



# Vacuum pumps

Operating Manual

TCM1-3; TC-5; TC-7-11



Edition 06/2015  
Print no. OM5001  
Language EN

Nash – Zweigniederlassung der  
Gardner Denver Deutschland GmbH  
Katzwanger Straße 150  
90461 Nuremberg  
Germany  
Phone: +49 (0) 911-1454-5256  
Fax: +49 (0) 911-1454-5252  
Internet: <http://www.GDNash.com>

We reserve the right to make technical changes.  
Read carefully before use.  
Save for future use.

## Table of contents

<b>1</b>	<b>About this document.....5</b>	4.3.1	Treating stainless steel machines for storage14
1.1	Target groups .....5	4.3.2	Treating gray cast-iron or steel machines for storage ..... 14
1.2	Other applicable documents .....5	4.4	Storage ..... 15
1.3	Warnings and symbols.....6	4.5	Removing the preservative ..... 15
1.4	Technical terms .....7	4.6	Disposal ..... 15
<b>2</b>	<b>Safety .....8</b>	<b>5</b>	<b>Setup and connection ..... 16</b>
2.1	Intended use .....8	5.1	Preparing the setup..... 16
2.2	General safety instructions .....8	5.1.1	Checking machine condition ..... 16
2.2.1	Product safety.....8	5.1.2	Checking the ambient conditions ..... 16
2.2.2	Operator's obligations .....9	5.1.3	Preparing the installation site ..... 16
2.2.3	Obligations of personnel .....9	5.1.4	Preparing the foundation and surface ..... 16
2.3	Specific hazards .....9	5.1.5	Removing the preservative ..... 16
2.3.1	Explosion-hazard area .....9	5.1.6	Balancing the rotors ..... 17
2.3.2	Hazardous pumped fluids and seal liquids.....9	5.2	Installation on a foundation/steel construction ..... 17
<b>3</b>	<b>Layout and function..... 10</b>	5.2.1	Preparing the foundation/steel construction.. 17
3.1	Name plates..... 10	5.2.2	Fastening the base frame ..... 17
3.1.1	Typenschild..... 10	5.2.3	Setting the machine onto the base frame ..... 17
3.1.2	ATEX plate..... 10	5.3	Installation on foundation blocks ..... 18
3.2	Layout..... 11	5.4	Installing the motor..... 18
3.3	Shaft seals ..... 11	5.5	Planning the pipelines ..... 19
3.3.1	Mechanical seals ..... 11	5.5.1	Specifying supports and flange connections . 19
3.3.2	Stuffing boxes ..... 11	5.5.2	Specifying nominal diameters ..... 19
3.4	Shaft bearing ..... 11	5.5.3	Discharging leaks..... 19
3.5	Function ..... 11	5.5.4	Providing safety and control devices (recommended)..... 19
3.5.1	Seal liquid ..... 12	5.6	Connecting the pipe lines.....20
<b>4</b>	<b>Transport, storage, and disposal ..... 13</b>	5.6.1	Keeping the pipe lines clean .....20
4.1	Transport ..... 13	5.6.2	Installing the seal liquid line .....20
4.1.1	Unpacking and inspection on delivery..... 13	5.6.3	Installing auxiliary pipes (if available).....20
4.1.2	Lifting ..... 13	5.6.4	Installing the inlet pipe .....20
4.2	Treating new machines..... 14	5.6.5	Installing the outlet pipe .....20
4.2.1	Standard storage treatment ..... 14	5.6.6	Checking the stress-free pipe connection .....20
4.2.2	Long-term storage..... 14	5.6.7	Checking the pipes for leaks .....20
4.3	Treating machines for storage which have been shut down temporarily..... 14	5.7	Electrical connection .....21
		5.7.1	Connecting the motor.....21
		5.8	Fine-adjustment of the coupling .....21

5.9	Installing safety guards .....	21	7.3	Assembly .....	31
5.10	Checking after assembly.....	21	7.4	Ordering spare parts .....	31
<b>6</b>	<b>Operation .....</b>	<b>22</b>	<b>8</b>	<b>Troubleshooting.....</b>	<b>32</b>
6.1	Preparations for the initial start-up .....	22	<b>9</b>	<b>Appendix.....</b>	<b>36</b>
6.1.1	Identifying the machine version .....	22	9.1	Drawings.....	36
6.1.2	Removing the preservative .....	22	9.1.1	Part numbers and name TCM1–TC-11 .....	36
6.1.3	Lubricating the bearings.....	22	9.1.2	Explosion drawing TCM1–TC-11 .....	38
6.1.4	Preparing auxiliary systems (if available).....	22	9.1.3	Assembly washer cross-section.....	42
6.1.5	Filling with seal liquid .....	22	9.1.4	Circuit diagram examples .....	43
6.1.6	Adjusting the seal liquid level before startup .....	22	9.1.5	Flushing liquid connection.....	44
6.1.7	Adjusting the shaft seal's flushing liquid.....	23	9.2	Technical specifications .....	46
6.1.8	Checking the direction of rotation .....	23	9.2.1	Ambient conditions.....	46
6.2	Start-up .....	23	9.2.2	Sound pressure level .....	46
6.2.1	Switching on .....	23	9.2.3	Vibration.....	46
6.2.2	Checking operation .....	24	9.2.4	Speed range TC/TCM.....	46
6.2.3	Switching off .....	24	9.2.5	Tightening torques .....	46
6.3	Shutting down the pump .....	24	9.2.6	Weight specifications .....	47
6.4	Start-up following a shutdown period .....	25	9.2.7	Gland packing sizes.....	47
<b>7</b>	<b>Maintenance .....</b>	<b>26</b>	9.2.8	Pumped fluids .....	47
7.1	Inspections.....	26	9.2.9	Seal liquids.....	48
7.1.1	Inspection .....	26	9.2.10	Flushing liquid for shaft sealing with external flushing .....	50
7.1.2	Reinspection .....	27	9.2.11	Lubricants .....	50
7.1.3	Antifriction bearings lubricated with grease... ..	27	9.2.12	Descaling solutions .....	51
7.1.4	Mechanical seals .....	27	9.2.13	Preservative.....	51
7.1.5	Stuffing boxes .....	28	9.2.14	Flange loads according to ISO 5199 .....	52
7.1.6	Cleaning the machine .....	29	9.3	Safety certificate .....	54
7.2	Disassembly .....	30			
7.2.1	Returning the machine to the manufacturer.. ..	30			
7.2.2	Preparations for disassembly.....	31			

## Table of figures

Fig. 1	Type plate.....	10
Fig. 2	ATEX plate .....	10
Fig. 3	TC/TCM layout .....	11
Fig. 4	Fastening lifting gear to individual machines .....	13
Fig. 5	Installation on foundation blocks .....	18
Fig. 6	Assembly washer .....	27
Fig. 7	Removing the packing rings .....	28
Fig. 8	Extractor for lantern gland (3.2 mm (1/8 in.) wire) .....	28
Fig. 9	Inserting a new gland packing .....	28
Fig. 10	Exploded view of TCM1 to TCM3 and TC-5 (delivered version may differ) .....	38
Fig. 11	Exploded view of TC-7 (delivered version may differ) .....	39
Fig. 12	Exploded view of TC-8 to TC-10 (delivered version may differ) .....	40
Fig. 13	Exploded view of TC-11 (delivered version may differ) .....	41
Fig. 14	Assembly washer .....	42
Fig. 15	Circuit diagram example.....	43
Fig. 16	Connection of pipelines/tubes: Stuffing box .....	44
Fig. 17	Connection of pipelines/tubes: Mechanical seal, single-acting.....	45
Fig. 18	Connection of pipelines/tubes: Mechanical seal, double-acting .....	45
Fig. 19	Overview of forces and torques to which the flanges are subjected .....	53

## List of tables

Table 1	Target groups and their duties.....	5
Table 2	Other applicable documents and their purpose .....	5
Table 3	Warnings and consequences of disregarding them.....	6
Table 4	Symbols and their meaning .....	6

Table 5	Technical terms and their meaning.....	7
Table 6	Labeling the shaft after balancing.....	17
Table 7	Measures to be taken if the machine is shut down.....	25
Table 8	Shutdown measures depending on the seal liquid properties .....	25
Table 9	Fault/number assignment .....	32
Table 10	Troubleshooting list .....	35
Table 11	Designation of components according to part number for TCM1–TC-11 .....	36
Table 12	Parts for the breeches pipe TC-8 to TC-10 .....	37
Table 13	Ambient conditions .....	46
Table 14	Sound pressure level.....	46
Table 15	Speed range .....	46
Table 16	Tightening torques for bolts of strength class A4-70 ( $\leq$ M20) or 8.8 and higher .....	46
Table 17	Tightening torques for bolts of strength class 4.8 to 6.8 .....	47
Table 18	Weight specifications.....	47
Table 19	Technical data for gland packing.....	47
Table 20	Pump pumped fluid.....	47
Table 21	Requirements for seal liquids .....	48
Table 22	Seal liquid flow rate in vacuum mode (ISO units).....	48
Table 23	Seal liquid flow rate in vacuum mode (US units).....	49
Tab. 24	Flushing liquid for shaft sealing with external flushing .....	50
Table 25	Recommended greases .....	50
Table 26	Minimum amounts for grease lubrication..	51
Table 27	Descaling solutions.....	51
Table 28	Forces and torques permissibly applicable to the flanges (ISO units).....	52
Table 29	Forces and torques permissibly applicable to the flanges (US units) .....	52
Table 30	Safety certificate .....	54

# 1 About this document

This manual:

- is part of the machine
- applies to all types noted on the bottom of the page
- describes safe and appropriate operation during all operating phases

## 1.1 Target groups

Target group	Duty
Operating company	<ul style="list-style-type: none"><li>▶ Keep this manual accessible at the site of operation of the equipment, including for later use.</li><li>▶ Make sure that personnel read and follow the instructions in this manual and the other applicable documents, especially the safety instructions and warnings.</li><li>▶ Observe any additional rules and regulations that relate to the system.</li><li>▶ Assign only qualified personnel to work with the machine.</li></ul>
Qualified personnel, fitter	<ul style="list-style-type: none"><li>▶ Read, observe, and follow this manual and the other applicable documents, especially all safety instructions and warnings.</li></ul>

Table 1 Target groups and their duties

## 1.2 Other applicable documents

Document	Purpose
Dimension drawing	Dimensions, installation dimensions
Text sheet	Description of the dimension drawing
Spare parts list	Ordering spare parts
ATEX supplementary operating manual	Notes on use in explosion-hazard areas
Supplementary operating manual for components included in scope of delivery	e.g. motor, mechanical seal, coupling

Table 2 Other applicable documents and their purpose

### 1.3 Warnings and symbols




Warning	Risk level	Consequences of disregard
 <b>DANGER</b>	Immediate acute risk	Death, serious bodily harm
 <b>WARNING</b>	Potential acute risk	Death, serious bodily harm
 <b>CAUTION</b>	Potentially hazardous situation	Minor bodily harm
<b>NOTE</b>	Potentially hazardous situation	Material damage

Table 3 Warnings and consequences of disregarding them



Symbol	Meaning
	Safety warning sign ► Take note of all information highlighted by the safety warning sign and follow the instructions to avoid injury or death.
►	Instruction
1. , 2. , etc.	Multiple-step instructions
✓	Requirement
→	Cross reference
	Information, advice

Table 4 Symbols and their meaning

## 1.4 Technical terms

Term	Meaning
Test pressure also: – Testing pressure	Pressure applied to the machine during leak test.
Unit	Assembly comprising machine and drive motor.
Intake pressure	Pressure of the gases/vapors to be pumped at the machine's inlet connection.
Drive end also: – D-side – AS – DE (drive end)	Side of the machine to which the drive is connected
Outlet pressure	Pressure of the gases/vapors to be pumped at the machine's outlet branch or flange.
Operating liquid	Liquid forming a liquid ring in the machine which serves in clearance sealing while at the same time aids in dissipating compression heat.
Qualified personnel	Persons who, due to their training, experience, and instruction as well as their knowledge of applicable standards, regulations, accident-prevention provisions, and work environment, are capable of performing certain tasks (e.g. commissioning, operation, maintenance, repair) and who, in doing so, are capable of identifying and avoiding hazards.  This includes knowledge of first aid and of the local emergency facilities.  Such persons must receive express authorization for performing the respectively required tasks from the party responsible for safe operation of the system.
Machine	In this context: Vacuum pump.  Assembly that takes in, delivers, and compresses gases and/or vapors as well as generates vacuum or overpressure. The drive is not considered part of the machine in this respect.
Machine group	Two or more machines connected to one another by couplings and mounted on a joint base frame.
Non-drive end also: – N-side – BS – NDE (non-drive end)	Side of the machine to which no drive is connected.
Flushing liquid	Liquid used to supply the shaft seals (mechanical seals as well as gland packings).
Vacuum pump	Machine for generating a vacuum
Discharge pressure	Pressure of the gases/vapors to be pumped at the machine's outlet flange, outlet pressure.

Table 5 Technical terms and their meaning

## 2 Safety



The manufacturer is not liable for damages caused by a failure to observe the provisions of this documentation.

### 2.1 Intended use

- Only use the pump to pump the stipulated fluids (→ order data sheet).
- Operate machine only with the stipulated seal liquids (→ order data sheet).
- Avoid dry running:  
Damage, such as the destruction of mechanical seals and plastic parts, will occur within only a few seconds.
  - Make sure the pump is only operated with, and never without, seal liquid.
- Avoid cavitation:
  - Always keep the suction-side fitting fully open and do not use it to adjust the flow rate.
  - If there is a risk of cavitation, have the machine factory-fitted with a cavitation protection device if one is available for this machine type (order code “-F80”).
- Avoid overheating:
  - Do not operate the machine while the discharge-side fitting is closed.
- Avoid damage to the motor:
  - Do not switch on the motor more than the maximum permissible number of times per hour (→ manufacturer's specifications).
- Consult the manufacturer about any other use.
- Machines delivered without a motor must be assembled into a machine group according to the provisions of EC Machine Directive 2006/42/EC.

### Prevention of obvious misuse (examples)

- Observe the operating limits of the machine concerning temperature, pressure, flow rate and motor speed (→ Chapter 9.2.1, Page 46, Chapter 9.2.9, Page 48).
- When using auxiliary systems, ensure there is a continuous supply of the appropriate operating medium.
- Only use the setup specified in this operating manual. For example, the following are not allowed:
  - Overhead installation
  - Installation in the immediate vicinity of extreme heat or cold sources
  - Installation too close to a wall

### 2.2 General safety instructions



Observe the following regulations before carrying out any work.

#### 2.2.1 Product safety

The machine has been constructed according to the latest technology and recognized technical safety rules. Nevertheless, operation of the machine can still put the life and health of the user or third parties at risk or damage the machine or other property.

- Only operate the machine if it is in perfect technical condition and only use it as intended, remaining aware of safety and risks, and adhere to the instructions in this manual.
- Keep this manual and all other applicable documents complete, legible and accessible to personnel at all times.
- Refrain from any procedures and actions that would pose a risk to personnel or third parties.
- In the event of any safety-relevant malfunctions, shut down the machine immediately and have the problem corrected by the personnel responsible.
- In addition to the entire documentation for the product, comply with statutory or other safety and accident-prevention regulations and the applicable standards and guidelines in the country where the system is operated.



## 2.2.2 Operator's obligations

### Safety-conscious operation

- Only operate the machine if it is in perfect technical condition and only use it as intended, remaining aware of safety and risks, and adhere to the instructions in this manual.
- Ensure that the following safety aspects are observed and monitored:
  - Adherence to intended use
  - Statutory or other safety and accident-prevention regulations
  - Safety regulations governing the handling of hazardous substances
  - Applicable standards and guidelines in the country where the machine is operated
- Make personal protective equipment available.

### Qualified personnel

- Make sure all personnel tasked with work on the machine has read and understood this manual and all other applicable documents, especially the safety, maintenance and repair information, before they start any work.
- Organize responsibilities, areas of competence and the supervision of personnel.
- Ensure that all work is carried out by specialist technicians only:
  - Fitting, repair and maintenance work
  - Work on the electrical system
- Make sure that trainee personnel only work on the machine under the supervision of specialist technicians.

### Safety equipment

- Provide the following safety equipment and verify its functionality:
  - For hot, cold and moving parts: on-site safety guards for the machine
  - For possible electrostatic charges: provide the necessary grounding
- Do not operate the machine if the safety devices are defective:
  - Regularly check and ensure that they function.

### Warranty

- Obtain the manufacturer's approval prior to carrying out any modifications, repairs, or alterations during the warranty period.

- Only use OEM parts or parts that have been approved by the manufacturer.

## 2.2.3 Obligations of personnel

- All directions given on the machine must be followed (and kept legible), e.g. the arrow indicating the direction of rotation and the markings for fluid connections.
- Machine, coupling guard and add-on components:
  - Do not step on them or use as climbing aids
  - Do not use them to support boards, ramps or beams
  - Do not use them as a fixing point for winches or supports
  - Do not use them for storing paper or similar materials
  - Do not use hot machine or motor components as a heating source
  - Do not de-ice using gas burners or similar tools
- Do not remove the safety guards for hot, cold or moving parts during operation.
- Use personal protective equipment whenever necessary.
- Only carry out work on the machine when it is at a standstill.
- Isolate the motor from its supply voltage and keep it locked when carrying out any fitting or maintenance work.
- Reinstall the safety equipment as required by regulations after any work on the machine.

## 2.3 Specific hazards

### 2.3.1 Explosion-hazard area

- See the ATEX supplementary operating manual (→ Chapter 1.2, Page 5).

### 2.3.2 Hazardous pumped fluids and seal liquids

- Follow the safety regulations for handling hazardous substances when handling dangerous (e.g. hot, flammable, toxic, or potentially harmful) pumped fluids and seal liquids.
- Use personal protective equipment when carrying out any work on the machine.

### 3 Layout and function

#### 3.1 Name plates

##### 3.1.1 Typenschild

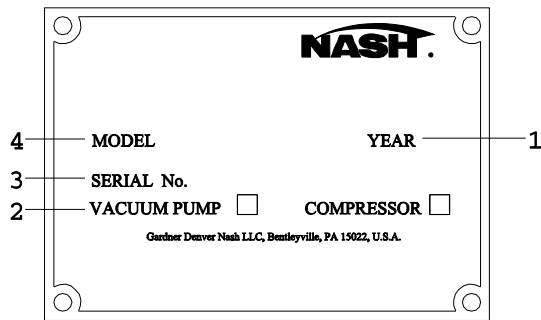


Fig. 1 Type plate

- 1 Year of manufacture
- 2 Use – vacuum pump
- 3 Serial number
- 4 Type

##### 3.1.2 ATEX plate

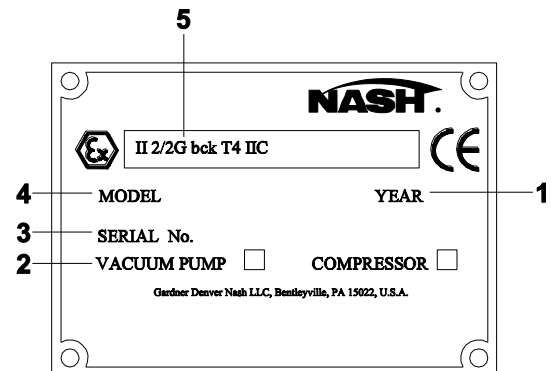


Fig. 2 ATEX plate

- 1 Year of manufacture
- 2 Use – vacuum pump
- 3 Serial number
- 4 Type
- 5 Permissible ATEX area

## 3.2 Layout

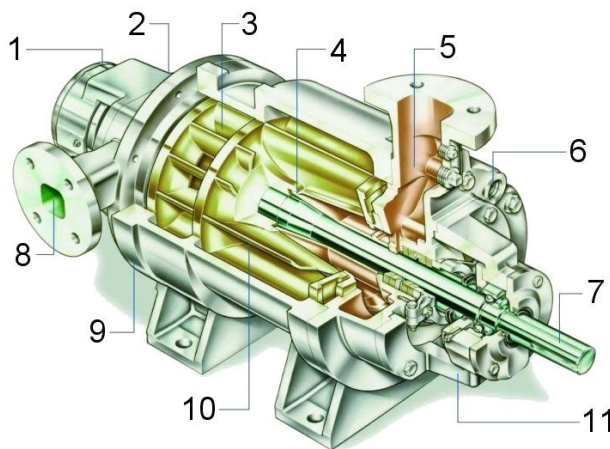


Fig. 3 TC/TCM layout

- |                            |                  |                             |
|----------------------------|------------------|-----------------------------|
| 1 External bearing housing | 4 Cone           | 7 Top shaft                 |
| 2 Side plate               | 5 Suction branch | 8 Outlet flange             |
| 3 Impeller 2nd stage       | 6 Side plate     | 9 Impeller 1st stage        |
|                            |                  | 10 External bearing housing |

## 3.3 Shaft seals

The type designation on the type plate specifies the installed shaft seal.

### 3.3.1 Mechanical seals



Mechanical seals have functional leaks. For further details, refer to the supplementary operating manual (→ Chapter 1.2, Page 5).

- Single-acting mechanical seal
- Double-acting mechanical seal

### 3.3.2 Stuffing boxes



The stuffing box must always leak slightly to dissipate the frictional heat.

- Stuffing box with internal flushing
- Stuffing box with external flushing

## 3.4 Shaft bearing

The fixed bearing on the non-drive end is the machine's guide bearing. It bears radial and axial forces. It is designed to bear normal axial loads generated through operation with flexible couplings.

The drive-end bearing only bears radial forces.

The bearings are grease lubricated.

### 3.5 Function

In liquid ring pumps, an impeller rotates inside a cylindrical or elliptical housing eccentric to the shaft.

The impeller's rotation results in the seal liquid becoming a revolving ring of liquid in the housing. Due to the eccentric position of the rotor, the ring of liquid oscillates inwards and outwards in a piston-like manner within the impeller's vane chambers.

At the suction end, the ring of liquid detaches from the impeller hub. The gas enters into the enlarged volume through the inlet connection.

At the pressure end, the ring of liquid approaches the impeller hub again and expels the compressed gas through the discharge connection.

#### 3.5.1 Seal liquid



Usable seal liquids (→ Chapter 9.2.9, Page 48).

Seal liquid is constantly expelled along with the compressed gas. For this reason, new, cooled seal liquid constantly needs to be supplied to the ring of liquid.

Purposes of the seal liquid:

- Clearance sealing in the machine
- Establishment of the liquid ring
- Dissipation of compression heat
- Cooling and lubrication of the shaft seal for version with internal flushing

## 4 Transport, storage, and disposal

### 4.1 Transport



Observe the weight specifications  
(→ Chapter 9.2.6, Page 47).

#### 4.1.1 Unpacking and inspection on delivery



Standard scope of delivery includes only the machine itself (excluding additional components such as fittings, valves, gate valves etc.)

1. Unpack the machine/package on delivery and inspect it for transport damage.
2. Report any transport damage to GD Nash immediately.
3. Dispose of packaging material according to local regulations.

#### 4.1.2 Lifting



**DANGER**

**Death or crushing of limbs caused by falling or overturning loads!**

- ▶ Use lifting gear appropriate for the total weight to be transported.
- ▶ Fasten the lifting gear as illustrated. Make sure that no connected fittings are damaged.
- ▶ Never fasten lifting gear to the shaft.
- ▶ Never fasten lifting gear to the motor eyebolt.
- ▶ Do not stand under suspended loads.
- ▶ Set the load down on a level surface.



Do not remove the rotor holding device (where provided), which is protecting the roller bearing until the transmission element is fitted.

- ▶ For transport when the transmission element has been fitted, undertake suitable measures to support the rotor axially.



Fig. 4 Fastening lifting gear to individual machines

1. Lift machine/package correctly.
2. Lower machine/package correctly.

## 4.2 Treating new machines

### 4.2.1 Standard storage treatment



The machine has been sufficiently treated with anti-corrosion agents and has undergone production measures to allow for a storage period of up to approximately 4 months.

### 4.2.2 Long-term storage



If the machine has been packed for carriage overseas, i.e. sealed air-tight using silica gel, the machine can be stored (if storage conditions are strictly observed) for up to 8 months.

To store the machine for an additional 8 months once the first 8 months have expired:

1. Open the seaworthy packaging.
2. Fill the machine one-third full of anti-corrosion agent (one-half for systems).
3. Turn the shaft manually 15 to 20 revolutions.
4. Reclose the flanges and apertures.
5. Add sufficient desiccant as well as a new humidity indicator.
6. Reseal the machine air-tight.
7. Document steps 1 to 6.

Carry out and document the following checks once a month throughout the entire storage period:

- Check that the foil is undamaged.
  - Check if the humidity indicator has registered humidity.
- If the foil is damaged or the indicator has registered humidity, carry out steps 1 to 6.



After 16 months, this procedure is no longer suitable to treat the machine longer.

- Turn the impeller through 5 to 10 revolutions every 2 weeks. Refill with preservative every fourth time.

## 4.3 Treating machines for storage which have been shut down temporarily



If a machine is shut down temporarily, it must be documented.

Documentation is to be made available to the manufacturer (GD Nash) on request.

### 4.3.1 Treating stainless steel machines for storage

1. Remove drain plug so that the machine can drain.
2. Turn machine until it has drained as fully as possible.
3. Screw drain plug back in.
4. Coat or spray all exposed machined metal surfaces (e.g. flange and shaft surfaces) with a suitable preservative agent (e.g. Hough ton's Rust Veto #342 or Cortec VCI 369). Wait for it to dry completely.
  - For machines with gland packing: Unscrew stuffing box flanges and remove packing rings.
  - Drain excess water.
  - Apply a suitable preservative agent (e.g. Houghton's Rust Veto #342) to the shaft surfaces in the packing area.
  - Insert new packing rings and re-assemble stuffing box.
5. Turn the impeller through 5 to 10 revolutions every 4 weeks.

### 4.3.2 Treating gray cast-iron or steel machines for storage

1. Remove drain plug so that the machine can drain.
2. Turn drive shaft manually through 5 to 10 revolutions to drain the remaining liquid.
3. Screw drain plug back in.
4. Fill the machine up to one-third (one-half for systems) with treatment agent via the flanges or inspection apertures (→ Chapter 9.2.13, Page 51).
5. Turn the shaft manually through 5 to 10 revolutions.
6. For storage, apply flange covers and seal them using adhesive tape.

7. Coat or spray all exposed machined metal surfaces (e.g. flange and shaft surfaces) with a suitable preservative agent (e.g. Houghton's Rust Veto #342 or Cortec VCI 369). Wait for it to dry completely.
  - For machines with gland packing: Unscrew stuffing box flanges and remove packing rings.
  - Drain excess water.
  - Apply a suitable preservative agent (e.g. Houghton's Rust Veto #342) to the shaft surfaces in the packing area.
  - Insert new packing rings and re-assemble stuffing box.
8. Turn the impeller through 5 to 10 revolutions every 2 weeks. Refill with preservative every fourth time.

#### 4.4 Storage

---

##### NOTE

---

##### Material damage due to inappropriate storage!

- ▶ Treat and store the machine properly.
- 
1. Make sure the storage room meets the following conditions:
    - Dry
    - Stays above freezing
    - Vibration-free
    - Level
  2. Turn the rotor according to the preservation manual. (→ Chapter 4.2, Page 14; Chapter 4.3, Page 14).

#### 4.5 Removing the preservative

1. Make sure that the preservative is compatible with the seal liquids and pumped fluids.
2. If necessary, purge machine before commissioning.

#### 4.6 Disposal



Plastic parts can be contaminated by poisonous or radioactive pumped liquids or seal liquids to such an extent that cleaning will be insufficient.



##### WARNING

##### Risk of poisoning and environmental damage by the pumped fluid and seal liquids!

- ▶ Use protective equipment when carrying out any work on the machine.
  - ▶ Prior to the disposal of the machine:
    - Collect and dispose of any leaking fluids or grease escaping from the bearings in accordance with local regulations.
    - Neutralize residues of pumped fluid and seal liquids in the machine.
    - Remove the preservative (→ Chapter 4.5, Page 15).
  - ▶ Remove the plastic parts and dispose of them in accordance with local regulations.
- 
- ▶ Dispose of the machine according to local regulations.

## 5 Setup and connection



For machines in explosion-hazard areas  
(→ Chapter 1.2, Page 5).

### NOTE

#### Material damage due to distortion or passage of electrical current in the bearing!

- ▶ Do not make any structural modifications to the machine group or machine casing.
- ▶ Do not carry out any welding work on the machine group or machine casing.

### NOTE

#### Risk of damage to bearings!

- ▶ Observe the operating instructions.
- ▶ Do not remove the rotor holding device (where provided) protecting roller bearing before transmission element is fitted.
- ▶ Do not attach crane rope to bearings.
- ▶ Remove anti-corrosion coating from shaft end with acetone. Do not use scrapers or emery cloth. Afterwards, coat shaft ends with grease.

### NOTE

#### Material damage caused by dirt!

- ▶ Do not remove any caps or transport and sealing covers until immediately before connecting the pipes to the machine.

## 5.1 Preparing the setup

### 5.1.1 Checking machine condition

1. Check the machine and components for damage.
2. Check the rotor/shaft assembly for smooth rotation.
3. Check the machine interior for foreign matter. To do so, remove the transport covers and check accessible interior spaces for foreign matter.

### 5.1.2 Checking the ambient conditions

- ▶ Make sure the required ambient conditions are fulfilled (→ Chapter 9.2.1, Page 46).

### 5.1.3 Preparing the installation site

#### NOTE

#### Risk of freezing during installation work in low temperatures!

- ▶ Make sure that no water enters into the machine or any already connected pipes.

- ▶ Ensure the installation site meets the following conditions:

- Machine is freely accessible from all sides
- Sufficient space for the installation/removal of the pipes and for maintenance and repair work, especially for the removal and installation of the machine and the motor
- Machine not exposed to external vibrations (damage to bearings)
- Frost protection
- Grounding in accordance with local regulations and in accordance with explosion-protection regulations if applicable (→ Chapter 1.2, Page 5).

### 5.1.4 Preparing the foundation and surface



Setup options:

- Foundation/steel construction
- Foundation blocks

- ▶ Make sure the foundation and surface meet the following conditions:

- Level
- Clean (no oil, dust or other impurities)
- Capable of bearing the weight of the package and all operating forces
- The package is stable and cannot tip over

### 5.1.5 Removing the preservative

- ▶ If the machine is to be put into operation immediately after setup and connection: Remove the preservative prior to set-up (→ Chapter 4.5, Page 15).



### 5.1.6 Balancing the rotors



The rotors are balanced in accordance with DIN ISO 8821. The DIN ISO 8821 norm requires labeling of the components according to the applied method. After balancing, the front face of the shaft near the shaft key groove must be labeled with the following letters.

Method	Code
Half key	H
Full key	F
No key	N

Table 6 Labeling the shaft after balancing

## 5.2 Installation on a foundation/steel construction

### NOTE

#### Material damage due to distortion of the base frame!

- Place the base frame on the foundation/steel construction and fasten it as described below.

### 5.2.1 Preparing the foundation/steel construction

1. Check horizontal alignment of the foundation/steel construction using a surveyor's level.
2. Compensate for irregularities using metal shims so that a supporting surface with a maximum tolerance of T is established.

Calculation of tolerance T:

$$T = 0.0005 * (L + W)$$

T = flatness tolerance (ISO 1101)

L = total length of base frame

W = total width of base frame

[mm or inches]

### 5.2.2 Fastening the base frame



Standard concrete shrinks when setting and is not suitable for use as a cast bed and cast filler for the base frame.

- Only use foundation concrete.

1. Set base frame upon foundation/steel construction.
2. Do not use shrinking foundation concrete as a cast bed for the base frame.
3. For box-type base frames: Fill the base frame with foundation concrete.
4. Allow foundation concrete to set.
5. Fasten base frame using anchor bolts.

### 5.2.3 Setting the machine onto the base frame

### NOTE

#### Material damage due to inappropriate alignment!

- Compensate for height differences exactly as described.
- Align the drive train.

1. Lift machine (→ Chapter 4.1.2, Page 13).
2. Set the machine onto the base frame.
3. Make sure that the machine sits equally on all four feet. If necessary, compensate completely for the remaining distance between foot and base frame by, for example, using metal shims.
4. Bolt the machine's feet to the base frame.

## 5.3 Installation on foundation blocks

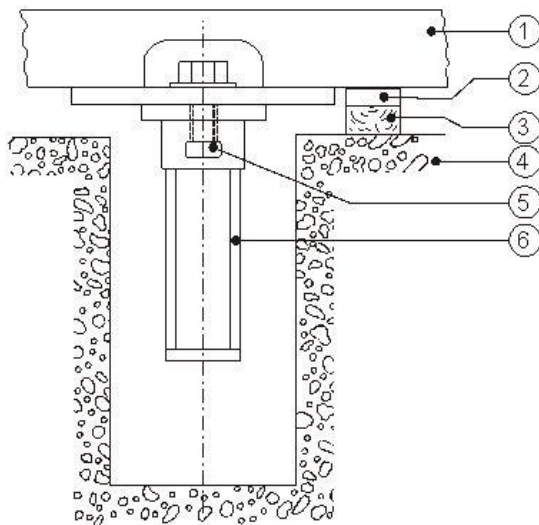


Fig. 5 Installation on foundation blocks

- 1 Alignment frame
  - 2 Machine wedge
  - 3 Wood or steel base plate
  - 4 Bare foundation
  - 5 Aperture (block up with piece of cloth, styrofoam or similar)
  - 6 Foundation block
1. Drill holes into the foundation at the appropriate positions. Dimensions in the dimension drawing (→ Chapter 1.2, Page 5).
  2. Construct an alignment frame.  
The dimensions and the fastening points for the machine correspond to those of a base frame.
  3. Attach the foundation blocks to the alignment frame and align precisely.
  4. Set the alignment frame onto the foundation.  
Guide the foundation blocks into the bore holes in the foundation when doing so.
  5. Check horizontal alignment using the surveyor's level.
  6. Compensate for irregularities so that a supporting surface with a maximum tolerance of T is established.

Calculation of tolerance T:

$$T = 0.0005 \cdot (L + W)$$

T = flatness tolerance (ISO 1101)  
L = total length of base frame  
W = total width of base frame

[mm or inches]

7. Fill the bore holes in the foundation with foundation concrete.

8. Allow foundation concrete to set.
9. Remove alignment frame.
10. Set the machine onto the foundation blocks.

### NOTE

#### Material damage due to inappropriate alignment!

- Compensate for height differences exactly as described.
- Align the drive train.

11. Make sure that the machine sits equally on all four feet. If necessary, compensate completely for the remaining distance between foot and foundation block by, for example, using metal shims.
12. Bolt the machine's feet to the foundation blocks.

## 5.4 Installing the motor



Observe the manufacturer's assembly and operating instructions.

### NOTE

#### Material damage caused by knocks and bumps!

- Keep the coupling halves properly aligned when slipping them on.
- Do not knock or hit any components of the pump.

1. Smear a very thin coat of molybdenum disulfide (e.g. Molykote) on the shaft ends of the machine and motor.
2. Insert the shaft keys.
3. Without a mounting fixture: Remove the rubber buffers and heat the coupling halves up to approximately 100 °C.
4. Slide on the machine-side and motor-side coupling halves until the shaft end is flush with the coupling hub. When doing this, ensure the prescribed spacing between the two halves of the coupling is maintained (→ Chapter 1.2, Page 5, assembly instructions of the coupling).
5. Use suitable metal shims on the motor to align the end of the motor shaft to the height of the machine shaft end.
6. Screw in the motor bolts, but do not tighten them yet.

## 5.5 Planning the pipelines



Typical pipeline diagrams (→ Chapter 9.1.4, Page 43).



Observe the technical specifications on pumped fluids, seal liquids, permissible pressures (intake, discharge, and test pressure) (→ Chapter 9.2, Page 46).

### 5.5.1 Specifying supports and flange connections

#### NOTE

**Material damage due to excessive forces and torques exerted by the piping on the machine!**

- ▶ Do not exceed the permissible values (→ Chapter 9.2.14, Page 52).

1. Calculate the pipeline forces, taking every possible operating condition into account:
  - Cold/warm
  - Empty/full
  - Depressurized/pressurized
  - Shift in position of flanges
2. Ensure the pipe supports have permanent low-friction properties and do not seize up due to corrosion.

### 5.5.2 Specifying nominal diameters



Keep the pressure drop in the pipes as low as possible.

1. Make sure the nominal inlet pipe diameter is  $\geq$  the nominal inlet flange diameter.
2. Make sure the nominal discharge pipe diameter is  $\geq$  the nominal discharge flange diameter.

### 5.5.3 Discharging leaks



#### WARNING

**Risk of injury and poisoning due to hazardous pumped fluids and seal liquids!**

- ▶ Safely collect any leaking fluids, then discharge and dispose of it in accordance with environmental regulations.

1. Provide equipment for collecting and discharging leaking liquids.
2. Ensure that leaking fluids can be discharged freely.

### 5.5.4 Providing safety and control devices (recommended)



For machines in explosion-hazard areas (→ Chapter 1.2, Page 5).

#### Avoiding impurities

#### NOTE

**Material damage due to limestone deposits when using limy seal liquids!**

**Chipping limestone solids can cause erosional damage.**

- ▶ Add water softener or install an ion exchanger.

1. Install the included strainers in the seal liquid supply line.
2. To monitor impurities, install a differential pressure gauge with a contact manometer if necessary.

#### Avoiding backflow

- ▶ Use a check valve in the suction pipe to ensure that no seal liquid or gas flows back once the machine is switched off.

#### Making provisions for isolating and shutting off the pipes



For maintenance and repair work.

- ▶ Provide shut-off devices in the inlet and discharge pipes.

### Allow measurements of the operating conditions

1. Provide manometers for pressure measurements in the inlet and discharge pipes.
2. Provide load monitors (overload and underload) on the motor side.
3. Provide for machine-side temperature measurements.
4. To measure the seal liquid flow rate, install a direction-dependent flow rate measurement device.

## 5.6 Connecting the pipe lines

### 5.6.1 Keeping the pipe lines clean

---

#### NOTE

---

**Risk of damage due to connecting the machine to pipe line system!**

**Welding shot (small pieces of very hard metal) in the pipe lines can cause substantial damage to the machine.**

- ▶ Make sure that the supplied temporary screen across the flange, if present, stays in place when connecting the machine to the pipe line system.
- ▶ Only remove the temporary screen (if present) once the inlet pipe is entirely clear, approx. after 3–4 weeks of operation.
- ▶ Clean screen periodically while in use.

---

---

#### NOTE

---

**Risk of damage due to impurities in the machine!**

- ▶ Make sure no impurities can enter the machine.

1. Clean all pipes and fittings prior to installation.
2. Ensure no flange seals extend inwards.
3. Remove any blank flanges, plugs, protective foils, and/or protective paint from the flanges.

### 5.6.2 Installing the seal liquid line

1. Remove the transport and sealing covers from the machine.
2. Install the seal liquid line.
3. Ensure no seals extend inwards.

### 5.6.3 Installing auxiliary pipes (if available)



Observe the manufacturer's specifications for any auxiliary operating systems (e.g. mechanical seal supply systems) which are present.

1. Connect the auxiliary pipes to the auxiliary connections so that they are stress-free and do not leak (→ setup drawing).
2. Avoid air pockets: Route the pipes with a continuous slope up to the machine.

### 5.6.4 Installing the inlet pipe

1. Remove the transport and sealing covers from the machine.
2. Install the inlet pipe.
3. Ensure no seals extend inwards.

### 5.6.5 Installing the outlet pipe

1. Remove the transport and sealing covers from the machine.
2. Install the outlet pipe.
3. Ensure no seals extend inwards.

### 5.6.6 Checking the stress-free pipe connection

- ✓ Piping installed and cooled down

---

#### NOTE

---

**Material damage due to distorted machine casing!**

- ▶ Ensure that all pipes are stress-free when connected to the machine.

1. Disconnect the pipe connecting flanges from the machine.
2. Check whether the pipes can be moved freely in all directions within the expected range of expansion:
  - Nominal diameter < 150 mm (5.9 inch): by hand
  - Nominal diameter > 150 mm (5.9 inch): with a small lever
3. Make sure the flange surfaces are plane-parallel.
4. Reconnect the pipe connecting flanges to the machine.

### 5.6.7 Checking the pipes for leaks

- ▶ Perform a leak test for the entire system with the pipes connected, e.g. a soap bubble test at 0.5 bar overpressure.

## 5.7 Electrical connection



**DANGER**

### Risk of electrocution!

- ▶ Have all electrical work carried out by qualified electricians only.



**DANGER**

### Risk of fatal injury due to rotating parts!

- ▶ Disconnect the motor from its power supply and keep it locked when carrying out any installation or maintenance work.

### 5.7.1 Connecting the motor



Follow the instructions of the motor manufacturer.

1. Connect the motor according to the connection diagram.
2. Make sure no danger arises due to electric power.
3. Install an EMERGENCY STOP switch.

## 5.8 Fine-adjustment of the coupling



We recommend having the coupling adjusted by GD Nash Service.

## 5.9 Installing safety guards

1. Secure moving parts with safety guards as per DIN EN 294.
2. Do not fasten any temperature-sensitive components or lines to hot machine parts.

## 5.10 Checking after assembly



Further checks may be necessary as per supplementary instructions or system-specific conditions.

- ▶ Ensure that:
  - The drive motor is adjusted correctly and assembled in such a way as to prevent axial movement.
  - The rotor/shaft assembly can be rotated without making contact.
  - Rotating parts are correctly guarded.
  - Pipe systems and fittings have been installed in the correct positions, are not distorted, and have been pressure-tested.
  - Any heat exchangers have been bled.
  - Any pressure booster pumps are ready for operation.
  - The separator, if present, is positioned correctly at the right height and features the specified fittings.

## 6 Operation

### 6.1 Preparations for the initial start-up



This section applies to an empty or dry machine (i.e. when commissioning or recommissioning after longer periods of disuse or repairs).

- ✓ All lines for pumped fluids and seal liquids have been connected correctly.
- ✓ All gate valves and valves have been closed.

#### 6.1.1 Identifying the machine version

- ▶ Identify the machine version (→ order data sheet).



Machine versions vary. For example, a vacuum pump, the type of shaft seal, differing materials.

#### 6.1.2 Removing the preservative



Only necessary for machines treated for storage.

- ▶ (→ Chapter 4.5, Page 15).

#### 6.1.3 Lubricating the bearings



Machines with grease-lubricated anti-friction bearings are ready for operation upon delivery.

- ▶ If the machine was stored for longer than 2 years: Lubricate bearings again (→ Chapter 3.3, Page 11).

#### 6.1.4 Preparing auxiliary systems (if available)



The manufacturer does not accept any liability for damage caused by installing or using a third-party or unapproved auxiliary system.

#### Seal supply systems

1. Verify that the sealing medium is suitable to mix (i.e. compatible) with the pumped fluid and the seal liquid.
2. Identify the sealing system:
  - (→ order data sheet)

3. Install the sealing system (→ manufacturer's specifications).
4. Make sure the parameters required for the installed sealing system are met.
5. Ensure that the permissible container pressure is not exceeded on seal supply systems (→ manufacturer's specifications).

#### 6.1.5 Filling with seal liquid

- ✓ Auxiliary operating systems ready for operation



#### WARNING

#### Risk of injury and poisoning due to hazardous fluids!

- ▶ Safely collect any leaking fluids and dispose of them in accordance with environmental rules and requirements.

#### NOTE

#### Material damage caused by dry running!

- ▶ Make sure the machine is filled properly with seal liquid.
- ▶ Ensure that no pipe connections are leaking.

#### 6.1.6 Adjusting the seal liquid level before startup



The seal liquid level may not be above the shaft center when starting the machine.

#### Machines with automatic discharge

1. Open the seal liquid shut-off fitting.  
The machine's process chamber fills up to overflow level at the outlet flange or welding neck flange.
2. Once no more fluid flows from the partial discharge flange (welding neck flange), start the machine.

## Machines with adjacent separator

- ✓ Separator assembled correctly.
  - ✓ Fluid level monitor installed in separator at same level as machine.
  - ✓ Compensation line and extra components installed below required fluid level.
  - ✓ Overflow, if present, installed in separator at maximum fluid level.
1. Open the shut-off fitting between the machine and the separator.
  2. Fill the machine with seal liquid via the separator.
  3. Check the fluid level via the fluid level monitor or via fluid discharge at overflow.
  4. Once the correct fluid level has been reached, start the machine.

### 6.1.7 Adjusting the shaft seal's flushing liquid

#### For stuffing boxes with internal flushing:



The stuffing box must always leak slightly to dissipate the frictional heat and to provide lubrication.  
Larger leaks in the initial hours of operation lessen during the running-in period.

- ▶ Make sure that sufficient seepage fluid is discharged:
  - Vacuum pumps: 1-2 drops per second

#### For stuffing boxes with external flushing:

1. Open the flushing liquid valves for gland packing flushing.
2. Set the supply pressure in accordance with the operating point.
3. Make sure that sufficient liquid is discharged to provide for stuffing box packing cooling later.
  - Vacuum pumps: 1-2 drops per second

#### For mechanical seals:

- ▶ Open the flushing liquid valve for a few seconds to humidify the mechanical seals.

### 6.1.8 Checking the direction of rotation

- ✓ Seal liquid level in machine casing is correct.
- ✓ Stuffing boxes are wet.
- ✓ For mechanical seals with external flushing: Flushing liquid valve opened briefly.
- ▶ Check direction of rotation.

## 6.2 Start-up

### 6.2.1 Switching on

- ✓ Machine set up and connected properly
- ✓ Motor set up and connected properly
- ✓ Motor exactly aligned with the machine
- ✓ All connections stress-free and sealed
- ✓ Any available auxiliary systems are ready for operation
- ✓ All safety equipment installed and tested for functionality
- ✓ Machine prepared properly
- ✓ Machine filled with seal liquid up to shaft center
- ✓ Shaft seal humidified



**DANGER**

#### Risk of injury due to running machine!

- ▶ Do not touch the machine while operating.
- ▶ Ensure that the coupling guard is attached.
- ▶ Do not carry out any work on the running machine.
- ▶ Allow the machine to cool down completely before starting any work.



**DANGER**

#### Risk of injury and poisoning due to expulsion of pumped fluids and seal liquids!

- ▶ Use personal protective equipment when carrying out any work on the machine.

## NOTE

#### Material damage caused by dry running!

- ▶ Make sure the machine is filled properly with seal liquid.
- ▶ Adjust the seal liquid level immediately before startup (→ Chapter 6.1.6, Page 22).



## NOTE

### Risk of cavitation when throttling down the suction flow rate!

- Always keep the inlet-side fitting fully open and do not use it to adjust the flow rate.

## NOTE

### Material damage if maximum compression pressure is exceeded!

- Do not operate the machine for long periods with the discharge-side or inlet-side fitting closed.

### Pump operation: startup



We recommend having the machine commissioned by GD Nash Service.

1. Open the inlet pipe's valve.
2. For shaft seal with external flushing:  
Open the flushing liquid valve.
3. Switch on drive motor.  
After switching on: Immediately open the seal liquid valve.
4. Adjust the seal liquid valve:
  - With flow rate measurement device: Open the seal liquid valve until the flow rate measurement device shows the required value (→ Chapter 9.2.9, Page 48). Correct the mass flow again once the final intake pressure has been reached.
  - With pressure gauge: Adjust the seal liquid valve so that the pressure gauge shows approximately 1.0 bar absolute during startup.
5. For stuffing boxes with internal flushing:  
Slight dripping is necessary. Check setting and correct if necessary.
6. For stuffing boxes with external flushing: Adjust the required flushing liquid pressure/flow using the flushing liquid valve.
7. For mechanical seals with external flushing:  
(→ Chapter 1.2, Page 5)

### 6.2.2 Checking operation



Proper operation must be checked immediately after the initial commissioning and subsequently at regular intervals.

1. Read and document pressure values and mass-flow rates set after commissioning.
2. Monitor and document the temperatures of the fluids (seal liquid and flushing liquid) and components (bearings, shaft seal) until steady-state is reached.
3. In the case of cavitation risk: Monitor machine for rattling and crackling noises.
4. If irregularities are observed, identify and eliminate causes (→ Chapter 8, Page 32).

### 6.2.3 Switching off



## WARNING

### Risk of injury due to hot machine parts!

- Use personal protective equipment when carrying out any work on the machine.

### Pump mode: switching off

1. Switch off the drive motor.
2. Close the seal liquid valve.
3. Close the flushing liquid valve.
4. Close the inlet pipe's valve.

## 6.3 Shutting down the pump

- ✓ Machine switched off and depressurized



## WARNING

### Risk of injury and poisoning due to hazardous fluids!

- Safely collect any leaking fluids and dispose of them in accordance with environmental rules and requirements.
- 
- Take the following measures whenever the pump is shut down:



Machine is to be	Measure
...shut down for a prolonged period	► Perform measures appropriate for the seal liquid.
...drained	► Close the inlet-side and discharge-side fittings.
...disassembled	► Isolate the motor from its power supply and secure it against unauthorized switch-on.
...put into storage	► Follow the storage instructions (→ Chapter 4.4, Page 15).

Table 7 Measures to be taken if the machine is shut down

Seal liquid properties	Duration of shutdown (depending on process)	
	Short	Long
Solidifying sediment	► Flush the machine.	► Flush the machine.
Solidifying/ freezing, non-corrosive	► Heat up or drain the machine.	► Drain the machine.
Solidifying/ freezing, corrosive	► Heat up or drain the machine.	► Drain the machine. ► Flush the machine with preservative. ► Dry machine and turn rotor every 2 weeks.
Remains liquid, non-corrosive	–	–
Remains liquid, corrosive	–	► Drain the machine. ► Flush the machine with preservative. ► Dry machine and turn rotor every 2 weeks.

Table 8 Shutdown measures depending on the seal liquid properties

#### Draining when there is a risk of freezing

1. Open the discharge valve to drain fluids from the machines, separators and lines.
2. Safely collect any fluids and dispose of them in accordance with environmental rules and requirements.
3. On depressurized machines, remove the full-draining plug in the head or port plates.
4. Safely collect any fluids and dispose of them in accordance with environmental rules and requirements.
5. For mechanical seals: Fully drain all fluids from all seal housings.
6. Safely collect any fluids and dispose of them in accordance with environmental rules and requirements.

#### 6.4 Start-up following a shutdown period

1. If the machine has been shut down for > 1 year, lubricate the bearings before recommissioning the machine.
2. Carry out all steps as for the initial commissioning (→ Chapter 5.10, Page 21, Chapter 6.2, Page 23).

## 7 Maintenance



For machines in explosion-hazard areas  
(→ Chapter 1.2, Page 5).



Trained service technicians are available for fitting and repair work. Present a pumped medium certificate when requesting service  
(→ Chapter 9.3, Page 54).

### 7.1 Inspections



The recommended intervals assume malfunction-free operation. In the event of malfunctions, the corresponding inspections or revisions should be performed immediately.



The inspection intervals depend on the operational conditions of the machine.



#### **DANGER**

##### **Risk of injury due to running machine!**

- ▶ Do not touch the machine while it is running.
- ▶ Do not carry out any work on the running machine.



#### **WARNING**

##### **Risk of injury and poisoning due to hazardous pumped fluids!**

- ▶ Use personal protective equipment when carrying out any work on the machine.

- ▶ For trouble-free operation, always ensure the following:
  - No dry running
  - No leaks
  - No cavitation
  - Unclogged and clean filters
  - No unusual running noises or vibrations
  - No excessive leakage at the shaft seal
  - Check the stuffing box settings. If the stuffing box glands can no longer be re-adjusted after longer periods of operation, replace the gland packing (→ Chapter 7.1.5, Page 28).

#### 7.1.1 Inspection



Perform a first general inspection approx. 150 operating hours after initial commissioning of the machine.

Perform a first inspection of the belt drive after approx. 5 operating hours.

Perform the following during the inspection:

1. Make sure that the pumped fluid and seal liquid do not display significant contamination.
2. Make sure that the specified technical data is observed (power consumption, temperatures etc.).
3. Ensure that no leaks are present (exception: necessary leaks at the stuffing boxes).
4. Check that the smooth running of the machine and the bearings' running noises have not deteriorated.
5. Check the foundation for sink marks and cracks.
6. Make sure that the valves, filters, and screens are free of foreign matter. Clean if necessary.
7. Check pipes, fittings, and containers for strength, leaks, and secure fit.
8. Check connecting elements and re-tighten if necessary.
9. Check the safety system.
10. For belt drives: Check belt pre-tensioning and correct if necessary.
11. Immediately eliminate any identified impermissible deviations and modifications.
12. Schedule appointment for reinspection based on soiling and wear.

## 7.1.2 Reinspection



Under favorable operating conditions, reinspections are subject to the same intervals applicable for lubrication or grease changes (→ Chapter 7.1.3, Page 27).

1. Perform inspection (→ Chapter 7.1.1, Page 26) durchführen.
2. Check that the impeller's alignment lies within the permissible tolerance range.
3. Make sure that all fastening bolts have been securely tightened (except for stuffing boxes).

## 7.1.3 Antifriction bearings lubricated with grease



Grease to be used and interval for replacing grease (→ Chapter 9.2.11, Page 50).



The temperature of the bearings can increase considerably after relubrication, however, after a running-in phase it must sink down to the normal value.

After lubricating with the relubrication system:

1. Clean lubrication nipple.
2. Apply the specified quantity of grease with the grease gun.  
Turn the shaft uniformly while doing this.

If no relubrication systems (lubrication nipples) are available, proceed as follows:

1. Fill the bearings' cavities completely with lubricating grease.  
Leave out the bearing covers to prevent excessive greasing.
2. Disassemble the axial shaft sealing rings (V-rings).
3. Grease the V-rings' sliding surfaces.
4. For external shaft seal rings:  
Install V-ring so that the front side of the bearing cover is flush with the V-ring's outer edge. Use assembly washers if necessary.

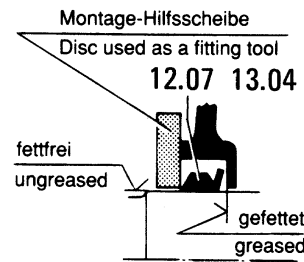


Fig. 6 Assembly washer

5. For internal shaft seal rings:  
Install the V-ring according to the groove in the shaft.

## 7.1.4 Mechanical seals

- Observe additional instructions (→ Chapter 1.2, Page 5).

## 7.1.5 Stuffing boxes



We recommend having replacement and re-adjustment of the gland packing performed by GD Nash Service.

### Disassembly of the gland packing

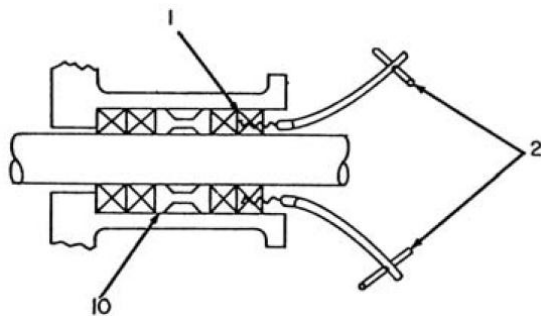


Fig. 7 Removing the packing rings

- 1 Packing ring
- 2 Packing extractor
- 10 Lantern gland
1. Push spray ring or V-ring away from stuffing box seal.
2. Remove the stuffing box gland's fastening bolts and/or nuts.
3. For single-piece glands: Push the gland as far away as possible from the sealing chamber.
4. For two-piece glands: Loosen both parts and remove them from the shaft.
5. Screw the packing extractor into the packing ring.
6. Pull the packing ring out of the sealing chamber.



Fig. 8 Extractor for lantern gland (3.2 mm (1/8 in.) wire)

7. Insert two extractors into the sealing chamber. Twist the extractor in between the packing rings so that the bent ends latch into the two opposite positions.
8. Pull the lantern gland out of the sealing chamber.
9. Remove the remaining packing rings using the packing extractor.
10. Thoroughly clean the packing chamber.

### Inserting a new gland packing

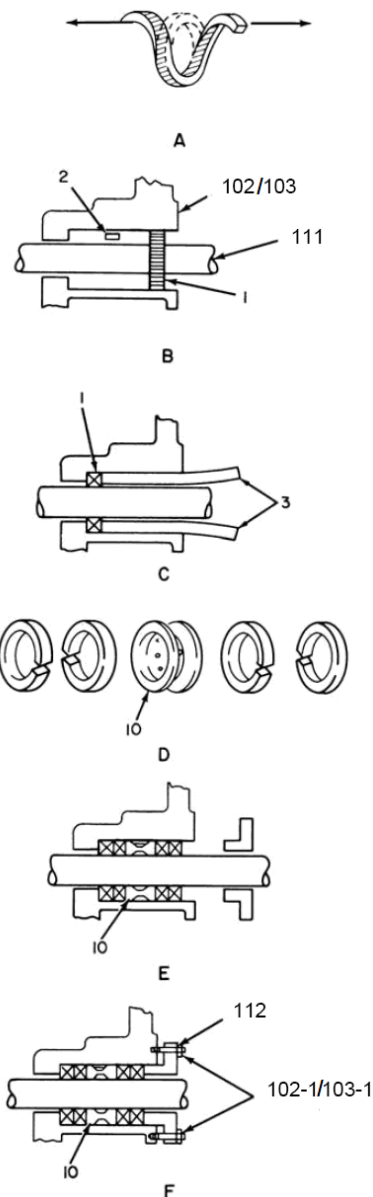


Fig. 9 Inserting a new gland packing

- 1 Packing rings
- 2 Inlet channel to the lantern gland
- 3 Packing stuffers
- 10 Lantern gland (if provided)
- 102 Head or Endschild on drive end
- 103 Head or Endschild on non-drive end
- 102-1/103-1 Stud bolts & nuts or bolts on drive end/non-drive end side
- 111 Shaft
- 112 Stuffing box gland



View F is shown at a 90° angle to present the gland locking bolts and nuts. **2** and **10** only where used.

1. Produce packing stuffers **3** from two strips of hard rubber. The stuffers need to fit between the shaft and the packing chamber's inner wall.
2. Apply Molykote G-N paste or a similar lubricant to the packing rings' inner surface.
3. Open the packing rings to form a spiral by offsetting the two ends axially (→ **A**).
4. Fit the packing ring around the shaft and insert it into the sealing chamber (→ **B**).
5. Push the packing ring into the packing chamber using the packing stuffers.  
Ensure that the packing ring lies flush against the packing chamber's front facing (→ **C**).
6. Install the packing rings so that their joining points are offset by 180° (→ **D**).
7. Insert the lantern gland, if included (→ **D**).
8. Install the remaining packing rings (→ **E**).  
When doing so, make sure that:
  - The joining points are offset by 180°.
  - The packing rings are installed tightly and evenly.
9. For two-piece glands:  
Fit the two-piece gland around the shaft and connect the nuts, washers, bolts (→ **F**). Push the gland onto the shaft and any locking bolts until it is flush with the last packing ring.
10. For single-piece glands:  
Push the gland onto the shaft and any locking bolts until it is flush with the last packing ring.
11. Tighten the gland locking bolts or nuts by hand.
12. Start up machine (→ Chapter 6.2.1, Page 23).  
During operation, monitor the temperature and leaks around the sealing chamber.
13. If required, adjust packing when machine is stopped. To do this, switch off the machine, disassemble the safety guard, adjust packing, replace safety guard and restart the machine.
14. Repeat steps 12 and 13 until the specified leakage amount is reached (→ Chapter 6.1.7, Page 23).

#### 7.1.6 Cleaning the machine



### CAUTION

#### Risk of injury when cleaning with compressed air!

- Make sure a suitable extraction system is employed.
- Use personal protective equipment.

### NOTE

#### Material damage due to unsuitable cleaning agents!

- Make sure the cleaning agents are compatible with the machine.



Schedule cleaning at intervals in accordance with the level of soiling determined during the first inspection.

1. To flush accumulated foreign matter out of the ring of liquid, open the drain pipe valves.
2. Alternatively: Remove the full-draining plugs.
3. Flush the machine with water.
4. Clean or replace the strainers and filters in the pipes.  
When doing so, make sure that no debris falls into the machine from the strainers or filters.

#### Removing lime deposits



Intervals for removing lime deposits depend on the lime content of the seal liquid and must be > 6 months.

We recommend having the descaling performed by GD Nash Service.

1. Flush the machine with a suitable solvent (→ Chapter 9.2.12, Page 51).
2. Flush the machine with water.

## 7.2 Disassembly



GD Nash can accept no liability if the machine is disassembled incorrectly.



### DANGER

#### Risk of injury due to running machine!

- ▶ Do not touch the machine while it is running.
- ▶ Do not carry out any work on the running machine.
- ▶ Disconnect the motor from its power supply and keep it locked when carrying out any installation or maintenance work.



### DANGER

#### Risk of electrocution!

- ▶ Have all electrical work carried out by qualified electricians only.



### WARNING

#### Risk of injury and poisoning due to hazardous pumped fluids!

- ▶ Use personal protective equipment when carrying out any work on the machine.
- ▶ Allow the machine to cool down completely before commencing any work.
- ▶ Make sure the machine is depressurized.
- ▶ Drain the machine, safely collect the pumped liquid, and dispose of it in accordance with environmental regulations.



### WARNING

#### Risk of injury due to heavy components!

- ▶ Be aware of the weight of components. Lift and transport heavy components using suitable lifting gear.
- ▶ Set down components safely and secure them against overturning and rolling away.



### WARNING

#### Risk of injury during disassembly!

- ▶ Secure the discharge-side valve against accidental opening.
- ▶ Depressurize the seal supply system, if included.
- ▶ Wear protective gloves as components can become very sharp due to wear or damage.
- ▶ Remove spring-loaded components carefully (e.g. mechanical seals, tensioned bearings, valves etc.), as components can be ejected by the spring tension.
- ▶ Observe the manufacturer's specifications (e.g. for the motor, coupling, mechanical seal, seal supply system, drive shaft, drives, belt drive).

#### 7.2.1 Returning the machine to the manufacturer

- ✓ Machine depressurized
- ✓ Machine fully drained
- ✓ Electrical connections disconnected and motor secured against being switched on again
- ✓ Machine cold
- ✓ Coupling guard removed
- ✓ Auxiliary systems shut down, depressurized, and drained
- ✓ Pressure gauge lines, pressure gauge, and brackets disassembled
- ▶ Enclose an accurate and fully completed safety certificate when returning machines or components to GD Nash (→ Chapter 9.3, Page 54).

### 7.2.2 Preparations for disassembly

- ✓ Machine depressurized
- ✓ Machine fully drained, flushed, and decontaminated
- ✓ Electrical connections disconnected and motor secured against being switched on again
- ✓ Machine cold
- ✓ Coupling guard removed
- ✓ Auxiliary systems shut down, depressurized, and drained
- ✓ Pressure gauge lines, pressure gauge, and fittings disassembled
- ▶ Observe the following during removal:
  - Mark the precise orientation and position of all components before disassembling them.
  - Disassemble components concentrically without canting.
  - Disassemble machine (→ Chapter 9.1, Page 36).

### 7.3 Assembly



Reinstall the components concentrically, without canting, in accordance with the marks applied.  
GD Nash can accept no liability if the machine is assembled incorrectly.



#### WARNING

#### Risk of injury due to heavy components!

- ▶ Be aware of the weight of components. Lift and transport heavy components using suitable lifting gear.



#### WARNING

#### Risk of injury during assembly!

#### Components may be ejected through spring tension.

- ▶ Take care when installing components with springs (e.g. mechanical seals, pretensioned bearings, valves).
- ▶ Observe the manufacturer's specifications (e.g. for the motor, coupling, mechanical seal, seal supply systems, drive shaft, drives, belt drive).

### NOTE

#### Material damage due to unsuitable components!

- ▶ Always replace lost or damaged screws with screws of the same strength (→ Chapter 9.2.5, Page 46).
- ▶ Only replace seals with seals of the same material.

1. Observe the following during assembly:
  - Replace worn parts with genuine spare parts.
  - Replace seals. Take care that the seal is seated correctly.
  - Maintain the prescribed tightening torques (→ Chapter 9.2.5, Page 46).
2. Clean all parts (→ Chapter 9.2.12, Page 51). Do not remove any markings when doing so.
3. Reassemble the machine (→ Chapter 9.1, Page 36).
4. Replace antifriction bearings and grease them (→ Chapter 7.1.3, Page 27).
5. Install the machine in the system (→ Chapter 5, Page 16).

### 7.4 Ordering spare parts



GD Nash can accept no liability if parts other than genuine parts are used.



Repairs are performed by GD Nash Service.

- ▶ Have the following information ready at hand when ordering spare parts:
  - Spare part order number as per spare parts list (→ Chapter 1.2, Page 5).
- ▶ If no spare parts list is available, have the following information from the type plate ready at hand:
  - Machine type (→ Chapter 3.1.1, Page 10)
  - Machine's serial number (→ Chapter 3.1.1, Page 10)
  - Machine's year of construction (→ Chapter 3.1.1, Page 10)
  - Part number as per drawing (→ Chapter 9.1, Page 36)

## 8 Troubleshooting

If malfunctions occur which are not specified in the following table or cannot be traced back to the specified causes, please consult GD Nash.

Possible malfunctions are identified by a number in the following table. This number identifies the respective cause and remedy in the troubleshooting list.

Fault	Number
Rough operation	1
Excessive power consumption	2
Flow rate too low	3
Housing too hot	4
Bearings too hot	5
Bearings whining	6
Bearings rattling	7
Vacuum not achieved	8
Motor will not start	9
Main circuit breaker activating	10

Table 9 Fault/number assignment

Fault number										Cause	Remedy
1	2	3	4	5	6	7	8	9	10		
X	–	–	–	–	–	–	–	–	–	Base plate vibrating	► Fill base plate and any gear base with foundation concrete or dry sand.
X	–	–	–	–	–	–	–	–	–	Pump assembly vibrating	► Check assembly's alignment and fastening.
X	–	–	–	–	–	–	–	–	–	Pipes vibrating	► Check the fastenings of the pipes.
X	–	–	–	–	–	–	–	–	–	Cavitation – rattling noise	► Use colder seal liquid. If necessary, also reduce the inlet pressure by adding secondary air or retrofit cavitation protection.
X	X	–	–	–	–	–	–	–	–	Pulsing flow	► Throttle down seal liquid until pulsing is eliminated, inspect check valves.
X	X	–	–	–	–	–	–	–	–	Excessive liquid at suction end	► Throttle down seal liquid, if necessary install upstream separator at suction end.
X	X	–	–	–	–	–	–	–	–	Separator level too high	► Install separator at lower level.
X	X	–	–	–	–	–	–	–	–	Rotor touches cone or port plate	► Open inspection cover, check gap adjustment and correct if necessary.



Fault number										Cause	Remedy
1	2	3	4	5	6	7	8	9	10		
–	X	–	–	–	–	–	–	–	–	Stuffing box bolted too tightly	<ul style="list-style-type: none"> <li>▶ Vacuum pump: Loosen gland far enough to allow leakage of 1-2 drops per second.</li> <li>▶ Compressor: Loosen gland far enough to allow flushing liquid to escape in a continuous drip or a steady flow.</li> </ul>
–	X	–	–	–	–	–	–	–	–	High amount of solids accumulating at suction end	<ul style="list-style-type: none"> <li>▶ Periodically or continuously flush housing, install dirt trap if necessary.</li> </ul>
–	X	–	–	–	–	–	–	–	–	Rotor jammed	<ul style="list-style-type: none"> <li>▶ Loosen housing bolts, turn rotor by lever, if necessary clean vacuum pump or compressor.</li> </ul>
–	X	–	–	–	–	–	–	–	–	Motor protection activating	<ul style="list-style-type: none"> <li>▶ If malfunctions of the vacuum pump or compressor can be ruled out, check motor protection and/or motor size.</li> </ul>
–	X	–	–	–	–	–	–	–	–	Erosion in housing	<ul style="list-style-type: none"> <li>▶ Replace housing, if necessary install lining, check chemical resistance of the material, if necessary filter seal liquid.</li> </ul>
–	X	–	–	–	–	–	–	–	–	Fluctuating power consumption	<ul style="list-style-type: none"> <li>▶ Check seal liquid flow rate.</li> <li>▶ Inspect check valve/fittings.</li> <li>▶ In the case of excessive pumping of liquid via the inlet pipe: Install a separator in the inlet pipe.</li> </ul>
–	X	X	–	–	–	–	–	–	–	Excessive compression	<ul style="list-style-type: none"> <li>▶ Check system, if necessary correct inlet or discharge pressure.</li> </ul>
–	X	X	–	–	–	–	–	–	–	Lime or other deposits	<ul style="list-style-type: none"> <li>▶ Descale machine (→ Chapter 9.2.12, Page 51).</li> <li>▶ If necessary disassemble and clean machine.</li> <li>▶ Add softener to seal liquid.</li> </ul>
–	X	X	–	–	–	–	–	–	–	Measurement devices display incorrect information	<ul style="list-style-type: none"> <li>▶ Check measurement devices, calibrate if necessary.</li> </ul>
–	X	X	–	–	–	–	–	–	–	Excessive discharge pressure	<ul style="list-style-type: none"> <li>▶ Check system.</li> </ul>
–	X	X	–	–	–	–	–	–	–	Maximum permissible pressure difference exceeded	<ul style="list-style-type: none"> <li>▶ Eliminate unnecessary throttling (e.g. closed lines, incorrectly adjusted gate valves) at inlet and discharge ends.</li> </ul>
–	–	X	–	–	–	–	–	–	–	Excessive clearance losses	<ul style="list-style-type: none"> <li>▶ Open hand aperture cover if one is available.</li> <li>▶ Check impeller gap and play.</li> <li>▶ Correct the length of the housing.</li> </ul>

Fault number										Cause	Remedy
1	2	3	4	5	6	7	8	9	10		
–	–	X	–	–	–	–	–	–	–	Inlet pressure too low	► Check system, if necessary increase inlet pressure.
–	–	X	–	–	–	–	–	–	–	Internal leaks	► Disassemble vacuum pump or compressor, check chemical resistance of the material, install new parts if corroded.
–	–	X	–	–	–	–	–	–	–	Port plate valve plates faulty	► Replace valve plates.
–	–	X	–	–	–	–	–	–	–	Suction end leaking	► Check gaskets on inlet flange and suction-end inspection cover, replace if necessary.
–	–	X	–	–	–	–	–	–	–	Stuffing box leaking	► Vacuum pump: Tighten gland far enough to allow leakage of 1-2 drops per second. ► Compressor: Tighten gland far enough to allow flushing liquid to escape in a continuous drip or a steady flow.
–	–	X	X	–	–	–	–	–	–	Not enough seal liquid	► Increase seal liquid flow rate or pressure.
–	–	X	X	–	–	–	–	–	–	Excessive seal liquid temperature	► Reduce temperature or increase seal liquid level.
–	–	–	–	X	–	–	–	–	–	Too much grease on bearing	► Remove excess grease.
–	–	–	–	X	–	–	–	–	–	Coupling exerting pressure	► Correct machine alignment.
–	–	–	–	X	–	–	–	–	–	Belt tension too high	► Reduce belt tension.
–	–	–	–	X	–	–	–	–	–	Bearing soiled	► Clean or replace bearing. Check seals.
–	–	–	–	X	–	–	–	–	–	Ambient temperature above limit value	► Use high-temperature grease.
–	–	–	–	X	X	–	–	–	–	Insufficient lubrication	► Lubricate as specified.
–	–	–	–	X	X	–	–	–	–	Bearing corroded	► Replace bearing, check seals.
–	–	–	–	–	–	X	–	–	–	Flaking in the bearings' races	► Replace bearings.
–	–	–	–	–	–	X	–	–	–	Score marks in the bearings' races	► Replace bearings, avoid jarring at standstill.
–	–	–	–	–	–	–	X	–	–	No seal liquid supply	► Check seal liquid inlet pipe.
–	–	–	–	–	–	–	X	–	–	Air ingress to system	► Check all connections and seals and re-tighten if necessary.
–	–	–	–	–	–	–	X	–	–	Incorrect direction of rotation	► Reverse direction of rotation by reversing electrical connections.
–	–	–	–	–	–	–	X	–	–	Wear in internal machine parts	► Disassemble the machine and replace damaged parts.

Fault number										Cause	Remedy
1	2	3	4	5	6	7	8	9	10		
–	–	–	–	–	–	–	X	–	–	Discharge-end valves faulty	► Replace valves.
–	–	–	–	–	–	–	–	X	–	One or more open circuits	► Check fuses, terminal clamps, and cables.
–	–	–	–	–	–	–	–	X	–	Impeller jammed	► Disassemble machine. ► Drain, descale, and clean machine. ► Assemble machine. ► Check and adjust gap between impeller, rotor, and housing.
–	–	–	–	–	–	–	–	–	X	Short circuit in motor coil	► Check motor coil.
–	–	–	–	–	–	–	–	–	X	Motor overloaded	► Reduce seal liquid flow rate.
–	–	–	–	–	–	–	–	–	X	Excessive counterpressure at outlet flange	► Reduce counterpressure.
–	–	–	–	–	–	–	–	–	X	Seal liquid flow rate too high	► Reduce seal liquid flow rate.

Table 10 Troubleshooting list

## 9 Appendix

### 9.1 Drawings

#### 9.1.1 Part numbers and name TCM1–TC-11



Commercially available standard parts are not included in the table. For type and size of these parts, please refer to the respective spare parts lists.

Part no.	Designation
1 *	Gland packing
3 *	Oil thrower
3-1 *	Tension spring (only TC-11)
4 *	Compensating disc
5 *	Shaft seal ring, internal
5-1 *	Shaft seal ring, external
10 *	Lantern gland
21	Aperture screw plug
22	Plug
22-1	Plug
22-2	Plug
22-3	Plug (only TCM1 ... TC-7)
23	Grease nipple
23-1	Reducer (only TC-11)
101	Housing
101-3 *	Gasket for housing, Drive end
101-4 *	Gasket for housing, Non-drive end
102	Endshield, drive-end
102-1	Nut for stuffing box gland
102-2	Washer for stuffing box gland
102-4	Bolt for side plate
102-5	Bolt for side plate
103	Endshield, non-drive-end
103-1	Nut for stuffing box gland
103-2	Threaded stud for stuffing box gland
103-4	Bolt for side plate
103-5	Bolt for side plate
103-6	Bolt for side plate (only TC-8 and TC-10)

Part no.	Designation
104	Cone, drive side
104-1	Bolt for cone
104-3 *	Gasket for cone
105	Cone, non-drive side
105-1	Bolt for cone
105-3 *	Gasket for cone
108	Bearing support, floating bearing
108-1	Bolt for bearing support, floating bearing
109	Bearing support, fixed bearing
109-1	Bolt for bearing support, fixed bearing
110	Impeller
111	Shaft
111-1	Shaft key
112	Stuffing box gland
115	Outer bearing cover, floating bearing
115-1	Bolt for outer bearing cover
115-2	Nut for outer bearing cover
115-3 *	Gasket for outer bearing cover
116	Inner bearing cover, floating bearing
116-3 *	Gasket for inner bearing cover
117	Outer bearing cover, fixed bearing
117-1	Bolt for outer bearing cover
117-2	Bolt for outer bearing cover
117-4	Nut for outer bearing cover
117-5	Sealing cap for outer bearing cover
118	Inner bearing cover, fixed bearing
119 *	Bearing, floating bearing
119-1	Gasket, drive end (only TC-11)
119-2	Gasket, drive end (only TC-11)
120 *	Bearing, fixed bearing
120-1 *	Nut for fixed bearing
120-2	Gasket, non-drive end (only TC-11)
120-3 *	Gasket for bearing, fixed bearing

Table 11 Designation of components according to part number for TCM1–TC-11

\*) Recommended spare parts

Part no.	Designation
102-6	Nut for breeches pipe
102-7	Washer for breeches pipe
102-8	Locking bolt for breeches pipe
103-7	Nut for breeches pipe
103-8	Washer for breeches pipe
103-9	Locking bolt for breeches pipe
134	Manifold pipe
134-1	Nut for breeches pipe
134-2	Washer for breeches pipe
134-3	Seal for breeches pipe, drive end
134-4	Seal for breeches pipe, non-drive end
134-5	Bolt for breeches pipe

Table 12 Parts for the breeches pipe TC-8 to TC-10

## 9.1.2 Explosion drawing TCM1–TC-11

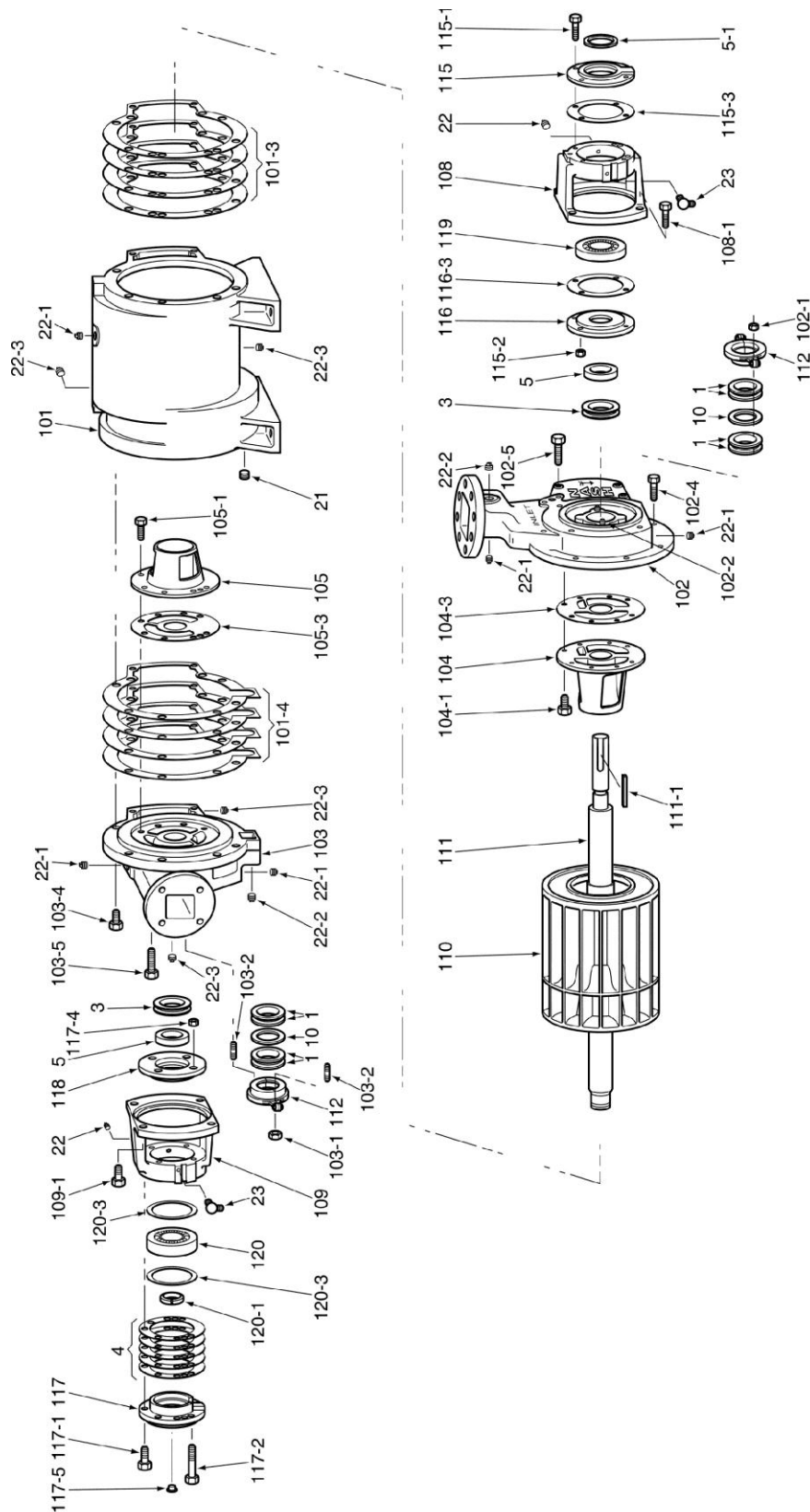


Fig. 10 Exploded view of TCM1 to TCM3 and TC-5 (delivered version may differ)

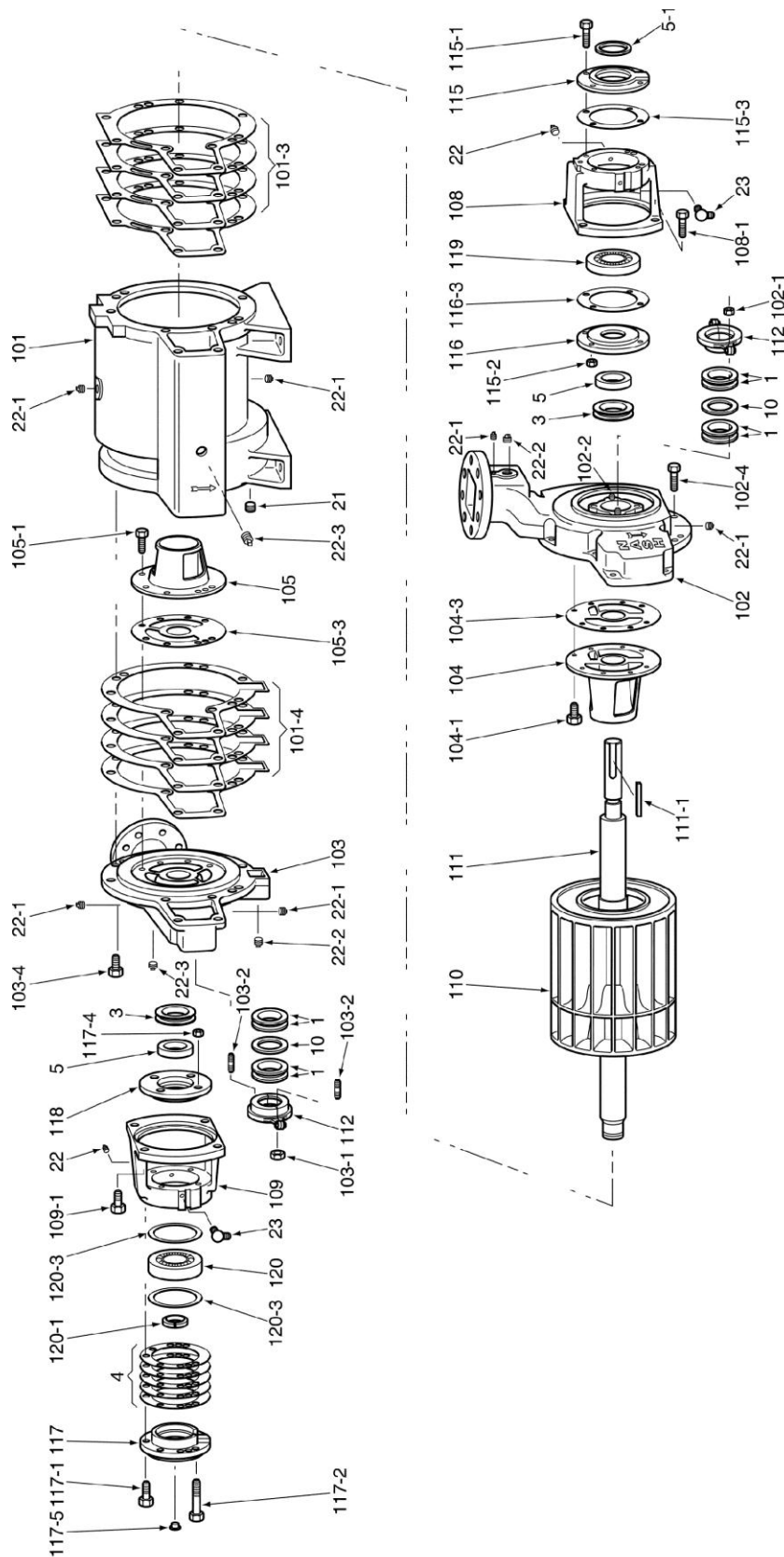


Fig. 11 Exploded view of TC-7 (delivered version may differ)



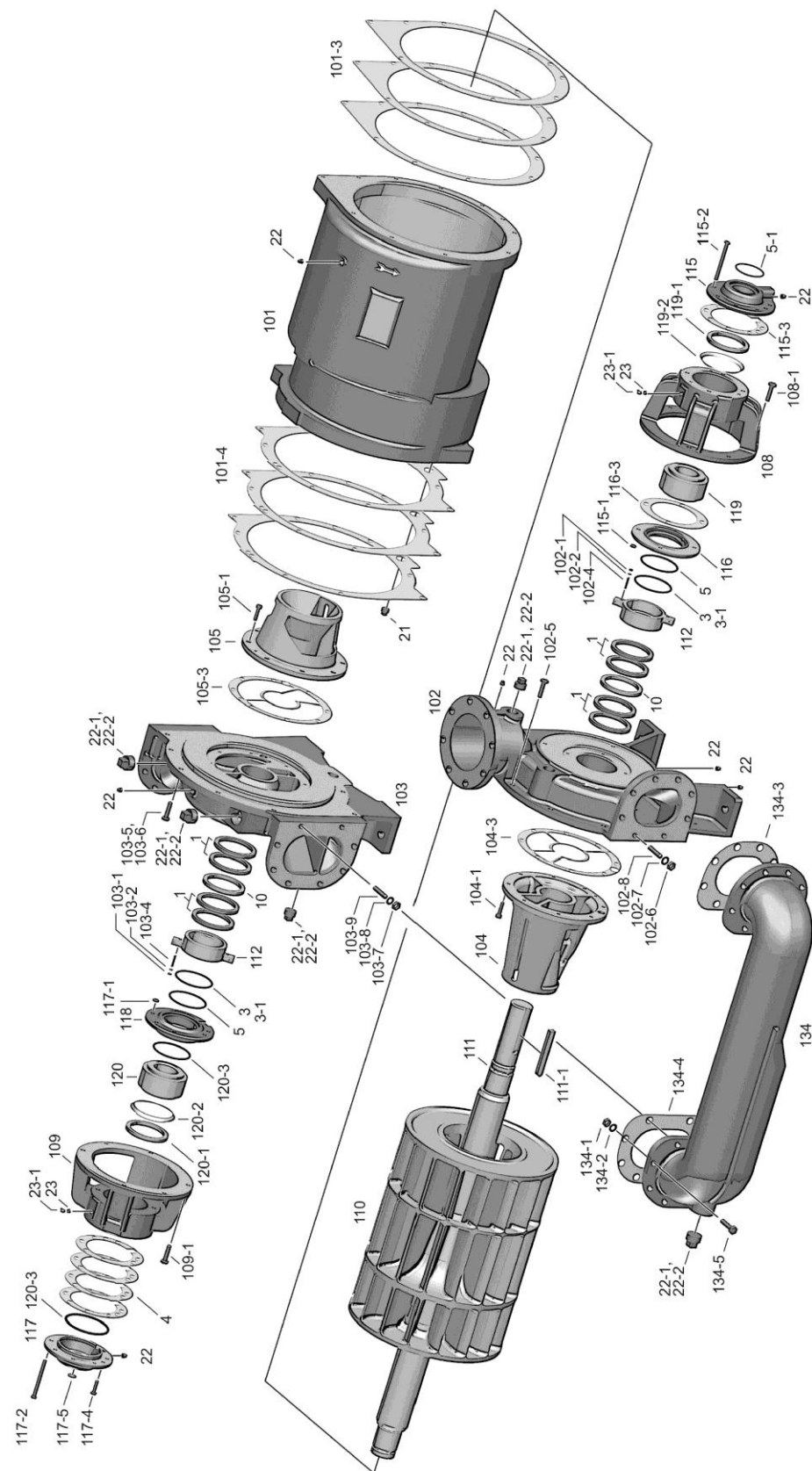
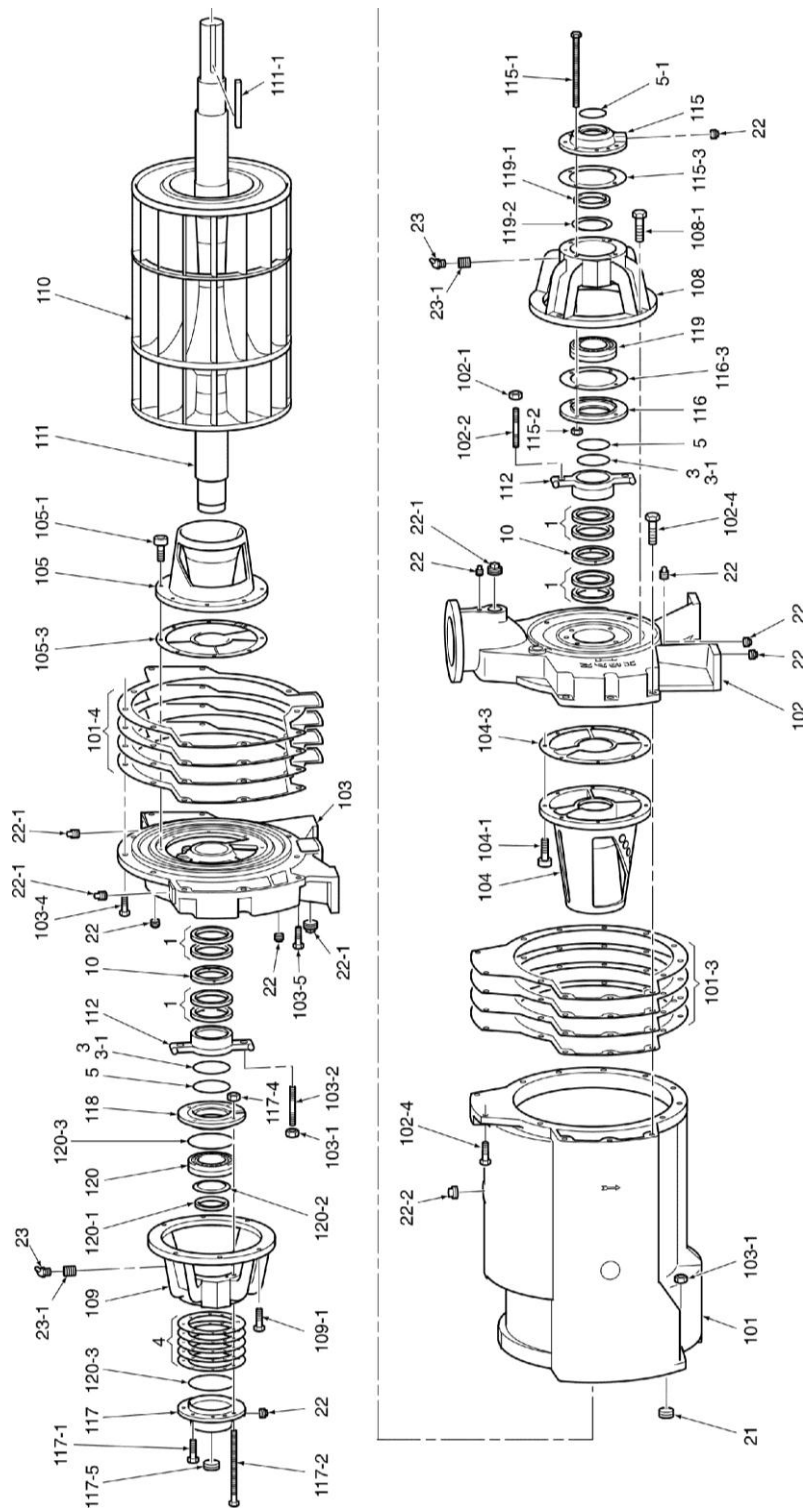


Fig. 12 Exploded view of TC-8 to TC-10 (delivered version may differ)





### 9.1.3 Assembly washer cross-section

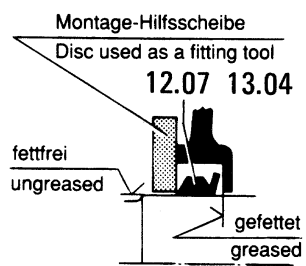


Fig. 14 Assembly washer

## 9.1.4 Circuit diagram examples

### Circuitry example

The following pipe diagram shows the essential components of an installation with separator, check valves and flushing liquid supply line

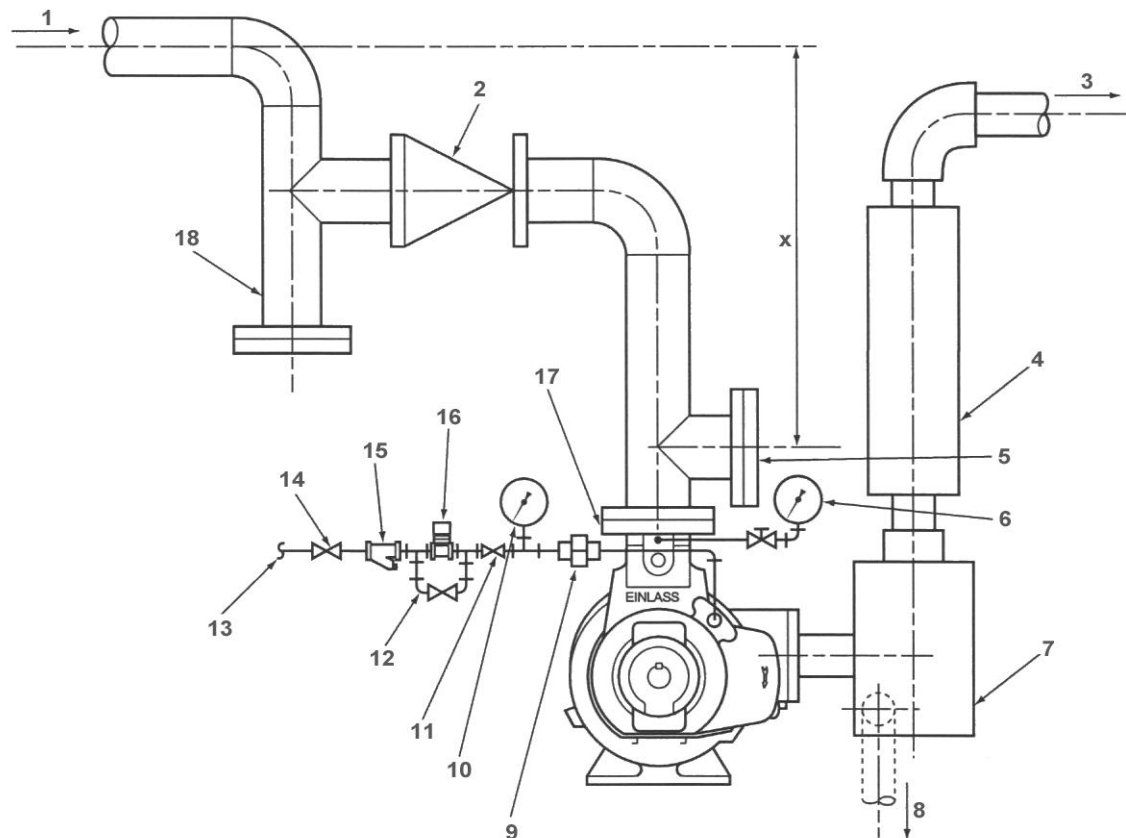


Fig. 15 Circuit diagram example

- |                            |                                                                                 |                                                                         |
|----------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| 1 Inlet, system connection | 7 Separator                                                                     | 13 Blocking fluid flange                                                |
| 2 Inlet check valve        | 8 Water outlet to outflow<br>► Immerse in water to 305 mm or<br>install siphon. | 14 Gate valve                                                           |
| 3 Gas outlet               | 9 Aperture screw connection or flow<br>quantity valve                           | 15 Strainer                                                             |
| 4 Noise damper             | 10 Pressure gage                                                                | 16 Magnetic valve                                                       |
| 5 Cleaning                 | 11 Tap                                                                          | 17 Temporary inlet filter                                               |
| 6 Vacuum meter             | 12 First filling bypass ball valve                                              | 18 If applicable dirt trap<br>(compulsory for stainless steel<br>pumps) |



In case of danger of water surges on the suction side:  
Select  $x \leq 3$  m

### 9.1.5 Flushing liquid connection

#### For stuffing boxes

For design with internal liquid wetting (TCM1...TCM3):

- ▶ Close connection for the supply line of the flushing liquid with a plug.
- ▶ It is not necessary to monitor the flushing liquid.

For design with external liquid supply (TC-5...TC-11):

- ▶ Attach flushing liquid supply line at the provided connection.
- ▶ In order to monitor the flushing liquid, install the following components in each flushing liquid supply line:
  - Flow rate measurement device (dependent on flow direction) or pressure gauge
  - Shut-off fitting

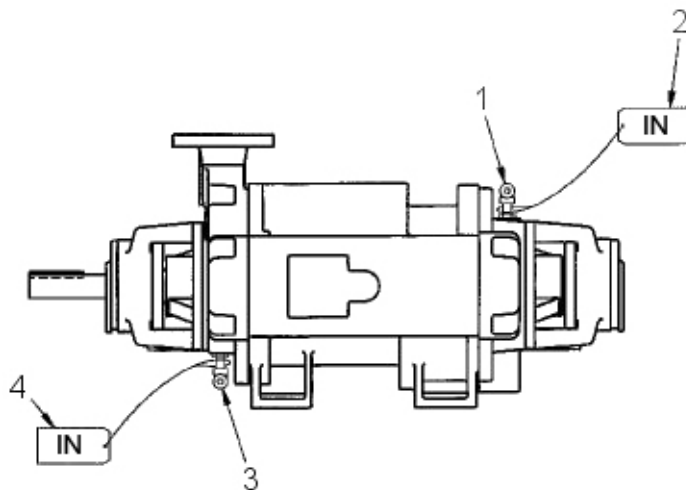


Fig. 16 Connection of pipelines/tubes: Stuffing box

- |                                                           |                                                       |
|-----------------------------------------------------------|-------------------------------------------------------|
| 1 Connection for flushing liquid supply, non-drive end    | 3 Connection for flushing liquid supply, drive end    |
| 2 Information sign, flushing liquid supply, non-drive end | 4 Information sign, flushing liquid supply, drive end |

## For mechanical seals

With mechanical seal, single-acting, with external flushing

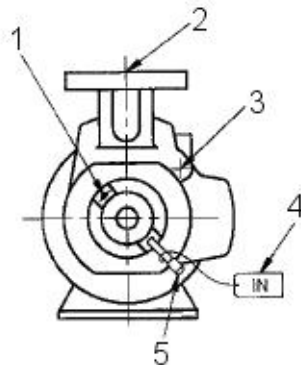


Fig. 17 Connection of pipelines/tubes: Mechanical seal, single-acting

- |                             |                               |                                         |
|-----------------------------|-------------------------------|-----------------------------------------|
| 1 Drain plug (double-sided) | 3 Operating liquid connection | 5 Connection for flushing liquid supply |
| 2 Suction branch            | 4 Flushing liquid supply      |                                         |

With mechanical seal, double-acting, with external flushing:

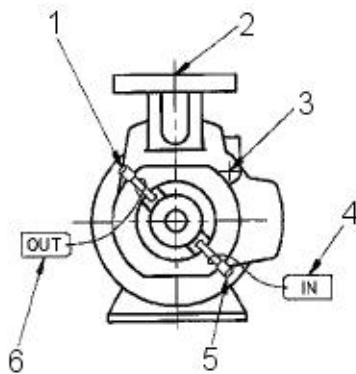


Fig. 18 Connection of pipelines/tubes: Mechanical seal, double-acting

- |                                         |                               |                                         |
|-----------------------------------------|-------------------------------|-----------------------------------------|
| 1 Connection for flushing liquid supply | 3 Operating liquid connection | 5 Connection for flushing liquid supply |
| 2 Suction branch                        | 4 Flushing liquid supply      | 6 Flushing liquid drain                 |

## 9.2 Technical specifications

### 9.2.1 Ambient conditions



Operation under any other ambient conditions should be agreed to with the manufacturer.

Temperature	Relative humidity [%]	
	Long-term	Short-term
-20 °C to +40 °C [≤ 104 °F]	≤ 85	≤ 100

Table 13 Ambient conditions

### 9.2.2 Sound pressure level

Type	Test speed [rpm]	Sound pressure level [dB (A)]
TCM1	1750	79.6
TCM2	1470	85
TCM3	1470	85
TC-5	1170	80
TC-7	980	83
TC-8	730	77
TC-9	590	80
TC-10	590	82
TC-11	590	90

Table 14 Sound pressure level



The A-rated sound pressure specifications (average sound pressure level at measurement surface or average sound power level) describe only the noise emitted by the vacuum pump.

They are applicable as per EN ISO 2251 and EN ISO 3746 exclusively within a test environment according to the standard with a tolerance of +3 dB.

The sound pressure levels at the site of installation may differ significantly due to the following factors:

- External noise not included in scope of supply (e.g. flow noise in connected pipes and components)
- Acoustic structural feedback (e.g. echoes, resonance).

### 9.2.3 Vibration

< 4.5 mm/s RMS for vacuum pumps



For special applications, the maximum value is 7.1 mm/s RMS.

### 9.2.4 Speed range TC/TCM

Type	Speed range in rpm	
	Vacuum pump	
TCM1	1470	2100
TCM2	1170	1750
TCM3	1170	1750
TC-5	980	1450
TC-7	890	1170
TC-8	600	980
TC-9	500	735
TC-10	450	705
TC-11	450	590

Table 15 Speed range

### 9.2.5 Tightening torques

**Bolts of strength class A4-70 (≤M20) or 8.8 and higher**

Thread size	Tightening torque	
	[Nm]	[ft lbs]
M8	20	15
M10	40	30
M12	70	52
M16	170	125
M20	340	250
M24	600	443

Table 16 Tightening torques for bolts of strength class A4-70 (≤ M20) or 8.8 and higher

## Bolts of strength class 4.8 to 6.8

Thread size	Tightening torque	
	[Nm]	[ft lbs]
M8	11	8
M10	22	16
M12	38	28
M16	92	68
M20	180	133
M24	310	230
M36	1080	797
M42	1700	1254

Table 17 Tightening torques for bolts of strength class 4.8 to 6.8

## 9.2.6 Weight specifications

Type	Material	Weight [kg]	Weight [lbs]
TCM1	Spheroidal iron	127	280
	Stainless steel	134	296
TCM2	Spheroidal iron	184	406
	Stainless steel	197	435
TCM3	Spheroidal iron	209	461
	Stainless steel	225	497
TC-5	Spheroidal iron	308	680
	Stainless steel	334	737
TC-7	Spheroidal iron	499	1100
	Stainless steel	544	1200
TC-8	Spheroidal iron	877	1934
TC-9	Spheroidal iron	1570	3462
TC-10	Spheroidal iron	1886	4158
TC-11	Grey cast iron	2126	4688
	Spheroidal iron	2159	4760
	Stainless steel	2313	5100

Table 18 Weight specifications

## 9.2.7 Gland packing sizes

Type	Cross-section [mm x mm]	Cross-section [inch x inch]	Number of rings
TCM1	3/8 x 3/8	95 x 95	4
TCM2	3/8 x 3/8	95 x 95	4
TCM3	3/8 x 3/8	95 x 95	4
TC-5	3/8 x 3/8	95 x 95	4
TC-7	1/2 x 1/2	127 x 127	4
TC-8	5/8 x 5/8	16 x 16	4
TC-9	5/8 x 5/8	16 x 16	4
TC-10	3/4 x 3/4	19 x 19	4
TC-11	3/4 x 3/4	19 x 19	4

Table 19 Technical data for gland packing

## 9.2.8 Pumped fluids

### Vacuum mode

Size	Value
Pumped fluid type	Gas as per planning documents or catalog
Permissible absolute intake pressure	33 mbar [0.48 psia]
Permissible absolute discharge pressure	1013 mbar [14.7 psia]
Permissible temperature range	0 °C to 80 °C [32 °F to 176 °F]

Table 20 Pump pumped fluid

### 9.2.9 Seal liquids

Size		Value
Properties		Non-flammable, non-explosive, non-aggressive, non-toxic (e.g. water) Free of foreign matter Matching the processed materials and media
Temperature	Nominal value	15°C [59 °F]
	Limit values	0°C...65°C [32 °F...140 °F]
Vapor temperature		At least 10 K above operating temperature
Particle size		< 10 µm
Solids content		< 200 ppm
Viscosity		< 25 cSt

Table 21 Requirements for seal liquids

### Standard seal liquid flow rates in vacuum mode

Type	Motor speed	Seal liquid flow rate [m³/h] per intake pressure [mbar]
	min <sup>-1</sup>	1013 – 33 mbar abs.
TCM1	1470	0.9
	1600	0.9
	1750	1.1
	2100	1.8
TCM2	1170	1.1
	1320	1.8
	1470	2.3
	1620	2.3
	1750	2.7
TCM3	1170	1.4
	1320	1.8
	1470	2.7
	1620	2.7
	1750	3.2
TC-5	1170	3.4
	1320	4.1
	1470	4.8
TC-7	890	3.4
	980	4.6
	1170	5.7
TC-8	All	5.7
TC-9	500	5.7
	All others	6.8
TC-10	All	8.0
TC-11	450	8.0
	500	10.2
	550	10.2
	590	10.2

Table 22 Seal liquid flow rate in vacuum mode (ISO units)



Type	Motor speed	Seal liquid flow rate [US gpm] per intake pressure [inch HgV]
	min <sup>-1</sup>	0 – 29 inch HgV
TCM1	1470	3.9
	1600	3.9
	1750	4.8
	2100	7.9
TCM2	1170	4.8
	1320	7.9
	1470	10.1
	1620	10.1
	1750	11.9
TCM3	1170	6.2
	1320	7.9
	1470	11.9
	1620	11.9
	1750	14.1
TC-5	1170	14.9
	1320	18.1
	1470	21.2
TC-7	890	14.9
	980	20.3
	1170	25.1
TC-8	All	25.1
TC-9	500	25.1
	All others	30
TC-10	All	35.2
TC-11	450	35.2
	500	44.9
	550	44.9
	590	44.9

Table 23 Seal liquid flow rate in vacuum mode  
(US units)

### 9.2.10 Flushing liquid for shaft sealing with external flushing

Size		Value
<b>Type</b>		→ Chapter 9.2.9, Page 48
<b>Temperature</b>	Nominal value	+15 °C [59 °F]
	Limit value	Min. 0 °C [32 °F] Max. 65 °C [149 °F]  Maximum temperature of 65 °C or minimum clearance of 10 K to vapor pressure of flushing liquid in the sealing chamber. The lower value must be applied.  Consult the manufacturer of the shaft sealing, if necessary.
<b>Inlet pressure</b>	For stuffing boxes:	0.1...0.3 bar [1.45...4.35 psi] above discharge pressure. Adjust to slight dripping.
	For single-acting mechanical seal:	Ca. 0.1...0.3 bar [ca. 1.45...4.35 psi] above inlet pressure of seal liquid (with branching of seal liquid supply line) OR above discharge pressure (with external supply line)
	For double-acting mechanical seal:	According to specifications of the manufacturer.
<b>Flow rate</b> (Supply on D- and N-side!)	For stuffing boxes:	0.5 dm <sup>3</sup> /min [0.132 gal (US)/min (0.017 ft <sup>3</sup> /min)] Heavily dependent on the setting of the stuffing box. Adjust to slight dripping.
	For mechanical seals:	According to specifications of the manufacturer.

Tab. 24 Flushing liquid for shaft sealing with external flushing

### 9.2.11 Lubricants

**i** Use heavy-duty bearing greases of consistency grade NLGI 2 with an operating temperature range of -18 °C to +120 °C (-0.4 °F to 248 °F).

Manufacturer	Grease name
Shell	Alvania EP (LF) 2
BP	Energrease LS2
Agip	GR MU EP2
Chevron	Dura-Lith Grease EP2
DEA	Paragon EP2
Esso	Baecon EP2
Mobil	Mobilux EP2
Texaco	Multifrak Multipurpose 2
Gulf	Gulfsrown no. 2
Century	Lupos A2
Nynas	Alexol L-42

Table 25 Recommended greases

Machine type	Machine end	Grease lubrication quantities	
		[g]	[oz.]
TCM1	D-side	51	1.8
	N-side	51	1.8
TCM2	D-side	51	1.8
	N-side	72	2.5
TCM3	D-side	51	1.8
	N-side	72	2.5
TC-5	D-side	85	3.0
	N-side	85	3.0
TC-7	D-side	63	2.2
	N-side	57	2.0
TC-8	D-side	84	2.9
	N-side	84	2.9
TC-9	D-side	150	5.3
	N-side	150	5.3
TC-10	D-side	150	5.3
	N-side	150	5.3
TC-11	D-side	233	8.2
	N-side	233	8.2

Table 26 Minimum amounts for grease lubrication

## Relubrication intervals

The bearings should be lubricated in intervals of 6 months.



The relubrication intervals are valid for normal-load, low-vibration running, approximately neutral ambient air and providing that high-quality antifriction bearing greases from the selection listed in the table are used. In the case of unfavorable conditions, e.g. increased humidity of ambient air, the relubrication intervals must be correspondingly shortened.

- Change the grease after every 50 000 hours of operation.

## 9.2.12 Descaling solutions

Descaling solutions	Notes
15-17 parts by weight of 80% phosphoric acid to 100 parts by weight of water	Cleaning when machine is at a standstill
2 parts by weight of 80% phosphoric acid to 100 parts by weight of water	Cleaning when machine is at a standstill
5% formic acid	

Table 27 Descaling solutions

## 9.2.13 Preservative



Recommended preservative AVILUB VCI 1414. AVILUB VCI 1414 is a ready-to-use mixture of organic corrosion inhibitors on an aqueous basis with film-coating properties. It is biologically degradable and its vapors are not harmful to health. AVILUB VCI 1414 contains no nitrites, chromates, or silicones.

### 9.2.14 Flange loads according to ISO 5199

Type	Flange 1 (inlet)							Flange 2 (outlet)						
	DN [mm]	F <sub>x</sub> [N]	F <sub>y</sub> [N]	F <sub>z</sub> [N]	M <sub>x</sub> [Nm]	M <sub>y</sub> [Nm]	M <sub>z</sub> [Nm]	DN [mm]	F <sub>x</sub> [N]	F <sub>y</sub> [N]	F <sub>z</sub> [N]	M <sub>x</sub> [Nm]	M <sub>y</sub> [Nm]	M <sub>z</sub> [Nm]
TCM1	50	392	783	393	78	155	78	50	392	392	783	78	78	155
TCM2	50	392	783	393	78	155	78	50	392	392	783	78	78	155
TCM3	50	392	783	393	78	155	78	50	392	392	783	78	78	155
TC-5	100	1158	2315	1158	445	890	445	75	810	810	1620	239	239	478
TC-7	150	2030	4060	2030	1175	2345	1175	100	1158	1158	2315	445	445	890
TC-8	150	2030	4060	2030	1175	2345	1175	100	1158	1158	2315	445	445	890
TC-9	200	3050	6100	3050	2326	4654	2326	150	2030	2030	4060	1176	1176	2345
TC-10	200	3050	6100	3050	2326	4654	2326	150	2030	2030	4060	1176	1176	2345
TC-11	200	3050	6100	3050	2326	4654	2326	150	2030	2030	4060	1176	1176	2345

Table 28 Forces and torques permissibly applicable to the flanges (ISO units)

Type	Flange 1 (inlet)							Flange 2 (outlet)						
	DN [inch]	F <sub>x</sub> [lbs]	F <sub>y</sub> [lbs]	F <sub>z</sub> [lbs]	M <sub>x</sub> [ft-lbs]	M <sub>y</sub> [ft-lbs]	M <sub>z</sub> [ft-lbs]	DN [inch]	F <sub>x</sub> [lbs]	F <sub>y</sub> [lbs]	F <sub>z</sub> [lbs]	M <sub>x</sub> [ft-lbs]	M <sub>y</sub> [ft-lbs]	M <sub>z</sub> [ft-lbs]
TCM1	2	88	176	88	57	114	57	2	88	88	176	57	57	114
TCM2	2	88	176	88	57	114	57	2	88	88	176	57	57	114
TCM3	2	88	176	88	57	114	57	2	88	88	176	57	57	114
TC-5	4	259	518	259	328	656	328	3	182	182	364	176	176	352
TC-7	6	456	912	456	867	1730	867	4	259	259	518	328	328	656
TC-8	6	456	912	456	867	1730	867	4	259	259	518	328	328	656
TC-9	8	685	1370	685	1716	3432	1716	6	456	456	912	867	867	1730
TC-10	8	685	1370	685	1716	3432	1716	6	456	456	912	867	867	1730
TC-11	8	685	1370	685	1716	3432	1716	6	456	456	912	867	867	1730

Table 29 Forces and torques permissibly applicable to the flanges (US units)

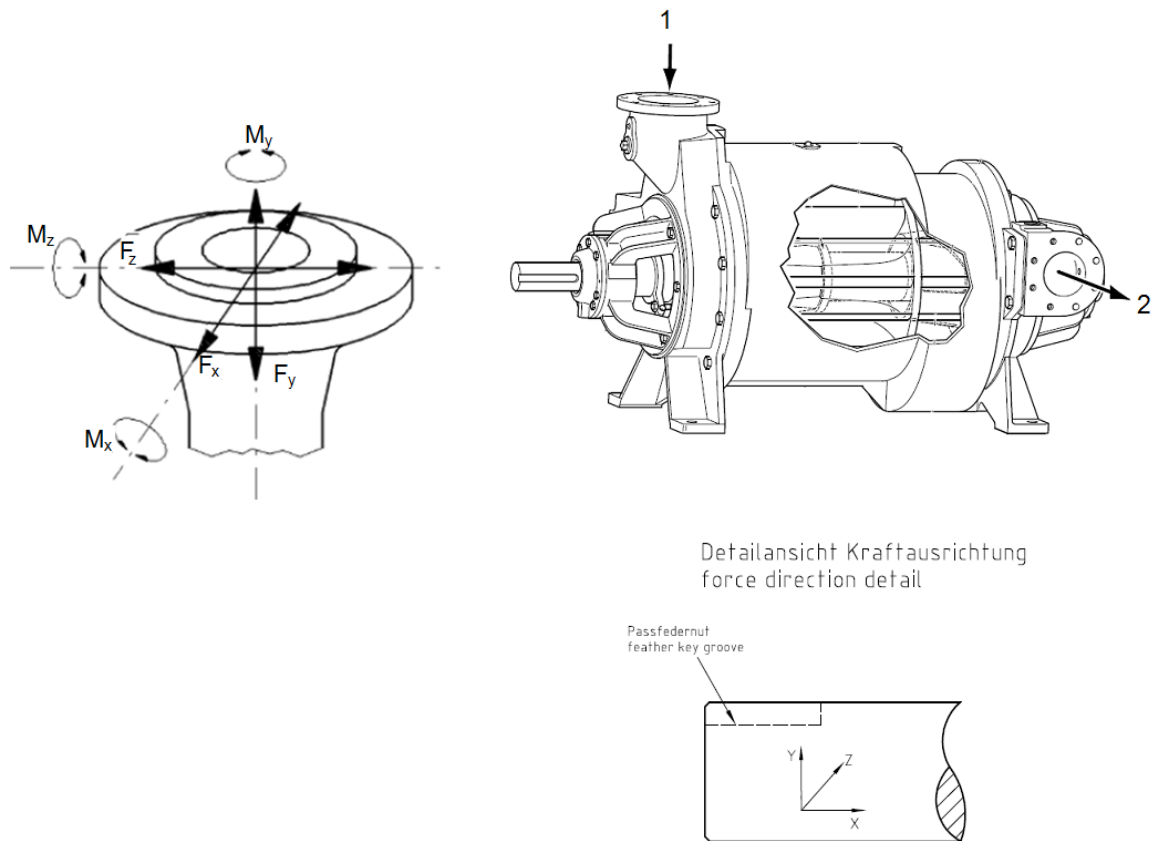


Fig. 19 Overview of forces and torques to which the flanges are subjected

### 9.3 Safety certificate

Fill in, sign, and submit this certificate when returning the assembly/machine for repairs and/or maintenance.

**Repair and/or maintenance of the returned assembly/machine will be performed only if this certificate has been filled in completely and submitted. A separate certificate needs to be submitted for each assembly/machine.**

**The certificate should be attached to the exterior packaging. An additional copy of the certificate needs to be submitted in advance, e.g. by fax, to the factory executing the order.**

**This certificate may be filled out by qualified personnel with the operator's express authorization.**

#### Operator's details:

Company/department/institute: \_\_\_\_\_  
 Street: \_\_\_\_\_  
 City, zip code: \_\_\_\_\_  
 Contact person: \_\_\_\_\_  
 Position: \_\_\_\_\_  
 Phone no.: \_\_\_\_\_  
 Fax no.: \_\_\_\_\_

#### Details of the assembly/machine:

Product designation: \_\_\_\_\_  
 Type: \_\_\_\_\_  
 Factory no. (No.N): \_\_\_\_\_  
 Reason for return: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

The signatory hereby certifies that the above assembly/machine<sup>\*)</sup>

- ☐ Has not been in contact with hazardous substances.  
☐ Has not been used in any materials and/or components, such as seals, containing asbestos.  
☐ Was used for the following application \_\_\_\_\_  
 \_\_\_\_\_

and came into contact with the following substances subject to mandatory identification or harmful to health:

Trade name:	Chemical name:	Substance properties (e.g. toxic, flammable, corrosive, radioactive):

<sup>\*)</sup> Check as appropriate

Table 30 Safety certificate

## Service Centers

Australia	Wetherill Park, Sydney, NSW
Brazil	Campinas-SP
China	Boshan, Beijing, Shanghai, Chengdu, Guangzhou
Germany	Nuremberg
The Netherlands	Assendelft
Singapore	Singapore
South Africa	Wadeville
South Korea	Seoul
United Kingdom	Winsford, Cheshire
USA	Birmingham, AL Cleveland, OH Houston, TX St. Peters, MO Vancouver, WA

Please refer to our website for the full addresses:

[www.GDNash.com](http://www.GDNash.com) → Sales & Service → Service Contacts



### **Nash – Zweigniederlassung der Gardner Denver Deutschland GmbH**

Katzwanger Straße 150

90461 Nuremberg

Germany

Edition 06/2015  
Print no. OM5001  
Language EN

Phone: +49 (0) 911-1454-0  
+49 (0) 911-1454-5256 (Service)  
Fax: +49 (0) 911-1454-6935  
+49 (0) 911-1454-5252 (Service)  
E-mail: [nash.de@gardnerdenver.com](mailto:nash.de@gardnerdenver.com)  
Internet: [www.GDNash.com](http://www.GDNash.com)

We reserve the right to make technical changes.