

May 16, 1950

R. E. BOLD

2,508,094

CIRCUIT INTERRUPTING APPARATUS

Filed April 6, 1945

2 Sheets-Sheet 1

Fig. 1.

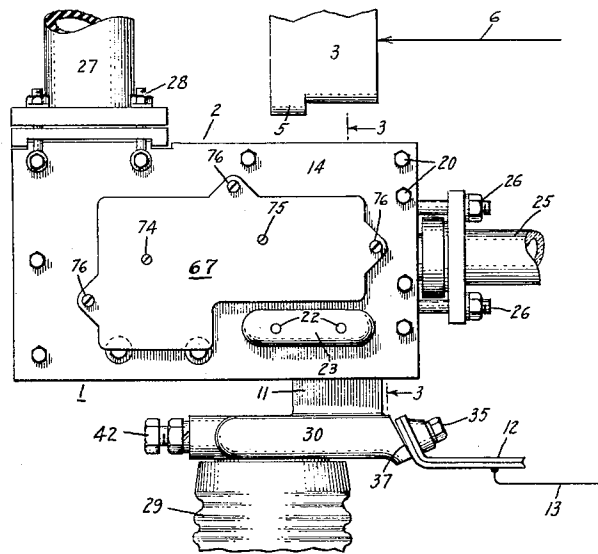
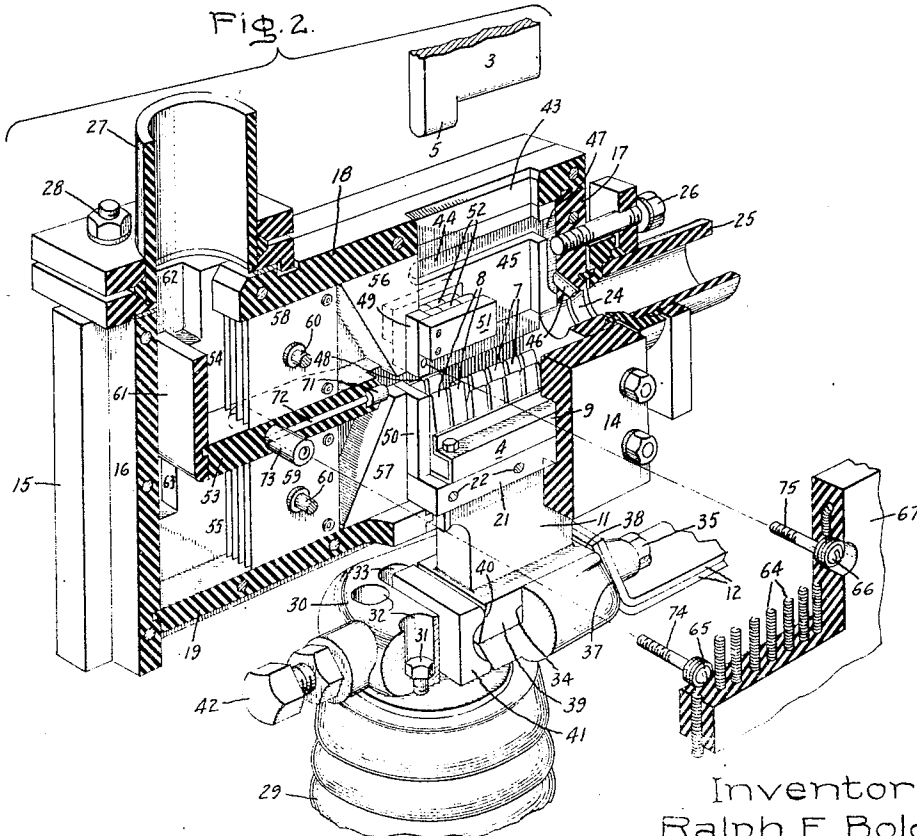


Fig. 2.



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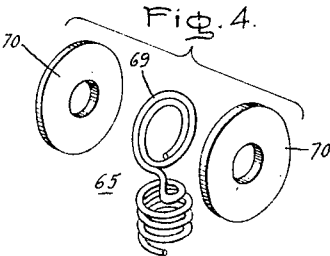
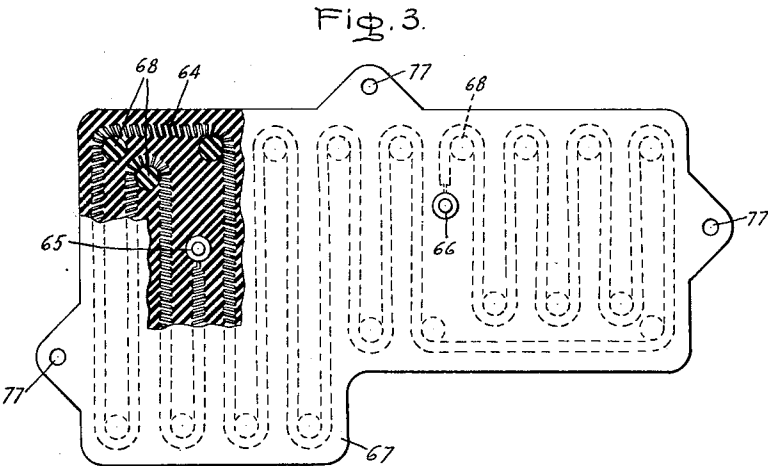
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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CIRCUIT INTERRUPTING APPARATUS

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3 Claims. (Cl. 201-64)

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My invention relates to improvements in circuit interrupting apparatus, and more particularly it relates to circuit interrupting apparatus in which a suitable impedance means, such as a resistor, is employed to aid in interrupting the circuit.

Circuit interrupters have been designed in which a resistor is employed to aid in interrupting the circuit by being inserted in the circuit at an appropriate time during the circuit interrupting operation. Such resistors heretofore have been expensive to manufacture and difficult to mount and apply to the circuit interrupter in intimate relationship therewith and without occupying additional over-all space.

It is an object of my invention to provide a new and improved resistor for use with an electric circuit breaker.

It is another object of my invention to provide a new and improved resistor and method of constructing the same, as well as a new and improved arrangement for supporting and mounting said resistor on an electric circuit interrupter.

Still another object of my invention is to provide a simple and compact arrangement of an electric circuit breaker and insulated resistor for association therewith.

It is another object of my invention to provide a generally flat resistor protected by insulation and constituting a wall of an arc chute.

Further objects and advantages of my invention will become apparent as the following description proceeds 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.

For a better understanding of my invention reference may be had to the accompanying drawings in which Fig. 1 is a side elevational view of an interrupting device embodying my invention; Fig. 2 is an enlarged perspective view partly in section of the circuit interrupting device shown in Fig. 1; Fig. 3 is an enlarged view, partly in section, of the resistor embodying my invention shown in Fig. 1, and Fig. 4 is an exploded perspective view of one of the terminals of the resistor.

Although my invention is applicable to any type of electric circuit interrupter, I have chosen to illustrate my invention as applied to an electric circuit interrupter such as is disclosed and claimed in copending joint application of Paul, Timmerman and Bold, Serial No. 586,892, now Patent 2,452,953, issued November 2, 1948, filed concurrently with the present application and assigned to the same assignee as the present appli-

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cation. My invention is particularly adapted for use with such a circuit interrupter, although it is readily adaptable for use with many other types of electric circuit breakers.

Referring now to Figs. 1 and 2 of the drawings, there is illustrated an electric circuit interrupting device 1, comprising an arc extinguishing structure 2 which includes a movable contact 3 and a stationary contact 4, stationary contact 4 being shown in Fig. 2. The movable contact 3 is illustrated as being separated from the stationary contact and in fact being clear of the arc extinguishing structure 2. The movable contact 3 is provided with a tip 5 formed of arc resisting material which tip will be generally referred to as the arcing tip 5. Movable contact 3 is connected by suitable means, such as a sliding contact or the like, to an external electrical circuit generally indicated at 6.

The fixed or stationary contact 4 comprises a plurality of current carrying contact fingers 7 and a plurality of longer arcing fingers 8, preferably formed of arc resistant material and adapted to cooperate with arcing tip 5 of movable contact 3. The contact fingers 7 and 8 are arranged in a contact assembly and held in this relationship by a suitable member 9 clearly shown in Fig. 2. This fixed or stationary contact assembly is bolted to an H-sectioned conducting member 11 which will be described in greater detail and which is electrically connected to terminal strips 12 which in turn are connected to an external electric circuit 13. It will be understood that contact fingers 7 and 8 are provided with suitable spring means or the like to provide the desired contact pressure when in engagement with movable contact 3. In the closed position of the circuit breaker movable contact 3 is seated between contact fingers 7 and 8 of fixed or stationary contact 4. Upon relative separation of contacts 3 and 4 the final separation occurs between arcing tip 5 and long arcing fingers 8.

The circuit interrupting device 1 is particularly adapted for use with operating mechanisms such as are disclosed and claimed in United States Letters Patent 2,436,190 to Boisseau et al., granted February 17, 1948, and Patent 2,436,191 to Timmerman granted February 17, 1948, filed November 17, 1944, and assigned to the same assignee as the present application.

The arc extinguishing structure 2 is a box-like structure having side walls 14 and 15, end walls 16 and 17, top wall 18 and bottom wall 19. These walls are preferably formed of some suitable gas evolving material, many such materials being available in the art, and an example of which is

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hard fiber. The walls 14, 15, 16, 17, 18, and 19 are suitably tongued and grooved so as to form a gas-tight or relatively gas-tight box or arc extinguishing structure when fitted together and held as a unitary structure by suitable fastening means, such as bolts 20, each passing through the side walls 14 and 15, with some passing through various ones of the walls 16, 17, 18 and 19. Preferably the arc extinguishing structure 2 is completely supported by H-sectioned conducting member 11. The upper flange 21 of H-sectioned conducting and supporting member 11 which supports fixed contact 4 extends into arc extinguishing structure 2 so that fixed contact 4 is positioned in one corner of the box-like structure. Suitable bolts 22 passing through the arm 21 of H-shaped or sectioned conducting and supporting member 11 and side walls 14 and 15 of the arc extinguishing structure 2 firmly hold the arc extinguishing structure 2 to H-sectioned member 11. The end of bolts 22 terminate in blister-like clamps 23 to spread the clamping force over a larger area of the insulating side walls 14 and 15. These clamps are provided with rounded surfaces as is clearly shown in Figs. 1 and 3 to afford electrostatic shielding for the bolt heads and ends which are recessed in the clamps.

As is disclosed in United States Letters Patent 2,284,842, Prince et al., granted June 2, 1942, and assigned to the same assignee as the present application, it is desired to direct a blast of air or other gas or fluid under pressure across the arc gap formed between separating contacts 3 and 4. To this end, end wall 17 is provided with an opening 24 and a blast supply conduit 25, preferably formed of insulating material, is suitably fastened to end wall 17 by clamping means including bolts 26 so as to be in sealing engagement therewith with the opening in the conduit 25 registering with the opening 24. Conduit 25 is preferably connected to a suitable source of gas or fluid under pressure in a manner such as is clearly disclosed in the above mentioned Boisseau et al. patent and Timmerman application.

It will be obvious to those skilled in the art that during a circuit interrupting operation the air or gas blast contacting with the arc will produce highly heated arc gases which must eventually be exhausted from arc extinguishing structure 2, and to this end there is provided an exhaust conduit 27 which is in registry with an opening formed in top wall 18. Suitable clamping means including bolts 28 hold exhaust conduit 27 in sealing engagement with the arc extinguishing structure 2.

The arc extinguishing structure 2 is preferably supported on a suitable insulator 29 to the base of the circuit breaker housing, as is disclosed in the above mentioned Boisseau et al. patent and Timmerman application. Insulator 29, which may be suitably shimmed to provide the proper level on the floor supports a contact base 30 permanently fastened to insulator 29 by suitable means, such as cap screws 31 inserted in counterbores 32. Contact base 30 is provided with an elongated transverse aperture 33 which is connected to a rectangular recess 34 extending from aperture 33 to the end of contact base 30. Preferably contact base 30 is a casting with the edges thereof rounded, as is clearly indicated in Figs. 1 and 2, for electrostatic shielding. The contact or terminal strips 12 are permanently connected by fastening means 35 to the inclined face 37 of contact base 30. The ends of the contact strips 12 project above the recess 34 to form a wedging

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contact surface 38. The lower flange 39 of H-sectioned conducting and supporting member 11 is of rectangular configuration with beveled front and rear edges, one of which is indicated at 40. This flange 39 is adapted to fit within the recess 34 and forms a dove-tailed pedestal for the arc extinguishing structure 2. Accommodated within the transverse slot 33 is a V-shaped clamping block 41. A single clamping bolt 42 in contact base 30 engages clamping block 41, which in turn forces the dove-tailed pedestal comprising flange 39 into intimate mechanical and electrical contact with the contact base 30 and the current carrying contact strips 12. Preferably, clamping bolt 42 thrusts against resilient means, such as spring washers (not shown) so that a limited resilience exists unaffected by slight contraction or expansion of the several parts due to temperature changes.

With the supporting means for the arc extinguishing structure 2 described above, the arc extinguishing structure 2 may readily be removed merely by backing off clamping screw 42 and disconnecting supply conduit 25 and exhaust conduit 27. The arc extinguishing structure 2 can then be slid toward clamping screw 42 thereby loosening clamping block 41, after which the chute unit 2 including its dove-tailed pedestal 11 may be lifted out of recess 34. In this removal operation the permanently fastened fixed contact base 30 and contact strips 12 have remained undisturbed so that when arc extinguishing structure 2 is replaced or a similar structure substituted, no realignment is necessary.

The movable contact 3 is movable through an opening 43 in top wall 18 of arc extinguishing structure 2. In order to prevent arc gases from leaking through the portion of opening 43 not filled by moving contact 3, there is provided an air seal which comprises a pair of recesses 44, one on either side of the space occupied by movable contact 3, which recesses are formed in insulating members 45 which fill the excess space in arc extinguishing structure 2 above fixed contact 4. Suitable air ducts 46 and 47 lead air from conduit 25 directly to pockets or recesses 44 thereby providing a high pressure air seal and insuring that no hot arc gases will exhaust from arc extinguishing structure 2 through opening 43. This arrangement is somewhat similar to that disclosed and claimed in the Rankin Patent 2,290,708, granted July 21, 1942, and assigned to the same assignee as the present application.

As illustrated in the drawings, there is provided a fixed arc gap construction associated with relatively movable contacts 3 and 4. This fixed arc gap 48 is defined by a pair of electrodes 49 and 50, respectively. The electrode 50, preferably formed of arc resisting material, forms a part of the stationary contact assembly 4 and is immediately adjacent the arcing fingers 8. Electrode 49, on the other hand, forms a part of a sliding contact assembly generally indicated at 51 including a plurality of spring pressed contact fingers 52 which are adapted to be in sliding engagement with movable contact 3. This sliding contact assembly 51 is preferably supported between suitable insulating members in arc extinguishing structure 2 so as to define the fixed gap 48 which has a predetermined dimension of the order of one-half inch or less, this dimension depending to a considerable extent upon the circuit constants involved. In any event, fixed gap 48 may be defined as a pre-

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ferred gap in that its dimension is the preferred dimension for most satisfactory arc extinction. It is obvious from the above description of the fixed gap 48 that upon relative separation of contacts 3 and 4 the arc drawn between arcing fingers 8 and arcing tip 5 will be transferred to the fixed gap even without the provision of any fluid blast as soon as the separation between contacts 3 and 4 exceeds the dimension of gap 48. The fluid blast issuing from conduit 25 will facilitate the transfer of the arc to the fixed gap 48. Movable contact 3 will remain electrically contacted to electrode 49 until it moves out of engagement with sliding contact 51, before which time the arc across gap 48 will have been extinguished.

The portion of arc extinguishing structure 2 beyond fixed gap 48 comprises the arc chute. In view of the fact that with the fixed gap construction described the arc is maintained at a relatively short length and the quantity of hot arc gases produced is much smaller than in prior art constructions, the arc chute may have very small dimensions. Mounted within the arc chute portion of the arc extinguishing structure 2 is a single partition or barrier 53 which is preferably formed of a gas evolving insulating material, such as fiber or the like. This single barrier or partition 53 divides the arc chute into two passages generally indicated as 54 and 55 and partition 53 has its transverse insulating edge portion closely adjacent to the fixed gap 48 whereby the arc across gap 48 is stretched around the edge portion of partition 53, part of the arc extending into passageway 54 and the other portion of the arc extending into passageway 55. In order that the arc drawn may be in more intimate contact with gas evolving insulating material, there is provided an insert of insulating material 56 in arc passageway 54 and a corresponding insulating insert 57 in arc passageway 55. Both of these inserts of insulating material insure that the arc formed across fixed gap 48 will be cooled by coming in contact with the gas evolving insulating material. To further cool the arc gases I provide arc cooling means 58 and 59 mounted in passageways 54 and 55, respectively. As shown, the cooling means 58 and 59 comprise a series of metal plates, such as copper, spaced from each other in any suitable way so as to permit the arc gases or vapors readily to pass therebetween. These plates are shown as secured in place on pins or bolts 60 which may extend through the chute side walls or may extend into recesses formed in the side walls.

In order to prevent the arc gases flowing in passageways 54 and 55 from coming together too soon, there is provided an insulating partition 61 fastened to the end of partition 53 and arranged at right angles therewith, as is clearly shown in Fig. 2, to guide the arc gases into exhaust conduit 27. To reduce the back pressure near the exhaust end of the arc chute, it has been found desirable to enlarge the volume of the arc chute exhaust by providing pockets 62 and 63 associated with the passageways 54 and 55, respectively.

As in the above mentioned Prince et al. patent the movable contact blade 3 is comparatively thin in cross section whereby the arc extinguishing structure 2 may be so designed that a high velocity air blast may be concentrated in a small space at the exact place where it should be, namely, between the arcing tip 5 and arcing fingers 8 and across fixed gap 48.

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The construction and arrangement of the circuit interrupting device described thus far forms no part of my present invention but is disclosed and claimed in the above mentioned copending Paul et al. application, filed concurrently with the present application.

As was mentioned above, it has been found desirable in order to aid in the circuit interrupting operation, to insert a resistance in series with the arc at a predetermined point during the circuit interrupting operation. To this end there is provided a resistance coil 64 having terminals 65 and 66, respectively, which resistance in accordance with my invention as will be described in greater detail hereinafter, is mounted in a slab of insulating material 67.

It is desirable to provide the resistance coil 64 in a compact manner fully insulated, and positioned so as not to interfere with the operating parts of the electric circuit breaker. In accordance with my invention, such a desirable resistor arrangement is obtained by winding the resistor coil 64 about plugs 68 of insulating material inserted in an open mold and held in a desired arrangement such as is best shown in Fig. 3. A suitable insulating molding compound may then be poured into the mold so as to form the slab 67 which requires no machining, whatever, and the plugs 68 remain molded in the slab. Because the resistor of my invention is intended for use with circuit breakers of high voltage rating on the order of from 15,000 to 35,000 volts, and must withstand voltage surges of considerably higher values, the coil 64 must be effectively invested within the surrounding high dielectric strength compound so that no hazard exists by which coil sections could short circuit with harmful internal sparking by reason of internal air or gas pockets.

Known methods for holding embedded resistor elements by means of positioning pegs which are withdrawn or ejected from the form during the molding process are not free from this hazard; but by using insulating plugs as in the embodiment of my invention, and preferably of material similar to that of the body 67, such hazard is entirely eliminated, for these permanent plugs are bonded to and become an integral part of the insulating body within which complete investment of the coil 64 is assured. Each of the terminals 65 and 66 of the resistor comprises a looped end 69 of the coiled resistor wire with a plurality of conducting washers 70 in contact on either side thereof which may be properly positioned in the slab 67 by means of locating plugs similar to the above-mentioned plugs 68. After the molding operation, suitable holes may be drilled or counterbored into the molded slab for exposing or facing the terminals 65 or 66 as depicted in the exploded section of slab 67 in Fig. 2. The terminals are relatively located so that suitable fastening means such as screws 74 and 75 extend through them and through aligned holes in the slab 67 and side wall 14 for connecting the resistor coil 64 to the desired portions within the circuit breaker with which it is associated. A resistor made in accordance with the above prescribed method whereby the insulating compound is caused to fill completely all internal interstices therefore provides a compact flat unit of high dielectric and mechanical strength which is particularly adapted for cooperative use with an interrupter of the arc chute type.

As is disclosed and claimed in the above mentioned Paul et al. copending application, a probe

electrode 71 having a long conducting portion 72 is embedded within partition 53 with the probe electrode portion 71 preferably formed of arc resisting material extending out of the edge of the barrier or partition 53 adjacent fixed gap 48. The long conducting portion 72, which is preferably of reduced cross section, is electrically connected to a terminal 73 extending in a direction substantially perpendicular to conducting portion 72.

In accordance with my invention insulating slab 67 is mounted to one of the side walls such as 14 of arc extinguishing structure 2, by means of bolts or screws 74 and 75. The bolt or screw 74 which passes through terminal 65 of resistor 64 also electrically connects one end of resistor 64 to probe electrode 71 by being connected to terminal 73. Similarly, screw or bolt 75 which passes through terminal 66 of resistor 64 is electrically connected to electrode 49 of arc gap 48. It will be apparent that the connector screws 65 and 66 could constitute the sole means for mounting the resistor slab 67 to the arc chute side; however, the wide spaced holes 77 provide for additional mounting screws 76 which screw into the side wall 14, so that a strong and rigid mechanical conjunction between the slab and the arc chute side wall may be established.

By designing the resistor unit in the form of a mechanically strong slab distributed over the central area of the arc chute side wall, as shown in Fig. 1, several resulting advantages accrue. Firstly, the resistor unit requires no increase in lateral space than an arc chute having no resistor, for the slab 67 need be no thicker than the adjacent blister-like side clamps 23. Secondly, projecting terminal posts and external connections which are common to conventional resistor units are eliminated, for the mounting connector screws 74 and 75 constitute direct and protected connections to the electrodes within the chute. Thirdly, the rigidly bolted slab 67 affords reinforcement to that area of the arc chute's confining structure which is subject to the greatest mechanical stress, for it will be appreciated that the central area of the arc chute sides constitutes the most extensive unsupported areas which furthermore have to withstand great internal pressures. Because the slab 67 and the side wall 14 mutually reinforce and stiffen one another, it follows that the thickness of the wall may be made less than one unsupported by any comparable reinforcing means.

Instead of the above-described mutually reinforcing arrangement in which the resistor slab is separate and demountable from the arc chute side, further economy in total wall thickness and manufacturing operations may be achieved by combining the side wall 14 and resistor slab 67 into one unitary flat insulating member, with the coils 64 preferably invested midway between the outer surfaces, i. e., in the plane of the side member's neutral axis as shown in Fig. 2. By way of illustrating this further embodiment of my invention, the slab 67 shown in the exploded view of Fig. 2 may be assumed to constitute a broken-off portion of the near side wall of the arc extinguishing structure 2. In such a case if the material into which the resistor is molded is not satisfactory for the inner surface of the chute walls a thin sheet of material such as fiber may be molded or cemented to the resistor slab which forms a wall of the arc chute.

Any suitable dielectrically and mechanically strong molding compound may be used and I have

found it desirable to make slab 67 from a synthetic casting resin. An example of such a resin is phenol-formaldehyde resin of the type or kind produced and sold by the Catalin Corporation of America under the trade-mark "Catalin" and described, for instance, in United States Patents 1,854,600; 1,858,168; 1,892,848; 1,909,786; 1,909,787; 1,909,788; and 1,909,789.

It should be understood that the slab 67 might be molded out of some other material such as methyl-methacrylate, phospho-asbestos as disclosed in United States Letters Patent 2,366,485, Brink et al., or any other suitable material having sufficient mechanical strength. Also, instead of molding the compound it may be possible under certain conditions to heat resistor 64 and place it between two slabs of insulating material of a thermoplastic type, such as methyl-methacrylate. When pressure is applied to the slabs of thermoplastic material the resistor is embedded in the slabs, which in effect become a unitary structure.

From the above description it will be obvious that I have disclosed an economical method of manufacturing an arc chute resistor for an electric circuit breaker. The method of connecting the terminals of the resistor to the parts within the arc chute is compact and simple. Furthermore, a resistor built in accordance with my invention takes up a minimum amount of space and does not interfere with any other parts of the circuit interrupter.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. In a high voltage circuit breaker having an arc chute, a plate-like resistor unit for mounting on a flat wall of the arc chute comprising a plurality of short insulating pegs disposed in a predetermined pattern, a resistance wire wound about said pegs, a molded insulating slab completely investing said wire and said pegs, an opening in said slab at each end of said wire, and a terminal connector disposed in each opening and arranged to extend through a wall of the arc chute for securing said resistor in position and for establishing an electrical connection between said resistor and said circuit breaker.

2. In a high voltage circuit breaker having an arc chute, a plate-like resistor unit for mounting on a flat wall of the arc chute comprising a plurality of short insulating pegs disposed in a predetermined pattern in substantially the same plane, a resistance wire wound about said pegs, a molded insulating slab completely investing said wire and said pegs, and a pair of bolts for interconnecting the conducting elements of the circuit breaker and the ends of said wire and for holding said resistor unit in position against a wall of the arc chute.

3. In a high voltage circuit breaker having an arc chute, a plate-like resistor unit for mounting on a flat wall of the arc chute comprising a plurality of short insulating pegs disposed in a predetermined pattern in parallel relationship to each other and arranged in a common plane, a resistance wire wound about said pegs, a slab of moldable insulating material completely investing

said wire and said pegs, and means for connecting the ends of said wire to said circuit breaker and for affording support for said resistor unit.

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