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CRYOGENIC TURBO-MOLECULAR VACUUM PUMP

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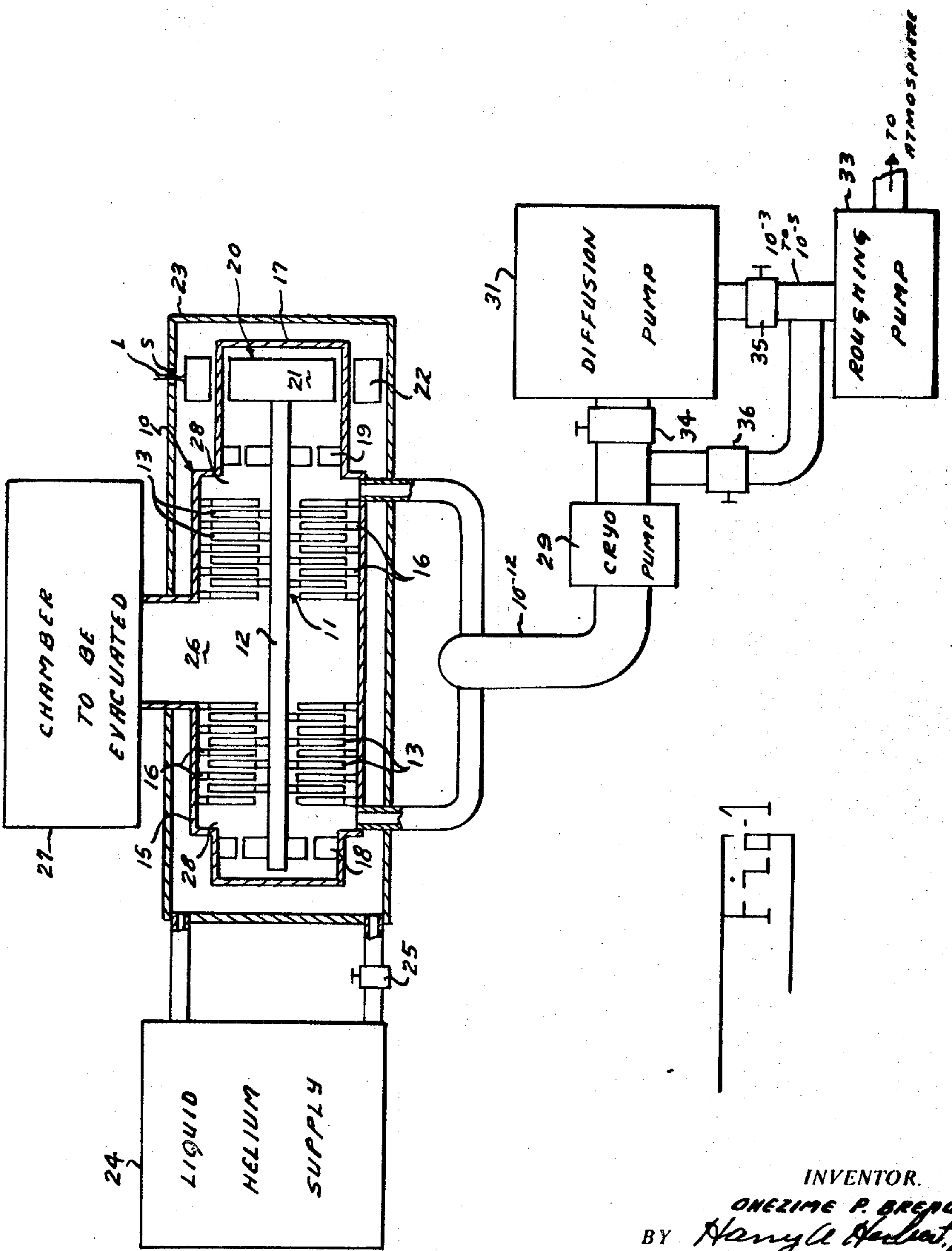


Fig-1

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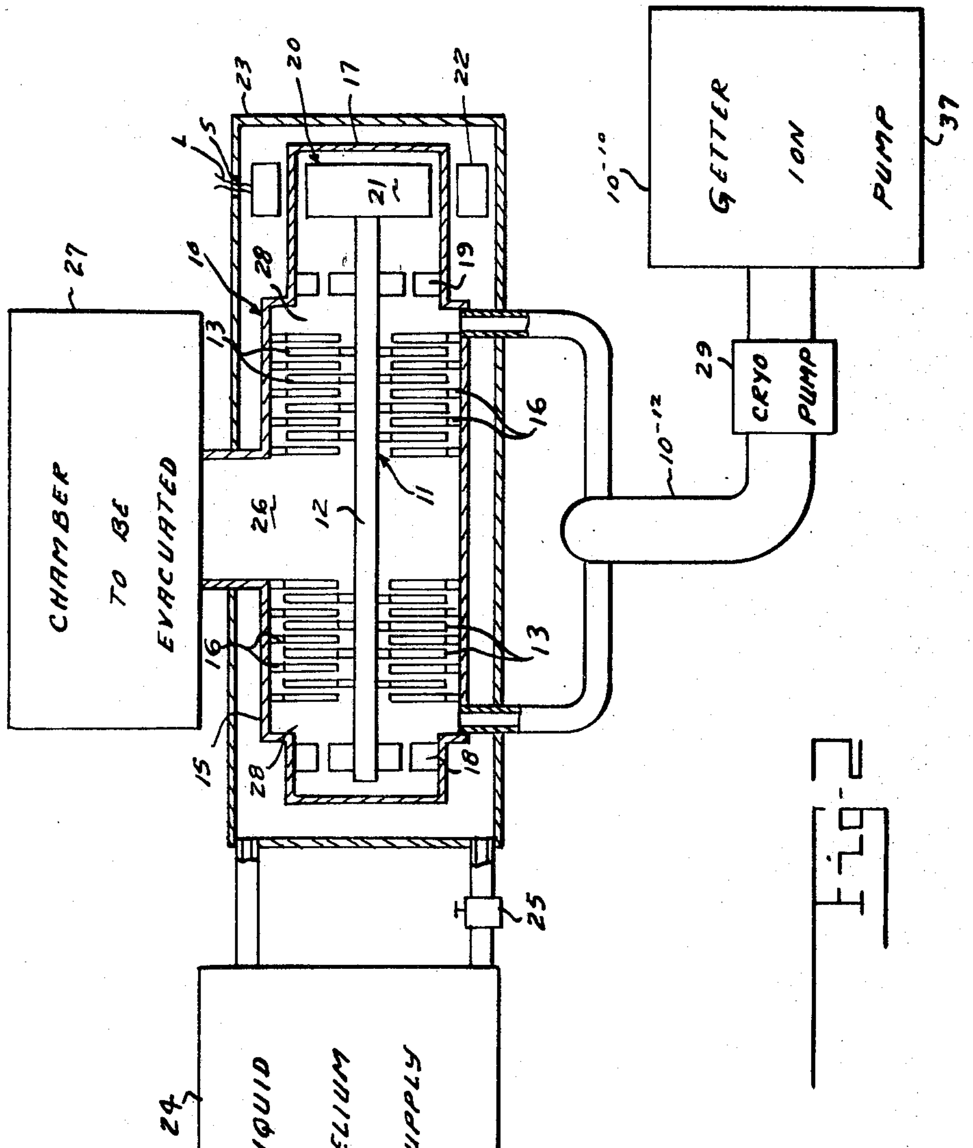


Fig-2

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# CRYOGENIC TURBO-MOLECULAR VACUUM PUMP

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## ABSTRACT OF THE DISCLOSURE

A turbo-molecular pump is cooled to cryogenic temperature with liquid helium so that the particles being pumped have very low thermal energy. The outlet pressure of the turbo-molecular pump is reduced to about $10^{-12}$ torr so that the reduced outlet pressure in combination with the low thermal energy of the particles substantially eliminates backstreaming through the turbo-molecular pump thus providing much higher vacuum in the chamber to be evacuated.

## BACKGROUND OF THE INVENTION

This invention relates to vacuum pumps for obtaining ultrahigh vacuum.

In simulating outer space conditions there is a continuing effort to obtain ultrahigh vacuum. Prior art systems which are used to obtain ultrahigh vacuum are the cryogenic vacuum pump, which is based on the condensation of gases and vapors on metal surfaces which have been cooled by substances at a very low temperature, such as, liquid helium, and the molecular pump wherein the molecules strike a moving surface which gives the molecules a resultant velocity in the direction of motion of the surface. Channels cut in a stator adjacent the moving surface direct the movement of the molecules such that a pumping action is produced. Cryogenic pumps will not effectively pump neon, helium or hydrogen, and molecular pumps suffer from backstreaming. Since these gases are always present in air, a vacuum of about $10^{-12}$ torr has been the limit of prior art pumping systems.

## SUMMARY OF THE INVENTION

According to this invention, a vacuum pump is provided which gives improved results in obtaining very high vacuums. In the device of the invention, a conventional turbo-molecular pump is cooled with liquid helium. The outlet pressure on the pump is reduced to about $10^{-12}$ torr, or lower, by conventional pumping. By reducing the outlet pressure and by cooling the turbo-molecular pump, such that the particles have very low thermal energy, backstreaming through the molecular pump is substantially eliminated. This backstreaming through the molecular pump will be reduced even when neon, helium, and hydrogen are the materials being pumped. Thus the device of the invention may be used to obtain higher vacuum than prior art devices.

## BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a partially schematic block diagram of a high vacuum pumping system according to the invention; and

FIG. 2 is a partially schematic block diagram of another embodiment of the device of FIG. 1.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIG. 1 of the drawing, reference character **10** shows a conventional turbo-molecular pump with a rotor **11** having a shaft **12** and a plurality of radial blades **13** and a stator **15** having a plurality of



blades **16** interleaved between blades **13**. Such a pump can be found on page 200 of "High Vacuum Pumping Equipment," by Powers, Reinhold Publishing Corporation, New York, 1966.

The pump **10** is located within a chamber **17** which is hermetically sealed except at the inlet and outlet and has its rotor **11** supported by conventional magnetic bearing **18** and **19**. The magnetic bearings reducing the frictional heat added to the system. The rotor **11** is driven by a conventional induction motor shown schematically at **20**. The rotor **21** and the stator **22** of motor **20** are located within the jacket **23** to reduce the heating effect of the motor by reducing the resistance in the motor windings. Leads L for the stator **22** are brought out through a liquid seal S. The fluid-tight jacket **23** is positioned around chamber **17** and has liquid helium supplied to it from supply **24**. A valve **25** controls the flow of helium to jacket **23**. The inlet end **26** of pump **10** is connected to the chamber **27** to be evacuated. The outlet ends **28** of pump **10** are connected to a cryo pump **29**, a diffusion pump **31** and a roughing pump **33**. Valves **34**, **35**, and **36** are provided to bypass the diffusion pump during initial pump down. Cryogenic pumps can be found in chapter 7 of the text "High Vacuum Pumping Equipment" reference above. The diffusion pump is described in chapter 2 of the same text. A Roots pump described in chapter 5 or an oil seal pump described in chapter 1 of the same text may be used for the roughing pump.

In the operation of the device, valves **34** and **35** are closed and valve **36** is opened and roughing pump **33** is started to bring the system to approximately $10^{-3}$ to $10^{-5}$ torr. The pump **10** is then started, the cryo pump **29** is supplied with coolant, valves **34** and **35** are opened and valve **36** is closed. The diffusion pump **31** is then started and the system is pumped to provide a pressure of about $10^{-12}$ torr at the outlet of the turbo-molecular pump. The cryogenic pump **29** reduces backstreaming from the diffusion pump **31**. Valve **25** is then opened to admit liquid helium to the jacket **23**. With the outlet pressure at the outlets **28** of pump **10**, at $10^{-12}$ torr, and with the cooling effect of the liquid helium on the turbo-molecular pump, much higher vacuums are attainable in chamber **27**.

While one system is shown in FIG. 1 for attaining a vacuum of $10^{-12}$ torr at the outlets **28** of pump **10**, other systems may be used, for example, as shown in FIG. 2, a Getter Ion Pump **37**, as described in chapter 9 of "High Vacuum Pumping Equipment," may be used together with cryogenic pump **29**.

The parts within the pumping system are preferably made of stainless steel or other material which will not outgas and contaminate the system. Those parts that cannot be made of stainless steel such as the magnetic bearing, can be covered with stainless steel.

There has thus been provided a vacuum pumping system for obtaining higher vacuum than prior art systems.

I claim:

1. A system for providing very high vacuum in a chamber to be evacuated, comprising: a turbo-molecular pump having an inlet and an outlet: said turbo-molecular pump being located within a housing which is hermetically sealed except for said inlet and said outlet; said inlet being connected to said chamber to be evacuated; means for reducing the pressure at the outlet of said turbo-molecular pump to at least $10^{-12}$ torr and means for cooling said turbo-molecular pump to approximately the temperature of liquid helium.

2. The device as recited in claim 1 wherein said means for reducing the pressure at the outlet of said turbo-molecular pump includes a roughing pump for initial

pump down, a diffusion pump for further reducing the pressure to approximately $10^{-12}$ torr and a cryogenic pump to impede backflow from the diffusion pump.

**3.** The device as recited in claim **2** wherein said turbomolecular pump has a rotor having means, connected thereto, for inductively driving the rotor through the wall of said housing.

**4.** The device as recited in claim **1** wherein the means for reducing the pressure at the outlet of said turbomolecular pump includes a getter ion pump and a cryogenic pump.

**5.** The device as recited in claim **4** wherein said turbomolecular pump has a rotor having means, connected thereto, for inductively driving the rotor through the wall of said housing.

**6.** The device as recited in claim **1** wherein said turbomolecular pump has a rotor having means, connected thereto, for inductively driving the rotor through the wall of said housing.



**7.** The device as recited in claim **6** wherein the turbomolecular pump rotor is supported by magnetic bearings.


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62—55; 417—423, 201, 89, 372, 901, 902