June 28, 1927.

1,634,201

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GLOW DISCHARGE TUBE

Filed March 20, 1922

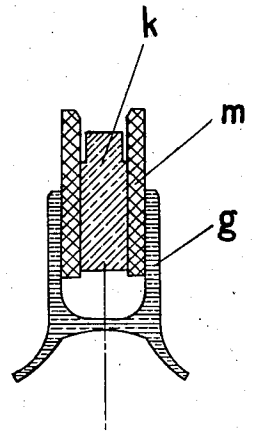

Fig.1

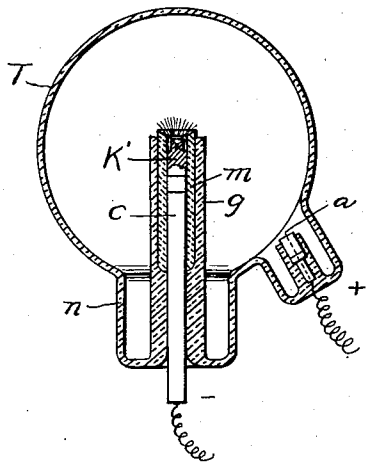

Fig.3

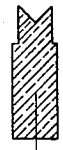

Fig.2

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Patented June 28, 1927. 1,634,201

UNITED STATES PATENT OFFICE.

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GLOW-DISCHARGE TUBE.

Application filed March 20, 1922, Serial No. 545,376, and in Germany March 24, 1921.

The invention relates to glow discharge tubes, that is, vacuum tubes or other glass vessels, containing a certain amount of gas, in which the passage of current through the tube between an anode and a cathode produces a "glow" or luminous effect within the tube. This effect appears in the form of what may be termed a luminous cloud adjacent to the cathode, and is believed to be due to the action of the electrons passing between the anode and cathode, upon the gas molecules. Such a glow discharge is well adapted for use in making photographic records, corresponding to the varying electric current with which the tube is supplied, because of the fact that the glow has no inertia; this in contradistinction to the glow of an incandescent body, such as a lamp filament, in which the heat and light do not change as rapidly as the electrical variations causing the change.

An object of the invention is the provision of improvements in glow discharge devices, particularly in regard to the form and arrangement of the cathode and adjacent parts, so that, as one result, the varying intensity or intrinsic brilliance of the glow will correspond more exactly to the varying current feeding the same. This may be accomplished by maintaining the glow light, or the base of the same adjacent to the cathode surface, practically constant, so that the effect of the varying currents received will be to vary the intensity of the glow, rather than its size.

The investigations of Gehrcke have made known the use of the cathode glow as a means for indicating the form of variable electrical phenomena. This use is based on the property of the cathode glow of varying its dimensions as the glow discharge current varies. The arrangement, as previously known, has various disadvantages. In the first place it is difficult to secure a regular variation of the spread of the glow upon the cathode since impurities in the material of the cathode and superficial impurities thereof greatly affect it. Further the intrinsic brilliance of the light is small on account of the comparatively large surface of the cathode, while a very large glow discharge current is consumed.

According to the present invention these disadvantages are avoided by the provision of a glow discharge tube for photographically recording electrical oscillations in which the whole effective cathode surface is permanently covered by the glow, so that variations of the glow discharge current only bring about variations in the intensity or intrinsic brilliance of the glow, and do not at all vary the size of the base of the glow. In order that the whole of the effective cathode surface may be covered with the glow even for a low value of the discharge current, and in order that the current density and intrinsic brilliance on the cathode may be large, the cathode surface must, in the first place, be small. It has been found advantageous to give it a surface of approximately five to ten square millimetres. A lower limit for the size of this surface is imposed by the properties of the cathode material as regards energy discharge per unit of surface and by the effectiveness of heat transmission to the surroundings, since the greater part of the electrical energy transformed into other forms of energy in the neighborhood of the cathode appears as heat energy on the cathode. On the other hand the surface need not be larger than is required to give the illumination necessary for the particular photographic system employed, when the cathodic glow is used for making photographic records.

The accompanying drawings show by way of example forms of construction of the cathode.

Figure 1 is a cross section showing the complete cathode with its holder, and

Figure 2 is a cross section showing a modified form of the cathode without holder.

Figure 3 is a sectional view of the cathode, Fig. 2 form, with its holder mounted in a glow discharge tube.

In Fig. 1 the reference character k indicates the cathode proper, formed of a suitable conductive material, preferably a metal, which preferably has a circular cross-section. In Figs. 2 and 3 k_1 shows an alternative construction of the cathode proper in which the cathode has a conical recess formed in it in order that great intrinsic brilliance may be obtained with a somewhat larger surface through overlapping of the rays of light. In order that the glow may be confined to the face of the cathode proper, i. e., the end surface of the cathode

of circular cross section shown, the cathode is surrounded by an insulating tube m; this may, for instance suitably be made of magnesia. To prevent creeping of the glow in the event of any disintegration of the metal of the cathode, the cathode k is reduced in diameter by a fraction of a millimetre for a short length downwardly from its upper end. The glow cannot penetrate into the narrow space thus left between the upper portion of the cathode and the insulating sleeve m, on account of the large free path necessary for ionization. Cathode k and insulating tube m together are sealed in known manner into a glass tube g serving as a holder and this is secured to the inner surface of the glass wall of the discharge vessel.

In regard to "creeping of the glow" it should be said that metal particles disintegrated from the cathode may fly against and adhere to the adjacent surface of the insulator. If the insulator hugs the cathode closely all the way to the end of the latter, disintegrated metal may form a coating on the adjacent surface of the insulator and form a conducting bridge leading to the cathode itself, so that the glow may extend from the cathode proper over on to the adjacent insulator surface. This is prevented by the slight annular gap between the end of the cathode and the insulator, m. The glow about the end of the cathode cannot penetrate into this narrow annular space, because, apparently, the glow is caused by the impact of electrons against the gas molecules, and a greater amount of free space is needed for such action, and to cause luminosity thereby, than is provided by the annular gap described.

It is preferred to employ as the material of the cathode a metal of high melting point and little subject to disintegration; for example iron or tungsten. In order that there may be adequate heat dispersion it may in some cases be desirable to make only the face or end of the cathode of such material and mount it upon a rod of good heat conducting material such as copper. The discharge vessel may preferably be filled with gases having great actinic acitivity, as for instance, nitrogen or argon, and at a pressure which will give little disintegration and large density of glow.

It may be noted that with too low a pressure there will be more disintegration of the cathode material, which will be thrown outwardly as a spray. Also with too low pressure, the density of the luminous cloud may be insufficient for photographic recording. If, on the other hand, the pressure of the gas is too great, the potential difference between anode and cathode may be larger than is desirable. The pressure of the gas will vary with the form of gas used, and with the cathode material.

It is desirable to have the end of the insulating tube project slightly beyond the end of the cathode, as is shown in Fig. 1, since this serves to somewhat condense the luminous cloud.

In Fig. 3 the cathode k^1 is shown mounted in a glow discharge tube T having an anode a, the cathode k^1 being mounted on and in electrical connection with a copper rod c extending out through the neck n of the tube.

We claim:—

1. In a glow discharge tube adapted for use in photographically recording electric current variations having a cathode and anode and containing a gas, adapted to provide a luminous discharge in the space adjacent to the cathode and based thereon, the combination of an elongated cathode member having a forward end surface adapted to be entirely covered with a negative glow discharge, and means for preventing the spreading of the glow from said forward end surface on to any surfaces adjacent to said forward end surface.

2. In a glow discharge tube adapted for use in photographically recording electric current variations having a cathode and anode and containing a gas, adapted to provide a luminous discharge in the space adjacent to the cathode and based thereon, the combination of a cathode having a forward end portion of tungsten, having a forward face portion of small area, said tungsten end portion being mounted upon a rod of high heat conducting material, and means for confining the base of the luminous discharge entirely to said forward face portion.

3. In a glow discharge tube adapted for use in photographically recording electric current variations, having a cathode and anode and containing a gas, adapted to provide a luminous discharge in the space adjacent to the cathode and based thereon, the combination of an elongated rod-like cathode extending into the interior of the tube, having a surface extending continuously and entirely across its forward or inner end, adapted to be entirely covered with a glow discharge, said cathode having a portion of reduced diameter extending rearwardly for a distance from said end surface, and means for preventing the spreading of the glow from said forward end surface on to any other surfaces, comprising an insulating sleeve surrounding said cathode closely up to said reduced portion and slightly spaced away from said reduced portion.

4. In a glow discharge tube adapted for use in photographically recording electric current variations, having a cathode and anode and containing a gas, adapted to provide a luminous discharge in the space adjacent to the cathode and based thereon, the combination of an elongated rod-like cathode extending into the interior of the tube, hav-

ing a surface extending continuously and entirely across its forward or inner end, adapted to be entirely covered with a glow discharge, and means for preventing the spreading of the glow from said forward end surface on to any other surfaces, comprising an insulating sleeve within the discharge tube, surrounding said cathode, said sleeve being spaced away slightly from said cathode for a distance back from said forward or inner end surface and closely surrounding said cathode for the remainder of the length thereof rearwardly or outwardly from said spaced away portion thereof.

5. In a glow discharge tube adapted for use in photographically recording electric current variations, having a cathode and anode and containing a gas, adapted to provide a luminous discharge in the space adjacent to the cathode and based thereon, the combination of an elongated cathode member having an end surface adapted to be entirely covered with a glow discharge, and means for preventing the spreading of the glow on to adjacent surfaces, said end surface having a conical recess therein.

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