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VACUUM TUBE

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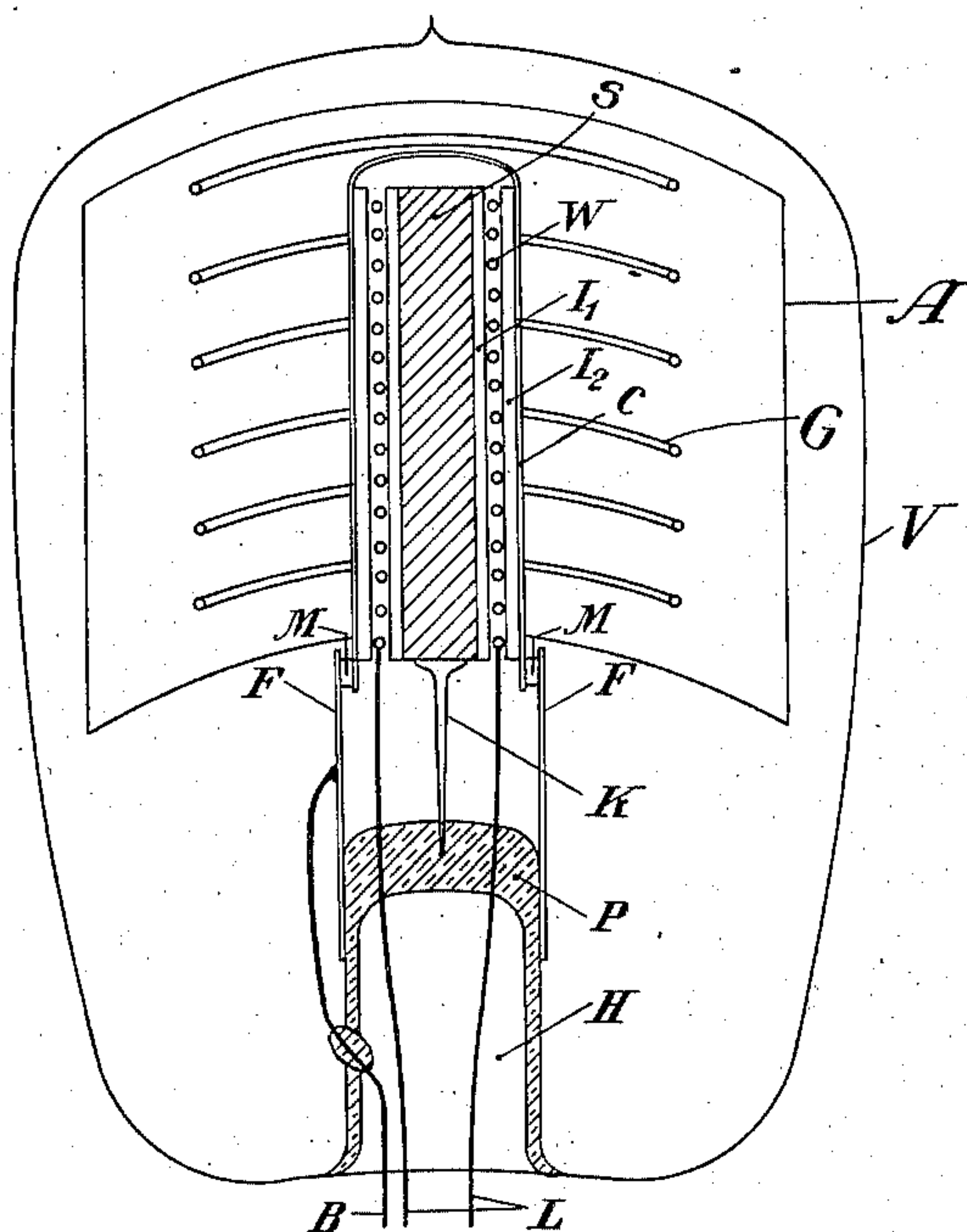


Fig. 1

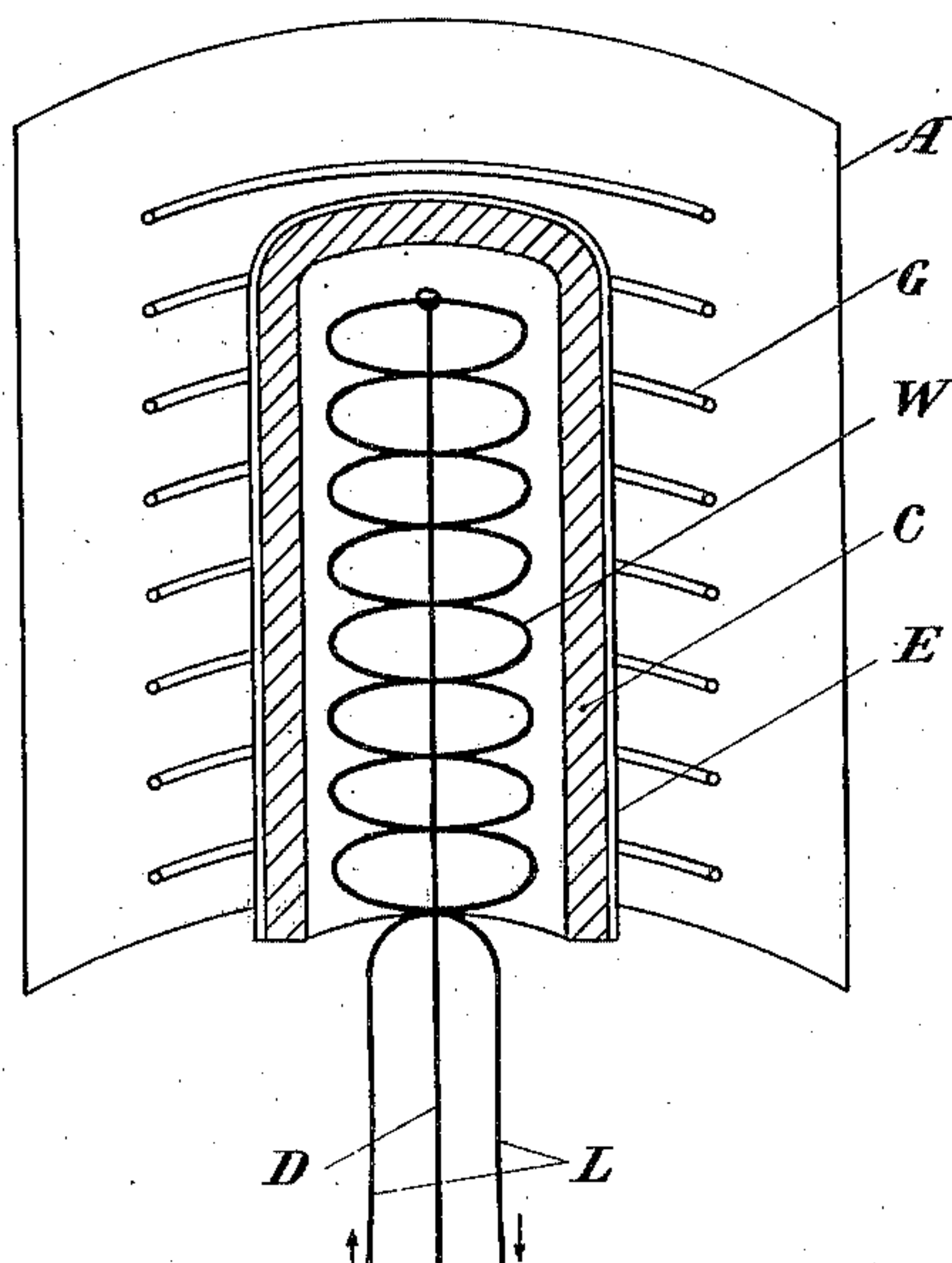


Fig. 2

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UNITED STATES PATENT OFFICE

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VACUUM TUBE

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This invention relates to vacuum tubes, and particularly to vacuum tubes of the unipotential cathode type, in which the cathodes may be maintained in a state of electron emission for a substantial and predetermined period of time after the sources of energy supply have been cut off therefrom.

In the art of vacuum tubes, there is a vacuum tube of the unipotential cathode type in which the cathode is rendered actively electron emitting by an element separate and distinct from the cathode itself. This element may, for example, be a heater of any type well known in the art, or, it may, perhaps, be some form of electron emitting device rendering the cathode active as an emitter of electrons by bombardment. It is well known in such devices that when the heater, or, on the other hand, the electron emitting device, is temporarily inactive, the cathode does not emit electrons at its usual rate, the discharge of electrons from the cathode decreasing considerably as soon as the heater, or the electron emitting device, as the case may be, is rendered inactive.

Accordingly, a form of vacuum tube is evolved in this invention, in which the cathode may continue to emit electrons at substantially the normal rate for a substantial and predetermined period of time after the heater becomes inactive. This is brought about in this invention by providing some means for storing energy in the form of heat, which energy may later be utilized to render the cathode electron emitting after the heater becomes inactive. Such a heat storing means may comprise a mass of material separate and distinct from the cathode itself; or, if desired, the cathode itself may be so proportioned and may be of such material and of such mass that it alone can store energy in the form of heat so that it, the cathode, may remain electron emitting for a substantial and predetermined period of time after the heater becomes inactive.

Accordingly, it is one of the objects of this invention to relate a heat storing body to the cathode of a vacuum tube so that said heat storing body may receive and absorb energy and then release that energy to main-

tain the cathode electron emitting after energy from a source of supply, such as a heater, has been cut off, or has otherwise been diminished.

It is another object of this invention to provide a vacuum tube with a cathode of suitable size, material and general physical proportions so that said cathode may, of itself, absorb and store considerable energy in the form of heat, and furthermore, so that said cathode may remain electron emitting, and maintain a steady state of electron emission, for a substantial and a predetermined period of time after a source of energy at some external point has been cut off, or has otherwise failed.

While the nature of the invention will be pointed out with particularity in the appended claim, the invention itself, both as to its further objects and features, will be better understood from the following description, when read in connection with the accompanying drawing, in which Figures 1 and 2 represent cross-sectional views of the cathode of a vacuum tube and some form of heater, embodying the principles of the invention.

Referring to Fig. 1 of the drawing, a heating element W of refractory material or a conductive material such as tungsten, molybdenum, etc., is provided, which comprises what is known in the art as a bifilar winding, i. e., a winding in which as much current flows in one direction as flows in the opposite direction, so that the magnetic field established by the flow of current in one direction is equal and opposite to the magnetic field established by the flow of current in the opposite direction. The resultant magnetic effect produced by such a winding is negligible. This heater W is enclosed surrounded by two insulators I₁ and I₂, respectively, insulator I₁ being adjacent to the inner surface of the heater W, and insulator I₂ being adjacent to the outer surface of the heater W, these insulators being preferably cylindrical and concentric with the heater W. A metallic cathode C surrounds the heater W and the adjacent insulators I₁ and I₂, and this cathode is preferably coated

with suitable material in order to increase the electronic emission at the temperature to which the cathode is heated. The cathode C may be in the form of a cylinder, either closed or open at the top, and it will also be understood that while the cathode has been shown herein as closed at the top merely for the purpose of illustration, it may equally well be open at the top, within the scope of this invention. Cathode C may be made of any metallic substance the properties of which are such as to withstand the normal operating temperatures and still retain the active material placed on its surface. Nickel or alloys of nickel have been found to be satisfactory substances for use as cathodes. Of course, a grid G and an anode A surround the cathode C, the normal electronic emission from the cathode taking place toward the anode and being under the control of the grid. Moreover, all of the electrodes are, of course, enclosed within some form of evacuated vessel or bulb V.

At the center of the cathode C there is a cylinder S which is employed in this invention as the heat storing or heat absorbing body, this body having good heat absorbing properties. The material chosen for this body should have a high density and a high specific heat and should be able to withstand the ordinary operating temperatures. Nickel, for example, has been found suitable for this purpose. This heat storing body is supported by a post K which is mounted in what is known as a press P. The cathode C is connected to shields F by means of connectors M, these shields being, preferably, gripped about the outer surface of the press P by the connectors. The shields F shield the grid and anode of the vacuum tube from the electrical field established by the leads L which are connected to the heater W. Although the shields F may be electrically connected to the cathode C, the heat conductivity from the cathode C to the shields F is nevertheless negligible. An electrode B is connected to the shields F, and is therefore connected electrically to the cathode C, and is sealed and fixed in position in the press P. The leads L may be supported by means of glass arbors mounted in the press P, and may, preferably, be terminated in the base of the vacuum tube so as to be readily connected with the conductors of a circuit in which the vacuum tube is to be used.

When current is conducted through the winding of the heater W, heat is generated therein which may flow inwardly and outwardly therefrom. The heat energy that flows inwardly passes insulator I₁ and is then absorbed by the heat storing body S, the temperature of which tends to equal that of the cathode C. The heat generated by the winding of the heater W that flows outwardly through insulator I₂ to the cathode C, heats

the cathode C rapidly to the proper electron emitting temperature. Consequently, the cathode is enabled to emit electrons to the anode at some predetermined rate. The insulators I₁ and I₂ electrically insulate the winding of the heater W from the heat storing body S and from the cathode C, respectively. Yet these insulators also allow heat to be transferred from the winding of the heater W to the heat storing body S and to the cathode C, respectively. Whenever current flowing in the leads L to the heater winding W fails, or decreases considerably from its normal value, then the heat storing body S replaces the heater W as a heat radiating body and, accordingly, transmits heat to the cathode C so that the cathode may continue to emit electrons for a substantial and predetermined period of time thereafter. The cathode C of this invention is shown herein merely for the purpose of illustration, to be of the unipotential type, i. e., the potential over its entire surface is substantially constant.

In Fig. 2, another form of embodiment of this invention is shown. In this figure, similar reference characters have been employed to represent parts similar to those of Fig. 1. The heat storing body of Fig. 1 is eliminated in this embodiment, for the cathode C itself is of such material, size and general physical dimensions that it alone can store heat which may be employed to continue the normal emission of electrons to the anode A for a considerable period of time after the current in the heater winding W has failed, or has otherwise fallen considerably below the normal current value. The heater of Fig. 2 also comprises a bifilar winding which is supported at its upper extremity by means of a rod D to prevent its collapse. The cathode is shown in this embodiment of the invention as covered with a layer or foil E of, for example, platinum and nickel, which elements may be combined in suitable proportions and then coated in the usual way to increase the electronic emission at the normal temperature of the cathode.

It seems hardly necessary to state that the cathode derives its heat from the winding of the heater W by radiation, so that the cathode, under normal conditions, may maintain a state of electronic emission to the anode A, and that this electronic emission may be controlled by the grid G. Moreover, the cathode C stores heat which may be employed to continue the electronic emission from the cathode C to the anode A for a fixed period of time after the heater W fails to supply the required amount of heat.

While this invention has been shown and described herein in certain particular embodiments merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied

to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claim.

What is claimed is:

5 A vacuum tube suitable for operation during a substantial, predetermined period of time after the source of current for heating purposes has been cut off, comprising a bifilar heating winding, a metallic heat storing
10 body of large proportions so as to be capable of storing a large amount of heat, a unipotential cathode, an insulator for electrically separating said heat storing body from said winding, and another insulator for
15 electrically separating said cathode from said winding.

In testimony whereof, I have signed my name to this specification this 17th day of August, 1926.

20 WILLIAM H. T. HOLDEN.

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