Operation Manual

for

Centrifugal Pumps Type

SLM N

with

Instructions for Working in Areas Subject to Explosion Hazards

10/2005

BAE-01900-Coversheet_Extras for ATEX 3.doc

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1. General

Pumps type SLM N can be used in areas subject to explosion hazards of Ex-protection zone 2, temperature category T1 to T4. This supplement to our General Pump Operation Manual provides important instructions for working in explosion protection zone 2.

2. Safety

2.1 Unauthorized Modification and Manufacture of Spare Parts

	**If the pump is modified or changed without authority and / or other than original spare parts are used for repair works, the explosion protection will be forfeited.**

2.2 Inadmissible Mode of Operation

	**In case of pumps for which no datasheet is available (e. g. pool pumps), it must be checked prior to their commissioning, whether the allowable surface temperatures are not exceeded (refer to article „Temperature Limits“)**
	**Driving motor and flexible coupling (in case of pumps of bearing-support construction) must have an approval for the use in areas subject to explosion hazards.**

2.3 Temperature Limits

	**When being operated to its designated use, the pump's maximum surface temperature must not exceed the temperature category of the explosion protection zone.**
	**The ignition temperature of the liquid must be at least by 50°C higher than the maximum surface temperature of the pump.**

The plant operator must ensure that the maximum allowable temperature of the hazardous area is not exceeded when hot liquids are processed. Refer to the following table for the maximum allowable temperature of the pumped liquid in accordance with the applicable temperature category:

Temperature Category	Maximum Temperature of the Pumped Liquid [°C]
T1	400
T2	270
T3	175
T4	110

In case of temperature categories T5 or T6, contact KLAUS UNION for further information.

2.4 Speed Limits

It is possible to operate the pump with a frequency converter. Lubrication of the journal bearing and cooling of the magnet drive are sufficient even at a slower speed.

	**The maximum allowable speed is mentioned on the rating plate and in the data sheet. If the pump is operated at a speed exceeding the maximum speed indicated, explosion protection is no longer granted.**

	**Prior to operating the pump unit with a frequency converter it must be checked, whether the driving motor is appropriate for that purpose.**

3. Installation and Assembly

3.1 General

	**Prior to installing the pump with the pertaining driving motor in areas subject to explosion hazards, ensure that the entire equipment has been approved for the prevailing explosion protection zone.**

	**Instructions given in the operation manuals of the driving motor and the flexible coupling are to be observed.**

3.2 Special Features in case of Pumps with Heating Jacket

	**If the pump is fitted with a heating jacket, the temperature of the heating medium must not exceed the maximum allowable surface temperature of the pump.**

	**The ignition temperature of the heating liquid must be at least by 50°C higher than the maximum surface temperature of the pump.**

3.3 Isulation

	**Do not insulate the pump in the area of the anti-friction bearings.**

4. Commissioning and Shutdown

4.1 Checking the Direction of Rotation

	**Only check the direction of rotation with the pump filled (close-coupled construction) or with the motor uncoupled (bearing-support construction).**

4.2 Filling and Venting

	**When a pump is operated which has not been completely filled, an ignition source can develop due to excessive heat input. When being operated in areas subject to explosion hazards, the pump must be completely filled. If the operating company cannot ensure the complete filling of the pump, appropriate monitoring measures must be taken.**

4.3 Monitoring Equipment

	**Monitoring equipment must have been approved for areas subject to explosion hazards.**

4.4 Commissioning

	**To prevent the pump from excessively heating up, never operate it against closed control valve on the discharge side. For start-up, the discharge-side control valve must be sufficiently open for the minimum rate of flow Q_{min}.**

	**On initial start-up, operate the pump for at least 3 hours under operation conditions while checking for unusual noises and high temperatures on the pump surface. Measure the surface temperature with commercially available surface temperature meters.**

	**In rare cases it may happen during acceleration of the pump that the magnet drive desynchronises ("breakaway of magnet drive"). This condition can be detected by monitoring the delivery head, capacity and pump power output. Operation of the pump with a desynchronised magnet drive can cause excessive temperatures.**

5. Maintanance

5.1 Anti-Friction Bearings

	**To avoid the anti-friction bearings becoming an ignition source, the anti-friction bearings must be maintained according to the instructions given in the operation manual.**

5.2 Wear Ring Allowance

	**If the clearance between rotating and stationary components is too narrow, it may happen that these components contact and the resulting frictional heat entails excessive temperatures.**

Operation Manual

Centrifugal Pump SLM N

Edition 03/2000
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Contents of Operation Manual

Edition 03/2000

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1. Introduction

This operation manual refers to centrifugal pumps type SLM N.

Prior to commissioning of the pump, this operation manual is to be read and its instructions are to be followed thoroughly by the operational staff (erecting staff and operators).

Only a complete understanding of this manual and its contents can avoid expensive damage to the pump and assure a long trouble-free operating life. It is therefore extremely important that this manual is made available to all personnel who are involved with installation, operating or maintenance of the pumps.

All the information and descriptions given in this manual are correct at the time of issue. However, it is our policy to constantly improve our products and technical modifications and improvements are subject to change.

2. Operative Range

The sealless centrifugal pump type SLM N is a centrifugal pump with magnet coupling. Its main dimensions and performance data correspond with DIN EN 22858 and ISO 2858 respectively.

By means of its characteristic feature - the permanent magnetic synchronous drive - this pump fulfills all requirements of environmental care. Therefore, it is used in all fields of the chemical and petrochemical industry for a leak-free processing of aggressive, explosive or toxic liquids. The pump is designed to provide reliable, trouble-free, and dependable operation even under the most arduous conditions.

3. Copyright

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1. General

This manual contains all basic instructions for the installation, operating and maintenance of the pump. It should be read and fully understood by all installation, commissioning, operating and maintenance personnel before the pump is operated. It is recommended that the manual is always available at the point of operation of the unit.
Not only the general safety instructions as mentioned in the section "Safety" of the operation manual have to be observed but also the special safety instructions to be found under the other main headlines.

2. Marking of References in this Operation Manual

The safety instructions mentioned in this operation manual are marked with the general danger sign according to DIN 4844-W9 and the special sign according to DIN 4844-W8 warning of electric tension. Non-compliance with safety instructions may cause danger to people.

To mark safety instructions and the dangers to the machine and its functions which can be caused in case of non-compliance the word

ATTENTION

has been inserted.

References made on the machine itself, such as
direction-of-rotation arrow
marks for fluid connections
must by all means be observed and kept completely legible.

3. Qualification and Training of Staff

The staff responsible for installation, commissioning, operation, and maintenance must have the appropriate qualifications to enable them to carry out these duties. The scope, competence and control of the staff is the responsibility of the operating company. If the staff are not fully conversant with magnetic drive pumps they should be given training and instruction. If required this training is available from the manufacturer/supplier of the equipment by arrangement. It is the operating company's responsibility to ensure that all staff are fully aware of and understand the contents of this manual.

4. Dangers of Non-Compliance with Safety Instructions

Non-compliance with the safety instructions can cause danger to people as well as to the environment and the machine. Non-compliance with the safety instructions can lead to loosing the right to claim for any damages.

In detail, non-compliance can - for example - result in the following dangers:

1. **Danger to people by electrical, mechanical and chemical influences**
2. **Danger to the environment by leakage of dangerous substances**
3. **Failure of important functions of the machine/plant**
4. **Failure of stipulated methods for maintenance**

5. Safety-Conscious Work

Safety instructions mentioned in this operation manual, existing national regulations for prevention of accidents as well as any internal working, operating and safety instructions of the operating company have to be observed.

6. Safety Instructions for Operating Company/Operator

Hot or cold machine parts resulting in any danger have to be protected against accidental contact by constructional means. A protection against accidental contact for moving parts (e. g. coupling) must not be removed during operation. Any dangers caused by electric energy are to be precluded (for details refer to the regulations of the Association of German Electricians (VDE) and your local electric supply company).

7. Safety Instructions for Maintenance, Inspection and Assembly

The operating company has to ensure that all maintenance, inspection and assembly works are carried out by authorised and qualified specialists who have thoroughly studied the operation manual. As a matter of principle, all works on the pump unit must be carried out during standstill. The procedures for the shutdown of the pump described in the operation manual must be observed at all times.
Pumps processing noxious liquids must be decontaminated. Immediately after terminating the works, all safety and protection devices must be reinstalled and put into operation again respectively. Before recommissioning, all instructions described in the section "Commissioning and Shutdown" have to be observed.

8. Unauthorised Modification and Production of Spare Parts

Modifications or changes of the pump may only be carried out upon agreement with the manufacturer. Original spare parts and accessories authorised by the manufacturer contribute to your safety. The use of other parts rules out our liability for any resulting consequences.

9. Inadmissible Operating Modes

The operational reliability of the supplied pump is only guaranteed when it is used as agreed in accordance with section "General" of the operation manual. The limiting values indicated in the data sheet must not be exceeded under any circumstances.

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1. Preservation

1.1 Drive shafts

1.1.1 Drive shafts for pumps supplied without couplings
- bare parts are protected against corrosion with "RUST-BAN 391"

1.1.2 Drive shafts supplied as spare parts
- completely protected against corrosion with "RUST-BAN 391"

1.2 Pump parts made of GG, GGG, and GS-C
- all surfaces in contact with the liquid are protected against corrosion with "RUST-BAN 391"

1.3 Deliveries for overseas destinations
- all specified parts are protected against corrosion with "TECTYL 864"

2. Depreservation

2.1 "RUST-BAN 391"
- by means of solvents (e. g. kinds of ESSOVARSOL)
  aqueous industrial cleaner

2.2 "TECTYL 846"
- with benzine, petroleum, special solvents

3. Protection against Damage and Dirt

3.1 Drive shafts

3.1.1 Drive shafts for pumps supplied without couplings
- the shaft end is protected against damage with a plastic cap

3.1.2 Drive shafts supplied as spare parts
- the shaft end is protected against damages with a plastic cap
- the complete shaft is protected against damages with woven textile

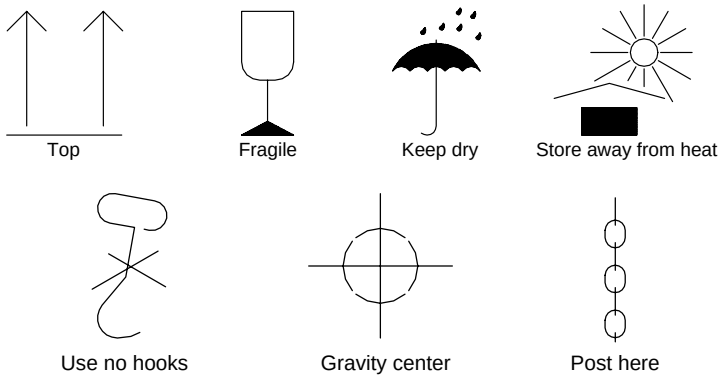
3.2 Pump casings
Pump casings of completely assembled pumps
Pump casings supplied as spare parts

- suction and discharge flanges are closed with flange covers as a protection against damage and dirt

The flange covers meet the safety regulations of the Chemical Industry.

4. Packing

The transport route is decisive for the packaging material. If not particularly stipulated in the contract, the packing corresponds with the packaging regulations HPE laid down by the Bundesverband Holzmittel, Paletten, Exportverpackung e. V. (Federal Association Wood for Packaging, Pallets, Export Packaging Inc.) and the VDMA (Association of German Engineering Shops). The graphical symbols attached to the packing have to be observed.
E. g.:



5. Degree of Disaggregation

The degree of disaggregation depends upon the size of the unit, the transport used, the local conditions and the lifting equipment available. In principle, it is possible to disassemble the pump into several sub-assemblies. It is our policy, however, to ship the pump in as complete a unit as possible. If the pump is dispatched as sub-assemblies, refer to the drawing enclosed with the packing list for degree of disaggregation and assembly.

6. Sensitivity

Transport the pump carefully to avoid damage. According to the transport mode and duration, appropriate transport safety devices are provided for. During transport, shocks and impacts are to be avoided. The pump itself is to be treated with the usual care.

7. Intermediate Storage

Store the pump carefully in a safe place and free from vibrations. For this purpose, it is to be duly covered so that no dust and no humidity may penetrate. The parts of the pump are to be provided with a preservative protecting the pump for about a year. If the intermediate storage lasts longer than a year, preservation has to be renewed.

8. Delivery

The contents of each packing unit is mentioned in the packing lists which have to be checked for completeness upon receipt. Any shipping damage and/or missing items have to be advised immediately in writing.

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1. General Description

The sealless centrifugal pump type SLM N is a centrifugal pump with magnet coupling. The main dimensions and performance data of chemical standard-type pumps correspond with DIN EN 22858 and ISO 2858 respectively. The pump corresponds with the VDMA (Association of German Engineering Shops) standard 24297, requirement B, DIN ISO 5199 and the VDMA standard 24479.

2. Construction and Operating Action

The special feature of these centrifugal pumps is a permanent magnetic synchronous coupling. An outer magnet carrier (part no. 818.1) connected with the drive shaft (part no. 213) transmits the required torque sliplessly to an inner magnet carrier (part no. 818.2) connected with the impeller (part no. 230).
The isolation shell (part no. 817) is situated between the outer magnet carrier (part no. 818.1) and the inner magnet carrier (part no. 818.2) and separates the liquid chamber from the atmosphere.
If the drive torque exceeds the maximum transmission moment of the magnet coupling, the transmission of force is interrupted, i. e. the magnet drive has broken away. There is no demagnetization of the magnets caused by the described slipping. However, damage may be caused to the isolation shell (part no. 817) and the magnets by a no longer existing flush flow circulation.
The arrangement of a hydrodynamic slide bearing in the liquid chamber requires that a liquid with the necessary lubricity is forcibly pumped through it. On the other hand, the rotating magnet system produces an eddy current in the isolation shell (part no. 817) thus causing a temperature rise of the pumped liquid. For this reason, various lubricating and flush flow circuits are provided to dissipate the heat.
Depending on the operating temperature the following magnet systems and roller bearings are used:

S-and SE-system resp.	-120°C	up to	+250°C	grease-lubricated roller bearings
A-system		up to	+450°C	oil-lubricated roller bearings

2.1 Pump Identification Marking

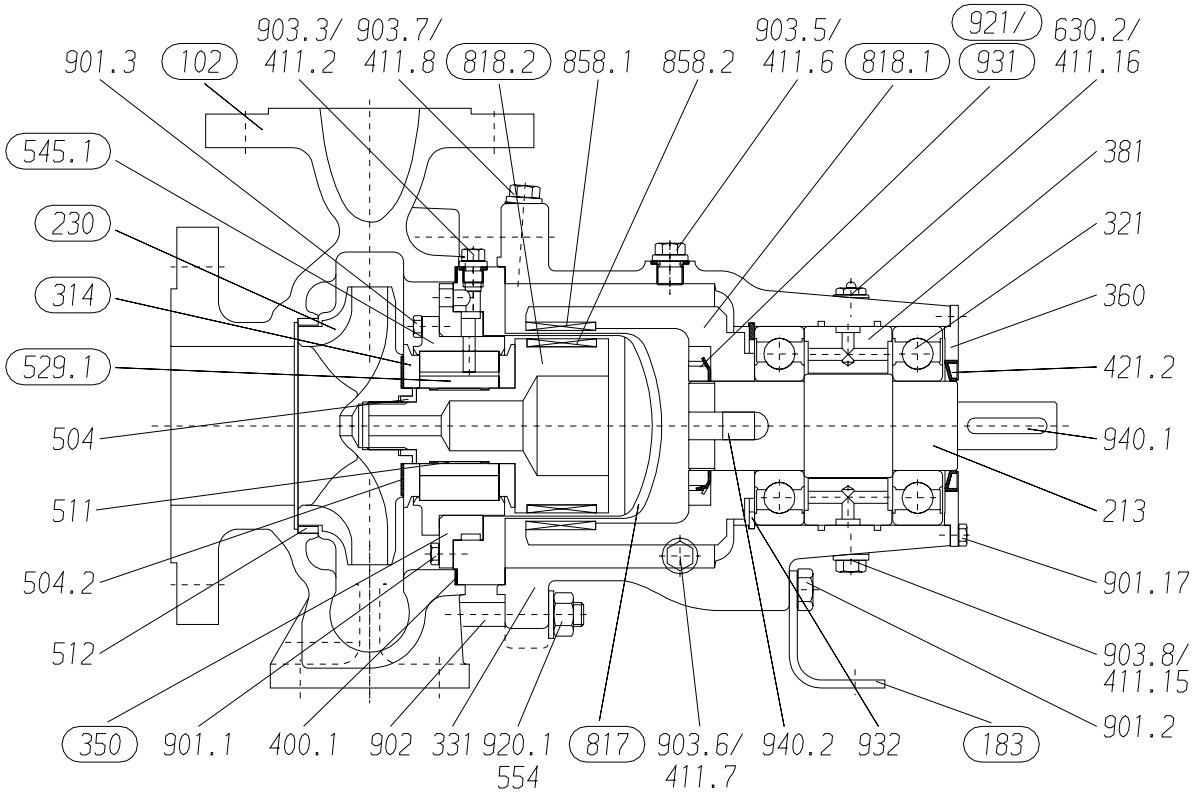
Example	**SLM N**	**32-**	**200-**	**90**	**S**	**1**	**N**	**G**
Line of Products	⇑	⇑	⇑	⇑	⇑	⇑	⇑	⇑
Nominal Diameter of Discharge Nozzle								
Diameter of Impeller								
Diameter of Magnet Coupling								
Material of Magnets								
Number of Magnet Rows								
Additional Designation (Materials)								

K	2.4685	L	2.4686
M	1.0619	N	1.4408
Y	3.7035	Z	Special Material

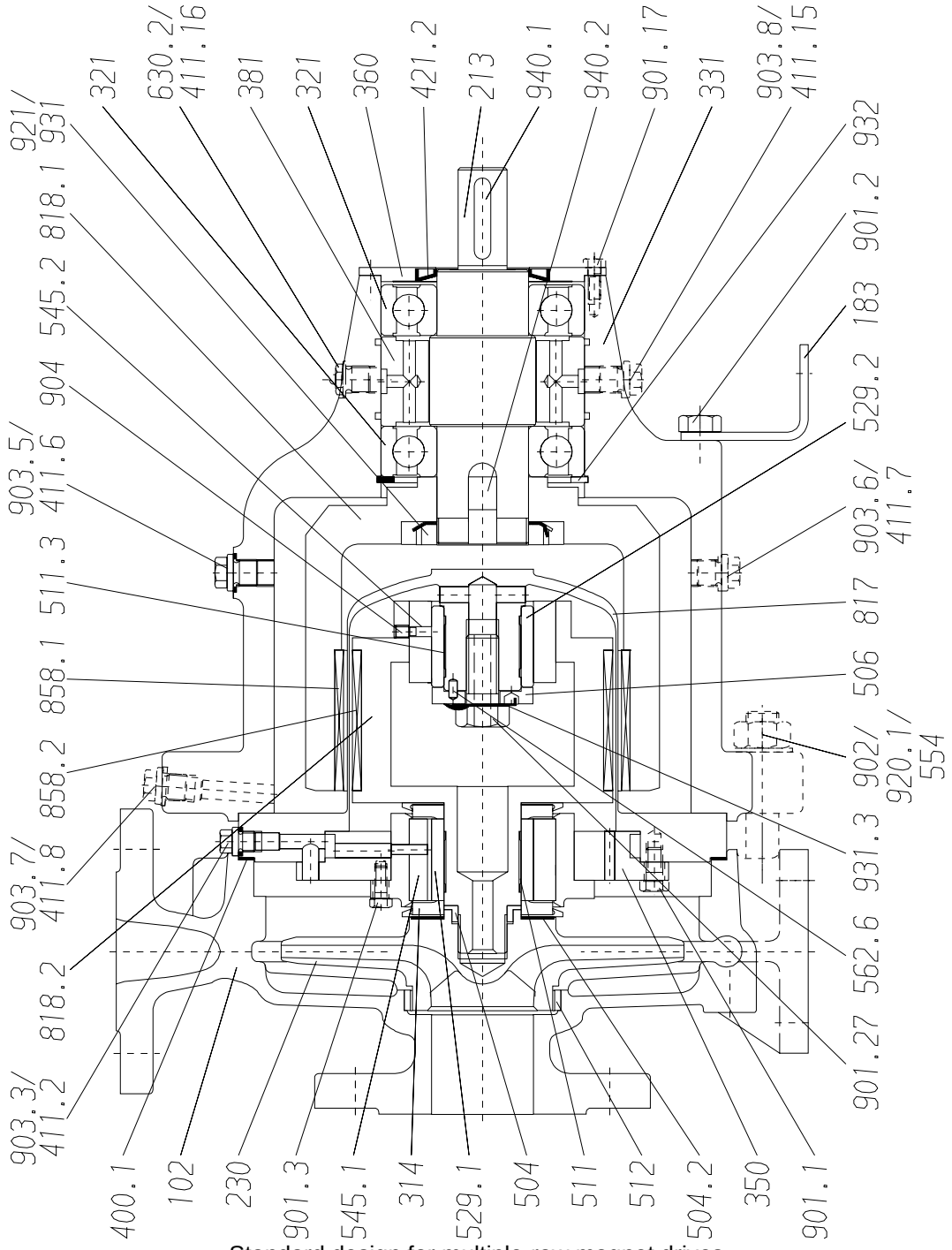
Additional Designation (Construction Type)

D	Double Isolation Shell "CDS"	F	Main Circuit Filter
G	Impeller Fastening	H1	Heating - Casing
H2	Heating - Isolation Shell	H3	Heating - Bearing Bracket
OE	Oil-Lubrication	U	Design for Boiling Liquids
W	Secondary Sealing		

3. Constructive Design



Standard design for single-row magnet drives



Standard design for multiple-row magnet drives

3.1 Pump Casing

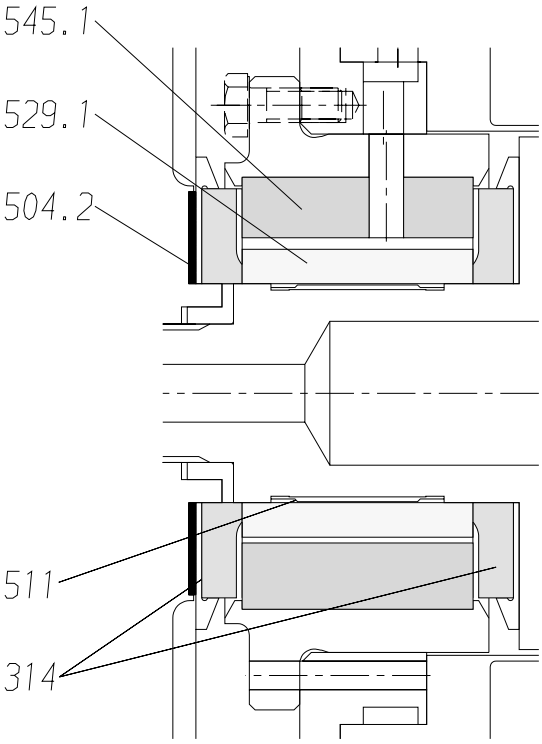
The pump casing is a cast construction with axial suction nozzle and centerline discharge nozzle. To fix it on the base plate it is equipped with supports. Refer to the dimensional chart for the type of casing drain.

3.2 Impeller

The impeller is constructed as a radial impeller. The impeller is fastened by a thread.

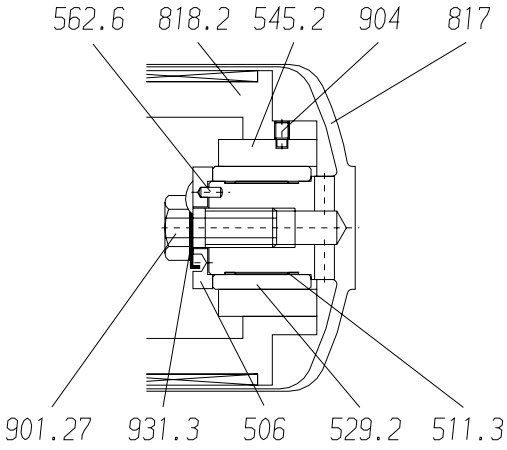
3.3 Slide Bearing

The parts of the pump rotating in the liquid chamber are guided by a slide bearing lubricated by the liquid. The slide bearing is constructed as a radial and thrust bearing and consists of the two thrust bearings (part no. 314), the bearing sleeve (part no. 529.1) and the bearing bush (part no. 545.1). To ensure the radial zero backlash between the bearing sleeve (part no. 529.1) and the inner magnet carrier (part no. 818.2), a tolerance ring (part no. 511) is assembled. The elastic parts (part nos. 504.2 and 511) compensate the varying thermal expansion over the complete thermal range of application.

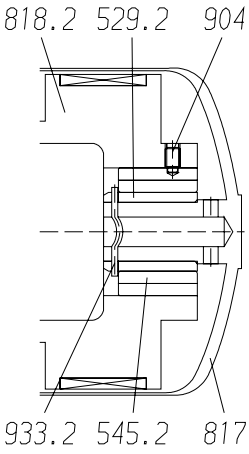


3.3.1 Double Bearing

For multiple-row magnet drives, a supplementary second slide bearing is employed.
The slide bearing is constructed as a radial bearing and consists of the bearing sleeve (part no. 529.2) and the bearing bush (part no. 545.2). To ensure radial zero backlash between the bearing sleeve (part no. 529.2) and the bearing journal, a tolerance ring (part no. 511.3) is inserted.



For magnet drives size 90A and size 130A a supplementary slide bearing as shown in the opposite illustration is employed. The slide bearing is constructed as a radial bearing consisting of bearing sleeve (part no. 529.2) and bearing bush (part no. 545.2). The bearing sleeve (part no. 529.2) will be axially and radially secured by locking pin (part no. 933.2) while the bearing bush (item no. 545.2) is secured by assembly screw (item no. 904).



3.4 Isolation Shell

The isolation shell (part no. 817) ensures a leak-free sealing of the system. The isolation shell serves to receive the bearing flange (part no. 350) and to conduct the flush flow.

3.5 Magnet Drive

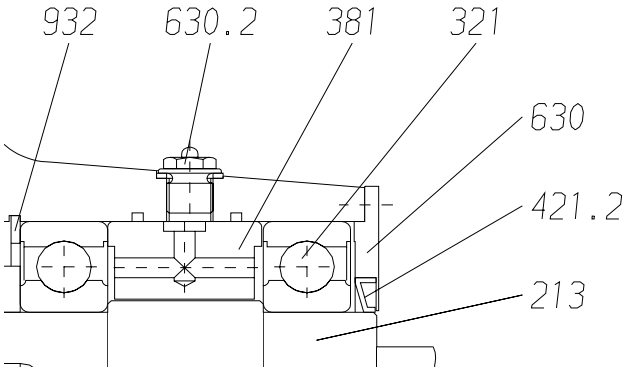
The magnet drive consists of a driver (part no. 818.1 outer magnet rotor) equipped with magnets and the carrier (part no. 818.2 inner magnet rotor). The magnets rotating in the liquid are encapsulated in noncorrosive materials. The carrier (part no. 818.2 inner magnet rotor) is connected with the impeller (part no. 230).

3.6 Shaft Bearing

The drive shaft (part no. 213) runs on ball bearings (part no. 321).

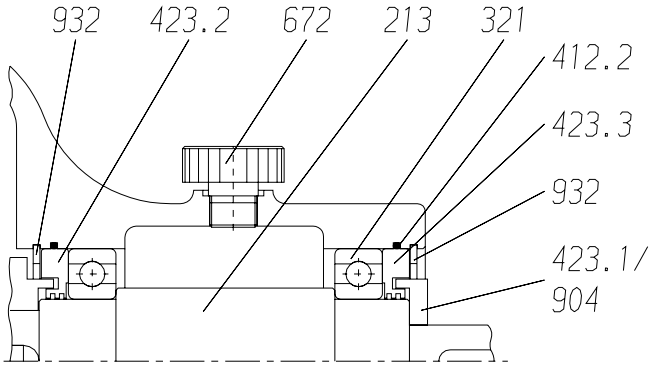
3.7 Sealing of Grease-Lubricated Bearings

The sealing of the grease-lubricated ball bearings is effected by cover disks; on the motor side, a radial shaft seal ring (part no. 421.2) is inserted as a protection against splash water.

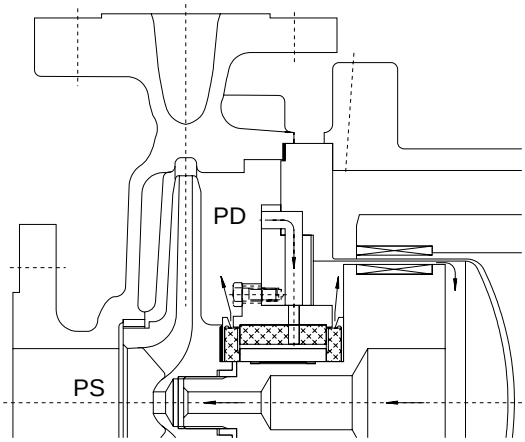


3.8 Sealing of Oil-Lubricated Bearings

The sealing of the oil-lubricated bearings is effected by labyrinth rings (part nos. 423.2 and 423.3).



4. Flushing System



The flush flow lubricates the axial and the radial slide bearings and dissipates the heat generated by the power loss. In an area of high pressure (PD), the flush flow is pumped internally via bores to the suction side of the impeller (PS).

4.1 Flush Flow Temperature Rise

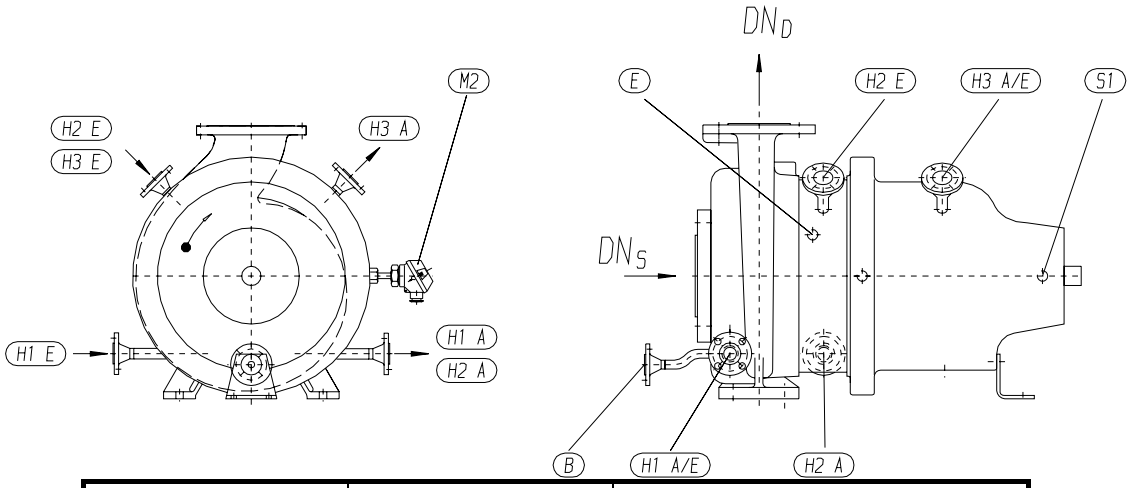
The quantity of the flush flow is designed to ensure that during operation the temperature rise of the flush flow ranges from approx. 1 °C to 8 °C (referring to water/water based liquids).

A T T E N T I O N

Inadmissible operation modes can cause inadmissible temperature rises, thus producing steam in the liquid.

5. Auxiliary Connections

Connections for casing drain and scavenging are provided for. The design depends on the client's order. Auxiliary connections are supplied with connection piece, flange and blind flange DN15 PN25.



Connections	Size	Designation
B	DN15 / PN25	casing drain
E	M 10x1	scavenging isolation shell
M2	G 1/4"	temperature probe isolation shell
S1	G 1/4"	button head lubricating nipple
H1 E	DN15 / PN25	casing heating inlet
H1 A	DN15 / PN25	casing heating outlet
H2 E	DN15 / PN25	isolation shell heating inlet
H2 A	DN15 / PN25	isolation shell heating outlet
H3 E	DN15 / PN25	bearing bracket heating inlet
H3 A	DN15 / PN25	bearing bracket heating outlet

Contents **Page**

1. General Instructions

We do not assume any liability for damage due to inexpert assembly. When turning by hand the pump shaft of the pump upon delivery, abradant noises may be heard. These noises result from the grease-free assembly of the slide bearings. Having lubricated the friction partners with the liquid, these noises disappear. Concerning liquid temperatures exceeding 100 °C, please refer to para. 5 of the present operation manual. The pictorial representations have been simplified.

2. Installation Conditions

Make available enough space to facilitate assembly and maintenance. Arrange preceding and succeeding pipings and units correspondingly. For dimensions of the centrifugal pump type SLM N refer to the attached dimensional chart.

3. Installation of the Completely Assembled Unit

The complete unit consisting of pump, coupling and motor is supplied by Klaus Union already assembled and mounted on a base plate to make sure that the shafts are exactly aligned. Coupling and rotating shaft ends are protected against accidental contact by means of a coupling guard.

Never commission a pump without coupling guard!

Risk of injury due to bare rotating parts!

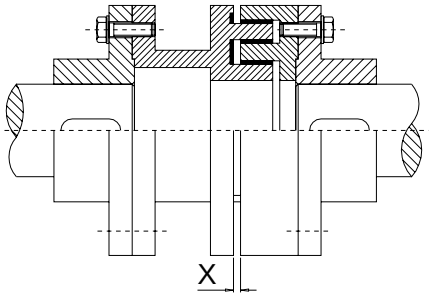
Install the unit according to the foundation plan and align it using a spirit level. Then grout the base plate and the foundation bolts with a fast setting grout-mixture. Only after the grout-mixture has set, the foundation bolts may be tightened.
Upon duly installing the unit connect all pipings - ensuring that they are subject to only low tension - (refer to para. 6 of the present operation manual). Afterwards, check the alignment of the shaft once again.

Align the shafts properly and exactly. Badly aligned shafts increase the wear of the bearings and the flexible coupling. Moreover, the pump will run unsteadily.

4. Installation of the Partially Assembled Pump

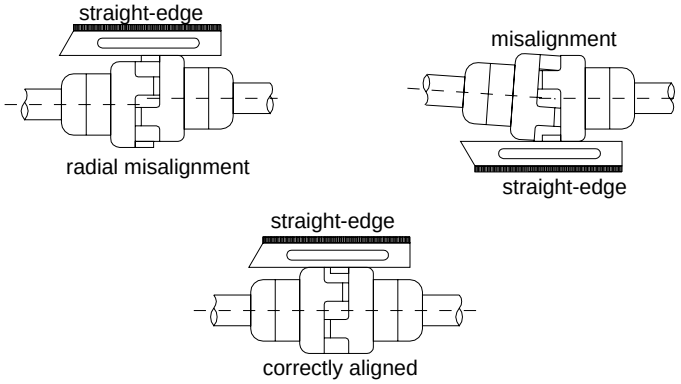
In case the pump is not supplied as a complete unit but in sub-assemblies such as pump, coupling, motor, and base plate, the installation is effected as described hereafter: insert the key into the key groove of the motor-side shaft end. Fit the motor-side coupling half on the shaft by means of a standard draw-on device.

The same goes for the pump-side coupling half.
Align the axial distance between motor and pump coupling halves (refer to dimensional chart and dimension X in u. m. table). Compensate vertical shaft displacements by plane-parallel shims.

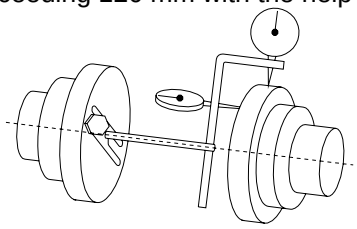


Coupling Size	X in mm
Without Cartridge Unit	
58 up to 140	2 - 4
160 up to 225	**2 - 6**
250 up to 280	2 - 8
With Cartridge Unit	
up to 140	5
160 up to 225	**6**
250	8

Eliminate misalignment of both coupling halves. Put a straight-edge on approx. 4 opposite points on the circumference of the coupling and refer to the u. m. drawing.



Align couplings with a diameter exceeding 120 mm with the help of a dial gauge.



Compensate a vertical displacement by placing underneath or removing the a. m. plane-parallel shims. Fit pump and motor on the base plate with the bolts provided for that purpose.

Equip the coupling and rotating shaft ends with a protection against accidental contact!
Risk of injury due to bare rotating parts!

Install the completely assembled unit as described in para. 3 of the present operation manual.

5. Specific Features of Pumps Processing Hot Liquids

When processing hot liquids, a misalignment of the shaft is caused by temperature differences between pump and motor. This shaft misalignment additionally increases the wear of the coupling parts and has an adverse effect on the pump's smoothness of operation. Heat the pump in the plant to its operating temperature. Having shut down the unit, check the axial/radial misalignment of both coupling halves. Prior to measuring the shaft misalignment, release the bolts (part no. 901.6). Compensate the assessed shaft misalignment by putting underneath motor and/or support plane-parallel shims. The following table indicates the pump types and the ranges of temperature requiring a realignment.

Liquid Temperature

Type/°C	100 up to 150	150 up to 200	200 up to 250	250 up to 300	300 up to 350	350 up to 450
25-125	⊗	⊗	**X**	**X**	**X**	**X**
32-125	⊗	⊗	X	X	X	X
40-125	⊗	⊗	**X**	**X**	**X**	**X**
25-160	⊗	X	X	X	X	Ø
32-160	⊗	**X**	**X**	**X**	**X**	**Ø**
40-160	⊗	X	X	X	X	Ø
50-125	⊗	**X**	**X**	**X**	**X**	**Ø**
25-200	⊗	X	X	X	Ø	Ø
32-200	⊗	**X**	**X**	**X**	**Ø**	**Ø**
40-200	⊗	X	X	X	Ø	Ø
50-160	⊗	**X**	**X**	**X**	**Ø**	**Ø**
50-200	⊗	X	X	X	Ø	Ø
65-125	⊗	**X**	**X**	**X**	**Ø**	**Ø**
65-160	⊗	X	X	X	Ø	Ø
32-250	**X**	**X**	**X**	**X**	**Ø**	**Ø**
40-250	X	X	X	X	Ø	Ø
40-315	**X**	**X**	**X**	**X**	**Ø**	**Ø**
50-250	X	X	X	X	Ø	Ø
50-315	**X**	**X**	**X**	**X**	**Ø**	**Ø**
65-200	X	X	X	X	Ø	Ø
80-160	**X**	**X**	**X**	**X**	**Ø**	**Ø**
80-200	X	X	X	X	Ø	Ø
65-250	**X**	**X**	**X**	**Ø**	**Ø**	**Ø**
65-315	X	X	X	Ø	Ø	Ø
65-400	**X**	**X**	**X**	**Ø**	**Ø**	**Ø**
80-250	X	X	X	Ø	Ø	Ø
80-315	**X**	**X**	**X**	**Ø**	**Ø**	**Ø**
80-400	X	X	X	Ø	Ø	Ø
100-200	**X**	**X**	**X**	**Ø**	**Ø**	**Ø**
100-250	X	X	X	Ø	Ø	Ø
100-315	**X**	**X**	**X**	**Ø**	**Ø**	**Ø**
100-400	X	X	X	Ø	Ø	Ø

⊗ to be aligned in cold condition
X to be aligned in warm condition
Ø to be aligned in warm condition, however, in case of important variations of temperature its is recommended to employ pump casings with feet arranged in the middle of the axle

6. Pipework

All pipework connections should be in accordance with the latest good engineering practices and designed for the operating conditions. Ensure that the forces and moments transmitted to the pump by the pipework do not exceed the values stipulated. The pipework should all be clean and free of all impurities such as weld slag, scale etc. A smooth flow to the pump inlet is required and any bends or reducers which could cause variable velocity should be avoided. A variable inlet velocity has an adverse effect on the pump capacity, the NPSH characteristics and the smooth operation of the pump.

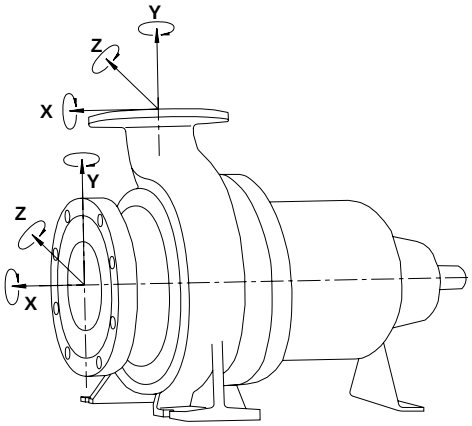
6.1 Suction-Side Pipework

The construction of the suction-side pipework has to have few baffles (bends, valves, etc.) as these elements are often responsible for variable velocity and eddying. Avoid malfunctions caused by asymmetric feed stream. When modifying nominal diameters use conical sections. If a shut-off valve is used, it must always be completely open during operation and must never be used to control the flow.
Always install the suction pipe ascending to the pump. When dimensioning the suction pipe, ensure that the flow velocity does not exceed 2 m/s.
Install the feed pipe descending to the pump. When dimensioning the feed pipe, ensure that the flow velocity does not exceed 2.5 m/s.
For liquids being processed close to their boiling point, the flow velocity shall not exceed 0.8 m/s.

6.2 Pressure Pipework

Install a control valve to adjust the flow directly behind the pump. Install a check valve between pump and shut-off valve on long pressure pipings or static delivery heads exceeding 10 m. This check valve protects the pump against liquid reflux and runback at shutdown. When dimensioning the pipework, make sure that the flow velocity does not exceed 5 m/s. When modifying nominal diameters use conical sections.

6.3 Admissible Pipework Forces and Moments



Explanatory Notes on Nozzle Load of Centrifugal Pumps

The indicated values represent the maximum admissible single forces and moments respectively. They are valid as long as they occur as single forces and moments respectively. At the superposition the admissible values must fulfill the following equation of condition without considering the direction of the forces and moments and their distribution on the nozzles of the pump!

$$(F_v / F_{v\,max})^2 + (F_h / F_{h\,max})^2 + (M / M_{max})^2 <= 1$$

The values for $F_{v\,max}$. , and $F_{h\,max}$. and M_{max}. are indicated in the table.

F_v , F_h and M are the sums of the absolute amounts of the corresponding loads acting upon the nozzles. These sums do neither consider the direction of the loads nor their distribution on the nozzles.

Key

Horizontal Forces F_h

$F_h = \Sigma \mid F_x \mid + \Sigma \mid F_Z \mid$

Vertical Forces F_v

$F_v = \Sigma \mid F_y \mid$

Pump on Base Plate Grouted with Cement:

The values are valid for the pump alone and the pump installed on a grouted base plate respectively or a pump alone installed on a rigid base plate.

Pump on Base Plate Grouted with Cement

Pump Size	Moments M_X , M_Y , M_Z (Nm)	Forces $F_X = F_Z$ (N)	Forces F_Y (N)	Pump Size
25-125	1000	3000	4500	**25-125**
25-160	**1000**	**3000**	**4500**	**25-160**
25-200	1000	3000	4500	**25-200**
32-125	**1000**	**3000**	**4500**	**32-125**
32-160	1000	3000	4500	**32-160**
32-200	**1000**	**3000**	**4500**	**32-200**
32-250	1000	3000	4500	**32-250**
40-125	**1200**	**4000**	**4500**	**40-125**
40-160	1200	3500	4500	**40-160**
40-200	**1200**	**3500**	**5000**	**40-200**
40-250	1200	3500	5000	**40-250**
40-315	**1200**	**3500**	**5000**	**40-315**
50-125	1200	3500	4500	**50-125**
50-160	**1200**	**3500**	**4500**	**50-160**
50-200	1200	3500	5000	**50-200**
50-250	**1500**	**4000**	**4500**	**50-250**
50-315	1500	4000	4500	**50-315**
65-125	**1500**	**4000**	**5000**	**65-125**
65-160	1500	4000	5000	**65-160**
65-200	**3000**	**5000**	**6000**	**65-200**
65-250	3000	5000	6000	**65-250**
65-315	**3000**	**5000**	**6500**	**65-315**
80-160	3000	6500	7500	**80-160**
80-200	**3000**	**6000**	**7500**	**80-200**
80-250	3000	6000	7500	**80-250**
80-315	**3000**	**6000**	**7500**	**80-315**
80-400	3500	6500	8000	**80-400**
100-200	**4500**	**7500**	**9500**	**100-200**
100-250	4500	8000	9500	**100-250**
100-315	**4500**	**7500**	**9500**	**100-315**
100-400	4000	7000	9000	**100-400**
125-250	**6000**	**10000**	**10000**	**125-250**
125-315	6000	10000	10500	**125-315**
125-400	**6000**	**10000**	**11500**	**125-400**
150-250	7000	12000	13000	**150-250**
150-315	**7000**	**12000**	**13000**	**150-315**
150-400	7000	12000	13000	**150-400**
150-500	**7200**	**12500**	**13000**	**150-500**
200-250	7000	12000	13000	**200-250**
200-315	**7000**	**12000**	**13000**	**200-315**
200-400	7000	12000	13000	**200-400**
200-500	**7300**	**13000**	**14000**	**200-500**
250-315	7200	12500	13000	**250-315**

Pump on Non-Grouted Base Plate:

These values are valid for the pump installed on a non-grouted base plate with normal rigidity.

Pump on Non-Grouted Base Plate

Pump Size	Moments M_X , M_Y , M_Z (Nm)	Forces $F_X = F_Z$ (N)	Forces F_Y (N)	Pump Size
25-125	350	2000	2500	**25-125**
25-160	**350**	**2000**	**2500**	**25-160**
25-200	350	2000	2500	**25-200**
32-125	**350**	**2000**	**2500**	**32-125**
32-160	350	2000	2500	**32-160**
32-200	**350**	**2000**	**2500**	**32-200**
32-250	500	2000	2500	**32-250**
40-125	**500**	**2000**	**2500**	**40-125**
40-160	500	2000	2500	**40-160**
40-200	**500**	**2000**	**2500**	**40-200**
40-250	500	2000	2500	**40-250**
40-315	**500**	**2000**	**2500**	**40-315**
50-125	500	2000	2500	**50-125**
50-160	**500**	**2000**	**2500**	**50-160**
50-200	500	2000	3000	**50-200**
50-250	**650**	**2200**	**3000**	**50-250**
50-315	650	2200	3000	**50-315**
65-125	**650**	**2200**	**3000**	**65-125**
65-160	650	2200	3000	**65-160**
65-200	**1000**	**2500**	**3500**	**65-200**
65-250	1000	2500	3500	**65-250**
65-315	**1000**	**2500**	**3500**	**65-315**
80-160	1500	2500	3500	**80-160**
80-200	**1500**	**3000**	**4500**	**80-200**
80-250	1500	3000	4500	**80-250**
80-315	**1500**	**3000**	**4500**	**80-315**
80-400	1500	3000	5000	**80-400**
100-200	**2000**	**3500**	**6000**	**100-200**
100-250	2000	3500	6500	**100-250**
100-315	**2000**	**3500**	**6000**	**100-315**
100-400	2000	3500	5500	**100-400**
125-250	**3000**	**5500**	**9000**	**125-250**
125-315	3000	5000	8000	**125-315**
125-400	**3000**	**5000**	**8000**	**125-400**
150-250	3500	6500	10000	**150-250**
150-315	**3500**	**6500**	**10000**	**150-315**
150-400	3500	6500	10000	**150-400**
150-500	**3600**	**6700**	**11000**	**150-500**
200-250	3500	6500	10000	**200-250**
200-315	**3500**	**6500**	**10000**	**200-315**
200-400	3500	6500	10000	**200-400**
200-500	**3700**	**6800**	**12000**	**200-500**
250-315	3600	6700	11000	**250-315**

Correction Factor for modified Design:

Range of Application: Pump installed on grouted base plate
Pump installed on non-grouted base plate

Design		Correction Factor
Material	1.0619 2.4685 2.4686	1,10
Pressure Nominal	PN25	1,15
Temperature	up to 120 °C up to 250 °C up to 300 °C up to 350 °C up to 400 °C	1,00 0,95 0,90 0,88 0,86
Centerline Support		1,20
Pump Feet fixed additionally with fitting screws		1,20
Casing Support fixed additionally with fitting screws		1,20
Pump without bearing support with flange-mounted motor (close-coupled design)		1,20

The figures of the schedule have to be multiplied with the corresponding correction factor in case the above mentioned design is concerned.

C o n t e n t s **P a g e**

1. List of Lubricants

Please observe the following recommendations for grease-lubricated roller bearings:

Manufacturer	Designation	Temperature Range
DEA	Caron EP 2	-20°C up to +110°C
DEA	Glissando FT2;FT3	-35°C up to +120°C
FAG	Arcanol L78	-30°C up to +130°C
SKF	LGHQ 3	-30°C up to +120°C
SKF	LGEP 2	-30°C up to +110°C
MOBIL OIL	Gargoyle Grease B No 3	-30°C up to + 70°C
MOBIL OIL	Mobilux 2	-20°C up to +120°C
ESSO	Beacon 2	-30°C up to +140°C
BP	Energrease PR 2	-40°C up to + 60°C

When mixing incompatible lubricants the consistency may be considerably affected in a way that the lubricant emerges and consequently the bearings get damaged. If it is not clear whether the lubricants can be mixed, the previously used lubricant has to be removed completely.

Please observe the following recommendations for oil-lubricated roller bearings:

Manufacturer	Designation	Temperature Range	Oil Characteristic
DEA	Falcon CLP 100	up to 100°C	mineral oil
ESSO	NUTO 100	up to 100°C	mineral oil
ARAL	Motanol GM 100	up to 100°C	mineral oil
BP	Energol CS 100	up to 100°C	mineral oil
MOBIL OIL	SHC 626	up to 100°C	** synthetic oils
MOBIL OIL	Glygole 11	up to 100°C	** synthetic oils

****The synthetic oils should be used preferentially for high working temperatures(t> 280°C)**

Never mix syntholubs with mineral oils !!

2. Preparation for Commissioning

Prevent the pump from dry-running by appropriate monitoring, e. g. by liquid level monitoring.

Suction-side pipes must always be filled with liquid, be tight, and thoroughly vented.
Dry-running causes destruction of the pump.

2.1 Grease-Lubricated Roller Bearings

All pumps are supplied fully greased. At commissioning/installation no greasing is necessary. For regreasing intervals refer to operation manual BA-xxxxx-07/x "Maintenance".

2.2 Oil-Lubricated Roller Bearings

Prior to the initial commissioning, please fill oil into bearing bracket (part no. 331). Regarding the oil change intervals, please refer to our operation manual BA-xxxxx-07/x "Maintenance".

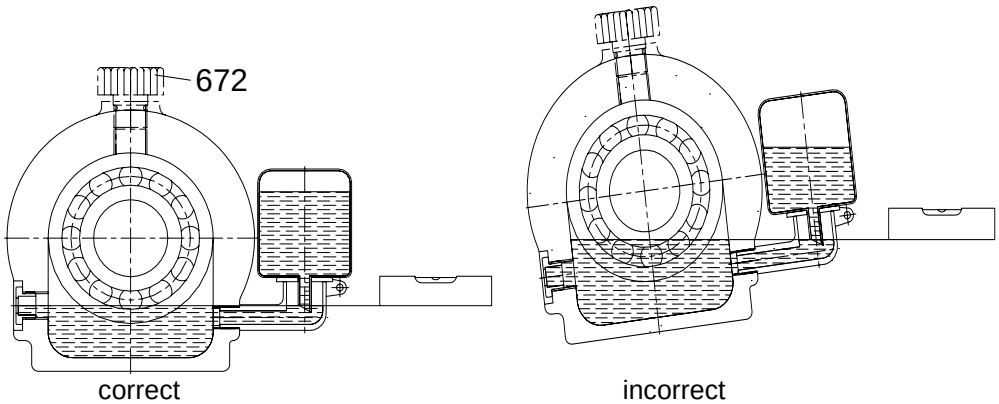
A T T E N T I O N

Prior to the initial commissioning, please fill oil into bearing bracket (part no. 331).

Remove vent plug (part no. 672) and fill bearing bracket (part no. 331) with oil until half of the gauge (part no. 743) is covered with oil. Avoid overcharging as excess oil emerges to the atmosphere.
When using a constant-level-oiler, please check with a spirit level, whether the constant-level-oiler and the complete unit respectively have been installed horizontally. The constant-level-oiler can only function properly when the screwed socket lies horizontally. Remove vent plug (part no. 672) and fill oil into the bearing bracket (part no. 331) until the oil becomes visible in the screwed socket with the oil reservoir folded back. Fill the reservoir through the chamfered drain pipe and fold it back. Now the oil level adjusts to the required level. As long as there is oil in the oil reservoir, the oil level will be correct.

A T T E N T I O N

When using a constant-level-oiler, do not refill oil through the vent bore but only into the oil reservoir of the constant-level-oiler.



2.3 Checking the Direction of Rotation

The motor's direction of rotation must correspond with the direction-of-rotation arrow on the pump.

A T T E N T I O N

To check the direction of rotation, the motor has to be uncoupled. The wrong direction of motor rotation causes damage to the pump.

2.4 Filling and Venting

Filling and venting of pump and plant are carried out at the same time. While filling the pump turn the shaft by hand. For that purpose, the current feed to the motor has to be interrupted and the coupling hood must be removed . No air pockets must remain in the system. Air and gas pockets can lead to the immediate failure of the pump.

3. Monitoring Equipment

Please refer to the attached operation manuals.

4. Commissioning

Open all suction-side shut-off valves. Close the control valve in the pressure piping.

When liquids are processed close to their boiling point, the pump must not be started against the closed pressure-side control valve . For starting the pump, the pressure-side control valve for the minimum flow Q_{min} has to be opened.

Switch the motor on.
If the delivery pressure does not rise with the motor's increasing speed, the pump has to be switched off immediately and to be vented again carefully. Open the control valve in the pressure piping slowly until the operation point is reached. The pump flow can be increased in accordance with the curve to such an extent as it is possible without putting pump and motor at risk. Avoid operating the pump against closed pressure-side control valve for a longer time. Otherwise the pump will be heated up inadmissibly and destroyed.
In case either the operation parameters are modified and they no longer correspond with the ones ordered (delivery head, pump flow, Q_{min}, Q_{max}, viscosity, density, liquid temperature) respectively, it is to be checked whether:

1. the magnet drive is still sufficient
2. the motor is not overloaded
3. on suction condition the suction head to be overcome does not get too high
4. on feed condition the available feed head is still sufficient

Please note that when hot liquid is being handled by the pump, unless the pump is of special construction with additional protection, the maximum instantaneous temperature change should not exceed 100 °C. Beyond this a maximum increase of 25 °C per minute should be observed.

5. Shutdown

Where the system permits slowly close the discharge valve before stopping the pump. Where the pump is being stopped for maintenance purposes shut both the suction and discharge valve before draining the pump.

5.1 Preservation and Storage

The centrifugal pump type SLM N has been provided with a preservative according to the customer's specification. For a longer-term storage of the centrifugal pump, special preservative measures are to be taken. For further details please refer to the section "Transport, Preservation and Storage" (BA/E-01000-03/X) of the present operation manual.

Having been packed into seaworthy cases for their transport, the pumps can be stored in their packing for up to one year without special measures having to be taken. Nevertheless, in order to avoid bearing damages to the pumps owing to vibrations during standstill, e. g. due to machines operated in close vicinity, the pumps should only be stored in rooms free of vibrations.

Concerning the anti-friction bearings it is understood that the lubricant in them will not be adversely affected during a one-year storage period provided the pumps are stored appropriately. The pumps' antifriction-bearings are equipped with relubricating facilities. Shortly after commissioning and as a precaution, the bearings should be relubricated with the pump running. For type and quantity of the lubricants to be used, please refer to paragraph 1 (List of Lubricants) of this section of the operation manual. Concerning the appropriate for lubricating intervals, please refer to the section "Maintenance" (BA/E-01000-07/X) of the present operation manual.

Contents **Page**

1. General Instructions

Please observe all "safety" warnings given in this manual in the workshop.
During the guarantee period, any works are either to be carried out by Klaus-Union staff or with Klaus-Union's authorisation. The dismantling and re-assembly of the centrifugal pump type SLM N are to be carried out by skilled labour exclusively. Observe the assembly steps and instructions described in the present operation manual. Prior to dismantling the pump it has to be emptied and cleaned (please refer to operation manual "Commissioning/Shutdown", para. 4/5).

1.1 Operating Materials: Filling Quantities and Consumption

1.1.1 Grease-Lubrication

In the plant, grease the ball bearings (part no. 321) according to the following table with 10 g of grease. The regreasing is effected with a grease gun through the lubricating nipple (part no. 630.2) screwed into the bearing bracket (part no. 331). The regreasing can be done either during a standstill or during operation of the pump.

Bearing Temperature	Pump Speed	Regreasing Intervals
up to 100°C	1450/1750 1/min	5000 h
	2900/3500 1/min	3500 h
>100°C	**1450/1750 1/min**	**1800 h**
	2900/3500 1/min	**650 h**

Completely replace the grease after longer periods of standstill (> 3 months).
Please refer to operation manual "Commissioning/Shutdown" for possible types of grease.

1.1.2 Oil-Lubrication

It is necessary to change the oil every 2500 operating hours. The quantity is 120 cm^3.
When using a constant-level-oiler, the supplementary quantity of oil amounts to 110 cm^3. Shut the pump down for the oil change. Clean the oil chamber in bearing bracket (part no. 331) and ball bearings (part no. 321) every 10000 operating hours. Please refer to operation manual "Commissioning/Shutdown" for possible types of oil.

2. Inspection and Maintenance

2.1 Inspection during Operation

For inspection during operation, the following parameters are to be assessed. With oil-lubricated roller bearings, the oil level has to be checked at regular intervals.

2.1.1 Pumping Capacity

Check whether the pump is operated at operation point (refer to operation manual "Accompanying Documentation"). If necessary, the operation point has to be adjusted by regulating the pressure-side control valve. If the required pump flow and/or delivery head is not reached despite fully opened control valve, the cause has to be ascertained. Irregularities of the Q-H characteristics are described in operation manual "Malfunctions, Causes and Elimination".

2.1.2 Power Consumption

In case of malfunctions, protect the unit by switching off the motor, e. g. by means of a performance controller (LC). Irregularities of the motor current and the performance respectively are described in operation manual "Malfunctions; Causes and Elimination".

2.1.3. Vibrations

To assess the actual condition of the centrifugal pump by means of a vibration monitoring system, the rate of vibrations is used as a judgement criterion. The following maximum values which must not be exceeded are to be applied on the rate of vibrations. Measure on the coupling-side end of the bearing bracket horizontally and vertically to the shaft axis. If the rates of vibrations determined exceed the maximum admissible values, the cause has to be found. Measures for failure corrective action are described in operation manual "Malfunctions, Causes and Elimination".

Speed n	**Maximum Effective Rate of Vibrations v_{eff} (mm/s) depending on the Shaft Height of the Pump h_1**	
	$h_1 \leq 225$ mm	$h_1 > 225$ mm
min $^{-1}$	**mm/s**	**mm/s**
$n \leq 1800$	2.8	4.5
1800 < n ≤ 4500	**4.5**	**7.1**

When using vibration measuring as a judgement criterion for the status of the ball bearings, the manufacturers' specifications on tolerances for measuring instruments are to be observed.

2.1.4. Temperature at the Isolation Shell

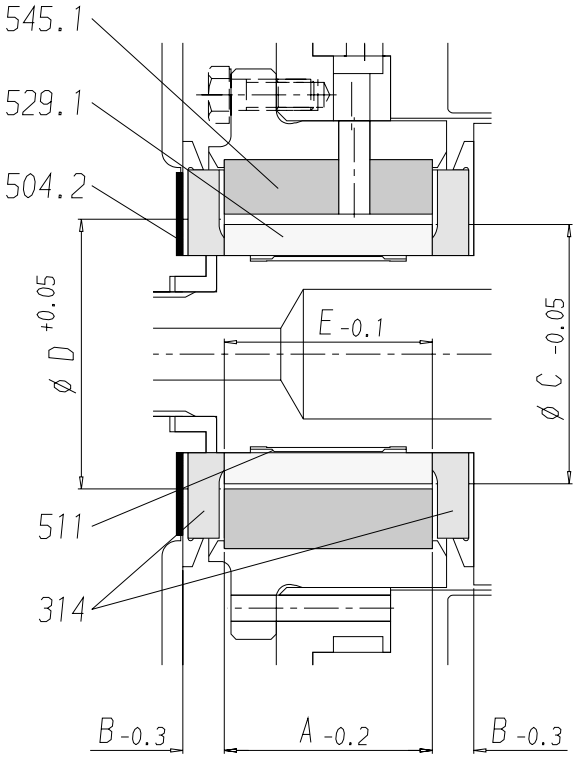
When monitoring the isolation shell temperature, ask the manufacturer for the admissible isolation shell temperature.

2.2 Maintenance

The following description of maintenance works requires that the pump has already been partially dismantled as described in para. 3 of the present operation manual. Check the parts for their tolerances regarding form, position and measures. Replace damaged parts by new original spare parts.

2.2.1 Slide Bearings

Replace the slide bearing or parts of it by new original spare parts when the maximum admissible tolerances are exceeded (refer to the following sketch). The ceramic parts (part nos. 529.1, 545.1, 314) must have a smooth and flawless surface.



	A	B	C	D	E
Drive Size 67	36	5	40	40	36
Drive Size 90 - 160	**40**	**8**	**50**	**50**	**40**
Drive Size 190	60	13	75	75	60

2.2.2 Wear Ring Allowance

Replace wear ring (part no. 512) by new original spare parts when the following maximum diameter allowances are exceeded.

Diameter in mm	Max. Diameter Allowance in mm
< 50	0.6
50 - < 76	**0.7**
76 - < 89	0.9
89 - < 150	**1.0**
150 - < 260	1.1

3. Dismantling

3.1 Preparations for the Disassembly of the Centrifugal Pump

Execute the following works:

- Interrupt the current feed to the motor.
- Close the shut-off valves in suction and pressure pipings.
- Dispose of the remaining residual liquid in the pump.
- Remove the coupling guard.
- Remove the motor from the base plate.

  When using couplings with cartridge unit, only the cartridge unit needs to be disassembled; the motor disassembly is not necessary.
- Remove the pump-side coupling half from the drive shaft (part no. 213).

A T T E N T I O N

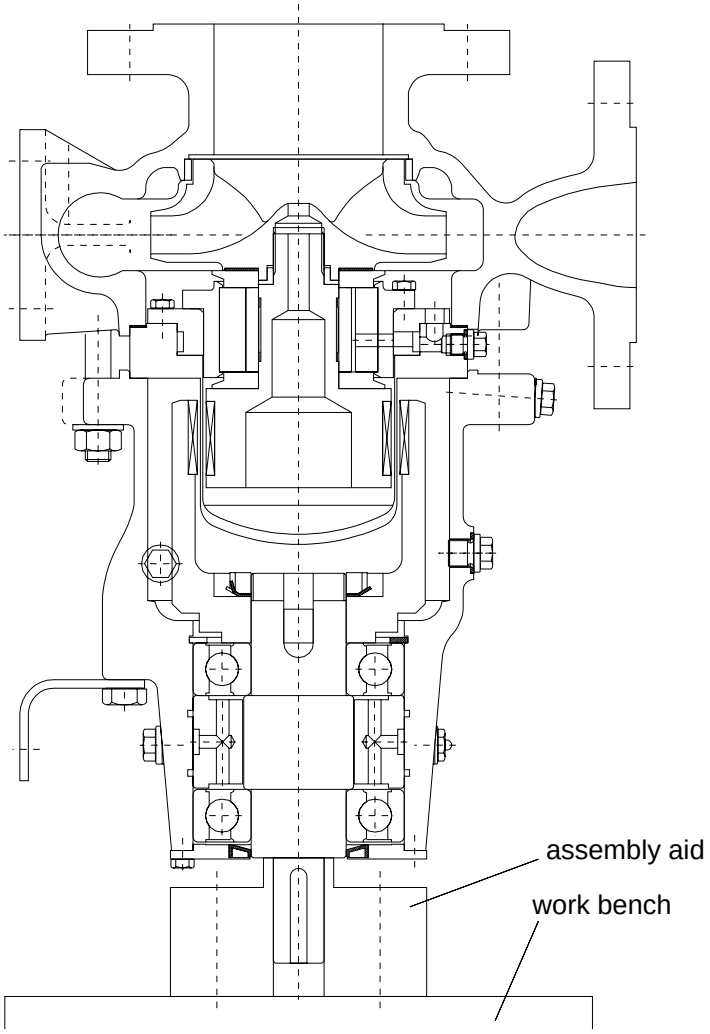
Use an offset cam for dismantling of the coupling.

- Disconnect suction and pressure nozzle from the piping.

3.2 Dismantling of the Centrifugal Pump

To execute repair works, use the u. m. assembly aid.

- Release and remove the hexagon nuts (part no. 920.1).
- Remove the spiral casing with a suitable lifting device. For dismantling use a pressure cam (KU-assembly aid).
- Unscrew and remove the hexagon screws (part no. 901.1).
- Remove the complete unit consisting of impeller/slide bearing/inner magnet carrier with a suitable lifting device.
- Remove the isolation shell (part no. 817). For dismantling use a pressure cam (KU-assembly aid).
- Fix the inner magnet carrier (part no. 818.2) in the clamping device (KU special tool).
- Remove the impeller (part no. 230). Unscrew it anticlockwise while looking in the direction of the suction orifice.
- Remove the graphite washer (part no. 504.2), the front thrust bearing (part no. 314), the spacer (part no. 504), the bearing bush (part no. 545.1), the bearing flange (part no. 350), the bearing sleeve (part no. 529.1), the back thrust bearing (part no. 314) and the tolerance ring (part no. 511).
- Unscrew and remove the hexagon screws (part no. 901.3).
- Press the bearing bush (part no. 545.1) out of the bearing flange (part no. 350).
- For dismantling the outer magnet carrier (part no. 818.1) and the ball bearings (part no. 321) release lock washer (part no. 931).
- Release and remove KM-nut (part no. 921) (KU special tool).
- Remove the outer magnet carrier (part no. 818.1) from the drive shaft (part no. 213). To facilitate dismantling, the outer magnet carrier (part no. 818.1) is equipped with threaded bores axially on the circumference on the face for receiving lifting-devices.



3.2.1 Disassembly of Ball Bearings (Grease-Lubrication)

As a precondition, procedures described in para. 3.2 must have been carried out.

- Unscrew and remove the hexagon screws (part no. 901.17).
- Remove the bearing cover (part no. 360) which is equipped with pulling-off bores (M6) for dismantling.
- Remove the complete bearing unit, the drive shaft (part no. 213), the ball bearing (part no. 321) and the bearing insert (part no. 381) from the bearing bracket (part no. 331).
- Dismantle the ball bearings (part no. 321) with standard offset cams.
- Remove the bearing insert (part no. 381) from the drive shaft (part no. 213).

3.2.2 Disassembly of Ball Bearings (Oil-Lubrication)

As a precondition, procedures described in para. 3.2 must have been carried out.

- Remove the front and the back snap ring (part no. 932).
- Release and remove the set screws (part no. 904).
- Remove the splash ring (part no. 423.1)
- Remove the bearing covers (part nos. 423.2 and 423.3) which are equipped with 2 threaded
  bores each to facilitate dismantling.
- Remove the O-rings (part no. 412.2).

- Push the complete bearing unit, drive shaft (part no. 213) and ball bearings (part no. 321) out of the bearing bracket (part no. 331) towards the motor.
- Dismantle the ball bearings (part no. 321) with standard offset cams.

4. Assembling Tools

Designation	Ident.-No.
Pressure Cam	54883
Spanner KM-Nut	**548891**
Clamping Device for Inner Magnet Carrier Size 67	1043
Clamping Device for Inner Magnet Carrier Size 90	**1044**
Clamping Device for Inner Magnet Carrier Size 130	1045
Clamping Device for Inner Magnet Carrier Size 160	**1046**
Clamping Device for Inner Magnet Carrier Size 190	1047

5. Re-Assembly

As a precondition for following the subsequent assembling instructions, the bearing must already have been assembled as described in para. 5.2 or para. 5.3.

- Prior to re-assembly check whether all pump parts are suitable for use.
- Protect the ball bearings from dirt and humidity.
- Tighten screws in accordance with tightening moments indicated in para. 5.1.
- Clean tight and bearing surfaces.
- Replace gaskets by new ones.
- Protect the drive shaft (part no. 213) against distortion (use one of a. m. assembling tools).
- Put the key (part no. 940.2) into the key groove of the drive shaft (part no. 213).
- Push the outer magnet carrier (part no. 818.1) and the lock washer (part no. 931) onto the drive shaft (part no. 213).
- Screw the KM-nut (part no. 921) on the drive shaft (part no. 213).
- Secure the KM-nut (part no. 921) with the lock washer (part no. 931).
- Fix the bearing bush (part no. 545.1) with hexagon screws (part no. 901.3) on the bearing flange (part no. 350).
- Fix the inner magnet carrier (part no. 818.2) in the clamping device (KU special tool).
- Push the back thrust bearing (part no. 314), the tolerance ring (part no. 511), the bearing sleeve (part no. 529.1), the bearing bush (part no. 545.1) with the bearing flange (part no. 350), the spacer (part no. 504) and the front thrust bearing (part no. 314) in this order on the inner magnet carrier (part no. 818.2).
- Put the graphite washer (part no. 504.2) in the impeller (part no. 230).
- Screw the impeller (part no. 230) clockwise on the inner magnet carrier (part no. 818.2) while looking in the direction of the suction orifice.
- Install the isolation shell (part no. 817) in the already assembled bearing bracket (part no. 331).
- Install the complete unit consisting of impeller/slide bearing/inner magnet carrier in the isolation shell.

To avoid injuries, the unit consisting of impeller/slide bearing/inner magnet carrier must not be held at the isolation shell flange but only at the impeller.

- Make sure that the positioning between bearing flange (part no. 350) and isolation shell (part no. 817) is correct! Insert the alignment pin of the bearing flange (part no. 350) in the corresponding location holes at the isolation shell.
- Fix the isolation shell (part no. 817) with the hexagon screws (part no. 901.1) at the bearing flange (part no. 350).
- Insert the gasket (part no. 400.1) in the spiral casing (part no. 102).

- Put the spiral casing (part no. 102) on. Watch the positioning of the isolation shell flange in the
  spiral casing (part no. 102)! Position the isolation shell screwing in the corresponding recess of the spiral casing (part no. 102). Tighten the assembly studs (part nos. 902, 554, 920.1) in accordance with the u. m. tightening moments.
- Put the key (part no. 940.1) into the key groove of the drive shaft (part no. 213).
- Mount the corresponding coupling half with a mounting device.
- Check whether there are the specified quantities of lubricants in the bearing bracket!

5.1 Tightening Moments for Screws

Part. No.	Material	Diameter	Tightening Moment in Nm
901. 1	A4-70	M8	25
901. 2	**5.6**	**M12**	**35**
901. 3	A4-70	M6	10
901.17	**8.8**	**M6**	**10**
920. 1	A4-70	M12	25
920. 1	**5.6**	**M12**	**25**
920. 1	24CrMo5	M12	25
920. 1	**A4-70**	**M16**	**60**
920. 1	5.6	M16	60
920. 1	**24CrMo5**	**M16**	**60**

5.2 Assembly of Ball Bearings (Grease-Lubrication)

- Warm up the ball bearings (part no. 321) to approx. 80 °C in the usual ways (oil-bath, heating plate, inductive heating).
- Push the front ball bearing (part no. 321) on the drive shaft (part no. 213).
- Push the bearing insert (part no. 381) on the drive shaft (part no. 213).
- Push the back ball bearing (part no. 321) previously warmed up to 80 °C on the drive shaft (part no. 213).
- For assembly of the complete bearing, warm up the bearing bracket (part no. 331) in the area of the seat of the bearing to approx. 80 °C in the usual ways (oil-bath, inductive heating).
- Insert the snap ring (part no. 932) in the bearing bracket (part no. 331).
- Push the complete bearing into the bearing bracket (part no. 331).
- Insert the shaft seal ring (part no. 421.2) in the bearing cover (part no. 360).
- Mount the bearing cover (part no. 360).
- Fix the bearing cover (part no. 360) with the hexagon screws (part no. 901.17).
- Fill the ball bearings (part no. 321) with grease through the lubricating nipple (part no. 630.2).

5.3 Assembly of Ball Bearings (Oil-Lubrication)

- Warm up the ball bearings (part no. 321) to approx. 80 °C in the usual ways (oil-bath, heating plate, inductive heating).
- Push the ball bearings (part no. 321) on the drive shaft (part no. 213).
- For assembly of the complete bearing, warm up the bearing bracket (part no. 331) in the area of the seat of the bearing to approx. 80 °C in the usual ways (oil-bath, inductive heating).
- Insert the back piece parts, snap ring (part no. 932), O-ring (part no. 412.2), bearing cover (part no. 423.2) and the complete bearing in this sequence in the bearing bracket (part no. 331).
- Assemble the motor-side piece parts, O-ring (part no. 412.2), bearing cover (part no. 423.3), snap ring (part no. 932) and the splash ring (part no. 423.1) in this sequence.
- Fix the splash ring (part no. 423.1) with the set screws (part no. 904).

6. Spare Parts

The attached spare parts list enumerates the recommended spare parts.

Contents **Page**

1. Malfunctions and Causes

No./Malfunction	Ref.-No. for Cause and Elimination
1/Flow is too low	**1, 8, 9, 12, 14, 15**
2/Flow is too high	**2, 16**
3/Delivery head is too low	**2, 3, 8, 9, 10, 11, 12, 15**
4/Delivery head is too high	**1, 16, 32, 33**
5/Pump does not suck or only to a limited extent	**3, 5, 8, 15**
6/Pump does not feed	**3, 4, 5, 6, 8, 15,**
7/Pump processes by fits and starts	**3, 5, 8**
8/Pump operates noisily	**3, 5, 6, 7, 12, 13**
9/Power consumption is too high	**2, 6, 7, 10, 11, 13,16**
10/Power consumption is too low	**9, 15, 32, 33**
11/Pump runs backwards	**12, 18**
12/Pump runs unsteadily	**7, 13, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29**
13/Pump casing leaks	**28, 30, 31**
14/Pump is running hot	**4, 15, 17**
15/Pump stalled	**6, 7, 13**

2. Causes and Proceedings for Elimination of Malfunctions

Ref.-No.:	Cause	Elimination
1	Piping resistance in pressure piping is too high.	Clean or replace the pipings and/or the valves. Check the dimensioning of the pipings' nominal diameter.
2	Pressure-side piping resistance is too low.	Throttle the pressure-side control valve.
3	Feed pressure is too low. Geodetic suction height is too high.	Increase the feed pressure on the feed-side.
4	Shut-off valve in the pressure-side and suction-side piping respectively is closed.	Open the shut-off valve. Check whether swing check valve opens.
5	The suction-side piping still contains gas bubbles.	Vent the unit and check the laying of the pipings.
6	Foreign matters in the pump.	Disassemble the pump and remove the foreign matters. Replace damaged parts by new original spare parts.
7	Wear of slide bearings.	Check the bearing clearance.
8	Suction piping leaks.	Check the suction-side piping connections and tightening moments of screws. Check the suction-side gaskets. Check the tightening moments of screws at the spiral casing. Check the gaskets at the spiral casing. Replace damaged gaskets by new original spare parts.
9	Speed is too low.	Check the frequency and the voltage.
10	Viscosity of liquid is too high.	Contact the manufacturer.
11	Viscosity and density of the liquid are too high.	Contact the manufacturer.
12	Wrong direction of rotation.	Reconnect the power lead at the motor according to the direction-of-rotation arrow.
13	Damaged roller bearings.	Replace the roller bearings. Clean the oil chamber in the bearing bracket. Check whether the lubricant is suitable for your field of application.
14	Inadmissible reduction of area of cross section in the suction piping.	Clean suction-side filters. Remove precipitations in the suction piping or replace the suction piping.
15	Breakaway of magnet drive.	Switch off the motor and wait until it stands still. Switch the motor on again. Contact the manufacturer.

Ref.-No.:	Cause	Elimination
16	Speed is too high.	Check the frequency and the voltage of the motor.
17	Flush flow is too low.	Clean the flush flow filter. Check the flushing system. Check whether you fall short of the minimum quantity Q_{min}.
18	Swing check valve got stuck.	Check the operativeness of your swing check valve.
19	The impeller is clogged or damaged.	Clean the impeller and replace it by a new original spare part respectively.
20	Precipitation of crystals from the liquid.	Increase the temperature of the liquid, e. g. by heating the pump. Contact the manufacturer.
21	Specified quantity of lubricant was not observed.	Check the roller bearings for their suitability (if necessary, replace them by new original spare parts) and increase the quantity of the lubricant according to the specification.
22	Unsuitable lubricant.	Check the roller bearings for their suitability (if necessary, replace them by new original spare parts) and check whether the lubricant is suitable for your field of application.
23	Inexpert assembly of roller bearings.	Check the roller bearings for their suitability (if necessary, replace them by new original spare parts) and assemble them properly.
24	Misaligned or loose coupling.	Check and correct the alignment of your coupling. Tighten the connecting bolts.
25	Elastic coupling elements are worn off.	Replace the elastic coupling elements.
26	Poor workmanship of the foundation.	Check and correct the construction of your foundation.
27	Base plate not rigid enough with foundationless execution.	Contact the manufacturer.
28	Pump casing is distorted.	Check and correct the piping lengths.
29	Pump design is wrong.	Contact the manufacturer.
30	Unsuitable casing gasket.	Replace the casing gasket by a new original gasket.
31	Casing screws have been tightened insufficiently.	Tighten the casing screws according to the specified tightening moments.
32	Density of liquid is too low.	Contact the manufacturer.
33	Viscosity and density of the liquid are too low.	Contact the manufacturer.