July 4, 1950 T. R. COGGESHALL 2,513,918

RESISTANCE UNIT FOR ELECTRIC CIRCUIT BREAKERS

Filed March 26, 1947

Fig. 1.

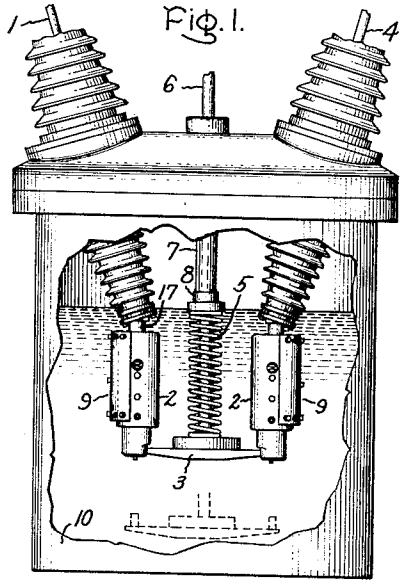


Fig. 6.

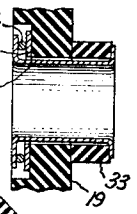


Fig. 4.

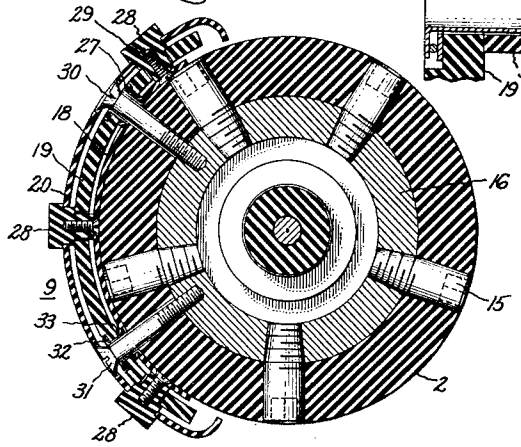


Fig. 2.

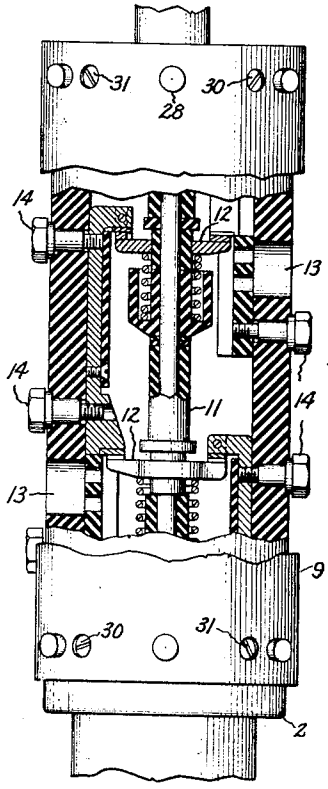


Fig. 3.

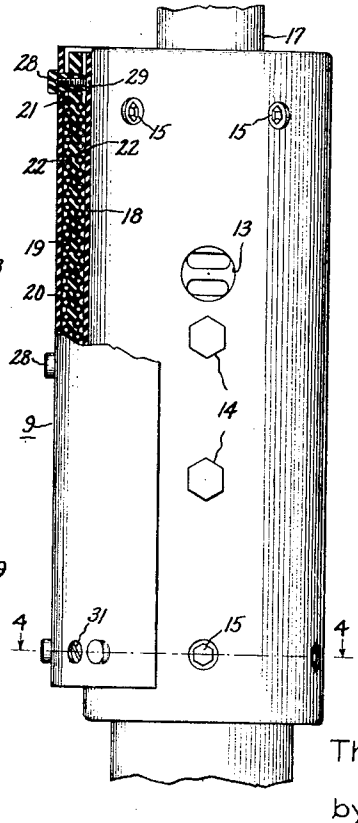
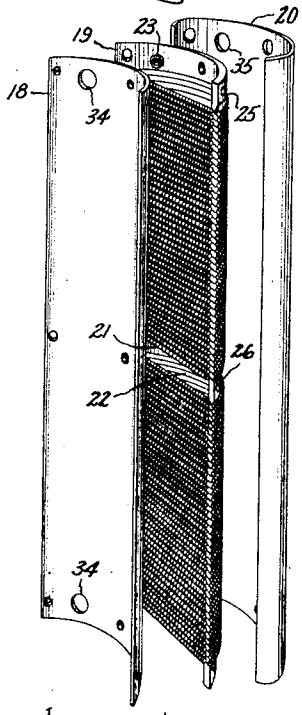


Fig. 5.



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UNITED STATES PATENT OFFICE

2,513,918

RESISTANCE UNIT FOR ELECTRIC CIRCUIT BREAKERS

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Application March 26, 1947, Serial No. 737,337

12 Claims. (Cl. 200—150)

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My invention relates to electric circuit breakers for interrupting high voltage power circuits in which the circuit breaking process is facilitated by the cooperation of an impedance such as a resistor associated with the interrupter elements of the circuit breakers. The benefits and performance characteristics of one type of interrupter-resistor combination falling within the purview of my invention is described and discussed in U. S. Patent 2,391,672, issued December 25, 1945, and assigned to the same assignee as the present invention.

More specifically, my invention is concerned with providing a practicable and economical form of resistor which is particularly applicable to an interrupter of the so-called multi-break oil-blast type such as is disclosed, for example, in U. S. Patent 2,164,175, issued June 27, 1939, and assigned to the same assignee as the present invention wherein the interrupter assumes the physical form of a cylindrical unit. Because the casing of such an oil-blast interrupter has certain side vents or blast ports provided in the curved wall thereof and because certain bolt heads and the like project therefrom, it is impracticable to apply a resistor in the convenient form of a wire helix disposed therearound such as is depicted, for example, in U. S. Patent 2,401,963, issued June 11, 1946, assigned to the same assignee as the present invention. Accordingly, it has been the usual practice hitherto to apply a resistor to a multi-break oil-blast interrupter as a separately assembled cylindrical unit, this unit being connected as a shunt resistance across the contact structure of the interrupter and mounted adjacent thereto as depicted diagrammatically in Fig. 2 of the aforesaid Patent 2,391,672.

Now although certain manufacturing advantages accrue when the resistor is constructed as a unit distinct from the interrupter element, certain disadvantages also must be borne, especially when the resistance, because of both ohmic and thermal reasons, requires a wire of such length that the cylindrical resistor unit assumes a bulk of undesirable proportions. Such bulk disposed adjacent the interrupter units can complicate the voltage problems, and interfere with the effectiveness of the blasts ejected from the interrupter. Moreover, the added space requirements necessitate a larger oil tank for enclosing the interrupters and resistors than otherwise would be required. Therefore, it would be desirable to provide a resistor for a multi-break interrupter which is free from the above enumerated disadvantages while nevertheless retaining the advantages of both the above discussed resistor types.

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In accordance with my invention, I achieve this desirable end by constructing the resistor in a relatively thin arcuate or segmental form which is preferably manufactured as a separate unit adapted for mounting closely upon an unbroken portion of the curved surface of its associated multi-break interrupter so as to not impede the blasts ejected from the ports or vents. This intimate disposition like a shield upon the interrupter casing side wall permits the combined bulk of the interrupter and resistor to approximate that desirable minimum which is attainable by coiling the resistor wire directly about the interrupter casing as in the aforesaid Patent 2,401,963.

It therefore is an object of my invention to provide an improved power circuit breaker characterized by a resistor-controlled interrupting device.

Another object of my invention is to provide an improved cylindrical circuit interrupter having mounted thereon a resistor the configuration of which conforms to the curvature of the interrupter casing.

A further object of my invention is to provide a circuit breaker resistor unit of predetermined curved configuration adapted for mounting intimately upon a correspondingly curved surface.

A still further object of my invention is to provide a new method of constructing a circuit breaker resistor unit in conformity to a predetermined curvature.

Further advantages and aspects of my invention will become apparent from the following description referring to the accompanying drawing and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In the drawing, Fig. 1 thereof is an elevational view of a single pole circuit breaker having the oil tank partially removed for disclosing in its interior a pair of interrupter units upon each of which is mounted a curved resistor embodying my invention; Fig. 2 is an enlarged side elevational view of one of the resistor equipped interrupters shown in Fig. 1 suitably cut away for revealing the interior; Fig. 3 is a side view of Fig. 2 with a part of the resistor cut away for showing certain internal details thereof; Fig. 4 is a sectional view of the interrupter and resistor of Fig. 3 cut transversely across by the plane 4—4; Fig. 5 is an exploded perspective view showing more clearly the several main contributary

parts which comprise the curved resistor of my invention; while Fig. 6 is an enlarged detail showing the construction of the resistor terminals.

Referring now to Fig. 1, which shows a single pole unit of a conventional tank-type oil circuit breaker in the closed position, the electrical circuit to be interrupted may be considered as flowing through the breaker via bushing conductor stud 1, the multi-break contact structure within the left hand interrupter unit 2, across the vertically reciprocable switch blade 3, up through the multi-break contact structure within the right hand interrupter 2, finally passing out through the bushing conductor stud 4. As is well known in the art, the circuit is interrupted whenever the switch blade 3 is caused to move rapidly downward from the closed position shown as from the urge of an opening spring 5 when a restraining means (not shown) is unlatched thereby permitting the operating rod 6 to slide within its guide tube 7 and the stationary spring stop 8 connected thereto. During the arc extinguishing process, which is consummated during the early portion of the downward travel of switch blade 3, each resistor 9 of my invention, which partially circumscribes its interrupter 2 as best illustrated by Fig. 4, renders effective aid during the interrupting operation in a manner, for example, as is clearly set forth in the aforesaid Patent 2,391,672. The breaker opening operation terminates with the arrest of blade 3 in its lower-most position, shown by dotted lines, after establishing a safe isolating gap with respect to the interrupters 2 in the oil contained in the tank 10.

Fig. 2 illustrates internal details of the multi-break structure of the interrupter 2. It will be understood that, coincident with the initial downward opening movement of the switch blade 3, the internal axial structure 11, upon which are mounted the several bridging contacts 12, moves in following relationship with the blade for a limited distance. In this movement, each of the multiple bridging contacts 12 moves from its associated fixed contact structure to draw therefrom a pair of series arcs, one of which is extinguished in a well-known oil-blast manner by being driven elongatingly toward, into, or through an adjacent blast port 13 provided in the interrupter side wall. It will be observed that the fixed contact structure is clamped immovably against the interrupter interior by means of insulated screws 14, and that, except for the irregularities due to the blast ports 13 and the projecting screw heads 14, the remainder of the interrupter external will constitute segmental portions having substantially unbroken curved surfaces, for it will be noted that headless screws 15 are used for securing other internal members within the interrupter unit 2. Fig. 4 shows this latter construction best, from which it will be evident that a plurality of headless screws 15 radially disposed through the interrupter casing wall engage, by means of tapered screw threads, into a cylindrical member 16 so that the latter is securely anchored inside the lower end of the casing of interrupter 2. In like manner the adapter casting 17, which supports the interrupter 2 from its associated roof-entrance bushing, projects into and is secured within the upper end of the interrupter casing, for adapter 17 has a cylindrical portion integral therewith comparable to member 16 into which another set of radially disposed taper-threaded screws 15 are tightly entered. It should be understood that the metallic adapter 17 is in electrical contact with the fixed contact structure disposed above the uppermost bridging contact 12 while the lower metallic cylindrical member 16 is in electrical contact with the fixed contact structure disposed below the lowermost bridging contact 12; for it will become apparent later that the upper and lower terminals of resistor 9 are connected into the interrupting circuit via the abovementioned upper and lower metallic member 17 and 16 respectively. Further detailed description of the construction of interrupter unit 2 is believed to be superfluous for a full understanding of my present invention, but in the event that further information is desired, reference may be had to my co-pending application Serial No. 684,813, filed July 19, 1946, and assigned to the same assignee as the present invention (and which application relates more specifically to the interrupter unit referred to herein).

The resistor 9 of my invention is constituted preferably by a laminar arragement of three main arcuate members 18, 19 and 20 as is most clearly shown by Fig. 5, in which these three parts are depicted as being exploded apart from their normal nesting relationship with each other as in Fig. 4. I prefer to preassemble these members into the relatively thin curved unit 9 for readily mounting upon one of the aforementioned unbroken segmental surface portions of the interrupter 2 which extends intermediate the vertically aligned blast ports 13 and insulated screw heads 14, as is best shown by Figs. 3 and 4. It will be obvious that, if additional resistance is required, another similar resistor unit may be mounted on the diametrically opposite side wall of the same casing without either of the resistors interfering in any way with the blasts ejected during interruption from the ports 13. However, when using one resistor per interrupter as shown in the drawing, I prefer the arrangement depicted in Fig. 1 in which each resistor occupies a position nearest to the side wall of the oil tank 10, and in which arrangement the blast ports 13 are directed outwardly and perpendicularly away from the common vertical plane intersecting the axes of the interrupters 2 and their supporting bushings.

Of the three curved sheet-like members shown in Fig. 5, the middle member 19 constitutes the arcuate core about which the resistance wire 21 is wound. Coreboard 19 is thicker than the other members and preferably is produced from a mechanically strong hot-molded insulating compound. Into it is impressed on both sides a series of parallel grooves 22 which provide rows of semi-circular beds for receiving the coiled resistor wire 21 and, as is best shown in Fig. 3, these outer and inner grooves are preferably arranged in staggered relationship with respect to each other. With this parallel staggered arrangement, the grooves in the convex side can not run into the grooves on the opposite concave side so that maximum strength is preserved in the coreboard 19 while short-circuiting between resistance coil sections on opposite sides of the board is a virtual impossibility. Prior to winding about the coreboard 19, the resistance wire 21, which may be on the order of .030 inch diameter, is first coiled into a long close-wound helical spring of some ¼ inch coil diameter. This long coil of wire may be wound temporarily on a spool for convenience in handling during assembly.

Commencing, say, at the top of the coreboard 19 in Fig. 5, one end of the coil resistance wire 21 is opened up to form a ring-like terminal 21*a* for securing clampingly between a flanged tubular terminal 23 and a washer 24 as is clearly illustrated in the enlarged detail of Fig. 6. Then the

coil is wound about the coreboard progressively from top to bottom. During this operation, as will be appreciated from inspection of Fig. 5, the coiled wire 21 beds readily and snugly into the grooves on the convex side of the core-board, whereas the coil sections at the concave side of the board are stretched directly across the coreboard edges with slight tension but with care having been taken into position each straight section so that it is suspended in proper registry opposite its appointed concave groove. In carrying out this winding process a turn of the coiled wire is opened up for making each transitional downward step from a groove on one side of the board 19 to a groove on the other side, so that only a single short relatively straight wire as at 25, rather than several wire coils, extends around the coreboard edge at each downward step from groove to groove. Although it may be desirable to provide an intermediate gap 26 in the winding for reasons which will later become apparent, it is to be understood that the electrical resistance circuit proceeds continuously about the coreboard 19 from the aforementioned upper terminal 23 to a similar lower terminal 27 shown in Fig. 4 which is disposed in a position with respect to the bottom of the coreboard 19 corresponding to that of terminal 23 with respect to the top of the coreboard. Accordingly, the sub-assembly comprising the coreboard 19 with the boiled resistance wire 21 wound thereon constitutes the significant resistor element which subsequently is to be applied to the interrupter 2.

At this juncture, if it is assumed that the above-defined resistor sub-assembly be applied to the interrupter 2, with the straight coiled sections tangential to the unbroken curved surface of the interrupter, and if then the sub-assembly be pressed against and secured to the interrupter side wall, it will be apparent that the straight coil sections would be stretched bowingly into their appointed registering grooves on the concave side of the coreboard 19. Consequently, all sections of the entire coil winding 21 would then lie securely each in its proper groove and be incapable of displacement therefrom. Assuming further that the terminals 23 and 27 are electrically connected into the metallic members 17 and 16 respectively, the resistor would then function to aid circuit interruption in known manner. However, instead of applying the wound core directly to the interrupter as indicated above, I prefer to facilitate the application of the resistor unit to the interrupter unit 2 and also to provide additional protection for the winding. To these ends, I provide the inner curved insulating retaining member 18 and the outer curved insulating cover member 20 which I attach to either side of the wound coreboard so as to constitute the complete laminar resistor unit 9 as clearly indicated in the sectional view of Fig. 4.

To produce the complete resistor unit 9, the already wound coreboard 19 is first laid nestingly inside the outer cover member 20, after which the curved retaining member 18 is applied with suitable pressure means against the yielding straight coiled sections until the wound coreboard 19 is intimately sandwiched between the curved members 18 and 20 with all the former straight coiled wire sections extended properly into their respective grooves. The three curved members 18, 19 and 20 are then secured together in this laminar relationship by means of a plurality of cylindrical fiber spacers 28 which are best shown in Fig. 4. As shown, each of these has a shouldered head at one end of the body, a tapped hole at the other end for receiving a cooperating clamping screw 29, and an annular shoulder toward the middle of the body. The tapped end face of each spacer 28 abuttingly engages the retaining member 18, while the shouldered head and body of the spacers 28 maintain the proper relationship of the coreboard 19 and the cover 20 with respect to the member 18. Sets of aligned holes for the screws 29 and the spacers 28 are provided in the curved members 18, 19 and 20 respectively and in my chosen embodiment it will be observed that I have provided three such sets of holes for receiving three spacers 28 at either end of the resistor unit 9. Where resistor units are of such length that the retainer member 18 would be apt to bend unduly toward the middle from the spring pressure of the restrained inner coil sections, I provide an intermediate horizontal row of clamping spacers 28 as indicated in the drawing, in which event the aforementioned gap 26 will have been allowed in the winding for the accommodation thereof. The gap 26, from which the coil receiving grooves in coreboard 19 preferably are omitted, also provides a suitable location in which to dispose a connector or splice, not visible for joining together upper and lower sections of the wire 21 in cases where a single length of wire would be impracticably long. I prefer to curve the longitudinal edges of the cover member 20 inwardly as shown, so that the winding 21 of the resistor unit 9 is protectively sheathed on all sides from possible damage due to mishandling or accident. From the description thus far, it will be discerned that the grooves 22 really constitute a predetermined guided or restricted route in the curved surface of the coreboard 19 into which the winding 21 is received and from which escape is prevented due to the restraint of the curved sheet members 18 and 20.

For mounting the resistor unit 9 upon the interrupter unit 2, tubular terminals 23 and 27 provide convenient apertures for receiving flat head mounting screws 30 which, passing through the interrupter casing wall, screw into tapped holes provided for them in the current carrying interrupter members 17 and 16 respectively. Hence, the mounting screws 30 also serve to electrically connect the resistance winding 21 into the interrupting circuit. For providing appropriate apertures in the resistor 9 for additional mounting screws 31, I find it convenient to employ a flanged tubular arrangement 32 which is identical to the arrangement of terminals 23 and 27 as shown in Fig. 6 except that the wire terminal ring 21*a* is omitted therefrom. Accordingly, mounting screws 31 and 30 are identical, the only distinction being that the latter carry resistor current while the former do not.

In order that the clamping pressure from the mounting screws 30 and 31 is borne directly upon the strong coreboard member 19 of the resistor unit 9, I provide a projecting fiber ring spacer 33 at each mounting aperture which, as is clear from Fig. 6, is secured to the coreboard 19 by a flanged tubular rivet or terminal such as 23. Suitable clearance holes 34 in the curved member 18, Fig. 5, permit these riveted spacers 33 to project therethrough so that the latter bear compressively upon the interrupter casing wall. Other clearance holes 35 in cover member 20, positioned so as to be in registry with holes 34, provide access for the insertion of mounting screws 30 and 31 into their respective mounting

apertures through the coreboard 19. Reviewing the above detailed description, it will be understood that the curved coreboard 19 provides the foundation for the entire structure of the resistor unit 9, for upon it is wound the resistance wire 21, to it is secured the protective members 18 and 20 by means of spacers 28 and screws 29, while the mounting screws 30 and 31 support it firmly against the interrupter 2 through the agency of the spacer members 33 which really constitute four short hollow supporting legs projecting from the coreboard body.

It will be apparent that when applied to an oil circuit breaker as in the chosen embodiment described herein, the above-described resistor unit 9 will be totally submerged so that oil will then virtually surround the entire coiled resistance wire 21. Accordingly, this resistor is capable of sustaining high voltage surges therethrough without hazard of short circuiting among coils or sections of the winding even though but a very small clearance space is allowed between adjacent turns of the coiled resistance wire. Obviously, forms of protective insulation other than liquid oil or free air may be employed for investing the coiled winding 21 between its core 19 and sheath members 18 and 20. Thus, for example, the interstices could be filled with a plastic insulating compound which also might be thermo-setting. Such construction would render such a resistor well suited for use with an air blast circuit interrupter.

From the above discussion it will be apparent that I have provided a new and useful resistor unit for readily mounting upon a curved surface which is capable of including a wire resistance element of considerable length, that is, of high ohmic and thermal capacity, which nevertheless is of a comparatively small volume. It should be understood that my invention is not limited to specific details of construction and arrangement thereof herein illustrated, and that changes and modifications may occur to one skilled in the art without departing from the spirit of my invention.

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

1. A high voltage resistor unit for aiding the circuit interruption of an electric circuit breaker having relatively separable contact structure comprising a relatively thin arcuate insulating foundation board, a helically coiled metallic resistance winding wound about said board so that the portion of each turn on the convex side of said board is caused to assume the shape of an arc and the portion of each turn on the concave side of said board is caused to assume the shape of a chord, and means conforming to the curvature of said board for engaging the portions of each turn of said winding disposed on the concave side of said board to cause such portions of said winding to elongate by spring action so as to conform with the curvature of said board.

2. A high voltage resistor unit for aiding the circuit interruption of an electric circuit breaker having relatively separable contact structure comprising a relatively thin arcuate insulating foundation board provided with a plurality of closely spaced grooves in and across a concave surface thereof, said grooves extending in substantially the same direction as the curvature of said arcuate foundation board, a metallic resistance winding including helically coiled sections disposed in said grooves, and means conforming to the concave curvature of said foundation board for retaining said coiled sections in said grooves against the contracting spring action of said helically coiled winding.

3. A high voltage resistor unit for aiding the circuit interruption of an electric circuit breaker having a relatively separable contact structure comprising a relatively thin arcuate insulating foundation board provided with a plurality of closely spaced parallel grooves on the opposite sides thereof, said grooves extending in substantially the same direction as the curvature of said arcuate foundation board, a helically coiled metallic resistance winding disposed in said grooves, a protective sheathing for retaining said winding in said grooves comprising a first arcuate insulating sheet closely conforming to the concave curvature of said foundation board for retaining said winding in the concave face of said foundation board against the mechanical tension of said helically coiled winding, a second arcuate insulating sheet closely conforming to the convex curvature of said foundation board, and means for maintaining said sheets in clamping relationship about said foundation board.

4. A high voltage resistor unit, for aiding the circuit interruption of an electric circuit breaker having a relatively separable contact structure comprising a relatively thin arcuate insulating foundation board having provided in the surface thereof a plurality of closely spaced parallel grooves, said grooves extending in substantially the same direction as the curvature of said arcuate foundation board, a helically coiled metallic resistance winding disposed in said grooves, and means conforming to the curvature of said foundation board for retaining said winding in said grooves.

5. A high voltage resistor unit for aiding the circuit interruption of an electric circuit breaker having a relatively separable contact structure comprising a relatively thin arcuate insulating foundation board, means defining a predetermined winding restricted route about the curved surface of said board in substantially the same direction as the curvature of said board, a helically coiled metallic resistance winding disposed along said predetermined route, and an insulating sheet closely conforming to the curvature of said foundation board and cooperating with said board for retaining said resistance winding in said route against the spring action of said winding.

6. The method of constructing a resistor for connecting to a circuit breaker to aid the circuit interruption thereof comprising the steps of coiling a resistance wire into a helical spring formation, disposing said coiled wire as a winding about a relatively thin curved insulating foundation board with certain portions of said winding lying in grooves provided across the convex side of said board while other portions of said winding are suspended across appointed grooves provided in the concave side of said board, and thereafter pressing said other portions into and maintaining them in their appointed grooves against the spring action of said helical spring formation.

7. The method of constructing a resistor for connecting to a circuit breaker to aid the circuit interruption thereof comprising the steps of coiling a resistance wire into a helical spring formation, disposing said coiled wire as a winding about a relatively thin curved insulating foundation board with certain portions of said winding suspended across a concave surface of said board and in registry with appointed grooves extending in substantially the same direction as the curva-

ture of said board and formed in said concave surface, and thereafter pressing said certain portions into and maintaining them in their appointed grooves against the spring action of said helical spring formation.

8. The method of constructing a resistor for connecting to a circuit breaker to aid the circuit interruption thereof comprising the steps of coiling a resistance wire into a helical spring formation, disposing said coiled wire as a winding about a relatively thin arcuate insulating foundation board with certain portions of said winding stretched across a concave surface of said board and in registry with appointed grooves provided in said concave surface, said grooves extending in substantially the same direction as the curvature of said arcuate foundation board, and thereafter applying an insulating sheathing about said winding to press said portions into maintaining them in their appointed grooves in said board against the spring action of said spring formation.

9. The method of constructing a resistor for connecting to a circuit breaker to aid the circuit interruption thereof comprising the steps of coiling a resistance wire into a helical spring formation, disposing said coiled wire so as to follow a predetermined winding restricted route about the surface of a relatively thin curved insulating foundation board extending in substantially the same direction as the curvature of said board and thereafter applying an insulating sheet in close conformation to the curvature of said board for retaining said coiled resistance wire in said restricted route against the tension of said spring formation.

10. In an electric circuit breaker having an insulating and arc extinguishing liquid, arc interrupting structure immersed in said liquid, a casing for said structure having a curved side wall, a resistor unit constructed for mounting on said casing and comprising a foundation board of insulating material curved to conform to the curved side wall of said casing, a helically coiled resistance winding disposed on said foundation board, said winding having portions thereof extending between opposite edges of said board and initially suspended across the concave side of said board, means for securing said board and its winding to said casing, said portions of said winding being elongated by the curved wall of said casing to conform to the curvature of said casing and said board when said board and said winding are secured to said casing, and means for electrically connecting said resistor to said interrupting structure.

11. In an electric circuit breaker having an arc interrupting structure casing immersed in an insulating and arc extinguishing liquid and provided with a curved outer surface with a plurality of peripherally disposed expulsion ports therein, a resistor unit comprising a sheet of insulating material secured to said casing and having a surface located close to and shaped to conform to the shape of a portion of said curved outer surface between two of said ports, and a helically coiled resistance wire spirally wound on said sheet with the turns of the spiral winding extending in substantially the same direction as the curvature of said casing and said sheet and having the portion of each turn of coiled wire located between the adjacent surfaces of said sheet and casing elongated relative to the remaining portion so as to conform to the shape of said adjacent surfaces.

12. A resistor unit for aiding the circuit interruption of an electric circuit breaker with relatively separable contact structure disposed within a casing having a curved wall, said unit comprising a curved insulating foundation board, and a resistance wire wound about said board so that the portions of each turn of said winding which are disposed on the concave side of said board are initially in the shape of chords substantially subtending the corresponding portions of each turn which are disposed on the convex side of said board in the shape of arcs, said portions of said wire which are initially in the shape of chords being yieldable so that such portions conform with the curved wall of the casing when said board is secured to the casing with the concave side thereof adjacent the curved wall of the casing.

THELLWELL R. COGGESHALL.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,005,360	Taylor	Oct. 10, 1911
1,402,587	Evershed	Jan. 3, 1922
1,630,874	Tuska	May 31, 1927
2,401,963	Rietz et al.	June 11, 1946
2,408,092	Patterson	Sept. 24, 1946