

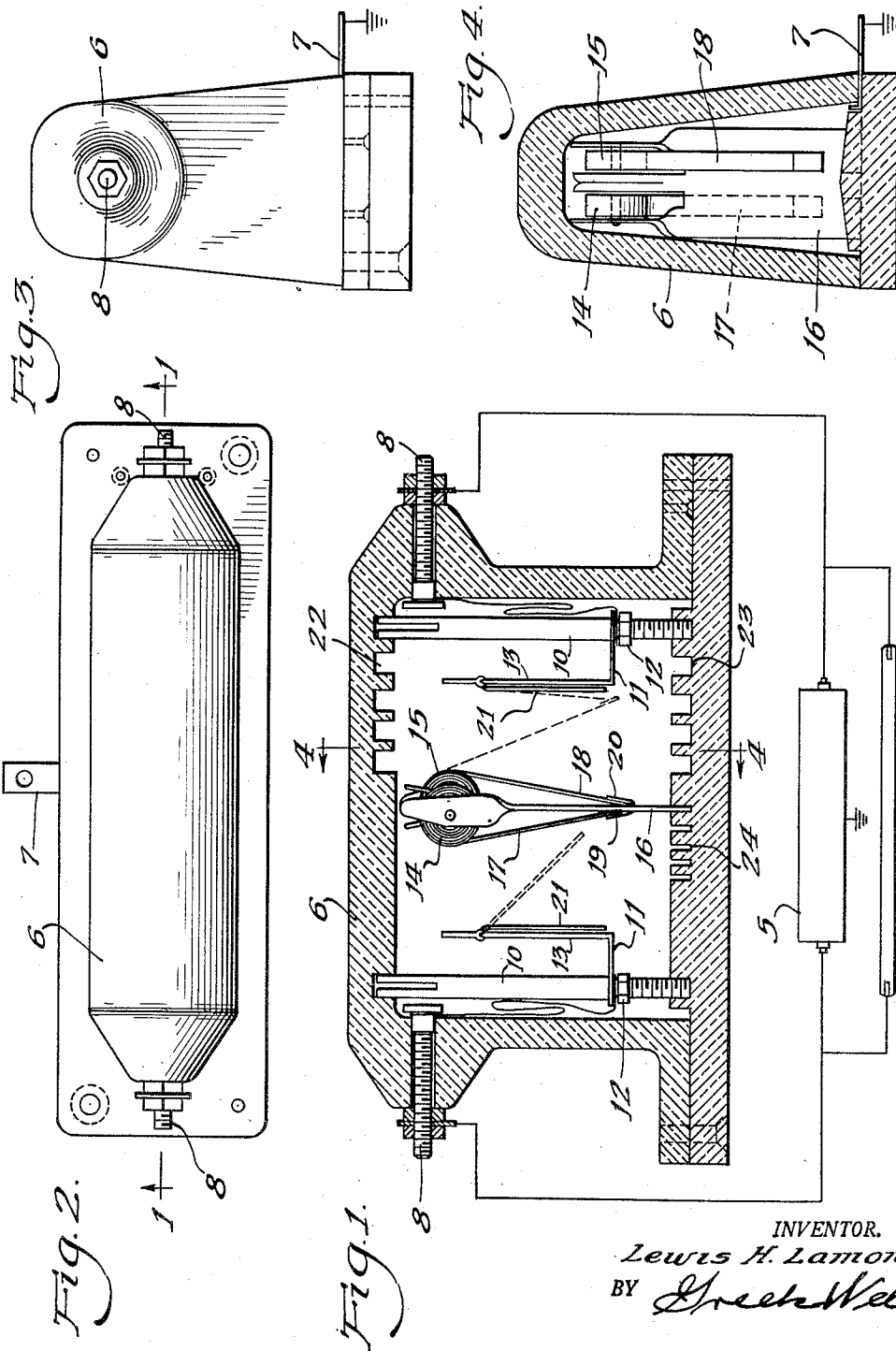
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CIRCUIT PROTECTOR

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CIRCUIT PROTECTOR

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The present invention relates to a protective device for preventing open circuit conditions to remain when there is a break or overload in a high tension circuit—also preventing hazardous arcing to ground caused by water, snow or any foreign matter. The device is particularly applicable as a safety device for protecting transformers of the current limiting type from the danger of having their secondary open circuited and kept in this position. Transformers of the type herein referred to have the characteristic of building up the secondary voltage as the resistance across the secondary increases.

The present invention contemplates a device of this character wherein a sudden increase in voltage across the high tension terminals will result in establishing an arc or spark discharge or short circuit which is maintained so long as the high tension terminals remain energized. The device is so arranged that if the current supply is cut off and the trouble remedied, the device automatically resets itself so as to be ready in the event of a further open circuit, overload or ground condition, to again act to protect against excessive high voltages.

Specifically, the present device is of particular advantage with transformers of the type herein above referred to. It will be readily apparent, however, that it is not so limited, and may be used wherever it is desirable to protect against excessive rises in voltage between two terminals by establishing a low resistance path or substantial short circuit across the terminals and releasing the short circuit path when the current is shut off.

The features and advantages of the present invention will appear more fully as the description proceeds, reference being had to the accompanying drawings wherein a preferred form of the invention is shown. It is to be understood, however, that the drawings and description are illustrative only, and are not to be taken as limiting the invention except insofar as it is limited by the claims.

In the drawings:

Figure 1 is a cross sectional view through a device embodying the present invention;

Figure 2 is a top plan view of the device;

Figure 3 is an end view of the device; and

Figure 4 is a sectional view on the line 4—4 of Figure 1.

Referring now to the drawings, in this device two terminals 8—8 are adapted to be connected to the secondary of a transformer 5 such as the current limiting high tension transformers

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customarily used for the purpose of stepping up the voltage from its normal commercial value to the necessary high voltage for energizing gaseous conduction signs and cold cathode lighting tubes and terminal 7 is connected to ground through a ground post when transformers are mid point grounded. The terminals lead through a porcelain housing 6 for the safety device which is the subject matter of the present invention.

The present invention concerns itself with a mechanism by which the high tension terminals 8—8 and 7 will be connected by a low resistance path, if at any time excessive voltage is built up between them. The stud posts 10 carry conducting plates 11 which are held in place by nuts 12. The terminals 8 are connected to the stud posts 10 by flexible wires. The plates 11 constitute terminal members for the purpose of establishing the low resistance path between the terminal stud posts 10. Each plate has a portion 13 which forms part of the initial short circuiting mechanism. Since this mechanism is a duplicate for each of the plates 11, it is believed to be sufficient to describe one of the mechanisms in detail. The short circuiting mechanisms 14 and 15 are mounted on a support 16 which is connected to ground terminal 7. The mechanisms comprise two coiled bimetallic strips which are suitably fastened to the grounded support 16. The bimetal strips 14 and 15 are so arranged that they are directly connected to the support 16 and are coiled at their upper ends and joined at the center of the coil which spirals outwardly and downwardly to provide contact arms 17 and 18. The arms 17 and 18 have contacting electrodes 19 and 20 on their free ends. The arrangement of each bimetal strip is such that if it is heated, the free end is caused to swing out from the vertical position, as shown by dotted line in Figure 1, thus bringing the contact elements 19 and 20 in contact with plates 11. In the normal operation there is of course no current flowing to the bimetallic strips 14 and 15, and therefore there is no heat condition that would cause them to swing the contacts 19 and 20 into an engagement with plates 11. Normal rise or fall of temperature to which the device is subjected would not cause any such action. Means are provided whereby an excessive rise in voltage between the terminals 8—8 or 8 and 7 will establish a conducting path for current to flow and heat up the bimetallic strips. Each plate 11, near its upper end, carries an electrostatically responsive leaf 21. The leaf 21 as shown, is hinged to the upper portion of the plate 11, so that they can swing

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out toward each other and the support 16. For practical purposes, I have found a light metal strip, such as a thin aluminum strip, is entirely satisfactory for the leaf 21.

In the normal operation of the device there is a direct conduction path established between the terminals 8—8 through the gaseous discharge tube 4 which is being energized from the transformer 5. If this conducting path is broken or disturbed, a charge builds up on each terminal, which charge increases as the voltage rises. Since the charge on the stud posts 10 is opposite in polarity, the leaves 21 are attracted to each other and swing outwardly to the position shown by the dotted line, until they come so close to the support 16 as to cause a spark discharge to start between their tips and the support. This discharge, once it is started, quickly causes an arc between the supporting plate 11 and the support 16, resulting in generation of a substantial amount of heat within the housing, and particularly adjacent to the bimetallic strips 14 and 15.

The heat generated from the arc which was just described causes the contacts 19 and 20 to move toward the leaves 21 and plates 11, and close a circuit between plates 11 and the support 16.

Of course when the contact elements engage, a short circuit is established between the terminals 8—8 and 7. This short circuit eliminates the excessive heating due to the arc, and as the elements 14 and 15 cool, the contacts 19 and 20 begin to return to normal position. The moment the contacts 19 and 20 separate from the plates 11, the voltage builds up in the secondary of the transformer 5 to start the arc between the contacts. The heat generated due to current flowing across this arc will overcome the separation of the contacts by heating the strips 14 and 15. Thus the strips 14 and 15 continue to move toward and away from the closed circuit position, and maintain a protecting circuit of comparatively low resistance between the terminals 8—8 and 7, until such time as the current supplied to them is cut off. When this happens, the strips 14 and 15 are returned to the normal position. The leaves 21 of course return to their normal resting position as soon as the arc is established and the electrostatic difference becomes too small to hold them in position.

The space in between plates 11 and the support 16 is varied depending upon the necessary voltage at which the transformer operates. With a high secondary voltage necessary for operation, the plates 11 and support 16 are spaced further apart than with a lower voltage. In all events, the spacing between the plates 11 and support 16 is much greater than is necessary to prevent the spark discharge starting between the leaves 21 and the ground support 16, in preference to current flowing through the gaseous discharge tube that is being energized.

When the transformer is first energized to start the tube in operation, the leaves 21 will flutter slightly because of the electrostatic difference between them, but will not come close enough to each other or the support 16 to establish an arc discharge. Once current is flowing in the gaseous discharge tube, there is no tendency for the leaves to swing toward each other unless an open circuit or circuit to ground raises the voltage between plates 11 or between either plate and the support 16. It is characteristic of these transformers, when a ground occurs on

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either side of the mid-point, that the opposite side will become overloaded, causing the voltage to rise. This in turn causes an electrostatic difference between the plate 11 and support 16, which in turn causes one leaf 21 to swing toward the support 16 establishing an arc as heretofore described. The arc sets up heat so as to move the adjacent bimetal strip. The bimetal strips are offset so that the section grounded (which has no arc) closes first, then the other section closes and the operation is as heretofore described. If the transformer is not mid-point grounded then both leaves 21 will swing toward the support 16, but only on open circuit or overload.

All parts of this protective device are so constructed as to resist the corrosive effects which result from the acid formed by an arc discharge through the air. The housing is of porcelain, the elements used for the several parts of the safety device are stainless steel for the plates 11 and parts 10 and 16, aluminum is used for the leaves 21 and cadmium plating is used upon the bi-metallic elements 14 and 15. In addition, the terminal posts 8—8 and 7 are made of stainless steel or other suitable metal that resists acid corrosion. The present invention has been found to be quite sensitive to voltage changes without a corresponding sensitivity to barometric conditions. Heretofore, safety devices consisting of two spaced stationary ball electrodes have been used to provide an arc discharge path parallel to the tubing across the transformer secondary. Such a device, however, is quite responsive to barometric conditions surrounding the device. Dry air increases and wet air decreases the breakdown resistance of the discharge path.

With the present safety device it is possible to have a very narrow range between operating voltage and the voltage at which the safety device will act. For example, most gaseous tube transformers are required by the Underwriters' Laboratories to be limited to 15,000 volts on open circuit. Many operators have sufficient tubing to require 12,000 to 13,000 volts starting voltage. The safety device has to operate upon a voltage rise of less than 2,000 volts and yet be reliable in all kinds of weather.

The electrostatic principle employed here makes it possible to operate within a small voltage range. It is well known that the attraction between two electrified bodies are in the inverse ratio of the square of their distance apart. In our device as the leaves swing toward the grounded support and each other a greater amount of force is required to overcome the weight of the leaves.

The repulsion of the leaf by its mounting decreases, but the attraction by the opposite leaf or support 16 is increased. I utilize these factors in obtaining a sturdy, reliable safety device which will act to protect high tension lines against excessive rises in voltage.

Figure 1 shows notches 22 and slots 23 in the porcelain, whereby one stud post 10 and its mechanism can be moved so as to operate on different transformer voltages, the support 16 must also be moved to corresponding slots 24 in the base of the housing.

From the foregoing description it is believed that the construction and operation of my invention will be readily apparent to those skilled in this art. Having thus described my inven-

tion, what I claim as new and desire to secure by Letters Patent is:

1. A safety device for protecting a current source against open circuit ground or overload, said device comprising, in combination, spaced conducting members adapted to be connected to the opposite terminals of the current source, a grounded conducting member between the first named members, an electrostatic charge responsive leaf connected with at least one member and being free to move in response to the attraction of opposite electrostatic charges on said members and shorten the gap between them to the point where spark discharge occurs across the gap between a pair of said members, a retractile gap bridging element connected to at least one of said members and operable in response to the resulting current flow from the discharge between the members to establish and maintain a low resistance path between said members so long as the current flow continues.

2. A safety device for protecting a current source against open circuit ground or overload, said device comprising, in combination, spaced conducting members adapted to be connected to the opposite terminals of the current source, a grounded conducting member between the first named members, an electrostatic charge responsive leaf suspended from each of the first named members and being free to move in response to the attraction of opposite electrostatic charges on said first named members and shorten the gap between them and the grounded member to the point where spark discharge occurs across the gap, retractile gap bridging elements connected to said grounded member and operable in response to the current flow from the discharge between the members to establish and maintain a low resistance path between said grounded member and said first named members so long as the current flow continues.

3. A safety device for protecting a current source against open circuit ground or overload, said device comprising, in combination, spaced conducting members adapted to be connected to the opposite terminals of the current source, a third grounded member between said first named members, an electrostatic charge responsive leaf connected with at least one member and being free to move in response to the attraction of opposite electrostatic charges on said first named members and shorten the gap between it and the grounded member to the point where spark discharge occurs across the gap, retractile bi-metallic discharge heated thermostatic strips connected to said grounded member and operable in response to the resulting heat from the arc discharge to establish and maintain a low resistance path be-

tween said first named members and the grounded member.

4. A safety device of the character described comprising a housing, spaced conducting members therein adapted to be connected to opposite sides of a high voltage source, an intermediate grounded conducting member, an electrostatic charge responsive leaf suspended from each of the first named members to swing toward the grounded member to establish an arc discharge between said members in said housing, and heat responsive elements on said grounded member movable toward the other members in response to the heat from said arc discharge to establish a low resistance path between the grounded member and said first named members.

5. A safety device of the character described comprising a housing, spaced conducting members therein adapted to be connected to opposite sides of a high voltage source, an intermediate grounded conducting member, an electrostatic charge responsive leaf suspended from each first named member to swing toward the grounded member to establish an arc discharge between said members in said housing, and heat responsive elements on said grounded member movable toward the other members in response to the heat from said arc discharge to establish a low resistance path between said members, said leaf comprising a thin strip of aluminum.

6. A safety device of the character described comprising a housing, spaced conducting members therein adapted to be connected to opposite sides of a high voltage source, an intermediate grounded conducting member, an electrostatic charge responsive leaf suspended from each of the first named members to swing toward the grounded member to establish an arc discharge between said members in said housing, and heat responsive elements on said grounded member movable toward the other members in response to the heat from said arc discharge to establish a low resistance path between the grounded member and said first named members, said housing having means to support the grounded member and one of said first named members at a plurality of points differently spaced from the other of said first named members.

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