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DISCHARGE LAMP BASE AND STARTER

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This invention relates to the basing of lamps and discharge devices, including fluorescent tubes or lamps of the positive column discharge type, and also to the starting control of discharge devices of this character. An important object of the invention is to provide for incorporating a starter in the lamp structure, and for also including associated accessories, particularly the usual capacitor or condenser for assisting starting and minimizing radio interference as well as arcing. The invention is hereinafter explained with reference to a lamp base containing a starter and a condenser.

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

In the drawing, Fig. 1 is a diagrammatic view of a fluorescent tube or lamp equipped with a base or terminal structure embodying my invention, this base structure being partly broken away and in section, and suitable circuit connections being diagrammatically illustrated.

Fig. 2 is a tilted inside or rear view of the starter-equipped base shown in Fig. 1 with part of its skirt or shell broken away, and with a diagrammatic showing of certain circuit connections.

Fig. 3 is a fragmentary tilted or perspective view, partly sectional, showing one end of a lamp tube with the parts of an associated base, and illustrating a stage in the basing of the lamp according to my invention.

The drawing shows an ordinary fluorescent lamp L (of positive column electric discharge type) with a tubular envelope 10 having the spaced-apart, activated thermionic cathodes 11, 12 in its ends, which may be specially heated cathodes of usual coiled filament type, and are shown connected through bipost lamp base or terminal structures B, C 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 contact terminal biposts 19 of the bases or

terminal structures B, C, the filamentary cathodes 11, 12 which may be connected between these biposts, and the starter S which is interposed between one of the biposts and the filament 11. A capacitor or condenser K of suitable capacity (e. g., 0.006 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, and to assist in starting.

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, 12 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 between the cathodes 11, 12 suffices to initiate discharge between them—or, in other words, starts the lamp.

As illustrated, the starter-equipped terminal or base structure B of the lamp L comprises as its main structural element (Figs. 2 and 3) a transverse insulative wall, web, or disc 20 through which the hollow bipost contacts 19, 19 are riveted, and which serves as a base for the starter switch S, mounted at the inner side of the disc next to the lamp envelope 10. In the particular lamp L here illustrated, the end wall of the tubular envelope 10 does not involve the disc or web 20, but is formed by the usual glass stem and flare 21 sealed into the end of the envelope 10. Besides the web or disc 20, the base B comprises a deep sheet metal shell or skirt 22 attached to the disc. As shown, the shell or skirt 22 has one end or margin internally shouldered at 23 and crimped around the edge of the disc 20 at 24, and has its other end secured around the end of the glass envelope 10 by cement 25. The central portion of the disc 20 is augmented in thickness or reinforced at its inner side, as by means of a double-ply disc 26 riveted to the disc 20 by means of the biposts 19, 19. The other base structure C may be similarly constructed, but not so deep. As thus far described, these bases B, C resemble those already in use, though the base B is considerably deeper than usual.

As shown in Fig. 2, the starter switch S is of thermal type, comprising a thermostatic strip member 30 which extends parallel to the disc 20 closely adjacent its inner side and may be heated by a resistance heater 31, here shown as consisting of fine wire coiled around the member 30 over an insulative covering or wrapping 32 of suitably refractory material, such as asbestos paper. At

one end, adjacent the heater 31, the thermostat 30 is fixedly anchored by being welded to a supporting stud 33 upstanding from the disc 20. This stud 33 may consist of one end of a U-bent wire inserted from the other (outer) side of the disc 20 through suitably spaced holes therein, and secured by bending its end 34 down on the inner side of the disc. The thermostatic member 30 is connected by a wire lead 35 to a hollow rivet or eyelet 36 that is riveted through the disc 20. As shown in Fig. 2, the free end portion of the thermostatic strip 30 is bent back at 37 in an arc of 180° so as to extend toward its anchored end at 33. Upstanding from the disc 20 at a suitable position is a fixed switch contact stud 38 which coacts with a movable switch contact 39 afforded or carried by the free end of the member 30. As here shown, the switch contacts 38 and 39 consist of (silver) wires extending at right angles to one another and welded or soldered into one of the hollow biposts 19 and to the free end of the thermostat 30, respectively—the wire 39 considerably extending the retroverted end of the bar 30 toward its anchorage at 33. The retroversion of the bar at 37 largely compensates for the general rise of temperature inside the base B due to the heater 31 and to the operation of the lamp L and the heating of the cathode 11, and is also helpful in other respects, as explained hereinafter. To the other bipost 19 is soldered or connected one end of the heater coil 31, and the other end of this coil is welded or connected to a hollow rivet or eyelet 40 riveted through the disc 20.

The matter of ambient temperature compensation by the J-bent thermostat strip 30 is of particular importance in the case of a starter S intimately incorporated in the lamp structure. This is because of the wide range of fluctuation of ambient temperature inside the base B, as between the condition when the lamp L has not been in operation for an hour or more and the condition when the lamp L has just been switched off after operating for some time and becoming thoroughly heated up above atmospheric temperature by the discharge and the heating of the cathode 11 close to the thermostat 30. As the ambient temperature variations in the base B affect the whole thermo-responsive length of the member 30 alike, the unbending flexure of the retroverted portion at 37 with rising ambient temperature throws the shorter J-arm with its extension 39 forward toward the contact stud 38, thus acting to offset the bodily backward motion of the portion 37 away from the contact 38 due to the concomitant bending back of the longer arm of the strip 30, and tending to maintain contact at 39, 38. A similar but reverse action occurs with falling ambient temperature inside the base B. On the other hand, the local heating of the longer arm of the thermostat strip 30 adjacent its anchorage at 33 by the surrounding heater 31, substantially without directly heating the retroversion 37, bends this portion of the strip 30 backward and so shifts the whole free portion of the J-bent strip 30 (including its extension 39) away from contact 38, thereby breaking contact at 39, 38. A similar but reverse action occurs when the circuit H is opened and heater 31 and the portion of member 30 within it cool off.

The lead wires 41, 41 to the cathode coil 11 are soldered into the hollow rivets or eyelets 36, 40, thus connecting this coil into a circuit of the base B and lamp L that may be traced from circuit H and one bipost 19 through the switch contacts 38, 39, the thermostat 30, lead 35, rivet 75

36, one lead 41, coil 11, other lead 41, rivet 40, heater coil 31, to the other bipost 19 and circuit P. The condenser K is shown with its leads 42, 42 connected to the bipost 19 that carries the fixed switch contact 38 and to the wire 33 that supports the thermostatic member 30, and as located to one side of the switch S, being thin enough not to project above the upper edge of the member 30 and its heater 31.

Basing cement commonly used for attaching bases B, C to the ends of the lamp envelope 10 as indicated at 25 in Figs. 1 and 2 requires a considerable degree of heat to cure or harden it properly after application. This temperature, however, would be liable to affect unfavorably some of the parts of the switch mechanism S, and especially the condenser K, which usually comprises sealing and insulating compounds that might be fused by the curing heat, with the result of virtually destroying the condenser. To overcome this difficulty, I do not fabricate the complete base B by union of disc 20 and shell 22 as usual, but instead make them up and keep them on hand as separate parts: the disc 20 with the biposts 19, 19, the switch mechanism S, and the condenser K mounted and fully connected thereon; and the shell 22 with the shoulder 23 formed therein, but without the edge crimping 24. After completion of the lamp L in other respects, I cement the still uncrimped shell 22 on one end of the envelope 10, as shown at the left of Fig. 3, and then add the disc 20 and attach it to the shell. To do this, I may simply place the disc 20 with its attached parts in the end of the shell 21 on the shoulder 23, inserting the cathode leads 41, 41 through the disc rivets or eyelets 36, 40; crimp over the shell edge 24 as shown at the right of Fig. 3, as by working around the shell with any suitable means; and solder the lead wires 41, 41 into the eyelets (this is done from the outer side of the disc) and cut off the ends of these wires.

The operation of the switch S will be readily understood from the foregoing description, but may be briefly outlined. When the switch 15 is open and the whole system is deenergized and has cooled off to ambient temperature, the switch S is closed, with the contacts 39, 38 resiliently pressed together by the springy bimetal 30, and the starting circuit H and the cathodes 11, 12 are connected across the discharge circuit P, ready to be energized by closure of the switch 15. When this happens, current flows through the circuits P and H, the switch S, and the cathodes 11, 12 in series, heating the cathodes. At the same time, current flows through the heater 31 of the thermostat 30, which is connected in circuit in series with the contacts 38, 39, gradually heating the heater 31 and the thermostat 30. The transmission of heat to the resilient thermostatic member 30 is slowed by the thermoinsulation 32, which also increases the thermal capacity of the thermostat. As the bimetallic member 30 gradually heats up, it bends backward, Fig. 2, away from the fixed contact 38, and the contact 39 pulls away from the contact 38 and opens the circuit H through one of the biposts 19, while leaving the circuit P energized through the other bipost 19 and the heater 31 to the cathodes 11, 12. The voltage kick consequent on breaking the circuit starts the discharge between the cathodes. The discharge current now flows through heater 31, and the thermostat 30 is thus kept flexed to hold the switch S open as long as the circuit P remains energized. When the circuit P is de-energized as by opening the switch 15, the heater 31 and the thermostats 30

cool off and the switch S closes, ready for a repetition of the starting cycle as described.

Certain features of the switch S which have only been glanced at heretofore are of considerable importance in its operation. It has been usual, heretofore, to provide thermal starting switches with condensers of about 0.05 microfarad capacity—about eight times the 0.006 microfarad capacity of a condenser K such as there is room for in the base B alongside the switch S—in order to delay the opening of the switch on a hot restart of the lamp L (when it is turned off and then at once turned on again), to give time for proper reheating of the cathodes 11, 12. This is needful because the cathodes 11, 12 cool off far more quickly than does the switch S, when the current to the lamp is shut off. A condenser of 0.05 microfarad produces adequate delay by causing a minute spot-weld between the contacts 38, 39 when it discharges through them as they come together on the turning off of the current; but a condenser of only 0.006 microfarad produces such a very minute weld that the reopening of the switch S follows almost instantly when the current is turned on again quickly—before the cathodes 11, 12 have time to reheat properly. In my switch S, the inadequacy of the very small condenser K in this respect is compensated for (in part, at least) by thermal inertia due to the thermal insulation 42; the heat developed in the winding 31 is transmitted but slowly through the asbestos 32 to the bimetal 30, giving time for reheating the cathodes 11, 12 before the switch S reopens. Any delay in the separation of the contacts 38, 39 when the member 30 heats that is produced by its retroversion at 37 (as already mentioned) also tends to compensate for the small capacity of the condenser K.

For the convenience of those desiring to use my invention, I give illustrative particulars of a switch S suitable for a 40 watt fluorescent lamp of the usual positive column discharge type, operating with a discharge current of some 0.42 ampere and with a cathode preheat current of some 0.42 to 0.65 ampere, and having a tube 10 of 1½ inch internal diameter. Assuming a base-disc 20 of 1½ inch diameter as usual, the anchorage stud 33 may be spaced about 12 to 13 mm. on centers from the contact stud 38 mounted in the bipost 19, and may be located nearly ¼ inch from the other bipost 19, on centers. The thermostat member or bar 30 may consist of a strip 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; it may be 0.004 inch thick, ⅛ inch wide, and 20 mm. long before bending. Its dimension from the anchorage 33 to the bottom of the 180° bend at 37 may be 16 mm., and the radius of this bend 37 may be 0.95 mm. The contacts 38 and 39

may be of 25 mil coin silver wire, and the overall length of the contact 39 may be about 7 mm., with about 1½ mm. of its length overlapping the end of the member 30 at the weld between them. The heater 31 may be constructed to have a cold resistance of 6 ohms, and may be made of 8½ turns (plus straight lead ends) of heating resistance wire such as hereinafter indicated, wound 75 turns per inch around an asbestos-paper wrapping 32 on a ¼ inch mandrel and then removed from the mandrel, flattened sufficiently, and then slipped on the bar 30. The wire for this heater 31 may consist of about 3¾ to 4 inches of 6 mil heating resistance wire such as is known commercially as "Nichrome V," which is an alloy of 75 per cent nickel, 12 per cent iron, 11 per cent chromium, and 2 per cent manganese. The condenser K may have a capacity of about 0.006 microfarad, and may be about ⅝ inch long, ½ inch wide, and ⅛ inch thick, or slightly more.

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

1. A base or terminal structure for an electric discharge device having therein a discharge electrode, said structure comprising a disc provided with contact terminals exposed at one side of the disc, switch means comprising a contact and a flexible bimetallic strip anchored by one end at the other side of said disc and exposed to the ambient temperature there, and having its free end retroverted and extending back toward the anchored end for coacting with said contact, said strip being arranged to flex toward said contact at its retroversion with rising temperature there while flexing away from said contact adjacent its anchorage with rising temperature there, an electric heater for locally heating said bimetallic strip adjacent its anchorage substantially without directly heating its retroversion, and means for connecting said switch means, said electrode, and said heater in circuit between said contact terminals.

2. A base or terminal structure for an electric discharge device having therein a discharge electrode comprising electric heating means, said structure comprising a disc provided with contact terminals exposed at one side of the disc, switch means comprising a flexible J-bent bimetallic thermostat strip anchored at the other side of the disc by its longer arm, a contact on said disc at the side of the shorter strip arm remote from the longer arm, said strip being arranged to flex outward toward said contact at its retroversion with rising temperature there while flexing away from said contact adjacent its anchorage with rising temperature there, an electric heater for locally heating the longer thermostat strip arm adjacent its anchorage substantially without directly heating the retroversion of the strip, and means for connecting said switch means, said electrode heating means, and said thermostat heater in circuit between said contact terminals.

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