This invention relates to circuit interrupters in general, and, more particularly, to arc-extinguishing structures for circuit interrupters of the single-bushing type.

In United States patent application filed December 20, 1956, Serial No. 629,604, by Winthrop T. Leeds, and assigned to the assignee of the instant application, there is shown and described a circuit interrupter of the single-bushing type having a single arc-extinguishing unit disposed at one end of the bushing. It is a general object of the present application to improve upon the single-bushing interrupter of the Leeds application and to render the same suitable for very high-voltage and high-current application.

It is a further object of the present invention to associate with one or more of the arc-extinguishing units a parallel-disposed impedance current interrupting unit, which may be used to facilitate the interruption of the current in the main-current arc-extinguishing unit.

Still a further object of the present invention is to provide an improved single-bushing type of circuit interrupter having a pair of arc-extinguishing units at opposite ends of a terminal bushing, in which a mechanism is provided operable to effect a simultaneous operation of both arc-extinguishing units.

Another object of the present invention is to provide an improved single-bushing type of circuit interrupter having a pair of arc-extinguishing units disposed at opposite ends thereof associated with a pair of parallel-disposed impedance current interrupting units, in which the mechanism is so arranged that the impedance current interrupting units are actuated following an actuation of the main-current interrupting unit.

Still a further object of the present invention is to provide a single-bushing type of interrupter having two arc-extinguishing units at opposite ends thereof suitable for use with a relatively heavy gas, such as sulfur hexafluoride (SF6).

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 somewhat diagrammatic, sectional view taken longitudinally through a single-bushing type of circuit interrupter embodying the principles of the present invention, with the contact structure being illustrated in the partially open-circuit position; and

Figure 2 is also a somewhat diagrammatic, side elevational view, partially in vertical section, of a modified type of single-bushing circuit interrupter, having a parallel pair of impedance current interrupting units, the contact structure being illustrated in the closed-circuit position.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral 1 generally designates a circuit interrupter of the single-bushing type, having a pair of arc-extinguishing units 2 disposed at the outer ends thereof. The arc-extinguishing units 2 are positioned internally within a pair of weatherproof casings 3, 4, made of a suitable weatherproof insulating material, such as porcelain, and having their inner ends suitably bolted to an intermediate disposed, grounded portion or mechanism housing 5. More specifically, the porcelain casings 3, 4 have their ends corrugated, as at 6, and a suitable cement 7 firmly secures mounting flanges 8 to the ends of the casings. The inner mounting flanges 8 are then secured by fastenings 9 to the centrally disposed grounded mechanism housing 5, a suitable ring-shaped gasket 10 preferably being employed.

The outer ends of the hollow porcelain casings 3, 4 are closed by closure plate casings 11, 12 constituting terminal means, each of which has a relatively stationary contact 13 integrally cast therewith, and both closure casings 11, 12 are bolted to the outer mounting flanges 8, as shown.

As illustrated in Fig. 1, suitable ring-shaped gaskets 14 may be employed, being disposed between the closure plate casings 11, 12 and the outer ends of the porcelain casings 3, 4 to insure a gas-tight construction. Another gasket 15 is also disposed between the outer mounting flanges 8 of the casings 3, 4 and flange portions 15 of the closure casings 11, 12 is a pair of ring-shaped plates 16 having apertured terminal lug portions 17 formed therewith. The line connections to the circuit interrupter 1 are made to these terminal lug portions 17.

Each arc-extinguishing unit 2 includes a movable rod-shaped contact 18, cooperable with a relatively stationary contact 13 to establish an arc, designated by the reference numeral 19. The movable contact 18 is fixedly secured by a pin connection 20 to a movable piston 21 slidable within an operating cylinder 22, and having an orifice member 23 of insulating material secured thereto. Thus, the movable contact 18, the orifice member 23 and the piston 21 all move together as a unit during the opening and closing operations. The piston 21 and operating cylinder 22 form a fluid-blast puffing structure highly effective to extinguish the arc 19.

Fixedly secured, by any suitable means, to the interior of the operating cylinder 22 is an apertured guide plate 25. The apertured guide plate 25 has an opening 25a therethrough, through which the movable contact 18 is guided. From an inspection of Fig. 1, it will be apparent that inward movement of the piston 21, within the operating cylinder 22, will compress the fluid, such as a suitable arc-extinguishing liquid, or gas, within the region 26, and will force this compressed fluid out through the orifice 27 of the orifice member 23 so that the fluid is directed against the established arc 19.

Pivotally secured to the inner end of each movable contact 18, as at 28, is a link 29, which links 29 are pivotally connected, as at 30, to a pair of bell-cranks 31. The bell-cranks 31 are stationarily pivotally mounted, as at 32, to brackets 33, which may be welded to the inside of the mechanism housing 5. The lower arms 34 of the bell-cranks 31 are pivotally connected together at 35 to a solenoid plunger 36, the latter being actuated by a suitable solenoid mechanism disposed within a mechanism compartment 37. Other conventional operating mechanisms, either pneumatic or hydraulic, may be employed. Surrounding the mechanism compartment 37, and serving to support the mechanism housing 5, is a truncated conical support member or grounded pedestal-type supporting means 38, which may be mounted upon a suitable base 39.

Extending through the mechanism housing 5, supported in a ring-shaped mounting plate 42, is a somewhat conventional terminal bushing 40, having a pair of current transformers 41 disposed thereabout. The terminal bushing 40 may be of the condenser type, having a terminal stud 42 passing therethrough. The ends of the terminal stud 42 may be threaded, as at 43, thereby threadedly...
supporting the inner ends 44 of the pair of operating cylinders 22. Surrounding the ends of the condenser winding section associated with the terminal bushing 40 is a porcelain shell 45, having petticoats 46 to increase the surface breakdown path. A centrally disposed, grounded, mounting flange 47 may be positioned between the shells 45 encircling the central portion of the condenser winding section of the terminal bushing 40. The mounting flange 47 rigidly supports the terminal bushing porcelain shells 45, to the pedestal plate 48 to the plate 24.

Preferably, a suitable arc-extinguishing fluid, such as a liquid, or gas, is disposed within the inner region 49 of the circuit interrupter 1. Particular advantage can be achieved by the use of SF₆, as mentioned heretofore. The remarkable arc-extinguishing characteristics of SF₆ gas are set out, and claimed, 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 instant application.

During the opening stroke the solenoid plunger, or operating rod, may be moved downwardly within the mechanism compartment 37, by the functioning of the mechanism disposed therein. The downward movement of the solenoid plunger 36 effects rotation of the bell-cranks 31 about their pivotal supports 32, and thereby effects inward motion of the movable contacts 18, driving simultaneously a pair of serially related arcs 19. The extinction of the arcs 19 is effected by the forcing of fluid out of the regions 26 within the operating cylinders 22 of the puffer structures and out through the orifice number 23 and into engagement with the arcs 19. Arc extinction, and hence circuit interruption, is quickly achieved, and the movable contacts 18 are maintained in their inward positions all the time that the interrupter is in the open circuit position.

When it is desired to effect a closing of the interrupter 1, the solenoid plunger 36 is moved upwardly, as brought about by the use of suitable closing springs disposed internally within the mechanism compartment 37. This will effect, through the linkage, closing engagement between the relatively movable and stationary contacts 13, 18. The current path through the interrupter then obviously includes the terminal plates 16, closure plate castings 11, 12, stationary contacts 13, movable contacts 18, flexible connectors 60, and through the conducting end portions 44 of the operating cylinders 22 to the terminal bushing 40, which passes centrally through the terminal bushing 40.

Since the intermediate sleeve portion 47 of the terminal bushing 40 is at ground potential, simple ring-shaped current transformers 41 may be used to measure the flow of current through the interrupter 1. The structure is simple and highly effective, since multibrakes are employed in connection with the two serially related arc-extinguishing units 2. The intermediate structure, including the mechanism housing 5 and the supporting pedestal-type shell 38, is all at ground potential, as is the mechanism contained within the mechanism compartment 37. It will be obvious that the circuit interrupter 1 may be mounted either horizontally or vertically depending upon the application.

Fig. 2 illustrates a modification of the invention in which both arc-extinguishing units 2 are electrically paralleled by a pair of serially related impedance means 61. Each comprises 61a in series with a pair of serially related impedance interrupting units, generally designated by the reference numeral 63. Each impedance interrupting unit 63 includes a relatively stationary contact 64 mounted upon a hook-shaped conducting spring support 65, the latter being supported by any suitable means interiorly within a hollow hood casing 66, the latter being supported upon a hollow upstanding insulating pedestal casing or column 67 enclosing the resistor element 62.

Cooperable with the relatively stationary contact 64 is a movable contact 68, the latter being fixedly mounted, by means of a spider 69, within a movable piston cylinder 70. The left-hand end of the movable piston cylinder 70 of the left-hand impedance interrupting unit 63, terminates in an insulating orifice portion 71 having an airfree opening 72 provided therethrough. Transitions 76a, b just laterally out from the side walls of the movable piston cylinder 70, having pivotally connected thereto a pair of insulating links 73. The movable piston cylinder 70 slides over a stationary supporting cylinder 75 forming a puffer structure. The opening movement of the movable piston cylinder 70 over the stationary supporting cylinder 75 generates pressure within the region 76 within piston cylinder 70, and thereby causes an ejection of compressed gas out through the orifice opening 72 into engagement with the residual current are established between the relatively stationary and movable contacts 64, 68.

The two pairs of insulating links, or operating rods 73 are preferably pivotally connected to the outer free ends of a T-shaped bell-crank member, generally designated by the reference numeral 77, and pivotally supported upon a stationary pivot pin 78. The pivot pin 78 is pivotally supported internally within a hollow mechanism housing 79, suitably supported upon a hollow, upstanding insulating casing or third column 80, the latter resting upon a mechanism housing 5a, generally similar to the mechanism housing 5 of Fig. 1.

An interconnecting housing 97 comprising insulating casings 98 and mechanism housing 79 interconnects the pedestal columns 67. This permits circulation of the dielectric gas SF₆.

As mentioned, the insulating operating rods 73 may be pivotally connected by pivot pins 81, 82 to the outer ends of arms 83, 84, respectively, of T-shaped bell-crank member 77. A third arm 85 integrally formed with the T-shaped bell-crank member 77 is pivotally connected, by a pivot pin 86, to an insulating operating rod 87 extending downwardly through the hollow casing 88, through the mechanism housing 5a, and terminating within a mechanism compartment 37a.

The mechanism housing 5a is grounded, and is supported at the upper end of a steel pedestal-type support cylinder 88, the latter resting upon a base 89. The stationary contact housings 90, disposed at the outer ends of the hollow casings 3, 4, may be identical to those illustrated in Fig. 1. The porcelain shells 45 of the terminal bushing 40 of Fig. 1 are omitted in the modified terminal bushing 40a, illustrated in Fig. 2. However, the arc-extinguishing units 2 within the hollow casings 3, 4 of the modified interrupter 91, shown in Fig. 2, may be threadedly secured to the ends of the terminal stud 42, not shown in Fig. 2, which extends centrally through the condenser winding section 92. The terminal bushing 40a may be supported on a pair of apertured support plates 24a secured to the inside of the mechanism housing 5a.

Line connections may be made to line terminals 93, 94, secured to the outer side walls of the stationary contact housings 90. The stationary contact housings 90 may be additionally supported by means of upstanding, hollow, insulating casings 95, the latter resting upon suitable pedestal supports 96.

The mechanism disposed within the mechanism compartment 37a is so arranged as to first effect downward opening movement of the pull rod 36, which actuates the arc-extinguishing units 2, and thereby effects extinction of the main current arcs 19 (Fig. 1). After these arcs are extinguished, the mechanism within mechanism
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5 compartment 37a functions to effect downward opening movement of the insulating operating rod 87. This latter movement will cause operation of the T-shaped bell crank 77, and thereby effect, through the insulating rods 73, opening movement of the two movable piston cylinders 70 effecting extinction of the residual current arcs in a manner as previously described.

The presence of the resistors 62 will facilitate the extinction of the main current arcs 19 by affording a parallel electrical path for the current flow through the interrupter 91. In addition, the resistors 62 will help to divide the voltage equally across the arc-extinguishing units 2 of Fig. 2. The resistors 62 will not only reduce the magnitude of the current flow through the interrupter 91, but also the power factor will be improved to render thereby arc extinction more quickly accomplished within the impedance interrupting units 63. Upon the extinction of the impedance current arcs, drawn within the two impedance interrupting units 63, all current flow through the interrupter 91 will cease. The operating rod 87 and the pull rod 36 will remain in their downward open position all the time that the interrupter 91 is open.

When it is desired to close the interrupter 91, the mechanism disposed within the mechanism compartment 37a will function to effect the upward movement of both operating rods 87 and pull rod 36 to close through the linkage, closing movement of the contact structures, so that the current path through the interrupter 91 will again be completed.

The use of the impedance means 61 comprising an impedance assembly 99 of Fig. 2 renders the interrupter I of Fig. 1 suitable for very high-voltage and high-power application. The use of the puffer structures, associated with the arc-extinguishing units 2 and the impedance interrupting unit 63, in combination with a heavy gas, such as SF₆, provides a very effective interrupting device, since the gas is compressed immediately adjacent to the current flow at the arcs. The terminal bushings 40, 40a may employ standard parts, which is highly desirable from an economic and manufacturing standpoint.

The supporting structure of Fig. 2, including the pedestal supports 96, the upstanding cylindrical support 88, and the several hollow casings 67, 80 provides a very rigid structure, interbraced to readily withstand either earthquake shocks, or other disturbances. The disclosed structure has the particular advantage of enabling the use of standard current transformers 41 surrounding a grounded, interconnected housing structure 47, 47a.

Although there have been 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 invention.

I claim as my invention:

1. A single-bushing type of fluid blast circuit interrupter including pedestal-type grounded supporting means, a single terminal bushing having its central portion supported by said grounded supporting means, said single terminal bushing including an elongated conductor extending axially therethrough, the axial length of the terminal bushing and the pedestal-type grounded supporting means being disposed substantially at right angles to each other, a pair of oppositely extending insulating casings surrounding at least the end portions of the terminal bushing and extending outwardly said grounded supporting means, terminal means disposed at the outer ends of said oppositely extending insulating casings supporting a pair of relatively stationary contact structures, a pair of movable contacts movable toward each other during the opening operation and operable to force a blast of fluid toward the respective arc to effect its extinction, operating-rod means extending generally longitudinally of said terminal bushing and operable to effect simultaneous operation of said fluid-blast puffer structures, an impedance assembly including a pair of insulating pedestal columns housing impedance elements and an interconnecting housing, said pedestal columns extending outwardly from said pair of terminal means, said interconnecting housing disposed therein a pair of serially-related impedance interrupting units, a puffer structure associated with each impedance interrupting unit, and operating means disposed intermediate said pair of impedance interrupting units and timed with respect to the aforesaid operating-rod means to effect opening said pair of impedance puffer structures subsequent to the opening of the first-mentioned puffer structures, whereby the pair of residual current arcs are interrupted subsequent to the interruption of the main current path through the interrupter.

2. A single-bushing type of fluid blast circuit interrupter including pedestal-type grounded supporting means, a single terminal bushing having its central portion supported by said grounded supporting means, said single terminal bushing including an elongated conductor extending axially therethrough, the axial length of the terminal bushing and the pedestal-type grounded supporting means being disposed substantially at right angles to each other, a pair of oppositely extending insulating casings surrounding at least the end portions of the terminal bushing and extending outwardly said grounded supporting means, terminal means disposed at the outer ends of said oppositely extending casings and supporting a pair of relatively stationary contact structures, a pair of movable contacts movable toward each other during the opening operation and operable to force a blast of fluid toward the respective arc to effect its extinction, operating-rod means extending generally longitudinally of said terminal bushing and operable to effect simultaneous operation of said fluid-blast puffer structures, an impedance assembly including a pair of insulating pedestal columns housing impedance elements and an interconnecting housing, said pedestal columns extending outwardly from said pair of terminal means, said interconnecting housing disposed therein a pair of serially-related impedance interrupting units, a puffer structure associated with each impedance interrupting unit, and operating means disposed intermediate said pair of impedance interrupting units and timed with respect to the aforesaid operating-rod means to effect opening said pair of impedance puffer structures subsequent to the opening of the first-mentioned puffer structures, whereby the pair of residual current arcs are interrupted subsequent to the interruption of the main current path through the interrupter.

3. A single-bushing type of fluid blast circuit interrupter including pedestal-type grounded supporting means, a single terminal bushing having its central portion supported by said grounded supporting means, said single terminal bushing including an elongated conductor extending axially therethrough, the axial length of the terminal bushing and the pedestal-type grounded supporting means being disposed substantially at right angles to each other, a pair of oppositely extending insulating casings surrounding at least the end portions of said terminal bushing and extending outwardly said grounded supporting means, terminal means disposed at the outer ends of said oppositely extending insulating casings supporting a pair of relatively stationary contact structures, a pair of movable contacts movable toward each other during the opening operation and operable to force a blast of fluid toward the respective arc to effect its extinction, operating-rod means extending generally longitudinally of said terminal bushing and operable to effect simultaneous operation of said fluid-blast puffer structures, an impedance assembly including a pair of insulating pedestal columns housing impedance elements and an interconnecting housing, said pedestal columns extending outwardly from said pair of terminal means, said interconnecting housing disposed therein a pair of serially-related impedance interrupting units, a puffer structure associated with each impedance interrupting unit, and operating means disposed intermediate said pair of impedance interrupting units and timed with respect to the aforesaid operating-rod means to effect opening said pair of impedance puffer structures subsequent to the opening of the first-mentioned puffer structures, whereby the pair of residual current arcs are interrupted subsequent to the interruption of the main current path through the interrupter.
said oppositely extending casings and supporting a pair of relatively stationary contact structures, a pair of movable contacts movable toward each other during the opening operation and cooperating with the relatively stationary contact structures to establish a pair of serially related arcs, a fluid blast puffer structure associated with each movable contact and operable to force a blast of fluid toward the respective arc to effect its extinction, operating rod means extending generally longitudinally of said terminal bushing and operable to effect simultaneous operation of said fluid blast puffer structures, an impedance assemblage including a pair of insulating pedestal columns housing impedance elements and an interconnecting housing, said pedestal columns extending outwardly from said pair of terminal means, said interconnecting housing having disposed therein a pair of serially related impedance interrupting units, a puffer structure associated with each impedance interrupting unit, operating means disposed intermediate said pair of impedance interrupting units and timed with respect to the aforesaid operating rod means to effect opening of the pair of impedance puffer structures subsequent to the opening of the first mentioned puffer structures, whereby the pair of residual current arcs are interrupted subsequent to the interruption of the main current path through the interrupter, and sulfur-hexafluoride gas circulating through said oppositely extending casings and also through said pair of insulating pedestal columns into the impedance interrupting units.

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