S. DUSHMAN.

IONIZATION MANOMETER.

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1,334,143.

Patented Mar. 16, 1920.

Fig. 1.

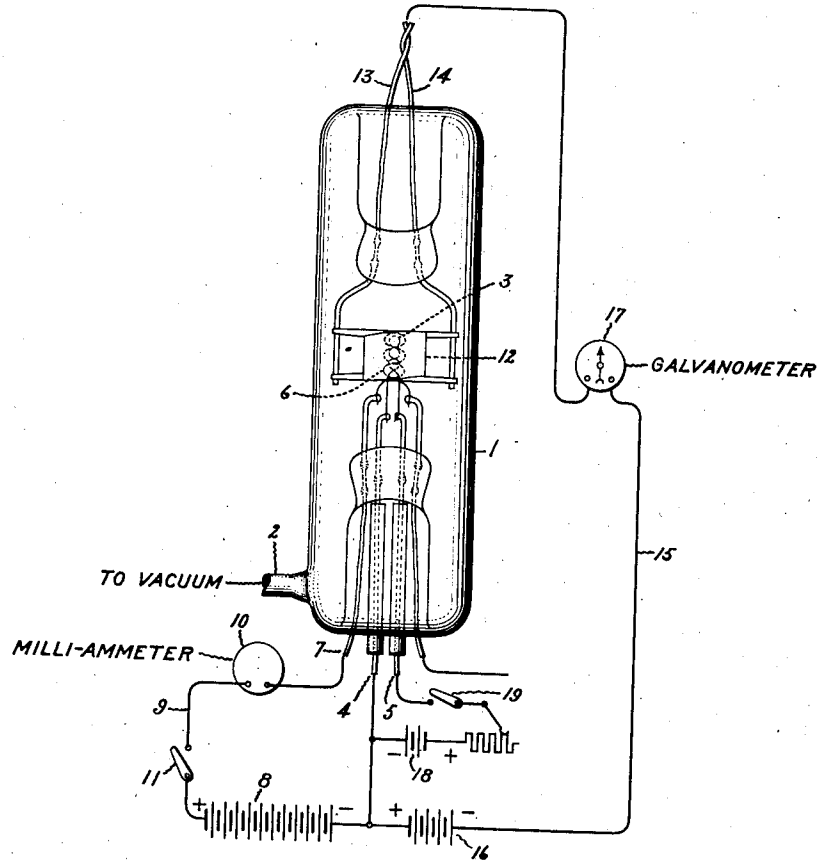
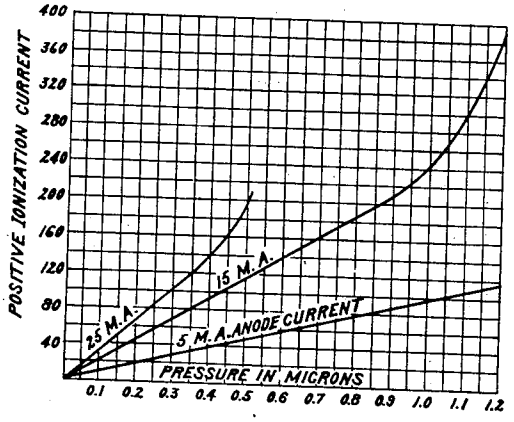


Fig. 2.



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UNITED STATES PATENT OFFICE.

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IONIZATION-MANOMETER.

1,334,143. Specification of Letters Patent. Patented Mar. 16, 1920.

Application filed September 27, 1918. Serial No. 255,883.

To all whom it may concern:

Be it known that I, SAUL DUSHMAN, a subject of the King of Great Britain, residing at Scotia, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Ionization-Manometers, of which the following is a specification.

The present invention comprises an improved device for determining gaseous pressure by measuring ionization produced in the gas.

It has been suggested heretofore to measure vacua by utilizing the ionizing effect on the residual gases of an electron discharge but the device recommended did not give a regular relation between the residual gas pressure and the observed ionization current, thereby rendering calibration of the device very difficult and making accuracy substantially unattainable.

The device proposed consisted of a glass bulb containing three parallel V-shaped filaments, two being used in the usual way as cathode and anode and the third electrode located intermediate the cathode and the anode, known as a collector, being maintained negative with respect to the cathode. An electron current between the cathode and the anode ionizes the residual gas, and the positive ions are attracted to the collector. The ionization current may then be measured by a galvanometer. In a device thus constructed, the relation between gas pressure and ionization is irregular and variable and a curve obtained from observed known value can not be extrapolated to lower values with assured accuracy.

It is the object of my invention to provide an improved ionization gage operating in such a manner as to give a regular relation between the ionization current and the gas pressures. One of the features of my invention is the symmetrical spacial relation of the electrodes. Another feature of my improved device is the location of the negatively charged collector electrode surrounding the cathode and the anode, the three electrodes, cathode, anode and surrounding collector being preferably arranged symmetrically with respect to each other.

In the accompanying drawing, Figure 1 illustrates an embodiment of my invention; and Fig. 2 illustrates by curves the relation of gas pressure to positive gas ionization.

Referring to the drawing the device comprises a container 1, which may be sealed by means of a tube 2 to the device in which the residual gas pressure is to be measured. In the container 1 is provided a cathode 3 adapted to be heated by the passage of current through conductors 4, 5. The cathode 3 preferably consists of tungsten although other refractory materials adapted to emit electrons when heated, for example, tantalum, may also be used. The cathode preferably consists of a helically arranged filament, as indicated. Surrounding the cathode, or otherwise symmetrically arranged with respect to the cathode, is an anode 6 which also consists of a helically arranged tungsten filament. The anode 6 is connected through leading-in conductor 7 to a source of current such as a battery 8, the negative terminal of which is connected to the negative terminal of the cathode 3. In circuit with the conductor 9 between the cathode and anode should be provided a milliammeter 10 and a switch 11.

Surrounding the cathode and the anode is a cylindrical electrode 12 which may also consist of a refractory material, such as tungsten or molybdenum, which acts as the collector electrode, and is connected to leading-in wires 13, 14, both of which are connected to an external circuit 15 containing a battery 16. The positive terminal of the battery 16 is connected to the negative terminal of the cathode 3, thereby charging the collector 12 negatively. A galvanometer 17 in circuit with the collector electrode serves to indicate the amount of positive ionization current. The cathode 3 may be heated to incandescence, for example, by a battery 18, the switch 19 being closed.

With the cathode at incandescence and the switch 11 closed the electron current traverses the residual gas atmosphere in the space within the container 1, thereby producing ionization by collision in the gas. The amount of ionization depends both on the electron current and upon the amount and character of the residual gas. Some of the positive ions which are produced are attracted to the negatively charged electrode 12, producing a current in the galvanometer circuit 15 and a deflection of the galvanometer. Using a given electron current between the cathode 3 and the anode 6 and applying a given voltage between the col-

lector electrode and the cathode, a regular relation is obtained between the ionization current flowing through the galvanometer and the pressure within the device. The values obtained when plotted give approximately a straight line until the ionization becomes considerable enough to produce blue glow within the tube. Under these conditions the relation deviates from a straight line relation as the amount of ionization increases. Even this deviation from a regular proportionality is a smooth one.

The relation between the pressure of residual gas and the positive ionization current between the cathode and the collector, as indicated by the galvanometer, will vary with the amount of current flowing between the cathode 3 and the anode 6. The greater this current is between cathode and anode, the steeper will be the curve of ionization current plotted against gas pressures.

In Fig. 2, three such curves are given, the abscissas representing pressures in microns of mercury and the ordinates ionization currents in galvanometer scale divisions. It will be observed that for a pressure of 0.5 micron a current of 25 milliamperes between the cathode and the anode produces a clearly defined deviation in the curve whereas for the same pressure currents of 5 and even 15 milliamperes produce no deviation in their corresponding curve. However, the curve corresponding to 25 milliamperes is steeper and hence more easily read for very low pressures below 0.5 micron than the curves corresponding to lower current values of anode current.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. An ionization manometer comprising the combination of a container, an electron-emitting cathode, an anode, a source of energy having a negative terminal connected to said cathode and a positive terminal to said anode, a collector electrode symmetrically arranged with respect to said electrodes, means for maintaining said collector electrode negatively charged with respect to said cathode and means for measuring a flow of current between said collector electrode and said cathode.

2. An ionization manometer comprising the combination of a container, an electron-emitting cathode, an anode symmetrically surrounding said cathode, means for passing an electric current between said electrodes, an electrode symmetrically surrounding said cathode and anode, and means for maintaining said surrounding electrode negatively charged with respect to said cathode.

3. An ionization gage comprising the combination of a container adapted to be placed in communication with a space in which gaseous pressure is to be measured, a cathode therein adapted to be heated to incandescence, a filamentary anode symmetrically located about said cathode, means for passing an electric current between said cathode and anode, a third electrode symmetrically surrounding said cathode and anode, a source of direct current, circuit connections respectively between the positive terminal of said source and said cathode and the negative terminal of said source and said third electrode and a galvanometer connected to measure the current transmitted between said cathode and said third electrode.

In witness whereof, I have hereunto set my hand this 25th day of Sept., 1918.

SAUL DUSHMAN.