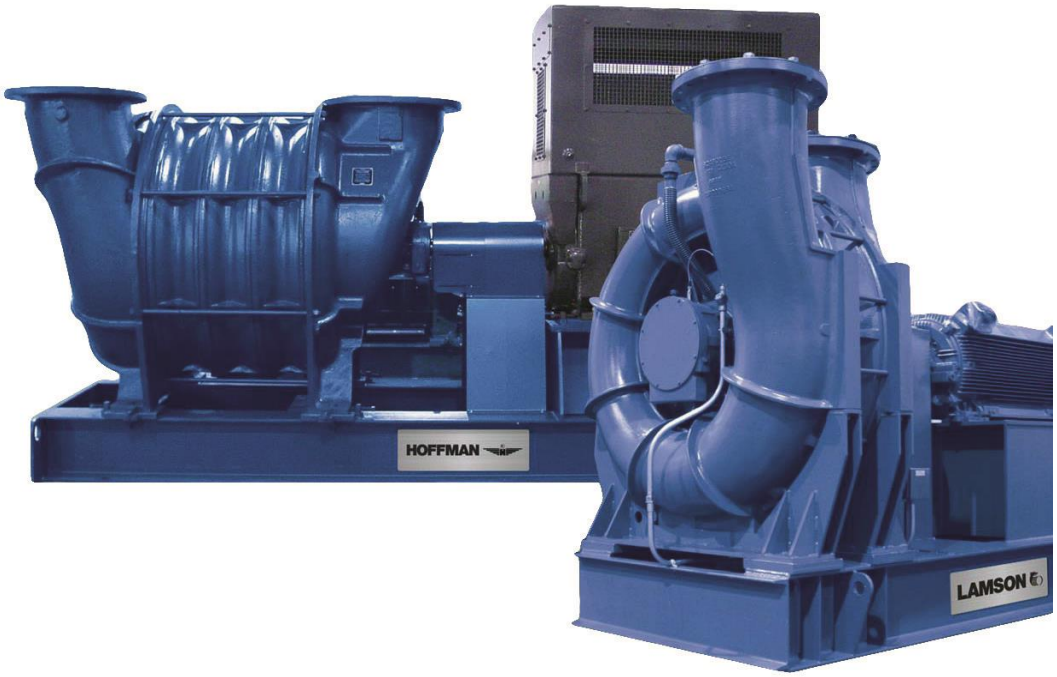
HOFFMAN LAMSON
by Gardner Denver

Multistage Centrifugal Blower

Original Operating Manual



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

Table of contents

Table of figures

List of tables

1 About this document

This manual:

- is part of the machine
- applies to all types noted on the bottom of the page (Chapter 1.3, Page 6)
- describes safe and appropriate operation during all operating phases

1.1 Target groups

Target group	Duty
Operating company	▶ Keep this manual accessible at the site of operation of the equipment, including for later use. ▶ Make sure that personnel read and follow the instructions in this manual and the other applicable documents, especially the safety instructions and warnings. ▶ Observe any additional rules and regulations that relate to the system. ▶ Assign only qualified personnel to work with the machine.
Qualified personnel, fitter	▶ Read, observe, and follow this manual and the other applicable documents, especially all safety instructions and warnings.

Table 1 Target groups and their duties

1.2 Other applicable documents

Document	Purpose
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, coupling, control systems • Instructions for handling the laser alignment device and the design data sheet for the specific machine
Technical data sheet	Dimensions, declaration of weight and power curves
Machine-specific construction sheet	Ensuring operation

Table 2 Other applicable documents and their purpose

1.3 Area of validity

This manual applies to the following models:

- Catalog models: 42, 260, 310, 400, 510, 550, 732, 741, 742, 751, 752, 761, 791, 850, 870, 1260, 1270, 1400, 1600, 1870, 2000, 2400, 930, 940, 950, and 960
- Non-catalog models: 40, 41, 250, 671 and 810
- Fabricated Models: T1, T2, and T3 series

1.4 Warnings and symbols

Warning	Risk level	Consequences of disregard
⚠ DANGER	Immediate acute risk	Death, serious bodily harm
⚠ WARNING	Potential acute risk	Death, serious bodily harm
⚠ CAUTION	Potentially hazardous situation	Minor bodily harm
NOTE	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

1.5 Technical terms

Term	Meaning
Test pressure also: – Testing pressure	Pressure applied to the machine during leak test.
Unit	Assembly comprised of machine and drive motor.
Intake pressure	Pressure of the gases/vapors to be charged at the machine's inlet port.
Drive end also: – D-side – DE (drive end)	End of the machine to which the drive is connected
Outlet pressure	Pressure of the gases/vapors to be charged at the machine's outlet port.
Blower/exhauster	Machine for generating vacuum or pressure (compressor)
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 explicit authorization for performing the respectively required tasks from the party responsible for safe operation of the system.
Machine	In this context: the blower. 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.
Non-drive end also: – N-side – NDE (non-drive end)	End of the machine to which no drive is connected.

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 machine to move the stipulated fluids (→ Machine-specific construction sheet).
- Do not operate the machine above the maximum permissible speed (→ Chapter 3.1.1, Page 10).
- Do not operate the machine below the permissible charged flow rate.
- Avoid surge:
  - Do not operate the machine with the fitting on the outlet end 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 the Machinery Directive 2006/42/EC.

Prevention of obvious misuse (examples)

- Observe the operating limits of the machine in respect of temperature, pressure, vibration and motor speed/amps.
- 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 have 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 inhale the air discharged at the outlet port
- 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 secured against restart 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 charged fluids

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

3 Layout and function

3.1 Name plates

3.1.1 Standard Name plate

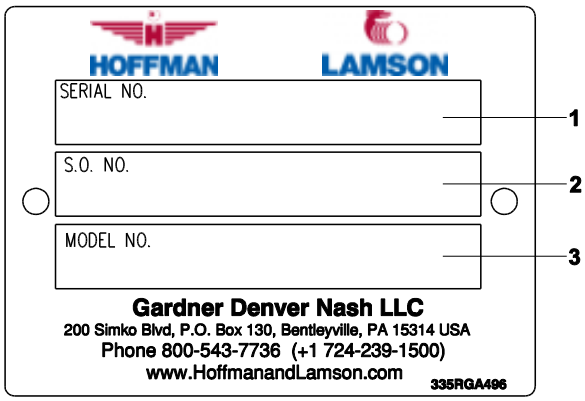


Fig. 1 Standard Name plate

1 Serial number
2 Sales order number
3 Model number

3.1.2 ATEX & CE Name plate

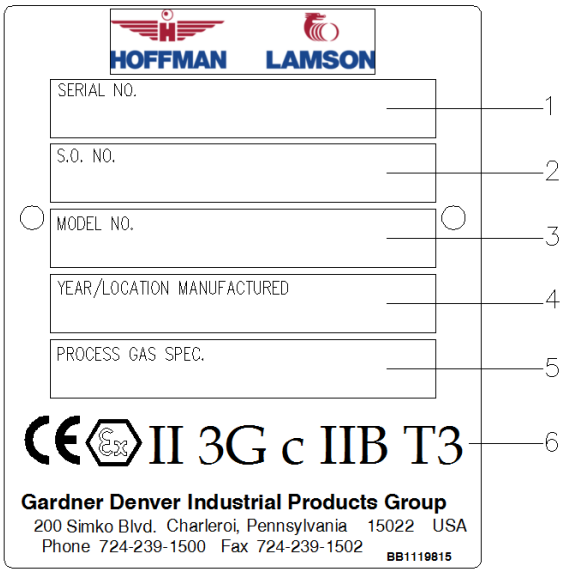


Fig. 2 ATEX & CE Name plate

1 Serial number
2 Sales order number
3 Model number
4 Manufactured location and year
5 Specific process gas data
6 Permissible ATEX classification

3.2 Layout

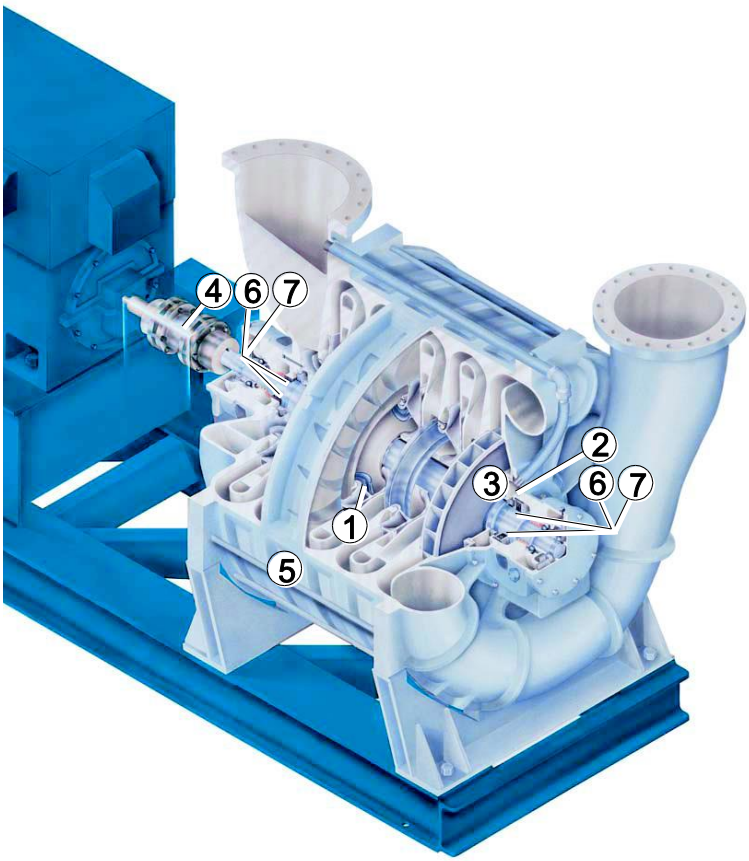


Fig. 3 Blower layout

1 Multistage guide plates

2 Hydraulic axial thrust compensation

3 Impellers

4 Flexible coupling

5 Housing

6 Labyrinth seal (standard)

7 Carbon ring seal/ MAX seal (optional)

3.3 Shaft bearing

The fixed bearing on the 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 bearing on the non-drive end only bears radial forces.

The bearings are lubricated with grease or oil.

3.4 Function

Blowers are dynamic low pressure compressors.

An impeller rotates within the casing. As the impeller rotates, air enters the eye of the impeller. The rotation of the impeller accelerates the air radially outwards. There, part of the dynamic pressure is converted into static pressure.

The overall characteristics of the blower are determined by the number of stages and the selection of the impellers. For example, higher pressure can be generated by employing several impellers in series. Air from a previous stage moves radially into the eye of the next impeller, so that the process is repeated, increasing the pressure at each stage.

The individual stages of the blower increase the compression heat causing raised temperatures at the outlet. This difference in the heat generated at the inlet and outlet ends requires a precise alignment of the blower to the motor, in particular when the operating temperature is reached. This generation of heat causes thermal growth of the blower at the outlet end and must be taken into account when aligning the coupling while it is cold (→ Chapter 5.7.3, Page 24).

3.4.1 Pressure surges

Pressure surges occur when the flow rate falls below the minimum permitted threshold for which the blower is designed. This causes an interruption of the flow that results in return flow and pulsation of the fluid.

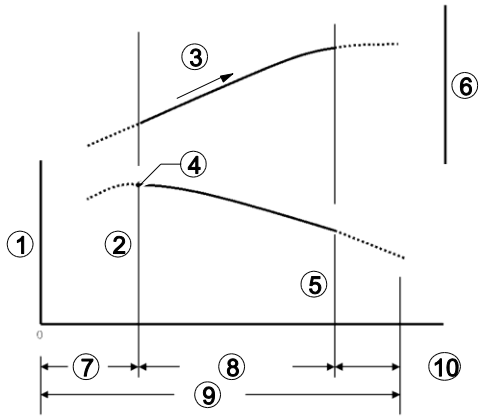


Fig. 4 Occurrence of pressure surges

1 Pressure (in bar/PSI)
2 Pressure surge limit
3 Increasing amperage as flow rate increases
4 Peak pressure
5 Maximum flow rate
6 Motor amperage
7 Pressure surges
8 Safe operating range
9 Flow rate (in m³/h/CFM)
10 Motor overload

The following problems can be caused by pressure surges and, in the worst case, damage the machine irreparably:

- Severe damage to the impellers
- Rotating components in the machine collide
- Bearing failure
- Damage to the shaft
- Damage to the machine due to increased operating temperature

3.5 Further equipment (if provided)

- Cooling Coils:

For optimized performance, use the lowest temperature cooling water available. If cooling is insufficient, increase the flow rate to improve the effectiveness of the cooling coil.

- Heat Shield:

In some applications, a heat shield may be installed. This design helps to block the bearing housing from weather and radiant heat from the machine surfaces.

- Cooling Fan:

⚠ CAUTION

Rotating equipment, risk of injury!

▶ Ensure the cooling fan guard is properly installed, preventing human contact with the fan.

- Purge Seals:

For optimized performance, supply a pressure of 3.5 KPa (0.5 PSIG) greater than the machine internal pressure. This will mitigate the chances for process leakage to ambient air.

4 Transport, storage, and disposal

4.1 Transport

Observe the weight specifications (→ order specific outline drawing).

4.1.1 Unpacking and inspection on delivery

Standard scope of delivery includes only the machine itself (excluding additional components such as fittings, valves, ball 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 accessories appropriate for the total weight to be transported.
- ▶ Fasten the lifting accessories as illustrated. Make sure that no connected fittings are damaged.
- ▶ Never fasten lifting accessories to the shaft.
- ▶ Never fasten lifting accessories to the motor eyebolt.
- ▶ Do not stand under suspended loads.
- ▶ Set the load down on a level surface.

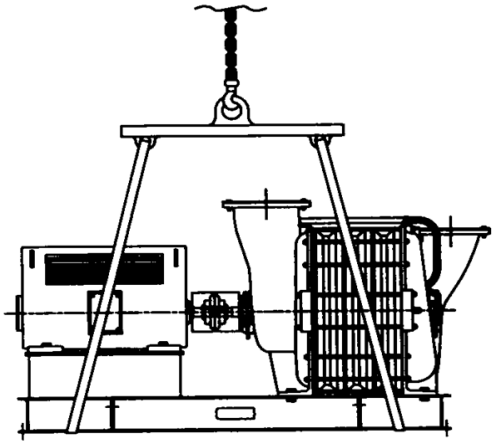


Fig. 5 Fastening the lifting accessories to the steel base of the machine group

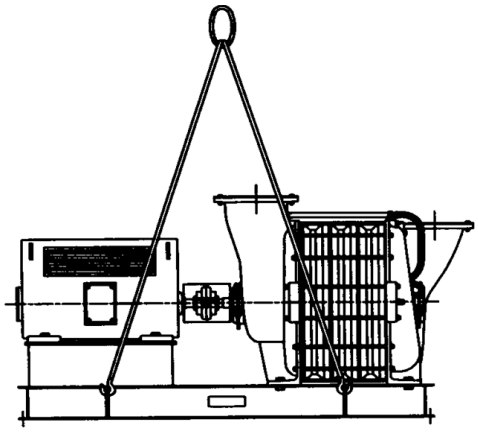


Fig. 6 Fastening the lifting accessories with eye bolts to the machine group

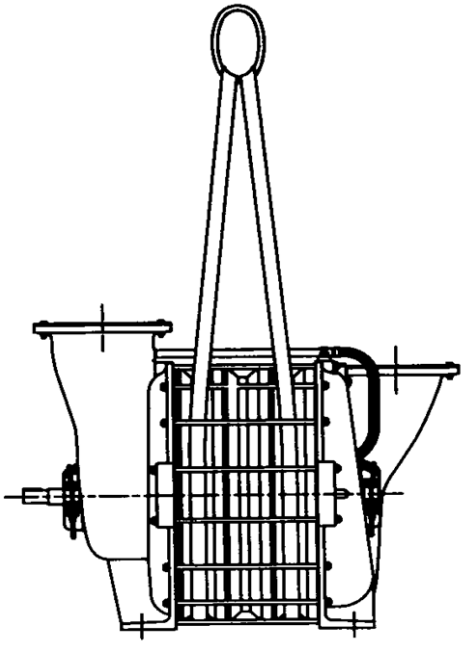


Fig. 7 Fastening the lifting accessories to an individual machine

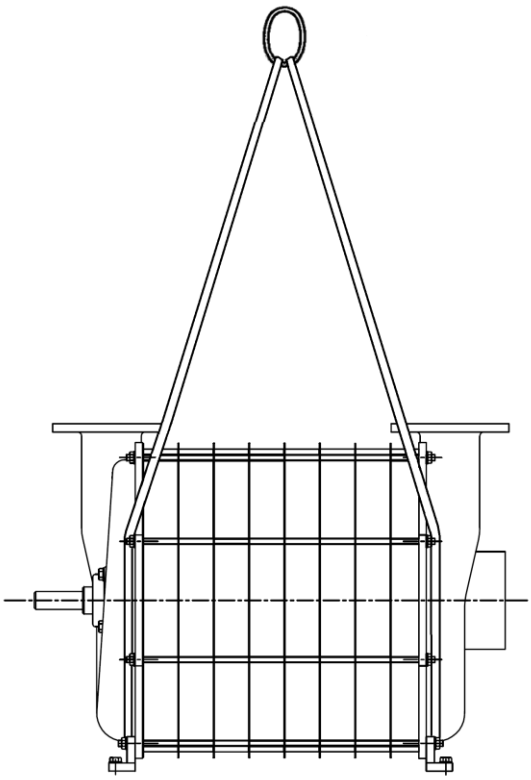


Fig. 8 Fastening the lifting accessories to an individual T–Series machine

1. Lift machine/package correctly.
   - A single cast machine: Fasten the slings as near as possible to the inlet and outlet heads and run them under the tie rods.
   - A single fabricated machine: Fasten the slings as near to the inlet and outlet mounting feet as possible and run them parallel to the heads.
   - Do not place the slings around the shaft or a flange.
   - Do not place the slings over the tie rods. Always run the slings under the tie rods.
2. Lower machine/package correctly.
   - Take care to prevent impacts.

4.2 Preservation

Machines can be preserved as follows:

- Capsules filled with anti-corrosion agents
- Rust-inhibitor spray

4.3 Storage

NOTE

Risk of damage due to inappropriate storage!

▶ Treat and store the machine properly.

4.3.1 Short term storage (within 90 days)

1. Make sure the storage room meets the following conditions:
   - Dry
   - Stays above freezing
   - Vibration-free
   - Level
   - Well ventilated
2. Turn the impeller through 5 to 10 revolutions every week.

4.3.2 Long-term storage

For storage periods longer than 90 days, the following instructions apply in addition to the instructions for short-term storage (→ Chapter 4.3.1, Page 14).

Storage of the machine

1. Every 6 months, remove a flange cover to inspect internal surfaces of the machine for signs of rust:
   - If there are signs of rust, reapply corrosion protection.
2. Check the external surfaces of the machine for signs of rust:
   - If there are signs of rust, apply an anti-corrosion coating to the machine.

Storage of the motor

▶ Observe the instructions of the motor manufacturer in respect to storage (→ Chapter 1.2, Page 5).

4.4 Removing the preservative

Anti-corrosion capsules (if used) must be removed:

1. Remove the covers of the inlet and outlet flanges.
2. Remove the anti-corrosion capsules.

4.5 Disposal

WARNING

Risk of poisoning and environmental damage by the charged fluids!

- ▶ 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, oil, or grease escaping from the bearings in accordance with local regulations.
  - – Neutralize residues of charged fluids in the machine.
  - – Remove the preservative (→ Chapter 4.4, 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).

If you have any questions or problems in respect of the installation and commissioning, you can obtain support from Hoffman & Lamson Service.

CAUTION

Risk of injury through burns due to high surface temperatures!

During operation of the machine, surface temperatures > 50 °C (122 °F) occur at the outlet end.

- ▶ Provide the personnel with thermal protective equipment.

NOTE

Risk of 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 attach crane rope to bearings.
- ▶ Remove anti-corrosion coating (if present) from the shaft end with acetone. Do not use scrapers or emery cloth. Afterwards, coat shaft ends with grease.

NOTE

Risk of 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 impeller/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

NOTE

Risk of overheating due to insufficient ambient air flow!

- ▶ Ensure an air turnover rate of at least 10, specifically in the area relative to the blower discharge.

- ▶ Make sure that the required ambient conditions are fulfilled.

5.1.3 Sliding foot arrangement (if present)

- ▶ Make sure that the sliding foot arrangement is not blocked on the non-drive end side.
- ▶ Make sure that all horizontal adjusting screws on the non drive end side are loose.

5.1.4 Preparing the installation site

NOTE

Risk of freezing during installation 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 is not exposed to external vibrations (damage to bearings)
- Frost protected
- Grounding in accordance with local regulations and in accordance with explosion-protection regulations if applicable (→ Chapter 1.2, Page 5).
- All valves and controls are easily accessible. Consider ladders and handrails to increase accessibility.

5.1.5 Preparing the foundation and surface

▶ Make sure that 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
- Will ensure the package is stable and cannot tip over

▶ Check the horizontal alignment of the foundation using a surveyor's level.

▶ Make sure the foundation meets the following requirements:

- Clean and level with a maximum unevenness of 0.5 % (1/16” per foot [5.3 mm/m] slope)
- Clean and level with a maximum deviation of 3.1 mm (1/8 inch) over the length and width of the foundation

5.1.6 Balancing the impellers and rotor assembly

The impellers and rotor assembly are balanced in accordance with ISO 1940/1 to G2.5 tolerance.

5.2 Installing the machine

NOTE

Risk of damage due to distortion of the base frame!

▶ The anchor bolts are only to be used as locating bolts:

- Hand tighten the hardware, then back off ½ turn.
- Lock the hardware in place with a jam nut.
- Make sure that there is space between the hardware and base.

▶ Do not set the base frame of the machine in concrete.

5.2.1 Setting the machine on the foundation

1. Lift the machine with the base frame (→ see Chapter 4.1.2, Page 13).
2. Place the supplied mounting dampers under the base frame as indicated by the decals on the base. Failure to comply may result in harmful vibrations.
3. Set the machine on the foundation.

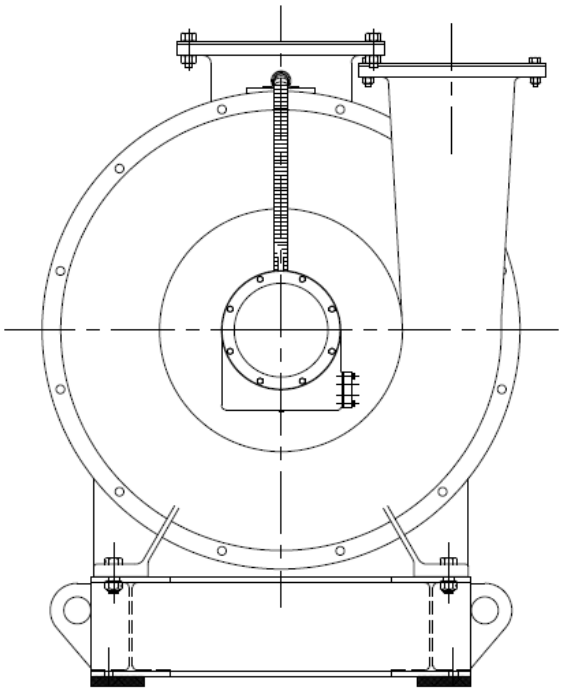


Fig. 9 Mounting dampers (black) under the machine

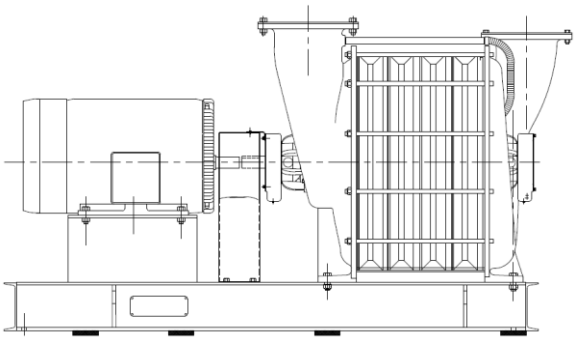


Fig. 10 Mounting dampers (black) under the machine – side view (reference only)

4. Ensure that the load is evenly distributed over the mounting dampers on the base (→ order specific outline drawing). Pad locations can be adjusted to reduce vibration.

5.2.2 Aligning the machine

NOTE

Risk of damage due to inappropriate alignment!

- ▶ Compensate for height differences exactly as described.
- ▶ Align the drive train exactly as described by THE HOT ALIGNMENT TAG.

1. Ensure that the machine stands steady. If necessary, compensate for any remaining distance between base frame and foundation by using, for example, metal shims.
   - – Place metal shims between the mounting dampers and the foundation.
2. If aligning pins are available, use only to position the machine.
   - – Ensure that there is space around the aligning pins.
   - – Ensure that the aligning pins are not in contact with the foundation.

5.3 Installing the motor

Observe the manufacturer's installation and operating instructions.

NOTE

Risk of damage due to knocks and bumps!

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

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 flexible element from coupling and heat the coupling halves up to approximately 100 °C [210 °F].
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, Coupling manufacturer's instructions).
5. Screw in the motor bolts, but do not tighten them yet.

5.4 Planning the pipe lines

Piping connection diagrams (→ Chapter 9.2, Page 40).

Observe the technical specifications on charged fluids, permissible pressures (intake, discharge, and test pressure) (→ Chapter 9.2.8, Page 44).

5.4.1 Specifying supports and flange connections

NOTE

Risk of damage due to excessive forces and torques exerted by the piping on the machine!

▶

1. Calculate the pipe line forces, taking every possible operating condition into account:
   - Cold/warm
   - 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.
3. Make sure that the pipe lines and all accessories are suitable for high temperatures (temperatures may exceed 149 °C [300 °F]. according to Machine-specific construction sheet).
4. Take precautions in respect of the thermal expansion of the machine and pipe lines. Use flexible connections as much as possible.

5.4.2 Specifying nominal diameters

Keep the flow resistance in the pipe lines as low as possible.

1. Make sure the nominal inlet pipe diameter is ≥ the nominal inlet port diameter.
2. Make sure the nominal outlet pipe diameter is ≥ the nominal outlet port diameter.

5.4.3 Providing accessories

Installing a throttle valve

Use a throttle valve in the inlet pipe line to ensure that the machine starts correctly and that the flow rate through the machine can be controlled.

1. Install a throttle valve in the inlet pipe line.
2. Ensure that a settling section of twice the pipe diameter is observed (→ Fig. 13, page 20).
3. Observe the correct alignment and opening direction of the throttle valve (→ Fig. 13, page 20).

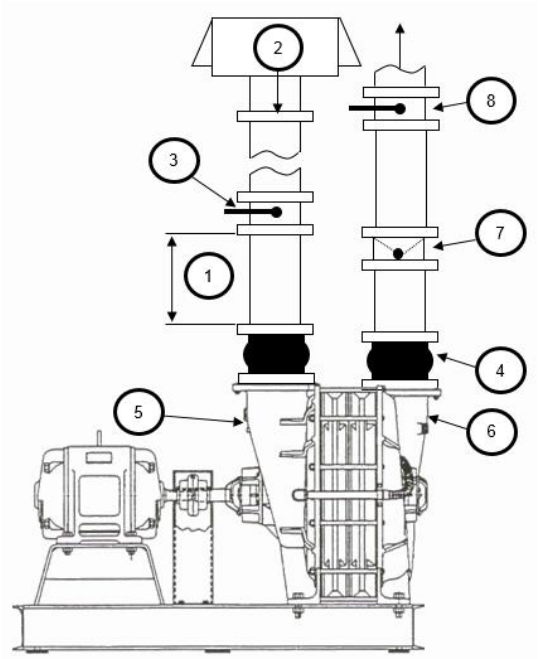


Fig. 11 Correct positioning of the throttle valve in the inlet pipe

1 Settling section (2 x inlet pipe diameter)
2 Air Flow
3 Throttle Valve
4 Expansion Joints
5 Inlet Head
6 Outlet Head
7 Discharge Check Valve
8 Discharge Isolation Valve

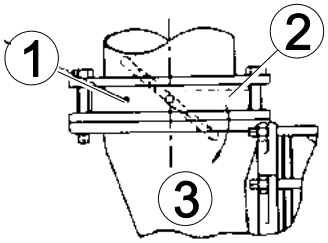


Fig. 12 Incorrect positioning of the throttle valve in the inlet pipe (detail)

1 Throttle Valve
2 Air Flow
3 Inlet End

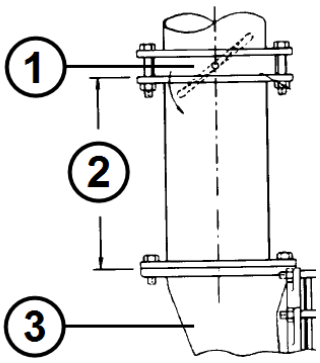


Fig. 13 Correct positioning of the throttle valve in the inlet pipe (detail)

1 Throttle Valve
2 Settling section (2 x inlet pipe diameter)
3 Inlet End

Providing flexible connections

▶ Install flexible connections in the inlet and outlet pipe lines to ensure that the pipe lines are insulated from the machine flanges:
  – Ensure that the maximum deviation of the pipe lines is according to the tolerances of the expansion joints (→ data sheet).
  – For temperatures >130 °C [266° F] use a stainless compensator.

5.4.4 Providing safety and control devices (recommended)

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

Avoiding impurities

1. Make sure that the inlet piping system is clear of foreign materials or debris prior to installing machine.
2. To monitor impurities, install a differential pressure gauge if necessary (by using a filter).

Avoiding backflow

▶ Use a check valve in the outlet pipe to ensure that gas does not flow back into the machine.
▶ On machines in vacuum systems, use a check valve in the inlet pipe to ensure that gas does not flow back into the vacuum system.

For the horizontal installation of the check valve:
▶ Install the check valve so that the fastening bolts that run through the check valve are vertical to the flow.

Making provision for isolating and shutting off the pipe lines

For maintenance and repair work.

▶ Provide isolation valves for both the inlet and outlet when maintenance is anticipated.

Allow measurements of the operating conditions

1. Provide manometers for pressure measurements in the inlet and outlet pipes.
2. Provide transformers (overload and underload) on the motor side.
3. Provide for machine-side temperature measurements.
4. Install a vibration monitor system (→ Table 11).

5.5 Connecting the pipes

5.5.1 Keeping the pipe lines clean

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 protrude inwards.
3. Remove any blank flanges, plugs, protective foils, and/or protective paint from the flanges.

5.5.2 Installing the inlet pipe

1. Remove transport and sealing covers and rust protection packages (if present) from the machine.
2. Install the suction pipe.
3. Make sure no seals protrude inwards.

5.5.3 Installing the pressure line

1. Remove the transport and sealing covers from the machine.
2. Install the pressure line.
3. Make sure no seals protrude inwards.

5.5.4 Installing the condensate discharge pipe (if present)

WARNING

Risk of injury and poisoning due to hazardous pumped fluids!

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

1. Install the condensate discharge pipes.
2. Connect the condensate discharge pipes to each other.

5.5.5 Shaft seals

All shaft seals can seal against volatile gases. Contact GD Nash to obtain spare parts. Have the model size, order number and serial number ready.

- Standard shaft seal:

The standard shaft seal has a labyrinth structure. This is a contactless seal with minimal wear.

- Single-acting carbon-ring seals (SCR):

Single-acting carbon-ring seals (SCR) are available for most machines. SCR seals have a lower leakage rate than labyrinth seals. The SCR seal is attached to the shaft. The replacement intervals depend on the process gas used.

- Double-acting carbon-ring seals (DCR):

Double-acting carbon-ring seals (DCR) are available for most machines. They have a lower leakage rate than SCR seals and can be used with purge gas. For toxic applications, purge gas should be used to minimize leaks to the atmosphere.

- MAX seals:

MAX seals are dry-running seals with a very low leakage rate. They provide the best protection for the bearings.

5.5.6 Checking the stress-free pipe connection

✓ Piping installed and cooled down

NOTE

Risk of machine damage due to excess pipe forces!

▶ 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.

5.5.7 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 (7 psi) overpressure.

5.6 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 secured against restart when carrying out any installation or maintenance work.

5.6.1 Electrical connection

1. Connect all the electric components according to the circuit diagram/manuals/data sheets. GD Nash recommends to use the following monitoring equipment:
   – Vibration sensors
   – Temperature sensors
   – Current transformer
4. Correctly connect the current transformer (→ Manufacturer's instructions).

Fig. 14 Installing the current transformer

1 2 turns
2 1 turn

5.6.2 Variable Frequency Drive (VFD)

If the machine is intended to be operated with VFD, approval is required by GD Nash engineering.

All blower models are designed to operate below the first critical speed. However, when coupled with a motor, coupling and coupling element, the combination of the machines may result in a natural resonance lower than the standard operating frequency.

5.6.3 Connecting the motor

Observe 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.

5.7 Aligning motor and machine

All units are shipped from the factory with a preliminary alignment only. The Customer is required to complete preliminary HOT alignment at job site. Centrifugal blowers must be operated stably at operating temperature: this can take up to 1 hour. Proper shimming and alignment procedures must be followed as listed below. Low vibration at start up does not necessarily indicate perfect alignment. Gardner Denver recommends checking all driver (motor) support feet for "soft foot". This aids in obtaining an exact alignment.

✓ Foundation is level

✓ Machine is set up correctly

✓ Pipe lines are attached to the machine with flexible connections

✓ Motor is standing steady on all its feet (a deviation of < 0.076 mm (0.003 inch) is permissible)

5.7.1 Aligning the coupling

The coupling can be aligned by Hoffman & Lamson Service.
The best method of alignment is with a laser alignment device.
Hoffman & Lamson offers factory trained technicians and laser alignment services.

Checking the alignment of the coupling

✓ Resources, tools and materials:
   – Dial indicator
     or
   – laser alignment device

▶ With a laser alignment device (recommended): See the instructions supplied with the laser device.

▶ With a dial indicator:

- Place the dial indicator on the coupling halves.
- Rotate both shafts simultaneously and take readings every 90°.
- Check the readings for vertical or angular misalignment and correct if necessary.

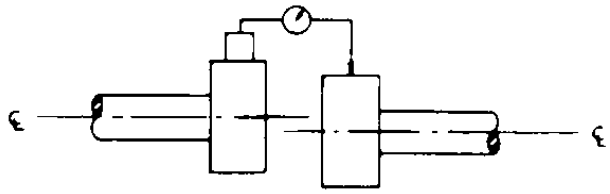
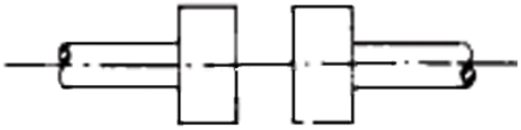


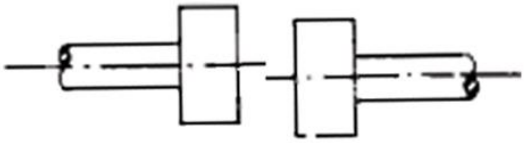
Fig. 15 Aligning the coupling with a dial indicator

The following scenarios may arise during coupling alignment:

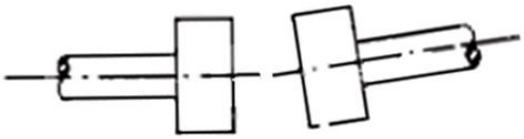
Correctly aligned:



Vertical misalignment:



Angular misalignment:



Aligning the coupling

All alignment changes are in respect to the alignment of the motor.

1. Make sure that the coupling halves have a maximum deviation of 0.05 mm (0.002 inch).
2. Correct vertical and angular misalignment with metal shims under the motor.
3. Ensure that there is enough clearence between coupling halves (→ Coupling manufacturer's instructions).

5.7.2 Aligning the motor

Aligning a sleeve bearing motor

1. Ensure that a suitable coupling is used (→ Coupling manufacturer's instructions). The coupling should prevent the axial movement of the motor.
2. Make sure that the magnetic axis is aligned correctly.

Aligning the belt drive

✓ Resources, tools and materials:

- Straightedge

1. Position the belt drive as close as possible to the machine.
2. Place a straightedge across the face of the driving and driven sheaves.
3. Check the alignment of the sheaves and correct if necessary.

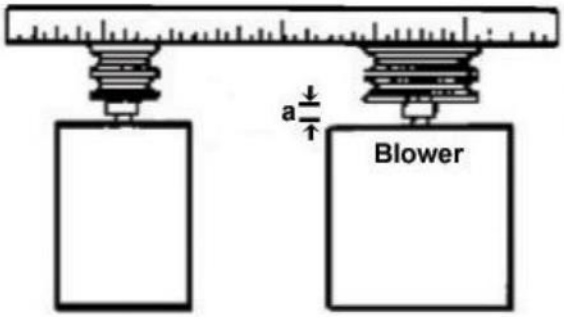


Fig. 16 Correctly aligned belt drive
Distance "a" must be minimized

DANGER

Risk of serious injury due to pinch point created by belt and sheave!

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

4. Check the belt tension and correct if necessary (→ Chapter 7.2.4, page 33).

5.7.3 Preparing the alignment of the coupling at operating temperature

Prior to the alignment at operating temperature, the necessary adjustments can be calculated. The following assumptions are made:

- The only thermal expansion at operating temperature occurs at the outlet end of the machine. The inlet end can be assumed to be constant.
- Thermal expansion of the motor is negligible.

In calculating the adjustments, the following variables are used:

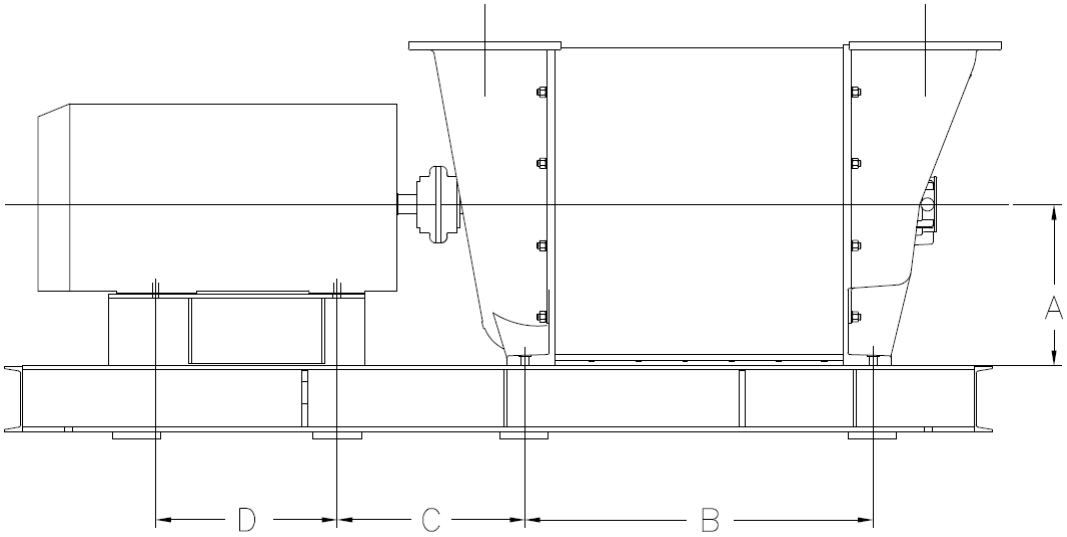


Fig. 17 Variables used in calculating the adjustment

Variable	Meaning
A	Height of shaft Distance from the center line of the shaft to the bottom of the blower feet (models 2400, 940,950, and 960: distance from shaft to bottom of support surface on head).
B	Distance between the machine feet, from the center lines of the fixing bolts
C	Distance from the drive end machine foot to the drive end motor foot
D	Distance between the motor feet
COE	Coefficient of linear expansion COE (gray cast iron) = 10.5 x 10^{-6} 1/K [6.0 x 10^{-6} 1/°R]
T (Δt)	Change in the temperature from the casing at the inlet end to the casing at the outlet end If the exact values are not known, 15 K [59 °R] can be assumed for each pressure stage
E	Thermal growth of the outlet head Calculated on the basis of: E = A x T (Δt) x COE

Table 6 Variables used in calculating the adjustment

In the calculation, a distinction must be made between two types of setup:

- Motor coupled to the inlet end of the machine
- Motor coupled to the outlet end of the machine

Motor coupled to the inlet end of the machine

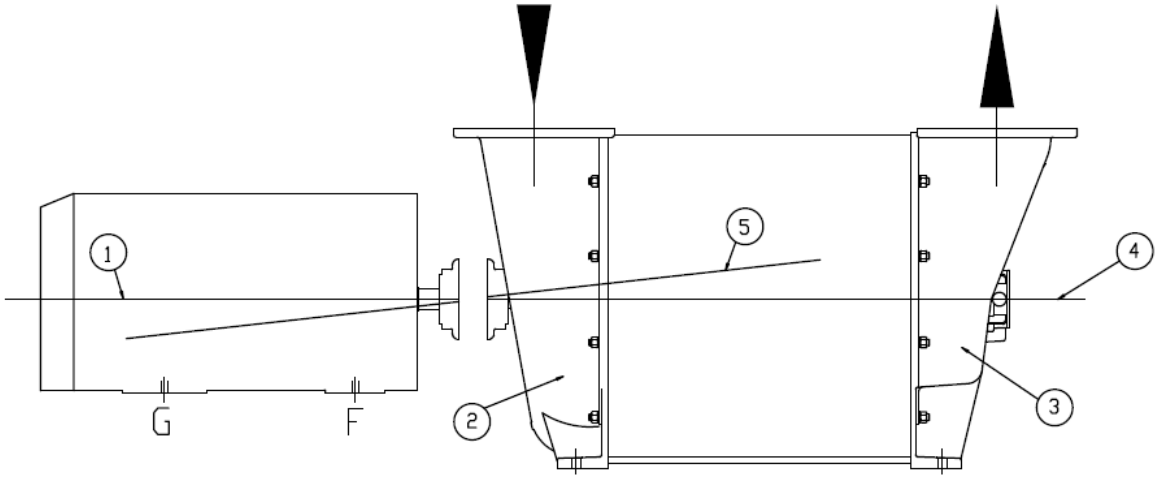


Fig. 18 Calculation of the adjustment with the motor on the inlet end

1 Motor shaft
2 Inlet end temperature
3 Outlet end temperature
4 Position of the cold machine shaft
5 Position of the hot machine shaft

As the motor is lower than the machine, the calculated adjustment will be a negative number.

1. Calculating the adjustment for the motor feet:
   – For motor feet on the drive end **F**:
     F = (C / B) x E
   – For motor feet on the non-drive end **G**:
     G = [(C + D) / B] x E
2. Align the cold motor with metal shims. Subtract the calculated values for F and G.

Motor coupled to the outlet end of the machine

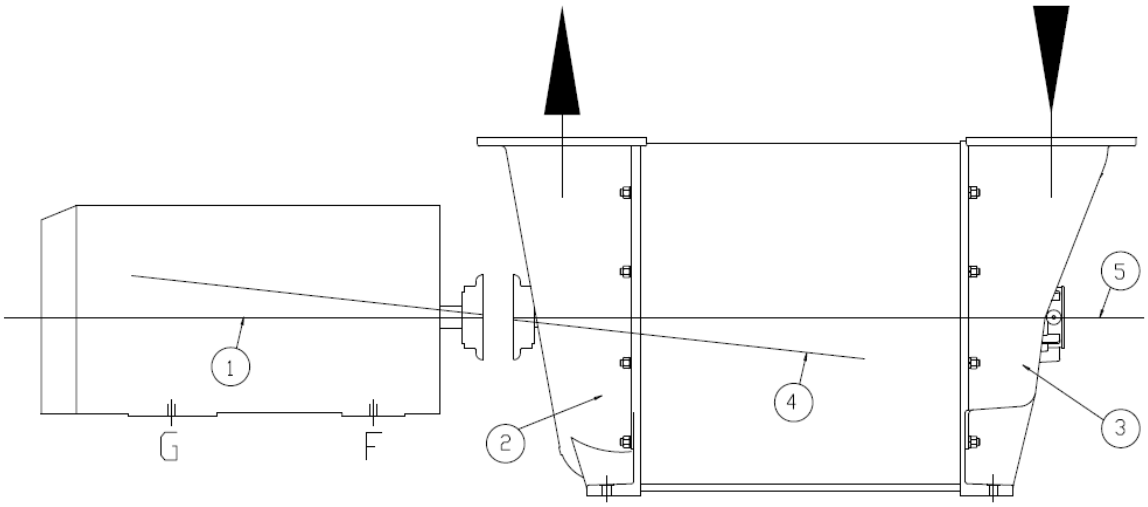


Fig. 19 Calculation of the adjustment with the motor on the outlet end

1 Motor shaft
2 Outlet end temperature
3 Inlet end temperature
4 Position of the hot machine shaft
5 Position of the cold machine shaft

As the motor is higher than the machine, the calculated adjustment will be a positive number.

1. Calculating the adjustment for the motor feet:
   – For motor feet on the drive end **F**:
     F = [(C + B) / B] x E
   – For motor feet on the non-drive end **G**:
     G = [(B + C + D) / B] x E
2. Align the cold motor with metal shims. Add the calculated values for F and G.

5.8 Installing safety guards

1. Secure moving parts and hot surfaces with safety guards to prevent serious injury. Ensure guards cover all rotating components, eliminating the ability to be accessed by hand during operation.
2. Do not fasten any temperature-sensitive components or lines to hot machine parts.

5.9 Checking the installation

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

▶ Ensure that:
   – The drive motor is correctly aligned and installed in such a way as to prevent axial movement.
   – The belt drive (if present) is correctly aligned and adjusted.
   – The machine is correctly installed.
   – The impeller/shaft assembly can be rotated without making contact.
   – The coupling is correctly aligned.
   – Rotating parts are correctly guarded.
   – Pipe systems and fittings have been installed in the correct positions, are not distorted and have been pressure-tested.

6 Operation

6.1 Preparing for the initial start-up

This section applies in respect of the commissioning or recommissioning after longer periods of disuse or repairs.

✓ All ball valves and valves have been closed.

6.1.1 Removing the preservative

Only necessary for machines treated for storage.

▶ (→ Chapter 4.4, Page 15).

6.1.2 Lubricating the bearings

Machines with grease-lubricated antifriction bearings are ready for operation upon delivery. The greatest cause of bearing failure is over-greasing rather than under-greasing. Excessive grease creates overheating which may result in bearing damage. Always follow the proper greasing procedure.

▶ Grease-lubricated bearings: if storage > 3 months before the initial start-up, check the bearing for water condensation and lubricate again if necessary.

▶ T-Series bearing housings are pre-packed at the factory. Do not re-grease before starting the unit.

▶ Oil-lubricated bearings: fill oil up to the middle of the sight glass.

6.1.3 Preparing the coupling

1. For gear type couplings: sufficiently lubricate the gears with grease (→ Coupling manufacturer's instructions).
2. For couplings with lubricating bushings: inject grease into the lubricating bushings until these are full (→ Coupling manufacturer's instructions).

6.1.4 Checking the direction of rotation

▶ Check direction of rotation by bumping the motor. The correct direction of rotation is indicated by an arrow on the inlet head.

6.1.5 Preheating the machine

If the machine is used for applications in which the inlet temperatures > 93 °C (200 °F) (such as for steam recompression):

▶ slowly preheat the machine to 82 °C (180 °F).

6.2 Initial start-up

We recommend having the machine commissioned by Hoffman & Lamson Service.

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

✓ All safety equipment installed and tested for functionality

✓ Entire system is ready for operation

✓ Machine prepared properly

DANGER

Risk of injury due to running machine!

▶ Do not touch the machine while it is running.

▶ Ensure that the coupling guard is attached.

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

▶ Allow the machine to cool down completely before starting any work.

NOTE

Risk of damage if the maximum discharge pressure is exceeded!

▶ Do not operate the machine with the outlet fitting closed.

NOTE

Risk of damage due to pressure surges in the machine!

▶ Ensure that the flow rate through the machine does not fall below the minimum.

NOTE

Risk of damage by introducing hot gases or vapors without preheating!

▶ Slowly preheat the machine to 82 °C (180 °F) for steam or hot temperature process gas conditions.

6.2.2 Precisely aligning the coupling

Observe the difference in thermal expansion of the inlet and outlet ends, when aligning the motor and the machine.

The thermal expansion data of the machine may be available on the hot alignment data plate (→ Chapter 3.1.1, Page 10).

1. Operate the machine for 1.5 to 2 hours (→ Chapter 6.3, Page 28).
2. Ensure that the vibrations do not exceed 10 mm/s (0.38 ips) during initial start up.
3. Switch off the machine.
4. Check the alignment of the coupling according to the alignment specifications (→ Coupling instructions, Chapter 5.7, Page 22).
5. If there is a deviation from the alignment specifications: correctly align the motor with metal shims.

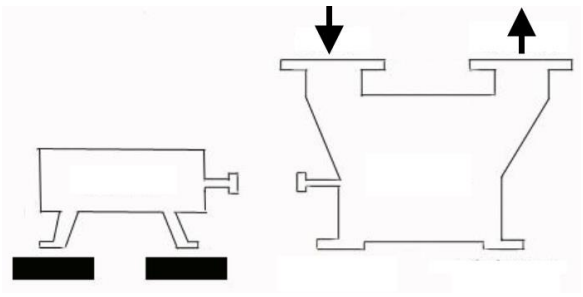


Fig. 20 Hot alignment data plate located next to the blower nameplate (Metal shims installed beneath motor feet only)

6.3 Start-up

6.3.1 Switching on

✓ Initial start-up completed

✓ Machine prepared properly

DANGER

Risk of injury due to running machine!

▶ Do not touch the machine while it is running.

▶ 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.

NOTE

Risk of damage if the maximum discharge pressure is exceeded!

▶ Do not operate the machine with the outlet or inlet fitting closed.

NOTE

Risk of damage due to pressure surges in the machine!

▶ Ensure that the flow rate through the machine does not fall below the minimum.

NOTE

Risk of damage by introducing hot gases or vapors without preheating!

▶ Slowly preheat the machine to 82 °C (180 °F) for steam or hot temperature process gas conditions.

NOTE

Risk of damage by shafts and impellers still rotating!

▶ After switching off of the machine or an EMERGENCY STOP, wait until the shafts and impellers come to a standstill.

Start up the machine without pressure.

Start up procedure for soft start and direct start

1. Open the section drain valves (if present).
2. Open the bypass valves (if present).
3. Open the throttle valve in the outlet pipe line.
4. Close the throttle valve in the inlet pipe line.
5. Switch on the drive motor.
   By using a soft start: Make sure that the drive motor reaches full speed within approx. 7 to 10 seconds.
6. After reaching full speed: Slowly open the throttle valve in the inlet pipe within 10 to15 seconds.

If the throttle valve cannot be opened in this time:

▶ Start the machine with the throttle valve minimally (10% to 15%) opened

7. Close the section drain valves (if present).
8. When operating temperature is reached: Regulate the flow rate with the throttle valve in the inlet pipe until the desired operating pressure is reached.
9. Adjust the bypass valves (if present).
10. If there are pressure surges in the machine, open the bypass valve.

Start up procedure for VFD start

1. Open the diffuser valves (if present).
2. Open the bypass valves (if present).
3. Open the throttle valve in the outlet pipe line.
4. Close the throttle valve in the inlet pipe line.
5. Switch on the drive motor.
   By using a VFD: Make sure that the drive motor reaches full speed within approx. 10 seconds.
   To do so:
   – Set the Ramp up time to 7 to 10 seconds.
   – Set the minimum speed ~10% above the surge point.

↳ On VFD operation: The inlet throttle valve opens to 100% and remains 100% open.

If the throttle valve cannot be opened in this time:

▶ Start the machine with the throttle valve minimally (10% to 15%) opened

6. Close the section drain valves (if present).
7. Adjust the bypass valves (if present).
8. Adjust the speed to keep the blower in operation range (above surge, below overload) while closing the bypass valve.
9. Once the section valves and bypass valves are closed: Adjust the speed to the desired operation conditions (i.e. pressure and flow).
10. If there are pressure surges in the machine, open the bypass valve.

6.3.2 Checking operation

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

1. Read and document the set pressure values and flow rates.
2. If unusual vibrations and bearing temperatures arise, check the alignment of motor and machine and adjust if necessary (→ Chapter 5.7, Page 22).
3. For belt drives: Regularly check the belt tension (→ Chapter 7.2.4, Page 33).
4. Monitor and document the temperatures of the components (bearings, shaft seal) until steady-state is reached.
5. Monitor the vibrations of the motor and the temperature of the bearings. Normal vibrations amount to 10 mm/s (< 0.38 ips) vertically and horizontally.
6. If irregularities are observed, identify and eliminate causes (→ Chapter 8, Page 37).

6.3.3 Switching off

WARNING

Risk of injury due to hot machine parts!

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

1. Switch off the drive motor.
2. Open the bypass valves (if present).

6.4 Shutting down

✓ 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 operation is interrupted:

Machine is to be	Measure
Drained	▶ Close the inlet and outlet fittings.
Disassembled	▶ Isolate the motor from its power supply and secure it against unauthorized switch-on.
Put into storage	▶ Follow the storage instructions (→ Chapter 4.3, Page 14).

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

6.5 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 5.9, Page 26, Chapter 6.3, Page 28).

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 46).

Anytime work is carried out on the machine, ensure there is sufficient lighting to avoid serious injury.

7.1 Testing the control systems

7.1.1 Surge control (if present)

1. Start the machine.
2. Set the trip point in surge control slightly above the point at which pressure surges occur in the machine (→ Surge control instructions).
3. With the machine operating normally, slowly close the throttle valve on the inlet end. Observe the amperage on the surge control.

↳ As soon as the amperage reaches the set trip point, the surge control must switch off the motor.

If motor is not switched off:

▶ Check the installation of the current transformer (→ see Chapter 5.6, Page 21).

7.1.2 Ammeter

▶ Check the readings of the ammeter:

- Start the machine.
- Attach an external ammeter to the machine when operating normally and read the actual amperage draw of the motor.
- Compare the reading with the reading displayed by the installed ammeter. The deviation must be < 5 %.

7.1.3 Overload protection

If the motor has overload protection, a high AMPS trip point is also set for the gage.

1. Start the machine.
2. With the machine operating normally, decrease the trip point until it is less than the actual reading.

↳ The overload alarm is triggered and/or the motor is switched off.

3. Ensure that all sirens, warning lights, etc. respond to the overload condition.

7.1.4 Monitoring the temperature of the bearings

An alarm is preset in the factory at a temperature of 104 °C (220 °F) as well as a trip point at 110 °C (230 °F). These values are sufficient for all applications and do not need to be adjusted.

7.1.5 Vibration sensors

1. Ensure that the following values are set (direct drive units):
   - Alarm: 10 mm/s (0.4 ips)
   - Trip point: 19 mm/s (0.75 ips)
2. Test the functionality of the vibration sensors according to the specifications of the manufacturer.

7.2 Monitoring

The recommended intervals assume malfunction-free operation.
In the event of malfunctions, the corresponding inspections or reinspections 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 charged fluids!

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

▶ For trouble-free operation, always ensure the following:

- No leaks
- Unclogged and clean filters
- No unusual running noises or vibrations
- Check the alignment of motor and machine due to seasonal variations in operating conditions every six months

7.2.1 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. 2 operating hours.

Perform the following during the inspection:

1. Make sure that the charged fluid does not display any signs of significant contamination.
2. Make sure that the specified technical data is observed (power consumption, temperatures etc.).
3. Ensure that there is no leakage.
4. Ensure that there are no pressure surges.
   - Filters are clean and free of foreign particles
   - Valves and fittings are functioning and set correctly
   - Pipe lines are laid out correctly
5. Check that the smooth running of the machine and the running noises of the bearings have not deteriorated.
6. Check the alignment of machine and motor and adjust if necessary.
7. Check the foundation for sink marks and cracks.
8. Check the mounting dampers and replace if necessary (recommended: every 3 years).
9. Make sure that the valves, filters, and screens are free of foreign matter. Clean if necessary.
10. Check pipes, fittings, and containers for strength, leaks, and secure fit.
11. Check connecting elements and re-tighten if necessary.
12. Check the safety system.
13. For belt drives: Check belt pre-tensioning and correct if necessary.
14. Immediately eliminate any identified impermissible deviations and modifications.
15. Schedule appointment for reinspection based on soiling and wear.

7.2.2 Reinspection

Under favorable operating conditions, reinspections are subject to the same intervals applicable for lubrication or grease changes (→ Chapter 7.2.5, Page 33).

1. Perform the inspection (→ Chapter 7.2.1, Page 32).
2. Check that the impeller's alignment lies within the permissible tolerance range.
3. Make sure that all fastening bolts have been properly tightened.

7.2.3 Packing Gland for Gas Tight Construction

NOTE

Risk of damage due to over-tightening of packing gland!

▶ Make sure not to over-tighten the packing gland to cause excessive friction, which would lead to a temperature spike in the bearing.

1. Check the hardware of the packing gland to ensure a self-locking nut design**.**
2. The packing gland is to contact the packing housing.
3. Tighten the packing gland an additional ¼ turn.
4. Observe the operation of the packing gland to ensure that the adjustmet does not result in excessive temperature.

GD Nash suggests the use of a temperature monitoring device to observe the temperature during operation once the gland has been adjusted.

7.2.4 Belt drive

NOTE

Risk of damage due to overtensioned belt drive!

An overtensioned belt drive causes excessive wear and the premature failure of the belt drive.

▶ Check the tension of the belt drive at regular intervals.

1. Check the belt drive regularly.
2. When replacing a belt drive in combination with other belt drives, replace all the belts.
3. Check the belt tension (→ Requirements of the manufacturer):
   – Divide the distance “L” of the sheaves by 64 into inches.
   The result is the deflection “d” of the belt.
   – Make sure that the belt has a tension of 22.5–31.5 N (5–7 lbs) at the calculated deflection.

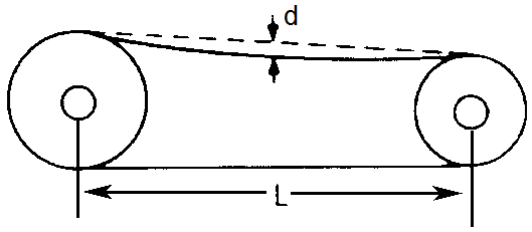


Fig. 21 Checking the belt tension

4. Correctly adjust the belt tension:
   – Adjust the belt tension 9 N (2 lbs) higher for new belts to allow for stretching.
   – Recheck the belt tension after 8 operating hours.

7.2.5 Antifriction bearings lubricated with grease

Grease to be used (→ Chapter 9.2.5, Page 42).

The temperature of the bearings can increase considerably after relubrication, however, after a running-in phase it must sink down to the normal value <93 °C (200 °F).

Bearing greasing procedure:

1. Remove the bearing covers and bearing plugs.
2. Remove the old grease from the bearings, bearing housing and covers.
3. Remove the plug at the rear of the bearing housing.
4. Inject fresh grease into this opening. Thereby, forcing the old grease from bearing.
5. Remove the excess grease.
6. Insert a small amount of lubricating grease into the bearing plug.
7. Replace the bearing covers and bearing plugs.

7.2.6 Bearings with oil lubrication

Oils to be used (→ Chapter 9.2.6, Page 43).

1. Stop the machine and let come to rest.
2. Read the oil level from the sight glass. There are sight glasses are on both sides of the oil reservoir.
   The correct oil level is in the middle of the inspection glass.
3. Refill with oil, if necessary:
   – Remove the filler and breather filter on the reservoir.
   – Slowly refill with oil until the proper level is reached.
   – Replace the filler and breather filter.

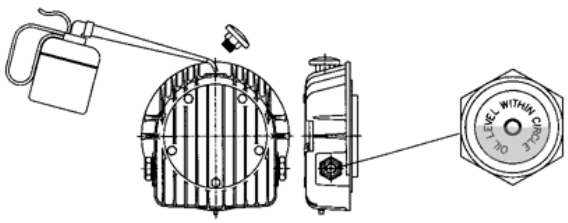


Fig. 22 Filling the oil reservoir

4. Clean the oiler, oil reservoir and sight glass.

7.2.7 Cleaning the external surfaces of the machine

CAUTION

Risk of injury when cleaning with compressed air!

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

NOTE

Risk of damage due to unsuitable cleaning agents.

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

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

- ▶ Clean or replace the screens and filters in the pipes.
  When doing so, make sure that no debris falls into the machine from the screens of filters.

Some installations may require a wash-down cycle for the machine interior. Not all machines are provided with the wash-down port. The Typical cleaning solvent is steam.

1. Open the condensation drain piping and close the isolation valves at the inlet and outlet.
2. Steam the interior of the machine.
3. Continue steam cleaning until the condensate discharge appears to be clean.

7.3 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 secured against restart 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 charged 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 that the machine is depressurized.
- ▶ Drain the machine, safely collect the charged fluid 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!

- ▶ 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, shaft seal, drive shaft, drives, belt drive).

7.3.1 Returning the blower to the manufacturer

- ✓ Machine depressurized
- ✓ Machine fully drained
- ✓ Electrical connections disconnected and motor secured against being switched on again
- ✓ Machine cold
- ✓ Coupling guard removed
- ✓ 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 46).

7.3.2 Preparing 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 brackets disassembled
- ▶ Observe the following during removal:
  - – Mark the precise orientation and position of all components before disassembling them.
  - – Disassemble components concentrically without canting.

7.4 Installing

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

Components may be ejected through spring tension.

- ▶ Take care when installing components with springs (e.g. pre-tensioned bearings, valves).
- ▶ Observe the manufacturer's specifications (e.g. for the motor, coupling, drive shaft, drives, belt drive).

NOTE

Risk of damage due to unsuitable components!

- ▶ Always replace lost or damaged bolts with bolts of the same strength (→ see Chapter 9.2.2, Page 41).
- ▶ Only replace seals with seals of the same material.

1. Observe the following during installation:
   - – Replace worn parts with genuine spare parts.
   - – Replace seals. Take care that the seal is seated correctly.
   - – Maintain the prescribed tightening torques (→ see Chapter 9.2.2, Page 41).
2. Clean all parts. Do not remove any markings when doing so.
3. Install the machine.
4. Replace antifriction bearings and grease them (→ Chapter 7.2.5, Page 33).
5. Install the machine in the system (→ Chapter 5, Page 16).

7.5 Ordering spare parts

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

Repairs are performed by Hoffman & Lamson 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)

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.

Malfunction	Number
Low flow rate or low pressure	1
Abnormal vibrations	2
Oil leakage	3
Machine overheating	4
Bearings overheating	5
Motor overheating	6
Repeated failure of bearings	7
Pressure surges	8

Table 8 Fault number assignment

Fault number								Cause	Remedy
1	2	3	4	5	6	7	8		
X			X					Incorrect direction of rotation	▶ Check the arrow indicating the direction of rotation on the machine. ▶ If necessary, reverse the direction of rotation.
X			X				X	Blocked inlet pipe line	▶ Open the throttle valve completely. ▶ Clean the filter. ▶ Remove the shipping covers.
X			X				X	Partially blocked outlet pipe line	▶ Open all valves in the outlet pipe line. ▶ Check that the valves are properly installed.
X								Instrumentation display error	▶ Check that the instrumentation works and replace if necessary.
X	X				X			Faulty motor wiring	▶ Check the motor wiring and correct it if necessary. – Voltage – Phases
X			X					Increased inlet temperature	▶ Adjust the temperature to the set value.
X			X					Increased inlet pressure	▶ Adjust the pressure to the set value.
X			X					Incorrect layout or installation of the pipe lines	▶ Adjust the pipe lines as specified.
X	X		X					Foreign particles in the machine	▶ Stop the machine and remove the foreign particles.

Fault number								Cause	Remedy
1	2	3	4	5	6	7	8		
	X							Incorrect installation of the base frame on the foundation	▶ Ensure that the base frame is not bolted to or cast into the foundation.
	X							Mounting dampers	▶ Ensure that they have been correctly installed. ▶ Check their condition. ▶ Ensure that their position and size is correct.
	X							Pipe line system	▶ Use flexible connections between the pipe line system and machine. ▶ Never bolt pipe lines directly to the machine. ▶ Support the pipe lines.
	X					X		Faulty coupling alignment	▶ Check the alignment of the coupling.
	X	X						Foundation	▶ Ensure that the foundation is level and that it can support the weight of the machine.
	X							Loose bolts	▶ Check the tightness of the connecting bolts of the machine and the motor to the base frame.
	X		X					Pressure surges	▶ Check the outlet and inlet pipe lines for blockages.
	X							Excessive motor vibration	▶ Switch off the motor. ▶ Check the motor bearings and replace if necessary. ▶ Check the flow rate. ▶ Check the motor for defective parts.
	X			X	X			Damaged bearings	▶ Check bearings and replace if necessary.
	X							Coupling	▶ Lubricate the coupling if necessary. ▶ Check the alignment of the coupling. ▶ Check the tightness of the bolts.
		X		X		X		Oil level too high	▶ Remove oil from the bearings.
		X		X		X		Wrong type of oil used	▶ Only use the types of oil recommended in this operating manual (→ Chapter 9.2.6, Page 43).
		X						Breather vent clogged	▶ Clean the breather vent.
		X						Gaskets leak	▶ Replace the gaskets.
		X		X		X		Bearings installed incorrectly	▶ Check the position of the oil slinger. ▶ Check the housing gasket. ▶ Check whether the oil return hole is clogged. ▶ Check whether the labyrinth is working
		X						Damaged sight glass	▶ Replace the sight glass.

Fault number								Cause	Remedy
1	2	3	4	5	6	7	8		
				X		X		Wrong type of lubricating grease used	▶ Only use the types of lubricating grease recommended in this operating manual (→ Chapter 9.2.5, Page 42).
				X		X		Excessive lubricating grease used	▶ Remove grease from the bearings.
				X		X		Worn bearing housing	▶ Replace the bearings.
					X			Inadequate air flow for motor cooling	▶ Ensure that the cooling openings are not blocked.
					X			Motor overloaded	▶ Check that the motor is large enough for the system.
					X			Belt tension	▶ Check the belt tension and correct if necessary.
						X		Machine in storage and/or used infrequently	▶ Turn the rotor every week 5–10 times.

Table 9 Troubleshooting list

9 Appendix

9.1 Drawings

9.1.1 Available flange variants

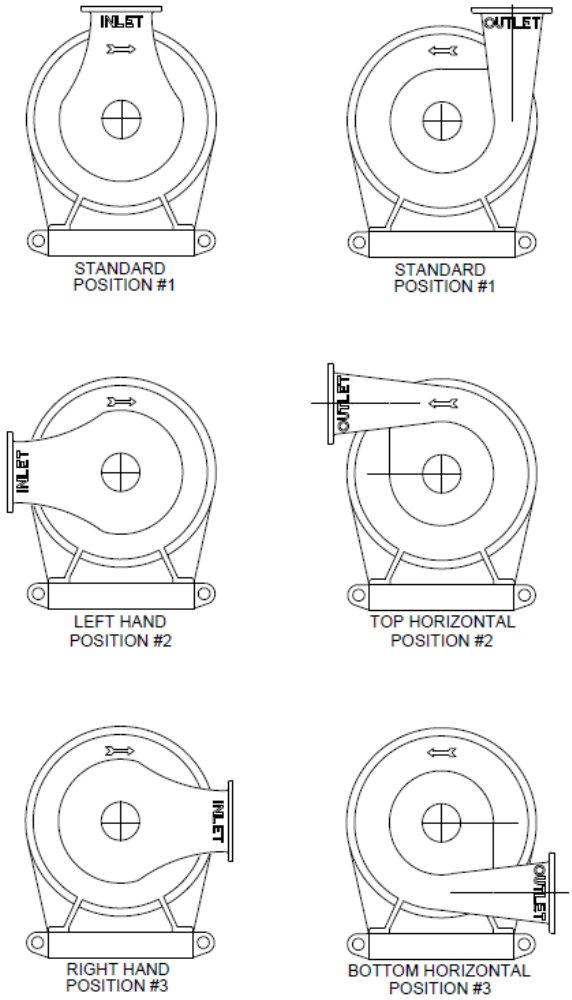


Fig. 23 Available flange variants

9.2 Technical specifications

9.2.1 Operating conditions

Information from the ATEX Supplementary Manual supersedes all limits provided in this manual.

Measurement	Value
Bearing temperature	• Inform Hoffman & Lamson Service in respect of temperatures > 104 °C (220 °F)
Outlet air temperature	• Inform Hoffman & Lamson Service in respect of temperatures > 149 °C (300 °F) • Higher outlet air temperatures are permissible if they are in accordance with the design data sheet

Table 10 Operating temperature limits

Measurement	Value
Direct Driven	• 6 mm/s (0.236 ips)
Belt Driven	• 14,5 mm/s (0.57 ips)

Table 11 Normal operating vibration limits

9.2.2 Tightening torques

All values are for dry threads. Torque tie rods to 75 % of the listed value, then repeat the torque sequence at 100 %.

Machine

Type	Tie rods			Housing Bolts		Bearing Caps Bolts		Labyrinth Bolts		Baffle Ring & Oil Slinger Screws	
	FT.LB	Size	Nm	FT.LB	Nm	FT.LB	Nm	FT.LB	Nm	FT.LB	NM
250, 260	7-8	5/16"	9-10	16-18	22-24	10-11	14-15	N/A	N/A	N/A	N/A
40, 310	30-35	1/2"	41-47	16-18	22-24	10-11	14-15	10-11	14-15	N/A	N/A
41, 400	30-35	1/2"	41-47	16-18	22-24	10-11	14-15	10-11	14-15	N/A	N/A
383, 510, 550, 732	30-35	1/2"	41-47	37-39	50-53	10-11	14-15	10-11	14-15	4 Min/ 5 Max	5 Min/ 7 Max
42, 600, 650	80-85	3/4"	108-115	37-39	50-53	10-11	14-15	10-11	14-15	N/A	N/A
651, 652 ,671	80-85	3/4"	108-115	37-39	50-53	10-11	14-15	10-11	14-15	4 Min/ 5 Max	5 Min/ 7 Max
725, 741, 742, 751, 752, 761, 772	80-85	3/4"	108-115	37-39	50-53	10-11	14-15	10-11	14-15	4 Min/ 5 Max	5 Min/ 7 Max
810, 850, 860, 870	80-85	3/4"	108-115	37-39	50-53	10-11	14-15	10-11	14-15	4 Min/ 5 Max	5 Min/ 7 Max
1210, 1250, 1260	80-85	3/4"	108-115	37-39	50-53	10-11	14-15	10-11	14-15	4 Min/ 5 Max	5 Min/ 7 Max
1400	80-85	3/4"	108-115	37-39	50-53	10-11	14-15	10-11	14-15	4 Min/ 5 Max	5 Min/ 7 Max
1850	80-85	3/4"	108-115	37-39	50-53	10-11	14-15	10-11	14-15	4 Min/ 5 Max	5 Min/ 7 Max
1270	80-85	7/8"	108-115	37-39	50-53	10-11	14-15	10-11	14-15	4 Min/ 5 Max	5 Min/ 7 Max
1600, 940	80-85	7/8"	108-115	37-39	50-53	10-11	14-15	10-11	14-15	4 Min/ 5 Max	5 Min/ 7 Max
2000, 950	90-100	7/8"	122-136	37-39	50-53	10-11	14-15	10-11	14-15	4 Min/ 5 Max	5 Min/ 7 Max
691, 791, 2400, 960	90-100	1"	122-136	37-39	50-53	10-11	14-15	10-11	14-15	4 Min/ 5 Max	5 Min/ 7 Max

Table 12 Torque requirements

Pipe threads

Fitting Size	Torque [FT.LB]	Torque [Nm]
1/8" NPT	12	16
1/4" NPT	25	34
3/8" NPT	40	54
1/2" NPT	50	68
3/4" NPT	75	102
1" NPT	110	149
1 1/4" NPT	150	203
1 1/2" NPT	200	271
2" NPT	240	325

Table 13 Pipe threads

Fasteners

Blower/Motor Hold Down Fasteners		
Size	**FT.LB**	**Nm**
1/2"	46	62
5/8"	93	126
3/4"	164	222
7/8"	281	381
1"	389	527
1 1/8"	500	678
1 1/4"	625	847

Table 14 Blower/Motor Hold Down Fasteners

9.2.3 NPT Tightening Torques

All values are for threads coated with pipe sealant.

Fitting Size	Turns Past Finger Tight	Torque	
		[FT/LBS]	[Nm]
1/8" NPT	1.5-2	12	16
1/4" NPT	1.5-2	25	34
3/8" NPT	1.5-2	40	54
1/2" NPT	1.5-2	50	68
3/4" NPT	1.5-2	75	102
1" NPT	1-1.5	110	149
1 1/4" NPT	1-1.5	150	203
1 1/2" NPT	1-1.5	200	271
2" NPT	1-1.5	240	325

Table 15 NPT Tightening Torques

9.2.4 Weight specifications

Information on weight and inertia: → Technical data sheet

9.2.5 Grease types

Only use the following type of grease:
- Gardner Denver AEON Centrifugal Lubricating Grease

Size	Value
NLGI grade	No. 2
Thickening agent	Lithium complex
Penetration, Worked, 25°C, ASTM D217	280
Dropping point, ASTM D2265	275 °C (527 °C)
4-Ball Weld, ASTM D 2596, Load	250 kg (550 lb)
Oil viscosity, ASTM D445	100 cSt @ 40 °C
Temperature range	-50 °C–+177 °C (-58 °F–+350 °F)

Table 16 Lubricants to be used for antifriction bearings

Type	Complete replacement		Periodic filling	
	[g]	[oz.]	[g]	[oz.]
310, 400	45	1.6	28	1.0
510, 550, 42	87	3.1	56	2.0
850, 732, 741, 742	154	5.5	84	3.0
870, 1260, 1270	196	7.0	112	4.0

Table 17 Minimum quantities for greasing antifriction bearings

Relubrication intervals: Grease

Operating conditions	Relubrication interval
Standard • Up to 24 hours/day • Clean environment • Light or normal load	Every 6 months or 3000 hours
Severe • 24 hours/day • Dusty or dirty environment	Every 3 months or 1500 hours
Extreme • 24 hours/day • Dusty or dirty environment • Very high dust levels or vibrations	Every month or every 750 hours

Table 18 Grease relubrication intervals

Relubrication intervals: Oil

Operating conditions	Relubrication interval
Standard • Up to 24 hours/day • Clean environment • Light or normal load	Every 6 months or 4000 hours
Severe • 24 hours/day • Dusty or dirty environment	Every 3 months or 2000 hours
Extreme • 24 hours/day • Dusty or dirty environment • Very high dust levels or vibrations	Every month or every 1000 hours

Table 20 Oil relubrication intervals

9.2.6 Lubricating oils

Only use the following types of oil:
AEON CF-46 is suitable for all standard applications.
AEON CF-150 is recommended for applications with outlet temperatures > 121 °C (250 °F).

Size	Gardner Denver AEON CF-46	Gardner Denver AEON CF-150
Specific gravity, ASTM D 4052, 15ºC/59 ºF	0.85	0.86
Pour point	-48 ºC (-54 ºF)	-45 ºC (-49 ºF)
Viscosity index, ASTM D 2270	135	144
Viscosity	48 cSt @ 40 ºC (104 °F)	143 cSt @ 40 ºC (104 °F)

Table 19 Suitable lubricating oils

9.2.7 Sound levels

Depending on the numbers of impeller stages different sound pressure level can be achieved.

Model	Max Sound Level [dB (A)]
550	73-91
870	81-87
1260	82-99
2000	86-92
2400	82-88
310	74-80
40	80-88
41	75-84
42	79-88
732	78-98
741	76-92
751	79-95
761	82-98
671	83-99
791	85-103

Table 21 Sound levels

9.2.8 Flange loads according to ISO 5199

Type	Flange 1 (inlet)						Flange 2 (outlet)					
	F_1 [N]	F_2 [N]	F_3 [N]	M_1 [Nm]	M_2 [Nm]	M_3 [Nm]	F_1 [N]	F_2 [N]	F_3 [N]	M_1 [Nm]	M_2 [Nm]	M_3 [Nm]
310	133	400	267	136	68	68	133	400	267	136	68	68
400	178	534	356	271	136	136	178	534	356	271	136	136
510	178	534	356	271	136	136	178	534	356	271	136	136
725	267	667	534	407	203	203	222	556	445	339	169	169
550	222	667	445	407	203	203	222	534	356	271	136	136
42	267	667	534	407	203	203	267	667	534	407	203	203
732	267	667	534	407	203	203	267	667	534	407	203	203
850	267	801	534	542	271	271	267	801	534	542	271	271
741	356	890	712	542	271	271	356	890	712	542	271	271
870	356	1068	712	678	339	339	356	801	534	542	271	271
742	445	1112	890	678	339	339	356	890	712	542	271	271
751	534	1334	1068	813	407	407	534	1334	1068	813	407	407
1260	445	1334	890	949	475	475	445	1334	890	949	475	475
752	623	1557	1246	949	475	475	445	1112	890	678	339	339
1270	667	2002	1334	1220	610	610	445	1334	890	949	475	475
761	623	1557	1246	949	475	475	623	1557	1246	949	475	475
1400	890	2669	1779	1627	813	813	890	2002	1334	1220	610	610
1600	801	2002	1601	1424	712	712	801	2002	1334	1220	610	610
1870	890	2936	1957	1898	949	949	890	2669	1779	1627	813	813
2000	890	2936	1957	1898	949	949	890	2669	1779	1627	813	813
2400	1068	3203	2135	2034	1017	1017	1068	2936	1957	1898	949	949

Table 22 Maximum permissible flange forces and torques (ISO units)

Type	Flange 1 (inlet)						Flange 2 (outlet)					
	F_1 [lbs]	F_2 [lbs]	F_3 [lbs]	M_1 [ft-lbs]	M_2 [ft-lbs]	M_3 [ft-lbs]	F_1 [lbs]	F_2 [lbs]	F_3 [lbs]	M_1 [ft-lbs]	M_2 [ft-lbs]	M_3 [ft-lbs]
310	30	90	60	100	50	50	30	90	60	100	50	50
400	40	120	80	200	100	100	40	120	80	200	100	100
510	40	120	80	200	100	100	40	120	80	200	100	100
725	60	150	120	300	150	150	50	125	100	250	125	125
550	50	150	100	300	150	150	50	120	80	200	100	100
42	60	150	120	300	150	150	60	150	120	300	150	150
732	60	150	120	300	150	150	60	150	120	300	150	150
850	60	180	120	400	200	200	60	180	120	400	200	200
741	80	200	160	400	200	200	80	200	160	400	200	200
870	80	240	160	500	250	250	80	180	120	400	200	200
742	100	250	200	500	250	250	80	200	160	400	200	200
751	120	300	240	600	300	300	120	300	240	600	300	300
1260	100	300	200	700	350	350	100	300	200	700	350	350
752	140	350	280	700	350	350	100	250	200	500	250	250
1270	150	450	300	900	450	450	100	300	200	700	350	350
761	140	350	280	700	350	350	140	350	280	700	350	350
1400	200	600	400	1200	600	600	200	450	300	900	450	450
1600	180	450	360	1050	525	525	180	450	300	900	450	450
1870	200	660	440	1400	700	700	200	600	400	1200	600	600
2000	200	660	440	1400	700	700	200	600	400	1200	600	600
2400	240	720	480	1500	750	750	240	660	440	1400	700	700

Table 23 Maximum permissible flange forces and torques (US units)

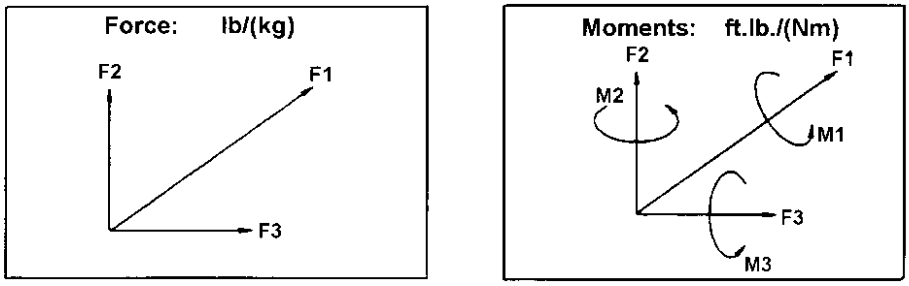


Fig. 24 Overview of forces and torques to which the flanges are subjected

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*)

☐ 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):

*) Check as appropriate

Table 24 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

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