Jan. 1, 1963 R. N. YECKLEY ET AL 3,071,670

CIRCUIT INTERRUPTERS

Filed July 1, 1959 2 Sheets-Sheet 1

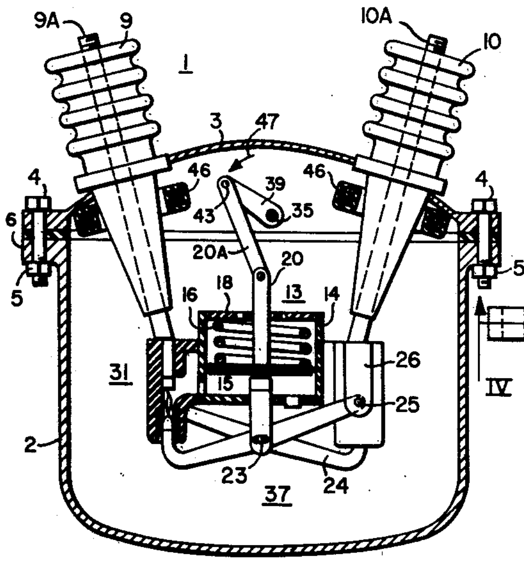


Fig.1.

Fig.3.

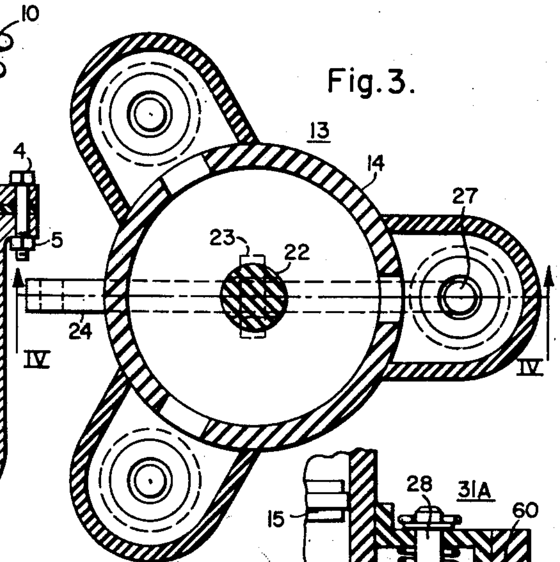


Fig. 4A.

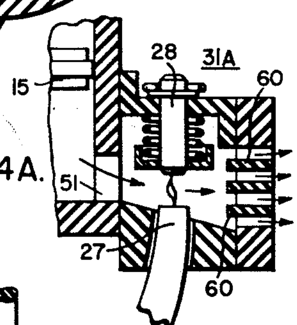


Fig. 2.

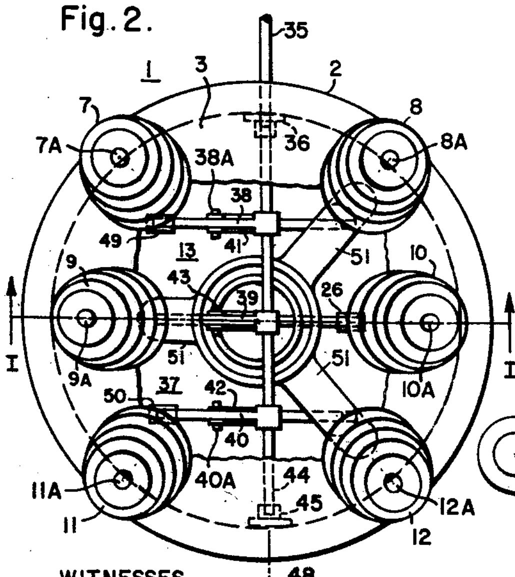
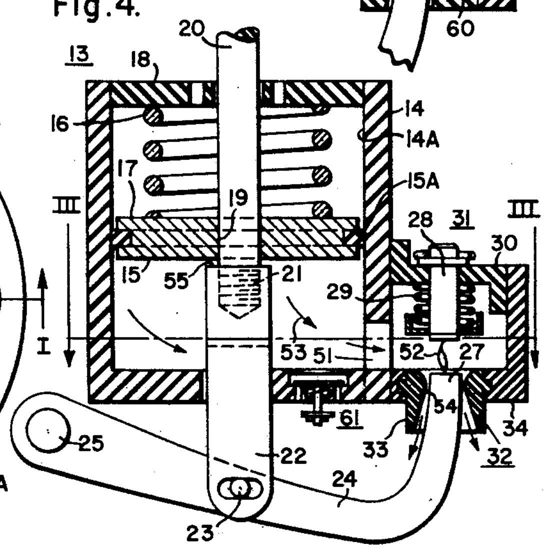


Fig.4.



WITNESSES

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CIRCUIT INTERRUPTERS

Filed July 1, 1959 2 Sheets-Sheet 2

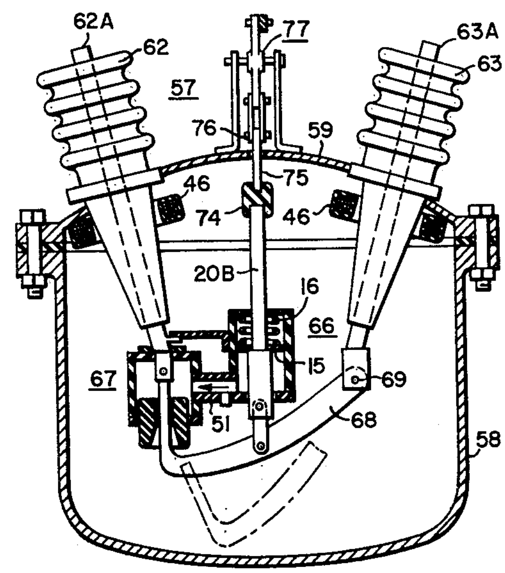


Fig. 5.

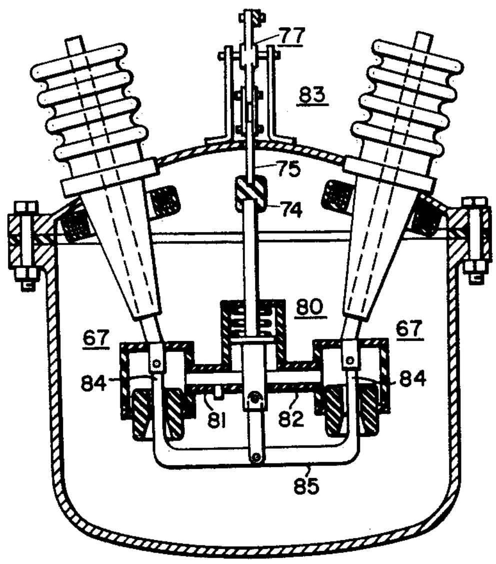


Fig. 7.

Fig. 6.

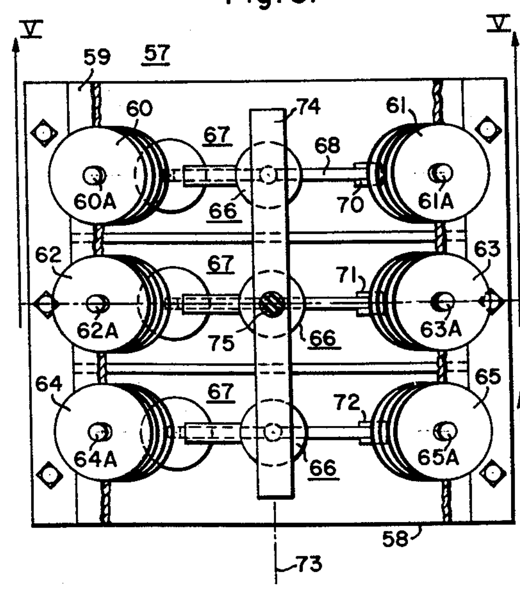
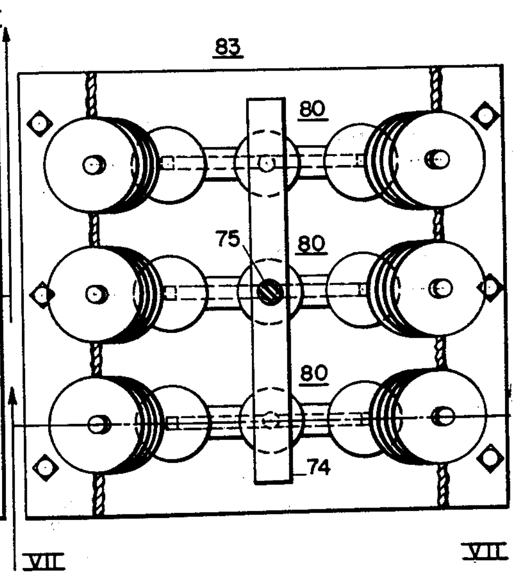


Fig. 8.



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CIRCUIT INTERRUPTERS

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4 Claims. (Cl. 200—145)

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

A general object of the present invention is to provide an improved circuit interrupter, which will be of simple and highly effective construction, and which will also cover a wide voltage range in interrupting ratings.

A more specific object of the present invention is to provide an improved circuit interrupter employing an improved pumping means for pumping arc-extinguishing fluid into the arc to be interrupted.

A further object of the present invention is to provide an improved, dead-tank-type of circuit interrupter, in which a fluid-driving pump is associated with the one or more arc-extinguishing units to effectively bring about circuit interruption.

Although the invention has applicability when employed with any arc-extinguishing medium such as a suitable liquid, for instance circuit-breaker oil, and to a gaseous arc-extinguishing medium, such as air, the invention has particular applicability when employed in a sealed-tank construction, employing a highly effective arc-extinguishing gaseous medium, such as sulfur hexafluoride (SF_6) or selenium hexafluoride (SeF_6), or mixtures of the aforesaid two gases, or mixtures of such gases with carbon dioxide, helium, nitrogen, argon and hydrogen.

Up to the present time, the present commercially-available, sulfur-hexafluoride (SF_6) gas, circuit interrupters have utilized a self-pressure-generating type of circuit interrupter, such as, for instance as disclosed in U.S. Patent 2,979,589, issued April 11, 1961, to Benjamin P. Baker, and assigned to the assignee of the instant application. With reference to the aforesaid Baker interrupting structure, an upstanding porcelain casing was employed to house the interiorly disposed interrupting units. Each interrupting unit in the Baker structure included a contact structure operable to establish a pressure-generating arc and a serially-related interrupting arc. A substantially closed interrupting unit was employed to effectively direct the gas flow.

It is a further object of the present invention to improve upon the individual, porcelain-clad pole-units of the aforesaid Baker interrupting structure, so as to provide an improved type of circuit interrupter, utilizing a puffer-type of interrupting structure, preferably with the three phases contained within a single dead-tank type of circuit interrupter. Where the ratings are higher, it may not be possible to position the three phases within a single dead-tank, and separate tank structures will, in this event, be preferable.

Yet a further object of the present invention is to provide an improved, simplified, puffer-type of circuit interrupter, in which a single piston and cylinder arrangement is operable to force fluid simultaneously into a plurality of interrupting structures. The interrupting structures may be adjacent pole units in the other phases of the circuit interrupter, or, in the high-voltage ratings, the interrupting structures may be associated with a single-pole unit, involving only a single phase of the circuit interrupter.

An auxiliary object of the invention is to provide a simplified, dead-tank-type of circuit interrupter, in which the number of gasketed joints for the tank structure is

a minimum. This obviously has particular advantage, when an expensive gaseous-type of arc-extinguishing medium is employed, such as sulfur hexafluoride (SF_6) gas.

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

FIGURE 1 is a vertical sectional view taken through the center pole-unit of the three-phase circuit interrupter illustrated in FIG. 2, taken substantially along the line I—I of FIG. 2, with the contact structure being illustrated in the partially open-circuit position;

FIG. 2 is a plan view of the three-phase circuit interrupter of FIG. 1, with a portion of the cover plate broken away to disclose the single internally disposed puffer structure;

FIG. 3 is a considerably enlarged, plan view in section taken substantially along the line III—III of FIG. 4;

FIG. 4 illustrates, in an enlarged fashion, the single puffer structure directing fluid into one of three interrupting structures, the contact structure being illustrated in the partially open-circuit position, and the view being taken substantially along the line IV—IV of FIG. 3. It will be noted that the view of FIG. 4 is taken from the opposite side of the puffer structure than that shown in FIG. 1;

FIG. 4A illustrates, fragmentarily, a modified type of interrupting unit, which may be substituted for the interrupting unit of FIG. 4;

FIG. 5 illustrates a modified type of circuit interrupter, in which a single puffer structure is utilized for each of the three phases, the contact structure being shown in the closed-circuit position, and the sectional view being taken substantially along the line V—V of FIG. 6;

FIG. 6 is a plan view of the three-phase circuit interrupter of FIG. 5, with a portion of the cover plate being broken away to disclose the internal interrupting structure;

FIG. 7 illustrates a vertical sectional view taken through still another modified type of three-phase circuit interrupter, again the contact structure being shown in the closed-circuit position, the sectional view being taken substantially along the line VII—VII of FIG. 8; and

FIG. 8 is a plan view of the circuit interrupter of FIG. 7, with a portion of the cover plate broken away to illustrate more clearly the internal interrupting arrangement.

Referring to the drawings, and more particularly to FIG. 1 thereof, the reference numeral 1 generally designates a three-phase circuit interrupter, wherein the three phases are disposed within a generally cylindrical tank 2. As shown, the tank 2 has a cover plate 3, which is secured, by mounting bolts 4 and associated nuts 5, to a mounting flange portion 6 of the tank 2.

Extending downwardly internally into the cover 3, and secured thereto, are three pairs of terminal bushings 7, 8, 9, 10, 11, 12. As is known by those skilled in the art, the cover plate 3 would be provided with cylindrical flange supporting structures, not shown, to support the grounded mounting flange of each terminal bushing. Extending longitudinally through each terminal bushing is the respective terminal stud therefor, such as stud 7A, 8A, 9A, 10A, 11A, or 12A.

As more clearly illustrated in FIG. 2, wherein a portion of the top cover plate 3 is broken away, there is provided a single pumping means, generally designated by the reference numeral 13, and including an operating cylinder 14, within which reciprocally moves a fluid-driving piston 15.

FIG. 4 more clearly shows, to an enlarged scale, the construction of the pumping means 13. The piston 15 has a piston ring 15A to provide a close fit with the internal wall 14A of the operating cylinder 14. A compression spring 16 is disposed between the top surface 17 of the piston 15 and the closure plate 18, which closes the upper end of the operating cylinder 14. Extending with a sliding fit through an aperture 19, provided in the piston 15, is a lift rod 20 formed of insulating material. As shown in FIG. 4, the lower end of the lift rod 20 has a threaded connection, as at 21, with a bifurcated rod-end 22, which is pivotally connected, as at 23, to a hook-shaped contact arm 24, the latter being pivotally mounted, as at 25 (FIG. 1), to a contact foot 26 secured to the lower end of the terminal stud 10A.

As shown in FIG. 4, the movable contact end 27 of the rotatable contact arm 24 makes separable engagement with a relatively stationary contact 28, which is resiliently supported, by a contact compression spring 29, to the upper wall 30 of an interrupting unit, generally designated by the reference numeral 31. An orifice structure 32, including a sleeve-like orifice member 33, is fixedly secured to the bottom wall 34 of the arc-extinguishing unit 31.

As illustrated in FIG. 2, all three poles of the three-phase circuit interrupter are disposed within a single tank 2. A horizontally extending main operating shaft 35 extends through a single gas-tight seal into the interior 37 of the tank 2. This rotatable operating shaft 35 has three crankarms 38–40 clamped thereto. The end crankarms 38 and 40 are pivotally mounted as at 38A, 40A to insulating lift rods 41, 42, which have their lower ends pivotally connected to the adjacent contact arms 24. The center crank arm 39 is pivotally connected, at 43, through a link 20A, to the insulating lift rod 20. Thus, rotatable opening and closing movements of the main shaft 35 will simultaneously effect opening and closing rotatable movement of the three contact arms 24.

As shown in FIG. 2, the other end 44 of the main operating shaft 35 is located within an internally disposed boss portion 45, which may be welded to the inner side wall of the tank 2, so that only a single gas-tight seal 36 is required for the main operating shaft 35.

FIG. 1 also shows current transformers 46, encircling the terminal bushings, for protective relaying functions, as well known by those skilled in the art.

From the foregoing description, it will be obvious as to the manner of operation of the circuit interrupter 1. However, by way of recapitulation, during the opening operation, the rotatable main shaft 35 is rotated, by any suitable external operating mechanism, not shown, in a counterclockwise direction, as indicated by the arrow 47 in FIG. 1. This will effect through the three crank-arms 38–40 downward movement of the three insulating lift-rods 20, 41, 42, to effect, through the pivotal connections 23, opening rotatable movement of the three contact arms 24. It will be noted, with reference to FIG. 2, that the middle contact arm 24 is hinged, as at 25, to the contact foot 26, which is disposed to the right of the center line 48 of FIG. 2. The outer two contact arms 24, however, are hinged to the contact feet 49, 50 disposed to the left of the center line 48 of FIG. 2. This provides a more compact construction, and, more importantly, permits a symmetrical location of the three exhaust outlets 51 associated with the single pump means 13, which lead to the three interrupting units 31. Thus, the three passages 51 provide a centrally-located, symmetrical Y-shaped fluid inlet conduit structure for substantially balancing the fluid reaction forces in the injecting operation.

Due to the sliding lost-motion connection of the operating rod 20, as at 19, with the piston 15, the operating rod 20 and rod end 22 may move freely downwardly, independently of following movement of the piston 15, the latter being biased downward by its own compression spring 16. As a result, contact separating movement is rapidly obtained entirely independently of relatively slow operation of the pumping means 13. Arcs 52, shown more clearly in FIG. 4, are drawn within each of the three interrupting units 31. Fluid flow is forced, by downward movement of the piston 15, out through the exhaust outlet 51 and into the arc-extinguishing units 31. Thus, fluid, such as a sulfur hexafluoride (SF_6) gas, is forced out of the operating cylinder 14, as indicated by the arrows 53, through the exhaust outlets 51, into the established arc 52, and out through the orifice restriction 54, as provided by the orifice sleeve 33. As a result, the arc-extinguishing gas is directed longitudinally of each arc 52 through the orifice structure 32 to quickly bring about its extinction.

During the closing operation, the main operating shaft 35 is rotated, by the external mechanism, in a clockwise direction, as viewed in FIG. 1. This will effect, through the three crankarms 38–40 upward movement of the three lift-rods 20, 41, 42 and reclosing of the several contact structures. Spring-biased normally open valves 61 assist in filling the piston chamber with fluid. During the interrupting operation, these valves 61, of course, are closed, as indicated in FIG. 4.

Because of the provision of a shoulder 55 (FIG. 4) on the rod-end 22, the fluid-driving piston 15 will be picked up by this shoulder 55 during the closing stroke, to effect the charging of the piston biasing spring 16. In the fully closed-circuit position of the interrupter, only partially indicated in FIG. 1, it will be noted that the several lift rods 20, 41, 42 and the crank arms 38–40 form substantially toggle linkages, which are almost on center, to thereby reduce the tension exerted upon the crank arms 38–40.

FIG. 4A illustrates a modified type of arc-extinguishing unit 31A, in which lateral flow of the fluid from piston 15 takes place, as indicated by the arrows. Insulating splitters 60 assist in effecting arc extinction.

With reference to FIGS. 5 and 6 of the drawings, it will be observed that there is disclosed a modified type of circuit interrupter, generally designated by the reference numeral 57, and including an elongated tank structure 58 having an elongated cover plate 59. The three pairs of bushings 60–65 extend downwardly, in pairs, through the elongated cover plate 59. Respective terminal studs 60A . . . 65A are associated with the terminal bushings 60 . . . 65. Current transformers 46 are again employed. In this case, however, due to the higher interrupting rating of the circuit interrupter 57, there is associated a single piston device 66 with each pole of the interrupter. In other words, with reference to FIG. 5, for each pole of the interrupter (FIG. 5 showing the middle pole) the piston device serves to force fluid into the adjacently disposed arc-extinguishing unit 67 in much the same manner, as was described in connection with FIG. 4 of the drawings.

Similarly to the construction employed in FIG. 1, again rotatable contact arms 68 are utilized. These may, however, in this instance be hinged by connections 69 to contact feet 70–72 secured to the lower interior ends of the terminal studs 61A, 63A, 65A all to the right of the center-line 73 of the circuit interrupter 57. As a result, the three identical arc-extinguishing units 67 may all be disposed to the left of the center-line 73 of FIG. 6, all depending respectively from the lower ends of the terminal studs 60A, 62A and 64A. The lift-rods 20B, which may be very similar to the insulating lift-rods 20 of FIG. 4, will be preferably interconnected by a horizontal extending isnulating yoke 74, which is vertically actuated by a single insulating lift-rod 75. The lift-rod 75 may extend externally through the top cover plate 59, and may be connected, as at 76, to a bell-crank 77, the latter being actuated by any suitable external mechanism, as well known by those skilled in the art.

Since the functioning of the arc-extinguishing units 67 is substantially identical with the functioning of the arc-extinguishing units 31, previously described in connection with FIG. 4, this description will not be repeated. Also, the actuation of the piston 15, associated with each piston device **66**, is identical to the actuation of the piston **15** illustrated in FIG. 4.

From the foregoing description, it will be apparent that rotation of the bell-crank **77** will effect, through the pivotal connection **76**, downward opening movement of the lift rod **75**. This will permit the insulating yoke **74** to move downwardly, as biased downwardly by accelerating springs, not shown, and associated with the externally provided operating mechanism.

The downward opening movement of the insulating close yoke **74** will simultaneously effect downward movement of the three insulating lift-rods **20B**. This will permit independent contact separating movement free of the slower travel of the piston **15**, as provided by the sliding connection **19** (FIG. 4) within the piston plates **15**. The compression spring **16**, in each piston device **66**, will effect downward driving motion of the piston **15**, forcing fluid, such as sulfur hexafluoride gas, through the exhaust outlet **51** and into the arc-extinguishing units **67**, where interruption occurs in the manner previously described.

For the higher interrupting ratings, it may be desirable to associate two interrupting units **67** with each pole of the interrupter, and FIGS. 7 and 8 show this slight variation over the interrupting structures illustrated in FIGS. 5 and 6. The operation is the same as described in connection with FIGS. 5 and 6, except that with respect to FIGS. 7 and 8, the piston devices **80** are operable to send fluid in opposite directions through the associated outlets **81, 82** into the two arc-extinguishing units **67**, associated with each pole of the modified type circuit interrupter **83**.

From the foregoing description, it will be apparent that there is described an improved interrupting structure employing novel pumping means, or puffer structures, associated in such a manner as to effectively direct fluid flow into the established arcs for efficient circuit interruption. Depending upon the interrupting ratings, a single pumping structure may be provided for the three phases, or, for the higher ratings, separate pumping structures may be provided for the different pole units. Where single breaks are adequate for the voltage and current ratings, only a single arc-extinguishing unit **31, 31A** or **67** may be associated with each pole unit.

For the higher interrupting ratings, as indicated in FIGS. 7 and 8, pairs of arc-extinguishing units **67** may be employed, each having its own movable contact **84**, the movable contacts being interconnected by a bridging cross-bar construction **85**.

Where a relative expensive gas, such as sulfur hexafluoride (SF_6) gas is employed, the disclosed construction has the advantage of employing only a single gas-tight seal for the operating shaft **35**, or for the lift-rod **75**.

As compared with the interrupting structure of the aforesaid Baker patent, it will be apparent that there are a number of advantages of the interrupting structure of our invention. These are:

(1) Use of the puffer makes possible an increased interrupting capacity.

(2) One puffer for the three phases reduces physical size and reduces costs over multiple piston designs.

(3) The single-tank construction reduces the number of gasketed joints for a three-phase circuit interrupter.

(4) The steel tank construction reduces the hazards and complications of all porcelain structures.

United States patent application, filed September 19, 1958, Serial No. 726,026, by Benjamin P. Baker, and assigned to the assignee of the instant application, covers broadly a single piston construction for forcing fluid into two adjacently disposed interrupting structures.

Also, United States patent application, filed September 27, 1957, Serial No. 686,775, now United States Patent 2,965,736, issued December 20, 1960, to Thomas E. Browne, Jr., and Albert P. Strom, and assigned to the assignee of the instant application, discloses and claims an SF_6 dead-tank structure employing pistons charged by the contact structure.

Although there have been illustrated and described particular interrupting 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 invention.

We claim as our invention:

1. A three-phase, fluid-blast circuit interrupter including a grounded dead tank, three pairs of terminal bushings extending into said grounded dead tank, three rotatable crank arms hinged in staggered relation to the interior ends of three of said terminal bushings, three relatively stationary contact structures in staggered arrangement associated with the interior ends of the remaining three terminal bushings, a single centrally located pumping device including an operating cylinder and a piston movable therein, a centrally-located symmetrical Y-shaped fluid inlet conduit structure including three radially extending inlet conduits associated with said single pumping device and leading adjacent the three relatively stationary contact structures and the pumping device being operable during the opening operation to force fluid simultaneously through the three inlet conduits and radially outwardly toward the three relatively stationary contact structures for arc interruption whereby to substantially balance the fluid-flow reaction forces.

2. A three-phase, fluid-blast circuit interrupter including a grounded dead tank, three pairs of terminal bushings extending into said grounded dead tank, three rotatable crank arms hinged in staggered relation to the interior ends of three of said terminal bushings, three relatively stationary contact structures in staggered relation associated with the interior ends of the remaining three terminal bushings, a single centrally located pumping device including an operating cylinder and a piston movable therein, a centrally-located symmetrical Y-shaped fluid inlet conduit structure including piston biasing means, three radially extending inlet conduits associated with said single pumping device and leading adjacent the three relatively stationary contact structures, an insulating lift rod associated with one of the rotatable crank arms, engaging means movable with said lift rod to charge said piston biasing means during the closing operation, and the pumping device being operable during the opening operation to force fluid simultaneously radially outwardly through the three inlet conduits and toward the three relatively stationary contact structures for arc interruption whereby to substantially balance the fluid-flow reaction forces.

3. A three-phase fluid-blast circuit interrupter including a grounded tank, three pairs of terminal bushings extending into said grounded tank, three rotatable crank arms hinged in staggered relation to the interior ends of three of said terminal bushings, three relatively stationary contact structures in staggered arrangement associated with the interior ends of the remaining three terminal bushings, a single substantially centrally-located fluid-blast pumping device disposed within said grounded tank and including a relatively stationary operating cylinder and a piston movable therein, an operating rod for operating one of said rotatable crank arms and having a portion thereof composed of insulating material so that said operating rod does not conduct current, said operating rod being movable through said relatively stationary operating cylinder and having a lost-motion connection with said movable piston, a centrally-located symmetrical Y-shaped fluid inlet conduit structure including three radially extending inlet conduits associated with said single pumping device and leading toward said three relatively stationary contact structures, biasing means associated with said piston for moving the same relative to the operating cylinder for forcing fluid out of the operating cylinder through said three radially extending inlet conduits toward said relatively stationary contact structures for effecting extinction of the arcs drawn thereat whereby to substantially balance the fluid-flow reaction forces, the closing motion

of said operating rod not only effecting closing motion of said one rotatable crank arm but also charging of said piston in opposition to said biasing means, and said lost-motion connection being effective during the opening operation to permit unimpeded opening travel of said one rotatable crank arm independently of motion of the piston.

4. The combination in a three-phase fluid-blast circuit interrupter of a grounded tank, three pairs of terminal bushings extending downwardly into said grounded tank, a rotatable main drive shaft extending laterally of said tank and disposed substantially horizontally, three rotatable crank arms hinged in staggered relation to the lower interior ends of three of said terminal bushings, three relatively stationary contact structures in staggered arrangement associated with the lower interior ends of the remaining three terminal bushings, a single substantially centrally-located fluid-blast pumping device disposed within said grounded tank and including a relatively stationary operating cylinder and a piston movable therein, three crank-arms secured to said rotatable main drive shaft, operating rod means interconnecting said three crank-arms rotatable with the main drive shaft with said three hinged crank arms for effecting the simultaneous opening and closing movements thereof in response to opening and closing rotatable movement of the main drive shaft, said operating rod means including an operating rod for operating the middle hinged crank arm and having a portion thereof composed of insulating material so that said operating rod does not conduct current, said operating rod being movable through said relatively stationary operating cylinder and having a lost-motion connection with said movable piston, a centrally-located symmetrical Y-shaped fluid inlet conduit structure including three radially extending inlet conduits associated with said single pumping device and leading toward said three relatively stationary contact structures, biasing means associated with said piston for moving the same relative to the operating cylinder for forcing fluid out of the operating cylinder through said three radially extending inlet conduits toward said relatively stationary contact structures for effecting extinction of the arcs drawn thereat, whereby to substantially balance the fluid-flow reaction forces, the closing motion of said operating rod not only effecting closing motion of said one rotatable crank arm but also charging of said piston in opposition to said biasing means, and said lost-motion connection being effective during the opening operation to permit unimpeded opening travel of said one rotatable crank arm independently of motion of the piston.

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