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GLOW DISCHARGE TUBE

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Fig. 1.

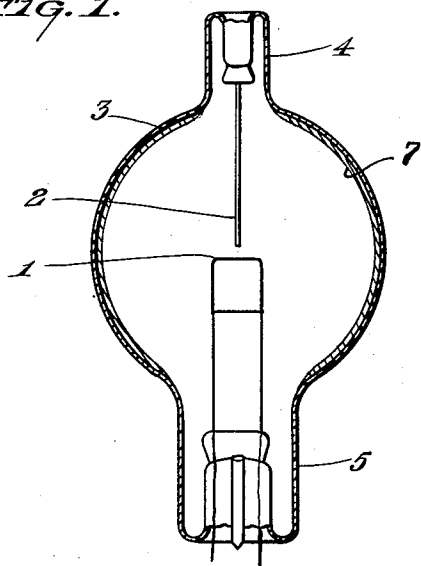


Fig. 2.

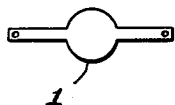


Fig. 3.

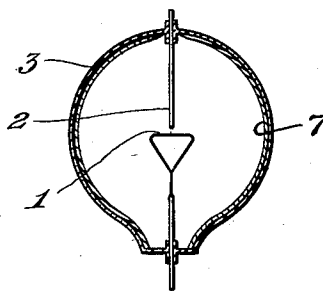


Fig. 4.

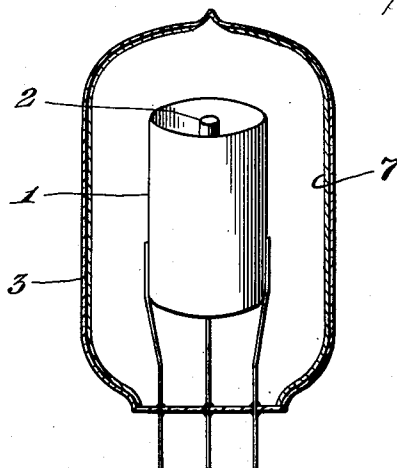
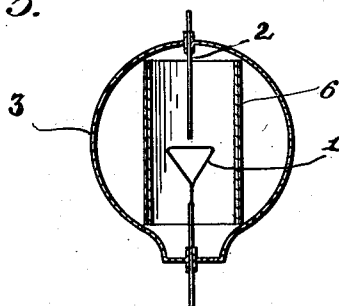


Fig. 5.



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GLOW DISCHARGE TUBE

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This invention relates to a glow discharge tube for use as an active element in an electric circuit arrangement, more particularly for measuring or stabilisation purposes, and to a method of manufacturing it. These glow discharge tubes differ from glowlamps in that in using them it is not the radiated light but the properties of their characteristic that are utilised. The invention has for its purpose to provide a tube with which the voltage remains constant in practice during its life and which is reproducible but for a few volts.

Tubes of this kind have hitherto been provided with a cathode of iron or nickel, sometimes covered with an alkaline earth metal. For purifying the gasfilling they often contain a getter consisting of barium or magnesium.

We have now found that the properties of these tubes can be greatly improved and in addition the method of manufacture can be simplified. According to the invention the cathode of a glow discharge tube consists, at least at its surface, of a metal having a melting point exceeding 1400° C. and the wall of the tube, at least the wall surrounding the discharge path, is practically entirely coated with a visible layer of one of these metals. According to the invention the cathode and the wall coating preferably consist of the same metal. The cathode may entirely be made from any of the said metals. It is sufficient, however, that solely the surface layer of the cathode consists thereof. We obtained excellent results with a molybdenum cathode. Beside the cathode the inner wall of the tube must be coated with a layer of a metal having a melting point of more than 1400° C. To such end it is not sufficient to coat the inner wall with an invisible metal layer having a thickness of a few atoms only. The layer must be clearly visible and practically entirely cover the wall surrounding the discharge path. If the discharge path within the glass envelope of the discharge tube be surrounded by a screen the latter will serve as a wall for the discharge path and will have to be coated with one of the aforesaid metals. The expression "visible metal layer" is to be understood to mean a layer which, when provided on a glass wall, absorbs about 20% of transmitted light. In general, the results will be better as a greater part of the wall is covered and for this reason the envelope of the discharge tube will be chosen in such manner that there are no dead spaces, such as tube arms, and the wall of the tube is substantially equidistant from the cathode surface throughout.

We have found that a glow discharge tube in which, according to the invention, the cathode surface and preferably also the wall coating consists of molybdenum, has particularly suitable properties in regard to a constant operating voltage and reproducibility.

The glow discharge tubes set out above may, according to the invention, be realized by subjecting the cathode in the tube itself to a purification process by means of disintegration or vaporization and to provide the wall coating likewise by disintegration or vaporization. For instance, the cathode may be purified by high frequency heating for a long time to a high temperature. Preferably, however, the cathode is disintegrated by means of a glow discharge with a current density corresponding at least to several times the normal current density. To save time the cathode may with advantage also be purified with such density of the glow current that the cathode is heated to incandescence. The purification

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process should take place during manufacture of the tube at such a point as to prevent impurities from entering the tube after its purification. For instance, it will be necessary in general to vaporize or to disintegrate the cathode after the tube has been sealed from the pump, since under the action of the high temperature required for this sealing operation, impurities from the glass may occur. It has turned out that after such a treatment detrimental impurities are no longer given off during operation of the tube.

The wall coating of the glow discharge tube may be realized by heating one of the aforesaid metals in the form of a wire or plate in such manner, or by disintegrating the metal by means of a glow discharge in such manner that it practically entirely covers the wall, which surrounds the discharge path, with a visible metal layer.

The method according to the invention may be greatly simplified when using for the wall coating the same metal as for the cathode. In this way purification of the cathode and the coating of the wall can be realized simultaneously by cathode disintegration, which has to be continued as long as is necessary for precipitating an adequate wall coating.

We have found that the operating voltage of glow discharge tubes according to the invention is extremely constant within wide time limits and may, for instance, vary less than 0.5 volt in a normal life of 1000 burning hours.

The metals used, according to the invention, to constitute the material for the cathode surface and the wall coating have a melting point exceeding 1400° C. When the price of such material, for instance Ti or Hf, would make the discharge tube too expensive, a choice will, in general, be made out of the metals Zr, Ta, Cr, Mo, W, Fe and Ni. Among the last-mentioned metals molybdenum excels in that it has a low cathode-anode voltage in the glow current range (100 volts in argon or neon) and by the facility with which the cathode of this metal can be prepared in such manner that the glow covers the cathode homogeneously. In addition molybdenum has the well-known properties of easy workability and high loading capacity. As a result of the low cathode-anode voltage in the glow current range the discharge does not settle at the poles, which often consist of metal, so that the poles need not be shielded.

In order that the invention may be clearly understood and readily carried into effect it will now be described more fully by giving several executional examples which are illustrated in the accompanying drawing in which: Fig. 1 is a sectional elevational view through the longitudinal axis of a glow discharge tube embodying the invention.

Fig. 2 is a horizontal sectional view of the cathode of the tube of Fig. 1.

Figs. 3, 4 and 5 are sectional elevational views of other embodiments of the tube of invention.

In Fig. 1 a cathode 1 and a rod-shaped anode 2 are contained in an envelope 3 which is furnished with extensions 4 and 5. The cathode 1 is developed in Fig. 2. The inner wall of the envelope is covered with a dark metal deposit which, similarly to the cathode, consists of any of the aforesaid metals and preferably of the same metal. The inner wall of the extensions 4 and 5 is practically not covered with metal deposit, since the vaporized or disintegrated metal cannot reach the interior of these extensions. In the form of construction shown in Fig. 3 this drawback is met, since in this case the extensions are missing and the envelope is substantially equidistant from the cathode surface throughout. In this way the inner wall may be very evenly covered with metal deposit.

Fig. 4 represents a tube having a cylindrical cathode 1, an anode 2 and an envelope 3 which, similarly to the tube shown in Fig. 3, is substantially equidistant from the cathode surface throughout.

Fig. 5 represents a glow discharge tube having an envelope 3 in which the space of the discharge path between the cathode 1 and anode 2 is surrounded by a cylindrical quartz wall 6. This wall is internally coated with a visible layer of metal 7, whereas the tube envelope shielded by the cylinder is left clear.

For the manufacture of a glow discharge tube accord-

ing to the invention use may be made of a tube as shown in any of the figures. In describing the method it is supposed that both the cathode and the wall coating consist of molybdenum and the cathode is purified and the inner wall is coated both by means of disintegration. First of all, all glass parts of the tube are degasified in a well-known manner by heating in a furnace at about 400°; the metal parts are also degasified as thoroughly as possible, for instance by high-frequency heating at a high temperature. After that the tube is filled with gas and now a glow discharge can be struck between the cathode and the anode by means of a small current. When slowly raising this current it is observed that the cathode glow contracts to a small spot, the operation voltage falling off. After that the glow slowly spreads again over the surface of the cathode. Finally the current is raised to about several hundreds of milliamperes per cm.², so that the cathode may be heated to white incandescence. Now the gas may be pumped away and the tube filled with a new quantity of pure gas. After sealing off the tube the disintegration process is repeated once more, so that ultimately both the cathode and the gasfilling are thoroughly purified so that practically the last traces of impurities are removed. At the same time the inner wall of the bulb is coated with a visible layer of molybdenum by disintegration of the cathode. In general the cathode will have been purified before the metal deposit on the inner wall has acquired a sufficient thickness. Consequently, it will be necessary to continue the disintegration until the inner wall of the tube is practically entirely covered with a visible layer of molybdenum.

Within the scope of the invention many variations of the method set out hereinbefore are possible. For instance, the molybdenum may be replaced by any of the other metals referred to both in regard to the cathode and for covering the wall. When using, for instance, a cathode of zirconium and a wall coating of nickel, a nickel wire or plate may be provided in the tube in the proximity of the cathode, so that upon disintegration nickel deposits on the inner wall. The inner wall coating may also be realized by heating the nickel wire by means of an electric current to such a high temperature as to precipitate nickel on the inner wall by vaporization of the wire. As an alternative the cathode may consist of a wire which is purified in the required manner by heating it to a high temperature by means of an electric current. For purifying the cathode it is not necessary to perform the disintegration in such manner that the cathode is heated to an extremely high temperature (in the case of molybdenum, for instance, to 1700°). In fact, this disintegration may take place with a smaller load and consequently at a lower temperature when making it last longer.

The gas pressure in glow discharge tubes according to the invention has the usual value of the order of magnitude of 1 cm. Thus, for instance, a gas pressure of 20 to 40 mm. neon or 5 to 20 mm. argon may be used. Glow discharge tubes according to the invention have a very constant operating voltage. If the disintegration or vaporization of the cathode is continued for a sufficient time and a visible layer of metal is precipitated on the inner wall of the tube, the operating voltage may vary less

than 0.5 volt and even only 0.1 volt within a normal life of about 1000 burning hours. The operating voltage is practically not affected by interruptions in using the tube.

What we claim is:

1. A glow discharge tube comprising a gaseous medium for producing a gaseous discharge, a cathode for said gaseous discharge having surface portions consisting of molybdenum, an anode for said gaseous discharge and defining with said cathode a gaseous discharge space, a wall portion enclosing said discharge space, and a molybdenum coating of visible thickness substantially entirely covering the surface of said wall portion facing said discharge space.

2. A glow discharge device comprising an envelope, a gaseous medium within said envelope, an anode electrode and a cold cathode electrode enclosed within said envelope to provide a glow discharge therebetween, a substantial portion of the interior surface of said envelope being exposed to said glow discharge, a metal coating on said cathode for determining its work function, said coating having inherent gettering properties, and a coating of the same metal on substantially the entire inside surface of said envelope exposed to said discharge to inhibit the liberation of gas from said surface, said latter coating being electrically isolated from said electrodes.

3. A glow discharge device comprising an envelope, a gaseous medium within said envelope, a rod-shaped anode electrode mounted within said envelope, a flat cold cathode electrode within said envelope, and spaced from said anode electrode to provide a glow discharge therebetween, a metal deposited on a portion of the surface of said cathode electrode for determining the work function of said cathode electrode, said metal having inherent gettering properties, and a metallic coating on the entire inside surface of said envelope exposed to said discharge to inhibit the liberation of gas from said surface, said metallic coating including the same metal deposited on said cathode portion, said latter coating being electrically isolated from said electrodes.

4. A glow discharge device comprising an envelope, a gaseous medium within said envelope, an anode electrode and a cold cathode electrode enclosed within said envelope to provide a glow discharge therebetween, a substantial portion of the interior surface of said envelope being exposed to said glow discharge, a metal coating on said cathode for determining its work function, said metal coating having a melting point greater than about 1400° C., said coating also having inherent gettering properties, and a coating of the same metal on substantially the entire inside surface of said envelope exposed to said discharge to inhibit the liberation of gas from said surface, said latter coating being electrically isolated from said electrodes.

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