Jan. 23, 1951 R. E. FRIEDRICH ET AL 2,538,773

CIRCUIT INTERRUPTER

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Fig. 1.

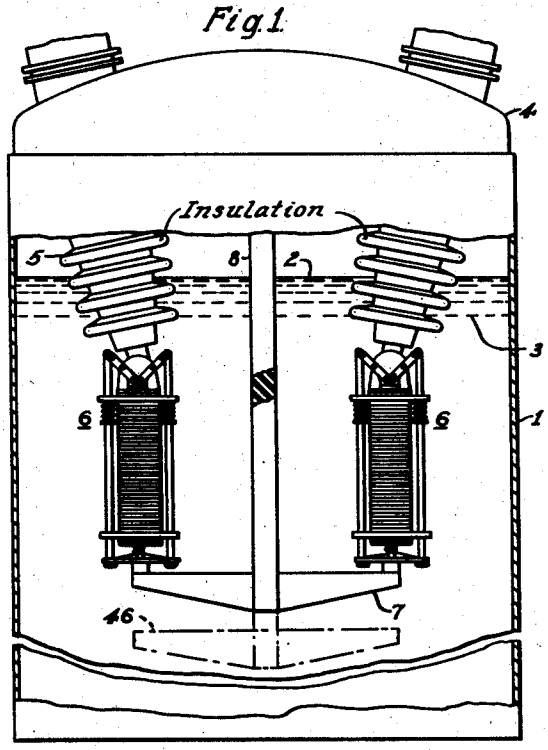
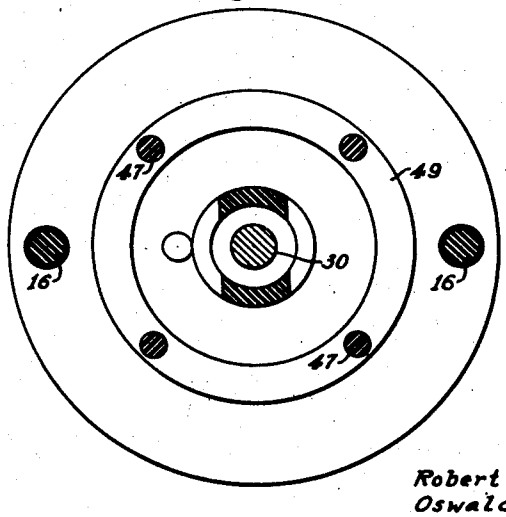


Fig. 3.



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CIRCUIT INTERRUPTER

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Fig. 2.

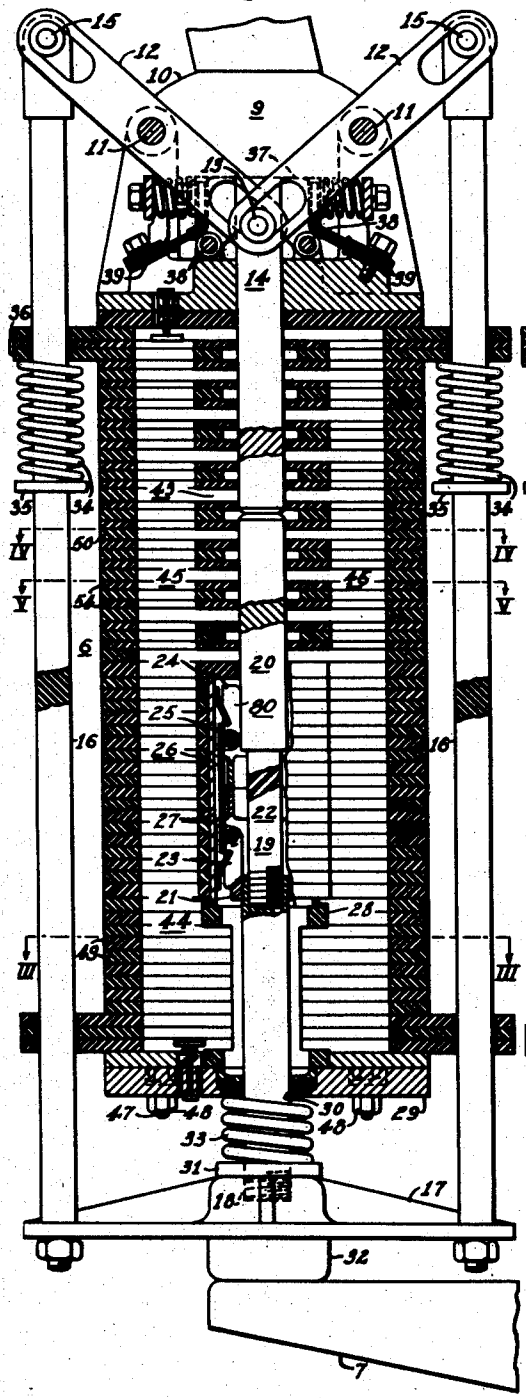

Fig. 6.

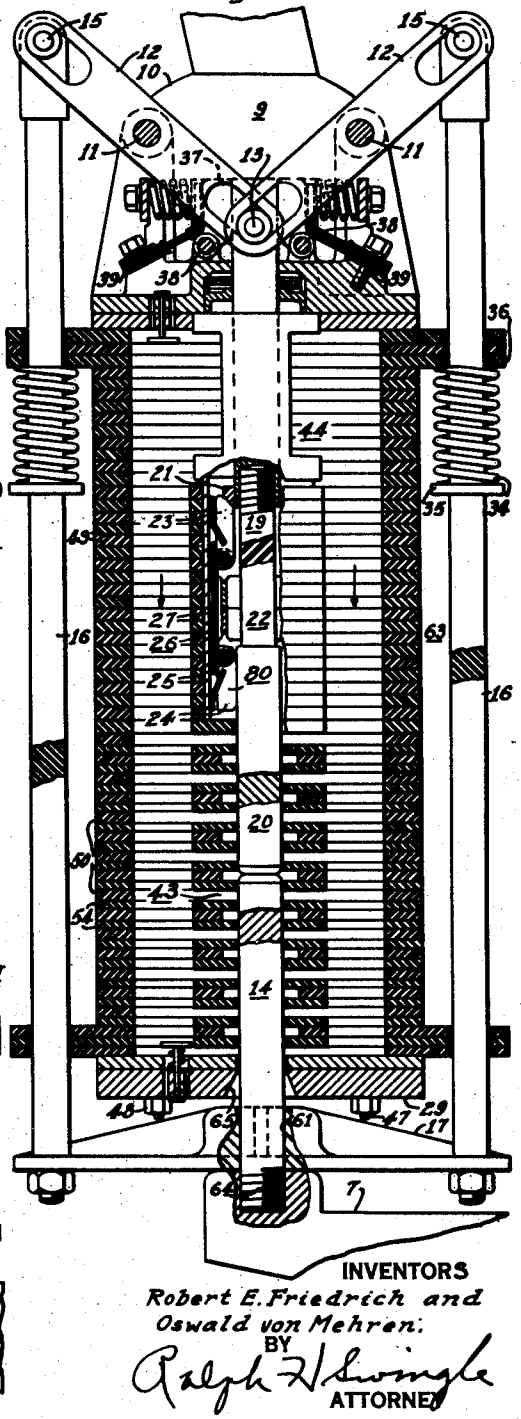

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Fig. 4.

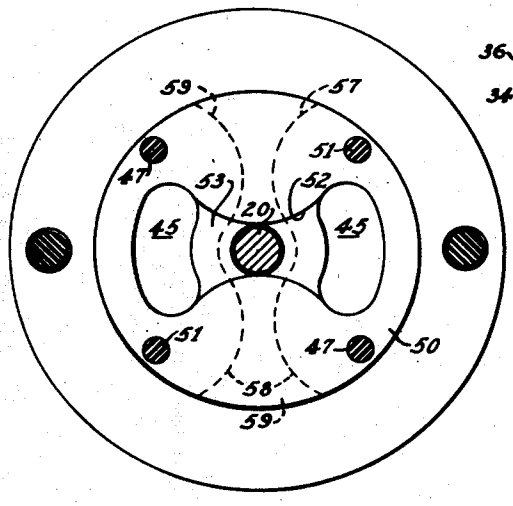


Fig. 5.

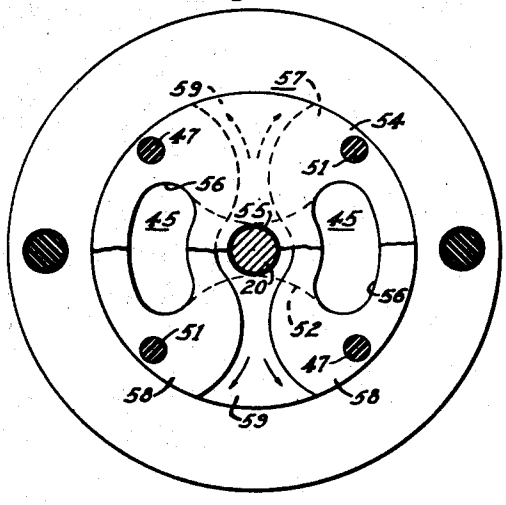
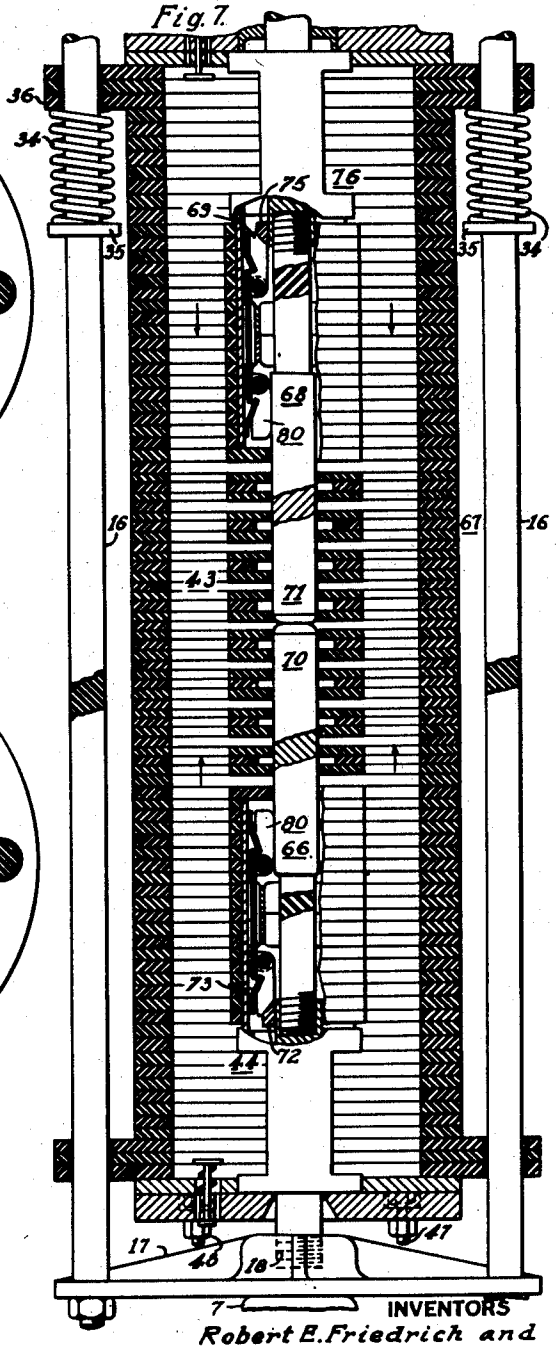


Fig. 7.



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UNITED STATES PATENT OFFICE

2,538,773

CIRCUIT INTERRUPTER

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Application May 2, 1947, Serial No. 745,541

8 Claims. (Cl. 200—145)

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

A general object of our invention is to provide an improved high speed type of circuit interrupter with an improved high speed mechanism therefor.

A more specific object of our invention is to provide an improved tank-type liquid-break circuit interrupter in which liquid under pressure from one break is utilized to effect extinction of another break in the circuit by a liquid blast and to provide an improved high speed operating mechanism and contact structure for such a type of interrupter.

Another object is to provide an improved high speed mechanism for a liquid break circuit interrupter having relatively few parts and insuring that the operation will be positive and rapid.

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 of a tank-type liquid break circuit interrupter embodying our invention and shown in the closed circuit position;

Fig. 2 is an enlarged vertical sectional view through the left-hand arc extinguishing unit of Fig. 1, the contacts being shown in the closed circuit position;

Fig. 3 is a sectional view taken along the line III—III of Fig. 2;

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

Fig. 5 is a sectional view taken along the line V—V of Fig. 2;

Fig. 6 is a modified type of arc extinguishing unit which may be used in place of the unit shown in Fig. 2; and

Fig. 7 is still another modified type of arc extinguishing unit which may be employed in place of either of the units of Figs. 2 or 6.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral 1 designates a tank or enclosure filled to the level 2 with a suitable arc extinguishing fluid 3, in this instance circuit breaker oil. Depending from the cover 4 of the tank 1 are two insulating terminal bushings 5, to the lower ends of which are fixedly mounted in place identical arc extinguishing units or arcing chambers, generally designated by the reference numeral 6. The units 6 are electrically interconnected in the closed circuit position, as shown in Fig. 1, by a conducting crossbar 7 actuated vertically in a reciprocal manner by an insulating lift rod 8. Suitable mechanism, not shown, is employed to cause actuation of the lift rod 8.

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Referring to Fig. 2, which more clearly illustrates the interior construction of the left-hand arc extinguishing unit 6, it will be observed that we have associated lever means, generally designated by the reference numeral 9, with the upper end of the unit 6 being supported upon the contact foot 10 upon fixed pivots 11. More specifically, the lever means 9 includes a pair of cooperating levers 12 having their interior ends pivotally mounted at 13 to, and thereby operatively associated with, an upper movable contact 14.

The outer ends of the levers 12 are pivotally connected at 15 to the upper ends of a pair of insulating operating rods or elongated members 16 extending longitudinally externally of the unit 6 and having their lower ends fixedly secured to the extremities of a yoke or actuating member 17. The yoke member 17 has threadedly secured thereto as at 18 a movable contact assembly, generally designated by the reference numeral 19. The movable contact assembly 19 is movable linearly in a vertical direction and includes a pair of movable contacts 20, 21 spaced along the direction of motion and operatively connected by an insulating rod 22. Preferably the insulating portion or rod 22 has its upper end threadedly secured to the lower end of the movable contact 20 and has its lower end secured to the movable contact 21. A relatively stationary contact 23 makes contacting engagement with the movable contact 21 in the closed circuit position as shown in Fig. 2.

Preferably we provide means 80 paralleling the insulating portion 22 and electrically interconnecting the relatively stationary contact 23 with the movable contact 20. Suitable slider contact means are employed, in this instance including one or more sliding contacts 24 bearing upon the side of the movable contact 20. The one or more slider contacts 24 are electrically connected to the relatively stationary contact 23 by flexible conducting straps 25. Also we mount the contacts 24, 23 and the straps 25 within a metallic cage, generally designated by the reference numeral 26 and including a metallic cylinder 27 supported at its lower end, as viewed in Fig. 2, by an insulating support cylinder 28. The lower end of the support cylinder 28 rests upon the bottom metallic plate 29 of the unit 6.

It will be observed that the extended lower end

of the movable contact 21 passes through an aperture 30 provided in the plate 29 and also passes through a washer 31 before being threadedly connected at 18 within the yoke member 17 to become operatively associated therewith. A block member 32 is integrally formed with yoke member 17 and is engaged by the cross-bar 7 during the initial portion of the opening operation and at the end of the closing operation. A compression spring 33 is interposed between the plate 29 and the washer 31 and serves to bias the yoke member 17, the two operating rods 16, and the lever means 9, together with the upper movable contact 14 in the circuit opening direction.

We have provided additional biasing means to assist the compression spring 33. More specifically, we have provided compression springs 34 encircling intermediate portions of the operating rods 16 and being disposed between flanges 35 integrally formed with the rods 16 and a plate 36 disposed at the upper end of the unit 6.

Thus, the compression springs 34 bias the rods 16 downwardly as does also the compression spring 33. It will be noted that we have provided pivotally mounted slider contacts 37 pivotally mounted on stationary pivots 38 and having flexible connection by straps 39 with the contact foot casting 10 of the interrupter.

Consequently, in the closed circuit position, as shown in Fig. 2, the electrical circuit through the interrupter includes the terminal stud extending interiorly through terminal bushing 5, contact foot 10, flexible straps 39, slider contacts 37, upper movable contact 14, movable contact 20, slider contacts 24, flexible straps 25, relatively stationary contact 23, movable contact 21 through the yoke member 17 and through the conducting cross-bar 7 to the other unit 6 of the interrupter. The electrical circuit passes through the right-hand arc extinguishing unit 6 in an identical manner with its passage through the left-hand arc extinguishing unit 6.

During the opening operation, suitable means, not shown, is employed in response to manual operation or to the existence of excessive current conditions in the circuit controlled by the interrupter to cause downward motion of the lift rod 8. The downward movement of lift rod 8 causes corresponding downward movement of the cross-bar 7. This permits the compression springs 33, 34 to cause downward opening movement of the yoke member 17 and rods 16. The lever means 9 rotates and causes opening motion of the contact 14. Further, the movable contact assembly 19 moves down together with movable contacts 20, 21.

The downward opening movement of the movable contact assembly 19, and the simultaneous upward separating motion of the movable contact 14, as caused by rotative motion of the lever means 9, simultaneously establishes two serially related arcs. In other words, the relatively stationary contact 23 is electrically connected to one of the movable contacts 20 of the movable contact assembly 19 during the entire opening operation, and separates from the other movable contact 21 of the assembly 19 to establish a pressure-generating arc. The third movable contact 14 separates upwardly away from the movable contact 20 to establish a second serially related arc. The arc, not shown, established between the contacts 14, 20, is drawn within an interrupting chamber, generally designated by the reference numeral 43, and formed by suitable plate structure more fully described hereinafter.

The arc, not shown, established between the contacts 21, 23 is established within a pressure-generating chamber, generally designated by the reference numeral 44 and also more fully described hereinafter. Fluid under pressure, in this instance oil, is forced upwardly through vertical flow passages, generally designated by the reference numeral 45, from the pressure-generating chamber 44 toward the interrupting chamber 43 to effect extinction of the interrupting arc drawn between the contacts 14, 20. Continued downward movement of the cross-bar 7 causes the lever means 9 to be halted by contact with the contact foot 10 to thereby halt the downward movement of the operating rods 16, the yoke member 17 and movable contact assembly 19. There then occurs separation between the cross-bar 7 and the block member 32 to interpose an isolating gap in the circuit as more clearly shown by the dotted lines 46 of Fig. 1.

We have provided suitably configured insulating plate structure forming the pressure-generating chamber 44 and the interrupting chamber 43. The plate structure is maintained in position by a plurality of, in this instance four, insulating tie rods 47 having nuts 48 threadedly secured to their lower ends. As more clearly shown in Fig. 3, the plates adjacent the lower end of the unit 6 are merely ring-shaped in configuration and are designated by the reference numeral 49. The alignment of the ring-shaped plates 49 forms the pressure-generating chamber 44.

Adjacent the upper end of the unit 6 there are provided three different types of plates. The first type is herein designated an insulating inlet plate and is designated by the reference numeral 50, the configuration of which is more clearly shown in Fig. 4. The insulating inlet plate 50 has apertures 51 formed therein for the accommodation of the tie rods 47, and a cutout portion 52 is provided therein to furnish two inwardly extending inlet passages 53 leading from the two vertical flow passages 45 toward the interrupting arc drawn between the contacts 14, 20. On each side of an insulating inlet plate 50 is positioned the second type of plate in the interrupting structure 43. The second type of plate is herein termed an orifice insulating plate and is designated by the reference numeral 54 being shown more clearly in Fig. 5. The orifice insulating plate 54 also has apertures 51 provided therein to accommodate the tie rods 47. The orifice insulating plate 54 also has formed therein an orifice 55 through which the movable contacts 14 or 20 pass and through which oil must flow before it is permitted to vent out of the unit 6. The orifice insulating plates 54 also have cutout portions 56 provided therein which, upon alignment, serve to form the vertical flow passages 45.

The third type of insulating plate employed in the interrupting chamber 43 is composite and is generally designated by the reference numeral 57, being herein termed a vent plate. The vent plate 57 is formed by the cooperation of two insulating half plates 58 which are laterally spaced apart by the tie rods 47 to form two opposing vent passages 59 leading in opposite directions out of the interrupting chamber 43 to the region exterior of the unit 6. The vent plates 57 have cutout portions 56 provided therein to cooperate with the cutout portions 56 provided in the other plates to form, upon alignment, the two vertical flow passages 45.

From the foregoing description of the plate structure, it will be apparent that oil under pres-

sure will flow upwardly through the vertical flow passages 45 and radially inwardly through the inlet passages 53 provided by the insulating inlet plates 50 to strike the interrupting arc, not shown, drawn between the contacts 14, 20. After striking the interrupting arc, the oil passes upwardly and downwardly through the orifices 55 provided by the orifice insulating plates 54 to pass in opposite directions out of the unit 6 through the opposed vent passages 59 provided by the vent plates 57.

Certain features of the interrupting construction herein disclosed are set forth in U. S. Patent 2,406,469, issued August 27, 1946 to Leon R. Ludwig, Winthrop M. Leeds and Benjamin P. Baker, and assigned to the assignee of the instant application. Also some of the constructional details of the unit 6 are described and claimed in U. S. Patent application filed May 2, 1947, Serial No. 745,542 by us and assigned to the assignee of the instant application.

It will therefore, be apparent that we have provided an improved circuit interrupter in which, by the opening movement of the movable contact assembly 19 in cooperation with the upward opening movement of the movable contact 14, we have provided an improved high speed contact structure simultaneously establishing two serially related arcs. One of these arcs is a pressure-generating arc established between the contacts 21, 23 within the pressure-generating chamber 44, and is utilized to force oil to flow upwardly through the passages 45 into the interrupting chamber 43 to effect the rapid extinction therein of the interrupting arc drawn between the rapidly separating movable contacts 14, 20. The use of the yoke member 17, operating rods 16 and lever means 9 provides a high speed mechanism which causes positive actuation of the contact structure and permits near the end of the opening operation separation of the cross-bar 7 from the yoke member 17 to interpose an isolating gap in the circuit.

The arc extinguishing unit set forth in Fig. 6 is of similar construction to that set forth in Fig. 2 and is generally designated by the reference numeral 63. In the modified unit 63, the pressure gap is formed at the upper end of the unit, whereas the interrupting gap is formed within the interrupting chamber 43 adjacent the lower end of the unit 63. The movable contact 14 is threadedly secured, as at 64, directly to the end of the cross-bar 7 after passing through the aperture 61 provided in the yoke member 17. The plate structure forming the pressure-generating chamber 44 and the interrupting chamber 43 is the same as that previously described in connection with Fig. 2; consequently, a further description thereof appears unnecessary. The movable contact assembly 19 is the same as that set forth in Fig. 2, with the exception that it is movable upwardly, being pivotally connected at 13 to the lever means 9 at the upper end of the unit 63.

During the opening operation, the cross-bar 7 moves downwardly as before, carrying with it the lower movable contact member 14. The downward movement of the cross-bar 7 permits following downward movement of the yoke member 17 as caused by the compression springs 34. This brings about upward opening movement of the movable contact assembly 19 within the unit 63. A pressure-generating arc, not shown, is established between the contacts 21, 23 within the pressure chamber 44 and causes oil to flow downwardly as indicated by the arrows toward the

interrupting chamber 43, where interruption of the interrupting arc drawn between the contacts 14, 20 occurs in a manner as previously set forth.

Following interruption of the circuit, the cross-bar 7 continues its downward opening movement carrying with it the movable contact 14 withdrawing the latter completely out of the unit 63 to interpose an isolating gap in the circuit.

During the closing stroke, the cross-bar 7 and the movable contact 14 move upwardly together, the contact 14 entering the aperture 61 in yoke member 17 to also enter the aperture 65 provided in the lower plate 29 of the unit 63. Continued upward motion of the movable contact 14 and cross-bar 7 causes the cross-bar 7 to pick up the yoke member 17 forcing it upwardly against the downward biasing action exerted by the compression springs 34. This causes actuation of the lever means 9 to force the movable contact assembly 19 downwardly into simultaneous contacting engagement with contacts 23 and 14.

From the foregoing description, it will be apparent that in Fig. 6 we have provided an improved arc extinguishing unit in which the pressure and interrupting gaps are inverted with respect to Fig. 2. The movable contact 14 is movable with the cross-bar 7 being directly connected thereto and has a lost-motion connection with the yoke member 17. The withdrawal of the movable contact 14 out of the unit 63 in the open circuit position, not shown, provides an isolating gap of considerable length which is desirable for high voltage applications.

The modified unit set forth in Fig. 7 is generally similar to that set forth in Figs. 2 and 6. However, it will be observed that here we have provided two movable contact assemblies. One movable contact assembly is generally designated by the reference numeral 66 and is disposed adjacent the lower end of the modified unit, generally designated by the reference numeral 67. Also, we have provided another movable contact assembly, generally designated by the reference numeral 68, which is positioned adjacent the upper end of the unit 67. The movable contact 70 associated with the movable contact assembly 66 makes abutting contacting engagement with the movable contact 71 of the upper movable contact assembly 68. The separation of the movable contacts 70, 71 establishes an interrupting or third arc, not shown, within the interrupting chamber 43. The separation of the movable contact 72 associated with the movable contact assembly 66 away from the relatively stationary contact 73 establishes a pressure-generating arc, not shown, within the pressure-generating chamber 44 disposed at the lower end of the unit 67.

Correspondingly, the separation of the movable contact 75 associated with the movable contact assembly 68 away from the relatively stationary contact 69 associated with the movable contact assembly 68 establishes another pressure-generating arc, not shown, within the pressure-generating chamber 76 adjacent the upper end of the unit 67.

Preferably the movable contact 72 associated with the movable contact assembly 66 is threadedly connected as at 18 to the yoke member 17, the latter being actuated by direct contact with the cross-bar 7. The lever means 9 interconnecting the operating rods 16 with the movable contact assembly 68 is the same as that set forth at the upper ends of Figs. 2 and 6. Thus, in this modification of our invention, we have utilized two movable contact assemblies 66, 68 to simul-

taneously bring about the establishment of two pressure-generating arcs drawn within two pressure-generating chambers 44, 76 disposed at the opposite ends of the units 67 and a single interrupting arc established within the interrupting chamber 43 disposed intermediate the ends of the unit 67. The continued opening motion of the cross-bar 7 effects disengagement with the yoke member 17 to interpose an isolating gap in the circuit as before.

From the foregoing description of a few embodiments of our invention, it will be apparent that we have provided an improved arc extinguishing structure with improved operating means therefor to simultaneously bring about the establishment of both a pressure-generating arc and an interrupting arc within a pressure-generating chamber and an interrupting chamber, respectively. The operation is positive and high speed. The mechanism is simple in construction and needs very little maintenance. Also, the operating parts are few and readily exposed for inspection.

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 therein 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, a movable contact assembly movable linearly and including two movable contacts spaced along the direction of motion and operatively connected by a portion of insulating material, a relatively stationary contact, means paralleling the insulating portion and electrically interconnecting the stationary contact with one of the movable contacts during the entire circuit opening operation, a third movable contact cooperable with said one movable contact, means for causing movement of the third movable contact away from said one movable contact to establish an arc therebetween and to establish a free unparalleled gap therebetween, and means for causing opening motion of the movable contact assembly to establish another serially related arc between the stationary and the other of said two movable contacts with only the insulating portion therebetween in the open position.

2. In a circuit interrupter, an arc extinguishing unit, means defining a substantially confined pressure-generating chamber within the unit, means defining a vented interrupting chamber within the unit, fluid flow passage means interconnecting the pressure-generating and interrupting chambers so that fluid may flow from the pressure-generating chamber toward the interrupting chamber, a movable contact assembly movable linearly including two movable contacts spaced along the direction of motion and operatively connected by a portion of insulating material, a relatively stationary contact disposed within the pressure-generating chamber, means paralleling the insulating portion and electrically interconnecting the stationary contact with one of the movable contacts during the entire circuit opening operation, a third movable contact cooperable with said one movable contact and movable within the interrupting chamber, means for causing opening movement of the third movable contact away from said one movable contact to establish an interrupting arc therebetween within the interrupting chamber and to establish a free unparalleled gap therebetween, and means for causing opening movement of the movable contact assembly to establish a serially related pressure-generating arc between the relatively stationary contact and the other of said two movable contacts within the pressure-generating chamber with only the insulating portion therebetween in the open position.

3. In a circuit interrupter, a movable contact assembly movable linearly and including two movable contacts spaced along the direction of motion and operatively connected by a portion of insulating material, a relatively stationary contact associated with the movable contact assembly, means electrically connecting the relatively stationary contact with one of the movable contacts of the movable contact assembly during the entire opening operation, the relatively stationary contact separating from the other of the two movable contacts during the opening operation to establish an arc therebetween, another movable contact assembly movable linearly and including two movable contacts spaced along the direction of motion and operatively connected by a portion of insulating material, another relatively stationary contact associated with said other movable contact assembly, means electrically connecting said other relatively stationary contact with one of the movable contacts of said other movable contact assembly during the entire opening operation, said other relatively stationary contact separating from the other of the two movable contacts of said other movable contact assembly to establish another arc therebetween, and means for simultaneously causing motion of the two movable contact assemblies away from each other to draw a third serially related arc between said one movable contact of the first said movable contact assembly and said one movable contact of said other movable contact assembly.

4. In a circuit interrupter of the liquid break type, means defining two pressure-generating chambers and an interrupting chamber, a movable contact assembly movable linearly and including two movable contacts spaced along the direction of motion and operatively connected by a portion of insulating material, a relatively stationary contact associated with the movable contact assembly, means electrically connecting the relatively stationary contact with one of the movable contacts of the movable contact assembly during the entire opening operation, the relatively stationary contact separating from the other of the two movable contacts during the opening operation to establish a pressure-generating arc therebetween within one of the pressure-generating chambers, another movable contact assembly movable linearly and including two movable contacts spaced along the direction of motion and operatively connected by a portion of insulating material, another relatively stationary contact associated with said other movable contact assembly, means electrically connecting said other relatively stationary contact with one of the movable contacts of said other movable contact assembly during the entire opening operation, said other relatively stationary contact separating from the other of the two movable contacts of said other movable contact assembly to establish another pressure-generating arc within the other pressure-generating chamber, and means for simultaneously causing motion of the two movable contact assemblies away from each other to draw a third serially

related interrupting arc between said one movable contact of the first said movable contact assembly and said one movable contact of said other movable contact assembly within the interrupting chamber.

5. In a liquid break circuit interrupter, a tank containing an arc extinguishing liquid, a terminal bushing having one end extending within the tank, an arc extinguishing unit supported at one end thereof by the said one end of the terminal bushing, lever means disposed at the supported end of the unit, an actuating member disposed adjacent the other end of the unit, an elongated member interconnecting the lever means and the actuating member, means for moving the actuating member, a movable contact assembly movable linearly and including two movable contacts spaced along the direction of motion and operatively connected by a portion of insulating material, a relatively stationary contact, means electrically connecting the relatively stationary contact to one of the movable contacts during the entire opening operation, the said relatively stationary contact separating from the other movable contact to establish an arc therebetween, the movable contact assembly being operatively related to the actuating member, a third movable contact movable within the unit and separable from the said one movable contact to establish an arc therebetween, and means operatively connecting the third movable contact with the lever means.

6. In a liquid break circuit interrupter, a tank containing an arc extinguishing liquid, a terminal bushing having one end extending within the tank, an arc extinguishing unit supported at one end thereof by the said one end of the terminal bushing, lever means disposed at the supported end of the unit, an actuating member disposed adjacent the other end of the unit, an elongated member interconnecting the lever means and the actuating member, means for moving the actuating member, a movable contact assembly movable linearly and including two movable contacts spaced along the direction of motion and operatively connected by an insulating portion connected to the actuating member and movable in one direction during the opening operation, and another movable contact assembly movable linearly and including two movable contacts spaced along the direction of motion and operatively connected by an insulating portion connected to the lever means and movable in the opposite direction during the opening operation.

7. In a circuit interrupter, an enclosure, a terminal bushing extending within the enclosure and having secured to its interior end an arcing chamber, lever means disposed adjacent the secured end of the arcing chamber, contact means movable within the arcing chamber and operatively connected to the lever means, an apertured yoke member disposed adjacent the other end of the arcing chamber, means connecting the lever means with the yoke member, and a contact rod having a lost motion connection with the yoke member and adapted to enter the aperture therein upon entering the arcing chamber.

8. In a circuit interrupter, an enclosure, a terminal bushing extending within the enclosure and having secured to its interior end an arcing chamber, lever means disposed adjacent the secured end of the arcing chamber, contact means movable within the arcing chamber and operatively connected to the lever means, an apertured yoke member disposed adjacent the other end of the arcing chamber, means connecting the lever means with the yoke member, a contact rod having a lost motion connection with the yoke member and adapted to enter the aperture therein upon entering the arcing chamber, and means biasing the lever means and yoke member to the open circuit position, the contact rod being completely withdrawn from the arcing chamber and yoke member to insert an isolating gap in the circuit.

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OSWALD VON MEHREN.

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