Oct. 19, 1943. R. F. HAYS, JR 2,332,077

ELECTRICAL SAFETY DEVICE

Filed June 20, 1941

Fig. 1.

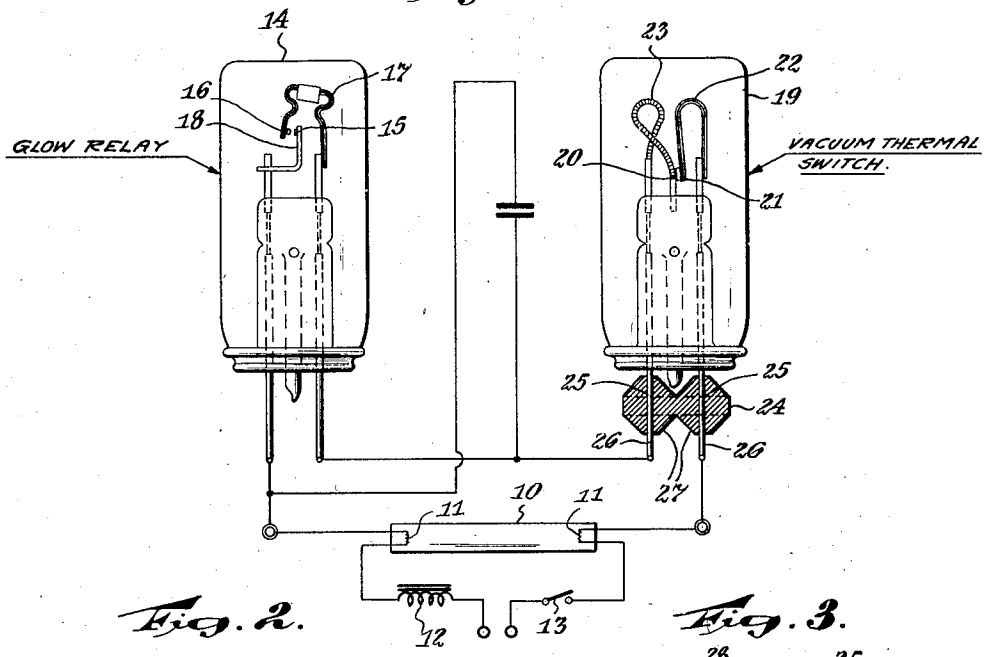


Fig. 2.

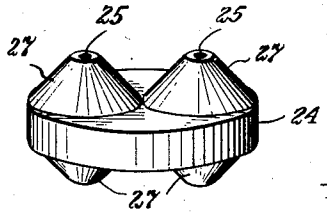


Fig. 3.

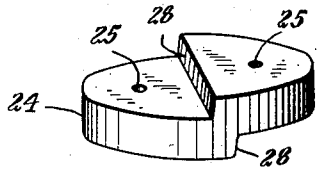
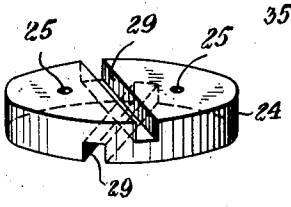


Fig. 8.

Fig. 4.



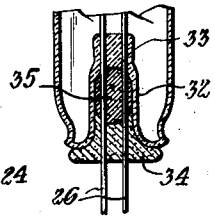


Fig. 5.

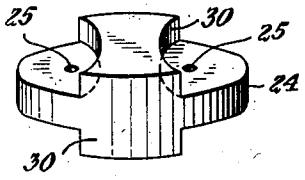


Fig. 6.

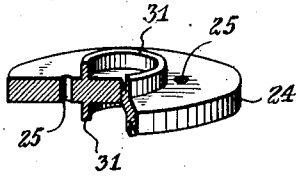
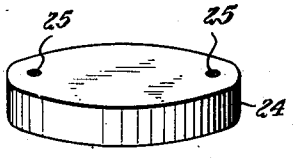


Fig. 7.



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ELECTRICAL SAFETY DEVICE.

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Application June 20, 1941, Serial No. 398,911

8 Claims. (Cl. 200—118)

This invention relates to electrical safety devices, and particularly to such devices which will function to prevent electrical overloads in such circuits as for fluorescent lamps.

Various circuit arrangements for the starting of fluorescent lamps are known to the art. One such circuit includes a glow relay with which is connected, in series, a thermal switch. The general relation of lamp and switch circuit also includes an inductance in series with the lamp, for building up a voltage charge above line potential for obtaining a transient voltage or surge across the lamp electrodes sufficient to establish ionization in the lamp envelope when the switch circuit automatically opens. It has been found that best thermal characteristics and consistently high transient voltage are obtained by evacuating the envelope of the thermal switch that interrupts the current. With the switch evacuated, the transient voltage, induced under the common condition of switch contacts repeatedly opening and closing, reaches a dangerously high value. Such voltage often rises to several thousand volts and breaks down the insulation of the aforementioned inductance and of the wiring.

It is, accordingly, an object of the present invention to provide means for overcoming the building up of voltages in the circuit dangerous thereto either as to the conducting wires or to the dielectrics utilized in connection with the wires or other parts.

Another object of the present invention is to provide a means which will act as a voltage limiter across the terminals of the vacuum thermal switch.

Another object of the present invention is to provide a voltage limiter which is automatic, requires no attention by the lamp user and will perform its function repeatedly as required during life of the associated lamp and thermal switch.

Another object is to provide a voltage limiter which functions gradually and becomes more conductive or effective as the transient voltage increases and vice versa.

Further objects of the invention are to obtain simplicity of construction and operation, sturdiness and economy.

Still further objects of the invention will appear to those skilled in the art as the description progresses, both by direct statement and by implication from the context.

Referring to the accompanying drawing in which like numerals of reference indicate similar parts throughout the several views:

Figure 1 is a partially structural and partially diagrammatic illustration of an electrical circuit for starting and operating a gaseous electric discharge lamp and employing my invention, shown in cross-section and mounted on the lead-in wires or electrode terminals of a vacuum thermal switch forming part of said circuit;

Figure 2 is a perspective view of the preferred embodiment of my electrical safety device;

Figures 3 to 7, inclusive, are perspective views each of a different modification, and

Figure 8 is a sectional view of an enclosure mounting for a modified form of my electrical safety device.

For an understanding of the function and use of my electrical safety device, one circuit arrangement and associated apparatus are shown in Figure 1, and that this description may be complete in itself, a brief review of the particular prior art circuit and parts will be here given. For more detailed description thereof, reference may be had to my prior application Serial No. 360,529, filed October 10, 1940, now Patent #2,313,744 issued March 16, 1943. Briefly, then, a gaseous electric discharge lamp **10** is shown with filamentary electrodes **11**, **11** across which an arc has to be struck and to do which a higher voltage than ordinary line and operating voltage is required. The said electrodes connect at one end of each to the source of electrical energy or line. In this part of the circuit is included an inductance **12** and a manually operated switch **13**, manipulated by the user for turning the lamp on or off. Closing the switch will not immediately strike the arc across the electrodes as the voltage is insufficient.

Relay and time delay means are, therefore, included to both give the electrodes opportunity to heat and for a voltage charge to build up. Accordingly, in series across the electrodes opposite from the line is a time delay circuit interrupting means including a glow relay **14**, the contacts **15**, **16** whereof are normally open. The said glow relay includes a bimetallic electrode **17** supporting one of the contacts, and, being heated by the ionized glow discharge inaugurated by electron emissive electrode **18**, causes closing of the contacts and extinguishes the glow discharge as well as completing the series circuit to the lamp electrodes.

In series with this glow relay **14** and with the other lamp electrode, is a thermal switch **19**, which, in this showing is an evacuated switch having approximately the same thermal characteristics as the thermionic filamentary electrode

of the lamp so as to be simultaneously heated therewith. The contacts **20**, **21** of this thermal switch are normally closed. At least one mounting for one of the contacts **22** is bimetal, and flow of current is arranged to create heat, as by including a heater element or wire **23** in series with the other contact, and the heat caused to influence the bimetal to flex and thereby separate the contacts. The circuit being thus interrupted the transient voltage should surge across the lamp electrodes and start the lamp in operation which then operates at so low a voltage as to no longer obtain glow discharge in the glow relay or to heat the heater element **23** even though contacts **20**, **21** are again closed.

However, in practice, the arc does not always strike across with the first interruption of the circuit. In fact it is quite common for the thermal switch to vibrate with repeated opening and closing of the circuit which will continue to occur until the arc strikes in the lamp. The thermal relay switch is enclosed in an evacuated envelope for purposes of giving to it the best thermal characteristics and consistently high transient voltage. But with the rapid recurrence of the opening and closing of the circuit which includes inductance, a transient voltage is established which may reach several thousand volts, which exceeds safe value for the usual dielectrics used on the wires, in the inductance coil and elsewhere in the circuit and apparatus.

In order to overcome the possible deleterious effects of abnormally high transient voltage and to control it from exceeding safe loads for the wires and other parts, a safety device is included preferably in association with the lead-in wires or terminals of the vacuum thermal switch **19**. Said means is shown as a button-like structure, the precise configuration of which may be considerably varied as indicated by the several modifications of Figures 2 to 7.

The several figures illustrate the safety device as comprising a disk-like member **24** having spaced parallel holes **25** therebetween parallel to the axis of the disk and offset on opposite sides thereof intersecting a common diameter. The spacing of these holes **25** is such that the lead-in wires **26** of the vacuum switch **19** may be passed therethrough with solid portion of the disk interposed therebetween. The disk-like member **24** in the several showings thereof is in each instance characterized by slight conductivity and high resistance when "cold," that is, at normal or room temperature, but which become more conductive as temperature thereof increases and in which current flow, opposed by the inherent resistance of the member, produces heat. As the voltage across the member increases from zero, the current through it increases first very slowly until a critical voltage will cause a tremendous increase in current. The said member for switches at present being manufactured, is preferably so constituted that there will be a tendency for it to limit the transient voltage to 1500 volts or less, and not to conduct enough current at line voltage, say 220 volts, to get hot.

A transient voltage may produce a spark between the lead wires over the surface of the member, and the spark may be followed or continued by a power arc. When the transient voltage causes arcing within the material forming the member, no power arc follows. The power arc will exist only across the surface and usually is of short duration, but it adds a considerable amount of heat to said member. Frequent repetition of the arcing can heat the member to a temperature at which it becomes a good conductor at the normal circuit voltage. In this case the normal circuit voltage causes considerable current to flow through the member which results in increased heating until the member becomes red hot and practically a short circuit. Also, power arc across the member or a high current flowing from the member to the lead wire will tend to burn off the lead wire. By using a configuration which makes the distance between the wires over the surface considerably greater than the straight-line distance between the wires through the body of the material, as in Figures 1 to 6, arcing or sparking over the surface can be prevented, and consequently the possibility of a power arc is eliminated, whereby heating of the member is reduced to such a value that the member cannot become too conductive at low voltage.

The same effect can be produced by using a flat disk-like member without protuberances, but with the holes too far apart to permit a spark or arc over the surface being followed by a power arc. This simple form is shown in Figure 7, and is preferable under the conditions mentioned, since molding and other fabrication and assembly processes are more readily performed when so made.

For obtaining conductive-resistance characteristics as above-described, the safety device member **24** may be made in one of several ways. Preferably, however, manufacture is by mixing and sintering appropriate ingredients under conditions of a carefully controlled heat treating schedule for producing the proper electrical characteristics.

The ingredients employed in fabrication of the member preferably are carborundum and a binder with or without other constituents for obtaining greater resistance or greater conductivity as may be found desirable. For instance, I have made the devices by mixing and sintering carborundum and clay; carborundum, clay and silicon; carborundum, clay and carbon, carborudnum and lead borate; carborundum, lead borate and silicon. The clay and lead borate function largely as permanent binders, and to a degree act as a resistance element; carborundum, carbon and silicon introduce the desired measure of a conductivity during high transient voltage. Carborundum has its substantial equivalent in boron-carbide, which may, accordingly, be substituted if desired.

Excellent results have been obtained by making the disk-like member **24** substantially three-eighths of an inch in diameter, one eighth of an inch thick and with the holes **25** four hundredths of an inch in diameter to substantially fit the lead-in wires **26**, and spaced three-sixteenths of an inch apart between centers. The mixture preferred consists of three parts by volume of 100-mesh carborundum, and one part of finely divided lead borate molded under pressure with a small amount of paraffin as a temporary binder. The compressed and formed member is then treated preferably to a temperature sufficient to raise it to a red heat and for a period of approximately thirty seconds to drive out the temporary binder and to sinter the mass into a permanent, hard, strong and complete unit. The electrical characteristics are thereafter independent of further heat effects in use or otherwise, not being changed by use, and accordingly, the device may repeatedly function and continue in

place and remain effective throughout the life of the vacuum thermal switch with which associated.

It is desirable to construct the device of the present invention with physical characteristics which will reduce likelihood of an electric arc forming along the surface from one lead-in wire to the other. The several modifications illustrated in the drawing are, accordingly, exemplifications of constructions for obtaining a path for high transient voltages and in most instances also obtaining a greater surface distance between the holes **25** than direct internal conductive distance.

In Figures 1 and 2, the increased surface distance between holes **25**, **25** is secured by molding the device with mounds or frusto-conical protuberances **27** on opposite sides of the disk axially coincident with the holes **25**.

In Figure 3 the increase of surface distance is obtained by off-setting opposite halves of the member or disk by steps **28**, **28** interrupting the surfaces transverse to the electric path between the holes.

In Figure 4 an even greater increase of surface distance is obtained by forming grooves or channels **29**, **29** in the opposite faces interrupting the surfaces transverse to the electric path between the holes. These channels may conveniently be arranged at angles to each other so as not to unduly weaken the member transversely thereof.

In Figure 5 the increase of surface distance between the holes is shown obtained by forming upstanding ribs **30**, **30** across the surfaces and situated between the holes transverse to the line of electrical path across the surface.

Again, in Figure 6, the increase of surface distance between the holes is obtained by upstanding annular ribs **31**, **31** of less diameter than the distance between the holes and co-axial with the disk member.

Figure 7 illustrates the simplified form of member wherein the same comprises a disk with spaced holes **25**, **25**, and wherein surface distance while equal to the internal electrical path distance between the holes, is too great for a spark over the surface to be followed by a power arc at the normal circuit voltage.

Figure 8 is a further modification of the invention for obtaining an ever-present safety-path for high transient voltages between lead-in wires. In this showing, an enclosure is made around a portion of the length of lead-in wires **26**, **26**, said enclosure conveniently formed as a part of re-entrant stem **32** below the press **33** thereof, by way of example. The bottom of the stem is closed, as by cement **34** after an appropriate quantity of conductive-resistance material **35** is applied thereabove. Preferably said material **35** is carborundum granules closely packed to fill the space within the enclosure, but this may be otherwise if found more desirable. As further examples, may be mentioned use of carborundum and lead borate, and, in fact, the several combinations of materials listed above in describing formation of the solid form of member may be used. The present modification differs principally from the previously described structures in the fact the material is here employed in a loose state, that is, not sintered into a solid mass, and retained, in compact formation, by inclusion within enclosure **32**. As shown, the enclosure may be concave on its interior at both ends, thereby increasing the surface distance across the material between lead-in wires **26**.

Since the various details of construction as well as the precise steps in the described procedure and method of manufacture are subject to variation and change without departing from the inventive concept or scope of the invention, it is intended that all the matter contained in the specification or illustrated in the drawing shall be interpreted as exemplary and not in a limiting sense. It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein shown and described, and all statements of the scope of the invention herein set forth as a matter of language which might be said to fall therebetween.

I claim:

1. An electrical safety device for limiting transient voltages in electrical circuits comprising a body portion mounted across the part of the circuit to be protected, said body portion comprising carborundum and lead borate.

2. An electrical safety device for limiting transient voltages in electrical circuits comprising a body portion mounted across the part of the circuit to be protected, said body portion comprising carborundum, lead borate and silicon.

3. An electrical safety device for limiting transient voltages in electrical circuits having two parallel wires, said device comprising a body portion having conductivity characteristic substantially the same throughout and of poorly conductive material under normal conditions, said device having parallel holes therethrough for attachment of said devices across the parallel wires of the circuit to be protected, and having physical means establishing as the shortest surface path across the device between said holes a path greater than the electrical path within the body portion between said holes.

4. An electrical safety device for limiting transient voltages in electrical circuits having two parallel wires, said device comprising a body portion having conductivity characteristic substantially the same throughout and of poorly conductive material under normal conditions, said device having parallel holes therethrough for attachment of said devices across the parallel wires of the circuit to be protected, and having physical means establishing as the shortest surface path across the device between said holes a path greater than the electrical path within the body portion between said holes, said physical means comprising mounds integral with the body portion around the points of attachment to the circuit.

5. An electrical safety device for limiting transient voltages in electrical circuits having two parallel wires, said device comprising a body portion having conductivity characteristics substantially the same throughout and of poorly conductive material under normal conditions, said device having parallel holes therethrough for attachment of said devices across the parallel wires of the circuit to be protected, and having physical means establishing as the shortest surface path across the device between said holes a path greater than the electrical path within the body portion between said holes, said physical means comprising an intervening transverse surface portion of the body portion with respect to the surface portions around the points of attachment to the circuit thereby establishing a devious surface path between said points.

6. An electrical safety device for limiting

transient voltages in electrical circuits having two parallel wires, said device comprising a body portion having conductivity characteristics substantially the same throughout and of poorly conductive material under normal conditions, said device having parallel holes therethrough for attachment of said devices across the parallel wires of the circuit to be protected, and having physical means establishing as the sortest surface path across the device between said holes a path greater than the electrical path within the body portion between said holes, said physical means comprising offset surface portions connected by walls perpendicular thereto substantially diametrical of the device and substantially midway between the points of attachment to the circuit, thereby establishing a devious surface path between said points.

7. An electrical safety device for limiting transient voltages in electrical circuits having two parallel wires, said device comprising a body portion having conductivity characteristics substantially the same throughout and of poorly conductive material under normal conditions, said device having parallel holes therethrough for attachment of said devices across the parallel wires of the circuit to be protected, and having physical means establishing as the shortest surface path across the device between said holes a path greater than the electrical path within the body portion between said holes, said physical means comprising interposing upstanding ribs transverse to the electrical path between said points of attachment of the circuit.

8. An electrical safety device for limiting transient voltages in electrical circuits having two parallel wires, said device comprising a body portion having conductivity characteristics substantially the same throughout and of poorly conductive material under normal conditions, said device having parallel holes therethrough for attachment of said devices across the parallel wires of the circuit to be protected, and having physical means establishing as the shortest surface path across the device between said holes a path greater than the electrical path within the body portion between said holes, said physical means comprising interposing upstanding ribs diametrically across the body portion transverse to the electrical path between said points of attachment of the circuit.

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