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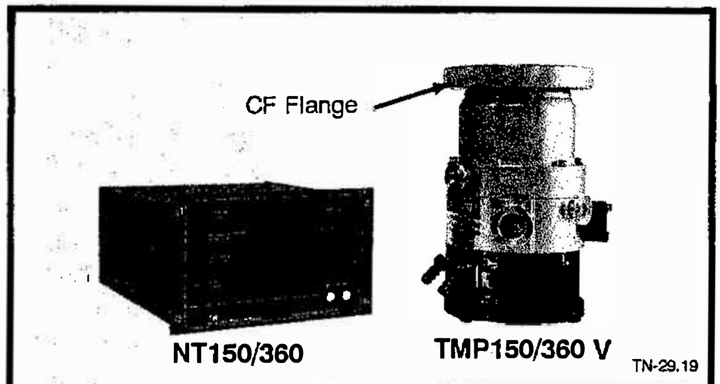
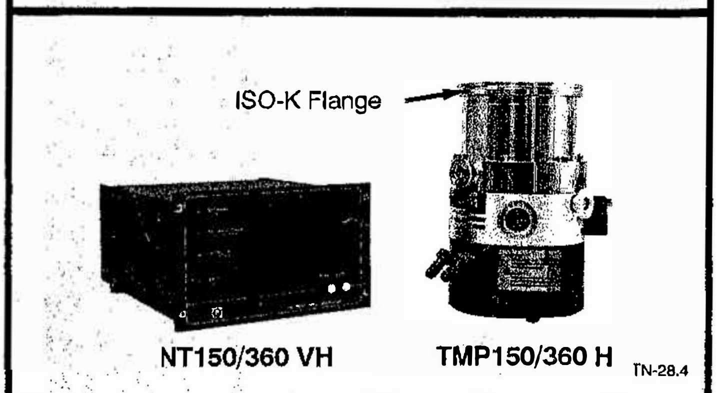
LEYBOLD VACUUM PRODUCTS INC.

Part Number 722-78-036 ■ Edition B

TMP/NT 150/360 V/H Turbomolecular Pump & Frequency Converter

MANUAL





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Contents

Important:

Failure to comply with the following could cause premature failure of your turbopump or converter and void your warranty.

- The TMP150/360 V pump models must not be tilted by more than 15° from vertical when they are operating. Tilting them more than 15° results in inadequate lubrication and premature bearing failure.
- Don't tilt the high-vacuum flange down on any oil-lubricated turbopump model when the pump contains oil. If the high-vacuum flange is tilted down, the high-vacuum area of the pump could become contaminated with oil. Always drain the oil from the pump before shipping.
- If the TMP150V or TMP360V model has been idle for more than two months, it must be primed with oil as described in Section 2.2.1 before operation. We also recommend priming a new pump before initial start-up because it is very likely that more than two months have passed since the pump was tested. Failure to prime the turbopump at these times could result in accelerated bearing wear.
- The TMP150/360 H models must be operated with their fore-vacuum port within the 90° A-B arc shown in the top of Figure 2-2; operating the pump greater than 10° outside this arc results in inadequate lubrication and premature bearing failure.
- Use only HE-500 vacuum oil in the turbopump and check the oil level often. Using nonapproved oils or running the pump with too much or too little oil could result in premature bearing failure.
- Don't run the pump without the inlet screen installed in the high-vacuum flange. The inlet screen prevents objects from falling into the pump and damaging the rotor.
- Always vent the pump during shutdown as described in Section 3.6 to prevent oil vapors from contaminating its high-vacuum section. If you will be pumping corrosive or aggressive gases or gas containing abrasives or dirt, purge and vent with inert gas through the purge port as described in Section 3.7 to protect the oil and bearings from premature failure.
- Ensure that air flow around the converter and near the optional air-cooling unit is unrestricted. The maximum ambient temperature for the converter is 110°F (45°C); the maximum temperature at the intake of the optional AC air-cooler is 85°F (30°C).
- Ensure that the converter's fuse and voltage selection card are correct for your AC power source as described in Section 2.3.1.
- Don't expose the turbopump to heavy external shocks or vibration which could result in accelerated wear of the bearings.
- Don't use the discontinued NT150/360 converter (P/N 85472-1) with the TMP150V pump model unless the converter has been modified. See Section 5.3 for details.

Table I — TMP150/360 V/H Turbopump Specifications

Pump Model	TMP150 V/H	TMP360 V/H
Compression Ratio:		
For Nitrogen	$>1 \times 10^9$	$>1 \times 10^9$
For Helium	7.4×10^4	1.0×10^5
For Hydrogen	850	3.5×10^3
Maximum Pressure at High-Vacuum Flange	5×10^{-1} mbar	1×10^{-1} mbar
Ultimate Pressure per DIN 28 400 and DIN 28 428	$<10^{-10}$ mbar	$<10^{-10}$ mbar
Fore-Vacuum Pressure:		
Recommended	10^{-2} to 10^{-3} mbar	10^{-2} to 10^{-3} mbar
Maximum	1 mbar	5×10^{-1} mbar
Recommended Backing Pump:		
without purge/vent flow	TRIVAC® D4B	TRIVAC® D16B
with purge/vent flow	TRIVAC® D16B	TRIVAC® D25B
Rotational Speed	50,000 rpm	45,000 rpm
Start-Up Time	1.5 minutes	2 minutes
Cooling*:		
Method	Water (Air optional)	Water (Air optional)
Minimum Water Flow at 15°C (59°F)	5.3 gal/hr (20 ltr/hr)	5.3 gal/hr (20 ltr/hr)
Water Pressure	<60 psig	<60 psig
Water Temperature (see Fig 2-9)	50 to 85°F (10 to 30°C)	50 to 85°F (10 to 30°C)
Water Connection, Hose Nozzle	7/16 inch (11 mm)	7/16 inch (11 mm)
Fore-Vacuum Port Fitting	KF25	KF25
Maximum Bakeout Temperature		
at CF High Vacuum Flange	212°F (100°C)	212°F (100°C)
at Pump Neck and Rotor	175°F (80°C)	175°F (80°C)
at Fore-Vacuum Flange	130°F (55°C)	130°F (55°C)
Maximum Magnetic Induction at Pump Housing (1mT = 10 Gauss)		
For a Radial Field	B = 5 mTesla	B = 5 mTesla
For an Axial Field	B = 15 mTesla	B = 15 mTesla
Maximum Vibration Velocity	<0.10 mm/sec	<0.10 mm/sec
Dimensions	See Leybold Catalog	See Leybold Catalog

*See Section 3.1 for information on temperature limits.

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Table I — TMP150/360 V/H Turbopump Specifications (Continued)

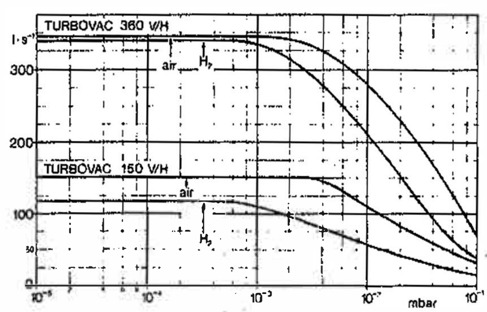
Pump Model	TMP150/360 V	TMP150/360 H
Mounting Position	Vertical, Maximum deviation is 15° from vertical	From horizontal to vertical while maintaining the required fore-vacuum flange position (see top of Figure 2-2.)
Lubricant	HE-500 Oil	HE-500 Oil
Oil Capacity	80 ml	40 to 90 ml depending on the pump's installation position (see Figure 2-2)

Weight	TMP150 V	TMP150 H	TMP360 V	TMP360 H	NT150/360 V	NT150/360 H
lbs (kg)	15.4 (7)	19.8 (9)	24.3 (11)	28.1 (13)	21 (9.5)	18.7 (8.5)

Pumping Speed (Volume Flow Rate — liters/second)					
Process Gas	**TMP150 V/H - High Vacuum Flange**			**TMP360 V/H - High Vacuum Flange**	
	63 ISO-K	*100 ISO-K & CF100*	*2-inch ASA*	*100 ISO-K & CF100*	160ISOK,CF150 & 4-inch ASA
Nitrogen	125	145	140	345	400
Helium	110	135	130	340	390
Hydrogen	95	115	110	340	390

NOTE: The actual pumping speed varies depending on the inlet flange (see above table).

Inlet Pressure (mbar)



Pumping Speed (liters/second)

Table II — NT150/360 Converter Specifications

Power Source	
Input Voltage, Selectable Single Phase	100/120/220/240 V AC, ±10%
Input Frequency	47 to 63 Hz (50/60 Hz)
Power Consumption:	
Transient (<0.5 sec)	750 VA
During Acceleration (max. 30 minutes)	680* VA
Normal Operation (maximum)	480* VA
Fuse Chassis:	
100/120 V AC	3AG/10A
220/240 V AC	3AG/5 A
Output Values	
Output Voltage (maximum)	3 x 45 V AC r.m.s.
Overload Current Limitation	3.5 A
Rated Output Frequency:	
TMP150 V/H	840 Hz
TMP360 V/H	760 Hz
Normal Operation Relay Contact Ratings:	
Maximum	8A @ 24 V DC and 10A @ 250 V AC
Minimum	1 mA @ 5 V DC
Inductive Load	24 V DC/5A and 220 V AC/5A
Environment	
Operating Temperature Range	32° to 110°F (0° to 45° C)
Storage Temperature Range	-100° to +185°F (-40° to +85° C)
Weight	21 lbs (9.5 kg)
Dimensions	8 3/8 x 5 1/16 x 11 7/16 Inch (213 x 129 x 290 mm)

*The power consumption is slightly higher for the NT150/360 VH model when the oil pump is operating.

Table III — Ordering Information for Pumps and Converters

TMP150 V/H Pumps	*Part Numbers*
TMP150 V Pump Models	
Pump with 63 ISO-K Flange	85610
Pump wi th100 ISO-K Flange	85611
Pump wi thCF100 Flange	85612
Pump wi th2-i nchASA Flange	89411
TMP150 H Pump Models	
Pump wi th100 ISO-K Flange	85616
Pump wi thCF100 Flange	85617
TMP360 V/H Pumps	*Part Numbers*
TMP360 V Pump Models	
Pump wi th100 ISO-K Flange	85620
Pump wi th160 ISO-K Flange	85622
Pump wi thCF100 Flange	85621
Pump wi thCF160 Flange	85623
Pump wi th4-i nchASA Flange	89421
TMP360 H Pump Models	
Pump with 100 ISO-K Flange	85625
Pump wi th160 ISO-K Flange	85627
Pup wi thCF100 Flange	85626
Pump wi thCF160 Flange	85628
NT150/360 Frequency Converters	*Part Numbers*
Standard NT150/360 Converter (for use wi thTMP150/360 **V** pumps - see Section 5.3) . . .	85472-3
NT150/360 VH Converter (for use wi thTMP150/360 **H** pumps - see Section 5.3) . . .	85572-1

Table IV - Ordering Information for Accessories

Accessories	Part Number
HE-500 Oil	
150 cc	98-198-052
1 Qt	98-198-053
1 gallon	98-198-030
Gaskets and Clamps for the High-Vacuum Flange	See Table 2-1
Fuses for Frequency Converter	
120-Volt, 10-Amp Fuse	721-95-000
240-Volt, 5-Amp Fuse	721-95-001
Air Cooler* (see Appendix A.1)	
115 V AC	89407
220 V AC	85516
Water Refrigeration Unit (see Appendix A.2)	99-239-003
Water Flow Switch (see Appendix A.3)	99-287-022
CF Flange Heaters (see Appendix A.4)	
CF100 115V	85428
CF100 220V	85427
CF120 115V	85438
CF160 220V	85437
Automatic KF10 Vent Valve (see Appendix A.5)	
115 V AC, Normally Open	899838
115 V AC, Normally Closed	98-273-011
240 V AC, Normally Open	899840
240 VAC, Normally Closed	899841
Purge/Vent Valve (see Appendix A.6)	
115V	85518
220V	85519
Adsorption Trap (see Appendix A.7)	
KF®16 Trap	85414
KF25 Trap	85415
Al_2O_3 Adsorbent, 2-liter can	85410
CF100 Vibration Damping Bellows (see Appendix A.8)	88595
TMP V to H Conversion Kit (see Appendix A.9)	200-17-894
NT150/360 Conversion Kit (see Appendix A.10)	728-40-005

*Contact the factory for information on the DC air cooler for high temperature processes.

1 — Introduction & Equipment Unpacking

Contents

1.1 Scope of Manual

This manual has installation, operation, description, and service information for the following equipment:

- **Oil-lubricated TURBOVAC® TMP150/360 V and H Pumps:**
  These turbomolecular pumps remove gas from a vacuum chamber or system to produce a high vacuum. The V or H after the model number indicates whether the pump can be operated in a vertical (V) or horizontal (H) position (see Section 2.4.1).

  The TMP150/360 H model was discontinued on October 1, 1991 and replaced by the TMP 151/361 which uses grease-lubricated ceramic ball bearings. This manual does not apply to grease-lubricated turbopump models.

- **NT150/360 and NT150/360 VH Frequency Converters:**
  (P/N 85472-3 or 85572-1)
  The converter is used to control the turbopump and to accelerate the turbopump to the rotational speed of 50,000 rpm for the TMP150 and 45,000 rpm for the TMP360.

See the front of this manual for important precautions and for specifications and ordering information.

"WARNING" statements are used in this manual to prevent personal injury.
"CAUTION" statements are used to prevent damage to equipment.

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1.2 Unpacking and Inspection

Proceed as follows to unpack and check the turbopump and frequency converter for shipping damages as soon as you receive it.

1. Inspect the outside of each shipping container for visible damage. If you will be making a damage claim, keep the shipping container and packing materials.

Caution: Don't remove the protective covers from the turbopump high-vacuum or fore-vacuum flanges, or the blank flanges from the purge and vent ports until it is ready for connection to the vacuum system. The pump is filled with dry nitrogen to protect it from corrosion and contamination during shipping.

2. Carefully unpack the turbopump and frequency converter and inspect it for damage.

3. If you find any evidence of damage, proceed as follows:

   - Save the shipping container, packing material, and damaged part for inspection.
   - Notify the carrier that made the delivery within 15 days of delivery in accordance with Interstate Commerce Commission regulations.
   - File a claim with the carrier for the damage. Any damage in transit is the responsibility of the carrier because all equipment is transported from our factory by private carriers.
   - Contact our Order Services Department in Export, PA or your nearest Leybold representative to order replacement parts.

1.3 Delivered Equipment

The following loose items are delivered with the turbopump and frequency converter:

TMP-150/360* with ASA Flange:

- One KF25 Centering Ring with Buna-N O-Ring (P/N 18327)
- One KF25 Clamp (P/N 18342)
- One 120 ml bottle of oil for the Turbopump (see Table 4-1 for P/N's)

TMP-150/360* with ISO-K Flange

- One ISO-K Centering Ring, VITON O-Ring, and Outer Ring (see Table 7-1 for P/N's)
- Two ISO-K Flange Clamps (P/N 26701)
- One KF25 Centering Ring with Buna-N O-Ring (P/N 18327)
- One KF25 Clamp (P/N 18342)
- One 120 ml bottle of oil for the Turbopump (see Table 4-1 for P/N's)

TMP-150/360* with CF Flange:

- One KF25 Centering Ring with Buna-N O-Ring (P/N 18327)
- One KF25 Clamp (P/N 18342)
- One 120 ml bottle of oil for the Turbopump (see Table 4-1 for P/N's)

Frequency Converter

- One Fuse (P/N 721-95-000), type 3AG/10 A, for operation at 120 VAC
- One Fuse (P/N 721-95-001), type 3AG/5 A, for operation at 220/240 VAC
- One Pump Cable with Connectors (P/N 99-700-1001), 20 ft. (6.1 m)
- One Power linecord with 115V plug (P/N 99-276-5134)
- One Spare 250V/20A right-angle plug (P/N 99-122-049)
- One TMP/NT-150/360 Instruction Manual (P/N 722-78-036)

*In addition, the TMP150H and TMP360H models have a cable (P/N 200-59-492) to provide power to the electric oil pump, a syringe with feed tube (P/N's 200-17-776 & 393-50-103) for adding oil, and a stand (P/N 200-17-535) for supporting the pump while you change the oil (see Figure 4-5). Don't overlook the stand in the packing material; its easy to miss because it fits into the packing material and both the stand and the packing material are black.

1.4 Brief Description of Pump and Converter

NOTE: See the front of this manual for important precautions for oil-lubricated pumps and for specifications and ordering information.

All turbopumps and their associated frequency converters work together to produce an ultra-clean, hydrocarbon-free high vacuum. The following is a brief description of these units. See Section 5 for detailed descriptions.

1.4.1 Turbopump

The TMP150/360 V/H turbomolecular pumps can produce an ultimate pressure of 10^{-10} mbar. However, to reach pressures lower than 10^{-7} mbar, you must use a CF-flanged pump and optional CF-flange heater and you must bakeout the vacuum chamber. A turbopump must be backed by a rotary vane pump to shorten the pumpdown time at higher pressures and to evacuate hydrogen. Other important pump characteristics are listed below:

- **The choice of models for vertical (V) or horizontal (H) mounting** (see Figure 1-1) - The V or H after the model number indicates the mounting position (see the nameplate on the base of your pump). If you have the TMP150V or TMP360V model, never tilt it more than 15° from vertical while it is operating. The TMP150H and TMP360H models can be mounted in any angle between vertical and horizontal as long as the fore-vacuum port is mounted within its 90° A-B arc as shown in the top of Figure 2-2. Never tilt the high-vacuum flange down on any oil-lubricated turbopump and always drain the oil before shipping an oil-lubricated turbopump.

- **Oil-lubricated bearings** - The oil-lubricated bearings provide superior reliability when they are properly maintained. Proper maintenance includes using only HE-500 oil, charging the pump with oil before start-up, monitoring the oil level and condition, and changing the oil as required. To minimize the chance of dry running, the TMP150/360 V pump models must be primed with HE-500 oil as described in Section 2.2.1 before a new pump is initially started and after the pump has been idle for two months or longer.

- **Dynamic balancing of the turbopump's rotor assembly** - This produces silent running with minimal vibration. Don't modify the rotor or it will affect its precision balancing. Also avoid blows and isolate the pump from heavy vibration which could result in accelerated bearing wear.

- **Standard water cooling and optional air cooling** (See Appendix A.1 for a description of the optional air cooling unit.)

- **Thermal protection** - The turbopump motor is protected from overheating by a thermal switch which turns off the frequency converter if the water or optional air cooling is inadequate.

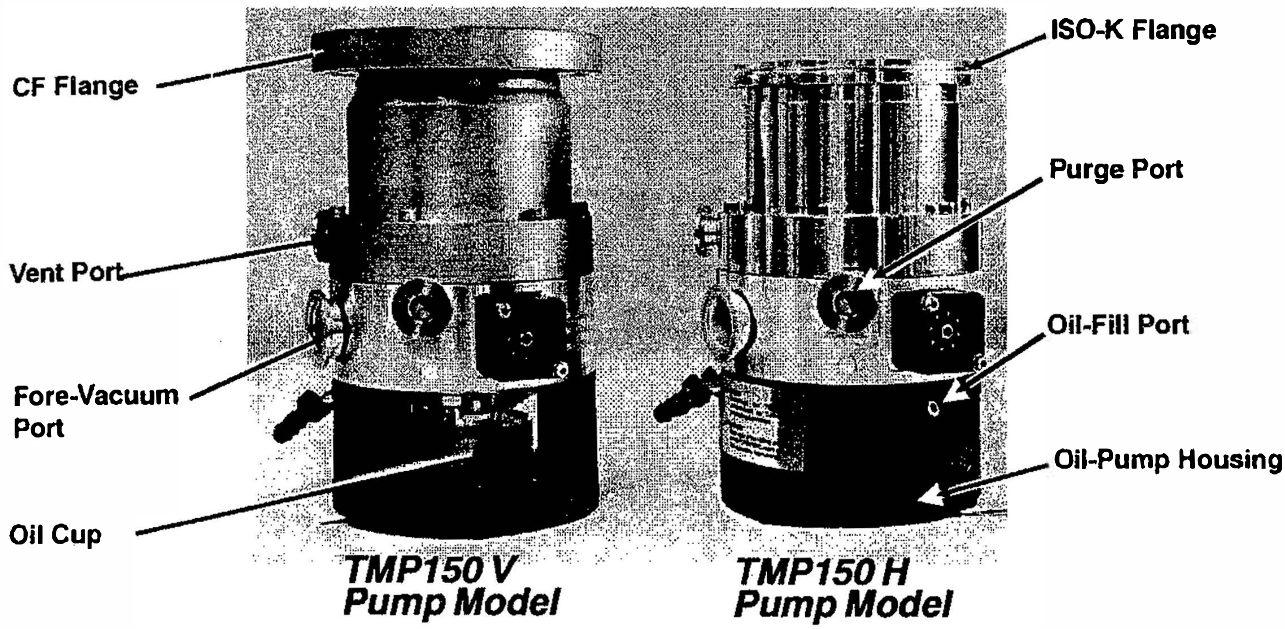

Figure 1-1. TMP150 V and H Pump Models

- **Purge and Vent ports on all TMP150/360 V/H pump models** (see Figure 1-1) - It is important to vent all turbopumps during shutdown to prevent the backing pump oil from contaminating the turbopump. For standard application, the purge port is sealed off and the pump is normally vented through the vent port as described in Section 3.6.

  If the pump will be exposed to corrosive or aggressive process gases or gases that contain dirt or abrasives, you must seal off the vent port and use dry inert gas to purge and vent the pump through its purge port as described in Section 3.7. The inert gas forms a protective gas seal around the motor/bearing cavity, thus protecting the bearings and oil from corrosive or abrasive attack. A larger capacity backing pump may be required to handle the increased gas load resulting from the purging.

- **Inlet screen** - A screen in the high-vacuum flange protects the turbopump from foreign objects that could fall into the pump and severely damage the rotor.

1.4.2 Frequency Converter

The frequency converter converts single-phase, 100-240 V AC, 50/60 Hz power into three-phase, variable voltage, variable frequency power as required by the turbopump's induction motor. The turbopump is turned "on" and "off" by the converter's front panel START and STOP pushbuttons. External control and monitoring devices can be connected to the converter's rear panel terminal block. Other features of this frequency converter include:

- **Universal Applicability** - There are two versions of the converter for oil-lubricated turbopumps: 1) the NT150/360 VH converter and 2) the standard NT150/360 converter. See Section 5.3 for details.

  The NT150/360 VH converter (P/N 85572-1) can drive all of the TMP150/360 V and H pump models. However, the standard NT150/360 converter (P/N 85472-3) is usually used for the TMP150/360 V pump models because it costs less. The standard NT150/360 converter can't be used with the TMP150H and TMP360H models because it doesn't have the circuitry needed to drive and control the TMP150/360H electric oil pump.

  The most obvious physical deference between the converters is that the standard NT150/360 model has an hours meter and the NT150/360 VH model doesn't.

- **LED Display/Self Tests** - Front panel POWER, ACCELERATION, NORMAL OPERATION, and FAILURE indicators show the status of the converter. During normal start-up, all LED indicators turn ON for the first few seconds. As soon as the converter completes the selftests, all indicators except POWER turn off. When the START pushbutton is pressed, the ACCELERATION LED turns ON and stays ON until the turbopump achieves its rated rotational speed. Then, the NORMAL OPERATION LED lights and the ACCELERATION LED turns off.

  If the converter fails its initial self test, all the LED will stay ON during start-up indicating a converter malfunction. If a problem develops with the converter or the pump during operation, the FAILURE LED lights and the converter shuts down the turbopump. The source of the failure is indicated by the flash rate of the FAILURE LED as summarized in Table 3-3. After the problem is remedied, the converter must be reset by pressing the STOP button or cycling the power.

  You can have the converter do a series of static tests to determine the circuit or component causing the fault. Static tests exercise all the circuitry, one block at a time to aid in troubleshooting. If the converter fails a static test, all the LEDs will light continuously. See Section 6.3 for detailed information on the static tests.

- **No Calibration** - No calibration is required to set the frequency, voltage, or current setpoints in this unit or to compensate for the turbopump's cable length. All are determined by the internal software.

- **Long Cable Drive Capability** - The converter is designed to drive a turbopump at distances as far as 328 feet (100 m). The unit automatically establishes the necessary voltage corrections to compensate for the cable losses and maintain maximum output power.

Section 2 Installation

This section contains information on how to install the Frequency Converters and the TMP150/360 V/H Turbomolecular Pumps. Also included is a procedure which checks if the turbopump's rotor is turning in the correct direction (see Section 2.3.8).

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2.1 Utility and Site Requirements

- Ensure the correct AC power source is available for the converter and any accessories. Avoid powering the converter from an AC line source that is noisy from line voltage drop outs and transient spikes. Also avoid mounting the converter near electrostatic discharge devices which can cause the converter to operate erratically.

- If the turbopump will be located more than 20 ft. (6.1 m) from the frequency converter, additional lengths of pump cable will be required.

- A source of dry inert gas and a Purge/Vent Valve (see Appendix A.6) are required if you will be pumping corrosive or aggressive gases or gas containing abrasives or dirt. A vent valve (see Appendix A.5) is required for standard application.

- You will need a source of clean tap water, the optional water-flow switch (see Appendix A.3), and 7/16-inch hose and clamps for the standard water-cooled turbopump. If tap water isn't available, use the optional Air Cooling Unit or Water Refrigeration Unit. Refer to Appendix A.1 and A.2.

- The turbopump requires a backing pump for proper operation. A larger capacity backing pump is required if you will be purging the turbopump with inert gas, or if the turbopump will be operated continuously between 1.3 x 10^{-3} mbar and its maximum rated pressure of 0.5 mbar. Contact Leybold for recommendations.

- The turbopump must be protected from heavy external shocks or vibration. Bellows are recommended if the turbopump is connected to any vibrating components. Use bellows to connect the turbopump's fore-vacuum port to the backing pump. Refer to Appendix A.6 for information on bellows for the high-vacuum flange.
- In addition to bellows, some mounting hardware is required for installing the turbopump to the vacuum system. See Table 2-1 for the P/N's of flange gaskets and clamps for the high-vacuum flange; see our catalog or contact us if your installation requires adapters.
- If the turbopump will be installed so that it tilts greater than 15° from vertical, you must use a TMP150H or 360H pump model. The TMP150/360H models can be mounted in any position between horizontal and vertical as long as the fore-vacuum port is positioned within the 90° arc shown as A-B near the top of Figure 2-2.
- Ensure that adequate convection cooling is available for the converter (see Section 2.3.5). Its ambient temperature range is 32° to 110°F. If the turbopump is cooled with the optional AC air cooler, temperatures above 85°F at the air intake should be avoided (see Section 2.4.4).
- When installing the turbopump within a magnetic field, ensure that the magnetic induction measured at the surface of the pump housing doesn't exceed 50 gauss [5 mT (millitesla)] in a radial field and 150 gauss (15 mT) in an axial field. If these values are exceeded, the resulting eddy currents might overheat the rotor; therefore, suitable magnetic shielding of the turbopump will be necessary.
- The standard turbopump is radiation resistant up to 10^5 rad (10^3 Gray). If higher radiation resistance is required, please contact Leybold.

2.2 Priming and Charging the Turbopump with Oil

2.2.1 Priming and Charging the TMP150V and TMP360V Models *(Requires 88 ml of oil)*

If you have a TMP150H or TMP360H model, skip this section (Sec. 2.2.1) and proceed to Section 2.2.2.

A 120 ml bottle of special vacuum oil is shipped with the turbopump. Using this oil, prime the TMP150V or TMP360V pump model and fill its oil cup as follows:

CAUTION: Don't tilt the TMP150/360 V pumps more than 15° from vertical while the oil cup is installed. Tilting it more than 15° could result in oil contaminating its high-vacuum section.

1. Unscrew the three thumbscrews and remove the oil cup from the bottom of the turbopump.

TMP150/360 V

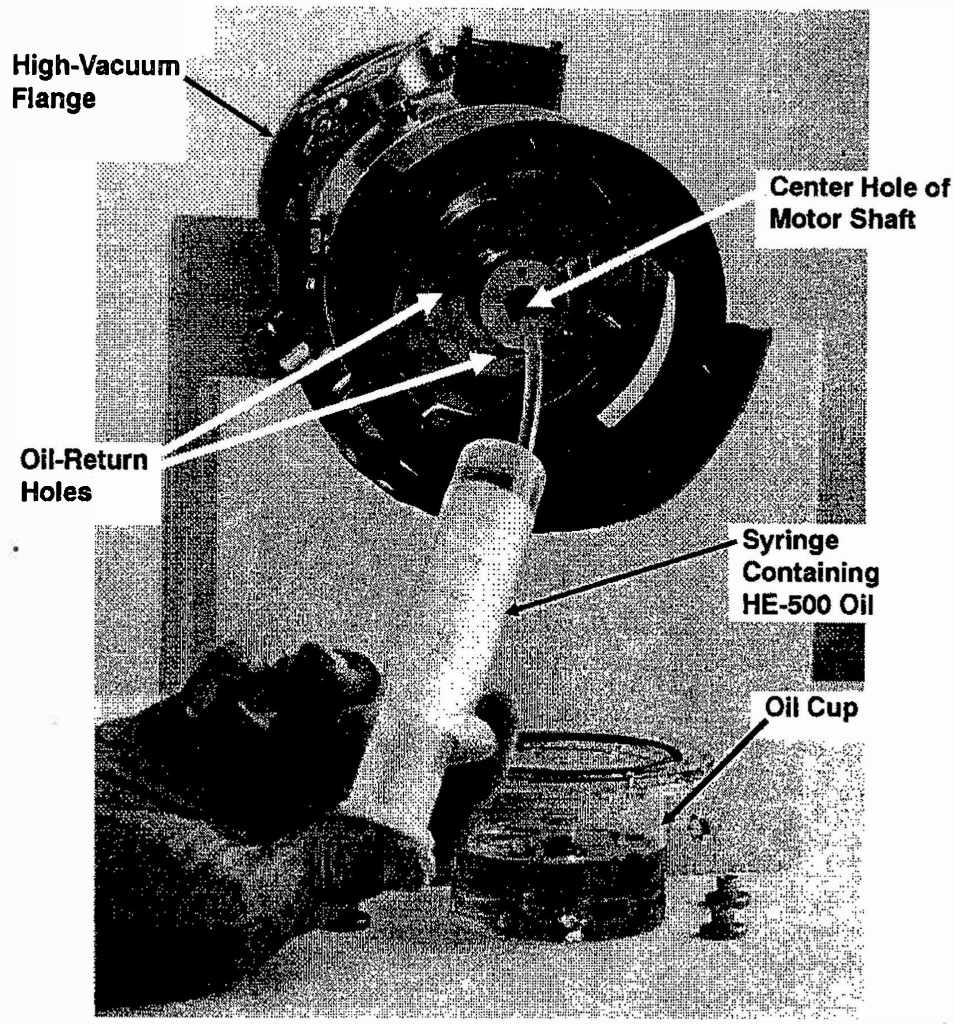


Figure 2-1. Priming the TMP150/360 V Pump Models

2. Fill a one-way syringe with HE-500 oil. Cut a piece of tubing so that its one end fits tightly over the tip of the syringe and its other end fits tightly over the small center hole in the Turbopump's shaft as shown in Figure 2-1. If a syringe isn't available, you can use a **clean** squeeze bottle or oil can.

3. Tilt the turbopump as shown if Figure 2-1 so that one of the two oil-return holes is at the lowest position. Inject HE-500 oil from a syringe or squeeze bottle up into the motor shaft's center hole until you see oil draining down from the lower oil-return hole (see Figure 2-1). Its OK to tilt the TMP150/360 V greater than 15° when the oil cup is removed; however, don't tilt it so that its high-vacuum flange is facing down.

4. Fill the oil cup with the vacuum oil supplied with the pump until the oil level is at the oil cup's "min" mark. It should take about 88 milliliters. Then, lower the turbopump onto the oil cup and reinstall the oil cup by cross tighten the thumbscrews finger tight; as you lift the oil cup up against the turbopump, the oil level rises to the "max" mark because it is displaced by the turbopump's shaft.

2.2.2 Charging the TMP150H and TMP360H Models with Oil

It isn't necessary to prime the TMP150H or TMP360H models because they have a built in oil pump.

The quantity of oil required depends on the mounting angle of the TMP 150/360H pump.

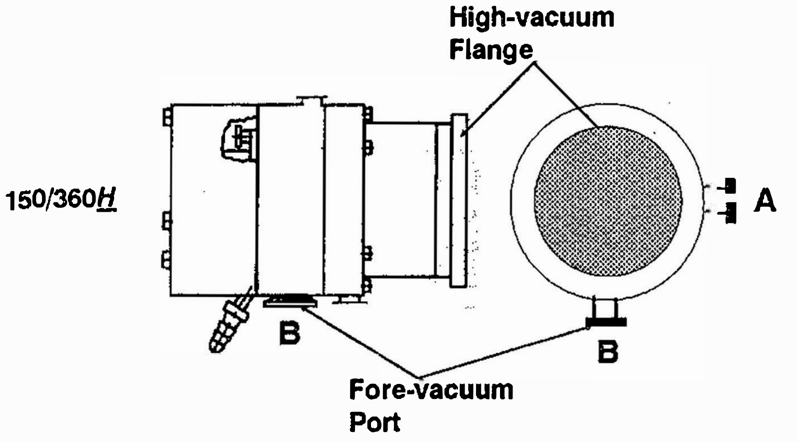
If the pump is mounted in the horizontal range (see the bottom part of Figure 2-2) and its fore-vacuum port is positioned within the 90° arc shown as A-B at the top of Figure 2-2, it requires 40 ml of oil. If the pump is mounted a maximum of 10° outside the 90° A-B arc, additional oil is required to fill the increased dead volume. When the pump is mounted horizontally, use the larger sight glass on the end of the black oil-pump housing to check the oil level (see Figure 4-2).

If the pump is mounted in the vertical range, it requires 90 ml of oil (see the bottom part of Figure 2-2). When the pump is mounted vertically, use the smaller sight glass on the side of the black oil-pump housing to check the oil level.

Remove the oil-fill capscrew and use the syringe to add the correct amount of oil to the pump. The oil-fill port is in the pump's black housing directly below the large cable connector (see Figure 1-1).

Installation

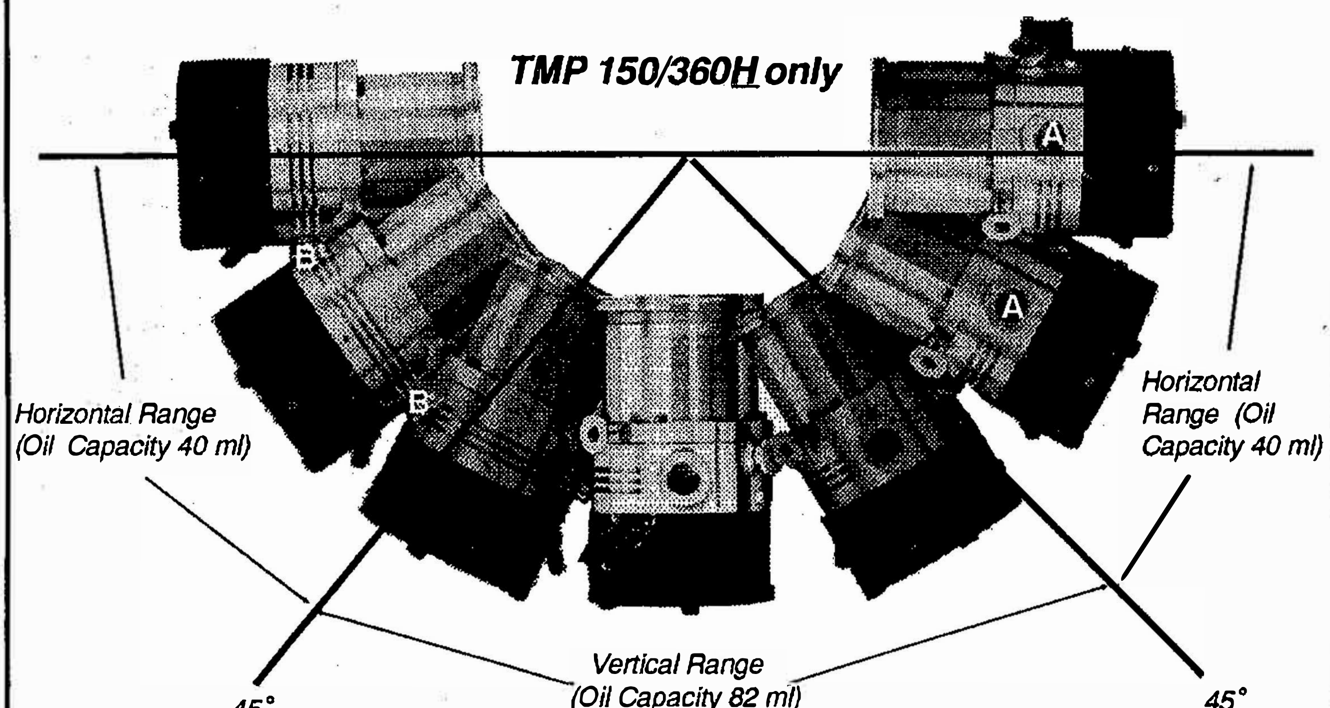
TMP150/360 H



Looking from the high-vacuum flange, the fore-vacuum port can be in any position between A and B. It is permissible to rotate the pump another 10° beyond A or B; however, additional oil is required to fill the increased dead volume. If the fore-vacuum port is rotated >10° beyond A or B, oil won't circulate properly.

TMP150/360 H

NOTE: This pump can't be mounted in any postion where the high-vacuum flange is tilted downward.



IMPORTANT: The mounting positions and oil quantities shown above apply only to the TMP150/360H models. The TMP150/360V models use 88 ml of oil and must be mounted vertically with a maxmum tilt of 15° from vertical.

Figure 2-2 -TMP150/360H Mounting Positions and Oil Quantity

2.3 Frequency Converter Installation

This section includes the following:

2.3.1 AC Voltage and Fuse Selection

WARNING!

To avoid personal injury from electrical shock, DO NOT plug the converter into an AC service outlet during the following procedure.

Voltage selection, fusing, and power connection are accomplished from the rear panel. To select the voltage or change the fuse and plug, see Figure 2-3 and do the following:

1. **Voltage Selection** — Ensure that the printed circuit card is inserted in the connector assembly below the fuse so that the correct AC voltage is visible. The card has four voltages etched on its faces. If the correct voltage isn't visible, turn the card over or reposition it as necessary so that the visible voltage matches your power source.

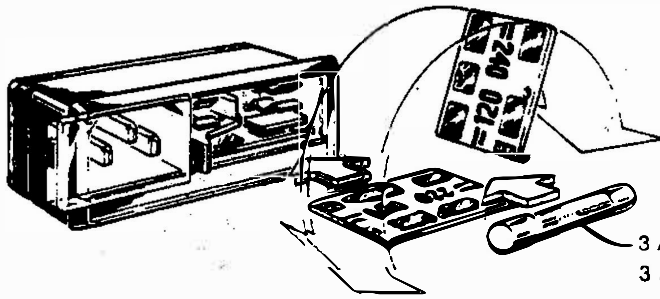
2. **Fuse** — Ensure that the fuse value corresponds to your applied AC voltage as listed in Figure 2-3. One 5 amp and one 10 amp fuse are supplied with the converter. Fuses are removed by moving the FUSE PULL mechanism to the left.

3. **Plug** — If your AC service is 240V 60-Hz, remove the standard 120V plug from the converter's linecord and replace it with the spare 250V, 20A right-angle plug provided with the converter.

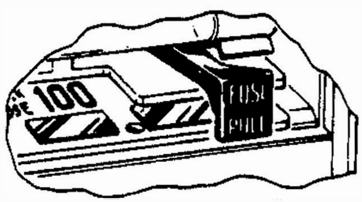
2.3.2 Converter Bench Checkout

Before installing the converter, check it for proper operation as follows:

1. Ensure that the correct AC voltage is selected at the rear panel power connector as described in Section 2.3.1.



Operating voltage is shown in VS&F Connector window.



HOW TO SELECT OPERATING VOLTAGE

1. Open cover door and rotate fuse-pull to left.
2. Select operating voltage by orienting PC Board to position desired voltage on top left side. Push board firmly into module slot.
3. Rotate fuse-pull back into normal position and re-insert fuse into holders, using caution to select correct fuse value.

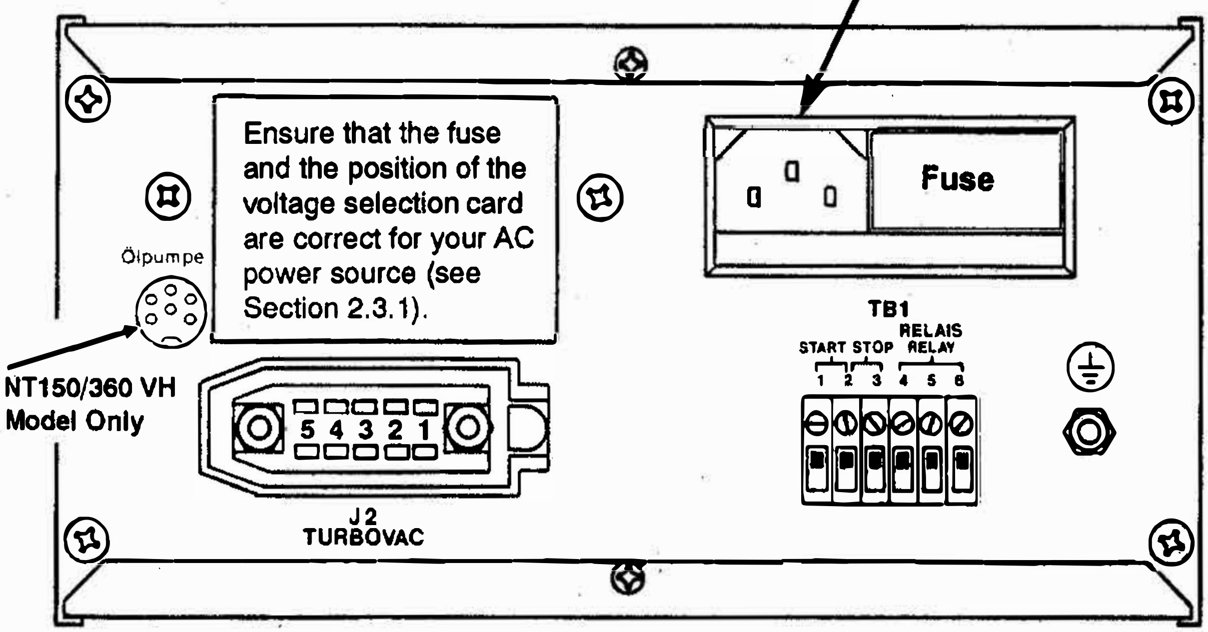


Figure 2-3. AC Voltage Selection and Fusing

2. Before installing the pump cable, apply power to the converter by plugging the AC power cord into the rear panel power connector (there is no power switch on the converter). Ensure that all four front panel indicators turn ON. The POWER indicator remains ON as long as AC power is applied.

3. The three front panel indicators (FAILURE, NORMAL OPERATION, and ACCELERATION) remain ON for approximately 4 seconds, after which one of the following occurs:

   a. The three indicators may flash in sequence; ACCELERATION, NORMAL OPERATION, and FAILURE, in that order. If this is the case, then your unit is functioning properly and may be installed.

   b. The ACCELERATION indicator may remain ON continuously. This indicates that a jumper wire, normally connected between rear panel terminal block TB1-2 and -3 is missing or making poor contact. Correct this condition and try powering up again. Refer to Section 2.3.3.

   c. The three indicators may remain ON continuously as long as AC power is applied. If, after several attempts of powering up, the indicators remain ON, then your unit is faulty and should be returned to Leybold.

2.3.3 Wiring the Converter's Rear Panel Terminal Block (TB1)

2.3.3.1 Initial Wiring

If you DO NOT wish to use the remote start-stop features, ensure that a jumper wire is connected between rear panel terminals TB1-2 and TB1-3. See Figure 2-4(a).

2.3.3.2 Remote Starting and Stopping

Terminals TB1-1, -2, -3 are inputs to be used for starting and stopping the turbopump from a remote location. The following are two methods that the converter may be wired for remote starting and stopping:

1. The first method uses two momentary pushbutton switches which function the same way as the converter's front panel START/STOP controls. This wiring arrangement uses a momentary switch closure to start the turbopump, and a momentary switch open to stop the turbopump. Note that a short term power failure will reset the converter and stop the turbopump. Wire according to Fig. 2-4(b).

2. The second method uses a single toggle switch. With this wiring configuration, the turbopump starts when the switch is closed and stops when the switch is open. An advantage of wiring your system in this fashion is that following a short term power failure, the turbopump will automatically restart without operator involvement. Wire according to Figure 2-4(c).

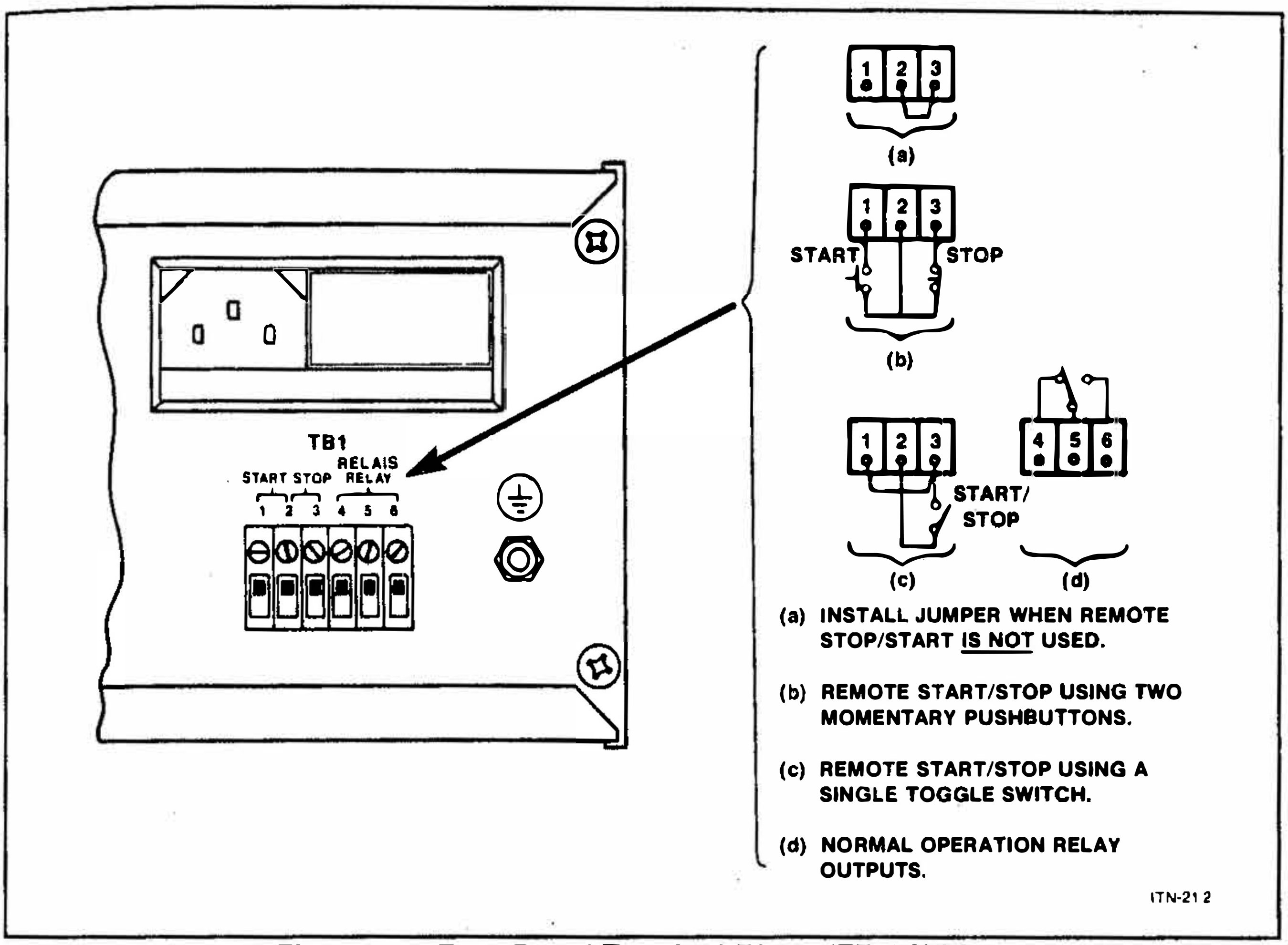


Figure 2-4. Rear Panel Terminal Block (TB1) Wiring

2.3.3.3 *Remote Normal Operating Sensing*

Rear panel RELAY terminals TB1-4, -5, -6 are connected to the normally-open and normally-closed contacts of a relay which is energized when the converter switches to normal operation. External indicating or control devices can be activated by these relay contacts which have a maximum rating of 8 amperes at 240 V AC and 24 V DC. See Figure 2-4(d).

Example: A remote normal-operation lamp and its power source can be connected in series with terminals TB-5 & TB-6. This remote lamp will then light when the converter achieves normal operation.

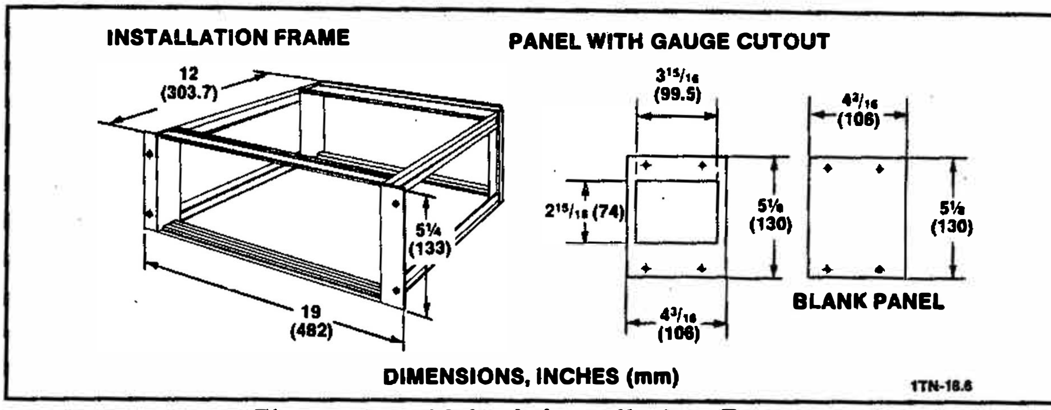


Figure 2-5. 19-Inch Installation Frame

2.3.4 Converter Mounting

The converter is supplied within a cabinet that has four rubber feet, allowing it to be placed on any hard surface up to 20 ft. (6.1 m) away from the turbopump. For greater distances [up to 328 ft. (100 m)], additional pump cable with connectors can be ordered from Leybold.

For mounting the converter in a standard 19-inch rack, an Installation Frame (Part No. 16100) should be used (Figure 2-5). The converter is mounted in the Installation Frame using its four front panel mounting holes. See the Leybold catalog for converter dimensional data.

The remaining space within the Installation Frame can then be covered using Blank Panels (Part No. 16102). Or the space can be used for the mounting of up to two Leybold Vacuum Gauge Control Units, using Gauge Port Cutout Panels (Part No. 16101).

2.3.5 Converter Cooling

The converter depends primarily on convection cooling to maintain an acceptable internal operating temperature. This temperature is easily achieved if air flow around the converter isn't restricted and if ambient air temperatures don't exceed 110°F (45°C).

Use care when installing the unit in an electrical enclosure. The ambient air temperature within the cabinet must not exceed the converter's maximum rated operating temperature and the air flow around the converter package must not be restricted. Provide at least 4 to 5 inches above and below the converter if it is rack mounted.

Excessive operating temperatures due to restricted air flow voids the warranty, may result in premature failure of the converter, and definitely degrades the reliability of the converter.

2.3.6 Grounding

The converter should be grounded to reduce the possibility of electrical shock, and to prevent a malfunction of the converter due to electrical noise.

Use the 4-mm grounding stud on the converter's rear panel to connect the converter chassis to either the enclosure in which it is installed, or to a nearby earth ground. Note that this ground connection is in addition to the ground wire contained in the converter's AC power cord.

Keep the inductance of the ground connection as low as practicable by using a short lead made of copper braid or heavy wire.

2.3.7 Turbopump and Converter Interconnection

The turbopump and converter are interconnected by a standard 20 ft. (6.1 m), 6-conductor pump cable which is supplied with the converter. Note that cable lengths of up to 328 ft. (100 m) are possible without any modifications to the converter. Additional pump cable with connectors can be ordered from Leybold.

Connect the cable's rectangular plug (at an angle) into the converter's TURBOVAC J2 connector so that the plug's tab mates with the slot in the connector. Then push the cable-end of the plug until the plug snaps in place.

Insert the octal plug on the other end of the cable into the mating connector on the turbopump ensuring that the key and keyway of these connectors are aligned.

For the TMP150H and TMP360H models, also connect the second cable between the pump and the "OELPUMPE" outlet on the back panel of the NT150/360 VH converter (see Figure 2-3). You must use the NT150/360 VH converter with a TMP150H or TMP360H pump model.

2.3.8 Checking the Turbopump's Direction of Rotation

Before installing the turbopump, check its rotation direction as follows:

WARNING!

This equipment has voltages which are dangerous and may be fatal if contacted. Use extreme caution when any of its protective covers are removed. To reduce the possibility of electrical shock, always connect the equipment to a low impedance ground.

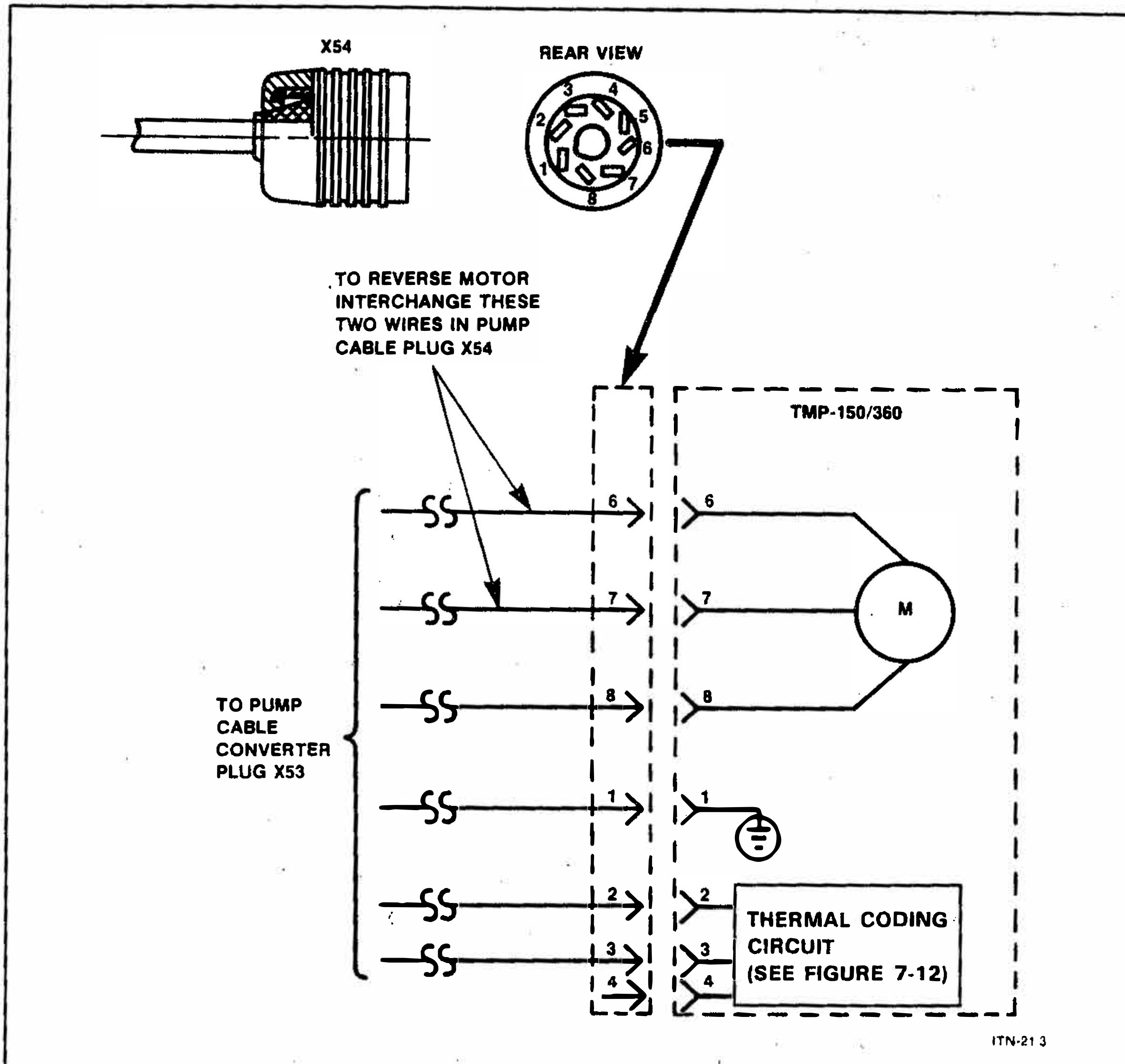


Figure 2-6. Rewiring the Pump Cable to Change the Rotation

CAUTION: Before plugging the converter into an AC service outlet, ensure that the converter has been set up to operate from the applied AC line voltage, and that the correct fuse is installed as described in Section 2.3.1.

1. Install the pump cable(s) between the turbopump and converter as described in Section 2.3.7.

2. Plug the converter into an AC service outlet. Observe that the front panel POWER indicator should be ON.

3. Press START, observe rotor rotation through the high-vacuum flange, then press STOP.

4. The rotor should be turning clockwise (as observed through the high-vacuum flange). The correct direction of rotation is also marked by an arrow on the TMP150/360 V oil cup. If the rotor is turning in the wrong direction, proceed as follows:

   a. Unplug the converter from the AC service outlet.

   b. Disassemble the pump cable's round octal plug.

   c. Interchange the wires connected to plug terminals 6 and 7 (see Figure 2-6).

   d. Reassemble the octal plug and repeat steps 2 through 4 to ensure that the rotor is turning in the correct direction.

5. After completing this procedure, unplug the converter. If the turbopump isn't going to be installed at this time, remove the pump cable(s) and place the turbopump back into its protective shipping material and store in a dry location.

2.4 Turbopump Installation

This section contains the following:

To install the turbopump, you must make connections to its high-vacuum flange, fore-vacuum port, and water nozzles (water-cooled turbopumps only). For standard applications, you should add a valve to the vent port as described in Section 2.4.6.1; for pumping process gas that are corrosive or aggressive or that contain abrasives or dirt, you must connect a purge/vent valve and a source of inert gas to the purge port as described in Section 2.4.6.2.

Before installing the turbopump, ensure that it has been primed and charged with HE-500 oil as described in Section 2.2.

2.4.1 Turbopump Mounting Positions

Oil-lubricated turbopumps can't be mounted in any position where the high-vacuum flange is tilted downward.

The TMP150/360 V models can be mounted vertically; the maximum deviation allowed from vertical is 15°.

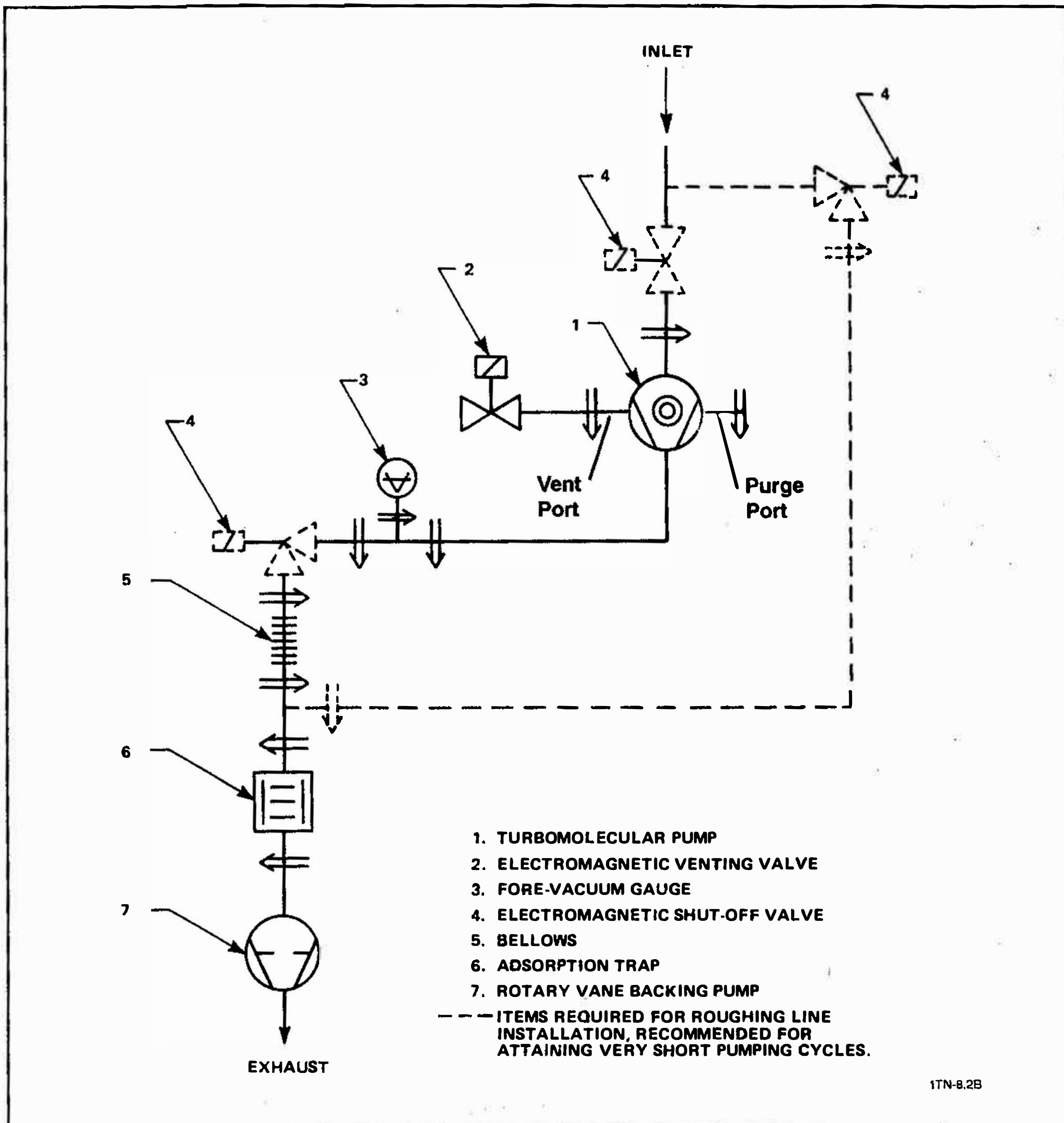


Figure 2-7. Typical Installation Schematic

The TMP150/360 H can be mounted in any position between horizontal and vertical as long as the fore-vacuum port is positioned within the 90° arc shown as A-B in the top of Figure 2-2. An additional 10° beyond A-B is permitted; however, the pump will require additional oil to fill the increased dead volume.

2.4.2 High-Vacuum Flange Connection

WARNING!

Ensure that the turbopump's high-vacuum flange is bolted or clamped securely to the vacuum system. If the turbopump crashes and the flange isn't bolted or clamped, rotor blades could fly out and cause injury or damage.

The high-vacuum flange of the TURBOVAC is either CF, ISO-K, or ASA.

CF-flanged pumps are required for ultra-high vacuum applications (see Figure 2-8). Ensure that there aren't any fingerprints or other residue in the pump's high-vacuum area that would prolong pumpdown; wipe with reagent alcohol as necessary. To achieve the lowest possible ultimate pressure, CF flanges should be baked out using the flange heater (see Appendix A.4) and the copper gaskets should be replaced each time you disconnect the flange. No mounting hardware is supplied with the CF flanged pumps. See Table 2-1 for the part number of the required copper gasket.

ISO-K flanged turbopumps are supplied with a centering ring, an O-ring, an outer ring, and two of the four flange clamps (P/N 26701) required for the high-vacuum connection. If not already done, fit the O-ring evenly over the centering ring without twisting the O-ring; then add the outer ring. Insert the assembly between the pump's high-vacuum flange and your system's flange. Use four clamps to secure the flange connection. Adapters are available to connect ISO-K flanges to ASA, ISO-F, or DIN type flanges. See our catalog for more information.

ASA-flanged pumps are supplied without mounting hardware. See Table 2-1 for the part number of the required sealing disc.

Table 2-1 -- Part Numbers of Gaskets and Clamps for the High-Vacuum Flange

CF Copper Gaskets	ISO-K Clamps (set of 4)	ASA Sealing Discs
CF100 - 83945-1	ISO-K 63 - 26701	2-inch ASA - 910-181-614
CF150 - 83946-1	ISO-K 100 - 26701	4-inch ASA - 910-181-617
	ISO-K 160 - 26701	

TMP150/360 V

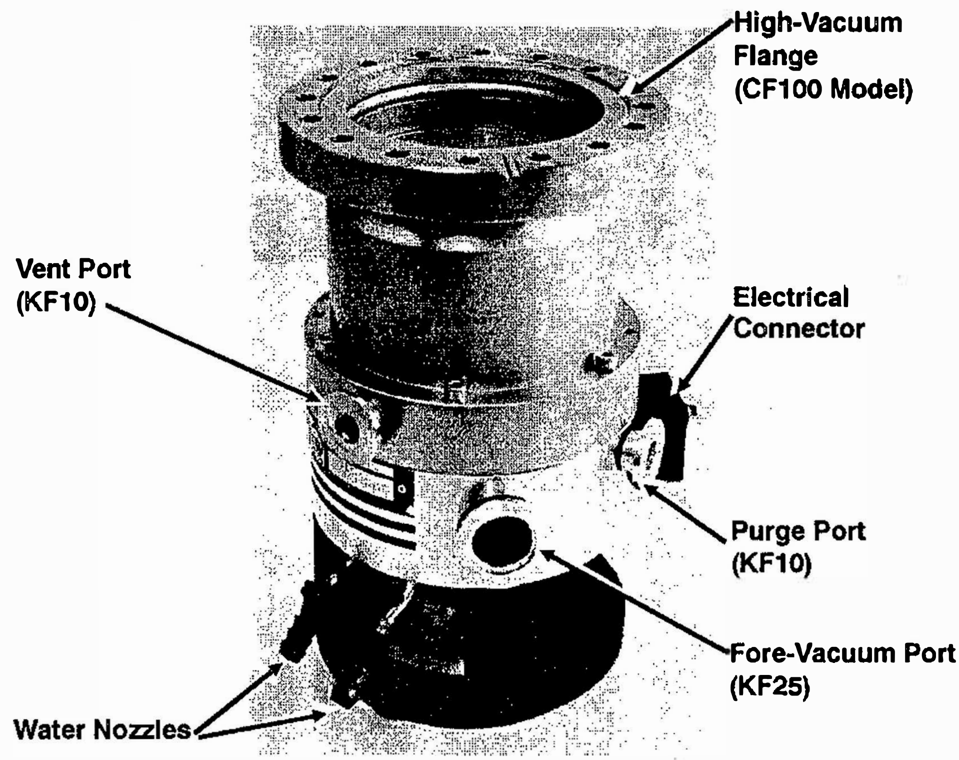


Figure 2-8. Turbopump Connections (TMP150V pump model shown)

In most cases the turbopump can be mounted directly by its high-vacuum flange to the vacuum system. See Section 2.4.1 for the acceptable turbopump mounting positions.

Connecting vibration-damping bellows to the pump's high-vacuum flange is necessary only if this flange is connected to a system that is vibrating heavily or to instruments that are highly sensitive to vibration. Refer to Appendix A.8 for information on vibration-damping bellows for pumps with a CF100 high-vacuum flange.

Before making the high-vacuum connection, remove the shipping cover and ensure that the inlet screen is inserted into the turbopump's high-vacuum flange.

2.4.3 Fore-Vacuum Port Connection

The turbopump fore-vacuum port is supplied with a KF25 clamp and centering ring with O-ring (see Figure 2-8). Assembly information for this and other types of vacuum fittings is located in the Leybold Catalog.

You must install an adequate backing pump at the turbopump's fore-vacuum port to achieve fast pump down times and low operating pressures. Table I in the front of this manual lists recommended backing pumps.

The recommended TRIVAC backing pumps have an internal anti-suckback device which automatically closes the fore-vacuum line when the backing pump is switched off. This device prevents oil from being sucked out of the backing pump and into the turbopump during shutdown or during a power failure. If another type of backing pump is used, install a vent/isolation valve that seals off the backing pump's inlet during shutdown or during a power failure. We recommend using the Leybold SECUVAC® valve (note that KF reducer fittings may also be required).

To ensure that the fore-vacuum space of the turbopump remains free from oil vapors during operation, we recommend installing an adsorption trap in the fore-vacuum line. See Appendix A.7 for information on the adsorption trap.

To prevent vibrations from being transmitted from the backing pump to the turbopump, use bellows or flexible tubing to connect these two pumps. Vibrations can result in premature failure of the turbopump's bearings.

2.4.4 Turbopump Cooling

The turbopump is normally water cooled using a clean source of tap water connected to its water nozzles (see Figure 2-8). Installation instructions for water cooling are given in Section 2.4.4.1.

The optional Air Cooling Unit should be used when tap water isn't available or if the water is contaminated. When using the optional AC air cooler, avoid air temperatures above 85°F (30°C) at the cooler's air intake. A "DC" air cooler is available for use at higher temperatures. The maximum operating temperature measured in the small bore just below the purge port on the outside of the turbopump's base housing is 130°F (55°C); if this temperature is exceeded, you must use water cooling. Air Cooling Unit installation instructions are given in Section 2.4.4.2.

The Water Refrigeration Unit should be used if tap water cooling isn't possible and the operating temperature exceeds limits for air cooling. This unit's installation instructions are contained in Section 2.4.4.3.

2.4.4.1 Water Cooling Connection

Connect a source of clean tap water to one of the turbopump's water nozzles; it doesn't matter which one is used (see Figure 2-8). Check your cooling-water temperature and refer to the graph, Figure 2-9, to determine the correct cooling water throughput. Maximum water pressure is 60 psig. Use 7/16 inch (11 mm) I.D. hose to make the water connection. Connect a second hose from the nearest water drain to the turbopump's other water nozzle. Use hose clamps to secure both hoses to the water nozzles.

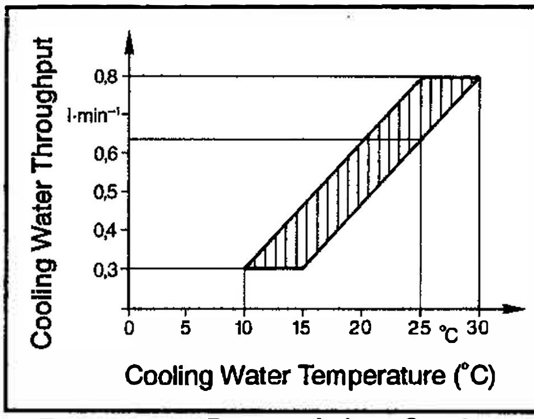


Figure 2-9. Determining Cooling Water Throughput

To ensure that clean water is being fed through the turbopump, we recommend installing a fine mesh strainer or automotive fuel filter in the cooling water supply line.

We also recommend installing the optional Water Flow Switch in the cooling water **drain** line as described in Section 2.4.5.

2.4.4.2 Installing the Optional Air Cooler

Where water cooling isn't possible, the Air Cooler (refer to Appendix A.1) can be used to cool the turbopump. Mount the air cooler on the side of the turbopump as shown in Figure A-1. Ensure that the turbopump's cooling-air intake is unobstructed and isn't near the heated air flowing from the backing pump. Maintain at least 4 inches (10 cm) between the fan and the nearest wall.

Connect the Air Cooling Unit to a source of either 115 or 220 V AC (depending on model ordered), single-phase power that can be switched on and off simultaneously with the turbopump. See the Air Cooling Unit's electrical specification label for the specific voltage required. If you have the DC air cooler, see the instructions that come with it for installation information.

2.4.4.3 Installing the Water Refrigeration Unit

Where neither water cooling nor air cooling is possible, the Water Refrigeration Unit (refer to Appendix A.2) can be used to cool the turbopump. Connect the water lines of the Water Refrigeration Unit to the water nozzles of the turbopump using 7/16 in. (11 mm) I.D. hose. Use hose clamps to secure both hoses to the water nozzles. Detailed installation and operating instructions are supplied with the Water Refrigeration Unit.

2.4.5 Installing the Water Flow Switch

In addition to the installation instructions presented below, also refer to the instruction sheet supplied with the Water Flow Switch.

1. Install the Water Flow Switch in the turbopump's water drain line using the switch's Low-Flow-Range "In" and "Out" connections [0.1 to 1.0 gal/min (0.4 to 3.8 l/min)]. These connections are 1/4-inch NPT female. The unused connections should be sealed using the plugs supplied with the switch. Observe that the water-switch rotor should spin in a clockwise direction when the water lines are correctly installed.

2. Adjust the potentiometer inside the Water Flow Switch to shut down the turbopump at a minimum water flow rate of 0.1 gal/min (0.4 l/min).

   NOTE: There is hysteresis in the switching process causing the trip point to be slightly different for rising and falling flow rates. For a precise measurement of the trip point, make the measurement while reducing the flow rate so that it falls through the trip point.

3. Electrically connect the Water Flow Switch to the remote STOP terminals on the rear panel of the converter as follows(see Figure 2-4):

   - If a jumper is installed between remote STOP terminals TB1-2 and TB1-3, remove this jumper and connect the normally open (N.O.) relay contacts of the Water Flow Switch between these two terminals.

   - If a remote stop switch is connected to terminals TB1-2 and TB1-3, connect the normally open (N.O.) relay contacts of the Water Flow Switch in series with the remote stop switch.

In operation, as long as there is sufficient water flowing through the turbopump, the Water Flow Switch will be closed and allow the turbopump to operate normally. However, if the water flow should fall below 0.1 gal/min (0.4 l/min), this switch opens and causes the converter to shut down the turbopump.

2.4.6 Installing Vent and Purge Devices

There are two KF10 ports on the turbopump. The upper KF10 port on the pump housing is the vent port; the lower KF10 port on the base housing is the purge port (see Figure 2-8).

If your pump will be used in standard applications, we recommend sealing the purge port with a blank flange and installing a vent valve onto the vent port as described in Section 2.4.6.1. Venting prevents oil from backstreaming from the foreline or from the turbopump's fore-vacuum space into the high-vacuum sections of the system during shutdown.

If your pump will be exposed to corrosive or aggressive process gases or to process gases containing abrasives or dirt, you must seal the vent port with a blank flange, and purge and vent through the purge port as described in Section 2.4.6.2.

2.4.6.1 Installing a Vent Valve for Standard Applications

Install the optional vent valve as follows:

1. Ensure that the purge port is sealed with its blank flange (see Figure 2-8).
2. Ensure that the sintering nozzle is in place inside the vent port. The nozzle controls the flow of venting gas in accordance with the pressure rise graph (Figure 3-3).
3. Use the KF10 centering ring and clamp ring to connect the vent valve to the turbopump's vent port as shown in Figure A-5).
4. Either leave the vent valve's other KF10 port open to the atmosphere, or preferably, connect it to a bottled source of venting gas such as dry nitrogen. DO NOT exceed a venting pressure of 7 psig when using a pressurized venting line. Ensure that the venting gas is dry to avoid condensation in the pump.
5. Wire the vent valve to a source of 115 VAC single-phase power such that the valve will close when the turbopump is running. Then when the turbopump is shut down, the valve automatically opens to allow the venting gas to enter the turbopump through its vent port. Both normally-closed (P/N 98-273-011) and normally-open valves (P/N 98-273-012) are available.

2.4.6.2 Connecting Purge/Vent Gas for Corrosive Applications

If your pump will be exposed to corrosive or aggressive gases or to gas containing abrasives or dirt, then you must purge and vent with inert gas through the purge port. Purging and venting with dry inert gas such as nitrogen protects the oil and the bearing from harmful process gases

WARNING!

It is essential that the Purge/Vent Valve is connected to a source of inert gas or is sealed when pumping toxic or reactive process gas. The Purge/Vent Valve isn't a shutoff device. If its inlet port is left open, toxic process gas could escape after shutdown or air could enter the pump and have a dangerous reaction with aggressive process gas.

Install the optional Purge/Vent valve as follows (see Figures 2-8 and A-6):

1. Ensure that the vent port is sealed with its blank flange (see Figure 2-8).

2. Ensure that the sintering nozzle is in place inside the purge port. The nozzle controls the flow of venting gas in accordance with the pressure rise graph (Figure 3-3).

3. Use the KF10 centering ring and clamp ring to connect the Purge/Vent Valve to the turbopump's purge port. Ensure that the Purge/Vent Valve is mounted so that the arrow sticker on the valve housing points toward the turbopump (see Figure A-6).

4. Connect the solenoid of the Purge/Vent Valve through an on/off switch to a source of 115 V AC, single phase power. In operation, the valve's solenoid should be energized when the turbopump is running, and should be de-energized when the turbopump is shutdown.

5. Connect the input side of the Purge/Vent Valve through a regulator and valve to a bottled source of dry inert gas. Ensure that the supply of inert gas is continuous to avoid exposing the oil and bearings to harmful gas, and ensure that the purge gas is dry to avoid condensation in the pump. The absolute moisture content of the purge gas should not exceed 10 ppm.

   Note that the Purge/Vent Valve has been sized to allow an inert gas flow rate of 12 standard cubic centimeters per minute (sccm) at atmospheric pressure. This flow rate maintains the motor cavity at a pressure that is approximately ten times higher than the normal foreline pressure. Other flow rates at elevated purge gas inlet pressures are listed in Table 2-2. Be certain that the backing pump is capable of handling this purge gas flow, in addition to the normal throughput of the turbopump and any expected process gas inflow.

6. Disengage the locking pin on the Purge/Vent Valve body by turning it to the horizontal position; when the locking pin is pressed in and turned to the vertical position, the vent portion of the valve can't open.

Table 2-2 -- Purge Gas Inlet Pressures & Flow Rates

Purge Gas Inlet Pressure (psig)	Standard Purge Gas Flow (sccm)	Purge Gas Flow When Pumping Oxygen or Chlorine*
0.0 psig	12 .0 sccm	36.0 sccm
2.0 psig	13.6 sccm	40.9 sccm
5.0 psig	16.0 sccm	48.2 sccm
7.5 (max. recommended)	18.1 sccm	54.4 sccm

* A larger capacity valve is required for these higher flow rates. The P/N of this larger valve is 85548 for 115V and 85549 for 220V.

2.4.7 Installing the CF Flange Heater

The CF flange heater is used only when operational pressures of 10^{-7} mbar are required (see Figure A-4). It can't be used on pumps with ISO-K high-vacuum flanges because their pump housings are made of aluminum; the pump housing on CF-flanged pumps are stainless steel.

We don't recommend using **bakeout jackets** on any turbopumps because the high temperatures changes the viscosity of the oil and could damage the bearing.

Position the flange heater around the pump's CF high-vacuum flange and secure it in place by tightening its clamp screw.

Connect the flange heater's power cord to a source of either 115 or 220 VAC (depending on model ordered), single-phase power. The flange heater consumes about 100 watts of power. It has a thermal switch that keeps the CF flange temperature within the acceptable range.

Section 3 Operation

WARNING!

Death or serious injury can result from the improper use or application of this pump. If the pump will be exposed to toxic, explosive, pyrophoric, highly corrosive, or other hazardous process gases including greater than atmospheric concentrations of oxygen, contact Leybold for specific recommendations.

This section contains information on how to start, operate, and shutdown the TMP 150/360 V/H vacuum pumping system. Information on turbopump operating temperatures, purging, venting, and bakeout is also presented.

Contents

3.1 Operating Temperature

Table 3-1 summarizes the temperatures for the turbopump and converter.

Table 3-1 — Temperatures

Normal Operating Temperature at Ultimate Pressure*	
With water cooling	95°F (35°C)
With air cooling and air temperature of 68°F (20°C) . . .	105°F (40°C)
Normal Operating Temperature at 10^{-2} mbar Inlet Pressure*	
With water cooling	140°F (60°C)
Maximum Temperature at High-Vacuum Flange†	212°F (100°C)
Maximum Temperature at Pump Neck & Rotor†	175°F (80°C)
Maximum Temperature at Fore-Vacuum Port	130°F (55°C)
Maximum Operating Temperature for Using Air Cooling* . .	130°F (55°C)
Maximum Ambient Temperature for a Pump with Air Cooling‡	85°F (30°C)
Ambient Temperature Range for Frequency Converter . . .	32° to 110°F (0° to 45°C)
Storage Temperature Range for Frequency Converter . . .	-100° to 185°F (-40° to 85°C)

*Measured in the small bore just below the purge port on the outside of the turbopump's base housing (see Figure 1-1).
†Use shields to avoid heat radiation from the vacuum chamber if necessary.
‡Avoid air temperatures exceeding 85°F at the air intake of the optional AC air cooler. A "DC" air cooler is available for use at higher temperatures. However, water cooling must be used if the operating temperature* exceeds 130°F.

There is a thermal switch inside the turbopump's base housing near the motor coil that shuts down the turbopump if the temperature exceeds 158°F (70°C). The TMP150/360 H models have an additional oil-flow sensor. It shuts down the pump if there is a problem with the oil circulation such as the oil level being too high or low.

To quickly reach pressures of 10^{-7}, we recommend baking out the CF-flanged pump and the vacuum chamber. The flange heater's thermal switch maintains the flange temperature within the acceptable range.

Don't use a bakeout jacket; bakeout jackets can damage the pump by overheating the oil and changing its viscosity and by damaging the heat-sensitive parts in the bearing.

3.2 NT150/360 Front Panel Controls and Indicators

The NT150/360 front panel controls and indicators are shown in Figure 3-1 and their functions are listed in Table 3-2.

Table 3-2 -- Front Panel Control and Indicator Functions

Pushbutton Controls	Function
START	Press the START button to initiate acceleration of the turbopump. The converter may be started even if it is connected to a turbopump whose rotor is already turning.
STOP	Press the STOP button to turn off power to the turbopump and to reset the converter's failure latch circuit. When a fault is detected, the converter remains latched in a nonfunctioning state until the STOP button is pressed. If the FAILURE LED lights continuously, you must unplug the convert and reconnect it to reset it.
Indicators	**Function**
HOURS Meter	Indicates the total time of turbopump operation. The meter increments once when power is applied and once every 1/100th hour for as long as the turbopump is being driven. Note that the rightmost two digits (colored red) indicate tenths and hundredths hours. The NT150/360 VH converter model doesn't have an hours meter.
POWER LED (yellow)	Indicates the presence of power to the converter's electronics. If no other indicators are ON, then the converter is operating in its idle mode.
ACCELERATION LED (green)	Indicates that the turbopump is accelerating to rated speed. Acceleration time may vary anywhere from a few seconds to a maximum of 10 minutes depending on the initial rotational speed and load of the turbopump.
NORMAL OPERATION LED (yellow)	Indicates when the turbopump has attained its rated rotational speed.
FAILURE LED (Red)	Indicates the detection of a fault and subsequent turbopump shutdown. Four types of faults are indicated by the flash rate of this indicator (see Table 3-3). The failure mode is a latched mode; after the fault condition is remedied, you must reset the converter by pressing the STOP button or Cycling the AC power.

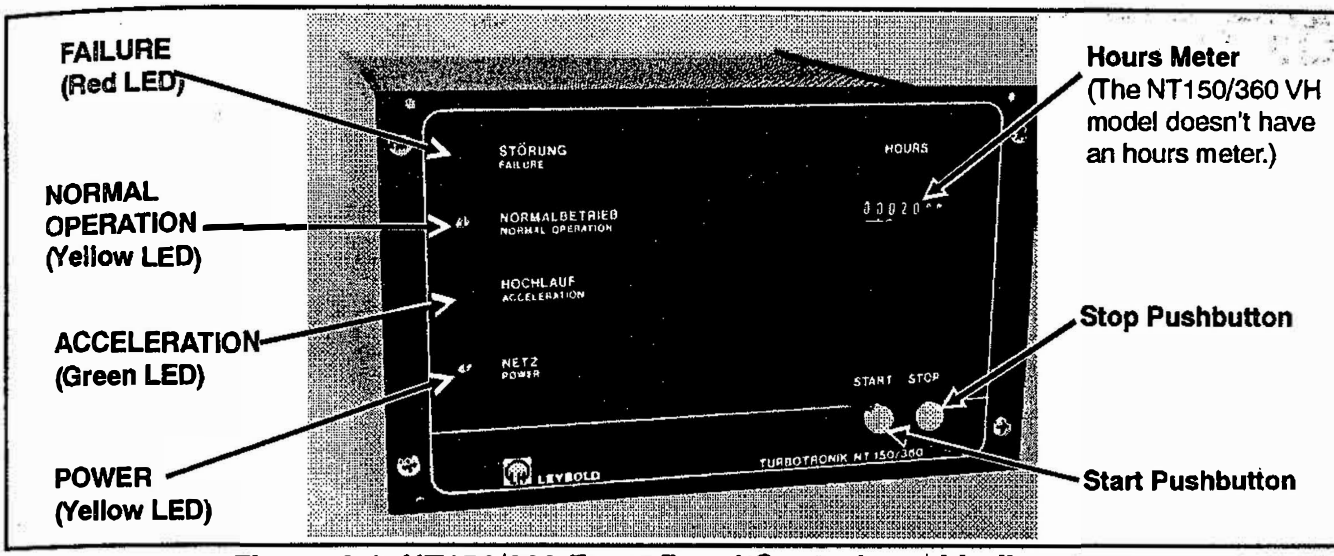


Figure 3-1. NT150/360 Front Panel Controls and Indicators

Table 3-3-- Fault Flash Rate Code for FAILURE LED

Flash Rate	Fault	Reset Procedure
Constant	Output Short*	Cycle AC Power*
1 Hz (once/second)	Pump Overload†	Press STOP Button
2 Hz (twice/second)	Pump Overtemperature‡	Press STOP Button
4 Hz (4 times/second)	Internal#	Press STOP Button

* Output Short - refers to the short circuiting of any one of the three-phase motor outputs to either of the other phases or to ground. To reset the converter when the FAILURE LED is lit constantly, you must unplug the converter and reconnect it.

† Pump Overload - refers to an unusually low output frequency, indicating a probable overload of the pump.

‡Pump Overtemperature - indicates a probable motor overtemperature. It is detected by a thermal switch inside the motor housing. On the TMP150/360 H models, it could also indicate inadequate oil flow as measured by a sensor in the oil-pump housing.

#Internal - Indicates a probable failure of the converter electronics.

3.3 Start-up

Proceed as follows to start the TMP/NT 150/360 vacuum pumping system:

1. Before start-up, ensure that the frequency converter and turbopump have been correctly installed as described in Sections 2.3 and 2.4.

2. Plug the converter into an AC service outlet.

   The converter spends the first few seconds performing initialization and selftest routines during which it outputs are turned off, and all four front panel LED indicators are turned ON. As soon as the converter completes the initialization and selftest tasks, all indicators except POWER are turned off. If all the indicators stay ON for more than a few seconds, then the converter has failed to perform the above tasks. This indicates a defective unit.

3. Ensure that the optional Venting Valve is closed. If the pump will be exposed to corrosive or aggressive process gases or gases that contain dirt or abrasives, open the purge-gas line and ensure that the optional Purge/Vent Valve is energized.

4. Turn ON the turbopump's cooling water flow or its optional Air Cooling Unit.

5. Start the backing pump.

   Run the backing pump for 10 to 15 minutes with the turbopump off if the turbopump is new, if it has been idle for over two months, or if the oil has just been changed. This degasses the turbopump's oil and minimizes bearing damage from cavitation in its oil-feed mechanism. After the foreline pressure reaches 5×10^{-1} mbar, start the turbopump.

   If the turbopump has been run within the past two months, it can be switched ON at the same time as the backing pump provided that the chamber is small enough to be evacuated to 5×10^{-1} mbar within 10 minutes.

   If you know the pumping speed of the backing pump (S) and the volume of the chamber (V), you can determine when to start the turbopump; as follows:

   If S/V >40, then you can start the turbopump and the backing pump at the same time.

   If S/V ≤ 40, then you must start the backing pump or a roughing pump before starting the turbopump; otherwise, the turbopump may not accelerate fast enough to avoid an overload failure. Refer to the graph (Figure 3-2) to estimate the start-up pressure for the turbopump when evacuating large volumes. Roughing can be accomplished either through the turbopump while it is at a standstill, or through a separate roughing line.

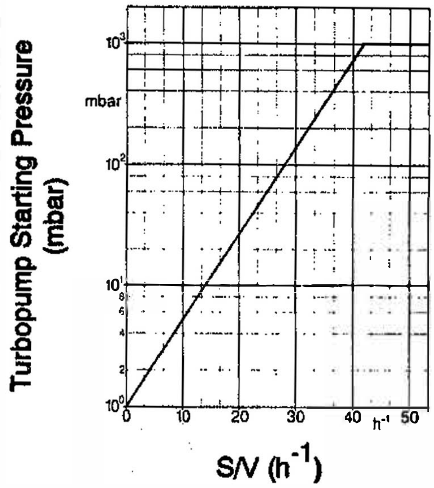


Figure 3-2. Estimating Turbopump Starting Pressure for Large Chambers

6. Start the turbopump by pressing the converter's START pushbutton. The converter's ACCELERATION indicator should light. (The turbopump can also be remotely started; refer to Section 2.3.3.2).

   If you have the TMP150H or TMP360H models, the gas in the oil sometimes causes the thermal oil-flow sensor to shutdown the pump. If this happens, clear the FAILURE by pressing the STOP button on the converter and then pressing its START button. You may have to do this 3 or 4 times to get the pump started.

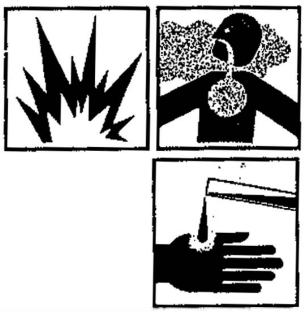
7. If operational pressures of 10^{-7} mbar are required, bakeout the vacuum chamber and use the optional flange heater to bakeout the turbopump as described in Section 3.8. We don't recommend using a bakeout jacket on the pump housing because the high temperatures could change the viscosity of the oil or damage the bearing.

8. As soon as the turbopump achieves its rated rotational speed, the NORMAL OPERATION indicator lights and the ACCELERATION indicator turns off. (Remote normal operation sensing is possible by using the normal-operation relay outputs at he rear of the converter; refer to Section 2.3.3.3).

3.4 Operation

WARNINGS!

DON'T pump oxidizers or higher than atmospheric concentrations of oxygen with pumps containing HE-500 or any other hydrocarbon oil. Pumping oxygen with a pump containing hydrocarbons can result in a fire or an explosion.



Many process gases are toxic, corrosive, or explosive. Some hazardous process gases have dangerous reactions with the air or with the hydrocarbon oil in the pump. In addition, some gases can react with air, moisture, or oil in the pump to form damaging deposits, acids, or tar. The harmful effects of such process gases can be reduced by purging and venting the pump with non-reactive gas such as dry nitrogen (see Section 3.7).

CAUTION: Never operate the turbopump without the inlet screen installed in its high-vacuum flange. This screen prevents small foreign objects from entering the pump and causing major damage to the rotor. Any damages that result from foreign objects entering the rotor region are excluded from the warranty.

Sudden, heavy external vibration and blows or shocks during pump operation should be avoided.

3.4.1 Failures

If the turbopump loading is increased after reaching normal operating speed, the converter increases first the drive current and then the drive voltage in an attempt to maintain full rotational speed. If full rotational speed can't be maintained, the converter begins to lower the drive frequency to maintain maximum motor torque.

If the load on the turbopump is excessive and the drive frequency drops below approximately 150 Hz, an overload fault is recognized. The converter then enters the failure mode and shuts down the turbopump.

The converter also enters the failure mode if it can't bring the turbopump up to its rated rotational speed within 10 minutes of acceleration.

In addition, the converter enters the failure mode if the turbopumps motor temperature becomes excessive as detected by the thermal switch mounted within the motor housing, or if the converter senses a fault within itself.

The failure mode is a latched mode, which means that the converter remains in the failure mode until it is manually unlatched by an operator. The failure mode is usually unlatched by pressing the STOP button except when the FAILURE LED is lit continuously. When the FAILURE LED is constantly lit, you must unplug and reconnect the plugs to reset the converter.

3.4.2 Restarting After an Interruption of Operation

If the turbopump is interrupted during operation by pressing the STOP button or by a power failure, it can be restarted at any rotational speed by pressing the START button. (Automatic restart after a power failure is possible by connecting an external start switch at the rear of the converter as described in Section 2.3.3.2).

3.5 Shutdown

Proceed as follows to shutdown the turbopump:

1. Stop the turbopump by pressing the converter's STOP pushbutton.

2. Turn off the cooling-water flow or air-cooling fan as soon as possible to avoid condensation of vapors within the turbopump.

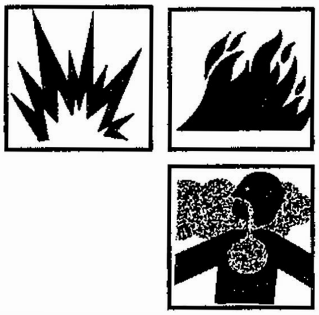
3. Switch off the TRIVAC backing pump.

   Its anti-suckback device automatically closes the fore-vacuum line to prevent backstreaming of oil vapor into the turbopump. If another type of backing pump is used, close the external airing/isolation valve before switching off the backing pump. If a Leybold SECUVAC valve is installed in the fore-vacuum line, this valve automatically closes when the backing pump is switched off.

CAUTION: Failure to vent the turbopump during shutdown results in the pump becoming contaminated with hydrocarbons.

4. Vent the turbopump immediately after shutting down the pump. For standard processes, the pump is vented through its vent port. If you have the optional Purge/Vent Valve, de-energize it to vent the pump through the pump's purge port. For additional venting information, refer to Section 3.6.

5. If the pump was exposed to corrosive or toxic gases, continue to purge the pump with inert gas for as long as several hours after shutdown depending on the aggressiveness of the process gas. Purging after shutdown protects the bearings from corrosive process gases. Purging is required before opening a pump that has been exposed to toxic or hazardous gases to dilute and/or force the toxic gases from the pump.



WARNINGS:

It is essential that the Purge/Vent Valve is connected to a source of inert gas or sealed when pumping toxic or reactive process gas. The Purge/Vent Valve isn't a shutoff device. If its inlet port is left open, toxic process gas could escape after shutdown or air could enter the pump and have a dangerous reaction with aggressive process gas.

If the pump has been exposed to toxic or reactive process gas, you must purge it with inert gas before opening the pump.

6. If the turbopump is removed from the vacuum system after venting with dry gas, seal off its high-vacuum flange and fore-vacuum ports with blank flanges to avoid contamination or corrosion. Also, when storing the turbopump for prolonged periods, place the turbopump into its polyethylene shipping bag with moisture adsorbent and store in a dry location.

3.6 Venting

Venting prevents the backstreaming of the process gas and/or oil vapors from the fore-vacuum area into the high-vacuum side of the turbopump.

Although venting directly from the atmosphere is possible, venting form a bottled source of dry air or nitrogen is recommended because it prevents condensation of water vapor in the pumping system. The absolute moisture content of the venting gas should be less than 10 ppm. If a pressurized venting line is used, DON'T exceed a vent-line pressure of 7 psig.

Using inert gas for venting and purging is essential if the process gas could have a hazardous or undesirable reaction with air or if process gas is toxic.

For standard applications, the turbopump can be vented to atmospheric pressure through its vent port or through its high-vacuum flange. The nozzle in the vent port regulates the flow of venting gas in accordance with Figure 3-3. If you vent the pump through its high-vacuum flange, we recommend that you control the pressure rise in accordance with Figure 3-3. Shock venting should be avoided, but it can be done in an emergency without damaging the turbopump.

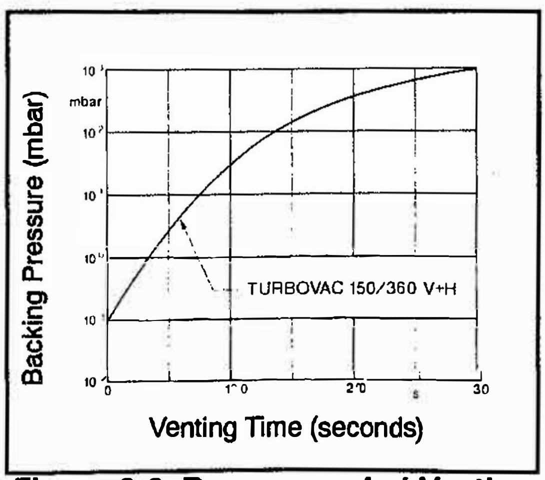


Figure 3-3. Recommended Venting Pressure Rise

When pumping corrosive or aggressive gases or gases containing dirt or abrasives, the turbopump must be vented with dry inert gas through its purge port using the optional Purge/Vent Valve (see Section 3.7). The purge port also contains a nozzle that avoids shock venting by regulating the flow of venting gas in accordance with Figure 3-3. Venting is accomplished by increasing the purge-gas flow rate through the Purge/Vent Valve to 4,800 sccm when the turbopump is switched off. Thus, the motor/bearing cavity is vented before the rest of the turbopump to prevent any corrosive gases or abrasive reaction products from being sucked into this cavity.

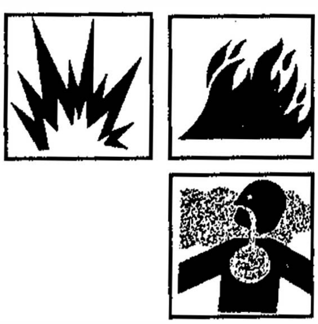
If you are also venting the vacuum chamber, ensure that the turbopump is vented before the vacuum chamber or that both are vented simultaneously. If the vacuum chamber is vented before the pump, the turbopump's bearing and oil could be exposed to harmful process gases.

3.7 Purging

When pumping corrosive or aggressive gases or gases containing dirt or abrasives, the turbopump must purged and vented through its purge port using the optional Purge/Vent Valve. See Section 3.6 for information on venting.

The Purge/Vent valve allows a constant flow of inert gas into the motor/bearing cavity which keeps the cavity pressure ten times higher than the normal foreline pressure (see Table 2-2 for purge gas inlet pressures and flow rates). This pressure difference prevents harmful process gas from entering the motor/bearing cavity during operation. It also prevents backstreaming oil vapors from contaminating the turbopump.

If the pressure in the motor/bearing cavity drops below the foreline pressure, then the bearings and oil are exposed to the harmful process gases. To prevent this, ensure that you have a continuous supply of dry inert gas to the Purge/Vent Valve, that the nozzle and filter in the Purge/Vent Valve are clean, and that the backing pressure is acceptable.



WARNING!

It is essential that the Purge/Vent Valve is connected to a source of inert gas or sealed when pumping toxic or reactive process gas. The Purge/Vent Valve isn't a shutoff device. If its inlet port is left open, toxic process gas could escape after shutdown or air could enter the pump and have a dangerous reaction with aggressive process gas.

3.8 Bakeout

To attain operational pressures of 10^{-7} mbar, the turbopump flange and the connected vacuum system should be baked out at the same time.

Only TURBOVAC models that have the CF flange can be baked out because they have a stainless steel housing and use a copper flange gasket.

CAUTION: ISO-K flanged turbopumps can't be baked out because their housing is made of aluminum.

Our optional flange heater is recommended for baking out the CF-flanged TURBOVACs. Its power requirements are about 100 watts. The flange heater's thermal switch maintains the flange temperature within the acceptable range. See Table IV in the front of this manual for the part numbers of the CF flange heaters.

Don't use a bakeout jacket; bakeout jackets can damage the pump by overheating the oil and changing its viscosity and by damaging the heat-sensitive parts in the bearing.

Normally a bakeout time of 6 hours for the turbopump is sufficient. Longer baking times won't, as a rule, significantly improve the base pressure.

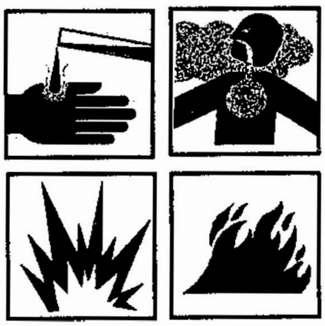
During bakeout, the turbopump high-vacuum flange temperature must not exceed 212°F (100°C)and its neck and rotor must not exceed 175°F (80°C). Take precautions to protect against direct heat radiation from other heaters attached to the vacuum system. When baking out components at the fore-vacuum side such as an adsorption trap, make sure that the temperature of turbopump's fore-vacuum port doesn't exceed 130°F (55°C).

A water-cooled turbopump can be continuously baked out while running if its operating pressure is less than 10^{-4} mbar and the ambient air temperature doesn't exceed 113°F (45°C). For an air-cooled pump, check the operating temperature in the small bore in the base housing just below the purge port; if this temperature exceeds 130°F (55°), you must use water cooling.

Section 4 Maintenance

WARNINGS!

The NT-150/360 Frequency Converter contains potentially lethal voltages and should only be serviced by qualified technicians.



If the pumping system has been exposed to corrosive, toxic, reactive, or hazardous gases, take proper safety precautions to protect personnel before removing the pump from the system or before disassembling the pump or opening its oil reservoir. Proper precautions could include inert gas purging; gloves or protective clothing to avoid skin contact with toxic or highly corrosive substances; specially ventilated work areas; fume hoods; safety masks; breathing apparatus; etc.

Contents

4.1 *Frequency Converter Maintenance*

The NT-150/360 Frequency Converter is maintenance free. There are no internal controls that need periodic readjustment. The only time maintenance may be required is if the converter is operated in a dusty environment, causing an excessive dust buildup to occur within the unit. Dust acts like a thermal insulator and prevents efficient heat dissipation. As necessary, remove the converter's top cover and clean the interior of the unit using a brush.

*Table 4-1 — Turbopump Oil Maintenance**

Check Oil Level	Every 24 operating hours
Correct Oil Level	
TMP150/360 V	Between "min" and "max" marks on oil cup while the pump is operating (see Figure 4-1).
TMP150/360 H	Between the top and bottom of the oil-level groove while the pump is operating (see Figure 4-2).
Change Oil	When oil looks contaminated and at least once a year.
Oil Quantity	
TMP 150/360 V	88 ml
TMP150/360 H	
Mounted between horizontal & 45° .	82 ml† (see Figure 2-2)
Mounted between vertical & 45° . . .	40 ml (see Figure 2-2.)
Oil Ordering Information	
150 ml of HE-500	P/N 98-198-052
1 quart of HE-500	P/N 98-198-053
1 gallon of HE-500	P/N 98-198-030

* Use the maintenance record page at the beginning of Section 1 or at the end of Section 7 to keep track of your maintenance.

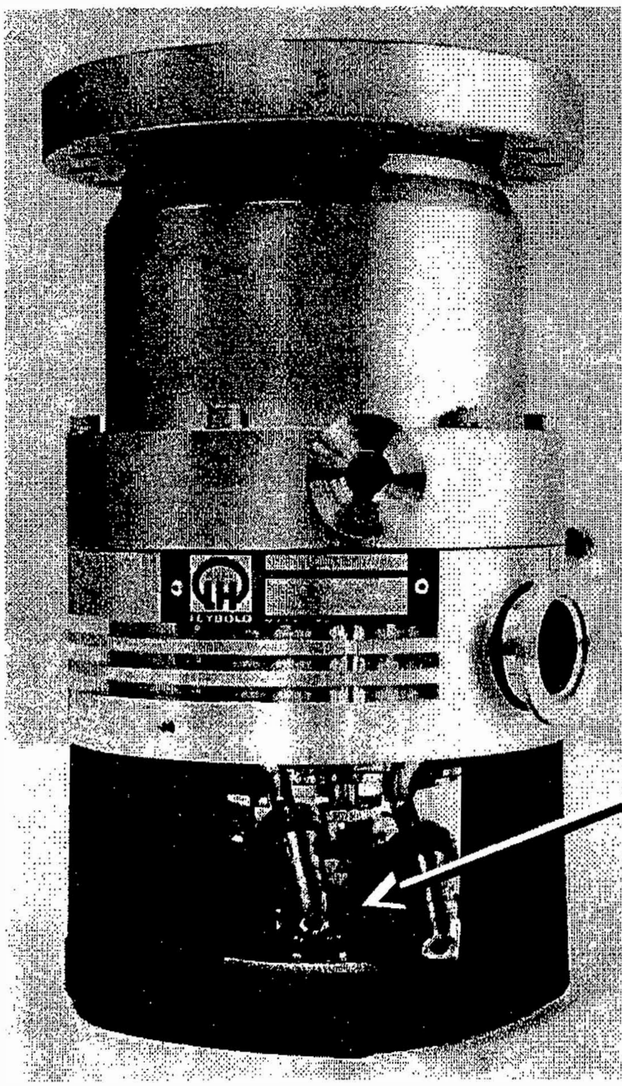
† Additional oil is required to fill the increased dead volume if the TMP150/360 H pump is mounted a maximum of 10° outside the 90° A-B arc shown at the top of Figure 2-2.

4.2 Checking the Turbopump Oil Level
(every 24 operating hours)

Oil consumption increases when the pump is vented frequently, when it is operating at high inlet pressures, and when it is purged. Thus we recommend checking the oil level once every 24 operating hours and after each oil change. The oil level should be checked while the pump is operating.

For the TMP150V and TMP360V models, the oil level must be between the "max" and "min" marks on the oil cup while the pump is operating (see Figure 4-1).

TMP150/360 V



The oil level should be between the "min" and the "max" marks while the pump is operating.
When the cup is detached from the pump, the oil level should be at the "min" mark.
As you install the cup onto the pump, some oil is displaced causing the oil level to rise to the "max" mark.

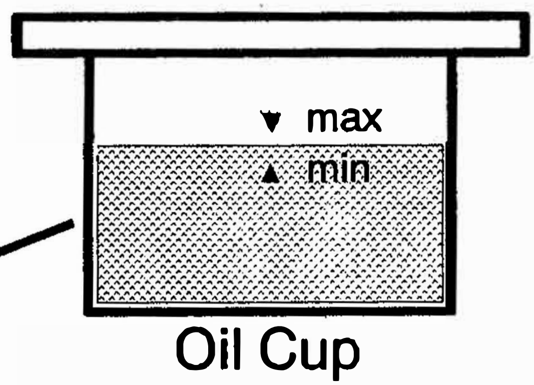


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Figure 4-1. TMP150/360 V Oil Level

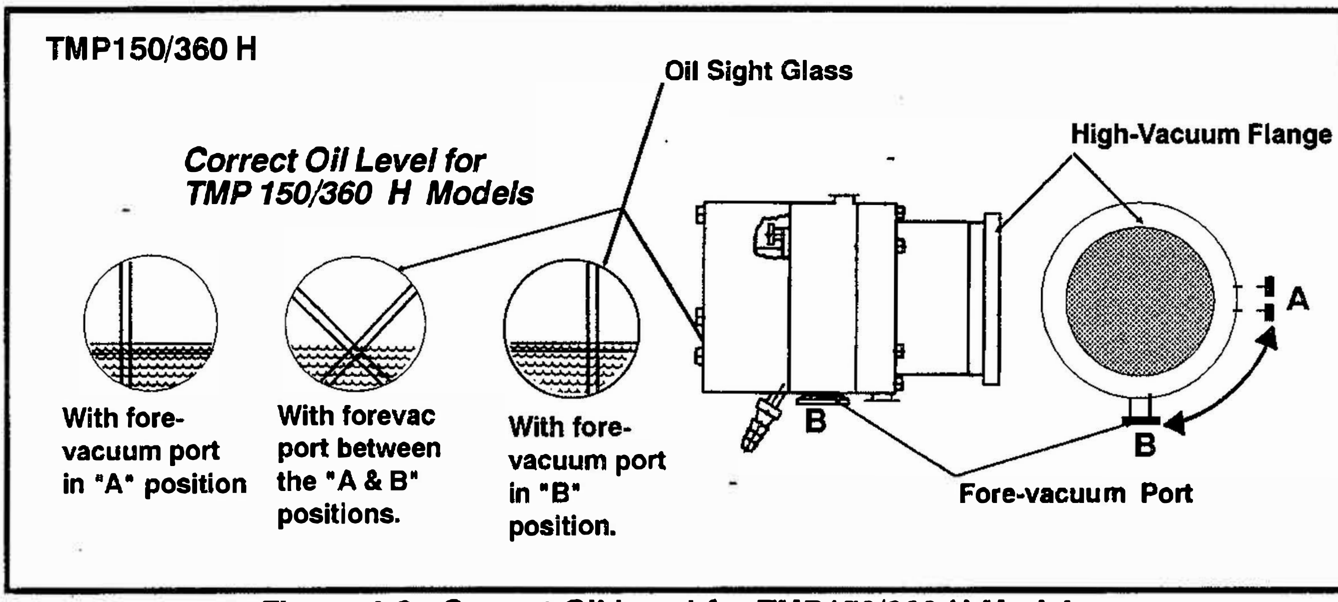


Figure 4-2 - Correct Oil Level for TMP150/360 H Models

For the TMP150H and TMP360H models, use the larger sight glass to monitor the oil level if the pump is mounted in the horizontal range. The correct oil level using the larger sight glass is shown in Figure 4-2. The oil-level grooves in this sight glass are almost 1/4 inch wide. The correct oil level is within this groove. If the oil level is above the groove, it is too high; if it is below the groove, it is too low. If you mount the TMP150H and TMP360H pumps vertically, use the smaller sight glass on the side of the oil-pump housing. The correct oil level is in the center of this small sight glass with the pump operating. If the oil level is too high or too low, the oil-flow sensor shutdowns the pump because oil isn't circulating properly.

4.3 Changing the Oil in the Turbopump

WARNING!

If the pump has been exposed to corrosive, hazardous, or toxic gases, the oil and sump could be contaminated with dangerous chemicals and gases. In such cases, take the proper precautions (such as using gloves, safety mask, or breathing apparatus) before opening the oil reservoir or changing the oil.

Oil-Change Interval - Change the oil at least once a year. If you are pumping abrasive or corrosive gases, change the oil more frequently. Also change the oil if it darkens or if you can see floating particles in the oil. Record the oil change in the maintenance record page at the beginning of Section 1 or at the end of Section 7.

Darkening of the oil usually indicates oil contamination or deterioration of the pump. Another cause of oil darkening is ultraviolet radiation. Although UV rays don't harm the oil, avoid exposing the oil to them because they prevent you from using the oil's color as an indicator of its condition.

4.3.1 Changing the Oil in the TMP150V and TMP360V Models

See Section 4.3.2 if you have the TMP150H or the TMP360H model.

Change the oil in the TMP150V and TMP360V models as follows:

1. Switch off and vent the turbopump.

2. Remove the three knurled thumbscrews from the oil cup and remove the cup by pulling it downwards.

3. Clean the oil cup as follows:

CAUTION: Don't use alcohol-based cleaning agents, esters, or asiotroope chemical solvents such as acetone, trichlorethane or methyl ethyl ketone for cleaning the oil cup. These solvents damage the cups's acrylic material.

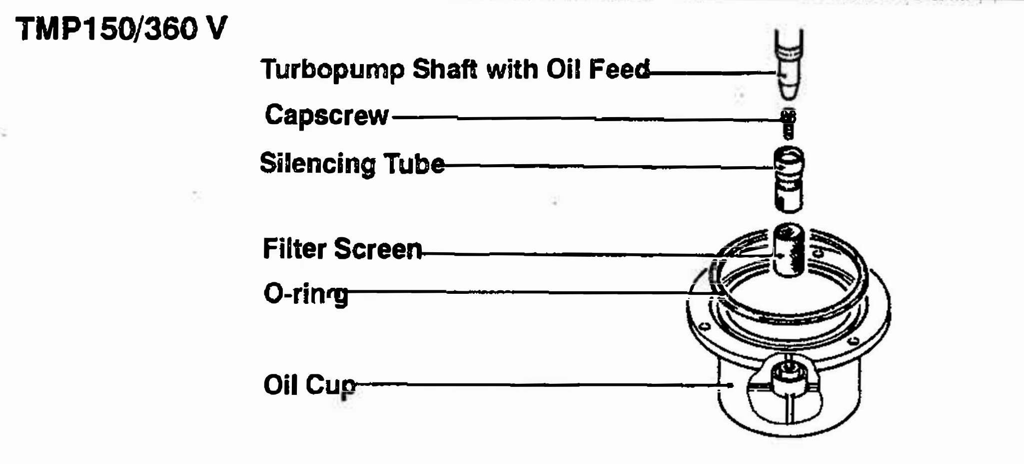


Fig 4-3. TMP150/360V Oil Cup, Silencing Tube & Filter Screen

a. Unscrew the capscrew to remove the wire-mesh filter and silencing tube from the center of the oil cup (see Figure 4-3).

b. Clean the wire-mesh filter and the oil cup with a suitable solvent such as petroleum ether (boiling range 50-70°C). Freon TF can also be used but we don't recommend it because of environmental concerns.

c. Ensure that the oil-feed bores in the side of the silencing tube and in the center of the shaft aren't clogged (see Figure 4-3).

d. Reinstall the silencing tube and wire-mesh filter into the oil cup (see Figure 4-3).

4. Add about 88 cc's of HE-500 oil to the oil cup (see Table 4-1 for the part number of the oil).

The correct oil level is at the "min" mark on the cup when the cup is detached from the pump; when you install the cup onto the pump, some of the oil is displaced by the turbopump's shaft causing the oil level to rise to the "max" mark.

Use a new Viton O-ring (P/N 239-70-301) if you see any evidence of swelling or cracking of the old O-ring.

5. Close the venting valve and run the backing pump for 10 to 15 minutes with the turbopump off. This degasses the oil and minimizes bearing damage from cavitation in the turbopumps oil-feed mechanism. After the foreline pressure is 5×10^{-1} mbar, start the turbopump to check its oil level.

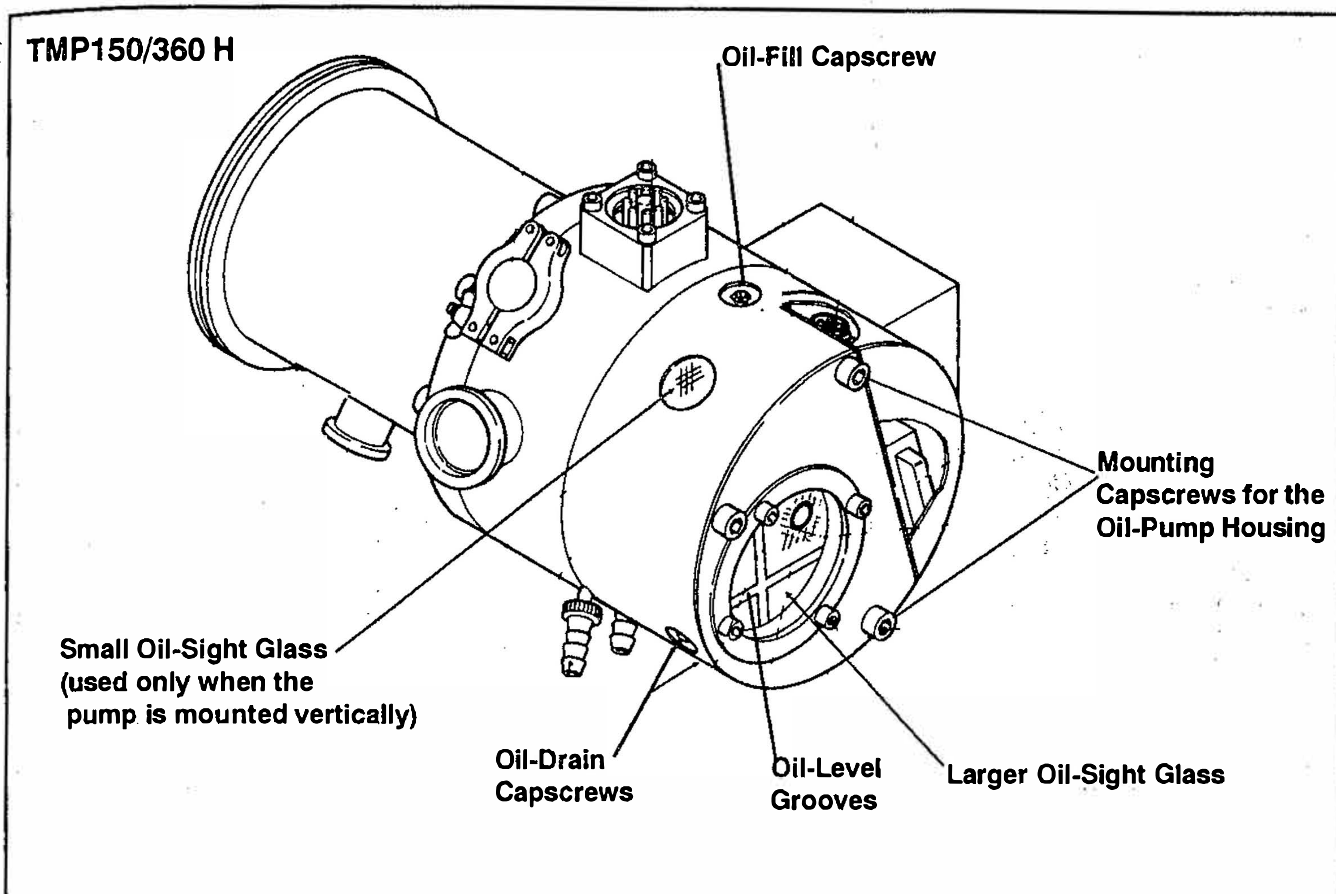


Figure 4-4. TMP150/360 H Pump Model

4.3.2 Changing the Oil in the TMP150H and TMP360H Models

See Section 4.3.1 if you have the TMP150V or the TMP360V model.

Change the oil for the TMP150H and TMP360H models as follows:

1. Switch off and vent the turbopump.

2. Remove the three capscrews to remove the black oil-pump housing from the pump. After removing this housing, you can set the turbopump on the stand that was supplied with the pump for this purpose (see Figure 4-5).

3. Drain the oil by removing one of the two oil-drain capscrews in the oil-pump housing (see Figure 4-4).

4. Disassemble and clean the oil-pump housing as follows (see Figure 4-5):

   a. Remove the larger sight glass.

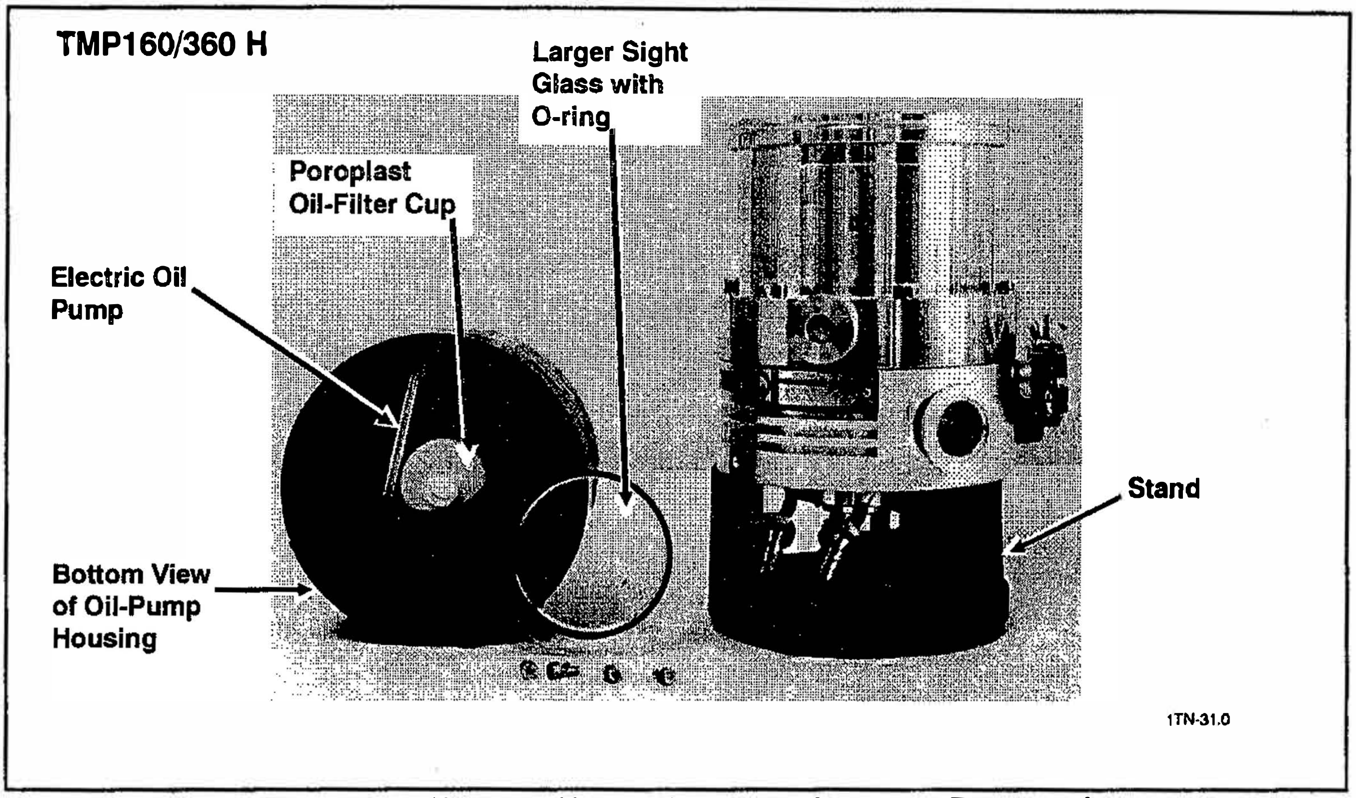


Figure 4-5. TMP150 H with Oil-Pump Housing Removed

b. Pull the white poroplast oil-filter cup downward from the from the oil-pump housing and work it around the oil-pump tube to remove it.

c. Clean the acrylic sight glass, the white poroplast oil-filter cup, and the oil reservoir with a suitable solvent such as petroleum ether (boiling range 50-70°C). Freon TF can also be used but we don't recommend it because of environmental concerns. If you can't get the white oil-filter cup clean, use a new one (P/N 200-17-773) during reassembly(see Figure 4-5).

d. Clean the oil-pump housing ensuring that the oil-flow channels are clear.

e. Use dry, oil-free, compressed air to **thoroughly** blow all solvent from the housing especially from the oil channels.

f. Fit the white foam oil-filter cup back inside the oil-pump housing so that the rim of the white cup fits up inside the metal center bore of the housing.

g. Reinstall the sight glass with O-ring and the oil-drain capscrew with gasket ring.

5. Ensure that the O-ring is correctly inserted into its groove and then reinstall the oil-pump housing onto the turbopump ensuring that it is flat and in full contact with the pump.

Use a new Viton O-ring (P/N 239-70-301) if you see any evidence of swelling or cracking of the old O-ring.

6. Remove the oil-fill capscrew and use the syringe supplied with the pump to add HE-500 oil to the oil-fill port in the pump base (see Figure 4-4). The correct oil quantity depends on the pump's mounting position as shown in Figure 2-2.

7. Close the vent valve and run the backing pump for 10 to 15 minutes with the turbopump off. This degasses the oil and minimizes bearing damage from cavitation in the turbopumps oil-feed mechanism. After the foreline pressure is 5 x 10^{-1} mbar, start the turbopump to check its oil level.

The gas in the oil sometimes causes the oil-flow sensor to shutdown the pump. If this happens, clear the FAILURE by pressing the STOP button on the converter and then pressing its START button. You may have to do this 3 or 4 times to get the pump started.

Excessive oil level also causes the oil-flow sensor to shutdown the pump. In this case drain some oil before restarting the pump.

4.4 Cleaning Without Disassembly

Slight contamination such as oil film can be cleaned without disassembling the turbopump. However, if the turbopump is severely contaminated, you must disassemble and clean it as described in Section 4.5.

To clean the turbopump without disassembly, proceed as follows:

CAUTION: DO NOT apply cleaning solvent to the O-rings. Some solvents such as acetone will dissolve or cause swelling and cracking of the O-ring material. Also, DO NOT allow the cleaning solvent or oil to enter the ball bearing assemblies.

1. Dismount the turbopump from the pumping system and remove the high-vacuum flange O-ring or copper seal.

CAUTION: Failure to drain the oil from the pump before turning it upside down for cleaning results in the oil draining down onto the rotor and housing.

2. Drain the oil from the turbopump and allow the pump to stand for several minutes so that most of the remaining oil drips off. **For the TMP150H and TMP360H models,** also remove the oil-pump housing from the pump.


! WARNING — Fire Hazard !

Many cleaning solvents including acetone, alcohol, and petroleum ether are a fire hazard. Others including triethane are a health hazard.

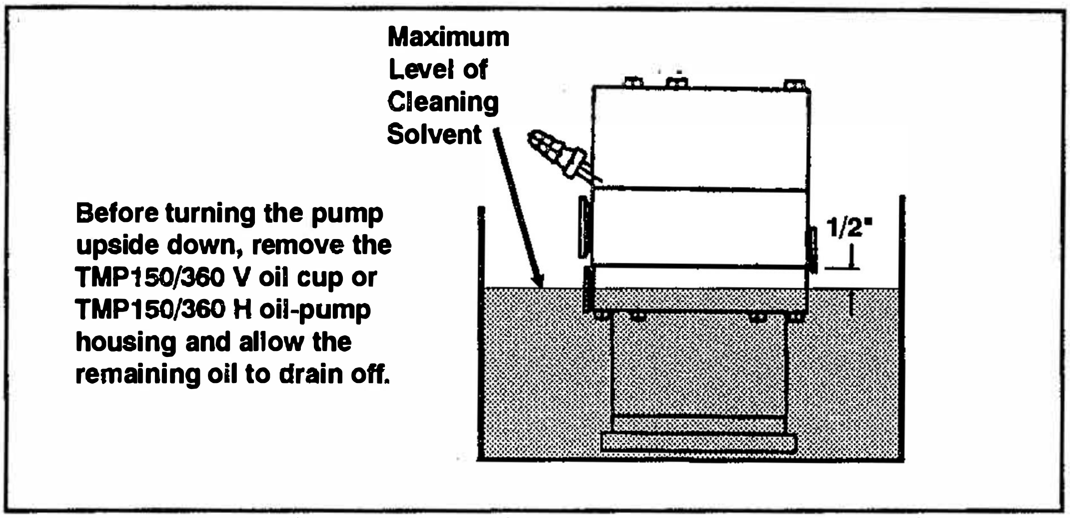


Figure 4-6. Turbopump Cleaning without Disassembly

CAUTION: In the following step, DO NOT allow the cleaning solvent level to be higher than 1/2 inch (12.7 mm) below the edge of the pump housing (see Figure 4-6). This prevents cleaning solvent from entering into the ball bearing assembly.

3. Slowly lower the turbopump upside down into a container filled with a suitable solvent such as acetone. Freon TF works well but isn't recommended because of environmental concerns (see Figure 4-6).

4. Allow the cleaning solvent to react for about 15 minutes. During this period, GENTLY lift and lower the turbopump several times to flush the rotor and stator components.

5. Repeat Steps 3 and 4 at least once using fresh solvent. If you use a solvent that leaves a residue (such as petroleum ether) rinse with reagent-grade alcohol to remove the residue.

CAUTION: After cleaning, DO NOT turn the turbopump right-side up until all cleaning solvent has been removed as described in Step 6. This prevents cleaning solvent from draining into the ball bearing assembly.

6. After cleaning, place the turbopump, with its high-vacuum port facing down, on a piece of cardboard for at least 2 hours to allow the solvent to drain and completely evaporate. During this period, place the turbopump for a short time on its side, and roll it around its axis to allow the solvent to drain from between the stator package and pump housing.

7. Reassemble the pump ensuring that its oil level is correct and then remount the turbopump to your system.

4.5 Turbopump Disassembly/Reassembly
(For trained personnel only)

This Section contains the following:

WARNING!

If the pumping system has been exposed to corrosive, toxic, reactive, or hazardous gases, take proper safety precautions to protect personnel before removing the pump from the system or before disassembling the pump or opening its oil reservoir. Proper precautions could include inert gas purging; gloves or protective clothing to avoid skin contact with toxic or highly corrosive substances; specially ventilated work areas; fume hoods; safety masks; breathing apparatus; etc.

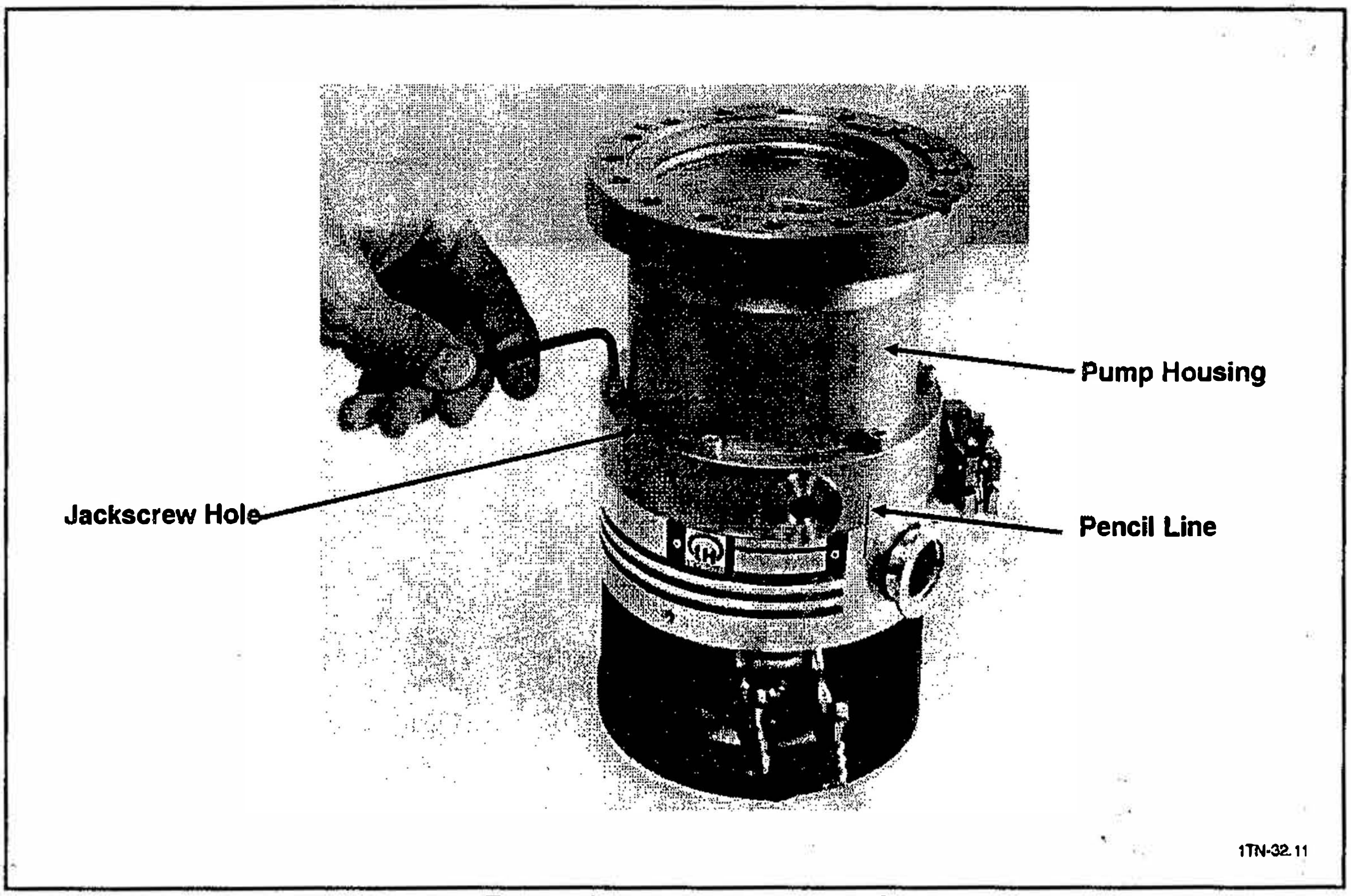
CAUTION: When disassembling, cleaning, and reassembling the turbopump, don't make any modifications to the rotor; it has been precision balanced and any change on any rotor part requires that the rotor be rebalanced by Leybold.

The turbopump should only be disassembled when it is heavily contaminated and requires cleaning. The following sections describe how to disassemble and then reassemble the turbopump. Please read all of these instructions before starting disassembly.

4.5.1 Tools and Materials Required

The following tools and materials are required to disassemble/ reassemble the turbopump.

- 6-mm Allen Wrench
- 1/8-inch Flat Blade Screwdriver
- Feeler Gauges
- Pencil
- Suitable Solvent - See Section 4.5.4.
- Pump Housing O-Ring (if required):
  P/N 239-50-224 for the TMP150 V/H O-ring,
  P/N 239-70-327 for the TMP 360 V/H O-ring



4-7. Removing the Pump Housing

4.5.2 Removing the Pump Housing

After dismounting the pump and removing the inlet screen, remove the turbopump's housing as follows (see Figure 4-7):

1. Using a pencil, draw a perpendicular line about 1-inch long between the pump base and pump housing. This line will be used during reassembly to align the screw holes.
2. Using a 4-mm Allen wrench, remove the six capscrews and washers from the pump housing.
3. Normally you can remove the pump housing after carefully prying up under it with a screwdriver. If you can't break it loose by prying, insert two 4-mm screws into the two jackscrew holes and tighten these two screws uniformly until the pump housing lifts off the pump base. You can't use the pump housing screws as jackscrews because their threads aren't long enough.
4. Grab the pump housing with both hands and pull it straight up from the pump base.

To disassemble the stator package, proceed to Section 4.5.3.

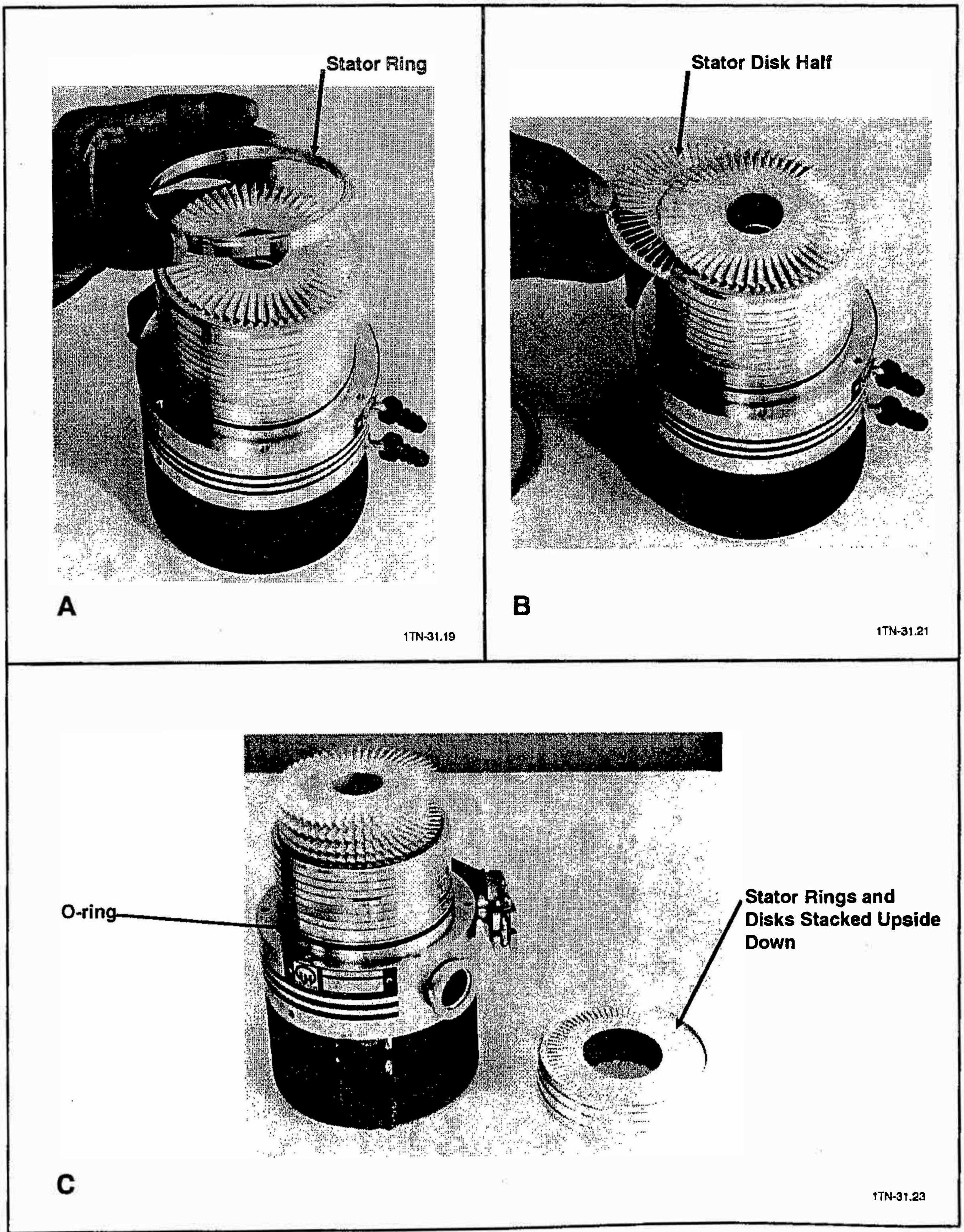


Figure 4-8. Removing the Stator Rings and Disks

4.5.3 Stator Package Disassembly

Disassemble the stator package as follows:

NOTE: During disassembly of the stator package, check for damaged stator rings and stator disk halves. Look for friction marks, cold welds, and deformed parts. Repair or replace any damaged stator part(s) before reassembling the turbopump.

1. If not already done remove the pump housing as described in Section 4.5.2.
2. Carefully lift off the first stator ring (Figure 4-8A) and place it upside down next to the turbopump (Figure 4-8C). Note that if the stator rings cling together, use a small flat-blade screwdriver to CAREFULLY pry the rings apart.

CAUTION: To avoid damaging the stator disk halves in the following step, compress the stator package with your fingers to allow enough clearance so the stator disks can be easily removed. DO NOT force the removal of any part.

3. Carefully pull out the first two stator disk halves (Figure 4-8B) and place them upside down in the first stator ring (Figure 4-8C).
4. Continue to lift off the stator rings and pull out the stator disk halves until the complete stator package is stacked upside down next to the turbopump. If you continue to stack them upside down on the previously removed rings and discs as you remove them, they will be stacked in the correct order for reassembly.
5. Refer to Section 4.5.4 to clean the stator package and rotor, then proceed to Section 4.5.5 to reassemble the turbopump.

Maintenance

4.5.4 Cleaning and Inspecting the Disassembled Pump

! WARNING — Fire Hazard !

Many cleaning solvents including acetone, alcohol, and petroleum ether are a fire hazard. Others including triethane are a health hazard.

CAUTION: Don't use alcohol-based cleaning agents, esters, or asiotroope chemical solvents such as acetone, trichlorethane or methyl ethyl ketone for cleaning the oil cup. These solvents damage the cups's acrylic material.

CAUTION: Don't apply cleaning solvent to any of the O-rings. Some solvents such as acetone will dissolve or cause swelling and cracking of the O-ring material. Also, don't allow the cleaning solvent to enter the ball bearing assemblies.

CAUTION: Don't change the order in which the stator package is stacked!

1. After disassembly, wipe the stator disk halves and stator rings with a suitable solvent. If ultrasonic cleaning equipment is available, also clean the stator disks and rings in an ultrasonic bath.

   Acetone can be used on the metal parts but must not come into contact with O-rings or the acrylic sight glass. Freon TF works well but isn't recommended because of environmental concerns. If you use a solvent that leaves a residue (such as petroleum ether), rinse with reagent-grade alcohol to remove the residue. However, use care since alcohol will damage the acrylic sight glass.

2. To clean the rotor, hold the turbopump upside down and apply a suitable solvent to the rotor blades with a brush. DO NOT turn the turbopump upright until all the cleaning solvent has evaporated. A convenient place to set the turbopump while drying is inside the pump housing, which has been placed upside down on its high-vacuum flange.

3. When cleaning the fore-vacuum area, ensure that cleaning solvent doesn't enter the motor vent hole located behind the fore-vacuum port.

4. Inspect the parts as follows:

   a. Inspect both ends on the straight edge of each stator disc to ensure they aren't bent or elongated. If the end is flattened and elongated, file it square. If the stator disc doesn't lie flat, carefully straighten it.

b. Spin the rotor and watch each row of blades to ensure that none is bent up or down. If a blade is bent up or down, grip the entire blade with needle-nose pliers to align it with the rest of the blades in the row. If the rotor has any other damage other than slight misalignment of blades, then the pump should be sent to Leybold for repair and rebalancing.

c. Inspect the inside of the stator rings. If there are grooves caused by the rotor rubbing against the stator rings, send the pump to Leybold for repair and rebalancing.

5. For CF-flanged pumps, wipe the top of the rotor and the upper portion of the pump housing with reagent alcohol to remove any fingerprints or other residue that would prolong pumpdown.

4.5.5 Turbopump Reassembly

This procedure describes how to reassemble the stator package and reinstall the pump housing. Before reassembling the turbopump, inspect the pump housing O-ring for signs of cracking or damage. Install a new O-ring if necessary. The O-ring part number is 239-50-224 for the TMP150 V/H and 239-70-327 for the TMP360 V/H.

The order in which the stator disk halves and stator rings are installed is very important. If the stator package was stacked upside down in the sequence in which it was disassembled, there shouldn't be a problem in reassembling the package in the correct order. However, if the stator disks or rings do get out of sequence, see Figure 4-12 or 4-13.

Be sure to inspect the stator disks and the rotor blades as described in Step 4 of Section 4.5.4 before reassembling the pump.

Proceed as follows to reassemble the pump:

1. Remove the pump housing O-ring and apply a thin film of high-vacuum grease. Then reinstall the O-ring, being careful not to twist it (Fig. 4-8C). If the O-ring doesn't have a grease film, the pump housing will be difficult to install and the O-ring could be damaged as you seat the pump housing.

2. Remove the top two stator disk halves from the upside down stacked stator package, and then reinsert the disks into the turbopump so that their outer edges lay on top of the pump base. Be very careful to ensure that the abutting joints of the stator disk halves DO NOT overlap.

3. Remove the top stator ring from the upside down stator stack and install it over the rotor. Make sure that the gap between all the stator rings are uniform over their entire outer circumference.

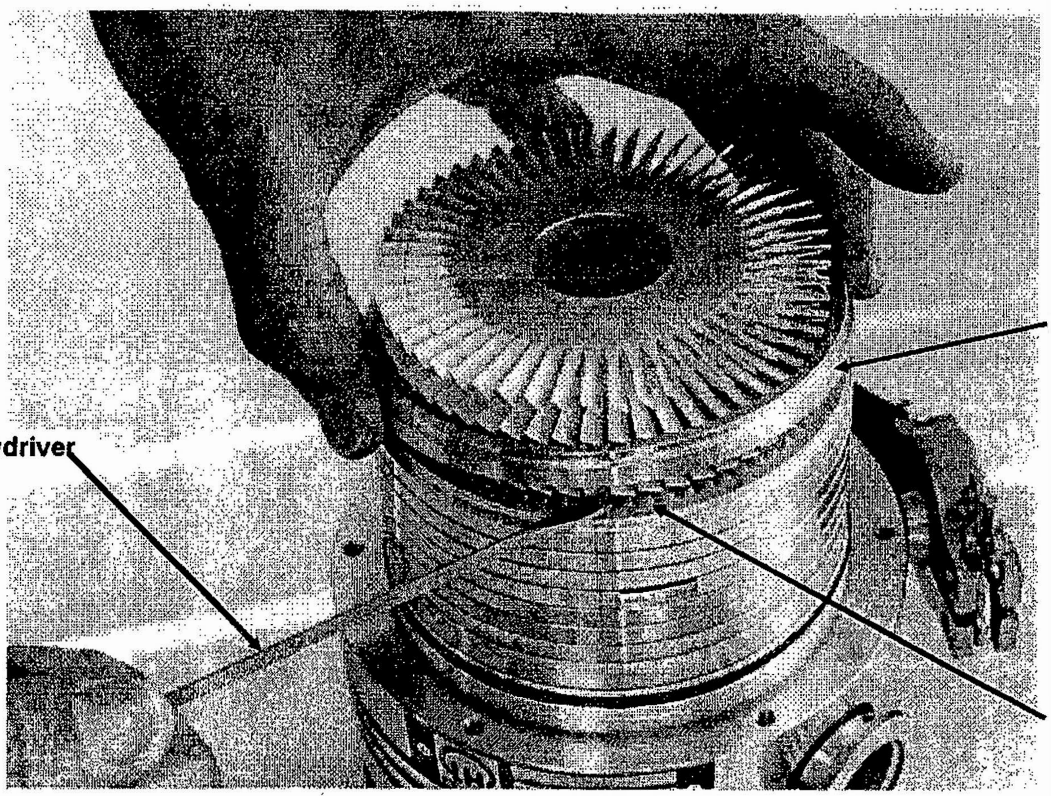


Figure 4-9. Using a Screwdirver to Prevent the Stator-Disk Halves from Overlapping as You Install the Stator Ring

4. Using your fingers, compress the stator package and alternately place stator disk halves and stator rings one above the other by repeating steps 2 and 3 until the entire stator package is reassembled onto the turbopump. You can use a small screwdriver as shown in Figure 4-9 to ensure that the stator discs don't overlap as you lower the stator ring. After you install the stator ring, check that the gap between it and the next lower stator ring is the same all around the circumference of the ring. If the gap is bigger on one side, it means that the tips of the stator discs are overlapping. As you install new stator disks, hold the previously installed ring in place so that it doesn't shift.

   Note that there is an exhaust opening in the fifth stator ring from the bottom. This exhaust opening must face the vent port as shown in Figure 4-10.

   It is normal that the rotor can't be turned by hand after the stator package is installed. This is because the spacer rings aren't yet sufficiently compressed downward to form the correct clearances between the stator and rotor blades. The rotor should move freely, however, after the pump housing has been installed and tightened down.

CAUTION: To prevent the stator package from becoming dislocated, DO NOT invert or turn the turbopump on its side before the pump housing has been replaced and tightened down.

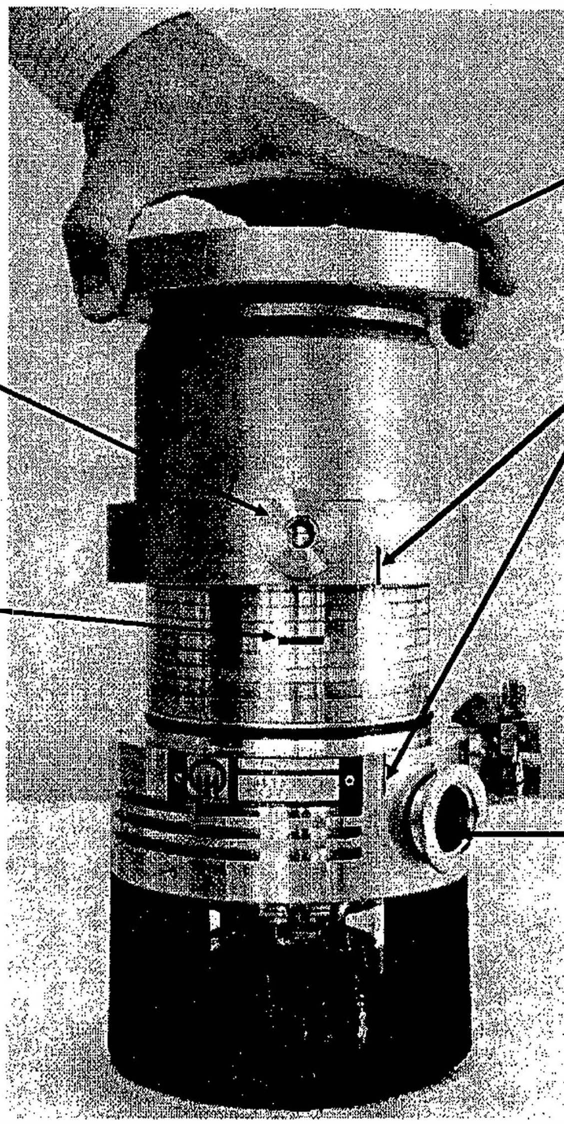


Figure 4-10. Installing the Pump Housing

5. Slowly lower the pump housing directly over the stator package, being careful not to turn the housing or to bump the stator rings and knock them out of place (Figure 4-10). Align the pencil marks that you made during disassembly to ensure that the housing's six screw holes are positioned over the screw holes in the pump base. This hole alignment is essential since the pump housing O-ring prevents you from easily rotating the pump housing once it has been seated. For pumps that have a CF flange, the slot in the high-vacuum flange must face the fore-vacuum port (see Figure 4-10).

6. Seat the pump housing by uniformly pressing down on the turbopump's high-vacuum flange. Ensure that the housing is straight relative to the stator stack. If the gap between the top row of rotor blades and the inside of the top stator ring is larger on one side, straighten the housing so that this gap is uniform.

Maintenance

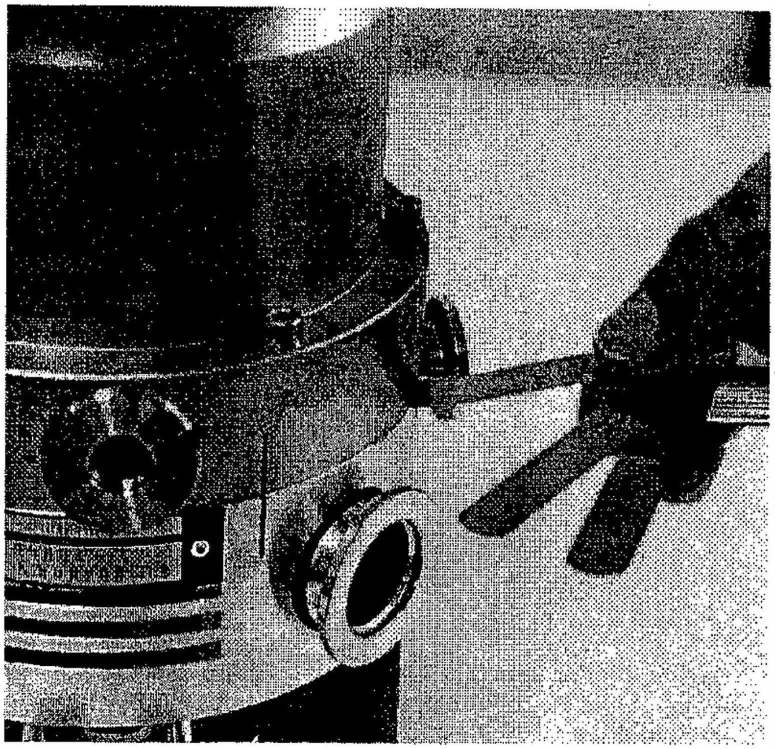


Figure 4-11. Checking that the Housing/Base Gap is Uniform

7. With the turbopump setting upright, hand tighten the six pump housing screws with washers. Slight realignment of the pump housing holes may be required to install the screws.

8. Using a 6-mm Allen wrench, uniformly tighten the six pump housing screws.

9. Check the gap between the pump base and housing as follows:

   a. Using a feeler gauge, ensure that there is a gap between the pump base and pump housing (Figure 4-11) and that this gap is uniform around the circumference of the pump base (the size of the gap isn't critical).

   b. If the gap isn't uniform, loosen the pump housing screws and retighten them again uniformly; then repeat Step 9a. If still unsuccessful, remove the pump housing and check whether any stator rings have slipped off from their position or whether any stator disk halves are overlapped; then repeat steps 7, 8, and 9.

10. After installing the pump housing, check for smooth running of the rotor by slightly pushing at the rotor hub. There should be no pinging noises and no perceptible resistance in the rotor bearings as the rotor spins.

11. Reinstall the inlet screen

Proceed to Section 4.5.6 to ensure that the turbopump has been reassembled correctly.

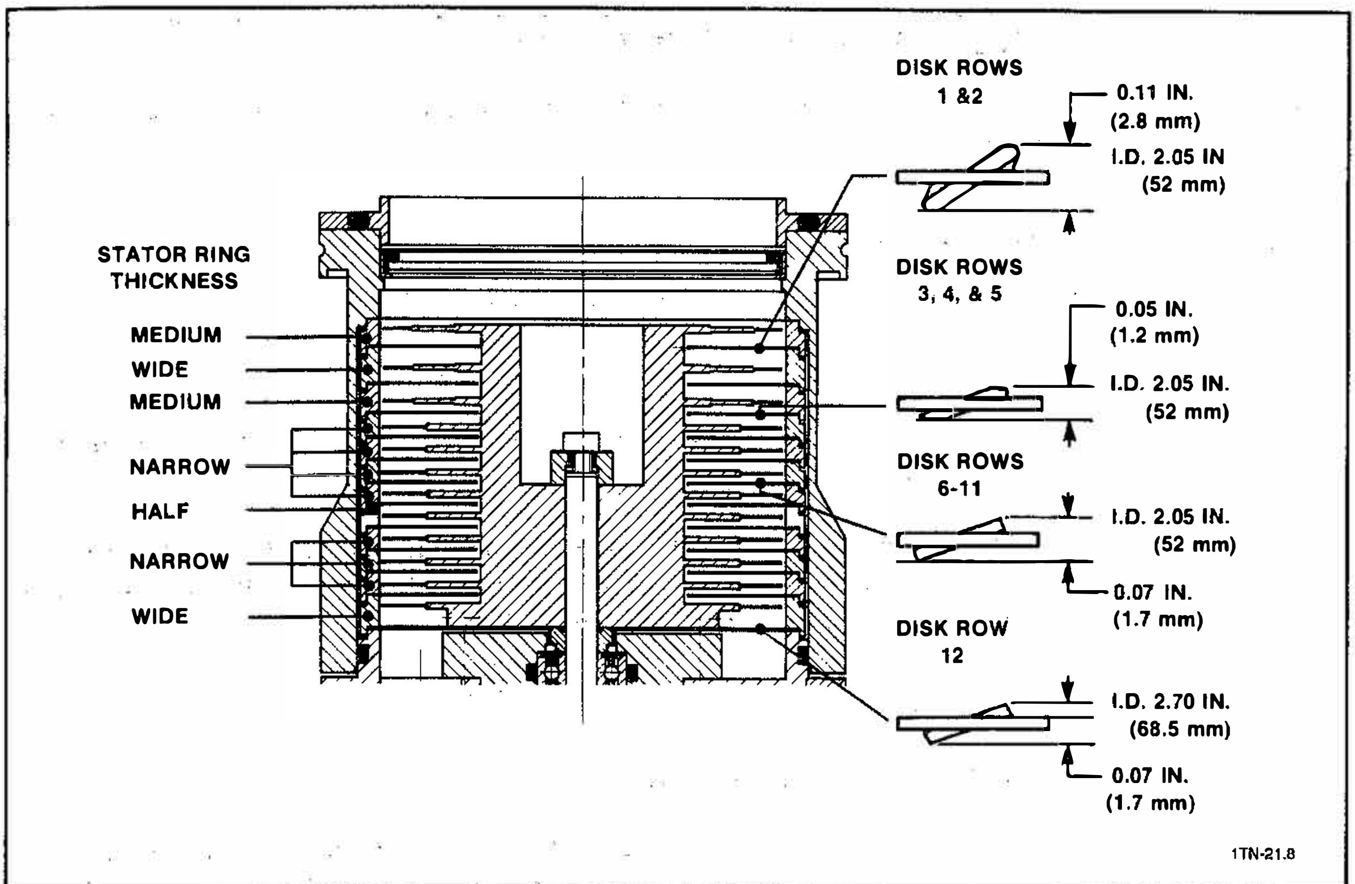


Figure 4-12. TMP150 V/H Stator Disk and Ring Placement

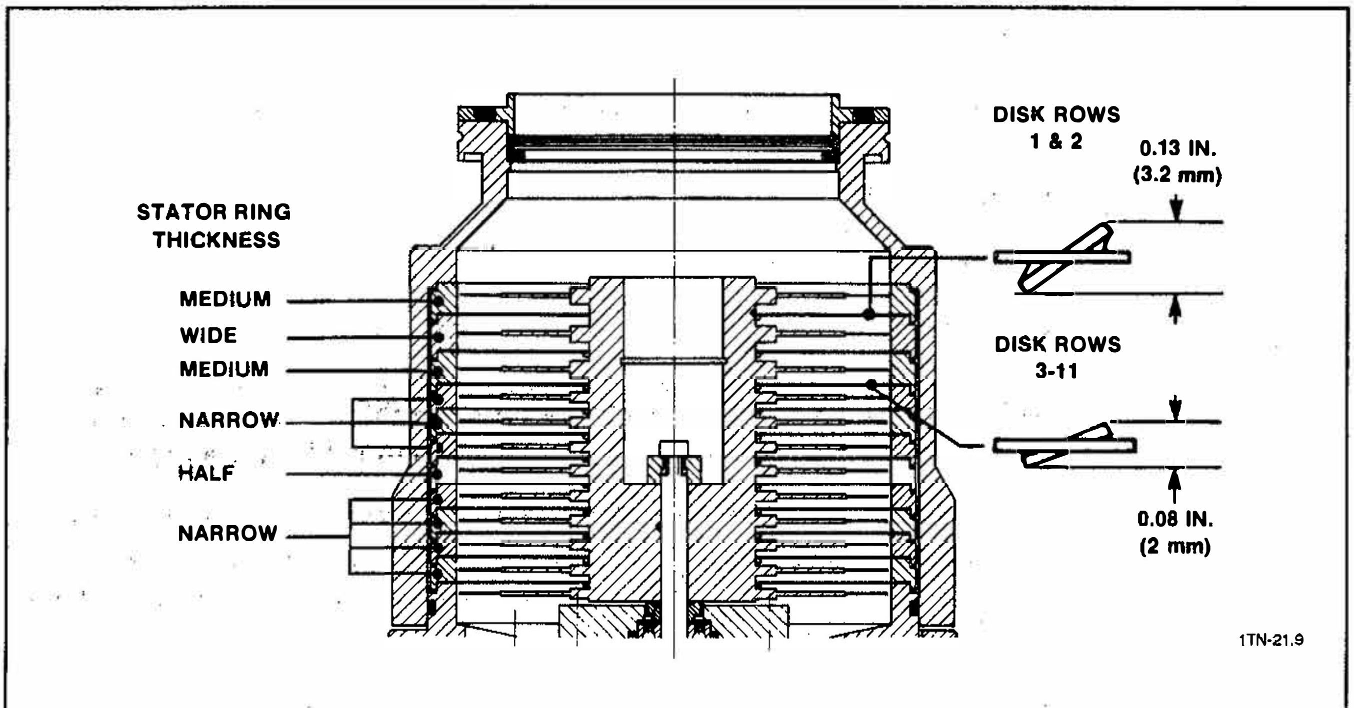


Figure 4-13. TMP360 V/H Stator Disk and Ring Placement

4.5.6 Turbopump Running Tests

After reassembling the turbopump, perform the following Run-Up Test, Leak Test, and Venting Test procedures.

Run-Up Test

1. Install a blank flange on the high-vacuum flange.
2. Connect a suitable backing pump to the fore-vacuum port.
3. Connect the turbopump to its frequency converter and start both the backing pump and turbopump.
4. Observe that within 1.5 minutes for the TMP150 and 3 minutes for the TMP360, the converter should switch from ACCELERATION to NORMAL OPERATION. A longer run-up time indicates improper assembly or a leak.

Leak Test

1. Install a blank flange on the high-vacuum flange.
2. Connect the turbopump to a helium leak detector. If a helium leak detector isn't available, the working pressure of the turbopump can be measured as an indication of any leaks. A turbopump that has a blank flange attached to its high-vacuum flange should attain a working pressure of $<1 \times 10^{-6}$ mbar.
3. Start the leak detector and turbopump.
4. Leak check the turbopump; the leak rate should be $<1 \times 10^{-6}$ mbar ltr/sec.

Venting Test

1. Switch off the turbopump.
2. Vent the turbopump.

CAUTION: Use extreme care to avoid scratching the turbopump's flange when prying the blank flange off of the high vacuum flange.

3. After the turbopump pressure begins to rise (in about 30 seconds), carefully pry off the blank flange from the high vacuum by flange. While detaching the blank flange, listen for any pinging noises.

If you don't hear pinging noises, the pump is ready for operation.
If you hear any pinging noises, disassemble the turbopump and check for proper assembly of the stator rings and stator disk halves. After reassembling the turbopump, repeat all of the running tests described in this section (Section 4.5.6)

5 — Detailed Description

Contents

5.1 TMP150/360 V/H Turbomolecular Pumps

This section applies to all TMP150/360 V/H pump models. The only physical difference between the TMP150 and the TMP360 models is the size. The only difference between the V (vertical) and H (horizontal) pump models is the oil feed for lubricating the bearings. The V models draw the oil up through the center of the shaft from an oil cup on the bottom of the pump (see Figure 5-1).

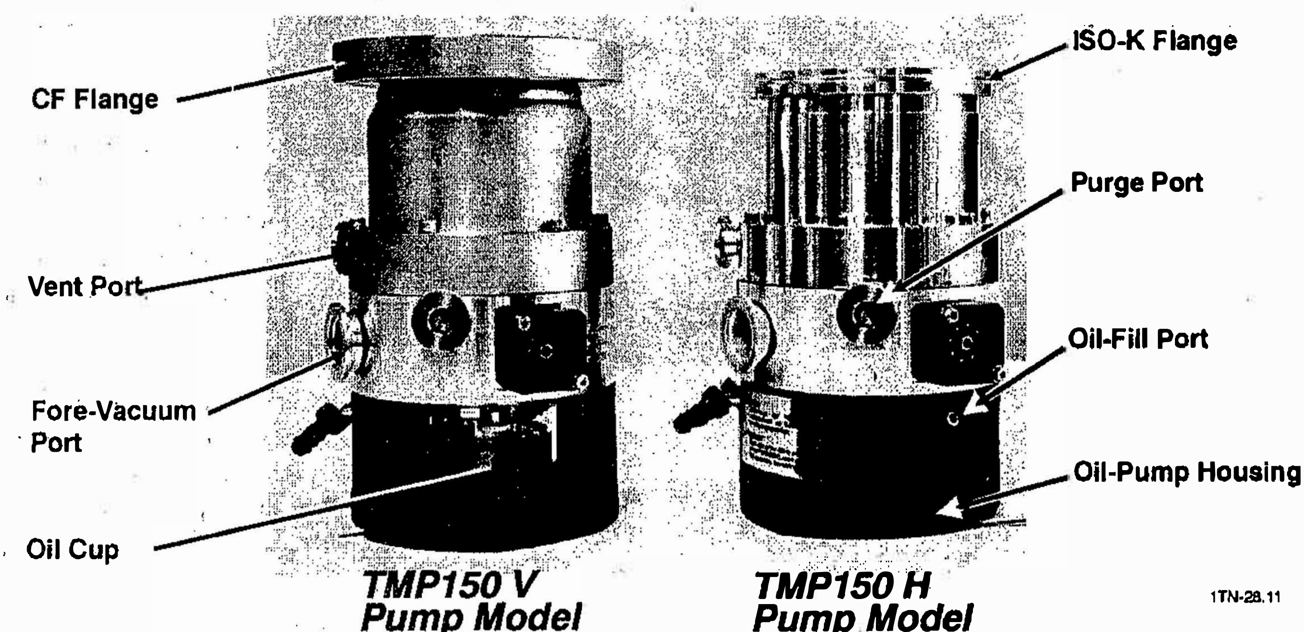


Figure 5-1. TMP150 V and H Pump Models

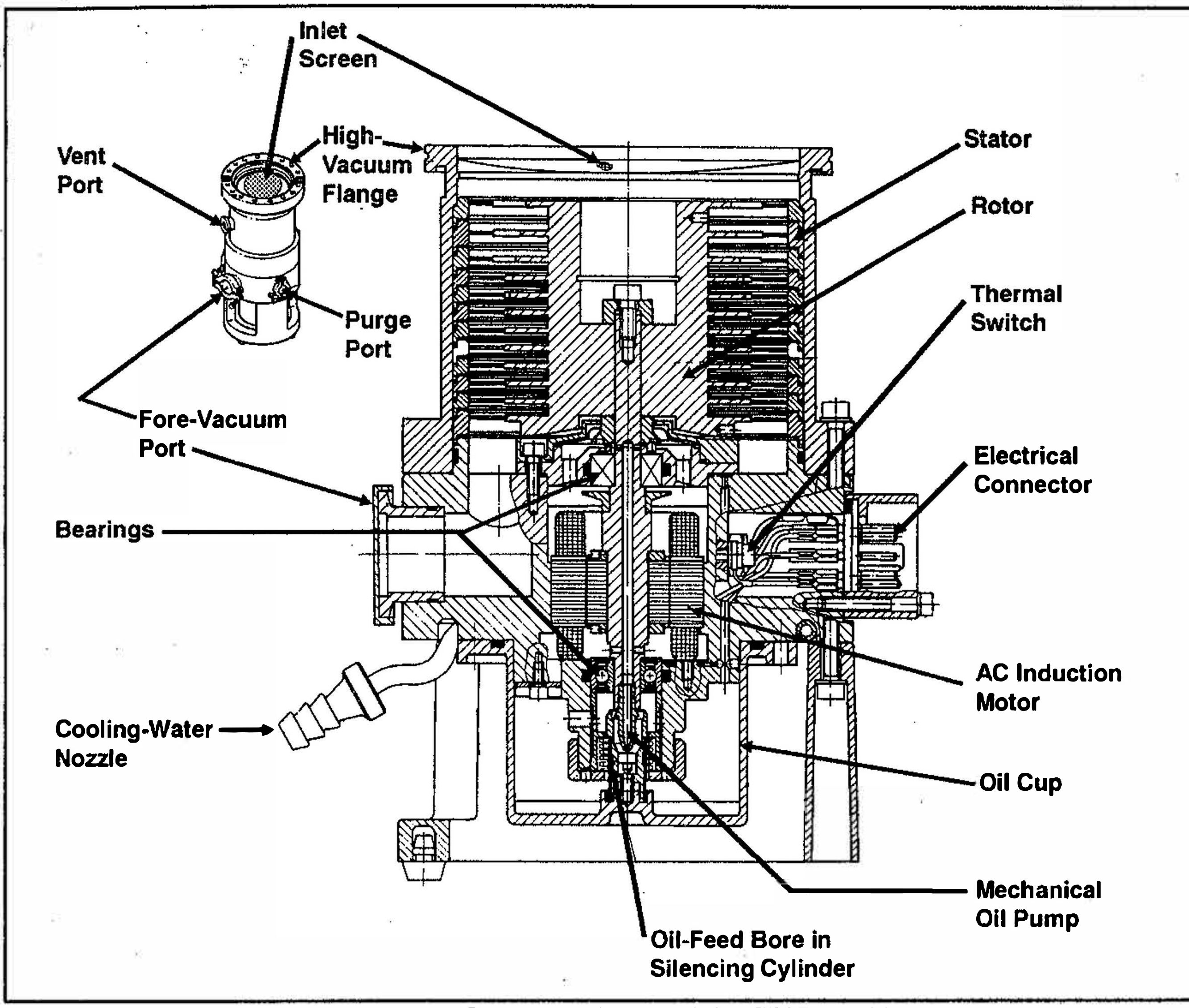


Figure 5-2. Sectional View of the TMP150 V

The H models have an electric oil pump that is needed to ensure that the bearings are lubricated when the pump is mounted horizontally (see Figure 7-3). The H pump also requires a different converter which contains the drive and safety circuit for the oil pump (see Section 5.5.11). See Section 2.4.1 for the acceptable mounting positions for the V and H models and Section 5.2 for additional information on the oil-pump housing for the H pump models.

The TURBOVAC is a turbomolecular pump used to evacuate a chamber or system to the high vacuum region. Its pumping speed is very high for heavy molecules while it is considerably lower for light molecules such as hydrogen. Its pumping speed also decreases at pressures above 10^{-2} mbar. Thus, a backing pump is required to shorten the pumpdown time at higher pressures and to evacuate the hydrogen. The ultimate total pressure is mainly determine by the amount of hydrogen present. At very low pressures, most of the hydrogen originates from the metal walls of the vacuum chamber.

To obtain pressures below 10^{-7}, the vacuum chamber and the inlet flange must be baked out. The CF-flanged turbopump models can be baked out because they have a metal inlet seal and a stainless steel housing. The ISO-K flanged pumps have aluminum housings and thus aren't suitable for bakeout. The ASA-flanged pump models have stainless steel housings; however, an ASA flange-heater isn't yet available for bakeout. The type of high-vacuum flange supplied is identified by the turbopump's catalog number (see Table III Ordering Information at the front of this manual).

The TURBOVAC pump consists of a multi-stage rotor/stator assembly and a drive assembly (see Figure 5-2). An inlet screen fits into the turbopump's high-vacuum flange to prevent foreign objects larger than 1.5 mm from falling into the pump and causing serious damage to the rotor.

The upper high-vacuum stages capture the process gas and the lower stages compress it. The drive motor and oil-lubricated ball bearings are located in the fore-vacuum area of the pump thus keeping the high-vacuum space free of oil contaminants (see Figure 5-2).

The rotor is made of aluminum and is dynamically balanced to produce a total vibration velocity of not more than 0.15 mm/second. Thus the rotor should never be altered except at the factory or at one of our service centers. However, customers that have been trained by Leybold can remove the stators and clean the rotor and stator if necessary (see Section 4.5 for this procedure).

The rotor shaft is supported by two precision ball bearing assemblies lubricated with a special oil. The oil flows from the oil reservoir, through a silencing tube, and then up through the shaft to the bearings. The TMP150V and TMP360V pumps can't be tilted more than 15° from vertical or the oil level will be below the oil intake thus preventing circulation of the lubricating oil to the bearings. See Section 5.2 for information on the TMP150H and TMP360H pumps which can be mounted horizontally.

The rotor is directly driven by a 3-phase, AC induction motor (see Figure 5-2). The motor is normally water cooled; however, an air cooling option is also available (see Appendix A.1).

A bi-metal thermal switch shuts down the pump if the temperature near the motor coil exceeds 158°F (70°C) (see Figure 5-2). This switch opens and causes the NT-150/360 Frequency Converter to shutdown the turbopump if the cooling water or air is inadequate. The turbopump can't be restarted until the thermal switch closes and the converter is reset by pressing the STOP pushbutton.

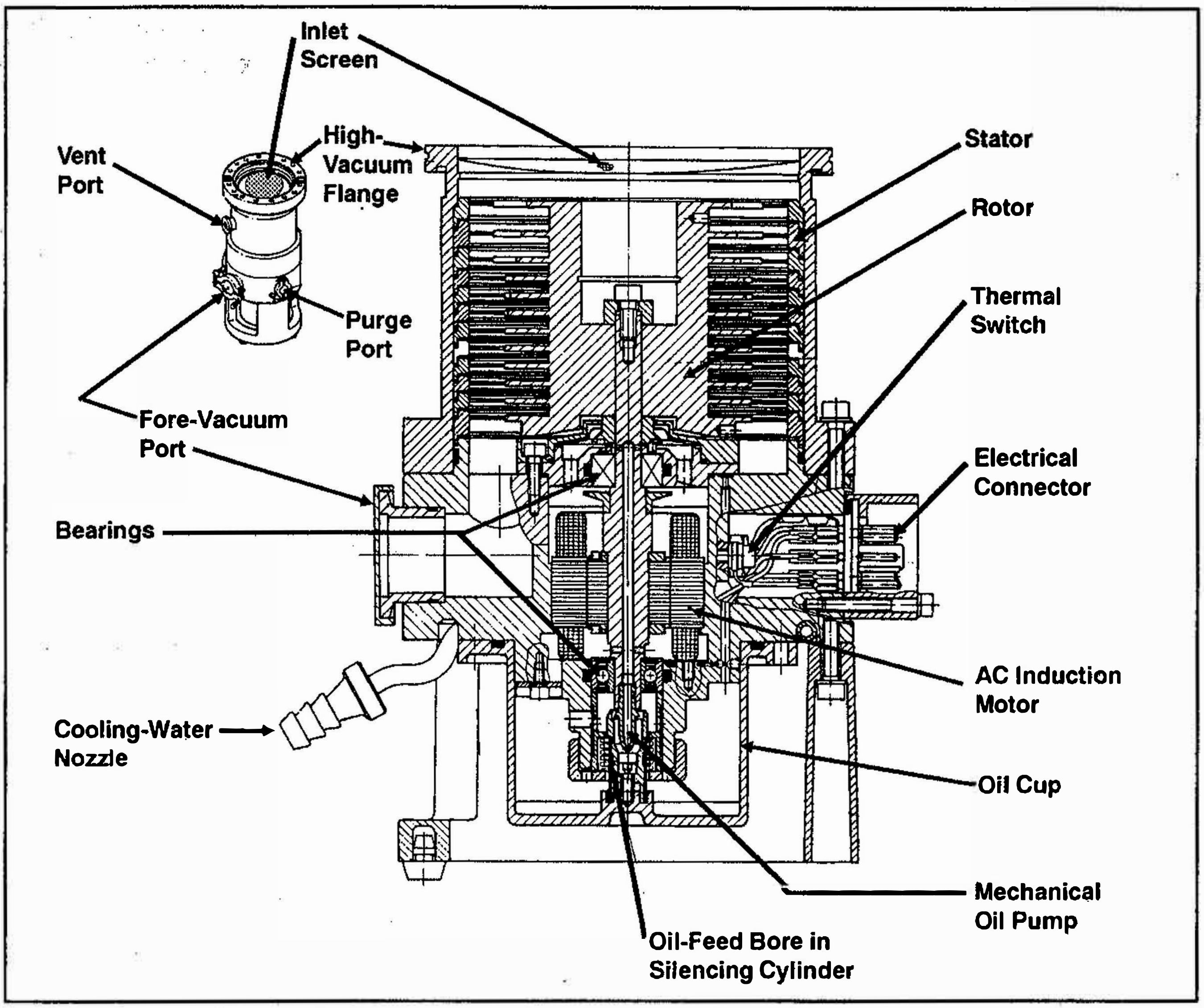


Figure 5-2. Sectional View of the TMP150 V

The H models have an electric oil pump that is needed to ensure that the bearings are lubricated when the pump is mounted horizontally (see Figure 7-3). The H pump also requires a different converter which contains the drive and safety circuit for the oil pump (see Section 5.5.11). See Section 2.4.1 for the acceptable mounting positions for the V and H models and Section 5.2 for additional information on the oil-pump housing for the H pump models.

The TURBOVAC is a turbomolecular pump used to evacuate a chamber or system to the high vacuum region. Its pumping speed is very high for heavy molecules while it is considerably lower for light molecules such as hydrogen. Its pumping speed also decreases at pressures above 10^{-2} mbar. Thus, a backing pump is required to shorten the pumpdown time at higher pressures and to evacuate the hydrogen. The ultimate total pressure is mainly determine by the amount of hydrogen present. At very low pressures, most of the hydrogen originates from the metal walls of the vacuum chamber.

All oil-lubricated pumps have a vent and a purge port (see Figure 5-1). The vent port is the KF10 port in the side of the upper pump housing; the purge port is the KF10 port on the pump's base housing near the KF25 fore-vacuum port. It is important to vent turbopumps during shutdown to prevent oil vapors from backstreaming from the backing pump into the high vacuum portion of the turbopump.

For standard application, the purge port is sealed off and the pump is normally vented through the vent port.

However, if the pump is exposed to corrosive or aggressive process gases or gases that contain or abrasives or metallic dust, venting through the vent port would result in harmful process gases entering the bearing cavity and damaging the oil film. Harmful process gas can also be drawn into the bearing area if the inlet pressure becomes higher than the original foreline pressure. Particles as small as 5 microns can cause damage.

Thus, for harmful process gases, you must seal the vent port and use dry inert gas to purge and vent the pump through its purge port. A special Purge/Vent Valve is required which allows a constant flow (minimum 12 sccm at 0 psig) during operation for purging and which automatically increases the flow to 4800 sccm to vent the pump during shutdown (see Appendix A.6).

This purge and venting gas keeps the motor/bearing cavity at higher pressure than the foreline, thus preventing the bearing and oil from being exposed to harmful process gas.

Even though inert gas purging allows you to pump many corrosive and aggressive gases, we don't recommend pumping oxidizers or higher than atmospheric concentrations of oxygen with any pump which uses HE-500 or any other hydrocarbon oil.