United States Patent

[11] 3,624,326

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[21] Appl. No. 813,441
[22] Filed Apr. 4, 1969
[45] Patented Nov. 30, 1971
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[54] **COMPRESSED-GAS CIRCUIT BREAKER WITH READILY REMOVABLE TERMINAL BUSHING MEANS**
11 Claims, 7 Drawing Figs.

[52] U.S. Cl. 200/148 R, 174/167
[51] Int. Cl. H01h33/54, H01h 33/86
[50] Field of Search 200/148, 148.2, 148.6; 174/161, 167, 18

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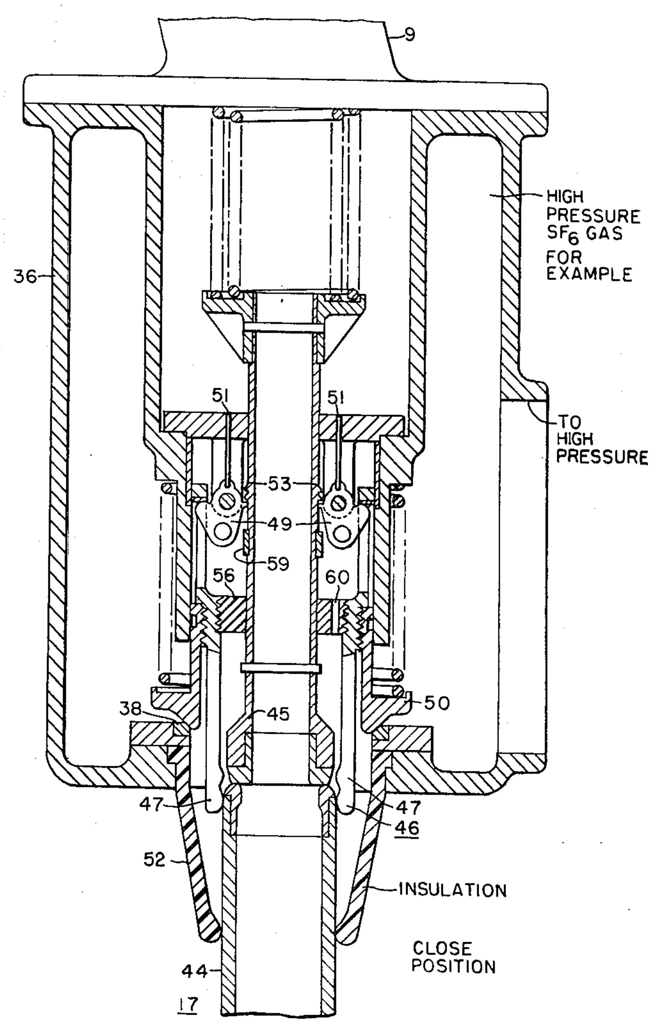
ABSTRACT: A high-voltage, high-power compressed-gas circuit interrupter is provided utilizing a grounded metal tank having a gas disposed therein at a relatively low pressure, say, for example 45 p.s.i. A pair of serially related arc-extinguishing units are supported within the metallic grounded tank and utilize a blast of gas directed through an orifice to bring about the extinction of the two series arcs simultaneously. A supporting structure disposed within the tank has lateral supports to properly locate the blast valve and contact housing associated with each arc-extinguishing unit. Additionally, the supporting structure supports an operating cylinder to accommodate a movable piston secured to the moving contact of each interrupter.

Terminal bushings are provided at the upper end of the metallic tank and are easily dismantled therefrom by a contact stud and terminal bushing finger arrangement, which easily separates and permits dismantlement at the upper mounting flange portions of the tank for inspection. The high pressure reservoir may be accommodated at the upper end of the tank between the two terminal bushings.



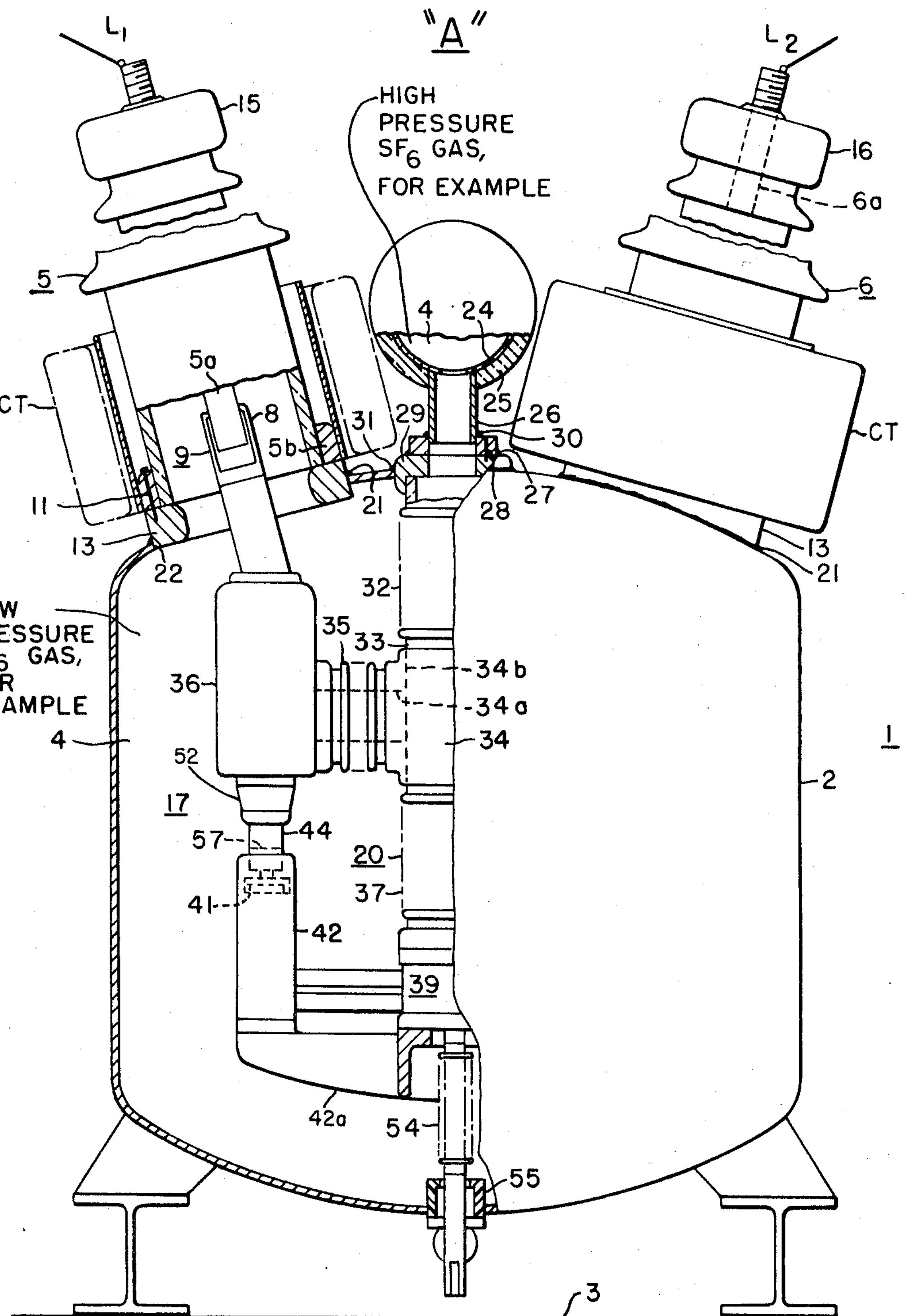


Fig.1

WITNESSES

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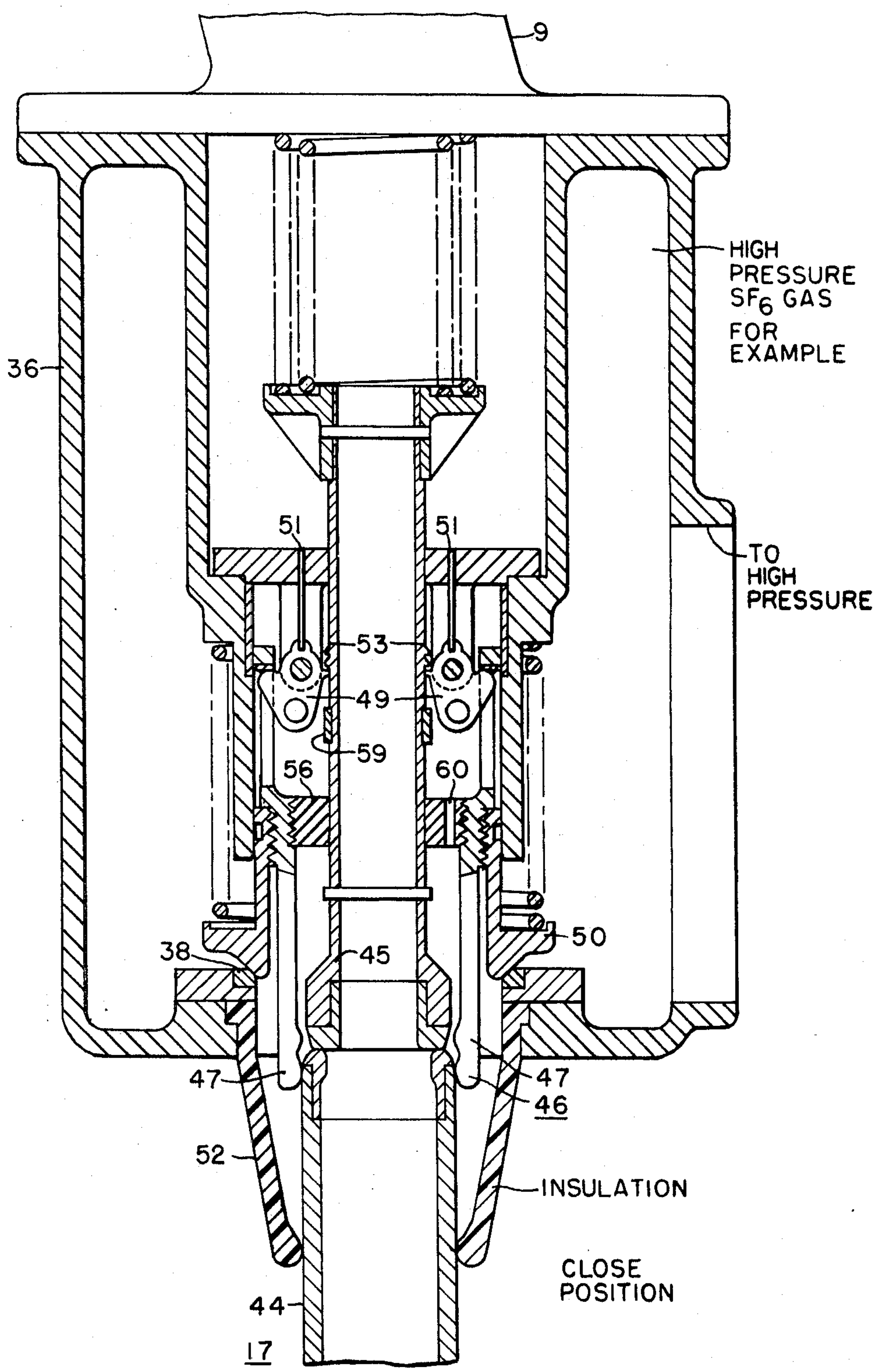
9
HIGH PRESSURE SF6 GAS FOR EXAMPLE
36
TO HIGH PRESSURE
51
51
53
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60
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38
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47
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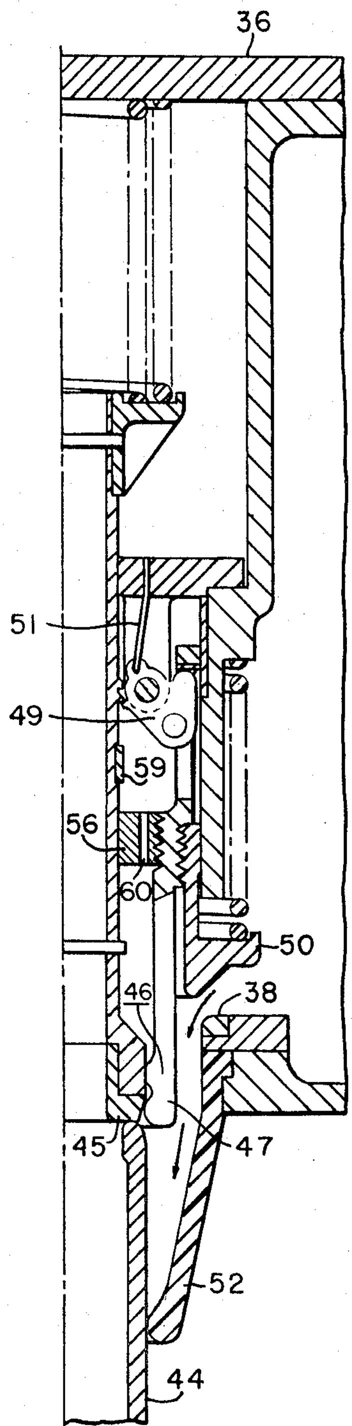
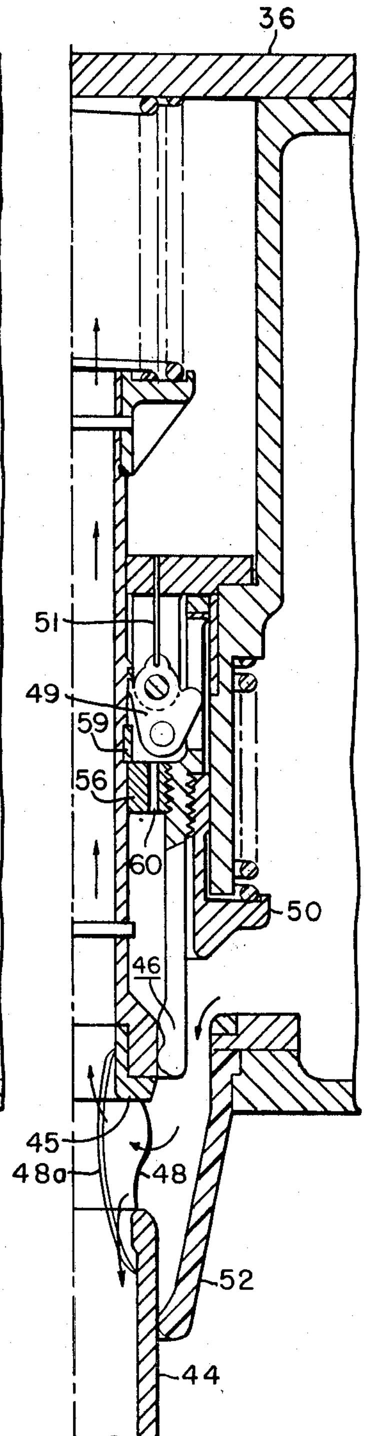
46
52
INSULATION
CLOSE POSITION
44
17

Fig. 2



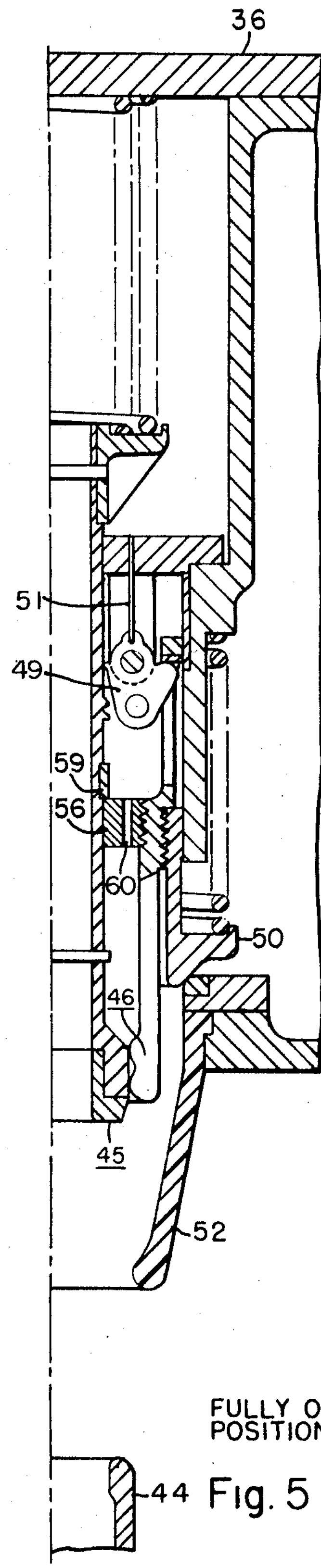
PARTIAL OPENING

Fig. 3



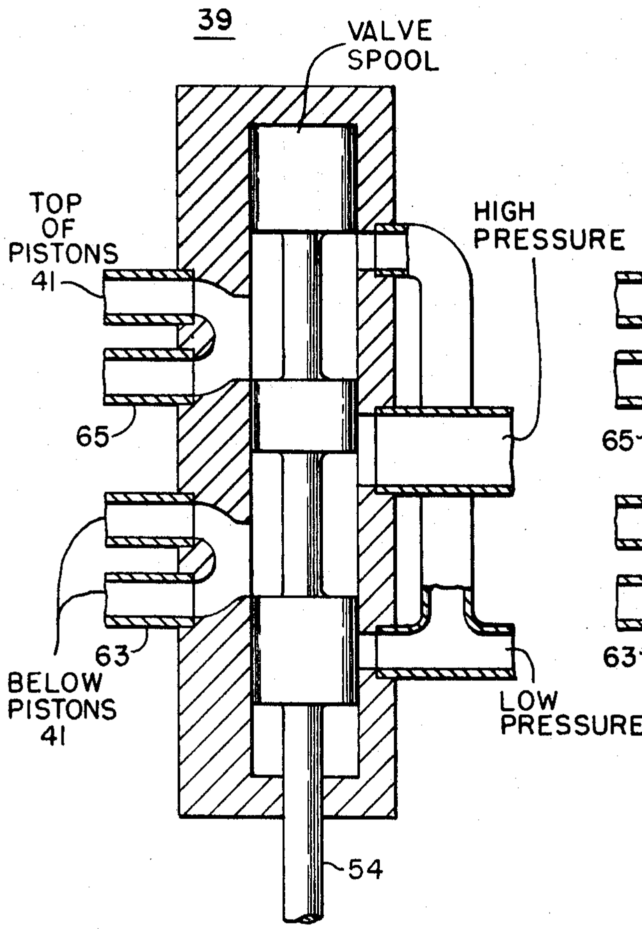
ARCING CONDITION

Fig. 4



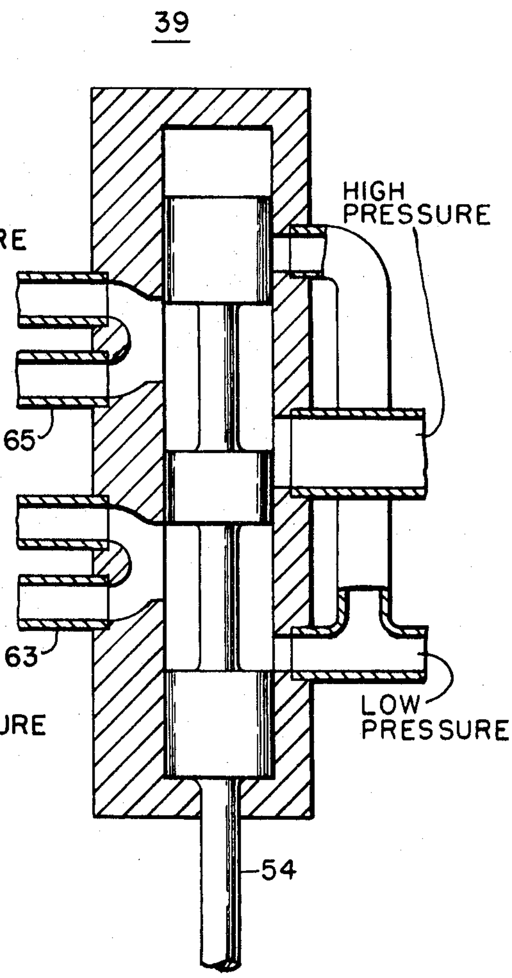
FULLY OPEN POSITION

Fig. 5



CLOSED POSITION OF BREAKER

Fig. 6



OPEN POSITION OF BREAKER

Fig. 7

COMPRESSED-GAS CIRCUIT BREAKER WITH READILY REMOVABLE TERMINAL BUSHING MEANS

CROSS-REFERENCES TO RELATED APPLICATIONS

Reference is made to U.S. Pat. application filed Jan. 21, 1970, Ser. No. 4,485 entitled "Contact Structure and Cooperating Blast-Valve Structure For a Compressed-Gas Circuit Interrupter" by Richard E. Kane and Robert L. Hess, and also to U.S. Pat. application filed Jan. 21, 1970, Ser. No. 4,483 by the same inventors, both applications being assigned to the assignee of the instant application.

BACKGROUND OF THE INVENTION

In a high-power, high-voltage compressed-gas circuit interrupter it is desirable to provide a structure adaptable for fast operation and capable of easy dismantlement for inspection and assembly. Preferably, the structure should be adapted for the use of a number of arc-extinguishing units in series and capable of ready dismantlement. In addition, the structure should be highly efficient in operation and compact in size. Moreover, desirably the number of parts should be reduced to a minimum, and complexities of structure should be avoided.

U.S. Pat. No. 3,154,658 illustrates an arc-extinguishing structure in which a high-pressure blast of gas issues through an orifice or interrupting chamber into the interior of a hollow movable vented contact. It is desirable to utilize such an interrupting structure adaptable for a wide range of voltages and yet to employ simplified structures.

SUMMARY OF THE INVENTION

It is a distinct purpose of the present invention to provide a high-power high-voltage circuit breaker structure which is of simplified construction and highly efficient in operation.

According to the preferred embodiment of the invention, there is provided a grounded metallic tank filled with gas at a relatively low pressure. A pair of upstanding terminal bushings bring the current into the tank structure, in which is located a pair of arc-extinguishing units in series. The movable contacts are piston actuated, and the control valve for the pressures used in the operating cylinders is adapted to bring about simultaneous operation of the two serially related arc-extinguishing units. In addition, the preferred embodiment of the present invention utilizes a supporting structure, which not only laterally supports a blast value and stationary contact housing, but also the operating cylinder for the piston effecting movement of the movable contact. This supporting structure, in one particular embodiment, is attached to the upper tank cover so that the entire supporting structure depends from the upper end of the tank.

According to the preferred embodiment, the supporting structure is hollow and serves to conduct high-pressure gas both to the operating cylinder and also to the blast valve and stationary contact housing.

It is a general object of the present invention to provide an improved high-speed compressed-gas circuit interrupter of the metallic grounded tank type.

Another object of the present invention is to provide of an improved compressed-gas circuit interrupter in which an interrupting structure may be laterally supported by a conduit or feed-tubestructure, which, itself, may depend from the upper end of the tank.

Still a further object of the present invention is the provision of an improved circuit breaker structure of the metallic tank type in which dismantlement and assembly of the terminal bushings may be readily achieved in a simplified manner.

Another object of the present invention is the provision of an improved high-voltage high-power compressed-gas circuit interrupter of the dual-pressure type in which the control valve is mechanically actuated and interconnects with other phase units of the device.

Still a further object of the present invention is the provision of an improvd compressed-gas circuit interrupter of the type utilizing hollow movable contacts supportd in a novè manner and adapted for series relation.

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;

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

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

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

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 nonarcing terminal-bushing 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 *5b* secured thereto, as by cement, and mounting bolts **11** extending through these mounting flanges and into the cooperating tank flanges **13**, the latter being secured, as by welding at **21**, to 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** at a low ambient temperature.

Extending downwardly from the high-pressure tank structure **24** is a supporting metal 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 opening **31** provided at the upper end of the tank **2**. Disposed below the supporting flange **29** 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 *34a*, *34b* are interconnected by laterally extending insulating supports **35**, which secure fixedly in position a blast valve and contact housing **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**, and serving to control the entrance of high-pressure gas to, 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**. An electrical tie-bar **42***a* electrically interconnects the units **17** and assists in supporting the operating cylinders **42**. 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 differential 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 secured 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 with the other two tank structures **2**, which collectively constitute a three-phase circuit breaker structure. FIGS. **6** and **7** illustrate diagrammatically the pneumatic operation of the control valve **39**.

As shown in FIG. **1**, it will be apparent that there are provided two circuit-breaker units **17**, only one of which is shown, 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 in FIG. **1**, and designated by the reference numeral **57**. Also reference may be made to FIG. **5** in this connection.

During the opening operation, the insulating operating rod **54** moves downwardly and effects actuation of the control valve **39** to exhaust pressure from below the actuating pistons **41**, and thereby permit 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 separating from the stationary finger contacts **46**.

BLAST VALVE AND SEPARABLE CONTACT OPERATION

A 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 **52**. Within the central cavity of the chamber **36** are positioned a spring biased cylindrical blast valve **50**. Fixed to the blast valve **50** is a finger contact assembly **47**. Between the blast valve **50** and contact follower **45** are mounted two latch assemblies **49**, which are located 180° apart. 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 in the finger contacts **47** and the spring biased follower **45** is in contact with the upper end of the moving contact **44**. The blast valve **50** is closed. The latches **49** are in their neutral position and held in this position by a wire spring rod **51**. FIGS. **3–5** show the sequence of operations of the various parts. When the breaker **1** is starting its opening cycle, the moving contact **44** is extracted from the contact fingers **47**. Being spring loaded, the contact follower **45** moves downwardly with the moving contact **44**. This movement of the contact follower **45** rotates the latch assemblies **49** by means of teeth **53** provided on the body of the follower **45** engaging the latches **49**. This rotation of the latches **49** lifts the blast valve **50** off of its seat **38**, and moves it in the opposite direction of the contact follower and moving contact. The contact fingers **47** move with the blast valve **50** as one unit. The second contact hump **56** behind the tip of the finger contact **47** provides a contact point for engagement on the contact follower. Thus the arcing, during interruption, is confined to the tips of the moving contact **44** and contact follower **45** which are lined with arc-resistant material. Once the blast valve **50** is unseated, the high pressure gas behind it causes the blast valve **50** to move rapidly upwardly to its fully open position. 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 of the contact follower **45** and blast valve **50**. As the blast valve **50** is moving to its fully open position, it engages the stop **59** on the contact follower **45**, as shown in FIG. **4** and moves the follower **45** upwardly in the same direction as the blast valve **50**. The latches **49** 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 of the valve **50** by means of the small gas communication hole **60**, the springs on the follower **45** and blast valve **50** overcome the equalizer 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 also the final 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** is moved upwardly and thereby 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 high-power, high-voltage compressed-gas circuit interrupter involving relatively few parts, and utilizing these parts in a compact manner to provide highly-efficient interrupting conditions to quickly bring about arc interruption. The two terminal bushings **5**, **6** are readily dismantled from the tank structure **2** by unbolting the mounting bolts **11** securing the flanges **5***b*, **13** together. The terminal bushing; finger contact assembly **9** and stud arrangement **5***a*, **6***a* readily permits such separation of the terminal bushings **5**, **6** from the tank structure **2**.

It will, moreover, be apparent that there has been provided an improved conduit and supporting system **20** interiorly of the tank structure **2** disposed in depending relationship within the tank structure, and providing a short distance of travel for the high-pressure gas **4**. Finally, the utilization of an insulating operating rod **54** mechanically bringing about actuation of the control valve **39** synchronizes the operation of the phase unit "A" with the adjacent phase units, not shown, which are identical in structure, and having the control valves **39** all mechanically interconnected, as shown.

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 modification may readily be made therein by those skilled in the art, without departing from the spirit and scope of the invention.

What we claim is:

1. A compressed-gas circuit interrupter including a grounded metallic tank having a pair of upper tank flanges encompassing openings provided at the upper end of the grounded metallic tank, a pair of stationary nonarcing terminal bushing contacts disposed adjacent the pair of tank openings, a pair of upstanding terminal bushings having line-conductor studs therein, interrupting means including a pair of separable arcing contacts disposed interiorly within said grounded metallic tank and supported independently of said pair of upstanding terminal bushings, said interrupting means supporting said pair of nonarcing terminal-bushing contacts, the lower ends of the line-conductor studs making substan-

tially linear ready separable contacting engagement with said pair of stationary nonarcing terminal-bushing contacts, whereby a ready disassembly of the terminal bushing may be achieved.

2. The combination of claim 1, wherein a cluster of stationary-contact fingers is associated with each stationary nonarcing terminal-bushing contact.

3. The combination of claim 1, wherein the tank contains a highly efficient arc-extinguishing gas, and each terminal bushing includes an insulating outer shell with gas-communication to the interior of the tank, and each line-conductor stud is spaced radially inwardly from the inner wall of the respective insulating shell.

4. A compressed-gas circuit interrupter including a grounded metallic tank with a pair of spaced upstanding terminal bushings extending upwardly from the upper end thereof through a pair of upper tank openings to accommodate the terminal bushings, a pair of stationary nonarcing terminal-bushing contacts disposed adjacent the pair of tank openings, a high-pressure reservoir located between the pair of spaced terminal bushings externally of the tank, a pair of arc-extinguishing units having separable arcing contacts disposed within the tank and electrically connected in series, a high-pressure supporting conduit assemblage depending downwardly from the upper end of the tank and supported from the upper end of the tank interiorly thereof, said high-pressure supporting conduit assemblage supporting said pair of arc-extinguishing units laterally thereof and independently from the terminal bushings, said pair of terminal bushings having line-conductor studs therein, said interrupting means supporting said pair of nonarcing terminal-bushing contacts, and the lower ends of the line-conductor studs making substantially linear ready separable contacting engagement with said pair of stationary nonarcing terminal-bushing contacts, whereby a ready disassembly of the terminal bushings may be achieved.

5. The compressed-gas circuit interrupter of claim 4, wherein each arc-extinguishing unit comprises an operating cylinder and a moving contact piston movable therein, a stationary electrical tie bar supports the lower end of each operating cylinder, and said stationary electrical tie bar is supported at the lower end of the high pressure supporting conduit assemblage.

6. The combination of claim 5, wherein a control valve is located above the electrical tie bar.

7. The combination of claim 6, wherein a pair of high and low-pressure feed tubes extend laterally from the control valve and pneumatically interconnect with the operating cylinder.

8. The combination of claim 4, wherein a high-pressure blast and contact chamber supports the stationary contact structure of each arc-extinguishing unit, and is disposed laterally and supported by said high-pressure supporting conduit assemblage.

9. The combination of claim 5 wherein a high-pressure blast and contact chamber supports the stationary contact structure of each arc-extinguishing unit and is disposed laterally and supported by said high-pressure supporting conduit assemblage.

10. The combination of claim 6, wherein an insulating control-valve rod extends through the lower end of the grounded metallic tank and serves to actuate the control valve.

11. The combination of claim 5, wherein a high-pressure blast and contact chamber supports the stationary contact structure of each arc-extinguishing unit and is disposed laterally and supported by said high-pressure supporting conduit assemblage, and insulating control-valve rod extends through the lower end of the grounded metallic tank and serves to actuate the control valve.

* * * * *