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J. R. WHITESIDE ET AL

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STARTING CONTROL FOR ELECTRIC DISCHARGE DEVICES

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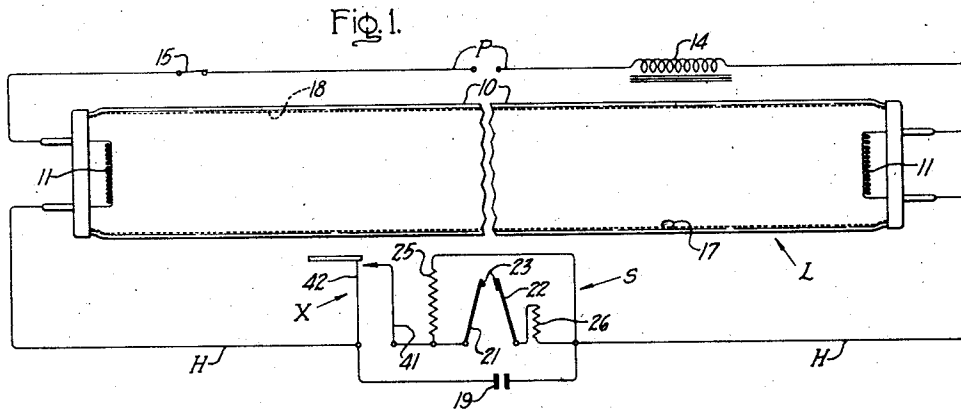


Fig. 2.

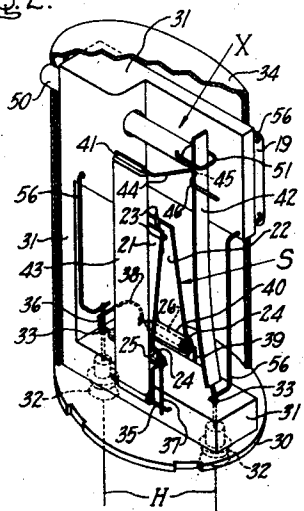


Fig. 3.

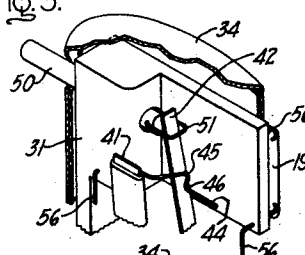


Fig. 4.

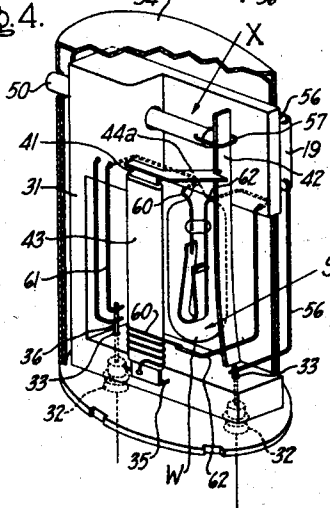


Fig. 6.

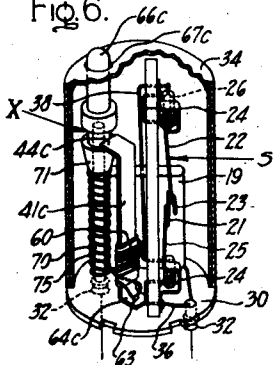
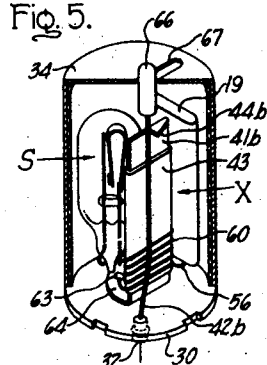


Fig. 5.



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UNITED STATES PATENT OFFICE

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STARTING CONTROL FOR ELECTRIC DISCHARGE DEVICES

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Application April 8, 1942, Serial No. 438,208

6 Claims. (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 1,951,112, March 13, 1934, to Wels, or Patent 2,212,427, August 20, 1940, to Peters, for instance.

Ordinary tubular fluorescent lamps have electrical starting circuits which are energized 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 the 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 this 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 is accomplished by keeping the starting circuit open or rendering the starter ineffective to close the starting circuit after repeated operation of the starter has failed to start the discharge, thus "locking out" the starter, so to speak. We have hereinafter described and explained this "lock-out" as applied to the type of starter disclosed in U. S. Patent No. 2,372,148, granted March 20, 1945, upon an application Serial No. 430,611, filed February 12, 1942, by Mark A. Townsend, in lieu of "lock-in" provisions there shown. However, our invention is also applicable to other types of starter, such as that disclosed in application Serial No. 422,416, filed December 10, 1941, by Jack R. Whiteside, or even

an ordinary glow-switch. Both of the applications here mentioned are assigned to the assignee of this application.

Various features and advantages of the invention will become apparent from the description of species and forms of embodiment, and from the drawing.

In the drawing, Fig. 1 is a digrammatic view of a fluorescent tube or lamp with circuit connections including the present invention, a mid-portion of the lamp envelope being broken out and omitted; Fig. 2 is a tilted or perspective view of one form of starting switch device; and Fig. 3 is a fragmentary view corresponding to the upper portion of Fig. 2, but showing certain parts in other operating positions.

Fig. 4 is a view similar to Fig. 2 illustrating our lock-out in connection with a glow-switch.

Figs. 5 and 6 are views similar to Fig. 2 illustrating other forms of embodiment of the invention.

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 thermal type. A capacitor or condenser 19 of suitable capacity (e. g., 0.007 microfarad) may be connected across the switch S, to minimize radio interference as well as arcing when the switch S opens and breaks the circuit H.

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 tem-

perature, and then suddenly opens the circuit H; and the resulting voltage kick between 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 switch device S is a thermal switch comprising switch members 21, 22 that are connected to opposite sides of the starting circuit H and coact in making and breaking this circuit. The switch members 21, 22 may consist of slender, straight, approximately upright thermostatic bimetal strips coacting as both temperature-responsive elements and current-carrying contact members. Contact pieces 23, 23 (as of coin silver wire) are shown welded to the upper free ends of the members 21, 22, and extending at right angles to one another. The members 21, 22 are preferably bent semicircularly near their anchored lower ends, these bends 24, 24 being both turned to the right in Fig. 2. Adjacent the thermostatic members 21, 22, about concentric with their bends 24, 24, there are resistance heaters 25, 26 for heating these members. The circuit connections of these heaters will be more fully described hereinafter; for the present it suffices to say that the heater 25 for the member 21 is connected across the circuits H and P in parallel with the members 21, 22, so as to respond essentially to the energization and voltage of the main discharge circuit P during starting, while the heater 26 for the member 22 is connected in the circuit H in series with the members 21, 22, so as to respond to the energization of this starting circuit H and to the current flow therein. The thermostatic switch members 21, 22 may be arranged to flex in the same direction (toward the right in Fig. 2) when heated, and vice versa.

The switch S may have as its base an insulative disc 30, and may also include an upright insulative frame structure 31, somewhat resembling an E with the short horizontal mid-stroke omitted. Underneath the base disc 30 are shown binding post connectors 32, 32 to which the wires of circuit H are connected, and their reduced shanks are fastened through the disc 30 and have attached extensions on up through the lower portion of the frame 31, which are headed over or expanded into flanges bearing on the frame at 33, 33 to secure it to the disc. A sheet metal cover, casing, or can 34 having an insulative lining may enclose the whole device from the base 30 up. The lower ends of the switch members 21, 22 are shown anchored at opposite sides of the lower member of frame 31, being attached by welding to staple-like fasteners 35, 35 whose shanks are suitably fixed in this frame member. The heater 25, which is preferably of high resistance, has one end connected by a lead 36 to one of the connectors 32, while its other end is connected by a lead 37 to the fastener 35 that carries the switch member 21, and is also normally connected (by means hereinafter described) to the other connector 32. One end of the heater 26 is connected by a lead 38 to the same connector 32 to which the lead 36 of heater 25 is connected, while its other end is connected by a lead 39 to the fastener 35 that carries the switch member 22, and is thus also connected through the switch S (when closed) to the other connector 32. The heater 25, which is subject and responsive to the high ballast output voltage when the switch S opens, is preferably of very high resistance, such as 100,000 ohms, for example, in order to prevent it from seriously lowering the voltage available for starting the discharge. It may also be found advantageous to

make the heating resistance 25 of a type having a negative temperature-resistance coefficient, so that it may heat more rapidly and cause the switch member 21 to close more quickly, though not moving far enough to close under the normal operating voltage of the lamp. The heater 26, through which flows the cathode preheating current in the starting circuit H when the switch S is closed, is preferably of low resistance, such as 3 ohms, in order to minimize its energy consumption. Any suitable provision may be made to cause the heater 26 to heat the thermostat 22 and to cool off rather slowly, such as enclosing this heater 26 in a "Nomen" glass sleeve 40, so as to give it a high heat capacity. On the other hand, the heating and cooling time of the heater 26 may be minimized, as by blackening it so as to lower its heat capacity.

When the switch S is closed for a cold start, line voltage is applied to energize the circuits P, H and the heater 26, and the thermostat member 21 is heated and flexes to the right into contact at 23 with the member 22, closing the switch S and fully energizing the circuit H and the heater 26. Closing of the switch S short-circuits heater 25, which is thus de-energized and starts to cool off, as well as thermostat 21. The current flow through the cathode coils 11, 11 and the heater 26 preheats the cathodes and also heats up the thermostat member 22, which flexes to the right out of contact with the member 21, breaking the circuit H. This opening of the starting circuit H is a quick, sharp action, giving a maximum voltage kick which is generally effective to start the discharge in the lamp L, if it is a good lamp. When the switch S opens in this manner, the heater 26 and the thermostat 22 are de-energized, and the de-energized thermostat 22 cools and unflexes to the left. The discharge in the lamp L shunts or short-circuits and de-energizes the heater 26 (in view of its high resistance) sufficiently to prevent it from reclosing the switch S. If this cycle of operation of the switch S fails to start the lamp L, it may be repeated one or more times.

As thus far described, the device and its operation correspond in main principles to the starter disclosed in the above-cited Townsend application, though the arrangement and construction are somewhat different.

In accordance with the present 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, an open-circuit condition of circuit H that prevents flashing of the lamp L is established and maintained, independent and regardless of any further action or operation of starter S, indeed, the ordinary operation of starter S may be suspended. For this 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 worthwhile, e. g., a period of about a minute under favorable voltage conditions, embracing some five to ten attempts, say. The action of this automatic control need not be an arbitrary matter of fixed adjustment, 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 effected by cumulative or progressive action involving the starter S, and more

particularly its heating means. As it is the circuit H that is to be opened and kept open, energy from another source than this circuit H is needed. Rather than provide a relay by connections from the main circuit P, we may employ an independent mechanical motor or source of energy, such as a spring brought into action in response to the energization and voltage of this circuit during starting.

For this purpose, there is shown in Fig. 2 a self-opening switch X connected in series with the automatic starter S, and comprising as switch members a slender, straight approximately upright thermostatic bimetal strip 41 and a somewhat similar spring strip 42. These members 41, 42 are arranged to flex and move at a substantial angle to one another, and preferably in planes at right angles to one another but both parallel to the axis of the can 31. As shown the lower end of the member 41 is anchored by welded attachment to the same fastener 35 as the member 21, while the lower end of the member 42 is anchored on the bottom member of frame 31 (and thus to the disc 30) by being welded or otherwise attached to the head 33 of the shank of one of the binding posts 32. Accordingly, the lower end of the member 41 lies in close proximity to the heater 25 and the member 21, so as to be heated by radiation, convection, and conduction from them. This member 41 is arranged to flex back to the left away from the members 21 and 42 when heated. To retard the action of the switch X as compared with the switch S, the thermostatic member 41 is shown lagged with a thermoinsulative wrapping of sheet asbestos 43, which slows the transfer of heat to it, and also gives it somewhat greater heat capacity. The free upper ends of the members 41, 42 coast as switch contacts and otherwise as hereinafter explained, and for this purpose the thermostat member 41 is shown provided with a wire latch and contact 44 welded thereto. The wire 44 extends diagonally to the right in Fig. 2 on a bevel, is then bent back at 45, and is again bent to the right at 46 to afford a reentrant angle presenting shoulders that engage against the corresponding edge of the spring member 42 when the latter is resiliently flexed back to the right as in Fig. 2, and the thermostat member 41 is cold, thus holding the member 42 stressed until released by the thermal flexure of the member 41.

When the switch X is thus "set" in closed condition, it completes the circuit from one connector 32 and one side of starting circuit H through heater 25 to the other connector 32 and the other side of circuit H, independently of switch S; when the switch X opens, this circuit is broken, and heater 25 and thermostats 21 and 41 are allowed to cool off. The spring switch member 42 is released to spring forward beyond and away from the wire 44 by the movement of the thermostat switch member 41 to the left in Fig. 2 as it heats up. For resetting the switch X in closed position, there is shown a push-pin type of operator 50 sliding in a bore in the upper end of the frame 31, with its inner end in position to push against the spring 42. A wire stirrup 51 attached to the inner end of the pin 50 engages around the upper end of the spring. This pin 50 extends out and operates through an opening in the side of the enclosing casing or can 34 and by its degree of projection indicates the condition of the switch X, whether closed as in Fig. 2

or open as in Fig. 3. When the pin 50 is pushed inward by hand after the switch X has opened, the edge of the switch spring 42 engages the sloping bevel of the wire 44 and forces the springy thermostat 41 back to the left, Fig. 3, until the spring finally slips or latches past the latch angle 45 into the reentrant angle 46, and the thermostat 41 springs forward again. Thus the switch X is reclosed, relatched, and reset, and the spring 42 is returned to restraint by the thermostat 41 and its latch, and the starting circuit is restored to the control of the starter S. During such resetting of the switch X, as well as at other times, the upper end of the contact member 42 is sustained against lateral thrust by the operator and indicator 50 sliding in its bore in the frame 31.

The thermostat 41 is preferably so adjusted as to press resiliently against the edge of the spring 42 when the switch is closed as in Fig. 2 with a certain elastic tension; in other words, the thermostat 41 is preflexed or pretensioned. As the thermostat 41 heats up from the heater 25, this pretension is taken up or relaxed before the thermostat actually begins to move. After this, the thermostat 41 moves to the left (Fig. 2) a short distance until the edge of the spring 42 rides on the beveled latch bend 45, forcing the thermostat back and slipping past it very quickly. This mode of operation is favorable to the desired slow action of the switch X, and allows its timing to be adjusted by adjusting the pretension of the thermostat 41.

As shown in Figs. 1, 2, and 3, the capacitor or condenser 19 may be mounted on the back of the frame 31 with its leads 56, 56 extending through the frame down to the heads 33, 33 of the connectors 32, 32 and welded to said heads. Thus the condenser 19 is connected across the circuit H, H in parallel with the switches S and X, to obviate or minimize radio interference as well as arcing at the switch contacts. In the case of a normal good lamp, starting is effected by the action of the switch S as above described, unaffected by the switch X and without bringing this switch X into operation. In other words, one or more operating cycles of the switch S and its thermostats 21, 22 start the discharge in the lamp L, after which the heaters 25, 26 cool off and the starting circuit H remains open. If repeated efforts of the starter S are required to start the lamp L, the thermostat 41 may heat up quite appreciably, but it does not flex enough to release the spring 42, and may not even relax its own pretension; and when the thermostat 21 cools off after the discharge has started, the thermostat 41 also cools off.

In the case of a defective lamp, however, or of one that has so nearly lost its activation as to be within a few hours of its end, and hence abnormally difficult to start, the repeated futile starting efforts of switch S result in a gradual accumulation of heat in heater 25 and in thermostat members 21 and 41, until eventually the member 41 flexes back to the left sufficiently to release the spring 42, which unflexes to the left and breaks the starting circuit H at 46, at the same time pushing out the pin 50 to afford a visual indication of a bad or abnormal lamp. This may happen with the switch S closed so as to short-circuit the heater 25, and under this condition the high-voltage kick due to opening of the switch X may start the discharge in an abnormally difficult lamp L, which will thus be operated to the very end of its possible life. Being

connected across the switch X as well as across the switch S, the condenser 19 functions to prevent arcing or radio interference at the switch X in such a case, just as in the ordinary operation of the switch S.

When the lamp L refuses to start on this action of the switch X, or to run any longer, its darkness and the indication at 50 show that renewal is necessary. When the lamp L is replaced with a new one, the pin 50 is pushed in to reset the switch X as shown in Fig. 2, so that the starter S can start the new lamp in the normal way.

For the convenience of those wishing to use the invention, particulars of a starter such as shown in Figs. 2 and 3 suitable for 30-40 watt fluorescent lamps of the usual positive column type are given:

The thermostatic members 21, 22 may be strips of the bimetal commercially known as "Chace #2400 bimetal," composed of laminae of Invar, an alloy of 64 per cent iron and 36 per cent nickel, and of chrome iron, an alloy of 75 per cent iron, 22 per cent nickel, and 3 per cent chromium, in equal thicknesses, welded together. Each of the strips 21, 22 may be 0.004 inch thick, and $\frac{1}{8}$ inch wide, and they may have lengths of $17\frac{1}{2}$ mm. and $19\frac{1}{2}$ mm., respectively, before being bent, while the lengths of their lower straight portions to which the fasteners 35, 35 are welded may be 3 mm. and 5 mm., and the horizontal distance apart of these portions may be about 5 mm. The diameters of their semi-circular bends 24, 24 may be about 2 mm. The contacts 23, 23 may be of 40 mil coin silver wire, and the gap between them when the switch is cold may be about 0.04 inch. The heater 26 may be a helical coil of about 10 turns of 5 mil resistance wire such as is commercially known as "Nichrome V," wound on a 40 mil mandrel, with end legs about 3 mm. long each, giving a total resistance of about 4 ohms, and its surrounding sleeve 36 may consist of a 5 mm. length of #15 gauge Nonex glass tubing. The "Nichrome" above referred to is an alloy of nickel 75 per cent, iron 12 per cent, chromium 11 per cent, and manganese 2 per cent. The heater 25 may be a solid rod of high resistance material of $\frac{1}{16}$ inch diameter $\frac{3}{8}$ inch long, showing a resistance of 100,000 ohms under a voltage of 100 volts D. C., and characterized by a negative temperature-resistance coefficient, such as the material commercially known as "Globar BNR." The thermostatic member 41 may be a strip of the above-mentioned "Chace #2400 bimetal," 0.005 inch thick, $\frac{1}{8}$ inch wide, and 23 mm. long, while the spring contact member 42 may be a strip of phosphor bronze 0.005 inch thick, 0.07 inch wide, and 27 mm. long.

The device illustrated in Fig. 4 differs from that in Figs. 1 and 2 principally in the substitution of another type of thermal switch for the two-bimetal thermal switch, such as a glow-switch W of ordinary type, and in the provision of a special heater 60 for heating the thermostat member 41, here shown as connected in series with the glow-switch W and with the switch X, and as consisting of fine wire coiled around the member 41 over its thermoinsulative covering 43, near its anchorage at 35. One of the glow switch leads 61 is connected directly to the lead 36 and thus to one connector 32, while the other glow switch lead 62 is connected through the heater 60 to the switch member 41 and through its latch and

contact 44a and the spring member 42 to the other connector 32. The part 44a differs from the part 44 in Figs. 2 and 3 in being stamped out of sheet metal such as nickel and welded to the upper end of the member 41, instead of being bent up out of wire; but its essential features and operation are the same.

Except as indicated above, the device shown in Fig. 4 is essentially like that in Figs. 2 and 3, and its homologous parts and features are marked with the same reference characters as are used in Figs. 1-3, in order to dispense with repetitive description, a distinctive letter being added where such distinction appears necessary.

Fig. 5 illustrates a device similar in principle to that of Fig. 4, but considerably simplified. The frame 30 of Figs. 2-4 is dispensed with, and the thermostatic member 41b is mounted directly on the base disc 30, being secured thereto by a rivet 63 through its laterally bent foot 64. The latch 44b consists of the bent over upper end of the strip 41b, which is beveled in correspondence to the bevels on the latches 44 and 44a. The spring member 42b consists of a phosphor bronze wire anchored at one end directly to the connector 32, and having its upper end provided with an insulative handle 66 which extends and moves sideways through an opening or guide slot 67 in the top or end wall of the casing 34.

The open or closed condition of the switch X is indicated by the position of the handle 66 at one end or the other of the slot 67. When the thermostat 41b and latch 44b move rearward and release the spring member 42b, this member and its handle 66 fly over to the right-hand end of the slot 67, which thus limits movement of the handle or operator 66. Thereafter, the latch 44b and the switch X can be reset by pushing the handle 66 to the left in the slot 67 until the latch 44b automatically re-engages the member 42b as shown in Fig. 5. The condenser 19 is shown connected only across the glow switch S, instead of across both the switches. Except as indicated above, the device shown in Fig. 5 is essentially like that in Fig. 4, and its homologous parts, features, and connections that appear in Fig. 5 are marked with same reference characters as are used in Fig. 4, in order to dispense with repetitive description, a distinctive letter being added where such distinction appears necessary.

For the convenience of those wishing to use the invention, particulars of the switch X shown in Fig. 5 suitable for ordinary 30-40 watt fluorescent lamps are given:

The thermostatic switch member 41b may be made of the "Chace #2400 bimetal" mentioned above. It may be a strip 0.030 inch thick $\frac{1}{8}$ inch wide, and 1 inch long from its foot that is riveted to the base 30 to its end that carries the laterally projecting latch 44b. The insulative wrapping 43 may be of asbestos paper 0.007 inch thick and extending 10 mm. lengthwise of the bimetal, while its length wrapped around the bimetal may be 13 mm. The heating winding 60 may be of the above mentioned "Nichrome V" resistance wire, of 0.0063 inch diameter, found $5\frac{1}{2}$ turns around the wrapped strip 41b, giving an active length of 72 mm., while the total length may be 105 mm. including the lead ends. The spring member 42b may be of brass-plated piano wire of 0.018 inch diameter, $1\frac{3}{8}$ inch long.

Fig. 6 illustrates a device somewhat resembling that shown in Figs. 2 and 3, but considerably simplified and modified. Certain structural features of this arrangement constitute part of the

subject matter of a sole application of Mark A. Townsend, Serial No. 490,048, filed June 8, 1943, which is a continuation-in-part of the instant application, and which is assigned to the assignee of this application. Here the frame 31 of Figs. 2 and 3 is replaced by an upright base plate 31c on one side of which at opposite ends the switch members 21, 22 are mounted to extend toward one another. The thermostatic member 41c resembles the member 41b in Fig. 5, but its bent-over latch and contact 44c is not beveled, and acts differently. Instead of a coacting springy switch member like those in Figs. 2-5, there is a fixed longitudinal support and guide rod 70 upstanding alongside the starters from one of the connectors 32 that is attached to the base 30, with a contact and latching head 71 mounted to slide thereon and coacting with the latch 44c. The head 71 has a conical downward bevel 72 surmounted by an annular latch-engaging shoulder 73, and also has an insulative shouldered handle or operator 66c which works or moves inward and outward through a hole 67c in the top or end wall of the casing 34. Around the upright guide rod 70 there is a switch-opening helical compression spring 75 that acts against the head 71 to yieldingly urge the head upward along the rod.

Normally, when the lamp controlled by the starter S is a good one, the contact head 71 is held down or retained as shown by the latch 44c of the thermostat 41c, that extends along adjacent the rod 70 and has its other end ultimately anchored or attached to the base 30, as at 63, and the handle 67c protrudes only slightly through the top of the casing 34, as shown in Fig. 6. But when the thermostat 41c bends back away from the head 71 as a result of repeated efforts to start a bad lamp, the head 71 and handle 76c fly up until stopped by engagement of the shoulder on the handle 66c with the top of the casing, through which the handle then protrudes very conspicuously. The switch X is reclosed and relatched by simply pushing down on the handle or button 67c, causing the bevel 72 of the head 71 to force back the thermostat member 41c and latch under it at 73.

To dispense with repetitive description, parts and features in Fig. 6 are marked with the same reference characters as their homologues in other figures, a distinctive letter being added where such distinction appears necessary.

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

1. Starting means for a discharge device having a starting circuit comprising, in combination, a casing-can open at one end and having an opening in its wall; a base disc closing the open end of the can; connectors for connection to the starting circuit fastened through said disc; an insulative frame structure upstanding from said disc in said can; a thermal starting switch in said can mounted on said frame structure and connected to one of said connectors; a lock-out switch in said can connected between said starting switch and the other connector and comprising resilient means with a latching contact urged in one direction thereby, with an operator extending through said can wall opening and operable therethrough to shift said latching contact against the action of said resilient means, and thus stress the latter, a thermostatic laterally resilient switch member, having one end anchored substantially at said disc, responsive to heat accumulated during repeated operation of said starting switch and thereby thermally flexed

away from said latching contact, and a beveled latch on the free end of said thermostatic member for latching past said latching contact and holding said resilient means stressed as aforesaid until released by the thermal flexure of the thermostatic member.

2. Starting means for a discharge device having a starting circuit comprising, in combination, a casing-can open at one end and having an opening in its wall; a base disc closing the open end of the can; connectors for connection to the starting circuit fastened through said disc; an insulative frame structure upstanding from said disc in said can, with means attached to said connectors for securing said frame structure to the disc; a thermal starting switch in said can connected to one of said connectors; a lock-out switch in said can connected between said starting switch and the other connector and comprising a flexible and resilient switch member anchored at one end to said frame structure, with an operator extending through said can wall opening and operable therethrough to flex and stress said resilient member, a thermostatic switch member also anchored at one end to said frame structure, responsive to heat accumulated during repeated operation of said starting switch and thereby thermally flexed away from said resilient member, and a beveled latch on the free end of said thermostatic member for latching past and holding said resilient member, when flexed as aforesaid, until released by the thermal flexure of the thermostatic member.

3. Starting means for a discharge device having a starting circuit comprising, in combination, a casing-can open at one end and having an opening in its wall; a base disc closing the open end of the can; connectors for connection to the starting circuit fastened through said disc; a thermal starting switch in said can connected to one of said connectors; a lock-out switch in said can connected between said starting switch and the other connector and comprising a laterally flexible and resilient switch member anchored at one end to said disc and extending substantially at least to the can end remote from said disc, with an operator extending through said can wall opening and operable therethrough to flex and stress said resilient member in a plane substantially parallel to the can axis, a thermostatic switch member anchored adjacent the anchored end of said resilient member, responsive to heat accumulated during repeated operation of said starting switch and thereby thermally flexed in a plane substantially parallel to the casing-can axis and substantially at right angles to the plane of flexure of the resilient member as aforesaid, and a beveled latch on the free end of said thermostatic member for latching past and holding said resilient member, when flexed as aforesaid, until released by the thermal flexure of the thermostatic member.

4. The combination with a discharge device having discharge and starting circuits, and starting switch means comprising coacting switch members for making and breaking the starting circuit to start the discharge, of means including a heater responsive to energization of one of said circuits for producing movement of one of said switch members toward the other, means including a second heater responsive to current flow in the starting circuit for producing movement of the said other switch member away from that first mentioned, and thus opening said starting circuit to start the discharge in said device, and

other circuit-opening switch means connected in the starting circuit in series with the aforesaid starting switch means and comprising a thermostat responsive to heat accumulation in one of said heaters for opening the starting circuit after repeated operation of said starting switch means fails to start the discharge.

5. Starting means for a discharge device having a starting circuit comprising, in combination, a casing-can open at one end and having a slot in its opposite end wall; a base disc closing the open end of the can; connectors for connection to the starting circuit fastened through said disc; a thermal starting switch in said can connected to one of said connectors; a lock-out switch in said can connected between said starting switch and the other connector and comprising a laterally flexible and resilient switch member anchored at one end to said disc and extending substantially at least to the can end remote from said disc, with an operating handle on the free end of said resilient member extending out through said slot and guided therein for sidewise movement to flex and stress said resilient member in a plane substantially parallel to the can axis, a thermostatic switch strip anchored to said disc, responsive to heat accumulated during repeated operation of said starting switch and thereby thermally flexed in a plane substantially parallel to the casing-can axis and substantially at right angles to the plane of flexure of the resilient member as aforesaid,

the free end of said thermostatic strip being bent and beveled into a latch for latching past and holding said resilient member, when flexed as aforesaid, until released by the thermal flexure of the thermostatic member.

6. The combination with a discharge device having discharge and starting circuits, and starting switch means comprising coacting switch members for making and breaking the starting circuit to start the discharge, of means including a heater connected in shunt with said switch members and responsive to energization of one of said circuits for producing movement of one of said switch members toward the other, means including another heater connected in series with said switch members within the shunt connection of the first-mentioned heater and responsive to current flow in the starting circuit for producing movement of the said other switch member away from that first mentioned, and thus opening said starting circuit to start the discharge in said device, and other circuit-opening switch means connected in the starting circuit in series with the aforesaid starting switch means and comprising a thermostat responsive to heat accumulation in the first-mentioned heater for opening the starting circuit after repeated operation of said starting switch means fails to start the discharge.

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