

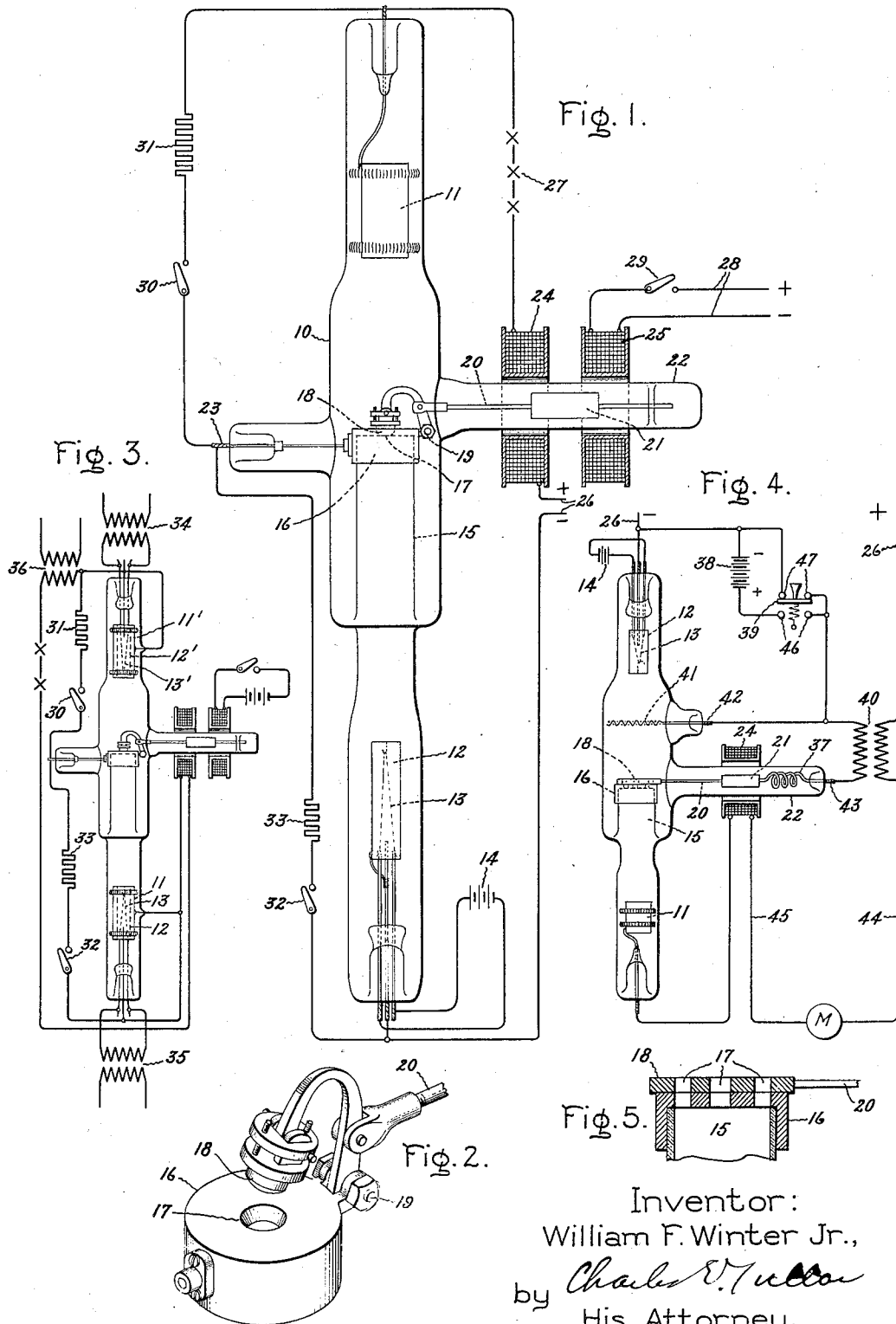
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VAPOR-ELECTRIC DISCHARGE DEVICE

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VAPOR-ELECTRIC DISCHARGE DEVICE

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5 Claims. (Cl. 250—27.5)

My invention relates to vapor electric discharge devices for controlling electric currents and more particularly to devices including a container which encloses spaced electrodes and is filled with a metal vapor, such as mercury vapor, or an inert ionizable gas such as argon or helium. In this type of discharge device, the current passes through the tube by virtue of the enormous increase in conductivity of the rarefied gas upon ionization, as contrasted to those devices in which the current flow is dependent upon electronic emission from an incandescent cathode in a very high vacuum. In the latter class of devices, the current flow can be controlled by controlling the bias on a grid or mesh interposed between the active electrodes. In many of those devices which depend for their operation upon the conduction of an ionized gas, a biased grid placed between the active electrodes has very little effect in controlling the current flow once an arc has been established between the electrodes.

One of the limitations of those devices utilizing electronic emission is the relatively small current which can be controlled; another limitation is the extremely high voltage drop in the tube for moderate values of current.

It is an object of this invention to provide a vapor-electric device combining the advantage of regulability, characteristic of electronic emission tubes, and that of large current capacity, characteristic of vapor electric devices. This object is accomplished by interposing between the active electrodes of the vapor-electric device a valve by means of which the current flow between the electrodes may be mechanically regulated.

Other objects will be apparent from the following description taken in conjunction with the accompanying drawing, and the features which I believe to be novel and patentable will be pointed out with particularity in the appended claims.

Referring to the drawing, Fig. 1 illustrates an elementary form of vapor electric device constructed according to this invention and so connected as to operate as a constant current regulator; Fig. 2 is a perspective of the valve mechanism shown in Fig. 1; Fig. 3 illustrates a modification of the device of Fig. 1, adapted for operation in alternating current circuits; Fig. 4 illustrates another form which my invention may take when adapted to operate as a circuit breaker; and Fig. 5 is a fragmentary cross-section of the grid mechanism of Fig. 4.

The vapor electric discharge device illustrated in Fig. 1 comprises a sealed envelope 10, preferably of glass, in which is mounted the anode 11 and the cathode 12, arranged to be heated by the filament 13 which, in turn, is heated to incandescence from an external source such as the battery 14. In the central body portion of the envelope 10 is a re-entrant tube 15, the open end

of which is closed by the cap 16 provided with an opening 17. Cooperating with this opening 17 is a valve 18 pivoted at 19 and connected by the link 20 to an armature 21 slidably mounted in the arm 22 of the envelope 10. An electric connection 23 is brought out from the cap 16 for a purpose explained hereinafter. The valve cap 16, and valve mechanism which are illustrated more clearly in Fig. 2, may be made entirely of metal or partly or entirely of a refractory material. Surrounding the arm 22 are mounted the solenoids 24 and 25 in such a position that either solenoid will, upon energization, attract the armature 21 and thereby operate the valve.

For purposes of explanation, the device illustrated in Fig. 1 is shown as connected to act as a constant current regulator for delivering a constant current from the source 26 to the load 27. To initiate an arc through the device, the switch 29 is closed which energizes the solenoid 25 from a source 28 and draws the armature 21 to the right, thereby opening the valve 18. The switch 30 is then closed which connects the cap 16 through the terminal 23 and resistor 31 to the anode terminal, thence through the load 27 and solenoid 24 to the positive side of the supply 26.

The closing of the switch 30 thus imposes a positive potential on the valve cap 16, which acts somewhat as a grid and aids in the starting of an arc through the device. As soon as the arc is established and the load 27 is being supplied from the source 26 through the device, the switch 30 is opened and the switch 32 closed thereby connecting the terminal 23 to the negative supply bus through the resistor 33. A negative bias is thus imposed upon the cap 16 through the terminal 23 which is effective, in case the discharge is interrupted by a fault in the load circuit or by any cause whatsoever, to act as a holding grid and prevent the starting of a discharge in the device until the fault has been clear and until the switch 32 has been manually opened and switch 30 closed as described above.

As will be seen from the diagram of Fig. 1, the load current flows through the solenoid 24 which exerts a pull on the armature 21 opposing that of the solenoid 25. The armature 21 will thus assume a position dependent upon the relative magnitudes of the attractions exerted by the solenoids 24 and 25 and thereby control the position of the valve 18 to which it is linked. If the load current tends to increase, the armature 21 will be moved to the left, the valve 18 will be moved toward the closing position, the effective area of opening 17 will thereby be decreased and the internal resistance of the tube increased thereby limiting the load current. By proper design and proper excitation of the biasing solenoid 25, the discharge device may be made to regulate the load current to any given

value. In case of a short circuit or a sudden severe overload, the armature 21 will be drawn instantaneously to the left, closing the valve 18 and immediately interrupting the discharge and
 5 disconnecting the load from the source. As soon as the load current is interrupted, the solenoid 24 is de-energized and the biasing solenoid 25 will move the armature 21 to the right and re-open the valve 18, but the negative bias on the
 10 cap 16 will prevent the restarting of the arc as explained above.

The above application of the improved vapor electric device is given merely by way of illustration and is only one of many uses to which
 15 it may be readily adapted.

In Fig. 3 is illustrated a modification of the device shown in Fig. 1, adapted to control an alternating current circuit. In this modification, both an anode and a cathode are provided in
 20 each end of the envelope. In the device illustrated, the anode surrounds the cathode and is separated therefrom. The filaments 13 and 13¹ are energized from the supply transformers 34 and 35 and the load circuit is supplied from the
 25 transformer 36 or any other suitable source of alternating current. As in Fig. 1, the resistors 31 and 33 and the switches 30 and 32 are provided for controlling the starting of the arc. The operation is similar to that of the device of Fig. 1. During one half-cycle the current will flow
 30 from the cathode 12 to the anode 11¹ and during the next half-cycle from the cathode 12¹ to the anode 11.

In the modification illustrated by Fig. 4, the
 35 valve mechanism is made in the form of two cooperating gratings as shown more clearly in Fig. 5, and in effect constitutes a grid of variable mesh which may be called the control grid. In addition, a holding grid 41 is interposed between
 40 the cathode and the valve mechanism and connected to the terminal 42. The valve is shown as biased to open position by means of the spring 37 connected to the terminal 43, though obviously a biasing solenoid might be used as in the
 45 device of Fig. 1.

In Fig. 4 my invention is illustrated as arranged to maintain a constant load upon a direct current motor M, and to protect it from overloads or short circuits. The control grid is connected to the holding grid through the secondary
 50 of a current transformer 40, the primary of which is connected in the motor lead 44. In order to start the motor, the push button switch 39 is momentarily operated to bridge contacts 46 and thus impose a positive charge from the battery
 55 38 upon the holding grid 41 and control grid 18 to initiate an arc in the device. Other starting devices, such as a controller or starting resistors have been omitted for the sake of simplicity, although they obviously may be incorporated in
 60 such a control scheme. After the discharge has started and the motor has accelerated, the push button 39 is released, bridging the contacts 47 to impress a negative bias on the two grids, but
 65 this negative bias is insufficient to interrupt the discharge after it is once established.

In case of a slowly increasing load above the value for safe operation of the motor M, the solenoid 24, connected in series with the motor,
 70 attracts the armature 21 against the force of the biasing spring 37 and partially closes the

grid valve 18, thus increasing the internal resistance of the discharge device and limiting the motor current to a safe value.

In case of a sudden serious overload or a short circuit, two results are effected: The valve 18
 5 tends to close as in the previous case, and at the same time, the surge of current through the primary of current transformer 40 induces a high voltage in the secondary thereof which impresses a high negative bias potential on the
 10 control grid 18. This enormous negative bias is, in itself, sufficient to interrupt the discharge, and, coupled with the mechanical effect due to the closing of the valve, renders the interruption of the discharge and the disconnection of
 15 the motor from the supply doubly sure. Again, this embodiment is merely illustrative of various applications to which my improved discharge device may be adapted.

The circuit system including the valve controlled vapor electric discharge device is claimed
 20 in a copending application Serial No. 658,548, filed February 25, 1933, which is a division of my present application.

In accordance with the provisions of the patent statutes, I have described particular embodiments of my invention, but I do not wish to be limited thereto, but aim in the following claims
 25 to secure patent protection on all various modifications which come within the spirit and scope of this invention.

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

1. A vapor electric discharge device comprising a sealed container, a cathode and an anode
 35 mounted therein, a mechanical valve interposed between said electrodes, and a grid interposed between said cathode and said valve.
2. A vapor electric discharge device comprising a sealed container, a cathode and an anode
 40 mounted therein, a control grid of variable mesh mounted between said electrodes and having a terminal, and a holding grid of constant mesh mounted between said cathode and said control grid.
3. A vapor electric discharge device comprising a sealed container, a cathode and an anode
 45 mounted therein, a control grid of variable mesh mounted between said electrodes and having a terminal, electromagnetic means for varying the mesh of said grid, and a holding grid mounted between said cathode and said control grid.
4. A vapor electric discharge device comprising a sealed container, a cathode and an anode
 50 mounted therein, an arm extending from said container and integral therewith, an electromagnet surrounding said arm, an armature mounted in said arm, a control grid of variable mesh mounted between said electrodes, a mechanical
 55 connection between said armature and said control grid, and a holding grid mounted between said cathode and said control grid.
5. A vapor electric discharge device comprising a sealed container, a plurality of spaced electrodes mounted therein, a holding grid and a
 60 control grid mounted between said electrodes, said control grid having a variable effective mesh, and electromagnetic means for varying the mesh of said control grid.

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