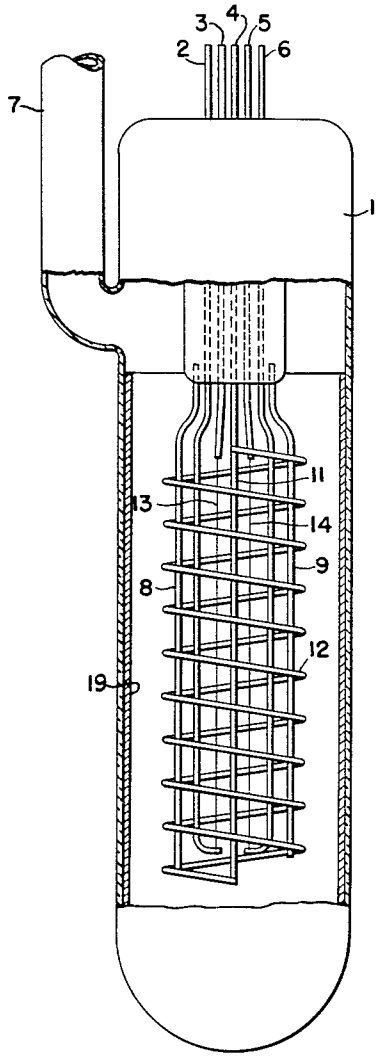
Dec. 13, 1955 D. ALPERT 2,727,167

ION PUMP

Filed April 18, 1952



WITNESSES:

John E. Hessley

Leon M. Garman

INVENTOR

Daniel Alpert

BY

F. E. Browder

ATTORNEY

United States Patent Office 2,727,167 Patented Dec. 13, 1955

2,727,167

ION PUMP

Daniel Alpert, Pittsburgh, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application April 18, 1952, Serial No. 282,992

8 Claims. (Cl. 313—7)

My invention relates to high-vacuum pumping devices and in particular comprises an electrical discharge tube in which electrons emitted from a thermionic cathode produce very high vacuums by capturing molecules of gas and affixing them to the walls of a vacuum system, which fixation is later made permanent by burying them under a coating of sublimed metal. By this means I have found it possible to evacuate to residual pressures of around 5×10^{-11} mm. of mercury (i. e. circa 7×10^{-14} atmospheres), which is only about one five-hundredth of the residual pressure ordinarily attainable with the diffusion pumps usually employed for high-vacuum pumping.

An object of my invention is accordingly to provide a high-vacuum pumping device of a novel type.

Another object is to provide a gas-evacuating system capable of exhausting vacuum apparatus to an extremely low residual pressure.

Still another object is to provide an evacuating system which is extremely simple and of low cost.

Other objects of my invention will become apparent upon reading the following description taken in connection with the drawings in which the single figure is an elevational view, partly broken away, of an evacuation device embodying the principles of my invention.

Referring in detail to the drawings, a vacuum-tight container 1, preferably in the form of a glass cylinder with a rounded lower end, and having at its upper end a press of conventional type through which in-leads 2, 3, 4, 5 and 6 are sealed vacuum-tight. Issuing also from the upper end is a pipe 7 which may be sealed or otherwise attached vacuum-tight to a vacuum-system embodying a vessel which is to be evacuated. The vacuum-system also embodies a suitable preliminary or "rough-pumping" device capable of reducing the pressure in the vacuum-system to a residual of the order of 0.001 mm. of mercury or less.

The press of the tube 1 supports two metal rods 8 and 9 extending into tube 1, and these together with an extension 11 of the in-lead 4 are so shaped as to extend parallel to the axis of tube 1, equidistant therefrom and from each other, for the greater part of their length. The parallel portions of the members 8, 9 and 11 support a helical conductor 12 which acts as anode to attract electrons. A filament 13 capable of being heated to a temperature at which it emits electrons freely is supported within the helix 12 parallel to the axis thereof on extensions of the in-leads 2 and 3. A second filament 14 of metal which can be heated to a temperature at which it evaporates copiously is similarly supported upon extensions of the in-leads 5 and 6. To give specific examples, the filament 13 may be of tungsten and the filament 14 of nickel or of one of the known metallic getters employed in tube-evacuation practice.

The filaments 13 and 14 extend well down into the rounded lower end of the tube 1, and the arrangement is such that that portion of the tube may dip into a

reservoir of liquid air or the like (not shown). Such immersion has been found to facilitate the evacuation process.

In using the above-described arrangement, the duct 7 is attached to the vacuum-system, and the latter pumped out to the best vacuum practicable with the preliminary pump. During this procedure no liquid-air is used with tube 1, but it may even be heated to a temperature safely below the melting point of its walls. The filaments 13 and 14 are heated by current flow sufficiently to effectively outgas them. When the preliminary pumping has reached the limits of its effectiveness in evacuation, the pump is preferably shut off from the remainder of the system, heating of filament 14 is stopped, and filament 13 maintained at its thermionically-emissive operating temperature. The tube 1 is immersed in liquid air, and a voltage impressed between in-leads 4 and 3 making the helix 12 positive by around 125 volts relative to filament 13.

The residual pressure within the entire vacuum system begins to drop, at a rate depending, of course, on the volume of the system being evacuated. While this operation of my arrangement is in no sense dependent, of course, on the correctness of this theory, it appears that the electrons accelerated by the electric field due to anode 12 collide with and capture molecules of the gas within container 1 and many of these pass between the turns of helix 12 into incidence with the walls of container 1 to which a large number of them adhere. Their progressive removal from the free space within the vacuum system, of course, lowers the residual gas pressure throughout the latter.

In the course of continued use the walls of tube 1 become saturated with adherent gas molecules and the effectiveness of the evacuation process is lost. However, I have found that its effectiveness may be restored by heating the filament 14 by current flow to the point where its metal evaporates and condenses on the walls of container 1 to form a getter coating 19, thereby apparently burying the adherent gas molecules on the container walls. In this way the pumping action may be carried on indefinitely.

However, the pumping arrangement is suitably effective for many purposes even where the evaporation of metal from the surface of filament 14 is not carried out at all.

I claim as my invention:

1. A vacuum-pumping device comprising a vacuum-tight container in the form of an elongated cylinder having its walls coated with a getter and having an offtake duct joined to its walls near one end, a thermionically-emissive filament supported within said container, an anode cooperating with said filament within said container, said anode comprising a conductor with spaced turns positioned between said filament and the walls of said container, a body comprising said getter to be heated electrically within said container, and in-leads for conveying current to said filament, said anode, and said body sealed through the walls of said container.

2. A vacuum-pumping device comprising a vacuum-tight container in the form of an elongated cylinder having its walls coated with a getter and having an offtake duct joined to its walls near one end, a thermionically-emissive cathode supported within said container to be heated by electric current, an anode cooperating with said cathode within said container, said anode comprising a conductor with spaced turns positioned between said walls and said cathode a body comprising said getter to be heated electrically within said container, and in-leads for said cathode, said body and said anode sealed through the walls of said container near said offtake duct.

3. In combination with a vessel to be evacuated, a pumping device comprising a vacuum-tight container in the form of an elongated cylinder having its walls coated with a getter and having an offtake duct near one end leading to said vessel, a thermionically-emissive cathode supported within said container to be heated by electric current, an anode cooperating with said cathode within said container, said anode comprising a conductor with spaced turns positioned between said cathode and the walls of said container, a body comprising said getter to be heated electrically in said container, and in leads for said cathode, said body and anode sealed through the walls of said container near said offtake duct.

4. In combination with a vessel to be evacuated to a pressure of the order of 7×10^{-14} atmospheres, a pumping device comprising a vacuum-tight container in the form of an elongated cylinder having its walls coated with a getter and having an offtake duct near one end leading to said vessel, a thermionically-emissive cathode supported within said container to be heated by electric current, an anode cooperating with said cathode within said container, a body comprising said getter to be heated electrically within said container, and in-leads for said cathode, said body and anode sealed through the walls of said container near said offtake duct.

5. In combination with a vessel to be evacuated, a pumping device comprising a vacuum-tight container having its walls coated with a getter and having an offtake duct near one end leading to said vessel, a thermionically-emissive cathode supported within said container to be heated by electric current, an anode cooperating with said cathode within said container, said anode comprising a helical conductor positioned between said cathode and the walls of said container, a body of said getter to be heated electrically in said container and in-leads for said cathode body and anode sealed through the walls of said container.

6. In combination with a vessel to be evacuated to a high vacuum, a pumping device comprising a vacuum-tight container having its walls coated with a getter and

having an offtake duct near one end leading to said vessel, a thermionically-emissive cathode supported within said container to be heated by electric current, an anode cooperating with said cathode within said container, a body comprising said getter to be heated electrically within said container, and in-leads for said cathode, said body and anode sealed through the walls of said container near said offtake duct.

7. A vacuum-pumping device comprising a vacuum-tight container having its walls coated with a getter and having an offtake duct near one end, a thermionically-emissive cathode supported within said container to be heated by electric current, an anode cooperating with said cathode within said container, said anode comprising a helical conductor positioned between said cathode and the walls of said container a body comprising said getter to be heated electrically within said container, and in-leads for said cathode body and anode sealed through the walls of said container.

8. In combination with a vessel to be evacuated, a pumping device comprising a vacuum-tight enclosure having its walls coated with a getter and having an offtake duct leading to said vessel, an electron-emissive cathode supported within said enclosure, an anode cooperating with said cathode within said enclosure, said anode comprising a conductor with spaced turns positioned between said cathode and the wall of said enclosure, a body of said getter to be heated electrically within said enclosure and in-leads for said anode, said body and said cathode sealed through the walls of said enclosure.

References Cited in the file of this patent

UNITED STATES PATENTS

2,179,437	Socolofsky	Nov. 7, 1939
2,222,005	Sutherlin	Nov. 19, 1940
2,393,650	Metcalf	Jan. 29, 1946
2,454,564	Nelson	Nov. 23, 1948
2,469,006	Shelby	May 3, 1949