

Sept. 30, 1947.

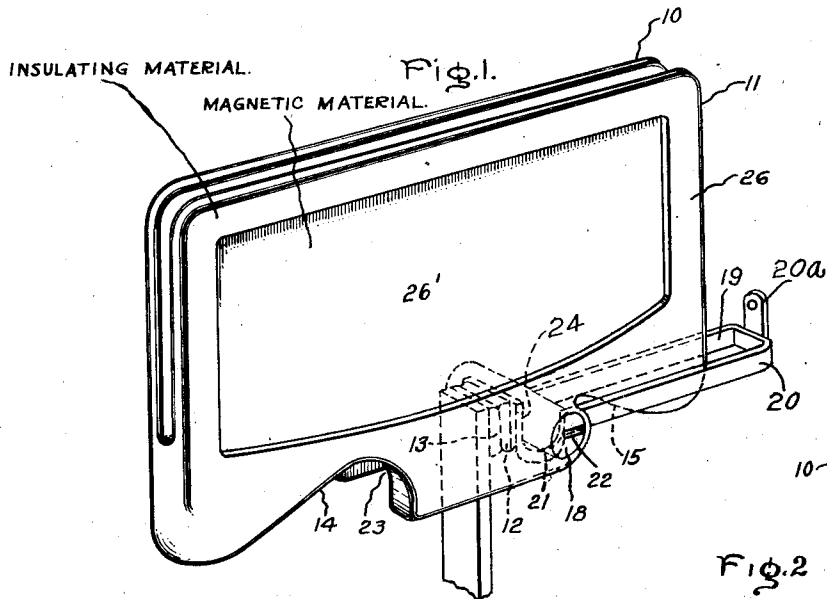
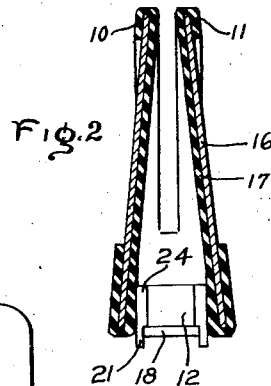
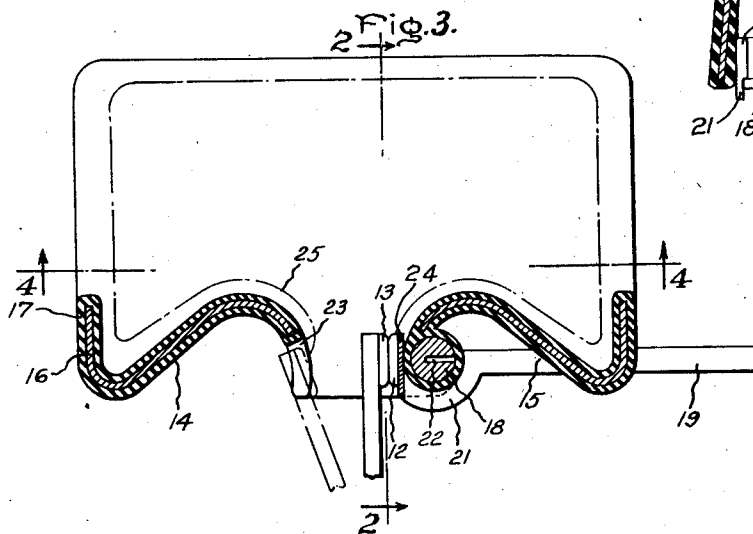
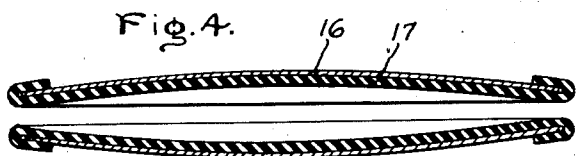
L. S. WALLE

2,428,254

CIRCUIT BREAKER

Filed March 21, 1944

2 Sheets-Sheet 1



Inventor:
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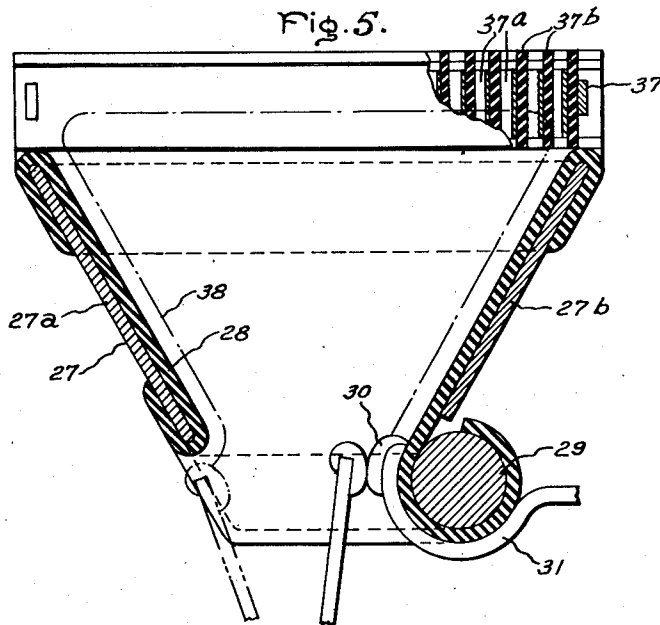
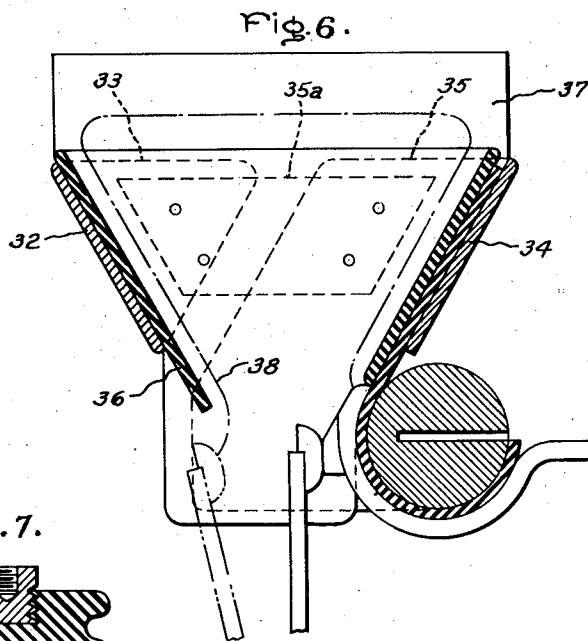
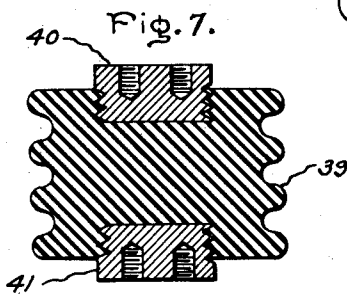
L. S. WALLE

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CIRCUIT BREAKER

Filed March 21, 1944

2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,428,254

CIRCUIT BREAKER

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Application March 21, 1944, Serial No. 527,391

6 Claims. (Cl. 200-147)

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My invention relates to circuit breakers, more particularly to arc extinguishers for circuit breakers, and has for its object a simple, effective, and low cost device for extinguishing an arc.

My invention is especially useful in arc extinguishers for circuit breakers of the low voltage branch circuit type operating on voltages on the order of 600 and required to interrupt short circuit currents up to 20,000 amperes.

In carrying out my invention in one form, I provide an electrically insulating arc chute without arc runners whereby the arc extends at all times from one contact to the other and is elongated to the fullest extent. I also provide an arc chute member made of iron to accelerate the arc and provided with an electrically insulating coating made of a mixture of asbestos and phosphoric acid molded on the iron arc chute member and joined integrally thereto.

For a more complete understanding of my invention, reference should be had to the accompanying drawings, Fig. 1 of which is a view in perspective of a circuit breaker provided with an arc chute embodying my invention; Fig. 2 is a sectional view of Fig. 1 taken along the line 2-2 of Fig. 3 looking in the direction of the arrows; Fig. 3 is a view in section of the device shown in Fig. 1; Fig. 4 is a sectional view taken along the line 4-4 of Fig. 3 looking in the direction of the arrows; Figs. 5 and 6 are sectional views of modified forms of my invention; Fig. 7 is a sectional view of a still further modified form of my invention as applied to an insulating support.

Referring to Figs. 1 to 4 of the drawing, I have shown my invention in one form as applied to an arc chute comprising two plates 10 and 11 having their edges lying in substantially parallel planes but each being bowed gradually outward, i. e., apart, from the top edge downward and outward from the side edges inward to provide an increased spacing between the plates at the bottom center for the stationary contact 12 and movable contact 13. At their lower edges, these two plates are joined together integrally by transversely extending irregularly shaped portions 14 and 15 extending in opposite directions from the vicinity of the contacts substantially along the path of movement extended of the movable contact 13.

The plates 10 and 11 consist each of an inner layer 16 of a magnetic material, preferably iron, covered by an outer layer 17 of electrically insulating heat refractory material, which layer 17 covers completely the inner adjacent sides of the magnetic layer 16 and covers the outer sides of the magnetic layer 16 of each plate, with the possible exception of a central portion 26' on the outer side of each plate, as hereinafter noted. The layer 17 of electrically insulating material

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is sufficiently electrically insulating to prevent the flow of any appreciable electric current through the insulating material at the voltages appearing between the contacts 12 and 13 when the contacts are separated so that an arc is formed between the separated contacts, which arc is located between the plates 10 and 11.

This electrically insulating material with which the iron plates are coated is preferably a mixture of short fibre chrysotile asbestos, and orthophosphoric acid which is molded under heat and pressure on the two plates. During the molding and heating operation the free phosphoric acid of the mixture combines with the other ingredients and with the iron or steel plates to form salts, silicates or phosphates. Thereby the mixture is formed into a dense coating having very good electrically insulating and heat refractory properties and a strong integral mechanical bond is formed between the coating and the iron. This bond is strong enough to prevent the formation of cracks in the coating and chipping of the coating from the iron under the intense heat of the arc. Thus the insulating material resulting from the molding with the iron plate under heat and pressure comprises a reaction product of chrysotile asbestos, phosphoric acid, and iron joined integrally with the iron plate.

Preferably I use a mixture of 50 parts by weight of 85 per cent orthophosphoric acid mixed with 100 parts by weight of short fibre chrysotile asbestos, such as described and claimed in U. S. Patent No. 2,366,485, issued on January 2, 1945, to Edwin H. Brink and Nicholas F. Arone, assigned to the same assignee as this invention. These materials are mixed together for a short time and form a thick paste which is then applied to the iron plate structure previously constructed. Or, if desired, the plates can be mounted in the mold and the material, which flows freely during molding, placed into the mold around the plates. The material during this molding operation is subjected to a pressure of from 3,000-6,000 pounds a square inch, a temperature being maintained in the molded mixture of from 100 deg. C. to 200 deg. C., preferably about 140 deg. C. This pressure and heating operation is continued for a period of from 3-10 minutes.

To assure a satisfactory integral joint between the heat refractory material and the iron, the iron plates must be chemically clean. Preferably also the plates are grit-blasted to assure good adhesion of the insulating material.

Also secured to the plates 10 and 11 is a cylindrical magnet core member 18 extending across the plates at the bottoms of the plates and just behind the stationary contact 12. As shown, this core member 18 is surrounded by continuations of the outer and inner layers 17 of electrically insulating material forming parts of the plates 10

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and 11 so as to be secured in place by the electrically insulating material. This core 18 is covered by the insulating material and is partly surrounded at each end by conductors 19 and 20 forming connections with one terminal 20a of the circuit breaker. Thus each conductor 19, 20 is shaped to form a half turn 21 with its end of the core 18 whereby a magnetic flux is set up in the core for the acceleration of the arc. A slot 22 extending lengthwise of the cylindrical core is provided to decrease to a great extent the currents induced in the core by the flux. The bottom portion 14 is terminated at its inner end a short distance above the lower end of the plates so as to leave a space 23 for the movable contact 13. As shown, the lower sides of the plates extend downward on opposite sides of the contacts. The stationary contact 12 is mounted centrally between the lower ends of the plates on a cross conducting member 24 extending between the two conductors 19 and 20 and electrically connecting together the ends of the two conductors.

In the operation of the circuit breaker when the movable contact 13 is moved to the left to its open position (shown in dotted lines, Fig. 3) an arc is formed between the two contacts, and this arc while continuing to play between the two contacts elongates and extends upward quickly to the form indicated by the dot-dash line 25. The movable contact, for example, may be mounted on the end of an arm which is swung by suitable mechanism between the closed circuit and open circuit positions.

The shape of the two plates is such as to produce this elongation of the arc by reason of the magnetic propulsive forces acting on the arc and generated by the magnetic flux produced by the arc itself. Thus the arc is moved by this magnetic force applied to it in a direction to surround or enclose the greatest possible amount of a magnetic flux. At the point where the contacts separate and the arc is formed, the plates are most widely separated in a direction transverse to a line joining the two contacts. From this point, the plates converge toward each other in an upward direction and also toward the left hand and right hand edges as seen in Figs. 1 to 4. It is a characteristic of an arc that under these circumstances it moves by reason of the magnetic force applied to it to the point where the converging iron members are closest together, which means that the arc very quickly elongates to the form indicated by the dot-dash line 25. Elongation of the arc is still further effected by the reverse curved shape of the bottom portions 14 and 15, especially by the downwardly extending left-hand and right-hand ends of these connecting portions. The open spacing between the two plates at their upper ends and on each side downward for a considerable distance provides for the free escape of any gases that may be generated.

If desired, and as shown, certain portions of the outer surfaces of the two iron plates may remain uncovered by the heat refractory insulating material. As shown, the plates are completely covered on their adjacent sides and edges and on the outer sides along a band 26 leaving an inner portion 26' uncovered. The point is that all surfaces of the plates to which the arc may strike are covered with the insulating material.

An important feature of the form shown in Figs. 1 to 4 is that no electrically conducting runner for the arc is provided. Thus the arc plays always

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between the two contacts whereby elongation of the arc is facilitated.

It will be observed that the arc chute of Figs. 1 to 4 produces elongation of the arc in three directions from the contacts, i. e., toward the left and toward the right and upward, as seen in Fig. 3 and also to some extent in a fourth direction, i. e., downward when the arc follows the downwardly bent portions of the transverse members 14 and 15. This movement and elongation of the arc are effected, as previously explained, by providing the greatest spacing between the two magnetic plates adjacent the contacts and arranging the plates to gradually converge toward each other in these directions.

Fig. 5 shows a modified and simplified form of my invention in which the arc chute is formed by a magnetic member or plate 27 having two parallel side walls spaced apart and connected together by end portions 27a and 27b, which end portions extend upward from a point adjacent the contacts in diverging relation with each other. This magnetic member is provided with an integral electrically insulating, heat refractory coating 28 molded thereon, as described in connection with Figs. 1 to 4. Likewise, a cylindrical magnetic core member 29 is provided adjacent the stationary contact 30 and partially encircled by the conducting lead 31 leading to the stationary contact.

Fig. 6 shows a modified form of my invention quite similar to Fig. 5. In this form of my invention, however, two magnetic members are provided, i. e., a magnetic member 32 having two spaced apart sides 33, only one of which is shown in dotted lines, and a second magnetic member 34 having spaced apart sides 35, only one of which is shown in dotted lines. The adjacent sides are connected mechanically together in each side of the chute by a sheet 35a of fibrous electrically insulating material. In this form of my invention, the insulating covering 36 for the magnetic members 32 and 34 is not molded on the magnetic members but comprises a sheet of suitable gas-producing electrically insulating material, such as fibrous material. The gases produced by this fiber when heated by the arc shorten the duration of the arc by increasing the turbulence and cooling of the arc.

In both forms of Figs. 5 and 6, an arc cooler and arc accelerator 37 is provided on the top of the arc chute, this arc cooler being provided with a plurality of vertically arranged sheets 37a of magnetic material, such as iron corrugated vertically, and separated and insulated from each other by strips 37b of electrically insulating material, as disclosed in my Patent No. 2,337,949 issued on December 28, 1943. This arc cooler, in addition to cooling the arc also accelerates the movement of the arc in an upward direction.

As shown in both Figs. 5 and 6, the arc strikes in all cases between the two contacts, no electrically conducting arc runners being provided, and it eventually, as shown by the dot and dash line 38, stretches upward until at the top it enters the arc cooler 37 for final completion of the extinguishment of the arc.

Although I have shown my invention as applied to an arc chute, it will be understood that the integrally united electrically insulating material has various other uses as applied to members made of a ferrous material; for example, as shown in Fig. 7, an electrically insulating support for electric bus bars consisting of a cylindrical mass 39 of material containing phosphoric acid and asbestos, such as I have hereinbefore described,

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in opposite ends of which are provided ferrous metal inserts 40 and 41 by means of which the insulator can be secured to a suitable support and the bus bar in turn secured to the insulator. The phosphoric acid-asbestos mixture is molded with the application of heat and pressure to the inserts 40 and 41, as previously described, and is thereby joined integrally with the inserts.

While I have shown a particular embodiment of my invention, it will be understood of course that I do not wish to be limited thereto since many modifications may be made and I therefore contemplate by the appended claims to cover any such 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. The combination in a circuit breaker of a pair of contacts at least one of which is movable to close and open an electric circuit through said contacts, arc chute plates made of magnetic material on opposite sides of the path of movement of said movable contact and a layer of electrically insulating material on adjacent surfaces of said plates whereby an arc is caused to play between said contacts until it is extinguished, said plates being most greatly separated adjacent said contacts and converging toward each other in at least three directions from said contacts thereby to effect the elongation of the arc by forces produced by the magnetic flux of the arc.

2. The combination in a circuit breaker of a pair of contacts at least one of which is movable to close and open an electric circuit through said contacts, arc chute plates made of ferrous material on opposite sides of the path of movement of said movable contact, and a coating of heat refractory electrically insulating material on adjacent surfaces of said plates joined integrally with said plates comprising a reaction product of phosphoric acid, asbestos and the iron of said plates, said plates being most greatly separated adjacent said contacts and converging toward each other in at least three directions from said contacts thereby to effect the elongation of the arc by forces produced by the magnetic flux of the arc.

3. The combination in a circuit breaker of a pair of contacts at least one of which is movable to close and open an electric circuit through said contacts, arc chute plates made of ferrous material spaced apart on opposite sides of the path of movement of said movable contact and extending in opposite directions from said contacts substantially along said path of movement extended and extending in a direction at right angles to said path of movement, plate portions made of ferrous material joining said plates adjacent said contacts extending transversely between said plates and in each direction from said contacts substantially along said direction of movement extended, and a layer of heat refractory electrically insulating material on the inner adjacent surfaces of said plates and transverse plate portions.

4. The combination in a circuit breaker of a pair of contacts at least one of which is movable to close and open an electric circuit through said contacts, arc chute plates made of ferrous material spaced apart on opposite sides of the path of movement of said movable contact and extending in opposite directions from said contacts

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substantially along said path of movement extended and in a direction at right angles to said path of movement, said plates extending in at least three directions in converging relation with each other from said contacts thereby to effect the elongation of an arc between said contacts, plate portions made of ferrous material joining the edges of said plates adjacent said contacts extending transversely between said plates and in each direction from said contacts substantially along said direction of movement extended, said plate portions being curved thereby to elongate an arc formed between said contacts, and a layer of heat refractory electrically insulating material on the inner adjacent surfaces of said plates and transverse plate portions.

5. In a circuit breaker having a pair of cooperating contacts one of which is movable to close and open an electric circuit through the contacts, an arc chute comprising two members of magnetic material disposed on opposite sides of the path of movement of said movable contact, transversely extending portions of magnetic material joining said members at the base of the arc chute, said portions being disposed adjacent the circuit breaker contacts and said arc chute members extending from a point adjacent said contacts in converging relation with respect to each other on each side of and above the contacts thereby to effect elongation of an arc between said contacts, and electrically insulating means on the inner surfaces of said arc chute members and transverse portions whereby an arc is caused to play between said contacts until it is extinguished.

6. In a circuit breaker having a pair of cooperating contacts one of which is movable to close and open an electric circuit through said contacts, an arc chute comprising two members of magnetic material disposed on opposite sides of the path of movement of the movable contact, said members being provided with transversely extending portions of magnetic material adjacent said contacts and said arc chute members being constructed and arranged to extend from a point adjacent said contacts in converging relation with respect to each other in at least three directions, and electrically insulating means on the inner surfaces of said arc chute members and transverse portions whereby an arc is caused to play between said contacts until it is extinguished.

LUDWIG S. WALLE.

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