July 8, 1969 R. G. COLCLASER, JR., ET AL 3,454,734

COMPRESSED-GAS CIRCUIT INTERRUPTER

Filed Sept. 22, 1965

Sheet 1 of 3

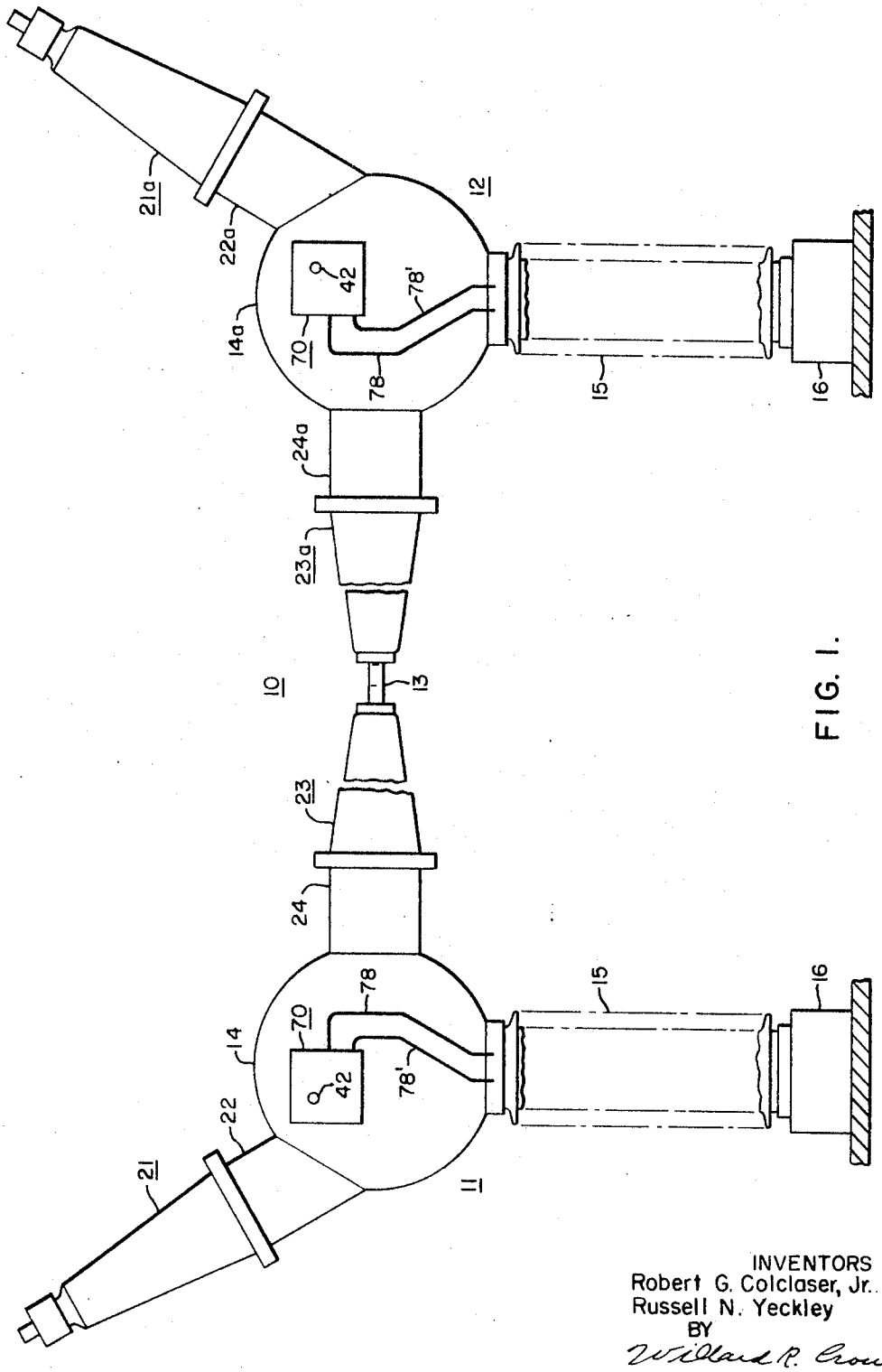


FIG. 1.

INVENTORS
Robert G. Colclaser, Jr. and
Russell N. Yeckley
BY
Willard R. Trout
ATTORNEY

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Sheet 2 of 3

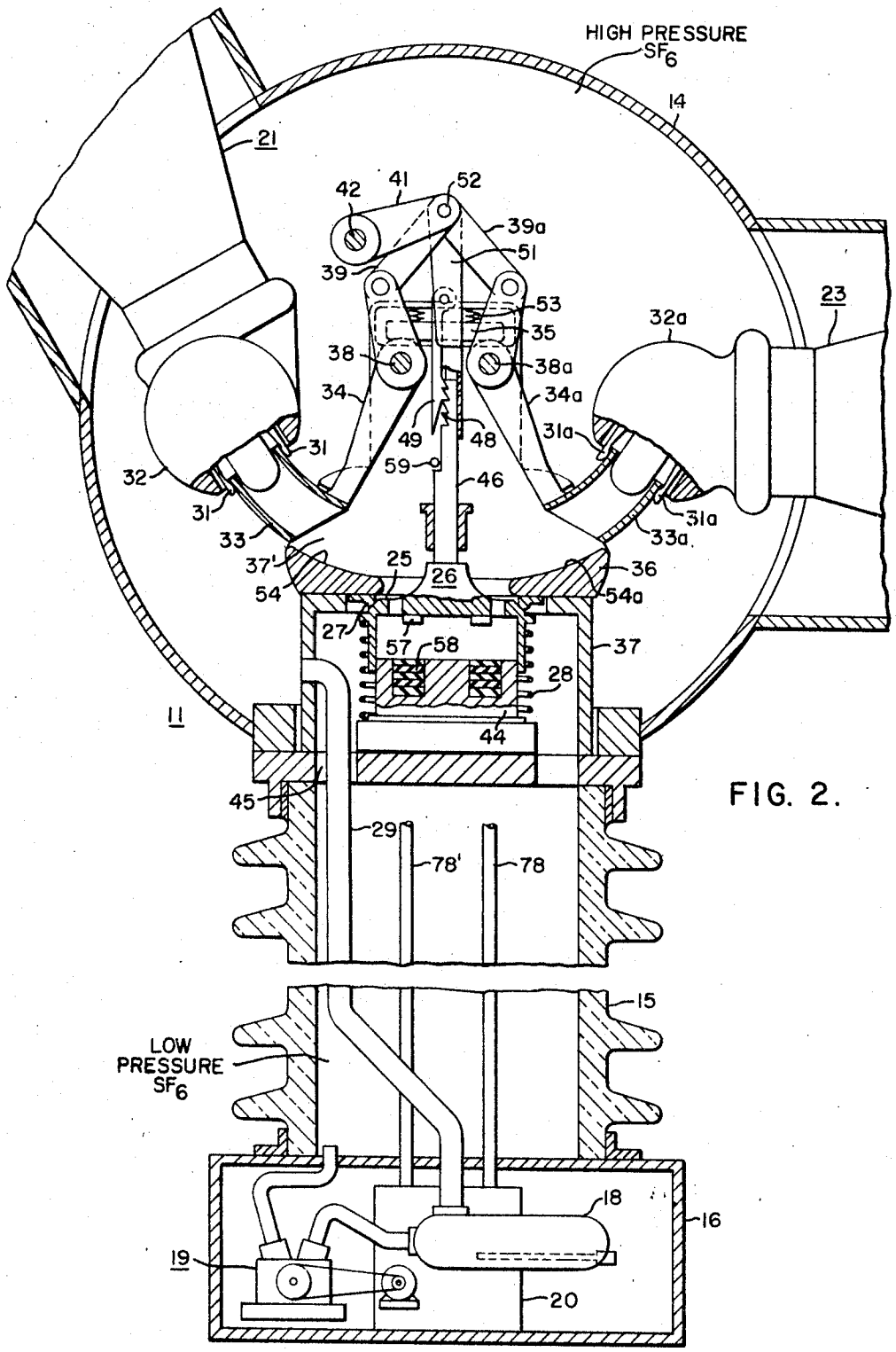


FIG. 2.

FIG. 3.

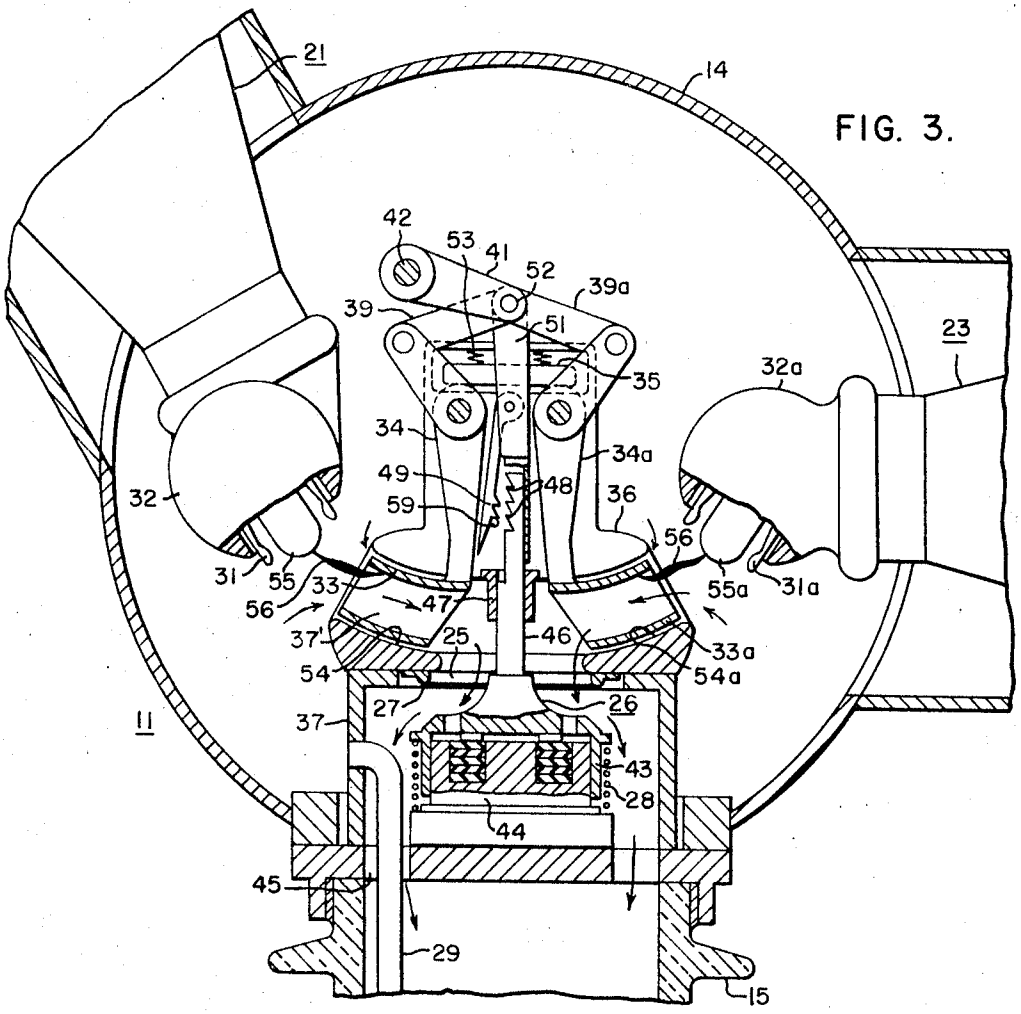
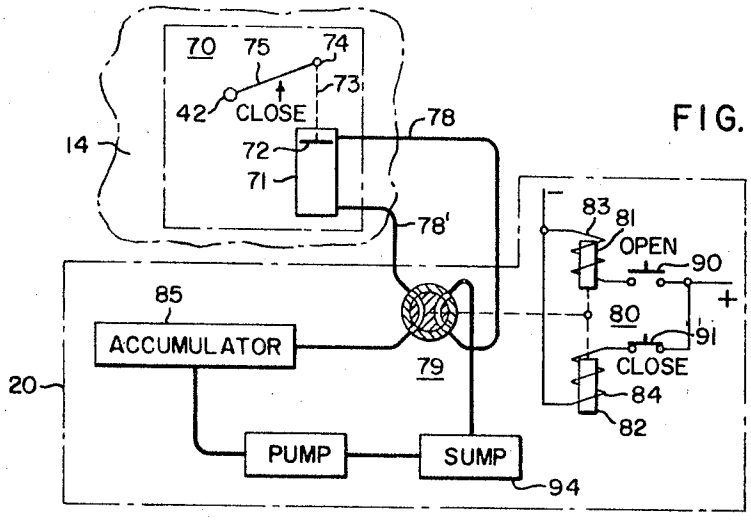

21
14
42
53
41
52
39a
39
51
23
35
32a
34
34a
49
48
36
32
59
56
31
55
33
55a
31a
56
47
37'
25
46
33a
54
54a
11
37
27
26
43
28
44
45
29
15

FIG. 4.


70
75
74
73
42
CLOSE
78
14
72
71
78'
83
81
OPEN
90
85
80
91
ACCUMULATOR
79
CLOSE
84
20
82
PUMP
SUMP
94

United States Patent Office

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COMPRESSED-GAS CIRCUIT INTERRUPTER

Robert G. Colclaser, Jr., Franklin Township, Delmont, and Russell N. Yeckley, Murrysville, Pa., assignors to Westinghouse Electric Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

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U.S. Cl. 200—148
11 Claims

ABSTRACT OF THE DISCLOSURE

A gas-pressurized tank at high potential encloses a pair of serially-related movable contacts making separable engagement with a spaced pair of stationary contacts enclosed within the tank. A centrally-arranged single downstream-type of blast valve closes an opening to an upstanding insulating column, which constitutes a low-pressure reservoir.

Means are provided to synchronize the opening of the single downstream blast valve with opening separating movement of the two movable contacts.

This invention relates, generally, to compressed-gas circuit interrupters and, more particularly, to compressed-gas circuit interrupters having interrupting units enclosed within pressurized tanks.

A general object of the present invention is to provide an improved compressed-gas circuit interrupter of the presurized-tank type, which is highly effective, may be utilized in multiple modular form, and, in addition, uses a downstream blast-valve construction.

A more specific object of the present invention is to provide an improved pressurized-tank type of compressed-gas circuit interrupter in which a movable tubular contact moves along an exhaust passageway, the flow of gas through which is controlled by a downstream blast valve.

Still a further object of the present invention is to provide an improved pressurized-tank type of high-voltage compressed-gas circuit interrupter in which a tank means is supported up in the air by an insulating column, the tank means containing a pressurized gas, and one or more serially-related arc-extinguishing units are disposed interiorly of the tank means, each unit containing a movable tubular contact movable along an exhaust passageway, and pneumatically connected with a downstream blast valve.

Prior circuit breakers for extra-high-voltage service are of the "live" tank type where the insulation to ground is supplied by a porcelain supporting column instead of by a gaseous medium. Also in prior SF_6 breakers of the dual-pressure type, the SF_6 gas is stored in a high-pressure chamber and admitted through an upstream blast valve into an interrupting unit, or units disposed within a low-pressure chamber.

Another object of this invention is to provide a circuit breaker which may include one interrupting unit, or two or more units connected in series, each unit being enclosed within a metal pressurized tank, which is supported and insulated from ground by a supporting column composed of porcelain or other insulating material.

Another object of the invention is to provide a circuit breaker of the dual-pressure type in which each interrupting unit is enclosed in a tank containing an interrupting gas at a relatively high pressure, and which is exhausted through a downstream blast valve into a low-pressure chamber during an interrupting operation.

A further object of the invention is to provide a double-break interrupter having two relatively stationary contact members and two series connected tubular movable contact members having an exhausting flow of gas therethrough.

Still another object of the invention is to provide a double-break interrupter having two series connected movable tubular contact members which are moved in opposite directions during an interrupting operation.

A still further object of the invention is to utilize one downstream blast valve to cause an interrupting gas to flow through two series-connected hollow moving contact members of an interrupter.

Other objects of the invention will be explained fully hereinafter, or will be apparent to those skilled in the art.

In accordance with one embodiment of the invention, the contact assembly of a double-break interrupter is enclosed in a steel tank containing sulfur hexafluoride, (SF_6) gas at a relatively high pressure. The tank is supported and insulated from ground by an upstanding insulating column containing SF_6 gas at a relatively low pressure. A spring-biased downstream blast valve normally closes the entrance to the upstanding column. During an interrupting operation, gas flows downwardly from the pressurized tank through two series-connected, hollow, rotatable contact members and a downstream blast valve into the upstanding supporting column, thereby interrupting the arcs drawn between the moving contact members and the stationary contact members.

For a better understanding of the nature and objects of the invention, reference may be had to the following detailed description, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a diagrammatic view of a circuit-breaker structure embodying principal features of the invention.

FIG. 2 is a view, partly in elevation, and partly in section, of one pole units of the breaker shown in FIG. 1, the contacts being shown in the closed-circuit position;

FIG. 3 is a fragmentary view, somewhat similar to that of FIG. 2, but illustrating the position of the movable contact members during an opening operation; and,

FIG. 4 is a diagrammatic view of the hydraulic actuating mechanism for effecting opening of the contact structure.

Referring to the drawings, and more particularly to FIG. 1 thereof, the circuit-breaker structure **10** shown therein includes two interrupting assemblies **11** and **12** which are connected in series-circuit relation through a conductor **13**. The interrupting assemblies **11** and **12** constitute one pole-unit **10**. As many pole units **10** as desired may be provided. Thus, in a three-phase power system, three pole-units **10**, similar to the one illustrated, would be required. Furthermore, one or a plurality of interrupting assemblies **11**, **12** may be provided for each pole-unit **10** depending upon the voltage of the power system.

The interrupting assembly **11** comprises a pressurized steel tank **14**, which is supported and insulated from ground by an upstanding porcelain column **15** mounted upon a base housing **16**. As indicated in FIG. 2, the base housing **16** contains a high-pressure tank **18**, a compressor unit **19**, and a hydraulic mechanism compartment **20**.

A terminal bushing **21** is mounted upon an angularly-extending collar **22** on the pressurized tank **14**. A similar bushing **23** is mounted upon a horizontally-extending collar **24** on the tank **14**. The interrupting assembly **12** is similar to the assembly **11** except that the bushings **21***a* and **23***a* and the collars **22***a* and **24***a* extend in different directions on the tank **14***a* from the directions of the corresponding members on the tank **14**.

As indicated in FIG. 2, the pressurized tank **14** contains an interrupting gas, such as sulfur hexafluoride (SF_6) gas, at a relatively high pressure, for example, 200 p.s.i.g. The supporting column **15** contains sulfur hexafluoride (SF_6) gas at a relatively low pressure such as 30 p.s.i.g. An opening **25** between the tank **14** and the column **15** is normally closed by a downstream blast valve **26**, which is biased to the closed position against a valve seat **27** by a compression spring **28**. Low-pressure SF_6 gas is drawn from the column **15**, compressed by the compressor **19** and supplied to the interior of the tank **14** through an insulating tube **29** disposed inside the supporting column **15**. The bushings **21** and **23** may be gas-filled, oil-filled, or shellac-impregnated, as desired.

The current path through the interrupting assembly **11** extends from the bushing **21** through relatively stationary contact fingers **31** mounted in a contact foot **32** on the inner end of the terminal bushing **21**, a hollow movable contact member **33**, which is engaged by the fingers **31**, and is carried by a rotatable arm **34**, a spring-biased contact member **35**, which bridges the arm **34**, and a similar arm **34***a*, a hollow contact member **33***a* carried by the arm **34***a*, contact fingers **31***a* and a contact foot **32***a* secured to the terminal bushing **23**. Thus, the movable tubular contact members **33** and **33***a* are connected in series-circuit relation, and the assembly **11** is of the double-break type since two interrupting gaps are provided between the two movable tubular contact members **33**, **33***a* and their associated stationary contact members **31**, **31***a*.

The moving contact assembly is supported by a metal casting support **36** mounted upon a support member **37**, which, in turn, is mounted upon the upper end of the insulating supporting column **15** and provides an exhaust passageway **37'**. The rotatable contact arms **34** and **34***a* are mounted upon pivot pins **38** and **38***a*, respectively, which are mounted in the metal support casting **36**. The arms **34** and **34***a* are connected by links **39** and **39***a* respectively, to a rotatable crank-arm **41** on an operating drive shaft **42**. The drive shaft **42** extends to the outside of the pressurized tank **14** through a suitable shaft seal (not shown), and may be driven by any suitable operating mechanism of a type well known in the art. The casting **36** may be made in two halves, one of which is shown in the drawing.

As shown in FIG. 4, the drive shaft **42** extends through the outer side wall of the pressurized metallic tank **14** and is actuated in the opening and closing directions by a hydraulic mechanism **70**, comprising a hydraulic cylinder **71**, within which moves a hydraulic piston member **72**. The hydraulic piston member **72** is connected to a piston rod **73** pivotally connected, as at **74**, to a crank-arm **75** affixed to the external end of the operating drive shaft **42**.

A hydraulic line **78** interconnects the upper end of the hydraulic cylinder **71** with an operating master valve, generally designated by the reference numeral **79**, disposed within the mechanism compartment **20** at ground potential, and which is electrically actuated by a double-solenoid device **80** also at ground potential. As shown in FIG. 4, the double-solenoid device **80** comprises a pair of armatures **81**, **82**, associated with energizing windings **83**, **84**, which may be energized by the closing of an "open" push-button **90**, or the closing of a "close" push-button **91**, as shown in FIG. 4.

Operation of the hydraulic master valve **79** at ground potential within mechanism compartment **20** will interconnect the high-pressure hydraulic fluid from an accumulator **85** through the master hydraulic valve **79**, and into the particular end of the hydraulic cylinder **71** depending on which particular operating button **90**, **91**, is pressed. Also, as well known by those skilled in the art, a sump **94** may be provided to be connected to the end of the hydraulic operating cylinder **71** in which the pressure is to be reduced.

FIG. 4 shows the electrical operating conditions at the end of the closing operation of the circuit interrupter **10**. It will be noted that the closing button **91** has energized the solenoid **84** to effect rotation of the master valve **79** to the position indicated, whereby the accumulator **85** is connected to the lower end of the hydraulic cylinder **71**, thereby forcing the hydraulic piston **72** upwardly, and effecting a closing operation of the driving crank **75**. This will close the movable contacts **33**, **33***a* as shown in FIG. 2.

The downstream blast valve **26** is essentially of the balanced type, and is held closed against the valve seat **27** by the compression spring **28**. The blast valve **26** has a skirt **43** surrounding an upwardly extending portion **44** on the support member **37**. An exhaust opening **45** in the support **37** provides an exhaust passageway from the interior of the tank **14** into the upstanding insulating column **15** when the blast valve **26** is lowered to open the valve opening **25**. The blast valve **26** has a stem **46**, which extends upwardlly through a valve guide **47** in the metal casting **36**. The upper end of the valve stem **46** has a plurality of ratchet teeth **48** provided thereon. The teeth **48** are engaged by a spring-biased pawl **49** carried by a bifurcated rod **51** pivotally attached to the crank-arm **41** by a pin **52**, which also attaches the links **39** and **39***a* to the crank arm **41**. Thus, the blast valve **26** is opened simultaneonsly with the contact members **33**, **33***a* of the interrupter **11**, as will be described more fully hereinafter.

The contact member **35**, which bridges hub portions of the contact arms **34** and **34***a* is disposed within a recess in the metal casting **36**, and is biased into engagement with the hub portions by compression springs **53**. As previously explained, the bridging member **35** electrically connects the moving contact members **33** and **33***a* in series-circuit relation.

The hollow contact members **33** and **33***a* are arcuate in shape since each moves in an arc defined by the rotatable contact arm **34** or **34***a* along the exhaust passageway **37'**. The metal casting member **36** has arcuate passageways **54** and **54***a* therein for receiving the moving contact members **33** and **33***a*, respectively. The passageways **54** and **54***a* communicate with the blast valve opening **25**, which, in turn, communicates with the interior of the supporting column **15** through the opening **45** in the support member **37**.

An opening operation is as follows: Upon receipt of the proper signal, the operating shaft **42** is rotated clockwise by the operating mechanism, thereby moving the crank-arm **41** downwardly. This rotates the contact arms **34** and **34***a* in opposite directions through the links **39** and **39***a*, respectively, thereby disengaging the contact members **33** and **33***a* from the stationary contact fingers **31** and **31***a*, respectively. Arcs are established, which quickly transfer to arc horns **55** and **55***a*, respectively, as indicated by the arcs **56** in FIG. 3. At the same time, the downward motion of the crank-arm **41** drives the blast valve **26** downwardly through the ratchet assembly **48**, **49**. This causes high-pressure sulfur-hexafluoride (SF_6) gas to flow from the interior of the tank **14** through the hollow contact members **33** and **33***a*, the exhaust passageway **37'**, the valve opening **25**, and the passageway **45** into the low-pressure chamber inside the upstanding insulating column **15**. Thus, the hollow moving contact members **33**, **33***a* serve as orifices for the gas flow. This flow of gas effects arc interruption in a manner somewhat similar to that described in Patent No. 3,154,658, issued Oct. 27, 1964 to R. G. Colclaser and R. N. Yeckley and assigned to the assignee of the instant application.

As described in the aforesaid patent, there is provided an axial flow of gas through the mouth of the orifice contacts **33**, **33***a*, but also there is provided a cross-blast action of the gas, since the arc is drawn between the tip portion of the arcing horn and the inner side wall of the movable hollow contact, as shown by the arcs **56** in FIG.

3. As a result, there is provided both a cross-blast action and an axial flow blast action of the gas during an interruption operation.

Downward motion of the blast valve **26** is stopped by a projection **57** engaging a buffer assembly **58** in the portion **44** of the supporting member **37**. Just prior to reaching the full-open position, the pawl **49** is disengaged from the ratchet teeth **48** by a pin **59**, thereby permitting the blast valve **26** to be reclosed by its biasing spring **28**. In this manner, the quantity of the high-pressure interrupting gas used during an interruption is conserved. As previously explained, gas is drawn from the low-pressure chamber inside the column **15** and returned by the compressor **19** through the insulating tube **29** to the high-pressure chamber inside the metal tank **14**.

From the foregoing description it is apparent that the invention provides a live-tank breaker, with contacts operated in a high-pressure gas, such as sulfur-hexafluoride (SF_6) gas, resulting in a structure of minimum required contact separation. More efficient use of the gas is obtained, when compared to prior breakers of the dual-pressure type, with a possible resultant of lower maximum gas pressures, and a corresponding reduction in auxiliary heater requirements. The double-break interrupter unit **11** is suitable for use at relatively high voltages, and, as previously explained, two or more interrupting assemblies **11**, **12** may be connected in series-circuit relation, thereby further increasing the service voltage. Minimum mass is accelerated, resulting in reduced mechanism requirements. The downstream blast valve arrangement makes high-pressure gas available right at the contacts, and two-cycle operation is easier to obtain than with upstream valve arrangements.

Reduced tank size is feasible because of the excellent dielectric property of the high-pressure sulfur-hexafluoride (SF_6) gas or other interrupting gas. Maintenance is simplified since only the high-pressure gas need be removed to gain access to the interior of the tank **14**, the blast valve **26** effectively sealing the low-pressure side. The operating mechanism **70** can be serviced without disturbing the gas since it is mounted exteriorly of the pressurized tank **14**.

Since numerous changes may be made in the above-described construction, and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all subject matter contained in the foregoing description, or shown in the accompanying drawing, shall be interpreted as illustraive and not in a limiting sense.

We claim as our invention:

1. A double-break circuit interrupter comprising a spherical tank containing an interrupting gas at a relatively high pressure, a column supporting and insulating the spherical tank from ground, a single spring-biased blast valve normally closing an opening between the tank and the column, two spaced relatively stationary contact members disposed inside the tank adjacent opposite ends thereof, two series-connected hollow rotatably movable contact members engaging the stationary contact members, a pair of rotatable crank-arms (**34**) carrying the movable contact members, operating means for disengaging the contact members in a rotatable fashion and opening the single blast valve to cause gas to flow from the spherical tank through the hollow contact members and through the single valve opening into the supporting column to interrupt the arcs drawn between the separated contact members, and the axis of rotation (**38**) for the rotatable crank-arm (**34**) being in close proximity to the center of the spherical tank.

2. A double-break circuit interrupter comprising a tank containing an interrupting gas at a relatively high pressure, a column supporting and insulating the tank from ground, a spring-biased blast valve normally closing an opening between the tank and the column, two spaced relatively stationary contact members disposed inside the tank, two series-connected hollow rotatable contact members engaging the stationary contact members, and operating means for driving the rotatable members toward each other to disengage them from the stationary contact members and for opening the blast valve to cause gas to flow from the tank through the hollow contact members and the valve opening into the supporting column to interrupt the arcs drawn between the separated contact members.

3. A double-break circuit interrupter comprising a metal tank containing an interrupting gas at a relatively high pressure, a column supporting and insulating the metal tank from ground, a spring-biased blast valve normally closing an opening between the metal tank and the column, two spaced relatively stationary contact members disposed inside the tank, two series-connected hollow rotatable contact members engaging the stationary contact members, operating means for driving the rotatable members toward each other to disengage them from the stationary contact members and to open the blast valve to cause gas to flow from the metallic tank through the hollow contact members and the valve opening into the supporting column to interrupt the arcs drawn between the separated contact members, and means permitting the blast valve to be reclosed by its biasing spring at the end of the opening operation.

4. A double-break circuit interrupter comprising a metal tank containing an interrupting gas at a relatively high pressure, a column supporting and insulating the tank from ground, a spring-biased blast valve normally closing an opening between the tank and the column, two spaced relatively stationary contact members disposed inside the tank, two series-connected hollow rotatable contact members engaging the stationary contact members, operating means for driving the rotatable members toward each other to disengage them from the stationary contact members, ratchet means actuated by the operating means to open the blast valve to cause gas to flow from the tank through the hollow contact members and the valve opening into the supporting column to interrupt the arcs drawn between the separated contact members, and means for releasing the ratchet means to permit the valve to be reclosed by its biasing spring at the end of the opening operation.

5. In a double-break circuit interrupter, in combination, a spherical metallic tank containing an interrupting gas at a relatively high pressure, a hollow column for supporting and insulating the tank from ground, two relatively stationary contact members mounted inside the tank in spaced relation, a supporting member disposed between said contact members and having an exhaust passageway therethrough with a single valve opening communicating with the interior of the column, a single spring-biasing downstream blast valve normally closing said single valve opening, a hollow rotatably movable contact member engaging each stationary contact member, a pair of rotatable crank-arms (**34**) carrying the movable contact members, operating means for moving the hollow contact members into said exhaust passageway to disengage them from the stationary contact members and for opening the single downstream blast valve to cause gas to flow from the tank through the hollow contact members and the single valve opening into the supporting column, and the axis of rotation (**38**) for the rotatable crank-arms (**34**) being in close proximity to the center of the spherical tank.

6. In a double-break circuit interrupter, in combination, a metallic spherical tank containing an interrupting gas at a relatively high pressure, a hollow column for supporting and insulating the tank from ground, two relatively stationary contact members mounted inside the tank in spaced relation adjacent opposite ends thereof, a centrally-located supporting member disposed between said contact members and having an exhaust passageway therethrough with a single valve opening communicating

with the interior of the column, a single spring-biased downstream blast valve normally closing said single valve opening, a hollow contact member engaging each stationary contact member, a contact arm rotatably mounted on the centrally-located supporting member for carrying each hollow contact member, and operating means for driving the contact arms in opposite directions to disengage the hollow contact members from the stationary contact members and move them into said passageway, said operating means also opening said single blast valve to cause gas to flow from the tank through the hollow contact members and the single valve opening into the supporting column, and the axis of rotation (38) for the rotatable contact arms (34) being in close proximity to the center of the spherical tank.

7. In a double-break circuit interrupter, in combination, a metallic tank containing an interrupting gas at a relatively high pressure, a hollow column for supporting and insulating the tank from ground, two relatively stationary contact members mounted inside the tank in spaced relation, a supporting member disposed between said contact members and having an exhaust passageway therethrough with a single valve opening communicating with the interior of the column, a single spring-biased blast valve normally closing said single valve opening, a hollow rotatable contact member engaging each stationary contact member, a contact arm rotatably mounted on the supporting member for carrying each hollow rotatable contact member, a bridging contact member engaging the rotatable contact arms to electrically connect the hollow contact members in series-circuit relation, operating means for driving the rotatable contact arms in opposite directions to disengage the hollow contact members from the stationary contact members and move them into said exhaust passageway, and ratchet means driven by the operating means to open the single downstream blast valve to cause gas to flow from the tank through the hollow contact members and the valve opening into the supporting column.

8. In a double-break circuit interrupter, in combination, a metallic tank containing an interrupting gas at a relatively high pressure, a hollow column for supporting and insulating the tank from ground, two relatively stationary contact members mounted inside the tank in spaced relation, a centrally-located supporting member disposed between said contact members and having an exhaust passageway therethrough with a single valve opening communicating with the interior of the column, a single spring-biased downstream blast valve normally closing said single valve opening, a hollow rotatable contact member engaging each stationary contact member, a contact arm rotatably mounted on the supporting member for carrying each hollow rotatable contact member, a bridging contact member engaging the contact arms to electrically connect the hollow rotatable contact members in series-circuit relation, operating means for driving the contact arms in opposite directions to disengage the hollow rotatable contact members from the stationary contact members and move them into said exhaust passageway, ratchet means driven by the operating means to open the single downstream blast valve to cause gas to flow from the tank through the hollow contact members and the single valve opening into the supporting column, and means for releasing the ratchet means to permit the downstream blast valve to be reclosed by its biasing spring.

9. The combination in a high-voltage compressed-gas circuit interrupter of spherical metallic tank means containing a high-pressure arc-extinguishing gas, a pair of spaced terminal bushings extending into said metallic tank means and carrying at the interior ends thereof relatively stationary contact structures, means defining an exhaust passageway, means defining a pair of arc-extinguishing units disposed within said spherical tank means and comprising each a relatively stationary contact carried by the interior end of one of said terminal bushings and a cooperable rotatably movable tubular contact movable along said exhaust passageway, a rotatably movable crank-arm (34) for moving each movable contact, means defining a single centrally-located downstream blast valve communicating with said exhaust passageway and exhausting into the supporting insulating column, means including a rotatable drive-shaft (42) extending through the wall of said tank means for effecting separation of the pair of movable tubular contacts and opening of said single downstream blast valve, means for effecting rotation of said drive-shaft externally of said tank means, whereby an exhausting flow of high-pressure gas will flow out of said spherical tank means through the pair of movable tubular contacts and past the single opened blast valve into the insulating supporting columns for arc-extinguishing purposes, and the axis of rotation (38) for the rotatable contact arms (34) being in close proximity to the center of the spherical tank.

10. The combination according to claim 9, wherein a releasable ratchet means interconnect opening driving motion of said drive shaft and opening motion of a blast-valve stem.

11. The combination of claim 9, wherein hydraulic means (70) at high potential disposed externally of the metallic tank means and operated at ground potential (80) causes rotation during the opening and closing operation of the rotatable drive-shaft (42).

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ROBERT S. MACON, *Primary Examiner.*