Aug. 25, 1959

L. F. WOUTERS

2,901,623

VAPOR VALVE

Filed May 26, 1947

3 Sheets-Sheet 1

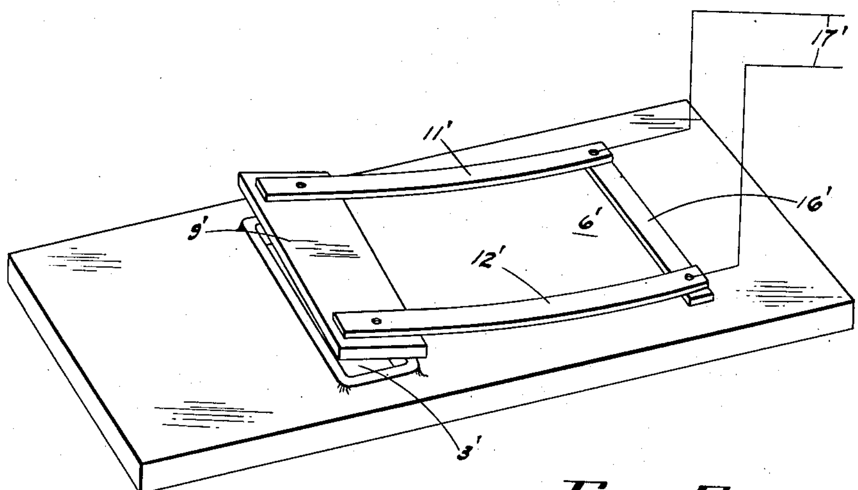

FIG. 6.

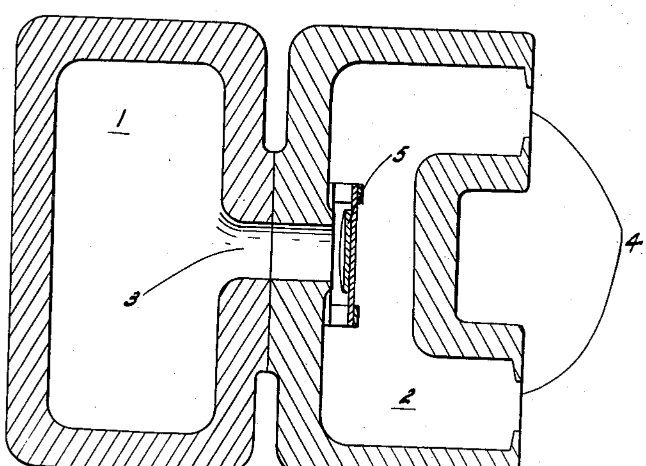

FIG. 1.

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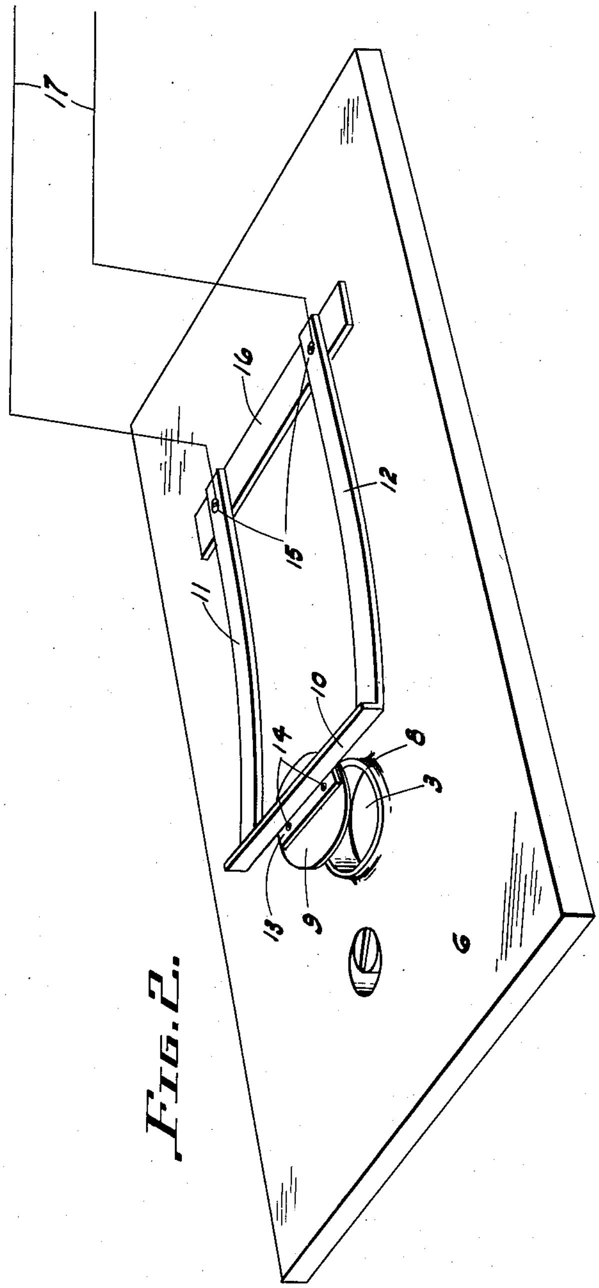

Fig. 2.

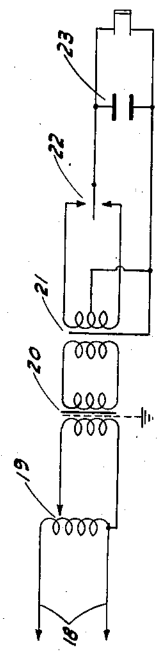

Fig. 5.

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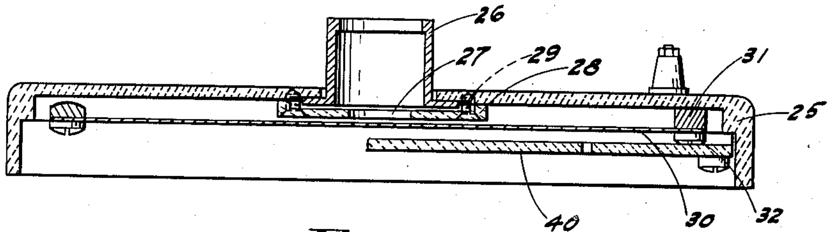

FIG. 4.

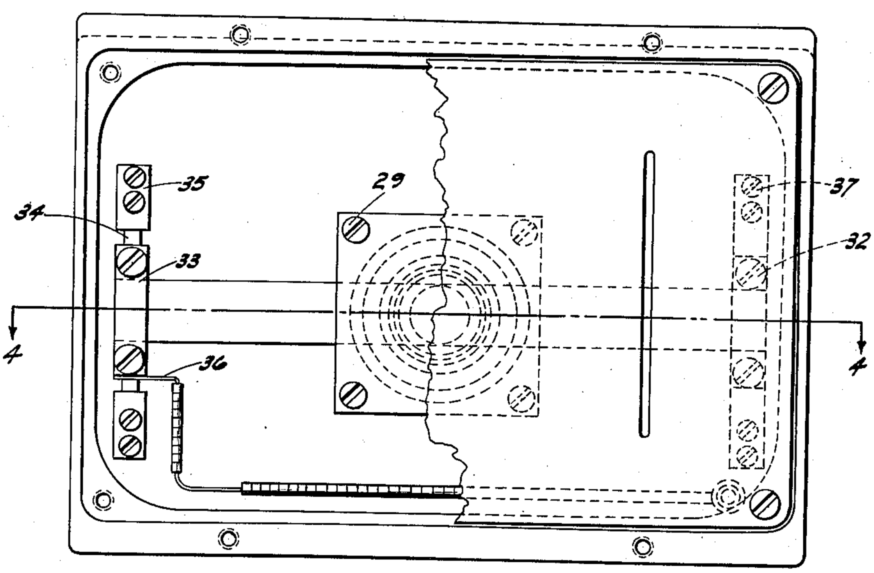

FIG. 3.

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VAPOR VALVE

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Application May 26, 1947, Serial No. 750,597

8 Claims. (Cl. 250—41.9)

My invention relates to valves and more particularly to electromagnetically operated vapor valves for apparatus employed in the separation of isotopes or elements to control the vapor flow between chambers.

In this field, and especially in apparatus such as the calutron, it has been the practice to place a charge in the chamber and apply heat thereto. As it vaporizes the vapors flow from the first chamber to a second chamber through a port or orifice, and the flow therethrough is customarily controlled by a manually operated valve. In the second chamber, a portion of the vapors are ionized by bombardment of electrons from a heated cathode, and the balance condenses on the walls of the housing or chamber. The ions thus formed are drawn out of the second chamber into a beam region by an accelerating electrode or electrodes. Ordinarily, a magnetic field normal to the calutron housing is provided so that the ions acted upon by the accelerating electrode, and the magnetic field are caused to travel in arcuate paths whose radii correspond to the masses of the respective ions or particles acted upon. Receivers are ordinarily provided at or near the focal points of the ion beams for collecting the ions of the isotopes or materials of various masses.

The process efficiency is a factor which is under constant study with a view to improvement. An element of process efficiency is the charge consumption rate and this is dependent, among other things, upon the vapor flow from the charge chamber to the ionization chamber. This, in turn, depends upon the size and the construction of the orifice connecting the two chambers.

In the prior art in this field, it has been customary to use a manually controlled valve to regulate the vapor flow through the orifice between the charge and the ionization chambers. Operators are ordinarily employed to make these adjustments and are in communication by telephone or otherwise with cubicle operators, who are generally back at some distance from the equipment, and who control the cathode heater current for the charge chamber, the electrode voltages in the ionization chamber, and the electrode voltage of the accelerating electrode together with temperature and other conditions within the system. Since the valve may have a series of different settings to correspond to changes in the other variables involved to provide maximum process efficiency, the cubicle operators must maintain constant communication with the valve operators. This often introduces a delay or time lag in the operations, and prolongs the time necessary to secure corresponding settings of the various controls, while the settings finally obtained may be only approximations of the best obtainable process efficiency.

Applicant with a knowledge of all of these defects in and objections to the prior art has for an object of his invention the provision of a valve which may be remotely controlled by the cubicle operator along with the other controls, resulting in better coordination.

Applicant has as another object of his invention the provision of an electromagnetically operated valve for controlling the flow of vapor from the charge chamber to the ionization chamber of a mass spectrometer.

Applicant has as a further object of his invention the provision of an electromagnetically operated vapor valve, the extent of opening and closing of which may be electrically controlled from a remote point in conjunction with other controls for regulating the process efficiency of a system.

Applicant has a further object of his invention the provision of a continuously variable electrically operated remote control valve for regulating the flow of vapor at low pressures thereby largely eliminating the necessity for operating the manually operated mechanical valves.

Applicant has as another object of his invention the provision of an electromagnetically controlled valve wherein the motive and the restoring force are derived from a common element.

Applicant has as a still further object of his invention the provision of an electromagnetically controlled valve for blocking an orifice wherein the same member is employed to carry the current which serves to establish the electromagnetic action, and to block the orifice between two chambers for regulating the vapor flow therebetween.

Other objects and advantages of my invention will appear from the following specification and the accompanying drawings, and the novel features thereof will be particularly pointed out in the annexed claims.

In the drawings Fig. 1 is a schematic of the charge and ionization chambers showing my improved valve positioned to control vapor flow between them. Fig. 2 is a perspective of one modification of my improved vapor valve. Fig. 3 is an elevation of a second modification of my improved vapor valve. Fig. 4 is a cross section of the second modification of my improved vapor valve taken along the line 4—4 of Fig. 3. Fig. 5 is a schematic of the circuit employed to operate my improved vapor valve. Fig. 6 shows a modified form of my improved valve element.

Referring to the drawings in detail, 1 designates the charge chamber for the reception of the charge and which may be heated by an electrical heating unit disposed about the walls thereof in a conventional manner. Charge chamber 1 communicates with ionization chamber 2 by a connecting orifice 3 in the wall or baffle separating them. This orifice may be closed by a vapor valve generally indicated at 5. In addition, orifices 4, 4 are provided in the ionization chamber for egress of the ions to the beam or spectrum region of a conventional calutron. The system is subjected to a magnetic field which extends normal to the plane of the cross-section shown in Fig. 1.

One form of the electromagnetically operated valve is shown in Fig. 2 wherein the orifice 3 in baffle plate 6, which may be positioned between the charge and ignition chambers, is surrounded by a circumferential flange 8 which acts as a seat for the valve. The valve, in the form of a disc 9, is carried by the valve actuating structure. This structure or means includes a pair of substantially parallel flat resilient leg portions 11, 12 mounted on an insulating strip 16 by screws 15, 15 which do not pass entirely through the strip and do not engage the baffle. When displaced, the resiliency of the legs tends to restore them to their original position. From the standpoint of cost and durability, carbon has been found to be a very satisfactory material for this purpose. The free ends of the strips 11, 12 are bridged by a crossarm or member 10 having a forwardly extending flange portion 13 intermediate its ends. The flange portion 13 extends substantially normal to the crossarm and has openings therein for the reception and passage of the shanks of rivets 14 which thread into disc 9 and serve to mount it on the flange 13. If desired both the legs and the cross member may be cut and formed from a single sheet of material. Another form of valve wherein the cross member also acts as the valve element to close the orifice is shown in Fig. 6.

The insulating strip 16 is mounted on the baffle plate 6 by set screws which pass through the baffle plate and thread into the strip 16, or by any other appropriate means. Power is fed to the legs or strips through power leads 17 which are electrically connected thereto.

The current flowing through the strips 11, 12 and crossarm 10 may be adjusted by the cubicle operator along with adjustments of the cathode current, charge chamber temperature, electrode voltages in the ionization chamber, and the accelerating electrode voltage. Since the legs or strips 11, 12 of the valve mechanism lie in and are substantially parallel to the direction of the main magnetic field of the unit, little or no reaction results from flow of current through these strips. However, the crossarm 10 is substantially normal to such magnetic field and is threaded by it so that the field set up by flow of current therethrough from leads 17 reacts with the main magnetic field and causes movement of the crossarm 10 therein, very much like a conductor of the armature of a motor. Accordingly, the disc valve 9 is moved towards or away from the valve seat depending upon the direction and the magnitude of the current flow through the crossarm 10. In this way the cubicle operator may adjust the constriction of the orifice 3 and in turn the vapor flow therethrough to correspond with changes in other variables, in order to provide and maintain maximum process efficiency.

Process efficiency, as previously indicated, is dependent upon the charge consumption rate and may be expressed as follows:

$$PE=\int\frac{(Q+R)\,dt}{\text{charge weight}}$$

Differentiating with respect to time the equation becomes:

$$PE=\frac{Q+R}{CCR}K$$

The charge consumption rate (CCR) is dependent upon vapor flow, and this in turn is dependent upon the charge temperature and the constriction of the various orifices, that is, between the charge chamber and the ionization chamber, and between the ionization chamber and the beam or spectrum region. Since the latter orifices are ordinarily constant, then for any given charge temperature the charge consumption rate depends upon the size of the constriction of the orifice between the charge and ionization chambers. This is accomplished with the vapor valve.

The control of the operation of the vapor valve, which controls the operating efficiency, is affected through a control circuit which furnishes power to the valve operating mechanism. In this control circuit, 18 represents the power leads which feed a variable auto-transformer 19, preferably of the type known as the "Variac." The secondary of the transformer, having the movable contact, feeds into a 35 kv. insulating transformer 20. and the secondary of the insulating transformer feeds into the primary of a step-down transformer 21 with a center tapped secondary that feeds a small selenium oxide rectifier 22, preferably of the 6V4A type. The rectifier 22 and the transformer 21 feed the electromagnetically controlled valve through filter 23, consisting primarily of a condenser of the size of about 4,000 mfd. across leads 17. The filter is incorporated into the circuit to prevent excessive 60 cycle vibration of the valve element.

The auto-transformer 19 is adjusted by the cubicle operator to vary the output voltage of transformer 20 and in turn the voltage input and output of transformer 21. This changes the potential across leads 17 and the current flowing through strips 11 and 12 and across arm 10, bridging those strips. The change in current through crossarm 10 changes the field setup and hence the reaction with the main magnetic field of the unit. These changes cause the valve to move towards or away from the seat and vary the constriction of the orifice.

In the arrangement of Fig. 6, the baffle plate is designated 6′, the legs 11′ and 12′, the insulating mounting 16′, and the cross member, which itself acts as a rectangular valve, is designated 9′. It cooperates with a rectangular flange defining opening 3′ to provide a seat. Current is fed through legs 11′, 12′ and cross member 9′ through leads 17′.

In another modification of my invention shown in Figs. 3 and 4, the strips or legs have been eliminated. Plate 25 is secured to the wall of the ionization chamber adjacent the charge chamber. A baffle 40 extends downwardly adjacent an orifice in the plate. A flanged tubular member 26 extends into the charge chamber and communicates with orifice 27 in plate 28. Both are mounted on plate 25 with screws 29. A thin flat crossarm 30, of preferably carbon material, serves as the valve for constricting the orifice 27. One end of the strip is rigidly mounted in clamp 31, held together with screws 32 and mounted on plate 25 with screws 37. The opposite end is held in a rocking insulated support consisting of metal clamp 33, pivotal extensions 34 and insulating supports 35 in which the pivotal extensions may rotate. Power is fed through opposite ends of crossarm 30, such as through lead 36 joined to clamp 33 and through clamp 31 grounded to the case. The arm 30 lies across the magnetic field of the system so that the current flow through the arm sets up a reaction and causes it to be displaced towards or away from the orifice about the rocking clamp 33 while the resiliency thereof tends to restore it to its original position. This is aided by the fact that the strip 30 is rigidly held by clamp 31 at one end. It will thus be seen that the general principle of operation is substantially the same as in the previous modification.

While applicant has disclosed two preferred embodiments of his invention, it will be apparent that the electromagnetically operated valve, having an electrical conductor lying across a magnetic field and responsive to the flow of current through the conductor to operate a control mechanism carried by it, may take many different forms, and it will be understood that the invention is not restricted to the specific embodiments disclosed in the drawings and foregoing specification.

Having thus described my invention, I claim:

1. An arrangement for controlling the flow of gaseous vapors comprising a charge chamber for vaporizing a charge, an ionizing chamber for ionizing vapors from said charge chamber, said charge chamber and said ionizing chamber being positioned in a magnetic field, means providing communication between said charge chamber and said ionizing chamber, and means for regulating the flow of vapors from said charge chamber to said ionizing chamber, said last means including a conductor disposed within and cutting said field for carrying a current whereby to produce movement thereof and close said communication means.

2. An arrangement for controlling the flow of gaseous vapors comprising a charge chamber for vaporizing a charge, an ionizing chamber communicating with the charge chamber, said chambers being disposed in a magnetic field, and valve means for regulating the flow of vapors from the charge chamber to the ionizing chamber, said valve means including a pair of resilient legs for supporting a cross member extending across said field, whereby reaction from the flow of current through the cross member imparts movement to the valve means for regulating the valve means.

3. An arrangement for controlling the flow of gaseous

vapors comprising a charge chamber for vaporizing a charge, an ionizing chamber in communication with said charge chamber for reception of vapors, said charge chamber and said ionizing chamber being positioned in a magnetic field, valve means for controlling the flow of vapors from the charge chamber to the ionizing chamber, said valve means including a pair of resilient legs bridged by a cross member, said cross member being positioned across said field, whereby the reaction from current flow therein regulates the operation of the valve means.

4. An arrangement for controlling the flow of gaseous vapors comprising a charge chamber for vaporizing a charge, an ionizing chamber communicating with said charge chamber, said charge chamber and said ionizing chamber being positioned in a magnetic field, valve means for controlling the flow of vapors from the charge chamber to the ionizing chamber, said means including a valve element actuated by a pair of substantially parallel resilient legs bridged by a cross member, said cross member being positioned across said field whereby reaction from current flow therethrough regulates said valve means.

5. An arrangement for controlling the flow of gaseous vapors comprising a charge chamber for vaporizing a charge, an ionizing chamber, an orifice connecting said ionizing chamber with said charge chamber, said charge chamber and said ionizing chamber being disposed in a magnetic field, and valve means for closing the mouth of the orifice to restrict the flow of vapors therethrough, said valve means including a valve element operatively connected to a pair of resilient leg portions having one set of ends rigidly mounted, the opposite free ends of said leg portions being bridged by a cross member, said cross member moving in response to current flow therethrough for movement towards and away from said orifice and actuate said valve to regulate the flow through said orifice.

6. An arrangement for controlling the flow of gaseous vapors comprising a charge chamber for vaporizing a charge, an ionizing chamber, said charge chamber and said ionizing chamber being disposed within a magnetic field, an orifice connecting said ionizing chamber with said charge chamber, and means for closing the mouth of the orifice for limiting the flow of vapors from the charge chamber to the ionizing chamber, said means including a pair of resilient parallel legs rigidly mounted adjacent one pair of their ends, a cross member bridging the opposite free ends of said legs to complete a circuit for the flow of current, said cross member being positioned across the field whereby reaction from current flow through said cross member results in movement of said cross member towards the mouth of said orifice to restrict flow of vapors therethrough.

7. An arrangement for controlling the flow of gaseous vapors comprising a charge chamber for vaporizing a charge, an ionizing chamber, said charge chamber and said ionizing chamber being positioned in a magnetic field, an orifice connecting the ionizing chamber with the charge chamber, valve means for closing the mouth of the orifice for regulating the flow of vapors therethrough, said valve means including a pair of resilient leg portions rigidly mounted through one pair of corresponding ends, a cross member bridging the opposite free ends of said leg portions to complete a circuit for the flow of current, said cross member being positioned across said field, and a valve carried by said cross member, and means for regulating current flow through said cross member for movement of said valve towards the mouth of the orifice to restrict the flow of vapors therethrough.

8. An arrangement for controlling the flow of gaseous vapors comprising a charge chamber for vaporizing a charge, an ionizing chamber, said charge chamber and said ionizing chamber being positioned in a magnetic field, an orifice connecting said ionizing chamber with said charge chamber, means for regulating the flow of vapors through said orifice, said means including a resilient metal strip rigidly mounted at one end and positioned in said field adjacent said orifice, and means for regulating the flow of current therethrough to produce movement thereof towards the mouth of said orifice and limit the flow of vapors from said charge chamber to said ionizing chamber.

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