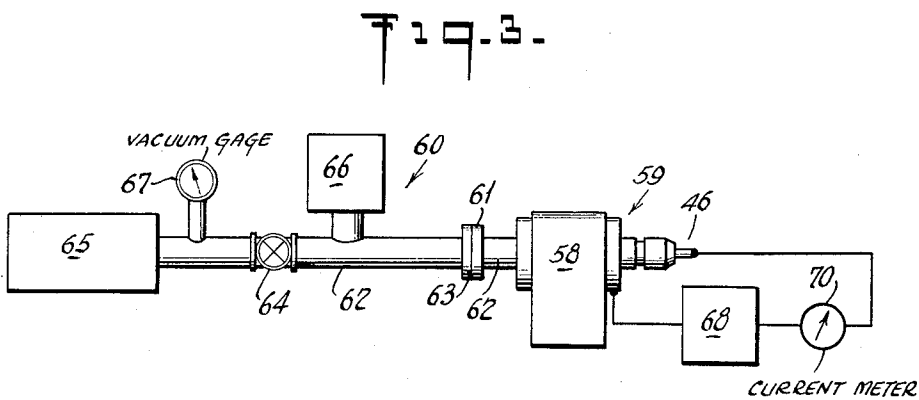
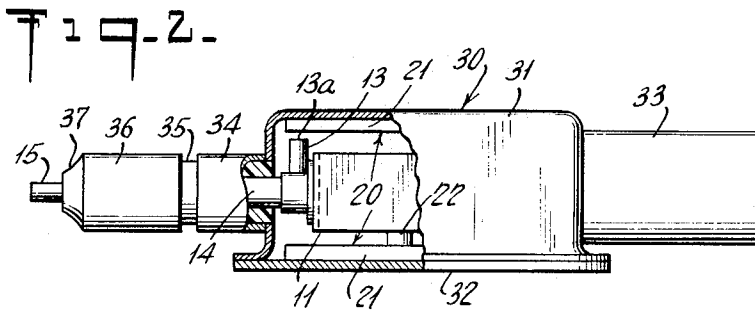
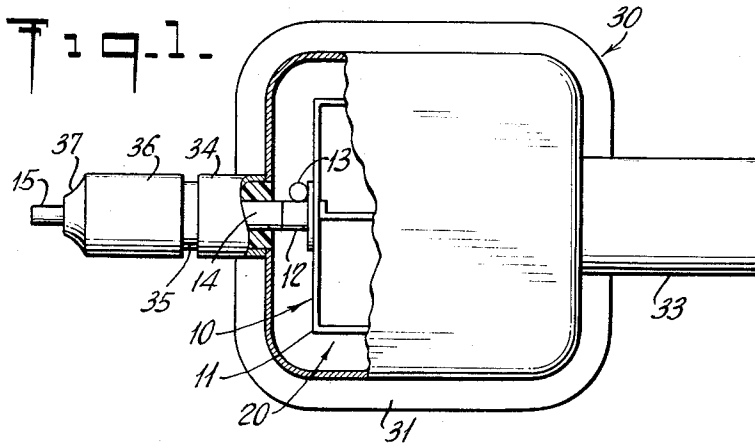


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ELECTRIC DISCHARGE VACUUM PUMP HAVING  
AN AUXILIARY PRESSURE SENSOR  
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3,233,169

## ELECTRIC DISCHARGE VACUUM PUMP HAVING AN AUXILIARY PRESSURE SENSOR

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2 Claims. (Cl. 324—33)

This invention relates to an electron discharge type vacuum device, and particularly to a cold cathode discharge type getter ion pump.

In the conventional cold cathode discharge type getter ion pump, as disclosed for example, in Japanese patent publications No. 16,136 and No. 35,203 of 1960, the pump current decreases in proportion to the pressure within the pump. Accordingly, when a very high vacuum is reached, the pump current becomes a very small value, such as for example, of the order of 1 microampere or less at a pressure of  $10^{-8}$  millimeters of mercury. On the other hand, even when the interior of the pump is approximately at atmospheric pressure, the pump current may also be close to zero due to the insulating effect of the gaseous atmosphere. Now considering an evacuating system which employs a pump of the type presently referred to, when the pump was evacuated to a high vacuum and the pump was subsequently not operated for several days, it was necessary in the prior art to employ additional equipment to determine whether the interior remained in a state of high vacuum or the vacuum had decreased to atmospheric pressure, since a pump current of substantially zero may be indicated for either condition. Such additional equipment heretofore employed was commonly in the form of a vacuum gauge.

Accordingly it is an object of this invention to eliminate the need for the additional vacuum indicating means previously required with pumps of the type referred to herein.

All of the objects, features and advantages of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawing, in which

FIG. 1 is a drawing of an illustrative embodiment of a pump constructed in accordance with this invention, the pump being shown partly in section,

FIG. 2 is an elevation view partly broken away, and

FIG. 3 shows a vacuum system wherein the electron discharge type vacuum device according to this invention is used as a getter ion pump and also as a vacuum measuring or indicating device.

Referring now to FIGS. 1 and 2, the numeral 10 indicates generally the anode of a cold cathode getter ion pump, 11 indicates the actual anode structure, and 12 is a coupling member which connects the anode to the electric power introducing rod 15. The numeral 13 is an electrode provided in accordance with the teaching of this invention which may be made of tungsten or other suitable material, and is electrically connected to the member 14 and adapted to produce an electric discharge current in the gap between the cathode 21 and the end 13a of the electrode 13 adjacent the cathode. The end 13a is positioned so that a discharge current will be produced across the gap even at low vacuum levels close to atmospheric pressure. The numeral 20 denotes generally a cathode, 21 indicates the actual cathode structure, and 22 is a spacer provided between the upper and lower cathodes in FIG. 2. Numeral 30 denotes a vacuum envelope generally, and 31 is a cup-shaped vessel comprising a portion of the envelope 30. The numeral 32 indicates a plate or cover which produces an airtight seal with

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the portion 31 and may be suitably secured such as for example, by argon welding. An exhaust pipe 33 is sealed to one side of the vessel portion 31. The numeral 34 denotes a suitable coupling member which is sealed to the vessel portion 31 and also to an insulator 36 by means of an airtight metal-ceramic seal 35. A metal-ceramic seal 37 is also provided between the insulator 36 and the rod 15. The assembly of the parts 14, 34, 35, 36 and 37 may be accomplished by brazing and spot welding. The material for the anode and cathode structure is preferably a metallic material having good getter action characteristics, such as titanium, zirconium, etc., while the vacuum envelope 30 is made of non-magnetic stainless material.

The process for assembly is as follows: The exhaust pipe 33 and the member 34, to which the members 14, 35, 36 and 37 are first secured, are fitted to the vessel 31. The upper portion of the cathode 21 is then inserted into the vessel 31 and secured therein; the anode structure is then mounted relative to this cathode portion. Next, the electrode 13 is mounted so that the space between its end 13a and the upper cathode portion 21 is approximately 0.5–1 millimeter. The parts 22, 21 and 32 are then assembled in that order.

Due to the fact that the gap between the electrode 13 and the upper cathode portion 21 has a small value of 0.5–1 mm., a spark discharge is generated and passes a comparatively large electric current even at pressures close to atmospheric, when a voltage normally of the order of 3–10 kv. is impressed on the pump. However, when the vacuum increases, in accordance with Paschen's Law, electrical discharge will not occur. Accordingly, no electric current will exist in the gap at a vacuum higher than approximately  $10^{-3}$  mm. Hg and therefore this arrangement will discriminate between a vacuum higher than this value and a pressure of the order of atmospheric pressure.

Referring now to FIG. 3, an evacuating system is indicated by the numeral 60 in which a getter ion pump 59 constructed in accordance with this invention is inserted into the gap of a magnetic field generating device 58 and is coupled to a vessel or body 66 to be evacuated, by means of piping 62, flanges 61 and 63, and suitable gaskets, bolts and nuts, not shown. The numeral 65 is a starting or fore pump and may be for example, of the oil rotary type. The numeral 67 is a vacuum gauge capable of measuring approximately  $10^{-2}$  mm. Hg. Numeral 64 indicates a sealing valve. A power supplying device 68 impresses a voltage between the cathode and the anode of the pump through terminal 46, which corresponds to the rod 15 of FIGS. 1 and 2. In starting, the valve 64 is opened and the starting pump 65 is operated to produce a vacuum of approximately  $10^{-2}$  mm. Hg. Then a voltage from the electric power source 68, which has a drooping characteristic, closes valve 64, the pump 59 then being in operation. Such a system is capable of producing a vacuum of the order of  $10^{-8}$  mm. Hg. When the pump is suspended from operation for several days, there is no problem when there is no leak in the system, however if a leak does exist, the vacuum will progressively become lower and may in time become practically nonexistent so that the system is substantially at atmospheric pressure. When a voltage is impressed several days after operation of the system, if the degree of vacuum in the interior has decreased to that approximating atmospheric pressure, the pump electric current measured by the meter 70 will show a value approximating the short circuit current value of the electric source 68. A current value close to zero would indicate that the system has been maintained in a condition of high vacuum.

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Although this system has been described with respect to a specific embodiment, it is not to be so limited as various changes and modifications may be made therein which are within the intended scope of this invention. For instance, the electrode 13 may be provided in a number of positions and it could also be in the form of a projection on the anode. The length of the gap between the electrode 13 and the cathode 21 will, of course, depend upon the potential of the electric source and the pressures employed in the system.

While the foregoing description sets forth the principles of the invention in connection with specific apparatus and certain suggested changes, it is to be understood that the description is made only by way of example and not as a limitation of the scope of the invention as set forth in the objects thereof and in the accompanying claims.

What is claimed is:

1. An electron discharge type vacuum device having means for discriminating a vacuum condition therein from a condition of atmospheric pressure therein, said device consisting of  
 a vacuum envelope,  
 an exhaust port provided in a wall of said envelope for cooperating with pumping means to create a vacuum in said envelope,  
 an anode element and a cathode element disposed in spaced relationship with respect to one another in the interior of said envelope,  
 a first electric conductor connected to one of said elements for impressing a first potential on said one element,

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a second electric conductor connected to the other of said elements for impressing a second potential on said other element,

and an electric discharge gap within said envelope, said gap comprising a small spacing between one of said elements and a conductive member directly connected to the other of said elements, the spacing of said gap being less than the smallest spacing between said anode and cathode elements, the dimension of said gap being selected so that a substantial electric current will pass across said gap and through said anode-cathode circuit for a preselected difference between said first and second potentials when the interior of said envelope is substantially at atmospheric pressure, said dimension also being selected so that no electric current discharge will occur across said gap when the interior of said envelope is at a predetermined vacuum level.

2. The invention described in claim 1 which further includes means connected to at least one of said conductors for indicating the amount of discharge current through said gap.

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ROBERT SEGAL, *Examiner*.