Sept. 9, 1952 A. M. MILES 2,610,310

FLUORESCENT STREET LIGHTING SYSTEM

Filed June 2, 1948 2 SHEETS—SHEET 1

Fig. 1.

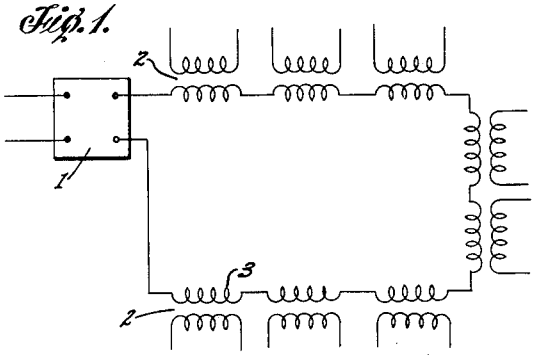

Fig. 2.

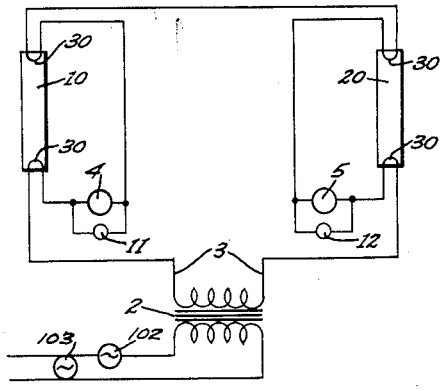

Fig. 3.

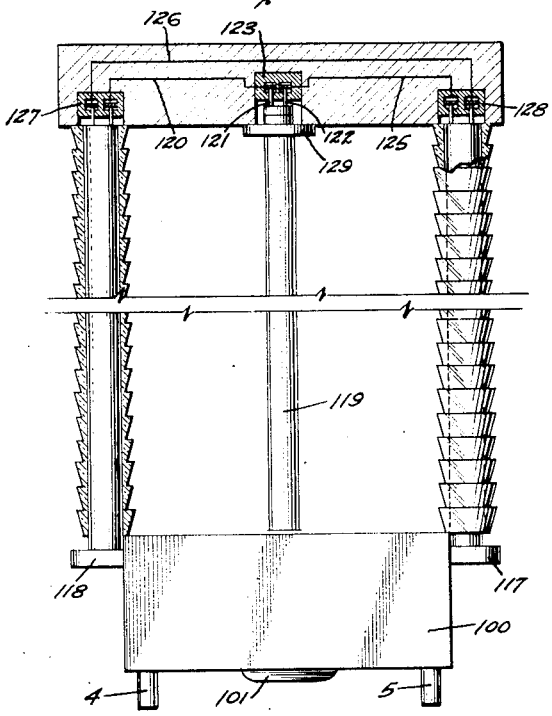

Fig. 5.

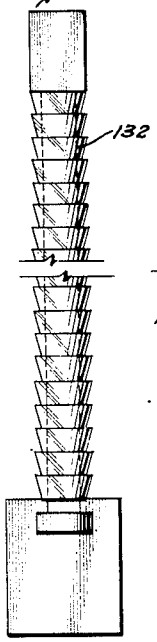

Fig. 6.

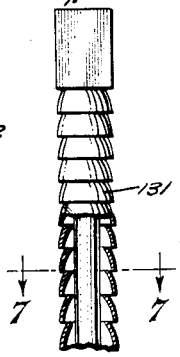

Fig. 7.

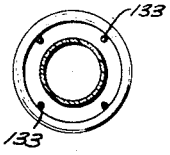

Fig. 4.

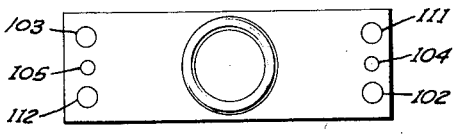

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Fig. 8.

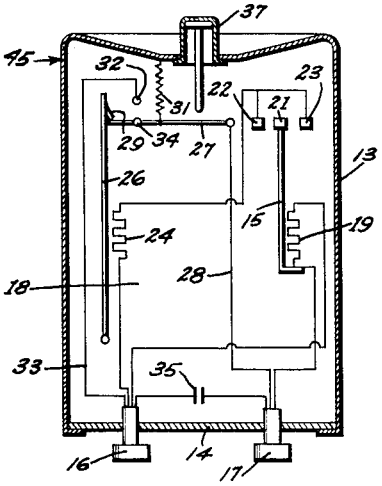


Fig. 9.

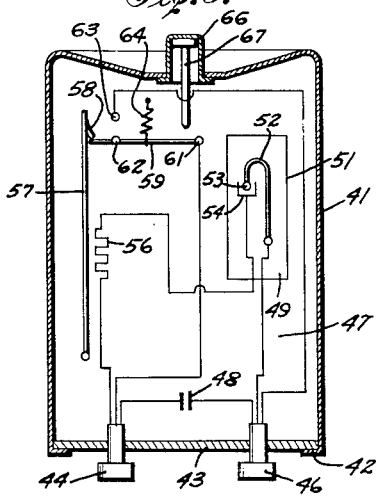


Fig. 10.

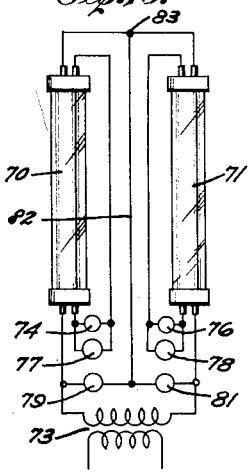
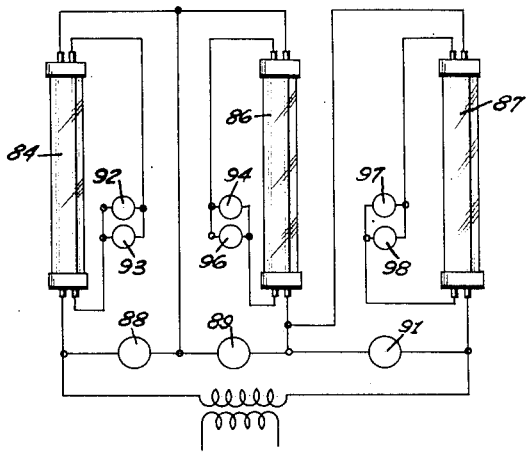


Fig. 11.



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UNITED STATES PATENT OFFICE

2,610,310

FLUORESCENT STREET LIGHTING SYSTEM

Alfred M. Miles, Spartanburg, S. C.

Application June 2, 1948, Serial No. 30,670

5 Claims. (Cl. 315—100)

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This invention relates to an improved fluorescent or gaseous discharge lighting system particularly suited for outdoor use and especially for street lighting. One of the important features of the invention is the provision of a high power factor system without the usual expensive auxiliary equipment.

This application is a continuation-in-part of my application Serial Number 592,216, filed May 5, 1945.

As is well known, the power factor of fluorescent or gaseous discharge lamp circuits is very low due to the reactors or chokes which must ordinarily be used to initiate the operation of such lamps. It has already been suggested heretofore that the power factor of fluorescent light system circuits can be improved by operating two such lamps in parallel from a common source of power; one lamp being operated in series with a reactor to give a lagging current while the other is operated in series with a condenser to give a leading current, the combined effect producing substantially unity power factor. It has also been suggested heretofore that the power factor of a circuit including fluorescent lamps can be improved by operating the lamps in series. This latter suggestion has been made in connection with lamps which are operated from the usual commercial constant voltage source of 110 to 120 volts. In both of these systems which usually use a low operating voltage, it is necessary to provide special equipment for the initiation of the gaseous discharge in the lamps. A special problem would develop if it was attempted to operate lamps in accordance with the previously mentioned systems in cold weather due to the fact that a minimum temperature must be reached in the lamp before the gas will ionize to initiate the operation of the tube because the voltage available is not very high.

In the conventional street lighting circuits the lamps on the different lamp posts are usually conected in series, suitable regulating apparatus being provided to maintain the proper amperage at constant voltage and automatic devices being provided to bridge the circuit around any defective lamp in order that the remaining lamps in the circuit can continue to operate. The advantage of the series circuit is lower initial cost and the operating characteristics can be made more uniform. Heretofore arc lamps and incandescent lamps have been used in such series street lighting circuits but as far as is known the operation of fluorescent or gaseous discharge lamps under the conditions encountered in outdoor street lighting has been considered to be impractical except possibly under the most ideal conditions. The primary difficulty in providing an outdoor fluorescent lighting system which could be used under variable outdoor temperature conditions is the initiation of the gaseous discharge and maintaining the lamp at the proper operating temperature for maximum efficiency.

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Accordingly, one of the primary objects of the present invention is to provide a lighting system which can be used in outdoor street lighting.

Another primary object is to provide a lighting system employing the dual voltage gaseous discharge lamps without substantially lowering the power factor.

Another object is to provide a series lighting system for fluorescent lamps in which means is provided for maintaining the operating current within the lamps in series at a substantially constant value in order not to damage the lamps and to permit the continued operation of the good lamps in the series in the event one of the lamps becomes defective or in the event the starter for one of the lamps becomes defective so that that lamp does not operate.

A still further object is to provide a lighting circuit arrangement in which two or more hot cathode gas discharge lamps are provided with appropriate starting devices for the individual lamps in such a manner that in the event of failure of one of the lamps its associated starter will close to serve as a circuit closing device to close the series circuit to permit the operation of the other tube or tubes in the series circuit.

A more specific object is to provide a lighting system employing two or more hot cathode fluorescent lamps in a series circuit with a plurality of starters connected in parallel for each lamp, one of the starters being of the thermal type so as to operate the lamps in cold weather, and the other being of the gaseous type and having a higher voltage operating characteristic whereby the starter with the higher voltage characteristic can serve to protect its associated lower starter in the event of failure of the associated fluorescent lamp and at the same time serve as a circuit closing device for the other lamp or lamps.

Other and further objects of the invention will appear from the following description taken in connection with the accompanying drawings in which:

Figure 1 is a diagrammatic view of the street lighting circuit showing the manner in which a

plurality of the devices in accordance with the present invention might be used;

Figure 2 is a diagrammatic view of a component of the lighting system embodying the principles of the invention;

Figure 3 is a side elevation of a lighting fixture in accordance with the present invention;

Figure 4 is a bottom plan view of the base of the fixture;

Figure 5 is an end view of Figure 3;

Figure 6 is a side elevation showing the construction of the louvered shade of the fixture;

Figure 7 is an enlarged cross section taken along the line 7—7 of Figure 6;

Figure 8 is an enlarged cross sectional elevation of the thermostatic type starter and exemplifying the principles of the present invention;

Figure 9 is a cross sectional elevational view of gaseous glow type starter exemplifying the principles of the present invention;

Figures 10 and 11 are modified forms of the circuit diagram exemplifying the invention.

Referring specifically to Figure 1 of the drawings, the present invention is illustrated as being adapted for series street lighting systems wherein a series circuit, for example, may supply all of the lamps in one block. The lamps on the individual lamp posts can be energized from the series circuit through a single constant current transformer or other suitable regulating equipment indicated at 1. Alternately, individual transformers 2, having their primaries connected in the series circuit for the block, could be utilized at each lamp post to supply the lamps on each lamp post in series. The only purpose of the transformers is to adapt the ampere demand of the lamp to the ampere characteristics of the line and to isolate the fixture from the distribution voltage. If the lamps on each individual lamp post are energized by a separate transformer, the regulating apparatus 1 would be of the type to provide a constant current to the primary circuit regardless of the total load taken by the different transformers. Also, the individual transformers 2 would be so designed as to provide a constant current output regardless of the load on the respective secondaries, that is, the transformers would be designed for high power factor and would have a low leakage magnetic circuit. This is essential for the continued operation of some of the lamps in series in accordance with the present invention in which it will be understood the regulation is due to the constant current supply when one or more of the other lamps may be defective. It will also be apparent to those skilled in the art that if the primaries of the individual transformers 2 were connected to the usual commercial source of power, the transformers would be so designed as to have constant current characteristics for the same purpose. In the latter event the lamps at the different lamp posts would be connected in series across the secondary 3 of the transformer as indicated in Figure 2. It will be readily understood that if desired the different lamps on two or more lamp posts might be connected in series in accordance with the present invention in an arrangement such as that shown in Figure 11.

Referring specifically to Figure 2, the reference characters 10 and 20 represent two fluorescent lamps of the dual voltage hot cathode type having filaments 30 at the opposite ends thereof. By dual voltage type is meant that the lamps are of the type which are started by a peak voltage of short duration after the hot cathodes have initiated the ionization of the gases inside the lamp and are thereafter operated at a lower voltage. In the operation of such lamps the filaments or hot cathodes are connected in a series circuit across a suitable source of alternating current indicated herein by the secondary 3 of the transformer 2. As will be understood from this description, a constant current supply is utilized, instead of the usual constant voltage supply, and for this reason no inductance is required to start the lamps in the series circuit. Because of the inherent nature of the constant current supply circuit, any tendency to open-circuit the load side immediately results in an increase in voltage so that upon open-circuit a peak voltage is produced. It is for this reason that an initial peak voltage is produced to start the operation of the lamps when the power is applied to the primary of the transformer.

Suitable heater type starters 4 and 5 are connected in series with the filaments 30 of the fluorescent lamps, the starter 4 being associated with the lamp 10 and the starter 5 being associated with the lamp 20. Gaseous glow discharge type starters 11 and 12 are connected in parallel respectively with heater type starters 4 and 5. As will be described later, these gaseous glow discharge type starters have a high breakdown voltage characteristic so that normally the lamps will be started in the conventional manner by the heater type starters 4 and 5 but in the event of failure of one of the lamps the associated glow discharge starter will break down and serve to dissipate the arc between the contacts of the heater type starter when it attempts to start the defective tube and at the same time will serve as a temporary circuit closing device so that the other tube may continue to operate.

In general, assuming that the line circuit is closed, the secondary of the transformer will become energized passing current through the four serially connected filaments 30 through the closed contacts of the thermostatic starter. If the starter 4, for example, breaks first, the arc will be struck through the tube 10. If when the starter 5 breaks, an arc is simultaneously struck in the tube 20, the secondary circuit remains closed and both tubes remain lit. If, however, in the absence of the glow starters the first opening of starter 5 fails to strike an arc, the circuit is broken and the arc in the tube 10 extinguished. The thermostatic starters make repeated tries and if the tube 20 is bad the tube 10 remains lighted when the starter 5 finally assumes its locked closed position.

The two principal drawbacks of such an arrangement are: (1) Due to the high voltage passing through the secondary circuit when one tube fails to operate, there will be excessive arcing between the contacts of the thermostatic starters, resulting in rapid destruction of the starters and possibly other parts of the fixture. (2) Intermittent action of the good tubes due to repeated opening and closing of the thermostatic starter associated with the bad tube, until said starter finally locks closed.

The presence of the gaseous glow starters connected across the gaps of the thermostatic starters remove both of these objections. Should one fail to light promptly when the points of its associated thermostatic starter sep-

arate the first time, the other tube or tubes on the same ballast, are not deprived of operating power, for the gaseous glow starter automatically ionizes and maintains the current constant to the other tube or tubes until operation is properly established in the first tube, or until the thermostatic starter of the first tube finally locks closed. Thus, the function of the gaseous starter in this case, although it is a conventional type starter, is not as a starter, but the action is that of a temporary circuit closing device.

When one tube does not promptly strike an arc, or is bad, so that the thermostatic starter makes several tries before assuming closed locked position, the gaseous starter prevents arcing by ionizing and carrying the current of the series circuit.

The details of the heater starting devices 4 and 5 are shown in Figure 8 while the details of the gaseous glow discharge type starters 11 and 12 are shown in Figure 9.

The starters are all provided with a so-called "no-blink" feature in that they are adapted to close their contacts to close the series circuit between their terminals after a few unsuccessful attempts to start their associated lamp. Referring specifically to Figure 8, the heater type starter comprises a suitable casing 13 which is provided with a suitable insulating base plate 14 having two projecting terminals 16 and 17 which are adapted to engage contacts in the conventional starter socket, the terminals of which, of course, would be connected in the lamp circuit in the well known manner. A suitable insulating supporting plate 18 is mounted on the base plate 14 on which the other elements of the starter can be mounted. A suitable heater resistor 19 is connected between the terminals 16 and 17. Associated in close proximity thereto is a bimetallic thermal member 15. The lower end of the bimetallic member 15 is connected to the terminal 17 and the upper end of the member 15 is provided with a suitable contact 21. A plurality of contacts 22 and 23 are mounted on the insulating plate 18 and are connected through a separate heater resistor 24 to terminal 16. A second bimetallic thermal member 26 mounted on the insulating plate 18, is associated in thermal relation to the heater 24 and is adapted to operate under the influence of heat from the heater 24 to short-circuit terminals 16 and 17. To this end, an armature 27 is pivotally mounted on the base plate 18 and is electrically connected through the conductor 28 to terminal 17. The upper end of the bimetallic thermal member 26 is provided with a latch 29 which is adapted to engage the outer end of the armature 27, the latter being spring biased in an upward direction by means of appropriate tension spring 31. A suitable contact 32 is electrically connected by suitable conductor 33 to terminal 16. Contact 34 on the armature 27 is adapted to cooperate with the contact 32 to short-circuit the terminals 16 and 17 when the latch 29 is disengaged from the outer end of the armature 27. A suitable condenser 35 is preferably connected across the terminals 16 and 17 to reduce the radio interference. A suitable reset button 37 extending through an aperture in the top of the casing 13 is provided for the purpose of manually returning the armature 27 to the initial position.

The starter and safety device shown in Figure 8 operates as follows: Assuming that the terminals 16 and 17 are connected in a circuit in series with the filaments of a fluorescent lamp in the position shown in Figure 2, when no power is applied to the circuit the contacts 22 and 21 are closed. When power is applied as by energization of the primary of the transformer 2, the circuit will be closed through the filaments 30 of both of the lamps 10, 20. The heater resistor 19 is of very low capacity and develops only enough heat to cause the bimetallic member 15 to operate. The thermal characteristics of the member 15 are such that contacts 22 and 21 remain closed long enough to preheat the filaments 30 so that the lamps 10, 20 are conditioned for glow discharge operation. When the contacts 22 and 21 open, the necessary high voltage peak for starting the associated lamp becomes available because of the constant current characteristics previously mentioned. As will be seen from Figure 8, the heater 19 remains in series with the circuit which energizes the glow discharge and supplies enough heat to the member 15 to cause the contact 21 to remain in an intermediate position between electrodes 22 and 23. In the event the lamp 10 is defective or fails to continue its glow discharge operation after the initial starting cycle the higher current through the filaments will cause the heater 19 to raise the temperature of the member 15 so that contacts 23 and 21 will be closed. When contacts 23 and 21 are closed, the heater 24 is placed in parallel with the heater 19, causing the latter to cool and the bimetallic member 15 to open contacts 21 and 23. This cycle of operation continues until the cyclic operations cause the bimetallic member 26 to become sufficiently heated so that its upper end bends to the left so that latch 29 is disengaged from the armature 27, thus permitting the spring 31 to move the armature 27 to close the contacts 32 and 34, thereby short-circuiting the terminals 16 and 17 and preventing further automatic starting cycles until the reset push button 37 is manually operated to reengage the latch 29 on the outer end of the armature 27.

In Figure 9 is shown the details of the gaseous glow discharge type fluorescent lamp starters which are designated by the numerals 11 and 12 in Figure 2. As in the heater type shown in Figure 8, the unit comprises an outer casing 41 provided with ears 42 which are adapted to engage an insulating base 43. The insulating base 43 has the conventional terminals 44 and 46 by means of which the starting unit is mounted in the conventional starter socket and by means of which the starter is connected into the lamp circuit. Also, as in the heater type starter a suitable insulating supporting plate 47 is mounted on the base plate 42 and is adapted to support the different elements of the starter unit.

The usual condenser 48, for the purpose of reducing radio interference, is connected between the terminals 44 and 46. In general, the starting unit of Figure 9 is quite similar to the starting unit shown in Figure 8 except that in the former a glow tube type starting switch 49 is used instead of the heater type starter. The glow type switch is preferably of the type shown in U. S. Patent to Dench 2,200,443, which comprises a glass envelope 51 having a gaseous environment therein such as neon, argon or a similar ionizable medium. A suitable bimetallic member 52 has its upper end provided with a contact 53, the lower end of the member being fixed in the press of the envelope. A second

contact 54 is adapted to cooperate with the contact 53 in circuit closing relation and is supported by a suitable terminal mounted in the press of the envelope 51. A suitable heater resistor 56 is connected in series with the glow type switch 49 between the terminals 44 and 46. The heater 56 is in thermal relation to a suitable bimetallic member 57, the lower end of which is fixed to the insulating supporting plate 47 and the upper end is provided with a suitable latch. 58. The latch 58 is adapted to engage the outer end of an armature 59, one end of which is pivoted at 61 to the insulating supporting plate 47. The armature 59 is provided with a suitable contact 62 which is operably associated with contact 63 fixed to the supporting plate 47. As will appear from the drawing, contact 63 is connected to the terminal 46, and the armature 59 and its contact 62 are electrically connected to the terminal 44. A suitable tension spring 64 is adapted to urge the outer end of the armature 59 in the upward direction against the latch 58 and to close contacts 62 and 63 when the latch 58 is disengaged from the outer end of the armature. A suitable reset button 66 extends upwardly through an aperture in top of the casing 41 and is provided with a suitable actuating stem 67 which is adapted to engage the armature 59 to the left of the pivotal connection 61 so that the lock-out mechanism of the starting unit can be reset. The operation of this glow type starter is similar to that of the heater type starter except that the former has a higher voltage and longer pre-heat characteristic for a purpose which will be apparent from description hereinafter. Assuming that no power is applied to the circuit in which the heater unit is connected, the contacts 53 and 54 will be open. If the voltage applied across the terminals 44 and 46 is sufficient to initiate the glow discharge in the switch 49 the bimetallic member 52 will become heated and thus cause the contacts 53, 54 to close. This will close the circuit between the terminals 44 and 46 through the heater 56 and assuming the starting unit is connected in the position shown at 11 or 12 in Figure 2, the circuit through the cathodes 30 would be closed to cause them to pre-heat. As soon as the contacts 53 and 54 are closed, the glow discharge in the switch 49 will stop. This will allow the bimetallic member 52 to cool, thus again opening the contacts 53 and 54. However, the characteristics of the thermal switch 49 are so related to the starting characteristics of the fluorescent lamps that under normal conditions the cathodes 30 will have been heated to the point that the glow discharge between cathodes 30 will be initiated when the contacts 53 and 54 open. So long as the glow discharge in the lamps 10 and 20 remains active, the voltage drop across the devices 11 and 12 (terminals 44 and 46) will not be sufficient to initiate the glow discharge in the switch 49 and therefore the glow starter remains inactive. However, in the event the lamp becomes defective and does not operate, the glow discharge starting unit will attempt to reinitiate the glow discharge in the fluorescent lamp. In the event that the fluorescent lamp is defective or does not continue to operate after the first starting cycle, the glow discharge starting unit will repeat its starting cycle until the intermittent operation of the resistor 56 raises the temperature of the bimetallic member 57 to the point where the latch 58 disengages the outer end of the armature 59 thus closing the contacts 62 and 63 and short-circuiting the terminals 44 and 46. It will be readily seen that when this happens the series circuit will be closed through the lamp cathodes so that the other lamp or lamp in series can continue to operate.

Now referring again to Figure 2, by using two starter units of different voltage characteristics in parallel in the series fluorescent lamp circuit, it will be understood that the starter having the lower voltage and lower pre-heat characteristic will normally start the associated lamp, it being understood that heater type starters are preferred for cold weather conditions. In the form of the invention illustrated herein the reference numerals 4 and 5 represent starters having the lower voltage and pre-heat characteristics while the reference numerals 11 and 12 represent starters having a higher voltage and a longer pre-heat characteristic, the starters 4 and 5 being of the heater type and the starters 11 and 12 being of the gaseous glow type. However, should a glow type starter having a sufficiently long pre-heat and other characteristics to operate lamps exposed to low temperatures become available, it could be substituted for the present starters 4 and 11 as used in parallel. When the heater type starters 4, 5 and the glow type starters 11, 12 are used in parallel, the glow type starter serves to prevent the flash-over of the points of the heater starter while the heater starter is going through the starting cycles and until it closes its contacts after several unsuccessful attempts to start the tube. At the same time, the glow type starter is serving as a temporary circuit closing device for the other fluorescent lamp or lamps in the series circuit it also serves as a protection to the contacts of its associated heater starter, and as a starter under abnormal conditions. By way of example, upon the application of power to the series lamp circuit shown in Figure 2 the circuit through the filaments of lamps 10 and 20 would normally be closed through the thermostatic starters 4 and 5. If, for instance, the lamp 10 is defective and fails to continue to burn after the starter contacts are open, the starter will again close its contacts and make several attempts to start the lamp. In the meantime the glow type starter 11 serves to dissipate the energy in the arc between the points of the thermostatic starter 4 and thereby prevent excessive burning thereof. At the same time, due to the fact that the lamp 10 is not in operation, the voltage drop would be sufficient to operate the glow type starter 11 so that it closes its contacts to complete the circuit through the lamp 20. In this way the function of the glow type starter is as a temporary circuit closing device. Assuming that the glow type starter 11 has closed its contacts, the lamp 20 will be started by the operation of the glow type starter. Normally this lamp would be started by the operation of its associated heater type starter 5. If the lamp 10 eventually fails to start after several attempts on the part of its heater type starter 4, the latter will close its contacts, thus short-circuiting the glow type starter 11 so that it is no longer in operation and the circuit will be permanently closed through the lamp 20. This, of course, is assuming that the filaments of the lamp 10 have not burned out. As is well known, the fluorescent operation of the lamp usually becomes defective before the filaments thereof become defective. It will be understood from the foregoing description that even though one of

the fluorescent lamps in the series becomes defective and the special starting device shorts out the defective lamp, the remaining lamp or lamps in series can be operated because in accordance with the present invention the power source has a constant current characteristic so that regardless of the number of lamps operating in the series circuit the voltage drop across the individual lamps will remain substantially constant.

Figures 10 and 11 show modified forms of the circuit arrangement shown in Figure 2 using the type of starters illustrated in detail in Figures 8 and 9. The only difference between the circuit of Figures 10 and 11 is that Figure 11 shows three lamps in series across a single source of power. It will be readily understood that the number of lamps in series could be increased in any desired amount by merely applying the necessary higher voltage.

Referring specifically to Figure 10, a plurality of fluorescent lamps 70 and 71 are connected in series across the secondary of transformer 73 which might correspond to the transformer 2 of Figure 2. An appropriate heater type starter 74 and a glow type starter 77 are connected in parallel in a series circuit including the filaments of the tube 70 and tube 71, the series circuit being completed through heater starter 76 and glow type starter 78 which are connected in parallel in a manner similar to the corresponding elements described in connection with Figure 2. The operation of the different starters and the fluorescent lamps is the same as in the circuit arrangement of Figure 2. In addition to the elements shown in Figure 2, additional glow type starters 79 and 81 are connected in series across the two sides of the input to the series circuit and an intermediate point between these starters is connected by the conductor 82 to a point 83 which is electrically common to terminals of the filaments of the tubes 70 and 71 in such a manner that the glow type starters 79 and 81 are each connected in parallel in the series circuit through the filaments of the individual lamps and their respective starters. The glow type starters 79 and 81 are identical and are similar to the glow type starters 77 and 78 except that the starters 79 and 81 have a higher voltage rating so that they are inoperative so long as the circuit exists through the lamps or associated starters across which it is connected, whether this circuit be completed through the lamp filaments or through gaseous discharge conduction. The purpose of the glow type starters 79 and 81 is to shunt out of the circuit any lamp which, with its associated starters, might under certain abnormal conditions present an open circuit. This permits the remaining lamps of the circuit to function normally and also prevents the formation of destructive arcs which might otherwise occur if the series circuit is accidentally opened when one of the lamps becomes defective or is broken. In the event one of the tubes should fail, the associated glow type starter 79 or 81, whichever is the case, would become conducting and close the circuit so that the remaining lamp or lamps would operate in a normal manner. In such event it will be understood that the high voltage glow type starter would go through the normal starting cycles of attempting to start a defective lamp and when the lamp failed to start the "lock-in" feature would operate so that a device similar to the latch 58 of the device shown in Figure 9 would disengage an appropriate armature to close the circuit through the respective glow type starter.

It will be noted that the circuit diagram of Figure 11 is merely an extension of that shown in Figure 10 and that the part of the circuit including the lamps 84 and 86 is identical to the arrangement of Figure 10, the lamp 87 and its associated starter merely being an addition to the type of circuit shown in Figure 10, appropriate glow type starters 88, 89 and 91 being connected in parallel with the filaments and the respective starters for the respective lamps. As in the previous circuit arrangements, the lamp 84 is provided with a heater type starter 92 and a glow type starter 93 connected in parallel arrangement in series with the filaments of the lamp. Likewise a heater type starter 94 and a glow type starter 96 are connected in parallel arrangement in series with the filaments of lamp 86 and heater type starter 97 and glow type starter 98 are connected in parallel arrangement in series with the filament of the lamp 87. As in the previous modifications, the pre-heat characteristics of the heater type starters 92, 94 and 97 are longer than those of the glow type starters 93, 96 and 98. Likewise the voltage rating of the glow type starters 93, 96 and 98 are higher than the associated heater starters 92, 94 and 97, respectively.

The Figures 3 to 7 inclusive show a practical embodiment of a lighting fixture incorporating the operating system of the present invention. It comprises a hollow base 100 in which the power transformer such as transformer 2, may be housed, having a socket 101 on the underside thereof to receive a lamp post, not shown. There are three sockets at each end of the underside, accessibly placed, two of these being sockets 102 and 103 for suitable testing instruments. The socket 102, being connected in series with one of the power lines, is adapted to normally receive a circuit-closing plug which can be removed to permit the insertion of a plug of a testing device. The socket 103 is connected in parallel with the power source. This permits the fixture to be supplied by an auxiliary power supply without otherwise disturbing the power supply line. Thus any fixture may be tested in the daytime, for example, without placing the normal high operating voltage on the supply line. The other sockets 104 and 105 are adapted to receive the heater starters 4 and 5 respectively and the sockets 111 and 112 are adapted to receive the glow type starters 11 and 12 respectively. It will be understood that as far as the present invention is concerned, the exact arrangement of the location of the conventional sockets for holding the starters is immaterial so long as they are conveniently accessible for ready replacement and are properly protected from the weather.

The laterally projecting sockets 117 and 118 are adapted to receive the lower end of the vertically positioned fluorescent lamps 10 and 20, respectively. A suitable supporting tube 119 is secured to the top side of the base 100 between the tubes and extends vertically. The supporting tube 119 contains insulated wires which lead to the upper filaments of the lamps 10 and 20 through terminals 121, 122 of a plug 123 fitted into an elongated cap 124.

The cap 124 is provided with openings at its underside near its opposite ends for receiving sockets 127 and 128 into which the terminals of the upper ends of the respective lamps 10 and 20

are engaged. The elongated cap 124 may be of any suitable insulating material and is preferably provided with suitable conductors 120 and 125 embedded therein for connecting the terminals 121 and 122 to one of each of the sockets 127, 128, respectively. The other terminal of the sockets 127, 128 would be so connected by suitable conductor 126 to form the series circuit shown in Figure 2, it being understood that the lower ends of the insulated wires in the post 119 would be connected to the appropriate starters to complete the circuit shown in Figure 2. The upper end of the supporting tube 119 is provided with a resilient collar 129 near its upper end on which the cap 124 rests. It will be readily seen that the cap 124 may be removed by moving it upwardly away from the supporting tube 119 and the lamps 10 and 20. The location of the plug 123 and sockets 127 and 128 on the underside of the cap 124 prevents ingress of water to the interior of the cap.

In order to maintain satisfactory efficient operation of the fluorescent lamps in low temperatures, it is desirable to reduce the radiation of heat from the lamps. For accomplishing this result and for directionally controlled illumination the individual lamps may be provided with surrounding shades. These may be in the form of louvered metal cylinders 131 as shown in Figures 6 and 7 or glass cylinders 132, preferably with refraction ridges as shown in Figures 3 and 5. The type of cylindrical shade shown in Figures 3 and 5 is continuous and spaced from the wall of the lamps providing air insulation which conserves the heat of the tube and prevents excessive cooling in cold climates.

The louvered shade shown in Figures 6 and 7 consists of a plurality of spaced annular baffles spot welded or otherwise secured to rods 133.

In servicing a lighting fixture the cap 124 is first removed, the defective lamps substituted by new ones, and the cap replaced. The weight of the cap keeps the resilient contacts of all the electrical sockets pressed against the corresponding terminals.

Although the invention has been described in considerable detail it will be apparent to those skilled in the art that many variations are possible without departing from the inventive concept. It is, therefore, desired that the invention not be limited except insofar as it is made necessary by the prior art and by the appended claims.

What is claimed is:

1. A fluorescent lighting system comprising a source of alternating current, a plurality of hot cathode gaseous discharge tubes each having a pair of cathode filaments, said cathode filaments being intercoupled in a series circuit across said source of alternating current, current peaking means in said series circuit, thermostatic make and break starters individual to said tubes of the type having normally closed bimetallic contact means heated on conduction of current therethrough for periodically open-circuiting the contacts for preselected intervals, said contact means being intercoupled across the filaments of the tube associated therewith, and gaseous starters of the type having normally open bimetallic contact means enclosed in an ionizable medium which is ionized on occurrence of preselected break-down voltage across the contacts thereof to close said open contact means for a preselected interval, the normally open contact means of said gaseous starters being connected across the contacts of each of said thermostatic starters, said gaseous starters being ionized to close the contact means thereof on opening of said thermostatic starter contact means intercoupled therewith and failure of their associated gaseous discharge tube to conduct.

2. A fluorescent lighting system comprising a source of alternating current, a plurality of hot cathode gaseous discharge tubes each having a pair of cathode filaments, the cathode filaments being intercoupled in a series circuit across said source of alternating current, current peaking means in said series circuit, thermostatic make and break starters individual to said tubes of the type having normally closed bimetallic contact means heated on conduction of current therethrough for periodically open-circuiting the contacts for a preselected interval, said normally closed contacts being intercoupled across the filaments of the tube associated therewith, and gaseous starter switch means coupled across the contacts of said make and break starters of the type having normally open bimetallic contact means enclosed in an ionizable medium which is ionized on occurrence of preselected break-down voltage across the contacts thereof to close said open contact means for a preselected interval, said switch means having a relatively higher voltage rating than said thermostatic starters to permit the make and break starters normally to perform their starting function and conditioning the switch means to ionize only on interruption of the contacts of the thermostatic starter intercoupled therewith and failure of their associated cathode tube to conduct, whereby ionization of said switch means effects closing of the contact means thereof to shunt out its associated thermostatic starter and cathode tube during open-circuiting of its associated thermostatic starter and non-conduction of its associated cathode tube.

3. A fluorescent lighting system comprising a source of alternating current, a transformer having a constant current secondary circuit, a plurality of dual voltage hot cathode gaseous discharge lamps each having a pair of cathode filaments intercoupled in series in said secondary circuit, thermostatic make and break starters of the type having normally closed bimetallic means heated on conduction of current therethrough for periodically open-circuiting the contacts for a preselected interval, said normally closed contacts being intercoupled between the terminal of each of said cathode filaments of each of said lamps to be alternately open-circuited and closed on energizing the series circuit and to initiate a conductive glow discharge between the cathodes on open-circuiting of said contacts, and gaseous discharge starter switch means having normally open bimetallic contact means enclosed in an ionizable medium which is ionized on occurrence of preselected break-down voltage to close said open contact means for a preselected interval, said normally open contact means being intercoupled in parallel with each of said thermostatic make and break starters, and said gaseous switch means being ionized to close the contacts thereof on interruption of the contacts of their associated thermostatic switch means and failure of the cathode tube intercoupled therewith to conduct.

4. A fluorescent lighting system comprising a source of alternating current, a transformer

coupled thereacross having a constant current secondary circuit, a plurality of dual voltage hot cathode gaseous discharge lamps having pairs of cathode filaments intercoupled in series in said secondary circuit, a thermostatic make and break starter individual to each of said lamps having normally closed bimetallic means intercoupled across the filament of its associated lamp heated on conduction of current therethrough for periodically open-circuiting the contacts for a preselected interval, and a gaseous discharge starter of the type having normally open bimetallic means enclosed in an ionizable medium which is ionized on occurrence of a preselected breakdown voltage across the contacts thereof to close said open contact means for a preselected interval, said normally open contact means being intercoupled in parallel with each of said thermostatic starters, said gaseous starters having a relatively higher voltage rating than its associated thermostatic starter for preventing ionization of the medium of said gaseous starters on open-circuiting of the contacts of their associated thermostatic starters and conduction of their associated cathode lamps and said gaseous starters being ionized only on open-circuiting of their associated thermostatic starter and failure of the cathode lamp intercoupled therewith to conduct for closing the contacts of said gaseous starter and by-passing its associated thermostatic starter and lamp during non-conduction and open-circuiting of the lamp and thermostatic starter.

5. A fluorescent lighting system as set forth in claim 3, having means for automatically short-circuiting said thermostatic starters after several unsuccessful starting operations.

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