

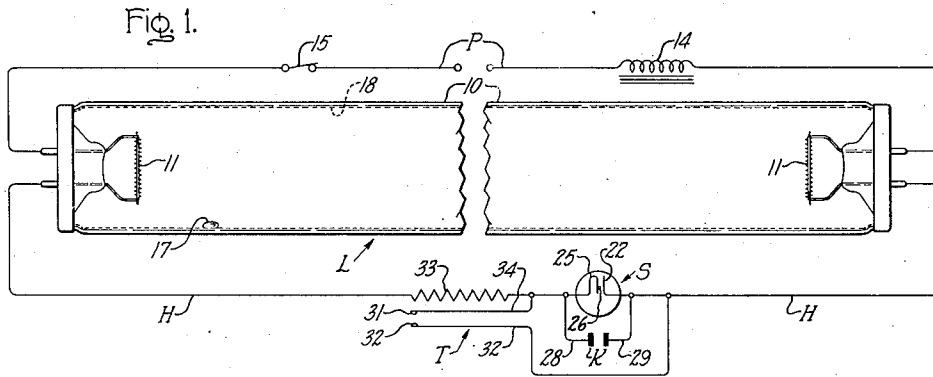
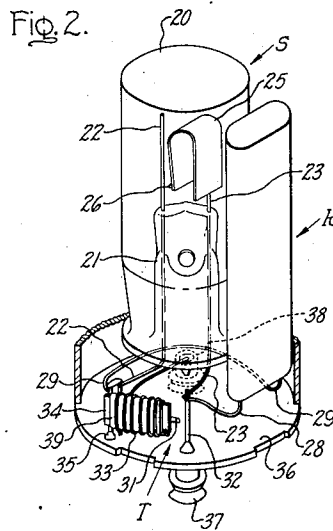
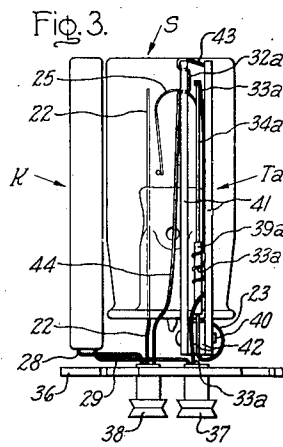
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STARTING CONTROL FOR ELECTRIC DISCHARGE DEVICES

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STARTING CONTROL FOR ELECTRIC
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1 Claim. (Cl. 315-100)

This invention relates to the control of electric discharge devices, and is especially concerned with the starting of such devices. The invention is very useful in connection with fluorescent tubes or lamps of the positive column discharge type, and is hereinafter explained with particular reference to lamps of this character and their usual starting arrangements—as exemplified in U. S. Patent 1,961,112, March 13, 1934, to Wels, or Patent 2,312,427, August 20, 1940, to Peters, for instance.

Ordinary tubular fluorescent lamps have electrical starting circuits which are made and broken to start the discharge. Sometimes this has to be done several times before the discharge actually starts. For this purpose, automatic means are commonly provided which will make and break the starting circuit indefinitely until starting is accomplished.

Through deterioration in service or as a result of accident, fluorescent lamps and other discharge devices often or eventually become incapable of starting and normal running, so that the only effect of the automatic efforts to start such a lamp is a continual flashing in it that is very annoying to those in the area that receives the light of the flashing lamp, besides uselessly wearing out the starter device. Usually, such incapacity for starting is due to loss of electron emission from one or both electrodes of the lamp, which may result from dissipation or other loss of activating material on which the emission depends. The objectionable flashing of such a lamp goes on indefinitely, until the power supply is shut off, or the lamp is removed from the circuit.

The purpose of my invention is to obviate the undesirable flashing of defective lamps without interfering with repetition of the attempts to start as long as there is any reasonable promise of success. This I accomplish by rendering the starter ineffective to open the starting circuit. Various features and advantages of the invention will become apparent from the description of one species and form of embodiment, and from the drawing.

In the drawing, Fig. 1 is a diagrammatic view of a fluorescent tube or lamp with circuit connections including my invention, a mid-portion of the lamp envelope being broken out and omitted; and Fig. 2 is a tilted or perspective view of starting switch apparatus suitable for the purposes of my invention, an enclosing casing for the apparatus being shown broken away.

Fig. 3 is a view similar to Fig. 2 illustrating a

different form of one of the switches there shown, the casing partly shown in Fig. 2 being omitted entirely.

I will first describe the portion of the circuits and apparatus shown which have heretofore been in use, and which permit the objectionable flashing of a defective lamp as described above.

Fig. 1 shows an ordinary fluorescent tube lamp L of the positive column electric discharge type with a tubular envelope 10 having spaced-apart activated thermionic cathodes 11, 11 in its ends, which may be specially heated cathodes of usual coiled filament type, and are shown connected across a power-supply circuit P including the usual ballast 14, which also serves as a starting inductance, and the manual make-and-break switch 15. The envelope 10 may contain a low-pressure atmosphere of starting gas, such as argon at a pressure of 2 to 5 mm. of mercury, and also a vaporizable and ionizable working substance such as mercury. A supply of mercury, which may exceed the amount that will vaporize during operation of the lamp L, is indicated by a drop 17 inside the envelope 10, and an internal coating of fluorescent material or phosphor 18 on the envelope walls is also indicated. A starting and electrode-heating circuit H is shown connected across the circuit P through the filamentary cathodes 11, 11, with a starting switch S included therein, which may be of a thermal type.

The general mode of operation in starting the lamp L with this circuit arrangement is that when the switch 15 is closed to turn on the lamp L, the switch device S permits flow of current through the circuit H and the cathode filaments 11, 11 in series therein for a sufficient length of time to preheat the cathodes to an adequate emissive temperature, and then suddenly opens the circuit H; and the resulting voltage kick across the cathodes 11, 11 suffices to initiate discharge between them—or, in other words, starts the lamp.

As shown in Figs. 1 and 2, the thermal switch S is of glow-switch type, comprising a glass envelope 20 containing a low pressure atmosphere of rare gas, such as argon at an absolute pressure of 25 mm. of mercury. The envelope 20 may include a stem 21 through which are sealed current leads 22, 23 that are connected to opposite sides of the circuit H, and are provided with terminals or electrodes inside the envelope between which a glow discharge takes place when the switch 15 is first closed. The lead 22 may have an extension (of nickel, for example) in-

ward or upward from the stem 21 to serve as one terminal, while the other terminal may be formed by the end of a U-bent thermostatic bimetal strip member 25 attached to the other lead 23, as by welding, and constituting the temperature-responsive element of the switch S. The free end of the member 25 lies adjacent the lead 22 to coact therewith both as an electrode for the glow discharge and as a switch contact. For the latter purpose, a contact piece 26 (as of molybdenum) is shown welded to the free end of member 25. A capacitor or condenser K is shown connected across the circuit H by its leads 28, 29 in shunt with the switch S, to minimize radio interference as well as arcing between the contacts 22, 26.

The general operation of such a switch S is that when the circuit H is energized as a result of closing the hand switch 15, a glow discharge takes place across the gap between the parts 22, 25. This discharge heats the member 25 until it unbends sufficiently to touch the part 22, thus closing the circuit H and shorting out the glow discharge. The thus augmented flow of current in the circuit H continues long enough to heat the filamentary cathodes 11, 11 to an adequate electron-emissive temperature; and by the time this has been accomplished, the thermostatic member 25 cools sufficiently to open the circuit H and start the main discharge between the electrodes 11, 11, as already described. After the main discharge has started, the voltage on the device S is no longer high enough to maintain any discharge across the gap between the parts 22, 25.

If, however, the main discharge does not start on the voltage kick due to the opening of the circuit H by the switch S as just described, a glow discharge again takes place between the parts 22, 25, and the switch S again closes and opens, just as before; and if this effort is not successful in starting the main discharge, it is repeated—and so on. If the main discharge cannot be started at all, the lamp L would (with the circuit arrangement and parts so far described) go on to flash in the objectionable manner explained above.

In accordance with my invention, means of control are provided for determining the condition of the circuit H as to continuity in such a way that after reasonable efforts of the starter S to start the main discharge, a condition of circuit H that prevents flashing of the lamp L is established and maintained, independent and regardless of any further action of starter S—indeed, the operation of starter S may be suspended. For my purpose, automatic control means may be employed whose period of operation (as fixed by design and adjustment) is long enough to include whatever number of attempts by starter S may be considered reasonably worth-while; e. g., a period of some seven to ten seconds under favorable voltage conditions, embracing some three to five attempts, say. The action of this automatic control need not be an arbitrary matter of fixed adjustments, however, but can be made responsive to the actual attempts of starter S to start the main discharge.

A simple control for this purpose is shown in Figs. 1 and 2 as comprising a thermal switch T whose contacts 31, 32 are connected across the starting circuit H in parallel with the starter S, to shunt the starter, but whose heating resistance 33 is connected into the circuit H in series with the starter S. As shown in Fig. 2, this switch T comprises as its temperature-responsive

element a thermostatic bimetal strip member 34 having one end attached by welding to an anchorage stud 35 upstanding from an insulative disc or base 36, and carrying the contact 31 (of molybdenum, for example) projecting from its free end to coact with a contact 32 in the form of a stud upstanding from the base 36. The stud 32 is shown as provided with an external connector 37 (such as a binding post at the other side of the base 36) for connecting it to one side of the circuit H, and the base carries a similar external connector 38 for connection to the other side of the circuit H. The heating resistance 33 is shown as a wire coil wound around the thermostatic strip 34 over a covering or wrapping of heat and electrical insulation 39—such as asbestos paper—which increases the thermal inertia of the thermostat and its time of operation. One end of the heating coil 33 is connected to the external connector 38; its other end is connected to the member 34, and thus to the stud 35; the starter lead 22 is connected to this same stud 35; and the other starter lead 23 is connected to the stud 32 and the other external connector 37. The condenser leads 28, 29 are shown as connected to the studs 35 and 32 between which the starter S is connected by its leads 22, 23, as just described.

In starting a good lamp L, the starter S functions in the usual way, just as if the control T were absent; i. e., its contacts 26, 22 are closed for only some 2 to 4 seconds, and the resultant heating of thermostatic member 34 is insufficient to close the control contacts 31, 32. Of course some current flows through the heater 33 during the glow discharge while the starter switch S is open, but this current is of low value, and the heating effect from it is insignificant. Even if several operating cycles of the starter S occur before the lamp L actually starts, the control contacts 31, 32 do not close, if the operating time of the control T is long enough. In the case of a defective lamp, on the other hand, the cumulation of heat in the member 34 from full energization of the heater 33 while the starter switch S is closed during repeated cycles of the starter eventually closes the control contacts 31, 32 and establishes circuit H independently of starter S. Current then flows continuously in circuit H, without any possibility of interruption or diminution by any action of starter S, and the lamp L ceases to flash.

However, if the circuit H is de-energized (by opening the hand switch 15, or by removing the defective lamp L and replacing it with a good one), and is allowed to remain de-energized long enough for the control thermostat 34 to cool off fully, the shunt at T will be opened, and the starter S will again be ready to start the lamp in the usual manner.

Fig. 3 illustrates a device also corresponding to Fig. 1, but different from that shown in Fig. 2 as regards the switch Ta. Instead of having its parts on whose relative locations its functioning depends mounted on the fiber base disc 36, which is subject to warp and affords such limited available room that the thermostat 34 in Fig. 2 must needs be very short, the switch Ta in Fig. 3 is made as a unit structurally independent of the base 36. As here shown, its bimetal thermostatic strip 34a extends parallel with the glow switch S and the condenser K, and may be as long as either of them. The lower end of the thermostat member 34a is clamped by a rivet 40 between insulative side members 41, 41 such as

fiber strips, insulative spacers 42, 42 being interposed at either side of the member 34a. The metal contact 32a that coacts with the other (free) end of the member 34a is mounted on the upper end of one of the strips or members 41, 41, 5 where they are positively and fixedly spaced apart by a metal spacer 43. As here shown, the parts 32a and 43 are formed by the upper end of a wire 44 that is laced through adjacent holes in said member 41 and then bent around the upper edge of said member so that its end engages laterally against the upper end of the other member 41. The other end of the wire 44 is shown connected to the connector 37.

In order to dispense with repetitive description, 15 various parts and features in Fig. 3 are marked with the same reference characters as their homologues in Figs. 1 and 2, a distinctive letter being added where such distinction appears necessary.

What I claim as new and desire to secure by 20 Letters Patent of the United States is:

In combination, a starting switch for a gaseous electric discharge device having spaced electrodes, said starting switch comprising a pair of cooperating contacts, means to connect said 25

contacts across said electrodes, means for actuating said contacts to repeatedly open and close them and to leave them open upon initiation of a discharge between said electrodes, and an auxiliary thermal switch comprising a pair of cooperating contacts electrically connected in multiple with said starting switch contacts, a heat responsive member carrying one of said auxiliary switch contacts and normally holding it spaced apart 5 from the cooperating contact, a resistance heater arranged to heat said heat responsive member, and means to electrically connect said heater across the electrodes of said discharge device in series with the contacts of both said switches, the heater and heat responsive member being in such 10 thermal relationship that the auxiliary switch contacts are closed thereby to shunt the starting switch contacts only after a predetermined time interval during which the starting switch contacts have opened and closed at least several 15 times, the heat responsive member automatically opening the auxiliary switch contacts upon cessation of current flow through said heater.

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