Dec. 10, 1940. H. J. McCARTHY 2,224,828

ELECTRIC DISCHARGE LAMP AND STARTING DEVICE THEREFOR

Filed Sept. 1, 1939

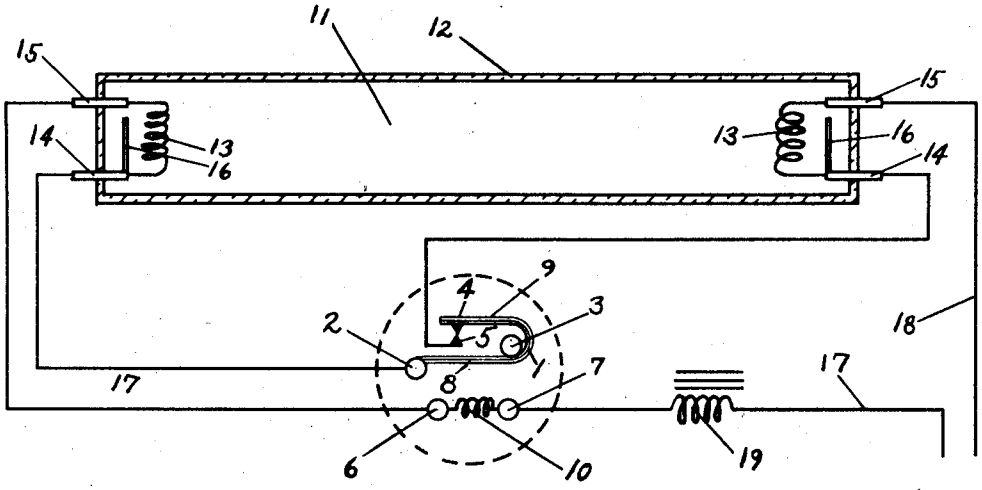

Fig. 1.

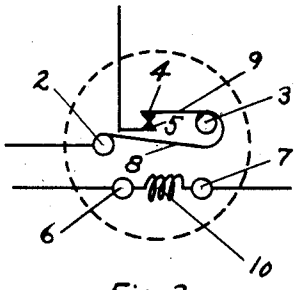

Fig. 2.

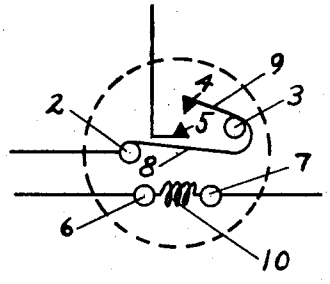

Fig. 3.

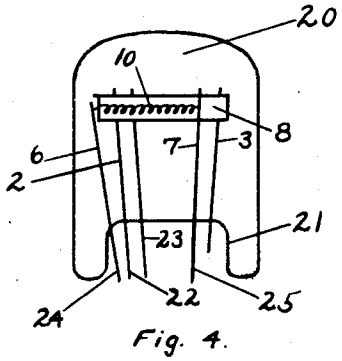

Fig. 4.

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ELECTRIC DISCHARGE LAMP AND STARTING DEVICE THEREFOR

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Application September 1, 1939, Serial No. 293,070

5 Claims. (Cl. 200—122)

This invention relates to electric gaseous discharge lamps, and in particular to such lamps having thermionic cathodes, and to apparatus for starting and operating such lamps.

An object of the invention is to provide an electric gaseous discharge lamp with thermionic cathodes and with apparatus for allowing the cathodes to preheat for a definite interval before the discharge is started between them. A further object is to provide a switch with the proper time delay to allow preheating of the cathodes under all possible conditions of starting and restarting.

A feature of the invention is a switch actuated by a bent bimetallic strip heated by a filament. A further feature is the delay secured by the initially opposing action of the two arms of the bent strip, and by the necessity for heat conduction from one arm to the other to complete the action of the switch.

Other objects, advantages and features of the invention will be apparent from the following description, taken with the accompanying drawing in which:

Figure 1 is a schematic drawing of a lamp and switch in circuit, according to the invention, with the contacts closed.

Figure 2 is a schematic view of the same switch with contacts still closed; and

Figure 3 is a schematic view of the switch with the contacts open; and

Figure 4 is a schematic side view of the switching device of which Figs. 1, 2 and 3 give a top view.

In Figure 1, a bimetallic strip 1, each of whose sides is of a different metal, one of iron and one of copper, for example, is bent in the shape of a U, one leg of the U preferably being slightly shorter than the other and attached firmly to the lead-in wire 2. A wire 3 projects into the bend of the U. A contact 4 is carried by the free end of the U, and the tension in the U is adjusted so that this contact 4 is normally closed against contact 5, which is rigidly supported. The wire 3, is placed close to the support side 8, of the U, and is spaced from the free side. A filament 10, preferably of tungsten is supported by the lead-in wires 6 and 7, so that it is close to the lower leg 8, of the U but shielded from the upper leg 9.

An electric discharge lamp 11, has the tubular glass envelope 12 with the electrodes 13, comprising a coiled-coil of tungsten wire coated with one or more of the alkaline earth oxides, sealed through each end of the tube by the lead-in wires 14, 15. The discharge tube 11, preferably contains an inert gas and mercury vapor, and may have a coating of fluorescent material on the interior surface of its envelope. A wire 16 may be connected to the lead-in wire 14, and extend along but out of contact with the filament 13, toward the other lead-in wire 15. The lead-in wires 15 at opposite ends of the lamp are connected to a suitable power supply line by the conductors 17 and 18, conductor 17 having the reactance coil 19 in its circuit to ballast the lamp during operation and to provide an inductive voltage surge at starting. The same conductor has the tungsten filament 10 of the switching device connected in series with it, although this filament 10 may be connected to the other side of the line, if desired. It should not, however, be connected in such a way that the reactance coil 19 is between filament 10 and the lamp, as in that case the voltage across the reactance coil will exist between filament 10 and the contact circuit, and cause arcing in the switching device, particularly at the instant of breaking the contacts. The lead-in wires 14, are connected together through the normally closed contacts 4 and 5 being closed a current will flow through the reactance coil 19 and the cathodes 13, heating the latter to an electron-emitting temperature and allowing a small current to flow from the wire 16 to the end of the filament 13 nearest the lead-in wire 15, as described for example, in my copending applications, Serial No. 269,423 filed April 22, 1939, and Serial No. 272,246 filed May 6, 1939. To permit such a discharge, the voltage across the filament must be above the excitation voltage of the gas in the tube, but it should be only slightly above it, to insure that the discharge will not be sufficient to damage the filament 13. For example, if the tube contains mercury vapor, whose ionizing potential is about 10.4 volts the filament drop may be 12 volts. While the filamentary electrode 13 of the discharge tube is heating up, the filament 10 of the switch device also is heating up, and is adjusted so that when the electrodes 13 reaches the proper electron-emitting temperature and is surrounded by the ions produced by the small discharge to the wire 16, the strip holding the contact 4 has just been heated sufficiently to separate the contacts 4 and 5, thus producing a voltage surge by discharging the inductance across the tube 11, starting the lamp.

When current flows through filament 10 on connecting the lamp circuit to the line, the lower part 8 of the U, nearest the filament, heats first

and moves downward bringing the upper part 9 down with it, actually making the contact between 4 and 5 more firm. When, as in Fig. 2, the upper part 8 of the U reaches the stop 3 it can move no further. The upper part 8 of the U farthest from the filament 10 has then become heated itself, however, and moves upward to break the contact between 4 and 5, as shown in Fig. 3. A definite time delay is thus secured before the contacts open, since the initial expansion of the bimetallic strip tends to keep the contact 4 and 5 closed, and since time is required for the heat to be conducted to the upper leg, the U-shaped strip should, of course, be arranged so that the ends of the U tend to move apart on expansion, which generally means that the metal of highest coefficient of expansion is on the inside of the U. The contacts may be of tungsten, but in many cases contact may be made directly from the bimetallic strip 1, to contact 5, which may be a nickel wire.

Figure 4 shows a side view of the switching device of Figs. 1, 2 and 3 with the switching unit placed in a glass bulb 20, having the stem 21, sealed to its neck. Lead-in wires 22, 23, and 24 and 25 project through the stem to support, respectively, the fixed end 8 of the U, the contact 5 (which may be one lead-in wire itself) and the end supports 6 and 7 of the filament itself. The bulb may be evacuated or filled with inert gas. The supports 6, 7, 2 and 3 are shown, for clarity, as of smaller diameter than shown schematically in Figs. 1, 2 and 3.

In order to reduce the amount of power required by the filament 10 to heat leg 8 of the bimetallic strip 1, the leg 8 may be coated with a black heat-absorbing surface, such as a layer of carbon, for example, on the side nearest the filament 10. The other side of leg 8, and both sides of the leg 9, may have a shiny, reflecting surface if desired to further reduce heat loss since these parts do not absorb heat from the filament 10.

It will be clearly seen, from the above description, that my switch gives a very definite preheating period before the switch contacts 4 and 5 open. This is due to the fact that the initial heating of the bimetallic strips 1, by the filament 10, causes the strip to move in the downward direction of the drawing, which pulls leg 9 tighter against the contact 5, holding the contact even more firmly. The heat absorbed by leg 8 is slowly conducted to leg 9, but before that leg can move to open the contacts, the tension due to the leg's being pulled downward by the bottom leg, must first be removed by the heating. The leg will then move, opening the contact.

To avoid the deterioration of the filament 13 in the discharge lamp, the contacts 4 and 5 must be kept closed for the time required for the filament 13 to heat sufficiently to allow the discharge to start instantly. The delay necessary may be only half a second but it must nevertheless be present if the lamp is to have any appreciable life.

The positive delay action of my switch is effective even when the lamp of Fig. 1 is turned off and then the circuit again closed before the bimetallic switch has had time to completely cool off. That is because the initial heating will, as before, tend at first to make the contact firmer, since the first leg 8 will be heated first. This prevents flickering of the lamp, which would occur in a switch which merely cooled off until the contact just closed and then immediately opened as the lamp current flowed through it, and opened so soon that the filaments of the lamp were not hot enough to start the discharge. Such a switch would produce a flash or flicker, through the lamp each time the contacts opened, due to the inductive discharge, and would ruin the cathode 13 without starting the lamp. My device avoids flickering.

By making the free leg 9 somewhat, but not much, shorter than supported leg 8, fairly good compensation of the device against ambient temperature changes may be achieved.

What I claim is:

1. A time delay electric switch, for discharge lamps, comprising a substantially fixed contact, a movable contact attached to a U-shaped bimetallic strip near one end of said strip, the other end being fixed to a support, a stop to limit the motion of the arm of the U nearest the support, and a heating coil placed outside of the U and shielded from the free leg of the U by the fixed leg.

2. The combination of claim 1 in which the stop is placed inside the bend of the U.

3. The combination of claim 1, in which the stop is placed inside the bend of the U, and in which the fixed contact, the fixed end of the U, the stop inside the U, and the heating coil outside the U, are attached to support wires extending from the stem of a sealed glass bulb enclosing the supported elements in the atmosphere of inert gases.

4. A time delay electric switch comprising a concentrated coiled tungsten filament as the actuating member, a U-shaped bimetallic strip with one leg close to said filament, and the other leg farther from said filament and at least partially shielded from the radiations of said filament by the first leg, the end of the first leg being fixed to a support, the end of the other leg being free but bearing a contact normally held against another and substantially fixed contact to close an electrical circuit, the bimetallic strip being arranged so that the ends of the U tend to move away from each other with increase of temperature, a stop inside the bend of the U and arranged to allow a small predetermined motion of the U-leg nearest the filament before stopping that motion and allowing the free leg to curl back to break the contact circuit.

5. A time delay electric switch for discharge lamps, comprising a substantially fixed contact, a movable contact attached to a U-shaped bimetallic strip near one end of said strip, the other end being fixed to a support, a stop to limit the motion of the arm of the U nearest the support, and a heating coil concentrated to heat the part of said U-shaped strip nearest the support.

HENRY J. McCARTHY.