



## Installation and Operating Instructions



### Rotary Vane Vacuum Pumps R 5 RA 0165, 0205, 0255, 0305 D 0.1 mbar versions

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## GENERAL

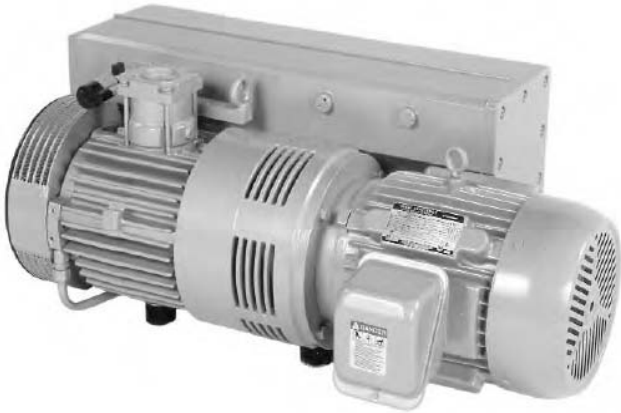
### Identification

For model identification, see the nameplate mounted on the side of the exhaust box.

This manual is written to cover installation and operation of the RA pump models 0165, 0205, 0255 and 0305 with a "D" appearing as the seventh character in the model type number stamped into the nameplate. For example it would appear as follows:

RA0XXX - DXXX - XXXX

When ordering parts, it is helpful to include the identification code stamped into the side of the cylinder as well as the serial number from the nameplate.



**Fig. 1 - Front of the R 5 RA 0255 D Pump**

### Operating Principles

All reference (Ref. XX) numbers listed in the text and on illustrations throughout this manual are related to the drawings and parts list near the end of this publication.

R 5 Series, Single Stage, Rotary Vacuum Pumps are direct-driven, air-cooled, oil-sealed rotary vane pumps which operate as positive displacement pumps. They consist of a rotor positioned eccentrically in a cylindrical stator (see Fig. 1). When the rotor spins, centrifugal force pushes the vanes, which glide in slots, towards the wall of the cylinder. The rotor has three vanes which divide the pump chamber into three segments. The gas to be pumped enters at the inlet port, passes through the inlet screen and the open anti-suck-back valve into the pump chamber. As the rotor rotates, the inlet aperture is closed, the gas is compressed and forced out through one-way valves between the pump cylinder and the exhaust box. Differential pressure constantly causes oil to be pressed into the compression chambers. The gas/oil mixture is separated by the discharge filters (Ref. 120). The oil-free medium is discharged through the exhaust cover plate (Ref. 140) to atmosphere. This operation is repeated three times each revolution.

All R 5 series pumps are designed to handle air. Vapor in the air stream can be tolerated when the pump is operated within certain operating parameters as defined by Busch LLC Engineering (see Section 2.2 - Gas Ballast). When you desire to use the pump on an air stream that contains vapors, contact Busch LLC Engineering for operating recommendations; otherwise, the warranty could be void.

## 1.0 INSTALLATION

### 1.1 Unpacking

Inspect the box and pump carefully for any signs of damage incurred in transit. R 5 Pumps pass a rigorous operating test in the factory and are packed carefully to avoid transit damage. Since all pumps are ordinarily shipped FOB our factory, such damage is the normal responsibility of the carrier and should be reported to them.

Remove any nuts from the bottom of the box/crate and pull the pump out of the container using a suitable lifting device and the lifting eye bolt (Ref. 391). Then, unscrew any remaining studs that secured the bottom of the rubber feet to the bottom of the crate.

The inlet port of the pump is covered with a plastic cap prior to shipment to prevent dirt and other foreign material from entering the pump. Do not remove this cover until the pump is actually ready for connection to your system.

### 1.2 Location

The pump must be installed in a horizontal position on a level surface so that the pump is evenly supported on its rubber feet. To allow for proper cooling, there must be a minimum 20 inches of clearance for the oil cooler (Ref. 241) and motor fan (axially). The left and right side of the pump require a minimum 8 inches of clearance. Adequate ventilation must be provided. Do not locate the pump in a stagnant air location.

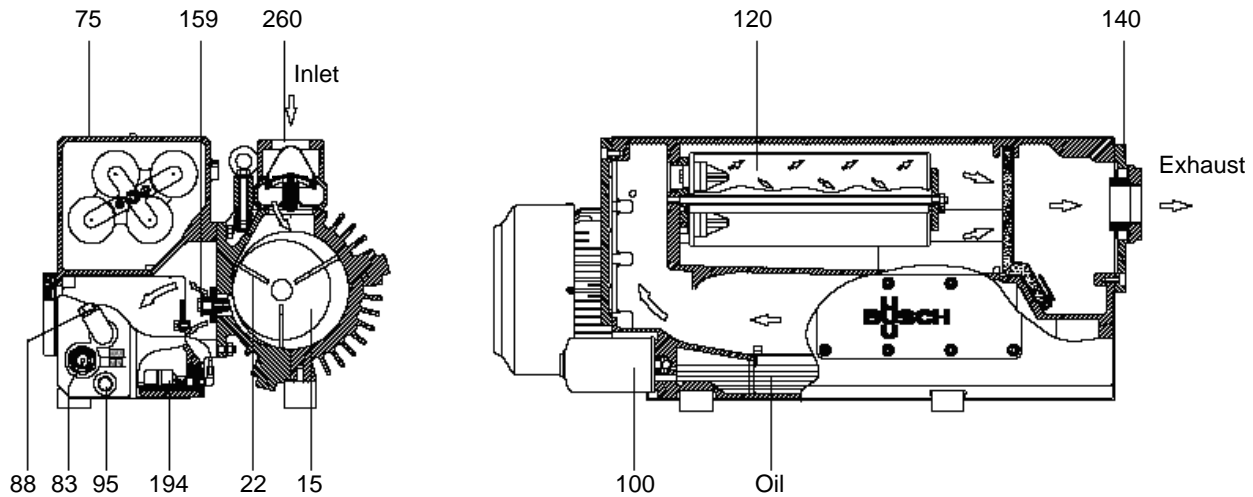
Whenever the pump is transported, be sure to drain the oil prior to shipping to avoid vane breakage when restarting the pump.

Do not tip the pump over if it is filled with oil.

Locate the pump for easy access to the oil sight glass (Ref. 83) in order to inspect and control the oil level properly. Allow clearance at the exhaust flange area to provide service access to the exhaust filters.

### 1.3 Power Requirements

The schematic diagram for the electrical connection is located in the junction box or on the nameplate of the pump motor.



**Fig. 2 - Basic R 5 RA 0165, 0205, 0255, and 0305 D Series Pump**

The motor must be connected according to the electrical codes governing the installation. The power supply must be routed through a fused switch to protect the motor against electrical or mechanical overloads. The motor starter has to be set consistent with the motor current listed on the motor nameplate.

**CAUTION: After the electrical connection has been made, but before the pump is filled with oil, the rotation of the motor must be checked. Open the inlet port and jog the motor briefly to make sure rotation is correct. If it runs backwards and if it is wired three phase power, reverse any two leads of the three at the power connection.**

If the pump is supplied with a manual motor starter, it is preset at the factory in accordance with the customer's specification. For other voltage requirements, contact the factory for motor and/or starter information.

**Note:** See the motor manufacturer's manual for start-up maintenance of the motor.

Correct direction of rotation is marked by an arrow on the motor fan housing and is counterclockwise when looking at the motor from the motor's fan side.

#### 1.4 Vacuum Connections

Use a line size to the vacuum system that is at least as large as that of the pump inlet. Smaller lines will result in lower pumping speeds than the rated values.

Install a drip leg and drain on the vertical pipe near the pump inlet. Drain the drip leg often to prevent condensation from entering the pump. Also, when installing discharge piping, a drip leg should be installed.

If more than one vacuum pump or a receiver tank is connected to a common main line, each pump should

have its own manual or automatic operated shut-off valve or positive action check valve. The built-in anti-suck-back valve should not be used as a shut-off valve for the vacuum system.

**CAUTION: Do not use the anti-suck-back valve as a check or shut-off valve for your vacuum system.**

Remove the plastic protective cap from the inlet port prior to connection of the pump to the system. Vertical connection of the vacuum line can be made directly to the pump inlet (Ref. 260).

The type and size of the inlet connections of the R 5 Series pump is shown in the TECHNICAL DATA page 13.

If the gas that is pumped contains dust or other foreign solid particles, a suitable (10 micron rating or less) inlet filter should be connected to the inlet port. Consult the factory for recommendations.

#### 1.5 Oil Filling

The pump is shipped without oil. After level installation, after correct rotation has been established and with the pump switched "off" and secured against accidental start-up, fill the pump with the recommended vacuum oil through the oil filling port (Ref. 88), observing the "MAX" and "MIN" position at the oil sight glass (Ref.83).

Non-detergent oil should be used. **Do not use detergent motor oil** as additives in detergent oil will plug exhaust filter elements and shorten their life.

It is recommended that Busch R500 Series oil be used to receive the best performance from your vacuum equipment. R500 Series oil is a high quality vacuum oil that will give longer running time between oil changes, will provide better lubrication at high operating temperatures, and will prolong the life of

exhaust filter elements. This oil can be obtained directly from Busch LLC in Virginia Beach, Virginia.

The strict use of Busch oils and parts from the day of purchase can extend the life of the vacuum pump.

For general applications, use R530. Use R590 or R570 in pumps that are operated in high ambient temperatures (above 90°F) or when the oil carbonizes (turns black) before the change interval. Contact the factory for recommendations when using other oils.

The TECHNICAL DATA chart on page 13 gives the approximate quantity of oil required. The oil capacity chart should only be used as a guide, since oil capacity may be slightly lower, depending on whether the pump was filled previously, and whether all components such as oil filter, oil lines, etc., were allowed to completely drain. Use only the sight glass reading for proper level. **Never overfill!**

**WARNING:** Keep the oil fill plug tight as pressure in the exhaust box could cause bodily injury if the plug is blown out. Do not fill/add the pump with oil through the exhaust/inlet ports as there is danger of breaking the vanes!

For ambient operating temperatures lower than 41°F, use Busch R580 synthetic oil. If this does not help (where the pump has difficulty starting due to high oil viscosity), contact the factory in Virginia Beach, Virginia.

Replace the oil fill plug (Ref. 88), and pressure gauge (Ref. 88), making sure that the gasket (Ref. 89) is in place and properly seated and secured. Pumps are equipped with an exhaust pressure gauge as an integral part of the oil fill plug. Switch the power back into the "on" position.

## 2.0 OPERATION

### 2.1 Start-up

Check rotation of the motor as described in Section 1.3.  
- Power Requirements.

Fill the pump with oil as described in Section 1.5.  
- Oil Filling

Start the pump and immediately close the inlet. Run the pump for a few minutes before checking the oil level again. With the pump shut off, the oil level should be visible in the oil sight glass (Ref. 83), between the "MIN" and "MAX" mark.

Add oil, if necessary, but only add it when the pump has been shut off and the circulating oil has had sufficient time to return to the oil sump.

### 2.2 Gas Ballast

R 5 Series RA 0165 through 0305 D pumps are equipped with an adjustable gas ballast valve (Ref. 470-480). The adjustable gas ballast valve should normally be left open. Its primary function is to prevent water vapor from condensing in the pump. Condensation causes emulsification of the oil, loss of lubricity, and possible rotor seizure.

Check the gas ballast filter periodically to ensure that air is flowing through it properly.

### 2.3 Process Gas

The R 5 series pumps are designed to pump air and are not intended for use when water vapor is being pumped. In some applications, when the quantity of the water vapor is moderate, R 5 pumps have been used with good results. On these occasions, the pump is run until it is up to operating temperature before it is allowed to pump the process gas. The pump is also operated for a period of time off process and on air (to clear it of process gas) before it is shut down. This operating technique prevents the vapor from condensing in the pump. Before attempting to pump a gas laden with water vapor, contact Busch Engineering for advice.

### 2.4 Stopping pump

To stop the pump, turn off the power. The pump has a built-in anti-suck-back valve (Ref. 251 thru 255) to prevent the pump from rotating backwards when it is shut off.

**CAUTION:** Do not use the anti-suck-back valve as a check or shut-off valve for your vacuum system.

Install a manual or automatic valve or check valve in each pipe leading to each pump when multiple pumps are pumping on a common header.

All R 5 Series pumps are vented internally to atmospheric pressure through venting holes which are next to the exhaust valve assembly.

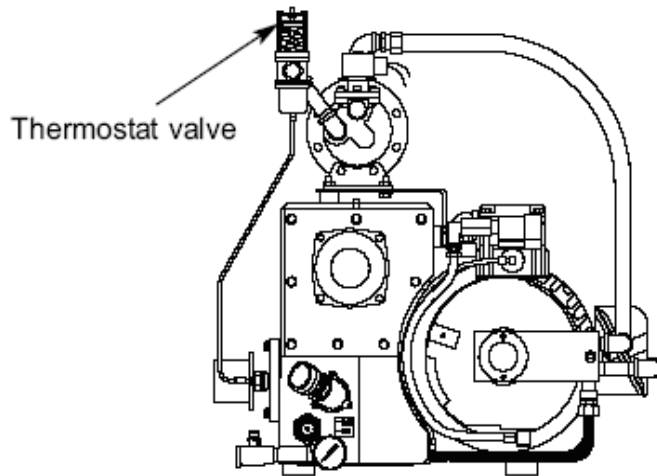
### 2.5 Water-Cooled Pumps (Optional)

Water-cooled pumps are cooled by circulating the oil through a shell-and-tube type heat exchanger. The circulation of the pump oil through the shell is created by vacuum in the pump, but the circulation of the cooling water through the tubes is thermostatically controlled. The flow rate of the cooling water is controlled by a thermostatically activated valve (see Fig. 3) that senses, through a capillary bulb mounted in the exhaust box, the pump's oil temperature as it is discharged from the compression chamber. The valve will open at its setpoint and close at approximately 3°F to 5°F below the set point. The valve set point is

adjustable as follows:

(a) Rotate the valve adjustment screw counterclockwise to cause the valve to open at a higher temperature. This makes the pump run hotter.

(b) Rotate the valve adjustment screw clockwise to make the valve open at a lower temperature. This makes the pump run cooler.



**Fig. 3 - Water Cooled Pump**

The thermostatic valve can be manually opened by inserting a screwdriver under each side of the spring guide and prying the spring and guide upward away from the valve body.

The water cooling option can be used to cool pumps operating in high ambient temperatures, or it can be used to maintain a pump at elevated temperatures to prevent condensation inside the pump in wet applications. Contact Busch Engineering in Virginia Beach for details.

## 2.6 Oxygen Service Pumps

Oxygen service pumps must be used in oxygen enriched applications that are defined as any application which has a process gas that is 25% or more oxygen. If this pump is contaminated by organic compounds do not attempt to use it on oxygen service until it has been decontaminated.

These pumps have been manufactured, solvent washed (to remove organic contaminants) and assembled according to the latest technical standards and safety regulations. If this pump is not installed properly or not used as directed, a dangerous situation or damage might occur.

**WARNING: This pump is filled with a special operating fluid. Do not use any other type of fluid, oil and/or grease. Use one of the following:**

- Fomblin Y LVAC 25/6
- Tyreno Fluid 12/25V (perfluorinated polyether)
- KRYTOX ® Vacuum pump fluid by Du Pont Company

If you have any questions, please phone our Customer Service Department for more information.

**It is mandatory that these operating instructions be read and understood prior to vacuum pump installation and start-up!**

**For overhaul/repair of oxygen service pumps, Busch LLC strongly recommends that all major repair operations be conducted at the factory. Improper handling of repairs could result in extreme danger to personnel operating the pump.**

## 3.0 MAINTENANCE

R 5 Series, Single Stage, Rotary Vacuum Pumps require very little maintenance; however, to insure optimum pump performance, the following steps are recommended.

### 3.1 Pump Oil

#### 3.1.1 Oil Level

**CAUTION: Do not add oil while the pump is running since hot unfiltered oil vapor may escape through the oil fill port.**

**WARNING: Insufficient oil quantity in the pump has the potential, under certain conditions, to lead to self-ignition of the remaining oil in the pump.**

With the pump installed relatively level, make sure that there is sufficient clean oil in the pump (see Section 1.5). The oil level should be observed on a daily basis and/or after 8 hours of operation and should be replenished if it drops below the 1/4 mark on the oil sight glass.

Oil level readings should be done only when the pump is turned off. Oil can be added to the oil fill port (Ref.88) if the pump is shut off and the circulating oil has sufficient time to return to the oil sump. The oil might appear to be foamy, which is a normal phenomenon with aerated oil.

Under normal circumstances, it should not be necessary to add or drain oil from the pump between recommended oil changes.

A significant drop in oil level means there is an oil leak or that an exhaust filter is broken, and the pump should

be smoking excessively. It is normal for the oil to be foamy and light in color in an operating pump. However, if the oil is milky colored, it is an indication that water is present in the oil. Normally, by operating the pump for an extended period, with the inlet suction blanked off and the gas ballast open, the water will be purged from the oil. If the oil is dark colored, it is contaminated or carbonized and must be changed. Depending on the severity of the contamination, a thorough flushing may be required. Contact the factory for flushing oil (Busch R568) and instructions.

### 3.1.2 Oil Type and Quantity

See Section 1.5 and the Technical Data page 13 for details on oil type and quantity.

**CAUTION: When changing the oil and filters, it may be necessary to flush the pump to remove any build-up of degraded oil from the sumps, oil lines, radiators, etc. to ensure proper oil flow through the pump. Reduced oil flow, especially through radiators and cooling coils, can cause mechanical damage or extreme overheating which could cause the oil vapors to ignite.**

**WARNING: Always take the necessary precautions concerning personal protective equipment when changing oil and make sure the pump is switched to the "off" so that accidental starting will not occur. Oil temperature can reach 212°F and may pose a danger of scalding.**

### 3.1.3 Oil and Filter Change

Check the oil for contamination on a weekly basis by shutting the pump off and draining some of the oil into a small glass or a similar transparent container through the oil drain port (Ref. 95).

Oil life is dependent upon the conditions to which it is exposed. A clean, dry air stream and an oil operating temperature under 210°F are ideal conditions. Oil must be changed after the first 100 initial hours of operation. After the initial oil change, and when using R530 (hydrocarbon oil), it is recommended that oil changes are made every three (3) to four (4) months or 500 to 750 hours of operation, or as necessary if high heat is contaminating the oil. The use of Busch R570 (synthetic) or R590 (semi-synthetic) oil may significantly extend the operating hours between oil changes; however, you may need to flush out the pump before changing. Contact the factory Service Department for advice or refer to Section 3.1.4 for the flushing procedure.

To change the oil, the pump must be switched off and ventilated to reach atmospheric pressure. Remove the oil drain plug (Ref. 95) and drain the oil. Dispose of the oil in compliance with local or national regulations.

When the oil stops draining, replace the oil drain plug.

Start the pump again for a few seconds. Stop the pump once again, and then reopen the drain plug and discharge any remaining oil.

Refasten the oil drain plug. Remove the oil filter (Ref.100) and replace it with a new one using a Busch genuine oil filter. Make sure to tighten the filter securely against the aluminum sealing surface so that leaks will not occur.

### Excessive Heat

When the pump is subjected to operating conditions that will cause the oil to be heated above 210°F, the oil will carbonize and become contaminated after a relatively low number of operating hours. The higher the temperature, the quicker the oil becomes contaminated. If the oil temperature is too severe, Busch R570 or R590 synthetic oil should be used to withstand the elevated temperatures. When changing to synthetic oil, the pump should be flushed with Busch R568 oil. Contact the factory for instructions on the flushing procedure. Auxiliary oil cooling is the most practical approach to a severe heating problem.

### Contaminated Air Stream

When the air stream contains solids and/or liquid that contaminate the oil, the oil must be changed more often. If the air stream contains a small percentage of contaminants and/or they are slightly aggressive\* (mild acids, etc.), synthetic oil, such as Busch R570, will resist breakdown better than the standard Busch R530. The solution is to install a filter or knock-out pot to keep the contaminants out of the pump.

\*Process air streams with a large percentage of contaminants and/or are more than slightly aggressive must use a chemical duty pump.

Oil change intervals can only be established by experience with the pump operating in the actual conditions (see previous paragraph for some of the conditions). Develop the oil change interval by periodically checking an oil sample removed from the pump. When the oil sample has become dark in color (from solids and carbonized particles) or is milky looking (from water), it is time to discard it. As mentioned before, a thorough flushing may be required.

### 3.1.4 Oil Flushing Procedure

Flushing is needed under certain conditions. Some pumps will be beyond flushing and will need to be overhauled.

To help determine if flushing is needed, observe the condition of the oil as it is drained from the pump. Is it



black and tar like or contaminated in any way? Was the pump noisy, overheating, or was the motor overload shutting the pump off? How old is the pump and when was the last time the oil was changed?

If the above conditions exist or you don't know when the last oil change was performed further investigation is needed. Also, when changing from one oil type such as R530 to another type such as R590 or R570 it will be beneficial to flush. Although the oils are compatible, mixing a lesser grade oil such as R530 with a synthetic oil like R570 will reduce the effectiveness of the synthetic oil.

All of the oil will be removed and replaced with the flushing oil (Busch R568), and eventually that will be replaced by whatever Busch oil is needed for your particular application. Have enough oil and oil filters on hand for a couple of flushes. The following describes the steps in the flushing procedure:

Shut the pump off and drain all the oil from the pump and remove the access plates (Ref. 205) from the exhaust box (Ref. 075). Remove the metal baffle (Ref.078) and take a good look at the internal walls of the oil sump. If the walls are discolored but have no build up of any kind one can proceed with the flushing. If gelled or burnt oil is clinging to the walls this material must be scraped and removed prior to flushing. Proceed by scraping and cleaning as much of the exhaust box as possible. The more debris that is removed now the more effective the flushing will be later. Re-install the metal baffle, cover and proceed with the flushing. At this point one must remember that the oil lines and oil cooler might also be plugged to a point where no amount of flushing will make a difference and a complete overhaul will be the only option. Depending on the severity of the oil contamination flushing may be a last ditch effort.

Drain all of the oil from the pump. The more contaminated oil you remove now the more effective the oil flushing will be.

Remove the oil filter (Ref. 100) and install a new one. It is recommended that you do not change the exhaust filter or filters until after the flushing to prevent contamination of any new filters.

Fill the exhaust box with the proper amount of flushing oil (Busch R-568).

If possible run the pump with the inlet closed and off of the process. Run the pump for approximately six hours, shut the pump off and drain a small sample of oil into a clear container.

Examine it. If it is clear to amber run the pump for another six hours and examine it again. If after the first six hours it is black drain it and fill again using another

new oil filter.

If after the second flushing the oil still remains black the pump may have too much contaminated oil in it to flush out properly. There may be residue remaining in the lines and cooler that will not flush out. An overhaul will be necessary.

If after the second six hour period the oil still remains clear to amber in color drain it, change the oil filter and fill with the regular oil. At this point also change the exhaust filters.

Run the pump with a fresh charge of the oil to be used in your application (not R-568), and monitor the operating conditions closely. Check for noise, overheating and oil condition until a regular oil change schedule can be established.

Do not let the oil turn black. Change it before it fails. If the oil is kept in good condition the pump will last for years. If the oil starts to turn black do not hesitate to flush again. Keeping on top of the oil changes will prevent costly overhauls.

If you are just switching from one type of oil to another a single six hour flush is all that is necessary (follow the above instructions). Remember to change to a new exhaust filter or filters after the flushing and not before.

### 3.2 Automotive-Type Oil Filter

**WARNING: Always wear safety glasses and other appropriate personal protective equipment when performing any maintenance or repair to your R 5 pump.**

The pump is equipped with an automotive-type oil filter (Ref. 100). When replacing the automotive-type oil filter, use only a Busch genuine filter.

**Note:** Make sure to tighten the Busch oil filter securely against the aluminum sealing surface so that leaks will not occur.

### 3.3 Exhaust Filter

**WARNING: If the gas entering this pump is a health hazard, use rubber gloves and all necessary personal protection equipment when performing the exhaust filter replacement operation.**

Exhaust filters (Ref. 120) should be checked monthly. A pressure gauge (Ref. 88) is supplied with your R 5 vacuum pump as part of the oil fill plug. This gauge has a green field and a red field. A pressure within the green field would indicate normal pressure. Any pressure in the red field (for a continuous period of time) requires an immediate change of the exhaust filter(s). Every nine (9) to twelve (12) months, or as necessary, replace the exhaust filter elements. The service life of the exhaust filters varies widely with pump application.

It is only necessary to change the filters when the elements become clogged with foreign material or burned oil. Indications of clogged filters are smoke and oil mist coming from the pump exhaust or higher than normal motor current.

**CAUTION: Excessively contaminated and/or clogged exhaust filters could possibly lead to elevated pump temperatures which could, under certain circumstances, cause the lubricating oil to self-ignite.**

In order to replace the exhaust filters, unscrew the screws and washers (Ref. 142/143) from the exhaust cover plate (Ref. 140). Remove the cover plate and gasket (Ref. 141).

Remove the distance pin (Ref. 137), the baffle strainer (Ref. 130) and the sheet metal plate (Ref. 136).

Remove the discharge filter assembly by unscrewing the nut (Ref. 134) and removing the lock washer (Ref. 132). Carefully slide the assembly out of the exhaust box (Ref. 75). Stand the filter assembly up on a clean flat surface.

To have access to the individual filters, unscrew the two cylinder cover screws (Ref. 126), and remove the two lock washers (Ref. 128) and the exhaust filter grip plate (Ref. 115).

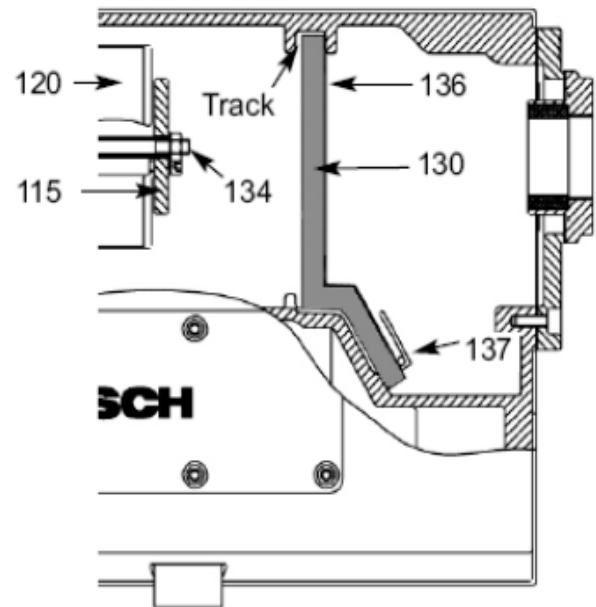
Remove the exhaust filters (Ref. 120) and O-rings (Ref.121). Remove the filter support (Ref. 118) and O-rings (Ref. 119).

Replace the support and O-rings with new ones. Make sure that the O-rings are fitted securely and that the filter elements (Ref. 120) fit securely into the depressions on the filter support (Ref. 118). The indicating arrow on each element must be pointing upward toward the top of the exhaust box after the assembly has been installed.

Carefully position the filter support tube (Ref. 133) between the exhaust filter bracket (Ref. 115) and the filter support without displacing the filters from their seated position in the filter support. Install the two lock washers (Ref. 128) and two screws (Ref. 126).

Insert the support and filter assembly into the exhaust box using the stud (Ref. 131) as a guide. The stud should slide through the hole in the support (Ref. 133). Secure the assembly with the lock washer (Ref. 132) and hexagon nut (Ref. 134).

Reinstall the sheet metal plate (Ref. 136) and the baffle strainer (Ref. 130) into the guide track of the exhaust box (see Fig. 3). Press to the bottom of the exhaust box. Make sure that the baffle strainer touches all sides of the exhaust box. Insert the distance sleeve (Ref.137) into the two grooves. This holds the sheet metal plate



**Fig. 4 - Exhaust Filters and Strainer**

and baffle strainer in place.

Inspect the exhaust box end cover gasket (Ref. 141) for damage and replace if damaged. With the gasket in place, secure the exhaust cover end plate (Ref. 140) to the exhaust box using eight hex head cap screws (Ref.142) and eight lock washers (Ref. 143).

To field test an exhaust filter element, remove it from the pump, allow it to cool, clean the sealing end (or O-ring end), and use compressed air to blow through the element. Apply approximately 3 to 6 psi, which is the maximum allowable operating pressure across the filter.

Use a shop rag to seal off the connection between the air hose and the filter.

If you can blow through it, the element is good. If not, discard it and install a new one. The filter cannot be cleaned successfully. Visually inspect the filter element for cracks.

Reinstall the filter elements as described previously.

### 3.4 Inlet Flange

The standard inlet flange assembly contains an inlet screen (Ref. 261) which may require occasional cleaning. The frequency of cleaning can only be determined by experience and is affected by hours of operation and particle size being trapped. An optional vacuum inlet filter is offered and can help minimize the need or frequency of cleaning the inlet screen.

To clean the screen, disconnect the flange from the process piping. Remove the four screws and lock washers (Ref. 265/266). Remove the inlet flange

(Ref.260). Remove the screen (Ref. 261) and clean with compressed air. After cleaning, install the screen and inlet securing them with the screws and lock washers. Make sure the O-ring (Ref. 265) is in place prior to securing the screws. Reattach the process piping to the inlet.

### 3.5 Vacuum Inlet Filter (optional)

If the pump is equipped with an optional special vacuum inlet filter in applications where powder, dust or grit is present, the filter cartridge should be cleaned on a weekly basis, or as required, depending on the amount of foreign particles to which the pump is exposed.

To clean the inlet filter, unsnap the lid clamps or remove the knobs and lift off the filter lid. Remove cartridge, being careful not to knock any foreign particles present inside the canister into the pump suction. Clean foreign particles from the canister with an air hose, and carefully back flush the filter cartridge with shop air. If the filter cartridge has been subjected to moisture or is extremely dirty it may need replacement.

### 3.6 Maintenance Chart

**Note:** See the motor manufacturer's manual for the periodic motor maintenance.

**Note:** Lack of proper maintenance can result in blocked filters, radiators, oil lines, etc. This condition can lead to excessive heat causing mechanical failure or ignition of the oil vapors.

**Daily:** Visually check oil level (see 3.1.1 and 3.1.2).

**Weekly:** Check oil for contamination (see 3.1.3). Inspect inlet filter (see Section 3.5).

**Every three (3) or four (4) months, 500 to 750 hours of operation, or as necessary:** See 3.1.3 and 1.5. Drain and discard oil from the hot pump. Replace the automotive-type oil filter and refill with fresh oil through the fill plug (see 3.1.2 through 3.2).

**Every nine (9) to twelve (12) months, or as necessary:** Replace exhaust filter elements (see 3.3).

**As necessary:** Check and/or clean the standard inlet screen. If the optional inlet filter is used, replace the filter material as practice determines.

**As necessary:** The radiator (Ref. 241), fan hood (Ref. 244) and motor cover should be inspected regularly for debris. Soiling prevents cool air intake and may lead to overheating of the pump.

### 3.7 Overhaul Kit/Filter Kit

An overhaul kit containing a set of gaskets and O-rings, vanes, bearings and bearing sleeves, shaft seals and taper pins, is available from the factory. Also, a filter kit containing oil drain plug, gaskets, automotive type oil filter, exhaust filter and synthetic baffle strainer is available from the factory. When ordering, please specify pump size and model (a 4-digit suffix after size), and serial number.

## 4.0 TROUBLESHOOTING

### 4.1 Trouble

**The pump does not reach "blank-off" pressure which is the lowest absolute pressure (best vacuum) when running with the inlet closed via a blank flange or a valve; or the pump takes too long to evacuate the system. "Blank-off" pressure can be measured by using a good quality capsule gauge.**

**Possible Cause:** Contaminated oil is by far the most common cause of not reaching the ultimate pressure.

**Remedy:** Shut off the pump, after the operating temperature has been reached, drain the warm oil from pump and exchange the automotive-type oil filter, if necessary. Flush and fill the pump with new oil and take a new "blank-off" measurement after operating temperature is reached (at least 20-30 minutes).

**Possible Cause:** The vacuum system or vacuum piping is not leak-tight.

**Remedy:** Check the hose and pipe connections for possible leak.

**Possible Cause:** The wire mesh inlet screen is plugged (Ref. 261).

**Remedy:** Clean the wire mesh inlet screen. Install an inlet filter if the problem repeats frequently.

**Possible Cause:** No oil or not enough oil in the oil reservoir.

**Remedy:** Shut off the pump, add the necessary oil, or if oil seems contaminated, drain the balance of the oil from the pump, exchange the automotive oil filter, and refill with fresh oil. Flush if necessary.

**Possible Cause:** The automotive-type oil filter is dirty or clogged .

**Remedy:** Replace the automotive-type oil filter, exchange the oil, if necessary, and refill with fresh oil.

**Possible Cause:** The inlet anti-suck-back valve plate (Ref. 251) is stuck in closed or partially open position due to contamination.

**Remedy:** Disassemble the inlet valve and screen. Clean as required.

**Possible Cause:** The oil tubing fittings are loose and leaking.

**Remedy:** Replace or retighten the oil fittings or oil tubing. Replace only with same size tubing.

**Possible Cause:** Shaft seal leaking.

**Remedy:** Replace the shaft seal following disassembly and assembly steps outlined in the Maintenance and Repair Manual. Check the shaft seal. It should have a spring installed inside and around the shaft sealing lip.

**Possible Cause:** Exhaust valve (Ref. 159) is not properly seated or it is partially stuck open.

**Remedy:** Contact the nearest Busch Factory Service Center for instructions.

**Possible Cause:** Vanes are blocked in rotor or are otherwise damaged.

**Remedy:** Free vanes or replace with new ones. Contact the nearest Busch Factory Service Center for instructions.

**Possible Cause:** The radial clearance between the rotor and cylinder is no longer adequate.

**Remedy:** Contact the nearest Busch Factory Service Center for instructions.

**Possible Cause:** The internal parts are worn or damaged.

**Remedy:** Contact the nearest Busch Factory Service Center for instructions.

**Possible Cause:** The inlet filter is clogged due to process material.

**Remedy:** Contact the factory for recommendation on proper filter cartridge.

#### 4.2 Trouble

##### **Pump will not start.**

**Possible Cause:** The motor does not have the proper supply voltage or is overloaded; the motor starter overload settings are too low or are the wrong setting; fuses are burned; or the wire is too small or too long, causing a voltage drop at the pump.

**Remedy:** Check correct supply voltage; check overload settings in motor starter for size and setting

according to motor nameplate data; check fuses; and install proper size wire. If the ambient temperature is high, use larger size overloads or adjust the setting 5% above nominal motor nameplate value.

**Possible Cause:** The pump or motor is blocked.

**Remedy:** Remove the fan cover and try to turn pump and motor by hand. If frozen, remove the motor from the pump and check the motor and the pump separately. If the pump is frozen, contact the nearest Busch Factory Service Center for instructions.

#### 4.3 Trouble

##### **The pump starts, but labors and draws a very high current.**

**Possible Cause:** The oil is too heavy (viscosity too high) or the ambient temperature is below 5 degrees C (41°F).

**Remedy:** Change to R580 vacuum oil if very cold, or warm up the oil before filling.

**Possible Cause:** Pump is running in the wrong direction.

**Remedy:** Check for the correct rotation which is counterclockwise when looking at the motor from the motor's fan side. Reverse any two leads on the motor to change the direction of rotation.

**Possible Cause:** The pump is over filled with oil or the wrong kind of oil is used.

**Remedy:** Correct the oil level and quality per Section 1.5 and use recommended motor oil.

**Possible Cause:** Exhaust filters in exhaust chamber are clogged and appear burned black with pump oil.

**Remedy:** Replace the exhaust filters, maintain proper oil condition, oil level, and use only Busch recommended vacuum oil and filters.

**Possible Cause:** Loose connection in motor terminal box; not all motor coils are properly connected. The motor operates on two phases only.

**Remedy:** Check the motor wiring diagram for proper hookup, especially on motors with six internal motor windings, tighten and/or replace loose connections.

**Possible Cause:** Foreign particle in pump, vanes broken, bearings seized.

**Remedy:** Contact the nearest Busch Factory Service Center for instructions.

#### 4.4 Trouble

##### **Pump smokes at the exhaust side or expels oil droplets from the exhaust.**

**Possible Cause:** Inlet to pump is in a wide open condition.

**Remedy:** Do not operate pump at high inlet pressures for more than a few minutes (pressures = 0.00-10.0" Hg vac.)

**Possible Cause:** The exhaust filter is not properly seated with the O-ring (Ref. 121) in filter base or the filter material is cracked.

**Remedy:** Check the condition and check for proper seating of the exhaust filters. Replace if necessary. Also, check the filter spring clips for tightness.

**Possible Cause:** The exhaust filter is clogged with foreign particles.

**Remedy:** Replace the exhaust filter.

#### 4.5 Trouble

##### **Pump runs very noisily.**

**Possible Cause:** Coupling insert is worn.

**Remedy:** Replace the coupling insert in motor/pump coupling.

**Possible Cause:** Bearing noise.

**Remedy:** Contact the nearest Busch Factory Service Center for instructions.

**Possible Cause:** Vanes stuck.

**Remedy:** Contact the nearest Busch Factory Service Center for instructions. Use only the recommended Busch oil and change oil more frequently.

#### 4.6 Trouble

##### **The pump runs very hot.**

**Note:** The oil temperature with a closed inlet should be approximately 185-225°F depending on pump type. At 24 in. Hg, the oil in the pump can go above 225°F. These values are taken at an ambient temperature of 68°F. The maximum recommended ambient operating temperature for an R 5 is 100°F on a continuous basis. When it is necessary to operate a pump in ambient temperatures above this limit, careful oil monitoring and/or optional water cooling is necessary. Contact the factory at Virginia Beach for details.

**Possible Cause:** Not enough air ventilation to the pump.

**Remedy:** Clean the motor and pump air grills. Clean the radiator. Do not install the pump in an enclosed cabinet unless a sufficient amount of fresh air is supplied to the pump. Bring the ambient air temperature down.

**Possible Cause:** The automotive-type oil filter clogged and pump does not receive enough oil.

**Remedy:** Change the automotive oil filter.

**Possible Cause:** Not enough oil in oil reservoir or badly burned oil is used for pump lubrication.

**Remedy:** Drain and refill the pump only with non-detergent oil and increase oil change intervals.

**Note:** On some high temperature applications, it maybe necessary to change to a high temperature oil such as R590 or R570. Contact the factory for recommendations.

#### 4.7 Trouble

##### **Pump is seized.**

**Possible Cause:** The pump operated without oil and vanes broke.

**Remedy:** Contact the nearest Busch Factory Service Center for instructions.

**Possible Cause:** The pump was operated for an extended period of time in the wrong rotation.

**Remedy:** Inspect vanes and replace. Contact the nearest Busch Factory Service Center for instructions.

**Possible Cause:** Liquid carry over into the pump cylinder broke vanes while pump was running, or oil broke vanes on start-up.

**Remedy:** Install a condensate trap on the inlet of the pump. Or, pump was over filled with oil in oil reservoir. Follow oil filling procedure (see Section 1.5) and do not overfill. Or, the built-in anti-suck-back valve (Ref. 250 through 255) is leaking while pump was shut down and vacuum was left in manifold. Clean the valve seat and check that anti-suck-back valve holds vacuum on inlet when pump is shut down.

#### 4.8 Trouble

**The automotive-type oil filter (Ref.100) does not get warm within two to five minutes when cold pump is started.**

**Possible Cause:** The automotive-type oil filter is clogged.

**Remedy:** Replace the automotive-type filter per Section 3.2 and exchange oil per Section 1.5.

**Possible Cause:** The wrong automotive-type filter is used and/or oil lines leading to pump are clogged.

**Remedy:** Use only automotive filter as listed in Section 3.2 and blow lines free. Flush oil cooler.

**Possible Cause:** The oil cooler is plugged internally with burnt oil.

**Remedy:** Remove oil cooler and flush. Pump may have to be disassembled completely to correct a severely contaminated condition.

## 5.0 LIMITED STANDARD WARRANTY

Busch LLC warrants that all products furnished by it are free from defects in material and workmanship at the time of shipment for a period of 18 months from the date of shipment, or 12 months from the date of installation, whichever occurs first. Claims must be made during that period and are limited to the replacement or repair of parts claimed to be defective.

In the case of components purchased by Busch LLC, such as starters, controls, mechanical seals, motors, couplings, etc., the warranty of that manufacturer will be extended to the purchaser in lieu of any warranty by Busch LLC. The replacement of wear items including, but not limited to, seals, bearings, couplings, exhaust cover gaskets, oil drain plugs, oil fill plugs etc., made in connection with normal service, are not covered by this Warranty.

The Limited Standard Warranty is valid only when the product has been properly installed, used in a normal manner, and serviced according to the operating manual. This warranty shall not extend to products that have been misused, neglected, altered, or repaired without factory authorization during the warranty period. We highly recommend the use of Busch oils and parts to achieve documented performance and efficient operation. The use of oils or parts other than Busch could limit the life expectancy of the equipment and could void any warranties if they are the cause of any damage. Operating conditions beyond our control such as improper voltage or water pressure, excessive ambient temperatures, or other conditions that would affect the performance or life of the product will also cause the warranty to become void.

Permission to return parts for warranty repair must be obtained, and all returns must be prepaid to the factory. If, after examination, the product or part is found to be defective, it will be repaired or replaced on a no-charge

basis and returned, FOB the factory. If it is determined that the Warranty has not been breached by Busch LLC then the usual charges for repair or replacement will be made, FOB the factory. Parts or products that are obsolete or those made to special order are not returnable.

This Limited Standard Warranty applies only to the above and is for the period set forth. Busch LLC's maximum liability shall not, in any case, exceed the contract price for the product, part, or component claimed to be defective; and Busch LLC assumes no liability for any special, indirect, or consequential damages arising from defective equipment.

**THERE ARE NO WARRANTIES IMPLIED OR EXPRESSED THAT EXTEND BEYOND THOSE CONTAINED IN THIS LIMITED STANDARD WARRANTY.**

TECHNICAL DATA

Model		165	205	255	305
Nominal pumping speed	ACFM	115	130	170	196
Ultimate Pressure	torr	0.075	0.075	0.075	0.075
Nominal motor rating	HP	7.5	7.5	10	12
Nominal motor speed	RPM	1800	1800	1800	1800
Sound level (ISO 2151)	dB(A)	72	74	74	76
Oil capacity	Qts	7	7	7	7
Gas inlet / outlet	NPT	2" / 2"	2" / 2"	2" / 2"	2" / 2"
Approximate weight	lbs	445	445	515	515

**Parts List for 0165-0305 D**

<b>Ref</b>	<b>Description</b>	<b>Ref</b>	<b>Description</b>	<b>Ref</b>	<b>Description</b>
0	Module	140	Exhaust cover plate	322	A-side fan
1	Cylinder	141	Exhaust cover gasket	326	Fan retaining ring
5	Plug, screw	142	Hex head cap screw	353	Socket head cap screw
6	Socket pipe plug	149	Socket head cap screw	360	Lock washer
15	Rotor	159	Exhaust valve	390	Eyebolt adapter
18	Shaft seal sleeve	162	O-ring	391	Eyebolt
22	Vane	169	Exhaust valve cover plate	392	Lock washer
25	Endplate, motor side	171	Oil tube insert	393	Hex head cap screw
26	Endplate, fan side	175	Socket head screw	400	Motor
30	Roller bearing	185	Gasket	401	Hex head cap screw
31	Endplate spacer	189	Stud	402	Lock washer
35	Shaft seal	191	Hex nut	417	Socket head cap screw
42	Shaft seal retaining plate	194	Oil return float valve complete	421	Rubber foot
43	Screw, hex head	195	Oil return float valve mount	422	Rubber foot
49	O-ring	196	Socket head cap set screw	431	Directional arrow label
50	O-ring	197	O-ring	436	Pump label
53	Hex head screw	198	Socket head cap screw	470-80	Gas ballast assembly
54	Lock washer	205	Side cover plate	488	Plug with seal
57	Socket head cap screw	206	Side cover plate gasket	492	Screw plug
58	Lock washer	207	Socket head cap screw	496	Socket head plug
60	Taper pin	222	Hyd. fitting, elbow	498	Plug with seal
61	Parallel pin	223	Hyd. fitting, elbow	530	B-side fan spacer
65	Shaft key	225	Hyd. fitting, banjo	9000	Socket head plug
66	Shaft key	228	Hyd. fitting, coupling	9013	Plug
75	Exhaust box	229	Hyd. fitting, straight		
80	Sheet metal baffle	230	Oil tubing		
83	Oil sight glass	231	Oil tubing		
84	Sight glass gasket	232	Oil tubing		
85	Socket head plug	235	Hydraulic fitting, straight		
87	Oil fill elbow	238	Socket head cap screw		
88	Oil fill plug	239	Lock washer		
89	Ring gasket	241	Oil cooler		
90	Fill plug with gauge	242	O-ring		
90.1	Exhaust pressure gauge	244	Fan cover		
92	Socket head plug	247	Socket head cap screw		
95	Oil drain plug	250	Lower inlet flange		
96	O-ring	251/2/4	Anti-suckback valve		
99	Nipple	253	O-ring		
100	Oil Filter	255	O-ring		
105	Front cover plate	260	Upper inlet flange		
106	Front cover plate gasket	261	Inlet screen		
107	Socket head cap screw	265	Hex head cap screw		
115	Exhaust filter bracket	266	Lock washer		
118	Exhaust filter mount	270	Hydraulic fitting, elbow		
119	O-ring	290	Teflon tubing		
120	Exhaust filter	291	Hydraulic fitting, elbow		
126	Socket head screw	300	Motor bracket		
127	Distance rod	301	Hex head cap screw		
128	Lock washer	302	Lock washer		
130	Baffle strainer	306	C-face adapter flange		
131	Stud	307	Socket head cap screw		
132	Flat washer	311	Coupling half, motor side		
133	Exhaust filter support tube	312	Coupling insert		
134	Hex nut	313	Coupling half, pump side		
136	Baffle strainer screw	319	Motor spacer		
137	Distance sleeve	321	B-side fan		



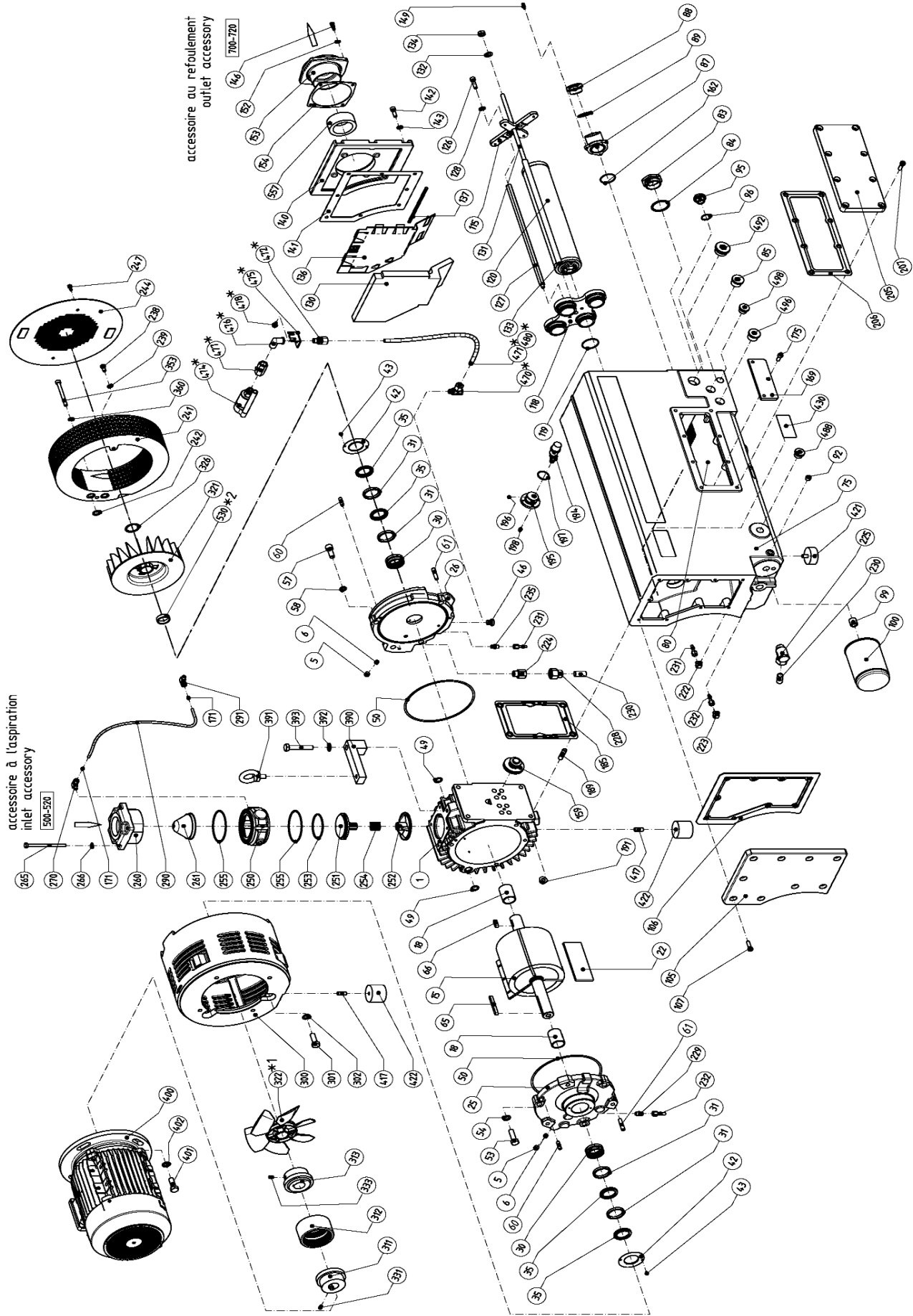


Fig. 5 - Exploded View Drawing





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