

June 16, 1942.

E. C. DENCH

2,286,790

STARTING CIRCUIT FOR FLUORESCENT LAMPS

Filed May 4, 1940

Fig. 1.

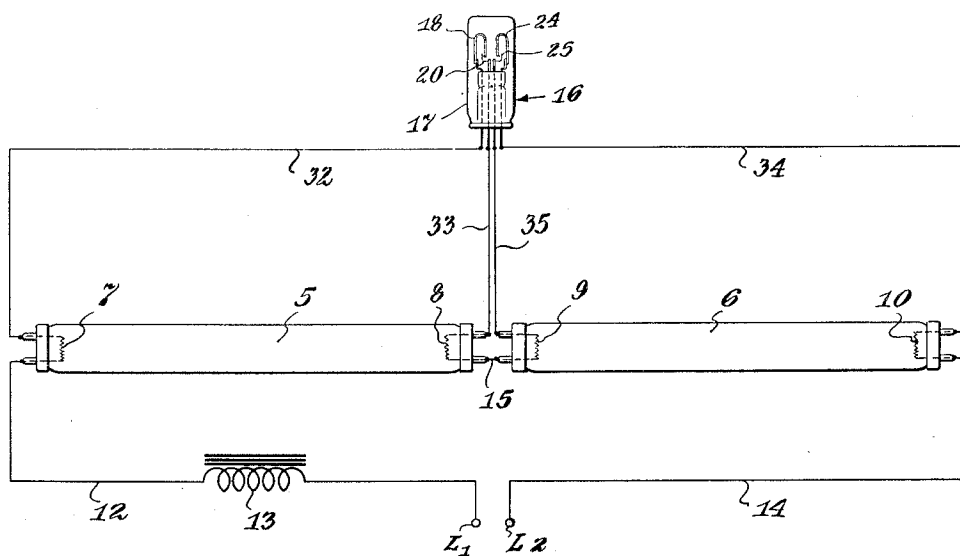
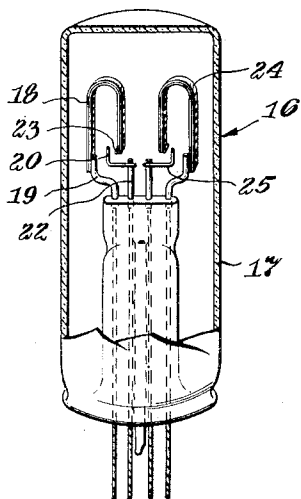


Fig. 2.



INVENTOR
E. C. DENCH.
BY *J. W. Greenhouse*
ATTORNEY

UNITED STATES PATENT OFFICE

2,286,790

STARTING CIRCUIT FOR FLUORESCENT LAMPS

Edward Charles Dench, South Orange, N. J., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application May 4, 1940, Serial No. 333,307

6 Claims. (Cl. 176—124)

The present invention relates to gaseous electric discharge lamps and more particularly concerns systems and apparatus employed in the operation of a plurality of such gaseous discharge lamps.

Lamps of this general type are now well known to the art as fluorescent lamps wherein a discharge occurs between two electrodes in a gaseous atmosphere with the interior surface of the envelope being coated with a material which is excited by the invisible radiations generated by the discharge so as to convert the invisible radiations into visible radiations.

These lamps operate from the customary source of domestic potential of 115 volts, but have a very poor power factor correction when so operated. In order to overcome this difficulty and more closely approach unity power factor, it has been suggested to operate such lamps in series from the domestic source of supply. This, however, involves numerous difficulties in initiating a discharge in such series connected discharge lamps.

It is accordingly an object of the present invention to provide a circuit arrangement wherein the series connected discharge lamps may be readily started with a fidelity of operation throughout the life of the lamps.

Another object of the present invention is the provision of a gaseous electric device which operates to initiate a discharge in a plurality of gaseous discharge lamps connected in series, with the gaseous electric device consuming no energy from the source of supply during the operation of the series connected discharge lamps.

Another object of the present invention is the provision of a starting and operating circuit for a plurality of series connected discharge lamps operable at substantially unity power factor and wherein a gaseous electric device is utilized for initiating a discharge in the lamps with the gaseous electric device consuming no energy from the source of supply during operation of the lamp and which device operates with fidelity during the entire life thereof.

Still further objects of the present invention will become obvious to those skilled in the art by reference to the accompanying drawing wherein:

Fig. 1 is a diagrammatic illustration of a starting and operating circuit in accordance with the present invention; and

Fig. 2 is a cross-sectional view of a novel gaseous electric device constructed in accordance with the present invention and as shown as an

element of the starting and operating circuit of Fig. 1.

Referring now to the drawing in detail, a plurality of gaseous electric discharge lamps 5 and 6 are shown which may be of the fluorescent type having a coating on the interior surface of the envelope (not shown) which is excited by the invisible radiations generated by the ensuing discharge between the electrodes. As will be noted the lamp 5 is provided with oppositely disposed filamentary electrodes 7 and 8, and similarly the discharge lamp 6 is provided with electrodes 9 and 10, all of which filamentary electrodes may be provided with an electron emissive coating, such as an oxide of barium, strontium, or the like, adapted to emit electrons when heated.

One terminal of the filament electrode 7 is connected by means of a conductor 12 and an inductance element 13 to one side of the source of supply of the customary domestic potential of 115 volts L—1. Likewise, one terminal of the filamentary electrode 10 of the lamp 6 is connected by means of a conductor 14 to the opposite side of the source of supply L—2. One terminal of the electrode 8 of the lamp 5 and the electrode 9 of the lamp 6 are connected together by a conductor 15 which thus connects the lamps in series with each other to the source of supply L—1, L—2.

In order to connect the respective filamentary electrodes of the lamps 5 and 6 in series with each other, a gaseous electric device 16 is employed. This device is similar in some respects to that shown in my Patent No. 2,200,443, issued May 14, 1940, and assigned to the same assignee as the present invention.

As therein shown, a glow relay device is employed for connecting the electrodes of a single lamp in a series heating circuit with the source of supply. Upon the application of a potential from the source of supply a glow discharge occurs between the electrodes of the device. Since one of the electrodes is a heat responsive element, heating thereof causes movement of the heat responsive electrode until it engages the other electrode. This engagement of the electrodes short-circuits the discharge, thus positively connecting the filamentary electrodes of the discharge lamp in a series heating circuit to the source of supply.

The electrodes of the lamp are thus heated to an electron emitting temperature; and upon cooling of the heat responsive electrode of the gaseous relay device, the engaged electrodes separate, thus causing a high voltage surge to be

impressed upon the lamp, causing the initiation of a discharge between the heated electrodes. Thus the discharge continues in the lamp until interruption of the energy supplied thereto, with the glow discharge device consuming no current during operation of the lamp.

While such device operates very effectively and efficiently with a single lamp, it is not practical to employ such a glow relay device for each individual discharge lamp when such lamps are connected in series with the source so as to obtain substantially unity power factor. For example, a glow relay device such as shown in the above noted patent cannot be employed with each of the lamps 5 and 6 as shown in Fig. 1 because the line voltage is approximately 115 volts. If an individual glow relay tube were employed for each lamp, this line voltage would be divided between the glow relay tubes, which voltage is insufficient to operate the relays for the purpose of initiating a discharge in the series connected discharge lamps 5 and 6.

To overcome this difficulty and at the same time provide a starting circuit for a plurality of series connected discharge lamps, an improved type gaseous electric relay device is herein provided which operates somewhat in the manner of that shown and described in my above noted patent.

As will be noted in Fig. 2, the modified form of glow relay device 16 is provided with a plurality of electrodes arranged in groups or pairs and in the embodiment shown, one pair provided for each discharge lamp in the series. Such electrodes are enclosed within an evacuated container 17 which is provided with an ionizable medium which may comprise an inert gas or mixture thereof, such as argon, neon, helium, etc. A heat responsive electrode 18, which may comprise a substantially U-shaped bimetallic element, is supported by a leading-in and supporting conductor 19 with the free end of the bimetallic element being disposed adjacent an electrode 20 of small area likewise supported by a leading-in conductor 22.

The bimetallic electrode 18 is provided at its extremity with a contact terminal 23 as well as an electron emissive material in the form of a metal of high electron emissivity, such as zinc or the like, or a coating of electron emissive material similar to that with which the filamentary electrodes of the discharge lamps 5 and 6 are provided. In addition, the device 16 is provided with another heat responsive or bimetallic electrode 24 identical to the previously described electrode 18, and a cooperating electrode 25 identical to that of the previously described electrode 20. Since a pair of cooperating electrodes such as 18 and 20 are provided for each lamp in the series which are of identical construction, further detailed description of such electrodes is believed to be unnecessary.

It will be noted, however, by reference to Fig. 2 that the cooperating electrodes of small area 20 and 25 are disposed adjacent each other and interposed between the heat responsive or bimetallic electrodes 18 and 24 of each pair for a purpose to be hereinafter described.

Referring again to Fig. 1, it will be noted that in order to connect the electrodes 7 and 8 of the lamp 5 in series with each other, as previously mentioned, a conductor 32 connects one terminal of the filamentary electrode 7 to the heat responsive electrode 18 of the gaseous electric device 16, and the electrode 20 thereof is

connected by a conductor 33 to the remaining terminal of the filamentary electrode 8. Likewise, a conductor 34 connects the remaining terminal of the filamentary electrode 10 of the lamp 6 to the heat responsive or bimetallic electrode 24 of the device 16, and similarly conductor 35 connects the electrode of smaller area 25 to the remaining terminal of the filamentary electrode 9 of the lamp 6.

The starting and operating circuit above described operates in the following manner. Upon closure of a suitable switch (not shown), the line voltage of approximately 115 volts is applied to the electrodes 18 and 24 of the gaseous electric device 16 from one side of the source of supply L—1 through the inductance 13, conductor 12, filamentary electrode 7 and conductor 32, and from the opposite side of the source of supply L—2 through the conductor 14, filamentary electrode 10 and conductor 34.

These two electrodes 18 and 24, being provided with an electron emissive material, cause a glow discharge to occur therebetween since the full line voltage of 115 volts is sufficient to ionize the medium within the envelope 17. The resulting discharge heats the electrodes 18 and 24 and, since they are heat responsive of bimetallic, they will flex into engagement with their respective cooperating electrodes 20 and 25.

Since the source of supply L—1, L—2 is alternating current, actually one or the other of the electrodes 18, 24 operate slightly ahead of the other, depending upon which has functioned the greater percentage of the time during the momentary discharge as cathode. Regardless of which particular electrode engages its cooperating electrode of smaller area, the operation is the same.

Assuming, therefore, that the heat responsive electrode 18 is heated more rapidly, the contact terminal 23 carried by the extremity thereof will engage its cooperating electrode 20, thereby short-circuiting these two electrodes and connecting the filamentary electrodes 7 and 8 of the lamp 5 in series. The completion of this series heating circuit for the lamp 5 thus applies the voltage from the source directly between the remaining electrodes, namely, 24 and 25, again causing a glow discharge between these two electrodes with further heating of the heat responsive electrode 24 until it moves into engagement with the electrode 25, short-circuiting the same and extinguishing the discharge.

Engagement of these two electrodes 24 and 25 thus connects the filamentary electrodes 9 and 10 of the lamp 6 in series with each other and by the same token, since the electrodes 7 and 8 of the lamp 5 are in series with each other, they are connected in series with the electrodes 9 and 10 of the lamp 6 so that a series heating circuit for all of the filamentary electrodes of all the series connected lamps is thus formed. All of the filamentary electrodes of the series connected discharge lamps are thus heated to an electron emitting temperature.

By the time they reach such temperature, the heat responsive electrodes 18 and 24 of the gaseous electric device 16 will have cooled sufficiently to cause movement thereof away from their respective cooperating electrode so as to disengage the same. At the moment of disengagement, a high voltage surge from the inductance element 13 is impressed across the heated electrodes of the lamps 5 and 6, thus initiating a discharge between their respective electrodes.

Such discharge will continue so long as the switch (not shown) in the source of supply remains closed and, during the continuance of such discharge, no energy is consumed by the gaseous electric device 16 since the resistance thereof is now higher than that of the series connected lamps 5 and 6 and the total voltage drop of the lamps 5 and 6 is approximately 80 volts, which renders the voltage available insufficient for further operation of the gaseous relay device 16, so that no glow discharge occurs between the cooperating electrodes of each group in the device 16 and it remains dormant.

If, however, for any reason a discharge fails to occur between the heated filamentary electrodes of the respective lamps 5 and 6 upon disengagement of the electrodes of the gaseous electric device 16, the latter repeats its cycle of operation, causing initiation of the discharge in the lamps 5 and 6. However, due to the construction of the gaseous electric device 16, it is very positive in its operation and very rarely fails to initiate the discharge during its initial cycle of operation; but in any event, its cycle of operation continues with such rapidity that a discharge is initiated in the series connected discharge lamps within approximately a second or so.

It thus becomes obvious to those skilled in the art that a starting and operating circuit for a plurality of gaseous discharge lamps is herein provided so that the lamps operate at substantially unity power factor inasmuch as the lamps are connected in a series circuit with the source of supply. Moreover, by the provision of a novel gaseous relay device, which operates to connect the electrodes of the gaseous discharge lamps in a series heating circuit with each other and with those of the remaining lamps of the series with such device subsequently operating to interrupt the series heating circuit and cause a high voltage surge to be impressed across the electrodes of the lamp, initiation of a discharge is facilitated.

In addition, such device is provided with a pair of electrodes for each lamp in the series and consequently operates with fidelity to perform its starting sequence for the series connected discharge lamps and, once the discharge is initiated, such device consumes no energy from the source of supply, thus increasing the efficiency of operation of the respective series connected discharge lamps.

Although one specific embodiment of the present invention has been shown and described, it is to be understood that other modifications thereof may be made without departing from the spirit and scope of the appended claims.

I claim:

1. An electric circuit for starting and operating at substantially unity power factor a plurality of gaseous electric discharge lamps provided with electrodes adapted to be heated to an electron emitting temperature from a source of electrical energy and having an ionizable medium therein comprising a source of electrical energy for energizing said lamps, an inductance element interposed between said source and one of the electrodes of one of said lamps, and means for connecting the electrodes of all of said lamps in series to cause heating of said electrodes to an electron emitting temperature comprising an auxiliary discharge device provided with a pair of electrodes therein for each discharge lamp in the series and between which

a discharge occurs upon the application of a potential from said source, one electrode of each pair having a heat responsive electron emitting element heated by the initial ensuing discharge therebetween, and one of said heat responsive elements being operable to engage the other electrode of its respective pair to extinguish said discharge and to cause a momentary discharge between the other heat responsive element and the respective electrode of its pair with attendant engagement thereof and extinguishment of said momentary discharge to complete a series heating circuit for the electrodes of said lamp, and said pairs of electrodes being operable to thereafter interrupt said heating circuit and cause an attendant voltage surge from said inductance element for initiating a discharge in all of said series connected discharge lamps.

2. An electric circuit for starting and operating at substantially unity power factor a plurality of gaseous electric discharge lamps provided with electrodes adapted to be heated to an electron emitting temperature from a source of electrical energy and having an ionizable medium therein comprising a source of electrical energy for energizing said lamps, an inductance element interposed between said source and one of the electrodes of one of said lamps, and means for connecting the electrodes of said lamps in series to cause heating thereof to an electron emitting temperature comprising an auxiliary discharge device provided with a plurality of electrodes therein and between which a discharge occurs upon the application of a potential from said source, one pair of said electrodes including a heat responsive element initially heated by a discharge between it and an electrode of another pair and operable to engage the electrode of its pair to short-circuit the same and to connect the electrodes of one lamp in a series heating circuit and operable to cause a momentary discharge between the other pair of electrodes, said other pair of electrodes including a heat responsive element heated by the momentary discharge and operable to engage the electrode of its pair to short circuit the same and extinguish said discharge and to connect the electrodes of the other lamp in a series heating circuit, and said device being operable to thereafter interrupt said heating circuit for the electrodes of said lamps and cause an attendant voltage surge from said inductance element for initiating a discharge in all of said series connected discharge lamps.

3. An electric circuit for starting and operating at substantially unity power factor a plurality of gaseous electric discharge lamps provided with electrodes adapted to be heated to an electron emitting temperature from a source of electrical energy and having an ionizable medium therein comprising a source of electrical energy for energizing said lamps, an inductance element interposed between said source and one of the electrodes of one of said lamps, and means for connecting the electrodes of said lamps in series comprising an auxiliary discharge device having a pair of electrodes for each lamp included in the series between which a discharge occurs upon the application of a potential thereto, each pair of said electrodes including a heat responsive element adapted to emit electrons to initially cause a glow discharge between one of the electrodes of each pair thereby heating each heat responsive electrode with attendant movement of one of said heat responsive electrodes into contact with the other electrode of its pair

to extinguish said discharge and to connect the electrodes of their associated lamp in a series heating circuit with the electrodes of the remaining lamps of the series and to cause a momentary discharge between the remaining heat responsive electrode and the other electrode of its pair to short circuit the same and extinguish said momentary discharge, and said device being thereafter operable to interrupt said heating circuit for the electrodes of said lamps and cause an attendant voltage surge from said inductance element for initiating a discharge in all of said series connected discharge lamps.

4. A gaseous electric device comprising an envelope provided with an ionizable medium therein, a plurality of electrodes within said envelope arranged in co-operating groups, one electrode of each group being a heat responsive electrode adapted to emit electrons to cause a discharge between one of the electrodes of each group thereby heating each heat responsive electrode with attendant movement of one of said heat responsive electrodes into contact with the respective co-operating electrode of its associated group to short-circuit the same and extinguish the discharge between the one electrode of each group and to cause a momentary discharge between the co-operating electrodes of the remaining group with attendant short-circuiting thereof and extinguishment of said momentary discharge.

5. A gaseous electric device comprising an envelope provided with an ionizable medium therein, a plurality of electrodes within said envelope

arranged in pairs, one electrode of each pair being a heat responsive electrode adapted to emit electrons to initially cause a glow discharge between one of the electrodes of each pair thereby heating each heat responsive electrode with attendant movement of said heat responsive electrodes into contact with the other associated electrode of its pair to short-circuit the same and extinguish the discharge and to thereafter cause a momentary discharge between the remaining heat responsive electrode and the associated electrode of its pair to short-circuit the same and extinguish said momentary discharge.

6. A gaseous electric device comprising an envelope provided with an ionizable medium therein, a plurality of electrodes within said envelope arranged in pairs, one electrode of each pair being a heat responsive electrode adapted to emit electrons to initially cause a glow discharge between one of the electrodes of each pair thereby heating each heat responsive electrode with attendant movement of one of said heat responsive electrodes into contact with the other associated electrode of its pair to short-circuit the same and extinguish the discharge and to thereafter cause a momentary discharge between the remaining heat responsive electrode and the associated electrode of its pair to short-circuit the same and extinguish said momentary discharge, the other electrodes of each pair being disposed adjacent each other and interposed between the heat responsive electrode of each pair.

EDWARD CHARLES DENCH.