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April 1997

Instruction Manual

VacIon Plus 500

StarCell	**Model 919-0106**
Triode	**Model 919-0206**
Noble Diode	**Model 919-0306**
Diode	**Model 919-0406**

SAFETY SUMMARY

Operators and service personnel must be aware of all hazards associated with this equipment. They must know how to recognize hazardous and potentially hazardous conditions, and know how to avoid them. The consequences of unskilled, improper, or careless operation of the equipment can be serious. This product must only be operated and maintained by trained personnel. Every operator or service person must read and thoroughly understand operation/maintenance manuals and any additional information provided by Varian. All warnings and cautions should be read carefully and strictly observed. Address any safety, operation, and/or maintenance questions to your nearest Varian office.

The following format is used in this manual to call attention to hazards:

WARNING
Warnings are used when failure to observe instructions or precautions could result in injury or death.

CAUTION
Cautions are used when failure to observe instructions could result in damage to equipment, whether Varian-supplied or other associated equipment.

NOTE
Information to aid the operator in obtaining the best performance from the equipment.

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1-1 General

Varian VacIon *Plus* pumps operate in the vacuum range from 10^{-2} to below 10^{-11} Torr (mbar).

The VacIon *Plus* 500 pump (see Fig. 1-1) is suitable for a variety of applications, such as particle accelerators, MBE mass spectrometers and general purpose UHV. They feature high pumping speed for getterable gases, pumping stability for noble gases, and low leakage current.

Varian also provides high voltage control units with current and pressure indication.

The pump heater option is integrated into the pump/magnet assemblies without changing exterior dimensions.

A unique, non-evaporable getter (NEG) option provides an extra margin of pumping, in order to achieve superior vacuum levels in the UHV range.

Fig. 1-1 - VacIon Plus 500 pump

1-2 Specifications

Figures 1-2, 1-3, 1-6, 1-7, 1-10, 1-11 and 1-14 show the pumping speed vs pressure diagrams for saturated and unsaturated pumps.

Figures 1-4, 1-5, 1-8, 1-9, 1-12, 1-13, 1-15, 1-16 show the pressure vs current diagrams. The diagrams are for pumps controlled by means of a MultiVac controller.

NOTE

The steps on the diagrams are characteristic of the MultiVac step operation: steps occur whenever the current reaches a value at which the MultiVac controller output varies.

STARCELL

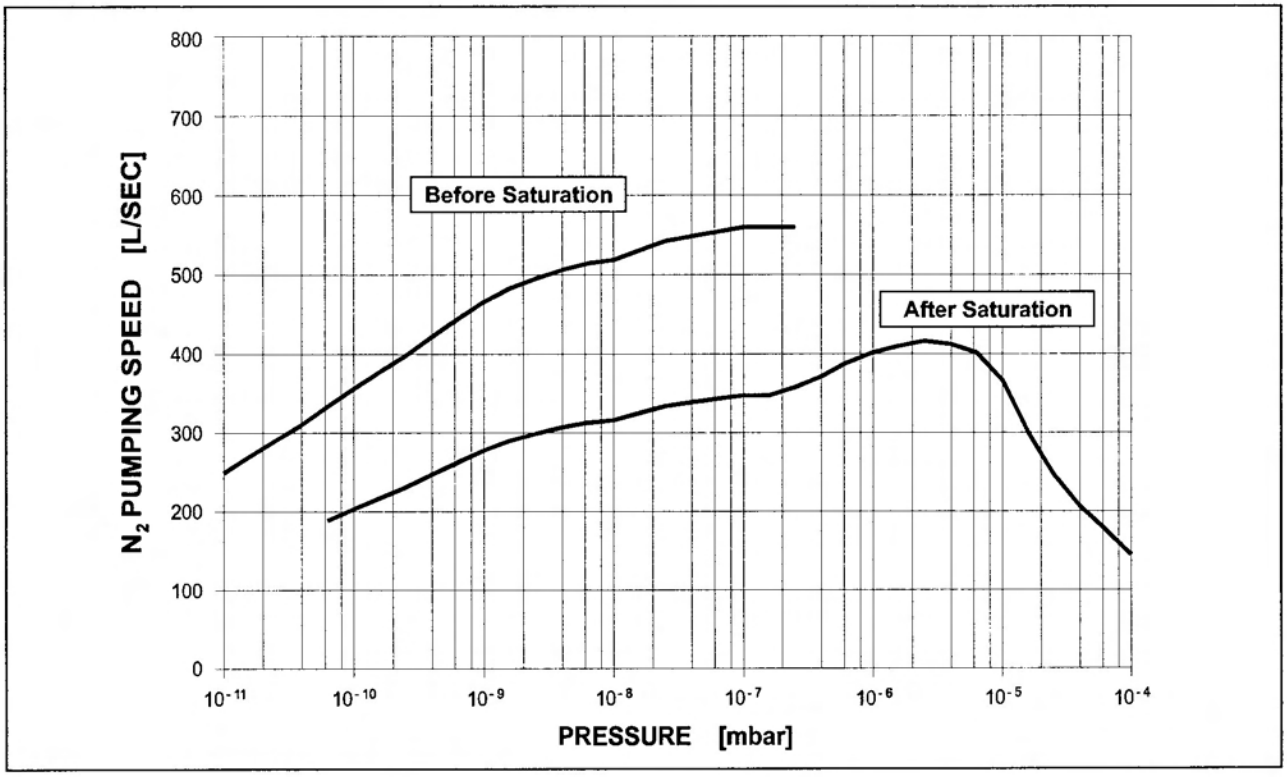

Fig. 1-2 - VacIon Plus 500 StarCell pum pumping speed vs pressure for Nitrogen

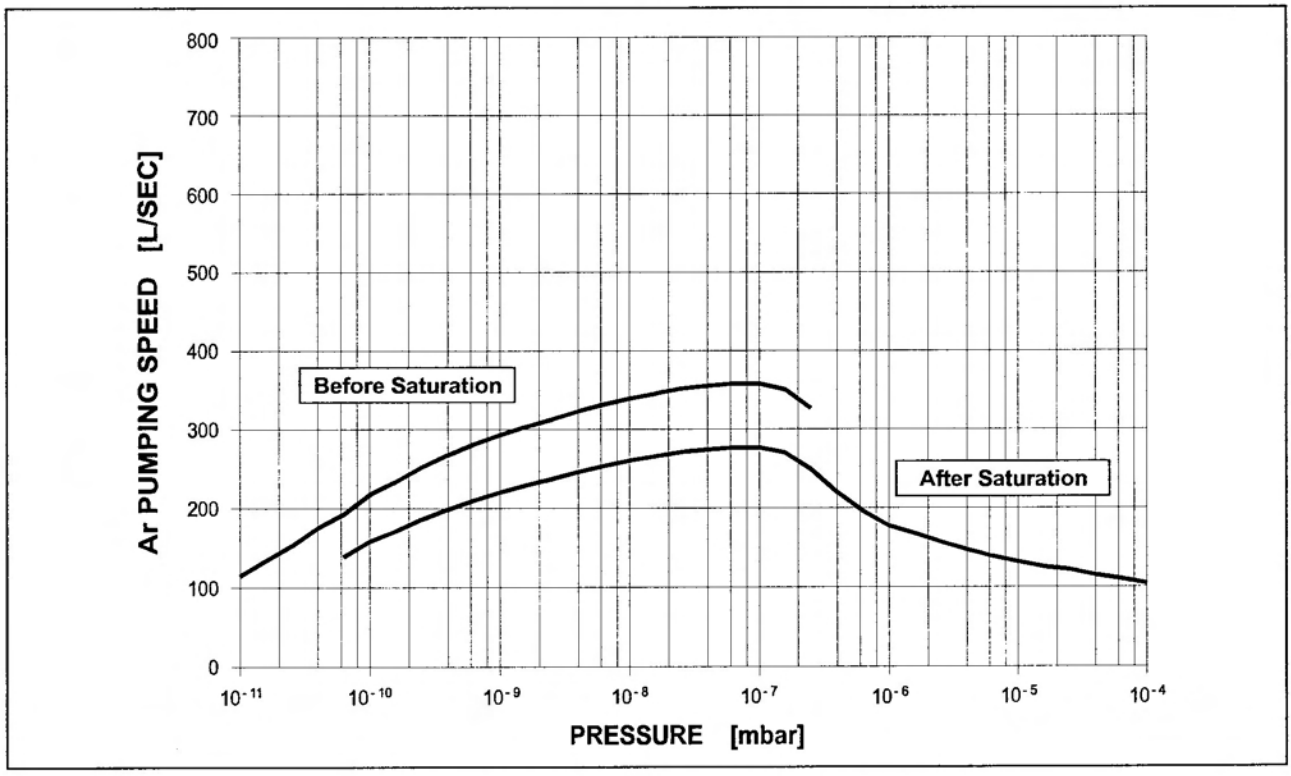

Fig. 1-3 - VacIon Plus 500 StarCell pump pumping speed vs pressure for Argon

STARCELL

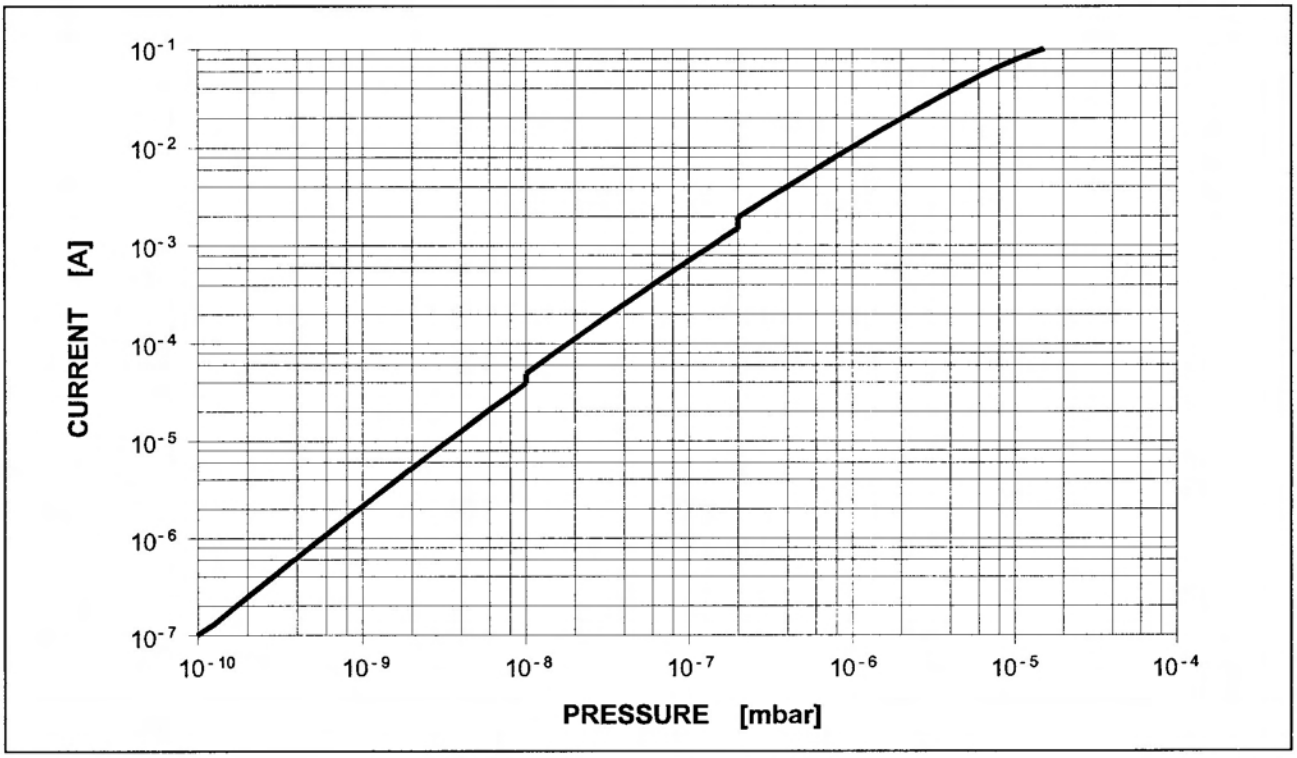

Fig. 1-4 - VacIon Plus 500 StarCell pump pressure (mbar) vs current diagram

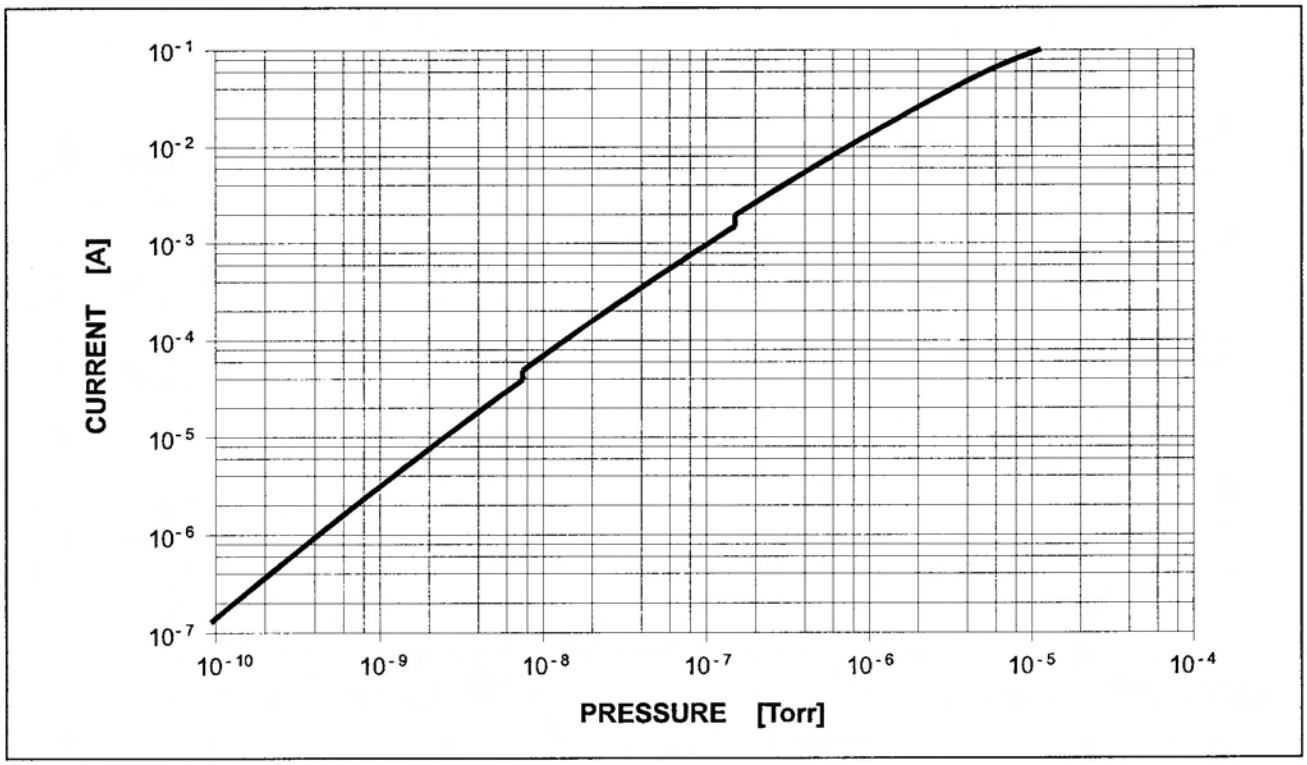

Fig. 1-5 - VacIon Plus 500 StarCell pump pressure (Torr) vs current diagram

TRIODE

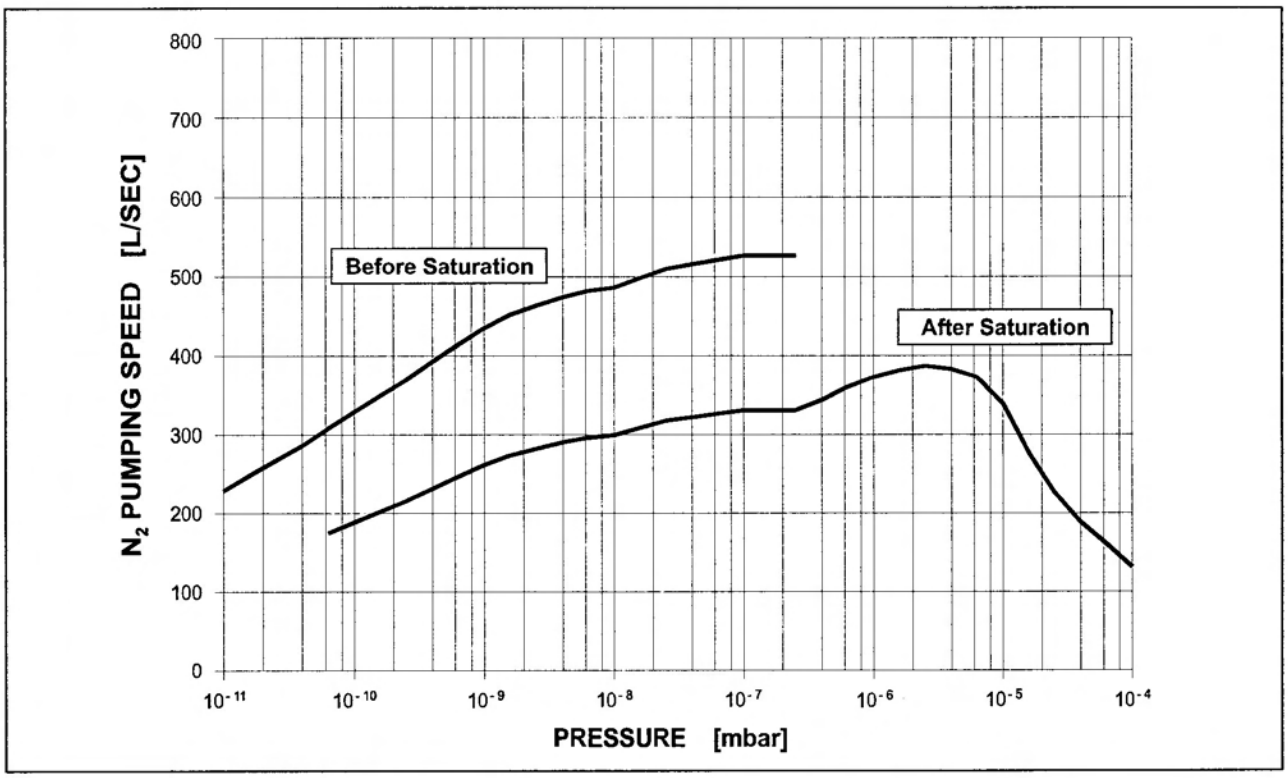

Fig. 1-6 - VacIon Plus 500 Triode pump pumping speed vs pressure for Nitrogen

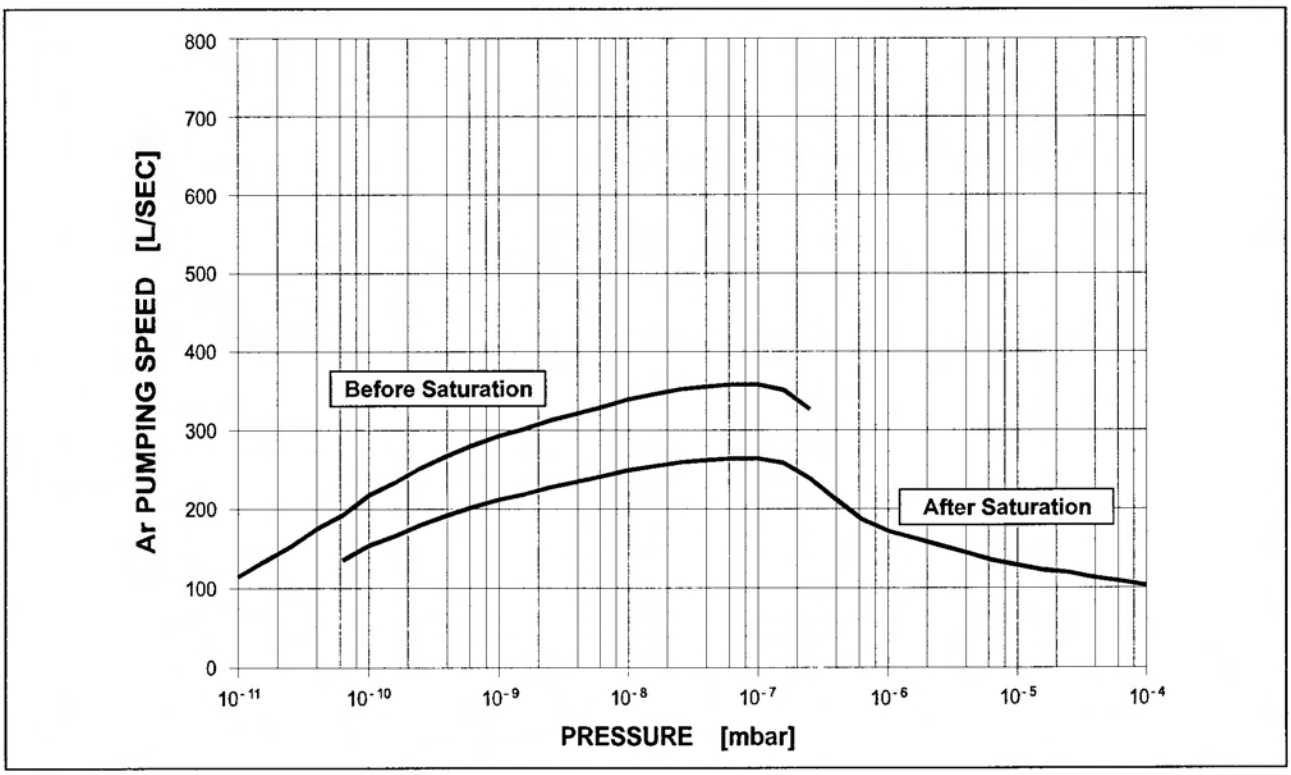

Fig. 1-7 - VacIon Plus 500 Triode pump pumping speed vs pressure for Argon

TRIODE

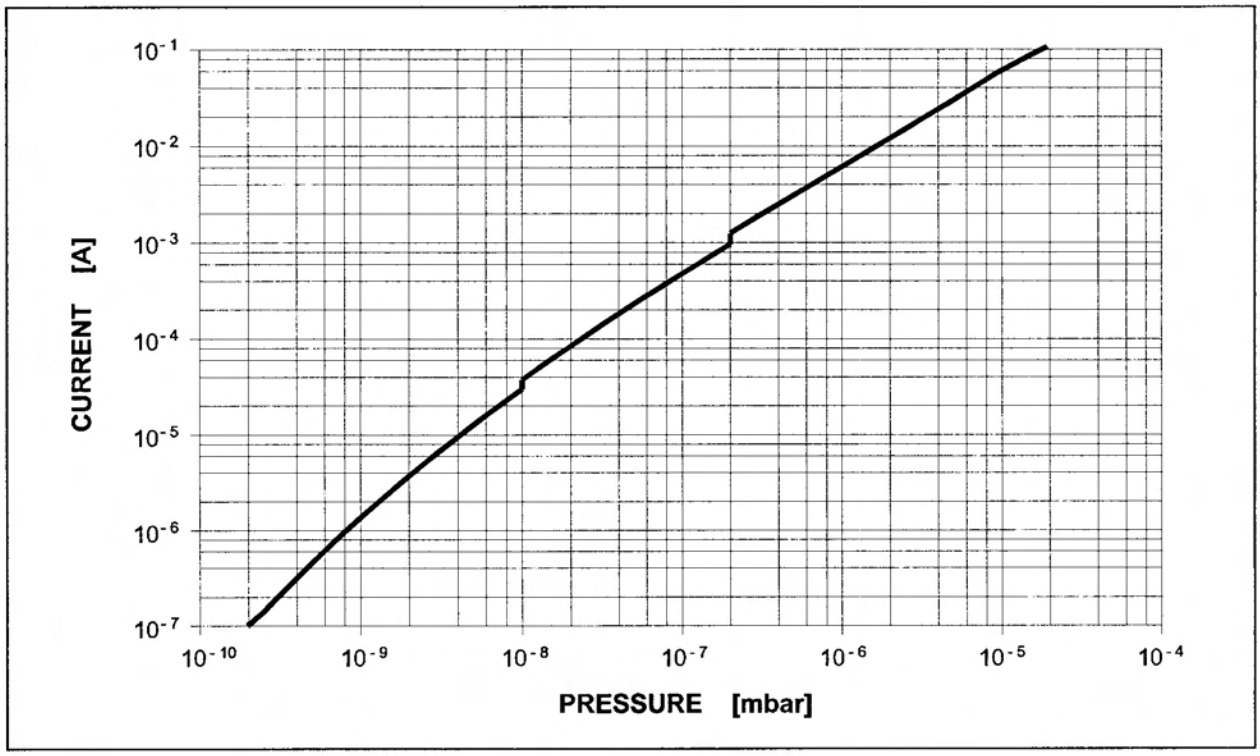

Fig. 1-8 - VacIon Plus 500 Triode pump pressure (mbar) vs current diagram

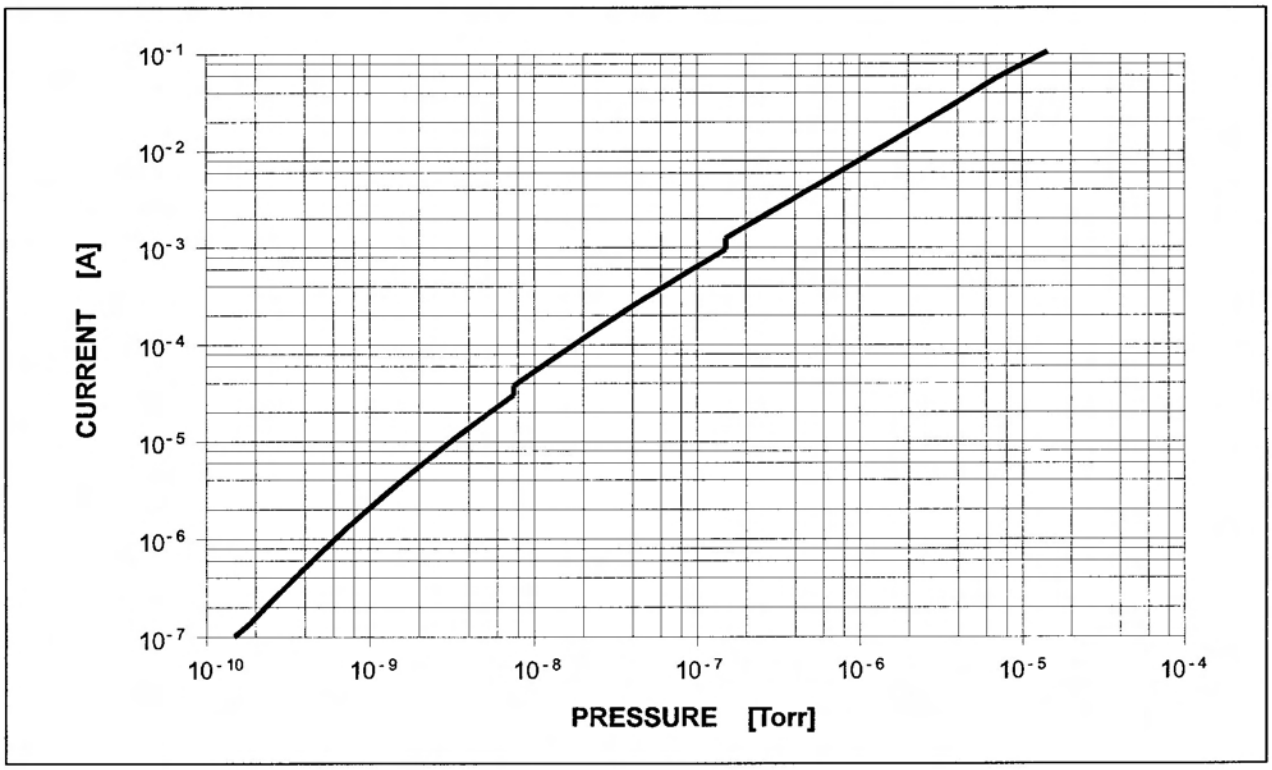

Fig. 1-9 - VacIon Plus 500 pump pressure (Torr) vs current diagram

NOBLE DIODE

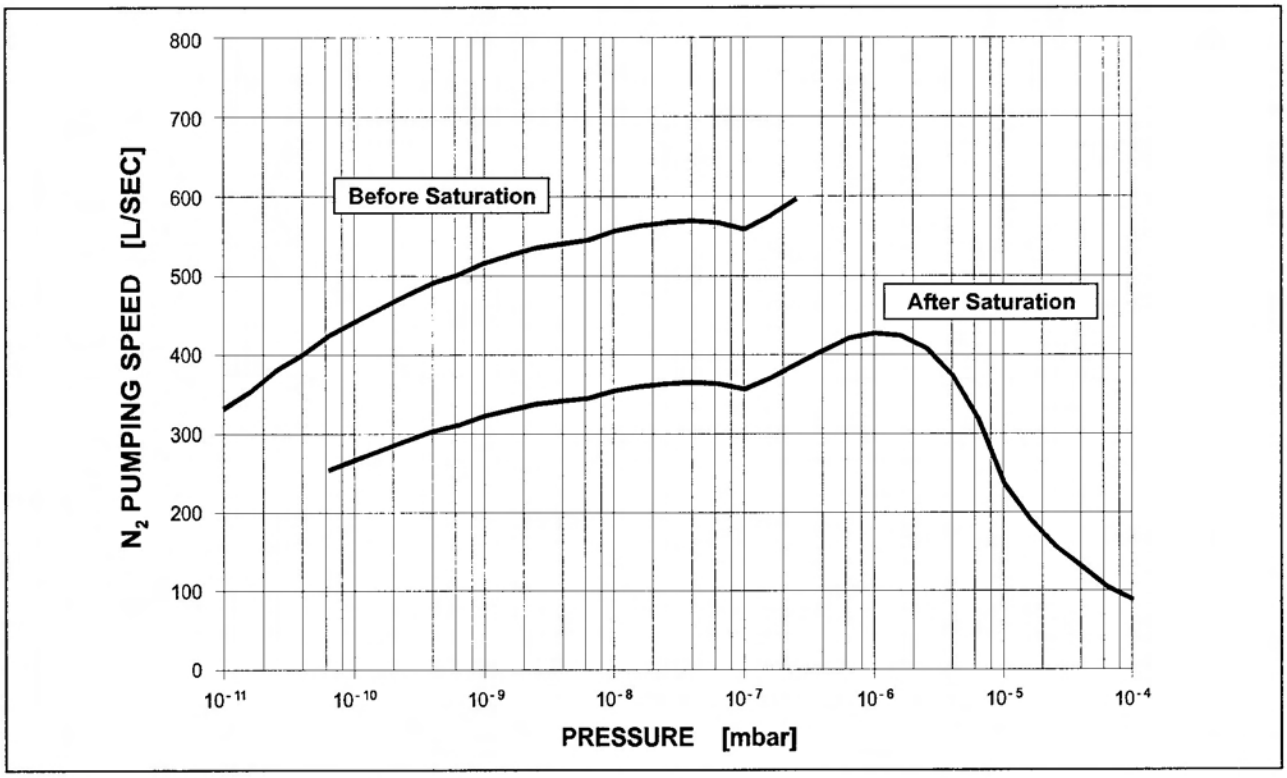

Fig. 1-10 - VacIon Plus 500 Noble Diode pump pumping speed vs pressure for Nitrogen

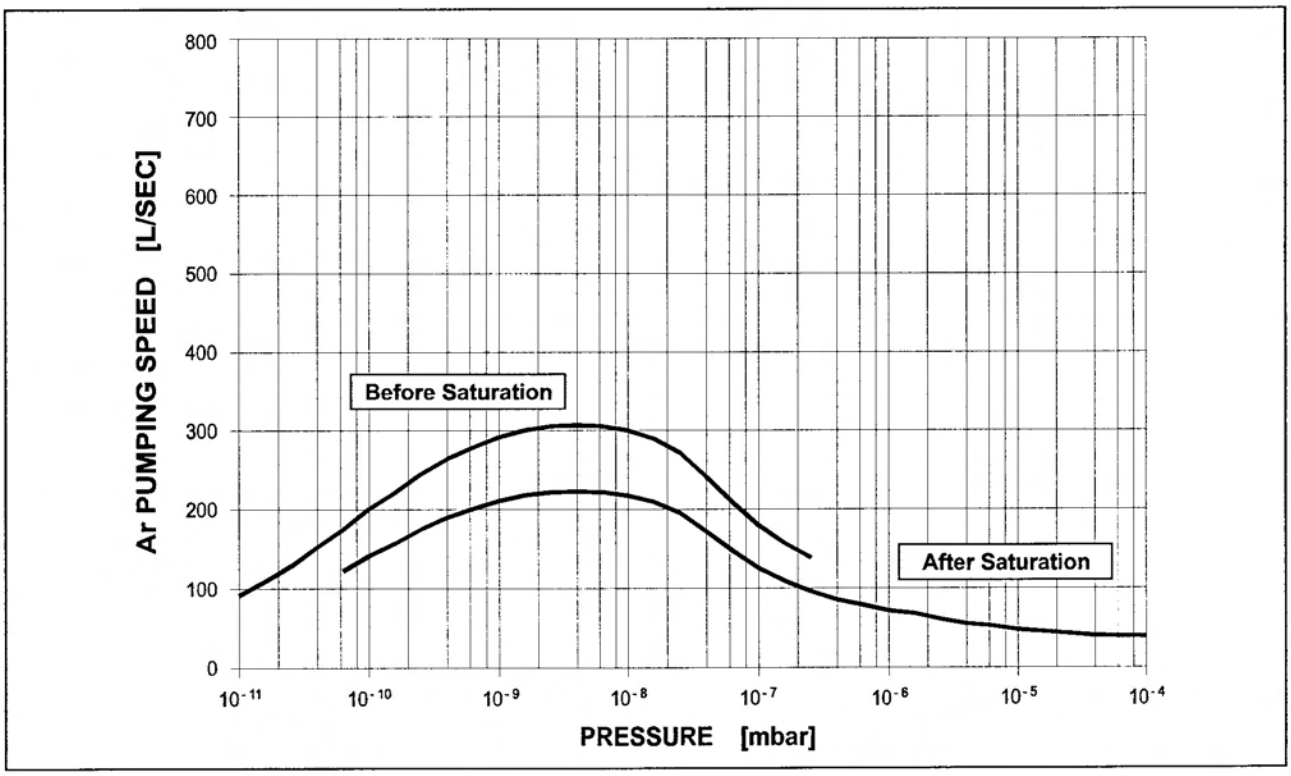

Fig. 1-11 - VacIon Plus 500 Noble Diode pump pumping speed vs pressure for Argon

NOBLE DIODE

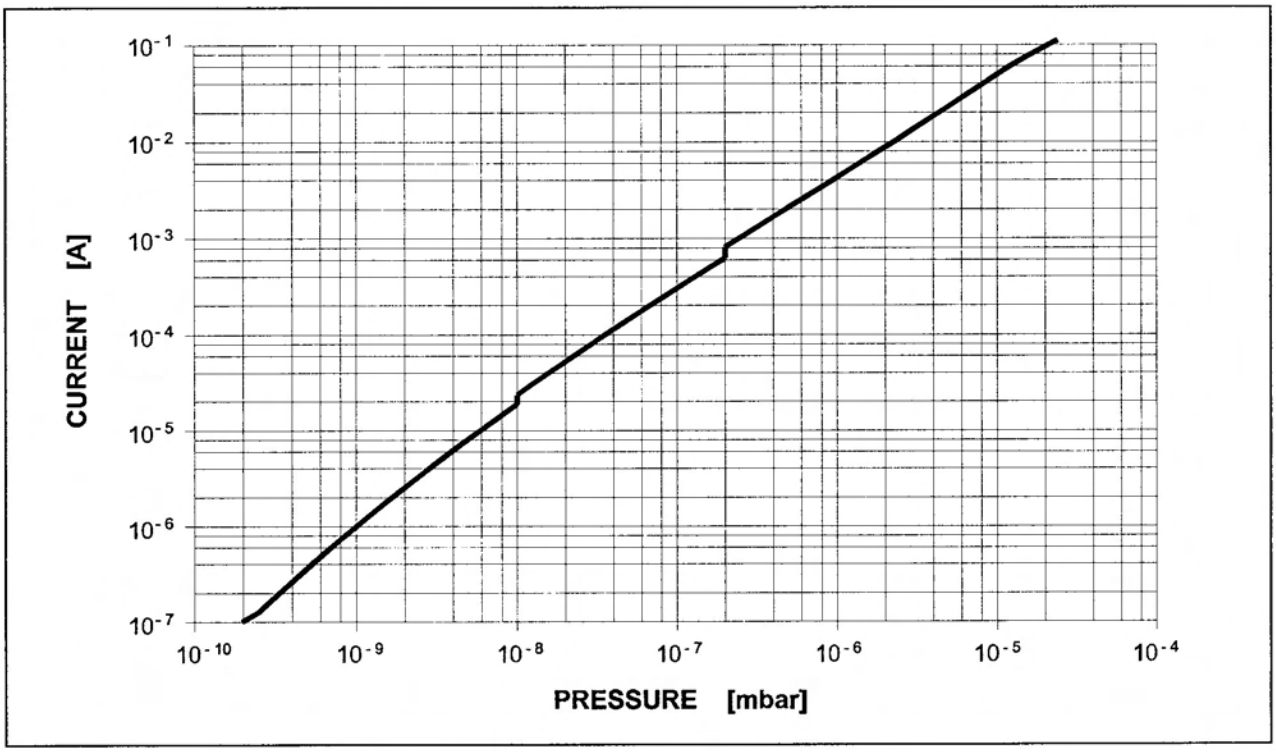

Fig. 1-12 - VacIon Plus 500 Noble Diode pump pressure (mbar) vs current diagram

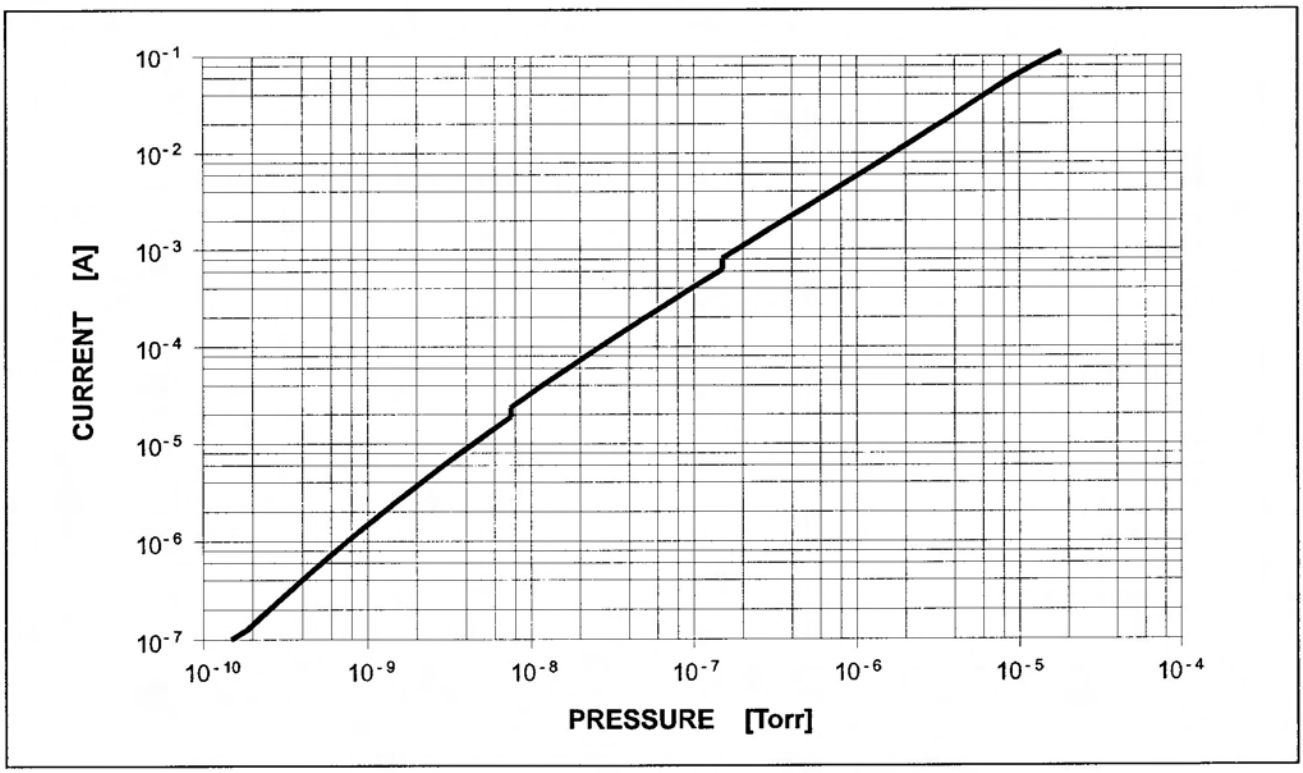

Fig. 1-13 - VacIon Plus 500 Noble Diode pump pressure (Torr) vs current diagram

DIODE

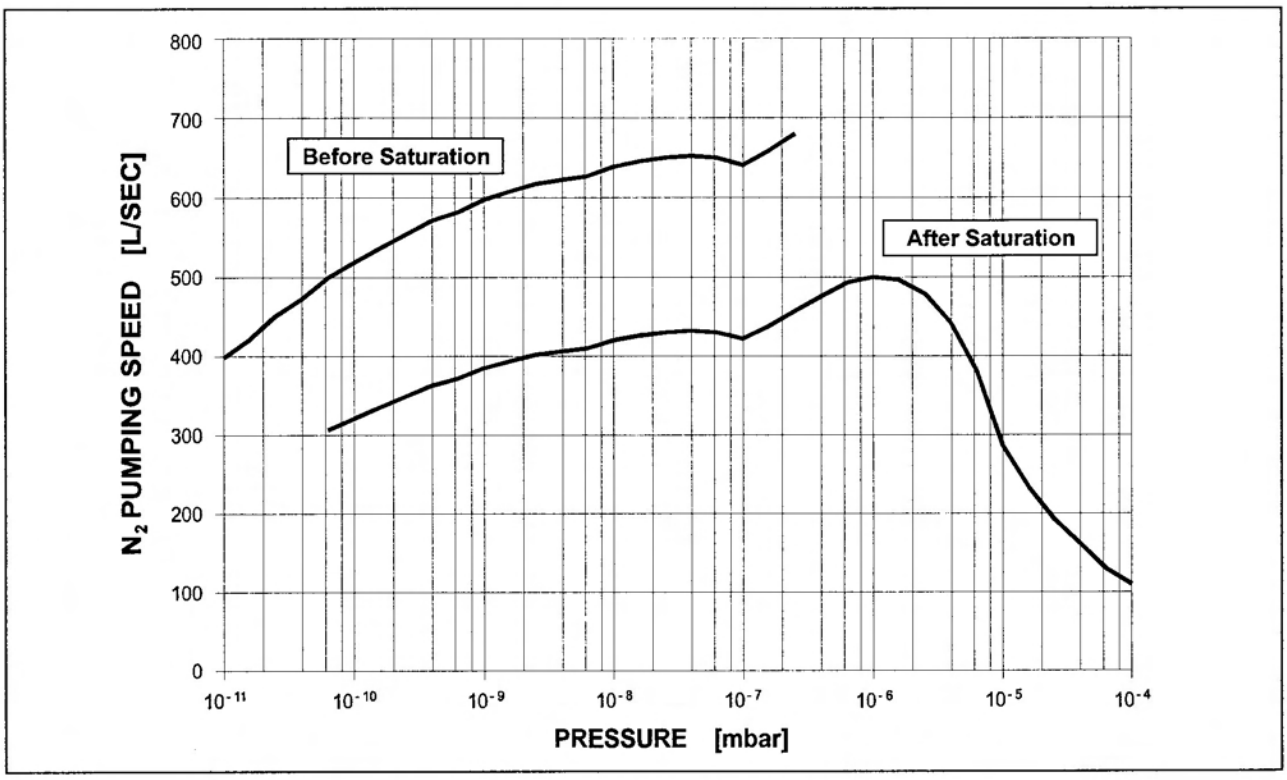

Fig. 1-14 - VacIon Plus 500 Diode pump pumping speed vs pressure for Nitrogen

DIODE

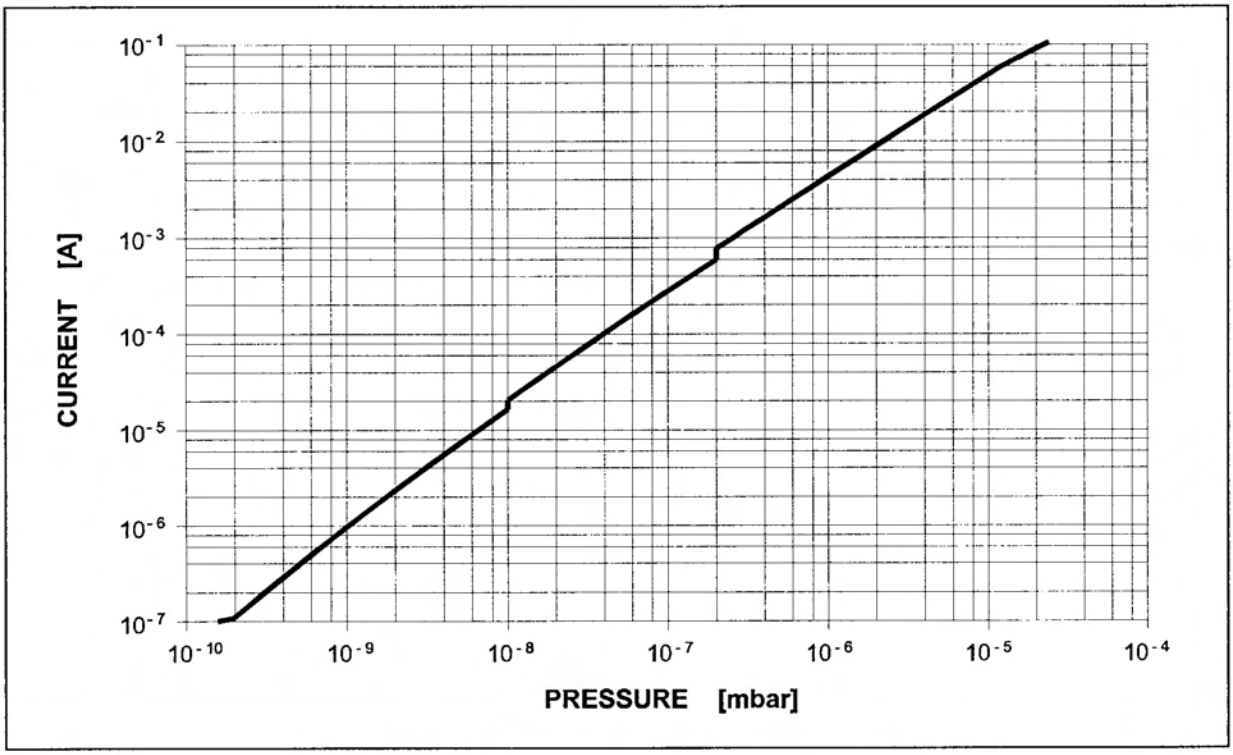

Fig. 1-15 - VacIon Plus 500 Diode pump pressure (mbar) vs current diagram

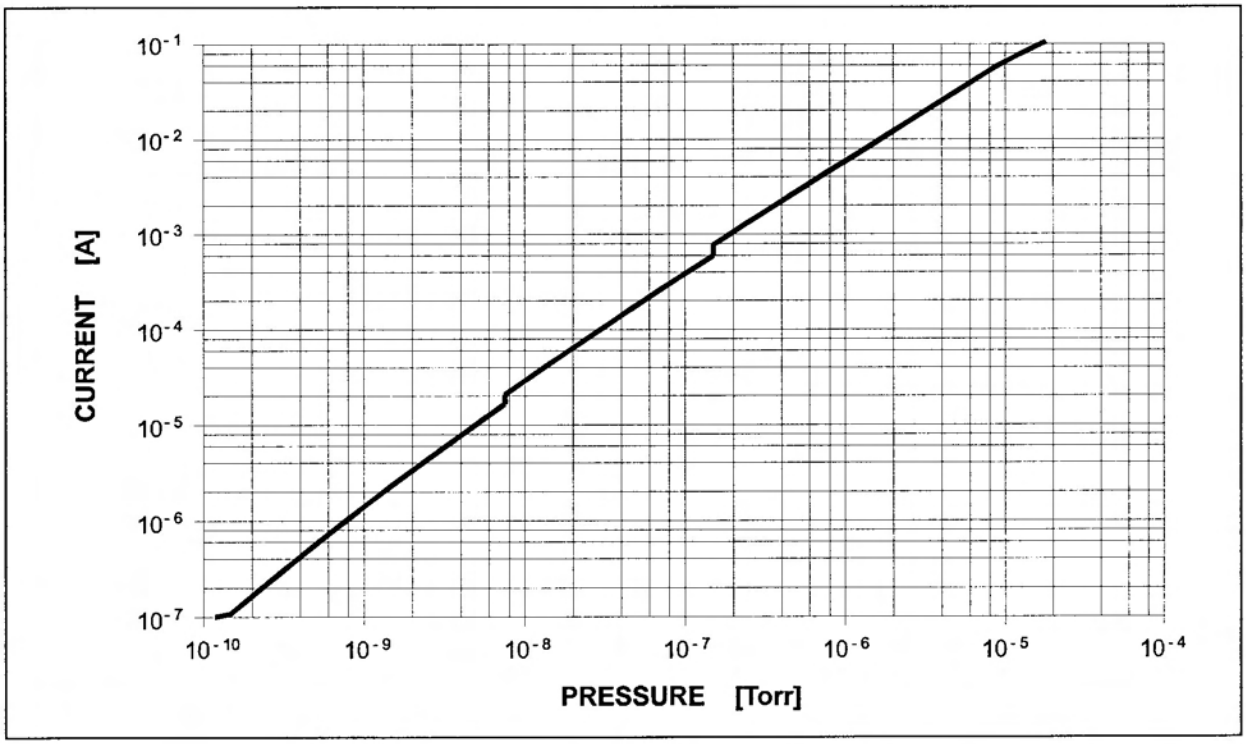

Fig. 1-16 - VacIon Plus 500 Diode pump pressure (Torr) vs current diagram

VacIon Plus 500 Specification

Specification \ Model	StarCell	Triode	Noble Diode	Diode
Nominal pumping speed * (l/s)	410	390	440	500
Operating life at $1x10^{-6}$ mbar (hours)	80,000	35,000	50,000	50,000
Operating Voltage (maximum)	-7000 Vdc +/-10%		+7000 Vdc +/-10%	
Maximum starting pressure (mbar)	$\leq 1x10^{-2}$	$\leq 1x10^{-2}$	$\leq 1x10^{-3}$	$\leq 1x10^{-3}$
Ultimate pressure (mbar)	Below 10^{-11}			
Inlet flange	8" CFF (NW 150) AISI 304 LN SST			
Internal volume (litres)	36.2			
Maximum baking temperature (°C)	350			
Temperature limits (°C): Pump / Magnet / Flange	400 / 350 / 500			
Material: Body	AISI 304 SST			
Cathode	Titanium	Titanium	Titanium/ Tantalum	Titanium
Anode	AISI 304 SST			
Magnet	Ferrite			
Weight, lbs (kg)	Net 264 (120), Shipping 297 (135)			

* Tested according ISO/DIS 3556-1-1992

1-3 Stray magnetic field

Curves of stray magnetic field strength along the center line of the pump and in the plane of the flange as a function of distance from the pump are shown in Figs. 1-18 through 1-22, where Bx is the magnetic field along X axis, By is the one along Y axis and Bz is the one along Z axis.

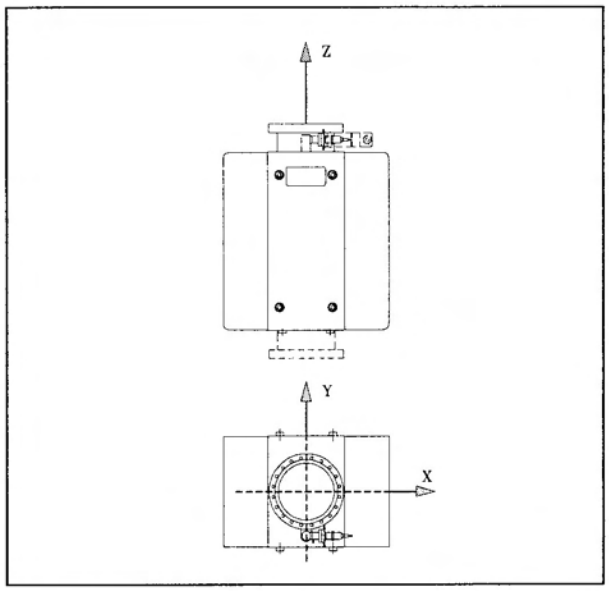

Fig. 1-17 - VacIon Plus pump axis identification

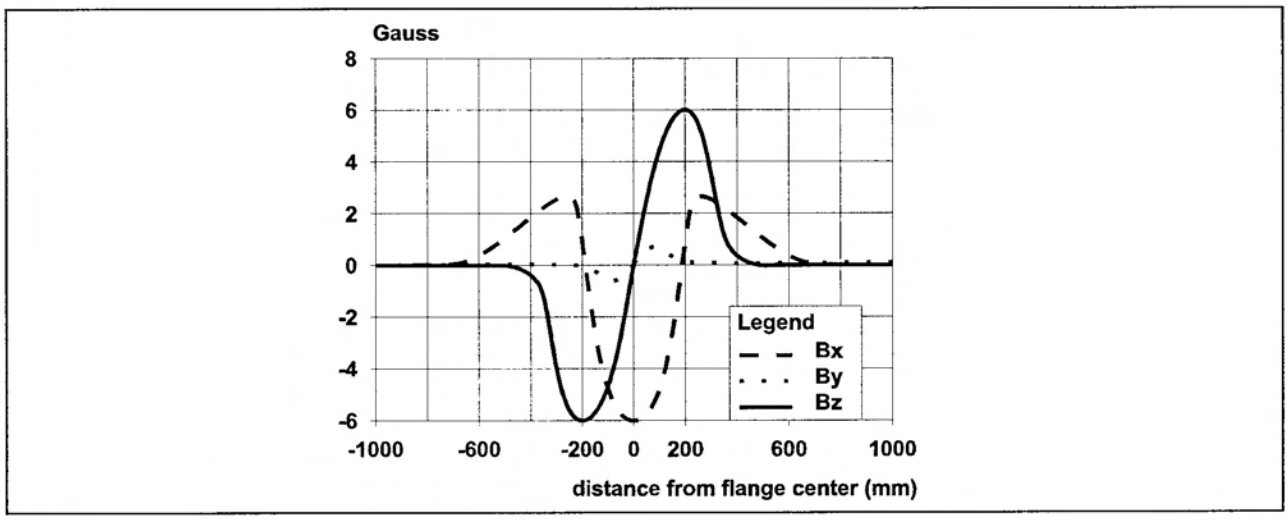

Fig. 1-18 - VacIon Plus 500 pump stray magnetic field from flange along x axis (z = 0)

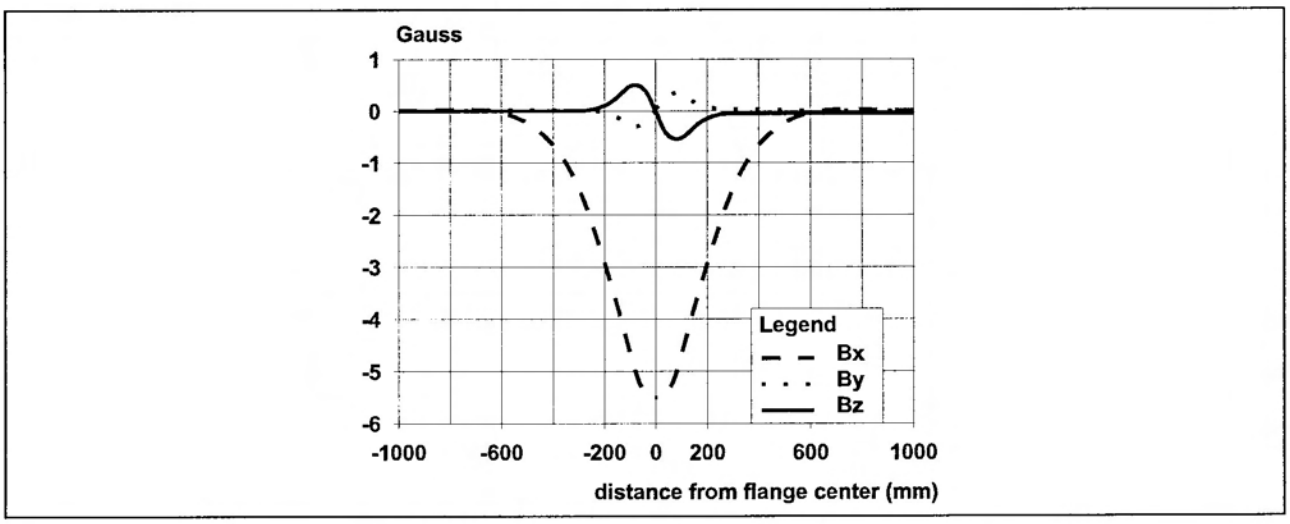

Fig. 1-19 - VacIon Plus 500 pump stray magnetic field from flange along y axis (z = 0)

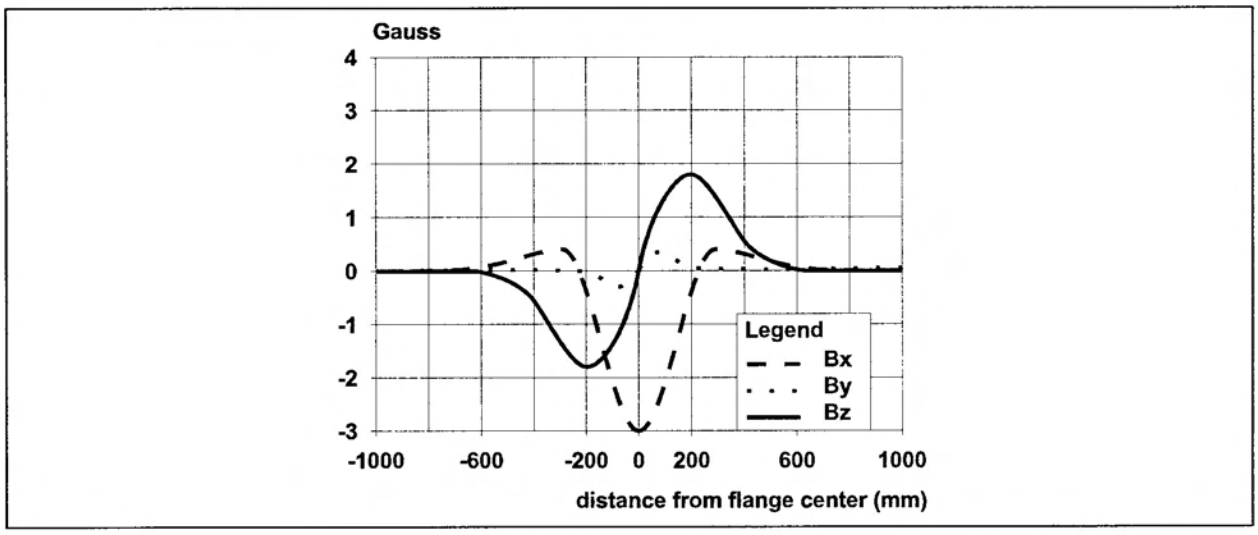

Fig. 1-20 - VacIon Plus 500 pump stray magnetic field from flange along x axis (z = 100 mm)

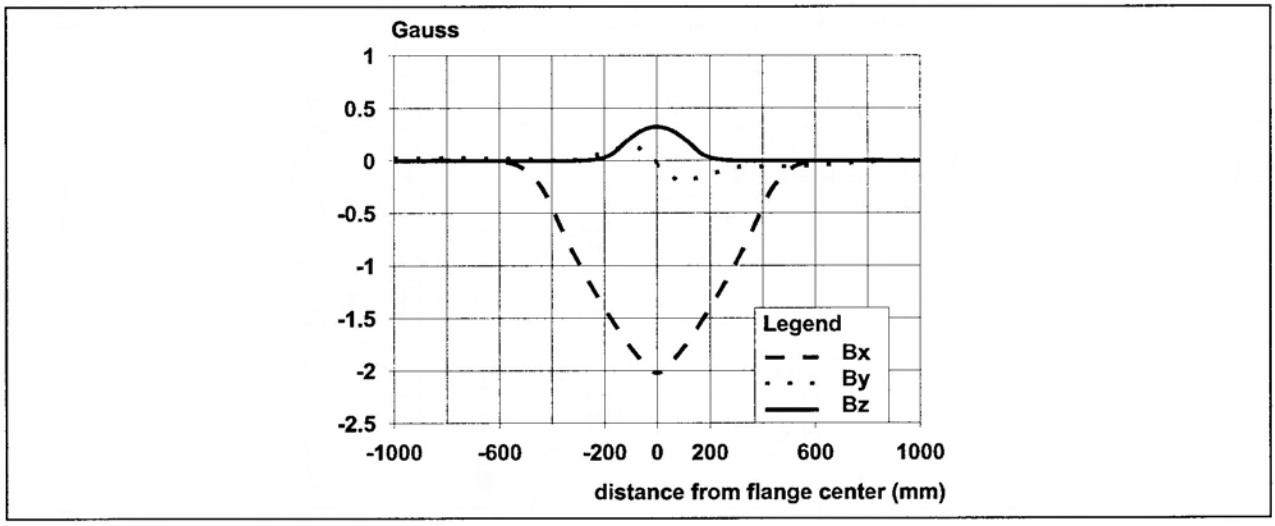

Fig. 1-21 - VacIon Plus 500 pump stray magnetic field from flange along y axis (z = 100 mm)

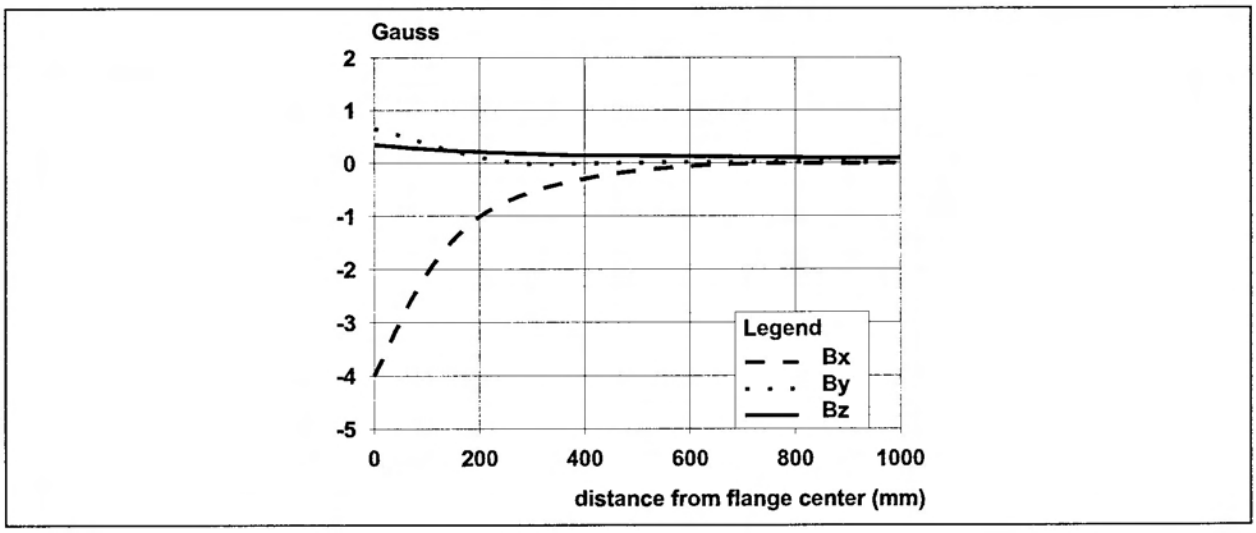

Fig. 1-22 - VacIon Plus 500 pump stray magnetic field from flange along z axis

1-4 Pump outline

The outline drawing for the VacIon *Plus* 500 pump is shown in Fig. 1-23.

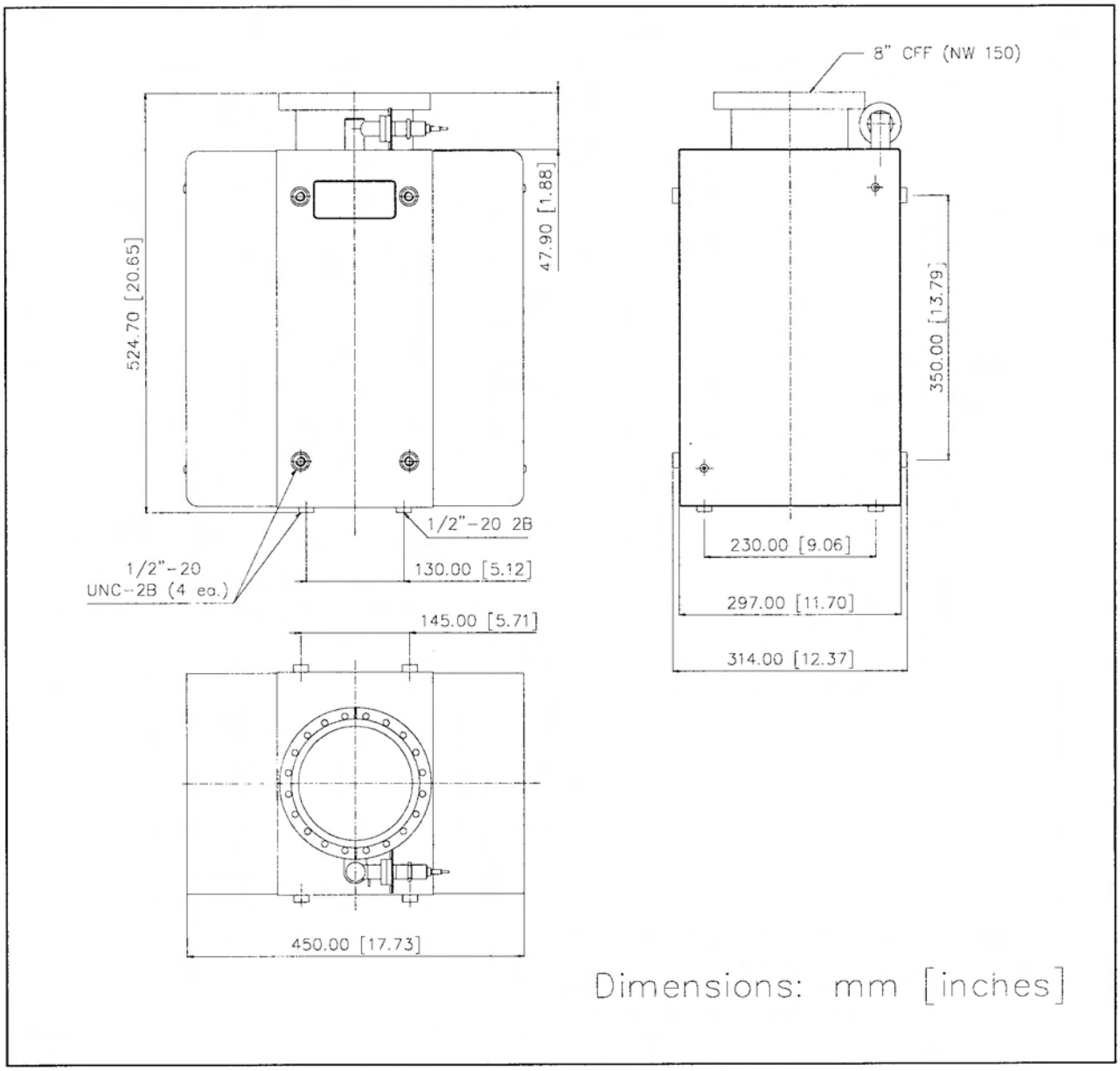

Fig. 1-23 - VacIon Plus 500 pump outline

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2-1 Inspection procedure

VacIon *Plus* pumps are baked out, sealed, leak-checked and evacuated to the $1x10^{-10}$ Torr (mbar) range prior to shipping.

The following information and procedures can be used to establish the vacuum integrity of a VacIon *Plus* pump before installation.

2-1.1 Visual inspection

Inspect the pump and magnet for physical damage which may have occurred during shipment. Examine, in particular, the brazed joints on the high voltage feedthrough.

WARNING

The pinch-off seal is extremely sharp. Be careful.

A VacIon *Plus* pump that has been exposed to atmosphere during shipment, or while in storage, will operate properly if it has not been damaged.

The pump is not harmed by atmospheric exposure, although it is good practice to keep it under vacuum when not in use to exclude dust and the accumulation of water vapour from the environment.

2-1.2 Vacuum evaluation

To determine the vacuum level of the unopened pump:

a) Connect the pump to the control unit as directed in the instruction manual of the control unit.

WARNING

The high voltage which is present in the ion pump when it is powered from the power unit can cause severe injury or death.

Be sure the garter spring is mounted on the high voltage feedthrough because the ground connection is brought from the control unit to the pump body through the garter spring. An additional safety ground connection for the pump body is made through the fixing screws of the H.V. cable connector.

b) With the main power switch in the OFF position, plug the control unit into a suitable power source.

c) Turn the power to ON.

d) Observe the reading for an indication of one of the following conditions:

   1) If the pump is free of leaks and is at a low pressure, the pressure indication shall quickly fall to the 10^{-8} Torr (mbar) range as the volume of gas is pumped.

   2) If the pressure inside the pump is at or near atmospheric level, an arc may strike inside the high voltage feedthrough with a popping sound and the pump current will fluctuate. If this occurs, turn the power OFF immediately. Note that pumps at atmosphere may not draw any current.

e) If the vacuum integrity has been lost, the pump should be leak-checked with a mass spectrometer leak detector before installation on the system.

NOTE

To prevent water vapour or dust particles from entering the pump, leave the pinch-off tubulation/tube flange assembly sealed until ready to attach the pump to the vacuum system.

2-1.3 Short circuits

If there is a short circuit between the anode and cathodes in the pump, the short-circuit current of the control unit will be drawn and zero voltage will be indicated. If a short circuit exists in the control unit or high voltage cable and connector, zero voltage will also be observed when the high voltage connector is disconnected from the pump (refer to the control unit manuals).

2-2 Typical installation

A typical installation is shown in Fig. 2-1 and consists of:

1) VacIon Plus pump.
2) A Valve to seal off the pump from the rest of the system (if required).
3) The control unit.
4) A roughing pump.
5) A thermocouple gauge capable of indicating pressure from atmosphere to 10^{-3} Torr (mbar) range.
6) A valve to seal off the roughing pump from the vacuum chamber. Roughing lines, are usually made of stainless steel or copper tubing, or other low vapour pressure material.
7) High voltage cable.
8) Baking pump.

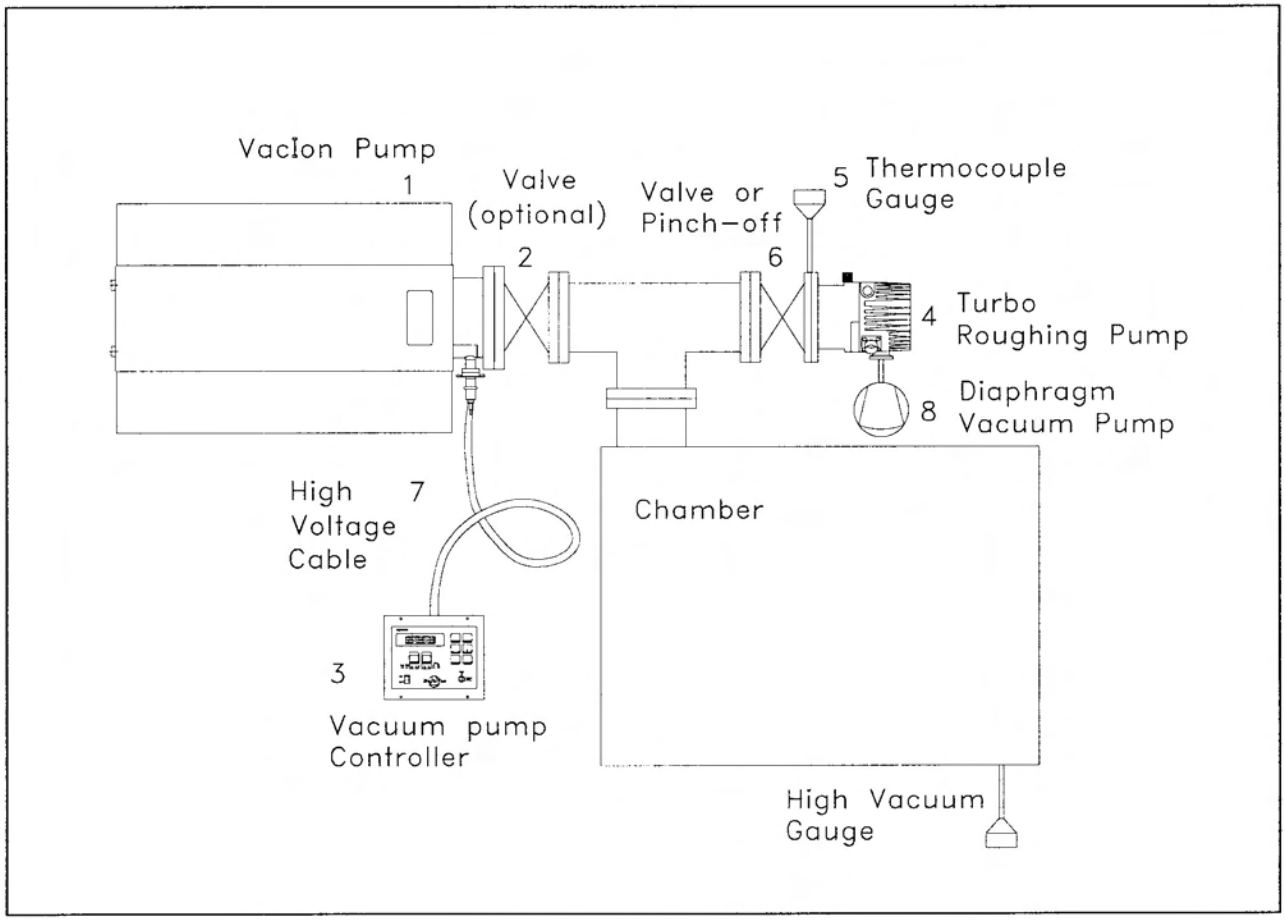

Fig. 2-1 - Typical installation

2-3 Pump installation

The pumps can be mounted in any orientation. For mountings other than vertical, the pump should be supported using the mounting feet at the bottom of the pump.

The pump should be kept sealed with its pinch-off tubulation until it is ready for attachment to the vacuum system. This avoids accumulation of dust and other undesirable materials. Before breaking the pinch-off seal, consult the inspection procedure (see paragraph 2-1).

CAUTION

Do not open the pinch off-seal with a saw or grinder. These methods will cause metal particles to be drawn into the pump by the inrushing air as the pump is opened.

When ready to install the pump, release the internal vacuum by using pliers to open the copper tube pinch-off (see Fig. 2-2).

WARNING

The pinch-off seal is extremely sharp. Be careful when opening. Watch your fingers.

Fig. 2-2 - Opening the copper tube pinch-off

Unscrew the main flange bolts and lift the blank flange with the help of a bolt screwed into the threaded hole as shown in Fig. 2-3.

Connect the pump to the vacuum chamber with a short length and large diameter tubulation in order to retain as much of the pumping speed of the pump as possible. Proceed as follows:

1) Inspect the mating flanges for cleanliness and absence of scratches on the knife edge.
2) Place a new copper gasket between pump flange and vacuum chamber flange.
3) Bolt mating flanges of the pump to the chamber with the screws provided with the ion pump. For flanges over NW 35 (2.75" O.D.) also mount washers below the nut and screw heads.
4) Apply high temperature lubricant to the screw threads. Lubrication simplifies sealing and disassembly. A recommended lubricant is Fel-Pro C-100.

NOTE

Lubrication is essential to prevent galling of the nut and screw after bakeout.

Fig. 2-3 - Removing the blank

5) Attach the nuts and tighten each one in turn to 4.5 - 8 ft.-lbs (0.6 - 1.1 Kgm) of torque. After tightening a nut, always tighten the opposite nut with respect to the center of the flange. This will partially close the gap between the flange faces.

6) Repeat the sequential tightening for two more cycles.

7) Continue tightening the bolts until the flange faces meet and a pronounced increase in torque is felt.

Note that it's not possible to fix the screws from lower side, but only from upper side of the flange.

To allow a complete flexibility in the installation, a stud mounting kit is available (see Fig. 2-4). For ordering information please refer to Section V of this manual.

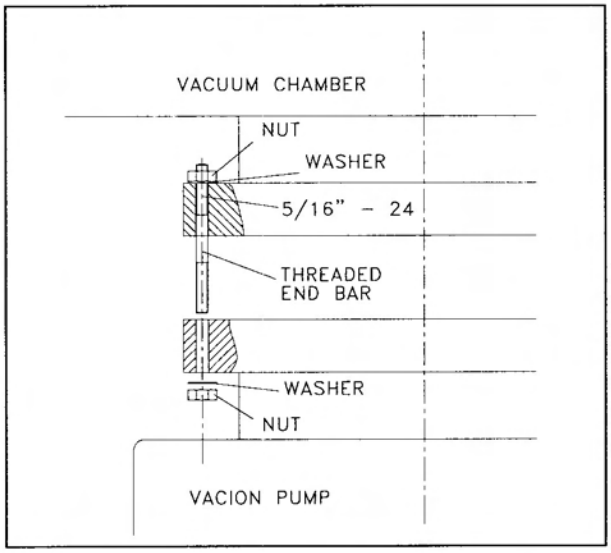

Fig. 2-4 - Flange connection by means of the stud mounting kit

2-4 Control unit connection

WARNING

The high voltage present in the high voltage cable which connects the control unit to the ion pump, can cause severe injury or death. Before mounting the high voltage connector of the cable on the pump high voltage feedthrough, or before removing it, be sure the main power is removed from the control unit.

Connect the control unit to the ion pump with the coaxial high voltage cable assembly as follows:

1) Be sure the garter spring is properly mounted on the pump high voltage feedthrough.

2) Push the female end of the cable connector over the high voltage feedthrough.

3) Lock the connector to the feedthrough brackets with the screws mounted on the high voltage connector.

4) Push the male end of the cable connector into the socket on the control unit rear panel. (Refer to the control unit instruction manual).

WARNING

Before removing the high voltage connector of the cable from the control unit, be sure the main power is removed from the control unit. Wait at least 10 seconds after removing the main power from the control unit, to allow capacitors to discharge completely.

To disconnect the coaxial high voltage cable assembly slide away the safety sleeve (very little sleeve travel is required) from the control unit and at the same time pull on the male end of the cable connector to remove the connector from the socket on the control unit.

3-1 General

WARNING

The high voltage present in the high voltage cable which connects the control unit to the ion pump, can cause severe injury or death. Before mounting the high voltage connector of the cable on the pump high voltage feedthrough, or before removing it, be sure the main power is removed from the control unit.

Before removing the high voltage connector of the cable from the control unit, be sure the main power is removed from the control unit. Wait at least 10 seconds after removing the main power from the control unit, to allow capacitors to discharge completely.

Rough pumping down to $1x10^{-4}$ Torr (mbar) is recommended for the most rapid starting. Roughing with an oil-sealed mechanical pump is not desirable, but when used, a trap in the roughing line is recommended to reduce pressure due to water vapor and oils from the mechanical pump. Be careful to minimize the time that this pump is open to the system and ion pump, since mechanical pump vapors will start diffusing into the system at pressures below $1x10^{-1}$ Torr (mbar) and cause contamination. In systems where oils must be completely eliminated, turbopumps or VacSorb roughing pumps should be used. VacIon *Plus* pumps can also be used in conjunction with titanium sublimation pumping. In these cases, the primary pumping is accomplished to the deposition of a fresh titanium film on a surface once the ion pump has evacuated the system to high vacuum.

Hygroscopic deposits and hydrogen absorption into titanium may cause starting times to increase with age. During exposure to air, the deposits of titanium compound absorb water vapor. In subsequent start ups, pump heating causes release of the water vapor and some previously pumped hydrogen; thus, the starting time may be lengthened.

3-2 Operating procedure

Refer to the relevant pump control unit instruction manual and follow the procedure below when operating the pump:

1) With a clean roughing pump, establish a roughing pressure of $1x10^{-2}$ Torr (mbar) or lower in the vacuum system.

2) Plug the control unit into a suitable power source and switch the power ON.

3) Observe the voltage, current, and roughing pressure. If started at $1x10^{-2}$ Torr (mbar), a controller voltage of approximately 300 to 400 volts is typical. A current value near the short-circuit current of the control unit could indicate that an unconfined flow discharge exists in the pump and system. A temporary rise in roughing pressure will usually be noticed during any starting procedure.

4) Allow the roughing valve to remain open after turning on the ion pump until an adequate starting pressure is reached. If the ion pump voltage drops after closing the roughing valves, reopen the valve for additional rough pumping. As the pressure decreases, the voltage again will rise.

5) When the voltage has increased to 2-3 kV, place the control unit in the PROTECT condition. The system is now automatically protected against pressure increases to 10^{-4} Torr (mbar) when the pump is left unattended. If such an increase should occur, the control unit will be turned off automatically.

6) Once in high vacuum, the pressure in the pump can also be determined by reading the current and converting this reading to pressure with the appropriate pressure versus current graph shown in figures of chapter 1.

NOTE

The steps on the charts are a characteristic of the MultiVac step voltage operation. When the current drown by the VacIon pump reaches the determinated values, the controller change the high voltage output.

7) When venting the pump, use dry nitrogen. This will avoid water vapor absorption on the pump walls.

3-3 Bakeout operation

For operation below 10^{-8} Torr (mbar), it is necessary to bake the system. This is done by heating the pump and all the components in the system.

1) Heat the pump body and the system with a bakeout oven unit or heating strips to temperatures between 150 °C and 250 °C (250 °C is the maximum allowable for most bakeable high voltage cables). This heat is high enough to degas the pump surfaces without damaging the magnet and high voltage connector. Note that the system components must be compatible with the bakeout temperature.

2) Leave the pump control unit on and monitor the pressure. It must never increase above 6.6×10^{-5} Torr (8.7×10^{-5} mbar); if this value is exceeded, turn the bakeout power off and then on again when low pressure is restored.
   To control the heaters and to monitor the high pressure limit during bakeout in automatic mode, an automatically controlled pressure-sensitive relay may be used.

3) Bake the VacIon pump and vacuum system for at least four hours. Longer bakeout periods are recommended when the pump has been used with heavy gas loads or when UHV pressure 10^{-9} Torr (mbar) or less is desired.

4) As the pump and system cool down to room temperature, a drop in pressure should be observed.

3-3.1 Bakeout of VacIon pump with the integral heaters

1) The integral heaters are to be powered with the appropriate voltage. (Please refer to the inscription on the heaters to apply correct voltage).

2) The integral heaters are designed to provide a temperature of 250 °C to 300 °C when the pump is wrapped in a 3-fold aluminum foil.

NOTE

A two-layer foil wrapping is advisable and sufficient to achieve full bakeout/regeneration if the standard European heaters (220 Vac) are operated at 240 Vac, thus preventing overheating.

3) Bakeout the VacIon pump for 24 hours. If the pump is used in heavy gas load applications, it is recommended to bakeout the pump for a longer period.

4) Wait until the pump cools down to room temperature and recovers its initial pressure before using it in the application.

4-1 General

WARNING

The high voltage present in the high voltage cable which connects the control unit to the ion pump, can cause severe injury or death. Before mounting the high voltage connector of the cable on the pump high voltage feedthrough, or before removing it, be sure the main power is removed from the control unit.

Before removing the high voltage connector of the cable from the control unit, be sure the main power is removed from the control unit. Wait at least 10 seconds after removing the main power from the control unit, to allow capacitors to discharge completely.

VacIon *Plus* pumps are maintenance free. In case of life time expiry or accidental premature failure of the pump, please contact your nearest Varian sales/service office for repair.

The VacIon *Plus* 500 pumps are designed with pump-elements and high-voltage feedthrough, both exchangeable.

4-2 Exchange of pumping element

1) Remove the internal high-voltage connections.
2) Remove the element holding brackets (see Fig. 4-1).
3) Pull the element out of the pocket and remove it through the inlet flange.

Fig. 4-1 - Inside view of a VacIon Plus pump

4) Clean the internal part of the pump with the appropriate solvent.
5) Put in the new element through the inlet flange. Make sure that the element is fixed at its rear by the two press-formed buttons of the element pocket, and at its front by the element holding clamp.
6) Reattach the high-voltage connections and test for continuity from the feedthrough.
7) Place a blank flange over the pump inlet and leak-check it with a leak detector.
8) Bake out the blanked off pump while it is operating, and leave it to cool down; then verify that the base pressure is below 10^{-9} Torr (mbar).

4-3 Exchange of the high voltage feedthrough.

1) Remove the 6 bolts of the Mini-ConFlat flange connection (see Fig. 4-2).
2) Remove the cable connection disc.
3) Gently relieve the feedthrough from the metal seal connection and turn the feedthrough counterclockwise until it is completely detached from the internal high voltage threaded connection.
4) Replace the feedthrough and the copper gasket.
5) Bake out the pump while it is operating, and leave it to cool down; then verify that the base pressure is below 10^{-9} Torr (mbar).

4-4 Leakage current check

If the pump current reading is to be used as pressure measurement, check the pump leakage currents as follows:

1) Turn off the pump control unit.
2) Remove the pump magnet.
3) Turn on the pump control unit and wait for current stabilization. The current reading should not be higher than 1 μA. Make sure that the control unit and the high voltage cable leakage current is negligible.

4) If leakage current comes from the pump, perform the "high-potting"; then recheck the pump and install the magnet.

5) If it is not possible to "high-pot" the pump, the pressure reading is biased by the leakage current value.

4-5 Hi-potting

A higher than normal pump current is often caused by field emission currents which prevent the use of the pump current as a pressure indicator. To reduce this field emission current, "hi potting" should be performed. "High potting" is the term used to describe the application of higher than normal operating voltage (10-12 KV, 20-50 mA) for the purpose of burning off "whiskers" (sharp edges) on the pump cathode.

The output of an appropriately sized AC transformer (i.e. neon sign type) may be applied to the pump for a period of about 30 seconds. This should effectively remove any "wiskers" or sharp edges on the pump cathode.

WARNING

Voltages developed in the High Potter power supply are potentially lethal. Use caution during operation and ensure correct grounding connection.

4-6 Heater replacement

To replace the pump heaters follow the directions below.

1) Remove the stainless steel cover by forcing with a screw driver as shown in Fig. 4-3 and Fig. 4-4.

2) Undo the screws (hexagonal insert) at each side with an allen key.

3) Slide away the pole piece (refer to Fig. 4-5).

4) Remove the faulty heaters from the pump body.

WARNING

To avoid injury to personnel and damage the equipment due to its heavy weight (25 kg, 55 lbs), be careful during removal/installation of the pole piece.

5) Mount the new pump heater rod onto the pump body.

6) Interconnect the heater leads as shown in Fig. 4-7.

7) Reinstall the pole-pieces (refer to Fig. 4-8), fasten their mounting screws tightly, and put in place the stainless steel cover.

Fig. 4-2 - High voltage feedthrough connection

Fig. 4-3 - Removing the stainless steel cover

Fig. 4-5 - Pole piece removed

Fig. 4-4 - Stainless steel cover removed

Fig. 4-6 - Installed pump heaters

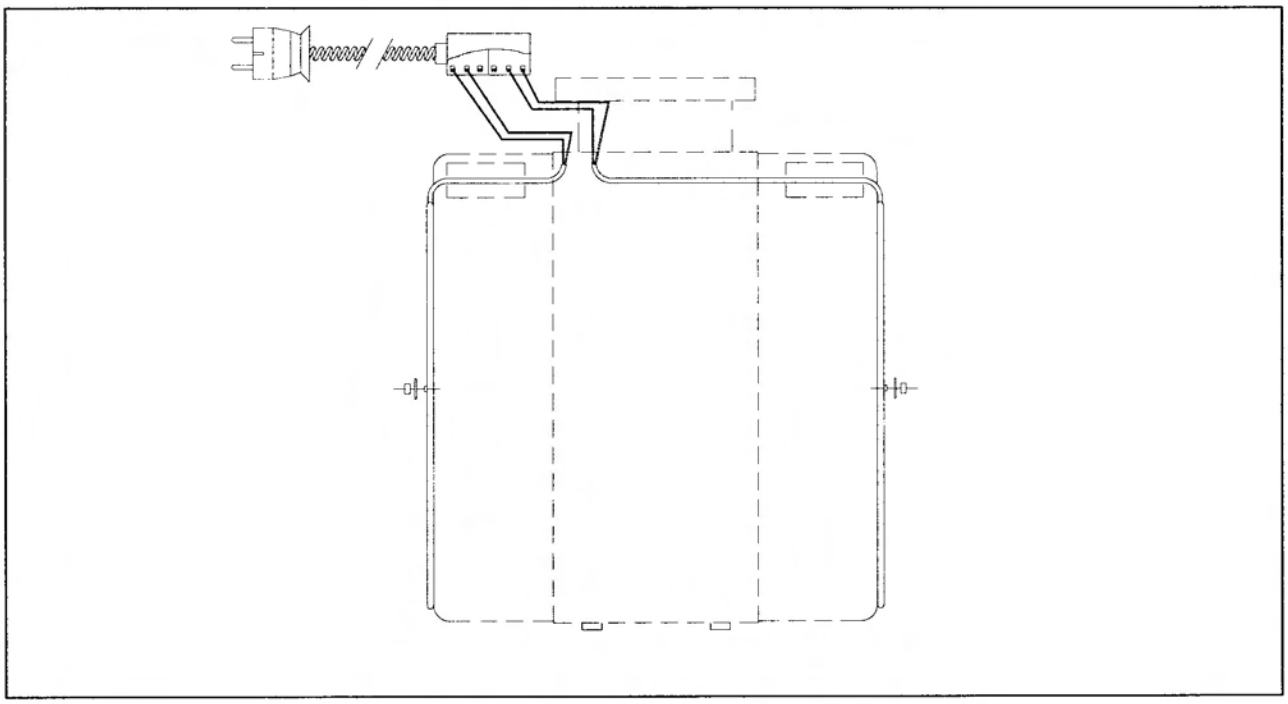

Fig. 4-7 - Interconnecting the heater leads

Fig. 4-8 - Reinstalling the pole-pieces

4-7 Pump troubleshooting

Symptom	Possible cause	Correction procedure
1) - Slow starting (more than 30 minutes).	*Air leaks* which limit pressure to above 10^{-6} Torr (mbar) and cause longer starting time.	Leak check the vacuum system with a helium leak detector.
2) - Slow pump-down due to long exposure of viton parts to air.	*Viton releases considerable gas* after long exposure to air. (A bell-jar system which reached 1.5×10^{-8} Torr (2×10^{-8} mbar) in 24 hours after 30 minutes air exposure, will only reach 7.5×10^{-8} Torr (1×10^{-7} mbar) in 24 hours after 20 hours air exposure).	With the system under vacuum, pump for several days, or heat to 100-150°C for up to 15 hours.
3) - Slow pump-down due to absorption of vapours on pump and system walls.	*Vapours and gases admitted to a system are absorbed* on the walls of the system and pump. Subsequent reduction in pressure depends on the rate of depletion of this vapour. Heavy hydrocarbons are most troublesome because of their relative low vapour pressure.	Heat the system walls,, thereby accelerating the desorption process. Baking mobilizes the vapours so they can be cracked and pumped by discharge.
4) - Slow starting or slow pump-down.	High voltage feedthrough is leaking.	Replace the feedthrough.
5) - Current higher than expected at any given pressure.	Ion pump leakage current causing higher pressure reading.	Highpot the pump.

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5-1 VacIon *Plus* 500 pump replacement parts and accessories

		Part Number			
		StarCell	**Triode**	**Noble Diode**	**Diode**
Basic pump		919-0106	919-0206	919-0306	919-0406
Pump with options					
With heaters installed	(120V) (220V)	919-0106S120 919-0106S220	919-0206S120 919-0206S220	919-0306S120 919-0306S220	919-0406S120 919-0406S220
Double ended		919-0106S001	919-0206S001	919-0306S001	919-0406S001
Double ended with heaters installed	(120V) (220V)	919-0106S121 919-0106S221	919-0206S121 919-0206S221	919-0306S121 919-0306S221	919-0406S121 919-0406S221
With NEG module installed		919-0106S003	919-0206S003	919-0306S003	919-0406S003
With NEG module and pump heater installed	(120V) (220V)	919-0106S123 919-0106S223	919-0206S123 919-0206S223	919-0306S123 919-0306S223	919-0406S123 919-0406S223
Cables and accessories					
HV Bakeable cable, 13' (4 m) long		929-0770			
HV Bakeable cable, radiation resistant, 13' (4 m) long		929-0770S900			
Stud mounting kit		SR03.648908			
Replacement parts					
HV Feedthrough		959-5120			
Pumping element (qty 4 needed)		919-9030			
			919-9035		
				919-9045	
					919-9040
Heaters (for S120/S121 pump only) Heaters (for S220/S221 pump only)	(120V) (220V)	919-0067 919-0065			
NEG Module (for -S003 pump only)		919-0083S300			
Garter spring		SR00.601410-01			
Copper gasket for 8" CF inlet flange (10-pack, individually sealed)		FG-0800-CI			
Nut and bolt set for 8" CF inlet flange, 5/16-24x2 1/4 (25-pack)		FB-0600-C12			

	Part Number			
	StarCell	Triode	Noble Diode	Diode
Copper gasket for 1 1/3" CF feedthrough flange (10-pack, individually sealed)	FG-0133-CI			
Nut and bolt set for 1 1/3" CF feedthrough flange, 8-32x3/4 (25-pack)	FB-0133-C			
H/V connector bracket	SR03.644342			

For a complete overview of Varian's extensive vacuum product line, please refer to the Varian Vacuum Catalogue.

5-2 VacIon *Plus* 500 pump controllers

	Part Number			
	StarCell	Triode	Noble Diode	Diode
MultiVac controller				
Base unit with one HV card (120V) (220V)	929-6000 (negative polarity); 929-6004 (positive polarity) 929-6008 (negative polarity); 929-6012 (positive polarity)			
Base unit with two HV card (120V) (220V)	929-6001 (negative polarity); 929-6005 (positive polarity) 929-6009 (negative polarity); 929-6013 (positive polarity)			
Large VacIon Plus HV card	929-4040	929-4040	929-4050	929-4050
Set Point/Remote Control	929-4110			
RS 232/422 Interface	929-4100			
Base unit with RS 232/422 Interface mounted and one HV card (120V) (220V)	929-6002 (negative polarity); 929-6006 (postive polarity) 929-6010 (negative polarity); 929-6014 (positive polarity)			
Base unit with RS 232/422 Interface mounted and two HV card (120V) (220V)	929-6003 (negative polarity); 929-6007 (postive polarity) 929-6011 (negative polarity); 929-6015 (positive polarity)			
MiniVac controller				
MiniVac (120V) (220V) (24Vdc)	929-0191 929-0290 929-0196			
MiniLink (120V) (220V)	929-0300 929-0301			

For a complete overview of Varian's extensive vacuum product line, please refer to the Varian Vacuum Catalogue.

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