

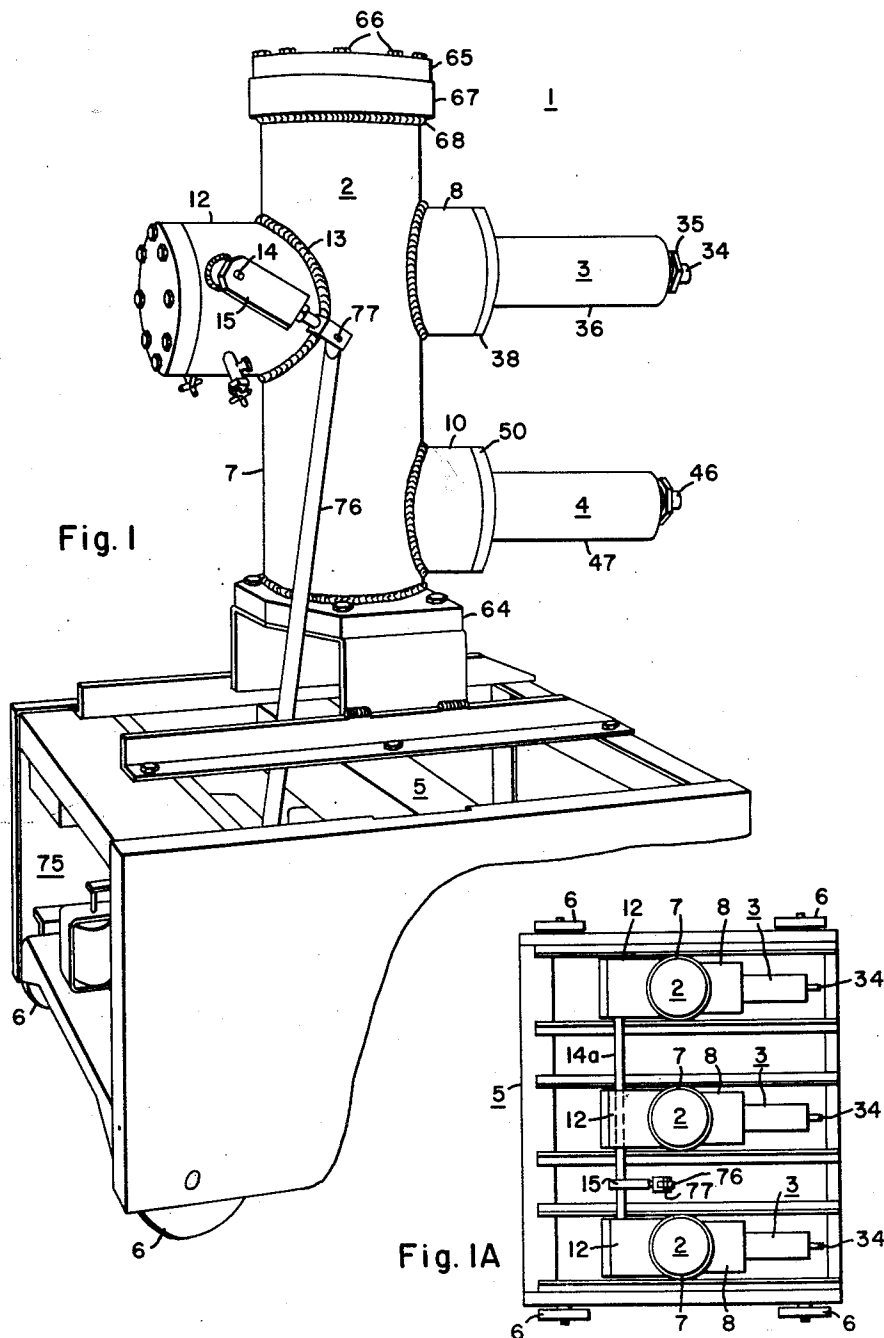
Jan. 1, 1963

W. M. LEEDS ET AL
CIRCUIT INTERRUPTERS

3,071,669

Filed Jan. 13, 1959

3 Sheets-Sheet 1



WITNESSES

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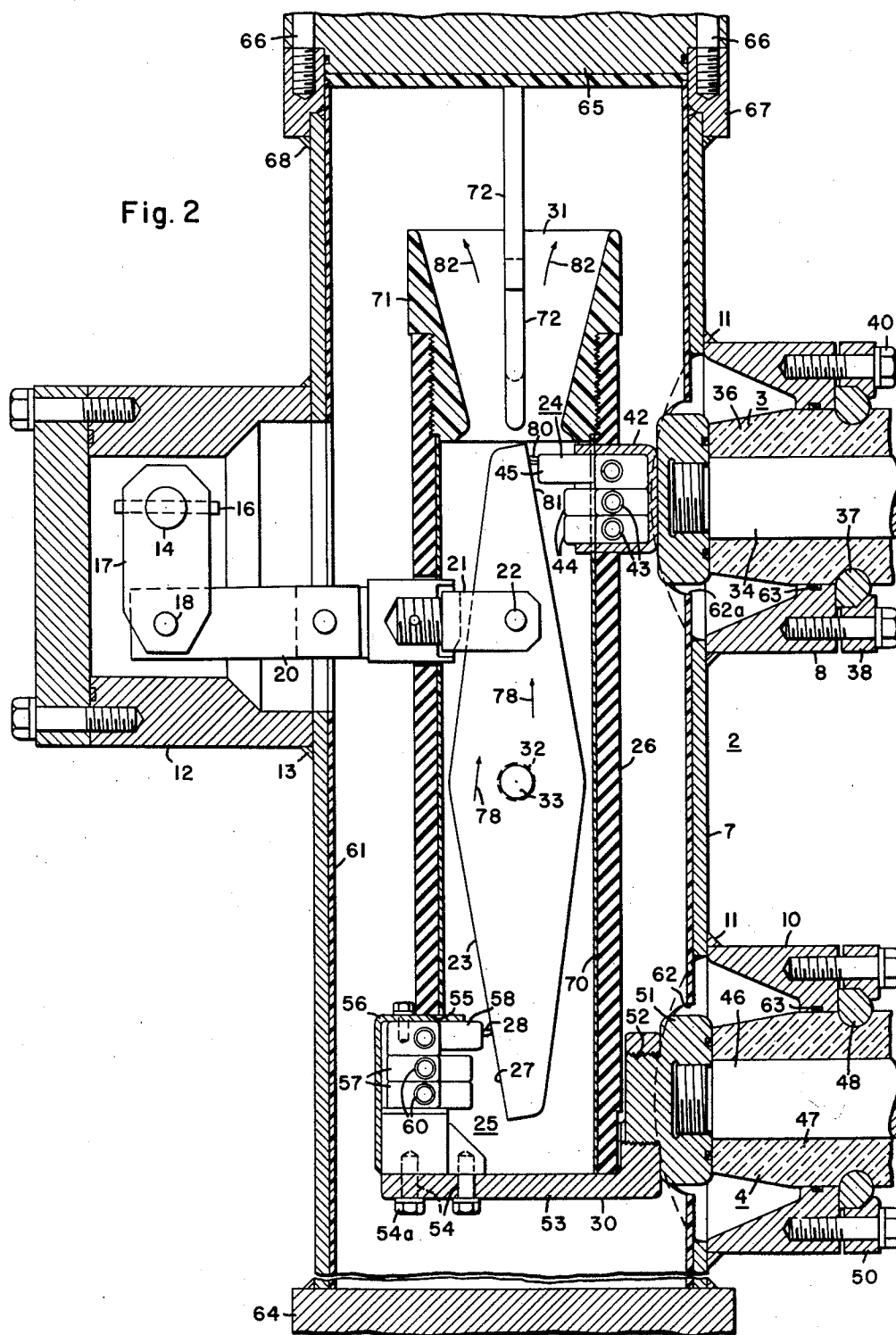
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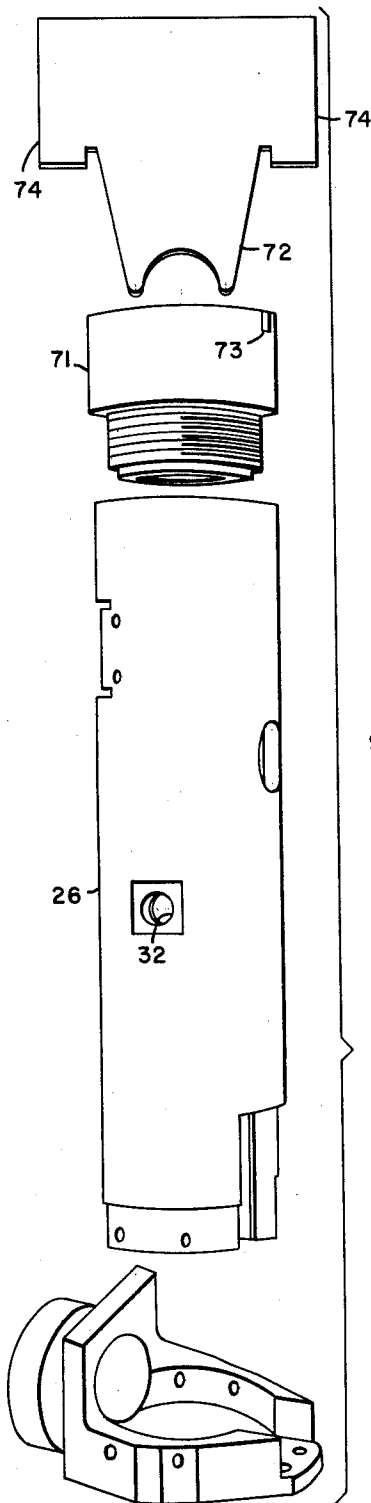
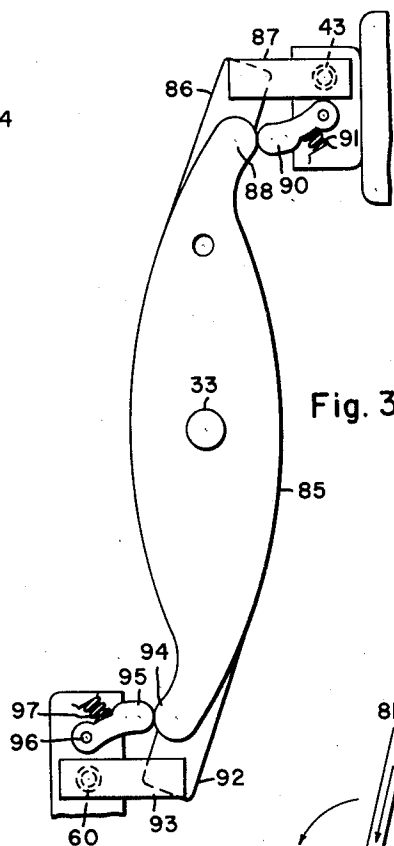


Fig. 3

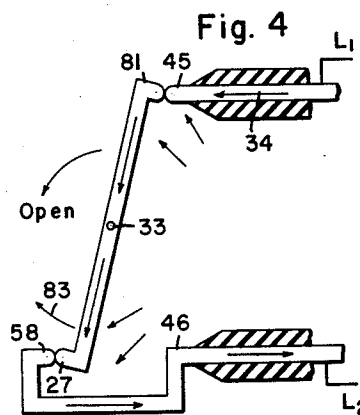


Fig. 4

Fig. 6

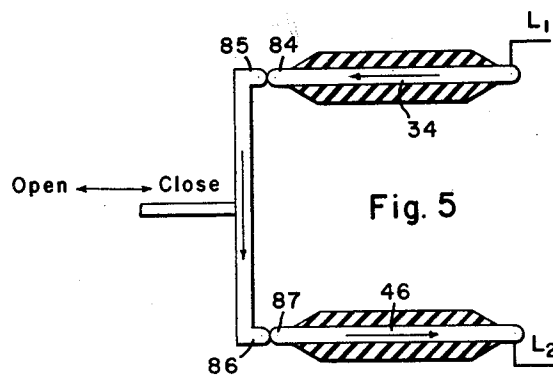


Fig. 5

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3,071,669

CIRCUIT INTERRUPTERS

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Filed Jan. 13, 1959, Ser. No. 786,587

18 Claims. (Cl. 200—145)

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

A general object of the present invention is to provide an improved circuit interrupter in which interrupting action is obtained more effectively than has heretofore been achieved.

A more specific object of the present invention is the provision of an improved interrupting device of the type which employs a pair of serially related arcs, one of which is a pressure-generating arc and is utilized to send a fluid blast toward the other serially related interrupting arc.

Another object of the invention is to provide an improved circuit interrupter involving a generally tubular interrupting structure, in which a pair of terminal bushings extend laterally into the tubular interrupting structure in spaced relation, and in which a rotatable contact blade is employed and establishes a pair of serially related breaks.

Another object of the invention is the provision of a circuit interrupter of the type set forth in the immediately preceding paragraph, in which one of the breaks is a pressure-generating break and the other serially related break is an interrupting break.

Yet a further object of the invention is the provision of an improved dead-tank circuit interrupter of strong construction, in which a liquefied fluid may be employed as the interrupting medium in a structure in which a rotatable contact blade simultaneously separates from two spaced stationary contact structures to establish pressure-generating and interrupting breaks.

In United States patent application filed September 13, 1957, Serial No. 683,760, by Winthrop M. Leeds and Benjamin P. Baker, and assigned to the assignee of the instant application, there is disclosed and claimed the use of liquefied gases, such as liquefied sulfur hexafluoride gas (SF_6) or liquefied selenium hexafluoride gas (SeF_6) or other liquefied gases, disclosed in this patent application, for use in circuit interrupters as arc-extinguishing mediums.

In one of the interrupting structures disclosed in the aforesaid patent application, a pressure-generating break is established in one of the disclosed liquefied gases, and the liquefied gas is forced under pressure toward a second serially related interrupting break to effect arc extinction at the latter break. It is a further object of the present invention to utilize the broad principles involved in the aforesaid Leeds and Baker patent application in the construction of a simple, and economical type of circuit interrupter, which, for example, may be used in the lower current and voltage ratings and is adaptable to truck movement into metal-clad, drawout, cubicle switchgear, say at a voltage rating, for example, from 15 kv. to 34.5 kv.

It will, however be obvious to those skilled in the art that some features of the present application are applicable to other arc-extinguishing mediums than liquefied gases. For example, ordinary circuit-breaker oil may be used, or even air for some applications. However, particular advantage is obtained by utilizing the interrupting construction disclosed herein with an effective arc-extinguishing gas, such as SF_6 or SeF_6 , or with liquefied

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arc-extinguishing gases, such as disclosed in the aforesaid Leeds and Baker patent application.

Another object of the present invention is the provision of an improved contact construction, in which the magnetic forces encountered during the closing operation during heavy-current conditions in the connected line are substantially balanced, so that a very light operating mechanism may be utilized to achieve the closing operation of the interrupter.

Another object of the invention is the provision of an improved circuit interrupter of simplified and economical construction, in which, by the use of a dead-tank structure, maximum safety is achieved for the operating personnel.

Another object is to provide an improved multiple-pole circuit interrupter for controlling a multiple-phase circuit.

A further object is to provide a multiple-pole circuit interrupter, which is portable, and includes a plurality of upstanding pressure chambers, all simultaneously actuable.

Another object is to provide an improved multiple-pole circuit interrupter employing grounded pressure chambers having common transversely extending operating rod means.

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

FIG. 1 illustrates, in perspective, a circuit interrupter of the single pole type utilizing the principles of the present invention, and shown truck mounted for use in metal-clad switchgear, the contact structure being shown in the closed-circuit position;

FIG. 1A is a somewhat diagrammatic plan view of a portable three-pole circuit interrupter for controlling a three-phase circuit;

FIG. 2 is an enlarged, vertical sectional view taken through the arc-extinguishing structure only of the circuit interrupter illustrated in FIG. 1, the contact structure being illustrated in the partially open-circuit position;

FIG. 3 illustrates a modified type of contact structure, which may be substituted for the contact structure illustrated in FIG. 2, the contacts being illustrated in the closed-circuit position;

FIGS. 4 and 5 are schematic diagrams illustrating the balancing of the magnetic forces achieved by the use of the contact structure illustrated in the present invention; and,

FIG. 6 is a fragmentary, exploded view of certain detailed parts associated with the interrupting tube employed in the present invention.

Referring to the drawings, and more particularly to FIG. 1 thereof, the reference numeral 1 designates a single pole circuit interrupter of the dead-tank type involving an upstanding interrupter 2, horizontally extending terminal bushings 3, 4, and a lower portable frame structure 5, which, as shown, may be adapted for truck mounting. In other words, the grounded frame support structure 5 may be mounted upon truck wheels 6 for metal-clad switchgear, as well known by those skilled in the art.

With reference to FIG. 2, it will be observed that the interrupter 2 comprises a tank 7 composed preferably of a strong metal, such as steel. The tubular tank 7 extends uprightly, as shown, and has extending laterally therefrom cylindrical mounting sleeves 8, 10, which may be welded into place, such as indicated at 11. The mounting sleeves 8, 10 serve to fixedly mount into place the terminal bushings 3, 4.

Extending laterally from the opposite side of the steel tank 7 is a third mounting sleeve 12, which may be welded into place, as at 13. The purpose of the mount-

ing sleeve 12 is to support a rotatable crank shaft 14, which extends exteriorly of the tank-structure 7, as shown in FIG. 1, and has an exteriorly located crank arm 15 (FIG. 1) secured to the exterior end thereof. Pinned, by a pin 16, to the inner portion of the crank shaft 14 is an interiorly disposed crank arm 17, composed of steel, for example, which is linked, as at 18, to an insulating operating rod 20. The operating rod 20 is secured to a metallic bifurcated rod end 21, which is pivoted, as at 22, to a rotatable main bridging contact blade 23. The rotatable contact blade 23 serves to electrically bridge a pair of substantially stationary contact structures 24, 25, which are affixed to the opposite sides of an insulating interrupting tube 26.

The interrupting tube 26 extends longitudinally upwardly within the surrounding steel casing 7, and is fixedly secured into position by attachment to the substantially stationary contact structures 24, 25, as more fully described hereinafter.

Although, as illustrated in FIG. 1, the interrupting structure 2 is disposed generally vertically, it will be obvious that, for particular applications where a liquid is not being utilized, that the orientation of the interrupting structure 2 may be varied, as desired. For example, where an insulating gaseous fluid is employed as the interrupting medium, the interrupting structure 2 may be positioned horizontally or even in a position inverted from the position shown in FIG. 1. For other applications, however, where a liquid is employed internally of the interrupting tube 7, it is desirable to position the interrupter 2 as shown in FIG. 1, since preferably the lower stationary contact structure 25 co-operates with a movable contact 27 to establish a pressure-generating arc 28 in the lower end of the insulating interrupting tube 26.

As shown in FIG. 2, the lower end of the interrupting tube 26 is closed, as by a cap structure 30, forming a part of the pressure-generating stationary contact structure 25. The upper end 31 of the interrupting tube 26 is left open, so that pressure generated within the lower closed end of the interrupting tube 26 may blow upwardly past the relatively stationary interrupting contact structure 24 and out of the open upper end 31 of the interrupting tube 26.

To permit a pivotal rotation of the movable main bridging blade 23 apertures 32 are provided upon opposite sides of the insulating interrupting tube 26 to accommodate a diametrically extending pivot pin 33. Thus, the ends of the pivot pin 33 are journaled within the side walls of the interrupting tube 26 at the apertures 32 formed thereon.

Extending internally through the upper terminal bushing 3 is a terminal stud 34 having one or more nuts 35 for connection to a line lead. The terminal stud 34 extends internally through a surrounding insulating sleeve 36, the latter being clamped into place by a ring 37 engaged by a surrounding flange ring 38. The flange ring 38 is secured by bolts 40 to the mounting sleeve 8. The inner end of the terminal stud 34 is threadedly secured to a base portion 41 of the relatively stationary interrupting contact structure 24. The stationary contact structure 24 includes a generally box-shaped contact casing 42 accommodating springs 43, which serve to bias inwardly main contact fingers 44 and an arcing contact finger 45. In addition, the contact casing 42 has, at opposite sides thereof, laterally extending mounting-blade portions, not shown, which are apertured and accommodate bolts, which secure the contact casing 42 securely to the upper end of the interrupting tube 26.

Similarly, the lower terminal bushing 4 includes a terminal stud 46 extending longitudinally through an insulating sleeve 47, clamped by a mounting ring 48 and mounting flange ring 50 to the lower mounting sleeve 10. The inner end of the terminal stud 46 likewise screws into a contact base 51, which is secured, as by threading 52, to a generally cup-shaped contact support 53. The

cup-shaped contact support 53 has a pair of mounting apertures 54 provided therein, which receive screws 54A securing into place the stationary pressure-generating contact structure 25.

The pressure-generating contact structure 25 is removable from an opening 55 provided at the lower end of the interrupting tube 26, and includes a box-shaped casing 56 for accommodating main contact fingers 57 and arcing contact fingers 58. The main contact fingers 57 and the arcing contact finger 58 are biased laterally toward each other by compression springs 60, in a manner similarly to the functioning of the springs 43 associated with the upper contact structure 24.

The inside of the steel tube 7 is lined by an insulating sleeve 61 which has apertures 62, 62A to accommodate the contact bases 51, 41, respectively. Also gaskets 63 are employed within the mounting sleeves 8, 10 forming a gas-tight construction. A lower closure plate 64 is secured, as by welding, to the lower end of the metallic interrupting tube 7, and an upper closure plate 65 is secured by bolts 66 to a mounting flange ring 67, welded, as at 68, to the upper end of the metallic tube 7.

For certain applications, it is desirable to line the inner wall of the interrupting tube 26 with a lining 70, composed of a material, such as polytetrafluoroethylene, as set out in United States Patent 2,757,261, issued July 31, 1956, to Harry J. Lingal, Thomas E. Browne, Jr., and Albert P. Strom, and assigned to the assignee of the application.

Located at the upper open end 31 of the insulating tube 26 and threadedly secured into place is an insulating orifice sleeve 71 more clearly shown in FIG. 6 of the drawings. Also a splitter plate 72 is positioned into slots 73 provided in the orifice sleeve 71, and has the outer ends 74 thereof positioned adjacent the inside wall of the metallic casing 7.

The opening operation of the circuit interrupter 1 shall now be explained. With reference to FIG. 1, a suitable operating mechanism 75, such as that for example set out in United States Patent 2,515,994, issued July 18, 1950, to Joseph D. Findley, Jr., Alvin W. Ogg, and Fritz E. Florschutz, may be employed. This operating mechanism 75 is effective to cause downward opening movement of the insulating rod 76, which is pivotally connected, as at 77, to the outer free end of the crank arm 15. This causes rotation of crank shaft 14, and, through the operating rod 20, causes opening counter-clockwise rotation of main bridging blade 23 simultaneously away from pressure-generating contact structure 25 and from the relatively stationary interrupting contact structure 24.

Since the movable contact 27, at the lower end of rotatable blade 23, separates last from arcing fingers 58, the arc 28 likewise establishes at this point. This arc 28 generates pressure within the fluid contained within casing 7 and forces the same upwardly in the direction indicated by the arrows 78 toward the interrupting arc 80 drawn between upper movable contact 81 and relatively stationary arcing finger 45. The disposition of the splitter 72 will facilitate extinction of the interrupting arc 80. Fluid will blow out of the upper end 31 of interrupting tube 26 through the orifice 71 as indicated by the arrows 82. With the particular structure described, there is only a short opening travel, such, for example as $1\frac{1}{32}$ ".

To effect the closing operation of the interrupter 1, the solenoid mechanism 75 is effective to move operating rod 76 upwardly to effect counter-clockwise rotation of crank shaft 14, and through the operating rod 20, clockwise rotation of bridging blade 23 to effect contact reengagement.

With the metallic casing 7, one-third full of liquefied sulfur hexafluoride, a prototype of the interrupter 1 interrupted current up to 25,000 amperes at 13.2 kv. and 20,000 amperes at 22 kv., that is, at room temperature.

As mentioned, other arc-extinguishing fluids may be employed, but particular advantage is obtained by the use of liquefied gases. Although liquefied SF₆ has been described as an example of a possible liquefied gas, in describing the operation of the present structure, it is to be clearly understood that liquefied selenium hexafluoride, or any one, or a mixture of two or more, of the liquefied gases enumerated below in the following table may be employed in substitution of liquified SF₆.

The various gases which are suitable in liquid or gaseous form for use in the interrupter of the type considered, have similar properties and characteristics as set out in the following table.

	Boiling Point	Vapor Pressure, #/sq. in. gauge at 20° C.	Dielectric Strength Compared With Air or N ₂
SO ₂ -----	-10	35	2.0
SF ₆ -----	-63.8	300	2.2
SeF ₆ -----	-34.5	-----	2.9
SOF ₂ -----	-30	160	2.5
CCl ₃ F ₂ -----	-28	68	2.4
ClO ₂ F-----	-47.5	139	3.0
C ₂ F ₆ -----	-78	-----	1.8
C ₃ F ₈ -----	-37	-----	2.0
CClF ₃ -----	-81.5	325	1.4
CF ₃ Br-----	-58	195	1.25

Although the foregoing liquefied gases may be used to advantage, exceptional and unusual performance is obtained with liquid SF₆ or liquid SeF₆ or mixtures of these two, since the gaseous phase of these two fluids are so highly effective in arc interruption and have high dielectric strength.

As mentioned, while the interrupting construction is useful for any suitable gas or liquid having good insulating and arc-quenching properties, a preferred embodiment would utilize sulfur hexafluoride (SF₆). For low interrupting ability it is sufficient to fill the tank with gas at 30 to 60 p.s.i. Higher interrupting ability can be obtained by using liquid SF₆ and filling to a level above the lower contacts at which the pressure-generating arc is formed. Maximum interrupting ability would require sufficient liquid to completely fill the entire interrupting chamber 26 containing both sets of contacts. The vapor pressure above the liquid varies from 100 to 500 p.s.i. over a temperature range from 0° F. to 110° F.

FIGS. 4 and 5 illustrate diagrammatically the use of the magnetic forces H, which are balanced during the closing stroke of an interrupter of the type illustrated in FIG. 2. The magnetic field generated at contacts 45, 81 tends to cause separation of contacts 45, 81, that is counterclockwise rotation of the pivotally mounted contact blade 23, and therefore opening of contact pair 27, 58. However, the electrodynamic effect at the contacts 27, 58 tends to blow these contacts closed. Since the closing force exerted upon the contacts 27, 58 equals the opening force exerted at the contacts 45, 81, the resultant magnetic forces are neutralized. More specifically, the current flowing through lower terminal stud 46 acts to set up a magnetic field, which acts upon the contacts 45, 81 tending to cause their separation. Since the electrodynamic closing force at 83 is equal to the electrodynamic opening force at the upper contacts 45, 81, and since the pivot axis 33 is fixed, it will be apparent that the oppositely directed magnetic forces are balanced as far as rotation of the contact blade is concerned. With the construction shown in FIG. 5, in which the current passing through the terminal studs 34, 46 acts to magnetically blow contacts 84, 85, 86, 87 open, the magnetic forces thus act cumulatively to expand the current

loop and open both sets of contacts, as well known by those skilled in the art.

Thus the particular contact structure utilized in circuit interrupter 1 acts to balance the magnetic forces encountered during the closing stroke so that there is no net magnetic effect to open or to close the circuit. This is particularly advantageous in closing the circuit during the existence of heavy overload conditions, or short circuit conditions in the lines L₁ and L₂.

FIG. 3 illustrates a modified type of rotatable bridging contact, designated by the reference numeral 85 and adapted to swing about a pivot axis 33. It will be noted that an arcing contact 86 at the upper end of rotatable main contact 85 makes contacting engagement between a pair of inwardly biased arcing contact fingers 87. The bridging contact 85 has a laterally extending main contact portion 88, which makes contacting engagement with a plurality of stationary main contact fingers 90, only one of which is shown. As shown in FIG. 3, the main contacting fingers 90 are biased by compression springs 91 to provide the requisite contact pressure between the stationary main contacts 90 and the main contacting portion 88 of rotatable switch blade 85.

Similarly the lower end of the rotatable bridging contact 85 has a movable arcing contact portion 92, which slides between a pair of inwardly biased arcing fingers 93. Also the rotatable bridging contact 85 has a lower main contact portion 94, which makes contacting engagement with a plurality of stationary main contact fingers 95, only one of which is illustrated. As shown, the stationary main contact fingers 95, pivotally mounted at 96, are biased by compression springs 97 into pressure engagement with main contacting portion 94 of rotatable switch blade 85. With this contacting arrangement shown in FIG. 3, the arcs are drawn on blade extensions 86, 92 pulling out of pairs of arcing fingers 87, 93 respectively. The main current carrying contacts consist of parallel butt-type bridging contacts of the type shown.

From the foregoing description of the invention it will be apparent that there is provided a novel circuit interrupter particularly adapted for use with an arc-extinguishing fluid under pressure, since the steel tank 7 and the welded cylindrical mounting bosses 8, 10, and 12 are very strong, and capable of withstanding considerable internal pressure. Although the devices illustrated in the drawings are capable of use with fluids, such as air, or ordinary liquids, such as oil, the device has particular advantage when employed with a liquefied gas, such as sulfur hexafluoride (SF₆) or with one of the liquefied gases set out in the above table.

It will be obvious that the elements are few in number and simple in construction. The provision of a serially related pressure-generating arc results in considerable pressure during high-current interruption, when such pressure is required. Also the amount of travel of the several rotatable elements is quite small. The entire device is of compact size and is capable of use in conventional metal-clad switchgear cubicles.

For controlling a three-phase circuit, three poles of the type shown in FIG. 1 would be employed, such as illustrated in FIG. 1A. The operating shaft 14 would be extended such as indicated at 14a so as to operate all three poles simultaneously. As shown in FIG. 1A a crank arm 15, moved by an insulating rod 76 connected to the mechanism 75, effects opening and closing rotation of the common crank shaft 14a. As a result, all three poles are simultaneously actuated at the same time to make or break the three-phase circuit. The interior of each pole unit is as shown in FIG. 2 of the drawings.

Although there have been illustrated and described specific structures, it is to be clearly understood that the same were merely for the purpose of illustration, and that variations 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 circuit interrupter of the type having a generally U-shaped current path including an insulating interrupting tube closed at one end thereof and open at its opposite end, only a single pair of spaced relatively stationary contact structures disposed along the tube, one of said relatively stationary contact structures having a reverse bend associated therewith to force the current passing therethrough to flow in a generally U-shaped reversed path, a rotatable bridging contact blade disposed longitudinally within said interrupting tube and making bridging engagement with said spaced pair of relatively stationary contact structures, means pivotally mounting said rotatable bridging contact blade intermediate the ends thereof about an axis which extends substantially diametrically across the interrupting tube internally thereof, said axis being disposed intermediate the ends of said interrupting tube, and means for causing rotation of said contact bridging blade about said axis.

2. A circuit interrupter of the type having a generally U-shaped current path including an insulating interrupting tube closed at one end thereof and open at its opposite end, only a single pair of spaced relatively stationary contact structures disposed along the tube, one of said relatively stationary contact structures having a reverse bend associated therewith to force the current passing therethrough to flow in a generally U-shaped reversed path, a rotatable bridging contact blade disposed longitudinally within said interrupting tube and making bridging engagement with said spaced pair of relatively stationary contact structures, means pivotally mounting said rotatable bridging contact blade intermediate the ends thereof about an axis which extends substantially diametrically across the interrupting tube internally thereof, said axis being disposed intermediate the ends of said interrupting tube, means for causing rotation of said contact bridging blade about said axis, and a splitter disposed adjacent the open end of said interrupting tube to facilitate arc extinction.

3. The combination in a fluid-blast circuit interrupter of the type having a generally U-shaped current path of an insulating interrupting tube closed at one end thereof and open at the opposite end thereof, only a single pair of spaced relatively stationary contact structures disposed at opposite sides of said interrupting tube, one of said relatively stationary contact structures disposed adjacent the open end of said tube and the other relatively stationary contact structure disposed adjacent the closed end of said tube, one of said relatively stationary contact structures having a reverse bend associated therewith to force the current passing therethrough to flow in a generally U-shaped reversed path, a rotatable conducting bridging contact blade disposed internally of said tube and adapted for rotative opening and closing motion, said rotatable contact blade bridging said spaced pair of relatively stationary contact structures, means pivotally mounting said bridging contact blade intermediate the ends thereof about an axis which extends substantially diametrically across the interrupting tube internally thereof, said axis being disposed intermediate the ends of said interrupting tube, and means causing the opening and closing rotative motion of said bridging contact blade about said axis.

4. The combination in a fluid-blast circuit interrupter of the type having a generally U-shaped current path of an insulating interrupting tube closed at one end thereof and open at the opposite end thereof, only a single pair of spaced relatively stationary contact structures disposed at opposite sides of said interrupting tube, one of said relatively stationary contact structures disposed adjacent the open end of said tube and the other relatively stationary contact structure disposed adjacent the closed end of said tube, one of said relatively stationary contact structures having a reverse bend associated therewith to

force the current passing therethrough to flow in a generally U-shaped reversed path, a rotatable conducting bridging contact blade disposed internally of said tube and adapted for rotative opening and closing motion, said rotatable contact blade bridging said spaced pair of relatively stationary contact structures, means pivotally mounting said bridging contact blade intermediate the ends thereof, about an axis which extends substantially diametrically across the interrupting tube internally thereof, said axis being disposed intermediate the ends of said interrupting tube, means causing the opening and closing rotative motion of said bridging contact blade about said axis, and a splitter disposed adjacent the open end of said interrupting tube to facilitate arc extinction.

5. The combination in a fluid-blast circuit interrupter of the type having a generally U-shaped current path of an insulating interrupting tube closed at one end thereof and open at the opposite end thereof, only a single pair of spaced relatively stationary contact structures disposed at opposite sides of said interrupting tube, one of said relatively stationary contact structures disposed adjacent the open end of said tube and the other relatively stationary contact structure disposed adjacent the closed end of said tube, one of said relatively stationary contact structures having a reverse bend associated therewith to force the current passing therethrough to flow in a generally U-shaped reversed path, a rotatable conducting bridging contact blade disposed internally of said tube and adapted for rotative opening and closing motion, said rotatable contact blade bridging said spaced pair of relatively stationary contact structures, means pivotally mounting said bridging contact blade intermediate the ends thereof about an axis which extends substantially diametrically across the interrupting tube internally thereof, said axis being disposed intermediate the ends of said interrupting tube, means causing the opening and closing rotative motion of said bridging contact blade about said axis, and said rotatable contact blade separating substantially simultaneously from said relatively stationary contact structures.

6. A circuit interrupter of the type having a generally U-shaped current path including an elongated sealed pressure chamber, a pair of terminal studs extending laterally into the side of said elongated pressure chamber, an interrupting tube composed largely of insulating material disposed longitudinally within said elongated pressure chamber and spaced inwardly thereof, only a single pair of relatively stationary contact structures associated with the interior ends of said laterally extending terminal studs, said interrupting tube being closed at one end thereof and open at the other end thereof, one of said relatively stationary contact structures disposed adjacent the closed end of said interrupting tube and the other relatively stationary contact structure disposed adjacent the open end of said interrupting tube, a rotatable contact bridging blade disposed longitudinally within said interrupting tube to electrically bridge said relatively stationary contact structures, and said rotatable contact bridging blade being rotatable about an axis which extends substantially diametrically across the interrupting tube internally thereof.

7. A circuit interrupter of the type having a generally U-shaped current path including an elongated grounded metallic pressure chamber, a pair of terminal bushings extending laterally into the side of said elongated grounded metallic pressure chamber, an interrupting tube composed largely of insulating material disposed longitudinally within said elongated grounded metallic pressure chamber and spaced inwardly thereof, only a single pair of relatively stationary contact structures associated with the interior ends of said laterally extending terminal bushings, said interrupting tube being closed at one end thereof and open at the other end thereof, one of said relatively stationary contact structures disposed adjacent the closed end of said interrupting tube and the other rela-

tively stationary contact structure disposed adjacent the open end of said interrupting tube, a rotatable contact bridging blade disposed longitudinally within said interrupting tube to electrically bridge said relatively stationary contact structures, and said rotatable contact bridging blade being rotatable about an axis which extends substantially diametrically across the interrupting tube internally thereof.

8. A circuit interrupter of the type having a generally U-shaped current path including an elongated pressure chamber, a pair of terminal studs extending laterally into the side of said elongated pressure chamber, an interrupting tube composed largely of insulating material disposed longitudinally within said elongated pressure chamber and spaced inwardly thereof, only a single pair of relatively stationary contact structures associated with the interior ends of said laterally extending terminal studs, said interrupting tube being closed at one end thereof and open at the other end thereof, one of said relatively stationary contact structures disposed adjacent the closed end of said interrupting tube and the other relatively stationary contact structure disposed adjacent the open end of said interrupting tube, one of said relatively stationary contact structures having a reverse bend associated therewith to force the current passing therethrough to flow in a generally U-shaped reversed path, a rotatable contact bridging blade disposed longitudinally within said interrupting tube to electrically bridge said relatively stationary contact structures, said bridging blade separating substantially simultaneously from said relatively stationary contact structures, and said rotatable contact bridging blade being rotatable about an axis which extends substantially diametrically across the interrupting tube internally thereof.

9. A circuit interrupter including an elongated pressure tube, a pair of mounting sleeves disposed in spaced relation on one side of said pressure tube, a third mounting sleeve disposed on the opposite side of said pressure tube, a pair of terminal bushings mounted within said pair of mounting sleeves and carrying a pair of spaced relatively stationary contact structures at the interior ends thereof, an insulating interrupting tube disposed longitudinally within said elongated pressure tube open at one end thereof and closed at the other end thereof, one of said relatively stationary contact structures disposed adjacent the closed end of said interrupting tube and the other relatively stationary contact structure disposed adjacent the open end of said interrupting tube, a rotatable bridging contact blade disposed longitudinally within said interrupting tube and electrically bridging said spaced pair of relatively stationary contact structures, a rotatable shaft extending through the side wall of said third mounting sleeve, linkage interconnecting said rotatable shaft with said rotatable bridging contact blade, and said rotatable contact bridging blade being rotatable about an axis which extends substantially diametrically across the interrupting tube internally thereof.

10. A circuit interrupter including an elongated pressure tube, a pair of mounting sleeves disposed in spaced relation on one side of said pressure tube, a third mounting sleeve disposed on the opposite side of said pressure tube, a pair of terminal bushings mounted within said pair of mounting sleeves and carrying a pair of spaced relatively stationary contact structures at the interior ends thereof, an insulating interrupting tube disposed longitudinally within said elongated pressure tube open at one end thereof and closed at the other end thereof, one of said relatively stationary contact structures disposed adjacent the closed end of said interrupting tube and the other relatively stationary contact structure disposed adjacent the open end of said interrupting tube, a rotatable bridging contact blade disposed longitudinally within said interrupting tube and electrically bridging said spaced pair of relatively stationary contact structures, a rotatable shaft extending through the side wall of said third mount-

ing sleeve, linkage interconnecting said rotatable shaft with said rotatable bridging contact blade, means causing a substantially simultaneous separation between the ends of said rotatable contact blade and said pair of relatively stationary contact structures, and said rotatable contact bridging blade being rotatable about an axis which extends substantially diametrically across the interrupting tube internally thereof.

11. A circuit interrupter including an interrupting insulating tube having one end thereof open and the other end thereof closed, a bridging contact blade having arcing extensions at the opposite ends thereof, means pivotally mounting said bridging contact blade for rotation intermediate the ends thereof about an axis extending diametrically across the tube, two pairs of relatively stationary arcing fingers fixedly secured to opposite inner side walls of the tube engaging said arcing extensions, said contact blade having main contact portions disposed adjacent opposite ends thereof at least one of which is disposed inwardly of said arcing extensions, and auxiliary spaced main stationary contacts making contacting engagement with the main contact portions of said rotatable bridging contact blade.

12. The combination in a multiple-phase circuit interrupter of a portable frame support at ground potential, a plurality of spaced pole units mounted upon said portable frame support, each pole unit including a grounded upstanding generally cylindrically-shaped metallic pressure chamber, a pair of terminal bushings extending laterally out the side of each grounded metallic pressure chamber, and rotatable operating rod means extending between the pole units to effect their simultaneous operation.

13. A circuit interrupter for controlling a multi-phase circuit including a portable grounded frame support, a plurality of upstanding spaced generally cylindrically-shaped metallic pole units supported at the upper side of said portable grounded frame support, a pair of terminal studs extending laterally from the side of each upstanding metallic pole unit, a rotatable common crank shaft extending between the pole units to effect their simultaneous operation, crank means disposed interiorly of each pole unit and connected to the common crank shaft, and interiorly disposed rotatable blade means within each pole unit connected to said crank means.

14. A circuit interrupter of the type having a generally U-shaped current path including a generally cylindrically-shaped sealed pressure chamber at ground potential, an insulating interrupting tube disposed interiorly of said grounded pressure chamber and spaced from the inner wall of said pressure chamber, contact means including only a single pair of relatively stationary contacts associated with said interiorly disposed interrupting tube, a pair of terminal bushings connected to said contact means and extending laterally out of said grounded pressure chamber, and said contact means including a rotatable contact blade pivotally mounted intermediate its ends within said interrupting tube about an axis which extends substantially diametrically across the interrupting tube internally thereof.

15. A circuit interrupter including a pair of spaced substantially parallel-disposed terminal bushings, a pair of relatively stationary contact structures associated with adjacent ends of the terminal bushings, one of said relatively stationary contact structures having a reverse bend associated therewith to force the current passing therethrough to flow in a generally U-shaped reversed path, a conducting bridging blade, means pivotally mounting said conducting bridging blade for rotative motion intermediate the ends thereof, contact portions associated with the extremities of said bridging blade making contacting engagement with said pair of relatively stationary contact structures, and the magnetic forces substantially balancing during the closing operation as a result of the configuration of the circuit path through the interrupter.

16. A circuit interrupter including a pair of spaced substantially parallel-disposed terminal bushings, a pair of relatively stationary contact structures associated with the adjacent ends of the terminal bushings, one of said relatively stationary contact structures having a reverse bend associated therewith to force the current passing therethrough to flow in a generally U-shaped reversed path, an interrupting tube bridging said pair of relatively stationary contact structures, a conducting bridging blade disposed within said interrupting tube longitudinally thereof, means pivotally mounting said conducting bridging blade for rotative motion intermediate the ends thereof, contact portions associated with the extremities of said bridging blade making contacting engagement with said pair of relatively stationary contact structures, and the magnetic forces substantially balancing during the closing operation as a result of the configuration of the circuit path through the interrupter.

17. A circuit interrupter including a pair of spaced substantially parallel-disposed terminal bushings, a pair of relatively stationary contact structures associated with the adjacent ends of the terminal bushings, one of said relatively stationary contact structures having a reverse bend associated therewith to force the current passing therethrough to flow in a generally U-shaped reverse path, an interrupting tube closed at one end and open at the other end bridging said pair of relatively stationary contact structures, a conducting bridging blade disposed within said interrupting tube longitudinally thereof, means pivotally mounting said conducting bridging blade for rotative motion intermediate the ends thereof, contact portions associated with the extremities of said bridging blade making contacting engagement with said pair of relatively stationary contact structures, and the magnetic forces substantially balancing during the closing operation as a result of the configuration of the current path through the interrupter.

18. A circuit interrupter including a pair of spaced

substantially parallel-disposed terminal bushings, a pair of relatively stationary contact structures associated with the adjacent ends of the terminal bushings, one of said relatively stationary contact structures having a reverse bend associated therewith to force the current passing therethrough to flow in a generally U-shaped reversed path, an interrupting tube supported by the adjacent ends of said terminal bushings and bridging said pair of relatively stationary contact structures, a conducting bridging blade disposed within said interrupting tube longitudinally thereof, means pivotally mounting said conducting bridging blade for rotative motion intermediate the ends thereof, contact portions associated with the extremities of said bridging blade making contacting engagement with said pair of relatively stationary contact structures, and the magnetic forces substantially balancing during the closing operation as a result of the configuration of the circuit path through the interrupter.

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