March 23, 1965 M. MATRICON 3,174,678

VACUUM PUMPS

Filed Nov. 29, 1961 2 Sheets-Sheet 1

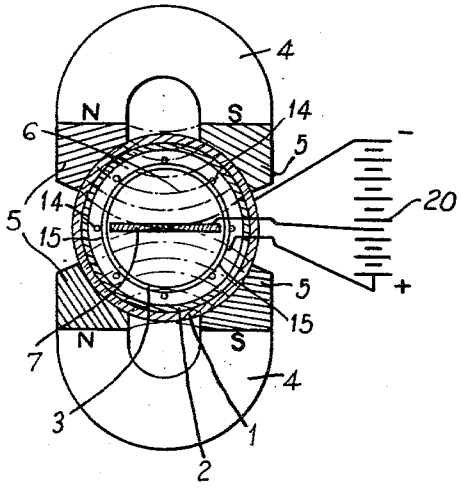


Fig.1

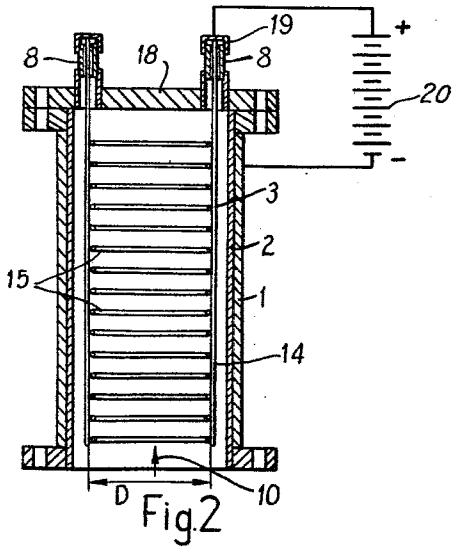


Fig.2

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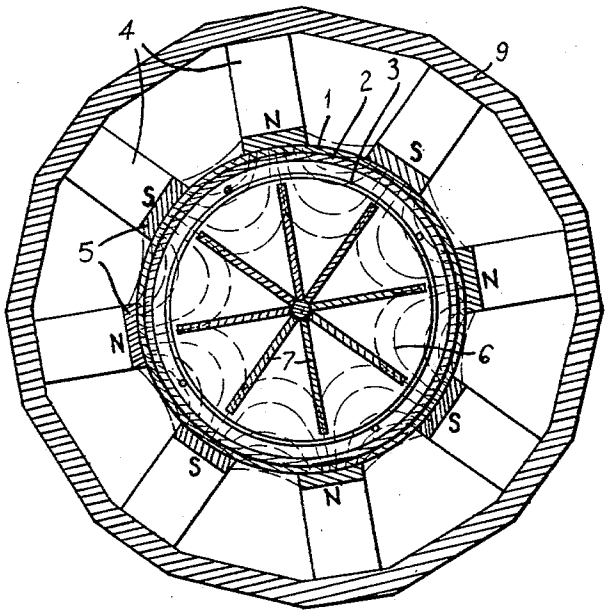


Fig.3

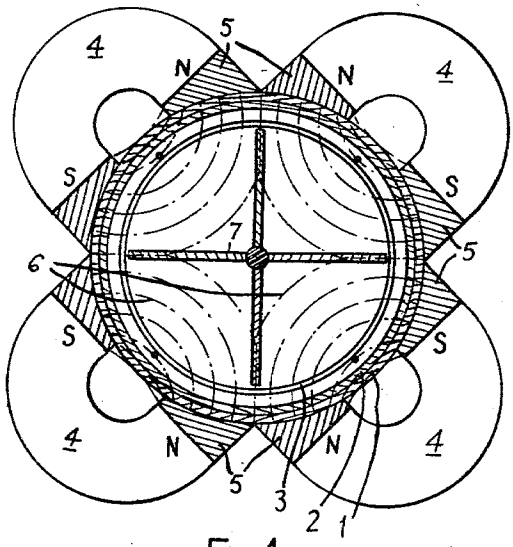


Fig.4

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VACUUM PUMPS

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4 Claims. (Cl. 230—69)

The present invention relates to improvements to vacuum pumps of the evaporation and ionization type.

It is known that electrical discharges in rarefied gases such as those which occur in the presence of a magnetic field and which are accompanied by an evaporation of the metal constituting the cathode, lead to the progressive disappearance of the residual gases. This phenomenon has been used as a method of perfecting the vacuum in sealed tubes and in vacuum pumps of the type known as evaporation and ionization pumps.

The present invention has for an object the construction of an improved pump implementing the above-mentioned phenomena.

One of the characteristics of the invention lies in a vacuum pump of the evaporation and ionization type which comprises, on the one hand, a hermetic cylindrical enclosure made from a magnetic material including an inside coating with good gas absorption properties, and a cylindrical grid, on the other hand, arranged on the inside of said enclosure and insulated therefrom, a difference of potential being applied between these two elements in such a way that the enclosure acts as a cathode in relation to the grid, said difference of potential being of sufficient amplitude to produce an electric discharge, the electrons which have been abstracted from the cathode under the impact of the positive ions being accelerated by the electrical field, and submitted to a magnetic field of suitable distribution which enables them to reach the grid after having effected a certain number of oscillations, during their travel these electrons ionizing the residual gas, the positive ions of which are accelerated towards the cathode where they cause the emission of new electrons, the cycle being repetitious.

As a result of this arrangement the positive ions which strike the cathode are absorbed by said cathode as a result of this above-mentioned constitution. As a consequence of its impact the metallic particles taken from the cathode will fix themselves to the walls of the enclosure, which brings about the imprisoning of the gaseous molecules in the cathodic metal layer.

According to another characteristic of the invention, appropriate screens are suitably arranged on the inside of the grid and parallel to the direction of the magnetic field in such a way that they receive the evaporated cathodic metal, these screens can, should it be necessary, be held at a suitable potential in order that they do not give rise to any disturbance in the distribution of the electrical field.

According to another characteristic of the invention, the above-mentioned magnetic field is of perpendicular direction in relation to that of the longitudinal axes of the enclosure and the grid, and is distributed in such a way that the major part of the lines of force do not encounter any element of the grid, as a result of which the electrons are able to accomplish a long oscillatory trajectory and consequently have considerable ionizing effect.

In order that the invention may be more clearly understood, reference will now be made to the accompanying drawings which show some embodiments thereof by way of example, and in which:

FIGURE 1 shows a cross-section of a first embodiment of a pump according to the invention,

FIGURE 2 shows an elevation thereof, and

FIGURES 3 and 4 respectively show cross-sections of two further embodiments.

Referring to the drawings, the pump is constituted by a gas-tight cylindrical enclosure 1, made of non-magnetic material having an internal conductive coating 2 having good gas absorption properties. On the inside of this enclosure is a grid 3, arranged coaxial to the whole. Between members 2 and 3 a difference of electrical potential is established so that the grid 3 becomes an anode and the cylinder 2 a cathode. Magnets 4 provided, for example, with pole-pieces 5, are arranged outside enclosure 1 in such a way that a magnetic field, the lines of force of which are shown in 6, are created on the inside of the device. When a suitable electrical voltage is applied between the cathode and the anode an electrical discharge results. The electrons abstracted from the cathode by the impact of the positive ions are accelerated by the electrical field which exists between the cathode 2 and the grid-formed anode 3 but they are guided by the magnetic field and can generally only attain the anode after having effected a large number of oscillations between the anode and the cathode. During this long trajectory they ionize the residual gases and the positive ions formed accelerate towards the cathode, causing the emission of new electrons.

The positive ions which strike the cathode can be absorbed into the metal constituting the cathode if this metal is appropriately chosen. On the other hand, the shock of the positive ions tears away particles of cathodic metal which fix themselves onto the walls of the enclosure. During this process the gaseous molecules are imprisoned beneath the cathodic metal layer.

Such are the two phenomena which confer their gas absorption properties on the system. In order to render the second process more efficient, surfaces such as 7 (not shown on FIGURE 2) can be arranged in the system, to receive the evaporated cathodic metal. These surfaces should be placed in such a way that they do not hinder the electrical discharge, i.e. parallel to the magnetic field. For the same reason they can be carried to the potential of anode 3 in order that they do not absorb the distribution of the electrical field in the system.

The grid-formed anode 3 is cylindrical in construction, long in relation to its diameter, with a large aperture D to facilitate the passage of the gases to be pumped which pass through a pump inlet 10, the diameter of which is approximately that of the cathode 2. The grid-formed anode 3 is constituted by a number of vertical rods 14 disposed in squirrel-cage fashion along the generators of a cylinder and within these rods 14 is fixed a plurality of parallel rings 15, in axially separated relationship, by any known convenient means such as soldering or binding. The rings 15 are preferably made of the same metal as the rods 14. The anode 3 as a structure is maintained in the pump by insulating members 8, and connected to the positive pole of a current source indicated as a battery 20, as well as to one of the rods 14 passing through the member 8. The members 8 and 9 (FIGURE 2) thus form between them an electrical connection means and an insulating support. This arrangement is convenient if it is intended to heat the anode by the Joule effect in order to degasify it and to provoke evaporation of the fixing body of the gas. For this last purpose the anode can be wholly or partly made of the body it is wished to evaporate. The anode can also be positioned by insulating supports which are suitably placed and arranged independent of the electrical connection.

FIGURES 3 and 4 show arrangements according to the invention wherein the reference numerals similar to those of FIGURES 1 and 2 designate like parts.

In the structure shown in FIGURE 3, the magnetic masses 4 are prismatic and the magnetic field is closed by a yoke 9.

Finally, according to the invention, surfaces 7 can be held at negative voltage in relation to anode 3 in such a way that these surfaces 7 function as ion collectors, thus favouring the fixing of the gases. The voltage to which these surfaces 7 is carried should be such that the ion collection be efficient but that the speed of these ions be too low to cause the automisation of the metal constituting these surfaces 7 or which is deposited on them. This method of operation can be accompanied by Joule heating of anode 3 and by its evaporation if said anode has been made of a metal able to fix the gases.

I claim:

1. An ionisation and evaporation vacuum pump, comprising a sealed cylindrical enclosure made of a non-magnetic material, an inlet on said enclosure for connecting said pump to a structure to be evacuated, a coating on the inside wall of said enclosure, said coating having good gas absorption properties, a cylindrical grid structure open at one end arranged axially within and electrically insulated from said enclosure, said grid structure consisting of a plurality of rods disposed in squirrel-cage fashion along the generators of a cylinder, and a plurality of rings secured to and within said rods in parallel axially spaced relationship, the outer diameter of said grid structure being of such size as to leave a gap between said inner wall of said enclosure, means for supporting said grid structure, means for heating said grid structure, said grid structure being made of a material having at least a coating of a metal to be evaporated, means for applying a potential difference between said grid structure and said enclosure to cause said enclosure to function as a cathode in relation to said grid structure, said potential difference being of a magnitude to set up an electrical field between the wall of said enclosure and said grid and to set up an electrical charge therebetween, and magnet means located outside said enclosure with their pole pieces thereunto adjacent for setting up a magnetic field within said enclosure to prevent electrons issuing from said inner wall of said enclosure from following said electrical field and reaching said grid structure during their first trajectory, whereby said electrons are caused to make a large number of oscillations before reaching said grid structure.

2. An ionisation and evaporation vacuum pump, comprising a sealed cylindrical enclosure made of a non-magnetic material, an inlet on said enclosure for connecting said pump to a structure to be evacuated, a coating on the inside wall of said enclosure, said coating having good gas absorption properties, a cylindrical grid structure open at one end arranged within and electrically insulated from said enclosure, said grid structure consisting of a plurality of rods disposed in squirrel-cage fashion along the generators of a cylinder, and a plurality of rings

secured to and within said rods in parallel axially spaced relationship, the outer diameter of said grid structure being of such size as to leave a gap between said inner wall of said enclosure, rod means passing through said enclosure for supporting said grid structure, said rod means being insulated from said enclosure, electrical connection members for said rod means, means for heating said grid structure, said grid structure being made of a material having at least a coating of a metal to be evaporated, means for applying a potential difference between said grid structure and said enclosure to cause said enclosure to function as a cathode in relation to said grid structure, said potential difference being of a magnitude to set up an electrical field between the wall of said enclosure and said grid structure to set up an electrical charge therebetween, magnet means located outside said enclosure with their pole pieces thereunto adjacent for setting up a magnetic field within said enclosure to prevent electrons issuing from said inner wall of said enclosure from following said electrical field and reaching said grid structure during their first trajectory, whereby said electrons are caused to make a large number of oscillations before reaching said grid structure.

3. An evaporation and ionisation vacuum pump as claimed in claim 2, and comprising further at least one screen located inside said grid structure, the surface of said screen being parallel to the direction of said magnetic field, said at least one screen being located to receive the cathodic metal evaporated from the coating on said inner wall of said enclosure, and means for supplying said at least one screen with an electrical potential causing no disturbance in the electrical field between said grid structure and said enclosure.

4. A pump as claimed in claim 3, and comprising further, means causing said magnetic field to follow a perpendicular direction in relation to the direction of the longitudinal axis of said enclosure and said grid structure, and means for effecting distribution of said magnetic field to cause the major part of the lines of force to miss the rods and rings of the grid structure on their entry into and exit from said enclosure whereby said electrons carry out a long oscillatory path between said grid structure and said enclosure.

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