March 29, 1938. D. W. BODLE 2,112,328

GAS-FILLED TUBE

Original Filed March 26, 1935

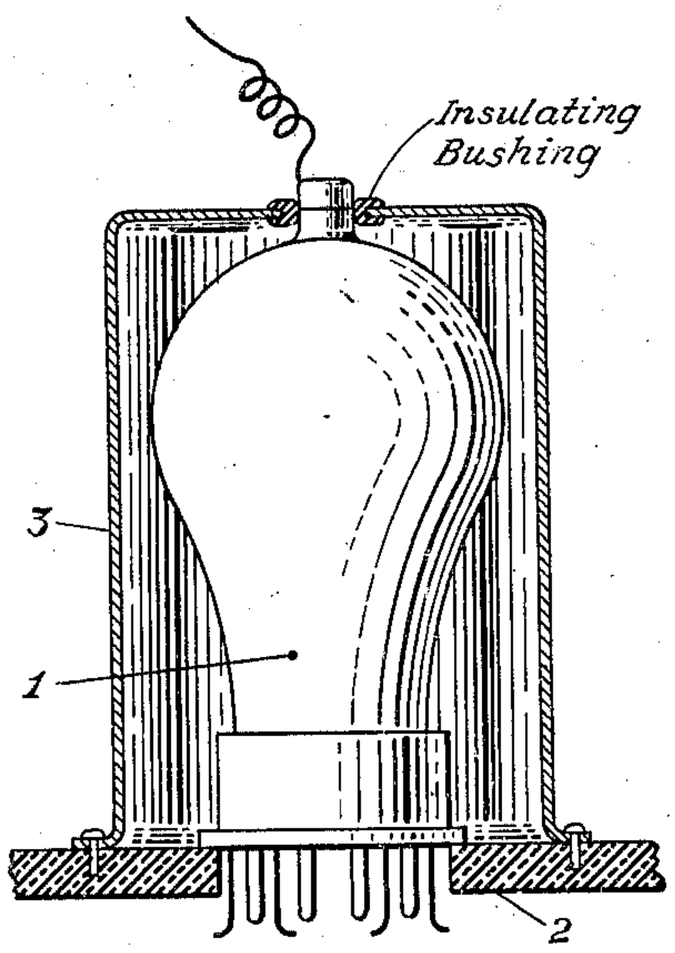

Fig. 1

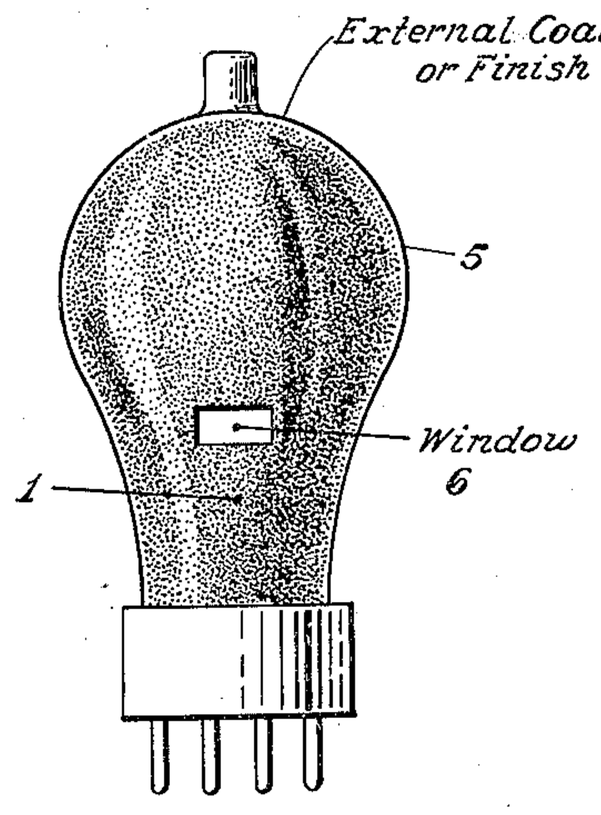

Fig. 2

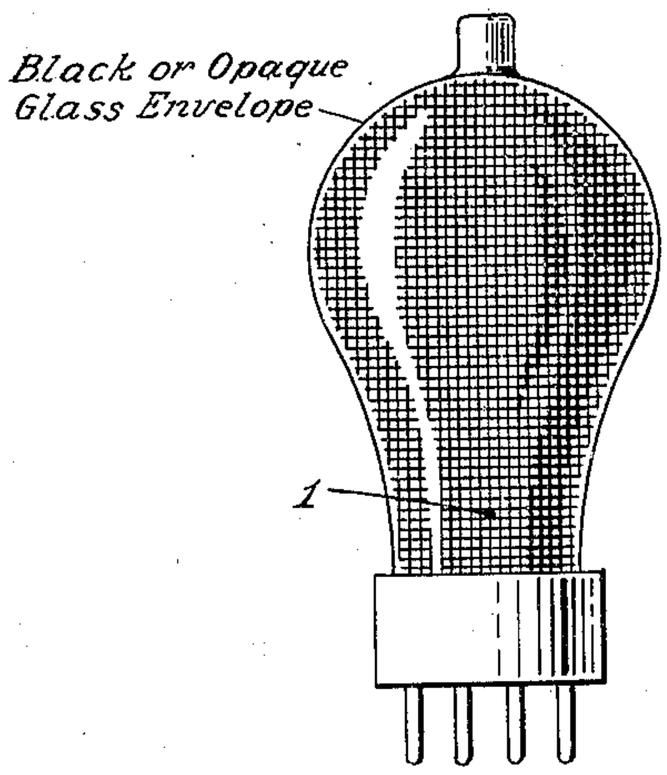

Fig. 3

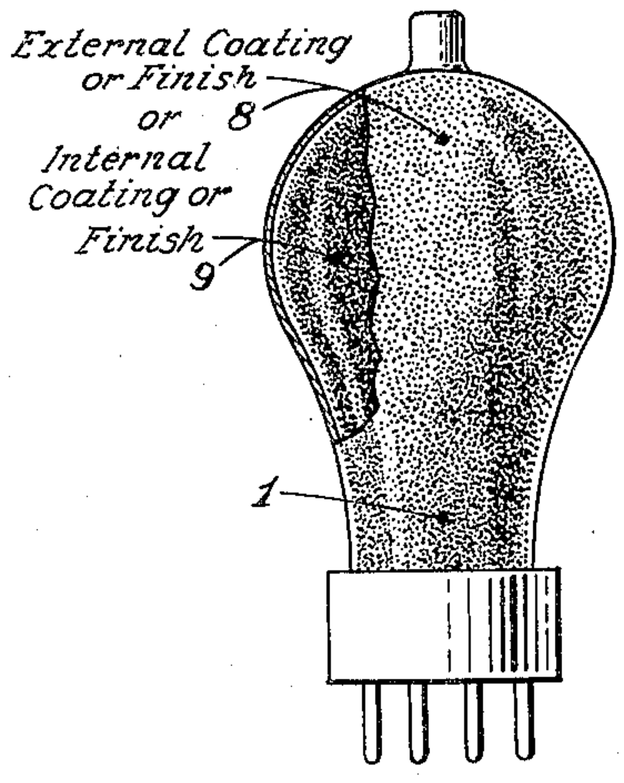

Fig. 4

INVENTOR
D. W. Bodle
BY William R. Ballard
ATTORNEY

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GAS-FILLED TUBE

David W. Bodle, Pequannock, N. J., assignor to American Telephone and Telegraph Company, a corporation of New York

Original application March 26, 1935, Serial No. 13,172. Divided and this application October 5, 1937, Serial No. 167,468

7 Claims. (Cl. 250—27.5)

This invention relates to gas-filled tubes. More particularly, this invention relates to means and methods for reducing and preventing instability in the properties and operating characteristics of gas-filled tubes.

This is a division of my copending application, Serial No. 13,172, filed March 26, 1935.

Gas-filled tubes generally consist of two or more spaced electrodes enclosed in an envelope, such as glass, filled with a gaseous medium such as neon, argon, krypton, or helium or a combination of these gases. These electrodes are so spaced within their envelopes that when a voltage exceeding a predetermined value, otherwise known as the breakdown voltage of the tube, becomes impressed across any two of its electrodes, a bluish, luminous, gaseous discharge will occur between these electrodes. This luminous discharge will generally continue as long as a somewhat lower voltage, i. e., the sustaining voltage, remains impressed across the aforementioned two electrodes. Immediately upon the discharge and throughout its duration, the impedance between all of the electrodes of the tube will be reduced from an almost infinite value to a low and practically negligible value.

It has been discovered that the presence of light and its impression upon the electrodes contained within the tube materially affects the breakdown voltage of the tube. It has been further discovered that the effect of light is generally to reduce the breakdown voltage value. The change in the breakdown voltage value has been found to be in different and varying degrees which are not readily predeterminable because they are dependent upon a number of changeable factors which are not easily controllable.

In a form of gas-filled tube commercially known as the cold cathode tube, it has been further discovered that the aforementioned reduction in breakdown voltage is most pronounced where such a tube has the upper side of its plate electrode or electrodes coated with an activating material and the reduction in the breakdown characteristic is especially marked in cases where current is passed from the anode of the tube to either or both of these plate electrodes. It has been determined that this activating material reacts to light to a considerable extent and that the larger the activating surface directly exposed to light, the greater will be the change in the breakdown voltage of the tube. It has been further determined that the reduction in breakdown voltage is a function of the intensity of the impressed light as well as of the kind of light, i. e., whether at or near one end of the spectrum or the other, to which the tube may be exposed. Ultra-violet rays, for example, have been found to be more effective in reducing the breakdown voltage of the tube than visible rays. Direct sunlight will actually reduce the breakdown voltage of a 900-type of tube approximately 25 per cent.

One of the primary objects of this invention is to reduce or eliminate the effect of the aforementioned factors upon the breakdown voltage of a gas-filled tube.

Another of the objects of this invention is to reduce or eliminate the undesirable effects of exposure to light upon gas-filled tubes and their operating characteristics and properties.

A further object of this invention is to provide means for continuously maintaining the breakdown voltage of gas-filled tubes highly constant.

These and further objects of this invention will be apparent from the description hereinafter following when read in connection with the accompanying drawing in which Figures 1 to 4 show four different embodiments of the invention.

Fig. 1 of the drawing shows a gas-filled tube **1**, the base of which is mounted in a panel **2** of, for example, Bakelite, rubber or the like. This tube is enclosed within a light-proof can **3** which may be of aluminum, tin, copper, or any material which will not transmit light. A metallic or conducting material will be preferred to a non-conducting material, however, for the reason that such a can may be made of a material which will electrostatically shield the tube against transient or other external effects. This is important where accuracy and precision in the continuous operation of the device are desirable factors.

Fig. 2 shows another embodiment of this invention in which the envelope of the tube **1** is coated with a light excluding material **5** produced, for example, by spraying the envelope with Bakelite, lacquer or other compound or paint which is opaque to light, the coating being such that it will permanently remain affixed to the envelope after it is applied. When so coating the tube envelope, it may be desirable to allow a small section **6** thereof, for example, an area ⅛'' x ¼'' to be uncoated. This uncoated area, although not generally necessary, may be desired, however wherever the elements of the tube or its operation ought to be observable.

Fig. 3 differs from Fig. 2 in that the envelope of the tube **1** containing the gaseous medium is made of a glass or material which excludes light rays of the visible spectrum as well as all other rays such as those of the ultra-violet spectrum. For

instance, the envelope may be formed of black glass or any opaque colored glass.

In Fig. 4 it is proposed to illustrate that the envelope of the tube 1 may be made of transparent glass and that either its external surface designated 8 or its internal surface designated 9, or both, may be coated or finished with a light excluding paint or substance such as may be produced by sand blasting, hydrofluoric acid, or the like.

It will be understood that the metallic can 3 of Fig. 1 may be employed to enclose the tubes of Figs. 2 to 4 for the purpose of electrostatically shielding the electrodes of these tubes against external effects.

It is important to note that this invention is primarily concerned with eliminating light from a gas-filled tube so that substantially no light whatever external to the tube will reach into the envelope of the tube and thereby affect its breakdown voltage characteristic by causing ionization of the gas therein due to photoelectric effects.

While this invention has been shown and described in certain particular arrangements 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 claims.

What is claimed is:

1. A multi-electrode gas-filled discharge tube having an envelope formed of glass which is impervious to light to maintain the breakdown voltage between the electrodes within the tube substantially constant and independent of ionization due to photoelectric effects.

2. The combination of a gas-filled discharge tube having a plurality of activated electrodes, and a coating for said tube which is impervious to light to maintain the breakdown voltage between said electrodes substantially constant and substantially independent of ionization due to photoelectric effects, said coating covering the entire envelope of said tube except a small area through which the action of the tube may be observed.

3. The combination of a gas-filled tube having activated electrodes, said tube having an envelope of opaque glass to maintain a dark space about said electrodes so that the breakdown voltage between said electrodes will be highly constant.

4. The combination of a plurality of spaced electrodes positioned in an atmosphere of gas, the breakdown voltage between said electrodes being variable according to different light conditions, and an opaque glass envelope to enclose said electrodes to eliminate from the electrodes within the envelope all external light.

5. A gas-filled discharge tube having an envelope of glass enclosing the electrodes thereof, the glass envelope being of a non-transparent material to prevent light external of the tube from entering the tube and from affecting the breakdown voltage between the electrodes of the tube.

6. A gas-filled discharge tube having only normally cold electrodes and having a light-excluding glass envelope to maintain the breakdown voltage between the electrodes substantially constant and independent of external light influences.

7. Means for maintaining the breakdown voltage of a gas-filled tube nearly constant and unaffected by external rays of light comprising a glass envelope for the tube which is opaque to light.

DAVID W. BODLE.