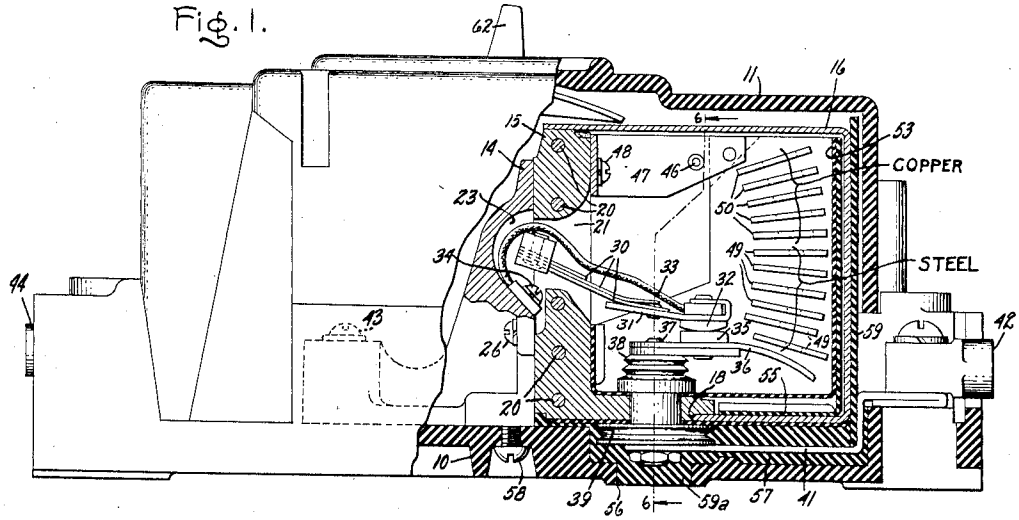
Oct. 11, 1938. D. W. VER PLANCK ET AL 2,133,158

CIRCUIT BREAKER

Filed Dec. 17, 1936 2 Sheets-Sheet 1

Fig. 1.



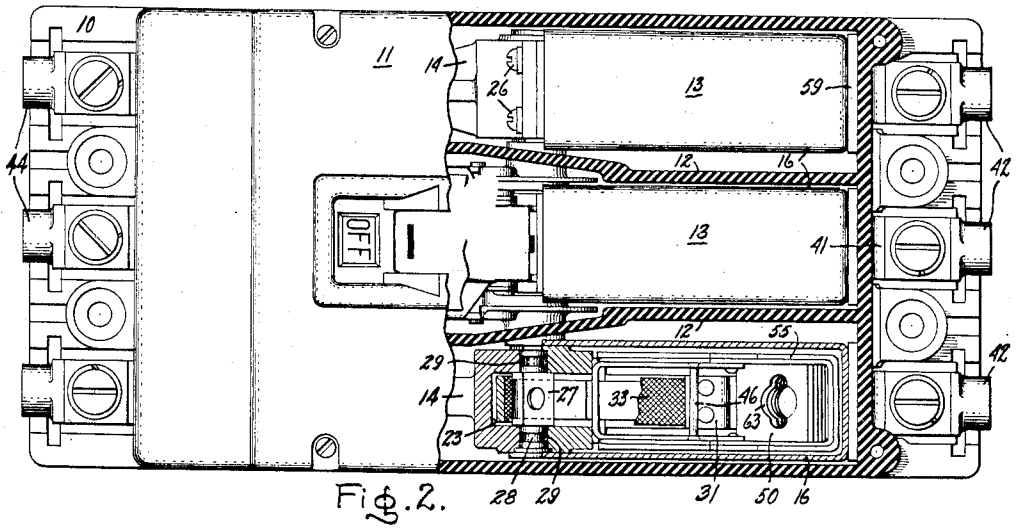


Fig. 2.

Fig. 3.

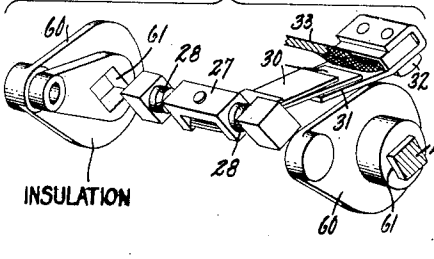


Fig. 4.

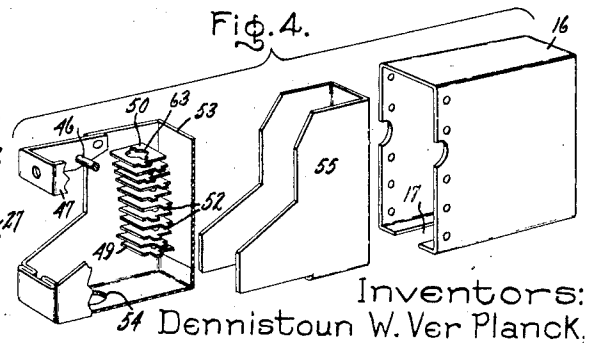


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Fig. 5.

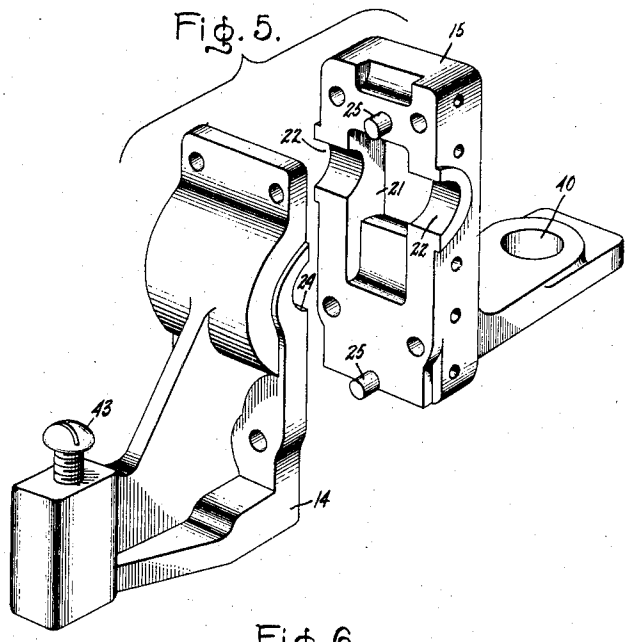
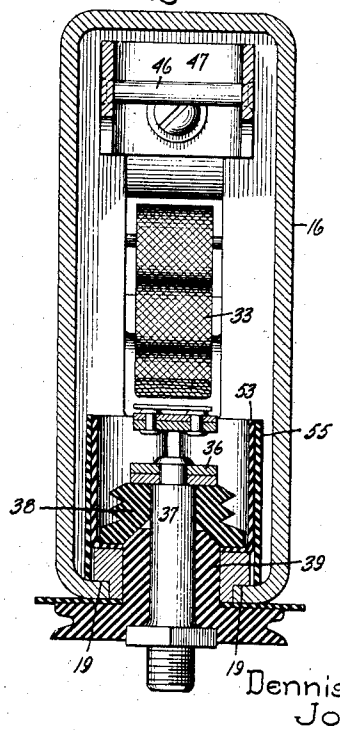


Fig. 6.



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UNITED STATES PATENT OFFICE

2,133,158

CIRCUIT BREAKER

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Application December 17, 1936, Serial No. 116,384

8 Claims. (Cl. 200—147)

Our invention relates to circuit breakers, more particularly to circuit interrupting devices of the compression chamber type in which the circuit interrupting contacts are enclosed within a gas-tightly sealed compression chamber and has for an object the provision of inexpensive and highly reliable interrupting devices of this character.

We have found that the pressure required to extinguish the arc is a direct function of the temperature of the entrapped gases, i. e., at low temperatures only relatively low pressures are required and at high gas temperatures relatively high gas pressures are necessary to extinguish the arc. Thus by cooling the arc, quick extinguishment may be obtained with limited pressures and the construction of the compression chamber may be considerably less rugged.

In carrying out our invention in one form, we provide a pair of contacts, one of which is movable between open and closed circuit position, together with walls of pressure resistant material enclosing the contacts to form a compression chamber having a volume such that gas pressures of substantial magnitude are generated in the chamber by the heat of the arc formed upon separation of the contacts, and a plurality of spaced metallic members disposed adjacent the path of movement of the movable contact for cooling the arc whereby the relatively low gas pressures effect a quick extinguishment of the arc.

Interrupters constructed in accordance with the present invention have successfully interrupted currents in the neighborhood of 10,000 amperes at 450 volts without detrimental burning of the contacts.

For a more complete understanding of our invention, reference should now be had to the drawings in which Fig. 1 is an elevational view, partly in section, of a multiple pole circuit breaker provided with interrupting units embodying our invention; Fig. 2 is a plan view, partly in section, and with certain parts broken away, of the circuit breaker shown in Fig. 1; Figs. 3, 4, and 5 are detail views in exploded perspective of various elements of our improved interrupting unit; and Fig. 6 is a fragmental sectional view taken along the line 6—6 of Fig. 1.

Referring now to the drawings, we have shown our invention as applied to a multiple pole circuit breaker of the type described and claimed in a copending application of Winfield A. Atwood, Serial No. 116,413, filed December 17, 1936, entitled "Circuit breakers", which application is assigned to the same assignee as the present invention. As shown, the circuit breaker comprises a base 10 formed of insulating material and provided with a cover member 11 having a plurality of walls 12 which divide the circuit breaker into three poles, each pole being provided with an interrupting unit 13 embodying our invention. Since the interrupting units 13 are identical in construction, only one will be described.

Each of the interrupting units comprises a plurality of walls arranged to form a gas-tightly sealed compression chamber, which walls comprise a pair of substantially L-shaped members 14 and 15 (Fig. 5) formed of conducting material, preferably die-cast aluminum, and a cup-shaped closure member 16 which may be formed from drawn steel. As shown, the drawn steel cup 16 is provided with a slot 17 in its lower wall into which slot extends the horizontal leg of the L-shaped member 15, this leg being provided with a plurality of notches 18 (Fig. 1) and 19 (Fig. 6) which engage the sides of the slot 17. The open face of the drawn steel cup 16 overlaps and is secured to the sides of the upstanding portion of the member 15, preferably by rivets 20 which extend through suitable apertures in the cup-shaped member 16 and the L-shaped member 15. If desired, a suitable sealing compound may be employed gas-tightly to seal the joint between the members 15 and 16.

As shown, the conducting member 15 is provided with an aperture 21 extending therethrough and with a pair of semi-cylindrical grooves or bearings 22 (Fig. 5) which extend from the aperture 21 to the outer edges of the member 15, and the conducting member 14 is provided with a recess 23 (Figs. 1 and 2) and with a pair of similar semi-cylindrical grooves or bearings 24. Thus, when the members 14 and 15 are secured together in face to face relation, as for example by dowel pins 25 and suitable screws 26, the member 14 serves as a closure member for the aperture 21 in the member 15 and the semi-cylindrical grooves 22 and 24 cooperate to form substantially cylindrical bearings.

Journaled in the bearings formed by the grooves 22 and 24, we provide a rotatable shaft 27, the ends of which extend outwardly from the compression chamber formed by the members 14, 15, and 16, and the bearing portions of which are provided with grooves 28 in which suitable packing material 29 (Fig. 2) is located. Connected to the portion of the shaft 27 intermediate its bearing portions, we provide a plurality of leaf springs 30 which extend through the aperture 21 into the compression chamber and constitute a switch arm, to the free end of which is

connected an arcing member 31, preferably formed of arc resisting material such as nickel, for supporting a movable contact member 32. As shown, a flexible conductor 33 is secured at one end to the arcing member 31 and the contact 32, the other end of the flexible conductor being secured to the L-shaped conducting member 14 by a suitable screw 34 (Fig. 1).

Arranged in cooperating relation with the movable contact 32, we provide a stationary contact 35 which is supported intermediate the ends of an arcing member 36 which extends substantially at right angles to the wall of the compression chamber formed by the conducting members 14 and 15 and which is supported on a conducting stud 37 extending through a pair of insulating bushings 38 and 39. As shown best in Fig. 6, a portion of the insulating bushing 39 extends through an aperture 40 in the horizontally extending portion of the conducting member 15. The lower extending end of the conducting member or stud 37 is connected to a conductor 41 which extends to a terminal member 42 supported on the right-hand end of the base 10, and the L-shaped conducting member 14 to which the flexible conductor 33 is connected is provided with an external terminal screw 43 (Fig. 1). As is more fully described in the above referred to Atwood application, the terminal screw 43 on the conducting member 14 is connected by means of a suitable conductor (not shown) to the current responsive element of a tripping mechanism and this current responsive element is likewise connected by a conductor (not shown) to a terminal member 44 mounted on the left-hand end of the base 10. Thus, it will be seen that we have provided a compression chamber type interrupting unit in which the only extending parts constitute the extending ends of the rotatable shaft 27 and the extending end of the conductor stud 37 and in which one wall of the chamber serves as a portion of the electric circuit to provide means for connecting the interrupting unit in an external circuit.

When the shaft 27 is rotated in a counterclockwise direction, the switch arm 30 and the contact 32 will be moved from the closed circuit position shown in the drawings to an open circuit position in which the back of the arcing member 31 engages a stop pin 46 which is supported between the legs of the U-shaped member 47, the yoke portion of which is secured to the conducting member 15 by a screw 48. Arranged along the path of movement of the movable contact 32, we provide a plurality of spaced members or plates 49 and 50, the plates 49 being formed of suitable magnetizable material, such as steel, and the plates 50 being formed of a material having a high heat conductivity such for example as copper. As shown best in Fig. 4, the plates 49 and 50 are provided with extending ears 52 which engage suitable notches (not shown) in the opposite walls of a supporting member 53 formed of suitable insulating material. The lower wall of this supporting member 53 is provided with an aperture 54 through which the insulating bushing 39 extends, the lower wall of the member 53 being clamped between the insulating bushing 38 and the horizontally extending portion of the conducting member 15 (Fig. 1). As shown, the upper portion of the insulating support 53 is connected to the outermost ends of the U-shaped member 47. In order effectively to insulate the extending ears 52 from the drawn steel cup 16, an insulating shield 55 is provided within which the insulating support 53 nests, the lower wall of the insulating shield 55 resting on the lower wall of the drawn steel cup 16, as shown in Fig. 1.

As shown, the base 10 of the circuit breaker is provided adjacent its right-hand end with an aperture 56 which communicates with a recess 57 in the upper wall of the base. After the interrupting unit has been assembled with the various parts in the above described relation, the unit is mounted on the base 10 with the insulating bushing 39 and the conductor 41 extending into the recess 57 and the interrupter unit may then be secured to the base by suitable screws (58) which extend through apertures in the base member 10 and threadedly engage the conducting member 14. An insulating barrier 59 is disposed adjacent the right-hand end of the interrupter unit effectively to insulate the drawn steel cup 16 from the conductor 41 and the terminal member 42 and the recess 57 may then be filled through the aperture 56 with a suitable insulating compound 59a which is fluid at high temperatures, but solid at normal temperatures.

The interrupting unit 13 for the center pole of the circuit breaker differs from the interrupting units for the outer poles of the circuit breaker only in that both ends of the shaft 27 extend outwardly from the interrupting unit for the center pole, while only the inner ends of the shafts 27 extend from the interrupting units for the outer poles. As is fully described in the above referred to Atwood application, the interrupting units for the three poles of the circuit breaker are arranged on the base 10 in side by side relation with the shafts 27 in spaced, axial alinement. As shown, the extending ends of the shafts 27 are non-circular or square in accordance with the invention described and claimed in the said Atwood application and a pair of insulating cranks or disks 60 are disposed in the spaces between the adjacent ends of the shafts and provided with non-circular apertures 61 (Fig. 3) into which the non-circular ends of the shafts 27 extend. It will be apparent that when the crank disks 60 are rotated, the shafts 27 will be simultaneously operated to actuate the movable contacts of the three interrupter units between their open and closed circuit position.

Although our invention is not limited thereto, the circuit breaker is preferably provided with a combined manual and automatic mechanism for rotating the crank discs 60, which operating mechanism is of the type described and claimed in the above referred to Atwood application. Since the detailed construction of this operating mechanism forms no part of the present invention, it is not deemed necessary herein to show or describe the mechanism further than to say that the mechanism is arranged to rotate the crank disks 60 so as to operate the contacts from their closed to their open circuit position either upon movement of a suitable handle 62 which projects from the cover member 11, or automatically in response to the occurrence of predetermined overload conditions.

It is now believed that a complete understanding of our invention may be had from a description of the operation under heavy overload or short-circuit conditions. With the contacts 32 and 35 in the closed circuit position shown, it will be assumed that an overload condition of short-circuit magnitude occurs and that the operating mechanism is thereby influenced as described in the above referred to Atwood application so as to

effect operation of the movable contact 32 to its open circuit position.

As the contact 32 is separated from the contact 35, an arc is drawn therebetween which heats the air or gas entrapped within the compression chamber so as to generate a pressure therewithin. The volume of the compression chamber is so proportioned that the heat of the arc generates a pressure of considerable magnitude and, as explained in the Walle Patent No. 2,047,842 issued July 14, 1936, the resistance of the arc increases rapidly with an increase in the pressure. If the pressure increases to a sufficiently high value, the resistance of the arc will become so great that the arc can no longer exist. We have found, however, that the pressures necessary to effect extinguishment of an arc, produced under the voltage and current conditions for which our improved interrupter is designed, are so great, due to the high temperatures generated, as to cause rupture of the compression chamber walls unless an expensive, heavy wall structure is provided. Accordingly, the metallic members 49 and 50 arranged adjacent the path of movement of the movable contact are provided for subdividing and cooling the arc to limit the heat developed and the pressures generated by the arc.

In addition to this cooling function, the metallic members 49 and 50 assist in effecting extinguishment of the arc. As is well understood in the art, subdividing an arc into a plurality of short arcs, increases greatly the instability of the arc and although the compression chamber and the spaced metallic members 49 and 50 are apparently directed toward diametrically opposite results one tending to produce high temperatures and pressures and the other tending to limit the temperatures and pressures, we have found that by properly proportioning the compression chamber and the number and spacing of the metallic plates, an interrupting unit may be provided which effects a much quicker extinguishment of the arc than either a conventional compression chamber interrupter or a conventional arc splitting device.

It is, of course, necessary that the arc be moved quickly into engagement with the metallic members 49 and 50 and accordingly the conducting stud 37, the arc members 36, the contacts 32 and 35, and the flexible conductor 33 are arranged as shown to provide a substantially U-shaped path for the current flowing therethrough. This U-shaped path forms a single turn magnetic blowout coil which exerts a magnetic force in a direction to move the arc toward the metallic plates 49 and 50 and which also prevents the arc from striking to the walls of the compression chamber. In addition, it will be remembered that the metallic plates 49 are formed of magnetizable material and accordingly these plates form a low reluctance path for the magnetic flux surrounding the arc and the resulting magnetic attraction assists in quickly moving the arc into engagement with the plates.

As stated above, the plates 50 are formed of a material having a high heat conductivity, such for example as copper, in order to improve the cooling properties of the plates. It will be understood, however, that our invention is not limited to the specific arrangement shown of magnetizable and non-magnetizable plates, and if desired all of the plates 49 and 50 may be formed of magnetizable material. Likewise, if additional means is provided for quickly moving the arc into engagement with the spaced metallic plates, all of the plates 49 and 50 may be formed of copper or other non-magnetizable high heat conductivity material.

In order to equalize the pressures generated by the short arc sections between the plates 49 and 50, each of these plates is provided with a small aperture 63.

While we have shown a particular embodiment of our invention, it will be understood, of course, that we do not wish to be limited thereto since many modifications may be made and we, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of our invention.

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

1. An electric circuit interrupter comprising a stationary contact, a movable contact arranged to engage said stationary contact, and a plurality of spaced arc extinguishing plates arranged along the path of movement of said movable contact and extending substantially at right angles to the path of movement of said movable contact, a plurality of said plates along the initial part of the opening movement of said movable contact being made of magnetizable material to move the arc formed between said contacts into said plates, and the remaining plate being made of a non-magnetizable material having high heat conductivity to cool the arc.

2. An electric circuit interrupter comprising a stationary contact, a pivotally mounted contact arm bearing a movable contact arranged to engage said stationary contact, and a plurality of parallel spaced arc extinguishing plates arranged adjacent substantially the entire path of movement of said movable contact and extending substantially at right angles to the path of movement of said movable contact, a plurality of said plates along the initial part of the opening movement of said movable contact being made of magnetizable material to move the arc formed between said contacts into said plates, and the remaining plates being made of a non-magnetizable material having high heat conductivity to cool the arc.

3. An electric circuit interrupter comprising a stationary contact, a pivotally mounted contact arm bearing a movable contact arranged to engage said stationary contact, a plurality of parallel spaced arc extinguishing plates arranged adjacent substantially the entire path of movement of said movable contact and extending substantially at right angles to the path of movement of said movable contact, a plurality of said plates along the initial part of the opening movement of said movable contact being made of magnetizable material to move the arc formed between said contacts into said plates, and the remaining plate being made of a more magnetizable material having high heat conductivity to cool the arc, and closure means forming a gas tightly sealed arc chamber around said plates and contacts.

4. An electric circuit interrupter comprising a closure member open at one end, a supporting member in said closure member having a portion fitting into the open end of said closure member, said portion being provided with an aperture, a second supporting member fitting onto the outer surface of said first supporting member to close said aperture and form an arc chamber, bearings on said supporting members, a shaft mounted in said bearings extending across said aperture, a stationary contact in said chamber, a contact

arm secured to said shaft carrying a movable contact cooperating with said stationary contact, a terminal on said second supporting member, means electrically connecting said movable contact to said terminal, and operating means for said movable contact connected to said shaft.

5. An electric circuit interrupter comprising a closure member open at one end, a supporting member made of electrically conducting material in said closure member having a portion closing the open end of said closure member, said portion being provided with an aperture, a second supporting member made of electrically conducting material fitting onto the outer surface of said first supporting member to close said aperture and form an arc chamber, bearings on said supporting members, a shaft mounted in said bearings extending across said aperture, a stationary contact in said chamber, a contact arm secured to said shaft carrying a movable contact cooperating with said stationary contact, a flexible conductor connecting said movable contact to said second supporting member whereby electrical connections for said movable contact are made with said second supporting member, and operating means for said movable contact connected to said shaft.

6. An electric circuit interrupter comprising a closure member open at one end, a supporting member made of electrically conducting material in said closure member having a portion closing the open end of said closure member, said portion being provided with an aperture, a second supporting member made of electrically conducting material fitting onto the outer surface of said first supporting member to close said aperture and form an arc chamber, bearings on said supporting members, a shaft mounted in said bearings extending across said aperture, a stationary contact in said chamber secured to said first supporting member in electrically insulated relation thereto and having a portion extending through said first supporting member to the exterior of said arc chamber, a contact arm secured to said shaft carrying a movable contact cooperating with said stationary contact, and operating means for said movable contact connected to said shaft in electrically insulated relation therewith.

7. An electric circuit interrupter comprising a closure member open at one end, a supporting member made of electrically conducting material in said closure member having a portion closing the open end of said closure member and gas tightly connected to said closure member, said portion being provided with an aperture, a second supporting member made of electrically conducting material fitting onto the outer surface of said first supporting member to close said aperture and form a gas tightly sealed arc chamber, said supporting members being provided with registering recesses forming bearings, a shaft mounted in said bearings extending across said aperture, said second supporting member being provided with a recess registering with said aperture, a stationary contact in said chamber secured to said first supporting member in electrically insulated relation thereto and having a portion extending through said first supporting member to the exterior of said arc chamber, a contact arm secured to said shaft carrying a movable contact cooperating with said stationary contact, a flexible conductor connecting said movable contact to said second supporting member whereby electrical connections for said movable contact are made with said second supporting member, operating means for said movable contact connected to said shaft in electrically insulated relation therewith, and a base and cover of electrically insulating material inclosing said supporting and closure members.

8. An electric circuit interrupter comprising a closure member open at one end, a supporting member made of electrically conducting material in said closure member having a portion closing the open end of said closure member and gas tightly connected to said closure member, said portion being provided with an aperture, a second supporting member made of electrically conducting material fitting onto the outer surface of said first supporting member to close said aperture and form a gas tightly sealed arc chamber, said supporting members being provided with registering recesses forming bearings, a shaft mounted in said bearings extending across said aperture, said second supporting members being provided with a recess registering with said aperture, a stationary contact in said chamber secured to said first supporting member in electrically insulated relation thereto and having a portion extending through said first supporting member to the exterior of said arc chamber, a contact arm secured to said shaft carrying a movable contact cooperating with said stationary contact, electrically insulated operating means for said shaft, and a plurality of parallel spaced arc extinguishing plates arranged adjacent the path of movement of said movable contact, a plurality of said plates along the initial part of the opening movement of said movable contact being made of magnetizable material and the remaining plates being made of a non-magnetizable material.

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