3 Screw Pumps

3.0 Operative Range

3.0.1 Operative Range (general)

Ground reclamation
Vacuum extraction of underground gases.

Printing
Paper folding; sorting; mat drying; vacuum page lifting.

Conveying
With vacuum.

Iron ore processing
Vacuum filtering to dry iron ore for pelletizing.

Glass processing
As a means of lifting flat glass; evacuation of test chambers; vacuum filtration of particles from cutting and grinding.

Wood impregnation
Evacuation of the impregnation chamber.

Food industry
Vacuum packing to prolong storage life.

Engineering
Vacuum chucking of workpieces for milling and surface grinding; vacuum clamping; dust collection.

Paper manufacturing
Paper machine vacuum; folding; as a means of lifting; fiber collection.

Steel works
Vacuum filtration

Textile industry
For introducing fluid into cloth bales.

Clay processing
Degassing raw materials in brick, tile and ceramic making.

Packing industry
Vacuum forming of plastics.

Pulp production
Vacuum filtering and de-watering

Unsuitable Applications

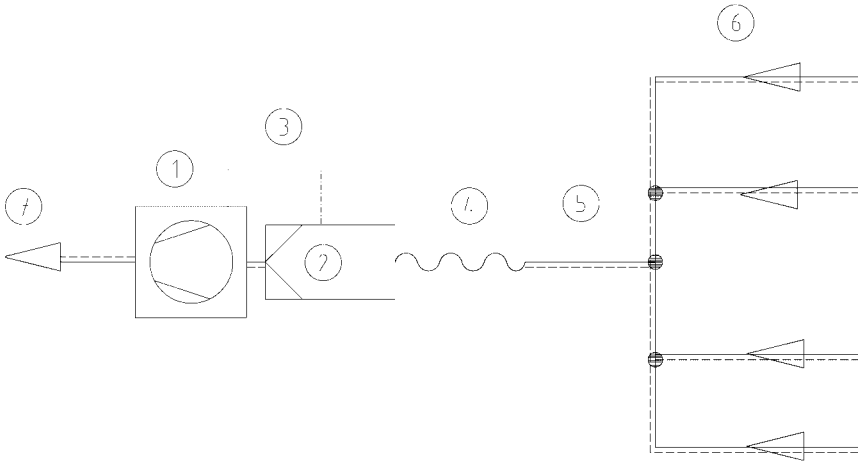
Suction of the following vapors is **not** possible:

Solvents
Acid vapors
Substances which lead to oil gumming up
Toxins and explosives
Residues of chemical waste
NaCl binders
residues of faces
Ammonia products

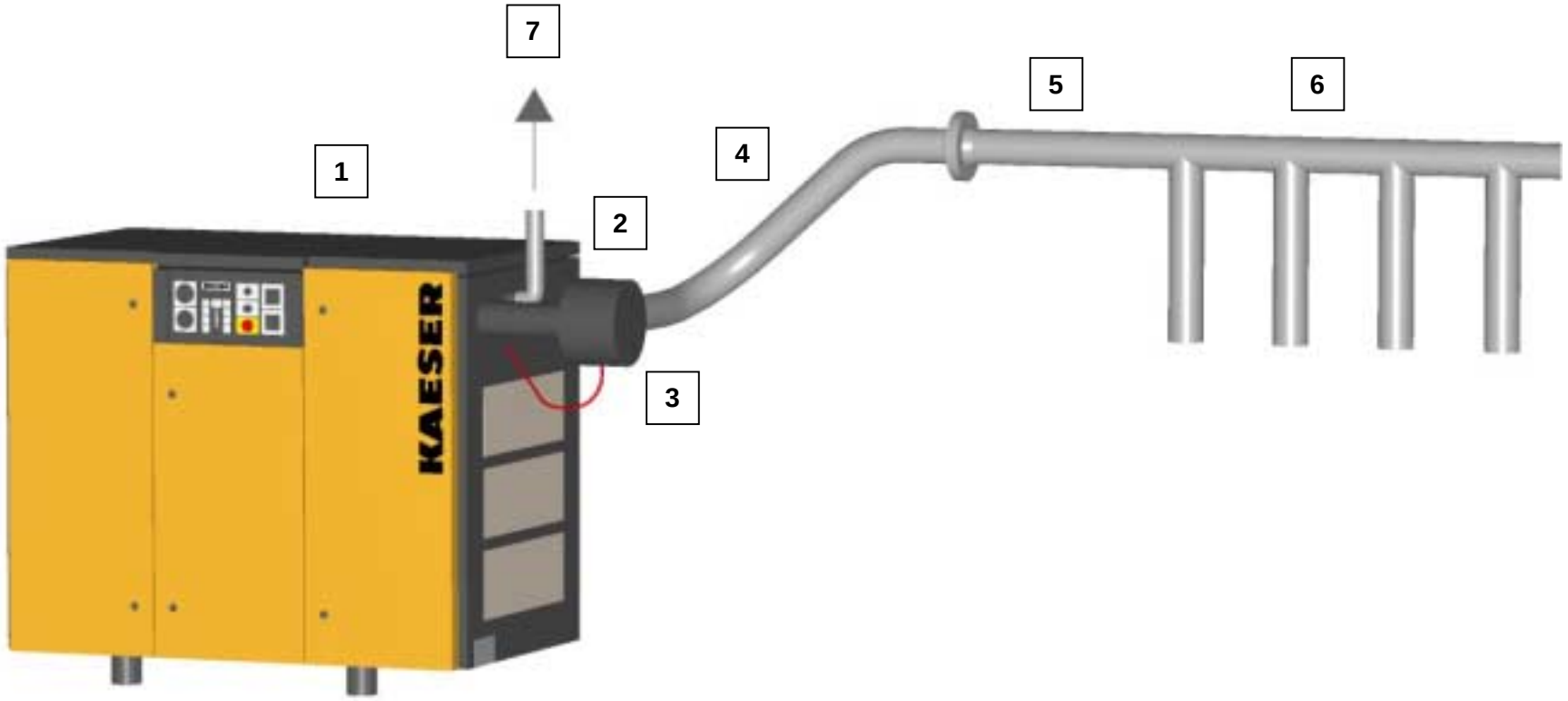
3.0.2 Standard filter

The **standard filter design** is used if inlet air is **pure and dry**, e.g. in printing works. The inlet filter supplied as standard is used to protect the package from possible impurities.
The connection hose to the vacuum network de-couples the pump package and prevents the transmission of vibrations to the network.

P + I diagram



1. Screw vacuum package
2. Standard inlet filter
3. Control line (for measuring the pressure drop, i.e. filter contamination)
4. Connecting hose
5. Vacuum collecting line
6. Vacuum network
7. Air discharge


7
5
6
1
4
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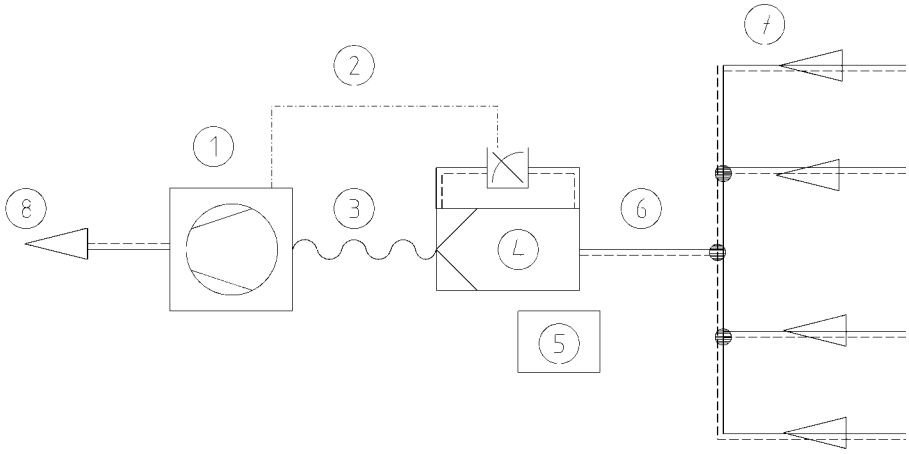
3
KAESER

3.0.3 Filter for dusty conditions

If the inlet medium is dusty, when conveying granulate material for example, additional separation is necessary.
The standard inlet filter with its limited filter area is insufficient.
For this purpose a type G vacuum filter is installed.
The filter can be fitted with a filter chamber extension to increase the volume of the chamber and thereby life of the filter.
It should be noted that emptying the chamber can only take place under atmospheric pressure.
It is necessary to install a second filter to ensure continuous operation.
The filter chambers can then be emptied alternately. The venting valve on the filter housing serves to equalize pressure.

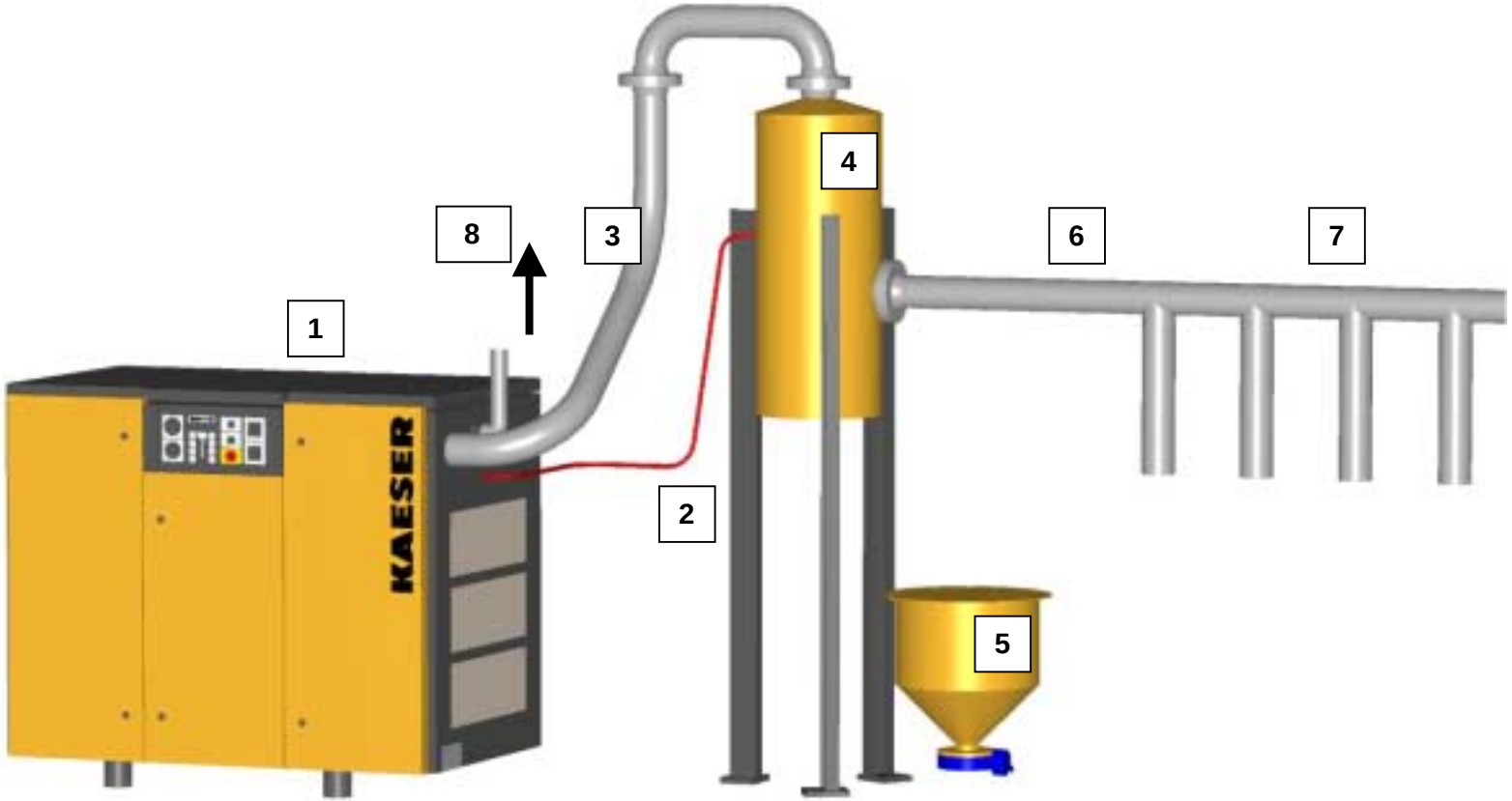
Version A - 1 vacuum filter
P & I diagram



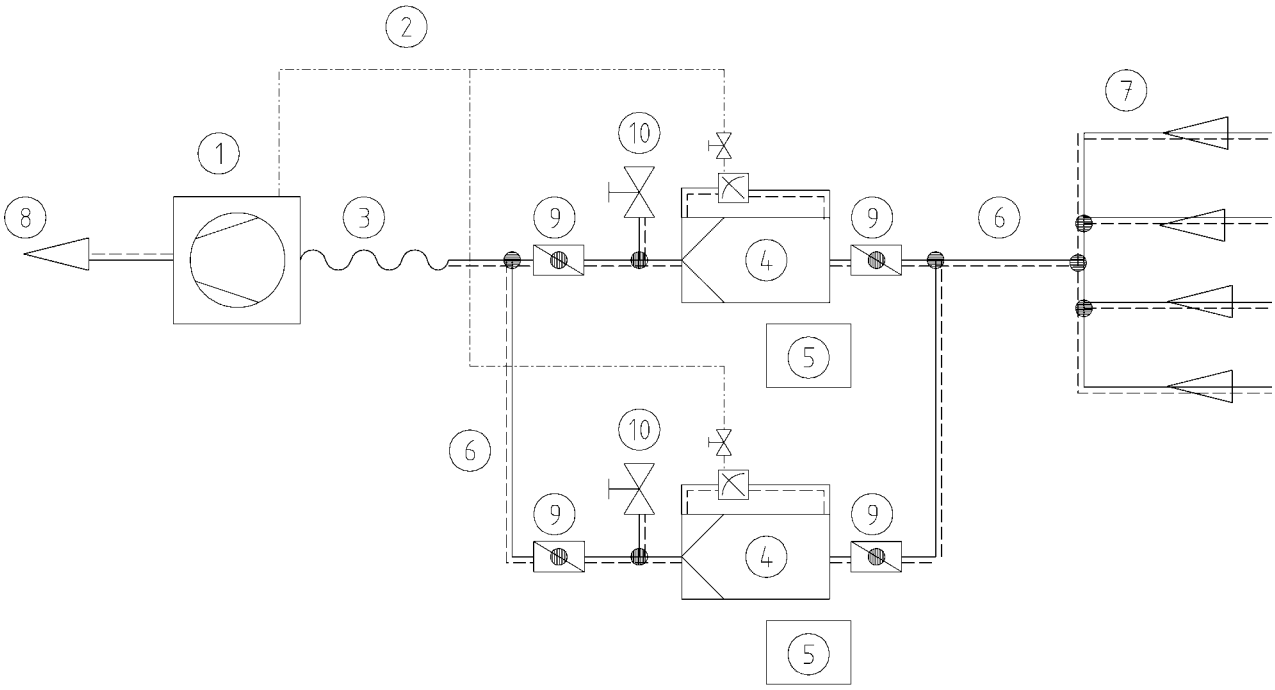
Legend

1 Rotary screw vacuum package
2 Control line (to measure pressure differential / contamination of the filter and stepless inlet regulation)
3 Connecting hose
4 Vacuum filter type G
5 Filter chamber extension
6 Vacuum collecting line
7 Vacuum network
8 Discharge

Version A - 1 vacuum filter
Arrangement



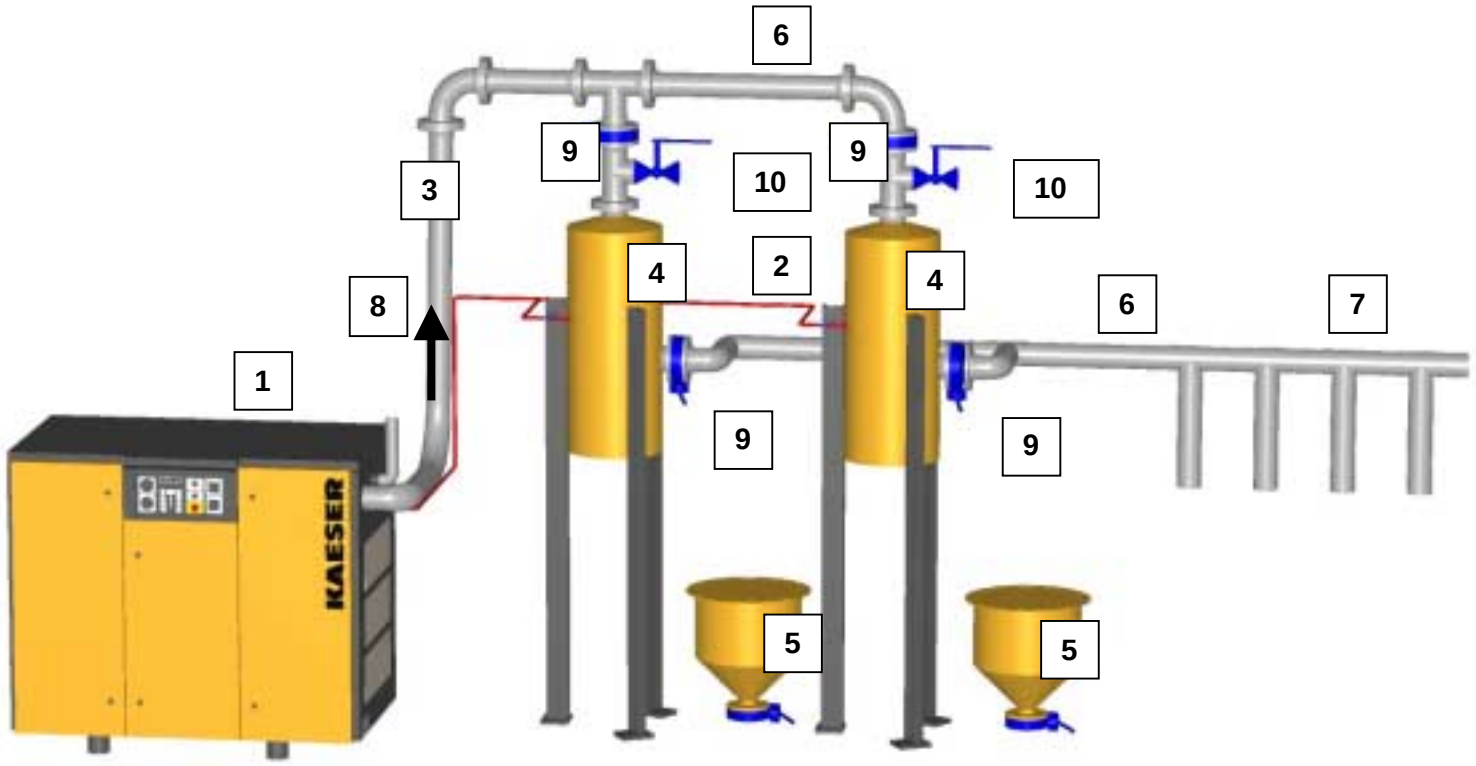
Version B - 2 vacuum filters with changeover facility
P & I diagram



Legend

1 **Rotary screw vacuum package**
2 Control line (to measure pressure differential / contamination of the filter and stepless inlet regulation)
3 Connecting hose
4 Vacuum filter type G
5 Filter chamber extension
6 Vacuum collecting line
7 Vacuum network
8 Discharge
9 Shutoff flap
10 Venting valve

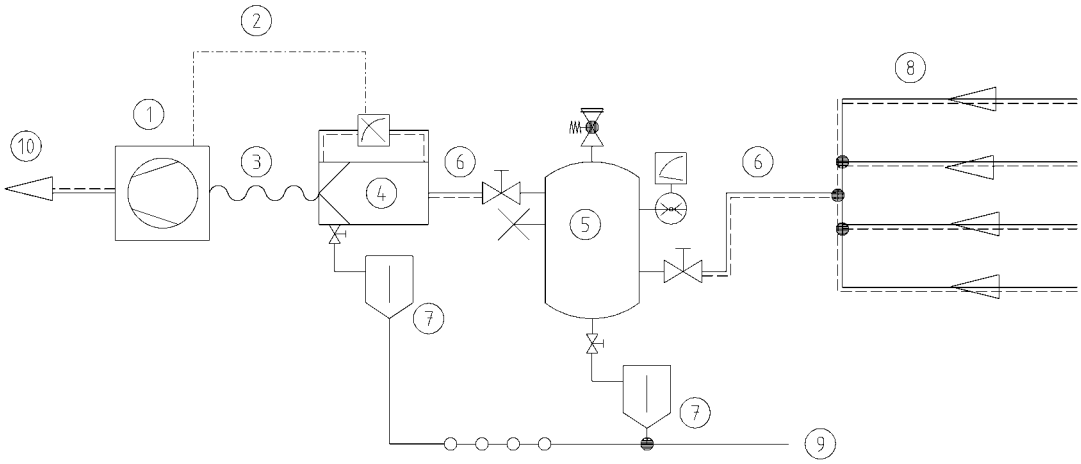
Version B - 2 vacuum filters with changeover facility
Arrangement



3.0.4 Filter for moist conditions

If the inlet medium contains much moisture it must be separated out before entry into the vacuum package.
The deflector on the special separator inlet causes an action similar to a centrifugal separator.
The precipitated condensate must be drained out via an ECO Drain V.
A vacuum filter type F with its filter element removes the residual moisture, which is also drained out via an ECO Drain V.
When this filter is installed, the standard inlet filter is omitted.
The inlet hose used to connect the filter prevents transmission of vibrations.
The pressure drop over the filter caused by element contamination is fed to the package by means of a control line.

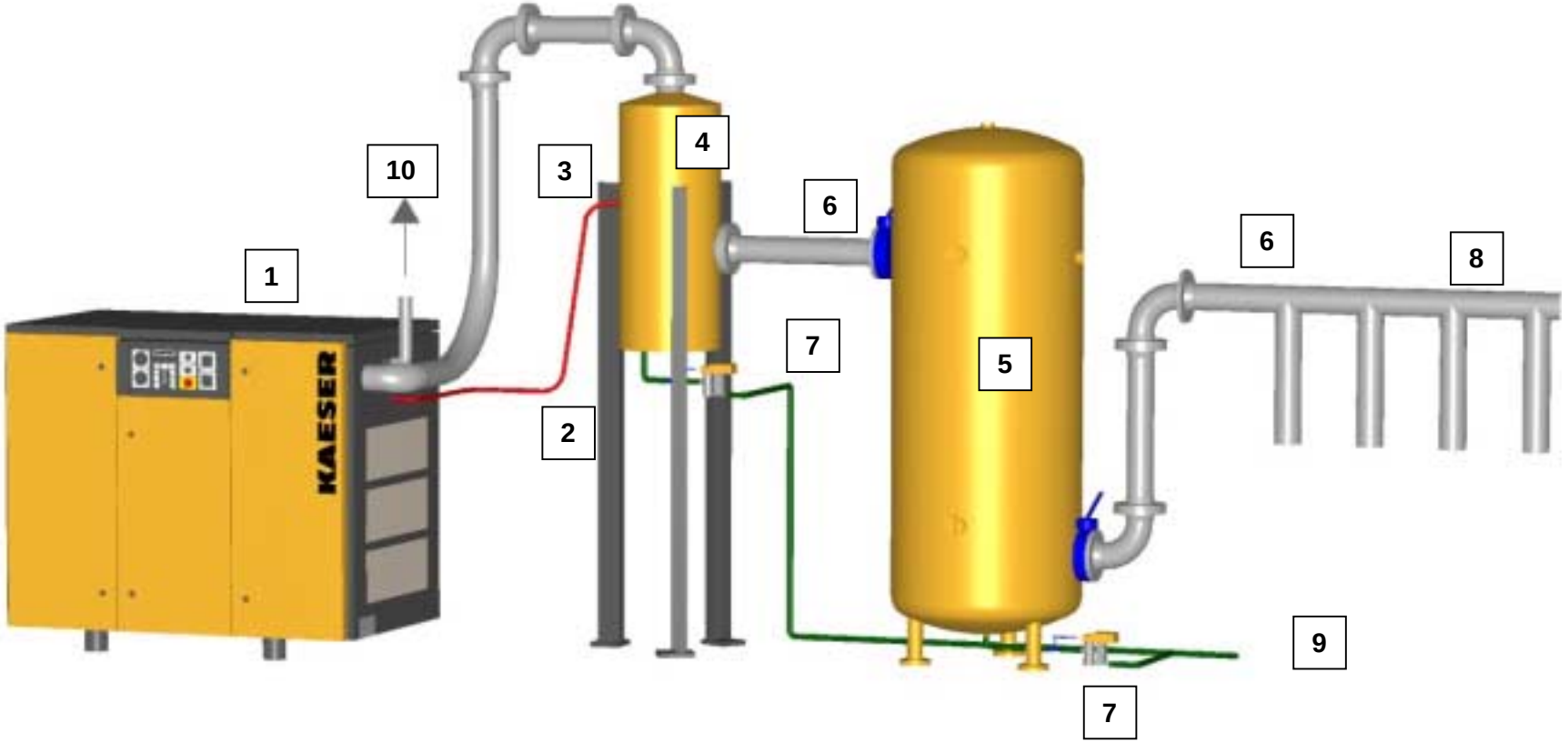
P & I diagram



Legend

1	Rotary screw vacuum package	6	Vacuum collecting line
2	Control line	7	ECO Drain V
3	Connecting hose	8	Vacuum network
4	Vacuum filter	9	Condensate drain line
5	Separator	10	Discharge

Arrangement

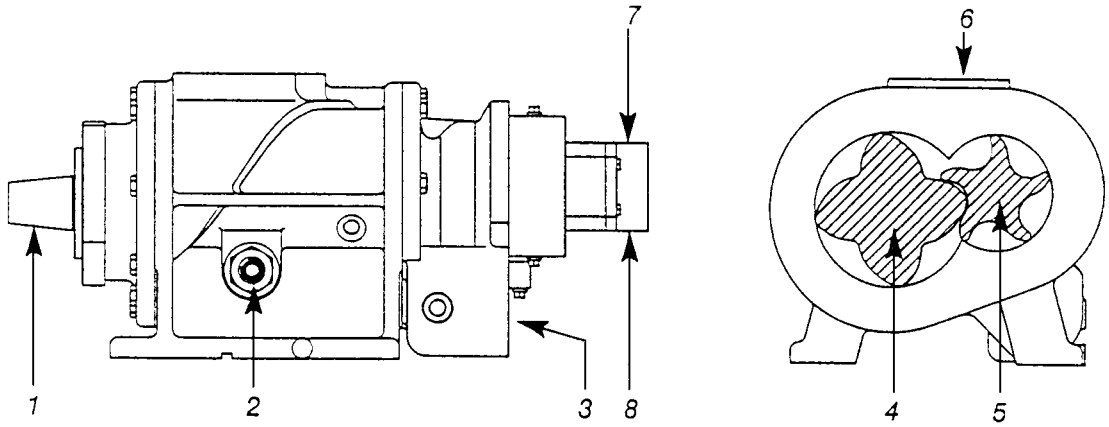


3.1 Package Design

3.1.1 Technical description

3.1.1.1 Principle of evacuation

The stationary vacuum package is fitted with a single stage, oil cooled vacuum airend. Two rotors supported by roller bearings are fitted in the airend casing. The male rotor is driven and in turn drives the female rotor. When the rotors are rotated, air is drawn in from the top through the inlet port and is compressed at the bottom. The oil that is injected at the bottom carries away the heat of compression, prevents metallic contact between the rotors themselves and the casing, seals the rotors to each other and to the casing and simultaneously acts as a lubricant for the roller bearings. The gear pump flanged to the female rotor produces the oil pressure required for oil circulation . The compressed oil/air mixture leaves the vacuum airend via the discharge port.



1. Drive shaft
2. Oil injection
3. Discharge port
4. Male rotor
5. Female rotor
6. Inlet port
7. Oil pump, inlet end
8. Oil pump, discharge end

3.1.1.2 Short description

The vacuum airend is driven from an electric motor via V-belts.

An oil separator cartridge is fitted in the oil separator tank that provides oil-free air.

The control of the vacuum package ensures that the vacuum remains within the preset pressure limits.

A safety shutdown system protects the package if important systems fail by shutting down automatically.

The fan ventilates the cabinet and passes air through the oil cooler.

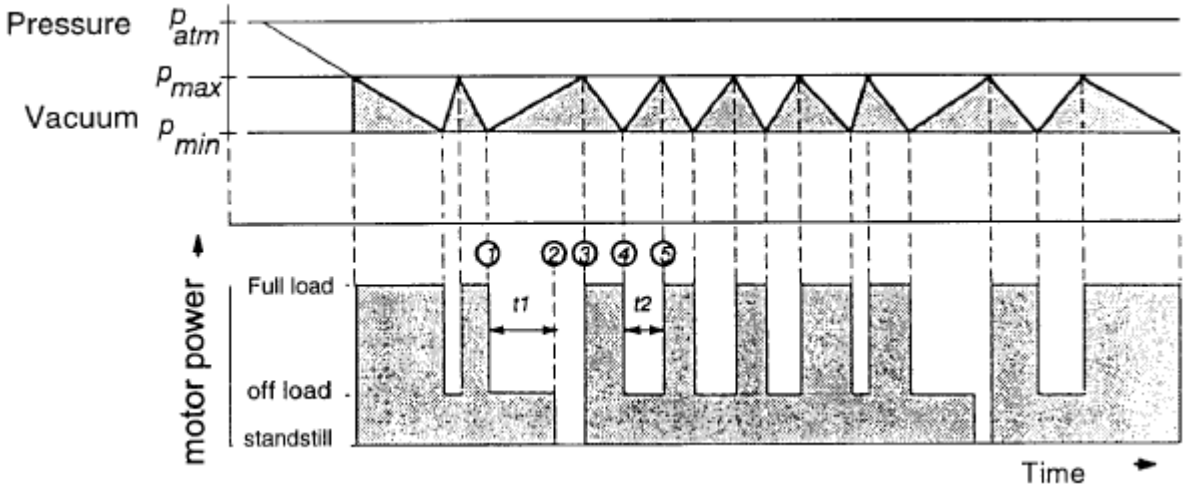
Because in vacuum operation there is no pressure drop between the separator and the airend, an oil pump is used to maintain the oil flow.

3.1.5 Types of Control

These vacuum packages can be controlled by the two following types of control:

- KAESER DUAL control (combined full load / off load running / intermittent control)
- Automatic vacuum control (continuous control)

3.1.5.1. DUAL Control



In DUAL Control (combined full load, off load running and intermittent control) the vacuum package normally runs at full load and off load running or standstill.

Operation is controlled by a vacuum switch within set limits between full load and off load running. The pressure limits are determined by the maximum required vacuum (i.e. minimum pressure p_{min}) and the minimum permissible vacuum (i.e. maximum pressure p_{max}).

If the vacuum package runs for longer than a preset time period, (1) to (2) e.g. t1 = 4 min, in off load running, the electric motor switches off completely (2). When the upper pressure switching point p_{max} (3) is reached the vacuum package is automatically restarted. The pressure now sinks to the lower switching point p_{min} (4) and the vacuum package runs in off load running. Should, however, the pressure rise within a shorter time period (4) to (5) e.g. t2 = 3 min again to p_{max} (5), the package will automatically switch from off load running to full load.

Setting the vacuum switch

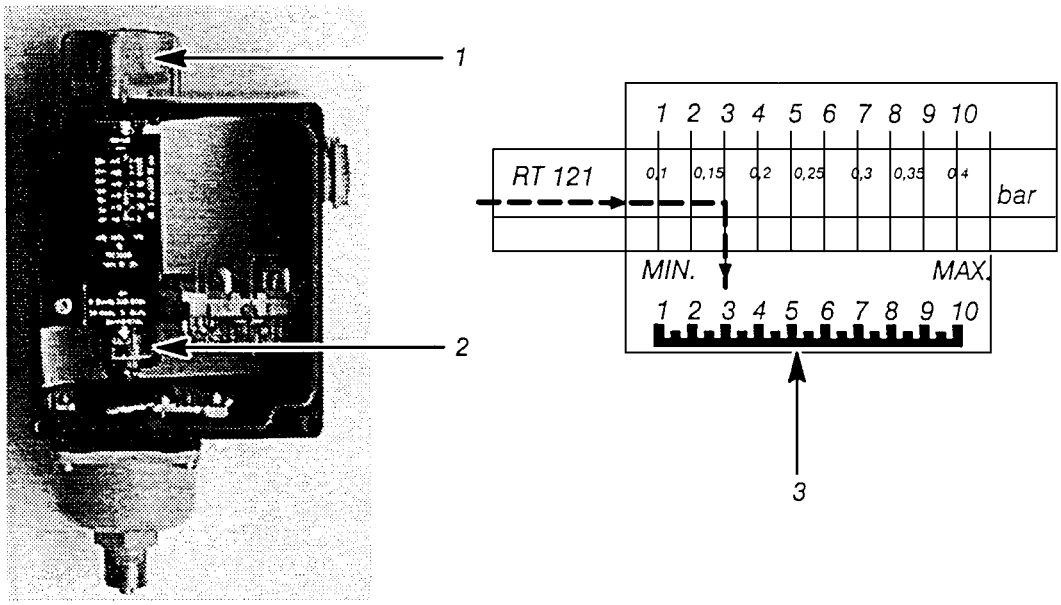
Disconnect the supply voltage to the vacuum package by switching off the main supply switch and ensure that the switch cannot be switched on again before any adjustments are carried out.

Setting the switching differential on the vacuum switch for limiting the cut-in frequency.

The cut-in frequency from on load to off load running is limited to max. twice per minute.

The cut-in frequency can be reduced to a limited degree by increasing the switching differential.

If this measure is insufficient, install a larger storage tank in the vacuum network at the inlet of the package to provide more buffer capacity.



1 Vacuum adjusting knob
2 Differential register
3 Diagram for differential register

The setting of the vacuum switch can be changed with the adjusting knob (1) on the outside of the switch cover.

The differential pressure can be set after removing the switch cover with the differential roller (2) according to the diagram (3).

Replace the switch cover after every readjustment of the pressure switch and before starting the vacuum package because of the danger of injury through electrical components.

For example:

A vacuum package required to work at -0.75 bar may have its vacuum switch set at -0.75 / -0.60 bar, which would mean that the package switches to full load running at -0.60 bar and at -0.75 bar switches to off load running.

The vacuum controller is then rendered inoperative by screwing out the adjusting screw fully.

3.1.5.2. Automatic vacuum control

1. Full load / partial load / off load running phases

Full load:

When the working pressure reaches approximately 0.5 bar above the maximal vacuum, the vacuum package runs under full load. The vacuum controller is closed in this situation, so that the line to the inlet valve is not pressurized and the inlet valve is 100% open in this state.

If the air volume flowing into the vacuum network is higher than the maximal suction capacity of the vacuum package, an operating point is arrived at that lies above the working pressure mentioned above, i.e. the vacuum reduces.

Partial load:

If the air volume flowing into the vacuum network is less than the maximal suction capacity of the vacuum package the pressure in the vacuum network sinks, causing the pressure in the control line to the vacuum controller to sink also. If the fore pressure falls below the setting of the vacuum controller, the valve seat opens causing the outlet pressure to the inlet valve to fall also and it starts to close. The vacuum package is switched over to partial load, which means that the suction capacity is automatically matched to the demand.

Off load running:

If the vacuum rises, the pressure in the control line to the vacuum controller falls further and the inlet valve closes.

2. Vacuum controller

For example: In a vacuum package intended to operate at -0.75 bar the vacuum controller may be set so that at 0.70 bar the inlet valve closes to slowly reduce the volume sucked into the package.

Variation in demand on the vacuum system are reflected in proportional variations in the position of the inlet valve and so in the volume sucked into the package. In this way the set vacuum pressure is maintained so long as the inflow of air into the vacuum does not exceed the pump capacity of the package. The vacuum switch should be set at 0.2 bar higher vacuum than the controller. If this is not possible it should be set at maximum possible vacuum (near 100%)

3. Mechanical setting or the vacuum controller

The required pressure is set with an adjusting screw.

Example: The vacuum package is to be set to a constant pressure of -0.70 bar.

☞ Loosen the locking nut (2) and turn the adjusting screw (1) on the controller (4) ten times counterclockwise. The controller is now closed down.

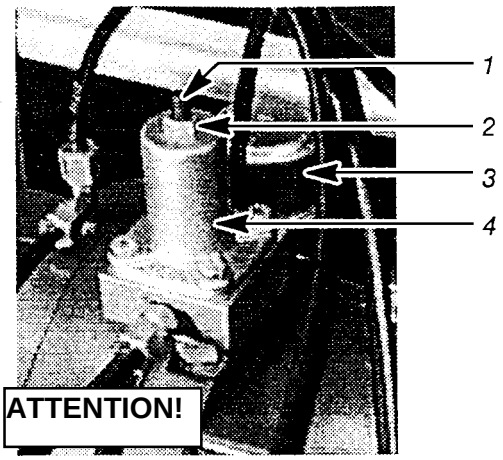
☞ Start the package and set up a pressure of -0.70 bar with a shut-off cock at the package inlet.

☞ Turn the adjusting screw (1) clockwise until the controller (4) reacts and the inlet valve starts to close.

☞ Simulate a fluctuating air flow by slowly opening and closing the shut-off cock at the inlet to the vacuum package.
The controller (4) now reacts and regulates the package via the inlet valve to a definite constant vacuum.

☞ The required vacuum can be set to a fixed point by turning the adjusting screw (1) further and the locking nut (2) tightened.

Check that the interlock switches on all inspection covers are functioning. Operating without fully functioning interlock switches is strictly prohibited because of the danger from moving parts and electrical equipment.



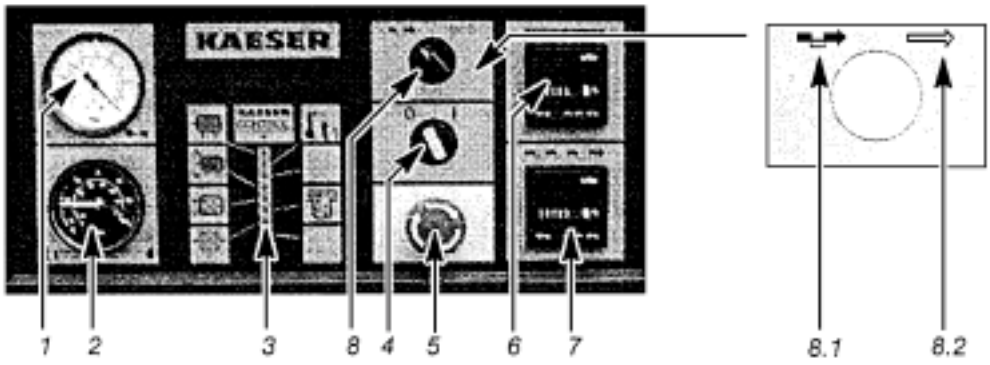
1 Adjusting screw
2 Locking nut
3 Controller air filter
4 Vacuum controller

ATTENTION!

Avoid sudden opening and closing of the shut-off valve at the inlet (between the package and the vacuum network) as this causes oscillations within the control loop.

3.1.6. Operation

1. Control panel



1	Vacuum gauge	6	Service hours counter
2	Temperature gauge switch	7	Load hours counter
3	KAESER-CONTROL	8	Control switch "Normal / Off Load Running"
4	Start / Stop "0 / 1"	8.1	Normal
5	EMERGENCY STOP push button	8.2	Off Load Running

2. Starting and Stopping the Vacuum Package

Starting:

ATTENTION!

kage starts automatically again after a power failure provided the inlet pressure is higher than cut-out pressure set on the inlet pressure switch.

Switch on the main supply switch.
Turn the control switch (8) to the normal position.
Turn the control switch (4) to the "I" position.

Stopping:

ATTENTION!

vacuum package with the main supply switch.
Always start and stop the vacuum package principally with the stop / start switch (4).

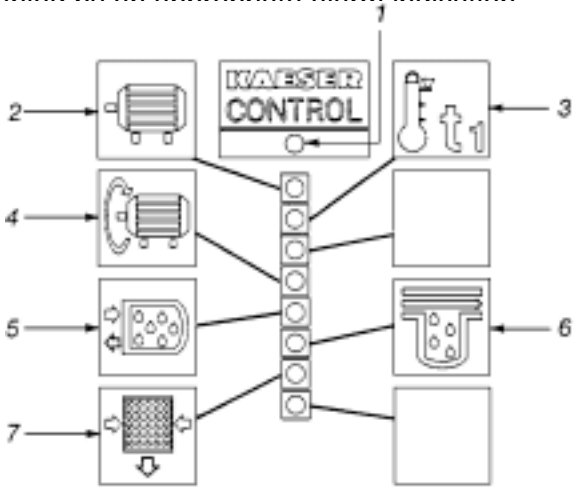
Turn the control switch (8) to the off load running position.
Turn the stop / start switch (4) to the "0" position.
Switch off and lock out the main supply switch.

3.1.7. Safety System

1. Safety System: KAESER CONTROL

The green LED "1" is illuminated if the package is running or ready for operation. It is extinguished if an alarm is apparent.

A malfunction detected by the control functions 2, 3 and 4 will shut down the package immediately, accompanied by an appropriate alarm indication.



Control functions with alarm indication and auto shut-down:

2 Overload trip of the drive motor shuts down the package at motor overload.
When the malfunction is removed, press the overload trip reset button.
3 Temperature gauge switch for detection of excess discharge temperature.
The package is shut down if a discharge temperature of 110 °C is reached.
4 Pressure switch, shuts down the package at wrong direction of rotation.

Control functions with alarm indication only:

5 Activation of the oil filter cartridge differential pressure switch.
The alarm indicates a need for oil filter cartridge maintenance at a pressure drop greater across the filter cartridge than 1.25 bar.
6 Activation of the oil separator cartridge differential pressure.
The alarm indicates a need for oil separator cartridge maintenance at a pressure drop across the cartridge greater than 0.8 bar.
7 Activation of the differential switch of the vacuum filter cartridge
The alarm indicates a need for vacuum filter maintenance at a differential pressure greater than 0.06 bar across the filter.
This differential pressure is valid for a working pressure of approximately 50% vacuum.
Change the setting of the differential pressure switch according to the accompanying diagram for other working pressures.

The LED of supervisory functions 5, 6 and 7 are indicative alarms only.
Alarms 5 and 6 are only valid if the vacuum package has reached normal running temperature.
Alarm 7 (vacuum filter clogged) is stored and remains illuminated until the cartridge is cleaned or replaced.

"EMERGENCY STOP Pushbutton"

If the EMERGENCY STOP pushbutton is pressed, the vacuum package is shut down and all LEDs on the KAESER CONTROL illuminate.

Reset the vacuum package after the cause of the alarm is removed.

☞ Reset the EMERG. STOP push button by turning the latched pushbutton in the direction of the arrow.

☞ Reset the vacuum package by turning the control switch from "I" to "0".

The vacuum package is now ready to restart.

Door interlock switch with shut-down function when access doors are opened

If the left-hand access door and the safety screen door are opened during compressor operation the vacuum package is shut-down by the door interlock switch.

If the door is closed again, the contact in the interlock switch closes. After the vacuum package is reset by turning the control switch from "I" to "0", it can be restarted again.

2. Temperature gauge switch

If the discharge temperature directly downstream of the vacuum pump reaches 110 °C, the temperature gauge switch activates.
Activation of the temperature gauge switch causes a shut-down of the package, coupled with appropriate indication on the KAESER CONTROL.

☞ Search for and remove the cause of the alarm.

Possible causes of alarms:

- Low oil
- Cooling system fault
- Ambient temperature too high or too low
- Clogged filter mat, oil filter or cooler
- Inlet pressure too high

☞ When the cause of the alarm is removed, reset the package by turning the control switch from "I" to "0".

Then vacuum package can then be started again as described in 3.1.6.

3.6 Piping in the vacuum area

3.6.1 General notes

Material

Plastic, galvanized pipe, stainless steel, copper.
Black pipe should not be used as this could contain traces of some undesirable material which would then be sucked into the pump. If this must be used, then the inlet filter provided in the standard scope of delivery must be installed.
Pressure resistance: Differential pressure in the vacuum system is max. 1 bar, ambient to vacuum.

Pipework

Most important is that all joints are sealed, i.e. welding, soldering or bonding is preferred. Hemp seals dry out.
Check for seal using pressurization, 1 – 2 bar(g) and search for leaks as in compressed air pipework.

Shut-off devices

Flaps, ball valves or other valves must be designed for low leakage rates.
Automatic shut-off valves that seal off the pump from the vacuum network/receiver are only necessary at ranges under 50 mbar. Otherwise, the inlet valve supplied with Kaeser screw vacuum pumps sufficient when the pump stops.

Humidity in the vacuum network

A centrifugal separator is needed upstream of the pump, chosen to suit the pump inlet section. (if in doubt – choose a larger size). This should be fitted with a condensate drain designed for vacuum use.
If there is high humidity in the vacuum network it is necessary to install a receiver, in which case the order of installation is: network – centrifugal separator – receiver – inlet filter – vacuum pump. Both the separator and the receiver should be fitted with condensate drains.
(Receiver size for BSV package – 500l; note inlet section!).

Pressure relief valve

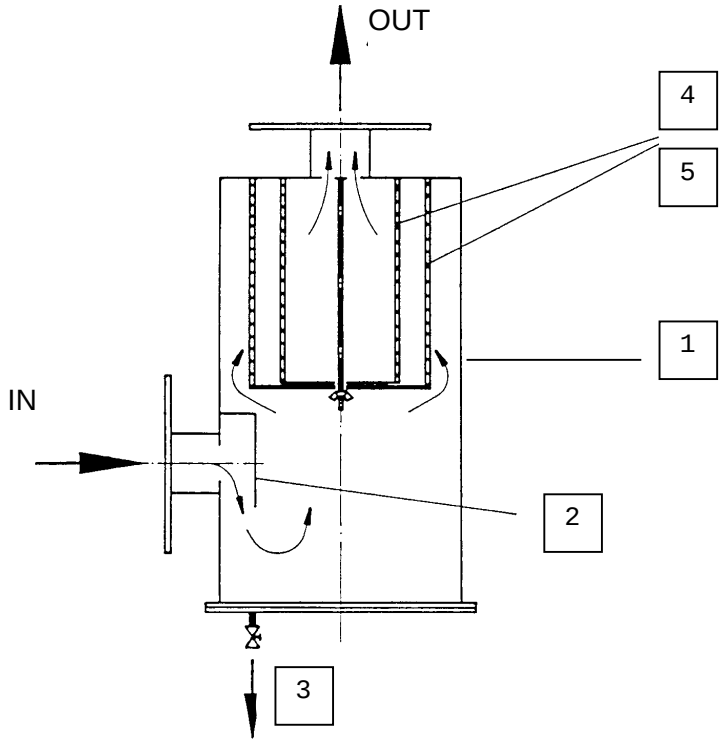
Not needed on the inlet side of Kaeser screw type vacuum pumps because of the method of internal control - essential on OMEGA blowers in every case.

3.7.1 Vacuum Filter

The package inlet is equipped with a factory-fitted particulate filter.

If the inlet air is particularly dusty of moist, a separate vacuum filter can be provided.

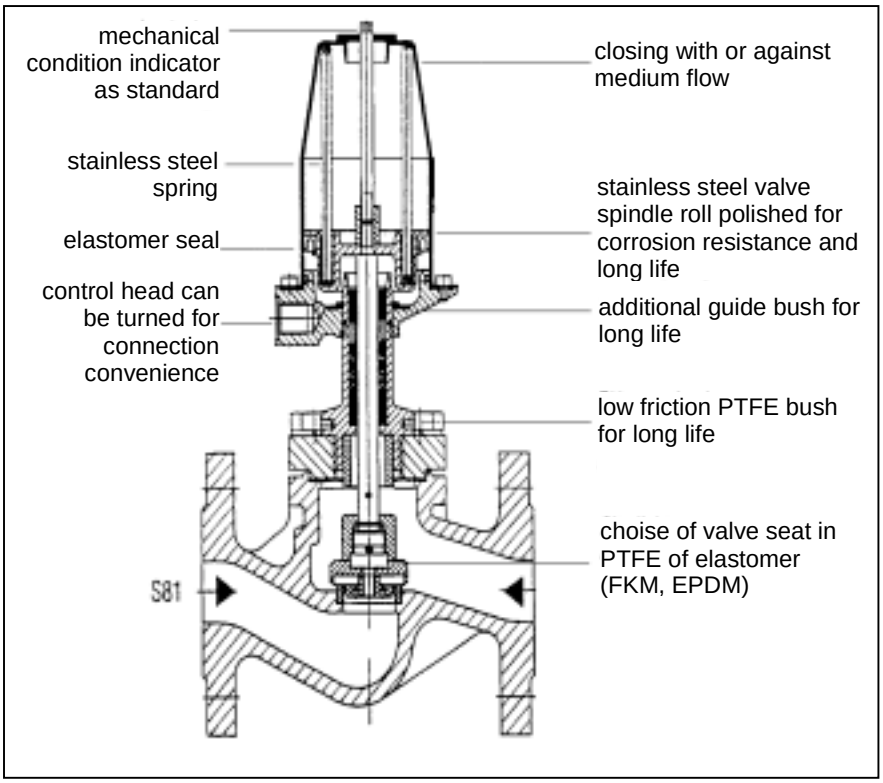
These filters can be equipped with different elements to capture solid particles and separate out moisture. Two elements can be installed concentrically and independent from each other in the same filter housing.



1 Housing
2 Deflector (mechanical separation)
3 Condensate drain (in the case of moisture separation)
4 Inner element
5 Outer element

3.8 Valves

3.8.1 Flange valves DN 65 and DN 100



In normal operation, the control of the vacuum package is carried out by the inlet valve. During shutdown of the aggregate, venting occurs at the inlet valve on the airend side to equalize pressure between that exhaust- and the inlet side of the airend to avoid airend cooling fluid being forced into the inlet line For security in operating several packages in a vacuum network, a supplementary vacuum sealing valve is necessary.