87-900-060-01
April 1995

Instruction Manual

VacIon Plus 40

StarCell	**Model 919-0101**
Triode	**Model 919-0201**
Noble Diode	**Model 919-0301**
Diode	**Model 919-0401**

Table of Contents

Section		Page
-	**Safety summary**	ii
I	**Description**	
1-1	General	1-1
1-2	Specifications	1-1
1-3	Stray magnetic field	1-11
1-4	Pump outline	1-13
II	**Installation**	
2-1	Inspection procedure	2-1
2-2	Typical installation	2-2
2-3	Inlet flange connection	2-3
2-4	Control unit connection	2-4
2-5	Support feet mounting	2-4
2-6	Heater installation	2-4
III	**Operation**	
3-1	General	3-1
3-2	Operating procedure	3-1
3-3	Bakeout operation	3-2
IV	**Maintenance & Troubleshooting**	
4-1	General	4-1
4-2	Exchange of the high voltage feedthrough	4-1
4-3	Leakage current check	4-1
4-4	Hi potting	4-1
4-5	Heaters replacement	4-2
4-6	Pump troubleshooting	4-2
V	**Spare parts list**	
5-1	VacIon Plus 40 pump replacement parts and accessories	5-1
5-2	VacIon Plus 40 pump controllers	5-2

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.

1-1 General

The Varian VacIon *Plus* 40 pumps (see Fig. 1-1) operate in the pressure range from 10^{-2} to below 10^{-11} Torr (mbar).

The VacIon *Plus* 40 Triode and StarCell pumps allow starting from as high as $5x10^{-2}$ Torr ($6.6x10^{-2}$ mbar), because ions are prevented from bombarding the system and pump walls at starting pressures, and have high speed for inert gases. The VacIon *Plus* 40 Diode and Noble Diode pumps require a lower starting pressure (i.e. 10^{-2} Torr (mbar)). The Diode contains more titanium than triode pumps, and thus has a higher hydrogen capacity and longer life.

The tantalum in the Noble Diode pump enhances the noble gas pumping capacity, although it somewhat reduces the high getterable gas pumping speed that the standard diode pump provides.

The VacIon *Plus* StarCell is the latest variation of the Triode configuration. Its patented design makes this ion pump the only one that can handle a high amount of Noble Gases (equal or better than Noble Diode and Triode) and Hydrogen (comparable to the Diode).

A positive polarity, high voltage supply is required to operate Diode and Noble Diode pumps. A negative polarity high voltage supply is required to operate Triode and StarCell pumps. The anode is grounded and the cathode is held at negative potential.

Figure 1-1 is a picture of the VacIon *Plus* 40 StarCell pump.

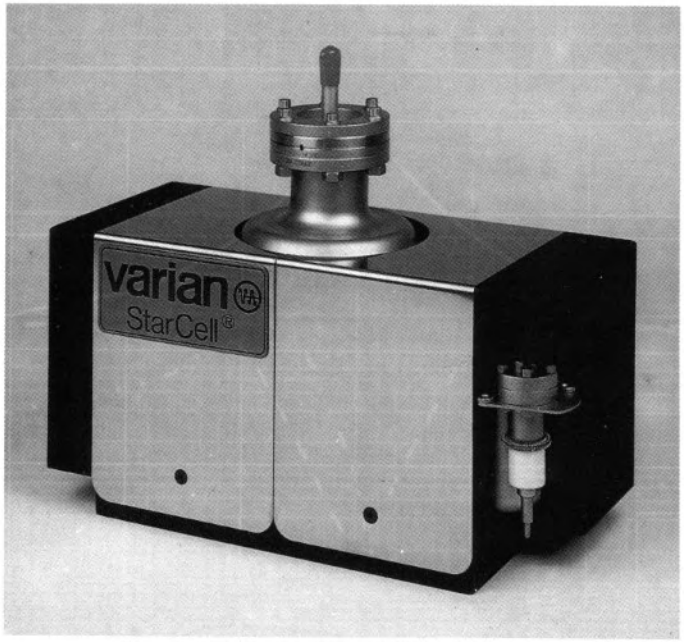

Fig. 1-1 - VacIon Plus 40 StarCell pump

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 and 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.

The pumping speed of a newly regenerated (i.e. baked) sputter ion pump decreases during operation until it reaches a stabilized level known as "saturation" (nominal pumping speed). To saturate the VacIon *Plus* 40 pump, it normally requires an amount of gas equal to 2.5 Torr-litres. Consequently, pumps can operate for extended periods of time at low pressures in the non-saturated state, if they are properly conditioned.

STARCELL

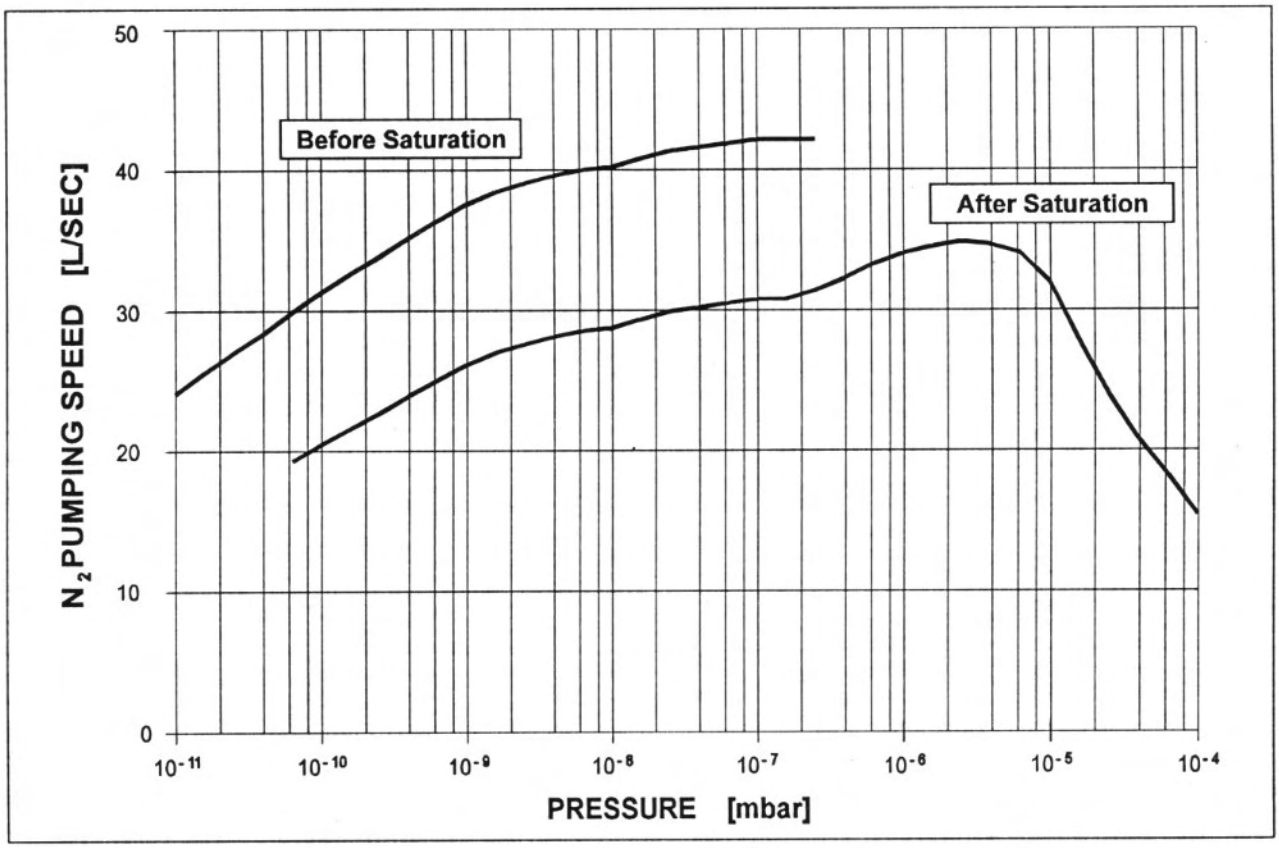

Fig. 1-2 - VacIon Plus 40 StarCell pump pumping speed vs pressure for Nitrogen

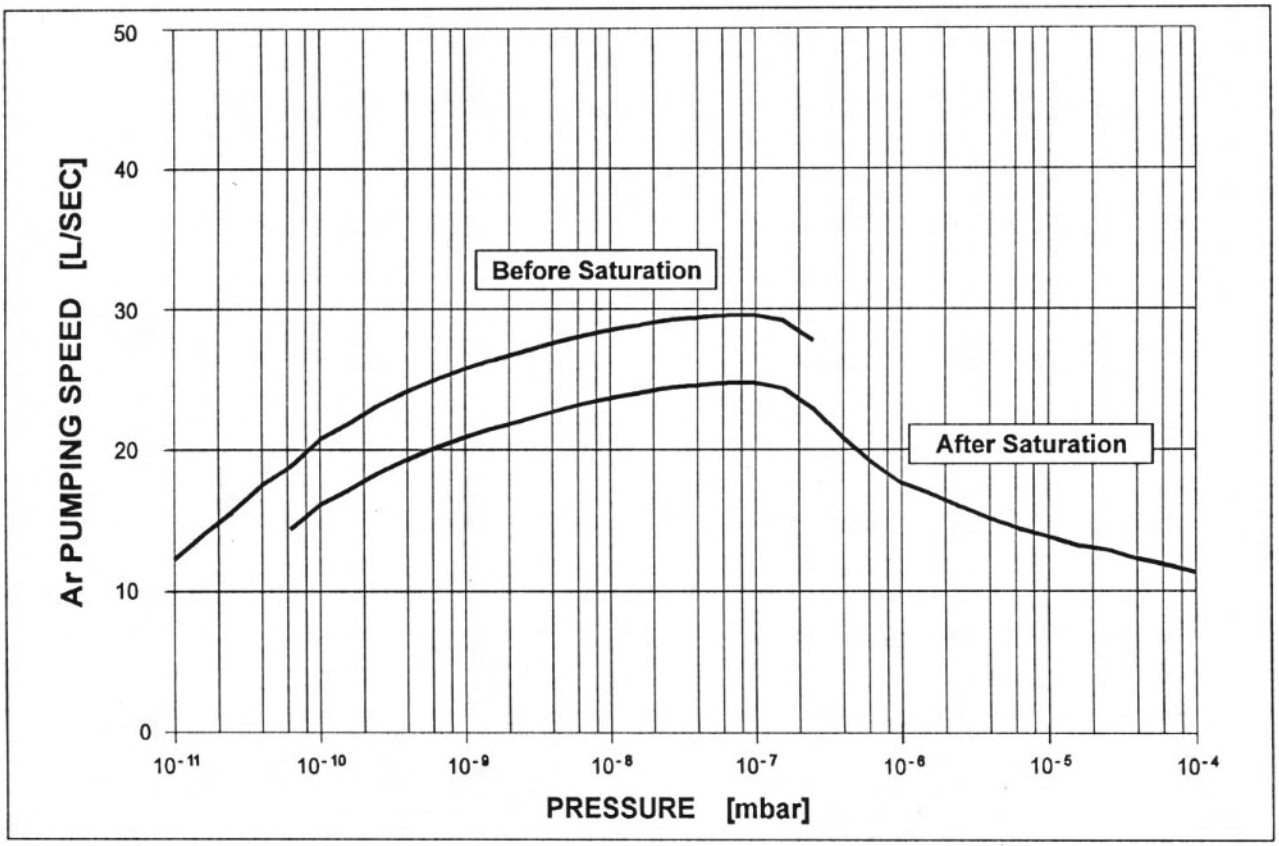

Fig. 1-3 - VacIon Plus 40 StarCell pump pumping speed vs pressure for Argon

STARCELL

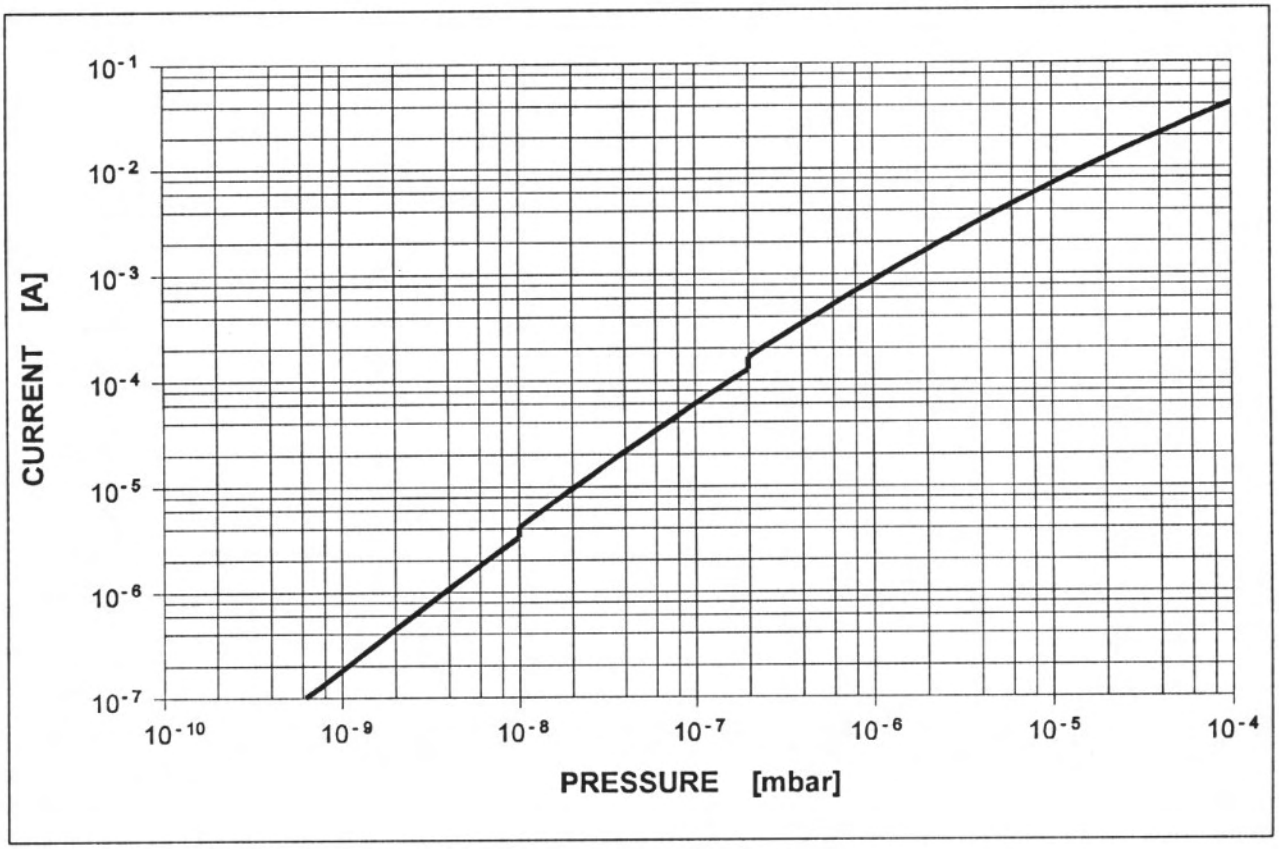

Fig. 1-4 - VacIon Plus 40 StarCell pump pressure (mbar) vs current diagram

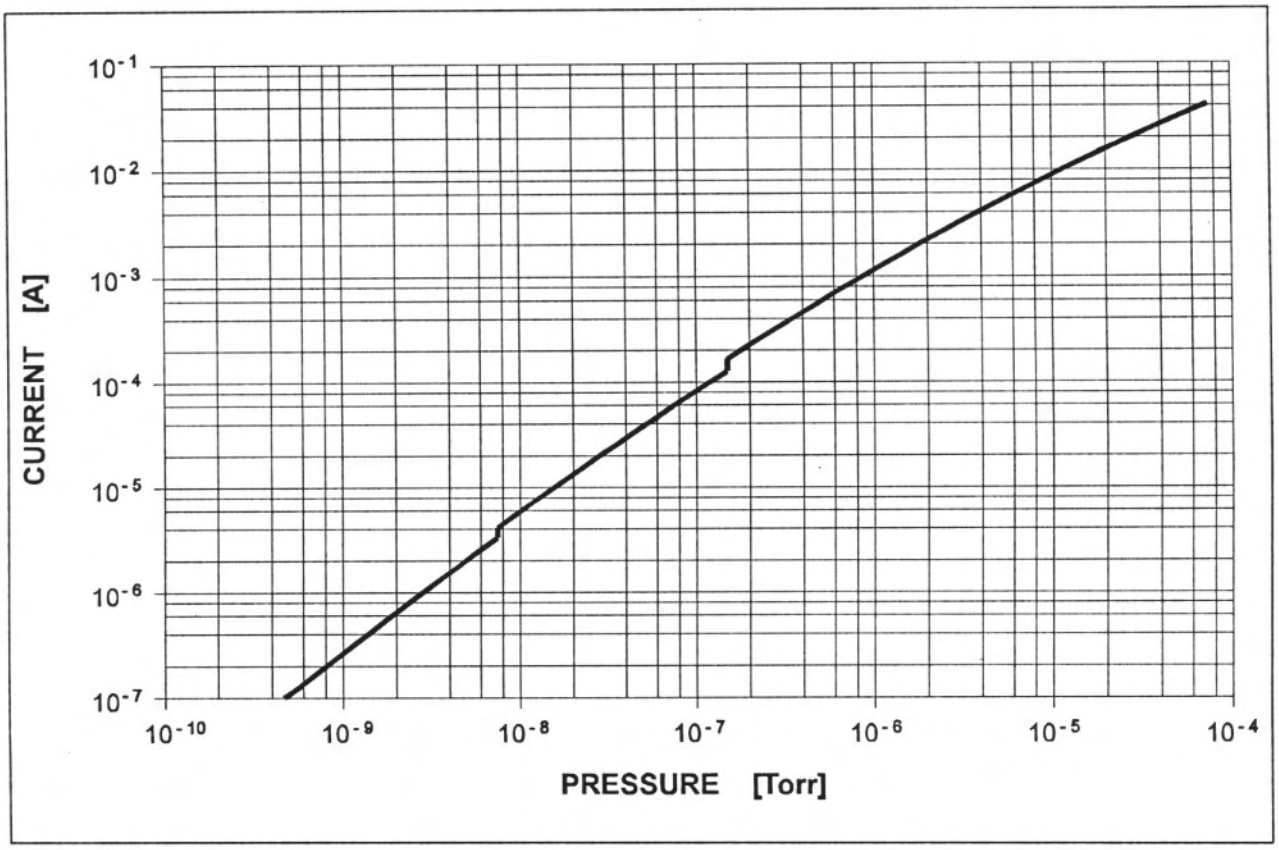

Fig. 1-5 - VacIon Plus 40 StarCell pump pressure (Torr) vs current diagram

TRIODE

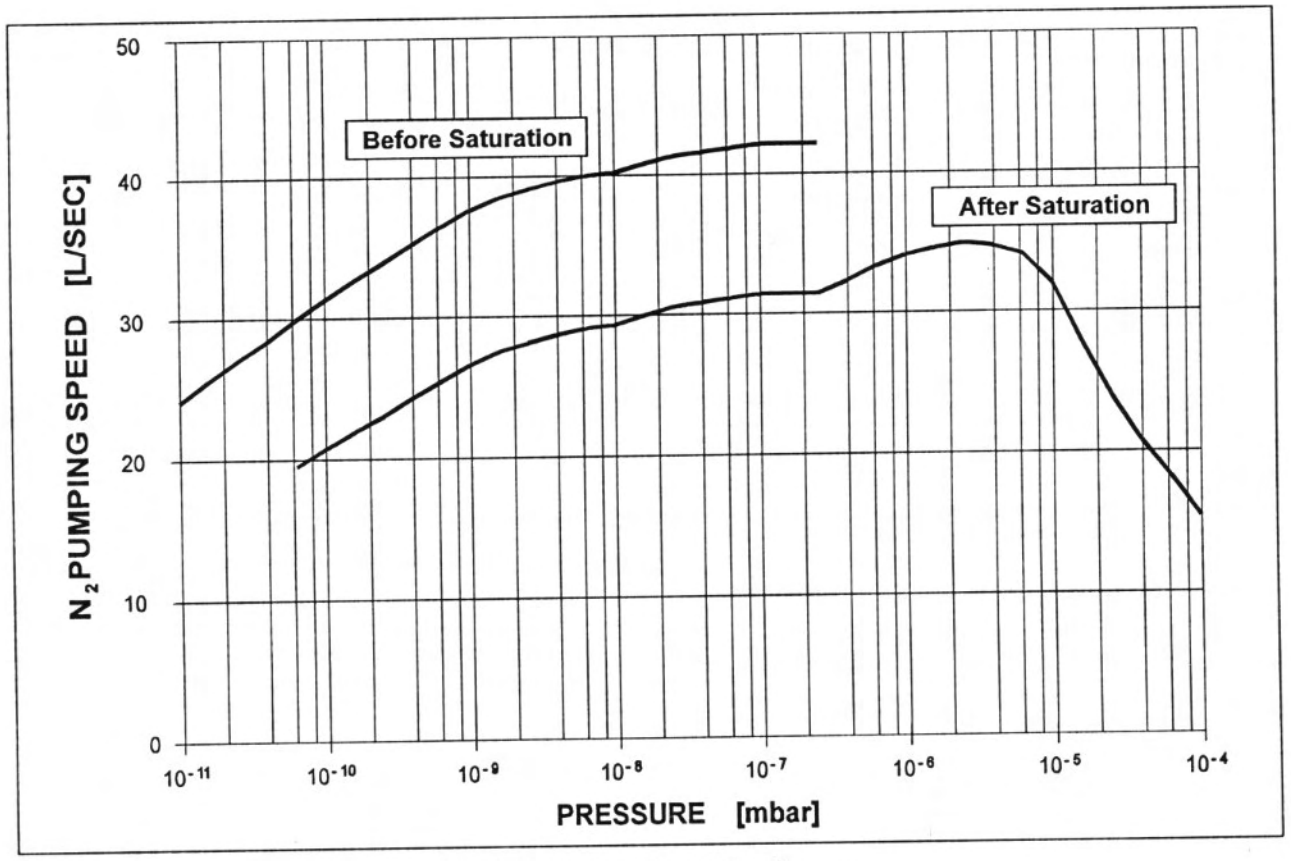

Fig. 1-6 - VacIon Plus 40 Triode pump pumping speed vs pressure for Nitrogen

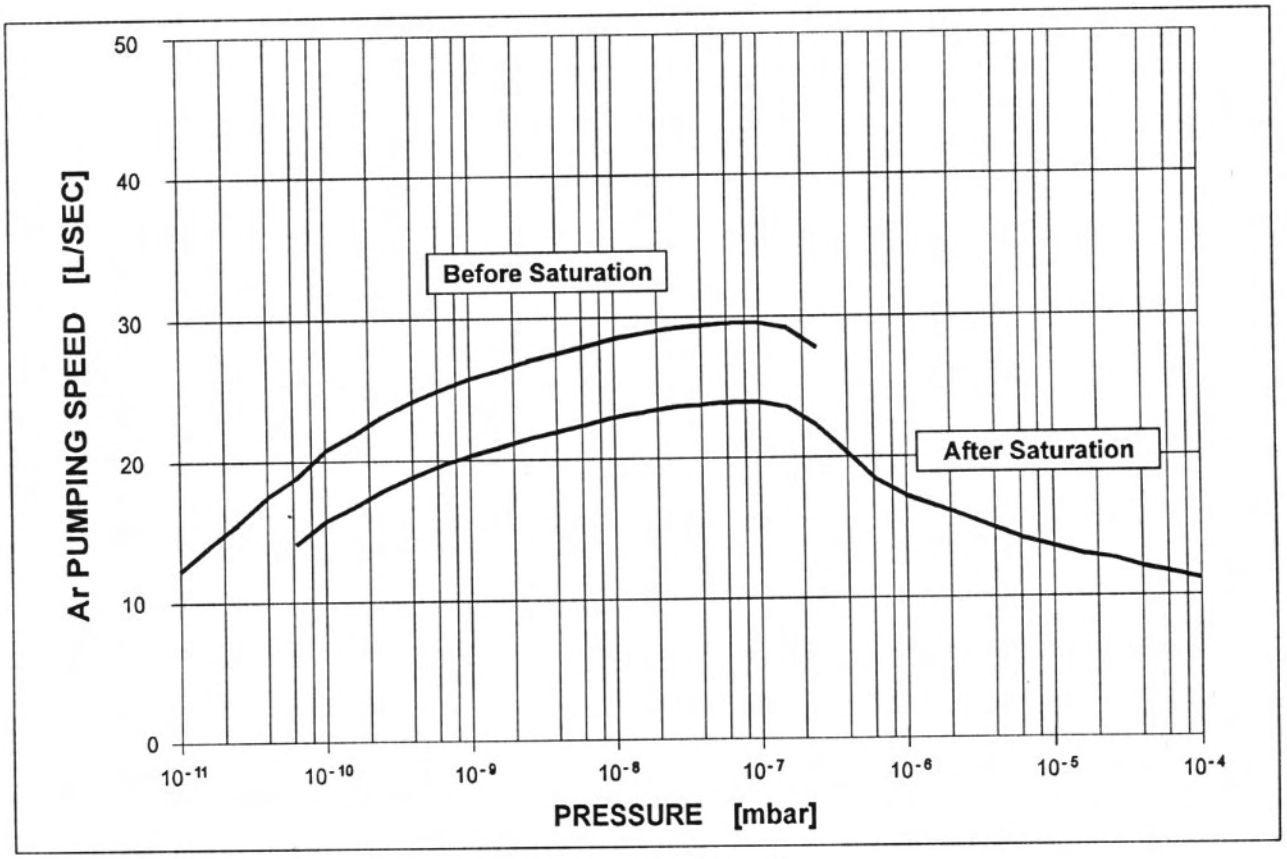

Fig. 1-7 - VacIon Plus 40 Triode pump pumping speed vs pressure for Argon

TRIODE

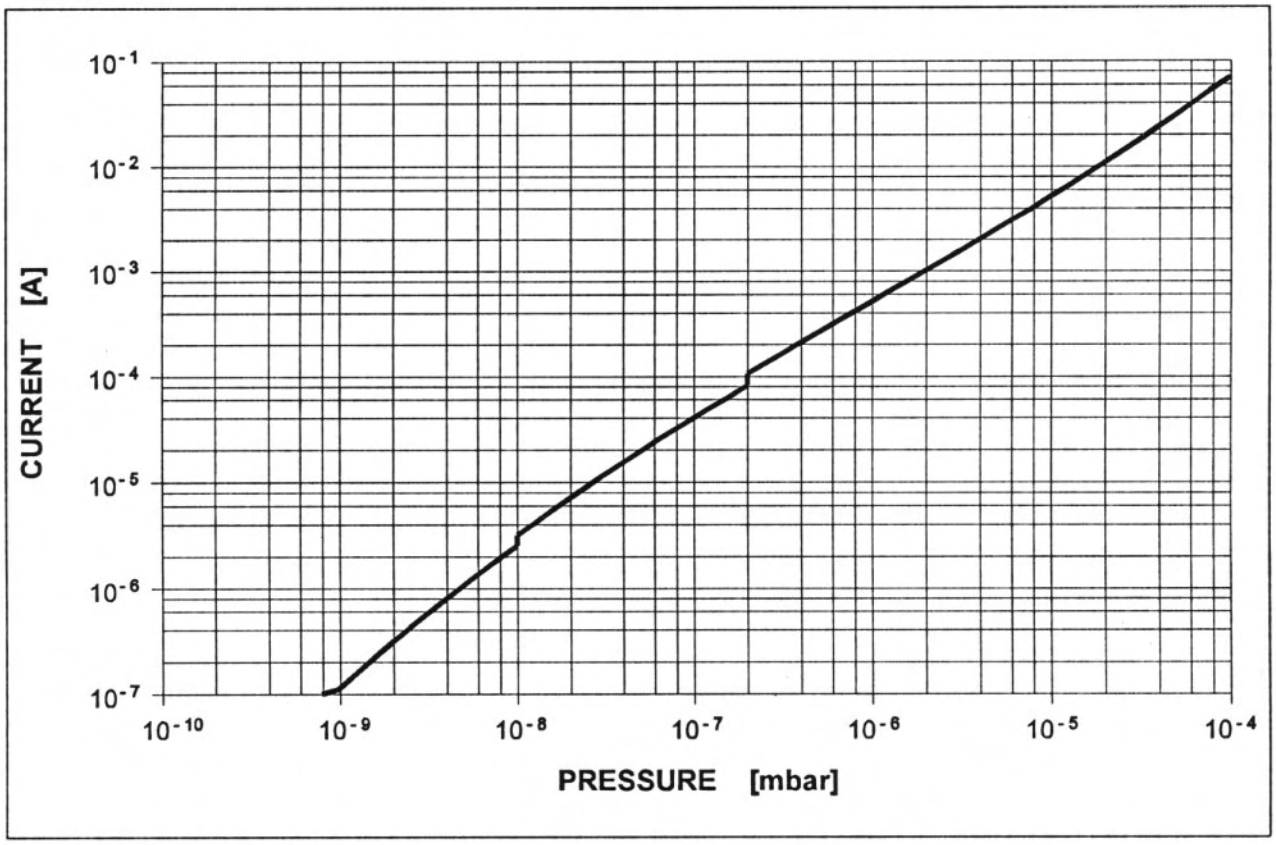

Fig. 1-8 - VacIon Plus 40 Triode pump pressure (mbar) vs current diagram

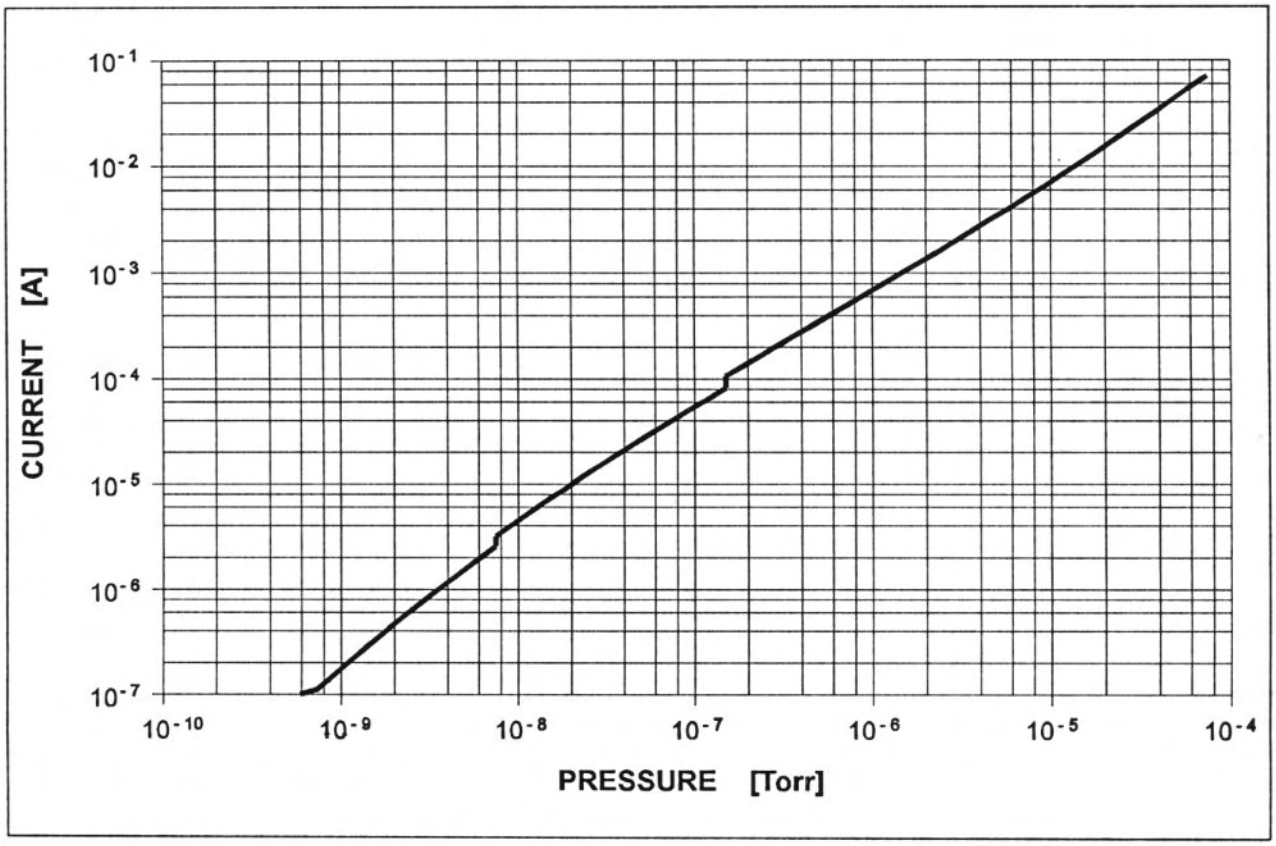

Fig. 1-9 - VacIon Plus 40 Triode pump pressure (Torr) vs current diagram

NOBLE DIODE

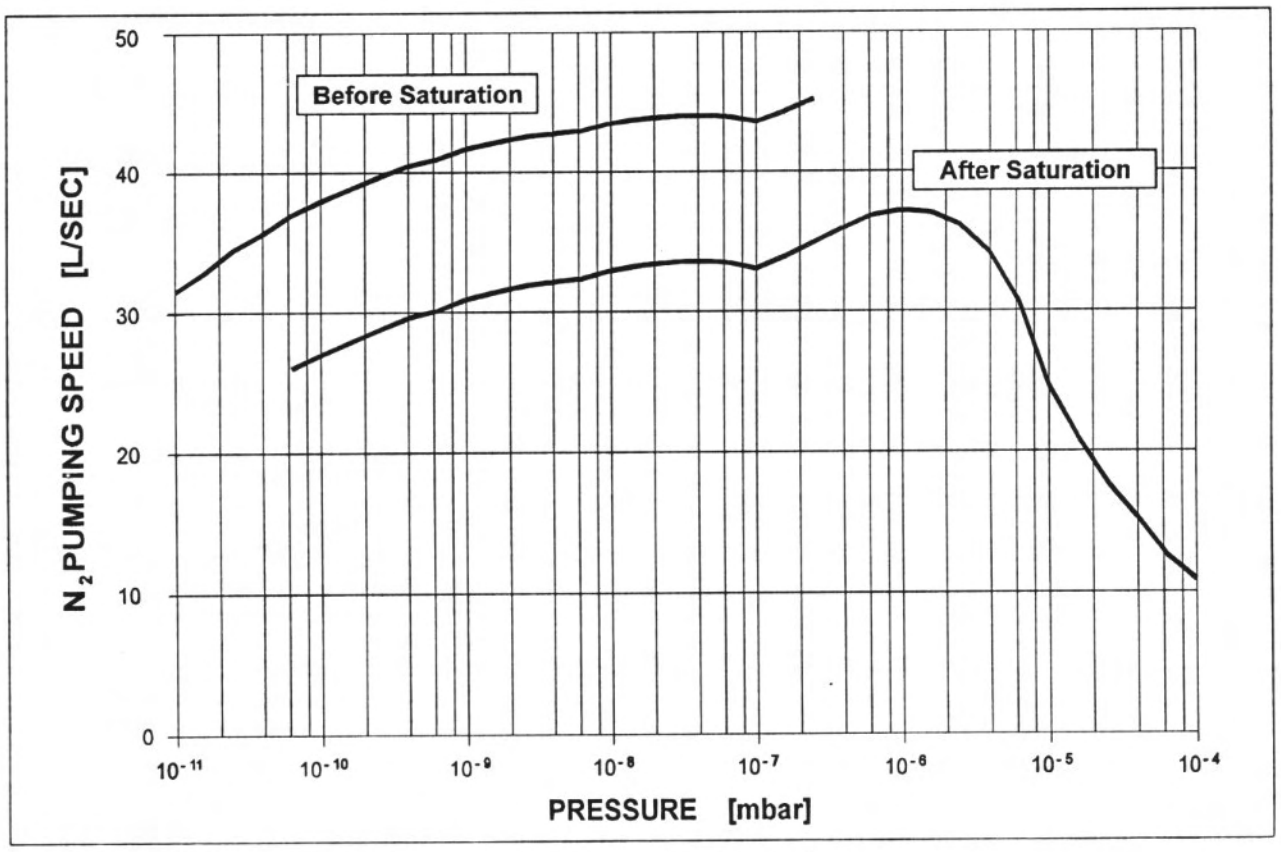

Fig. 1-10 - VacIon Plus 40 Noble Diode pump pumping speed for Nitrogen

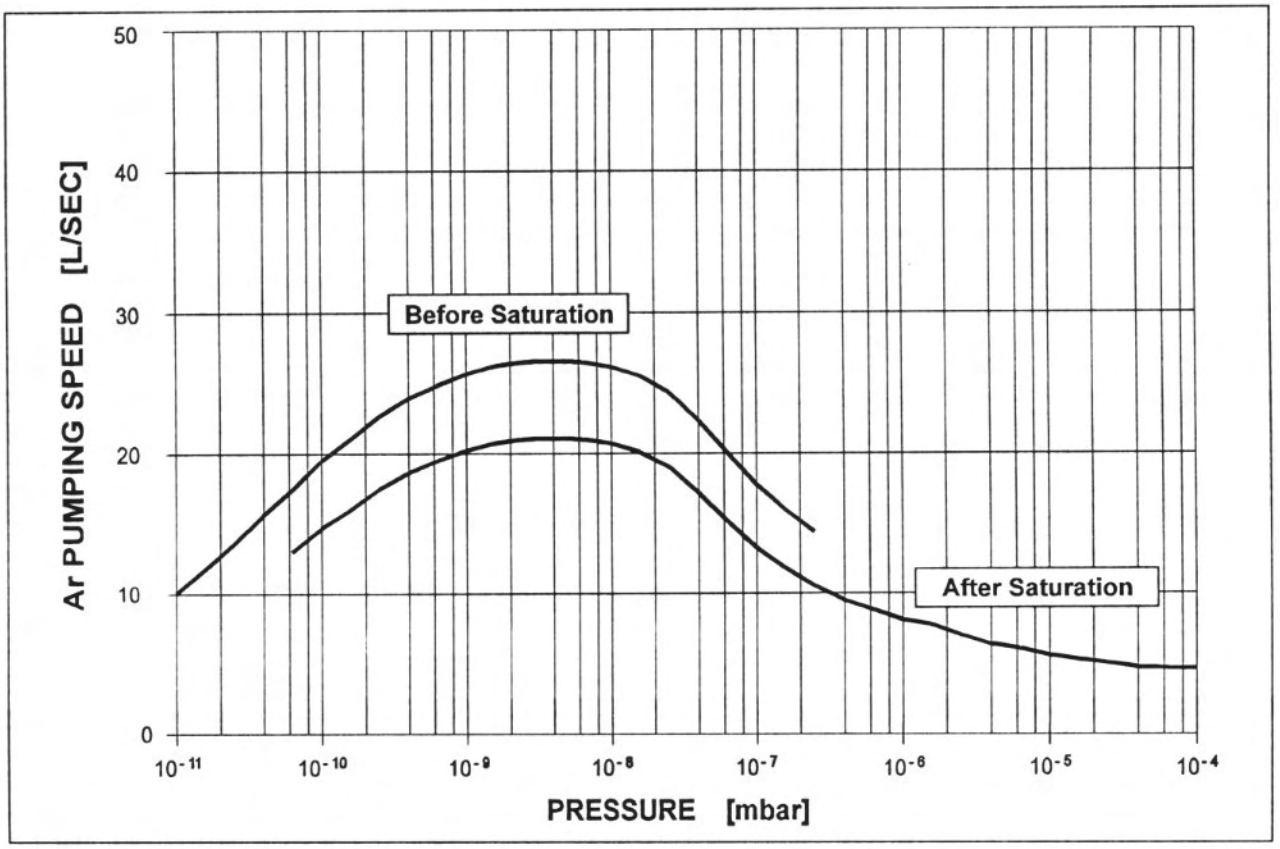

Fig. 1-11 - VacIon Plus 40 Noble Diode pump pumping speed for Argon

NOBLE DIODE

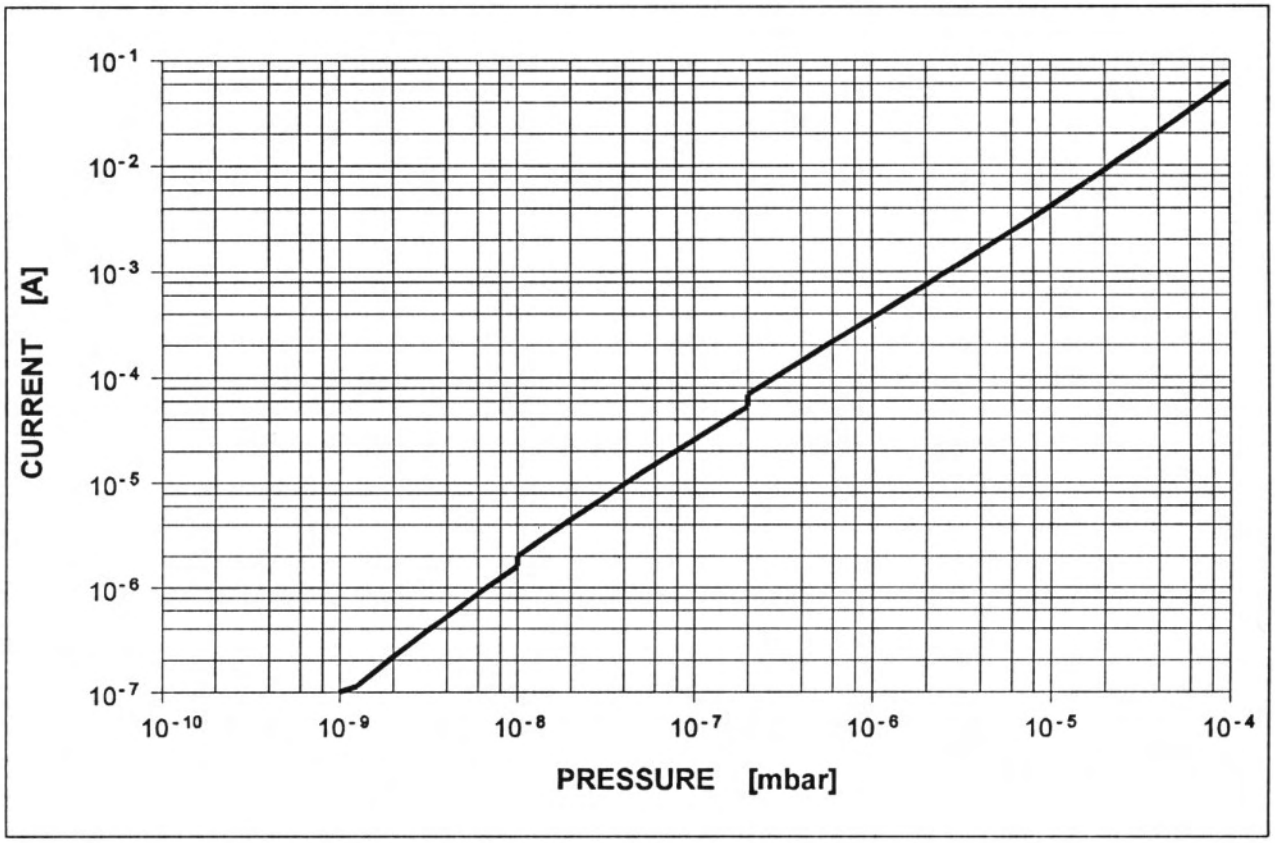

Fig. 1-12 - VacIon Plus 40 Noble Diode pump pressure (mbar) vs current diagram

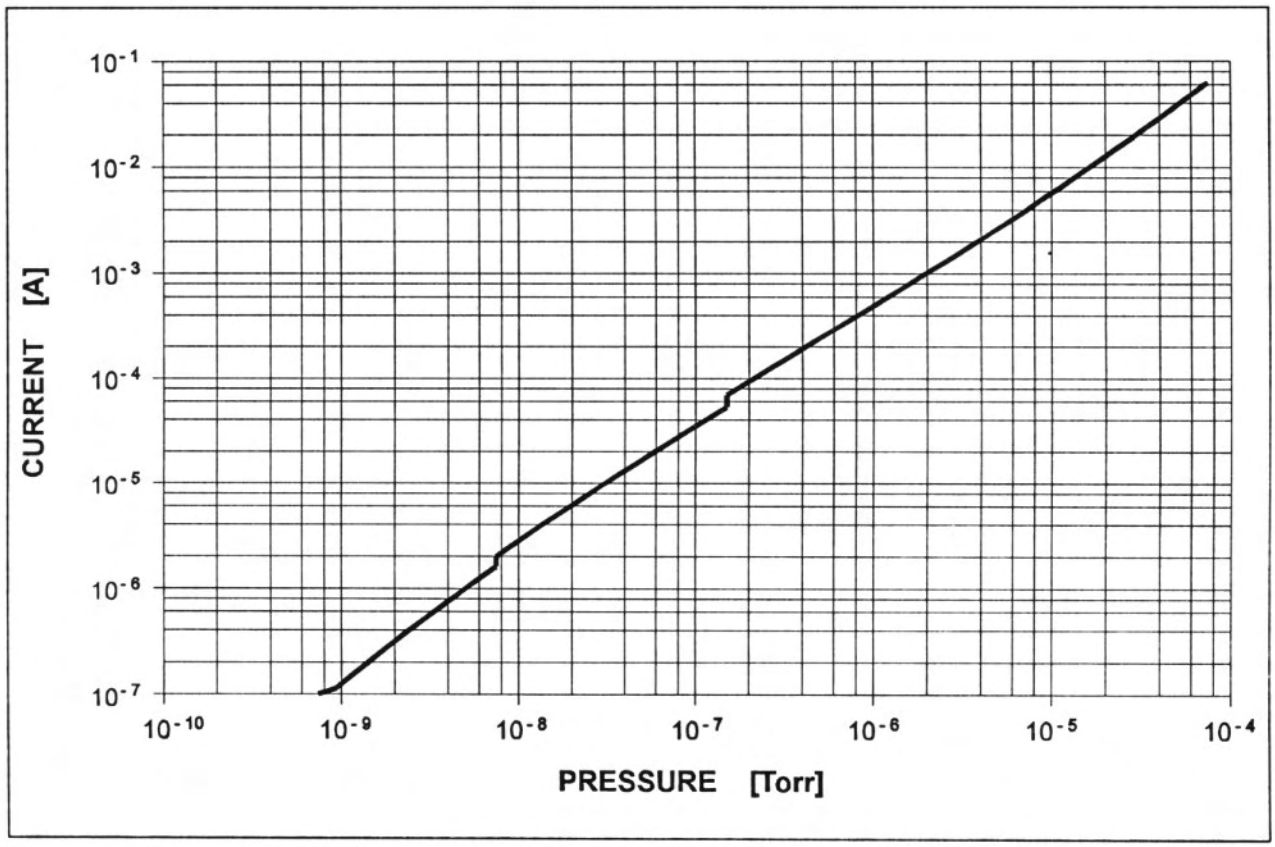

Fig. 1-13 - VacIon Plus 40 Noble Diode pump pressure (Torr) vs current diagram

DIODE

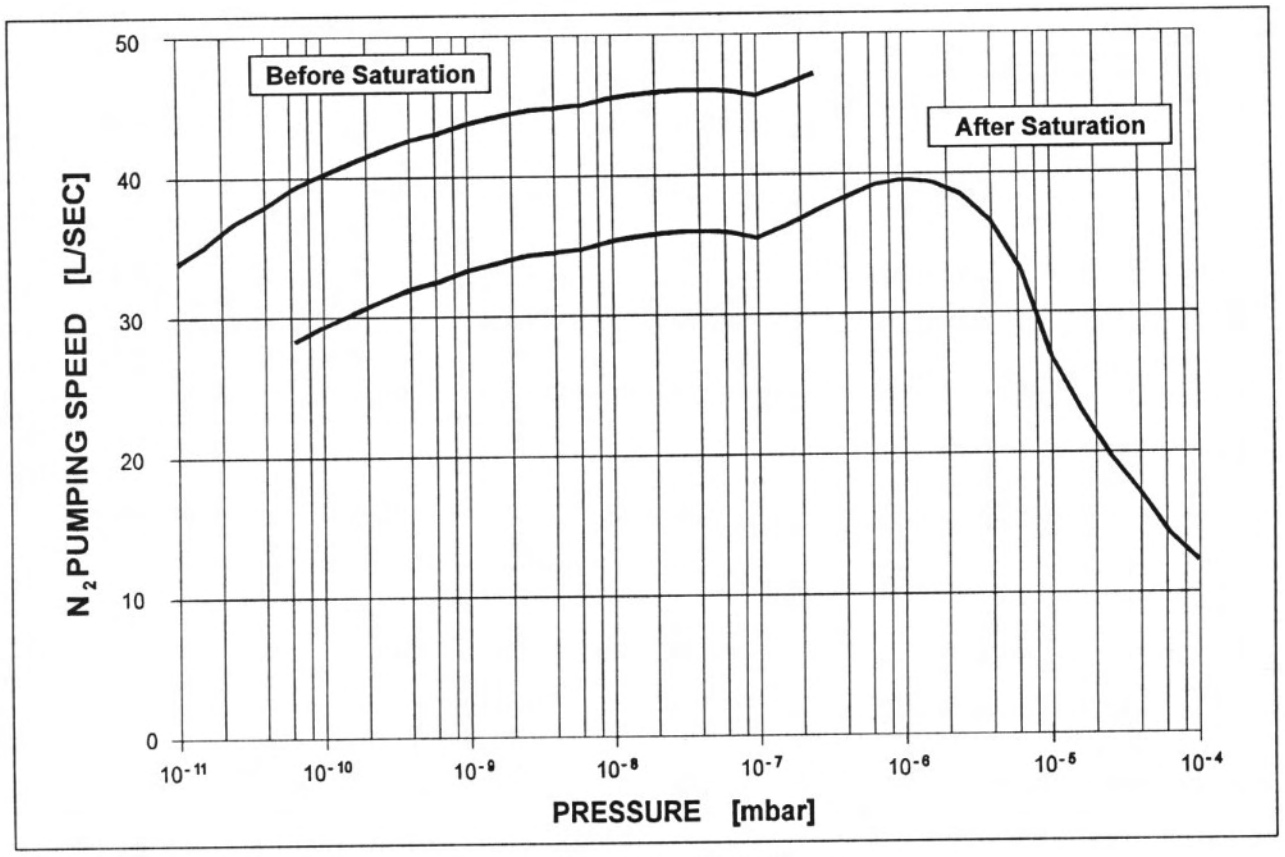

Fig. 1-14 - VacIon Plus 40 Diode pump pumping speed for Nitrogen

DIODE

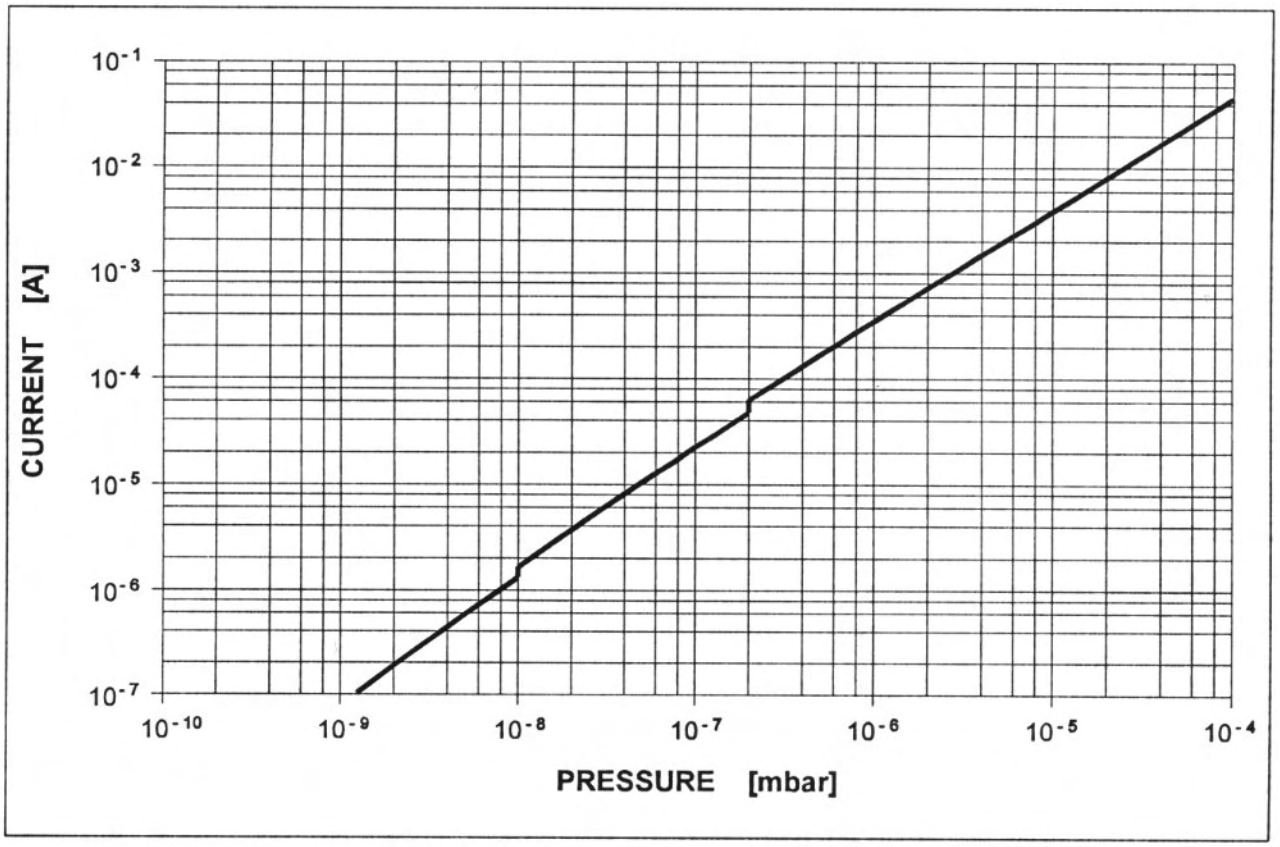

Fig. 1-15 - VacIon Plus 40 Diode pump pressure (mbar) vs current diagram

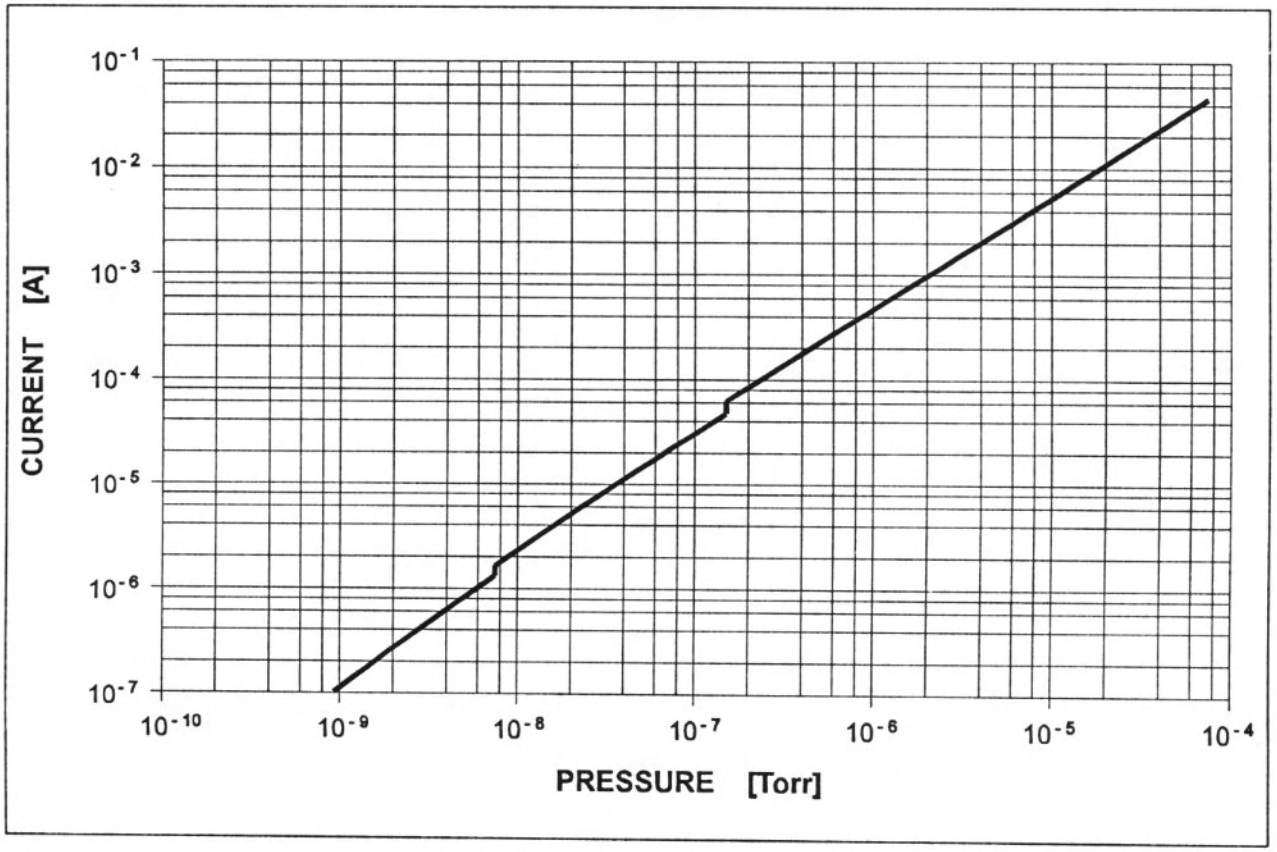

Fig. 1-16 - VacIon Plus 40 Diode pump pressure (Torr) vs current diagram

VacIon Plus 40 Specification

Specification \ Model	StarCell	Triode	Noble Diode	Diode
Nominal pumping speed for Nitrogen * (l/s)	34	33	36	40
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)	$\leq 5x10^{-2}$	$\leq 5x10^{-2}$	$\leq 1x10^{-3}$	$\leq 1x10^{-3}$
Ultimate pressure (mbar)	Below 10^{-11}			
Inlet flange	2 3/4" CFF (NW 35) AISI 304 LN SST			
Internal volume (litres)	1.9			
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 37 (17), Shipping 46 (21)			

* Tested according ISO/DIS 3556-1-1992

1-3 Stray magnetic field

Curves of field strength along the centre 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 1-20.

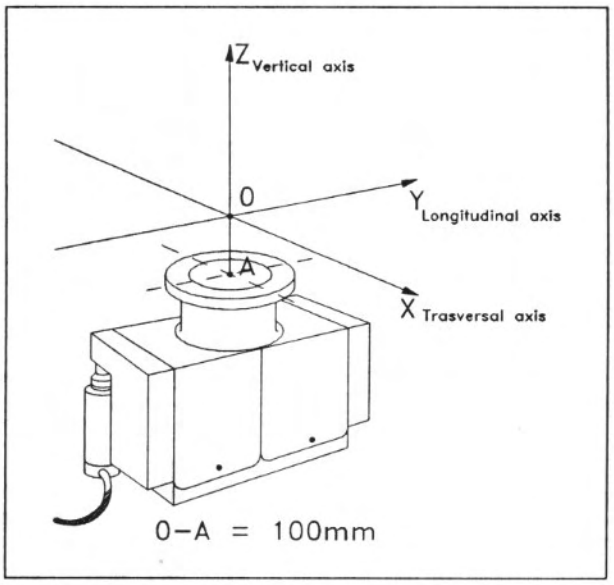

Fig. 1-17 - VacIon Plus pump axis identification

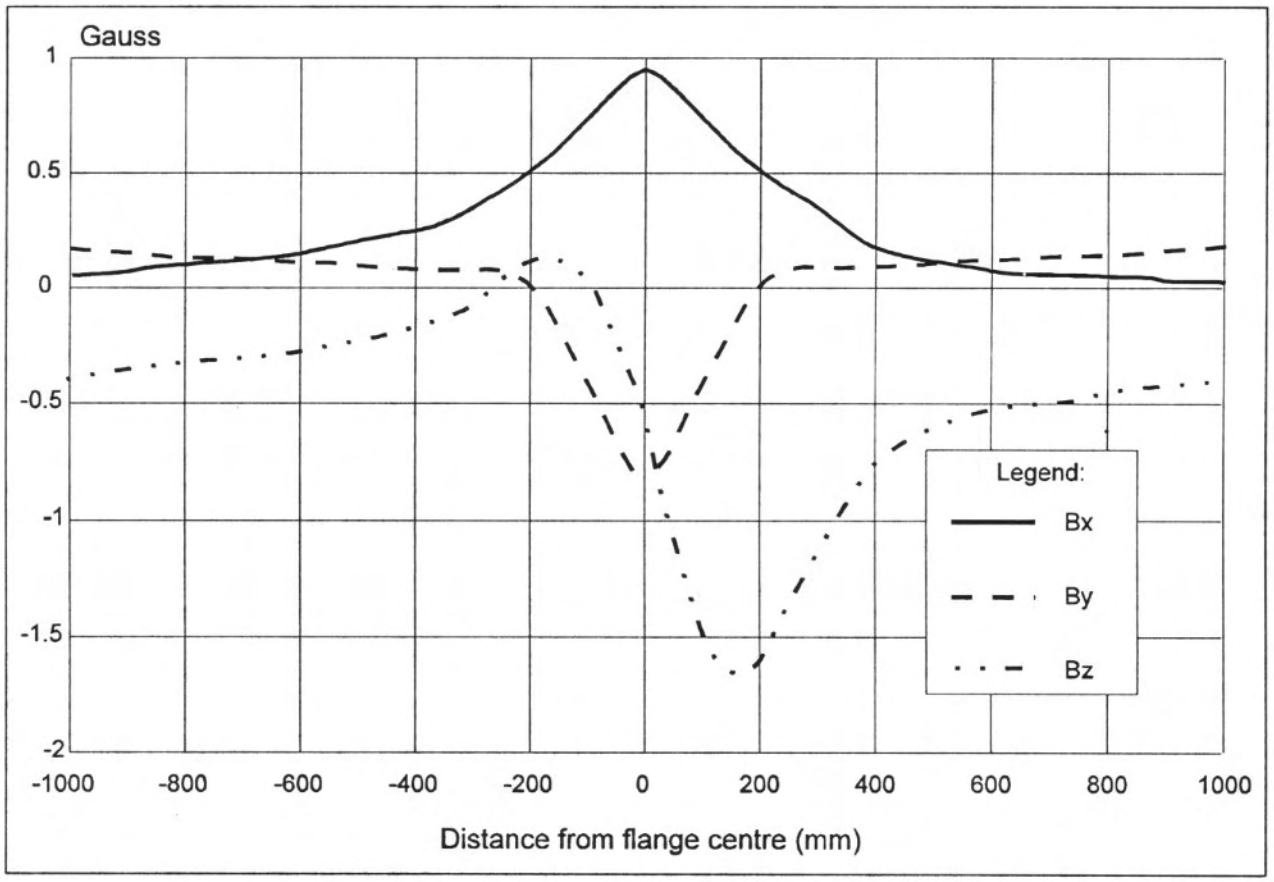

Fig. 1-18 - Longitudinal stray magnetic field

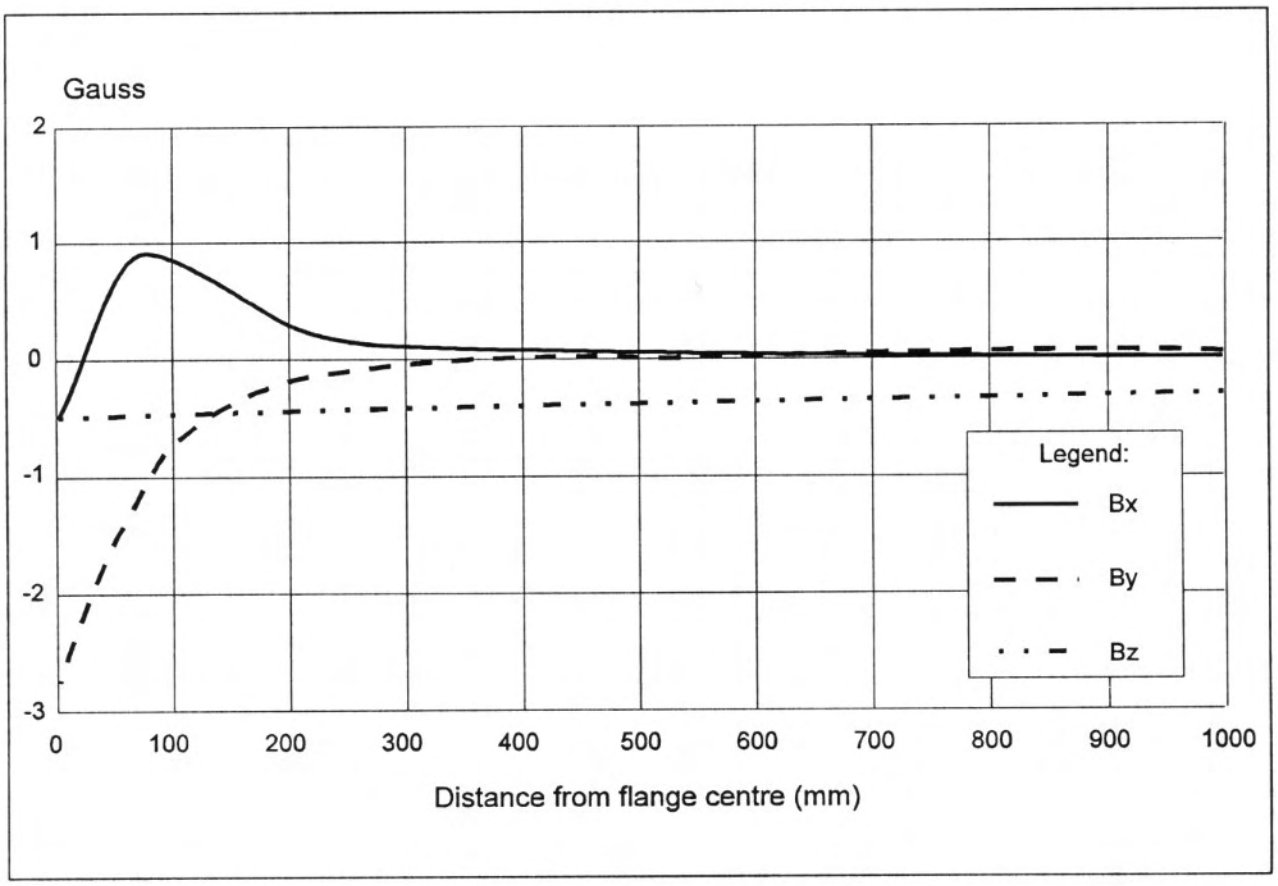

Fig. 1-19 - Vertical stray magnetic field

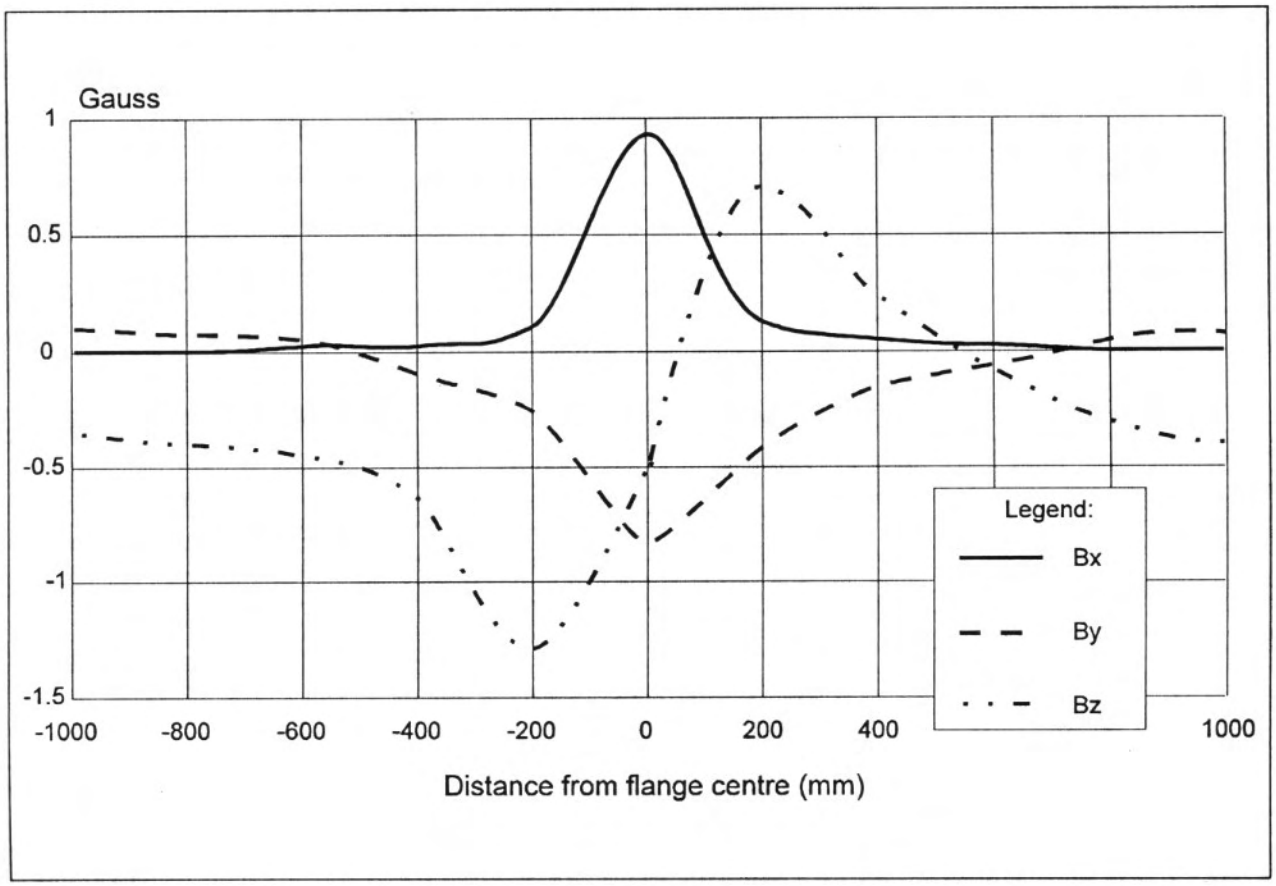

Fig. 1-20 - Transversal stray magnetic field

1-4 Pump outline

The outline drawing for the VacIon *Plus* 40 pump is shown in Fig. 1-21.

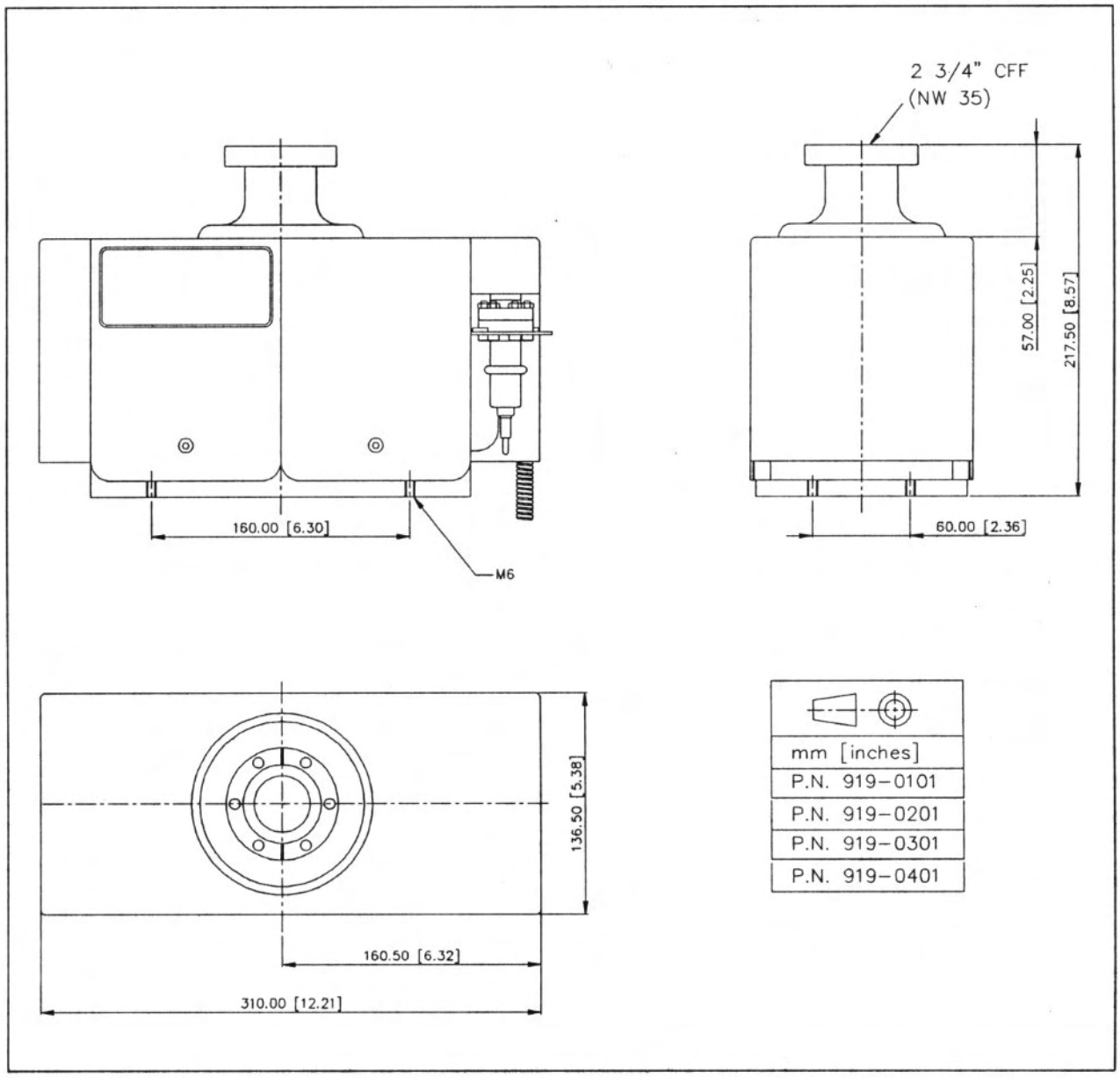

Fig. 1-21 - VacIon Plus 40 pump outline

This page intentionally left blank

2-1 Inspection procedure

VacIon *Plus* pumps are evacuated, baked out, sealed and leak-checked at below $1x10^{-9}$ Torr ($1.33x10^{-9}$ mbar) prior to shipping.

The following information and procedures can be used to optimize 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.

Inspect the pinch-off seal. If it is open, the pump is at atmospheric pressure.

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 otherwise not been damaged.

The pump is not harmed by such 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 new pump before air releasing it:

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 or below 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 giving a popping sound and the pump current will fluctuate. If this occurs, turn the power OFF immediately.

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.

2-1.3 Short circuits

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

An ohm meter reading on the pump feedthrough may not be effective in finding a short.

Short circuits may be caused by mechanical shock to the pump. If the pump is shorted, contact Varian.

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 clean roughing pump (i.e. turbo or sorption).
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) Backing pump.

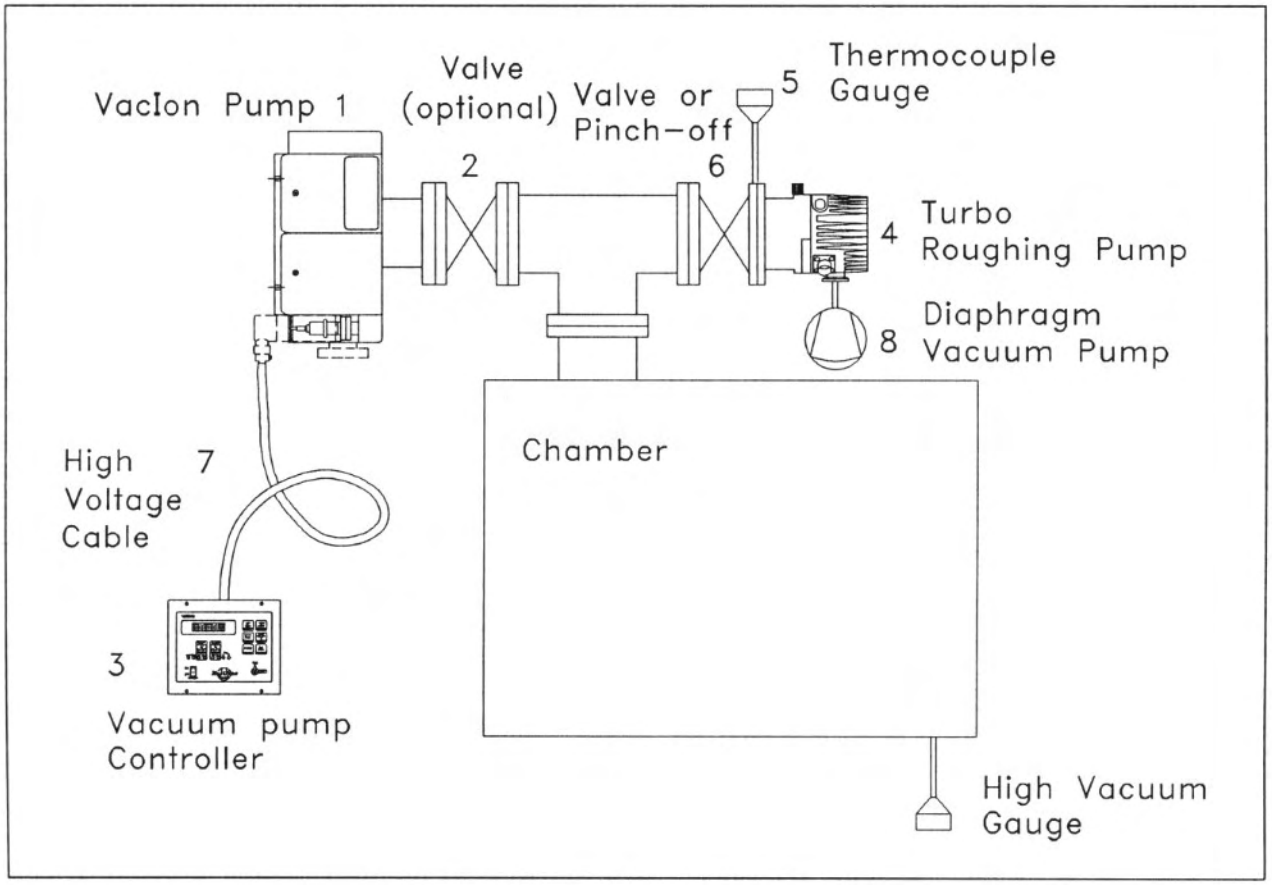

Fig. 2-1 - Typical installation

2-3 Inlet flange connection

CAUTION

To avoid pump contamination, always use gloves or other protection when handling parts exposed to high vacuum.

The pumps can be mounted in any orientation. For convenience, a pump is usually mounted vertically with the inlet up, or placed horizontally.

Pumps can be supported by the mounting flange in any position.

The pump should be mounted allowing a minimum of clearance for the removal of the high voltage connector.

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.

WARNING

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

Unscrew the main flange bolts. Remove the ConFlat flange and the copper gasket plate. Some particles of copper oxide may adhere to the outer edge of the flange gasket. Be careful not to allow them or any other foreign materials to fall into the pump.

Connect the ion pump to the vacuum chamber with a short length and large diameter tubulation in order to retain as much pumping speed 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 nuts 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.

5) Attach the nuts and tighten each one 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.

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 feed-through.

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 from the controller, slide the safety locking 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 it from the socket on the control unit.

2-5 Support feet mounting

In the iron yoke (see Fig. 2-2) of the magnet, four threaded holes (A) are drilled. They can be used to hold the pump or to insert support feet (refer to Fig. 1-21 for dimension).

The two threaded holes (B) are used to mount the heater.

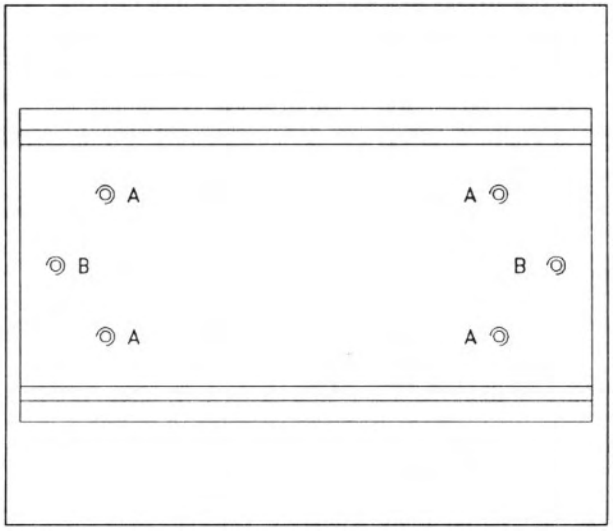

Fig. 2-2 - Location of holes A and B on iron yoke
6 threaded holes M6 (6 mm)

2-6 Heater installation

The heating element is a coaxial resistance heater shaped to fit the bottom of the pump body.

There are two threaded holes in the iron yoke for mounting the heater (see Fig. 2-2).

To install it proceed as follows:

1) Disassemble the cover. See Fig. 2-3.

WARNING

If mechanical shock occurs to the magnet assembly when removed from the pump, the magnets can attract each other with the possibility of trapping fingers, shattering the magnets or damaging the equipment. In order to avoid this insert a piece of wood or plastic between the magnets to keep them separated.

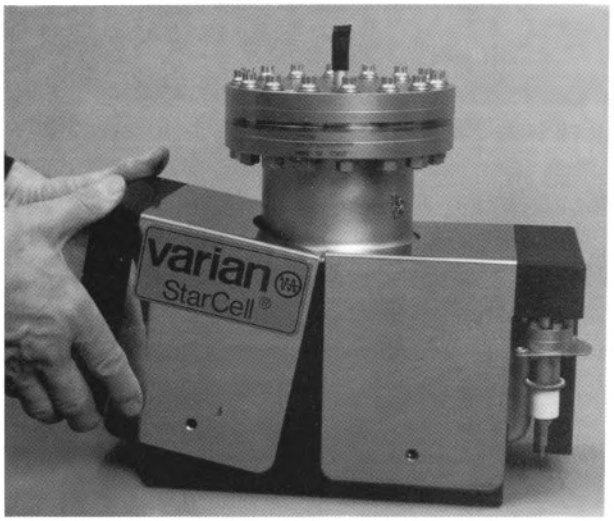

Fig. 2-3 - Disassembling the pump cover

2) Remove the pump from the magnet. See Fig. 2-4.

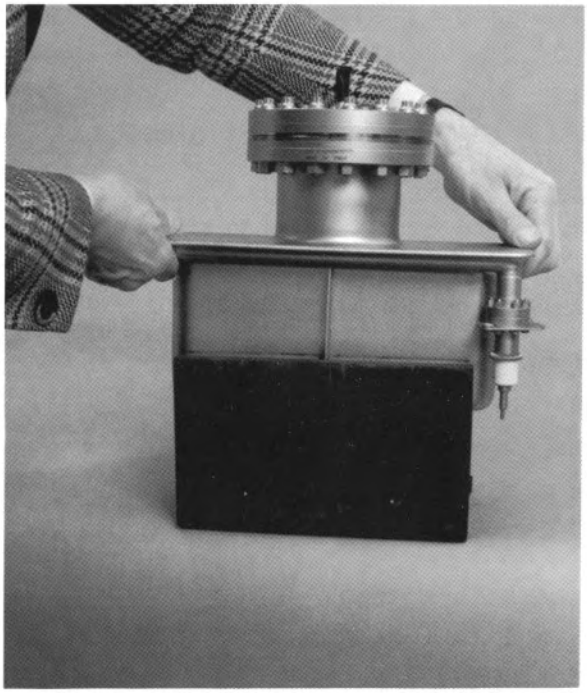

Fig. 2-4 - Removing the pump body

3) Insert the heater around the pump pocket. See Fig. 2-5.

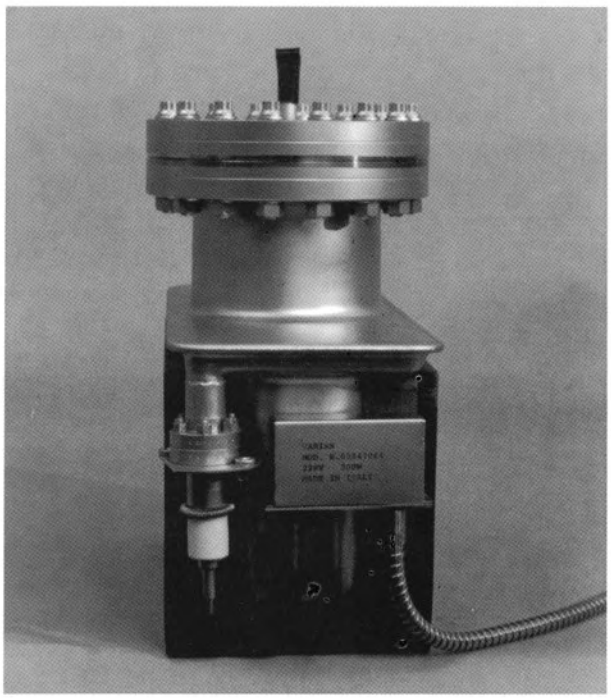

Fig. 2-5 - Inserting the heater

4) Reinstall the pump and the cover.

5) Insert the 2 screws found in the heater kit into the 2 above mentioned holes in the iron yoke. See Fig. 2-6.

6) Do these 2 screws in until the heater touches the pump body.

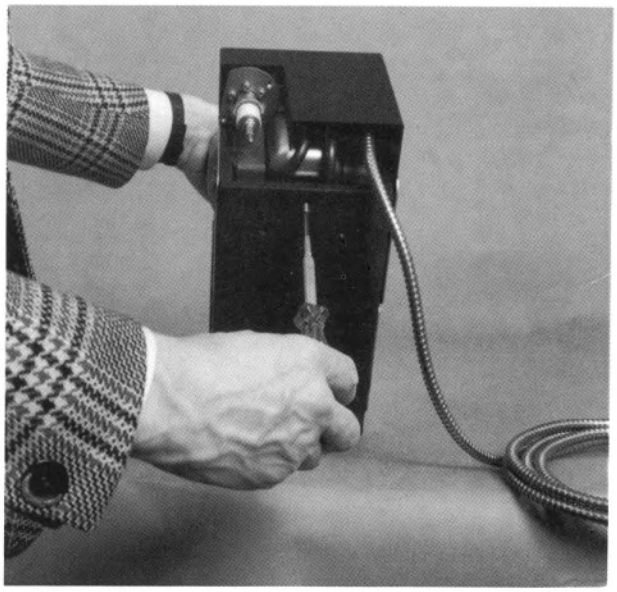

Fig. 2-6 - Inserting screws for heater installation

This page intentionally left blank

3-1 General

Rough pumping to below $1x10^{-3}$ 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 vapour 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 vapours will start diffusing into the system at pressures below $1x10^{-1}$ Torr and cause contamination. In systems where oils must be completely eliminated, turbopumps or VacSorb roughing pumps should be used.

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 vapour. In subsequent start ups, pump heating causes release of the water vapour and some previously pumped hydrogen and thus the starting time may be lengthened.

3-2 Operating procedure

Check that the controller HV polarity is correct for the pump. 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 high voltage 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, and the roughing valve should be closed.

5) When the voltage has increased to 2-3 kV, if required 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) 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 the figures of section 1.

NOTE

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

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

3-3 Bakeout operation

When a VacIon pump does not reach the desired base pressure, and there are no leaks, it is necessary to bake the system. This is done by heating the pump and all the components in the system, and is geberally required to achieve less than 10^{-8} Torr (mbar) base pressures.

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 temperature 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 $5x10^{-5}$ Torr ($6.6x10^{-5}$ mbar); if this value is exceeded, turn the bakeout off and then on again when low pressure is restored.

3) Bake the VacIon *Plus* pump for at least eight 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.

Note that the pump can be also baked when off, into an external turbo pump through a bakeable isolation valve.

4-1 General

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

The VacIon *Plus* 40 pumps are designed with exchangeable high-voltage feedthrough.

WARNING

Before maintenance, turn off the control unit and remove high voltage connector from the pump.

4-2 Exchange of the high voltage feedthrough

1) Remove the 6 bolts of the Mini-ConFlat flange connection (see Fig. 4-1).

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, making sure that the feedthrough is connected to the pumps internal connector. Check that the feedthrough is not shorted.

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).

4-3 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 100 nA. 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 increased by the leakage current value.

4-4 Hi-potting

A constant pump current when no vacuum leak exists is often caused by field emission currents which prevent the use of the pump current as UHV 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.

High potting should be done under vacuum and preferably without pump magnets installed (to reduce the drawn current).

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.

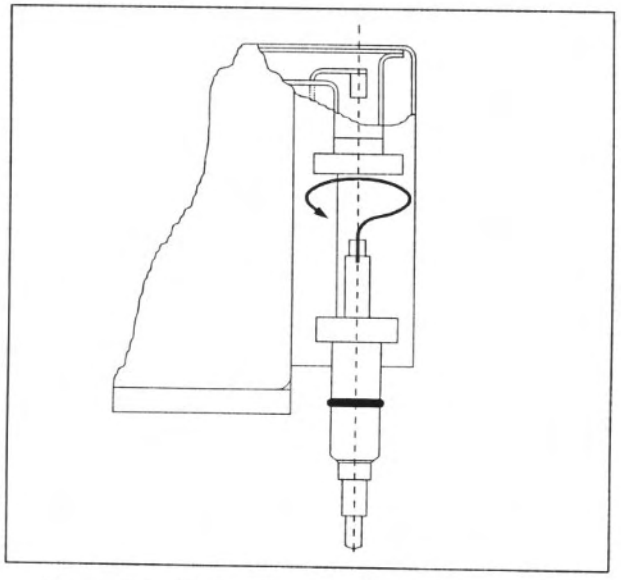

Figure 4-1 - High voltage feedthrough connection

4-5 Heaters replacement

To replace the pump heaters, first remove the faulty heater following in the reverse order the instructions of para. 2-6, and then reassembly the new heater following the instructions of same para. 2-6.

4-6 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 and are very difficult to remove, even by baking.	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.

5-1 VacIon Plus 40 pump replacement parts and accessories

	Part Number			
	StarCell	**Triode**	**Noble Diode**	**Diode**
Basic pump	919-0101	919-0201	919-0301	919-0401
Pump with options				
With additional 2 3/4" CFF port	919-0101S004	919-0201S004	919-0301S004	919-0401S004
Cables				
HV Bakeable cable, 13' (4 m) long	929-0770			
HV Bakeable cable, radiation resistant, 13' (4 m) long	929-0770S900			
Replacement parts and accessories				
HV Feedthrough	959-5120			
Pump without magnets and covers	919-0101S007	919-0201S007	919-0301S007	919-0401S007
Heaters (for basic pump) (120V) (220V)	919-0048 919-0047			
Heaters (for S004 pump) (120V) (220V)	919-0048S004 919-0047S004			
Magnet assembly	03642726			
Garter spring	0060141001			
Copper gasket for 2 3/4" CF inlet flange (10-pack, individually sealed)	FG-0275-CI			
Nut and bolt set for 2 3/4" CF inlet flange, 1/4 - 28 x 1 1/4 (25-pack)	FB-0275-C12			
Copper gasket for 1 1/3" CF feedthrough flange (10-pack, individually sealed)	FG-0133-CI			
Nuts and bolt set for 1 1/3" CF feedthrough flange, 8 - 32 x 3/4 (25-pack)	FB-0133-C			
High voltage connector bracket	03644341			

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

5-2 VacIon Plus 40 pump controllers

	Part Number			
	StarCell	**Triode**	**Noble Diode**	**Diode**
MultiVac controller				
Base unit (120V) (220V)	929-4000 929-4010			
HV Module	929-4025		929-4035	
Set Point/Remote Control	929-4110			
RS 232/422 Interface	929-4100			
Base unit with RS 232/422 Interface mounted (120V) (220V)	929-4011 929-4001			
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.