Feb. 22, 1949. J. R. WEBB ET AL 2,462,795

CIRCUIT INTERRUPTER

Filed Jan. 13, 1945

2 Sheets-Sheet 1

Fig. 1.

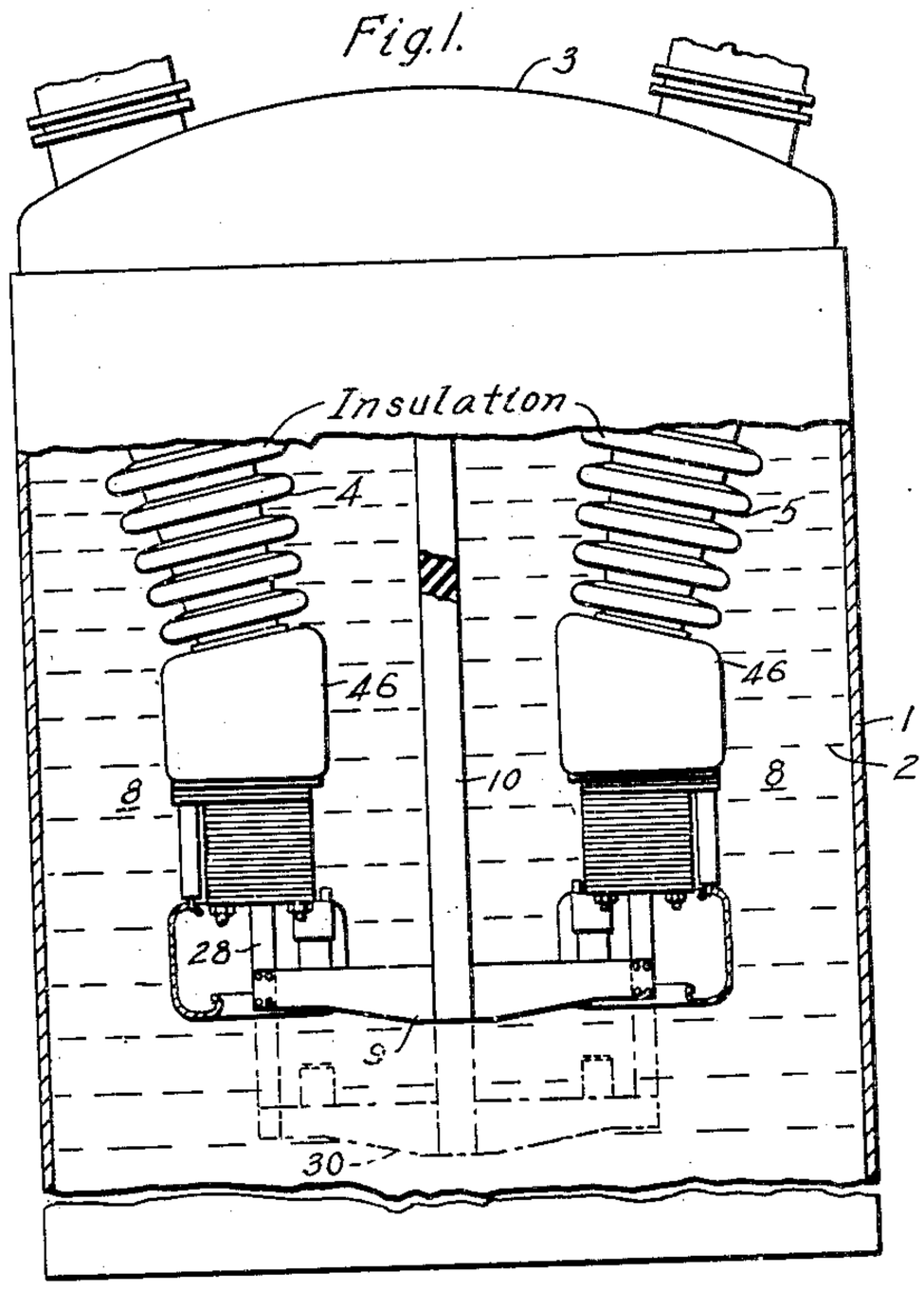


Fig. 2.

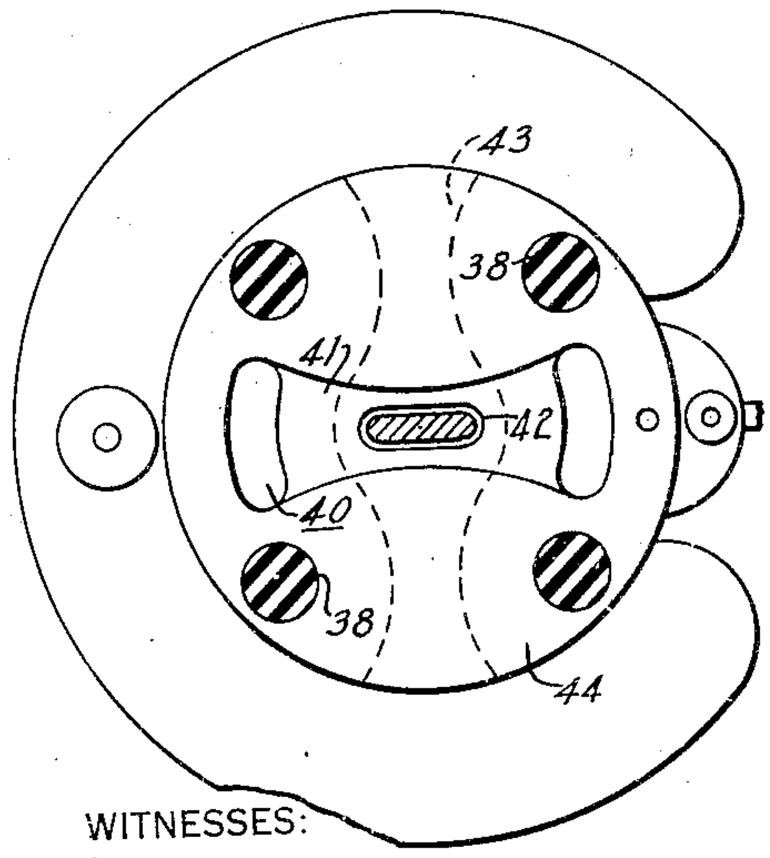
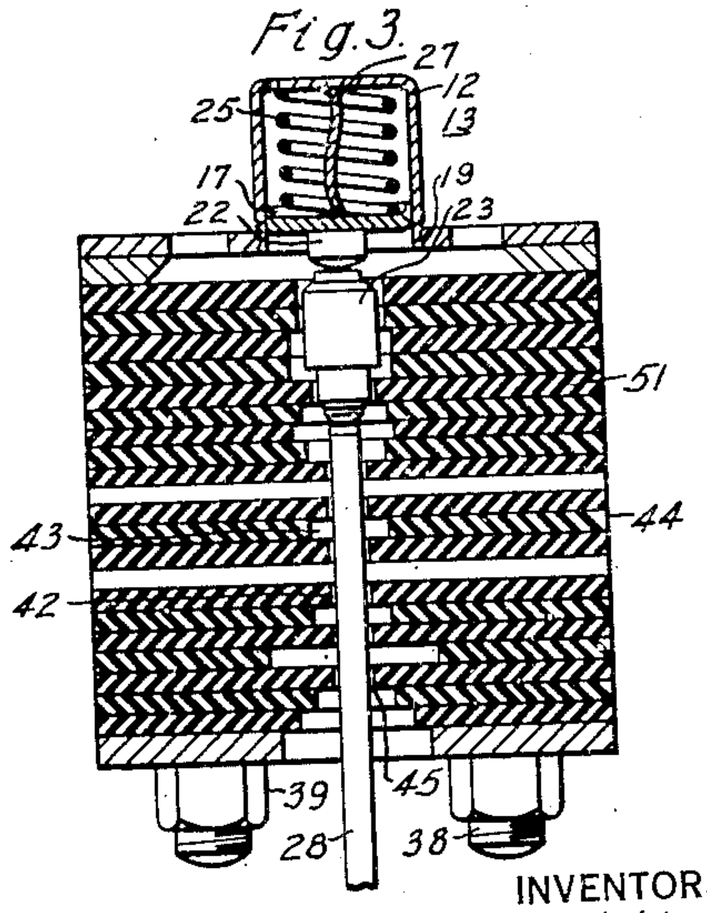


Fig. 3.



WITNESSES:

H. F. Susser.

W. R. Crout

INVENTORS

Josephine R. Webb and

Herbert J. Webb.

BY F. W. Lyle.

ATTORNEY

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2 Sheets-Sheet 2

Fig. 4

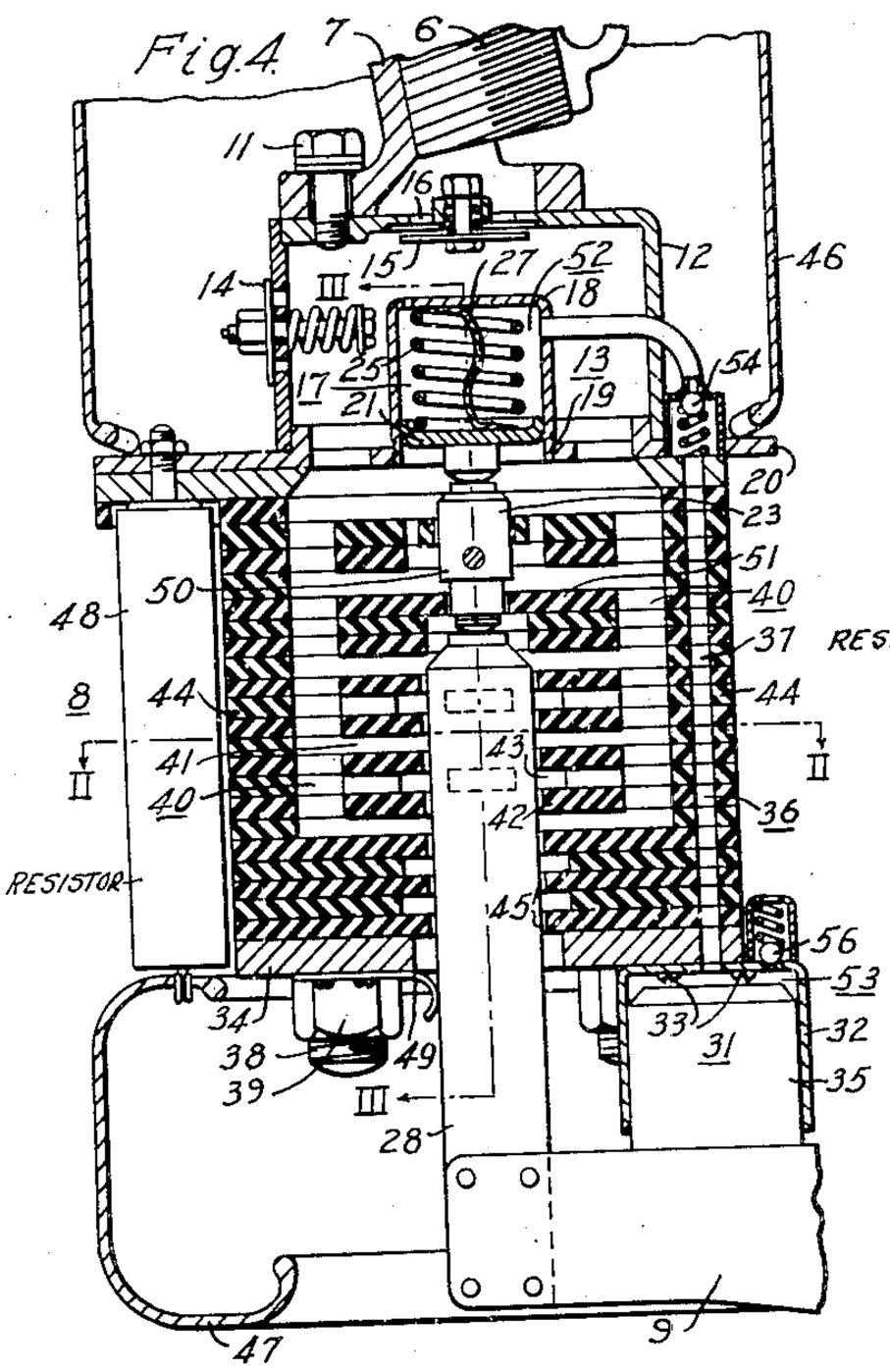


Fig. 5.

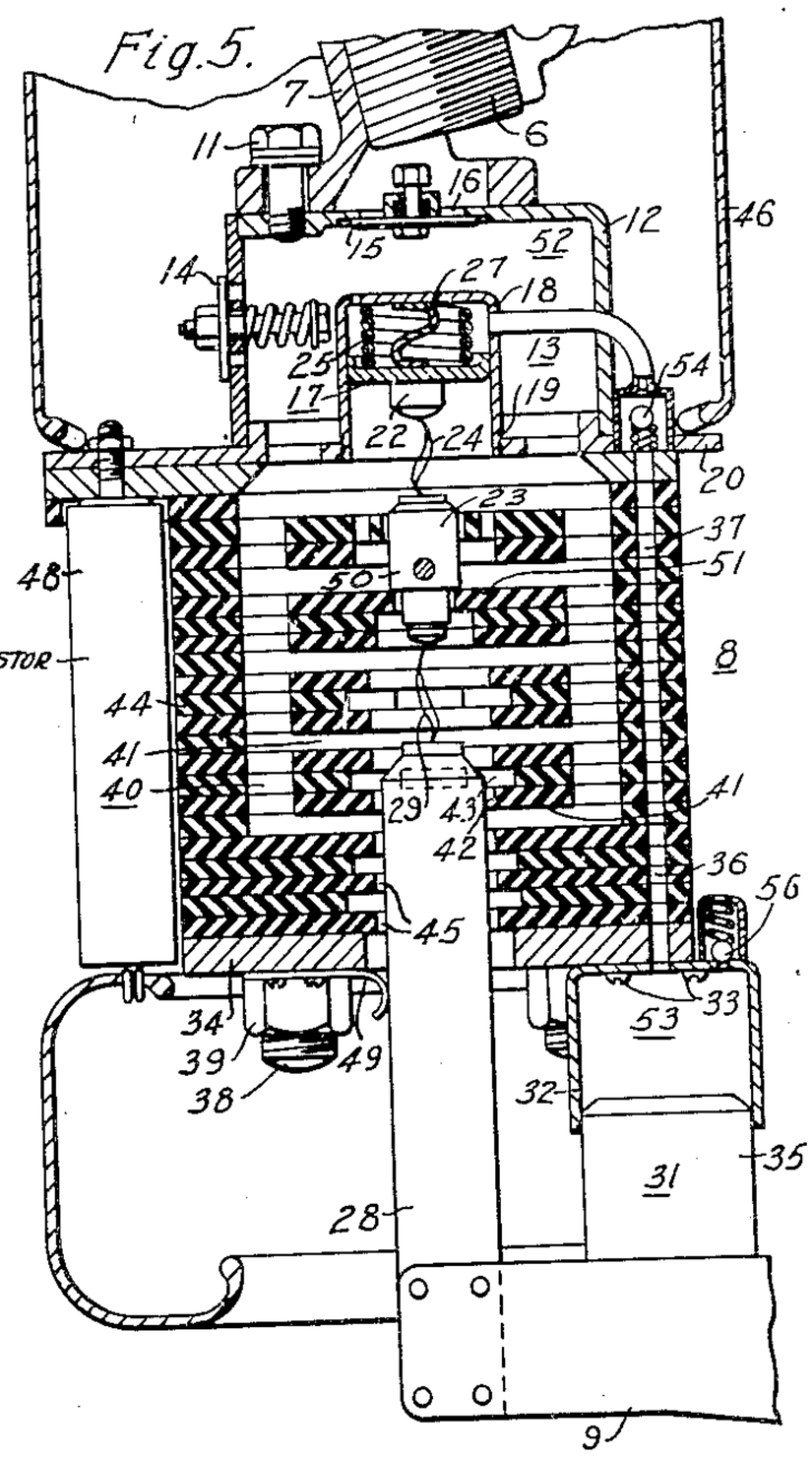


Fig. 6.

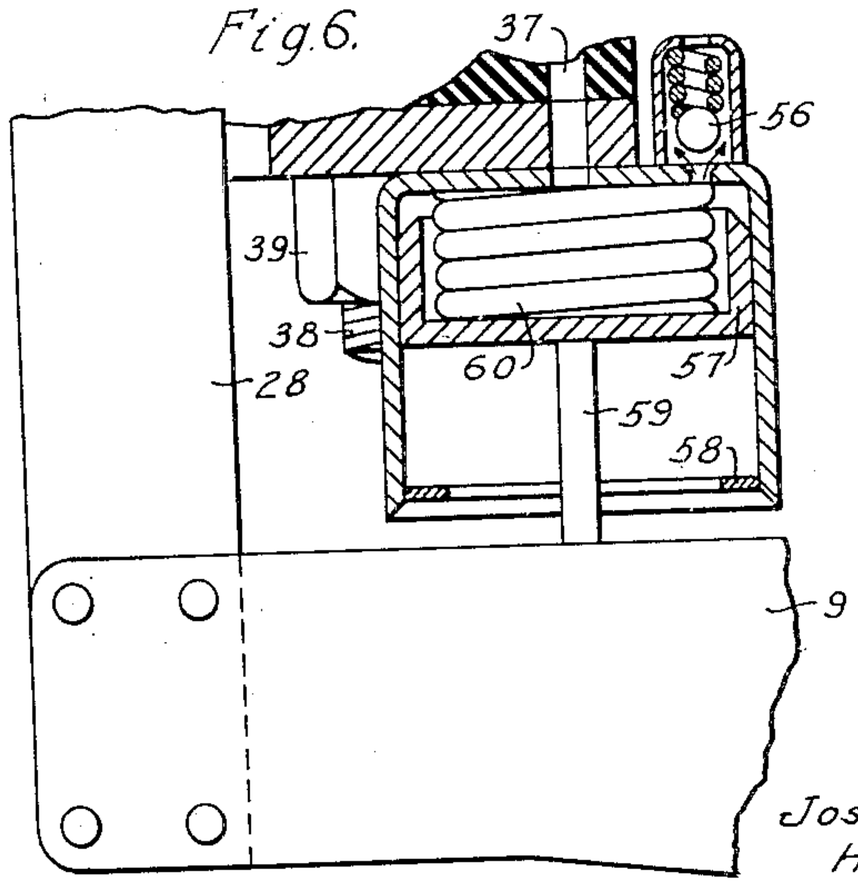
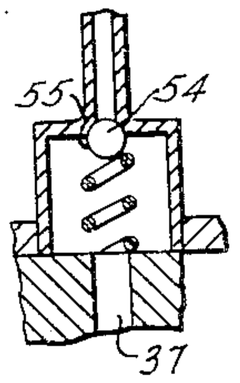


Fig. 7.



WITNESSES:

N. F. Susor

W. R. Crout

INVENTORS

Josephine R. Webb and

Herbert J. Webb.

BY

F. N. Lyle.

ATTORNEY

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UNITED STATES PATENT OFFICE

2,462,795

CIRCUIT INTERRUPTER

Josephine R. Webb and Herbert J. Webb, Forest Hills, Pa., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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8 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 our invention is to provide an improved circuit interrupter of improved construction to more effectively interrupt the circuit therethrough than has heretofore been achieved.

A more specific object is to provide an improved circuit interrupter in which hydraulic means are utilized for causing the separation of separable contacts to draw an arc therebetween. Such a construction has peculiar advantages as applied to an interrupter of the type employing both a pressure-generating arc and an interrupting arc in which simultaneous operation of the contact structure is desired.

A more specific object is to provide an improved circuit interrupter in which hydraulic means are employed to cause the separation of a pair of cooperable contact members and initiation of the hydraulic means is obtained by piston means operatively connected with a third contact member which cooperates with one of the aforesaid contact members to establish a second serially related arc.

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 an elevational view, partly in section, of a circuit interrupter embodying our invention and shown in the closed-circuit position;

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

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

Fig. 4 is a vertical sectional view taken through the left-hand arc extinguishing unit of Fig. 1, the parts being shown in the closed-circuit position;

Fig. 5 is a view similar to Fig. 4 but showing the disposition of the parts at an intermediate point in the opening operation;

Fig. 6 is an enlarged fragmentary view of a modified type of circuit interrupter embodying our invention; and

Fig. 7 is an enlarged fragmentary detailed view in vertical section of the valve means which we employ in utilizing our invention.

Referring to the drawings and, more particularly, to Fig. 1 thereof, the reference numeral 1 designates a tank in which a suitable arc extinguishing fluid 2 is disposed, in this instance circuit breaker oil, filling the tank 1. Depending from the cover 3 of the tank 1 are two insulating bushings 4, 5 through which extend terminal studs 6 (see Fig. 4).

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To the terminal studs 6 are threadedly secured contact feet 7 which serve to hold fixedly in position identical arc extinguishing units generally designated by the reference numeral 8. A conducting cross-bar 9 electrically interconnects the two arc extinguishing units 8 and is reciprocally operated in a vertical direction by an insulating operating rod 10. The operating rod 10 is actuated by suitable means not shown.

Referring more particularly to Figs. 4 and 5 it will be noted that the contact foot 7 is secured by a bolt 11 to a casting member 12 which forms a pressure-generating chamber 13 being provided with an over-pressure valve 14 and a gas relief valve 15. The gas relief valve 15 closes during high pressure conditions within the chamber 13 and opens following an interrupting operation to permit accumulated gas to escape through the apertures 16. The over-pressure valve 14 is operative to prevent the attainment of excessive pressure within the pressure-generating chamber 13.

Positioned within the pressure-generating chamber 13 is a first piston means generally designated by the reference numeral 17 and in this instance comprising a piston chamber 18 threadedly secured adjacent its lower end 19 to the top metallic plate 20 of the unit 8. Within the piston chamber 18 moves a piston 21 having secured to its lower end a second or pressure-generating contact 22 which cooperates with a first or intermediate contact 23 to establish a pressure-generating arc 24 as shown in Fig. 5.

A compression spring 25 is disposed within the piston chamber 18 and serves to bias the piston 21 downwardly.

A flexible conductor 27 electrically interconnects the second or pressure-generating contact 22 with the piston chamber 18.

Cooperable with the first or intermediate contact 23 is a third or lower movable contact 28 to establish an interrupting arc 29 more clearly shown in Fig. 5. The lower movable or third contact 28 moves out of the unit 8 during the opening operation to a position indicated by the dotted lines 30 of Fig. 1.

Positioned adjacent the lower end of the unit 8 is a second piston means generally designated by the reference numeral 31 and in this instance comprising a piston chamber 32 secured by screws 33 to the lower metallic plate 34 of the unit 8. A piston 35 carried by the conducting cross-bar 9 operates within the piston chamber

32 during a portion of its opening travel. Fluid passage means generally designated by the reference numeral 36 and in this instance comprising a liquid passage 37 interconnects the first and second piston means 17 and 31, the purpose for which will appear more fully hereinafter.

The interrupting structure for the unit 8 will now be described. The interrupting structure is formed by a plurality of suitably shaped insulating plates secured in contiguous relation by insulating tie rods 38 and nuts 39. These plates form two vertical flow passages generally designated by the reference numeral 40 and a plurality of, in this instance three, pairs of inlet passages 41 as more clearly shown in Figs. 2, 4 and 5. Certain of the plates form orifices 42 separating the inlet passages 41 from vent passages 43, the vent passages 43 being formed by similarly shaped insulating plates 44 positioned in the same horizontal plane.

From the foregoing description it will be apparent that oil under pressure generated at the pressure-generating arc 24 will flow downwardly through the two vertical flow passages 40 to pass inwardly through the six inlet passages 41 toward the interrupting arc 29. After striking the interrupting arc 29 the fluid will pass through the orifices 42 to exhaust out of the arc extinguishing units 8 through the vent passages 43. The particular shape of the passages in the interrupting structure is more fully described and claimed in United States patent application Serial No. 465,244, filed November 11, 1942, now U. S. Patent 2,406,469, issued August 27, 1946, by Leon R. Ludwig, Winthrop M. Leeds and Benjamin P. Baker and assigned to the assignee of the instant application.

The lower insulating plates of the stack 8 form orifices 45 through which the bayonet-shaped movable contact 28 moves as it is withdrawn from the unit 8. An electrostatic shield 46 is secured by suitable means, not shown, to the upper metallic plate 20 of the unit 8 to minimize corona formation at sharp corners. Likewise, an electrostatic shield 47 is secured by means, not shown, to the lower metallic plate 34 of the unit 8 to minimize corona formation at sharp corners. A resistor tube 48 electrically interconnects the top metallic plate 20 with the lower metallic plate 34 of the unit 8 and hence to a flexible contact clip 49 bearing against the movable contact 28 during a portion of the latter's opening travel. The function of the resistor tube 48 and its correct numerical value is more fully described in the aforesaid Patent 2,406,469. Briefly, its function is to divide the voltage equally between the two arc extinguishing units 8 during the opening operation and to decrease the rate of rise and the amplitude of the recovery voltage transient following circuit interruption.

The operation of the interrupter will now be explained. In the closed-circuit position thereof as shown in full lines in Figs. 1 and 4, the electrical circuit passing therethrough comprises terminal stud 6, contact foot 7, bolt 11, casting member 12, top metallic plate 20, piston chamber 18, flexible conductor 27, piston 21, second or pressure-generating contact 22, first or intermediate contact 23, third or lower movable contact 28, through the conducting cross-bar 9 and through the right-hand arc extinguishing unit 8 in an identical manner to the right-hand terminal stud 6 of the interrupter.

When it is desired to open the electrical circuit passing through the interrupter, or in response to overload conditions existing in the circuit controlled by the interrupter, suitable actuating means, not shown, operates to cause downward opening travel of the insulating operating rod 10. The downward movement of the operating rod 10 causes downward movement of the conducting cross-bar 9 and hence downward movement of both the movable contact 28 and the piston 35 secured to the cross-bar 9. The intermediate contact 23 follows the initial downward movement of the movable contact 28 until the shoulder 50 thereof strikes the plate 51, at which time the interrupting arc 29 is drawn between the intermediate and movable contacts 23, 28. The piston 21 secured to the pressure-generating contact 22 moves upward in response to downward movement of the piston 35 to thereby draw a pressure-generating arc 24 between the pressure-generating and intermediate contacts 22, 23. It will be noted that downward movement of the piston 35 with the cross-bar 9, the former moving within the piston chamber 32, draws oil downwardly through the liquid passage 37 from the region 52 in back of the piston 21 to the region 53 in back of the piston 35 to cause thereby upward movement of the piston 21 against the biasing action exerted by the compression spring 25. During this time the ball-valve 54 is opened. It will be apparent then that during the opening operation the hydraulic means which we provide causes substantially simultaneous separation of the several contact members to practically simultaneously establish both a pressure-generating arc and an interrupting arc. The piston 35 will pull completely out of the piston chamber 32 as the movable contact 28 moves out of the unit 8. To prevent thereby rapid retraction of the piston 21 and hence closing movement of the pressure-generating contact 22, the ball-valve 53 can be provided which seats following withdrawal of the piston 35 from the piston chamber 32. The leak rate of the ball-valve 54, as determined by the by-pass channel 55 as shown in Fig. 7, will determine the rate of closing movement of the pressure-generating contact 22.

To prevent retardation during the closing stroke of the interrupter as the piston 35 enters the piston chamber 32, we provide a valve 56 which opens at a predetermined load during such a closing stroke, as shown in Fig. 6, to permit oil within the region 53 to be forced out of the piston chamber 32.

In the modification of our invention as shown in Fig. 6, we provide a piston 57 solely movable within the piston chamber 32, its downward movement being limited by the stop 58. The push rod 59 carried by the cross-bar 9 operates the piston 57. A strong compression spring 60 biases the piston 57 downwardly during the opening operation to again draw oil downwardly through the liquid passage 37 from the first piston means 17. In this embodiment of our invention, inasmuch as the piston 57 is not movable out of the piston chamber 32, the ball-valve 54 will be omitted.

From the foregoing description it will be apparent that we have provided an improved circuit interrupter of the type drawing both a pressure-generating arc and an interrupting arc simultaneously without resort to a side operating rod as is shown in U. S. patent application filed December 22, 1945, S. N. 636,940, a divisional case of the aforesaid patent. We have disclosed a means of producing a simultaneous parting hy-

draulically. The cross-arm 9 and the lower movable contact 28 preferably move downwardly together for about ½ inch, at which time the intermediate contact 23 is halted. The pressure-generating arc 24 is drawn in the upper gap in response to downward motion of piston 35. It will be noted that the compression spring 25 associated with the first piston means 17 provides the contact pressure in the closed circuit position of the interrupter as shown in Fig. 4. The piston 21 may carry the pressure-generating contact 22 either directly on the bottom surface thereof or on an extension of any length depending upon how the upper contact should be lined up with respect to the grid stack 8. Piston 35 and piston cylinder 32 can be made larger than piston 21 and piston cylinder 18 as shown in Fig. 4 to compensate for leakage and the upper contact spring load, thus allowing the upper contact 22 to move upwardly at a predetermined speed as the cross-arm 9 moves down. The channel or liquid passage 37 is preferably formed by the alignment of a plurality of holes in the fiber plates of the grid stack 8 or it could be formed by other suitable insulated connecting means.

It will be noted that when the upper arc 24 is drawn, the pressure produced thereby will tend to increase the upward opening motion of the upper piston contact 22, supporting the action produced hydraulically. If it is desired to delay the return of the top arcing contact 22 to the closed position, the check valve 54 may be employed, being inserted in the channel 37. This valve is free to open when oil is flowing downwardly during the opening operation and its backward leak rate will determine the time it takes the upper piston 21 to resume its closed position. In addition, the small valve 56 is employed in the wall of the cylinder 32 which will open when the interrupter is closing to control the pumping action to the upper cylinder 18 on closing. A piston 35 of about three inches diameter is adequate to impart sufficient force to overcome the contact pressure spring 25 and move the upper contact 22 upwardly at 15 feet per second on opening.

The modification as shown in Fig. 6 is to have the lower piston 57 spring-biased downwardly powerfully enough to overcome the contact biasing spring 25 and add accelerating force to open the top gap by oil flow. This piston 57 can be designed for less leakage and closer tolerances since it does not leave the cylinder 32 but is merely operated by the plunger 59 attached to the cross-arm 9. In this modification the check valve 54 which is optional in the first modification would not be used.

From the above description it is apparent that our design will reduce the size and complication of the interrupter, and remove a possible source of voltage breakdown by eliminating the side operating rod and associated mechanisms. Correct contact compression and travel are inherent in the design and will require little adjustment, whereas the present mechanical system, as set forth in the aforesaid divisional application, is sensitive to the setting of four stops on the side operating rod and the contact springs. All parts of our invention can be readily made accessible without the removal of the stack 8 from a pole unit so that the contacts may be renewed or parts examined.

From the foregoing it will be apparent that we have provided an improved interrupter which employs hydraulic means to simultaneously open

both the pressure and interrupting gaps. Size and complication are considerably reduced and contact pressure is easily obtained. By eliminating the side operating rod and the rocking pressure-generating contact as disclosed in the aforesaid divisional application, the mechanism is considerably simplified and voltage breakdown possibilities are eliminated.

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

We claim as our invention:

1. In a circuit interrupter of the liquid break type, an arc extinguishing structure forming a pressure chamber, a first contact cooperable with a second contact to establish a pressure-generating arc within the pressure chamber, a third contact cooperable with said first contact to establish a second serially related interrupting arc, operating means for said interrupter for moving said third contact to an open circuit position, a first piston means connected to said second contact and arranged to be acted on at one side thereof by the pressure within the pressure chamber, a second piston means and an insulating liquid filled conduit connecting the other side of said first piston means to said second piston means, said second piston means being actuated by the opening movement of said third contact to cause a reduction in pressure in said conduit whereby the pressure in said pressure chamber acts in conjunction with the reduced pressure in said conduit to cause opening of said second contact substantially at the same time upon opening movement of said third contact and to maintain said second contact open during interruption of the arcs.

2. In a circuit interrupter of the liquid break type, an arc extinguishing structure forming a pressure chamber, a first contact cooperable with a second contact to establish a pressure-generating arc within the pressure chamber, a third contact cooperable with said first contact to establish a second serially related interrupting arc, operating means for said interrupter for moving said third contact to an open circuit position, a first piston means connected to said second contact and arranged to be acted on at one side thereof by the pressure within the pressure chamber, a second piston means, and an insulating liquid filled conduit connecting the other side of said first piston means to the second piston means, means actuated during the first part of the opening movement of said third contact for actuating said second piston means to cause a reduction in pressure in said conduit whereby the pressure within the pressure chamber acts in conjunction with the reduced pressure within said conduit to cause opening of said second contact substantially simultaneously with the opening of said third contact.

3. In a circuit breaker of the liquid break type, an arc extinguishing unit having a pressure-generating chamber and an interrupting chamber, a first contact cooperable with a second contact to establish a pressure-generating arc within said pressure-generating chamber, a third contact cooperable with said first contact to establish a serially related interrupting arc within said interrupting chamber, fluid passage means interconnecting said pressure-generating and in-

terrupting chambers so as to cause said interrupting arc to be acted upon by the pressure generated by the pressure-generating arc within the pressure-generating chamber, operating means for moving said third contact to an open circuit position externally of said arc extinguishing unit, hydraulic means comprising a first piston means connected to said second contact and arranged to be acted upon at one side thereof by the pressure of the liquid within said pressure-generating chamber, a second piston means, an insulating liquid filled conduit connecting the other side of said first piston means to the second piston means, and means for causing the actuation of said second piston means during the first part of the opening movement of said third contact to reduce the pressure in said conduit and thereby cause opening of said second contact.

4. In a circuit interrupter of the liquid break type, an arc extinguishing unit, a second contact disposed adjacent one end of said unit, a first contact cooperable with said second contact to establish a pressure-generating arc, a third contact disposed adjacent the other end of said unit, said third contact being cooperable with said first contact to establish an interrupting arc, a first piston means disposed adjacent said one end of the arc extinguishing unit and connected to said second contact, a second piston means disposed adjacent the said other end of the arc extinguishing unit, hydraulic actuating means including an insulating conduit in one lateral wall of said unit interconnecting said first and second piston means, operating means for causing actuation of the third contact and also substantially simultaneous movement of the second piston means.

5. In a circuit interrupter of the liquid break type, an arc extinguishing unit, a second contact disposed adjacent one end of said unit, a first contact cooperable with said second contact to establish a pressure-generating arc, a third contact disposed adjacent the other end of said unit, said third contact being cooperable with said first contact to establish an interrupting arc, a first piston means disposed adjacent said one end of the arc extinguishing unit and connected to said second contact, a second piston means disposed adjacent the said other end of the arc extinguishing unit, hydraulic actuating means including an insulating conduit extending longitudinally of said unit, and interconnecting said first and second piston means, operating means for causing actuation of the third contact and also substantially simultaneous movement of the second piston means.

6. In a circuit interrupter of the liquid break type, an arc extinguishing unit, a first contact, a second contact cooperable with said first contact to establish a pressure-generating arc, a third contact cooperable with said first contact to establish an interrupting arc, said third contact being movable out of said arc extinguishing unit, actuating means for the third contact, hydraulic means comprising a piston means connected to said second contact, a second piston means adapted to be moved by operation of said actuating means, and an insulating conduit interconnecting said first and said second piston means, a one-way time delay valve in said conduit which allows hydraulic liquid to flow substantially uninhibited when said liquid is flowing in such a direction as to cause opening movement of said second contact and to partially block flow of said hydraulic liquid when said hydraulic liquid tends to flow in a direction such as to allow closure of said second contact, said actuating means being movable to a position disconnected from said second piston means whereby a clean break in liquid exists between said actuating means and said arc extinguishing unit.

7. In a circuit interrupter of the liquid break type, an arc extinguishing unit, a first contact, a second contact cooperable with said first contact to establish a pressure-generating arc, a third contact cooperable with said first contact to establish an interrupting arc, said third contact being movable out of said arc extinguishing unit, hydraulic means comprising a piston means connected to said second contact, a cylinder, a piston connected to said third contact and movable to a position out of contact with said cylinder, and an insulaing conduit interconnecting said piston means and said cylinder.

8. In a circuit interrupter of the liquid break type, an arc extinguishing unit, a first contact, a second contact cooperable with said first contact to establish a pressure-generating arc, a third contact cooperable with said first contact to form an interrupting arc, said third contact being movable completely out of said arc extinguishing unit, actuating means for the third contact, hydraulic means comprising a piston means connected to said second contact, a second piston means adapted to be moved by said actuating means, said actuating means being connected to said third contact and an insulating conduit interconnecting said first and said second piston means, and said second piston means being disconnected from said actuating means in the open position of the circuit interrupter whereby a clean break in liquid exists between said actuating means and said arc extinguishing unit.

JOSEPHINE R. WEBB.
HERBERT J. WEBB.

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