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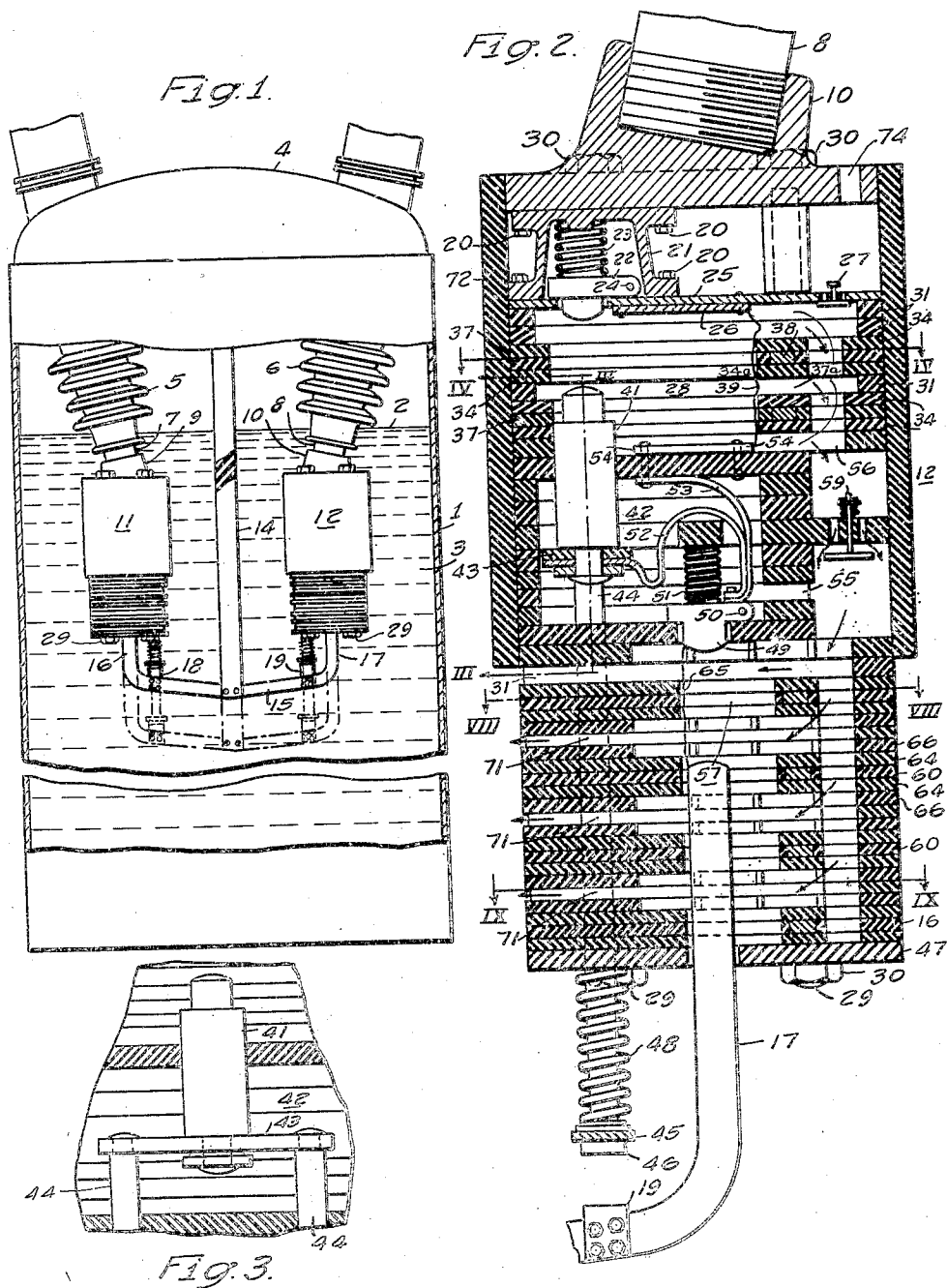
B. P. BAKER ET AL

2,462,708

CIRCUIT INTERRUPTER

Filed Jan. 19, 1945

5 Sheets-Sheet 1



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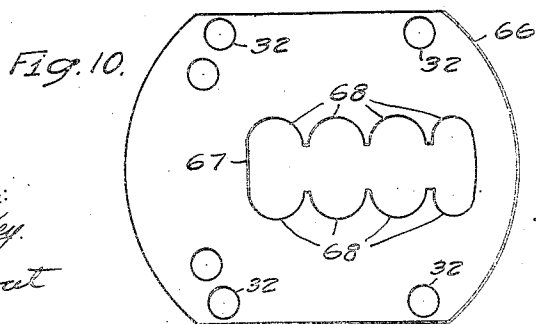
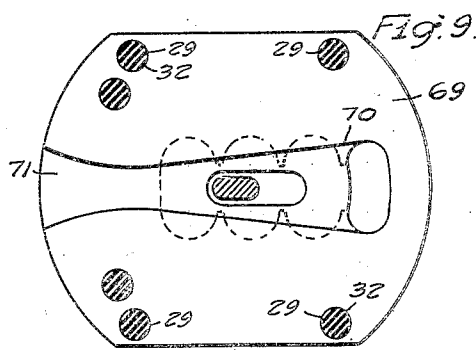
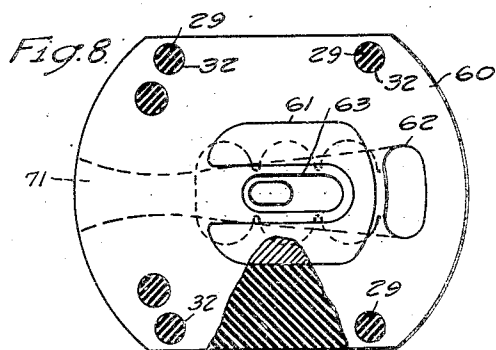
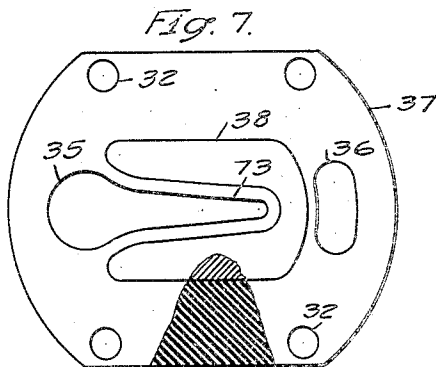
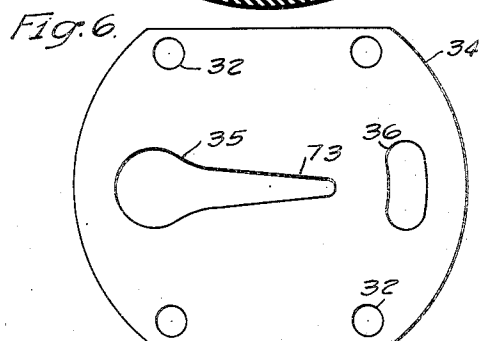
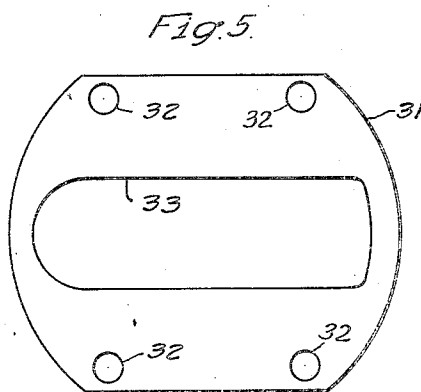
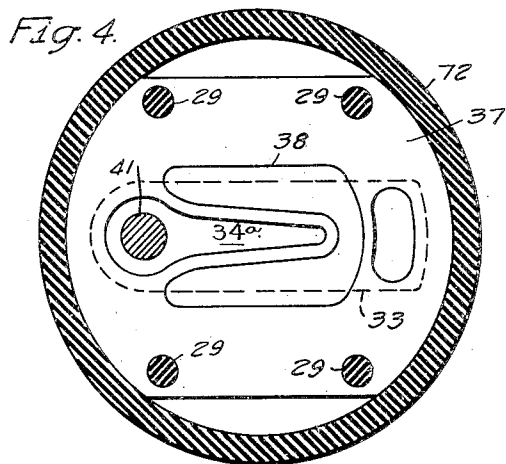
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CIRCUIT INTERRUPTER

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5 Sheets-Sheet 2



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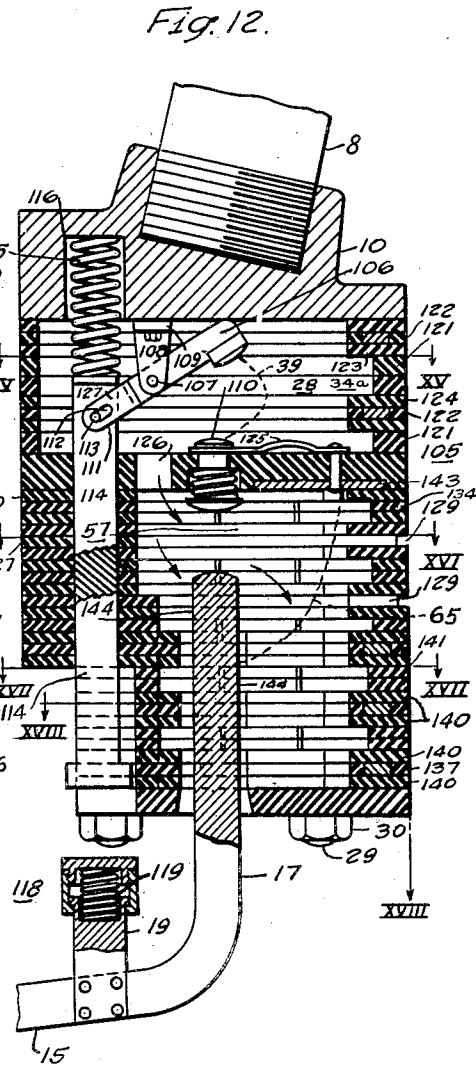
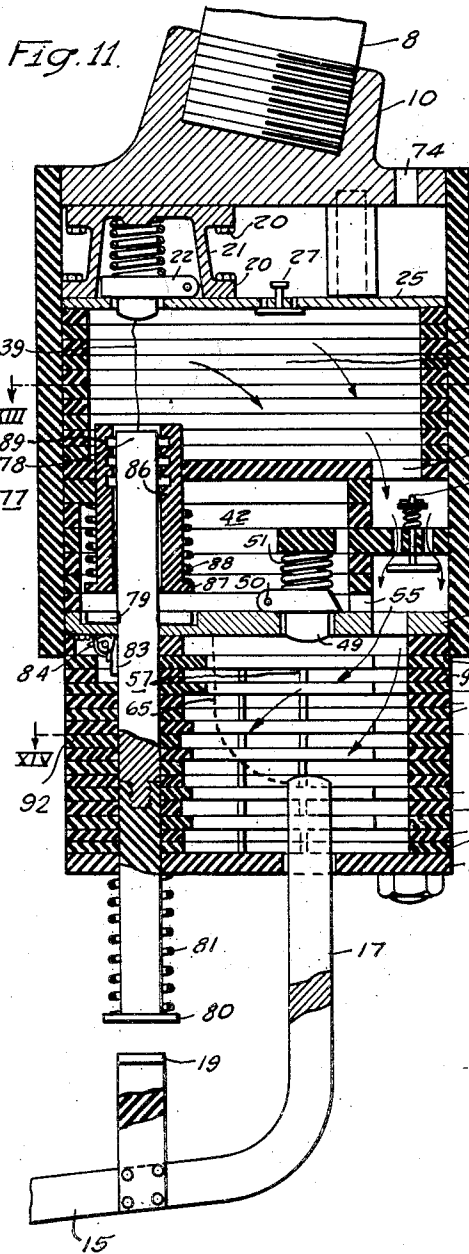
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CIRCUIT INTERRUPTER

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5 Sheets-Sheet 3



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2,462,708

CIRCUIT INTERRUPTER

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Fig. 13.

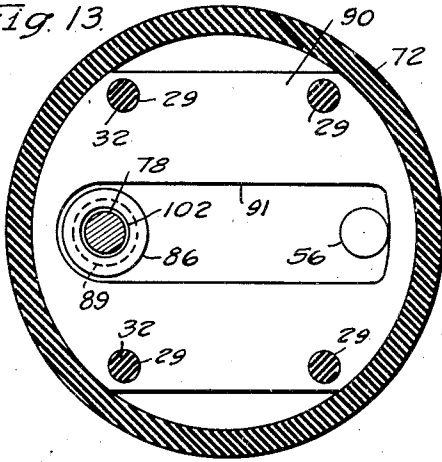


Fig. 14.

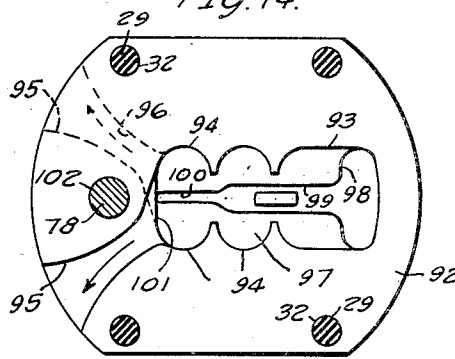


Fig. 15.

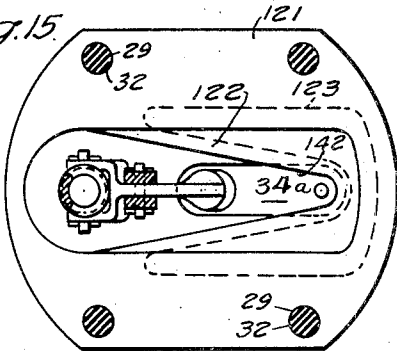


Fig. 16.

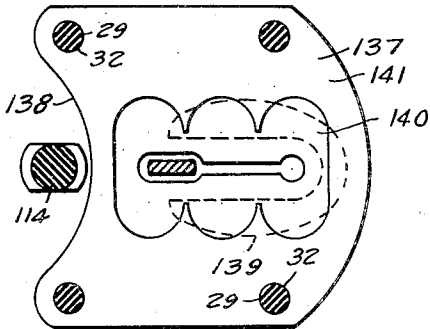
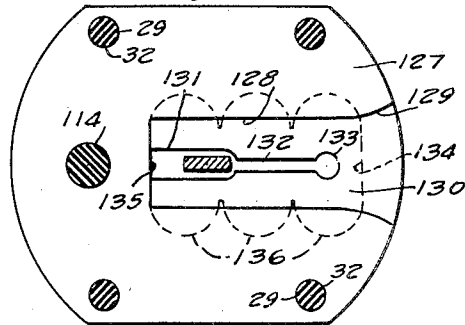


Fig. 17.

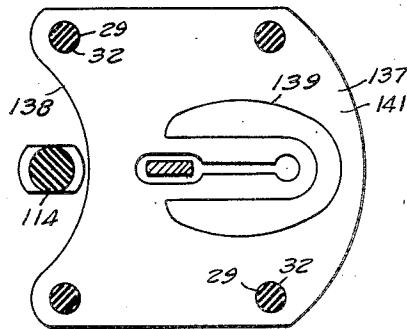


Fig. 18.

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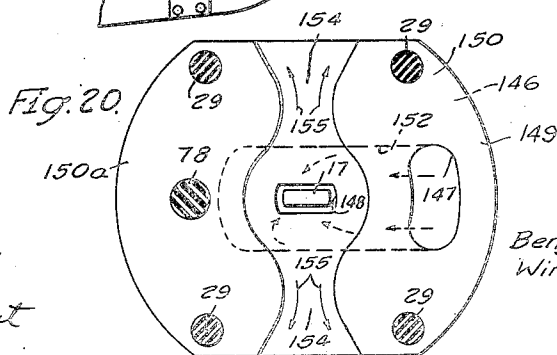
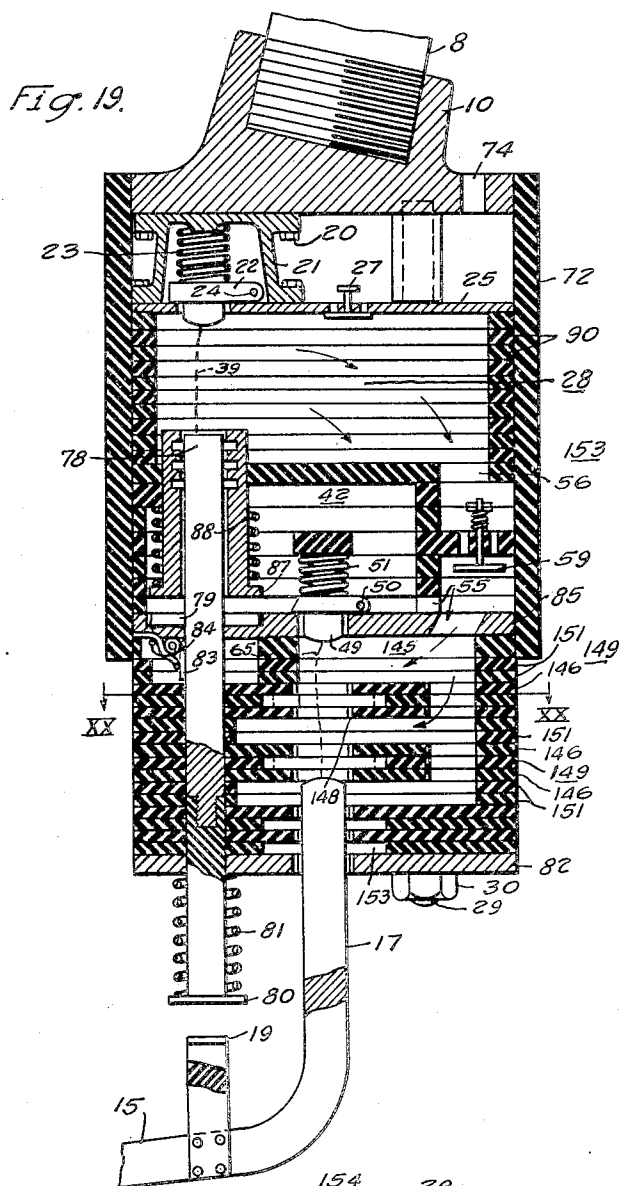
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B. P. BAKER ET AL
CIRCUIT INTERRUPTER

2,462,708

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5 Sheets-Sheet 5



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2,462,708

CIRCUIT INTERRUPTER

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Application January 19, 1945, Serial No. 573,522

11 Claims. (Cl. 200—150)

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This invention relates to circuit interrupters, in general, and, more particularly, to circuit interrupters of the liquid-break type.

An object of our invention is to provide an improved circuit interrupter in which improved operation is obtained both during the interruption of low and high currents.

A more specific object is to provide an improved circuit interrupter of the type establishing both a pressure-generating arc and an interrupting arc and to provide piston means associated therewith in a novel manner to assist in the interruption of low currents.

Another object is to provide an improved circuit interrupter in which a pressure-generating arc and an interrupting arc are established in an arc-extinguishing unit and to provide means for magnetically moving the pressure-generating arc laterally to increase the pressure formed thereat.

Further objects and advantages will readily become apparent upon a reading of the following specification taken in conjunction with the drawings, in which:

Figure 1 shows a complete circuit interrupter embodying our invention and shown in the closed circuit position;

Fig. 2 is an enlarged vertical sectional view of the right-hand arc-extinguishing unit of Fig. 1, the parts thereof being shown in an intermediate position during the opening operation;

Fig. 3 is a fragmentary vertical sectional view taken substantially on the line III—III of Fig. 2;

Fig. 4 is a plan view in section taken along the line IV—IV of Fig. 2;

Figs. 5 through 7 show plate details used in the construction of the pressure-generating chamber associated with Fig. 2;

Fig. 8 is a plan view in section taken along the line VIII—VIII of Fig. 2;

Fig. 9 is a plan view in section taken along the line IX—IX of Fig. 2;

Fig. 10 is a plate detail used in constructing the interrupting chamber associated with Fig. 2;

Fig. 11 is a vertical sectional view of a modified type of arc-extinguishing unit embodying another modification of our invention, the parts being shown in an intermediate position during the opening operation;

Fig. 12 is a vertical sectional view of still another modified type of arc-extinguishing unit embodying our invention, the parts being shown in an intermediate position during the opening operation;

Fig. 13 is a plan view in section taken along the line XIII—XIII of Fig. 11;

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Fig. 14 is a plan view in section taken along the line XIV—XIV of Fig. 11;

Fig. 15 is a plan view in section taken along the line XV—XV of Fig. 12;

Fig. 16 is a plan view in section taken along the line XVI—XVI of Fig. 12;

Fig. 17 is a plan view in section taken along the line XVII—XVII of Fig. 12;

Fig. 18 is a sectional view taken along the line XVIII—XVIII of Fig. 12; and

Figs. 19 and 20 collectively illustrate a further modified type of arc-extinguishing unit.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral 1 designates a tank filled to the level 2 with a suitable arc-extinguishing fluid 3 in this instance, oil, and having a cover 4 from which depend two insulating bushings 5, 6 through which extend terminal studs 7, 8. The terminal studs 7, 8 are threadedly secured to contact feet 9, 10 which support in position two serially related arc-extinguishing units 11, 12. The arc-extinguishing units 11, 12 are identical in construction.

Reciprocally operable within the tank 1 and actuated by suitable mechanism, not shown, is an insulating operating rod 14 having rigidly secured to its lower end a conducting bridging member 15 at the opposed outer ends of which are upstanding portions 16, 17 forming the lower movable contacts of the interrupter. The bridging member 15 carries bumpers 18, 19, the purpose for which will appear more clearly hereinafter.

Referring to Fig. 2, which shows an enlarged vertical sectional view of the right-hand arc-extinguishing unit 12 of Fig. 1, it will be observed that the contact foot 10 supports by bolts 20 a stationary contact housing 21 in which pivotally moves a relatively stationary contact 22 biased downwardly by a compression spring 23 and pivotally mounted at 24. Immediately below the housing 21 is a conducting plate 25 which supports an arcing horn 26. The conducting plate 25 also supports a check valve 27 which closes during high-pressure conditions within the pressure-generating chamber 28, but opens following a subsidence of pressure to permit accumulated gas to pass out of the pressure-generating chamber 28 through the check valve 27 following the completion of an opening operation of the interrupter.

The pressure-generating chamber 28 is formed by a plurality of suitably shaped insulating plates maintained in abutting relation by insulating tie rods 29 which extend axially through the unit 12

and have nuts 30 threadedly secured to their outer ends.

The insulating plates forming the pressure-generating chamber 28 are of three types, as shown more clearly in Figs. 5 through 7. Immediately below the conducting plate 25 are positioned two insulating plates 31 having a configuration more clearly shown in Fig. 5. Each insulating plate 31 has apertures 32 formed therein for the accommodation of the tie rods 29 and a large cutout portion 33. Immediately below the plates 31 is a group of three plates, the outer two of which are designated by the reference numeral 34 and shown more clearly in Fig. 6. The plates 34 have cutout portions 35, 36 formed therein. Between the two plates 34 is a magnetic insert plate 37 having a configuration more clearly shown in Fig. 7. The magnetic insert plate also has cutout portions 35, 36, but additionally has inserted therein a U-shaped member 38 composed of a suitable magnetic material such as iron. It will, therefore, be apparent that the two guard insulating plates 34 protect the magnetic insert 38 from contact with the pressure-generating arc 39 which is drawn in the pressure-generating chamber 28 during the opening operation. Below the group of two insulating plates 34 and the insert plate 37 is a plate 31 which is followed by a second group of the plates 34, 37.

The successive groups of plates 34, 37 form substantially V-shaped restricting means 34a disposed within the pressure-generating chamber 28. The spacing of these groups of plates 34, 37 as achieved by the plates 31 form a plurality of vent passages 37a disposed along the V-shaped restricting means 34a.

Movable into engagement with the stationary contact 22 is an intermediate contact 41. The intermediate contact 41 also moves into a piston chamber, generally designated by the reference numeral 42, and disposed intermediate the ends of the unit 12. The intermediate contact 41 has an insulating cross-bar 43 rigidly secured to its lower end as shown in Fig. 3. At the opposed outer ends of the cross-bar 43 are two insulating operating rods 44 which are joined at their lower ends by a cross member 45 having a bumper 46 rigidly secured thereto. Encircling the lower end of each of the operating rods 44 and positioned between the bottom plate 47 of the unit 12 and the cross member 45 is a compression spring 48. The two compression springs 48 bias the operating rods 44 and hence the intermediate contact 41 downwardly. During the closing operation of the interrupter, the bumper 19 strikes the bumper 46 to raise the operating rods 44 and the intermediate contact 41 until the intermediate contact 41 strikes the stationary contact 22, slightly raising the latter so that the requisite contact pressure therebetween is provided by the compression spring 23.

The volume of the operating rods 44 movable out of the piston chamber 42 during the opening operation is considerably less than the volume of the intermediate contact 41 movable into the piston chamber 42, the purpose for which will appear more clearly hereinafter.

Associated with the intermediate contact 41 is a relatively stationary contact 49 pivotally mounted at 50 and biased downwardly by a compression spring 51. A conductor 52 electrically connects the intermediate contact 41 and the stationary contact 49. Another conductor 53 electrically connects the arcing horn 54 with the

stationary contact 49. The piston chamber 42 is substantially enclosed with the exception of a passage 55 which joins the passage 56 leading from the pressure-generating chamber 28 to the interrupting chamber, generally designated by the reference numeral 57 and disposed adjacent the lower end of the arc-extinguishing unit 12. A valve 59 is provided in the passage 56, the purpose for which will appear hereinafter.

The interrupting chamber 57 is formed by a plurality of adjacently positioned suitably shaped insulating plates maintained in abutting relation by the tie rods 29. These plates are of four different types, as indicated more clearly in Figs. 8 through 10. The first type is herein called an insert plate and designated by the reference numeral 60 being shown more clearly in Fig. 8. The plate 60 has apertures 32 provided therein to accommodate the tie rods 29. Also the insert plate 60 has a U-shaped member 61 inserted therein which is composed of a suitable magnetic material, in this instance, iron. The plate 60 also has a cutout portion 62 formed therein and a second cutout portion 63. Immediately above and below the insert plate 60 are two insulating guard plates 64 of identical shape as the insulating plate 60 with the exception that no magnetic insert 61 is employed. The guard plates 64 protect the insert 61 from the interrupting arc 65 which is drawn between the stationary contact 49 and the lower movable contact 17.

Immediately above and below each group of two guard plates 64 and one insert plate 60 is a pocket insulating plate 66 having a configuration more clearly shown in Fig. 10. Each pocket insulating plate 66 has a cutout portion 67 provided therein, the periphery of which defines a plurality of pockets 68 which serve to retain additional liquid adjacent the arc 65.

Between adjacent pocket insulating plates 66 is disposed an insulating vent plate 69 and having a configuration more clearly shown in Fig. 9. The vent plate 69 has a cutout portion 70 which vents at 71 to the region exterior of the unit 12. An insulating cylinder 72 surrounds the upper end of the arc-extinguishing unit 12 and not only provides support, but minimizes leakage out of the unit 12 between the several insulating plates. The cylinder 72 lends considerable strength to the unit 12.

The operation of the arc-extinguishing unit 12 will now be explained. In the closed circuit position of the interrupter, as shown by the full lines in Fig. 1, the electrical circuit therethrough comprises terminal stud 8, contact foot 10, housing 21, bolt 20, conducting plate 25, stationary contact 22, intermediate contact 41, conductor 52, stationary contact 49, movable contact 17, bridging member 15, through the left-hand arc-extinguishing unit 11 in an identical manner to the terminal stud 7.

When it is desired to open the electrical circuit through the interrupter, or in response to overload conditions existing in the circuit controlled by the interrupter, suitable operating mechanism, not shown, is actuated to cause downward movement of the operating rod 14. The downward movement of the operating rod 14 also causes downward movement of the bumpers 18, 19 and the movable contacts 16, 17. Consequently, considering only the right-hand arc-extinguishing unit 12, the downward movement of the bumper 19 permits the compression springs 48 to move the intermediate contact 41 downwardly away from the stationary contact 22 to draw a pressure-gen-

erating arc 39. At the same time, the movable contact 17 separates from the stationary contact 49 to draw an interrupting arc 65 within the interrupting chamber 57. Assume that the current being interrupted by the unit 12 is high. In this event, the pressure formed in the pressure-generating chamber 28 will be considerable, and furthermore because of the high amperage passing through the pressure-generating arc 39, the magnetic field associated therewith will be greatly distorted by the magnetic inserts 38 to consequently cause a lateral motion of the pressure-generating arc 39 onto the arcing horns 26 and 54, and toward the right as indicated in Fig. 2. It is apparent that the arc 39 is biased to the right by the magnetic inserts 38 more strongly during high-current conditions than during low-current conditions.

Consequently, during the interruption of high current, the pressure-generating arc 39 will be strongly affected by the magnetic field to move to the right and into the constriction 73 provided by the plates 34 and 37. The constriction 73 will tend to deionize the arc 39 to effect the extinction thereof, and, consequently, there is considerable interrupting ability associated with the pressure-generating chamber 28. The pressure created at the pressure-generating arc 39 will close the check valve 27 and act downwardly through the passage 56 to cause opening of the valve 59 and to pass downwardly into the interrupting chamber 57 to tend to force the interrupting arc 65 to the left toward the vents 71.

During relatively high instantaneous values of arcing current, the magnetic inserts 61 will hold the interrupting arc 65 toward the right away from the vents 71. However, during relatively low values of instantaneous arcing current, that is, near a current zero, the biasing force exerted by the magnetic inserts 61 toward the right will be decreased to permit the oil flow to carry the interrupting arc 65 to the left toward the vents 71 to effect the extinction thereof. The oil disposed in the pockets 68 of the insulating pocket plates 66 will provide an additional readily available quantity of oil to be acted upon by the interrupting arc 65 to facilitate the deionizing thereof. The foregoing is assumed to take place during the interruption of high currents passing through the interrupter.

During the interruption of low currents passing through the interrupter, the pressure generated within the pressure-generating chamber 28 by the pressure-generating arc 39 will correspondingly be low. Consequently, there may not be sufficient pressure formed by the arc 39 to effect a rapid extinction of the interrupting arc 65 by adequate oil flow. This is a hazard which is present during the interruption of charging currents or low value magnetizing currents. To remedy this defect, we have provided the piston chamber 42 into which the intermediate contact 41 moves. This contact displaces considerably greater volume than the operating rods 44 which move out of the piston chamber 42 during the opening operation. The net result is a displacement of oil out of the piston chamber 42 through the passage 55 to cause closure of the valve 59 and to effect a passage of oil downwardly into the interrupting chamber 57 where the interruption of the arc 65 takes place in a manner as previously described. It is to be observed that during the interruption of low currents the pressure-generating arc 39 remains with its terminals positioned on the contacts 22 and 41 and does not transfer to the arcing horns 26

and 54. It is only during the interruption of high currents that lateral motion of the arc 39 onto the arcing horns 26 and 54 takes place.

The valve 59 is provided to be sure that oil displaced out of the piston chamber 42 will go into the interrupting chamber 57 and will not circulate back into the pressure-generating chamber 28.

It will be apparent that the downward speed of the intermediate contact 41 will be about the same both during the interruption of high currents as during the interruption of low currents because of the approximate balance of pressure on the two sides of the contact 41. Following interruption of the circuit through the interrupter, the movable contact 17 moves downwardly out of the unit 12 to provide an isolating gap in the circuit. The check valve 27 opens to permit accumulated gas within the pressure-generating chamber 28 to pass therethrough and out of the unit 12 through a vent 74 provided in the contact foot 10. As a result, fresh oil of high dielectric strength is thereby permitted to enter the unit 12 in preparation for the next opening operation. During the closing operation, the movable contact 17 moves upwardly to pick up the bumper 46 raising the intermediate contact 41 so that engagement is made between the contacts 22 and 41, and between the contacts 17 and 49 to re-establish the electrical circuit through the interrupter.

Fig. 11 shows a modified type arc-extinguishing unit 77 of slightly different construction. A modified type of intermediate contact 78 is employed having a pin 79 passing therethrough and having a flange 80 integrally formed at its lower end. A compression spring 81 is disposed between the bottom plate 82 of the unit 77 and the flange 80. The intermediate contact 78 makes sliding electrical connection with a contact 83, the latter being electrically connected by a conductor 84 to a conducting plate 85 which supports the stationary contact 49. Surrounding the intermediate contact 78 is an insulating cylindrical piston member 86 having a flange 87 integrally formed at its lower end. A compression spring 88 is disposed about the piston member 86 and has its lower seat on the flange 87; consequently, the spring 88 biases the piston member 86 into the piston chamber 42. At the upper end of the piston member 86 are disposed a plurality of annular corrugations 89.

The pressure-generating chamber 28 is formed by a plurality of insulating plates 90 having a configuration more clearly shown in Fig. 13. Each plate 90 has apertures 32 formed therein to accommodate the tie rods 29 and also has an enlarged cutout portion 91. The cutout portions 91 of the several plates 90 align to form the pressure-generating chamber 28 in which the pressure-generating arc 39 is established between the stationary contact 22 and the intermediate contact 78.

The pressure generated at the pressure-generating arc 39 forces oil out of the pressure-generating chamber 28 through the passage 56 through the valve 59 (during high current interruption) and downwardly into the interrupting chamber 57.

In this embodiment of our invention, the interrupting chamber 57 is formed by a plurality of insulating plates having a configuration more clearly shown in Fig. 14. The plates are of four different types. The first type is designated by the reference numeral 92 and is clearly shown by the full lines in Fig. 14. The plate 92 has a cutout portion 93 which forms a plurality of pockets 94. The plate 92 also has a vent passage

95. The second type of plate used in the interrupting chamber 57 of Fig. 11 is identical to the plate 92 previously described but it is inverted so that the vent passage 95 is positioned on the opposite side of the intermediate contact 78. This plate may be designated by the reference numeral 96.

A third type of plate is designated by the reference numeral 97 and has a cutout portion 98 which communicates with a widened portion 99, the latter also, in turn, communicating with a restricted portion 100, as more clearly shown in Fig. 14. The fourth type of plate is designated by the reference numeral 101 and has a configuration substantially the same as the configuration of the insulating plate 92 with the exception that the vent passage 95 is omitted.

The foregoing insulating plates are stacked to form the interrupting chamber 57 in Fig. 11 in the following order: plate 97, plate 96, plate 97, two plates 101, plate 97, plate 92, plate 97, two plates 101, plate 97, plate 96, plate 97, two plates 101 and finally bottom insulating plate 92. All of the foregoing plates have apertures 32 provided therein to accommodate the tie rods 29. Also, all of the above-mentioned plates have apertures 102 which align to form a passage through which slidably moves the intermediate contact 78.

The operation of this embodiment of our invention will now be explained. In the closed circuit position of the interrupter, the electrical circuit therethrough comprises terminal stud 8, contact foot 10, bolt 20, housing 21, bolt 20, conducting plate 25, stationary contact 22, intermediate contact 78, contact 33, conductor 34, conducting plate 35, stationary contact 49, movable contact 17 through the conducting bridging member 15 through the other arc-extinguishing unit 77 in like manner to the other terminal stud 7. During the interruption of high amperage currents, the pressure-generating arc 39 forms sufficient pressure within the pressure-generating chamber 28 to open the valve 59 and to force oil downwardly into the interrupting chamber 57, in which the oil flow biases the interrupting arc 65 toward the left in the direction of the vents 95. During relatively high instantaneous values of arcing current, that is, during the peak of the alternating-current wave, the cross-sectional area of the interrupting arc 65 is too large to permit the oil flow to carry it toward the left into the restricted portions 100 provided in the insulating plates 97. It is only during relatively low instantaneous values of arcing current, that is, near a current zero, when the cross-sectional area of the interrupting arc 65 is sufficiently small to permit the oil flow to carry it toward the left into the restricted portions 100. When this occurs, the interrupting arc 65 engages fresh oil disposed in the pockets 94 and is subjected to a deionizing blast of oil as the oil passes out of the interrupting chamber 57 through the vents 95. Extinction soon follows, and the electrical circuit through the unit 77 is interrupted.

During the interruption of low amperage currents, the pressure generated within the pressure-generating chamber 28 is not sufficient to provide an adequate oil flow to effect a rapid extinction of the interrupting arc 65. In this event, the cylindrical piston member 86, moving downwardly independently of the intermediate contact 78, moves into the piston chamber 42 under the biasing action of the compression spring 38 to displace oil therefrom, which oil flows through the passage 55 to close the valve 49 and to pass downwardly

into the interrupting chamber 57 where extinction of the interrupting arc 65 takes place in a manner as previously described.

It will be observed that in this embodiment of our invention, the downward motion of the intermediate contact 78 is not impeded by the piston 86, and consequently the pressure-generating arc 39 is very rapidly drawn. During the closing operation, the bumper 19 picks up the intermediate contact 78 to raise the pin 79 which engages the cylindrical piston member 86 to cause the charging of the latter. It will be observed that the annular corrugations 89 provided on the inner wall of the piston member 86 retains a plentiful supply of oil adjacent to the pressure-generating arc 39 as the latter is quickly lengthened by the rapid downward movement of the intermediate contact 78. Consequently, considerable interrupting ability is provided at the pressure-generating arc 39 by the provision of the annular corrugations 89.

Fig. 12 shows a modified type of arc-extinguishing unit generally designated by the reference numeral 105. In this embodiment of our invention, the pressure-generating arc 39 is established between a pivotally mounted pressure-generating contact 106, the latter being pivoted at 107 to a bifurcated bracket 108 secured by bolts 109 to the contact foot 10 of the unit 105, and the intermediate contact 110. The left-hand end of the contact 106 is bifurcated at 111 and has slots 112 disposed therein through which passes a pin 113 carried by an insulating operating rod 114 biased downwardly by a compression spring 115. The compression spring 115 has its upper seat in a recess 116 formed in the contact foot 10.

The operating rod 114 is engaged by a bumper 19 secured to the bridging member 15 and having a resilient dashpot arrangement, generally designated by the reference numeral 118, to provide the requisite contact pressure between the contacts 106, 110 and also between the contacts 110 and 17. In other words, the compression spring 119 associated with the dashpot 118 provides the requisite contact pressure for the several contacts.

The pressure-generating chamber 28 is formed by the abutting relation of three types of insulating plates. The first type is designated by the reference numeral 121 and is more clearly shown by the full lines in Fig. 15. The second type of plate is herein called a magnetic insert plate 122 and is also shown by the full lines in Fig. 15. Inserted in the insert plate 122 is a U-shaped member 123 composed of a suitable magnetic material, such as iron. On either side of each insert plate 122 is an insulating guard plate 124 and having a configuration identical to the configuration of the magnetic insert plate 122 with the exception that no magnetic insert 123 is employed. Again the function of the insulating guard plates 124 is to protect the insert 123 from the effect of the pressure-generating arc 39 as it is magnetically moved laterally within the pressure-generating chamber 28 and to form substantially V-shaped restricting means 34a.

Preferably an arcing horn 125 is associated with the intermediate contact 110 to facilitate the rightward movement of the arc 39. A passage 126 interconnects the pressure-generating chamber 28 with the interrupting chamber 57 of the unit 105.

The upper portion of the interrupting chamber 57 is formed by three different types of plates. The first type is herein called an insulating vent

plate 127 and is more clearly shown by the full lines in Fig. 16. The vent plate 127 has an enlarged cutout portion 128 which vents at 129 to the region exterior of the unit 105. The second type of plate is designated by the reference numeral 130 and has an enlarged cutout portion 131 which communicates with a restricted portion 132, the latter, in turn, communicating with a slightly enlarged region 133. The third type of plate is herein called an insulating pocket plate 134 and is shown by the dotted lines in Fig. 16. The pocket plate 134 has an enlarged cutout portion 135 which provides a plurality of pockets 136.

The plates are positioned in the upper portion of the interrupting chamber 57 so that two pocket plates 134 are positioned between two plates 130. The vent plates 127 are positioned between adjacent insulating plates 130.

The lower portion of the interrupting chamber 57 is formed by three types of insulating plates more clearly shown in Figs. 17 and 18. The first type of plate 137 is herein called a magnetic insert plate and is more clearly shown in Fig. 18. This plate has a concave portion 138 to accommodate the operating rod 114 and the dashpot 118. This plate also has a magnetic insert 139 positioned therein. Otherwise, this plate has a configuration identical to that of plate 130 previously described. Immediately above and below each insert plate 137 is an insulating guard plate 140 having a configuration identical to the insert plate 137. Separating adjacent groups of insert and guard plates 137 and 140 are pocket insulating plates 141 having a configuration identical to the pocket plates 134 previously described with the exception that the plates 141 have the concave portion 138 removed therefrom. The pocket plates 141 are more clearly shown by the full lines of Fig. 17.

The operation of this embodiment of our invention will now be explained. In the closed circuit position of the interrupter, the electrical circuit therethrough comprises contact foot 10, bracket 108, pin 107, contact 106, intermediate contact 110, and lower movable contact 17. During the opening operation, the bumper 19 and the movable contact 17 move downwardly, thereby permitting the compression spring 115 to force the operating rod 114 downwardly, pivoting the contact 106 in a counterclockwise direction about the pivot 107, thus separating the contact 106 from the intermediate contact 110 to establish a pressure-generating arc 39. Substantially at the same time that separation of the contacts 106 and 110 takes place, the movable contact 17 separates from the contact 110 to draw an interrupting arc 65. The reaction of the magnetic inserts 123 on the pressure-generating arc 39 biases the pressure-generating arc 39 toward the right into the restriction 142 provided by the plates 122 and 124. As a result, considerable interrupting ability is possessed by the pressure-generating chamber 28, the arcing horn 125 facilitating the lateral motion of the arc 39. The pressure generated at the pressure-generating arc 39 forces oil to flow in the direction indicated by the arrows in Fig. 12 to carry the interrupting arc 65 toward the vents 129. Not only is the interrupting arc 65 biased toward the vents 129 by the oil flow passing through the passage 126, but also the magnetic inserts 139 bias the interrupting arc 65 to the right. As a result, the arc 65 moves very rapidly to the right having its upper terminal moving along the arcing horn 143 and having its lower terminal run down the side 144 of the movable contact 17. The net result is that the arc 65 lengthens at a far greater speed

during low instantaneous values of arcing current than the speed of separation of the contacts 17 and 110. The relatively short gap then existing between the contacts 17 and 110 is then scavenged by the oil flow moving through the passage 126.

Figs. 19 and 20 illustrate a further embodiment of our invention which is similar to that disclosed in Fig. 11, except that the interrupting chamber 145 is modified to incorporate improved interrupting characteristics as set forth in a patent application by Leon R. Ludwig, Winthrop M. Leeds and Benjamin P. Baker filed November 11, 1942, Serial No. 465,244, now U. S. Patent 2,406,469, issued August 27, 1946, and assigned to the assignee of the instant application. This patent also covers some other features of our improved constructions.

More specifically, the interrupting chamber 145 comprises a plurality of suitably formed insulated plates which are of four different types. The first type is designated by the reference numeral 146 and is herein designated as an orifice plate. This plate has a cutout portion 147 provided therein, as shown more clearly in Fig. 20, and a second opening 148 provided therein which relatively closely surrounds the lower contact 17. Between adjacently positioned orifice plates 146 are vent plates generally designated by the reference numeral 149 which comprise two plates 150, 150a disposed in the same horizontal plane and illustrated more clearly in Fig. 20.

Between the two vent plates 149 are disposed inlet plates designated by the reference numeral 151 and having a configuration more clearly shown in Fig. 20, wherein the cutout portion 147 communicates with an enlarged inlet portion 152. Adjacent the lower end of the modified interrupting structure are a plurality of plates which form recesses 153 adjacent the vertical path of movement of the movable contact 17.

The operation of this embodiment of our invention is the same as that previously described in connection with Fig. 11, except that in the interrupting chamber 146, the fluid passes inwardly toward the interrupting arc 65 through the inlet portions 152 after having passed downwardly through the passage 56 and through the valve 59. After the inwardly flowing fluid has struck the interrupting arc 65, it passes through the openings 148 provided by the orifice plates 146 in intimate contact with the interrupting arc 65 to exhaust out of the arc extinguishing unit through the vents 154 as indicated by the arrows 155 in Fig. 20.

The interrupting structure 145 has been found to give excellent interrupting ability with very low dissipation of arc energy and a corresponding low arc voltage.

Certain broad features of our invention are described and broadly claimed in a patent application filed September 18, 1942, Serial No. 458,778, by Winthrop M. Leeds and Benjamin P. Baker, now United States Patent 2,372,589, issued March 27, 1945, and a patent application filed January 9, 1943, Serial No. 471,847, now U. S. Patent 2,412,857, issued December 17, 1946, by Benjamin P. Baker, all of the foregoing applications being assigned to the assignee of the instant application.

From the above disclosure, it will be apparent that we have provided an improved circuit interrupter which utilizes the pressure created at a pressure-generating arc to effect the extinction of the interrupting arc during relatively high amperage currents, and which utilizes a novel

piston arrangement to effect the extinction of the interrupting arc during the interrupting of low currents when the pressure generated at the pressure-generating arc is not sufficient to provide an adequate oil flow. The piston may be an integral portion of the intermediate contact, or it may be independently movable therefrom to enable the pressure-generating arc to be more rapidly lengthened. We have also disclosed how the pressure-generating arc may be magnetically moved laterally to not only increase the pressure formed thereat, but also to increase the interrupting ability in the pressure-generating chamber.

Although we have shown and described specific structures, it is to be clearly understood that the same are merely for the purpose of illustration, and that changes and modifications may readily be made by those skilled in the art without departing from the spirit and scope of the appended claims.

We claim as our invention:

1. In a circuit interrupter, an arc-extinguishing unit, a substantially enclosed first chamber disposed adjacent one end of the unit, a piston chamber disposed intermediate the ends of the unit, an interrupting chamber disposed adjacent the other end of the unit, means comprising an intermediate contact for establishing a pressure-generating arc within the first chamber, means for establishing an interrupting arc within the interrupting chamber, and piston means associated with the intermediate contact and movable into the piston chamber during the opening operation of the interrupter, the piston means being charged by closing movement of the intermediate contact but independently movable therefrom during the opening operation of the interrupter.

2. In a circuit interrupter, an arc-extinguishing unit, a substantially enclosed first chamber disposed adjacent one end of the unit, a piston chamber disposed intermediate the ends of the unit, an interrupting chamber disposed adjacent the other end of the unit, means comprising an intermediate contact for establishing a pressure-generating arc within the first chamber, means for establishing an interrupting arc within the interrupting chamber, and piston means associated with the intermediate contact and movable into the piston chamber during the opening operation of the interrupter, first passage means interconnecting the first chamber and the interrupting chamber and bypassing the piston chamber, and second passage means interconnecting the piston chamber and the interrupting chamber.

3. In a circuit interrupter, an arc-extinguishing unit, a substantially enclosed first chamber disposed adjacent one end of the unit, a piston chamber disposed intermediate the ends of the unit, an interrupting chamber disposed adjacent the other end of the unit, means comprising an intermediate contact for establishing a pressure-generating arc within the first chamber, means for establishing an interrupting arc within the interrupting chamber, piston means associated with the intermediate contact and movable into the piston chamber during the opening operation of the interrupter, first passage means interconnecting the first chamber and the interrupting chamber and bypassing the piston chamber, second passage means interconnecting the piston chamber and the interrupting chamber, and valve means disposed in the first passage means.

4. In a circuit interrupter, an arc-extinguishing unit, a pressure-generating chamber disposed adjacent one end of the unit, substantially V-shaped restricting means disposed within the pressure-generating chamber, an interrupting chamber disposed adjacent the other end of the unit, means comprising a pivotally operable movable contact cooperable with an intermediate contact to establish a pressure-generating arc within the pressure-generating chamber, a movable contact cooperable with the intermediate contact to establish an interrupting arc within the interrupting chamber, and means for magnetically moving the pressure-generating arc laterally into the restricting means to increase the pressure formed thereat.

5. In a circuit interrupter, an arc-extinguishing unit, a substantially enclosed first chamber disposed adjacent one end of the unit, a piston chamber disposed intermediate the ends of the unit, an interrupting chamber disposed adjacent the other end of the unit, means comprising an intermediate contact for establishing a pressure-generating arc within the first chamber, means for establishing an interrupting arc within the interrupting chamber, and piston means comprising an independently movable cylinder surrounding the intermediate contact and movable into the piston chamber during the opening operation of the interrupter, the cylinder having one or more annular corrugations to be moved adjacent the pressure-generating arc.

6. In a circuit interrupter of the liquid break type, an arc extinguishing unit, a pressure-generating chamber disposed adjacent one end of the unit, a piston chamber positioned intermediate the ends of the unit, an interrupting chamber disposed adjacent the other end of the unit, a relatively stationary pressure-generating contact disposed adjacent the said one end of the unit within the pressure-generating chamber, a relatively stationary interrupting contact disposed intermediate the ends of the unit within the interrupting chamber, two movable contacts movable in the same direction and substantially simultaneously separable from the two relatively stationary contacts to establish a pressure-generating arc within the pressure-generating chamber and an interrupting arc within the interrupting chamber, at least a portion of the movable contact separable from the relatively stationary pressure-generating contact acting as a piston by moving into the piston chamber, and passage means connecting the piston chamber with the interrupting chamber, and other passage means bypassing the piston chamber and connecting the pressure-generating chamber with the interrupting chamber.

7. In a circuit interrupter of the liquid break type, an arc extinguishing unit, a pressure-generating chamber disposed adjacent one end of the unit, a piston chamber positioned intermediate the ends of the unit, an interrupting chamber disposed adjacent the other end of the unit, a relatively stationary pressure-generating contact disposed adjacent the said one end of the unit within the pressure-generating chamber, a relatively stationary interrupting contact disposed intermediate the ends of the unit within the interrupting chamber, two movable contacts movable in the same direction and substantially simultaneously separable from the two relatively stationary contacts to establish a pressure-generating arc within the pressure-generating chamber and an interrupting arc within the interrupt-

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ing chamber, at least a portion of the movable contact separable from the relatively stationary pressure-generating contact acting as a piston by moving into the piston chamber, passage means connecting the piston chamber with the interrupting chamber, other passage means bypassing the piston chamber and connecting the pressure-generating chamber with the interrupting chamber, and valve means positioned within the said other passage means to prevent circulation of liquid back into the pressure-generating chamber during low current interruption.

8. A circuit interrupter including an arc-extinguishing unit, means defining a pressure-generating chamber disposed adjacent one end of the unit, substantially V-shaped restricting means disposed within the pressure-generating chamber, means defining an interrupting chamber disposed adjacent the other end of the unit, means establishing a pressure-generating arc within the pressure-generating chamber, means establishing an interrupting arc within the interrupting chamber, and means for magnetically moving the pressure-generating arc laterally into the restricting means to increase the pressure formed thereat.

9. A circuit interrupter including an arc-extinguishing unit, a substantially enclosed first chamber disposed adjacent one end of the unit, a piston chamber disposed intermediate the ends of the unit, an interrupting chamber disposed adjacent the other end of the unit, means comprising an intermediate contact for establishing a pressure-generating arc within the first chamber, means establishing an interrupting arc within the interrupting chamber, piston means associated with the intermediate contact and movable into the piston chamber during the opening operation of the interrupter, first passage means interconnecting the first chamber and the interrupting chamber and by-passing the piston chamber, second passage means interconnecting the piston chamber and the interrupting chamber, and means for magnetically moving the pressure-generating arc laterally to increase the pressure formed thereat.

10. A circuit interrupter including an arc-extinguishing unit, a substantially enclosed first chamber disposed adjacent one end of the unit, a piston chamber disposed intermediate the ends

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of the unit, an interrupting chamber disposed adjacent the other end of the unit, means comprising an intermediate contact for establishing a pressure-generating arc within the first chamber, means for establishing an interrupting arc within the interrupting chamber, piston means associated with the intermediate contact and including an independently movable cylinder surrounding the intermediate contact and movable within the piston chamber during the opening operation of the interrupter, first passage means interconnecting the first chamber and the interrupting chamber and by-passing the piston chamber, and second passage means interconnecting the piston chamber and the interrupting chamber.

11. A circuit interrupter including an arc-extinguishing unit, means defining a pressure-generating chamber disposed adjacent one end of the unit, substantially V-shaped restricting means disposed within the pressure-generating chamber, one or more vent passages disposed along the substantially V-shaped restricting means, means defining an interrupting chamber disposed adjacent the other end of the unit, means establishing a pressure-generating arc within the pressure-generating chamber, means establishing an interrupting arc within the interrupting chamber, means for magnetically moving the pressure-generating arc laterally into the restricting means to increase the pressure formed thereat, and fluid passage means interconnecting the pressure-generating and interrupting chambers and including said one or more vent passages.

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