

July 6, 1943.

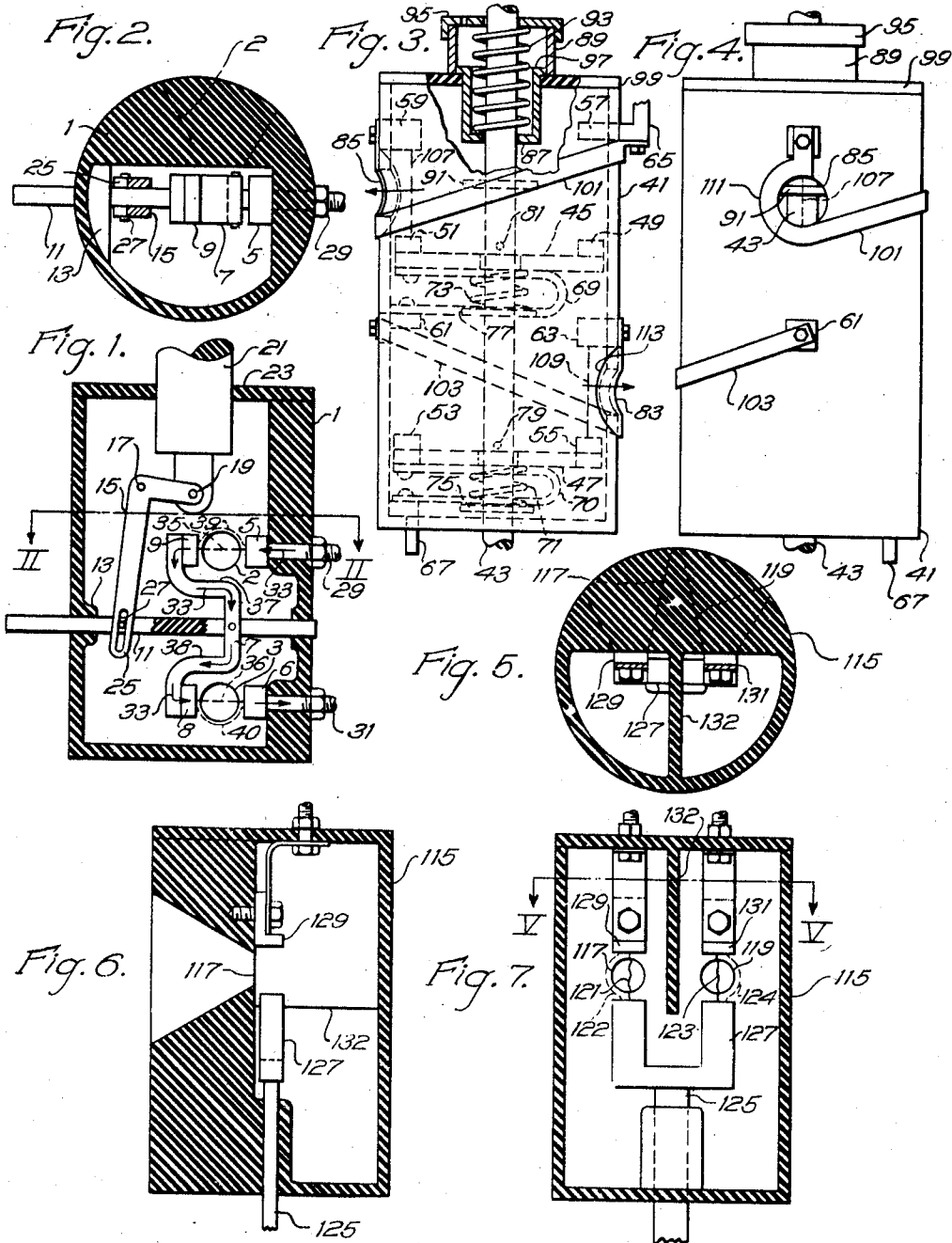
B. P. BAKER

2,323,642

CIRCUIT INTERRUPTER

Filed March 31, 1942

2 Sheets-Sheet 1



WITNESSES:

Robert C. Baird
Willard R. Croust

INVENTOR

Benjamin F. Baker
BY *Ralph H. Swingle*
ATTORNEY

July 6, 1943.

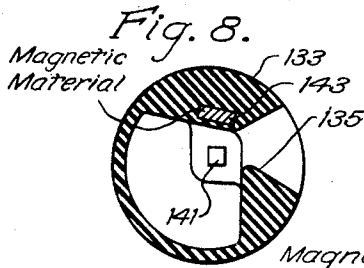
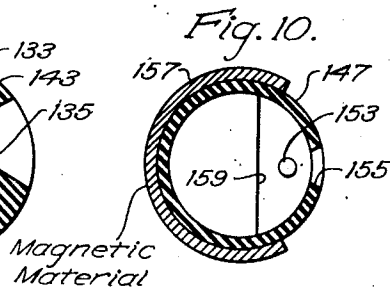
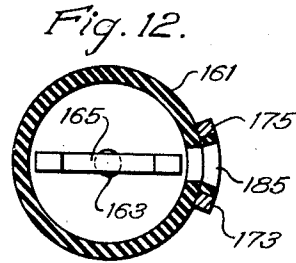
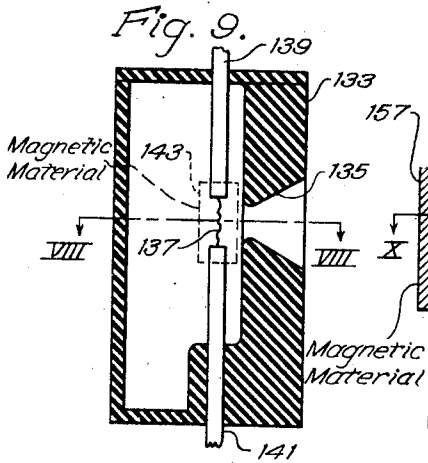
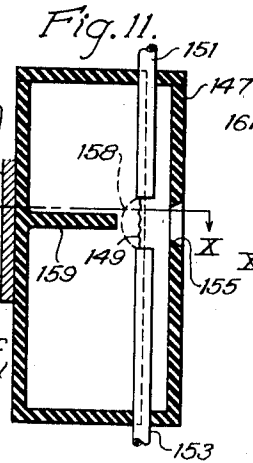
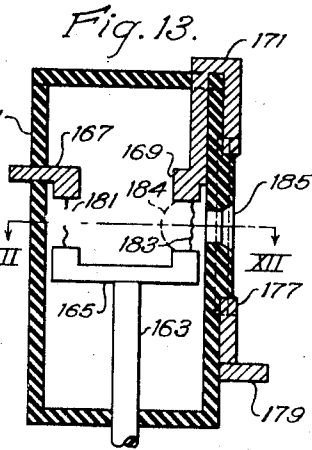
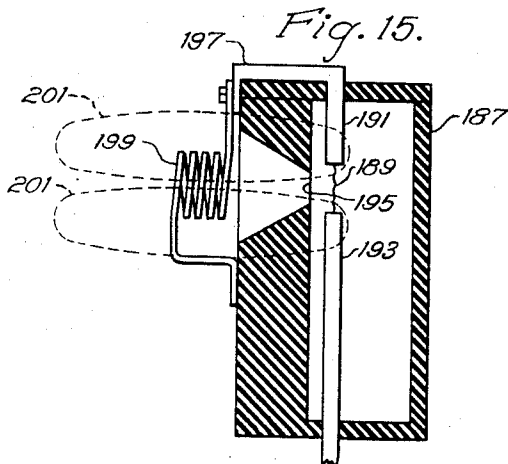
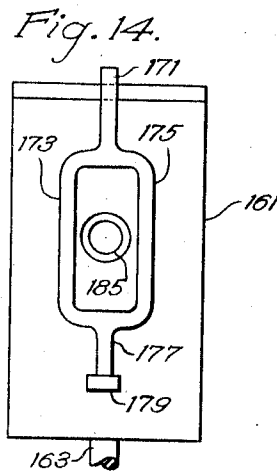
B. P. BAKER

2,323,642

CIRCUIT INTERRUPTER

Filed March 31, 1942

2 Sheets-Sheet 2



WITNESSES:

Robert C. Baird
Willard R. Croft

INVENTOR

Benjamin P. Baker.
BY *Ralph H. Swingle*
ATTORNEY

UNITED STATES PATENT OFFICE

2,323,642

CIRCUIT INTERRUPTER

Benjamin P. Baker, Turtle Creek, Pa., assignor
to Westinghouse Electric & Manufacturing
Company, East Pittsburgh, Pa., a corporation
of Pennsylvania

Application March 31, 1942, Serial No. 437,001

24 Claims. (Cl. 200—150)

This invention relates in general to circuit breakers, and, more particularly, to circuit breakers of the type wherein the arc to be interrupted is drawn adjacent a vent or port in the wall of a substantially closed arcing chamber filled with a suitable arc extinguishing fluid. The arc is interrupted by a substantially transverse cross-blast of arc extinguishing fluid through the arc stream and out of the arcing chamber through said port or vent in the wall of the arcing chamber.

The broader aspects of the present invention are set forth and broadly claimed in my copending application Serial No. 435,380, filed March 19, 1942, now Patent 2,303,524, issued December 1, 1942, entitled Circuit interrupters, and assigned to the assignee of this application.

It is well known that two conductors carrying current in opposite directions and disposed adjacent one another will tend to repel each other. I use this well known principle in controlling the position of the arc in circuit breakers of the foregoing type as a function of the instantaneous arcing current. Thus during relatively high instantaneous values of current I move the arc to one side, or directly away, from the port, adjacent to which it is drawn, to permit a comparatively free venting of the arc extinguishing fluid under pressure through said port and out of the arcing chamber. During relatively low instantaneous values of current at a time suitable for arc interruption I permit the arc to return to the place where it was initially drawn, that is, directly in front of the port. Here it is blasted by a substantially transverse flow of arc extinguishing fluid to cause its extinction.

I control the position of the arc and the movement thereof with respect to said vent by the disturbance of the magnetic field surrounding said arc. I may do this in a number of ways. First, a series conductor in the electrical circuit passing through the interrupter may be disposed near to the point of drawing the arc, and the interaction of the magnetic fields set up surrounding said arc and said series conductor may be such as to force the arc away from the vent in the arc extinguishing chamber during high instantaneous values of arcing current, the effect of low values of instantaneous current being to diminish the strength of the magnetic fields surrounding said arc and said series conductor and hence to result in the arc being permitted to return to the position where it was initially drawn.

I may also draw two series arcs adjacent one

another, the interaction of the magnetic fields surrounding said series arcs being such to move each of said series arcs away from the vent in a wall of the arc extinguishing chamber adjacent to which it is drawn.

Or I may draw a single arc and dispose adjacent thereto a sheet of magnetic material, the effect of the magnetic material being to attract the arc and hence to displace the position of the same. Instead of providing a single sheet of magnetic material I may provide a piece of magnetic material substantially surrounding the arcing chamber and moving the arc to a new position directly away from the vent adjacent to which it is drawn.

I may also use a series coil in the interrupter circuit so disposed that the magnetic field resulting therefrom will be such as to move the arc laterally to one side of, or directly away from, a vent provided in a wall of the arc extinguishing chamber. Or I may use an arc extinguishing chamber in which two series arcs are drawn, and one or more series conductors disposed adjacent to one of said arcs to effect the movement of the same.

In all of the previously mentioned embodiments of my invention it will be apparent that maximum interaction of the magnetic fields will take place during the peak of the current wave, the effect of low instantaneous values of current being such as to diminish the strength of the magnetic fields set up about the arcs or conductors, and hence to permit the arc to be moved back to the position where it was initially drawn.

In many of the interrupters now on the market the method of arc extinction is to draw an arc adjacent a vent disposed in a wall of a suitable arc extinguishing chamber within which is disposed a suitable arc extinguishing fluid. When circuit interruption is desired, pressure is produced by some suitable means within the arc extinguishing chamber and an arc is drawn adjacent a vent or aperture in the wall of said chamber to receive a cross blast of arc extinguishing fluid which traverses the arc stream substantially perpendicular thereof and passes through the vent or aperture out of the chamber.

This method of arc extinction produces high internal pressure within the arcing chamber because regardless of the instantaneous value of arcing current arc extinguishing fluid is blasted through the arc stream and out of the chamber to effect the extinction of the arc. By blasting a stream of arc extinguishing fluid through the arc stream and substantially perpendicularly

thereto regardless of the value of instantaneous arcing current, the arc voltage increases unnecessarily and the amount of gas generation is high. The internal pressure within the arcing chamber is correspondingly high.

In the method of arc extinction which I use in my invention I provide a cross-blast of arc extinguishing fluid through the arc stream at or near a current zero in the current wave. During relatively high values of instantaneous arcing current I move the arc stream laterally to one side of the vent or aperture in the casing of the arc chamber, or I may move the arc directly away from the vent or aperture to permit a relatively free flowing of arc extinguishing fluid out through the vent during high instantaneous values of arcing current without disturbing the continuity of the arc stream, and consequently producing little increase in arc voltage and little generation of gas. When, however, the instantaneous value of arcing current is relatively low, the arc is permitted to move back to the position where it was initially drawn or near the vent and splitters which may form the interrupting element and in this position it receives the full effect of a cross-blast of arc extinguishing fluid through the arc stream and out through the vent from the arcing chamber.

In this latter method of arc extinction by disturbing the continuity of the arc as little as possible during high instantaneous values of arcing current interrupting performance is improved by lower arc voltage and a lower amount of gas generation. When the instantaneous value of arcing current falls to a relatively low value, and at this time when the conditions are ripe for arc extinction, the arc stream is moved directly in front of the vent at the position where it was initially drawn and arc extinction is effected at or near a current zero.

It is a general object of the present invention to provide a circuit interrupter which operates in accordance with the principles outlined in the aforementioned method of arc extinction.

It is also an object of the present invention to provide an interrupter in which the arc to be interrupted is moved in accordance with the value of the instantaneous arcing current.

It is also an object of my invention to provide an interrupter in which a varying field of flow of arc extinguishing fluid is provided, and in which means are provided to move the arc to be interrupted during high instantaneous values of arcing current from a point of high velocity of flow to a point of low velocity of flow, and upon the return of low instantaneous values of arcing current to permit a return of the arc to a position of high velocity of fluid flow.

It is also an object of the present invention to provide a circuit interrupter in which a flow of arc extinguishing fluid is produced and to vary said flow with respect to an arc to be interrupted as a function of the instantaneous value of arcing current.

Another object is to provide a circuit interrupter with a substantially closed arcing chamber, said chamber containing a vent across which an arc to be interrupted is drawn, means for producing a flow of fluid through said vent, and means for moving said arc during high instantaneous values of arcing current to one side of said vent where the flow of fluid is relatively small.

Another object is to provide a circuit interrupter in which a varying field of flow of arc

extinguishing fluid is produced and to move the arc to be interrupted during high instantaneous values of arcing current to a point of low fluid velocity by placing magnetic material adjacent the arc path.

A specific object of the present invention is to utilize the magnetic field set up by either a series arc or one or more series conductors in the interrupting circuit to effect this movement of the arc with respect to the vent adjacent to which it is drawn.

Another object is to provide an interrupter in which one or more series arcs are drawn, one of said series arcs being utilized to provide the necessary pressure within the arcing chamber and the other of said series arcs being moved by any of the means mentioned above.

Another object of the present invention is to disturb the magnetic field surrounding an arc and consequently to displace the position of the arc stream substantially only during relatively high instantaneous values of arcing current.

Many more objects of the present invention will be readily ascertainable by a reading of the following description concerning several embodiments of the present invention.

Figure 1 is an elevational view, partially in section, of a circuit interrupter constructed in accordance with the principles of my invention and shown in the partly open circuit position;

Fig. 2 is a transverse cross-sectional view of the interrupter shown in Fig. 1 taken substantially on the lines II—II of Fig. 1 and looking in the direction of the arrows;

Fig. 3 is an elevational view of a modified type of circuit interrupter, partially in section, and constructed in accordance with my invention;

Fig. 4 is an elevational view of the circuit interrupter shown in Fig. 3 taken substantially at right angles to the circuit interrupter shown in Fig. 3;

Fig. 5 is a transverse cross-sectional view of a modified type of circuit interrupter illustrated in Fig. 7, taken along the line V—V of Fig. 7 looking in the direction of the arrows;

Fig. 6 is an elevational view, partially in section, of the modified type of circuit interrupter shown in Fig. 7 and taken at substantially right angles to the interrupter shown in Fig. 7;

Fig. 7 is an elevational view, partially in section, of a modified type of circuit interrupter;

Fig. 8 is a transverse cross-sectional view of a modified type of circuit interrupter shown in Fig. 9 taken along the line VIII—VIII of Fig. 9 and looking in the direction of the arrows;

Fig. 9 is an elevational view, partially in section, of a modified type of circuit interrupter;

Fig. 10 is a transverse cross-sectional view of the modified form of interrupter shown in Fig. 11, taken substantially on the line X—X of Fig. 11 and looking in the direction of the arrows;

Fig. 11 is a side elevational view, partially in section, of a modified form of interrupter;

Fig. 12 is a transverse cross-sectional view of the modified form of circuit interrupter illustrated in Fig. 13, taken substantially along the line XII—XII of Fig. 13 and looking in the direction of the arrows;

Fig. 13 is an elevational view, partially in section, of still another embodiment of the present invention;

Fig. 14 is a side elevational view taken at right angles to the view in Fig. 13; and

Fig. 15 is a side elevational view, partially in

section, of still another embodiment of the present invention.

Referring particularly to Fig. 1, the reference numeral 1 designates an insulating casing provided with two flared apertures or vents 2, 3 bored in the wall of said casing. A relatively movable contact structure provided in the interior of said casing 1 comprises two stationary contacts 5, 6 and a conducting bridging bar 7, at the ends of which are the two movable contacts 8, 9. The bridging bar 7 is actuated by an insulating operating rod 11, which is guided through an extension 13 of the wall of the casing 1. A bell crank 15 pivoted at 17 to the wall of the casing 1, is pivotally connected at one end 19 to a piston-shaped operating rod 21, which projects through the top 23 of the casing 1. The other end of the bell crank 15 contains a slot 25 which cooperates with a pin 27 rigidly secured to the operating rod 11.

It will be apparent that downward motion of the piston-shaped operating rod 21 will cause a clockwise rotation of the bell crank 15 about the pivot point 17 to actuate the insulating operating rod 11 to the left, as viewed in Fig. 1, to separate the respective movable contacts 8, 9 from the stationary contacts 6, 5. It is also apparent that the electrical circuit through the interrupter consists of the external line terminal 29, the upper stationary contact 5, the upper movable contact 9, the conducting bridging bar 7, the lower movable contact 8, the lower stationary contact 6 and the lower external line terminal 31.

The insulating casing 1 is immersed in a suitable arc extinguishing liquid, such as oil. It will be observed that when the insulating operating rod 11 is actuated to the left, as viewed in Fig. 1, two series arcs will be drawn in the interior of the casing 1 between the respective stationary contacts 5, 6 and the movable contacts 9, 8. These arcs will react upon the arc extinguishing liquid contained within the casing 1 to create pressure therein. At the same time that the series arcs are being drawn, piston-shaped operating rod 21, actuated by external means not shown, moving downward into the insulating casing 1 will displace arc extinguishing liquid to further increase the pressure of the liquid contained therein.

Assuming that the instantaneous current passing through the interrupter is in a direction indicated by the arrows 33, it will be apparent that the series arcs, the initial positions of which are indicated by the dotted lines 35, 36 have their own magnetic fields surrounding them, which fields interact with the magnetic fields set up around horizontal portions 37, 38 of the conducting bridging bar 7. The interaction of the respective magnetic fields set up about the arcs 35, 36, and about the horizontal portions 37, 38 of the conducting bridging bar 7 will be such as to force the arcs 35, 36 to the respective positions indicated by the dotted lines 39, 40.

Consequently, during high instantaneous values of current passing through the interrupter the arcs 35, 36 will be forced to respective positions 39, 40 to one side of the vents 2, 3. The fluid under pressure within the casing 1 may then freely pass out through the vents 2, 3 carrying with it the excess ionized gas surrounding the arc stream without substantially interfering with the displaced arcs 39, 40. When, however, the instantaneous value of current through the interrupter falls to a relatively low value, the mag-

netic fields surrounding the arcs 39, 40 and the horizontal portions 37, 38 of the conducting bridging bar 7 will diminish. The result of the diminution of the magnetic field strength will be to permit the arcs 39, 40 to return to their former positions 35, 36, at which positions the arcs will be subjected to a strong cross-blast of fluid transversely to the arc streams and out of the insulating casing 1 through the vents 2, 3.

Thus I have provided an interrupter in which two series arcs are drawn within an insulating casing 1. During high instantaneous values of arcing current the arcs are moved laterally to one side of the vents 2, 3 to permit a relatively free flowing of the fluid under pressure out of the casing 1 through the vents 2, 3. The pressure within the casing 1 is caused by the arcs themselves, and also by the downward movement of the piston-shaped operating rod 21 during a circuit opening operation of the interrupter. When the arcing current falls to a relatively low value in the alternating current wave the arcs will return to the position at which they were initially drawn, that is, to a position directly across the center of the vent holes 2, 3, where the arcs 35, 36 are blasted by a cross-blast of fluid through the vents 2, 3 to the region external to the insulating casing 1.

By the provision of such an interrupter, the arc is disturbed very little during high instantaneous values of arcing current, it being noted that interruption is not possible at times of high instantaneous values of arcing current. When, however, the arcing current falls to a relatively low instantaneous value and the arc is in a condition susceptible to interruption, the arc is returned to its cross-blast position at which time extinction is readily effected.

In the interrupter illustrated in Figs. 3 and 4 there is provided a cylindrically-shaped insulating casing 41, in which is disposed a centrally positioned insulating operating rod 43 adapted for longitudinal movement within the insulating casing 41 and supporting two conducting bridging members 45 and 47. At the ends of the conducting bridging members 45 and 47 are movable main contacts 49, 53 and movable arcing contacts 51, 55.

These movable contacts engage in the closed circuit position of the interrupter the respective stationary contacts 57, 61 and 59, 63. External line terminals 65 and 67 connect the breaker to an external circuit. In the closed circuit position of the interrupter the electrical circuit therethrough includes the external line terminal 65, the stationary main contact 57, the movable main contact 49, the conducting bridging member 45, a flexible conductor 69, the stationary main contact 61, the movable main contact 53, the conducting bridging member 47, flexible conductor 70 to lower external line terminal 67.

Encircling the insulating operating rod 43 are two compression springs 71 and 73. The compression springs 71 and 73 are disposed between washers 75 and 77, which are rigidly secured to the insulating operating rod 43, and the lower surfaces of the conducting bridging members 45 and 47. Pins 79 and 81 limit the upward motion of the conducting bridging members 45 and 47 with respect to the insulating operating rod 43.

There is a permissible pivoting of the conducting bridging members 45 and 47 about the pins 81 and 79 on the insulating operating rod 43. The purpose of the permissible pivoting motion of the conducting bridging members 45 and 47

about the pins 81 and 79 with respect to the insulating operating rod 43 is to open the main contacts 57—49, 61—53, before the opening of the arcing contacts 59—51, 63—55. By the placing of the main stationary contacts 57 and 61 slightly above the respective stationary arcing contacts 59, 63, the upward and closing motion of the insulating rod 43 will result in closing the arcing contacts 63—55, 59—51, before the closing of the main contacts 57—49, 61—53.

The pressure within the cylindrical insulating casing 41 is created by the arcs drawn therein. However, when low currents are being interrupted by the breaker the pressure provided by drawing series arcs in the liquid, in which the casing 41 is submerged, may not be sufficient to provide a sufficiently strong cross-blast of arc extinguishing fluid out through the vents 83, 85 provided in the walls of the casing 41. Because of this I have provided a piston 87, which is adapted for longitudinal motion within a piston casing 89 upon being engaged by a pin 91 rigidly secured to the insulating operating rod 43.

Consequently, when the breaker is closed, the insulating operating rod 43 moves upward to cause engagement of the pin 91 with the piston 87 to move the piston 87 upward within the piston casing 89 against the bias of a compression spring 93, the latter disposed between the upper side of the piston 87 and the lower side of a cover plate 95. Closing movement of the breaker hence moves the piston 87 upwards to store energy in the compression spring 93. During a circuit opening operation when the current being interrupted is low the piston 87 will be forced downward by the compression spring 93 to increase the pressure of the liquid within the insulating casing 41. If, on the other hand, the current being interrupted is high, the pressure within the insulating casing 41 created by the arcs may be sufficient to prevent downward motion of the piston 87. When, however, the pressure eventually subsides within the casing 41 after or during an interruption, the piston 87 will at this time move downward until the flange 97 engages the top surface of the top insulating plate 99 of the casing 41. A scavenging of the arcing region and a building up of dielectric is thereby obtained.

When it is desired to open the interrupter, or when external overload conditions exist in the electrical circuit connected to the breaker, suitable actuating mechanism, not shown, provides a downward movement of the insulating operating rod 43. The initial downward movement of the insulating operating rod 43 produces a separation between the main contacts 57—49, 61—53, due to the initial pivoting motion of the conducting bridging members 45, 47 about the pivot pins 81, 79 being created by the disposition of the stationary main contacts 57, 61 at a higher level than the stationary arcing contacts 59, 63.

After the separation of the main contacts 57—49, 61—53, the electrical circuit passing through the interrupter consists of the external line terminal 65, a stationary conductor 101 disposed adjacent the external surface of the casing 41 and connecting the external line terminal 65 with the stationary arcing contact 59, the arcing contact 59, movable arcing contact 51, conducting bridging member 45, flexible conductor 69, stationary main contact 61, a second stationary conductor 103 disposed adjacent the external surface of the casing 41 and connecting the stationary main contact 61 with the stationary arc-

ing contact 63, stationary arcing contact 63, movable arcing contact 55, conducting bridging member 47, flexible conductor 70 to external line terminal 67. At this point in the opening operation of the breaker no arcs have been formed.

Further downward motion of the insulating operating rod 43 separates the arcing contacts 59—51, 63—55. When this occurs two series arcs will be drawn respectively between stationary arcing contact 59, movable arcing contact 51, stationary arcing contact 63, movable arcing contact 55. The electrical circuit now through the interrupter will be as follows: external line terminal 65, stationary conductor 101, stationary arcing contact 59, arc 107, movable arcing contact 51, conducting bridging member 45, flexible conductor 69, stationary main contact 61, stationary conductor 103, stationary arcing contact 63, arc 109, movable arcing contact 55, conducting bridging member 47, flexible conductor 70, and external line terminal 67.

Referring particularly to Fig. 4 it will be observed that the stationary conductor 101 encircles the vent hole 85, and referring to the lower portion of Fig. 3 it will be apparent that the stationary conductor 103 also encircles the vent hole 83. The interaction during high instantaneous values of arcing current between the magnetic fields set up by the respective arcs 107, 109 and the portions 111, 113 of stationary conductors 101 and 103 is such as to produce a lateral movement of the arcs 107, 109, to one side of the respective vent holes 85, 83. Thus the pressure formed within the casing 41 by the piston 87 and by the arcs 107, 109 forces the liquid freely out through the vent holes 83, 85 during high instantaneous values of current without substantially disturbing the continuity of the arcs, which at this time are displaced to one side of the vent holes 85, 83. When, however, the instantaneous value of arcing current decreases, the arcs 107, 109 are returned to the position where they were initially drawn, that is, directly in front of the vent holes 85, 83, to receive a transverse cross-blast of arc extinguishing liquid through the arc stream and out of the vent holes 85, 83 to effect the extinction of the arc.

In the embodiment of my invention shown in Figs. 5, 6 and 7 the reference numeral 115 designates an insulating casing suitably shaped so as to provide two flared vent holes 117, 119, across the inner ends of which are drawn two serially related arcs 121, 123 produced by downward movement of the insulating operating rod 125 and hence a moving of the conducting bridging member 127 away from the upper stationary contacts 129, 131. An insulating barrier 132 is provided between the two arcs 121, 123 for insulational purposes.

In this embodiment of my invention the magnetic fields surrounding the two arcs 121, 123 interact to force the two arcs 121, 123 to opposite sides of vent holes 117, 119 during relatively high instantaneous values of arcing current. The displaced positions of the arcs 121, 123 are indicated by reference numerals 122, 124. The pressure generated within the insulating casing 115 by the arcs 122, 124 during relatively high instantaneous values of current forces liquid within the casing 115 out through the vent holes 117, 119. During relatively high instantaneous values of arcing current the fluid is ejected through the casing 115 through the vent holes 117, 119 without substantially disturbing the continuity of the two serially related arcs 122, 124 which at this

time are displaced laterally to opposed sides of the vent holes 117, 119. When, however, the instantaneous value of arcing current decreases the magnetic fields surrounding the two arcs 122, 124 decreases and the interaction between the two magnetic fields being correspondingly less, the arcs 122, 124 are permitted to return to the position where they were initially drawn, that is, directly in front of the vent holes 117, 119. At this position the two series arcs receive the direct effect of a cross-blast of liquid through the arc stream and out through the vent holes 117, 119 to extinguish the arcs.

In the embodiment of my invention shown in Figs. 8 and 9 there is provided a suitably shaped insulating casing 133 provided with a flared vent hole 135 and submerged in a suitable arc extinguishing liquid. Across the inner edge of the flared vent hole 135 an arc, the position of which is indicated by the reference numeral 137, is drawn between the stationary contact 139 and the movable contact 141. Imbedded in the insulating casing 133 is a piece of magnetic material 143 positioned adjacent the arc 137. The arc 137 will be affected by the presence of the piece of magnetic material 143 to cause the arc 137 to be attracted toward the piece of magnetic material 143 and hence to be drawn laterally to one side of the vent hole 135. Consequently, the pressure formed by the arc 137 within the casing 133 by the high instantaneous values of arcing current will cause the arc extinguishing fluid contained therein to be ejected through the vent hole 135 freely, the arc 137 at this time being displaced laterally to one side of the vent hole 135.

During relatively low instantaneous values of arcing current the attractive force exerted by the magnetic piece of material 143 will be less, and the arc will then be permitted to return to its former position directly in front of the vent hole 135, at which position it receives the full effect of the cross-blast of arc extinguishing fluid through the vent hole 135. This cross blast extinguishes the arc.

In the embodiment of my invention illustrated in Figs. 10 and 11, the reference numeral 147 designates an insulating casing in which an arc 149 is drawn between a stationary contact 151 and a movable contact 153 directly in front of a vent hole 155. Partially encircling the insulating casing 147 is a cylindrically-shaped sheet of magnetic material 157. The effect of the cylindrical sheet of magnetic material 157 on the arc 149 is to draw the arm 149 directly away (not to one side) of the vent hole 155 during relatively high values of instantaneous arcing current to a position indicated by reference numeral 158. A horizontal barrier of insulating material 159 is provided to prevent the arc 158 from being drawn too far away from the vent hole 155, since otherwise the attractive force between the cylindrically-shaped sheet of magnetic material 157 and the arc 158 would continue to increase as the arc 158 moved to the left, to result in the arc 158 being displaced too far away from vent hole 155.

During the displacement of the arc to its position away from the vent hole 155, the liquid within the casing 147 has free access through the vent hole 155 without substantially disturbing the continuity of the arc 158 in its displaced position. At the same time the ionized gases are freely carried away without clogging the vent or interrupting structure. It is apparent that during relatively high instantaneous values of arcing current the arc will create pressure within the

casing 147, this pressure forcing the ejection of fluid from the casing 147 out through the vent hole 155. When, however, the instantaneous value of arcing current decreases, the attractive force exerted by the cylindrically-shaped sheet of magnetic material 157 decreases, and the arc is permitted to return to its former position directly in front of the vent hole 155, at which position it receives a cross-blast of arc extinguishing liquid through the arc stream and out through the vent hole 155 to produce extinction of the arc.

In the embodiment of my invention shown in Figs. 12, 13 and 14 there is provided an insulating cylindrical casing 161 longitudinally in which moves an insulating operating rod 163 carrying at its upper end a conducting bridging member 165, which connects in the closed circuit position of the interrupter two stationary contacts 167, 169. A stationary conductor 171 extends upward from the stationary contact 169 and at the outer surface of the casing 161 separates into two parallel branches 173, 175. The parallel branches 173, 175 connect at 177 to lead to an external line terminal 179.

When the insulating operating rod 163 moves downward in a circuit interrupting operation of the interrupter, two serially related arcs 181, 183 are drawn. Associated with each arc 181, 183 is a magnetic field. Also associated with each of the two parallel conductors 173, 175 is a magnetic field. The strength of the magnetic field is a function of the instantaneous value of arcing current. The effect on the arc 183, which is initially drawn opposite vent hole 185, of the magnetic field associated with the arc 181 and the magnetic fields surrounding the stationary parallel conductors 173, 175 is such as to force the arc 183 directly back from the vent hole 185 (not to one side) during relatively high instantaneous values of arcing current to the position 184.

It is obvious that the arc 183 tends to be forced directly away from the arc 181, but the effect of the magnetic fields set up about the two parallel branches 173, 175 is such as to overcome the repulsive effect of the arc 181, and, in fact, to force the arc 183 in a direction towards the arc 181 and hence directly back from the vent hole 185 to position 184.

Consequently, as before, liquid within the insulating casing 161, which is subjected to pressure by the two arcs 181, 183, is forced out through the vent hole 185 during relatively high instantaneous values of arcing current, and in doing so substantially interferes very little with the displaced arc 184. When, however, the instantaneous value of arcing current diminishes, the strength of the respective magnetic fields will also diminish and the displaced arc 184 will return to the position at which it was initially drawn, that is, directly in front of the vent hole 185, at which position it will receive a strong cross-blast of liquid through the vent hole 185 to result in its extinguishment.

In the embodiment of my invention shown in Fig. 15 there is provided an insulating casing 187 in which is drawn an arc 189 between a stationary contact 191 and a movable contact 193. The arc 189 is drawn directly across a vent hole 195. The stationary contact 191 is connected by means of a conductor 197 to a series coil 199 so disposed that the magnetic field set up thereby is as indicated by the lines 201. The effect of the magnetic field 201 set up by the series coil 199 upon the arc 189 during relatively high instantaneous

values of arcing current is such as to move the arc 189 laterally to one side of the vent hole 195. Thus during relatively high instantaneous values of arcing current the arc extinguishing liquid disposed within the casing 187 has free access to the vent hole 195 without substantially interfering with the continuity of the displaced arc 189. When, on the other hand, the value of instantaneous arcing current decreases the strength of the magnetic field set up by the series coil 199 correspondingly decreases, and the arc 189 will then be permitted to return to its former position directly in front of the vent hole 195, in which position it receives a direct cross-blast of arc extinguishing liquid to effect the extinguishment thereof.

I do not wish to limit the scope of my invention to the utilization of an arc extinguishing liquid, it being readily apparent to one skilled in the art that my invention may be easily applied to gas blast breakers utilizing a gaseous arc extinguishing medium.

I have provided an interrupter in which the arc is drawn adjacent a vent, and the movement of the arc with respect to the vent depends upon the instantaneous value of arcing current. During high instantaneous values of arcing current the arc is moved away or to one side of the vent at which position it does not receive a direct cross-blast of arc extinguishing fluid. During this displaced position, however, it helps to generate pressure within the arc extinguishing chamber, this pressure being utilized during low values of instantaneous arcing current to help create a cross-blast through the arc as it returns to its former position directly across the vent. Thus I move the arc to a position where it receives the full effect of the cross-blast of arc extinguishing fluid at a time when it is most susceptible to extinction, that is, at a time when the current through the arc stream is approaching a current zero. By moving the arc away or to one side of the vent hole and thus disturbing it as little as possible during high instantaneous values of arcing current, the arc voltage is correspondingly kept low and the internal pressure within the arcing chamber is kept within reasonable limits.

Although in the description of each of the above embodiments of my invention the vent has been assumed to be the interrupting structure, naturally splitters or various kinds of arcing chutes which are well known in the art could be used in conjunction with the vent hole to assist in the extinguishment of the arc drawn adjacent thereto.

It will be observed that by moving the arc laterally to one side of the vent, or directly away from the vent, the relatively large quantity of gas which is formed during high instantaneous values of arcing current is not formed directly in front of the vent, as is the case with many commercial breakers now on the market. Consequently, the gas formed in a liquid breaker utilizing my invention during relatively high instantaneous values of arcing current does not clog, or raise the pressure at, the vent hole to interfere with the free venting of the liquid through the vent hole. Instead, being formed away from the vent hole, this relatively large quantity of gas is freely washed out of the breaker by the liquid flow. No clogging of the vent hole with products of decomposition or a raising of the pressure at the vent hole to prevent liquid flow, is the result of an application of my invention to a liquid circuit interrupter.

Although I have shown and described specific embodiments of my invention, it is to be understood that the same were merely for the purpose of illustration and that changes and modifications may be made by those skilled in the art, without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. In a circuit interrupter, an arcing chamber, a passage leading from said chamber, means for establishing an arc adjacent said passage, means for producing a flow of arc extinguishing fluid through said passage, and means for moving said arc away from said passage and laterally to one side thereof during relatively high instantaneous values of current.
2. In a circuit interrupter, an arcing chamber, a passage leading from said chamber, means for establishing an arc adjacent said passage, means for producing a flow of arc extinguishing fluid through said passage, and means for disturbing the magnetic field surrounding said arc to move said arc away from said passage and laterally to one side thereof substantially only during relatively high instantaneous values of arcing current.
3. In an alternating current circuit interrupter, arc extinguishing fluid, means defining a substantially closed arcing chamber, a passageway leading from said chamber for the ejection of fluid from said chamber, means for causing a flow of arc extinguishing fluid through said passageway, means for establishing an arc across said passageway within said chamber, and magnetic means for displacing said arc away from said passageway and laterally to one side thereof only during relatively high instantaneous values of arcing current, the arrangement being such as to minimize the effect of said flow on said arc during relatively high instantaneous values of arcing current.
4. In a circuit interrupter, a substantially closed arcing chamber having a vent, means for establishing an arc within said chamber and adjacent the vent, means for extinguishing said arc by a cross blast of arc extinguishing fluid through the vent, and magnetic means for minimizing said cross-blast only during relatively high instantaneous values of arcing current by moving the arc laterally to one side of the vent while permitting said arc to receive the full effect of said cross blast during relatively low instantaneous values of arcing current.
5. In a circuit interrupter of the cross-blast type, a substantially closed arcing chamber having a vent through which a cross-blast of arc extinguishing fluid may be established, means for establishing an arc within said chamber and adjacent the vent, means for extinguishing said arc by a cross-blast of arc extinguishing fluid through the vent, and means disturbing the magnetic field surrounding said arc to displace said arc laterally to one side of the vent substantially only during relatively high instantaneous values of arcing current, the effect of said displacement being to minimize the cross-blast during high instantaneous values of current and to effect an interruption of said arc only during relatively low instantaneous values of current.
6. In a circuit interrupter, an arcing chamber, a passageway leading from said chamber, means for establishing an arc adjacent said passageway, means for producing a flow of arc extinguishing fluid through said passageway to help extinguish said arc, and magnetic means for varying said

flow with respect to said arc as a function of the instantaneous value of arcing current by shifting the position of said arc laterally to one side of said passageway as a function of the instantaneous current through said arc.

7. In a circuit interrupter, a substantially closed chamber, a vent provided in the wall of said chamber, means for establishing two or more serially related arcs, at least one of said arcs being drawn adjacent said vent, means for producing a flow of arc extinguishing fluid through said vent to extinguish said arc, the disposition of said two or more serially related arcs being in such proximity that said arc is displaced away from said vent during relatively high instantaneous values of arcing current.

8. In a circuit interrupter, means defining an arcing chamber, an orifice for said chamber, means for establishing two or more serially related arcs, at least one of said arcs being drawn adjacent said orifice, arc extinguishing fluid disposed within said chamber, means for creating pressure within said chamber to force fluid under pressure through said orifice and out of said chamber, the disposition of said two or more serially related arcs being such that said arc is displaced laterally to one side of said orifice during relatively high instantaneous values of arcing current.

9. In a circuit interrupter, a substantially closed arcing chamber, two or more vents provided in the wall of said chamber, means for producing a flow of arc extinguishing fluid under pressure through said vents and out of said chamber, means for establishing at least two serially related arcs within said chamber, each of said arcs being drawn adjacent one of said vents, the disposition of said serially related arcs being such that each repels the other laterally to one side of the respective vents during relatively high instantaneous values of arcing current.

10. In a liquid alternating current circuit breaker, a substantially closed chamber, two vents in the walls of said chamber, means for establishing two serially related arcs directly across said vents, that is one arc across each vent, said arcs generating pressure within said chamber to force liquid out of said chamber through said vents, said arcs being in such close proximity that each repels the other laterally to one side of the respective vents during relatively high instantaneous values of arcing current to permit a relatively free venting of liquid from said chamber, the two arcs returning to their initial positions in front of said vents to receive the full effect of the cross-blast of liquid through said vents during relatively low instantaneous values of arcing current.

11. In a circuit interrupter, an arcing chamber, an orifice in the wall of said chamber, means for establishing an arc adjacent said orifice, means for producing a flow of arc extinguishing fluid through said orifice to help extinguish said arc, and means comprising magnetic material for varying the amount of said flow which acts on said arc as a function of the instantaneous value of arcing current by moving the arc laterally to one side of the orifice only during relatively high instantaneous values of arcing current.

12. In a liquid break alternating current circuit interrupter, an arc extinguishing liquid, a substantially closed arcing chamber submerged in said liquid, a vent in the wall of said chamber, means for establishing an arc across said vent within said chamber, said arc producing pressure

within said chamber to force liquid under pressure through said vent and out of said chamber, a sheet of magnetic material at least in part being disposed adjacent the wall of said chamber to attract said arc away from said vent during relatively high instantaneous values of arcing current to permit a relatively free venting of liquid through said vent, and a barrier member of insulating material disposed so as to prevent said arc moving too far away from said vent, the arrangement being such as to minimize the cross-blast of liquid through said arc during relatively high instantaneous values of arcing current and permitting the full effect of the cross-blast of liquid through said arc during relatively low instantaneous values of arcing current.

13. In a circuit interrupter, one or more series conductors composed of solid conducting material, means for establishing at least two serially related arcs, means for producing a flow of arc extinguishing fluid adjacent one of said arcs, the disposition of the other of said arcs and of said series conductors being such as to vary said flow with respect to said first-mentioned arc by shifting the position of said first-mentioned arc as a function of the instantaneous value of current through said first-mentioned arc.

14. In a circuit interrupter, a substantially closed chamber, a vent in the wall of said chamber, one or more series conductors composed of solid conducting material, means for establishing at least two serially related arcs, at least one of said arcs being established adjacent said vent, means for producing a flow of arc extinguishing fluid through said vent, the disposition of the one or more other of said arcs and of said series conductors being such as to move said first-mentioned arc away from said vent during relatively high instantaneous values of arcing current.

15. In a liquid break alternating current circuit interrupter, a substantially closed arcing chamber, a suitable arc extinguishing liquid in which said chamber is submerged, a vent in the wall of said chamber, two serially related arcs being established within said chamber, one of said arcs being established within said chamber, one of said arcs being established across said vent, both of said arcs producing pressure within said chamber to force liquid out of said chamber through said vent, two parallel related series conductors straddling said vent externally of the wall of said chamber, said two serially related arcs and said vent being in substantial alignment, the arrangement being such that said first-mentioned arc is forced during relatively high instantaneous values of arcing current directly away from said vent toward said second-mentioned arc to permit a comparatively free venting of liquid through said vent, said first-mentioned arc returning to its initial position across said vent to receive the full effect of the liquid flow through said vent during relatively low instantaneous values of arcing current.

16. In a circuit interrupter, an arc extinguishing fluid, a substantially closed arcing chamber, a vent in the wall of said chamber, means for creating a flow of said arc extinguishing fluid through said vent and out of said chamber, means for establishing an arc adjacent said vent within said chamber, a series conductor composed of solid conducting material, said series conductor being so disposed with respect to said arc that during relatively high instantaneous values of

arcing current said arc is moved laterally to one side of said event.

17. In a circuit interrupter, an arc extinguishing medium, a substantially closed arcing chamber, one or more vents disposed in the wall of said chamber, means for producing a flow of said arc extinguishing medium through said one or more vents and out of said chamber, a stationary contact disposed adjacent each vent, a movable contact disposed adjacent each vent to establish an arc adjacent each vent, one or more series conductors, said one or more series conductors being so disposed with respect to said arcs that said arcs are moved laterally to one side of said vents during relatively high instantaneous values of arcing current.

18. In a liquid break alternating current circuit interrupter, a substantially closed arcing chamber, arc extinguishing liquid disposed in said chamber, two vents disposed in the wall of said chamber, a stationary contact disposed adjacent each vent, a movable bridging member engaging said stationary contacts and cooperating therewith to draw two serially related arcs directly across said two vents, means for creating pressure within said chamber to force arc extinguishing liquid through said two vents and out of said chamber, said bridging member comprising a series conductor so shaped and disposed as to move said two established arcs laterally to one side of their respective vents during relatively high instantaneous values of arcing current, the arrangement being such that during low instantaneous values of arcing current said two arcs return to their initial positions directly across said vents to receive substantially a cross-blast of arc extinguishing liquid through the arcs to effect the extinction thereof.

19. In a circuit interrupter, a substantially closed arcing chamber, one or more main contacts, one or more arcing contacts, a vent in said chamber adjacent each of said arcing contacts, means for producing a flow of arc extinguishing fluid through said one or more vents and out of said chamber, means for opening said one or more main contacts before the opening of said one or more arcing contacts to establish an arc adjacent each vent, and one or more series conductors composed of solid conducting material connected in series circuit during at least part of the arcing period to move said arcs away from said vents during relatively high instantaneous values of arcing current.

20. In a liquid break alternating current circuit interrupter, a substantially closed cylindrically-shaped arcing chamber, arc extinguishing liquid disposed in said chamber, an operating rod movable longitudinally within said chamber, two pivotable bridging members, said rod carrying said two bridging members, two stationary main contacts, two stationary arcing contacts, two vents disposed in the wall of said chamber, each vent disposed adjacent a stationary arcing contact, means for producing a

flow of said arc extinguishing liquid through said two vents and out of said chamber, each bridging member carrying a movable main contact at one end and a movable arcing contact at the other end, means for opening said arcing contacts after the opening of said main contacts to draw two serially related arcs across said two vents, two series conductors, each of said conductors connecting a stationary main contact with a stationary arcing contact and curving around a vent in such a manner that the arc drawn adjacent thereto is moved with respect to said vent during relatively high instantaneous values of arcing current.

21. In a liquid break alternating current circuit interrupter, a substantially closed arcing chamber, liquid disposed in said chamber, a vent disposed in the wall of said chamber, means for establishing an arc across said vent, a piece of magnetic material disposed adjacent said arc to draw said arc laterally to one side of said vent only during relatively high instantaneous values of arcing current, means for forcing said liquid under pressure through said vent and out of said chamber, said arc remaining across said vent substantially only during relatively low instantaneous values of arcing current to receive the cross-blast of said liquid.

22. In a circuit interrupter, a substantially closed chamber, a vent in the wall of said chamber, means for establishing an arc adjacent said vent, arc extinguishing fluid, means for producing a flow of arc extinguishing fluid through said vent and out of said chamber, a series coil, said series coil being so disposed with respect to said arc that said arc is moved laterally to one side of said vent during relatively high instantaneous values of arcing current.

23. In a liquid break alternating current circuit interrupter, a substantially closed chamber, a vent in the wall of said chamber, liquid disposed in said chamber, means for establishing an arc across said vent, said arc creating pressure to force said liquid through said vent and out of said chamber, a series coil, the magnetic field created by said coil interacting with said arc to move said arc laterally to one side of said vent during relatively high instantaneous values of arcing current.

24. In a circuit interrupter, a substantially closed arcing chamber having a vent, means for establishing an arc within said chamber and adjacent the vent, means for extinguishing said arc by a cross-blast of arc-extinguishing fluid through the vent, and magnetic means comprising magnetic material for minimizing said cross-blast only during relatively high instantaneous values of arcing current by moving the arc laterally to one side of the vent while permitting said arc to receive the full effect of said cross-blast during relatively low instantaneous values of arcing current.

BENJAMIN P. BAKER.