Nov. 25, 1952 W. M. LEEDS 2,619,568

CIRCUIT INTERRUPTER

Filed April 4, 1947 3 Sheets-Sheet 1

Fig. 1.

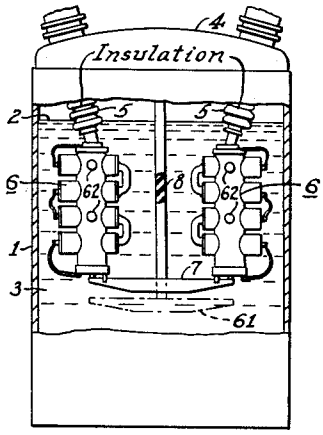


Fig. 3.

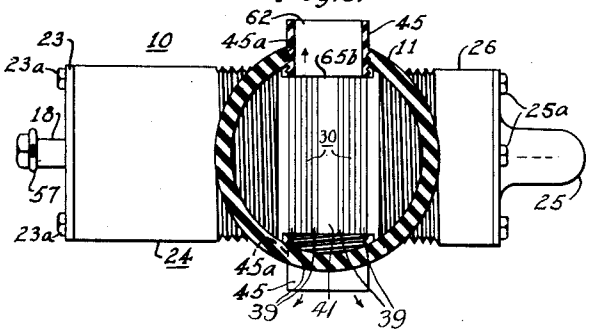


Fig. 4.

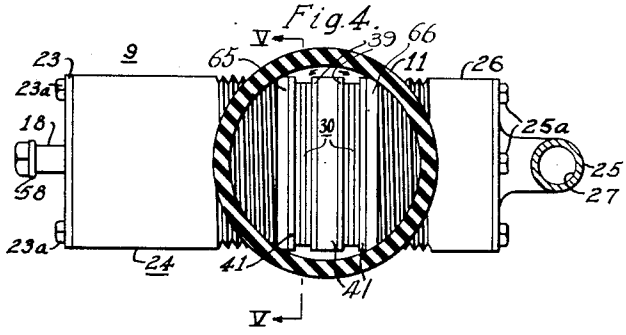
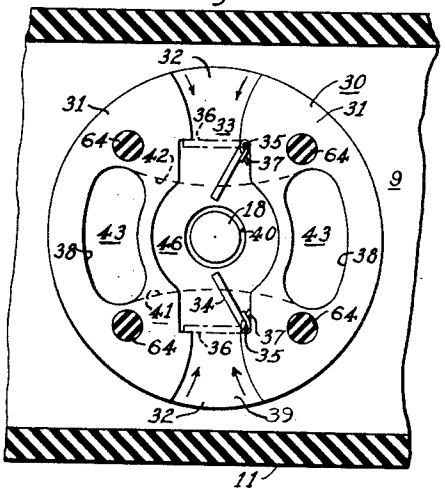


Fig. 5.



WITNESSES:

N. J. Susser.

W. R. Crout

INVENTOR

Winthrop M. Leeds.

BY

Ralph W. Swingle

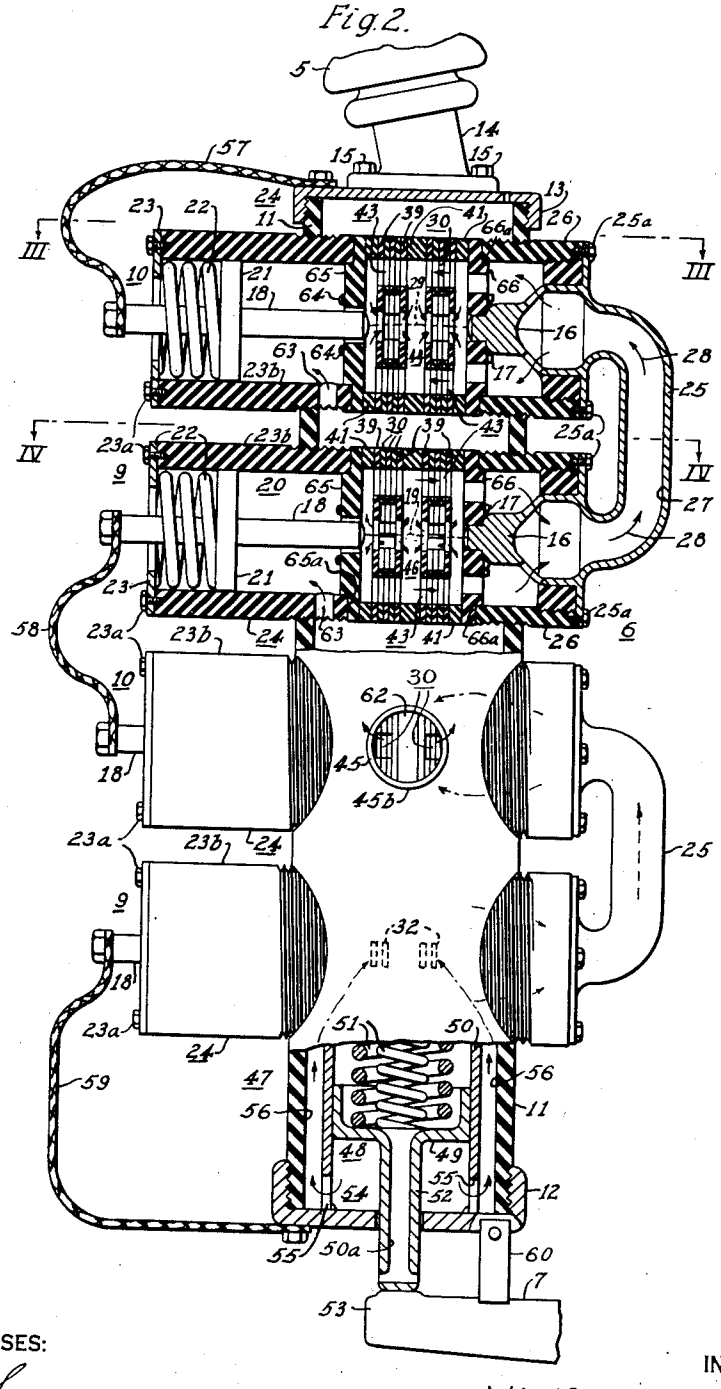
ATTORNEY

Nov. 25, 1952 W. M. LEEDS 2,619,568

CIRCUIT INTERRUPTER

Filed April 4, 1947 3 Sheets-Sheet 2

Fig. 2.



WITNESSES:

N. J. Susser

W. R. Crout

INVENTOR

Winthrop M. Leeds.

BY

Ralph W. Swingle

ATTORNEY

Nov. 25, 1952 W. M. LEEDS 2,619,568

CIRCUIT INTERRUPTER

Filed April 4, 1947 3 Sheets-Sheet 3

Fig. 6.

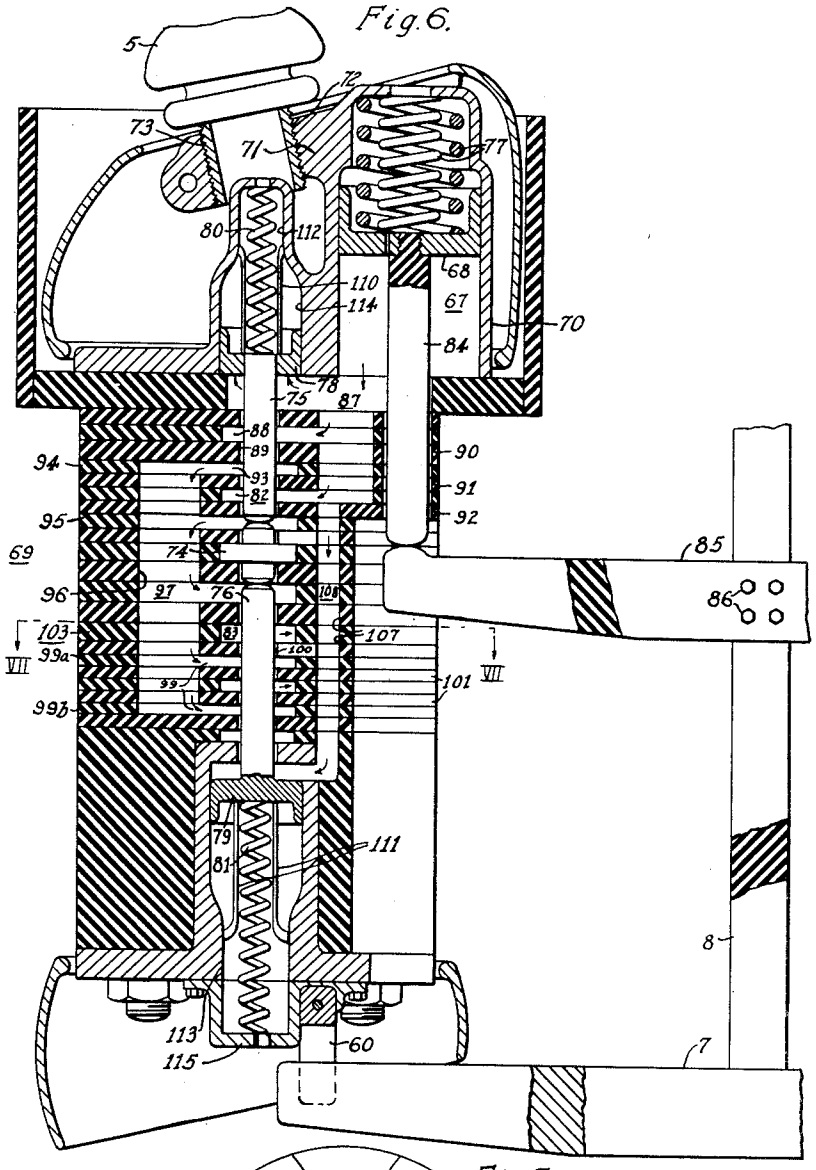
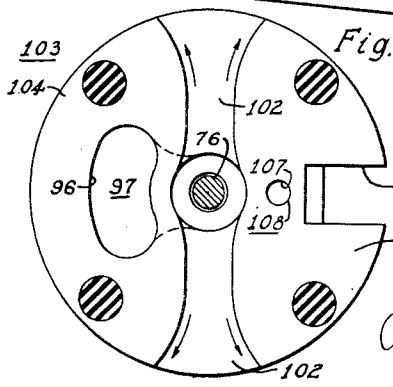


Fig. 7.



WITNESSES:

N. F. Susan

W. R. Crout

INVENTOR

Winthrop M. Leeds.

BY

Ralph H. Swingle

ATTORNEY

Patented Nov. 25, 1952

2,619,568

UNITED STATES PATENT OFFICE

2,619,568

CIRCUIT INTERRUPTER

Winthrop M. Leeds, Pittsburgh, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application April 4, 1947, Serial No. 739,273

21 Claims. (Cl. 200—150)

1

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

A general object of my invention is to provide one or more improved arc extinguishing assemblages including a plurality of improved arc extinguishing units or circuit interrupting elements in which an improved hydraulic operating mechanism is provided to effect operation of the contact structure.

Another object is to provide an improved circuit interrupter of the type comprising a pair of serially-related arc extinguishing assemblages which are electrically connected in the closed circuit position of the interrupter by a conducting cross-bar, and to provide an improved liquid pressure operating means for each assemblage to be actuated by the cross-bar.

Still another object is to provide an improved circuit interrupter in which longitudinal space is saved by providing one or more serially-related circuit interrupting elements in which the movable contact members are horizontally actuated.

A further object of my invention is to provide an improved arc extinguishing assemblage including a plurality of circuit interrupting elements in which hydraulic means is employed to not only effect opening motion of the several movable contact members but also to provide fluid flow to effect extinction of the arcs.

Still another object is to provide an improved arc extinguishing assemblage comprising circuit interrupting elements of different types in which a hydraulic drive is employed to effect fluid motion into a circuit interrupting element of the pressure-generating type during low or intermediate values of current interruption, and in which the hydraulic drive will be ineffective to force fluid into the pressure-generating circuit interrupting element during the interruption of high power. Preferably, the pressure-generating circuit interrupting element is self-sufficient during the interruption of high power to force fluid flow into one or more circuit interrupting elements of the interrupting type.

Another object is to provide an improved arc extinguishing assemblage comprising two pairs of circuit interrupting elements of the pressure-generating type and the interrupting type serially related and adapted for simultaneous operation in which the movable contact members are so adapted as to be horizontally actuated to save longitudinal space.

A further object is to provide an interrupter

2

of the type specified in the preceding paragraph in which improved liquid pressure operating means are disposed at the lower end of the assemblage to be actuated by a movable bridging member.

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, partially in section, of a complete circuit interrupter embodying my invention and shown in the closed circuit position;

Fig. 2 is an enlarged side elevational view, partially in vertical section, of the left-hand arc extinguishing assemblage of Fig. 1, the contact structure being shown in the partially open circuit position and the interruption of relatively low current being assumed;

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 an enlarged sectional view taken along the line V—V of Fig. 4;

Fig. 6 is a vertical sectional view through a modified form of my invention, the contact structure being shown in the closed circuit position; and

Fig. 7 is a sectional view taken along the line VII—VII of Fig. 6.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral 1 designates a tank 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 terminal bushings 5 supporting at their lower ends identical arc extinguishing assemblages, generally designated by the reference numeral 6. The two arc extinguishing assemblages 6 are electrically interconnected in the closed circuit position of the interrupter, as shown in Fig. 1, by a conducting cross-bar 7 reciprocally operated in a vertical direction by an insulating lift rod 8.

The insulating lift rod 8 is actuated by suitable mechanism not disclosed but which is responsive to either manual operation or to the existence of excessive current conditions in the circuit controlled by the interrupter.

Referring more particularly to Fig. 2, which shows more clearly than does Fig. 1 the improved arc extinguishing assemblage of my invention, it will be observed that I have provided two pairs of circuit interrupting elements of two

different types. The first type of circuit interrupting element is designated a pressure-generating circuit interrupting element and is generally designated by the reference numeral 9 in Fig. 2. The second type of circuit interrupting element is herein designated as an interrupting circuit interrupting element and is designated generally by the reference numeral 10 in Fig. 2. Preferably, the four circuit interrupting elements 9, 10 are alternately disposed and threadedly supported in a substantially horizontal manner as shown in Fig. 2.

More specifically, the arc extinguishing assemblage 6 comprises an insulating cylindrical casing 11 having its lower end closed by a closure cap 12 formed of metal and threadedly secured to the casing 11. The upper end of the casing 11 is likewise closed by an upper closure cap 13 threadedly secured to the upper end of the casing 11. The contact foot 14 of the assemblage 6 is secured by bolts 15 to the cap 13.

The pressure-generating circuit interrupting elements 9 are identical in construction; consequently, only a description of one is necessary. Referring to Fig. 2, it will be apparent that the pressure-generating circuit interrupting element or pressure-generating arc extinguishing unit 9 includes stationary contact means, generally designated by the reference numeral 16, and including a stationary contact 17 cooperable with a rod-shaped movable contact member 18 to establish a pressure-generating arc designated by the reference numeral 19 in Fig. 2.

For causing the actuation of the movable contact member 18, I provide a liquid pressure actuated operating means, generally designated by the reference numeral 20. The operating means 20 preferably consist of an operating piston 21 rigidly secured to the movable contact member 18 intermediate the ends thereof and biased toward the right, as viewed in Fig. 2, by a compression closing spring 22. The compression spring 22 seats at its right-hand end against the operating piston 21 and seats at its left-hand end against a metallic ring-shaped plate 23 secured by any suitable means such as screws 23*a* to the cylindrical extension 23*b* of the insulating tubular casing 24 of the circuit interrupting element 9.

It will be observed that the stationary contact means 16 is part of a removable tubular conducting member 25 secured to the interrupting element 9 by screws 25*a* which terminate in a cylindrical extension 26 of the tubular casing 24. The removable contact member 25 is laterally removable from the assemblage 6 upon the removal of the screws 25*a*.

Also, the contact member 25 has a passage 27 formed therein to permit communication between the pressure-generating circuit interrupting element 9 and the interrupting circuit interrupting element 10 disposed at the upper extremity of the assemblage 6. The arrows 28 indicate such a passage of fluid, in this instance oil, under pressure from the unit 9 to the unit 10 to effect the extinction of the interrupting arc 29 drawn in the latter.

Referring to Fig. 2, taken in conjunction with Fig. 4, it will be observed that the movable contact member 18 enters a multi-orifice structure formed by the use of a plurality of suitably configured insulating plates disposed in contiguous relation and held in position by the insulating tie bolts 64. As more clearly shown in Fig. 5, the plates are of three different types. The first type is herein designated an insulating inlet plate and is generally designated by the reference numeral 30, being shown more clearly in Fig. 5. The inlet plate 30 comprises two insulating halves 31 disposed on the same level and separated to form a pair of inwardly extending inlet passages 32 leading from the casing 11 to the interior of the pressure-generating circuit interrupting element 9. Preferably, I provide valve means generally designated by the reference numeral 33 controlling the passage of fluid through the inlet passages 32.

More specifically, the valve means 33 includes a pair of gate valves 34 pivotally mounted at 35 and biased toward the closed position as shown by the dotted lines 36 of Fig. 5 by a coil spring 37 encircling the pivot pin 35. It will be observed that the passage of oil into the unit 9 during the interruption of low and medium powers will cause opening of the valve means 33 as shown in Fig. 5. During the interruption of high powers when the pressure generated at the pressure-generating arc 19 is sufficient to cause the requisite fluid flow toward the interrupting circuit interrupting element 10, the pressure within the unit 9 will overcome the pressure of the oil entering into the unit 9 and cause closure of the valve means 33, the purpose for which will appear more fully hereinafter.

The insulating inlet plate 30 has cut-out portions 38 provided in each insulating half 31, the purpose for which will also appear more clearly hereinafter.

I have provided three of the insulating inlet plates 30 grouped together as shown more clearly in Fig. 2. Adjacent the end inlet plates 30 are insulating orifice plates designated by the reference numeral 39, and having a configuration more clearly shown in Fig. 2 and Fig. 5. Each orifice plate 39 has formed therein the cut-out portions 38 and also a centrally disposed orifice designated by the reference numeral 40, through which the movable contact member 18 passes during its opening movement. Adjacent each orifice plate 39 is an insulating exhaust plate designated by the reference numeral 41, and having a configuration more clearly shown in Fig. 5. The exhaust plate 41 has an enlarged cut-out portion 42 provided therein, the configuration of which is more clearly shown in Fig. 5.

The cut-out portions 38 of the inlet plates 30 and the orifice plates 39 align to form horizontally extending passages, generally designated by the reference numeral 43, and permitting fluid communication from the pressure arc 19 to the passage 27 provided in the removable contact member 25.

The interrupting arc extinguishing unit 10 will now be described. The interrupting unit 10 is also provided with a movable contact member 18, an operating piston 21, a closing spring 22, ring-shaped closure plate 23 and stationary contact means 16 identical in configuration to that employed in the pressure unit 9. Thus, the contact construction for the unit 10 is exactly the same as the unit 9 and is hydraulically operated in the same manner. The interrupting chamber 44 for the interrupting arc 29 established within the interrupting unit 10 is formed by the superpositioning of a plurality of insulating plates similar in shape to those previously described in connection with the unit 9 and hence given the same reference numerals.

More specifically, I have provided orifice insulating plates 39 which are the same as those previously described. Also, the plates 41 which

were termed "exhaust plates" in the unit 9 are also employed in the unit 10, but in the unit 10 may be termed "inlet plates" 41. Thus, the plates 41 in the unit 9 permitted the exhaust of fluid away from the pressure-generating arc 19. The inlet plates 41 of the unit 10 have exactly the same shape as the exhaust plates 41 of the unit 9, but in the unit 10 permit the flow of fluid, in this instance oil under pressure, from the horizontally extending passages 43 radially inwardly toward the interrupting arc 29 to effect the extinction of the latter.

The third type of plate employed in the interrupting unit 10 has the same configuration as the inlet insulating plate 30, previously described, and is in the unit 10 designated by the same reference numeral. However, the insulating inlet plate 30 is in the unit 10 designated as an exhaust insulating plate 30 inasmuch as it permits the fluid flow to pass in the opposite direction to that permitted in the unit 9. Thus, the oil flows out of the unit 10 through the exhaust insulating plates 30. To allow the oil to exhaust out of the casing 11 tubular members 45 of insulating material are provided which are threadedly secured into apertures 45*a* of the casing 11. As a result, the tubular members 45 permit the exhaust of fluid out of the unit 10 through the exhaust plates 30 and to the region entirely exterior of the casing 11.

It will be observed that the pressure-generating chamber 46 is formed by a sub-assembly plate structure including the plates 30, 39, 41 and the end plates 65, 66 held together as a unit by the tie bolts 64. The heads of the bolts 64 abut against the plate 66. The ends of the tie bolts 64 are threaded through apertures provided in the other end plate 65. The plates 65, 66 have annular grooves 65*a*, 66*a* provided therein, as shown in Fig. 2, to permit the sub-assembly plate structure to be held rigidly in place by compressive forces exerted by the tubular cylinders 23*b*, 26 forming the ends of the tubular casing 24.

The interrupting chamber 44 is likewise formed as a sub-assembly plate structure held together as a sub-unit by the insulating tie bolts 64. The end plates 65, 66 of the sub-assembly are also grooved at 65*a*, 66*a* to permit the compression members 23*b* and 26 to hold the sub-assembly rigidly in place.

The sides of each interrupting chamber sub-assembly are counterbored as at 65*b* in Fig. 3 to permit the flat ended tubes 45 to come to a flush stop against the flat counterbored sides 65*b* of the plate sub-assembly, as shown in Fig. 3.

Certain features of the pressure-generating chamber 46 of the pressure-generating unit 9 and the interrupting chamber 44 of the interrupting unit 10 are set forth and claimed in U. S. patent application, Serial No. 552,132, filed August 31, 1944, now U. S. Patent 2,445,442, issued July 20, 1948, to Winthrop M. Leeds and Robert E. Friedrich and assigned to the assignee of the instant application.

I have provided an improved hydraulic drive or hydraulic operating mechanism, generally designated by the reference numeral 47, and including a liquid moving device 48 disposed adjacent the lower end of the assemblage 6. Preferably, the liquid moving device 48 includes a pump piston 49 operating within a metallic actuating cylinder 50 and biased downwardly in the circuit opening direction by a battery of compression springs 51. The pump piston 49 has a downwardly extending projection 52 integrally formed therewith which is engaged in abutting relationship by the extremity 53 of the conducting cross-bar 7, as shown more clearly in Fig. 2.

The cylinder 50 is secured as by welding to the closure cap 12 of the casing 11. A venting passage 50*a* is provided through the projection 52 so that oil may easily circulate to the back side of the piston 49.

Thus, during the closing operation, the upward movement of the cross-bar 7 as caused by upward closing movement of the lift rod 8, effects upward charging closing movement of the pump piston 49 against the downward biasing action exerted by the battery of compression springs 51.

During the opening operation, suitable mechanism, not shown, but which is responsive to either manual operation or to the existence of overloads existing in the circuit controlled by the interrupter causes downward opening movement of the lift rod 8. The downward movement of the lift rod 8 causes corresponding downward opening movement of the conducting cross-bar 7. The downward motion of the bridging member 7 permits the compression springs 51 to force or drive the pump piston 49 downwardly to thereby effect the flow of oil under pressure out of the pump chamber 54 and outwardly through apertures 55 provided at the lower end of the operating cylinder 50 and upwardly through an annular passage 56 as provided between the walls of the casing 11 and the cylinder 50. The operating oil under pressure, passing upwardly through the annular passage 56, enters the inlet passages 32 provided by the inlet plates 30 of the two pressure-generating arc extinguishing units 9 of the assemblage 6. The operating liquid also passes through apertures 63 in the several tubes 23*b* of the units 9, 10 to act upon the several pistons 21 to thereby effect simultaneous opening of the several movable contacts 18.

This is assuming a state of affairs where low or medium powers are being interrupted. The oil under pressure as caused by downward movement of the pump piston 49 is sufficient to cause opening of the valve means 33, as indicated by the full lines in Fig. 5, to permit the passage of oil under pressure through the inlet passages 32 to strike the pressure-generating arc 19 drawn by the cooperation of the contacts 17, 18.

After striking the pressure-generating arc 19, the oil passes through the orifices 40 provided by the insulating orifice plates 39 to pass outwardly within the cut-out portion 42 as provided by the insulating exhaust plates 41 of the units 9. The oil under pressure then passes along the horizontally disposed passages 43 to enter the conduits 27 as provided by the two removable contact members 25 of the assemblage 6. After passing through the two contact members 25 the oil enters into the two interrupting arc extinguishing units 10 to pass along the horizontally disposed passages 43.

Then the oil passes radially inwardly as provided by the cut-out portions 42 of the inlet plates 41 of the units 10 to strike the interrupting arc 29 drawn between the interrupting contacts 17, 18. After striking the interrupting arc 29, the oil under pressure flows longitudinally of the arc 29 through the orifices 40 provided by the orifice insulating plates 39 to pass completely out of the units 10 and also out of the casing 11 through exhaust passages 32 as provided by the insulating exhaust plates 30 of the units 10.

Thus, during the interruption of low or me-

dium values of current, the hydraulic drive 47 is operable not only to force simultaneous opening motion of the several movable contact members 18, but is also operable to effect fluid motion into the two pressure-generating units 9 as permitted by opening of the valve means 33.

During the interruption of high powers, on the other hand, the pressure generated at the pressure-generating arcs 19 will overcome the pressure of the oil as caused by operation of the liquid moving device 43 to thereby cause closure of the valve means 33. This will prevent gas and contaminated oil from the pressure units 9 from passing out of the said units through the inlet passages 32 in a reverse direction from that during normal operation so as to enter the casing 11. If this were permitted to happen, the gas and contaminated oil entering the casing 11 during the interruption of high short-circuit currents would reduce the dielectric strength of the medium between successive interrupting units 9 and 10. Also the cushioning effect of gas bubbles inside the casing 11 would reduce the effectiveness of the liquid moving device 43 when several operations are attempted in rapid succession.

Consequently, the provision of the valve means 33 in the inlet passages 32 of the pressure units 9 prevents contaminated gas and oil from entering the casing 11 during the interruption of high short-circuit currents when the pressure generated at the pressure-generating arcs 19 is of itself sufficient to cause the requisite fluid flow under pressure through the contact members 25 toward the interrupting units 10.

It is obvious from the foregoing description that the circuit through the interrupter in the closed circuit position thereof includes the terminal stud, not shown, passing through the terminal bushing 5, contact foot 14, flexible conductor 57 to movable interrupting contact 18 of the upper interrupting unit 10 of the assemblage 6. The circuit then passes through the upper removable contact member 25 to the upper pressure-generating unit 9, from whence the circuit passes through the movable pressure-generating contact 18 associated with the upper pressure-generating unit 9, through the flexible conductor 58 to the movable interrupting contact 18 of the lower interrupting unit 10.

The circuit then extends through the lower contact member 25 into the lower pressure-generating unit 9. The electrical circuit then extends through the movable pressure-generating contact 18 of the lower pressure unit 9 through a flexible conductor 59 to the conducting lower closure cap 12 of the assemblage 6.

I have provided a pair of stationary disconnect fingers 60 which make electrical contact with the sides of the cross-bar 7 during the initial portion of the opening operation so that the arcs are interrupted within the several units 9, 10, before the cross-bar 7 parts company with the stationary disconnect fingers 60. Thus, the circuit is broken within the units 9, 10 and not at the disconnect fingers 60.

The cross-bar 7 moves downwardly during the opening operation to assume a position as shown by the dotted lines 61 of Fig. 1 in which position two isolating gaps are interposed in the circuit.

High speed oil circuit breakers for 230 kv. ratings and above usually utilize multi-break contact arrangements. The mechanical linkages for operating these contacts simultaneously may become complicated. My invention, as disclosed above, provides hydraulic operation of multi-break contacts making use of the same piston required for developing pressure to interrupt line charging currents or other low or medium currents.

By this arrangement the contacts are made to open horizontally giving easy accessibility for inspection. During the opening stroke, heavy springs 51 behind the main piston 49, located at the bottom of the assemblage 6 put all of the oil in the large supporting tube 11 under pressure. Thus, each of the four moving contacts 18 is opened rapidly by hydraulic pressure applied to the contact pistons 21.

During the interruption of low or medium currents, oil is forced through the inlet channels 32 of the second and fourth grids, or pressure-generating grids 9, through the multi-orifice structure to conduits 43 leading to the hollow stationary contacts 17. The oil then flows upwardly to the first and third interrupting grids 10. After passing through another multi-orifice structure associated with the interrupting grids 10, where the interrupting arcs 29 are deionized, oil and gas are discharged through the front and back vent openings 62 provided by the tubular members 45 as shown in Fig. 3.

During the interruption of heavy short-circuit currents, the deionizing flow into the first and third grids 10 is put in motion by the pressure generated in the second and fourth grids 9, or pressure breaks.

The provision of the check valves 33 located in the inlet passages 32 of the second and fourth pressure grids 9 avoids gas being expelled into the main tube 11. The main piston 49 will operate even during high current interruption to force the contact pistons 21 to open hydraulically. After arc extinction, valves 33 open and completion of the main piston stroke will send a flushing flow of oil through all of the grids 9, 10.

The springs 22 will then retrieve the contacts 18, 17 to permit closing of the circuit to take place at the disconnect fingers 60, thereby avoiding prestriking between the contacts during the closing stroke. When closing against a fault, gas and contaminated oil from even a short closing arc may reduce the interrupting effectiveness on the opening operation immediately following. From the foregoing description, it will be apparent that I have provided an improved arc extinguishing assemblage in which the circuit is interrupted within the units 9, 10, and during the closing stroke the contact structure already being closed by the springs 22 in the assemblage 6 completion of the circuit occurs exteriorly of the casing 11 at the disconnect fingers 60. Thus, contamination of the oil due to prestriking on the closing stroke will occur exteriorly of the casing 11 and not interiorly of the units 9, 10. The term "prestriking" is meant herein to mean arcing between the approaching contacts during the closing operation when voltage is impressed upon the system. In a high voltage system, the high voltage encountered tends to cause flashover between the approaching contacts even before the contacts have actually made contacting engagement during such a closing operation. Certain features of closing the contact structure within the assemblage 6 in the full open circuit position of the interrupter, so that the circuit will be made exteriorly thereof during the closing stroke are

described and claimed in my copending application, Serial No. 679,087 filed June 25, 1946, continued as application, Serial No. 103,683, filed July 8, 1949 which issued as Patent No. 2,580,354 on December 25, 1951, and assigned to the assignee of the instant application.

In the modification of my invention, as shown in Figs. 6 and 7, it will be noted that I have provided a modified type of hydraulic drive 67 which includes a pump piston 68 disposed adjacent the upper end of the arc extinguishing unit 69. The pump piston 68 is reciprocally operable within an operating cylinder 70 provided integrally with a modified contact foot 71, the latter being threadedly secured at 72 to the lower end of a conducting tube 73 extending interiorly through the terminal bushing 5.

I have provided a relatively stationary contact 74 disposed intermediate the ends of the unit 69 and making engagement in the closed circuit position of the interrupter, as shown in Fig. 6, with an upper pressure-geenerating contact 75 and a lower interrupting contact 76.

Downward movement of the pump piston 68 as caused by the compression springs 77 effects the motion of fluid, in this instance oil, under pressure downwardly and against the operating pistons 78, 79 secured respectively to the pressure and interrupting contacts 75, 76. The oil under pressure forces the opening movement of the contacts 75, 76 against the closing biasing action exerted by compression springs 80, 81. The movement of the contact 75 upwardly away from the intermediate contact 74 draws a pressure-generating arc, not shown, within a pressure-generating chamber 82. The downward motion of the lower movable interrupting contact 76 draws an interrupting arc, not shown, within an interrupting chamber, generally designated by the reference numeral 83 in Fig. 6. The pump piston 68 has an insulating projection 84 extending downwardly therefrom which makes abutting engagement with an offstanding insulating arm or actuating part 85 rigidly secured at 86 to the insulating lift rod 8 of the interrupter. As in the preceding embodiment of my invention, the conducting cross-bar 7 makes contacting engagement in the closed circuit position of the interrupter, as shown in Fig. 6, with a pair of stationary disconnect fingers 60, only one of which is shown in Fig. 6.

It will be observed from an inspection of Fig. 6 that oil under pressure passes downwardly through a conduit 87 to pass inwardly through two inlet passages 88 toward the pressure-generating arc established between the contacts 74, 75. After striking the pressure-generating arc, the oil flows longitudinally through orifices 89 provided by orifice insulating plates 90, 91 and 92 to discharge through exhaust passages 93 provided by insulating exhaust plates 94, 95. The plates are provided with cut-out portions 96 which upon alignment form a vertical flow passage, generally designated by the reference numeral 97 and leading downwardly toward the interrupting chamber 83.

The oil passing downwardly through the vertical flow passage 97 under pressure as provided by the pressure-generating arc and/or the pump piston 68 enters the interrupting chamber 83 through inlet passages 99 provided by insulating plates 99*a*, 99*b*. After striking the interrupting arc drawn between the contacts 74, 76 within the interrupting chamber 83 the oil passes longitudinally of the said interrupting arc through orifices 100 provided by insulating orifice plates 101 to pass outwardly out of the unit 69 through exhaust passages 102 as more clearly shown in Fig. 7.

The exhaust passages 102 are provided by an insulating exhaust plate, generally designated by the reference numeral 103, and including two separated insulating halves 104, 105. The insulating half 104 has the cut-out portion 96 provided therein and the insulating half 105 has a segment 106 removed therefrom to permit downward travel of the insulating arm 85. Also, the insulating half 105 has an aperture 107 formed therein which upon alignment with apertures 107 formed in the other adjoining plates forms a vertical conduit, generally designated by the reference number 108, permitting intercommunication between the pump piston 68 and the operating piston 79 secured to the lower end of the movable interrupting contact 76. Sliding fingers 110, 111 are respectively secured to the operating pistons 78, 79 to provide sliding contacting engagement along the end portions 112, 113 of the operating cylinders 114, 115 respectively.

Thus, in the closed circuit position of the interrupter, as shown in Fig. 6, the electrical circuit therethrough includes conducting tube 73 positioned interiorly of the terminal bushing 5, contact foot 71, portion 112 of casting 71, fingers 110, movable pressure-generating contacts 75, intermediate stationary contact 74, lower movable interrupting contact 76, fingers 111, portion 113 of operating cylinder 115 to the stationary disconnect fingers 60. The circuit then extends through the conducting cross-bar 7 to the right-hand arc extinguishing unit 69, not shown, of the complete interrupter. The circuit extends through the right-hand unit 69 in an identical manner to its passage through the left-hand unit 69 shown in Fig. 6 to the right hand terminal bushing 5 of the interrupter.

During the interruption of relatively low or intermediate values of current, the pump piston 68 moves downwardly to force oil to flow through the conduit 87 and the conduit 108 toward the operating pistons 78, 79 respectively. This causes upward and downward motion respectively of contacts 75, 76 to effect thereby simultaneous drawing of a pressure-generating arc, not shown, within the pressure-generating chamber 82 and an interrupting arc, not shown, within the interrupting chamber 83. Fluid, in this instance oil, passes in a manner as previously mentioned toward the pressure arc and downwardly through the passage 97 to the interrupting arc to effect the extinction of the latter. Circuit interruption soon follows and the continued downward motion of the cross-bar 7 effects separation from the disconnect fingers 60 to interpose an isolating gap in the circuit.

During the interruption of high power, that is, during the interruption of large amperage currents, the pressure established within the pressure-generating chamber 82 stalls the downward movement of the pump piston 68. However, the pressure established at the pressure-generating chamber 82 causes oil to flow downwardly through the conduit 108 to effect opening movement of the sliding piston 79 even more rapidly than usual. Also, some of the oil under pressure at the pressure-generating chamber 82 passes upwardly to flow through the conduit 87 to act upwardly upon the operating piston 78 to effect opening motion of the movable pressure-generating contact 75.

Further, oil under pressure passes downwardly from the pressure chamber 82 through the vertical flow passage 97 to pass into the interrupting chamber 83 to effect interruption of the interrupting arc in the manner previously mentioned.

Upon a subsidence of the pressure within the unit 69, downward motion of the pump piston 68 following the interruption of such high power causes a flushing flow of oil to take place through the pressure chamber 82 and through the interrupting chamber 83.

During the closing stroke, it will be noted that electrical contact is not made between the conducting cross-bar 7 and the disconnect fingers 60 until after the main piston 68 has been lifted part way. This has the advantage that should the breaker be closed during the existence of short-circuit conditions still existing in the line controlled by the interrupter, the immediate reversal of the operating mechanism as caused by such closing on a short-circuit will permit the piston 68 to be effective to cause opening of the contacts in the manner previously described. Thus I have provided an arrangement in which the piston 68 is part way charged before there is any possibility of flashover between the disconnect contact 60 and the cross-bar 7 when closing on a short circuit.

It will be observed that the construction as set forth in Figs. 6 and 7 is particularly suitable where the voltage encountered is not as high as that which requires a greater number of breaks. Thus, where a greater number of breaks is necessary, the construction of Fig. 2 may be employed. For lower voltage applications the construction of Fig. 6 may be adequate.

From the foregoing description of two embodiments of my invention, it will be apparent that I have provided an improved circuit interrupter of the type utilizing a hydraulic drive for effecting opening of the contact structure and for also directing fluid or liquid under pressure into the interrupting chambers during the interruption of low or medium powers to effect the extinction of the arcs drawn therein. During the interruption of high powers, the pressure generated at the pressure arc is sufficient to provide the requisite fluid flow and the main pump pistons may be stalled, to later bring about a flushing flow of fluid following circuit interruption.

It will be noted that with the construction of Fig. 2, the contact structure is removable laterally from the assemblage 6 for inspection or replacement. Also, with the construction of Fig. 2, the number of pairs of units may be accommodated to the voltage rating. Thus, two of the units, instead of four as shown in Fig. 2, may be used for moderate voltage applications. For very high voltages, six or even eight units may be provided.

It will also be observed that with the construction shown, the contact structure is reclosed by spring pressure in the fully open circuit position of the interrupter so that closing of the circuit takes place exteriorly of the assemblage 6 or the unit 69. Thus, prestriking or flashover during the closing stroke will not tend to contaminate oil within the assemblage 6 or the unit 69.

Although I 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.

I claim as my invention:

1. In a circuit interrupter of the liquid break type, an arc extinguishing assemblage including hollow casing means, a pressure-generating circuit interrupting element having a pair of separable contacts provided therein, the pressure-generating element being supported substantially transversely of the casing means, an interrupting circuit interrupting element also having a pair of separable contacts provided therein, the interrupting circuit interrupting element being supported substantially transversely of the casing means, liquid passage means interconnecting the interior of the hollow casing means with the pressure-generating element, passage means disposed externally of the casing means interconnecting the two circuit interrupting elements so that liquid under pressure from the pressure-generating circuit interrupting element may flow therethrough to extinguish arcing within the interrupting circuit interrupting element, and exhaust passage means for the interrupting element extending completely out of the casing means.

2. In a circuit interrupter of the liquid break type, an arc extinguishing assemblage including hollow casing means filled with liquid, a pressure-generating circuit interrupting element having a pair of separable contacts provided therein, the pressure-generating element being supported substantially transversely by the hollow casing means, an interrupting circuit interrupting element also having a pair of separable contacts provided therein, the interrupting circuit interrupting element being supported substantially transversely by the hollow casing means, liquid passage means interconnecting the interior of the casing means with the pressure-generating element, passage means disposed externally of the casing means interconnecting the two circuit interrupting elements, exhaust passage means for the interrupting element extending completely out of the casing means, and valve means disposed in the first-mentioned passage means to prevent back flow of gas or liquid from the pressure-generating element into the casing means during high current interruption.

3. In a circuit interrupter of the liquid break type, an arc extinguishing assemblage including hollow casing means filled with liquid, a pressure-generating circuit interrupting element having a pair of separable contacts provided therein, the pressure-generating element being supported substantially transversely of the casing means, an interrupting circuit interrupting element also having a pair of separable contacts provided therein, the interrupting circuit interrupting element being supported substantially transversely of the casing means, liquid passage means interconnecting the interior of the casing means with the pressure-generating element, passage means disposed externally of the casing means interconnecting the two circuit interrupting elements, exhaust passage means for the interrupting element, extending completely out of the casing means, and a hydraulic operating mechanism disposed at one end of the casing means for effecting simultaneous separation of the two pairs of separable contacts within the two circuit interrupting elements.

4. In a circuit interrupter, contact means for establishing a pressure-generating arc within a substantially confined pressure-generating chamber, contact means for establishing an interrupting arc within a vented interrupting chamber,

passage means interconnecting the two chambers so that fluid from the pressure chamber may flow toward the interrupting chamber to effect the extinction of the arc therein, biasing means for biasing both contact means to the closed circuit position, disconnect means, hydraulic operating means for effecting simultaneous opening of the contact means against the biasing action exerted by the biasing means, means whereby the disconnect means causes operation of the hydraulic operating means, and passage means interconnecting the hydraulic operating means with the pressure-generating chamber to assist low current interruption so that liquid may flow sequentially toward the pressure-generating arc and subsequently onwardly through said first-mentioned passage means to the interrupting arc.

5. In a circuit interrupter of the liquid break type, a tubular insulating casing filled with liquid, two pairs of pressure-generating and interrupting circuit interrupting elements disposed alternately and supported substantially transversely by the tubular casing, passage means disposed externally of the casing connecting the two pairs of elements so that liquid under pressure from the pressure-generating elements may extinguish arcing within the interrupting circuit interrupting elements, and contact means for all the elements removable laterally from the casing.

6. In a circuit interrupter, a hollow casing, a pair of circuit interrupting elements supported transversely by the casing, one being a pressure-generating element and the other being an interrupting element, contact rod means removable laterally from one end of each element, and a tubular stationary contact member interconnecting the two elements at their other ends for permitting the passage of fluid between the two elements.

7. In a circuit interrupter of the liquid break type, a tank containing an arc extinguishing liquid, means supporting a tubular casing adjacent one end thereof within the tank, a pair of tubular circuit interrupting elements supported by the casing substantially transversely thereto, disconnect means disposed at the other end of the casing, contact means for the elements laterally separable and laterally removable from the elements, hydraulic means for operating the contact means, and means whereby the disconnect means causes actuation of the hydraulic means.

8. In a circuit interrupter of the liquid break type, a tank containing an arc extinguishing liquid, means supporting a tubular casing adjacent one end thereof within the tank, a pair of tubular circuit interrupting elements supported by the casing substantially transversely thereto and extending therethrough, disconnect means disposed at the other end of the casing, contact means for the elements laterally separable and laterally removable from the elements, and a hydraulic drive disposed at the said other end of the casing actuated by the disconnect means and operable to effect simultaneous motion of the contact means in the two elements.

9. In a circuit interrupter of the liquid break type, contact means separable to establish substantially simultaneously a serially related pressure-generating arc and an interrupting arc, passage means interconnecting the two arcs so that liquid under pressure may flow from the pressure-generating arc toward the interrupting arc to effect the extinction of the latter, means biasing the contact means towards the closed circuit position, disconnect means, hydraulic operating means, means whereby the disconnect means causes charging motion of the hydraulic operating means during the closing stroke of the interrupter, and passage means interconnecting the hydraulic operating means with the two arcs so that liquid under pressure may flow, at least during low current interruption, from the hydraulic operating means toward the pressure-generating arc and subsequently onwardly through said passage means toward the interrupting arc.

10. In a circuit interrupter of the liquid break type, an arc extinguishing assemblage including a hollow casing filled with liquid, a plurality of serially related arc extinguishing units supported substantially transversely of the casing, each unit having at least a movable contact member adapted for motion, a liquid pressure operating means associated with each unit for causing the motion of the movable contact member, means causing communication between the interior of the hollow casing and each liquid pressure operating means, a hydraulic drive for simultaneously effecting opening motion of the contact members by suddenly putting the liquid disposed within the hollow casing under pressure, and a conducting actuating member for charging the hydraulic drive during the closing operation of the circuit interrupter and separable from the hollow casing in the fully open circuit position of the interrupter for inserting an isolating gap in the circuit.

11. In a circuit interrupter of the liquid break type, an arc extinguishing assemblage including hollow casing means filled with liquid, a pressure-generating circuit interrupting element having a pair of separable contacts provided therein, the pressure-generating element being supported substantially transversely of the casing means, an interrupting circuit interrupting element also having a pair of separable contacts provided therein, the interrupting circuit interrupting element being supported substantially transversely of the casing means, liquid passage means interconnecting the interior of the casing means with the pressure-generating element, separate passage means interconnecting the two circuit interrupting elements so that liquid under pressure from the pressure-generating circuit interrupting element may flow therethrough to extinguish arcing within the interrupting circuit interrupting element, exhaust passage means for the interrupting element extending completely out of the casing means, and a hydraulic operating mechanism for effecting simultaneous separation of the two pairs of separable contacts by putting the liquid within the casing under pressure.

12. In a circuit interrupter of the liquid break type, an arc extinguishing assemblage including hollow casing means filled with liquid, a pressure-generating circuit interrupting element having a pair of separable contacts provided therein, the pressure-generating element being supported substantially transversely of the casing means, an interrupting circuit interrupting element also having a pair of separable contacts provided therein, the interrupting circuit interrupting element being supported substantially transversely of the casing means, liquid passage means interconnecting the interior of the casing means with the pressure-generating element, passage means interconnecting the two circuit interrupting elements, exhaust passage means for the interrupting element extending completely out of the casing means, a hydraulic operating mechanism disposed adjacent one end of the casing means for

effecting simultaneous separation of the two pairs of separable contacts by putting the liquid within the casing under pressure, and a conducting actuating member for charging the hydraulic operating mechanism during the closing operation of the interrupter and separable away from the casing means in the fully open circuit position of the interrupter for placing an isolating gap into the circuit.

13. In a circuit interrupter of the liquid break type, an arc extinguishing assemblage including hollow casing means, a pressure-generating circuit interrupting element having a pair of separable contacts provided therein, the pressure-generating element being supported by the casing means, an interrupting circuit interrupting element also having a pair of separable contacts provided therein, the interrupting circuit interrupting element being supported by the casing means, liquid passage means interconnecting the interior of the hollow casing means with the pressure-generating element, passage means interconnecting the two circuit interrupting elements so that liquid under pressure from the pressure-generating circuit interrupting element may flow therethrough to extinguish arcing within the interrupting circuit interrupting element, and exhaust passage means for the interrupting element extending completely out of the casing means.

14. In a circuit interrupter of the liquid break type, an arc extinguishing assemblage including a hollow casing filled with liquid, a plurality of serially related arc extinguishing units supported substantially transversely by the casing, each unit having at least a movable contact member adapted for motion, a liquid pressure operating means associated with each unit for causing the motion of the movable contact member, means causing communication between the interior of the hollow casing and each liquid pressure operating means, a hydraulic drive for simultaneously effecting opening motion of the contact members by suddenly putting the liquid disposed within the casing under pressure, and a conductive tubular conduit interconnecting at least a pair of the arc extinguishing units for permitting the flow of liquid between the units and also for electrically connecting said pair in series.

15. A circuit interrupter of the liquid break type including an arc extinguishing assemblage, the arc extinguishing assemblage comprising an arc extinguishing unit, means supporting the arc extinguishing assemblage adjacent one end thereof within an arc extinguishing liquid, contact structure associated with the arc extinguishing unit to establish an arc, a liquid pressure operating means associated with the unit for causing separation of the contact structure associated therewith, a hydraulic drive including a piston for putting a liquid under pressure to effect operation of the liquid pressure operating means, a relatively stationary disconnect contact member disposed adjacent the other end of the arc extinguishing assemblage, a movable disconnect contact member including an actuating part separable away from the relatively stationary disconnect contact and also away from the assemblage during the opening operation of the interrupter for inserting an isolating gap in the circuit, and the actuating part causing part charging of the piston during the closing operation prior to closing of the electrical circuit through the interrupter.

16. A circuit interrupter of the liquid break type including a tank containing an arc extinguishing liquid, an arc extinguishing assemblage comprising an arc extinguishing unit, means supporting the arc extinguishing assemblage adjacent one end thereof within the liquid, contact structure associated with the arc extinguishing unit to establish arcing, means biasing the contact structure to the close circuit position, a liquid pressure operating means associated with the unit for causing separation of the contact structure, a hydraulic drive including a piston for putting liquid under pressure to effect operation of the liquid pressure operating means to thereby cause separation of the contact structure against the biasing action exerted by said biasing means, a relatively stationary disconnect contact member disposed adjacent the other end of said arc extinguishing assemblage, a movable disconnect contact member including an actuating part separable away from the relatively stationary disconnect contact member and also away from the arc extinguishing assemblage during the opening operation for inserting an isolating gap in the circuit, the contact structure being closed in the fully open circuit position of the interrupter so that during the closing operation the circuit is made at the disconnect contacts, and the actuating part causing part charging of the piston during the closing operation prior to closing of the electrical circuit at the disconnect contacts.

17. In a circuit interrupter of the liquid break type, an arc extinguishing assemblage including hollow casing means, a pressure-generating circuit interrupting element having a pair of separable contacts provided therein, the pressure-generating element being supported substantially transversely of the casing means, an interrupting circuit interrupting element also having a pair of separable contacts provided therein, the interrupting circuit interrupting element being supported substantially transversely of the casing means, liquid passage means interconnecting the interior of the hollow casing means with the pressure-generating element, passage means interconnecting the two circuit interrupting elements so that liquid under pressure from the pressure-generating circuit interrupting element may flow therethrough to extinguish arcing within the interrupting circuit interrupting element, and exhaust passage means for the interrupting element extending completely out of the casing means.

18. In a circuit interrupter of the liquid break type, an arc extinguishing assemblage including hollow casing means filled with liquid, a pressure-generating circuit interrupting element having a pair of separable contacts provided therein, the pressure-generating element being supported substantially transversely by the hollow casing means, an interrupting circuit interrupting element also having a pair of separable contacts provided therein, the interrupting circuit interrupting element being supported substantially transversely by the hollow casing means, liquid passage means interconnecting the interior of the casing means with the pressure-generating element, passage means interconnecting the two circuit interrupting elements, exhaust passage means for the interrupting element extending completely out of the casing means, and valve means disposed in the first-mentioned passage means to prevent back flow of gas or liquid from the pressure-generating element into the casing means during high current interruption.

19. In a circuit interrupter, contact means for establishing a pressure-generating arc within a substantially confined pressure-generating chamber, contact means for establishing an interrupting arc within a vented interrupting chamber, passage means interconnecting the two chambers so that fluid from the pressure chamber may flow toward the interrupting chamber to effect the extinction of the arc therein, biasing means for biasing both contact means to the closed circuit position, disconnect means, hydraulic operating means for effecting opening of the contact means against the biasing action exerted by the biasing means, means whereby the disconnect means causes operation of the hydraulic operating means, and passage means interconnecting the hydraulic operating means with the pressure-generating chamber to assist low current interruption so that liquid may flow sequentially toward the pressure-generating arc and subsequently onwardly through said first-mentioned passage means to the interrupting arc.

20. In a circuit interrupter of the liquid break type, contact means separable to establish a serially related pressure-generating arc and an interrupting arc, passage means interconnecting the two arcs so that liquid under pressure may flow from the pressure-generating arc toward the interrupting arc to effect the extinction of the latter, means biasing the contact means towards the closed circuit position, disconnect means, hydraulic operating means, means whereby the disconnect means causes charging motion of the hydraulic operating means during the closing stroke of the interrupter, and passage means interconnecting the hydraulic operating means with the two arcs so that liquid under pressure may flow, at least during low current interruption, from the hydraulic operating means toward the pressure-generating arc and subsequently onwardly through said passage means toward the interrupting arc.

21. In a circuit interrupter of the liquid break type, means for suspending a pair of serially related arc extinguishing units in a body of liquid, a conducting cross-bar for electrically interconnecting the two units in a closed circuit position, a lift rod connected intermediate the ends of the cross-bar for effecting actuation of the same, contact means in each unit to draw simultaneously pressure and interrupting arcs, hydraulic means disposed at the upper ends of the units, an offstanding actuating arm secured to and movable with the lift rod, the cross-bar interposing two isolating gaps in the fully open circuit position of the interrupter, and the actuating arm causing operation of the hydraulic means prior to closing of the electrical circuit through the interrupter to thereby effect part charging of the hydraulic means before closing of the electrical circuit.

WINTHROP M. LEEDS.

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