April 28, 1959 D. K. DORIAN 2,884,501

CIRCUIT PROTECTIVE DEVICE

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Fig. 1.

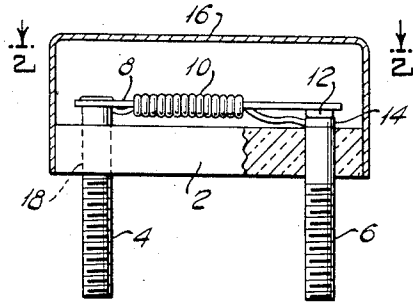


Fig. 2.

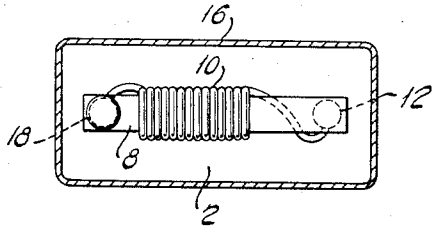


Fig. 3.

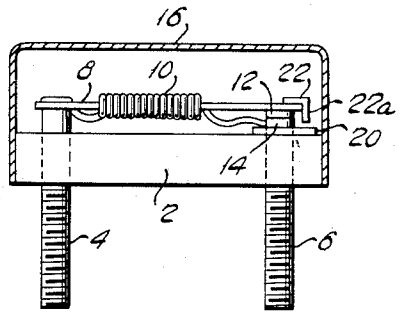
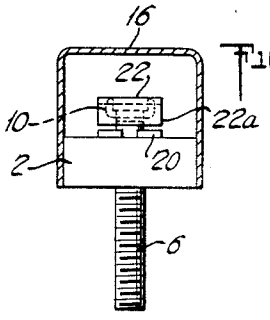


Fig. 5.



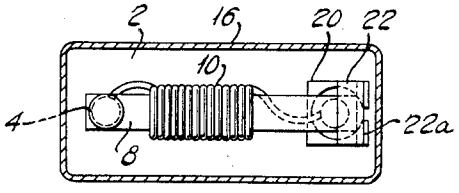


Fig. 4.

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CIRCUIT PROTECTIVE DEVICE

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2 Claims. (Cl. 200—122)

The present invention comprises a novel circuit protective device which is simple and economical of construction, has a long operating life without change in rating even after subjection to short circuit conditions and may be reset after operation by manipulation of the usual switch. The new device differs from the type of circuit breaker or non-destructible fuse which when operated is latched in open circuit position in that access thereto is not necessary for reclosure of the protected circuit. The device differs from the usual self-closing bimetallic circuit breaker in that after the movable element thereof has moved to contact-opening position due to excessive current therethrough the element will remain in that position until the circuit switch has been manipulated. The device differs from the usual bimetal thermostat in that it is primarily current responsive and relatively insensitive to ambient temperature.

The movable member of the new device is a flat bi- or multi-metallic blade so dimensioned with respect to the current rating as to flex when heated by the passage of excess current therethrough. The blade is mounted at one end, as by riveting, on an end of a stud or post, the other end of which provides one terminal of the device. A second stud or post comprising the other terminal of the device carries a contact positioned to engage a contact carried by the blade, the contacts being normally in engagement and thereby closing the circuit between the terminal posts. When excess current, that above the rated value for the device, flows through the blade differential expansion of the metallic constituents thereof causes flexure of the blade about an axis transverse to the length of the blade.

In accordance with the invention a heating coil is insulatedly wound about the blade and electrically connected across the terminals of the device so as to be shunted by the blade under normal current conditions and to be energized when the contacts are opened as a result of flexure of the blade, heat radiated from the energized coil to the blade being sufficient to maintain the blade flexed in contact open position. The return of the blade to circuit closing position is readily effected merely by opening of the circuit at the usual switch, thereby cutting off the current to the heater coil. Upon reclosure of the manual switch, if the circuit still carries excessive current, the blade again moves to contact open position and remains at such position.

The particular resistance of the blade material and the dimensions of the blade depend upon the current rating of the device. Irrespective of the rating, the device is so constructed that the contacts will not open until the temperature of the blade exceeds at least 240° F. The device, therefore, is relatively insensitive to ambient temperature.

The resistance of the heater coil is so chosen as to yield a high heater temperature, say 700° F. and thereby to prevent chattering of the contacts.

In the preferred embodiment of the invention magnetically permeable elements are so mounted on the fixed and movable elements as to increase the flux density of

the magnetic field set up about the conducting elements during current flow and thereby provide a magnetic force tending to keep the contacts in engagement.

For a better understanding of the invention reference may be had to the accompanying drawing of which:

Fig. 1 is a side view partly broken away of a circuit breaker embodying the invention;

Fig. 2 is a horizontal plan view taken on line 2—2 of Fig. 1;

Fig. 3 is a side view of a circuit breaker representing another and preferred embodiment of the invention;

Fig. 4 is a top plan view of the circuit breaker of Fig. 3; and

Fig. 5 is an end view of the device of Figs. 3 and 4.

The circuit protective device of Figs. 1 and 2 comprises a base element 2 of insulating material and of generally rectangular form, a pair of support posts 4 and 6 each of which is embedded in the base over most of the upper portion thereof and threaded at its lower end, a blade 8 of generally rectangular outline and a heater coil 10.

The blade 8 is composed of metal layers of different coefficients of thermal expansion. Preferably the blade is composed of three layers, one an alloy of nickel, chromium and iron, another an alloy of nickel and iron and the last a layer of nickel. The dimensions of the blade and the exact composition of the blade material will depend upon the current rating of the device. For a 40 ampere circuit breaker at a rated voltage of 12 volts the blade may be .25" thick, .925" long, .210" wide and have a resistivity of 125 ohms per circular mil foot. With an active length of blade of .50", determined by the spacing of the posts 4 and 6, the resistance at room temperature of a blade of the above indicated specifications, will be about .0014 ohm with a resistance temperature coefficient of approximately .0023 ohm/ohm/° F. At rated current with a voltage drop of 74 to 84 millivolts, the blade temperature will be roughly 250° F. The blade of a 5 ampere circuit breaker for a rated voltage of 12 volts may have about twice the resistance of the blade of the 40 ampere breaker and a resistance temperature coefficient of about one third of that of the 40 ampere breaker.

The heater coil 10, of wire provided with an insulating cover, is wrapped around the blade so as to be in close heat transfer relation thereto. The resistance of the winding is high compared to that of the blade and will depend upon the current rating of the device and the voltage of the circuit in which it is to be used. For a 40 ampere circuit breaker at a rated voltage of 12 volts, a resistance of about 20 ohms is satsifactory. For a 5 ampere circuit breaker, rated voltage of 12 volts, the coil resistance may be about 50 ohms.

A contact 12 is mounted on the underside of the end of the blade 8 above the upper end of rod 6 and a contact 14 is secured to the upper end of the rod 6 for engagement with contact 12 when the current through the blade is below the rated value. In mounting the blade 8 on the upper end of rod 4 the blade is preloaded by flexing to increase the pressure between the contacts 12 and 14 and to insure that the blade will not move to open circuit position at temperatures below those corresponding to excess current. For the above described 40 ampere circuit breaker a preloading of about one pound twelve ounces insures opening of the circuit at temperatures above 300° F. and below 400° F., the latter temperature corresponding to a 125% overload. A suitable cover 16 of metal or the like fits over the plastic base 2 and is crimped into the indentations 18 provided in the base.

When the threaded lower ends of the rods or posts 4 and 6 are connected in a circuit to be protected and the current does not exceed that for which the device is designed, current flows through the posts and blade 8

in series and, as the total resistance of these elements is small and the contact resistance is small due to the initial pressure introduced during the mounting of the blade, the winding **10** is shunted. When the current in the circuit increases, due, for example, to a short circuit at some point, the blade becomes heated and the differential expansion thereof causes stresses to be set up in the blade tending to open the contacts. When the temperature becomes sufficiently high to cause opening of the contacts the full circuit voltage is impressed across the winding **10** and hence current flows through the winding and heat is generated in close proximity to the blade to hold the blade in open circuit position and thereby prevent reclosure of the circuit. To test the circuit the operator opens the circuit at the usual control switch to cut off the current to winding **10**. After dissipation of heat from the enclosure, the blade **8** returns to its normal contact closing position. Upon reclosure of the circuit by the operator, if excessive current conditions are still present, the blade **8** will again flex to open contact position and remain in that position under the influence of the heat from winding **10**.

Depending upon the amount of excess current through the device and upon the rapidity of heating of the winding **10** some chattering of contacts may occur upon initial opening of the contacts. In the embodiment of the invention illustrated in Figs. 3, 4 and 5 magnetic means are provided for eliminating any tendency toward chattering of contacts. These means comprise magnetically permeable elements mounted on the blade and on the fixed parts of the device. On the plastic base **2** is mounted a generally U-shaped flat iron core **20** in a position to partially encircle the fixed contact **14**. Mounted on the free end of the blade **8** is an armature **22** having a depending flange **22***a* extending down over the end of the blade and of a width to bridge the legs of core **20**. When the contacts are closed and current is flowing through the blade **8** the magnetic field set up about the conductors is concentrated in the elements **20** and **22**, a magnetic loop being formed from one leg of the core **20** through the flange **22***a* of the armature to the other leg of core **20** and back through the looped portion of the core **20**. The magnetic force tends to hold the contacts closed during current flow. When the temperature of the blade is such as to overcome the initial pressure plus the force developed by the magnetic field, the contacts open and the magnetic field collapses.

Rapid opening results and chattering is thereby avoided.

The invention has now been described with reference to two embodiments thereof. Obviously various changes in the particular constructions illustrated and described could be made without departing from the spirit of the invention and the scope of the accompanying claims.

The following is claimed:

1. A current responsive protective device comprising a bimetallic blade adapted to flex from a circuit closing position to a circuit opening position when heated by passage of excess current therethrough, electrically conductive means for supporting said blade and comprising one terminal of the device, an electrical contact carried by a second terminal of the device and positioned to be engaged by said blade when the blade is in circuit closing position and to be disengaged when said blade flexes to the circuit opening position, a heater coil connected across said terminals so as to be shunted by said blade when in circuit closing position, said coil being insulatedly wrapped about said blade to heat the same when energized and thereby to maintain the blade in flexed open circuit position, a magnetically permeable element mounted on the free end of said blade and a second magnetically permeable element fixed adjacent said contact, said elements being positioned and shaped to concentrate the magnetic field set up by current through said blade when said contacts are closed whereby when the blade is carrying current there is created a magnetic force tending to maintain the blade in circuit closing position.

2. The device according to claim 1 wherein said blade is mounted on said conductive means under a stress sufficient to cause engagement under pressure with said contact and to prevent movement of the blade to circuit opening position at temperatures below 240° F.

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