Sept. 8, 1931. T. W. CASE 1,822,865

METHOD AND APPARATUS FOR PRODUCING PHOTOGRAPHIC RECORDS

Filed June 10, 1924

Fig. 1.

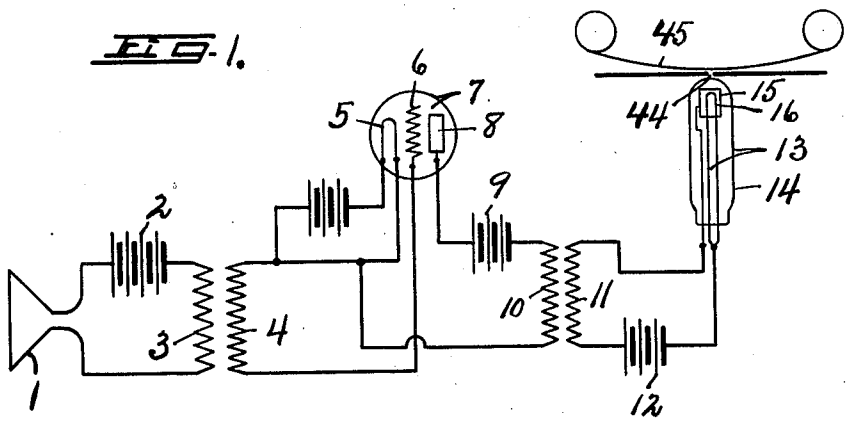


Fig. 2.

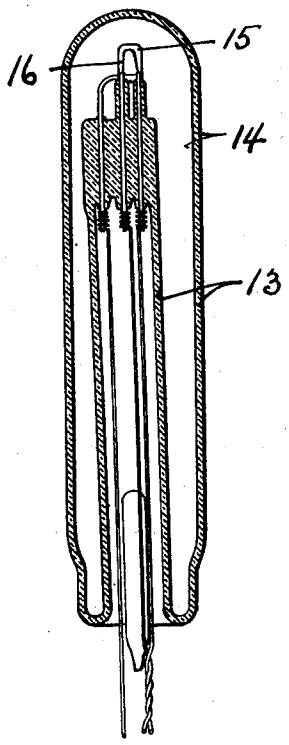
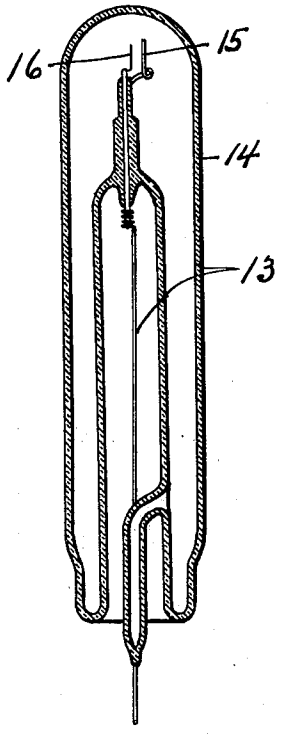


Fig. 3.



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METHOD AND APPARATUS FOR PRODUCING PHOTOGRAPHIC RECORDS

Application filed June 10, 1924. Serial No. 719,098.

This invention relates to a new and improved method and apparatus for producing a photographic record of light variations corresponding to electrical variations as may be produced by sound variations or other means and this application is a continuation in part of my application Serial No. 616,704 filed Feby. 23, 1923.

I have discovered that the cathode glow particularly about an electrode having a coating of an alkaline earth oxide, preferably barium oxide, in a bulb containing an ionizable gas, preferably helium, is peculiarly efficient as constituting the source of light to be varied in accordance with electrical variations, and which light as varied, is registered upon a photographic film and constitutes a record of light wave variations corresponding to electrical variations, which electrical variations may be produced by sound.

This cathode glow has a high intrinsic brilliancy as compared to the ordinary gas glow between electrodes, and a high actinic value, and the variations in the light are freer from lag or inertia than if the said material were not on the cathode, and the lamp will operate with a comparatively low voltage, especially adapting the lamp for use in producing an accurate photograph record for the purpose described and in the association described.

It is further found that where the cathode or negative glow is produced about an electrode having a coating of an alkaline earth oxide that the response of the glow in terms of light emission to quick variations of electrical impulses as induced by sound is a more faithful reaction than if such coating is not present, and this characteristic is extremely important if not essential to the correct recording of complex and high frequency sound variations. Further, the light seems to be intensified on the alkaline earth oxide on the cathode by an existing, or at least a seeming fluorescence.

The invention further relates to the details of the structure and the form and relation of the electrodes and the particular pressure of the gas within the bulb, all as will more fully appear from the following description, taken in connection with the accompanying drawings, in which:—

Figure 1 is a diagrammatic illustration of an apparatus of my invention.

Figure 2 is a sectional view of the lamp of this invention.

Figure 3 is a sectional view of the lamp of this invention taken at right angles to Figure 2.

In a general way, the apparatus of this invention includes a microphone —1— or other element for translating sound wave variations into variations of an electric current flowing in a circuit, including the battery —2— and a primary —3— of a transformer, the secondary —4— of which is connected in circuit with the filament —5— and grid —6— of an audion —7—, the plate —8— and filament —5— of which are connected in a circuit including a source of potential —9— and a primary —10— of a transformer, the secondary —11— of which transformer is connected in a circuit including a source of potential —12— and lamp —13—.

It will be obvious that the audion and its circuits are inserted for amplifying purposes, and that altho one stage of amplification is shown, any number may be utilized, or other arrangements of the circuit may serve the same purpose.

The light emanating from the lamp —13— as varied in accordance with the currents flowing in the circuits passes through the narrow slot —44— and is registered upon the photographic film —45— as it moves past the slot. The lamp —13— includes a bulb —14— preferably of glass or quartz, and within this bulb are arranged two electrodes —15— and —16—, the electrode —15— being preferably in the form of a small plate while the electrode —16— is substantially U-shaped and preferably constitutes the negative electrode or cathode, about which electrode the glow used for photographic purposes is concentrated. At present it is not possible to state positively from exactly what causes the high efficiency of this lamp results, as such causes are at best a matter of more or less intelligent speculation. It can, however, be stated with positiveness that the material

such as barium, strontium, etc., with which the cathode is coated is an electron emitter at high temperatures, and such material may retain or partially retain this property at the normal temperature at which this lamp operates. Further, the material is photo-electric, i. e. the material is capable of reacting to variations of light intensity to which it may be exposed, and it may well be that the glow reacting upon the photo-electric coating produces additional electron-emission thereby effecting the highly efficient operation of the lamp. Further, the material becomes fluorescent under electron bombardment. To what extent or in what relative proportions the above characteristics enter into the efficient operation of the lamp cannot be stated, and it is only possible to state positively that the lamp so constituted produces a cathode or negative glow of high efficiency for the purpose described.

A lamp of my invention highly efficient for the purpose described may be manufactured in the following manner:—

The electrode which is to act as the cathode may be formed of a platinum strip .011 inch wide, and .0025 inch thick. The strip is bent into U-shaped form in conformity with the illustration of the electrode —16— shown in the drawings.

The platinum strip is first preferably coated with calcium nitrate to prevent too much reaction upon the strip of the alkaline earth compound, such as barium nitrate, with which the platinum strip is later coated.

The platinum filament is then coated with an alkaline earth compound, preferably barium nitrate. Both of these nitrates are heated in air on the platinum strip to form oxides before being put in lamp. The electrodes are then assembled in the lamp, as illustrated, and the platinum filament or strip is connected in circuit with a source of potential, and is gradually heated to a red heat to volatilize water absorbed by the oxides. A baking furnace is then placed over the tube and the structure is baked for about one-half hour at a temperature of approximately 540 degrees centigrade, during which time the coated platinum filament remains heated, and a partial vacuum is maintained. The structure is then allowed to cool slowly to about 350 deg. centigrade, and then the baking apparatus is removed. The bulb or tube is then pumped to a high vacuum, the filament is heated by about 2.7 amperes for two seconds, and the plate electrode —15— is heated by electron-bombardment and outgassed. The current is then shut off through the filament, and helium gas is let into the tube or bulb —14— while the electrodes —15— and —16— are connected in a circuit including a source of potential of about 250 volts in series with a resistance of 10,000 ohms.

When the gas such as helium within the bulb reaches a pressure where a discharge starts between the electrodes and the glow practically fills the space between the electrodes —15— and —16—, there are about 10 to 12 milliamperes flowing in the circuit, which includes the electrodes. The apparatus is permitted to run in this condition until the glow is evenly distributed over the entire cathode. Usually the glow starts in a non-uniform manner and later spreads out more or less uniformly over the entire U-shaped electrode. The voltage in the circuit is then reduced to about 180 volts and the resistance to about 2000 ohms with a current of approximately 3 milliamperes flowing in the circuit. More helium gas is then admitted to the bulb until the glow between the electrodes separates, and one part substantially blue or blue-white concentrates on and about the cathode becoming quite intense, and a pink glow exists on the surface of the anode, such cathode and anode glows being distinct and separate. The alkaline earth oxide coating on the cathode seems to become fluorescent, and the whole combination produces a light of high actinic value.

The pressure which I have found in practice to be the preferable one is approximately 50 to 60 millimeters of mercury, altho it may vary within limits from 20 to 300 millimeters of mercury. The electrodes —15— and —16— are arranged in close relation, preferably about $\frac{1}{8}$th of an inch apart, altho variation is possible between $\frac{1}{16}$th and $\frac{1}{4}$th of an inch, and the structure illustrated in Figs. 2 and 3 is substantially a scale reproduction of the practical apparatus that I have found highly efficient for the purpose at hand.

The use of a U-shaped filamentary cathode is peculiarly adapted for the purpose at hand, as distinguished, for instance, from a straight cathode strip, as more current passes through the bulb at a certain voltage with the U-type cathode. This may be because the electrons given off from the respective legs of the U-shaped filament strike the opposite leg and intensify the ionization. It may be desirable to substitute a U-shaped electrode similar to the electrode —16— for the electrode —15— whereby the circuit connections may be reversed and either electrode be utilized as the cathode, for instance, when the alkaline earth oxide coating on one of the electrodes becomes dissipated, or partially so.

The lamp so produced is peculiarly efficient for the purpose of causing light variations to follow electrical variations faithfully, such as produced by sound variations as the inertia in ionization is reduced by the oxide coating on the cathode, and as it will operate at a comparatively low voltage, as for instance, 150 volts, altho I prefer a voltage of 300 to 350 volts with a resistance of about 10,000 ohms and it will be understood

that the production of the cathode glow typical of this lamp and constituting the light to be varied and photographed is dependent upon a number of related conditions, such as the pressure of the gas; the form and spaced distance of the electrodes; the coating of the electrode or electrodes; the voltage used; and that the specific disclosure here is of one particular related condition of the elements of the structure by which a cathode glow highly efficient for the purpose is produced, and variations in one related condition will necessitate variations in other related conditions. By "cathode glow" as used in the specification and claims hereby is meant a glow concentrated about the negative electrode or cathode of the lamp whether that glow be technically the so-called "cathode glow" or the so-called "negative glow".

Altho I have shown and described a specific structure as illustrative of an embodiment of my invention, I do not desire to restrict myself to the details of the same except where they are specifically set forth in the claims, as variations, changes and modifications may be made without departing from the invention.

I claim:

1. A source of light for use in producing a photographic record of light wave variations corresponding to sound wave variations impressed upon a circuit connected to the source of light comprising a bulb, a pair of non-thermionic electrodes within the bulb, the negative one of which comprises an alkaline earth material and an ionizable gas within the bulb at such a pressure that a voltage not substantially greater than 400 volts, direct current across the electrodes, will produce a glow about the negative electrode separate from the anode glow and suppress the anode glow to such an extent that the concentrated negative glow is the only effective glow during the photographing process.

2. A source of light for use in producing a photographic record of light wave variations corresponding to sound wave variations impressed upon a circuit connected to the source of light comprising a bulb, a pair of non-thermionic electrodes within the bulb, the negative one of which comprises barium and an ionizable gas within the bulb at such a pressure that a voltage not substantially greater than 400 volts direct current across the electrodes will produce a glow about the negative electrode separate from the anode glow and suppress the anode glow to such an extent that the concentrated negative glow is the only effective glow during the photographing process.

3. A source of light for use in producing a photographic record of light wave variations corresponding to sound wave variations impressed upon a circuit connected to the source of light comprising a bulb, a pair of non-thermionic electrodes within the bulb, the negative one of which comprises an alkaline earth material and helium within the bulb at such a pressure that a voltage not substantially greater than 400 volts, direct current across the electrodes, will produce a glow about the negative electrode separate from the anode glow and suppress the anode glow to such an extent that the concentrated negative glow is the only effective glow during the photographing process.

4. A source of light for use in producing a photographic record of light wave variations corresponding to sound wave variations impressed upon a circuit connected to the source of light comprising a bulb, a pair of non-thermionic electrodes within the bulb, the negative one of which comprises barium and helium within the bulb at such a pressure that a voltage not substantially greater than 400 volts, direct current across the electrodes, will produce a glow about the negative electrode separate from the anode glow and suppress the anode glow to such an extent that the concentrated negative glow is the only effective glow during the photographing process.

5. A source of light for producing a photographic record of light wave variations corresponding to electrical variations as modulated by sound waves locally applied comprising a bulb, a non-thermionic anode and cathode within the bulb, an atmosphere of an inert gas within the bulb at such a pressure that a concentrated glow is produced about the negative electrode with a voltage not substantially greater than 400 volts, direct current across the electrodes, and said cathode including a photo-electrically activated coating comprising an alkaline earth material actuated for electron emission by the said glow concentrated about the cathode.

6. A source of light for producing a photographic record of light wave variations corresponding to electrical variations as modulated by sound waves locally applied comprising a bulb, a non-thermionic anode and cathode within the bulb, an atmosphere of helium within the bulb at such a pressure that a concentrated glow is produced about the negative electrode with a voltage not substantially greater than 400 volts direct current across the electrodes, and said cathode including a photo-electrically activated coating comprising barium actuated for electron emission by the said glow concentrated about the cathode.

7. A source of light for producing a photographic record of light wave variations corresponding to electrical variations as modulated by sound waves locally applied comprising a bulb, a non-thermionic anode and cathode within the bulb, an atmosphere of an inert gas within the bulb at such a pressure that a concentrated glow is produced about

the negative electrode with a voltage not substantially greater than 400 volts direct current across the electrode, and said cathode including a photo-electrically activated coating comprising barium actuated for electron emission by the said glow concentrated about the cathode.

8. A source of light for producing a photographic record of light wave variations corresponding to sound wave variations impressed upon a circuit connected to the source of light comprising a bulb, a non-thermionic anode and cathode within the bulb, an atmosphere of an inert gas within the bulb at such a pressure that a voltage not substantially greater than 400 volts direct current across the electrodes will produce a glow about the negative electrode separate from the anode glow and suppress the anode glow to such an extent that the concentrated negative glow is the only effective glow during the photographing process, and said cathode including a coating of a photo-electric material actuated for electron emission by the said glow concentrated about the cathode as modulated in accordance with the voltage fluctuations impressed across the anode and cathode corresponding to sound wave variations.

In witness whereof I have hereunto set my hand this 26 day of May 1924.

THEODORE WILLARD CASE.