March 9, 1965 L. GUYOT 3,172,597

IONIC PUMP

Filed July 5, 1961

Fig.1

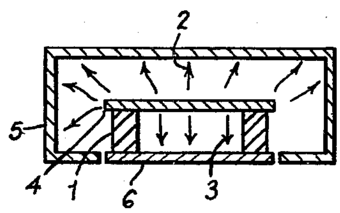


Fig.2

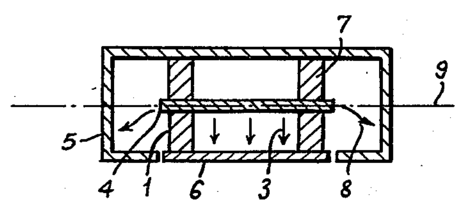


Fig.3

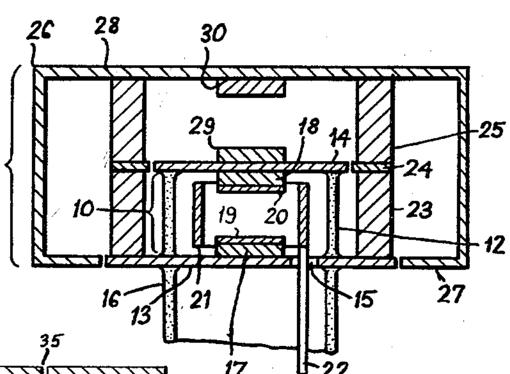
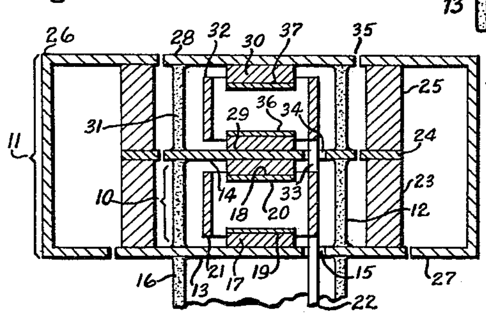


Fig.4.



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IONIC PUMP

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The present invention relates to an ionic pump of the getter type with a self-actuated discharge in a magnetic field and having the advantages of negligible outer magnetic field, reduced size and very light weight.

It is known that in certain ionic pumps of the getter type, such as those described in U.S. Patent No. 2,755,014 filed April 24, 1953, an autonomous ionic discharge known as the Penning discharge is used, said discharge being produced in non-parallel electrical and magnetic fields. According to a preferred embodiment, the ionization chamber of such a pump contains a positive electrode in the shape of a hollow cylinder and two negative electrodes made of a material, such as titanium or carbon which absorbs gaseous ions. These two electrodes are oppositely arranged at the open ends of the positive electrode. This system is located in a magnetic field parallel to the axis of the cylinder and produced by a magnet arranged outside the enclosed space containing the system. When an ionic discharge takes place between these electrodes, the electrons produced can only reach the positive electrode along very long helical paths. Thus the likelihood of ionizing shocks is increased to the point at which the discharge is maintained at extremely low pressures. The ions produced travel towards the negative electrodes which absorb them.

These pumps, which require no other means of operation than a high voltage supply, are very suitable to remain sealed permanently to electronic tubes in which it is desired to maintain a high vacuum. However, up to now they could not be associated with tubes using precision electron optical systems, and more particularly those in which low speed electrons are encountered, such as camera tubes and image tubes. In fact, these pumps have a considerable outer magnetic field which introduces intolerable defects into the electron optics. In principle it is possible to have an effective magnetic screening either of the pump or of the electronic tube, but this increases the volume and the weight of the assembly to a prohibitive extent, in particular in the very frequent cases in which the electronic tube is fragile and in which furthermore it must operate in transportable devices.

The present invention has for an object to provide an ionic pump of the getter type with a magnetic field which, whilst having a small volume and a light weight, has hardly any outer magnetic field. The principle of the invention consists in reducing the outer field by means of a compensating magnetic structure.

The present invention provides an ionic pump of the getter type using an ionization chamber, in which there prevails a magnetic field, having the following arrangements:

The ionization chamber is essentially constituted by a hollow cylinder of a non-ferromagnetic material connected on either side to ferromagnetic plates. It is surrounded by a magnet in the shape of a hollow cylinder magnetized in the direction of its axis and magnetically connected to the two ferromagnetic plates. Outside the chamber and coaxial with it, is arranged a second magnet, a so-called compensation magnet, preferably of identical shape to the first, magnetized in the opposite direction to that of the first and magnetically connected by one of its polar faces to one of the two plates of the chamber and by the other to a third ferromagnetic plate.

According to a preferred embodiment, the assembly is surrounded by a magnetic screen in the form of a box, two opposite walls of which are magnetically connected respectively to the two end plates of the assembly, each of the plates being capable of constituting one of the walls of the box.

The term "magnetically connected," as applied to these elements of the magnet circuit indicates, according to common usage, any arrangement for which the reluctance between these elements is very small in relation to the total reluctance of the circuit. The magnetically connected elements can therefore be either in immediate contact, or integral with one another, but may also be separated by a fairly narrow gap or connected by means of a third ferromagnetic element.

The invention will now be further described with reference to the accompanying drawings, in which:

FIGURE 1 illustrates a non-compensated structure,

FIGURE 2 illustrates the principle according to this invention,

FIGURE 3 illustrates one construction of ionic pump according to this invention, and

FIGURE 4 illustrates an embodiment comprising two ionic pumps.

The pump which is the object of the invention, even in its most simple form, i.e. without screening, has a very small leakage field. In fact, its magnetic structure is approximately symmetrical in relation to a plane. The external fields produced by each half thus practically compensate for each other at a certain distance from the structure. For this reason, the screening which is used in the preferred embodiment can have reduced dimensions and its walls can be thin.

Another advantage of this pump arises from the fact that the compensation magnet, while weakening the leakage field, reinforces the field in the useful area of the pump. This effect will be illustrated by FIGURES 1 and 2, wherein FIGURE 1 diagrammatically shows the induction spectrum for a non-compensated structure and FIGURE 2 shows that found in a structure according to the invention. It may be seen that in the first case the magnet **1** produces a flux the parasitic component of which, corresponding to the induction lines **2**, is comparable to the useful component **3**. This latter stems from the large extent of the polar faces, one of which is constituted by one whole side of the plate **4** and the other by the inner surface of the screening box **5** connected to the plate **6**.

This is no longer the case in the structure according to the invention and diagrammatically shown in FIGURE 2. In this figure, a second magnet **7** magnetized in the opposite direction to that of **1**, is connected on the one hand to the outer surface of the plate **4** and on the other hand to an inner surface of the screening box **5**. The parasitic flux is very reduced because the parasitic induction lines can only originate in the half situated towards the magnet **1** of the circumferential zone of the plate **4**. In fact no induction line produced by the magnet **1** can pass through the plane of symmetry **9** of the structure. The lessening in the parasitic flux results in an advantageous reinforcement of the useful induction, allowing the volume of the pump to be reduced and thus facilitating its use on fragile electronic tubes.

The invention preferably applies to the ionic pumps of the type shown in U.S. Patent No. 2,755,014. In this case each of the two ferromagnetic plates supports an electrode made of a material which absorbs the ions of the gas to be pumped whilst a third electrode of annular shape taken to a positive potential in relation to the two previous ones is arranged in the space between the latter coaxially in relation to the line connecting them.

But the invention is not limited to these types of pumps and it may be applied to any system of ionic absorption pumps, the ionization chamber of which is subjected to a magnetic field.

FIGURE 3 diagrammatically shows an embodiment of the ionic pump which is the object of the invention.

The pump in FIGURE 3 is made up of a discharge structure contained in an ionization chamber **10** and of an outer structure **11** co-operating with the members of the chamber **10** in order to create a magnetic field limited to the chamber **10**. This chamber is constituted by a glass cylinder **12** sealed to two plates **13**, **14** of ferromagnetic material, for example Kovar. The plate **13**, which has a greater diameter than **14**, comprises a gas inlet port **15**. A glass pipe **16** sealed to the plate **13** connects the pump to the electronic tube to be pumped. These plates **13** and **14** have projections **17**, **18** extending into the chamber **1**. The projections **17**, **18** are covered with sheets **19**, **20** of a material such as carbon or titanium which can absorb the gases in the ionized state. These sheets are intended to constitute the negative electrodes of a Penning discharge, the positive electrode being constituted by a hollow cylinder **21** arranged coaxial with the first electrodes and supported by its supply conductor **22** which passes through the opening **15**. The outer structure **11**, built up on the edge of the plate **13**, comprises a permanent magnet **23** in the shape of a hollow cylinder magnetized along its axis, a flat ring **24** surrounding the plate **14** and spaced therefrom by a short distance, a magnet **25** of the same shape as **23** but magnetized in the opposite direction and a box **26** of ferromagnetic material enclosing the assembly. One of the walls **27** comprises an opening into which is located the plate **13**, whilst the opposite wall **28** comes into contact with the magnet **25**. Finally the cylindrical members **29**, **30** of ferromagnetic material, similar to the members **17**, **18** are fixed within the axis of the structure on to the inner surface of the wall **28** and on to the outer surface of the plate **14**. In this pump the plate **14** is magnetically connected to the polar faces of the two magnets **23** and **25** by means of the ferromagnetic ring **24**, and the wall **28** of the box **26** forms the ferromagnetic plate connected, according to the invention, to the end of the compensation magnet **25**. The induction flux obtained with this pump thus has the spectrum diagrammatically shown in FIGURE 2. By reason of the small value of the parasitic flux, the screening box **26** can be very light and very small.

The pump according to the present invention can be arranged in various ways, a few of which will be listed.

(*a*) The cavity formed by the compensation magnet and the two adjacent ferromagnetic plates at its ends can enclose the ionization chamber of a second pump co-operating with the first.

(*b*) In pumps containing a single active structure, the compensation magnet can be constituted by a solid cylinder arranged on the axis of the pump.

(*c*) The discharge electrode or electrodes of the pump can be directly fed by the current conductors of the electronic tube to be pumped, the connecting conductor being inside the vacuum enclosure.

FIGURE 4 shows an embodiment comprising two ionic pumps and having two ionization chambers, as described in paragraph (*a*) above.

Certain elements of this latter embodiment, referenced **10** to **30**, have substantially the same functions as those elements bearing the numbers corresponding references in FIGURE 3. In addition, the embodiment of FIGURE 4 comprises the following parts:

A second glass cylinder **31**, constituting with the elements **12**, **13**, **14**, **28** the vacuum-tight enclosure.

A second hollow cylinder **32** constituting the positive electrode of the second ionization chamber.

An electrical conductor **33** connecting the electrode **32** to the electrode **21** through an aperture **34** in the ferromagnetic plate **14**.

Sheets **36** and **37** of a material absorbing gases in the ionized state, just like the sheets **19** and **20**. These sheets **36** and **37** cover the ferromagnetic cylindrical elements and constitute the negative electrodes of the second ionization chamber.

It is clear that for constructional reasons the casing **26** cannot form a single part with the plate **28**, as is the case in FIGURE 3, but these two elements are magnetically connected as hereinbefore explained. The plate **28** is separated from the box **26** by the spacing shown at **35**. The magnetic connection between the plate **28** and the magnet **25** is therefore ensured.

I claim:

1. An ionic pump of the getter type having an ionization space which is subjected to a magnetic field, comprising a hollow cylinder of non-ferromagnetic material defining the ionization space, a first ferromagnetic member arranged at one end of the hollow cylinder, a second ferromagnetic member arranged at the other end of said hollow cylinder, at least one of said ferromagnetic members supporting an electrode of ion absorbing material on its surface facing the interior of the hollow cylinder, an annular electrode within the hollow cylinder arranged between the first and the second ferromagnetic members and having its open ends directed towards these members and adapted to be carried to a positive potential with respect to these members, an aperture in one of said ferromagnetic members forming an inlet for the gas to be pumped, a supply conductor to said annular electrode extending through said aperture, a first magnet in the form of a hollow cylinder magnetized in the axial direction which surrounds said hollow cylinder and is magnetically connected to the first and the second ferromagnetic members, a second magnet arranged outside the assembly formed by said first magnet and the first and the second ferromagnetic members coaxially therewith and acting as a compensation magnet which is magnetically connected by one of its polar faces to the second ferromagnetic member and magnetized in the opposite direction to the first magnet, and a third ferromagnetic member magnetically connected to the other polar face of the second magnet.

2. A pump as claimed in claim 1, comprising a surrounding magnetic screening structure in the form of a box magnetically connected to the first and third ferromagnetic members.

3. A pump as claimed in claim 2 in which the third ferromagnetic member constitutes one of the walls of the box.

4. A pump as claimed in claim 1, including a second ionic pump structure co-operating with the first ionic pump and arranged between the second and third ferromagnetic members, said second pump structure also comprising a hollow cylinder of non-ferromagnetic material defining the ionization space and extending between said second and third ferromagnetic members, an electrode of ion absorbing material supported by at least one of said second and third ferromagnetic members and facing the interior of the hollow cylinder, an annular electrode within the hollow cylinder having its ends directed towards said second and third ferromagnetic members, an aperture in said second ferromagnetic member forming an inlet for the gas to be pumped and providing communication between the ionization spaces of the two pumps, a supply conductor for connecting said annular electrode to a positive potential extending through said aperture and connecting with the supply conductor to the annular electrode of the first pump, and said second pump structure being surrounded by said second magnet.

5. A pump as claimed in claim 1, in which the second magnet is similar to the first magnet.

6. A pump as claimed in claim 1, in which the second magnet is constituted by a hollow cylinder.

7. In an ionic pump comprising a member of non-ferromagnetic material defining an ionisation chamber containing members of ion absorbing material and surrounded by a magnet structure producing a magnetic field directed axially of the chamber, the improvement which comprises arranging compensating magnet means which are magnetized in the opposite direction to the magnet structure externally of said chamber in order to reduce the magnetic field produced outside said chamber.

8. In an ionic pump comprising a member of non-ferromagnetic material defining an ionisation chamber containing two spaced members of ion absorbing material and an annular electrode arranged between said two members which is adapted to be carried to a positive potential and wherein a magnet structure is arranged around said chamber to produce a magnetic field extending axially of said chamber and said annular electrode, the improvement which comprises arranging compensating magnet means which are magnetised in the opposite direction to said magnet structure externally of said chamber in order to substantially reduce the magnetic field produced outside said chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

2,146,025	Penning	Feb. 7, 1939
2,755,014	Westendorp et al.	July 17, 1956