May 9, 1933. C. SPAETH 1,908,650

ELECTRICAL DISCHARGE DEVICE

Filed Oct. 23, 1930

Fig. 1.

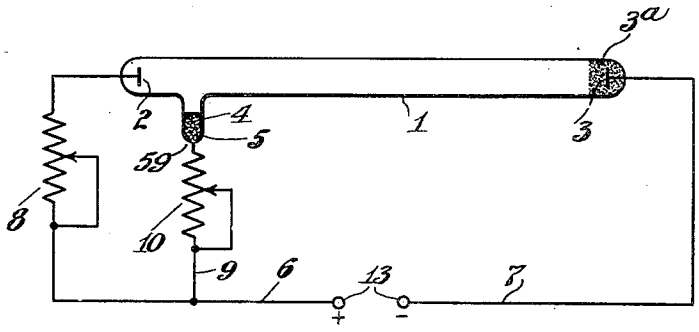
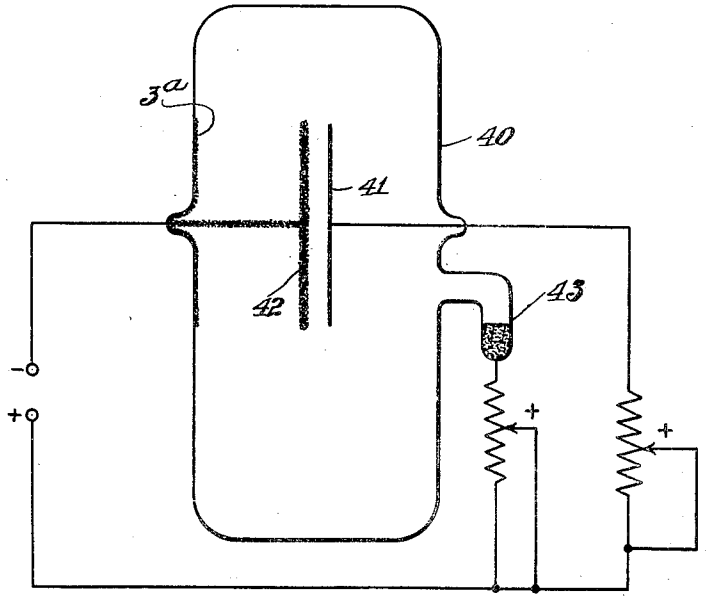


Fig. 2.



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Patented May 9, 1933

1,908,650

UNITED STATES PATENT OFFICE

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ELECTRICAL DISCHARGE DEVICE

Application filed October 23, 1930. Serial No. 490,649.

This application is a continuation in part of my copending application Serial No. 343,873, filed March 2, 1929.

The invention relates to electrical discharge devices, particularly to devices used for purposes of illumination.

It is an object of the present invention to provide an electrical discharge tube which is capable of producing a very efficient white light.

Another object is to provide an electrical discharge illuminating tube wherein the color characteristics of the emitted light may be readily modified in a predetermined manner or be maintained constant at any desired value.

A further object is the provision of an electrical discharge tube operating at high efficiency and adapted to produce a concentrated brilliant light emission approximating sunlight.

In accordance with my invention a radiant energy emitting discharge device is constructed having a filling of gas at reduced pressure and a plurality of electrodes for conducting an electrical discharge therethrough. For modifying the light emission from the device, auxiliary means are arranged to add to the gas filling in the desired amounts an agent for modifying the radiation spectrum. This auxiliary device is preferably in the form of a mercury reservoir provided with means for liberating mercury vapor.

A preferred form of my invention for illuminating purposes comprises an envelope containing an atmosphere of rare gas, such as neon, and having a reservoir of mercury. Electrodes are provided for passing a discharge directly through the rare gas and another electrode for causing a discharge to be passed to the mercury in order to vaporize it. In order to secure the desired characteristics of illumination from the device, means, such as resistances, inductances, or capacitances, may be provided for controlling the relative intensities of the discharges. For liberating the mercury suitable heating means may be employed in place of the auxiliary electrode. This heating means may comprise any suitable source of external heat, but preferably is in the form of a heating coil placed adjacent to the mercury reservoir and adapted to be energized by the discharge current.

When it is desired to secure a white light approximating that of sunlight, the filling of the envelope may be of neon gas used in conjunction with a reservoir or other means for supplying an exactly proportioned amount of mercury vapor. It is advisable where the tube is to be operated over a relatively long period of time to maintain the mercury vaporizing means in operation at the correct intensity during the entire operation of the device. It is, however, possible to start the discharge through the rare gas column and then supply the necessary quantity of mercury vapor for a short period of time, after which the device will continue to emit a white light for some time. As operation is continued the mercury is cleaned up, apparently either by condensation, occlusion, absorption or some other phenomena and the light emitted by the device gradually reverts to the characteristic color of the rare gas, which in the case of neon, is substantially red. By operating the mercury vaporizing device at the correct intensity mercury vapor is supplied at the same rate at which it is used up and hence the color of the emitted light remains constant.

For producing other colors of light other monatomic gases, for example, helium, argon, xenon, crypton, may be used with mercury vapor, or one of a mixture of the rare gases of a given characteristic color emission may be used in conjunction with the means for liberating the vapor.

In the drawing, Fig. 1 shows a device constructed in accordance with my invention wherein the modification of the emitted spectrum is obtained by the passage of a discharge to a spectrum modifying material; and in

Fig. 2 a lamp suitable for television use is illustrated.

Referring more particularly to the drawing, Fig. 1 illustrates an electrical discharge tube comprising a light transmitting envelope 1 filled with rare gas, such as neon, and having a pair of main discharge elec-

trodes 2 and 3 of any well known type, having the usual lead-in wires. The pressure of the gaseous atmosphere may range anywhere from .1 to 50 millimeters, but I find it preferable to use a pressure in the neighborhood of 6 millimeters. A reservoir for a quantity of mercury 4 is provided in the form of an appendix 5. For energizing the tube the main electrodes 2 and 3 are connected across a suitable source of current 14 by means of conductors 6 and 7. The source 13 may be of either direct or alternating current of a suitably high potential. Connected in series with the conductor 6 is an adjustable resistance 8. For causing discharge to pass to the mercury 4 a connection 9 is made between a lead-in wire 59 sealed through the wall of the reservoir 5 and making contact with the mercury, and the conductor 6. In series with the conductor 9 is an adjustable resistance 10.

During the construction of the device a quantity of alkali metal is introduced into the tube envelope adjacent to the cathode 3. This alkali metal may for example be distilled into the envelope in the well known manner, so that a film 3^a is formed on the inside of the wall thereof, or a small quantity of it may be put in in solid form. It is preferable for best operation that this deposit of alkali metal form a contact with the cathode 3 or its lead-in wires. The metal used may be sodium, potassium, rubidium, cæsium or an alloy of these metals. For commercial purposes potassium may be used alone to save expense.

This alkali metal is very important to the prolonged operation of the tube as it appears to function as a clean-up agent for excess mercury within the main body of the tube. When a tube is used having no alkali metal it turns entirely blue after a relatively short period of operation and can not be restored to its original mercury free color. During the operation of the discharge device a minute amount of mercury vapor is continuously generated by the auxiliary electrode and carried over into the main body of the tube, where it is excited by the main discharge current. When the exciting current is cut off this mercury vapor remains in the main tube and apparently forms an amalgam or other association with the alkali metal, of such character that the mercury is not liberated during future operation of the device. This action is particularly effective where the alkali metal is electrically connected to the cathode. Without the alkali metal the mercury vapor relatively quickly reaches such density in the main tube that only blue light is generated.

In operation a current is caused to pass from the source 13 between the two electrodes 2 and 3, thereby energizing the filling of rare gas and causing it to emit light having certain color characteristics. For example, where the rare gas is neon, the light will be predominantly red. In order to modify these color characteristics the resistance 10 is adjusted so that a discharge passes between the electrode 3 and mercury 4, thereby causing a quantity of the mercury to be vaporized. The mercury vapor diffuses through the gas in the envelope 1, emitting light rays of its characteristic blue color. By properly adjusting the resistance 10 it is possible so to balance the blue rays emitted against the characteristic color of the rare gas as to produce a light emission of any desired color. For example, where the rare gas is neon, a proper adjustment of the resistance 10 may be made to cause the emission of white light, the blue rays of the mercury being complementary to the red rays of the neon. The resistances 8 and 10 serve also as ballast resistances for balancing the negative resistance of the gaseous discharge path. These resistances should therefore never be cut entirely out of circuit as the discharge current would increase to an excessive value. While the mercury reservoir is illustrated as positioned near to one of the main electrodes, it need not necessarily be so located. The device will likewise be operative with the reservoir at other positions. By placing the reservoir as shown, the impedance of its discharge path is made relatively large.

Fig. 2 illustrates a lamp adapted for television purposes, the lamp comprising a gas filled envelope 40 having a pair of plate electrodes 41 and 42 spaced apart a distance less than the mean free path of the gas in the well-known manner. The envelope is filled with an atmosphere of inert gas, for example, neon, and a reservoir 43 containing mercury is provided. In operation, a white light is obtained in the same manner as set forth in connection with Fig. 1. The discharge cannot pass directly between the two plates because of their close spacing and therefore passes around to the outside faces of the plates illuminating them in the well-known manner.

The coating 3^a in this case may be applied adjacent to the electrode just as described in connection with Fig. 1. In fact if the alkali metal is distilled into the envelope some of it will collect on the electrodes as well as the wall of the device. This will not interfere with the operation of the device but rather will aid it.

Where neon gas and an auxiliary mercury electrode are used, as set forth, the color may be adjusted from the characteristic neon color, through white, to the characteristic mercury color. The efficiency of tubes constructed in accordance with my invention is extremely high. For example, when using neon gas with mercury vapor to produce a white light, the amount of energy consumed

is only about 0.20 watt per spherical candle-power. Because of this relatively high efficiency the amount of heat generated by the device is correspondingly small.

Lamps of this type are substantially silent in operation, especially when direct current is used. They are therefore of great value where a white, silent and relatively cool, high intensity, illuminating source is desired.

It will be obvious to those skilled in the art that the invention is capable of a wide variety of modifications and adaptations and that the present disclosure is intended merely to illustrate its nature without limiting its scope which is set forth in the appended claims.

What is claimed is:

1. In a television lamp an envelope, two closely positioned electrodes within the limit of the mean free path and adapted to have an electric discharge pass therebetween, a filling of rare gas within said envelope, a reservoir containing a quantity of mercury, means for controlling the rate of vaporization of such mercury and an alkali metal for removing the mercury from the light column in substantially the amount in which it is vaporized.

2. A device in accordance with claim 1, wherein the rare gas comprises neon.

In testimony whereof: I have signed my name to this specification this 21st day of October, 1930.

CHARLES SPAETH.