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WATER-PROOFED SERIES CIRCUIT CUT-OUT DEVICE

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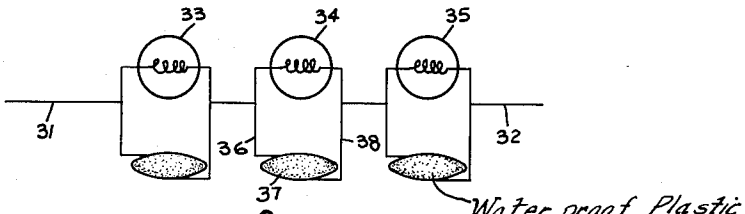


fig-1

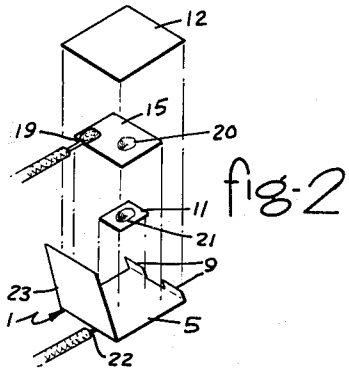


fig-2

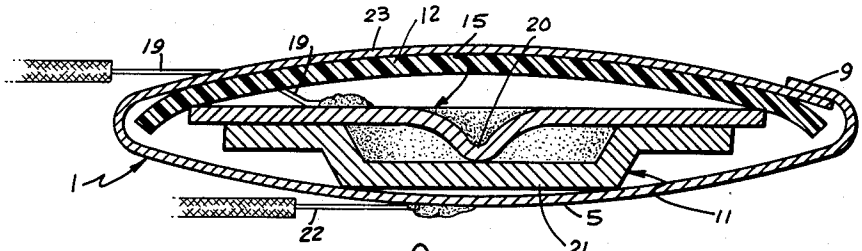


fig-3

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WATER-PROOFED SERIES CIRCUIT CUT-OUT DEVICE

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This invention relates to a series circuit cut-out device and more particularly to a compact, water-proof, disposable series circuit cut-out device which is substantially unaffected by age and weather.

When units of electrical equipment, for example lamps, are placed in series, the failure of a single unit causes the failure of the entire series. For many purposes such circuits are desirable, even with the disadvantage above mentioned, since as in the case of street lighting, wiring costs can be reduced. Thus, to operate the lamps in series, means are necessary for preventing the outage of the remaining lamps in the series, upon failure of any one lamp. Without such means, a single lamp that has failed is difficult to locate and further, a high open circuit voltage of the entire series string develops at the failed lamp and an arc may occur in the lamp or socket thus ruining the fixture.

It has been previously known to incorporate series-circuit cut-out devices in lamps or in associated fixtures. Commonly, those cut-out devices which have been associated with fixtures have been bulky, lacking in permanence and often erratic in operation due to weather conditions and water seepage. In the more conventional cut-out devices, an oxide-coated, copper disc was held between a pair of opposing springs. Upon failure of the associated lamp, the open circuit voltage caused breakdown of the oxide coating and the conduction of electricity from one spring through the copper and then to the other spring. Since breakdown voltages are proportional to the pressure exerted by the spring upon the disc, the tension of the springs must remain constant to obtain uniform and predictable breakdown voltages of the oxide coating. Because of atmospheric conditions, such as are associated with the change of the seasons, and also because of varying temperatures due to climatic differences, the tension will vary, thus resulting in varying breakdown voltages. Since the spring assembly is a permanent installation with only the coated disc being changed after failure and removal of the lamp, the device will be gradually rendered useless upon continued operation over a period of years because the spring pressure will decrease.

Less commonly, cut-out devices have been installed inside the lamp. However, due to lamp fabrication methods now commonly used, such devices are difficult to install and inordinately increase lamp fabrication costs and as such are not desirable.

We have found, however, that a small, compact, cut-out device may be fabricated which is inexpensive and disposable. Our cut-out device may be easily associated with most of the series circuit fixtures now in use and throughout its life, the device will maintain a generally constant spring pressure and be entirely waterproof.

In particular, our invention uses a conductive plate having a coating of an insulating material which will short circuit upon the occurrence of voltage in excess of line voltage, that is, the coating electrically insulates the conductive plate at and below operating voltages, but breaks down to allow the passage of current above such operating voltages. When a failure occurs in a constant voltage series circuit, the line voltage surges due to the attempt of the transformer to maintain constant voltage. Thus, large voltages are built up across the point of failure and

when our series circuit cut-out device is incorporated into the circuit across this failure, the adhering coating breaks down and the circuit is completed through a contact electrode and across the conductive plate.

Surrounding the contact electrode and the coated conductive plate is a resilient metal shield which forms a resilient outer shield jacket for the assembly. This shield, which can be about ⅜ inch square, is formed by folding a rectangular sheet of metal in the middle. After placing the coated conductive plate, the contact electrode, and an insulator in the folded resilient shield, the ends are joined and a uniform and constant spring action or biasing force is produced upon the elements, thereby holding them firmly in place. Because of the uniform biasing force, uniform breakdown voltages of the insulating coating are obtained and the effects of the temperature and age are minimized.

Accordingly, an object of this invention is to fabricate a disposable series circuit cut-out device which has a uniform breakdown voltage.

Another object of this invention is to prepare a series circuit cut-out device which is unaffected by age or surrounding atmosphere.

These and other objects, features and advantages will become apparent to those skilled in the art upon reading the following specification when taken in conjunction with the accompanying drawing in which:

FIGURE 1 is a schematic illustration of a plurality of lamps arranged in series with one of our series circuit cut-out devices shunting each lamp.

FIGURE 2 is an exploded perspective view of our series circuit cut-out device, showing in particular, the structural relation of the elements before the outer shield jacket is closed and before encapsulation in a waterproof material.

FIGURE 3 is a cross-sectional view of an assembled cut-out device, illustrating the position of the elements and particularly showing the mechanical biasing effect obtained upon the cut-out plate when using a resilient metal outer shield. This figure does not shown, however, the encapsulation of our cut-out device in a waterproofing plastic.

In each of the figures of the drawing, similar numerical designations illustrate similar elements.

Details of the various elements in our device are shown in FIGURE 3, in which a conductive plate **11** is positioned between a contact electrode **15** and a lower portion **5** of a resilient metal shielding jacket **1**. The conductive plate **11** may be of any desired peripheral shape or size, provision being made, of course, for the ultimate shape and compactness of the fabricated device. In particular, we prefer a conductive plate **11** having a generally round peripheral shape, with a diameter generally less than about ⅜ of an inch. The surface of the conductive plate **11** may be flat or concave, as desired, but we prefer a flat plate with a centrally located depression **21**, since breakdown voltages are most uniform with such shapes and the possibility of arcing between the conductive plate **11** and the shield jacket **1** is minimized. Arcing could be quite a problem since heat is produced and metal expansion due to such heat changes the biasing force of the shield jacket **5**, thereby producing erratic starting.

A layer of insulating material which breaks down upon the application of open line circuit voltage resulting from the failure of an associated lamp surrounds and adheres to the external surfaces of a conductive plate **11**. This layer, which is not shown in the drawing, may preferably be an oxide of the metal to which the coating adheres, but other adhering insulators which break down under excess voltages and allow the passage of current may also be used.

To prepare an oxide coating, a pre-shaped metal plate is heated to high temperatures in the presence of excess oxygen. Precise control over the thickness of the coat can be obtained by controlling the duration and temperature of the heating operation. We prefer a copper-black copper oxide conductive plate for our purposes since copper is a good conductor and the oxide coating is durable and relatively easy to form in uniform thicknesses. Of course, other conductive plates, such as lead with lead-oxide coating or aluminum with an aluminum-oxide coating, may be used. Furthermore, conductive plates coated with dissimilar insulators such as glass or resins may also be used.

The thickness of the insulating coating adhering to the conductive plate **11** may vary depending upon the characteristics of the circuit, for example, high voltage circuits will require thick coatings. For most circuits, when using a copper-black copper oxide conductive plate, the copper oxide coating should be from 0.001 to 0.01 inch thick.

When using a conductive plate **11** having a depression **21**, it is generally preferred to use a contact electrode **15** that has an indentation **20** which biases against the insulating coating. In this manner, when an associated lamp fails, the open line circuit voltage is concentrated in a single point in the cut-out device and erratic breakdown of the coating is minimized.

Generally, any electrically conducting material may be used for the contact electrode **15**; however, for convenience and cost we prefer copper, although aluminum or steel may also be used. Attached to the contact electrode **15** is a lead-in wire **19** and such attachment may be by means conventional in the art such as soldering or spot welding. Through the use of a contact electrode, we have provided a more rigid and easily made attachment than previously afforded. We have preferred to use a generally rectangular-shaped, flat contact electrode **15**, with the indentation **20** offset to one side since the flat side affords a convenient place for attaching the lead-in wire **19**. For maximum compactness of the cut-out device and to enhance its stability, we prefer to have the cut-out plate no wider than the width of the resilient metal shield.

Insulating the cut-out plate **15** from the upper shield portion **23** is an insulator **12**. Many materials are possible for this insulator and, for example, we have successfully used rubber, paper, mica and molded silicone resins; however, care must be taken to select a resin that will not flow within the shield jacket **1**. Since the insulator **12** helps bias the contact electrode **15** against the conductive plate **11**, which in turn is biased against the lower portion **5** of the shielding jacket, it is generally quite desirable to select a material which is quite pliant. Although the drawing illustrates the insulation extending over the entire surface of the upper portion **23** of the shield **1**, other configurations are possible so long as contact electrode **15** is insulated from shielding jacket **1**.

Enclosing the various elements of our cut-out device is the shield jacket **1**, which is divided into an upper and lower portion **23** and **5** and we prefer to prepare the shielding jacket **1** of a resilient metal which is folded over in the middle. After insertion of the various elements of the assembly, both the lower and upper portions of the resilient metal bow out to form a spring. Conveniently, the ends of the folded metal are attached together with tabs **9** that are prolongations of the sheet.

Soldered or welded to the shield, preferably to the lower portion **5** thereof, is another lead-in electrode **22** which will complete the circuit after the breakdown of the insulating coating on the conductive plate **11**.

Since the conductive plate **11** and the contact electrode **15** tightly fit against each other and since the conductive plate **11** is firmly biased against the lower portion **5** of the shield, erratic and unpredictable breakdowns of the insulating coat are eliminated. The pressure exerted by the indentation **20** upon the conductive plate **11** may be

varied by extending the length of the upper and lower portions of the shielding jacket **1** or by varying the thicknesses of the various internal associated elements. Additionally, the pressure exerted by the indentation **20** upon the conductive plate **11** may be varied by changing the thickness of the insulator **12**.

The compactness of design of our series circuit cut-out is shown in FIGURE 2, and, as seen therein, the conductive plate **11** has an area smaller than the area of the contact electrode **15**; however, these relations are not essential in all cases. The insulator **12** should be of a convenient size so as to insulate the contact electrode **15** from the shielding jacket **1** and generally it will be about the same size as the upper portion **23** of the shield jacket **1**. The upper and lower portions of the shielding jacket **1** are secured together by means of a pair of tabs **9** which we have found desirable for economy and efficiency of operations; however, many other means of joining the ends together may also be used, for example they may be welded or joined together by a U-shaped spring clamp. Irrespective of the means used for joining the ends of the shield jacket **1**, a spring action is obtained after closure.

In FIGURE 1 of the drawing, a series of lamps are shown arranged in a series circuit with each lamp associated in parallel with a series circuit cut-out device. Even though lamps are shown as the electrical equipment in the circuit, it is apparent that other electrical devices may also be used. The lead-in wires **31** and **32** are generally attached to a constant-current power source (not illustrated), for example a constant-current transformer. Each of the lamps **33**, **34** and **35** are arranged in series and during normal operation each of the lamps will light. Upon failure of any one of the lamps, for example lamp **34**, the current bypasses the lamp **34**, through the connector **36**, through the series circuit cut-out device **37**, through connector **38** and then through lamp **35** to illuminate it. The open circuit line voltage causes the breakdown of the insulating coating on the conductive plate of the cut-out device, which is not shown in this figure. Upon subsequent replacement of the lamp **34**, the series circuit cut-out device **37** is also replaced and discarded. Because of the very low cost, such replacement methods are economical and feasible and give the added advantage of a known and predictable breakdown voltage for each cut-out device.

As illustrated in FIGURE 1, each of the series circuit cut-out devices are encapsulated in a plastic covering. Although for some installations, such covering is not essential, it is quite desirable where the fixture or the cut-out device is exposed to the atmosphere. Plastics which are suitable for the cut-out devices are, for example, epoxies or vinyls, however many thermo-setting or even silicone resins may also be used. We have found that the encapsulation may be conveniently prepared by dipping the individual cut-out devices in the plastic and then removing them to dry and set. Encapsulated cut-out devices are so moisture proof that they may be operated while submerged in water.

It is apparent that other changes and modifications may be made within the spirit and scope of the instant invention, however, it is our intent only to be limited by the scope of the appended claims.

As our invention we claim:

1. A series circuit cut-out device adapted to be associated with electrical equipment, said device comprising: a conductive plate and a contact electrode; means adhering to said conductive plate for electrically insulating said conductive plate from said contact electrode at predetermined operating voltages, but capable of breaking down above said operating voltages, thereby allowing the passage of electric current between said contact electrode and said conductive plate; a resilient outer shielding jacket disposed below and extending to above and circumscribing said contact electrode and said conductive plate means to attach together the end of the portion disposed below

to the end of the portion extending above, thereby biasing said contact electrode against said conductive plate; means electrically insulating said shielding jacket from said contact electrode; means to conduct electricity to each of said contact electrodes and said shielding jacket and a water-proofing layer of plastic encapsulating said device.

2. A series circuit cut-out device adapted to be associated with electrical equipment, said device comprising: a conductive plate and a contact electrode; depressions in each of said cut-out plate and said contact electrode, the depression in said contact electrode adapted to fit in the depression of said conductive plate; means adhering to conductive plate for electrically insulating said conductive plate from said contact electrode at predetermined operating voltages, but capable of breaking down above said operating voltages, thereby allowing the passage of electric current between said contact electrode and said conductive plates; a resilient outer shielding jacket disposed below and extending to above and circumscribing said contact electrode and said conductive plate means to attach together the end of the portion disposed below to the end of the portion extending above, thereby biasing said contact electrode against said conductive plate; means electrically insulating said contact electrode from said outer shielding jacket and a water-proofing plastic layer encapsulating said device.

3. A series circuit cut-out device adapted to be associated with electrical equipment, said device comprising: a conductive plate and a contact electrode; means adhering to said conductive plate for electrically insulating said conductive plate from said contact electrode at predetermined operating voltages, but capable of breaking down above said predetermined voltage to allow the passage of electric current between said contact electrode and said conductive plate; a resilient outer shielding jacket disposed about said contact electrode and said conductive plate, said jacket being formed of a sheet of resilient metal folded substantially at its middle and having disposed at one end thereof a means to join the free ends of said sheet together, thereby biasing said contact electrode against said adhering insulation coating of said conductive plate; means electrically insulating said shielding jacket from said contact electrode; means to conduct electricity to said contact electrode and means to conduct electricity to said shielding jacket water-proofing means disposed about said series circuit cut-out device.

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