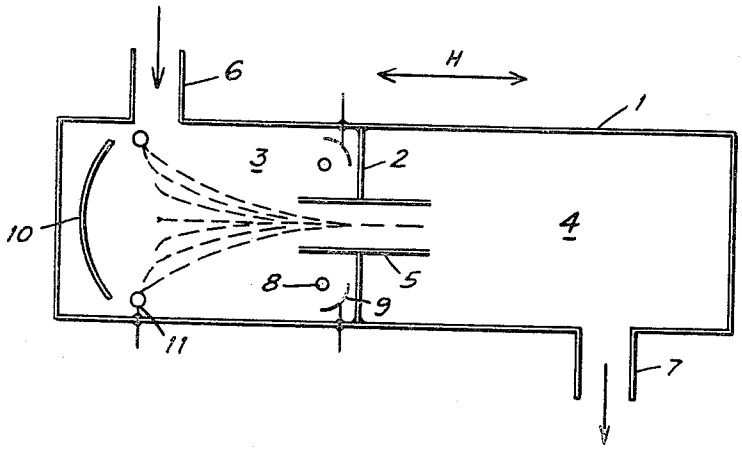
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ION PUMP

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ION PUMP

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This invention relates to an ion pump and more particularly to an ion pump which works upon the principle of producing a pressure difference between two volumes.

Of the ion pumps available heretofore, two different types have found wide use. The first of these types works upon the principle of ionized gases being collected upon some appropriate collector means. This type of ion pump was generally constructed in substantially the following manner. The pump generally comprised a vacuum type envelope which was connected to a system that was to be evacuated. Located within this vacuum type envelope was a filament-like structure for producing electrons, and at least one ion collector element. Located externally of the envelope was some type of ion focusing means such as a magnetic coil.

When the pump was in operation, the gas molecules diffused from the area which was being evacuated into the envelope where they were subjected to bombardment by the electrons produced by the filament arrangement. This electron bombardment resulted in positive charged ions being produced. These ions were attracted to, and absorbed by, the collector arrangement. In this manner, certain gases which could not be chemically gettered were removed from the system to be evacuated.

The second type of ion vacuum pump commonly found in use today is constructed substantially along the following lines. A vacuum type envelope has located therein a filament arrangement for producing a flow of electrons. The envelope is provided with an inlet means which is connected to the area to be evacuated, and an outlet connection which is connected to a pumping arrangement. Located externally of the envelope is an electron focusing means such as a magnetic coil.

The electrons produced by the filament are focused by the coil arrangement into an electron beam. This electron beam is used to ionize any gas molecules that may diffuse through the inlet connection into the high vacuum envelope. The positive ions produced by this bombardment of electrons are drawn back into the area of the filament due to a negative charge placed upon the filament winding. This drifting of the positive ions into the filament region causes a concentration of ion particles in this area but, unlike the first system described above, the ions are not allowed to strike the negative charged filament. This striking of the filament by the positive charged ions is prevented by the ions being pumped or drawn out of the vacuum envelope through the outlet connection.

In each type of instrument just described, some difficulty has been experienced in obtaining very low vacuums due to their mode of operation. These pumping arrangements are also undesirable because of the critical material used in their construction which adds materially to the cost of the finished product. Further, these pumps, in order to attain any degree of efficiency, had to have relatively large dimensions, thus making them extremely hard to adapt to certain uses.

According to the present invention, it has now been found that these difficulties may be overcome by constructing a pump which uses the ions formed to impart motion to the gas molecules within the pump. This is accomplished by subjecting a portion of the gas molecules to an electron bombardment, thereby forming ions. These ions are then formed into a beam which is accelerated into an exhaust chamber. Any neutral molecules caught in this ion beam will have momentum applied to them due to the impact force of the ions and will be driven out of the pump along with the charged ions.

A principal object of the present invention is to provide a novel ion pump construction which is more compact, less complicated, less expensive to produce, and which results in improved pumping characteristics.

Another object of this invention is to produce an ion pump which works upon the principle of producing a pressure difference between two or more chambers.

Yet another object of this invention is to produce an ion pump in which neutral molecules are transported due to the ion beam pressure exerted upon them.

These and further objects and advantages of the invention will become more apparent upon reference to the following description and claims and the appended drawing wherein:

The single figure of the drawing is a cross-sectional view of the ion pump of this invention.

With reference to the figure, there is shown an ion pump constructed in accordance with this invention. The ion pump consists of a housing 1 which may be constructed of glass, metal or other suitable material and which is divided into two chambers 3 and 4. The chambers 3 and 4 are separated by a partition 2 through which passes a tube 5. The housing 1 has a conduit section 6 to receive an outlet from the object to be pumped or evacuated. Located at the other end of the housing 1 is a second conduit section 7 which is arranged for connection with some other type of fore-vacuum pumping arrangement. Any appropriate pumping means may be connected to the outlet 7 such as, for example, a mercury vapor pump or oil pump which will withdraw the molecules which accumulate in chamber 4.

Located within the chamber 3 and surrounding the tube 5 is a filament 8 which serves as a source of electrons. Located adjacent to the filament and constructed so as to focus the electrons emitted by the filament is a focusing plate arrangement 9. Surrounding a curved cathode 10 is an anode arrangement 11 which is of a circular configuration. Both the anode and cathode are so constructed as to add to the focusing effect exerted on the ions formed by the electron bombardment. A magnetic field, represented by the arrow H, may also be arranged to exert an additional focusing effect upon the ions.

The operation of the circuit may be described substantially as follows. With the inlet tube 6 connected to the object to be pumped or evacuated, and with the outlet 7 connected to an appropriate pumping means, current is applied to the filament 8 so that electrons will be produced. Appropriate voltages will also be applied to focusing plate 9, cathode 10 and anode 11. For purposes of simplicity, these voltage and current sources have not been shown. The electrons emitted by filament 8 are accelerated towards anode 11 and will be formed by focusing plate 9 and cathode 10 so that the electron beam has a minimum diameter at a point between the filament 8 and anode 11. This electron movement ionizes the gas in the chamber 3. The cathode and anode are shaped and biased so that any ions present in chamber 3 will be formed into a beam as represented by the dotted lines. This beam is concentrated so that it will have maximum intensity within the tube 5.

As the molecules to be pumped diffuse into the chamber 3 through the inlet 6, they will become subjected to a bombardment produced by the electron beam from filament 8. From this bombardment, a cloud of positive ions is produced in the area of the cathode 10. The potentials on the anode 11 and cathode 10 causes the ions to be accelerated toward tube 5. Thus energy will be

imparted to any molecules that may be hit by this ion beam and they will be accelerated from chamber 3, through tube 5, into chamber 4. This movement of molecules and ions from chamber 3 into chamber 4 causes a difference in pressure to exist between the chambers, with chamber 3 being at a lower pressure than chamber 4. This build-up in pressure in chamber 4 is prevented from reaching a point where diffusion back into chamber 3 occurs by molecules being taken out of the chamber 4 through outlet 7.

It can be readily seen that chamber 3 will always be at a lower pressure than chamber 4 and that this will cause more molecules to be drawn into chamber 3 through inlet 6. Once within the chamber 3, they are subjected to the force exerted by the ion beam and will subsequently be forced into chamber 4 where they are exhausted through outlet 7. Thus, regardless of whether the particles are neutral or charged, they will be forced from chamber 3 into chamber 4.

From this description it can be seen that the more concentrated the ion beam becomes, the higher efficiency the ion pump will possess. To increase the concentration of the ion beam, various other focusing plates or magnetic fields may be used. It may also be advantageous under certain conditions to connect a plurality of such ion pumps in cascade, thereby increasing the total pressure difference that may occur between the object that is being pumped or evacuated and the pumping arrangement connected to outlet 7.

Any diffusion which may occur if molecules move from chamber 4 through tube 5 into chamber 3 may be reduced to a minimum if the connecting tube is longer than the mean-free-path of the gas molecules in the ion beam. This assures that the large momentum of the beam ions will be partly transferred to the gas molecules.

It will be apparent from the foregoing that by using the large momentum possessed by the ion beam to impart motion to molecules undergoing a pumping operation, a much higher pumping speed will ultimately be obtained. It should also be apparent that a pumping system arranged in accordance with the above teaching will be less expensive to produce and will result in an improved pumping characteristic since neutral particles as well as ions will be pumped. The ability to vary the tubular connecting means between various elements of the ion pump

is also highly desirable since this allows the pump to be operated at maximum efficiency regardless of the type of molecules that may be undergoing pumping.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

An electron vacuum pump comprising a cylindrical housing, separator means located within said housing for forming a first and second chamber, tubular means passing through said separator means for joining said chambers, an inlet located in said first chamber, means for connecting said inlet to an area to be evacuated, an outlet located in said second chamber, means adapted to connect said outlet to additional pumping means, filament means for producing electrons located in said first chamber, electron focusing means located adjacent said filament for forming said electrons into a beam, anode means located in said first chamber for accelerating said electron beam so that ions are formed by electrons bombarding gas molecules, and cathode means located in said first chamber for focusing said ions into a beam which passes through said tubular means into said second chamber whereby any molecules located within said ion beam will be transported by the collision and momentum transfer from the ions in said ion beam into said second chamber where said ions and molecules are drawn out by said additional pumping means.

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