

July 2, 1946.

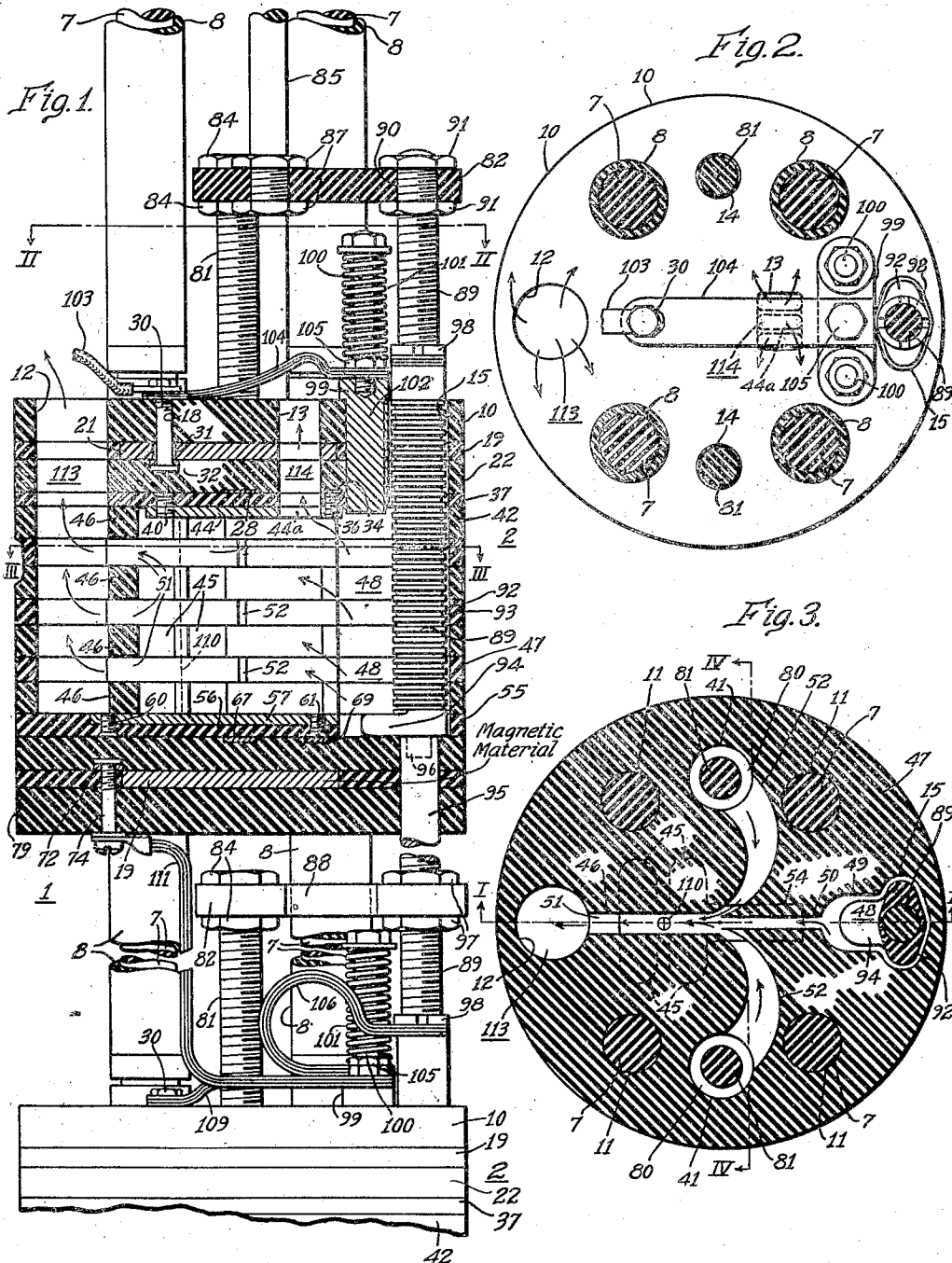
W. M. LEEDS

2,403,103

CIRCUIT INTERRUPTER

Filed Feb. 20, 1943

5 Sheets-Sheet 1



WITNESSES:

Le J. Welles.

W. R. Croft

INVENTOR

Winthrop M. Leeds.

BY

Ralph H. Swingle
ATTORNEY

July 2, 1946.

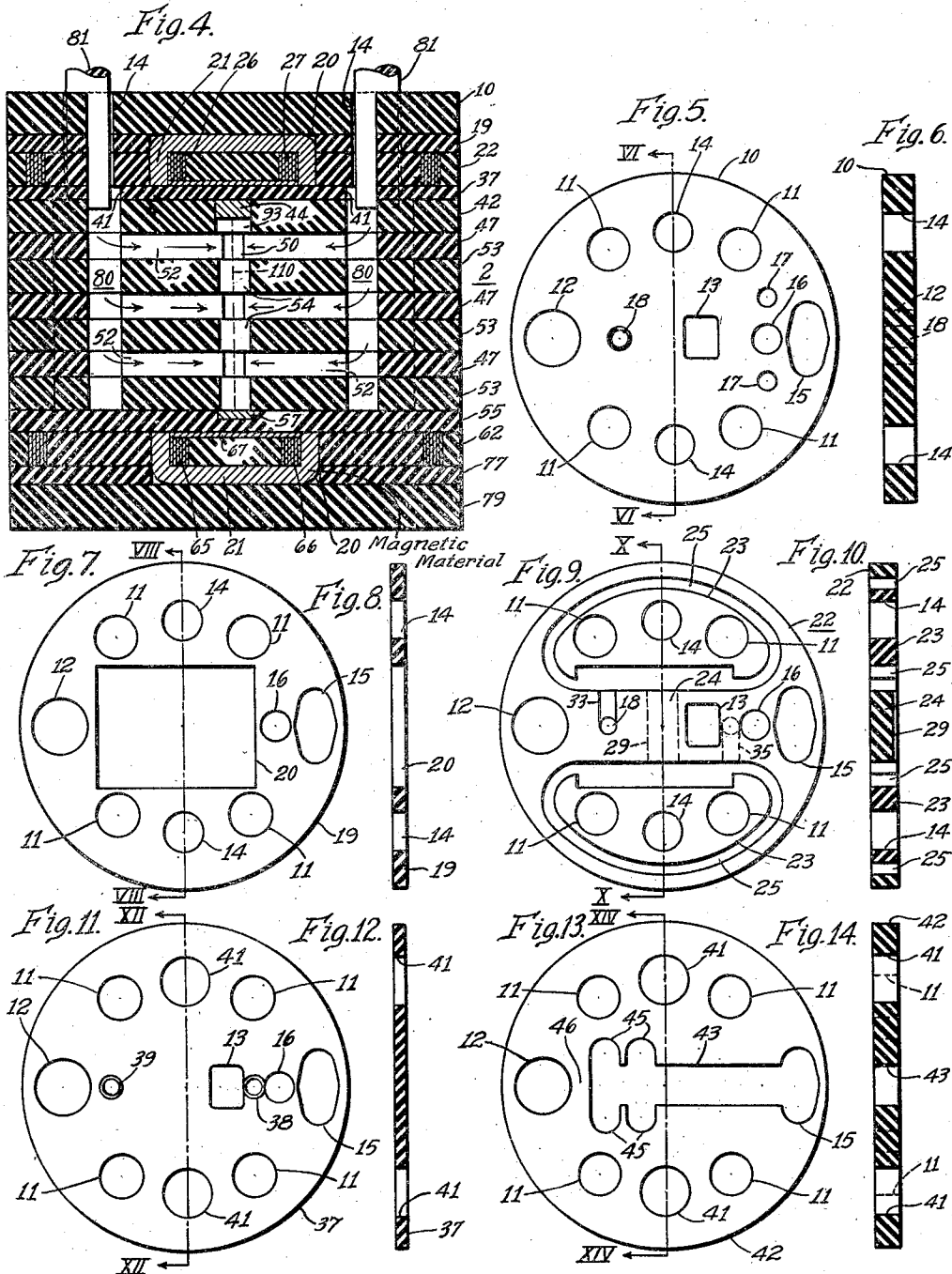
W. M. LEEDS

2,403,103

CIRCUIT INTERRUPTER

Filed Feb. 20, 1943

5 Sheets-Sheet 2



WITNESSES:

W. J. Weller.

W. R. Crouit

INVENTOR

Winthrop M. Leeds.

BY

Ralph Z. Swingle
ATTORNEY

July 2, 1946.

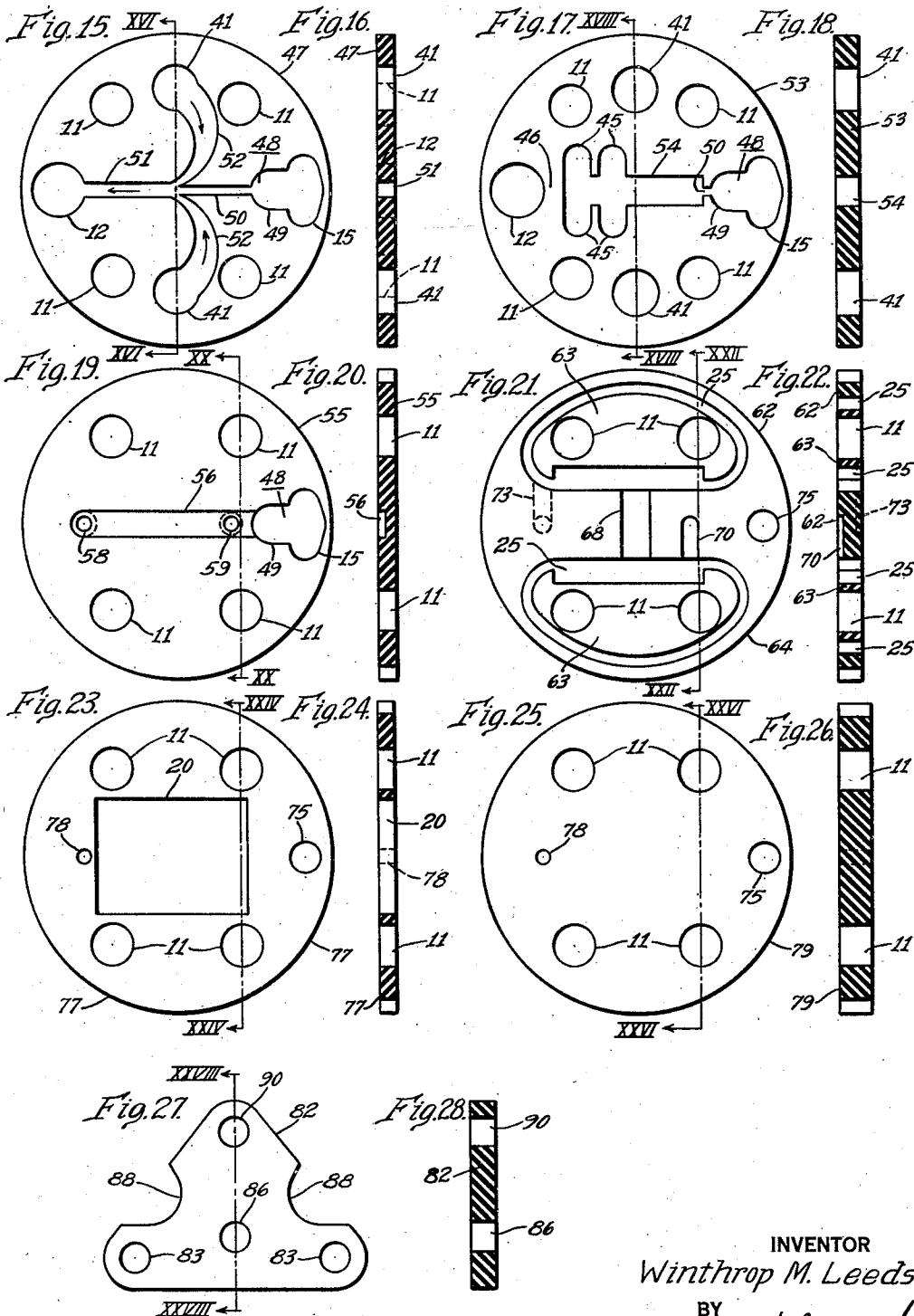
W. M. LEEDS

2,403,103

CIRCUIT INTERRUPTER

Filed Feb. 20, 1943

5 Sheets-Sheet 3



INVENTOR
Winthrop M. Leeds.
BY
Ralph L. Swingle
ATTORNEY

July 2, 1946.

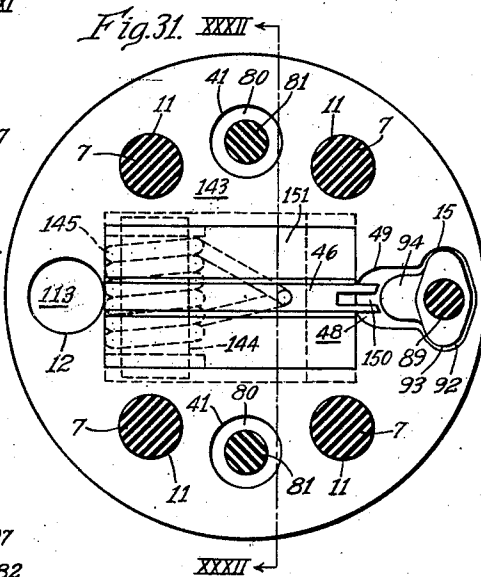
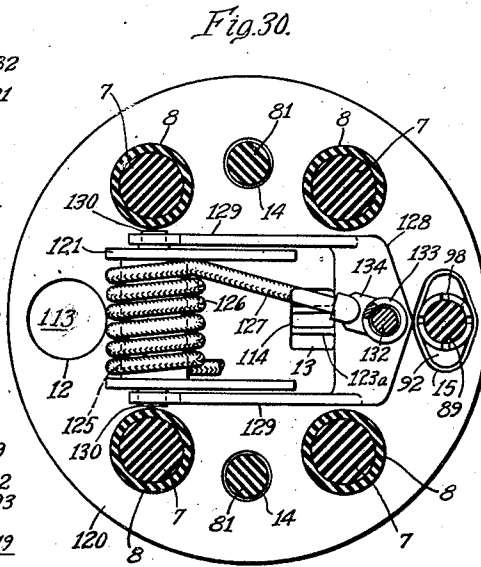
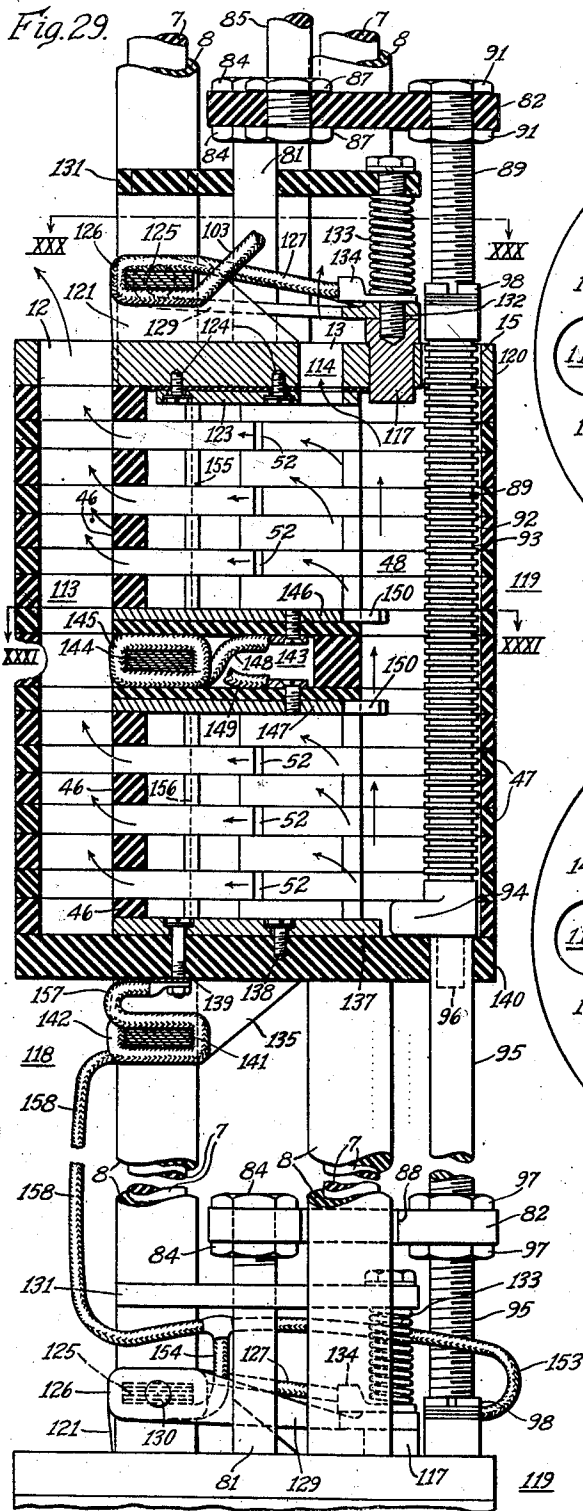
W. M. LEEDS

2,403,103

CIRCUIT INTERRUPTER

Filed Feb. 20, 1943.

5 Sheets-Sheet 4



INVENTOR
Winthrop M. Leeds.

BY
Ralph H. Swingle
ATTORNEY

July 2, 1946.

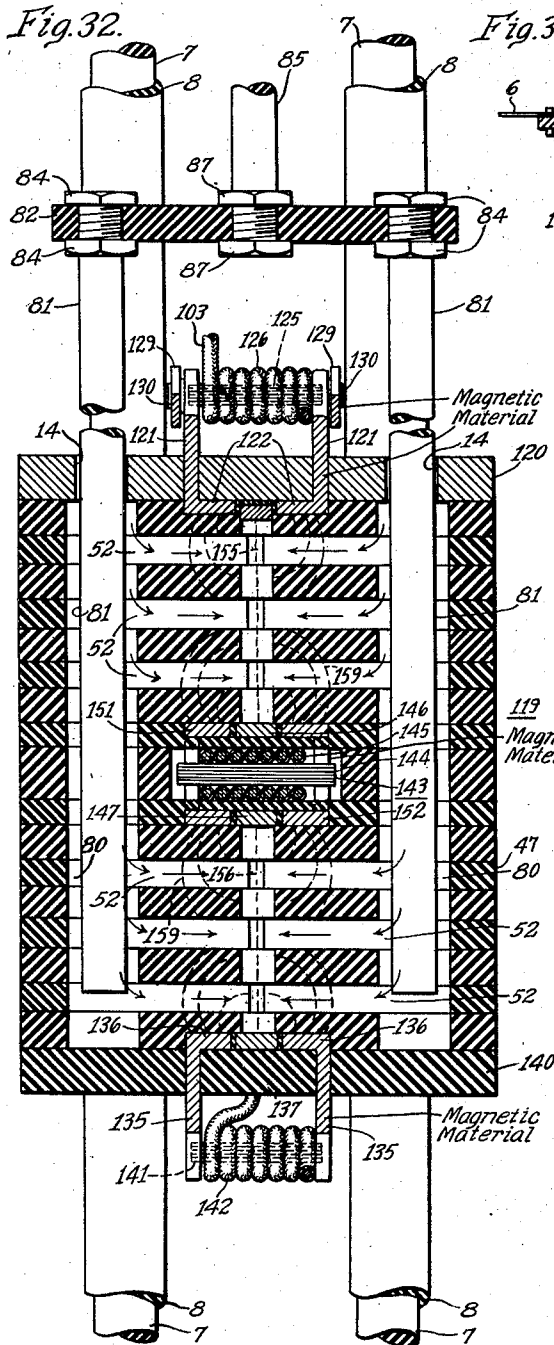
W. M. LEEDS

2,403,103

CIRCUIT INTERRUPTER

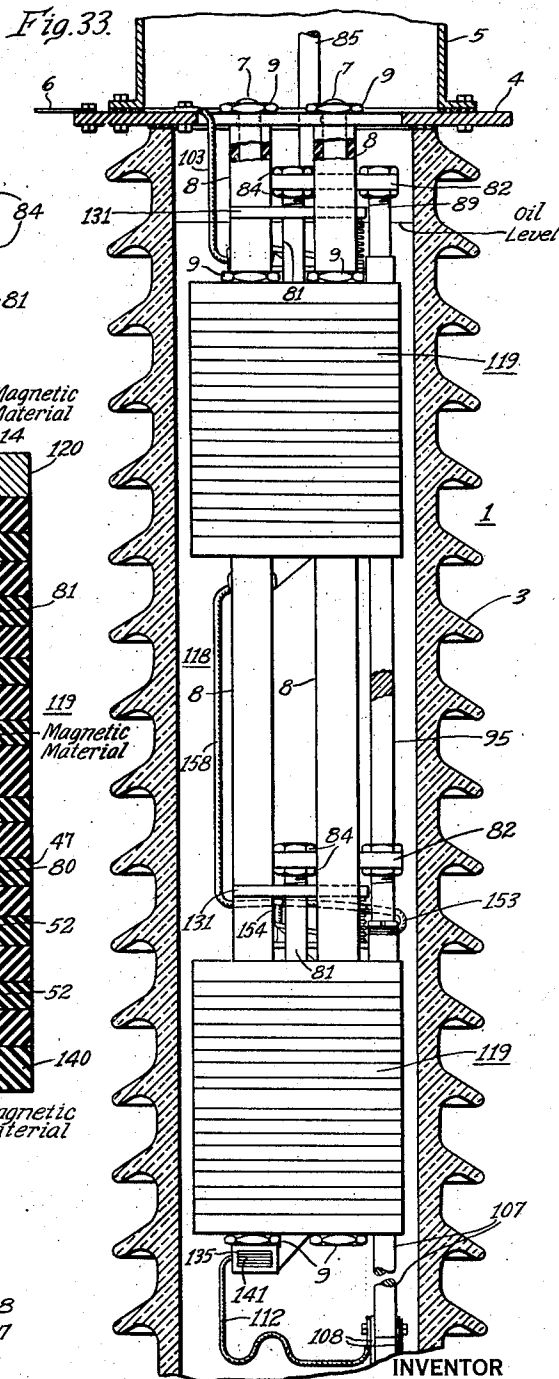
Filed Feb. 20, 1943

5 Sheets-Sheet 5



WITNESSES:

E. J. Weller.
W. R. Crout



INVENTOR

Winthrop M. Leeds.

BY

Ralph F. Swingle
ATTORNEY

UNITED STATES PATENT OFFICE

2,403,103

CIRCUIT INTERRUPTER

Winthrop M. Leeds, Wilkinsburg, Pa., assignor to
Westinghouse Electric Corporation, East Pitts-
burgh, Pa., a corporation of Pennsylvania

Application February 20, 1943, Serial No. 476,510

26 Claims. (Cl. 200—150)

1

This invention relates the circuit interrupters in general, and, more particularly, to arc extinguishing structures therefor.

First, during the greater portion of time arc current is flowing, particularly in the region of the peak of the current wave, the arc should be disturbed as little as possible by cross blasts, restricting walls, or strong magnetic action, so as to keep the arc voltage and the consequent gas generation as low as possible. Second, vents, passages and liquid flow should be arranged to drive the products of decomposition of the arc out of the arc chamber as fast as they are formed so as to maintain high dielectric in the arc chamber and keep the internal pressure reasonably low. Third, just prior to current zero when the arc current is relatively low, strong deionizing action should be brought into play, as for instance, subjecting the arc to turbulent cross-blasts of liquid and gas, confining the arc within a restricted passage or rapidly moving or lengthening the arc. These methods of treatment to produce rapid deionization, either singly or in combination, though preferably the latter, insure complete interruption of the circuit at current zero.

The main object of my invention is to provide an improved arc rupturing device which functions in accordance with the aforementioned principles.

Another object of my invention is to provide an improved circuit interrupter in which the arc established is moved laterally, and to drive fluid at the arc after it has moved laterally to effect its extinction.

Another object is to provide an improved circuit interrupter in which is produced both a first flow of fluid and a second flow of fluid. I use the first flow of fluid to assist moving the established arc laterally, and arrange the second flow of fluid to contact the arc after it has moved laterally to effect its extinction.

Another object is to provide an improved circuit interrupter in which is produced a flow of fluid. I establish an arc not in the flow of fluid and move it laterally into the flow to effect its extinction.

A more specific object of my invention is to provide an improved circuit interrupter in which an arc is established, and to provide means for moving the arc laterally during relatively low instantaneous values of arcing current. I also provide means for driving fluid into the arc after it has been moved laterally to effect its extinction.

Further objects and advantages will readily

2

become apparent upon a reading of the following specification taken in conjunction with the drawings, in which:

Figure 1 is a view taken in vertical section on line I—I of Fig. 3 of a circuit interrupter embodying my invention and shown in the open circuit position;

Fig. 2 is a view taken substantially on the line II—II of Fig. 1;

Fig. 3 is a view in cross section taken on the line III—III of Fig. 1;

Fig. 4 is a vertical sectional view taken on the line IV—IV of Fig. 3;

Figs. 5 through 26 show plate details;

Fig. 27 is a plan view of a support plate;

Fig. 28 is a sectional view taken on the line XXVIII—XXVIII of Fig. 27;

Fig. 29 is an elevational view in vertical section taken through a modified type circuit interrupter embodying my invention, the interrupter being shown in the open circuit position;

Fig. 30 is a view taken on the line XXX—XXX of Fig. 29;

Fig. 31 is a view in section taken on the line XXXI—XXXI of Fig. 29;

Fig. 32 is a view in section taken on the line XXXII—XXXII of Fig. 31; and

Fig. 33 is an elevational view of a circuit interrupter of the type shown in Fig. 29 supported in a suitable casing, the parts being shown in the open circuit position.

Referring to the drawings and, more particularly, to Fig. 1 and Fig. 33, the reference numeral 1 generally designates an arc extinguishing assemblage comprising a plurality, in this instance two, arc extinguishing units 2 disposed within a weather-proof casing 3 (see Fig. 33). An annular terminal and support plate 4 is supported on the casing 3 and supports a housing 5, only a portion of which is shown. A line terminal 6 is connected to the support plate 4.

Insulating tie rods 7 support the arc extinguishing units within the casing 3, and insulating spacing sleeves 8 maintain the arc extinguishing units in spaced relation with respect to each other and also with respect to the terminal and support plate 4. Nuts 9 are utilized to secure the tie rods 7 to the support plate 4 and also to maintain the insulating plates forming the arc extinguishing units in a compressed relation.

Referring to Fig. 1, the top insulating plate 10 of each arc extinguishing unit 2 is shown more clearly in Figs. 5 and 6. It will be observed that circular apertures 11 are provided in the plate 10 to accommodate the tie rods 7. A circular

3

vent aperture 12 is provided, the purpose of which will appear more clearly hereinafter. A rectangular vent aperture 13 is provided, and circular piston guide apertures 14 are provided, the purpose for which will also appear more clearly hereinafter.

An oval-shaped aperture 15 is formed in the plate 10, and a stationary contact aperture 16 is provided in the plate 10. Two tapped apertures 17 are provided in the plate 10 adjacent to the stationary contact aperture 16. A coil connector aperture 18 is provided in the plate 10.

Immediately below the insulating top plate 10 is an insulating magnet plate 19, more clearly shown in Figs. 7 and 8. The insulating magnet plate 19 has circular apertures 11 for the tie rods 7, a circular vent aperture 12, circular piston guide apertures 14, a stationary contact aperture 16, and a cutout portion 20 which accommodates the insertion of the bight portion of a U-shaped magnet 21 composed of magnetic material, in this instance iron, as more clearly shown in Fig. 4.

Below the magnet plate 19 is an insulating coil plate, generally designated by the reference numeral 22, the configuration of which is more clearly shown in Figs. 9 and 10. The coil plate 22 has apertures similar to those already described. The coil plate 22 comprises three insulating parts, two of which are indicated by the reference numeral 23 and the other by the reference numeral 24 which are more clearly shown in Figs. 9 and 10. The space 25 between the insulating parts 23, 24 is used to accommodate the insertion of coils 26, 27 (see Fig. 4). A connector 28 which electrically connects the coils 26, 27 is disposed in a slot 29 provided in the coil plate 22.

A coil connector stud 30 passes through the coil connector apertures 18 provided in plate 10 and partly in coil plate 22, also passing through an aperture 31 provided in the bight portion of the U-shaped magnet 21 as more clearly shown in Fig. 1. A connector 32 electrically connects the coil connector stud 30 with coil 27, the connector 32 being disposed in a slot 33 provided in the coil plate 22, as shown in Fig. 9.

A connector 34 disposed in a slot 35 provided in the coil plate 22 is connected at one end to the coil 26 and at its other end to an arcing horn screw 36, as more clearly shown in Fig. 1. Immediately below the coil plate 22 is an insulating plate 37, more clearly shown in Figs. 11 and 12. The plate 37 has apertures similar to those previously described and which are designated by the same reference numerals. In addition, the plate 37 has a beveled aperture 38 for the arcing horn screw 36. Another beveled aperture 39 is provided in the plate 37 to accommodate the other arcing horn screw 40, as shown in Fig. 1. The insulating plate 37 has two enlarged piston apertures 41 which are larger in diameter than the circular piston guide apertures 14 provided in plates 10, 19, and 22, the purpose for which will appear more clearly hereinafter.

Below the insulating plate 37 is an insulating plate 42, the configuration of which is more clearly shown in Figs. 13 and 14. The plate 42 has disposed therein an elongated slot 43 which is provided to accommodate the insertion of an upper arcing horn 44, as more clearly shown in Fig. 1. The arcing horn 44 has a grating portion 44a (see Fig. 2), the purpose for which will also appear more clearly hereinafter. The insu-

4

lating plate 42 has disposed therein a plurality, in this instance four, pockets 45. A barrier portion 46 is provided between the elongated slot 43 and the circular vent aperture 12, as shown in Fig. 13. Immediately below the insulating plate 42 is an insulating inlet plate, the configuration of which is more clearly shown in Figs. 15 and 16. The insulating inlet plate 47 has a passage generally designated by the reference numeral 48 of irregular outline. The passage 48 has a relatively wide portion 49 and a relatively restricted portion 50 which leads into a less restricted section at 51, the latter communicating to the circular venting aperture 12, as more clearly shown in Fig. 15. A plurality, in this instance two, inlet passages 52 are provided in the insulating plate 47 which lead from the enlarged piston apertures 41 to the less restricted section 51, as more clearly shown in Fig. 15.

Below the insulating inlet plate 47 is an insulating pocket plate 53, the configuration of which is more clearly shown in Figs. 17 and 18. The passage 48 in the insulating pocket plate 53 has an irregular outline and has a widened portion 54 which leads into the pockets 45.

Then follows an insulating inlet plate 47, an insulating pocket plate 53, an insulating inlet plate 47 and an insulating pocket plate 53. Below the last insulating pocket plate 53 is an insulating arc horn plate 55, the configuration of which is more clearly shown in Figs. 19 and 20. The insulating arc horn plate 55 has a slot 56 formed therein to accommodate the insertion of the lower arcing horn 57. A beveled aperture 58 accommodates a lower arcing horn screw 60, as more clearly shown in Fig. 1. A beveled aperture 59 provided in the insulating arc horn plate 55 accommodates a lower arc horn screw 61, as shown in Fig. 1.

Below the insulating arc horn plate 55 is an insulating coil plate, generally designated by the reference numeral 62, and shown more clearly in Figs. 21 and 22. The insulating coil plate 62 comprises two insulating parts 63 and a surrounding insulating part 64, as more clearly shown in Fig. 21. The space 25 between the parts 63 and the part 64 is used to accommodate the insertion of coils 65, 66, more clearly shown in Fig. 4.

A connector 67 electrically connects the coils 65, 66 in series and is disposed in a slot 68 provided in the insulating coil plate 62. A connector 69 (see Fig. 1) secured, as by welding, to the lower arc horn screw 61 lies in a slot 70 disposed in the insulating coil plate 62 and electrically connects the coil 65 with the lower arc horn 57. A connector 72 lying in a slot 73 provided in the insulating coil plate 62 electrically connects coil 66 with stud 74, as more clearly shown in Fig. 1.

The insulating coil plate 62 has disposed therein a circular aperture 75, the purpose for which will appear more clearly hereinafter. Below the insulating coil plate 62 is an insulating magnet plate 77, the configuration of which is more clearly shown in Figs. 23 and 24. An aperture 78 is provided in the magnet plate 77 to accommodate the stud 74. A cutout portion 79 is also provided in the insulating magnet plate 77 to accommodate the insertion of a U-shaped magnet 21 composed of magnetic material, in this instance iron, as shown more clearly in Fig. 4.

The bottom insulating plate 79 of the arc extinguishing unit 2 has a configuration more clearly shown in Figs. 25 and 26. The insulating plate 79 has apertures similar to those previously de-

scribed and are designated by the same reference numerals.

When the insulating plates are all aligned on the insulating tie rods 7 and compressed by the nuts 9, the several apertures align to form elongated passages. More particularly, the enlarged piston apertures 41 align to form piston chambers, generally designated by the reference numeral 80, and as more clearly shown in Fig. 4.

Referring to Figs. 1 and 4, it will be observed that I have provided two insulating second pistons 81 collectively constituting a second fluid moving means which are operative into the piston chambers 80 to compress the fluid, in this instance oil, disposed in the piston chambers 80. The insulating pistons 81 are supported at their upper ends to a triangular-shaped insulating support plate 82, more clearly shown in Figs. 27 and 28. The support plate 82 has piston apertures 83 formed therein which serve to support the insulating pistons 81, nuts 84 being utilized to secure the upper portion of the insulating pistons, which are preferably threaded, to the insulating support plate 82. Also secured to the insulating support plate 82 is an insulating operating rod 85, more clearly shown in Fig. 1. The insulating support plate 82 has an operating rod aperture 86 formed therein in which the insulating operating rod 85 is secured by the nuts 87, as more clearly shown in Fig. 1.

The insulating support plate 82 has notches 88 formed therein to accommodate the insulating tie rods 7 and the sleeves 8 surrounding the tie rods 7.

Also secured to the insulating support plate 82 is an insulating piston member 89 more clearly shown in Fig. 1. The support plate 82 has a piston aperture 90 formed therein through which is inserted the upper end of the insulating piston member 89. Nuts 91 may secure the piston member 89 to the insulating support plate 82, as shown in Fig. 1.

The first fluid moving means or first insulating piston member 89 supports a plurality of oval-shaped insulating washers 92, 93 as more clearly shown in Fig. 1. The oval-shaped washers 92 have an external dimension that is greater than the external dimension of the oval-shaped insulating washers 93. Consequently the surface of the insulating piston member 89 is corrugated as shown in Fig. 1.

The first piston member 89 moves through the oval-shaped apertures 15 provided in plates 10, 19, 22, 37, 42, 47, 53, and 55.

A movable contact 94, having a configuration more clearly shown in Figs. 1 and 3, is secured to the insulating piston member 89. Below the movable contact 94 is a metallic coupling member 95 making a press fit at 96 with the insulating piston member 89. Nuts 97 rigidly secure the metallic coupling member 95 to the insulating support plate 82 of the lower arc extinguishing unit 2 of Fig. 1. Threadedly secured to the metallic coupling member 95 is a spanner nut 98 which clamps a flexible conductor 106 to the piston member 89 of the lower arc extinguishing unit 2.

Extending transversely across the top of the upper arc extinguishing unit 2, as more clearly shown in Fig. 2, is a contact carrying member 99 having two spaced bolts 100 passing therethrough, which spaced bolts 100 are supported in the two tapped apertures 17 provided in the top insulating plate 10. Compression springs 101 surrounding the spaced bolts 100 and disposed between the heads of the two bolts 100 and the contact carrying member 99 serve to bias the

contact carrying member downwardly as viewed in Fig. 1. A stationary contact 102 is provided. Preferably the stationary contact 102 is integrally formed with the contact carrying member 99 and extends through the stationary contact apertures 16 provided in insulating plates 10, 19, 22, and 37.

In the closed circuit position of the interrupter, not shown, the electrical circuit therethrough comprises (see Fig. 33) line terminals 6, annular terminal and support plate 4, flexible conductor 103, flexible conductor 104 (see Fig. 2), bolt 105, stationary contact 102, movable contact 94, metallic coupling member 95, flexible conductor 106, bolt 105, to the contact carrying member 99 of the lower arc extinguishing unit 2 shown in Fig. 1. The circuit then extends through the lower arc extinguishing unit 2 of Fig. 1 in the same manner as it extended through the upper arc extinguishing unit 2 of Fig. 1. The metallic coupling member 107 of the lower arc extinguishing unit 2 (see Fig. 33) supports two disconnect fingers 108 which are engaged by a conducting actuating member, not shown. The conducting actuating member may be electrically connected to the other terminal of the interrupter by a sliding connection, not shown.

The opening operation of the interrupter shown in Fig. 1 will now be explained. When it is desired to open the electrical circuit passing through the interrupter, or when overload conditions exist in the electrical circuit controlled by the interrupter, suitable operating means, not shown, but which may be of the form shown in Patent 2,133,332 are actuated to permit downward movement of the metallic coupling member 107 of the lower arc extinguishing unit 2 of Fig. 1 (see Fig. 33). The metallic coupling member 107 and the two piston members 89 of both units 2 in Fig. 1 move downwardly as a unit, suitable spring means being provided within the housing 5 of Fig. 33, not shown, to bias the insulating operating rod 85 downwardly. As the insulating operating rod 85 and the two insulating support plates 82 of both units 2 move downwardly together as a unit, the movable contacts 94 separate from the stationary contacts 102 to draw an arc, the upper end of which is readily transferred to the upper arcing horn 44.

It will be observed that the downward motion of the insulating first piston member 89 will produce through piston action an upward flow of fluid, in this instance oil, upward in the enlarged portion 49 of the arcing passage 48 to vent through the grating 44a of the upper arcing horn 44 and out of the unit 2 through the rectangular vent apertures 13 provided in insulating plates 10, 19, 22, and 37. This upward flow of fluid is indicated by the arrows in Fig. 1. The volume of the first piston member 89 entering the enlarged portion 49 of the arcing passage 48 is greater than the volume of the metallic coupling member 95 which is leaving the enlarged portion 49 of the arcing passage 48. Consequently, a displacement of fluid within the enlarged portion 49 results, and this fluid is displaced upwardly in the direction shown by the arrows in Fig. 1 through the arcing horn 44 and out of the unit 2 as previously described. This venting of the fluid upward and through the rectangular vent passages 13 helps to transfer the upper terminal of the arc to the upper arcing horn 44.

The electrical circuit now through the interrupter comprises line terminal 6 (see Fig. 33), support plate 4, connector 103, coil connector

stud 30, connector 32, coil 27, connector 28, coil 26, connector 34, arcing horn screw 36, upper arcing horn 44, the arc itself (not designated), movable contact 94, metallic coupling member 95, flexible conductor 106, bolt 105, flexible conductor 109 (see Fig. 1), lower coil connector stud 30 through the upper series coils 27, 26 of the lower arc extinguishing unit 2 through the arc, not shown in the lower arc extinguishing unit 2, movable contact 94 of the lower unit 2, metallic coupling member 107 (see Fig. 33), disconnect fingers 108, conducting actuating member, not shown, to the other terminal of the interrupter.

It will, therefore, be apparent that the transfer of the upper terminal of the arc to the upper arcing horn 44 cuts into series circuit the two series coils 26, 27 of each arc extinguishing unit 2. These coils produce a magnetic field perpendicular to the plane of the drawing of Fig. 1. Assuming that the instantaneous current through the interrupter is in a downward direction, the magnetic field thus provided is in a direction coming outwards toward the reader perpendicular to the plane of Fig. 1. This magnetic field acts to bias the arc in a leftward direction, as viewed in Fig. 1, and tends to force the arc from the widened portion 49 of the arcing passage 48 through the restricted portion 50 and into the less restricted portion 51, as more clearly shown in Fig. 3.

During relatively large instantaneous values of arcing current the cross-section of the arc is too large to permit it to enter the restricted portion 50. It is only when the instantaneous value of arcing current is relatively small that the cross-sectional area of the arc stream is sufficiently small for it to enter the restricted portion 50 of the arcing passage 48.

It is apparent that during the time that the arc is in the enlarged portion 49 the upward fluid flow, created by the piston action of the piston member or first fluid moving means 89, will serve to wash gas and contaminated fluid out of the units 2 through the upper arcing horns 44 and through the rectangular vent apertures 13. Consequently the dielectric strength within the arc-extinguishing units 2 is maintained at a high value while the arc is positioned in the widened portion 49 of the arcing passage 48. Also, the provision of the venting means, generally designated by the reference numeral 114, in Fig. 1, prevents the internal pressure within the units 2 from attaining too great a value.

As mentioned previously, during relatively low instantaneous values of arcing current, the cross-sectional area of the arc is sufficiently small to permit the somewhat diagonal fluid flow caused by the piston action of the first fluid moving means or first piston 89, and coupled with the biasing action exerted by the magnetic field within the units 2, to force the arc to the left, as viewed in Fig. 1, through the restricted portion 50 of the arcing passage 48, and into the less restricted portion 51.

When the arc is in the less restricted portion 51 it is rapidly forced to the left by the fluid flow in the portion 51 provided in the insulating inlet plates 47, which portion communicates with the circular vent aperture 12. The rapid movement to the left of the arc into the less restricted portion 51 transfers the lower terminal of the arc from the movable contact 94 over to the lower arcing horn 57.

The electrical circuit now through the interrupter is as follows: line terminal 6, support plate

4 (see Fig. 33), connector 103, coil connector stud 30, connector 32, coil 27, connector 28, coil 26, connector 34, arcing horn screw 36, upper arcing horn 44, arc 110, lower arcing horn 57, lower arc horn screw 61, connector 69, coil 65, connector 67, coil 66, connector 72, stud 74, flexible connector 111, flexible conductor 109, coil connector stud 30 of the lower arc extinguishing unit 2 of Fig. 1, through the lower arc extinguishing unit 2 in a similar manner as through the upper unit 2 to the flexible conductor 112 (see Fig. 33), disconnect fingers 108, conducting actuating member, not shown, to the other line terminal of the interrupter.

It will be observed that while the arc 110 is positioned within the less restricted portion 51 of the arcing passage 48, it is subjected to a blast of fluid, in this instance oil, through the inlet passages 52 provided in the insulating inlet plates 47 caused by the piston action of the insulating second pistons 81. It will be observed that the piston chambers 80 are considerably larger in diameter than the insulating pistons 81, and, consequently, fluid pressure is maintained through all of the inlet passages 52 at the same time.

This feature is very important in the functioning of the insulating pistons 81, that is, the maintaining of the fluid in all of the inlet passages 52 under pressure. The fluid passing through the inlet passages 52 into the less restricted portion 51 of arcing passage 48 and toward the venting passage, generally designated by the reference numeral 113 in Figs. 1 and 3, causes a blast of fluid to contact the arc 110 and to quickly deionize the same at the first current zero and prevents its reignition when the recovery voltage builds up. It will also be observed that the arc 110, while in the less restricted portion 51, has ample opportunity to contact fluid disposed in the pockets 45 provided in the insulating plates 42 and 53. Thus, it is apparent that a large quantity of fluid disposed within the pockets 45 is available to send a blast of un-ionized gas and oil particles into the arc core 110 to deionize the same. The barrier portions 46 disposed in insulating plates 42 and 53 prevent the arc 110 from being swept completely into the venting passage 113.

The direction of the fluid flow is indicated by the arrows in Figs. 1, 3, and 4.

After the arc 110 has been extinguished and the movable contacts 94 are at their full open circuit position, as shown in Fig. 1, the conducting actuating member, not shown (see Fig. 33), separates from the disconnect fingers 102 to introduce an isolating gap into the circuit.

During the closing operation, the conducting actuating member, not shown, moves upwardly to engage the disconnect fingers 108 and to move the metallic coupling member 107 and the two piston members 89 disposed in the two units 2 upwardly as a unit against the biasing action of the springs, not shown, disposed in the upper housing 5 (see Fig. 33). This upward movement continues until the movable contacts 94 engage the stationary contacts 102, the compression springs 101 furnishing the requisite contact pressure between the movable contacts 94 and the stationary contacts 102.

It will be readily apparent from the foregoing description that I have provided piston means for blasting fluid at the arc 110 after it has been moved laterally by the magnetic field through the restricted portion 50 of the arcing passage 48. It is also apparent that the fluid flow through the inlet passages 52 does not strike the arc 110 until

the current through the arc 110 has a relatively low instantaneous value. Consequently, the piston is not operative to blast the arc during relatively high instantaneous values of arcing current when the arc 110 is positioned in the widened portion 49 of the arcing passage 48, but only strikes the arc 110 after the latter has passed through the restricted portion 50, and at a time when the instantaneous current is small and when conditions are right for arc extinction.

The flux lines 159 in Fig. 4 indicate schematically the direction of the magnetic field in the arc extinguishing units 2 when the current through the arc 110 is in a downward direction.

In the embodiment of my invention shown in Figs. 29 through 33, inclusive, the reference numeral 117 designates a stationary contact, the lower end of which is disposed through a top metallic plate 120 and into a modified type of arc extinguishing unit, generally designated by the reference numeral 119. The arc extinguishing assemblage, generally designated by the reference numeral 118, is analogous to the arc extinguishing assemblage 1 of Fig. 1.

Extending through the top metallic plate 120 are two brackets 121 composed of magnetic material, in this instance iron. At the lower end of each bracket 121 and disposed within the unit 119 is a pole piece 122, more clearly shown in Fig. 32. Disposed between the pole pieces 122 is an upper arcing horn 123 having a grating portion 123a, as more clearly shown in Fig. 30. Screws 124 secure the upper arcing horn 123 to the top metallic plate 120.

A laminated core 125 is secured to the upper ends of the brackets 121, as shown in Fig. 32. Around the laminated core 125 is wound a series magnetizing coil 126, more clearly shown in Fig. 32.

A plate member 128 (see Fig. 30) has two off-standing integral lever arms 129 which are pivotally mounted at 130 to the core 125, as more clearly shown in Figs. 30 and 32.

An insulating bracket 131 secured at its left-hand end, as viewed in Fig. 29, to the tie rods 7, has a stud 132 slidable therethrough. The lower end of the stud 132 passes through a lug 134, the plate member 128 and is threadedly secured to the stationary contact 117. A compression spring 133 encircles the stud 132 and is disposed between the insulating bracket 131 and the lug 134 as shown in Fig. 29. It will, therefore, be apparent that the compression spring 133 biases the stationary contact 117 in a downward direction, as viewed in Fig. 29. The flexible conductor 127 terminates at its right-hand end in the lug 134.

At the lower end of the arc extinguishing unit 119 are disposed two brackets 135 composed of magnetic material, in this instance iron. At the upper ends of the brackets 135 and extending toward each other are pole pieces 136, preferably integrally formed with the brackets 135. Between the pole pieces 136 is disposed a lower arcing horn 137, as more clearly shown in Fig. 32. A screw 138 secures the lower arcing horn 137 to the bottom insulating plate 140. A bolt 139 secures the lower arcing horn 137 to the bottom insulating plate 140 and also serves to bring an electrical connection from the lower arcing horn 137 out of the arc extinguishing unit 119. Disposed between the brackets 135 is a laminated core 141, more clearly shown in Fig. 32. Around the laminated core 141 is wound a magnetizing coil 142.

Within the arc extinguishing unit 119, and preferably intermediate the ends thereof, is an intensifying magnet structure, generally designated by the reference numeral 143. The intensifying magnet structure 143 comprises a laminated core 144 around which is wound a magnetizing coil 145. Arcing horns 146, 147 are provided and are electrically connected to the magnetizing coil 145 through the terminals 148, 149, as shown more clearly in Fig. 29.

The right-hand ends of the arcing horns 146, 147, as viewed in Fig. 29, are forked, as at 150 (see Fig. 31) so that the vertical flow of fluid within the enlarged portion 49 of the arcing passage 48 will not be impeded. The vertical direction of flow is indicated by the arrows in Fig. 29. Adjacent the arcing horn 146 are upper pole pieces 151 which are a part of the magnetic circuit through the laminated core 144. Also adjacent the lower arcing horn 147 are lower pole pieces 152 which also are a part of the magnetic circuit passing through the laminated core 144, as shown more clearly in Fig. 32.

In the closed circuit position of the interrupter, the electrical circuit therethrough comprises line terminal 6, conducting support plate 4, conductor 103, series magnetizing coil 126, flexible conductor 127, lug 134, stationary contact 117, movable contact 94, metallic coupling member 95, flexible conductor 153, terminal conductor 154 of magnetizing coil 126 of lower arc extinguishing unit 119, flexible conductor 127, lug 134, stationary contact 117 of lower arc extinguishing unit 119, movable contact 94 of lower unit 119 (not shown) to metallic coupling member 107 (see Fig. 33), disconnect fingers 108, conducting actuating member, not shown, to the other line terminal of the interrupter.

The opening operation of the interrupter which is shown in Figs. 29 to 33, inclusive, will now be described. When it is desired to open the electrical circuit through the interrupter or when overload conditions exist in the electrical circuit controlled by the interrupter, suitable operating mechanism, not shown, moves the conducting actuating member, not shown, downwardly to permit the metallic coupling member 107 (see Fig. 33) to move downwardly under the biasing action of the compression springs disposed in the housing 5 (not shown). As in the previously described embodiment of my invention, the metallic coupling member 107 and the two piston members 89 in both arc extinguishing units 119 move downwardly as a unit, separating the movable contacts 94 from the stationary contacts 117. As in the previous modification of my invention, the upper terminal of the arcs consequently drawn are transferred to the upper arcing horns 123 by the upward flow of fluid out through the vent passages 114 (see Fig. 29).

The top metallic plate 120 serves as an electrical connector between the stationary contact 117 and the upper arcing horn 123. The electrical circuit now through the interrupter is the same as that previously described with the exception that arcs are interposed between the movable contacts 94 and the upper arcing horns 123. As the piston members 89 move downwardly the lower terminal of the arc is transferred to the arcing horn 146 (see Fig. 29). The reference numeral 155 designates the arc which is thus transferred to the arcing horns 123, 146. As the movable contacts 94 move downwardly past the arcing horns 147, a terminal of the arc transfers to the arcing horn 147 to cut the magnetizing coil 145 into series

11

circuit. The cutting of the magnetizing coil 145 into series circuit creates a magnetic field within the interior of the arc extinguishing unit 119, as designated by the reference numeral 159 in Fig. 32.

When the movable contacts 94 approach the end of their travel, the lower terminal of the arc transfers from the movable contacts 94 to the lower arcing horn 137. This transfer is largely caused by the reaction of the magnetic field set up by the magnetizing coil 145 in the arc extinguishing units 119. The reference numeral 159 designates the position of the arc after the lower terminal thereof has transferred to the lower arcing horn 137. This transfer cuts in the magnetizing coil 142 disposed at the lower end of the arc extinguishing units 119.

The electrical circuit now through the interrupter comprises line terminal 6, conducting support plate 4, conductor 103, series magnetizing coil 126, flexible conductor 127, lug 134, stationary contact 117, top metallic plate 129, upper arcing horn 123, arc 155, arcing horn 146, terminal 148, magnetizing coil 145, terminal 143, arcing horn 147, arc 156, lower arcing horn 137, bolt 139, terminal 157 of magnetizing coil 142, magnetizing coil 142, flexible conductor 153, terminal 154 of lower magnetizing coil 126 through the lower arc extinguishing unit 119 in an identical manner as through the upper unit 119 to flexible conductor 112, disconnect fingers 108, conducting actuating member, not shown, to the other line terminal of the interrupter.

The deionizing action and the operation of the piston members 81 are identical to that described previously in connection with the interrupter shown in Fig. 1. Therefore, a further description seems unnecessary. It will, however, be observed that by providing the intensifying magnet structure 143 which is cut into series circuit by the arc, a means has been provided to intensify the magnetic field within the arc extinguishing units 119, and hence to more strongly bias the arc to the left, as viewed in Fig. 29, and through the restricted portion 50 of arcing passage 48. After the arcs have been extinguished, the actuating member, not shown, separates from the disconnect fingers 108 to introduce an isolating gap into the circuit.

Although I have utilized oil as an arc extinguishing fluid, it is to be clearly understood that my invention is applicable to the use of other arc extinguishing fluids, for instance, gases or even air. In the latter event the several insulating plates making up the arc extinguishing units 2, 119, may be composed of horn fiber which will evolve an arc extinguishing gas upon being contacted by an arc. The term "fluid" as used herein and in the appended claims comprises liquids, gases, vapors, and sprays.

Instead of using pistons 81 to produce the pressure within the piston chambers 80 to cause the fluid flow through the inlet passages 52, I may use a series pressure generating arc to produce the requisite pressure. It is to be clearly understood that my invention is not to be limited to the use of piston means, but includes any other suitable pressure generating means.

Although I have shown and described specific structures, it is to be clearly understood that the same were merely for purposes 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 invention.

I claim as my invention:

12

1. In a circuit interrupter, an elongated arcing passage having a relatively wide portion and a relatively restricted portion, means for establishing an arc in the wide portion, coil means for creating a magnetic field to bias the arc into the restricted portion, one or more inlet passages positioned laterally along the walls of the restricted portion leading into the restricted portion of the elongated arcing passage, and means operative to force fluid through the inlet passages into the restricted portion to strike the arc after the arc has entered the restricted portion to assist in its extinction.

2. In a circuit interrupter, an elongated arcing passage having a relatively wide portion and a relatively restricted portion, means for establishing an arc in the wide portion, coil means for creating a magnetic field to bias the arc into the restricted portion to effect its extinction therein, the restricted portion being so narrow that the arc enters the restricted portion only during relatively low instantaneous values of arcing current, one or more inlet passages positioned laterally along the walls of the restricted portion leading into the restricted portion of the elongated arcing passage, and means operative to force fluid through the inlet passages into the restricted portion to strike the arc after the arc has entered the restricted portion to assist in its extinction.

3. In a circuit interrupter, means for establishing an arc, means for moving the arc laterally only during relatively low instantaneous values of arcing current, and piston means for directing a plurality of jets of fluid at the arc on opposite sides thereof at a plurality of spaced points along the length of the arc after it has been moved laterally to effect its extinction.

4. In a circuit interrupter, an elongated arcing passage having a relatively wide portion and a relatively restricted portion, means for establishing an arc in the wide portion, means for moving the arc laterally into the restricted portion, at least one fluid inlet passage positioned laterally on one wall of the restricted portion leading into the restricted portion of the elongated arcing passage, and means for forcing fluid through the inlet passage into the restricted portion to blast the arc after it has moved laterally into the restricted portion.

5. In a circuit interrupter, an elongated arcing passage having a relatively wide portion and a relatively restricted portion, means for establishing an arc in the wide portion, means for moving the arc laterally into the restricted portion, a plurality of fluid inlet passages positioned laterally on one wall of the restricted portion leading into the restricted portion of the elongated arcing passage, and means for forcing fluid through the inlet passages into the restricted portion to blast the arc after it has moved laterally into the restricted portion, the arc only moving laterally into the restricted portion during relatively low instantaneous values of arcing current.

6. In a circuit interrupter, an elongated arcing passage having a relatively wide portion and a relatively restricted portion, means for establishing an arc in the wide portion, means for moving the arc laterally into the restricted portion, at least one fluid inlet passage positioned laterally on one wall of the restricted portion leading into the restricted portion of the elongated arcing passage, and piston means for forcing fluid through the inlet passage into the restricted portion to blast the arc after it has moved laterally into the restricted portion.

7. In a circuit interrupter, means for establishing an arc, means defining a restricted slot into which the arc is moved only during low instantaneous values of arcing current, a piston chamber disposed in a lateral wall of the slot, a plurality of fluid inlet passages leading from the piston chamber laterally into the slot, a piston movable into the piston chamber, the piston having such a small volume as compared with the piston chamber that pressure is maintained through all the inlet passages for forcing fluid therethrough to facilitate the extinction of the arc after the arc has moved into the restricted slot.

8. In a circuit interrupter, means for establishing an arc, means for causing a first flow of fluid substantially longitudinally of the arc, means other than the arc for producing a second flow of fluid, and means comprising the first flow of fluid for moving the arc laterally, the arc contacting the second flow of fluid after having moved laterally to facilitate its extinction.

9. In a circuit interrupter, an elongated arcing passage having a relatively wide portion and a relatively restricted portion, means for establishing an arc in the relatively wide portion, means for moving the arc laterally into the relatively restricted portion only during relatively low instantaneous values of arcing current, and means for directing a plurality of jets of fluid at the arc on opposite sides thereof at a plurality of spaced points along the length of the arc after it has been moved laterally into the relatively restricted portion to effect its extinction.

10. In a circuit interrupter, an elongated arcing passage having a relatively wide portion and a relatively restricted portion, means for establishing an arc in the relatively wide portion, means for moving the arc laterally into the relatively restricted portion only during relatively low instantaneous values of arcing current, and piston means for directing a plurality of jets of fluid at the arc on opposite sides thereof at a plurality of spaced points along the length of the arc after it has been moved laterally into the relatively restricted portion to effect its extinction.

11. In a circuit interrupter, means for establishing an arc, means for moving the arc laterally only during relatively low instantaneous values of arcing current, means at least partly of insulating material for forming a plurality of spaced independent fluid inlet passages terminating collectively at a place where the arc will be after it has moved laterally, and means for forcing fluid through the fluid inlet passages so as to strike the arc substantially along one side thereof at a plurality of spaced points after it has moved laterally to facilitate its extinction.

12. In a circuit interrupter, means for establishing an arc, means for moving the arc laterally only during relatively low instantaneous values of arcing current, means at least partly of insulating material for forming a plurality of spaced independent fluid inlet passages terminating collectively at a place where the arc will be after it has moved laterally, and piston means for forcing fluid through the fluid inlet passages so as to strike the arc substantially along one side thereof at a plurality of spaced points after it has moved laterally to facilitate its extinction.

13. In a circuit interrupter, means for establishing an arc, means for moving the arc laterally only during relatively low instantaneous values of arcing current, means at least partly of insulating material for forming a plurality of spaced

independent fluid inlet passages terminating collectively into two groups on opposite sides of the arc at a place where the arc will be after it has moved laterally, and means for forcing fluid through the fluid inlet passages so as to strike the arc substantially on opposite sides thereof at a plurality of spaced points along its length after it has moved laterally to effect its extinction.

14. In a circuit interrupter, means for establishing an arc, means for moving the arc laterally only during relatively low instantaneous values of arcing current, means at least partly of insulating material for forming a plurality of spaced independent fluid inlet passages terminating collectively into two groups on opposite sides of the arc at a place where the arc will be after it has moved laterally, and piston means for forcing fluid through the fluid inlet passages so as to strike the arc substantially on opposite sides thereof at a plurality of spaced points along its length after it has moved laterally to effect its extinction.

15. In a circuit interrupter, means for establishing an arc, a first fluid moving means to bias the arc laterally, means restraining the lateral movement of the arc until only low instantaneous values of arcing current, and a second independent fluid moving means to force fluid at the arc after it has moved laterally to effect its extinction.

16. In a circuit interrupter, means for establishing an arc, a first fluid moving means to bias the arc laterally, means restraining the lateral movement of the arc until only low instantaneous values of arcing current, and a second independent fluid moving means to force fluid at the arc at a plurality of spaced points along the length of the arc after it has moved laterally to effect its extinction.

17. In a circuit interrupter, means for establishing an arc, a first piston means to bias the arc laterally, means restraining the lateral movement of the arc until only low instantaneous values of arcing current, and a second independent piston means to force fluid at the arc after it has moved laterally to effect its extinction.

18. In a circuit interrupter, means for establishing an arc, a first piston means to bias the arc laterally, means restraining the lateral movement of the arc until only low instantaneous values of arcing current, and a second independent piston means to force fluid at the arc at a plurality of spaced points along the length of the arc after it has moved laterally to effect its extinction.

19. In a circuit interrupter, an arc extinguishing unit, means at least partly of insulating material defining an elongated arcing passage having a relatively wide portion and a relatively restricted portion, means for establishing an arc in the relatively wide portion, means for moving the arc into the relatively restricted portion, two piston chambers spaced on opposite sides of the restricted portion, two piston members simultaneously movable within the two piston chambers, and at least one fluid inlet passage leading from each piston chamber into the restricted portion to blast fluid laterally at the arc after it has entered the restricted portion.

20. In a circuit interrupter, an arc extinguishing unit, means at least partly of insulating material defining an elongated arcing passage having a relatively wide portion and a relatively restricted portion, means for establishing an arc in the relatively wide portion, means for moving the arc into the relatively restricted portion, two

15

piston chambers spaced on opposite sides of the restricted portion, two piston members simultaneously movable within the two piston chambers, at least one fluid inlet passage leading from each piston chamber into the restricted portion to blast fluid laterally at the arc after it has entered the restricted portion, and the spacing of the restricted portion being so narrow that the arc can only move therein during relatively low instantaneous values of arcing current.

21. In a circuit interrupter, an arc extinguishing unit, means at least partly of insulating material defining an elongated arcing passage having a relatively wide portion and a relatively restricted portion, a relatively stationary contact, a first piston member carrying a movable contact and cooperable with the stationary contact to establish an arc in the relatively wide portion, the first piston member moving fluid to bias the arc into the relatively restricted portion, two piston chambers spaced on opposite sides of the restricted portion, two second piston members simultaneously movable within the two piston chambers, and at least one fluid inlet passage leading from each piston chamber into the restricted portion to blast fluid laterally at the arc after it has entered the restricted portion.

22. In a circuit interrupter, an arc extinguishing unit, means at least partly of insulating material defining an elongated arcing passage having a relatively wide portion and a relatively restricted portion, a relatively stationary contact, a first piston member carrying a movable contact and cooperable with the stationary contact to establish an arc in the relatively wide portion, the first piston member moving fluid to bias the arc into the relatively restricted portion, two piston chambers spaced on opposite sides of the restricted portion, two second piston members simultaneously movable within the two piston chambers, at least one fluid inlet passage leading from each piston chamber into the restricted portion to blast fluid laterally at the arc after it has entered the restricted portion, and the spacing of the restricted portion being so narrow that the arc can only move therein during relatively low instantaneous values of arcing current.

23. In a circuit interrupter, means defining an elongated arcing passage having a relatively wide portion and a relatively restricted portion leading to a less restricted portion, means for establishing an arc in the wide portion, means for moving the arc laterally through the relatively restricted portion and into the less restricted portion, at least one fluid inlet passage positioned laterally on one wall of the less restricted portion leading into the less restricted portion of the elongated arcing passage, and means for forcing fluid through the inlet passage into the less restricted portion to blast the arc after it has moved laterally through the restricted portion.

16

24. In a circuit interrupter, means defining an elongated arcing passage having a relatively wide portion and a relatively restricted portion leading to a less restricted portion, means for establishing an arc in the wide portion, a first fluid moving means for biasing the arc laterally through the relatively restricted portion and into the less restricted portion, at least one fluid inlet passage positioned laterally on one wall of the less restricted portion leading into the less restricted portion of the elongated arcing passage, and second fluid moving means for forcing fluid through the inlet passage into the less restricted portion to blast the arc after it has moved laterally through the restricted portion.

25. In a circuit interrupter, an arc extinguishing unit, means defining an elongated arcing passage, the arcing passage including a relatively wide portion and a relatively restricted portion leading to a less restricted portion, means defining venting means beyond the less restricted portion, a relatively stationary contact, a first piston member carrying a movable contact and cooperable with the relatively stationary contact to establish an arc within the relatively wide portion of the arcing passage, two piston chambers spaced on opposite sides of the less restricted portion, two second piston members movable within the piston chambers, a plurality of spaced fluid inlet passages leading from each piston chamber to the less restricted portion of the arcing passage, the second piston members being operable to blast fluid at the arc on opposite sides thereof from a plurality of spaced points along its length after it has passed through the restricted portion.

26. In a circuit interrupter, an arc extinguishing unit, means defining an elongated arcing passage, the arcing passage including a relatively wide portion and a relatively restricted portion leading to a less restricted portion, means defining venting means beyond the less restricted portion, a relatively stationary contact, a first piston member carrying a movable contact and cooperable with the relatively stationary contact to establish an arc within the relatively wide portion of the arcing passage, two piston chambers spaced on opposite sides of the less restricted portion, two second piston members movable within the piston chambers, a plurality of spaced fluid inlet passages leading from each piston chamber to the less restricted portion of the arcing passage, the second piston members being operable to blast fluid at the arc on opposite sides thereof from a plurality of spaced points along its length after it has passed through the restricted portion and the spacing of the restricted portion being such that the arc may only enter through the restricted portion during relatively low instantaneous values of arcing current.

WINTHROP M. LEEDS.