Aug. 25, 1942. H. W. LORD 2,294,191

STARTING SWITCH

Filed Nov. 12, 1941

Fig.1.

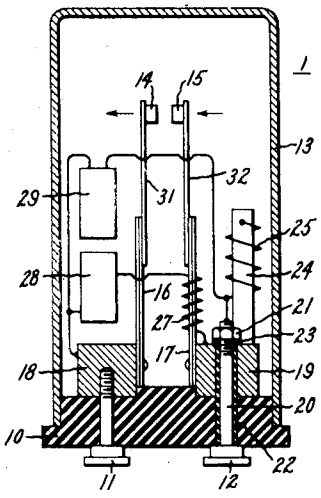


Fig.2.

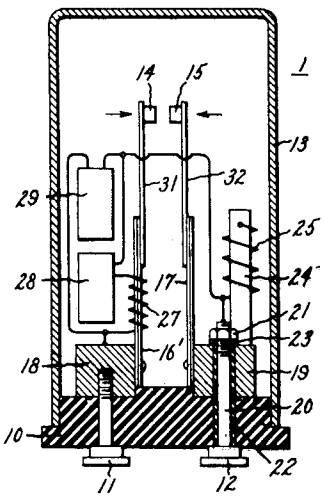


Fig.3.

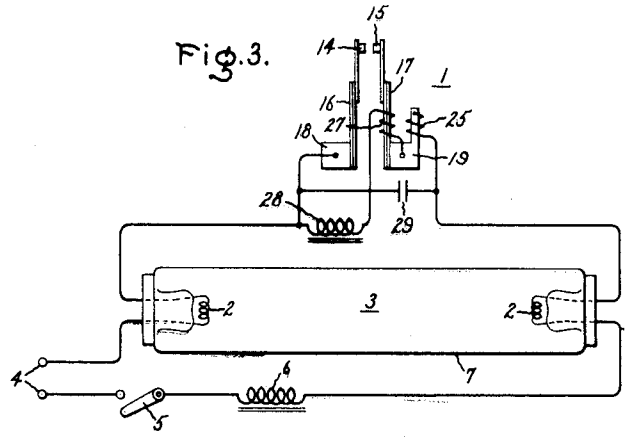
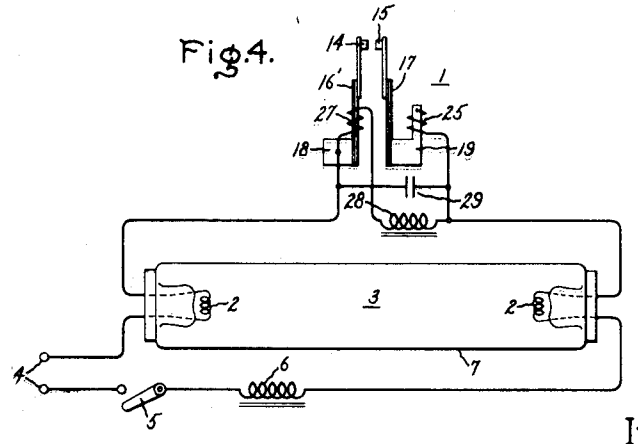


Fig.4.



Inventor:
Harold W. Lord,
by Harry E. Dunham
His Attorney.

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STARTING SWITCH

Harold W. Lord, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application November 12, 1941, Serial No. 418,737

9 Claims. (Cl. 200—122)

My invention relates to switches for starting electric discharge devices.

Discharge devices of one form in common use at the present time, such as fluorescent lamps, are provided at opposite ends with thermionic electrodes or cathodes of filamentary form which prior to the starting of the discharge in the device 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 devices usually comprise a coil of refractory metal wire such as tungsten coated with suitable electron emissive material such as alkaline earth oxides and are enclosed in a sealed envelope containing a rare gas or vapor or both in which the discharge takes place. Not infrequently the device 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 device is started.

In the event that the device 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 a contamination of its gaseous filling such as would result from a leak in the envelope, the switch will make repeated efforts to start the device. If the device is a lamp the repeated glowing of its electrodes in its unsuccessful attempts to get started may soon become quite annoying to a person observing the lamp. Moreover if this condition is allowed to continue it may result in the overheating of the ballast for the device and in the injury or destruction of the starting switch.

Where the starting switch employed is of a common form of thermal switch in which at least one of the contacts is mounted on a heat responsive deflectible member such as a bimetallic strip, I have found that there is sometimes enough heat produced by the small arc that occurs at the separation of the contacts, particularly where the deflectible member is thin and has very little mass, to interfere seriously with the intended function of the switch by causing an undesired deflection of the member.

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 device with which it is used will thereafter cease making further attempts as long as existing conditions remain the same.

Another object is the provision of an improved starting switch which if employed for starting a discharge device that is cold or is hard to start due, for example, to having deteriorated with use, will make a number of successive efforts to effect the starting of the device and will cause the closed circuit intervals of the switch corresponding to the electrode heating intervals of the discharge device progressively to increase in length.

A further object of my invention is to provide a starting switch having a contact mounted on a thermal member of light construction which will avoid the above-mentioned objection of the member becoming undesirably heated by an arc produced between the switch contacts.

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, Fig. 1 is a cross sectional view of a switch embodying my invention; Fig. 2 is a similar view showing a modification; Figs. 3 and 4 are circuit diagrams of the forms of my invention shown respectively by Figs. 1 and 2.

As represented in Fig. 3, the switch 1 comprising my invention is shown connected between the electrodes 2 of the discharge device 3 so that before it starts the discharge in the device it controls the heating of the electrodes in a well known manner. The device is shown connected with a source of supply of alternating current 4 which for example may be a 60 cycle 115 volt lighting circuit, the connections including the control switch 5 and the ballast 6 which is shown as a reactor. The device may be of the usual tubular form of fluorescent lamps now in common use comprising the glass envelope 7 containing mercury vapor at low pressure and having its inner walls coated with a suitable phosphor which under the influence of an electric discharge through the mercury vapor produces fluorescence. The electrodes 2 are shown of filamentary form and may comprise a suitable refractory metal such as tungsten wire wound in a helix and coated with a suitable electron emitting material such as barium oxide or strontium oxide.

Referring now to Figs. 1 and 3, I have shown the switch mechanism supported on the insulating base 10 and connected with the terminals 11 and 12 thereon. A suitable cap 13 fits the

base and forms therewith a dust-tight enclosure for the switch mechanism. The switch mechanism shown comprises the cooperating contacts 14 and 15 supported respectively by the thermal members 16 and 17. The member 16 is firmly secured to the metal block 18 which in turn is secured to the base 10 by the terminal 11. Member 17 is firmly secured to the metal block 19 so as to have good thermal and electrical connection therewith. The block 19 is secured to the base 10 by the terminal 12 whose shank 20 and securing nut 21 thereon are electrically insulated from the block 19 by the insulating sleeve 22 and the insulating washer 23. A portion of the block 19 comprises the upstanding post 24 upon which is the low resistance series heating coil 25. The block 19 and its post 24, constructed for example of copper, constitute a high thermal capacity member whereby considerable time is required for heat produced by the heating coil 25 to raise the temperature of the block and finally to heat the thermal member 17 connected therewith. Surrounding the thermal member 17 or otherwise in good thermal relation therewith is the heating coil 27 whose function is to heat the member 17 to cause the contact 15 to move toward and engage the contact 14. The two thermal members 16 and 17 are so constructed and arranged that as the temperature thereof increases they move their respective contacts 14 and 15 in the same direction, namely, to the left in Fig. 1 as shown by the small arrows. In series with the heater 27 is the voltage sensitive impedance 28 which preferably is a self-saturating reactor, being constructed to saturate before the discharge starts in the device when the voltage across the device is nearly equal to that of the source 4. After the discharge starts, however, the impedance offered by the voltage sensitive impedance materially decreases by reason of the lower voltage then appearing across the lamp. The series winding 25 has one end connected with the post 24 and hence with the block 19, and the other end connected with the terminal 12 whereby whenever the two switch contacts 14 and 15 engage each other the winding 25 is included in the low impedance path between the electrodes through which electrode heating current passes during the electrode preheating interval. Inasmuch as both of the thermal members 16 and 17 deflect in the same direction in response to an increase in temperature they serve to compensate for variations in the temperature of the ambient. The usual capacitor 29 connects between the two terminals of the switch for the purpose of reducing the sparking at the contacts and for reducing radio interference.

The contacts 14 and 15 are supported from the thermal members 16 and 17 by means of the strips 31 and 32 which form extensions of the thermal members. These strips are constructed of material having low heat conductivity whereby heat of the arc produced between the contacts is not readily transmitted to the thermal members. I have found that stainless steel is quite satisfactory for the construction of the members 31 and 32.

The operation of the apparatus, as shown in Figs. 1 and 3, is as follows: When the switch 5 is closed to energize the discharge device current flows in series through the electrodes 2, the impedance 28, the heaters 27 and 25 and the ballast 6. This current is not sufficient materially to heat the electrodes but by energizing the heater 27 heats the thermal member 17 to cause it to deflect and move its contact 15 into engagement with the contact 14, short circuiting heater 27 and impedance 28. This provides a low impedance path including the series heater 25 between the electrodes whereby the resulting current quickly raises the temperature of the electrodes to the point of electron emission. By that time or soon after, the thermal member 17 will have cooled enough to separate the contacts and by their separation a voltage surge is produced in the well known manner across the device which presumably is sufficient to start the discharge therein. If it starts the resulting lower voltage applied to the impedance 28 and the heater 27 is insufficient to cause enough heat to be supplied to that heater to cause the switch contacts to reengage, hence the discharge device continues to operate with the switch in open circuit position. If the device fails to start upon the first attempt of the starting switch the switch may make a second or third attempt, the above described cycle of operation being repeated one or more times.

Should the device be defective or should it become so as a result of continued use and as a result thereof the switch continues to make successive unsuccessful attempts to start the device, the accumulated heat produced by the series heater 25 which is effectively energized each time that the switch contacts close will finally raise the temperature of the block 19 and hence the thermal member 17 to the point where the contact 15 will permanently engage contact 14 thus maintaining the switch in closed circuit position and preventing any further attempts of the switch to start the device. The switch thus will be locked in closed circuit position.

If the device is cold or is defective only to the extent that it is hard to start, the switch may make a number of unsuccessful efforts to start the discharge before it is finally successful and before it is automatically locked closed. It is to be noted that heat which with each successive operation of the switch is supplied by the winding 25 to the block 19 and accumulated thereby is steadily transferred to the thermal member 17. This results in a steady decrease in the successive gaps separating the contacts 14 and 15 as the switch goes through its cycles of operation whereby the periods during which the contacts are in engagement and hence during which the electrodes are being preheated steadily become longer. This operation favors the starting of a lamp which is hard to start since at each successive starting attempt made by the switch the electrodes are given a greater heating than before.

In the modified form of my invention as shown by Fig. 2 the parts and the arrangement thereof are similar to that shown by Fig. 1 except that the thermal member 16' is constructed and arranged to move its contact 14 in the opposite direction, that is to the right, when its temperature is raised as shown by the small arrow; also, the heater 27 in this case surrounds or is in good thermal relation with the thermal member 16', the other thermal member 17 being without a heater thereon. However, this thermal member is heated as before by heat produced by the series winding 25 accumulated by the block 19.

The operation of this form of my invention is similar to that described above in connection with the form shown by Fig. 1 with the exception that the thermal member 16', the member supporting the contact 14, is deflected by current through the heater 27 to cause the switch to close and the thermal member 17 is deflected

only by heat transmitted to it from the series winding 25 through the heat accumulating block 19.

While I have shown and described the voltage sensitive impedance 28 as being a saturable reactor I may employ various other voltage sensitive impedance means such as a glow discharge device or that known to the trade as "Thyrite."

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

1. A thermal switch for controlling a circuit comprising a plurality of cooperating contacts biased to open circuit position, time delay means responsive to a potential difference between said contacts for causing them to engage each other whereby they alternately close and open the circuit thereof, and means operative after said contacts have successively closed and opened said circuit a number of times for holding them in closed circuit position, said means comprising means for accumulating energy in said circuit during the successive closed circuit intervals thereof.

2. A thermal switch for controlling a circuit comprising a plurality of cooperating contacts biased to open circuit position, means responsive to a potential difference between said contacts for producing heat, means responsive to said heat for causing said contacts to engage each other whereby they alternately close and open the circuit thereof, and means operative after said contacts have successively closed and opened the circuit a number of times for holding them in closed circuit position, said means comprising a resistance heater in series with said contacts and having a high thermal capacity coupling with said heat responsive means.

3. A thermal switch for controlling a circuit comprising a plurality of cooperating contacts biased to open circuit position, a resistance heater connected between said contacts, means responsive to said heater for causing said contacts to engage each other whereby they alternately close and open the circuit controlled thereby, and means operative after said contacts have successively closed and opened the circuit a number of times to hold them in closed circuit position, said means comprising a resistance heater in series with the contacts and heat storage means for transferring heat produced by said series heater to said heat responsive means.

4. A thermal switch for controlling a circuit comprising a plurality of cooperating contacts biased to open circuit position, a resistance heater connected between said contacts, a thermal member for moving one of said contacts into engagement with the other contact in response to heat produced by said heater whereby said contacts alternately close and open the circuit controlled thereby, and means operative after the contacts have successively closed and opened the circuit a predetermined number of times to hold them in closed circuit position, said means comprising a second resistance heater connected in series with said contacts and a heat storage member associated with said second resistance heater and with said thermal member.

5. A starting switch for an electric discharge device comprising a plurality of cooperating normally spaced contacts arranged to be connected with a source of current supply, a resistance heater bridged across said contacts, a thermal member responsive to heat produced by said heater for causing said contacts to engage each other whereby the contacts alternately engage and disengage, and means connected in series with said contacts operative to produce heat and means for accumulating the heat produced during a plurality of successive engagements of the contacts, said thermal member being arranged to be responsive to the accumulated heat for holding the contacts in engagement.

6. A starting switch for an electric discharge device comprising a plurality of cooperating contacts biased to open circuit position, a thermal member for moving each of said contacts, a resistance heater connected between said contacts and arranged to heat one of said thermal members for causing it to move its contact into engagement with the other contact, whereby said contacts go through successive cycles of alternate closing and opening, and means operative after a plurality of such cycles for maintaining the contacts in closed circuit position comprising a second resistance heater connected in series with said contacts and a metallic mass for receiving heat produced by said second heater and transferring it to one of said thermal members.

7. A thermal switch for controlling a circuit comprising a plurality of cooperating contacts biased to open circuit position, a resistance heater connected between said contacts, means responsive to said heater for causing said contacts to engage each other whereby they go through successive cycles of alternate closing and opening, and means operative after said contacts have initially engaged each other to cause the periods of engagement thereof during the subsequent successive cycles to gradually lengthen.

8. A switch comprising a plurality of cooperating contacts biased to open circuit position, means responsive to a potential difference between said contacts for causing them to engage each other whereby they alternately engage and disengage each other, and means comprising an energy storage device responsive to the energy stored during a number of successive engaging intervals of said contacts for causing a lengthening of the time said contacts thereafter engage each other.

9. A thermal switch for controlling a circuit comprising a plurality of cooperating contacts biased to open circuit position, a resistance heater connected between said contacts, means responsive to said heater for causing said contacts to engage each other whereby they alternately close and open the circuit controlled thereby, and means operative after said contacts have successively closed and opened the circuit a number of times to cause a lengthening of the times that the contacts thereafter close the circuit, said means comprising a resistance heater in series with said contacts and heat storage means associated with said series heater and with said heat responsive means.

HAROLD W. LORD.