ELECTRIC LIGHTING EQUIPMENT

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Fig. 2.

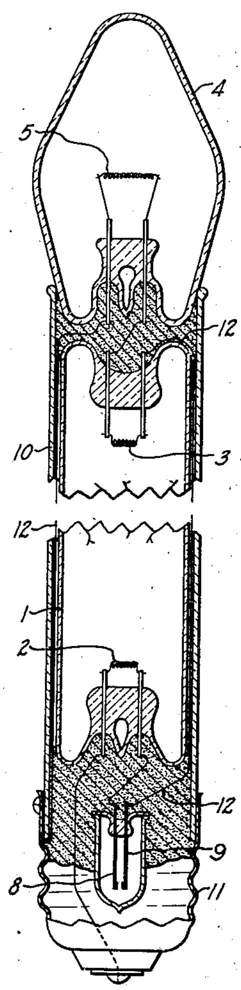


Fig. 3.

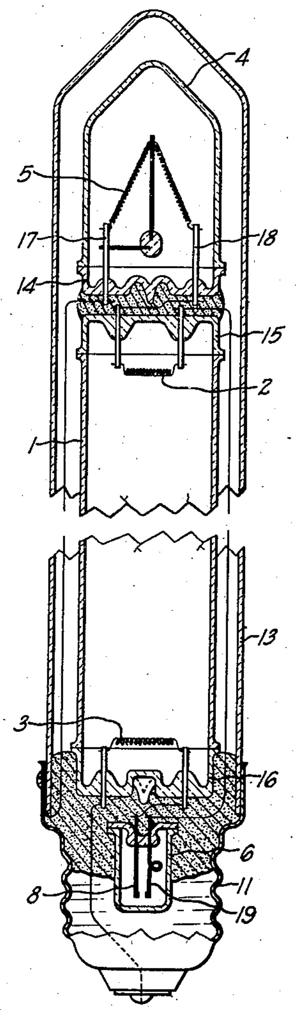


Fig. 4.

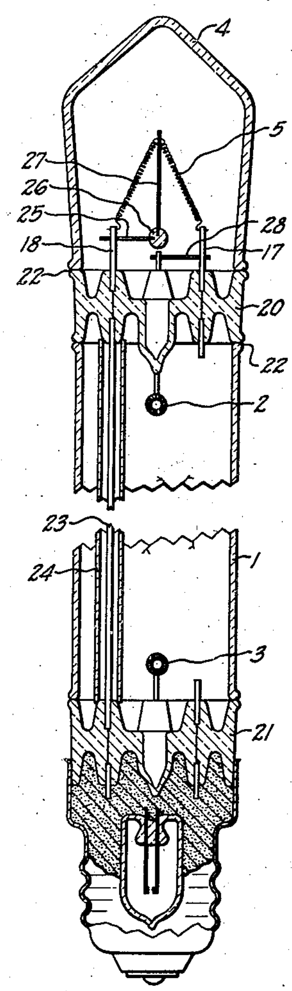
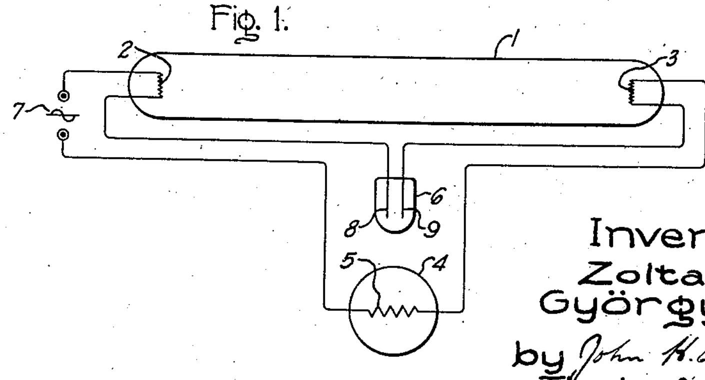


Fig. 1.



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ELECTRIC LIGHTING EQUIPMENT

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8 Claims. (Cl. 315—49)

The invention relates to an electric lighting equipment by which light of a desired composition, preferably resembling sunlight, is supplied at a high efficiency, and which is exempt to a high degree from the drawbacks of the various kinds of equipment proposed for this purpose earlier.

It is well known that the light of the artificial sources of light generally employed deviates more or less from white light, i. e., from the kind of light the color distribution of which is similar to that of sunlight. Thus, for instance, those sources of light in which the radiation of incandescent bodies, as for instance of electric incandescent lamps, is utilized emit relatively more red and yellow rays than blue ones, because the temperature of their incandescent body is lower than the surface temperature of the sun, and no such material is known as could be kept at sun temperature during any considerable length of time. It is true that the color distribution of the light of electric incandescent lamps can be altered at will by means of color filters, and that thus, for instance, an incandescent filament glowing in an atmosphere of rare gas and enclosed in a blue glass bulb will supply light similar to sunlight, but the economy of illumination will be reduced in a very high degree by the employment of the color filter.

The flow of light of an arc-light operating in mercury vapor contains a relatively high proportion of blue light, and it has therefore been proposed that the light emitted by a mercury vapor arc should be mixed with that emitted by a solid incandescent body. Thus, for instance, there are employed luminous electrodes or special incandescent lamps beside the mercury vapor lamp. As, however, the current characteristic of the mercury vapor lamp is negative, it is necessary to connect a choke-coil in series with this lamp; such a choke-coil is, on the one hand, expensive and, on the other hand, it takes up room, and finally, it produces a phase displacement between voltage and current in the alternating-current mains system, whereby the load-carrying capacity of the mains is influenced in a disadvantageous sense. In view hereof it has already been proposed to connect an incandescent lamp in series with the mercury vapor lamp. In this case, however, a difficulty is caused by the circumstance that the high-pressure mercury vapor lamp will during a period of a few, say of 5 to 15 minutes from the moment of lighting, burn at a lower terminal voltage than after having reached normal or equilibrium operating condition, which means that during the period following the moment of lighting the voltage drop along the filament of the incandescent lamp will be substantially higher than during the subsequent period of normal operating conditions. This fact exercises a very detrimental influence on the term of life of the incandescent lamp, whilst on the other hand, if the incandescent lamp is dimensioned so as not to be overloaded at the initial voltage, its utilization of light during ordinary operating conditions will be very poor. In addition hereto the light effect produced by mixing the light of the mercury vapor discharge lamp with the incandescent lamp is saddled with the particular drawback that it will under no circumstances enable the effect of the natural white color to be obtained, because the spectrum of the light of the mercury vapor lamp is not a continuous, but a line spectrum, and thus certain colors will always be missing from it, even though the direct sensation experienced by the human eye should be that of white light. Another drawback of this type of equipment is that it is only about a quarter of an hour after lighting that it begins to emit its full measure of light.

Moreover, it has already been proposed to employ mercury vapor lamps dimensioned in such a manner as to ensure that during their normal operation the discharge should energize the so-called resonance line situated in the ultra-violet spectrum of mercury and that this radiation, obtainable at a very high efficiency, should impinge on a fluorescent substance of such a kind as will, under the influence of the ultra-violet radiation, emit visible light. These substances supply a continuous spectrum and thus natural white light can be closely approximated by mixing various fluorescent substances the colors of fluorescence of which are different. Up to now, however, investigators have not been successful in producing a fluorescent substance of such a kind as would have supplied light possessing a continuous spectrum, and possessing sufficient intensity at the longest wave-lengths of visible light, and therefore the light supplied by such lamps will give a strange, cold impression and, particularly, it will not allow the natural colors of human faces and lips to present themselves with their proper effect. In addition hereto it is only by connecting a choke-coil or a leakage or reactance transformer in series with it that each of these lamps can be operated, this circumstance, accordingly, giving rise to the same drawbacks as have been described above in connection with high-pressure mercury vapor lamps.

We found that the light of such a mercury vapor lamp equipped with incandescent cathodes and utilizing the resonance line of mercury by energizing fluorescent substances can be mixed advantageously with the light of a gas-filled incandescent lamp, particularly of an incandescent lamp filled with krypton gas. In order to enable this mixed light to be produced not only with a satisfactory color effect, but also in a simple manner, and without the drawbacks of the circuit arrangements mentioned above, the lighting equipment according to the invention provides for the connection in series of the filament of the incandescent lamp, of the incandescent cathodes arranged for being heated by means of current of the discharge tube, and of a circuit-breaker equipment of such a kind as, by breaking the circuit of the conductor short-circuiting the path of discharge, will enable the discharge to start and will at the same time preferably also open the circuit of the current flowing through the incandescent cathodes. In this case the current flows through the discharge space and through the incandescent filament connected in series with the latter. The circuit-breaking apparatus is preferably arranged in the conductor connecting the two incandescent electrodes of the discharge tube, and is of a special design as described below in order to render the operation of the lighting equipment automatic.

The apparatus according to the invention and its method of operation will be described in a few examples with reference to the annexed drawing in which

Fig. 1 is a diagram of connection of the apparatus, whilst

Figs. 2 to 4 are axial longitudinal sections of the candle-shaped lamps constituting the equipment.

Into the closed tubular glass bulb 1 of the discharge tube of the equipment shown on Fig. 1 there are sealed the incandescent electrodes 2 and 3 both terminals of which are led out through the wall of the tube by means of metal conductors so as to enable the electrodes to be heated by means of current passed through them. The incandescent electrodes 2 and 3 are preferably constituted by coiled tungsten wires coated with a substance possessing a high capacity of emission, e. g., with some earth alkali metal oxide. The two incandescent electrodes are connected in series with each other, with the filament 5 of the incandescent lamp 4, and with the circuit breaker apparatus 6 which serves as a starting switch or thermal controller for current flow to the electrodes. The circuit-breaker 6 breaks the circuit of the conductor on that part of the latter which in the closed condition of the circuit-breaker short-circuits the path of discharge between the electrodes 3 and 4. When putting the equipment in circuit, the current of the source of alternating-current 7 flows through the incandescent electrode 2, the circuit breaker 6 which is an open condition, the incandescent electrode 3 and the filament 5 of the incandescent lamp 4, this being possible owing to the fact that the circuit-breaker 6 is designed in such a manner as to allow a current of low intensity to pass through it even though its contactors 8 and 9 are not in mutual contact. Under the thermal effect of the current flowing through them, the contactors of the circuit breaker equipment will after a certain time come into mutual contact. For this purpose the circuit-breaker apparatus is preferably designed in such a manner that at least one of the metal plates 8 and 9 constituting or carrying the contactors should be constructed by the assembly of two metal plates possessing different coefficients of thermal expansion, so that it should alter its shape when heated. As soon as the contactors have come into contact, a current of high intensity will flow through the circuit, which current will within a short time heat the electrodes 2 and 3 to their operating temperature. During this time, on the other hand, the circuit-breaker gets into such a condition of operation as will cause it to break the circuit after the lapse of a certain time. If the dimensions of the apparatus are chosen in a suitable manner, this breaking of the circuit will take place at a time when the incandescent electrodes 2 and 3 will, under the influence of the current flowing through them, already have reached the condition of incandescence, so that when the circuit is broken a discharge will be set up between the two electrodes in the low-pressure rare gas filling the glass tube 1. The small quantity of mercury vapor likewise placed into the glass tube 1 will become energized within a short time and the discharge tube, the semitransparent glass wall of which is coated with a fluorescent substance and/or contains such substances, begins to emit light. The discharge tube is, in a manner per se known, dimensioned so as to supply, in the visible spectrum, in the form of an emission possessing a line spectrum, not more than 10 per cent of its total emission, whilst the rest of the emission is situated in the ultra-violet part of the spectrum and causes the fluorescent substance to emit light. Within a short time, for instance within one or two seconds, the discharge tube will reach its normal condition of operation. In consequence hereof it is the electrodes 2 and 3 which are connected in series with the incandescent lamp during these first few seconds of the period of lighting the tube, and these electrodes can be dimensioned so as to ensure that the aggregate voltage drop set up in them should be equal to the voltage drop set up between the two terminal points of the discharge taking place in the apparatus in its regular operative condition, i. e., between the terminals of the discharge tube. This will also enable the overloading of the incandescent lamp during the initial period to be avoided, although, as already mentioned, the importance of such overloading is very slight, as the period of lighting the tube is very short. Another method for avoiding this overloading is to insert an additional special ohmic resistance into the conductor connecting the electrodes 2 and 3 with the circuit-breaker, which ohmic resistance, being situated in a conductor branch through which no current is passing after the discharge has started, will not consume any current during the normal operation of the equipment.

In the case of the lighting equipment according to Fig. 2, the incandescent lamp is mounted on one end of the discharge tube, whereas by its other end the discharge tube joins on to an incandescent lamp cap. In the case of this equipment the inner surface of the glass wall of the discharge tube 1 is coated with a powder of magnesium tungstate. The interior of the discharge tube contains argon gas having a pressure of 5 mm. mercury column, as well as a quantity of about 30 milligrams of mercury. The electrodes 2 and 3 are so dimensioned as to have a voltage drop of 8 volts. The glass wall of the incandescent lamp 4 is made of opal glass and the tungsten incandescent filament 5 arranged in it, which is surrounded by a gas filling consisting of a mixture of 90 per cent of krypton and 10 per cent of nitrogen, is dimensioned in such a manner as to ensure that with a voltage drop of 80 volts the term of life of the lamp should amount to one thousand hours. The incandescent lamp is fixed on one end of the glass tube 10, which glass tube also contains the discharge tube 1. This glass tube 10 is preferably frosted on its internal surface or made of opal glass. Its other end is fixed into the lamp cap 11. It is in the interior of this same cap that the circuit-breaking device 6 is located, the design and method of operation of which may, for example, be the following: In the cold nonoperative condition the bi-metallic electrode elements 8 and 9 arranged symmetrically are not in contact with each other and accordingly a voltage of 110 volts exists between the two elements at the moment of putting the apparatus in circuit. Under the action of this voltage a glow-light discharge will start between the contactor elements now serving as electrodes, which discharge will pass through the rare gas of low pressure contained in the glass vessel 6, and will heat the elements so that they will be deflected and their contactors will come into mutual contact. At this moment a current will flow through them as well as through the two electrodes and through the filament of the incandescent lamp connected in series with them, so that the incandescent lamp will begin to emit light. At the same time the two incandescent electrodes will also become heated to the temperature necessary for emission. In the meantime the two bimetals of the circuit-breaker will assume the temperature of the gas surrounding them, and being thus cooled down, will become straightened out again and will accordingly break the circuit. At this moment the discharge between the electrodes 2 and 3 in the path of discharge situated in parallel to the circuit-breaker will start and it is now only the difference of potential of about 30 volts corresponding to the voltage drop of the discharge that exists between the bimetals of the circuit-breaker. This is no longer sufficient for starting the glow discharge, so that during the further operation of the lighting equipment the circuit breaker will not function. It is in the interior of the glass tube 10, between its wall and that of the glass tube 1, that the current leads by which the filament of the incandescent lamp, the two electrodes and the circuit-breaker are mutually connected and which have been marked 12 on the figure are located.

The lamp according to the above example will during its operation absorb 110 volts, whereof 80 volts represents the share of the incandescent lamp and 30 volts that of the discharge tube. As the lamp will operate in a reliable manner without any choke-coil, and its construction is symmetrical, it can be screwed into any lamp-holder connected into any 110 volt direct or alternating-current mains. The magnesium tungstate placed on the glass wall of the discharge tube will emit light of a bluish color and this light together with the light of the krypton-filled incandescent lamp will give an agreeable white effect greatly resembling that of sunlight, and as the spectrum of the light emitted is continuous, it will show the colors of the objects illuminated in their proper hues. In addition hereto the lamp constructed in the manner shown on the drawing also possesses the advantage that neither the incandescent lamp, nor the discharge tube is situated in the path of the maximum light flow of the other source of light, so that they will not screen each other's light.

If it is desired to use the lamp according to the example on a 110-volt direct-current mains system, provision has to be made for ensuring that the discharge should start safely. For this purpose it is possible in a manner per se known to provide a starting electrode on the discharge tube which electrode is connected in an electrically conductive manner with the anode of the discharge and which reaches into the vicinity of the cathode of the discharge. For this purpose it will be preferable to provide a tube-lighting electrode in the vicinity of each of its two electrodes, thus enabling the lamp to be used with both polarities.

Fig. 3 represents another embodiment of the equipment according to the invention, which is designed for a mains system of 220 volts direct current or alternating current. In this figure the lighting equipment consisting of a structural combination of the discharge tube 1, the incandescent lamp 4 and the circuit-breaker 6 is arranged inside an external bulb 13 closed on its end adjacent to the incandescent lamp, whilst the Edison cap 11 is fixed on its open end. From the point of view of its method of operation this lamp hardly differs from the lamp described in the second figure; it is only the voltage conditions which are, of course, different. Notably, in the case of this type of apparatus the voltage drop of the discharge tube is 50 volts, whereas that of the incandescent lamp connected in series with it is 170 volts. The incandescent lamp is constructed without any supporting tube, notably, the internal leads (electrodes) 17 and 18 of the incandescent filament 5 are hermetically sealed through the disc 14 made of pressed glass. It is to this disc that the bulb 4 of the incandescent lamp is sealed. The glass discs 15 and 16 made of pressed glass are arranged on the two ends of the discharge tube 1 and it is through these discs that the pair of current leads of each of the incandescent electrodes 2 and 3 passes. The method of operation of the circuit-breaker apparatus is identical with the one described in connection with Fig. 2; it is only its design that differs in so far that it is only the electrode 8 which is made of bimetal sheet, whereas the molybdenum wire 19 facing it is indeed constructed resiliently, but will not alter its shape in any appreciable extent under the effect of heating. In the case of this example also the tube-lighting voltage of the glow light discharge tubes constituted by the circuit-breaker apparatus 6 is higher than the service terminal voltage of the mercury vapor discharge tube, and amounts accordingly, for instance, to 110–200 volts. The inner surface of the glass tube 1 is coated with a mixture of magnesium tungstate and of zinc-beryllium silicate, which in itself supplies light of white color. This light will, mixed with the light of the krypton-filled incandescent lamp, supply a pleasant warm mixed light. The external bulb 13 is preferably made of opal glass.

Fig. 4 represents a further embodiment of the lighting equipment according to the invention, which can likewise be employed on a mains system having a voltage of 220 volts. Only a part of the internal connecting conductors is shown on the figure.

The glass wall 1 of the discharge tube is made of semi-transparent glass containing a fluorescent substance. The two ends of the tube are closed by closing bodies 20 and 21 made of pressed glass to which the glass tube is fused at the points of fitting 22. The bulb 4 of the incandescent lamp is made of semi-transparent opal glass and likewise fused to the glass body 20. The current-lead wire 17 of the incandescent filament 5, which wire is embedded into the glass, but does not project through it, stands in electrically conductive connection through the nickel wire 28 with the incandescent electrode 2 the other terminal of which is connected by means of a conductor situated in the gas space of the bulb 4 and not shown on the drawing with the current lead 29 projecting through the base 20, to which current lead a conductor surrounded by an insulating glass tube joins on. These members, which are substantially identical with the members 23 and 24 described below, have not been shown on the drawing. The lead 18 of the incandescent filament is connected by means of the insulated wire 23 with the incandescent electrode 3. The wire 23 is led along the interior of the discharge tube and is insulated from the path of discharge by the glass tube 24. It is to the current lead 18 of the incandescent lamp that the supporting wire 25 is fixed and to this wire there is fixed by means of the glass bead 26 the support 27 consisting in a known manner of thin molybdenum wire.

We would remark that the invention is not limited to the examples described with reference to the drawing, as for instance it is also possible for a gas discharge tube of a kind differing from the one described above and for the incandescent lamp to constitute separate units, whilst the circuit breaker, which may if desired also be installed into the discharge tube, may also be constructed in such a manner that it is in the non-operative condition that its contactors are closed, whereas under the thermal effect of the incandescent cathode they open, etc., all this being possible without deviating thereby from the invention as characterized by the claims following below.

What we claim is:

1. A lamp unit comprising a gaseous electric discharge lamp having a sealed tubular envelope with electrodes therein, a base at one end of said discharge lamp, and an incandescent lamp comprising a sealed bulb containing a filament and secured to the other end of said discharge lamp.

2. A lamp unit comprising a gaseous electric discharge lamp having a sealed tubular envelope with electrodes therein, a base at one end of said discharge lamp, and an incandescent lamp comprising a sealed bulb containing a filament and secured to the other end of said discharge lamp, said filament being electrically connected in series with the discharge gap between the electrodes of said discharge lamp and serving as a ballast therefor.

3. A lamp unit comprising a gaseous electric discharge lamp having a sealed tubular envelope with electrodes therein, a base at one end of said discharge lamp, an incandescent lamp comprising a sealed bulb containing a filament and secured to the other end of said discharge lamp, and a starting switch for said discharge lamp enclosed in said base.

4. A lamp unit comprising a low-pressure mercury-vapor electric discharge lamp having a sealed tubular envelope with electrodes therein and containing a fluorescent material responsive to the ultraviolet radiation produced by the discharge, a base at one end of said discharge lamp, and an incandescent lamp comprising a sealed bulb containing a filament and secured to the other end of said discharge lamp, the said fluorescent material being selected to produce, in combination with the light emitted by said filament, a white light.

5. A self-contained lamp unit comprising a gaseous electric discharge lamp having a sealed tubular envelope with electrodes therein, a base at one end of said discharge lamp having a pair of contacts, an incandescent lamp comprising a sealed bulb containing a filament and secured to the other end of said discharge lamp, means connecting said base contacts to said electrodes and filament so that said filament is in series with the discharge gap between said electrodes and serves as a ballast therefor, and a starting switch for said discharge lamp enclosed in said base, said switch being electrically connected across said electrodes to shunt the gap therebetween during starting and cause a preheating current to flow through the electrodes and being automatically operable to break said shunt and permit starting of the discharge between said electrodes.

6. A lamp unit comprising a gaseous electric discharge lamp having a sealed tubular envelope with electrodes therein, a base at one end of said discharge lamp, and an incandescent lamp comprising a sealed bulb containing a filament and secured to the other end of said discharge lamp, the said discharge lamp envelope and incandescent lamp bulb having a common pressed glass disc-like wall.

7. An imitation candle lamp unit comprising a tubular glass outer jacket, a gaseous electric discharge lamp having a sealed tubular envelope with electrodes therein, said discharge lamp being secured within said jacket, a base secured to one end of said jacket, and an incandescent lamp comprising a sealed bulb containing a filament and secured at one end to the other end of said jacket.

8. An electric discharge lamp having an envelope and electrodes in said envelope and an exterior base on the envelope, a thermal controller for current flow to said electrodes, said thermal controller being situated within said base and between said base and envelope, and said base having contact terminals connected in series to the thermal controller and one electrode.

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