Feb. 13, 1934. L. L. BECK ET AL 1,946,477

LUMINESCENT TUBE

Original Filed Nov. 15, 1929

FIG.1.

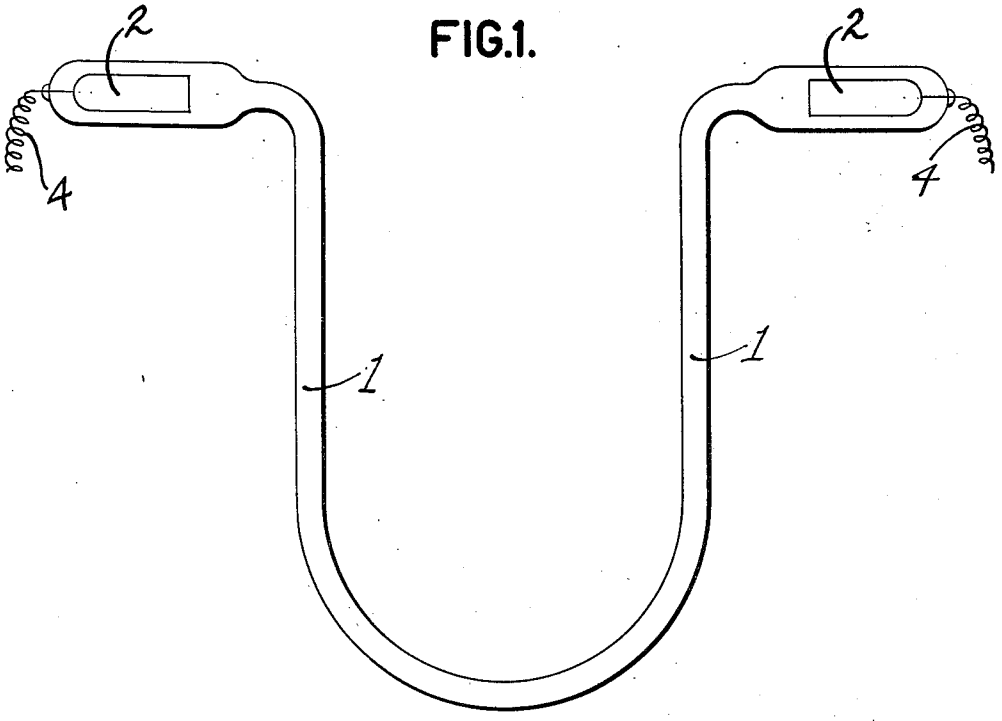
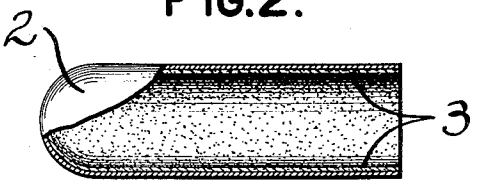


FIG.2.



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Patented Feb. 13, 1934

1,946,477

UNITED STATES PATENT OFFICE

1,946,477

LUMINESCENT TUBE

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Application November 15, 1929, Serial No. 407,415
Renewed November 2, 1933

6 Claims. (Cl. 176—122)

The present invention relates to gaseous discharge devices in which the discharge of electricity through rare gases causes the emission of light.

The invention provides a device adapted to emit light which conveys to the eye the impression that the light is white.

The invention provides furthermore a luminous tube device containing a large proportion of helium which nevertheless is adapted to emit a color giving the impression of whiteness and is also adapted to possess a long life notwithstanding the tendency of helium to be rapidly absorbed or rendered ineffective by electrode action and other phenomena.

The invention furthermore comprises a luminous tube device containing a mixture of helium and argon so proportioned that the color of the light emitted by the mixture gives the impression of whiteness to the eye and comprises a suitable combination of the spectra of the gases in the mixture.

The invention furthermore comprises a luminous tube device which although containing a relatively very active gas at comparatively low pressure, nevertheless possesses a remarkably long life in use.

The invention furthermore comprises the combination of a mixture of gases so proportioned as to emit light which gives the impression of whiteness, operating at a relatively low pressure and at a high energy efficiency, with electrodes constructed in such a way that the combination provides a highly efficient white light possessing a long life.

When helium is employed as the path of a gaseous discharge in a tube provided with electrodes, the disappearance of the helium is ordinarily very rapid owing probably to its destructive action upon the cathode. The life of the device can be increased by employing helium at relatively high pressures as for example, 10 to 15 millimeters of mercury but the increased life secured thereby is not sufficient to meet the demands of a long life commercial luminous tube device and furthermore the consumption of energy per unit gas volume at such high pressures is so high as to materially lower the efficiency of the device as a light producing medium. On the other hand, when helium is employed at more efficient pressures such as in the neighborhood of 5 millimeters or less, the life of the device is inordinately short and may be as low as 30 to 50 hours. Furthermore, the color of helium even at low pressures is a tan color, and does not convey to the eye the impression of whiteness.

According to the present invention, the tan color of helium is bleached by the cooperative action of argon, the latter gas being employed in a proportion sufficient to carry out the said bleaching action, although the proportion of argon employed for this purpose is relatively small as compared with the proportion of helium. The proportion of argon necessary to effect a bleaching action is nevertheless much larger than that which would be required where the object is merely to lower the potential gradient of the gas mixture. For example, the proportions of helium and argon may be represented by 99.6 per cent of helium and 0.4 per cent of argon. Such a mixture under the influence of a suitable electric discharge is adapted to produce a white light. By the term white light as herein employed, is meant a light which conveys to the eye an impression similar to that which is conveyed when sunlight is reflected from a white surface such as the surface of white paper or white marble. The predominant color of argon is blue and its effect upon the tan helium color is analogous to the effect of "blueing" used by laundries to create the impression of whiteness on laundered articles. The importance of carefully proportioning the argon helium mixture will be evident when it is explained that a mixture of helium with argon in which the proportion of argon is greater than 0.6 per cent would be one in which the impression on the eye of the light emitted therefrom would be less white than that desired.

While the use of a mixture of helium and argon, carefully proportioned in the manner described has been found to be adapted to emit light of the desired character when subjected to an electric discharge, such a mixture would be ordinarily unfitted for commercial use inasmuch as the rapid disappearance of helium particularly at the low pressures such as 3 to 5 millimeters hereinabove mentioned, would result in commercial failure on account of short life of the device.

By employing electrodes suitably activated in combination with a helium argon mixture at pressures such as 3 to 5 millimeters and employing the helium and argon in the correct proportions as herein described, the present invention provides a device which possesses first, relatively high efficiency that is to say, a relatively small consumption of electrical energy per unit length of tube or unit volume of gas and a relatively high light emission for a given electrical energy consumption as compared with gaseous mixtures op-

erating at higher pressures, secondly, a long life notwithstanding the low pressures and consequently the relatively small amount of gas present, and thirdly, the capacity to emit a light which conveys to the eye, the impression of whiteness.

The activation of the electrodes or cathode may take place in several ways. It is to be observed in this connection that the electrode is so activated that it not only provides a long life by reducing the absorption of the helium, but also acts in such a manner as to preserve the proper balance of the ratio of argon to helium so that the color of the light emitted may be constant. The proportion of argon is very small with reference to that of helium, and although the helium tends to be absorbed much more rapidly than argon, the latter gas would ordinarily tend to disappear rapidly on account of its very small proportion. The present invention however, provides activating means whereby the balance between the very small proportion of argon and the large proportion of helium can be maintained so that the color of the light emitted by the mixture of helium and argon may be maintained at a more or less constant or quality value.

If direct current is employed, it is necessary to activate only the cathode whereas, since in the case of alternating current each electrode acts alternately as the cathode, it is necessary to activate both electrodes.

One method of providing the necessary treatment of the cathode to act in conjunction with the other elements of the combination comprises providing the cathode with a metal of the alkali group, such as sodium, potassium, lithium, cæsium and the like. For example, an iron, copper or nickel cathode coated or otherwise treated with metallic cæsium may be used. Instead of cæsium, potassium may be likewise employed and with an electrode so provided a tube life of about 340 hours may be attained.

In some cases, a hot cathode may be employed comprising a metallic filament, for example, adapted to be heated by an auxiliary electric current to a high temperature or incandescence. Under these circumstances emission of electrons from the heated cathode tends to guard the same from bombardment by positive ions of the gas such as helium and assists in lengthening the tube life and maintaining proper balance between the small proportion of argon and the very large proportion of helium.

It has been found however, that if the cathode is provided with suitable oxides or decomposition products thereof, that the life of the tube and the maintenance of suitable balance between the proportions of gases employed therein and consequently the maintenance of light of the desired quality is attained in a remarkable degree. By such means, herein, described, a tube life of three thousand hours or better may be secured, even though the gas pressure is of the order of 5 millimeters or less, and even though the composition of the gas is largely helium as described. This is to be contrasted with the much shorter life attained by using an alkali metal as hereinabove described. Furthermore, the balance between the very small proportion of argon present and the large proportion of helium is satisfactorily maintained.

For effecting activation of the cathode oxides of the electro-positive elements may be used, as for example, the oxides of the alkaline earth metals and, in some cases, the oxides of the rare earth metals. The oxides employed are deposited or coated on the cathode or electrodes in such a manner as to provide a permanent adherent coating. The oxides themselves may be employed for this purpose or may be generated by the thermolytic decomposition of suitable compounds.

The suboxides are particularly desirable. These may be generated by coating a refractory metallic electrode with an oxygen derivative as for example, a peroxide and decomposing the peroxide by means of heat in the presence of the refractory metal such as iron, nickel, copper and the like and thereby obtaining an activated residue. For example, an iron electrode may be coated with barium peroxide and then subjected to heat to bring about decomposition or reduction in order to form the reduced and activated coating or suboxide which will possess the stabilizing properties hereinabove described in conjunction with the helium-argon mixture as set forth.

The invention will be described in more detail by reference to the accompanying drawing in which

Figure 1 represents a tube provided with electrodes and adapted to contain a rare gas filling of the character described, and

Figure 2 presents a refractory metallic electrode provided with a suitably stabilized coating.

The tube 1 may be bent into any desired shape and is represented as a U-tube. It is provided with electrodes 2, the said electrodes being connected to a source of electric discharge current not shown adapted to activate the rare gas by electrical discharge and cause the emission of light.

The electrode 2 illustrated in greater detail in Figure 2 represents a cathode in the case where direct current is employed. Where alternating current is employed the electrodes at each end of the tube may be identical or the cathode may be constructed as herein described and a double anode used. The electrode 2 consists of a hollow metallic cylinder such as a nickel cylinder open at one end and provided on the inside with a suitable coating 3 as herein described.

The tube is provided with a mixture of helium and argon at a pressure of 3 to 5 millimeters, as for example 4 millimeters, measured in terms of mercury in the usual way. The proportion of argon in the mixture is such as to distinctly modify the helium color to the extent desired and to produce a light which conveys to the eye the impression of whiteness and consists of a combination of the helium and argon spectra. A proportion of argon which has been found suitable for this purpose is, as already stated, about four-tenths of one per cent. Since the total pressure in the tube is of the order of 3 to 5 millimeters, it will be noted that the quantity of argon is extremely small and it will also be noted that the invention provides a means for preventing the destruction or absorption of this extremely small quantity or proportion of argon and thereby maintaining a suitable balance of the ratio of argon to helium.

The electrodes 2 of the tube are connected through the lead wires 4 to a source of discharge potential, not shown, which may be a transformer adapted to deliver to the tube current of the order of magnitude of 25 milliamperes at a potential of 15,000 volts for a tube having a length of 17 feet and a diameter of 11 millimeters. The current supplied may be alternating current and in this event both electrodes may be of identical construction and composition and may

alternately act as a cathode and an anode.

The electrode or cathode 2 shown in Figure 2 consists of a nickel cylinder closed at one end. It is provided on the inside thereof with a coating of what is herein termed barium suboxide, this coating being formed, according to one method, by the thermolytic decomposition of barium peroxide in contact with the nickel cylinder.

In operation the electrodes, being connected to a suitable source of potential an electric discharge is passed through the gaseous column to produce positive column light and this discharge may be passed through for a period in excess of 2,000 hours as for example, 3,000 hours or more, the light during such period being successfully maintained at uniform intensity and quality.

It will thus be noted that the invention provides a new and improved gaseous discharge device, capable of providing for long periods a light which conveys to the eye the impression of whiteness and which is therefore an apparently white light or a pseudo-white light.

It is to be emphasized that the proportion of argon necessary to produce a light that is white within the definition herein set forth requires careful adjustment and in the specific example herein set forth should be less than six-tenths of one per cent, as for example four-tenths of one per cent. By white light is meant light that is apparently white as distinguished from light that is white in the sense that it has a well balanced spectrum such as sunlight.

In the attainment of light of the character herein defined as white, it is also to be noted that control of the pressure is of importance. When the helium-argon mixture is employed at pressures above 5 millimeters of mercury the color is not as convincingly white to the eye, as when the total gas pressure is below 5 millimeters, as measured in terms of mercury in the usual way and may even be distinctly yellow.

The proportion of argon to helium in combination with an adjustment of the total pressure is therefore one of the features of the present invention.

The advantages of the invention have been set forth in some detail and the preferred embodiments have been described. It is to be understood, however, that various changes may be made without departing from the invention or sacrificing any of the advantages enumerated, or any other advantageous results which may be attained by an application of the principles and facts set forth.

What is claimed is:—

1. A positive column gas discharge tube which when operated radiates positive column light that appears substantially white to the eye of an observer, the tube containing a principal filling of helium which, alone, has a characteristic tan-colored positive radiation, together with just enough argon to bleach the tan helium radiation, upon operation of the tube, and thereby produce an aggregate radiation that creates the visual impression of whiteness.

2. A positive column gas discharge tube which when operated radiates positive column light that appears substantially white to the eye of an observer, the tube containing a principal filling of helium together with less than one per cent of argon.

3. A positive column gas discharge tube which when operated radiates positive column light that appears substantially white to the eye of an observer, the tube containing a principal filling of helium together with approximately 0.4 per cent of argon.

4. A positive column gas discharge tube which when operated radiates positive column light that appears substantially white to the eye, the tube containing a principal filling of helium, together with less than one per cent of argon and a cold cathode comprising the thermolyzed decomposition product of an oxygen compound of an alkaline earth metal.

5. A positive column gas discharge tube which when operated radiates positive column light that appears substantially white to the eye of an observer, the tube containing a principal filling of helium having a pressure range at the ordinary temperature corresponding to an optimum potential drop through the positive column, together with less than one per cent of argon, and a cold cathode comprising the thermolyzed decomposition product of an oxygen derivative of an alkaline earth metal, the cooperation between the gas filling at the specified pressure range and the cathode providing a tube which when operated radiates light having the stated color characteristic throughout a period of useful commercial life.

6. A positive column gas discharge tube which when operated radiates positive column light that appears substantially white to the eye of an observer, the tube containing a principal filling of helium having a pressure range at the ordinary temperature corresponding to an optimum potential drop through the positive column, together with less than one percent of argon, and a cold cathode comprising the thermolyzed decomposition product of an oxygen derivative of barium, the cooperation between the gas filling at the specified pressure range and the cathode providing a tube which when operated radiates light having the stated color characteristic throughout a period of useful commercial life.

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