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ELECTRIC DISCHARGE CONTAINER

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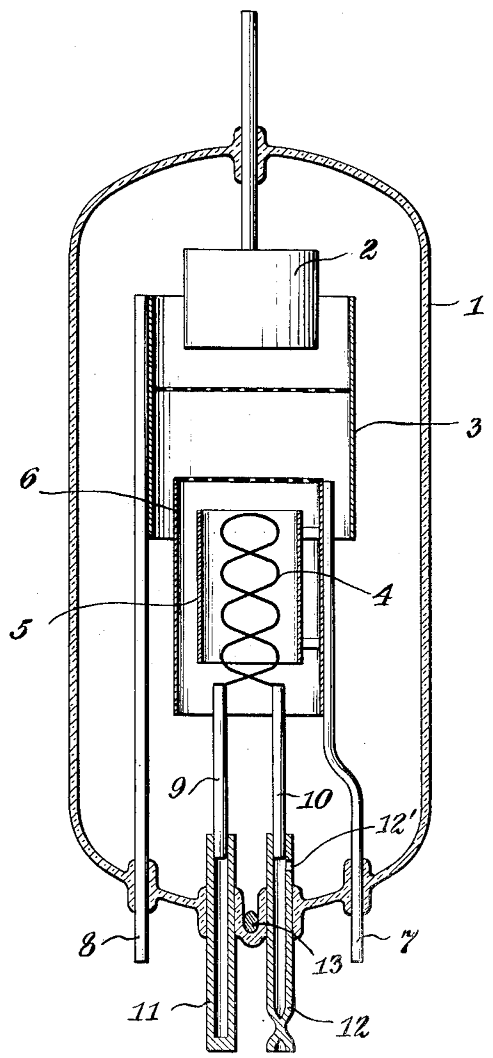

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ELECTRIC DISCHARGE CONTAINER

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The invention relates to discharge devices and especially to discharge devices utilizing a vaporizable metal such as mercury.

An object of the invention is to quickly vaporize the metal to the desired vapor pressure without increasing the pressure beyond the proper value.

Other objects and advantages will be apparent from the following description and drawing, in which,

The figure is a view, in cross-section of a preferred embodiment of the invention.

The present invention relates to an electric discharge vessel filled with metal-vapor, which contains inside the vessel, and more in particular on the bottom of the vessel, a certain amount of an evaporable metal such as mercury. This metal, when heated under operating conditions by the heat developed in the discharge vessel, will produce the vapor-pressure required for operating the vessel. It is necessary that the amount of metal stored in such a discharge vessel shall be brought up to the proper temperature without appreciable delay, in order that the vapor-pressure in the vessel will rapidly reach its normal operating value. This requirement is especially important in the case of a discharge vessel having an oxide-coated cathode, for in such a vessel there is always the danger that the active cathode-layer may be destroyed when a potential difference is applied between anode and cathode before the vapor-pressure inside the vessel has reached a sufficiently high value. And if the anode voltage is not applied until after the vessel is brought into the proper operating condition, a time-delay of considerable length will be the result.

Discharge tubes heretofore proposed to deal with this problem are unsatisfactory for either one of two reasons: either the final vapor-pressure, although having the proper value, is not reached until after a long time-delay, or the vapor-pressure, although reaching quickly the proper value, will rapidly increase beyond the permissible value determined by the desired blocking voltage of the tube, on account of the continuing supply of heat received by the metal. In fact, such discharge vessels can only be made operable by skillfully compromising between the length of the heating-up interval and the magnitude of the blocking voltage.

The present invention seeks to avoid the disadvantages just outlined. In accordance with this invention, measures are taken so that, in an electric discharge vessel of the hot-cathode type containing a certain amount of evaporable metal, this metal can only accumulate in the vicinity of the lead-in wires through which the heating current is supplied to the cathode. The accumulation of the metal in the vicinity of the lead-in wires through which the emission-current flows is made impossible. The measures specifically consist in giving the bottom of the vessel a special shape. Furthermore, the dimensions of the lead-in wires for the heating current and of the heater for the cathode, and at the same time the material of which these members are to be made, are chosen so as to make the vapor-pressure inside the vessel reach or have reached its normal operating value at the instant at which the temperature of the cathode reaches its normal operating value.

In order to meet the latter requirement, the arrangement should be made such that, as soon as the vessel becomes energized, there will be immediately delivered a considerable quantity of heat to the stored metal (present in the form of drops produced by condensation), so that the temperature and thus the vapor-pressure of the metal will rapidly increase. On the other hand, the rate at which energy in the form of heat will be delivered to the metal must be automatically reduced when the cathode-temperature approaches more and more closely its normal operating value, so that finally a state of equilibrium will be reached in which only a relatively small amount of heat is continuously supplied to the stored metal.

This can be done in practice by using for the lead-in wires a material whose resistivity has a temperature-coefficient that is as small as possible, and by using for the cathode-heater, which may be provided, for instance, in the form of a heating spiral, a material whose resistivity has a temperature-coefficient that is as large as possible. The electric resistance of the entire heating circuit at the instant at which the vessel becomes energized will then be equal to the sum of the lead-in wire resistance and the very low initial resistance of the heating spiral. In other words, application of the heater-voltage, which should preferably be constant, will result in the flow of an initially very strong current, which will produce a correspondingly large amount of heat in the lead-in wires.

In the final state of equilibrium, however, the resistance of the heating spiral will be so high that the initially very strong heating current, and thus the amount of energy that is being converted into heat in the lead-in wires, will be reduced to a fraction, such as one-quarter to one-tenth, of the initial value. It can be concluded, therefore, that immediately after the vessel becomes energised, a relatively large portion, or even a major portion, of the amount of produced heat will be supplied to the stored metal, while after the current has been flowing for some time, the amount of heat supplied to the cathode-heater will increase at the expense of the amount supplied to the stored metal. Under certain conditions, it may be advisable to manufacture the lead-in wires that pass through sealed-off openings in the bottom of the vessel of a material whose resistivity has a negative temperature-coefficient.

It has been found that by taking the measures just outlined, the time-interval required by the vessel for reaching its normal operating condition can be considerably shortened, without danger that subsequently the vapor-pressure will increase still further and reach an inadmissible value. The requirement that the vacuum-tightness of the glass seals for the lead-in wires shall not be endangered naturally limits the permissible temperature rise of these wires. Good results were obtained, for instance, with lead-in wires made of chromium-iron or of nickel-iron, and with heating spirals made of tungsten, of molybdenum, of tantalum, of iron, and of nickel. The effectiveness of an arrangement in accordance with the present invention can be further improved by adopting a special arrangement for the lead-in wires at the points where these wires are sealed in the glass. It will be advantageous, for instance, to provide the portions of the lead-in wires for the cathode, i. e., for the heating current for the cathode, that are sealed in the glass in the form of tubular members. The adoption of this particular arrangement will facilitate the transfer of the developed heat to the stored metal, and will make it unnecessary, therefore, to raise the temperature of the lead-in wires beyond a reasonable limit. At the same time the advantage will be secured that the lead-in wires will be mechanically very rigid, so that it becomes possible to use one of them in the course of the manufacturing process for connecting the vessel to the vacuum pump.

An example of an arrangement in accordance with the present invention is illustrated on the drawing. The discharge vessel shown has an indirectly heated cathode, and is equipped with a control grid. Inside the vessel 1, which may be made of an insulating material or of a metal, are mounted the anode 2, the control grid 3, the heating spiral 4, and the electron-emitting cylindrical cathode 5, the latter being surrounded by a protective cylinder 6. For the flow of the emission-current coming from the cathode there is provided a lead-in wire 7 that is located at a certain distance from the center-portion of the bottom of the vessel; the lead-in and supporting wire 8 for the control grid is similarly located. The heater current is supplied to 4 through rod-shaped conductors 9 and 10 to which are attached sealed-in conductor-portions 11 and 12 that are provided in the form of tubes. A quantity of mercury stored on the bottom of the discharge vessel is designated by 13; it is located between the two tubular lead-in wires for the heating spiral, in a position such as to make the heat developed in these lead-in wires transfer rapidly and unimpeded to the mercury. One of the two conductor-portions just referred to, i. e., the conductor-portion 12, is provided in such a form that it can be used as a connection between vessel and vacuum pump in which case it will have an opening into the vessel indicated at 12.

It should be understood, of course, that the arrangement shown on the drawing is only one example of possible forms of application of the present invention. For instance, the invention can also be applied when the cathode-structure is different from the one shown on the drawing, or when the cathode is of the directly-heated type. When the cathode is of the latter type, the emission-current can be drawn from it through one or more separate lead-in wires that are connected to the cathode at suitably chosen points, so that the amount of heat developed in the lead-in wires for the heating current will not be increased on account of the flow of emission-current. It is further self-evident that in so far as the arrangement of the electrode-structure is concerned, the vessel can be designed in various manners, and that the vessel may be equipped, instead of with the three electrodes shown, with only two electrodes, or with more than three electrodes. And finally, a gas such as a noble gas, may be added to the vapor with which the vessel is filled.

I claim:

1. A discharge device comprising a container having a vaporizable metal therein, a portion of said container adapted to receive said metal, a cathode heater coil in said container, connections from said heater coil, said connections having a portion productive of heat by current flow and passing through said portion of the container for heating said metal.

2. A discharge device comprising a container having a vaporizable metal therein, a portion of said container adapted to receive said metal, a cathode heater coil in said container, connections from said heater coil, said connections having a portion productive of heat by current flow and passing through said portion of the container for heating said metal, the resistivity of the material used for the heater cathode coil having a higher temperature coefficient than the resistivity of the material used in said connection.

3. A discharge device comprising a container having a vaporizable metal therein, the bottom portion of said container being shaped to store the unvaporized metal, a cathode surface in said container, a heater coil for said surface, connections from said coil passing through the bottom portion of said container for heating said unvaporized metal and a cathode connection to said cathode surface passing through a portion of said container spaced from said unvaporized metal.

4. A discharge device comprising a container having an ionizable fluid therein and having a cathode and an anode, a heater for said cathode, and electric-resistance heating means for said fluid, both said heater and heating means being electrically in series and physically remote one from the other.

5. A discharge device comprising a container having an ionizable fluid therein and having a cathode and an anode, a heater for said cathode, and electric-resistance heating means for said fluid, the temperature-coefficients of heater and heating means being one larger than the other.

6. A discharge device comprising a container having an ionizable fluid therein and having a cathode and an anode, a heater for said cathode,

and electric-resistance heating means for said fluid, the temperature-coefficient of said heater being large with respect to the temperature-coefficient of said heating means.

7. A discharge device comprising a container having an ionizable fluid therein and having a cathode and an anode, a heater for said cathode, and electric-resistance heating means for said fluid, said heater and heating means being in electrical series and said heater having a relatively large temperature-coefficient and said heating means having a relatively small temperature-caefficient by which initial current flow will be maximum and will produce an initial large amount of heat in said heating means and a subsequent lesser heat therein and increased heat in the heater.

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