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MIXED-LIGHT ELECTRIC LAMP

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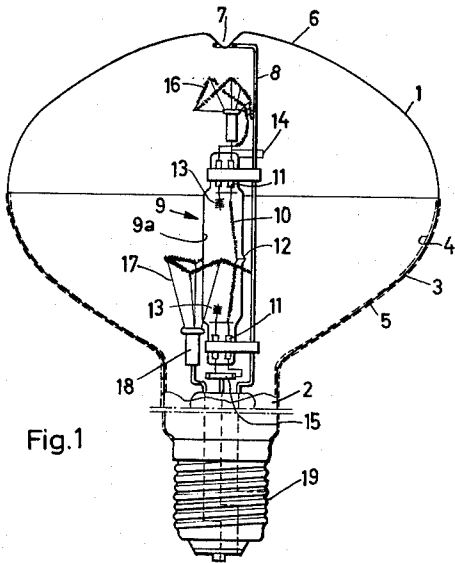


Fig. 1

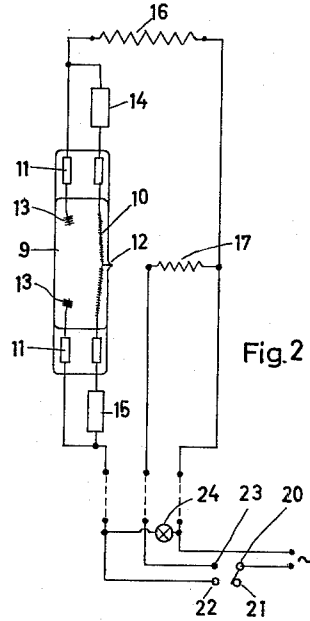


Fig. 2

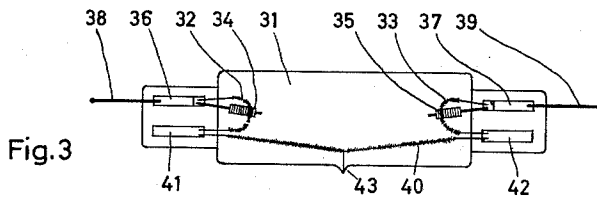


Fig. 3

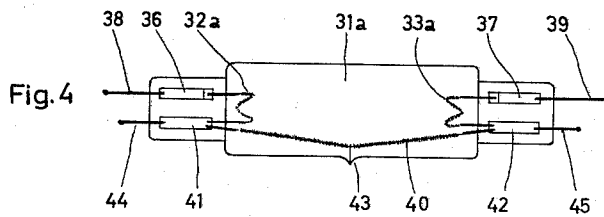


Fig. 4

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MIXED-LIGHT ELECTRIC LAMP

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This invention relates to electric lamps, and more particularly, to a mixed-light electric lamp which may be used either as mixed-light lamp or as a lamp for medical purposes, preferably with ultraviolet and/or infrared radiation.

Heretofore, in order to limit the current of the discharge within the outer bulb of conventional mixed-light electric lamps, preferably around the longitudinal axis of the discharge container, an incandescent filament is connected in series with the high pressure discharge lamp. This incandescent filament becomes incandescent during the operation of the discharge lamp, thereby producing a radiation which contains red or infrared radiation in addition to the shorter wave or ultraviolet radiation produced by the discharge lamp. With such conventional mixed-light electric lamp it is not possible to operate the incandescent filament alone without operating the discharge lamp or vice versa.

Furthermore, it is also known in the art (when the conventional mixed-light electric lamp is utilized to produce only infrared radiation) to provide an additional filament in series with the ballast of the electric discharge lamp, which additional filament is rated in such a manner that when line voltage is applied, the current carried by the incandescent filament and the additional filament is limited to provide a suitable lamp life. Since the incandescent filament is used as a series resistance in both ultraviolet operation and in infrared operation, its life will be much shorter than that of the additional filament which is operated to produce infrared radiation only.

Such prior art mixed-light electric lamps which are connected in parallel to a voltage supply (having an incandescent filament in series with the discharge lamp) are not practical because, if the line voltage drops or fails, the incandescent filament immediately becomes incandescent again when the voltage returns to its normal value or is reapplied to the mixed-light electric lamp. However, the high vapor pressure within the discharge lamp is maintained by the almost continuous heating-up by the incandescent filament, and as a result the starting voltage of such discharge lamp is greater than the voltage supply. The discharge lamp can be restarted only after having disconnected the incandescent filament and after permitting the discharge lamp to cool down for about three minutes.

It is the general object of the present invention to provide a mixed-light electric lamp which avoids and overcomes the above-mentioned difficulties of and objections to prior art mixed-light electric lamps.

It is another object of the invention to provide a mixed-light electric lamp having improved starting characteristics.

It is a further object of the present invention to provide a mixed-light electric lamp having improved restarting characteristics after a short-time failure of the voltage supply.

It is a still further object of the present invention to provide a mixed-light electric lamp which is adapted for simultaneous or separate operation of the discharge lamp and the incandescent filament.

The foregoing objects of the present invention, and

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other objects which will become apparent as the description proceeds, are achieved by providing a mixed-light electric lamp having a common outer envelope which contains a high-pressure discharge lamp provided with a fill pressure of less than 2 atmospheres and an incandescent filament. According to the invention the discharge lamp envelope contains two main electrodes and a starting filament of suitable rating and arrangement connected in parallel with the main electrodes and disposed in such a manner as to prevent cross discharges between the starting filament and the main electrodes; and so that starting or restarting, respectively, of the discharge lamp is possible at once and after any desired switch interval.

For a better understanding of this invention reference may be had to the following drawings wherein like numerals of reference indicate similar parts throughout the several views and wherein:

FIG. 1 is a side-elevational view of the mixed-light electric lamp of the present invention, with a portion of the reflector coating omitted to show the details thereof.

FIG. 2 is a wiring diagram for the mixed-light electric lamp shown in FIG. 1.

FIGS. 3 and 4 are side-elevational views of alternative embodiments of discharge lamps having other ratings or starting filament arrangements, which discharge lamps may be used within the outer envelope of the mixed-light electric lamp of the invention.

With specific reference to the form of the present invention shown in the drawings and referring particularly to FIG. 1, an outer envelope 1 of a mixed-light electric lamp of the present invention is formed of glass which is transparent to ultraviolet light. In order to prevent any damage by short-wave radiation the ultraviolet transparency of the envelope glass is chosen so that the short-wave radiation lying below 300 mμ is filtered off to a large extent. The outer envelope 1 has a neck portion 2 with an adjacent paraboloid-shaped reflector portion 3 serving as a reflector, which reflector portion 3 is provided with an inner reflector coating 4 deposited thereon as by vaporization. The inner reflector coating 4 may be aluminum which has a high reflecting power in the ultraviolet range. The neck portion 2 and the reflector portion 3 are coated externally with a protective layer 5 which is impervious to light and which may be enamel lacquer, aluminum or the like.

A spherical bowl portion 6 through which the rays are emitted is connected to paraboloid-shaped reflector portion 3. In order to prevent any glare during radiation this bowl portion 6 is coated on its inner surface with a frosting. Furthermore, the outer envelope 1, or at least its bowl portion 6, may be provided with colored inner or outer coatings, or such bowl portion 6 may be formed of colored glass. On the top of the bowl portion 6 an indentation 7 is provided, which indentation 7 projects into the inside of the outer envelope 1, and has affixed thereto a support wire 8 carrying the mount. The other end of the support wire 8 is fastened in the stem. An elongated ultraviolet radiator, such as a high-pressure discharge lamp 9 is attached to the support wire 8 by means of two clips so that the axis of the discharge lamp 9 coincides with the axis of the outer envelope 1. The discharge lamp 9 is encircled adjacent its mid-portion by an annular infrared radiator, such as the incandescent filament 17. Both the discharge lamp 9 and the incandescent filament 17 are arranged within the outer envelope 1 in such a manner that their light centers lie on the outer envelope axis between the focus of the reflector portion 3 and bowl portion 6. Although the light-emitting bowl portion 6 of the outer envelope 1 has a diameter of about 170 mm., a uniformly illuminated circular plane is provided at a dis-

tance of 1 m. therefrom and having a diameter of about 100 cm.

The high-pressure discharge lamp 9 consists of a quartz or other ultraviolet transparent high-temperature glass envelope 9a. Within the high-pressure discharge envelope 9a two conventional electrodes 13 are mounted, which electrodes 13 may be covered with an electron emissive coating of alkaline earth oxides thereby reducing the electron work function of such electrodes 13. The discharge envelope 9a is filled with a basic rare gas fill, such as neon or argon, at a pressure of about 200 mm. Hg and provided with about 5 to 50 mg. of mercury, which mercury is operable to provide an operating pressure within the discharge envelope 9a of about one atmosphere or more. Besides mercury other metals, such as cadmium, zinc, and calcium, may be utilized.

A starting filament 10 consisting of a single or multiple coiled tungsten wire is connected in parallel to the discharge path within the discharge envelope 9a and extends adjacent the electrodes 13 the length of such discharge path. Molybdenum foil portions 11 of the lead wires for the starting filament 10 extend through vacuum tight seals at the ends of the discharge envelope 9a. The starting filament 10 is also supported at 12 in the middle of the discharge envelope 9a.

Outside the discharge envelope 9a the starting filament 10 is connected by starting resistors or semi-conductor resistors 14, 15 with lead wires for the electrodes 13. The semi-conductor resistors 14, 15 are arranged within the outer envelope 1 in a heat conducting connection with the discharge envelope 9a. The semi-conductor resistors 14, 15 have a negative resistance-temperature characteristic. In cold condition their resistance is high, as required, because when such semi-conductor resistors 14, 15 are connected to the voltage supply, the entire line voltage is applied to the starting filament 10. After heating their resistance is low. The ratio of the cold resistance of such semi-conductor resistors 14, 15 to their hot resistance is about 100:1 and such semi-conductor resistors 14, 15 because of their negative voltage characteristics reach a temperature of about 450° C. when heated. The resistance of these semi-conductor resistors 14, 15 with negative voltage characteristics amounts, for instance, in the cold condition to about 3000 ohms, whereas such resistance amounts to about 30 ohms only at 450° C. As a result the desired starting coil current is automatically provided.

For the purpose of limiting the current in the discharge arc within the discharge lamp 9, a series resistor 16, which consists in the given example of a tungsten coiled coil is provided. This series resistor 16 is carried by a bridge of hardened glass and molybdenum support wires between the light-emitting bowl portion 6 and the quartz discharge envelope 9a. Such series resistor 16 is constructed in such a manner that it emits infrared radiation during ultraviolet operation of the discharge lamp 9, thereby producing a mixed ultraviolet and infrared radiation. The series resistor 16 and high-pressure discharge lamp 9, have a power consumption of about 450 watts during operation thereof.

The separately connectable infrared radiator or incandescent filament 17 is also constructed for a wattage of 450 watts. Such incandescent filament 17 consists of a single or multiple coiled tungsten wire which is arranged annularly around the middle of the discharge envelope 9a. The outer envelope 1 is filled with a protective gas, such as nitrogen or a mixture of 80% of argon and 20% of nitrogen at a filling pressure of about 650 mm. Hg.

The outer envelope 1 is sealed-off by a reentrant type stem containing three current inleads and an exhaust tube. In the usual manner a base 19 is cemented to the neck portion 2 of the outer envelope 1.

The mixed-light electric lamp of the present invention is mounted in a socket (not shown) on a stand (not shown) of the usual construction. As shown in FIG. 2

the "operating" circuit for the mixed-light electric lamp is provided with a switch 20, the movable contact 21 of which switch 20 is shown in its "open" position wherein the electric lamp is deenergized. Connection of the ultraviolet radiator or discharge lamp 9 is made across contact 22 and connection of the infrared radiator or incandescent filament 17 is made across contact 23.

Owing to the fact that the bowl portion 6 of the electric lamp is frosted in the direction of emission and may be colored, if desired, the user of the electric lamp cannot see which radiator is in operation. In order to prevent a harmful dosage of ultraviolet radiation, the stand (not shown) is, suitably provided with warning or switching devices, which warning devices may consist of one or several, if desired, differently colored glow discharge lamps 24 (FIG. 2).

To provide protection against harmful radiation, a short-time switch clock (not shown) may be provided in the "operating" circuit of the ultraviolet radiator, or discharge lamps.

The electric lamp of the invention makes it possible (as distinguished from conventional radiation lamps used hitherto) for it to be used alternatively as an ultraviolet and an infrared radiator. Such electric lamp has the special advantage namely that immediately after a longer infrared radiation treatment a short ultraviolet radiation treatment may be applied to the patient.

If the mixed-light electric lamp should be used for lighting purposes it may be desirable to connect the incandescent filament 17 and the high-pressure discharge lamp simultaneously or separately.

The starting filament 10 of the high-pressure discharge lamp (which is connected by the semi-conductor resistors 14, 15 with negative voltage characteristics across the electrodes 13) may be a multiple coil, e.g. a coiled coil or a triple coil. Such starting filament 10 is rated for a voltage of more than 100% (preferably more than 150%) of the lamp operating voltage and for a current capacity of about 2 to 30% (preferably 10 to 20%) of the rated current and for an efficiency between 3 and 15 lm./w. (preferably between 5 and 8 lm./w.). These semi-conductor resistors 14, 15 with negative voltage characteristics should be rated so that they produce the required starting current in either cold or hot condition. Such semi-conductor resistors 14, 15 with negative voltage characteristics are rated in such a manner that the voltage drop in said semi-conductor resistors 14, 15 (in hot condition) lies in the range between 3:1 to 300:1. In high-pressure discharge lamps operated at line voltage of about 220 volts and with an operating voltage of about 80 volts, it is desirable to rate the starting filament 10 for a voltage of about 180 volts; and for a coil current of about 20% of the rated current. The ratio of the resistance of said semi-conductor resistors 14, 15 in cold condition to that in hot condition is about 100:1.

Alternative Embodiments

FIG. 3 shows a high-pressure discharge lamp 31 for a mixed-light electric lamp, which discharge lamp 31 is provided at each end with coiled electrodes 32, 33 and solid electrodes 34, 35. One end of each of the heating coils or coiled electrodes 32, 33 and one core wire of each of the main electrodes or solid electrodes 34, 35 are connected to the lead wires 38, 39 by means of foil portions 36, 37 sealed in the end portions of the discharge lamp 31. The other end of each of the coiled electrodes 32, 33 is connected to one end of a starting filament 40 by means of a common foil portion 41, 42. The starting filament 40 is attached to the envelope wall at 43 adjacent its middle. By means of this coil and electrode arrangement the starting filament 40 is disposed in series with the coiled electrodes 32, 33 and is connected to the lead wires 38, 39. The solid electrodes 34, 35 are also connected directly to the lead wires 38, 39 and project into the discharge path beyond the coiled electrodes 32, 33. When

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the discharge is initiated, a gaseous discharge appends to the starting filament 40 by connection of such starting filament 40 to the line voltage, which line voltage is reduced by a voltage drop of about 10% in both the coiled electrodes 32, 33. At this time the total lamp current flows through the low-ohmic coiled electrodes 32, 33 which coiled electrodes 32, 33 reach incandescence and thereby have a resistance which is ten times their normal resistance value. The coiled electrodes 32, 33 then take over the discharge and, consequently, the total lamp current flows therethrough until the solid electrodes 34, 35 are sufficiently heated so that such solid electrodes 34, 35 take over the discharge. The discharge lamp current no longer passes through the coiled electrodes 32, 33 and as a result they cool down, again becoming a low-ohmic resistance and thereby preventing any formation of additional arcs from the solid electrodes 34, 35 to the starting filament 40.

A high-pressure discharge lamp 31 for a mercury mixed-light electric lamp of the 500 watt type operates at a line voltage of 220 volts with an operating nominal current of about 2.35 amperes. The voltage drop in each of the coiled electrodes 32, 33 is between 2-20% (preferably about 5%) thus making a total voltage drop of about 22 volts. The starting filament 40 is, accordingly, designed for operation at about 200 volts.

According to the embodiment of the present invention (shown in FIG. 3) the starting filament 40 in series with coiled electrodes 32, 33 is connected with the lead wires 38, 39 and is rated for a line voltage reduced by the voltage drop on the coiled electrodes 32, 33. The low-ohmic coiled electrodes 32, 33 with positive temperature resistance coefficient is so rated that they can take up momentarily the entire lamp current. The starting filament 40 is connected in series with the coiled electrodes 32, 33 which act as preheating coils for the stronger solid electrodes 34, 35 which solid electrodes 34, 35 are in parallel with the starting filament 40 and the coiled electrodes 32, 33 and project preferably beyond the coiled electrodes 32, 33 at least partly into the discharge path.

FIG. 4 shows a high-pressure discharge lamp 31a for a mixed-light electric lamp on the ends of which discharge lamp 31a the coiled electrodes 32a, 33a are operable as directly heated or indirectly heated main electrodes. One end of each of the coiled electrodes 32a, 33a is (as in the case of the discharge lamp 31 shown in FIG. 3) connected to lead wires 38, 39 by means of foil portions 36, 37. The other end of each of the coiled electrodes 32a, 33a is connected to one end of the starting filament 40 by means of common foil portions 41, 42, which foil portions 41, 42 are connected to lead wires 44, 45. Across the lead wires 38, 44 and lead wires 39, 45 a suitable voltage may be applied to cause direct heating of the coiled electrodes 32a, 33a. As shown in FIG. 4 the starting filament 40 is attached at 43 to the envelope wall. Starting of the discharge lamp 31a takes place in a manner similar to that employed for the discharge lamp 31 shown in FIG. 3. It will be noted that the solid electrodes, however, are omitted in the discharge lamp 31a and, as in the case of fluorescent lamps, only directly-heated or indirectly-heated coiled-coil or triple coiled electrodes provided with an emissive coating are used, for the coiled electrodes 32, 33 in the discharge lamp 31a. The coiled electrodes 32, 33 shown in FIG. 3 are operable to withstand the entire lamp current only for a short time. The coiled electrodes 32a, 33a (shown in FIG. 4) are adapted to sustain the entire lamp current during continuous operation. The starting filament 40 for the discharge lamp 31a is similar to that shown in FIG. 3. Because special series resistors are used in the discharge lamp 31a shown in FIG. 4, the discharge arc burns quietly and the cost of the manufacture of such discharge lamp 31a is lower.

In the embodiment of the present invention (shown

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in FIG. 4), the coiled electrodes 32a, 33a function as self-heating or separately heated main electrodes and are also connected in series with the starting filament 40. In this latter case the coiled electrodes 32a, 33a are, suitably, provided with an emissive coating.

In all of the above embodiments (FIGS. 3 and 4) the coiled electrodes 32, 33, 32a, 33a are rated in such a manner that a voltage drop of 2-20% of line voltage occurs in each of them at nominal current. The starting filament 40 is rated for an efficiency of 3-15 lm./w. (preferably 5-8 lm./w.) and for a coil current of about 5 to 30% (preferably 10-20%) of the lamp current.

A special advantage of using a high-pressure discharge lamp with starting filament 10, 40 is that the starting of the discharge lamp takes place even if the discharge lamp contains (in addition to mercury) a basic rare gas fill having a higher pressure than usual. Generally to facilitate starting, a high-pressure mercury discharge lamp is provided with a basic rare gas fill of argon, neon or the like or of mixtures of different rare gases having a fill pressure of 25 mm. Hg. In case of discharge lamps having a starting filament 10, 40 this pressure may be increased up to 1200 mm. Hg. Preferably, a rare gas fill pressure of 100 to 300 mm. Hg is chosen.

By means of this high fill pressure the time of heating up the high-pressure mercury discharge lamp (i.e. the time between connection of the lamp or starting of the glow discharge, respectively, and that time at which the mercury is completely vaporized whereby normal operating condition of the lamp is obtained) is very much shortened. In the case of mixed-light electric lamps immediately after connecting the lamps to line voltage, the desired ratio between the ultraviolet radiation of the high-pressure mercury discharge lamp and the infrared radiation of the incandescent filament is obtained.

If a radiation treatment is first applied with the ultraviolet and infrared radiation lamp, then an ultraviolet radiation should, thereupon, be made in corresponding dosage. Such procedure is only possible if the heating-up period of the ultraviolet radiator is kept as short as possible.

The principles of the mixed-light electric lamp and its associated "operating" circuit as described in the present invention are, for instance, very suitable for high-pressure metal-vapour lamps with or without an inert gas fill having a fill pressure of 10 to 700 mm. Hg (preferably about 100 to 300 mm. Hg) and for high-pressure rare-gas lamps having a fill pressure of 0.1 to 2 atmospheres, such as mercury mixed-light lamps, high-pressure mercury vapor lamps and xenon lamps for medium and low voltage operation. If several mixed-light electric lamps of the present invention are connected in series with the proper corresponding line voltage, connections and the proper starting resistor or resistors with negative voltage characteristics, as described in this invention, reliable starting is guaranteed for such series operation.

It will be apparent to those skilled in the art that the objects of this invention have been obtained by providing a mixed-light electric lamp comprising a high-pressure discharge lamp and an incandescent filament within an outer envelope, the discharge lamp being provided with a starting filament in parallel with the main electrodes.

Although specific embodiments have been disclosed, it will be understood that the modifications may be made within the spirit and scope of the invention.

We claim:

1. A mixed-light electric lamp comprising an outer envelope, a first incandescent filament and a high-pressure discharge lamp mounted within said outer envelope, said discharge lamp comprising a transmissive bulb, two main electrodes within said bulb and a gaseous atmosphere having a filling pressure of less than 2 atmospheres, a second incandescent filament mounted within but out of the axis of said bulb and parallel to the arc path, said

second incandescent filament proportioned for an electric current of 2 to 30% of the lamp current, and series resistors within said outer envelope connected to the end portions of said second incandescent filament in parallel to the arc path, said series resistors having negative temperature coefficients of the resistance.

2. An electric lamp according to claim 1, said lamp being proportioned for an operating voltage of 80 volts, said second incandescent filament being operable at 180 volts and at an electric current of 10 to 20% of the lamp current, and said series resistors being operable at said electric current during operation of said lamp.

3. An electric lamp according to claim 2, said series resistors being operable with a voltage drop of 5 to 20 volts while in the hot resistance condition.

4. An electric lamp according to claim 1, the ratio of the resistance of said negative temperature coefficient resistors in the cold state to the resistance in the hot state during operation is in the range of 3:1 to 300:1.

5. An electric lamp according to claim 1, the ratio of the resistance of said negative temperature coefficient resistors in the cold state to the resistance in the hot state during operation is about 100:1.

6. A mixed-light electric lamp comprising an outer envelope, a first incandescent filament and a high-pressure discharge lamp mounted within said outer envelope, said discharge lamp comprising a transmissive bulb, two activated main electrodes within said bulb and a gaseous atmosphere having a filling pressure of less than 2 atmospheres, a second incandescent filament mounted in parallel to the arc path within said bulb, said second incandescent filament being proportioned for an electric current of 2 to 30% of the lamp current and for a voltage of more than 100 percent of the lamp operating voltage and for producing a luminous efficiency of 3 to 15 lm./w., and series resistors connected to the end portions of said

second incandescent filament in parallel to the arc path, said series resistors having negative temperature coefficients of the resistance.

7. An electric lamp according to claim 6, said second incandescent filament being proportioned for a voltage of more than 150 percent of the lamp operating voltage and for producing a luminous efficiency of 5 to 8 lm./w.

8. A mixed-light electric lamp comprising an outer envelope, a first incandescent filament and a two-ended high-pressure discharge lamp mounted within said outer envelope, said discharge lamp comprising a bulb of transparent vitreous material with a stem press at each end, two activated main electrodes, each connected to a first foil portion in each of said stem presses, a second foil portion within each stem press, a second incandescent filament within said bulb in parallel to the arc path connected to said second foil portions, said negative temperature coefficient resistors mounted outside said bulb and within said envelope and connecting said first foil portions to said second foil portions, said negative temperature coefficient resistors being in heat conductive relationship to said bulb of the discharge lamp.

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