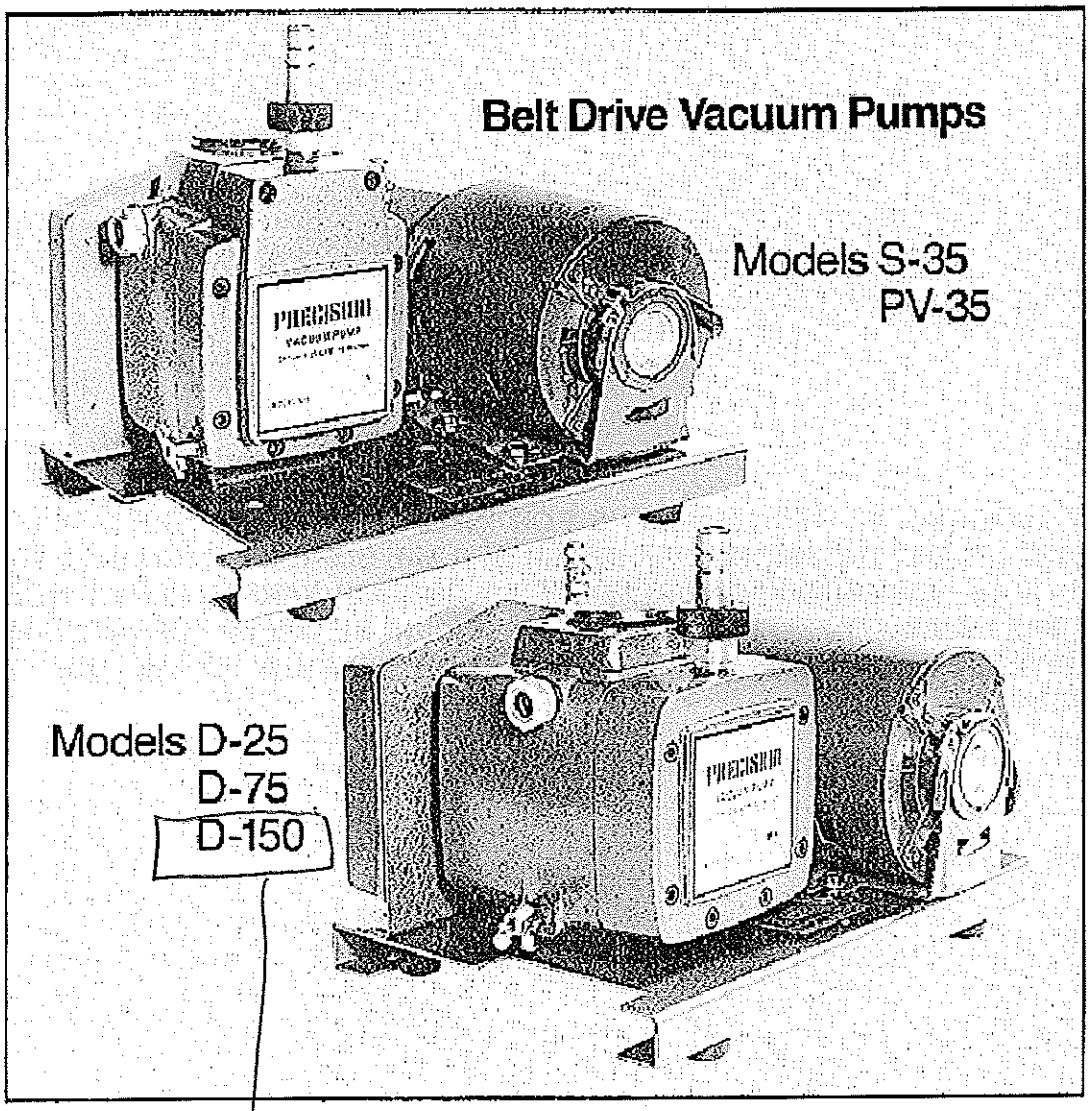
# PRECISION

# Instruction Manual

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# *REVISION STATUS*

| INDEX | DATE | AMENDED PAGES | NOTES |
|---|---|---|---|
| A | 9/99 | | Initial release |

# Table of Contents

## Introduction

Your satisfaction and safety are important to PRECISION and a complete understanding of this unit is necessary to attain these objectives.

As the ultimate user of this apparatus, you have the responsibility to understand its proper function and operational characteristics. This instruction manual should be thoroughly read and all operators given adequate training before attempting to place this unit in service. Awareness of the stated cautions and warnings, and compliance with recommended operating parameters — together with maintenance requirements — are important for safe and satisfactory operation. The unit should be used for its intended application; **alterations or modifications will void the warranty.**

### WARNING

*AS A ROUTINE LABORATORY PRECAUTION, ALWAYS WEAR SAFETY GLASSES WHEN WORKING WITH THIS APPARATUS.*

This product is not intended, nor can it be used, as a sterile or patient connected device. In addition, this apparatus is not designed for use in Class I, II, or III locations as defined by the National Electrical Code.

## Unpacking and Damage

This product was carefully packed and thoroughly inspected before leaving our factory. Save all packing material if apparatus is received damaged.

Responsibility for safe delivery was assumed by the carrier upon acceptance of the shipment; therefore, claims for loss or damage sustained in transit must be made upon the carrier by the recipient as follows:

**Visible Loss or Damage**: Note any external evidence of loss or damage on the freight bill or express receipt, and have it signed by the carrier's agent. Failure to adequately describe such external evidence of loss or damage may result in the carrier's refusing to honor your claim. The form required to file such claim will be supplied by the carrier.

**Concealed Loss or Damage**: Concealed loss or damage is any loss or damage which does not become apparent until the merchandise has been unpacked and inspected. Should either occur, make a written request for inspection by carrier's agent within 15 days of the delivery date; then file a claim with the carrier.

If you follow the above instructions carefully, PRECISION will guarantee our full support of your claim to be compensated for loss or damage in transit.

**DO NOT — for any reason — return this unit to PRECISION without first obtaining return authorization.** In any correspondence with PRECISION please supply the nameplate data, including catalog number and serial number.

## General Information

This instruction manual encompasses the following models listed below with their specific electrical characteristics.

| | Single-Stage Models | | 2-Stage Models | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Model Number** | **PV-35** | **S-35** | **D-25** | | **D-75** | | **D-150** | |
| Catalog Number | 51220002 | 51220001 | 51220006 | 51220003 | 51220004 | 51220007 | 51220005 | 51220008 |
| Electrical Service | (1 phase)<br>120V<br>60 Hz.<br>1/3 H.P.<br>6.8 amps | | (1 phase)<br>120V<br>60 Hz.<br>1/3 H.P.<br>6.8 amps | (1 phase)<br>240V<br>50 Hz.<br>1/3 H.P.<br>3.4 amps | (1 phase)<br>120V<br>60 Hz.<br>1/3 H.P.<br>6.8 amps | (1 phase)<br>240V<br>50 Hz.<br>1/3 H.P.<br>3.4 amps | (1 phase)<br>120/240V<br>60 Hz.<br>3/4 H.P.<br>11.4/5.7 amps | (1 phase)<br>120/240V<br>60 Hz.<br>3/4 H.P.*<br>11.4/5.7 amps |
| * Explosion-Proof Motors | | | | | | | | |

**WARNING**

*DO NOT USE THESE PUMPS FOR OXYGEN SERVICE. HYDROCARBON OIL AND SEALS ARE NOT COMPATIBLE FOR THIS APPLICATION, AND AN EXPLOSIVE CONDITION WILL RESULT.*

All of the above vacuum pumps are two-stage, oil-sealed, rotary vane design, except the Models PV-35 and S-35, which are single stage. They are equipped with a gas ballast valve to help prevent the condensation of contaminant vapors within the pump, thereby protecting the pump from corrosive action of these condensed vapors. Air is bled into the pump via the adjustable valve on top of the pump just before the gas is exhausted through the oil.

With the gas ballast open, the pump will not reach its rated vacuum. The pump will also run warmer with the gas ballast valve open because of the greater amount of gas (air) it is handling.

When all traces of the contaminant vapors have disappeared from the system and oil, the gas ballast valve must be closed to permit the pump to attain its ultimate vacuum.

**NOTE**

*THE GAS BALLAST VALVE HAS BEEN SEALED INTO THE PUMP WITH GLYPTAL. EXERCISE CARE TO PREVENT THIS SEAL FROM BEING BROKEN. ONE COUNTERCLOCKWISE TURN WILL OPEN THE VALVE. TO OBTAIN A LEAK-TIGHT CLOSURE, "FINGER-TIGHTEN" IN A CLOCKWISE DIRECTION TO ASSURE A SNUG FIT. DO NOT OVERTIGHTEN OR YOU WILL LOSE YOUR VACUUM SEAL.*

Other standard features include drain valve, quick-release intake fitting, and an oil level sight glass.

## Technical Specifications

| PUMPS | S-35 | PV-35 | D-25 | D-75 | D-150 |
|---|---|---|---|---|---|
| Free air displacement CFM (Liters/Min) | 1.23 (35) | 1.23 (35) | 0.88 (25) | 2.65 (75) | 5.30 (150) |
| Ultimate Vacuum Microns (Torr) | 15 (15x10-3) | 15 (15x10-3) | 0.1 1x10-4) | 0.1 1x10-4) | 0.1 1x10-4) |
| Pumping Speed at: CFM (Liters/Min) | 100 microns 0.60 (17.1) | 100 microns 0.60 (17.1) | 1 micron 0.69 (19.8) | 1 micron 1.51 (42.8) | 1 micron 3.18 (90) |
| Pumping Efficiency at: | 100 microns 49% | 100 microns 49% | 1 micron 79% | 1 micron 57% | 1 micron 60% |
| Operating Temperature (± 10°C) | 55°C | 55°C | 65°C | 65°C | 65°C |
| Intake Tubing - I.D. Inches (mm) | 1/2 (13) | 1/4 (6) | 1/2 (13) | 3/4 (19) | 3/4 (19) |
| Exhaust Diameter (NPT) Inches | 1/2 | 1/4 (6) | 3/4 | 3/4 | 3/4 |
| Oil Capacity Quarts (Liters) | 3/4 (0.8) | 3/4 (0.8) | 1 (1.1) | 1-¼ (1.3) | 2-½ (2.7) |
| Pumping Speed RPM | 600 | 600 | 600 | 600 | 600 |
| Net Weight Pounds (Kg.) | 39 (18) | 39 (18) | 48 (22) | 64 (29) | 110 (50) |

## Technical Illustrations

FIG 1.- MODEL S-35

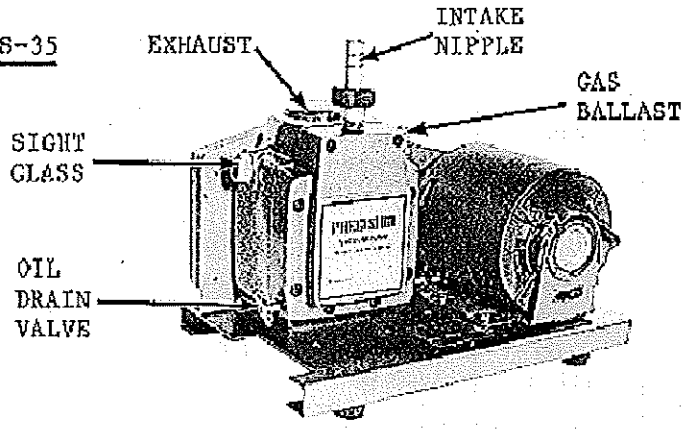



FIG 2.- MODEL PV-35

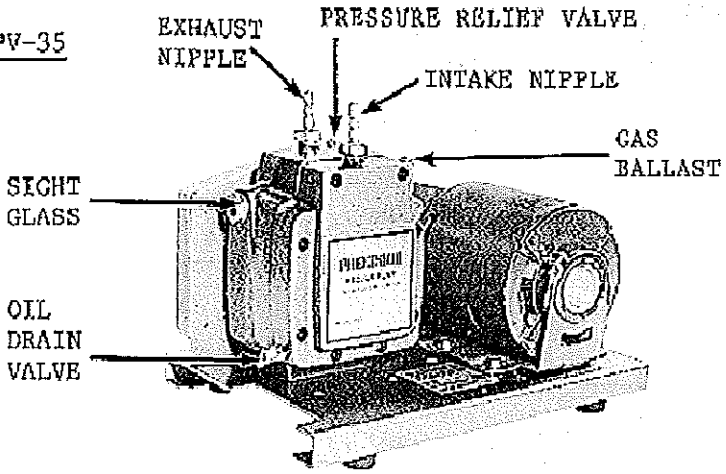
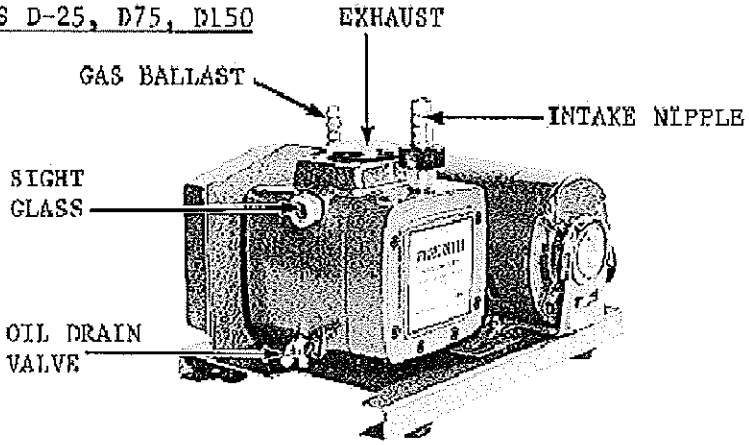



FIG. 3.- MODELS D-25, D75, D150



## Installation/Operation

**Electrical Connections:** Important (Please Read Carefully)

### WARNING

*FOR PERSONAL SAFETY, THIS APPARATUS MUST BE PROPERLY GROUNDED.*

The power cord is equipped with a three-prong (grounding) plug which mates with a standard three-prong (grounding) wall receptacle to minimize the possibility of electric shock hazard from this apparatus. The user should have the wall receptacle and circuit checked by a qualified electrician to make sure the receptacle is properly grounded. Where a two-prong receptacle is encountered, it is the personal responsibility and obligation of the user to have it replaced with a properly grounded three-prong wall receptacle.

Explosion-proof motors are not supplied with a cord and plug and should be electrically connected by a qualified electrician. Local safety and electrical codes should be followed when installing explosion-proof pumps. A wiring diagram is provided on the motor.

### CAUTION

*BE SURE THE POWER SUPPLY IS OF THE SAME VOLTAGE AS SPECIFIED ON THE NAMEPLATE.*

When possible, it is suggested that a vacuum pump be connected to a separate fused circuit, free of other devices that may occasionally start simultaneously and take away needed power. The voltage specified is that which is needed at the motor. When pumps slow down or fail to start under vacuum, many times it can be traced directly to low voltage at the motor.

### CAUTION

*DO NOT OPERATE THE PUMP UNTIL BOTH SHIPPING PLUG AND DISC ARE REMOVED.*

Remove the shipping disc provided on the Models D-25, D-75, D-150, and S-35. The disc is located under the intake nipple and both parts (disc and nipple) are held in place by the circular black nut.

The PV-35 is supplied with a removable plastic plug in the intake nipple and exhaust nipple.

Remove the threaded shipping plug and "O" ring from the exhaust port which is provided on the D-25, D-75, D-150, and S-35 vacuum pumps. Attach the dome which is supplied in a separate bag. Save the shipping plugs and disc for future storage and/or shipment.

**Operational Check:**

This procedure is a check for proper oil level and operation.

- Place a large rubber stopper over pump intake nipple.
- Close gas ballast valve if open (knurled knob on top of pump). Turn knurled knob clockwise finger-tight.
- Activate the pump motor electrically.
- After 5 minutes or less the pump should no longer gurgle. A consistent gurgling sound indicates one of more of the following conditions: insufficient oil, the gas ballast is not closed completely, or the intake is not completely sealed.
- If oil level appears low (less than 3/4 full in the sight glass), add oil slowly through the intake until gurgling stops. Do not fill above the top of the sight glass; excess oil may be ejected from the exhaust.

**Vacuum Connection:**

Intake fittings are quick release fittings held in place with a round knurled nut. (The Model PV35 does not have a quick disconnect). Other size fittings can be obtained from PRECISION. The simplest, most efficient system has a pump connected directly to the vessel to be evacuated. Speed of evacuation is a function of pump capacity, vessel size, type, length, diameter, and bends in the connecting tubing.

Keep vacuum lines as short as possible and of adequate diameter. The time required to evacuate a system will increase in direct proportion to the length of pipe; it will decrease in direct proportion to the cube of the inside diameter of the connecting line. Reducing pipe length by one half (while retaining diameter) can increase pumping speed to 67% of rated pumping speed. More important, doubling line diameter (while retaining length) increases effective speed to 90% of rated pumping speed.

The most common deterrent to maximum pumping speed is the use of small diameter vacuum lines. If the vessel outlet is smaller than the pump inlet, the connecting line should be sized for the pump inlet. Reduction should be made at the vessel, not at the pump.

Traps will usually reduce effective pumping speed by approximately 50%.

Do not use high vacuum pumps to "control" the pressure level of a vacuum system. Operating these pumps continuously above 100 microns will cause excessive overheating and an added load on the motor.

**Traps—protecting the vacuum system:**

All mechanical, oil-filled vacuum pumps allow oil molecules to migrate backward toward the system under vacuum. To reduce "backstreaming" install a Precision trap near the pump inlet. This self-contained cartridge is filled with Linde molecular sieves (13X). Glass Bead cartridges are available as an additional accessory and they will further prevent "backstreaming." Both types can be regenerated. The Precision trap has quick-connect fittings which mate with the pump inlet, and hose nipples are provided.

All vacuum pumps should be trapped to prevent internal damage. A trap is simply a capture device between the pump inlet and the system under vacuum.

The Precision trap (Linde 13X) serves as a particle filter and absorbs molecules with diameters up to 13 angstroms. Traps can also be made from vacuum-tight metal containers or Pyrex glass suitable for vacuum service. These devices can be filled with continuous strand glass wool (particle traps), or they can be submerged in cold liquid (dry ice and acetone, liquid nitrogen, etc.) to condense volatile materials. In many cases, silica gel can be used to absorb water vapor.

**Shutdown Procedure:**

A pump that is allowed to run continuously under vacuum will last longer and remain cleaner. Never cycle a pump "ON" and "OFF". When desired vacuum has been achieved in a system, isolate the pump from the system with a shutoff valve, and allow the pump to continue operating at low pressure. This will improve "wear in" of moving parts and reduce the possibility of corrosion which is more likely to occur in an idle pump. When a task is completed and the pump removed from service, bleed air into the system, allowing the pump to come to atmospheric pressure, and turn the pump "OFF". Prior to storage, drain, flush and refill the pump with new Precision vacuum oil. Replace the exhaust shipping plug and shipping disc in the intake opening.

**Vacuum Oil:**

Vacuum oils must perform other important functions, in addition to lubricating internal parts of the pump. Vacuum pump oil must be specially formulated to resist oxidation degradation, lubricate precision fitting rotating parts, have low vapor pressure at pump operating temperature, and provide a seal against gas leakage during the compression/expansion cycles. PRECISION vacuum oils are premium grade, containing no additives.

**When and How to Change Oil:**

**WARNING**

*USE EXTREME CARE WHEN CHANGING OIL. USED OIL IN THE PUMP MAY CONTAIN HAZARDOUS OR TOXIC SUBSTANCE FROM PREVIOUS APPLICATIONS.*

Contaminated oil is the most common cause or pump failure and unsatisfactory performance. If water or acid vapors have passed through the pump and the oil is allowed to stand for any length of time, severe corrosion and damage to any pump may occur.

The simplest guide for indicating the need for an oil change is to connect a McLeod gauge directly to the pump and determine if the rated ultimate vacuum can be attained. Refer to "VACUUM GAUGES" section for information on the various levels of vacuum and limitations to expect from different types of gauges.

An odor may indicate the presence of solvent, or a cloudy color may indicate water contamination. When in doubt, change the oil.

If the pump is used occasionally or loaned to another operator, it is good practice to drain and refill the pump with fresh oil before the pump is placed in temporary storage. For convenience, many users attach a tag recording dates of oil change. New oil costs a fraction of repair charges for a corroded pump. Keep a supply of PRECISION vacuum oil on hand. The oil container should be sealed from the atmosphere to keep the oil from absorbing moisture.

The draining procedure is simple. Close the vacuum intake, and run the pump until the oil is warm. Open the vacuum intake to atmosphere, disconnect electrical power and open the drain valve. If possible, tip the pump to assure complete drainage. When flow has stopped, turn power "ON" for a few seconds to clear any oil remaining in stator cavities. Sufficient oil coating remains to protect moving parts. Remember, any contaminated oil left in the pump will degrade new oil.

**Filling:**

1. De-activate the pump motor electrically.

2. Fill the pump by slowly pouring PRECISION vacuum oil through the exhaust port. (PV35 ONLY - fill pump through intake nipple while pump is OPERATING.)

3. The proper oil level is indicated when the oil is observed 3/4 up the oil level sight glass.

4. Activate the pump motor electrically and operate for 15 minutes allowing the oil to reach operating temperature.

5. If additional oil is required - oil maybe added thru the intake nipple while the pump is OPERATING - (all pumps).

6. If overfilled, oil may be drained from the pump thru the drain valve located near the bottom of the pump.

## Troubleshooting

**Overheating:**

Operating temperature of the pump is related to ambient temperature. Under normal conditions when operating at low pressures, pump oil temperatures may be expected to rise approximately 45°C above ambient temperature. Operation is satisfactory if oil temperature does not exceed 80°C. Most frequently, overheating is caused by handling too large a volume of air for prolonged periods or operating with contaminated oil. A pump should never be used as a "control" to regulate a specific vacuum. If allowed to cycle "ON" and "OFF" frequently, the motor will probably overheat and fail to start because the motor thermoprotector will prevent the motor from operating.

**Other causes of failure:**

- Oil level is low. Add oil. (See Filling paragraph).
- Oil is gummy. Drain, flush, and refill with new oil.
- Gas ballast valve is open. Close valve by turning knurled knob clockwise finger-tight.
- Abrasive particles have entered the pump. Disassemble, clean, and replace any scored parts. Refill with fresh oil.
- Pump is binding mechanically due to parts misaligned during shipping. File damage claim with carrier and advise dealer or PRECISION for authorization to return pump for repairs.

**Noisy Pump:**

Noise, of course, is relative. When evaluating the sound level of a new pump, be sure comparison is with another pump of comparable performance with regard to free air displacement. Also, be sure that the pump is not on a platform that amplifies normal operating sound, and evaluate with the intake closed.

Sound should be analyzed for probable origin with respect to the following points:

- Low oil level. Refer to section on proper filling procedure and add oil.
- Load is too large for the pump, causing prolonged operation at intermediate pressures, which results in a normal but noisier pumping sound. Add smoke elliminator (accessory), or select a larger pump.
- System has pronounced leaks, causing prolonged operation at intermediate pressures, resulting in noisier than normal pumping sound. Locate and seal leaks.
- Damaged exhaust valve. Replace.
- Check exhaust valve for proper alignment. The exhaust hole must be covered by the valve.
- Internal damage or corrosion. Replace malfunctioning components or return pump to factory for refurbishing.

**Pump Does Not Produce Expected Vacuum:**

Pumps are tested at the factory with a McLeod gauge. Other types of gauges may give higher readings. Refer to "VACUUM GAUGES" section. When a pump is connected to a system, the rated ultimate may not be achieved due to the configuration of the system. Always check to see that oil in the mechanical pump is at the proper level. Leaks are always possible, and a complete check should be made, preferably with a leak detector. Quite frequently volatile materials in the system will be releasing vapor at such a rate (outgassing) that a higher than expected vacuum will be experienced. Water vapor in the air is a prime example. If a pump's performance is to be evaluated, remove the pump from the system and gauge the pump alone directly at the intake. The following points can also be investigated.

- Gas ballast valve is open. Close valve by turning knurled knob clockwise finger-tight.
- Plain grease instead of high vacuum silicone grease was used at slip joints or seals. (Only a very thin film of vacuum grease is necessary at joints. Remove any excess.)
- Oil is contaminated, or improper oil used. Drain, flush, and refill.
- Check gauge calibration.

Under vacuum, most liquids turn to vapors. Many tables show vapor pressure of a liquid relative to temperature. As soon as a particular pressure is reached, equilibrium shifts to the vapor phase. Water, the most common liquid, has a vapor pressure of 17 mm of mercury at room temperature. This means that as long as water is present, no vacuum pump can achieve a vacuum greater than 17 mm of mercury. The same phenomenon is true for all other volatiles. However, water is almost always

present to some degree in the atmosphere as humidity, and may be absorbed in solids. If water vapor is present in the gas entering the pump in such quantities that it cannot be handled by the gas ballast, it will emulsify with oil, requiring an oil change.

Running the pump with the gas ballast open will separate water from the oil and exhaust it as a vapor. The pump cannot reach ultimate pressure until water or other volatiles are removed from the oil. Contaminated oil should be replaced promptly. This will speed attainment of an ultimate vacuum and removes the risk of corrosion damage. A suitable trap prevents vapors from entering the pump.

Gases adhere and are occluded in most solids. Gases are also present in liquids. Gases in a vacuum leave the surfaces and depths of solids and liquids including vacuum pump oil during normal operation. This outgassing increases the amount of gas a pump must handle. Therefore, a pump may evacuate a system at a slower rate than anticipated. Heating or baking the components will speed release of gas, but will increase pump load during such heating.

**Pump Won't Start:**

Occasionally a vacuum pump may be found that is difficult to start. This rarely indicates a defective pump, and several considerations may cause the condition. Very often, it reflects the particular application, and hard starts can be common to pumps of any manufacture. Proper sizing of the pump to the task insures a fairly rapid pumpdown and prevents motor overload. Trapping strongly reactive agents that would turn high vacuum oil into a gummy substance will avoid seizure. If condensable vapors are continually drawn through any pump, vapor accumulation will distort oil level. If the pump is cold, below 5 C (40 F), it should be warmed to 10 C (50 F) before attempting restart.

The following points can also be checked:

- Check fuse, line cord, and switch.
- Check voltage at motor for excessive line loss.
- If the pump has been abused with frequent "ON-OFF" cycling, check that the motor has not overheated and that the malfunction is not a result of normal thermoprotector cutout protection (Disconnect electrical power and allow the pump to cool.
- Drain a small amount of oil and examine for increased viscosity.
- Oil is contaminated. Drain, flush and refill.
- Check the oil level. Too much oil can cause a hydraulic lock; that is, oil has filled the space within the stators, preventing the vanes to rotate. Bleed some oil, remove belt guard & belt, turn pump pulley manually, clockwise facing pulley.
- If none of the above is found to be the cause of the pump seizure, then the pump should be returned for repair. Contact the Technical Service Department of PRECISION for shipping instructions.

**Pumping Speed Is Too Slow:**

The variety of pump applications is impossible to anticipate. Therefore, speed curves for all vacuum pumps are plotted to standards of the American Vacuum Society. Pumping speed is reduced by each bend and any restriction in connecting tube, and by any valve or trap in the line. These factors, as well as length/diameter of connecting tubing, should be considered when calculating evacuation speed and selecting proper pump size.

Additional considerations are:

- Gas load is too great for the pump. Use larger pump.
- Leaks in system. Locate and seal.
- Oil is contaminated. Drain, flush, and refill.
- Material in system is outgassing. Heat material if possible.

**Pump Smokes:**

Some oil is continuously exhausted with gas during normal operation of any vacuum pump. At intermediate pressures, this mist is commonly referred to as smoke. If operation is to be continued at intermediate pressures, add a smoke eliminator. A smoking condition may also indicate low oil level. Small quantities of oil can be added slowly into the intake nipple while operating until the sight glass is 3/4 full.

**Pump Ejects Oil From Exhaust Port:**

Oil level is too high. Drain oil to proper level. Oil expands with heat after the pump has been operating. If the pump was overfilled slightly while cold, oil may eject at operating temperature due to expansion. Also, other liquids or condensed vapor may have entered the pump from the system and have raised the oil level.

**Pump Leaks Oil:**

Do not confuse an accumulation of condensed oil vapors with a leak. When in doubt, wipe off pump and isolate the source.

- Ejection from exhaust port. See earlier paragraph and drain oil partially.
- Loose or defective drain valve. Tighten or replace.
- Housing gasket. Tighten screws or replace.
- Shaft seal. Replace.

## VACUUM GAUGES

Pump performance is measured by gauges, and a brief discussion on the more common types should be helpful. The gauge must be properly located in the system. It should be placed near the pump inlet. Other locations in the system will show higher pressures.

All gauges, except McLeod, measure total pressure exerted by both gases and vapors; and different gases give different readings at the same pressure. The McLeod gauge is the primary standard used to test all mechanical vacuum pumps. Other types of gauges will read higher pressures because they indicate both gas and vapor. Absolute values of pressure levels, therefore, depend on the gases and vapors present and calibration of the gauge. Selection of a gauge should be made based on the necessity to read absolute or relative vacuum levels, ease of operation, and the desired investment.

**BOURDON TUBE** gauges are simple mechanical types generally used to measure pressure. As a vacuum gauge they are usually used only to indicate the condition of the system. They are not suitable for high vacuum measurements.

**"U" TUBE MANOMETERS** can be read more accurately than Bourdon Tube gauges in the range of O to 10 mm of mercury. With modification, such as using an auxiliary pump and measuring the differential pressure, or by inclining the "U" tube, their accuracy can be improved in this range. Usually used only to 0.5 mm of mercury.

**McLEOD GAUGE** is the primary standard for absolute measurement of pressure. A chamber (part of the gauge) of known volume is evacuated and filled with mercury. This chamber terminates in a sealed capillary calibrated in microns of mercury. As mercury fills the chamber, gas is compressed to approximately atmospheric pressure, and trapped vapors are liquified, and have no significant volume. In other words, this gauge does not measure pressure caused by any vapors present.

Its reading represents only the total pressure of gases. A cold trap is sometimes employed with this gauge to prevent transfer of vapors from the pump to the gauge, or from the gauge to the pump. These gauges, while accurate to approximately $10^{-5}$ mm of mercury, are not considered suitable for common use because they do not read continuously and are usually fragile.

**PIRANI GAUGE** measures the presence of a gas by indicating the ability of gas to conduct heat away from a hot filament. The greater the density (or pressure) of a gas, the greater the conduction of heat from the filament. As the filament temperature varies, so does its ability to carry current. A Wheatstone Bridge circuit is usually employed with a microammeter calibrated to read in microns of mercury.

Thus pressure is read based upon the current flowing through the filament which is a function of filament temperature. Since heat is conducted away from the filament by vapors as well as gases, these gauges measure the presence of vapors. Also, different gases have different thermal conductivities. Used in the same system, a Pirani gauge will yield a higher reading than a McLeod gauge, which measures only the pressure caused by gases. Pirani gauges are usually used in the pressure range of I micron to 1 mm of mercury.

**THERMOCOUPLE GAUGE** is similar to Pirani gauge in many ways. The basic difference is that a thermocouple measures filament temperature, and the thermocouple output is shown on a meter calibrated in microns of mercury. A Thermocouple gauge will also give a different reading for the same pressure of different gases and vapors. This gauge is more rugged, smaller and slightly less sensitive than the Pirani type. Range is approximately the same, 1 micron to 1 mm of mercury.

**IONIZATION GAUGES** are more sophisticated, sensitive, and fragile than Pirani and Thermocouple types. Ionization gauges are usually used to measure beyond the range of simpler gauges—up to 10-4 mm of mercury—depending upon specific type and design. These gauges form ions of the gas molecules present. The amount of current carried by this ionized gas depends upon the amount of gas present, the density or pressure of which is proportional to the gas. Ionization gauges are of two basic types—the thermionic, which forms gas ions by electrons emitted from a hot filament—and the cold cathode. The Bynard-Albert type is a common example of thermionic design. Penning or Philips are the most common examples of cold cathode design. These gauges also give different readings for different gases and vapors at the same pressure.

OTHER TYPES of gauges use radioactivity, viscosity, discharge tubes, or radiometer principles to measure pressure.

## Parts Replacement

In case of pump malfunction, check the "TROUBLESHOOTING" section for probable cause and corrective action. Pump disassembly may be necessary for thorough cleaning and inspection of internal parts.

### WARNING

*HANDLE PARTS WITH EXTREME CARE TO AVOID PERSONAL INJURY OR EQUIPMENT DAMAGE. PART SURFACES ARE PRECISION GROUND; EDGES ARE BURR-FREE BUT VERY SHARP.*

*PARTS SHOULD BE CLEANED WITH A SOFT BRUSH DIPPED IN ALKALINE CLEANER WITH RUST INHIBITORS.*

**Trap Gasket replacement:**

The trap gasket is readily replaced by removing the trap from the pump housing. First, drain oil. Remove eight (six on the D-25) trap bolts. Brace the pump housing with one hand, firmly strike top of housing with wooden or rubber mallet (do not use a metal hammer). This will free housing.

Peel gasket off (carefully scrape, if necessary). Use soft brush dipped in alkaline cleaner with rust inhibitors to remove any residue from surfaces.

**Exhaust valve and/or cover gasket replacement:**

Model's D-25, D-75, & D-150 only
Remove dome from the top of the pump then remove (4) cover screws that fasten the cover and cover gasket to the pump housing. (See Exploded View of the Models D-25, D-75, D-150 for parts location.)

Remove and replace cover gasket if necessary.

The exhaust valve is a rectangular spring metal component that is fastened to the exhaust stator with a machine screw. Remove the valve and visually check for cracks or corrosion. Replace the valve if defective or is questionable.

Model PV-35 and S-35 Only
Drain oil from the pump and remove (8) trap bolts that fastens the trap to the pump housing. (See Exploded View of the Models PV-35 and S-35 for orientation of the parts).

The exhaust valve is a rectangular spring metal component that is fastened to the stator with a machine screw. Remove the valve and visually check for cracks or corrosion. Replace the valve if defective or is questionable.

**Shaft Seal Replacement** (See section on "Disassembly" of pump):

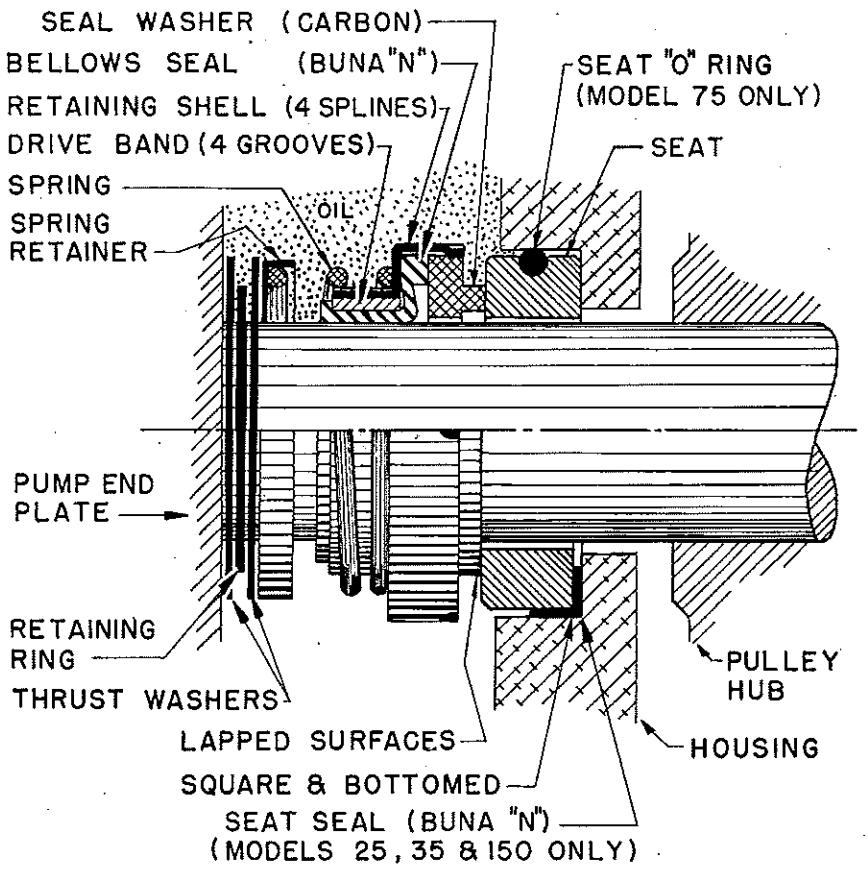
Careful seal installation pays dividends in excellent service. Less care means short service life, even failure after just minutes of operation. The seal should be replaced any time the pump is disassembled. Do not misinterpret condensed oil vapor on the pump as an oil leak.

See exploded view of the pump to determine the location of the shaft seal and other components.

Before replacing the seal, be sure the leakage is actually occurring at the shaft seal and is not oil from some other source.

1. Drain pump completely while pump is running and intake is open.
2. Disconnect line cord.
3. Remove V-belt and pump pulley.
4. MODEL D-150 ONLY
   a) Remove four screws and cover from the top of pump.
   b) Remove screw and sheet metal housing in opening under cover.
5. MODELS D-25, D-75, and D-150 ONLY
   The gas ballast body passes through a washer and "O" Ring and screws into the end plate. Remove by turning counterclockwise.

   MODELS PV-35 & S-35 ONLY
   It is not necessary to remove the gas ballast body.
6. Remove screws (around periphery of nameplate) holding trap to housing. Carefully pull trap and pump assembly from housing.
7. Slide worn shaft seal from shaft.
8. Remove any burrs on shaft, especially near end of keyway.
9. Coat shaft and new oil seal with vacuum oil.




Carefully slide the seal assembly on the shaft using the part which will be mounted in the housing as a pushing tool. See drawing for proper seal assembly and location of lapped surfaces.

10. Remove old seat (part of the shaft oil seal) from the pump housing by pressing the seat away from the recess in the housing. Do not scratch or destroy the edges of the hole in the housing with a sharp tool.

11. Coat the replacement seat with vacuum oil and press squarely and firmly into the housing. Make sure it is pressed into its recess as far as possible.

## NOTE

*LAPPED SURFACE (SHINED SURFACE) OF SEAL SEAT MUST FACE CARBON SEAL WASHER.*

12. Refill the pump as described on the nameplate. Gaskets should be replaced if leak free seal cannot be made.

13. Some oil leakage at the seal may occur for a short time. If leakage continues, replace seal again, exercising greater care in each step.

**Disassembly of PV-35 & S-35:**

1. Drain oil. Operate the pump with the intake open. Open drain valve and when the oil flow reduces to a trickle, turn the motor "OFF". Tip the pump towards drain valve to remove the remainder of the oil in the housing.
2. Remove belt guard, belt and pump pulley.
3. Remove pump from base.
4. Remove 8 trap bolts (38). This will release the trap (37) from the oil housing (5).
5. Wrap a layer of scotch tape around the keyway of the shaft (13) so not to damage the seal (6) when the oil housing (5) is being removed.
6. Remove housing carefully not to damage the seal (6) or gasket (23).
7. Remove seal assembly (6) and C clip (8).
8. Loosen and remove 5 end plate bolts (9) & washers (10).
9. Remove end plate (12) from the shaft (13).
10. Remove stator (22) carefully holding the vanes (15) from springing out of the rotor (18).

11. Remove vanes (15), spring (17), and pin (16).
12. Remove rotor (18).
13. Clean all parts carefully with an Alkaline Cleaner with rust inhibitors.
14. Visually check all parts for scratches, gouging and nicks to parts of the pump module. Replace all parts that are damaged.

**Reassembly Of PV-35 & S-35:**

Reassembly of the pump is in the reverse procedure of the disassembly with a few precautions.

1. Apply a light film of pump oil to all parts.
2. Clearance between the rotor and arc of the stator should be less than .001". A .001" feeler gauge should not penetrate between the two mating surfaces.
3. When tightening end plate to pump, apply pressure to stator so that the rotor does not lose contact with the stator as shown below in Figure 5. Tighten bolts in a criss-cross fashion.
4. Be careful when assembling oil housing (5) to pump so not to damage the seal (6).
5. We recommend installing a new seal and gasket on a pump that is completely overhauled.

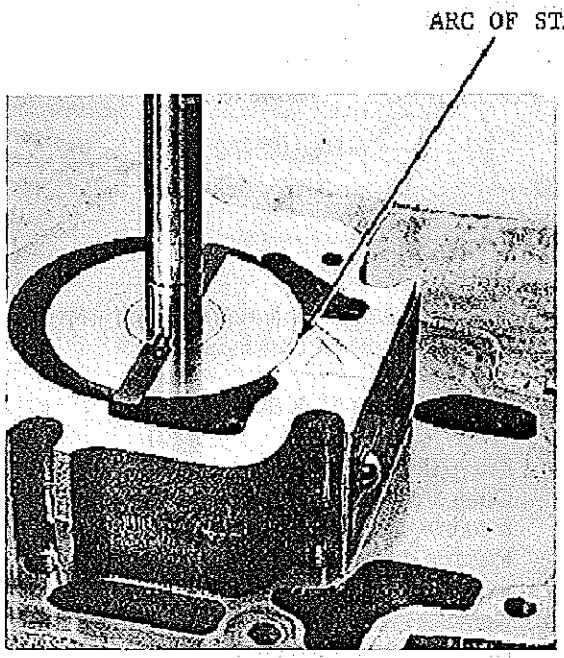



FIG. 4

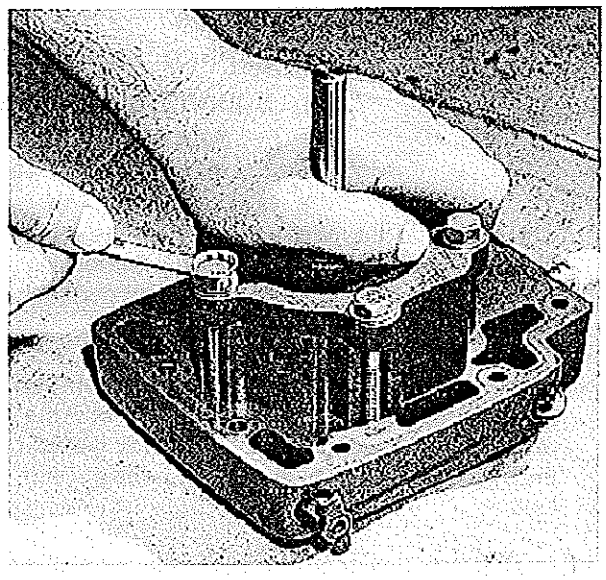
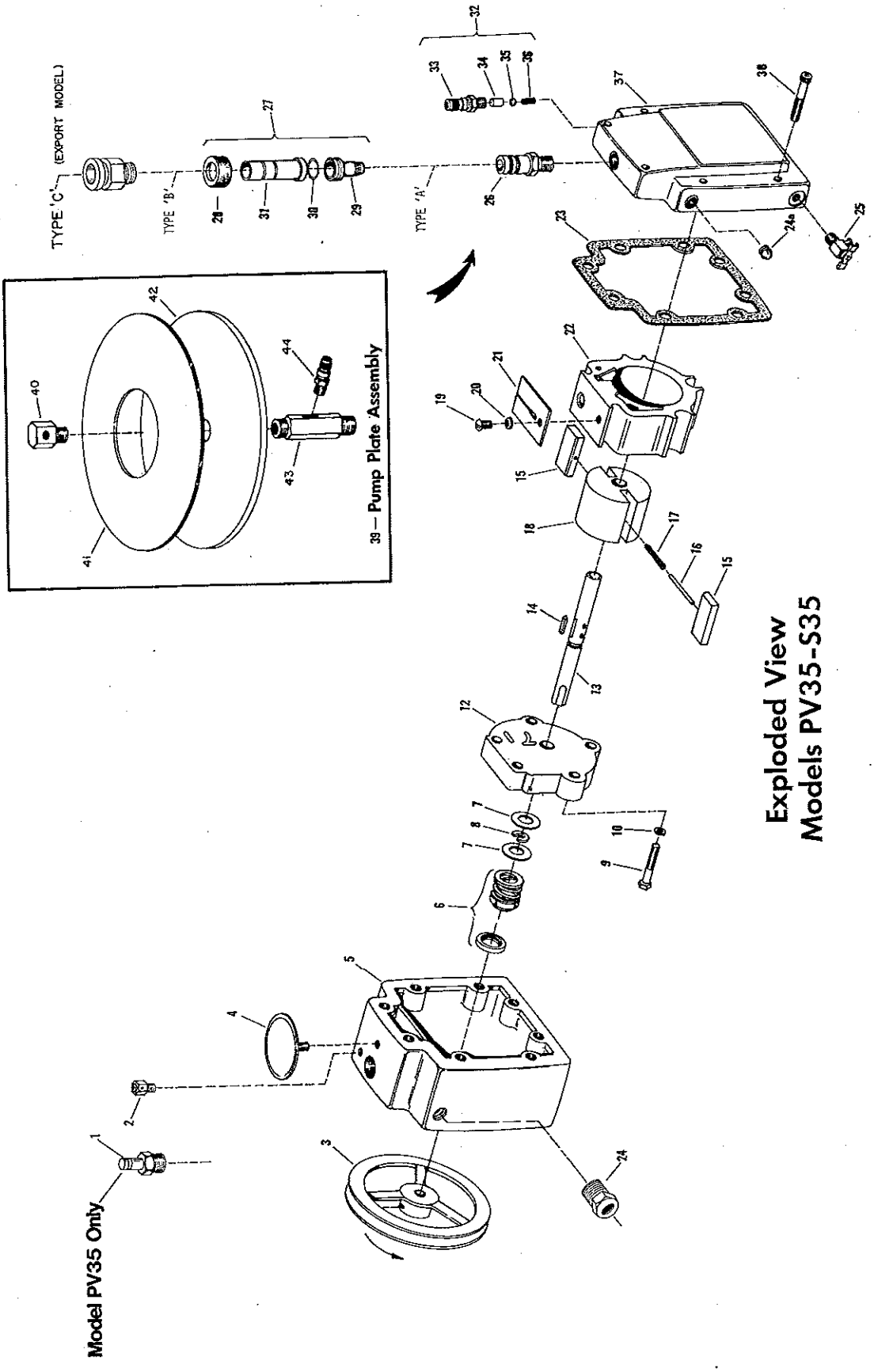


FIG. 5


Exploded View
Models PV35-S35
Model PV35 Only
TYPE 'C' (EXPORT MODEL)
TYPE 'B'
TYPE 'A'
39 — Pump Plate Assembly

| PARTS LIST (For Models S-35 & PV-35) | | |
|---|---|---|
| ITEM | DESCRIPTION | QTY |
| 1 | Exhaust Nipple | 1 |
| 2 | Pressure Relief Valve | 1 |
| 3 | Pump Pulley (5/16-18 x 3/8 Set Screw) | 1 |
| 4 | Dome | 1 |
| 5 | Pump Housing | 1 |
| 6 | Shaft Seal | 1 |
| 7 | Shaft Seal Thrust Washer | 2 |
| 8 | C-Clip | 1 |
| 9 | End Plate Asssembly Bolts | 5 |
| 10 | End Plate Washers | 5 |
| 11 | Plastic Plug, Exhaust (not shown) | |
| 12 | End Plate | 1 |
| 13 | Shaft | 1 |
| 14 | Shaft Key | 1 |
| 15 | Vane | 2 |
| 16 | Vane Spring Pin | 1 |
| 17 | Vane Spring | 1 |
| 18 | Rotor | 1 |
| 19 | Exhaust Valve Screw (10-24 x 1/4) | 1 |
| 20 | Exhaust Valve Screw Washer | 1 |
| 21 | Exhaust Valve | 1 |
| 22 | Stator | 1 |
| 23 | Trap Gasket | 1 |
| 24 | Sight Glass, Housing | 1 |
| 25 | Drain Valve | 1 |
| 26 | Intake Nipple - Type B | 1 |
| 28 | Nut | 1 |
| 29 | Coupling Body | 1 |
| 30 | O-Ring | 1 |
| 31 | Hose Nipple | 1 |
| 32 | Gas Ballast Vavle Assembly | 1 |
| 33 | Valve | 1 |
| 34 | Plug | 1 |
| 35 | Ball | 1 |
| 36 | Spring | 1 |
| 37 | Trap | 1 |
| 38 | Trap Bolts (1/4-20 x 1-1/2) | 8 |
| 45 | V Belt 28 Inch (not shown) | 1 |
| 46 | Motor Pulley 2.10" O.D. (not shown) | 1 |
| 49 | Sealing Plug Exhaust | 1 |
| 50 | O-Ring (Exhaust Sealing Plug) | 1 |
| 51 | Belt Guard (Back Panel) | 1 |
| 52 | Belt Guard (Front Cover) | 1 |
| 53 | Pump Base Assy (not shown | 1 |
| 54 | Cord & Plug | 1 |
| (For Motor Part No. See Page 18) | | |

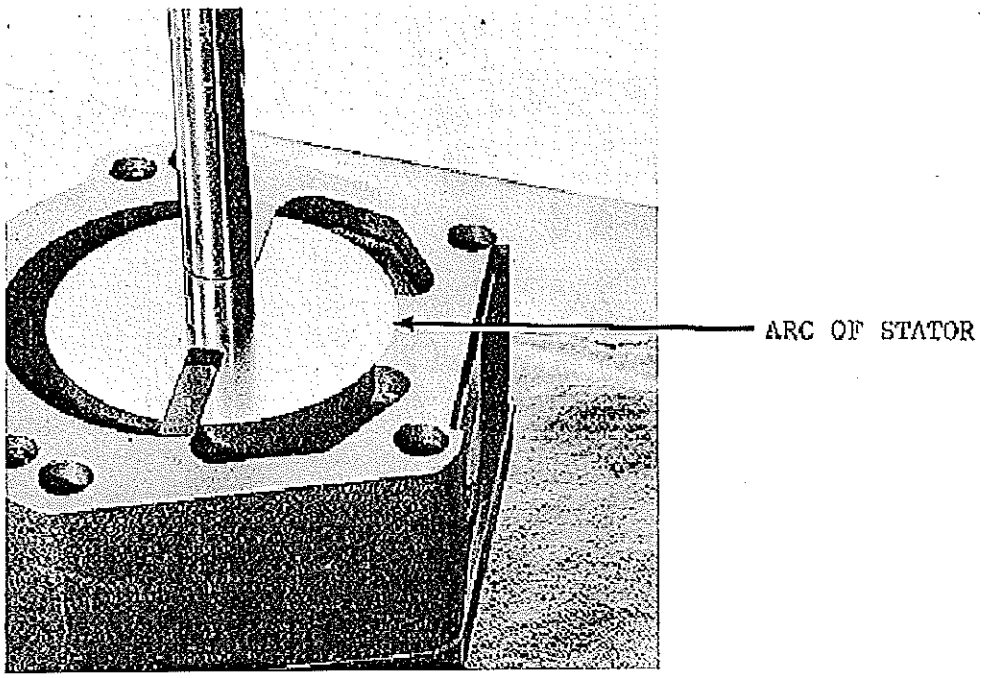
**Disassembly of Models D-25, D-75 & D-150:**

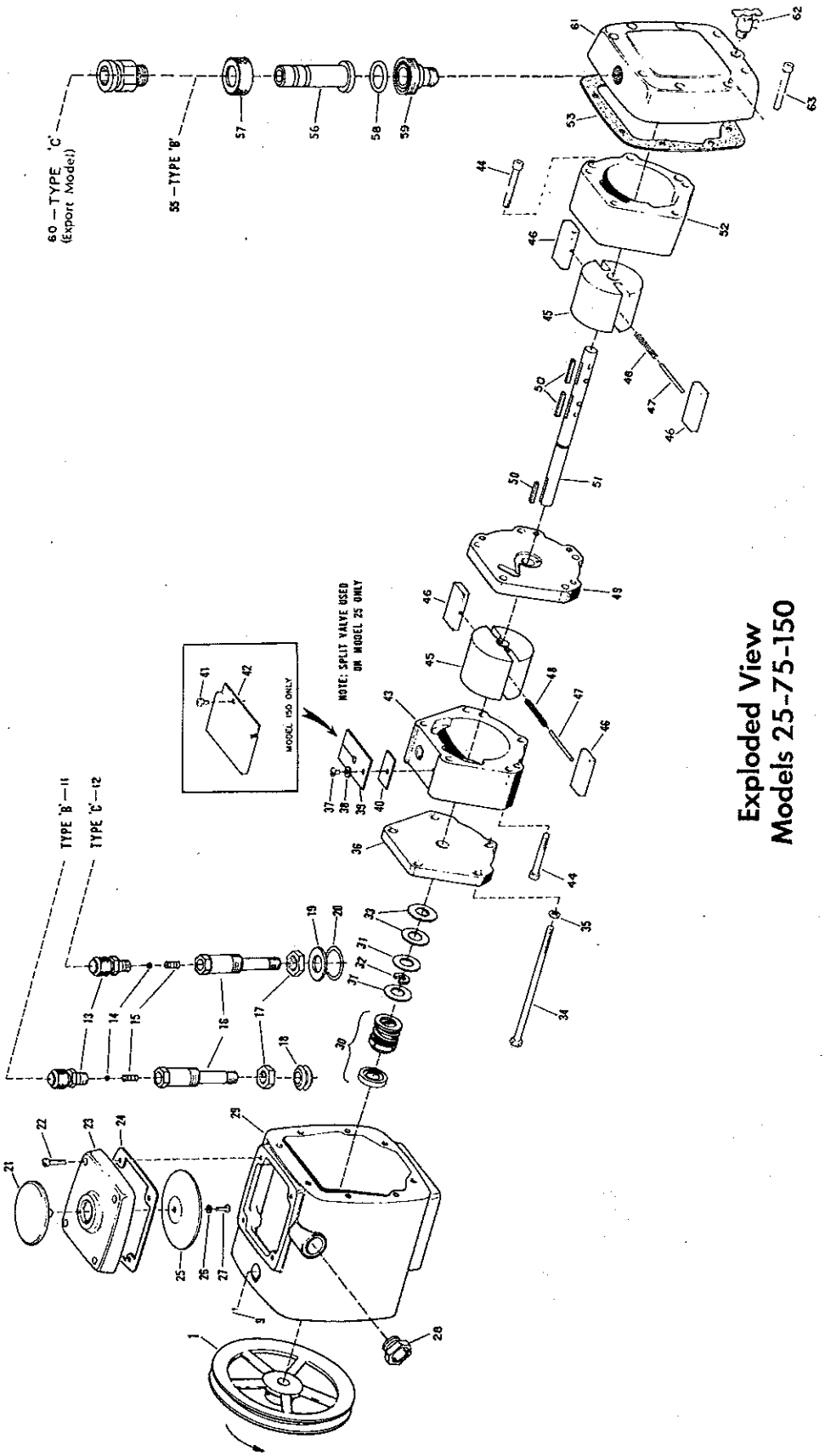
1. Drain oil. Operate the pump with intake open. Open drain valve and when the oil flow reduces to a trickle, turn the motor "OFF". Tip the pump towards drain valve to remove the remainder of the oil in the housing.
2. Remove belt guard, belt and pump pulley.
3. Remove pump from base.
4. Remove gas ballast assembly (12) from oil housing (29).
5. Remove cover (23) to remove baffle (25).
6. Remove 8 bolts (6 on the D-25) (63) which holds the trap (61) to the oil housing (29).
7. Wrap a layer of scotch tape around the keyway of the shaft (51) so not to damage the seal (30), when removing the oil housing (29) from the pump.
8. Remove the oil housing (29) carefully so not to damage the shaft seal (30) or the trap gasket (53) if possible.
9. Remove the seal assembly (30) and the C clip (32).
10. Remove 5 bolts (34), this will dismantle the end plate (36) and the pump module from the trap (61).
11. Remove 2 bolts (44) from the exhaust stator (43).
12. Remove the exhaust stator (43) carefully holding the vanes (46) from springing out of the rotor (45).
13. Remove vanes, (46) pin, (47) and spring (48).
14. Remove rotor (45).
15. Turn pump over 180 , lay pump on center plate (49) with shaft in a hole or between two objects, carefully not to damage or scratch center plate.
16. Remove 2 bolts (44) from intake stator (52).
17. Remove intake stator (52) carefully holding the vanes (46) from springing out of the rotor (45).
18. Remove vanes, (46) pin, (47) and spring (48).
19. Remove rotor (45).
20. Visually check all parts carefully for scratches, gouging and bad nicks. Replace all parts that are damaged. Clean all parts with Alkaline Cleaner with rust inhibitors.

**Reassembly of Models D-25, D-75 & D-150:**

The reassembly of the pump is in the reverse procedure of disassembly with a few precautions to follow:

1. Apply a light film of oil to all parts before starting the assembly.
2. Be sure that the rotors are in complete contact with the arc in the stators as shown in the figure below.
3. When tightening the stators to the end plate, apply pressure to the stators against the rotors so the stators will not move away from the rotors.
4. Be careful when assembling the oil housing to the pump so not to damage the shaft seal.
5. We recommend a new seal and gasket be replaced on a pump that is completely overhauled.






## Exploded View
## Models 25-75-150

| PARTS LIST (for Models D-25, D-75, D-150) | | |
|---|---|---|
| ITEM | DESCRIPTION | QTY |
| 1 | Pump Pulley (5/16-18 x 3/8 Set Screw) | 1 |
| 11 | Gas Ballast - Type "B" | 1 |
| 12 | Gas Ballast - Type "C" (STANDARD) | 1 |
| 13 | Valve | 1 |
| 14 | Ball | 1 |
| 15 | Spring | 1 |
| 16 | Body | 1 |
| 17 | Nut | 1 |
| 18 | Grommet - Type "B" Only | 1 |
| 19 | Washer | 1 |
| 20 | O'Ring - Type "C" Only | 1 |
| 21 | Dome | 1 |
| 22 | Cover Screws (10-24 x 7/8) | 4 |
| 23 | Cover | 1 |
| 24 | Cover Gasket | 1 |
| 25 | Baffle | 1 |
| 26 | Baffle Lock Washer (#10) | 1 |
| 27 | Baffle Screw | 1 |
| 28 | Sight Glass, Threaded (STANDARD) | 1 |
| 29 | Pump Housing | 1 |
| 30 | Shaft Seal | 1 |
| 31 | Shaft Thrust Washer | 2 |
| 32 | C-Clip | 1 |
| 33 | Shaft Seal Washer | 2 |
| 34 | End Plate Assembly Bolt | 5 |
| 35 | End Plate Assembly Washer | 5 |
| 36 | End Plate | 1 |
| 37 | Exhaust Valve Screw (10-24 x 1/4) | 1 |
| 38 | Exhaust Valve Screw Washer | 1 |
| 39 | Exhaust Valve | 1 |
| 40 | Exhaust Valve Spacer | 1 |
| 41 | Exhaust Valve Oil Shield Screw (D-150 Only) | 1 |
| 42 | Exhaust Valve Oil Shield (D-150 Only) | 1 |
| 43 | Exhaust Stator | 1 |
| 44 | Stator Positioning Screw | 4 |
| 45 | Rotor | 2 |
| 46 | Vane | 4 |
| 47 | Vane Spring Pin | 2 |
| 48 | Vane Spring | 2 |
| 49 | Center Plate | 1 |
| 50 | Shaft Key (As Required) | A/R |

| PARTS LIST (for Models D-25, D-75, D-150 continued) | | |
|---|---|---|
| ITEM | DESCRIPTION | QTY |
| 51 | Shaft | 1 |
| 52 | Intake Stator | 1 |
| 53 | Trap Gasket | 1 |
| 55 | Intake Nipple - Type "B" (STANDARD) | 1 |
| 56 | Hose Nipple | 1 |
| 57 | Nut | 1 |
| 58 | O'Ring | 1 |
| 59 | Coupling Body, Threaded | 1 |
| 60 | Intake Nipple - Type "C" | 1 |
| 61 | Trap | 1 |
| 62 | Drain Valve | 1 |
| 63 | Trap Bolt (6 on Model 25) | 8 |
| 64 | Belt Guard (Back Panel) | 1 |
| 65 | Belt Guard (Front Cover) | 1 |
| 69 | "V" Belt<br>(For All Models Not Listed In Item 70) | 1 |
| 70 | "V" Belt (For Cat. No. 51220007) | 1 |
| 71 | Plastic Plug (Exhaust Shipping and Storage) | 1 |
| 72 | Sealing Disc (Intake Shipping and Storage) | 1 |
| 73 | Motor Pulley 2.1" O.D..1/2" Bore<br>(For Cat. No. 51220006) | 1 |
| 75 | Motor Pulley 2.5" O.D. 1/2" Bore<br>(For Cat. No.'s 51220003, 51220004) | 1 |
| 77 | Motor Pulley 3.1" O.D. 1/2" Bore<br>(For Cat. No. 51220007) | 1 |
| 79 | Motor Pulley 2.4" O.D. 5/8" Bore<br>(For Cat. No.'s 51220005, 51220008) | 1 |
| 80 | Pump Base | 1 |

| MOTORS | | |
|---|---|---|
| CATALOG NO.'S | DESCRIPTION | PART NO. |
| 51220001<br>51220002<br>51220006<br>51220004 | Motor, 1/3 H.P., 115V, 60 Hz | 36223711 |
| 51220003<br>51220007 | Motor, 1/3 H.P., 240V, 50 Hz | 36223275 |
| 51220005 | Motor, 3/4 H.P., 120/230V 50/60 Hz (E.P.) | 36223712 |
| 51220008 | Motor, 3/4 H.P., 120/240V 60 Hz | 36223299 |

| PUMP ACCESSORIES | | |
|---|---|---|
| IN-LINE TRAPS | | |
| **USED ON MODEL NO.'S** | **CATALOG NO.** | **DESCRIPTION** |
| S-35, D-25 & PV-35 | 34001052<br>34532141<br>34310063 | Trap, Molecular Sieve, Complete<br>Cartridge, ONLY<br>Linde 13X Molecular Sieve, 1 Lb. |
| D-75 & D-150 | 34001053<br>34532141<br>34310063 | Trap, Molecular Sieve, Complete<br>Cartridge, ONLY<br>Linde 13X Molecular Sieve, 1 Lb. |
| S-35, D-25, D-75 & D-150 | 34001055<br><br>34330242<br>34532141 | Cartridge With Glass Bead<br>For Cat. No.'s 34001052 & 34001053 Traps<br>Glass Bead, 1 Lb.<br>Cartridge, ONLY |
| SMOKE ELIMINATORS | | |
| D-25, S-35 & PV-35 | 34002649<br>34310039 | Smoke Eliminator<br>Element, Only |
| D-75 & D-150 | 34002650<br>34310041 | Smoke Eliminator<br>Element, Only |

| Maintenance and Repair Kits |
|---|
| BASIC KIT includes a complete set of gaskets, O-rings, and gas ballast components.<br><br>MINOR KIT includes the contents of the BASIC KIT plus flutter valve, sight glass, drain, and shaft seal.<br><br>MAJOR KIT includes the contents of MINOR KIT plus vane assembly. |

| Model | Basic | Minor | Major |
|---|---|---|---|
| D-25 | 51245024 | 51245161 | 51245023 |
| S-35 | 51245215 | 51245162 | 51245025 |
| PV-35 | 51245215 | 51245162 | 51245025 |
| D-75 | 34000423 | 51245163 | 34000419 |
| D-150 | 51245026 | 51245164 | 51245230 |

| VACUUM TUBING, RED GUM RUBBER | | |
|---|---|---|
| | **Inner Diameter Inches (mm)** | **Wall Thickness Inches (mm)** |
| 34166732 | 1/4 (6.4) | 3/8 (9.5) |
| 34166873 | 3/8 (9.5) | 3/8 (9.5) |
| 34167006 | 1/2 (13) | 3/8 (9.5) |
| 34167068 | 3/4 (19) | 3/8 (9.5) |
| 34167095 | 1 (25) | 3/8 (9.5) |
| 34167100 | 1-1/4 (32) | 1/2 (13) |
| 34167105 | 1-1/2 (38) | 1/2 (13) |
| 34257012 | Adjustable tubing clamp for 34167068, 34167095, & 34167100 | |
| 34257053 | Adjustable tubing clamp for 34166783, 34166732 & 34167006 | |

## Vacuum Gauge Assembly

Catalog No. 34001058

Assembly consists of a gauge registering 0 to 30 inches of mercury vacuum mounted on a tee with two 1/4-inch serrated hose valves. Placement between vacuum pump and system provides a constant vacuum reading.

## Precision B+ Vacuum Pump Oil

Catalog No.'s 36069125, 34002655 and 34002656

A highly purified premium grade oil for use in all vacuum pumps. Double vacuum distilled for increased stability and reduced oxidation degradation, the low vapor pressure characteristics of this oil also reduce backstreaming and help prolong pump life. Suitable for all makes of rotary, vane type, oil sealed vacuum pumps.

## Warranty

PRECISION warrants its products against defects in material or in workmanship, when used under appropriate conditions and in accordance with appropriate operating instructions for a period of no less than one (1) year from the date of delivery of the products.

Sole obligation of PRECISION shall be to repair or replace at our option, FOB factory or locally, without charge, any part(s) that prove defective within the warranty period, provided the customer notifies PRECISION promptly and in writing of any such defect. Compensation for labor by other than PRECISION employees will not be our obligation. Part(s) replacement does not constitute an extension of the original warranty period.

PRECISION MAKES NO WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, AS TO THE DESIGN, SALE, INSTALLATION, OR USE OF ITS PRODUCTS, AND SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF ITS PRODUCTS.

PRECISION will not assume responsibility for unauthorized repairs or failure as a result of unauthorized product modifications, or for repairs, replacements, or modifications negligently or otherwise improperly made or performed by persons other than PRECISION employees or authorized representatives.

While our personnel are available to advise customers concerning general applications of all manufactured products, oral representations are not warranties with respect to particular applications and should not be relied upon if inconsistent with product specifications or the terms stated herein.

In any event, the terms and conditions contained in PRECISION formal sales contracts shall be controlling; and any changes must be in writing and signed by an authorized executive of PRECISION.

All defective components will be replaced without charge one (1) year from the date of delivery. There will be no charge for labor if the apparatus is returned to the factory prepaid.

Conditions and qualifications of the warranty statement shall prevail at all times.

To: "Gladys Makdissy" <Makdissy@ecs.umass.edu>
From: David Reckhow <reckhow@ecs.umass.edu>
Subject: Re:
Cc:
Bcc:
Attached:

Gladys,

I just got off the phone with Precision. They suggest that we need to simply replace the pump oil. He thought it would be best to do a "hot flush" which involves the following steps:

1. replace oil while "cold"
2. disconnect pump from freeze dryer
3. seal intake and turn pump on; run with gas ballast completely open for ~1 hour (it will get very hot!)
4. turn pump off and drain oil
5. fill with new oil again
6. re-connect pump and use freeze dryer

Dave

At 07:13 AM 4/18/2004 -0600, you wrote:

David

Attached is the manual for Rota Vapor and Vacuum Pump model D150 for freeze dryer.

Gladys Makdissy

Post-doctoral Research Associate

Civil and Environmental Engineering

18 Marston Hall

University of Massachusetts