June 19, 1934. M. W. BRAINARD ET AL 1,963,643

CIRCUIT INTERRUPTER

Filed Feb. 23, 1933 2 Sheets-Sheet 1

Fig. 1.

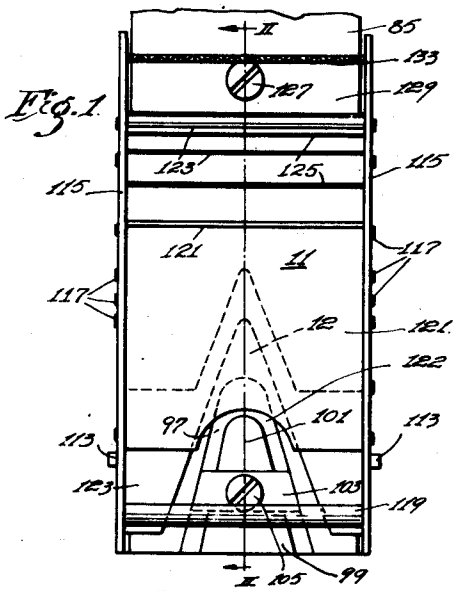


Fig. 2.

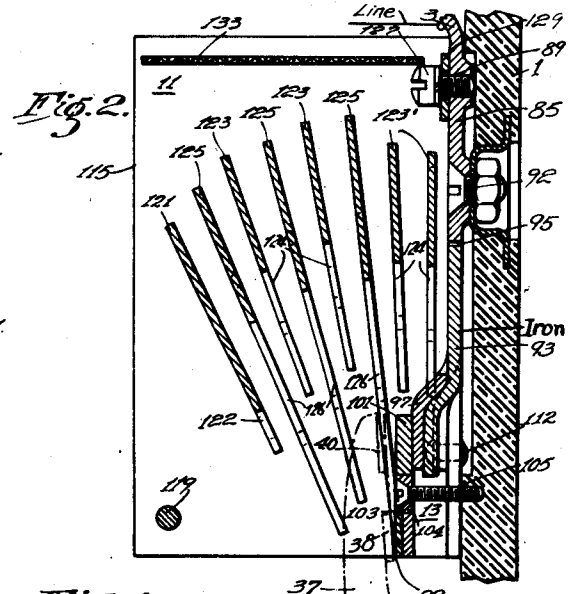


Fig. 3.

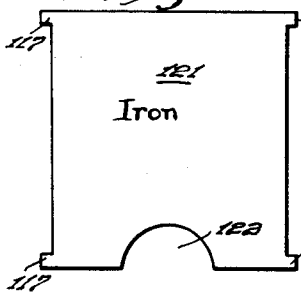
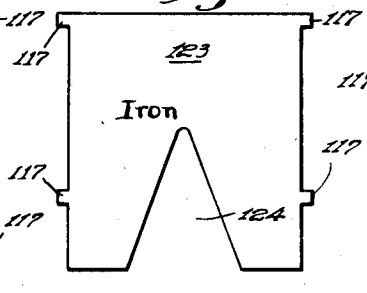


Fig. 4.



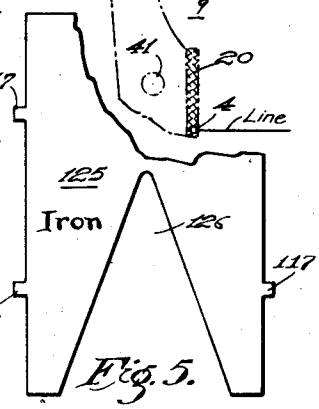


Fig. 5.

Fig. 6.

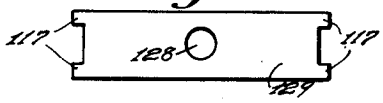


Fig. 7.

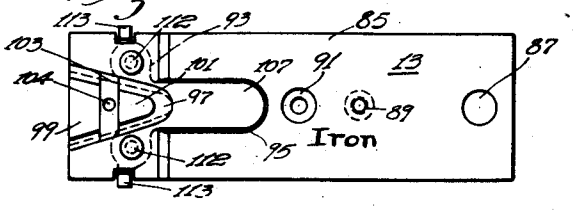


Fig. 9.

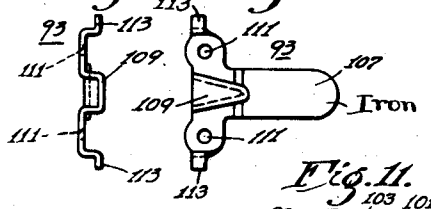


Fig. 10.

Fig. 11.

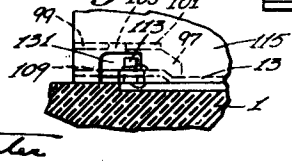
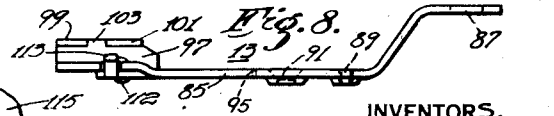


Fig. 8.



WITNESSES:

E. C. Leiding.

Paul J. Blanchet

INVENTORS.

Maurice W. Brainard &

Benjamin P. Baker.

BY

F. W. Lyle.

ATTORNEY

June 19, 1934. M. W. BRAINARD ET AL 1,963,643

CIRCUIT INTERRUPTER

Filed Feb. 23, 1933 2 Sheets-Sheet 2

Fig. 12.

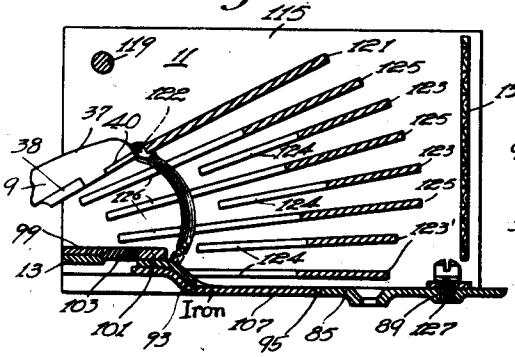


Fig. 14.

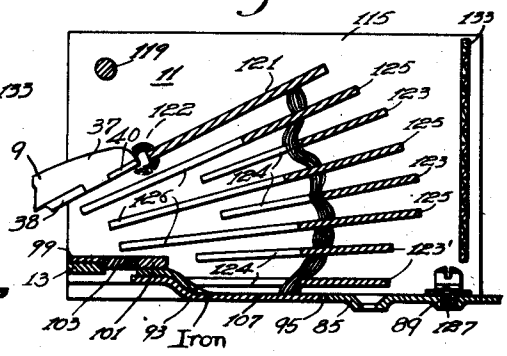


Fig. 13.

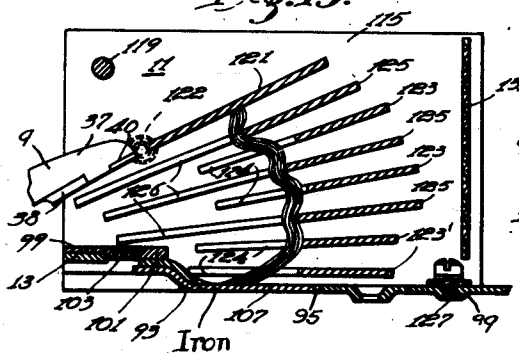


Fig. 15.

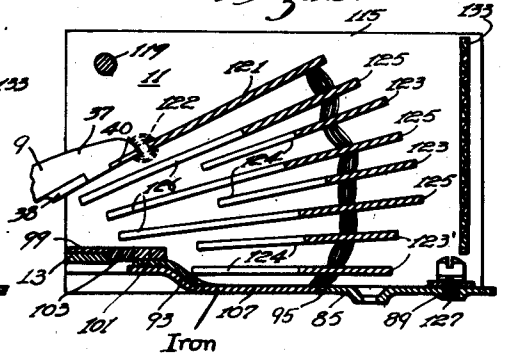


Fig. 16.

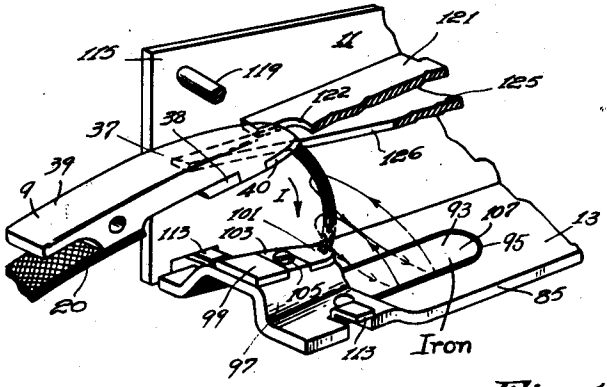


Fig. 17.

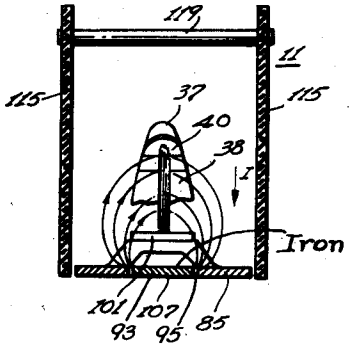
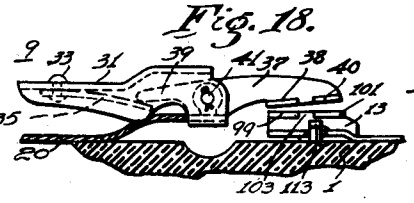


Fig. 18.



WITNESSES:

E. C. Gliding.

Paul J. Blaister

INVENTORS.

Maurice W. Brainard &

Benjamin P. Baker.

BY

F. W. Leyh.

ATTORNEY

Patented June 19, 1934 1,963,643

UNITED STATES PATENT OFFICE

1,963,643

CIRCUIT INTERRUPTER

Maurice W. Brainard, Los Angeles, Calif., and Benjamin P. Baker, Turtle Creek, Pa., assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application February 23, 1933, Serial No. 658,060

12 Claims. (Cl. 200—144)

Our invention relates to circuit breakers, and particularly to arc extinguishers of the spaced-plate type for use therewith.

It is one object of our invention to provide an improved arc extinguisher of this type that shall be capable of extinguishing the arc formed incident to the interruption of an electrical circuit more rapidly, more reliably, and more effectively than has been possible with the previously known structures.

Another object of our invention is to provide an improved arrangement for the slotted plates of a spaced-plate arc extinguisher, our improved arrangement to cause a progressive lengthening of the arc during the extinguishing process.

A further object of our invention is to provide an improved spaced-plate arc extinguisher which shall have a greater number of arc extinguishing plates, and hence a greater capacity, for a given separation of the relatively movable contacts than the previously known extinguishers of this type.

A further object of our invention is to provide a spaced-plate arc extinguisher wherein the process of dividing the single arc formed incident to the separation of the current-carrying contacts into a plurality of small arcs is carried out in at least two steps.

A still further object of our invention is to provide an improved contact structure intended particularly for use with spaced-plate arc extinguishers, our improved contact structure to include means of magnetic material for lengthening and for controlling the movement of the initially formed arc.

The principal field for immediate application of our invention is in connection with circuit breakers for controlling lighting and distribution feeder circuits, and we shall hereinafter describe an embodiment of our invention particularly intended for use with such circuit breakers without, however, in any way intending to restrict the scope of our invention, except as indicated in the appended claims. In circuit breakers of this type it is customary to provide a switch member and a cooperating stationary contact assemblage for each of the plurality of poles, a manually operable mechanism for opening and closing all of the breaker contacts, a trip device for causing the opening of the contacts in response to a predetermined electrical condition in any one pole, and an arc extinguishing device, for each of the poles.

Since our invention is not concerned particularly with the operating mechanism, the trip device, or the structural features of the circuit breaker proper, we have limited the showing of the preferred embodiment of our invention to those parts of the circuit breaker to which our invention is especially applicable, namely, the arc extinguisher and the stationary contact assemblage.

The features of our invention which we believe to be new are particularly pointed out in the appended claims, and for a full understanding of these principles reference may be had to the accompanying drawings, in which:

Figure 1 is an enlarged plan view of the preferred form of the arc extinguishing device of our invention,

Fig. 2 is a sectional view on the line II—II of Fig. 1,

Figs. 3, 4, and 5 are plan views showing the various types of plates used in the preferred embodiment of our arc extinguisher,

Fig. 6 is a plan view of the plate used for supporting and positioning the arc extinguishing device on the base of the circuit breaker,

Fig. 7 is a plan view of the stationary contact assemblage drawn to a somewhat smaller scale than Fig. 2,

Fig. 8 is an elevational view of the structure shown in Fig. 7,

Figs. 9 and 10 are detailed views of the magnetic insert forming a part of the contact assemblage shown in Figs. 7 and 8,

Fig. 11 is a fragmentary elevational view showing the structure whereby the arc extinguishing device is retained in position relative to the stationary contact assemblage,

Figs. 12 to 15, inclusive, are sectional views, similar to Fig. 2, showing progressive steps in the extinguishing of an arc by our improved arc extinguisher,

Figs. 16 and 17 are fragmentary perspective views showing the magnetic effect on the arc of the insert shown in Figs. 7 to 10.

Fig. 18 is a fragmentary view of the switch member used in conjunction with this embodiment of our invention.

Referring to the drawings, the circuit breaker base 1 is of molded insulating material, and has mounted thereon the circuit breaker operating mechanism (not shown) which has associated therewith the switch member 9, the arc extinguisher 11, and the stationary contact assemblage 13. We prefer to use an operating mechanism similar to that shown in the copending patent application of B. P. Baker, Serial No. 667,377, which is likewise assigned to the assignee of this

invention. Any suitable operating mechanism would be equally satisfactory, however, for the purposes of this invention.

The electrical circuit is shown diagrammatically in Fig. 2. Beginning with the line 3, the current passes successively through the stationary contact assemblage 13, the moving contact 37 and its associated shunt 20 which form a part of the switch member 9, and thence to the other line 4.

Each of the switch members 9 (as shown in Fig. 18) has an iron frame 31 upon which the remainder of the structure is assembled. Fastened to the frame 31, by means of two rivets 33, is a flat spring member 35 which is adapted to press against the heel portion 39 of the moving contact member 37, the moving contact member 37 being pivotally supported on the frame 31 by means of the pivot pin 41. The flexible shunt 20 is brazed or otherwise conductively fastened to the moving contact member 37 immediately beneath the support point.

Each of the stationary contact assemblages 13, as shown particularly in Figs. 7 to 10 inclusive, comprises a flat base member 85, preferably of copper, which is provided with an opening 87 to permit the passage of the terminal contact stud, a threaded opening 89, the function of which will be pointed out later, a depressed opening 91 to permit the entry of the screw 92 which is utilized to fasten the base 85 to the base 1 of the circuit breaker, a cut-out portion 95 to permit the entry of the arcing member 93, and a raised contact portion 97. The raised contact portion 97 is provided with a main contact 99, preferably of silver and an arc resisting contact 101 which is preferably of an arc resisting material. The central part 103 of the raised contact portion 97 has an opening 104 to permit the passage of a screw 105 (Figs. 1 and 2) which is utilized to aid in fastening the base member 85 to the circuit breaker base 1. The moving contact 37 has contact portions 38 and 40 for cooperating with the stationary contact portions 99 and 101, respectively.

The arcing member 93 is constructed by magnetic material, preferably iron, and, as shown particularly in Figs. 9 and 10, is provided with a flat arcing portion 107, a raised central portion 109 which is adapted to be positioned beneath the raised stationary arcing contact 101 in the assembled structure, openings 111 to permit the passage of rivets 112 which support and position the arcing member 93 with respect to the base 85, and ears 113 which, as will be described later, aid in supporting and positioning the arc extinguishing device 11.

The arc extinguishing device 11 comprises, in general, a plurality of slotted plates of magnetic material which are supported and positioned between side walls 115 of insulating material. All of the plates are provided with projecting lugs 117 which are adapted to engage suitable openings in the side walls 115 and which are swedged over in the completed structure, thereby giving a rigid and mechanically sound unit. A pin 119 extends across the arc extinguisher directly above the path of movement of the associated movable contact 37 and provides a further strengthening means.

Three types of plates are utilized in this embodiment of our invention. The top plate 121 is not slotted but contains a cut away portion 122 of substantially the same outline as the end of the moving contacts 37. The arc extinguishing plates 123 and 125 are provided with slots 124 and 126, respectively. The plates 123 and 125 are disposed in a fan-like arrangement beneath the top plate 121, and are so positioned with respect to each other that the closed end of the slot in some of the plates is positioned nearer the path where the arc is initially drawn than the closed end of the slot in the other plates. This positioning secures a staggering of the apices of the slots with respect to the arc path, which, as will be discussed later is a very desirable and almost necessary feature in the securing of a progressive or multi-stage breaking up of the single arc which is initially drawn.

In addition to the usual number of plates positioned perpendicular to the axis of the arc as initially drawn and spaced along its length, we have provided a number of plates 123' which are disposed in planes beneath the plane of the stationary contact member 99. These added plates 123' permit an appreciable increase in the voltage rating of any particular arc extinguisher without necessitating any additional contact separation.

As shown, particularly in Figs. 1, 2, and 16 the arc extinguishers 11 are so disposed with respect to the path of movement of the contact members 37 that the arc is established within the slots 126 but not within the slots 124 due to the differing length of the slots and to the staggered arrangement of the apices with respect to the arc path. The maximum inductance (or minimum reluctance) of each of the individual magnetic circuits about the arc path formed by the slotted plates 123 and 125 is secured when the arc has moved a considerable distance above the apex of the slot in the particular plate being considered. As a result, the reaction force exerted on the arc by the plates 125 will be greater, at the instant of arc inception, than the corresponding force exerted by the plates 123—due to the immediate proximity of the sides of the slots 126 and to the lesser distance from the arc path to the apices of the slots 126 in the plates 125. As the arc moves into the extinguisher, however, the force exerted by the plates 123 increases in magnitude and assures an uninterrupted movement of the arc. The combined effect of the magnetic reactions set up by both of the plates is to cause the arc to move outwardly upon the arcing contacts 40 and 101 and into the arc extinguisher. This is shown diagrammatically in Fig. 12 and the desirability of this effect will be discussed at some length in a subsequent paragraph.

The arc extinguisher 11 is fastened to the associated stationary contact assemblage 13 by means of a screw 127 which extends downwardly through the opening 128 in the cross bar 129 (shown particularly in Fig. 6). An additional fastening and positioning means is provided by the openings 131 in the side members 115. These openings 131, as is shown particularly in Fig. 11 are adapted to engage the projecting ears 113 of the stationary contact assemblage 13. A metal screen 133 is provided for cooling the gases which pass through the arc extinguisher and thereby lessen the possibility of a short circuit between adjacent poles.

The operation of our invention may best be described in conjunction with Fig. 2 and Figs. 12 to 18, inclusive. The moving contact 37 is shown in the closed position in Fig. 2. As the opening operation begins, the frame 31 of the switch member 9 is moved from the position shown in Fig. 2 toward the position shown in Fig. 16. Simultaneously, the moving contact 37 rotates clockwise about the pivot pin 41, under the influence of the

spring member 35, until the heel portion 39 engages the frame 31. The above-mentioned rotation of the contact member 37 first causes the engagement of the arcing contacts 40 and 101, and as the opening operation progresses, then causes the separation of the main contacts 38 and 99. The next step is the establishing of an arc between the arcing contacts 40 and 101, and following this the moving contact member 37 moves to the fully open position shown in Fig. 16. The opening operation is preferably carried on at high speed, in order to secure the maximum possible lengthening of the arc before it moves into the extinguisher.

The arc, as initially drawn, exists between the arcing portion 40 of the moving contact 37 and the arc resisting portion 101 of the stationary contact assemblage 13. The movable contact takes the position shown in Figs. 12 to 17 immediately following the initiation of the arc. The previously described magnetic effect of the slotted plates of the arc extinguisher begins to bow the arc away from the contact members. At the same time, the magnetic effect of the arcing member 93 begins to exert a very appreciable force tending to move the end of the arc from off the arc resisting portion 101 downwardly toward the base 1. The direction of the flux lines is shown particularly in Figs. 16 and 17. The first result of the cumulative magnetic effect of the slotted plates 123 and 125 and the magnetic arcing portion 93 is to move the arc to substantially the position shown in Fig. 12. It will be noticed that the lower end of the arc has moved downwardly toward the arcing member 93, the central portion of the arc has begun to bow inwardly toward the apices of the slots, and the upper end of the arc has begun to move from the arc resisting contact 40 onto the top plate 121.

Fig. 13 illustrates the position of the arc a short time after that shown in Fig. 12. The lower end of the arc has now moved down onto the arc resisting member 93. The upper portion of the arc has moved entirely off the moving contact 37, and the central portion of the arc has begun to intersect the inner edge of the slots of several of the plates. The secondary arc which exists between the end of the moving contact 37 and the top plate 121 during the remainder of the extinguishing process, has now made its appearance.

Considerable force is required to divide the single initially formed arc into one or more portions, and for that reason, it is very desirable to carry out the division in as many steps as possible. It is important to note in this connection that the force tending to move the arc within the slots is substantially proportional to the number of plates and is greatest when the arc is at some point near the apices of the slots; thus, if a plurality of plates are provided and the division of the arc is carried out in two steps, double the force is available for each of the divisions. Furthermore, if the slots in some of the plates are disposed—as is done in this embodiment of our invention—some distance from the arc path an additional, progressively increasing force is made available at the instant of each arc subdivision. This obviously secures much more effective and much more reliable operation of the interrupter.

Fig. 14 shows the position of the arc after the first division. It will be noted that the arc now comprises approximately five divisions.

Fig. 15 shows the disposition of the various short arcs just before extinction is effected. The single arc has now been divided into eight shorter arcs, and, due to the rapid movement of those short arcs into the structure, the individual cathode drops are used with a maximum effectiveness.

One feature of our invention which has not been particularly pointed out is the arrangement of the various component plates. As is shown, particularly in Fig. 2, it will be seen that the central plane of each of the plates intersects along a line substantially coinciding with the axis of the pivot pin 41 of the moving contact 37. We have found that the center of curvature of the arc at the time when it intersects the nearest ends of the slots to be substantially along this line, and as a result somewhat more satisfactory operation of the extinguisher is secured by this arrangement. In addition, we have found that this arrangement of plates provides a very satisfactory means for securing a progressive lengthening of each of the short arcs. In fact, the combination of this arrangement of the plates and the provision of the additional plates beneath the plane of the engaging contact members makes possible the lengthening of the initial arc to several times its original length within a very short space of time. This lengthening is entirely independent of the contact separation and thus permits the use of smaller and less expensive operating mechanisms.

It will be seen that we have disclosed a new type of arc extinguisher which is capable of operating more satisfactorily and more reliably than previously known arc extinguishers of this type. Our improved arc extinguisher is particularly effective during unusual circuit conditions, due to its novel structural features which cause the division of the initially formed arc into a plurality of short arcs to be carried out in at least two steps, thereby making possible the utilization of more arc extinguishing plates for a predetermined contact separation than has been hitherto possible. In addition, we have disclosed an improved contact structure which is particularly suitable for use with the arc extinguisher of our invention, but which is obviously capable of use in other ways.

While in accordance with the patent statutes we have disclosed one embodiment of our invention, the principles herein involved are applicable to other structures, and we desire, therefore, that the language of the accompanying claims shall be accorded the broadest reasonable construction, and that our invention be limited only by what is explicitly stated in the claims and by the prior art.

We claim as our invention:

1. In a circuit interrupter, relatively movable contact members for opening and closing the circuit, an arc extinguishing device disposed adjacent the path of movement of said relatively movable contact members, magnetic means for moving the arc formed incident to the opening of the controlled circuit into said device, and other magnetic means including a member of magnetic material having a portion associated with one of said relatively movable contact members for effecting a longitudinal lengthening of the arc during the movement into said arc extinguishing device.

2. In a circuit interrupter, relatively movable contact members having engaging contact portions for opening and closing the circuit, a member of magnetic material associated with one of said relatively movable contact members, and an arc extinguishing device including a plurality of spaced plates of magnetic material, each of which

has a substantially V-shaped slot therein, disposed adjacent the path of movement of said relatively movable contact members, said spaced slotted plates, splitting the arc formed incident to the opening of the controlled circuit into a plurality of serially connected short arcs, the total length of all of said short arcs being appreciably greater than the length of said arc at its inception, one of said relatively movable contact members having a portion whereon one end of said initially formed arc is caused to move by the magnetic effect of said member of magnetic material, said movement of said arc effecting a longitudinal lengthening thereof which results in an effective utilization of all of said spaced plates during the arc extinguishing process, said member of magnetic material having a portion extending beneath the contact portion of its associated contact member for augmenting the magnetic effect thereof.

3. In a circuit interrupter, a stationary contact member, a movable contact member for cooperating therewith to open and to close the circuit, and an arc extinguishing device, said stationary contact member including a raised contact portion having a substantially flat conducting surface for engaging said movable contact member, said arc extinguisher comprising a plurality of spaced plates of magnetic material, each of which has a substantially V-shaped slot therein, for splitting the arc formed incident to the interruption of the controlled circuit into a plurality of short arcs and for moving said short arcs into the spaces between said plates, some of said plates being disposed in planes beneath the plane of said raised contact portion, each end of said initially formed arc and said serially connected arcs contacting one of said contact members at all times, said stationary contact member having a means of magnetic material associated therewith for moving one end of said arc off said raised contact portion and thereby facilitating the splitting of the arc by those plates disposed in planes beneath the plane of said raised portion.

4. In a circuit interrupter, a stationary contact assemblage, a movable switch member cooperating therewith to open and close the circuit, and an arc extinguishing device for extinguishing the arc formed incident to the opening of the controlled circuit, said stationary contact assemblage comprising a substantially flat strip of conducting material having a raised contact portion which projects outwardly from the plane of said strip, and a member of magnetic material disposed beneath said raised portion for moving the arc off said raised contact portion toward the plane of said conducting strip.

5. In a circuit interrupter, a stationary contact assemblage and a movable switch member cooperating therewith to open and to close the circuit, said stationary contact assemblage comprising a substantially flat strip of conducting material having a raised contact portion which projects outwardly from the plane of said strip, a cut-out portion disposed adjacent said raised portion, and a member of magnetic material disposed in said cut-out portion and extending beneath said raised contact portion, said member of magnetic material causing one end of the arc to move off said raised contact portion and to contact said member of magnetic material during the circuit interrupting operation.

6. In a circuit interrupter, relatively movable contact members for opening and closing the circuit, and an arc extinguishing device positioned adjacent the path of the arc formed during the interruption of the controlled circuit, said arc extinguishing device comprising a plurality of spaced plates of magnetic material having slots therein for splitting said arc into a plurality of short arcs and then moving those short arcs in the spaces between the plates, the closed end of the slots in some of said plates being disposed at different distances from the path where the arc is initially drawn in order to facilitate the splitting of the arc by separating the process into at least two steps.

7. In a circuit interrupter, means for establishing an arc and extinguishing means for said arc including a plurality of superposed, spaced plates of magnetic material, each of which has a substantially V-shaped slot therein, and supporting means for said plates, the apex of the V-shaped slot in some of said plates being staggered with respect to the apices of the adjoining plates.

8. In a circuit interrupter, means for establishing an arc, and extinguishing means for said arc including a plurality of superimposed spaced plates of magnetic material having slots extending therein from one edge thereof and being disposed in planes which intersect along a substantially straight line, the inner edge of the slot in some of said plates being positioned nearer the path where the arc is initially drawn than the inner edge of some of the other plates.

9. In a circuit interrupter, means for establishing an arc, and extinguishing means for said arc including a plurality of slotted plates of magnetic material, said slotted plates being positioned in planes substantially perpendicular to the axis of an arc and being so disposed with respect to the arc path that the arc is initially established within the slots in some of said plates but outside the slots in the remainder of said plates.

10. In a circuit interrupter, means for establishing an arc, and extinguishing means for said arc including a plurality of slotted plates of magnetic material, said slotted plates being positioned in converging planes substantially parallel to each other and substantially perpendicular to the axis of the arc, said slotted plates being so disposed with respect to the arc path that the arc is initially established within the slots in some of said plates but outside the slots in the remainder of said plates, the apices of the slots in the plates surrounding the arc at its inception being nearer the arc than the apices of the slots in the remaining plates in order to cause the subdivision of the initially formed arc to take place in at least two steps.

11. In a circuit interrupter, means for establishing an arc, and an arc-extinguishing device therefor, said device comprising a plurality of slotted plates of magnetic material so disposed with respect to the path of said arc that said arc is caused to move in a direction toward the closed end of the slot in each of said plates solely by the magnetic reaction caused by the proximity of said slotted plates to said arc, said plates being so proportioned and so positioned with respect to the path of said arc that the point of maximum inductance of some of the individual magnetic circuits formed by the said slotted plates of magnetic material is spaced a different distance from the arc path than the similar point of maximum inductance of some others of the said plates.

12. In a circuit-interrupter, contact means

movable in a substantially fixed path for establishing an arc, and an arc-extinguishing device therefor, said device comprising a plurality of plates of magnetic material each of which has a substantially V-shaped slot therein, said plates being positioned in planes substantially perpendicular to the path of movement of said contact means and having the flared portions of the V-shaped slots therein substantially aligned so as to cause said arc to move in a direction toward the closed end of the slots in each of said plates, said plates being so proportioned and so positioned with respect to the path of movement of said contact means that the point of maximum inductance of some of the individual magnetic circuits formed by the said slotted plates is spaced a different distance from the path of movement of the arc forming contact means than the similar point of maximum inductance of some others of the said plates.

MAURICE W. BRAINARD.
BENJAMIN P. BAKER.