Feb. 29, 1944. L. W. COOK 2,343,172

STARTING SWITCH AND LOCK-OUT DEVICE FOR ELECTRIC DISCHARGE LAMPS

Filed April 4, 1942

Fig. 1.

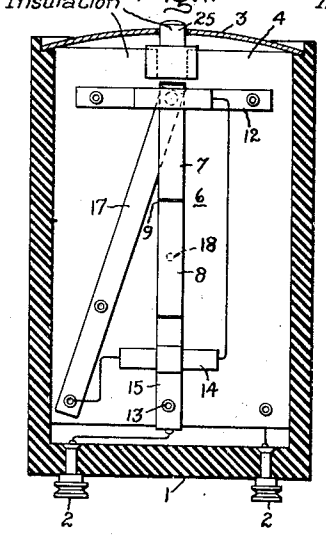


Fig. 2.

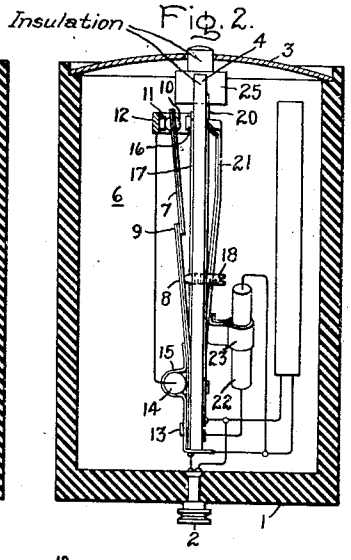


Fig. 3.

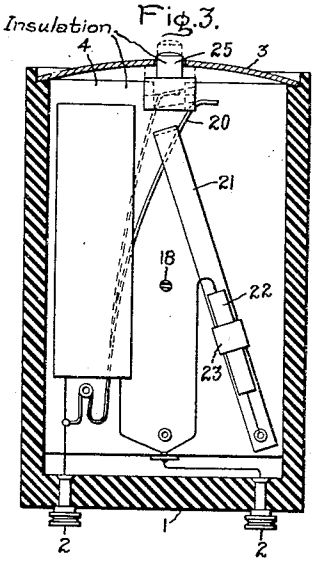


Fig. 4.

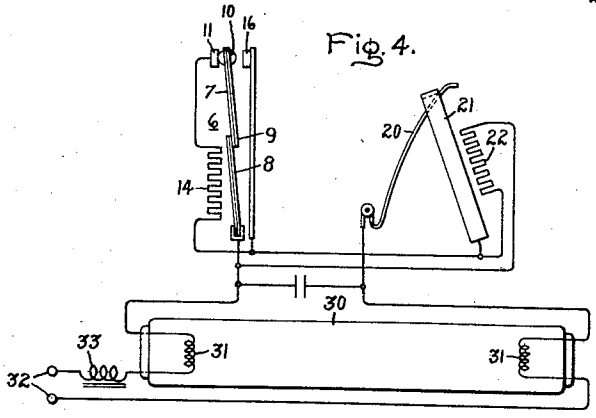


Fig. 5.

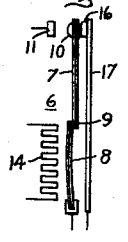


Fig. 6.

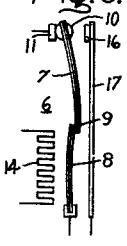
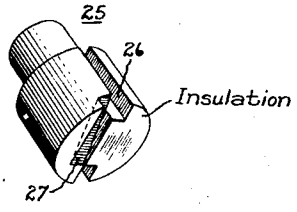


Fig. 7.



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UNITED STATES PATENT OFFICE

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STARTING SWITCH AND LOCKOUT DEVICE FOR ELECTRIC DISCHARGE LAMPS

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Application April 4, 1942, Serial No. 437,689

4 Claims. (Cl. 315—100)

My invention relates to the starting of electric discharge lamps. Such lamps of a form in common use at the present time, for example fluorescent lamps, are provided at opposite ends with thermionic electrodes of filamentary form which prior to the starting of the discharge in the lamp have their temperatures raised to the point of electron emission by passing current through them in series with the ballasting means employed. When the temperature of the electrodes has reached that point the circuit is interrupted between them automatically by some form of switch whereby a surge of sufficient voltage is produced across the device to start the discharge. The electrodes of such lamps usually comprise a coil of refractory metal wire such as tungsten coated with suitable electron emissive material such as an alkaline earth oxide and are enclosed in a sealed envelope containing a rare gas or vapor, or both, in which the discharge takes place.

Not infrequently the discharge fails to start at the first opening of the switch for, if at the instant of opening, the current is at or near the zero value of the wave, the applied voltage may be insufficient to effect starting so that a second or even a third attempt may be required before a discharge in the lamp is started. In the event that the lamp is defective or has become so in use and will not start due, for example, to a loss of emission of its electrodes or to contamination of its gaseous filling such as would result from a leak in the envelope, the switch will make repeated efforts to start the lamp. The repeated glowing of the electrodes of the lamp in its unsuccessful attempts to get started may soon become annoying to a person observing the lamp; moreover, if this condition is allowed to continue, it may result in the overheating of the lamp ballast and in the injury or destruction of the starting switch.

One object of my invention is the production of an improved starting switch which after having made a number of unsuccessful attempts to start a discharge in the lamp with which it is used will automatically cease making further attempts.

Another object of my invention is the provision in combination with a lamp and a starting switch therefor of a device which after the switch has made a number of successive unsuccessful attempts to start the lamp will operate automatically to deenergize the circuit of the starting switch and before the switch can again function as such will require the manual operation of means to effect the reenergization of the switch.

My invention will be better understood from the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

Referring to the drawing, Figs. 1, 2 and 3 are cross sectional views of an embodiment of my invention showing the switch structure respectively in front, side and rear elevation; Fig. 4 is a circuit diagram; Figs. 5 and 6 are detail views of the starting switch as it appears under different operating conditions; and Fig. 7 is a detail of the re-set button for the lock-out device. In Figs. 1, 2 and 3 the starting switch and lock-out device are shown mounted within the enclosing casing 1 preferably constructed of insulating material having the terminals 2 projecting from one end thereof by which the casing is adapted to be secured in a suitable socket and the switch and lock-out device electrically connected with the discharge device. The open end of the casing is shown closed by the disk 3 which is adapted to be sprung into position. Snugly fitting within the casing 1 is the transverse plate 4 of insulating material which serves to support the various elements of the switch and lock-out device. Secured to the plate 4 at one side thereof is the thermal switch 5 which comprises the two parts 7 and 8 each composed of a bimetallic strip. The two strips are welded together at the point 9 with the one reversely arranged with respect to the other whereby in response to an increase in temperature the lower part 8 warps to the right, as viewed in Fig. 2, and the upper part 7 warps to the left. At its upper end the thermal member is provided with the ball-like contact 10 which in the unheated condition of the thermal member makes engagement with the back contact 11 supported from the plate 4 by the strap 12. The lower end of the thermal member 8 is secured to the plate 4 by the rivet 13 and adjacent to that end the resistance heater 14, which may have a resistance of 8,000 ohms, is held in good thermal relation therewith by the strap 15 which I weld to the part 8 above the heater and which preferably is of material such as steel which has low heat capacity. As shown on the drawing, the same rivet 13 serves to secure both the thermal member and that part of the strap 15 below the heater to the plate 4. When the lower part 8 of the thermal member is heated by the heater 14, it warps moving the contact 10 out of engagement with the back contact 11. Although this opens the circuit of the heater, the heat inertia of the thermal system carries the contact 10 into engagement with the front contact 16 thereby closing the electrode heating circuit. The contact 16 is secured to the strap 17 which may be fastened by rivets to the plate 4. The small screw 18 which is threaded into the plate 4 and engages the lower part 8 of the thermal member enables one to adjust the initial tension of the thermal member thereby determining the contact pressure between the contact 10 and the cooperating back contact 11. If the screw 18 is adjusted to produce but a slight ten-

sion in the thermal member and hence a very light initial pressure between the contacts 10 and 11, the part 8 of the thermal member may be warped sufficiently to make those contacts disengage after only a small amount of heat has been applied but that small heat impulse may not suffice to warp the thermal member far enough to make the contact 10 engage the front contact 16. Moreover, if the screw is adjusted to produce a large initial tension in the thermal member and hence considerable pressure between the contacts 10 and 11, the thermal member even though heated to a much higher temperature than before still may not be able to move the contact 10 into engagement with the contact 16 because of the great tension in the thermal member. The adjustment of the screw 18 to select the proper tension of the thermal member therefore is critical between certain well defined limits.

Mounted on the opposite side of the plate 4 by rivets is the lock-out device which comprises the resilient member 20 which may be a small steel wire and the latch 21 therefor which, as shown, comprises a bimetallic strip whose upper end is bent at right angles to the body of the strip and is bevelled as shown in Fig. 2. When not heated, the bevelled end of the latch 21 is pressed against the plate 4 and thereby restrains the spring 20 in the circuit closing position shown in Fig. 3. The latch 21 is arranged to be heated by the resistance heater 22, which may have a resistance of 30,000 ohms, and is thermally connected with the heater by the yoke 23 which preferably is constructed of copper. Since time delay is necessary in the action of the latch, I prefer to employ copper for the yoke because of its high specific heat and high conductivity. The yoke absorbs a large quantity of heat produced in the heater and later transmits the absorbed heat efficiently to the latch 21 without radiating it to other parts of the apparatus.

In response to being heated by the heater, the latch 21 warps away from the plate 4 to release the spring 20, the released position of the spring being indicated by dotted lines. In order that the spring may be re-set after it has been released and without requiring the opening of the enclosing casing, I have provided the resetting button 25, the shank of which slides freely through an opening in the disk 3 and the enlarged base portion has slots 26, see Fig. 7, formed therein which receive and are guided by parts of the plate 4 bordering a portion cut away to receive the button. The under side of the button has the bevelled slot 27 which receives the bent upper end of the spring 20, the construction being such that when the spring is released by the latch 21, its movement to the left, as seen in Fig. 3, pushes the button upward and when the button is pushed down by the finger of a person to re-set the lock-out device, the spring 20 is forced to the right past the bevelled end of the latch 21 and is thereby retained in that position.

The circuit connections of the starting switch and lock-out device are more clearly shown in the circuit diagram comprising Fig. 4, where the discharge lamp 30 having electrodes 31, the starting switch, and the lock-out device are shown connected to a source of alternating current supply 32, such, for example, as a 220-volt, 60-cycle lighting circuit through the ballast reactor 33.

The operation of the apparatus is as follows. When the apparatus is initially connected with the source of supply, a series circuit is closed through the ballast reactor 33, the electrode 31 at one end of the lamp, the thermal member 6, contacts 10 and 11, the resistance heater 14, the bimetallic strip 21, spring 20 and the other electrode 31, the heater 22 being subject to the potential difference across the lamp. Because of the high resistance of the heater 14, the voltage applied to the heater 22 at this time is substantially that of the source, and the current which flows is not sufficient to heat the lamp electrodes appreciably. Heat delivered to the part 8 of the thermal member from the heater 14 causes that part to warp to the right and the contact 10 to disengage from the back contact 11 thereby opening the circuit of the heater. Because of the temperature head of the heater 14, heat continues to flow from the heater to the part 8 even after the circuit of the heater has been opened and by the resulting continued warping of the part 8 the contact 10 is carried to the right until it engages the front contact 16, the switch in that position being illustrated by Fig. 5. A low resistance path is thus closed between the two electrodes 31 and the resulting current flow quickly raises the temperature of the electrodes to the point of electron emission. By the time they have reached that temperature or soon thereafter the part 8 will have cooled sufficiently to cause its contact 10 to separate from the front contact 16 and thus open the electrode heating circuit and, in the well known manner, apply a high inductive starting voltage to the lamp. The lamp presumably then starts. By reason of further cooling of the part 8 the contacts 10 and 11 reengage and the voltage applied to the heater 14 drops from a value which previously was substantially equal to that of the source to the value of the arc drop voltage of the lamp. The heater with the latter voltage applied to it, however, is unable to supply sufficient heat to the thermal member to cause the contacts 10 and 16 again to engage to close the electrode heating circuit. Instead, the switch contact 10 floats between the front and rear contacts never touching the front contact 16 but intermittently touching the rear contact 11 to which it returns as a result of cooling to re-energize the heater 14. Because of the high resistance of the heater, the intermittent energization thereof by the engagement of contacts 10 and 11 produces no noticeable effect on the operation of the lamp.

Should the lamp have failed to start, the cooling of the thermal member will cause the contacts 10 and 11 to reengage each other, and because the voltage across the heater is then substantially that of the source the aforesaid operation of the starting switch will be repeated one or more times. Each time that the part 8 is heated in an attempt to start the lamp a certain amount of heat passes from the part 8 into the part 7 through the welded joint therebetween and as the temperature of the part 7 rises with continued starting attempts, it warps more and more to the left. Finally after a number of unsuccessful attempts have been made to start the lamp, which may be defective or may have become so with use, the part 7 will have become warped to the left to such an extent, as illustrated by Fig. 6, that the contact 10 will no longer disengage the back contact 11. Thus the switch will have automatically locked itself against closing the electrode heating circuit, in which condition the switch will remain until by the interruption of the current supply to the apparatus or by the replacement of the lamp, the

heater and the thermal member are allowed to cool. Inasmuch as the parts 7 and 8 comprising the thermal member 6 warp in opposite directions with a rise in temperature, the thermal member compensates for variations in temperature of the ambient since equal increases in temperature of both parts result in no appreciable movement of the contact 10.

If after the starting switch has automatically locked itself out in the manner described above because of its inability to start the lamp, the current supply is interrupted long enough for the heated parts of the switch to cool, the switch will again attempt to start the lamp when the supply voltage is restored. It has been found that with the switch so locked out, it may under certain other conditions make renewed attempts to start the lamp even though the supply voltage is not interrupted. For example, a drop in the voltage of the source of supply, a cold draft on the starting switch or a jar may be sufficient to upset the thermal balance of the switch system in its locked-out condition and cause a momentary recycling of the switch. The function of the lock-out device comprising the cooperating members 20 and 21 and the heating means of the latter is to de-energize automatically the circuit of the starting switch after the switch has made a number of unsuccessful attempts to start the lamp in order to insure that the switch shall not make any renewed effort to start the lamp due to causes such as a reduction in voltage, a cold draft on the switch, a jar or after the supply voltage has been reestablished after an interruption. Moreover, the lock-out device requires a manual resetting to effect the re-energization of the starting switch. Since the resistance heater 22 of that device is connected across the lamp and as it comprises a high resistance it is responsive to the voltage across the lamp; hence, during those intervals when the starting switch contacts 10 and 16 are not in engagement, the heater 22 is energized. This heater, the bimetallic latch 21, and the thermal connection therebetween are so constructed that after the starting switch has made a number of unsuccessful attempts to start the device and has ceased to make further attempts sufficient heat is received by the latch 21 from its heater 22 to cause it to release the spring 20 thus opening the circuit by which the switch is energized. It will be noted that whereas substantially the full voltage of the source is applied to the heater 22 before the lamp starts (except during those intervals when the contacts 10 and 16 are in engagement) after it starts, the voltage applied to the heater is only that of the arc drop across the lamp. The latter voltage produces insufficient heat in heater 22 under normal lamp conditions to actuate the latch 21 even though applied continuously.

Many discharge lamps, particularly those which have nearly reached the ends of their useful lives, operate dimly and in a flickering manner since the arc discharge on each half cycle occurs well up on the voltage wave and the arc drop voltage is nearly equal to the no-load voltage supplied to the lamp. The starting switch may be able to start such a lamp but the continued operation thereof may be very annoying to those using the lamp. A further function of the lock-out device which I have provided is that with such a lamp operating the heat produced by the heater 22 will be great enough to release the latch 21, thus opening the circuit of the starting switch. The lamp continues to operate, but to extinguish it one needs only to interrupt the supply voltage for an instant. The lock-out device having already opened the starting switch circuit, the lamp cannot restart.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a starting switch for an electric discharge lamp constructed alternately to insert high resistance between its terminals and to provide a short circuit therebetween, a lock-out switch biased to open circuit position connected in series with said starting switch, latching means for holding said lock-out switch closed, a high resistance heater connected across said starting switch and means responsive to a predetermined amount of accumulated heat received from said heater during a plurality of successive periods of high resistance between said terminals for releasing said latching means.

2. In combination, an electric discharge lamp having spaced electrodes adapted to be preheated by current flow therethrough, means for connecting one end of each of said electrodes with a source of current supply, a starting switch for said lamp connected between the other ends of said electrodes and constructed alternately to close and open until the lamp starts, a heater responsive to the voltage between said other ends of the electrodes, and a thermal switch arranged to interrupt the connection between said starting switch and said lamp in response to heat received from said heater and accumulated during a plurality of unsuccessful operations of said starting switch, the heat of said heater being insufficient under normal lamp conditions to open said thermal switch after the lamp starts.

3. In combination, an electric discharge lamp having spaced electrodes adapted to be preheated by current flow therethrough, means for connecting one end of each of said electrodes with a source of current supply, a starting switch for said lamp connected between the other ends of said electrodes and constructed alternately to short-circuit said lamp through its electrodes and to insert a high resistance in series therewith until the lamp starts, a resistance heater responsive to the voltage across said starting switch, and a switch arranged to interrupt the connection between said starting switch and said lamp, said switch being biased to open circuit position and provided with a latch to retain it in closed circuit position, said latch being released in response to heat received from said heater and accumulated during a plurality of the successive intervals at which a high resistance is inserted between the electrodes, the voltage applied to the heater after the lamp starts being insufficient under normal lamp conditions to cause a release of said latch.

4. In combination, a starting switch for an electric discharge lamp constructed to undergo successive cycles alternately inserting high resistance between its terminals and producing a short circuit therebetween, the periods of high resistance predominating over the periods of short circuit, a lock-out switch biased to open circuit position connected in series with said starting switch, a high resistance heater connected across said starting switch and latching means constructed to release said lock-out switch in response to a predetermined amount of accumulated heat from said heater.

LEONARD W. COOK.