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D. S. GUSTIN ET AL
DISCHARGE LAMP AND CIRCUIT

2,231,999

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Fig. 1.

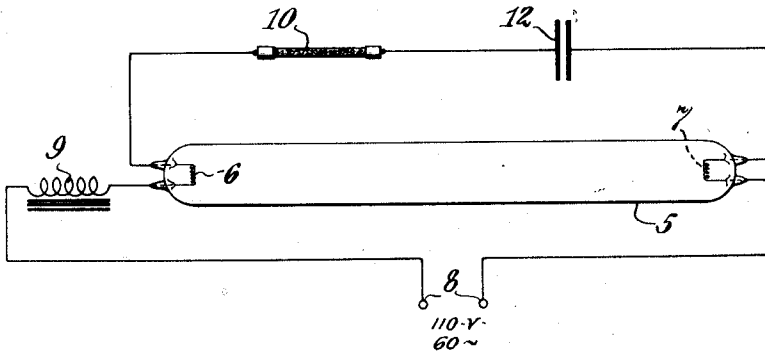


Fig. 2.

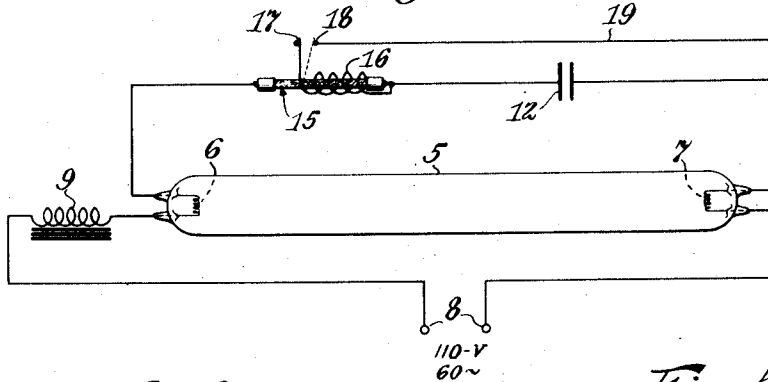


Fig. 3.

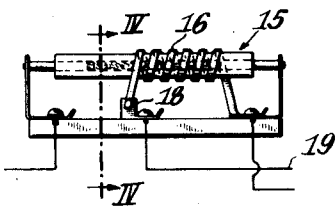


Fig. 5.

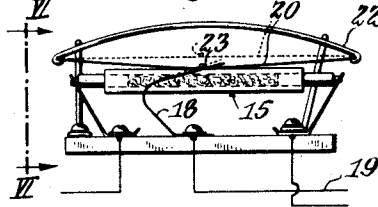


Fig. 4.

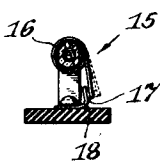
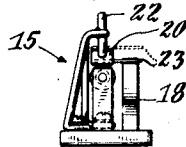


Fig. 6.



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DISCHARGE LAMP AND CIRCUIT

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11 Claims. (Cl. 176—124)

The present invention relates to discharge lamps and particularly to a starting arrangement therefor which prolongs the useful life of such lamps.

5 Discharge lamps at the present time are well known to the art, and one of the characteristics of lamps of this type is the difficulty in starting a discharge between the electrodes. In the majority of cases discharge lamps employ electrodes
10 of the type known as "cold" electrodes, that is to say, electrodes which are heated to the point of emitting electrons solely by the resulting discharge. This requires a comparatively high starting voltage, and since lamp life is dependent
15 more on the number of times the lamp is started, rather than on the number of hours burning, such lamps have had a comparatively short useful life.

To facilitate starting and thus to prolong useful life, it has been suggested in the art to employ
20 "hot" electrodes which are heated to an electron-emitting temperature prior to the imposition of a voltage across the electrodes of the lamp. In instances of this kind, the heating elements for the electrodes are usually connected in series
25 and some switching device is employed to interrupt the flow of current through the heating elements after the initiation of a discharge, since the electrodes may then be heated by the discharge itself.
30

Despite the employment of heated electrodes to lower the starting voltage, it nevertheless has heretofore been higher than the customary domestic source of supply of 110 volts. Moreover,
35 the switching device for interrupting the flow of current through the heating elements for the electrodes has been a power consuming device, which is objectionable from the standpoint that the average consumer pays for electrical energy
40 which is not converted into visible light.

It is accordingly the primary object of the present invention to provide a starting arrangement for discharge devices which is operable
45 from the customary domestic source of supply.

Another object of the present invention is the provision of a starting arrangement for gaseous discharge lamps having a low starting voltage, enabling them to be readily energized from the
50 usual commercial source of supply.

Another object of the present invention is the provision of a starting arrangement for gaseous discharge lamps wherein starting of the device from the customary domestic source of supply is
55 facilitated, and substantially all of the current

derived from the source of supply is converted into visible light.

Another object of the present invention is the provision of an impedance device connected in series with a heater element for the electrodes
5 which has a negative temperature coefficient so that upon the initiation of a discharge between the electrodes, current flow through such device is negligible.

Another object of the present invention is the provision of a thermal relay for interrupting the flow of current through the heater element for the electrodes of a gaseous discharge device,
10 which relay has a negative temperature coefficient so that after the initiation of a discharge
15 between the electrodes of the lamp, current flow through the relay is substantially negligible, thus eliminating any loss of power.

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

Fig. 1 is a schematic diagram of a starting circuit for a gaseous discharge device in accordance with the present invention;
25

Fig. 2 is a schematic diagram of a starting circuit for a gaseous discharge device showing still another form which the present invention may take;

Fig. 3 is a side elevational view showing one form which the relay shown in the circuit of Fig. 2 may take in accordance with the present invention;
30

Fig. 4 is a sectional view taken on the line IV—IV of Fig. 3 looking in the direction indicated
35 by the arrows;

Fig. 5 is a side elevational view of still another form which the relay, as shown in the circuit of Fig. 2, may take in accordance with the present invention, and
40

Fig. 6 is a sectional view taken on the line VI—VI of Fig. 5 and looking in the direction indicated by the arrows.

Referring now to the drawing in detail, in Fig. 1 a gaseous discharge device is shown comprising an evacuated envelope 5 provided with filamentary electrodes 6 and 7 consisting of a refractory metal, such as tungsten or the like, and which may be coated with a material which emits a copious flow of electrons when heated, such as the oxides of barium, strontium, or the like.
45

The envelope is provided with an ionizable medium such as mercury, sodium, or other readily volatile material, as well as an inert gas, such as argon, neon, etc., to facilitate starting. The
55

electrodes 6 and 7 are connected to a suitable source of electrical energy 8, such as the customary domestic source of 110 volts, and a self-inductance 9 is connected in series with the electrodes and the source 8.

These electrodes 6 and 7 are also connected in series through a resistance device 10 and a capacitor 12 of approximately 6 microfarads with the capacitor 12 and self-inductance 9 being of such dimensions that they are in or near resonance for the fundamental frequency of the alternating current source. The resistance element 10 has a negative temperature coefficient so that when cold, the resistance thereof is comparatively high; and, conversely, when hot, the resistance thereof is low. This device may comprise a glass tube filled with silicon crystals or the device may be formed of a solid rod of zinc oxide or similar material, so long as it has a negative temperature coefficient.

When the lamp 5 is connected to the 110 volt source 8, upon the closure of a suitable switch (not shown), the total reactance of the lamp circuit is low and the resistance is high, with the result that a small current initially flows. This current gradually heats the electrodes 6 and 7 to an electron-emitting temperature and at the same time gradually heats the resistance element 10. As the resistance element heats up, its resistance gradually decreases with a corresponding increase in current. The increase of current through the resistance device 10 is gradual enough that the increase of the electrode temperature does not lag appreciably.

By the time the current flow through the device 10 increases to substantially maximum, the voltage across the capacitor 12 rises to a value sufficient to strike an arc between the electrodes 6 and 7. Upon the initiation of the discharge, the resistance element 10 and capacitor 12 are practically disconnected from the circuit, since the current will follow the path of least resistance across the arc, and any current flowing through the resistance 10 and device 12 is very inappreciable.

Inasmuch as the resistance device 10 practically disconnects the capacitor 12 due to its high increase in resistance, the possibility of surge current flowing through the lamp is substantially eliminated. Moreover, the voltage available for starting the arc is actually higher than the voltage across the condenser, which voltage is not dangerously high, reaching a maximum of only approximately 150 volts.

The various elements of the circuit just described may be so adjusted that in case the lamp fails to start for any reason, the current will not be abnormally high, which thus dispenses with the necessity of other protective devices, such as fuses or the like. Also the inductance element 9 may be of comparatively small size, since it decreases the voltage between the line voltage of 110 to approximately 60-65 volts across the electrodes of the lamp.

Referring now to Fig. 2, the circuit differs from that of Fig. 1 in that the various elements thereof are not necessarily selected to make the circuit at or near resonance for the frequency of the supply source. In addition, what has been termed a thermal silicon relay 15, or the like, has been substituted for the resistance device 10 of Fig. 1.

However, this relay is very similar to the resistance element 10 in that it has a negative temperature coefficient and differs from the resistance element 10 solely in the provision of a coil 16 surrounding the device, which is heated by the flow

of current through the device. One end of this coil 16 is connected to one end of the tubular portion of the device 15 and one side of the capacitor 12, which latter in this particular modification may be of much smaller size of approximately 2 microfarads.

The coil 16 consists of a metal responsive to temperature changes, and its opposite end is provided with a small contact 17 which, when the device is cold, establishes a connection with a stationary contactor 18, the latter of which is connected by means of a conductor 19 to the opposite side of the capacitor 12.

In this circuit the capacitor 12 is used to produce a high voltage for starting the lamp 5 and is of such size as to impress a high enough starting voltage across the electrodes with the filaments hot to initiate a discharge, but which does not draw enough current to heat the filaments. Consequently, the thermal relay 15 is utilized to connect the electrodes in series and to short-circuit the capacitor 12 until the electrodes have reached an electron-emitting temperature, at which time the relay opens, thus connecting the capacitor again in the circuit for impressing a sufficiently high starting voltage across the electrodes.

In the normal or "cold" position of the thermal relay 15, the contacts 17 and 18 are closed. Upon closure of the switch (not shown), energy will be supplied from the source 8 which will flow through the inductance element 9, electrodes 6 and 7 and thermal relay 15. This flow of current heats the electrodes 6 and 7 to an electron-emitting temperature in the same manner described relative to Fig. 1 and at the same time causes a gradual increase in the temperature of the thermal relay 15.

As the temperature of this latter device gradually increases, it heats the coil 16, causing the contacts 17 and 18 to open due to the thermal characteristics of the material of which the coil is composed, thus connecting the capacitor 12 in series with the electrodes in the same manner as previously described with reference to Fig. 1.

Frequently the transient voltage flowing through the inductance 9 is sufficient to give a voltage kick higher than the line voltage and initiate an arc, but in order to assure a sufficiently high enough starting voltage, the capacitor 12 is nevertheless included in the circuit. This allows the voltage to build up across the capacitor to the value required to initiate a discharge between the electrodes 6 and 7. Again, as in Fig. 1, upon the initiation of a discharge, the current through the device 15 is inappreciable, since current flow is across the path of least resistance, namely, the discharge.

The thermal relay 15 will accordingly decrease in temperature and again close the contacts 17 and 18. However, as the resistance of the device 15 is very high when cold, practically no current will flow therethrough, since the voltage across the lamp has decreased to approximately 60-65 volts.

By reference to Fig. 3, one form of thermal relay is shown wherein the core may consist of a glass tube filled with silicon crystals, or a solid rod of carborundum or zinc oxide as hereinbefore mentioned. This core is surrounded by a helical metallic winding or coil having a suitable thermal expansion so that when cold, its free end flexes laterally to make and break contact with the stationary terminal or contact 18, as shown more clearly by the full and dotted lines in Fig. 4.

In Fig. 5 a slightly different modification of the thermal relay forming a part of the present inven-

tion is shown. In this embodiment, the stationary contact 18 is of angular configuration and disposed adjacent one side of the core 15. A metallic strip 20 responsive to temperature changes is supported in a saddle 22 so that when no current is flowing through the core 15, and hence the relay is cold, the strip 20 sags in the center so that a laterally extending pin 23 secured thereto, and corresponding to the contact 17, engages the stationary angular contact 18.

When current flows through the core 15 and the temperature thereof increases, the strip 20 expands and rises to the position shown by the dotted lines in Fig. 5, thus opening the contacts 18 and 23 with the result as previously described with reference to Fig. 2.

It thus becomes obvious to those skilled in the art that a starting circuit for a gaseous discharge device is herein provided wherein the device may be operated from the customary domestic source of supply. Moreover, a resistance device is employed having a negative temperature coefficient which, when cold, has a high resistance to the flow of current. This device, being connected in series with a capacitor and the electrodes of the lamp, allows the gradual flow of current there-through until the electrodes are raised to an electron-emitting temperature.

Shortly after the electrodes reach an electron-emitting temperature, the resistance device enables an increased flow of current so that a starting voltage may be built up in the capacitor, which then delivers a sufficiently high starting voltage to initiate a discharge between the electrodes. Upon the initiation of the discharge, the resistance device cools off, automatically increasing its resistance to a high enough value as to substantially preclude the flow of current there-through, thus operating to interrupt the flow of heating current through the electrodes, enabling the latter to be sustained at an electron-emitting temperature solely by the heat generated by the discharge.

In addition, a thermal relay has been herein shown and described, which relay has a negative temperature coefficient. This device may be incorporated in the starting circuit for a gaseous discharge device and operates to connect a capacitor to the circuit for the purpose of supplying a voltage in excess of the normal line voltage for initiating a discharge, after which the capacitor is again shunted from the circuit.

In both the modifications herein shown and described, the device utilized for interrupting the flow of heating current through the electrodes is such as to consume no power during operation of the device.

Although several embodiments of the present invention have been shown and described, it is to be understood that other embodiments thereof may be made without departing from the spirit and scope of the appended claims.

What is claimed:

1. The combination of an electric discharge device comprising a container having a gaseous atmosphere therein, electrodes sealed in said container and each provided with a pair of terminals, a source of electrical energy of the usual domestic potential connected to one terminal of each electrode, and means having a negative temperature coefficient of resistance interposed between the remaining electrode terminals for connecting said electrodes in series to said source to heat said electrodes to an electron-emitting temperature and operable to reduce the flow of heating cur-

rent through said electrodes upon initiation of a discharge between said electrodes.

2. The combination of an electric discharge device comprising a container having a gaseous atmosphere therein, electrodes sealed in said container and each provided with a pair of terminals, a source of electrical energy of the usual domestic potential connected to one terminal of each electrode, a self-inductance element interposed between said source and the terminal of one of said electrodes, and means interposed between the remaining electrode terminals for connecting said electrodes in series to said source to heat said electrodes to an electron-emitting temperature, said means including an element having a negative temperature coefficient of resistance and a high resistance when cold which gradually decreases as said element becomes heated simultaneously with heating of said electrodes and operable to reduce the flow of heating current through said electrodes upon the initiation of a discharge between said electrodes.

3. The combination of an electric discharge device comprising a container having a gaseous atmosphere therein, electrodes sealed in said container and each provided with a pair of terminals, a source of electrical energy of the usual domestic potential connected to one terminal of each electrode, a self-inductance element interposed between said source and the terminal of one of said electrodes, and means interposed between the remaining electrode terminals for connecting said electrodes in series to said source to heat said electrodes to an electron-emitting temperature, said means including an energy accumulating device for storing and delivering a starting voltage sufficient to initiate a discharge between said electrodes, and an element having a negative temperature coefficient of resistance and a high resistance when cold which gradually decreases as said device becomes heated simultaneously with heating of said electrodes and operable to reduce the flow of heating current through said electrodes upon initiation of the discharge.

4. The combination of an electric discharge device comprising a container having a gaseous atmosphere therein, electrodes sealed in said container and each provided with a pair of terminals, a source of electrical energy of the usual domestic potential connected to one terminal of each electrode, a self-inductance element interposed between said source and the terminal of one of said electrodes, and means connecting said electrodes in series to said source of electrical energy to heat said electrodes to an electron-emitting temperature and for reducing the flow of heating current through said electrodes upon the initiation of a discharge between said electrodes, said means being so proportioned relative to said self-inductance element that they are in resonance for the fundamental frequency of the source.

5. A circuit for starting and operating an electric discharge device having electrodes therein to be heated to an electron-emitting temperature prior to the initiation of a discharge and each provided with a pair of terminals comprising a source of electrical energy of the usual domestic potential connected to one terminal of each of said electrodes, and an energy storage device and an element having a negative temperature coefficient of resistance connected to the remaining terminals of said electrodes to connect the latter in series to said source of heating said electrodes to an electron-emitting temperature, and for sup-

plying a voltage to said electrodes sufficiently high to initiate a discharge, and said element having a negative temperature coefficient of resistance being operable to reduce the flow of heating current through the series connected electrodes upon the initiation of the discharge.

5 6. A circuit for starting and operating an electric discharge device having electrodes therein to be heated to an electron-emitting temperature
10 prior to initiation of a discharge and each provided with a pair of terminals comprising a source of electrical energy of the usual domestic potential connected to one terminal of each of said electrodes, and an energy storage device and an
15 element having a negative temperature coefficient of resistance connected in series with each other and with the remaining terminals of said electrodes, said energy storage device being operable to supply a starting voltage to said electrodes sufficient to initiate a discharge after said electrodes
20 have attained an electron-emitting temperature, and said element having a negative temperature coefficient of resistance being operable to gradually decrease in resistance as it becomes heated
25 by said source simultaneously with the heating of said electrodes and operable to increase in resistance and reduce the flow of heating current through said electrodes following initiation of the discharge.

30 7. A circuit for starting and operating an electric discharge device having electrodes therein to be heated to an electron-emitting temperature prior to initiation of a discharge and each provided with a pair of terminals comprising a source
35 of electrical energy of the usual domestic potential connected to one terminal of each of said electrodes, means adapted to be connected to the electrodes of said discharge device for supplying a starting voltage sufficient to initiate a discharge,
40 and a thermal relay having a negative temperature coefficient of resistance interposed between the remaining terminal of said electrodes for connecting said electrodes in series to said source to heat said electrodes to an electron-emitting temperature, and said thermal relay being operable
45 to open and close a low resistance path in parallel with said means and to reduce the flow of heating current through said electrodes upon the initiation of a discharge therebetween.

50 8. A circuit for starting and operating an electric discharge device having electrodes therein to be heated to an electron-emitting temperature prior to initiation of a discharge and each provided with a pair of terminals comprising a source of
55 electrical energy of the usual domestic potential

connected to one terminal of each of said electrodes, an energy accumulating device adapted to be connected to the electrode of said discharge device for accumulating a starting voltage and delivering the same to said electrodes to initiate a
5 discharge therebetween, and a thermal relay having a negative temperature coefficient of resistance interposed between the remaining terminal of said electrodes for connecting said electrodes in series to said source to heat said electrodes to an electron-emitting temperature, said thermal relay
10 being provided with contact terminals operable to complete a parallel circuit including said energy accumulating device upon the relay becoming heated simultaneously with the heating of said
15 electrodes, and operable to reduce the flow of heating current through said electrodes upon the initiation of a discharge therebetween.

9. The combination of an electric discharge lamp having a pair of electrodes one of which is
20 of the filamentary type, an inductance element in series with said lamp, an impedance device connecting one end of the filamentary electrode to the other electrode, and a thermo-expansive element in position to be distorted by the heat developed
25 in said impedance device when the latter passes current to cause a variation in the current supplied to said filamentary electrode.

10. The combination of an electric discharge lamp having a pair of electrodes one of which is
30 of the filamentary type, an inductance element in series with said lamp, an impedance device having a negative temperature coefficient of resistance connecting one end of the filamentary electrode to the other electrode, and a thermo-expansive
35 element in position to be distorted by the heat developed in said impedance device when the latter passes current to cause a variation in the current supplied to said filamentary electrode and initiation of a discharge between said electrodes.
40

11. The combination of an electric discharge lamp having a pair of electrodes one of which is
45 of the filamentary type, an inductance element in series with said lamp, an impedance device connecting one end of the filamentary electrode to the other electrode and having an impedance large compared with that of said inductance element, and a bimetallic element in position to be distorted by the heat developed in said impedance device when the latter passes current to cause a
50 variation in the current supplied to said filamentary electrode and initiation of a discharge between said electrodes.

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