United States Patent

[11] 3,590,187

[72] Inventors Richard E. Kane
Monroeville;
Robert L. Hess, North Versailles, both of, Pa.

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[73] Assignee Westinghouse Electric Corporation
Pittsburgh, Pa.

[54] **SEPARABLE CONTACT AND BLAST-VALVE STRUCTURE FOR A COMPRESSED-GAS CIRCUIT BREAKER**
7 Claims, 15 Drawing Figs.

[52] **U.S. Cl.** .... **200/148 R,** 200/148 BV
[51] **Int. Cl.** **H01h 33/82,** H01h 33/54
[50] **Field of Search** .... 200/148 R, 148

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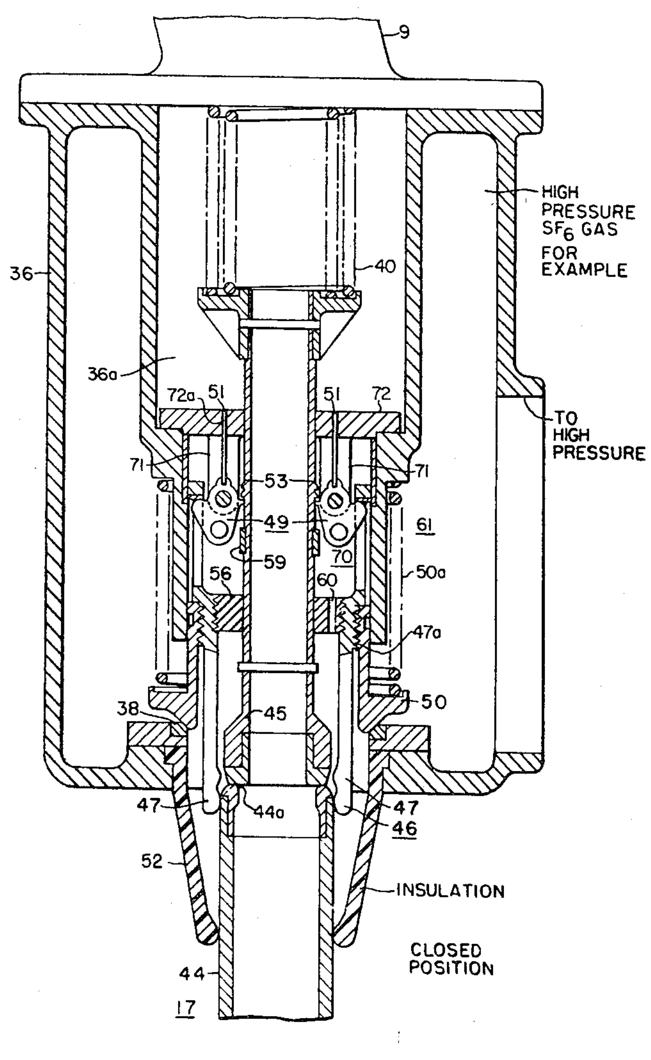
Primary Examiner—Robert S. Macon
Assistant Examiner—Robert A. Vanderhye
Attorneys—A. T. Stratton, C. L. McHale and W. R. Crout

ABSTRACT: A separable contact structure is provided for a compressed gas circuit interrupter involving a differential blast valve cooperating with an orifice chamber, or an interrupter chamber, to direct the gas flow during the opening operation. The construction is such that a contact follower initially follows the opening movement of the movable contact, until it is picked up and retracted by the opening movement of a differentially acting blast valve. Subsequently, upon a pressure equalization, the spring-biased blast valve recloses, carrying with it the contact follower, so that in the fully open circuit position of the interrupter the blast valve is closed, and the arc horn follower is extended. Contact is initially made between the movable contact and the extended contact follower contact during the closing stroke. Such structure eliminates erosion on the main stationary contact fingers, and, additionally, simplifies the actuation of the blast valve structure.



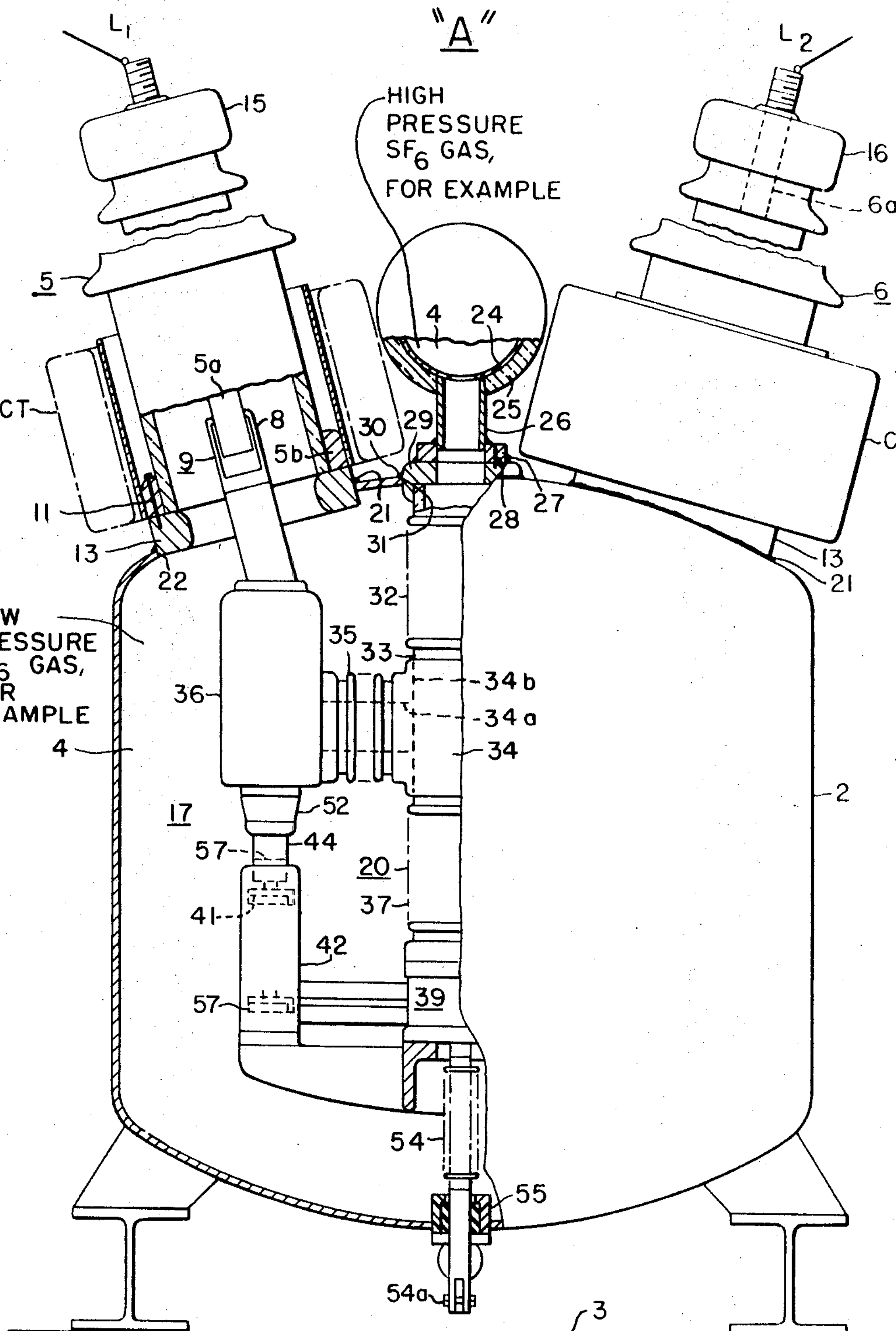


Fig. 1

INVENTORS
Richard E. Kane and
Robert L. Hess
BY
Willard R. Crout
ATTORNEY

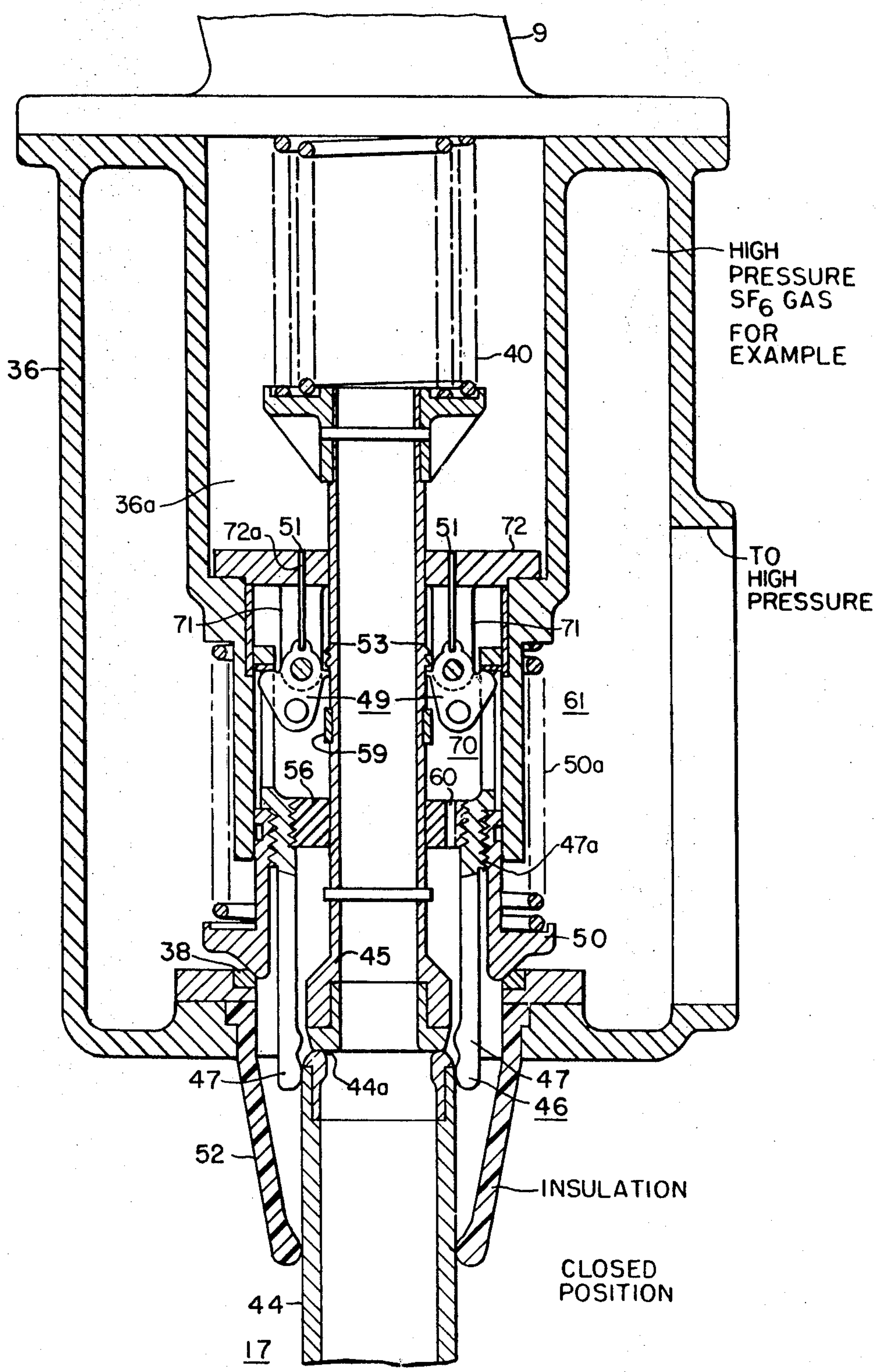
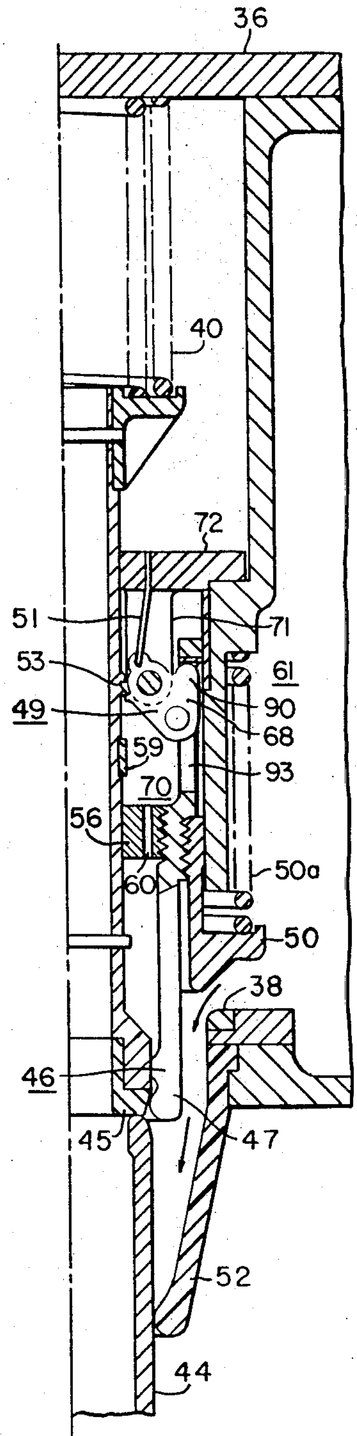
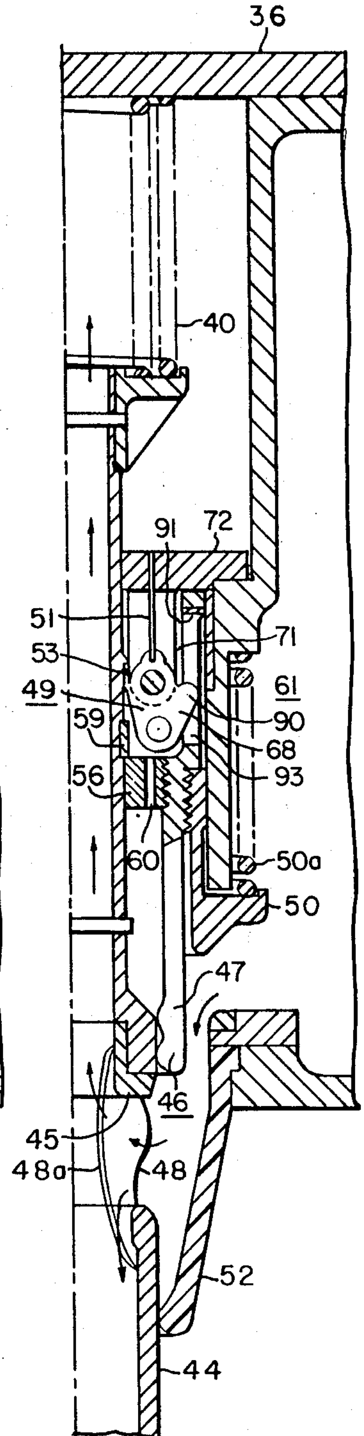

9
HIGH PRESSURE SF_6 GAS FOR EXAMPLE
40
36
36a
72a
51
51
72
TO HIGH PRESSURE
71
71
53
49
61
59
70
56
60
50a
47a
38
45
50
47
44a
47
46
52
INSULATION
CLOSED POSITION
44
17

Fig. 2



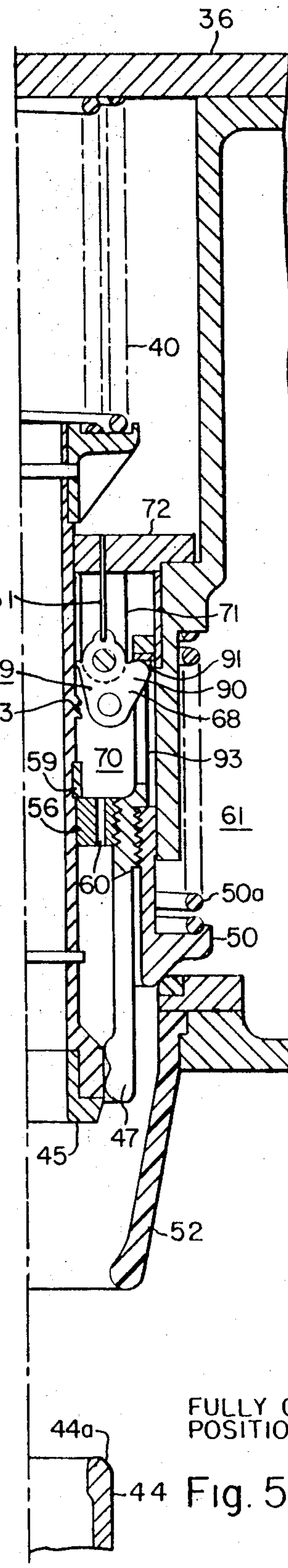
PARTIAL OPENING

Fig. 3



ARCING CONDITION

Fig. 4



FULLY OPEN POSITION

Fig. 5

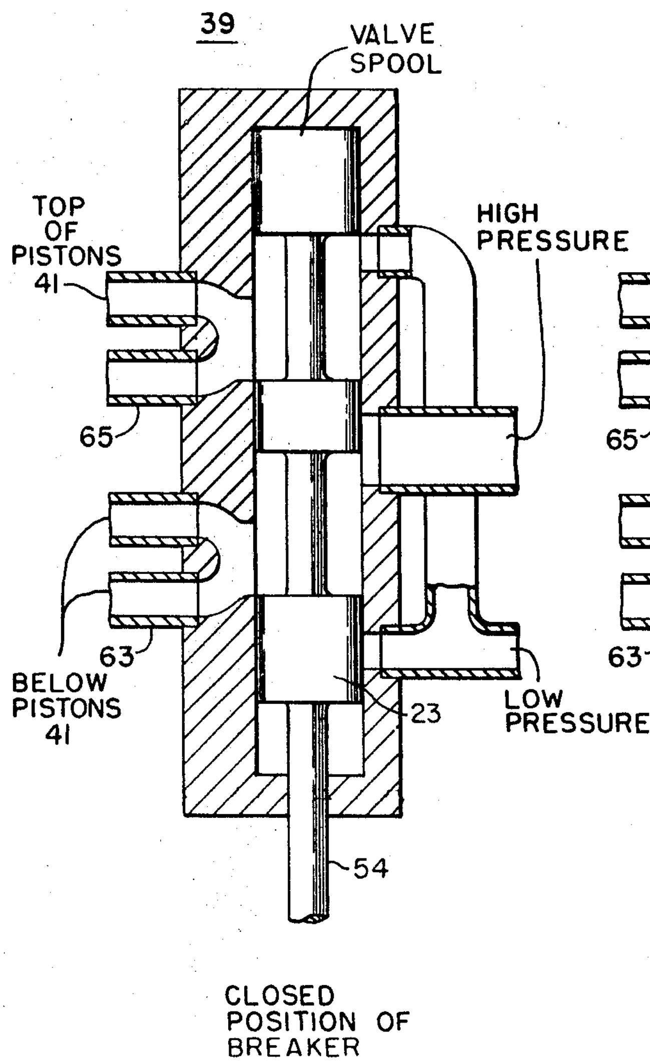

39
VALVE SPOOL
TOP OF PISTONS 41
HIGH PRESSURE
65
63
BELOW PISTONS 41
23
LOW PRESSURE
54
CLOSED POSITION OF BREAKER

Fig. 6

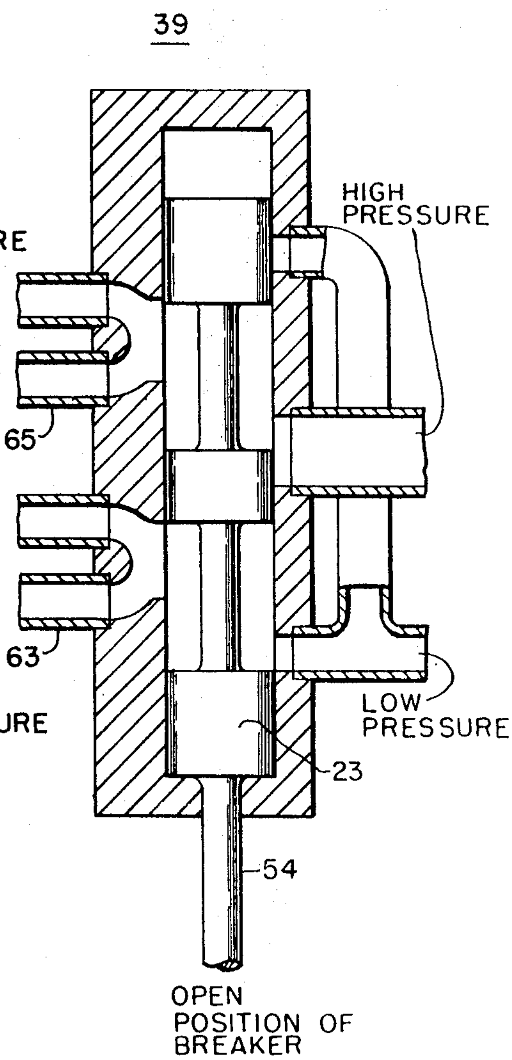

39
HIGH PRESSURE
65
63
LOW PRESSURE
23
54
OPEN POSITION OF BREAKER

Fig. 7

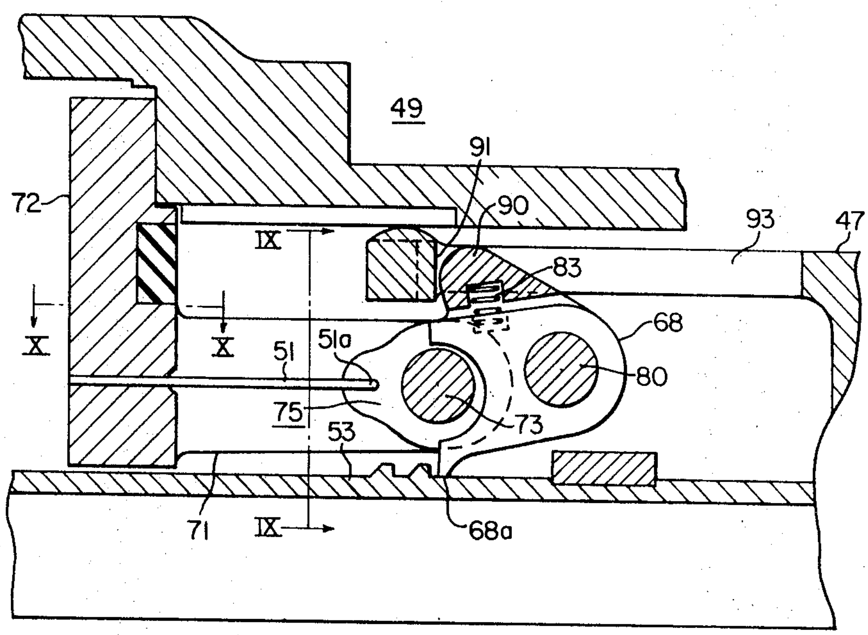


Fig. 8.

Fig. 9.

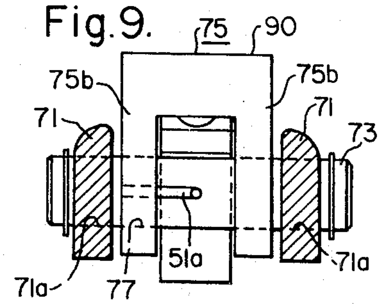


Fig. 10.

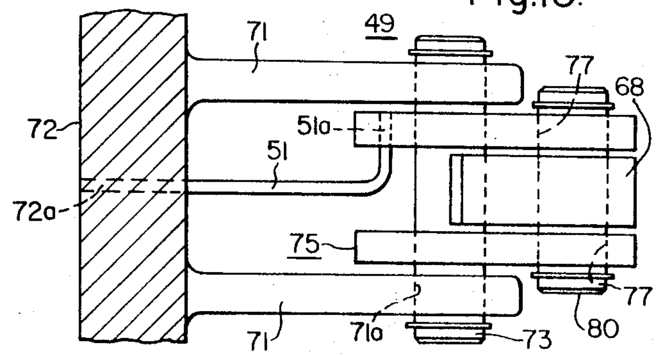
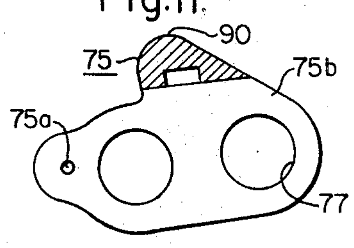


Fig. 11.



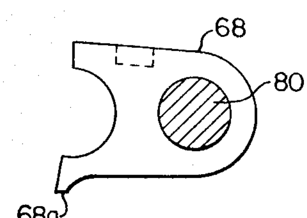


Fig. 14.

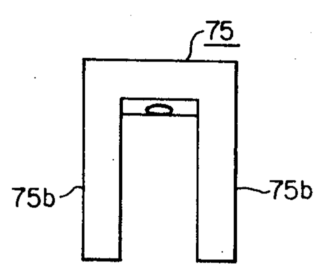
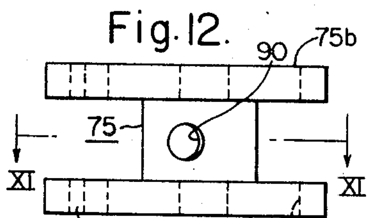


Fig. 13.

Fig. 12.



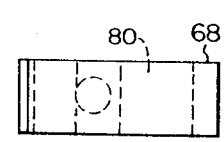


Fig. 15.

SEPARABLE CONTACT AND BLAST-VALVE STRUCTURE FOR A COMPRESSED-GAS CIRCUIT BREAKER

CROSS-REFERENCE TO RELATED APPLICATIONS

Reference is made to U.S. Pat. application filed Apr. 4, 1969, Ser. No. 813,441 and entitled "Compressed-Gas Circuit Breaker," by Richard E. Kane and Robert L. Hess, and also to U.S. Pat. application filed Jan. 21, 1970, Ser. No. 4483 by the same inventors, both of the aforesaid patent applications being assigned to the assignee of the instant patent application.

BACKGROUND OF THE INVENTION

In a high-power, high-voltage compressed gas circuit interrupter it is desirable to provide a simplified type of blast valve construction, which may, desirably, be relatively independent in operation, and actuated by opening movement of the movable contact alone. It is, of course, old in the art to utilize cams, or mechanical levers to effect opening of a blast valve for a compressed gas circuit interrupter. U.S. Pat. No. 2,272,380 Ludwig et al. and U.S. Pat. No. 2,473,843 Baker et al. illustrate such mechanically operating arrangements. However, this leads to some complexities and inaccuracies in timing.

Accordingly, it is desirable to eliminate such mechanical levers, cams, and similar parts, and to rely upon a simplified type of pneumatic operator, taken in conjunction with synchronized motion of the moving contact assembly.

SUMMARY OF THE INVENTION

It is a distinct purpose of the present invention to provide a simplified type of separable contact structure for a compressed gas circuit interrupter, which also initiates opening movement of the blast valve, which is, preferably, differentially operated. According to a preferred embodiment of the invention, there is provided a blast valve and contact housing, which encloses a high-pressure gas. Preferably attached to one end of the aforesaid blast valve and contact housing is an orifice structure, or interrupting chamber, which directs the gas flow into the arc. A movable contact, which may be tubular, enters through the orifice opening and into abutting engagement with a contact follower, which during the opening operation, is spring-biased into following engagement with the movable contact.

Additionally, there is provided a differentially acting blast valve, which may be initially opened by a latching device initiated by opening movement of the movable contact structure, until the pressure conditions are such that the blast valve is fully opened by the high-pressure gas flowing out of the orifice chamber. The opening operation of the differentially acting blast valve picks up the contact follower, and reverses its initial opening movement, so that both the blast valve and the contact follower are retracted as a unit during the time of full gas flow. Subsequently, pressure equalization occurs to permit thereby a reclosing operation of the differential blast valve, and spring-biased contact follower, so that in the fully open circuit position of the circuit interrupter, the blast valve closes, and the contact follower extends to a forward position to thus engage the moving contact upon a subsequent closing operation of the interrupter.

Accordingly, it is a general object of the present invention to provide an improved separable contact structure for a compressed-gas circuit interrupter, which cooperates with a differential blast valve in a novel manner.

Another object of the present invention is to provide an improved differentially acting blast valve, which is independent of mechanical levers and links, and may have its initial opening movement dependent upon the initial opening movement of the movable contact.

Still a further object of the present invention is the provision of a novel latching arrangement interconnecting a contact follower and a differentially acting blast valve.

Yet a further object of the present invention is the provision of an improved compressed gas circuit interrupter in which the opening of the blast valve may be accurately timed.

Another object of the present invention is the provision of an improved separable contact structure for a compressed-gas circuit interrupter in which contact erosion is eliminated on the main stationary contact fingers.

An ancillary object of the present invention is the provision of an improved separable contact structure for a compressed-gas circuit interrupter of compact dimensions, and acting independently of linkages, being initiated at the proper time by the initial opening movement of the movable contact.

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

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view, partially in side elevation, of an improved compressed gas circuit interrupter embodying the principles of the present invention, and illustrated in the closed circuit position;

FIG. 2 is an enlarged vertical sectional view taken through the blast valve and contact housing of the device, the contact structure being illustrated in the closed circuit position;

FIG. 3 is a view similar to that of FIG. 2, but illustrating the disposition of the several parts in an intermediate portion of the opening operation, before arcing has taken place;

FIG. 4 is a view similar to FIG. 3, but illustrating the blast valve open, the arc drawn, and the gas blast in the process of extinguishing the arc;

FIG. 5 shows the fully open circuit position of the contact structure with the blast valve closed;

FIGS. 6 and 7 illustrate two positions of the control valve spool;

FIG. 8 is a fragmentary enlarged side elevational view, partly in section, of the latching construction utilized in the present invention;

FIG. 9 is a fragmentary sectional view taken substantially along the line IX–IX of FIG. 8;

FIG. 10 is a fragmentary bottom view of the latching arrangement of FIG. 8;

FIG. 11 is a sectional detail view taken through the bifurcated latch support used in the latching arrangement of the present invention;

FIG. 12 is a top plan view of the bifurcated latch support of FIG. 11;

FIG. 13 is an end elevational view of the bifurcated latch support;

FIG. 14 is a side elevational view of the latch; and

FIG. 15 is a bottom view of the latch illustrated in FIG. 14.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, and more particularly to FIG. 1 thereof, the reference numeral 1 generally designates a high-voltage high-power compressed gas circuit interrupter of the dual-pressure type. As shown in FIG. 1, there is illustrated, generally, a grounded metallic tank structure 2 supported upon a foundation 3 and containing interiorly thereof a relatively low-pressure gas 4, such as sulfur hexafluoride (SF_6) gas, at a relatively low pressure, say, for example, 45 p.s.i.

Extending upwardly from the metallic tank structure 2 is a pair of terminal bushings 5, 6 having line conductors *5a*, *6a* disposed therein, and making separable stud and finger engagement, as at 8, with a pair of stationary contacts 9. This permits the terminal bushings 5, 6 to be unbolted at the mounting bolts 11, and the entire terminal bushing structure removed upwardly from the mounting flanges 13 for the tank 2. As shown, the terminal bushings 5, 6 comprise upper caps 15, 16 and interiorly extending conductor studs *5a*, *6a*, which provide line current to a pair of serially related arc-extinguishing units, generally designated by the reference numeral 17, and supported laterally from a hollow conduit or high-pressure feed tube assembly, generally designated by the reference numeral 20.

The lower ends of the terminal bushings 5, 6 have metallic mounting flanges such as 5*b*, secured thereto, as by cement, and the mounting bolts 11 extend through these mounting flanges, such as 5*b*, and into the cooperating tank flanges 13, the latter being secured, as by welding at 21, to entrance holes 22 provided in the upper end of the tank structure 2.

Situated between the upstanding two terminal bushings structures 5, 6 is a high-pressure gas reservoir 24, which may contain a suitable high-pressure gas 4, such as sulfur hexafluoride (SF_6) gas, at a pressure, say, for example, 220 p.s.i. Thermal insulation 25 may be provided about the high-pressure reservoir 24 to prevent liquefaction of the high-pressure gas 4 therein at low ambient temperatures.

Extending downwardly from the high-pressure tank structure 24 is a supporting metallic tube 26, which may be secured to a flange 27, itself secured, as by bolts 28, to a supporting flange, designated by the reference numeral 29, and secured, as by welding 30, in an upper central opening 31 provided at the upper end of the tank 2. Disposed below the supporting flange 29, and secured thereto, is a hollow insulating conduit or feed tube 32, which has its lower end secured, as by a cemented attachment 33, within a casting 34 having four openings therein. As shown in FIG. 1, the lateral openings, such as openings 34*a*, are interconnected by laterally extending insulating supports 35, which secure fixedly into position blast valve and contact housings 36, illustrated more in detail in FIGS. 2—5 of the drawings.

The conduit casting 34 may have a downwardly extending insulating feed tube 37, which supports a control valve, generally designated by the reference numeral 39, which serves to control the entrance of high-pressure gas, or an exhausting therefrom, from the bottom of a piston 41, which reciprocates within an operating cylinder 42, and providing movement of a movable tubular vented contact, designated by the reference numeral 44. The movable contact 44 makes separable contacting engagement with a relatively stationary contact structure 46, and, during the opening operation of the interrupter 1, draws an arc 48 therebetween. This arc 48 is extinguished by a flow of high-pressure gas 4 past a differentially acting blast valve 50 and issuing through an orifice, or an arcing chamber, designated by the reference numeral 52, and directing the flow of high-pressure gas 4 interiorly within the movable tubular vented contact 44.

The operation of the control valve 39 is mechanically obtained by an operating rod 54 formed of insulating material, and extending through a seal 55 at the lower end of the tank 2. After passing through the seal 55, the operating rod 54 is mechanically interconnected at 54*a* with the other two tank structures 2, which collectively constitute a three-phase circuit breaker structure. FIGS. 6 and 7 illustrate structurally the pneumatic operation of the control spool 23 of control valve structure 39.

As shown in FIG. 1, it will be apparent that there are provided two serially arranged circuit breaker units 17, simultaneously actuated and providing two series breaks within the interrupter 1. In the fully open circuit position of interrupter 1, the movable contacts 44 move downwardly to a position illustrated by the dotted lines 57 in FIG. 1. Reference may also be had to FIG. 5 in this connection.

During the opening operation, the insulating operating rod 54 effects actuation of the control valve 39 to exhaust pressure from below the two actuating pistons 41, and thereby permits the high-pressure gas, existing in the space above the operating pistons 41, to force the pistons 41 downwardly within the operating cylinders 42. This causes both movable tubular contacts 44 to move downwardly simultaneously separating from the respective stationary finger contacts 47 of stationary contact structure 46.

BLAST VALVE AND SEPARABLE CONTACT OPERATION

The high-pressure chamber 36 is mounted at some convenient place within the breaker tank 2 and in line with the moving contact 44. This chamber 36 is fitted with a blast valve seat 38 and provides a mounting for the orifice chamber 52. Within the central cavity 36*a* of the chamber 36, at relatively low pressure, are positioned a spring-biased cylindrical contact follower 45 and the spring-biased cylindrical blast valve 50. Fixed to the blast 50 at 47*a* is the finger contact assembly 47. Between the blast valve 50 and contact follower 45 are mounted two latch assemblies 49 approximately 180° apart, and shown in more detail in FIGS. 8—15 of the drawings.

FIGS. 8—10 illustrate more clearly the detailed construction of the latch assemblies 49. It will be noted that there is provided a pair of stationary spaced supports 71 extending downwardly from an integral guide plate 72. The guide plate 72 has a small hole 72*a* therethrough, through which extends the wire spring 51 tending to maintain the latch 68 in a neutral position.

Pivotally mounted through apertures 71*a* of the support 71 is a stationary pivot pin 73, which rotatably supports a bifurcated latch support member, more clearly shown in FIGS. 11—13, and generally designated by the reference number 75. The bifurcated latch support member 75 has a hole 75*a* therethrough, through which extends a lateral portion 51*a* of the wire spring 51. Additionally, the bifurcated latch support 75 has end plate portion 75*b* providing holes 77 therethrough accommodating a floating pivot pin 80, which rotatably supports the latch 68, the latter being biased in a counterclockwise direction about the floating pivot pin 80 by a small compression spring 83. The details of the latch member 68 are set forth in FIGS. 14 and 15 of the drawings. As will be apparent, the latch 68 has a nose portion 68*a*, which engages the teeth 53 provided on the side of the arc-horn contact follower member 45. The bifurcated latch support member 75 has a cam portion 90, which engages the bight portion 91 of a slotted portion 93 of the contact finger assembly 47.

FIG. 2 shows the general arrangement of the parts of the operator with the breaker 1 in the closed position. The moving contact 44 is engaged within the finger contacts 47, and the spring-biased follower 45 is in abutting contact with the tip 44*a* of the moving tubular contact 44. The blast valve 50 is closed. The latches 49 are in their neutral position, and held in this position by the wire spring rods 51. FIGS. 3—5 shows the sequence of the opening operation of the various parts. When the breaker 1 is starting its opening cycle, the moving contact 44 is extracted, or lowered from the contact fingers 47. Being spring loaded, as by springs 40, the contact follower 45 moved downwardly with the moving tubular contact 44. This movement of the contact follower 45 rotates the latch assemblies 49 by means of teeth 53 (FIG. 8) on the body of the follower 45 engaging the latches 68. This rotation of the latches 68 lifts the blast valve 50 off its seat 38, and moves it in the opposite direction of the contact follower and moving contact that is in an upward direction, as viewed in the drawing. The contact fingers 47 move upwardly with the blast valve 50 as one unit. The second contact hump or stop 56, behind the tip of the finger contact 47 provides a contact point of abutment for engagement with the contact follower 45 at 59. Thus, the arcing, during interruption, is confined to the tips of the moving contact 44 and contact follower 45, which are therefore lined with arc-resistant material. Once the blast valve 50 is unseated, the high-pressure gas behind or below it causes the blast valve 50 to move rapidly upwardly to its fully open position, as shown in FIG. 4. The areas exposed to high-pressure are arranged such as to have a total force applied to them greater than that of the low-pressure side plus the spring loads 40, 50*a* of the contact follower 45 and blast valve 50 respectively. As the blast valve 50 is moving upwardly to its fully open position, it engages the stop 59 on the contact follower 45 and moves the follower 45 upwardly in the same direction as the blast valve 50. The latches 68 are so designed as to allow the teeth 53, on the follower 45, to ratchet over them in the opposite direction. FIG. 4 shows the blast valve 50 in its fully open position.

As the high-pressure gas from the blast valve chamber 61 slowly equalizes on the other side 70 of the valve 50 by means of the small gas communication hole **60**, the springs **40** on the follower **45** and springs **50***a* biasing the blast valve **50** downwardly overcome the equalized pressure, and move the blast valve **50** and contact follower **45** as a unit downwardly to the closed position, as shown in FIG. 5. This is the closed position of the blast valve **50** and final extended position of the contact follower **45**, when the breaker **1** is in the fully open position. When the breaker **1** is again closed, the moving contact **44** engages the contact follower **45** and moves it upwardly to its reset, or breaker-closed position, as shown in FIG. 2.

To effect a closing operation of the device, the insulating operating rod **54** effects operation of the control valve **39** to place high-pressure gas below the piston **41**. This will force the movable tubular contact **44** upwardly into contacting engagement with the relatively stationary contact structure **46**, thereby completing the electrical circuit through the circuit breaker **1**. The closed circuit position of the device is illustrated in FIG. **1** of the drawings.

From the foregoing description, it will be apparent that there has been provided an improved separable contact structure for a compressed gas circuit interrupter involving a differential blast valve construction **50**, which is actuated in accordance with the opening movement of the movable contact **44**. The time of blast valve opening can be accurately timed by the construction set forth previously, and the contact erosion of the relatively stationary main contact fingers may be entirely eliminated by the utilization of the contact-follower arrangement.

Although there has been illustrated 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 readily be made therein by those skilled in the art, without departing from the spirit and scope of the invention.

We claim:

1. A compressed gas circuit interrupter including, in combination:
   a. means defining a high-pressure gas reservoir chamber;
   b. blast valve means controlling the flow of high-pressure gas out of said high pressure gas reservoir chamber;
   c. said blast valve means including a differential-pressure-movable blast valve and a stationary blast valve seat;
   d. a conducting movable contact follower;
   e. stationary contact means;
   f. a movable contact engageable with said stationary contact means to complete the electrical circuit through the interrupter;
   g. first biasing means biasing the conducting movable contact follower in the direction of opening movement of the movable contact;
   h. latching means mechanically interconnecting the movable contact follower with the movable blast valve, whereby initial opening movement of the movable contact follower initiates opening movement of the differential-acting movable blast valve;
   i. second biasing means biasing the movable blast valve to the valve-closed position;
   j. and pressure-equalizing means for equalizing the pressure on both sides of the movable blast valve so that the first and second biasing means will cooperate to close the movable blast valve and project the movable contact follower in a forward position.

2. The compressed gas circuit interrupter of claim **1**, wherein at least the movable contact is tubular and vented.

3. The compressed gas circuit interrupter of claim **1**, wherein the movable contact follower is hollow and also the movable contact is tubular and vented.

4. The compressed gas circuit interrupter of claim **1**, wherein the stationary contact means is a cluster of stationary contact fingers interposed between the movable blast valve and the internally located movable contact follower.

5. A compressed gas circuit interrupter including in combination:
   a. a contact and blast valve chamber supporting an insulating orifice member;
   b. means defining a high-pressure gas reservoir chamber within said contact and blast valve chamber;
   c. blast valve means controlling the flow of high-pressure gas out of said high-pressure gas reservoir chamber and out through said orifice member;
   d. said blast valve means including a differential-acting pressure-responsive movable blast valve and a stationary blast valve seat disposed at the entrance to said insulating orifice member;
   e. a conducting movable contact follower;
   f. stationary contact means disposed externally of said conducting movable contact follower;
   a movable contact movable through said orifice member and into contact engagement with said stationary contact means to complete the electrical circuit through the circuit interrupter;
   h. first biasing means biasing the conducting movable contact follower in the direction of opening movement of the movable contact;
   i. latching means mechanically interconnecting the movable contact follower with the movable blast valve, whereby initial opening movement of the movable contact follower initiates movement of the differential-acting movable blast valve;
   j. second biasing means biasing the movable blast valve to the valve-closed position;
   k. and pressure-equalizing means for equalizing the pressure on both sides of the movable blast valve so that the first and second biasing means will cooperate to close the movable blast valve and project the movable contact follower in a forward position.

6. The compressed gas circuit interrupter according to claim **5**, wherein the movable contact is tubular and vented.

7. The compressed gas circuit interrupter according to claim **5**, wherein the stationary contact means comprises a cluster of circumferentially arranged stationary contact fingers.