

Dec. 15, 1942.

C. I. HALL

2,305,385

STARTING SWITCH

Filed Sept. 5, 1941

Fig. 1.

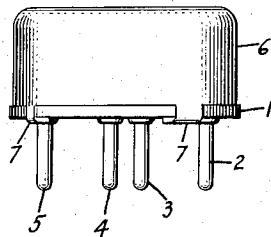


Fig. 2.

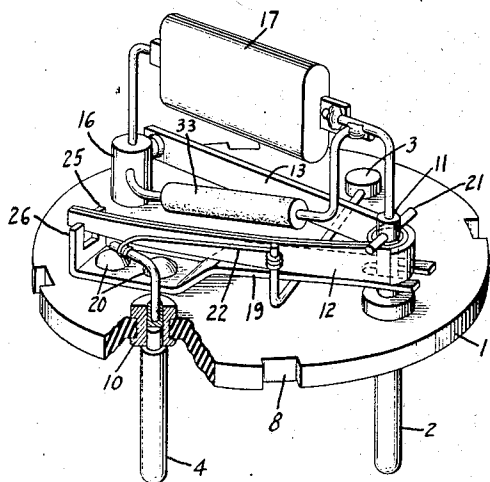


Fig. 3.

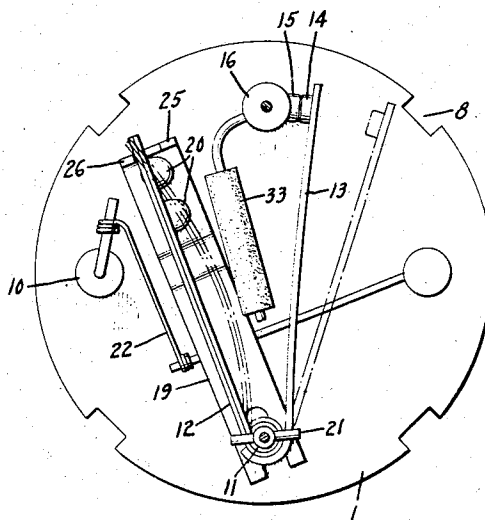
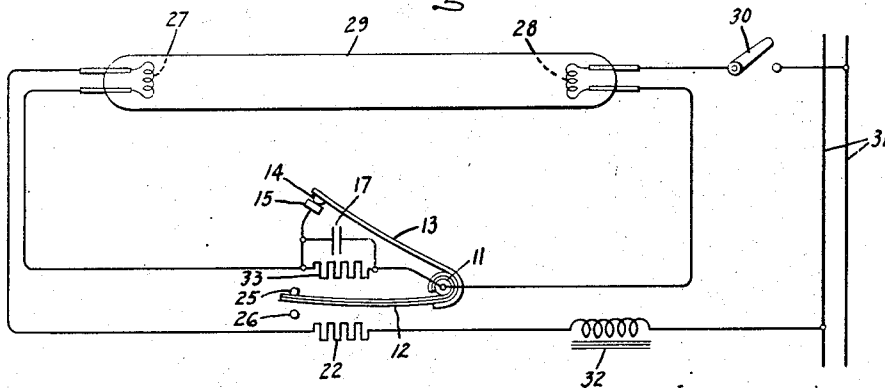


Fig. 4.



Inventor:
Chester I. Hall,
by *Harry C. Dunham*
His Attorney.

UNITED STATES PATENT OFFICE

2,305,385

STARTING SWITCH

Chester I. Hall, Rexford, N. Y., assignor to General Electric Company, a corporation of New York

Application September 5, 1941, Serial No. 409,610

6 Claims. (Cl. 200-122)

My invention relates to switches for starting electric discharge devices.

Discharge devices of a 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 temperature 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 metal vapor or both in which the discharge takes place. It is well known that if the temperature of the electrodes is materially lower than that at which free electron emission occurs at the instant that the starting voltage is applied to the device the electrodes will be injured by having more or less of the coating thereon knocked off. 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.

Serious damage to the electrodes of such devices has been found to occur with various starting switches in common use. The switch may provide ample time delay for the electrodes to attain a proper temperature before the first application of the starting voltage but in the event that the device fails to start at the first attempt and requires a second or third attempt, it has been found that at some or all of those subsequent attempts the electrode temperature has been too low to avoid injury to the electrodes. The electrodes, having as they do very small heat inertia, that is, much smaller than that of the thermal switch, may have ample time to attain their required electron emitting temperature before the switch operates to open the circuit for the first time but not on the second or other subsequent attempts. When the first attempt at starting is unsuccessful, subsequent attempts are made in rapid succession since the opening and closing movements of the switch are very slight and re-

quire only small changes in the temperature of the thermal element of the switch. Obviously, each time the switch opens in an unsuccessful attempt to start the device, the temperature of the electrodes drops rapidly due to heat losses by conduction and radiation. Before sufficient time has elapsed for the temperature of the electrodes again to rise to the required point as a result of the next closure of the switch, however, the switch will have again opened, thereby prematurely applying the starting voltage. A loss of emission due to the continued injury to the electrodes in this manner will result in starting difficulty if not in a complete failure of the device to start.

Such a failure to start whether it be due to loss of emission of the device electrodes or to contamination of the gaseous filling of the device resulting from a leak in the envelope has the further disadvantage that with the use of starting switches as heretofore commonly constructed, there is a rapid cycling of the switch in its repeated effort to start the device, in most cases from two to four times per second. This is not only injurious to the switch but is annoying to one observing the device.

It is an object of my invention to provide an improved form of starting switch for discharge devices by which the above-mentioned disadvantages may be largely if not wholly overcome. A further object of my invention is to provide such a starting switch with means which after the switch has made a number of unsuccessful attempts to start the device will thereafter be held in open circuit position as long as electric energy is supplied to the device.

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 side view of the complete switch with its enclosing cover; Fig. 2 is a perspective view of the switch drawn to a larger scale with the cover removed and with the moving parts in their normal unenergized position; Fig. 3 is a plan view of the switch also with the cover removed and with the moving parts in a different position; and Fig. 4 is a circuit diagram.

As shown by Fig. 1, the starting switch has the base 1 which may be constructed of suitable insulating material from the bottom of which project the four terminal studs 2, 3, 4, and 5. The switch mechanism which is mounted on the upper side of the base is arranged to be covered by the

cap 6 which is shown having the ears 7 arranged to fit into the notches 8 in the base and to be clinched under the base to hold the cap firmly in position. The several terminal studs are shown mounted in the base by means of rivets 10. One terminal stud, 2, has the reduced extension 11 upon which is movably and frictionally mounted the moving system of the switch. This system comprises the resilient thermal member 12 which is represented as being a bimetallic strip having one end bent to partially surround and engage the extension 11. The contact-carrying resilient arm 13 which may be a bronze strip has one end bent around the bent portion of the member 12 and firmly secured thereto as, for example, by soldering. The opposite end of the arm 13 which carries the movable contact 14 of the switch is arranged to engage the fixed contact 15, the latter contact being secured to the rivet 16 connecting with the terminal stud 5. Connected across the contact is the usual capacitor 17 for making the effect of the break between the contacts more pronounced and for reducing radio interference therefrom. The capacitor being of very small size is conveniently supported by the wires by which it is connected in the circuit.

An important feature of my invention is the provision of a frictional mounting of the thermal starting switch, that is, a frictional connection between the moving system of the switch and the stud extension upon which it is mounted. For effecting such frictional connection I have provided the spring 19 which is secured to the base 1 as by the rivets 20 and has a bifurcated end arranged to press upwardly against the bent portions of the members 12 and 13 where they surround the stud extension 11. The upward thrust of the spring 19 is opposed by the cross pin 21 extending through the stud extension 11. If preferred, one may use a washer between the moving members and the pin 21.

Connected between the terminal studs 3 and 4 is the resistance heater 22 which has small thermal storage capacity, is supported by the connecting wires thereof and is arranged adjacent to and opposite one side of the bimetallic strip 12. Movement of the free end of the bimetallic strip is limited by the two stops 25 and 26 which are represented in the drawing as comprising two ears projecting from that end of the spring 19 at which it is secured to the base. The stops are spaced apart somewhat more than the thickness of the bimetallic strip whereby the latter has a certain amount of free movement.

As shown by the circuit diagram comprising Fig. 4, the starting switch is connected between the two electrodes 27 and 28 of the electron discharge lamp 29 so as to control the initial flow of line current therethrough. In the normal unenergized position of the apparatus, as illustrated by Figs. 2 and 4, the switch contacts 14 and 15 are held firmly against each other and the bimetallic strip is in engagement with the stop 25. Upon closing the control switch 30, current passes in series from the source of supply 31 through the lamp electrodes, the switch contacts 14, 15, the heater 22 and the ballast 32. The heat supplied by the heater 22 causes the bimetallic strip to warp in a manner to move the free end of the strip away from the stop 25 into engagement with the stop 26. Because of the static friction in the mounting of the moving system of the switch the separation of the contacts 14 and 15 does not occur immediately thereafter but occurs

only after the further warping of the strip builds up sufficient force therein to overcome the mounting friction. When this happens, the arm 13 shifts by a quick movement and thereby separates the contacts 14 and 15, thus interrupting the flow of electrode heating current and causing the application of starting voltage across the lamp. Because of the length of the spring 13 and the fact that kinetic friction is always less than static friction, the contacts separate at relatively high speed, producing in effect a snap action. In Fig. 3 the bimetallic strip is shown after it has moved under the influence of the heater 22 from engagement with the stop 25 into engagement with the stop 26. Continued heating of the bimetallic strip causes it to warp further and to take approximately the shape indicated by the dot and dash lines when by the quick movement of the moving system on its friction mounting the switch opens, spring arm 13 and contact 14 taking the position indicated by the dot and dash line.

Presumably the lamp has now started, after which the current passing through the heater 22 is reduced but nevertheless is sufficient to maintain the switch in open circuit position. If the lamp did not start, the bimetallic member in cooling first re-engages the stop 25 and then after being tensioned by further cooling causes a quick return movement on the stud to effect a reclosing of the switch. Now the parts are in their original positions and since the heater 22 is reenergized with the closing of the switch the original starting cycle described above is repeated.

An important feature of my invention is that when this cycle is repeated, whether it be the second, third, or any other further attempt to start the lamp, the length of each cycle is substantially the same as the first; hence there is no possibility of the switch applying a starting voltage to the lamp in any attempt after the first at an instant when the electrodes are not at the proper temperature.

Should the lamp through some defect therein be incapable of being started by the starting switch there is a relatively slow cycling of the starting attempts, for example, one every ten seconds, in contrast to the rapid cycling, producing a flickering effect, of the many thermal switches now in common use. Such slow cycling is decidedly less annoying to a person in the vicinity of the lamp and obviously is less effective in shortening the life of the switch.

In accordance with another feature of my invention I have provided means whereby after a number of unsuccessful attempts have been made to start the lamp no further attempts will be made. For this purpose I provide an additional resistance heater having considerable thermal storage capacity. In the drawing this heater is represented at 33 as supported by its connecting wires adjacent to the bimetallic strip 12 at the side thereof opposite to the main heater 22 and connected across the switch contacts. Because of its heat storage capacity the heater 33 is not perceptibly effective immediately upon being energized but after the switch has gone through a number of cycles of unsuccessful starting attempts the bimetallic strip becomes sufficiently heated by it to maintain the switch thereafter in open circuit position. Preferably I employ for the heater 33 a voltage sensitive material such, for example, as that known to the trade as "Thyrite." Such a heater may

require from forty seconds to one minute to reach its ultimate temperature. Each time that the switch opens in an unsuccessful attempt to start a defective lamp a pulse of energy, which may be at about 145 volts on a 115 volt line, is received by the heater 33 and causes an increase in the temperature thereof until after four to six attempts the switch will be held permanently open. If, in the meantime, however, the lamp starts the voltage applied to the heater 33 is reduced to the arc drop voltage of the lamp which, for example, may be 70 volts but at this voltage the voltage sensitive heater will have a greatly increased resistance so that very little energy will be dissipated from the heater, thus insuring normal operating conditions within the switch.

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

1. A thermal switch comprising a plurality of normally closed cooperating contacts, a resistance heater having small heat storage capacity connected in series with said contacts, means responsive to said heater for opening said contacts whereby they go through successive cycles alternately opening and closing, and means operative after a number of such cycles for holding said contacts in open position, comprising a resistance heater having a large heat storage capacity associated with said heat responsive means and connected across said contacts.

2. In combination an electric discharge device having spaced electrodes adapted to be preheated by current flow therethrough, means including a resistance heater for connecting said device to be supplied from a source of current, a thermal switch responsive to said heater connected across said device and in series with said electrodes for controlling the preheating current thereof and means having high heat storage capacity and including a second resistance heater comprising voltage sensitive material connected across said contacts for slowly supplying additional heat to said switch, whereby after the device starts the energy loss in said second heater is small and if the device fails to start after the switch has made a number of trials to start it the switch is held in open circuit position.

3. A starting switch for an electric discharge device arranged to be connected between and in series with the electrodes of the device, comprising a fixed contact, a moving system including a thermal strip and another strip joined together in end-to-end relation, friction mounting means for said system arranged to engage it adjacent

to the junction of said strips, a movable contact carried by the free end of said other strip and adapted to cooperate with said fixed contact, means for limiting the movement of said thermal strip, and a heater adjacent to said thermal strip.

4. A starting switch for an electric discharge device arranged to be connected between and in series with the electrodes of the device, comprising a fixed contact, a moving system including a thermal strip and another strip joined together in end-to-end relation, friction mounting means for said system arranged to engage it adjacent to the junction of said strips, a movable contact carried by the free end of said other strip and adapted to cooperate with said fixed contact, means for limiting the movement of said thermal strip comprising stops arranged at opposite sides thereof and spaced apart a distance materially greater than the distance between said sides, and a resistance heater adjacent to said thermal strip.

5. A starting switch for an electric discharge device arranged to be connected between and in series with the electrodes of the device, comprising a fixed contact, a moving system including a thermal strip and a resilient strip joined together in end-to-end relation, friction mounting means engaging said system adjacent to the junction of said strips, a contact secured to the free end of said resilient strip for engagement with said fixed contact, stops arranged at opposite sides of said thermal strip for limiting the movement of the free end thereof, said stops being spaced apart a distance materially greater than the distance between said sides, and a resistance heater for said thermal strip connected in series with said contacts.

6. A starting switch for an electric discharge device arranged to be connected between and in series with the electrodes of the device, comprising a fixed contact, a moving system including a thermal strip and a resilient strip joined together in end-to-end relation, a post upon which said system is mounted for rotative movement, means associated with said post for frictionally engaging said system, a contact secured to the free end of said resilient strip for engagement with said fixed contact, limiting stops adjacent to the free end of said thermal strip and spaced apart a distance sufficient to allow a material movement of that end, and a resistance heater adjacent to said thermal strip and connected in series with said contacts.

CHESTER I. HALL.