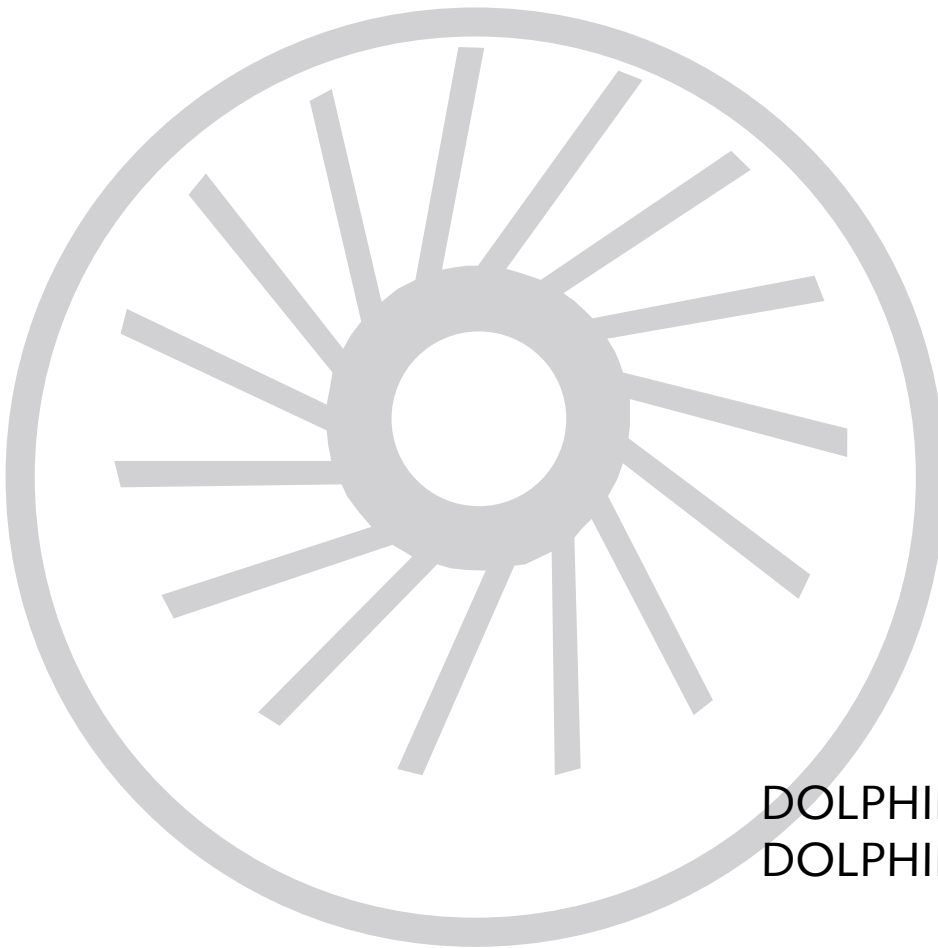




**VACUUM SOLUTIONS**

## Installation and Operating Instructions



Vacuum Pumps

DOLPHIN LA 0053-1111 A  
DOLPHIN LB 0063-1011 A

CE UK EAC  
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**VACUUM APP**

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# Preface

Congratulations on your purchase of the Busch vacuum pump. With watchful observation of the field's requirements, innovation and steady development Busch delivers modern vacuum and pressure solutions worldwide.

These operating instructions contain information for

- product description,
- safety,
- transport,
- storage,
- installation and commissioning,
- maintenance,
- overhaul,
- troubleshooting and
- spare parts

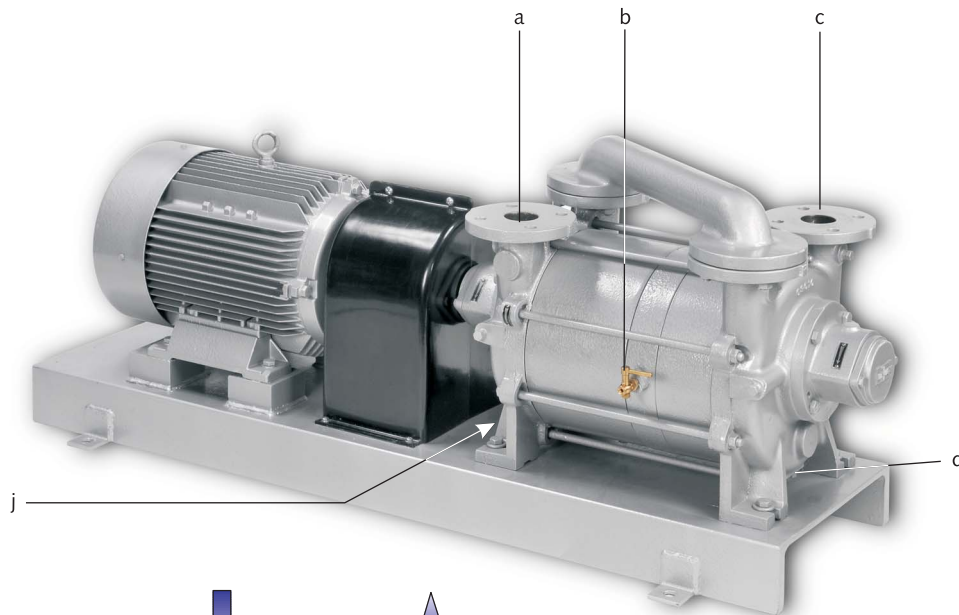
of the vacuum pump.

The operating liquid supply system is either subject to a separate documentation or to be furnished by the operator.

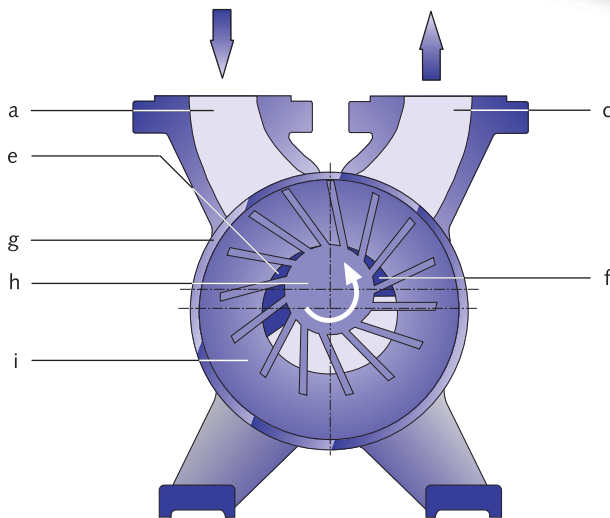
For the purpose of these instructions, "handling" the vacuum pump means the transport, storage, installation, commissioning, influence on operating conditions, maintenance, troubleshooting and overhaul of the vacuum pump.

**Prior to handling the vacuum pump these operating instructions shall be read and understood. If anything remains to be clarified please contact your Busch representative!**

**Keep these operating instructions and, if applicable, other pertinent operating instructions available on site.**



- a Suction connection
- b Level plug
- c Gas discharge
- d Drain
- e Suction port
- f Discharge port
- g Housing
- h Impeller
- i Liquid ring
- j Service liquid inlet



## Product Description

### Use

The vacuum pump is intended for

- the suction
- of
- non-explosive gases and vapours

The vacuum pump may only be used as contractually agreed with Busch. The conveyed medium, the operating liquid and the temperature ranges thereof may not be changed without written consent of Busch.

Maximum allowed temperatures:

gas dry:	120 °C
gas saturated:	100 °C
operating liquid:	80 °C

The vacuum pump is intended for the placement in a non-potentially explosive environment.

The vacuum pump is thermally suitable for continuous operation (100 percent duty).

The vacuum pump is not ultimate pressure proof. Operation with a closed ("blanked") suction line will damage the vacuum pump.

### Principle of Operation

The vacuum pump works on the fluid ring principle.

At standstill, the pump housing (g) shall be filled with an operating liquid (usually water) to approx. the shaft centreline. On starting the vacuum pump, the impeller throws the liquid to the periphery of the housing, where it forms a liquid ring that rotates in the pump housing. This liquid ring seals the space between the impeller (h) and the housing (g). In the 12 o'clock position the liquid ring touches the hub of the impeller (h). As the impeller rotates counterclockwise (view from non-drive end), the liquid ring moves away from the hub, making space for gas to be drawn in through the intake port (e) (approx. from the 11 o'clock to the 8 o'clock position). The chamber surrounded by the hub, the liquid ring and two adjacent impeller blades achieves its maximum volume in the 6 o'clock position. As the impeller continues to rotate, the liquid ring moves closer to the impeller hub, the volume of the chamber decreases and the enclosed gas is expelled through the discharge port (f) (approx. from the 3 o'clock position to the 12 o'clock position). This sequence is repeated for every chamber between two impeller blades with each revolution.

The operating liquid also absorbs the heat of compression and condensation (when conveying saturated media).

The control of the level and the temperature of the operating liquid are essential for the satisfactory operation of the vacuum pump. The chapter Installation Prerequisites (→ page 5) gives advice and explains typical installation options.

2 stages, both working on the principle described above, are installed in line in order to achieve a better ultimate/differential pressure.

### Cooling

The vacuum pump is cooled by

- the air flow from the fan wheel of the drive motor

- the process gas
- the operating liquid

## Start Controls

The vacuum pump comes without start controls. The control of the vacuum pump is to be provided in the course of installation.

# Safety

## Intended Use

**Definition:** For the purpose of these instructions, "handling" the vacuum pump means the transport, storage, installation, commissioning, influence on operating conditions, maintenance, troubleshooting and overhaul of the vacuum pump.

The vacuum pump is intended for industrial use. It shall be handled only by qualified personnel.

**The allowed media and operational limits (→ page 3: Product Description) and the installation prerequisites (→ page 5: Installation Prerequisites) of the vacuum pump shall be observed both by the manufacturer of the machinery into which the vacuum pump is to be incorporated and by the operator.**

The maintenance instructions shall be observed.

**Prior to handling the vacuum pump these installation and operating instructions shall be read and understood. If anything remains to be clarified please contact your Busch representative!**

## Safety Notes

The vacuum pump has been designed and manufactured according to state-of-the-art methods. Nevertheless, residual risks may remain. These operating instructions highlight potential hazards where appropriate. Safety notes are tagged with one of the keywords DANGER, WARNING and CAUTION as follows:



**DANGER**

Disregard of this safety note will always lead to accidents with fatal or serious injuries.



**WARNING**

Disregard of this safety note may lead to accidents with fatal or serious injuries.



**CAUTION**

Disregard of this safety note may lead to accidents with minor injuries or property damage.

## Noise Emission

For the sound pressure level in free field according to EN ISO 2151 → page 25: Technical Data.

# Transport

## Transport in Packaging

Packed on a pallet the vacuum pump is to be transported with a forklift.

## Transport without Packaging

In case the vacuum pump is packed in a cardboard box with inflated cushions:

- ◆ Remove the inflated cushions from the box

In case the vacuum pump is in a cardboard box cushioned with rolled corrugated cardboard:

- ◆ Remove the corrugated cardboard from the box

In case the vacuum pump is laid in foam:

- ◆ Remove the foam

In case the vacuum pump is bolted to a pallet or a base plate:

- ◆ Remove the bolting between the vacuum pump and the pallet/base plate

In case the vacuum pump is fastened to the pallet by means of tightening straps:

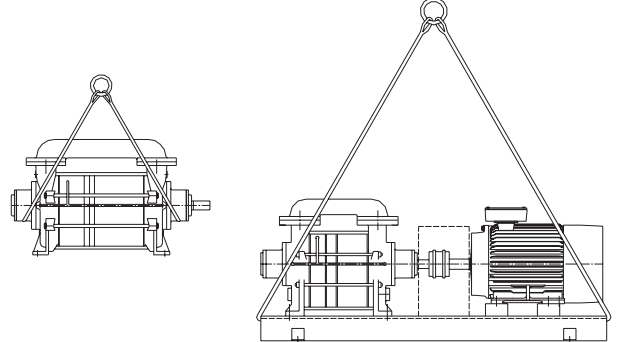
- ◆ Remove the tightening straps



**CAUTION**

Do not walk, stand or work under suspended loads.

- Attach lifting gear as shown in the illustration



- Attach the lifting gear to a crane hook with safety latch
- Lift the vacuum pump with a crane

In case the vacuum pump was bolted to a pallet or a base plate:

- ◆ Remove the stud bolts from the rubber feet

# Storage

## Short-term Storage

- Make sure that the suction connection and the gas discharge are closed (leave the provided plugs in)
- Store the vacuum pump
  - if possible in original packaging,
  - indoors,
  - dry,
  - dust free and
  - vibration free

## Conservation

In case of adverse ambient conditions (e.g. aggressive atmosphere, frequent temperature changes) conserve the vacuum pump immediately. In case of favourable ambient conditions conserve the vacuum pump if a storage of more than 3 months is scheduled.

- Make sure that all ports are firmly closed; seal all ports that are not sealed with PTFE-tape, gaskets or o-rings with adhesive tape

**Note:** VCI stands for "volatile corrosion inhibitor". VCI-products (film, paper, cardboard, foam) evaporate a substance that condenses in molecular thickness on the packed good and by its electro-chemical properties effectively suppresses corrosion on metallic surfaces. However, VCI-products may attack the surfaces of plastics and elastomers. Seek advice from your local packaging dealer! Busch uses CORTEC VCI 126 R film for the overseas packaging of large equipment.

- Wrap the vacuum pump in VCI film
- Store the vacuum pump
  - if possible in original packing,
  - indoors,

- dry,
- dust free and
- vibration free.

For commissioning after conservation:

- Make sure that all remains of adhesive tape are removed from the ports
- Commission the vacuum pump as described in the chapter Installation and Commissioning (→ page 5)

# Installation and Commissioning

## Installation Prerequisites



### CAUTION

In case of non-compliance with the installation prerequisites, particularly in case of insufficient cooling:

Risk of damage or destruction of the vacuum pump and adjoining plant components!

Risk of injury!

The installation prerequisites must be complied with.

- Make sure that the integration of the vacuum pump is carried out such that the essential safety requirements of the Machine Directive 2006/42/EC are complied with (in the responsibility of the designer of the machinery into which the vacuum pump is to be incorporated; → page 16: note in the EC-Declaration of Conformity)

## Ancillary Conditions

The chapter Principle of Operation (→ page 3) describes the basic function of a vacuum pump. This description assumes, that the liquid ring stays liquid all the time.

Actually the condition of both the operating liquid and the conveyed media depend on the physical conditions pressure and temperature.

At very low pressures and sufficiently high temperatures the operating liquid can locally transfer into the vapour phase, creating bubbles within the operating liquid. As the pressure rises towards the outlet port (e) the bubbles collapse. This process is called cavitation. In case of bubbles that have been located on surfaces the operating liquid cannot intrude the cavity left by the bubble equally from all directions. Instead the inflowing liquid hits the surface with high speed. This causes erosion, which can destroy the vacuum pump rapidly. Also the formation of bubbles deteriorates the pump performance. Cavitation is clearly audible by its rumbling noise.

For a trouble-free operation the vacuum pump shall be filled with operating liquid approx. up to the shaft centre before the pump is switched on. A low liquid level deteriorates the pump performance. A dry start causes failure of the mechanical seal on the shaft of the vacuum pump. A start with a completely flooded housing damages the blades of the impeller.

Once the vacuum pump is running operating liquid can be supplied. Excess operating liquid will then be thrown out through the outlet. The pressure of the supplied operating liquid shall not exceed the outlet pressure of the vacuum pump by more than 0.1 bar, otherwise the pump performance will deteriorate. The best solution is a reservoir under atmospheric pressure from which the vacuum pump sucks in operating liquid automatically.

The pressure control and the operating liquid supply system of a vacuum pump must therefore fulfill the following tasks:

- limit the operating pressure to a value at which no cavitation will occur

- control the level in the operating liquid separator and if appropriate, cool the operating liquid to a temperature at which no cavitation will occur

Operating the vacuum pump close to its ultimate pressure requires large quantities of cool operating liquid. In order to avoid cavitation it is usually more prudent to limit the minimum working pressure.

The pressure on the suction side of the vacuum pump must not fall below the minimum allowed operating pressure. Therefore it is not allowed to use a pressure control the actuator of which would throttle or even close the suction line.

The most effective measure to limit the inlet pressure is the use of a vacuum relief valve.

The vacuum relief valve can either be installed in the suction line or on the housing of the vacuum pump. The gas supply line of the vacuum relief valve is usually connected to the liquid separator. Alternatively ambient air can be used to limit the vacuum.

Feeding ambient air cools, acts against condensation or solution of process gas in the operating liquid and therefore reduces the risk of cavitation, however, it mixes the process gas with ambient air, i.e. with oxygen, which is possibly not desired. Drawing air from the liquid separator avoids mixing with ambient air, however, this air is usually warmer, promotes the accumulation of condensed or solved process gas in the operating liquid, hence increasing the risk of cavitation. If the primary task is to suck vapours, a non-condensing gas should be selected for the admixing.

## Layout Proposals

The working principle of the liquid ring is dependent upon a continuous supply of clean operating liquid, which is normally water. The operating liquid enters the Vacuum pump/ Compressor/ Vacuum and pressure pump/ Blower through a connection B on the housing and is discharged from the Vacuum pump/ Compressor/ Vacuum and pressure pump/ Blower along with the process gas.

For the layout of an operating fluid supply system there are basically three different models:

- Once through cooling / no recovery
- partial recovery
- closed loop / total recovery

All of these arrangements have four basic elements:

- Source of the operating liquid (from the water main or reservoir)
- Regulating device to control flow of liquid
- Means of stopping the flow when the Vacuum pump/ Compressor/ Vacuum and pressure pump/ Blower is shut off (manual or with solenoid valve)
- Means of separating the gas-liquid exhaust mixture

## Legend:

**Note:** The diagrams below show examples of typical installations. The actual scope of delivery is always contractually agreed upon. Consult the contract piping and instrument diagram for the exact scope of delivery.

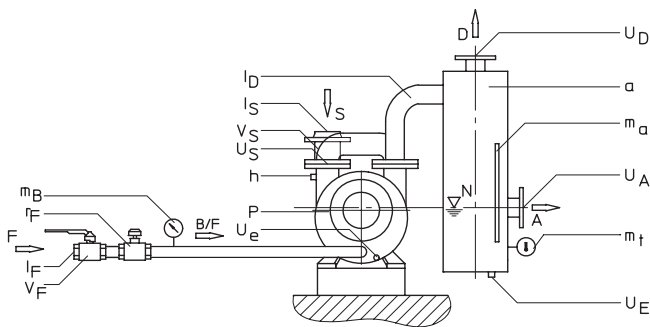
A	Discharge liquid
B	Operating liquid
F	Fresh liquid
K	Cooling liquid
U	Circulation liquid
N	Liquid level
S	Process suction side
D	Process pressure side
P	Liquid ring-vacuum pump
P <sub>B</sub>	Circulating pump
a	Liquid separator
b	Fresh liquid vessel
h	Aeration connection
w	Heat transmitter
V <sub>B</sub>	Vacuum relief valve
V <sub>F</sub>	Shut-off valve
V <sub>K</sub>	Shut-off valve

V <sub>S</sub>	Non-return valve
r <sub>B</sub>	Regulating valve
r <sub>C</sub> (=PC)	Regulating valve (anti-cavitation)
r <sub>F</sub>	Regulating valve
r <sub>F1</sub>	Regulating valve (float valve)
r <sub>F2</sub>	Regulating valve (thermostatical)
r <sub>F3</sub>	Regulating valve (pressure reducer)
r <sub>K</sub>	Regulating valve (cooling water)
l <sub>B</sub>	Operating liquid pipe
l <sub>c</sub>	Anti-cavitation pipe (optional)
l <sub>F</sub>	Fresh liquid pipe
l <sub>K</sub>	Cooling liquid pipe
l <sub>S</sub>	Suction pipe
l <sub>D</sub>	Discharge pipe
l <sub>U</sub>	Circulation pipe
m <sub>a</sub> (=Li)	Level indicator
m <sub>B</sub> (=Pi)	Compound (vacuum & pressure) gauge
m <sub>D</sub>	Pressure gauge
m <sub>t</sub> (=Ti)	Thermometer
m <sub>t1</sub>	Temperature sensor to r <sub>F2</sub>
U <sub>A</sub>	Liquid discharge
U <sub>B</sub>	Connection for operating liquid
U <sub>S</sub>	Suction pipe connection
U <sub>D</sub>	Discharge pipe connection
U <sub>E</sub>	Drain (liquid separator)
U <sub>e</sub>	Drain (pump)
U <sub>U</sub>	Connection for circulation liquid

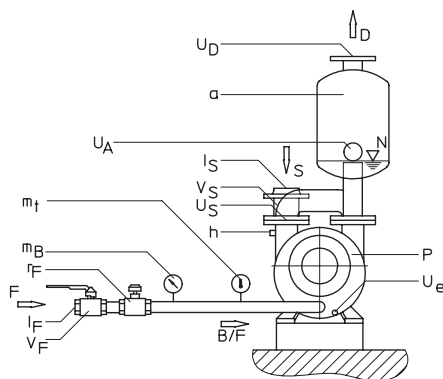
### Once Through Operation / No Recovery

The operating liquid is taken directly from a main supply to the vacuum pump. The operating liquid is separated from the gas and wasted to a drain. No recirculation or recovery takes place. This arrangement can be used where operating liquid conservation or contamination are not a concern. An automatic solenoid valve can provide for flow of operating liquid simultaneously with vacuum pump operation (i.e. upon motor stopping, the valve closes preventing the housing to be filled with too much operating liquid). With a manual operating liquid shut off valve, it is **important** to open valve immediately after starting the motor and to close the valve immediately before switching the motor off.

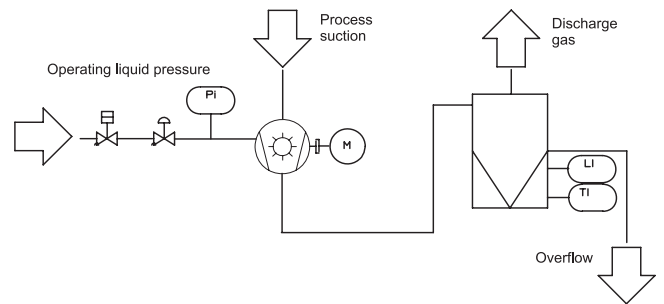
Version with lateral liquid separator:



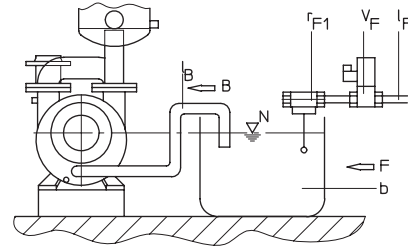
Version with top liquid separator:



Circuit diagram:



Alternative tank with float valve:

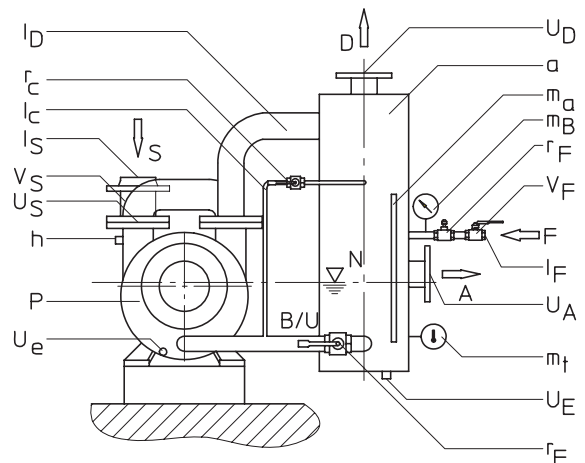


### Partial Recovery

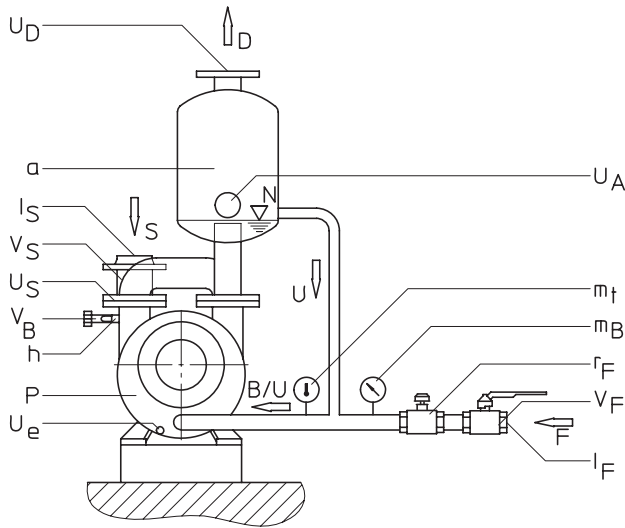
The operating liquid enters and leaves the vacuum pump in the same manner as with the once through arrangement. A portion of the operating liquid is recirculated from the separator tank to the vacuum pump. The remainder is discharged from the separator and wasted to the drain. The fresh liquid F is introduced in sufficient quantity to maintain proper temperature essential for good vacuum pump performance. This type of arrangement is used where seal liquid conservation is possible, and, if other than water is utilised, the consumption can be reduced by upto 50 percent depending upon the fluid vapour pressure and temperature.

The operating liquid level in the separator/recirculation tank should be at, or slightly below, the centreline of the pump shaft. Provisions may also be made for high level overflow. This will help prevent starting the vacuum pump with the housing full of water, which could overload the vacuum pump and the drive motor.

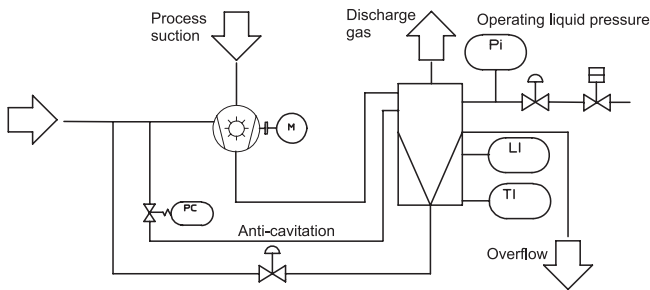
Version with lateral liquid separator:



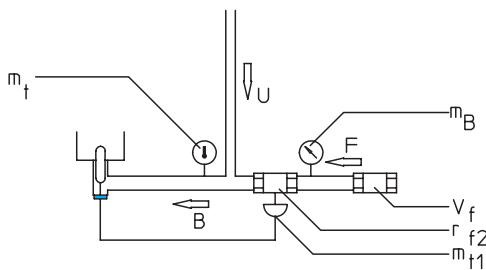
Version with top liquid separator:



Circuit diagram:



Alternative thermostatically controlled operating liquid temperature:



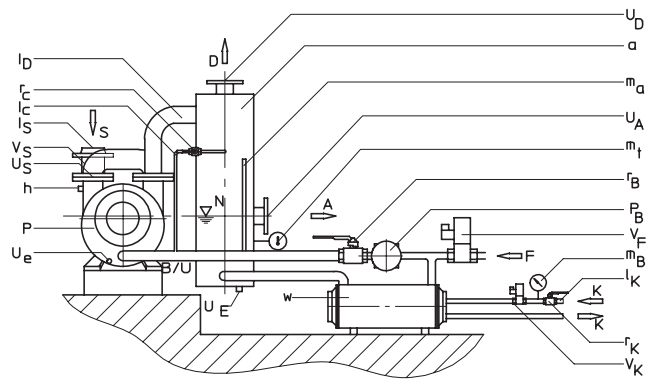
### Closed Circuit Cooling / Total Recovery

This arrangement provides for total recirculation of the operating liquid. A heat exchanger is added to remove the heat of compression, friction and condensation from the operating liquid before it is re-introduced back into the vacuum pump. For prolonged operation at suction pressure above 300 hPa abs (300 mbar abs) a circulating pump is normally installed and mandatory at suction pressure above 400 hPa abs (400 mbar abs) or when suction pressure varies during cycling operations.

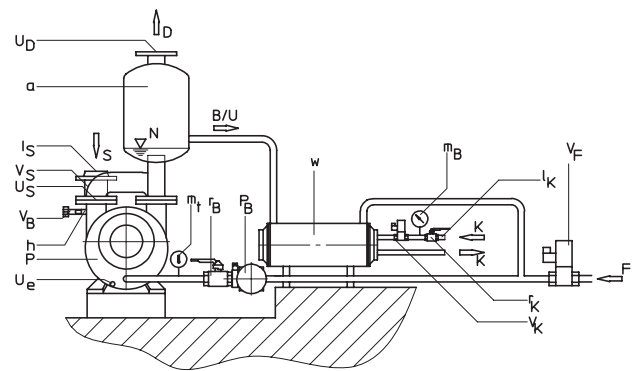
The operating liquid level in the separator/recirculation tank should be at, or slightly below, the centreline of the pump shaft. Provisions may also be made for high level overflow and low level make-up. This will help prevent starting the vacuum pump with the housing full of water, which could overload the vacuum pump and the drive motor.

The heat exchanger W must be capable of removing approx. 85 percent of the drive power and possibly appearing condensation heat.

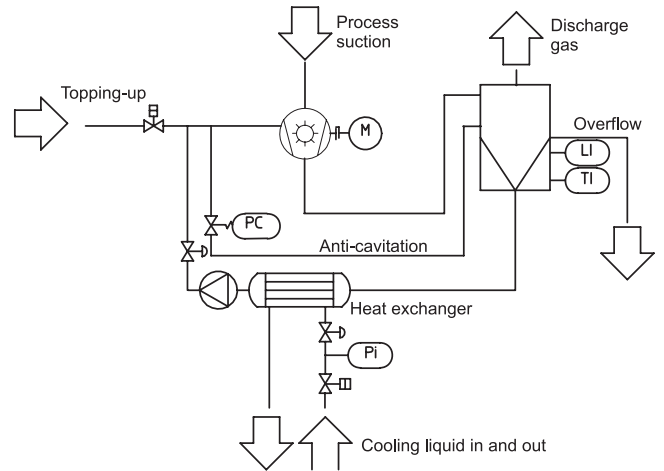
Version with lateral liquid separator:



Version with top liquid separator:





Circuit diagram:



### Mounting Position and Space

- Make sure that the following ambient conditions will be complied with:
  - ambient temperature: 5 ... 40 °C
  - ambient pressure: atmospheric
- Make sure that the environmental conditions comply with the protection class of the drive motor (according to the nameplate)
- Make sure that the vacuum pump will be placed or mounted horizontally
- Make sure that the base for placement / mounting base is even
- Make sure that in order to warrant a sufficient cooling there will be a clearance of minimum 0.1 m between the vacuum pump and nearby walls
- Make sure that no heat sensitive parts (plastics, wood, cardboard, paper, electronics) will touch the surface of the vacuum pump

- Make sure that the installation space or location is vented such that a sufficient cooling of the vacuum pump is warranted


**CAUTION**

During operation the surface of the vacuum pump may reach temperatures of more than 70 °C.

Risk of burns!

- Make sure that the vacuum pump will not be touched inadvertently during operation, provide a guard if appropriate

## Suction Connection



**CAUTION**

Intruding foreign objects or liquids can destroy the vacuum pump.

In case the inlet gas can contain dust or other foreign solid particles:

- Make sure that the suction line fits to the suction connection (a) of the vacuum pump
- Make sure that the line size of the suction line over the entire length is at least as large as the suction connection (a) of the vacuum pump

In case the length of the suction line exceeds 2 m it is prudent to use larger line sizes in order to avoid a loss of efficiency and an overload of the vacuum pump. Seek advice from your Busch representative!

In case the vacuum shall be maintained after shutdown of the vacuum pump:

- ◆ Provide a manual or automatic operated valve (= non-return valve) in the suction line
- Make sure that the suction line does not contain foreign objects, e.g. welding scales

## Gas Discharge

Version with top liquid separator:

The discharge piping should not exceed an elevation more than 600 mm above the discharge flange (c) of the pump housing until the liquid is separated. Too high an elevation will cause back pressure and possible drive motor overload.

**The discharged gas must flow without obstruction. It is not permitted to shut off or throttle the discharge line or to use it as a pressurised air source.**

- Make sure that the discharge line fits to the gas discharge (c) of the vacuum pump
- Make sure that the line size of the discharge line over the entire length is at least as large as the gas discharge (c) of the vacuum pump

In case the length of the discharge line exceeds 2 m it is prudent to use larger line sizes in order to avoid a loss of efficiency and an overload of the vacuum pump. Seek advice from your Busch representative!

- Make sure that the discharge line either slopes away from the vacuum pump or provide a liquid separator or a drip leg with a drain cock, so that no liquids can back up into the vacuum pump

## Electrical Connection / Controls

- Make sure that the stipulations acc. to the EMC-Directive 2004/108/EC and Low-Voltage-Directive 2006/95/EC as well as the EN-standards, electrical and occupational safety directives and the local or national regulations, respectively, are complied with (this is the responsibility of the designer of the machinery into which the vacuum pump is to be incorporated; → page 16: note in the EC-Declaration of Conformity).
- Make sure that the power supply for the drive motor is compatible with the data on the nameplate of the drive motor
- Make sure that an overload protection according to EN 60204-1 is provided for the drive motor

- Make sure that the drive of the vacuum pump will not be affected by electric or electromagnetic disturbance from the mains; if necessary seek advice from the Busch service

In case of mobile installation:

- ◆ Provide the electrical connection with grommets that serve as strain-relief

## Installation

### Mounting

- Make sure that the Installation Prerequisites (→ page 5) are complied with
- Set down or mount the vacuum pump at its location
- Make sure that the base plate is not bent and that the flexible coupling is properly aligned  
**Note:** A misaligned coupling leads to increased loads onto the coupling and the bearings and hence to premature failure of the vacuum pump.

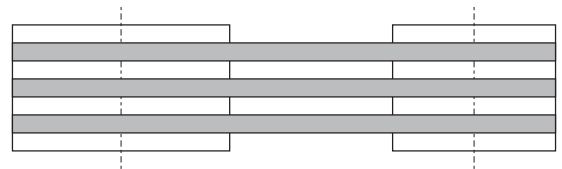
### Mounting the V-belt Drive

- Mount the v-belt drive

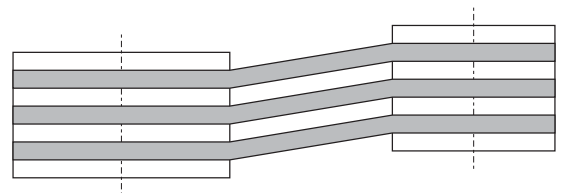
### Checking the Alignment of the Pulleys

- Make sure that the v-belt drive is properly aligned:

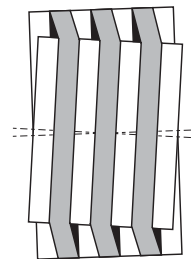
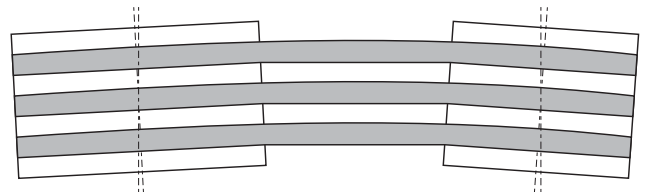
Proper alignment: both pulleys / pulley packages in one plane



Improper alignment: axial offset



Improper alignment: pulleys / pulley packages angled



- Adjust the v-belt tension after the installation of the operating liquid supply system (the vacuum pump shall not run dry)



## Connecting Electrically



**WARNING**

Risk of electrical shock, risk of damage to equipment.

Electrical installation work must only be executed by qualified personnel that knows and observes the following regulations:

- IEC 364 or CENELEC HD 384 or DIN VDE 0100, respectively,
- IEC-Report 664 or DIN VDE 0110,
- BGV A2 (VBG 4) or corresponding national accident prevention regulation.

- Electrically connect the drive motor
- Connect the protective earth conductor
- Determine the intended direction of rotation with the arrow (stuck on or cast)

Version with mechanical seal:

- Make sure that the pump housing (g) is filled with an operating liquid (usually water) to approx. the shaft centreline (a mechanical seal shall not run dry)
- "Bump" the drive motor
- Watch the fan wheel of the drive motor and determine the direction of rotation just before the fan wheel stops

If the rotation must be changed:

- ◆ Switch any two of the drive motor wires
- Connect the switches for
  - level monitoring
  - temperature
  - pressure
 (according to the diagram) to the system control

## Connecting Lines/Pipes

- Connect the suction line
- Connect the discharge line

Installation without discharge line:

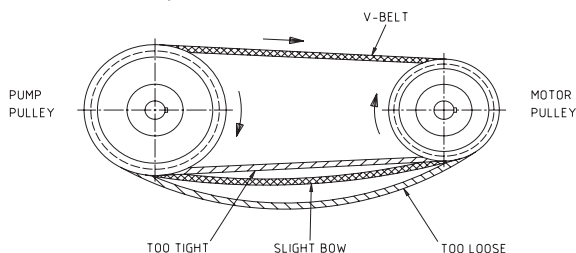
- ◆ Make sure that the gas discharge (c) is open
- Make sure that all provided covers, guards, hoods etc. are mounted
- Make sure that cooling air inlets and outlets are not covered or obstructed and that the cooling air flow is not affected adversely in any other way

## Filling in Operating Liquid

The handling of the operating liquid supply system is not subject to these operating instructions (→ separate documentation or furnished by the operator).

## Adjusting the V-belt Tension

- Make sure that all belts are in their grooves
- Tension the belt drive to take up all the slack until the belts are fairly taut
- Start the drive
- Continue to adjust until the belts have only a slight bow on the slack side while operating under load conditions



After several days of operation:

- Check the tension again

Insufficient tension is often evidenced by slipping (squealing) at start-up

## Recording of Operational Parameters

As soon as the vacuum pump is operated under normal operating conditions:

- Measure the drive motor current and record it as reference for future maintenance and troubleshooting work

## Operation Notes

### Use

The vacuum pump is intended for

- the suction of
  - non-explosive gases and vapours

The vacuum pump may only be used as contractually agreed with Busch. The conveyed medium, the operating liquid and the temperature ranges thereof may not be changed without written consent of Busch.

Maximum allowed temperatures:

gas dry:	120 °C
gas saturated:	100 °C
operating liquid:	80 °C

The vacuum pump is intended for the placement in a non-potentially explosive environment.

The vacuum pump is thermally suitable for continuous operation (100 percent duty).

The vacuum pump is not ultimate pressure proof. Operation with a closed ("blanked") suction line will damage the vacuum pump.



**CAUTION**

During operation the surface of the vacuum pump may reach temperatures of more than 70 °C.

Risk of burns!

The vacuum pump shall be protected against contact during operation, it shall cool down prior to a required contact or heat protection gloves shall be worn.

- Make sure that all provided covers, guards, hoods etc. remain mounted
- Make sure that protective devices will not be disabled
- Make sure that cooling air inlets and outlets will not be covered or obstructed and that the cooling air flow will not be affected adversely in any other way
- Make sure that the installation prerequisites (→ page 5: Installation Prerequisites) are complied with and will remain complied with, particularly that a sufficient cooling will be ensured



**CAUTION**

The shaft of the vacuum pump is sealed by means of a mechanical seal (433.0).

Starting the vacuum pump without operating liquid will result in mechanical seal failure.

Never start the vacuum pump without operating liquid.

## Setting Operating Conditions

### Selection of Operating Liquid

Water is usually used as operating liquid for the conveyance of air and other inert gases. Other ring liquids may be used in order to comply with the selected gases and separation methods.

The kinematic viscosity at operating temperature shall not exceed 2 mm<sup>2</sup>/s. Higher viscosities require increased drive power. The vapour pressure of the ring fluid in case of vacuum operation shall not exceed 16 mbar. Higher vapour pressures deteriorate the suction capacity and the ultimate pressure as stated in the performance tables or curves resp. In case of use of ring liquids other than water confirmation of the vacuum pump's conveying characteristics shall be sought from Busch.

If liquids get conveyed together with the process gas (three to five times the quantity of the circulating liquid rate as given in the datasheet) the addition of fresh liquid can be reduced significantly.

Condensation of vapour inside the vacuum pump can cause cavitation and destroy components of the vacuum pump. Condensation upstream of the vacuum pump (jet or surface condenser) shall therefore be preferred. Under certain conditions the accumulating condensate can be conveyed along by the vacuum pump. Otherwise a separate liquid pump must be provided for. The design shall be performed by the manufacturer/supplier.

The suction capacity (or volume flow) as given in the performance table is achieved at an operating water temperature of 15 °C. Operation at higher water temperatures leads to a reduced suction capacity (or volume flow), but leaves the option to save fresh water or cooling liquid in case of open or closed circuit cooling. This liquid rate shall be set by means of the regulating valve  $r_F$  or  $r_B$  only to such a quantity, that the required suction capacity (or volume flow) is achieved. The regulating valve shall be locked in this position.

### Fresh Water Requirement

Fresh water flow rate requirements are shown in the technical data section → page 25. The data given applies to once through operation.

These water flow rates result in approximately a 5.5 °C rise in temperature for a single stage vacuum pump, and a 2.7 °C rise for a two stage vacuum pump when handling dry air. Condensable vapours in the gas stream, however, will add to the heat load and cause a higher temperature rise through the vacuum pump.

Partial recovery flow rates may be reduced by up to 50 percent dependant upon temperature rise through the vacuum pump (see above comment).

If operating speed is varied from the given values, the flow rate requirements vary accordingly.

### Operating Liquid Level

**Note:** The options to check the level depend on the installation. In case the installation provides no means for level check, undo the plug (b). Excess operating liquid will then flow out of the port. If necessary fill in operating liquid, until it reaches the bottom edge of the port. Reinsert the plug (b) prior to starting the vacuum pump.



#### CAUTION

Starting the vacuum pump with a completely flooded housing can bend the blades of the rotor.

The operating liquid shall reach the middle of the shaft only when the vacuum pump is to be started.

- Make sure that the operating liquid reaches the middle of the shaft when the vacuum pump is to be started

### Pressure Control

At very low pressures and sufficiently high temperatures the operating liquid can locally transfer into the vapour phase, creating bubbles within the operating liquid. As the pressure rises towards the outlet slot the bubbles collapse. This process is called cavitation. In case of bubbles that have been located on surfaces the operating liquid cannot intrude the cavity left by the bubble equally from all directions. Instead the inflowing liquid hits the surface with high speed. This causes ero-

sion, which can destroy the vacuum pump rapidly. The formation of bubbles also deteriorates the pump performance. Cavitation is clearly audible by its crackling noise.

The working pressure of the vacuum pump shall therefore be sufficiently above the vapour pressure of the operating liquid. In particular the pressure control in the vacuum system must by no means be achieved by throttling or even closing of the suction line!

The vapour pressure of the operating liquid and consequently the ultimate pressure can be reduced by cooling. However, this increases the cooling water flow considerably. In most cases the low ultimate pressure is not required and cavitation shall be avoided by means of vacuum limitation rather than cooling.

## Removing Contaminations and Deposits

- In closed operating liquid circuits with water use softened water
- Make sure that no dirt particles with a diameter larger than 0.1 mm will intrude the vacuum pump, neither via the process gas nor via the operating liquid. Filter out larger dirt particles before the vacuum pump.

The dirt concentration shall not exceed 5 volume percent.

## Maintenance



**DANGER**

**In case the vacuum pump conveyed gas that was contaminated with foreign materials which are dangerous to health, harmful material can reside in filters.**

**Danger to health during inspection, cleaning or replacement of filters.**

**Danger to the environment.**

**Personal protective equipment must be worn during the handling of contaminated filters.**

**Contaminated filters are special waste and must be disposed of separately in compliance with applicable regulations.**



**CAUTION**

During operation the surface of the vacuum pump may reach temperatures of more than 70 °C.

Risk of burns!

- Prior to disconnecting connections make sure that the connected pipes/lines are vented to atmospheric pressure

## Maintenance Schedule

### Monthly:

- Check for audible abnormal noise, e.g.:
  - Excessive rumble (possible cavitation problem)
  - Periodic click/knock (possible mechanical contact / bearing degradation)

Version with mechanical seals:

- Mechanical seal squealing noise (possible lack of lubrication)
- Check for excessive vibration

Vibration should be less than 5.5 mm/s RMS when measured in the axial, vertical radial and vertical horizontal planes on the bearing housing.

High vibration could indicate a coupling misalignment, fixing bolt looseness or bearing degradation.
- Check the operating liquid temperature (with a hand held probe or a permanent gauge, if fitted; consult

the order documentation for the specified operating liquid temperature)

- Check the bearing temperature (with a hand held probe or a permanent gauge, if fitted; at 25 °C ambient temperature the bearing temperature should not exceed 60 °C (operating liquid = water) or 80 °C (operating liquid = oil); for other ambient temperatures adjust accordingly)
- Check that the vacuum pump achieves the usual/specified vacuum level
- Check all pipe work for leakage

Version with mechanical seals:

- Check the mechanical seals for leakage
- Make sure that the vacuum pump is shut down and locked against inadvertent start up

In case of operation in a dusty environment:

- ◆ Clean as described under → page 11: Every 6 Months:

### Every 4 Months or 3000 Operating Hours:

Larger units (size 6 and above):

- Regrease the bearings (lithium based grease NLGI class 2)

Smaller units up to and including size 5 are greased for life

### Every 6 Months:

- Make sure that the housing is free from dust and dirt, clean if necessary
- Make sure that the vacuum pump is shut down and locked against inadvertent start up
- Clean the fan cowling, the fan wheel, the ventilation grille and the cooling fins

### Every Year:

- Make sure that the vacuum pump is shut down and locked against inadvertent start up

In case an inlet screen is installed:

- ◆ Check the inlet screen, clean if necessary
- Remove the fan cowling of the drive motor, turn the shaft by hand and check for ease of rotation (seizure or binding could indicate ingress of foreign material, misalignment or the vacuum pump bed plate out of flatness)

Version with relubricatable bearings:

- ◆ Check the grease condition of the bearings (e.g. water or debris contamination)

Version with mechanical seal:

- ◆ Disassemble the mechanical seal and check for signs of wear, scratches or cracks on the faces. Check also the o-rings for damage and replace if necessary.
- Replace the bearings

Version with mechanical seal:

- Replace the mechanical seals

## Dismantling and Reassembly

**Note:** Complete disassembly is seldom necessary and the vacuum pump need only be disassembled to the point required to repair or service it.

See the sectional drawings for cross-reference.

Series 1 = Gland packing or cartridge mechanical seal

Series 2 & 3 = Mechanical seal

### Dismantling

- Disconnect from electrical supply and process piping
- Drain as much operating liquid from the vacuum pump as possible
- Stand the vacuum pump vertically with the drive end upwards

- Mark the castings to ensure the correct reassembly and alignment
- Remove the manifold or crossover part (147.1, as applicable)
- Remove the bearing caps (360.0, 360.1)

Size 9 to 11:

- ◆ Slacken the locknuts (923.)
- ◆ Slacken the inner bearing caps (360.2, 360.3) and slide back

Sizes 3 to 8, series 1:

- ◆ Remove the drive end bearing housing (350) using bearing pullers

Sizes 3 to 8, series 2:

- ◆ Remove the drive end bearing housing (357) using two jacking screws

Size 9, 10, 11:

- ◆ Remove the drive end bearing housing (350) using bearing pullers
- ◆ Remove the drive end bearing using pullers

Version with mechanical seal:

- ◆ Remove the drive end mechanical seal (433)

Version with gland packing:

- ◆ Remove the drive end gland follower (452)

Size 9, 10, 11 only:

- ◆ Refit the drive end bearing housing with a dummy bearing to support the shaft

- Stand the vacuum pump up in vertical position with the drive end pointing down

Sizes 3 to 8, series 1:

- ◆ Remove the non drive end bearing housing (350) using bearing pullers

Sizes 3 to 8, series 2:

- ◆ Remove the non drive end bearing housing (357) using two jacking screws

Size 9, 10, 11:

- ◆ Remove the non drive end bearing housing (350) using bearing puller
- ◆ Remove the non drive end bearing using pullers

Version with mechanical seal:

- ◆ Remove the non drive end mechanical seal (433)

Version with gland packing:

- ◆ Remove the non drive end gland follower (452)

- Remove the tie rods (905)
- Remove the non drive end end casing (107) complete with the side plate (137.4) and the valve (741, if fitted)
- Remove the impeller casing (110.1)
- Remove the shaft assembly complete with the parts 210, 137.3, 137.2, 230, 521 and 921 (as applicable)
- Secure the impeller assembly and remove the locknut (922) using a C-spanner
- Remove the impeller(s) and inter plates (two stage only) from the shaft

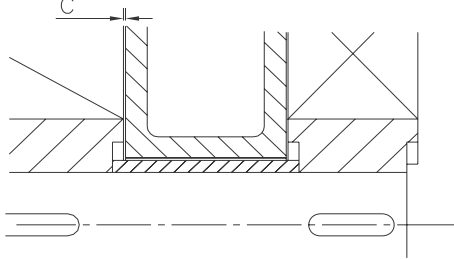
### Reassembly

The vacuum pump is built up in reversal of the dismantling instructions.

- Clean all parts thoroughly before commencing rebuild

To be checked during assembly:

- The impellers must be placed on the shaft with the blades leaning in the direction of rotation (clockwise as viewed from the drive end - except size 3 is anticlockwise).
- The clearance between the impellers and the side plates is set at manufacture. If new parts are fitted the abutment ring may need to be re-machined or shimmed for pump sizes 3 to 8 (shim packs are available from Busch). For size 9 to 11 pumps, the impeller to side plate clearance is set by using bearing caps at the non drive end
- The clearance between the inter plate and the 1st and 2nd stage impellers must be checked when the rotating assembly is built up as shown below.



- Standard construction (cast iron): the impellers and impeller casings are machined so as to give the desired clearance 'C', liquid gasket is used to seal the components and so does not affect the clearance.
- Stainless steel and bronze construction: the impellers and impeller casings are machined the same width as each other. Gaskets are used to create the required clearance.

Clearances:

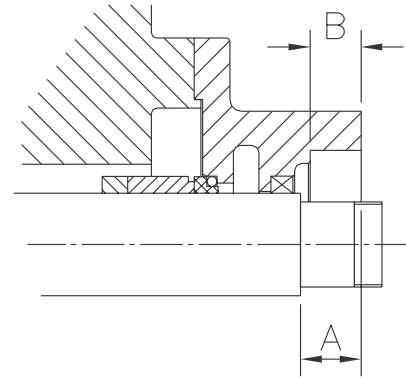
The impeller spacer (521, two stage only) should be either machined or shimmed to give a clearance 'C'. For size 9 pumps the clearance can be centralised at the non drive end by adjusting the bearing end caps (360.1, 360.3)

Pump size	Cast iron	Bronze, 316ss
3	0.10 ... 0.15 mm (0.004" ... 0.006")	0.15 ... 0.23 mm (0.006" ... 0.009")
4	0.10 ... 0.15 mm (0.004" ... 0.006")	0.15 ... 0.23 mm (0.006" ... 0.009")
5	0.15 ... 0.20 mm (0.006" ... 0.008")	0.23 ... 0.30 mm (0.009" ... 0.012")
6	0.20 ... 0.25 mm (0.008" ... 0.010")	0.30 ... 0.38 mm (0.012" ... 0.015")
7	0.25 ... 0.35 mm (0.010" ... 0.014")	0.35 ... 0.45 mm (0.014" ... 0.018")
8	0.30 ... 0.40 mm (0.012" ... 0.016")	0.40 ... 0.50 mm (0.016" ... 0.020")
9	0.30 ... 0.40 mm (0.012" ... 0.016")	0.40 ... 0.50 mm (0.016" ... 0.020")
10, 11	0.35 ... 0.45 mm (0.014" ... 0.018")	0.45 ... 0.55 mm (0.018" ... 0.021")

#### Fitting of the Abutment Ring (Sizes 3 to 8 Only)

This operation should be carried out when the pump is built up except for the ball bearings, mechanical seals and bearing caps. The abutment ring enables the impellers to be spaced equally from the plates. The distance from the shoulder on the shaft to the bearing location in the housing has to be found. This is done with the use of a depth gauge as

shown below.



The abutment width is determined as the mean value of 'A' when the shaft is moved in both directions less 'B'. Use a dummy bearing to slide the shaft backward and forward. Once the abutment has been determined the bearing seal housing can be removed and the mechanical seals fitted (series 2 only).

## Overhaul

Busch service will only accept vacuum pumps that come with a completely filled in and legally binding signed "Declaration of Contamination" (form downloadable from [www.busch-vacuum.com](http://www.busch-vacuum.com)).

## Removal from Service

### Temporary Removal from Service

- Prior to disconnecting pipes/lines make sure that all pipes/lines are vented to atmospheric pressure

In case water is being used as operating fluid and the ambient temperatures can fall below 0 °C or the vacuum pump is scheduled to be shut down for more than 12 weeks:

- ◆ Drain the water

In case water is being used as operating fluid, the ambient temperatures can fall below 0 °C and the water is not meant to be drained:

- ◆ Make sure the water sufficiently provided with antifreeze

### Recommissioning

- Observe the chapter Installation and Commissioning (→ page 5)

### Dismantling and Disposal

- Make sure that materials and components to be treated as special waste have been separated from the vacuum pump
- Make sure that the vacuum pump is not contaminated with harmful foreign material

According to the best knowledge at the time of printing of this manual the materials used for the manufacture of the vacuum pump involve no risk.

- Dispose of the vacuum pump as scrap metal

## Spare Parts

When ordering spare parts from Busch please quote the following:

- Pump type / model number
- Pump serial number
- Pump ID number
- Part number
- Description of part

# Troubleshooting



**WARNING**

Risk of electrical shock, risk of damage to equipment.

Electrical installation work must only be executed by qualified personnel that knows and observes the following regulations:

- IEC 364 or CENELEC HD 384 or DIN VDE 0100, respectively,
- IEC-Report 664 or DIN VDE 0110,
- BGV A2 (VBG 4) or equivalent national accident prevention regulation.



**CAUTION**

During operation the surface of the vacuum pump may reach temperatures of more than 70 °C.

Risk of burns!

Let the vacuum pump cool down prior to a required contact or wear heat protection gloves.

Problem	Possible Cause	Remedy
The vacuum pump does not reach the usual pressure The drive motor draws a too high current (compare with initial value after commissioning) Evacuation of the system takes too long	The vacuum system or suction line is not leak-tight	Check the hose or pipe connections for possible leak
	The operating liquid is too warm (the characteristic curves are based on 15 °C warm water as operating liquid, with higher temperatures the achieved pressure and the flow rate deteriorate)	Reduce the temperature of the operating liquid
	The mechanical seal (433.0) leaks	Replace the mechanical seal (433.0)
	Gas or liquid channels are blocked	Dismantle and clean the vacuum pump
	In case a screen is installed in the suction connection (a): The screen in the suction connection (a) is partially clogged	Clean the screen If cleaning is required too frequently install a filter upstream
	The filter on the suction connection (a) is partially clogged	Clean or replace the inlet air filter, respectively
	Partial clogging in the suction, discharge or pressure line	Remove the clogging
	Long suction, discharge or pressure line with too small diameter	Use larger diameter
	Internal parts are worn or damaged	Repair the vacuum pump (Busch service)
The gas conveyed by the vacuum pump smells displeasing	Process components evaporating under vacuum	Check the process, if applicable
The vacuum pump does not start	The drive motor is not supplied with the correct voltage or is overloaded	Supply the drive motor with the correct voltage
	The drive motor starter overload protection is too small or trip level is too low	Compare the trip level of the drive motor starter overload protection with the data on the nameplate, correct if necessary
	One of the fuses has blown	Check the fuses
	The connection cable is too small or too long causing a voltage drop at the vacuum pump	Use sufficiently dimensioned cable

	The vacuum pump or the drive motor is blocked	Make sure the drive motor is disconnected from the power supply Remove the fan cover Try to turn the drive motor with the vacuum pump by hand If the vacuum pump is blocked: Repair the vacuum pump (Busch service)
	The drive motor is defective	Replace the drive motor (Busch service)
The vacuum pump is blocked	Solid foreign matter has entered the vacuum pump	Repair the vacuum pump (Busch service) Make sure the suction line is equipped with a screen If necessary additionally provide a filter
	Corrosion in the vacuum pump from remaining condensate	Repair the vacuum pump (Busch service) Check the process
	Corrosion between the rotor (h) and the housing (g)	Eliminate by use of anti-rust liquid
	Ice in the vacuum pump The operating liquid is congealed	Carefully warm up the vacuum pump Defrost the operating liquid
	The vacuum pump was run in the wrong direction	Repair the vacuum pump (Busch service) When connecting the vacuum pump make sure the vacuum pump will run in the correct direction (→ page 8: Installation)
The drive motor is running, but the vacuum pump stands still	The coupling between the drive motor and the vacuum pump is defective	Replace the coupling element
The vacuum pump starts, but labours or runs noisily or rattles The drive motor draws a too high current (compare with initial value after commissioning)	Loose connection(s) in the drive motor terminal box Not all drive motor coils are properly connected The drive motor operates on two phases only	Check the proper connection of the wires against the connection diagram Tighten or replace loose connections
	The operating liquid level is too high	Adjust the regulating valves
	Density or viscosity of the operating liquid too high	The performance data is based on water (1000 kg/m <sup>3</sup> , 1 mm <sup>2</sup> /s), higher density or viscosity require higher shaft power Provide a different operating liquid or a stronger drive motor
	Friction between the rotor and the front of the housing	Disassemble the vacuum pump, clean it and adjust to proper clearances
	The vacuum pump runs in the wrong direction	Verification and rectification → page 5: Installation and Commissioning
	Foreign objects in the vacuum pump Stuck bearings	Repair the vacuum pump (Busch service)
The vacuum pump runs very noisily	Defective bearings	Repair the vacuum pump (Busch service)
	The vacuum pump cavitates (periodic formation and collapsing of steam bubbles in the operating liquid; → page 5: Installation and Commissioning)	Increase the working pressure (vacuum relief valve) or decrease the temperature of the operating liquid In case of suction of condensable vapours: make sure that enough non condensable gas is conveyed along CAUTION: continuous operation under cavitation will destroy the vacuum pump
	Worn coupling element	Replace the coupling element

	Insufficient air ventilation	Make sure that the cooling of the vacuum pump is not impeded by dust/dirt Clean the fan cowling, the fan wheel, the ventilation grille and the cooling fins Install the vacuum pump in a narrow space only if sufficient ventilation is ensured
	Ambient temperature too high	Observe the permitted ambient temperatures
	Temperature of the inlet gas too high	Observe the permitted temperatures for the inlet gas
	Insufficient gas transfer	
	Mains frequency or voltage outside tolerance range	Provide a more stable power supply
	Partial clogging of filters or screens Partial clogging in the suction, discharge or pressure line	Remove the clogging
	Long suction, discharge or pressure line with too small diameter	Use larger diameter

# EU Declaration of Conformity

This Declaration of Conformity and the CE-mark affixed to the nameplate are valid for the machine within the Busch scope of delivery. This Declaration of Conformity is issued under the sole responsibility of the manufacturer. When this machine is integrated into a superordinate machinery the manufacturer of the superordinate machinery (this can be the operating company, too) must conduct the conformity assessment process for the superordinate machine or plant, issue the Declaration of Conformity for it and affix the CE-mark.

The manufacturer

**Busch GVT Ltd.  
Westmere Drive  
Crewe Business Park Crewe  
Cheshire, CW1 6ZD  
United Kingdom**

declares that the machine(s)

**DOLPHIN LX 0030 B – DOLPHIN LX 0430 B  
DOLPHIN LA 0053 A – DOLPHIN LA 5109 A  
DOLPHIN LB 0063 A – DOLPHIN LB 4409 A  
DOLPHIN LM 0100 A – DOLPHIN LM 0800 A  
DOLPHIN LT 0130 A – DOLPHIN LT 0750 A  
DOLPHIN VL 0100 A – DOLPHIN VL 0800 A**

fulfil(s) all the relevant provisions from European directives:

- 'Machinery' 2006/42/EC
- 'Electromagnetic Compatibility' 2014/30/EU
- 'Motor (LVD)' 2014/35/EU

and comply(-ies) with the following designated standards that have been used to fulfil those provisions:

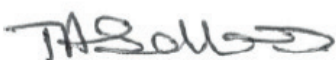
Standard	Title of the Standard
EN ISO 12100 : 2010	Safety of machinery - Basic concepts, general principles of design
EN ISO 13857 : 2019	Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs
EN 1012-1 : 2010 EN 1012-2 : 1996 + A1 : 2009	Compressors and vacuum pumps - Safety requirements - Part 1 and Part 2
EN ISO 2151 : 2008	Acoustics - Noise test code for compressors and vacuum pumps - Engineering method (grade 2)
EN 60204-1 : 2018	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN IEC 61000-6-2 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Immunity for industrial environments
EN IEC 61000-6-4 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Emission standard for industrial environments
ISO 21940-11:2016	Mechanical vibration - Rotor balancing

<sup>(1)</sup> In case control systems are integrated.

Legal person authorized to compile the technical file  
and authorized representative in the EU  
(if the manufacturer is not located in the EU):

Busch Dienste GmbH  
Schauinslandstr. 1  
DE-79689 Maulburg

Crewe, 14.05.2021



**Tracey Sellars, General Manager**



# UK Declaration of Conformity

This Declaration of Conformity and the UKCA-mark affixed to the nameplate are valid for the machine within the Busch scope of delivery. This Declaration of Conformity is issued under the sole responsibility of the manufacturer. When this machine is integrated into a superordinate machinery the manufacturer of the superordinate machinery (this can be the operating company, too) must conduct the conformity assessment process for the superordinate machine or plant, issue the Declaration of Conformity for it and affix the UKCA-mark.

The manufacturer

**Busch GVT Ltd.  
Westmere Drive Crewe  
Business Park Crewe  
Cheshire, CW1 6ZD  
United Kingdom**

declares that the machine(s)

**DOLPHIN LX 0030 B – DOLPHIN LX 0430 B  
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DOLPHIN LM 0100 A – DOLPHIN LM 0800 A  
DOLPHIN LT 0130 A – DOLPHIN LT 0750 A  
DOLPHIN VL 0100 A – DOLPHIN VL 0800 A**

fulfil(s) all the relevant provisions from UK legislations:

- Supply of Machinery (Safety) Regulations 2008
- Electromagnetic Compatibility Regulations 2016
- 'Motor (LVD)' 2014/35/EU

and comply(-ies) with the following designated standards that have been used to fulfil those provisions:

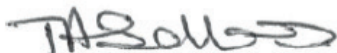
Standard	Title of the Standard
BS EN ISO 12100 : 2010	Safety of machinery. Basic concepts, general principles of design. Risk assessment and risk reduction.
BS EN ISO 13857 : 2019	Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs.
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ISO 21940-11:2016	Mechanical vibration - Rotor balancing

<sup>(1)</sup> In case control systems are integrated.

Legal person authorized to compile the technical file  
and importer in the UK  
(if the manufacturer is not located in the UK):

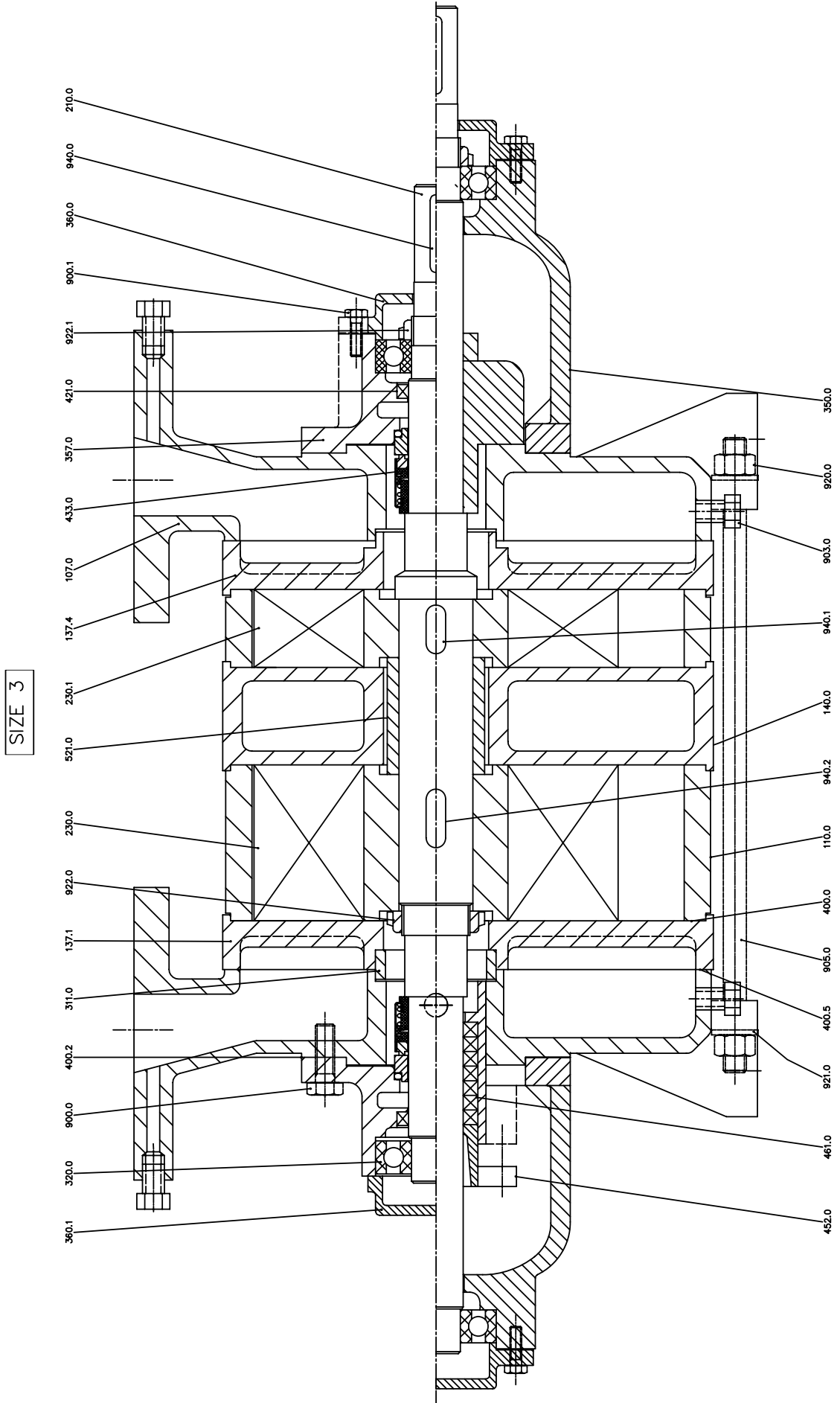
Busch (UK) Ltd  
30 Hortonwood  
Telford - UK

Crewe, 14.05.2021



**Tracey Sellars, General Manager**

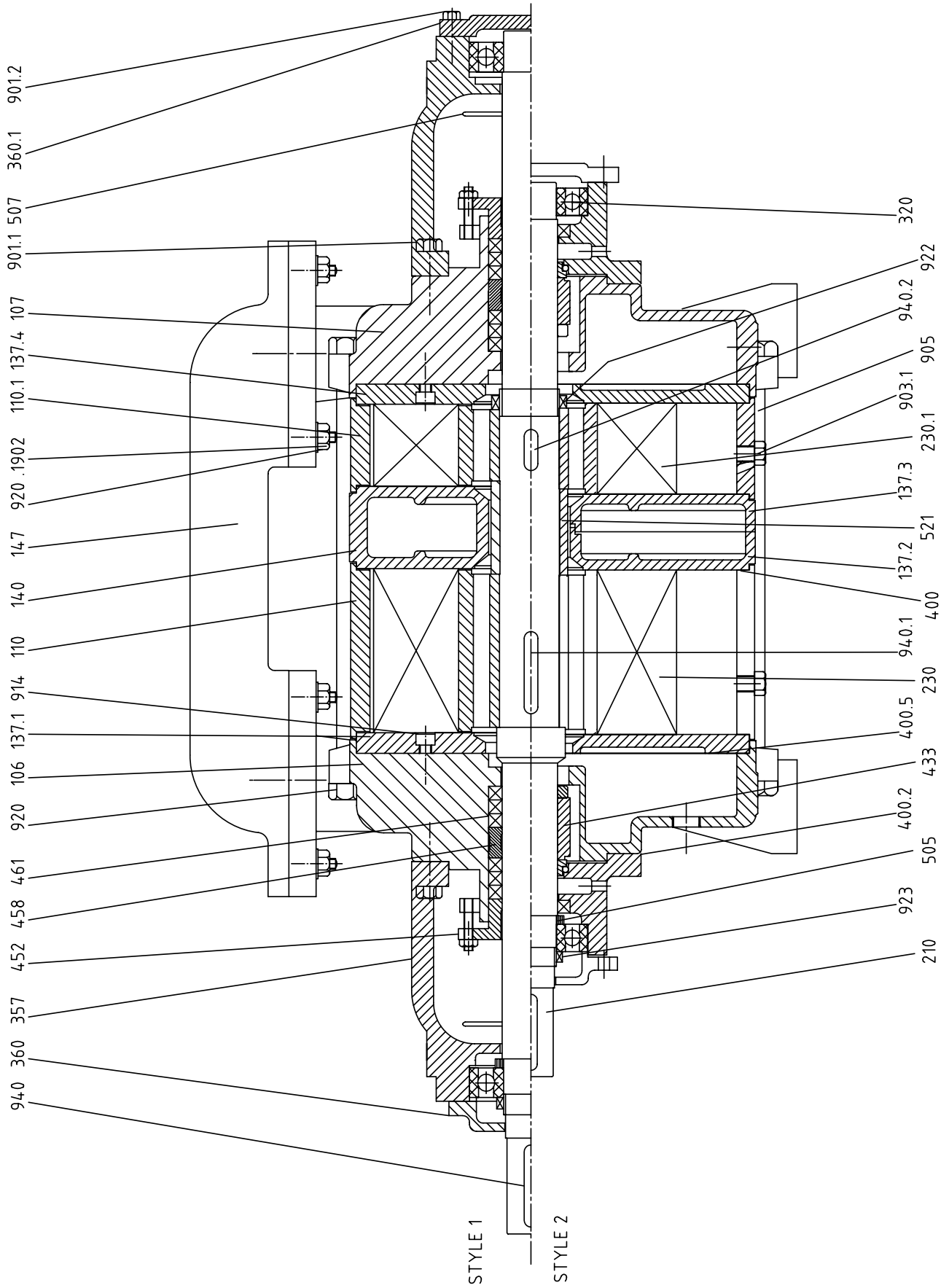
# Sectional Drawings and Spare Parts Lists



### Size 3

940,2	2nd stage impeller key
940,1	1st stage impeller key
940	Shaft end key
922,1	Bearing locknut
922	Impeller locknut
921	Washer
920	Nut
905	Tie rod
903	Plug
900,1	Set screw
900	Set screw
521	Impeller spacer
461	Gland packing
452	Gland follower
433	Mechanical seal
421	Oil seal
400,5	End casing gasket
400,2	Bearing seal housing gasket
400	Impeller casing gasket
360,1	N.D.E. bearing cap
360	N.D. bearing cap
357	Bearing seal housing
350	Bearing housing
320	Bearing
311	Guide ring
230,1	2nd stage impeller
230	1st stage impeller
210	Shaft
137,4	Interplate
137,1	Discharge end plate
110	Impeller casing
107	End casing

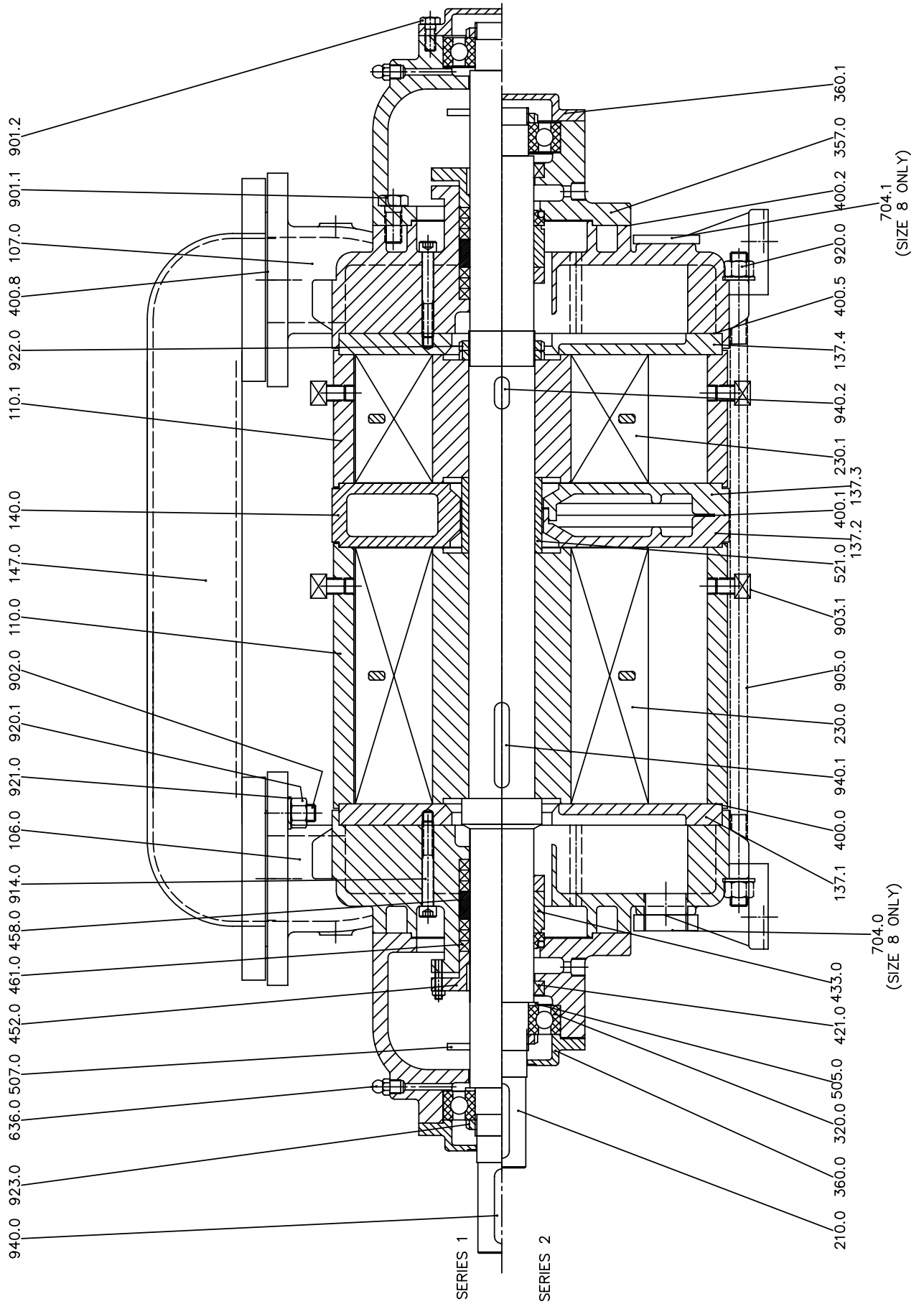
SIZE 4 & 5



## Size 4, 5

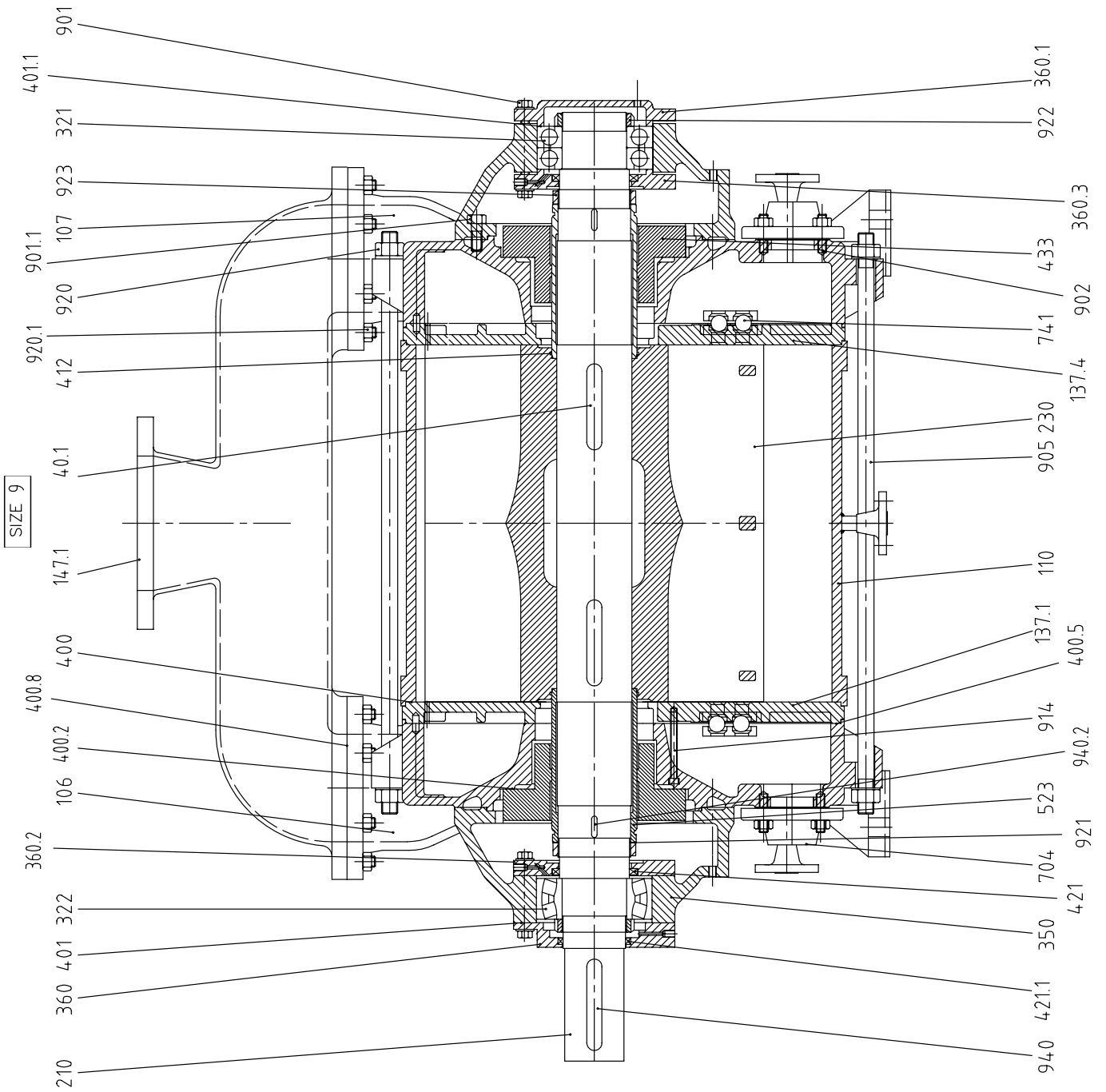
940,2	2nd stage impeller key
940,1	1st stage impeller key
940	Shaft end key
923	Bearing locknut
922	Impeller locknut
920,1	Crossover pipe nut
920	Tie rod nut
914	Socket head cap screw
905	Tie rod
903,1	Plug
902	Stud
901,2	Bearing cap bolt
901,1	Bearing seal housing bolt
521	Impeller space
507	Flinger ring
505	Abutment ring
461	Gland packing
458	Lantern ring
452	Gland follower
433	Mechanical seal
400,5	End casing gasket
400,2	Bearing seal housing gasket
400	Impeller casing gasket
360,1	N.D.E. bearing cap
360	D.E. bearing cap
357	Bearing seal housing
320	Bearing
230,1	2nd stage impeller
230	1st stage impeller
210	Shaft
147	Crossoverpipe
140	Joint / intermediate plate
137,4	Discharge side plate
137,3	Suction inter plate
137,2	Discharge inter plate
137,1	Suction side plate
110,1	2nd stage impeller casing
110	1st stage impeller casing
107	Discharge end casing
106	Suction end casing

SIZE 6, 7 & 8



## Size 6, 7, 8

940,2	2nd stage impeller key
940,1	1st stage impeller key
940	Shaft end key
923	Bearing locknut
922	Impeller locknut
921	Washer
920,1	Crossover pipe nut
920	Tie rod nut
914	Socket head cap screw
905	Tie rod
903,1	Plug
902	Stud
901,2	Bearing cap bolt
901,1	Bearing seal housing bolt
704,1	Counterflange blank
704	Counterflange
636	Grease nipple
521	Impeller spacer
507	Flinger ring
505	Abutment ring
461	Gland packing
458	Lantern ring
452	Gland follower
433	Mechanical seal
421	Oil seal
400,8	Crossover pipe gasket
400,5	End casing gasket
400,2	Bearing seal housing gasket
400,1	Inter plate gasket
400	Impeller casing gasket
360,1	N.D.E. bearing cap
360	D.E. bearing cap
357	Bearing seal housing
320	Bearing
230,1	2nd stage impeller
230	1st stage impeller
210	Shaft
147	Crossover pipe
140	Joint / intermediate plate
137,4	Discharge side plate
137,3	Suction inter plate
137,2	Discharge inter plate
137,1	Suction side plate
110,1	2nd stage impeller casing
110	1st stage impeller casing
107	Discharge end casing
106	Suction end casing





## Size 9, 10, 11

940,2	Shaft sleeve key
940,1	Impeller key
940	Shaft end key
923	Shaft sleeve locknut
922	Bearing locknut
921	Tab washer
920,1	Manifold nut
920	Tie rod nut
914	Socket head cap screw
905	Tie rod
902	Stud
901,1	Bolt
901	Bolt
900,1	Bolt
900	Bolt
741	Valve plate assembly
704	Service liquid flange
523	Shaft sleeve
433	Mechanical seal
421,1	Oil seal
421	Oil seal
412	O-ring
401,1	N.D.E. bearing cap gasket
401	D.E. bearing cap gasket
400,8	Manifold pipe gasket
400,5	End casing gasket
400,2	Seal plate gasket
400	Impeller casing gasket
360,3	Bearing cap N.D.E.
360,2	Bearing cap D.E.
360,1	Bearing cap N.D.E.
360	Bearing cap D.E.
350	Bearing housing
322	Bearing D.E.
321	Bearing N.D.E.
230	Impeller
210	Shaft
147,1	Manifold
137,4	Side plate N.D.E.
137,1	Side plate D.E.
110	Impeller casing
107	End casing N.D.E.
106	End casing D.E.

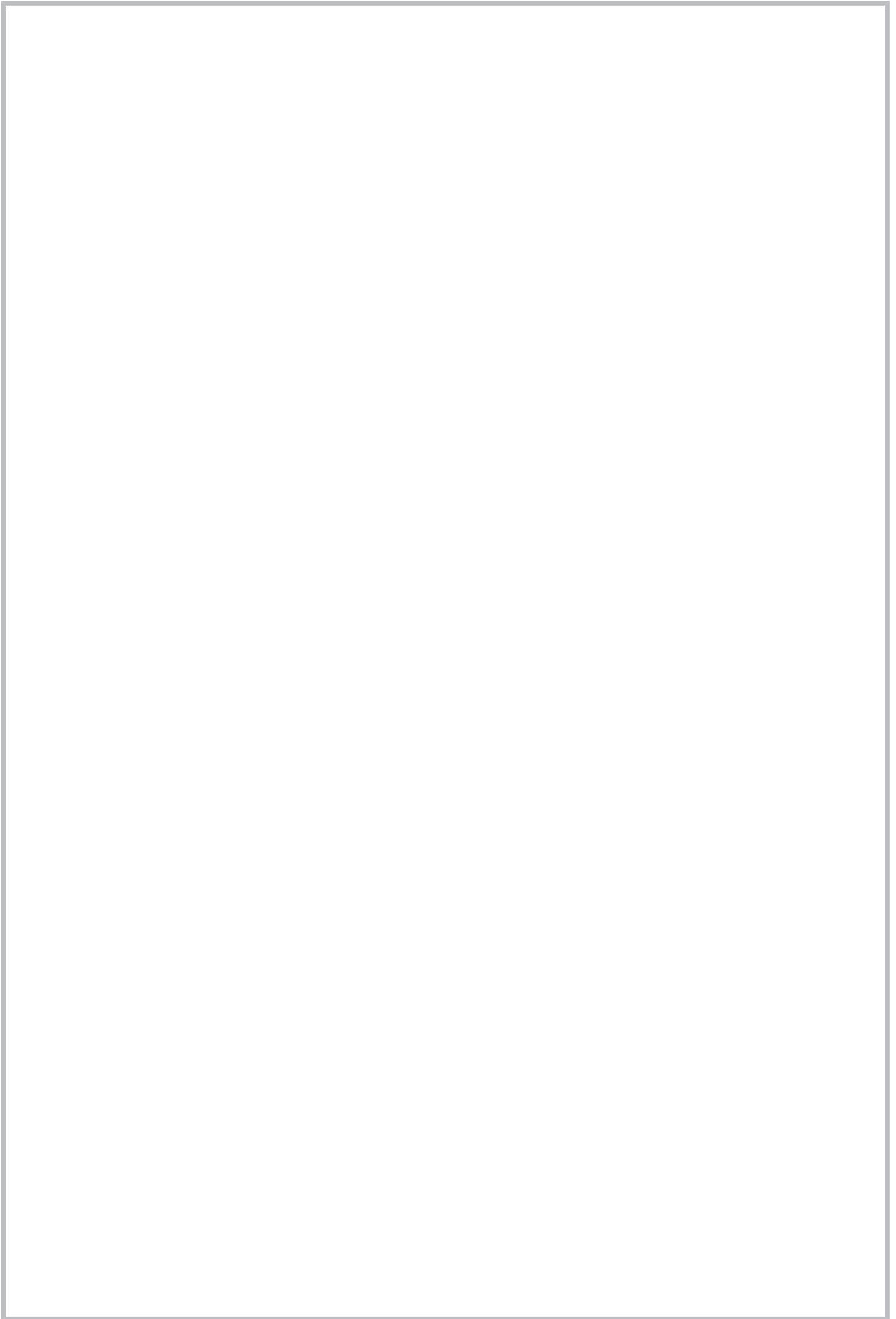
# Technical Data

For motor connection parameters see nameplate

	Frequency [Hz]	Nominal motor rating [kW]	Speed [min <sup>-1</sup> ]	Volume flow [m <sup>3</sup> /h]	Sound pressure level (ENO ISO 2151) [db(A)]	Dry weight (bareshaft pump) [kg]	Once through operating liquid flow [m <sup>3</sup> /h]	Ultimate pressure [hPa abs = mbar abs]
LA 0053 A	50	2.2	1450	47	71	44	0.8	130
	60	2.2	1750	58	72			
LA 0103 A	50	4	1450	100	71	48	0.8	
	60	4	1750	135	72			
LA 0143 A	50	4	1450	139	71	52	0.8	
	60	5.5	1750	188	72			
LA 0224 A	50	5.5	1450	216	71	88	1.4	
	60	7.5	1750	272	72			
LA 0325 A	50	11	1450	305	74	150	2.7	
	60	15	1750	372	75			
LA 0435 A	50	11	1450	422	74	185	3	
	60	15	1750	522	75			
LA 0475 A	50	18.5	1450	470	74	210	3.2	
	60	22	1750	570	75			
LA 0756 A	50	22	1450	715	74	290	6	
	60	30	1750	865	75			
LA 0906 A	50	30	1450	950	74	320	6	
	60	37	1750	1120	75			
LA 1157 A	60	30	880	955	76	540	6	
	50	30	980	1150				
	60	45	1150	1388				
LA 1507 A	60	37	880	1370	76	600	8	
	50	45	980	1500				
	60	55	1150	1800				
LA 1807 A	50	55	980	1835	76	660	8.5	
LA 1908 A	50	75	735	1850	78	1400	13	
	60	90	880	2265	79			
LA 2408 A	50	75	735	2355	78	1550	13	
	60	110	880	2600	79			
LA 2808 A	50	90	735	2810	78	1700	13.7	
	60	150	880	3170	79			
LA 3809 A	-	75	465	2680	85	1950	13	
	-	90	600	3560				
	-	110	650	3750				
	-	132	700	3915				
LA 5109 A	-	90	465	3380	85	2050	13	
	-	110	600	4495				
	-	132	650	4850				
	-	150	700	5260				

	Frequency [Hz]	Nominal motor rating [kW]	Speed [min <sup>-1</sup> ]	Volume flow [m <sup>3</sup> /h]	Sound pressure level (ENO ISO 2151) [db(A)]	Dry weight (bareshaft pump) [kg]	Once through operating liquid flow [m <sup>3</sup> /h]	Ultimate pressure [hPa abs = mbar abs]
LB 0063 A	50	3	1450	58	71	72	1.3	33
	60	4	1750	67	72			
LB 0113 A	50	4	1450	102	71	73	1.3	
	60	5.5	1750	124	72			
LB 0144 A	50	4	1450	145	71	97	1.6	
	60	5.5	1750	181	72			
LB 0184 A	50	5.5	1450	180	71	111	1.8	
	60	7.5	1750	225	72			
LB 0265 A	50	9.2	1450	265	74	155	2.3	
	60	11	1750	328	75			
LB 0355 A	50	11	1450	338	74	171	2.5	
	60	15	1750	416	75			
LB 0425 A	50	15	1450	408	74	180	3	
	60	15	1750	502	75			
LB 0526 A	50	18.5	1450	517	74	264	6	
	60	30	1750	588	75			
LB 0726 A	50	30	1450	711	74	278	6	
	60	37	1750	777	75			
LB 0857 A	50	30	980	822	76	510	7	
	60	37	1150	995	77			
LB 1207 A	60	30	880	1100	76	600	7.4	
	50	37	980	1200				
	60	55	1150	1382				
LB 1507 A	60	37	880	1410	76	685	8	
	50	45	980	1510				
	60	75	1150	1694				
LB 1757 A	60	55	880	1555	76	770	8	
	50	75	980	1720				
	60	90	1150	2000				
LB 2108 A	50	55	735	2000	78	1460	9.5	
	60	90	880	2325	79			
LB 2508 A	50	75	735	2490	78	1580	9.5	
	60	110	880	3080	79			
LB 3008 A	50	90	735	2860	78	1700	10.5	
	60	150	880	3210	79			
LB 3108 A	50	110	735	3080	78	1940	12	
	60	150	880	3505	79			
LB 3809 A	-	90	465	2605	85	2100	17	
	-	110	600	3270				
	-	150	700	3780				
LB 4409 A	-	90	465	3050	85	2200	18	
	-	150	600	3830				
	-	185	700	4780				

Please note: Power requirements for 2 stage pumps models highlighted in pink are based upon throttling back the seal flow in the range of suction pressures between 1013mbara and 300mbara. Manual or automatic intervention is therefore required. If intervention is not possible, please choose the next motor size up.



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