March 21, 1950 J. M. CUMMING 2,501,318

FLUID BLAST CIRCUIT BREAKER

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Fig. 1.

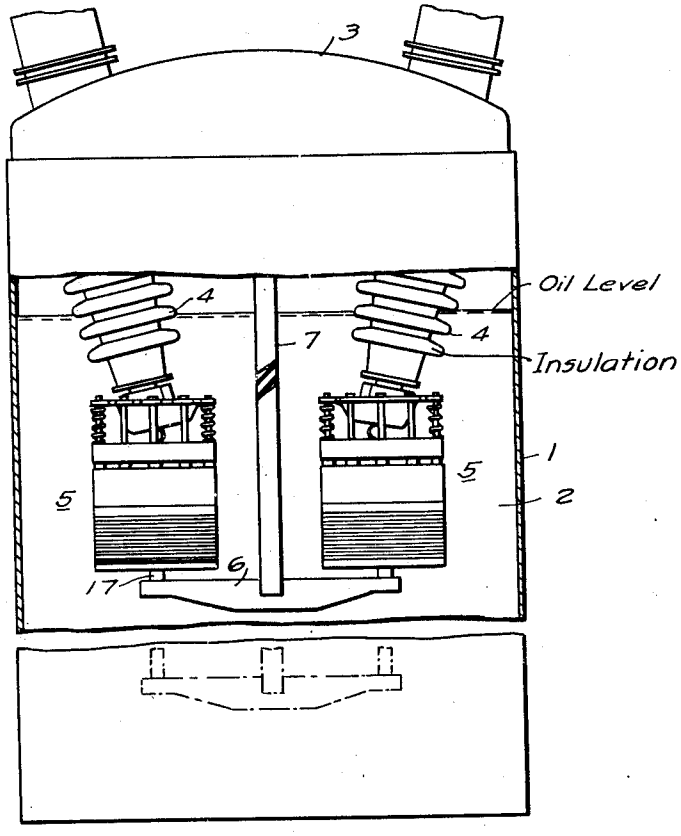
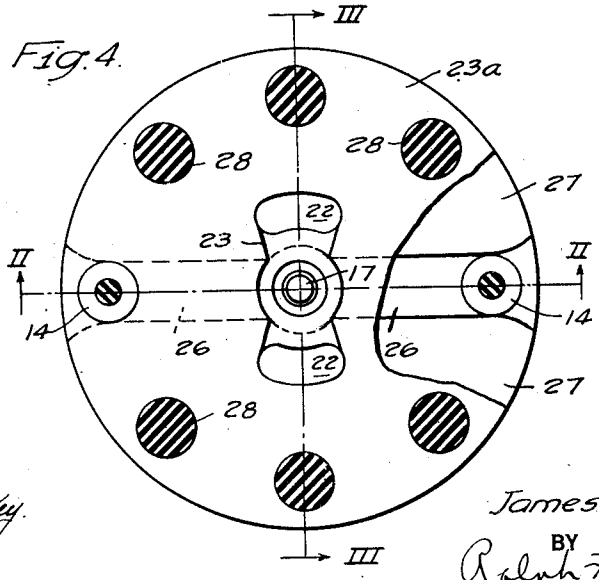


Fig. 4.



WITNESSES:
E. A. Mikolasky
W. R. Court

INVENTOR
James M. Cumming
BY
Ralph W. Summerhill
ATTORNEY

March 21, 1950 J. M. CUMMING 2,501,318

FLUID BLAST CIRCUIT BREAKER

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Fig. 2.

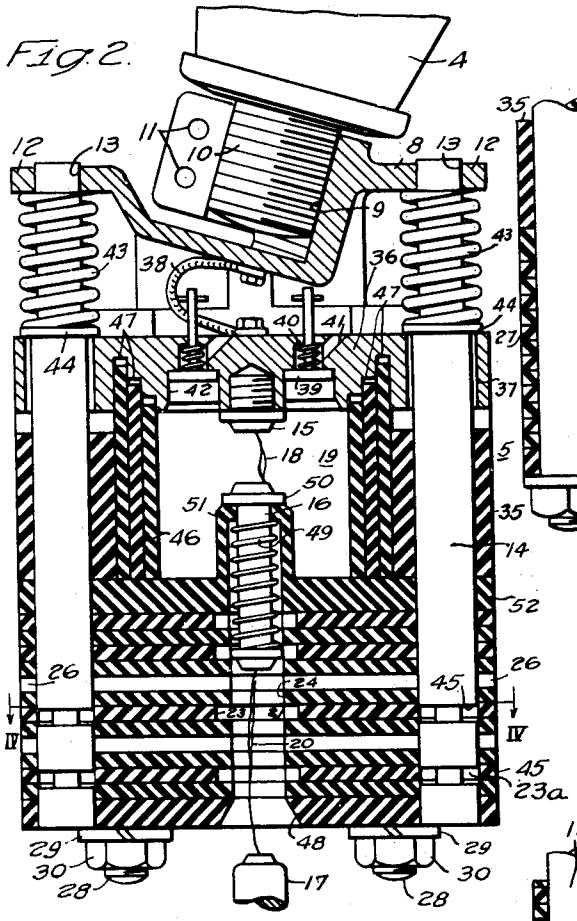


Fig. 3.

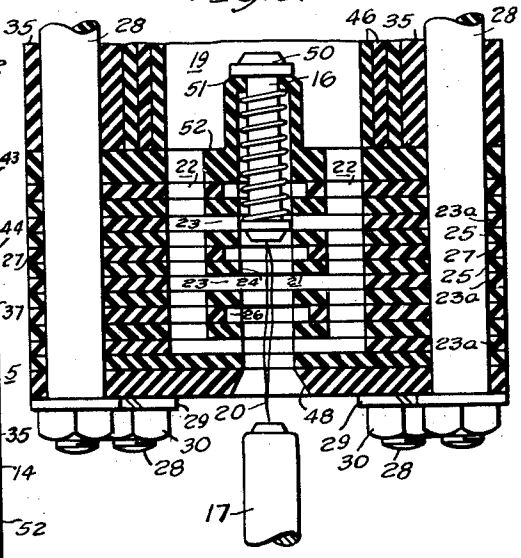


Fig. 5.

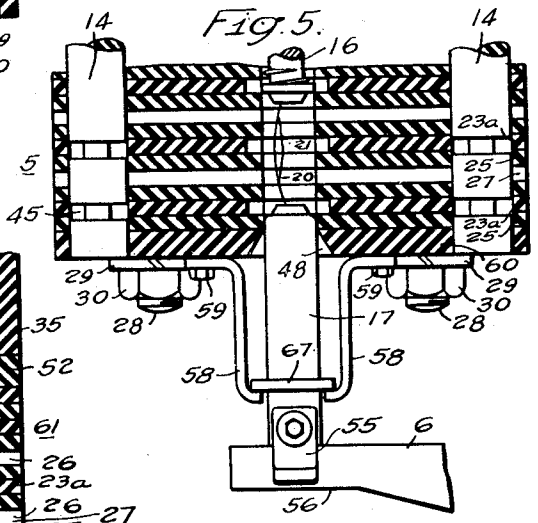
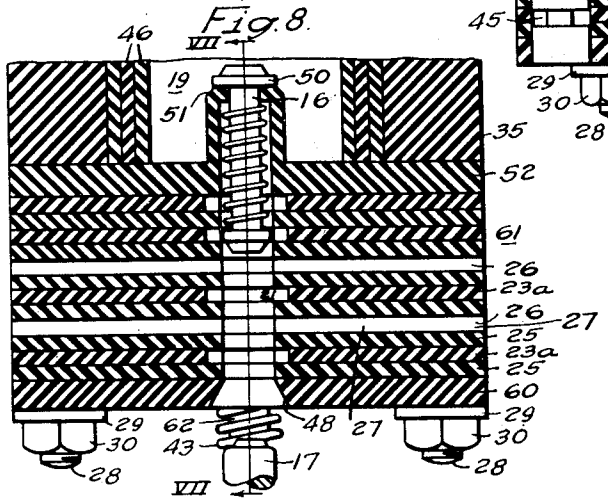


Fig. 8.



INVENTOR

James M. Cumming.

BY

Ralph H. Swingle

ATTORNEY

March 21, 1950 J. M. CUMMING 2,501,318

FLUID BLAST CIRCUIT BREAKER

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Fig. 7.

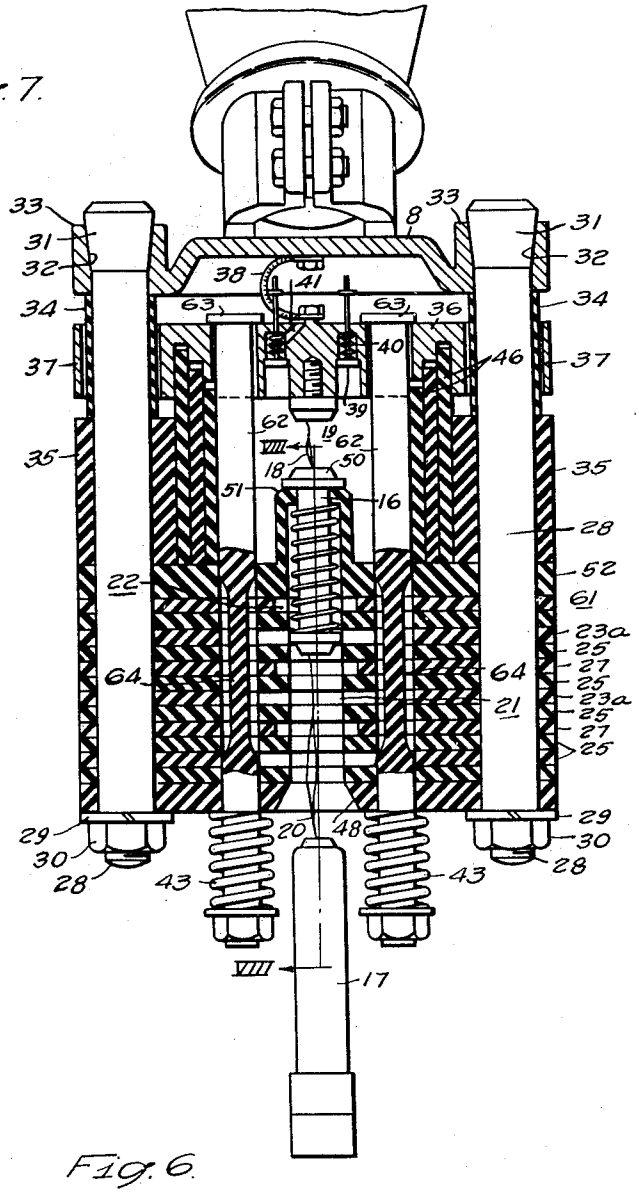
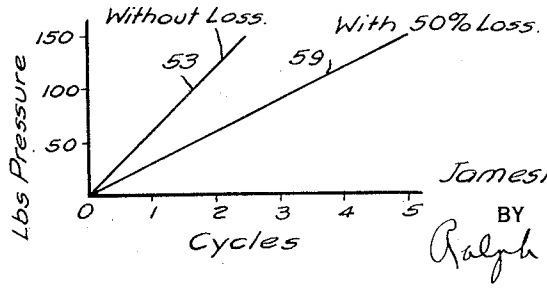


Fig. 6.



WITNESSES:
B. A. McCloskey.
W. R. Court

INVENTOR
James M. Cumming.
BY
Ralph H. Swingle
ATTORNEY

March 21, 1950 J. M. CUMMING 2,501,318

FLUID BLAST CIRCUIT BREAKER

Filed Sept. 12, 1946 4 Sheets-Sheet 4

Fig. 9.

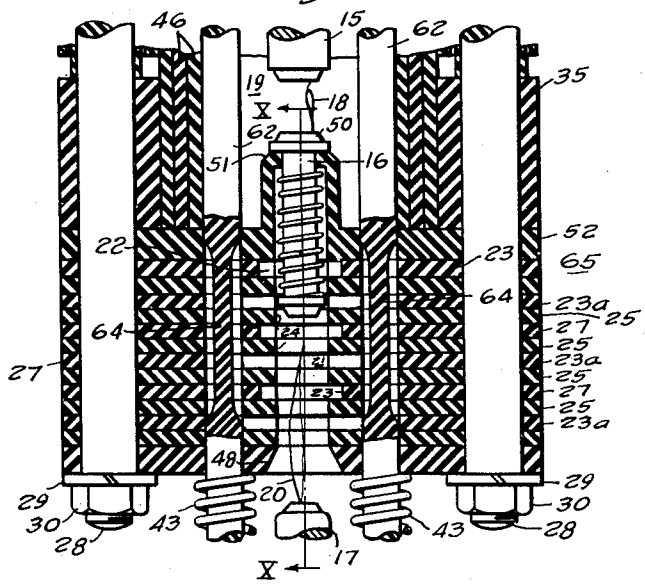
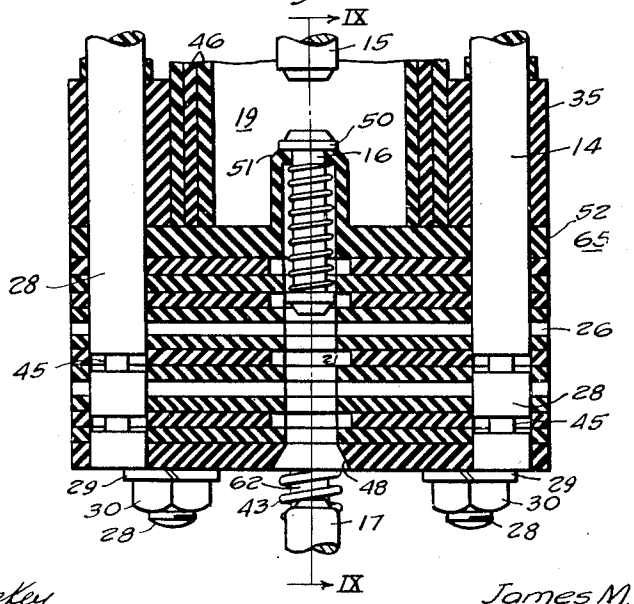


Fig. 10.



WITNESSES:

E. G. McCloskey.

W. R. Court

INVENTOR

James M. Cumming.

BY

Ralph W. Swingle

ATTORNEY

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UNITED STATES PATENT OFFICE

2,501,318

FLUID BLAST CIRCUIT BREAKER

James M. Cumming, Turtle Creek, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application September 12, 1946, Serial No. 696,573

11 Claims. (Cl. 200—150)

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

A general object of my invention is to provide an improved arc-extinguishing unit in which the pressures within the unit are controlled to effectively bring about circuit interruption.

A more specific object is to provide a circuit interrupter embodying one or more arc-extinguishing units in which valve means are incorporated to control the venting to or exhaust from the interrupting chamber of fluid directed from the pressure-generating chamber. Preferably, the valve means is responsive to the pressure within the pressure-generating chamber.

A further object is to provide an improved arc-extinguishing structure of the type having pressure-generating, intermediate and movable contacts in which the interrupting arc established between the intermediate and movable contacts is subjected to more effective fluid flow and pressure conditions than has been obtained heretofore.

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

Figure 1 is a side elevational view, partly in section, of a circuit interrupter embodying my invention and shown in the closed circuit position;

Fig. 2 is an enlarged vertical sectional view through the right-hand arc-extinguishing unit of Fig. 1, the contacts being shown in the partially open circuit position, low current conditions being assumed;

Fig. 3 is a fragmentary enlarged vertical sectional view taken along the line III—III of Fig. 4;

Fig. 4 is a sectional view taken along the line IV—IV of Fig. 2;

Fig. 5 is a modified type of arc-extinguishing unit similar to that set forth in Figs. 1–4, except that a modified type of disconnecting arrangement is provided;

Fig. 6 is a curve showing the advantages of employing my invention;

Fig. 7 is a modified type of arc-extinguishing unit in which valve means are only employed in the inlet passage means;

Fig. 8 is a fragmentary vertical sectional view taken along the line VIII—VIII of Fig. 7;

Fig. 9 is a sectional view of a modified type of arc-extinguishing unit having valve means both disposed in the inlet passage means and also in

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the exhaust passage means taken on the line IX—IX of Fig. 10; and

Fig. 10 is a fragmentary sectional view taken along the line X—X of Fig. 9.

Referring to the drawings, and more particularly to Fig. 1, the reference numeral 1 designates a tank in which is disposed a suitable arc-extinguishing fluid 2, in this instance circuit breaker oil, filling the tank 1 to the level indicated. Depending from the cover 3 of the tank 1 are two insulating bushings 4 of identical construction, carrying at their lower ends identical arc-extinguishing units generally designated by the reference numeral 5 and electrically interconnected by a conducting bridging member 6 actuated vertically in a reciprocal manner by an insulating operating rod 7.

Referring to Fig. 2, which shows more clearly than Fig. 1 the internal construction of the arc-extinguishing unit 5, it will be observed that I have provided a stationary contact foot casting 8 which is threadedly secured as at 9 to the lower end of the terminal stud 10, which passes upwardly interiorly through the bushing 4. After the contact foot 8 is threadedly secured in position, it may be clamped in place by bolts (not shown) extending through apertures 11 provided in the contact foot 8. The contact foot 8 has off-standing lug portions 12 integrally formed therewith, the latter having apertures 13 provided therethrough. A pair of valve rods 14 have their upper extremities serving as guide portions for projecting upwardly through the apertures 13 of the lug portions 12 of contact foot 8. The body portions of the valve rod 14 constituting valve means extending interiorly within the arc-extinguishing unit 5.

The contact structure associated with the arc-extinguishing unit 5 includes a relatively stationary pressure-generating contact 15, an intermediate contact 16 and a lower movable contact 17, the latter constituting an upstanding portion of the conducting bridging member 6. The stationary pressure-generating contact 15 cooperates with the intermediate contact 16 to establish a pressure-generating arc 18 within a substantially confined pressure-generating chamber, generally designated by the reference numeral 19. An interrupting arc 20 is established between the tip portion of the lower movable contact 17 and the lower extremity of the intermediate contact 16 within a vented interrupting chamber generally designated by the reference numeral 21. The plate structure forming the pressure-generating chamber 19 and the vented interrupting chamber

21 is of the type more clearly set forth and claimed in United States patent application Serial No. 465,244, filed November 11, 1942, by Leon R. Ludwig, Winthrop M. Leeds and Benjamin P. Baker, now U. S. Patent 2,406,469, issued August 27, 1946, and assigned to the assignee of the instant application.

Referring more particularly to Figs. 3 and 4, it will be observed that the pressure-generating chamber 19 communicates through inlet passage means, including two vertically disposed fluid passages generally designated by the reference numeral 22 and formed upon alignment of openings provided in the several insulating plates. The fluid passages 22 communicate with a plurality, in this instance three, pairs of inlet passages 23 leading toward the interrupting arc 20 and provided by a plurality of inlet plates 23a. After the fluid contacts the interrupting arc, it may pass through orifices 24 provided by a plurality of orifice insulating plates 25 and pass laterally outwardly from the interrupting chamber 21 to the region exterior of the unit 5 through exhaust passage means, including oppositely disposed exhaust passages 26 formed by the cooperation of two identically formed vent plates 27 (Fig. 4). It will, consequently, be apparent that fluid under pressure formed at the pressure-generating arc 18 will be forced downwardly through the two vertical flow passages 22, or inlet passage means, through the inlet passages 23 to contact the interrupting arc 20 and pass laterally out of the unit 5 through the exhaust passages 26.

The several plates are held fixedly in position by a plurality, in this instance six, insulating tie rods 28, the disposition of which is more clearly shown in Fig. 4. The tie rods 28 extend longitudinally of the unit 5 and have lock washers 29 together with nuts 30 at their lower ends, with the upper ends of the tie rods 28 being enlarged as at 31 (Fig. 7) and extending through apertures 32 provided in off-standing lug portions 33 of the contact foot casting 8. Insulating sleeves 34 are disposed between the lower side of the contact foot 8 and a ring-shaped insulating block member 35 which rests upon the upper side of the several plates forming the interrupting chamber or passage 21. Thus, the several plates constituting the interrupting chamber 21 with the ring-shaped insulating member 35 are secured fixedly in position relative to the contact foot 8.

It will be observed that the substantially confined pressure-generating chamber 19 has a conducting movable pressure plate 36 disposed at its upper end having a plurality of circumferentially disposed apertures 37 therein through which extend the two valve rods 14 and the six insulating tie rods 28. The pressure plate 36 thus is slidably guided by means of the two valve rods 14 and the insulating sleeves 34 surrounding the tie rods 28.

The conducting pressure plate 36 is electrically connected to the contact foot 8 by a flexible connector 38. The pressure plate 36 carries the relatively stationary pressure-generating contact 15. Also, an annular gas relief valve 39 is associated with the pressure plate 36, being spring-biased downwardly to its open position by compression springs 40 so that gas collected within the pressure-generating chamber 19 may exhaust from the said chamber through passages 41 provided in the pressure plate 36. The volume of the annular recess 42 within which the annular valve 39 moves is such that during the closing

stroke, the volume of the intermediate contact 16 projected into the pressure chamber 19 is compensated by the volume provided by upward movement of the annular valve 39 within the annular operating recess 42. Consequently, there is no tendency for the incompressible oil within the pressure chamber 19 to block upward movement of the intermediate contact 16 during the closing operation of the interrupter.

It will be observed that the two valve rods 14 are biased downwardly by compression springs 43 disposed between flanges 44 integrally formed with the valve rods 14 and the lug portions 12 of the contact foot 8. Thus, the valve rods 14 are biased downwardly so that reduced portions 45 cut in the valve rods 14 do not register with the exhaust passages 26 provided by the vent plates 27. Therefore, in the closed circuit position of the interrupter, as shown in Fig. 1 of the drawings, the exhaust passages 26 are closed by the valve rods 14 and are only opened upon a predetermined pressure within the pressure-generating chamber 19.

The pressure-generating chamber 19 has wall means including a plurality of overlapping cylindrical members 46 having their upper ends disposed in a plurality of annular recesses 47 formed in the lower side of the pressure plate 36. Thus, when the expansible pressure-generating chamber 19 expands by upward movement of the pressure plate 36, the effective area on the pressure plate 36 upon which the pressure within the pressure-generating chamber 19 acts is progressively increased by successive uncovering of the ends of the cylindrical members 46. Thus, the spring pressure is constant during the operation because of the design of the chamber top which works in a series of cylinders, exposing a variable area to the pressure as the top lifts. The flexibility in the chamber top is also used when the interrupter is closed to supply contact pressure. This is possible because of the short travel necessary for that function.

It will be observed that the valves 14 shut off exit of oil or gas from the unit 5 until the valves 14 are opened by pressure within the pressure chamber 19. This storing of energy in the grid until such time as it reaches anything from five to ten atmospheres before the valves 14 are opened superimposes pressure on the oil which surrounds the interrupting arc 20 holding it to a minimum size, whereby it can be more easily interrupted. The use of this high pressure combination with sudden release thereof will make the interruption of arcing over a longer range from low to high current possible. Previous designs of interrupter have used pressure arc energy to push the oil into the arc, but instead of holding that pressure, allow probably fifty percent of the pressure to escape through the open exhaust ports thus lengthening the time necessary to build up sufficient pressure to take care of interrupting low currents. In the case of extremely low currents where insufficient pressure may be generated to open the exhaust port valves 14, the full pressure will be behind the flow of oil which will blow through the opening 46 left by the moving contact 17 when it leaves the unit 5. This condition is shown in Figs. 2 and 3 where very low current conditions are assumed and where the pressure within the pressure chamber 19 is insufficient to cause appreciable opening of the valves 14 to open the exhaust passage means 26.

The operation of my improved interrupter will now be explained. In the closed circuit position

the electrical circuit includes terminal stud 10, contact foot 8, flexible connector 38, conducting pressure plate 36, stationary contact 15, intermediate contact 16 through lower movable contact 17 and across the conducting bridging member 6 to the other arc-extinguishing unit 5 of the interrupter. The circuit extends through the other unit 5 in an identical manner with its passage through the right-hand unit 5. When it is desired to open the electrical circuit passing through the interrupter or in response to overload conditions existing in the electrical circuit controlled by the interrupter, suitable mechanism (not shown) is actuable to cause downward movement of the insulating operating rod 7. The downward movement of the operating rod 7 causes corresponding downward movement of the conducting bridge 6 and the lower movable contacts 17 secured to the extremities thereof.

Referring to Fig. 2, the downward movement of the lower movable contact 17 permits the downward movement of the intermediate contact 16 as caused by the compression spring 49 to thereby establish a pressure-generating arc 18 within the substantially confined pressure-generating chamber 19. When the flange 50 secured to and movable with the intermediate contact 16 strikes the shoulder portion 51 afforded by the insulating plate 52, the intermediate contact 16 will cease its downward movement. The consequent separation between the lower movable contact 17 and the lower extremity of the intermediate contact 16 will establish an interrupting arc 20 within the interrupting chamber or passage 21.

Fluid under pressure from the pressure-generating arc 18 will flow downwardly through the vertical flow passages or inlet passage means 22, more clearly shown in Figs. 3 and 4, to pass radially inwardly toward the interrupting arc 20 through a plurality of pairs of inlet passages 23. After contacting the interrupting arc 20, the fluid passes through the orifices 24 provided by the orifice insulating plates 25 to pass out the exhaust passages 26, assuming that the valve rods 14 have raised sufficiently to permit opening of the exhaust passages 26. This condition, however, is not assumed in Figs. 2 to 4, these figures merely assuming the current being interrupted to be so low as to cause insufficient pressure within the chamber 19 to cause opening of the valve rods 14.

The amount of pressure generated within the pressure-generating chamber 19 will determine the amount of upward movement of the pressure plate 36. The pressure plate 36 is, of course, biased downwardly by the compression springs 43 which also bias the valves 14 to their closed position. As the pressure plate 36 moves upwardly, it successively uncovers the upper ends of the cylindrical members 46 to thereby permit an increasingly greater cross-sectional area of the pressure plate 36 to be acted upon. Thus, the spring pressure exerted by the compression springs 43 as these springs collapse is offset by the increasing area upon which the pressure acts against the pressure plate 36.

Fig. 6 shows a graph which explains the benefits in time saving where no loss in generated pressure is allowed. This curve is represented by the reference numeral 53. The curve 54 represents the condition which exists where approximately fifty percent of the pressure is allowed to escape through open exhaust ports. From this graph it will be apparent that the interrupting time is reduced by approximately half because of the provision of the valve control rods 14 which close the exhaust passages 26 until a predetermined pressure exists within the pressure-generating chamber 19.

Fig. 5 shows a construction in which the lower end of the interrupting passage 21 is not opened upon continued downward movement of the lower movable contact 17. In this case the lower movable contact 17 has an identical construction and functions the same as the lower movable contact 17 of Fig. 2 except that it has a disconnect portion 55 which is engaged by a movable disconnect contact 56 which is disposed at the extremity of the conducting bridging member 6. The downward movement of the movable contact 17 is determined by a flange 67 secured thereto and movable therewith which strikes stop lugs 58 secured by screws 59 to the bottom plate 60 of the grid or unit 5. With this construction the pressure within the interrupting chamber 21 is not permitted to be relieved by unplugging of the interrupting passage 21 by withdrawal of the movable contact 17 entirely from the unit 5. The presence of the movable contact 17 in the lower end of the interrupting passage 21 maintains the pressure high within the interrupting passage 21 which is beneficial where very low currents are being interrupted of not sufficient magnitude to cause raising of the valve rods 14 and consequent opening of the exhaust passages 26.

It will, of course, be apparent to those skilled in the art that continued downward movement of the conducting cross member 6 provides a disconnect gap between the disconnect portion 55 of the movable contact 17 and the movable disconnect contact 56 in the fully open circuit position of the interrupter (not shown). Thus, in Fig. 5 I show a modified construction in which the lower end of the interrupting passage 21 is not vented near the end of the opening operation. As mentioned previously, this has distinct advantages in the interruption of very low amperage currents where insufficient pressure is generated at the pressure-generating arc 18 within the pressure chamber 19.

Figs. 7 and 8 show a modified construction of arc-extinguishing unit generally designated by the reference numeral 61 in which the valve rods 14 are omitted and the exhaust passages 26 are open at all times, as clearly shown in Fig. 8. However, in this modified construction, I provide valve rods 62 responsive to the pressure within the pressure-generating chamber 19 which control the opening of the inlet passage means 22 interconnecting the pressure-generating chamber 19 with the interrupting chamber 21. The valve rods 62 are of generally similar construction to the valve rods 14 previously described in connection with Figs. 1–4.

Thus the valve rods 62 have heads 63 integrally formed therewith which are responsive to upward movement of the pressure plate 36 and hence responsive to the pressure within the pressure-generating chamber 19. The valve rods 62 controlling the inlet passage means 22 have annular reduced sections 64 formed therein and are biased downwardly by compression springs 43 which have a similar function to the compression springs 43 of the valve rods 14 described in connection with Fig. 2. Thus, the compression springs 43 of Fig. 7 not only bias the valve rods 62 toward their closed position but also bias the pressure plate 36 downwardly against the cylindrical members 46.

It will be apparent that in this embodiment of my invention the fluid directed from the pressure-

generating arc 18 toward the interrupting arc 20 within the inlet passage means 22 is controlled by the movement of the valve rods 62 which are responsive to the pressure within the pressure-generating chamber 19. When the pressure is sufficient within the pressure chamber 19 to cause upward movement of the pressure plate 36, this will raise the rods 62 to permit opening of the inlet passage means 22 and thereby permit fluid to flow from the pressure arc 18 toward the interrupting arc 20 in a manner as set forth previously in connection with Figs. 2–4. However, in the modified construction of Fig. 7, the exhaust passages 26 are open at all times as indicated in Fig. 8 and, consequently, once the valves 62 are raised, there is permitted free passage of fluid from the pressure arc 18 downwardly through the vertical flow passages 22 radially inwardly toward the interrupting arc 20 through the several pairs of inlet passages 23. After contacting the interrupting arc 20, the fluid passes through orifices 24 and freely out of the unit 61 through the open exhaust passages 26, the latter not being controlled by any valve means whatsoever.

Figs. 9 and 10 show a modified arc-extinguishing unit, generally designated by the reference numeral 65 and incorporating two sets of valve means. The first valve means is of the type set forth in Fig. 7 and consists of a pair of valve rods 62 having an identical construction to the valve rods 62 of Fig. 7. Also, the exhaust passages 26 in the modified type of arc-extinguishing unit 65 are controlled by valve rods 14 having an identical construction with the valve rods 14 of Fig. 2. Thus, in the modified unit 65 of Figs. 9 and 10, I have provided a first valve means for controlling the inlet passage means 22 and a second valve means 14 for controlling the exhaust passages 26. The direction of fluid flow from the pressure arc 18 toward the interrupting arc 20 is the same as previously described; consequently, a further description thereof appears unnecessary for an understanding of this embodiment of my invention.

It will be apparent that in all the constructions the entire grid is stationary and only the pressure plate 36 moves, being guided by the tie rods 28 and the valve rods 14 and/or 62. Thus, the movable pressure plate 36 is the expandable portion of the pressure-generating chamber 19 and by the expansion thereof controls the opening of the valve rods 14 controlling the exhaust passages 26 or the valve rods 62 controlling the opening of the inlet passage means 22.

It will be apparent that my invention describes a novel use of the pressure-generating arc in a two break type of arc extinguisher wherein the interrupting arc is contained under pressure and held to a minimum size for easy interruption. The invention reveals a way of containing the interrupting arc within the grid by the use of valves on the exhaust port which are opened by the pressure generated by the pressure-generating arc within the pressure-generating chamber. It will also be apparent that the construction of the pressure chamber is such that the top is flexible and controlled by spring pressure.

Preferably, the valves 14 store the energy within the grid until such time as it reaches anything from five to ten atmospheres before the valves 14 are open. This superimposes pressure upon the oil which surrounds the interrupting arc 20 holding it to a minimum size whereby it can be more easily interrupted. The use of this high

pressure combination with sudden release thereof will make the interruption of arcing over a longer range from low to high current possible. In the case of extremely low currents wherein insufficient pressure may be generated to open the exhaust port valves 14, the full pressure will be behind the flow of oil which will blow through the opening left by the moving contact when it leaves the grid. The disk valve 39 in the pressure chamber top is so designed that in closing the moving contact 16 moving into the pressure chamber 19 displaces approximately the same amount of oil that the valve chamber 42 will hold when moved up by the closing operation.

Although I have shown and described specific structures, it is to be clearly understood that the same were merely for the purposes of illustration and that changes and modifications may be readily made therein 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, means defining an arc-extinguishing unit, a substantially confined pressure-generating chamber disposed within the unit, an interrupting chamber positioned within the unit, exhaust passage means venting the interrupting chamber to the region exterior of the unit, contact means for establishing a pressure-generating arc within the pressure-generating chamber and an interrupting arc within the interrupting chamber regardless of the pressure therein, inlet passage means interconnecting the two arcs, valve means for opening the said inlet passage means responsive to the pressure within the pressure-generating chamber, and second valve means responsive to the pressure within the pressure-generating chamber for controlling the exhaust passage means.

2. In a circuit interrupter, means for establishing a pressure-generating arc within a substantially confined pressure-generating chamber, means for establishing a serially related interrupting arc within a vented interrupting chamber regardless of the pressure therein, inlet passage means interconnecting the two chambers so that fluid under pressure at the pressure-generating arc may flow toward the interrupting arc to effect the latter's extinction, and valve means responsive to the pressure within the pressure-generating chamber for controlling the opening of the inlet passage means.

3. In a circuit interrupter, an arc-extinguishing unit, means defining an expansible pressure-generating chamber, means defining an interrupting chamber, means for establishing a pressure-generating arc within the expansible pressure-generating chamber, means for establishing an interrupting arc within the interrupting chamber, exhaust passage means venting the interrupting chamber, inlet passage means interconnecting the pressure-generating and interrupting chambers, valve means responsive to the expansion of the expansible pressure-generating chamber for controlling the opening of the inlet passage means, and second valve means also responsive to the expansion of the expansible pressure-generating chamber for controlling the opening of the exhaust passage means.

4. In a circuit interrupter, an arc-extinguishing unit, means defining an expansible pressure-generating chamber, means defining an interrupting chamber, means for establishing a pressure-generating arc within the expansible pres-

sure-generating chamber, means for establishing an interrupting arc within the interrupting chamber regardless of the pressure therein, exhaust passage means venting the interrupting chamber, inlet passage means interconnecting the pressure-generating and interrupting chambers, and valve means responsive to the expansion of the expansible pressure-generating chamber to control the opening of inlet passage means.

5. In a circuit interrupter, an arc-extinguishing unit, a substantially confined pressure-generating chamber disposed at one end of the unit, an interrupting passage leading out of the other end of the unit, a pressure-generating contact, an intermediate contact cooperable with the pressure-generating contact to establish a pressure-generating arc within the pressure-generating chamber, a movable contact having a disconnecting portion separable from the intermediate contact to establish an interrupting arc within the interrupting passage, means preventing removal of the movable contact from the interrupting passage, a movable disconnect contact for moving the movable contact to the closed circuit position, exhaust passage means separate from the interrupting passage and leading from the interrupting passage to the region exteriorly of the unit, and valve means responsive to the pressure within the pressure-generating chamber for controlling the opening of the exhaust passage means.

6. In a circuit interrupter, means defining a pressure-generating chamber, means defining an interrupting chamber, contact means for establishing a pressure-generating arc within the pressure-generating chamber and an interrupting arc within the interrupting chamber, regardless of the pressure therein, and valve means other than the contact means responsive to the pressure within the pressure-generating chamber to control the flow of fluid into the interrupting chamber to effect the extinction of the interrupting arc therein.

7. In a circuit interrupter, means including a movable pressure plate defining a pressure-generating chamber wall means for the chamber including a plurality of overlapping cylindrical portions, and means permitting successive opening of the ends of the cylindrical portions to provide a progressively greater surface area on the pressure plate upon which the pressure acts as the pressure plate moves outwardly.

8. In a circuit interrupter, means including a movable pressure plate defining a pressure-generating chamber, wall means for the chamber including a plurality of overlapping cylindrical portions, means permitting successive opening of the ends of the cylindrical portions to provide a progressively greater surface area on the pressure plate upon which the pressure acts as the pressure plate moves outwardly, and biasing means for biasing the movable pressure plate inwardly.

9. In a circuit interrupter, an arc-extinguishing unit, means defining a pressure-generating chamber within the unit, means defining an interrupting passage leading out of the unit, a relatively stationary contact cooperable with an intermediate contact to establish a pressure-generating arc within the pressure-generating chamber, a movable contact movable out of the unit through the interrupting passage and cooperable with the intermediate contact to establish an interrupting arc within the interrupting passage regardless of the pressure therein, laterally extending vent means for the interrupting passage, and valve means responsive to the pressure within the pressure-generating chamber to control the opening of the vent means.

10. In a circuit interrupter, means including a movable pressure plate defining a pressure-generating chamber, wall means for the chamber including a plurality of overlapping cylindrical members, means permitting successive opening of the ends of the cylindrical members to provide a progressively greater surface area on the pressure plate upon which the pressure acts as the pressure plate moves outwardly, biasing means for biasing the movable pressure plate inwardly, and a relatively stationary contact secured to the pressure plate.

11. In a circuit interrupter, an arc-extinguishing unit, means defining a pressure-generating chamber within the unit, means defining an interrupting passage leading out of the unit, a relatively stationary contact cooperable with an intermediate contact to establish a pressure-generating arc within the pressure-generating chamber, a movable contact movable out of the unit through the interrupting passage and cooperable with the intermediate contact to establish an interrupting arc within the interrupting passage regardless of the pressure therein, inlet passage means interconnecting the pressure-generating chamber with the interrupting passage, and valve means responsive to the pressure within the pressure-generating chamber for controlling the opening of the inlet passage means.

JAMES M. CUMMING.

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