Jan. 8, 1952 B. P. BAKER ET AL 2,581,571

CIRCUIT INTERRUPTER

Filed Oct. 24, 1945 3 Sheets-Sheet 1

Fig. 1.

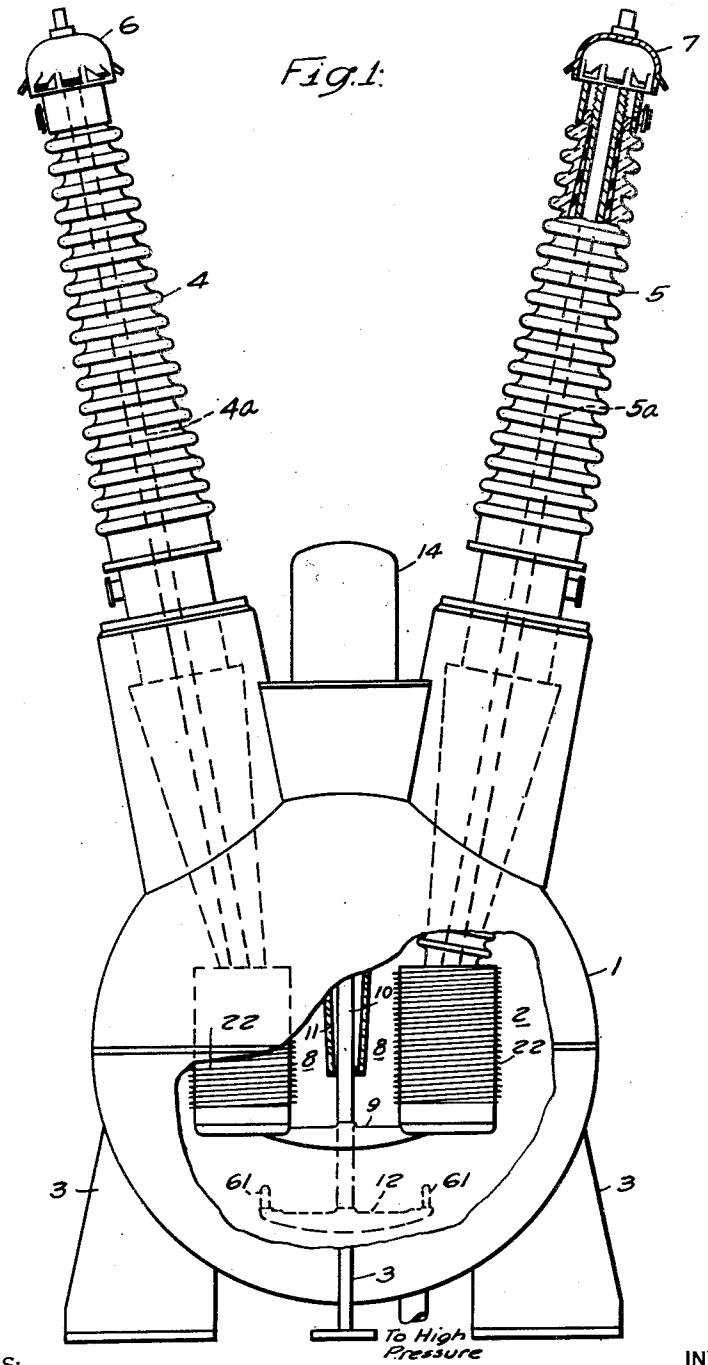

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Fig. 2.

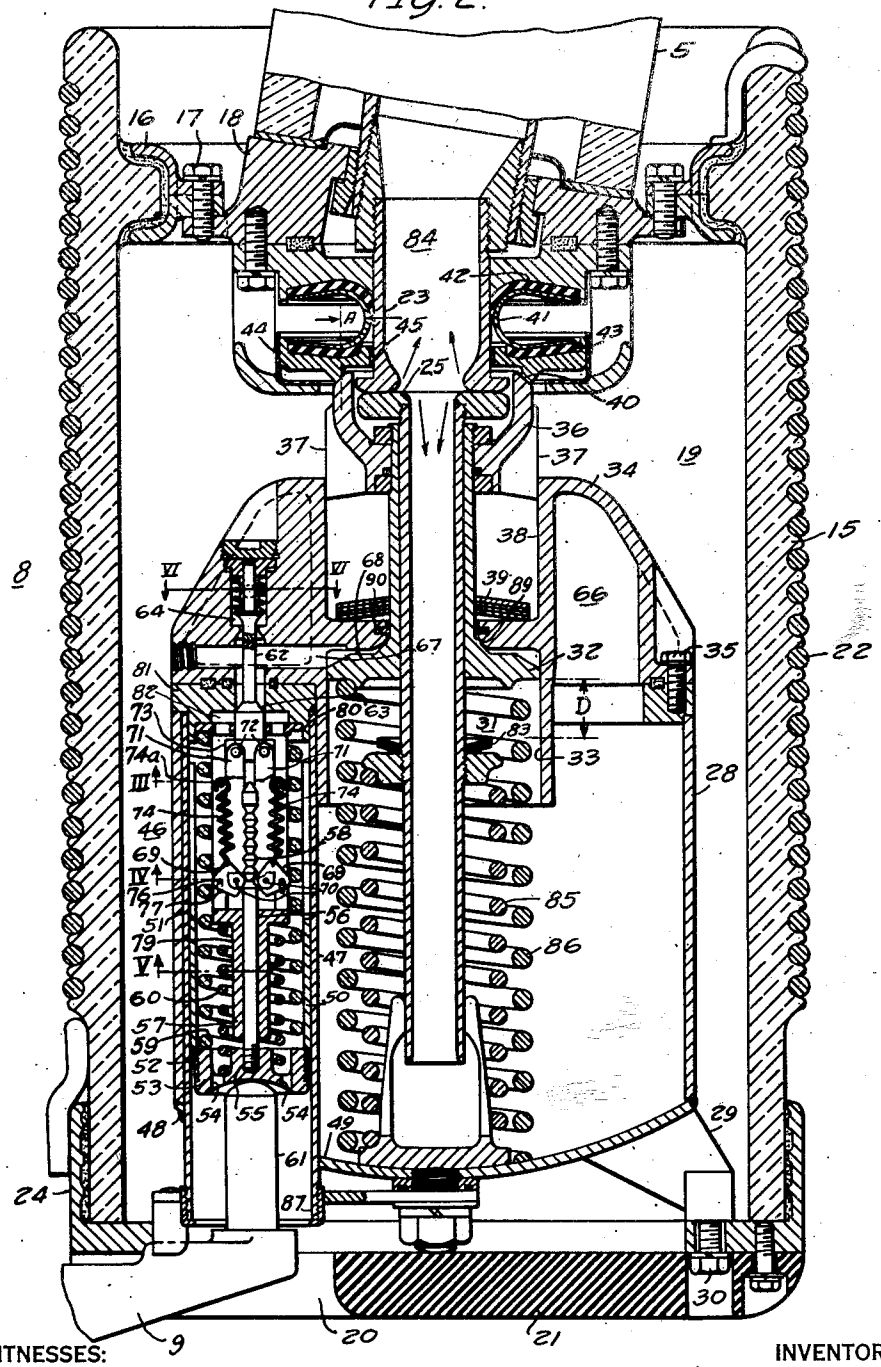

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Fig. 3

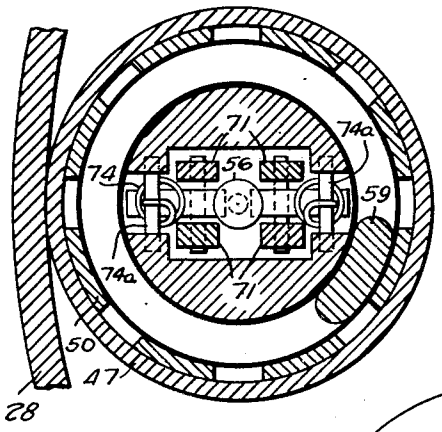


Fig. 4.

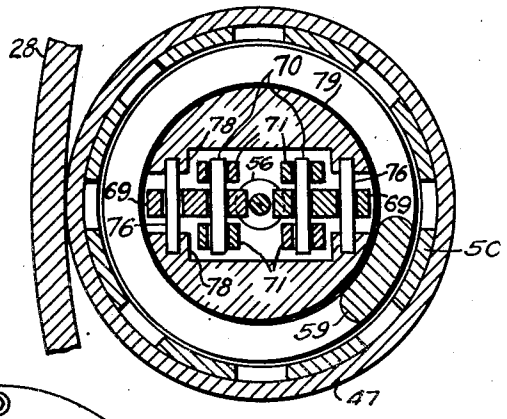


Fig. 7.

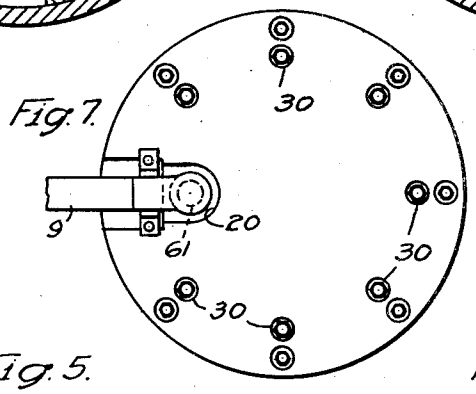


Fig. 5.

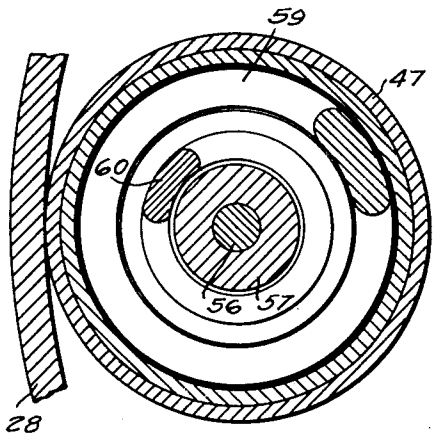
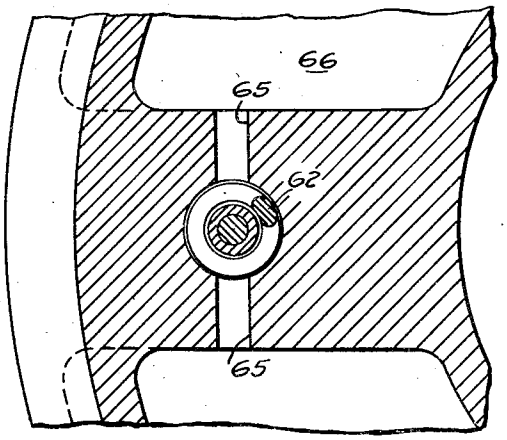


Fig. 6.



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Patented Jan. 8, 1952 2,581,571

UNITED STATES PATENT OFFICE

2,581,571

CIRCUIT INTERRUPTER

Benjamin P. Baker, Turtle Creek, Pa., and Oswald von Mehren, Lorain, Ohio, assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application October 24, 1945, Serial No. 624,284

13 Claims. (Cl. 200—148)

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This invention relates to circuit interrupters, in general, and more particularly to devices in which the arc is extinguished by compressed gas.

Certain features of the invention are set forth and claimed in our divisional application filed June 6, 1951, Serial No. 230,196, and assigned to the assignee of the present application.

In United States patent application by Benjamin P. Baker, Serial No. 569,349, filed December 22, 1944, now United States Patent 2,459,612, issued January 18, 1949, entitled "Compressed Gas Circuit Interrupter" and assigned to the assignee of the instant application there is disclosed and claimed a novel form of compressed-gas circuit interrupter utilizing a pressurized chamber.

An object of our invention is to provide an improved circuit interrupter of the compressed-gas type involving a pressurized chamber construction as in the aforesaid application.

It is also an object of our invention to provide an improved circuit interrupter of the foregoing type involving improved arc-extinguishing units and improved tank shape.

Another object is to provide an improved circuit interrupter of the foregoing type in which opening of the contact structure may be effected at any one of a plurality of different positions during the closing stroke, so that if the interrupter is closed on a short circuit and reversal of the operating mechanism takes place before the breaker is fully closed due to flashover at the contact structure, the reversal of the mechanism will serve to open the contact structure and effect extinction of the arc drawn thereat, even though the operating mechanism has not reached the fully closed position.

Another object is to provide an improved blast valve construction for a circuit interrupter of the compressed-gas type so that proper sealing may be assured in the closed position of the blast valve structure.

Another object is to provide an improved circuit interrupter of the type described in the aforesaid patent in which impedance means are employed to control the division of voltage between a pair of arc-extinguishing units, and the residual current arc is extinguished in a novel manner after extinction of the main arc drawn at the separated contact structure.

Another object is to provide an improved mechanism especially adaptable for a gas blast type of circuit interrupter of the pressurized chamber type in which opening of the blast valve and contact structure may be obtained at any

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one of a plurality of points during the closing operation upon reversal of the mechanism when closing against a fault.

Another object is to provide an improved circuit interrupter of the gas blast type in which extinction of the main current arc is not only brought about by utilizing a gas blast, but extinction of a residual current arc is also brought about by employing a gas blast.

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

Figure 1 is a side elevational view, partly in section, of a circuit interrupter embodying our invention and shown in the closed circuit position;

Fig. 2 is an enlarged vertical sectional view through the right-hand arc-extinguishing unit of Fig. 1;

Fig. 3 is an enlarged sectional view, taken along the line III—III of Fig. 2;

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

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

Fig. 6 is an enlarged fragmentary sectional view taken along the line VI—VI of Fig. 2; and

Fig. 7 is a fragmentary inverted plan view of Fig. 2.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral 1 designates a tank of substantially spherical shape to form a pressurized container of maximum strength with minimum material. The region 2 within the tank 1 is filled with compressed gas under pressure by any suitable means such as a motor-driven compressor unit (not shown).

Base supports 3 are provided to support the tank 1. Extending through the top of the tank 1 are two hollow terminal bushings 4, 5 having exhaust passages 4a, 5a therethrough at the top of which are secured line termianls 6, 7. Secured to the lower ends of the terminal bushings 4, 5, in a manner as shown more fully in Fig. 2, are a pair of arc-extinguishing units, generally designated by the reference numeral 8 and electrically interconnected in the closed circuit position, as shown by the full lines in Fig. 1, by a conducting cross-bar 9. The cross-bar 9 is actuated vertically in a reciprocating manner by an insulating operating rod 10, which is guided by a stationary guide bushing 11. The fully open circuit position of the cross-bar 9 is indicated by the dotted lines 12 in Fig. 1.

The operating mechanism for the operating rod 10 may be of any suitable type. Preferably, however, we employ a type set forth and claimed in United States patent application by Benjamin P. Baker and Oswald von Mehren, Serial No. 630,350, filed November 23, 1945, now United States Patent 2,542,790, issued February 20, 1951, and assigned to the assignee of the instant application. The operating mechanism is contained within a housing 14 disposed at the top of the tank 1 and is arranged to move the operating rod up and down to close and open the interrupter, respectively.

The lower half of the tank 1 is generally semi-circular in cross section taken in a vertical plane, parallel to the plane of the drawing, and extending through the tank 1 and through the two terminal bushings 4, 5. The lower half of the sides of the tank 1 on opposite sides of said vertical plane comprise curved surfaces. The tank 1 has an extended portion at its upper end for receiving the two terminal bushings 4, 5. It will be observed that the cross-sectional area of the extended portion taken on any horizontal plane is smaller than the cross-sectional area through the mid-portion of the tank 1 taken on a horizontal plane.

The extended portion includes the mechanism housing 14 jutting upwardly between the two terminal bushings 4, 5. It will be observed that the lower interior ends of the terminal bushings 4, 5 extend adjacent the mid-portion of the tank 1, or in other words adjacent the portion of the tank 1 of greatest cross-sectional area taken on a horizontal plane.

The extension at the top portion of the tank 1 has a cross-section which is long in one horizontal direction, the direction from right to left in the plane of the drawing of Fig. 1, to receive the two terminal bushings 4, 5 with a space therebetween for the operating mechanism. This extension is narrow in the other horizontal direction, that is perpendicular to the plane of the drawing of Fig. 1, adjacent the two terminal bushings 4, 5, being at these points only slightly wider than the terminal bushings 4, 5. The supplementary mechanism housing 14 in no manner interferes with the disposition of the terminal bushings 4, 5 being disposed therebetween. It will moreover be noted that the radius of the semi-circular lower portion of the tank 1 is less than half the length of the terminal bushings 4, 5.

Referring to Fig. 2, which shows more clearly the internal construction of the right-hand arc-extinguishing unit 8 of Fig. 1, it will be observed that an enclosure member 15, in this instance consisting of a cylindrical ceramic member, is clamped by an annular clamping member 16 and bolts 17 to a contact foot 18 secured to the lower end of the terminal bushing 5. The enclosure member 15 forms a high pressure chamber, generally designated by the reference numeral 19, and communicates with the region 2 within the tank 1 by an opening or arc extinguisher 20 provided in a lower insulating closure member 21.

Impedance means, in this instance comprising resistance windings 22, are employed to control the voltage between the two arc-extinguishing units 8 during the opening operation and to control the rate of rise and the overshoot of the recovery voltage transient in each unit 8. The resistance winding 22 is helically wound upon the external surface of the enclosure member 15 and is electrically connected at its upper end to the stationary orifice-shaped contact 23, and hence to the lower end of the terminal bushing 5. The lower end of the resistance winding 22 is connected electrically to a lower annular flange member 24 and hence electrically to the movable orifice-shaped contact 25. Thus the resistance winding 22 is in shunt with the contact structure. The residual current arc is broken adjacent the opening or arc extinguisher 20 during the opening operation after extinguishing of the main current arc drawn between the contacts 23, 25 by a blast of gas passing through the opening 20, as will more clearly appear hereinafter.

Disposed in the interior of the enclosure member 15 is a low pressure container 26 normally at atmospheric pressure by exhausting to atmosphere through the contact structure and hollow bushing 5. The container 26 is supported by base brackets 29, the latter being secured by bolts 30 to the annular flange member 24. Disposed within the low pressure container 26 is a fluid motor, generally designated by the reference numeral 31 and comprising a piston 32 movable within a piston cylinder 33. The piston cylinder 33 is preferably integrally formed with a top closure member 34 secured by bolts 35 to the lower main portion of the container 28. Gasket means are preferably used throughout in the construction of the arc-extinguishing unit 8 in a manner well known in the art to prevent gas leakage.

The piston 32 is secured to a movable annular blast valve 36, which is guided by axial fins 37 within a guide cylinder 38 forming an extension of the piston cylinder 33. A plurality of spring washers 39 are provided about the piston 32 to assume the shock in the fully open position of the piston 32 during the opening operation of the circuit interrupter.

The movable annular blast valve 36 makes abutting engagement with a relatively stationary annular blast valve seat 40, the latter encircling the orifice-shaped contact 23 and being biased downwardly by an annular U-shaped metallic member 41, the top and bottom sides of the latter pressing against rubber washers 42, 43. The relatively stationary annular blast valve seat 40 is insulated from the stationary contact 23 by an L-shaped annular member 44 and an insulating sleeve 45. The air pressure on the annular space A plus the spring pressure exerted by the spring member 41 provides the blast valve sealing force in the closed position of the interrupter, as shown in Fig. 2.

Valve means, generally designated by the reference numeral 46 and at high pressure disposed within the low pressure container 28, are employed to effect operation of the fluid motor 31 to bring about blast valve operation and subsequently contact operation. Preferably the valve means 46 at high pressure comprises a metal cylinder 47 which is stationarily maintained in position by being welded at 48 through the lower end 49 of the container 28. Slidably movable within the cylinder 47 is a contact sleeve 50 with the upper portion thereof slotted as at 51 to thereby make the upper portion of the contact sleeve 50 resilient so as to press resiliently outwardly into good contacting sliding engagement with the interior of the cylinder 47. The lower end of the contact sleeve 50 is threadedly secured as at 52 to a metallic bumper 53 having apertures 54 formed therein communicating with the high pressure tank 1. Threadedly secured as at 55 to the bumper 53 is a rod shaped ratchet or other engaging member 56 guided by a station-

ary cylinder 57. The upper end of the ratchet member 56 has a plurality of notches 58 formed therein, the purpose for which will appear more fully hereinafter.

A battery of compression springs are provided to bias the ratchet member 56 and the bumper 53 downwardly in this instance comprising two compression springs 59, 60. An actuating member 61 secured to the outer end of the cross-bar 9 is provided to effect the actuating of the valve means 46 by making abutting engagement with the bumper 53.

The valve means 46 comprises a two-way acting valve member 62 controlling an inlet port 63 and an exhaust port 64. The exhaust port 64 communicates by means of lateral passages 65 (Fig. 6) to a low pressure region 66 within the interior of the container 28 which is at atmospheric pressure by communicating through the contact structure, through hollow bushing 5 to the region exterior of tank 1. The inlet port communicates by way of a passage 67 to the top side 68 of the piston 32.

From the foregoing description it will be apparent that within the high pressure chamber 1 there are positioned two high pressure chambers 19 communicating through openings 20 to the interior of the high pressure tank 1. Disposed in each high pressure chamber 19 is the low pressure chamber 66 defined by the container 28 and top closure member 34. The low pressure chamber 66 is at low pressure by communicating through the contact structure, and through the hollow bushings to atmosphere exterior of the high pressure tank 1. Disposed within the low pressure chamber 66 is the high pressure valve means 46 defined by the cylinder 47 which extends within the low pressure chamber 66.

The notches 58 of the ratchet member 56 engage a pair of plates 69 or releasing means pivotally connected by pins 70 (Fig. 4) to four links 71, the upper ends of which make pivotal connection at 72 to the lower end 73 of the valve members 62. A pair of tension springs 74 are provided having their lower ends secured to the upper ends of the plates 69 and their upper ends to pins 74a. Pins 76 extend through the plates 69 and move in slots 77 provided in the opposite upstanding portions 78 of a machined casting 79 having a configuration more clearly shown in Fig. 4. Preferably, the casting 79 is an integral part of the stationary cylinder 57. The upper end of the casting 79 has a flange portion 80 which is secured as by a press fit to a cap member 81, which also forms the seat of the inlet port 63.

From the foregoing description of the valve means 46, it will be apparent that when the actuating member 61 moves downwardly, the compression springs 59, 60 will force the bumper 53 and hence the ratchet or engaging member 56 downwardly. The downward movement of the notches 58 associated with the ratchet member 56 will cause by successive ratcheting action the plates 69 or releasing means to rotate and to remain rotated about the pins 76 at the upper ends of the slots 77 to thereby effect downward holding movement of the links 71 and hence opening movement of the valve member 62. This will open the inlet port 63 and close off the exhaust port 64 to permit high pressure gas disposed within the region 82 of the high pressure valve means 46 to pass past the inlet port 63 to act through the passage 67 on top of the piston 32. Since the lower side of the piston 32 communicates with the low pressure region 66 at atmospheric pressure, and since the top side of the piston 32 now communicates through the inlet port 63 to the high pressure region 82, the piston 32 will be forced downwardly.

The downward movement of the piston 32 will move the movable blast valve 36 downwardly away from the stationary blast valve seat 40 to thereby permit high pressure gas to come immediately adjacent to the now closed contacts 23, 25. When piston 32 strikes the spring washers 83 after traveling the distance D, it will pick up the orifice-shaped movable contact 25 to thereby bring about separation between the contacts 23, 25 to draw a main current arc therebetween. The arc which is drawn between the contacts 23, 25 is rapidly extinguished by a blast of gas which passes downwardly through the movable tubular contact 25 into the region 66 at low pressure and upwardly through the orifice-shaped stationary contact 23 to the low pressure region 84, which communicates through the hollow terminal bushing 5 to atmosphere exterior of the tank 1. Thus, the main current arc is extinguished in an arc extinguisher comprising the two contacts 23, 25, and there only remains to interrupt the residual current passing through the resistance winding 22.

The continued downward movement of the conducting actuating member 61 permits continued downward movement of the bumper 53. However, the continued downward movement of the ratchet or engaging member 56 finally causes separation between the upper end of the ratchet member 56 and the plate 69. When this occurs, the valve member 62 will move upwardly by virture of the tension springs 74 to close the inlet port 63 and to open the exhaust port 64. This permits communication between the top surface of the piston 32 and the region 66 by way of the exhaust port 64 and the lateral passages 65. Consequently, there occurs an equalization of pressure on both sides of the piston 32 and the compression springs 85, 86, which now both act on the piston 32, will effect the upward movement thereof.

Thus, the valve means 46 is free to close when the bumper 53 strikes the lower flange 87 of the cylinder 47 when the actuating member 61 separates from the bumper 53. However, before the blast valve and contact structure have reclosed, the residual current arc which is drawn between the conducting actuating member 61 and the conducting bumper 53 is extinguished by the passage of high pressure gas through the opening or arc extinguisher 20 provided in the closure member 21. This follows inasmuch as high pressure gas within the chamber 19 is being exhausted out through the orifice-shaped stationary contact 23, the contact structure being open at this time. Thus we provide a passage or region 19 pneumatically interconnecting the arc extinguisher 20 with the main current arc extinguisher comprising contacts 23, 25.

Following interruption of the residual current arc as a result of the residual current passing through the resistance winding 22 which is in shunt with the main contact structure, the conducting cross-bar 9 and actuating member 61 move to the dotted open circuit position, as shown in Fig. 1, to interpose two isolating gaps in the circuit. This is necessary inasmuch as the main contact structure recloses following interruption of the residual current arc.

During the closing operation, the cross-bar and actuating member 61 move upwardly. When the actuating member 61 strikes the bumper 53, which now rests against the flange 87, the bumper 53 and ratchet member 56 are moved upwardly against the downward biasing action exerted by the compression springs 59, 60. However, the upward movement of the notches 58 does not cause opening of the valve means 46 by virtue of the permissible rotative movement possible of the releasing means or plates 69 because of the provision of the slots 77. In other words, during the closing stroke, the notches 58 cause the pins 76 to move downwardly in the slots 77, thus rendering the valve actuating mechanism inoperable. Consequently, during the closing operation, the valve member 62 remains in the position shown in Fig. 2.

Should, however, the interrupter be closed on a fault or during the existence of overload conditions in the power line controlled by the interrupter, the mechanism for operating the interrupter will be reversed even before the closing operation is complete. This follows inasmuch as during the entire closing operation, the contact structure is closed and flashover may occur between the member 61 and bumper 53 to trip the overload protective relay to cause immediate reversal of the mechanism even before the closing operation is complete. Should this occur, the provision of a plurality of notches 58 will cause the valve means 46 to be opened as in a normal opening operation even though the movable parts have not assumed their fully closed circuit position. Thus, any notch 58 will be sufficient to permit opening of the valve means 46 and a separation of the contact structure 23, 25 with extinction of the arc drawn thereacross in in a manner as previously described.

Instead of using the ratchet means disclosed in conjunction with the releasing means or plates 69, other means such as frictional engaging devices operative during the opening operation and inoperative during the closing operation may be employed.

It will furthermore be noticed that in the closed position, a portion 89 of the piston 32 serves as a valve to prevent leakage of high-pressure gas past the piston ring 90. The provision of the sealing means effective during the closed position of the blast valve structure prevents leakage of high-pressure gas out through the terminal bushing 5. By insulating the stationary blast valve seat 40 from the stationary contact 23, no arcing whatever takes place on the engaging surfaces of the blast valve. Hence, these members do not become pitted by arcing to thus permit leakage thereacross in the closed position.

By providing the resistance winding 22 about the enclosure member 15, as shown, a convenient means is thus employed for inspecting the winding or to replace the same. From the above it will be apparent that we have provided an improved arc-extinguishing unit of the type set forth in the aforesaid application. Also, by the spherical construction of the tank 1, maximum strength for the high-pressure gas contained therein is obtained with a minimum use of material. By employing a double orifice contact construction forming an effective arc extinguisher, rapid extinction of the arc is achieved by virtue of the passage of the high-pressure gas through both the stationary and movable contacts inasmuch as the gas within the container 26 is at relatively low pressure and, in fact, is at atmospheric pressure at the beginning of the opening operation.

The pressurized tank construction decreases the clearance distances necessary for voltage isolation. Also, the structure is rigid and mechanically strong. It is to be observed also that the high-pressure gas which passed through the movable tubular orifice-shaped contact 25 into the region 66 during the opening operation, passes back through the contact 25 and through the stationary orifice-shaped contact 23 and through the terminal bushing 5 in the closed position of the interrupter. Thus, in the closed position of the interrupter, region 66 is at atmospheric pressure, the exhaust gas which entered region 66 having been exhausted through the contact structure in the closed position of said contact structure. It is furthermore to be noticed that the high-pressure gas which enters the region 19 is utilized at the opening 20 to effect extinction of the residual current arc drawn between the actuating member 61 and the bumper 53 thereby utilizing the gas twice in timed sequence to extinguish the two arcs. The insulating enclosure member 15 provides insulation for full voltage between the contacts 23, 25 during the interrupting period. The lost motion connection between the movable blast valve and the movable contact 25 permits high-pressure gas to be readily available immediately adjacent the contact structure when the latter is separated to draw an arc.

Certain features of the structure are disclosed and claimed in a patent application by Albert P. Strom, filed December 14, 1944, Serial No. 568,104, entitled "Compressed Gas Circuit Interrupter" which issued as U. S. Patent 2,459,600 on January 18, 1949, and which is assigned to the assignee of the present application.

Certain broad features of the invention are set out and claimed in U. S. patent application filed August 10, 1944, by James M. Cumming, Serial No. 548,815, issued December 21, 1948, as Patent 2,456,926, and assigned to the assignee of the present application.

Although we have shown and described a specific structure, it is to be clearly understood that the same was merely for the purpose of illustration and that changes and modifications may be made therein without departing from the spirit and scope of the appended claims.

We claim as our invention:

1. In a circuit interrupter of the gas-blast type, an arc-extinguishing unit comprising a pressurized chamber, a container disposed within the chamber at atmospheric pressure, contact means separable to draw an arc, piston means for operating the contact means movable within the container, valve means for controlling the piston means, an opening leading into the pressurized chamber through which compressed gas may pass into the chamber, an actuating member movable through the opening to cause actuation of the valve means, impedance means shunting the contact means, and the actuating member being in series with the impedance means to break the residual current adjacent the opening leading into the pressurized chamber.

2. In a circuit interrupter of the gas-blast type, an arc-extinguishing unit comprising a pressurized chamber, a container disposed within the chamber at atmospheric pressure, contact means separable to draw an arc, piston means for operating the contact means movable within the container, valve means for controlling the piston

means, an opening leading into the pressurized chamber through which compressed gas may pass into the chamber, an actuating member movable through the opening to cause actuation of the valve means, impedance means shunting the contact means, the actuating member being in series with the impedance means to break the residual current adjacent the opening leading into the pressurized chamber, and the volume of the pressurized chamber and the size of the opening being such that the gas flowing through the opening assists in extinguishing the residual current arc drawn adjacent thereto.

3. In a circuit interrupter of the gas-blast type, a pressurized tank, a terminal bushing extending into the tank, an arc-extinguishing unit depending from the lower end of the terminal bushing and including means defining a substantially enclosed chamber, a stationary orifice contact secured to the lower end of the bushing, a movable contact cooperable with the stationary contact to draw an arc, a container disposed within the chamber, blast valve means, piston means for actuating the blast valve means, valve means disposed within the container, and means for operating the valve means at any one of a plurality of positions during the opening operation but being inoperative during the closing operation.

4. In a circuit interrupter of the gas-blast type, a pressurized tank, a terminal bushing extending into the tank, an arc-extinguishing unit depending from the lower end of the terminal bushing and including means defining a substantially enclosed chamber, a stationary orifice contact secured to the lower end of the bushing, a movable orifice-shaped contact cooperable with the stationary contact to draw an arc, a container disposed within the chamber, blast valve means, piston means for actuating the blast valve means, valve means disposed within the container, means for operating the valve means at any one of a plurality of positions during the opening operation but being inoperative during the closing operation, and an actuating member movable adjacent the lower end of the unit for actuating the means.

5. In a circuit interrupter of the gas-blast type, a pressurized tank, a terminal bushing extending into the tank, an arc-extinguishing unit depending from the lower end of the terminal bushing and including means defining a substantially enclosed chamber, a stationary orifice contact secured to the lower end of the bushing, a movable contact cooperable with the stationary contact to draw an arc, a container disposed within the chamber, an annular stationary blast valve seat, an annular movable blast valve, a piston secured to the movable blast valve and movable within the container, and means for causing the piston to effect opening of the movable contact after a predetermined opening travel.

6. In a circuit interrupter of the gas-blast type, a pressurized tank, a terminal bushing extending into the tank, an arc-extinguishing unit depending from the lower end of the terminal bushing and including means defining a substantially enclosed chamber, a stationary orifice contact secured to the lower end of the bushing, a movable contact cooperable with the stationary contact to draw an arc, a container disposed within the chamber, an annular stationary blast valve seat, an annular movable blast valve, a piston secured to the movable blast valve and movable within the container, means for causing the piston to effect opening of the movable contact after a predetermined opening travel, valve means for controlling operation of the piston, means for opening the valve means at any one of a plurality of positions during the opening operation but being inoperative during the closing operation, and an actuating member for effecting motion of the means.

7. In a circuit interrupter of the gas-blast type, a pressurized tank, a terminal bushing extending into the tank, an arc-extinguishing unit depending from the lower end of the terminal bushing and including means defining a substantially enclosed chamber, a stationary orifice contact secured to the lower end of the bushing, a movable contact cooperable with the stationary contact to draw an arc, a container disposed within the chamber, an annular stationary blast valve seat, an annular movable blast valve, a piston secured to the movable blast valve and movable within the container, means for causing the piston to effect opening of the movable contact after a predetermined opening travel, valve means for controlling operation of the piston, means for opening the valve means at any one of a plurality of positions during the opening operation but inoperative during the closing operation, an actuating member for effecting motion of the means, impedance means shunting the stationary and movable contacts, and means for drawing the residual current arc at the point of engagement of the actuating member and the means.

8. In a circuit interrupter of the gas-blast type, a pressurized tank, two bushings extending into the tank and having exhaust passages therethrough, an arc-extinguishing unit depending from the lower end of each bushing, a conducting cross-bar for electrically interconnecting the units in the closed position, each unit including an enclosure member, contact means disposed within the enclosure member separable to establish a main current arc, the high pressure gas from within the pressurized tank passing into the enclosure member and out through the associated bushing to effect the extinction of the main current arc, a resistance winding wound around each enclosure member to divide the voltage between the units, one end of each resistance winding being electrically connected to the lower end of the bushing, the other end of each resistance winding being electrically connected to the end of the conducting cross-bar at least during the initial portion of the opening operation so that the resistance is in parallel with the main current arc, valve means associated with each arc-extinguishing unit controlling the flow of gas from the pressurized tank through the respective bushing, and opening movement of the cross-bar causing opening movement of the two valve means.

9. In a circuit interrupter of the gas-blast type, means defining a pressurized chamber, a terminal bushing extending into the pressurized chamber and having an exhaust passage therethrough, an enclosure member disposed within the chamber and secured to the interior end of the terminal bushing, exhaust means leading out of the enclosure member and through the terminal bushing, an opening leading into the enclosure member from the pressurized chamber, contact means for establishing a main current arc within the enclosure member, impedance means in parallel with the contact means, and means for drawing a residual current arc adjacent to the opening so that the high pressure gas from the pressurized chamber may extinguish the residual current

arc and subsequently be used to extinguish the main current arc during the next opening operation of the interrupter.

10. In a circuit interrupter of the gas-blast type, means defining a pressurized chamber, a pair of terminal bushings extending into the pressurized chamber and having exhaust passages therethrough, a pair of serially related arc-extinguishing units disposed within the chamber and secured to the interior ends of the terminal bushings, valve means associated with each arc-extinguishing unit, contact means associated with each unit and separable to establish a main current arc, impedance means in parallel with both contact means to divide the voltage between the units, disconnect means in series with the contact means to establish a residual current arc associated with each unit including a cross-bar interconnecting the units, means utilizing a blast of gas for extinguishing the main current arcs which passes past the valve means and out of the pressurized chamber through the terminal bushings, means utilizing a blast of gas for extinguishing the residual current arcs, and opening motion of the cross-bar causing opening of the valve means.

11. In a circuit interrupter of the gas-blast type, means defining a pressurized chamber, a pair of terminal bushings extending into the pressurized chamber and having exhaust passages therethrough, a pair of serially related arc-extinguishing units disposed within the chamber and secured to the interior ends of the terminal bushings, means for establishing a main current arc within each unit, means employing a blast of gas from the pressurized chamber to effect the extinction of the main current arc within each unit, impedance means in parallel with the two units to divide the voltage between the units, means for subsequently establishing a residual current arc for each unit, and means utilizing a blast of gas from the pressurized chamber for effecting the extinction of the residual current arcs.

12. In a circuit interrupter of the compressed gas type, main contact means for drawing a main current arc, impedance means shunting the main contact means, disconnect contact means for establishing a residual current arc after interruption of the main current arc and for inserting an isolating gap in the circuit after the interruption process is completed, a gas blast arc extinguisher through which a blast of gas flows to extinguish the main current arc, another gas blast arc extinguisher through which a blast of gas flows to extinguish the residual current arc, and a passage pneumatically interconnecting the said two arc extinguishers and causing the high pressure gas to be utilized twice in timed sequence to first extinguish one of the arcs and then the other of the arcs.

13. In a circuit interrupter of the compressed gas type, main contact means for drawing a main current arc, impedance means shunting the main contact means, disconnect contact means for establishing a residual current arc after interruption of the main current arc and for inserting an isolating gap in the circuit after the interruption process is completed, a gas blast arc extinguisher through which a blast of gas flows to extinguish the main current arc, another gas blast arc extinguisher through which a blast of gas flows to extinguish the residual current arc, a passage pneumatically interconnecting the said two arc extinguishers and causing the high pressure gas to be utilized twice in timed sequence to first extinguish one of the arcs and then the other of the arcs, and means maintaining the disconnect contact means under constant gas pressure to minimize the necessary length of isolating gap.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
Re. 22,298	Wyman	Apr. 6, 1943
1,987,885	Whitney et al.	Jan. 15, 1935
2,153,400	Trencham	Apr. 4, 1939
2,159,830	Hobson	May 23, 1939
2,279,536	Thommen	Apr. 14, 1942
2,340,827	Thommen	Feb. 1, 1944
2,367,934	Flurscheim	Jan. 23, 1945
2,381,353	Hall	Aug. 7, 1945
2,386,958	Jackson	Oct. 16, 1945

FOREIGN PATENTS

Number	Country	Date
172,658	Great Britain	Mar. 2, 1922
454,816	Germany	Jan. 18, 1928