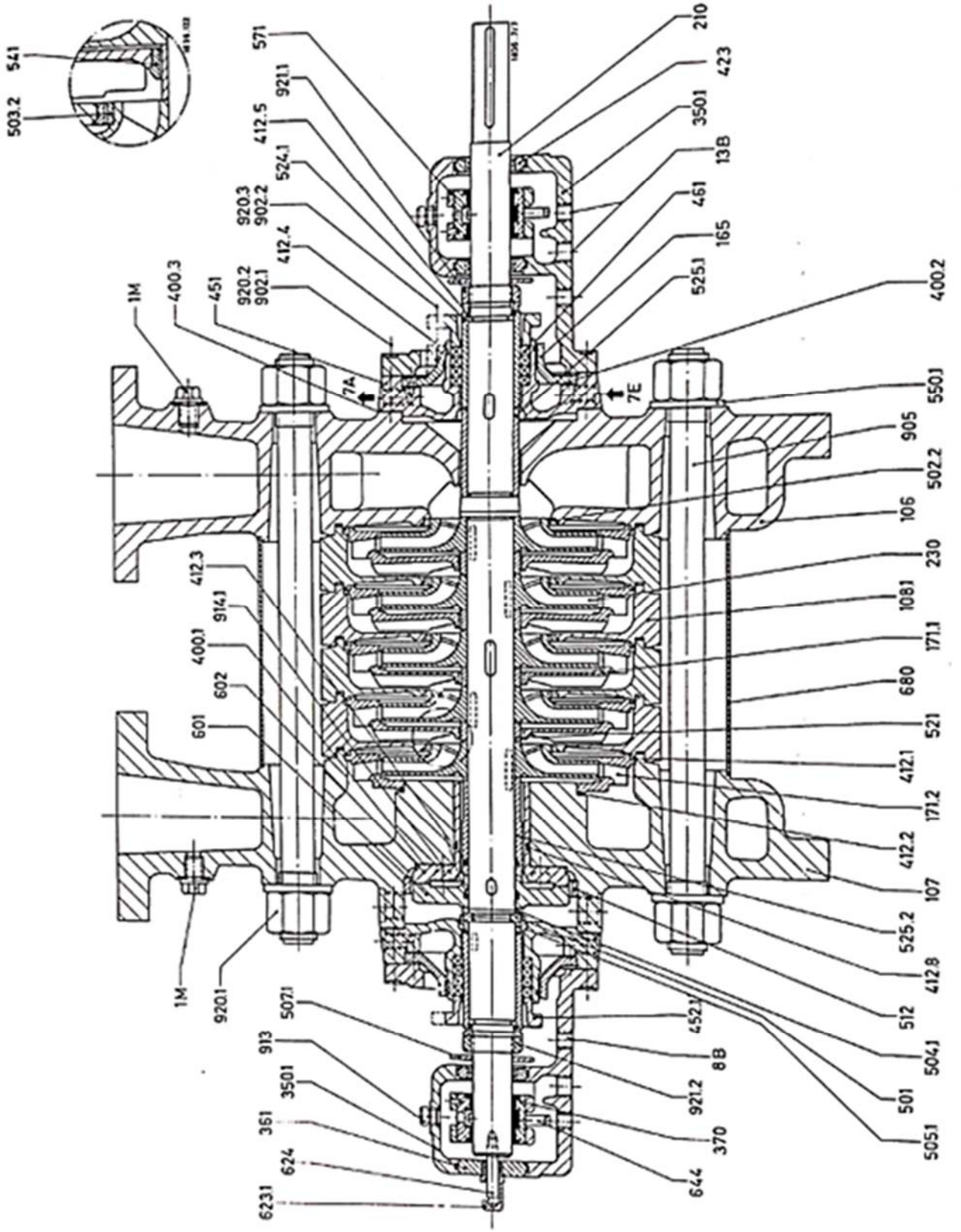


Figure 47

19.3 Sizes 125 and 150

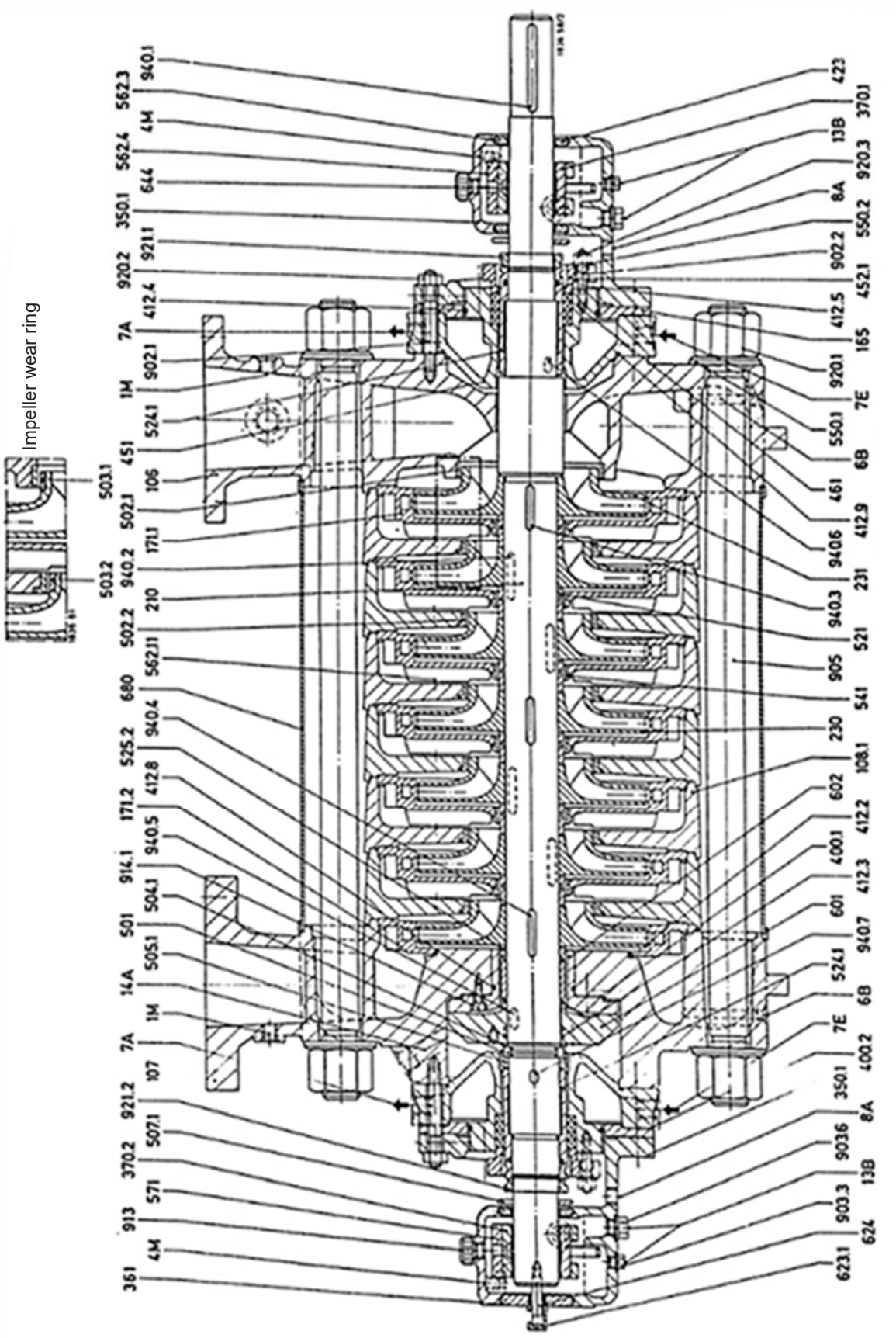


Figure 48

Part no.	Description
106	Suction casing
107	Pressure casing
108.1	Stage casing
108.2	Stage casing with extraction
108.3	Stage casing with extraction
165	Cooling chamber cover
171.1	Diffuser
171.2	Last stage diffuser
210	Shaft
230	Impeller
231	1st stage impeller ③
322	Radial roller bearing
350.1	Bearing housing
360	Bearing cover
361	Bearing end cover
370.1	Bearing shell
370.2	Bearing shell
370	Bearing shell ①
400.1	Gasket
400.2	Gasket
400.3	Gasket ①
412.1	O 'ring ①
412.2	O 'ring
412.3	O 'ring
412.4	O 'ring
412.5	O 'ring
412.8	O 'ring
412.9	O 'ring ③
422.1	Felt ring
423	Labyrinth ring
451	Stuffing box housing
452.1	Gland follower
461	Gland packing
500.1	Ring
500.2	Ring
501	Split ring ②
502.1	Casing wear ring ③
502.2	Casing wear ring
503.1	Impeller wear ring ③
503.2	Impeller wear ring
504.1	Spacer ring ②
505.1	Loose collar②
507.1	Thrower
512	Wear ring for bal. disc and bal. disc seat ass. ①
521	Stage sleeve

Part no.	Description
52-1	Fastening bush
524.1	Shaft protection sleeve
524.2	Shaft protection sleeve
525.1	Spacer sleeve on suction side ①
525.2	Spacer sleeve on pressure side
541	Stage sleeve
54-1	Blind stage sleeve
550.1	Washer
550.2	Washer
560.2	Tapered pin
562.3	Cylindrical pin
562.4	Cylindrical pin
562.11	Cylindrical pin
571	Clamp
601	Balance disc
602	Balance disc seat
623.1	Shaft position indicator
624	Pin wear indicator
638	Constant level oiler
644	Oil ring
680	Guard
731.8	Pipe union
901.2	Hexagon head bolt
902.1	Stud
902.2	Stud
903.3	Plug
903.6	Plug
905	Tie bolt
913	Vent plug cover
914.1	Socket head cap screw
914.2	Socket head cap screw
920.1	Hexagon nut
920.2	Hexagon nut
920.3	Hexagon nut
920.6	Hexagon nut
921.1	Shaft nut ②
921.2	Shaft nut ②
932.3	Circlip
940.1	Key for coupling
940.2	Key for impeller
940.3	Key for 1st stage impeller
940.4	Key for last stage impeller
940.5	Key for balance disc
940.6	Key for shaft protection sleeve, suction side
940.7	Key for shaft protection sleeve, pressure side

1M	Connection for pressure gauge
6B	Pump drain
7A	Cooling liquid outlet / stuffing box outlet
7E	Cooling liquid inlet / stuffing box inlet
8B	Bearing housing drain
13B	Oil outlet
14A	Hydraulic balance liquid outlet
4M	Connection for temperature indicator
8A	Dripping liquid outlet

legend:

① sizes 40 up to 100
② sizes 65 up to 150
③ sizes 125 and 150

19.4 Special features

19.4.1 Blind stage

In case of future operation with higher pressure than first operating condition, one or more impellers will be replaced by blind stage spacer sleeve and blind stage sleeve. The impellers required for the future operation will be supplied with the pump.

PART Nº	DESCRIPTION
525.5	SPACER SLEEVE
54-1	BLIND STAGE BUSHING

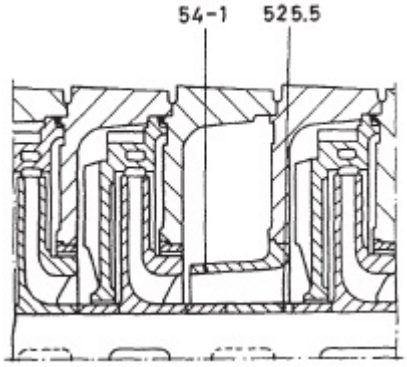


Figure 49 – Blind stage

19.4.2 Stage casing with extraction

When a lower pressure is required at the same time of the pump final pressure (for example, for injection inside an intermediate heat exchanger) stage casings with a connection for extraction can be supplied.

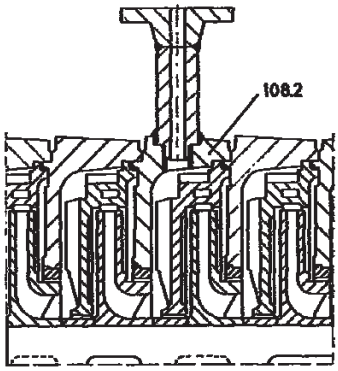


Figure 50 – Stage casing with threaded and welded extraction

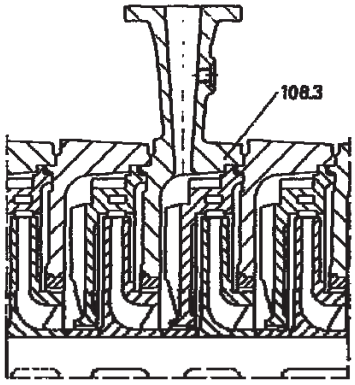


Figure 51 – Stage casing with cast extraction

Pump Size	Threaded and welded extraction		Cast extraction	
	DN	Maximum partial flow Q (l/s)	DN	Maximum partial flow Q (l/s)
40	15	1.4	40	10
50	15	1.4	50	15.5
65	25	4	65	26
80	25	4	80	40
	-	-	40	10
100	25	4	100	60
	-	-	40	10
125	25	4	50	15.5
150	25	4	50	15.5

Table 18 – Technical data for Figures 50 and 51

16.4.2.1 Material variants for threaded and welded extraction

HDB 40 up to 150	Stage casing (material)	Extraction (material)
	A216 Gr. WCB	SAE 1020
	A743 CA6NM	AISI 420

Table 19 – Materials for stage housing with extraction

16.4.3 Gear pump assembled on the pump shaft

Gear pump is used on pumps with lift-off device and forced feed lubrication. It is driven by a gear set assembled on the pump main shaft.
The purpose of the gear pump is to supply pressurized oil to the main bearings without continuous use of the lube oil system, saving energy and assuring suitable lubrication.

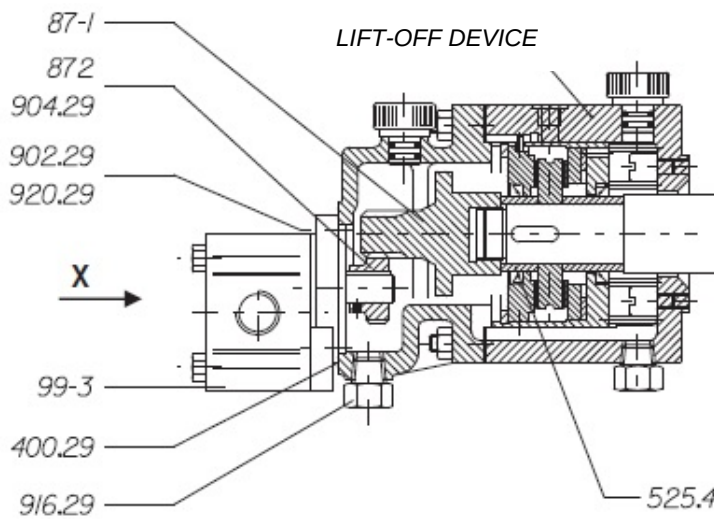
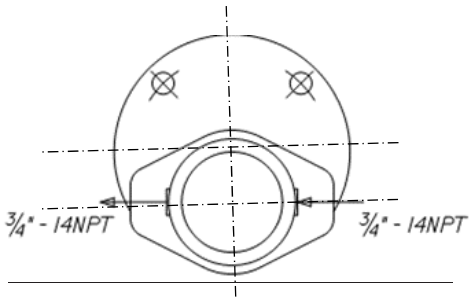


Figure 52 – Gear pump



"X" View

Part	Qty	Description
400.29	1	Gasket
525.4	1	Spacer sleeve
87-1	1	Pinion
872	1	Gear wheel
99.3	1	Gear pump
902.29	2	Stud
904.29	1	Grub screw
916.29	1	Threaded plug
920.29	2	Nut

Table 20 – Gear pump parts list

16.4.4 Minimum flow valve installation

Minimum flow can be maintained by a minimum flow valve installed at the discharge piping. The selection of this valve shall be made on a case by case basis.

16.4.5 Strainers

Strainers are frequently necessary to protect the pump from impurities on the installation and to protect the clearances between the stationary and rotating pump components against contamination.
A strainer is especially important if the vessels and pipes were not completely picked and blown during the commissioning of new installations. Besides that the welding residue, scrubs or similar impurities often appear after some period of time after maintenance or repair.
The strainers can be installed on the suction piping, on horizontal or vertical position, at the nearest possible location to the pump nozzles as preferred position.
It is recommended to install temporary strainers inside the suction piping.

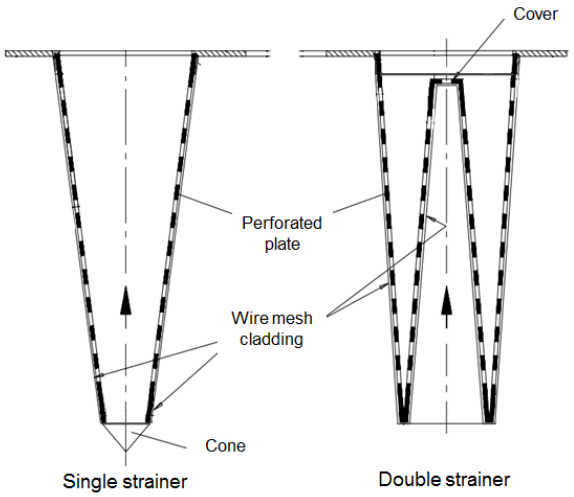


Figure 53 – Single and Double strainer

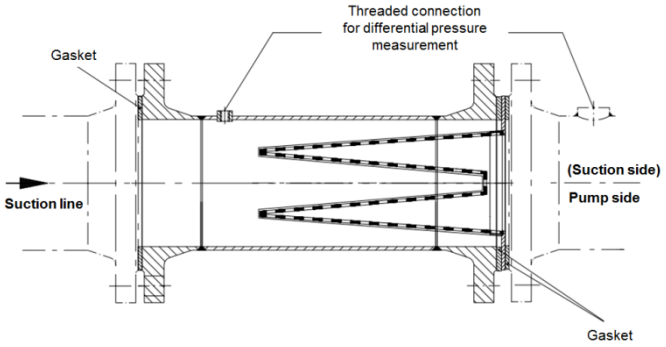


Figure 54 – Example of horizontal installation

A threaded connection on the upstream and downstream piping of the suction strainer filter assembly should be provided for differential pressure monitoring

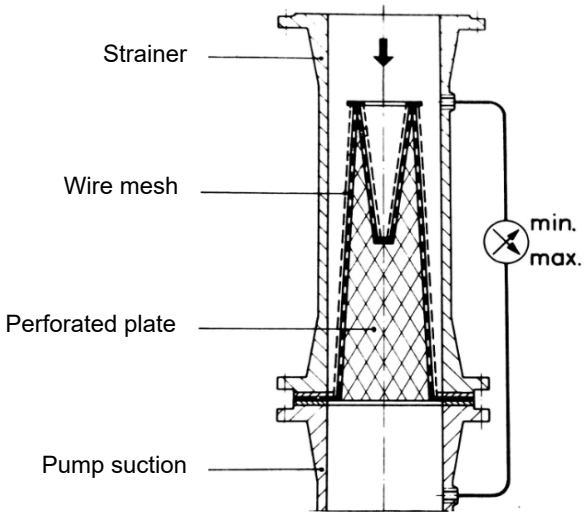


Figure 55 – Suction strainer with monitoring

16.4.6 Special tools

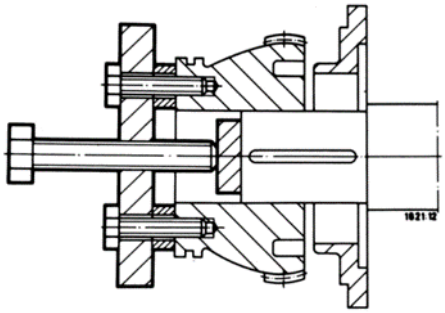


Figure 56 – Special too for coupling removal

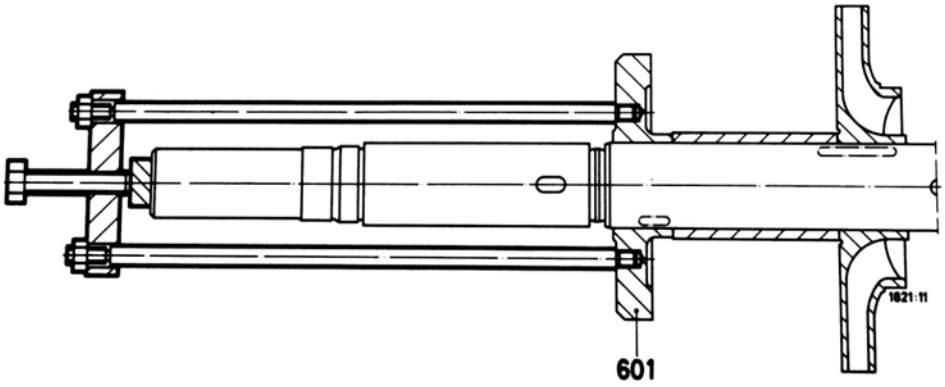
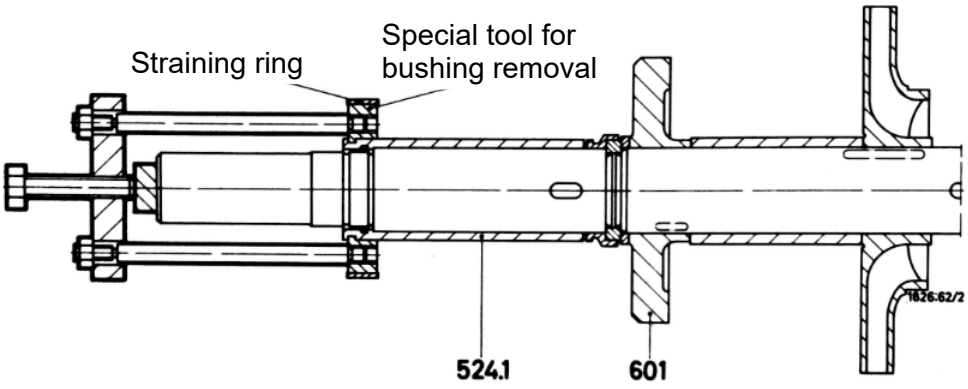


Figure 57 – Special tool for balance disc removal



Part no.	Description
524.1	Shaft protection sleeve
601	Balance disc

Figure 58 – Special tool for shaft protection sleeve

16.4.7 Tools

Pump Size	Closed-end wrench (N 85) DN	Ring wrench (N 89) DN	Allen Wrench (DIN 911)	Beating star wrench (ZN 7444)	Pliers for safety rings (DIN 5254)
40	46	41	6	41	--
50	46	46	6	46	--
65	--	50	6 e 8	50	--
80	--	60	6 e 8	60	--
100	--	70	6 e 10	70	--
125	--	80	8 e 10	80	A40 and C40
150	--	90	8 e 14	90	A40 and C40

Table 21 – Tools

17 Characteristic curves

See characteristic curves catalog A1826.4P.

07/05/2018

A1836.0EN/0

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